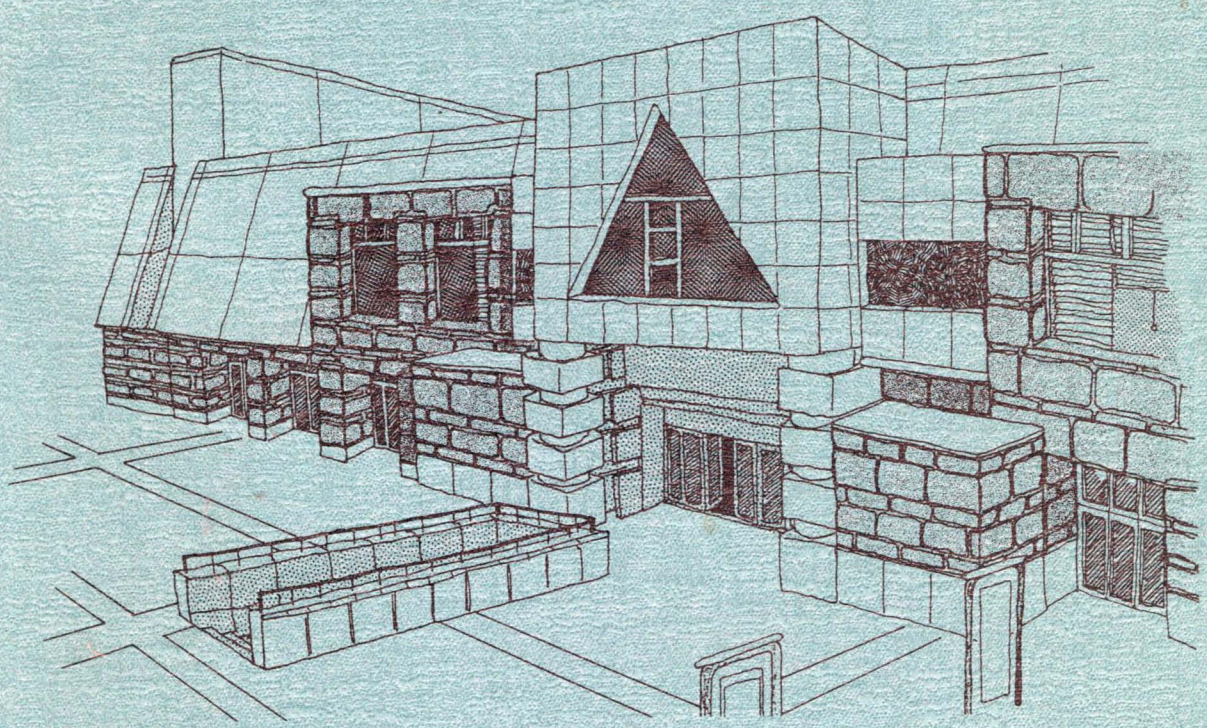
HEACC 89 TSUKUBA

XIV INTERNATIONAL CONFERENCE
ON HIGH ENERGY ACCELERATORS
Aug. 22 – 26, 1989 Tsukuba, Japan

CATALOGUE OF HIGH ENERGY ACCELERATORS



XIVth International Conference on High Energy Accelerators

CATALOGUE OF HIGH ENERGY ACCELERATORS

(Revised Version)

Complied by:

Shin-ichi Kurokawa

Tsukuba, Japan

October 1989

Foreword

Nine years have passed since the last catalogue of high energy accelerators was distributed at the 11th International Conference on High Energy Accelerators in 1980, held at CERN. Since many new accelerators have been completed during these years and some new ones are under construction or in planning at present, the Organizing Committee of the 14th International Conference on High Energy Accelerators has decided to compile a new catalogue with up-to-date information.

This catalogue contains the parameters and status of high energy accelerators and storage rings with the energy higher than 1 GeV or 1 GeV/n together with their injectors. An exception has been made for the accelerators for meson factories and ISIS at Rutherford Appleton Laboratory. One difference between the previous catalogue and the present one is that we include storage rings used as synchrotron radiation sources. The other change from the last catalogue is that we have created a new heading "Heavy Ion Accelerators" and "Linear Collider".

We would like to express our thanks to all those who took time to complete data-sheets. We also acknowledge with thanks Professor H. Nakayama for his careful proof reading, Ms. C. Tanaka for her assistance in organizing this catalogue and Ms. S. Shimazaki for her typing the manuscripts.

Shin-ichi Kurokawa
Compiler of the Catalogue
August, 1989

After the workshop we received some data-sheets the contents of which were not included in the catalogue distributed at the Conference; therefore, we have decided to revise the catalogue. Some small corrections were made at the same time.

Shin-ichi Kurokawa
October, 1989

LIST OF HIGH ENERGY ACCELERATORS

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III. Electron Linear Accelerators
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IV. Accelerators for Meson Factories
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China, (People's Republic of), IHEP, Beijing, 2.8 GeV, electron-positron; BEPC 58
Germany, (Fed. Rep. of), DESY, Hamburg, 5.6 GeV, electron-positron; DORIS II 59
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Germany, (Fed. Rep. of), DESY, Hamburg, 14 GeV ES and 40 GeV PS; PETRA II 61
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Japan, KEK, Tsukuba, 30 GeV, electron-positron; TRISTAN 65
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USA, Fermilab, Batavia, 0.9-1 TeV, proton-antiprotron; Tevatron 68
USA, SLAC, Stanford, 16 GeV, electron-positron; PEP 69
USA, SSC Laboratory, Waxahachie, 20 TeV, proton-proton; SSC 70
USSR, IHEP, Serpukhov, 3 TeV, proton-proton; UNK 71
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VII. Linear Collider

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Germany, (Fed. Rep. of), DESY/HASY Lab., Hamburg, 5.6 GeV, electron storage ring; DORIS II 77
Italy, INFN, Frascati, 1.5 GeV, electron storage ring; ADONE 78
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Japan, KEK, Tsukuba, 2.5 GeV, electron storage ring; Photon Factory 80
Japan, KEK, Tsukuba, 5.8-6.5 GeV, electron storage ring; TRISTAN AR 81
Japan, RIKEN-JAERI, 8 GeV, electron storage ring 82

Korea, POSTECH, Pohang, 2.5 GeV, electron storage ring; PLS 83
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USA, LBL, Berkeley, 1.9 GeV, electron storage ring; ALS 91
USA, ANL, Argonne, 8.0 GeV, electron storage ring; APS 92
USSR, INP, Novosibirsk, 2.0 GeV, electron storage ring; VEPP-3 93
USSR, INP, Novosibirsk, 5.5 GeV, electron storage ring; VEPP-4M 94
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NAME OF SYNCHROTRON: KAON FACTORY DRIVER SYNCHROTRON
INSTITUTION: TRIUMF
LOCATION: 4004 Wesbrook Mall, Vancouver, B.C., Canada V6T 2A3
PERSON IN CHARGE: A. Astbury DATE: July 1989
DATA SUPPLIED BY: M.K. Craddock

HISTORY AND STATUS

CONSTRUCTION STARTED (date): --
FIRST BEAM OBTAINED, or GOAL (date): 1995
TOTAL COST OF FACILITY: $620 M (Cdn)
TOTAL ACCELERATOR STAFF (now):
ANN. OPERAT. BUDGET: (without salaries)
ANN. OPERATING TIME: 5900 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES: Proton
ENERGY: 30 GeV
RING DIAM. 245 x 399 m; TUNNEL SECT. (W x H) 7.2 x 5.4 m

Injector

TYPE: Booster Synchrotron (50 Hz)
OUTPUT (max): 0.1 mA at 3000 MeV
EMITTANCE*: 60 x 60 πmm-mrad
INJECTION PERIOD: 3 μs, or 1 turns
INFLECTOR TYPE: Kicker

Magnet System

FOCUSING TYPE: AG FIELD INDEX n = Sep. Fn.
FOCUSING ORDER: FODO
BETATRON FREQ. ν_H: 13.22 ν_V: 14.18
No. MAGNETS (dipole) 96 LENGTH (ea) 5 m
BENDING FIELD at inj 0.167 T; at max 1.35 T
No. QUADS 128 LENGTH (ea) 1.4 m
GRAD. at inj. 1.46 T/m; at max 11.8 T/m
No. SHORT STRAIGHT SECT 0 LENGTH – m
No. LONG STRAIGHT SECT 2 LENGTH 154 m
RISE TIME 75 ms; FLAT-TOP TIME – s
POWER INPUT PEAK MW; MEAN 15 MW

Acceleration System

No. CAVITIES 20 LENGTH (ea) 2.1 m
HARMONIC NUMBER 225
RF RANGE 60.8 to 62.6 MHz
ENERGY GAIN 2560 KeV/turn
RADIATION LOSS – KeV/turn
RF POWER INPUT PEAK 7625 kW; MEAN 3622 kW

Vacuum System

MATERIAL OF VAC. CHAMBER: 316 LN S.S./96% Alumina
APERTURE OF VAC. CHAMBER: 100 x 150 mm
AVERAGE PRESSURE: 3×10^{-9} torr

Extraction System

TYPE i) Fast kicker, e.s. & magnetic septa
ii) [Slow extraction from Extender (i.e. stretcher) ring]
LENGTH OF SPILL i) to 3 μs
ii) to 100000 μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	30	
RESOLUTION ΔE/E (%)	0.17	
REPET. RATE (pulse/s)	10	
PULSE WIDTH AT PEAK E	2.4 ns	
INTERNAL BEAM (part/pulse)	6×10^{13}	
(part/s)	6×10^{14}	
EMITTANCE* AT PEAK E	90 x 90	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
	0.4 - 0.55 GeV/c	1	1 Elec. Separator
	0.5 - 0.8	1	2 Elec. Separator
$\bar{p}$ $K^{\pm}$ $\pi^{\pm}$	0.8 - 1.5	1	2 Elec. Separator
	1.5 - 2.5	1	2 Elec. Separator
	2.5 - 6.0	1	3 RF Separator
	6.0 -20.0	1	3 RF Separator
K^0	~5 GeV/c	2	
$\bar{p}$	3-30	1	
ν	broadband	1	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS: 8000 m²
No. INTERNAL TARGETS – No. EXT. TARGETS 4
No. SEPARATED BEAMS 6
No. BEAMS SERVED AT SAME TIME 6
TOTAL POWER USED (AVERAGE) FOR RESEARCH 20 MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME 5000 h

Other Relevant Parameters, Recent Improvements, etc.

The KAON Factory will consist of a chain of 6 accelerators and storage rings:

H^- cyclotron:	452 MeV cw (see separate entry)
Accumulator:	stores beam of 20 ms periods
Booster:	50 Hz synchrotron (452-3000 MeV)
Collector:	collects 5 pulses and inflates ε_L
Driver:	10 Hz synchrotron (3-30 GeV)
Extender:	Stretcher with bunched/debunched slow extraction

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Super Proton Synchrotron (SPS)
INSTITUTION CERN
LOCATION Prévessin (France)
PERSON IN CHARGE B. de Raad DATE: 1. 7. 89.
DATA SUPPLIED BY G. Brianti

HISTORY AND STATUS

CONSTRUCTION STARTED (date) February 1970
FIRST BEAM OBTAINED, or GOAL (date) May 1976
TOTAL COST OF FACILITY 625 MCHF (in 1970 CHF)
TOTAL ACCELERATOR STAFF (now) 400
ANN. OPERAT. BUDGET 13 MCHF (without salaries)
ANN. OPERATING TIME 3500 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Protons
ENERGY 450 GeV
RING DIAM. 2200 m; TUNNEL SECT. (W x H) 4 x 3 m

Injector

TYPE Proton Synchrotron
OUTPUT(max) 1400 mA at 14000 MeV
EMITTANCE* 30π πmm-mrad
INJECTION PERIOD 2 x 11.5 μs, or 2 x 1/2 turns
INFLECTOR TYPE Fast Kicker

Magnet System

FOCUSING TYPE Sep Function FIELD INDEX n =
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 26.6 ν_V 26.6
No. MAGNETS 744 LENGTH (ea) 6.26 m
BENDING FIELD at inj 0.063 T; at max 2.025 T
No. QUADS 216 LENGTH (ea) 3.05 m
GRAD. at inj. 0.07 T/m; at max 22.5 T/m
No. SHORT STRAIGHT SECT 216 LENGTH 2.3 m
No. LONG STRAIGHT SECT 6 LENGTH 128 m
RISE TIME 3 s; FLAT-TOP TIME 2.8 s
POWER INPUT PEAK 210 MW; MEAN 57 MW

Acceleration System

No. CAVITIES 4 LENGTH(ea) 20 m
HARMONIC NUMBER 4620
RF RANGE 199.4 to 200.4 MHz
ENERGY GAIN 7200 KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK (each) 750 kW; MEAN 500 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless steel
APERTURE OF VAC. CHAMBER 150 x 50 mm
AVERAGE PRESSURE 10^{-10} torr

Extraction System

TYPE i) Fast
ii) Fast resonant
iii) Slow 1/3 int resonant
LENGTH OF SPILL i) 5 to 23 μs
ii) 1000 to 5000 μs
iii) 0.5 to 2 sec

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	400	450
RESOLUTION ΔE/E (%)	± 0.1	± 0.05
REPET. RATE (pulse/s)	0.1	0.1
PULSE WIDTH AT PEAK E	2	3
INTERNAL BEAM (part/pulse)	2×10^{13}	3.3×10^{13}
(part/s)	2×10^{12}	3.3×10^{12}
EMITTANCE* AT PEAK E	50π πmm-mrad	

SECONDARY BEAMS (1989)

Particle	Momentum range	No. of beams	Other inform.
$\nu, \bar{\nu}$	≤ 450 $\langle p_\nu \rangle \sim 25$ GeV/c	1	N1 Wide Band Beam
K^0_L, K^0_S	$\langle 450, \langle p_K \rangle \sim 100$ GeV/c	1	K4
$\mu^\pm$	≤ 280 GeV/c	1	M2
Σ^-	≤ 350 GeV/c	1	Y1 Hyperon Beam
Protons	450 GeV/c	2	P0,P8 Micro-spot bm
Hadrons $e^\pm$	<400 GeV/c	4	H1,H3,H2,H8 } tagged
"	< 250 GeV/c	1	H6 }
Tertiary $\pi^\pm, e^\pm$	≤ 100 GeV/c	4	X1,X3,X5,X7 test beams

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 4 ~ 32'000 m² m²
No. INTERNAL TARGETS 0 No. EXT. TARGETS 10
No. SEPARATED BEAMS e, μ, ν beams are 'pure'
No. BEAMS SERVED AT SAME TIME 12
TOTAL POWER USED (AVERAGE) FOR RESEARCH 21 MW
No. USER GROUPS, in house mixed with outside 110
TOTAL RESEARCH STAFF, in house 35 outside 800
ANN. RESEARCH BUDGET, in house 3.7 MCHF (without sal.)
ANNUAL RESEARCH TIME ~ 3000 h
(1989)

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON CERN Proton Synchrotron (CPS) - See Linac I, Linac II, PSB, AA, AC, LEAR, LIL, EPA
INSTITUTION EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
LOCATION Meyrin, CH-1211 Geneva 23, Switzerland
PERSON IN CHARGE Roy BILLINGE, D.J. SIMON DATE: June 1989
DATA SUPPLIED BY M. BOUTHEON

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1955
FIRST BEAM OBTAINED, or GOAL (date) November 24, 1959
TOTAL COST OF FACILITY 200 MSF (1954-1959)
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 6600 h
"Beam on" 94% of scheduled time

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES Protons (antiprotons/light ions/ e^+/e^-)
ENERGY 26 (10 GeV/c nucleon/ 3.5 e^+e^-) GeV
RING DIAM. 200 m; TUNNEL SECT. (W x H) 6 x 6 m

Injector
TYPE Booster (protons)
OUTPUT(max) 1280 mA at 1000 MeV
EMITTANCE* 55 H/28 V πmm-mrad
INJECTION PERIOD 2.5 μs, or 1 turn
INFLECTOR TYPE magnetic septum and pulsed kicker

Magnet System
FOCUSING TYPE AG FIELD INDEX n = 288
FOCUSING ORDER FOFDOD
BETATRON FREQ. ν_H 6.25 ν_V 6.25
No. MAGNETS 100 LENGTH (ea) 4.26 m
BENDING FIELD at inj 0.0147 T; at max 1.4 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT 80 LENGTH 1.6 m
No. LONG STRAIGHT SECT 20 LENGTH 3.0 m
RISE TIME 0.7 s; FLAT-TOP TIME 0.5-0.7 s
POWER INPUT PEAK 41 MW; MEAN 2.8 MW

Acceleration System
No. CAVITIES 11 LENGTH(ea) m
HARMONIC NUMBER 20 (6/10/12/14/16/18)
RF RANGE 2.8 to 9.55 MHz
ENERGY GAIN 220 KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK 100 kW; MEAN 50 kW

Vacuum System
MATERIAL OF VAC.CHAMBER Austenitic steel
APERTURE OF VAC. CHAMBER 146 x 70 (178 x 67) mm
AVERAGE PRESSURE 1×10^{-8} torr

Extraction System
TYPE i) Fast extractions (FE)
ii) Slow extraction (SE)
iii) Radial shaving on 5 turns
LENGTH OF SPILL i) 0.1 to 2.1 μs
ii) 200 to 500 ms
iii) 6.3 to 10.5 μs

- Booster - PS injection was raised from 0.8 to 1 GeV
- PS RF accelerating system is able to cope with new increased beam loading and complex harmonic number gymnastics. 200 and 114 MHz are used in addition to the original 9.5 MHz system.
- PS vacuum chamber and poleface windings are new, leading to improved vacuum and high energy magnetic conditions.

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	26	28
RESOLUTION ΔE/E (%)	± 0.05	
REPET. RATE (pulse/s)	0.5	1
PULSE WIDTH AT PEAK E	2.1 μs	
INTERNAL BEAM (part/pulse)	2×10^{13}	2.34×10^{13}
(part/s)	10^{13}	1.75×10^{13}
EMITTANCE* AT PEAK E	H : 60 ; V : 30	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$\pi^+ \pi^-$		4	East Hall (SE)
p^+	0.5-15 GeV/c	(t_7 to t_{10} t_{11})	unseparated beams
$e^+ e^-$			
p	0.1-2 GeV/c	7 experimental	zones in South
$\bar{p}$	spill time	Hall feeded by	LEAR machine
	0.1-4 hours		

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 2000 (East) + 2000 (South) m²
No. INTERNAL TARGETS - No. EXT. TARGETS 2 (East Hall)
No. SEPARATED BEAMS 4+9
No. BEAMS SERVED AT SAME TIME 4+3
TOTAL POWER USED (AVERAGE) FOR RESEARCH 6-10 MW
No. USER GROUPS, in house - outside -
TOTAL RESEARCH STAFF, in house - outside -
ANN. RESEARCH BUDGET, in house - (without sal.)
ANNUAL RESEARCH TIME 5600 h

*Emittance = area x βγ at 90% of current (for p-machines)

Other Relevant Parameters, Recent Improvements, etc.

The PS machine is owning 7 injection/extraction points with their complete related septum/kicker/bumpers pulsed systems. Using different injectors, it can deliver (an example) on a pulse to pulse basis in normal operation :

- 2.2×10^{13} ppp at 14 GeV/c to SPS
- 1.5×10^{13} ppp in 5 bunches at 26 GeV/c for $\bar{p}$ production
- 5×10^{11} ppp at 24 GeV/c 400 ms spill length
- twice 4 bunches of 2×10^{10} e^+/e^- at 100 μs rep. rate at 3,5 GeV/c for SPS-LEP filling.
- 3×10^{10} $\bar{p}$/h decelerated down to 0.6 GeV/c to LEAR.

During SPS collider run, up to 10^{12} $\bar{p}$/24 h can be delivered.

4 batches of 3×10^7 sulfur ions pp at 10 GeV/c /nucleon were provided to SPS (repetition rate 1.2 s) in 1987.

NAME OF SYNCHROTRON CERN Proton Synchrotron Booster (PSB, four rings stacked vertically)
INJECTOR FOR CERN PS
LOCATION CERN, Geneva, Switzerland
PERSON IN CHARGE R. BILLINGE, K. SCHINDL DATE: 22.06.1989
DATA SUPPLIED BY K. Schindl, H. Schönauer

HISTORY AND STATUS

CONSTRUCTION STARTED (date) January 1968
FIRST BEAM OBTAINED, or GOAL (date) May 1972
TOTAL COST OF FACILITY 60 MSF (Swiss)
TOTAL ACCELERATOR STAFF (now) 46 man-years/y
ANN. OPERAT. BUDGET 1025 kSF (without salaries)
ANN. OPERATING TIME 6300 h
(staff and budget including overheads)

ACCELERATOR PARAMETERS

O^{8+} figures in brackets

General
ACCELERATED PARTICLES Protons (light ions)
ENERGY 1.0 (0,326/amu) GeV
RING DIAM 50 m; TUNNEL SECT. (W x H) 4,05 x 5,15 m

Injector
TYPE Linac 2 (Linac 1)
OUTPUT(max) 140 (0.07) mA at 50 (11·4/amu) MeV
EMITTANCE* H:7 (3.5) ; V : 7 (3·5) πmm-mrad
INJECTION PERIOD up to 100 μs, or 4 x 15 (8) turns
INFLECTOR TYPE Magnetic

Magnet System
FOCUSING TYPE A.G.Sep.Fun.FIELD INDEX n =
FOCUSING ORDER L1/2-B-L2-F-L3-D-L3-F-L2-B-L1/2
BETATRON FREQ. ν_H 4.30 (4.20)→4.17 ν_V 5.60(5.26)→5.23
No. MAGNETS 32 LENGTH (ea) 1.62 m
BENDING FIELD at inj. 0.125 T; at max 0.686 T
No. QUADS 32F, 16D LENGTH (ea) 0.50, 0.88 m
GRAD. at inj. 0.81 T/m; at max 4.44 T/m
No. SHORT STRAIGHT SECT. 64 LENGTH .37/.65 m
No. LONG STRAIGHT SECT. 16 LENGTH 2.65 m
RISE TIME 0.45 s; FLAT-TOP TIME 0.035 s
POWER INPUT PEAK 5.6 MW; MEAN ∿ 2.1 MW

Acceleration System
No. CAVITIES 2 per ring LENGTH(ea) 2.23 ; 1.40 m
HARMONIC NUMBER 5 ;10 (10)
RF RANGE 2·95; 5·90 to 8·4 ; 16.8 MHz
ENERGY GAIN 1-3 , 0 KeV/turn
RADIATION LOSS -- KeV/turn
RF POWER INPUT PEAK 7.5 ; 2.5 kW; MEAN 4 ; 1.5 kW
(per ring)

Vacuum System
MATERIAL OF VAC.CHAMBER Inconel 750, 316L
APERTURE OF VAC. CHAMBER 132 x 61 (bending) mm
AVERAGE PRESSURE 10^{-8} torr

Extraction System
TYPE Fast vertical recombination of the beams from the four rings
LENGTH OF SPILL 0.6 to 2.5 μs

ACCELERATOR PERFORMANCE

		Normal (or Goal)	Maximum achieved
ENERGY (GeV)		0,8(0,28/amu)	1.0(0.32/amu)
RESOLUTION ΔE/E (%)		+ 0.19	
REPET. RATE (pulse/s)		0.83	1.25
PULSE WIDTH AT PEAK E		4x0.62 μs	
INTERNAL BEAM	(part/pulse)	1×10^{13} (2×10^{9})	3×10^{13} (2.5×10^{9})
	(part/s)	0.83×10^{13}	0.5×10^{13}
BEAM EMITTANCE *		H : 60(25) ; V : 30(10)	πmm-mrad
BEAM LINES TO		CPS, measurement line	

Other Relevant Parameters, Recent Improvements, etc.

Bending magnets and quadrupoles are 4-gaps stacked units fed by a static power converter. At 1 GeV, the four beams are ejected in sequence and combined by vertical septum and kicker magnets. Alternatively, the twenty bunches may be recombined into ten by simultaneous ejection of rings 3+2 and 4+1, and vertical funnelling by a radiofrequency dipole, giving higher line density for antiproton production.

Recent improvements

1) Tunes varying with time, necessitating compensation of $2Q_V$ =11 and $3Q_V$=16 (structural stop-band).
2) Increase of acceptance of PSB rings and PSB-CPS line.
3) Implementation of a second acceleration station per ring working at h=10, twice the fundamental, to flatten the bunch shape and thus raise the space-charge limit.
4) Increase of ejection energy to 1 GeV to ease space-charge effects in the CPS.
5) Acceleration of O^{8+} and S^{16+} ions to 326 MeV/amu with Linac 1 as injector.

Published articles describing machine

Dubna 1976, Vol. 2	p. 221
Stanford 1974	p. 1855
Geneva 1980	p. 299
Washington 1981	p. 2803
Washington 1987	p. 526 (ions)
" "	p. 1298
Chicago 1989	R. Cappi et al., Upgrading of the CERN PS Booster to 1 GeV for improved anti-proton production

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC CERN 50 MeV Proton (ion) Linac 1
INJECTOR FOR LEAR (PS Booster)
LOCATION CERN, Geneva, Switzerland
PERSON IN CHARGE R. BILLINGE, K. SCHINDL DATE: 22.06.1989
DATA SUPPLIED BY C.E. Hill

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1956
FIRST BEAM OBTAINED, or GOAL (date) 1959
TOTAL COST OF FACILITY -
TOTAL ACCELERATOR STAFF (now) ~ 14 man-years/y
ANN. OPERAT. BUDGET 500 kSF (without salaries)
ANN. OPERATING TIME 2000 h
(staff and budget including overheads)

ACCELERATOR PARAMETERS O^{6+} figures in brackets

Physical Dimensions
TOTAL LENGTH 29 m; No. TANKS 3
TANK DIAM. ~ 1 m; No. DRIFT TUBES 113
DRIFT TUBE LENGTHS 39.6 - 320.8
DRIFT TUBE DIAMETERS 61.6 - 177.8
GAP/CELL LENGTH 0.25 - 0.305
APERTURE DIAM. 16 mm to 33 mm

Ion Source
TYPE Duoplasmatron (ECR 15 GHz)
OUTPUT 80 (0.1) mA at 50 (5.6/amu) KeV
EMITTANCE* 2 (< 1) πmm-mrad

Injector
TYPE RFQ (RFQ)
OUTPUT 75 (0.1) mA at 516 (139.5/amu) KeV
EMITTANCE* 2 (< 1) πmm-mrad

Bunchers
TYPE 2 re-buncher systems
MODULATION 0(18) KeV, DRIFT ℓ - mm at 202.57 MHz
18(18) KeV, DRIFT ℓ - mm at " MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System
RF FREQ. 202.57 MHz
FIELD MODE TM010 Q ~ 50000
EQUIL. PHASE -30^0 ACCEL. RATE 1.7 MeV/m
REPETITION RATE up to 1 pps
DUTY FACTOR up to 0.03 % (RF); up to 0.011 % (Beam)
PULSE LENGTH ~ 300 μs (RF); ~ 110 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE ~ 30 MΩ/m
FILLING TIME ~ 170 μs
RF POWER INPUT PEAK 5 (8) MW; MEAN 0.002 MW

Focusing System 42 pulsed
No. QUADS 112 TYPE 70 DC ORDER FD
GRADIENTS 75 (100) to 4(5) T/m
OTHER

Vacuum System
MATERIAL CHAMBER Steel
AVERAGE PRESSURE 1.10^{-6} torr

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	49.7 (11.4/amu)	
ENERGY SPREAD ΔE/E (%)	± 0.3	± 0.2
CURRENT (mA)	7 (0.06)	120 (0.07)
EMITTANCE*	7 (3.5)	πmm-mrad

Other Relevant Parameters, Recent Improvements, etc.

1) Normally used as a p and H^- injector for LEAR
2) Light ions (O^{6+}, S^{12+}) are accelerated in 2 βλ mode. They are fully stripped at 11.4 MeV/amu for injection into the PS Booster.

Published articles describing machine

E. Regenstreif "The CERN Proton Synchrotron" CERN 60-26;

Improvements and Performances reported at Linac Conferences e.g.

Mura	(1964)	p. 353
Los Alamos	(1966)	p. 48
Brookhaven	(1968)	p. 694
Chalk River	(1976)	p. 381
Seeheim	(1984)	p. 56
Stanford	(1986)	p. 355

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF LINAC: CERN 50 MeV Proton Linac 2
INJECTOR FOR: 1 GeV PS Booster
LOCATION: CERN Geneva, Switzerland
PERSON IN CHARGE: R. BILLINGE, K. SCHINDL — DATE: 22.06.1989
DATA SUPPLIED BY: D. Warner, C.E. Hill

HISTORY AND STATUS

CONSTRUCTION STARTED (date): November 1973
FIRST BEAM OBTAINED, or GOAL (date): September 1978
TOTAL COST OF FACILITY: 23 MSF
TOTAL ACCELERATOR STAFF (now): ~18 man-years/y
ANN. OPERAT. BUDGET: 650 kSF (without salaries)
ANN. OPERATING TIME: 7000 h
(staff and budget including overheads)

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH: 33.6 m; No. TANKS: 3
TANK DIAM.: See 1) m; No. DRIFT TUBES: 125 + 6 (1/2)
DRIFT TUBE LENGTHS: 48 mm to 316 mm
DRIFT TUBE DIAMETERS: 180 mm (tank 1), 160 mm (rest)
GAP/CELL LENGTH: 0.22-0.31 , 0.20-0.29 , 0.26-0.32
APERTURE DIAM.: 20 mm to 30 mm

Ion Source
TYPE: Duoplasmatron (with expansion cup)
OUTPUT: 400 mA at 0 KeV
EMITTANCE*: nmm-mrad

Injector
TYPE: High gradient column with Cockroft-Walton
OUTPUT: 350 mA at 750 KeV
EMITTANCE*: 2 nmm-mrad

Bunchers
TYPE: Three buncher system
MODULATION: 37 KeV, DRIFT ℓ 950 mm at 202.56 MHz
16 KeV, DRIFT ℓ 800 mm at 405.12 MHz
35 KeV, DRIFT ℓ 160 mm at 202.56 MHz

Acceleration System
RF FREQ.: 202.56 MHz
FIELD MODE: TM010 (see 2) Q: 60000
EQUIL. PHASE: See 2) ACCEL. RATE: 1.48 MeV/m
REPETITION RATE: 1 PPS (normal) ; 2 pps (max.)
DUTY FACTOR: 0.03 % (RF); 0.01 % (Beam)
PULSE LENGTH: 300 μs (RF); 110 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE: 36 MΩ/m
FILLING TIME: - μs
RF POWER INPUT PEAK: 10 MW; MEAN: 0.002 MW

Focusing System
No. QUADS: 131 TYPE: Pulsed ORDER: FD
GRADIENTS: 100 to 20 T/m
OTHER: pulse flat top ~220 μs

Vacuum System
MATERIAL CHAMBER: copper clad steel accelerating tanks
AVERAGE PRESSURE: 2×10^{-7} torr

ACCELERATOR PERFORMANCE [3]

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	50	
ENERGY SPREAD ΔE/E (%)	± 0.25	
CURRENT (mA)	140	150
EMITTANCE*	5 nmm-mrad	

Other Relevant Parameters, Recent Improvements, etc.

1) 3 accelerating tanks 0.75-10.4-30.5-50.0 MeV of diameter 0.94, 0.90, 0.86 m resp.
2) Post coupled Alvarez Accelerating System Equilibrium phase -35° to -25° (Tank 1), -25° (rest) RF parameters quoted are total or mean for 150 mA accelerated current at 1 pps.
3) Performance is quoted after debunching.
4) Also accelerated deuterons (20 mA) to 11,6 MeV/amu

Published articles describing machine

"The New CERN 50 MeV Linac", Proc. 1979, Linear Accel. Conf. (Montauk, Sept. 1979)

"Performance of the New CERN 50 MeV Linac", Proc. 1979 Particle Accelerator Conf., IEEE Trans. NS-26 No. 3, p. 3674.

"Ancillary Systems described in Proc, 1979 Linac Conf, (Ibid.) and Proc. 1976 Linac Conf. (AECL-5677)

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON AA Antiproton Accumulator
INJECTOR FOR SPS, LEAR, PS
LOCATION CERN, Meyrin, CH-1211 Geneva 23, SWITZERLAND
PERSON IN CHARGE R. BILLINGE, F. PEDERSEN DATE: 21.06.1989
DATA SUPPLIED BY F. PEDERSEN, S. MAURY

HISTORY AND STATUS

CONSTRUCTION STARTED (date) July 1978
FIRST BEAM OBTAINED, or GOAL (date) July 1980
TOTAL COST OF FACILITY 135 MSF (AC+AA)
TOTAL ACCELERATOR STAFF (now) 41 man-years/y
ANN. OPERAT. BUDGET 2300 kSF (AC+AA) (without salaries)
ANN. OPERATING TIME 6200 h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES Antiproton
ENERGY 2,69 GeV
RING DIAM 50 m; TUNNEL SECT. (W x H) 5x3 m

Injector
TYPE AC (Antiproton Collector)
OUTPUT(max) 0,032 mA at 2760 MeV
EMITTANCE* 95x95 πmm-mrad
INJECTION PERIOD 0.5 μs, or 1 turn
INFLECTOR TYPE

Magnet System
FOCUSING TYPE FODO FIELD INDEX n =
FOCUSING ORDER
BETATRON FREQ. ν_H 2.268 ν_V 2.255
No. MAGNETS 8 , 4 LENGTH (ea) 3, 5 m
BENDING FIELD at inj. 1.8/1.6 T; at max T
No. QUADS 24 LENGTH (ea) m
GRAD. at inj. F:2.5/ D:1.8 T/m; at max T/m
No. SHORT STRAIGHT SECT. 8 LENGTH 2.6 m
No. LONG STRAIGHT SECT. 12 LENGTH 6 m
RISE TIME s; FLAT-TOP TIME s
POWER INPUT PEAK 3.2 MW; MEAN 3.2 MW

Acceleration System
No. CAVITIES 1 LENGTH(ea) 2.5 m
HARMONIC NUMBER 1
RF RANGE 1.840 to 1.86 MHz
ENERGY GAIN 14 KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK kW; MEAN kW

Vacuum System
MATERIAL OF VAC.CHAMBER Stainless steel
APERTURE OF VAC. CHAMBER up to 1100 mm
AVERAGE PRESSURE 7×10^{-11} torr

Extraction System
TYPE Fast kickers + septum magnets
LENGTH OF SPILL to μs

ACCELERATOR PERFORMANCE

		Normal (or Goal)	Maximum achieved
ENERGY (GeV)		2,69	
RESOLUTION ΔE/E (%)		$\pm 1.5 \times 10^{-3}$	
REPET. RATE (pulse/s)		2,4	
PULSE WIDTH AT PEAK E			
INTERNAL BEAM	(part/pulse)	5×10^{7}	8×10^{7}
	(part/day	1×10^{12}	1.15×10^{12}
BEAM EMITTANCE *		< 7.7 x 7.7	πmm-mrad
BEAM LINES TO			

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 95% of current (for p-machines)

NAME OF SYNCHROTRON ANTIPROTON COLLECTOR : AC
INJECTOR FOR AA
LOCATION CERN, Meyrin, CH-1211 Geneva 23, SWITZERLAND
PERSON IN CHARGE R. BILLINGE, F. PEDERSEN DATE: 21.06 1989
DATA SUPPLIED BY F. PEDERSEN, S. MAURY

HISTORY AND STATUS

CONSTRUCTION STARTED (date) July 1986
FIRST BEAM OBTAINED, or GOAL (date) June 1987
TOTAL COST OF FACILITY 135 MFS (AC+AA)
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (included in AA) (without salaries)
ANN. OPERATING TIME 6200 h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES Antiprotons
ENERGY 2.76 GeV
RING DIAM 54 m; TUNNEL SECT. (W x H) 5 x 3 m

Injector
TYPE Target
OUTPUT(max) 0,032 mA at 2760 MeV
EMITTANCE* 762 x 762 πmm-mrad
INJECTION PERIOD 0.5 μs, or 1 turns
INFLECTOR TYPE septum magnet and fast kickers

Magnet System
FOCUSING TYPE FODO FIELD INDEX n =
FOCUSING ORDER
BETATRON FREQ. ν_H 5.46 ν_V 5.44
No. MAGNETS 24 LENGTH (ea) 2.20 m
BENDING FIELD at inj. 1.50 T; at max T
No. QUADS 56 LENGTH (ea) 0.86 m
GRAD. at inj. 4.6/6.8 T/m; at max T/m
No. SHORT STRAIGHT SECT. 8 LENGTH 1.80 m
No. LONG STRAIGHT SECT. 24 LENGTH 2.50 m
RISE TIME s; FLAT-TOP TIME s
POWER INPUT PEAK 3.5 MW; MEAN 3.5 MW

Acceleration System (Bunch rotation + debunching cavities)
No. CAVITIES 2 LENGTH(ea) 2.40 m
HARMONIC NUMBER 6
RF RANGE 9.536865 to - MHz
ENERGY GAIN 1500 (on both cavities) KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK kW; MEAN kW

Vacuum System
MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER up to 500 mm
AVERAGE PRESSURE $< 10^{-8}$ torr

Extraction System
TYPE Fast kickers + septum magnets
LENGTH OF SPILL to < 0.36 μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved	
ENERGY (GeV)	2.76		
RESOLUTION ΔE/E (%)	± 3		
REPET. RATE (pulse/s)	0.417	0.417	0.208
PULSE WIDTH AT PEAK E			
INTERNAL BEAM (part/pulse)	1×10^8	4.0×10^7	7.6×10^7
(part/s)			
BEAM EMITTANCE *	95x95	69x65	19x23

BEAM LINES TO π mm.mrad

Other Relevant Parameters, Recent Improvements, etc.

Acceleration system :(rebunching cavity)

No: cavities : 1 length : 1.23 m
Harmonic number : 1
RF range : 1.5877 to 1.5907 MHz
Energy gain : 0.8 KeV/turn

*Emittance = Area x $\beta\gamma$ at 95 % of current (for p-machines)

NAME OF SYNCHROTRON: LEAR (Low Energy Antiproton Ring)
INSTITUTION: CERN PS
LOCATION: PS South Hall
PERSON IN CHARGE: R. BILLINGE, F. PEDERSEN — DATE: 21.06.1989
DATA SUPPLIED BY: M. CHANEL, D. MOEHL

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1981
FIRST BEAM OBTAINED, or GOAL (date): End 1982
TOTAL COST OF FACILITY: ~ 10 MSF = 5 MFS (consolidation)
TOTAL ACCELERATOR STAFF (now): 21 man-years/y
ANN. OPERAT. BUDGET: 650 kFS (without salaries)
ANN. OPERATING TIME: 6000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES: Antiprotons, protons, H^-
ENERGY: 5 - 1200 MeV GeV
RING DIAM.: 25 m; TUNNEL SECT. (W x H): Hall m

Injector

TYPE: Antiproton Accumulator via PS
OUTPUT (max): 2.10^{10}/1 hour mA at 175 MeV
EMITTANCE*: Vert: 10 - Hor. : 20 πmm-mrad
INJECTION PERIOD: 0,48 μs μs, or single turn
INFLECTOR TYPE: magnetic septum + full aperture kicker

Magnet System

FOCUSING TYPE: Sep. function FIELD INDEX n =
FOCUSING ORDER: OFDOBODFO
BETATRON FREQ. ν_H: 2.30 ν_V: 2.73
No. MAGNETS: 4 LENGTH (ea): 6.6 m
BENDING FIELD at min. 0.08 T; at max 1.6 T
No. QUADS: 8 LENGTH (ea): 0.5 m
GRAD. at min. 0.5 T/m; at max 9.4 T/m
No. SHORT STRAIGHT SECT: 8 LENGTH: 1.16 m
No. LONG STRAIGHT SECT: 4 LENGTH: 8 m
RISE TIME: ~ 10 s s; FLAT-TOP TIME: > 1000 s
POWER INPUT PEAK: 1 MW; MEAN: 0,5 MW

Acceleration System

No. CAVITIES: 2 LENGTH (ea): 1.7 m
HARMONIC NUMBER: 1/2/4/8
RF RANGE: 0.38 to 3.5 MHz
ENERGY GAIN: < 10 KeV/turn
RADIATION LOSS: KeV/turn
RF POWER INPUT PEAK: kW; MEAN: kW

Vacuum System

MATERIAL OF VAC.CHAMBER: Stainless steel bakeable
APERTURE OF VAC. CHAMBER: 155x90 to 170x54 mm
AVERAGE PRESSURE: 2-5 10^{-12} torr

Extraction System

TYPE: i) Superslow stochastic extraction
ii) Fast extraction < 1200 MeV/c
iii)
LENGTH OF SPILL: i) 10^8 to 2.10^{10} μs
ii) 0,05 ns to 0,50 μs
iii) to μs

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	0.005-1.230	1.200
RESOLUTION ΔE/E (%)	0.002	0.002
REPET. RATE (pulse/s)	1/4200	1/15000
PULSE WIDTH AT PEAK E	3600	14000
INTERNAL BEAM (part/pulse)	3-4 10^9	2.10^{10}
(part/s)	5.10^5	2.10^6
EMITTANCE* AT PEAK E	Vert. 10 * Hor. 10 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$p\bar{p}$	"0" 2 GeV/c		

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS: ~ 2000 m²
No. INTERNAL TARGETS: No. EXT. TARGETS:
No. SEPARATED BEAMS: 9
No. BEAMS SERVED AT SAME TIME: 3
TOTAL POWER USED (AVERAGE) FOR RESEARCH: MAX 7 MW
No. USER GROUPS, in house: outside:
TOTAL RESEARCH STAFF, in house: outside:
ANN. RESEARCH BUDGET, in house: (without sal.)
ANNUAL RESEARCH TIME: ~ 4500 h

Other Relevant Parameters, Recent Improvements, etc.

Duty cycle, stretcher with acceleration/deceleration facility, slow ejection of 10^9 to 2.10^{10} particles in 10 min to 4 hours (momentum and schedule dependent).

Options :
- internal gas jet target (installation in progress)
- co-rotating beams of H^- and $\bar{p}$ for protonium formation in flight
- p-$\bar{p}$ colliding beams.

Improvements

Lower momenta (61,2 MeV/c ↔ 2 MeV), electron cooling, beam stability for high beam density.

NAME OF SYNCHROTRON SATURNE
INSTITUTION SATURNE NATIONAL LABORATORY - J. ARVIEUX - Directeur
LOCATION C.E.N. SACLAY 91191 GIF SUR YVETTE CEDEX
PERSON IN CHARGE PA. CHAMOUARD - Operation Service DATE: July 89
DATA SUPPLIED BY M. OLIVIER - A. TKATCHENKO - PA. CHAMOUARD.

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1974
FIRST BEAM OBTAINED, or GOAL (date) 1978
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 5000 h

ACCELERATOR PARAMETERS

1) *General*
ACCELERATED PARTICLES $\vec{p}$, $\vec{d}$, and HI ; p,d
ENERGY 3GeV p GeV
RING DIAM. 33,6 m; TUNNEL SECT. (W x H) m

2) *Injector*
TYPE LINAC (p,d) - Synch. MIMAS (others)
OUTPUT (max) mA at MeV
EMITTANCE* πmm-mrad
INJECTION PERIOD μs, or turns
INFLECTOR TYPE Electrostatic

Magnet System
FOCUSING TYPE STRONG FIELD INDEX n = 0
FOCUSING ORDER FODO - SEP. FUNCTIONS
BETATRON FREQ. ν_H 3,64 ν_V 3,61
No. MAGNETS 16 LENGTH (ea) 2,49 m
BENDING FIELD at inj 0,1 T; at max 1,9 T
No. QUADS 24 LENGTH (ea) 0,45 ; 0,47 m
GRAD. at inj. T/m; at max T/m
3) No. ~~SHORT~~ STRAIGHT SECT 32 LENGTH 0,73 m
No. LONG STRAIGHT SECT 8 LENGTH 3,94 m
RISE TIME 0,5 s; FLAT-TOP TIME See spill s
POWER INPUT PEAK 16 MW; MEAN MW

Acceleration System
No. CAVITIES 2 LENGTH(ea) 3,94 m
HARMONIC NUMBER 3
RF RANGE P; 1.7 to 8.3 MHz
ENERGY GAIN 2.8 KeV/turn
RADIATION LOSS / KeV/turn
RF POWER INPUT PEAK 56 each kW; MEAN kW

Vacuum System
MATERIAL OF VAC.CHAMBER Stainless stell
APERTURE OF VAC. CHAMBER 240 x 120 mm
AVERAGE PRESSURE 4.10^{-9} torr

Extraction System
TYPE i) Third Int. Res. Extraction
ii)
iii)
LENGTH OF SPILL i) 30 ms to 1000 ms μs
ii) to μs
iii) to μs

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE / P

		Normal (or Goal)	Maximum achieved
ENERGY (GeV)		3	
RESOLUTION ΔE/E (%)		$\pm 3.10^{-4}$	
REPET. RATE (pulse/s)		0,33	
PULSE WIDTH AT PEAK E	→	11	12
INTERNAL BEAM (part/pulse)	p.	1.510	p. 1.510
~~(part/s)~~	→	11	d. 0,710 12
EMITTANCE* AT PEAK E	d.	2.10	πmm-mrad

H 16 π mm mrd
V 49 π mm mrd
polarization: > 90% $\vec{d}$
> 80% $\vec{p}$

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$\vec{n}$	0.8 - 1.9 GeV/c	2	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 6000 m²
No. INTERNAL TARGETS / No. EXT. TARGETS 12
No. SEPARATED BEAMS 9
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH 7 MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house 120 outside 120
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

1) See also HI Synchrotrons
2) See Linacs and Synchrotron MIMAS
3) A long straight section is 2 SD of 3.94 m each.

NAME OF SYNCHROTRON MIMAS
INJECTOR FOR SATURNE - SATURNE NATIONAL LABORATORY - J. ARVIEUX - Director
LOCATION C.E.N. SACLAY 91191 GIF SUR YVETTE CEDEX
PERSON IN CHARGE PA. CHAMOUARD - Operation Service DATE: July 89
DATA SUPPLIED BY M. OLIVIER - A. TKATCHENKO - PA. CHAMOUARD.

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1983
FIRST BEAM OBTAINED, or GOAL (date) 1987
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4500 h

ACCELERATOR PARAMETERS

General

1) ACCELERATED PARTICLES $\vec{p}$, $\vec{d}$, H.I.
ENERGY 47 MeV p ; 12 MeV/amu HI GeV
RING DIAM 11.7 m; TUNNEL SECT. (W x H) m

Injector

TYPE RFQ and 400 KV C.W.
OUTPUT(max) mA at MeV
EMITTANCE* 3.10^{-6} πmm-mrad
INJECTION PERIOD 1000 μs, or 130 turns
INFLECTOR TYPE Electrostatic

Magnet System

FOCUSING TYPE STRONG FIELD INDEX n = 0
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 2.22 ν_V 2.18
No. MAGNETS 8 LENGTH (ea) 0.842 m
BENDING FIELD at inj. 0.08 T; at max 0.97 T
No. QUADS 16 LENGTH (ea) 0.4 m
GRAD. at inj. 0.04 T/m; at max 1.85 T/m
No. SHORT STRAIGHT SECT. 16 LENGTH 0.45 m
No. LONG STRAIGHT SECT. 8 LENGTH 2.034 m
RISE TIME 0.18 s; FLAT-TOP TIME 40 ms s
POWER INPUT PEAK 10 MW; MEAN .5 MW

Acceleration System

No. CAVITIES 2 LENGTH(ea) 1.4 m
HARMONIC NUMBER 1
RF RANGE 0.16 to 2.48 MHz
ENERGY GAIN 0.2 KeV/turn
RADIATION LOSS / KeV/turn
RF POWER INPUT PEAK 4 each kW; MEAN kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless steel
APERTURE OF VAC. CHAMBER 150 x 280 mm
AVERAGE PRESSURE 3.10^{-11} torr

Extraction System

TYPE FAST/KICKERS
LENGTH OF SPILL 0.2 to 1. μs

ACCELERATOR PERFORMANCE /P

	Normal (or Goal)	Maximum achieved
ENERGY (GeV) 2)		
RESOLUTION ΔE/E (%)	2	
REPET. RATE (pulse/s)	1	
PULSE WIDTH AT PEAK E	0.2 -1 s	
3) INTERNAL BEAM (part/pulse)		
(part/s)		
BEAM EMITTANCE *	H : 10 V : 30	πmm-mrad

BEAM LINES TO SATURNE

Other Relevant Parameters, Recent Improvements, etc.

1) HI : from Carbon to Krypton (1989)
2) 47MeV $\vec{p}$
12MeV/amu $\vec{d}$, C, N, Ne (q/A = .5)
7.6 MeV/amu Ar16+ (q/A = .5)
6 MeV/amu Kr30+ (q/A = .357)
3) $\vec{p}$ $1.5 10^{11}$ p/pulse
$\vec{d}$ 2.10^{11}
C 9.10^{8}
N 8.10^{8}
Ne 2.10^{8}
Ar 1.10^{8}
Kr 2.10^{6}

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC 20 MeV LINAC
INJECTOR FOR SATURNE
LOCATION LABORATOIRE NATIONAL SATURNE - J. ARVIEUX - Director
PERSON IN CHARGE JL. LEMAIRE DATE: 20/06/89
DATA SUPPLIED BY JL. LEMAIRE

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1966
FIRST BEAM OBTAINED, or GOAL (date) 1969
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 500 h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	20	20
ENERGY SPREAD ΔE/E (%)	0.8	
CURRENT (mA)	20	40
EMITTANCE*	2.8	πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 10.47 m; No. TANKS 1
TANK DIAM. 1 m; No. DRIFT TUBES 58
DRIFT TUBE LENGTHS 4.53 to 20.73 cm
DRIFT TUBE DIAMETERS 18 to 15 cm
GAP/CELL LENGTH 0.26 to 0.32
APERTURE DIAM. 0.79 cm mm to 1.25 cm mm

Ion Source

TYPE Duo plasmatron - Von Ardenne
OUTPUT mA at KeV
EMITTANCE* πmm-mrad

Injector

TYPE Pressurized Cochroft Walton 750 KV
OUTPUT 50 mA at 750 KeV
EMITTANCE* 0.31 πmm-mrad

Bunchers

TYPE
MODULATION 27 KeV, DRIFT ℓ 840 mm at 200 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 200 MHz MHz
FIELD MODE TM010 Q 80 000
EQUIL. PHASE 45 to 20 ACCEL. RATE 1.84 MeV/m
REPETITION RATE 1 HZ
DUTY FACTOR 0.1 % (RF); % (Beam)
PULSE LENGTH 1000 μs (RF); 500 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE 60 MΩ/m
FILLING TIME μs
RF POWER INPUT PEAK 2.3 MW; MEAN 0.3 MW

Focusing System

No. QUADS 58 TYPE magn ORDER + -
GRADIENTS 53 to 6.4 T/m
OTHER

Vacuum System

MATERIAL CHAMBER ionic pumps
AVERAGE PRESSURE 1.10 -7 torr

Other Relevant Parameters, Recent Improvements, etc.

a) used in 2 $\beta\lambda$ mode for particles injected at 187.5 Kew/Amu and accelerated to 5 MeV/Amu

d_3, He^{2+}, He^{2+}_4

b) used for multiturn injector in Saturne

t = 450 μs ; 260 turns.

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON 12 GeV Proton Synchrotron (KEK-PS)
INSTITUTION KEK, National Laboratory for High Energy Physics
LOCATION Tsukuba, Ibaraki, 305, Japan
PERSON IN CHARGE M. Kihara DATE: July 1989
DATA SUPPLIED BY M. Kihara

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1971
FIRST BEAM OBTAINED, or GOAL (date) March 1976 (8 GeV)
TOTAL COST OF FACILITY 5×10^9 ¥
TOTAL ACCELERATOR STAFF (now) 55
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES 4.5×10^{12} ppp
ENERGY 12 GeV
RING DIAM. 108 m; TUNNEL SECT. (W x H) 4 × 6 m

Injector

TYPE 40 MeV Linac + 500 MeV Booster Synchrotron
OUTPUT(max) 7×10^{11} ppp mA at 500 MeV
EMITTANCE* 35 (H), 25 (V) (99 %) πmm-mrad
INJECTION PERIOD 5×10^5 μs, or 9 pulses turns
INFLECTOR TYPE magnetic septum + fast kickers

Magnet System

FOCUSING TYPE AG, separated FIELD INDEX n =
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 7.11 ν_V 7.22
No. MAGNETS 48 LENGTH (ea) 3.2 m
BENDING FIELD at inj 0.15 T; at max 1.75 T
No. QUADS 56 LENGTH (ea) 0.6 m
GRAD. at inj. 1.5 T/m; at max 18.1 T/m
No. SHORT STRAIGHT SECT 48 LENGTH 1.84 m
No. LONG STRAIGHT SECT 8 LENGTH 5.46 m
RISE TIME 0.65 s; FLAT-TOP TIME 0.65 s
POWER INPUT PEAK 27 MW; MEAN 2.9 MW

Acceleration System

No. CAVITIES 4 LENGTH(ea) 1.8 m
HARMONIC NUMBER 9
RF RANGE 6.03 to 7.93 MHz
ENERGY GAIN 20 KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK 160 kW; MEAN 80 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel (316L)
APERTURE OF VAC. CHAMBER 145 × 50 mm
AVERAGE PRESSURE 1×10^{-7} torr

Extraction System

TYPE i) Slow extraction (half-integer)
ii)
iii)
LENGTH OF SPILL i) to 5×10^5 μs
ii) to μs
iii) to μs

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	12	12
RESOLUTION ΔE/E (%)	± 0.3	± 0.3
REPET. RATE (pulse/s)	0.4	0.5
PULSE WIDTH AT PEAK E	0.5 sec	0.5 sec
INTERNAL BEAM (part/pulse)	4×10^{12}	5×10^{12}
(part/s)	1.6×10^{12}	1.8×10^{12}
EMITTANCE* AT PEAK E	65 (V) (99 %)	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$\pi^\pm/K^\pm/P^\pm$	0.5 - 2 GeV/c	2×10^7 ppp(π^+)	K3
$\pi^\pm/K^\pm/P^\pm$	0.5 - 1 GeV/c	5×10^7 ppp(π^+)	K2
$K^0/n/\gamma$	0 - 8 GeV/c	3×10^7 ppp(K^0)	K0
π/μ	0.1 - 1 GeV/c	1×10^5 ppp(μ)	πμ
$\pi^\pm/P$	1 - 4 GeV/c	2×10^5 ppp(π^+)	π2
$\pi^\pm/P$	0.5 - 2.3 GeV/c	5×10^4 ppp(π^+)	T1
$\pi^\pm/P$	0.5 - 6 GeV/c	1×10^4 ppp(π^+)	T3

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS (50 m × 100 m) 5000 m²
No. INTERNAL TARGETS 1 No. EXT. TARGETS 4
No. SEPARATED BEAMS 2 (total secondary beams = 8)
No. BEAMS SERVED AT SAME TIME max. 7
TOTAL POWER USED (AVERAGE) FOR RESEARCH 6 MW
No. USER GROUPS, in house 5 outside 8
TOTAL RESEARCH STAFF, in house 20 outside 300
ANN. RESEARCH BUDGET, in house 1.2×10^8 yen (without sal.)
ANNUAL RESEARCH TIME 4000 h

Other Relevant Parameters, Recent Improvements, etc.

Improvement programs underway:

(1) Duty-factor improvement (Present 0.5 ms to 2 ms) will finish in October, 1990.

(2) A new experimental hall will be available late 1989.

NAME OF SYNCHROTRON Booster Synchrotron for KEK-PS
INJECTOR FOR 12 GeV Proton Synchrotron
LOCATION Tsukuba, Ibaraki, 305, Japan
PERSON IN CHARGE M. Kihara DATE: July 1989
DATA SUPPLIED BY M. Kihara

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1971
FIRST BEAM OBTAINED, or GOAL (date) December 1974
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES 2.2×10^{12} ppp
ENERGY 0.5 GeV
RING DIAM 12 m; TUNNEL SECT. (W x H) m

Injector

TYPE Linac (H^-)
OUTPUT(max) 10 mA at 40 MeV
EMITTANCE* 3 πmm-mrad
INJECTION PERIOD 80 μs, or turns
INFLECTOR TYPE magnetic

Magnet System

FOCUSING TYPE AG, Combined FIELD INDEX n = 12.1
FOCUSING ORDER FDDFO
BETATRON FREQ. ν_H 2.17 ν_V 2.36
No. MAGNETS 8 LENGTH (ea) 2.6 m
BENDING FIELD at inj. 0.28 T; at max 1.1 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 8 LENGTH 2.0 m
No. LONG STRAIGHT SECT. LENGTH m
RISE TIME 20 Hz s; FLAT-TOP TIME s
POWER INPUT PEAK MW; MEAN 0.5 MW

Acceleration System

No. CAVITIES 2 LENGTH(ea) 1.6 m
HARMONIC NUMBER 1
RF RANGE 2.25 to 6.03 MHz
ENERGY GAIN 6.4 KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK 100 kW; MEAN 30 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel (316L) (corrugated)
APERTURE OF VAC. CHAMBER 140 × 60 mm
AVERAGE PRESSURE 1.5×10^{-6} torr

Extraction System

TYPE one-turn extraction by kickers

LENGTH OF SPILL to 0.08 μs

ACCELERATOR PERFORMANCE

		Normal (or Goal)	Maximum achieved
ENERGY (GeV)		0.5	0.5
RESOLUTION ΔE/E (%)		± 0.5	± 0.5
REPET. RATE (pulse/s)		20	20
PULSE WIDTH AT PEAK E		80 ns	80 ns
INTERNAL BEAM	(part/pulse)	2×10^{12}	2.2×10^{12}
	(part/s)	4×10^{13}	4.4×10^{13}
BEAM EMITTANCE *		35 (H), 45 (V)+ (99 %)	πmm-mrad
BEAM LINES TO		KEK-PS and BSF++	

Other Relevant Parameters, Recent Improvements, etc.

+) At a beam intensity of 1.8×10^{12} ppp.

++) BSF: Booster Synchrotron Utilization Facility. It consists of pulsed spallation neutron source (KENS), Meson Science Laboratory (BOOM) and Particle Radiation Medical Science Center (PARMS).

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC 40 MeV Injector for KEK-PS
INJECTOR FOR 12 GeV Proton Synchrotron
LOCATION Tsukuba, Ibaraki, 305, Japan
PERSON IN CHARGE M. Kihara DATE: July 1989
DATA SUPPLIED BY M. Kihara

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1971
FIRST BEAM OBTAINED, or GOAL (date) August 1974
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4000 h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved	
OUTPUT ENERGY (MeV)	40.3		
ENERGY SPREAD ΔE/E (%)	0.8		
CURRENT (mA)	10		
EMITTANCE*	2 ∿ 3		πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 15.5/12.9 m; No. TANKS 2
TANK DIAM. 0.94/0.9 m; No. DRIFT TUBES 90/35
DRIFT TUBE LENGTHS 2.329 ∿ 28.79 cm
DRIFT TUBE DIAMETERS 18/16 cm
GAP/CELL LENGTH 0.21 ∿ 0.317
APERTURE DIAM. 20∿30 (1st tank) mm to 30 (2nd tank) mm

Ion Source

TYPE Cusp H^- Ion Source
OUTPUT 25 mA at 750 KeV
EMITTANCE* 1.4 πmm-mrad

Injector

TYPE Cockcroft-Walton
OUTPUT 25 mA at 750 KeV
EMITTANCE* 1.4 πmm-mrad

Bunchers

TYPE Coaxial, two gap
MODULATION 16 KeV, DRIFT ℓ 944.2 mm at 201 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 201.0669 MHz
FIELD MODE TM_{010} Q ∿ 65,000
EQUIL. PHASE -30° ACCEL. RATE 1.23/1.57 MeV/m
REPETITION RATE 20 Hz
DUTY FACTOR 0.55 % (RF); 80μs × 20=0.16 % (Beam)
PULSE LENGTH 275 μs (RF); 80 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE 53/46 MΩ/m
FILLING TIME ∿ 60 μs
RF POWER INPUT PEAK 1.3 MW; MEAN 0.006 MW

Focusing System

No. QUADS 90/35 TYPE Magnet ORDER FD
GRADIENTS 110 to 22 T/m
OTHER Permanent magnet for 2nd tank

Vacuum System

MATERIAL CHAMBER Copper plating steel
AVERAGE PRESSURE 1×10^{-7} torr

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON ISIS
INSTITUTION Rutherford Appleton Laboratory
LOCATION Chilton, Didcot, Oxon., UK
PERSON IN CHARGE D.A. Gray DATE: 1/8/89
DATA SUPPLIED BY M.R. Harold

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1977
FIRST BEAM OBTAINED, or GOAL (date) 1984
TOTAL COST OF FACILITY £60M new + £60M old (incl. staff costs)
TOTAL ACCELERATOR STAFF (now) 105
ANN. OPERAT. BUDGET £3400 K (without salaries)
ANN. OPERATING TIME ∿ 5000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Protons
ENERGY 0.8 GeV
RING DIAM. 52 m; TUNNEL SECT. (W x H) m

Injector

TYPE Alvarez Linac
OUTPUT(max) Design 20 mA at 70.4 MeV
EMITTANCE* " 9.9 πmm-mrad
INJECTION PERIOD " 470 μs, or 300 turns
INFLECTOR TYPE H^- Stripping foil

Magnet System

FOCUSING TYPE AG FIELD INDEX n = 3.3
FOCUSING ORDER BF_1 OD_1 OF_2 OD_2
BETATRON FREQ. ν_H 4.31 ν_V 3.83
No. MAGNETS 10 LENGTH (ea) 4.4 m
BENDING FIELD at inj 0.176 T; at max 0.697 T
No. QUADS 30 LENGTH (ea) 0.7 & 0.4 m
GRAD. at inj. 0.8 T/m; at max 3.1 T/m
No. SHORT STRAIGHT SECT 10 LENGTH 3.05 m
No. LONG STRAIGHT SECT 10 LENGTH 5.32 m
RISE TIME 0.01 s; FLAT-TOP TIME – s
POWER INPUT PEAK – MW; MEAN 1.75 MW

Acceleration System

No. CAVITIES 6 LENGTH(ea) 3.14 m
HARMONIC NUMBER 2
RF RANGE 1.34 to 3.06 MHz
ENERGY GAIN 65 KeV/turn
RADIATION LOSS – KeV/turn
RF POWER INPUT PEAK 910 kW; MEAN 530 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Alumina
APERTURE OF VAC. CHAMBER 140 mm
AVERAGE PRESSURE $< 10^{-7}$ torr

Extraction System

TYPE i) Single turn
ii)
iii)
LENGTH OF SPILL i) 0.45 to – μs
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	0.8	0.75
RESOLUTION ΔE/E (%)	0.4	
REPET. RATE (pulse/s)	50	50
PULSE WIDTH AT PEAK E	2 × 100 ns	2 × 100 ns
INTERNAL BEAM (part/pulse)	2.5×10^{13}	1.6×10^{13}
(part/s)	1.2×10^{15}	0.7×10^{15}
EMITTANCE* AT PEAK E	220 × 125 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
Neutron		14	18 available
Neutrino		1	
Muon		1	μSR, μCF, etc
Proton		1	Test beam

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 3050 m²
No. INTERNAL TARGETS 1 No. EXT. TARGETS 2
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 16
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house 6 outside > 50
TOTAL RESEARCH STAFF, in house 25 outside 400
ANN. RESEARCH BUDGET, in house £3000K (without sal.)
ANNUAL RESEARCH TIME ∿ 4700 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC ISIS Injector
INJECTOR FOR ISIS Synchrotron
LOCATION Rutherford Appleton Laboratory, Chilton, Didcot, Oxon., UK
PERSON IN CHARGE D.A. Gray DATE: 1/8/89
DATA SUPPLIED BY N.D. West

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1977-Conversion to H^-
FIRST BEAM OBTAINED, or GOAL (date) Jan. 1983
TOTAL COST OF FACILITY See note below
TOTAL ACCELERATOR STAFF (now) See ISIS Synchrotron
ANN. OPERAT. BUDGET " (without salaries)
ANN. OPERATING TIME " h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	70.4	
ENERGY SPREAD ΔE/E (%)	+/- 0.26(Design after debuncher)	
CURRENT (mA)	10 - 14	
EMITTANCE*	4.7 (90 %), 10.0 (99 %)	πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 44 m; No. TANKS 4
TANK DIAM. .94-.81 m; No. DRIFT TUBES 148
DRIFT TUBE LENGTHS 45.4 - 340.7 mm
DRIFT TUBE DIAMETERS 180.0, 177.8, 177.8, 160 mm
GAP/CELL LENGTH 0.21 - 0.37
APERTURE DIAM. 20 mm to 30 mm
(Tanks 2&3 - 33.3 mm)

Ion Source

TYPE H^- Penning
OUTPUT max 30 mA at 18 KeV
EMITTANCE* — πmm-mrad

Injector

TYPE Cockcroft-Walton
OUTPUT max 30 mA at 665 KeV
EMITTANCE* 1.7 × 3.5 πmm-mrad

Bunchers

TYPE Coaxial resonator-double gap
MODULATION 23 KeV, DRIFT ℓ 800 mm at 202.5 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 202.5 MHz
FIELD MODE E(010) Q 40,000 - 60,000
EQUIL. PHASE - 30° ACCEL. RATE 0.84 - 1.77 MeV/m
REPETITION RATE 50 Hz
DUTY FACTOR Design 3.5 % (RF); Design 2.5 % (Beam)
PULSE LENGTH " 700 μs (RF); " 500 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE — MΩ/m
FILLING TIME 125 μs
RF POWER INPUT PEAK 7.0 MW; MEAN 0.24 MW

Focusing System

No. QUADS 152 TYPE Pulsed & dc ORDER FFDD
GRADIENTS 40 to 4.6 T/m
OTHER

Vacuum System

MATERIAL CHAMBER Steel
AVERAGE PRESSURE 1×10^{-6} torr

Other Relevant Parameters, Recent Improvements, etc.

Originally built as a low duty cycle proton linac, 1973-76, at construction cost (capital) of £1.8M. Converted to high duty cycle, H^- linac at cost (capital) of £0.9M.
Tanks 2&3 originally formed part of an earlier 50 MeV proton linac which operated 1960-69.

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON: Alternating Gradient Synchrotron
INSTITUTION: Brookhaven National Laboratory
LOCATION: Upton, New York 11973
PERSON IN CHARGE: D.I. Lowenstein/Th. Sluyters — DATE: 6/19/89
DATA SUPPLIED BY: L.A. Ahrens/Y.Y. Lee

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1953
FIRST BEAM OBTAINED, or GOAL (date): July 29, 1960
TOTAL COST OF FACILITY: $30.65 M
TOTAL ACCELERATOR STAFF (now): 325
ANN. OPERAT. BUDGET: $10.9 M (without salaries)
ANN. OPERATING TIME: 4,400 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES: Proton
ENERGY: 30 GeV
RING DIAM.: 256.9 m; TUNNEL SECT. (W x H): 5.49x5.49 m

Injector

TYPE: Alvarez Linear Accelerator
OUTPUT (max): 30 mA at 200 MeV
EMITTANCE*: 10 πmm-mrad
INJECTION PERIOD: ≤ 400 μs, or ≤ 80 turns
INFLECTOR TYPE: H- injection

Magnet System

FOCUSING TYPE: AG, Comb. Funct. FIELD INDEX n = 365
FOCUSING ORDER: (F/2)0(F/2)(D/2)0(D/2)
BETATRON FREQ. ν_H: 8.75 ν_V: 8.75
No. MAGNETS: 240 LENGTH (ea): 2.28 or 1.90 m
BENDING FIELD at inj: 0.0251 T; at max: 1.31 T
No. QUADS: 240 LENGTH (ea): 2.28 or 1.90 m
GRAD. at inj.: 0.105 T/m; at max: 5.5 T/m
No. SHORT STRAIGHT SECT: 72 LENGTH: 1.63 m
No. LONG STRAIGHT SECT: 24 LENGTH: 3.15 m
RISE TIME: 0.6 s; FLAT-TOP TIME: 1-2 s
POWER INPUT PEAK: 60 MW; MEAN: 6 MW

Acceleration System

No. CAVITIES: 10, 4 gaps ea. LENGTH (ea): 2 m
HARMONIC NUMBER: 12
RF RANGE: 2.52 to 4.46 MHz
ENERGY GAIN: 192 KeV/turn
RADIATION LOSS: 0 KeV/turn
RF POWER INPUT PEAK: 1,000 kW; MEAN: 800 kW

Vacuum System

MATERIAL OF VAC. CHAMBER: Inconel - 750
APERTURE OF VAC. CHAMBER: 173 x 77.8 mm
AVERAGE PRESSURE: 1.0×10^{-7} torr

Extraction System

TYPE: i) Fast Extraction
ii) Slow Extraction
iii) Single Bunch Extraction

LENGTH OF SPILL: i) 3.0 to μs
ii) 0.5 to 2.5 μs sec.
iii) 0.3 to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	24/28.5	33
RESOLUTION ΔE/E (%)	0.2	0.1
REPET. RATE (pulse/s)	0.4	0.8
PULSE WIDTH AT PEAK E	0.5-2.5 sec	
INTERNAL BEAM (part/pulse)	1.5×10^{13}	1.7×10^{13}
(part/s)	1.2×10^{13}	1.3×10^{13}
EMITTANCE* AT PEAK E	20 x 20	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$\pi^{\pm}$	0.1-24 GeV/c	10	
$K^{\pm}$	0.5-22 GeV/c	11	
$K^{\pm}$	0.5-6 GeV/c	4 x 2 Branches	Separated
$\bar{p}$	0.4-20 GeV/c	11	
$\bar{p}$	0.4-9 GeV/c	4 x 2 Branches	Separated
p	0.2-28.5 GeV/c	11	
$\mu^{\pm}$	0.028-20 GeV/c	11	
K^{o}	0.5-18 GeV/c	2	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS: 4 total of 15,000 m²
No. INTERNAL TARGETS: 0 No. EXT. TARGETS: 6
No. SEPARATED BEAMS: 3
No. BEAMS SERVED AT SAME TIME: 10
TOTAL POWER USED (AVERAGE) FOR RESEARCH: 25 MW
No. USER GROUPS, in house: 4 outside: 50
TOTAL RESEARCH STAFF, in house: 45 outside: 300
ANN. RESEARCH BUDGET, in house: 1.5 M (oper.) (without sal.)
ANNUAL RESEARCH TIME: 3000 h

Other Relevant Parameters, Recent Improvements, etc.

Longitudinal phase space dilution cavity (1989).

Gamma-transition jump to be commissioned in 1990.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON BNL AGS Booster
INJECTOR FOR AGS
LOCATION Upton, New York 11973
PERSON IN CHARGE W. T. Weng DATE: June 15, 1989
DATA SUPPLIED BY W. T. Weng

HISTORY AND STATUS

CONSTRUCTION STARTED (date) October, 1985
FIRST BEAM OBTAINED, or GOAL (date) January, 1991
TOTAL COST OF FACILITY $32M
TOTAL ACCELERATOR STAFF (now) 85
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME Under Construction h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Proton & Heavy Ions
ENERGY 1.5 GeV
RING DIAM 64.118 m; TUNNEL SECT. (W x H) 3.35 (D) m

Injector

TYPE Alvarez Linear Accelerator
OUTPUT(max) 35 mA at 200 MeV
EMITTANCE* 6 nmm-mrad
INJECTION PERIOD 250 μs, or 200 turns
INFLECTOR TYPE Ring Dipole (H^- injection)

Magnet System

FOCUSING TYPE AG Separated FIELD INDEX n =
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 4.82 ν_V 4.83
No. MAGNETS 36 LENGTH (ea) 2.40 m
BENDING FIELD at inj. 0.156 T; at max 0.546 T
No. QUADS 48 LENGTH (ea) 0.5 m
GRAD. at inj. 1.26 T/m; at max 4.23 T/m
No. SHORT STRAIGHT SECT. LENGTH m
No. LONG STRAIGHT SECT. 12 LENGTH 2.72 m
RISE TIME 7.5 Hz s; FLAT-TOP TIME s
POWER INPUT PEAK 12 MW; MEAN 0.75 MW

Acceleration System

No. CAVITIES 2 LENGTH(ea) 2.5 m
HARMONIC NUMBER 3
RF RANGE 2.52 to 4.46 MHz
ENERGY GAIN 25 KeV/turn
RADIATION LOSS 0 KeV/turn
RF POWER INPUT PEAK 370 kW; MEAN 185 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Inconel-625
APERTURE OF VAC. CHAMBER 150 x 70 mm
AVERAGE PRESSURE 3×10^{-11} torr

Extraction System

TYPE One turn extraction by kicker bunch to bucket transfer to AGS
LENGTH OF SPILL to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)		
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)		
PULSE WIDTH AT PEAK E		
INTERNAL BEAM (part/pulse)		
(part/s)		
BEAM EMITTANCE *		nmm-mrad
BEAM LINES TO		

Other Relevant Parameters, Recent Improvements, etc.

In addition to accelerate regular proton, the Booster also accelerates polarized proton and heavy ions from oxygen to gold.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC Brookhaven 200 MeV Linac
INJECTOR FOR Brookhaven Alternating Gradient Synchrotron
LOCATION Brookhaven National Laboratory
PERSON IN CHARGE D.I. Lowenstein/Th. Sluyters DATE: 6/19/89
DATA SUPPLIED BY J.G. Alessi

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April, 1967
FIRST BEAM OBTAINED, or GOAL (date) November, 1970
TOTAL COST OF FACILITY $22.4 M
TOTAL ACCELERATOR STAFF (now) 13
ANN. OPERAT. BUDGET Inc. in AGS Budget (without salaries)
ANN. OPERATING TIME 5,000 h

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH 144.8 m; No. TANKS 9
TANK DIAM. 0.9 m; No. DRIFT TUBES 277
DRIFT TUBE LENGTHS 5 cm - 45 cm
DRIFT TUBE DIAMETERS 16 cm (18 cm in first tank)
GAP/CELL LENGTH 0.20 - 0.47
APERTURE DIAM. 20 mm to 40 mm

Ion Source
TYPE H^- Magnetron
OUTPUT 70-100 mA at 35 KeV
EMITTANCE* 1.1 - 1.5 πmm-mrad

Injector
TYPE RFQ
OUTPUT 50-55 mA at 750 KeV
EMITTANCE* 1.2 - 2.0 πmm-mrad

Bunchers
TYPE Double Drift-Space
MODULATION 27 KeV, DRIFT ℓ mm at 201.25 MHz
12 KeV, DRIFT ℓ mm at 201.25 MHz
24 KeV, DRIFT ℓ mm at 201.25 MHz

Acceleration System
RF FREQ. 201.25 MHz
FIELD MODE TM 010 Q 40,000 - 50,000
EQUIL. PHASE -32° ACCEL. RATE 1.6 - 2.6 MeV/m
REPETITION RATE 5 pulses/sec
DUTY FACTOR 0.35 % (RF); 0.25 % (Beam)
PULSE LENGTH 700 μs (RF); 500 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE 50 - 15 MΩ/m
FILLING TIME 50 μs
RF POWER INPUT PEAK 27 MW; MEAN 0.0945 MW

Focusing System
No. QUADS 277 TYPE Electromag. ORDER +-+-
GRADIENTS 0.92 to 0.10 T/m
OTHER

Vacuum System
MATERIAL CHAMBER Copper-clad steel
AVERAGE PRESSURE < 10^{-7} torr

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	200	
ENERGY SPREAD ΔE/E (%)	0.3% FWHM	
CURRENT (mA)	25	
EMITTANCE*	6 πmm-mrad	

Other Relevant Parameters, Recent Improvements, etc.

Recent upgrade from Cockcroft-Walton to an RFQ preinjector (1/89).

80-85% transmission from Linac entrance to 200 MeV.

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON Tevatron
INSTITUTION Fermilab
LOCATION Batavia, Illinois 60510
PERSON IN CHARGE David Finley DATE: 27 June 1989
DATA SUPPLIED BY David Finley

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1979
FIRST BEAM OBTAINED, or GOAL (date) August 1983
TOTAL COST OF FACILITY 136M$
TOTAL ACCELERATOR STAFF (now) 10 physicists
ANN. OPERAT. BUDGET 4.0M$ (without salaries)
ANN. OPERATING TIME 4000 h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES Protons
ENERGY 800-1000 GeV
RING DIAM. 2000 m; TUNNEL SECT. (W x H) 3 x 2.4 m

Injector
TYPE Alternating Gradient Synchrotron
OUTPUT(max) $2x10^{13}$ mA at 150 GeV
EMITTANCE* 15 πmm-mrad
INJECTION PERIOD 21 μs, or 1 turns
INFLECTOR TYPE Magnetic septum & kicker magnet

Magnet System Alternating
FOCUSING TYPE Gradient FIELD INDEX n = 0
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 19.42 ν_V 19.41
No. MAGNETS 774 LENGTH (ea) 6.12 m
BENDING FIELD at inj 0.66 T; at max 4.40 T
No. QUADS 216 LENGTH (ea) 1.68 m
GRAD. at inj. 11.4 T/m; at max 76.0 T/m
No. SHORT STRAIGHT SECT 6 LENGTH 12 m
No. LONG STRAIGHT SECT 6 LENGTH 50 m
RISE TIME 13 s; FLAT-TOP TIME 23 (1988) s
POWER INPUT PEAK 43 MW; MEAN 7 MW

Acceleration System
No. CAVITIES 8 LENGTH(ea) 2.5 m
HARMONIC NUMBER 1113
RF RANGE 53.103688 to 53.104700 MHz
ENERGY GAIN 1000 KeV/turn
RADIATION LOSS 1 eV per turn @ 900 GeV
RF POWER INPUT PEAK 1600 kW; MEAN kW

Vacuum System
MATERIAL OF VAC.CHAMBER Stainless 304
APERTURE OF VAC. CHAMBER 75 mm
AVERAGE PRESSURE 10^{-10} torr

Extraction System
TYPE i) Slow respondant
ii) fast
iii)
LENGTH OF SPILL i) 23 sec to N/A μs
ii) 2 msec to N/A μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1000	800
RESOLUTION ΔE/E (%)	0.08	0.08
REPET. RATE (pulse/s)	1/minute	1/minute
PULSE WIDTH AT PEAK E	4 nsec per bunch	
INTERNAL BEAM (part/pulse)	N/A	N/A
(part/s)	"	"
EMITTANCE* AT PEAK E	18 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
pion	250-600 GeV	8	
electron	250-400 GeV	3	
Σ^-, Ω^-	400-600 GeV	1	hyperons
Muon	550 GeV	1	
antiproton	300 GeV	1	
proton	200 GeV	1	polarized
K^0	125 GeV	1	average E
ν	125 GeV	1	average E

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS 0 No. EXT. TARGETS 16
No. SEPARATED BEAMS 16
No. BEAMS SERVED AT SAME TIME 12
TOTAL POWER USED (AVERAGE) FOR RESEARCH 15 MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house 80 outside 800
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME 4000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Fermilab Main Ring
INJECTOR FOR Tevatron
LOCATION Fermilab, Batavia, IL 60510
PERSON IN CHARGE Phil Martin DATE: 6/27/89
DATA SUPPLIED BY Stan Pruss

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1967
FIRST BEAM OBTAINED, or GOAL (date) 1972
TOTAL COST OF FACILITY 243.5M$
TOTAL ACCELERATOR STAFF (now) 4 physicists
ANN. OPERAT. BUDGET 1.6M$ (without salaries)
ANN. OPERATING TIME 4000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES protons and antiprotons
ENERGY 150 GeV
RING DIAM 2000 m; TUNNEL SECT. (W x H) 3x2.4 m

Injector

TYPE Rapid cycling alternating gradient synchrotron
OUTPUT(max) 220 mA at 8000 MeV
EMITTANCE* 8-16 πmm-mrad
INJECTION PERIOD .067 to .8 seps, or 1 turns
INFLECTOR TYPE kicker magnet

Magnet System

FOCUSING TYPE Alternating gradient FIELD INDEX n = 0
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 19.42 ν_V 19.38
No. MAGNETS 774 LENGTH (ea) 6 m
BENDING FIELD at inj. .04 T; at max .675 T
No. QUADS 192/48 LENGTH (ea) 2.1/1.2 m
GRAD. at inj. .54 T/m; at max 9.1 T/m
No. SHORT STRAIGHT SECT. 6 LENGTH 12 m
No. LONG STRAIGHT SECT. 6 LENGTH 50 m
RISE TIME 1.9 s; FLAT-TOP TIME 5.5 s
POWER INPUT PEAK 20 MW; MEAN 4 MW

Acceleration System

No. CAVITIES 18 LENGTH(ea) 1.7 m
HARMONIC NUMBER 1113
RF RANGE 52.8 to 53.1 MHz
ENERGY GAIN 2553 KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK 3500 kW; MEAN 1500 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless steel
APERTURE OF VAC. CHAMBER 125 x 50 mm
AVERAGE PRESSURE 1×10^{-7} torr

Extraction System

TYPE Single turn kicker
LENGTH OF SPILL 1.6 to 18 μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	120-150	500
RESOLUTION ΔE/E (%)	0.1%	
REPET. RATE (pulse/s)	1/2 sec	1/2.4 sec
PULSE WIDTH AT PEAK E	1.6 μs	
INTERNAL BEAM (part/pulse)		
(part/s)		

BEAM EMITTANCE * 8-24 πmm-mrad
BEAM LINES TO Tevatron, Pbar production target

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Fermilab Booster
INJECTOR FOR Fermilab Main Ring, Antiproton Source (Test Beams)
LOCATION Batavia, Illinois
PERSON IN CHARGE Vinod K. Bharadwaj DATE: 6/27/89
DATA SUPPLIED BY Booster Group

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1969
FIRST BEAM OBTAINED, or GOAL (date) 1971
TOTAL COST OF FACILITY ~$19M
TOTAL ACCELERATOR STAFF (now) 13
ANN. OPERAT. BUDGET $400K (without salaries)
ANN. OPERATING TIME 7500 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Protons
ENERGY 8 GeV (Kinetic) GeV
RING DIAM 150.94 m; TUNNEL SECT. (W x H) 3x2.5 m

Injector

TYPE Linac
OUTPUT(max) 35 mA at 200 MeV
EMITTANCE* 7 πmm-mrad
INJECTION PERIOD 2.8 n μs, or 1-10 turns
INFLECTOR TYPE Multi-turn H^- with stripping foil

Magnet System

FOCUSING TYPE Alt. gradient FIELD INDEX n =
FOCUSING ORDER FOFDOOD, combined function
BETATRON FREQ. ν_H 6.7 ν_V 6.8
No. MAGNETS 96 LENGTH (ea) 3.048 m
BENDING FIELD at inj. .050 T; at max 0.7 T
No. QUADS 96 LENGTH (ea) combined function m
GRAD. at inj. .12 T/m; at max 1.75 T/m
No. SHORT STRAIGHT SECT. 24 LENGTH 1.2 m
No. LONG STRAIGHT SECT. 24 LENGTH 6 m
RISE TIME 0.033 s; FLAT-TOP TIME 15 Hz sinusoidal s
POWER INPUT PEAK 4 MW; MEAN 1 MW

Acceleration System

No. CAVITIES 18 LENGTH(ea) 2.4 m
HARMONIC NUMBER 84
RF RANGE 30.3 to 52.8 MHz
ENERGY GAIN 550 KeV/turn
RADIATION LOSS --- KeV/turn
RF POWER INPUT PEAK 1800 kW; MEAN kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless steel
APERTURE OF VAC. CHAMBER 57 (minimum) mm
AVERAGE PRESSURE $5x10^{-7}$ torr

Extraction System

TYPE Single turn, fast kicker and septum magnet
LENGTH OF SPILL 0 to 1.6 μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	8	10
RESOLUTION ΔE/E (%)	.01	
REPET. RATE (pulse/s)	15	
PULSE WIDTH AT PEAK E	1.6 μs	
INTERNAL BEAM (part/pulse)	$2.5x10^{12}$	$3.5x10^{12}$
(part/s)		
BEAM EMITTANCE *	15	πmm-mrad

BEAM LINES TO Main Ring, Antiproton Source

Other Relevant Parameters, Recent Improvements, etc.

1. Combined function magnets.
2. Fast cycling resonant power supply system. Current is a 15 Hz biased sine wave excitation.
3. H^- injection with carbon foil stripping for multi-turn operation.
4. Upgrade for 400 MeV injection in progress.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Accumulator
INJECTOR FOR Main Ring (collider mode)
LOCATION Fermilab
PERSON IN CHARGE John Marriner DATE: 6/13/89
DATA SUPPLIED BY John Marriner

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1982
FIRST BEAM OBTAINED, or GOAL (date) 1985
TOTAL COST OF FACILITY 30 M$
TOTAL ACCELERATOR STAFF (now) 10
ANN. OPERAT. BUDGET 700 K$ (without salaries)
ANN. OPERATING TIME 7000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Anti-protons
ENERGY 8 GeV
RING DIAM 477 m; TUNNEL SECT. (W x H) 6 x 2.4 m

Injector

TYPE Storage Ring
OUTPUT(max) 0.002 mA at 8000 MeV
EMITTANCE* 5 πmm-mrad
INJECTION PERIOD μs, or 1 turns
INFLECTOR TYPE Septum-kicker

Magnet System

FOCUSING TYPE Strong FIELD INDEX n =
FOCUSING ORDER Triplet-FODO-Triplet
BETATRON FREQ. ν_H 6.610 ν_V 8.607
No. MAGNETS 30 LENGTH (ea) 4.5 m
BENDING FIELD at inj. 1.7 T; at max 1.7 T
No. QUADS 84 LENGTH (ea) 0.7 m
GRAD. at inj. 10 T/m; at max 10 T/m
No. SHORT STRAIGHT SECT. 12 LENGTH 7 m
No. LONG STRAIGHT SECT. 6 LENGTH 15 m
RISE TIME s; FLAT-TOP TIME s
POWER INPUT PEAK 2 MW; MEAN 2 MW

Acceleration System

No. CAVITIES 2 LENGTH(ea) 1.6 m
HARMONIC NUMBER 84
RF RANGE 52.812 to 52.822 MHz
ENERGY GAIN 1 KeV/turn
RADIATION LOSS 0 KeV/turn
RF POWER INPUT PEAK 200 kW; MEAN 20 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless Steel
APERTURE OF VAC. CHAMBER 35 mm
AVERAGE PRESSURE 3×10^{-10} torr

Extraction System

TYPE Kicker/Lambertson
LENGTH OF SPILL to 0.2 μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	8	8
RESOLUTION ΔE/E (%)	0.02	0.02
REPET. RATE (pulse/s)	2.4	1.5
PULSE WIDTH AT PEAK E		
INTERNAL BEAM (part/pulse)	1.5×10^{7}	1.5×10^{7}
(part/s)		
BEAM EMITTANCE *	1	πmm-mrad
BEAM LINES TO	Main Ring	

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Debuncher
INJECTOR FOR Accumulator
LOCATION Fermilab
PERSON IN CHARGE John Marriner DATE: 6/13/89
DATA SUPPLIED BY John Marriner

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1983
FIRST BEAM OBTAINED, or GOAL (date) 1985
TOTAL COST OF FACILITY 30 M$
TOTAL ACCELERATOR STAFF (now) 10
ANN. OPERAT. BUDGET 700 K$ (without salaries)
ANN. OPERATING TIME 7000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Antiprotons
ENERGY 8 GeV
RING DIAM 505 m; TUNNEL SECT. (W x H) 6 x 2.4 m

Injector

TYPE Target
OUTPUT(max) .003 mA at 8000 MeV
EMITTANCE* 20 πmm-mrad
INJECTION PERIOD μs, or 1 turns
INFLECTOR TYPE Septum/Kicker

Magnet System

FOCUSING TYPE Strong FIELD INDEX n =
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 9.77 ν_V 9.76
No. MAGNETS 66 LENGTH (ea) 1.6 m
BENDING FIELD at inj. 1.7 T; at max 1.7 T
No. QUADS 114 LENGTH (ea) 0.70 m
GRAD. at inj. 10 T/m; at max 10 T/m
No. SHORT STRAIGHT SECT. 36 LENGTH 3.5 m
No. LONG STRAIGHT SECT. 0 LENGTH m
RISE TIME s; FLAT-TOP TIME s
POWER INPUT PEAK 2 MW; MEAN 2 MW

Acceleration System

No. CAVITIES 6 LENGTH(ea) 1.6 m
HARMONIC NUMBER 90
RF RANGE 53.1 to 53.1 MHz
ENERGY GAIN 0 KeV/turn
RADIATION LOSS 0 KeV/turn
RF POWER INPUT PEAK 5000 kW; MEAN 0.1 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless Steel
APERTURE OF VAC. CHAMBER 45 mm
AVERAGE PRESSURE 10^{-8} torr

Extraction System

TYPE Septum/Kicker
LENGTH OF SPILL to 1.6 μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	8	8
RESOLUTION ΔE/E (%)	0.2	0.2
REPET. RATE (pulse/s)	2.4	1.5
PULSE WIDTH AT PEAK E		
INTERNAL BEAM (part/pulse)	2×10^7	2×10^7
(part/s)		
BEAM EMITTANCE *	5	πmm-mrad

BEAM LINES TO Accumulator

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC Fermilab 200-MeV Proton Linac
INJECTOR FOR 8 GeV Booster Synchrotron
LOCATION Batavia, Illinois
PERSON IN CHARGE D. E. Young DATE: 30 June 1989
DATA SUPPLIED BY D. E. Young

HISTORY AND STATUS

CONSTRUCTION STARTED (date) December 1968
FIRST BEAM OBTAINED, or GOAL (date) November 30, 1970
TOTAL COST OF FACILITY $12.7M
TOTAL ACCELERATOR STAFF (now) 8 (part of Accel. Div.)
ANN. OPERAT. BUDGET $600K (without salaries)
ANN. OPERATING TIME 8000 h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	201	
ENERGY SPREAD ΔE/E (%)**	0.35	
CURRENT (mA)	35	46
EMITTANCE*	4 (@35 mA)	πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 1448 m; No. TANKS 9
TANK DIAM. 0.84-0.94m No. DRIFT TUBES 286
DRIFT TUBE LENGTHS 47-446
DRIFT TUBE DIAMETERS 180-160
GAP/CELL LENGTH 0.21-0.47
APERTURE DIAM. 20 mm to 40 mm

Ion Source

TYPE Magnetron H^- source
OUTPUT 60 mA at 18 KeV
EMITTANCE* πmm-mrad

Injector

TYPE Cockcroft-Walton
OUTPUT 55 mA at 750 KeV
EMITTANCE* 0.8 x 1.5 πmm-mrad

Bunchers

TYPE Single gap re-entrant cavity
MODULATION ~25 KeV, DRIFT ℓ 750 mm at 201.25 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 201.25 MHz
FIELD MODE TM 010 Q 50-60x10³
EQUIL. PHASE -32° ACCEL. RATE 1.4 MeV/m
REPETITION RATE 15
DUTY FACTOR 0.2 % (RF); to 0.1 % (Beam)
PULSE LENGTH 150 μs (RF); 60 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE 27-15 MΩ/m
FILLING TIME 120 (70-160) μs
RF POWER INPUT PEAK 35 MW; MEAN 0.075 MW

Focusing System

No. QUADS 295 TYPE Pulsed Mag ORDER FO
GRADIENTS 70 to 7 T/m
OTHER

Vacuum System

MATERIAL CHAMBER Copper Clad Steel
AVERAGE PRESSURE 5×10^{-8} torr

Other Relevant Parameters, Recent Improvements, etc.

**Energy spread adjustable to optimize the performance of a 3-cell debuncher which reduces the energy spread at the input of the booster synchrotron.

The linac delivers only H^- beam which is time shared between injection into the booster for the fixed target high energy physics program, the colliding beam physics program, the production of antiprotons for the anti-proton source, accelerator physics experiments, and neutron cancer therapy.

In the period from 1975 to 1978, high current duo-plasmatron sources were used to provide short linac beam pulses of 150 to 300 mA for single-turn injection into the booster.

Recent Improvements or Modifications to Machine. The major modification in the last two years involved the switch over in March 1978 to a negative ion source for routine operation to provide multi-turn injection into the booster via a carbon stripping foil.

Published articles describing machine.

Particle Accelerators 1, 51 (1970).
1968 Linear Accel.Conf. Proceedings, BNL 50120.
1970 Linear Accel.Conf. Proceedings.
1972 Linear Accel.Conf. Proceedings, LA 5115.
1976 Linear Accel. Conf. Proceedings, AECL 5677.
Proceedings of the Fourth All-Union Nat.Conf.on Part. Accel. Vol. I, p. 136 (Moscow 1974).
IEEE Trans. Nucl. Sci., NS-18, No. 3, 517 (1971).
IEEE Trans. Nucl. Sci., NS-26, No. 3, 3760 (1979).
IEEE Trans. Nucl. Sci., NS-26, No. 3, 4120 (1979).

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON 76 GeV Proton Synchrotron
INSTITUTION Institute for High Energy Physics
LOCATION Serpukhov, Moscow Region
PERSON IN CHARGE E.A. Myae DATE: 01,07,89
DATA SUPPLIED BY E.A. Myae

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1961
FIRST BEAM OBTAINED, or GOAL (date) 1967
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now) 350
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4500 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES protons
ENERGY 70 GeV
RING DIAM. 236.3 m; TUNNEL SECT. (W x H) 6 x 8 m

Injector

TYPE Fast Cycling Booster (20Hz)
OUTPUT(max) 9.10^{11} ppp mA at 1500 MeV
EMITTANCE* 15 πmm-mrad
INJECTION PERIOD 0.1 μs, or 1/30 turns
INFLECTOR TYPE Kicker Magnet

Magnet System

FOCUSING TYPE AG FIELD INDEX n = -
FOCUSING ORDER FODO (combined function)
BETATRON FREQ. ν_H 9.85 ν_V 9.8
No. MAGNETS 120 LENGTH (ea) 10.4 and 9.3 m
BENDING FIELD at inj 0.038 T; at max 1.2 T
No. QUADS - LENGTH (ea) - m
GRAD. at inj. - T/m; at max - T/m
No. SHORT STRAIGHT SECT 36 LENGTH 2.62 m
No. LONG STRAIGHT SECT 24 LENGTH 4.87 m
RISE TIME 2.5 s; FLAT-TOP TIME 2 s
POWER INPUT PEAK 80 MW; MEAN 15 MW

Acceleration System

No. CAVITIES 40 LENGTH(ea) 1.5 m
HARMONIC NUMBER 30
RF RANGE 5.5 to 6.1 MHz
ENERGY GAIN 200 KeV/turn
RADIATION LOSS - KeV/turn
RF POWER INPUT PEAK kW; MEAN 1000 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless Steel
APERTURE OF VAC. CHAMBER 170 x 115 mm
AVERAGE PRESSURE $3\text{-}4.10^{-7}$ torr

Extraction System

TYPE i) Fast
ii) Slow
iii) Internal Target
LENGTH OF SPILL i) 0.1 to 5 μs
ii) to 1.5 μs
iii) to 1.8 μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	70	76
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)	0.1 (with the booster)	
PULSE WIDTH AT PEAK E		
INTERNAL BEAM (part/pulse)		$1.7.10^{13}$
(part/s)		
EMITTANCE* AT PEAK E	1.5 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
hadrons$^{+,-}$	20-70 GeV/c	6	internal target
- " -	3-17	1	10^8 pps
- " -	3.5-70	2	ext. target
			2.10^9 pps
$e^{+,-}$	5-70	2	ext. target
			10^8 eps

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 17500 m²
No. INTERNAL TARGETS 4 No. EXT. TARGETS 2
No. SEPARATED BEAMS -
No. BEAMS SERVED AT SAME TIME 5 - 6
TOTAL POWER USED (AVERAGE) FOR RESEARCH 30 MW
No. USER GROUPS, in house 20 outside 20
TOTAL RESEARCH STAFF, in house 150 outside 150
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME 3500 h

Other Relevant Parameters, Recent Improvements, etc.

1985 - New Injection System

1989 - High Intensity Slow Extraction System

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON: 1,5 GeV Fast Cycling Booster Synchrotron
INSTITUTION: Institute for High Energy Physics
LOCATION: Serpukhov, Moscow Region
PERSON IN CHARGE: E. A. Myae DATE: 01,07,89
DATA SUPPLIED BY: E. A. Myae

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1975
FIRST BEAM OBTAINED, or GOAL (date): 1983
TOTAL COST OF FACILITY:
TOTAL ACCELERATOR STAFF (now): 100
ANN. OPERAT. BUDGET: (without salaries)
ANN. OPERATING TIME: 4700 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES: protons
ENERGY: 1,5 GeV
RING DIAM. 31,6 m; TUNNEL SECT. (W x H) 4,5 x 4,5 m

Injector

TYPE: RFQ Linac
OUTPUT(max): 100 mA at 30 MeV
EMITTANCE*: 30 πmm-mrad
INJECTION PERIOD: 1,3 μsec/turn μs, or 1 to 5 turns
INFLECTOR TYPE: 4 kickers, 1 septum

Magnet System

FOCUSING TYPE: AG FIELD INDEX n = -
FOCUSING ORDER: triplets, separate function
BETATRON FREQ. ν_H: 3,85 ν_V: 3,8
No. MAGNETS: 24 LENGTH (ea): 1,5 m
BENDING FIELD at inj: 0,14 T; at max: 1,3 T
No. QUADS: 12/24 LENGTH (ea): 0,57/0,33 m
GRAD. at inj.: 0,011 T/m; at max: 0,11 T/m
No. SHORT STRAIGHT SECT: 24 LENGTH: 0,76 m
No. LONG STRAIGHT SECT: 12 LENGTH: 2 m
RISE TIME: 30 ms s; FLAT-TOP TIME: - s
POWER INPUT PEAK: 10 MW; MEAN: 2,5 MW

Acceleration System

No. CAVITIES: 9 LENGTH(ea): 1,2 m
HARMONIC NUMBER: 1
RF RANGE: 0,75 to 2,8 MHz
ENERGY GAIN: 50 (max) KeV/turn
RADIATION LOSS: - KeV/turn
RF POWER INPUT PEAK: kW; MEAN: 500 kW

Vacuum System

MATERIAL OF VAC.CHAMBER: Stainless Steel
APERTURE OF VAC. CHAMBER: 140 x 61 mm
AVERAGE PRESSURE: $2 \cdot 10^{-7}$ torr

Extraction System

TYPE i) one turn
ii)
iii)
LENGTH OF SPILL i) to 0.1 μs
ii) to μs
iii) to μs

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1,35	1,5
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)	16,7	20
PULSE WIDTH AT PEAK E		
INTERNAL BEAM (part/pulse)	$8 \cdot 10^{11}$	$9,5 \cdot 10^{11}$
(part/s)		
EMITTANCE* AT PEAK E	15	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS: m²
No. INTERNAL TARGETS: No. EXT. TARGETS:
No. SEPARATED BEAMS:
No. BEAMS SERVED AT SAME TIME:
TOTAL POWER USED (AVERAGE) FOR RESEARCH: MW
No. USER GROUPS, in house: outside:
TOTAL RESEARCH STAFF, in house: outside:
ANN. RESEARCH BUDGET, in house: (without sal.)
ANNUAL RESEARCH TIME: h

Other Relevant Parameters, Recent Improvements, etc.

NAME OF LINAC: I-100 linear proton accelerator (Alvarez type)
INJECTOR FOR:
LOCATION: Serpukhov, Moscow region
PERSON IN CHARGE: V. M. Ledenev DATE: 01.07.89
DATA SUPPLIED BY: V. M. Ledenev

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1961
FIRST BEAM OBTAINED, or GOAL (date): 1967
TOTAL COST OF FACILITY:
TOTAL ACCELERATOR STAFF (now): 40
ANN. OPERAT. BUDGET: 5000 (without salaries)
ANN. OPERATING TIME: h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	100	100
ENERGY SPREAD ΔE/E (%)	2 %	2 %
CURRENT (mA)	100	100
EMITTANCE*	8	πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH: 80 m; No. TANKS: 3
TANK DIAM.: ** m; No. DRIFT TUBES: ***
DRIFT TUBE LENGTHS: 62 ÷ 623,83 mm
DRIFT TUBE DIAMETERS: 232 ÷ 100 mm
GAP/CELL LENGTH: 0,250÷0,255; 0,185÷0,284; 0,222÷0,277
APERTURE DIAM.: 20 mm to 40 mm

Ion Source

TYPE: Plasmatron
OUTPUT: 1500 mA at 0,01 KeV
EMITTANCE*: 2 πmm-mrad

Injector

TYPE: Pulsed DC accelerator
OUTPUT: 1000 mA at 700 KeV
EMITTANCE*: 2,5 πmm-mrad

Bunchers

TYPE: Clystron
MODULATION: 25,4 KeV, DRIFT ℓ 995 mm at 148,5 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ.: 148,5 MHz
FIELD MODE: E_{010} Q
EQUIL. PHASE: 37° ACCEL. RATE: 0,8 MeV/m
REPETITION RATE: 1 herz
DUTY FACTOR: 30 % (RF); 63 % (Beam)
PULSE LENGTH: 300 μs (RF); 100 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE: MΩ/m
FILLING TIME: μs
RF POWER INPUT PEAK: 5 MW; MEAN: MW

Focusing System

No. QUADS: *** TYPE: FODO ORDER: N=2; K=1
GRADIENTS: 60 to 4 T/m
OTHER:

Vacuum System

MATERIAL CHAMBER: Copper
AVERAGE PRESSURE: 10^{-7} torr

Other Relevant Parameters, Recent Improvements, etc.

** 1,324 m; 1,22 m; 1,087 m

*** $\frac{1}{2} + 93 + \frac{1}{2}$; $\frac{1}{2} + 41 + \frac{1}{2}$; $\frac{1}{2} + 26 + \frac{1}{2}$

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON U-10
INSTITUTION ITEP
LOCATION Moscow
PERSON IN CHARGE L.L. Goldin DATE: 1.7.89
DATA SUPPLIED BY L.L. Goldin

HISTORY AND STATUS

CONSTRUCTION STARTED (date) –
FIRST BEAM OBTAINED, or GOAL (date) 1961
TOTAL COST OF FACILITY –
TOTAL ACCELERATOR STAFF (now) –
ANN. OPERAT. BUDGET – (without salaries)
ANN. OPERATING TIME h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES p, He^{2+}
ENERGY 9,3 GeV (p) 4.7 GeV/n (He) GeV
RING DIAM. 80 m; TUNNEL SECT. (W × H) 12 × 7 m

Injector

TYPE Linac (U-2)
OUTPUT(max) 200 mA at 25,4 MeV
EMITTANCE* 14 πmm-mrad
INJECTION PERIOD 3,8 μs, or 1 turns
INFLECTOR TYPE Electrostatic

Magnet System

FOCUSING TYPE strong FIELD INDEX n = 300
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 9,3 ν_V 9,3
No. MAGNETS 96 LENGTH (ea) 1,9 m
BENDING FIELD at inj 0,024 T; at max 1,0 T
No. QUADS – LENGTH (ea) – m
GRAD. at inj. – T/m; at max – T/m
No. SHORT STRAIGHT SECT 80 LENGTH 0,35 m
No. LONG STRAIGHT SECT 16 LENGTH 2,4 m
RISE TIME 0,65 s; FLAT-TOP TIME 1,2 s
POWER INPUT PEAK 18,0 MW; MEAN 2,5 MW

Acceleration System

No. CAVITIES 5 LENGTH(ea) 1,6 m
HARMONIC NUMBER 4
RF RANGE 1,1 to 4,8 MHz
ENERGY GAIN 15 KeV/turn
RADIATION LOSS – KeV/turn
RF POWER INPUT PEAK 12 × 5 kW; MEAN 3 × 5 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 110 × 80 mm
AVERAGE PRESSURE $1 \cdot 10^{-8}$ torr

Extraction System

TYPE i) Internal Targets, slow
ii) Internal targets, fast
iii) Fast, for medicine, up to 200 MeV
LENGTH OF SPILL i) 1 sec to μs
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	9,3	10,0
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)	0,3	0,5
PULSE WIDTH AT PEAK E	2,5 sec	
INTERNAL BEAM (part/pulse)	$1 \cdot 10^{12}$	$1,5 \cdot 10^{12}$
(part/s)	$3 \cdot 10^{11}$	$7 \cdot 10^{11}$
EMITTANCE* AT PEAK E		πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
	1 - 9 GeV/c	7	
neutral		1	
d, t, ^{3}He	1 - 4 GeV/c	1	polarized
p	E=70-200 MeV	1	separated
^{4}He	5,2 GeV/c	1	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 5000 m²
No. INTERNAL TARGETS 5 No. EXT. TARGETS –
No. SEPARATED BEAMS 2
No. BEAMS SERVED AT SAME TIME 4 - 6
TOTAL POWER USED (AVERAGE) FOR RESEARCH 3 MW
No. USER GROUPS, in house 12 outside
TOTAL RESEARCH STAFF, in house – outside –
ANN. RESEARCH BUDGET, in house – (without sal.)
ANNUAL RESEARCH TIME 3500 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON ITEP Proton and Heavy Ion Accelerator Complex (U-10, Saving Ring)
INSTITUTION ITEP
LOCATION Moscow
PERSON IN CHARGE L. L. Goldin DATE:
DATA SUPPLIED BY L. L. Goldin

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1985
FIRST BEAM OBTAINED, or GOAL (date) 1990
TOTAL COST OF FACILITY —
TOTAL ACCELERATOR STAFF (now) —
ANN. OPERAT. BUDGET — (without salaries)
ANN. OPERATING TIME — h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES p - U
ENERGY 3,5 - 9,3 GeV/A GeV
RING DIAM. 40 m; TUNNEL SECT. (W x H) 12 × 7 m

Injector
TYPE Resonator with four accelerating gaps
OUTPUT(max) mA at 3 - 8 MeV
EMITTANCE* 20 - 100 πmm-mrad
INJECTION PERIOD 20 - 100 μs, or 1 turns
INFLECTOR TYPE Electrostatic

Magnet System of Saving Ring (See U-10)
FOCUSING TYPE strong FIELD INDEX n =
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 5,7 ν_V 5,7
No. MAGNETS 42 LENGTH (ea) 1,5 m
BENDING FIELD at inj T; at max 1,3 T
No. QUADS 42 LENGTH (ea) 0,357 m
GRAD. at inj. T/m; at max 10 T/m
No. SHORT STRAIGHT SECT 42 LENGTH 0,47 m
No. LONG STRAIGHT SECT 42 LENGTH 3,0 m
RISE TIME — s; FLAT-TOP TIME — s
POWER INPUT PEAK — MW; MEAN — MW

Acceleration System
No. CAVITIES 1 LENGTH(ea) 1,6 m
HARMONIC NUMBER > 4
RF RANGE 1,1 to 4,8 MHz
ENERGY GAIN < 10 KeV/turn
RADIATION LOSS — KeV/turn
RF POWER INPUT PEAK 12 kW; MEAN — kW

Vacuum System
MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER mm
AVERAGE PRESSURE $1 \cdot 10^{-10}$ torr

Extraction System
TYPE i) Slow Extraction
ii) Fast Extraction
iii)
LENGTH OF SPILL i) to μs
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	3,5 - 9,3 GeV/A	
RESOLUTION ΔE/E (%)	—	
REPET. RATE (pulse/s)	20	
PULSE WIDTH AT PEAK E	—	
INTERNAL BEAM (part/pulse)		
(part/s)		
EMITTANCE* AT PEAK E	πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC I-2
INJECTOR FOR 10 GeV PS
LOCATION ITEP, Moscow
PERSON IN CHARGE I.M. Kapchinskij DATE: July 1989
DATA SUPPLIED BY N.V. Lazarev

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1962
FIRST BEAM OBTAINED, or GOAL (date) 1966
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 6000 h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	24,6	24,6
ENERGY SPREAD ΔE/E (%)	1,0	0,8
CURRENT (mA)	170	230
EMITTANCE*	10	πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 18,4 m; No. TANKS 2
TANK DIAM. 1,9 m; No. DRIFT TUBES 20+35
DRIFT TUBE LENGTHS 137-313; 196-314
DRIFT TUBE DIAMETERS 190-150; 150
GAP/CELL LENGTH 0,2-0,3; 0,16-0,3
APERTURE DIAM. 20 mm to 25 mm

Ion Source

TYPE Cold cathode duoplasmatron
OUTPUT 2000 mA at 40 KeV
EMITTANCE* πmm-mrad

Injector

TYPE Pulse transformer
OUTPUT 1200 mA at 700 KeV
EMITTANCE* 8 πmm-mrad

Bunchers

TYPE One gap
MODULATION 30 KeV, DRIFT ℓ 850 mm at 148,5 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 148,5 MHz
FIELD MODE E_{010} Q 65000
EQUIL. PHASE 37 ACCEL. RATE 1,3 MeV/m
REPETITION RATE 0,5-2 1/s
DUTY FACTOR 0,06 % (RF); 0,002 % (Beam)
PULSE LENGTH 300 μs (RF); 5-30 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE 22 MΩ/m
FILLING TIME 150 μs
RF POWER INPUT PEAK 1,0+2,0 MW; MEAN 0,002 MW

Focusing System

No. QUADS 36+68 TYPE d.c. ORDER FOD:FOFDOD
GRADIENTS 55 to 18 T/m
OTHER Each drift tube cotain 2 lenses of opposite signs

Vacuum System

MATERIAL CHAMBER Stainless steel
AVERAGE PRESSURE $2\text{-}3 \cdot 10^{-6}$ torr

Other Relevant Parameters, Recent Improvements, etc.

For He_4 ions acceleration by the linac I-2 the APF structure is installed between the preinjector and the first resonator. After stripping He^{2+} ions are injected into the first resonator, which is used only as a focusing channel. The ions are accelerated by second resonator with period of acceleration.

Accelerator performance for He^{2+}

Output energy (MeV)	6
Energy spread ΔE/E (%)	1,2
Current (mA)	1,5
Emittance	10 mm mrad

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF LINAC ISTRA
INJECTOR FOR reconstructed PS ITEP
LOCATION ITEP, Moscow
PERSON IN CHARGE I.M. Kapchinskij DATE: July 1989
DATA SUPPLIED BY A.M. Kozodaev

HISTORY AND STATUS

CONSTRUCTION STARTED (date) March 1988
FIRST BEAM OBTAINED, or GOAL (date) 1992
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now) 30
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	56	3
ENERGY SPREAD ΔE/E (%)	1,32	
CURRENT (mA)	150	250
EMITTANCE*	5	(3,7) πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 30 m; No. TANKS 1 (RFQ) + 3 (DTL)
TANK DIAM. 0,65 m; No. DRIFT TUBES 119
DRIFT TUBE LENGTHS 67,8 - 236,5
DRIFT TUBE DIAMETERS 100 (DTL1) : 85 (DTL2,3)
GAP/CELL LENGTH 0,17 - 0,29
APERTURE DIAM. DTL 12;16;24 mm to mm

Ion Source

TYPE Cold cathode duoplasmatron
OUTPUT mA at KeV
EMITTANCE* πmm-mrad

Injector

TYPE Pulse transformer
OUTPUT 350 mA at 90 KeV
EMITTANCE* 1,5 πmm-mrad

Bunchers

TYPE One gap (between RFQ and DTL)
MODULATION 200 KeV, DRIFT ℓ 430 mm at 297 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System DTL

RF FREQ. 297 MHz
FIELD MODE E_{010} Q 35000:36000;28000
EQUIL. PHASE 50°- 30° ACCEL. RATE 2,17 MeV/m
REPETITION RATE
DUTY FACTOR % (RF); % (Beam)
PULSE LENGTH μs (RF); μs (Beam)
EFFECTIVE SHUNT IMPEDANCE 26 MΩ/m
FILLING TIME 100 μs
RF POWER INPUT PEAK 13 MW; MEAN MW

Focusing System

No. QUADS 119 TYPE PM ORDER FODO
GRADIENTS 60,0 to 23,6 T/m
OTHER

Vacuum System

MATERIAL CHAMBER Three-ply metal
AVERAGE PRESSURE $1 \cdot 10^{-6}$ torr

Other Relevant Parameters, Recent Improvements, etc.

Acceleration system RFQ

Output energy	3,03 MeV
RF freq.	148,5 MHz
Field mode	H_{211}
Equil. phase	90°-35°
Length	4,7 m
No. cells	156
Potential diff.	185 kV

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF SYNCHROTRON ELSA (Electron Stretcher and Accelerator)
INSTITUTION Bonn University, Physics Institute
LOCATION D - 5300 Bonn 1, Western Germany, Nussallee 12
PERSON IN CHARGE Dirk Husmann DATE: July 1989
DATA SUPPLIED BY Dirk Husmann

HISTORY AND STATUS

CONSTRUCTION STARTED (date) June 1983
FIRST BEAM OBTAINED, or GOAL (date) Febr.1988
TOTAL COST OF FACILITY 18.5 MDM
TOTAL ACCELERATOR STAFF (now) 23
ANN. OPERAT. BUDGET * 3.2 MDM (without salaries)
ANN. OPERATING TIME * 4,500 h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES electrons
ENERGY max. 3.5 GeV
RING DIAM. 52.3 m; TUNNEL SECT. (W x H) 2.5 x 2.3 m

Injector
TYPE 2.5 GeV Synchrotron
OUTPUT(max) 30 mA at 500 - 2,000 MeV
EMITTANCE* πmm-mrad
INJECTION PERIOD 0.548 μs, or 1 turns
INFLECTOR TYPE septum magnet

Magnet System
FOCUSING TYPE AG, sep.fct. FIELD INDEX n =
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 4.65 ν_V 4.60
No. MAGNETS 24 LENGTH (ea) 2.84 m
BENDING FIELD at inj 0.15 - 0.61 T; at max 1.07 T
No. QUADS 32 + 4 LENGTH (ea) 0.45 m
GRAD. at inj. T/m; at max 7.7 T/m
No. SHORT STRAIGHT SECT 24 LENGTH 1.50 m
No. LONG STRAIGHT SECT 8 LENGTH 4.69 m
**RISE TIME 150 ms; FLAT-TOP TIME 500 ms
POWER INPUT PEAK 3.7 MW; MEAN 1.6 MW

Acceleration System (two systems)
No. CAVITIES 2//1 LENGTH(ea) 1.5//0.3 m
HARMONIC NUMBER 274
RF RANGE 500 MHz
ENERGY GAIN 3,000 KeV/turn
RADIATION LOSS 1,225 KeV/turn
RF POWER INPUT PEAK 200 kW; MEAN 200 kW

Vacuum System
MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 100 x 50 mm
AVERAGE PRESSURE 10^{-8} torr

Extraction System
TYPE i) horizontal betatron resonance (ν_H = 14/3)
ii) scattering on Carbon fiber (for low intensity)
iii)
LENGTH OF SPILL i) stretcher: to 19.8×10^3 μs
ii) post accel.: to 500×10^3 μs
iii) to μs

*) Staff and Budget: together for ELSA and injector synchrotron
**) only relevant for post accelerator mode

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE ***

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	3.5	2.0
RESOLUTION ΔE/E (%)	0.1	
REPET. RATE (pulse/s)		
PULSE WIDTH AT PEAK E		
INTERNAL BEAM (part/pulse)		
(part/s)		
EMITTANCE* AT PEAK E	πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

EXPERIMENTAL FACILITY (Medium Energy Nucl. Phys.)

TOTAL EXPERIMENTAL AREAS 1,500 m²
No. INTERNAL TARGETS 0 No. EXT. TARGETS 3
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 1
TOTAL POWER USED (AVERAGE) FOR RESEARCH 2 MW
No. USER GROUPS, in house 3 outside
TOTAL RESEARCH STAFF, in house 50 outside
ANN. RESEARCH BUDGET, in house 1.1 MDM (without sal.)
ANNUAL RESEARCH TIME 3,700 h

Other Relevant Parameters, Recent Improvements, etc.

***) ELSA is operated in three different modes:
1.) Stretcher
2.) Post Accelerator
3.) Storage Ring (dedicated SR source)
Further information: Proceedings of EPAC I, Rome 1988, vol. 1, page 356

NAME OF SYNCHROTRON 2.5 GeV Electron Synchrotron
INJECTOR FOR ELSA (Electron Stretcher and Accelerator)
LOCATION D - 5300 Bonn 1, Western Germany, Nussallee 12
PERSON IN CHARGE Dirk Husmann DATE: July 1989
DATA SUPPLIED BY Dirk Husmann

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1965
FIRST BEAM OBTAINED, or GOAL (date) March 1967
TOTAL COST OF FACILITY 12.3 MDM
TOTAL ACCELERATOR STAFF (now) * 23
ANN. OPERAT. BUDGET * 3.2 MDM (without salaries)
ANN. OPERATING TIME 5,000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES electrons
ENERGY now: 0.5 - 2.0 GeV
RING DIAM 22.15 m; TUNNEL SECT. (W x H) 3.5 x 2.2 m

Injector

TYPE linac
OUTPUT (max) 500 mA at 21 MeV
EMITTANCE* 3 πmm-mrad
INJECTION PERIOD 1.0 μs, or 5 turns
INFLECTOR TYPE septum magnet

Magnet System

FOCUSING TYPE AG, com.fct FIELD INDEX n = +23.26 / -22.26
FOCUSING ORDER OFDO
BETATRON FREQ. ν_H 3.4 ν_V 3.4
No. MAGNETS 12 LENGTH (ea) 4.005 m
BENDING FIELD at inj. 0.009 T; at max 0.87 T
No. QUADS - LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 12 LENGTH 1.80 m
No. LONG STRAIGHT SECT. - LENGTH m
RISE TIME 8.8 ms; FLAT-TOP TIME sinus s
POWER INPUT PEAK MW; MEAN 0.55 MW

Acceleration System

No. CAVITIES 1 LENGTH (ea) 0.90 m
HARMONIC NUMBER 116
RF RANGE to 499.67 MHz
ENERGY GAIN max. 500 KeV/turn
RADIATION LOSS at 2 GeV: 186 KeV/turn
RF POWER INPUT PEAK 100 kW; MEAN 40 kW

Vacuum System

MATERIAL OF VAC. CHAMBER porcelain and Al_2O_3
APERTURE OF VAC. CHAMBER 125 x 42 mm
AVERAGE PRESSURE 5×10^{-7} torr

Extraction System

TYPE fast extraction: shaving method
LENGTH OF SPILL 0.230 to 0.600 μs

*) Budget and Staff: together for injector synchrotron and ELSA

ACCELERATOR PERFORMANCE

(after conversion to injector synchrotron)

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	0.5 - 2.0	
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)	50	
PULSE WIDTH AT PEAK E	0.23 - 0.60 μs	
INTERNAL BEAM (part/pulse)	5×10^{10}	
(part/s)	2.5×10^{12}	
BEAM EMITTANCE *	πmm-mrad	
BEAM LINES TO	ELSA	

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON 1.3 GeV Electron Synchrotron (INS-ES)
INSTITUTION Institute for Nuclear Study, University of Tokyo
LOCATION Midori-cho, Tanashi-shi, Tokyo 188, Japan
PERSON IN CHARGE K. Yoshida DATE: June, 1989
DATA SUPPLIED BY K. Yoshida

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1957
FIRST BEAM OBTAINED, or GOAL (date) 1961
TOTAL COST OF FACILITY ∿ $10M
TOTAL ACCELERATOR STAFF (now) 10
ANN. OPERAT. BUDGET ∿ $0.5M (without salaries)
ANN. OPERATING TIME 3,000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Electron
ENERGY 1.3 GeV
RING DIAM. 11.06 m; TUNNEL SECT. (W x H) m

Injector

TYPE Linac
OUTPUT(max) 150 mA at 15 MeV
EMITTANCE* ∿1 πmm-mrad
INJECTION PERIOD 1.2 μs, or 10 turns
INFLECTOR TYPE Electric Pulser

Magnet System

FOCUSING TYPE A.G. FIELD INDEX n = 14.8
FOCUSING ORDER 1/2 0• 1/2F•D•1/2F•1/2 0
BETATRON FREQ. ν_H 2.25 ν_V 2.25
No. MAGNETS 8 LENGTH (ea) 3.14 m
BENDING FIELD at inj 0.0125 T; at max 1.08 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT 8 LENGTH 1.2 m
No. LONG STRAIGHT SECT LENGTH m
RISE TIME 20m s; FLAT-TOP TIME s
POWER INPUT PEAK 0.9 MW; MEAN 0.45 MW

Acceleration System

No. CAVITIES 1 LENGTH(ea) 0.3 m
HARMONIC NUMBER 16
RF RANGE 138 MHz(Fixed) to MHz
ENERGY GAIN 10 KeV/turn
RADIATION LOSS 63 KeV/turn
RF POWER INPUT PEAK 20 kW; MEAN 4 ∿ 5 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Welded stainless-steel bellows
APERTURE OF VAC. CHAMBER 33 mm
AVERAGE PRESSURE 1×10^{-7} torr

Extraction System

TYPE i) Slow extraction system of Piccioni method
ii) Internal radiator
iii) Fast extraction system for storage ring
LENGTH OF SPILL i) 10msec(max.) to μs
ii) 10msec(max.) to μs
iii) 60nsec to μs

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.3	1.27
RESOLUTION ΔE/E (%)	0.1	0.1
REPET. RATE (pulse/s)	21.5	21.5
PULSE WIDTH AT PEAK E	sinusoidal	
INTERNAL BEAM (part/pulse)	5×10^{10}	1×10^{11}
(part/s)	1×10^{12}	2×10^{12}
EMITTANCE* AT PEAK E		πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
Tagged γ	≤1.100MeV		

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 1,000 m²
No. INTERNAL TARGETS 3 No. EXT. TARGETS 1
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 4
TOTAL POWER USED (AVERAGE) FOR RESEARCH 0.7 MW
No. USER GROUPS, in house 2 outside 5
TOTAL RESEARCH STAFF, in house 5 outside 50
ANN. RESEARCH BUDGET, in house ∿ $0.5M (without sal.)
ANNUAL RESEARCH TIME 3,000 h

Other Relevant Parameters, Recent Improvements, etc.

The synchrotron works also as a injector of 400 MeV storage ring for synchrotron radiation utilization.
The duty cycle of extracted electron beam (and also of the tagged γ beam) has been extended to be 20% at maximum.

NAME OF SYNCHROTRON Cornell Electron Synchrotron
INSTITUTION Laboratory of Nuclear Studies, Cornell University
LOCATION Ithaca, NY, USA
PERSON IN CHARGE David Rice DATE: July, 1989
DATA SUPPLIED BY David Rice

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1965
FIRST BEAM OBTAINED, or GOAL (date) May 1967
TOTAL COST OF FACILITY $11.5 Million
TOTAL ACCELERATOR STAFF (now) 60 **
ANN. OPERAT. BUDGET $3.5 M ** (without salaries)
ANN. OPERATING TIME 6000 ** h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES e^-, e^+
ENERGY 4-12 GeV
RING DIAM. 240 m; TUNNEL SECT. (W × H) 3 x 2.4 m

Injector
TYPE TW linac 2856 MHz
OUTPUT(max) 100 mA at 300 MeV
EMITTANCE* 6 πmm-mrad
INJECTION PERIOD 2.5 μs, or 1 turns
INFLECTOR TYPE magnetic

Magnet System
FOCUSING TYPE AG FIELD INDEX n = 437
FOCUSING ORDER FDDF
BETATRON FREQ. ν_H 10.7 ν_V 10.8
No. MAGNETS 192 LENGTH (ea) 3.4 m
BENDING FIELD at inj 0.01 T; at max 0.4 T
No. QUADS (comb. func) LENGTH (ea) --- m
GRAD. at inj. --- T/m; at max --- T/m
No. SHORT STRAIGHT SECT 4 LENGTH 6.1 m
No. LONG STRAIGHT SECT 2 LENGTH 12.2 m
RISE TIME .008 s; FLAT-TOP TIME 60 Hz sine wave s
POWER INPUT PEAK MW; MEAN 1.1 MW

Acceleration System
No. CAVITIES 5 LENGTH(ea) 5 m
HARMONIC NUMBER 1800
RF RANGE --- to 713.94 MHz
ENERGY GAIN 6000 KeV/turn
RADIATION LOSS 8800 KeV/turn
RF POWER INPUT PEAK 500 kW; MEAN 120 kW

Vacuum System
MATERIAL OF VAC.CHAMBER s.s. (magnets internal)
APERTURE OF VAC. CHAMBER magnets 50 x 25 mm
AVERAGE PRESSURE 10^{-5} torr

Extraction System
TYPE i) single turn
ii) resonant
iii)
LENGTH OF SPILL i) 1 bunch to μs
ii) 30 to 3000 μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	12	12.2
RESOLUTION ΔE/E (%)	0.5	0.5
REPET. RATE (pulse/s)	60	60
PULSE WIDTH AT PEAK E	2 mS	2 mS
INTERNAL BEAM (part/pulse)	10^{11}	3×10^{10}
(part/s)		
EMITTANCE* AT PEAK E	0.1	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS N.A. ** m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

** Synchrotron is used as injector for Cornell Electron Storage Ring only. Operating figures are for complete accelerator facility. Present operation: 4.5-6 GeV, 14 bunches, single turn extraction.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Syrius (Electron Synchrotron)
INSTITUTION Institute for Nuclear Physics, Polytechnical Institute of Tomsk
LOCATION USSR, Tomsk
PERSON IN CHARGE J.P.Usov, Dir. DATE: July, 1989
DATA SUPPLIED BY N.A.Lashuk

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1958
FIRST BEAM OBTAINED, or GOAL (date) 1965
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 3000 h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES electron
ENERGY 1,3 GeV
RING DIAM. 10,47 m; TUNNEL SECT. (W x H) m

Injector
TYPE Microtron
OUTPUT(max) 80 mA at 6,4 MeV
EMITTANCE* $6,3 \times 1,6\ 10^{-3}$ πmm-mrad
INJECTION PERIOD 5 μs, or 50 turns
INFLECTOR TYPE electrostatic

Magnet System
FOCUSING TYPE weak FIELD INDEX n = 0,58
FOCUSING ORDER
BETATRON FREQ. ν_H 0,72 ν_V 0,85
No. MAGNETS 4 LENGTH (ea) 6,65 m
BENDING FIELD at inj 53 10 T; at max 1,02 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT LENGTH m
No. LONG STRAIGHT SECT 4 LENGTH 6,28 m
RISE TIME 0,04 s; FLAT-TOP TIME 0,02 s
POWER INPUT PEAK MW; MEAN MW

Acceleration System
No. CAVITIES 1 LENGTH(ea) m
HARMONIC NUMBER 4
RF RANGE to 36,5 MHz
ENERGY GAIN 3,25 KeV/turn
RADIATION LOSS 65 KeV/turn
RF POWER INPUT PEAK 80 kW; MEAN 2,5 kW

Vacuum System
MATERIAL OF VAC.CHAMBER porcelain
APERTURE OF VAC. CHAMBER 200x94 mm
AVERAGE PRESSURE $1\ 10^{-6}$ torr

Extraction System
TYPE i) Septum-magnet
ii)
iii)
LENGTH OF SPILL i) to μs
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1,0	1,3
RESOLUTION ΔE/E (%)	0,1	
REPET. RATE (pulse/s)	10	
PULSE WIDTH AT PEAK E	20 ms	
INTERNAL BEAM (part/pulse)	$5\ 10^{10}$	
(part/s)	$2,5\ 10^{11}$	$5\ 10^{11}$
EMITTANCE* AT PEAK E		πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
pol. I		1	diamond
tagged		1	
synch.rad.		3	
-pol.II			

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 500 m²
No. INTERNAL TARGETS 3 No. EXT. TARGETS
No. SEPARATED BEAMS 3
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house 5 outside 1
TOTAL RESEARCH STAFF, in house 50 outside 5
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Yerevan 6-GeV Electron Synchrotron (ARUS)
INSTITUTION Yerevan Physics Institute
LOCATION Yerevan, Armenia, USSR
PERSON IN CHARGE A.Ts. Amatuni, Director DATE: june 1989
DATA SUPPLIED BY V.Ts. Nickogossian, Head of Accelerator

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1962
FIRST BEAM OBTAINED, or GOAL (date) 25.10.67.
TOTAL COST OF FACILITY 14.3 Mill. Rb.
TOTAL ACCELERATOR STAFF (now) 96
ANN. OPERAT. BUDGET 3.5 Mill. Rb. (without salaries)
ANN. OPERATING TIME 5000 h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES e^-
ENERGY 6 GeV
RING DIAM. 68.98 m; TUNNEL SECT. (W x H) 6.8x7.5 m

Injector
TYPE linac
OUTPUT(max) 210 mA at 75 MeV
EMITTANCE* 5(horiz.) 2(vert.) πmm-mrad
INJECTION PERIOD 1 μs, or 1 turns
INFLECTOR TYPE pulsed electrostatic 68 kV

Magnet System
FOCUSING TYPE AG FIELD INDEX n = 114.76
FOCUSING ORDER FOFDOD
BETATRON FREQ. ν_H 5.31 ν_V 5.32
No. MAGNETS 48 LENGTH (ea) 3.21 m
BENDING FIELD at inj 0.01 T; at max 0.795 T
No. QUADS 6 LENGTH (ea) 0.15 m
GRAD. at inj. T/m; at max 23.34 T/m
No. SHORT STRAIGHT SECT 24 LENGTH 1.29 m
No. LONG STRAIGHT SECT 24 LENGTH 1.328 m
RISE TIME 9.3 ms; FLAT-TOP TIME 4 ms
POWER INPUT PEAK – MW; MEAN 1.9 MW

Acceleration System
No. CAVITIES 23 LENGTH(ea) 0.7 m
HARMONIC NUMBER 96
RF RANGE CW to 132.8 MHz
ENERGY GAIN 720 KeV/turn
RADIATION LOSS 4500 KeV/turn
RF POWER INPUT PEAK 520 kW; MEAN 70 kW

Vacuum System
MATERIAL OF VAC.CHAMBER ceramic
APERTURE OF VAC. CHAMBER 42 x 120 mm
AVERAGE PRESSURE 10^{-6} torr

Extraction System
TYPE i) quad.-sext.-beam bump-septums for exp. hall
ii)
iii)
LENGTH OF SPILL i) 1000 to 3000 μs
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal* (or Goal)	Maximum ** achieved
ENERGY (GeV)	4.5	6.1
RESOLUTION ΔE/E (%)	0.25	9.1
REPET. RATE (pulse/s)	50	50
PULSE WIDTH AT PEAK E	4 ms	3ms
INTERNAL BEAM (part/pulse)	1×10^{11}	
(part/s)	5×10^{12}	
EMITTANCE* AT PEAK E		πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
e^-		1	internal target
γ		2	internal target
γ		1	polarized
synchr.	radiation	3	***

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 2600 m²
No. INTERNAL TARGETS 3 No. EXT. TARGETS 2
No. SEPARATED BEAMS 2 e^- 3 γ
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house 19 outside 6
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house 8 Mill. Rb. (without sal.)
ANNUAL RESEARCH TIME 4800 h

Other Relevant Parameters, Recent Improvements, etc.

* with flat-top
** without flat-top
***parameters of synchrotron radiation:
500 - 2500 Å VUV Intens.- 10^9 fotons/s Å
50 - 500 Å soft X-ray - 10^9 fotons/s Å
5 - 50 Å Lithography
0.4 - 1.5 Å EXAFS

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF ELECTRON LINEAR ACCELERATOR The 1.1/1.4 GeV Electron Positron Linac
INSTITUTION Institute of High Energy Physics
LOCATION Beijing, China
PERSON IN CHARGE ZHOU Shu DATE: June, 1989
DATA SUPPLIED BY ZHOU Shu

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April, 1984
FIRST BEAM OBTAINED, or GOAL (date) Dec. 1987
TOTAL COST OF FACILITY $ 8 million
TOTAL ACCELERATOR STAFF (now) 40
ANN. OPERAT. BUDGET $ 1.5 million (without salaries)
ANN. OPERATING TIME 5700 h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH 202 m
TUNNEL SIZE (L x W x H) 215 x 3.5 x 3 m

Injector

TYPE Travelling wave linac
OUTPUT 500 mA - 3 A mA at 30 MeV
BEAM EMITTANCE / πmm-mrad
INJECTION PERIOD 0.0025 μs, 12.5 RF cycles

Acceleration System

No. SECTIONS 56 LENGTH(ea) 3.05 m
FIELD MODE 2/3 π mode FREQUENCY 2856 MHz
GROUP VELOCITY 0.0208-0.0070 c; PHASE VEL. 1 c
WAVE TYPE TM_{010} FILLING TIME 0.83 μs
SHUNT IMPEDANCE 53 MΩ/m
ATTENUATION 0.19 Np/m
IRIS, APERTURE 26.231-19.243 mm, THICKNESS 6 mm
IRIS SPACING 34.99 mm
Q 14000
POWER UNITS, No. 16 TYPE klystron amplifier
POWER RATING 16-22 MW/unit
FEED SPACING 3 m
RF POWER INPUT PEAK 272 MW; MEAN 0.01 MW

Focusing System

TYPE, No. of LENSES and SPACING Solenoid and triplets
The ubhection solenoid with a length of 3 meters long, positron source solenoid with a length of 9 meters long, and 15 sets of triplet with variable spacing in between them

Vacuum System

MATERIAL OF VAC.CHAMBER oxygen free copper or s.s.
APERTURE OF VAC. CHAMBER 20 mm
AVERAGE PRESSURE 5×10^{-8} torr

Other Relevant Parameters, Recent Improvements, etc.

ACCELERATOR PERFORMANCE

Electrons	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.1/1.4	1.1/1.5
ENERGY GAIN (MeV/m)	8 - 10	9
RESOLUTION ΔE/E (%)	± 0.6%	± 0.6%
REPET. RATE (pulse/s)	7 - 14	12.5
PULSE WIDTH (μs)	0.0025	0.0025
DUTY FACTOR, macroscopic (%)	3×10^{-8}	3×10^{-8}
BEAM CURRENT (μA)	2×10^{5}	1×10^{6}
BEAM EMITTANCE (πmm·mrad)	/	0.15
Positrons		
ENERGY (GeV)	1.1/1.4	1.3
ENERGY GAIN (MeV/m)	8 - 10	9
RESOLUTION ΔE/E (%)	1%	1%
REPET. RATE (pulse/s)	7 - 14	12.5
PULSE WIDTH (μs)	0.0025	0.0025
DUTY FACTOR, macroscopic (%)	3×10^{-8}	3×10^{-8}
BEAM CURRENT (μA)	4×10^{3}	6×10^{3}
BEAM EMITTANCE (πmm·mrad)	2	1.6

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
π, K mesons			2

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANN. RESEARCH TIME h

NAME OF ELECTRON LINEAR ACCELERATOR KEK Photon Factory 2.5 GeV Electron Linac
INSTITUTION National Laboratory for High Energy Physics
LOCATION 1-1, Oho, Tsukuba-shi, Ibaraki-ken, 305 JAPAN
PERSON IN CHARGE Akira Asami DATE: August 1, 1989
DATA SUPPLIED BY Akira Asami

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1, 1978
FIRST BEAM OBTAINED, or GOAL (date) Feb., 1982
TOTAL COST OF FACILITY 7000 M¥
TOTAL ACCELERATOR STAFF (now) 25
ANN. OPERAT. BUDGET 668 M¥ (without salaries)
ANN. OPERATING TIME 5,100 (in 1988) h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH 415 m
TUNNEL SIZE (L × W × H) 400 × 5 × 3 m

Injector

TYPE Gun, PB, B, 2 × 2 m Acc. guides
OUTPUT 50 mA at 35 MeV
BEAM EMITTANCE 1.5 πmm-mrad
INJECTION PERIOD 2 ns ∿ 2 μs, 25 ~~RF cycles~~ pps

Acceleration System

No. SECTIONS 160 LENGTH(ea) 1.9 m
FIELD MODE 2/3 π FREQUENCY 2856 MHz
GROUP VELOCITY 0.019 ∿ 0.0083 c; PHASE VEL. 1 c
WAVE TYPE T.W. Const. grad. FILLING TIME 0.46 ∿ 0.56 μs
SHUNT IMPEDANCE 55.4 ∿ 60.3 MΩ/m
ATTENUATION 0.12 ∿ 0.29 Np/m
IRIS, APERTURE 24 ∿ 19.5 mm, THICKNESS 5 mm
IRIS SPACING 35 mm
Q > 13,000
POWER UNITS, No. 40 TYPE Klystron
POWER RATING 30 MW/unit
FEED SPACING ∿ 10 m
RF POWER INPUT PEAK 1200 MW; MEAN 0.09 MW

Focusing System

TYPE, No. of LENSES and SPACING Quadrupole triplets, 28 triplets, ∿ 10 m interval in the first fifth, ∿ 20 m interval in the remainder of acceletator.

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 57, 40 mm
AVERAGE PRESSURE < 10^{-7} torr

Other Relevant Parameters, Recent Improvements, etc.

ACCELERATOR PERFORMANCE

Electrons	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	2.5	3.0
ENERGY GAIN (MeV/m)	8.22	9.87
RESOLUTION ΔE/E (%)	≲ 0.7	
REPET. RATE (pulse/s)	25	
PULSE WIDTH (μs)	∿0.8, 0.002	
DUTY FACTOR, macroscopic (%)	0.002, 0.000005	
BEAM CURRENT (μA)	50, 250	
BEAM EMITTANCE (πmm·mrad)		
Positrons		
ENERGY (GeV)	2.5	
ENERGY GAIN (MeV/m)	8.22	
RESOLUTION ΔE/E (%)	∿ 0.5	
REPET. RATE (pulse/s)	25	
PULSE WIDTH (μs)	0.04, 0.002	
DUTY FACTOR, macroscopic (%)		
BEAM CURRENT (μA)	2, 15	
BEAM EMITTANCE (πmm·mrad)	∿ 0.6	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANN. RESEARCH TIME h

NAME OF ELECTRON LINEAR ACCELERATOR PLS 2.0 GeV Electron Linac Injector System
INSTITUTION Pohang Light Source, POSTECH, KOREA
LOCATION Pohang, KOREA
PERSON IN CHARGE Saewoong Oh DATE: June 21, 1989
DATA SUPPLIED BY Soo Yong Park

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1989.4.1 (project started)
FIRST BEAM OBTAINED, or GOAL (date) 1993.1.1
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH 220 m
TUNNEL SIZE (L x W x H) 250×3.5×3.0 m

Injector

TYPE Linac
OUTPUT 100 mA at 80 MeV
BEAM EMITTANCE 1.25 πmm-mrad
INJECTION PERIOD 0.0025 μs, 2856 RF cycles

Acceleration System

No. SECTIONS 58 LENGTH(ea) 3.05 m
FIELD MODE TM01 FREQUENCY 2856 MHz
GROUP VELOCITY 0.0204 → 0.0065 c; PHASE VEL. 1.0 c
WAVE TYPE TRAVELING FILLING TIME 0.83 μs
SHUNT IMPEDANCE 53 MΩ/m
ATTENUATION 0.57 Np/m
IRIS, APERTURE 26.2 → 19.1 mm, THICKNESS 5.84 mm
IRIS SPACING 35.014 mm
Q 130.000
POWER UNITS, No. 16 TYPE Klystron
POWER RATING 65 MW/unit
FEED SPACING 3. m
RF POWER INPUT PEAK 45 MW; MEAN 0.04 MW

Focusing System

TYPE, No. of LENSES and SPACING Triplet, 18
Spacing varies

Vacuum System

MATERIAL OF VAC.CHAMBER
APERTURE OF VAC. CHAMBER mm
AVERAGE PRESSURE torr

Other Relevant Parameters, Recent Improvements, etc.

ACCELERATOR PERFORMANCE

Electrons	Normal (or Goal)	Maximum achieved
ENERGY (GeV)		
ENERGY GAIN (MeV/m)		
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)		
PULSE WIDTH (μs)		
DUTY FACTOR, macroscopic (%)		
BEAM CURRENT (μA)		
BEAM EMITTANCE (πmm·mrad)		
Positrons		
ENERGY (GeV)		
ENERGY GAIN (MeV/m)		
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)		
PULSE WIDTH (μs)		
DUTY FACTOR, macroscopic (%)		
BEAM CURRENT (μA)		
BEAM EMITTANCE (πmm·mrad)		

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANN. RESEARCH TIME h

NAME OF ELECTRON LINEAR ACCELERATOR CEBAF Superconducting Linac
INSTITUTION SURA/CEBAF
LOCATION NEWPORT NEWS, VA
PERSON IN CHARGE Christoph Leemann, Director of Operations DATE: June 30, 1989
DATA SUPPLIED BY CEBAF Accelerator Division Staff

HISTORY AND STATUS

CONSTRUCTION STARTED (date) February 1987
FIRST BEAM OBTAINED, or GOAL (date) Injector 1990, Full Energy 194
TOTAL COST OF FACILITY $265M
TOTAL ACCELERATOR STAFF (now) ~170
ANN. OPERAT. BUDGET 50M$ 1) (without salaries)
ANN. OPERATING TIME TBD h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH (active superconducting) 160 m
TUNNEL SIZE (L x W x H) racetrack 1460 x 4 x 3 m

Injector

TYPE Thermionic gun;1 rm temp. + 18 superconducting accel. sections
OUTPUT 0.200 mA at 45 MeV
BEAM EMITTANCE < 0.044 πmm-mrad
INJECTION PERIOD CW

Acceleration System

No. SECTIONS 318 Supercond LENGTH(ea) (active) 0.5 m
FIELD MODE 5 cell π FREQUENCY 1497 MHz
GROUP VELOCITY Standing wave c; PHASE VEL. ---- c
WAVE TYPE TM01 FILLING TIME 1400 μs
SHUNT IMPEDANCE 2300 MΩ/m
ATTENUATION ------- Np/m
IRIS, APERTURE diameter 70 mm, THICKNESS ----- mm
IRIS SPACING ---------- mm
Q 2.4 10^9
POWER UNITS, No. 318 TYPE Klystron
POWER RATING 0.005 CW MW/unit
FEED SPACING ------ m
RF POWER INPUT PEAK ---- MW; MEAN ---- MW

Focusing System

TYPE, No. of LENSES and SPACING Nine isochronous
Second-order pseudo-achromatic FODO
Transport beamlines for 5 passes

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless Steel
APERTURE OF VAC. CHAMBER >20 mm
AVERAGE PRESSURE $\leq 10^{-6}$ warm regions torr
$\leq 10^{-10}$ cold regions

ACCELERATOR PERFORMANCE

Electrons	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	4	
ENERGY GAIN (MeV/m)	5	
RESOLUTION ΔE/E (%)	0.01 FW	
REPET. RATE (pulse/s)	CW	
PULSE WIDTH (μs)	----	
DUTY FACTOR, macroscopic (%)	100	
BEAM CURRENT (μA)	200	
BEAM EMITTANCE (πmm·mrad)	210^{-3}	

Positrons		
ENERGY (GeV)		
ENERGY GAIN (MeV/m)		
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)		
PULSE WIDTH (μs)		
DUTY FACTOR, macroscopic (%)		
BEAM CURRENT (μA)		
BEAM EMITTANCE (πmm·mrad)		

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 3 experimental halls
No. INTERNAL TARGETS 0 No. EXT. TARGETS 3
No. SEPARATED BEAMS NA
No. BEAMS SERVED AT SAME TIME 3
TOTAL POWER USED (AVERAGE) FOR RESEARCH ~30 2) MW
No. USER GROUPS, in house TBD outside TBD
TOTAL RESEARCH STAFF, in house TBD outside
ANN. RESEARCH BUDGET, in house 50M$ 1) (without sal.)
ANN. RESEARCH TIME TBD h

Other Relevant Parameters, Recent Improvements, etc.

CEBAF is a superconducting cw, standing wave recirculating linac.
Its major components are a 45 MeV injector, two 400 MeV superconducting linac segments, and recirculation arcs connecting the two linac segments.

1) Total projected operating expense in 1995 (accelerator ops, research, and administration, including salaries).
2) Total power use, accelerator and experimental equipment.

NAME OF ELECTRON LINEAR ACCELERATOR SLAC Three-Kilometer-Long Linear Accelerator (Also see under Linear Colliders)

INSTITUTION Stanford Linear Accelerator Center (SLAC)

LOCATION Stanford, California 94309 USA

PERSON IN CHARGE Burton Richter DATE: June 1989

DATA SUPPLIED BY Gregory A. Loew

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1962
FIRST BEAM OBTAINED, or GOAL (date) May 21, 1966
TOTAL COST OF FACILITY $114 M
TOTAL Laboratory STAFF (now) Approximately 1,400
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH 3050 m
TUNNEL SIZE (L x W x H) 3050 × 3.05 × 3.35 m

Injector[1]

TYPE(s) Linacs with thermionic and polarized guns
OUTPUT See below, note 1. mA at MeV
BEAM EMITTANCE nmm-mrad
INJECTION PERIOD μs, RF cycles

Acceleration System

No. SECTIONS 932 LENGTH(ea) 3.05 m
FIELD MODE 2π/3 FREQUENCY 2856 MHz
GROUP VELOCITY 0.02 - 0.0065 c; PHASE VEL. 1.0 c
WAVE TYPE TM_{01} FILLING TIME 0.83 μs
SHUNT IMPEDANCE 57 MΩ/m
ATTENUATION 0.19 Np/m
IRIS, APERTURE 26 - 19 mm, THICKNESS 5.84 mm
IRIS SPACING 35 mm
Q 13,000
POWER UNITS, No. 247 TYPE Klystrons
POWER RATING 65 MW/unit
FEED SPACING 3.05 m; each klystron feeds 4 sections
RF POWER INPUT PEAK 16,000 MW; MEAN 7 at 120 pps MW

Focusing System

TYPE, No. of LENSES and SPACING Quad FODO Array
Quad Spacing: 3 m to 200 m point, 6 m to 400 m point, 12 m to 3000 m point

Vacuum System

MATERIAL OF VAC.CHAMBER Cu and SS
APERTURE OF VAC. CHAMBER 17 mm
AVERAGE PRESSURE 1×10^{-8} torr

ACCELERATOR PERFORMANCE

Electrons	Possible[2]	Non-SLC[2] maximum achieved
ENERGY (GeV)	35/56	See Note 3
ENERGY GAIN (MeV/m)	12.5/20	~10
RESOLUTION ΔE/E (%)	<1	0.1 (min)
REPET. RATE (pulse/s)	120	120
PULSE WIDTH (μs)	2.7/0.1	1.6/0.1
DUTY FACTOR, macroscopic (%)	0.03/0.001	0.03/0.001
BEAM CURRENT, peak (mA)	50/200	50/100
BEAM EMITTANCE (πmm·mrad)(inv)	400	400

Positrons	SLC e^+ source	Old e^+ source[4]
ENERGY (GeV)	35/56	15
ENERGY GAIN (MeV/m)	12.5/20	~8
RESOLUTION ΔE/E (%)	<1	1.0
REPET. RATE (pulse/s)	60 (120 goal)	120
PULSE WIDTH (μs)	single bunches	1.6
DUTY FACTOR, macroscopic (%)		0.02
BEAM CURRENT	$2 \times 10^{10} e^+$	5 mA peak
BEAM EMITTANCE (πmm·mrad) (inv)		4000

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$K^\pm$	1-16 GeV/c	1	10/pulse
P	1-16 GeV/c	1	40/pulse
$\bar{P}$	1-16 GeV/c	1	6/pulse
$\pi^\pm$	1-16 GeV/c	1	10^3/pulse
e^+	1-25 GeV/c	1	1/pulse
γ Brems.	0-21.5 GeV/c	1	4×10^9 Eq.

RESEARCH PROGRAMME (Other than SLC and PEP)

TOTAL EXPERIMENTAL AREAS 2650 m²
No. INTERNAL TARGETS -- No. EXT. TARGETS 3
No. SEPARATED BEAMS 1 (Presently not operational)
No. BEAMS SERVED AT SAME TIME 4 possible (other than SLC)
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS, in house 1 outside 8
TOTAL RESEARCH STAFF, in house 42 outside 183
ANN. RESEARCH BUDGET, in house (without sal.)
ANN. RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

1. There are presently two injectors on the linac: one at the front end and one at Sector 25, approximately 600 m from the end. The first injector is used predominantly for the SLC and to fill SPEAR and PEP with single bunches of electrons and positrons. This injector can produce single or pairs of bunches with up to 10^{11} electrons/bunch (~16 nC) at 40 MeV with an invariant emittance of 300 πmm·mrad at 120 pulses per second. In the near future it will also have a photocathode gun capable of producing longitudinally polarized electrons of similar characteristics. The second injector at Sector 25 is used predominantly to fill SPEAR for SSRL (e^- only) and for medium energy nuclear physics experiments (up to ~5 GeV). This injector can produce trains of bunches (from 2 to 2700 ns) with a peak current of up to 100 mA, an energy of 35 MeV, an invariant emittance of approximately 100 πmm·mrad, a pulse length of up to 2.7 μsec, and 120 pulses per second.
2. The first number refers to the "non-SLED" mode in which the SLED cavities are detuned, the second to the "SLED" mode in which the cavities are tuned. The SLED energy gain is ~1.6. The maximum energy actually achieved with the SLC at the end of the linac is approximately 53 GeV.
3. The non-SLC energies for electrons are limited by the present capabilities of the End-station A line (25 GeV) and the End-station B line (32 GeV).
4. This positron source, located at the 1000-meter point, is not presently in operation.

Published Articles Describing Machine:

a) R. B. Neal (ed.), *"The Stanford Two-Mile Accelerator,"* W. A. Benjamin, Inc., 1968.

b) Z. D. Farkas, H. A. Hogg, G. A. Loew and P. B. Wilson, "Recent Progress on SLED, The SLAC Energy Doubler," Proceedings of the 1975 Particle Accelerator Conference, Washington, D.C., March 12-14, 1975. SLAC-PUB-1561, March 1975.

NAME OF MACHINE TRIUMF Cyclotron
INSTITUTION TRIUMF (Universities of Alberta, B.C., Simon Fraser and Victoria)
LOCATION 4004 Wesbrook Mall, Vancouver, B.C., CANADA V6T 2A3
PERSON IN CHARGE E.W. Vogt DATE: August 8, 1989
DATA SUPPLIED BY D.R. Pearce

HISTORY AND STATUS

CONSTRUCTION STARTED (date) January 1970
FIRST BEAM OBTAINED, (date) December 1974
TOTAL COST OF FACILITY $60M Can. (1989)
TOTAL ACCELERATOR STAFF (now) 110
ANN. OPERAT. BUDGET $8M Can. (without salaries)
ANN. OPERATING TIME 5,500 h

ACCELERATOR PARAMETERS

Ion Source

INTERNAL
EXTERNAL H^- Ehler, CUSP and Lamb Shift Polarized Sources

Magnet

POLE FACE DIAM. 34.34 m; R ext 7.8 m
GAP, min 52.8 mm; FIELD 5.8 T
max mm; FIELD 2.0 T at 0.72×10^6 AT
AVE FIELD at R max 4.6 T
AVF SECTORS 6
TOTAL POWER 1.338 MW

Acceleration System

No. DEES 2, WIDTH 16.25 m
HARMONIC NUMBER 5
RF RANGE 23.055 MHz
ENERGY GAIN 340 KeV/turn
RF POWER INPUT PEAK 110 MW; MEAN MW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
AVERAGE PRESSURE 5×10^{-8} torr

Extraction System

TYPE Electron stripping in carbon foil

* includes experimental facilities
** includes 4 funding universities

ACCELERATOR PERFORMANCE-EXTERNAL P-BEAM

	Normal	Maximum achieved
ENERGY (MeV)	70-110,183-520 MeV	
CURRENT (μA)	150	400 @ 50% duty factor
RESOLUTION ΔE/E (%)	0.2	0.1
REPET. RATE (pulse/s)	23×10^6	
DUTY FACTOR, macroscopic (%)	99	99
EMITTANCE* AT PEAK E	0.3	nmm-mrad

OTHER DATA 3 beams simultaneously extracted with a split ratio down to 10^{-5}

SECONDARY BEAMS

Particle	Energy range	No. of beams	Other inform.
μ	surface	2	
μ	20-80 MeV/c	2	
μ	70-80 MeV/c	1	RF separator
π	18-100 MeV/c	1	
π	180 MeV/c	1	biomedical
π	80-300 MeV/c	1	
n	180-480 MeV	1	polarized

rates up to 8×10^6 particle/sec at nominal currents

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 2350 m^2
No. INTERNAL TARGETS – No. EXT. TARGETS 12
No. SEPARATED BEAMS 18
No. BEAMS SERVED AT SAME TIME 10
TOTAL POWER USED (AVERAGE) FOR RESEARCH 2 MW
No. USERS , inhouse 205** outside 377
TOTAL RESEARCH STAFF, in house 50 outside
ANN. RESEARCH BUDGET, in house $4.64 Can. (without sal.)
ANNUAL RESEARCH TIME 5,000 h

Other Relevant Parameters, Recent Improvements, etc.

Superconducting muon channel

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF MACHINE: PSI 590 MeV Ring Cyclotron
INSTITUTION: PSI, Paul Scherrer Institute
LOCATION: CH-5232 Villigen PSI Switzerland
PERSON IN CHARGE: Dr. Urs Schryber DATE: 07/27/89
DATA SUPPLIED BY: Dr. Urs Schryber

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1969/1974
FIRST BEAM OBTAINED, (date): 01/18/1974
TOTAL COST OF FACILITY: 134 MSFR (1975)
TOTAL ACCELERATOR STAFF (now): 70
ANN. OPERAT. BUDGET: 5 MSFR (without salaries)
ANN. OPERATING TIME: 5,000 h

ACCELERATOR PARAMETERS

Ion Source Injection from 72 MeV
INTERNAL: Cyclotron into the 590 MeV ring*
EXTERNAL:

Magnet
POLE FACE DIAM. 9.20 m; R ext 4.45 m
GAP, min 50 mm; FIELD 2.09 T
max 90 mm; FIELD 1.50 T at 150,000 AT
AVE FIELD at R max 0.87 T
AVF SECTORS 8
TOTAL POWER 0.65 MW

Acceleration System
No. DEES 4 cavities, WIDTH 45 cm
HARMONIC NUMBER 6
RF RANGE 50.63 (fixed frequency) MHz
ENERGY GAIN ∿ 1700 KeV/turn
RF POWER INPUT PEAK MW; MEAN 0.68 MW

Vacuum System
MATERIAL OF VAC.CHAMBER: Aluminum
AVERAGE PRESSURE: 2E-6 torr

Extraction System
TYPE: Electrostatic septum

ACCELERATOR PERFORMANCE-EXTERNAL P-BEAM

	Normal	Maximum achieved
ENERGY (MeV)	595	595
CURRENT (μA)	250	370**
RESOLUTION ΔE/E (%)	< 0.05	
REPET. RATE (pulse/s)	50	
DUTY FACTOR, macroscopic (%)	100	
EMITTANCE* AT PEAK E	1(axial) 2(radial)	πmm-mrad

OTHER DATA:

SECONDARY BEAMS

Particle	Energy range	No. of beams	Other inform.
p	590 MeV	3	
p(pol)	590 MeV	1	6 μA
n(pol)	590 MeV	1	$5 \cdot 10^6 n/(s \cdot cm^2)$
pion	40 - 350 MeV/c	3	
pion	medical pion therapy program		

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS ∿ 1000 m²
No. INTERNAL TARGETS — No. EXT. TARGETS 2
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 2 protons 4 pions 2 muons
TOTAL POWER USED (AVERAGE) FOR RESEARCH 5 MW
No. USER GROUPS, inhouse outside tot 233
TOTAL RESEARCH STAFF, in house ∿ 50 outside ∿ 400
ANN. RESEARCH BUDGET, in house 3 MSFR (without sal.)
ANNUAL RESEARCH TIME 5,000 h

Other Relevant Parameters, Recent Improvements, etc.

* tow injector cyclotrons for alternative use
Inj. 1: variable energy, protons or light ion
Inj. 2: fixed energy, i > 1000 μA

** Upgrading program for max. current 1500 μA under way

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF MACHINE LAMPF (Clinton P. Anderson Meson Physics Facility)
INSTITUTION Los Alamos National Laboratory
LOCATION Los Alamos, New Mexico 87545 USA
PERSON IN CHARGE Gerald T. Garvey, Director DATE: June 30, 1989
DATA SUPPLIED BY L. Agnew, G. Swain, and O. van Dyck

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1968
FIRST BEAM OBTAINED, or GOAL (date) 1972
TOTAL COST OF FACILITY $75 M
TOTAL ACCELERATOR STAFF (now) 245 (direct staff)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME >2800 h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH 800 m
TUNNEL SIZE (L × H × W) 800 X 3.6 X 4 m

Injection System

ION SOURCE H^+: Duoplasmatron
OUTPUT 35mA (peak) EMITTANCE* - πmm-mrad
INJECTOR TYPE Cockcroft-Walton
OUTPUT 750 keV EMITTANCE* 0.4 πmm-mrad
BUNCHER 201.25 MHz, ~10 kV
See below for additional injection systems.

ACCELERATOR SYSTEM

	I	II
TYPE (Linac)	Drift Tube	Side-coupled
BEAM ENERGY (MeV)	0.75-100	100-800
TOTAL LENGTH (m)	62	727
ENERGY GAIN (MeV/m)	1.6	0.96
RF FREQ. (MHz)	201.25	805
FIELD MODE	0,π/2,π/2,π/2	π/2 (TM_{010})
Q (× 10^3)	~50	16 to 24
EQUIL. PHASE (degree)	-26	-36 to -20
SHUNT IMPED. (MΩ/m)	42	30 to 42
FILLING TIME (μs)	200	150
No. TANKS	4	104
TANK DIAM.	~90 cm	~27 cm
No. DRIFT TUBES	165 total	-
DRIFT TUBE LENGTH (mm)	300 to 50	-
DRIFT TUBE DIAM. (mm)	bore:7.5 to 15	-
GAP/CELL LENGTH RATIO	0.21-0.41	0.32-0.43
IRIS THICKNESS	-	-
IRIS SPACING	-	-
APERTURE (mm)	-	bore: 32 to 38
No. QUADS	135	204
GRADIENT (T/m)	8 to 0.8	2.2 to 3.2
No. RF POWER UNITS	4	44
RF POWER INPUT, PEAK (MW)	2.7 per unit	0.9 per unit
MEAN (MW)	0.25 per unit	0.1 per unit

Vacuum System

MATERIAL OF VAC.CHAMBER copper(int), stainless steel(ext)
APERTURE OF VAC.CHAMBER 20 to 1000 mm
AVERAGE PRESSURE 5×10^{-7} torr

Two additional injection systems:
H^- Cs converter source, 18 mA(peak), and polarized H^- optically pumped source, 10μA(peak). Both have injectors similar to H^+.

ACCELERATOR PERFORMANCE

	Goal	Maximum achieved
ENERGY (GeV)	0.8	0.8
RESOLUTION ΔE/E (%)	0.1	.05
REPET. RATE (pulse/s)	macro: 120	120
PULSE WIDTH AT PEAK E	1000μs	900μs
DUTY FACTOR, macroscopic (%)	12	11
INTERNAL BEAM (part/pulse)	5×10^{13}	6×10^{13}
(part/s)	H^+ 6×10^{15}	7.2×10^{15}
EMITTANCE* AT PEAK E	H^+ 0.4 πmm-mrad	
OTHER DATA		

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
pions	100-700 MeV/c	3	up to 3×10^9 s^{-1}
muons	50-150 MeV/c	1	10^7 to 10^8 s^{-1}
pol. protons	700-1500 MeV/c	3	10^{11} s^{-1}
pol. neutrons	700-1500 MeV/c	1	10^5 to 10^6 s^{-1}
neutrinos	20-50 MeV/c	1	7×10^6 s^{-1} cm^{-2} at 20 m

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 3 areas 8000 m^2
No. INTERNAL TARGETS 5 No. EXT. TARGETS 4
No. SEPARATED BEAMS -
No. BEAMS SERVED AT SAME TIME 9
TOTAL POWER USED (AVERAGE) FOR RESEARCH 25 MW
No. USER GROUPS, in house 24 outside 55
TOTAL RESEARCH STAFF, in house 100* outside 400
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME 2800 h

*About 40 full time equivalents.

Other Relevant Parameters, Recent Improvements, etc.

LAMPF also provides beam to 800 MeV Proton Storage Ring (PSR) which delivers 270-ns-long pulses at 20 Hz with average current of 50μs (1989 performance) to intense spallation neutron source for condensed matter research. PSR operating parameters and research program not included in above compilation.

*Emittance = Area × βγ at 90% of current

NAME OF MACHINE: INR Moscow Meson Factory Linac
INSTITUTION: Institute for Nuclear Research of the Academy of Sciences of the USSR
LOCATION: Troitzk, Moscow Region, USSR
PERSON IN CHARGE: Professor V.A.Matveev - Director DATE: July I4, I989
DATA SUPPLIED BY: Professor S.K.Yessin - Head of Accelerator Department

HISTORY AND STATUS

CONSTRUCTION STARTED (date)	I977
FIRST BEAM OBTAINED, or GOAL (date)	I990
TOTAL COST OF FACILITY	I30,0 MRoubles
TOTAL ACCELERATOR STAFF (now)	260
ANN. OPERAT. BUDGET	5,5 MRoubles (without salaries)
ANN. OPERATING TIME	— h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH: 450 m
TUNNEL SIZE (L x H x W): 68x6,0x6,0 + 360x4,0x4,5 m

Injection System

ION SOURCE: H^+ duoplasmatron ; H^- Dubnikov-type
OUTPUT H^+: 250 mA EMITTANCE* H^+: 3,0 πmm-mrad
INJECTOR TYPE: Pulsed transformer+accelerating tube
OUTPUT H^+: II0 mA EMITTANCE* H^+: 4,0 πmm-mrad
BUNCHER: I98,2 MHz Two-cavity

ACCELERATOR SYSTEM

	I	II
TYPE (Linac)	Drift-tube	DAW
BEAM ENERGY (MeV)	I00,I	602,03
TOTAL LENGTH (m)	68	360,82
ENERGY GAIN (MeV/m)	12;1,8;1,65;1,5;0,9	2,0-2,5
RF FREQ. (MHz)	I98,2	99I
FIELD MODE	TM_{010}	TM_{012}
Q (x 10^3)	62,0-50,0	20-30
EQUIL. PHASE (degree)	32-37;26;26;26;60	33
SHUNT IMPED. (MΩ/m)	40,0	24-45
FILLING TIME (μs)	200-I50	I5,0
No. TANKS	5	28
TANK DIAM. (cm)	108;86;86;86;86	45-39
No. DRIFT TUBES	I86+I/2 • I0	—
DRIFT TUBE LENGTH (mm)	47,8-390,5	—
DRIFT TUBE DIAM. (mm)	I50	—
GAP/CELL LENGTH RATIO	0,24- 0,43	0,4-0,56
IRIS THICKNESS	—	—
Cell length, cm	6,2-64,7	6,5-I2,0
APERTURE (mm) diameter	I5,0-28,0	34,0-38,0
No. QUADS	I96	II3 doublets
GRADIENT (T/m)	60,0-8,0	I9,0
No. RF POWER UNITS	5+2	28+5
RF POWER INPUT, PEAK (MW)	4,0	4,75
MEAN (MW)	0,I5	0,06

Vacuum System

MATERIAL OF VAC.CHAMBER: copper+stainless steel
APERTURE OF VAC.CHAMBER: diameter 28 - 38 mm
AVERAGE PRESSURE: $6 \cdot I0^{-8}$ torr

ACCELERATOR PERFORMANCE

	Goal	Maximum achieved
ENERGY (GeV)	0,602	
RESOLUTION ΔE/E (%)	±0,3	
REPET. RATE (pulse/s)	I00	
PULSE WIDTH AT PEAK E	I00 μs	
DUTY FACTOR, macroscopic (%)	I	
INTERNAL BEAM (part/pulse)	$3 \cdot I0^{13}$	
(part/s)	$3 \cdot I0^{15}$	
EMITTANCE* AT PEAK E	3,9 πmm-mrad	

OTHER DATA

SECONDARY BEAMS (Goal)

Particle	Momentum range	No. of beams	Other inform.
$I0^{11}$ π^+	200-520 MeV/c		
$I0^{10}$ π^-	200-520		
$3 \cdot I0^9$ π^+	< 200		
$5 \cdot I0^8$ π^-	< 200		
$I0^9$ μ^+	< 200		
$2 \cdot I0^8$ μ^-	< 200		
$I0^{14}$ $\bar{p}$	800-I220		
$5 \cdot I0^8$ $\bar{n}$	400-I200		
$I0^8$ ν/cm²	~ I00		

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS: 7800 m²
No. INTERNAL TARGETS: - No. EXT. TARGETS: 9
No. SEPARATED BEAMS: I
No. BEAMS SERVED AT SAME TIME: 9
TOTAL POWER USED (AVERAGE) FOR RESEARCH: 30,0 MW
No. USER GROUPS, in house: II outside: 6
TOTAL RESEARCH STAFF, in house: 75 outside:
ANN. RESEARCH BUDGET, in house: (without sal.)
ANNUAL RESEARCH TIME (Goal): 4500 h

Other Relevant Parameters, Recent Improvements, etc.

Proton stretcher-compressor ring is under development (Energy - 600 MeV, circulating current - II A, orbit circumference I06,7 m, duty factor max-98%, min-$3 \cdot I0^{-3}$ %, rep.rate-I00 Hz).

*Emittance = Area x $\beta\gamma$ at 90% of current

NAME OF HEAVY ION ACCELERATOR SPS 200 GeV/n Synchrotron
INSTITUTION CERN
LOCATION Prévessin (France)
PERSON IN CHARGE B. de Raad DATE: 1. 7. 89.
DATA SUPPLIED BY G. Brianti

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1986
FIRST BEAM OBTAINED, or GOAL (date) 1986
TOTAL COST OF FACILITY 3 MCHF (ion source and pre-injector)
TOTAL ACCELERATOR STAFF (now) 400
ANN. OPERAT. BUDGET 2 MCHF (without salaries)
ANN. OPERATING TIME 700 h

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES $^{16}O^{8+}$, $^{32}S^{16+}$
ENERGY 200 GeV/n
RING DIAM. 2200 m; TUNNEL SECT. (W x H) 4 x 3 m

Injector
TYPE Proton Synchrotron
OUTPUT(max) 0.3 mA at 10000 MeV /n
EMITTANCE* πmm-mrad
INJECTION PERIOD 2μs, or 1/11 turns
INFLECTOR TYPE Fast kicker

Magnet System
FOCUSING TYPE Sep function
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 26.6 ν_V 26.6
No. MAGNETS 744 LENGTH (ea) 6.26 m
BENDING FIELD at inj. 0.09 T; at max 1.8 T
No. QUADS 216 LENGTH (ea) 3.05 m
GRAD. at inj. 0.1 T/m; at max 20 T/m
No. SHORT STRAIGHT SECT. 216 LENGTH 2.3 m
No. LONG STRAIGHT SECT. 6 LENGTH 128 m
RISE TIME 3 s; FLAT-TOP TIME 4.4 s (200 GeV/n) s
POWER INPUT PEAK 160 MW; MEAN 57 MW

Acceleration System
No. CAVITIES 4 LENGTH(ea) 20 m
HARMONIC NUMBER 4620
RF RANGE 199.4 to 200.4 MHz
ENERGY GAIN 7200 KeV/turn
RF POWER INPUT PEAK (each) 750 kW; MEAN 500 kW

Vacuum System
MATERIAL OF VAC.CHAMBER St. steel
APERTURE OF VAC. CHAMBER 150 x 50 mm
AVERAGE PRESSURE 10^{-10} torr

Extraction System
TYPE i) slow 1/3 integer resonant
ii)
iii)
LENGTH OF SPILL i) 4.2 sec at 200 GeV/n
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

Particle	Energy(GeV/n)	Resolution ΔE/E(%)	Beam (PART / PULSE)
$^{16}O^{8+}$	60	±0.1	4×10^9
	200		
$^{32}S^{16+}$	200	±0.1	6×10^7

	Normal (or Goal)	Maximum achieved
REPT. RATE (pulse/s)	0.07	0.07
PULSE WIDTH AT PEAK E	4.2s at 200 GeV/n	
EMITTANCE* AT PEAK E		πmm-mrad

SECONDARY BEAMS (1990)

Particle	Momentum range	No. of beams	Other inform.
^{16}O, ^{32}S	60, 200 GeV/n	2	H1, H3
		2	H2, H8
		1	P0, H10 high intensity

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 3 29000 m²
No. INTERNAL TARGETS – No. EXT. TARGETS –
No. SEPARATED BEAMS All beams pure
No. BEAMS SERVED AT SAME TIME 5
TOTAL POWER USED (AVERAGE) FOR RESEARCH 15 MW
No. USER GROUPS, in house mixed with outside 60
TOTAL RESEARCH STAFF, in house 9 outside 400
ANN. RESEARCH BUDGET, in house 0.3 MCHF (without sal.)
ANNUAL RESEARCH TIME 800 h

Other Relevant Parameters, Recent Improvements, etc.

A project exists to accelerate heavier ions, up to $^{208}Pb^{82+}$ of 5×10^7 Pb ions/pulse to a maximum energy of 160 GeV/n.

*Emittance = Area x $\beta\gamma$ at 90% of current

NAME OF HEAVY ION ACCELERATOR SATURNE

INSTITUTION SATURNE NATIONAL LABORATORY - J. ARVIEUX - Director

LOCATION C.E.N. SACLAY 91191 GIF SUR YVETTE CEDEX

PERSON IN CHARGE PA. CHAMOUARD - Operation Service DATE: July 89

DATA SUPPLIED BY M. OLIVIER - A. TKATCHENKO - PA. CHAMOUARD.

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1974
FIRST BEAM OBTAINED, or GOAL (date) 1978
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 5000 H h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES p, d, H.I, $\vec{p}$ $\vec{d}$
ENERGY 3 GeV-p GeV/n
RING DIAM. 33.6 m; TUNNEL SECT. (W x H) m

Injector

TYPE LINAC (p,d) ; Synchrotron (others)
OUTPUT(max) mA at MeV
1) EMITTANCE* πmm-mrad
INJECTION PERIOD μs, or turns
INFLECTOR TYPE Electrostatic

Magnet System

FOCUSING TYPE STRONG - SEP.FUNCTIONS
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 3.64 ν_V 3.61
No. MAGNETS 16 LENGTH (ea) 2.49 m
BENDING FIELD at inj. 0.1 (p) T; at max 1.9 T
No. QUADS 24 LENGTH (ea) 0.45 ; 0.47 m
GRAD. at inj. T/m; at max T/m
3) No. SHORT STRAIGHT SECT. 32 LENGTH 0.73 m
No. ~~LONG~~ STRAIGHT SECT. 8 LENGTH 3.94 m
RISE TIME 0.5 s; FLAT-TOP TIME Sec Spill s
POWER INPUT PEAK 16 MW; MEAN MW

Acceleration System

No. CAVITIES 2 LENGTH(ea) 3.94 m
HARMONIC NUMBER 3
2) RF RANGE p ; 1.7 to 8.3 MHz
ENERGY GAIN p ; 2.8 KeV/turn
RF POWER INPUT PEAK 56 each kW; MEAN kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless Steel
APERTURE OF VAC. CHAMBER 240 x 120 mm
AVERAGE PRESSURE 4.10-9 TORR torr

Extraction System

TYPE i) Third Integ. Res. Extraction
ii)
iii)
LENGTH OF SPILL i) 30 ms to 1000 ms μs
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

Particle	Energy(GeV/n)	Resolution ΔE/E(%)	Beam (PART / PULSE)
p	3	$\pm 3.10^{-4}$	$1.5\ 10^{12}$
d	1.15	" "	$0.7\ 10^{12}$
c	"	" "	9.10^{8}
N	"	" "	8.10^{8}
Ne	"	" "	2.10^{8}
Ar 16+	.82	" "	10^{6}
Kr 30+	.7	" "	2.10^{6}
$\vec{p}$	.3	" "	$1.5\ 10^{11}$
$\vec{d}$	1.15	" "	2.10^{11}

polarization > 90% $\vec{d}$; > 80% $\vec{p}$

	Normal (or Goal)	Maximum achieved
REPT. RATE (pulse/s)	0.33	1
PULSE WIDTH AT PEAK E		
EMITTANCE* AT PEAK E	p - extracted beam	πmm-mrad

Hor 16 π mm.mrd
Ver 49 π mm.mrd

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$\vec{n}$	0.8 - 1.9 Gev/c	2	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 6000 m²
No. INTERNAL TARGETS / No. EXT. TARGETS 12
No. SEPARATED BEAMS 9
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH 7 MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house 120 outside 120
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME 5000 h

Other Relevant Parameters, Recent Improvements, etc.

1) See Linacs and Synchrotron MIMAS

2) to cover all ion species

f min = 0.8 MHZ
f max = 8.3 MHZ

3) a long straight section is

2 SD of 3.94 m each

*Emittance = Area x $\beta\gamma$ at 90% of current

NAME OF HEAVY ION ACCELERATOR SCHWER IONEN SYNCHROTRON (SIS)
INSTITUTION G S I - GESELLSCHAFT FOR SCHWERIONENFORSCHUNG mbH, POB 110552
LOCATION DARMSTADT, FEDERAL REPUBLIC GERMANY
PERSON IN CHARGE K. BLASCHE DATE: 30.6.1989
DATA SUPPLIED BY K. BLASCHE

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1.11.1986
FIRST BEAM OBTAINED, or GOAL (date) April 1989
TOTAL COST OF FACILITY 44 MDM
TOTAL ACCELERATOR STAFF (now) 20
ANN. OPERAT. BUDGET ~ 2 MDM (without salaries)
ANN. OPERATING TIME 5000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES (p) - U
ENERGY 1 - 2 (4.5) GeV/n
RING DIAM. 69 m; TUNNEL SECT. (W x H) 4.5 x 3.5 m

Injector

TYPE UNILAC (HEAVY ION LINAC)
OUTPUT(max) 1 mA at 10-20 MeV
EMITTANCE* ~ 5 πmm-mrad
INJECTION PERIOD ~ 200 μs, or 40 turns
INFLECTOR TYPE ELECTROSTATIC SEPTUM

Magnet System

FOCUSING TYPE DOUBLET / TRIPLET
FOCUSING ORDER FD (F)
BETATRON FREQ. ν_H 4.2 ν_V 3.4
No. MAGNETS 24 LENGTH (ea) 2.6 m
BENDING FIELD at inj. > 0.08 T; at max 1.8 T
No. QUADS 36 LENGTH (ea) 1 (0.5) m
GRAD. at inj. 0.2 T/m; at max 7.9 T/m
No. SHORT STRAIGHT SECT. 12 LENGTH m
No. LONG STRAIGHT SECT. - LENGTH 6 m
RISE TIME 0.1-0.3 s; FLAT-TOP TIME variable s
POWER INPUT PEAK 30 MW; MEAN 2 MW

Acceleration System

No. CAVITIES 2 LENGTH(ea) 3 m
HARMONIC NUMBER 4
RF RANGE 0.85 to 5.6 MHz
ENERGY GAIN 22 x charge state KeV/turn
RF POWER INPUT PEAK 60 kW; MEAN 30 kW

Vacuum System

MATERIAL OF VAC.CHAMBER STAINLESS STEEL
APERTURE OF VAC. CHAMBER 200 x 80 mm
AVERAGE PRESSURE $5 \cdot 10^{-11}$ mbar

Extraction System

TYPE i) FAST EXTRACTION
ii) RESONANT EXTRACTION
iii) ULTRA SLOW EXTRACTION
LENGTH OF SPILL i) 0.2 to 3 μs
ii) 10^4 to 10^6 μs
iii) 10^5 to 10^8 μs

ACCELERATOR PERFORMANCE

Particle	Energy(GeV/n)	R esolution ΔE/E(%)	Beam 1) (PART / PULSE)
(p)	4.5	$1 \cdot 10^{-3}$	
Ne	2	$1 \cdot 10^{-3}$	$2 \cdot 10^{11}$
Ar	1.8	$1 \cdot 10^{-3}$	
Kr	1.5	$1 \cdot 10^{-3}$	$5 \cdot 10^{10}$
Xe	1.4	$1 \cdot 10^{-3}$	
U	0.9	$1 \cdot 10^{-3}$	$2 \cdot 10^{10}$

1) Space charge limit

	Normal (or Goal)	Maximum achieved
REPT. RATE (pulse/s)	1-3	3
PULSE WIDTH AT PEAK E		
EMITTANCE* AT PEAK E	1-20 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
Neutron or proton rich projectile fragments separated by a magnetic system			

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 3000 m²
No. INTERNAL TARGETS - No. EXT. TARGETS 6-8
No. SEPARATED BEAMS 1
No. BEAMS SERVED AT SAME TIME 1
TOTAL POWER USED (AVERAGE) FOR RESEARCH 5 MW
No. USER GROUPS, in house - outside -
TOTAL RESEARCH STAFF, in house - outside -
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME ca. 4000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current

NAME OF HEAVY ION ACCELERATOR EXPERIMENTAL STORAGE RING (ESR)
INSTITUTION GSI - GESELLSCHAFT FÜR SCHWERIONENFORSCHUNG mbH
LOCATION DARMSTADT, FEDERAL REPUBLIC GERMANY
PERSON IN CHARGE BERNHARD FRANZKE DATE: 30.6.1989
DATA SUPPLIED BY BERNHARD FRANZKE

HISTORY AND STATUS

CONSTRUCTION STARTED (date) November 1986
FIRST BEAM OBTAINED, or GOAL (date) January 1990
TOTAL COST OF FACILITY 26 MDM
TOTAL ACCELERATOR STAFF (now) 15
ANN. OPERAT. BUDGET 1 MDM (without salaries)
ANN. OPERATING TIME Goal for 1991: 5000 h

ACCELERATOR PARAMETERS

General
PARTICLES Ne - U (protons)
ENERGY 3 to 830 MeV/u
RING DIAM. m; TUNNEL SECT. (W x H) m

Injector
TYPE SYNCHROTRON(SIS)
OUTPUT(max) 100 mA at 500-800 MeV/u
EMITTANCE* 20 h and 5 (v) πmm-mrad
INJECTION PERIOD 0.5 μs, or 1 turns
INFLECTOR TYPE septum magnet

Magnet System
FOCUSING TYPE COMBINED DOUBLET/TRIPLET
FOCUSING ORDER variable
BETATRON FREQ. ν_H 2.22 ν_V 2.38
No. MAGNETS 6 LENGTH (ea) 6.54 m
BENDING FIELD min 0.08 T; at max 1.6 T
No. QUADS 20 LENGTH (ea) 0.75 - 1.15 m
GRAD. at inj. 0.31 T/m; at max 6.2 T/m
No. SHORT STRAIGHT SECT. 4 LENGTH 3.5 m
No. LONG STRAIGHT SECT. 2 LENGTH 10 m
RISE TIME 1.5 s; FLAT-TOP TIME variable s
POWER INPUT PEAK 7.5 MW; MEAN 2.5 MW

Acceleration System
No. CAVITIES 2 LENGTH(ea) 1.7 m
HARMONIC NUMBER 2 or 4
RF RANGE 0.85 to 5.6 MHz
ENERGY GAIN = 0.7 x charge state KeV/turn
RF POWER INPUT PEAK 20 kW; MEAN 10 kW

Vacuum System
MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER (mean) 220 (h) x 60 (v) mm^2
AVERAGE PRESSURE 1×10^{-11} mbar

Extraction System
TYPE i) FAST
ii) RESONANT
iii) BY CHARGE EXCHANGE OF IONS
LENGTH OF SPILL i) 0.5 to 1 μs
ii) 10^4 to 10^6 μs
iii) 10^6 to 10^8 μs

ACCELERATOR PERFORMANCE

Particle	Energy MeV/u	R esolution ΔE/E(%)	Beam 1) 2) (PART / PULSE)
Ne^{10+}	834	0.05	$8.4 \cdot 10^{10}$
Ar^{18+}	709	0.05	$4.7 \cdot 10^{10}$
Kr^{36+}	656	0.05	$2.4 \cdot 10^{10}$
Xe^{54+}	609	0.05	$1.6 \cdot 10^{10}$
U^{92+}	556	0.05	$9.2 \cdot 10^{9}$
(p)	2200	0.05	$8.2 \cdot 10^{11}$

1) With electron cooling up to 560 MeV/u
2) Space charge limits

	Normal (or Goal)	Maximum achieved
REPT. RATE (pulse/s)	0.3	-
PULSE WIDTH AT PEAK E		-
EMITTANCE* AT PEAK E	1 π mm mrad	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 3000 m^2
No. INTERNAL TARGETS 1 No. EXT. TARGETS 5
No. SEPARATED BEAMS 1
No. BEAMS SERVED AT SAME TIME 1
TOTAL POWER USED (AVERAGE) FOR RESEARCH 5 MW
No. USER GROUPS, in house - outside -
TOTAL RESEARCH STAFF, in house - outside -
ANN. RESEARCH BUDGET, in house - (without sal.)
ANNUAL RESEARCH TIME 4000 h

Other Relevant Parameters, Recent Improvements, etc.

Electron cooling: 30 - 560 MeV/u
Stochastic cooling at 500 MeV/u
Internal gas jet target: 10^{11} - 10^{14} atom/cm^2

*Emittance = Area x $\beta\gamma$ at 90% of current

NAME OF HEAVY ION ACCELERATOR: Alternating Gradient Synchrotron
INSTITUTION: Brookhaven National Laboratory
LOCATION: Upton, New York 11973
PERSON IN CHARGE: D.I. Lowenstein/Th. Sluyters DATE: 6/23/89
DATA SUPPLIED BY: L.A. Ahrens, Y.Y. Lee

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1953
FIRST BEAM OBTAINED, or GOAL (date) October, 1986
TOTAL COST OF FACILITY ----
TOTAL ACCELERATOR STAFF (now) 20 + High Energy
ANN. OPERAT. BUDGET $1.0 M (without salaries)
ANN. OPERATING TIME 1,000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES H, O, Si
ENERGY 14.5 GeV/n
RING DIAM. 256.9 m; TUNNEL SECT. (W x H) 5.5x5.5 m

Injector

TYPE Tandem Van de Graaff
OUTPUT(max) 20 μA (Si) ~~XXA~~ at 6.7 MeV/n
EMITTANCE* 0.50 πmm-mrad
INJECTION PERIOD 260 μs, or 12 turns
INFLECTOR TYPE Electrostatic

Magnet System

FOCUSING TYPE AG, Comb. Function
FOCUSING ORDER (F/2)0(F/2)(D/2)0(D/2)
BETATRON FREQ. ν_H 8.75 ν_V 8.75
No. MAGNETS 240 LENGTH (ea) 2.28 or 1.90 m
BENDING FIELD at inj. 0.009 T; at max 1.31 T
No. QUADS 240 LENGTH (ea) 2.28 or 1.90 m
GRAD. at inj. 0.038 T/m; at max 5.5 T/m
No. SHORT STRAIGHT SECT. 72 LENGTH 1.63 m
No. LONG STRAIGHT SECT. 24 LENGTH 3.15 m
RISE TIME 1.0 s; FLAT-TOP TIME 1-2 s
POWER INPUT PEAK 60 MW; MEAN 6 MW

Acceleration System

No. CAVITIES 1,2gaps+10,4gaps LENGTH(ea) 2 m
HARMONIC NUMBER 12
RF RANGE 0.5 to 4.46 MHz
ENERGY GAIN 192 KeV/turn
RF POWER INPUT PEAK 1,000 kW; MEAN 800 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Inconel-750
APERTURE OF VAC. CHAMBER 173 x 77.8 mm
AVERAGE PRESSURE 1.0×10^{-7} torr

Extraction System

TYPE i) Slow Extraction
ii)
iii)
LENGTH OF SPILL i) 0.5 to 2.5 sec ~~μs~~
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

Particle	Energy(GeV/n)	Resolution ΔE/E(%)	Beam (PART/PULSE)
O	14.5	0.05	1×10^9
Si	14.5	0.05	2×10^8

	Normal (or Goal)	Maximum achieved
REPT. RATE (pulse/s)	0.4	
PULSE WIDTH AT PEAK E	0.5-2.5 sec	
EMITTANCE* AT PEAK E	20 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
H	0 - 28 GeV/c	4	
O^{16}	0 - 230 GeV/c	4	
Si^{28}	0 - 400 GeV/c	4	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 15,000 m²
No. INTERNAL TARGETS 0 No. EXT. TARGETS N/A
No. SEPARATED BEAMS All
No. BEAMS SERVED AT SAME TIME 4
TOTAL POWER USED (AVERAGE) FOR RESEARCH 20 MW
No. USER GROUPS, in house 4 outside 50
TOTAL RESEARCH STAFF, in house 25 outside 225
ANN. RESEARCH BUDGET, in house $0.7M (oper.) (without sal.)
ANNUAL RESEARCH TIME 1,000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current

NAME OF HEAVY ION ACCELERATOR Bevalac
INSTITUTION University of California Lawrence Berkeley Laboratory
LOCATION Berkeley, CA
PERSON IN CHARGE Jose R. Alonso DATE: June 30, 1989
DATA SUPPLIED BY Fred Lothrop

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1949
FIRST BEAM OBTAINED, or GOAL (date) 1954
TOTAL COST OF FACILITY ∿ $12M (1954 dollars)
TOTAL ACCELERATOR STAFF (now) 140
ANN. OPERAT. BUDGET $ 5.25M (without salaries)
ANN. OPERATING TIME 5000 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES protons through uranium
ENERGY .030 - 2.1 GeV/n
RING DIAM. 40 m; TUNNEL SECT. (W x H) n/A m

Injector

TYPE two Alvarez-type linacs
OUTPUT(max) 0.5 mA at 8.5 A MeV
EMITTANCE* ∿ 10 πmm-mrad
INJECTION PERIOD 500 μs, or turns
INFLECTOR TYPE electrostatic

Magnet System

FOCUSING TYPE weak
FOCUSING ORDER n/A
BETATRON FREQ. ν_H 0.6 ν_V 0.8
No. MAGNETS 4 LENGTH (ea) 24 m
BENDING FIELD at inj. .04 T; at max 1.26 T
No. QUADS n/A LENGTH (ea) — m
GRAD. at inj. n/A T/m; at max n/A T/m
No. SHORT STRAIGHT SECT. n/A LENGTH n/A m
No. LONG STRAIGHT SECT. 4 LENGTH 6 m
RISE TIME 1.5 s; FLAT-TOP TIME 1 - 1.5 s
POWER INPUT PEAK 60 MW; MEAN 5.0 MW

Acceleration System

No. CAVITIES 1 LENGTH(ea) 4 m
HARMONIC NUMBER 1
RF RANGE 0.200 to 2.50 MHz
ENERGY GAIN 1.3 KeV/turn
RF POWER INPUT PEAK 50 kW; MEAN 50 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Copper + NEMA G-10 epoxy glass
APERTURE OF VAC. CHAMBER 160 × 1160 mm
AVERAGE PRESSURE 1×10^{-9} torr

Extraction System

TYPE i) resonant
ii)
iii)
LENGTH OF SPILL i) 30 to 1000 ms
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

Particle	Energy(GeV/n)	Resolution ΔE/E(%)	Beam (PART / PULSE)
protons	4.9	0.1	3e9
He	2.1	0.1	3e10
Ne	2.1	0.1	3e9
Ar	1.7	0.1	1e9
Fe	1.8	0.1	5e8
Nb	1.4	0.1	3e8
La	1.25	0.1	4e7
AU	1.08	0.1	1e7
U	0.96	0.1	3e6

	Normal (or Goal)	Maximum achieved
REPT. RATE (pulse/s)	0.25	0.25
PULSE WIDTH AT PEAK E	1 sec	1 sec
EMITTANCE* AT PEAK E	15	πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
n/A	n/A	n/A	n/A

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 2400 m²
No. INTERNAL TARGETS 0 No. EXT. TARGETS 10
No. SEPARATED BEAMS 0
No. BEAMS SERVED AT SAME TIME 1
TOTAL POWER USED (AVERAGE) FOR RESEARCH 8 MW
No. USER GROUPS, in house 5 outside 20
TOTAL RESEARCH STAFF, in house n/A outside n/A
ANN. RESEARCH BUDGET, in house n/A (without sal.)
ANNUAL RESEARCH TIME 4000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current

NAME OF STORAGE RINGS Large Hadron Collider (LHC)
INSTITUTION CERN
LOCATION CH-1211 Genève 23 Switzerland
PERSON IN CHARGE G. Brianti DATE: June 1989
DATA SUPPLIED BY L. Burnod

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Existing LEP tunnel
FIRST COLLISIONS, or GOAL (date) 1996
TOTAL COST OF FACILITY
TOTAL MACHINE STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES proton-proton
ENERGY 2 x 8000 GeV
APPROX. SHAPE circular DIMENTIONS Ø 8486 m
ORBIT: Length 26658.8 m, time 88.92 μs
No. INTERSECTS 3 to 5 CROSSING ANGLE 96 μrad

Injector System

TYPE Synchrotron (CERN-SPS)
INJ. ENERGY 26 GeV OUTPUT 450 GeV
EMITTANCE* 15 πmm-mrad
FILLING SPEED 8.7 mA/s
TOTAL FILLING TYME 200 s

Magnet System

FOCUSING TYPE Strong BEND. RAD. 2668.5 m
LATTICE ORDER FODO
No. MAGNETS 1760 LENGTH (ea) 9.54 m
No. QUADS 568 LENGTH (ea) 3.08 m
MAX BEND. FIELD 10 T; MAX GRAD. 250 T/m
OTHER MAGNETS Tuning quads, sextupoles, corr. dipoles
BETATRON FREQ. ν_H 70.28 ν_V 70.31
AMPL. FUNCT. AT INTERSECT. (H) 0.25 m (V) 0.25 m

Acceleration System

HARMONIC No. 35640 FREQUENCY 400.8 MHz
No. TRANSMITTERS 7 No. CAVITIES 7
BUNCH TO BUNCH TIME 15 ns
BUNCH SIZE (L x W x H) (300x0.55x0.55) mm^3
PEAK RF VOLTAGE PER BEAM 18 MV
MAX RF POWER 2x7 MW ON BEAMS 2x9 kW

Vacuum System

PRESSURE IN RINGS, NO BEAM $3x10^{-12}$ Torr
WITH BEAM Torr/mA
PRESSURE AT INTERSECTIONS Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	2 x 8000	
RESOLUTION ΔE/E (%)	0.03	
LUMINOSITY ($cm^{-2} sec^{-1}$)	$3.8\ 10^{34}$	
BEAM SIZE, horizontal	21 μm	
vertical	21 μm	
CURRENT, PER BEAM (mA)	865	
BEAM LIFE, AT 865 mA	12.5 h	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 3 x 1150 m^2
No. EXPERIMENTAL INTERSECTS 3
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET (without sal.)
ANN. RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS: SPS Proton-Antiproton Collider ($S\bar{p}pS$)
INSTITUTION: CERN
LOCATION: Prévessin (France)
PERSON IN CHARGE: B. de Raad — DATE: 1. 7. 89.
DATA SUPPLIED BY: G. Brianti

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1980
FIRST COLLISIONS, or GOAL (date): July 1981
TOTAL COST OF FACILITY: 200 MCHF (in 1980 CHF)
TOTAL MACHINE STAFF (now): 400
ANN. OPERAT. BUDGET: 9 MCHF (without salaries)
ANN. OPERATING TIME: 2500 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES: Protons - Antiprotons
ENERGY: 315 GeV
APPROX. SHAPE: Circular — DIMENTIONS: 1100 m rad
ORBIT: Length: 6911 m, time: 23 μs
No. INTERSECTS: 2 — CROSSING ANGLE: 0

Injector System

TYPE: Proton Synchrotron
INJ. ENERGY: 800 MeV(P) 3.5 GeV($\bar{p}$) — OUTPUT: 26 GeV
EMITTANCE*: 10 πmm-mrad
FILLING SPEED:
TOTAL FILLING TYME: 28.8 sec

Magnet System

FOCUSING TYPE: Sep Function — BEND. RAD.: 740 m
LATTICE ORDER: FODO
No. MAGNETS: 744 — LENGTH (ea): 6.26 m
No. QUADS: 216 — LENGTH (ea): 3.05 m
MAX BEND. FIELD: 1.4 T; MAX GRAD.: 15.7 T/m
OTHER MAGNETS:
BETATRON FREQ. ν_H: 26.7 — ν_V: 27.7
AMPL. FUNCT. AT INTERSECT, (H): 1 m — (V): 0.5 m

Acceleration System * (Combined 100 MHz and 200 MHz)

HARMONIC No.: 4620 — FREQUENCY: 200.4 MHz
No. TRANSMITTERS: 4 — No. CAVITIES: 4
BUNCH TO BUNCH TIME: 3.83 microsec
BUNCH SIZE (L x W x H): 0.9 m x 2 mm x 1.5 mm
PEAK RF VOLTAGE PER BEAM: 3.6 MV
MAX RF POWER (per cav): 750 kW — ON BEAMS: -

Vacuum System

PRESSURE IN RINGS, NO BEAM: 10^{-10} Torr
WITH BEAM: Torr/mA
PRESSURE AT INTERSECTIONS: 10^{-10} Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	270	315
RESOLUTION ΔE/E (%)	0.1	0.1
LUMINOSITY ($cm^{-2} sec^{-1}$)	1×10^{30}	2.8×10^{30}
BEAM SIZE, horizontal	0.2 mm	0.2 mm
vertical	0.15 mm	0.15 mm
CURRENT, PER BEAM (mA)	400	400
BEAM LIFE, AT 400 mA		200 hours

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA: 1200 m²
No. EXPERIMENTAL INTERSECTS: 2
No. EXPERIMENT/INTERSECT: 2
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

1 internal gas jet

TOTAL POWER USED (average) FOR RESEARCH: 90 MW
No. USER GROUPS, in house: mixed with — outside: 40
TOTAL RESEARCH STAFF, in house: 45 — outside: 400
ANN. RESEARCH BUDGET: 3.5 MCHF (without sal.)
ANN. RESEARCH TIME: 2400 h

Other Relevant Parameters, Recent Improvements, etc.

* 100 MHz Acceleration System

Harmonic No. 2310 — frequency 100.13 MHz
100.2 MHz
No. transmitters 6 — No. cavities 6
Peak RF voltage per beam 2MV
Max RF power (per cav) 16kW

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS LEP (Large Electron Positron) Collider
INSTITUTION CERN
LOCATION Geneva, Switzerland
PERSON IN CHARGE E. Picasso DATE: 27.6.89
DATA SUPPLIED BY G. Plass

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1.9.83
FIRST COLLISIONS, or GOAL (date) August 1989
TOTAL COST OF FACILITY 1294 MCHF
TOTAL MACHINE STAFF (now) approx. 750
ANN. OPERAT. BUDGET To be determined (without salaries)
ANN. OPERATING TIME To be determined h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES Electrons - Positrons
ENERGY 20 to 55 GeV
APPROX. SHAPE Circular DIMENTIONS R = 4242.89 m
ORBIT: Length 26 658.883 m, time 88.9245 μs
No. INTERSECTS 8 CROSSING ANGLE Zero

Injector System

TYPE Synchrotron
INJ. ENERGY 3.5 GeV OUTPUT 20 GeV
EMITTANCE* 0.64 πmm-mrad
FILLING SPEED 0.25 mA/min
TOTAL FILLING TYME 24 min

Magnet System

FOCUSING TYPE Strong BEND. RAD. 3096.2 m
LATTICE ORDER FODO
No. MAGNETS 3304+64+24 LENGTH (ea) 5.75 m
No. QUADS 816 LENGTH (ea) 1.6 + 2.0 m
MAX BEND. FIELD 0.135 T; MAX GRAD. 10.9 T/m
OTHER MAGNETS 504 sextupoles + 516 correctors
BETATRON FREQ. ν_H 70.42 ν_V 78.35
AMPL. FUNCT. AT INTERSECT, (H) 1.75 m (V) 0.07 m

Acceleration System

HARMONIC No. 31 320 FREQUENCY 352.309 MHz
No. TRANSMITTERS 16 No. CAVITIES 128
BUNCH TO BUNCH TIME 22.23 μs
BUNCH SIZE (L x W x H) 18 mm x 3 mm x 0.4 mm
PEAK RF VOLTAGE PER BEAM 360 MV
MAX RF POWER 16 MW ON BEAMS 14.8 MW

Vacuum System

PRESSURE IN RINGS, NO BEAM $8\ 10^{-12}$ Torr
WITH BEAM 10^{-7} to 10^{-9} Torr/mA
PRESSURE AT INTERSECTIONS 10^{-9} Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	55	
RESOLUTION ΔE/E (%)	0.1	
LUMINOSITY ($cm^{-2} sec^{-1}$)	$1.7\ 10^{31}$	
BEAM SIZE, horizontal	300 μm	
vertical	12 μm	
CURRENT, PER BEAM (mA)	3	
BEAM LIFE, AT 3 mA	5 h	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA m^2
No. EXPERIMENTAL INTERSECTS 4
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH 75 MW
No. USER GROUPS, in house * outside
TOTAL RESEARCH STAFF, in house ~40 outside ~800
ANN. RESEARCH BUDGET (without sal.)
ANN. RESEARCH TIME not applicable yet h

Other Relevant Parameters, Recent Improvements, etc.

* Aleph CERN + 28 outside Groups
Opal CERN + 24 " "
L3 CERN + 40 " "
Delphi CERN + 38 " "

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS Beijing Electron Positron Collider (BEPC)
INSTITUTION Institute of High Energy Physics
LOCATION Beijing, China
PERSON IN CHARGE Fang Shouxian DATE: June 20, 1989
DATA SUPPLIED BY Fang Shouxian

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 24,1984
FIRST COLLISIONS, or GOAL (date) Oct. 16, 1988
TOTAL COST OF FACILITY $ 80 millions
TOTAL MACHINE STAFF (now) 500
ANN. OPERAT. BUDGET $ 5 millions (without salaries)
ANN. OPERATING TIME 6000 h

STORAGE RINGS PARAMETERS

General
COLLIDING PARTICLES e, e^+
ENERGY 1.55--2.8 GeV
APPROX. SHAPE round DIMENTIONS 38.26 m R
ORBIT: Length 240.4 m, time 0.801 μs
No. INTERSECTS 2 CROSSING ANGLE 0

Injector System
TYPE Electron Linac
INJ. ENERGY 1.1-1.4 GeV OUTPUT 600 ma e,6ma e^+
EMITTANCE* 0.15 (for e), 2 (for e^+) πmm-mrad
FILLING SPEED 2 ma/min (e^+), 120 ma/min (e)
TOTAL FILLING TYME 40 min

Magnet System
FOCUSING TYPE Sep. funct. BEND. RAD. 10.345 m
LATTICE ORDER FOBODOBO
No. MAGNETS 40B+4BL(Weak) LENGTH (ea) 1.6 m
No. QUADS 60Q+8IQ LENGTH (ea) o.4(Q),o.6(IQ) m
MAX BEND. FIELD o.9028 T; MAX GRAD. 3.3 T/m
OTHER MAGNETS 5 wiggler
BETATRON FREQ. ν_H 6.18 ν_V 7.12
AMPL. FUNCT. AT INTERSECT, (H) 1.3 m (V) 0.1 m

Acceleration System
HARMONIC No. 160 FREQUENCY 199.53 MHz
No. TRANSMITTERS 8 No. CAVITIES 2
BUNCH TO BUNCH TIME 801.33 ns/2
BUNCH SIZE (L x W x H) 104mm x 1.8mm x 0.14mm (I.P.)
PEAK RF VOLTAGE PER BEAM 1.35 MV x 2
MAX RF POWER 200kW ON BEAMS 62 kW

Vacuum System
PRESSURE IN RINGS, NO BEAM 5×10^{-10} Torr
WITH BEAM Torr/mA
PRESSURE AT INTERSECTIONS 10^{-10} Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	2.8	1.55--2.2
RESOLUTION ΔE/E (%)	7.4×10^{-4}	2×10^{30} 8×10^{30}
LUMINOSITY ($cm^{-2}sec^{-1}$)	1.7×10^{31}	
BEAM SIZE, horizontal	1.8 mm	
vertical	0.14 mm	
CURRENT, PER BEAM (mA)	65 mA	14 mA 30 mA
BEAM LIFE, AT mA	6 hrs	5 hrs 8 hrs

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 1000 m^2
No. EXPERIMENTAL INTERSECTS 2
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

BES-- Beijing Spectrometer

TOTAL POWER USED (average) FOR RESEARCH 1.5 MW
No. USER GROUPS, in house 1 outside 0
TOTAL RESEARCH STAFF, in house 80 outside 10
ANN. RESEARCH BUDGET 1.5 millions (without sal.)
ANN. RESEARCH TIME 4000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS: DORIS II
INSTITUTION: Deutsches Elektronen-Synchrotron DESY
LOCATION: Hamburg W. Germany
PERSON IN CHARGE: H. Nesemann — DATE: June 89
DATA SUPPLIED BY: H. Nesemann, H. Schröder

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1970
FIRST COLLISIONS, or GOAL (date): Dec. 1973
TOTAL COST OF FACILITY: 120 MDM
TOTAL MACHINE STAFF (now): see "DESYII"
ANN. OPERAT. BUDGET: see "DESYII" (without salaries)
ANN. OPERATING TIME: 6600 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES: e^- and e^+
ENERGY: 5.6 GeV
APPROX, SHAPE: oval — DIMENTIONS: 55 x 111 m^2
ORBIT: Length: 288 m, time: 0.96 μs
No. INTERSECTS: 2 — CROSSING ANGLE: 0

Injector System

TYPE: Synchrotron DESY II
INJ. ENERGY: working energy of DORIS II
EMITTANCE*: Hor.:560 at 5.3 GeV nmm-mrad
FILLING SPEED: e^-: ∿1 mA/sec e^+: ∿2 mA/sec
TOTAL FILLING TYME: 1 - 2 min

Magnet System

FOCUSING TYPE: separated function — BEND. RAD.: 12.22 m
LATTICE ORDER:
No. MAGNETS: 24 — LENGTH (ea): 3.2 m
No. QUADS: 68 — LENGTH (ea): 0.6/1.1 m
MAX BEND. FIELD: 1.5 T; MAX GRAD.: 21 T/m
OTHER MAGNETS: 40 sextupoles
BETATRON FREQ. ν_H: 7.163 — ν_V: 5.235
AMPL. FUNCT. AT INTERSECT, (H): 0.63 m — (V): 0.04 m

Acceleration System

HARMONIC No.: 480 — FREQUENCY: 500 MHz
No. TRANSMITTERS: 4 — No. CAVITIES: 11 5-cell
BUNCH TO BUNCH TIME: 2 - 960 nsec
BUNCH SIZE (L x W x H): 36 x 6 x 0.6 mm^3
PEAK RF VOLTAGE PER BEAM: 13 MV
MAX RF POWER: 1.2 MW — ON BEAMS: 0.5 MW

Vacuum System

PRESSURE IN RINGS, NO BEAM: 2×10^{-9} Torr
WITH BEAM: 0.2×10^{-9} Torr/mA
PRESSURE AT INTERSECTIONS: 1×10^{-9} Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved	
ENERGY (GeV)	5.3		
RESOLUTION ΔE/E (%)	0.13		
LUMINOSITY ($cm^{-2} sec^{-1}$)	2.5×10^{31}	3.3×10^{31}	at 5.3GeV
BEAM SIZE, horizontal	σ = 600 μ		
vertical	σ ∿ 30 μ		
CURRENT, PER BEAM (mA)	42		
BEAM LIFE, AT 42 mA	∿ 1 h		

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA: 2100 m^2
No. EXPERIMENTAL INTERSECTS: 2
No. EXPERIMENT/INTERSECT: 1 and 0
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH: 2 MW
No. USER GROUPS, in house: 1 — outside: 0
TOTAL RESEARCH STAFF, in house: 20 — outside: 65
ANN. RESEARCH BUDGET: 500 KDM (without sal.)
ANN. RESEARCH TIME: 4400 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS HERA
INSTITUTION Deutsches Elektronen-Synchrotron DESY
LOCATION Notkestraße 85, 2000 Hamburg 52, West Germany
PERSON IN CHARGE G.-A. Voss, B. H. Wiik DATE: June 20, 1989
DATA SUPPLIED BY J. Roßbach

HISTORY AND STATUS

CONSTRUCTION STARTED (date) May 1984
FIRST COLLISIONS, or GOAL (date) 1990
TOTAL COST OF FACILITY
TOTAL MACHINE STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES electrons or positrons vs. protons
ENERGY 26 x 820 GeV
APPROX. SHAPE Ring DIMENTIONS 2 km Ø
ORBIT: Length 6336 m, time 21.13 μs
No. INTERSECTS 3 CROSSING ANGLE 0.0

Injector System

TYPE Linac → Synchrotron → Booster Storage Ring
INJ. ENERGY 14 GeV/40 GeV OUTPUT
EMITTANCE* 0.039 (e) / 17, (p) πmm-mrad
FILLING SPEED
TOTAL FILLING TYME 15 min / 20 min

Magnet System

FOCUSING TYPE FODO BEND. RAD. 611/584 m
LATTICE ORDER 4x (Straight section - ARC)
No. MAGNETS 396/416 LENGTH (ea) 9.135/8.824 m
No. QUADS 580/280 LENGTH (ea) 0.76 /1.86 m
MAX BEND. FIELD 0.278/4.7 T; MAX GRAD. 19/91 T/m
OTHER MAGNETS Sextupoles, Skew Quads, 10-pole, 12-pole
BETATRON FREQ. ν_H 47.2 (e)/31.15 (p) ν_V 48.3 (e)/32.18 (p)
AMPL. FUNCT. AT INTERSECT. (H) 2m (e)/10m (p) (V) 0.7m / 1m

Acceleration System

HARMONIC No. 10560/4400 FREQUENCY 500/208 MHz
No. TRANSMITTERS 12 (e)/1 (p) No. CAVITIES 82/6
BUNCH TO BUNCH TIME 96 ns
BUNCH SIZE (L x W x H) 20 in arcs: 17x2x0.5 (e)/170x1x1(p)/mm^3
PEAK RF VOLTAGE PER BEAM 143 MV / 4. MV
MAX RF POWER 8.2/0.24 MW ON BEAMS 4.1/0.004 MW

Vacuum System

PRESSURE IN RINGS, NO BEAM $< 4\times10^{-9}$(e)/ $< 3\times10^{-11}$(p) Torr
WITH BEAM Torr/mA
PRESSURE AT INTERSECTIONS Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	26/820	13.9/ -
RESOLUTION ΔE/E (%)	0.1/0.13	
LUMINOSITY ($cm^{-2} sec^{-1}$)	1.6×10^{31}	
BEAM SIZE, horizontal 10 at IP	280/265 μm	
vertical	37/ 84 μm	
CURRENT, PER BEAM (mA)	58/163	0.2/ -
BEAM LIFE, AT GOAL mA	> 5/>10 h	1.5 h/ -

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 4x1000 m²
No. EXPERIMENTAL INTERSECTS 2
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

Electron spin rotator for longitudinally polarized $e^{+/-}$ beam at IP

TOTAL POWER USED (average) FOR RESEARCH MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET (without sal.)
ANN. RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

$e^{+/-}$ polarization time: 24 min

beam-beam tune shifts per IP:

ΔQ_x = 0.019 (e) / 0.0011 (p)

ΔQ_z = 0.021 (e) / 0.0008 (p)

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON PETRA II
INJECTOR FOR HERA
LOCATION DESY; Hamburg
PERSON IN CHARGE Martin Leneke DATE: 21.06.89
DATA SUPPLIED BY Martin Leneke

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Nov. 86
FIRST BEAM OBTAINED, or GOAL (date) Mar. 87 (Okt. 89)
TOTAL COST OF FACILITY 98 MDM (PETRA I)
TOTAL ACCELERATOR STAFF (now) see DESY II
ANN. OPERAT. BUDGET see DESY II (without salaries)
ANN. OPERATING TIME see below h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES $e^{\pm}$, (p)
ENERGY 14 (40) GeV
RING DIAM 733.4 m; TUNNEL SECT. (W x H) 3.1 x 2.5 m

Injector

TYPE Synchrotron DESY II (DESY III)
OUTPUT (max) mA at MeV
EMITTANCE* nmm-mrad
INJECTION PERIOD μs, or turns
INFLECTOR TYPE

Magnet System

FOCUSING TYPE sep. fct. FIELD INDEX n =
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 25.20 (11.4) ν_V 23.24 (11.16)
No. MAGNETS 224 + 8 LENGTH (ea) 5.317 m
BENDING FIELD at inj. 0.12 T; at max 0.24 (0.7) T
No. QUADS 232/72 LENGTH (ea) 0.66/1.0 m
GRAD. at inj. 8 T/m; at max 16 T/m
No. SHORT STRAIGHT SECT. 4 LENGTH 64.8 m
No. LONG STRAIGHT SECT. 4 LENGTH 108.0 m
RISE TIME 60 (120) s; FLAT-TOP TIME s
POWER INPUT PEAK 4.1 (15.6) MW; MEAN MW

Acceleration System

No. CAVITIES 16 (2) LENGTH (ea) 2.2 (1.6) m
HARMONIC NUMBER 3840 (400)
RF RANGE 499.665 (51.6) to 499.665 (52.0) MHz
ENERGY GAIN KeV/turn
RADIATION LOSS 17.7 at 14 GeV KeV/turn
RF POWER INPUT PEAK 2000 (100) kW; MEAN kW

Vacuum System

MATERIAL OF VAC. CHAMBER AL
APERTURE OF VAC. CHAMBER 114 x 56 mm
AVERAGE PRESSURE 10^{-8} torr

Extraction System

TYPE Fast Kicker with variable pulse width for single or multibunch extraction
LENGTH OF SPILL to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	14 (40)	
RESOLUTION ΔE/E (%)	8.4×10^{-2}	
REPET. RATE (pulse/s)	1 / 5 min	
PULSE WIDTH AT PEAK E		
INTERNAL BEAM (part/pulse)	$2.5\ (7) \times 10^{12}$	
(part/s)		
BEAM EMITTANCE*	0.1 (13.9)	nmm-mrad

BEAM LINES TO HERA e^-/e^+ and p^+ main rings

Other Relevant Parameters, Recent Improvements, etc.

Data in brackets relate to operation with protons.

For high energy physics operation until the end of 1986 the annual operating time was typically 6000 hours. 1987 to 1989 PETRA is being modified as e^-/e^+ and p^+-injector for the HERA main rings. Consequently, 1990 ff the operating time will be determined by HERA.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON DESY III
INJECTOR FOR PETRA II protons
LOCATION DESY, Hamburg, West Germany
PERSON IN CHARGE Günter Hemmie DATE: 23.06.89
DATA SUPPLIED BY Günter Hemmie

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Nov. 1986
FIRST BEAM OBTAINED, or GOAL (date) Febr. 22, 1989
TOTAL COST OF FACILITY 10 MDM *
TOTAL ACCELERATOR STAFF (now) see DESY II
ANN. OPERAT. BUDGET see DESY II (without salaries)
ANN. OPERATING TIME h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES 1.1×10^{12} p (goal)
ENERGY 7.5 GeV
RING DIAM 100.84 m; TUNNEL SECT. (W x H) 8.8 x 3.7 m

Injector

TYPE H^- RFQ + 3 x Alvares
OUTPUT(max) 7 mA at 50 MeV
EMITTANCE* 8 nmm-mrad
INJECTION PERIOD 30 μs, or 10 turns
INFLECTOR TYPE stripping foil + 4 kicker bump

Magnet System

FOCUSING TYPE AG FIELD INDEX n = (F) 69.51, (D) 70.16
FOCUSING ORDER 8 x (3 BMF + 3 BMD + QF1 + QD1 + QF2 + QD2)
BETATRON FREQ. ν_H 5.90 ν_V 4.82
No. MAGNETS 48 LENGTH (ea) 4.15 m
BENDING FIELD at inj. 0.0326 T; at max 0.788 T
No. QUADS 32 LENGTH (ea) 0.58 m
GRAD. at inj. 0.7 T/m; at max 16.9 T/m
No. SHORT STRAIGHT SECT. 8 LENGTH 1.85 m
No. LONG STRAIGHT SECT. 8 LENGTH 5.54 m
RISE TIME s; FLAT-TOP TIME s
POWER INPUT PEAK 1.5 MW; MEAN 0.5 MW

Acceleration System

No. CAVITIES 1 LENGTH(ea) 2.2 m
HARMONIC NUMBER 11
RF RANGE 3.27 to 10.324 MHz
ENERGY GAIN 5 KeV/turn
RADIATION LOSS - KeV/turn
RF POWER INPUT PEAK 40 kW; MEAN 15 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER Ø 84 mm
AVERAGE PRESSURE 10^{-7} torr

Extraction System

TYPE beam bump + septum + 2 kicker
LENGTH OF SPILL - to - μs

ACCELERATOR PERFORMANCE

		Normal (or Goal)	Maximum achieved
ENERGY (GeV)		7.5	7.5
RESOLUTION ΔE/E (%)		± 0.1	-
REPET. RATE (pulse/s)		0.25	0.25
PULSE WIDTH AT PEAK E		-	-
INTERNAL BEAM	(part/pulse)	1.1×10^{12}	6×10^{10} (May 89)
	(part/s)	2.75×10^{11}	1.5×10^{10}
BEAM EMITTANCE *		1	nmm-mrad

BEAM LINES TO PETRA II

Other Relevant Parameters, Recent Improvements, etc.

* without buildings and components already in existence from DESY I

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON DESY II
INJECTOR FOR DORIS and PETRA electrons and positrons
LOCATION DESY, Hamburg, West Germany
PERSON IN CHARGE G. Hemmie DATE: 23.06.89
DATA SUPPLIED BY G. Hemmie

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1983
FIRST BEAM OBTAINED, or GOAL (date) March 22, 1985
TOTAL COST OF FACILITY 14 MDM *
TOTAL ACCELERATOR STAFF (now) see below
ANN. OPERAT. BUDGET see below (without salaries)
ANN. OPERATING TIME 7500 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES e^-: $3x10^9$, e^+: $4x10^9$
ENERGY 7.0 .. 8.0 GeV
RING DIAM m; TUNNEL SECT. (W x H) 8.8x3.7 m
shared with DESY III

Injector

TYPE e^-Linac (or e^+-accumulator PIA)
OUTPUT(max) $5x10^9$ e^- ($8x10^9$ e^+) mA at 200 (450) MeV
EMITTANCE* 0.5 πmm-mrad
INJECTION PERIOD 1 μs, or 1 turns
INFLECTOR TYPE Septum + full apertur kicker

Magnet System

FOCUSING TYPE sep. funct. FIELD INDEX n = 0
FOCUSING ORDER FODO 8x (6BH + 3QF + 3QD +2SD + 1SE)
BETATRON FREQ. ν_H 6.575 ν_V 5.623
No. MAGNETS 48 LENGTH (ea) 3.55 m
BENDING FIELD at inj. 0.0246 T; at max 0.984 (8 GeV) T
No. QUADS 48 LENGTH (ea) .58 m
GRAD. at inj. .294 T/m; at max 11.7 T/m
No. SHORT STRAIGHT SECT. 8 LENGTH .93 m
No. LONG STRAIGHT SECT. 24 LENGTH 2.22 m
RISE TIME 40 m s; FLAT-TOP TIME - sinusoidal - s
POWER INPUT PEAK - MW; MEAN 1.7 MW

Acceleration System

No. CAVITIES 8 LENGTH(ea) 2.10 m
HARMONIC NUMBER 488
RF RANGE to 499.65 (fixed) MHz
ENERGY GAIN max. 314 KeV/turn
RADIATION LOSS max. 1318 KeV/turn
RF POWER INPUT PEAK 750 kW; MEAN 00 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 80 x 40 mm
AVERAGE PRESSURE 1×10^{-9} torr

Extraction System

TYPE 4 * Beam bump, Septum, Kicker

LENGTH OF SPILL to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	7	8
RESOLUTION ΔE/E (%)	0.1	0.1
REPET. RATE (pulse/s)	12.5	12.5
PULSE WIDTH AT PEAK E	< 1 ns (single bunch ejection)	
INTERNAL BEAM (part/pulse)	2×10^9	5×10^9
(part/s)	2.5×10^{10}	7×10^{10}

BEAM EMITTANCE * Ey = 1, Ez = .5 (7GeV) nmm-mrad
BEAM LINES TO DORIS (e^+,e^-), PETRA (e^+,e^-) + 3 -test (hall 2)

Other Relevant Parameters, Recent Improvements, etc.

* without buildings and components already in existence for DESY I.

The DESY accelerator complex consisting of LINAC I (200 MeV e^-), LINAC II with PIA (450 MeV e^+), LINAC III (50 MeV p^+), DESY II, DESY III, PETRA and DORIS, into which the 2 HERA-Main Rings will be incorporated after completion in 1990, is operated by the Accelerator Division, including also the electrical power, cooling, ventilation and heating facilities for the entire institute, and the experimental support group.

Total staff (now) 380
Ann. Operat. Budget without salaries and electrical power but including R&D and current investments for the accelerators already in existence 15 MDM

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS ADONE
INSTITUTION I.N.F.N. - Istituto Nazionale di Fisica Nucleare
LOCATION L.N.F. - Laboratori Nazionali di Frascati - c.p. 13 - 00044 Frascati (Rome) - Italy
PERSON IN CHARGE Miro Andrea PREGER DATE: 29/6/1989
DATA SUPPLIED BY Miro Andrea PREGER, F. TAZZIOLI

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1964
FIRST COLLISIONS, or GOAL (date) 1969
TOTAL COST OF FACILITY ~9×10^6 US $
TOTAL MACHINE STAFF (now) 80
ANN. OPERAT. BUDGET ~1000 K $ (without salaries)
ANN. OPERATING TIME See Notes h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES e^+, e^-
ENERGY 1.55 GeV
APPROX. SHAPE circular DIMENTIONS 33.42 m Ø
ORBIT: Length 104.9 m m, time 0.35 μs
No. INTERSECTS 6 CROSSING ANGLE 0

Injector System

TYPE LINAC
INJ. ENERGY 350 MeV OUTPUT 100mA e^-, 2mA e^+ (10ns)
EMITTANCE* 1 e^- + 10 e^+ πmm-mrad
FILLING SPEED 10mA/S e^- - .1 mA/S e^+
TOTAL FILLING TYME 20 minutes

Magnet System

FOCUSING TYPE Separated Functions BEND. RAD. 5.00 m
LATTICE ORDER 0/2 FODOBODOFO/2
No. MAGNETS 12 LENGTH (ea) 2.618 m
No. QUADS 48 LENGTH (ea) .532 m
MAX BEND. FIELD 1.1 T; MAX GRAD. 5 T/m
OTHER MAGNETS 1 WIGGLER (6 Polex - 1.85 T)
BETATRON FREQ. ν_H 3.05 ν_V 3.05
AMPL. FUNCT. AT INTERSECT. (H) 4.5 ÷ 9 m (V) 15 ÷ 3

Acceleration System

HARMONIC No. 18 FREQUENCY 51.4 MHz
No. TRANSMITTERS 1 No. CAVITIES 1
BUNCH TO BUNCH TIME 350 ns (1 bunch beam) 117 ns (3 bunches/beam)
BUNCH SIZE (L x W x H) (250 x 4.3 x 2.6) 1.5 GeV FWHM
PEAK RF VOLTAGE PER BEAM 200 KV
MAX RF POWER 40 KW ON BEAMS 10 KW

Vacuum System

PRESSURE IN RINGS, NO BEAM 50×10^{-10} Torr
WITH BEAM 5×10^{-11} Torr/mA
PRESSURE AT INTERSECTIONS 5×10^{-9} Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.55	
RESOLUTION ΔE/E (%)	5.7×10^{-4} r.m.s.	
LUMINOSITY ($cm^{-2} sec^{-1}$)	3×10^{29}	
BEAM SIZE, horizontal	3.2 (26)	
vertical	1.8 (26)	
CURRENT, PER BEAM (mA)	50	
BEAM LIFE, AT 50 mA	~5 h	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA ~80 m^2
No. EXPERIMENTAL INTERSECTS 1
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

- LADON: Laser backscatter monochromatic Tagged - ray facility ($5 \leq E\gamma \leq 80$ MeV)
- JET TARGET: Internal gas target for nuclear physics (10^{-8} g/cm^2)

See Storage Rings for Synchrotron Radiations Sources

TOTAL POWER USED (average) FOR RESEARCH 1.5 MW
No. USER GROUPS, in house 3 outside 16
TOTAL RESEARCH STAFF, in house 23 outside 75
ANN. RESEARCH BUDGET 620 ML (without sal.)
ANN. RESEARCH TIME 60% Adone beam time h

Other Relevant Parameters, Recent Improvements, etc.

The storage rings has been used with a single electron beam since 1978.
Colliding beam operation foreseen in 1989 for $e^+ + e^- \rightarrow N\bar{N}$ experiment.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS: TRISTAN Main Ring
INSTITUTION: National Laboratory for High Energy Physics, KEK
LOCATION: 1-1 Oho, Tsukuba, Ibaraki, 305, Japan
PERSON IN CHARGE: Koji Takata / Shin-ichi Kurokawa — DATE: July, 1989
DATA SUPPLIED BY: Shin-ichi Kurokawa

HISTORY AND STATUS

CONSTRUCTION STARTED (date)	Nov. 1981
FIRST COLLISIONS, or GOAL (date)	Nov. 1986
TOTAL COST OF FACILITY	8×10^{10} Yen
TOTAL MACHINE STAFF (now)	100
ANN. OPERAT. BUDGET	1.0×10^{10} Yen (without salaries)
ANN. OPERATING TIME	3500 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES: electron and positron
ENERGY: 2 × 30 GeV
APPROX. SHAPE: * DIMENTIONS: 960 m diam.
ORBIT: Length: 3018 m, time: 10 μs
No. INTERSECTS: 4 CROSSING ANGLE: 0 degree

Injector System

TYPE: TRISTAN Accumulation Ring**
INJ. ENERGY: 2.5 GeV OUTPUT: 8.0 GeV
EMITTANCE*: 0.44 πmm-mrad
FILLING SPEED: 4 ∿ 6 fill / beam
TOTAL FILLING TYME: 20 - 30 min

Magnet System

FOCUSING TYPE: separated function BEND. RAD.: 247 m
LATTICE ORDER: FODO
No. MAGNETS: 272 LENGTH (ea): 5.86 m
No. QUADS: 344 LENGTH (ea): 0.8 or 1.0 m
MAX BEND. FIELD: 0.406 T; MAX GRAD. 16.1or18.0 T/m
OTHER MAGNETS: 240 sextupole, 48 experimental insertion quads
BETATRON FREQ. ν_H: 36.6 ν_V: 38.7
AMPL. FUNCT. AT INTERSECT, (H): 1.8 m (V): 0.1 m

Acceleration System

HARMONIC No.: 5120 FREQUENCY: 508.58 MHz
No. TRANSMITTERS: 30 klystrons No. CAVITIES: **
BUNCH TO BUNCH TIME: 5 μsec
BUNCH SIZE (L × W × H): 1.2 cm × 1 mm × 0.1 mm (σ)
PEAK RF VOLTAGE PER BEAM: 400 MV
MAX RF POWER: 22 MW ON BEAMS: 3 MW

Vacuum System

PRESSURE IN RINGS, NO BEAM: 1×10^{-9} Torr
WITH BEAM: 2×10^{-9} Torr/mA
PRESSURE AT INTERSECTIONS: $\sim 10^{-9}$ (with beam) Torr

* Four quadrant arcs of 347 m in the mean curveture radius are connected together by four 194-m long straight sections

** Injector for the TRISTAN Accumulation Ring is KEK 2.5 GeV linac (see KEK 2.5 GeV linac).

*** 104 9-cell APS cavities and 16 5-cell superconductin cavities

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	30.0	30.7
RESOLUTION ΔE/E (%)	0.16 (σ)	
LUMINOSITY ($cm^{-2} sec^{-1}$)	1.0×10^{31}	1.4×10^{31}
BEAM SIZE, horizontal	480 μm (σ)	
vertical	12 μm (σ)	
CURRENT, PER BEAM (mA)		7
BEAM LIFE, AT 10 mA		3 ∿ 4

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA: 5600 (Sum of 4 exp. area) m^2
No. EXPERIMENTAL INTERSECTS: 4
No. EXPERIMENT/INTERSECT: 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

Three out of four experimental intersections are occupied. The name of detectors are: VENUS, TOPAZ, and AMY.

TOTAL POWER USED (average) FOR RESEARCH: 10 MW
No. USER GROUPS: 3
TOTAL RESEARCH STAFF, in house: 64 outside: 246
ANN. RESEARCH BUDGET: 2×10^9 Yen (without sal.)
ANN. RESEARCH TIME: 2500 h

Other Relevant Parameters, Recent Improvements, etc.

1. Superconducting cavities were installed during the summer shutdown of 1988. The RF voltage supplied by conventional cavities is 320 MV, and that by superconducting cavities is 100 MV at 30.7 GeV operation.

2. During the summer shutdown of 1989, another 16 5-cell cavities will be installed; which increase the energy of MR to 32 - 33 GeV.

3. During the summer shutdown of 1989, mini-β superconducting quadrupole magnets are to be installed; factor two increase of the luminosity is expected.

NAME OF STORAGE RINGS: RELATIVISTIC HEAVY ION COLLIDER (RHIC)
INSTITUTION: BROOKHAVEN NATIONAL LABORATORY
LOCATION: UPTON, NEW YORK 11973 USA
PERSON IN CHARGE: S. OZAKI DATE: OCTOBER 1989
DATA SUPPLIED BY: E.B. FORSYTH

HISTORY AND STATUS

CONSTRUCTION STARTED (date)	October 1990
FIRST COLLISIONS, or GOAL (date)	September 1996
TOTAL COST OF FACILITY	$395M
TOTAL MACHINE STAFF (now)	33
ANN. OPERAT. BUDGET	$32M (without salaries)
ANN. OPERATING TIME	6700 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES: Protons and ions up to gold
ENERGY: 100 GeV/Amu GeV
APPROX. SHAPE: Circular DIMENTIONS: Beam tube 8 cm dia
ORBIT: Length: 3833 m, time: 12.8 μs
No. INTERSECTS: 6 CROSSING ANGLE: 0

Injector System

TYPE: Synchrotron
INJ. ENERGY: ∿ 30 GeV OUTPUT:
EMITTANCE*: 20 (protons) 10 (H.I.) πmm-mrad
FILLING SPEED: ∿ 1 bunch/second
TOTAL FILLING TYME: ∿ 2 min (both rings)

Magnet System

FOCUSING TYPE: Separated Function BEND. RAD.: 381 m
LATTICE ORDER: FODO
No. MAGNETS: 288 (arcs) LENGTH (ea): 9.71 m
No. QUADS: 276 (arcs) LENGTH (ea): 1.1 m
MAX BEND. FIELD: 3.5 T; MAX GRAD.: 72 T/m
OTHER MAGNETS: Insertion Injection Ejection
BETATRON FREQ. ν_H: 28.825 ν_V: 28.825
AMPL. FUNCT. AT INTERSECT, (H): 2 to 6 m (V): 2 to 6 m

Acceleration System

(Store) 26.7 (accel)
HARMONIC No. 342 (accel) 2052 FREQUENCY: 160 (Store) MHz
No. TRANSMITTERS: 4 (accel) 12 (Store) No. CAVITIES: 4 (accel) 12 (Store)
BUNCH TO BUNCH TIME: 225 ns
BUNCH SIZE (L × W × H): 31×0.016×0.016cm (proton with β*=2m)
PEAK RF VOLTAGE PER BEAM: 400 kV (Accel) 4.5 MeV (Store)
MAX RF POWER: 180kw (Accel) 1.5MW (Both Rings) ON BEAMS: 3kw (per beam during accel.) (Store)

Vacuum System

PRESSURE IN RINGS, NO BEAM: $< 10^{-10}$ Torr
WITH BEAM: Not applicable Torr/mA
PRESSURE AT INTERSECTIONS: $< 10^{-10}$ Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	100 GeV/Amu	
RESOLUTION ΔE/E (%)	0.25×10^{-3} (rms)	
LUMINOSITY ($cm^{-2} sec^{-1}$)	1.4×10^{31} (proton)	1×10^{27} (gold)
BEAM SIZE, horizontal	3 mm	GOLD at γ = 30
vertical	3 m	
CURRENT, PER BEAM (mA)	67 (protons)	
BEAM LIFE, AT ____ mA	10 h	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA: 4046 m^2
No. EXPERIMENTAL INTERSECTS: 6
No. EXPERIMENT/INTERSECT: 1 to 4
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

The research equipment will include approximately 3 large collider detectors whose design and performance specifications will be determined by a process of proposals and review by program committee. It is expected that the call for proposals will be made in October 1990.

TOTAL POWER USED (average) FOR RESEARCH: 8.8 MW
No. USER GROUPS, in house: 3 outside: 20
TOTAL RESEARCH STAFF, in house: ∿ 25 outside: 200
ANN. RESEARCH BUDGET: ∿ $30M (without sal.)
ANN. RESEARCH TIME: 6000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS CESR - Cornell Electron Storage Ring
INSTITUTION Cornell University
LOCATION Ithaca, NY, USA
PERSON IN CHARGE David Rice DATE: July, 1989
DATA SUPPLIED BY David Rice

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Nov. 1978
FIRST COLLISIONS, or GOAL (date) June, 1979
TOTAL COST OF FACILITY $20Million
TOTAL MACHINE STAFF (now) 60
ANN. OPERAT. BUDGET $3.5 Million (without salaries)
ANN. OPERATING TIME 6000 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES $e^+ e^-$
ENERGY 8 x 8 GeV
APPROX. SHAPE circular DIMENTIONS R = 120 m
ORBIT: Length 768 m, time 2.5 μs
No. INTERSECTS 2 CROSSING ANGLE 0

Injector System

TYPE Synchrotron / linac
INJ. ENERGY 300 MeV OUTPUT 8 GeV
EMITTANCE* 0.1 πmm-mrad
FILLING SPEED 12 mA/min e^+, 30 mA/min e^-
TOTAL FILLING TYME 20 minutes

Magnet System

FOCUSING TYPE AG BEND. RAD. 88 m
LATTICE ORDER FODO
No. MAGNETS 94 LENGTH (ea) 6.6 m
No. QUADS 104 LENGTH (ea) 0.6 m
MAX BEND. FIELD 1.1 T; MAX GRAD. 15 T/m
OTHER MAGNETS REC perm mag. quads, 1.5 T wiggler
BETATRON FREQ. ν_H 9.43 ν_V 9.38
AMPL. FUNCT. AT INTERSECT. (H) 1.0 (V) .015

Acceleration System

HARMONIC No. 1281 FREQUENCY 500 MHz
No. TRANSMITTERS 2 No. CAVITIES 2
BUNCH TO BUNCH TIME 360 nS
BUNCH SIZE (L x W x H) (sigma) 17 x 0.5 x 0.011 mm
PEAK RF VOLTAGE PER BEAM 8 MV
MAX RF POWER 700 kW ON BEAMS 250 kW

Vacuum System

PRESSURE IN RINGS, NO BEAM 10^{-9} Torr
WITH BEAM 10^{-10} Torr/mA
PRESSURE AT INTERSECTIONS 5×10^{-9} Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	8	6
RESOLUTION ΔE/E (%)	0.1	0.07
LUMINOSITY ($cm^{-2} sec^{-1}$)	10^{32}	10^{32}
BEAM SIZE, horizontal	0.5 mm	
vertical	11 um	
CURRENT, PER BEAM (mA)	100	80
BEAM LIFE, AT 2 x 80 mA		3 hours

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 1000 m^2
No. EXPERIMENTAL INTERSECTS 2
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

CLEO II-general purpose magnetic detector w/ photon calorimeter

CUSB -photon detector

CHESS - synchrotron radiation facility

TOTAL POWER USED (average) FOR RESEARCH 2.7 MW
No. USER GROUPS, in house 1 outside 15
TOTAL RESEARCH STAFF, in house 38 outside 75
ANN. RESEARCH BUDGET $ 1 M (without sal.)
ANN. RESEARCH TIME 4000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS Tevatron
INSTITUTION Fermilab
LOCATION Batavia, Il. 60510
PERSON IN CHARGE David Finley DATE: June 27, 1989
DATA SUPPLIED BY David Finley, et al

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1979
FIRST COLLISIONS, or GOAL (date) October 1985
TOTAL COST OF FACILITY 136M$
TOTAL MACHINE STAFF (now) 10 physicists
ANN. OPERAT. BUDGET 4.0M$ (without salaries)
ANN. OPERATING TIME 4000 h

STORAGE RINGS PARAMETERS

General
COLLIDING PARTICLES proton and antiproton
ENERGY 1.8 TeV center-of-mass ~~GeV~~
APPROX. SHAPE circular DIMENTIONS 1km radius
ORBIT: Length 2πkm time 21 μs
No. INTERSECTS 12 (1989) CROSSING ANGLE zero

Injector System
TYPE alternating gradient synchrotron
INJ. ENERGY 150 GeV OUTPUT 900 GeV (1989)
EMITTANCE* 15 πmm-mrad
FILLING SPEED 1 bunch per 8 seconds
TOTAL FILLING TYME 13 minutes

Magnet System
FOCUSING TYPE Alternating Gradient BEND. RAD. 754 m
LATTICE ORDER FODO
No. MAGNETS 774 LENGTH (ea) 6.12 m
No. QUADS 216 LENGTH (ea) 1.68 m
MAX BEND. FIELD 4.40 T; MAX GRAD. 76.0 T/m
OTHER MAGNETS 8 low-beta quads
BETATRON FREQ. ν_H 19.415 ν_V 19.410
AMPL. FUNCT. AT INTERSECT. (H) 1/2m (V) 1/2 m

Acceleration System
HARMONIC No. 1113 FREQUENCY 53 MHz
No. TRANSMITTERS 8 No. CAVITIES 8
BUNCH TO BUNCH TIME 3.8 μs for 6 bunches
BUNCH SIZE (L x W x H) 240 cm x 3.0 mm x 3.0 mm
PEAK RF VOLTAGE PER BEAM 1.2 MV
MAX RF POWER 800 KW ON BEAMS neglect.

Vacuum System
PRESSURE IN RINGS, NO BEAM 10^{-10} Torr
WITH BEAM no change with beam Torr/mA
PRESSURE AT INTERSECTIONS 10^{-9} Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	2x1000	2x900
RESOLUTION ΔE/E (%)	0.09	0.09
LUMINOSITY ($cm^{-2} sec^{-1}$)	$1x10^{30}$	$2x10^{30}$
BEAM SIZE, horizontal	43 μm	43 μm
vertical	43 μm	43μm
CURRENT, PER BEAM (mA)	see below	
BEAM LIFE, AT ____ mA	24 hours	40 hours

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 740 m^2
No. EXPERIMENTAL INTERSECTS 4
No. EXPERIMENT/INTERSECT one
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH 3 MW
No. USER GROUPS, in house 3 outside 29
TOTAL RESEARCH STAFF, in house 40 outside 300
ANN. RESEARCH BUDGET (without sal.)
ANN. RESEARCH TIME 4000 h

Other Relevant Parameters, Recent Improvements, etc.

"current, per beam (MA)" is not convenient for the Tevatron Collider. Rather we propose:

	Normal (or goal)	Maximum achieved
protons	$6x10^{10}$	$7x10^{10}$
antiprotons	$6x10^{10}$	$3x10^{10}$

6 bunches per beam.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS PEP (Positron Electron Project)
INSTITUTION Stanford Linear Accelerator Center (SLAC)
LOCATION Stanford, California 94309 USA
PERSON IN CHARGE Burton Richter DATE: June 1989
DATA SUPPLIED BY Max Cornacchia, Martin Donald

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1976
FIRST COLLISIONS, or GOAL (date) May 1980
TOTAL COST OF FACILITY $78 Million
TOTAL MACHINE STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 1700 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES Electron - Positron
ENERGY 13.7 GeV
APPROX. SHAPE Hexagon DIMENTIONS
ORBIT: Length 2,200 m, time 7.33 μs
No. INTERSECTS 1 CROSSING ANGLE 0

Injector System

TYPE Linac
INJ. ENERGY 13.7 GeV OUTPUT
EMITTANCE 0.1 πmm-mrad
FILLING SPEED 10 mA/min
TOTAL FILLING TYME 10 minutes

Magnet System

FOCUSING TYPE FODO BEND. RAD. 165 m
LATTICE ORDER
No. MAGNETS 192 LENGTH (ea) 5.4 m
No. QUADS 242 LENGTH (ea) various m
MAX BEND. FIELD 0.28 T; MAX GRAD. 7.8 T/m
OTHER MAGNETS Sextupoles
BETATRON FREQ. ν_H 21.28 ν_V 18.2
AMPL. FUNCT. AT INTERSECT, (H) 1.35 (V) 0.054

Acceleration System

HARMONIC No. 2592 FREQUENCY 353.21 MHz
No. TRANSMITTERS 12 No. CAVITIES 24
BUNCH TO BUNCH TIME 2.4 μsec (1 beam)
BUNCH SIZE (L×W×H)* 17.1 × 0.36 × 0.015 mm³ (at IP)
PEAK RF VOLTAGE PER BEAM 30 MV
MAX RF POWER 3.3 MW ON BEAMS 0.85MW at 13.7GeV for 20mA/beam

Vacuum System

PRESSURE IN RINGS, NO BEAM 1×10^{-9} Torr
WITH BEAM 1×10^{-8} Torr/mA
PRESSURE AT INTERSECTIONS Torr

STORAGE RINGS PERFORMANCE

	Recent	Maximum † achieved
ENERGY (GeV)	13.7	16
RESOLUTION ΔE/E (%)	0.091	
LUMINOSITY ($cm^{-2} sec^{-1}$)	5.0×10^{31}	5.9×10^{31}
BEAM SIZE, horizontal *	0.36 mm	
vertical *	0.015 mm	
CURRENT, PER BEAM (mA)	20	21
BEAM LIFE, AT 18 mA	4 hours	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 1000 m²
No. EXPERIMENTAL INTERSECTS 1
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH 12 MW‡
No. USER GROUPS, in house 1 outside 6
TOTAL RESEARCH STAFF, in house 5 outside 64
ANN. RESEARCH BUDGET (without sal.)
ANN. RESEARCH TIME h

*The numbers here are σ's.
†Not obtained simultaneously.
‡This number includes the ring and one detector.

Other Relevant Parameters, Recent Improvements etc.

Published Articles Describing Machine:

a) A proposal for a Positron Electron Colliding Beam Storage Ring Project (PEP), SLAC-Report-171.

b) PEP Conceptual Design Report, SLAC-Report-189.

c) J. R. Rees, The Positron Electron Project – PEP, IEEE, Vol. NS-24, No. 3, p 1836 (1977).

d) J. M. Paterson, PEP, Proceedings of the 11th International Conference on High Energy Accelerators, Geneva, Switzerland, July 7-11, 1980. SLAC-PUB-2555, July 1980.

e) J. R. Rees, The PEP Storage Ring: Current Status, Proceedings of the 1981 Particle Accelerator Conference, Washington, D.C., March 11-13, 1981. SLAC-PUB-2684, February 1981.

NAME OF STORAGE RINGS Superconducting Super Collider
INSTITUTION SSC Laboratory
LOCATION Stoneridge Office Park, 2550 Beckleymeade Ave. Suite260, Dallae, Tx 75237
PERSON IN CHARGE Roy Schwitters DATE: 7/24/89
DATA SUPPLIED BY A. Chao, H. Edwards

HISTORY AND STATUS

CONSTRUCTION STARTED (date) goal 1990
FIRST COLLISIONS, or GOAL (date) goal 1998
TOTAL COST OF FACILITY est. $6B
TOTAL MACHINE STAFF (now) 30
ANN. OPERAT. BUDGET 160 M$ (without salaries)
ANN. OPERATING TIME 6000 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES proton proton
ENERGY 20 x 20 TeV
APPROX. SHAPE recetrack DIMENTIONS R11.6x14.2
ORBIT: Length 86,760 m, time 289 μs
No. INTERSECTS 6 CROSSING ANGLE 75 μr

Injector System

TYPE Cascade chain, 3 synchrotron, linac
INJ. ENERGY 2 TeV OUTPUT
EMITTANCE* 4.6 πmm-mrad
FILLING SPEED
TOTAL FILLING TYME 1/2 hr.

Magnet System

FOCUSING TYPE FODO BEND. RAD. 10187 m
LATTICE ORDER
No. MAGNETS 5040 x 2 LENGTH (ea) 12.7 m
No. QUADS 802x2 (cell) LENGTH (ea) 5.2 m
MAX BEND. FIELD 6.6 T; MAX GRAD. 205 T/m
OTHER MAGNETS triplet IR quads, insertion, utilities
BETATRON FREQ. ν_H 121.285 ν_V 122.265
AMPL. FUNCT. AT INTERSECT. (H) 0.5 m (V) 0.5 m

Acceleration System

HARMONIC No. 104112 FREQUENCY 360 MHz
No. TRANSMITTERS 2/ring No. CAVITIES 8/ring
BUNCH TO BUNCH TIME 16.7 nsec
BUNCH SIZE (L x W x H) rms 75 mm x 0.13 mm x 0.13 mm
PEAK RF VOLTAGE PER BEAM 20 MV
MAX RF POWER 2 MW ON BEAMS

Vacuum System

PRESSURE IN RINGS, NO BEAM Torr
WITH BEAM 10**-8 Torr. full beam
PRESSURE AT INTERSECTIONS Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	20,000	
RESOLUTION ΔE/E (%)	0.175 ini	
LUMINOSITY ($cm^{-2} sec^{-1}$)	10*33/IP	
BEAM SIZE, horizontal	5 μm IP	
vertical	5 μm IP	
CURRENT, PER BEAM (mA)	73	
BEAM LIFE, AT 73 mA	24 hrs	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 7500 m^2 (4 IR Halls) m^2
No. EXPERIMENTAL INTERSECTS 4 - 6
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

4 π detectors, etc.

TOTAL POWER USED (average) FOR RESEARCH NA MW
No. USER GROUPS, in house NA outside NA
TOTAL RESEARCH STAFF, in house 400 (est) outside
ANN. RESEARCH BUDGET NA (without sal.)
ANN. RESEARCH TIME 5000 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area x $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS: UNK (3 TeV Accelerating and Storage Complex)
INSTITUTION: IHEP
LOCATION: Serpukhov, Moscow Dist., USSR
PERSON IN CHARGE: K. P. Myznikov — DATE: 27.06.89
DATA SUPPLIED BY: K. P. Myznikov

HISTORY AND STATUS

CONSTRUCTION STARTED (date)	1982
FIRST COLLISIONS, or GOAL (date)	1995
TOTAL COST OF FACILITY	$1.5 \cdot 10^9$
TOTAL MACHINE STAFF (now)	500
ANN. OPERAT. BUDGET	— (without salaries)
ANN. OPERATING TIME	5000 h

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES: p-p
ENERGY: 3000 GeV
APPROX. SHAPE: ellipse — DIMENTIONS: 3.1×3.5 km
ORBIT: Length: 20772 m, time: 69.3 μs
No. INTERSECTS: 4 — CROSSING ANGLE: 350 μrad

Injector System

TYPE: synchrotron
INJ. ENERGY: 400 GeV — OUTPUT:
EMITTANCE*: 30 πmm-mrad
FILLING SPEED:
TOTAL FILLING TYME: 10 min

Magnet System

FOCUSING TYPE: FODO — BEND. RAD.: 2003.639 m
LATTICE ORDER: 1
No. MAGNETS: 2194 — LENGTH (ea): 5.8 m
No. QUADS: 496 — LENGTH (ea): 3.7 m
MAX BEND. FIELD: 5 T; MAX GRAD.: 17 T/m
OTHER MAGNETS:
BETATRON FREQ. ν_H: 36.70 — ν_V: 36.70
AMPL. FUNCT. AT INTERSECT, (H): 1 m — (V): 1 m

Acceleration System

HARMONIC No.: 13860 — FREQUENCY: 200 MHz
No. TRANSMITTERS: — No. CAVITIES: 8
BUNCH TO BUNCH TIME: 25 ns
BUNCH SIZE (L×W×H): 10 cm × 1 mm × 1 mm
PEAK RF VOLTAGE PER BEAM: 7 MV
MAX RF POWER: 6 MW — ON BEAMS: 1.46 MW

Vacuum System

PRESSURE IN RINGS, NO BEAM: $5 \cdot 10^{-10}$ Torr
WITH BEAM: Torr/mA
PRESSURE AT INTERSECTIONS: $1 \cdot 10^{-10}$ Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	3000	
RESOLUTION ΔE/E (%)	$\pm 5 \cdot 10^{-3}$	
LUMINOSITY ($cm^{-2} sec^{-1}$)	$4 \cdot 10^{32}$	
BEAM SIZE, horizontal	100 μm	
vertical	100 μm	
CURRENT, PER BEAM (mA)	550	
BEAM LIFE, AT ____ mA	10 H	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA: 3 × 1000 m^2
No. EXPERIMENTAL INTERSECTS: 2
No. EXPERIMENT/INTERSECT: 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH: 160 MW
No. USER GROUPS, in house: — outside: —
TOTAL RESEARCH STAFF, in house: — outside: —
ANN. RESEARCH BUDGET: — (without sal.)
ANN. RESEARCH TIME: — h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF STORAGE RINGS VEPP-4M
INSTITUTION Institute of Nuclear Physics
LOCATION Novosibirsk, USSR
PERSON IN CHARGE I.Ya.Protopopov, A.A.Zholents DATE: July 12, 1989
DATA SUPPLIED BY

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Reconstr 1987
FIRST COLLISIONS, or GOAL (date) 1990
TOTAL COST OF FACILITY
TOTAL MACHINE STAFF (now) 30
ANN. OPERAT. BUDGET - (without salaries)
ANN. OPERATING TIME h

STORAGE RINGS PARAMETERS

General
COLLIDING PARTICLES e^+, e^-
ENERGY 6 GeV
APPROX. SHAPE ring DIMENTIONS
ORBIT: Length 365 m, time μs
No. INTERSECTS 1 CROSSING ANGLE 0

Injector System
TYPE Linac+Synchrotron+Booster storage ring VEPP-3
INJ. ENERGY 1.85 GeV OUTPUT
EMITTANCE* H:0.4, V:0.02 (E=6 GeV) nmm-mrad
FILLING SPEED 3 mA/min
TOTAL FILLING TYME 15 min

Magnet System
FOCUSING TYPE FODO+combine+fun BEND. RAD. 33 m
LATTICE ORDER
No. MAGNETS 78 LENGTH (ea) 2 m
No. QUADS 150 LENGTH (ea) 1 m
MAX BEND. FIELD 0.6 T; MAX GRAD. 6 T/m
OTHER MAGNETS
BETATRON FREQ. ν_H 9.6 ν_V 8.6
AMPL. FUNCT. AT INTERSECT. (H) 0.8 M (V) 0.05M

Acceleration System
HARMONIC No. 222 FREQUENCY 180 MHz
No. TRANSMITTERS No. CAVITIES 6
BUNCH TO BUNCH TIME 0.6 mks
BUNCH SIZE (L x W x H) L:5 cm
PEAK RF VOLTAGE PER BEAM 5 MV
MAX RF POWER 1 MW ON BEAMS 0.3 MW

Vacuum System
PRESSURE IN RINGS, NO BEAM 10^{-9} Torr
WITH BEAM Torr/mA
PRESSURE AT INTERSECTIONS Torr

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	5.5	6
RESOLUTION ΔE/E (%)	0.1	
LUMINOSITY ($cm^{-2} sec^{-1}$)	10^{32}	
BEAM SIZE, horizontal	1 mm	
vertical	0.05 mm	
CURRENT, PER BEAM (mA)	40	
BEAM LIFE, AT mA		

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 20 m^2
No. EXPERIMENTAL INTERSECTS 1
No. EXPERIMENT/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES: tagging system scattering electrons

TOTAL POWER USED (average) FOR RESEARCH MW
No. USER GROUPS, in house outside -
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET (without sal.)
ANN. RESEARCH TIME h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINEAR COLLIDER: SLAC Linear Collider (SLC) (Also see under SLAC Linac)
INSTITUTION: Stanford Linear Accelerator Center (SLAC)
LOCATION: Stanford, California 94309 USA
PERSON IN CHARGE: Burton Richter DATE: June 1989
DATA SUPPLIED BY: Andrew Hutton, John Sheppard

HISTORY AND STATUS

CONSTRUCTION STARTED (date): October 1983
FIRST BEAM OBTAINED, or GOAL (date): March 1987
TOTAL COST OF FACILITY: $115 Million
TOTAL ACCELERATOR STAFF (now):
ANN. OPERAT. BUDGET: (without salaries)
ANN. OPERATING TIME: h

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH: 3050 m
TUNNEL SIZE (L x W x H): 3050 × 3.05 × 3.35 m

Damping Ring and Source

ENERGY: 1.15 - 1.21 GeV
CIRCUMFERENCE: 35.27 m
DAMPED EMITANCE*: Hor. 16 nmm-mrad; Ver. 16 nmm-mrad
DAMPED ΔE/E: 7.3×10^{-2} %
DAMPING TIME: τ_H 3.4 msec; τ_V 3.4 msec; τ_L 1.5 msec
BUNCHER, PRE-ACCELERATION: 178.5 MHz/2856 MHz
POSITRON SOURCE: 30 GeV e^- on Tungsten Rhenium Target
POLARIZATION: 42% e^-, planned for 1990

Main Linac Acceleration System See under SLAC Linac.

No. SECTIONS: LENGTH(ea): m
FIELD MODE: FREQUENCY: GHz
GROUP VELOCITY: c; PHASE VEL.: c
WAVE TYPE: FILLING TIME: μs
SHUNT IMPEDANCE: MΩ/m
ATTENUATION: Np/m
IRIS, APERTURE: mm, THICKNESS: mm
IRIS SPACING: mm
Q:
POWER UNITS, No.: TYPE:
POWER RATING: MW/unit
FEED SPACING: m
RF POWER INPUT PEAK: MW; MEAN: MW
PEAK GRADIENT: MV/m

Main Linac Focusing System

TYPE, No. of LENSES and SPACING:

Main Linac *Vacuum System*

MATERIAL OF VAC.CHAMBER:
APERTURE OF VAC. CHAMBER: mm
AVERAGE PRESSURE: torr

FINAL FOCUS

FINAL FOCUS LENGTH (1 BEAM): 152 m
CHROMATIC CORRECTION: 2 sextupole families
FINAL QUAD: Presently Iron Quad Triplet, Superconducting
CROSSING ANGLE: Zero mrad Quad Triplet in 1990

COLLIDER PERFORMANCE

	Normal	Maximum† achieved
ENERGY (GeV)/ at Inter-action Point	46	46.5
ENERGY SPREAD ΔE/E (%) (σ)	0.2	0.2
LUMINOSITY ($cm^{-2}sec^{-1}$) 10^{28}	(6×10^{30} goal)	1.3×10^{28}
REPET. RATE (pulse/s)	60 (120 goal)	60
No. PART/BUNCH 1.5×10^{10}	(6×10^{10} goal)	2×10^{10}
BUNCH LENGTH (mm)	~1	1
BUNCH / TRAIN	1	1
BEAM SIZE, horizontal (μm)	3 (1.6 goal)	2.5
vertical (μm)	3 (1.6 goal)	2
β* at COLL. POINT, horizontal (mm)	10 (5 goal)	10
vertical (mm)	10 (5 goal)	10
FREE SPACE AT COLL. POINT (m)	5.6‡	5.6

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS: 1400 m^2
TOTAL POWER USED (AVERAGE) FOR RESEARCH: 3.5 MW*
No. USER GROUPS, in house: 6 outside: 40
TOTAL RESEARCH STAFF, in house: 86 outside: 268
ANN. RESEARCH BUDGET, in house: (without sal.)
ANN. RESEARCH TIME: ~6000 h
SPECIAL RESEARCH EQUIPMENT FACILITIES:

*This power includes only the Collider Hall and Mark II detector.

†Not obtained simultaneously.

‡This number will be reduced to 4.4 m when the Superconducting Quads are installed in 1990.

Other Relevant Parameters, Recent Improvements etc.

Published Articles Describing Machine:

SLC Design Handbook, SLAC, December 1984.

*Normarized emittance, coupled.

NAME OF SYNCHROTRON LIGHT SOURCE BSRL
LOCATION Institute of High Energy Physics, Beijing, 100039, P.R. China
PERSON IN CHARGE Prof. Dingchang Xian DATE: June 16, 1989
DATA SUPPLIED BY Shouxian Fang and Dingchang Xian

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X, SYNCHROTRON ____
CONSTRUCTION STARTED (date) Apr. 1984
FIRST BEAM, or GOAL (date) Oct. 16, 1988
TOTAL COST OF FACILITY $ 80 M
TOTAL MACHINE STAFF (now) 500
ANN. OPERAT. BUDGET $ 5 M (without salaries)
ANN. OPERATING TIME 5000 h
OPERATION TIME OF RING:
USER EXPERIMENT ____ hrs dedicated, ____ hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION ____ hrs/day, ____ days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
W	com	1.8	1+2	167	9380

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR electron LINAC
INJECTION CYCLE (Hz) 12.5
INJECTION ENERGY (GeV) 1.1 - 1.4
ORBITAL PERIOD(nsec) 801.33
BENDING RADIUS(m) 10.344
RF ACCELERATION FREQUENCY(MHz) 199.55
MAXIMUM ENERGY ACHIEVED(GeV) 1.6 at 200 mA
MAXIMUM ENERGY PLANNED (GeV) 2.8 at 150 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) ____ at ____ GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME			
ELECTRON OR POSITRON			
ENERGY (GeV)			
NUMBER OF BUNCHES			
INITIAL CURRENT (mA)			
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at ____ mA			
EMITTANCE (nmrad) Hor			
Ver			
BUNCH DURATION (nsec)			

Beam Lines

MAIN PORTS : IN OP ____, IN CONST 3, TOTAL POSSIBLE 20

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)		2	
UV/VUV (6 - 300 eV)		1	
SOFT X (> 300 - 3000eV)		2	
X (>3000eV)		5	

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 9 outside ____
TOTAL RESEARCH STAFF, in house 40 outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total) ____
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

All beam lines and experimental stations are in commissioning/construction stage.

NAME OF SYNCHROTRON LIGHT SOURCE EUROPEAN SYNCHROTRON RADIATION FACILITY
LOCATION GRENOBLE FRANCE
PERSON IN CHARGE R. HAENSEL DIRECTOR GENERAL DATE: 30 06 89
DATA SUPPLIED BY JL LACLARE, PROJECT DIRECTOR , M. ALTARELLI, A. MILLER, DIRECTORS OF RESEARCH

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) 01 01 88
FIRST BEAM, or GOAL (date) 01 07 92
TOTAL COST OF FACILITY 1400 MFF
TOTAL MACHINE STAFF (now) 50
ANN. OPERAT. BUDGET 75 MFF (without salaries)
ANN. OPERATING TIME 7000 h
OPERATION TIME OF RING:
USER EXPERIMENT 6000 hrs dedicated, ____ hrs parasitic
MACHINE STUDY 1000 hrs
TYPICAL OPERATION 24 hrs/day, 7 days/week

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR 200 Mev e^-/Mev e^+ Linac+Synchrotron
INJECTION CYCLE (Hz) 10
INJECTION ENERGY (GeV) 6
ORBITAL PERIOD(nsec) 2847
BENDING RADIUS(m) 25
RF ACCELERATION FREQUENCY(MHz) 352.2
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 6 at 100 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 100 at 6 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	Chasman-Green		
ELECTRON OR POSITRON	$e^{+/-}$	$e^{+/-}$	
ENERGY (GeV)	6	6	
NUMBER OF BUNCHES	1	992	
INITIAL CURRENT (mA)	10	100	
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at ____ mA	8	8	
EMITTANCE (nmrad) Hor	6.3	6.3	
Ver	0.63	0.63	
BUNCH DURATION (nsec)	0.05	0.02	

Beam Lines

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE 50

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)			7–10

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy k (eV)
2xU	Built	0.5	66	4.8	2 25
2xW	Design	0.8	40	8	4 60
AW	Design	1.8	9	20	4 200
HU	Design	0.15	32	10	1 4
U	Design	0.5	66	48	2 25

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source
HU: helical undulator
AW: assymetric wiggler

EXPERIMENTAL ACTIVITIES (planned for 1994)

No. USER GROUPS, in house ____ outside 2000
TOTAL RESEARCH STAFF, in house 100 outside ____
ANN. RESEARCH BUDGET, in house 10 MF (without sal.)
ANNUAL RESEARCH TIME 6000 h
ACTIVE PROPOSALS (total) ____
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE L.U.R.E (C.N.R.S. - CEA. MENJS)
LOCATION 209 D Universite Paris-Sud 91405 Orsay France
PERSON IN CHARGE Y. Petroff DATE: August 9-1989
DATA SUPPLIED BY "

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) ____
FIRST BEAM, or GOAL (date) July 1975
TOTAL COST OF FACILITY ____
TOTAL MACHINE STAFF (now) 80*
ANN. OPERAT. BUDGET *33 MF = 5.2 M$ (without salaries)
ANN. OPERATING TIME 3000 hrs h
OPERATION TIME OF RING:
USER EXPERIMENT 2600 hrs dedicated, ____ hrs parasitic
MACHINE STUDY 400 hrs
TYPICAL OPERATION 16 hrs/day, 4 or 5 days/week

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR	LINAC			
INJECTION CYCLE (Hz)	25			
INJECTION ENERGY (GeV)	1.1			
ORBITAL PERIOD(nsec)	315			
BENDING RADIUS(m)	3.82			
RF ACCELERATION FREQUENCY(MHz)	25.35			
MAXIMUM ENERGY ACHIEVED(GeV)	1.87	at	300	mA
MAXIMUM ENERGY PLANNED (GeV)		at		mA
BEST BEAM CURRENT ACHIEVED (mA)	350	at	1.1	GeV
BEST BEAM CURRENT PLANNED (mA)		at		GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	3.8-1.8	4.2-2.2	
ELECTRON OR POSITRON	e^+	e^+	
ENERGY (GeV)	1.85	1.85	
NUMBER OF BUNCHES	1	1	
INITIAL CURRENT (mA)	300	300	
AVERAGE CURRENT (mA) FOR USER	230		
LIFETIME (hrs) at 260 mA	55		
EMITTANCE (nmrad) Hor	1600	900	
Ver	170	100	
BUNCH DURATION (nsec)	1	1	

Beam Lines

MAIN PORTS : IN OP 5 , IN CONST ____ , TOTAL POSSIBLE 8

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)	17	3	2

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
Wiggler	Op	4.8	5		3 - 70 keV

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house * 80 outside 700
TOTAL RESEARCH STAFF, in house 40 outside
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h

ACTIVE PROPOSALS (total)	420
SOLID STATE PHYSICS/MATERIAL SCIENCE	135
BIOLOGY/BIOCHEMISTRY	65
CHEMISTRY/ATOM AND MOLECULAR PHYS	160
MEDICINE	
TECHNOLOGY/INDUSTRIAL USE	30
EARTH/SPACE SCIENCE	10
OTHERS	20

Other Relevant Parameters, Recent Improvements, etc.

* The machine staff has also to take care of Super ACO (E = 0.8 GeV): 22 experiments at the end of 1989.

The 420 proposals concern DCI and Super ACO.

NAME OF SYNCHROTRON LIGHT SOURCE DORIS II
LOCATION DESY/HASY Lab., Hamburg, West Germany
PERSON IN CHARGE H. Nesemann DATE: June 89
DATA SUPPLIED BY P. Gürtler, H. Nesemann

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1970
FIRST BEAM, or GOAL (date) 1973
TOTAL COST OF FACILITY 120 MDM
TOTAL MACHINE STAFF (now) see "DESY II"
ANN. OPERAT. BUDGET see "DESY II" (without salaries)
ANN. OPERATING TIME 6600 h
OPERATION TIME OF RING:
USER EXPERIMENT 2200 hrs dedicated, 4400 hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION 24 hrs/day, 7 days/week

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Synchrotron DESY II
INJECTION CYCLE (Hz) 12.5
INJECTION ENERGY (GeV) Working energy of DORIS II
ORBITAL PERIOD(nsec) 960
BENDING RADIUS(m) 12.2
RF ACCELERATION FREQUENCY(MHz) 500
MAXIMUM ENERGY ACHIEVED(GeV) 5.3 at 90 mA
MAXIMUM ENERGY PLANNED (GeV) 5.6 at 30 mA
BEST BEAM CURRENT ACHIEVED (mA) 100 at 3.7 GeV
BEST BEAM CURRENT PLANNED (mA) 100 at 3.7 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	SYN	LUM4	
ELECTRON OR POSITRON	e^-	$e^- + e^+$	
ENERGY (GeV)	3.7	5.3	
NUMBER OF BUNCHES	4	$1e^- + 1e^+$	
INITIAL CURRENT (mA)	100	42 + 42	
AVERAGE CURRENT (mA) FOR USER	65	31 + 31	
LIFETIME (hrs) at ____ mA	3	1.5	
EMITTANCE (nmrad) Hor	270	560	
Ver	15	6-60	
BUNCH DURATION (nsec)	.12	.12	

Beam Lines

MAIN PORTS : IN OP 24 , IN CONST — , TOTAL POSSIBLE ____

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)		1	
UV/VUV (6 - 300 eV)	7		
SOFT X (> 300 - 3000eV)	3		
X (>3000eV)	24		

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
MPW/u	INOP	.60	32	13.2	30 eV - 20 KeV
W	"	.94	20	24	5 KeV - 50 "
W	"	.31	8	12	5 eV - 5 "
EMPW	INCONST	.68	20	24	5 KeV - 20 "
u	PLAN	.55	254	3.14	8 " - 9 "
3 * W	"	1.01	56	14	5 " - 30 "
MPW/u	"	.89	24	22.3	5 eV - 20 "
EMPW	"	1.1	38	21	5 KeV - 30 "
u	"	.71	66	11.91	50 eV - 400 eV

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

u	PLAN	.54	90	8.83	200 eV - 1000 eV
u	"	.38	120	6.58	800 " - 2000 "

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 5 outside 160
TOTAL RESEARCH STAFF, in house 21 outside 750
ANN. RESEARCH BUDGET, in house 2 MDM (without sal.)
ANNUAL RESEARCH TIME 6600 h
ACTIVE PROPOSALS (total) 200
SOLID STATE PHYSICS/MATERIAL SCIENCE 130
BIOLOGY/BIOCHEMISTRY 20
CHEMISTRY/ATOM AND MOLECULAR PHYS 15
MEDICINE 5
TECHNOLOGY/INDUSTRIAL USE 30
EARTH/SPACE SCIENCE —
OTHERS —

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE ADONE I.N.F.N. - Istituto Nazionale di Fisica Nucleare
LOCATION L.N.F. - LABORATORI NAZIONALI DI FRASCATI - c.p. 13 - 00044 Frascati (Rome) Italy
PERSON IN CHARGE Miro Andrea PREGER DATE: 29/6/1969
DATA SUPPLIED BY Miro Andrea PREGER, F. TAZZIOLI, S. MOBILIO

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING x, SYNCHROTRON
CONSTRUCTION STARTED (date) 1964
FIRST BEAM, or GOAL (date) 1978 (FOR S.R.)
TOTAL COST OF FACILITY 9×10^6 U.S. $
TOTAL MACHINE STAFF (now) 80
ANN. OPERAT. BUDGET ~1000 K $ (without salaries)
ANN. OPERATING TIME 4500 - 5500 h
OPERATION TIME OF RING:
USER EXPERIMENT 4000-5000 hrs dedicated, 0 hrs parasitic
MACHINE STUDY 200 hrs
TYPICAL OPERATION 24 hrs/day 6 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
MPW	USED	1.85	6	65.4	2800
U	Notused	0.45	40	11.6	2.4 (1° harmonic)
SCW	TEST	6.0	1	-	9000

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR LINAC
INJECTION CYCLE (Hz) 1
INJECTION ENERGY (GeV) 0.35
ORBITAL PERIOD(nsec) 350
BENDING RADIUS(m) 5
RF ACCELERATION FREQUENCY(MHz) 51.4
MAXIMUM ENERGY ACHIEVED(GeV) 1.5 at 100 mA
MAXIMUM ENERGY PLANNED (GeV) 1.5 at 100 mA
BEST BEAM CURRENT ACHIEVED (mA) 150 at 1.5 GeV
BEST BEAM CURRENT PLANNED (mA) 150 at 1.5 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME			
ELECTRON OR POSITRON	e^-		
ENERGY (GeV)	1.5		
NUMBER OF BUNCHES	18		
INITIAL CURRENT (mA)	100		
AVERAGE CURRENT (mA) FOR USER	60		
LIFETIME (hrs) at 400 mA	5		
EMITTANCE (nmrad) Hor	200		
Ver	20		
BUNCH DURATION (nsec)	1 FWHM		

Beam Lines

MAIN PORTS : IN OP 8, IN CONST 2, TOTAL POSSIBLE 12

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)	1	-	-
UV/VUV (6 - 300 eV)	2	1	-
SOFT X (> 300 - 3000eV)	2 + 1	-	-
X (>3000eV)	3	1	2

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 7 outside 50
TOTAL RESEARCH STAFF, in house 15 outside 180
ANN. RESEARCH BUDGET, in house 6.105 $ (without sal.)
ANNUAL RESEARCH TIME 2160 h
ACTIVE PROPOSALS (total) 120
SOLID STATE PHYSICS/MATERIAL SCIENCE 72
BIOLOGY/BIOCHEMISTRY 28
CHEMISTRY/ATOM AND MOLECULAR PHYS 12
MEDICINE 2
TECHNOLOGY/INDUSTRIAL USE 1
EARTH/SPACE SCIENCE -
OTHERS 5

Other Relevant Parameters, Recent Improvements, etc.

Shared with H.E.P. and nuclear physics
(see STORAGE RINGS)

NAME OF SYNCHROTRON LIGHT SOURCE ELETTRA
LOCATION SINCROTRONE, TRIESTE, TRIESTE - ITALY
PERSON IN CHARGE MARIO PUGLISI DATE: 22 - 6 - 1989
DATA SUPPLIED BY ALBIN WRULICH

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1989
FIRST BEAM, or GOAL (date) End of 1992
TOTAL COST OF FACILITY 110 M US$
TOTAL MACHINE STAFF (now) 60
ANN. OPERAT. BUDGET 20 M US$ (without salaries)
ANN. OPERATING TIME 1993 h
OPERATION TIME OF RING: 1992
USER EXPERIMENT N.A. hrs dedicated, N.A. hrs parasitic
MACHINE STUDY N.A. N.A. hrs
TYPICAL OPERATION N.A. hrs/day, N.A. days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
U		0.8	51	9.1	10 - 1000
U		0.47	81	5.6	100 - 1500
U		0.28	111	4.1	500 - 2500
MPW		1.5	63	12.5	10 - 30000

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR LINAC+BOOSTER SYNCHROTRON
INJECTION CYCLE (Hz) 10
INJECTION ENERGY (GeV) 2
ORBITAL PERIOD(nsec) 864
BENDING RADIUS(m) 5.5
RF ACCELERATION FREQUENCY(MHz) 500
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 2 at 400 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 400 at 2 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	Expanded	Chasman-Green	
ELECTRON OR POSITRON	Electrons		
ENERGY (GeV)	MAX 2GeV		
NUMBER OF BUNCHES	MAX 432		
INITIAL CURRENT (mA)	MAX 400 mA		
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at 400 mA	10 hrs		
EMITTANCE (nmrad) Hor	7.1		
Ver	0.71		
BUNCH DURATION (nsec)	0.035		

Beam Lines

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE ____

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)			

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total) ____
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE Photon Factory
LOCATION National Laboratory for High Energy Physics (KEK), Tsukuba, Japan
PERSON IN CHARGE Jun-ichi Chikawa DATE: July 31, 1989
DATA SUPPLIED BY Hisashi Kobayakawa

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING × , SYNCHROTRON ____
CONSTRUCTION STARTED (date) April, 1978
FIRST BEAM, or GOAL (date) March, 1982
TOTAL COST OF FACILITY 18.3 billion yen
TOTAL MACHINE STAFF (now) 53
ANN. OPERAT. BUDGET 2040 million yen (without salaries)
ANN. OPERATING TIME 3,400 h
OPERATION TIME OF RING:
USER EXPERIMENT 2,720 hrs dedicated, ____ hrs parasitic
MACHINE STUDY 680 hrs
TYPICAL OPERATION 24 hrs/day, 11 days/2 weeks days/week

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR	Linac			
INJECTION CYCLE (Hz)	25			
INJECTION ENERGY (GeV)	2.5			
ORBITAL PERIOD(nsec)	620			
BENDING RADIUS(m)	8.66			
RF ACCELERATION FREQUENCY(MHz)	500			
MAXIMUM ENERGY ACHIEVED(GeV)	3.0	at	1	mA
MAXIMUM ENERGY PLANNED (GeV)		at		mA
BEST BEAM CURRENT ACHIEVED (mA)	500	at	2.5	GeV
BEST BEAM CURRENT PLANNED (mA)		at		GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	FODO	FODO	
ELECTRON OR POSITRON	Electron	Positron	
ENERGY (GeV)	2.5	2.5	
NUMBER OF BUNCHES	312	312	
INITIAL CURRENT (mA)	350	350	
AVERAGE CURRENT (mA) FOR USER	195	200	
LIFETIME (hrs) at ____ mA	22	25	
EMITTANCE (nmrad) Hor	130	130	
Ver	2.3	—	
BUNCH DURATION (nsec)	2σ=0.1	2σ=0.1	

Beam Lines

MAIN PORTS : IN OP 18 , IN CONST 2 , TOTAL POSSIBLE 23

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)	0	0	0
UV/VUV (6 - 300 eV)	12	2	1
SOFT X (> 300 - 3000eV)	14	0	3
X (>3000eV)	24	1	2

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
SCW	Op	5.0	3		< 100,000
U	Op	0.3∿0.05	119	6	400 ∿ 5,000
MPW/U	Op	1.47∿0.05	54	12	30 ∿ 70,000
U	Op	0.6∿0.05	29∿93	5,7.2,10,16.4	10 ∿ 1,100
MPW/U	Op	1.5∿0.05	29	18	30 ∿ 70,000
WMPW	Op	1.0∿0.05	25	16	10 ∿ 20,000

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 2 outside 250
TOTAL RESEARCH STAFF, in house 25 outside 1500
ANN. RESEARCH BUDGET, in house 560 million yen (without sal.)
ANNUAL RESEARCH TIME 2720 h

ACTIVE PROPOSALS (total)	420
SOLID STATE PHYSICS/MATERIAL SCIENCE	160
BIOLOGY/BIOCHEMISTRY	105
CHEMISTRY/ATOM AND MOLECULAR PHYS	71
MEDICINE	13
TECHNOLOGY/INDUSTRIAL USE	20
EARTH/SPACE SCIENCE	4
OTHERS	47

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE TRISTAN Accumulation Ring

LOCATION National Laboratory for High Energy Physics (KEK), Tsukuba, Japan

PERSON IN CHARGE Jun-ichi Chikawa (Light Source), Koji Takata and Shin-ichi Kurokawa (Accelerator) DATE: July 31, 1989

DATA SUPPLIED BY Masami Ando, Shin-ichi Kurokawa

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X, SYNCHROTRON ____

CONSTRUCTION STARTED (date) November 1981

FIRST BEAM, or GOAL (date) October 1983

TOTAL COST OF FACILITY ____

TOTAL MACHINE STAFF (now) see comment 2

ANN. OPERAT. BUDGET ____ (without salaries)

ANN. OPERATING TIME 4500 h

OPERATION TIME OF RING:

USER EXPERIMENT 1100 hrs dedicated, 1100 hrs parasitic

MACHINE STUDY 300 hrs

TYPICAL OPERATION 24 hrs/day, 7 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
EMPW	Op	1(V)/0.3(H)	41	16	100 ∿ 70,000
U	Const	0.6	180	4.0	5000 ∿ 20,000

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Linac

INJECTION CYCLE (Hz) 25

INJECTION ENERGY (GeV) 2.5

ORBITAL PERIOD(nsec) 1250

BENDING RADIUS(m) 23.2

RF ACCELERATION FREQUENCY(MHz) 508.58

MAXIMUM ENERGY ACHIEVED(GeV) 8.0 at 25 mA

MAXIMUM ENERGY PLANNED (GeV) ____ at ____ mA

BEST BEAM CURRENT ACHIEVED (mA) 30 at 6 GeV

BEST BEAM CURRENT PLANNED (mA) ____ at ____ GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	FODO		
ELECTRON OR POSITRON	Electron		
ENERGY (GeV)	5.8-6.5		
NUMBER OF BUNCHES	1		
INITIAL CURRENT (mA)	20		
AVERAGE CURRENT (mA) FOR USER	10		
LIFETIME (hrs) at 10 mA	6		
EMITTANCE (nmrad) Hor	250		
Ver	—		
BUNCH DURATION (nsec)	2σ=0.11		

Beam Lines

MAIN PORTS : IN OP 2, IN CONST 1, TOTAL POSSIBLE 3

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)	1		
X (>3000eV)	4	2	

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 4 outside 4

TOTAL RESEARCH STAFF, in house 9 outside 30

ANN. RESEARCH BUDGET, in house 122 million yen (without sal.)

ANNUAL RESEARCH TIME ____ h

ACTIVE PROPOSALS (total)	17
SOLID STATE PHYSICS/MATERIAL SCIENCE	10
BIOLOGY/BIOCHEMISTRY	0
CHEMISTRY/ATOM AND MOLECULAR PHYS	2
MEDICINE	3
TECHNOLOGY/INDUSTRIAL USE	1
EARTH/SPACE SCIENCE	1
OTHERS	0

Other Relevant Parameters, Recent Improvements, etc.

1. TRISTAN Accumulation Ring (AR) is the injector to TRISTAN Main Ring (MR), 30 GeV × 30 GeV electron-positron collider. AR is operated as a synchrotron light source when MR is not operated or during the interval between the beam fillings in MR.

2. AR is operated as a part of TRISTAN complex. See TRISTAN Main Ring.

NAME OF SYNCHROTRON LIGHT SOURCE RIKEN-JAERI SR FACILITY (TENTATIVE)
LOCATION HARIMA SCIENCE GARDEN CITY HYOGO-PREF. JAPAN
PERSON IN CHARGE Hiromichi KAMITSUBO DATE: July 1989
DATA SUPPLIED BY Masahiro HARA

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1990
FIRST BEAM, or GOAL (date) 1995
TOTAL COST OF FACILITY ∿100 Billion Yen
TOTAL MACHINE STAFF (now) 38
ANN. OPERAT. BUDGET ____ (without salaries)
ANN. OPERATING TIME ____ h
OPERATION TIME OF RING:
USER EXPERIMENT ____ hrs dedicated, ____ hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION ____ hrs/day, ____ days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Synchrotron
INJECTION CYCLE (Hz) 1
INJECTION ENERGY (GeV) 8
ORBITAL PERIOD(nsec) 4.77
BENDING RADIUS(m) 43.7
RF ACCELERATION FREQUENCY(MHz) 508.58
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 8 at 100 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 100 at 8 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I planned	II	III
LATTICE NAME	CG		
ELECTRON OR POSITRON	electron		
ENERGY (GeV)	8		
NUMBER OF BUNCHES	1∿2424		
INITIAL CURRENT (mA)			
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at ____ mA			
EMITTANCE (nmrad) Hor	4.8		
Ver	0.48		
BUNCH DURATION (nsec)			

Beam Lines

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE 50

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)			

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total) ____
- SOLID STATE PHYSICS/MATERIAL SCIENCE ____
- BIOLOGY/BIOCHEMISTRY ____
- CHEMISTRY/ATOM AND MOLECULAR PHYS ____
- MEDICINE ____
- TECHNOLOGY/INDUSTRIAL USE ____
- EARTH/SPACE SCIENCE ____
- OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE Pohang Light Source
LOCATION POSTECH, Pohang, KOREA
PERSON IN CHARGE Saewoong Oh DATE: June 20, 1989
DATA SUPPLIED BY Young-Soo Kim, Kwanghee Nam, Ki Bong Lee

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1988.4.1(Project authrized)
FIRST BEAM, or GOAL (date) 1993.10.1
TOTAL COST OF FACILITY W 74 Billion(US $110M)
TOTAL MACHINE STAFF (now) 60
ANN. OPERAT. BUDGET ____ (without salaries)
ANN. OPERATING TIME ____ h
OPERATION TIME OF RING:
USER EXPERIMENT ____ hrs dedicated, ____ hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION ____ hrs/day, ____ days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
U	planned	0.221	280	3	1060(2GeV)
MPW/U	"	2	40	15	5340(2GeV)

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Linac (full energy)
INJECTION CYCLE (Hz) 10
INJECTION ENERGY (GeV) 2.0
ORBITAL PERIOD(nsec) 924
BENDING RADIUS(m) 6.3
RF ACCELERATION FREQUENCY(MHz) 500.1
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 2.5 at 100 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 250 at 2.0 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	TBA		
ELECTRON OR POSITRON	electron		
ENERGY (GeV)	2-2.5		
NUMBER OF BUNCHES	462(Max)		
INITIAL CURRENT (mA)			
AVERAGE CURRENT (mA) FOR USER	100(planned)		
LIFETIME (hrs) at ____ mA			
EMITTANCE (nmrad) Hor	13 nmrad(thoretical)		
Ver			
BUNCH DURATION (nsec)			

Beam Lines

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE 36

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			1(in 1993)
SOFT X (> 300 - 3000eV)			1(")
X (>3000eV)			2(")

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total) ____
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE Synchrotron Radiation Research Center (SRRC)
LOCATION Hsinchu, TAIWAN, R. O. C.
PERSON IN CHARGE Professor Edward Yen DATE:
DATA SUPPLIED BY Project Management Division SRRC

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X, SYNCHROTRON
CONSTRUCTION STARTED (date) Sept. 1987
FIRST BEAM, or GOAL (date) Dec. 1992
TOTAL COST OF FACILITY 90 Million US $
TOTAL MACHINE STAFF (now) *
ANN. OPERAT. BUDGET * (without salaries)
ANN. OPERATING TIME * h
OPERATION TIME OF RING:
USER EXPERIMENT * hrs dedicated, hrs parasitic
MACHINE STUDY * hrs
TYPICAL OPERATION * hrs/day, days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Synchrotron
INJECTION CYCLE (Hz) 10
INJECTION ENERGY (GeV) 1.3
ORBITAL PERIOD(nsec) 400.277
BENDING RADIUS(m)
RF ACCELERATION FREQUENCY(MHz) 500
MAXIMUM ENERGY ACHIEVED(GeV) at mA
MAXIMUM ENERGY PLANNED (GeV) 1.3 at 200 mA
BEST BEAM CURRENT ACHIEVED (mA) at GeV
BEST BEAM CURRENT PLANNED (mA) at GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	TBA		
ELECTRON OR POSITRON	e^-		
ENERGY (GeV)	1.3		
NUMBER OF BUNCHES	140		
INITIAL CURRENT (mA)	200		
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at 200 mA	10		
EMITTANCE (nmrad) Hor	19.0		
Ver	1.9		
BUNCH DURATION (nsec)	0.05		

Beam Lines

MAIN PORTS : IN OP , IN CONST X , TOTAL POSSIBLE 22

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)		X	
SOFT X (> 300 - 3000eV)			X
X (>3000eV)			

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h
ACTIVE PROPOSALS (total)
- SOLID STATE PHYSICS/MATERIAL SCIENCE
- BIOLOGY/BIOCHEMISTRY
- CHEMISTRY/ATOM AND MOLECULAR PHYS
- MEDICINE
- TECHNOLOGY/INDUSTRIAL USE
- EARTH/SPACE SCIENCE
- OTHERS

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE SRS
LOCATION Daresbury Laboratory, England
PERSON IN CHARGE D. J. Thompson/J. Bordas DATE: 23.6.89
DATA SUPPLIED BY D. J. Thompson

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING yes , SYNCHROTRON
CONSTRUCTION STARTED (date) 1975
FIRST BEAM, or GOAL (date) 1980
TOTAL COST OF MACHINES £5M
TOTAL MACHINE STAFF (now) approx. 70 man years per year
ANN. OPERAT. BUDGET £1.3M (machine) (without salaries)
ANN. OPERATING TIME 6500 h
OPERATION TIME OF RING:
USER EXPERIMENT 5750 hrs dedicated, 0 hrs parasitic
MACHINE STUDY 750 hrs
TYPICAL OPERATION 24 hrs/day, 7 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
SCW	Oper.	5	3	50	13.3 keV
SCW	Plan	6	3	50	16.0 keV
U	Oper.	0.4	21	10	300 eV

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Linac & Synchrotron
INJECTION CYCLE (Hz) 10
INJECTION ENERGY (GeV) 0.6
ORBITAL PERIOD(nsec) 320
BENDING RADIUS(m) 5.56
RF ACCELERATION FREQUENCY(MHz) 500
MAXIMUM ENERGY ACHIEVED(GeV) 2.0 at mA
MAXIMUM ENERGY PLANNED (GeV) 2.0 at mA
BEST BEAM CURRENT ACHIEVED (mA) 350 at 2.0 GeV
BEST BEAM CURRENT PLANNED (mA) 500 at 2.0 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	SRS-2	SRS-2	
ELECTRON OR POSITRON	e⁻	e-	
ENERGY (GeV)	2.0	2.0	
NUMBER OF BUNCHES	160	1	
INITIAL CURRENT (mA)	300	40	
AVERAGE CURRENT (mA) FOR USER	220	20	
LIFETIME (hrs) at 200 mA	35	20	
EMITTANCE (nmrad) Hor	110	268	
Ver	3.3	5.4	
BUNCH DURATION (nsec)	0.2	0.25	

Beam Lines

MAIN PORTS : IN OP 9 , IN CONST 3 , TOTAL POSSIBLE 13

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)	1	1	0
UV/VUV (6 - 300 eV)	8	4	0
SOFT X (> 300 - 3000eV)	3	1	0
X (>3000eV)	14	4	6*

* Funded but construction not yet started.

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 8 outside 170
TOTAL RESEARCH STAFF, in house 24 outside 1600
ANN. RESEARCH BUDGET, in house £420k (without sal.)
ANNUAL RESEARCH TIME 5750 h
ACTIVE PROPOSALS (total) 208
SOLID STATE PHYSICS/MATERIAL SCIENCE 55
BIOLOGY/BIOCHEMISTRY 76
CHEMISTRY/ATOM AND MOLECULAR PHYS 67
MEDICINE 1
TECHNOLOGY/INDUSTRIAL USE 12
EARTH/SPACE SCIENCE 2
OTHERS 0

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE Cornell High Energy Synchrotron Source
LOCATION Cornell University, Wilson Laboratory, Ithaca, NY 14853, USA
PERSON IN CHARGE Professor Boris W. Batterman DATE:
DATA SUPPLIED BY Professor Boris W. Batterman

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING XX, SYNCHROTRON
CONSTRUCTION STARTED (date)
FIRST BEAM, or GOAL (date)
TOTAL COST OF FACILITY Storage Ring $20M, Sync. Rad. Lab $1.4M
TOTAL MACHINE STAFF (now) Sync. Rad. Lab Only: 18
ANN. OPERAT. BUDGET $800K (without salaries)
ANN. OPERATING TIME 7,000 (80%) h
OPERATION TIME OF RING:
USER EXPERIMENT 580 hrs dedicated, 6420 hrs parasitic
MACHINE STUDY hrs
TYPICAL OPERATION 24 hrs/day, 7 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
U	Oper	0.5	123	3.3	4,000-30,000
Wigg	" "	1.7	6	20	4,000-150,000
Wigg	Const.	1.3	24	10cm	6,000-100,000

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Linac/Synchrotron
INJECTION CYCLE (Hz) 60
INJECTION ENERGY (GeV) 5.5
ORBITAL PERIOD(nsec) 2560
BENDING RADIUS(m) 32
RF ACCELERATION FREQUENCY(MHz) 500
MAXIMUM ENERGY ACHIEVED(GeV) 5.5 at 100 mA
MAXIMUM ENERGY PLANNED (GeV) 5.5 at 200 mA
BEST BEAM CURRENT ACHIEVED (mA) 130 at 5.3 GeV
BEST BEAM CURRENT PLANNED (mA) 200 at 5.5 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	Luminosity	Dedicated	
ELECTRON OR POSITRON	Both	Elect.	
ENERGY (GeV)	5.3	5.3	
NUMBER OF BUNCHES	7-14	1-7	
INITIAL CURRENT (mA)	80		
AVERAGE CURRENT (mA) FOR USER	60		
LIFETIME (hrs) at 80 mA	4		
EMITTANCE (nmrad) Hor	100	50	
Ver	10	1	
BUNCH DURATION (nsec)	0.13	0.13	

Beam Lines

MAIN PORTS : IN OP 3, IN CONST 3, TOTAL POSSIBLE 6

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)	3	3	

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house 4 outside
ANN. RESEARCH BUDGET, in house $100K (without sal.)
ANNUAL RESEARCH TIME 4,000h h
ACTIVE PROPOSALS (total) 169
SOLID STATE PHYSICS/MATERIAL SCIENCE 56
BIOLOGY/BIOCHEMISTRY 55
CHEMISTRY/ATOM AND MOLECULAR PHYS 31
MEDICINE 3
TECHNOLOGY/INDUSTRIAL USE 16
EARTH/SPACE SCIENCE 2
OTHERS 6

Other Relevant Parameters, Recent Improvements, etc.

We are just completing a doubling of the synchrotron radiation capabilities. Part of the facility is a high level Bio-secure x-ray station. We run an undulator with a fundamental in the hard x-ray regime in a dedicated mode for one month per year.

NAME OF SYNCHROTRON LIGHT SOURCE SPEAR/SSRL
LOCATION Stanford Linear Accelerator Center/Stanford University
PERSON IN CHARGE Arthur Bienenstock DATE: 6/21/89
DATA SUPPLIED BY Herman Winick

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING x , SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1970
FIRST BEAM, or GOAL (date) 1972
TOTAL COST OF FACILITY $55M excluding rings
TOTAL MACHINE STAFF (now) Changing
ANN. OPERAT. BUDGET ~ $5M (without salaries)
ANN. OPERATING TIME ~ 2500 h
OPERATION TIME OF RING:
USER EXPERIMENT ~2000 hrs dedicated, -- hrs parasitic
MACHINE STUDY ~150 hrs
TYPICAL OPERATION 24 hrs/day, 7 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
W	Oper	1.9	8	45	ε_c = 11,400
W	Oper	1.9	8	45	ε_c = 11,400
MPW/u	Oper	1.2	54	7	ε_c = 7,200
MPW/u	Oper	1.4	30	12	ε_c = 8,400
u	Oper	.5-7	20-60	6-18	10-1200 in fund.

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Linac (Booster Synch. in construction)
INJECTION CYCLE (Hz) 10-30 (10 with Booster)
INJECTION ENERGY (GeV) 2/35 (3.0 with Booster)
ORBITAL PERIOD(nsec) 780
BENDING RADIUS(m) 12.7
RF ACCELERATION FREQUENCY(MHz) 358
MAXIMUM ENERGY ACHIEVED(GeV) 3.7 at 60 mA
MAXIMUM ENERGY PLANNED (GeV) 3.7 at 100 mA
BEST BEAM CURRENT ACHIEVED (mA) 100 at 3 GeV
BEST BEAM CURRENT PLANNED (mA) 200 at 3 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	HEP	Low Emit	
ELECTRON OR POSITRON	Electron	Electron	
ENERGY (GeV)	3	3	
NUMBER OF BUNCHES	~20	~20	
INITIAL CURRENT (mA)	80-100		
AVERAGE CURRENT (mA) FOR USER	50		
LIFETIME (hrs) at 50 mA	20		
EMITTANCE (nmrad) Hor	450	130	
Ver	~10	~ 3	
BUNCH DURATION (nsec)	~0.2	0.2	
		Not yet operational	

Beam Lines

MAIN PORTS : IN OP 9 , IN CONST -- , TOTAL POSSIBLE ~17

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)	0	0	0
UV/VUV (6 - 300 eV)	3		
SOFT X (> 300 - 3000eV)	7	1	1
X (>3000eV)	15		1

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 10 outside 149
TOTAL RESEARCH STAFF, in house 20 outside 400
ANN. RESEARCH BUDGET, in house ~$1.2 (without sal.)
ANNUAL RESEARCH TIME 55,000 h
ACTIVE PROPOSALS (total) 209

SOLID STATE PHYSICS/MATERIAL SCIENCE	108
BIOLOGY/BIOCHEMISTRY	71
CHEMISTRY/ATOM AND MOLECULAR PHYS	24
MEDICINE	2
TECHNOLOGY/INDUSTRIAL USE	0
EARTH/SPACE SCIENCE	4
OTHERS	0

Other Relevant Parameters, Recent Improvements, etc.

A 3 GeV, 10 Hz Booster Synchrotron is in construction as a dedicated electron injector to SPEAR. It is expected to be operational by the Fall of 1990. Operation of SSRL has been limited by the lack of availability of the SLAC Linac as an injector due to its use for the SLC Program.

NAME OF SYNCHROTRON LIGHT SOURCE PEP/SSRL
LOCATION Stanford Linear Accelerator Center/Stanford University
PERSON IN CHARGE Arthur Bienenstock DATE: 6/21/89
DATA SUPPLIED BY Heinz-Dieter Nuhn

HISTORY AND STATUS

See listing under Storage Rings*
TYPE OF SOURCE RING: STORAGE RING x*, SYNCHROTRON ____
CONSTRUCTION STARTED (date) ____
FIRST BEAM, or GOAL (date) ____
TOTAL COST OF FACILITY ____
TOTAL MACHINE STAFF (now) ____
ANN. OPERAT. BUDGET ____ (without salaries)
ANN. OPERATING TIME ____ h
OPERATION TIME OF RING:
USER EXPERIMENT ____ hrs dedicated, ____ hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION ____ hrs/day, ____ days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
U	Oper	0.19-0.074	52	7.7	12-20
U	Oper	0.19-0.074	52	7.7	12-20

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR LINAC
INJECTION CYCLE (Hz) 30
INJECTION ENERGY (GeV) 5-15
ORBITAL PERIOD(nsec) 7338
BENDING RADIUS(m) 165.5
RF ACCELERATION FREQUENCY(MHz) 353.21
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) ____ at ____ mA
BEST BEAM CURRENT ACHIEVED (mA) 33 at 7 GeV
BEST BEAM CURRENT PLANNED (mA) 100 at 7-10 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	4 cm	PEP29	
ELECTRON OR POSITRON	Electrons		
ENERGY (GeV)	13-15	7-10	
NUMBER OF BUNCHES	3	1-40	
INITIAL CURRENT (mA)	24	15	
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at ____ mA			
EMITTANCE (nmrad) Hor	102	8.2	
Ver			
BUNCH DURATION (nsec)	0.020 @13.6GeV	0.044 @8GeV	

Beam Lines

MAIN PORTS : IN OP 2, IN CONST ____, TOTAL POSSIBLE ~12

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)	2		2

EXPERIMENTAL ACTIVITIES **

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total) ____
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

**PEP is not routinely running at present.

References:

SRI88 -A. Bienenstock, G. Brown, H. Winick, and H. Winick, "PEP as a Synchrotron Radiation Source," Proceedings of SRI88 to be published in Review of Scientific Instruments, 1989, Volume 60.

PAC89 -James M. Paterson, "PEP as a Synchrotron Radiation Source: Status and Review," Proceedings of PAC89 to be published in IEEE Particle Accelerator Conference, 1989.

H.-D. Nuhn and H. Winick, "Workshop on Accelerator Physics Issues Relating to the Use of PEP as a Synchrotron Radiation Source," 1988.

NAME OF SYNCHROTRON LIGHT SOURCE Aladdin
LOCATION SRC,University of Wisconsin-Madison, Stoughton, WI USA
PERSON IN CHARGE David L. Huber DATE: June 26, 1989
DATA SUPPLIED BY Walter Trzeciak

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) Fall 1977
FIRST BEAM, or GOAL (date) Jan. 1982
TOTAL COST OF FACILITY $9M (without beamlines)
TOTAL MACHINE STAFF (now) 6
ANN. OPERAT. BUDGET $1M (without salaries)
ANN. OPERATING TIME 3300 h
OPERATION TIME OF RING:
USER EXPERIMENT 2700/yr hrs dedicated, 0 hrs parasitic
MACHINE STUDY 600/yr hrs
TYPICAL OPERATION 12 hrs/day, 5 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
U	Oper	0.81	60	6.1	1.8 → 140 (2)

(2) Depends on storage ring energy; $0.17 \leq E \leq 1$ GeV

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR microtron
INJECTION CYCLE (Hz) 1.25
INJECTION ENERGY (GeV) 0.109
ORBITAL PERIOD(nsec) 296
BENDING RADIUS(m) 2.083
RF ACCELERATION FREQUENCY(MHz) 50.58
MAXIMUM ENERGY ACHIEVED(GeV) 1.0 at 100 mA
MAXIMUM ENERGY PLANNED (GeV) 1.0 at 500 mA
BEST BEAM CURRENT ACHIEVED (mA) 320 at 0.8 GeV
BEST BEAM CURRENT PLANNED (mA) 500 at 1.0 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	Aladdin	Aladdin	
ELECTRON OR POSITRON	electron	electron	
ENERGY (GeV)	0.8	1.0	
NUMBER OF BUNCHES	15	15	
INITIAL CURRENT (mA)	200	80	
AVERAGE CURRENT (mA) FOR USER	93		
LIFETIME (hrs) at 100 mA	3.6	~6	
EMITTANCE (nmrad) Hor	82		
Ver	0.73		
BUNCH DURATION (nsec)	1.0	1.0	

Beam Lines

MAIN PORTS : IN OP 21 , IN CONST 6 , TOTAL POSSIBLE 36

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)	2 (1)	2 (1)	
UV/VUV (6 - 300 eV)	9	1	
SOFT X (> 300 - 3000eV)	10	3	
X (>3000eV)	0	0	0

(1) machine diagnostic ports are classified as visible lines

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 3 outside 62
TOTAL RESEARCH STAFF, in house 3 outside 300
ANN. RESEARCH BUDGET, in house $0.5M (without sal.)
ANNUAL RESEARCH TIME 2700 h
ACTIVE PROPOSALS (total) 65
SOLID STATE PHYSICS/MATERIAL SCIENCE 50
BIOLOGY/BIOCHEMISTRY
CHEMISTRY/ATOM AND MOLECULAR PHYS 13
MEDICINE
TECHNOLOGY/INDUSTRIAL USE 2
EARTH/SPACE SCIENCE
OTHERS

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE NSLS X-RAY RING
LOCATION USA, BNL, Upton, New York
PERSON IN CHARGE _____ DATE: _____
DATA SUPPLIED BY Samuel Krinsky

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X, SYNCHROTRON ____
CONSTRUCTION STARTED (date) October 1977
FIRST BEAM, or GOAL (date) _____
TOTAL COST OF FACILITY 180,000 K
TOTAL MACHINE STAFF (now) 150
ANN. OPERAT. BUDGET 5,875 K (without salaries)
ANN. OPERATING TIME 6,800 h
OPERATION TIME OF RING:
USER EXPERIMENT 5,100 hrs dedicated, ____ hrs parasitic
MACHINE STUDY 5 days/month hrs
TYPICAL OPERATION 24 hrs/day, 7 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
U		0.3	71	8	250-2000
U		0.3	21	8	"
MPW		1.1	27	12	6000-15000
MPW		1.1	27	12	"
SCW		5.2	5	17	30000-100000

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR 80 MeV linac, 750 MeV Booster
INJECTION CYCLE (Hz) 0.7
INJECTION ENERGY (GeV) 0.75
ORBITAL PERIOD(nsec) 567
BENDING RADIUS(m) 6.875
RF ACCELERATION FREQUENCY(MHz) 52.888
MAXIMUM ENERGY ACHIEVED(GeV) 2.5 at 250 mA
MAXIMUM ENERGY PLANNED (GeV) ____ at ____ mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) ____ at ____ GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME			
ELECTRON OR POSITRON	Electron		
ENERGY (GeV)	2.5		
NUMBER OF BUNCHES	25		
INITIAL CURRENT (mA)	220		
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at 200 mA	20		
EMITTANCE (nmrad) Hor	100		
Ver	1		
BUNCH DURATION (nsec)	0.5		

Beam Lines

MAIN PORTS : IN OP 52, IN CONST 16, TOTAL POSSIBLE 69

EXPERIMENTAL STATION

TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)	1		
UV/VUV (6 - 300 eV)	2	2	
SOFT X (> 300 - 3000eV)	15	3	1
X (>3000eV)	35	11	1

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house 2 outside 120
TOTAL RESEARCH STAFF, in house 13 outside 1000
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME 5100 h
ACTIVE PROPOSALS (total) 422
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE ADVANCED LIGHT SOURCE
LOCATION LAWRENCE BERKELEY LABORATORY, BERKELEY, CA 94720 USA
PERSON IN CHARGE JAY N. MARX DATE: JUNE 20, 1989
DATA SUPPLIED BY ARTHUR L. ROBINSON

HISTORY AND STATUS (SEE NOTE 1 BELOW)

TYPE OF SOURCE RING: STORAGE RING X, SYNCHROTRON ____
CONSTRUCTION STARTED (date) OCTOBER 1987
FIRST BEAM, or GOAL (date) APRIL 1993
TOTAL COST OF FACILITY (Construction) $99.5 million
TOTAL MACHINE STAFF (now) NA
ANN. OPERAT. BUDGET NA (without salaries)
ANN. OPERATING TIME NA h
OPERATION TIME OF RING:
USER EXPERIMENT NA hrs dedicated, ____ hrs parasitic
MACHINE STUDY NA hrs
~~TYPICAL~~ PLANNED OPERATION 24 hrs/day, 7 days/week

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR LINAC + SYNCHROTRON
INJECTION CYCLE (Hz) 1
INJECTION ENERGY (GeV) 1 - 1.9 (matched to storage ring)
ORBITAL PERIOD(nsec) 656.4
BENDING RADIUS(m) 4.89
RF ACCELERATION FREQUENCY(MHz) 499.654
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 1.9 at 400 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 400 at 1.9 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	MULTIBUNCH -I-	FEW-BUNCH -II-	III
LATTICE NAME	TRIPLE-BEND ACHROMAT		
ELECTRON OR POSITRON	ELECTRON	ELECTRON	
ENERGY (GeV)	1.5	1.5	
NUMBER OF BUNCHES *	250	1 to 8	
INITIAL CURRENT (mA)			
AVERAGE CURRENT (mA) FOR USER	400	7.6/BUNCH	
LIFETIME (hrs) at average mA**	6	6	
EMITTANCE (nmrad) Hor	<10	<10	
Ver	<1	<1	
BUNCH DURATION (nsec) +	0.028	0.047	

*The harmonic number is 328. ** Half-life. + 2σ

Beam Lines (SEE NOTE 2 BELOW)

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE 59

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			X
UV/VUV (6 - 300 eV)			X
SOFT X (> 300 - 3000eV)			X
X (>3000eV)			X

INSERTION DEVICES (SEE NOTE 3 BELOW)

Device	Status	B(T)*	~~Poles~~ Periods	Period(cm)	Photon energy (eV)**
U	PLANNED	1.33	61	8.0	5.4 - 1100
U	PLANNED	0.82	98	5.0	52 - 1900
U	PLANNED	0.58	123	3.9	169 - 2500
W	PLANNED	2.07	16	13.6	E_c = 3.1 keV

*Peak Field **First, Third, and Fifth Harmonics

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

EXPERIMENTAL ACTIVITIES (SEE NOTES 2, 4 BELOW)

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total) ____

SOLID STATE PHYSICS/MATERIAL SCIENCE	X
BIOLOGY/BIOCHEMISTRY	X
CHEMISTRY/ATOM AND MOLECULAR PHYS	X
MEDICINE	
TECHNOLOGY/INDUSTRIAL USE	X
EARTH/SPACE SCIENCE	X
OTHERS (SURFACE SCIENCE)	X

Other Relevant Parameters, Recent Improvements, etc.

(1) Initial operations for users are planned to begin in April 1993.

(2) Participating Research Teams will help provide beam lines and experimental facilities.

(3) Eleven straight sections will be available for insertion devices.

(4) PRT proposals for the initial experimental facilities are due August 15, 1989. Proposals are expected in all the checked experimental areas.

NAME OF SYNCHROTRON LIGHT SOURCE Advanced Photon Source
LOCATION Argonne National Laboratory, Argonne, Illinois, USA
PERSON IN CHARGE David E. Moncton DATE: June 15, 1989
DATA SUPPLIED BY Lee C. Teng

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING X , SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1990 (EST)
FIRST BEAM, or GOAL (date) 1995 (EST)
TOTAL COST OF FACILITY M$ 450 (EST)
TOTAL MACHINE STAFF (now) Approx. 30
ANN. OPERAT. BUDGET M$ 50 (EST) (without salaries)
ANN. OPERATING TIME 7000 (EST) h
OPERATION TIME OF RING:
USER EXPERIMENT ____ hrs dedicated, ____ hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION ____ hrs/day, ____ days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
U	Plan	0.77	156	3.3	3,500
U	Plan	0.45	226	2.3	13,500
U	Plan	0.24	86	6.0	4,000
U	Plan	0.27	38	13.6	500
W	Plan	1.0	10	15.0	32,600
W	Plan	0.3	20	25.0	9,800

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Linac + Accumulator + Synchrotron
INJECTION CYCLE (Hz) 2.0
INJECTION ENERGY (GeV) 7.0
ORBITAL PERIOD(nsec) 3682.5
BENDING RADIUS(m) 38.96
RF ACCELERATION FREQUENCY(MHz) 351.93
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 8.0 at 100 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 300 at 7 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	C-G		
ELECTRON OR POSITRON	e^+		
ENERGY (GeV)	7.0		
NUMBER OF BUNCHES	1-60		
INITIAL CURRENT (mA)			
AVERAGE CURRENT (mA) FOR USER	5-100		
LIFETIME (hrs) at 100 mA	>10		
EMITTANCE (nmrad) Hor	8		
Ver	<0.8		
BUNCH DURATION (nsec)	0.01		

Beam Lines

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE 70

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)			

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total)
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE VEPP-3
LOCATION Institute of Nuclear Physics, Novosibirsk
PERSON IN CHARGE Kulipanov G.N. (concerning SR works) DATE: 13.07.89
DATA SUPPLIED BY Pindyurin V.F.

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING Y, SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1969
FIRST BEAM, or GOAL (date) 1970
TOTAL COST OF FACILITY
TOTAL MACHINE STAFF (now) 50
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h
OPERATION TIME OF RING:
USER EXPERIMENT 48 per week hrs dedicated, 96 per week hrs parasitic
MACHINE STUDY 24 per week hrs
TYPICAL OPERATION 24 hrs/day, 7 days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
wiggler	in op.	2	3	-	3000-30000
2U	in op.	0.57	68	10	1.8-5.2

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR Synchrotron
INJECTION CYCLE (Hz) 1
INJECTION ENERGY (GeV) 0.35
ORBITAL PERIOD(nsec) 250
BENDING RADIUS(m) 6.15
RF ACCELERATION FREQUENCY(MHz) 4 and 72
MAXIMUM ENERGY ACHIEVED(GeV) 2 at 250 mA
MAXIMUM ENERGY PLANNED (GeV) at mA
BEST BEAM CURRENT ACHIEVED (mA) 250 at 2 GeV
BEST BEAM CURRENT PLANNED (mA) at GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME		FEL	
ELECTRON OR POSITRON	e^-	e^-	
ENERGY (GeV)	2	0.36	
NUMBER OF BUNCHES	1 or 2	2	
INITIAL CURRENT (mA)	200	30	
AVERAGE CURRENT (mA) FOR USER	150	20	
LIFETIME (hrs) at 150 mA	3	10 min at 20 mA	
EMITTANCE (nmrad) Hor	850	40	
Ver	31	10	
BUNCH DURATION (nsec)	1.2	0.3	

Beam Lines

MAIN PORTS : IN OP 8, IN CONST 1, TOTAL POSSIBLE ____

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)	1 (FEL)		
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)	1		
X (>3000eV)	7	1	

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house both 96 ~~outside~~
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h
ACTIVE PROPOSALS (total) 96
SOLID STATE PHYSICS/MATERIAL SCIENCE
BIOLOGY/BIOCHEMISTRY
CHEMISTRY/ATOM AND MOLECULAR PHYS
MEDICINE
TECHNOLOGY/INDUSTRIAL USE
EARTH/SPACE SCIENCE
OTHERS

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE VEPP-4M
LOCATION Institute of Nuclear Physics, Novosibirsk
PERSON IN CHARGE Kulipanov G.N. (concerning SR works) DATE: 13.07.89
DATA SUPPLIED BY Pindyurin V.F.

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING y , SYNCHROTRON ____
CONSTRUCTION STARTED (date) reconstruction 1988
FIRST BEAM, or GOAL (date) planned 1990
TOTAL COST OF FACILITY ____
TOTAL MACHINE STAFF (now) 30
ANN. OPERAT. BUDGET ____ (without salaries)
ANN. OPERATING TIME ____ h
OPERATION TIME OF RING: 50% planned of total
USER EXPERIMENT ____ hrs dedicated, oper. hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION ____ hrs/day, ____ days/week

INSERTION DEVICES

Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR storage ring VEPP-3
INJECTION CYCLE (Hz) ____
INJECTION ENERGY (GeV) 1.85
ORBITAL PERIOD(nsec) 1200
BENDING RADIUS(m) 33
RF ACCELERATION FREQUENCY(MHz) 180 (q=222)
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 6 at ____ mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 40 at 5.5 GeV

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME			
ELECTRON OR POSITRON	e^+, e^-		
ENERGY (GeV)	5.5		
NUMBER OF BUNCHES	2		
INITIAL CURRENT (mA)	40		
AVERAGE CURRENT (mA) FOR USER	20		
LIFETIME (hrs) at ____ mA	4		
EMITTANCE (nmrad) Hor	1260		
Ver	63		
BUNCH DURATION (nsec)	0.17		

Beam Lines

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE ____

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)			10

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total) ____
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON LIGHT SOURCE Siberia-2
LOCATION Kurchatov Institute, Moscow
PERSON IN CHARGE Korchuganov V.N.(Novosibirsk),RybakovB.V.(Moscow) DATE: 13.07.89
DATA SUPPLIED BY Pindyurin V.F.

HISTORY AND STATUS

TYPE OF SOURCE RING: STORAGE RING Y, SYNCHROTRON ____
CONSTRUCTION STARTED (date) 1990
FIRST BEAM, or GOAL (date) 1991
TOTAL COST OF FACILITY ____
TOTAL MACHINE STAFF (now) ____
ANN. OPERAT. BUDGET ____ (without salaries)
ANN. OPERATING TIME ____ h
OPERATION TIME OF RING:
USER EXPERIMENT ____ hrs dedicated, ____ hrs parasitic
MACHINE STUDY ____ hrs
TYPICAL OPERATION ____ hrs/day, ____ days/week

INSERTION DEVICES

	Device	Status	B(T)	Poles	Period(cm)	Photon energy (eV)
2	SCW	planned	12	3	32	50000
5	MPW/U	planned	0.7	23	11	3000

U: undulator, SCW: superconducting wiggler
MPW/U: wiggler or undulator mode available
EMPW: elliptically polarized source

STORAGE RINGS PARAMETERS

General Ring Parameters

TYPE OF INJECTOR booster storage ring "Siberia-1"
INJECTION CYCLE (Hz) 0.5
INJECTION ENERGY (GeV) 0.450
ORBITAL PERIOD(nsec) 414
BENDING RADIUS(m) 4.905 and 19.62
RF ACCELERATION FREQUENCY(MHz) 181.14 (q=75)
MAXIMUM ENERGY ACHIEVED(GeV) ____ at ____ mA
MAXIMUM ENERGY PLANNED (GeV) 2.5 at 100/300 mA
BEST BEAM CURRENT ACHIEVED (mA) ____ at ____ GeV
BEST BEAM CURRENT PLANNED (mA) 100 single at 2.5 GeV
300-multibunch

Typical Electron/Positron Beam Characteristics for User Experiment

	I	II	III
LATTICE NAME	chasman - Green		
ELECTRON OR POSITRON	e^-		
ENERGY (GeV)	2.5		
NUMBER OF BUNCHES	15		
INITIAL CURRENT (mA)			
AVERAGE CURRENT (mA) FOR USER			
LIFETIME (hrs) at 100 single mA	10		
EMITTANCE (nmrad) Hor bunch	76.5		
Ver	3.1		
BUNCH DURATION (nsec)	0.15		

Beam Lines

MAIN PORTS : IN OP ____, IN CONST ____, TOTAL POSSIBLE 39

EXPERIMENTAL STATION TYPE	IN OP	IN CONST	PLANNED
IR/VISIBLE (<6 eV)			
UV/VUV (6 - 300 eV)			
SOFT X (> 300 - 3000eV)			
X (>3000eV)			

EXPERIMENTAL ACTIVITIES

No. USER GROUPS, in house ____ outside ____
TOTAL RESEARCH STAFF, in house ____ outside ____
ANN. RESEARCH BUDGET, in house ____ (without sal.)
ANNUAL RESEARCH TIME ____ h
ACTIVE PROPOSALS (total)
SOLID STATE PHYSICS/MATERIAL SCIENCE ____
BIOLOGY/BIOCHEMISTRY ____
CHEMISTRY/ATOM AND MOLECULAR PHYS ____
MEDICINE ____
TECHNOLOGY/INDUSTRIAL USE ____
EARTH/SPACE SCIENCE ____
OTHERS ____

Other Relevant Parameters, Recent Improvements, etc.

NAME OF SYNCHROTRON SYNCHROPHASOTRON
INSTITUTION Joint Institute for Nuclear Research
LOCATION Dubna, USSR
PERSON IN CHARGE A. M. Baldin DATE: August 1989
DATA SUPPLIED BY I. B. Issinskiy

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1952
FIRST BEAM OBTAINED, or GOAL (date) March 1957
TOTAL COST OF FACILITY 36 MRubls
TOTAL ACCELERATOR STAFF (now) 160
ANN. OPERAT. BUDGET 1.4 MRubls (without salaries)
ANN. OPERATING TIME 1,200 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES protons
ENERGY 9.2 GeV
RING DIAM. 66.2 m; TUNNEL SECT. (W x H) m

Injector

TYPE Alvarez linac
OUTPUT(max) 50 mA at 20 MeV
EMITTANCE* 7 πmm-mrad
INJECTION PERIOD 400 μs, or ∿ 100 turns
INFLECTOR TYPE electrostatic

Magnet System

FOCUSING TYPE weak FIELD INDEX n = 0.67
FOCUSING ORDER
BETATRON FREQ. ν_H 0.626 ν_V 0.892
No. MAGNETS 4 LENGTH (ea) 43.9 m
BENDING FIELD at inj 0.0116 T; at max 1.2 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT LENGTH m
No. LONG STRAIGHT SECT 4 LENGTH 8 m
RISE TIME 3 s; FLAT-TOP TIME 0.6 s
POWER INPUT PEAK 7.2 MW; MEAN MW

Acceleration System

No. CAVITIES 1 LENGTH(ea) 6.2 m
HARMONIC NUMBER 2
RF RANGE 0.586 to 2.87 MHz
ENERGY GAIN 2.4 KeV/turn
RADIATION LOSS KeV/turn
RF POWER INPUT PEAK 90 kW; MEAN 30 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 400 × 2000 mm
AVERAGE PRESSURE 3.10^{-7} torr

Extraction System

TYPE i) slow resonance 2/3
ii) fast resonance 2/3
iii)
LENGTH OF SPILL i) 0.1 to 0.6 μs
ii) 800 to 1,500 μs
iii) to μs

*Emittance = Area × $\beta\gamma$ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	0.65 - 9.2	10
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)	0.12 - 0.1	
PULSE WIDTH AT PEAK E	0.6	
INTERNAL BEAM (part/pulse)	4.10^{-12}	
(part/s)	4.10^{-11}	
EMITTANCE* AT PEAK E	300 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$\pi^{\pm}$	1 - 7 GeV/c	2	no
$e^{\pm}$		2	separated
μ		2	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 10,000 m²
No. INTERNAL TARGETS 1 No. EXT. TARGETS 3
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 5
TOTAL POWER USED (AVERAGE) FOR RESEARCH 9.3 MW
No. USER GROUPS, in house 12 outside 7
TOTAL RESEARCH STAFF, in house 220 outside 40
ANN. RESEARCH BUDGET, in house 3 MRubls (without sal.)
ANNUAL RESEARCH TIME 1,100 h

Other Relevant Parameters, Recent Improvements, etc.

NAME OF LINAC LU-20
INJECTOR FOR Synchrophasotron of the Joint Institute for Nuclear Research
LOCATION Dubna, USSR
PERSON IN CHARGE Yu. Beznogikh DATE: August 1989
DATA SUPPLIED BY V. Monchinskiy

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1965
FIRST BEAM OBTAINED, or GOAL (date) 1974
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now) 18
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4500 h

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	20(p), 5 MeV/n	(nuclei)
ENERGY SPREAD ΔE/E (%)	+0.15% with debuncher	
CURRENT (mA)	50 (p)	
EMITTANCE*	7 (p) 5 (nuclei)	πmm-mrad

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 14.5 m; No. TANKS 1
TANK DIAM. 1.4 m; No. DRIFT TUBES 58
DRIFT TUBE LENGTHS 50 mm to 320 mm
DRIFT TUBE DIAMETERS 135 mm to 90 mm
GAP/CELL LENGTH 0.25
APERTURE DIAM. 17 mm to 25 mm

Ion Source

TYPE Duoplasmatron, Laser, EBIS, D↑
OUTPUT 300 (p) mA at 40 KeV
EMITTANCE* πmm-mrad

Injector

TYPE Pulse Transformer
OUTPUT 150 (p) mA at 600 KeV
EMITTANCE* 5.0 πmm-mrad

Bunchers

TYPE One-gap Buncher
MODULATION 20 KeV, DRIFT ℓ 1200 mm at 144.5 MHz
KeV, DRIFT ℓ mm at MHz
KeV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 144.5 MHz
FIELD MODE TM_{010} Q 40000
EQUIL. PHASE 30° ACCEL. RATE 1.4 MeV/m
REPETITION RATE 0.15
DUTY FACTOR 0.01 % (RF); 0.008 % (Beam)
PULSE LENGTH 600 μs (RF); 500 μs (Beam)
EFFECTIVE SHUNT IMPEDANCE 10 MΩ/m
FILLING TIME 150 μs
RF POWER INPUT PEAK 3.5 MW; MEAN MW

Focusing System

No. QUADS 58 TYPE magnetic ORDER FODO
GRADIENTS 50 to 8 T/m
OTHER

Vacuum System

MATERIAL CHAMBER steel
AVERAGE PRESSURE 6.10^{-7} torr

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% current

NAME OF HEAVY ION ACCELERATOR SYNCHROPHASOTRON
INSTITUTION Joint Institute for Nuclear Research
LOCATION Dubna, USSR
PERSON IN CHARGE A. M. Baldin DATE: August 1989
DATA SUPPLIED BY I. B. Issinskiy

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1952
FIRST BEAM OBTAINED, or GOAL (date) March 1957
TOTAL COST OF FACILITY 36 MRubls
TOTAL ACCELERATOR STAFF (now) 160
ANN. OPERAT. BUDGET 1.4 MRubls (without salaries)
ANN. OPERATING TIME 2,800 h

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES D, D↑, He, C, O, F, Mg
ENERGY 4.2 GeV/n
RING DIAM. 66.2 m; TUNNEL SECT. (W × H) m

Injector

TYPE Alvarez linac
OUTPUT(max) 1 - 10 mA at 5 MeV
EMITTANCE* 5 πmm-mrad
INJECTION PERIOD 20 - 400 μs, or 3 - 60 turns
INFLECTOR TYPE electrostatic

Magnet System

FOCUSING TYPE weak
FOCUSING ORDER
BETATRON FREQ. ν_H 0.626 ν_V 0.892
No. MAGNETS 4 LENGTH (ea) 43.9 m
BENDING FIELD at inj. 0.0116 T; at max 1.2 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. LENGTH m
No. LONG STRAIGHT SECT. 4 LENGTH 8 m
RISE TIME 3 s; FLAT-TOP TIME 0.6 s
POWER INPUT PEAK 7.2 MW; MEAN 6 MW

Acceleration System

No. CAVITIES 1 LENGTH(ea) 6.1 m
HARMONIC NUMBER 2
RF RANGE 0.297 to 2.84 MHz
ENERGY GAIN 2.4 KeV/turn
RF POWER INPUT PEAK 90 kW; MEAN 30 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 400 × 2000 mm
AVERAGE PRESSURE 3.10^{-7} torr

Extraction System

TYPE i) slow resonance 2/3
ii) fast resonance 2/3
iii)
LENGTH OF SPILL i) 0.1 to 0.6 μs
ii) 800 to 1,500 μs
iii) to μs

ACCELERATOR PERFORMANCE

Particle	Energy(GeV/n)	Resolution ΔE/E(%)	Beam (PART / PULSE)
D			1.10^{12}
D↑			1.10^{9}
He			5.10^{10}
Li			5.10^{9}
C	0.2 - 4.2	± 0.1	1.10^{9}
O			5.10^{7}
F			5.10^{7}
Mg			3.10^{7}

	Normal (or Goal)	Maximum achieved
REPT. RATE (pulse/s)	0.12 - 0.1	
PULSE WIDTH AT PEAK E	0.6 s	
EMITTANCE* AT PEAK E	300 πmm-mrad	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.
$\pi^{\pm}$		2	
$e^{\pm}$	1 - 3 GeV/c	2	
μ		2	
^3T	1 - 4.5 GeV/c.n	1	

EXPERIMENTAL FACILITY

TOTAL EXPERIMENTAL AREAS 10,000 m²
No. INTERNAL TARGETS 1 No. EXT. TARGETS 3
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 5
TOTAL POWER USED (AVERAGE) FOR RESEARCH 9.3 MW
No. USER GROUPS, in house 12 outside 7
TOTAL RESEARCH STAFF, in house 220 outside 40
ANN. RESEARCH BUDGET, in house 3 MRubls (without sal.)
ANNUAL RESEARCH TIME 2,500 h

Other Relevant Parameters, Recent Improvements, etc.

*Emittance = Area × $\beta\gamma$ at 90% of current

NAME OF ELECTRON LINEAR ACCELERATOR 2 GeV Electron Linac
INSTITUTION Institute of Physics and Technology
LOCATION Kharkov 310108, USSR
PERSON IN CHARGE V. Boldyshev DATE: September, 1989
DATA SUPPLIED BY A. Dovbnya, Ju. Tur, V. Vishnyakov

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1958
FIRST BEAM OBTAINED, or GOAL (date) 1964
TOTAL COST OF FACILITY
TOTAL ACCELERATOR STAFF (now) 80
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4200 h

ACCELERATOR PARAMETERS

Physical Dimensions
ACCELERATOR LENGTH 240 m
TUNNEL SIZE (L x W x H) 260 × 3 × 3 m

Injector
TYPE TW Linac
OUTPUT 400 mA at 20.0 MeV
BEAM EMITTANCE 2.13 πmm-mrad
INJECTION PERIOD 1.8 μs, 50/100 RF cycles

Acceleration System
No. SECTIONS 49 LENGTH(ea) 4.3 m
FIELD MODE π/2 FREQUENCY 2797.2 MHz
GROUP VELOCITY 0.04/0.02 c; PHASE VEL. 1 c
WAVE TYPE TM_{010} FILLING TIME 0.4/1.0 μs
SHUNT IMPEDANCE 49/5.4 MΩ/m
ATTENUATION 0.0785/0.168 Np/m
IRIS, APERTURE 30/24 ∿ 19 mm, THICKNESS 4.0 mm
IRIS SPACING 2.67/2.67 mm
Q 10000/10000
POWER UNITS, No. 50 TYPE klystron amplifier
POWER RATING 20 MW/unit
FEED SPACING 4.8 m
RF POWER INPUT PEAK 900 MW; MEAN 0.09/0.9 MW

Focusing System
TYPE, No. of LENSES and SPACING solenoid, quad FODO

Vacuum System
MATERIAL OF VAC.CHAMBER Cu, SS
APERTURE OF VAC. CHAMBER 30 mm
AVERAGE PRESSURE 5×10^{-7} torr

Other Relevant Parameters, Recent Improvements, etc.

ACCELERATOR PERFORMANCE

Electrons	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	2	1.87
ENERGY GAIN (MeV/m)	10.0	8/20
RESOLUTION ΔE/E (%)	5	1
REPET. RATE (pulse/s)	50	50/100
PULSE WIDTH (μs)	1.5	1.5
DUTY FACTOR, macroscopic (%)	0.013	0.013/0.026
BEAM CURRENT (μA)	1	5/10
BEAM EMITTANCE (πmm·mrad)		0.15
Positrons		
ENERGY (GeV)		1.2
ENERGY GAIN (MeV/m)		8
RESOLUTION ΔE/E (%)		1
REPET. RATE (pulse/s)		50/100
PULSE WIDTH (μs)		1.5
DUTY FACTOR, macroscopic (%)		0.014/0.028
BEAM CURRENT (μA)		0.02
BEAM EMITTANCE (πmm·mrad)		0.5

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 800 m²
No. INTERNAL TARGETS 1 No. EXT. TARGETS 3
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH 1.0 MW
No. USER GROUPS, in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANN. RESEARCH TIME 5200 h