SDC-92-402

SDC
SOLENOIDAL DETECTOR NOTES

SDC COLLABORATION MEETING
SSCL

DECEMBER 10-12, 1992

SOLENOIDAL DETECTOR COLLABORATION MEETING

December 10 - 12, 1992
SSC Laboratory
AGENDA

December 10

Plenary Session (Auditorium - Bldg. 4)

8:30	SDC DoE Review and Future Planning - *F. Gilman*
9:00	SDC Status Reports - *G. Trilling* and *T. Kirk*
9:45	SDC Test Beam Needs and Proposal - *J. Siegrist*
10:15	Detector disassembly integration issues - *T. Thurston*
10:35	*Break*
11:00	The Phenomenology of Supersymmetric Higgs Bosons at the SSC and LHC -*F. Zwirner* (CERN)
12:00	Lunch
1:00	Subgroup meetings Note: There should be a meeting of the tracking group with rapporteurs to discuss status and progress on outer tracking review.
	Evening Group Dinner
9:00 p.m.	Executive Board Meeting (Please note date change)

December 11

Subgroup meetings continue

1:30 - 2:30 Institutional Board Meeting (Auditorium - Bldg. 4)

December 12

Selected status reports (Auditorium - Bldg. 4)

8:30	Status of preparations for tracking review - *W. Ford*
9:00	Status report(s) on calorimeter issues - *D. Green, P. Mantsch et al.* - light yield(choice of SCSN38,etc) - plans for endcap review - plans for shower maximum detector review - barrel prototype status - Other issues
10:00	Report on muon tower prototype - *J. Bensinger/H. Lubatti*
10:30	*Break*
11:00	Report(s) on electronics for prototypes - *A. Lankford et al.* - calorimeter electronics - muon electronics - "portable" DAQ
11:30	Computing update - *I. Gaines*
12:00	Adjourn

SDC Collaboration Meeting
December 10-12, 1992

Phenomenology of Supersymmetric Higgs Bosons at the SSC & LHC

F. Zwirner

December 10

F. ZWIRNER
CERN-TH.

TESTING THE SUSY HIGGS SECTOR AT FUTURE HADRON COLLIDERS (SSC, LHC)

Z. KUNSZT and F.Z., Aachen Workshop 1990.
& preprint CERN-TH.6150/91 (Nucl. Phys. B, in press)

Motivation:

- Given our limited grasp on the symmetry-breaking sector of the SM, one should be prepared for ALTERNATIVES TO THE S.M. HIGGS

- Among the various possibilities, a plausible one is the MINIMAL SUSY HIGGS SECTOR

  - <u>motivated</u> (solution of the hierarchy problem)
  - <u>acceptable</u> (no problems with precision tests)
  - <u>calculable</u> (well-defined perturbative model)
  - <u>predictive</u> (only 2 parameters at tree-level)
  - <u>intriguing</u> ($\sin^2\theta_W$ prediction in SUSY-GUTs)

CERTAINLY WORTH A DETAILED STUDY FOR THE LHC

important differences with the SM case!

Realistic supersymmetric models require AT LEAST two Higgs doublets

→ TO AVOID HIGGSINO-INDUCED CHIRAL ANOMALIES

→ TO GIVE MASS TO ALL QUARKS AND CHARGED LEPTONS

$$H_1 \equiv \begin{pmatrix} H_1^0 \\ H_1^- \end{pmatrix} \sim (1,2,-1/2) \qquad H_2 \equiv \begin{pmatrix} H_2^+ \\ H_2^0 \end{pmatrix} \sim (1,2,+1/2)$$

MSSM ⇒ ONLY two Higgs doublets

$$w = \underbrace{h^U Q U^c H_2 + h^D Q D^c H_1 + h^E L E^c H_1}_{\substack{\text{acceptable Yukawa couplings} \\ \cancel{\text{FCNC}}}} + \underbrace{\mu H_1 H_2}_{\substack{\text{globally supersymmetric} \\ \text{Higgs mass term}}}$$

After inclusion of SOFT susy-breaking terms

$$V_0 = m_1^2 |H_1|^2 + m_2^2 |H_2^2| + m_3^2 (H_1 H_2 + h.c.)$$
$$+ \frac{g^2}{8}(H_2^+ \vec{\sigma} H_2 + H_1^+ \vec{\sigma} H_1)^2 + \frac{g'^2}{8}(|H_2|^2 - |H_1|^2)^2$$

QUARTIC HIGGS COUPLINGS ARE GAUGE COUPLINGS!

$$\langle H_1^0 \rangle \equiv v_1 \qquad \langle H_2^0 \rangle \equiv v_2 \qquad (v_1, v_2 \in \mathbb{R}^+)$$

$$m_W^2 = \frac{g^2}{2}(v_1^2 + v_2^2) \qquad m_Z^2 = \frac{g^2 + g'^2}{2}(v_1^2 + v_2^2)$$

$$m_t = h_t v_2 \qquad m_b = h_b v_1 \qquad m_\tau = h_\tau v_1$$

Spectrum :

($G^0, G^\pm$ unphysical Goldstone bosons)

$H^\pm$ charged $\quad h, H$ neutral CP-even $\quad A$ neutral CP-odd.

Parameters :

At tree-level, only two! e.g.: $\left(m_A,\ \tan\beta \equiv \frac{v_2}{v_1}\right)$

enough to determine all other masses $(m_h, m_H, m_{H^\pm})$ and couplings (Functions of β and α, the mixing angle in the neutral CP-even sector)

Tree-level predictions :

$$m_{H^\pm}^2 = m_W^2 + m_A^2 \qquad m_h^2 + m_H^2 = m_Z^2 + m_A^2$$

$$m_{h,H}^2 = \frac{1}{2}\left[m_A^2 + m_Z^2 \mp \sqrt{(m_A^2 + m_Z^2)^2 - (2 m_A m_Z \cos 2\beta)^2}\right]$$

$$\Rightarrow \quad m_{H^\pm} \geq m_W \qquad m_A > m_h \qquad m_h \leq m_Z |\cos 2\beta| \leq m_Z$$

$$\cos 2\alpha = -\cos 2\beta \left(\frac{m_A^2 - m_Z^2}{m_H^2 - m_h^2}\right) \qquad \left(-\frac{\pi}{2} < \alpha \leq 0\right)$$

$\Downarrow$

POSSIBILITY OF A CRUCIAL TEST AT LEP II ($\sqrt{s} = 190$ GeV, $\int \mathcal{L}\, dt = 500\, pb^{-1}$)

As in non-supersymmetric models, one might abandon the economy principle

→ extra doublets (in real representations)
potential problems with FCNC, charge breaking, ...

→ extra triplets (or even higher representations)
problems with ρ parameter, charge breaking, strings, ...

→ extra singlets (as in First susy models by Fayet)

mildly attractive possibility

one extra singlet N
with purely cubic superpotential

$$\mathcal{W}: \quad \cancel{\mu H_1 H_2} \longrightarrow \lambda H_1 H_2 N + k N^3$$

$$V_{soft}: \quad \cancel{m_3^2 (H_1 H_2 + h.c.)} \longrightarrow \lambda A_\lambda H_1 H_2 N + k A_k N^3 + h.c.$$

$\Longrightarrow$ 2 more low-energy parameters

$\Longrightarrow$ 2 more neutral states H', A'

MSSM recovered for $\langle N \rangle \to \infty$ ($\lambda \langle N \rangle, k \langle N \rangle$ Fixed)

NILLES-SREDNICKI-WYLER FRERE-JONES-RABY DERENDINGER-SAVOY
ELLIS, GUNION, HABER, ROSZKOWSKI, F.Z., and many others

more complicated phenomenology
but who ordered that?

Folklore arguments :

i) μ GLOBALLY SUPERSYMMETRIC MASS $O(G_F^{-1/2})$ FOR PHENOMENOLOGICAL REASONS [$\mu = 0 \Rightarrow$ GLOBAL $U(1)_{PQ}$ SYMMETRY].

WITHOUT BEING RELATED TO SUSY-BREAKING SCALE

ii) STRING-DERIVED SUPERGRAVITIES HAVE ONLY CUBIC (OR HIGHER) SUPERPOTENTIAL COUPLINGS

Counterarguments :

a) In the "Flat limit" (BARBIERI-FERRARA-SAVOY / CHAMSEDDINE-ARNOWITT-NATH) OF SOME supergravity models, one can relate μ to the scale OF LOCAL susy breaking : $\mu \sim m_{3/2}$

GIUDICE-MASIERO INOUE-KAWASAKI-YAMAGUCHI-YANAGIDA LOUIS ...

b) Possible non-renormalizable superpotential terms

$$w \ni \frac{\phi^n H_1 H_2}{M^{n-1}} \qquad \langle \phi \rangle \sim \tilde{M} < M \qquad \mu \sim \frac{\tilde{M}^n}{M^{n-1}}$$

KIM-NILLES

c) In the singlet model, $k=0 \Rightarrow$ global $U(1)_{PQ}$ symmetry

$k \neq 0$ DIFFICULT (IMPOSSIBLE?) TO GET FROM STRINGS

Personal conclusion:

Non-minimal models not excluded

but (For now) rather weakly motivated

TREE-LEVEL FORMULAE RECEIVE LARGE RADIATIV CORRECTIONS, DOMINATED BY t-$\tilde{t}$ (b-$\tilde{b}$) LOOPS

(BERGER) ELLIS RIDOLFI F.Z. OKADA YAMAGUCHI YANAGIDA HABER HEMPFLING ...

Main calculational methods :

1) RENORMALIZATION GROUP APPROACH

$$M_{SUSY}\left(\sim m_{\tilde{t}} \sim m_{H,A,H^\pm}\right) \overset{\text{(example)}}{>>} m_Z \quad (\sim m_h \sim m_t)$$

SUSY FIXES $\lambda(Q=M_{SUSY})$ AS FUNCTION OF $g^2, g'^2, \tan\beta$

SOLVING NON-SUSY RGE ONE CAN DETERMINE $\lambda(Q=m_Z) \longrightarrow m_h$

- RESUMS THE LEADING LOGARITHMS $\log \frac{M_{SUSY}}{m_Z}$
- CUMBERSOME FOR SPECTRUM SPREAD AROUND $G_F^{-1/2}$

BARBIERI FRIGENI CARAVAGLIOS O.Y.Y. ESPINOSA QUIRÓS DIAZ HABER SASAKI CARENA WAGNER ...

2) EFFECTIVE POTENTIAL APPROACH

$$\mathcal{M}^2_{ij} \equiv \left.\frac{\partial^2 V_{eff}}{\partial\varphi_i\,\partial\varphi_j}\right|_{min}, \qquad \lambda_{ijk} \equiv \left.\frac{\partial^3 V_{eff}}{\partial\varphi_i\,\partial\varphi_j\,\partial\varphi_k}\right|_{min}, \quad \ldots$$

- EASILY DERIVED APPROXIMATE FORMULAE (ZERO-MOMENTUM LIMIT OF SELF-ENERGIES AND VERTICES)
- NEEDS R.G.-IMPROVEMENT IF $M_{SUSY} >> m_Z$

E.R.Z. O.Y.Y BARBIERI FRIGENI BRIGNOLE-ELLIS-RIDOLFI-F.Z. ...

3) DIAGRAMMATIC APPROACH

Full one-loop renormalization programme

- momentum-dependent effects included
- Formally gauge- and scale-independent
- CARE MUST BE TAKEN TO IMPROVE CONVENIENTLY THE NAIVE ONE-LOOP CALCULATION WHEN NECESSARY TO PRESERVE THE VALIDITY OF THE LOOP EXPANSION

YAMADA CHANKOWSKI-POKORSKI-ROSIEK BRIGNOLE ...

Main results for the <u>spectrum</u>

LARGE CORRECTIONS TO THE NEUTRAL CP-EVEN MASSES

$$\Delta m_{22}^2 \simeq \frac{3 g^2 m_t^4}{8\pi^2 \sin^2\beta \, m_W^2} \log \frac{m_{\tilde{t}}^2}{m_t^2} + \dots$$

MUCH SMALLER CORRECTIONS TO THE CHARGED HIGGS MASS

General analytical expressions ✓

Good agreement among different calculations ✓

Two-loop corrections small ✓

In the following, corrections from t-b-$\tilde{t}$-$\tilde{b}$ sector only, in the limit of negligible mixing ($A_t = A_b = \mu = 0$)

example: $m_t = 140$ GeV $m_{\tilde{q}} = 1$ TeV

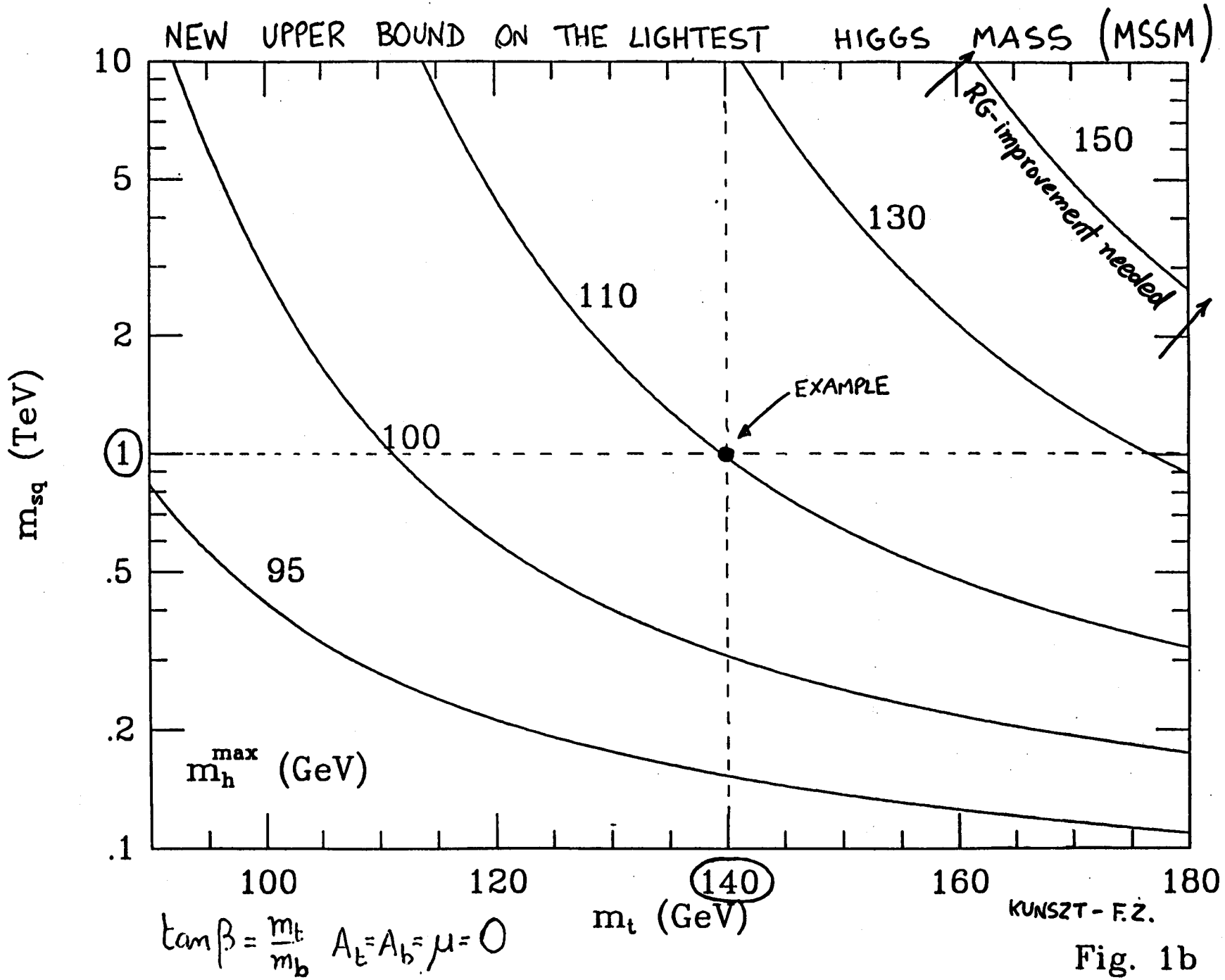

NEW UPPER BOUND ON THE LIGHTEST HIGGS MASS (MSSM)
RG-improvement needed
150
130
110
100
95
EXAMPLE
m_{sq} (TeV)
10
5
2
1
.5
.2
.1
m_h^{max} (GeV)
100
120
140
160
180
m_t (GeV)
KUNSZT - F.Z.
$\tan\beta = \frac{m_t}{m_b}$ $A_t = A_b = \mu = 0$

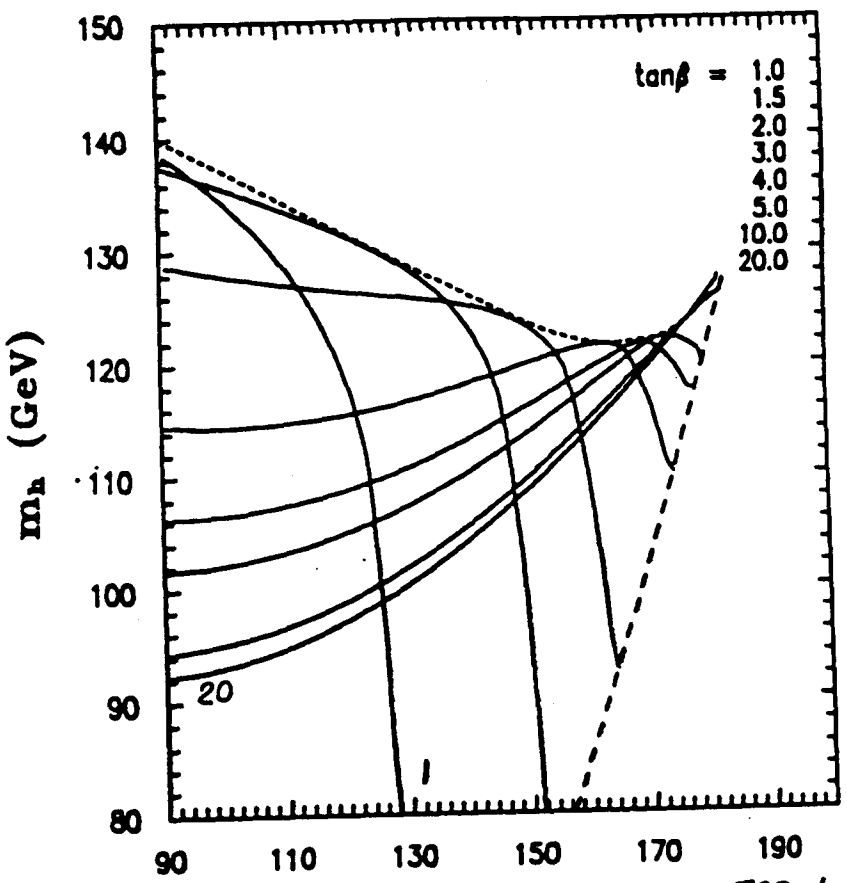
Fig. 1b

UPPER BOUND ON m_h IN THE NON-MINIMAL SINGLET MODEL

DREES
DURAND-LOPEZ
BINETRUY-SAVOY

E.G.H.R.Z.

$$m_{h,tree}^2 \leq m_Z^2 \left(\cos^2 2\beta + \frac{2\lambda^2 \cos^2\theta_W \sin^2 2\beta}{g^2} \right)$$



$M_{susy} = 1$ TeV

ESPINOSA
QUIROS

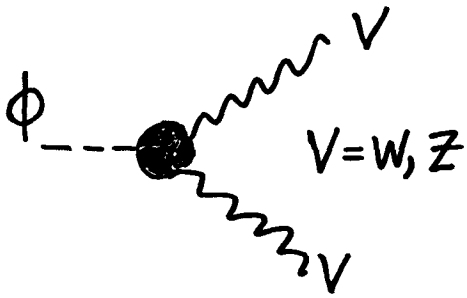
Figure 1. Upper bounds on the lightest scalar Higgs boson in NMSSM with singlets(including RAD.CORR.)

SIMILAR BOUNDS ARE OBTAINED IN OTHER NON-MINIMAL MODELS

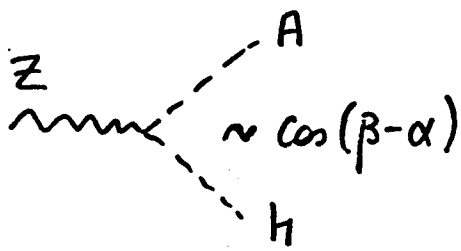
in analogy with the CABIBBO-MAIANI-PARISI-PETRONZIO analysis of the SM case

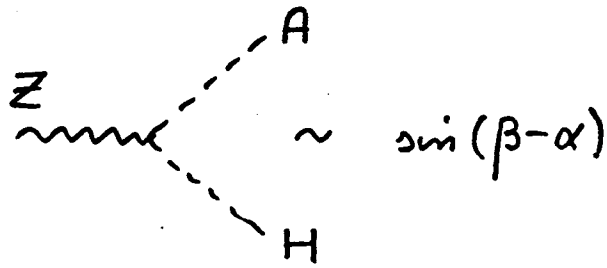
crucial ingredient: theory valid up to $\Lambda \sim M_{GUT}$

Radiative corrections to Higgs couplings



$$\phi = \begin{cases} h: & \sin(\beta-\alpha) \\ H: & \cos(\beta-\alpha) \\ A: & 0 \end{cases}$$

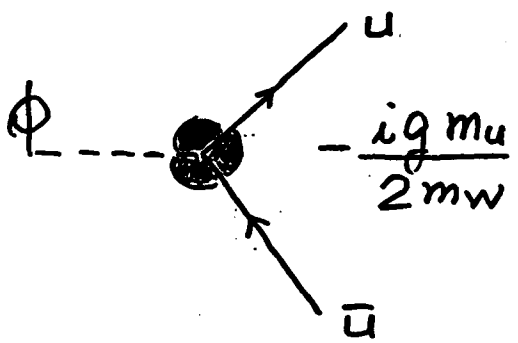




LEADING CORRECTIONS EMBODIED IN ONE-LOOP VALUE OF α

SOME DIAGRAMMATIC COMPUTATIONS ALSO AVAILABLE

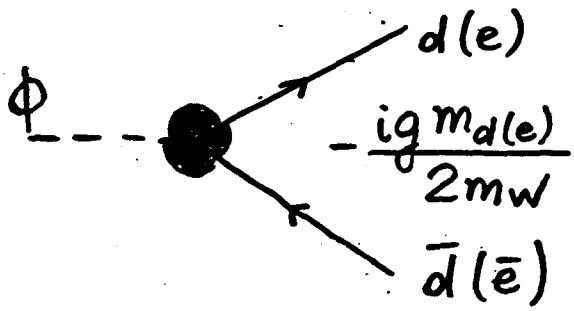
[CHANKOWSKI-POKORSKI-ROSIEK PIERCE-PAPADOPOULOS]



$h: \frac{\cos\alpha}{\sin\beta}$

$A: -i\gamma_5 \cot\beta$

$H: \frac{\sin\alpha}{\sin\beta}$



$h: -\frac{\sin\alpha}{\cos\beta}$

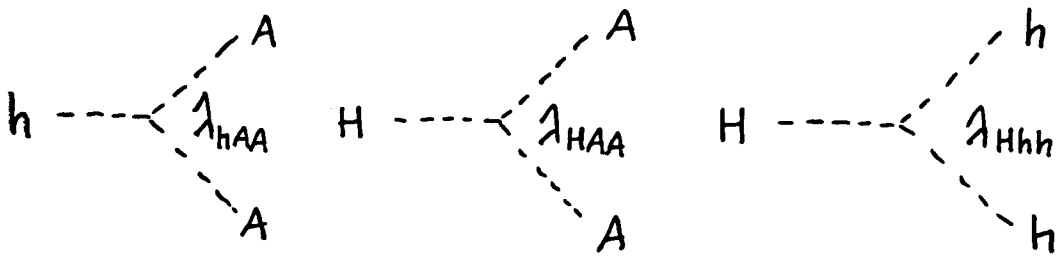
$A: -i\gamma_5 \tan\beta$

$H: \frac{\cos\alpha}{\cos\beta}$

LEADING CORRECTIONS EMBODIED IN ONE-LOOP VALUE OF α

AND RUNNING FERMION MASSES AT $Q \sim m_\Phi$

NO DIAGRAMMATIC COMPUTATIONS AVAILABLE YET



CORRECTIONS TO CUBIC HIGGS COUPLINGS

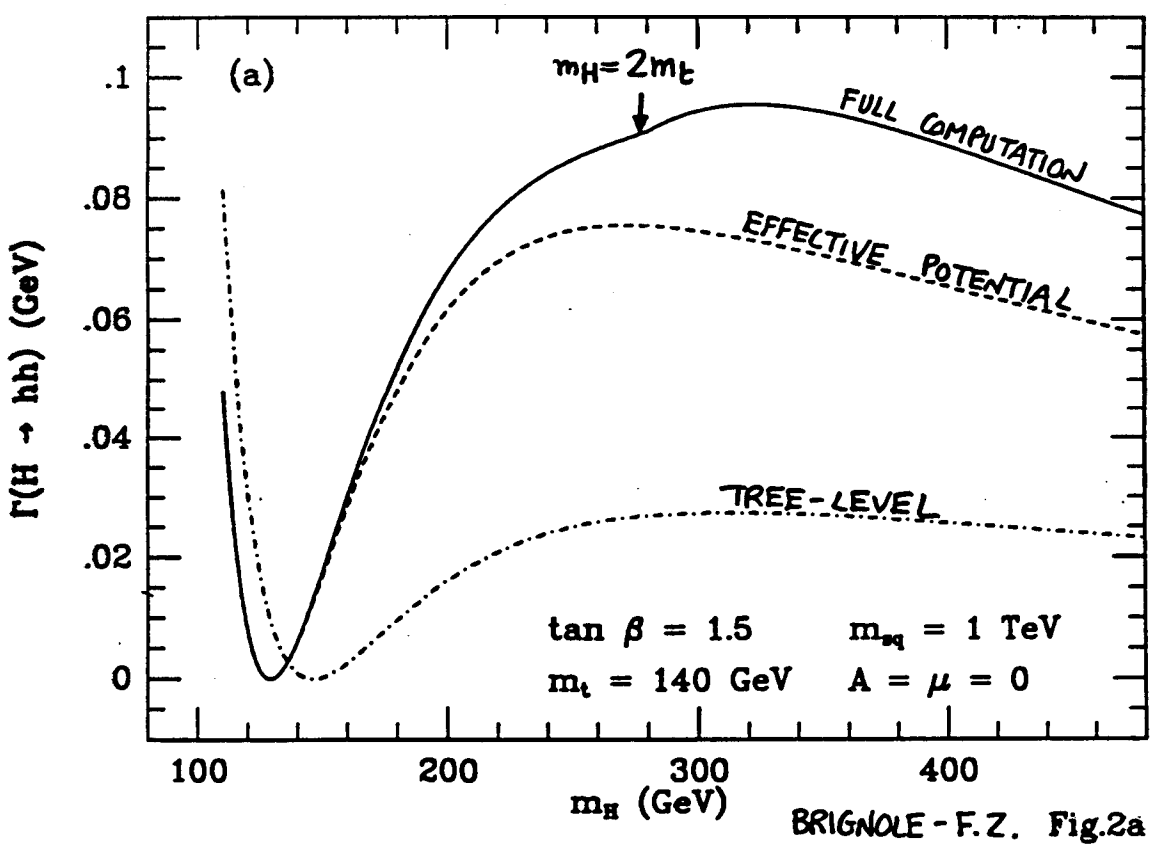
CAN BE LARGE $\Delta\lambda \sim \frac{m_t^4}{m_W^4} \log \ldots$

COMPUTATIONS EXIST IN THE THREE MAIN APPROACHES

BRIGNOLE B.E.R.Z. BARGER-BERGER-STANGE-PHILLIPS

HABER-HEMPFLING-NIR BRIGNOLE-F.Z. H.H.

Example : $\Gamma(H \to hh)$ at one loop



BRIGNOLE-F.Z. Fig.2a

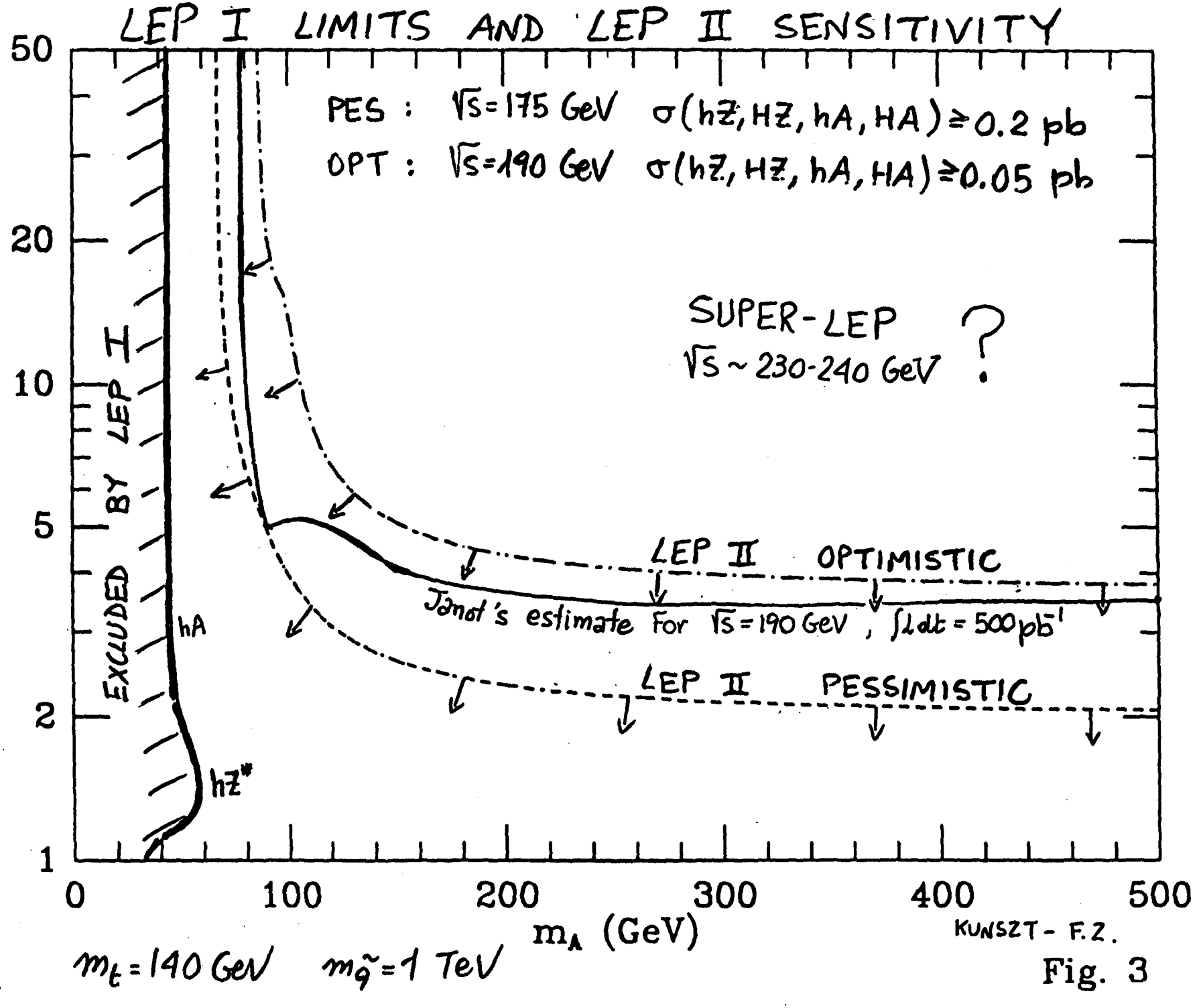
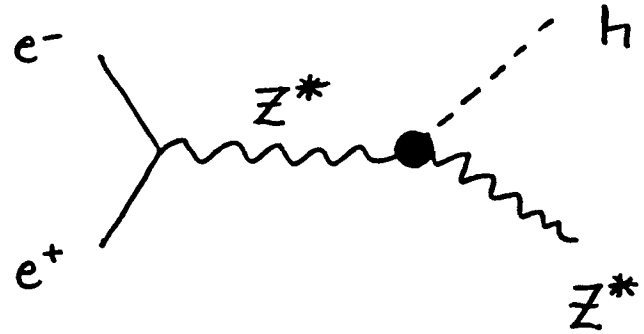
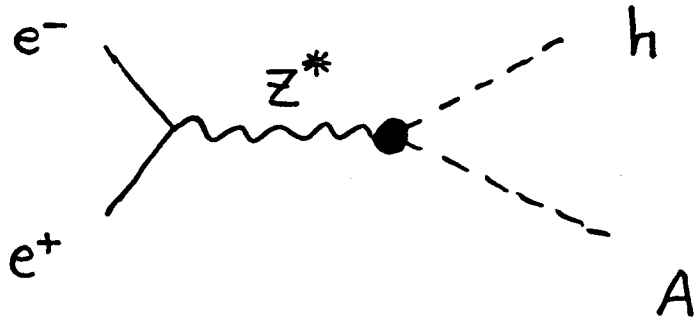

LEP I LIMITS AND LEP II SENSITIVITY
PES : √s = 175 GeV σ(hZ, HZ, hA, HA) ≥ 0.2 pb
OPT : √s = 190 GeV σ(hZ, HZ, hA, HA) ≥ 0.05 pb
SUPER-LEP
√s ~ 230-240 GeV ?
EXCLUDED BY LEP I
hA
hZ*
LEP II OPTIMISTIC
Janot's estimate for √s = 190 GeV, ∫L dt = 500 pb⁻¹
LEP II PESSIMISTIC
m_A (GeV)
KUNSZT - F.Z.
m_t = 140 GeV m_q̃ = 1 TeV

Fig. 3

SUSY HIGGS SEARCHES AT LEP



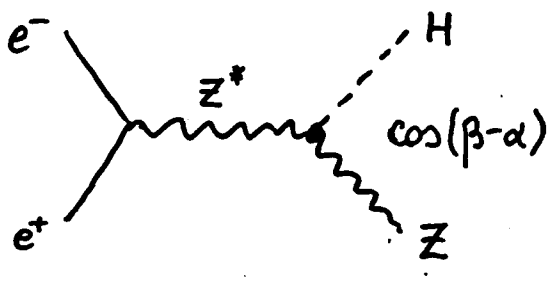
$\sin(\beta-\alpha)$

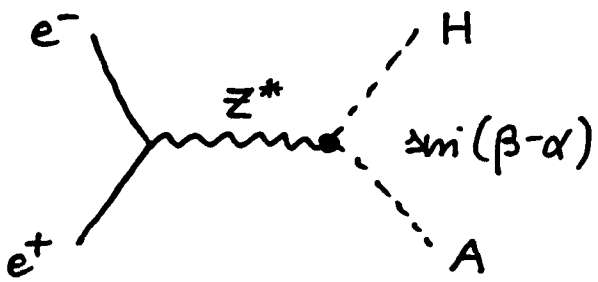


$\cos(\beta-\alpha)$

For some values of the parameters $h \to AA$ can dominate over $h \to b\bar{b}$, $h \to \tau^+\tau^-$, ...

At LEP II, one can also consider the processes





but after including radiative corrections they are marginally important. Challenge of $m_h \gtrsim m_W$: c.o.m. energy, luminosity, b-tagging become crucial!

LEP II discovery potential discussed in P. JANOT, LAL 91-61, 92-27

KUNSZT F.Z

SUSY HIGGS SEARCHES AT THE LHC / SSC

(see also BAER et al., GUNION et al., BARGER et al.)

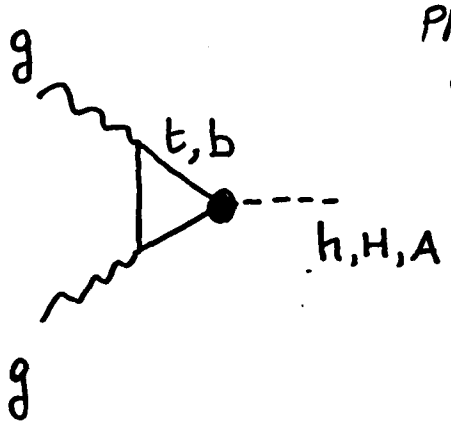
CONSERVATIVE ASSUMPTION

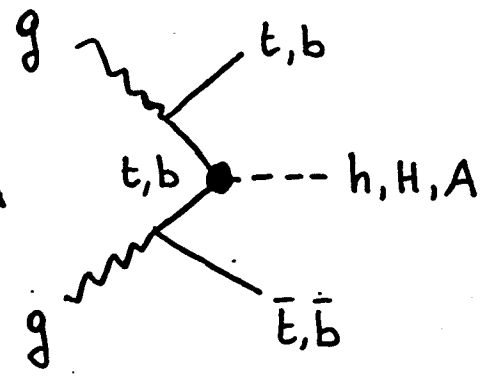
R-ODD SPARTICLES HEAVY

$\Downarrow$

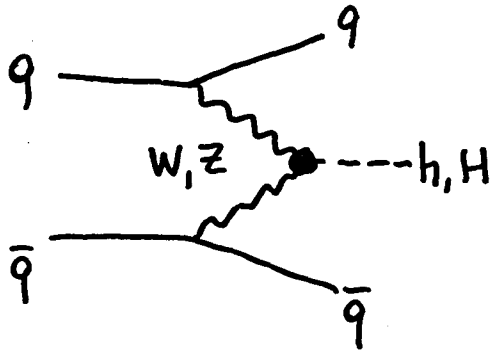
NEGLIGIBLE CONTRIBUTIONS TO CROSS-SECTIONS (LOOPS) AND BRANCHING RATIOS (SUSY DECAY MODES, LOOPS)

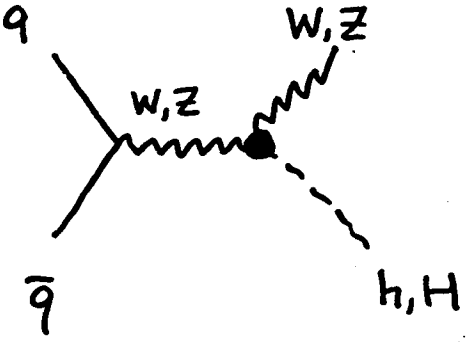
PRODUCTION MECHANISMS



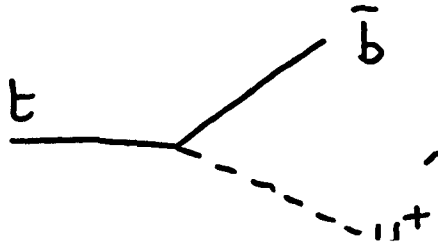


MODIFIED COUPLINGS TO FERMIONS IMPORTANT



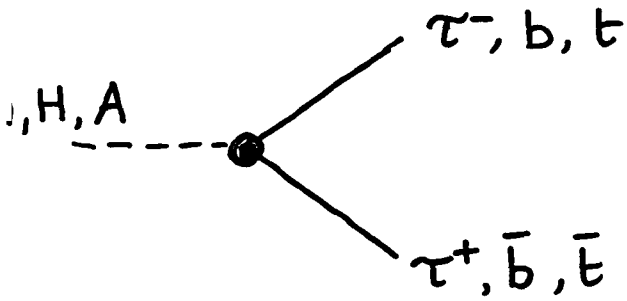


MODIFIED COUPLINGS TO VECTORS IMPORTANT



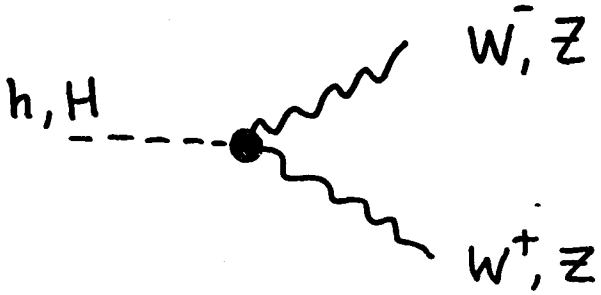
$$\sim \left[m_t \cot\beta \,(1+\gamma_5) + m_b \tan\beta \,(1-\gamma_5) \right]$$

DECAY MODES



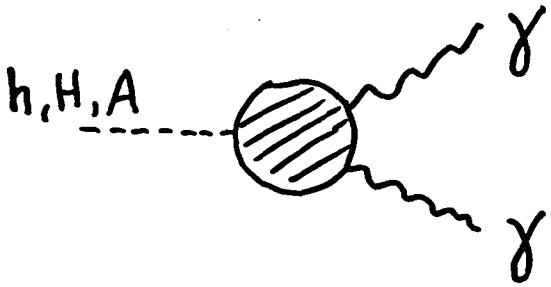
ENHANCEMENT OF τ, b

SUPPRESSION OF t



SUPPRESSION

WIDTHS ALWAYS SMALL
(IN THE GEV RANGE)



MODIFIED COUPLINGS FOR THE W, b, t LOOPS

CHARGED HIGGS LOOP

IN GENERAL SUPPRESSION

IN ADDITION, ONE IS <u>FORCED</u> TO INCLUDE NEW DECAY MODES

$H \to \underline{hh}, AA \qquad A \to Zh \qquad H^{\pm} \to W^{\pm} h$

Even in this simplified case

A CHALLENGING QUESTION

ARE LEP and SSC/LHC ENOUGH TO PROBE THE FULL $(m_A, \tan\beta)$ PLANE ?

h BRANCHING RATIOS

h → AA only for $m_A \lesssim 25$GeV in this example

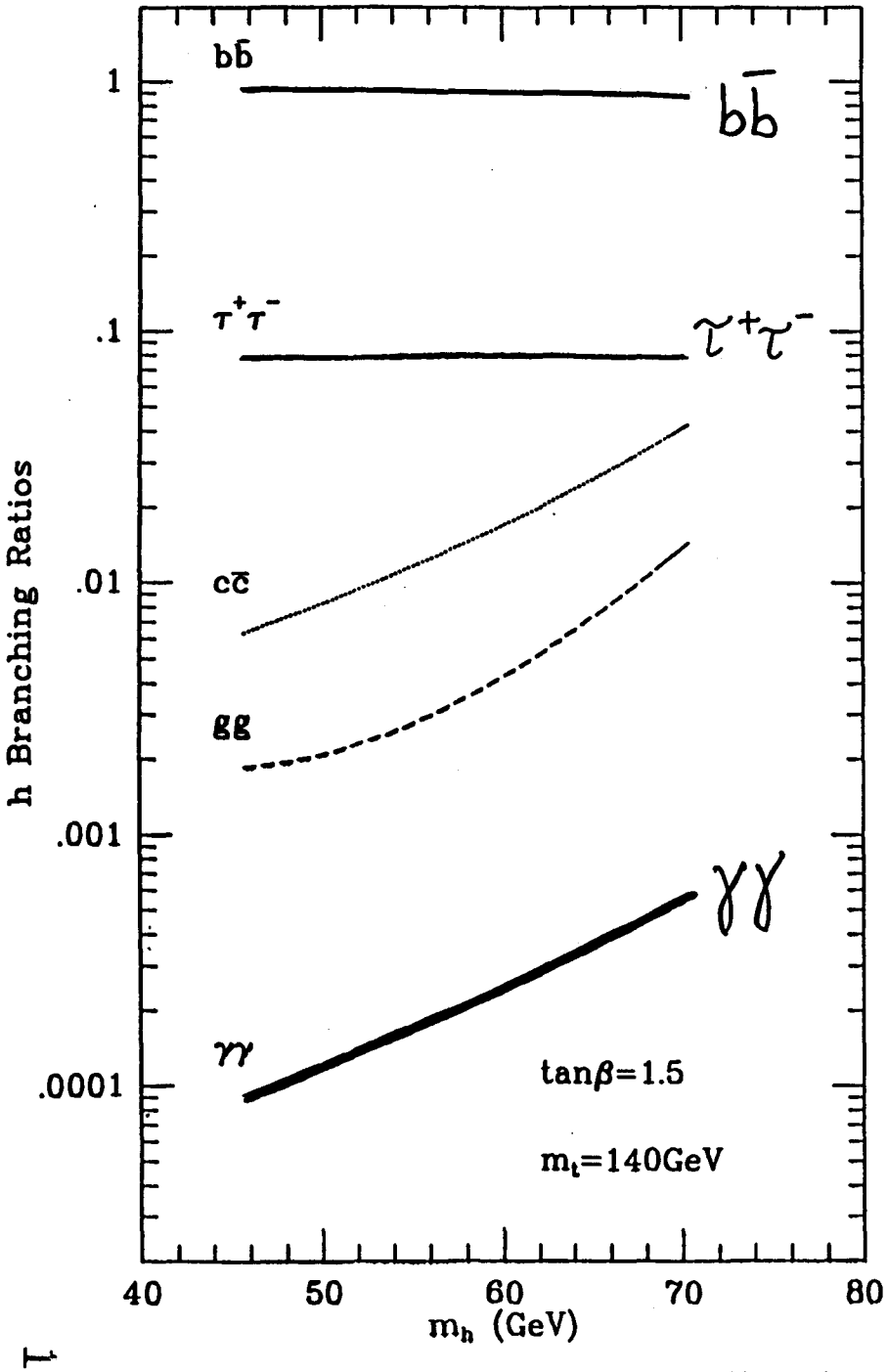


Fig. 10a

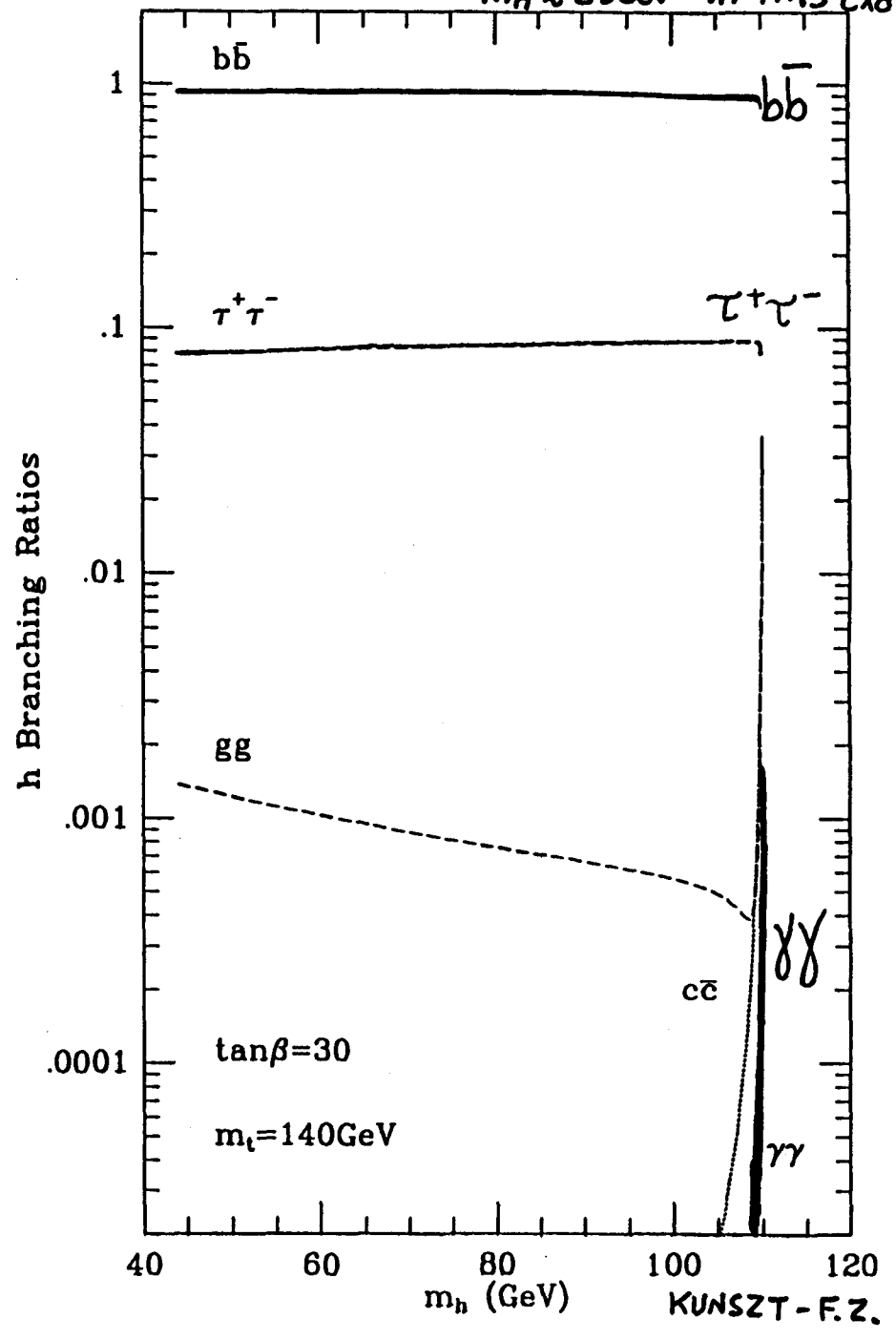


Fig.

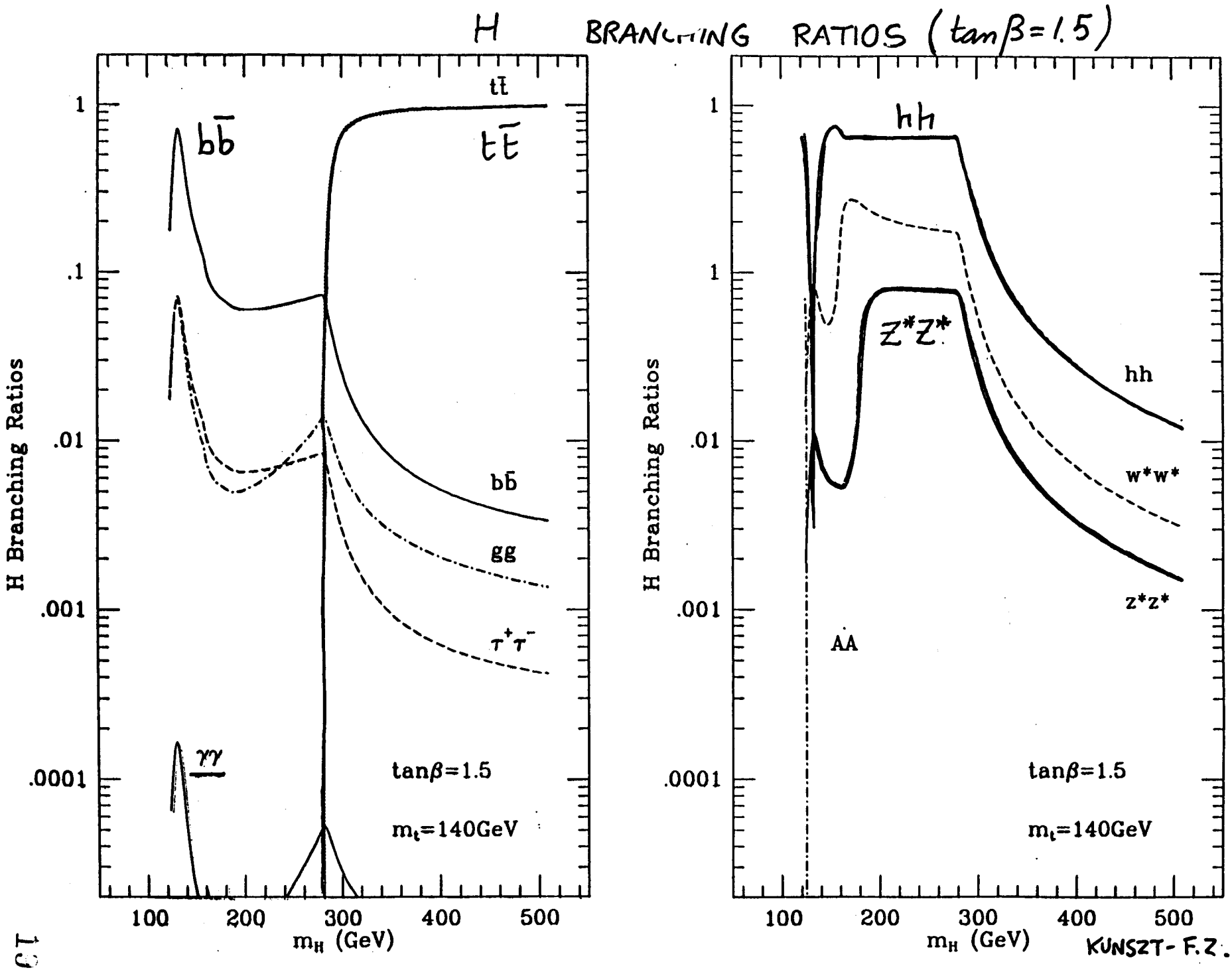
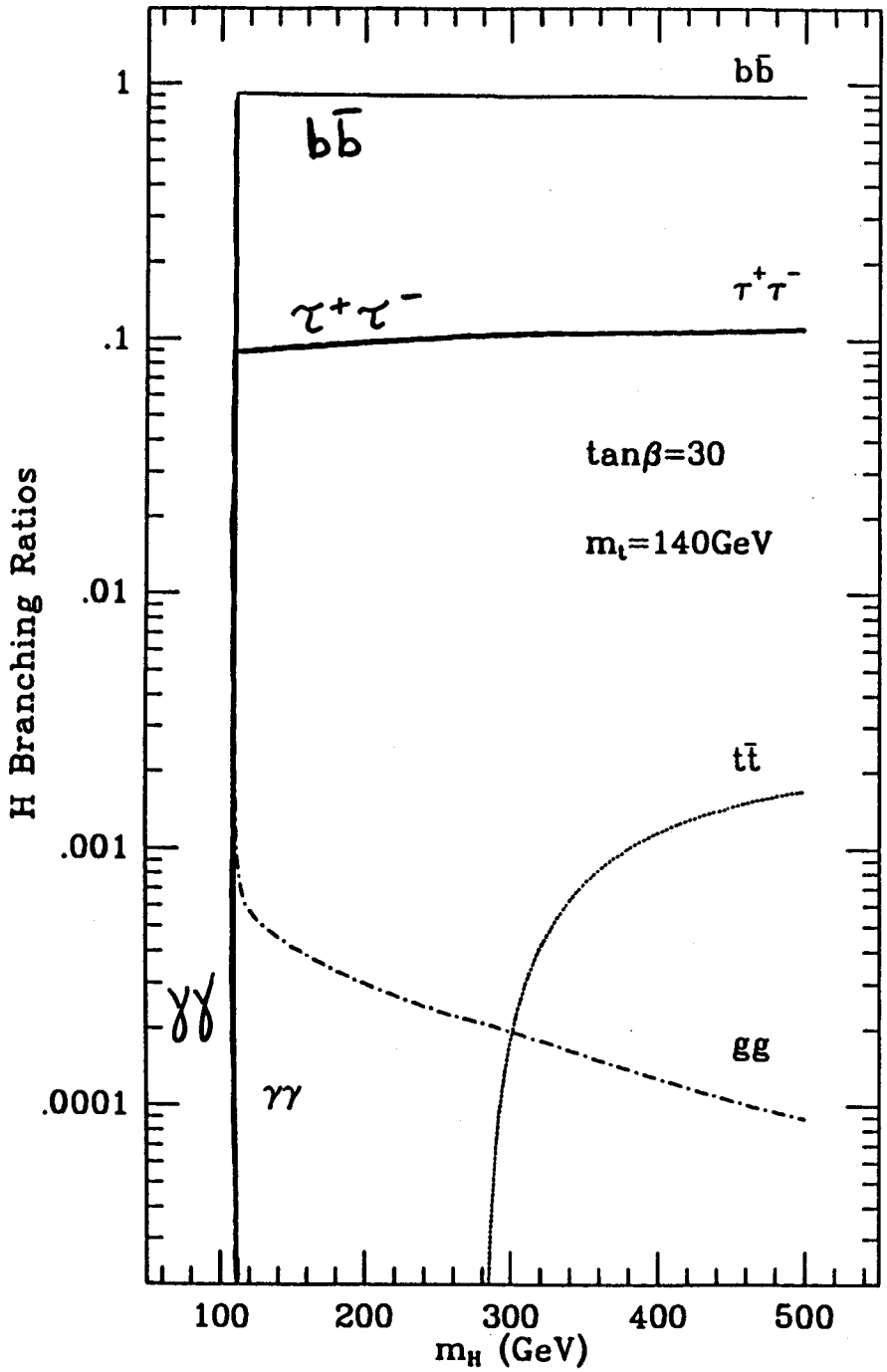
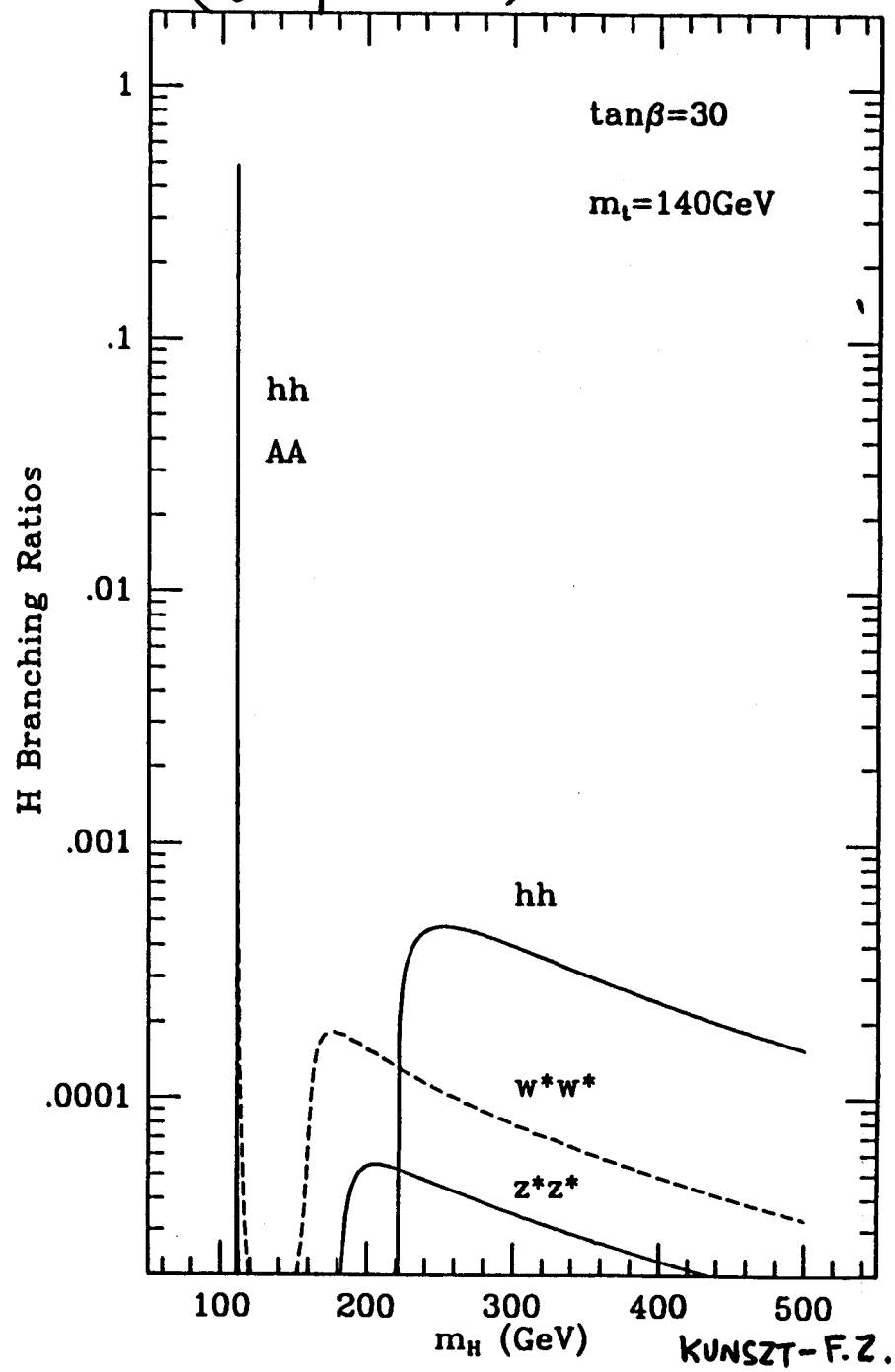

H BRANCHING RATIOS (tanβ=1.5)
H Branching Ratios
1
.1
.01
.001
.0001
bb̄
tt̄
tt̄
bb̄
gg
τ⁺τ⁻
γγ
tanβ=1.5
m_t=140GeV
100
200
300
400
500
m_H (GeV)
hh
Z*Z*
hh
w*w*
z*z*
AA
tanβ=1.5
m_t=140GeV
KUNSZT-F.Z.

Fig. 11a

H BRANCHING RATIOS ($\tan\beta = 30$)





KUNSZT-F.Z.

Fig. 11b

A BRANCHING RATIOS

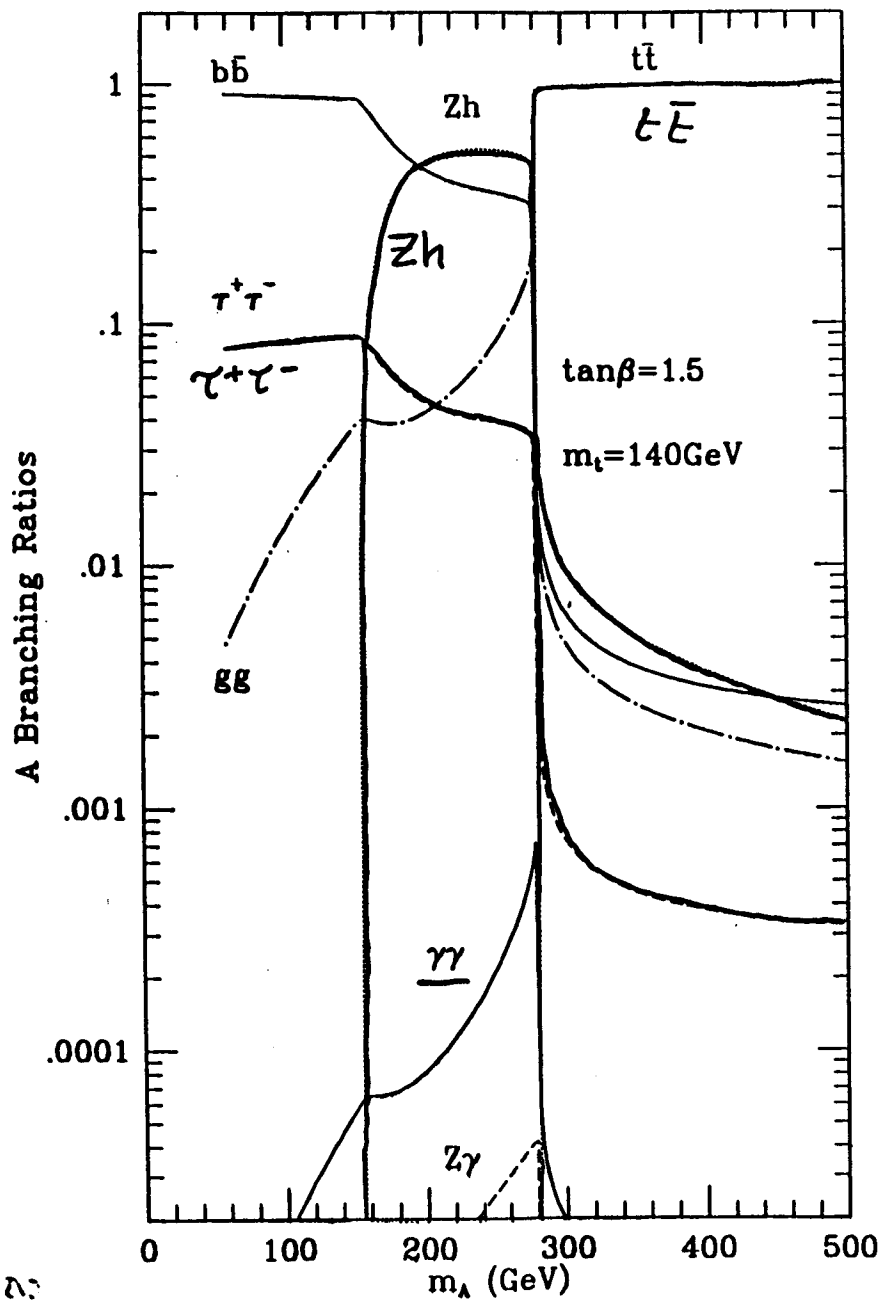
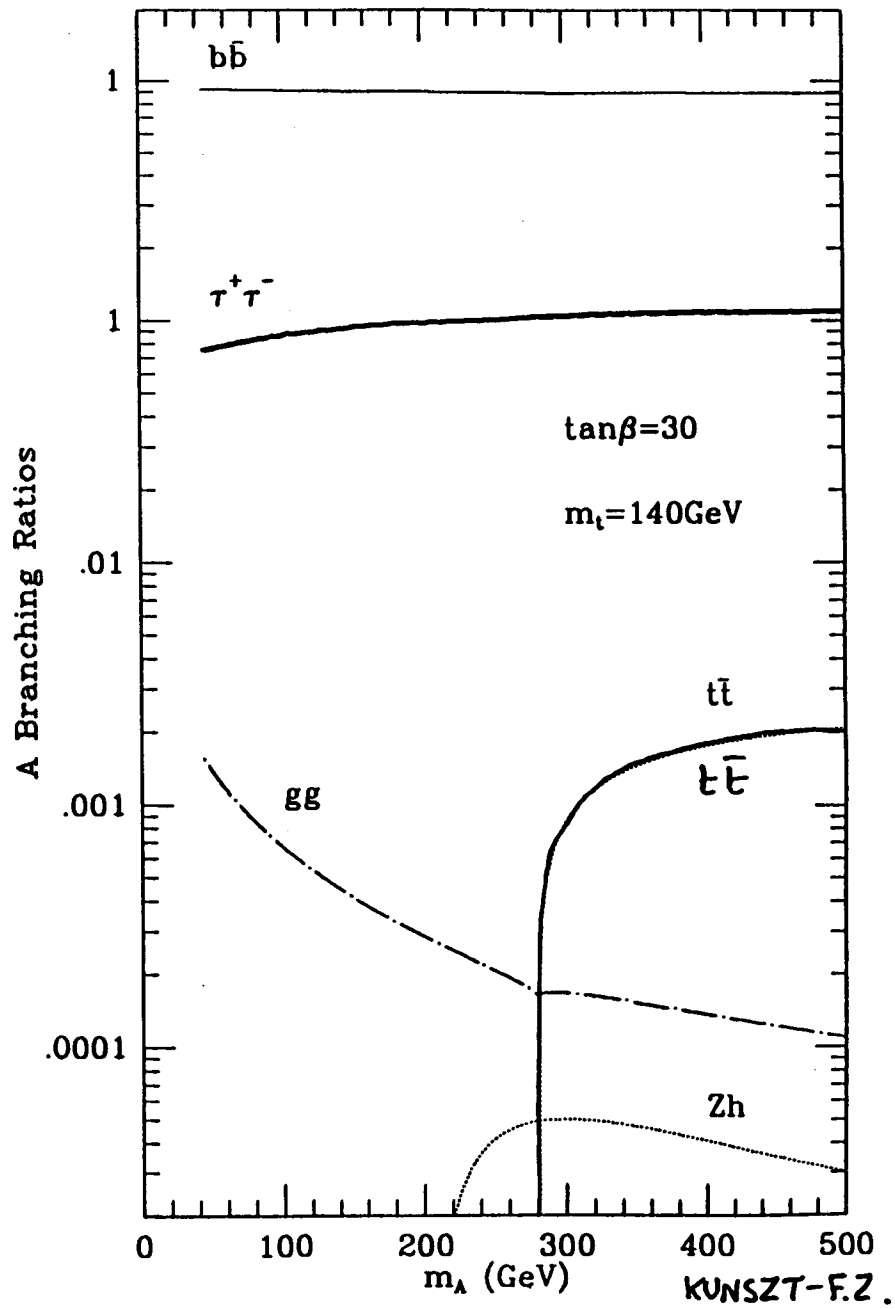


Fig. 12a



KUNSZT-F.Z.

Fig. 12b

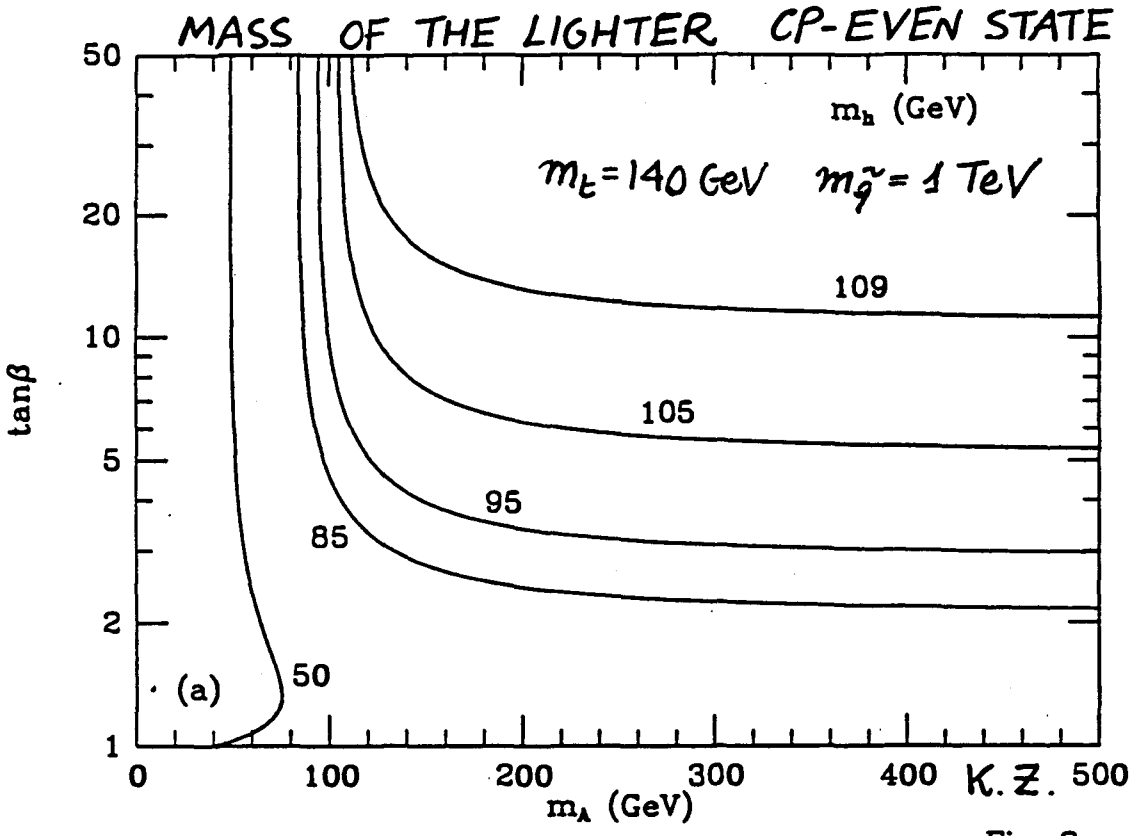

MASS OF THE LIGHTER CP-EVEN STATE
m_h (GeV)
m_t = 140 GeV $m_{\tilde{q}}$ = 1 TeV
109
105
95
85
50
(a)
tanβ
m_A (GeV)
K.Z.

Fig. 2a

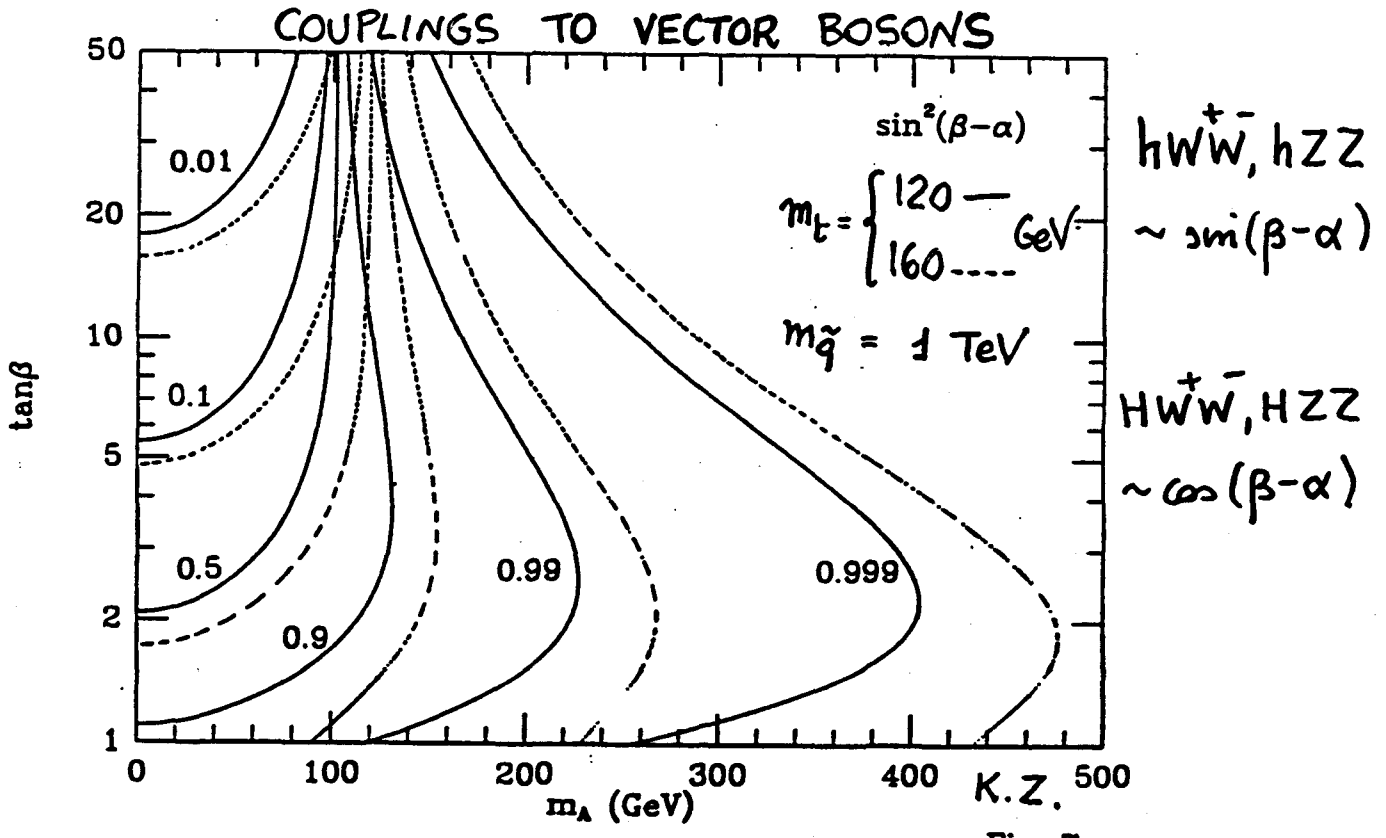
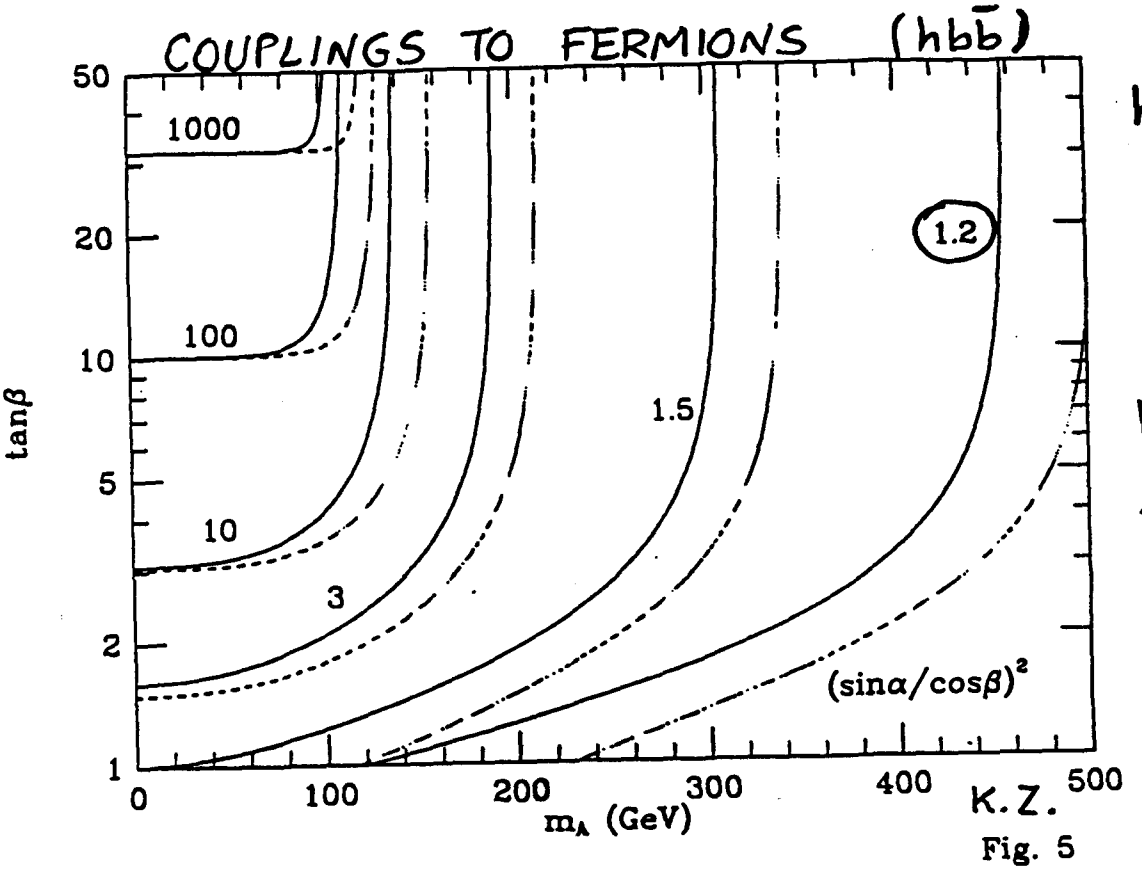

COUPLINGS TO VECTOR BOSONS
$\sin^2(\beta-\alpha)$
m_t = 120 — 160 ---- GeV
$m_{\tilde{q}}$ = 1 TeV
0.01
0.1
0.5
0.9
0.99
0.999
tanβ
m_A (GeV)
K.Z.
$hW^+W^-, hZZ \sim \sin(\beta-\alpha)$
$HW^+W^-, HZZ \sim \cos(\beta-\alpha)$

Fig. 7

$m_t = \begin{cases} 120 & \text{—} \\ 160 & \text{-----} \end{cases}$ GeV $\qquad m_{\tilde{q}} = 1$ TeV

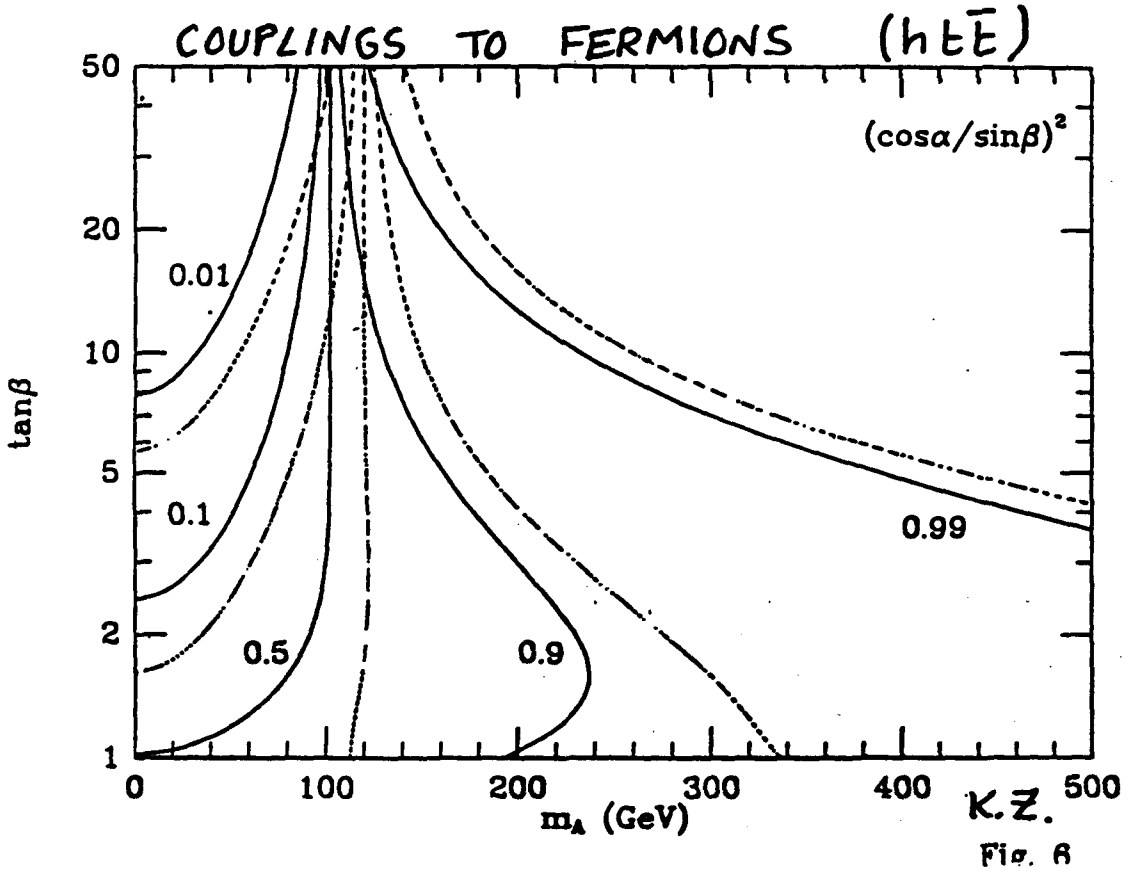


$hb\bar{b}, h\tau^+\tau^- \sim \frac{-\sin\alpha}{\cos\beta}$

$Hb\bar{b}, H\tau^+\tau^- \sim \frac{\cos\alpha}{\cos\beta}$

$Ab\bar{b}, A\tau^+\tau^- \sim -i\gamma_5 \tan\beta$

Fig. 5



$ht\bar{t} \sim \frac{\cos\alpha}{\sin\beta}$

$Ht\bar{t} \sim \frac{\sin\alpha}{\sin\beta}$

$At\bar{t} \sim -i\gamma_5 \cot\beta$

Fig. 6

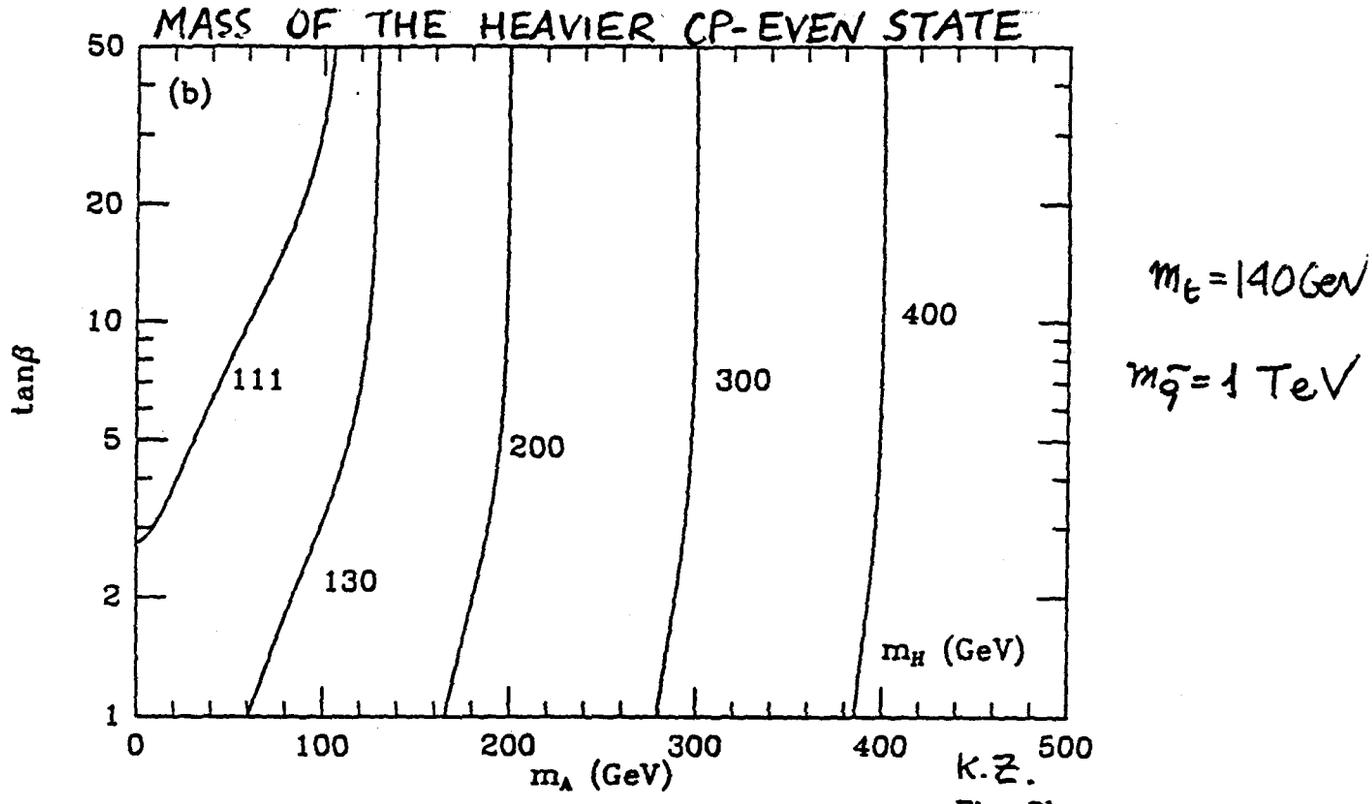
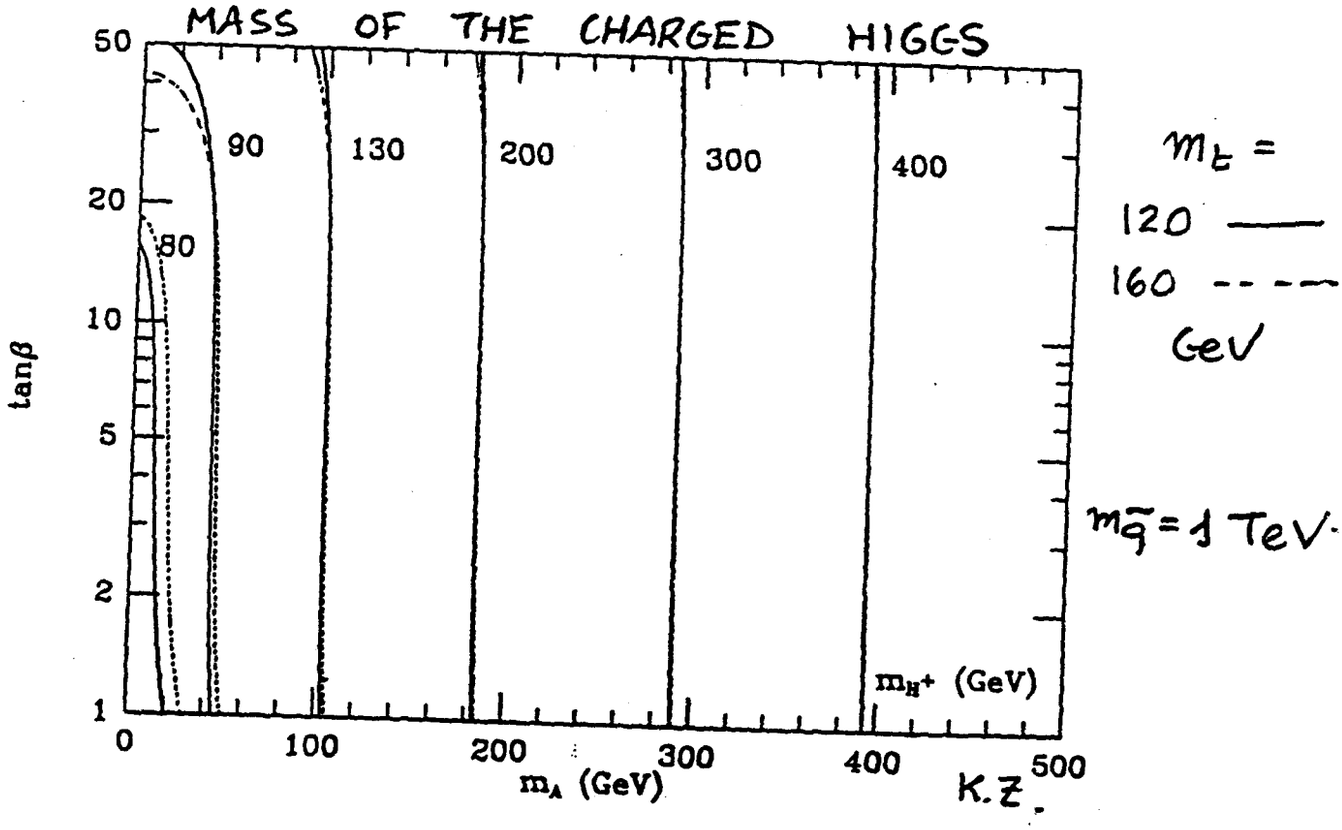

MASS OF THE HEAVIER CP-EVEN STATE
(b)
tanβ
50
20
10
5
2
1
0
100
200
300
400
500
111
130
200
300
400
m_H (GeV)
m_A (GeV)
m_t = 140 GeV
$m_{\tilde{q}}$ = 1 TeV
K.Z.

Fig. 2b


MASS OF THE CHARGED HIGGS
tanβ
50
20
10
5
2
1
0
100
200
300
400
500
90
130
200
300
400
80
m_{H^+} (GeV)
m_A (GeV)
m_t =
120
160
GeV
$m_{\tilde{q}}$ = 1 TeV
K.Z.

INCLUSIVE $\phi \to \gamma\gamma$

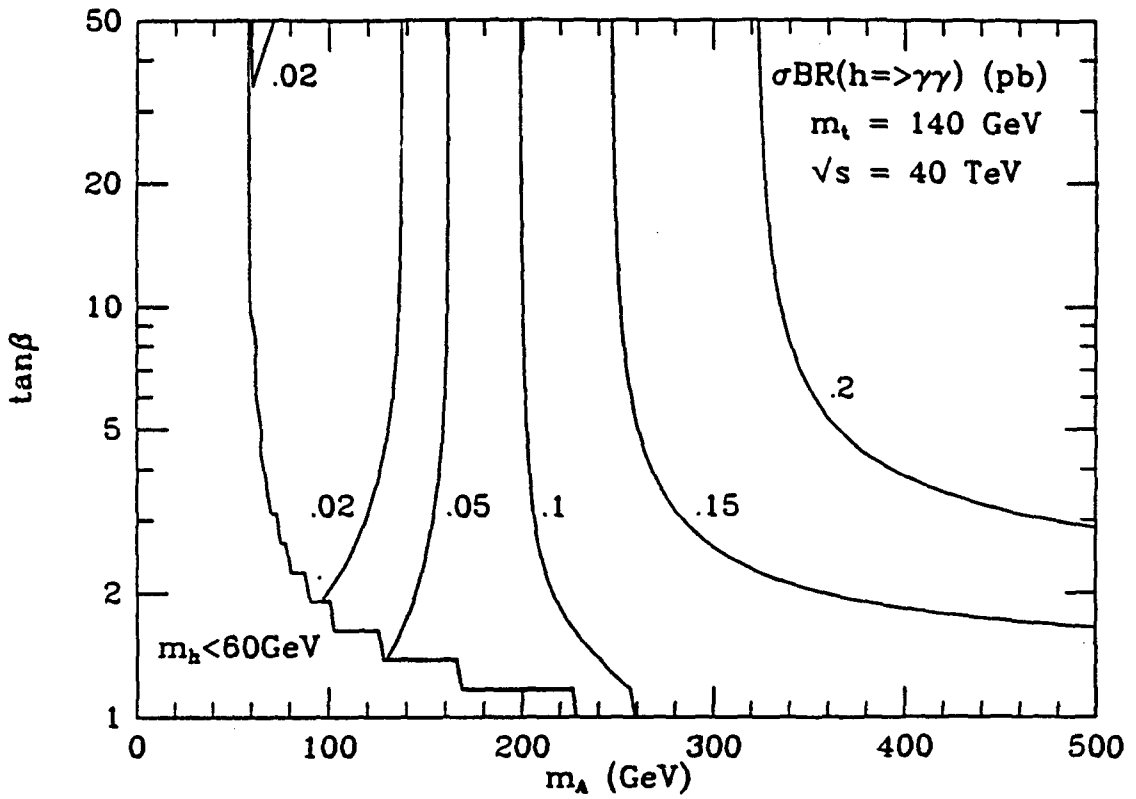


Fig. 22c

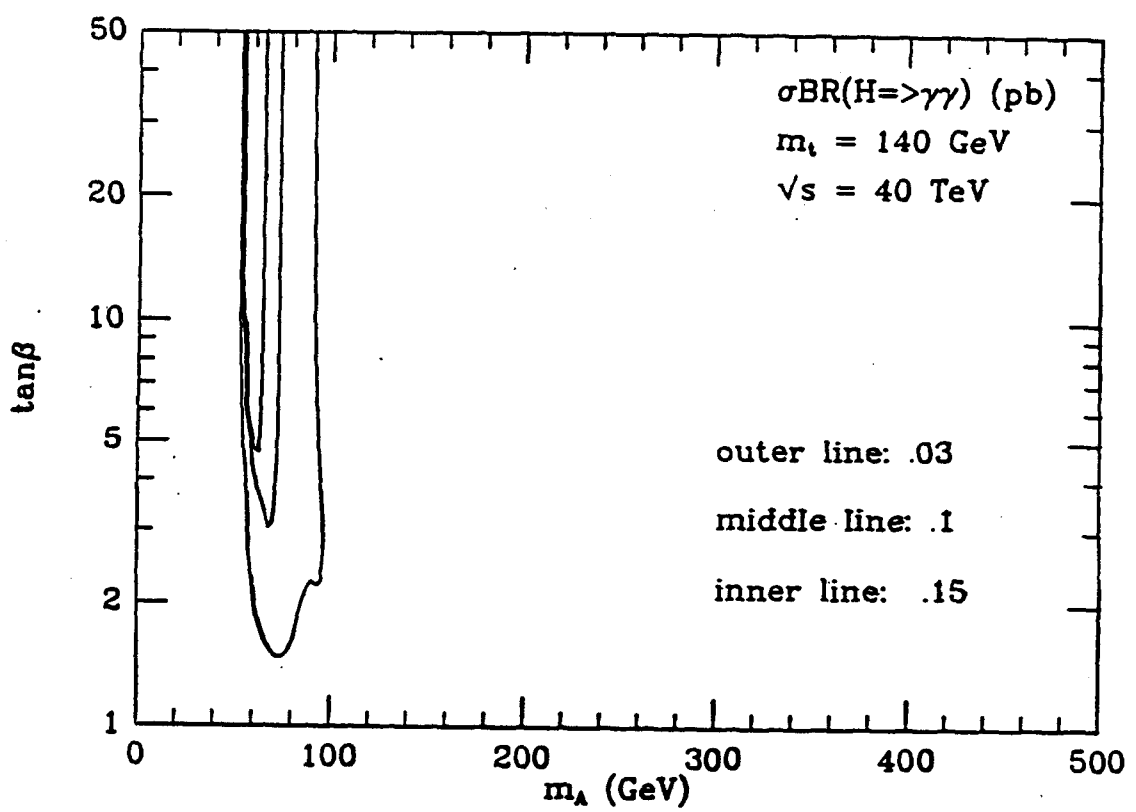


Fig. 22d

THE MOST PROMISING PHYSICS SIGNALS

- TWO ISOLATED PHOTONS (INCLUSIVE $h, H \to \gamma\gamma$)

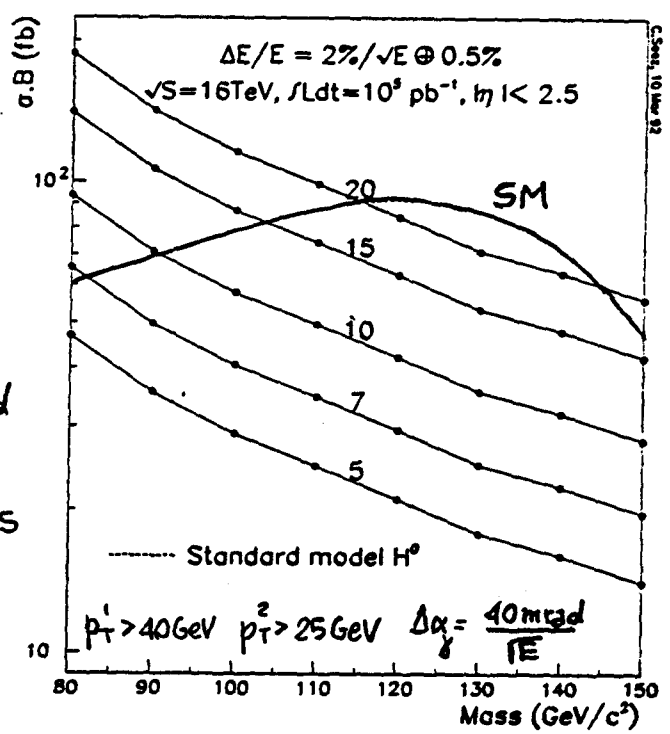
good For the SM-Higgs in the intermediate mass region, can be suppressed in the MSSM

possible to rescale the SM simulation studies

energy resolution !

rejection efficiency $R \sim 10^4$ For jets Faking isolated γ !

CMS simulation (Seez, Virdee) $\Rightarrow$



S/√B contours

QCD corrections included ($K \sim 1.5-1.7$ for $gg \to \phi$)

recent: GRAUDENZ - SPIRA - ZERWAS

$\int \mathcal{L}\, dt = 10^5\ pb^{-1}$

also EAGLE study (Fayard, Unal) for ATLAS collaboration

Fig. 21

- ONE ISOLATED LEPTON AND TWO ISOLATED PHOTONS

associated $t\bar{t}\phi$, $W\phi$ production with $\phi \to \gamma\gamma$ and the isolated lepton from top or W decay

irr. $W\gamma\gamma$, $t\bar{t}\gamma\gamma$

red $b\bar{b}\gamma\gamma$, $b\bar{b}\gamma$, $b\bar{b}\gamma g$, $W\gamma j$ ...

similar considerations as above

more interesting at the SSC than at the LHC

UNAL-FAYARD recent LHC study small number of events !

($\phi \to \gamma\gamma$) + ISOLATED LEPTON

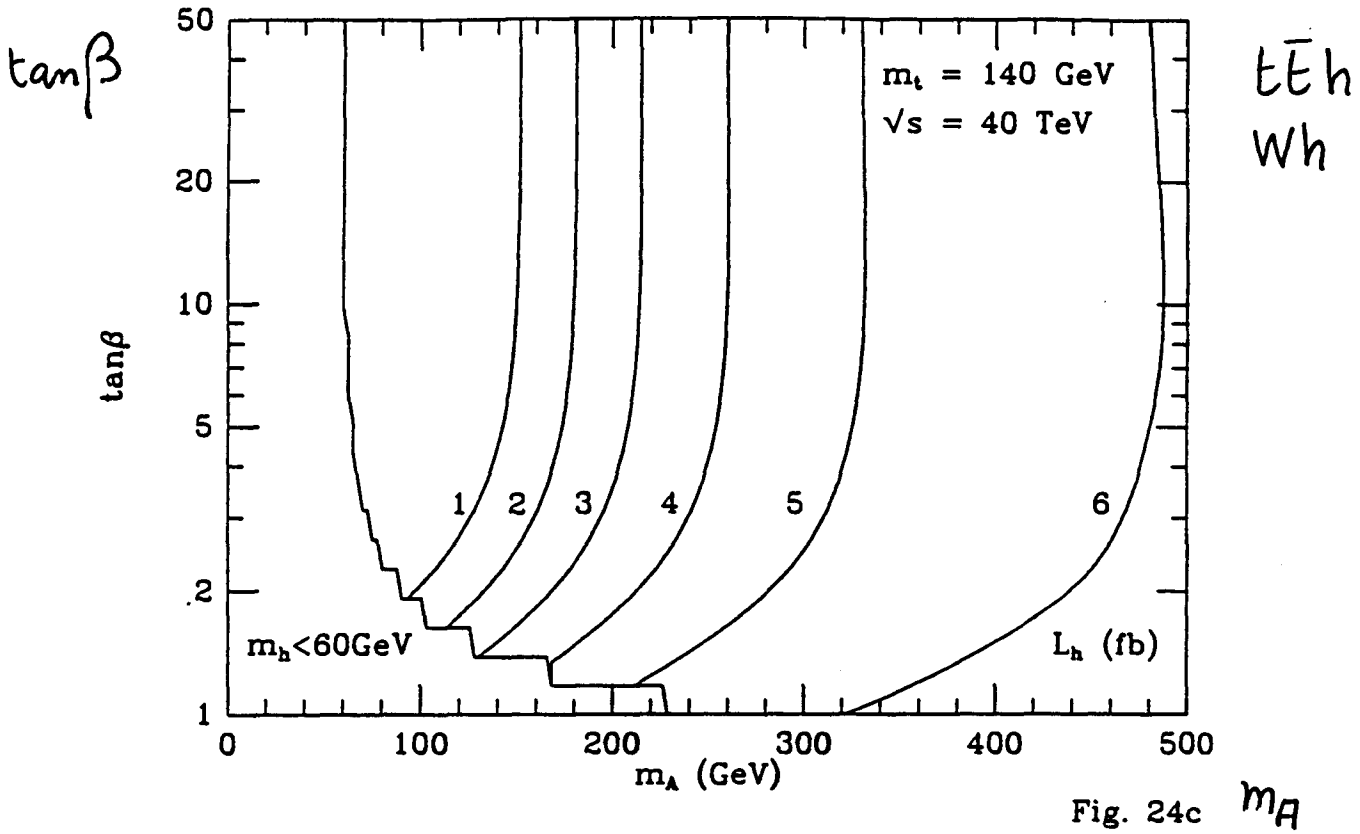


Fig. 24c

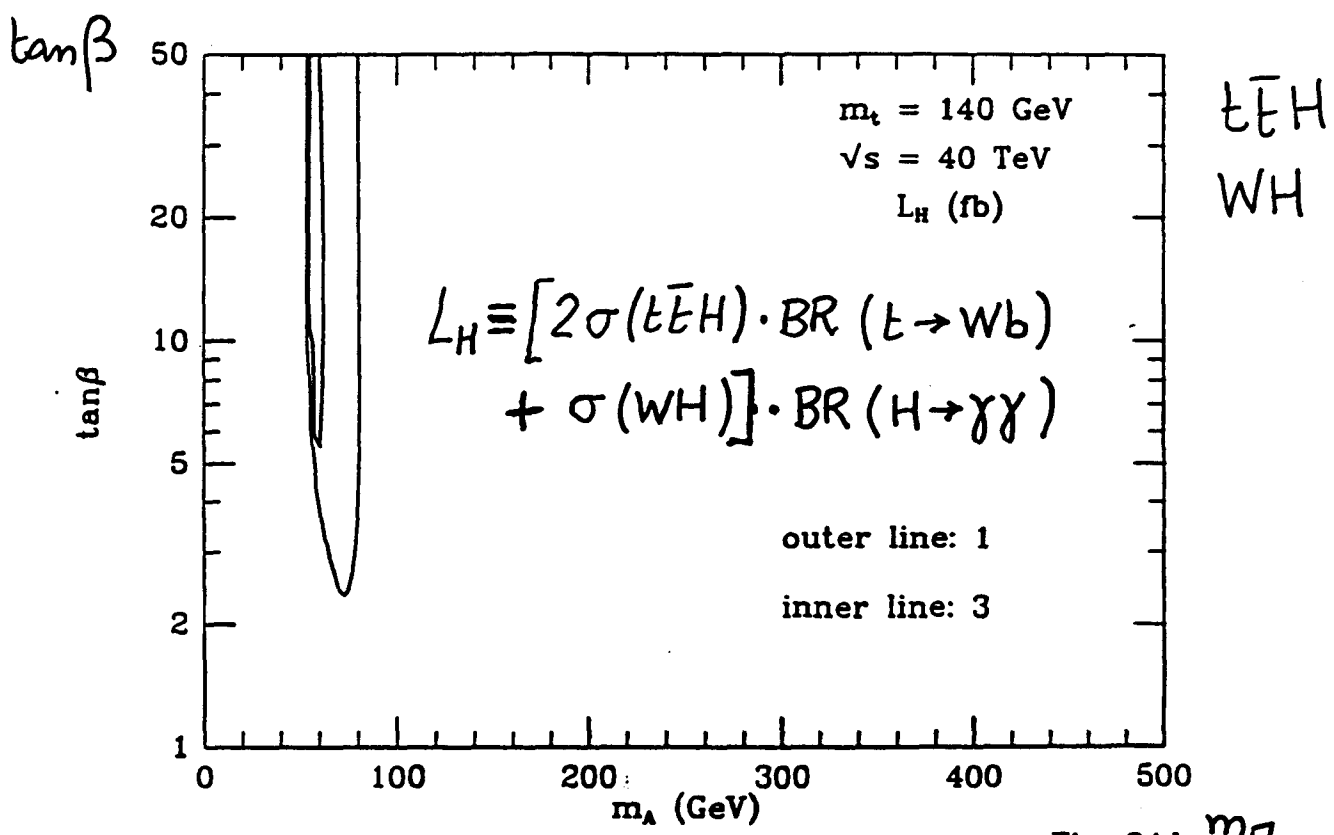


Fig. 24d

K.Z.

- FOUR CHARGED LEPTONS $(H \to ZZ^{(*)} \to 4\ell^{\pm}, \ \ell = e, \mu$

it is the gold-plated mode for the SM Higgs able to cover the mass region 130 ÷ 800 GeV

very suppressed rate in the MSSM!

- reduced couplings to vector bosons
- competition with $H \to hh$, $H \to t\bar{t}$

only advantage: the total width is smaller $\Gamma_{TOT}(H) \lesssim 2$ GeV in the relevant region

one can rescale the SM background studies, but take advantage of the narrow H width

lower acceptance for $m_H < 2m_Z$

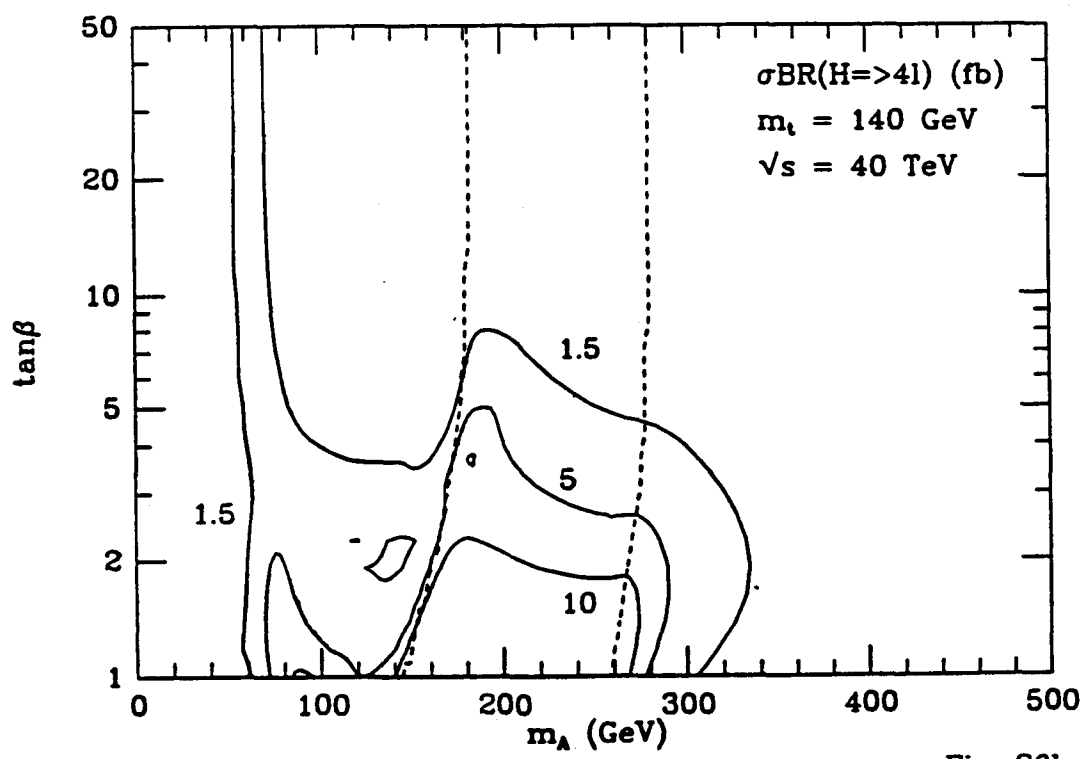


Fig. 26b

K.Z.

- THE $\tau^+\tau^-$ CHANNEL (h, H, A)

LHC studies by DI LELLA, FELCINI, PAUSS, UNAL-CAVALLI-COZZI-PERINI

HOPELESSLY DIFFICULT FOR THE SM HIGGS
(bad mass resolution, large backgrounds)
$t\bar{t}$ WW + jets DY Z + jets

IN THE MSSM, ONE CAN TAKE ADVANTAGE OF ENHANCED CROSS-SECTIONS AND BRANCHING RATIOS

iF p_T^{ϕ} is large, m_ϕ can be reconstructed
ELLIS-HINCHLIFFE-SOLDATE-VAN DER BJ

Two signals:

- $\tau^+\tau^- \longrightarrow e^\pm \mu^\mp$ + missing p_T
- $\tau^+\tau^- \longrightarrow \tau$-jet + $\ell^\pm$ + missing p_T

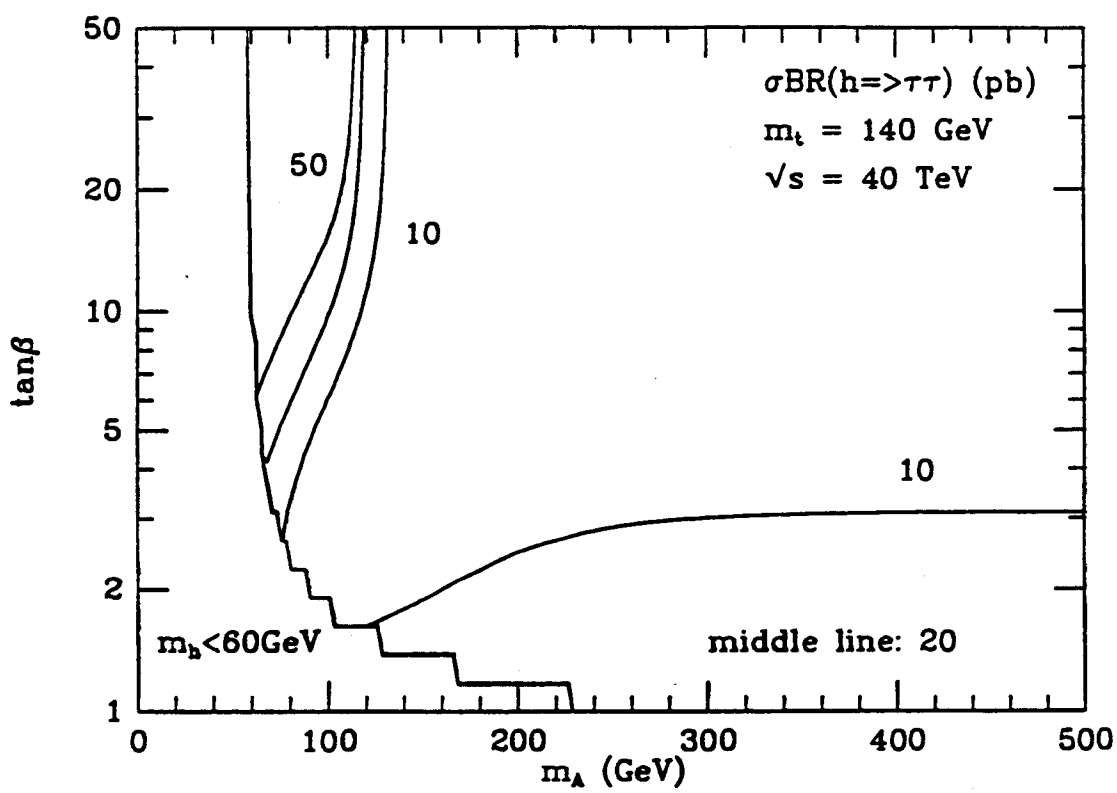


Fig. 28d

K.Z.

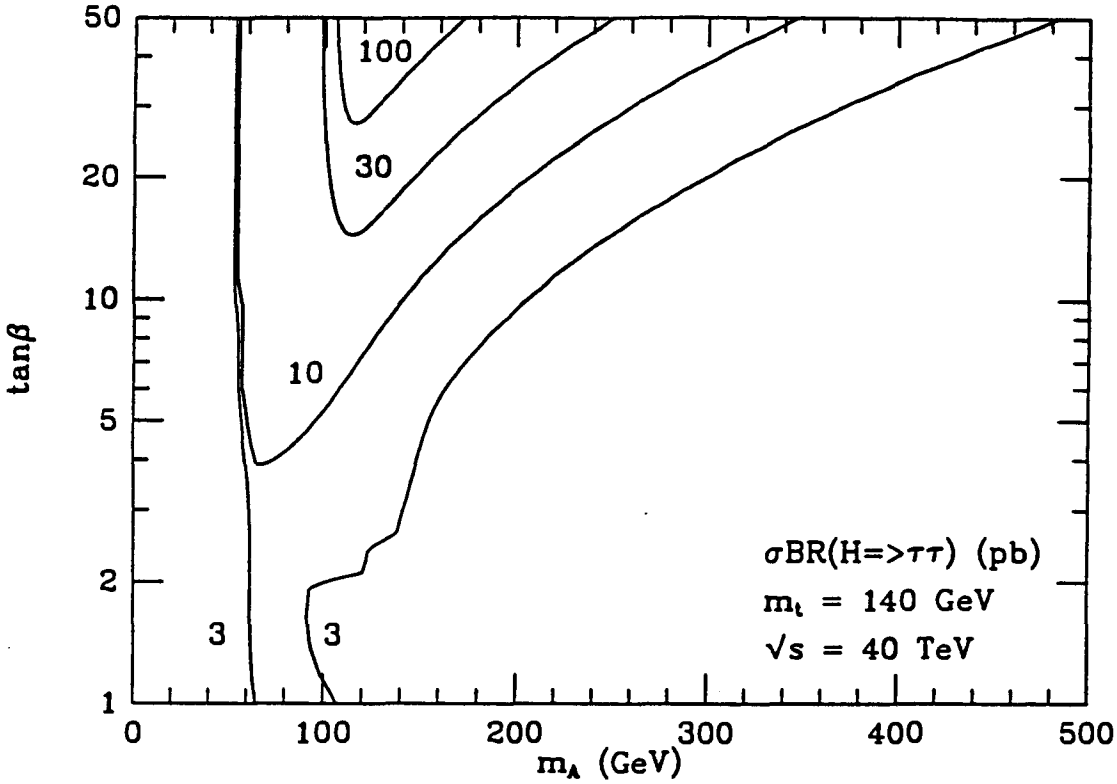


Fig. 28e

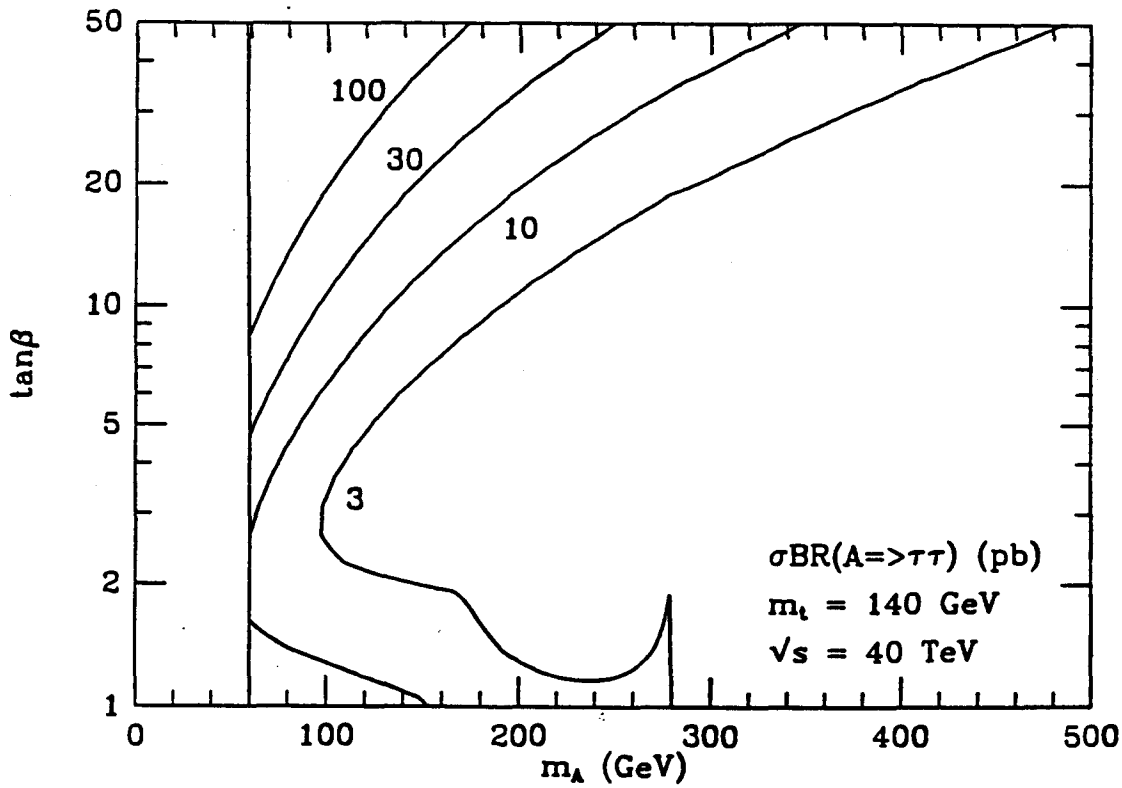
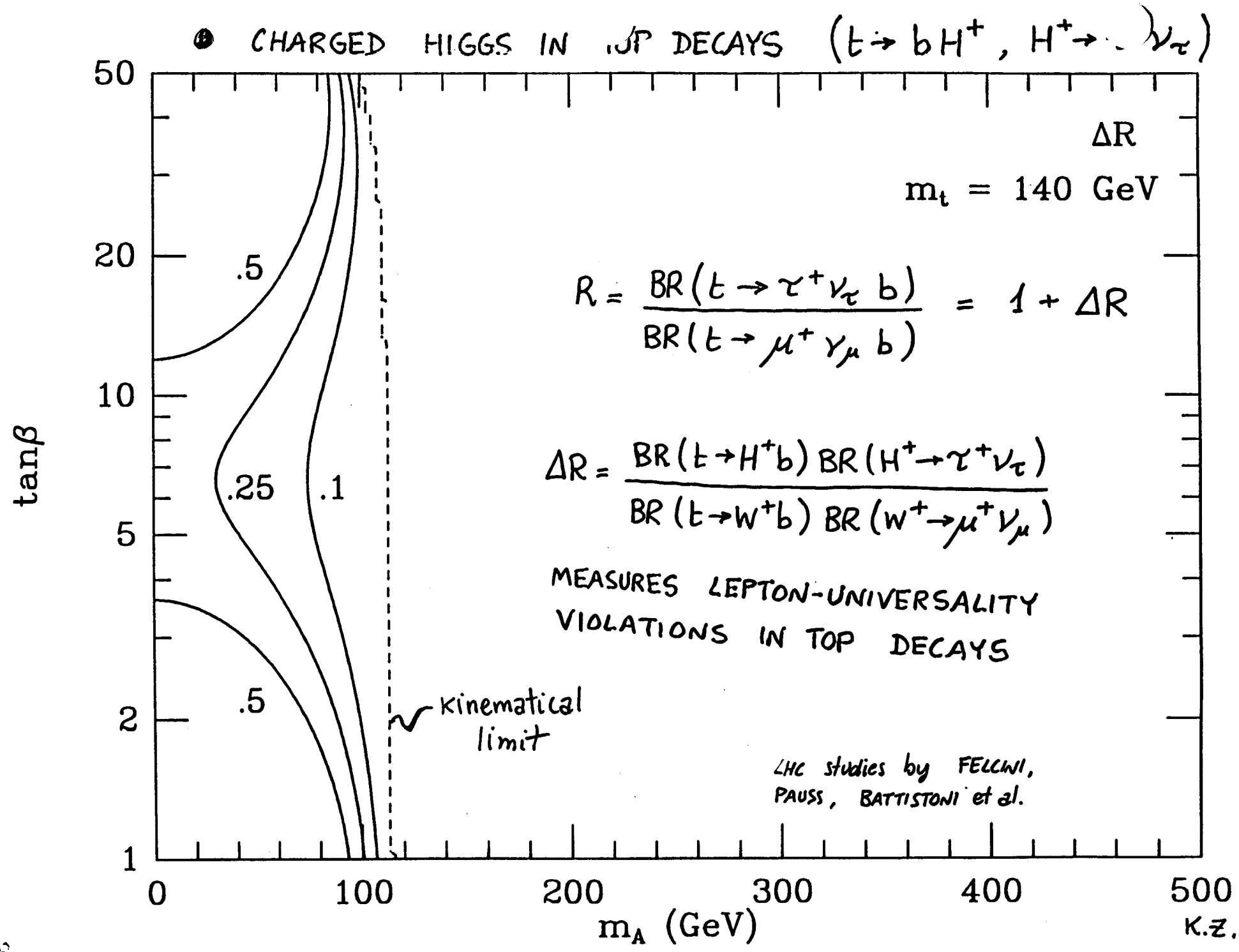


Fig. 28f

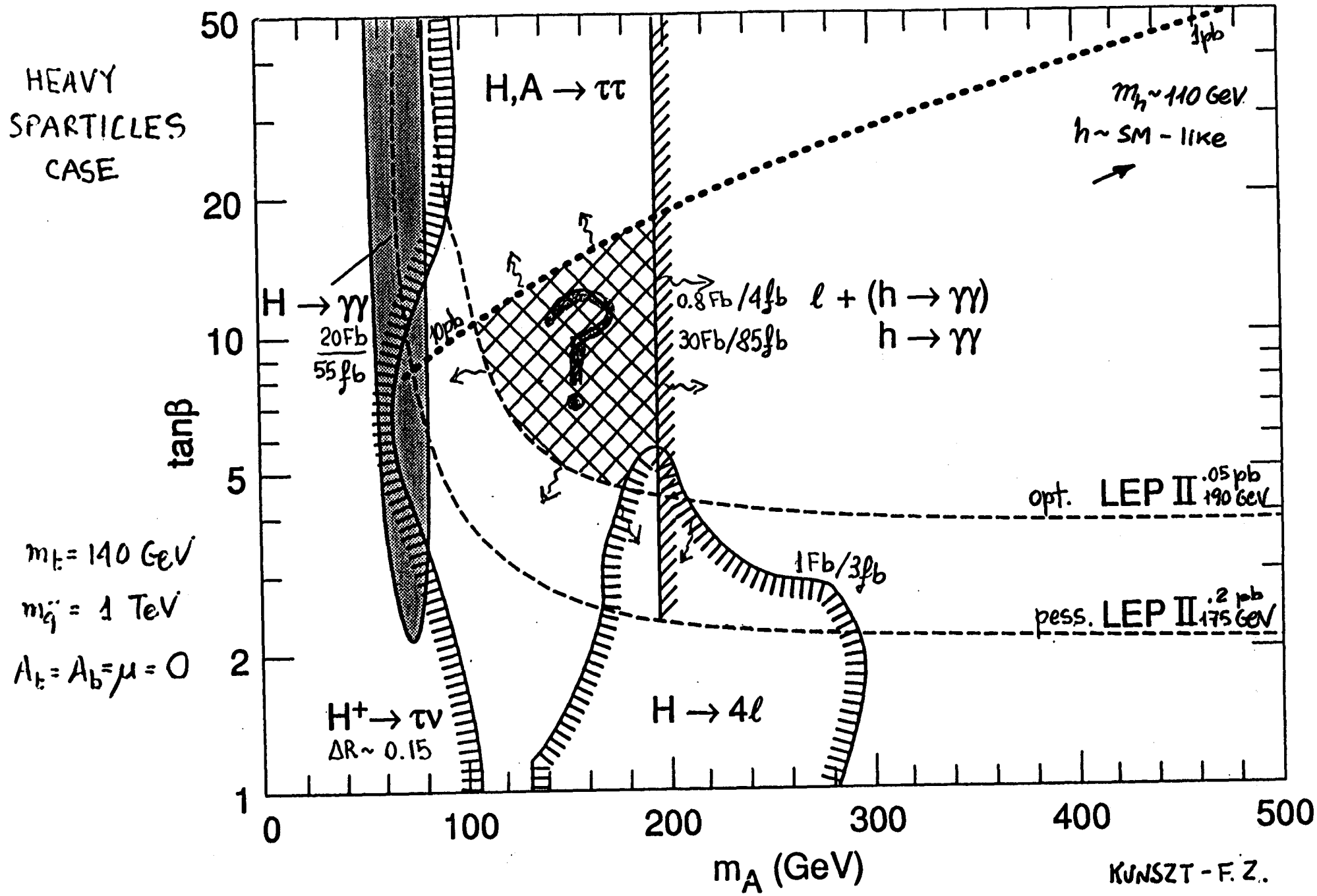
K.Z.


CHARGED HIGGS IN TOP DECAYS ($t \to bH^+$, $H^+ \to \ldots \nu_\tau$)
ΔR
m_t = 140 GeV
$R = \frac{BR(t \to \tau^+ \nu_\tau b)}{BR(t \to \mu^+ \nu_\mu b)} = 1 + \Delta R$
$\Delta R = \frac{BR(t \to H^+ b)\, BR(H^+ \to \tau^+ \nu_\tau)}{BR(t \to W^+ b)\, BR(W^+ \to \mu^+ \nu_\mu)}$
MEASURES LEPTON-UNIVERSALITY VIOLATIONS IN TOP DECAYS
.5
.25
.1
.5
Kinematical limit
LHC studies by FELCINI, PAUSS, BATTISTONI et al.
tanβ
m_A (GeV)
50
20
10
5
2
1
0
100
200
300
400
500

K.Z.

Fig. 29a

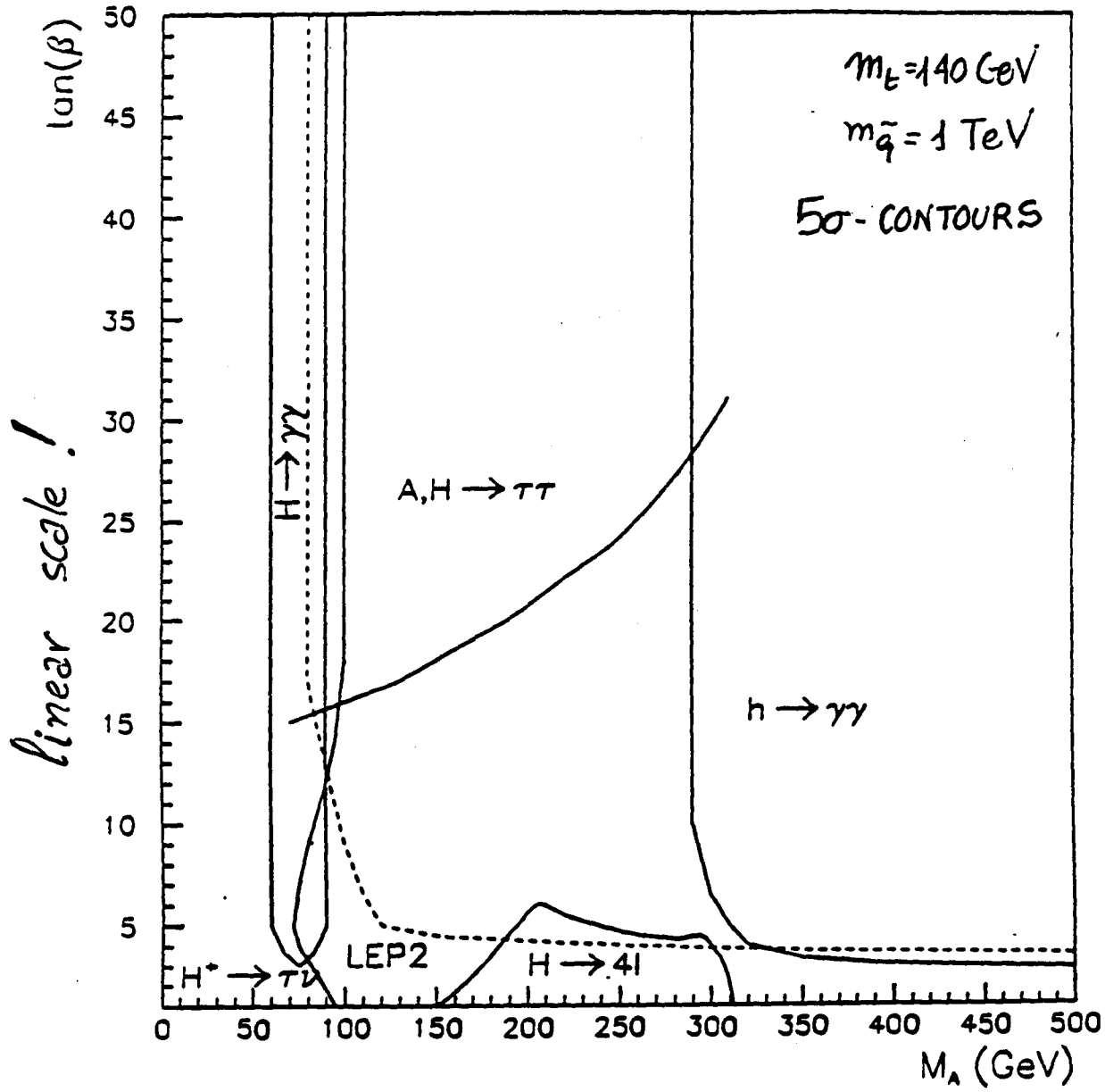
SUSY HIGGSES AT HADRON COLLIDERS: A PRELIMINARY GLOBAL VIEW



KUNSZT - F. Z.

ASCOT (EAGLE) SIMULATION

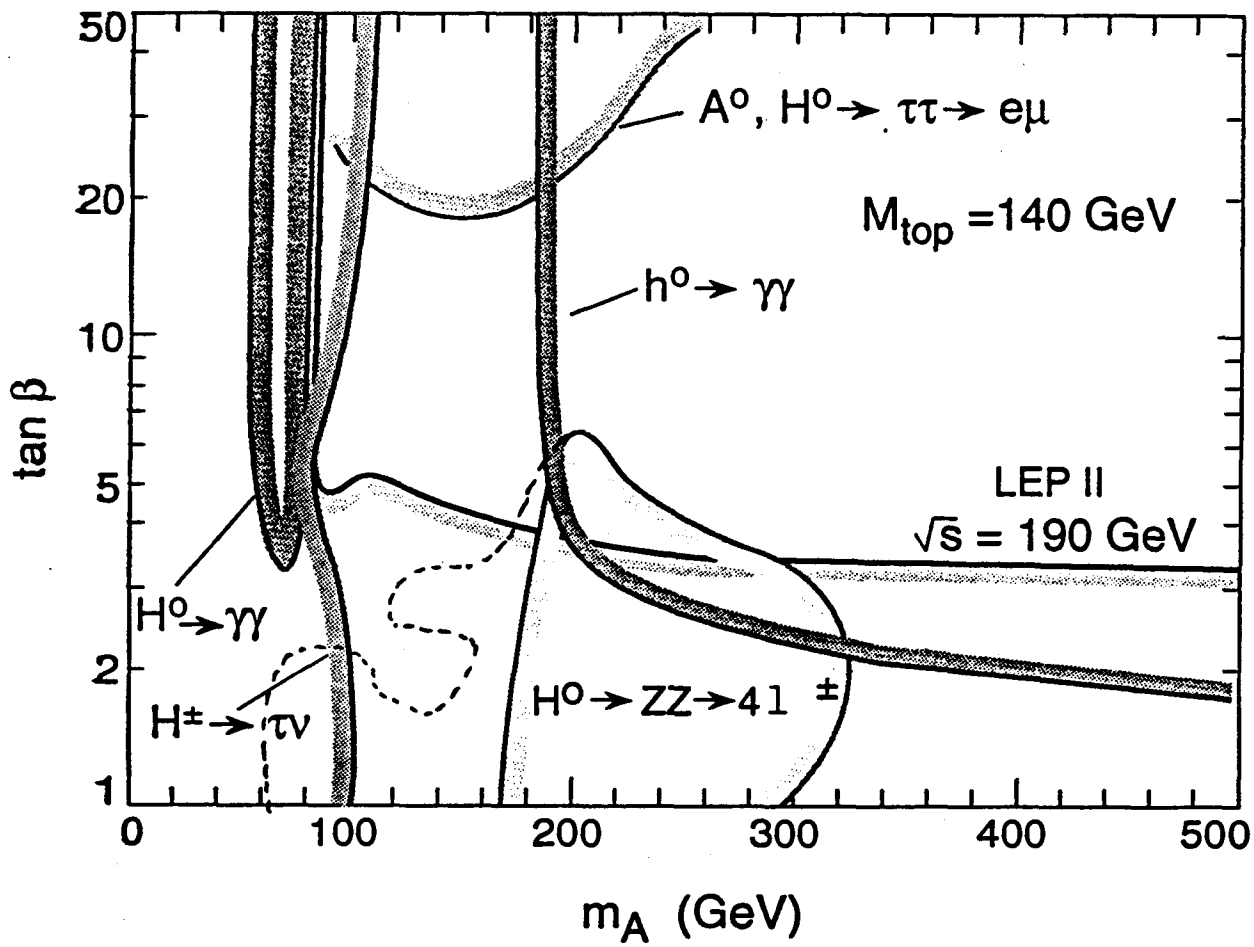
(conservative : K-factors = 1)



4) Sensitivity of various channels (at 5 sigmas) in the (M(A),tan(β)) plane, for the MSSM Higgs sector

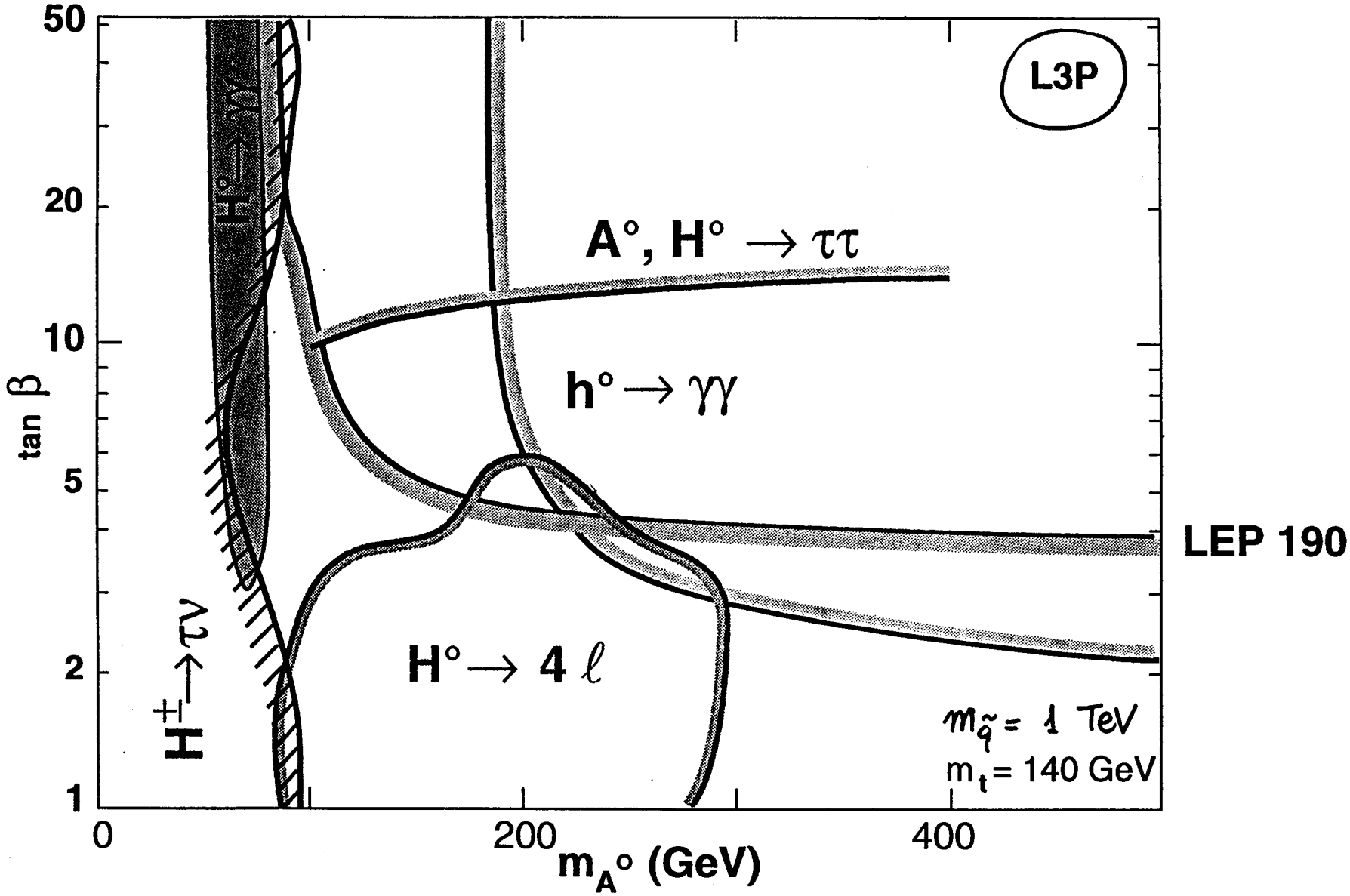
Search Regions in SUSY Parameter Space

- 5 σ contours
- h^0, $H^0 \rightarrow \gamma\gamma$ and $H^0 \rightarrow 4l^{\pm}$ for 10^5 pb^{-1}
- A^0, $H^0 \rightarrow \tau\tau$ and $H^{\pm} \rightarrow \tau\nu$ for 10^4 pb^{-1}



CMS collaboration

Supersymmetric Higgs Bosons



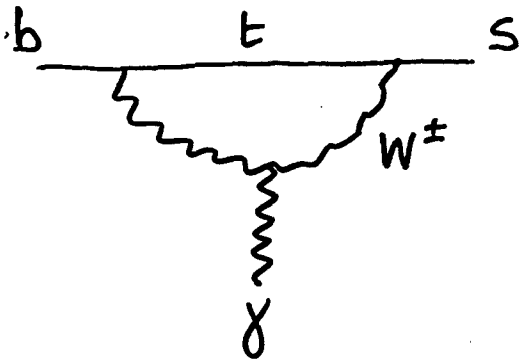
25c/a/yb/4.11..92Pauss

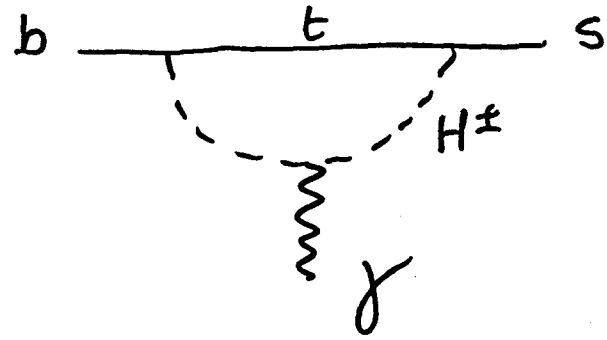
FURTHER REMARKS

- In the case of heavy sparticle masses, interesting indirect constraints could come from $b \to s\gamma$

  present CLEO bound $BR(b \to s\gamma) < 8.4 \times 10^{-4}$ (90% c.l.)

  recent observation by BARGER-BERGER-PHILLIPS HEWETT
  based on calculations by GRINSTEIN ET AL., BURAS ET AL., HOU-WILLEY
  GENG-NG, BARGER ET AL., ...





one should treat conservatively theoretical errors (~50% ?)

- $A \to Zh$, with $Z \to \ell^+\ell^-$ and $h \to \tau^+\tau^-$ might be worth studying for $m_A \lesssim 2m_t$, $\tan\beta \sim 1$

  BAER-KAO-TATA GUNION

  major backgrounds: $Z + 2j$, ZZ, $Zt\bar{t}$, Zh, ZWW, $Z\gamma$

- Also the case of light sparticle masses (much more complicated to deal with) has started receiving some attention

  BAER, TATA, ...

CONCLUSIONS

- AT SSC & LHC, MSSM HIGGS SEARCH IS IN GENERAL MORE DIFFICULT THAN SM CASE
- DISCOVERY POTENTIALS OF LEP AND SSC/LHC SHOW A CERTAIN AMOUNT OF COMPLEMENTARITY HOWEVER, ONE CANNOT CLAIM YET A "NO-LOSE" THEOREM FOR MSSM HIGGSES

  "OZONE-HOLE" $5 \lesssim \tan\beta \lesssim 15$ $100\ \text{GeV} \lesssim m_A \lesssim 200\ \text{GeV}$

- THERE ARE REGIONS OF PARAMETER SPACE WHERE MORE THAN ONE SIGNAL CAN BE FOUND
- A HIGH-ENERGY HIGH-LUMINOSITY e^+e^- COLLIDER WOULD BE IDEAL FOR SUSY-HIGGS-BOSON SEARCHES

  For example, with $\sqrt{s} = 500\ \text{GeV}$ $\int \mathcal{L}\,dt \sim 10\ \text{Fb}^{-1}$
  - guaranteed to discover at least one Higgs
  - likely to explore the Full MSSM Higgs sector if spectrum light enough
- ONE EXPECTS FURTHER PROGRESS IN THE SIMULATION WORK FOR THE SSC AND LHC

SDC Collaboration Meeting
December 10-12, 1992

Status on Preparations for Tracking Review

W. Ford

December 12

W. FORD

STRAW+ITD/FIBER TRACKING DECISION REVIEW

Outer tracker baseline: straws in the barrel and gas microstrips in the intermediate tracking region.

Alternate: scintillating fibers in place of both the straws and microstrips.

Final choice based upon a thorough technical review by the Technical Board

An ad-hoc committee of rapporteurs will

* Ensure that the issues are well explored
* " " definitive comparisons are drawn
* Evaluate proponents' responses to the charge
* Critically compare these responses in presentations to the Technical Board

A brief report will be assembled by the rapporteurs from inputs supplied by the proponents. ("Short on words and long on tables and figures.")

TB to recommend a choice between the system proposals at a meeting scheduled February 6-7, 1993 at SSCL.

This meeting will be open for the presentations by the rapporteurs, but closed during the deliberations of the Technical Board.

Outcome will be presented at the February 11-13 collaboration meeting.

W. Ford 12/12/92

Charge to proponents:

1. State clearly what the system is:

   * Distribution of elements

   * Eta and phi coverage

   * Number of coordinates of each type

   * Their radial distribution.

2. State the cost.

3. Provide a map of the radiation thickness (eta = 0 to 2.5).

   * Si system

   * Each superlayer of the proposed outer tracker

   * Cumulative amounts of radiator vs. eta

   * Show the treatment of phi distributed materials (space frame, electronics, cables, pipes, etc.).

4. Present simulations of the performance, including

* Track reconstruction efficiency

* Momentum resolution

* Event reconstruction efficiency

* Triggering efficiency

* Eta dependence, Pt cutoff

* track reconstruction efficiencies and ghost track creation rates

* Identify the treatment in the simulations of
  * Electronic signal processing
  * Nature of the physics process studied
  * Nature of the background processes
  * Nature of the propagation of charged and neutral particles in the field and through the material
  * Response to the flux of particles
  * Alignment uncertainty
  * Dead channels.

Benchmark physics processes and conditions for these simulations:

a. Higgs (M_h=300 GeV) -> ZZ -> mu mu e e
   Luminosity = (0, 1, 3, 10) * 10**33

   Address: Lepton finding efficiency
   Lepton ID efficiency Momentum resolution M(Z) resolution M(H) resolution

b. b -> mu nu X, pt_min = (25, 100, 200) GeV
   Luminosity = 10**33

   Address: Efficiency for finding tracks with pt>1 GeV in the signal event Efficiency for finding the muons from b decay Impact parameter resolution Momentum resolution

Data files containing event 4-vectors (signal and background interactions) will be generated and used as common input for simulation of both detector systems. Common control commands for interactions will be used for particle tracking in detector simulations.

5. Discuss survivability

* Radiation damage (robustness over 10, 100 years of SSC luminosity)

* Other aging effects.

6. Address the impact on the rest of the detector (integration).

7. Evaluate the technical and schedule risks.

DRAFT OUTLINE OF TRACKING REPORT

Names listed after each topic are the rapporteurs for the topic.

1. DESCRIPTION of straw and fiber systems (M. Gilchriese)
    - 1.1 Physical description (drawings, tables, few words, etc)
        - 1.1.1 Straws+ITD
        - 1.1.2 Fibers
    - 1.2 Material budgets
        - 1.2.1 Straw+ITD: details of materials including elecs.
        - 1.2.2 Fiber: details of materials
        - 1.2.3 Comparison plots of radiation lengths vs. eta

2. PERFORMANCE Characterization (D. Coupal and A. Seiden)
    - 2.1 Efficiency
        - 2.1.1 Straws+ITD (results from prototypes, dead space, etc)
        - 2.1.2 Fibers (light yields, dead spaces,etc
    - 2.2 Time resolution and occupancy
        - 2.2.1 Straws+ITD (include elecs. model,...)
        - 2.2.2 Fibers(includes elecs. model,.....)
    - 2.3 Spatial precision
        - 2.3.1 Straws+ITD (intrinsic resolution, placement, alignment, calibration,....)
        - 2.3.2 Fibers (all of the above + impact of efficiency, staggered layers,....)
    - 2.4 Summary of models used for pattern recognition studies
        - 2.4.1 Straws+ITD
        - 2.4.2 Fibers

3. PATTERN RECOGNITION and Momentum Resolution (G. Trilling)
    - 3.1 Code comparison and assumptions (role of silicon, semi-stand alone capability,.....)
    - 3.2 Comparison of efficiencies (includes luminosity dependence, silicon dependence,...)
        - 3.2.1 High pt muons in Higgs events
        - 3.2.2 High pt electrons in Higgs events
        - 3.2.3 B-Jet events
        - 3.2.4 Summary tables and comparison

4. ELECTRON iDENTIFICATION Comparison (A. B. Wicklund)

5. SURVIVABILITY (M. Gilchriese)
    - 5.1 Environment
    - 5.2 Straws+ITD (results and extrapolations)
    - 5.3 Fibers (results and extrapolations)

6. TRIGGER (J. Butler and W. Smith)
   6.1 Requirements (including luminosity dependence,....)
   6.2 Straws+ITD
   6.3 Fibers
   6.4 Comparison of performance, cost and risk

7. INTEGRATION (T. Thurston)
   7.1 Compatibility with other SDC systems
   7.2 Access, maintenance
   7.3 Safety

8. COST and Schedule (D. Etherton)
   8.1 Comparison of straws+ITD and fibers
   8.2 Estimate of other cost/schedule impacts

9. TECHNICAL and SCHEDULE RISK (H. Sadrozinski)
   9.1 Straws+ITD
   9.2 Fibers
   9.3 Comparison of performance, cost and risk

Outer Tracker Decision Review Planning Meeting

12/10/92

1:30	I.	**Deadlines**		
		Drafts by proponents to rapporteurs	1/5/93 ~~12/30/92~~	W
		Drafts by rapporteurs to contacts	1/12/93	T
		Revisions by proponents to rapporteurs	1/18/93	M
		Final sections to editor	1/21/93	Th
		Report to TB	1/28/93	Th
	II.	**Outline of planned content by section**	**Rapporteur**	
		1. Description of System	Gilchriese	
2:00		Geometry - Hanson, Edwards		
2:10		Material - Ford, Oakham		
		2. Performance Characteristics	Coupal / Seiden	
2:25		Efficiency, resl'n - Oh, Armitage ~~/ Martin~~		
2:40		Time resln, occ. - Rust, "		
2:55		Simulation model - Corden		
		3. Pattern recognition and p_t resln. - Corden	Trilling	
		4. Electron ID - Corden	Wicklund	
3:30		Break		
0		5. Survivability - Rust, Oakham	Gilchriese	
4:10		6. Trigger - Chapman, ~~Niekoreen~~	Butler / Smith	
4:30		7. Integration - Swensrud, ~~O'Neill~~	Thurston	
4:50		8. Cost, Schedule - Ogren, Oakham	Etherton	
5:00		9. Techn. & Schedule Risk - Williams, Ogren, Edwards	Sadrozinski	
5:30		Adjourn		

13	14 3 45 Seminar	15	16	17 11 00 Luncheon	18 10 00 pdst users ph. cor	19
20	21	22	23	24	25 10 00 pdst users, ph. cor	26
27	28	29	30	31	November	January

Month view by Calendar Manager

January 1993

12/10/92 0:38 pm

coupal@tuna

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5 Draft to Rapporteurs FOR SURE	6	7	8	9
10	11	12 Back to proponents	13	14	15	16
17	18 Revisions	19	20	21 To Editor	22	23
24	25	26	27	28 Distribute to TB	29	30
31					December	February

February 1993

12/10/92 0:38 pm

coupal@tuna

Sun	Mon	Tue	Wed	Thu	Fri	Sat
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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28					January	March

Month view by Calendar Manager

SURVIVABILITY OF THE SDC SCINTILLATING FIBER TRACKER

S. MARGULIES
University of Illinois at Chicago

for the
FIBER TRACKING GROUP

B. Abbott[i], D. Adams[i], T. Armstrong[g], M. Atac[a,b], A. Baumbaugh[b], B. Baumbaugh[a], M. Binkley[b], S. Bird,[a], J. Bishop[a], N. Biswas[a], A.D. Bross[b], C. Buchanan[a], N. Cason[a], R. Chaney[g], D. Chrisman[a], M. Chung[a], D. Cline[a], G. Collins [a], M. Corcoran[i], D. Davis[f], R. Davies[i], J. Elias[b], H. Fenker[b], E. Fenyves[l], D. Finley[b], G.W. Foster[b], H. Goldberg[a], H. Hammack[l], A. Hasan[g], S. Heppelmann[g], J. Jaques[a], R. Jesik[a], J. Kauffman[l], R. Kehoe[a], C. Kelley[d], M. Kelly[a], V. Kenney[a], R. Kephart[b], C. Kim[b], D. Koltick[j], J. Kolonko[a], J. Kubic[a], R.A. Lewis[g], J. LoSecco[a], B. Lowery[l], J. Marchant[a], R. McIlwain[j], S. Margulies[a], H. Mendez[a], H. Miettenen[i], R. Moore[g], R.J. Mountain[a], B. Oh[g], J. Orgeron[l], H. Park[b], J. Park[a], J. Passaneau[g], A. Pla-Dalmau[b], C. Rivetta[b], R. Ruchti[a], R. Scalise[g], J. Schmitz[i], W. Shephard,[a], E. Shibata[i], J. Skeens[i], G.A. Smith[g], J. Solomon[a], J. Thomas[h], S. Tkaczyk[b], W. Toothacker[g], F. Vacs[a], D. Vandergriff [f], R. Wagner[b], J. Warchol[a], M. Wayne[a], and J. Whitmore[g]

(a) University of California at Los Angeles
(b) Fermi National Accelerator Laboratory
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(e) University of Notre Dame
(f) Oak Ridge National Laboratory
(g) Pennsylvania State University
(h) Philadelphia College of Pharmacy and Science
(i) Purdue University
(j) Rice University
(k) Superconducting Super Collider Laboratory
(l) University of Texas at Dallas

1. INTRODUCTION

- SURVIVABILITY ISSUES

  i) Long-term stability of components;

  ii) Radiation damage.

Reminder:

Detection elements (scintillating fibers) are passive, generating no heat, requiring no electrical services, coolants, or flammable gases in the tracking volume. Only an inert atmosphere (N_2) may be required.

Tracking volume contains only scintillating fibers and a portion of the clear waveguide fibers. All photodetectors (VLPCs and associated cryogenics) and read-out and trigger electronics are located outside the calorimeter in a low radiation environment.

LONG-TERM STABILTY

CERN fiber-tracking systems (UA2, L3) have been in operation for several years.

Candidate fibers for SDC tracker, stored in darkness, show no changes after 1yr.

RADIATION DAMAGE

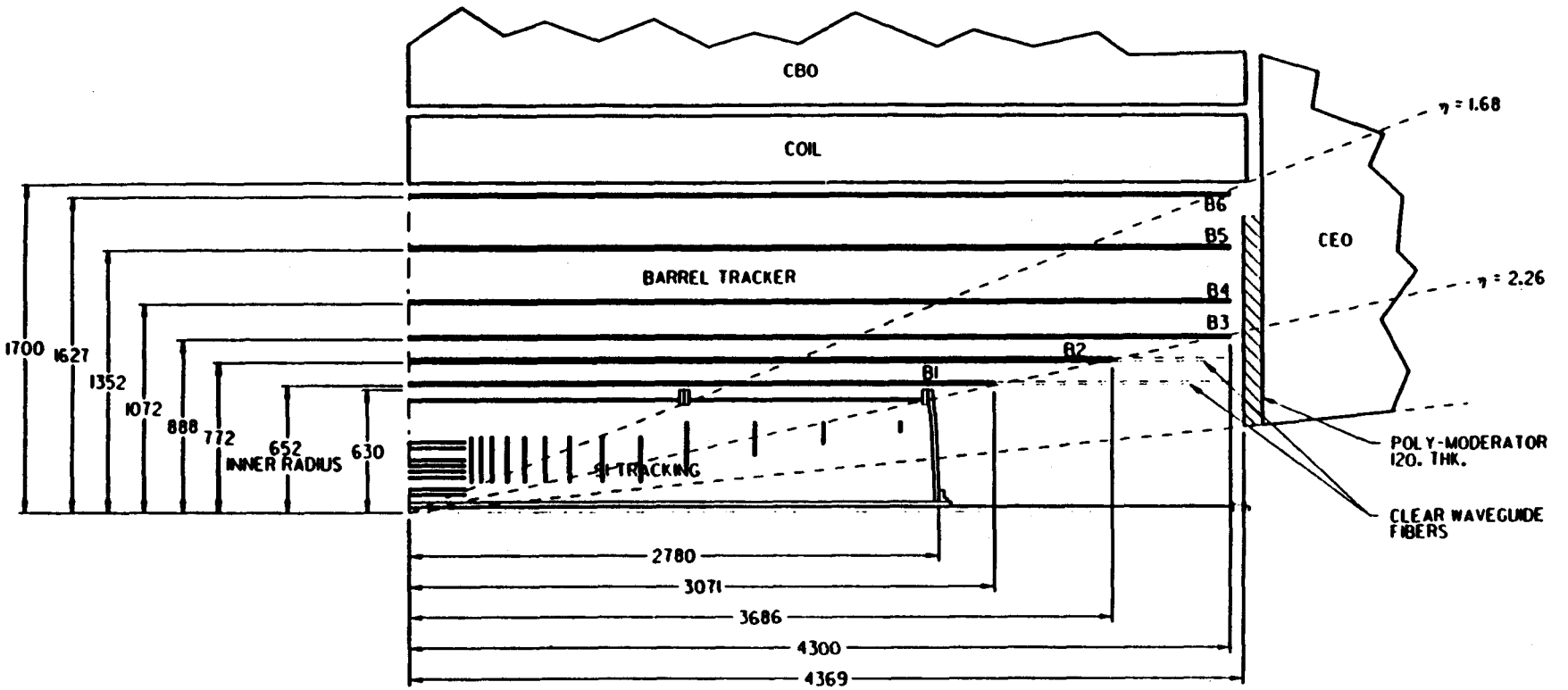
Because of the design geometry, potential risk is limited to scintillating and waveguide fibers.

This talk will concentrate on

i) the SDC radiation environment, with estimates of doses, and

ii) effects of radiation on fibers, including experimental results.

Basic conclusion: while more work is required, radiation does not appear to pose a significant hazard, especially at $\mathcal{L} = 10^{33}\,cm^{-2}\,s^{-1}$.



DETECTOR GEOMETRY

Reference: SDC Detector Parameters, SDT-000010 (Rev. F), 14 Sept. 1992.

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11 DE 192

DEFINITIONS

Time:

$$1 \text{ SSC yr} \equiv 10^7 \text{ s} = 2.8 \times 10^3 \text{ hrs};$$

$$1 \text{ SSC month} \equiv 1 \text{ SSC yr}/12 .$$

Radiation dose:

$$1 \text{ Gy} \equiv 1 \text{ J/kg};$$
$$1 \text{ rad} \equiv 100 \text{ ergs/g};$$
$$1 \text{ Gy} = 100 \text{ rad}.$$

2. SDC RADIATION ENVIRONMENT

INTRODUCTION

Radiation is produced by

i) directly ionizing particles resulting from collisions of beam particles, and including loopers, gammas, conversions, etc.;

ii) directly ionizing particles (mostl low-energy gammas and betas) from activation;

iii) indirectly ionizing particles, basically neutrons from the calorimeter albedo.

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DIRECTLY IONIZING PARTICLES

Particles from beam collisions

Reference: D.E. Groom, "Radiation Levels in SSC Detectors", Nucl. Instr. & Meth. A279, 1 (1989).

The SSC annual dose at a distance $r_\perp$ (in cm) from the beam due to charged particles from beam collisions at $\mathcal{L} = 10^{33}\ cm^{-2}\ s^{-1}$ is taken to be

$$D_{beam} = f\left(\frac{4 \times 10^5}{r_\perp^2}\right) \quad Gy \ .$$

To account for loopers, gammas, conversions, etc., we conservatively take $f = 2$.

- This gives the following doses:

Tracker Layer	$r_\perp$ (cm)	SSC Annual Dose	
		(Gy)	(Krad)
B1	65	190	19
B2	77	135	14
B3	89	100	10
B4	107	70	7
B5	135	44	4
B6	163	30	3

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Particles from endcap calorimeter activation

Reference: R.W. Kadel, "Radiation Dose Profiles and Activation of the Endcap Calorimeter", SDC-92-176, 17 Jan. 1992.

Dose-equivalent rates at the endcap calorimeter face are given for 30 days of operation plus 1-day cooldown at $\mathcal{L} = 10^{34}\,cm^{-2}\,s^{-1}$:

$$10\,\frac{mrem}{hr} \text{ at } \eta = 2 \lesssim \dot{H}_{30d}(\eta) \lesssim 160\,\frac{mrem}{hr} \text{ at } \eta = 3$$

This must be converted to total dose after 1 SSC yr at $\mathcal{L} = 10^{33}\,cm^{-2}\,s^{-1}$.

First, calculate applicable average dose-equivalent rates assuming

i) neglect of 1-day cooldown;

ii) linearity with $\mathcal{L}$ (reasonable);

iii) linearity with operating time (probably an overestimate because of simultaneous formation and decays of activated states).

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This gives

$$\langle \dot{H}'(\eta) \rangle = \dot{H}_{30d}(\eta) \times \underbrace{\frac{1}{10}}_{\text{luminosity}} \times \underbrace{\frac{1}{3.15}}_{\text{SSC time}} \times \underbrace{6}_{\text{av. operatin months}} ,$$

$$= 0.19\, \dot{H}_{30d}(\eta) .$$

The dose-equivalent rate is related to the dose rate by

$$\dot{H} = Q\, \dot{D} ,$$

where $Q = 1$ rem/rad since the activa radiation is mostly gammas and soft betas.

The annual dose is then

$$D^{\text{end cap}}_{\text{activation}} = Q^{-1} \langle \dot{H}'(\eta) \rangle \Delta t ,$$

$$= 0.19\, Q^{-1}\, \dot{H}_{30d}(\eta)\, \Delta t ,$$

$$= \begin{cases} 85 \text{ rads at } \eta = 3 \\ 5 \text{ rads at } \eta = 2 . \end{cases}$$

- These contributions are negligible.

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Particles from fiber tracker activation

Reference: R. Barrall, UIC (private communication).

Dose from activation depends on

i) fluence rates of activating particles;
ii) activation cross-sections;
iii) density and amount of material;
iv) lifetimes of activated states;
v) activation decay energy;
vi) time.

Tracker consists mostly of polystyrene fibers, $(CH)_n$, $\rho = 1\,g/cm^3$, total mass $\approx 1.4 \times 10^3$ kg.

Principal activation comes from

$$^{12}_{6}C(\gamma, n)\,^{11}_{6}C \,, \quad E_\gamma > 20\ MeV,$$

with $^{11}_{6}C$ de-exciting via β^+ decay ($\tau_{1/2} = 20$ min, $E_{\beta max} = 0.96$ MeV).

- A rough calculation assuming 200 γs per interaction gives

$$D^{tracker}_{activation} < 1\ rad,$$

which is negligible.

INDIRECTLY IONIZING PARTICLES

Neutron albedo

References: D.E. Groom, "Radiation Levels in SSC Detectors", Nucl. Instr. & Meth. A279, 1 (1989);
H.F.-W. Sadrozinski, "Neutron Fluences in the SDC Detector Cavity", SCIPP 91/01, Jan. 1991.

Groom considers a uranium/scintillator calorimeter with a spherical cavity of 2 m radius down to $|\eta| = 3$ (6°) of the beam axis. At luminosity $\mathcal{L} = 10^{33}\,cm^{-2}s^{-1}$, the SSC annual fluence is

$$\Phi = 1.2\times10^{12}(1 + \text{no. reflections}) \quad (cm^{-2}).$$

The neutrons form a roughly uniform gas, whose kinetic energy distribution is approximately Gaussian in the log of the energy, with the peak at 1.3 MeV.

Using no. reflections = 1 and a correction factor of 1/2 for a lead/scintillator calorimeter gives

$$\Phi = 1.2\times10^{12}\ cm^{-2}.$$

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Sadrozinski corrects for the shape, using an 8.4-m-long × 2.05-m-radius cylinder having beam holes at 6°. He calculates fluences with and without a 10-cm-thick end-cap polyethelene liner (SDC liner is 12 cm).

Based on this work, we assume SSC annual fluences

$$\Phi = \begin{cases} 8 \times 10^{11}\ \mathrm{cm}^{-2} & \text{(no liner)}; \\ 4 \times 10^{11}\ \mathrm{cm}^{-2} & \text{(liner)}. \end{cases}$$

<u>Question</u>: How to convert radiation damage by neutrons to an equivalent charged-particle dose?

Naively, this is tabulated in handbooks:

- At 1 MeV: 1 neutron/cm^2 $\leftrightarrow$ 1.9×10^{-9} rad.

("Measurement of Absorbed Dose of Neutrons, and of Mixtures of Neutrons and Gamma Rays", NCRP Report No. 25, NBS Handbook 75, 3 Feb. 1961.)

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However, little data exist on the specific damage done by neutrons to plastic scintillator. Preliminary results from a new study indicate essentially no effect below $\sim 10^{13}$ cm^{-2}; damage above this fluence seems to vary with fiber type and manufacturer. (W.L. Dunn, et al., "Neutron/Photon Damage Assessment of Commercial Plastic Scintillating Fibers", to appear in the Proceedings of RADDAM 92, Tallahasee, FL.)

For the present, we use the handbook value, which gives

$$D_{neutrons} = \begin{cases} 1.5 \text{ krad} & \text{(no liner)}; \\ 0.8 \text{ krad} & \text{(liner)}. \end{cases}$$

This dose is independent of position.

TOTAL ANNUAL DOSES

Combining the previous results,

$$D_{Total} = D_{beam} + D^{end\,cap}_{activation} + D^{tracker}_{activation} + D_{neutrons},$$

$$\approx D_{beam} + D_{neutrons}.$$

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● Tabulation of annual doses

Tracker Layer	$r_\perp$ (cm)	D_{beam} (Gy)	$D_{neutrons}$		D_{Total}			
			Without	Liner	Without liner		Liner	
			(Gy)	(Gy)	(Gy)	(krad)	(Gy)	(krad)
B1	65	190	15	8	205	20.5	198	19.8
B2	77	135	15	8	150	15.0	143	14.3
B3	89	100	15	8	115	11.5	108	10.8
B4	107	70	15	8	85	8.5	78	7.8
B5	135	44	15	8	59	5.9	52	5.2
B6	163	30	15	8	45	4.5	38	3.8

Notes: 1. Generous factor of 2 for loopers, gammas, conversions, etc. included in D_{beam}.

2. Uniform neutron fluences of 8×10^{11} cm^{-2} (no liner) and 4×10^{11} cm^{-2} (liner) used.

3. Handbook conversion factor, 1 neutron/cm^2 $= 1.9 \times 10^{-9}$ rad, used.

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3. EFFECTS OF RADIATION ON FIBERS

INTRODUCTION

Fibers used:

i) clear waveguide fibers
(polystyrene core, acrylic cladding)

ii) scintillating fibers
(same as clear fibers, but including waveshifters — currently p-terphenyl plus 3-hydroxyflavone; light output peaks near 530nm)

Justification:

Very little transmission loss beyond 500nm for polystyrene irradiated to more than 10 Mrad (500SSC yrs) after recovery in O_2.

pT+3HF are efficient waveshifters at these wavelengths.

Light output determined by

i) Light yield, I_0;

ii) Attenuation length, λ;

$$I(x) = I_0 e^{-x/\lambda}.$$

Radiation-damage possibilities

damage to: core
waveshifters
core-cladding interface

Possible variables (interrelated):

i) total dose (essentially no damage below ~200 Krad (10 SSC yrs));

ii) dose rate (especially in the presence of O_2, accelerated rates (>100 Krad/hr) may cause less damage than the same dose accumulated at actual detector rate; rate effect not present for irradiation in inert atmospheres, e.g., N_2);

iii) particle type (probably no difference, except possibly for neutrons — very little data);

iv) atmosphere, related to ii);

v) scintillator geometry, which affects gas diffusion;

vi) recovery after irradiation, related to iv) and v).

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EXPERIMENTAL RESULTS

Considerable work has been done, but more is still required.

Experiments irradiate either:

- <u>bulk samples</u> (generally cylinders 1 in. dia x 1 cm thick);
- <u>actual fibers</u> (~1 mm dia. x several m long).

Some results from bulk samples

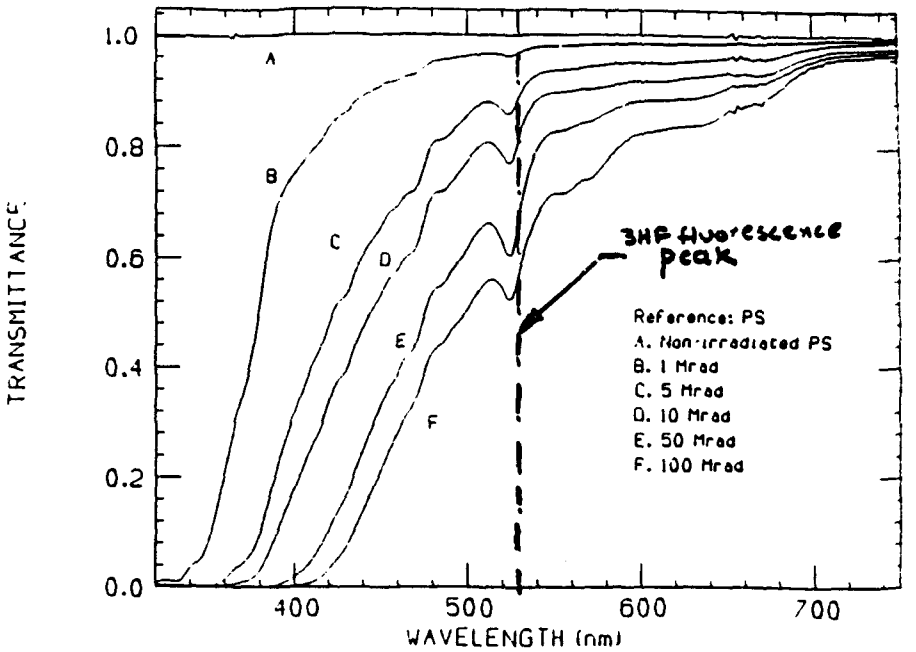
References:

A.D. Bross and A. Pla-Dalmau, "Radiation Induced Hidden Absorption Effects in Polystyrene Based Plastic Scintillator," Am. Chem. Soc. Symposium Series, Oct. 1990.

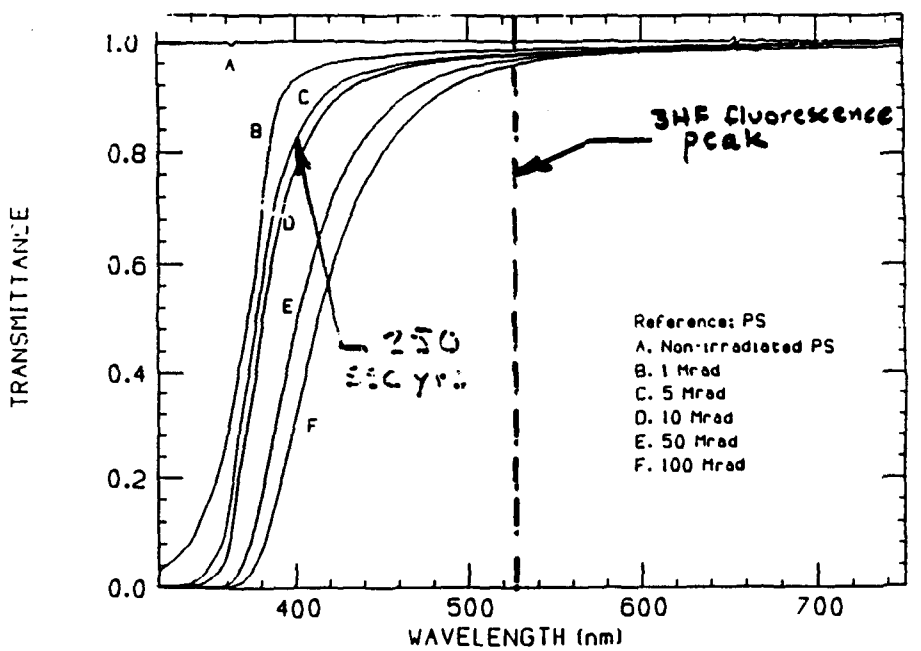
A. D. Bross and A. Pla-Dalmau, "Radiation Effects in Intrinsic 3HF Scintillator," FERMILAB-PUB-92/247, 16 Sept. 1992.

WAVEGUIDES

Transmission through 1-cm-thick polystyrene irradiated in N_2.



Immediately after irradiation (gammas from ^{60}Co).



After 2 weeks in O_2.

Conclusion: no problems with clear waveguide fibers anticipated.

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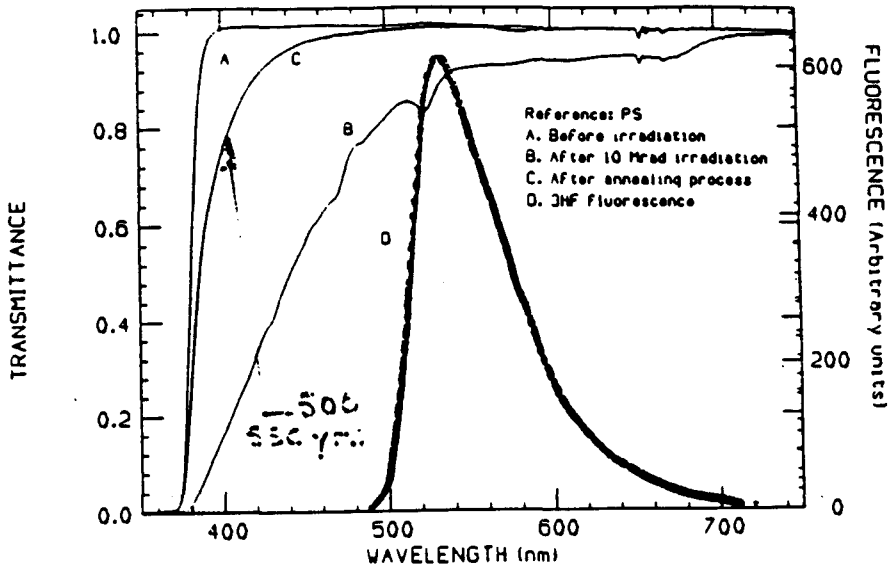
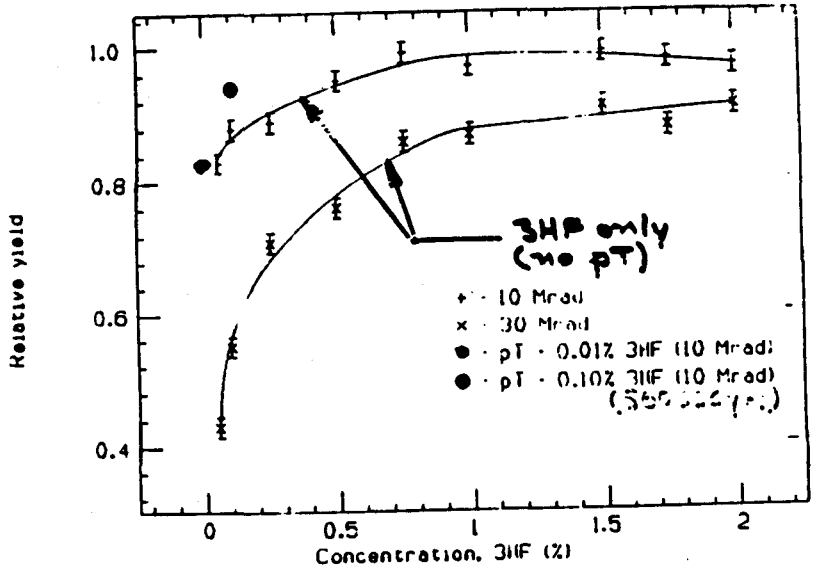
SCINTILLATOR

Transmission through 1-cm-thick polystyrene + 1.25% pT + 0.01% 3HF scintillator:



Light yields, after recovery of 10 days in O_2 at 40 psig, for polystyrene-based scintillators with different waveshifter concentrations:



Sample with 1% pT + 0.1% 3HF shows only 6% light loss after 10 Mrad.

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Interpretation by authors:

i) No damage to waveshifters (even with 3HF crystals irradiated to 100 Mrad!).

ii) Light-yield loss due to "hidden" absorption in irradiated polystyrene, which interferes with pT → 3HF energy transfer.

iii) Transmission losses following irradiation due to absorption in damaged polystyrene. Much of this damage is cured in O_2 atmosphere (especially above 500 nm).

- Conclusion: no problems with scintillating fibers anticipated.

Some results from fiber samples

a. Low dose-rate studies

Reference:

B. Abbott, et al., "Effects of a Hadron Irradiation on Scintillating Fibers", submitted to IEEE Trans. Nucl. Sci.

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Experiment:

Fibers: 10 different fiber types from Bicron (polystyrene core, 830 μm O.D., 15-μm-thick acrylic cladding 4 m long).

Fiber Type	Color	Dopants
BI-1	blue	pT + BBOT
BI-2	green	pT + BBQ
BI-3	green	0.6% 3HF
BI-4	green	pT + 3HF
BI-5	green	pT + BBQ
BI-6	green	pT + 3HF
BI-7	blue	pT + BBOT
BI-8	green	BPBD + BBQ
BCF-9905	green	pT + 3HF
BCF-10	blue	pT + DMPOPOP

Table I. Bicron fibers irradiated in this test. Abbreviations used: pT = p-terphenyl; BBOT = thiophene derivative; 3HF = 3-hydroxyflavone; BBQ = isoquinoline derivative; BPBD = oxadiazole derivative; DMPOPOP = phenyloxazol derivative.

Atmospheres: ambient air (atmospheric pressure)

dry air, dry N_2, argon } (15 psig)

vacuum (~ 0.2 torr).

Irradiating particles: hadrons from injection losses and aborts in Fermilab Tevatron CØ region.

Exposure: 49 days; doses to ~60 Krad (3 SSC yrs) at ~50 rad/hr.

Measurements: relative light yields; attenuation lengths.

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11 DEC. 1992

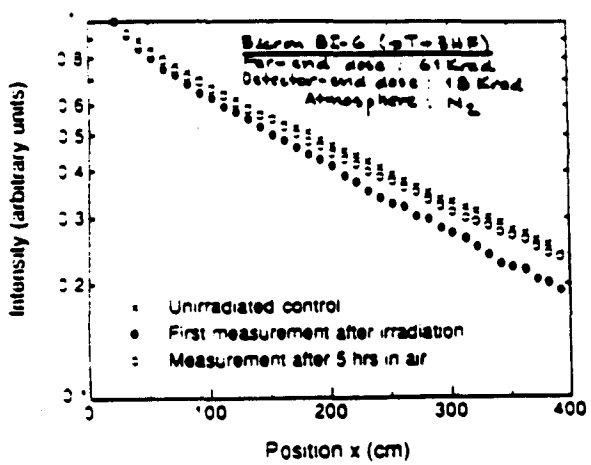
Results for pT+3HF fibers:

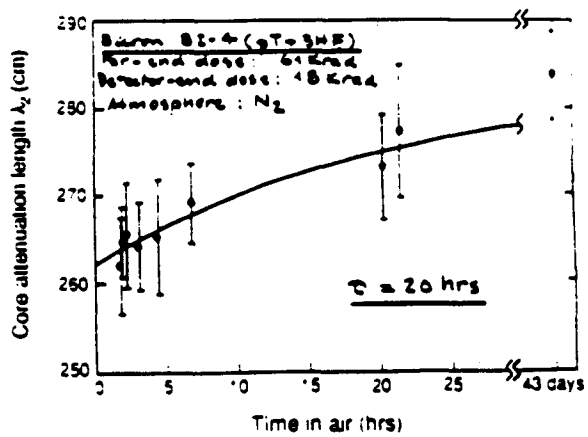
i) Light yield loss immediately after irradiation is smaller than measurement uncertainty of ~ ± 15%.

ii) Decrease of attenuation length immediately after irradiation is ~ 10%.

iii) Attenuation lengths recover fully after a few days in air.

iv) No change in properties of control fibers after 1 yr.





Recovery of attenuation length after exposure to air.

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b. High dose-rate studies

Reference: A. D. Bross, private communication

Experiment:

Fibers: various green and blue fibers (polystyrene core, 830 μm O.D., acrylic cladding, 5 m long).

Atmosphere: N_2.

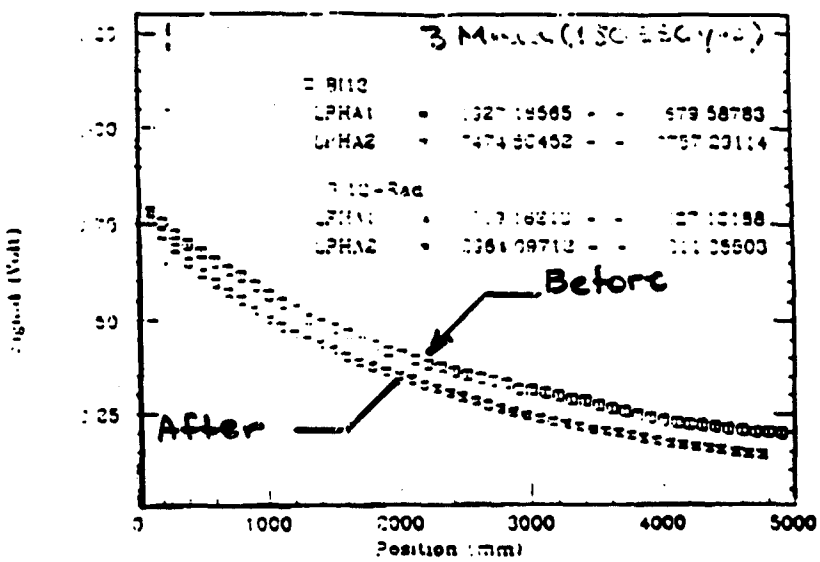
Irradiating particles: gammas from ^{60}Co.

Exposure: 3 Mrad (150 SSC yrs) over a few days.

Measurements: attenuation lengths after 2 weeks in O_2 at 20 psig.

Analysis is still in progress.

Measurement for a BI-12 (pT + 0.01% 3HF) fiber:



- Preliminary result: Attenuation length at $x = 5$ m has decreased by ~25%. For $\lambda = 6$ m, this corresponds to a relati light loss of 20% for light producta at 4 m.

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11 DEC. 1992

4. SUMMARY

- Worst-case annual radiation dose is ~ 20 Krad/SSC yr at $\mathcal{L} = 10^{33}\,cm^{-2}\,s^{-1}$. This is a relatively small dose for polystyrene + pT + 3HF fibers which seem to show no unrecoverable damage below ~ 200 Krad (10 SSC yrs).
- Clear polystyrene, after recovery in O_2, shows very little loss of transmission above 500 nm for doses up to at least 5 Mrad (250 SSC yrs). Thus, no problems with clear waveguides anticipated.
- Low dose-rate irradiation of scintillating fibers shows essentially no effects, after a few days recovery in air, for doses up to at least 60 Krad (3 SSC yrs).
- High-dose-rate irradiation of bulk samples of scintillator shows an unrecoverable intrinsic light yield loss of only 6% after 10 Mrad (500 SSC yrs).

- Preliminary results from a high-dose-rate irradiation of scintillating fibers show ~25% decrease in attenuation length after 3 Mrad (150 SSC yrs).

  A similar experiment, using 6 MeV x-rays and doses to ~ 1 Mrad, will begin soon (UIC).

- Basic conclusion: SDC detector radiation levels do not appear to pose a significant hazard.

S. MARCULIES/UIC
11 DEC 1992

SDC Collaboration Meeting
December 10-12, 1992

Status on Calorimeter Issues

D. Green
P. Mantsch et al.

December 12

P. MANTSCH

SDC Calorimeter Endcap Internal Conceptual Design Review

January 12 and 13, 1993 - LBL, Berkeley

Objective

The design of the barrel calorimeter is essentially complete. The endcap, however, is still in the conceptual stage. An alternative EM design is being prepared by LBL. Design changes are also being considered for the endcap hadronic absorber. The objective of the review is to assess the designs presented and recommend the best and most cost effective design capable of achieving the technical, cost and schedule performance requirements of the experiment. Presenters of the design alternatives will be responsible for addressing issues of integration, installation, maintenance, operation, quality and ES&H.

Charge

The responsibility of the committee is to evaluate the alternative designs and make recommendations as to whether these designs should replace the baseline as described in the Technical Design Report. The committee is also encouraged to recommend improvements to the proposed designs that will enhance performance and/or reduce cost. The committee will base their recommendations on the following considerations:

1) **Technical performance of the alternate designs relative to experiment and engineering requirements.**

2) **Comparison of the costs of the alternate designs to the baseline.**

3) **Schedule impact on alternate designs.**

4) **Optics (including shower max).**

5) **Radiation damage**

6) **Calibration plan.**

7) **Magnetic fields and forces**

8) **Integration, installation, maintenance, and operation.**

9) **Environment, safety and health issues in fabrication and operation.**

Tentative Committee:

Chair: Bob Kephart

Bob Wands
Jim Siegrist
Jean Ernwein
Koji Takikawa
Roger Rusack
Virgil Barnes
Arie Bodek
Julian Budagov
David Austin
Jon Piles
Tom Winch
Jim Freeman (EM)

Ex officio: Paul Mantsch and Jim Missig

SDC CALORIMETER CALIBRATION REVIEW

December 11, 8:30 - 12:30, SSCL

Charge

The committee will evaluate the overall calibration plan, progress on hardware development, and implementation of the calibration system in the prototype. The review will cover charge injection, light flashers, source system, cosmic ray, beam and in situ calibration. The evaluation should also address safety issues such as source radiation hazards. The committee will prepare recommendations on the calibration system and its implementation.

The review committee:

Chris Hearty - Chair
Steve Gourlay
Richard Kadel
Jim Freeman
Virgil Barnes
Andy White
Bob Wagner
Jean Ernwein
Steve Hahn
Jim Missig - ex officio
Paul Mantsch - ex officio

~50 action items produced.
No report yet.

Overview of Calibration System

- moving source calibration
  - radioactive source tests tiles/fibers/pmt

- light flasher system
  - light pulse calibrates PMT and front end electronics

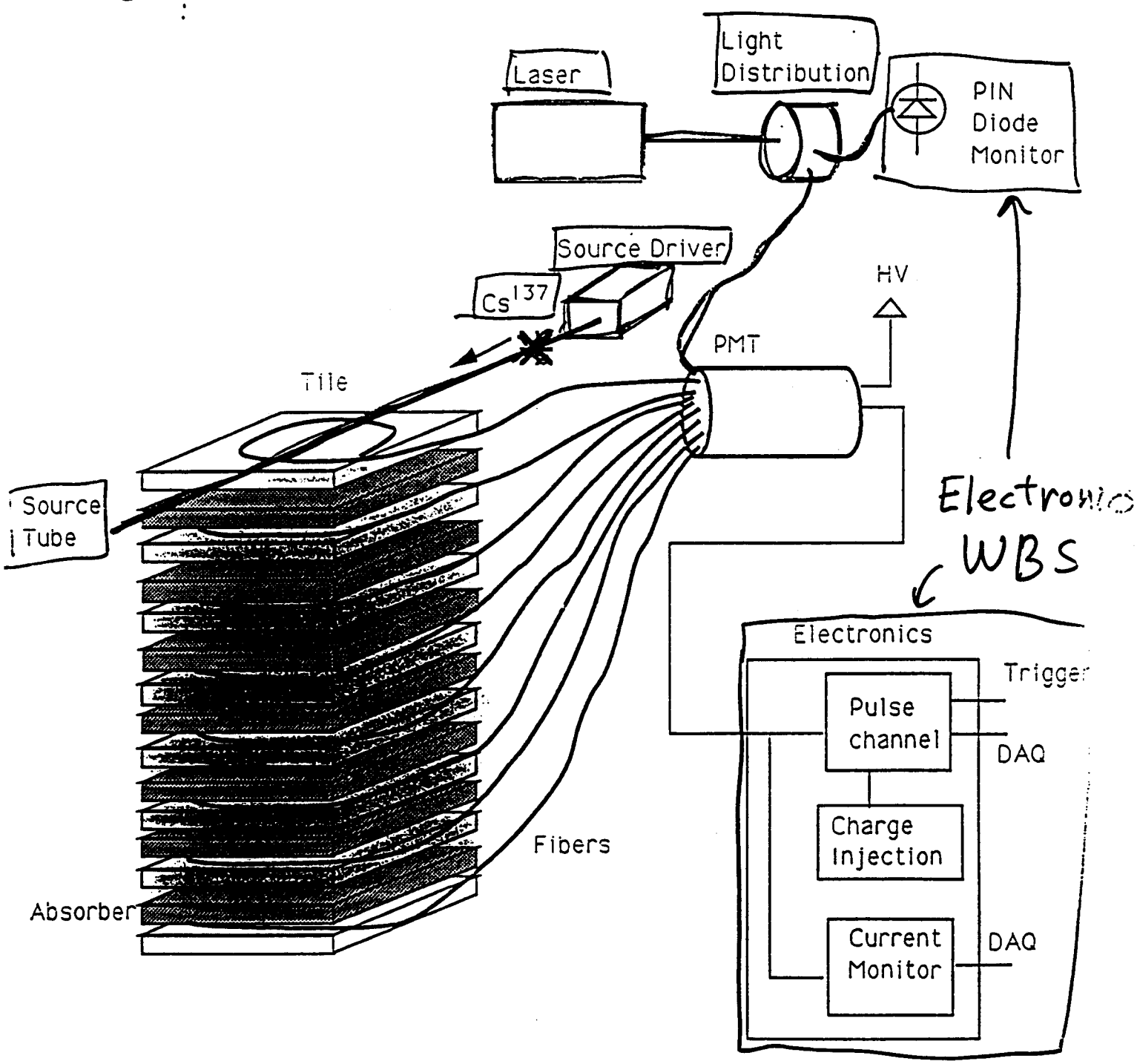
- front end electronics charge injection
  - front end electronics and trigger

- in situ calibration
  - set absolute gain; test full system

- beam tests, cosmic rays
  - calibrate some modules

In general, good progress being made on all systems.

Schematic of Calibration System



C. Blocker

Source Calibration

Every tile will be scanned during assembly and installation. Only a subset during normal operation.

Many goals for this system:

<u>before data taking:</u>

- QA
- determine initial tower calibration; carry beam calibration to untested modules.
- determine tile-to-tile mask (if needed)
- study B-field on/off effects.

<u>during data taking:</u>

- scintillator/fiber aging
- radiation damage profile

Major Issues:

- Engineering needed to study driver and source wire reliability and fatigue; evaluate commercial drivers; study alternative source wire designs. Current design does not easily work in ECEM.

- Evaluate alternative isotopes.

Light Flasher System

- monitor temporal gain stability of PMT and measure linearity.

- N2 laser UV light wavelength shifted to green and distributed to each PMT. Monitored with pin diodes and PMTs.

<u>Major Issues</u>:

- Stability of monitoring system

- Integration (laser location; space required on outer radius).

- Requirement on PMT stability during *in situ* calibration.

- Interaction between linearity and constant term.

Charge Injection

Measure linearity and absolute gain of front end pulse-monitoring electronics.

Probably not necessary to calibrate current-monitoring circuits.

Major Issues:

The committee did not have the expertise to evaluate this subsystem.

In situ Calibration

Establishes tower-to-tower relative calibration (≤0.2%) and absolute energy scale.

In EM, use E/p for e- (W,Z) or mass constraint of Z-->ee. Initial studies indicate that either works in a reasonable amount of time.

Hadronic: use γ,Z+jet, dijet pt balance.

Major Issues:

- Studies are in an early stage. Eventually want to understand systematic errors, rather than statistical.

- hadronic section needs work.

Test Beam/Cosmics Rays

- Calibrate some fraction of modules in beam at SSCL or FNAL.

- cosmic ray tests of modules?

<u>Major Issues</u>:

Experience with 1993 barrel prototype will guide decisions in this area. Decisions have impact on assembly area and procurement.

Shower Max Reviews

Mon-Wed, February 8-10 @ SSCL

Feb 8 SM design and performance

Presentations : Jean Ernwein

Review : Paul Mantsch

Feb 9 SM photodetectors

Presentations : Roger Rusack

Review : Paul Mantsch

Feb 10 SM front-end electronics

Presentations : Patrick Le Dû

Review : Andy Lankford

Shower Max Design & Performance Review

Monday, February 8 @ SSCL

Requirements for SM and MG/PS

Barrel and endcap designs

Segmentation, depth

Fabrication and assembly procedures

Calibration, QA/QC

Performance Photostatistics, hadrons

$e^{\pm}/\pi^{\pm}$, π^0/γ separation vs. η

Physics benchmarks $t \to b \to e$

$t\bar{t}H \to \gamma\gamma$

$t \to W/H \to \tau \to \rho$

Upgrade scenario Which $\mathcal{L}$? Now?

Cost/schedule

Shower Max Photodetector Review

Tuesday, February 9 @ SSCL

Requirements for SM and MG/PS

Quantum efficiency, signal/noise
Gain and uniformity
Cross talk with 1 or 2 fibers
Long-term stability and saddam
System cost

Choose MCPMT for 93 test ? QE ≈ 10%

Philips 2×2 mm² Fiber window Cushman
Hamamatsu 5×5 mm² Glass window Hauser

Continue APD R&D ? QE ≈ 80%

API, EG&G, GE Leedom
100 K$ FY93 for preamp ?

APD - PMT status QE ≈ 35%

Litton Industries Rusack
Litton covers NRE costs

Shower Max Front-end Electronics Review

Wednesday, February 10 @ SSCL

Requirements for SM and MG/PS

- Dynamic range (incl. gain non-uniformity)
- Calibration

Performance of analog and digital options

Evaluation of digital solution

- Block diagram
- Technical feasibility (CMOS)
- Dynamic range
- L1 trigger
- L2 and DAQ: Zero suppression ?
  Cluster finding ?

Cost / schedule

Institutional responsibilities

- Saclay, LBL, FNAL

S. GOURLAY
FERMILAB
12/12/92

BARREL CALORIMETER
PROTOTYPE STATUS

HADRON ABSORBER

FNAL MODULE —

- STEEL - ORDERED
- PLATE MACHINING - QUOTES CLOSED YESTERDAY
- START STACKING IN JANUARY
- ASSEMBLY TOOLING - PARTS ON HAND
  CONSTRUCTION STARTED

COMPLETE 3/20/93

PRC MODULE —

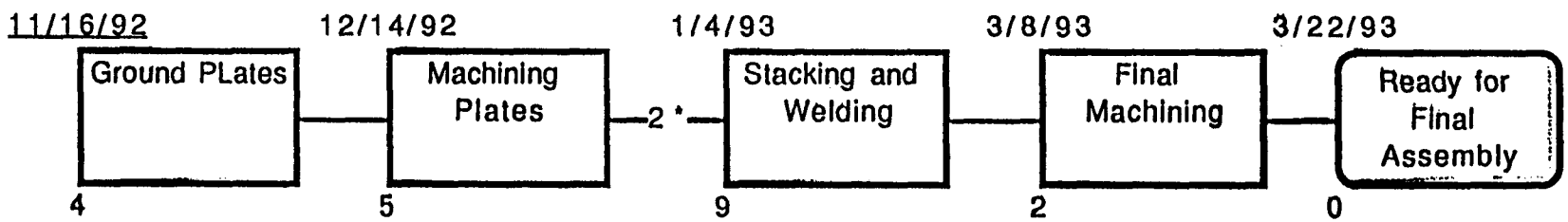
- MATERIAL ON HAND
- CLARIFYING DRAWING DETAILS
  WITH FNAL ENGINEERS
- POISED TO CUT METAL
- ESTABLISH WELD PROCEDURES

MODULE TO ARRIVE AT FNAL IN MAY

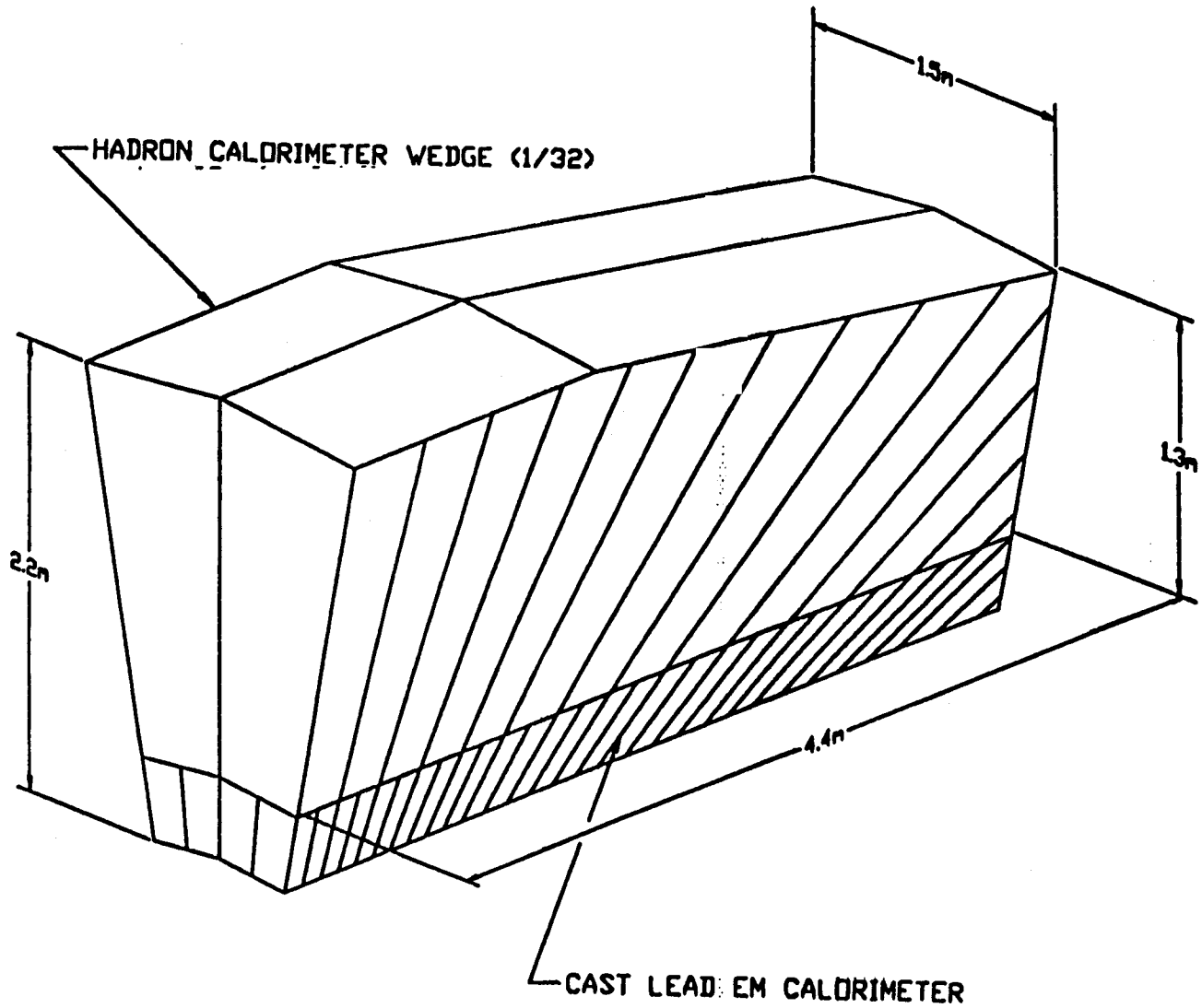
→ SHIPPING CONTAINERS (2) TO PRC BY MARCH

November 23, 1992

FNAL Wedge Procurement and Fabrication Schedule

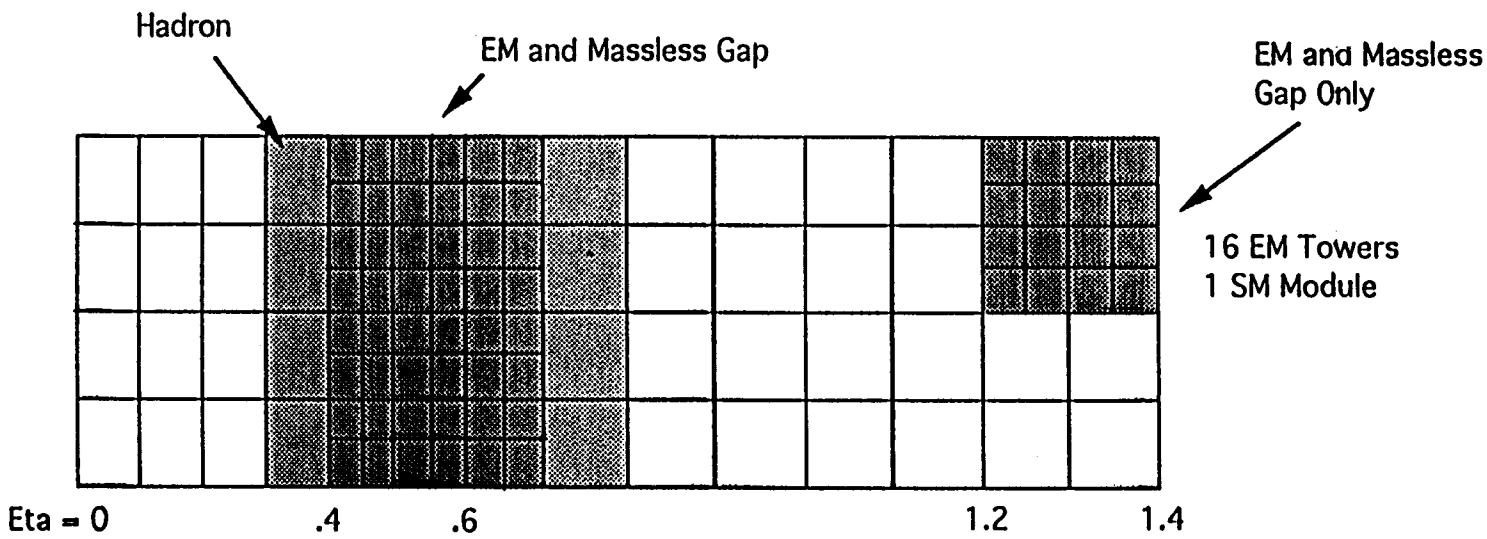


PREPRODUCTION PROTOTYPE WEDGE



Instrumented Sections of SDC Barrel Prototype

Edgeview



20 Hadron Towers
48 EM Towers
4 SM Modules
64 Massless Gap Tiles

<u>Totals</u>

104 Channels of standard PMT's

320 Shower Max channels

64 Massles Gap channels

EM ABSORBER - ANL/WSTC

- PROCUREMENTS - OUT
- FABRICATION - WELL ALONG

FRAME FOR 1ST MODULE BY 1/25/93

STILL CLOSE TO SCHEDULED DATE

TILE/FIBER ASSEMBLIES

"CONVENTIONAL" TILES, FIBERS - TSUKUBA, FNAL/ANL
UDINE

- FINAL DESIGN DETAILS IN PROGRESS
- DELAY IN SCINTILLATOR PROCUREMENT
  (DYE AVAILABILITY)

NO IMPACT ON SCHEDULE

SHOWER MAX ASSEMBLIES - SACLAY, [illegible]

- FINAL DESIGN IN PROGRESS
- FIBER ROUTING STUDIES @ FNAL

FINAL ASSEMBLY

FNAL

- MODULE LIFTING FIXTURE – OUT

DESIGN 95%
- EM/HAD MERGE FIXTURE
- ASSEMBLY FIXTURE
- STORAGE FIXTURE/PRC WEDGE MERGE FIXTURE

BEGUN
- SAFETY REVIEWS
- BACKBONE LAYOUT/ASSEMBLY
  - PMT'S
  - ELECTRONICS
  - CALIB/MONITORING SYSTEM PURDUE/SSCL/UTA
- FIBER ROUTING – MOCKUP
- ASSEMBLY TOOLING DESIGN

ANL

- EM MODULE HANDLING FIXTURES

  CONCEPTUAL DESIGN

EVALUATION AND TESTING

- COSMIC RAY - M. LAMM (FNAL)

  ORGANISING GROUP

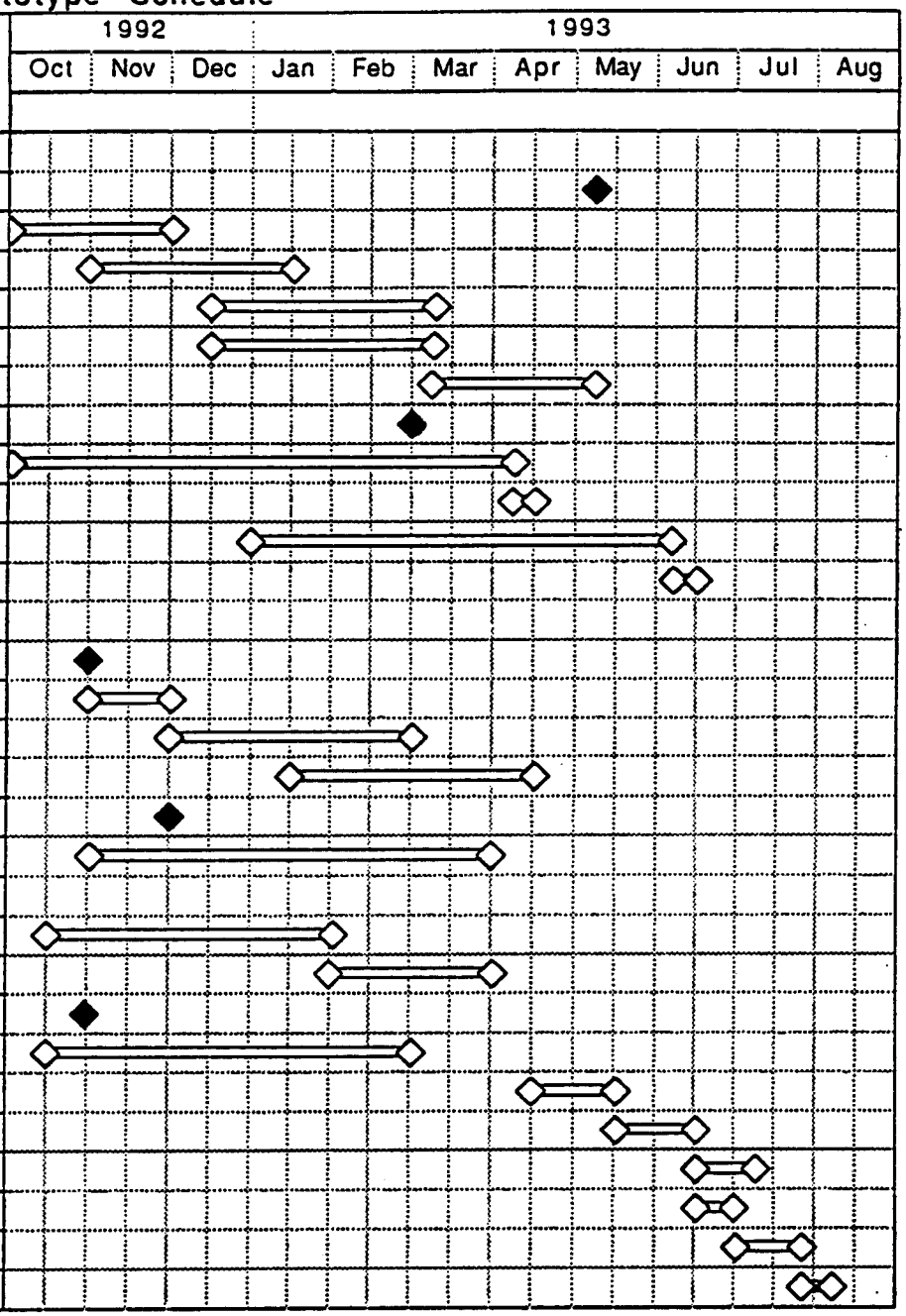
  DEFINING THE TASK

- BEAM TEST - J. SIEGRIST (SSCL)

  PRAYING

SDC Calorimeter Barrel Prototype Schedule

S. Gourlay
Fermilab
:tober 19, 1992



Fri, Oct 23, 1992

SCHEDULE SUMMARY

1ST MODULE 7/93

2ND MODULE 8/93

NO CHANGE IN ENDPOINT

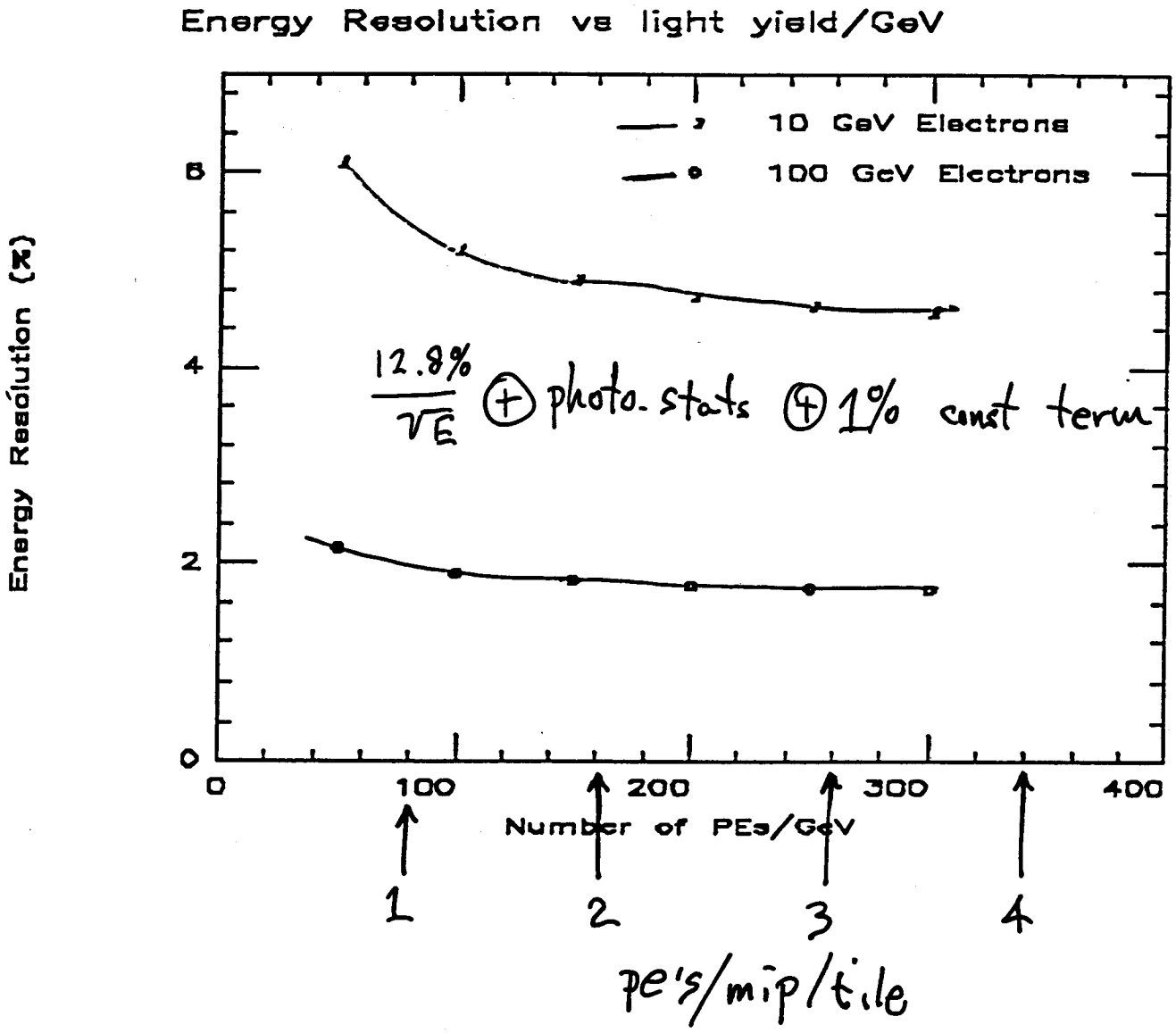
MILESTONES

• BEGIN FABRICATION OF HADRON ASSEMBLY TOOLING	11/1/92
• TILE/FIBER MATERIAL SPEC	11/1/92
• HADRON ABSORBER DESIGN	12/1/92
• FINAL TILE DESIGN / PMT SPEC	1/15/93
• 1ST EM FRAME ASSEMBLY	1/25/93
• 1ST EM CASTING	3/1/93
• FNAL HADRON ABSORBER	3/22/93
• TILE/FIBER ASSEMBLIES / PMT'S MODULE 1	4/15/93
• 1ST 1/32 EM MODULE	4/20/93
• PRC HADRON ABSORBER	5/10/93
• 2ND 1/32 EM MODULE	5/25/93
• TILE/FIBER ASSEMBLIES / PMT'S MODULE 2	6/15/93

J. FREEMAN

Barrel Calorimeter Optical System

- transverse uniformity $\lesssim$ 2% rms
- light yield $\gtrsim$ 200 pe/GeV
  corresponds to $\gtrsim$ 2 pe/mip/tile
  (Doe Review suggested goal of
  ~ 4 pe/mip/tile)


Energy Resolution vs light yield/GeV
10 GeV Electrons
100 GeV Electrons
Energy Resolution (%)
0
2
4
6
0
100
200
300
400
Number of PEs/GeV
12.8%/√E ⊕ photo. stats ⊕ 1% const term
1
2
3
4
pe's/mip/tile

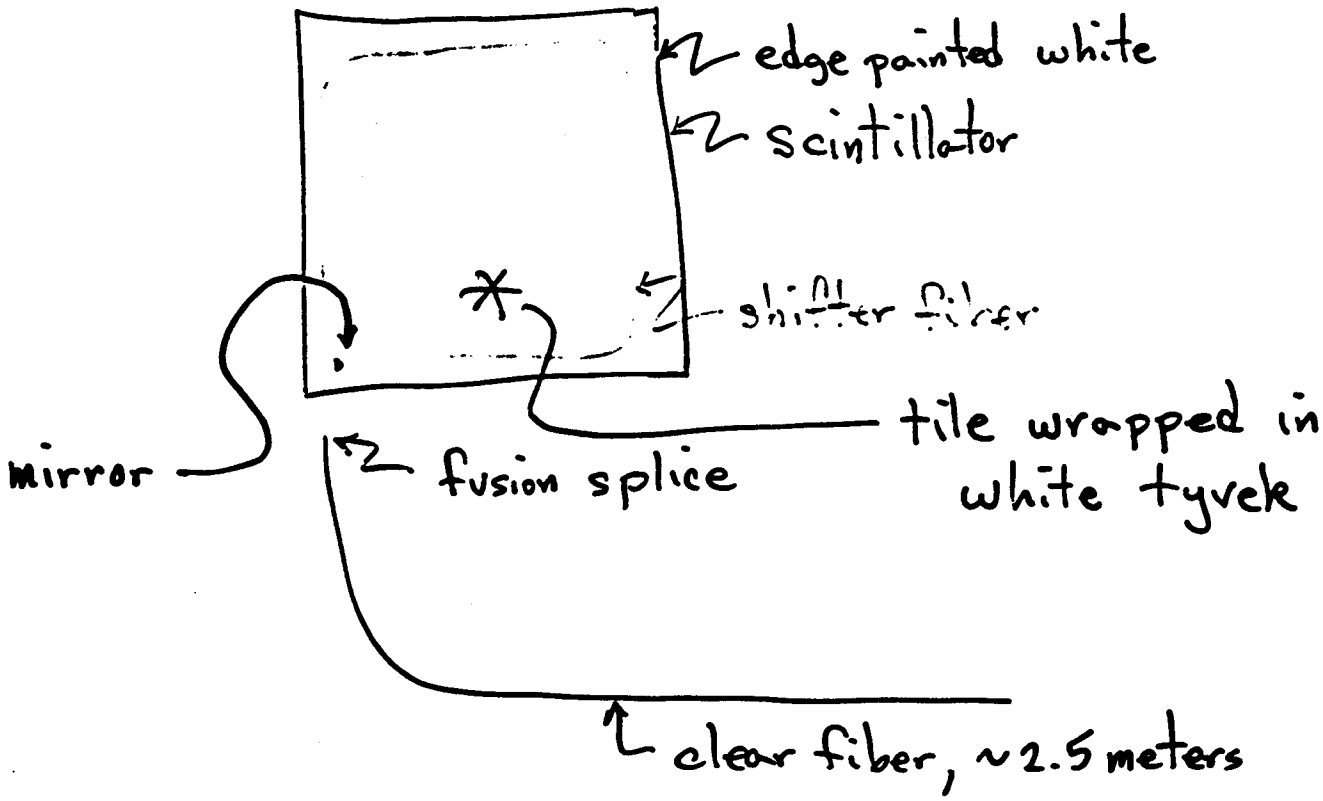
Default design

<u>scintillator</u> SC SN 38, 4mm thick
(used by CDF, ZEUS, CDF upgrade)
for doses of ~ 1 MRad, about as
Rad hard as SCSN81. Better
long term agins properties than 81
~ 1.5X more light than 81

<u>wave shifter</u> Kuraray Y-11 or Bicron BCF91A

<u>clear fiber</u> Kuraray multiclad clear fiber
fiber diameter 1mm Ø (0.83 is
also being studied)

Default design

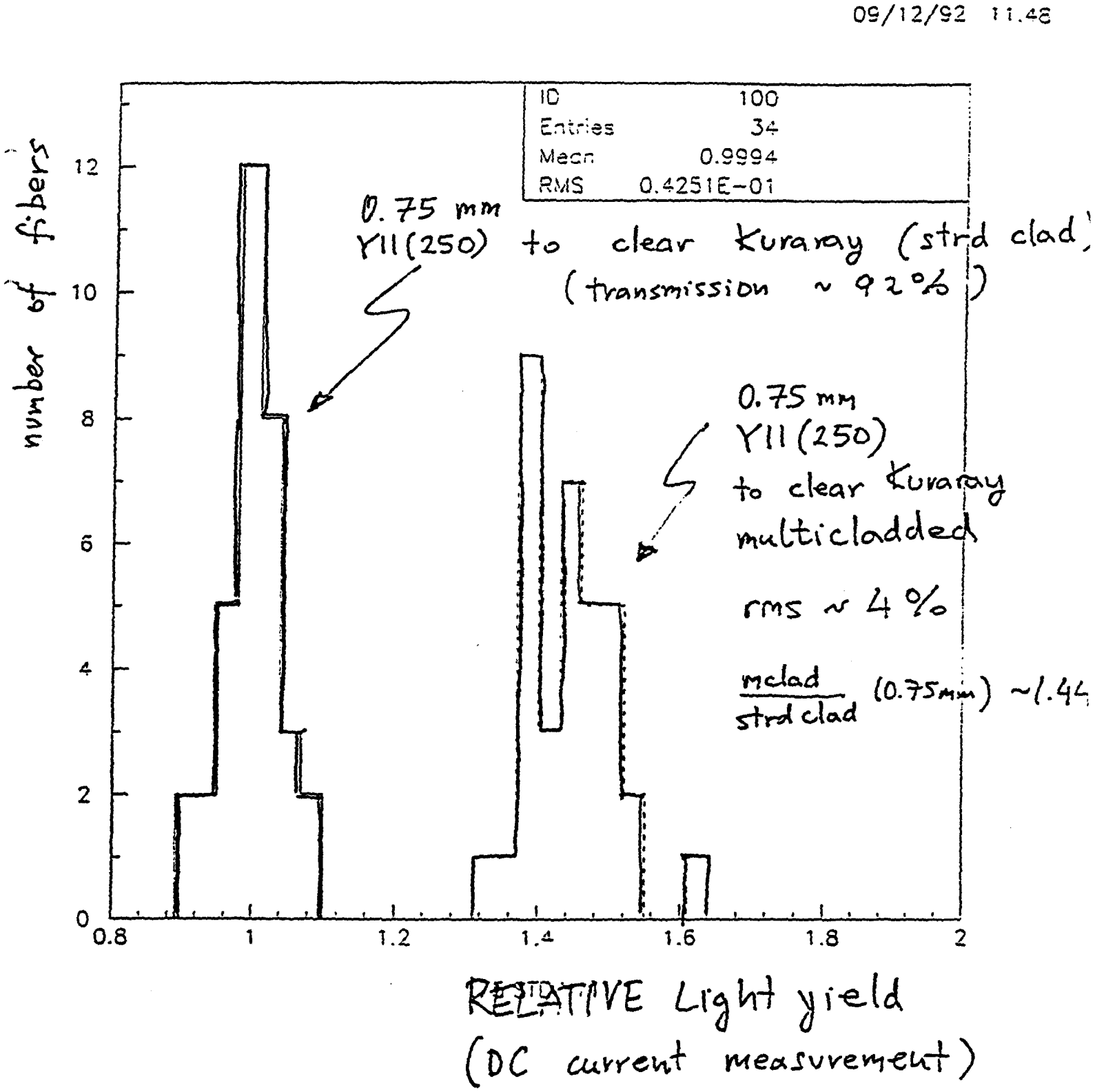


light yield (0.83mm ⌀, multiclad clear)

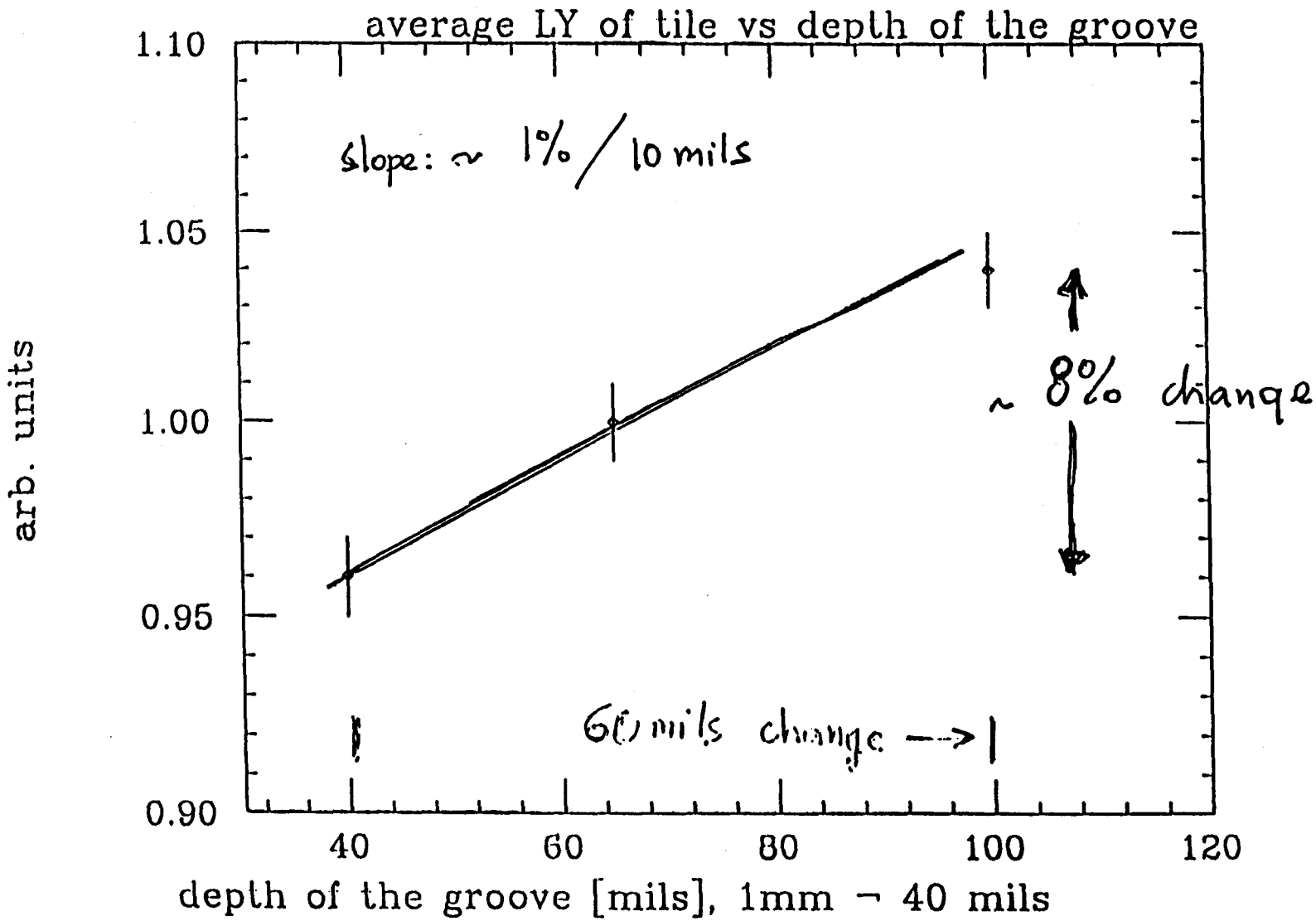
SCSN38 + BCF91A ~4 pe/mip/tile

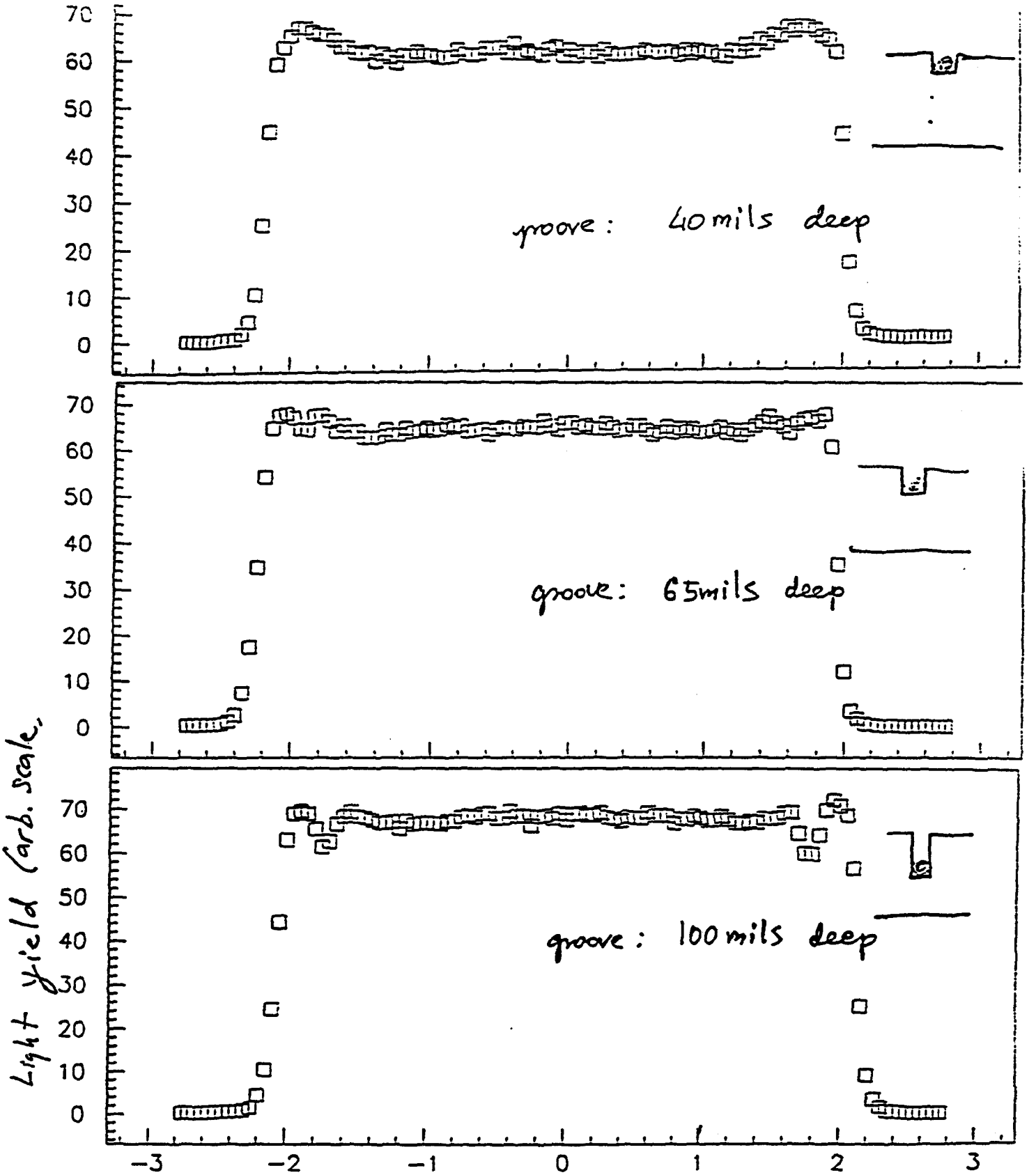
SCSN38 + multiclad ~~clear~~ Y11 ~4.5 pe/mip/til

Reproducibility of HSL splicing



Sensitivity of the tile light yield to the depth of the groove:



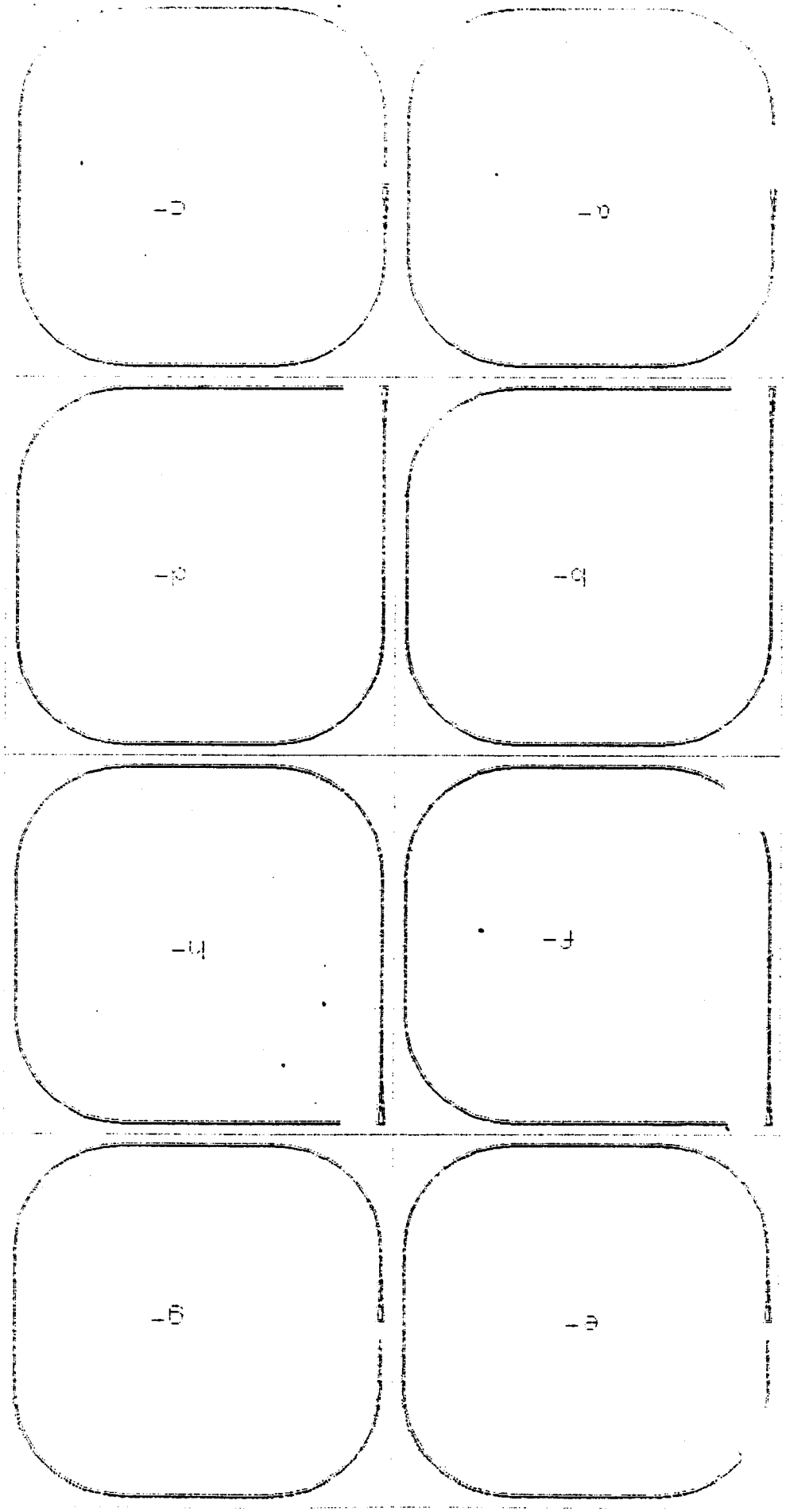


position of source [inches]

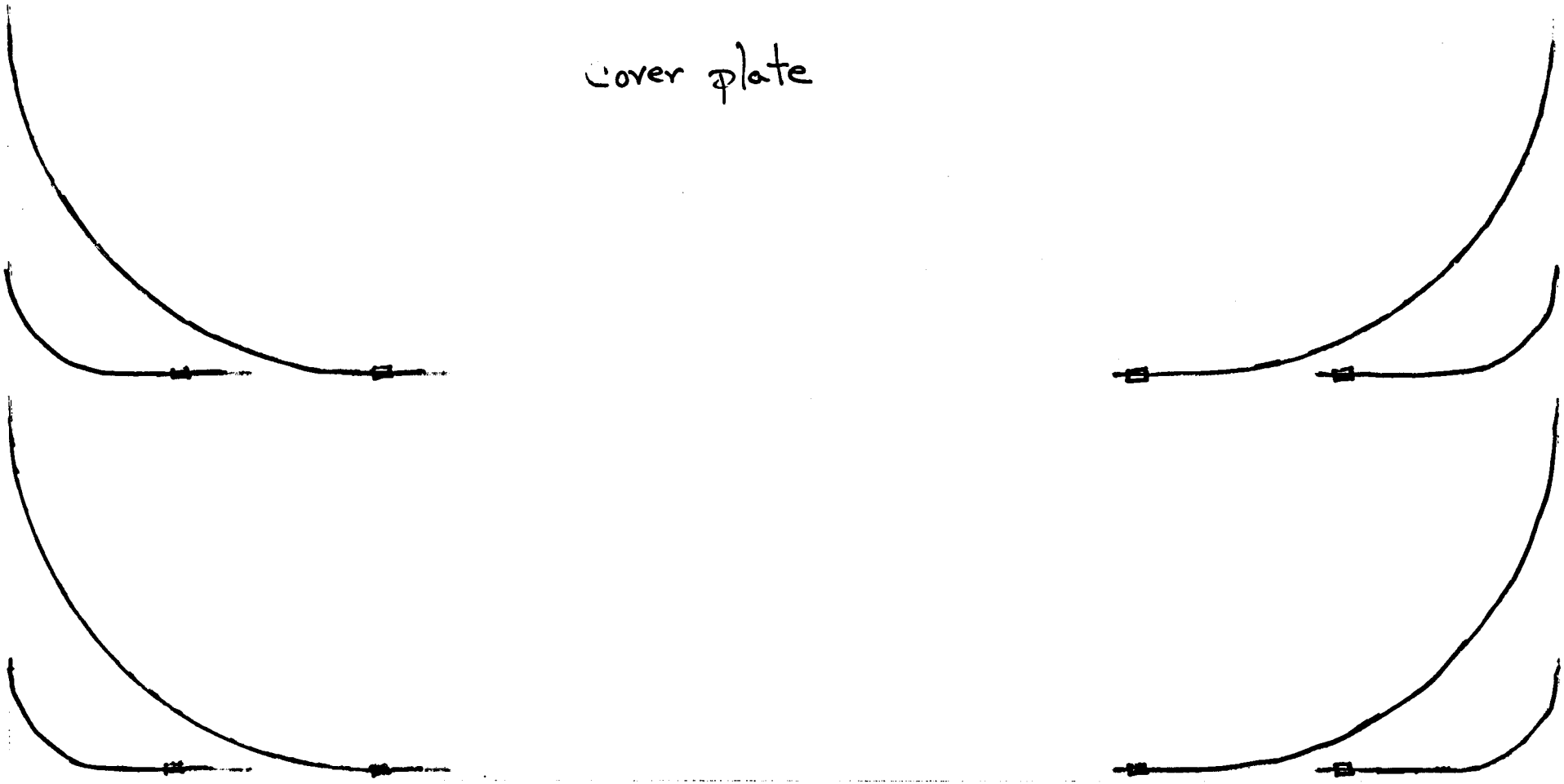
.mm SCSN-38

10.8 cm × 10.8 cm

step = 0.050" (50 mils)


-b
-p
-q
-d
-f
-e
-c
-a

cover plate



Conclusions

- We have done extensive studies of light yield vs material, uniformity vs fiber position, -----
- We have a design that meets requirements:

  $\gtrsim$ 4pe/mip/tile + uniformity of ~2%

- We are preparing computer generated data base for machining tiles + format to transmit data to Japan for manufacture.

SDC Collaboration Meeting
December 10-12, 1992

Status on Muon Tower Prototype

H. Lubatti

December 12

MUON TOWER PROTOTYPE

Presented to the SDC
Collaboration Meeting

December 12, 1992

Henry Lubatti

SDC PROTOTYPE TOWER

WBS 3.2.1.5.8

Build BW(2,2)/BW(3,2) Tower in SSC Muon Lab at Stoneridge

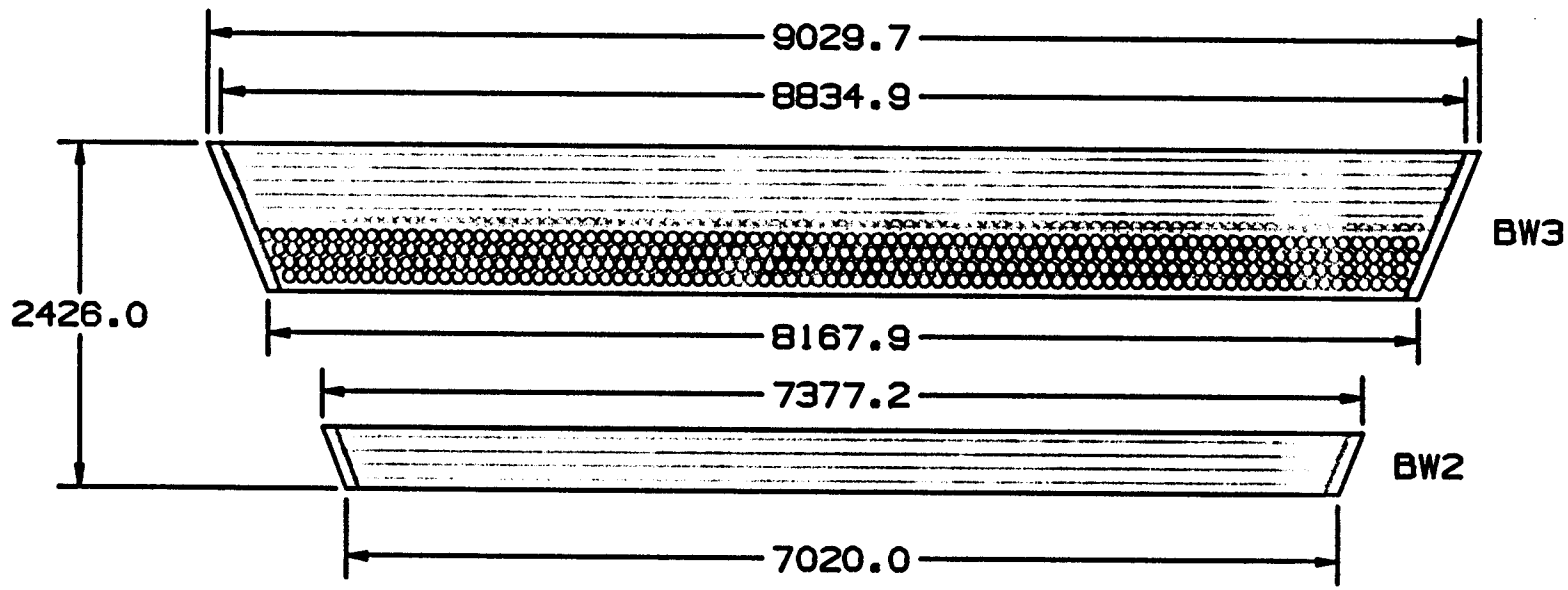
Build BW(2,1) at UT Arlington

Test

- *Assembly procedures*
- *Alignment schemes*
- *Electronics*
- *Trigger??*

H. Lubatti
Tower Workshop
December 12, 1992

PROTOTYPE TOWER - OCTANT 1, MODULE 2(4)

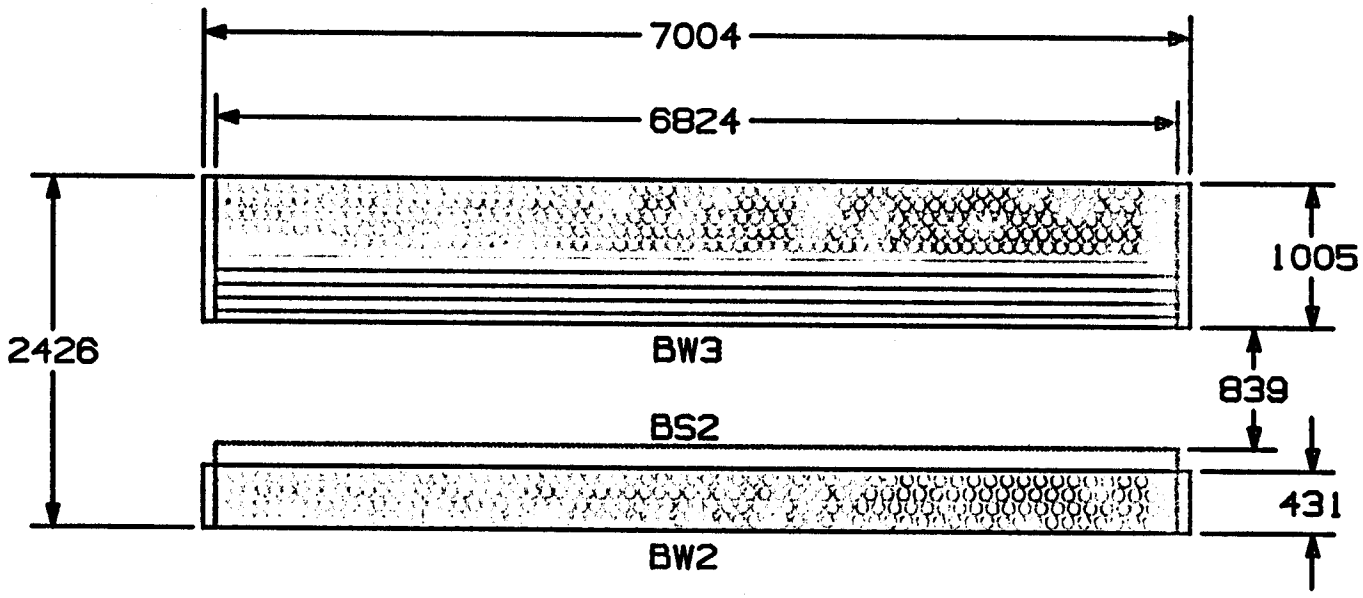


Theta Tubes

Stereo Tubes

Phi Tubes

PROTOTYPE TOWER - OCTANT 1, MODULE 2(4)



Theta Tubes - 273 (BW3) , 262 (BW2)
Stereo Tubes - 144 ea.
Phi Tubes - 340 ea.

PROTOTYPE MODULE TASKS

TASK	RESPONSIBILITY	CONTACT
Enlarge and modify existing Muon Lab	*SSCL Muon Group*	*J. Thunborg* *G. Pennycuff*
Final module design	*Seattle/SSCL*	*C. Daly*
Assembly procedures	*Seattle/SSCL*	*H. Lubatti*
Jigging for module assembly	*Seattle/SSCL*	*R. Davisson*
Issuing POs for module, jigging & end caps	*SSCL*	*J. Thunborg* *H. Lubatti*
Front-end electronics (ASD)	*KEK/Harvard/Michigan*	*S. Terada* *J. Oliver* *J. Chapman*
Scintillators, bases and PMs	*Michigan/Protvino*	*R. Thun* *V. Kubarovsky*
HV distribution system	*SSCL*	*P. Schuler*
Gas distribution system	*SSCL*	*P. Schuler*
Drift tubes	*Boston/Seattle*	*G. Feldman* *T. Zhao*

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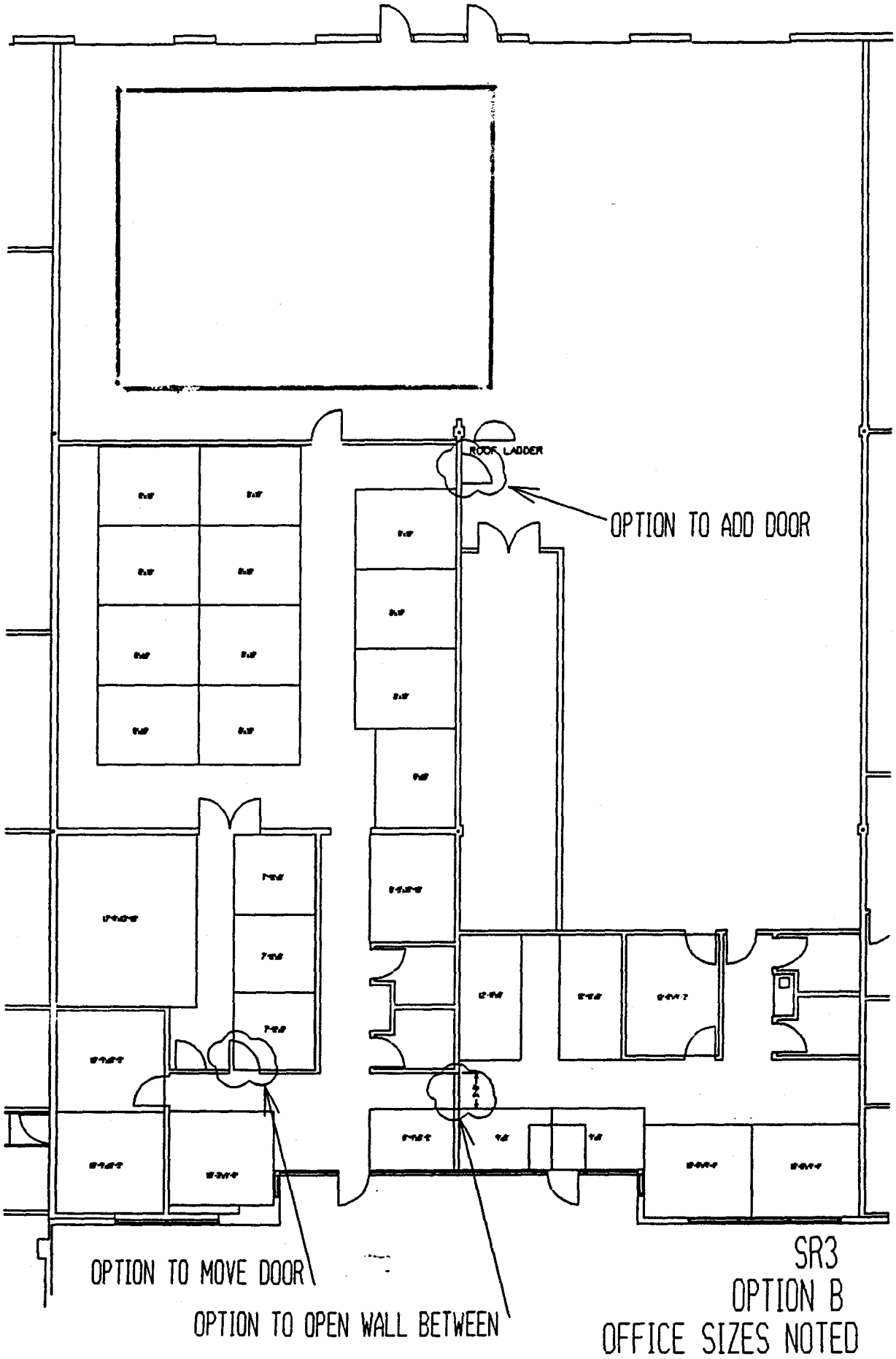
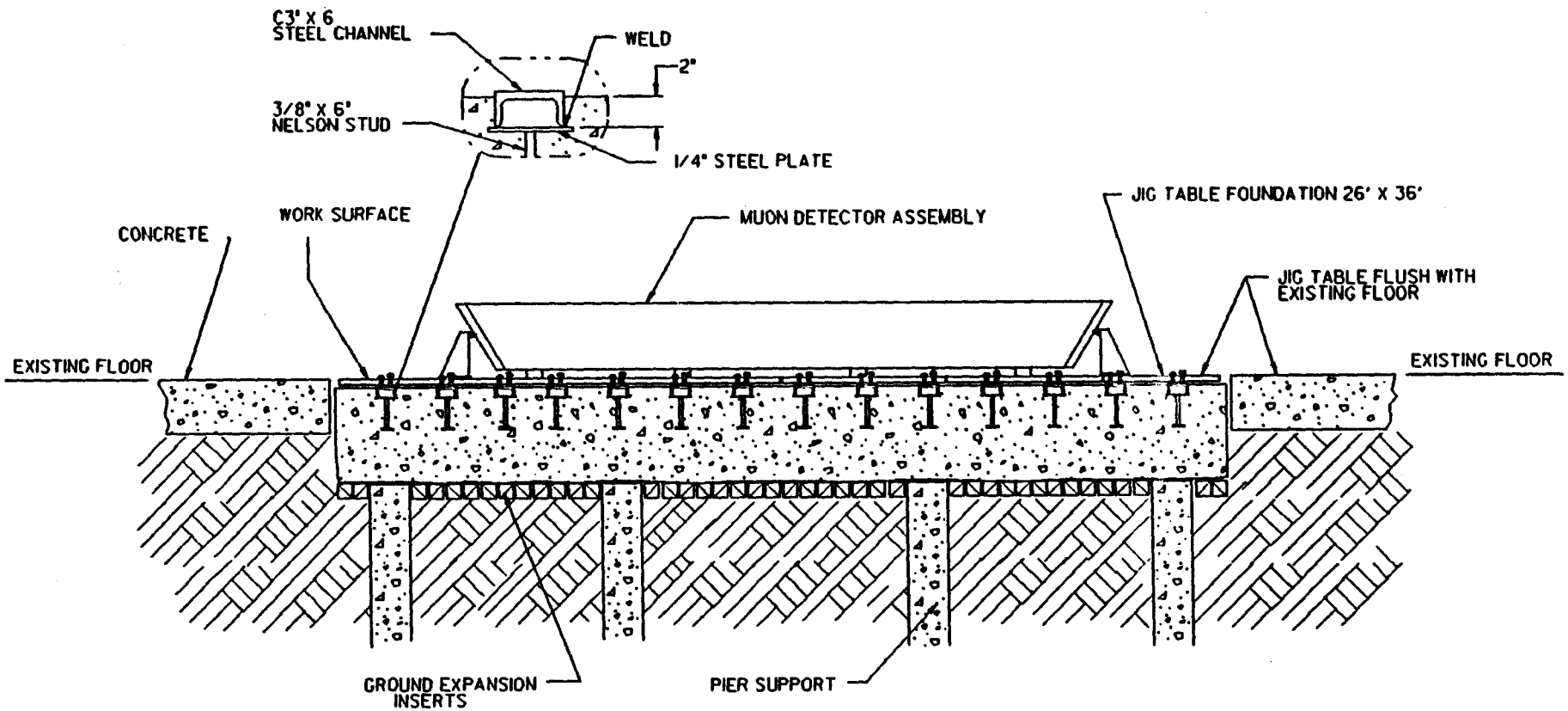
December 12, 1992

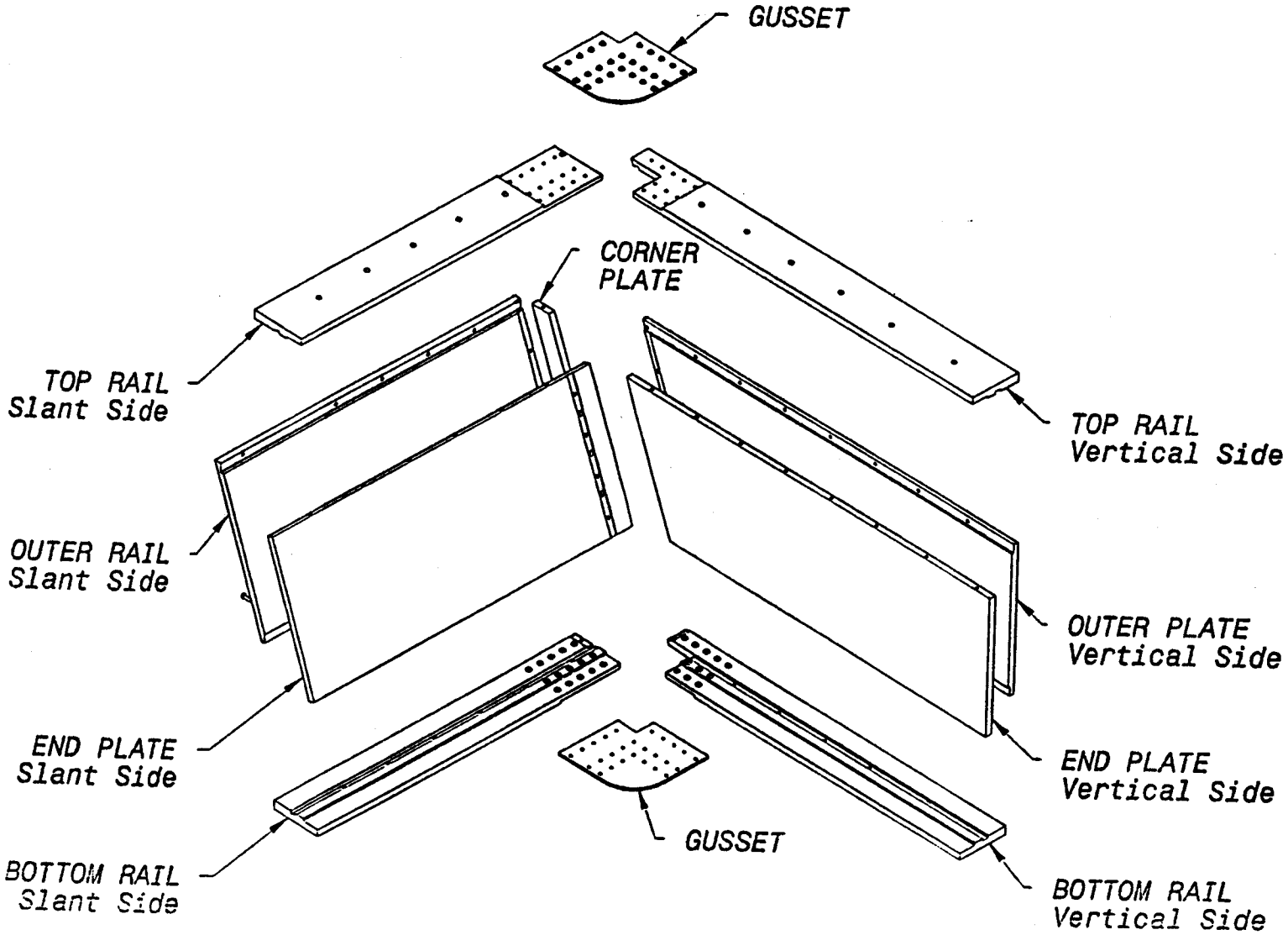

ROOF LADDER
OPTION TO ADD DOOR
OPTION TO MOVE DOOR
OPTION TO OPEN WALL BETWEEN
SR3
OPTION B
OFFICE SIZES NOTED



TOOL/JIGGING MUON DETECTOR MODULES BW2 AND BW3
DEC. 8, 1992
/home/nova/prd/kelly/thunberg/fig2

CIN2002327

F-22


GUSSET
CORNER PLATE
TOP RAIL Slant Side
TOP RAIL Vertical Side
OUTER RAIL Slant Side
OUTER PLATE Vertical Side
END PLATE Slant Side
END PLATE Vertical Side
GUSSET
BOTTOM RAIL Slant Side
BOTTOM RAIL Vertical Side

ASSEMBLY PROCEDURE

- *Installation of jigging*

  Jigging establishes angles and positions

- *Installation of module peripheral structure (side plates and bottom rails)*

  Side plates shipped from machine shop with bottom rails attached.

  Then install on assembly jigging.

- *Installation of bottom surface of module*

  1.5 x 3m, 6mm thick aluminum plates (epoxy bound)

  For BW2, load-spreading plates are attached to bottom plates prior to installation

- *Installation of tubes*

  Step 1: Install fiducial tubes

  Step 2: Install remaining tubes

- *Installation of tube spacers and stiffeners*

  Tubes with $\Delta < 2mm$ - epoxy directly

  Tubes with $2mm < \Delta < 4mm$ spacers at intermittent spaces

H. Lubatti
Tower Workshop
December 12, 1992

Tubes when sparse have 10-90mm separation, so use 1.6mm thick aluminum plates along common tangents.

- *Installation of shear transferring membrane*

  1.6mm aluminum sheets

- *Install remaining layers*

  Repeat above steps

- *Install top plates and rails*
- *Install gas and electrical connections*
- *Install outer plates*

  BW1 - attach 19mm outer plate

  BW2/3 scintillators, walkways, access ladders

  Attach BW2 to BW3

- *Attach Lee bearing spreader plates*
- *Move module to storage or alignment station.*

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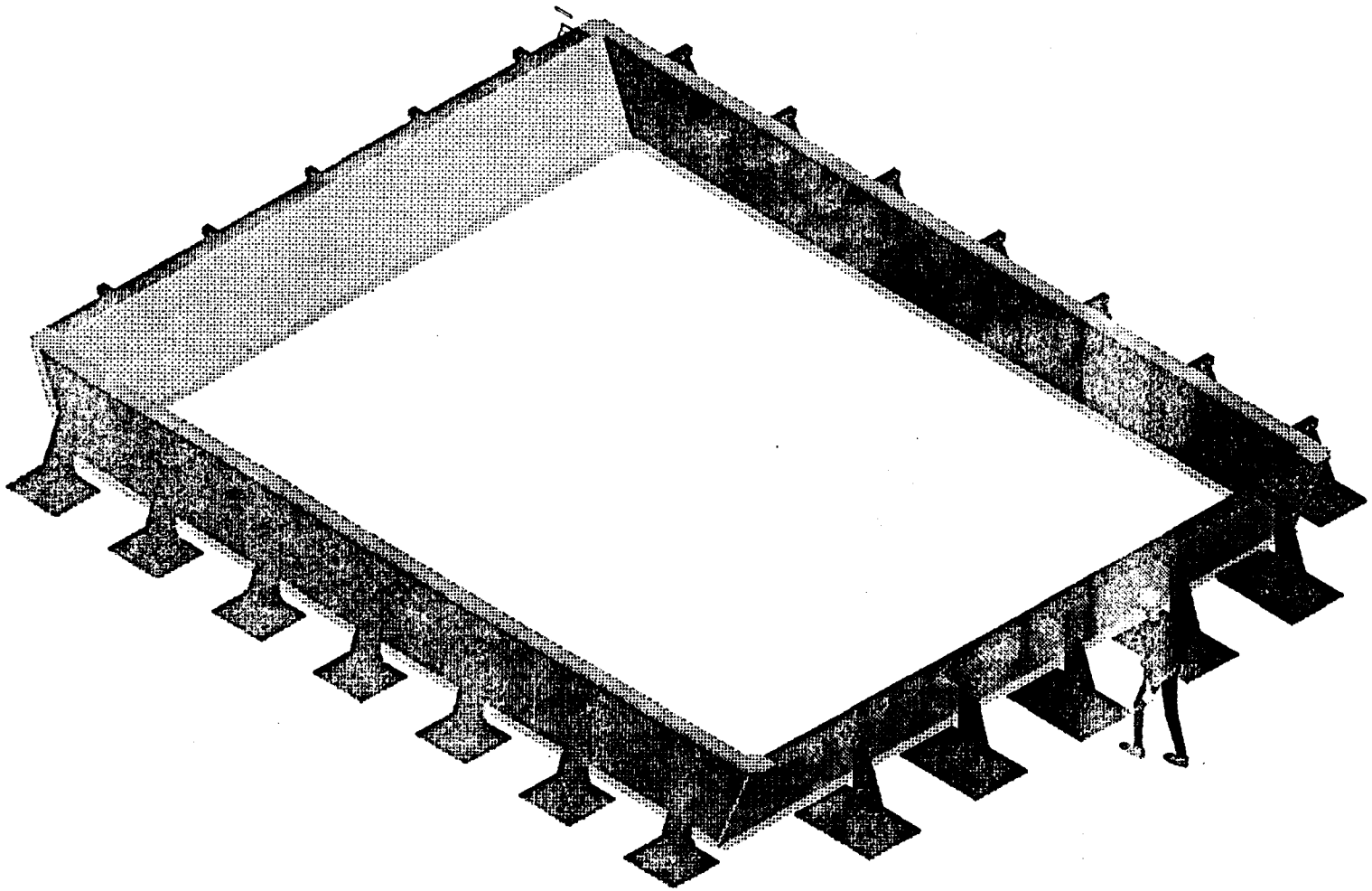

BW 3

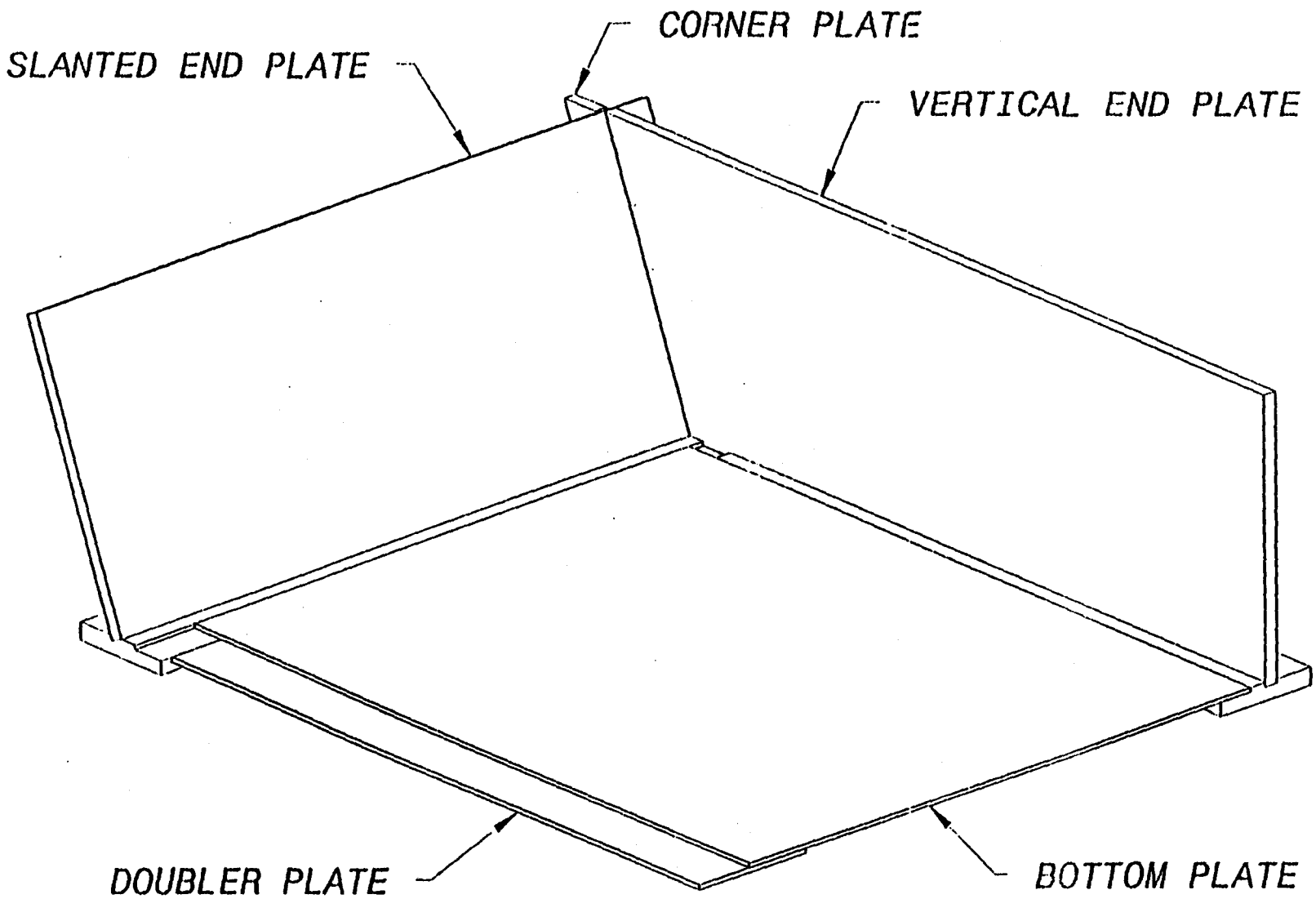

FIGURE 4. INSTALLATION OF BOTTOM PLATE

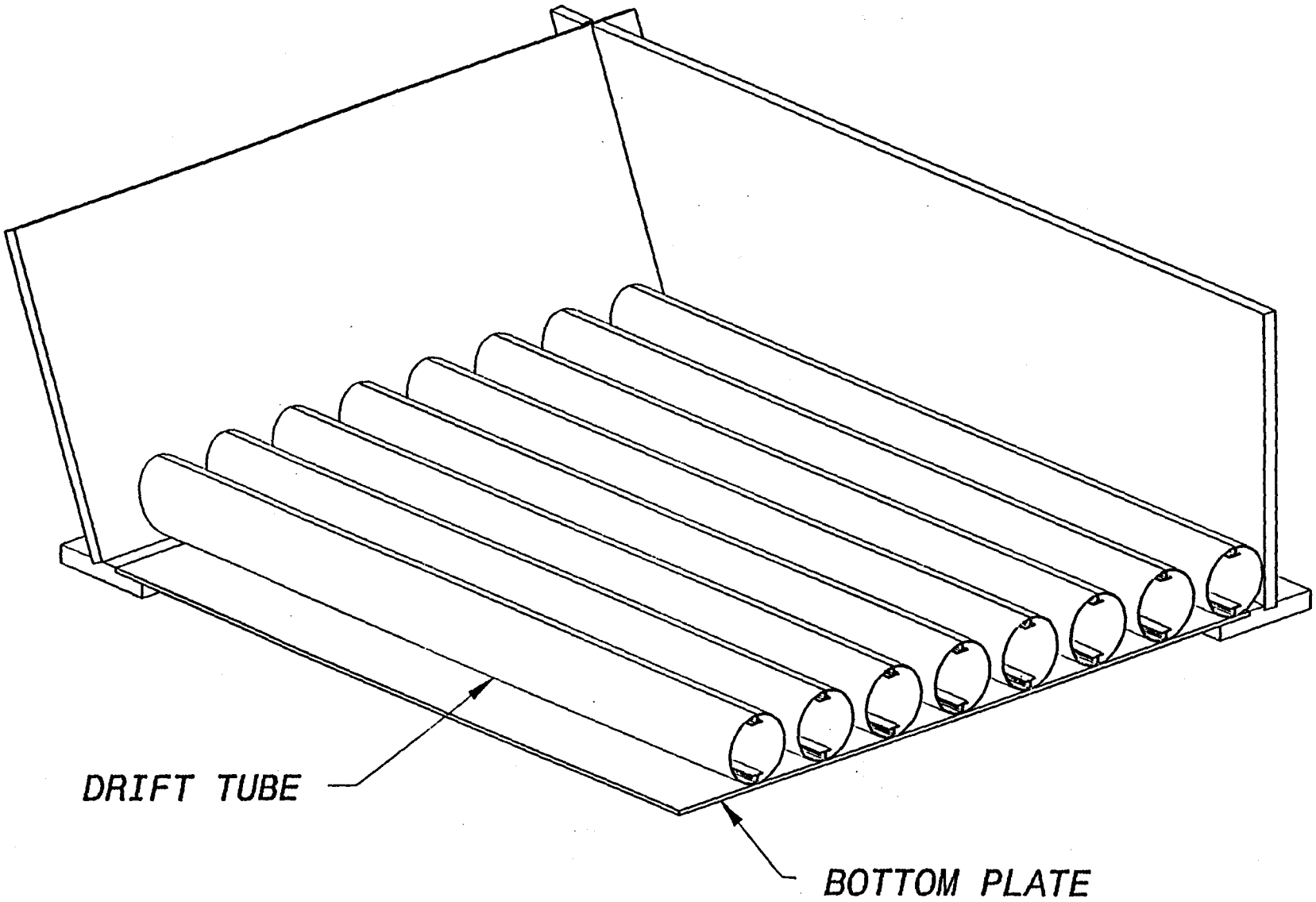

FIGURE 6. INSTALLATION OF FIRST TUBE LAYER

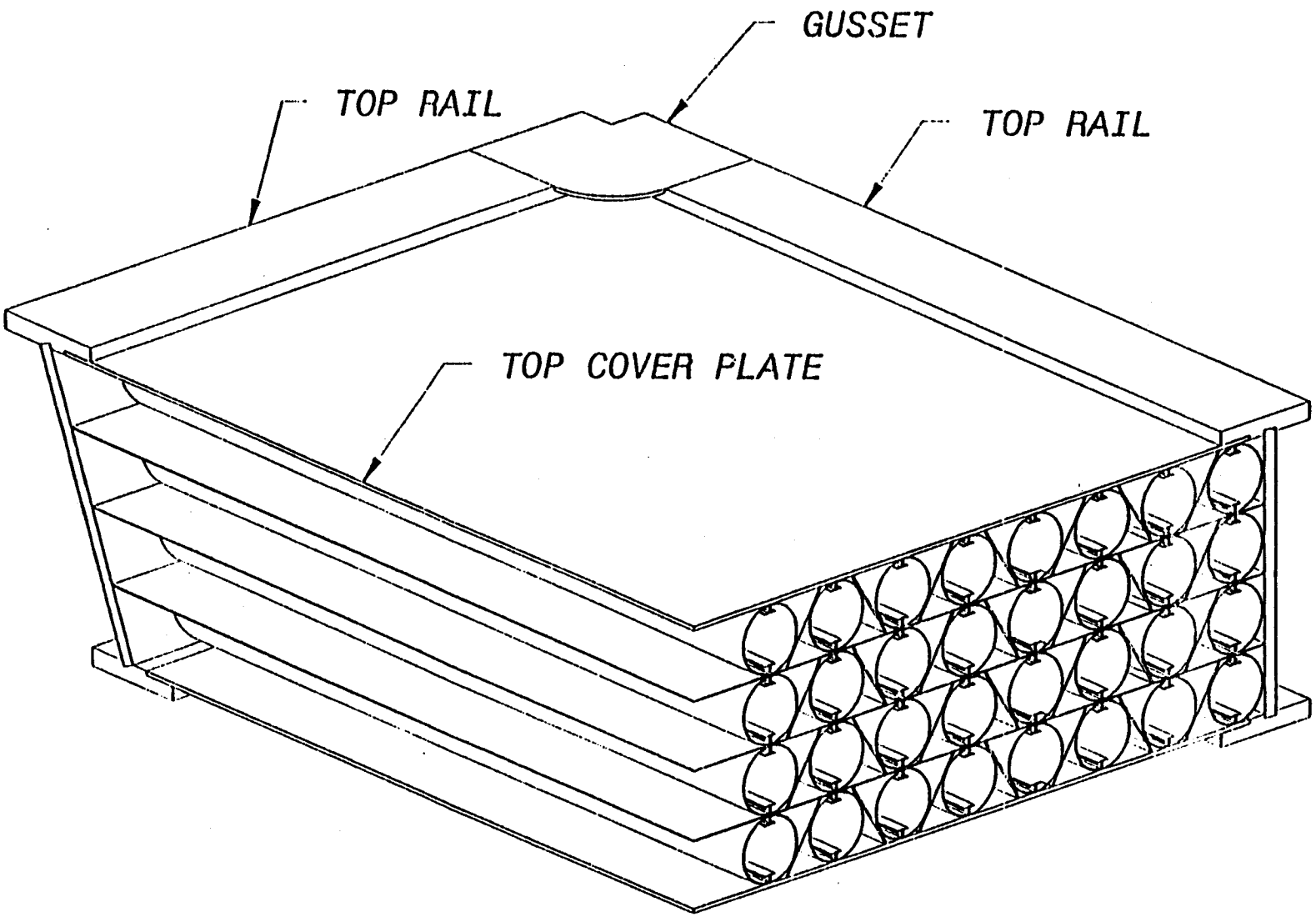

FIGURE 11. INSTALLATION OF TOP COVER PLATE AND RAILS

PROTOTYPE MODULE TUBE PRODUCTION PERSONNEL

PHYSICIST		UNIVERSITY
J. Bensinger		*Brandeis*
G. Brandenburg		*Harvard*
R. Davisson		*U of Washington*
G. Feldman	*(QAQC Officer)*	*Harvard*
P. Hurst		*Harvard*
H. Lubatti		*U of Washington*
A. Mann	*(QAQC Officer)*	*Tufts*
R. Milburn		*Tufts*
A. Napier		*Tufts*
H. Wellenstein		*Brandeis*
J. Wilkes		*U of Washington*
T. Zhao	*(QAQC Officer)*	*U of Washington*

ENGINEER	UNIVERSITY
B. Dennis	*U of Washington*
E. Sadowski	*Harvard*

H. Lubatti
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December 12, 1992

TECHNICAL SERVICES SUPERVISION	UNIVERSITY
H. Guldenmann	*U of Washington*

SHOP FOREMAN/LEADMAN	UNIVERSITY
F. Dalrymple	*Harvard*
L. McMaster	*Tufts*
D. Skow	*U of Washington*

MACHINIST/TECHNICIAN	UNIVERSITY
Y. Chen	*U of Washington*
D. Dupuis	*Tufts*
R. Haggerty	*Harvard*
P. Long	*Brandeis*
E. Lucia	*Harvard*
R. Musgrave	*U of Washington*
J. O'Kane	*Harvard*
M. Renteman	*U of Washington*
J. Roze	*U of Washington*
S. Sansone	*Harvard*
L. Stark	*U of Washington*

H. Lubatti
Tower Workshop
December 12, 1992

PROTOTYPE TOWER DRIFT TUBE PRODUCTION

- *ORGANIZATION*

Institution	Contact
Brandeis	*H. Wellenstein*
Harvard	*G. Feldman*
Tufts	*A. Mann*
U of Washington	*T. Zhao*

- *TASK RESPONSIBILITIES*

Items	
Aluminum extrusion	*E. Sadowski* *H. Guldenmann*
Noryl/aluminum extrusion	*H. Guldenmann*
End caps	*J. Thunborg*

H. Lubatti
Tower Workshop
December 12, 1992

- *TUBE ASSEMBLY EQUIPMENT AND FACILITY*

Clean room and tube storage	*E. Sadowski* *A. Mann* *H. Guldenmann* *T. Zhao*
Tube end finishing machine	*A. Mann* *H. Guldenmann*
Tube cleaning machinery	*E. Sadowski* *A. Mann* *W. Song*
Tube assembly station and jigging	*E. Sadowski* *A. Mann* *H. Guldenmann* *T. Zhao*
End cap interference fit apparatus	*H. Wellenstein*
Electrode cutting and trimming	*H. Guldenmann*
Electrode zipper	*H. Guldenmann*
Wire tensioning and crimping	*H. Wellenstein*
Wire dispensing and stringing	*E. Sadowski* *R. Davisson*

H. Lubatti
Tower Workshop
December 12, 1992

- *TUBE TESTING PROCEDURE AND EQUIPMENT*

G. Feldman, P. Hurst, T. Zhao

- *ITEMS TO BE TESTED*

  Dark current

  Gas leak rate

  Wire tension

  Observe signal

- *WIRE POSITION - X-RAY* *H. Wellenstein*

- *INFORMATION TO BE STORED ON PC OR MAC*

  Tube number

  Manufactured location and date

  Module number and layer number (ϕ, θ and stereo)

  High voltage and dark current

  Gas leak rate

  Wire tension

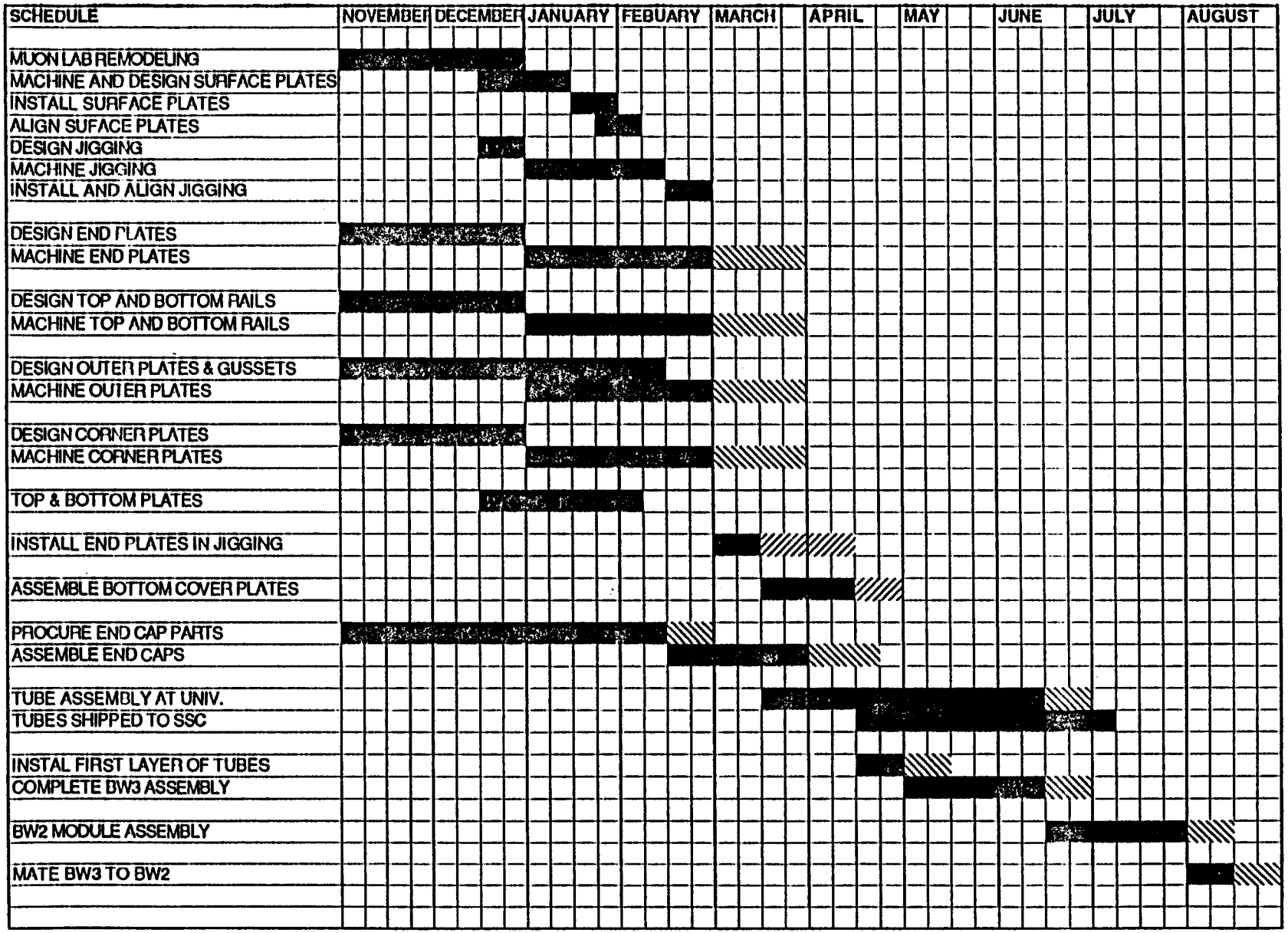
  Signal response to source and cosmic ray

- *UNIVERSAL BAR CODING FOR TUBE ID*

  W. Song

H. Lubatti
Tower Workshop
December 12, 1992

PROTOTYPE TOWER SCHEDULE



SDC Collaboration Meeting
December 10-12, 1992

Status on Electronics for Prototypes

A. Lankford et al.

December 12

REPORT on

ELECTRONICS FOR PROTOTYPES

Muon Prototypes	**Terada**
Calorimeter Prototypes	**Lankford**
Portable DAQ	Nickerson ~~**Lankford**~~

SDC Collaboration Meeting

December 12, 1992

SDC Portable DAQ Effort
(SSC,LBL,KEK,Saclay,TIT, U.C.Irvine,U.Michigan)

- o Start to develop some local expertise
- o Establish working relationships throughout the collaboration
- o provide a UNIX based, low-cost, portable system for use in testing detector prototypes.

Attributes

- o highly modular; directed toward use of high speed links
- o scalable and platform independent

A. Fry

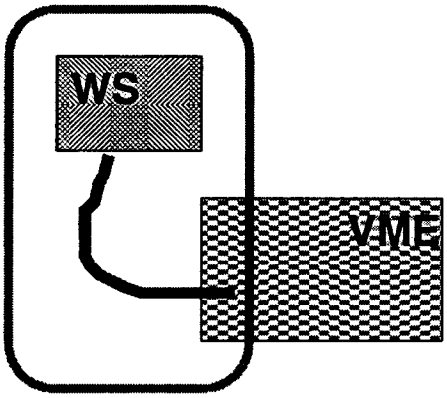
UNIDAQ

Portable data acquisition system on UNIX
Modular system (Hardware & Software are replaceable)

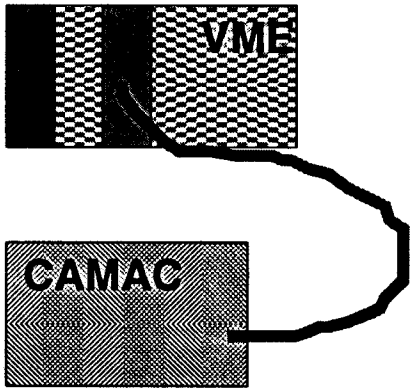
SSCL, KEK/TIT, U.Mich, LBL/SACLAY

SPARC, DEC station, (VxWorks, HP)

Access to VME



Access to CAMAC



SPARC + SFVME	K3922 + K2917
DECstation + Tuobo-VME	K3922 + K2917
MVME167(VxWorks)	K3922 + K2917
SPARC + VIC	(VIC + CAMAC)
HP + BIT3	

~ 600 event/sec on SPARC station

Masa Nomachi

Portable DAQ Features

1. Runs on Unix systems.
   (a) SUN-SPARC with Solflower VME interface
   (b) DEC-ULTRIX with DEC VME interface
   (c) HP-UX with Bit3 VME interface
   (d) Access to CAMAC from all 3 via Kinetics Systems board set.
      (i) Sun and DEC use KEK CAMAC driver.
      (ii) HP currently has no transparent interface from user programs to CAMAC.
   (e) Access to VME is not yet user-transparent.
2. Distribution via tar file
3. Recompilation of entire package via top-level Makefile
   (a) 2.5 minute elapsed time on HP 9000-710
4. Start entire canned package of processes via single command
5. Current version runs on single processor
   (a) Planned next version for multiple processors

Software

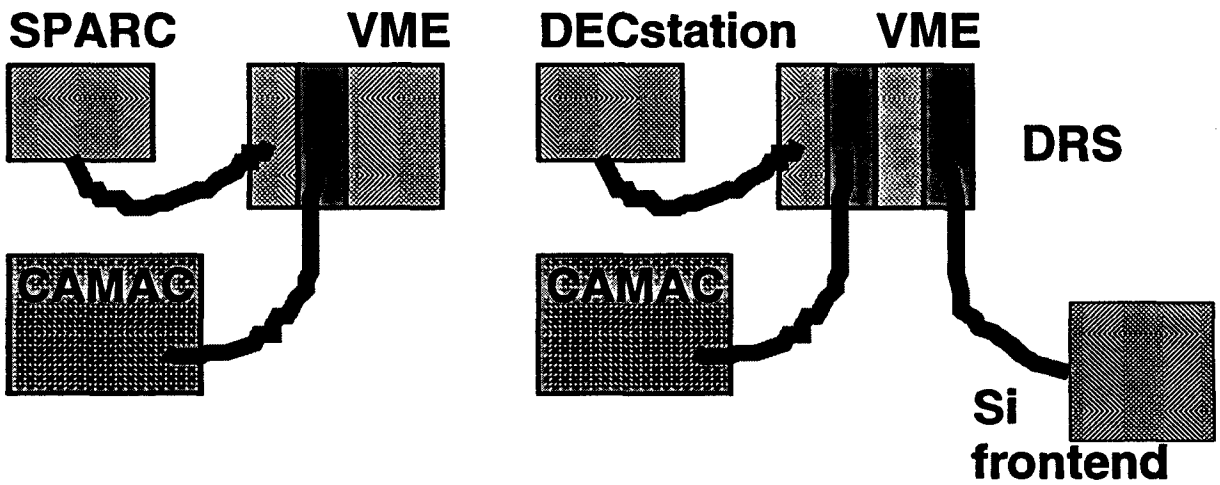
Data flow ———— simplie buffer manager
Control flow ———— control message handling

run control
error logging ——— Murmur
message logging
GUI

HBOOK + PAW

Installed at

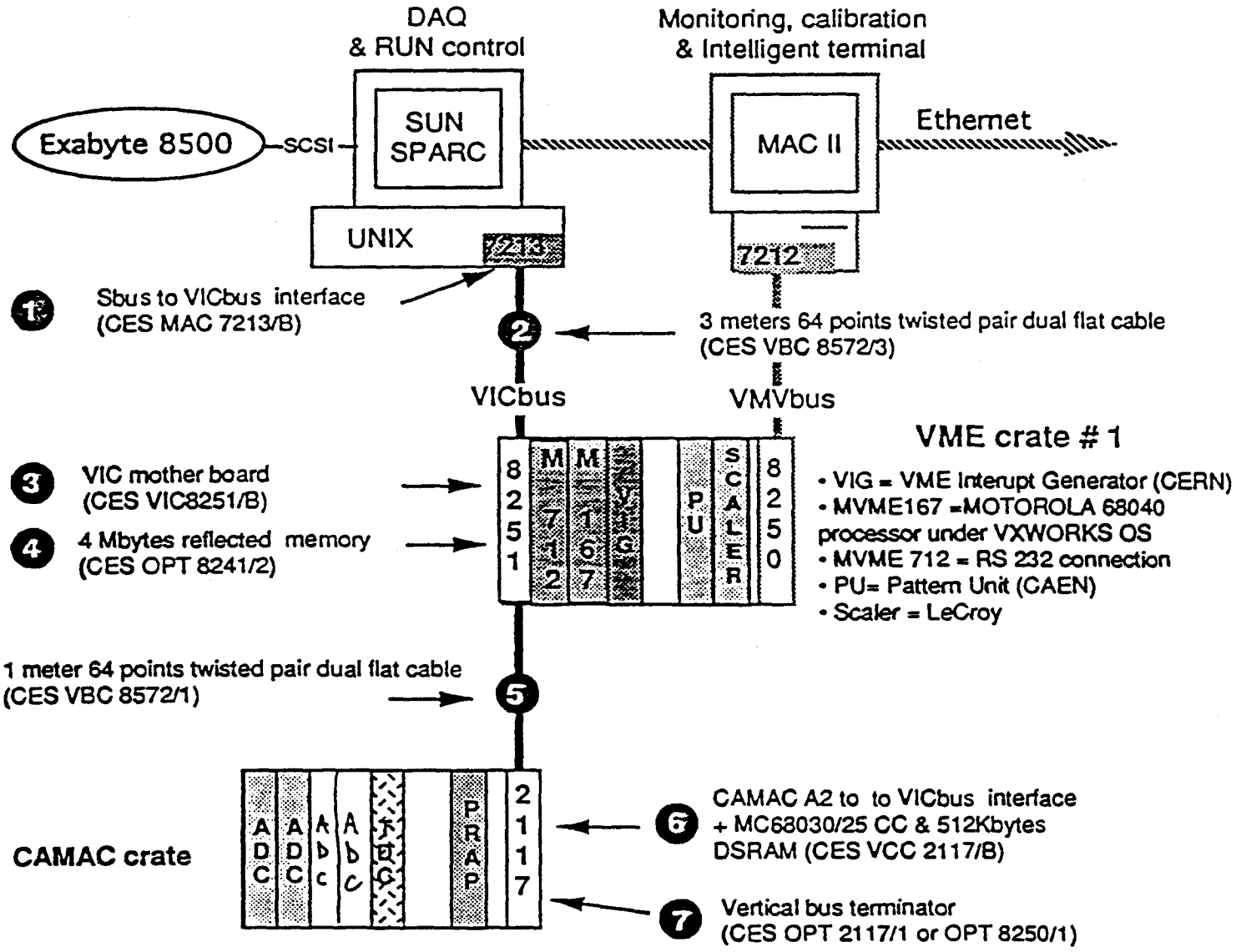
at SSCL (muon lab) for cosmic-ray test
at LBL for evaluation
at KEK for Si beam test & muon beam test

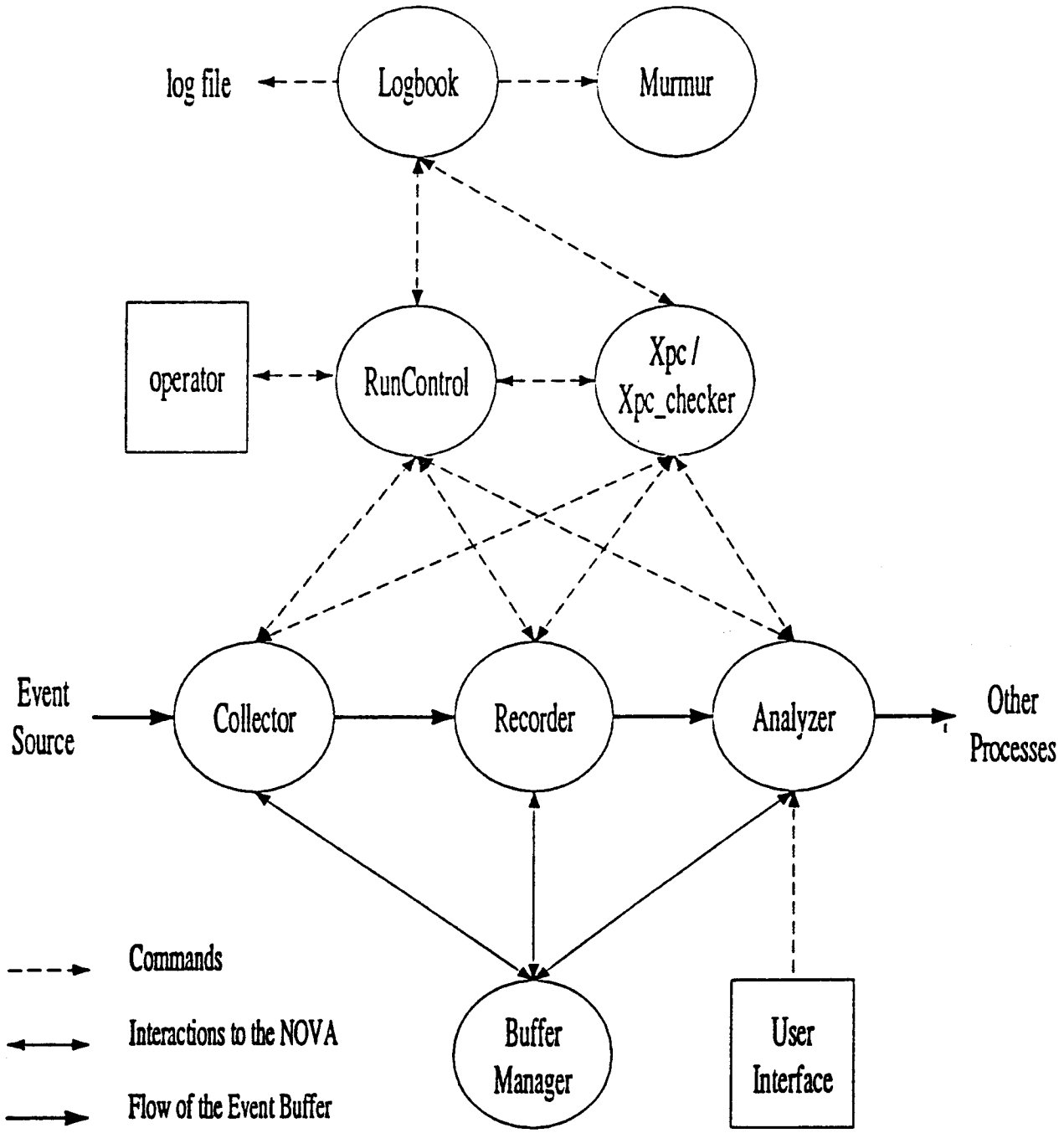


Masa Nomachi

ECEM & ShowerMax test @ BNL 1993 set-up
(LBL & Saclay)

Hardware Configuration





Interaction of the processes.

PORTABLE DAQ
(continued)

Status:

integration of hardware & software complete
- for standard rates
- Unix workstation + 1 VME crate + CAMAC
- Operational at KEK Silicon Test now

work on extension to high rate system in progress
- real-time "Unix" (VxWorks)
- multiple VME crates + CAMAC

Focus now shifts from building framework to applying existing framework to tests of prototypes.

Major FY93 Tests:

Silicon	KEK	Abrams *et al*
Muon Minitower	KEK	
ECEM + SMD	BNL	Abrams *et al*
Muon Tower	SSCL	
Calorimeter Wedge	FNAL	Abrams *et al*

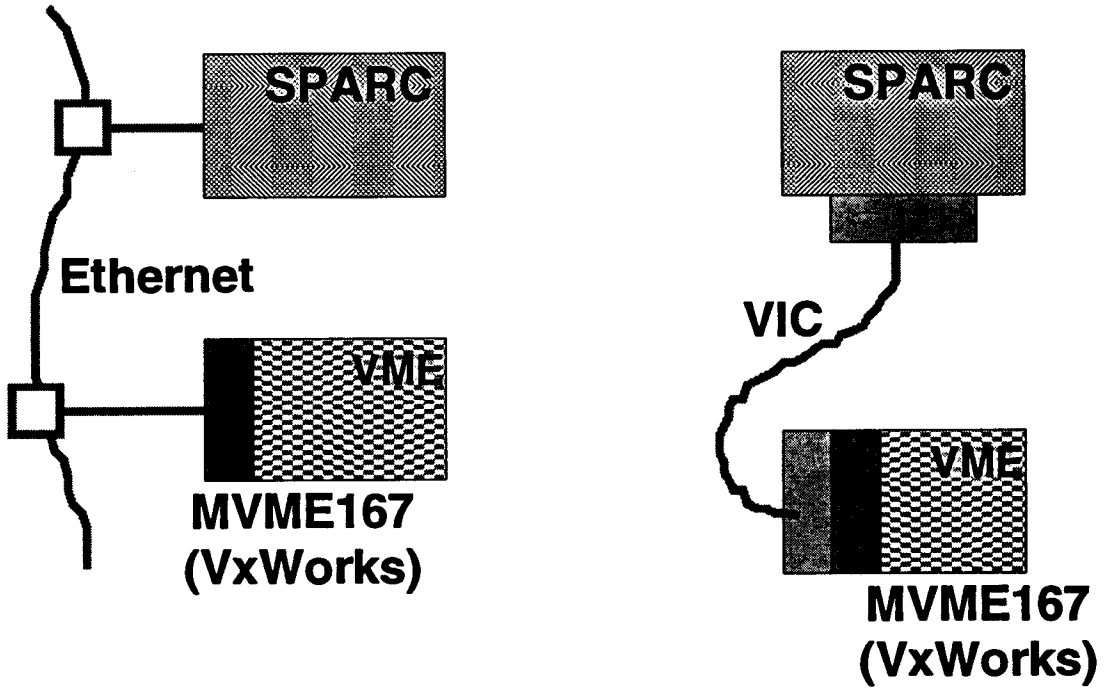
Scope of Portable DAQ Contribution:

The portable DAQ provides the framework on which to hang application code specific to a particular test. The detector group needs to provide the application code which specifies its hardware configuration and which analyzes its performance. The portable DAQ group has provided the processes in which to install these lines of code.

Extension

Calorimeter/Shower max beam tests requre

Higher event Rate	**Real time OS (VxWorks)**
Larger system	**Data link between computers**



Send buffer/Receive buffer over

- Socket one Ethernet
- Socket on FDDI
- Socket on Fiber Channel
- VIC, MXI, BIT3
- Fiber channel

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ELECTRONICS FOR ECEM & SMD TEST

Front-end Electronics:

SMD (see figure): **LeDu**

1 64 channel MAPMT
Saclay charge integrator and shaper ASICs
packaged on PMT mother board and in CAMAC
CAMAC ADC

ECEM: **Kadel & Hearty**

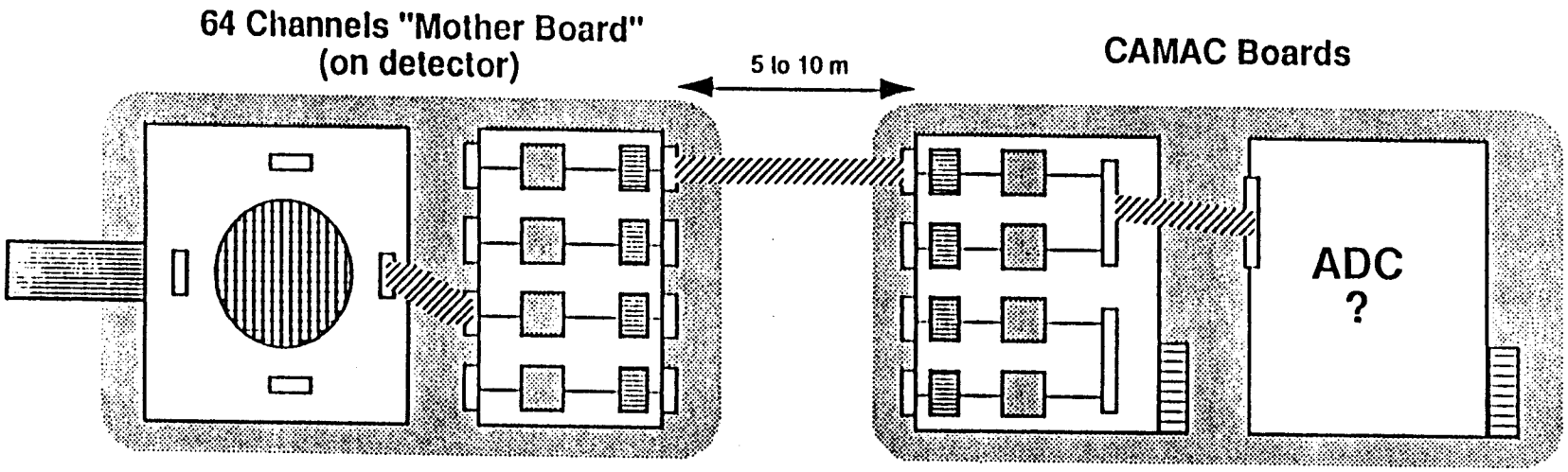
same instrumentation as 1992 BNL tests
same CAMAC ADC as SMD

Data Acquisition and Software:

SDC portable DAQ (see figure)

ECEM & SMD applications code **Abrams *et al***

Electronics implementation



- Philips MCPMT (New!)
- Hamamatsu MCPMT
- VAPD
- APD's (Preampli?)

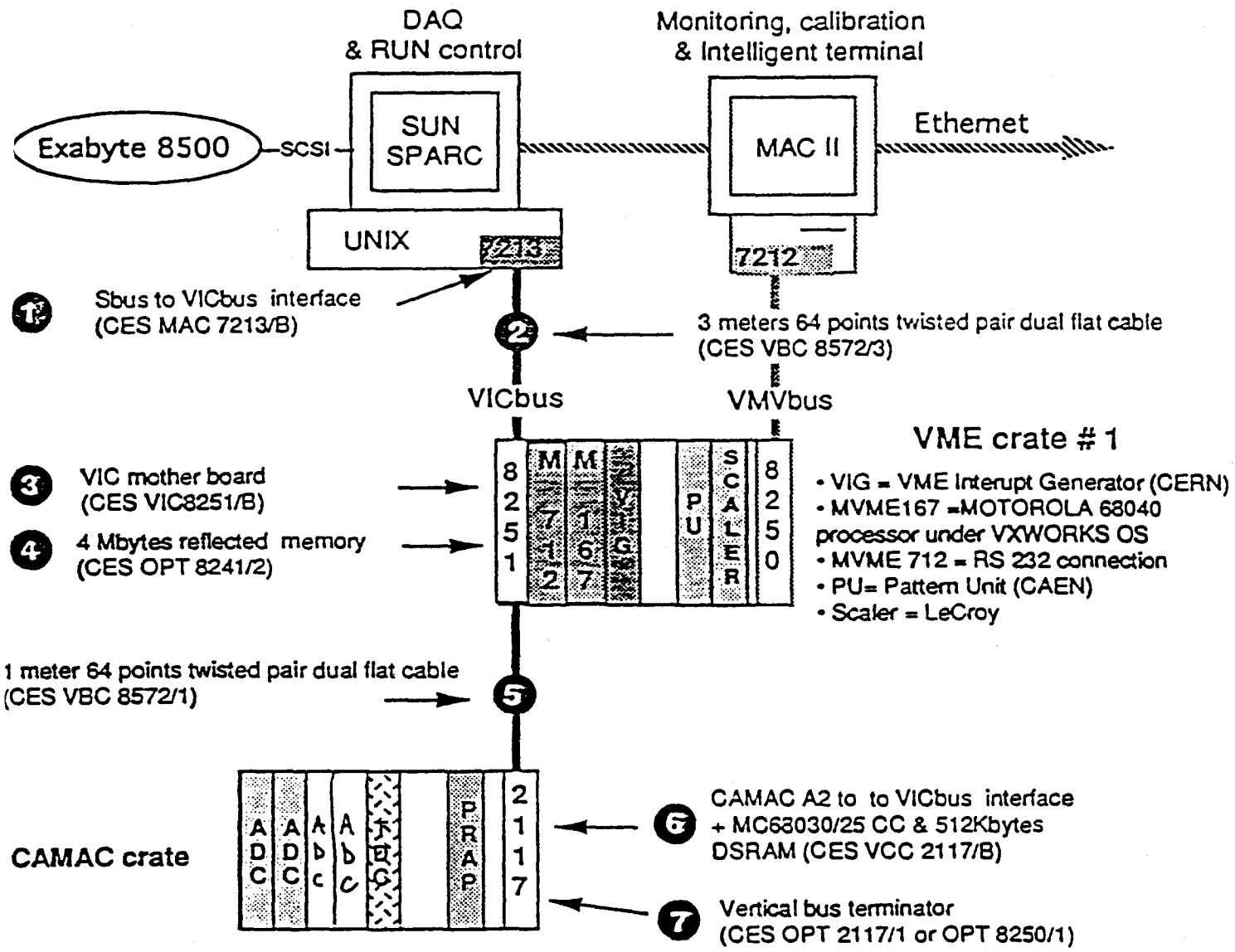
- Input connector
- ASIC#1 (Charge Integrator)
- Line Driver
- Output connector
- test pulse
- DC current calibration

- Input connector
- Line receiver
- ASIC# 2 (Shaper + GV + Comp.)
- Logic (Clock, ...)
- Trigger output
- Output connector to ADC ...
(Differential output..)

- Is CIA OK ?
- Other solution ?

ECEM & ShowerMax test @ BNL 1993 set-up
(LBL & Saclay)

Hardware Configuration



ELECTRONICS for CALORIMETER WEDGE
An Electronics Group Perspective*

SCOPE:

Summer 1993: cosmics, sources, laser
Summer 1994: + resolution measurements in beam

approximately:
100 channels low gain PMT
300 channels SMD photodetector

GENERAL PLAN for PMT's

Summer 1993:
- instrument all channels with "old-fashioned" readout
- instrument some channels with prototype digital PMT readout

Summer 1994:
- instrument all channels with full preproduction or prototype digital PMT readout

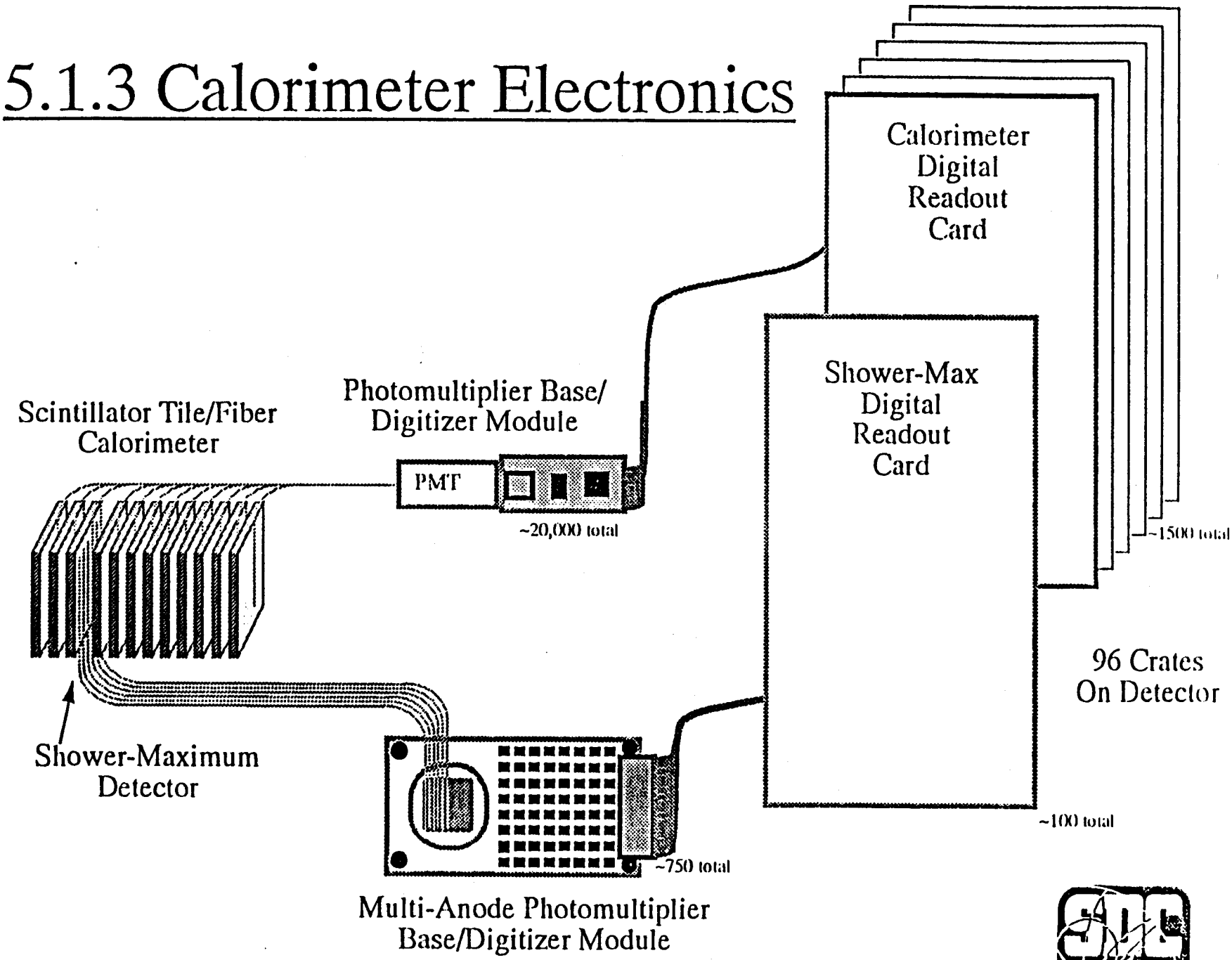
GENERAL PLAN for SMD:

Summer 1993:
- instrument 64 channels with traditional readout (same as ECEM)

Summer 1994:
- instrument all channels with traditional readout
- instrument 64 channels with prototype digital SMD readout

* to be designed jointly with Calorimetry Group

5.1.3 Calorimeter Electronics



ELECTRONICS FOR CALORIMETER WEDGE (continued)

"Old fashioned" readout of PMT's:

signal/source current monitor split at base

preamp (e.g.: NIM-based) at end of short cable
CAMAC charge integrating ADC (e.g.: 2249W)

scanning ADC to measure source current (e.g.: SAM)
HV supply with voltage monitoring (e.g.: COW+SAM)

1993 Digital PMT readout:

digital PMT base
- with full functionality
  - except calibration
- including Cockcroft-Walton HV
- prototype digitizer ASIC
- approximately 10 channels

existing bit pattern readout card
- may migrate to prototype readout card

power supply card
i/o register for control
SAM for HV readback

1994 Digital PMT Readout:

preproduction digital PMT base

preproduction or prototype readout card
- on SDC StandardBus

ELECTRONICS FOR CALORIMETER WEDGE (continued)

Common Electronics throughout Test:

SMD readout through CAMAC

Test pulse & calibration circuitry
Source and laser control circuitry

Beam logic
Misc. CAMAC, including beam conditions

TEM (Trigger Emulation Module)
Portable (?) DAQ

S. TERADA : KEK

Dec. 12, 1992

Muon Front-end Electronics

Development plan and

Prototype System Test

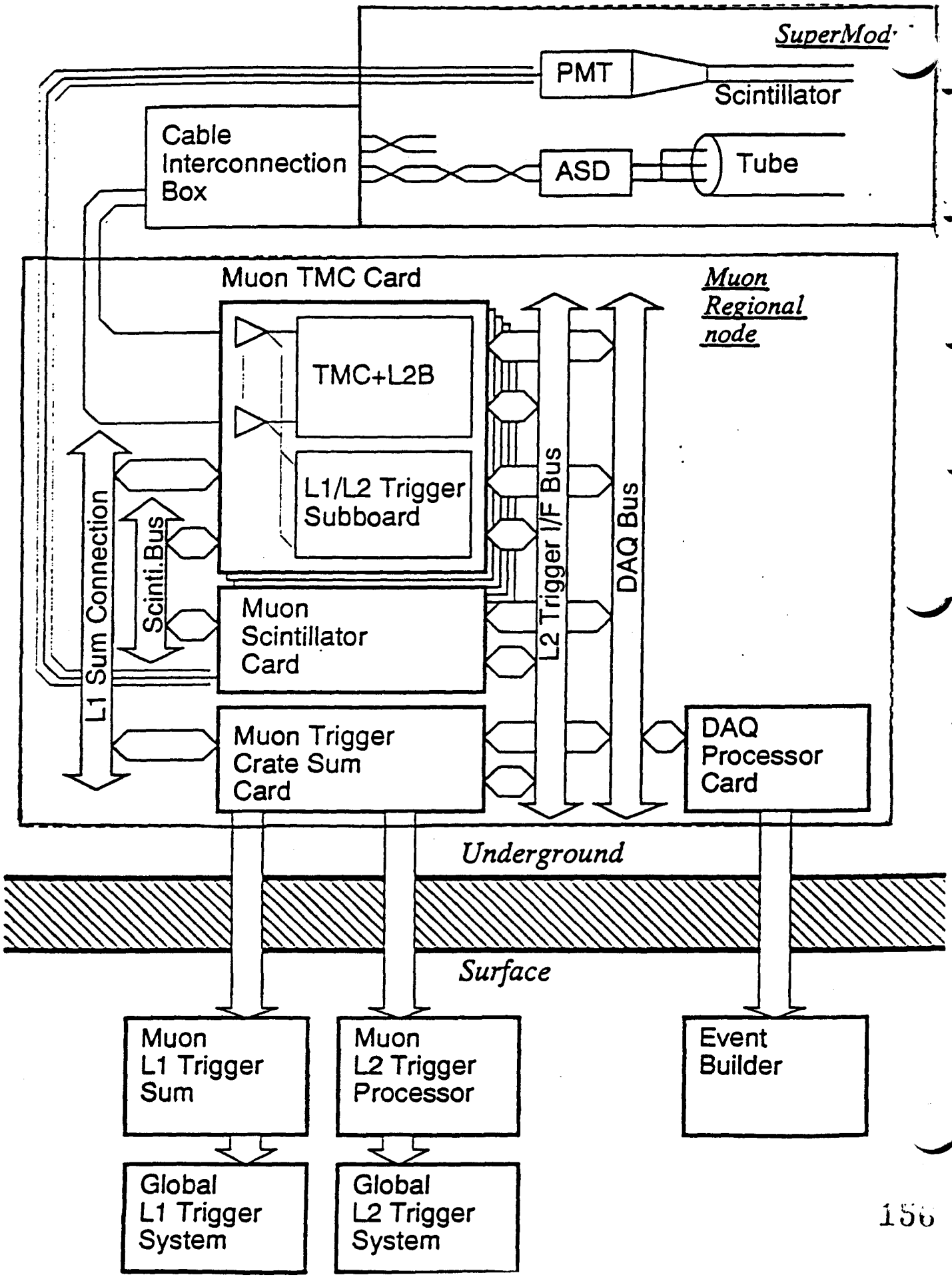
① Minitower Beam Test at KEK

Feb. 1993 ---

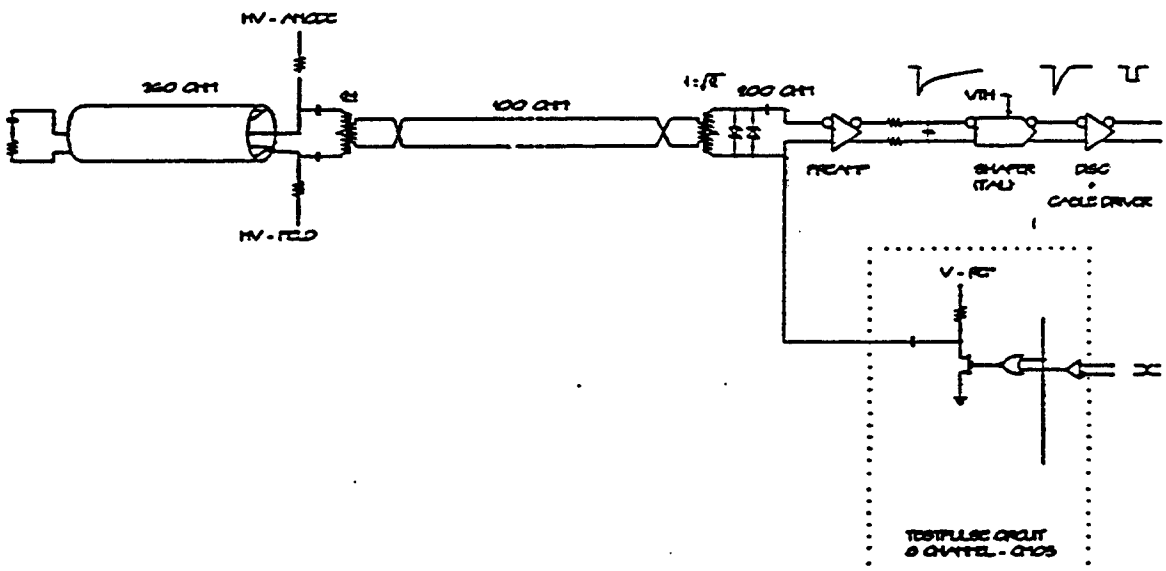
② Supertower Prototype : Cosmicray Test

Sep. 1993 ~ Mar. 1994

SDC Muon Readout & Trigger System

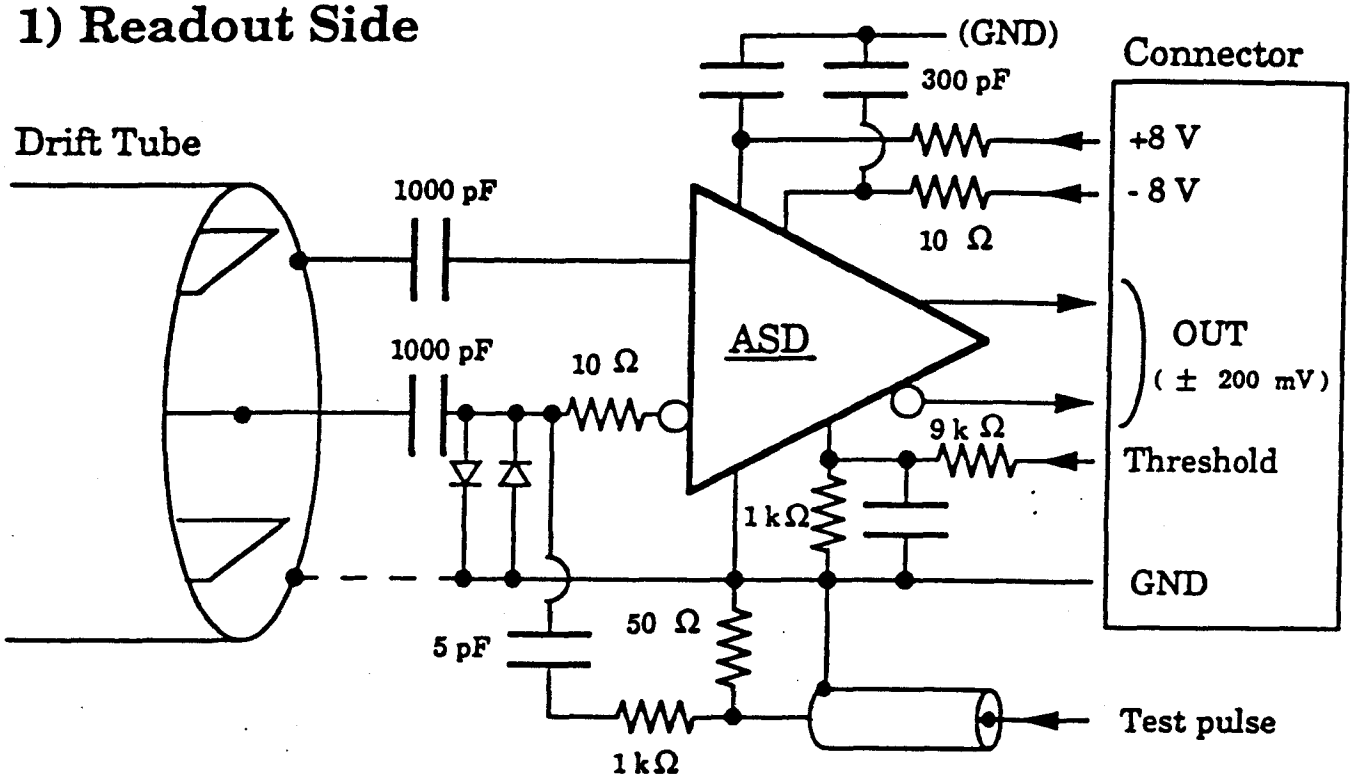


J.Oliver

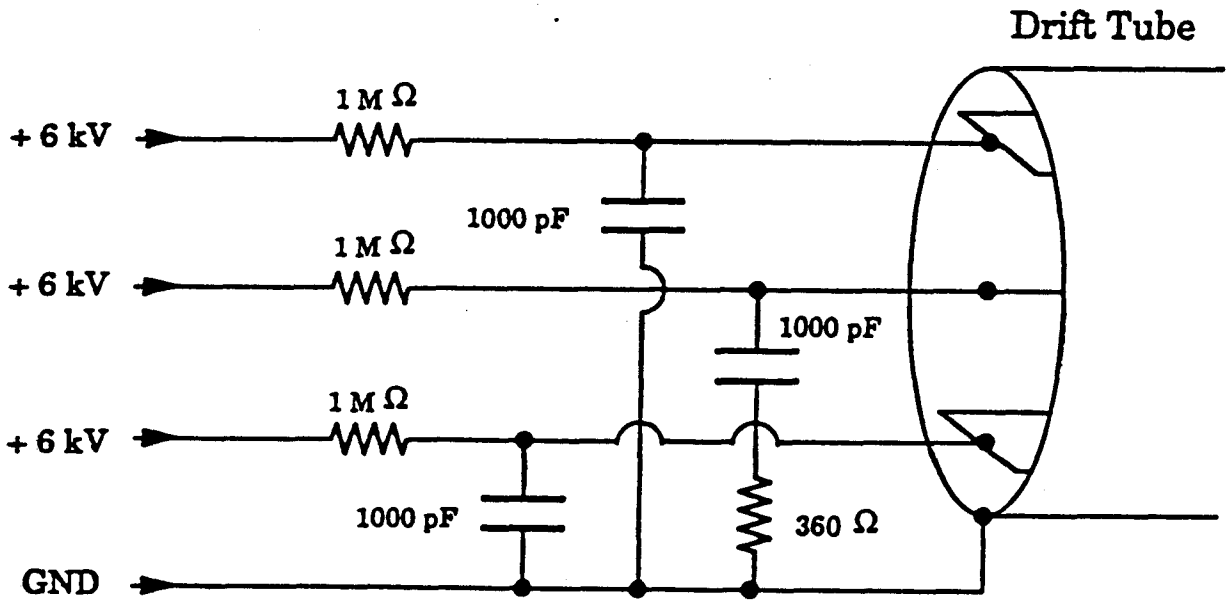

HV - ANODE
HV - FIELD
100 OHM
1:√2
100 OHM
VTH
PREAMP
SHAPER
(TAU)
DISC
+
CABLE DRIVER
V - REF
TESTPULSE CIRCUIT
8 CHANNEL - CMOS

On-tube parts (ASD card etc.)

1) Readout Side

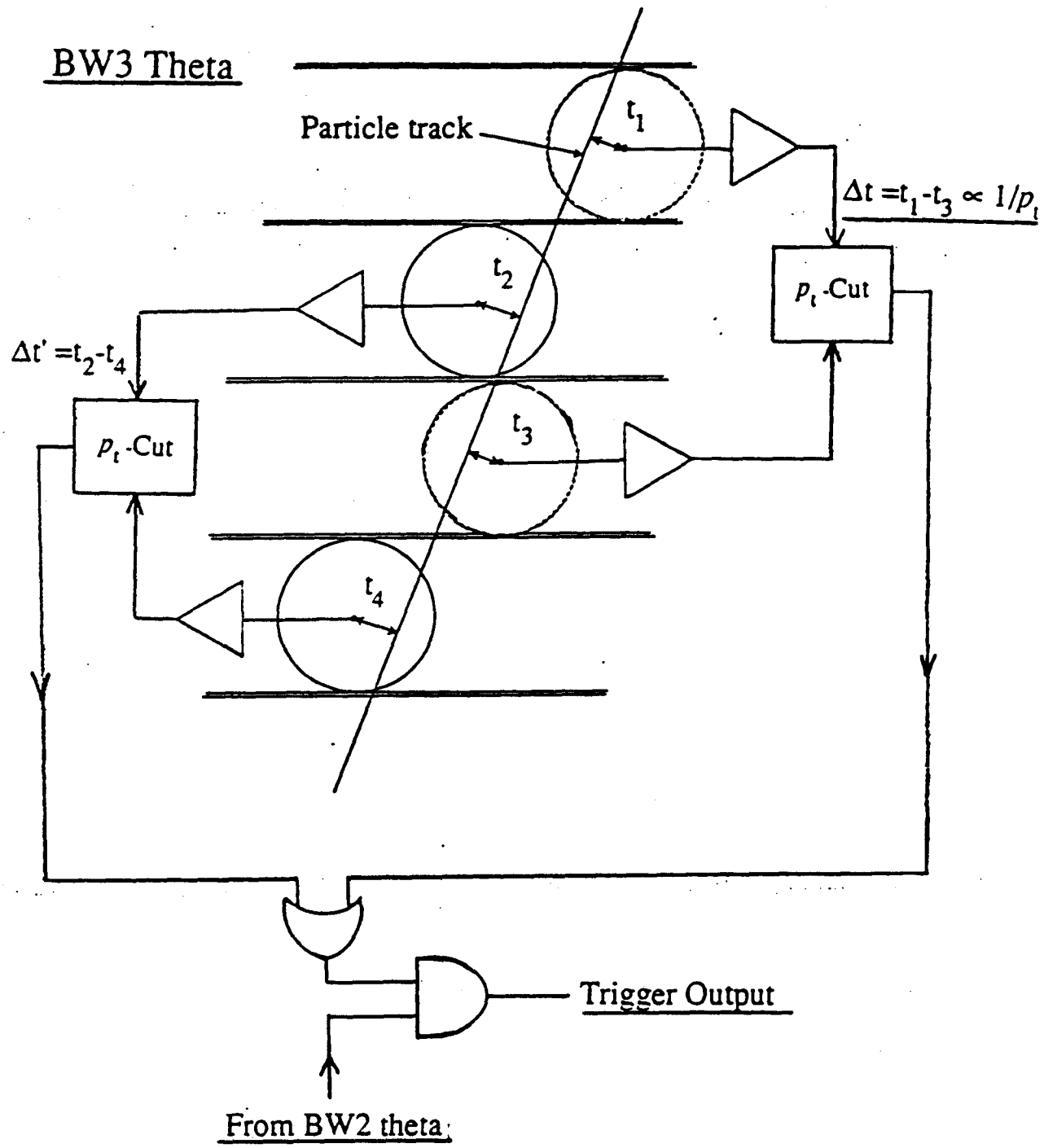


2) HV Side

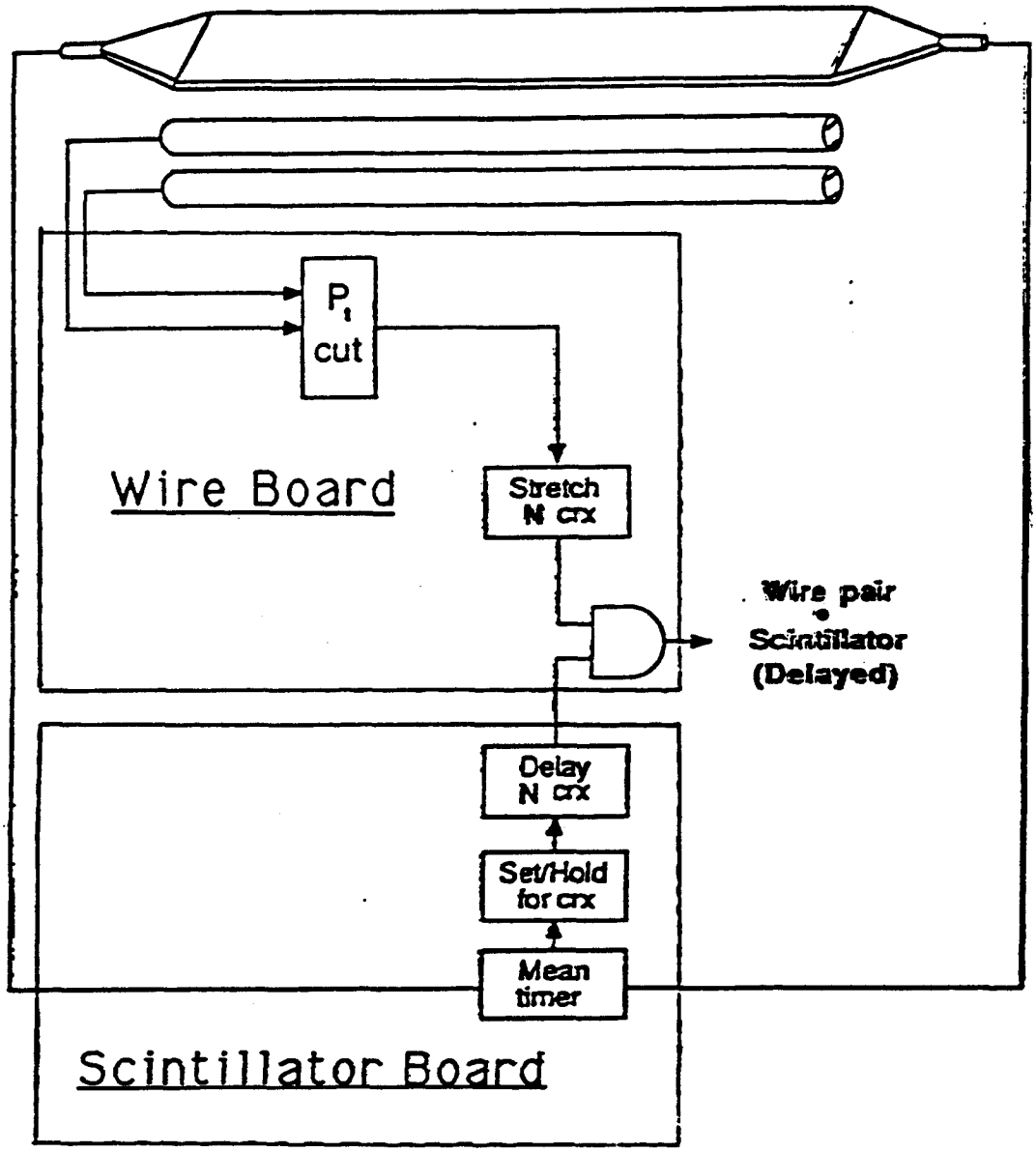


Drawing
H. Iwasaki
Sep. 26, 1992

Wir Chamber Trigger Concept



Muon Trigger Primitive



December 11, 1992
S. Terada;KEK

Mini-tower Beam Test at KEK-PS (T283)

Approved by PS-PAC at KEK held on Dec. 1-2, 1992

- Beam Time: Feb. 22-28, 1993
- Purpose:
  - i) Test of front-end electronics; Trigger, TMC, ASD
  - ii) Tube performance test; Spatial resolution Two track separation
  - iii) Test of DAQ based on VME
- Set-up:
  - 31 tubes and one scintillation counter
- Electronics:
  - Tube mounted hybrid ASD
  - TMC-CAMAC modules
  - Scintillator trigger module
  - Wire trigger modules
  - Trigger emulation module
  - VME-9u/6u Crate
- Portable DAQ system

H. Iwasaki

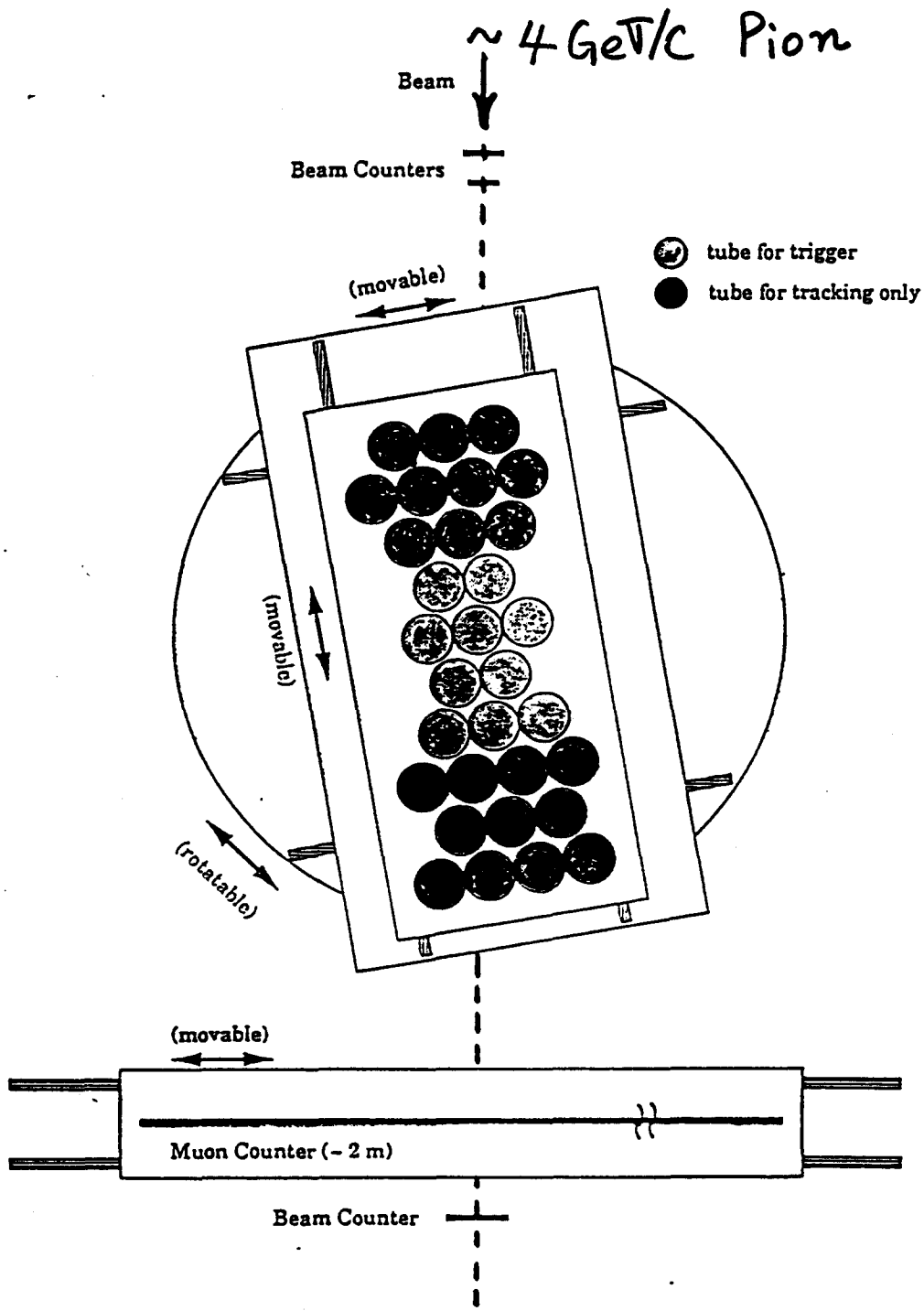
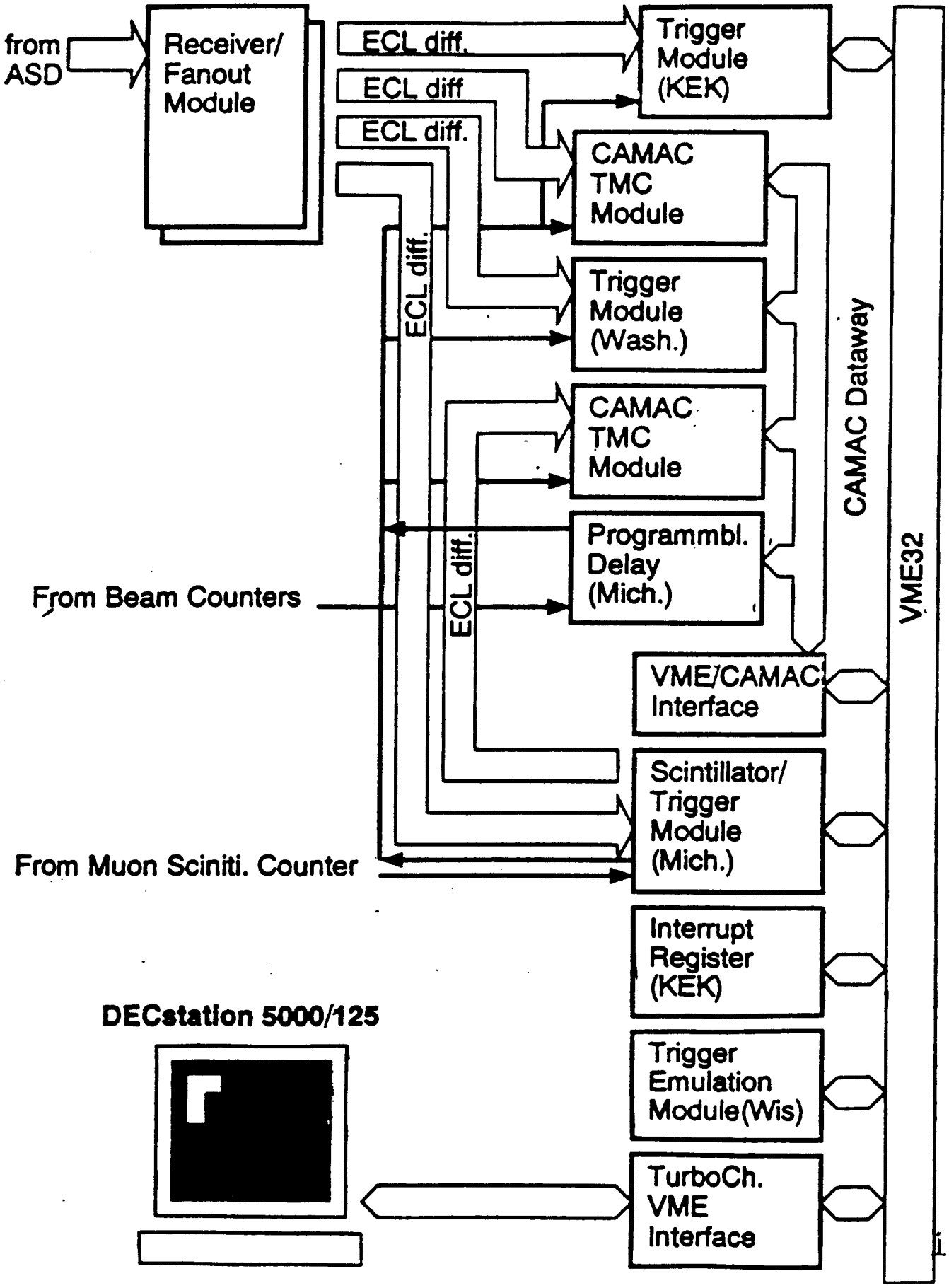


Fig.1 A schematic top view of the setup.

Minitower Trigger/Readout Module Setup

H. SAKAMOTO



Mini-tower Test Interconnects

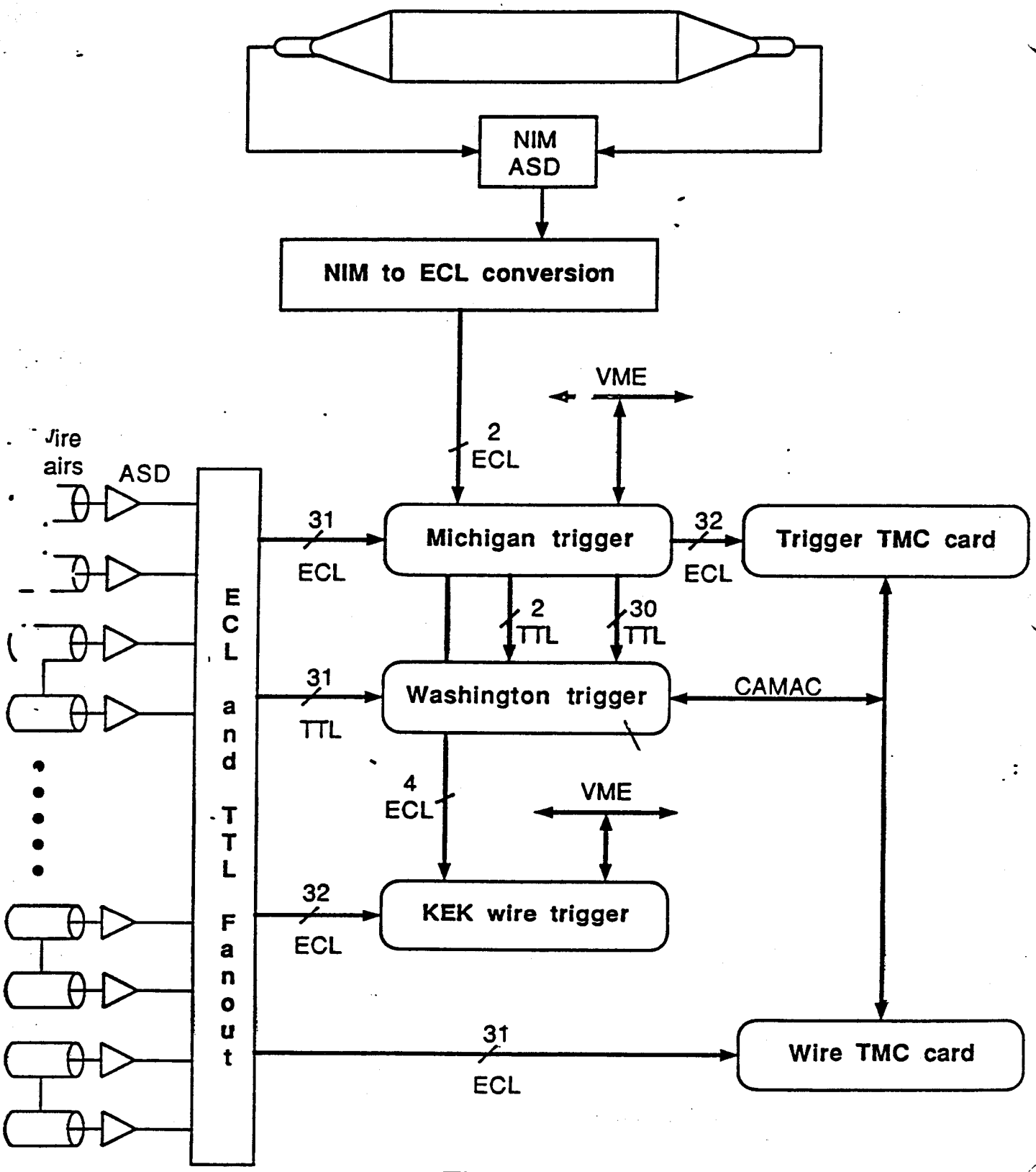
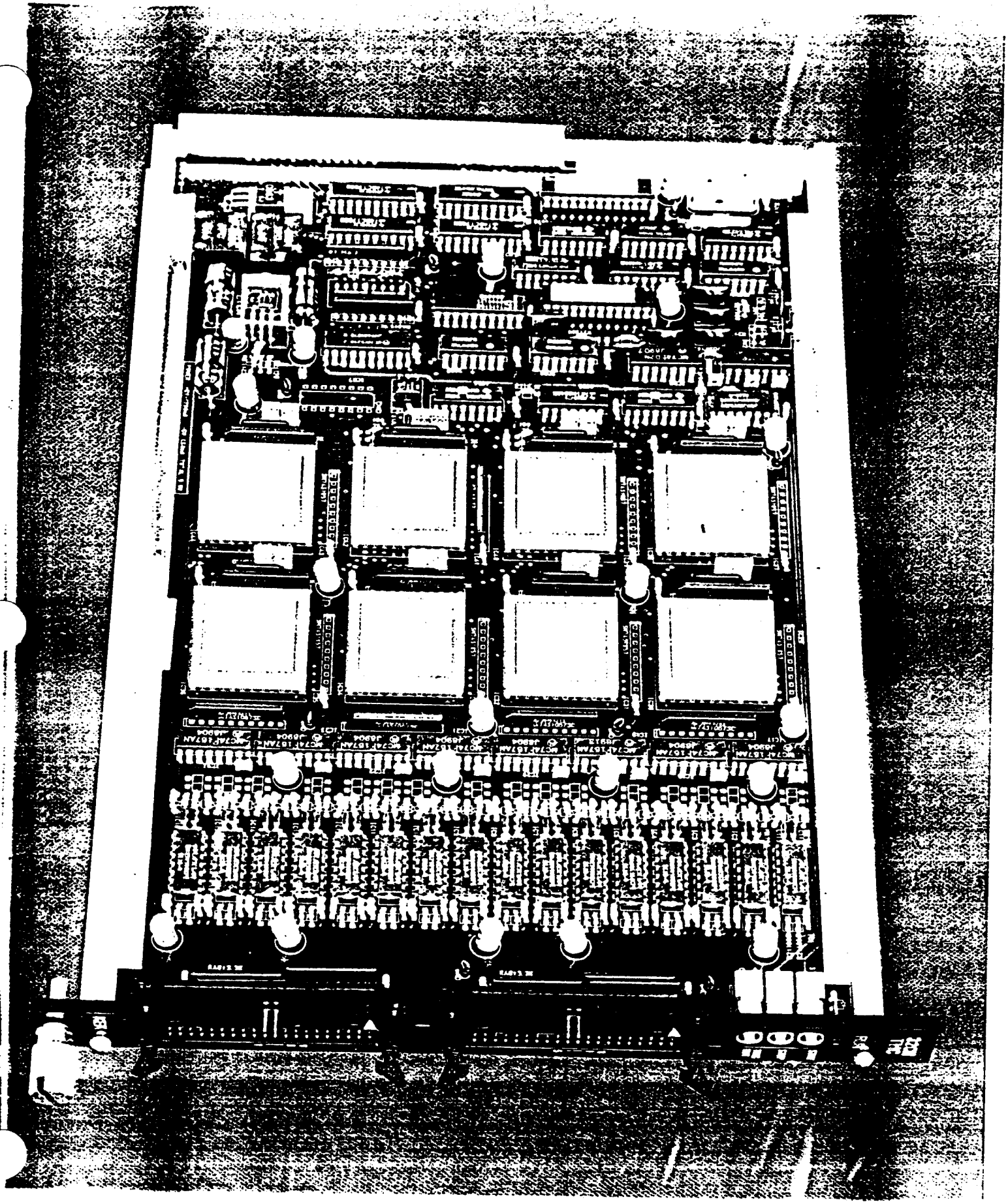


Figure 1



CAMAC-TMC Module (32 ch.)

Nickerson

SI & GMD F/E "DAG/L2"

- UNSERVICABLE [DIAGNOSTICS OF LIMITED VALUE]
- LOW POWER (20μW → 40μW)
- LOW MASS (Si area)

→ HIGHLY IIe
→ REDUNDANT

} CHIP FAILURE RATE NOT KNOWN

- LOW SOFT FAILURE RATE

10μs DRIVES BOTH BANDWIDTH & R/C SCHEME

- R/C AFTER L-1

100kHz <L1>
10 MRad, 10^{14} n/cm²
⋮

TAKE ADVANT OF 4 SPACES BETWEEN TRIG.
4μs → 250 (USE 6 INTERNAL)
SYST. TALKS TO CUSTOM DET

SB

Choose:

i) Minimise copper/aluminum tracery

ii) Make architecture insensitive to choice of DAT [1st order]

iii) SINGLE "ELEMENT" FAILURE SAFETY [CHIP, LINK]

iv) NO SEPERATE DAQ CHIP

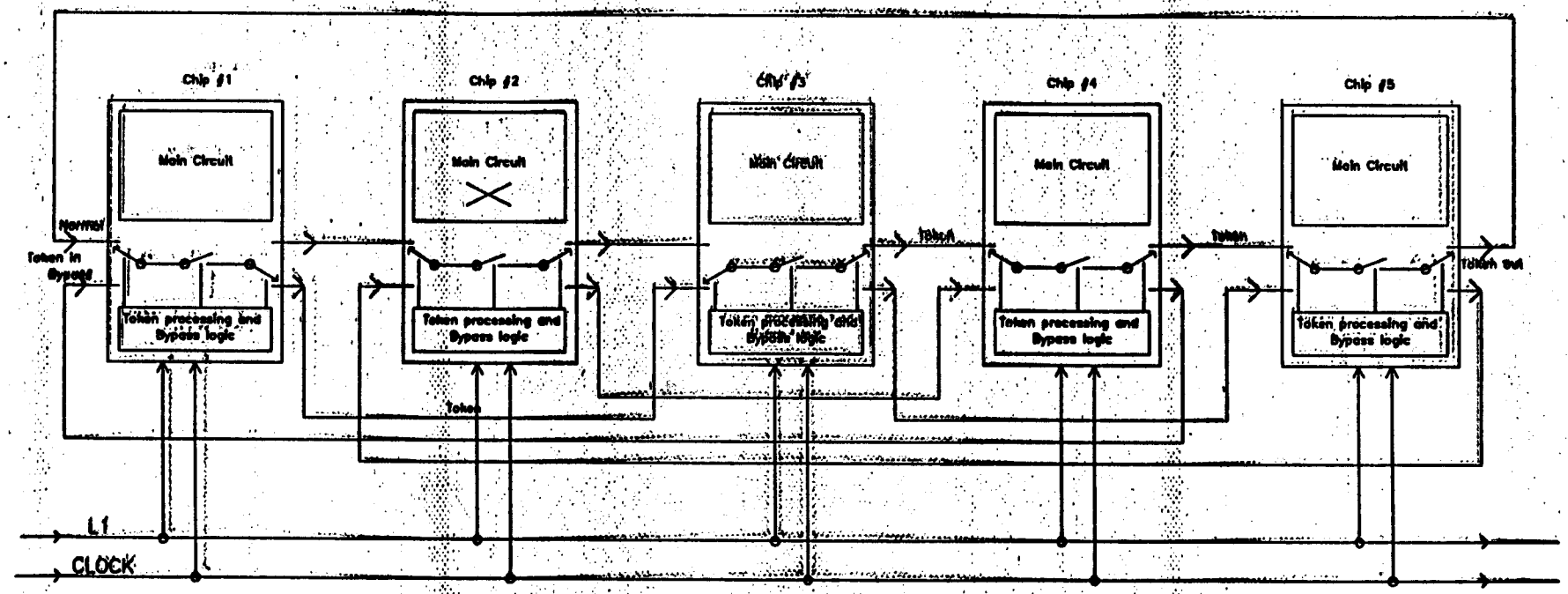
→ • GROUPS OF CHIPS SERVED BY SERIAL LINK

• ENCODE CTL COMMANDS ON L-1

→ • SERIAL LOOPS [5 chips]

• 11ℓ CLK, L-1 DUPLICATED (no driven bus)

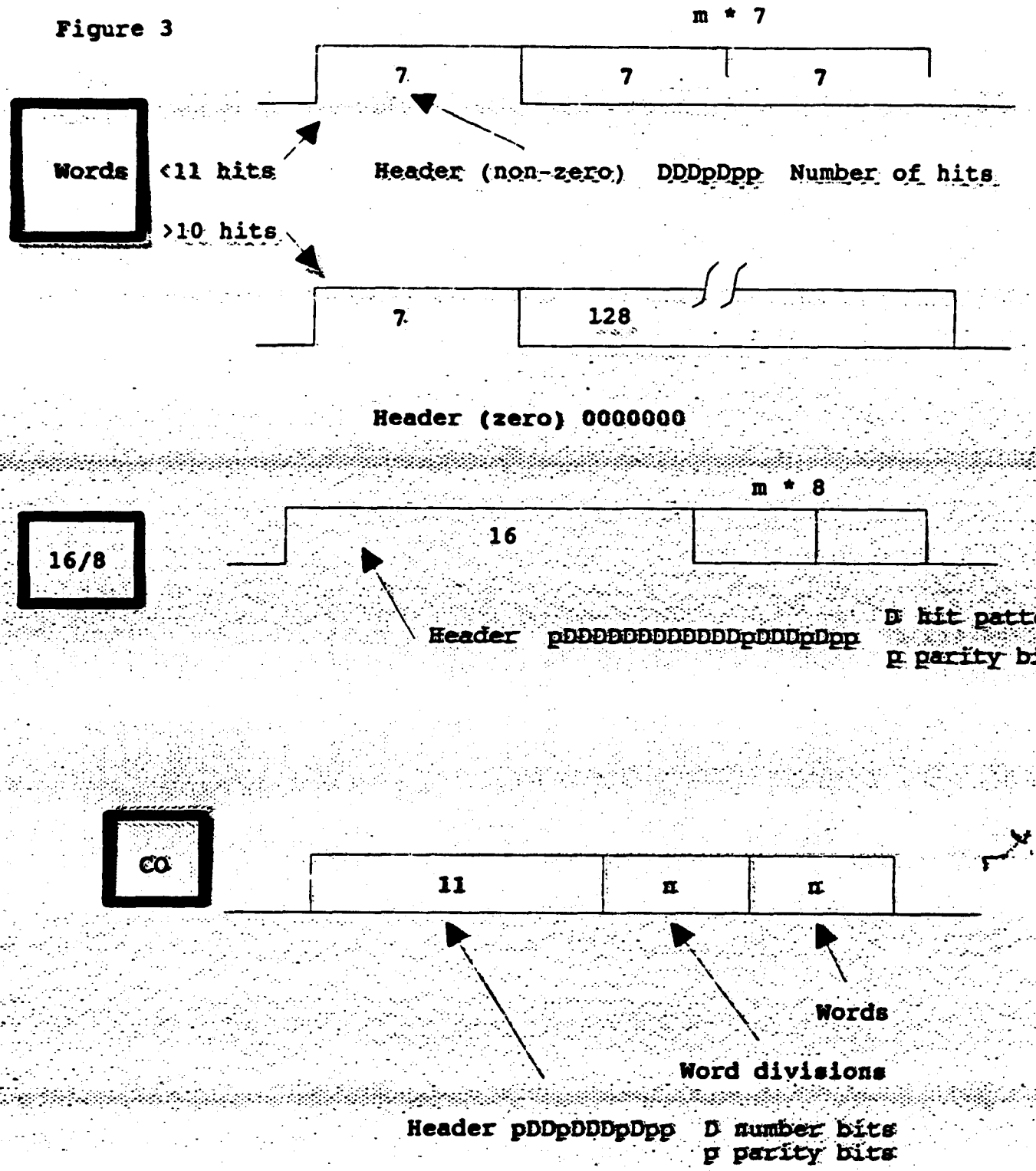
• PAIRS OF LOOPS CONFIGURED TO ALLOW SHARING OF SERIAL LINKS



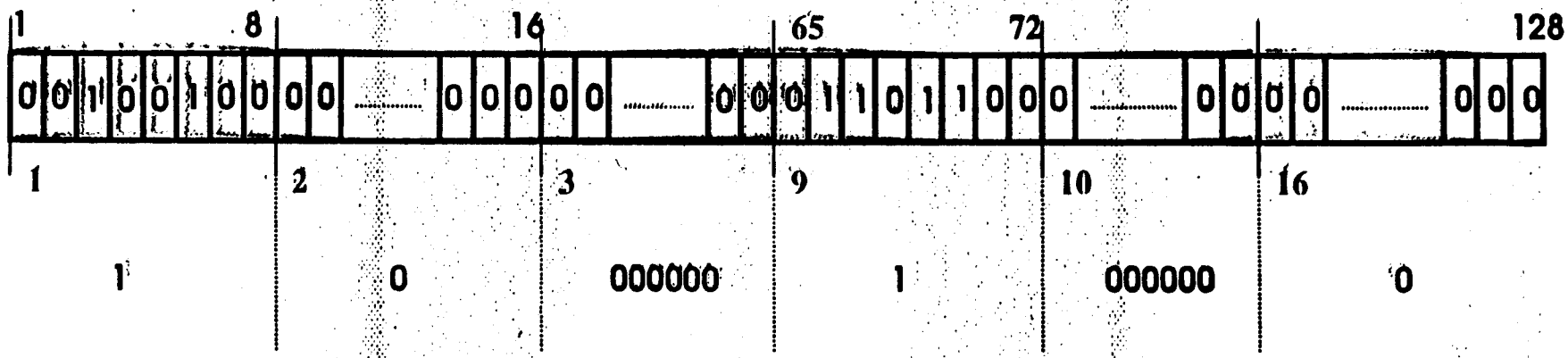
Failed circuit bypass scheme

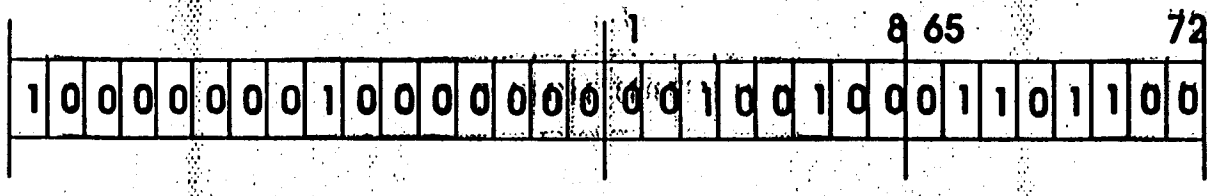
Fig. 14

Figure 3


m * 7
7
7
7
Words
<11 hits
Header (non-zero) DDDpDpp Number of hits
>10 hits
7
128
Header (zero) 0000000
m * 8
16/8
16
Header pDDDDDDDDDDDDpDDDpDpp
D hit pattern
p parity bits
CO
11
n
n
Words
Word divisions
Header pDDpDDDpDpp D number bits
p parity bits

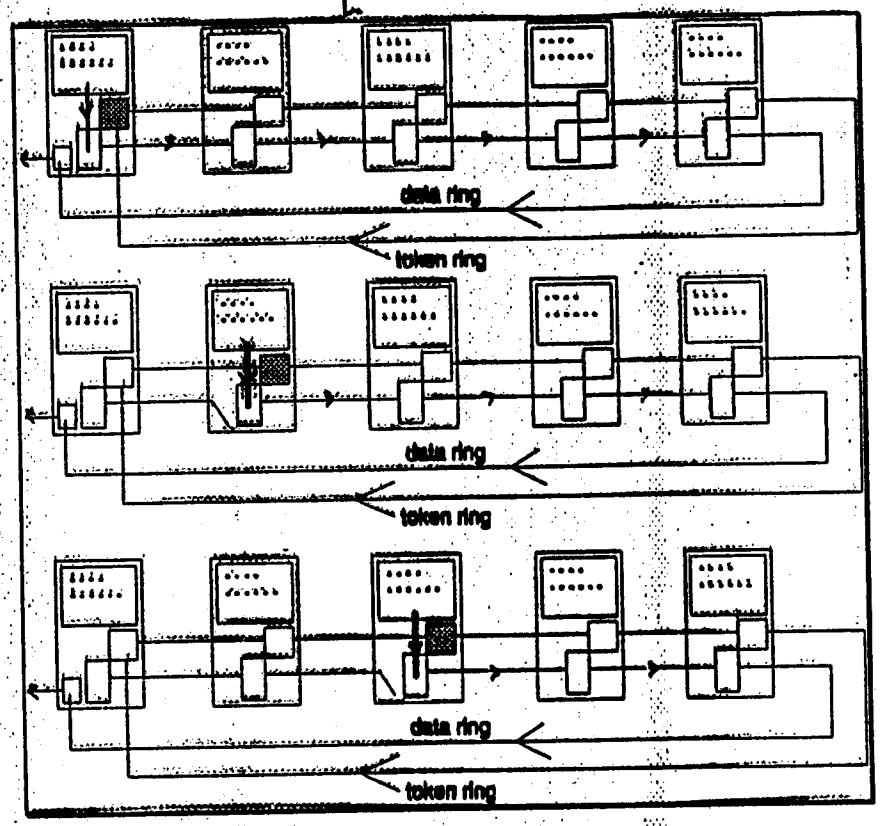
16/8 Data Compression.



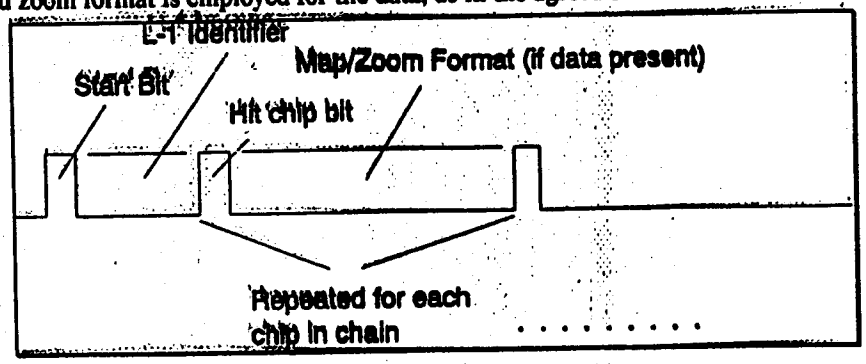


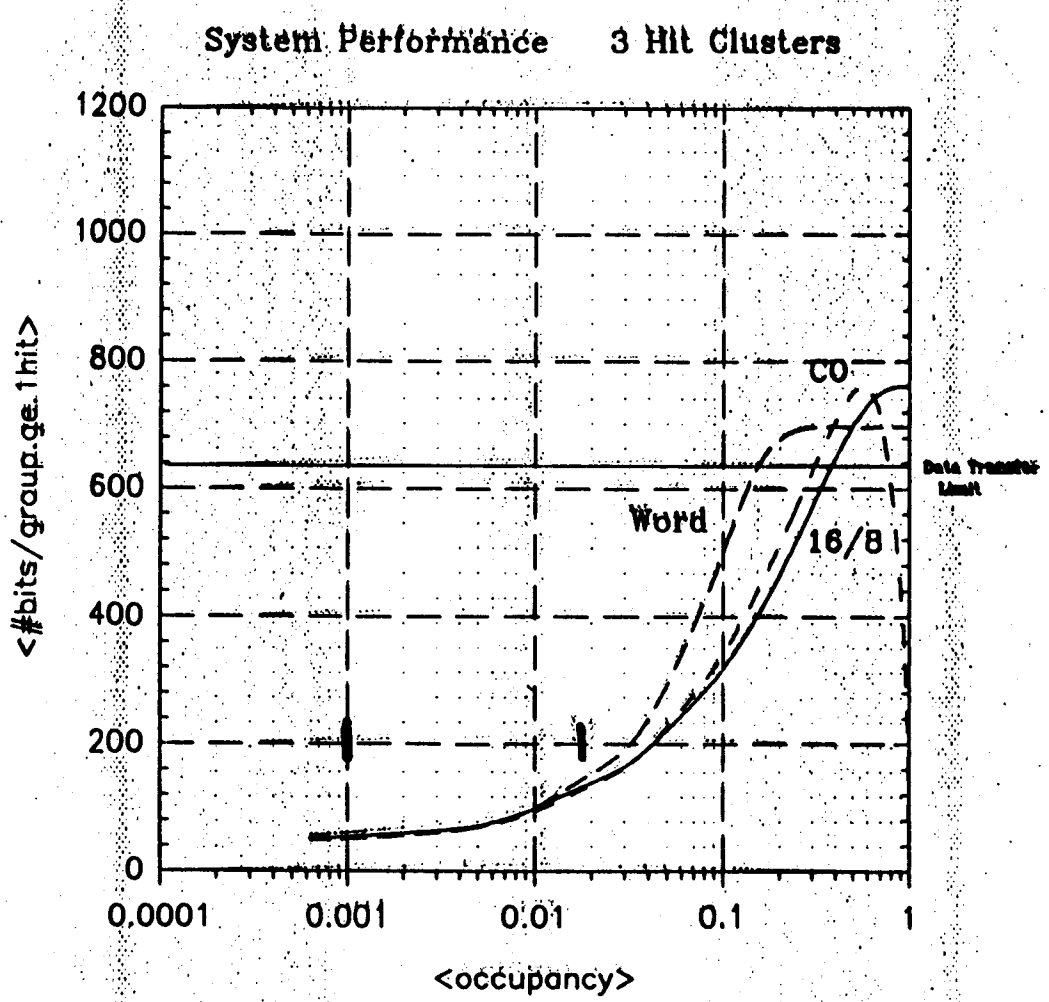
know its location etc.. It is prop[illegible]
proposed by A.Dorenbosch.

In response to a L-1, the master passes a token round the ring. The data ring is clocked continuously. The chip in possession of the token places its data into the serial data loop, breaking the ring connection from the previous chip in the ring.



The new format is shown below. It consists of a header, generated by the master, which is the start bit plus a four bit L-1 identifier plus Hamming code. Following this each chip in turn places data into the stream. When a chip gets the token, it first places a bit (plus Hamming code) into the data stream which indicates if it has any hit data. If not, it passes on the token with no further data transfer. If there is hit data, then a 16/8 map and zoom format is employed for the data, as in the agreed scheme.

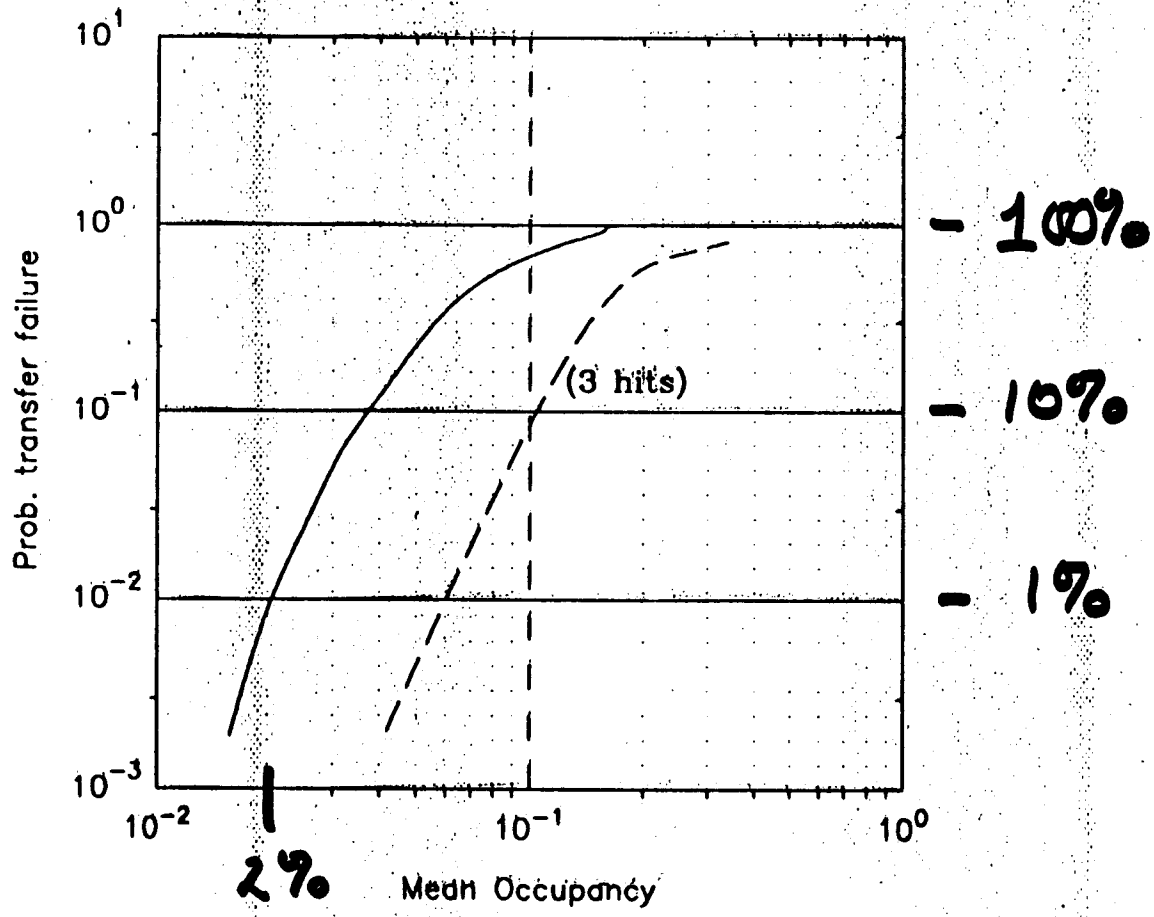



System Performance 3 Hit Clusters
1200
1000
800
600
400
200
0
<#bits/group.ge.1hit>
0.0001
0.001
0.01
0.1
1
<occupancy>
CO
Word
16/8
Data Transfer Limit

TRIG ONLY

DATA ALWAYS OK

Probability of failing to transfer the data inside 640 clock cycles for 16/8 1 hit data



for 100kHz L-1 rate

FIG 11

the input data. Each of these can be mapped into one bit in a 16 bit fixed length string. Each bit of this string is the logical OR of all 8 inputs of the corresponding cluster.

The 16 bit map string is transmitted first. Generation of this string can be done in one clock cycle as it involves only OR gates. While this string is being transmitted, scanning of the 16 bits is done. Scan and scan controller are the same as discussed in the previous two schemes. If any bit is found set, the corresponding 8 input bits of are directly loaded into the serializer. No data buffering is required before serialization in this scheme.

Comparison of schemes :

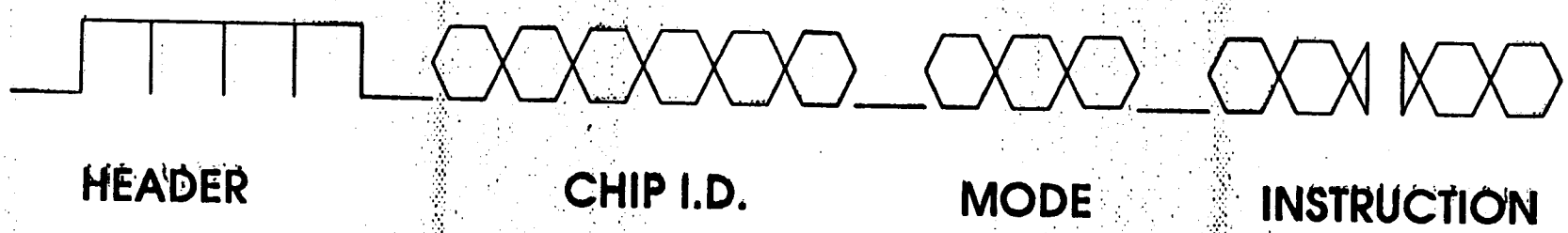
	CO	WORD	16/8
Complexity	High	Moderate	Low
Total no. of gate used (data compression only)	4420	1229	230
Intermediate Data buffering.	required	required	Not required
Time required before first bit is transmitted.	Long (Max. upto 128 clock)	Medium (Max. upto 30 clock)	Much less than other schemes. (1 clock)

Conclusion

The hardware simplicity of the 16/8 scheme makes it highly attractive. The delay in data preparation is one clock cycle and its performance is comparable to the *Words* scheme at higher occupancies. It is only at these higher occupancies that system performance is questionable (figure 9), at the low occupancy end, where the *Words* scheme is clearly better, the 16/8 system is also more than adequate.

The hardware complexity of the *CO* scheme makes it highly unattractive; furthermore there are essentially no relevant occupancies where it performs significantly better than the other two schemes.

Level 1 line : Instruction formatt.



SOFT ERROR CORRECTING

EXTERNAL SYSTEM

a) USES START BIT TO TRIGGER READ-IN

b) CHECKS L-1 ID IS SEQUENTIAL (IGNORES SINGLE BIT SINGLE OUT-OF SEQUENCE)

c) CHECKS "HIT CHIP" & "HIT MAP" FOR BIT ERRORS → CORRECTS SINGLE DETECTS DOUBLE

SYSTEM FAILURE

a) START MISSING OR SPURIOUS

b) "CHIP HIT" OR "MAP" MISINTEPRETED

c) ≥ 1 BAD L-1 ID OR
> 1 BAD BIT IN L-1 ID

→ UNRECOVERABLE SOFT ERROR

IC CHIP STRING → 1280 test channels
$\sim$ 0.02 % of system

RESET

STOP L-1 TRIGS FOR $> 4\mu s$ (256 CLKs)
ISSUE RESET STRING (16 CLKs)
RESTART L-1

~ 270 LOST

$5\mu s$ DEAD TIME

LIMIT SDC to 0.5% → .05% FOR Si (?)

SO $\frac{5\mu s}{T^{-1}} = 5 \times 10^{-4}$ $T = 100/\text{sec}$

T – maximum reset rate

SOURCES OF RESETS

TAKE $\varepsilon = 10^{-10}$

START BIT 10^4 fibres 6.3 MHz
→ 6.3×10^{11} bit/s

fakes $= 6.3 \times 10^{11} \varepsilon = 63/s$

⇒ use double bit → $6.3 \times 10^{-7}/s$

L-1 10^3 @ 6.3 MHz → 6/s

- **L-1** 6/sec

THIS ERROR IS UNDETECTABLE IN CURRENT FORMAT

→ REGULAR RESETS

1/100ms

- **CLK** (Internal counters lost)

10^3 @ 63MHz → 6/s

also data shifting

↳ small fraction of cycles but long (~20) strings

→ ~ 10/s

≃ 16/s WORSE W/ OCCUPANCY

DATA STREAM

L-1 ID 100kHz * 10^4 * 5 bits

→ 5×10^9/s

→ 0.5 errors/sec

but single bit corrected → negligible

CHIP HIT

similarly → 3/sec

but Hamming attached → negligible

MAP similarity → 10/s

Hamming → negligible

ZOOM Ignored

SUMMARY

100/s ¾ MAX

63	START	INSIDE → OUT
1/2	L-1 ID	
3	CHIP HIT	→ NEGLIGBLE USING ERROR CORRECTING CODES
10	MAP	

16	CLK	OUTSIDE → IN
6	L-1	

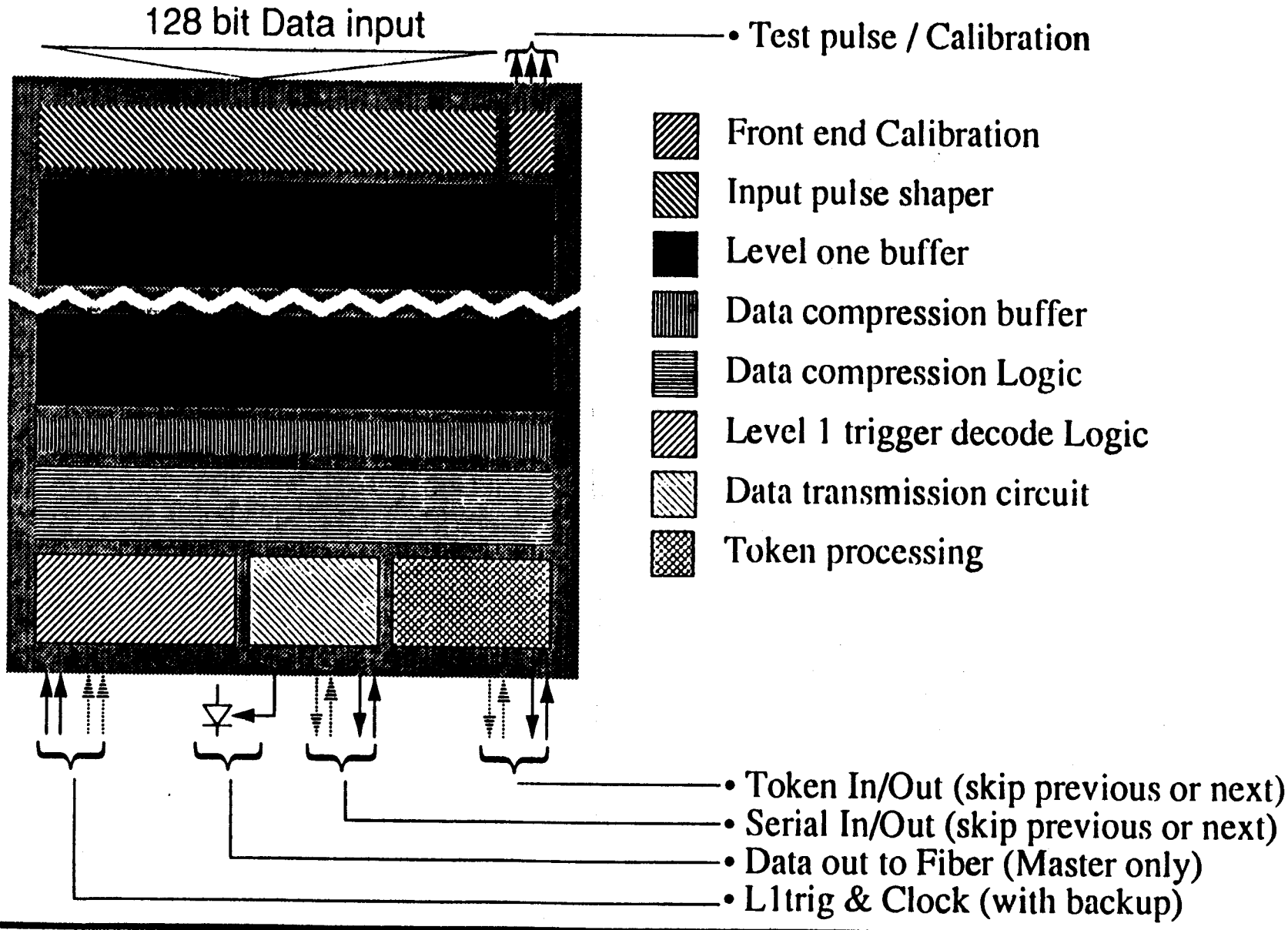
↓

MAKE $\varepsilon < 10^{-10}$!

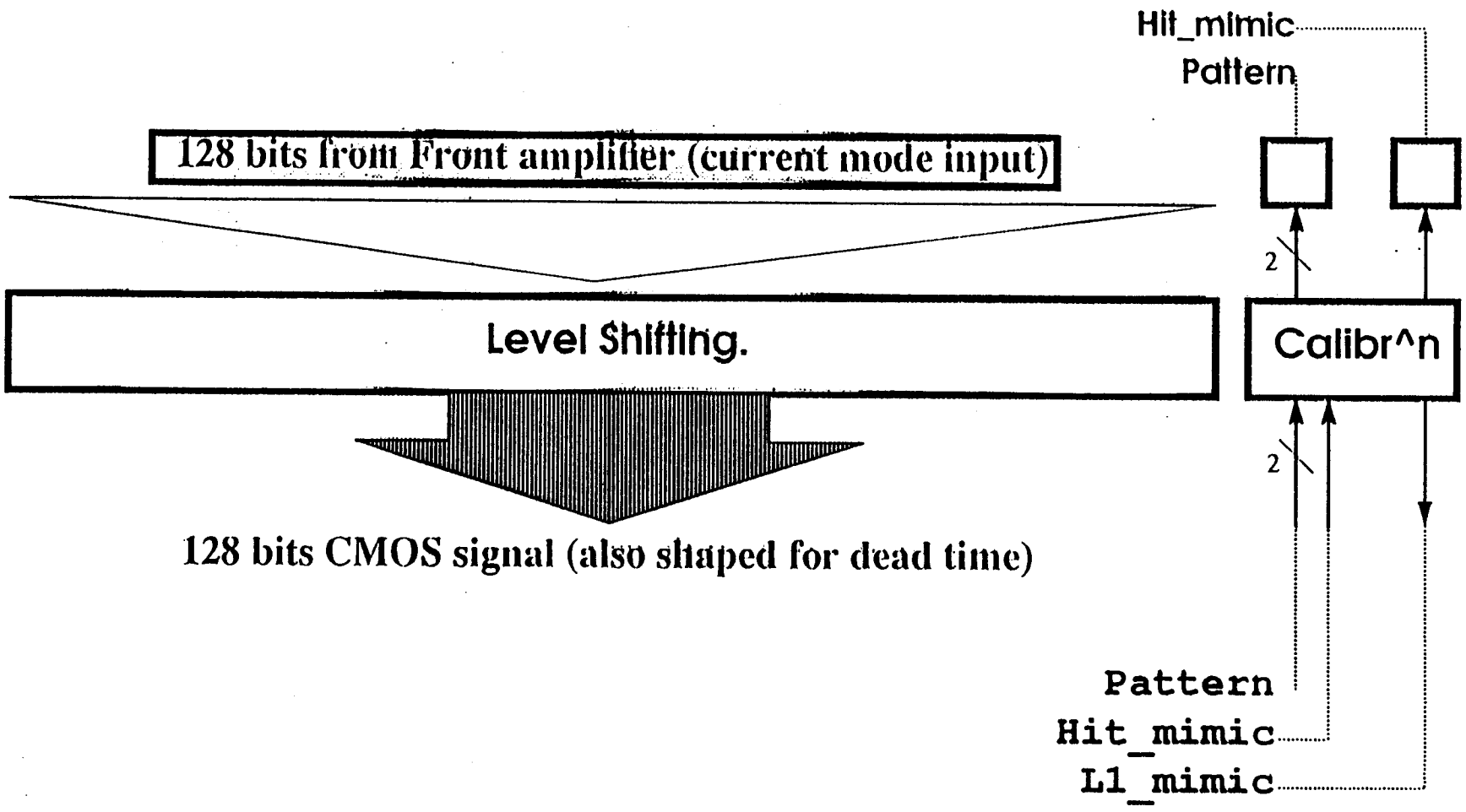
RESETS @ > 1E Hz

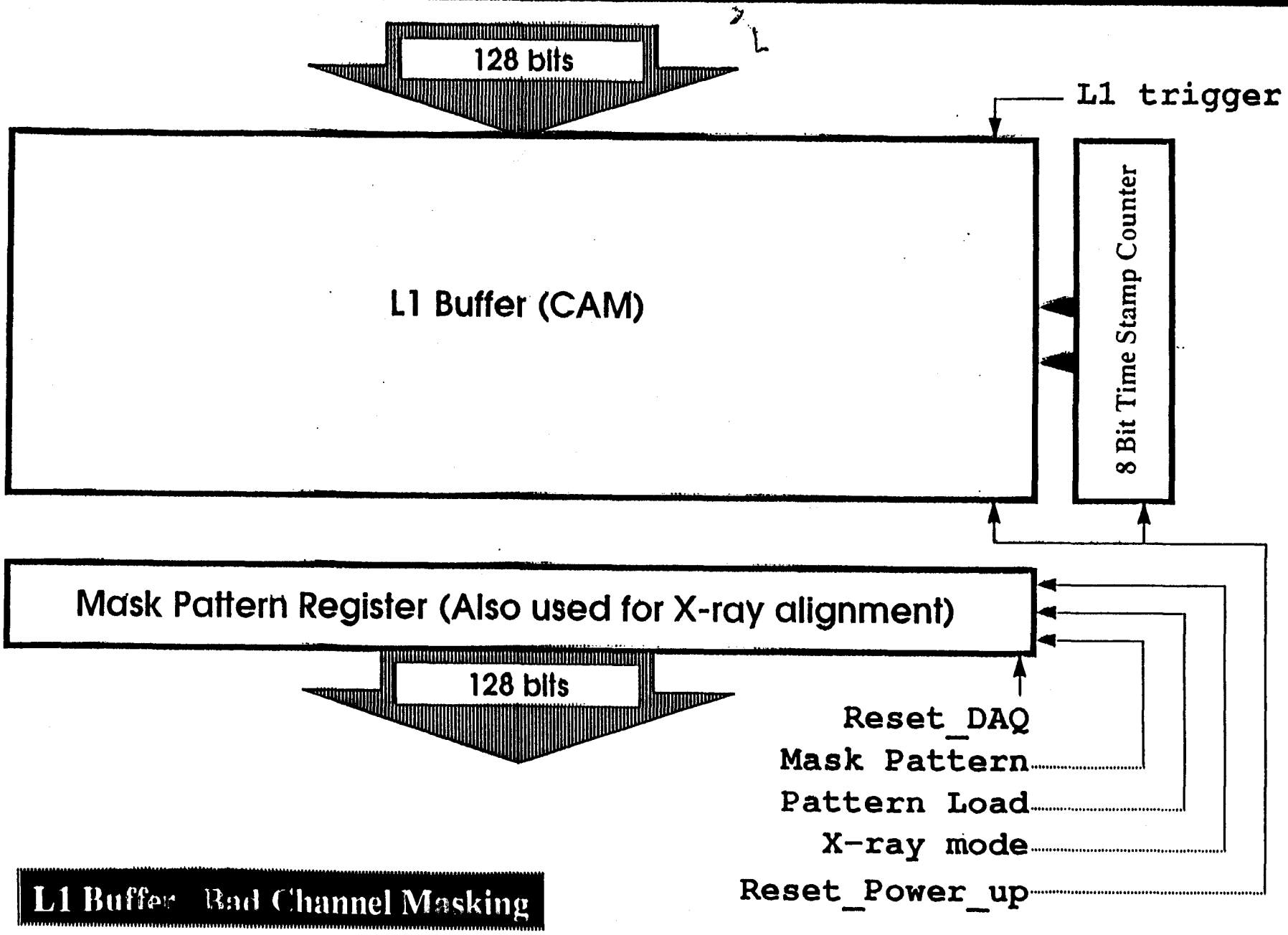
ALL ASSUMES GAUSSIAN ERRORS

FLOORPLAN OF A READOUT CHIP.

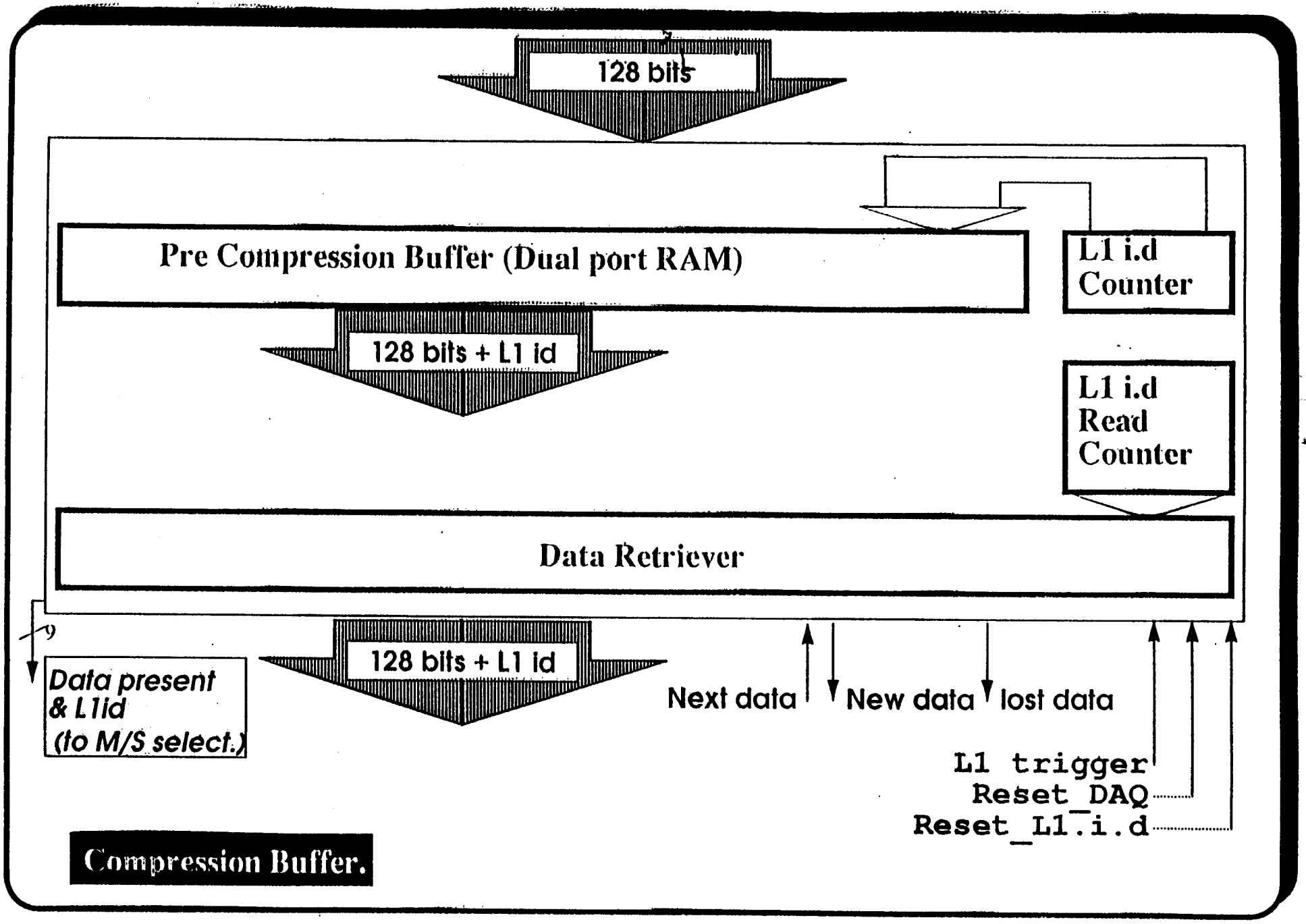


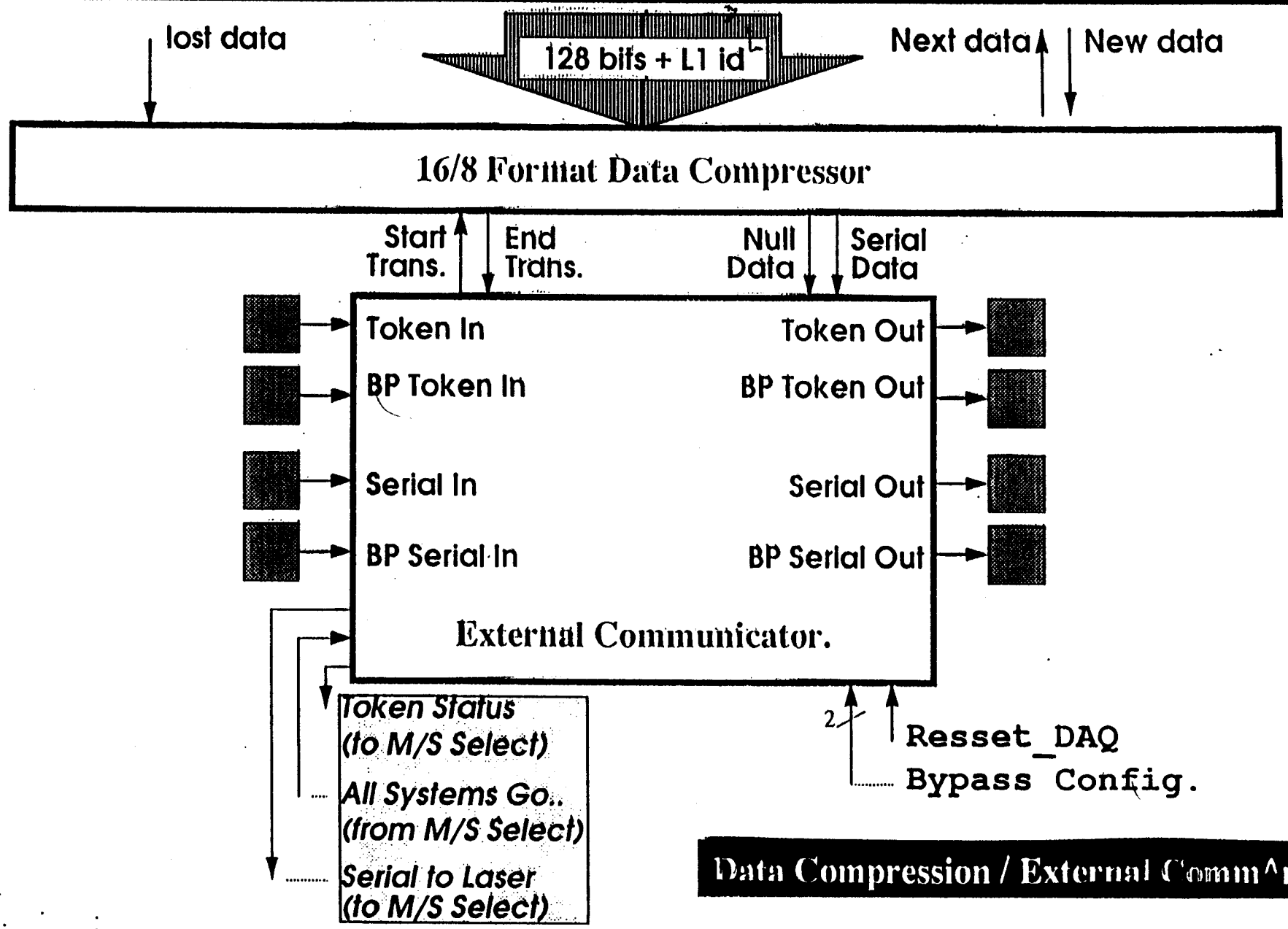
Pulse shaping / Calibration.



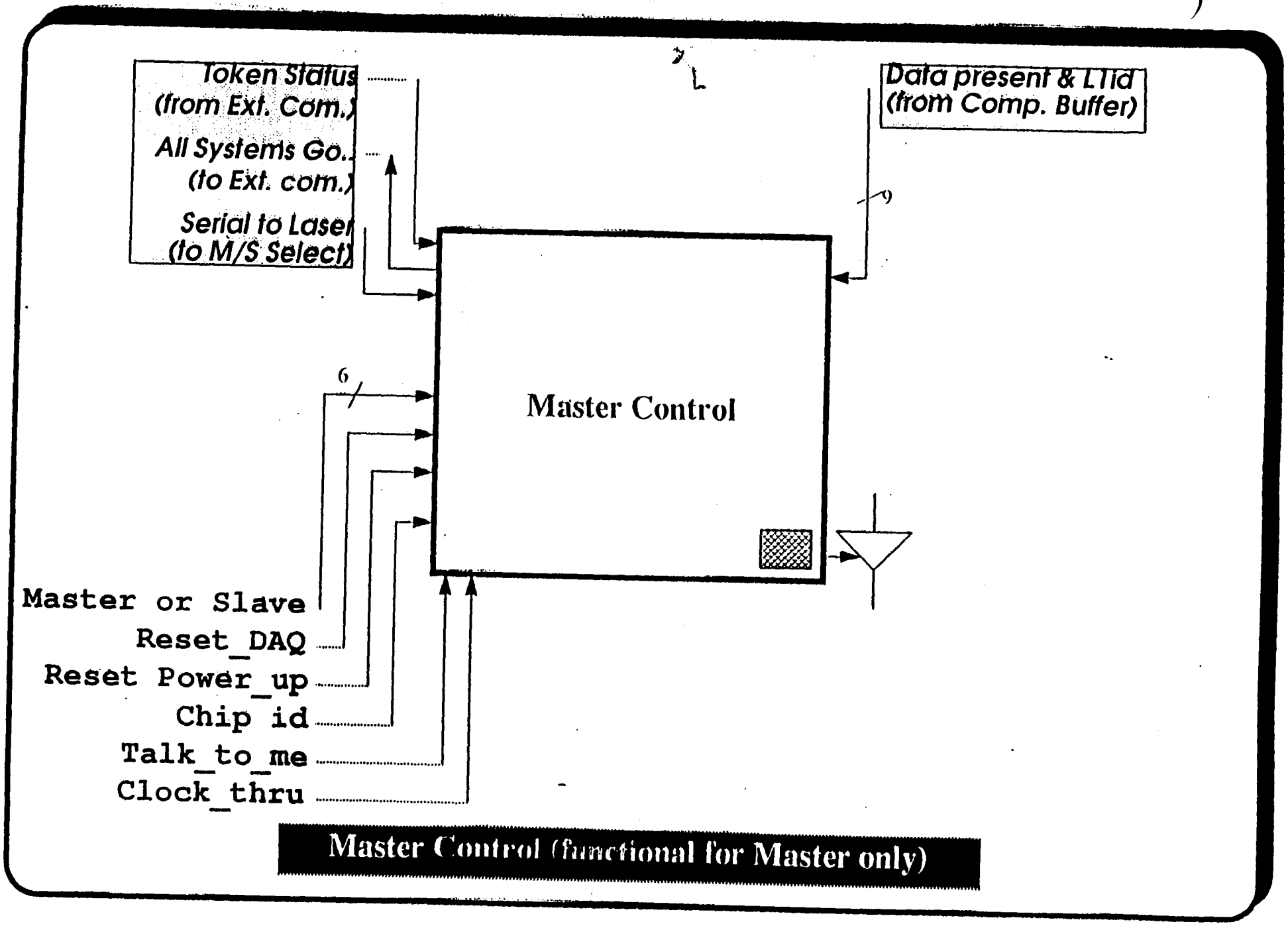


L1 Buffer Bad Channel Masking


128 bits
Pre Compression Buffer (Dual port RAM)
L1 i.d Counter
128 bits + L1 id
L1 i.d Read Counter
Data Retriever
9
Data present & L1id (to M/S select.)
128 bits + L1 id
Next data
New data
lost data
L1 trigger
Reset_DAQ
Reset_L1.i.d
Compression Buffer.

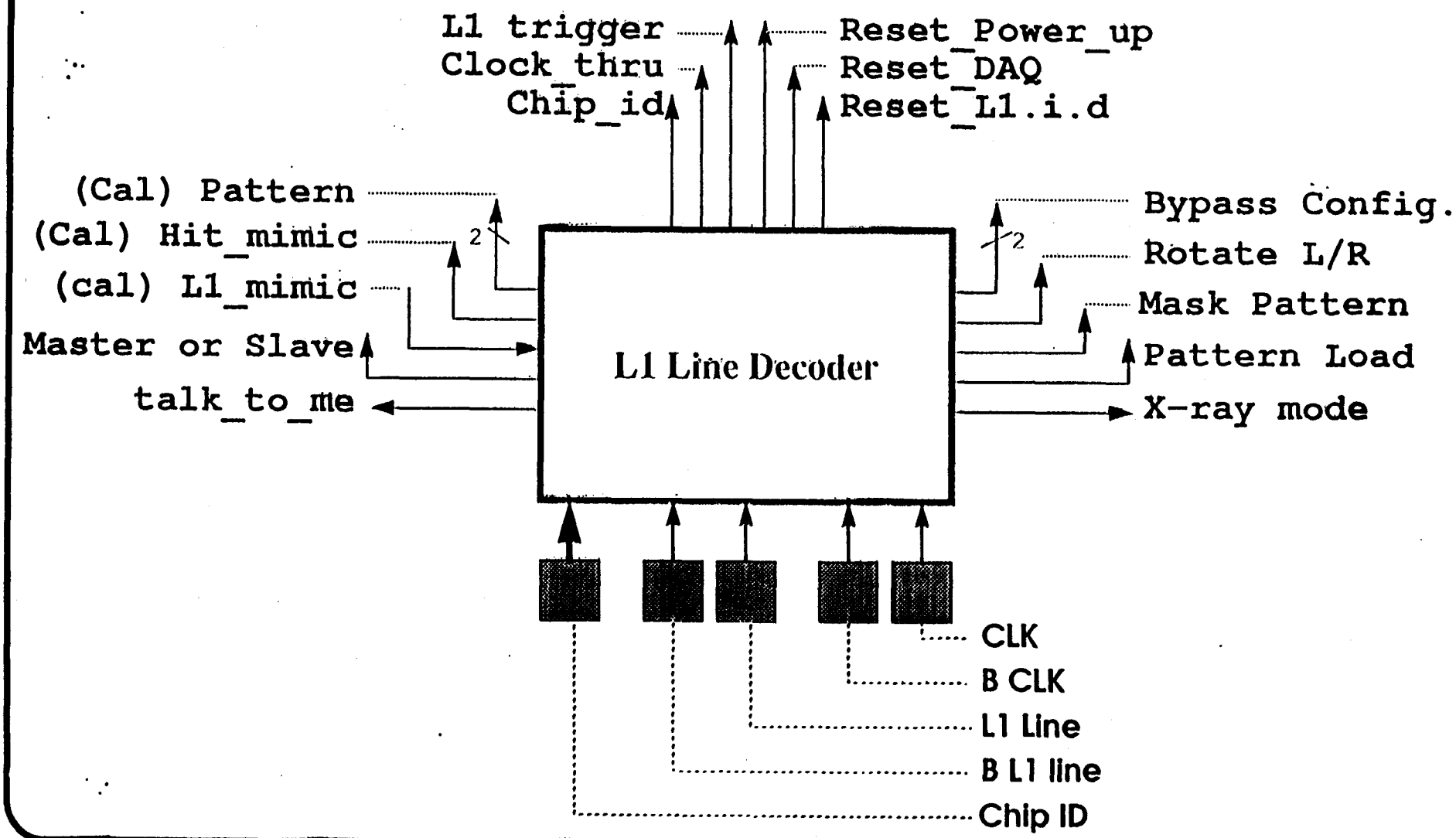


Data Compression / External Comm^n.



Master Control (functional for Master only)

L1 Line Decoder



7.3.4 Rear Edge

1. Chip id (7 pads)	BIAS <CHIPID>
2. Master Select	BIAS <MS>
3. Level 1 line + Backup (differential- 2x2 pads)	I <L1,L1_,BL1,BL1>
4. Clock + Backup (differential-2x2 pads)	<CLK,CLK_,BCLK,BCLK_>
5. Token_In_Bypass (differential-2 pads)	I <BTI,BTI_>
6. Token_Out_Bypass (differential-2 pads)	O <BTO,BTO_>
7. Serial_In_Bypass (differential-2 pads)	I <BSI,BSI_>
8. Serial_Out_Bypass (differential-2 pads)	O <BSO,BSO_>
9. Data_Out (differential-2 pads)	I <DO,DO_>

Total Width of Chip: ≤ 6.2 mm (<128 ch * 50 um) after sawing and including all bond pads.
Total Length of Chip: < 8.3mm after sawing and including all bond pads.

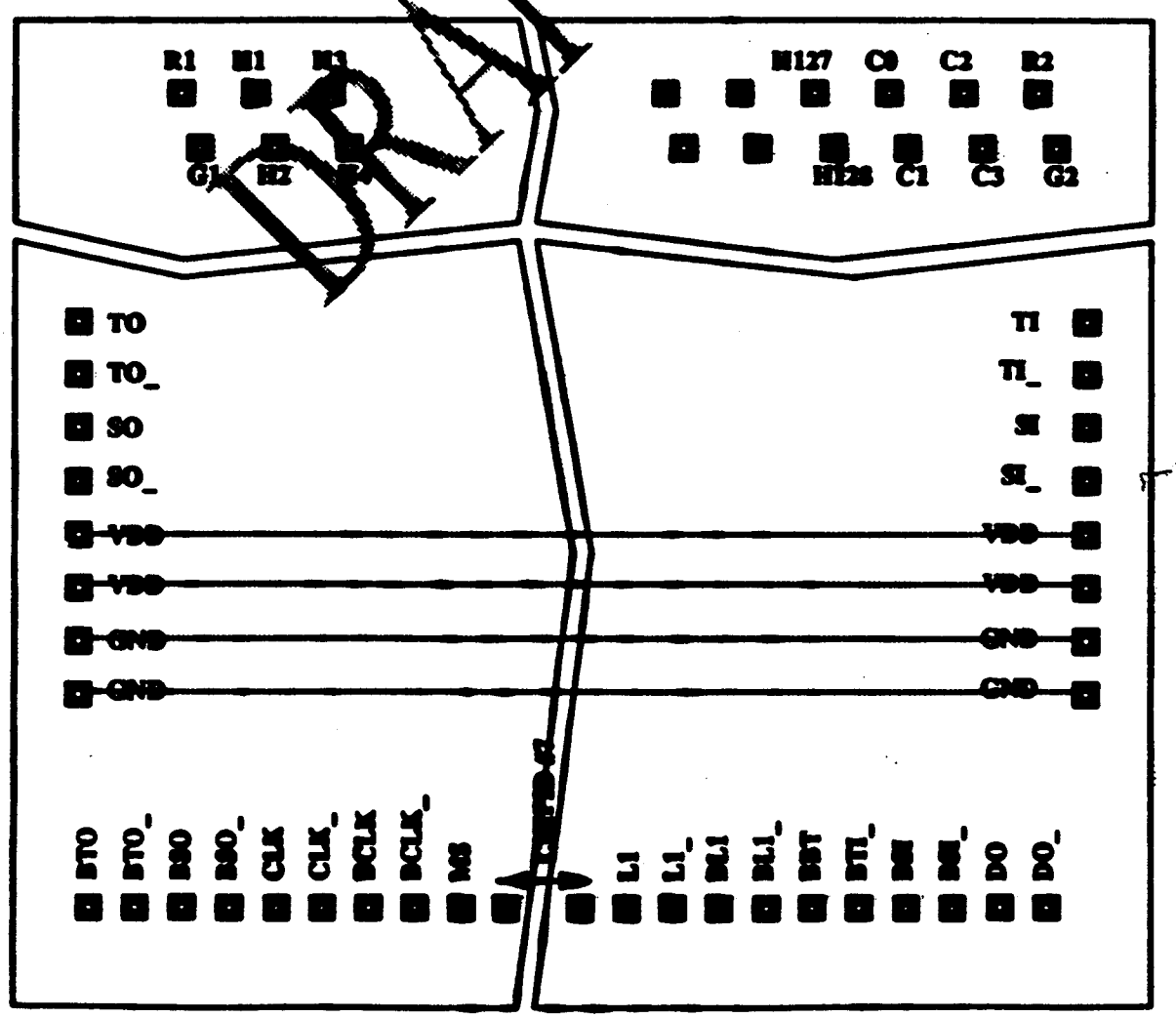
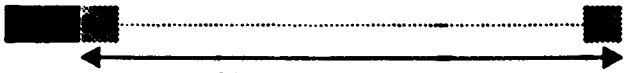


FIGURE 2. Rad Layout of DDR2.

Appendix a. List of Instructions on Level 1 line.

Instruction	
□□■□□□	Gets Master to respond back with its chip id
□□□■□□	Resets Level 1 Counter.
□□□□■□	Empties all the buffers
□□□□□■	Resets to Power Up
□■■□□□	Bypass Previous Chip on the Ring (also Set Calibration pattern to 00)
□■□■□□	Bypass Next Chip On the Ring (also Set Calibration pattern to 00)
□■□□□□	Set Calibration pattern to 00
□■□□□■	Set Calibration pattern to 01
□■□□■□	Set Calibration pattern to 10
□■□□■■	Set Calibration pattern to 11
■□□■□□	If a chip is in its nomal mode Switch to Clock_Thru mode.(*)
■□□□■□	If a chip is in its normal mode Switch to X-Ray mode.(*)
■□□□□■	If a chip is in its normal mode Switch to Calibration mode.(*)
■□□□□□	Return to normal mode.
(*) Chip must be returned its normal mode before changing into another mode.	

Instruction for Loading a Mask Pattern



128 bit Mask Pattern

SDC Collaboration Meeting
December 10-12, 1992

Status on Computing

I. Gaines

December 12

SDC Computing Update

- SDC Computing Subsystem: Mission & Organization
- SDC Offline Software Concepts Document
  - Computing Tasks
  - Core Software and Application Software
  - "Tootsie Roll" Model
  - Categories of software and Software Development Processes
  - "Toaster" Architectural Model
  - Data Modeling
- Core and Data Modeling Prototypes

Irwin Gaines
Dec 12,1992

Computing Activities in Japan

Computing Subgroup Meeting
SDC Collaboration Meeting at SSCL, Dec. 11, 1992

K. Amako (KEK)

Plan of the talk

I. Members

II. Present Activities

1) Task Forces
2) SDCSIM and Computing Farm
3) Prodig
4) Facom
5) Remote Computing Center, Remote Detector Control Center

III. What do we want to do for the SDC computing?

IV. Key issues for remote institutes to do efficiently the computing collaboration

IV. Key issues for remote institutes to do efficiently the computing collaboration

- job sharing
  - well defined sharing is essential for people at remote
- scheduling and milestones
- improve communication
  - vedeo meetings don't help at the present for university people
  - meeting / workshop at active institutes (not only at SSCL)
- how to manage various computing environment in each site

Summary of Suggestions – Saul Youssef

- o We should think of ourselves as a service organization as much as designers of the ultimate SDC software. Insights gained in solving immediate problems will be very helpful.

- o Find a more inclusive way to have meetings.

- o Provide short term solutions to current software efforts. Ideally these result in components which fit into the asymtotic system.

- o A decisive solution to data abstraction is desparately needed for BOTH cultures. Existing software must make a transition to types/classes.

- o Use news groups and clearly identified responsibility rather than a software review board.

- o "Requirements" could be used more effectively.

- o Follow the C++ standards in hepnet.c++

- o Use commercial software whenever possible(?)

- o Capture machine dependencies and eliminate Patchy.

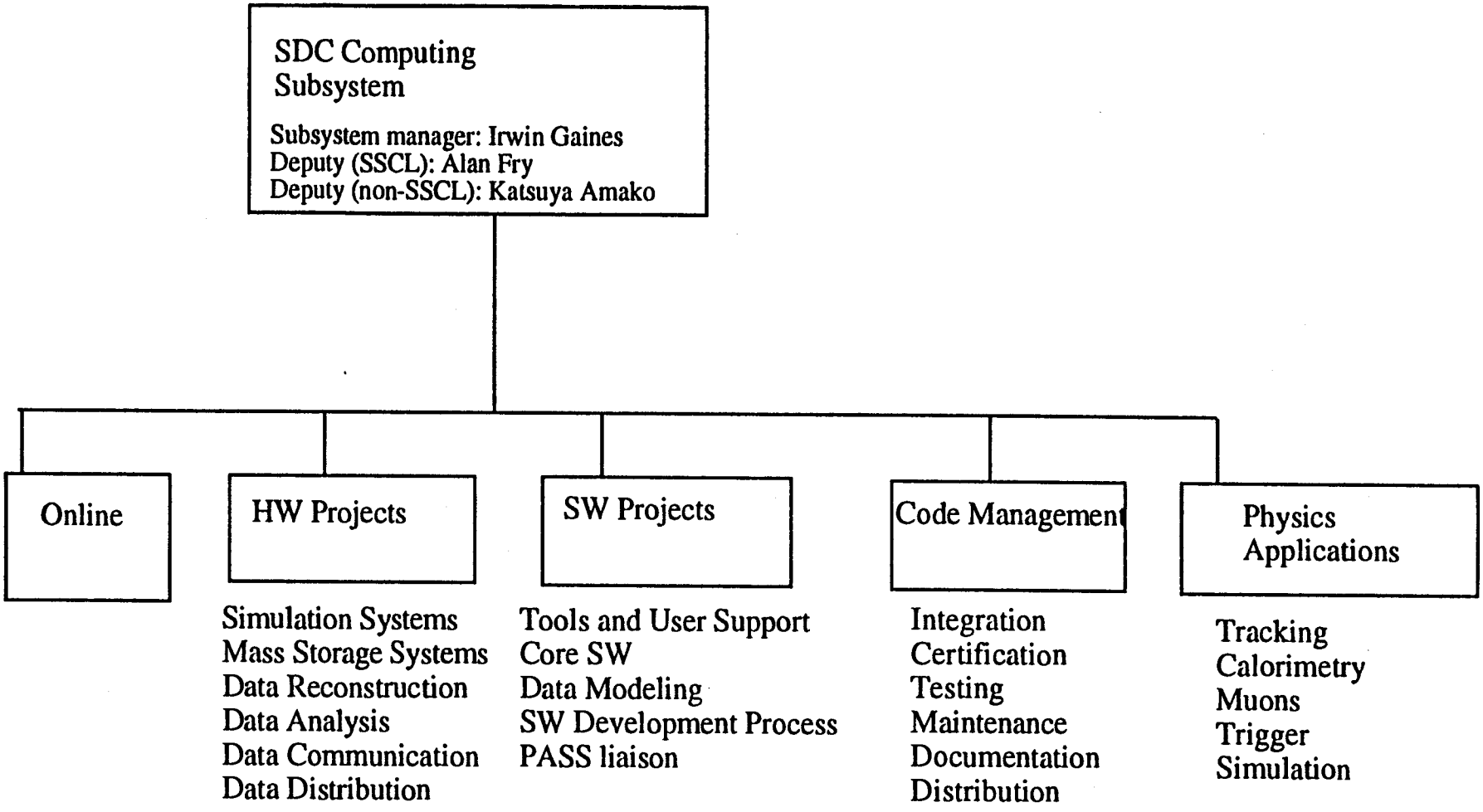
SDC Computing Subsystem

Mission: To provide both line management and organization of SDC offline and online computing activities. This includes:

1) Ensuring there are adequate computing hardware resources to meet SDC needs;

2) Ensuring that SDC physics software is available to produce physics results; and

3) Providing computing tools and environments to maximize physicist productivity.


SDC Computing Subsystem
Subsystem manager: Irwin Gaines
Deputy (SSCL): Alan Fry
Deputy (non-SSCL): Katsuya Amako
Online
HW Projects
Simulation Systems
Mass Storage Systems
Data Reconstruction
Data Analysis
Data Communication
Data Distribution
SW Projects
Tools and User Support
Core SW
Data Modeling
SW Development Process
PASS liaison
Code Management
Integration
Certification
Testing
Maintenance
Documentation
Distribution
Physics Applications
Tracking
Calorimetry
Muons
Trigger
Simulation

SDC Offline Software Concepts

Version 1.0
December 11, 1992

SDC Data Modeling Working Group
SDC Core Software Working Group
SDC Software Process Working Group

Comments to FNAL::GAINES

SDC Computing Tasks

• Physics Analysis

This task requires software involved with the selection of events and/or pieces of events, and with cataloging the data samples for later use, in addition to physics analysis tools and programs (both commonly used and individually written) which execute on the data samples. Convenient access to large amounts of data must also be provided.

• Application Code Development

This task utilitzes tools for analysis, design, coding, testing and debugging of software. Tools are provided both for the "professionals" to develop core software and common tools, and for the physicist to write private application code. The application code can be written in FORTRAN or C++.

• Simulation

Software for this task must provide an accurate model of the actual detector and physics processes under study, and must generate simulated events that are capable of passing through all subsequent stages of analysis.

• Calibration

This task is involved with reading large amounts of raw data for specialized analysis of particular subsystems to determine calibration constants and monitor detector performance. The task must provide easy and straightforward access to user-chosen data samples and ways to incorporate personal code into the application.

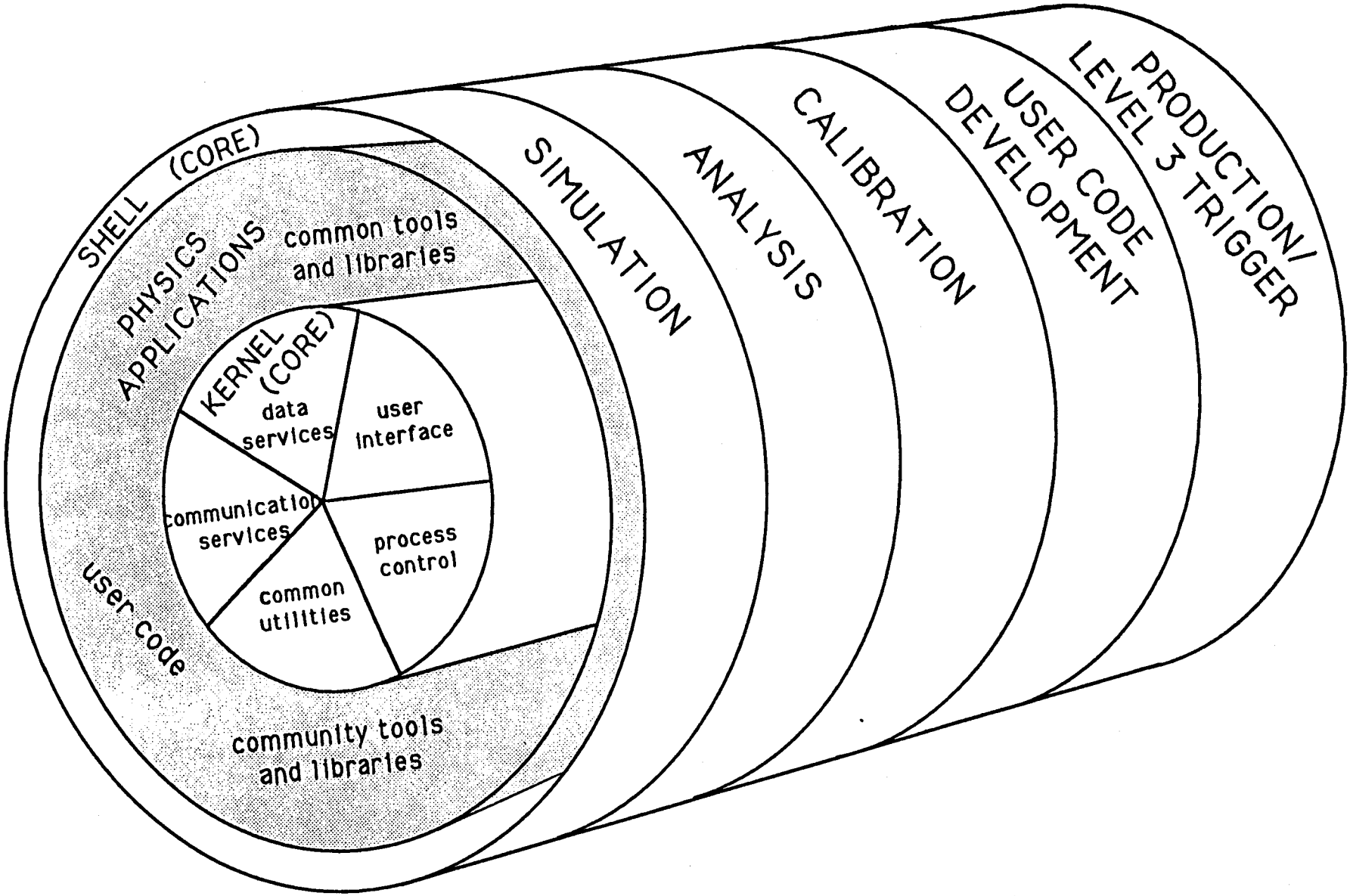
• Level 3 Trigger and Production Reconstruction

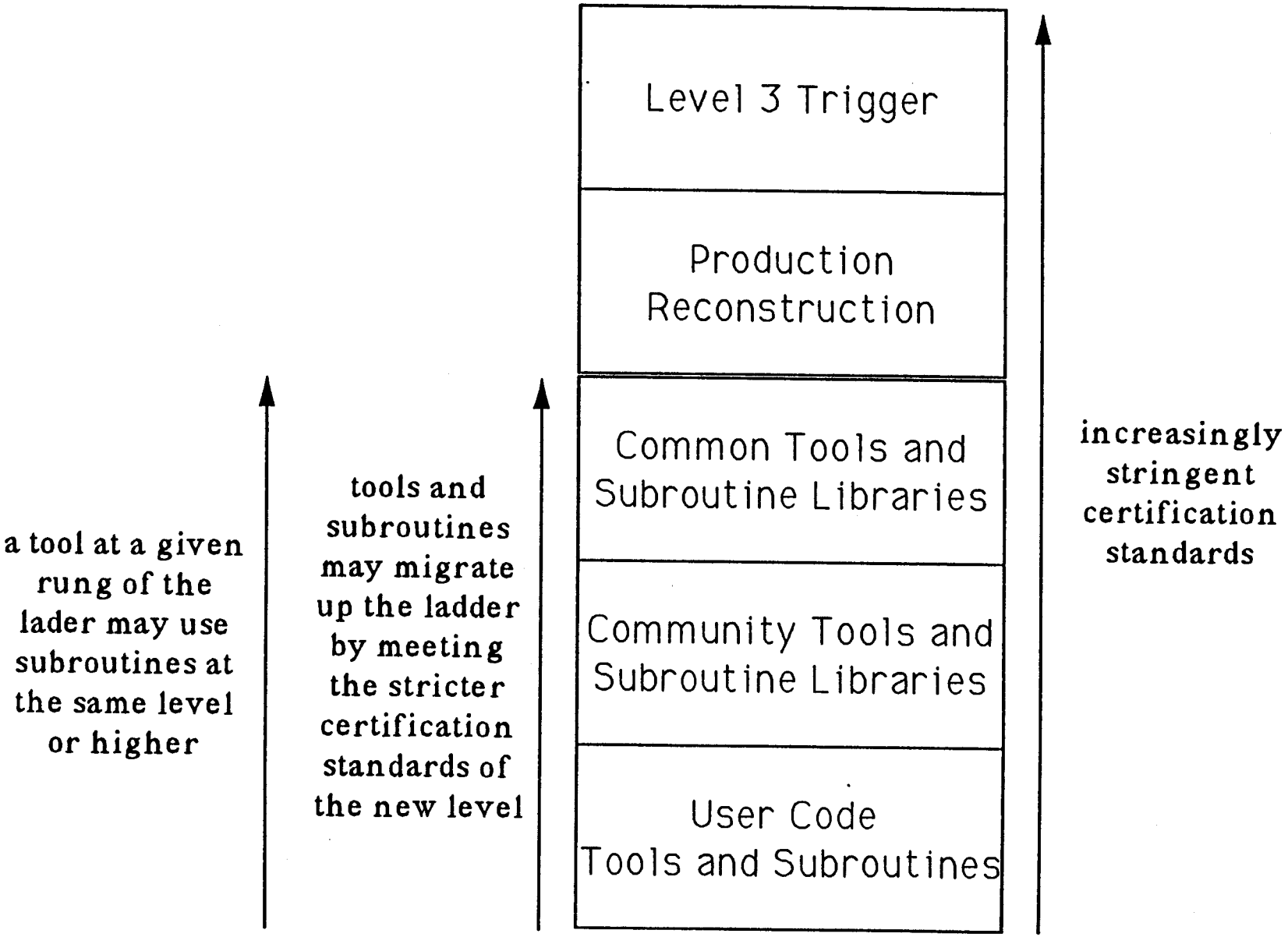
This task requires software programs which execute against all events, "reconstructing" the raw data into physically meaningful quantities that can be used in later stages of physics analysis. In particular, the Level 3 trigger programs cause events to be discarded. The software will require considerable computing power, and typically will not be repeated. Therefore, it must meet the highest standards of software engineering to ensure its functionality and correctness.

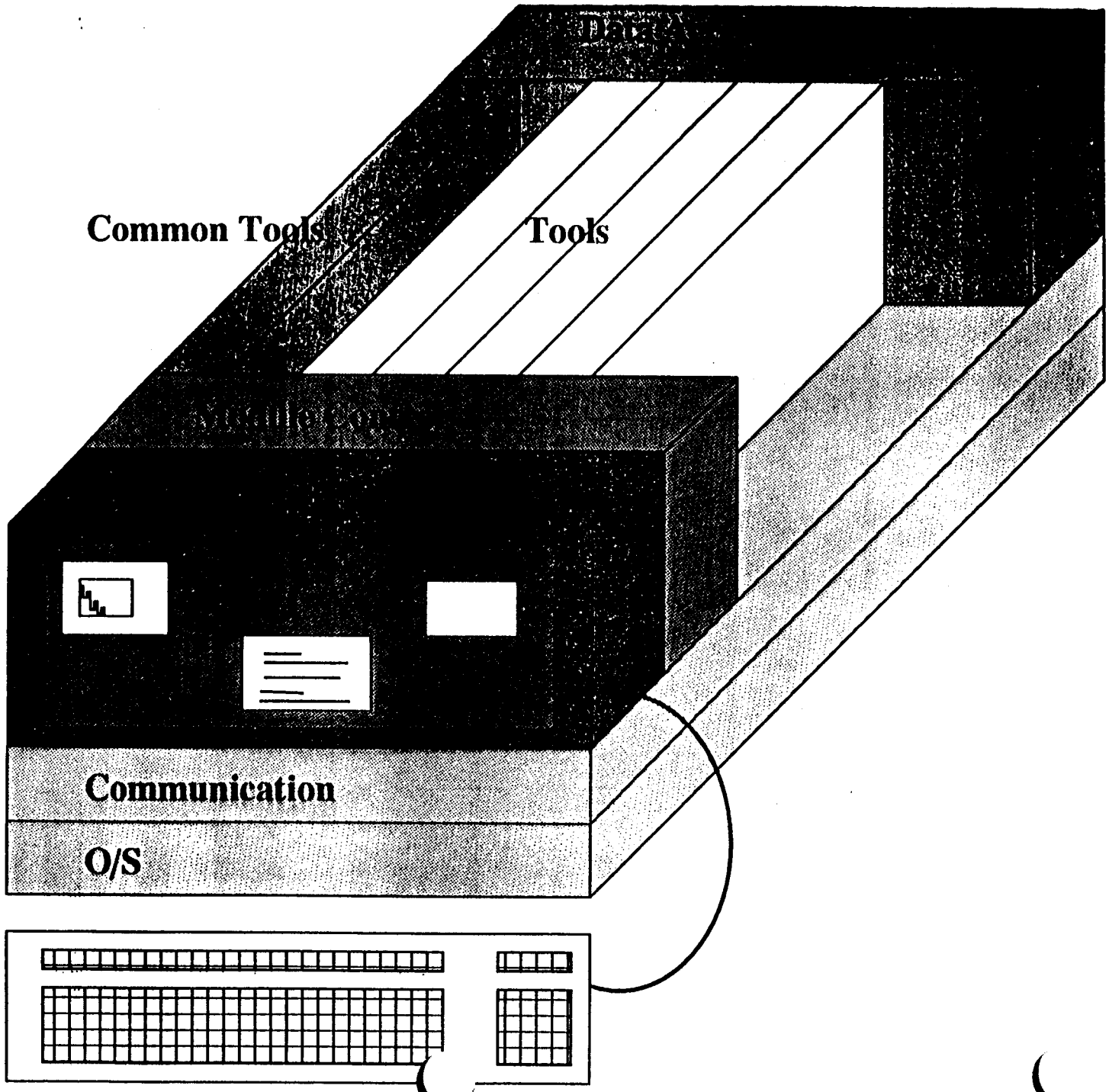
SDC Core Software

- Core = Shell + Kernel

- Kernel includes:
    - User Interface
    - Process Control
    - Communication Services
    - Data Access Services
    - Common Utilities


SHELL (CORE)
PHYSICS APPLICATIONS
common tools and libraries
KERNEL (CORE)
data services
user interface
communication services
process control
common utilities
user code
community tools and libraries
SIMULATION
ANALYSIS
CALIBRATION
USER CODE DEVELOPMENT
PRODUCTION/ LEVEL 3 TRIGGER


Level 3 Trigger
Production Reconstruction
Common Tools and Subroutine Libraries
Community Tools and Subroutine Libraries
User Code Tools and Subroutines
a tool at a given rung of the lader may use subroutines at the same level or higher
tools and subroutines may migrate up the ladder by meeting the stricter certification standards of the new level
increasingly stringent certification standards


Data
Common Tools
Tools
Modules
Communication
O/S

Data Modeling
(On Beyond Zebra)

- Data Modeling Tools (defining data structures)
- Data Repository (physical manifestation of data)
- API (programmer interface) to repository: user methods to access and manipulate data
- Data viewing tool: allows user to browse both data itself and data descriptions (metadata)

Core Software Prototype

- User Interface: Unidraw (public domain X-based graphical editor)

- Communication layer: Unix system V IPC and SUN RPC based C++ code

- Data Access: Extensions to SDCSIM SZ package (based on Zebra banks but hidden from user)

- Process Control: Our code

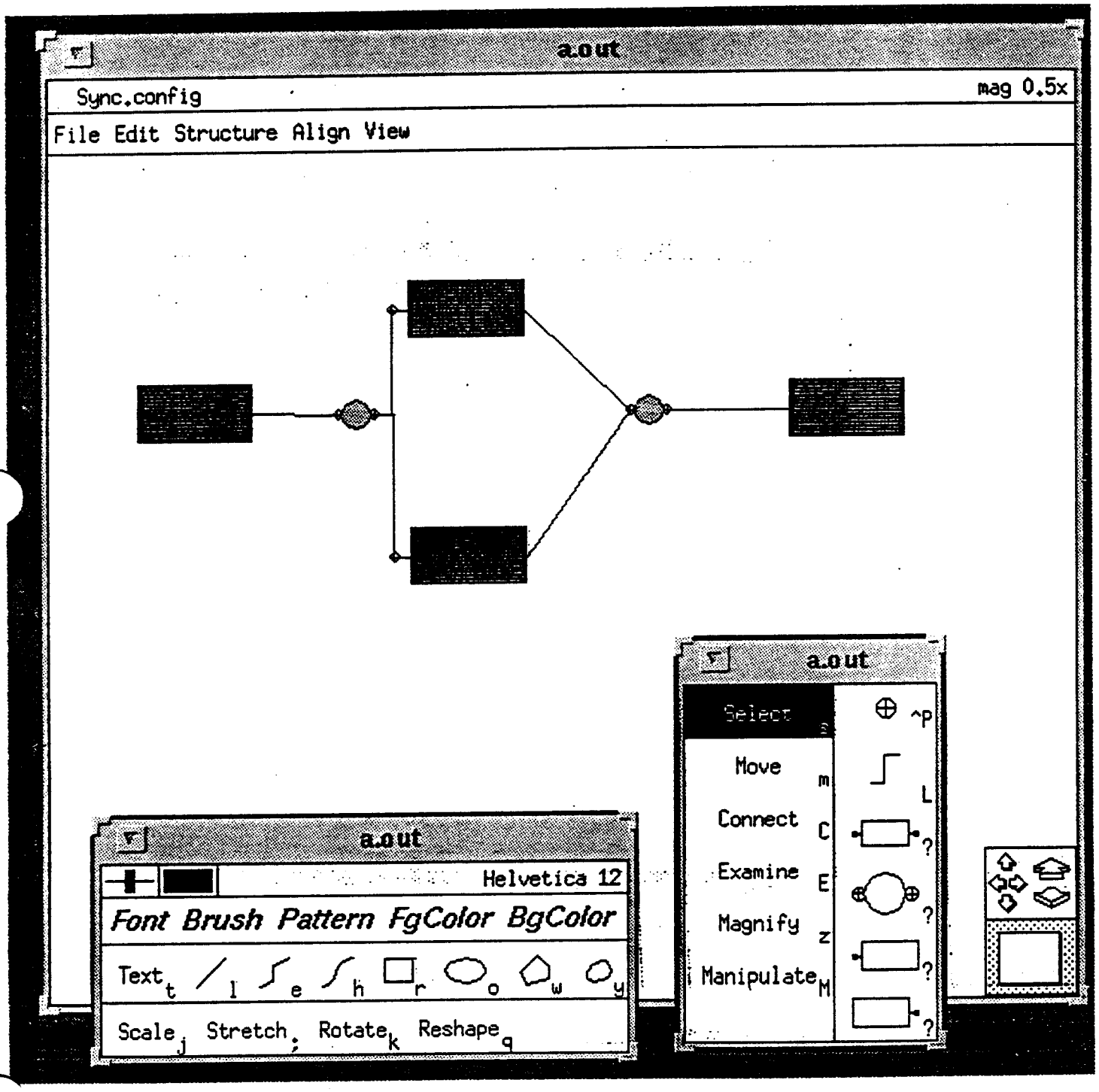
Requirements

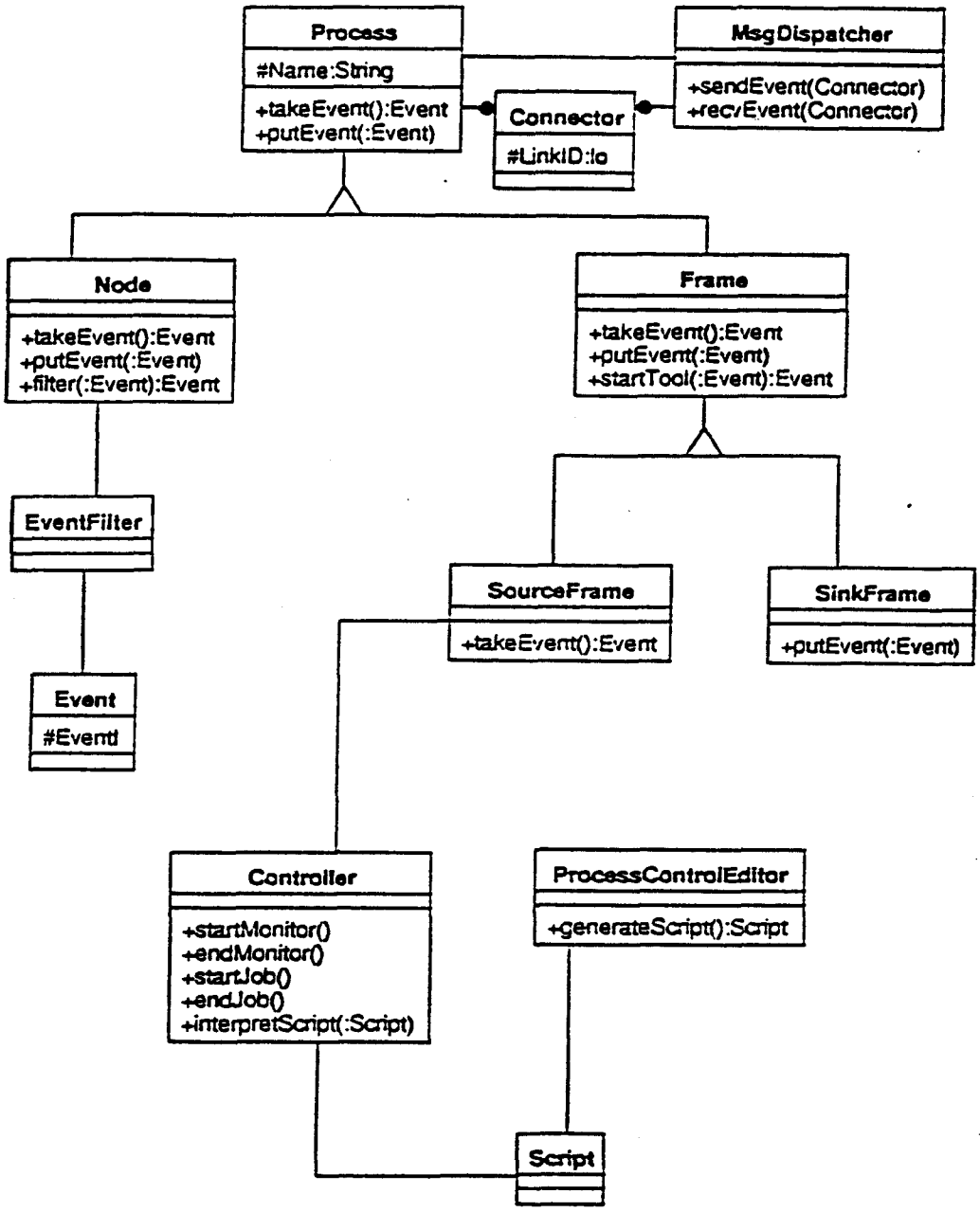
- A good graphical editor -- View.
- External representation -- Script.
- Mapping between the view and the script.
- Mapping between the view and the execution, continuously (msg passing) or at certain times(read shared memory).

Unidraw

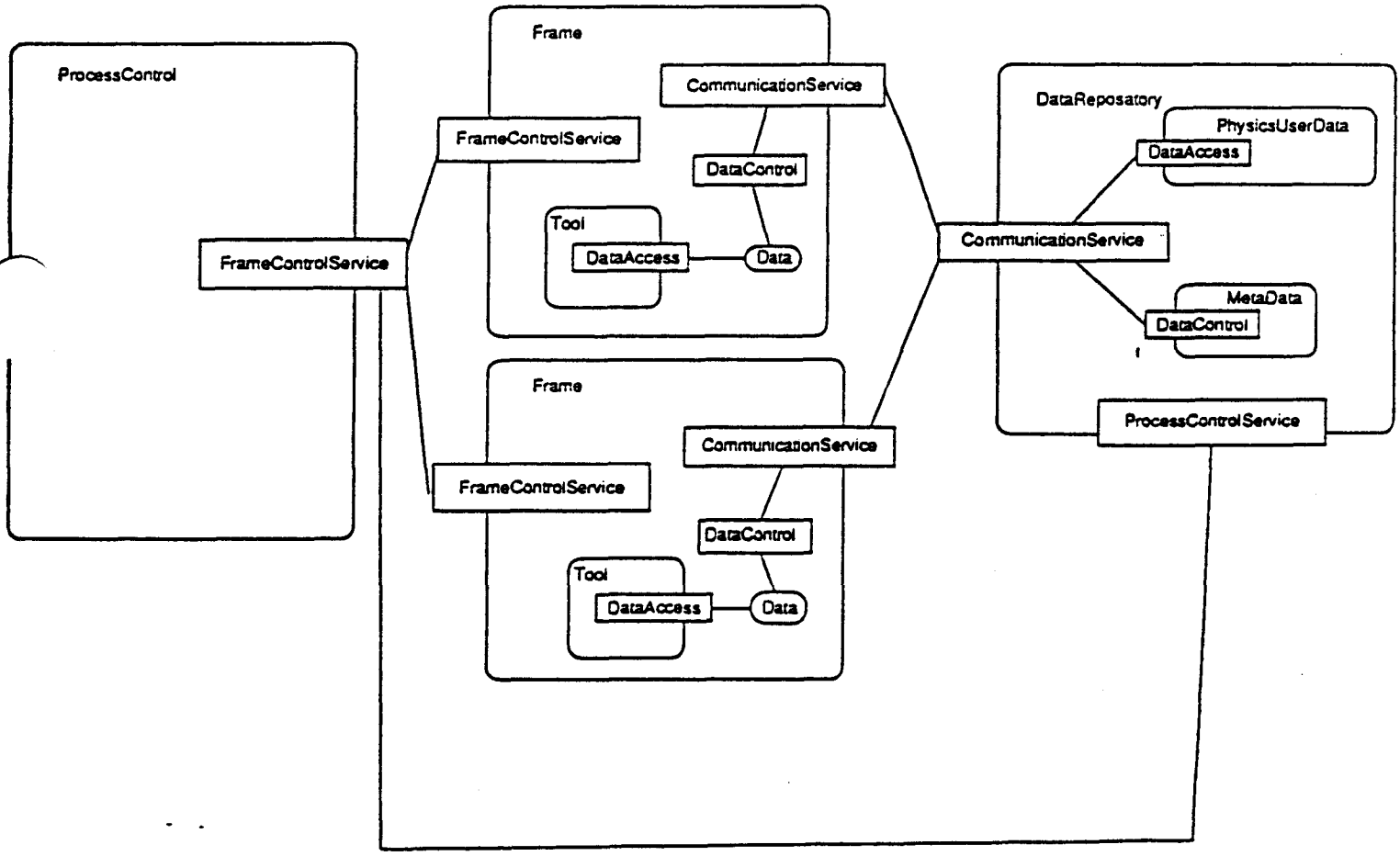
Unidraw is a class library for creating object-oriented graphical editors. It has 180 classes, the interface is 5020 lines and implementation is 18000 lines. It defines four abstractions:

- Components: encapsulate appearance and semantics of objects -- geometric objects etc.
- Tools: support direct manipulation of components -- select, rotate, connect.
- Commands: define operations on components and other objects -- change attributes, group objects.
- External Representations: define mapping between components and the file.


a.out
Sync.config
mag 0.5x
File Edit Structure Align View
a.out
Select
Move
Connect
Examine
Magnify
Manipulate
a.out
Helvetica 12
Font Brush Pattern FgColor BgColor
Text
Scale
Stretch
Rotate
Reshape


Process
#Name:String
+takeEvent():Event
+putEvent(:Event)
MsgDispatcher
+sendEvent(Connector)
+recvEvent(Connector)
Connector
#LinkID:Io
Node
+takeEvent():Event
+putEvent(:Event)
+filter(:Event):Event
Frame
+takeEvent():Event
+putEvent(:Event)
+startTool(:Event):Event
EventFilter
SourceFrame
+takeEvent():Event
SinkFrame
+putEvent(:Event)
Event
#EventI
Controller
+startMonitor()
+endMonitor()
+startJob()
+endJob()
+interpretScript(:Script)
ProcessControlEditor
+generateScript():Script
Script

Prototype Object Design

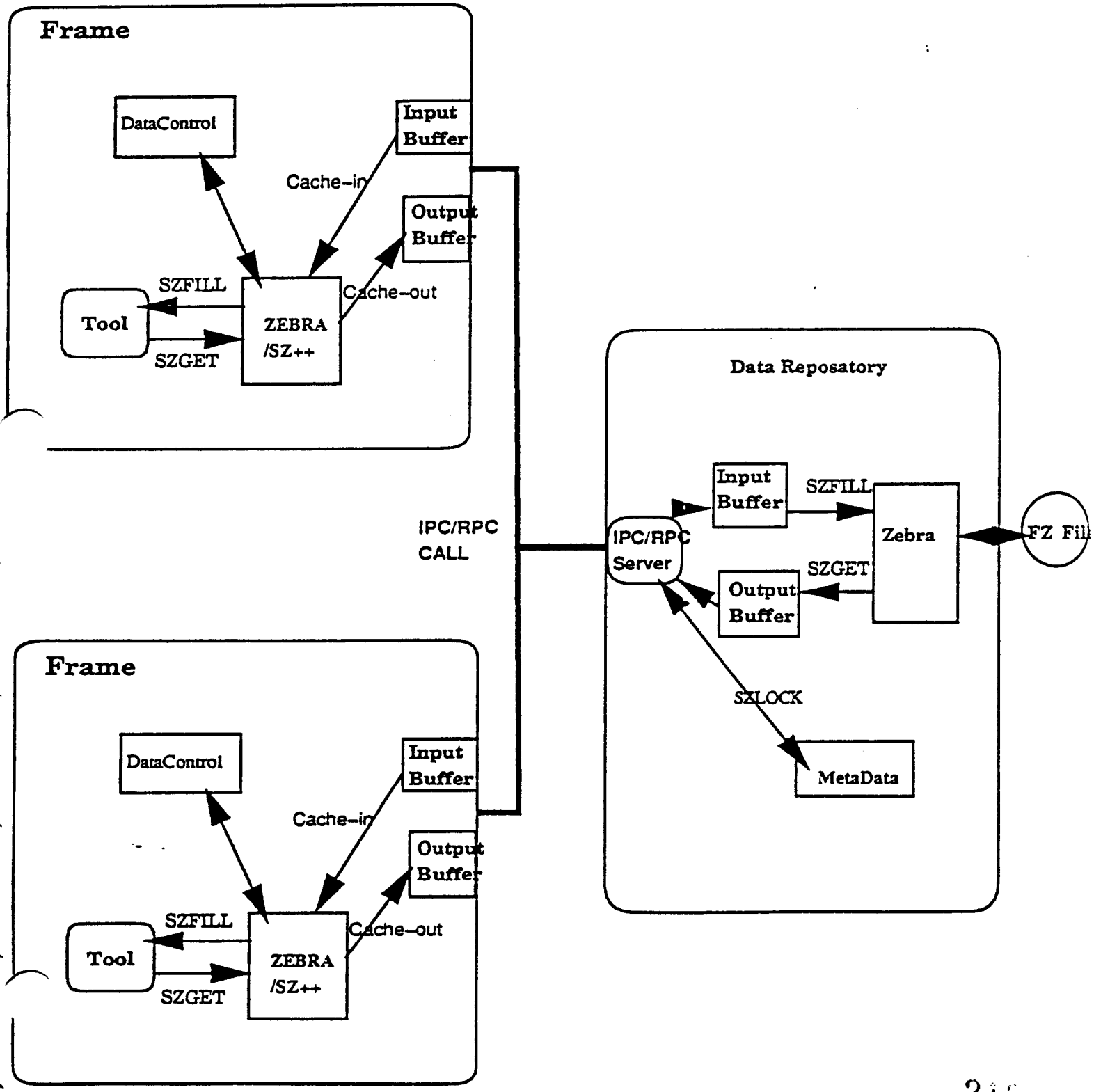


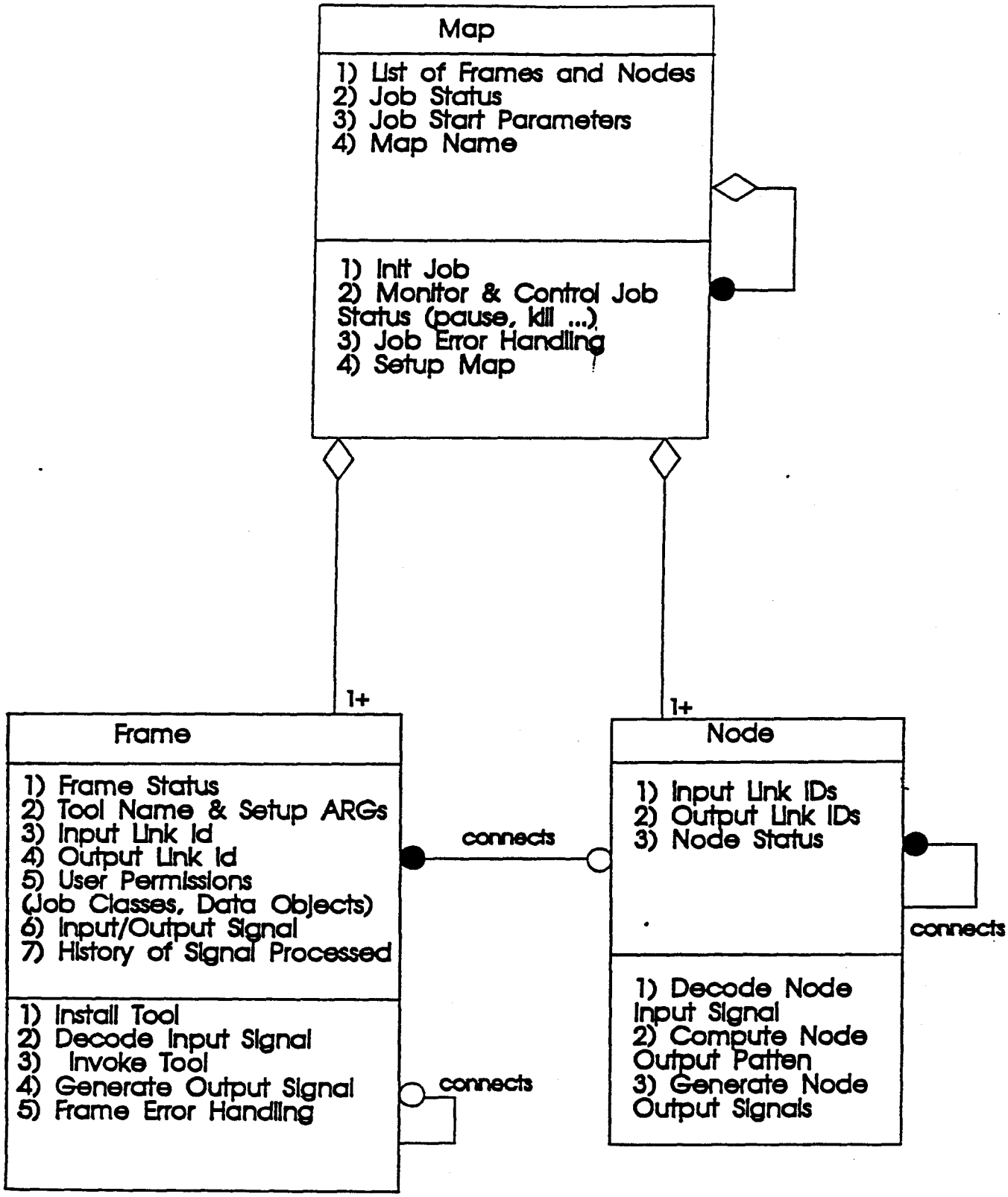
PhysicsUserData Object

We are using the Shell/SZ package interface for impenting the **DataAcess** Interface.

```
Class PhysicsUserData {

Private:

Public:
        /* Initialization  and I/O */

 void szini();              // Initialize SZ structure from
                            // zebctl.zeb
 void szread(char *filename);       // Readfile FZ X format
 void szwrite(char *filename);      // Write FZ X format

        /* Full backward compatibility
           with Shell/SZ interface */

 void szfill( char *action, char *bktree, int *nbk,
          int *nd1, int *nd2, int *data,
          int *status);                         // fill  individual bank

 void szget(  char *bktree, int *nbk,
          int *nd1 , int *nd2, int *data,
          int *status);                         //  get individual bank


void szfillTree( char *action, char *bktree, int *nbk, int *level,
          int *nd1, int *nd2, int *data,
          int *status);                         // fill  complete tree

 void szgetTree(  char *bktree, int *nbk, int *level,
          int *nd1 , int *nd2, int *data,
          int *status);                         //  get individual bank
```

Object DataReposatory Implementation




Map
1) List of Frames and Nodes
2) Job Status
3) Job Start Parameters
4) Map Name
1) Init Job
2) Monitor & Control Job Status (pause, kill ...)
3) Job Error Handling
4) Setup Map
1+
1+
Frame
1) Frame Status
2) Tool Name & Setup ARGs
3) Input Link Id
4) Output Link Id
5) User Permissions (Job Classes, Data Objects)
6) Input/Output Signal
7) History of Signal Processed
1) Install Tool
2) Decode Input Signal
3) Invoke Tool
4) Generate Output Signal
5) Frame Error Handling
connects
connects
Node
1) Input Link IDs
2) Output Link IDs
3) Node Status
connects
1) Decode Node Input Signal
2) Compute Node Output Patten
3) Generate Node Output Signals

Data Modeling Prototype

- Based on OMTool: Object oriented commercial tool
- Investigating various public domain data viewing packages
- Will not choose a data repository but will implement for both Zebra and OODBMS for now

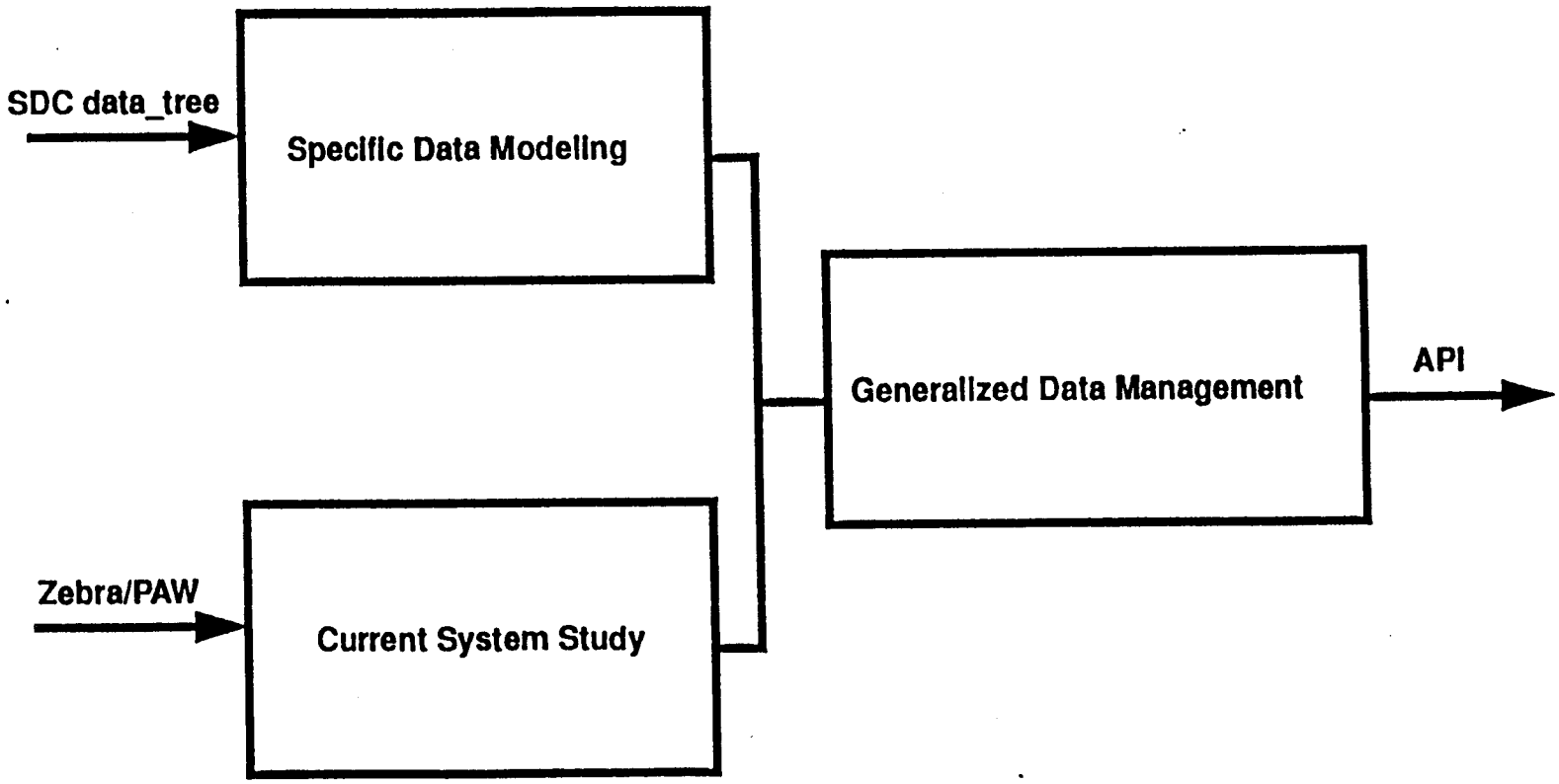


Figure 1 - Data Modeling Prototyping approach

PHASE-I Prototyping Approach

- **Specific Data Modeling**

  INPUT: SDC data tree - tracking/raw, tracking/reconstructed

  - Define classes according to elements of SDC data tree structure
  - Build prototype for different data repositories

  OUTPUT: Class library for more generalized object management

- **Existing system studying**

  INPUT: Zebra/PAW systems

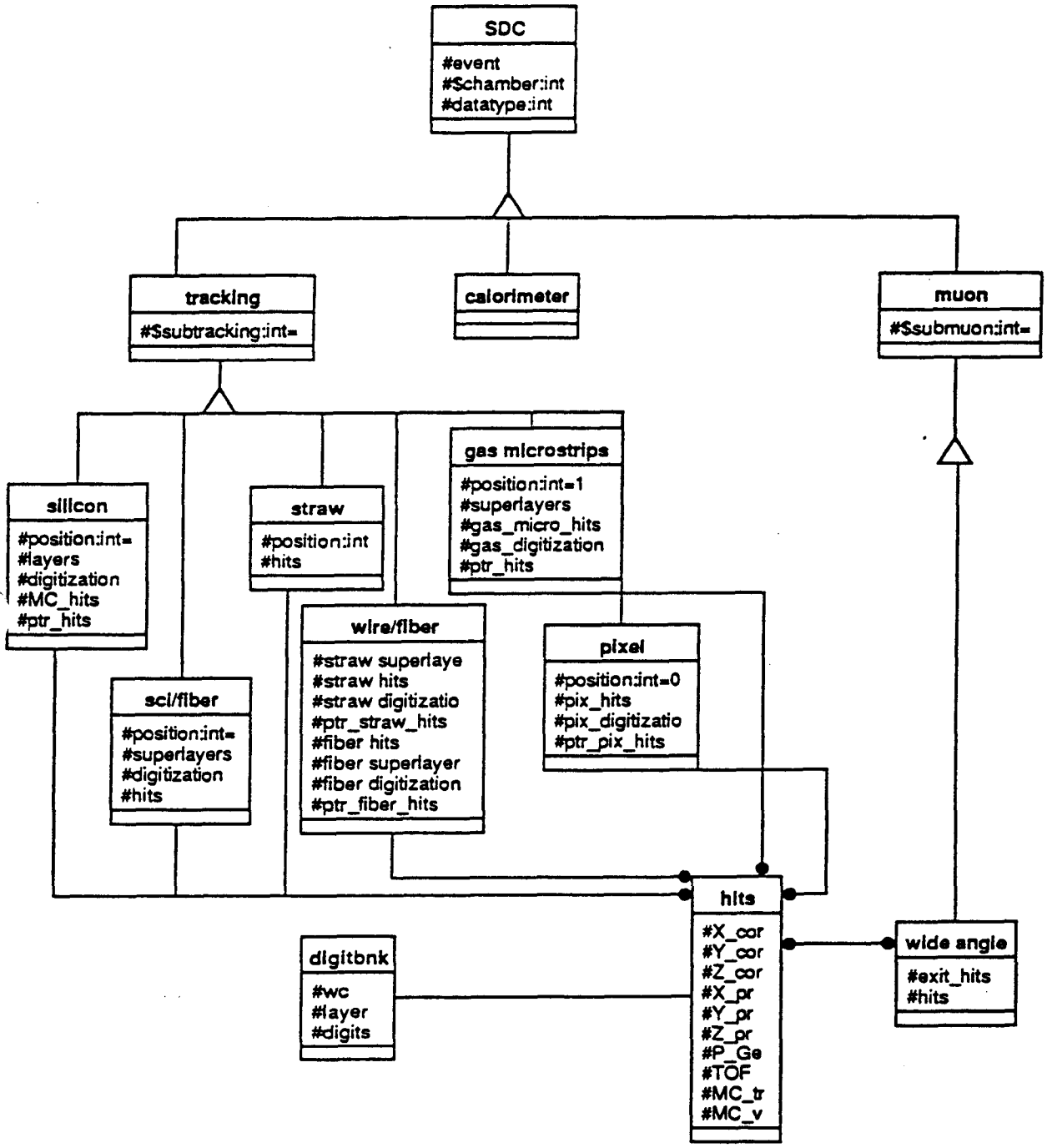
  - Understand current API - Why it has been accepted by the physics society
  - Collect applicable features - What we may apply to the new model
  - Transfer to newer technology - How the transition be best made

  OUTPUT: Suggestions, design ideas for more generalized object management

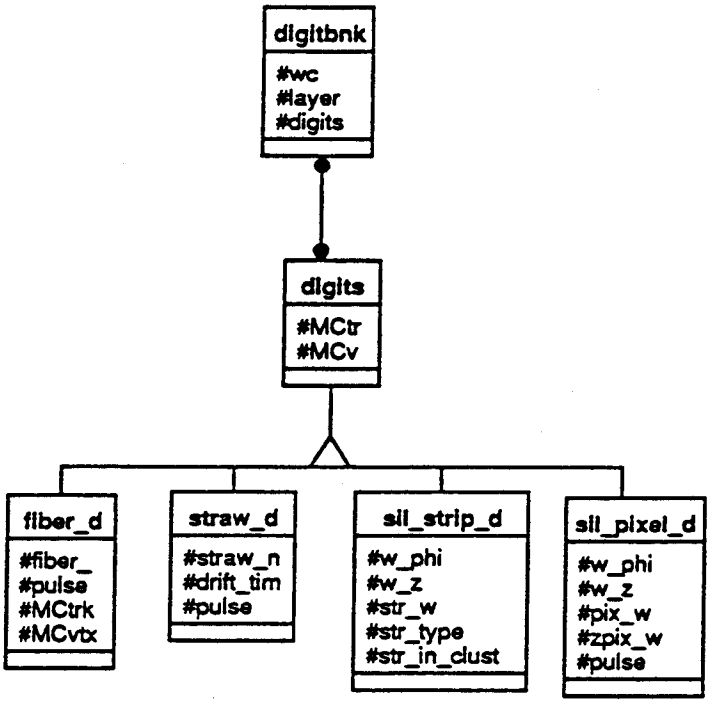
PHASE-II Prototyping Goal

- Generalized Data Management System
- API supporting Fortran to OODB & RDBMS
- Ground work for refinement

Module: sdc_data_tree Sheet: 1: 1 Panel: (0,0) Time: Sat Dec 11 12:11:14 1999



Module: sdc_data_tree Sheet: 2: 1.2 Panel: (0,0) Time: Sat Dec 11 12:11:14 1999



Public Domain Data Visualization Tool

- XImage, XDataSlice, from Univ of Illinois, National Center for Super Computing
- HippoDraw, Hippoplotamus from SLAC
- Image, NIH
- SciAn (only on SGI and IBM), Florida State
- KHORO, Univ of New Mexico
- FAST, by NASA Ames Research Center

3.3 Proposed Schedule

Various components of the SDC software system need to be in place as soon as possible to allow application software development to proceed. The current proposed schedule plans on providing limited functionality prototypes of various software components as soon as feasible to allow collaboration physicists to begin using and evaluating the software. The proposed near-term schedule for delivery of these prototype components is:

Selection of prototype data modeling methodology and first version of corresponding tools	Dec., 1992
Version 1.0 of core SW (frameworks and primitive kernel services)	Feb., 1993
Selection of SW Development methodology	Mar., 1993
First version of SW development tools/developers guide	June, 1993
Evaluation of and feedback on initial prototypes	Apr.-Sept., 1993
Preliminary fully functional version of core software provided for use in application code development	Sept., 1994

The core prototype will include versions of data modeling software (based on ZEBRA), process control, communication and user interface (using public domain tools). Version 1.0 will be simple and easy to use while providing the basic core functionality. The separate prototype data modeling package will make use of the commercial OMTool package to model some already existing SDC data structures.

Later versions of the various software system components will follow, based on user experiences with the early versions.