SSCL-N-809

Working Session on Beam Profile Technique for SSC

E. Tsyganov

Superconducting Super Collider Laboratory*
2550 Beckleymeade Ave.
Dallas, TX 75237

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WORKING SESSION ON BEAM PROFILE TECHNIQUE FOR SSC. (SSCL)

DECEMBER 16, 1992

SSC LABORATORY

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Collider Group
Information

To: Distribution
From:E. Tsyganov

A working two hour session devoted to the beam profile measurements at the SSC will be held at the Apollo Room on December 16, Wednesday, at 1:00 p.m.

Speakers are:

1. W. Nexsen -Introduction on the beam profile technique for the SSC (5').

2. E. Tsyganov - Computations on the residual gas and electron beam profile monitors (25').

3. K. Kauffmann - Interpretation of the electron beam profile monitor data (15').

4. A. Maschke - Neutral beam profile monitor (15').

5. K. Kauffmann - Molecular beam profile monitor (10').

Presentations will be followed by discussion on possible construction and tests of the prototype divices. Minutes of session will be distributed.

Participants:

A. Chao	M.S.7000
P. Datte	M.S.4005
A. Drozhdin	M.S.1040
S. Dutt	M.S.1042
J. Ellison	M.S.1042
K. Kauffmann	M.S.1042
A. Maschke	M.S.1046
R. Meinke	M.S.1040
N. Mokhov	M.S.1040
W. Nexsen	M.S.1040
S. Saritepe	M.S.1040
R. Soundranayagam	M.S.1040
E. Tsyganov	M.S.1040

W. Nexsen

Introduction on the beam profile technique for the SSC

We have surveyed the known minimal interference techniques for measuring beam size and have evaluated them for possible collider usage. We conclude that the use of a strong magnetic field and a parallel electric field normal to the beam to image electrons produced by ionization of background gas presents the best approach for continuous monitoring of beam size in most of accelerators of the SSC. Several other approaches offer promise and should have further study before a final decision is made. We recommend that flying wires be used for cross checking calibrating the selected diagnostic but not be used as the primary diagnostic because their limited lifetime.

Minimal interference beam size diagnostics

Type	Principle
Flying wire	Monitor radiation vs wire position as wire transits beam
Synchrotron radiation	Image synchrotron radiation from accelerated beam particles
Ionization products	1D or 2D imaging of beam produced ionization of background gas or vapor
Excitation light	Image light produced by beam excitation of background gas
Stripline monitors	Beam quadrupole moment from quadrupole mode of wall current .
Schottky noise	Measurement of incoherent betatron noise power
Compton scattering	Measure scattering of laser probe photons by primary beam
Electron beam probe	Measure deflection of probe beam by primary beam fields
Neutral beam probe	Measure ionization of narrowly collimated energetic neutral beam probe by primary beam

- PDRR suggested use of flying wire and synchrotron radiation

- Closer look exposes problems with these diagnostics.

E. Tsyganov

Limitations of a residual gas ionization beam profile monitor for the SSC

A residual gas ionization beam profile monitor for the Superconducting Super Collider is considered in detail using the Monte Carlo simulation code. It is shown that a good spatial resolution of about 5 micrometers could be obtained using a combination of strong electrical and magnetic fields. The technique could be chosen as a major instrument for the most of the SSC accelerators.

RESIDUAL GAS IONIZATION BEAM PROFILE MONITOR

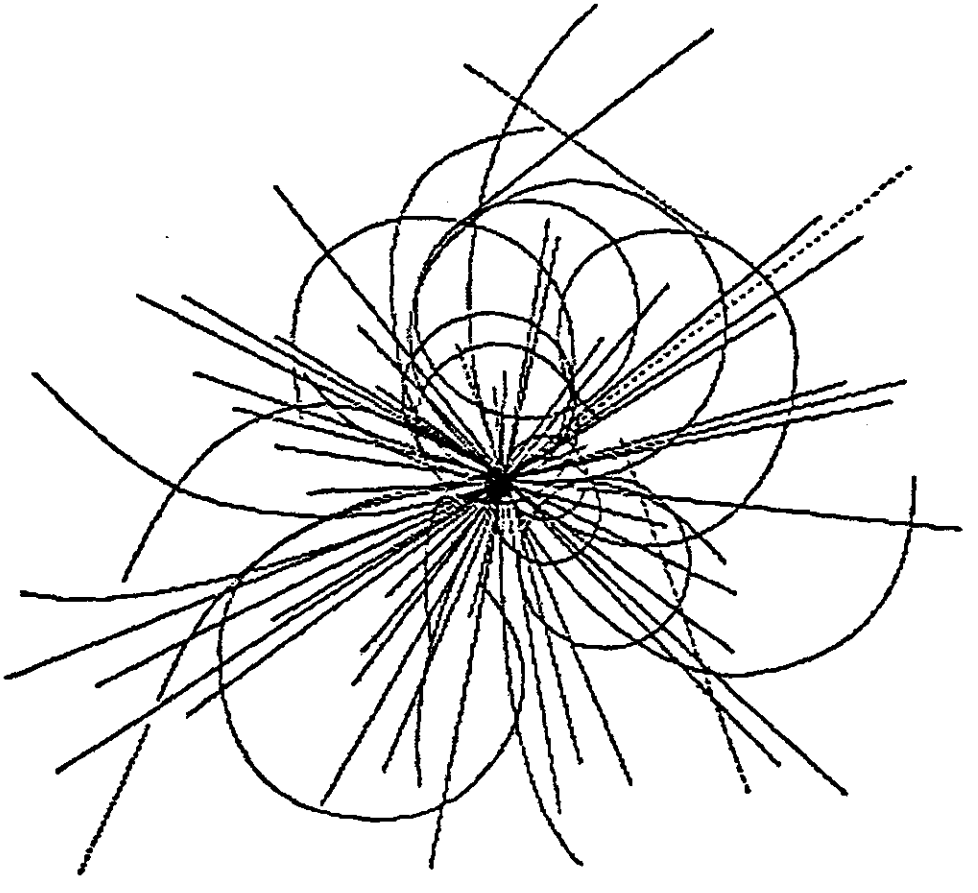
- STATISTICS ESTIMATIONS
- INFLUENCE OF BEAM CHARGE
- INITIAL VELOCITIES OF ELECTRONS
- MAGNETIC FIELD TRAP
- ZBEAM TRAJECTORY CODE
- RESULTS ON RESOLUTION

SSCL-602

SSCL-602
November 1992
Distribution Category: 414

R. Meinke
W. Nexsen
E. Tsyganov
A. Zinchenko

Limitations of a Residual Gas Ionization Beam Profile Monitor for the SSC Collider

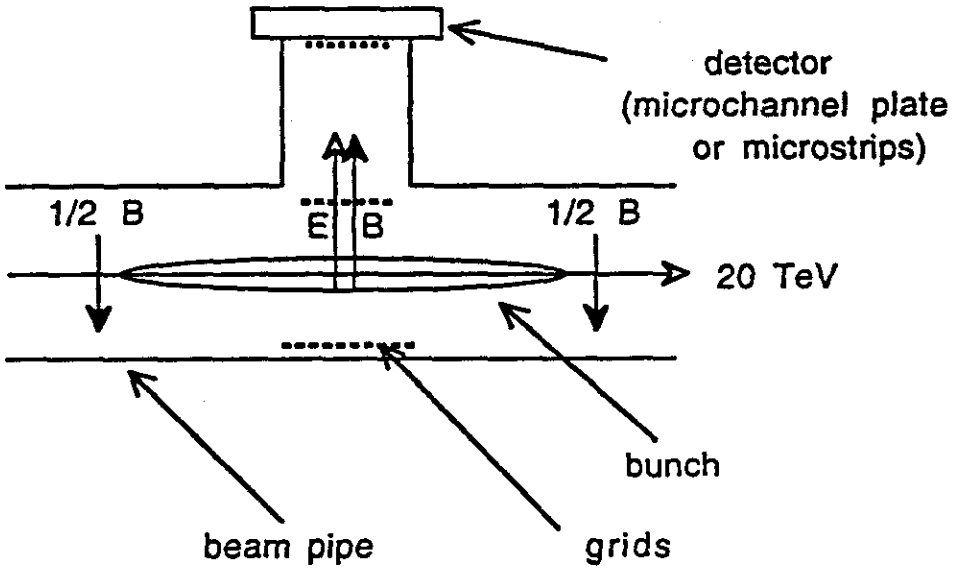


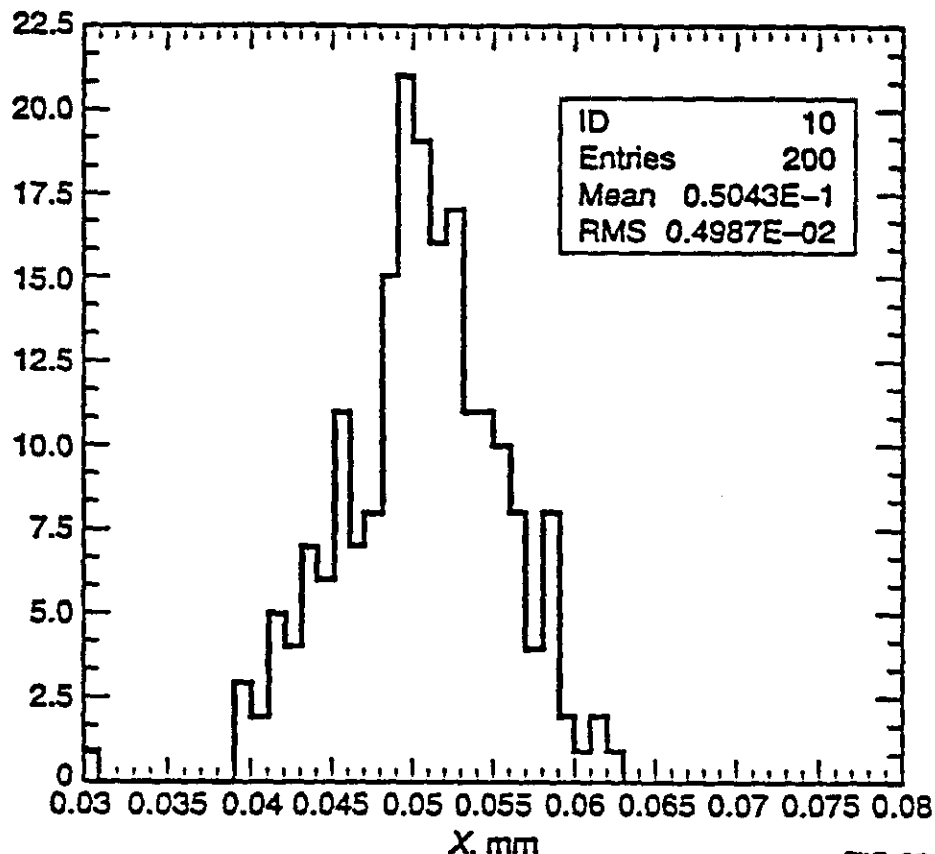
Superconducting Super Collider Laboratory

TABLE 1. PARAMETERS FOR WARM AND COLD SECTIONS OF COLLIDER.

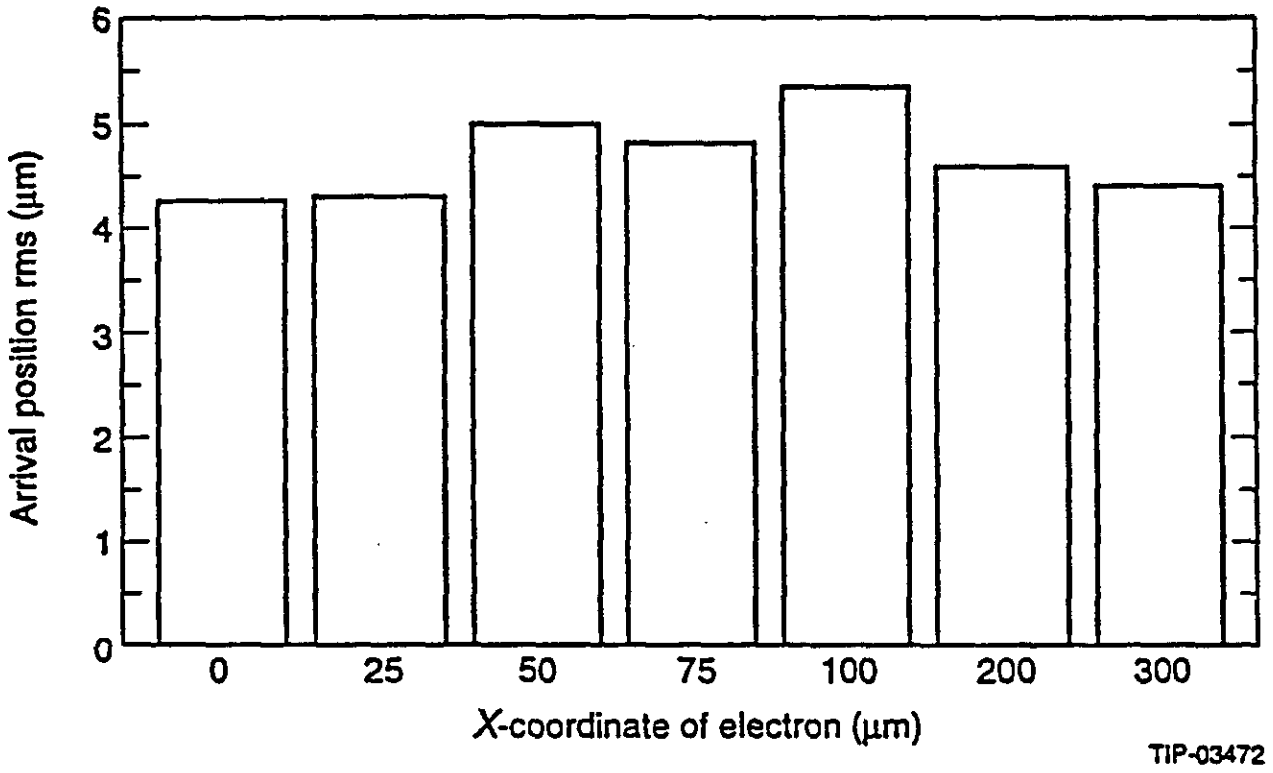
Warm Section	
Pressure (nitrogen)	10^{-9} Torr (1.65×10^{-15} g/cm^3)[1]
Ionization losses of MIP in nitrogen	1.82 MeV/g/cm^2[2]
Average energy loss of MIP to produce one primary electron-ion pair in nitrogen	196 eV[3]
Beam intensity	75 mA (0.45×10^{18} p/s)
Number of ionization electrons	0.7×10^7/cm-s
Cold Section	
Hydrogen density	3×10^8 H_2/cm^3 (1.0×10^{-15} g/cm^3)[1]
Ionization losses of MIP in hydrogen	4.12 MeV/g/cm^2[2]
Average energy loss of MIP to produce one primary electron-ion pair in hydrogen	65 eV[3]
Beam intensity	75 mA (0.45×10^{18} p/s)
Number of ionization electrons	2.8×10^7/cm-s

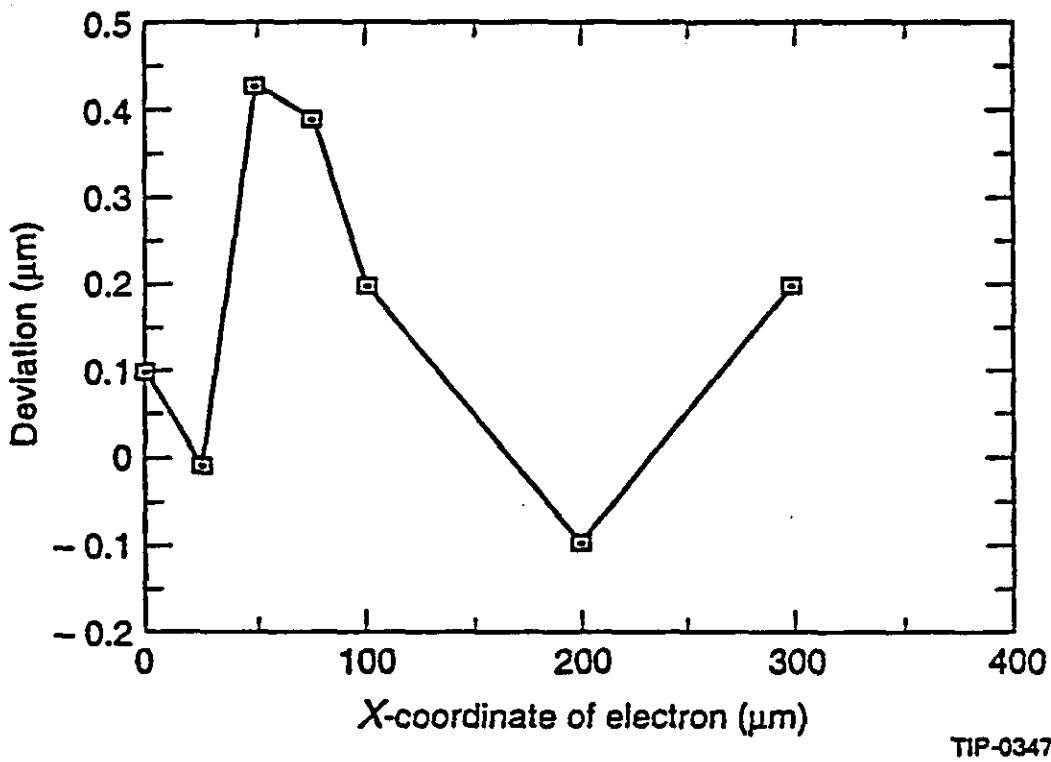
RESIDUAL GAS EMITTANCE MONITOR



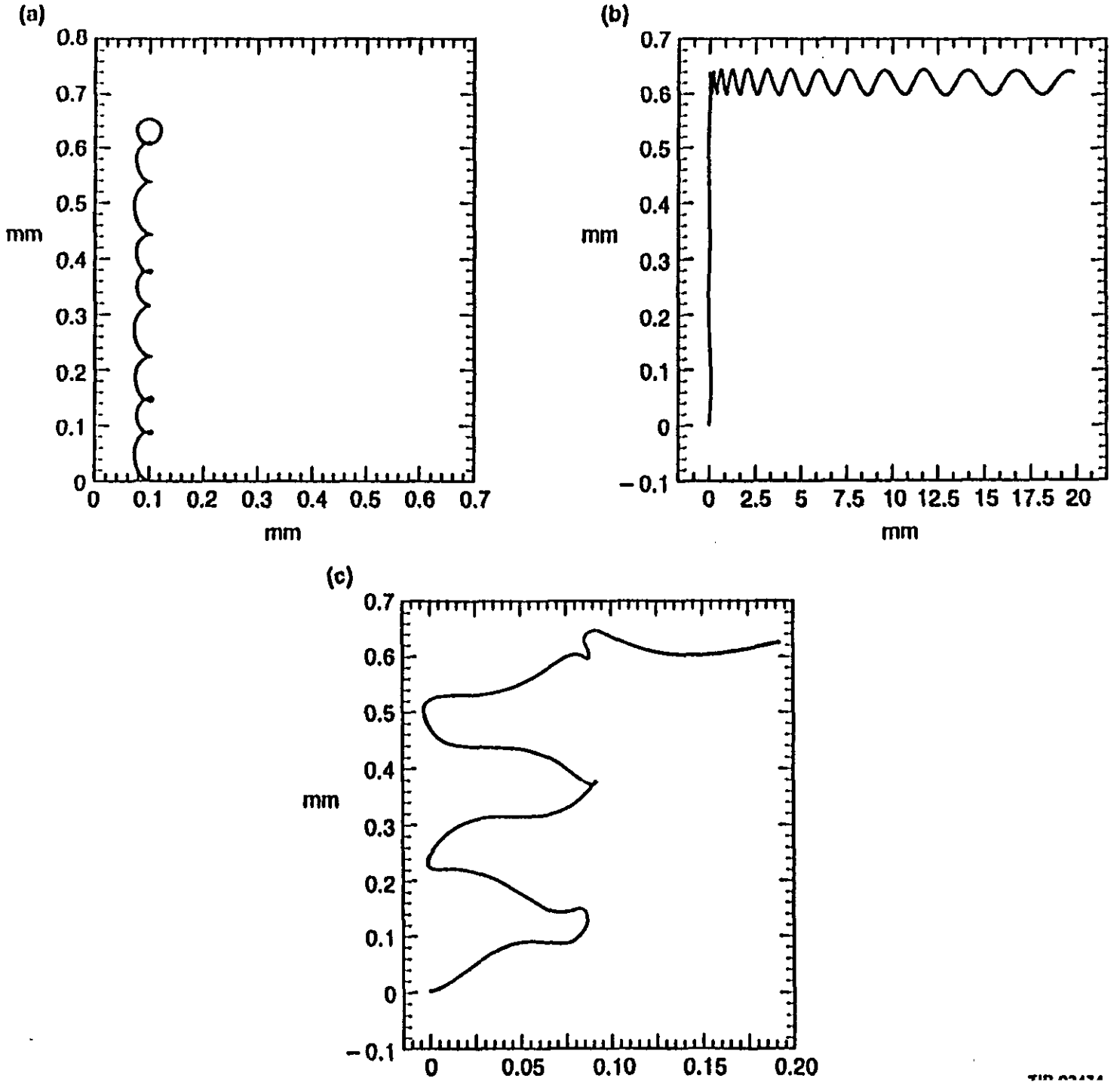

ID 10
Entries 200
Mean 0.5043E-1
RMS 0.4987E-02
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
0.03 0.035 0.04 0.045 0.05 0.055 0.06 0.065 0.07 0.075 0.08
X, mm

TIP-03471


Arrival position rms (μm)
0
1
2
3
4
5
6
0
25
50
75
100
200
300
X-coordinate of electron (μm)
TIP-03472


0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
Deviation (μm)
0
100
200
300
400
X-coordinate of electron (μm)

TIP-03473


(a)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
mm
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
mm
(b)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
mm
0
2.5
5
7.5
10
12.5
15
17.5
20
mm
(c)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.1
mm
0
0.05
0.10
0.15
0.20

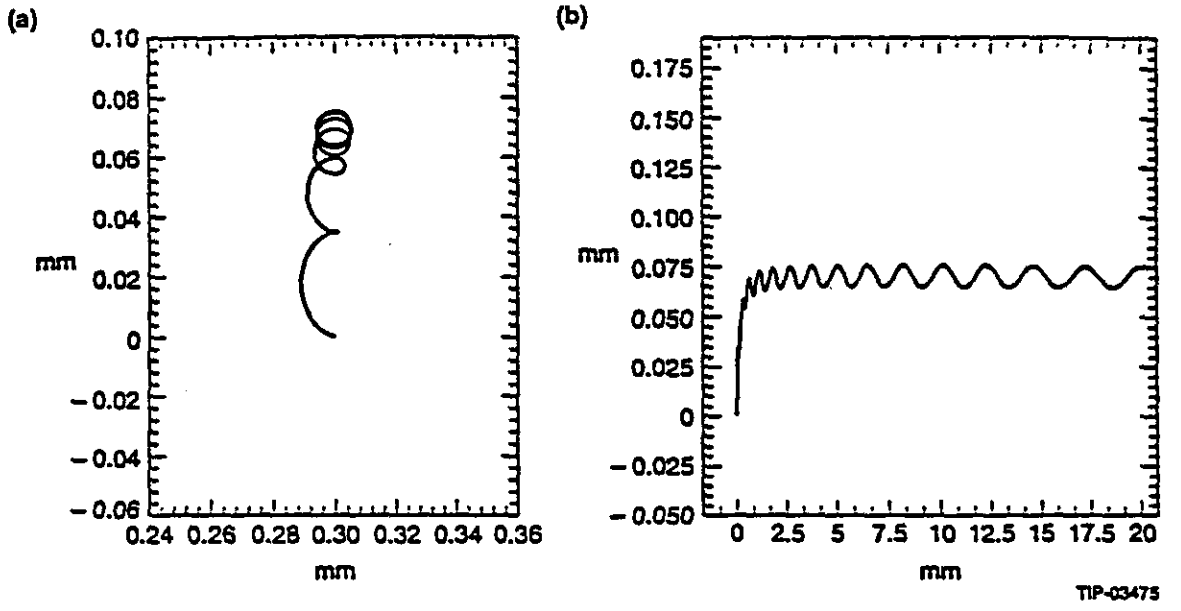


Figure 6. The same as in Figure 5, except the initial electron position is 300 μm. There are no oscillations.

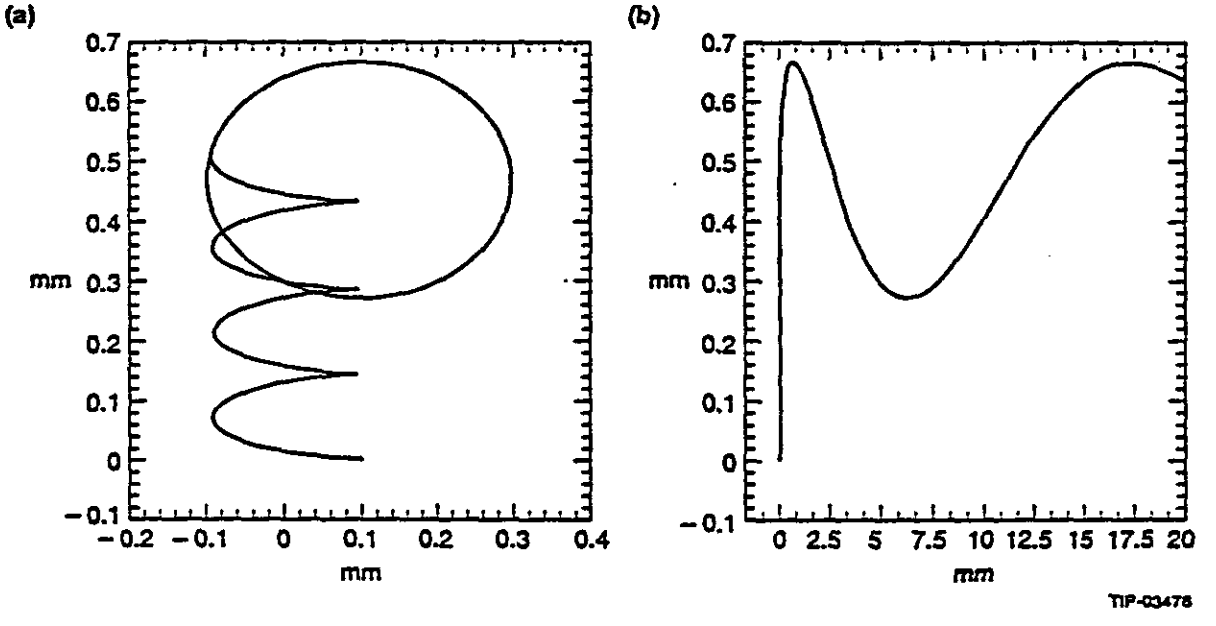


Figure 7. The same as in Figure 5, except $B = 0.1$ T.

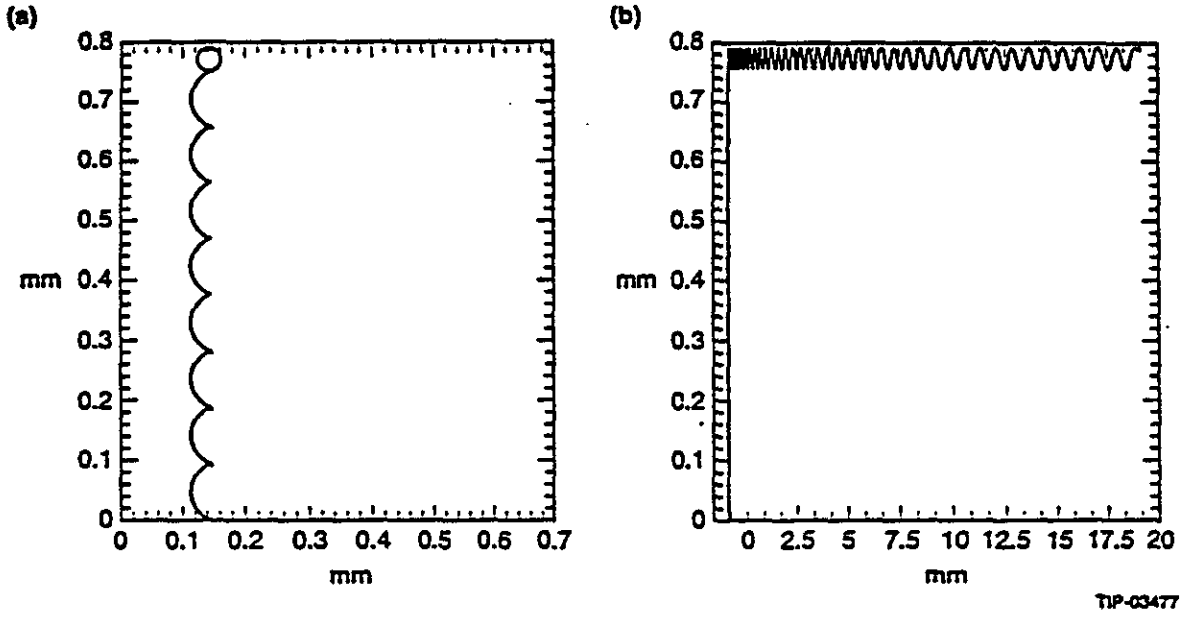


Figure 8. The same as in Figure 5, except $E = 1$ kV/cm.

E. Tsyganov

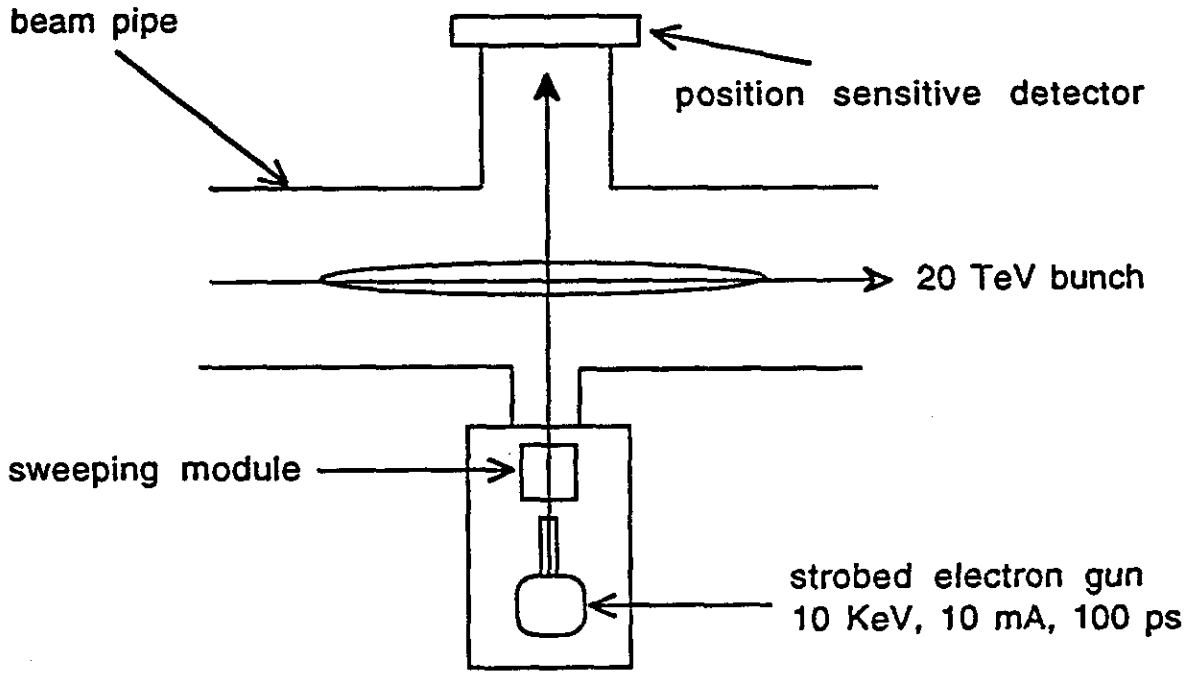
Electron beam emittance monitor for the SSC

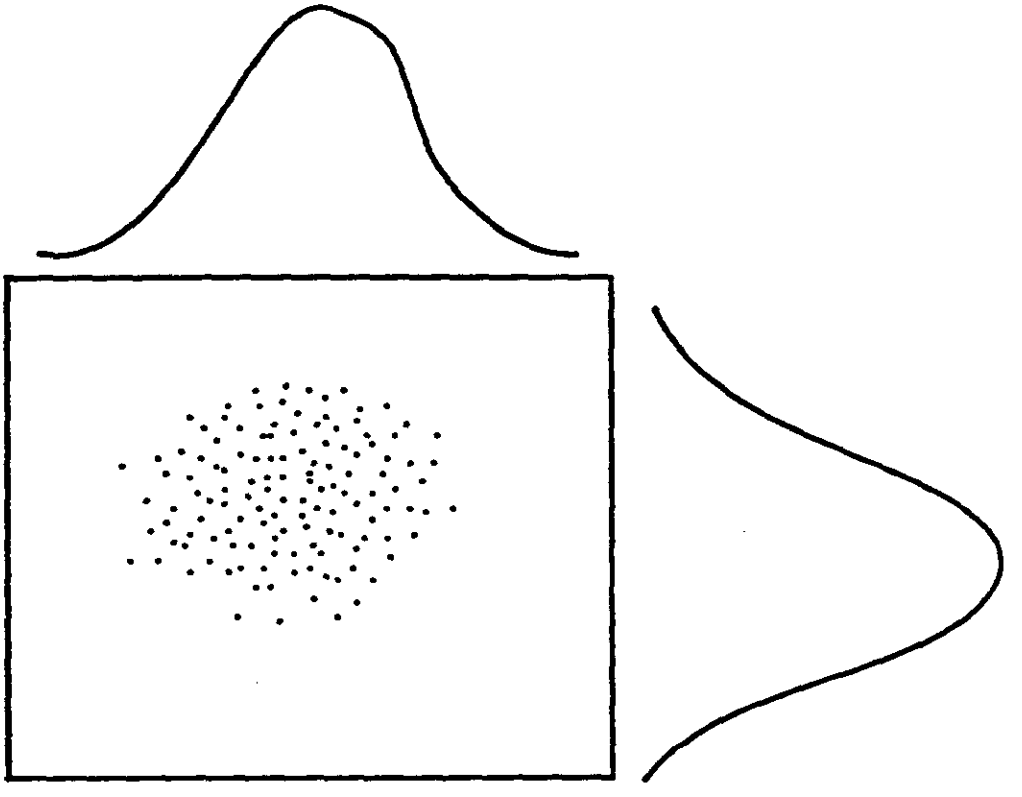
A nondestructive beam profile monitor for the SSC is presented using as a probe a low energy electron beam interacting with the proton bunch charge. Results using a full Monte Carlo simulation code look promising for the tranverse and longitudinal beam profile measurements. Further detailed studies of the process are needed, including construction of a prototype of the device and testing its performance on high energy beams.

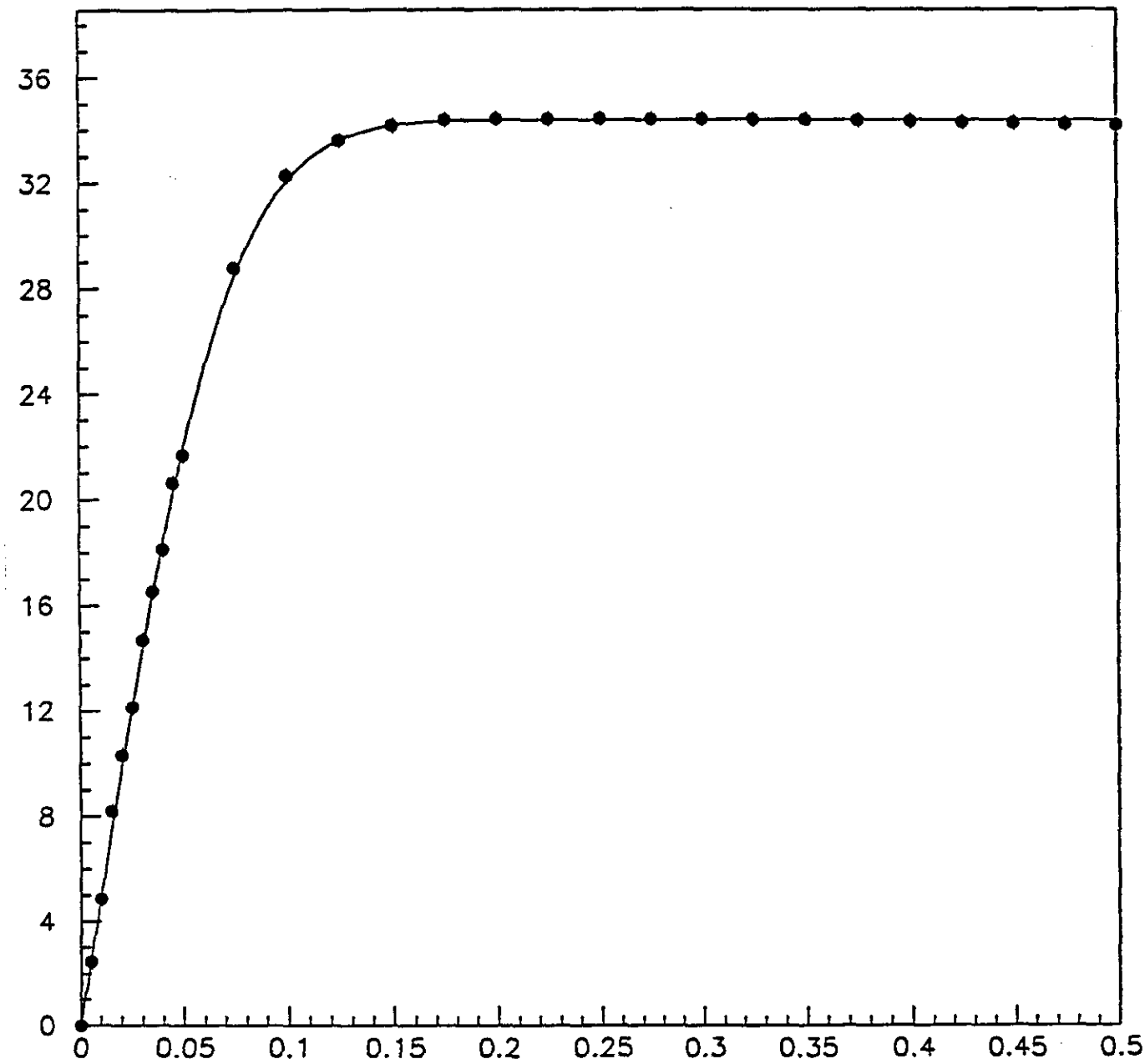
ELECTRON BEAM EMITTANCE MONITOR

- PRINCIPLES
- CALCULATION OF DEFLECTION ANGLES
- COLLIMATED ELECTRON BEAM, BUNCH PARAMETERS
- WIDE ELECTRON BEAM, BUNCH PARAMETERS

ELECTRON BEAM PROFILE MONITOR

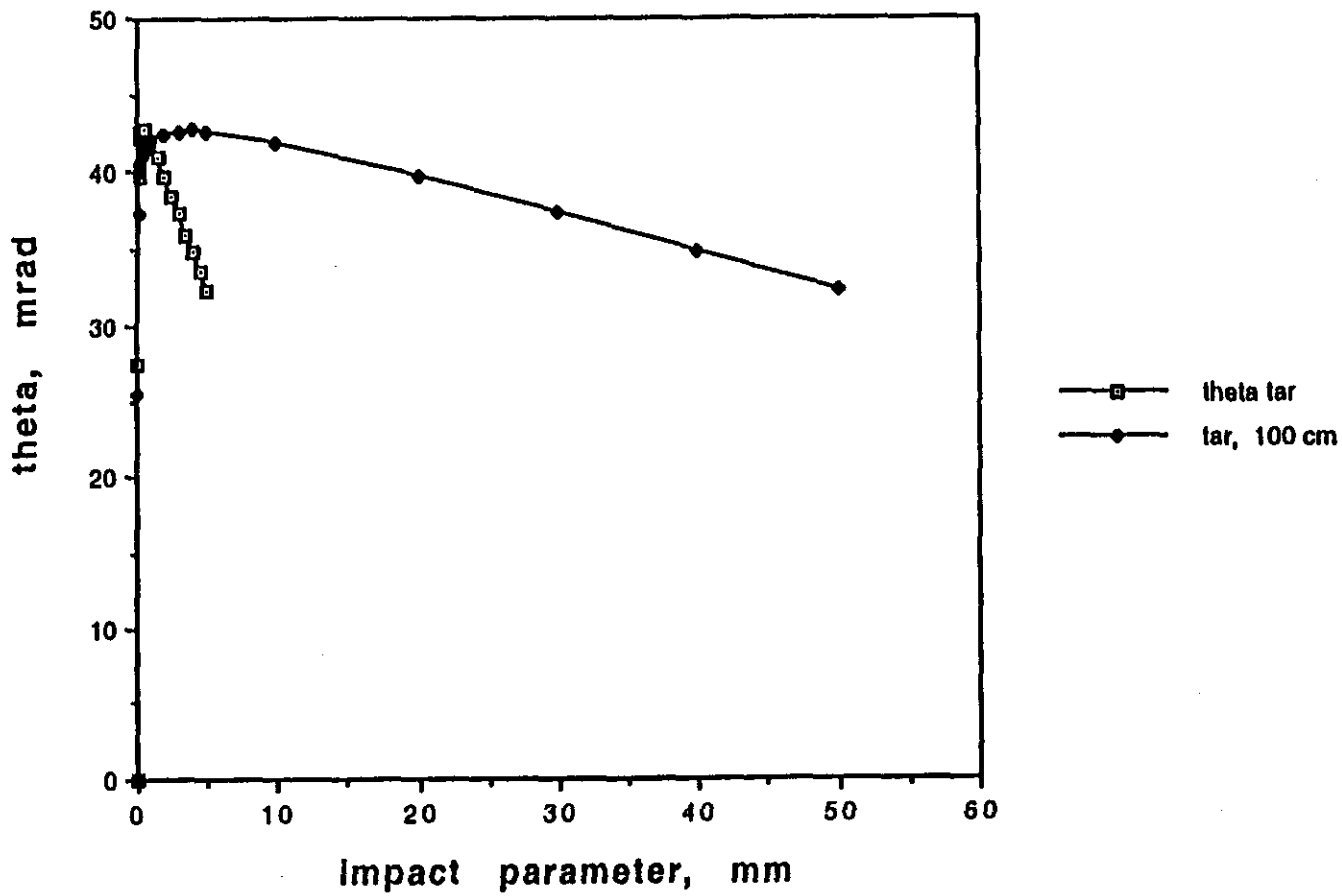






Deflection angles (mrad) versus impact parameter (mm)

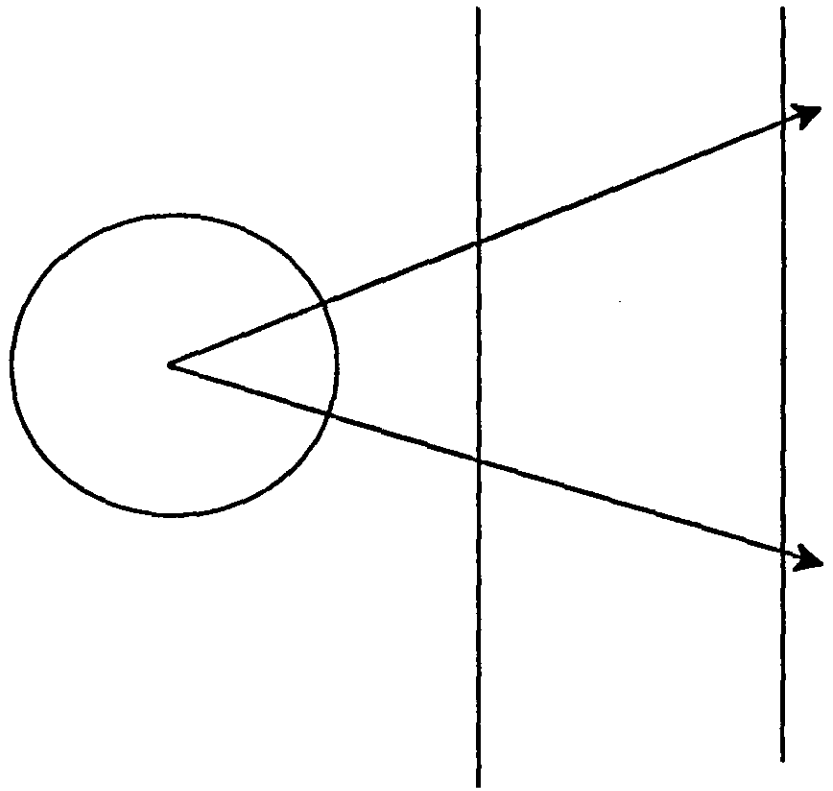
SHORT BUNCH AND LONG BUNCH

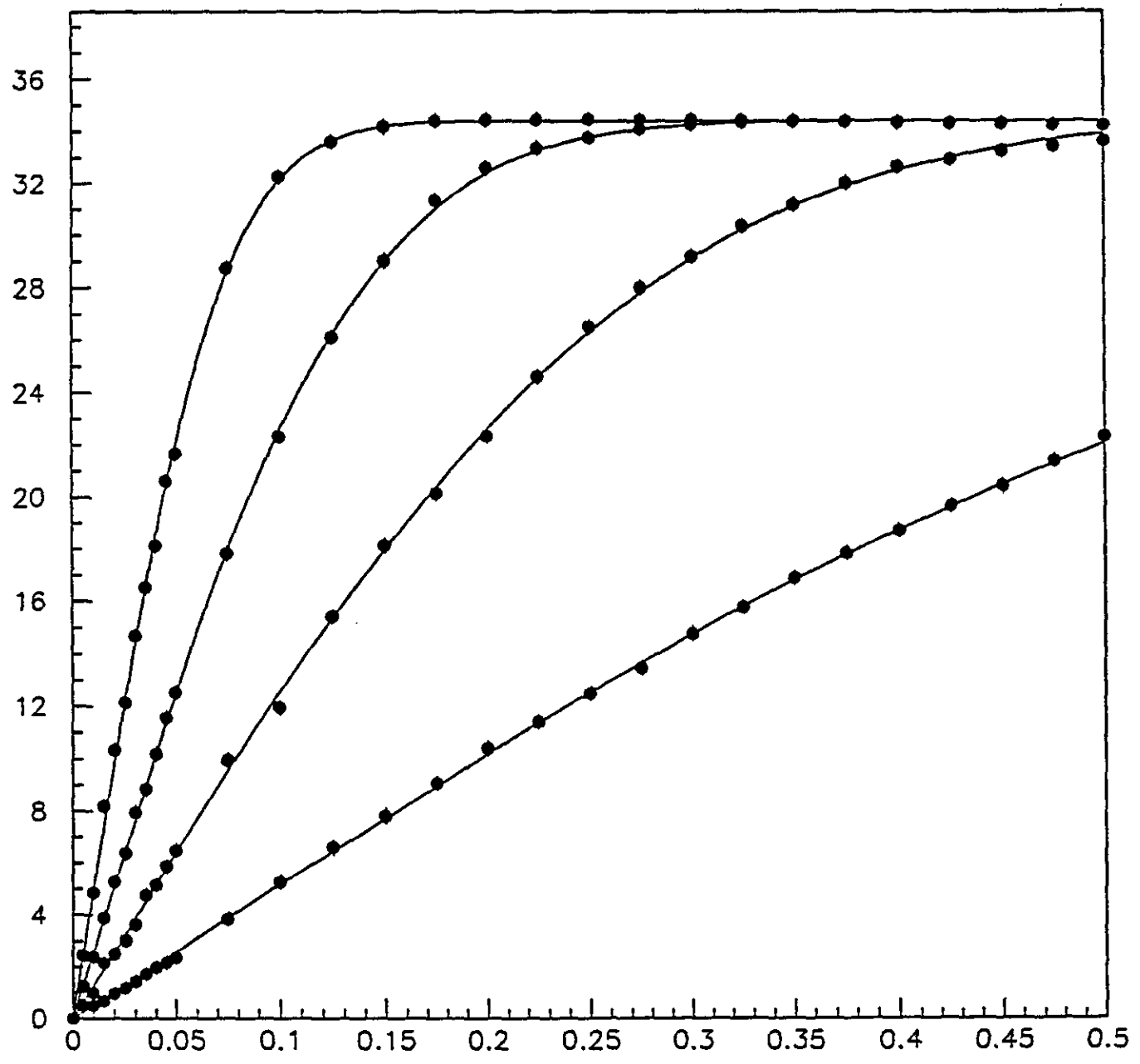


F = A/R

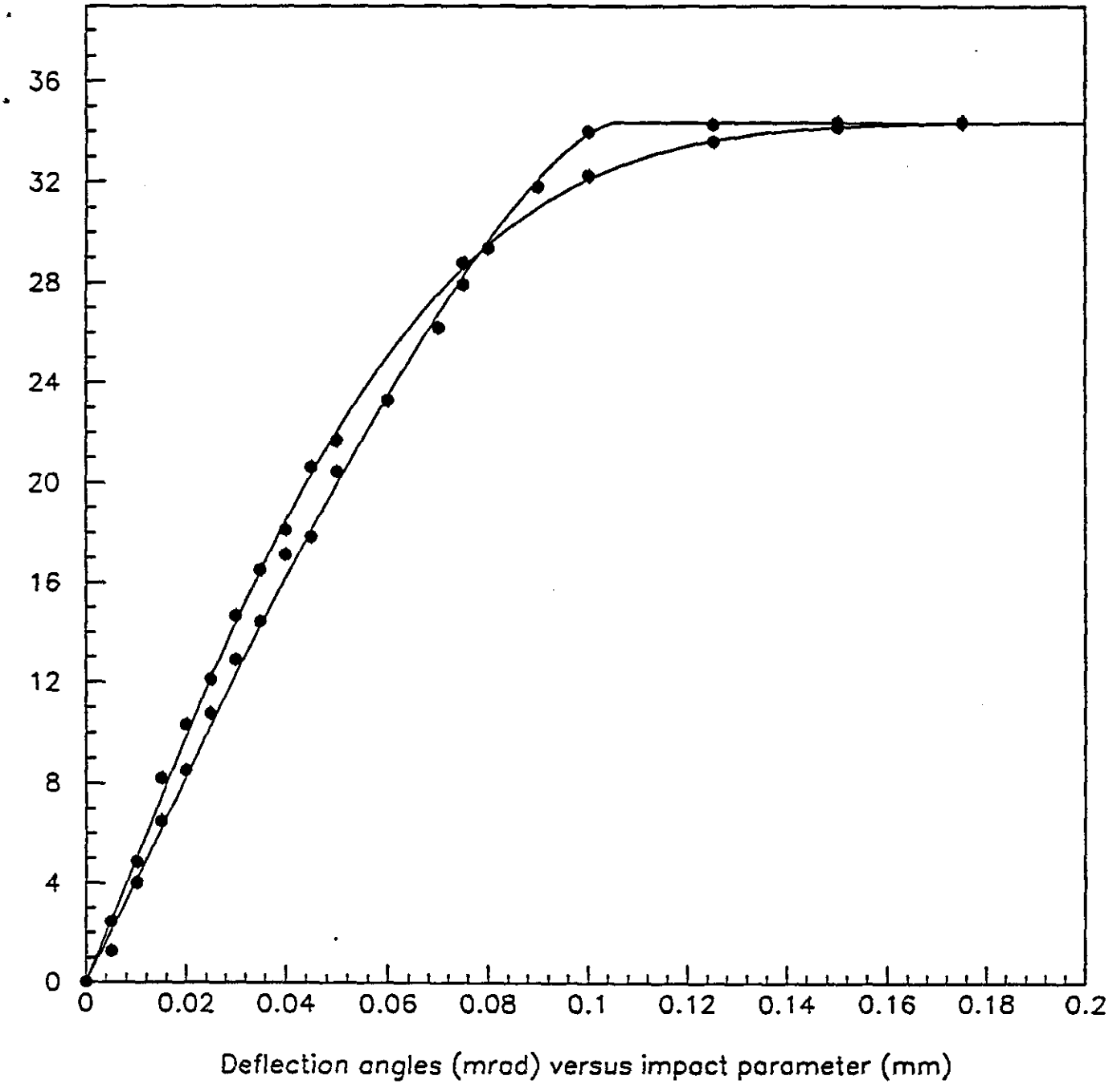
t = BR

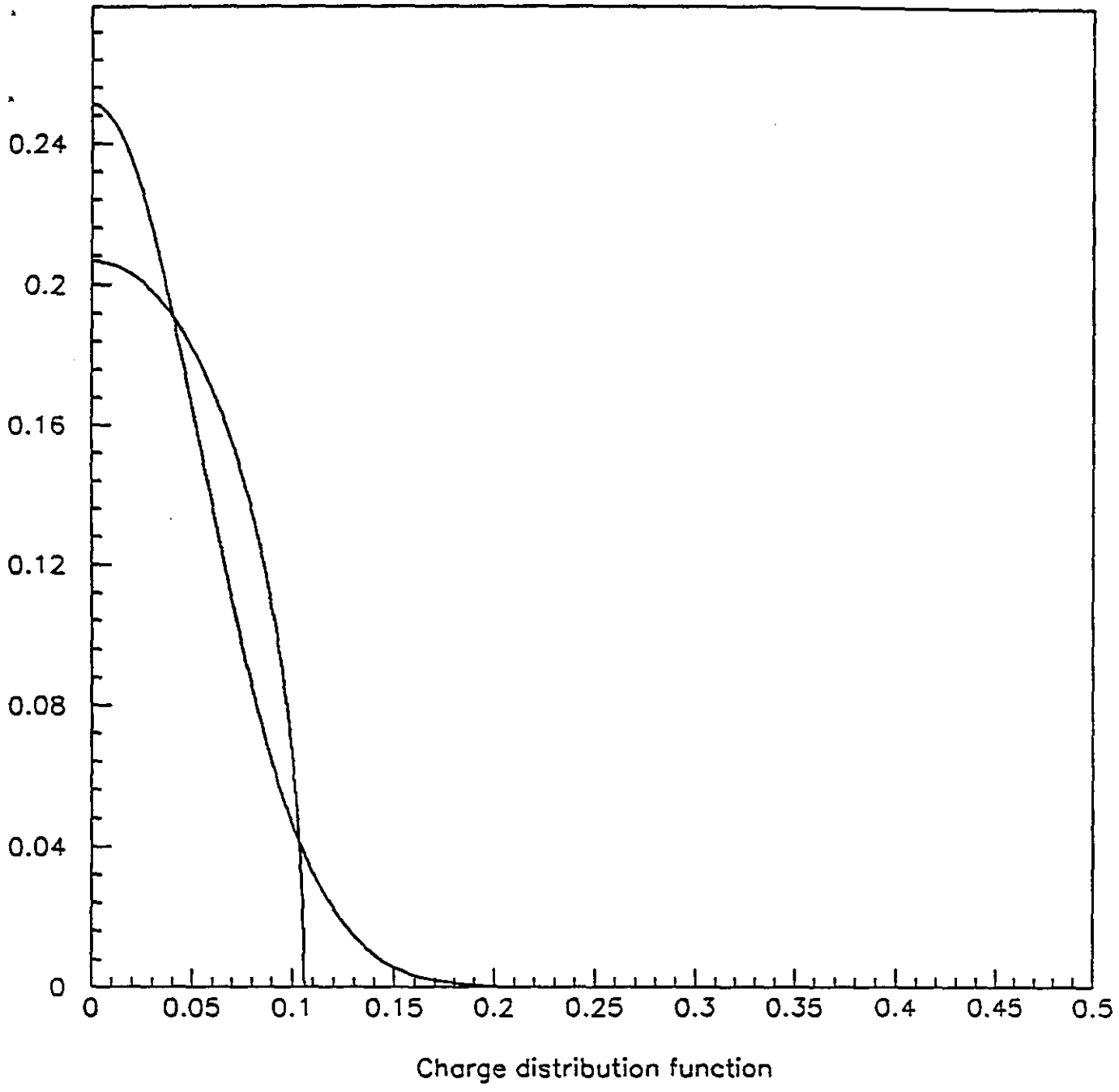
Ft = AB





Deflection angles (mrad) versus impact parameter (mm)


36
32
28
24
20
16
12
8
4
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
Deflection angles (mrad) versus impact parameter (mm)


0.24
0.2
0.16
0.12
0.08
0.04
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Charge distribution function

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	P1	0.54538E-01	0.15797E-05	0.65015E-08	-24434.

CHISQUARE = 0.1173E+01 NPFIT = 13

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	P1	0.10598	0.46656E-05	0.16874E-06	-1414.2

CHISQUARE = 0.2297E+00 NPFIT = 19

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	P1	0.21128	0.38477E-05	0.44812E-07	1469.4

CHISQUARE = 0.5254E+00 NPFIT = 27

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	P1	0.49920	0.74952E-05	0.59510E-07	621.97

CHISQUARE = 0.4182E+00 NPFIT = 36

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	P1	0.10553	0.15515E-05	-0.26794E-08	4716.4

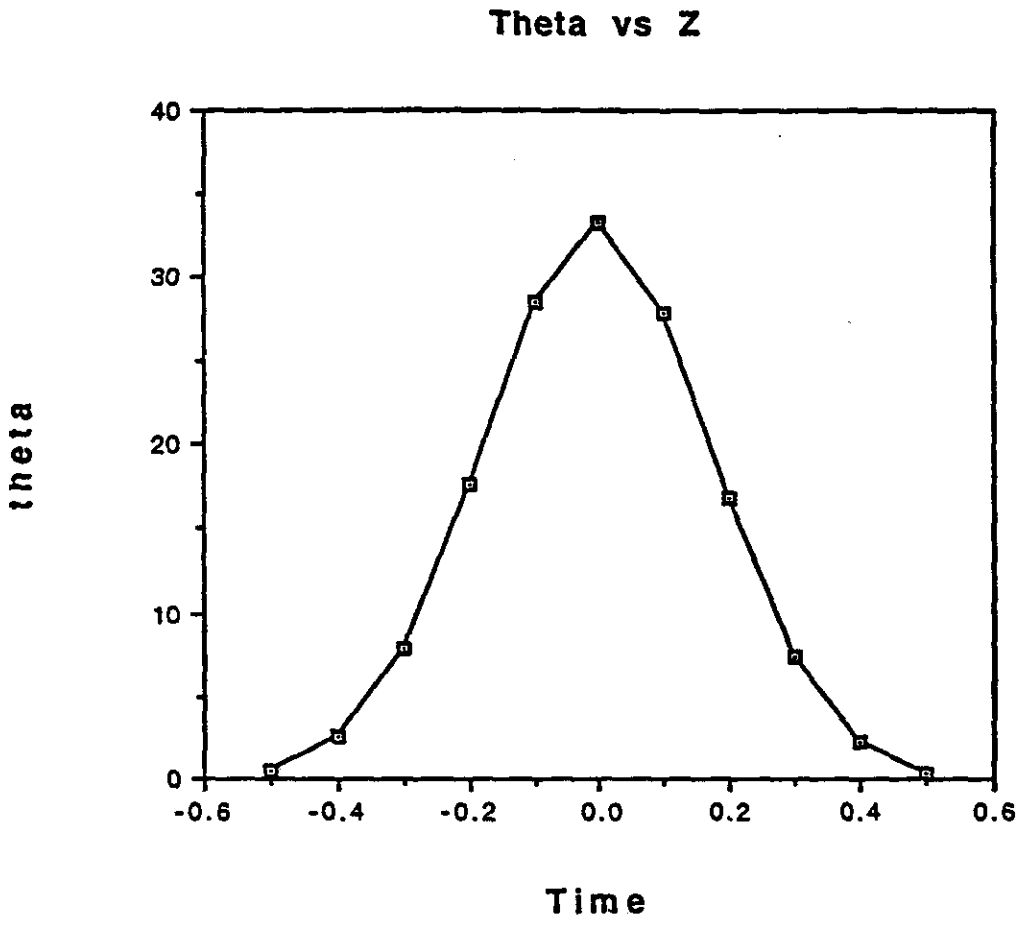
CHISQUARE = 0.1628E+01 NPFIT = 23

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	P1	0.10578	0.19016E-05	0.67197E-08	2217.4

CHISQUARE = 0.1136E+01 NPFIT = 31

EXT PARAMETER NO.	NAME	VALUE	ERROR	STEP SIZE	FIRST DERIVATIVE
1	P1	0.54498E-01	0.72779E-06	0.32359E-08	3448.2

CHISQUARE = 0.5407E+00 NPFIT = 27


Theta vs Z
40
30
20
10
0
theta
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
Time

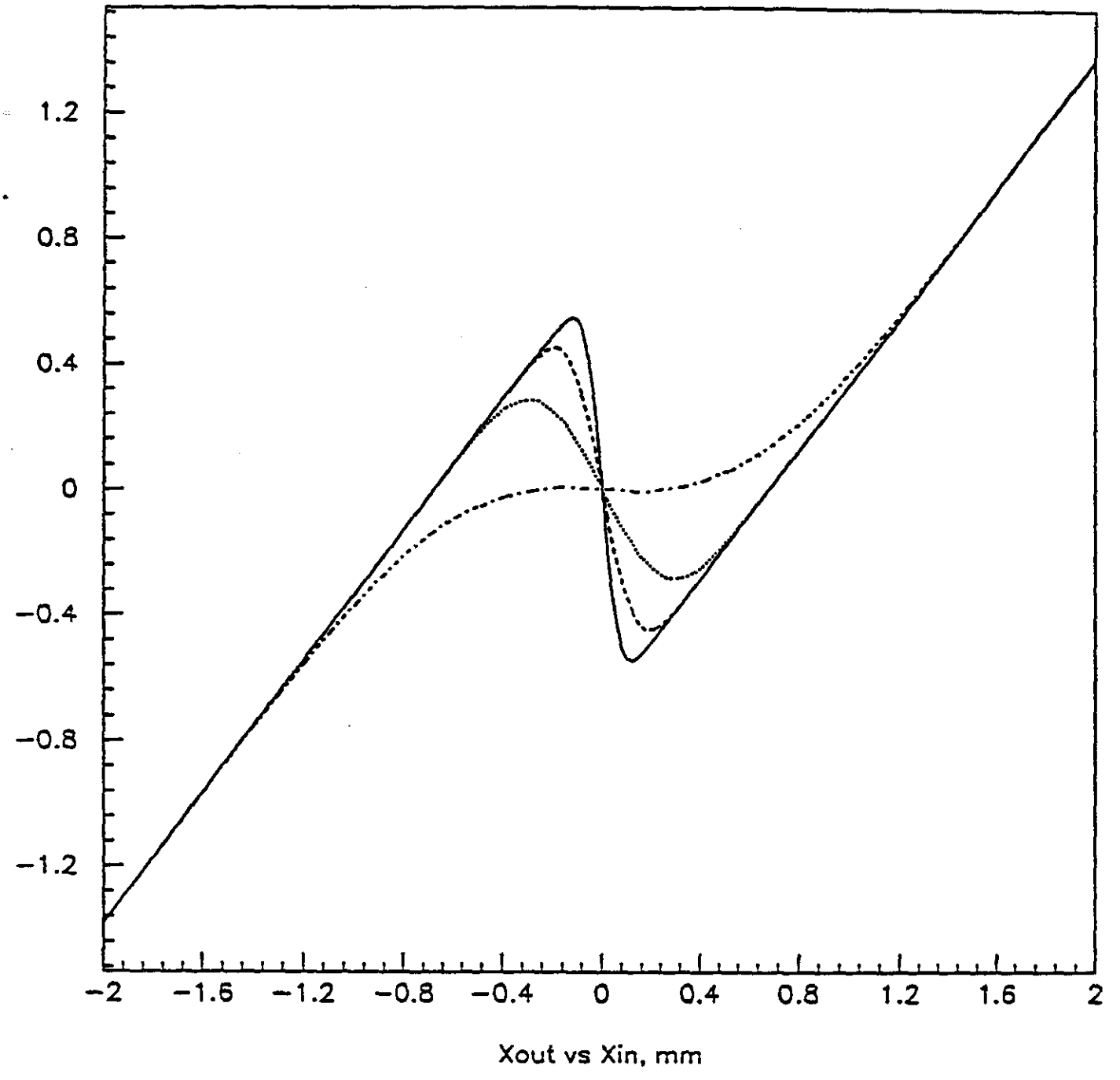


Figure 6. X-position of an electron at the plane Y = 2 cm versus its X-position at the plane Y = -1 cm. Solid line is for Gaussian beam with sigmaX = sigmaY = 50 micrometers, dashed line - for 100 micrometers, dotted line - for 200 micrometers, dash-dotted line - for 500 micrometers.

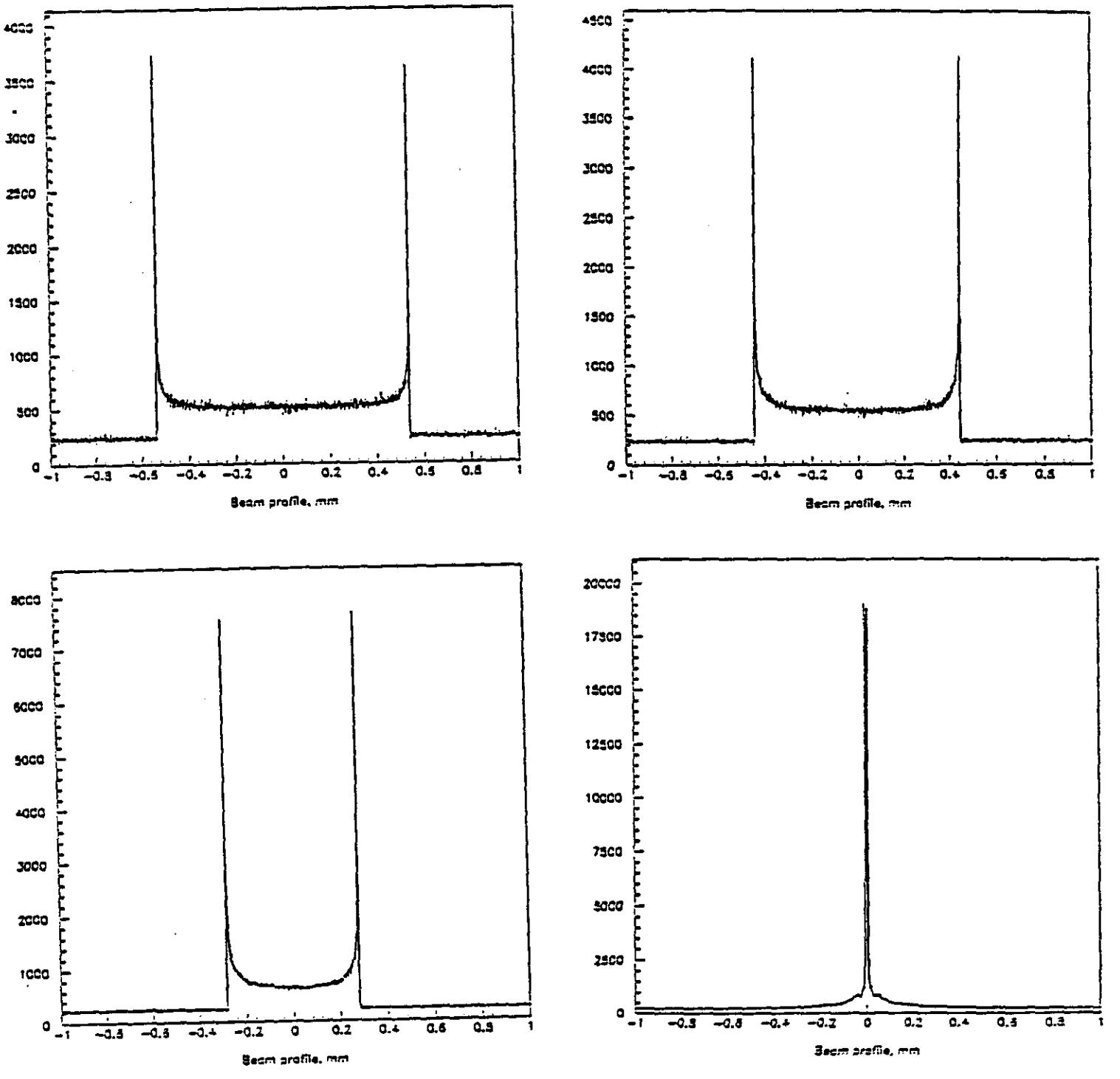


Figure 7. Electron beam profiles at the plane Y = 2 cm for different proton beam sizes. Upper left - for sigma 50 micrometers, upper right - for sigma 100 micrometers, lower left - for sigma 200 micrometers, lower right - for sigma 500 micrometers. Uniform distribution of the electron beam from -2 mm to +2 mm with no angular divergence is assumed at the plane Y = -1 cm. 10^6 electrons are used.

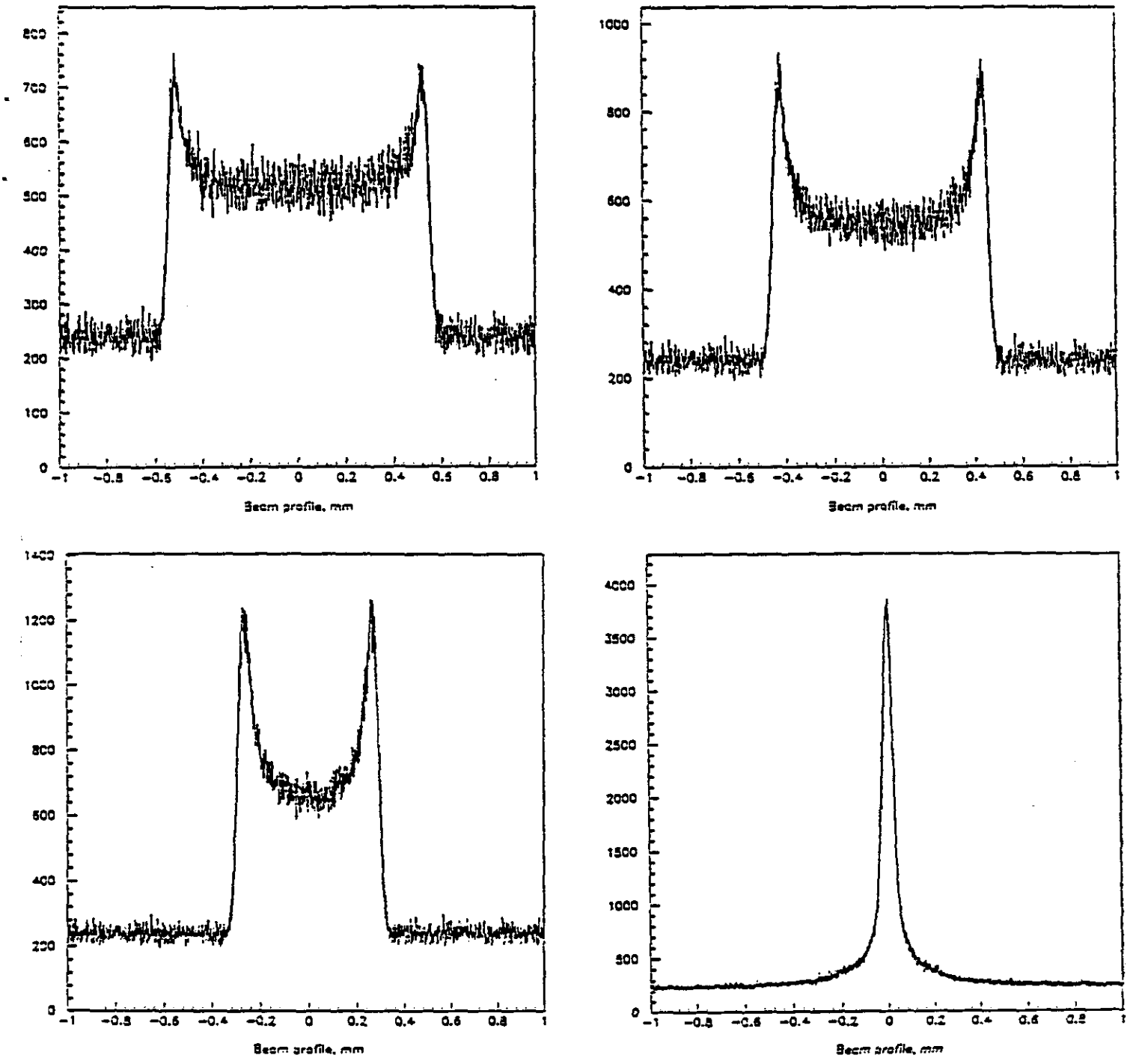


Figure 8. The same, as on Figure 7, but Gaussian divergence with sigma of 1 milliradian is used for the primary electron beam.

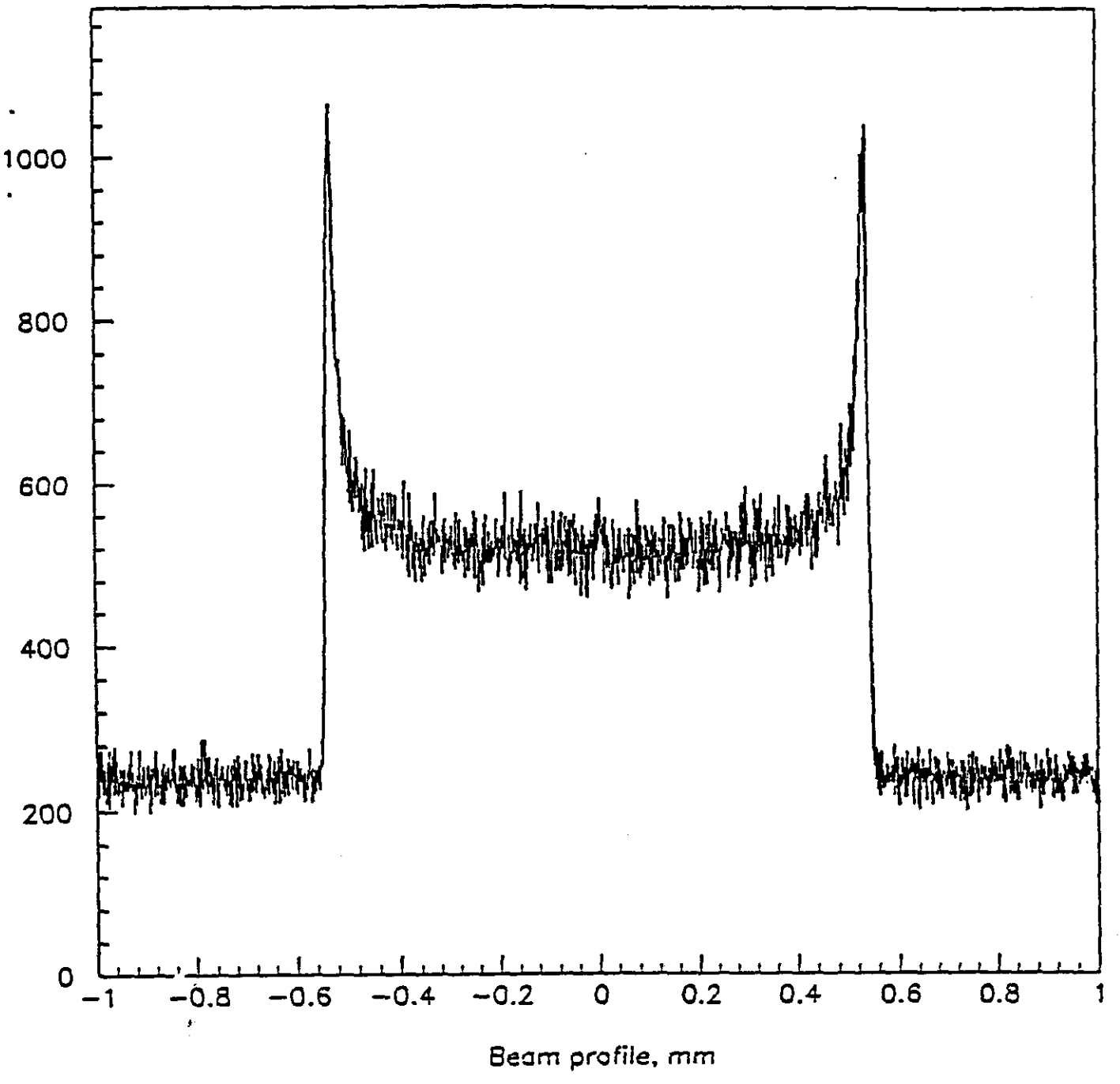


Figure 9. The same, as on figure 7 for sigma 50 micrometers (upper left), but Gaussian energy spread of 1% is introduced.

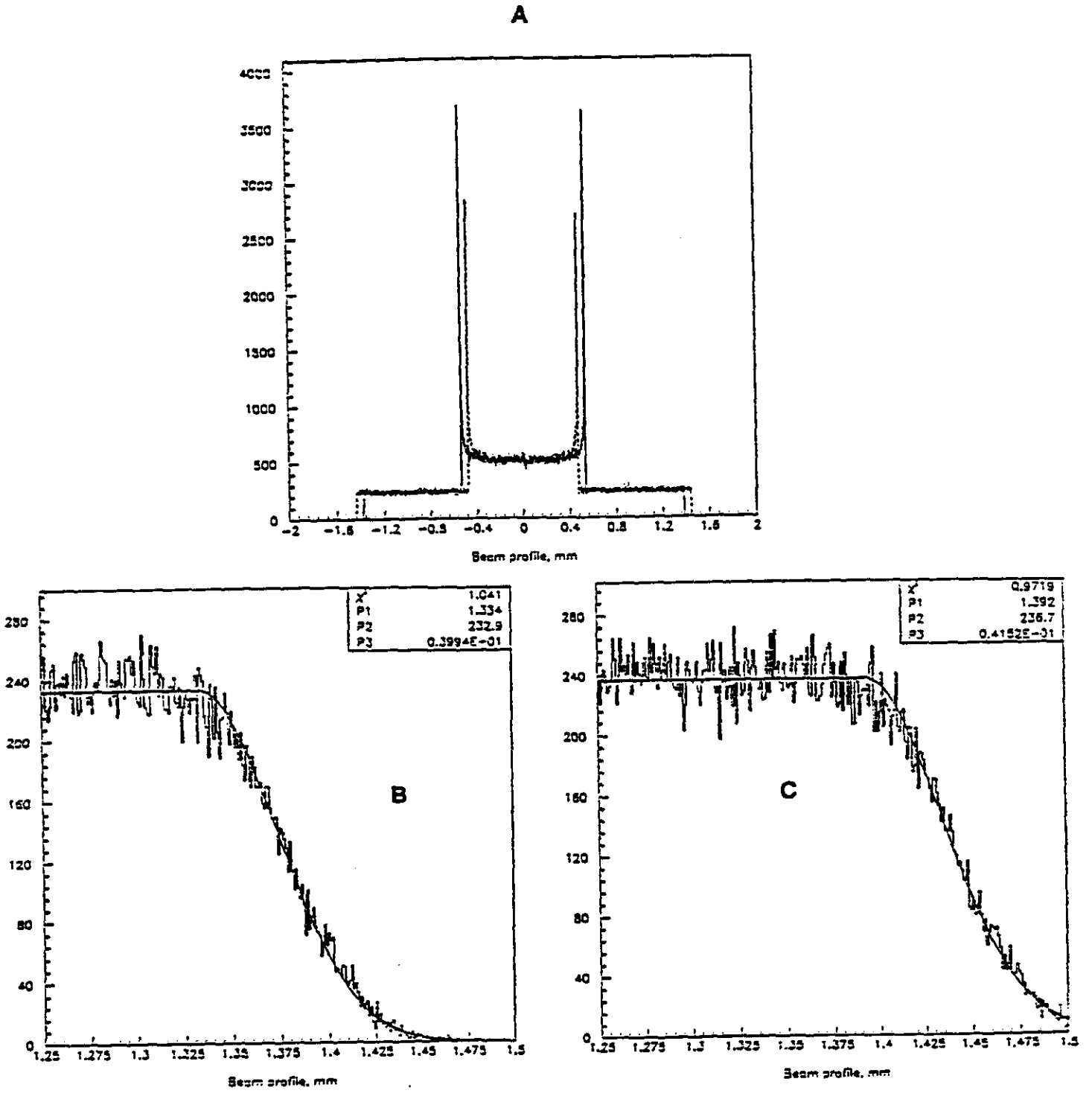


Figure 10. On figure **A** the X-distrubution of electrons at the plane Y = 2 cm is presented for the two bunch intensities - $1.0 \cdot 10^{10}$ protons and $0.9 \cdot 10^{10}$ protons. 10^6 initial electrons at Y = -1 cm with no angular spread are distributed uniformly from X = -2 mm to X = 2 mm. One can see the sensitivity of the edges of the distribution to the bunch charge density. On figures **B** and **C** the edges of the distributions are presented separately with introduction of 1 milliradian angular spread in the electron beam. Solid lines on figures **B** and **C** represent a fit.

K. Kauffmann

Interpretation of the electron beam profile monitor data

In the approximation of the infinitively long bunch (in comparison to its X- and Y- sizes) and using the small angle or eiconal approach it is shown that the derivative of the deflection angle as a function of the X-coordinate (impact parameter) of the probe electron beam is proportional to the Y-integrated profile of the transverse beam charge distribution. This happen to be precisely the same information as one obtain from a flying wire method.

From E. Tsyganov, et al.

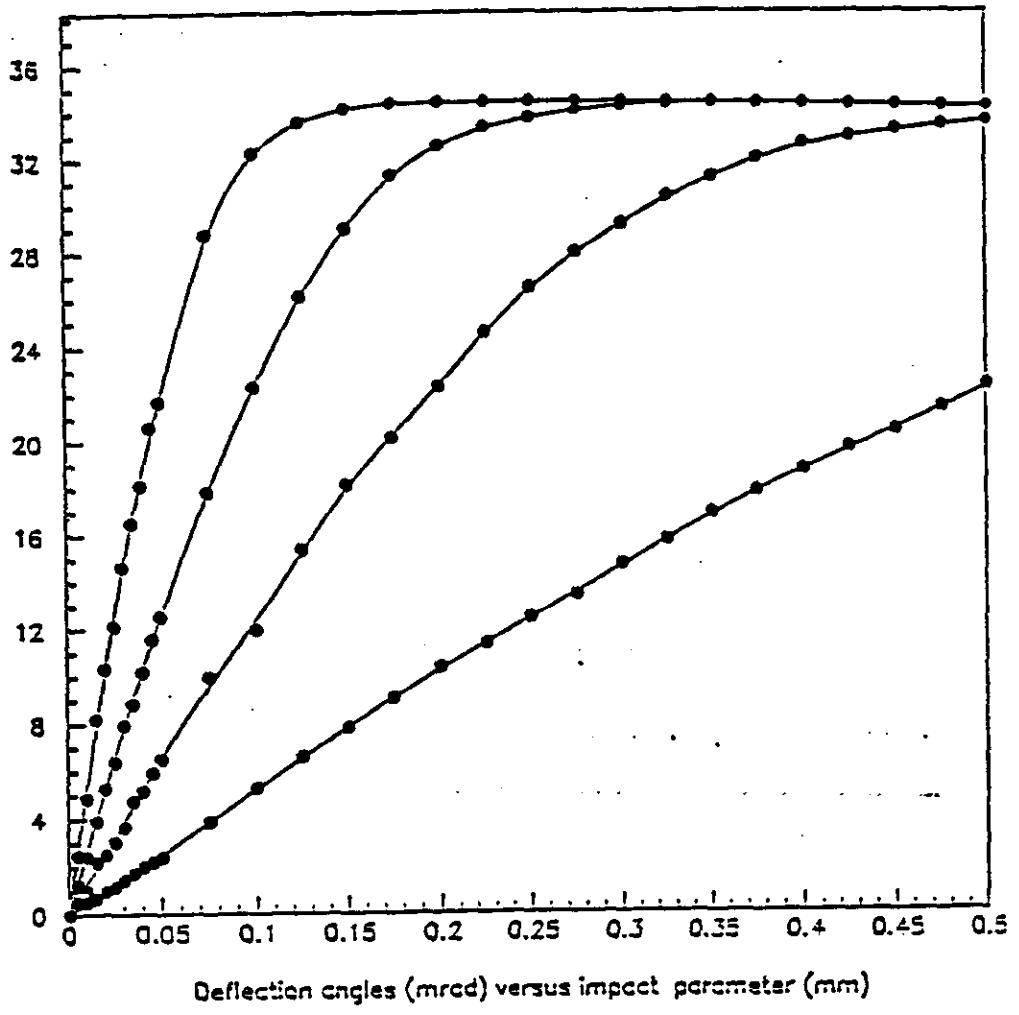


Figure 4. Deflection angles versus electron beam positions relatively to the center of a proton bunch. Data for three dimentional Gaussian distributions of the bunch charge with sigmaX = sigmaY equal to 50 um, 100 um, 200 um and 500 um. SigmaZ is equal to 5 cm. Smooth curves represent an interpolation of the simulation data.

If bunch length is large compared to its thickness and the electron deflections are small, can we find a simple model for the constant deflection angle at large impact parameters?

Try infinite line charge model,

$$\vec{F}(\vec{r}) = -2 e q_L \frac{\vec{r}}{|\vec{r}|^2} \quad ,$$

q_L is the charge per unit length,
e is the electron's charge,
$\vec{F}$ is the force.

Asymptotic change in momentum,

$$\Delta \vec{p} = \int_{-\infty}^{\infty} dt \; \vec{F}(\vec{r}(t))$$

(next)

Since ultimate deflection is small, we can approximate $\vec{r}(t)$ by its initial asymptote,

$$\vec{r}(t) \approx (b, vt),$$

where b is impact parameter, v is electron speed. So,

$$\Delta\vec{p} = -2eq_L \int_{-\infty}^{\infty} dt \, \frac{(b, vt)}{b^2 + (vt)^2}$$

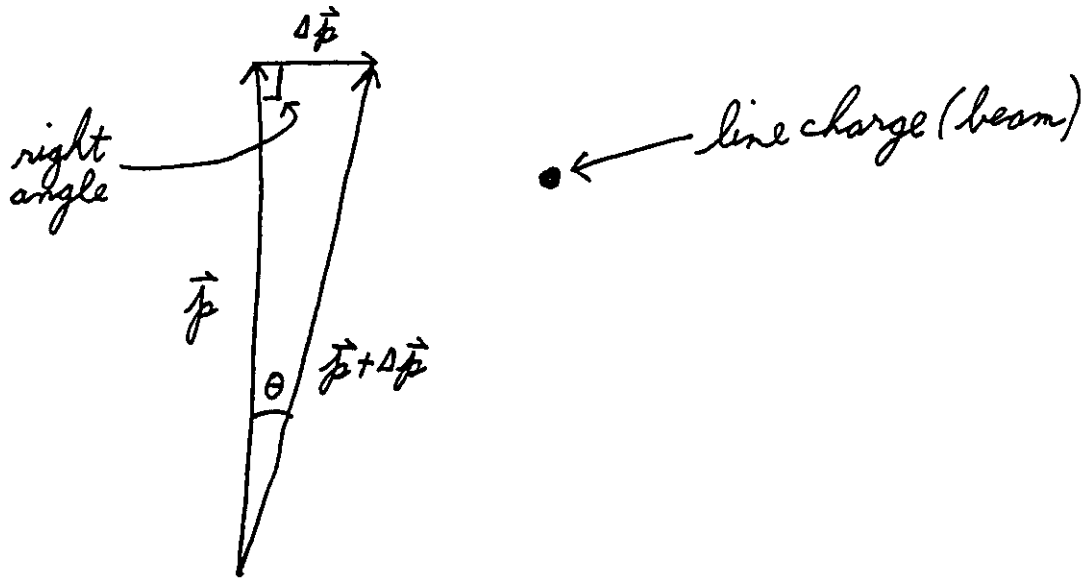
$$= \frac{-2\pi e q_L \, \mathrm{sgn}(b)}{v} (1, 0),$$

where sgn is the sign function,

$$\mathrm{sgn}(x) = \begin{cases} +1 & \text{if } x > 0 \\ -1 & \text{if } x < 0 \end{cases}.$$

Note that $\Delta\vec{p}$ is at right angles to $\vec{p} = (0, m\gamma v)$.

(next)



So, $\dfrac{|\Delta\vec{p}|}{|\vec{p}|} = \tan\theta \approx \theta$ for assumed small deflection.

Thus, for line charge model,

$$\theta(b) = \frac{-2\pi e\, q_L\, \mathrm{sgn}(b)}{m\gamma v^2},$$

and there is indeed no variation in the deflection angle θ as a function of impact parameter b except for the jump in θ to its opposite sign for negative b ("other side" of the line charge).

Now let's get more ambitious. Extend this model to arbitrary X-Y charge distribution, still constant in Z-direction.

(next)

Linear charge distribution $\rho_L(X,Y)$, (or $\rho_L(\vec{r})$)

$$q_L = \int_{-\infty}^{\infty} dX \int_{-\infty}^{\infty} dY\, \rho_L(X,Y) = \int d^2\vec{r}\, \rho_L(\vec{r}).$$

Now,

$$\vec{F}(\vec{r}) = -2e \int d^2\vec{r}\,' \rho_L(\vec{r}\,') \frac{(\vec{r}-\vec{r}\,')}{|\vec{r}-\vec{r}\,'|^2}.$$

Again, $\Delta\vec{p} = \int_{-\infty}^{\infty} dt\, \vec{F}(\vec{r}(t))$,

and $\vec{r}(t) \approx (b, vt)$, so,

$$\Delta\vec{p} = -2e \int_{-\infty}^{\infty} dX' \int_{-\infty}^{\infty} dY' \rho_L(X',Y') \int_{-\infty}^{\infty} dt \frac{(b-X', vt-Y')}{(b-X')^2+(vt-Y')^2}$$

$$= \frac{-2\pi e}{v} \int_{-\infty}^{\infty} dX' \int_{-\infty}^{\infty} dY' \rho_L(X',Y') \operatorname{sgn}(b-X')\,(1,0).$$

Again, since $\Delta\vec{p}$ is at right angles to $\vec{p} = (0, m\gamma v)$,

(next)

$$\theta(b) = \frac{-2\pi e}{m\gamma v^2} \int_{-\infty}^{\infty} dX \int_{-\infty}^{\infty} dY \, \rho_L(X,Y) \, \mathrm{sgn}(b-X) .$$

If the impact parameter b is beyond the X-range in which $\rho_L(X,Y)$ is non-vanishing, we recover the line charge result,

$$\theta(b) = \frac{-2\pi e q_L \, \mathrm{sgn}(b)}{m\gamma v^2} .$$

Even more interestingly, since

$$\frac{d}{db} \mathrm{sgn}(b-X) = 2\,\delta(b-X),$$

where δ is the Dirac delta function,

$$\frac{d\theta}{db} = \frac{-4\pi e}{m\gamma v^2} \int_{-\infty}^{\infty} dY \, \rho_L(b,Y) .$$

But, $\int_{-\infty}^{\infty} dY \, \rho_L(b,Y)$ is just the beam profile one gets from a probe wire ("flying wire") which passes $\perp$ to the beam through the X-value b in the Y-direction!

(next)

So, for small deflections, and assuming that the bunches are far longer than they (the beam) are thick, the <u>derivative</u> of the electron deflection angle with respect to <u>impact parameter</u> gives the "flying wire" type of beam profile information!

In practice, a thin (compared to the beam thickness), steady probe electron beam is maximally deflected by the centers of the beam bunches, less by the bunch margins, and is undeflected by the spaces between the bunches. One gets a "two-spot" pattern, and θ is to be read off the deflected spot's distance from the undeflected spot. Such θ's need to be measured for a range of impact parameter b's, so as to get the beam profile from $\frac{d\theta}{db}$.

From: J. A. Pasour & M. T. Ngo
Mission Research Corp., Newington, VA 22122
Rev. Sci. Instrum. 63(5), May 1992, p. 3027.

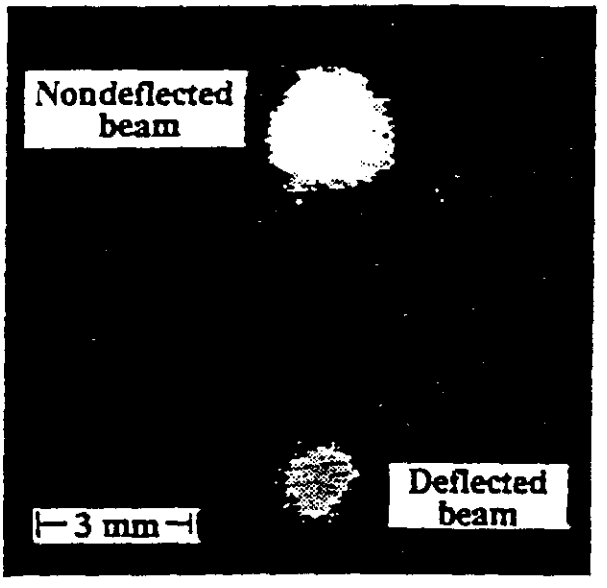


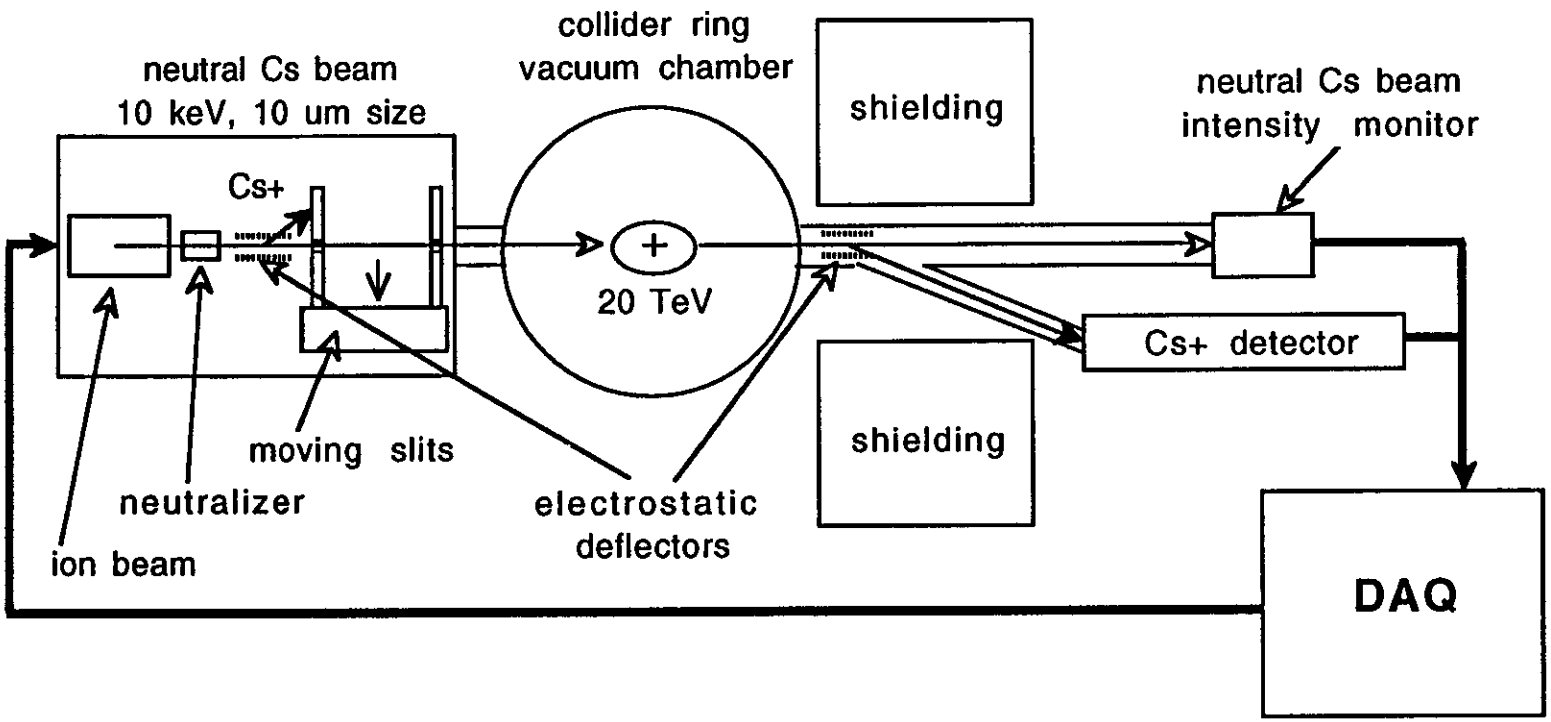
FIG. 19. Image of probe electron deflection by a modulated electron beam.

A. Maschke

Neutral beam profile monitor

The method uses a narrowly collimated beam of neutral atoms, defined by a pare of slits that are a few centimeter long and 5-10 microns high, separated by a distance comparable with the distance needed for the neutral beam to travel before its natural divergence significantly increases its heith. For the SSC beam tube sizes, this distance would be a few at most locations. This beam, upon crossing another, will have a certain fraction ionized. By collecting and counting these ions, we obtain a measure of the beam density in the plane of the neutral beam. As an example, consider a beam of 10 KeV Cesium atoms crossing the path of the collider beam at a typical lattice location, i.e. a beam size of about 100 microns, and the design current of 72 mA. Assuming an ionization cross-section of 10^{-18} cm^2, the ionization fraction is 3.75×10^{-6}. Then, if we want a count rate of 1000 ions/second, we need a neutral beam intensity of 2.7×10^8 atoms/second. To have a flux of about 10^{13} atoms/second with the necessary parameters is quite realistic. Therefore we have ample margin to reduce the slit sizes, and the source brightness. An interesting feature of this method is that, since the defining slits can be precisely referenced from outside of the vacuum chamber, the absolute position of the beam can be inferred.

NEUTRAL BEAM EMITTANCE MONITOR



K. Kauffmann

Molecular beam profile monitor

We report on the status of a research effort aimed at demonstrating the feasibility of an SSC beam profile monitor based upon ionization of a neutral molecular beam directed orthogonally to the proton beam. The molecular beam is thin compared to the 100 um proton beam and may be cylindrical or ribbon shaped. The molecular beam probe is swept slowly across the proton beam using a precision translator, and the total low energy (few eV) ionization products, ions or electrons, are collected by a particle detector/counter system. Hence, this technique is analogous to flying wire profile measurements, but is much less perturbative and potentially much more reliable. We propose to test a prototype diagnostic using a pulsed molecular beam source producing a 10 cm long, 60 um diameter argon beam with a number density of 10^{13}-10^{15} cm^{-3} at the crossing point. A 1 mm diameter, 20 keV electron beam will be used to simulate the proton beam in the initial feasibility tests. We expect ion-electron pair production rates of 10^4-10^8 per second with this apparatus. The ionization products are swept into a detector using a weak transverse electric field of a few 100 V/cm. We will reduce the size of the molecular beam.

Abstract Submitted
to the 1993 IEEE PARTICLE ACCELERATOR CONFERENCE
May 17-20, 1993

Beam Profile Measurement Using Thin Molecular Beams. R. D. RICHARDSON, S. K. KAUFFMANN, A. M. MASCHKE AND W. NEXSEN, SSCL* We report on the status of a research effort aimed at demonstrating the feasibility of an SSC beam profile monitor based upon ionization of a neutral molecular beam directed orthogonally to the proton beam. The molecular beam is thin compared to the ≈100 μm proton beam and may be cylindrical or ribbon shaped. The molecular beam probe is swept slowly across the proton beam using a precision translator, and the total low energy (few eV) ionization products, ions or electrons, are collected by a particle detector/counter system. Hence, this technique is analogous to flying wire profile measurements, but is much less perturbative and potentially much more reliable. We are testing a prototype diagnostic using a pulsed molecular beam source producing a 10 cm long, 60 μm diameter argon beam with a number density of 10^{13}-10^{15} cm^{-3} at the crossing point. A 1 mm diameter, 20 keV electron beam will be used to simulate the proton beam in the initial feasibility tests. We expect ion-electron pair production rates of 10^4-10^8 per second with this apparatus. The ionization products are swept into a detector using a weak transverse electric field of a few 100 V/cm. We will reduce the size of the molecular beam in later tests using smaller diameter collimators or narrow slits.

* Operated by URA, Inc. for the U.S. DOE.

Submitted by:

_____
Signature

Rex D. Richardson
SSC Laboratory
2550 Beckleymeade Av.
Dallas, Tx 75237
Telephone: (214) 708-4537
Fax: (214) 708-5590

Classification Number: 2.2.1
Presentation Option: Poster

(1) Consider a "free jet" of argon gas with aperture 0.3 mm with one atmosphere of pressure in the argon reservoir.

According to "free jet" theory, at a distance x downstream the centerline density can be expected to be,

$$0.12 \times \left(\frac{0.3\,\text{mm}}{x}\right)^2 \times (\text{initial density}) \quad \text{if } x > 4 \times 0.3\,\text{mm}.$$

If we want to place two skimmer-collimators 10 cm apart downstream of the jet, we might wish to place them far enough downstream that the centerline density gas has a mean free path of no less than 10 cm. Since the collisional cross section of argon is about $6 \times 10^{-15}\,\text{cm}^2$, the position x_0 of the first of the two skimmer-collimators should satisfy,

$$0.12 \times \left(\frac{0.03\,\text{cm}}{x_0}\right)^2 \times \left(\frac{6.022 \times 10^{23}}{2.24 \times 10^4\,\text{cm}^3}\right) = \frac{1}{(6 \times 10^{-15}\,\text{cm}^2)(10\,\text{cm})},$$

or $$x_0 = 0.03\,\text{cm}\left(0.12 \times \frac{6.022 \times 10^{23}}{2.24 \times 10^4\,\text{cm}^3} \times 6 \times 10^{-15}\,\text{cm}^2 \times 10\,\text{cm}\right)^{\frac{1}{2}}$$

$$\approx 13.2\,\text{cm}.$$

If we pulse our argon jet, in order to allow for effective pump-out of the residual argon between pulses, and we

(next)

2) minimize "skimmer interference" phenomena by thus putting our first skimmer at 13.2 cm, we can reasonably expect the centerline density past the two skimmers to still be pretty well given by the formula,

$$0.12 \times \left(\frac{0.3\,mm}{x}\right)^2 \times \left(\frac{6.022 \times 10^{23}\ atoms}{2.24 \times 10^4\ cm^3}\right).$$

Now $x \approx 13.2\ cm + 10\ cm + 10\ cm = 33.2\ cm.$

between the skimmer-collimators

vacuum chamber diameter

So gas jet density at the crossing with SSC proton beam $\approx$

$$.12 \times \left(\frac{0.03\ cm}{33.2\ cm}\right)^2 \times \left(\frac{6.022 \times 10^{23}\ atoms}{2.24 \times 10^4\ cm^3}\right) = \underline{\underline{2.63 \times 10^{12}\ atoms/cm^3}},$$

or 7.4×10^{-5} torr.

Now, argon ions produced per second =

(No. of target argons in proton beam) $\times$ (ionization cross section) $\times$ (Proton beam flux).

$$\text{Proton beam flux} \approx \frac{72 \times 10^{-3} \times (6.24 \times 10^{18})\ protons/s}{\pi (2\,\sigma_{beam})^2}, \text{ where } \sigma_{beam} = 0.12\ mm.$$

(next)

3)

Argon ionization cross section for 20 TeV protons $\approx 2.21 \times 10^{-18}\ cm^2$

No. of target argons in proton beam $\approx$

$$(2\sigma_{beam}) \times (2.63 \times 10^{12}\ argons/cm^3) \times \pi \times (5\ \mu m)^2,$$

for argon jet collimated down to 10 μm diameter.

So, no. of argon ions produced per second $\approx$

$$\frac{(2.63 \times 10^{12}/cm^3) \times (5 \times 10^{-4}\ cm)^2 \times (2.21 \times 10^{-18}\ cm^2) \times (72 \times 6.24 \times 10^{15}/s)}{2.4 \times 10^{-2}\ cm} = 2.72 \times 10^{7}\ ions/s.$$

This ion counting rate would swamp a small detector (Amptektron®) of channeltron type, which is limited to 10^6 counts/s. One could use a smaller jet aperture and less argon pressure in the reservior, or a more robust detector.

For proof of principle, it is envisioned to use a 50 μa, 10 keV electron beam with 1 mm spot size in place of the accelerator proton beam.

$$\text{electron flux} = \frac{50 \times 10^{-6} \times 6.24 \times 10^{18}\ electrons/s}{\pi \times (0.05\ cm)^2}$$

(next)

4)

Argon ionization cross section for 10 keV electrons $\approx 10^{-17}\,cm^2$

No. of target argons in electron beam $\approx$

$$(0.05\,cm) \times (2.63 \times 10^{12}\,\text{argons}/cm^3) \times \pi \times (30 \times 10^{-4}\,cm)^2$$

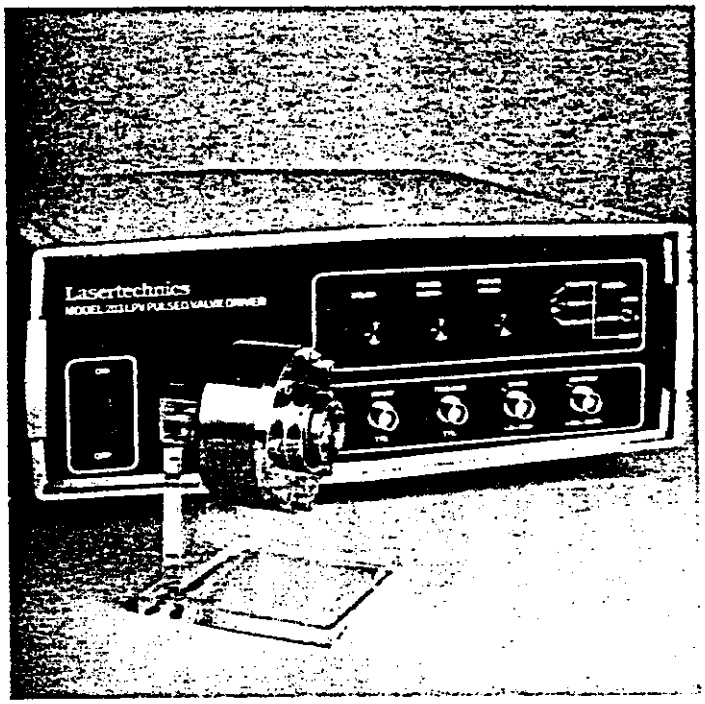
for the smallest diameter (60 μm) skimmers currently available.

So, no. of argon ions produced per second in electron beam test setup $\approx$

$$\frac{(2.63 \times 10^{12}/cm^3) \times (30 \times 10^{-4}\,cm)^2 \times (10^{-17}\,cm^2) \times (50 \times 6.24 \times 10^{12}/s)}{5 \times 10^{-2}\,cm} \approx 1.48 \times 10^6\,\text{ions}/s.$$

So the proof of principle looks very feasible.

THE LASERTECHNICS MODEL LPV PULSED MOLECULAR BEAM VALVE AND MODEL 203B VALVE DRIVER



The Lasertechnics Model LPV Pulsed Molecular Beam Valve produces gas pulses with widths of 150 microseconds and repetition rates of over 500 hertz at temperatures of up to 80° C. All virtual leak volumes are ported for vacuum-immersible operation, which is achieved without water cooling. All materials are corrosion-resistant and the nozzles can be interchanged without removing the LPV from the vacuum chamber.

The active element in the Model LPV is a nickel-plated monomorph crystal which requires electrical pulses of 100 volts and has a maximum power dissipation of 10 milliwatts. The valve can be operated as a continuous beam source or as a pulsed beam source providing square wave modulation and variable pulse widths.

Many applications of supersonic molecular beams involve the coexpansion of two or more components. Under moderate backing pressures (one atmosphere), the seed gas may require 40 to 50 microseconds to attain the flow conditions of the carrier gas after the valve is open. The largest concentration, highest throughput, and lowest attainable temperature of the seed gas may not be realized with pulses shorter than 100 microseconds.

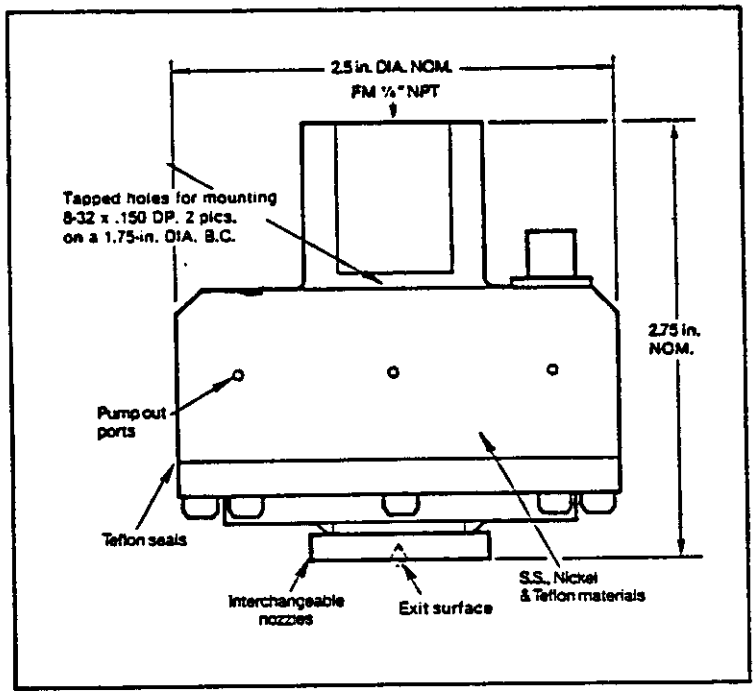
The Model LPV employs interchangeable nozzles which are easily exchanged and adjusted from the outside of the valve. The nozzles are available in three exit-surface configurations. The flat configuration allows ultra-low temperatures to be achieved with a minimum of cluster formation during the gas expansion. The conical (30° full angle) configuration promotes cluster formation at ultra-low temperatures for studies of condensation, Van der Waals complexes and matrix isolation deposition. The tapered configuration allows a laser beam to be focused close to the nozzle orifice without irradiating the nozzle. The nozzles are supplied in non-magnetic 316 stainless steel for applications involving electron beams or the production and collection of ions.

The gas seal at the nozzle is designed to allow nozzle-limited gas flow for maximum throughput and lowest temperatures. Nozzles with orifice diameters of up to 1.0 millimeter are available from Lasertechnics in any exit-surface configuration. Blank nozzles are also available for customers with special requirements.

Designed for easy disassembly, the body of the Model LPV is constructed of 303 stainless steel and supplied with an FM¼" pipe thread to accept a wide range of conversion fittings. The face plate containing the nozzle provides an unobstructed azimuthal view of the nozzle for interaction with the gas pulse at the beginning of its expansion. All threaded holes in the body are ported to eliminate virtual leaks and minimize pump-down time.

SPECIFICATIONS
Model LPV Pulsed Molecular Beam Valve

Active element:	PTZ monomorph disc
Pulse repetition rate:	variable to over 500Hz.
Pulse width:	variable from 150 microsec. FWHM
Opening/closing time:	50 microsec.
Backing pressure:	up to 10 atmospheres
Housing material:	303 stainless
Interior surface materials:	FEP Teflon, stainless, nickel
Dimensions:	Max. diameter, 2.5 in. length, 2.75 in.
Drive voltage:	80 Volts, typical
Power dissipation:	less than 10 milliwatts (no cooling required)
Electrical connection provided:	connector and 3 ft. coax cable
Maximum operating temperature:	80° C
Weight:	560 grams
Gas connection:	FM¼" NPT
Interchangeable nozzles: (User selection)	
Exit surface:	flat, conical or tapered
Orifice diameters:	blank, 0.1, 0.3, 0.5, 1.0 millimeter
	Non-magnetic 316 stainless steel



Model 203B LPV Valve Driver

The Lasertechnics Model 203B LPV Valve Driver provides electrical pulses to control the Lasertechnics Model LPV Pulsed Molecular Beam Valve. It can be used as a delay generator to provide a pulse with a variable delay and width after a trigger pulse or as an internally triggered pulse generator.

Voltage Output (variable):	15 to 100 Volts (75 ohms output impedance)
Risetime (loaded):	30 microseconds
Pulse Width (variable):	0-2 milliseconds
Pulse Delay (from external trigger):	0.1-3.0 milliseconds
Internal Repetition Rate:	2 to 130 hz.
SYNC OUT Voltage:	Output Voltage/10
Trigger Output:	4V
Trigger Input:	4V, 620 ohms

Warranty

Lasertechnics warrants the Model LPV and the Model 203B to be free from defects in materials and workmanship for a period of one year from the date of receipt by the purchaser. The PZT monomorph crystal is the only exception to this warranty. The crystals are warranted for a period of 30 days from the date of receipt by the purchaser.

LPV 10-91 SC

Lasertechnics

5500 Wilshire Avenue, NE
Albuquerque, NM 87113
TELEPHONE (505) 822-1123
FAX (505) 821-2213

Lasertechnics

MODEL LPV MOLECULAR BEAM VALVE

Price List

September 1, 1991

Basic Equipment

LPV Valve (without Nozzle), Part No. 203-2000-00 ..... $ 1,595.00

Model 203-B Valve Driver, Part No. 203-5000-00B 1,295.00

Accessories

Non-magnetic nozzles (specify flat or conical)

Flat: Part No. 203-9000-XX
Conical: Part No. 204-9150-XX

0.1, 0.3 mm ..... $ 220.00

0.5. 1.0 mm, blank 110.00

Tapered Configurations (all sizes)
Part No. 204-9000-XX 220.00

Replacement Crystals, Part No. 203-3201-05 ..... 295.00

Additional Information

- Prices are valid for shipments to U.S. and Canada only. Overseas shipments are subject to a 10% surcharge.
- Prices are in U.S. dollars and are subject to change without notice. Freight charges and applicable taxes, if any, are additional.
- FCA/FOB is Albuquerque, NM, unless otherwise specified.
- Payment Terms: U.S & Canada, Net 30 Days
  Overseas, Letter of Credit or Advance Payment.

5500 Wilshire Avenue NE, Albuquerque, NM 87113 (505) 822-1123 FAX (505) 821-2213

SERIES 9

PULSED SOURCE FOR MOLECULAR BEAM LASER SPECTROSCOPY EXPERIMENTS

GENERAL VALVE CORPORATION's SERIES 9 High Speed Solenoid Valve is available in a flange mount, axial flow, two-way Normally Closed version. Constructed of corrosion resistant materials, this field proven unit provides extreme repeatability and will operate at pulse widths of 160 microseconds. Capable of operating at pressures up to 85 atmospheres and 120 Hz. supersonic gas pulses can be delivered with "First shot" accuracy. A variety of inlet fittings are available including 1/8" or 1/4" Swagelock male connectors, 1/4"-28 straight thread or standard pipe fittings.

Supersonic carrier gas pulses for helium, Ar., etc. can be controlled in place of "CW," therefore reducing the size and cost of high vacuum systems. Synchronizing the gas pulse to the laser pulse reduces the pumping size, increases the signal to noise ratio and lowers the temperature. Molecules are cooled without changing to liquid and thus higher peak intensities can be achieved, due to the simpler spectra of cold molecules. Less sample is used.

The **SERIES 9** Pulse valves are set for 2 milliseconds at rated voltage. To achieve shorter pulse width, we overdrive the valve: the **IOTA ONE** which we offer for sale applies a 300 volt pulse for 165 microseconds which achieves the short response time. The voltage is then automatically lowered to approximately 8 volts for holding for the duration of the desired pulse width. This technique allows us to achieve short response times and high repetition rates. The **IOTA ONE** operates at a frequency up to 250 Hz. Despite the application of 300 volts, the dropping circuit permits the valve to run cool.

IOTA ONE **$1,995.00***

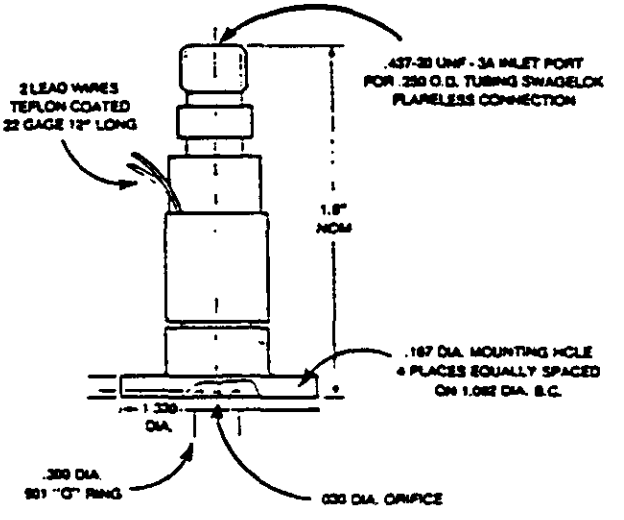
COMPLETE SYSTEM FOR DRIVING THE SERIES 9 FOR PULSED GAS MOLECULAR BEAM EXPERIMENTS.

*Includes SERIES 9 Pulse Valve

FEATURES

- **High speed**
- **Corrosion resistant**
- **Flange mounted**
- **Repeatable pulses**
- **Compact**
- **High rep rates**
- **Field proven**
- **Low cost**

$345.00 each



SPECIFICATIONS

OPERATING PRESSURE
1 x 10^{-9} TORR —85 Atmospheres

RESPONSE TIME
2 MS (At Rated Voltage)

VOLTAGES AVAILABLE

	Current	Power
12 VDC	1.0 Amps	12 Watts
24 VDC	0.5 Amps	12 Watts
28 VDC	.45 Amps	12 Watts

LEAK RATE
1 x 10^{-9} CC Per Sec. HE/ATM

ORIFICE SIZE
.8 Millimeter Standard
(Others available on request)

LEAD WIRES
12" (Teflon Coated)

HIGH CYCLE LIFE WITHOUT LUBRICATION

POTTED COIL

VACUUM OR PRESSURE SERVICE

SIZE
1.33" Diameter x 1.8" High

USE FOR GASES OR LIQUIDS

All Valves are 100% tested to insure maximum performance to rigid specifications. All parts are passivated and ultrasonically cleaned.

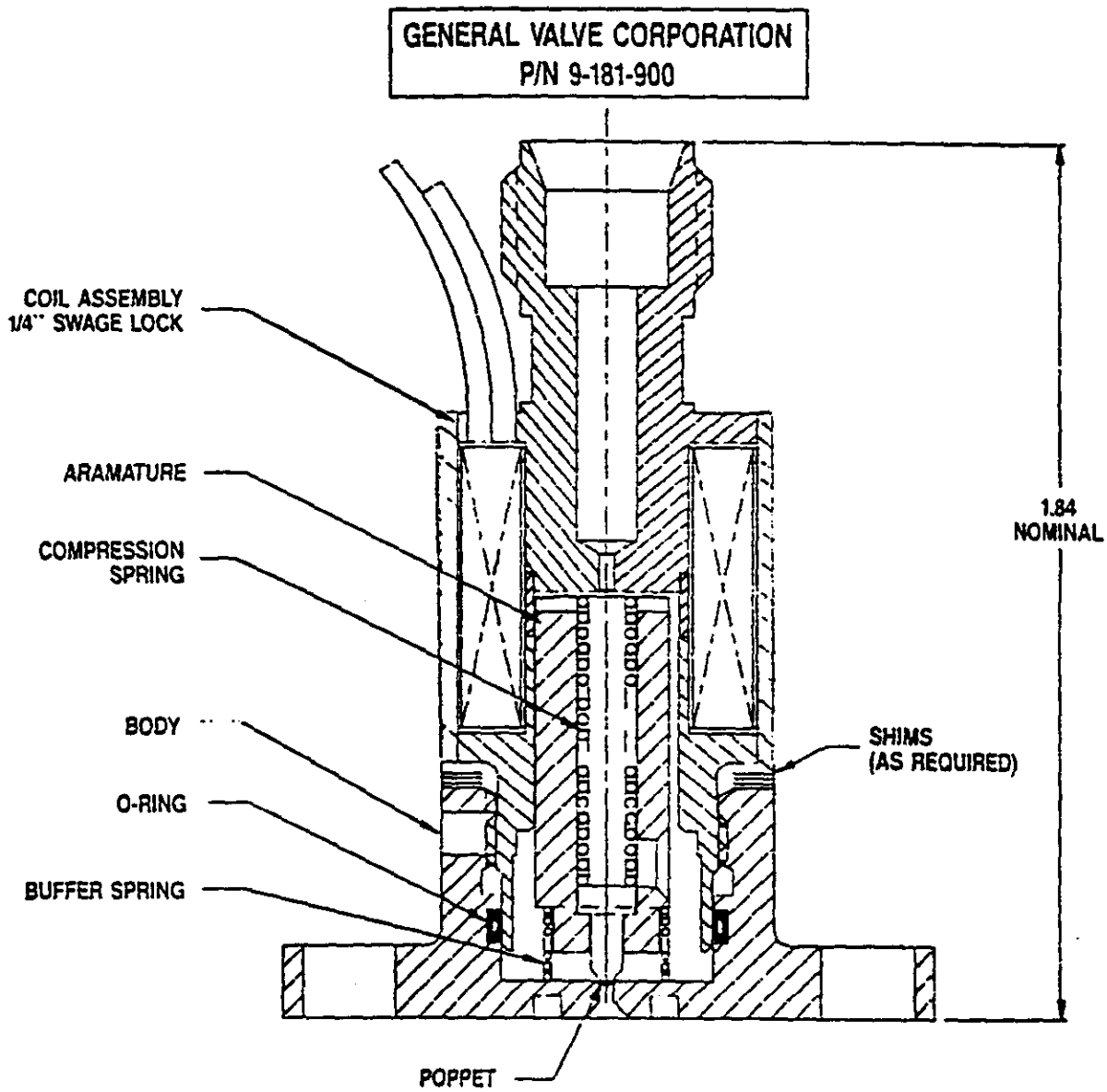
GV GENERAL VALVE CORPORATION
Quality without compromise

19 GLORIA LANE, PO BOX 1333
FAIRFIELD, N.J. 07004
(201) 575-4844 FAX: (201) 575-4011

MAR 1990, REV. A

SERIES 9

PULSED SOURCE FOR MOLECULAR BEAM LASER SPECTROSCOPY EXPERIMENTS



GENERAL VALVE
CORPORATION
Quality without compromise

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FAIRFIELD, N.J. 07004
(201) 575-4844 FAX: (201) 575-4011

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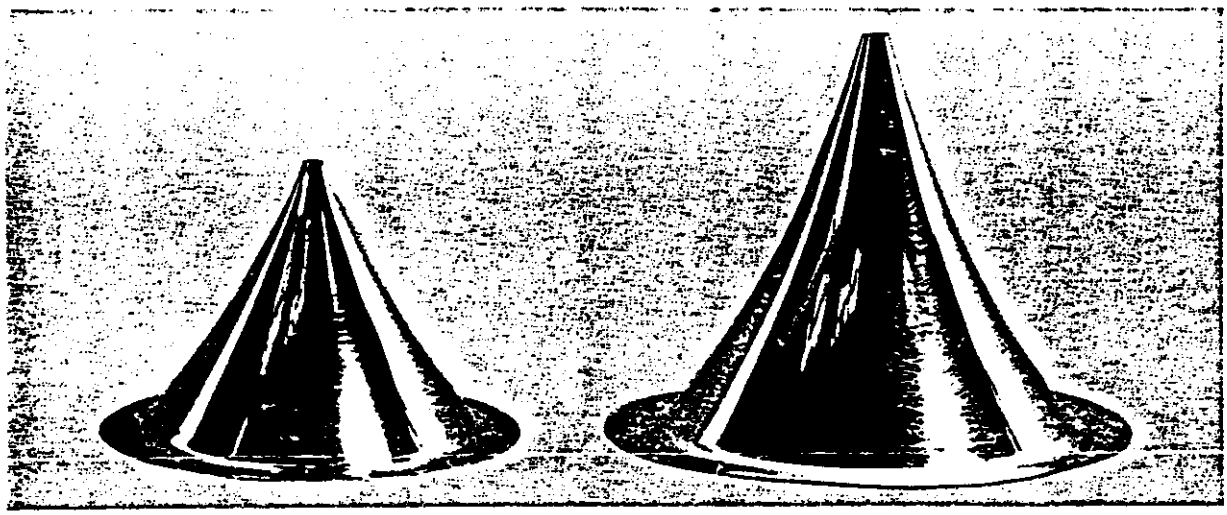
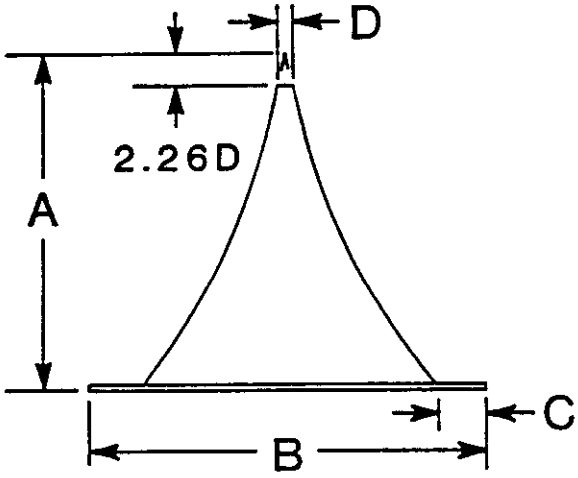
MOLECULAR BEAM SKIMMERS



MODEL 1 MODEL 2

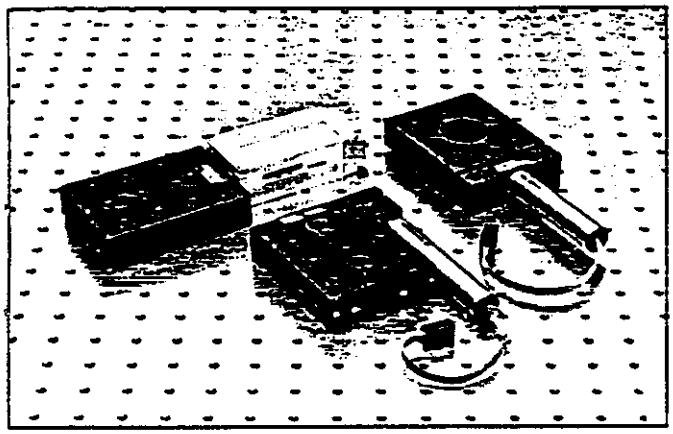
Beam Dynamics, Inc. manufactures two standard skimmer cones with a range of orifice diameters. These feature a very sharp orifice edge and a shape which gives minimal disturbance of the gas passing through the orifice. These models are made from nickel or copper by an electroforming process, and are strong enough to withstand a one atmosphere pressure differential during vacuum system pumpdown. Normally, the nickel skimmer is preferable because it is slightly harder; copper skimmers can be useful when magnetic fields are present. The skimmers have a base which can be clamped in place or soldered with lead-tin or silver solder. Customer-designed skimmers can also be manufactured. In general, there will be a one-time extra charge to cover tooling costs for custom designs.



TECHNICAL SPECIFICATIONS

DIMENSION	MODEL 1	MODEL 2
A. Length (to apex)	1.92 cm (0.750")	2.54 cm (1.000")
B. Base dia.	2.22 cm (0.875")	2.79 cm (1.100")
C. Width of flat part of brim (approx.)	1.0 mm (0.04")	1.5 mm (0.06")
D. Orifice dia.	0.2 mm to 1.3 mm (0.008" to 0.050")	0.2 mm to 2.0 mm (0.008" to 0.080")
	(in increments of 0.1 mm, tolerance ± 0.05 mm)	
Total included angle at orifice	25° internal 30° external	25° internal 30° external
Total included angle at base	70°	70°
Material	Nickel or Copper	Nickel or Copper
Orifice edge thickness	10 um max., 5 um typ.	10 um max., 5 um typ.

BEAM DYNAMICS, INC.
708 East 56th Street
Minneapolis, Minnesota 55420
Telephone: (612) 823-8151



DC and stepping motor driven translators. (We only list the space saving side drive models. Contact the Sales Department for end drive models.)

- **Precise positioning or constant speed scanning**
- **DC or stepping motor actuator driven stages**
- **Remote control via stand alone controller or computer**
- **0.5 and 1 inch travel lengths**
- **Inch and metric mounting surfaces**

For precise submicron or full travel translation of fiber optics, laser focusing assemblies, optical mounts, or most rod or base mounted components, select one of these translators and its matching controller. These linear stages use a DC or stepping motor actuator for high resolution translation over 0.5 or 1 inch (13 or 25 mm). You can remotely control the actuators via a stand alone controller or a computer and controller. See pages 4-40 to 4-59 for controllers.

The moving surface of the translators has an inch or metric hole pattern. Base mounted optical mounts up to 2 inches and any rod mounted component will fit on the mounting surface.

You can couple two of these stages together to build an X-Y or X-Z positioner.

CONSTRUCTION

The movable tops of these translators ride on pre-stressed ball bearings lying in ground hardened steel ways. This enables stable, wobble-free translation even with loads up to 100 lbs (45 kg).

MOTOR MIKE™, ENCODER MIKE™, OR STEPPER MIKE™ DRIVE?

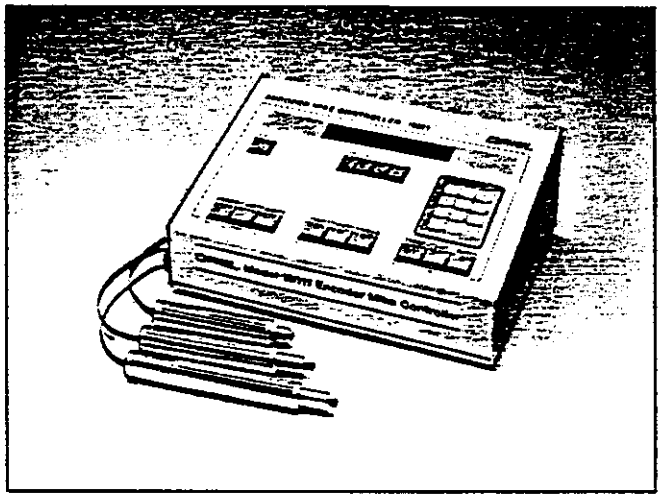
We supply these stages with Motor Mikes™, Encoder Mikes™, or Stepper Mikes™. These actuators are described on the pages listed below; here we summarize the key benefits of each.

Motor Mikes™ (page 4-36)
- Inexpensive and compact
- Submicron resolution
- Variable speed to 300 µm/s
- Regulated velocity for scanning

Encoder Mikes™ (page 4-42)
- Submicron resolution
- Position readout on controller or computer to 0.1 µm
- Variable speed to 300 µm/s
- Highly regulated velocity for scanning

Stepper Mikes™ (page 4-52)
- <2 µm resolution
- Higher speed; to 1 mm/s
- Digital type motion matches computer operation
- Position readout on controller or computer
- Inexpensive computer interfaces and controllers

CONTROLLERS



18011 Encoder Mike™ Controller with Encoder Mikes™.

Our large selection of controllers ensures we have one to meet your needs. We offer inexpensive, single channel controllers; three channel, completely programmable models; and many in between.

ORIEL MOTORIZED HORIZONTAL TRANSLATORS

BUILD COMBINATION POSITIONERS WITH OTHER ORIEL TRANSLATORS

Our family of translators and rotators is modular so you can couple them to make combination positioners. Build an X-Y, X-Z or X-Y-Z with these and the Vertical Translators from page 4-64.

SPECIFICATIONS

	Motor/Encoder Mike™ Driven Translators	Stepper Mike™ Driven Translators
Travel Length:	0.5 or 1 inch (13 or 25 mm)	0.5 or 1 inch (13 or 25 mm)
Angular deviation:	<130 µrad (26 arc sec)	10 µrad (2 arc sec)
Maximum load*:	100 lb (45 kg)	100 lb (45 kg)
Resolution:	<0.1 µm**	<2 µm
Uni-directional repeatability:	<2 µm	<2 µm
Maximum speed:	300 µm/s***	1000 µm/s
Minimum speed:	0.5 µm/s	N/A
Encoder readout: (Encoder Mike™ models only)	Every 0.1 µm	

*When translator is mounted horizontally.
**The display resolution on Encoder Mike™ Controllers is 0.1 µm.
***Controller dependent. Maximum speed with 18011 Encoder Mike™ Controller is 200 µm/s.

ORDERING INFORMATION

Mounting Hole Pattern	Travel Length in (mm)	Actuator Type	Model No.	Price ($)
Inch	0.5 (13)	Motor Mike™	16037	$ 518.00
		Encoder Mike™	16038	$ 789.00
		Stepper Mike™	16039	$ 1090.00
	1 (25)	Motor Mike™	16137	$ 552.00
		Encoder Mike™	16138	$ 851.00
		Stepper Mike™	16139	$ 1159.00
Metric	0.5 (13)	Motor Mike™	16077	$ 518.00
		Encoder Mike™	16078	$ 789.00
		Stepper Mike™	16079	$ 1090.00
	1 (25)	Motor Mike™	16177	$ 552.00
		Encoder Mike™	16178	$ 851.00
		Stepper Mike™	16179	$ 1159.00

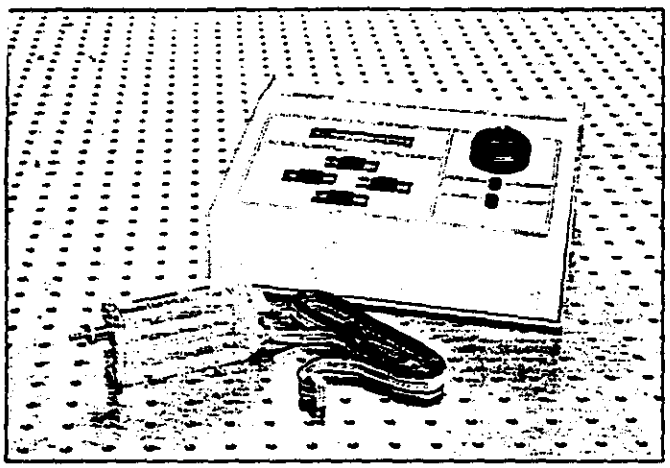
For dimensional drawings of these translators, see the following page.

For motorized vertical translators, see page 4-64.

ORIEL STEPPER MOTOR CONTROLLERS

These stand-alone stepper motor controllers allow operation of one or two Stepper Mike™ actuators, stepper driven translators or rotators. We offer five controllers; single and double channel units with RS 232 or RS 232 and GPIB/IEEE 488 interfaces, and a basic single channel manual unit. You can operate the controllers manually from the front panel controls or remotely using the interfaces.

SINGLE CHANNEL INTELLIGENT CONTROLLERS



18705 Single Channel Intelligent Controller with Stepper Mike™.

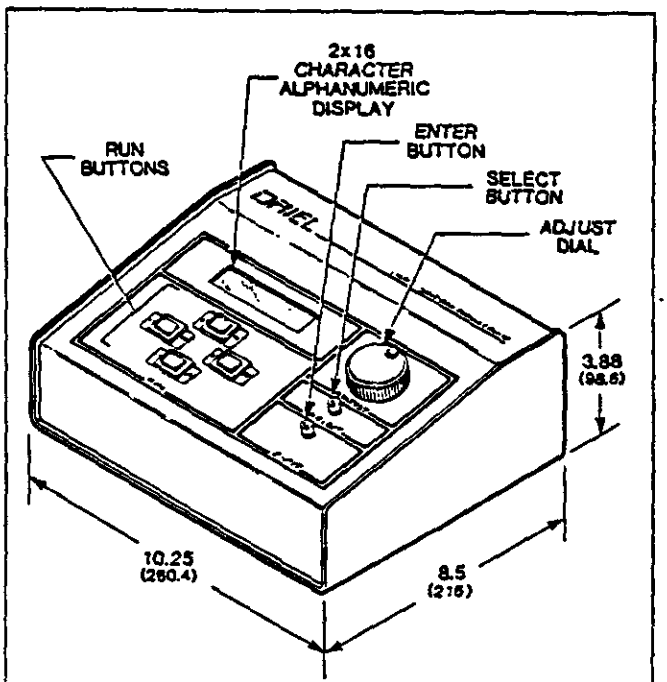
- **Control one actuator**
- **RS 232 and GPIB IEEE 488 Computer Interfaces**
- **2 by 16 Character Alphanumeric Display**
- **Automatic backlash compensation**
- **Reads Stepper Mike™ end of travel limits**
- **Holding position power-down to minimize actuator heating**
- **Half or full step operation**

These intelligent controllers provide manual or computer control of a single stepper motor driven positioner. They are built around a 16 bit micro-controller. The micro-controller manages the motion parameters, acceleration, deceleration ramping, and position; it also stores control programs. A display allows entry of operating mode and shows the current position. To minimize thermally induced drift from a set position, we automatically reduce the stepper motor current to 20% of the driving value.

Menu Selection Simplifies Operation

All manual functions are available from 5 controls, making this unit exceptionally easy to operate. A large dial on the front panel along with a 2 line 16 character display provides access to operating mode and parameters. You can also use the dial to move the motor directly.

You use the dial to scroll through the operating modes while the "Select" button is depressed. The upper line of the 2 by 16 character alphanumeric display shows the modes in turn as you turn the knob. When you have selected the appropriate mode you release the "Select" button to modify the operating parameters. The value is stored when you press the "Enter" button. Two "Run" buttons start the actuator operating in the selected mode. These controllers recognize the end of travel switches built into the Stepper Mike™, and stop the motor operation.



Dimensions in inches (mm).

Fig. 1 Single and Double Channel Controller.

Modes of Operation

JOG: The RUN buttons act as jog controls.

INDEX: In this mode the RUN buttons command a set increment.

TARGET: Select one or two destinations: A and B. Pressing the RUN (-) causes the actuator to move to target A and RUN (+) makes it move to target B.

CONTINUOUS: The RUN buttons make the stepper motor run continuously. You can stop the movement by pressing Select.

SCAN: The RUN buttons initiate scans in the forward or reverse directions. You can set suitable scan parameters, beginning, end, rate, etc., and how often you want to repeat the scans.

PROGRAM: The RUN buttons start either of two motion programs downloaded through the interface.

Choose Your Own Parameters

These controllers allow you to set your own parameters. You can set speed and acceleration for the actuators, target positions, scan parameters, number of steps you want to index and number of steps of backlash compensation. You can also set the displayed position to match your equipment.

POSITIONING EQUIPMENT

RS 232 and GPIB/IEEE 488 Interfaces

The 18705 has a built in RS 232 computer interface. You can set the baud rates from 300-19200. The interface allows a computer such as a PC™ to send ASCII character commands to the 18705 and read back the position and other parameter values.

The 18706 Controller has an RS 232 and GPIB/IEEE 488 interface.

Specifications

Input Voltage:	95-130, 208-250VAC 50/60 Hz, hardware selectable
Power:	90 VA
Connectors:	
18705 Controller:	25 pin RS 232 male socket 10 pin Stepper Mike™ socket
18706 Controller:	25 pin RS 232 male socket IEEE 488 24 pin socket 10 pin Stepper Mike™ socket.

A 6.5 ft (2 m) long cable is included with each Stepper Mike™ to connect to these controllers. We do not supply a computer interface cable.

ORDERING INFORMATION

18705	Single Channel Intelligent Controller With RS 232 interface	$ 1495.00
18706	Single Channel Intelligent Controller With RS 232 and GPIB/IEEE 488 interfaces	$ 1785.00

DOUBLE CHANNEL INTELLIGENT CONTROLLERS

- **Control two actuators, independently or simultaneously**
- **RS 232 and GPIB/IEEE 488 Computer Interfaces**
- **2 by 16 Character Alphanumeric Display**
- **Automatic backlash compensation**
- **Reads Stepper Mike™ end of travel limits**
- ***Holding position power-down to minimize actuator heating***

These controllers include all the outstanding capabilities of the single channel controllers and allow you to control two Stepper Mikes™, stepper driven translators or rotators, simultaneously. You can choose whether to activate the "X" or the "Y" axis using an **ACTIVE AXIS SELECT** function. Activating an axis allows you to set the full range of parameters for that axis. Separate X and Y axis run buttons start the motion. We also added a **COORDINATED MOTION MODE**. When you select this mode, the Target, Index and Continuous commands apply to both axes simultaneously. These controllers use linear interpolation to complete unequal movements in the same time. In this mode the speed is the speed along the combined path, rather than the speed for the individual actuators.

See Fig. 1 for functions and dimensions of these controllers. Specifications are the same as the 18700 and 18705 single channel units.

RS 232 and GPIB/IEEE 488 Interfaces

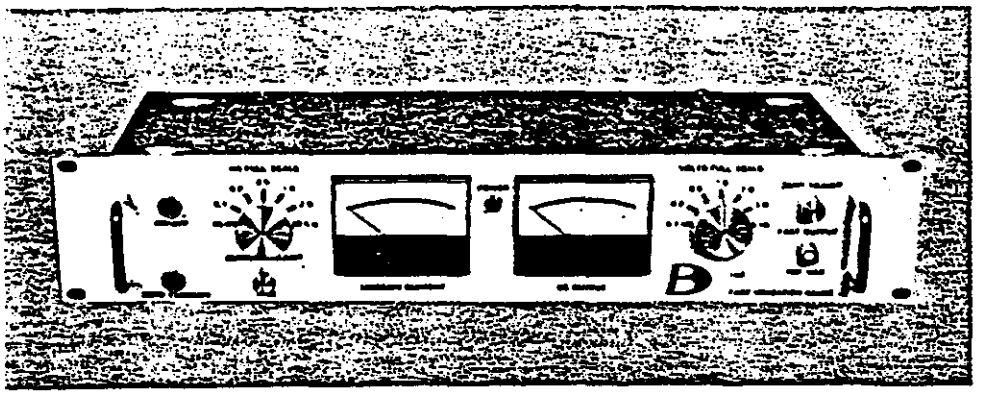
The 18708 comes with an RS 232 computer interface. The 18709 has an RS 232 and GPIB/IEEE 488 interface.

A 6.5 ft (2 m) long cable is included with each Stepper Mike™ to connect to these controllers. We do not supply a computer interface cable.

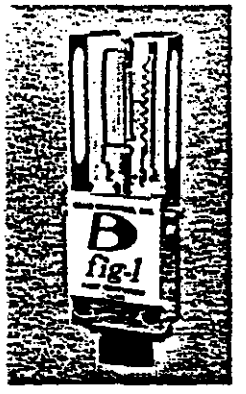
ORDERING INFORMATION

18708	Double Channel Intelligent Controller With RS 232 interface	$ 1845.00
18709	Double Channel Intelligent Controller With RS 232 and GPIB/IEEE 488 interfaces	$ 2095.00

FAST IONIZATION GAUGE



MODEL FC-1 CONTROL UNIT



MODEL FH-1
GAUGE HEAD

The Beam Dynamics, Inc. Model FIG-1 Fast Ionization Gauge operates similarly to a standard Bayard-Alpert ionization gauge, but responds extremely quickly to changes in pressure (3 μsec risetime). Typical applications include the detection and characterization of pulsed molecular beams and as a sensor for rapid-acting vacuum interlocks. The versatility of the device offers many other possible uses. With pulsed molecular beams, used close to the valve, the gauge can accurately measure the shutter function of the valve. At larger distances, the time-of-flight distribution reflects the speed distribution of the molecules in the beam. In an experiment which requires the intersection of a pulsed molecular beam with a laser pulse or another pulsed beam, the use of this gauge at the crossing point enables the experimenter to know the pulse timing independently of the signal from the experiment being performed. The pumping speed in a vacuum chamber of known volume can be simply determined by measuring the exponential pressure decay following a pulse of gas into the chamber, without knowing the absolute pressure.

The instrument consists of a control unit, gauge head, vacuum feedthrough, and connecting cables.

Model FC-1 Control Unit

The rack mountable Model FC-1 Control Unit contains the on-off power switch, power supplies, and emission current and D.C. voltage meters with range switches and adjustment controls. The fast response can be monitored by an oscilloscope or other device connected to BNC outputs on the front and rear panels. The emission current is regulated over the range from 5 μA to 3 mA, and is continuously adjustable. The D.C. voltage output can be easily zeroed so that the voltage output is directly proportional to the pressure, and the instrument can be calibrated against a regular ionization gauge or other vacuum measuring device.

Model FH-1 Gauge Head

The filament-grid and grid-collector distances on the Model FH-1 Gauge Head are small, permitting good linearity up to high pressures. The open "fly-through" structure does not perturb molecular beams by scattering due to pressure build up, and allows beam detection even at large distances from the nozzle with good signal-to-noise ratio. Except for the power supplies and meters, all the circuit components are mounted on the gauge in order to give the very fast response. The low power dissipation operational amplifier is easily replaceable; other components are epoxied into the body of the gauge. Additional amplifiers are provided. The filament is user-replaceable, and a spare filament is supplied with each unit. For mounting the gauge, two screw holes are available.

Feedthrough and Cables

The cable between the control unit and vacuum feedthrough is four meters long. A two meter length of cable fitted with a connector for the gauge head is also supplied. This cable can be shortened by the user for connecting to the vacuum side of the feedthrough. The feedthrough has eight pins and an outside diameter of 1.25". A vacuum flange is not supplied as standard equipment—the feedthrough can be soldered by the user into a flange, or an O-ring seal can be made, using a schematic diagram included in the operating instructions manual. An O-ring is provided.

BEAM DYNAMICS, INC.
708 East 56th Street
Minneapolis, Minnesota 55417
Telephone: (612) 823-8151

BEAM DYNAMICS, INC.
708 East 56th Street
Minneapolis, Minnesota 55417
Telephone: (612) 823-8151

FAX: 612-938-2731
BEAM DYNAMICS

Form BD-3-13

PRICE LIST
Jan. 1, 1992

MOLECULAR BEAM SKIMMERS

Model 1 and Model 2

Orifice diameter:	0.5 mm or larger	0.4 mm	0.3 mm	0.2 mm
Price (each) in nickel:	$390	$430	$510	$630
Price (each) in copper:	$430	$490	$590	$730

Quantity discount schedule: For quantity orders, including assortments of Model 1 and Model 2 in any orifice diameters, deduct from the prices above:

10% for orders of 2 to 4 skimmers
20% for orders of 5 to 9 skimmers
25% for orders of 10 or more skimmers.

Custom Skimmers

The prices shown above will generally apply also to custom skimmer designs. There is a one-time-only tooling charge of $200 for fabricating a custom mandrel, which will remain the property of Beam Dynamics, Inc. There is no additional charge for a custom skimmer if the mandrel is in stock.

Chromium or Rhodium Plating

For extra protection against corrosive gases, both nickel and copper skimmers may be ordered with chromium or rhodium plating. The charge is $70 per skimmer, subject to the same quantity discounts listed above.

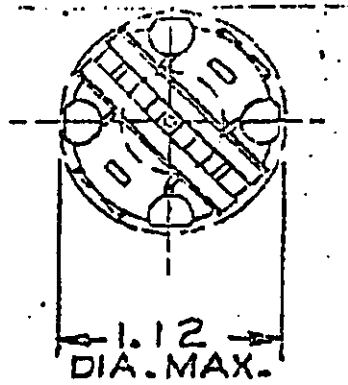
FAST IONIZATION GAUGE

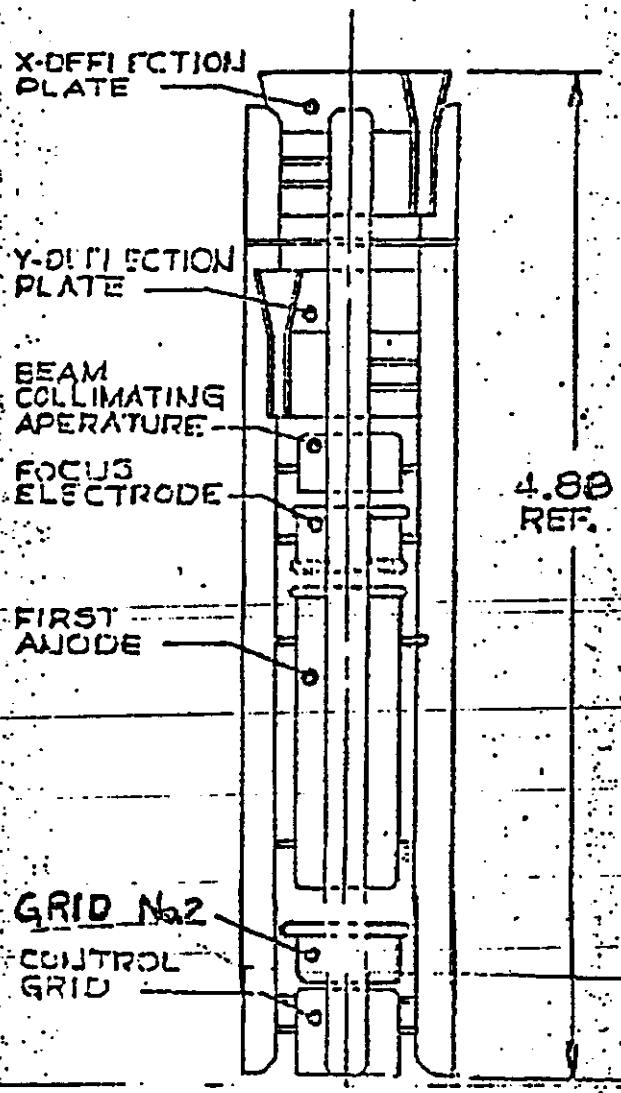
Model FIG-1 Fast Ionization Gauge

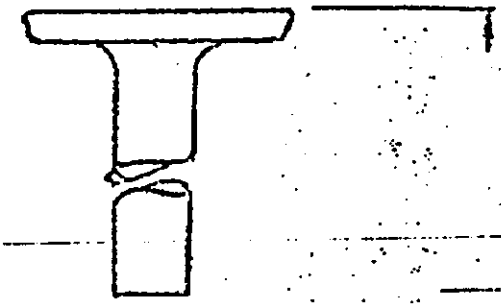
Complete system, including all components listed below — $2,650
Please specify operating voltage, 115 VAC or 230 VAC.

Components:		
	Gauge Head	$1,260
	Control Unit	$1,390
	Vacuum Feedthrough	$75
	Cable, Control to Feedthrough	$125
	Cable, Feedthrough to Head	$125
	Plug-in Filament (replacement)	$50

Order Information: Skimmer prices are f.o.b. domestic destination; all other prices are f.o.b. Minneapolis. On foreign orders there is a standard shipping/handling fee of $50 per shipment for up to 10 skimmers, and $80 each for fast ionization gauge systems. *On foreign orders, all bank charges must be prepaid by customer.*







DESCRIPTION:

THE TYPE 406 ELECTRON GUN IS AN ELECTROSTATIC FOCUS AND DEFLECTION TYPE, SUITABLE FOR A LARGE RANGE OF ACCELERATING VOLTAGES.

THE GUN IS AVAILABLE WITH OXIDE, TUNGSTEN OR IRIDIUM EMITTERS AND VARIOUS HEADER OR FLANGE MOUNTINGS. ALSO, FOR SPECIAL SPOT SIZE AND BEAM CURRENT REQUIREMENTS, WE CAN CUSTOMIZE THE GUN TO MEET YOUR NEEDS.

ELECTRICAL CHARACTERISTICS:

FILAMENT VOLTAGE:
OXIDE EMITTER 6.3 VOLTS
TUNGSTEN, IRIDIUM 2.0-2.5 VOLTS
FILAMENT CURRENT:
OXIDE EMITTER 0.6 AMPERE
TUNGSTEN EMITTER 3.0 - 3.5 AMPERES
IRIDIUM EMITTER 4.0-5.0 AMPERES
ACCELERATING VOLTAGE: 200 EV TO 10 KEV
FOCUS VOLTAGE-(AT 15CM FROM GUN) 25%±5% OF ACCELERATOR V.
FOCUS RANGE - 2 TO 20 CM
DEFLECTION FACTOR @2KEV AND 15 CM DISTANCE
"Y" DEFLECTION PLATES 18-24*VOLTS/CM
"X" DEFELCTION PLATES 22-30*VOLTS/CM
*X2 FOR METAL FLANGE MOUNTING

APEX ELECTRONICS, INC.
100 GRIFFIN STREET, PASSAIC, NEW JERSEY 07055
(201) 773-1222

QUALITY UNSURPASSED *Manufacturers of Cathode ray guns*

APEX ELECTRONICS, INC.
160 EIGHTH STREET, PASSAIC, NEW JERSEY 07055
(201) 773-1230

MAY 1, 1991

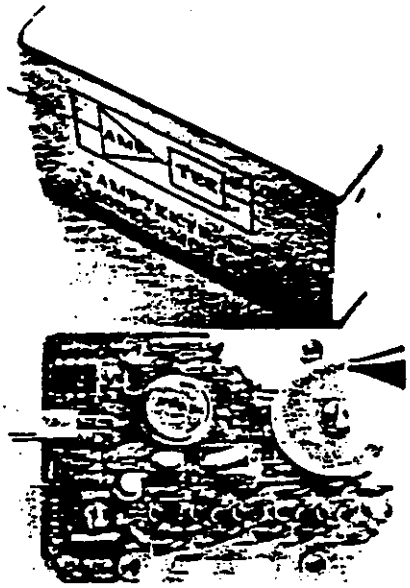
PRICE LIST

3K/5U	GUN BODY WITHOUT CATHODE-UNMOUNTED WITH HOOK-UP WIRES	$ 70.00
3K/5U	GUN WITH OXIDE CATHODE MOUNTED ON A 10 WIRE STEM	115.00
5UW	TUNGSTEN FILAMENT MOUNTED ON A 12 WIRE 90° STEM	147.50
5UW	TUNGSTEN FILAMENT MOUNTED ON A 2 3/4" CONFLAT FLANGE	480.00
5UT	THORIATED IRIDIUM FILAMENT MOUNTED ON A 12 WIRE 90° STEM	186.00
5UT	THORIATED IRIDIUM FILAMENT MOUNTED ON A 2 3/4" CONFLAT FLANGE	513.00
5UT	THORIATED IRIDIUM FILAMENT MOUNTED ON A 2 3/4" CONFLAT FLANGE, INSULATED FOR 20KV OPERATION	545.00
	CE 406	
406S	UNMOUNTED WITH WIRE CONNECTOR, NO CATHODE	92.50
406S	MOUNTED ON A 12 WIRE 90° STEM	158.50
406S	MOUNTED ON A 2 3/4" CONFLAT FLANGE	406.00
406W	TUNGSTEN FILAMENT MOUNTED ON A 12 WIRE 90° STEM	175.00
406W	TUNGSTEN FILAMENT MOUNTED ON A 2 3/4" CONFLAT FLANGE	530.00
406TB	THORIATED IRIDIUM FILAMENT UNMOUNTED	197.00
406T	THORIATED IRIDIUM FILAMENT MOUNTED ON A 12 WIRE 90° STEM	225.00
406T	THORIATED IRIDIUM FILAMENT MOUNTED ON A 2 3/4" CONFLAT FLANGE	566.00
406H	GUN BODY WIRE HOOK-UP, NO CATHODE	147.50
406HT	BODY WITH IRIDIUM FILAMENT UNMOUNTED	225.00

AMPTEKTRON®

MD-501

THE CHANNEL ELECTRON MULTIPLIER (CEM) COMES OF AGE !!!



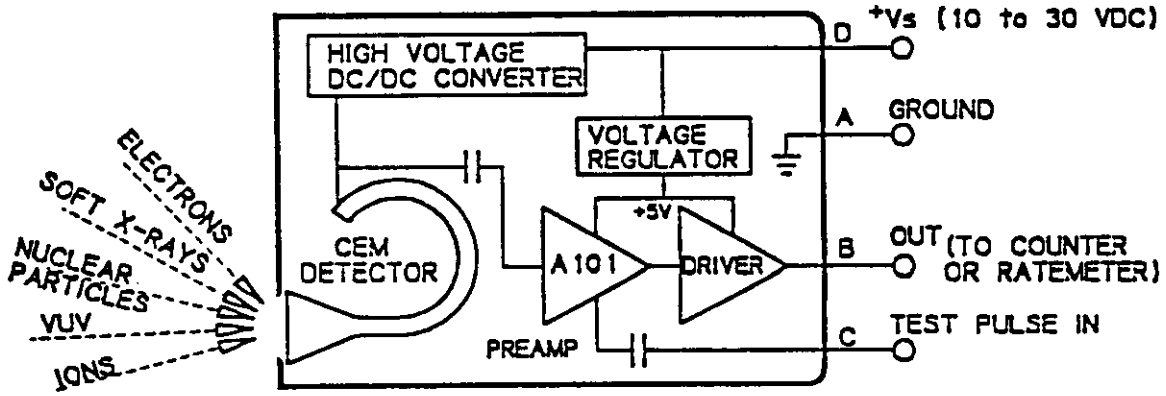
A COMPLETE CEM DETECTOR SYSTEM
FOR VACUUM USE

It Contains:

- CEM
- High Voltage Supply
- Charge Sensitive Preamplifier & Discriminator
- Line Driver
- Fully Packaged Electronics

The AMPTEKTRON is a compact, easy to use electron multiplier system capable of detecting Electrons, Ions, VUV, Soft X-rays, and other Nuclear Particles at rates greater than one million events per second. It is configured in a pulse counting mode and operates from a single low voltage supply.

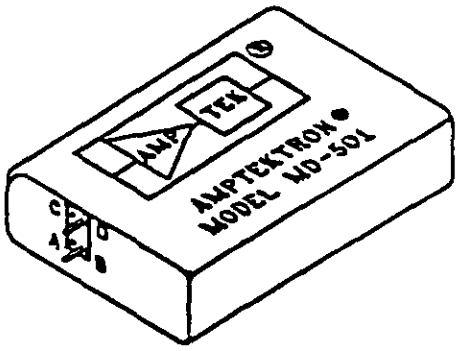
The AMPTEKTRON is designed for direct applications in the field of aerospace instrumentation, mass spectrometer, laboratory and research experiments, vacuum process monitoring and beam diagnosis.



Features:

- Small size [3.25 x 2.25 x 0.75 inches] [8.3 x 5.7 x 1.9 cm]
- Eliminates detector system design
- Single low voltage supply operation (+10 to +30VDC)
- Low voltage interface eliminates high voltage vacuum feed through
- Power required is typically 0.3 Watts
- +5 volt logic output interface directly with CMOS and TTL
- Rugged design simplifies handling and use

AMPTEK INC. 6 De ANGELO DRIVE, BEDFORD, MA 01730 U.S.A. TEL:(617) 275-2242 FAX: (617) 275-3470



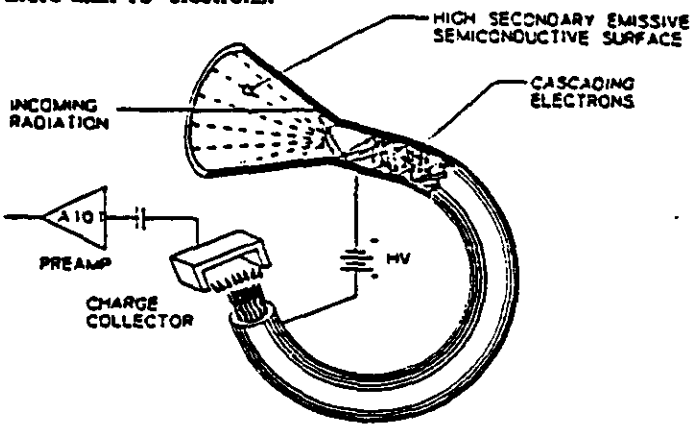
A - Ground (Power and Signal)
B - Pulse Output
C - Test Pulse Input
D - Vs (+7 to +30 VDC) normal mode
(+4.5 to 10 VDC) low voltage option

Specifications:

Count Rate:	0 - 1.0×10^6 cps random
Pulse Pair Resolution:	250 ns
Dark Current:	<0.1 cps typical
Output Pulse:	+5 V: 220 ns wide, nominal
Operating Voltage:	+7.0 to +30.0 VDC or+4.5 to +10 VDC (See page 5, paragraph 2.4 for instructions)
Operating Current:	25 mA typical (depends on supply voltage)
Temperature:	-55° to +70° C operational
Weight:	3 ounces (85 grams)
CEM Cone Size	10 mm Diameter
Aperture:	Shipped with .141 inch (3.6 mm) Dia. hole, Area=0.1 cm^2
Dimensions:	3.25 X 2.25 X 0.75 inches
Connector:	Positronics GFPL2M2FACORV (mating connector GF2M2FBDSCL provided)

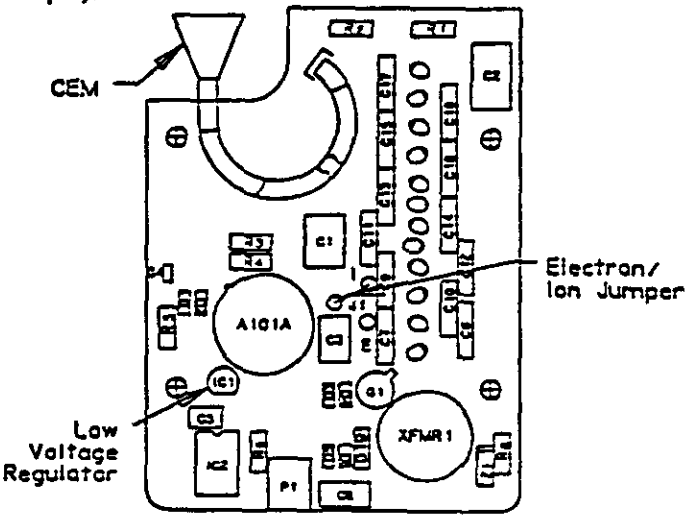
Operational Pressure: The Amptektron should be operated in pressures $\leq 1.0 \times 10^{-4}$ Torr. Prior to shipment the Amptektron is "burnt in" for 28 hours of continuous operation resulting in 2×10^9 total accumulated counts. The pressure during "burn in" is typically 4×10^{-8} Torr.

Channel Electron Multiplier: The following figure shows schematically the process that occurs inside the Amptektron to detect energetic particles or photons. The primary incoming radiation passes through the Amptektron inlet aperture and strikes the surface of the channel electron multiplier. If the energy of the collision is sufficient, at least one electron is ejected from the CEM wall. The ejected electrons are accelerated into the interior of the CEM by the local electric field developed by the bias voltage. If the magnitude of the bias voltage is sufficient, the accelerated electrons acquire enough energy to trigger more secondaries when they strike the CEM surface again. This process continues down the length of the CEM, striking the CEM surface many times, each time generating more and more secondaries. A single photon or particle input event will trigger an output electron avalanche of more than 10^7 electrons!



CHANNEL ELECTRON MULTIPLIER (CEM)

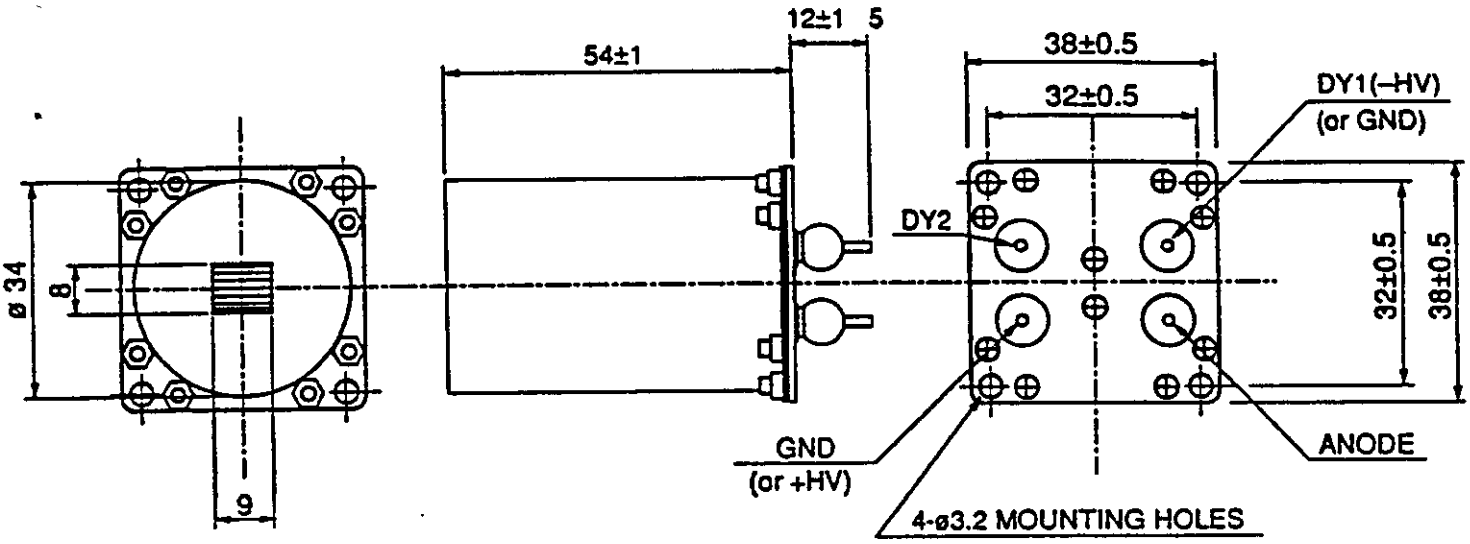
Power Requirements: The Amptektron is intended to operate from a wide range of low voltage supplies. (7 to 30 VDC). To allow this range of operation there is a series voltage regulator that supplies a stable 5 VDC to the charge amplifier/discriminator (A101A) and the output driver. If the user wishes to operate at 5 VDC (from a logic supply for example) the 5 volt regulator (IC1) should be removed and a jumper installed in its place (Input to Output).



The Amptektron will then operate with 4.5 to 10 VDC input supply. The A101A and output driver are now running at the input supply level and the output pulses height will be ~95% of that voltage amplitude. The Amptektron current requirements vary somewhat as a function of the supply voltage. The following figure gives a typical power consumption for low counting rates.

COMPACT ELECTRON MULTIPLIER R5150

Figure: Dimensional Outline (Unit:mm)



HAMAMATSU

HAMAMATSU PHOTONICS K.K., Electron Tube Center
314-5, Shimokanzo, Toyooka-village, Iwata-gun, Shizuoka-ken, 438-01 Japan, Telephone:0539/62-5248, Fax:0539/62-2205 Telex:4289-625
U.S.A.: Hamamatsu Corporation: 360 Foothill Road, P.O.Box 6910, Bridgewater, N.J. 08807-0910, Telephone:1-908-231-0960, Fax:1-908-231-1539
Germany: Hamamatsu Photonics Deutschland GmbH:Arzbergestr. 10, D-8036 Herrsching am Ammersee, Telephone:49-8152-375-0, Fax:49-8152-2658, Telex:527731
France: Hamamatsu Photonics France: Z.A. Orlytech-BT 523, 3, Allee du Cdt-Mouchotte, Paray Vieille Poste, 91781 Wissous Cedex,
Telephone:33-(1)49 75 56 80, Fax:33-(1)49 75 56 87, Telex:HPF262082F
United Kingdom: Hamamatsu Photonics UK Limited:Lough Point, 2 Gladbeck Way, Windmill Hill, Enfield, Middlesex EN2 7JA, Telephone:44-81-367-3560, Fax:44-81-367-6384, Telex:927817
North Europe: Hamamatsu Photonics Norden AB:Kanalvagen 20, S-194 61 Upplands Vasby, Sweden, Telephone:46-760-32190, Fax:46-760-94567
Italy: Hamamatsu Photonics Italia S.R.L.:Via Montegrappa 30, 20020 Arese, Milano,Telephone:39-(2)935 81 733, Fax:39-(2)935 81 741
Spain: Hamamatsu Photonics Espana S.L.:Calle Sabadell, 41-08191-RUBI, Barcelona, Telephone:34-3 699 65 53, Fax:34-3 588 19 66

MAR. 1992 E
Printed in Japan (500)

HAMAMATSU

TENTATIVE DATA
Feb. 1992

COMPACT ELECTRON MULTIPLIER R5150

Price: $1165 (borrow?)

GENERAL

Parameters		Ratings	Units
Dynode	Structure	Linear focused	–
	Number of Stages	16	–
	Material	Cu-BeO	–
	Radiation Opening	8.0 × 9.0	mm
Interelectrode Capacitance		4	pF
Built-in Resistors		16	MΩ

MAXIMUM RATINGS (Absolute Maximum Values)

Parameters		Ratings	Units
Supply Voltage	Between Anode and First Dynode	3500	Vdc
	Between Anode and Last Dynode	300	Vdc
Average Anode Current		10	μA
Operating Pressure		1×10^{-4}	Torr
Baking Temperature		300	℃

CHARACTERISTICS (at 25℃)

Parameter	Typical	Unit
Current Amplification at 2400V	1×10^{6}	–

Price: $1165 (borrow?)

Nonlinear at 60μA, which is 370 million counts per second at the 10^6 gain.

Information furnished by HAMAMATSU is believed to be reliable. However, no responsibility is assumed for possible inaccuracies or ommissions. Specifications are subjected to change without notice. No patent rights are granted to any of the circuits described herein.

Conclusion

Different methods of beam profile measurements were discussed during the session and compared in details. Residual gas ionization monitors present reliable possibility of the device for the most of the SSC accelerators. Neutral beam profile monitor is natural extension of the flying wire technique with no its shortcomings, and could provide an absolute measurements of a beam profile and its position, therefore serve as reliable calibration for the other methods. Electron beam technique for proton beam emittance measurements in the case of SSC accelerators permits straitforward interpretation of data, happen to be fast, i.e. is applicable to a bunch-by-bunch measurement, and it is truly nonperturbative. It could serve in transfer lines, where other methods meet difficulties. All these methots require further R&D and laboratory tests, although priorities should be discussed in more details.