HARDWARE DEVELOPMENTS

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ON BEHALF OF CTF3 COLLABORATION

CTF3 REVIEW 2 OTTOBRE 2001

CTF3 Combiner Ring Impedance Contributing Elements (Very preliminary)

1. Phenomena' (not discontinuities)

a) Coherent Synchrotron Radiation;
b) Space Charge;
c) Resistive Walls

2. Big Vacuum Chamber Objects

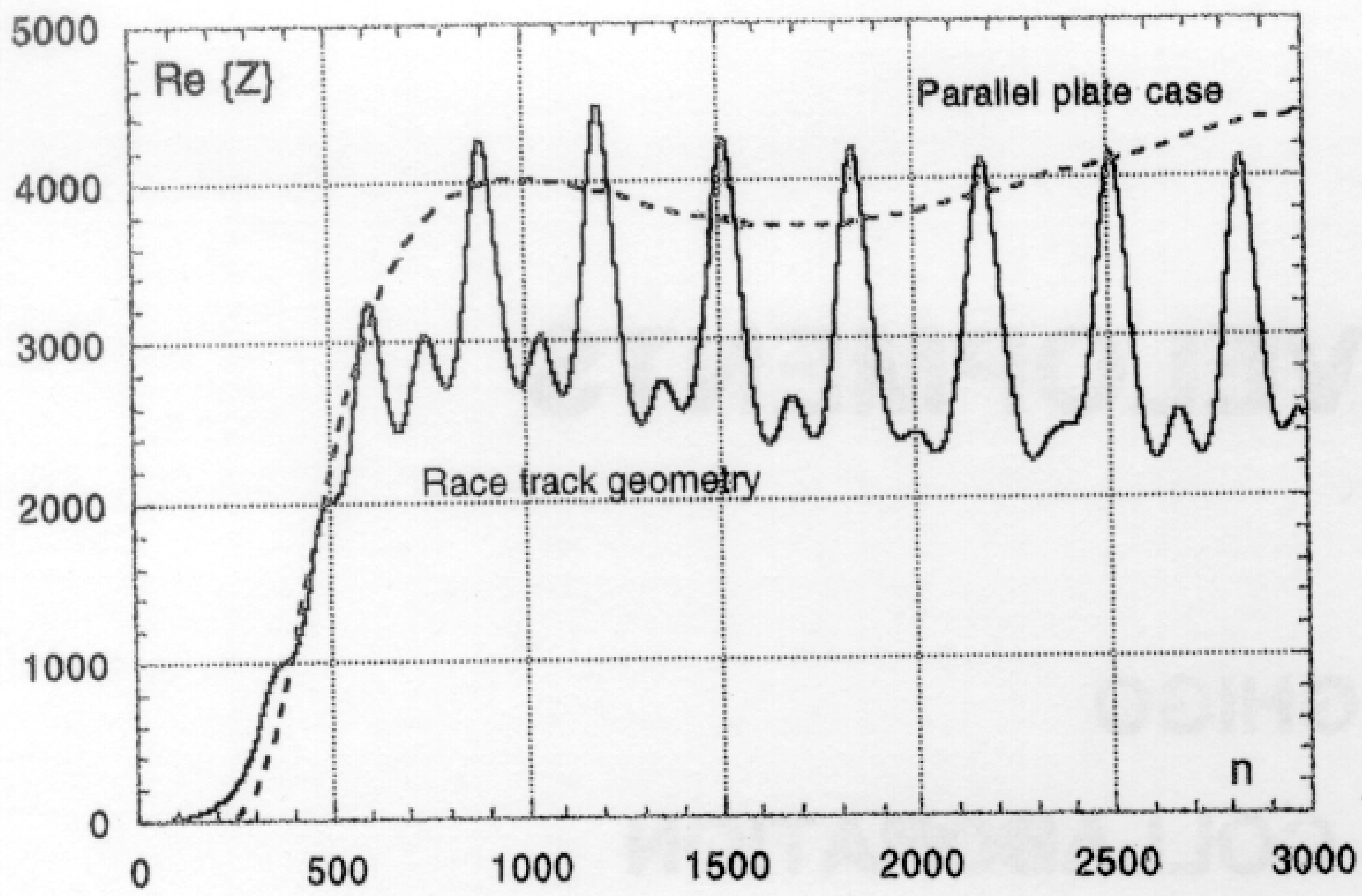
a) RF Deflectors
b) Extraction Kicker
c) BPMs or Striplines
d) Synchrotron Radiation Port
e) Injection Port
f) Extraction Port
g) Cavity if necessary

3. Small Discontinuities

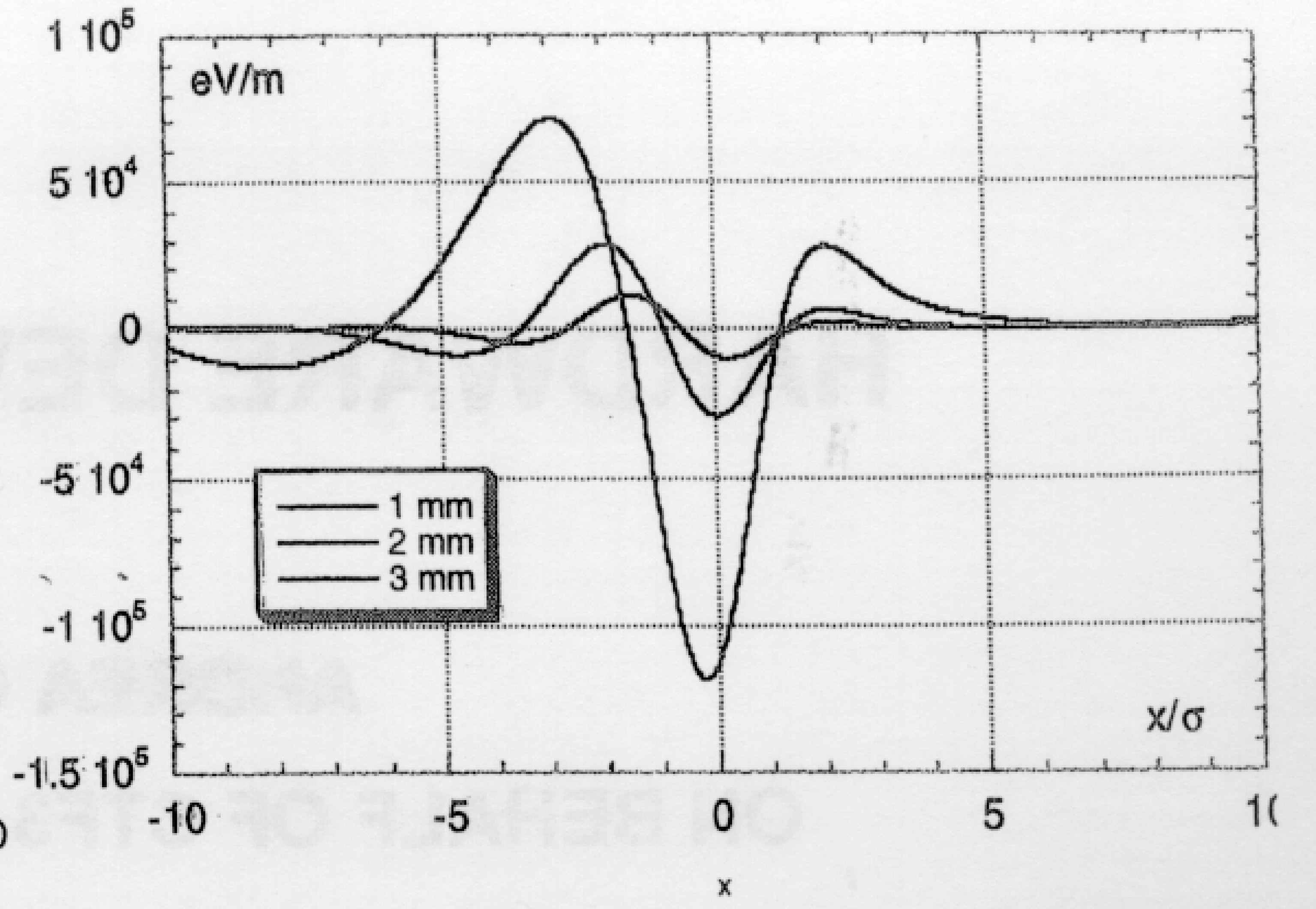
a) Tapers
b) Pumping Slots
c) Valves
d) Flanges
e) Shielded Bellows
f) Surface Roughness

CSR in CTF3 COMPRESSOR RING MAGNETS

CSR IMPEDANCE (real part)

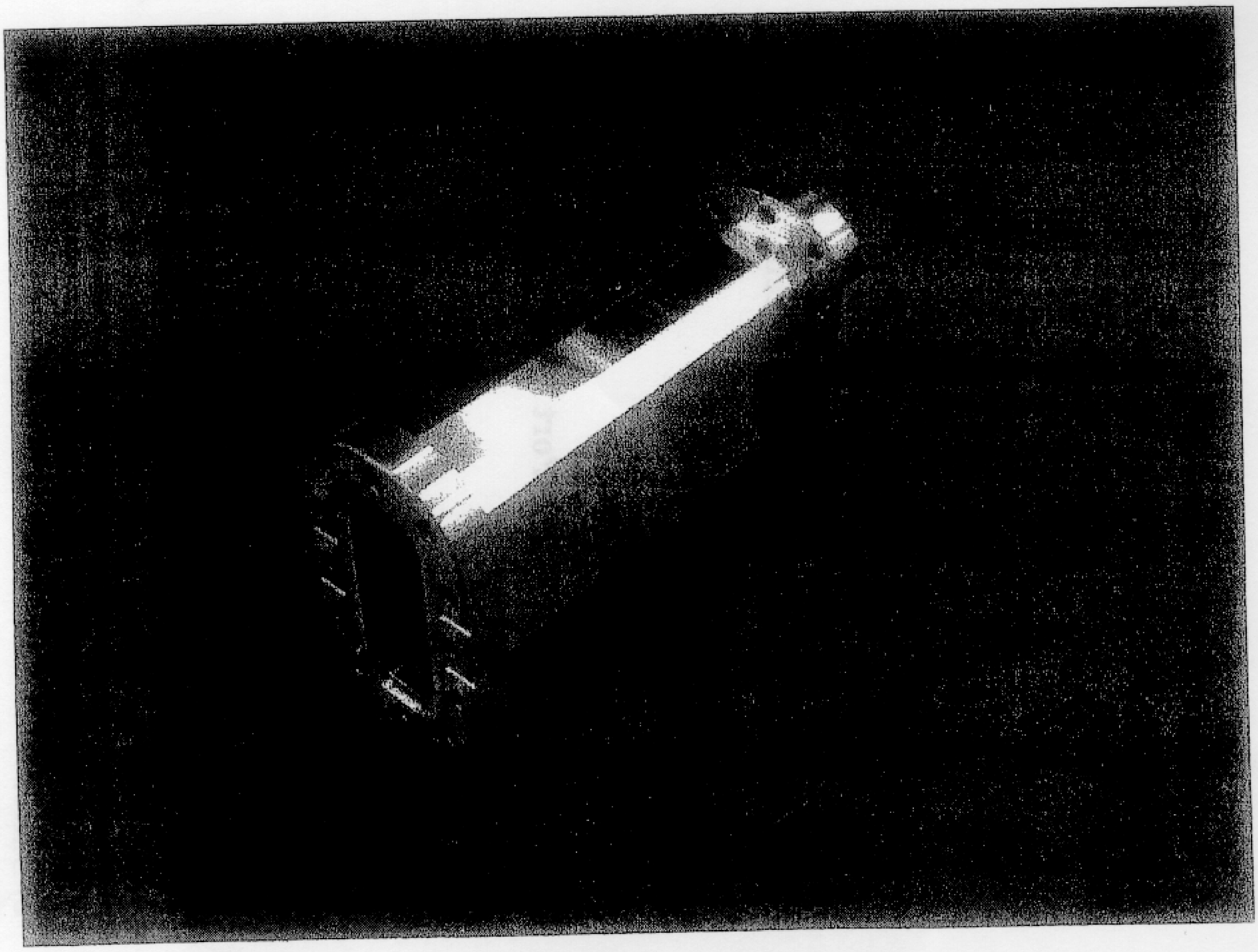


CSR WAKE FORCE (for different bunch length)



For EPA magnets incorporated in CTF3 compressor ring design and the vacuum chamber of 90x36 mm^2 the parallel plate approximation can be applied to estimate the energy loss and energy spread

For a bunch of 2 mm long with a charge 2.33 nC the energy spread due to CSR after 5 turns is contained within ±0.5% of the nominal ring energy



Resistive Wall Impedance and Wake

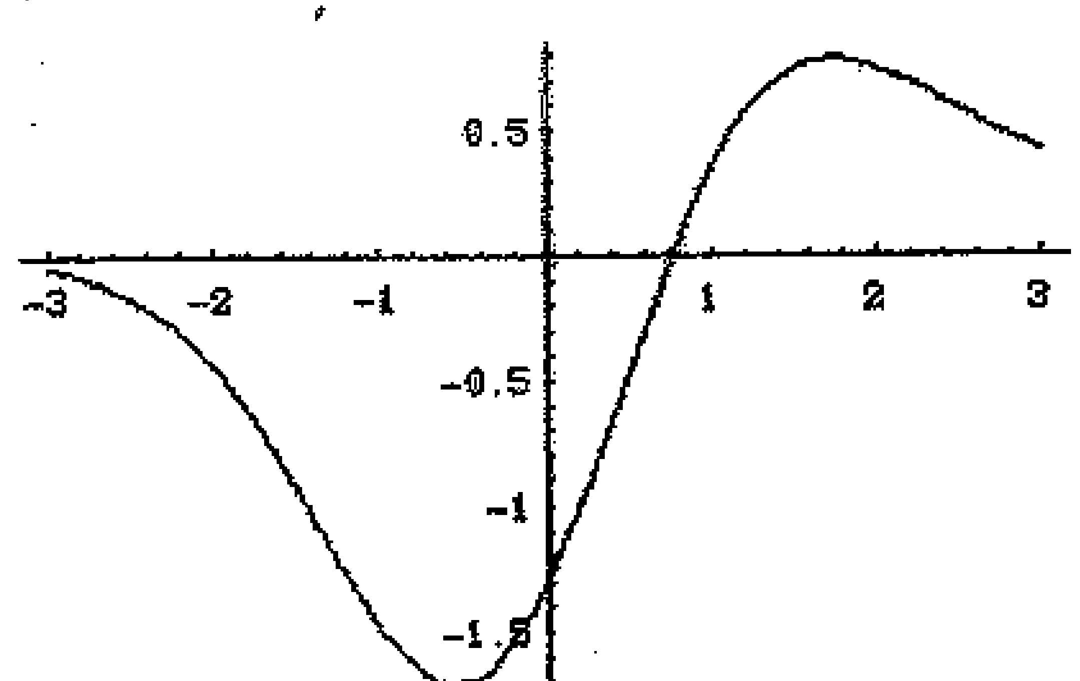
$$\frac{Z}{L}(\omega) = (1+j)\frac{\omega}{c}\frac{Z_o\delta}{4\pi b}F_0\left(\frac{b}{a}\right)$$

$$\frac{dk}{dL} = \frac{c}{4\pi^2 b\sigma_z^{3/2}}\sqrt{\frac{Z_0\rho}{2}}\Gamma\left(\frac{3}{4}\right)F_0\left(\frac{b}{a}\right)$$

$$\boxed{\begin{aligned} W(s) &= \frac{Bc^{3/2}}{4\sigma_z^{3/2}}\left(\frac{|s|}{\sigma_z}\right)^{3/2}\exp\left\{-\frac{s^2}{4\sigma_z^2}\right\}\times \\ &\left\{I_{-3/4}\left(\frac{s^2}{4\sigma_z^2}\right) - I_{1/4}\left(\frac{s^2}{4\sigma_z^2}\right) \mp I_{-1/4}\left(\frac{s^2}{4\sigma_z^2}\right) \pm I_{3/4}\left(\frac{s^2}{4\sigma_z^2}\right)\right\}\end{aligned}}$$

where

$$B = \frac{1}{4\pi b}\sqrt{\frac{2\rho Z_0}{c}}$$

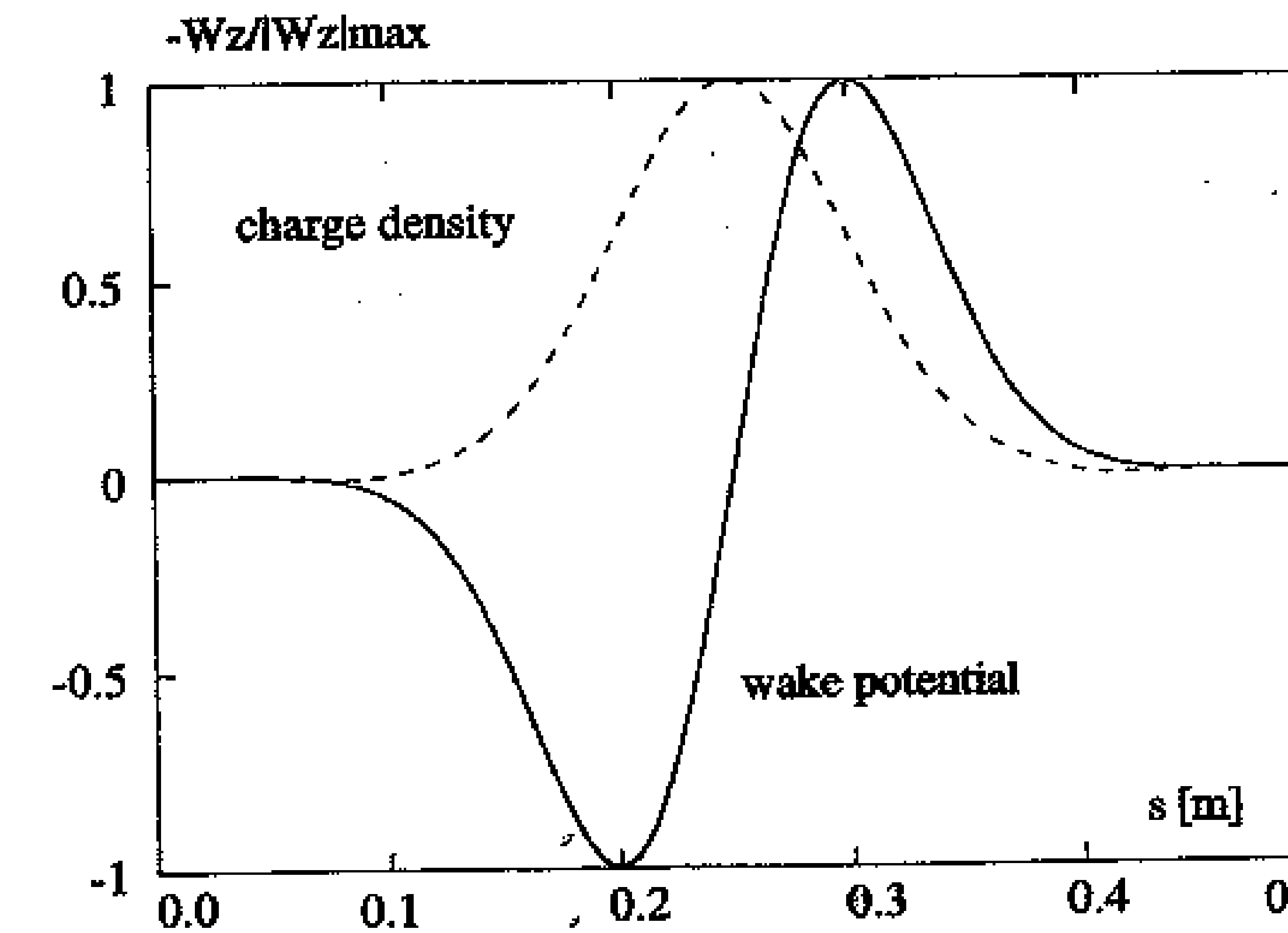


For CTF3 Combiner Ring after 5 turns:

E lost = 13.35 keV
ΔE = 35.25 keV

Low Frequency Impedance Limit

Assume purely inductive machine impedance jωL. Then, the wake potential and the maximum energy spread ΔE are:



$$\boxed{\Delta E = Q\left(W_z^{\max} - W_z^{\min}\right) = \frac{2QLc^2}{\sqrt{2\pi}e\sigma^2} = \frac{2Qc^2|Z/n|}{\omega_0\sqrt{2\pi}e\sigma^2}}$$

For the bunch with rms length σ = 2 mm and the charge Q = 2.33 nC and assuming that the energy spread is equal to 1% the low frequency impedance limit is:

$$\boxed{\left|\frac{Z}{n}\right| \cong 0.32\Omega}$$

139

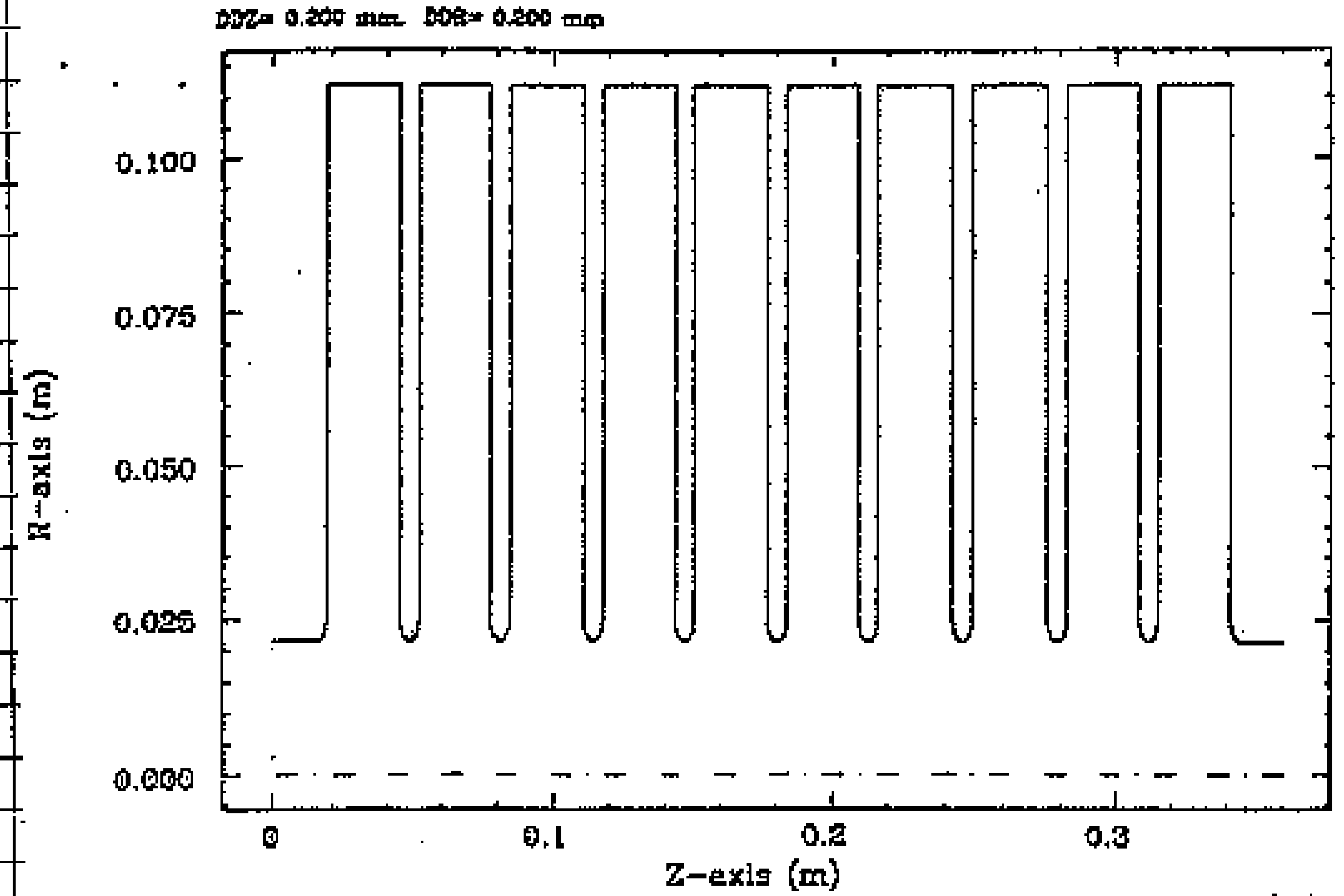
CTF3 RF deflector

Cavity Shape Input

21/10/00 19.28.39

A B C I 8.7 : RF DEFLECTOR CTF3 COMPRESSOR RING

DDZ= 0.200 mm DDR= 0.200 mm

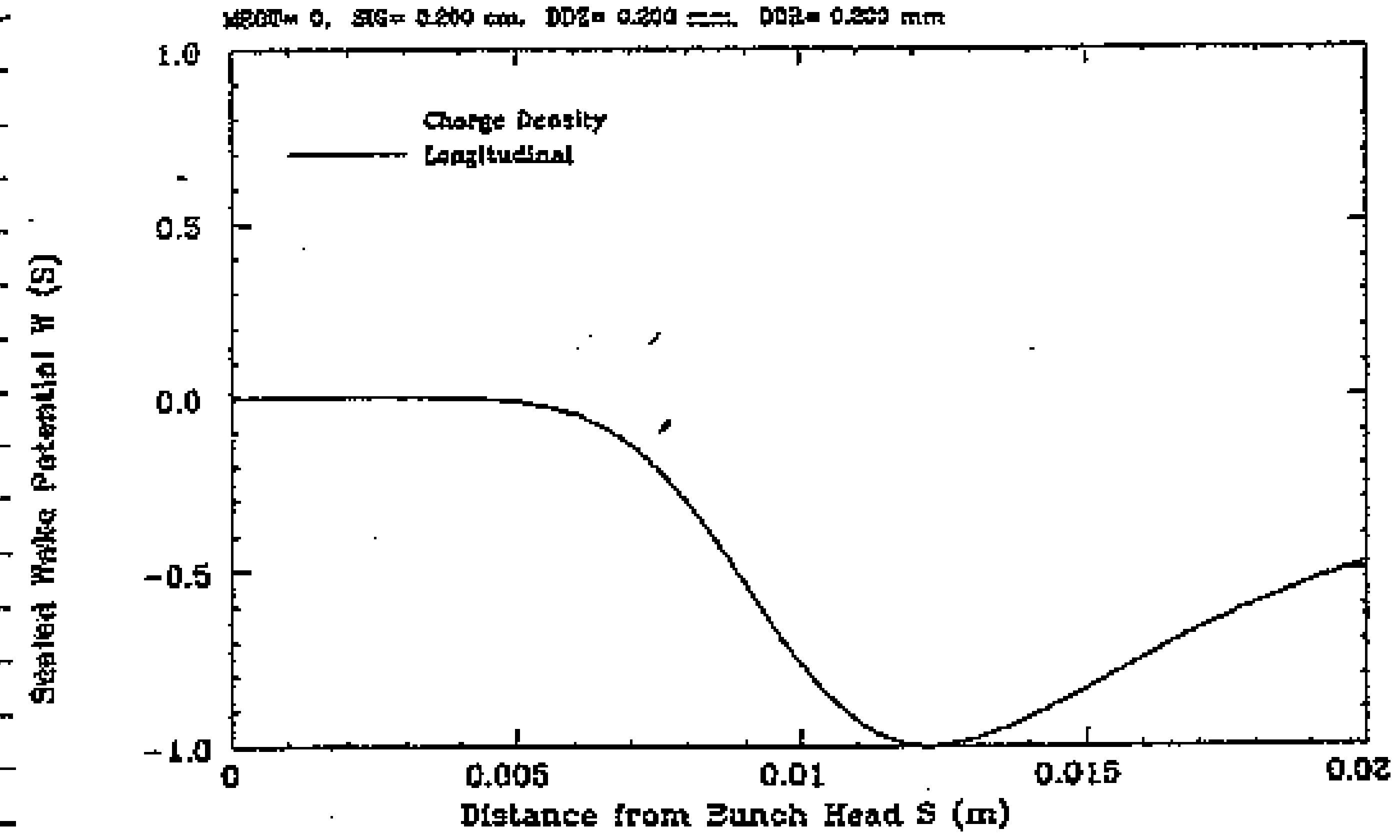


Wake Potentials

Cpu Time Used: 2.510E+02(s)
21/10/00 19.28.38

A B C I 8.7 : RF DEFLECTOR CTF3 COMPRESSOR RING

MROT= 0, SIG= 0.200 cm, DDZ= 0.200 mm, DDR= 0.200 mm



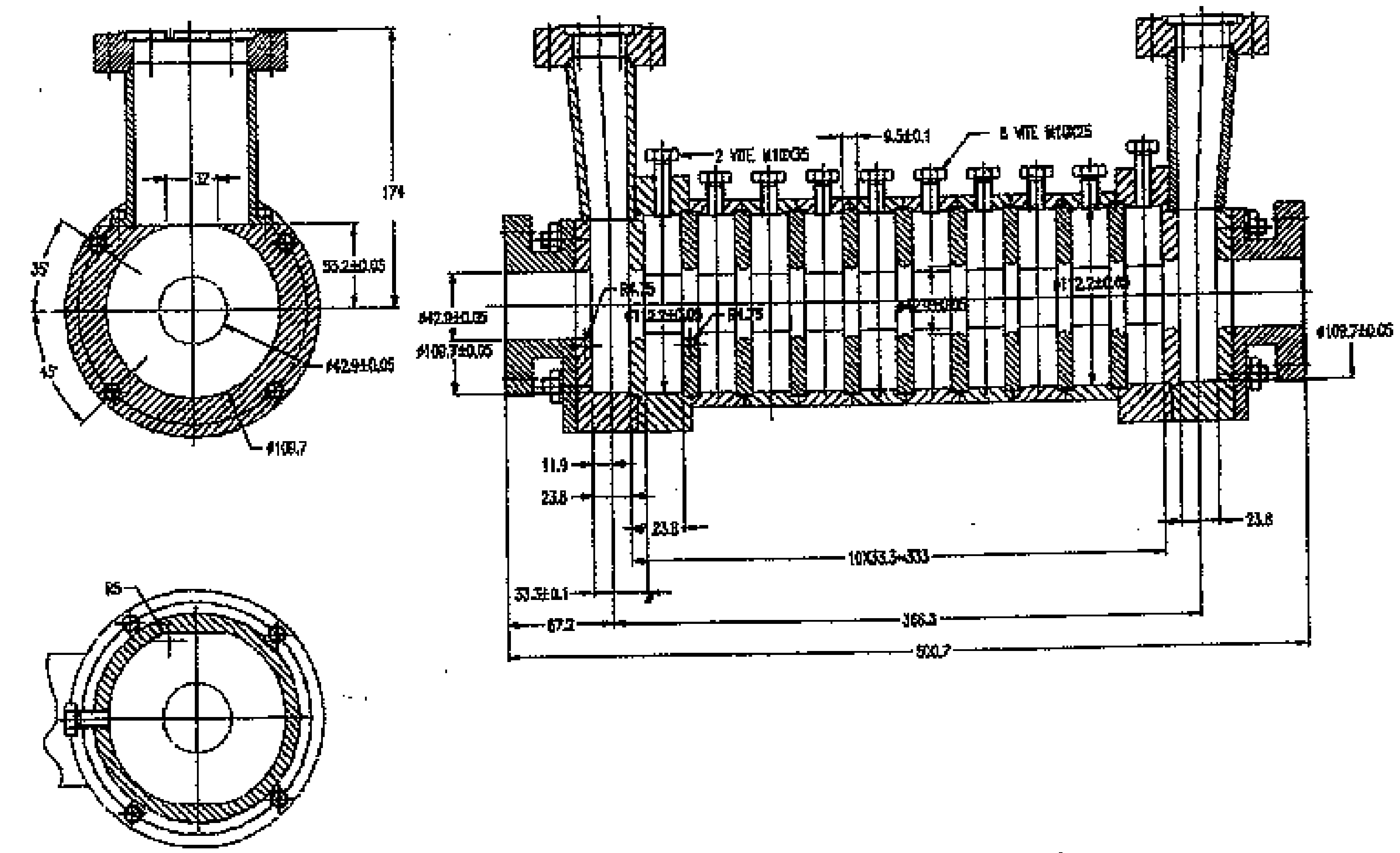
Longitudinal Wake Min/Max= -9.759E+00/ 1.949E-06 V/pC, Loss Factor= -6.585E+00 V/pC

σ_z, MM	k_e, $\frac{V}{C}$	$\lvert W_{MAX}\rvert$, $\frac{V}{C}$
0.5	$1.466 \cdot 10^{13}$	$1.567 \cdot 10^{13}$
1	$8.532 \cdot 10^{12}$	$1.170 \cdot 10^{13}$
2	$6.585 \cdot 10^{12}$	$8.759 \cdot 10^{12}$
3	$5.665 \cdot 10^{12}$	$8.449 \cdot 10^{12}$

at $\sigma_z = 2$ MM for 2 deflectors after stalin and 1.75 nC:

$e\Delta V = 268$ keV (spread)

$eV = 181$ keV



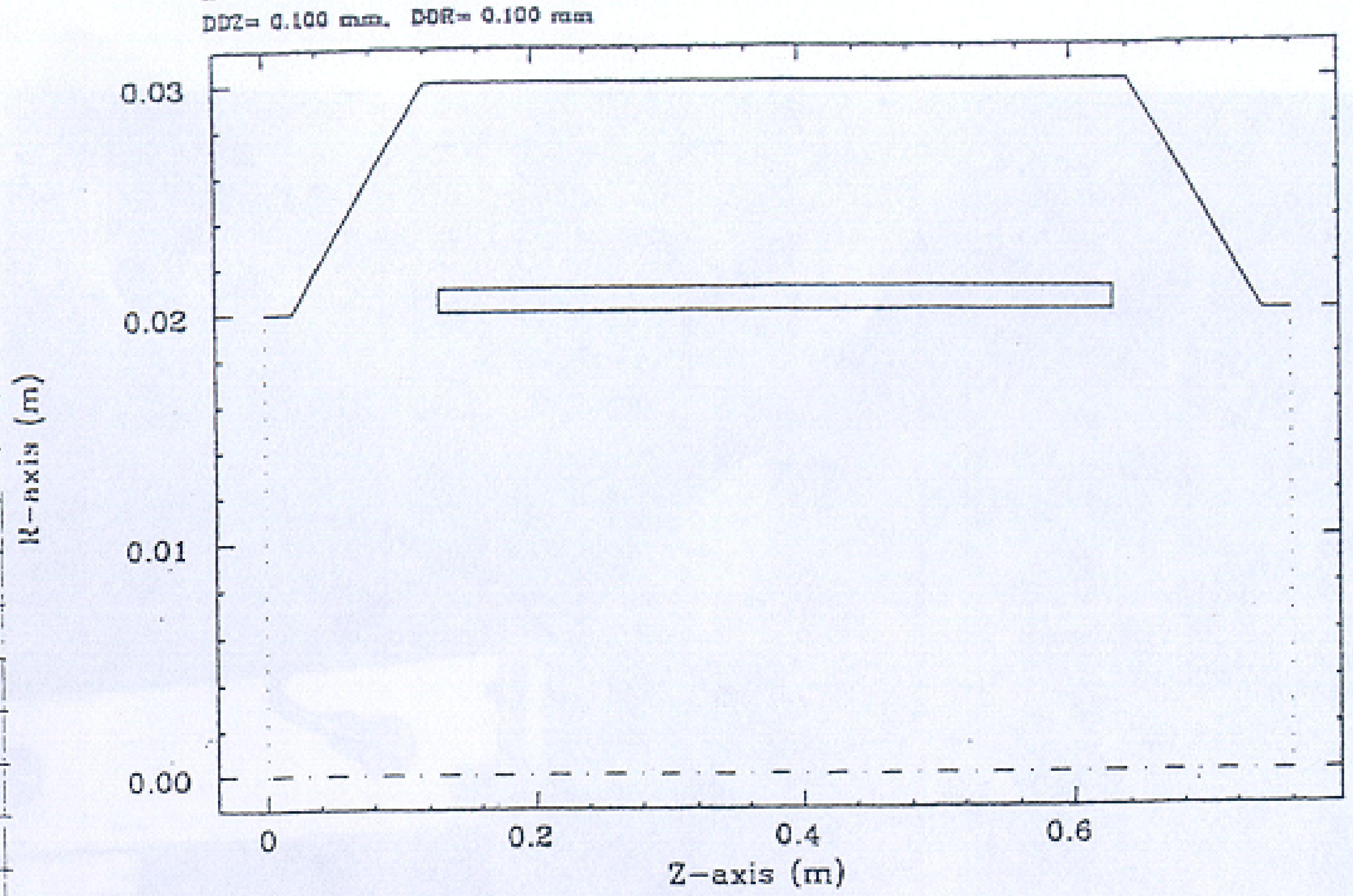
- 140 -

CTF3 Extraction Kicker

Cavity Shape Input 30/10/00 12.51.06

A B C I 8.7 : EXTRACTION KICKER CTF3 COMBINER RING

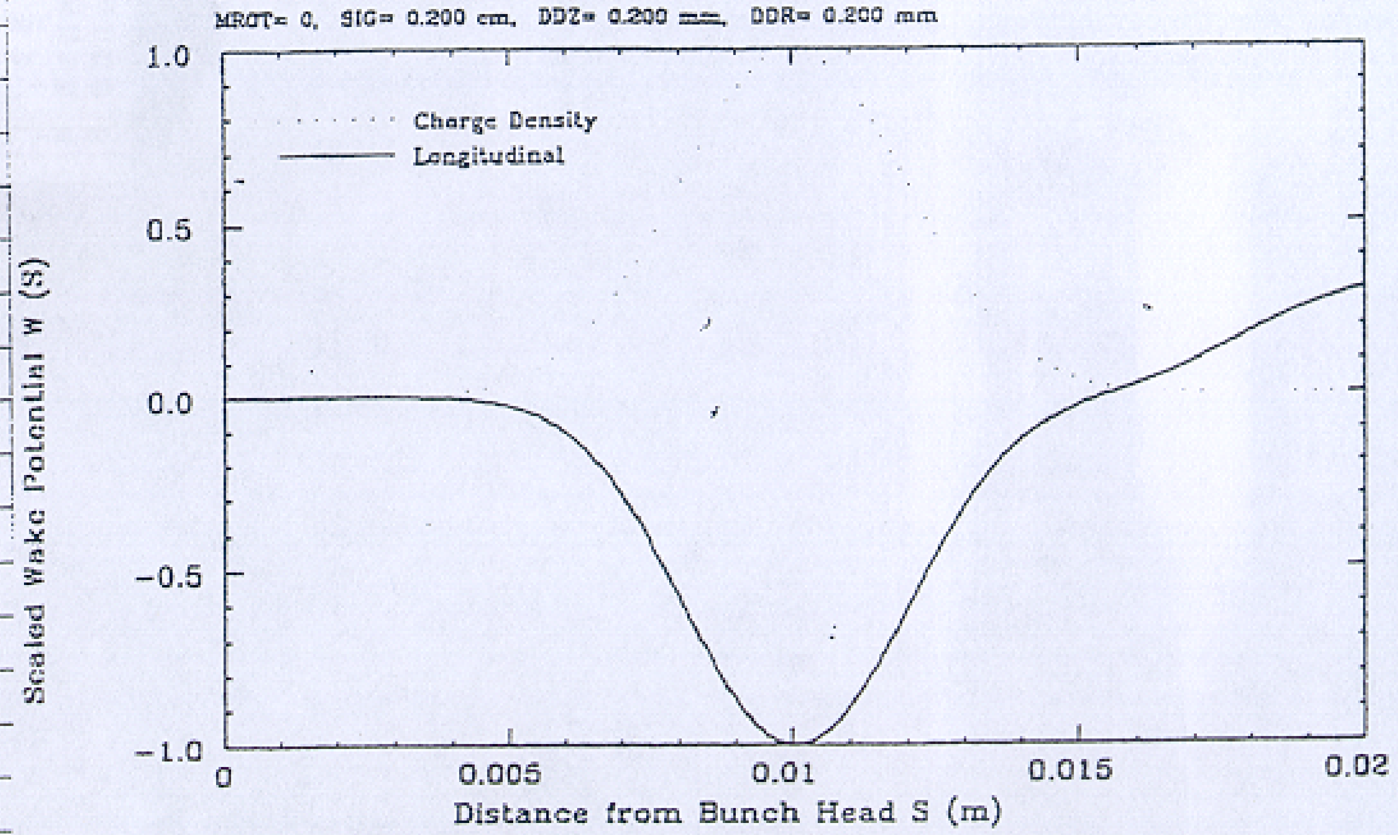
DDZ= 0.100 mm. DDR= 0.100 mm



Wake Potentials Cpu Time Used: 0.666E+01(s) 30/10/00 12.36.17

A B C I 8.7 : EXTRACTION KICKER CTF3 COMBINER RING

MROT= 0, SIG= 0.200 cm, DDZ= 0.200 mm, DDR= 0.200 mm



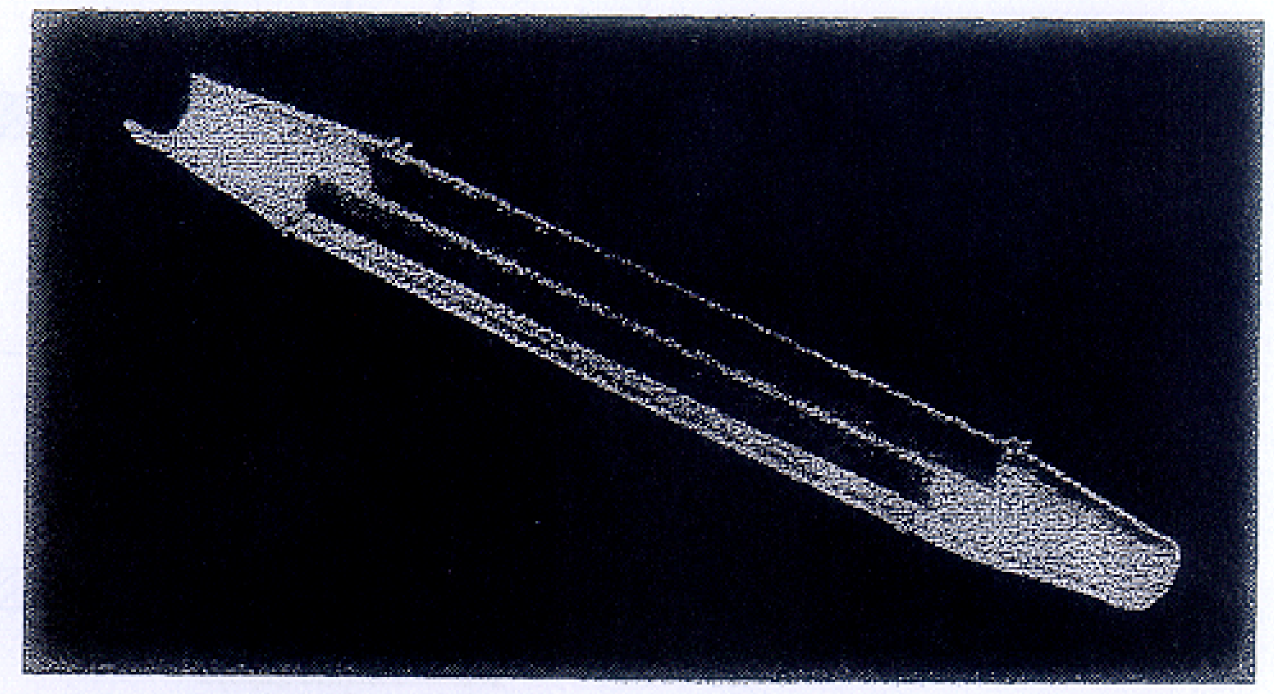
Longitudinal Wake Min/Max= −2.215E+00/ 6.905E−01 V/pC, Loss Factor= −1.544E+00 V/pC

σ_z, MM	$Ke, \frac{V}{C}$	W_{MAX}	$W_{min}, \frac{V}{C}$
0.5	$5.914 \cdot 10^{12}$	$5.667 \cdot 10^{11}$	$-9.667 \cdot 10^{12}$
1	$3.008 \cdot 10^{12}$	$9.420 \cdot 10^{10}$	$-4.205 \cdot 10^{12}$
2	$1.544 \cdot 10^{12}$	$6.905 \cdot 10^{11}$	$-2.215 \cdot 10^{12}$
3	$9.897 \cdot 10^{11}$	$7.935 \cdot 10^{11}$	$-1.429 \cdot 10^{12}$

After 5 turns with $Q = 2.33\,nC$:

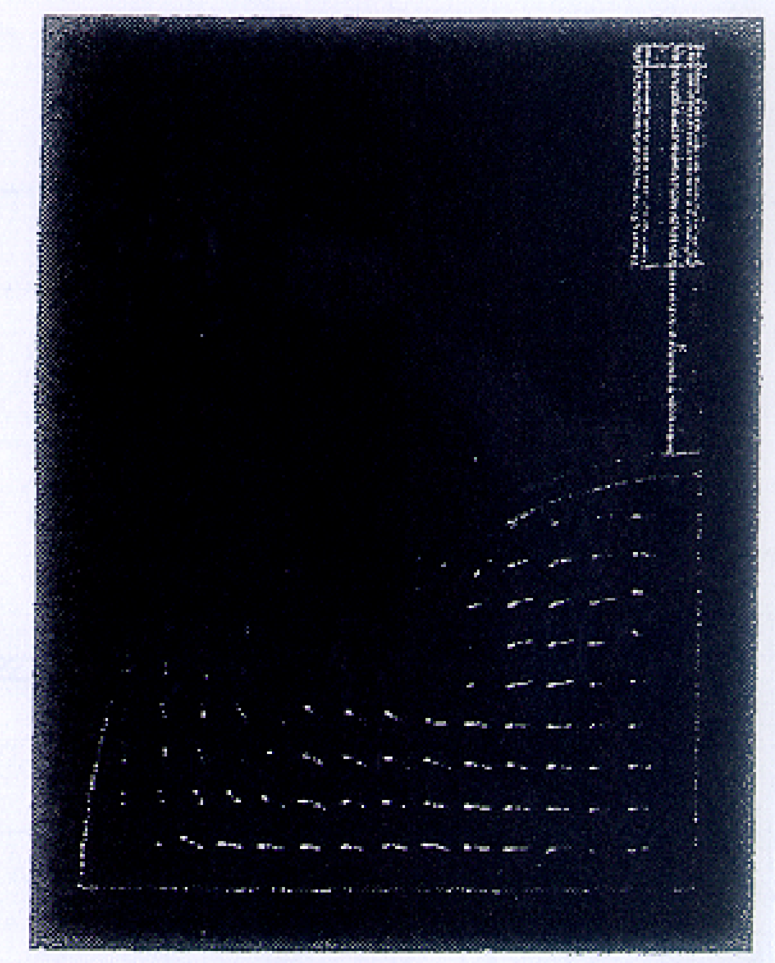
$$\left.\begin{aligned} E_{lost} &= 18\ keV \\ \Delta E_{MAX} &= 34\ keV \end{aligned}\right\} \text{for } \sigma_z = 2\ MM$$

CTF3 Extraction Kicker

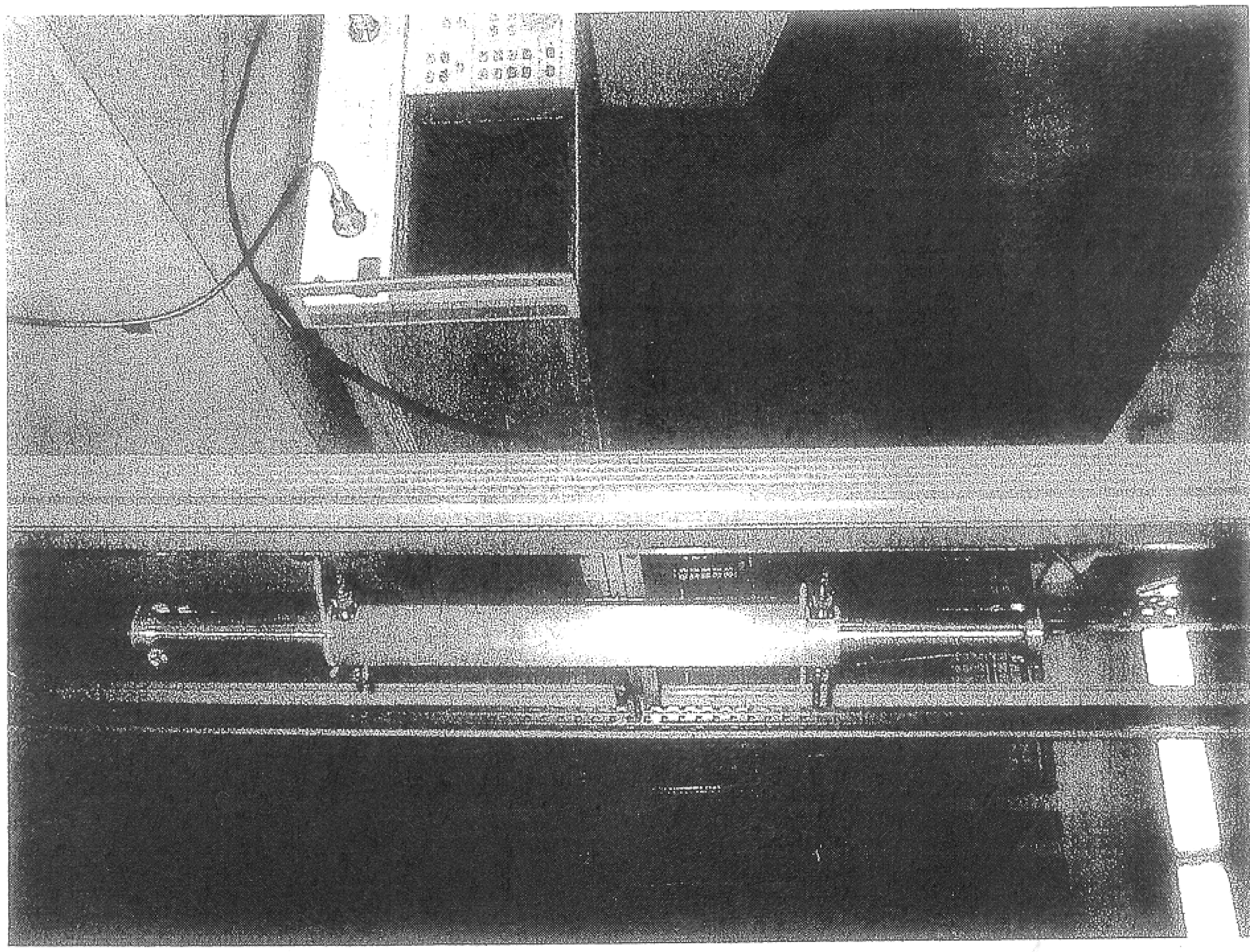


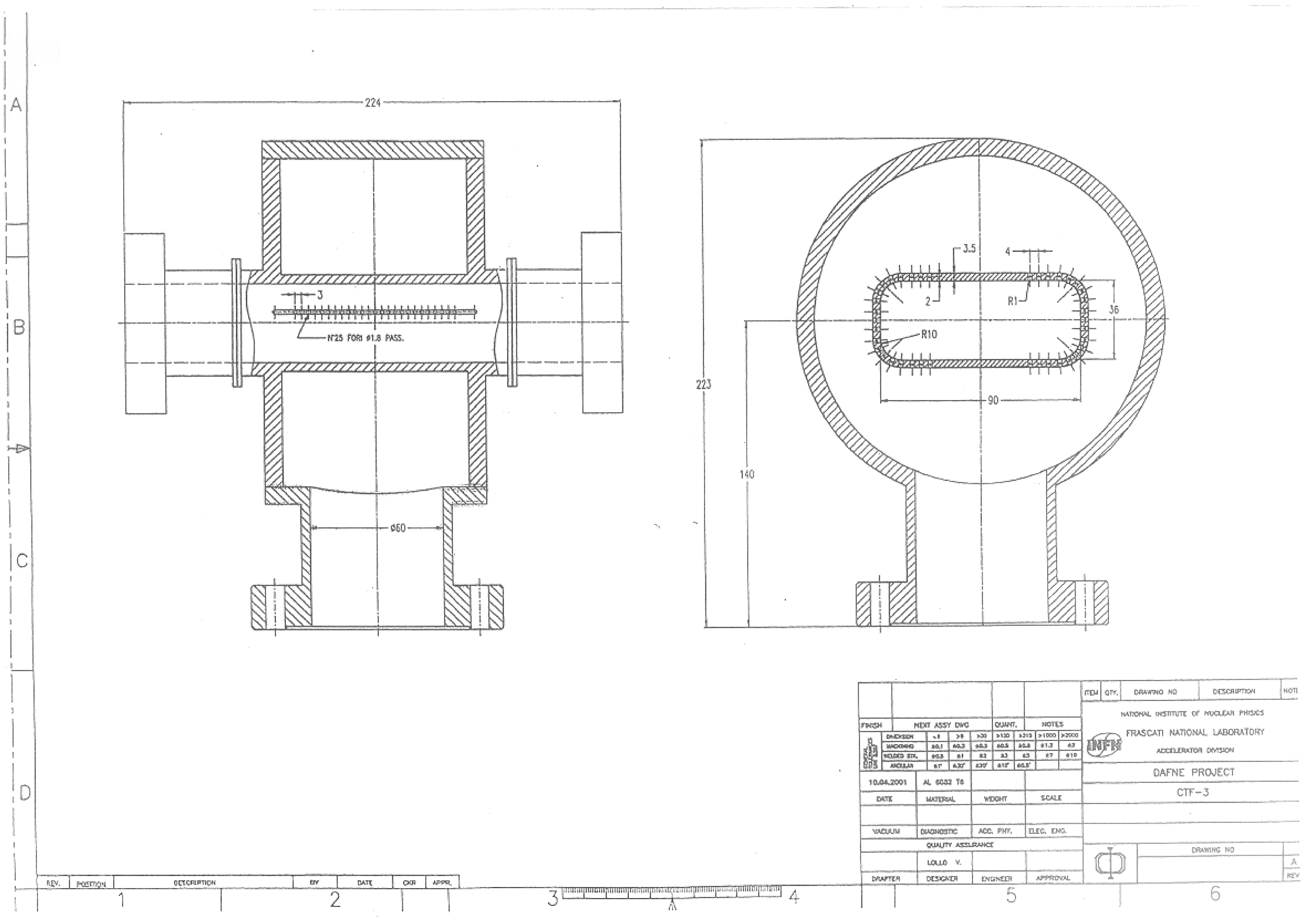
Transverse E–field

Transverse H–field



Shunt impedance of the deflecting mode: higher than 60 KΩ.





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ACC. PHY.
ELEC. ENG.
QUALITY ASSURANCE
LOLLO V.
DRAFTER
DESIGNER
ENGINEER
APPROVAL
ITEM
QTY.
DRAWING NO
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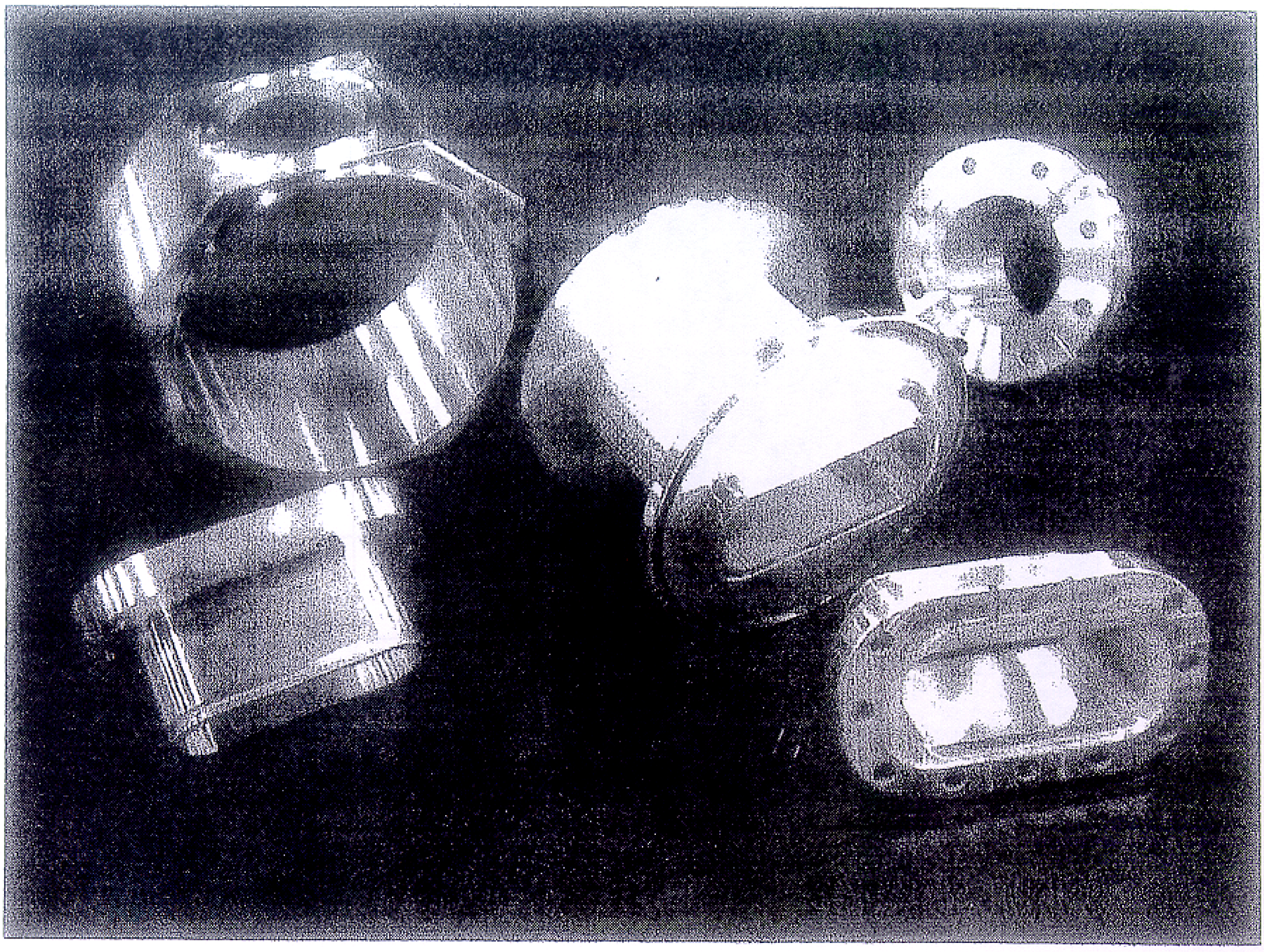
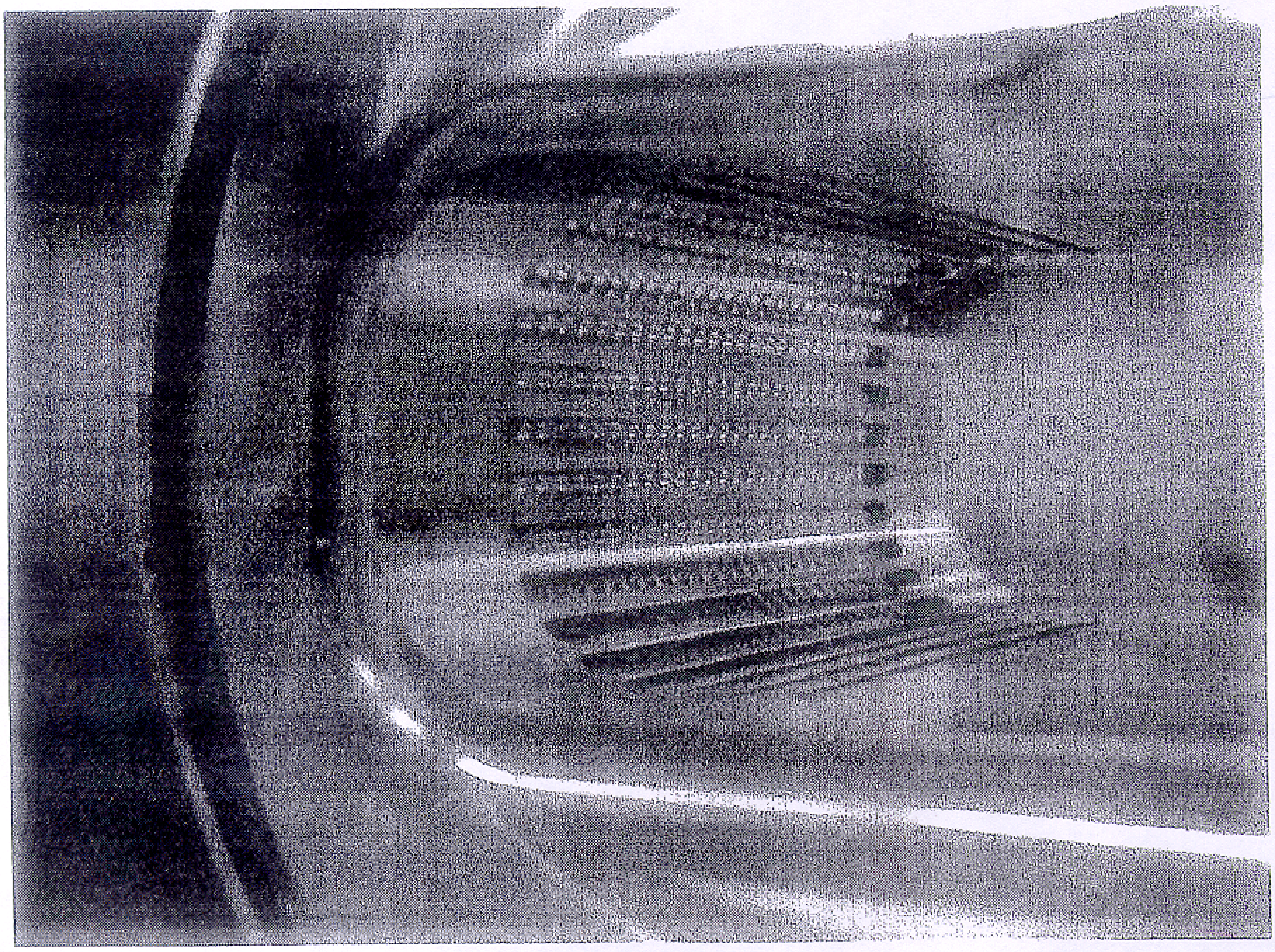
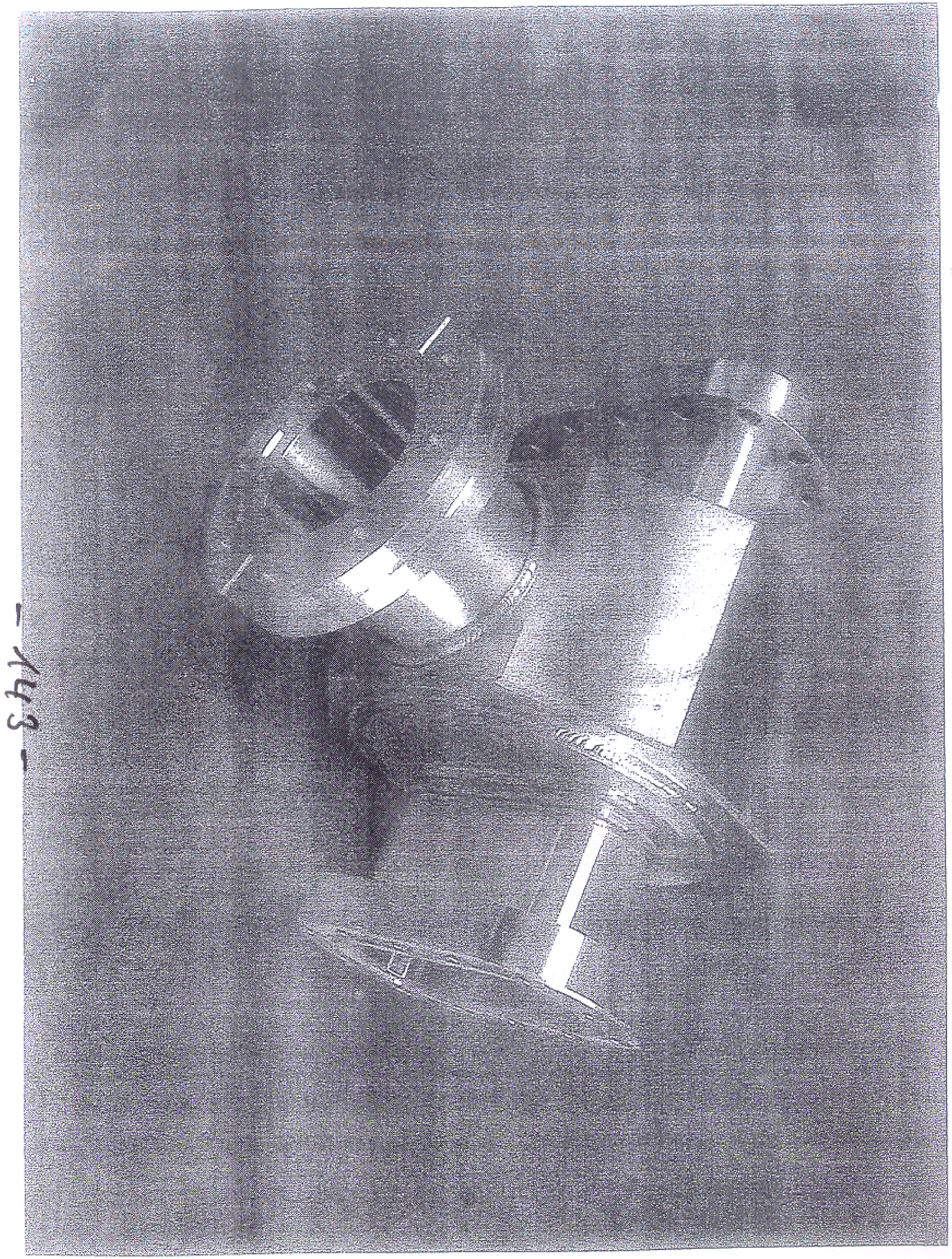
NATIONAL INSTITUTE OF NUCLEAR PHYSICS
FRASCATI NATIONAL LABORATORY
ACCELERATOR DIVISION
DAFNE PROJECT
CTF-3
DRAWING NO

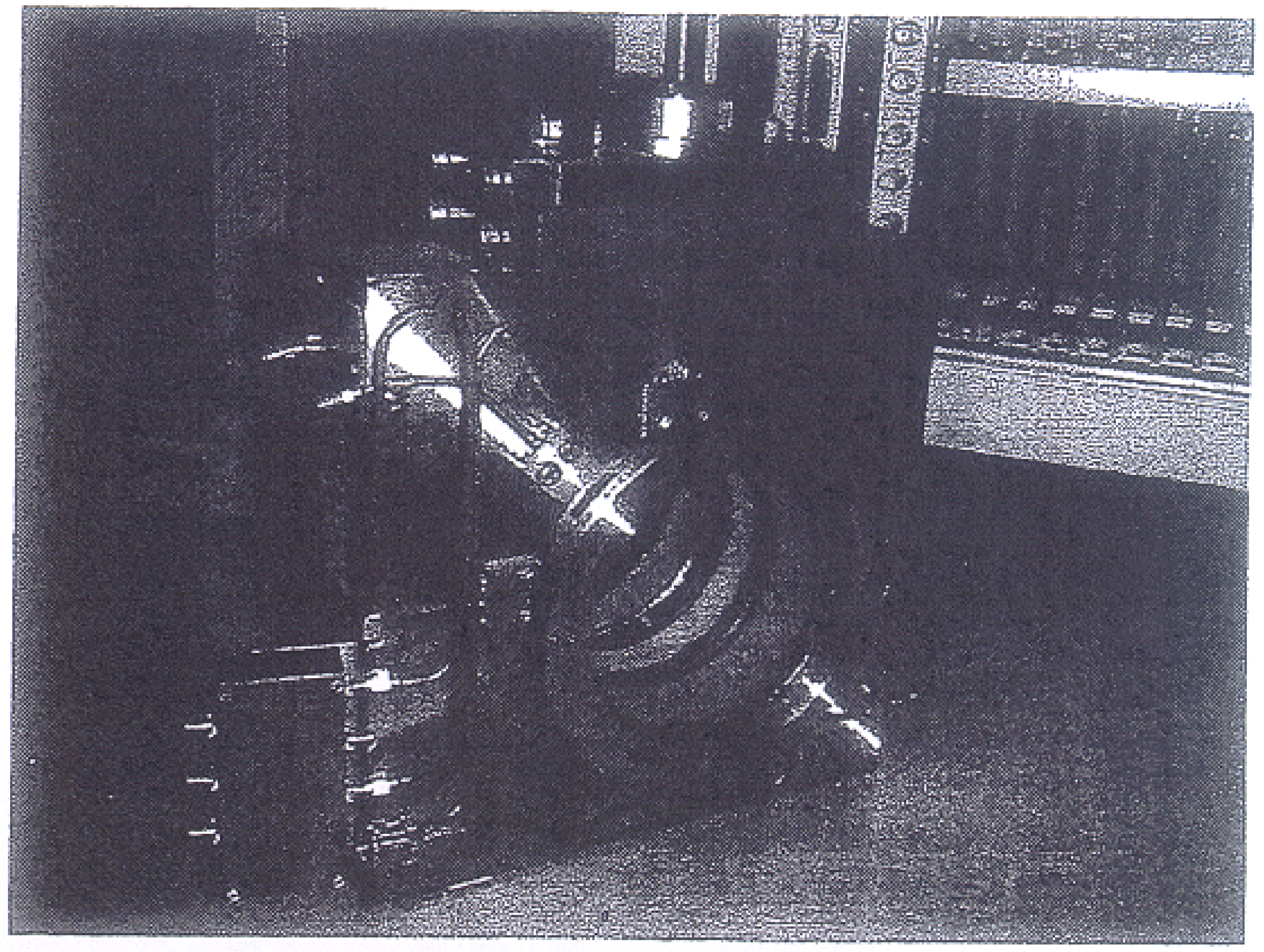


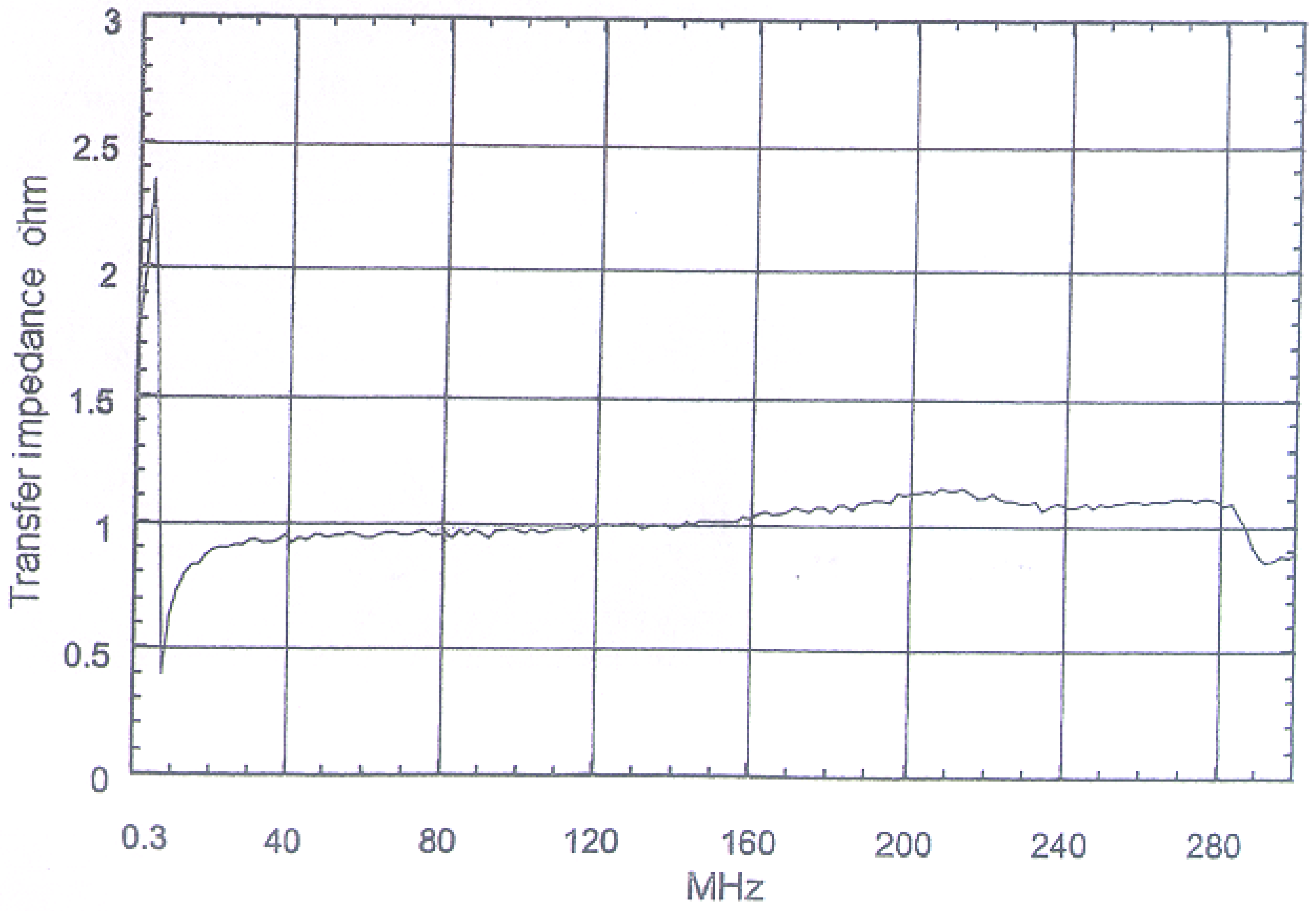




UMA Beam Position Monitor

Transfer Impedance Measurements





-144-