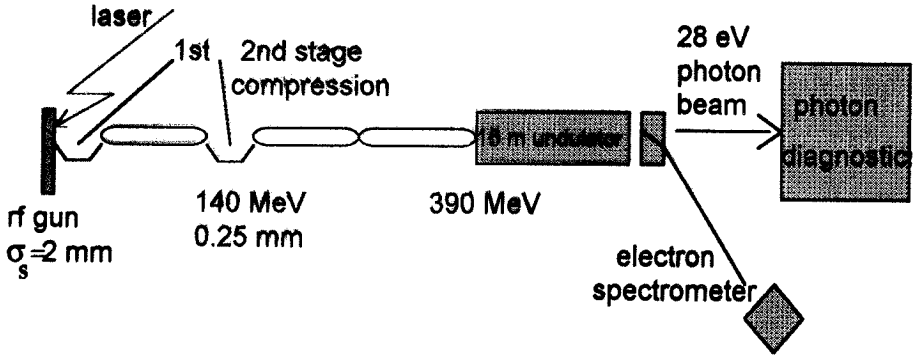
17TH ADVANCED BEAM DYNAMICS WORKSHOP ON

FUTURE LIGHT SOURCES

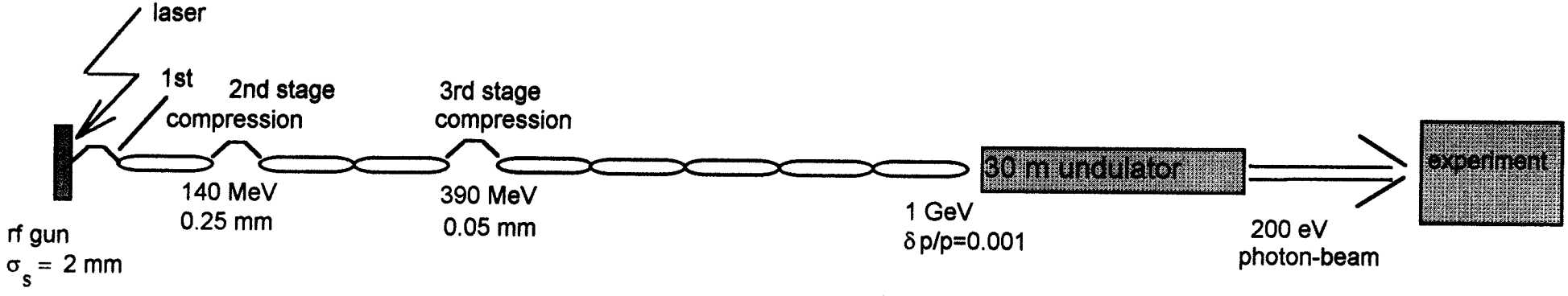
The TESLA Test Facility Free-Electron Laser

J. Rossbach, DESY

APRIL 6-9, 1999
ARGONNE NATIONAL LABORATORY, ARGONNE, IL U.S.A.



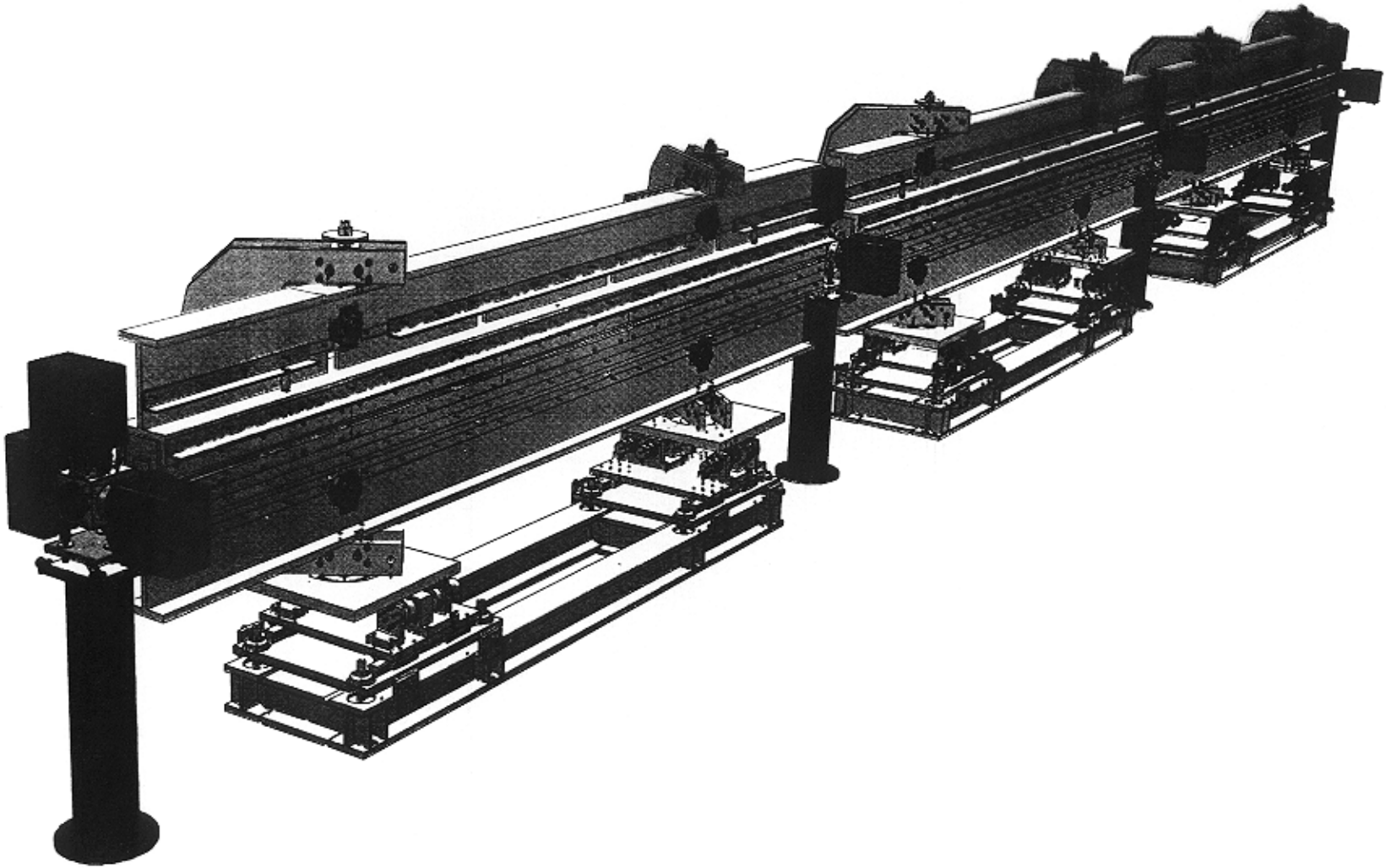
Phase 1 of the TTF Free Electron Laser



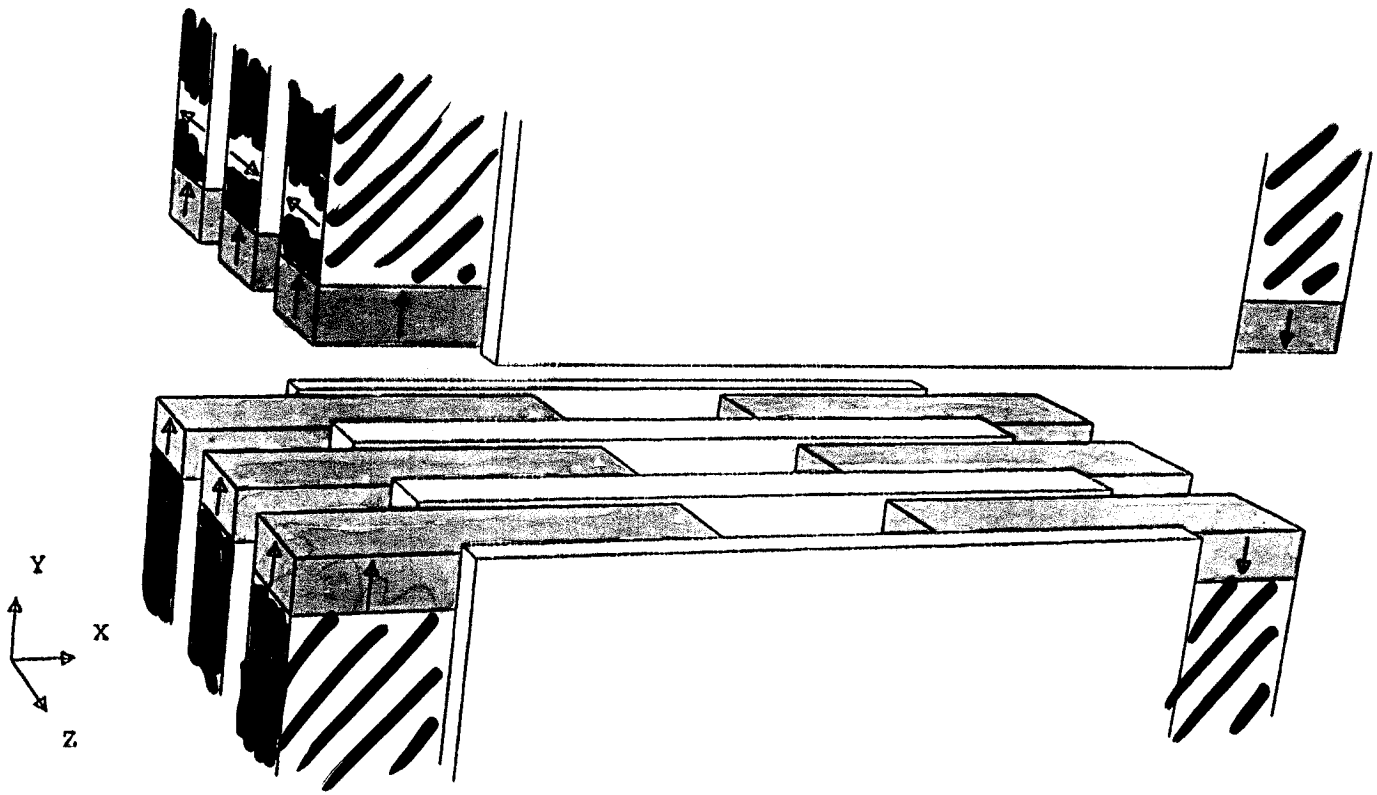
Phase 2 of the FEL facility based on the TESLA Test Facility including the energy upgrade to 1 GeV (assuming 15 MV/m). The bunch length is reduced from 2mm to 50μm within three steps of bunch compression. The over-all length is approx. 300 meters.

TTF-FEL Parameters

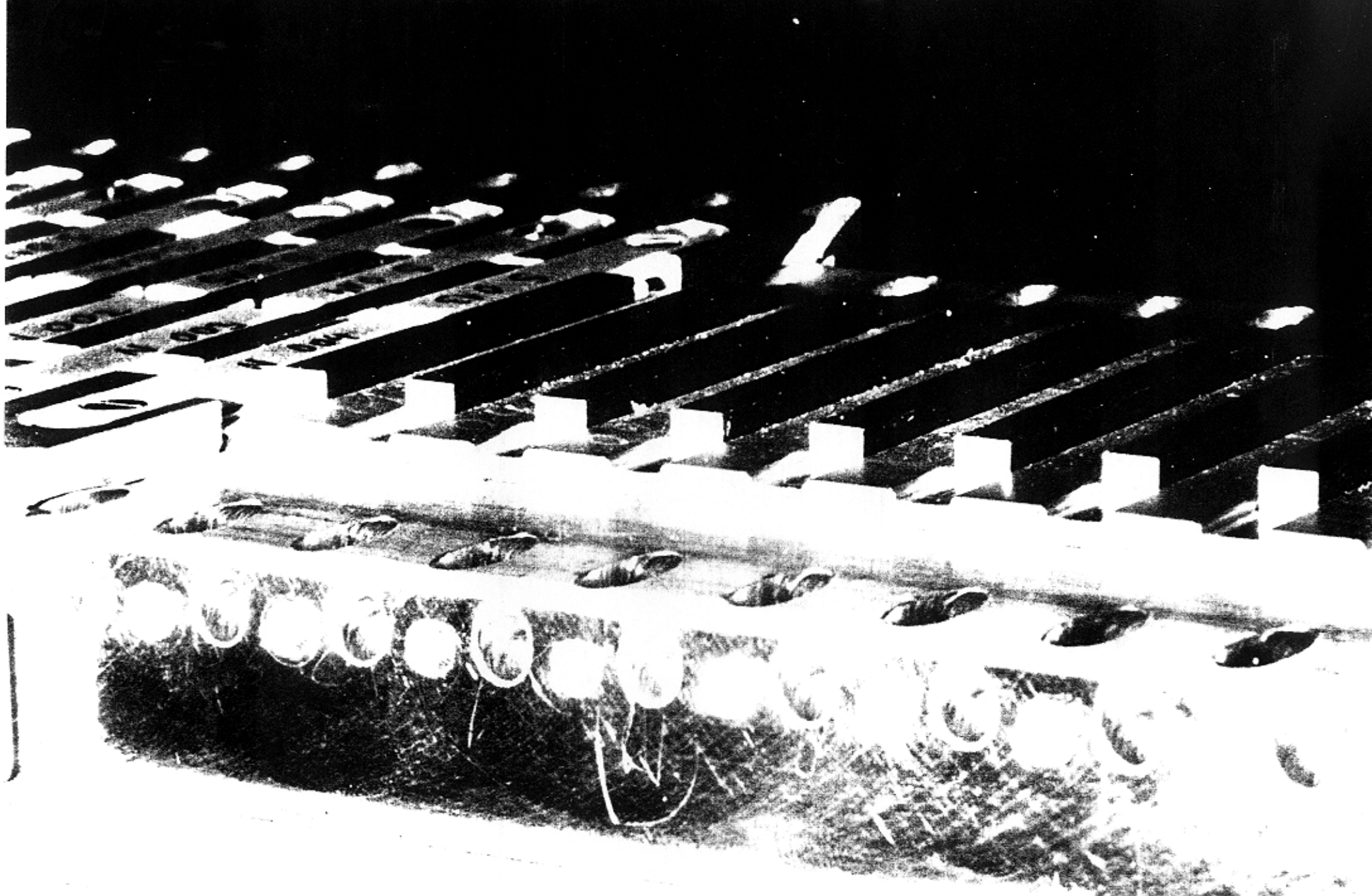
Parameters	Unit	Phase I	Phase II
Electron Beam			
Energy	MeV	230 - 390	1000
Peak Current	A	500	2500
Bunch Length (rms)	μm	250	50
Normalized Emittance (rms)	mm mrad	2	2
Energy Spread (rms)	MeV	0.5	1.0
Transverse Beam Size (rms)	μm	70	57
#Bunches / Train	–	7200	7200
Repetition Rate	Hz	10	10
Undulator			
Type		planar	planar
Length	m	15	30
Period Length	cm	2.73	2.73
Magnetic Peak Field	T	0.497	0.497
Undulator Parameter (rms)	-	0.894	0.894
Radiation			
Wavelength	nm	120 - 40	6.4
Bandwidth (rms)	%	0.7 - 0.4	0.5
FEL-Parameter	10^{-3}	4.6 - 2.8	2.1
Diffraction Parameter	-	1.1 - 2.3	14
Saturation Power	GW	0.23 - 0.5	2.4
Saturation Length	m	13.5 - 20.0	24.0

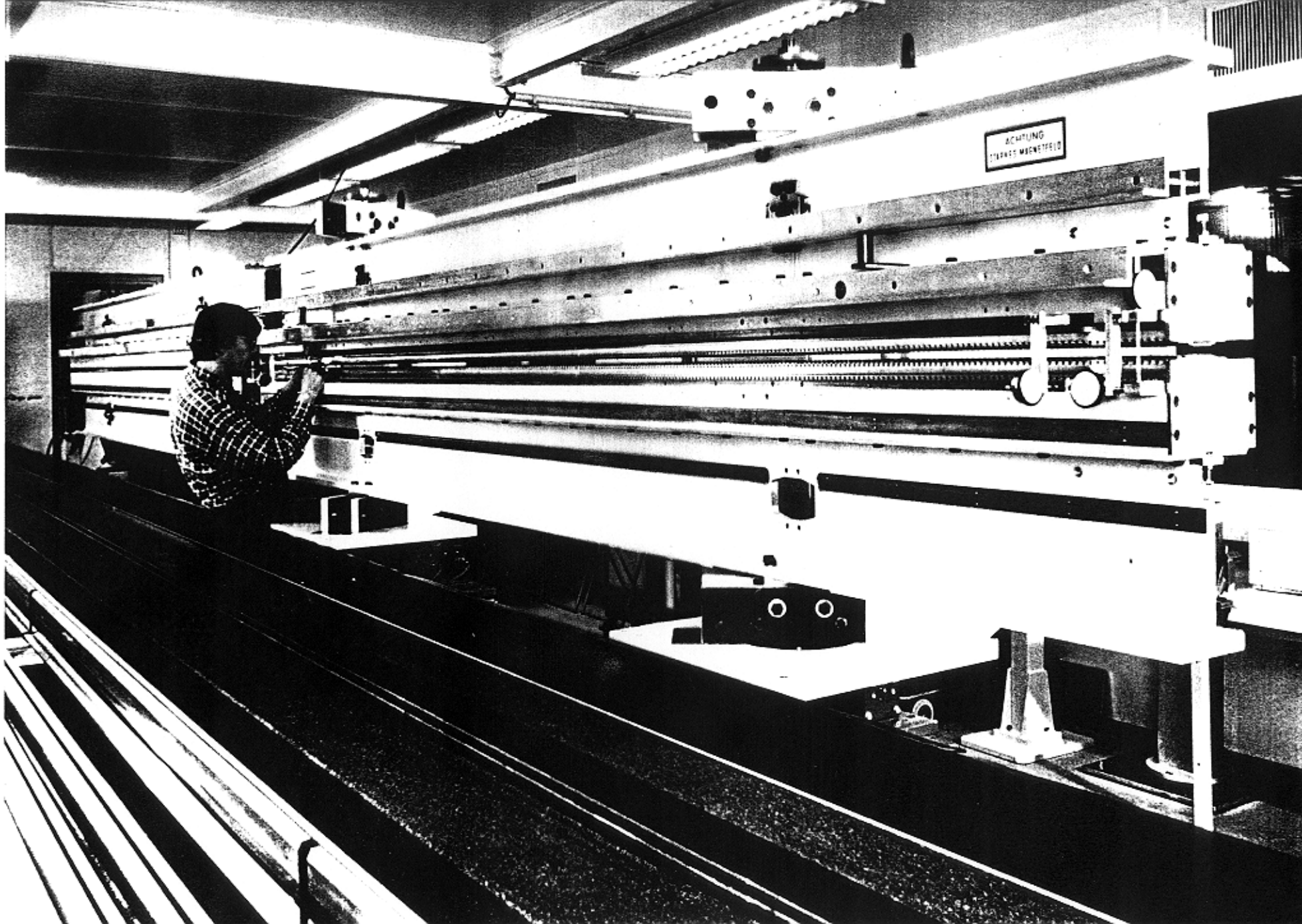


J. Pflüger, DESY

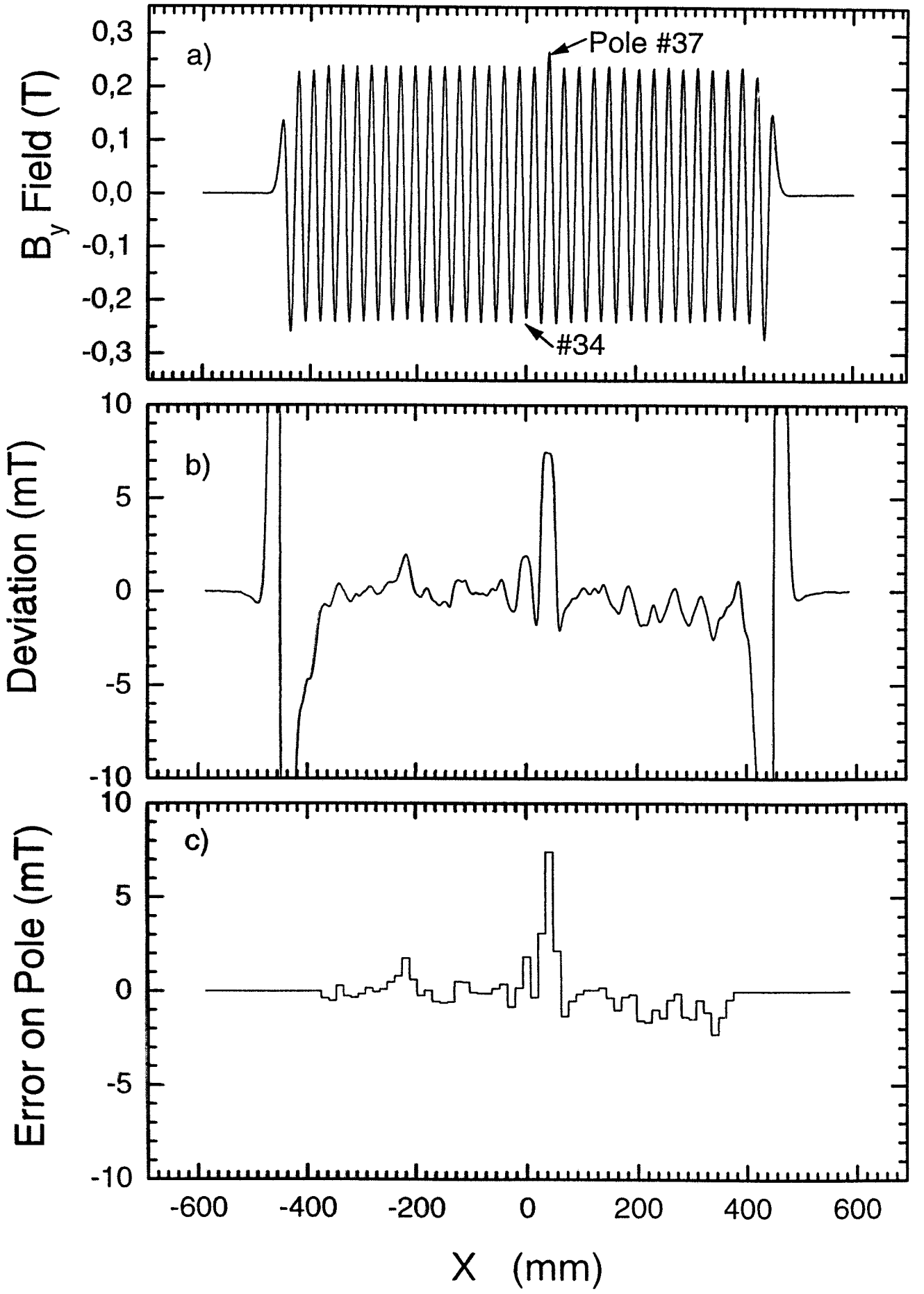


planar hybrid undulator with superimposed focusing

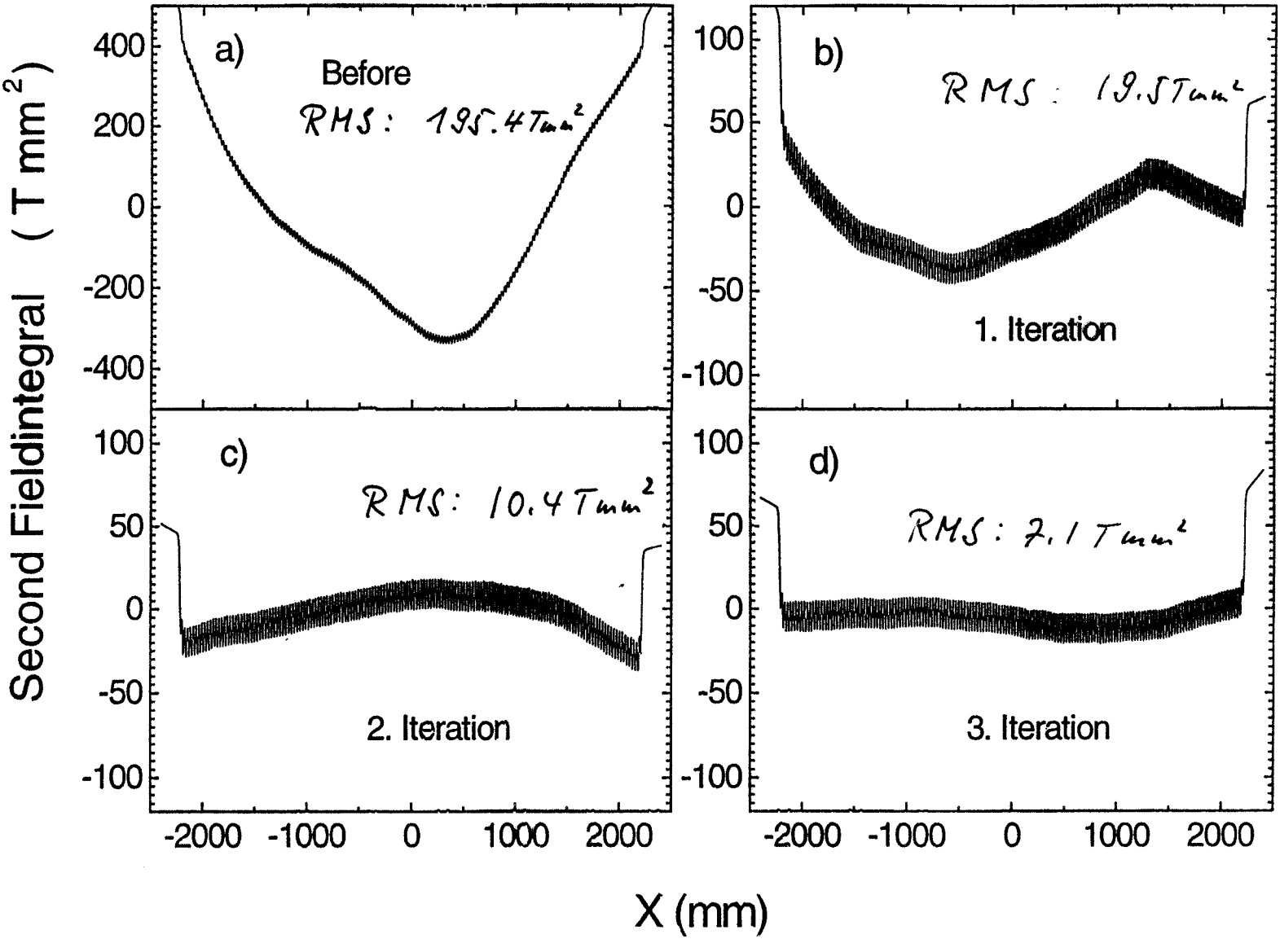


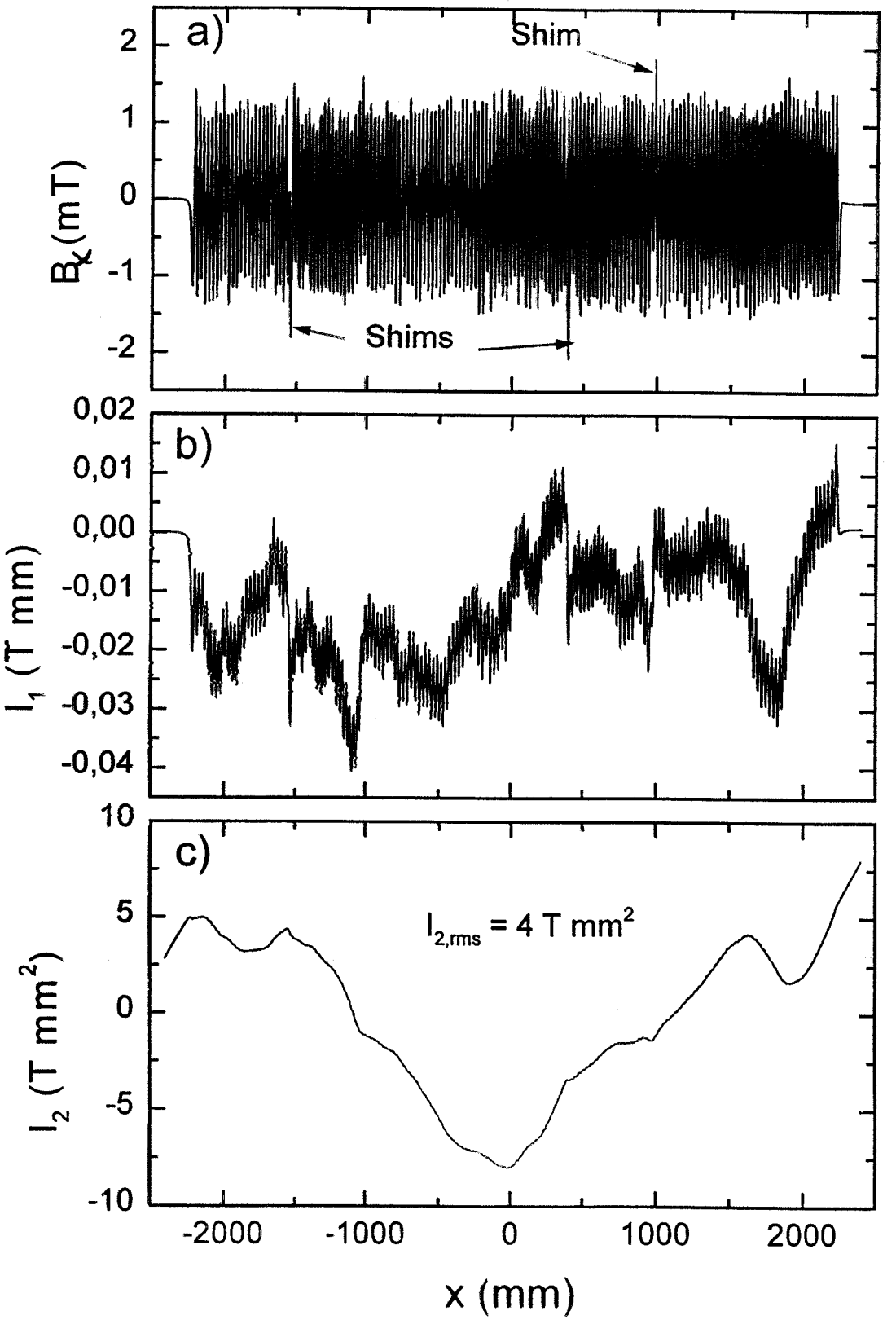

ACHTUNG
STARKES MAGNETFELD

Vertical (=main) field



$\frac{1}{2} \cdot \left(\frac{\lambda}{2\pi}\right)^2 B_0 = 4.7\,T\,mm^2$





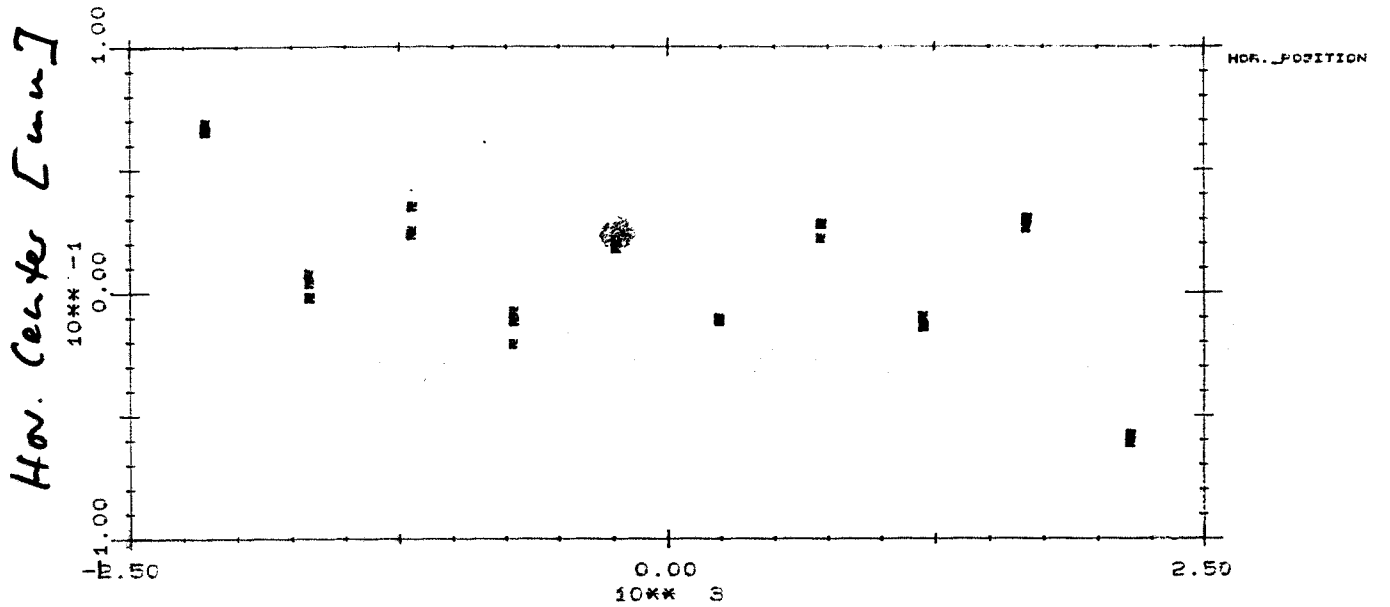
For constant Field $\bar{B}$:

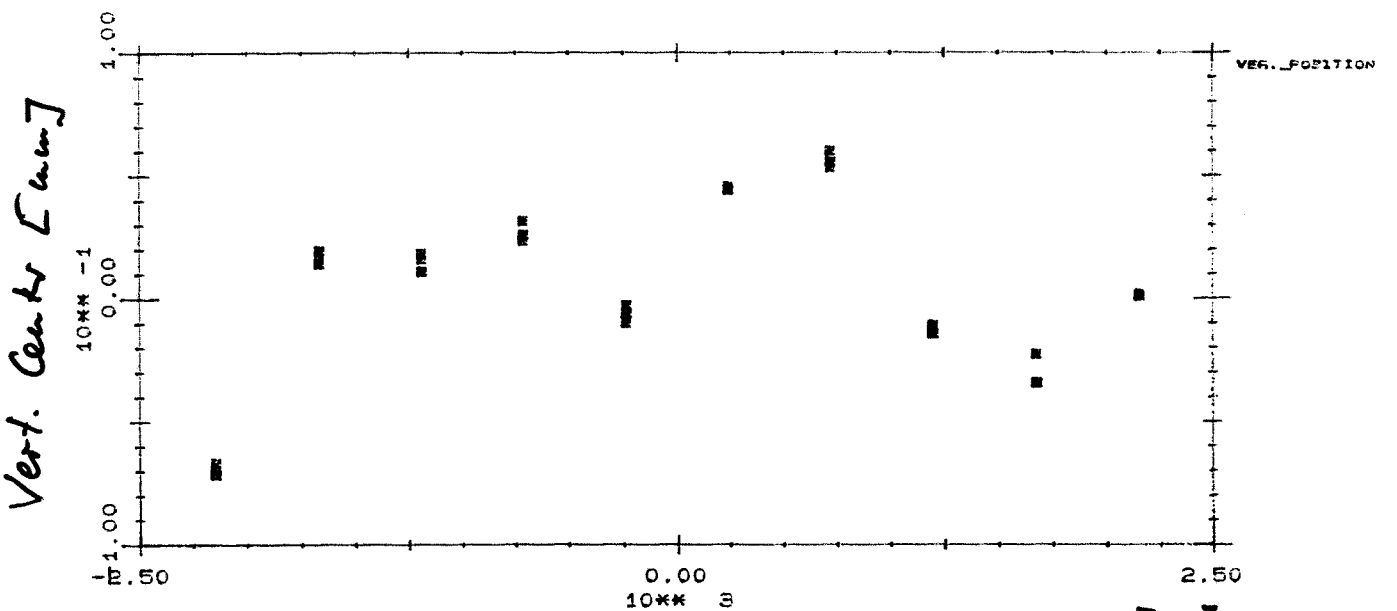
$I_2 = \bar{B} \cdot \frac{x^2}{2}$; If $I_2 \simeq 10$ T mm^2 $\hat{=}$ 10 µm @ 300 MeV

$x \simeq 5$ m

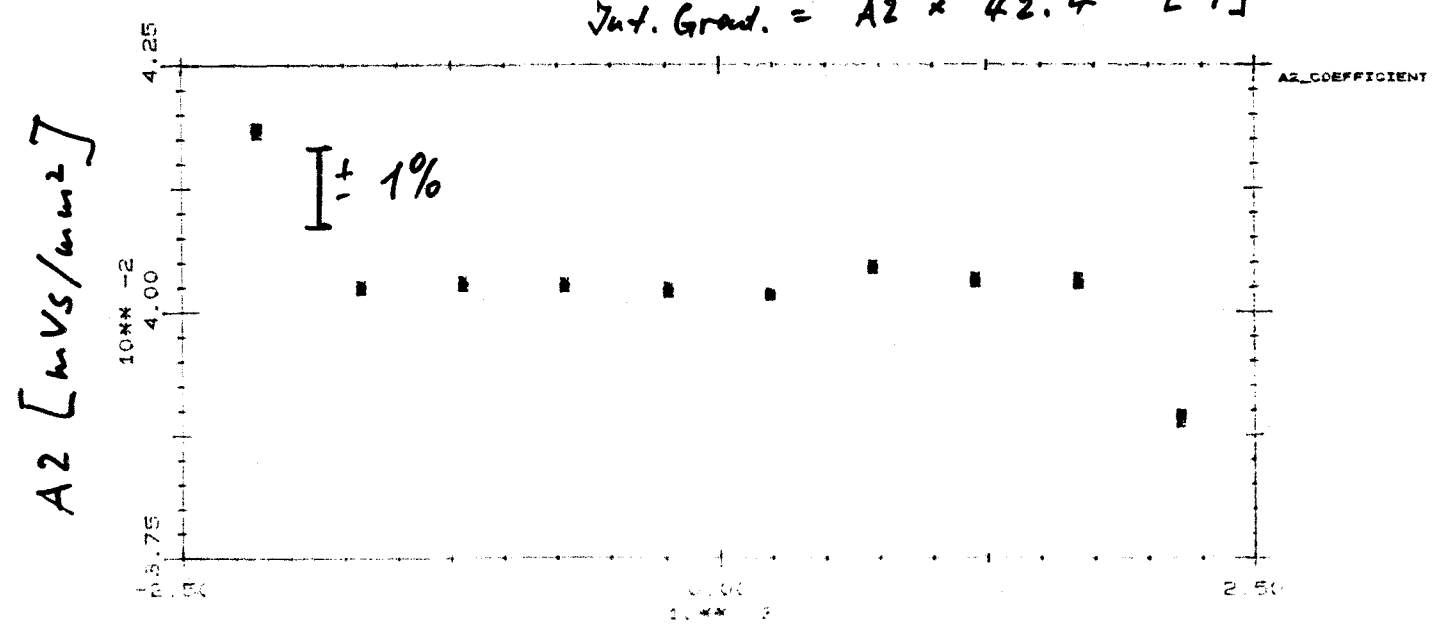
Fig 4

28.2.99





Int. Grad. = A2 × 42.4 [T]



The Undulator Vacuum System

length: ~ 15m, ∅ 9.5 mm

vacuum: outgassing rate <1• 10 $^{-11}$ mbar•l/sec•cm^{-2} particle free according TESLA secification

4 monitor blocks (185 mm long)

monitoring of the particle beam position in front and at the end of the 3 undulator modules

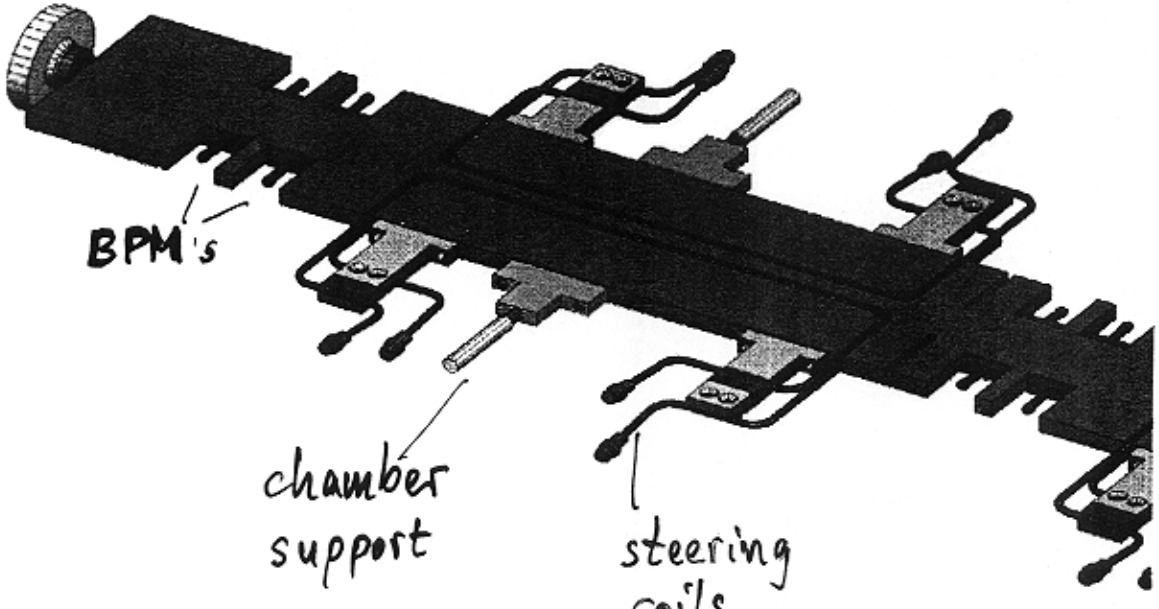
3 FEL - vacuum chambers 4.5m long 128x11.5mm^2

monitoring of the particle beam position in the gap of the undulator modules

steering of the particle beam in the gap of the undulator modules

ITF FEL vacuum chamber

design and production : DESY and Argonne Natl. Lab

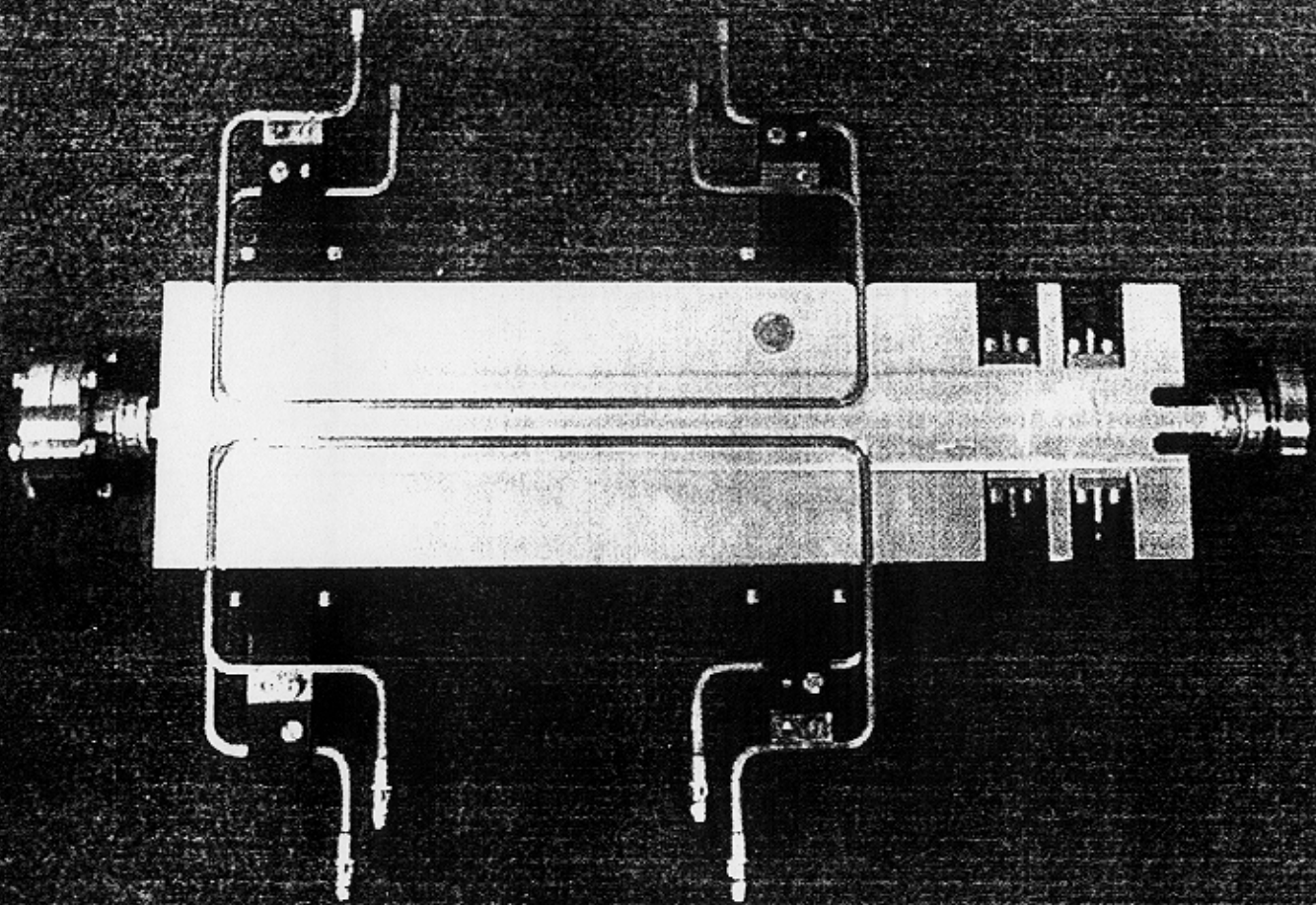


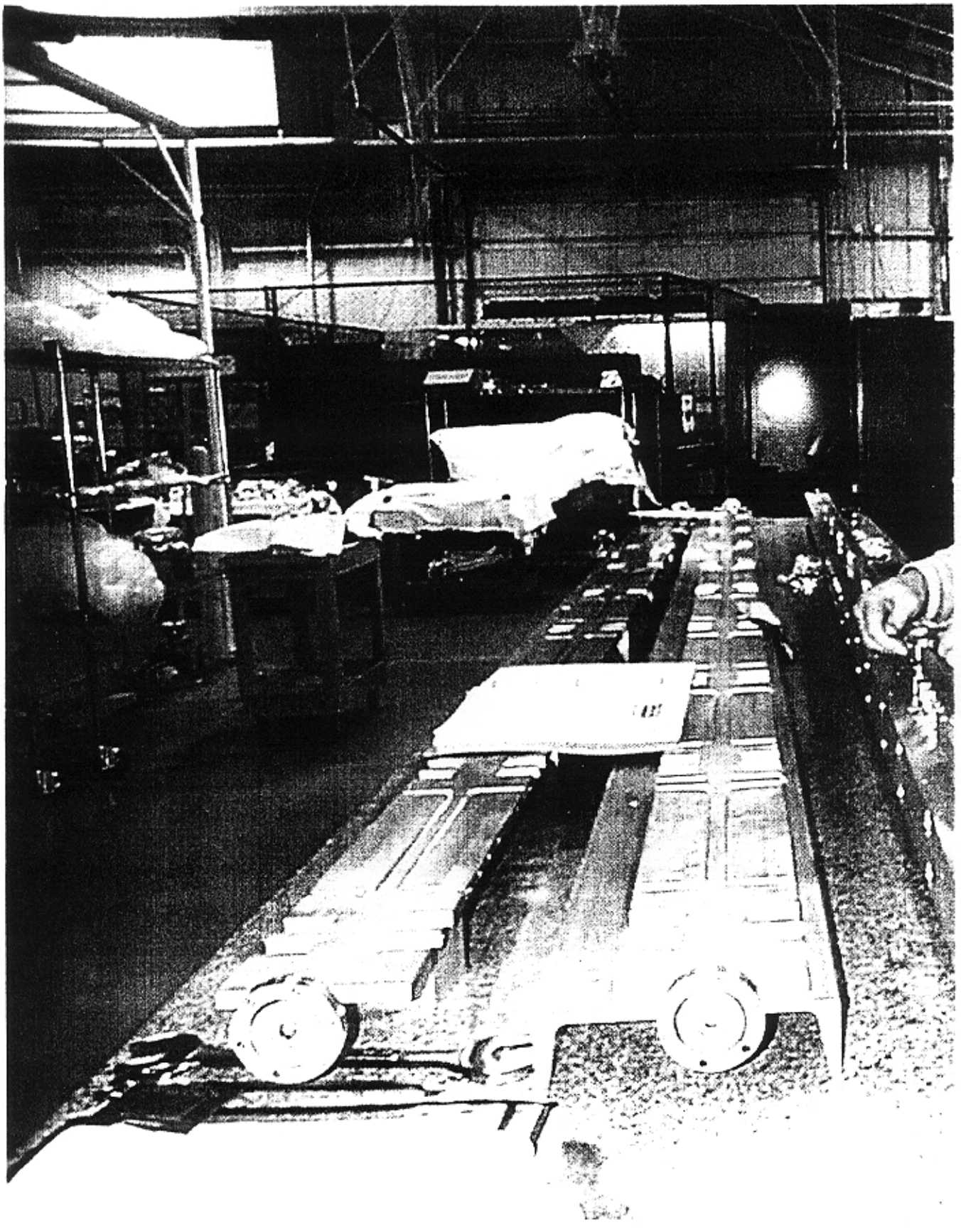
Length: 4.5 m

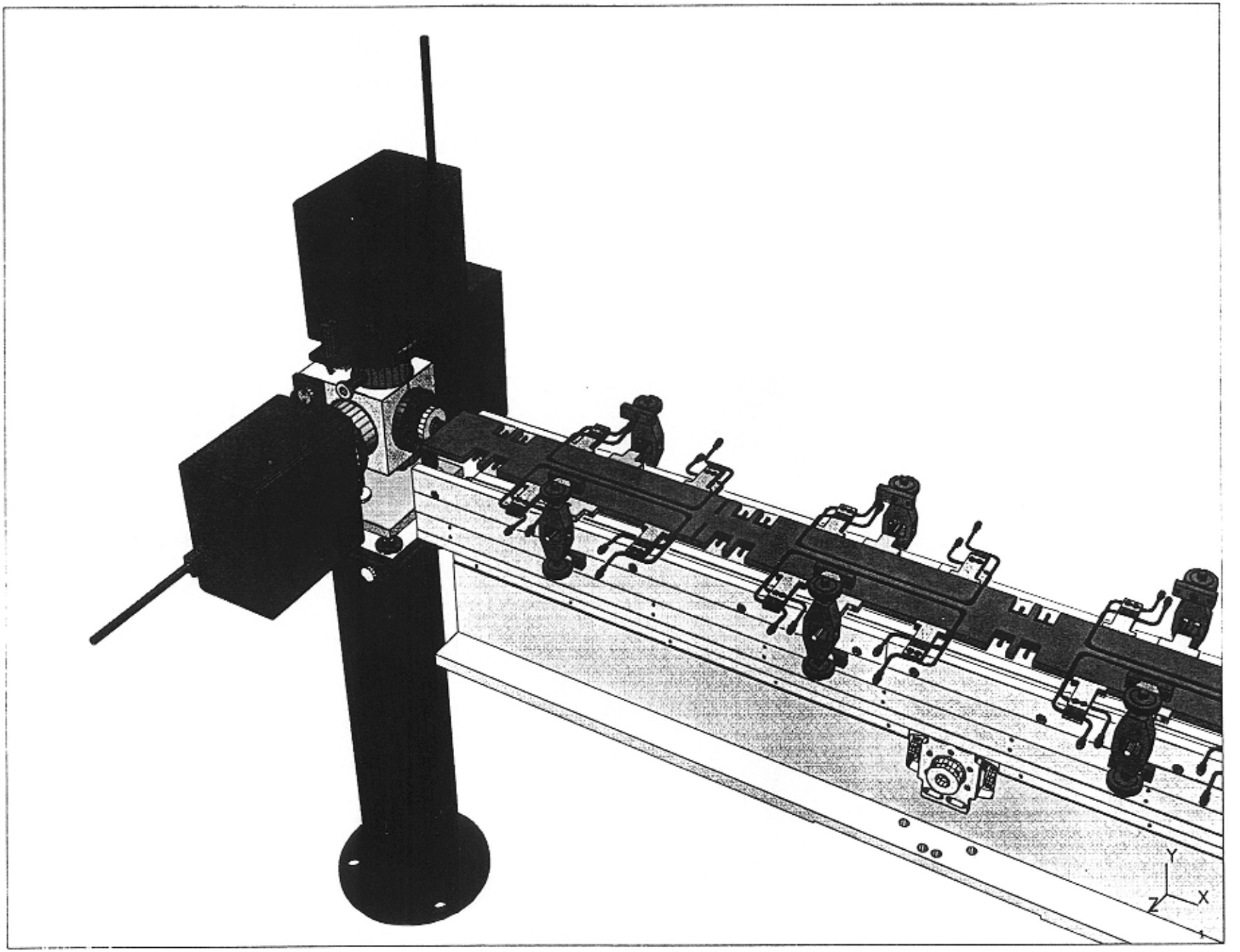
cross section : 128 x 11.5 mm²

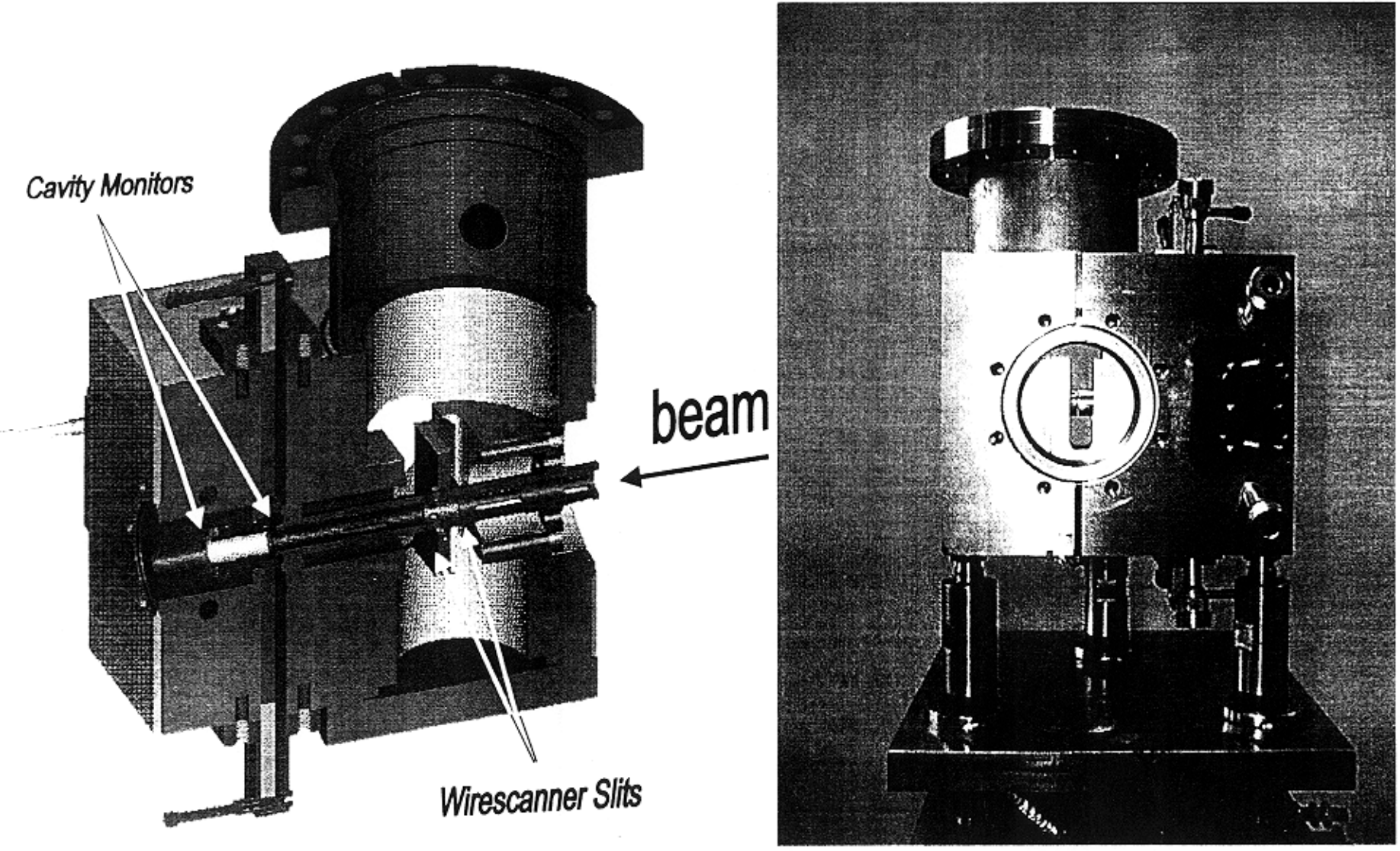
beam pipe ∅: 9.5 mm bore

material : extruded Al
+ stainless steel flanges






Y
Z
X


Cavity Monitors
beam
Wirescanner Slits

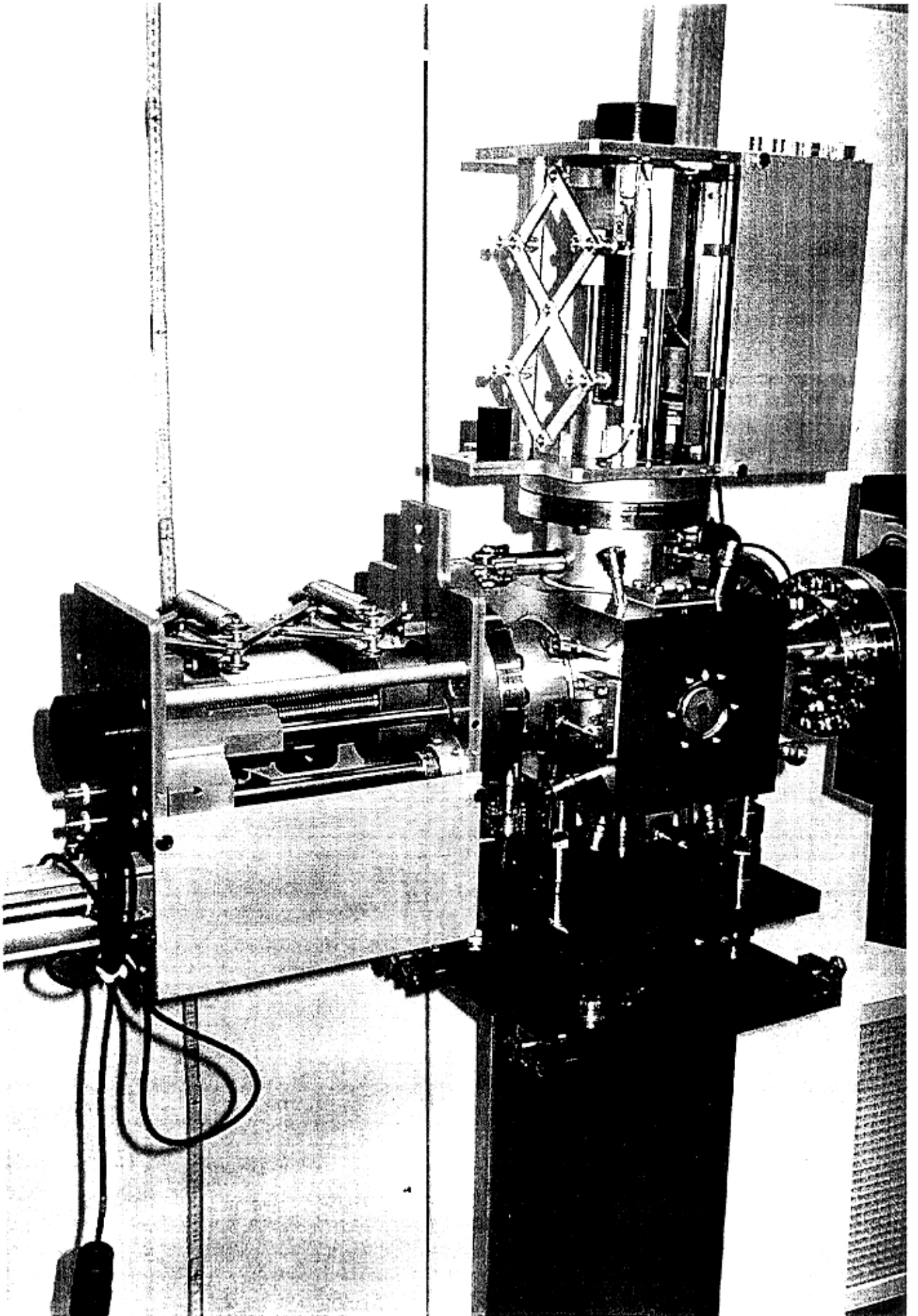
Monitor Block

absolute *beam position measurement*
horizontal and vertical wirescanners
horizontal and vertical cavity monitors (absolute after calibration)

FEL - Vacuum Chamber

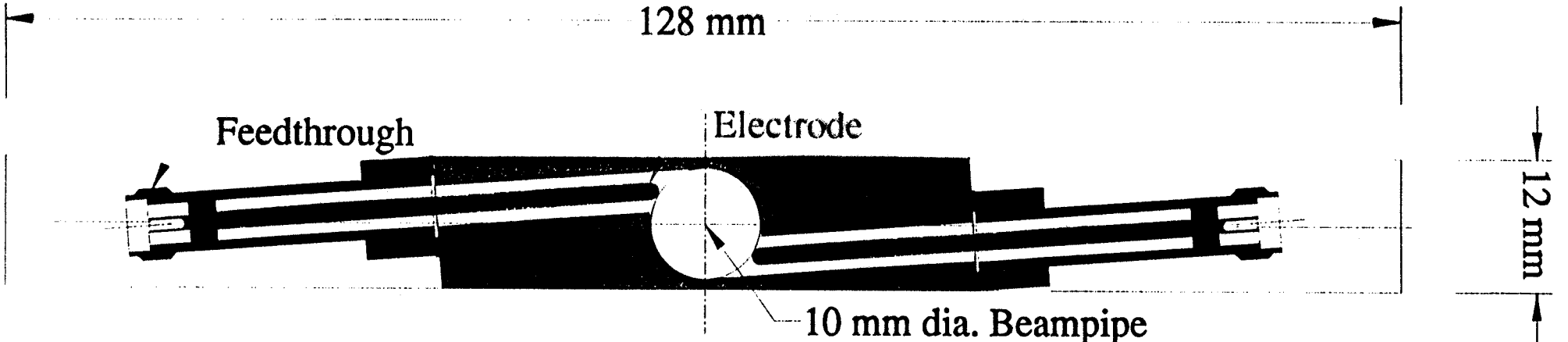
relative *beam position measurement*
10 pick up monitors (40 electrodes - vertical - horizontal)
or
10 waveguide monitors (40 electrodes - vertical - horizontal)

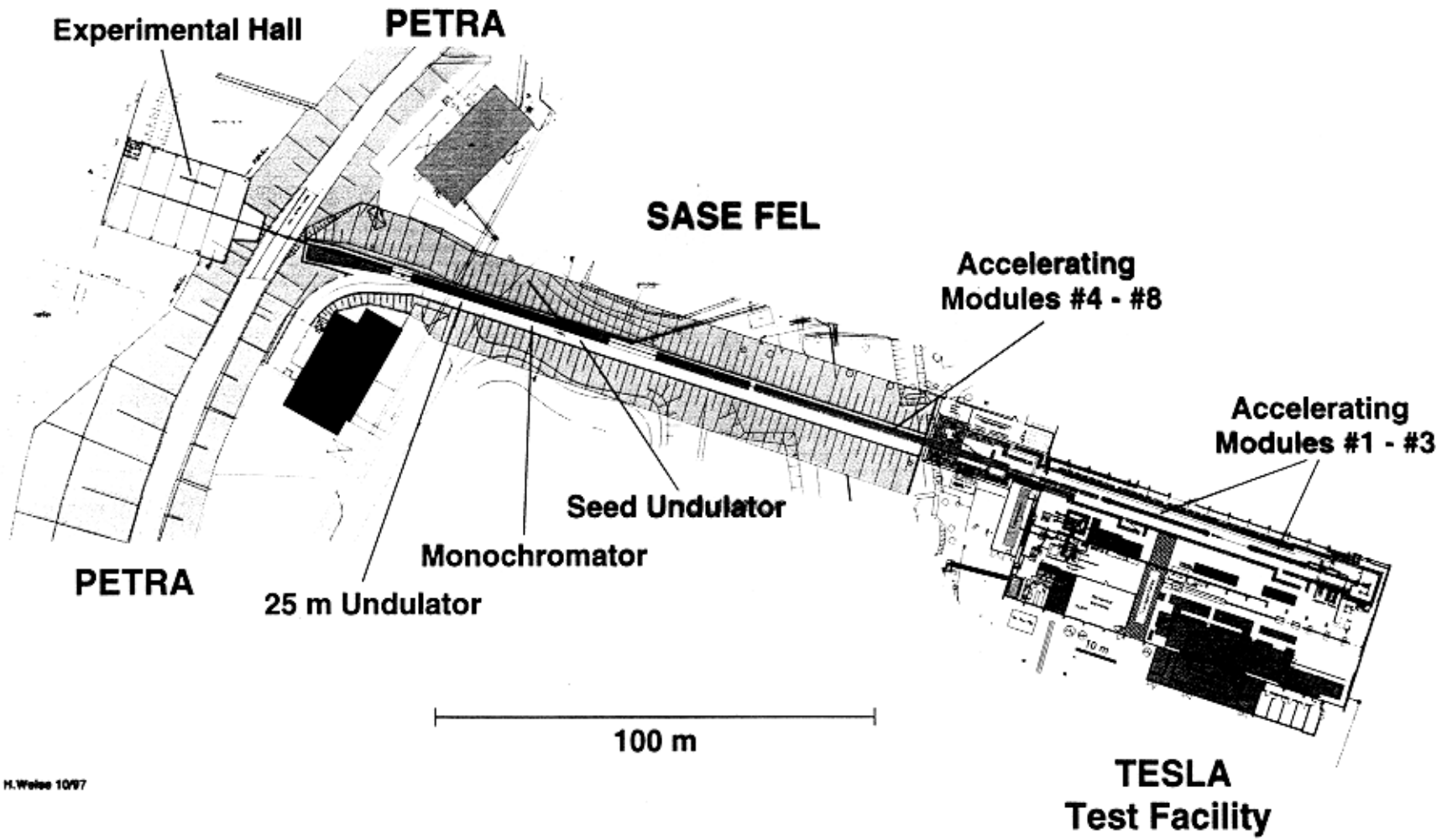
beam steering
36 steering coils



TTFL-FEL: Electrostatic BPM Pickup

Cross-section of a couple of opposide electrodes




Experimental Hall
PETRA
SASE FEL
Accelerating
Modules #4 - #8
Accelerating
Modules #1 - #3
Seed Undulator
Monochromator
PETRA
25 m Undulator
100 m
H.Weise 10/97
TESLA
Test Facility