Undulator Vacuum

Ulrich Hahn, HASYLAB at DESY

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Outline

Introduction

Undulator Vacuumchambers

Structure of the Vacuumchambers

Chamber Alignment

Pressure Distribution

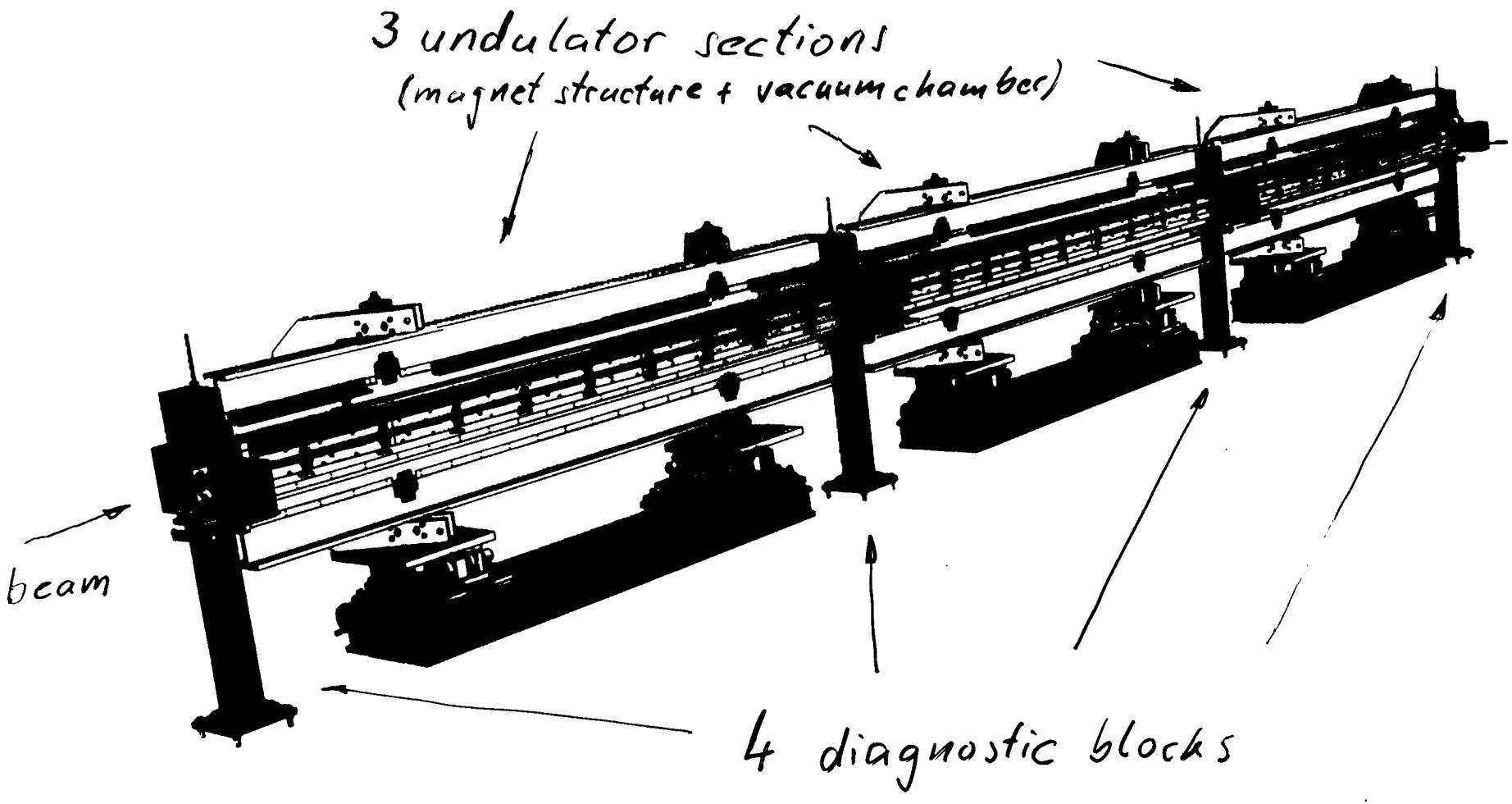
People involved at DESY:

N. v. Bargen
J. Brehling
C. Boudou
S. Greulich
U. Hahn
D. Hubert
T. Kamps
R. Lorenz
G. Marquart
M. Meschkat
J. Pflüger
M. Rüter
H. Schlarb
G. Schmidt
H. Schultz
A. Swiderski
H. Thom
S. Vilcins
H. – P. Wedekind
M. Wendt
M. Werner
K. Wittenburg
K. Zapfe – Dueren

at APS – ANL:

P. DenHartog, M. Erdmann, E. Gluskin, E. Trakhtenberg, G. Wiemerslage, S. Xu

J. Noonan et. al.


3 undulator sections
(magnet structure + vacuum chamber)
beam
4 diagnostic blocks

The Undulator Vacuum System

length: ~ 15m, ∅ 9.5 mm

vacuum: *outgassing rate* $< 1 \bullet 10^{-11}$ *mbar•l/sec•cm*$^{-2}$

particle free: *according TESLA specification*

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

VACUUM CHAMBER DESIGN

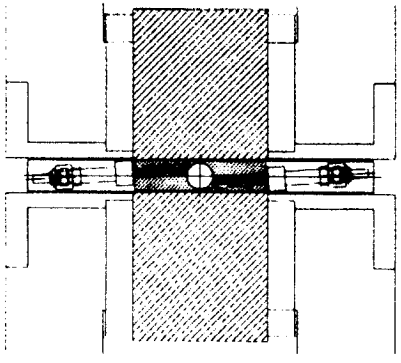
There are several design criteria for the undulator vacuum chamber:

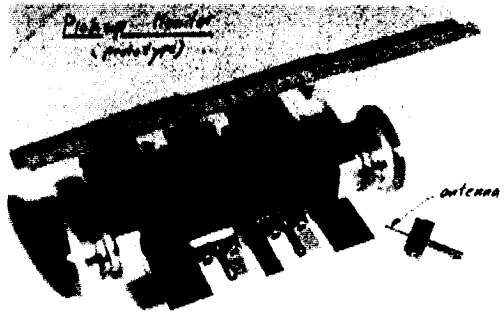
- The undulator gap size is 12 mm
- The chamber has to permit beam position measurement and steering in the gap
- The chamber has to be vertical and horizontal aligned within 0.1mm
- Low electrical resistance and small micro-roughness of the inner beampipe are needed to minimize resistive wall and wake field effects on the beam
- Two types of beam position monitors
- Pick up monitors (chamber 1 and 2) danger of sparking for short bunches
- Waveguide monitor (chamber 3) no risk of sparking $\rightarrow$ TTF phase II

BEAMPOSITION MONITORS

Pick up monitors (chamber 1 and 2) (M. Wendt et. al)

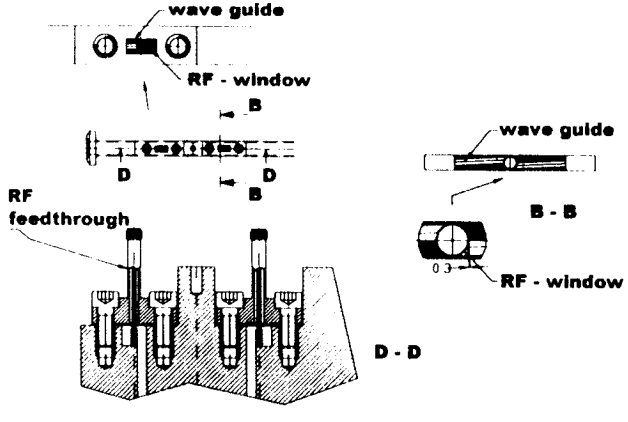
danger of sparking for short bunches





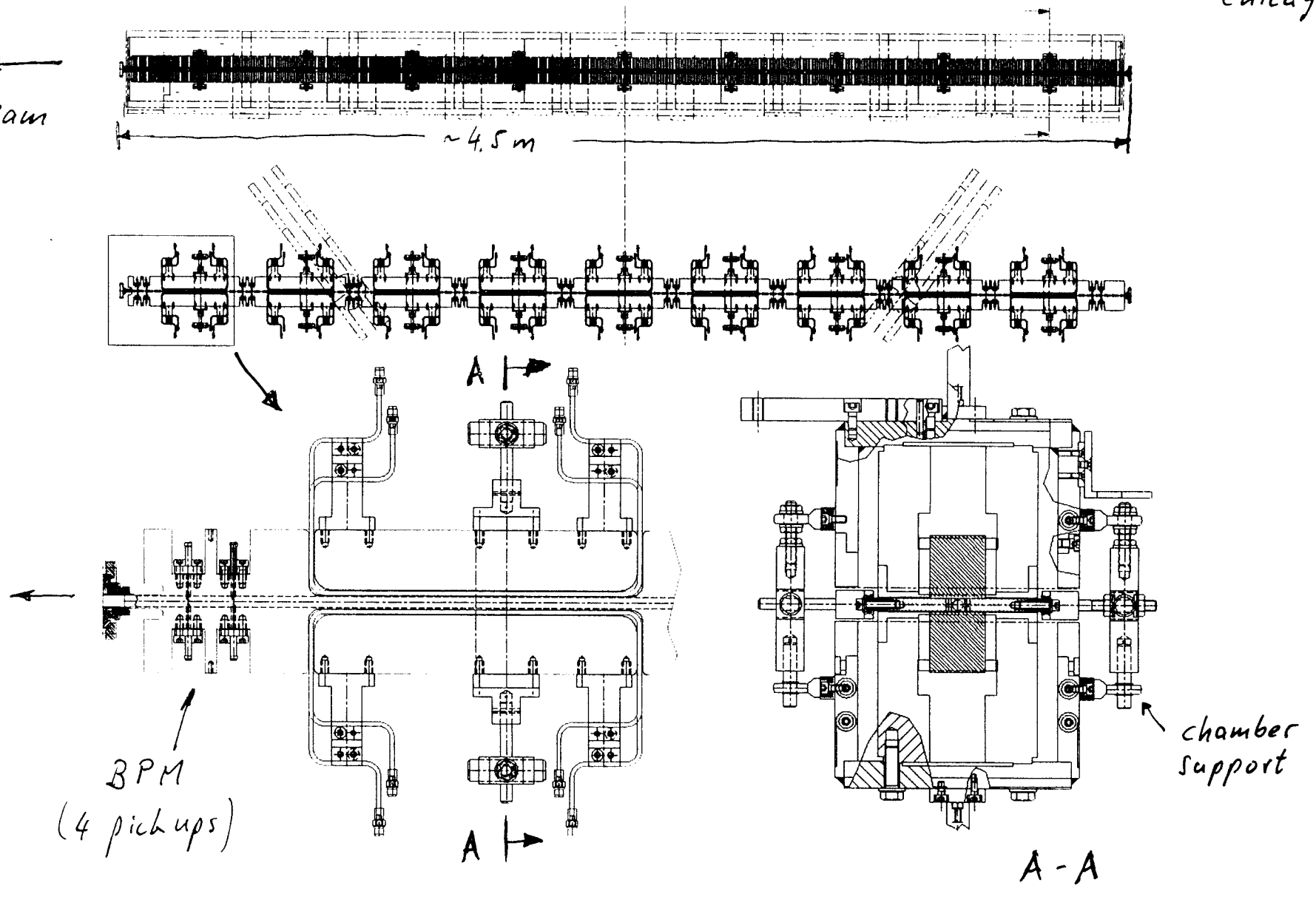
Waveguide monitor (chamber 3) (R. Lorenz et. al)

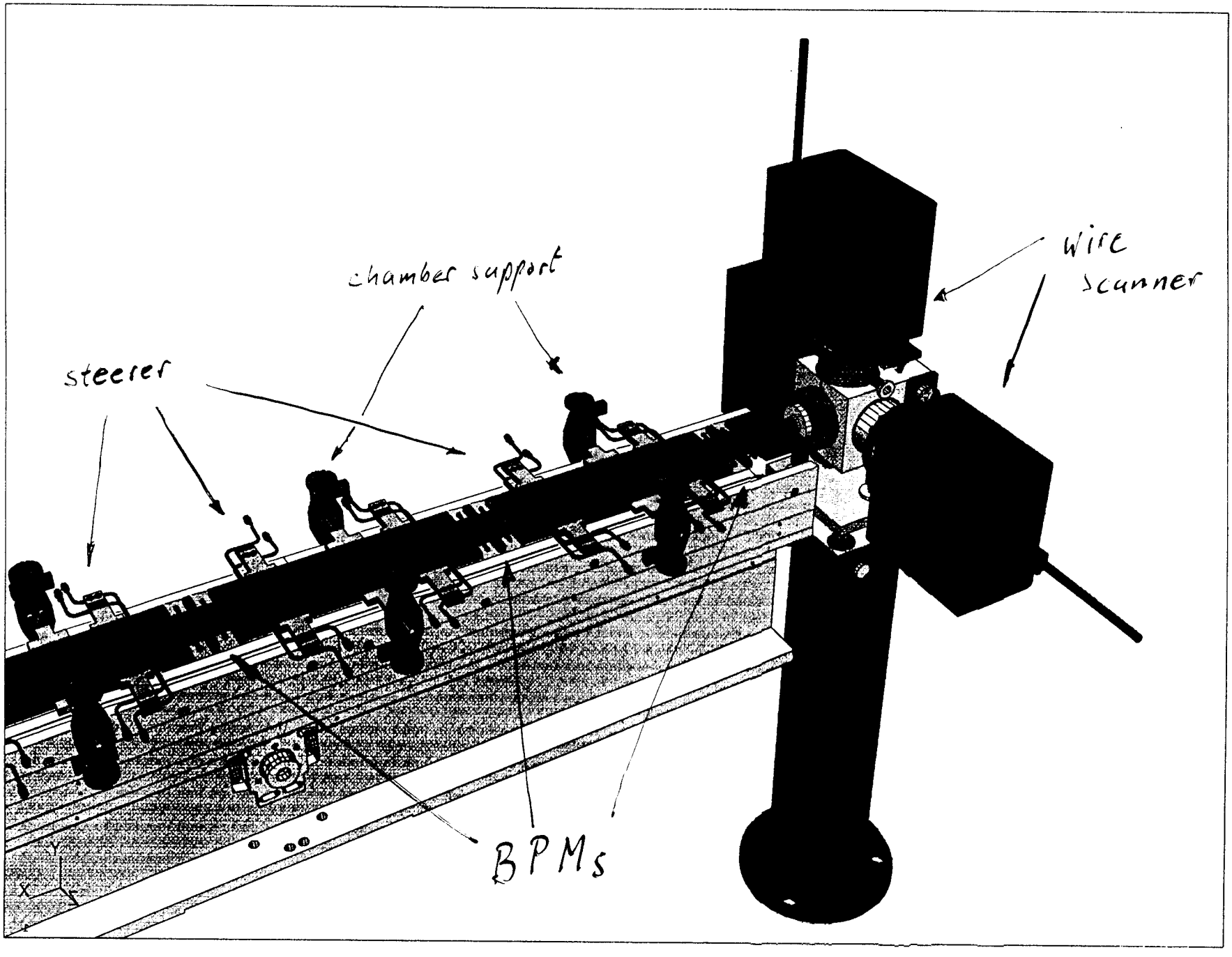
no risk of sparking → TTF phase II



FEL vacuum chamber

designed and manufactured by DESY-HASYLAB and APS-Argonne Natl Lab Chicago

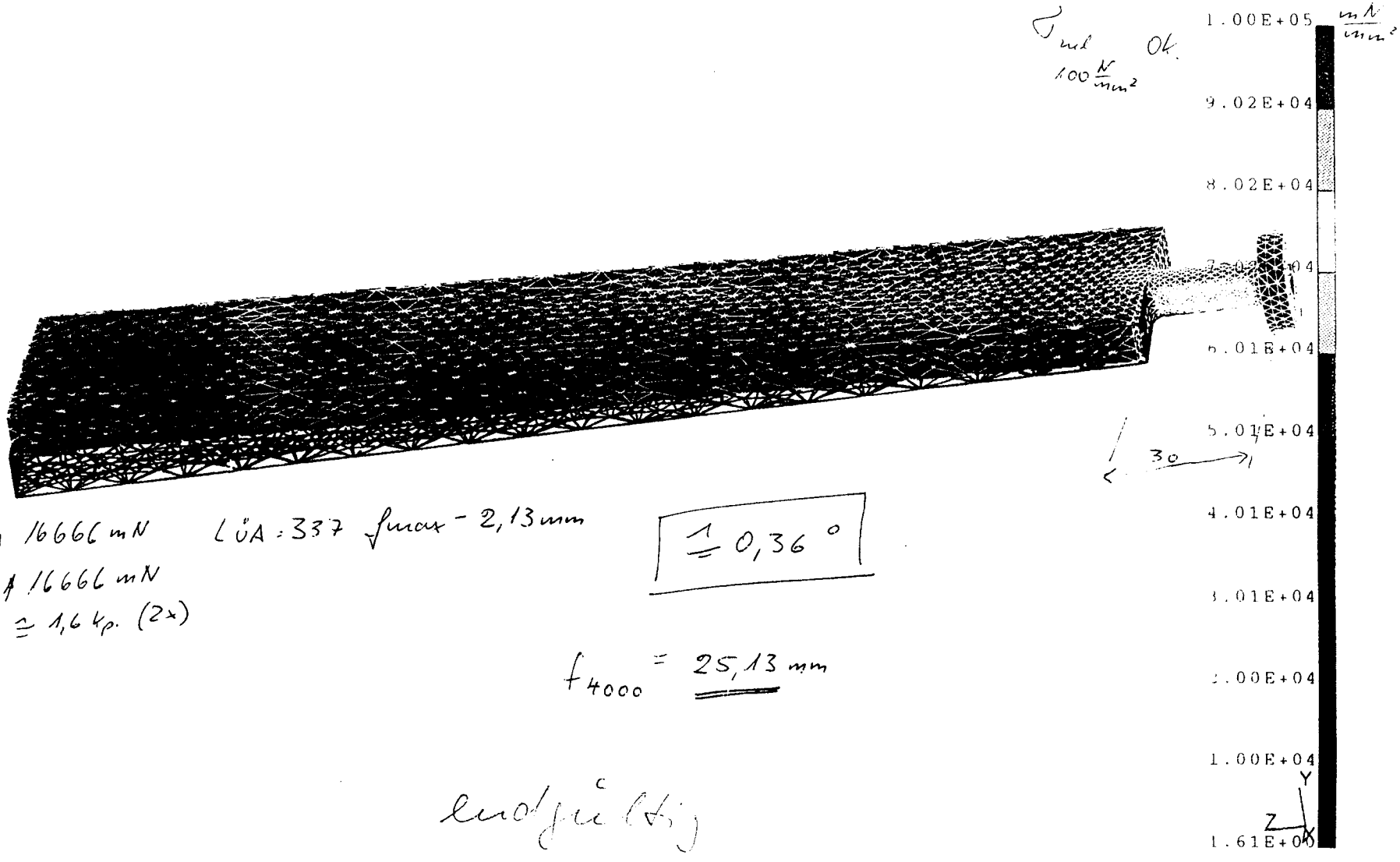



chamber support
steerer
wire
scanner
BPMs

Telkam

RESULTS: 3 B.C. 1,STRESS_3,LOAD SET 1
STRESS - VON MISES MIN: 1.61E+00 MAX: 1.00E+05
DEFORMATION: 1- B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT - MAG MIN: 0.00E+00 MAX: 2.13E+00
FRAME OF REF: PART

VALUE OPTION:ACTUAL



σ_{zul} OK.
$100 \frac{N}{mm^2}$

30°

16666 mN
16666 mN
≙ 1,6 kp. (2x)

LÜA: 337 f_{max} = 2,13 mm

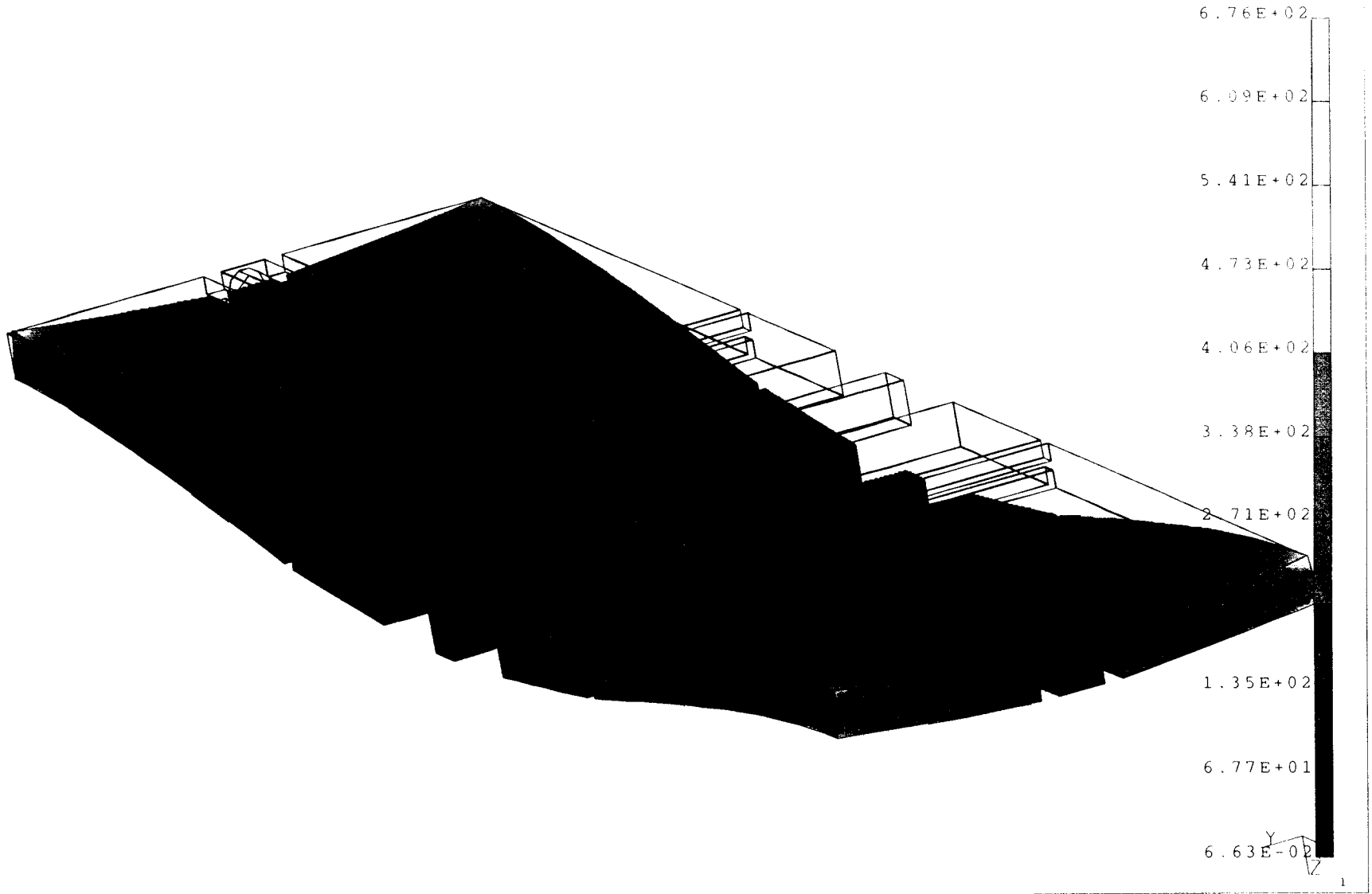
≙ 0,36°

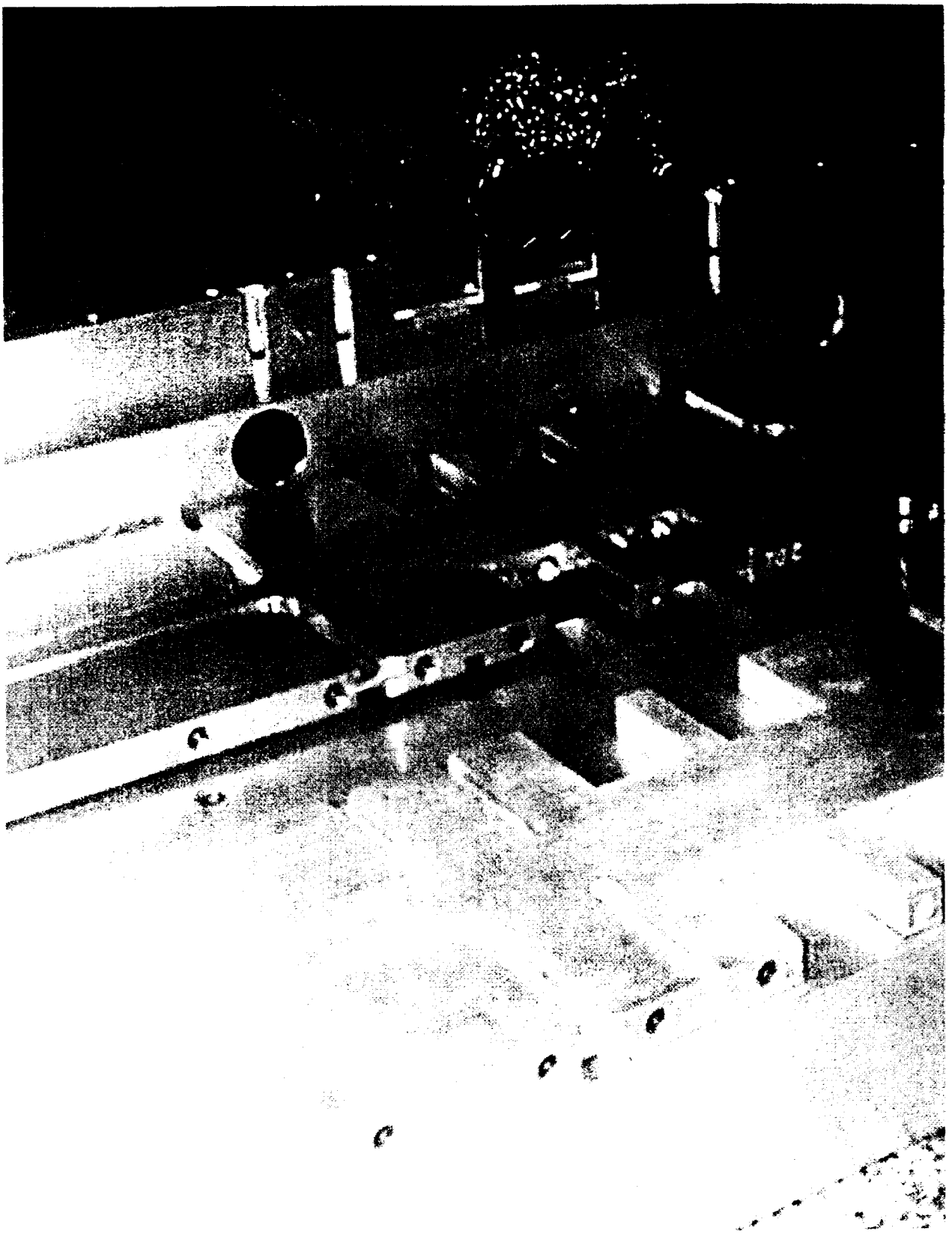
f_{4000} = 25,13 mm

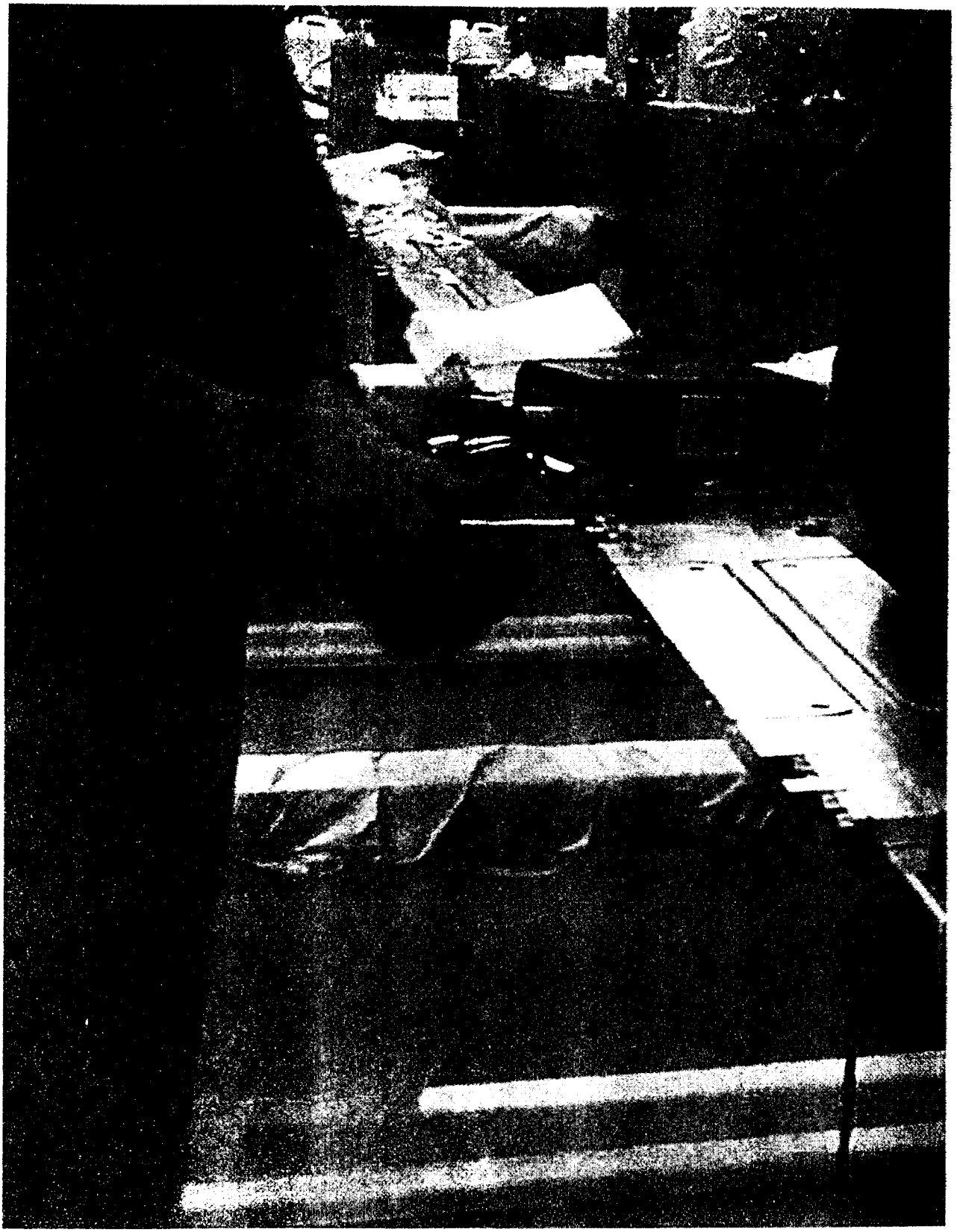
Endgültig

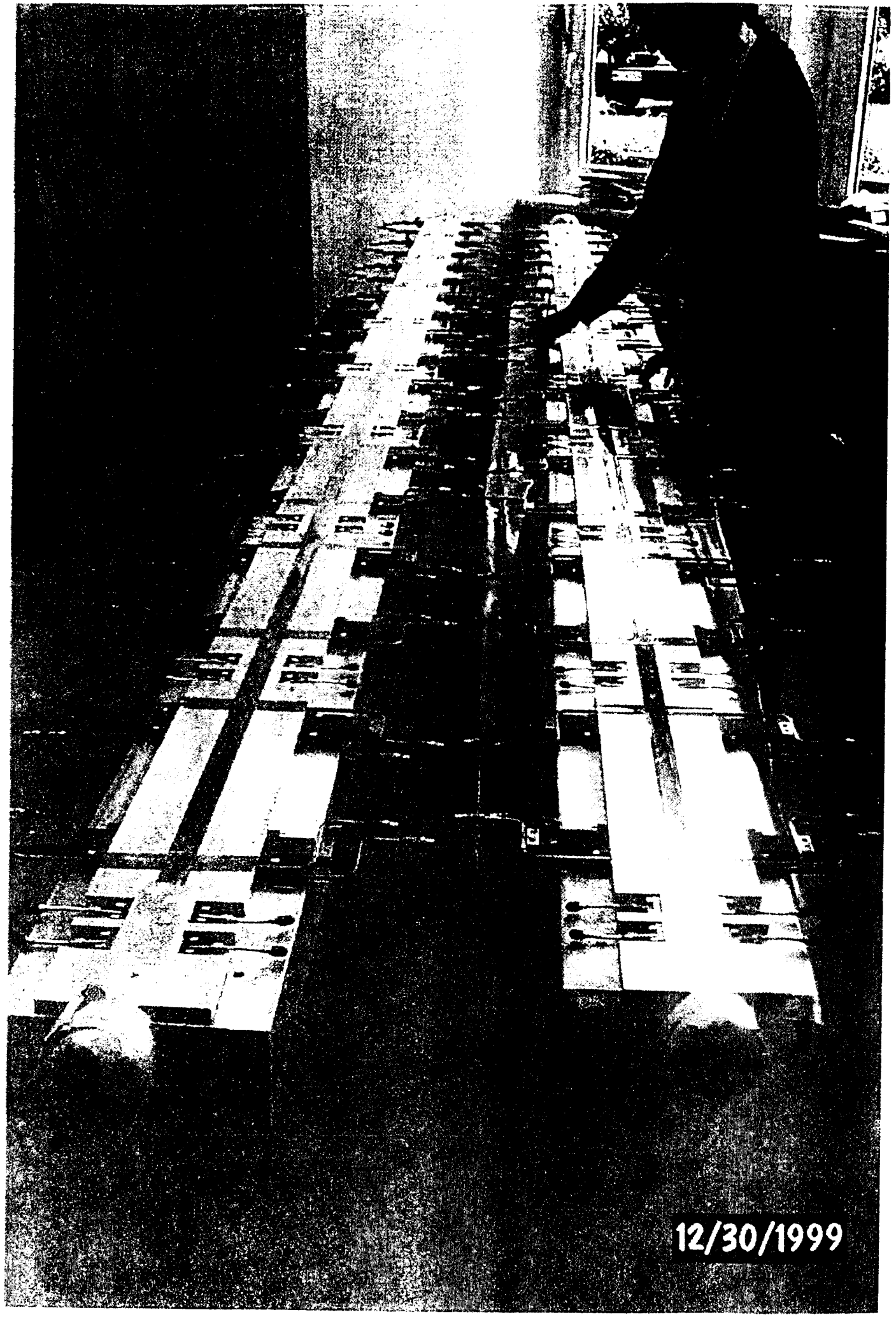
/home/rueter/ideas_work/ideas_light/kammeraufhaengung.mf1
RESULTS: 3- B.C. 1,STRESS_3,LOAD SET 1
STRESS - VON MISES MIN: 6.63E-02 MAX: 6.76E+02
DEFORMATION: 1- B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT - MAG MIN: 0.00E+00 MAX: 7.55E-03
FRAME OF REF: PART

VALUE OPTION:ACTUAL





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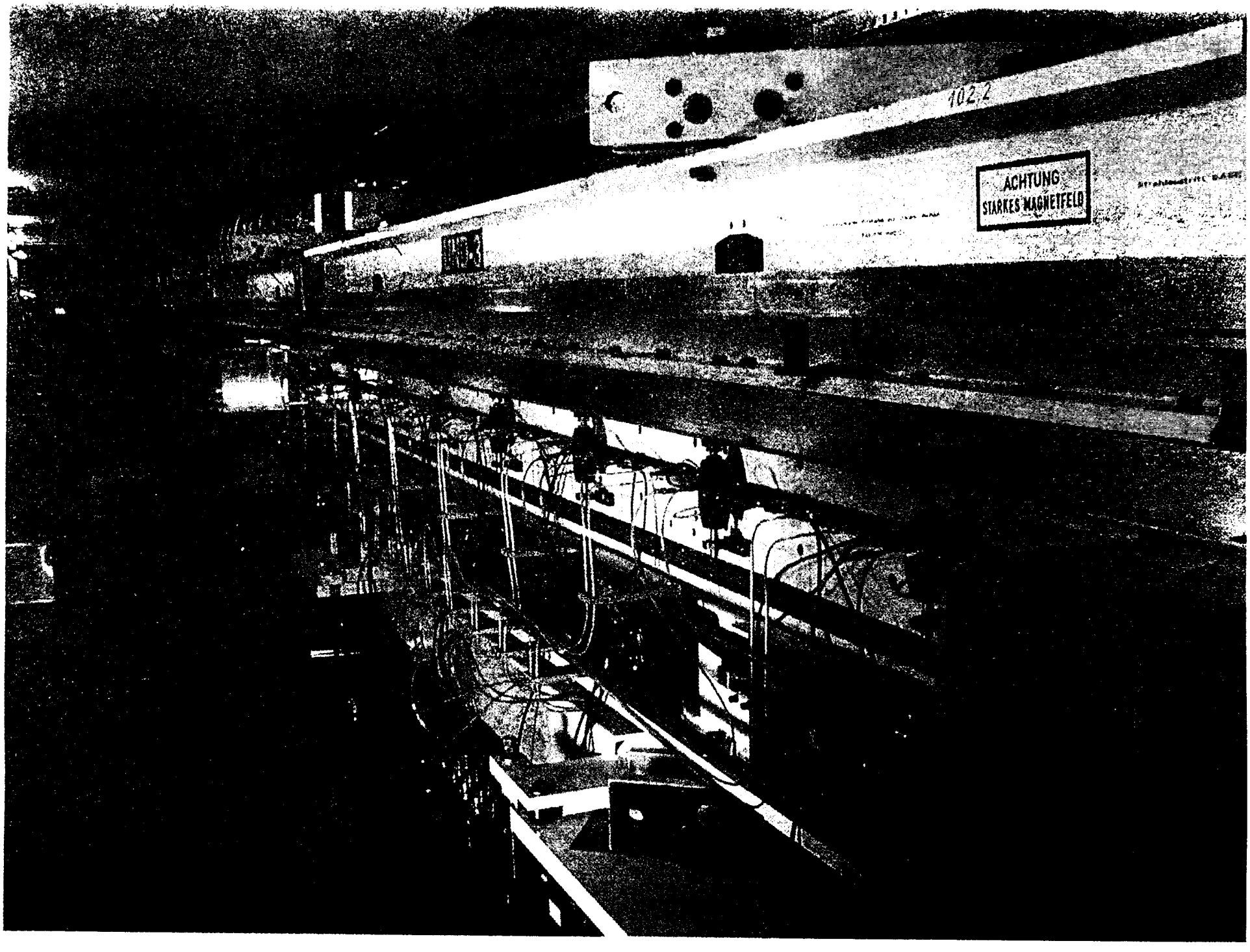
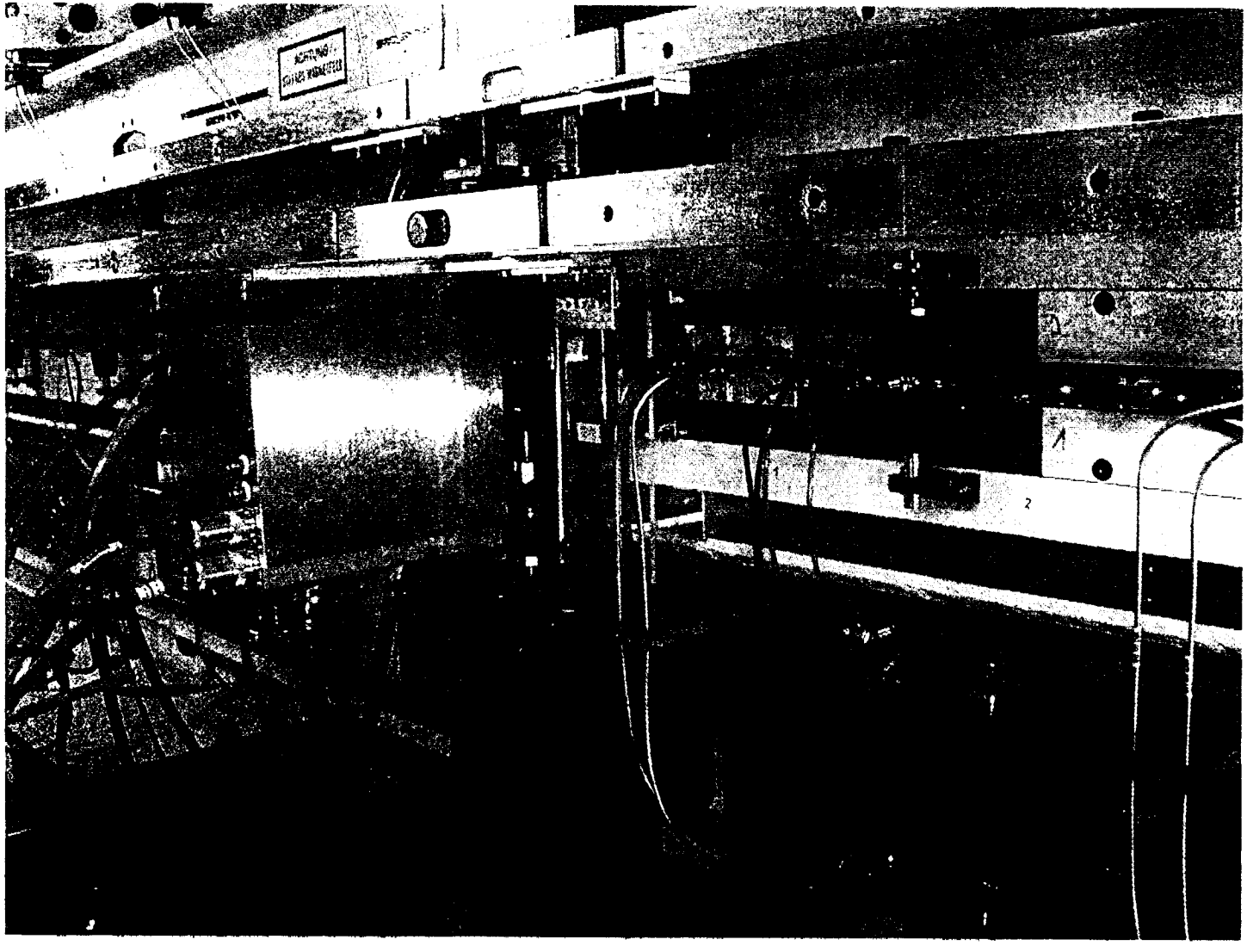
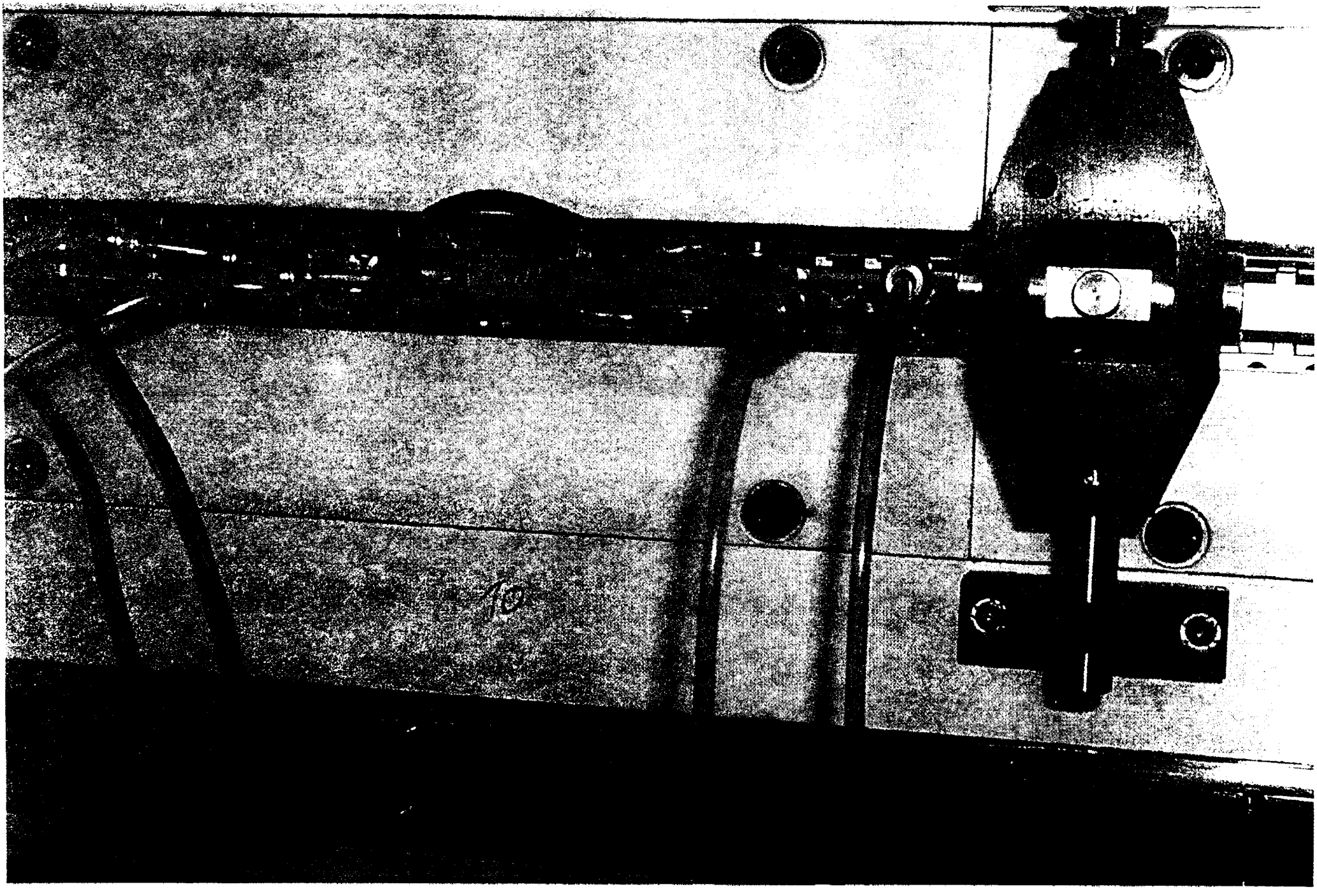
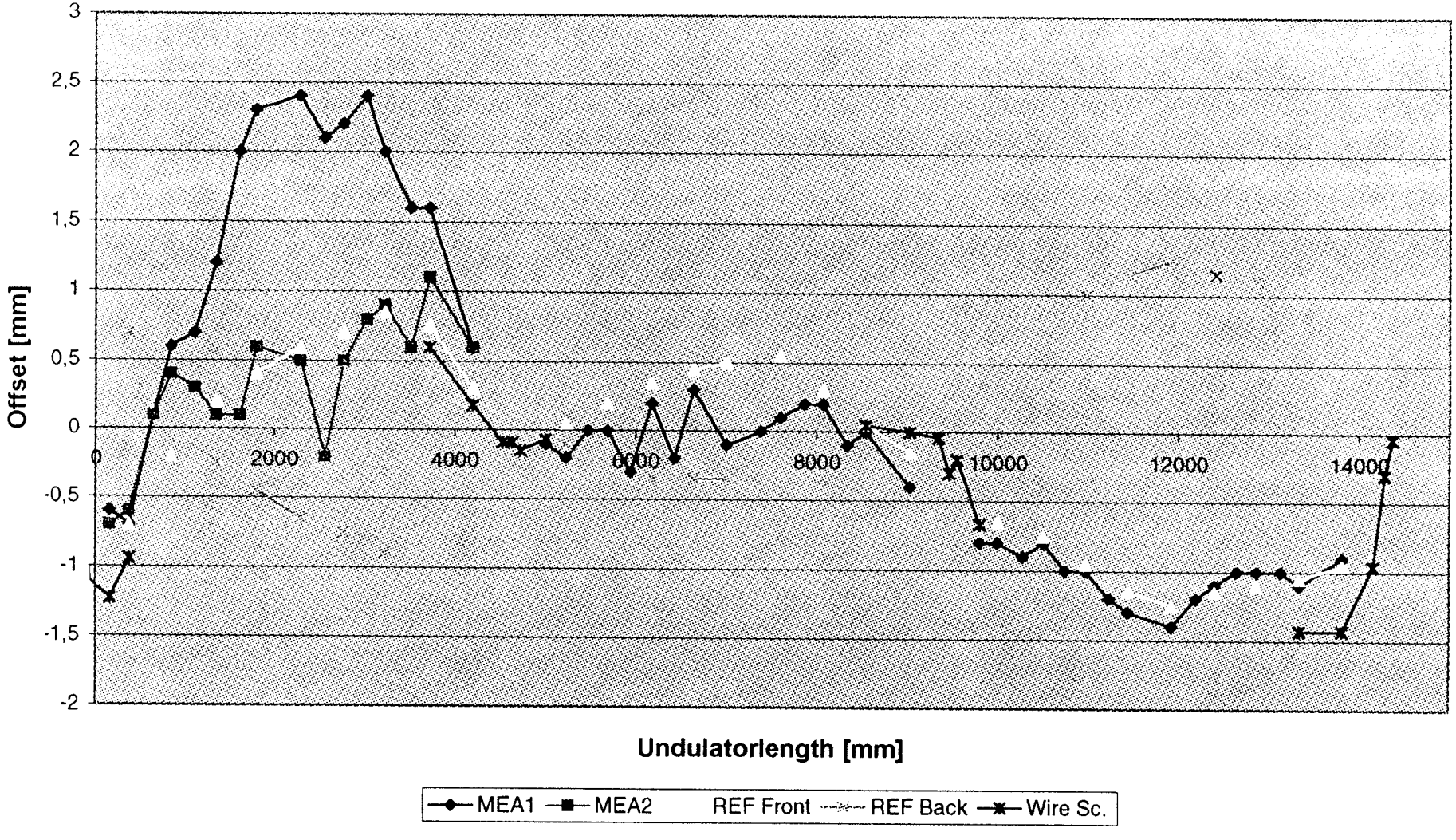

1022
ACHTUNG
STARKES MAGNETFELD




10

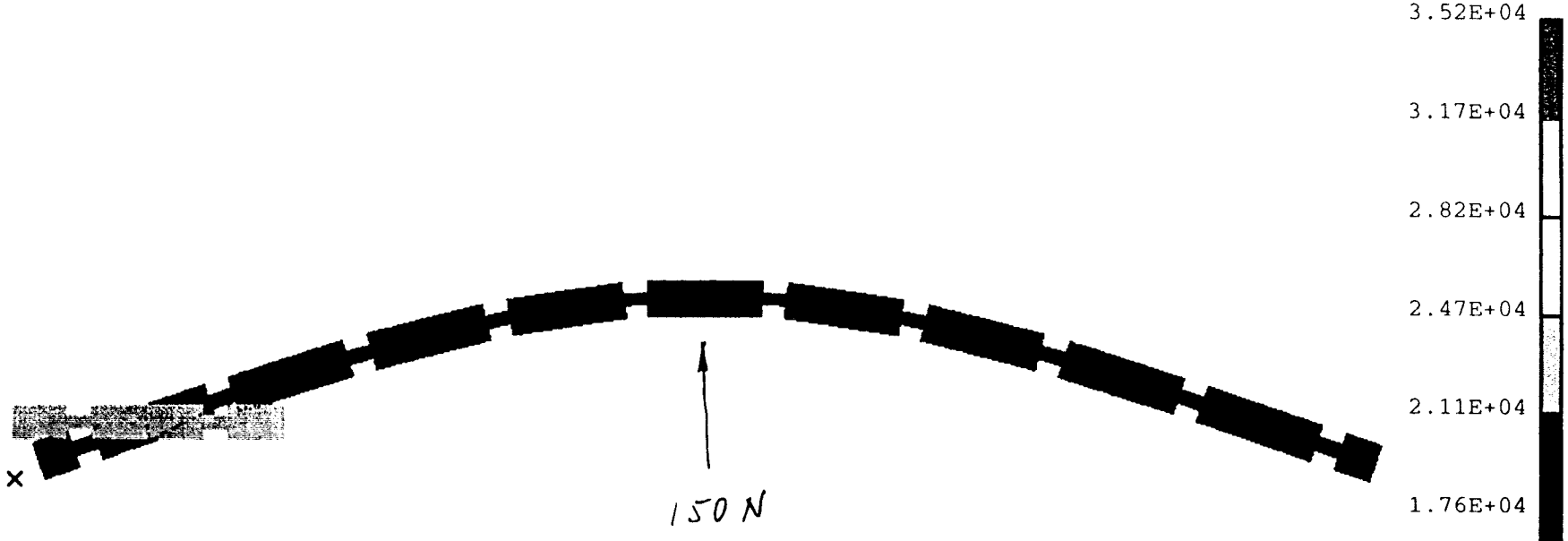
Horizontal Offset of the Undulatorchamber



/home/rueter/ideas_work/ideas_light/FE-udkam-Biegung.mf1

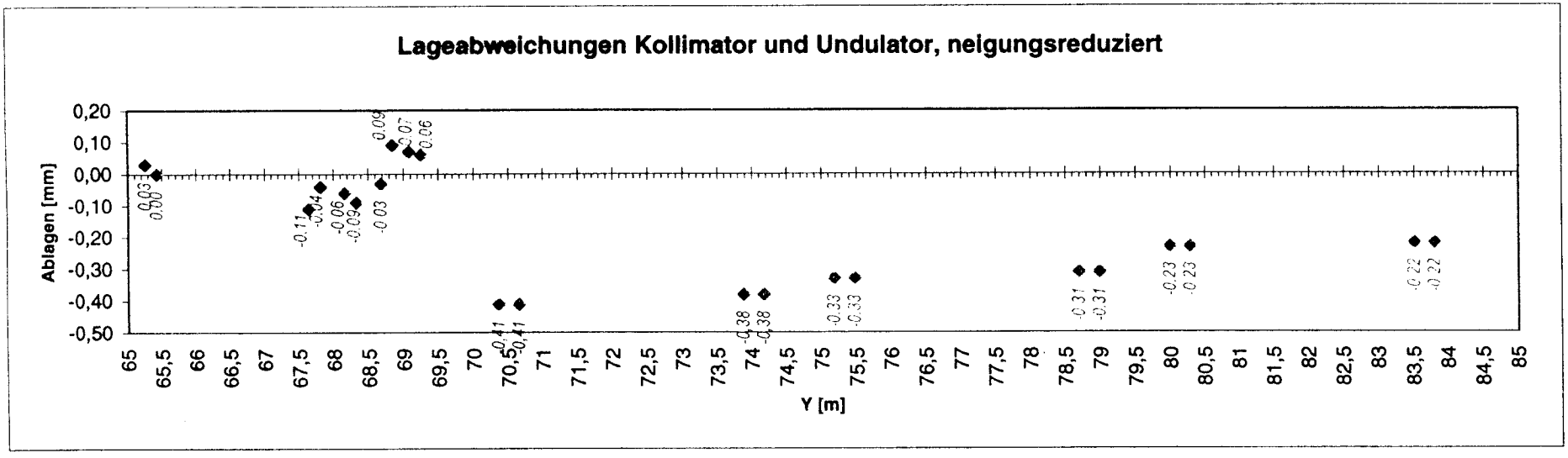
RESULTS: 3- B.C. 1,STRESS_3,LOAD SET 1
STRESS - VON MISES MIN: 2.66E-08 MAX: 3.52E+04
DEFORMATION: 1- B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT - MAG MIN: 0.00E+00 MAX: 5.75E+00
FRAME OF REF: PART

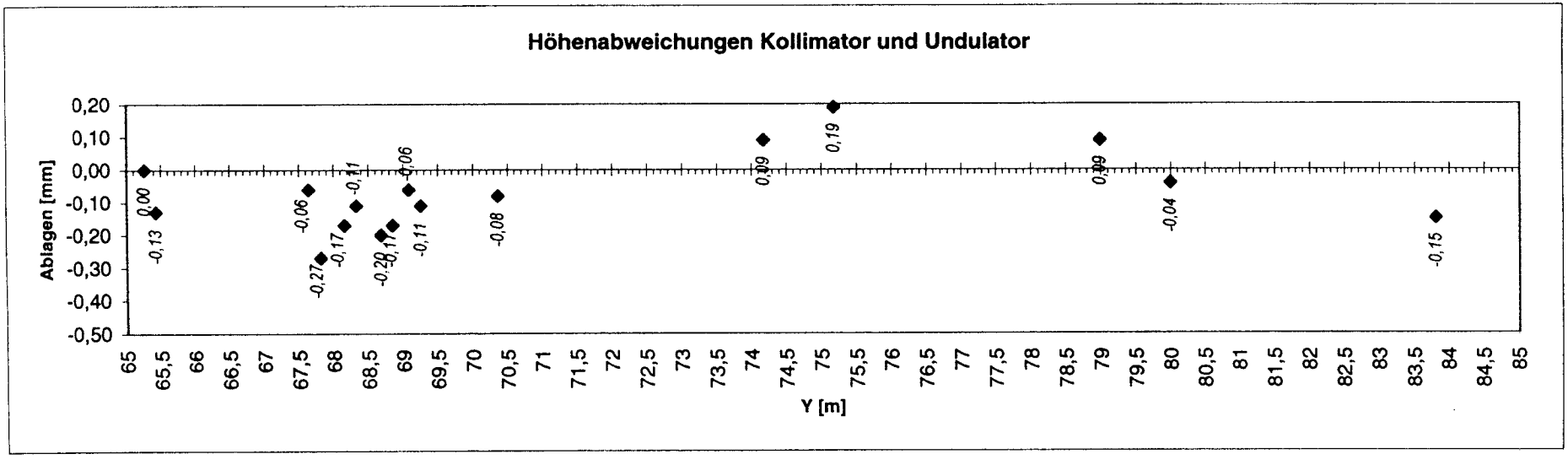
VALUE OPTION:ACTUAL
SHELL SURFACE: TOP



3.52E+04
3.17E+04
2.82E+04
2.47E+04
2.11E+04
1.76E+04
1.41E+04
1.06E+04
7.04E+03
3.52E+03
2.66E-08

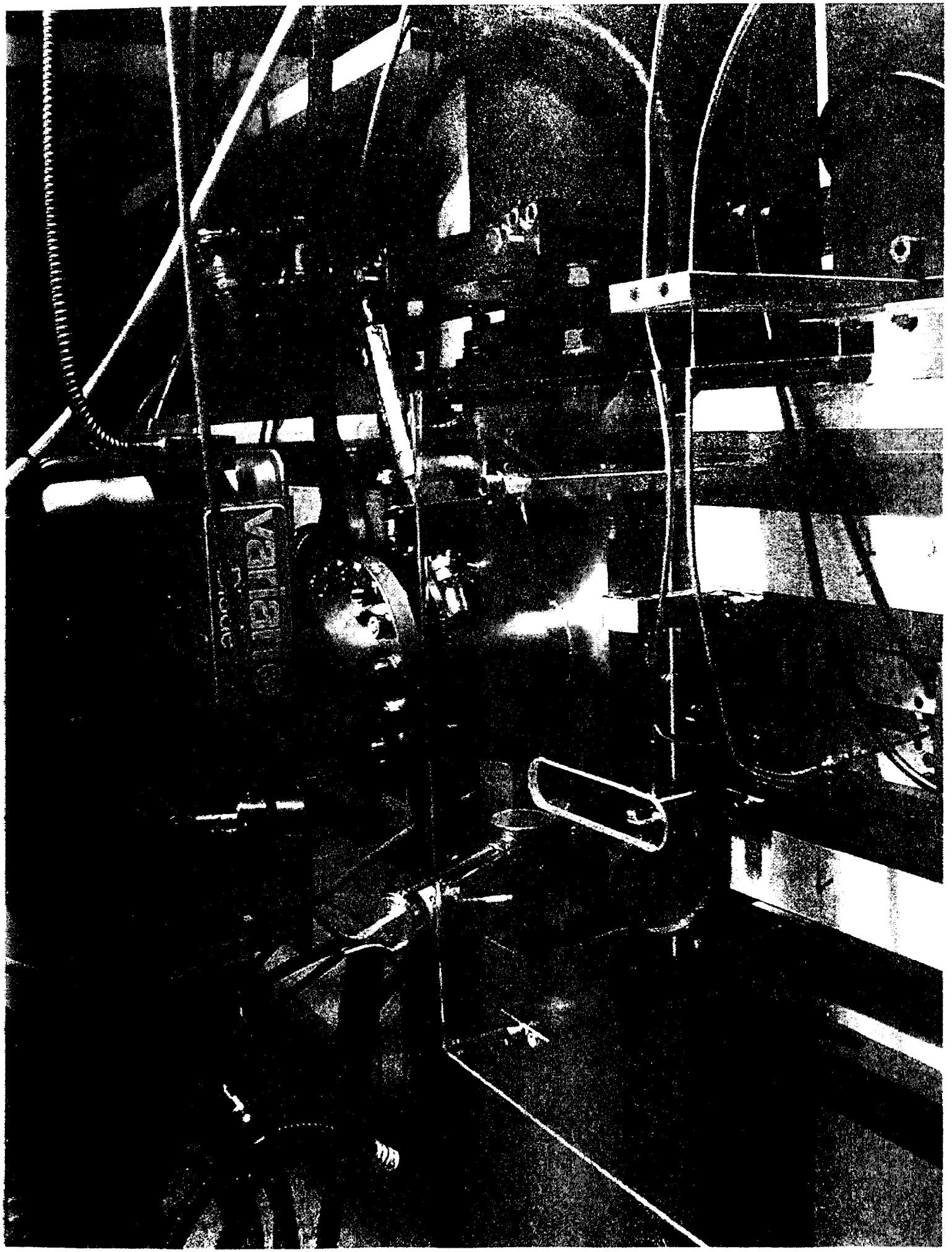
1

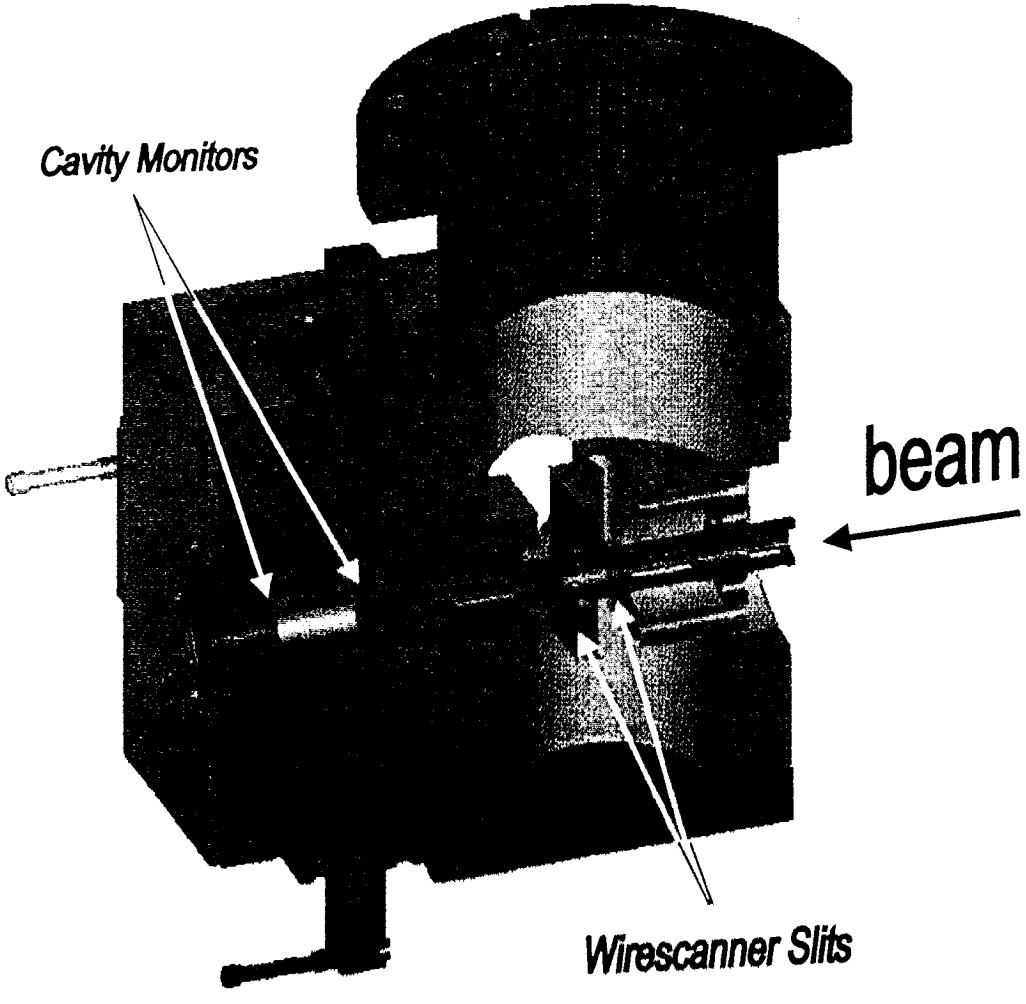


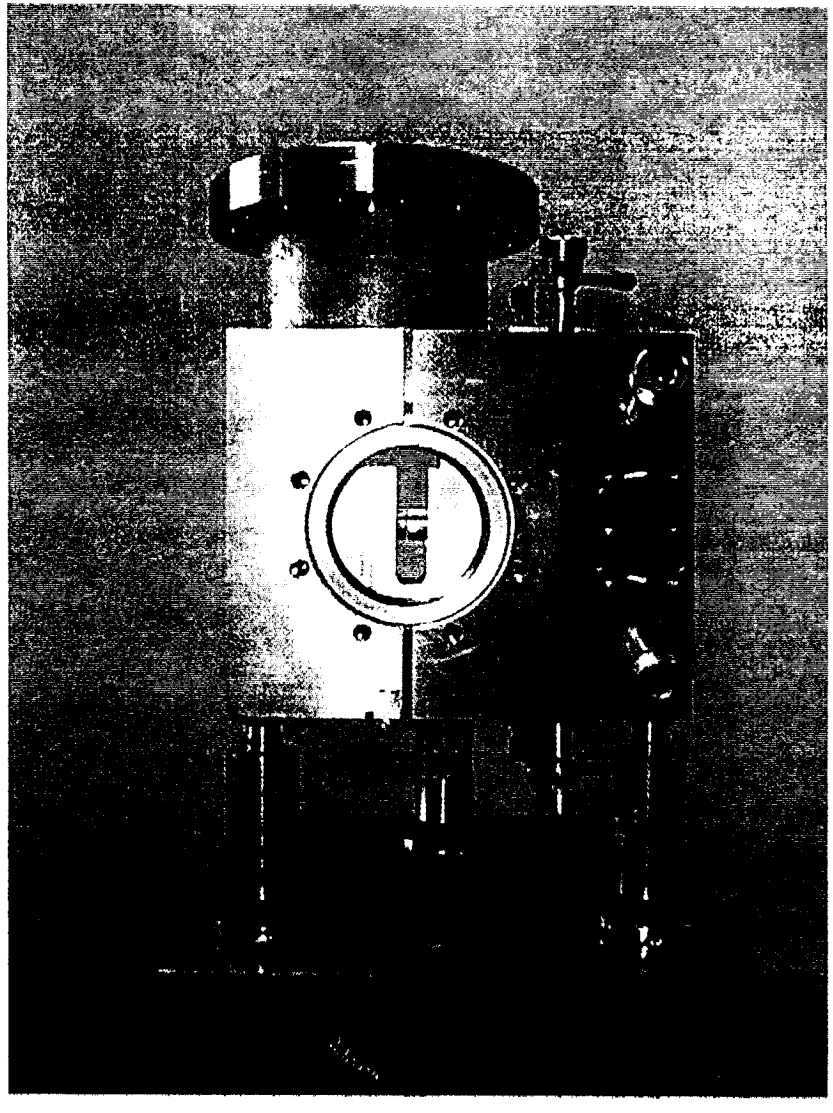


Prenting,
ZMEA 2 - Vermessung

03.11.1999

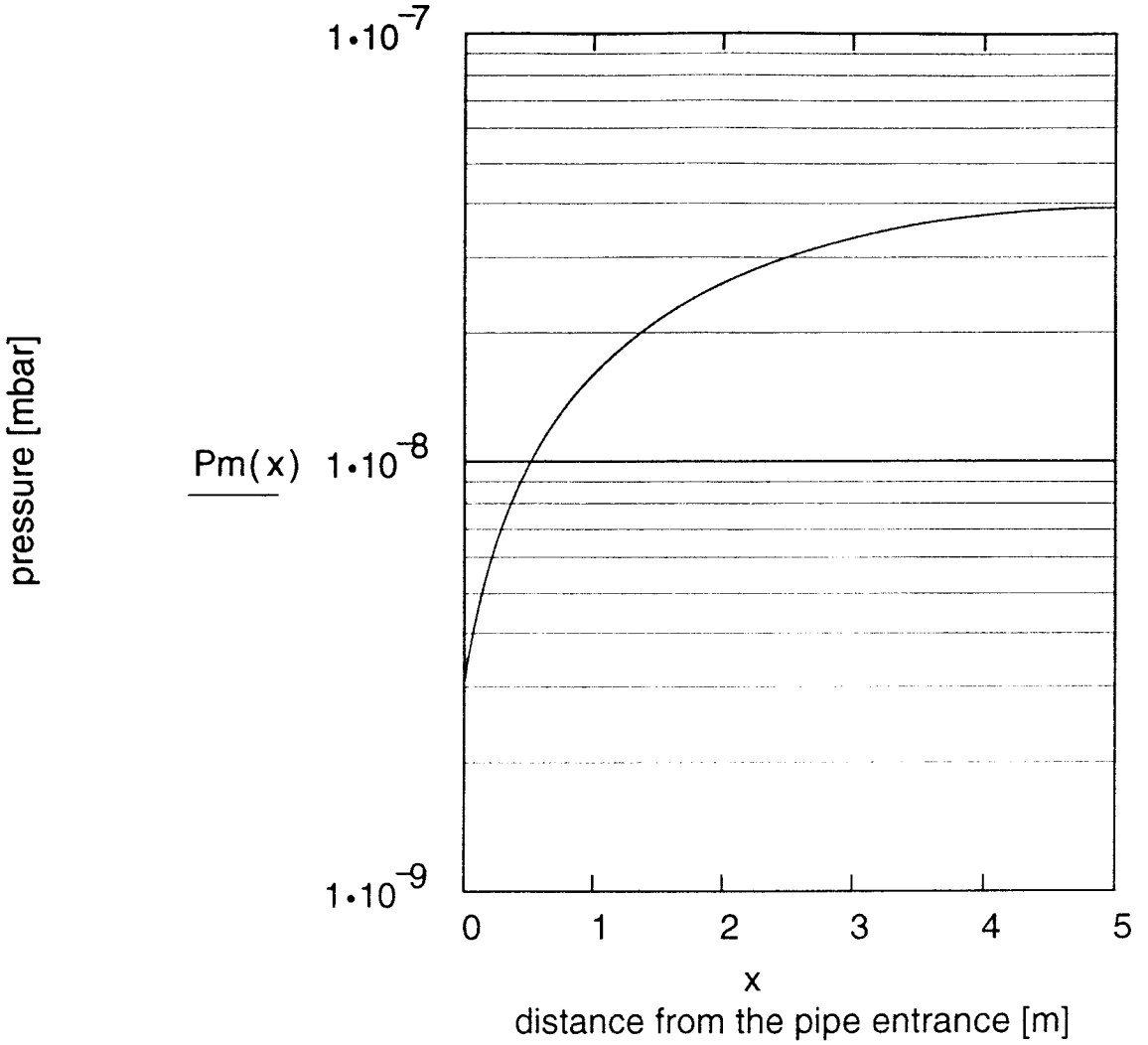



Cavity Monitors
beam
Wirescanner Slits



Pressure distribution of a 5m long vacuum pipe

pumping speed at 0m: 0.5 l/sec, outgassing rate: 10^{-12}mbar*l/(sec*cm^2)
pipe diameter: 9.5 mm - conductance C: 0.02l/sec



$$P(x) := a \cdot u \cdot \left[\frac{L}{S} + \frac{x}{C} - \frac{x^2}{2 \cdot C \cdot L} \right]$$