PROFILING CCDs WITH THE OXFORD WIPM SYSTEM

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LCD Meeting, SLAC

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- **Background to UK CCD R&D**
- **What is WIPM?**
- **Oxford metrology setup**
- **Results on dummy ladder**
- **Plans**

A PROPOSAL TO INITIATE RESEARCH AND DEVELOPMENT FOR A VERTEX DETECTOR AT THE FUTURE e^+e^- LINEAR COLLIDER

Linear Collider Flavour Identification (UK) Collaboration

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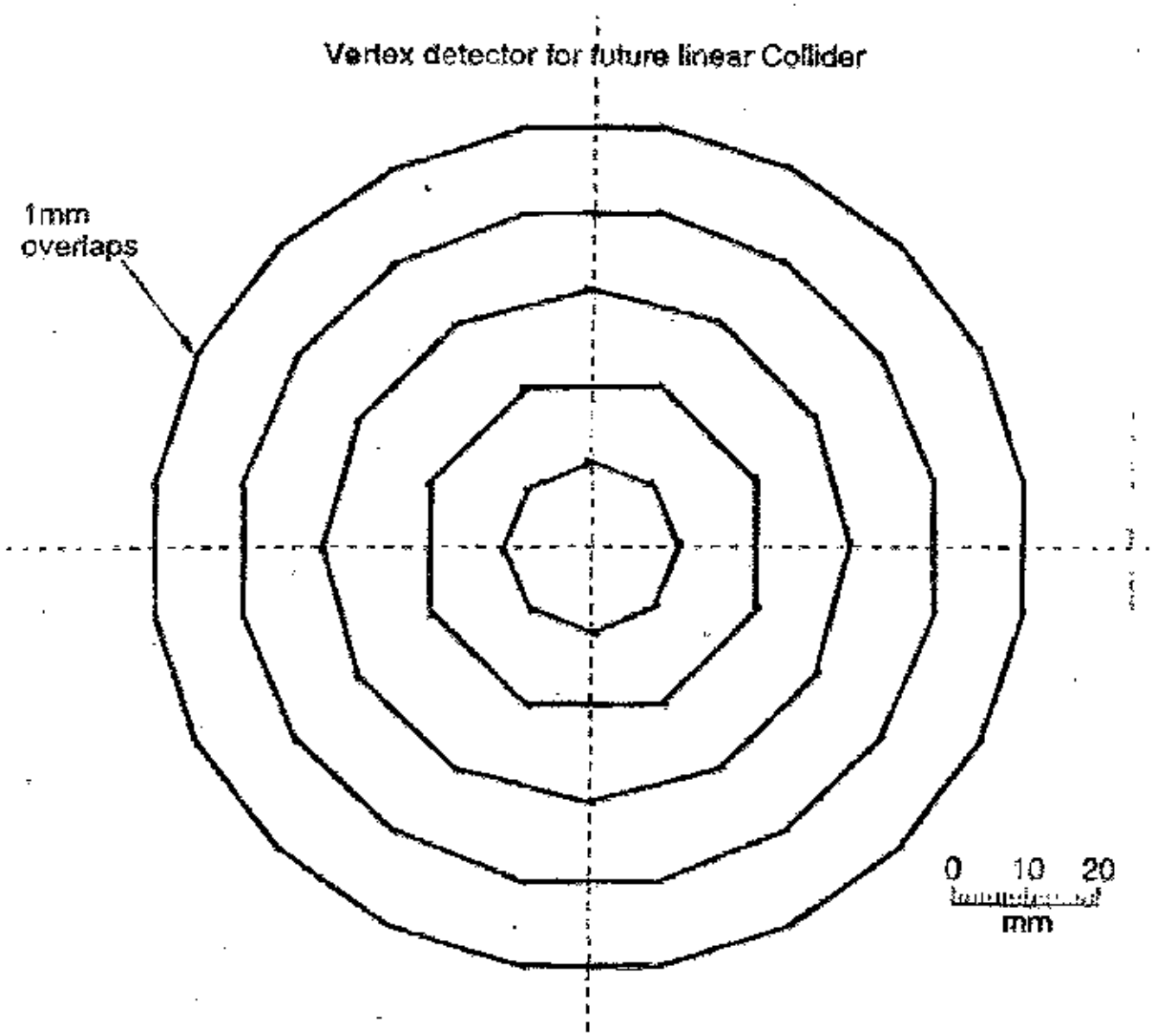
Brunel University
Glasgow University
Lancaster University
Liverpool University
Oxford University
Rutherford-Appleton Laboratory

- **Approved by UK PPESP October 1998**
- **Collaboration with CCD manufacturer (EEV)**

CCD based vertex detector end view



DESIGN CHALLENGES

Item	SLD	LC	factor	
longest CCD (mm)	80	125	1.6	
largest CCD area (mm^2)	1280	3000	2.3	
ladder thickness (% X_0)	0.4	0.12	3.3	←
layer 1 radius (mm)	28	12	2.3	
readout rate (MHz)	5	50	10	←
# ladders	48	64	1.3	
# pixels (M)	307	900	3	

+ higher radiation tolerance w.r.t. neutrons ←

+ compatibility with detector solenoid + RF pickup

R&D PROGRAMME

Phase 1

- Use 'setup grade' CCDs from EEV

- Two modular CCD test rigs:

  RAL: readout + electrical tests

  Liverpool: radiation damage + low-T operation

- Mechanical test setup:

  Oxford/RAL: prototype ladder supports

  thermal distortions

Phase 2 (later):

- Custom CCDs

- System design issues

* Share results (+ swap CCDs) with US, Japanese groups

Our Survey Needs

Area: 25 $\times$ 2.4 cm^2 ladders

Resolution: < 10 μm

Temperature: -100^0C $< T < 20^0$C

Cryostat: double-glazed heated window

WHAT IS WIPM?

B. Bowe, V. Toal, Proc. Appl. Opt. Div. Conf., Reading, 1996, p. 211

White light Interferometer

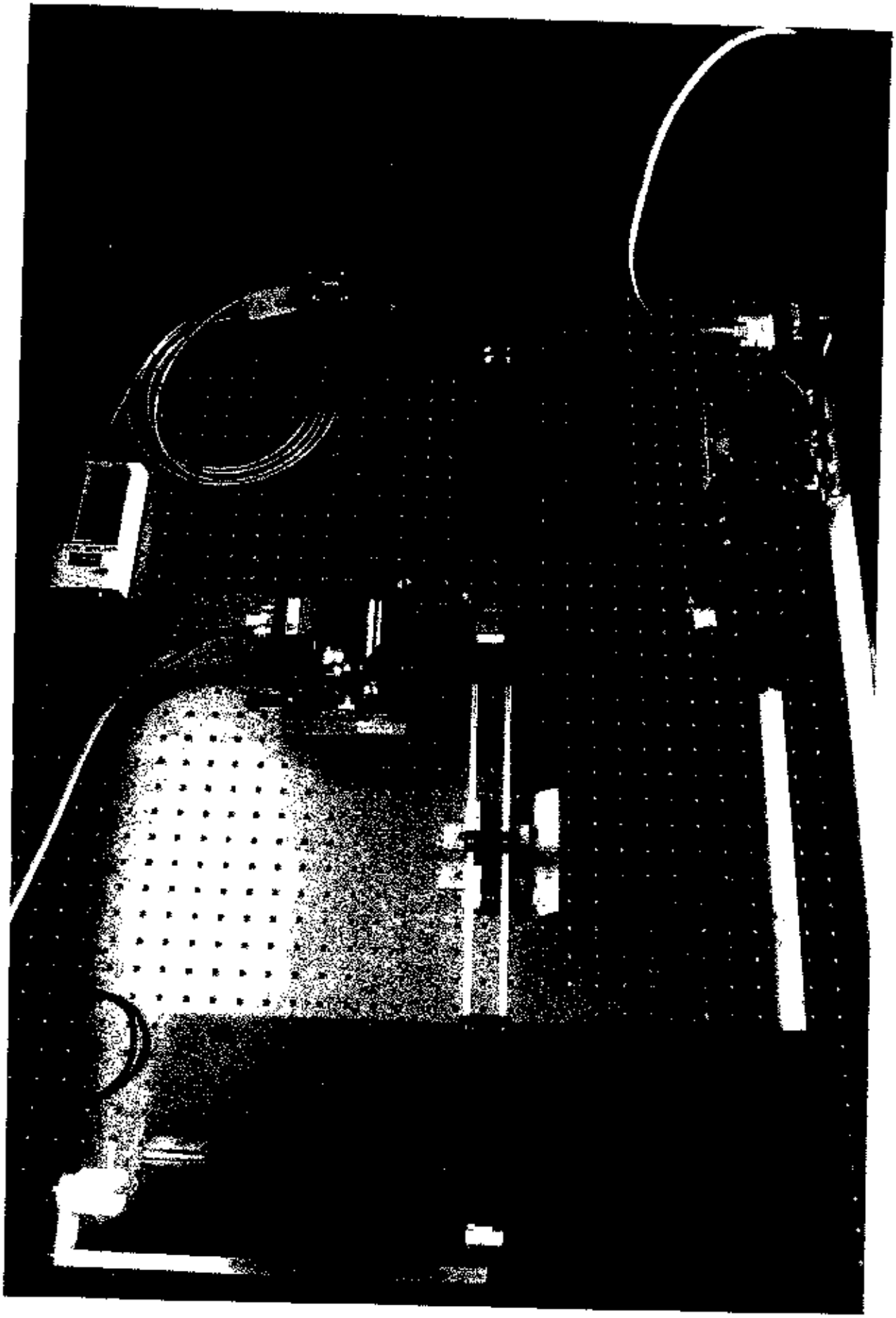
Profile Metrology

- **Michelson Interferometer**

- **White light, lousy laser:**

  $\lambda = 850 \pm 20$ **nm**

  coherence length $\sim$ **30**μ**m**



ADVANTAGES OF WIPM

- Resolution $\simeq \lambda \leq 1\ \mu$m
- Digitised surface profile

c.f. conventional optical metrology (*eg.* MIT VXD3 survey using OMIS2)

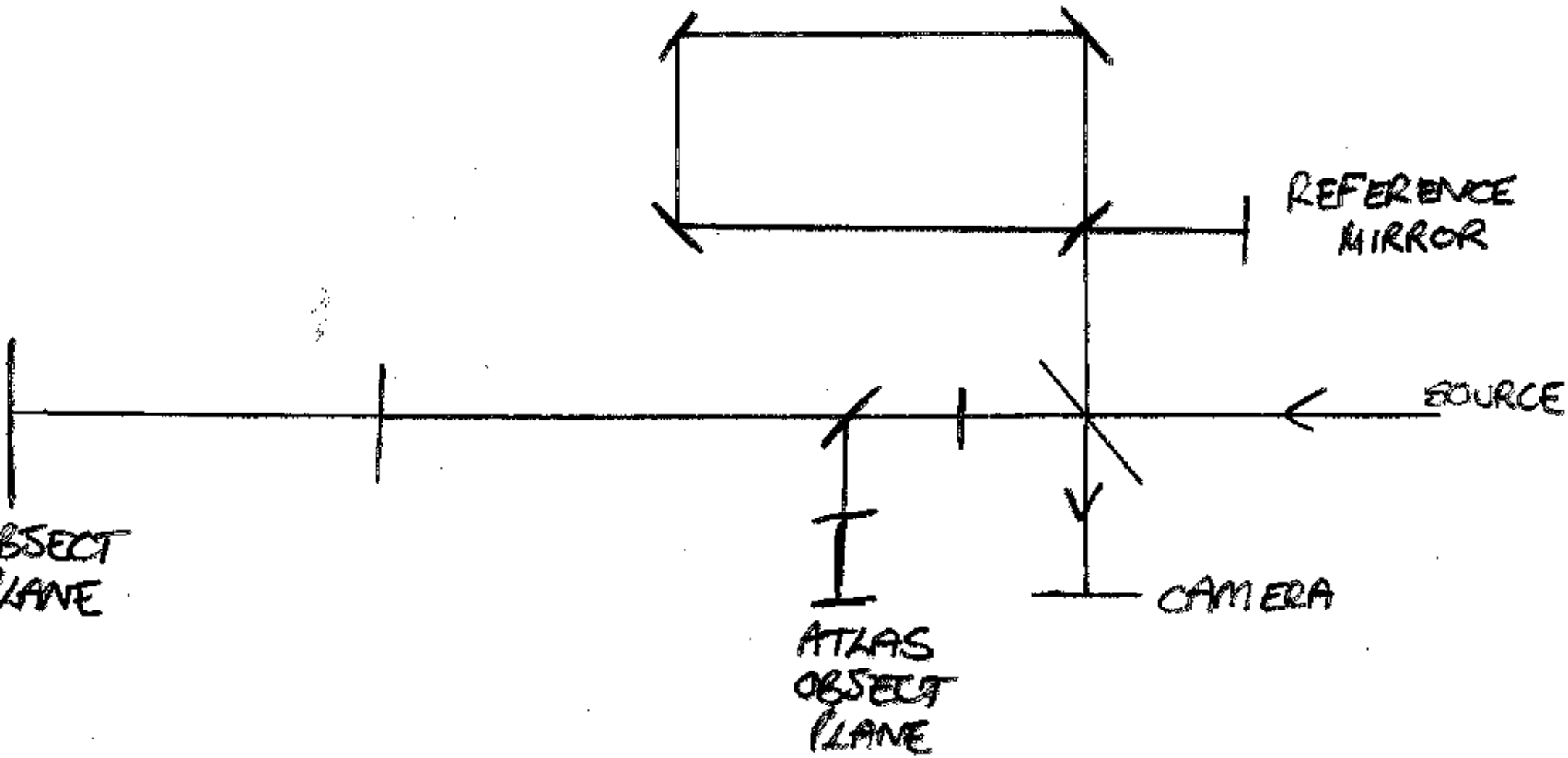
- Need fiducial marks
- Illumination/contrast issues
- Offline fitting of disgusting polynomial surfaces to sparse data
- Potential for interpolation errors?
- Hard to get $< 10\mu$m accuracy

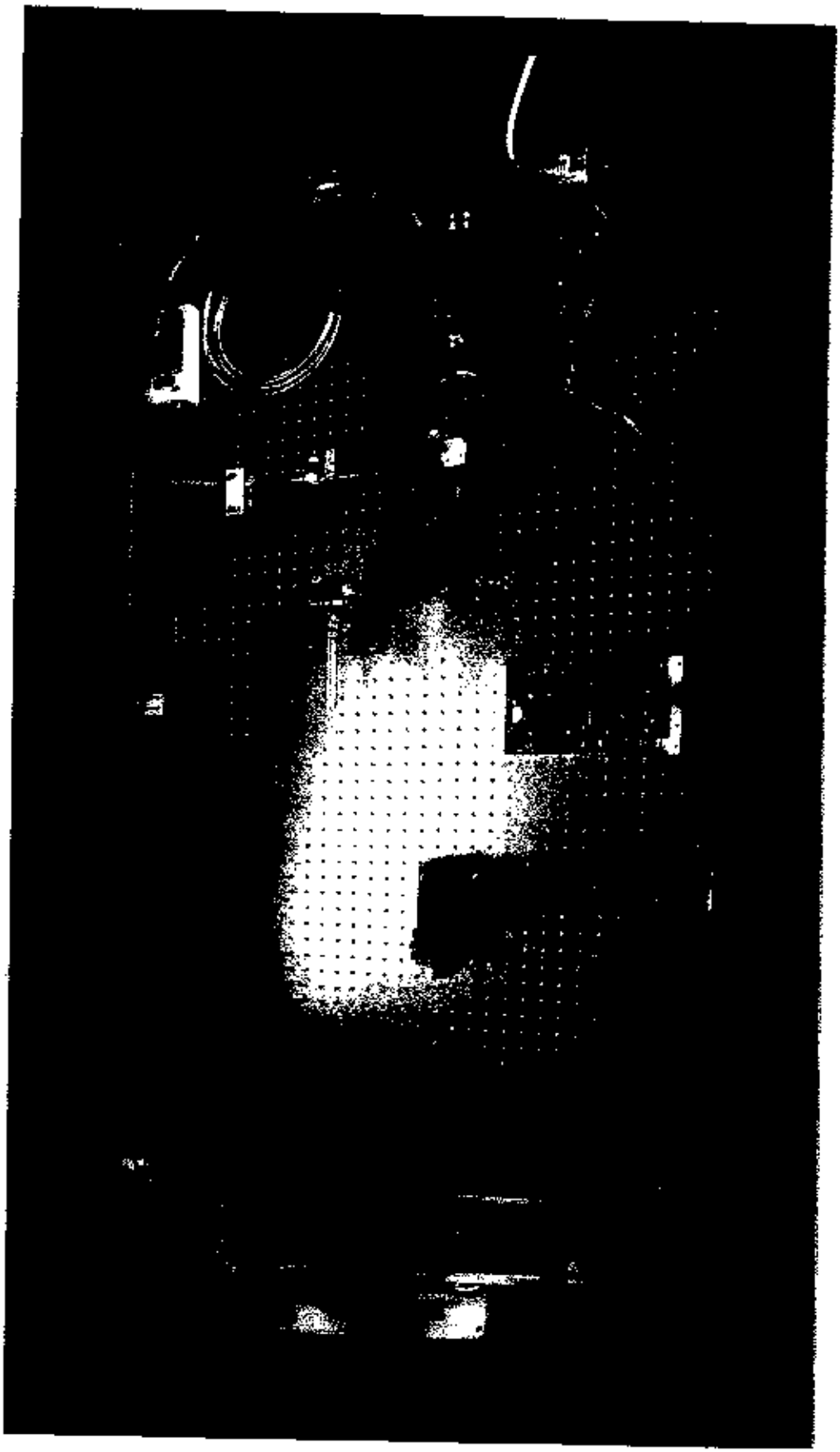
WHIPM Upgrades

- Table raised by $\sim$ 8 inches
- New optics layout:

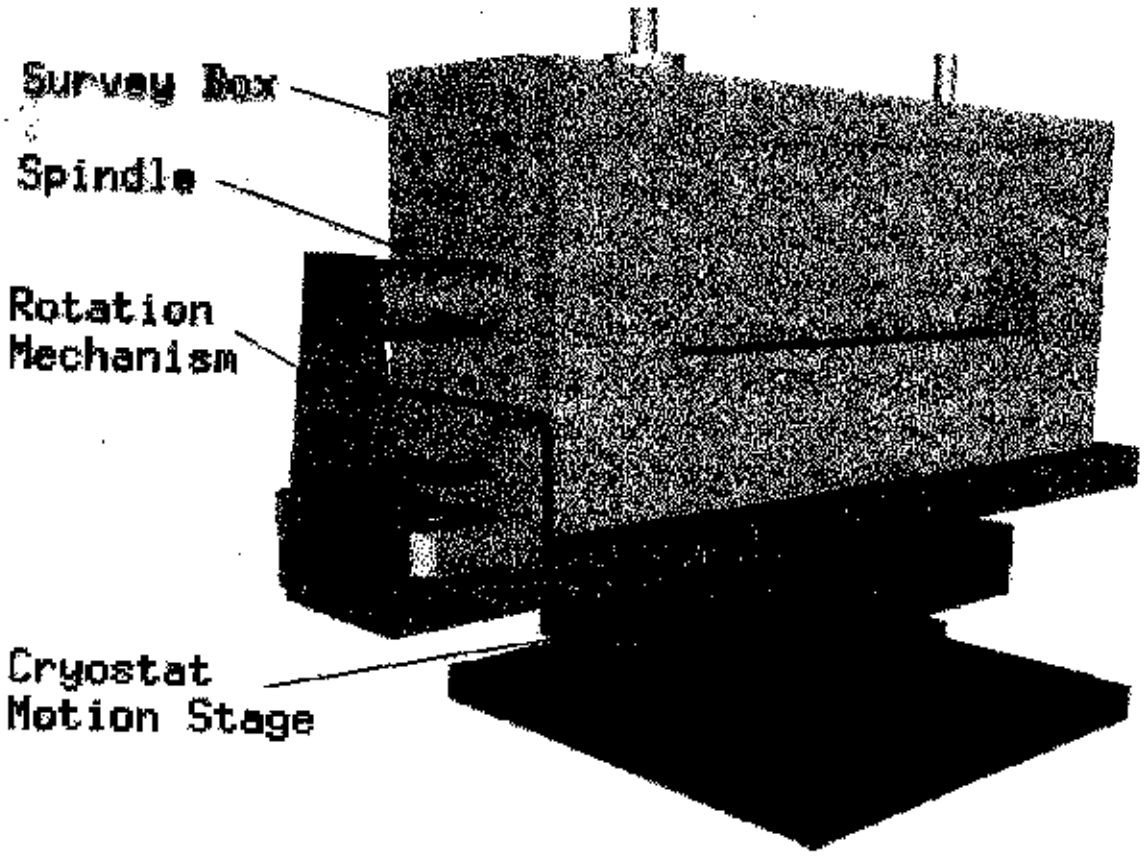
  LC/ATLAS compatible
- Manual motion stage for object translation
- New support mechanism for cryostat

NEW WhiPM LAYOUT

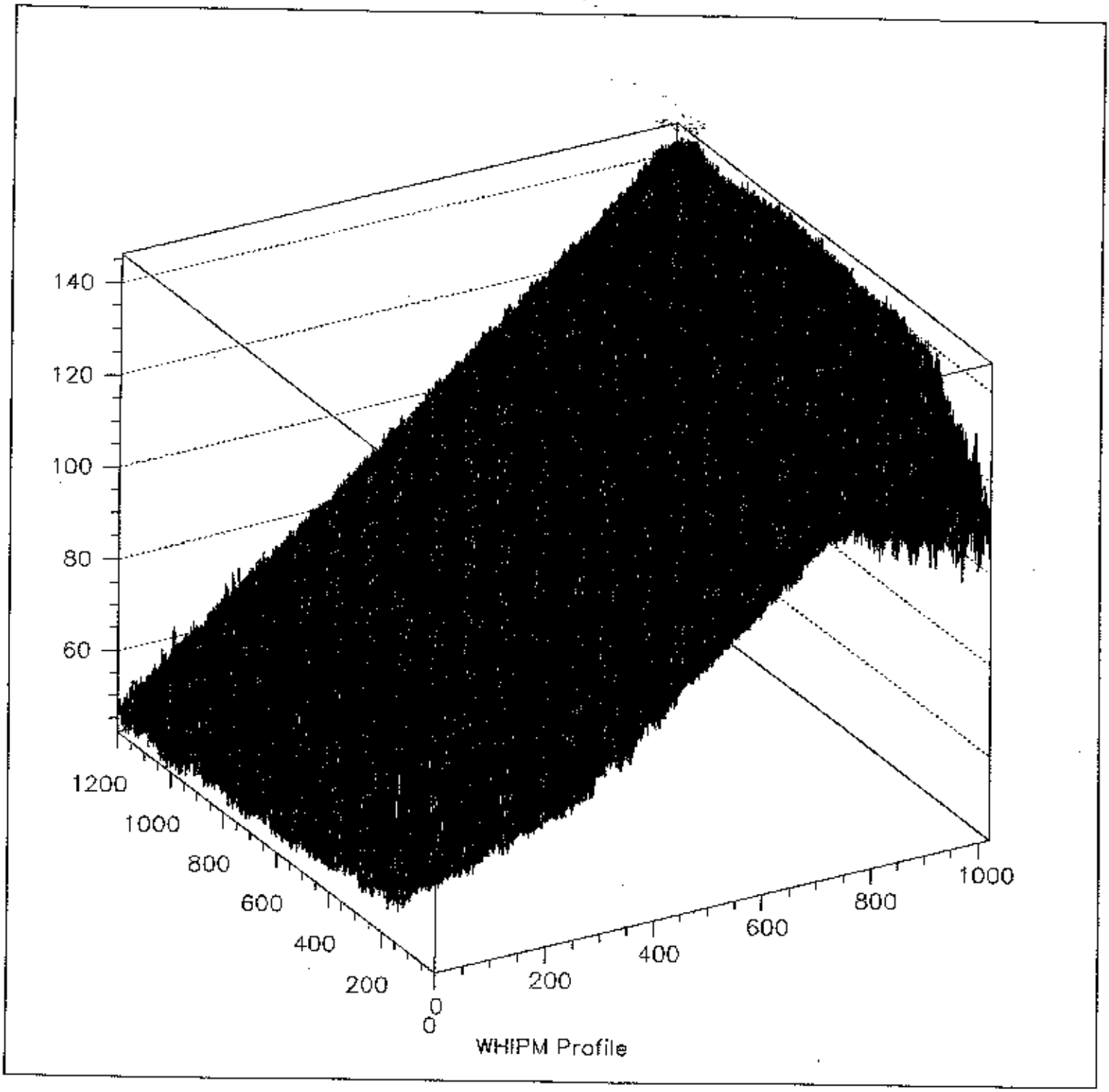




Survey box, motion stage, and support mechanism



Alan Holmes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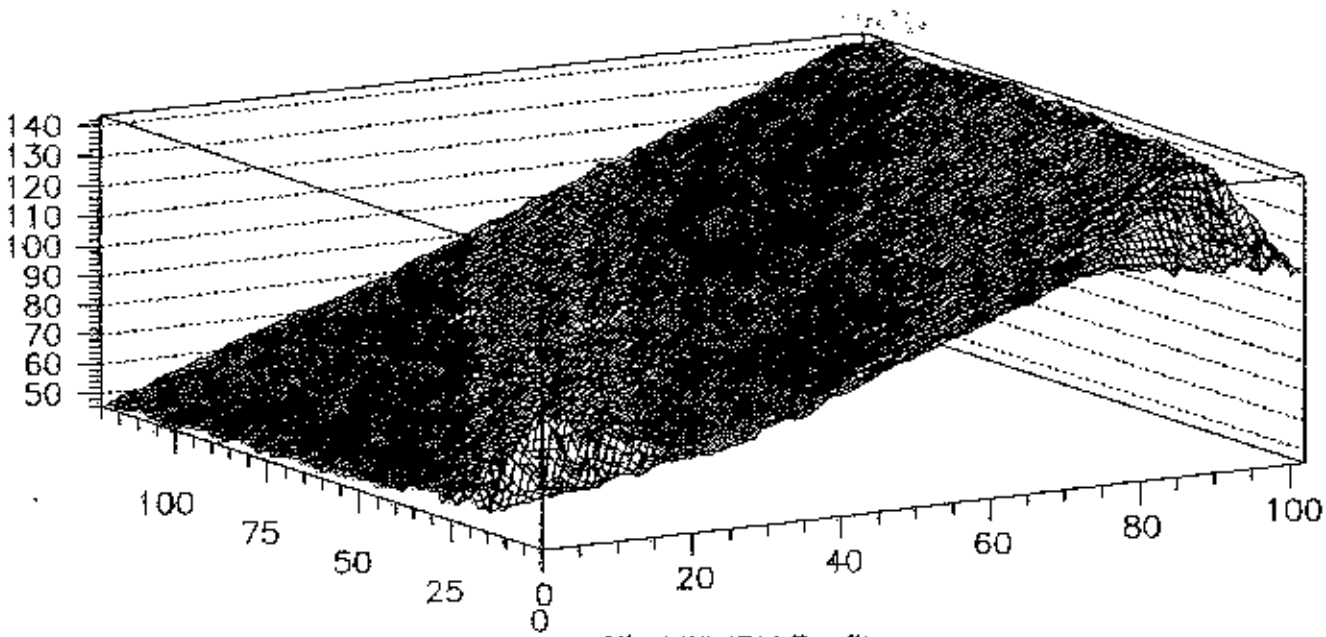
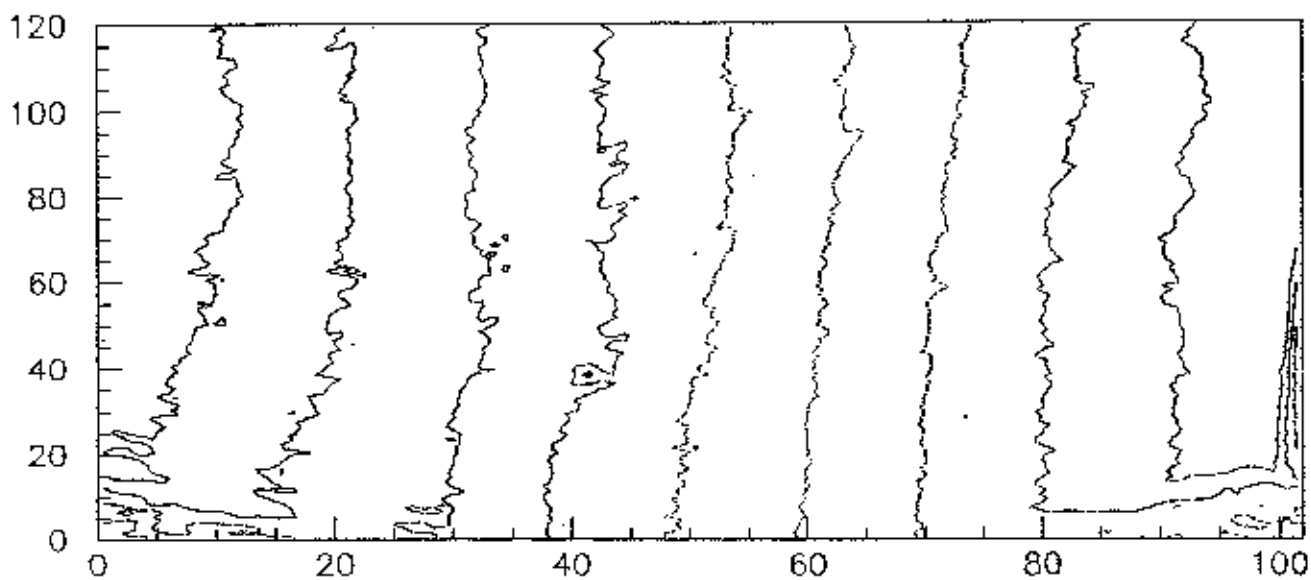
WHIPM Profile



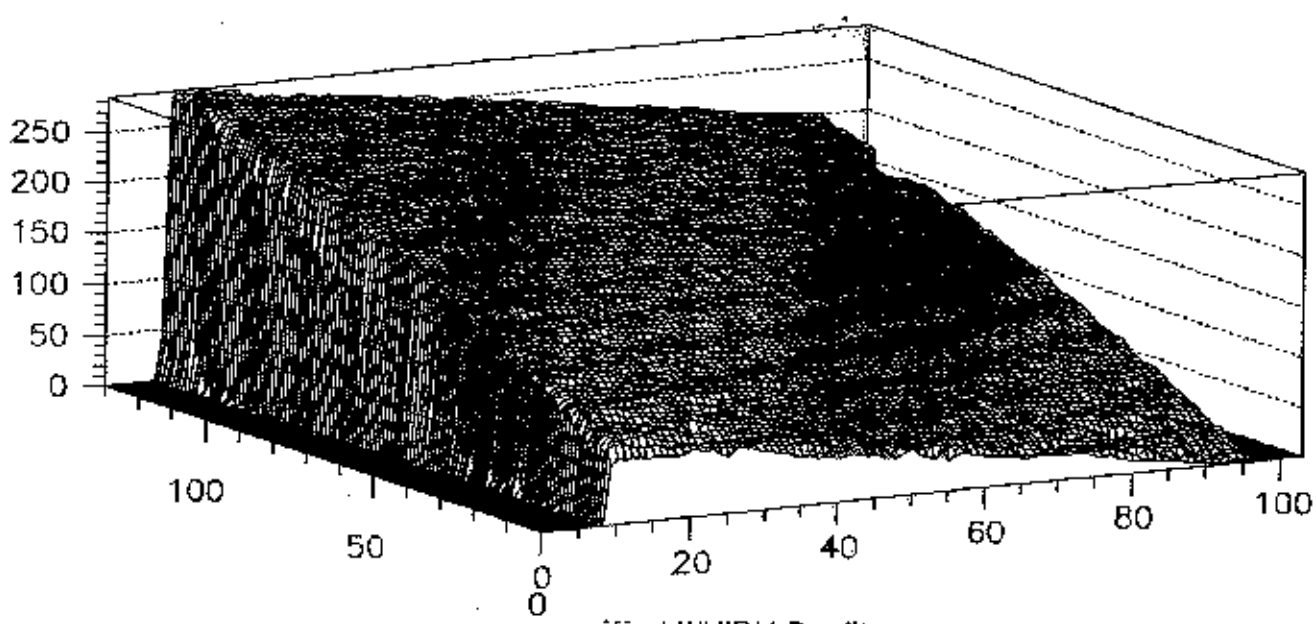
sparsified WHIPM Profile

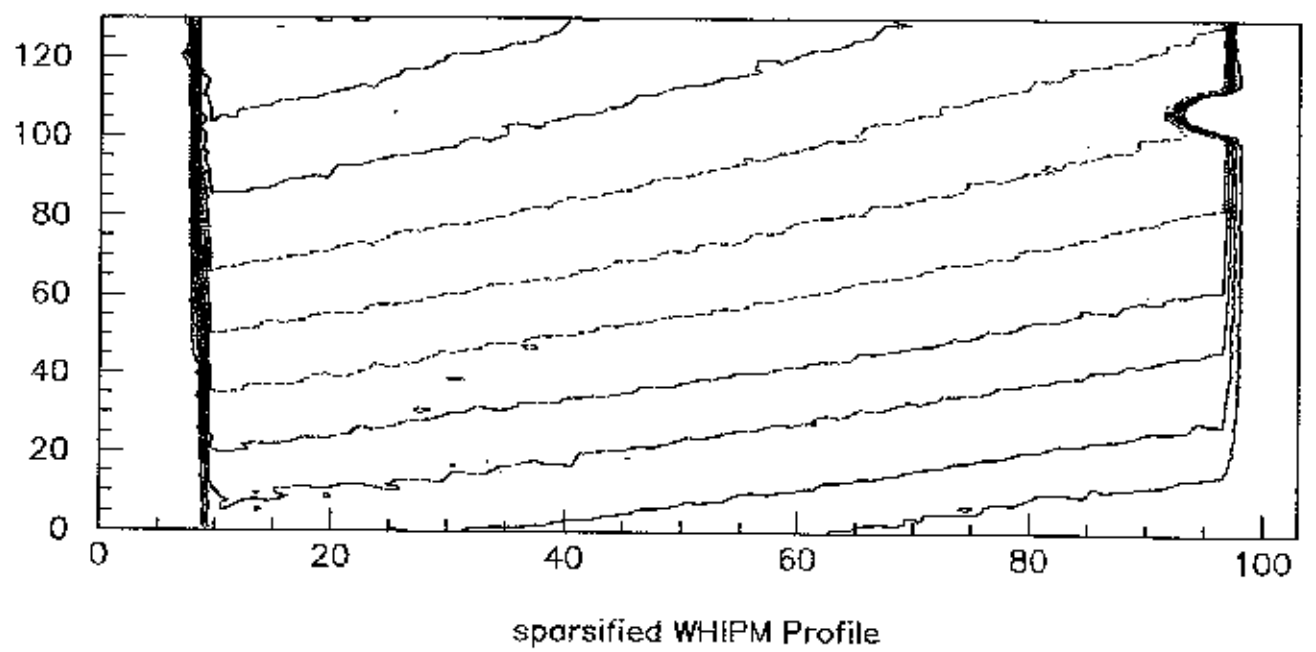


sparsified WHIPM Profile

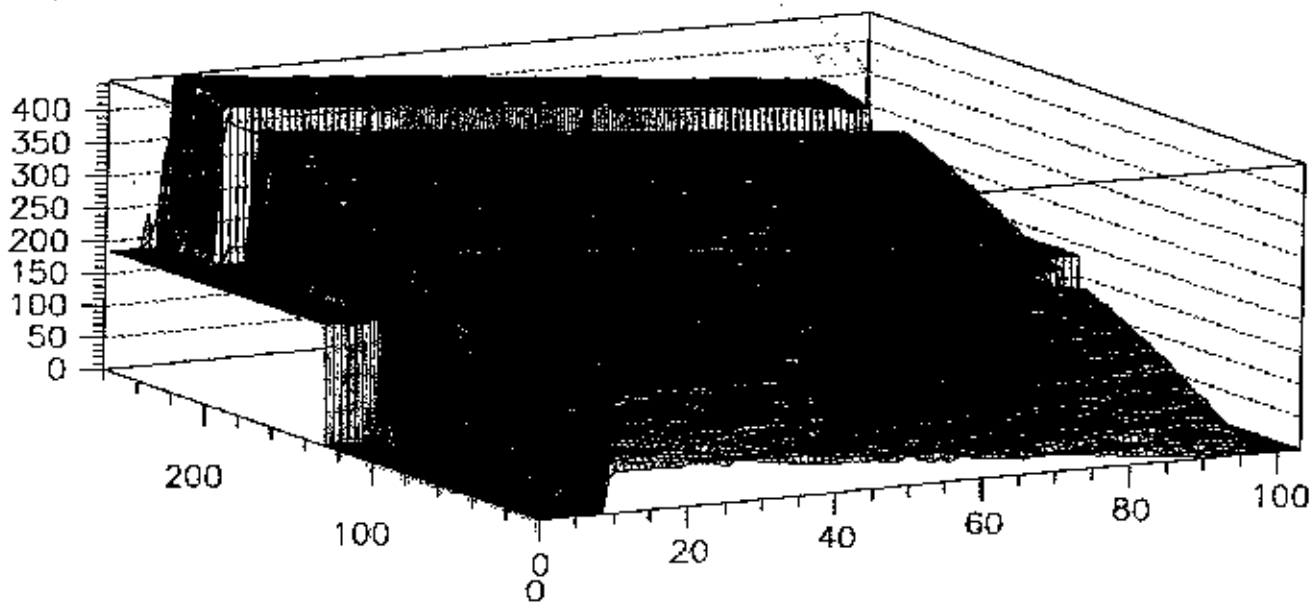
Single frame of ladder

($1\ inch^2$)

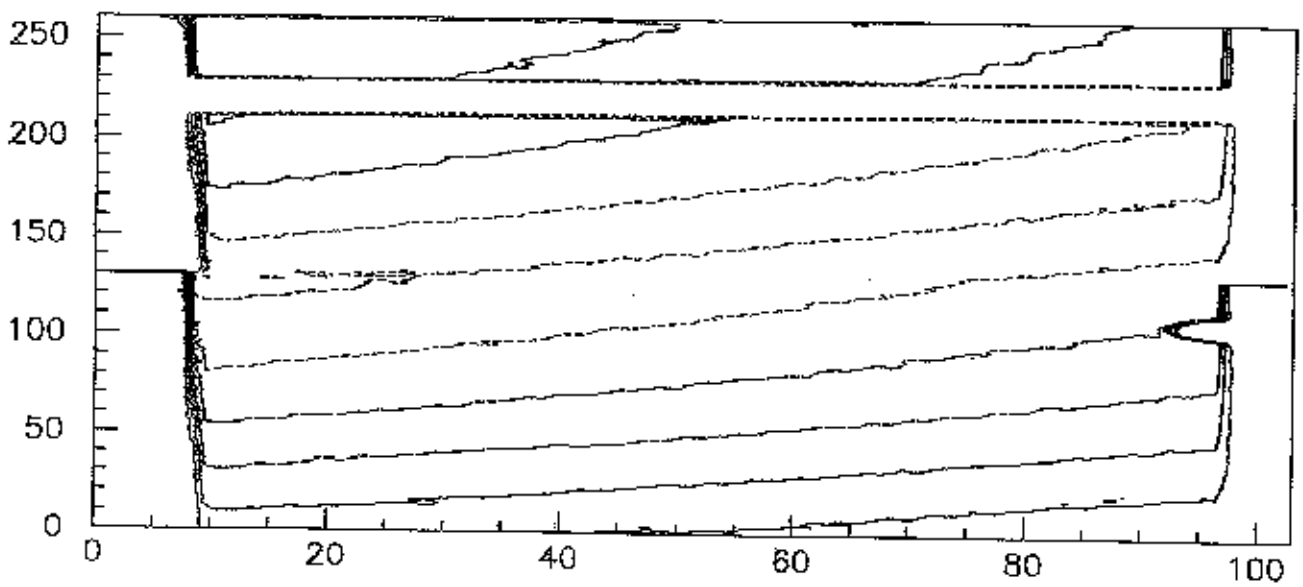




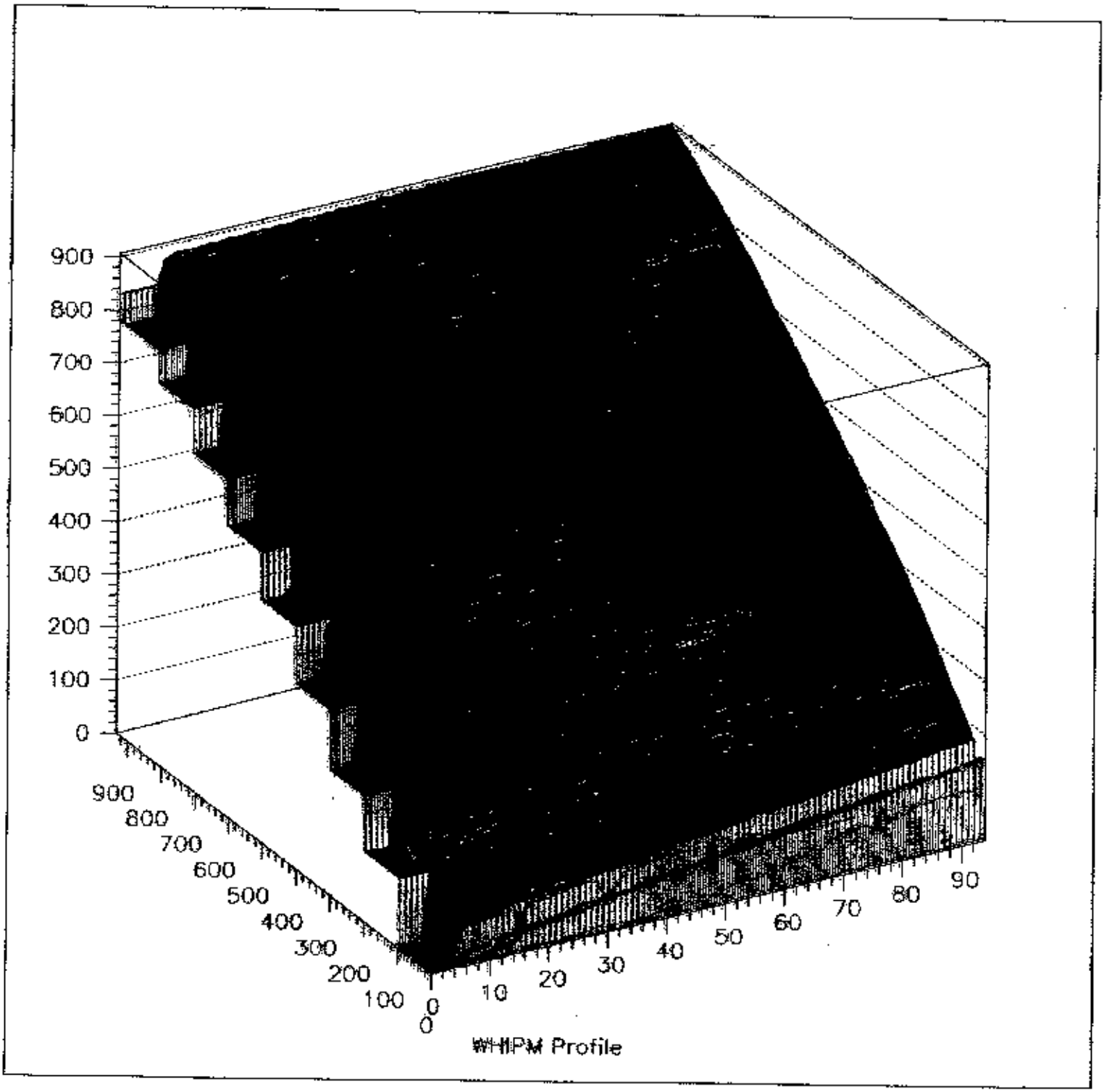
2 frames stitched



sparsified WHIPM Profile



sparsified WHIPM Profile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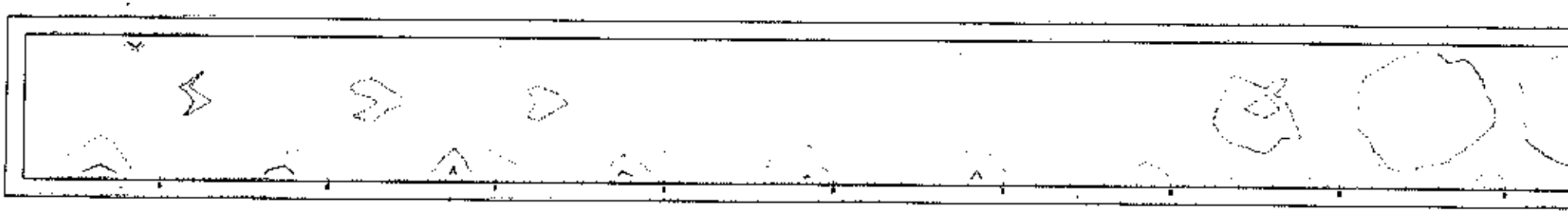
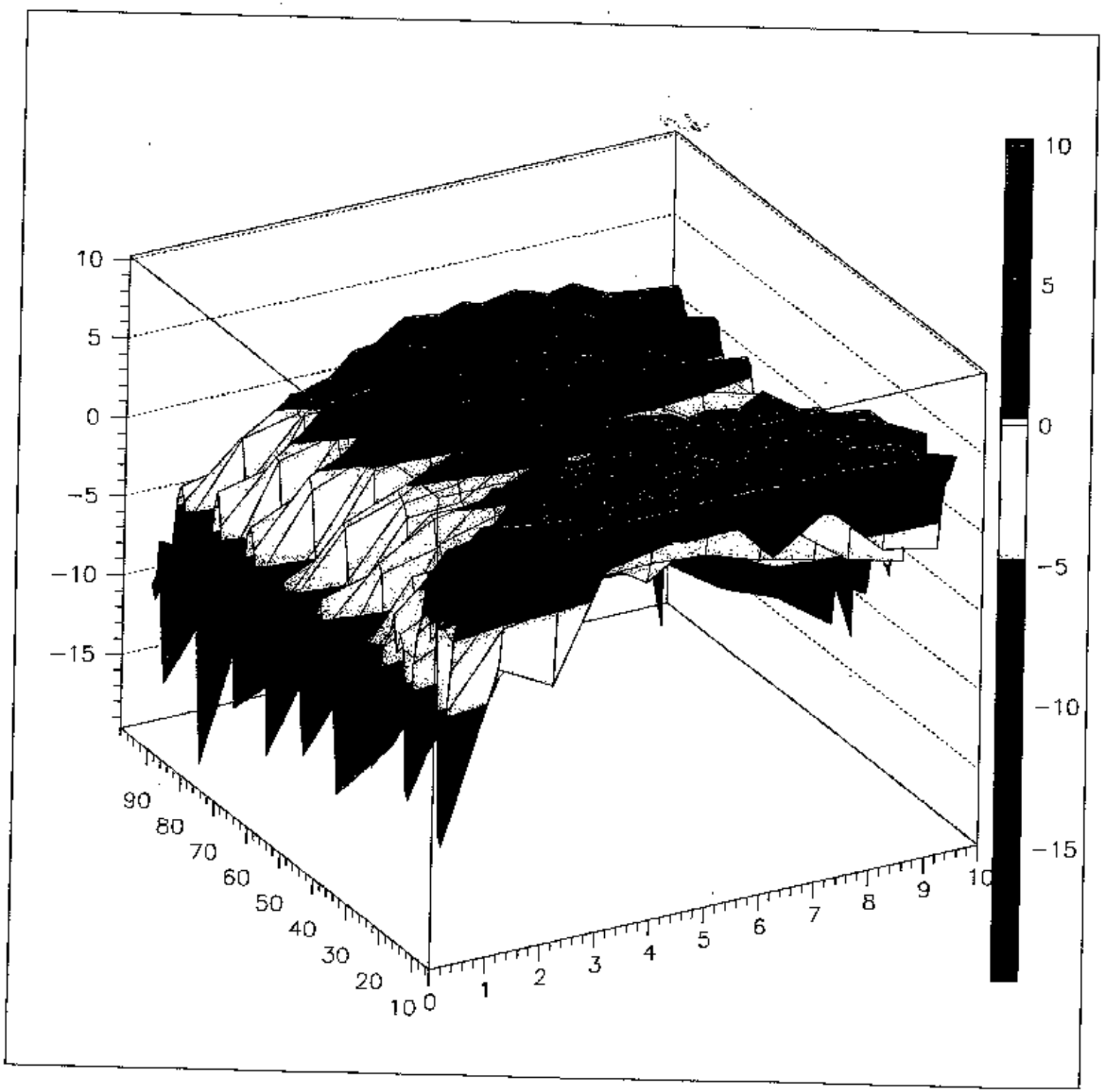
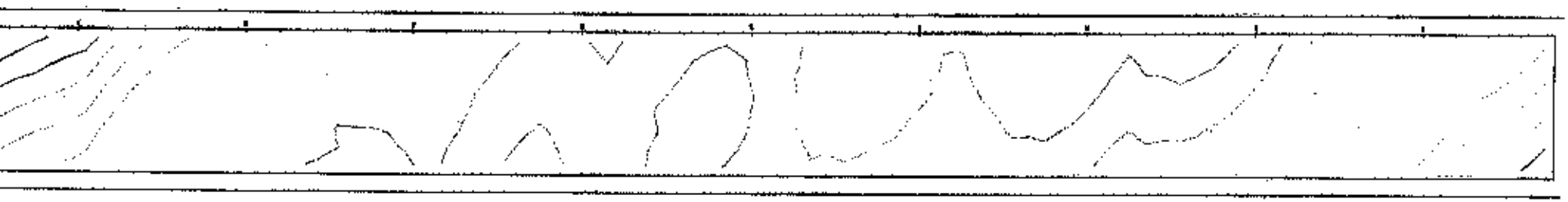
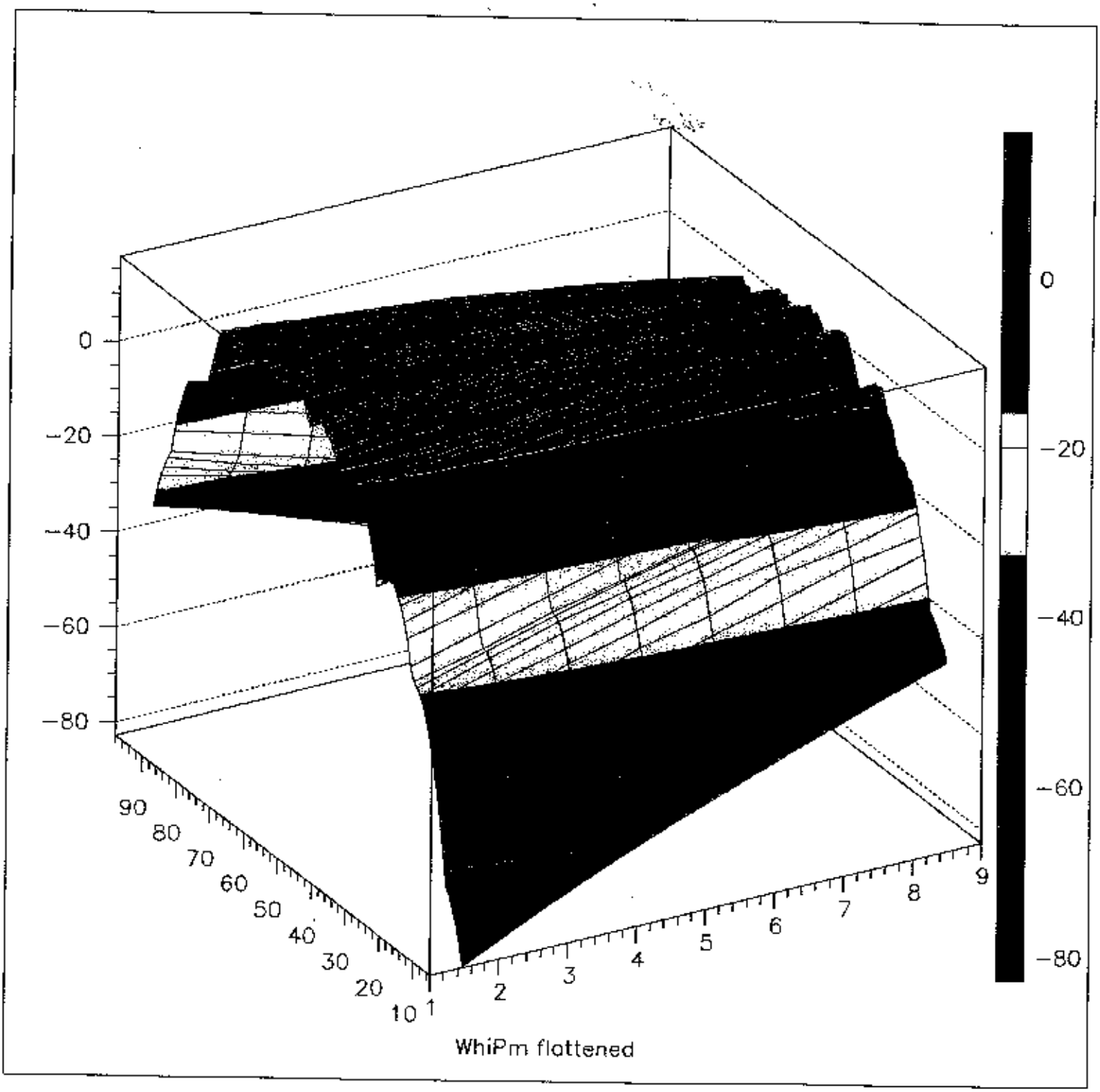
WHIPM Profile



Gauge block, tilt subtracted



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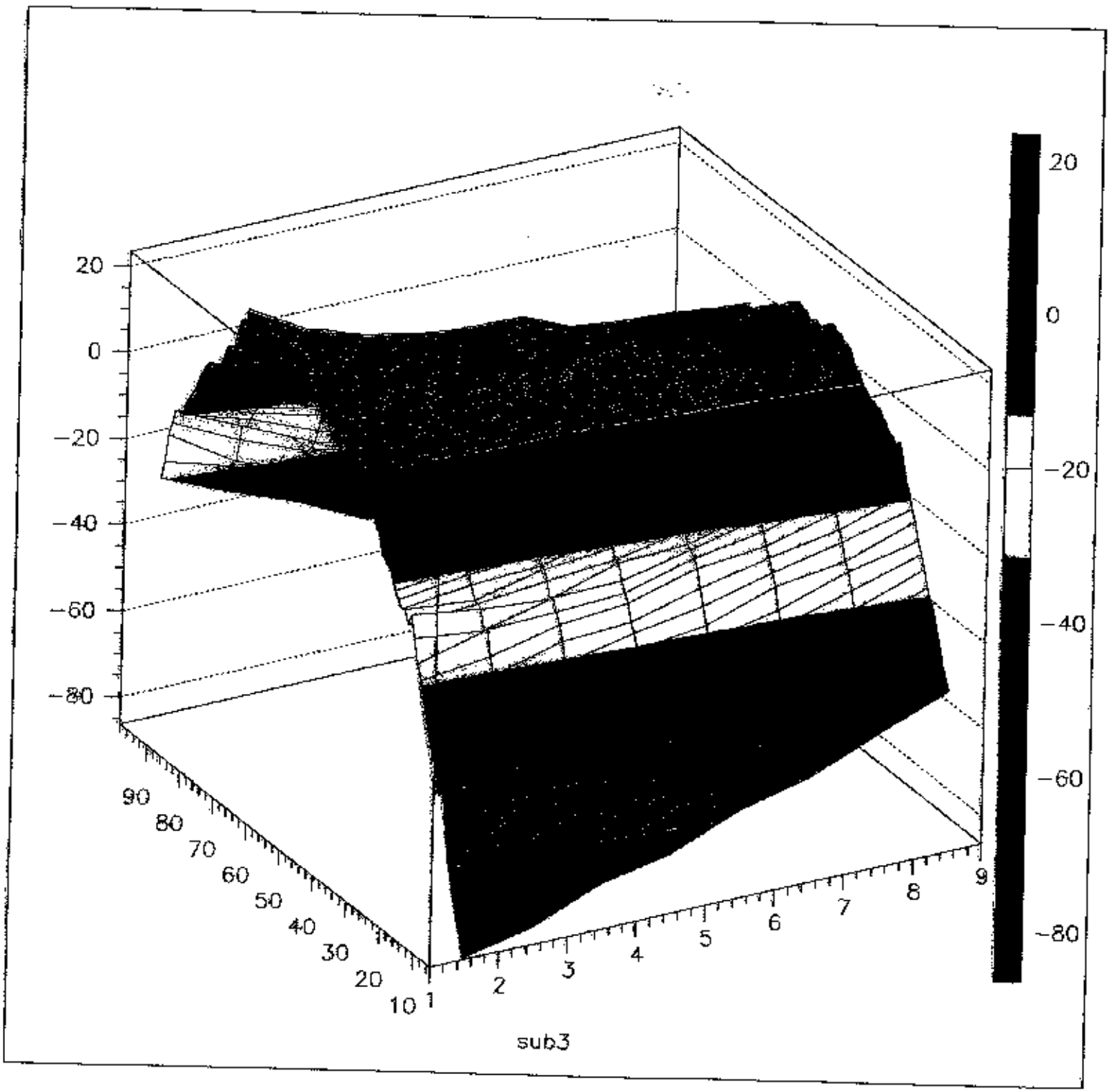
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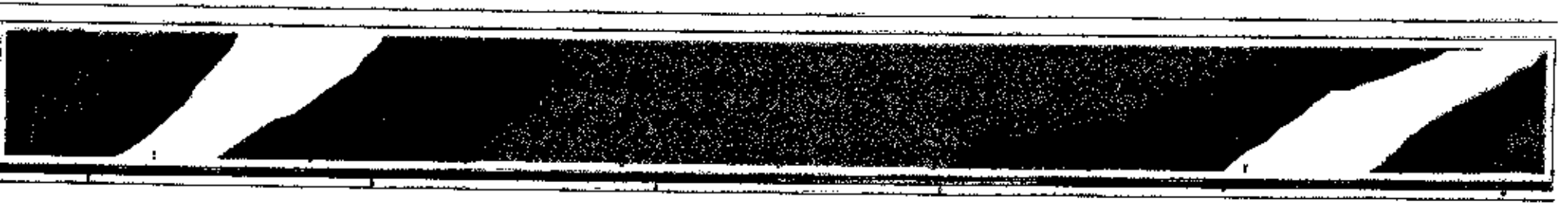

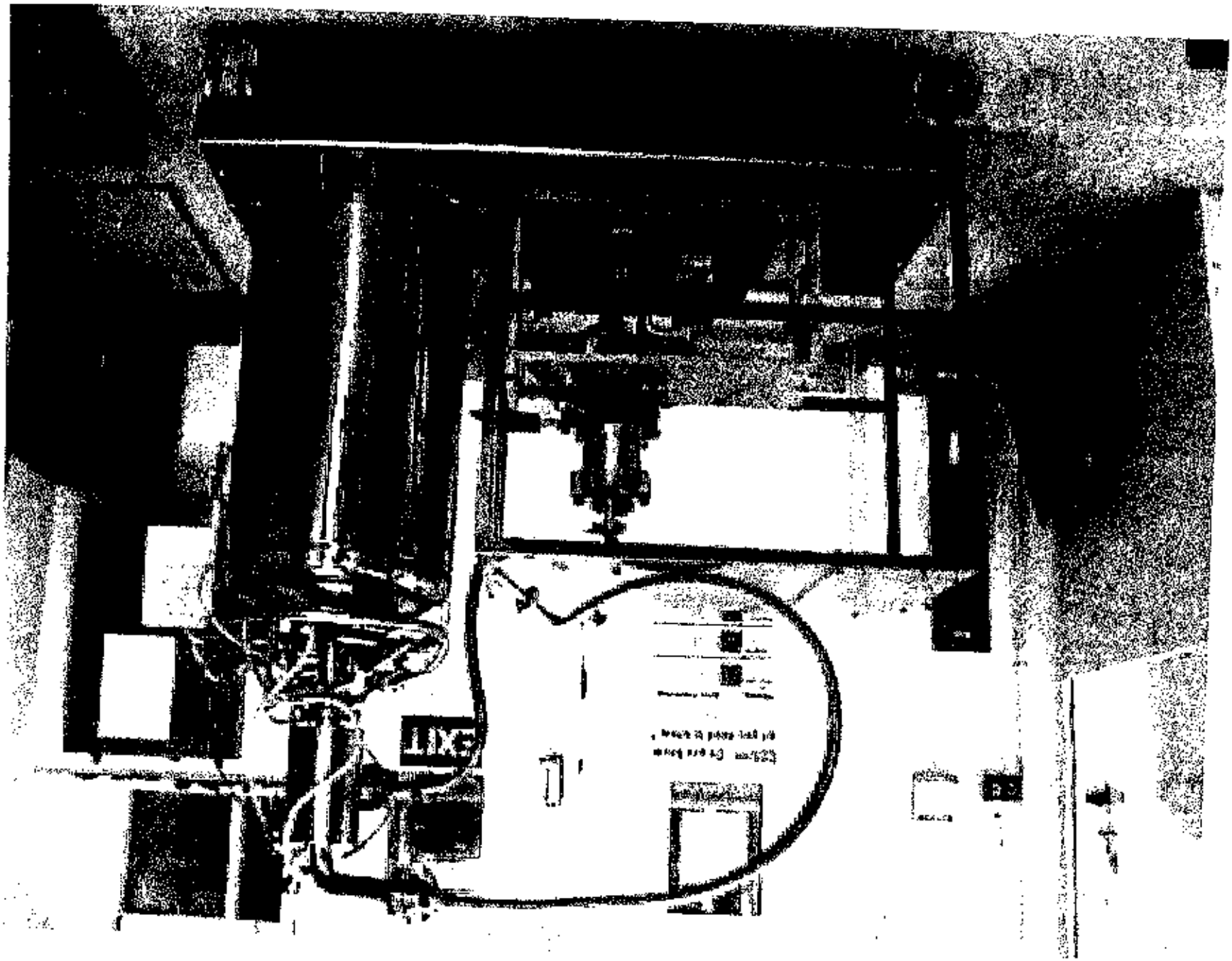
EXIT