

KEKB VACUUM SYSTEM

5/Mar/98 KEK-B Vacuum Group
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○ Specifications

○ Vacuum components under construction

- LER Vacuum chambers
- HER Vacuum chambers
- Bellows chambers

○ Installation

- Receiving work
- Ultimate pressures etc.
- Present status

○ Schedule

- Delivery of chambers
- Commissioning of vacuum (simulation)

Specifications

Main parameters of KEKB related to vacuum system

	LER	HER
Beam Energy	3.5	8.0
Beam Current	2.6	1.1
Bunch length		4 ---> Impedance
Circumference		3016
Bending radius	16.31	104.46
Total power of SR	2117(arc)	3817
Max. power density (bend)	14.8	5.8 ---> Heat load
Critical energy of SR	5.84	10.9
Total photon flux	7.35×10^{21}	7.11×10^{21}
Ave. photon flux	3.3×10^{18}	3.2×10^{18} ---> Gas desorption

Goal pressures

Ave. pressure with beam	[Torr]	$<1 \times 10^{-8}$
Pressure near the detector	[Torr]	$<1 \times 10^{-9}$
Ave. base pressure	[Torr]	$<1 \times 10^{-9}$
LER : Low Energy Ring	HER : High Energy Ring	

Vacuum system

Vacuum system		LER	HER
Vacuum chambers			
Chamber material		OFC(t6 mm)	
Cleaning		Chemical polish ($\text{H}_2\text{SO}_4 + \text{H}_2\text{O}_2$)	
Cross section of chamber		Circle	Racetrack
Conductance (m)	[l/s]	102	52
Vacuum seal		Helicoflex (Delta)	
Welding		Electron beam welding	
Pump system			
Pumping scheme		Array of port	Integrated+port
Main pump	#2595	NEG(cartridge)	NEG(strip+cartridge)
Aux. pump	#579	Ion pump [400 l/s]	
Ave. pumping speed (arc)	[l/s/m]	70*	60*
Vacuum Monitors			
Pressure	#579	CCG (Cold Cathode Gauge)	
Gas components		QMA (Quadrupole Mass Analyzer)	
Temperature	#2284	Pt thermo resistors (for bellows etc.)	

*We obtain the average pressure of $\sim 2 \times 10^{-9}$ [Torr] at $\eta = 1 \times 10^{-6}$ [molecules/photon].

(η :Photo-desorption coefficient)

**Rough pumping port for the turbo-molecular pump are every 40 m.

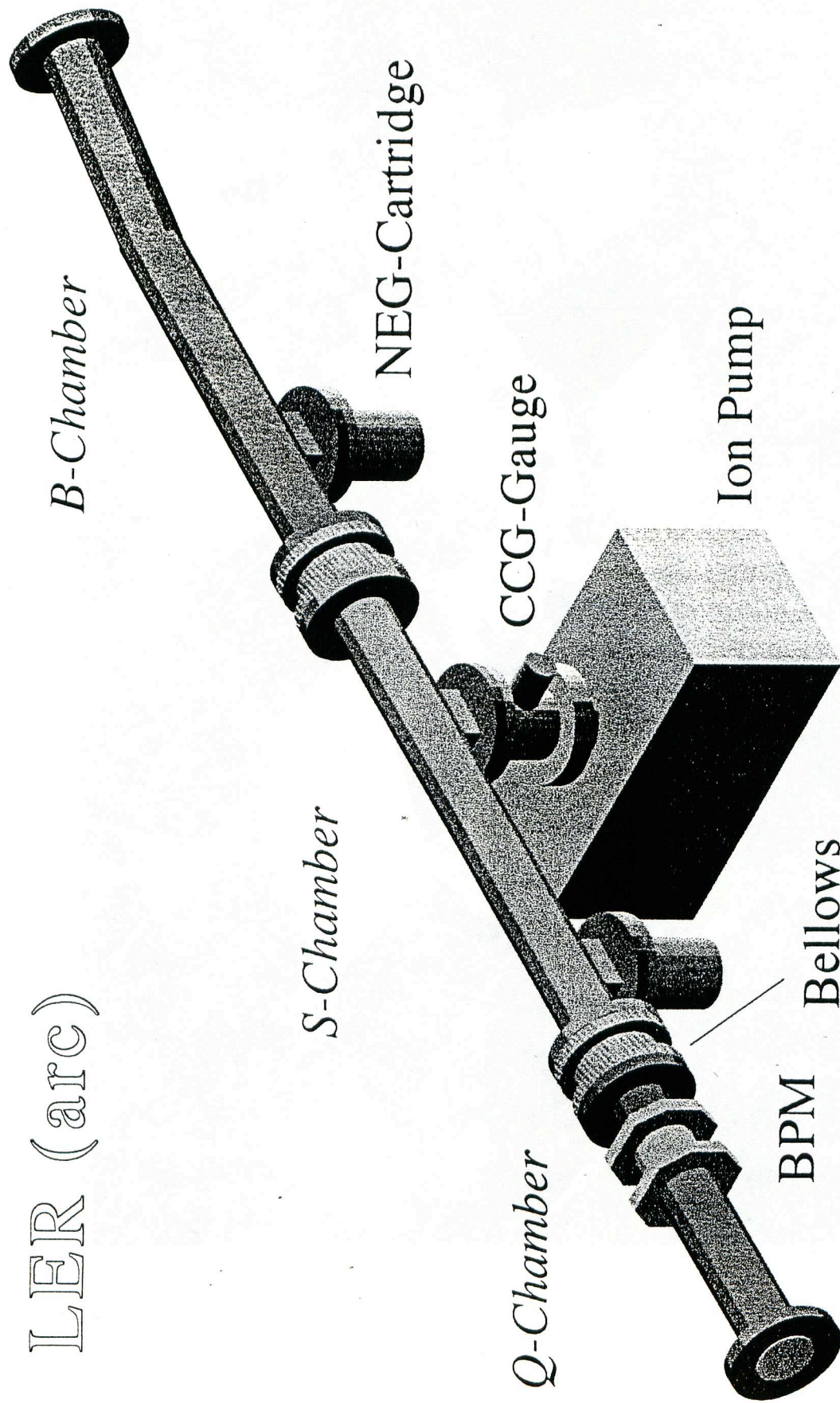
Number of vacuum chambers

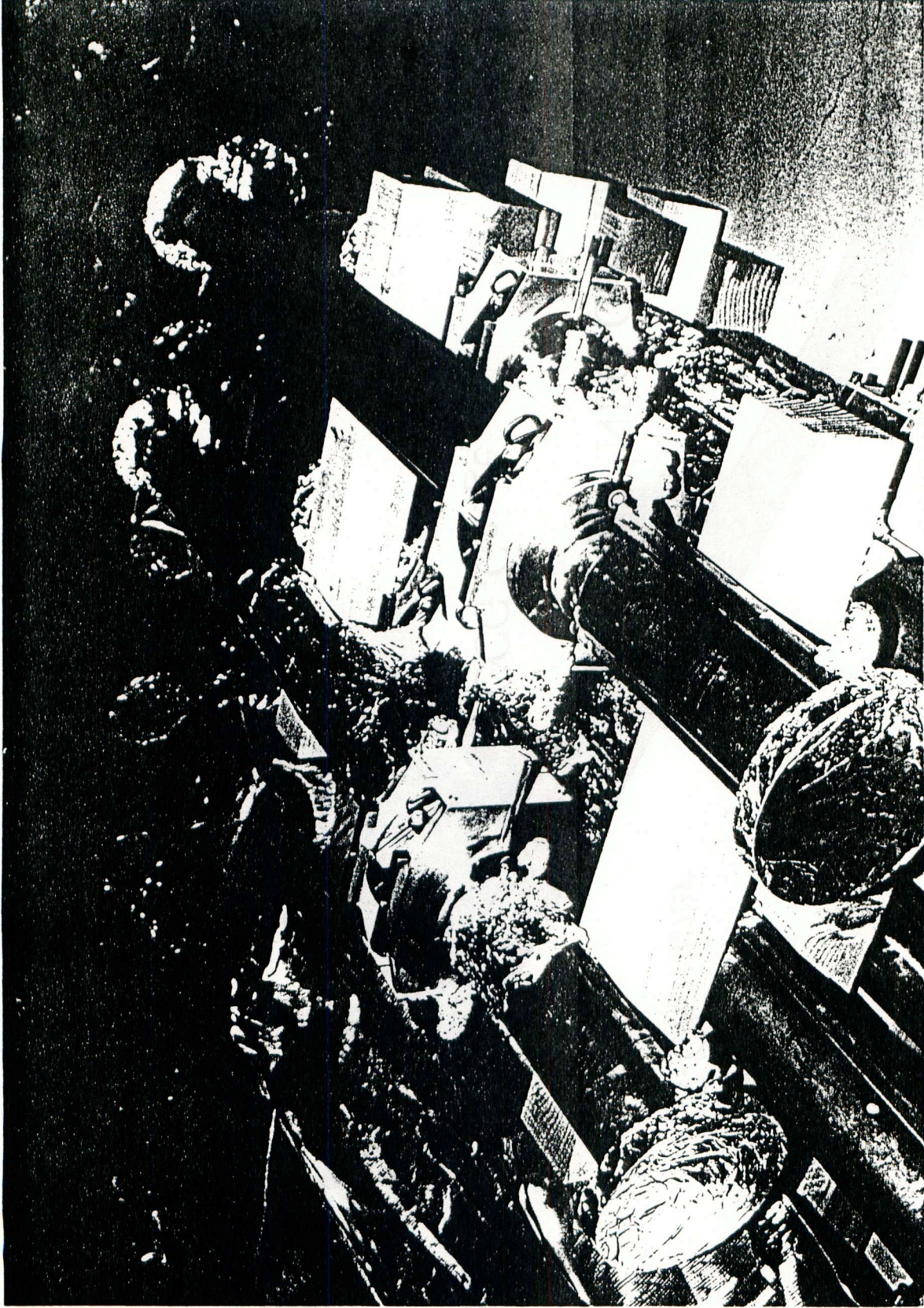
	LER(type)[length]	HER(type)[length]	
Arc section			
Q-chambers	340 (4) [1695~2000]	348 (12) [1500~3815]	688
B-chambers	113 (12) [3417~5775]	120 (3) [6348~1679]	233
S-chambers	280 (16) [1667~5100]	234 (20) [693~4983]	514
Straight section			
Q-chambers	136	92	228
Others	208	194	402
Total	1077	988	2065

Bellows chambers	2006
Gate valves	70

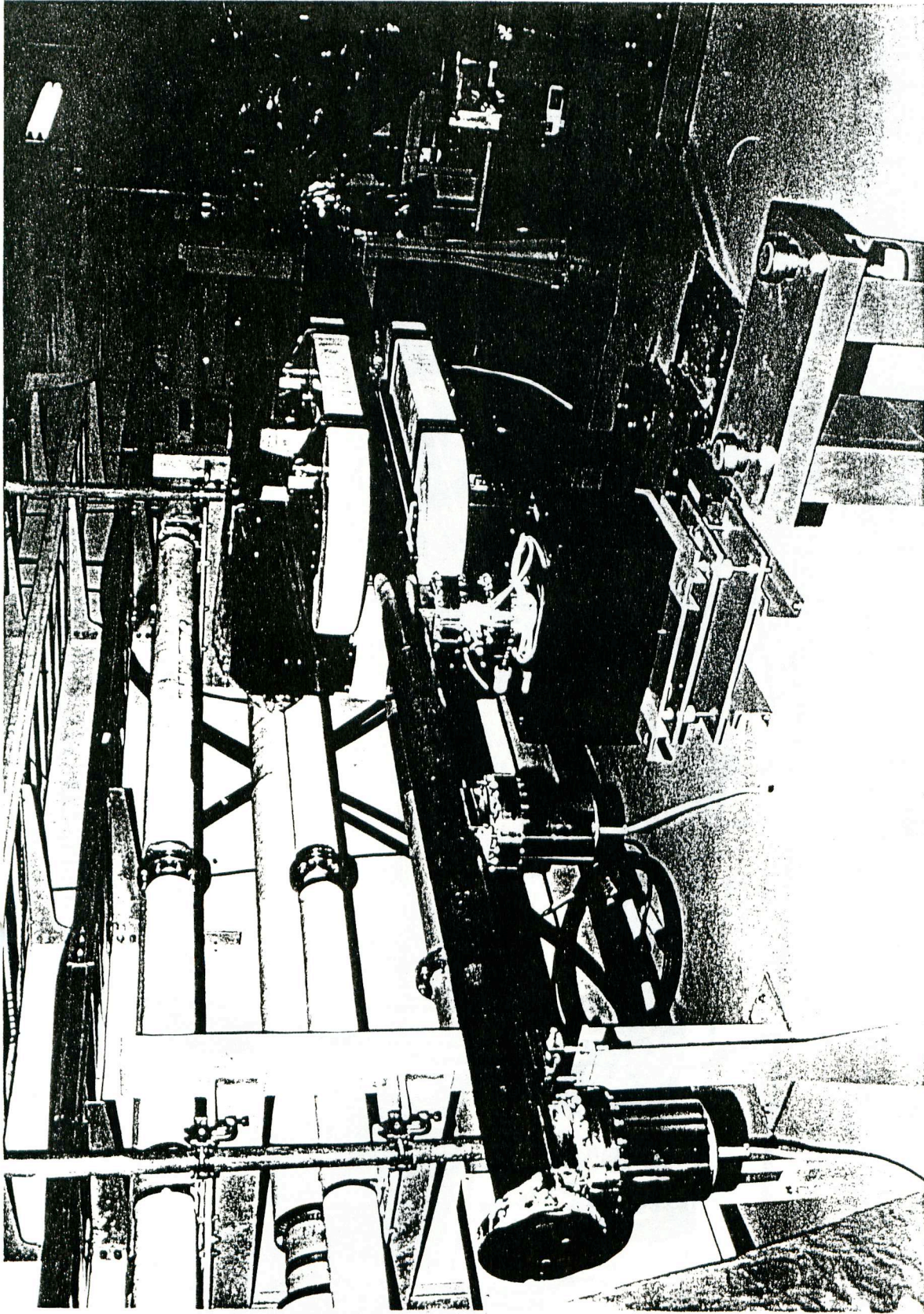
Q-chambers : Chambers for Qadrapole magnet
 B-chambers : Chambers for Bending magnet
 S-chambers : Straight Chambers
 Others : S-chambers, HOM absorber, SR monitor, RF dummy,
 FB kicker, Injection kicker, Abort kicker, CT, DCCCT, etc.

LER (arc)

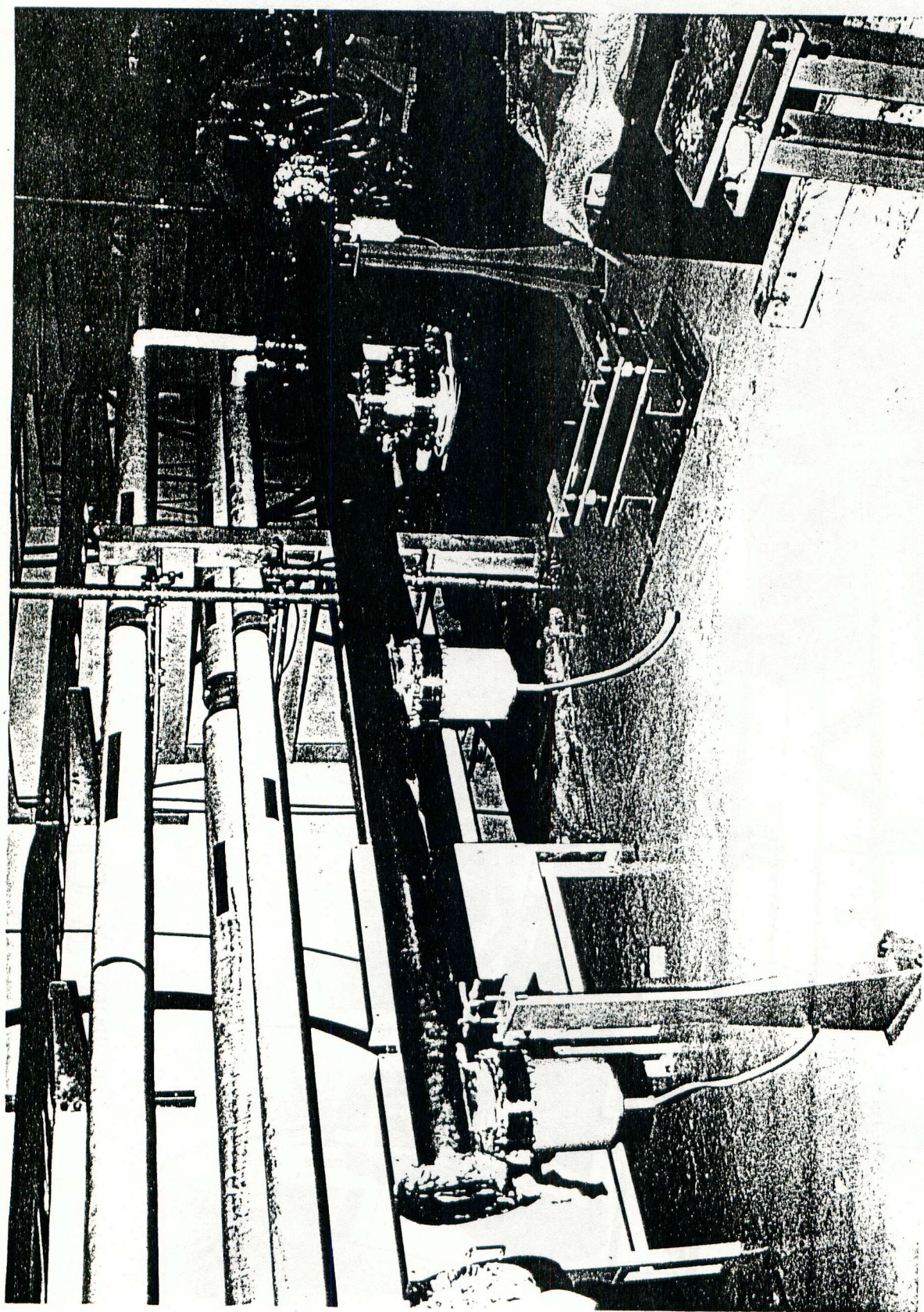




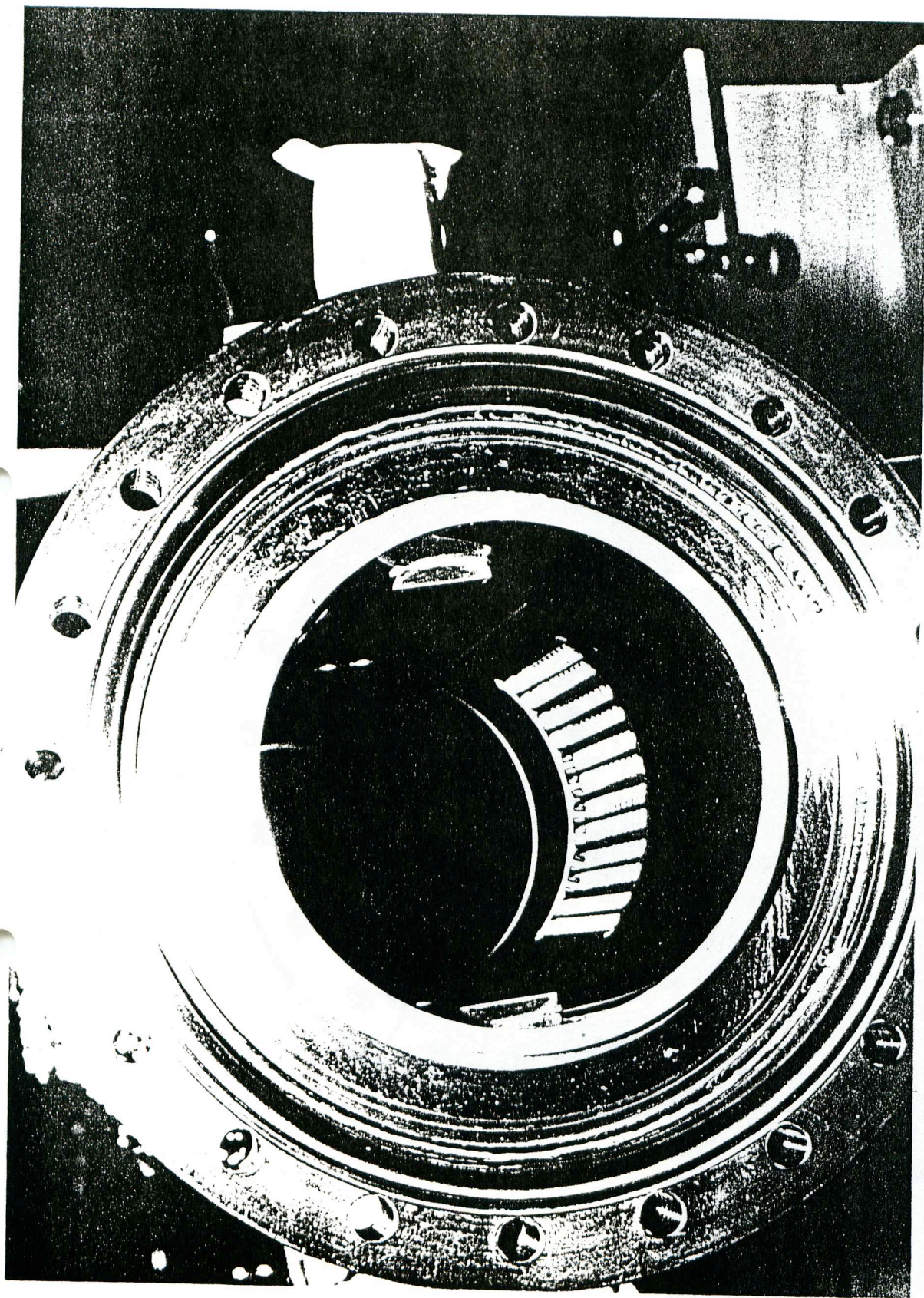
LER Q Chamber



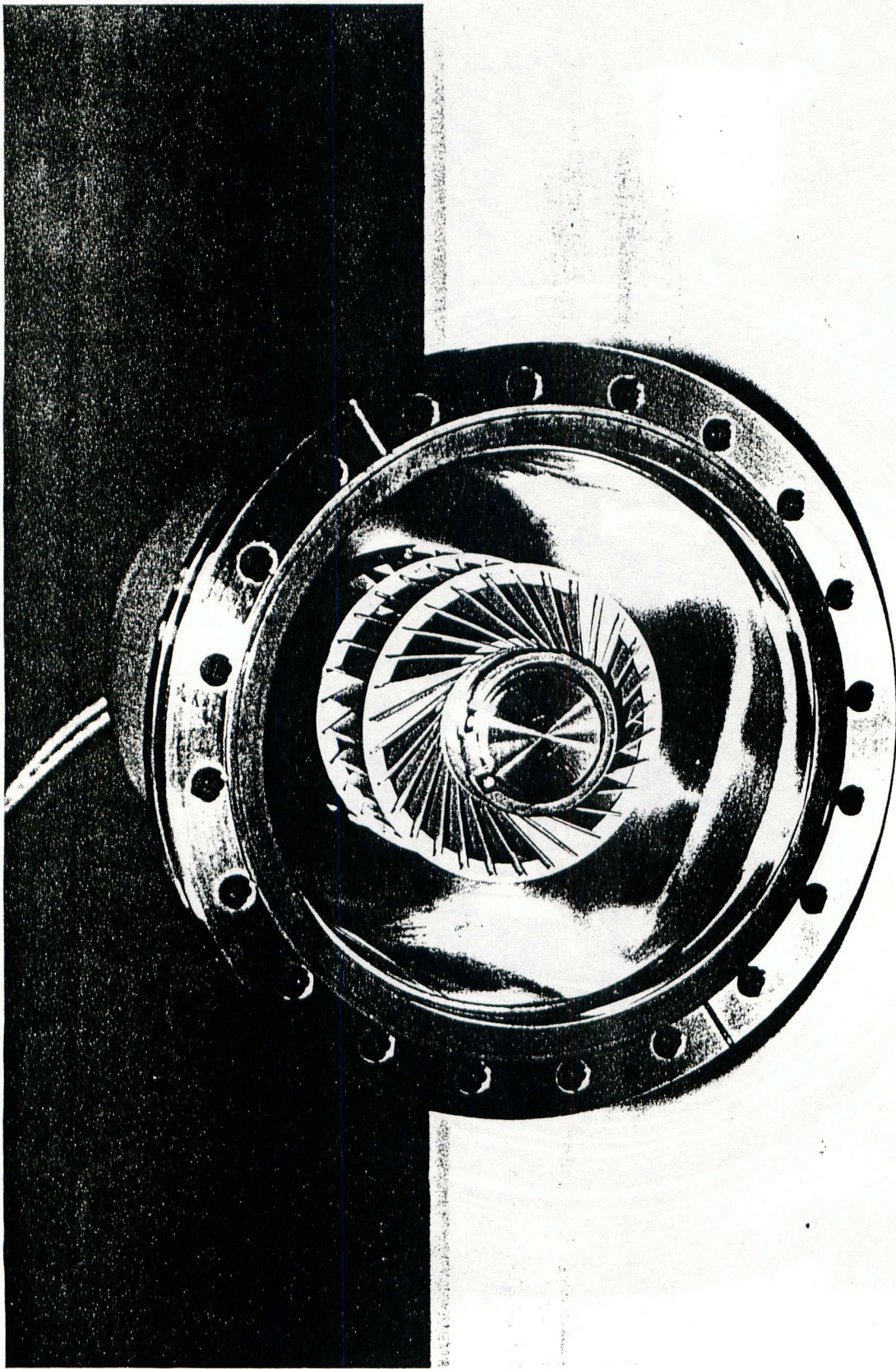
LER B Chamber (in the tunnel)



LIER S Chamber (in the tunnel)

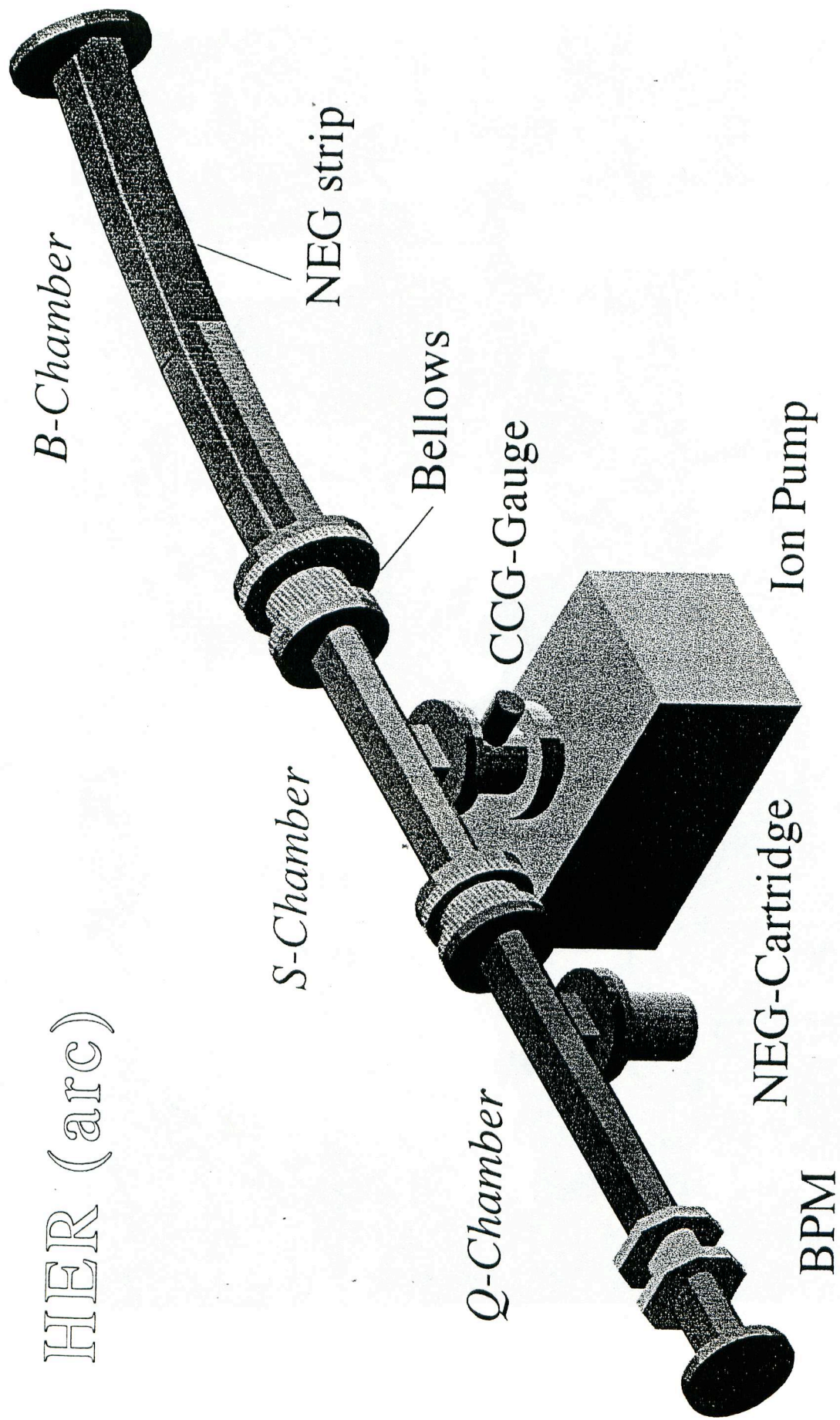


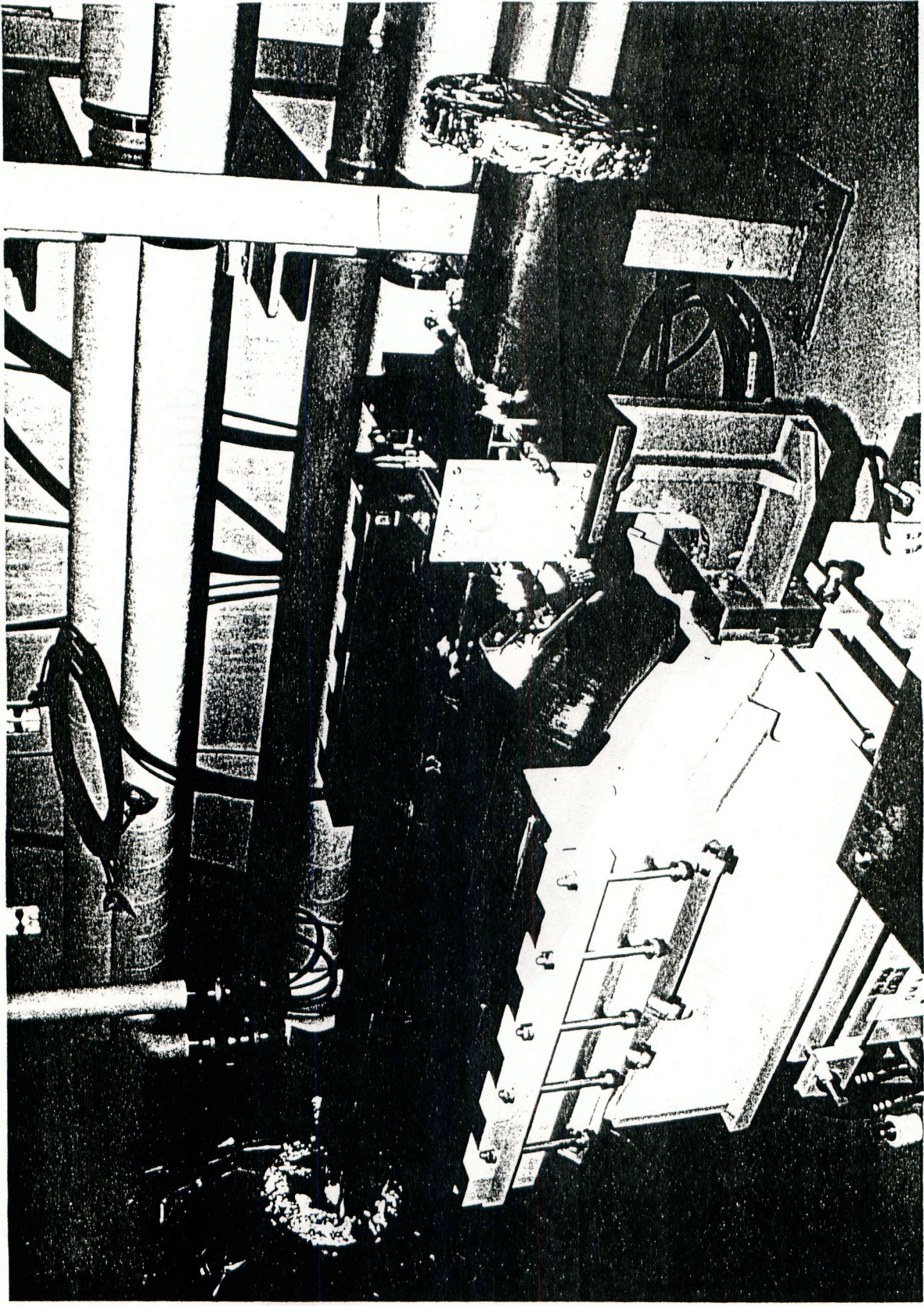
Screen of pump port and masks against SR



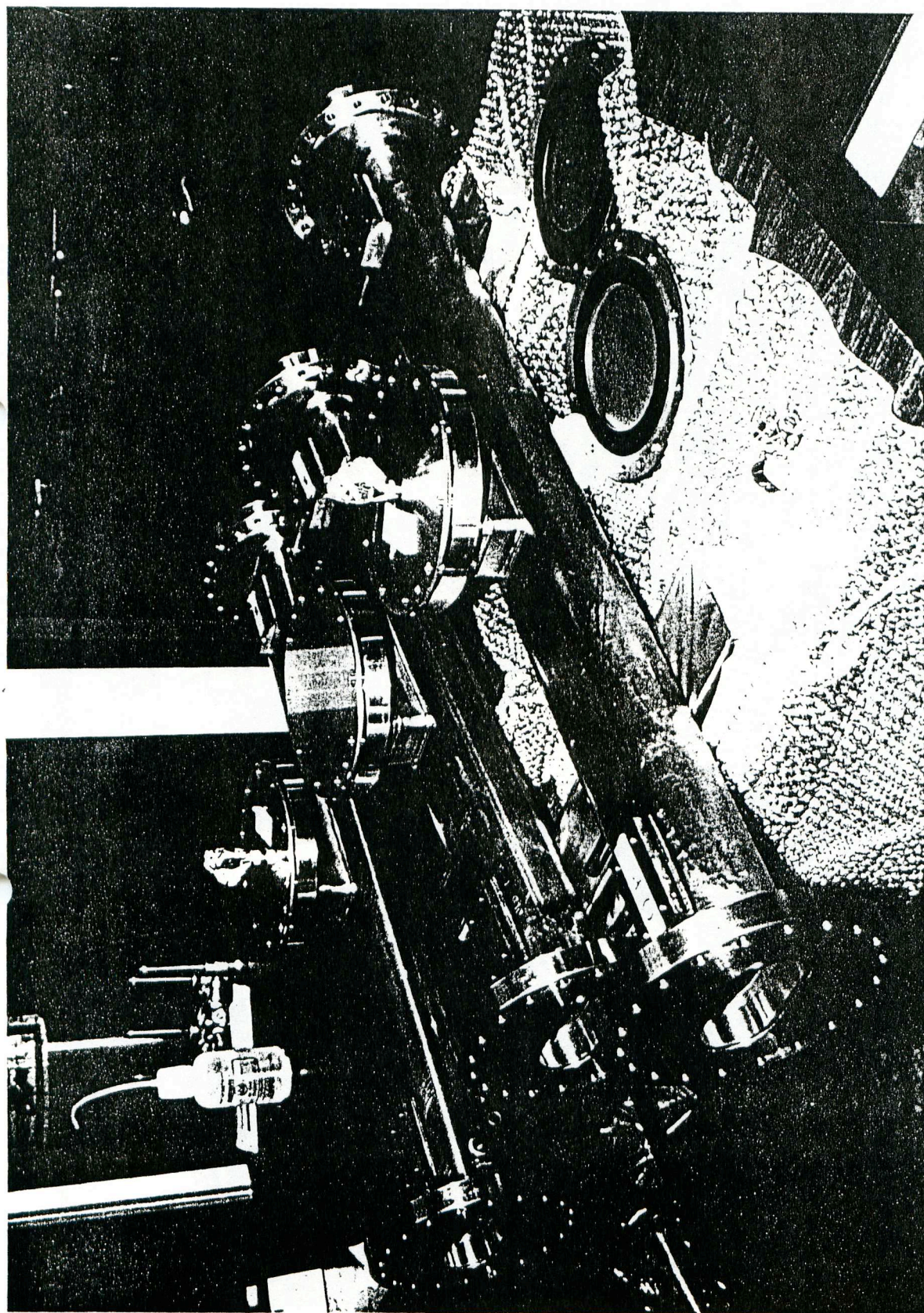
NEG cartridge

HER (arc)

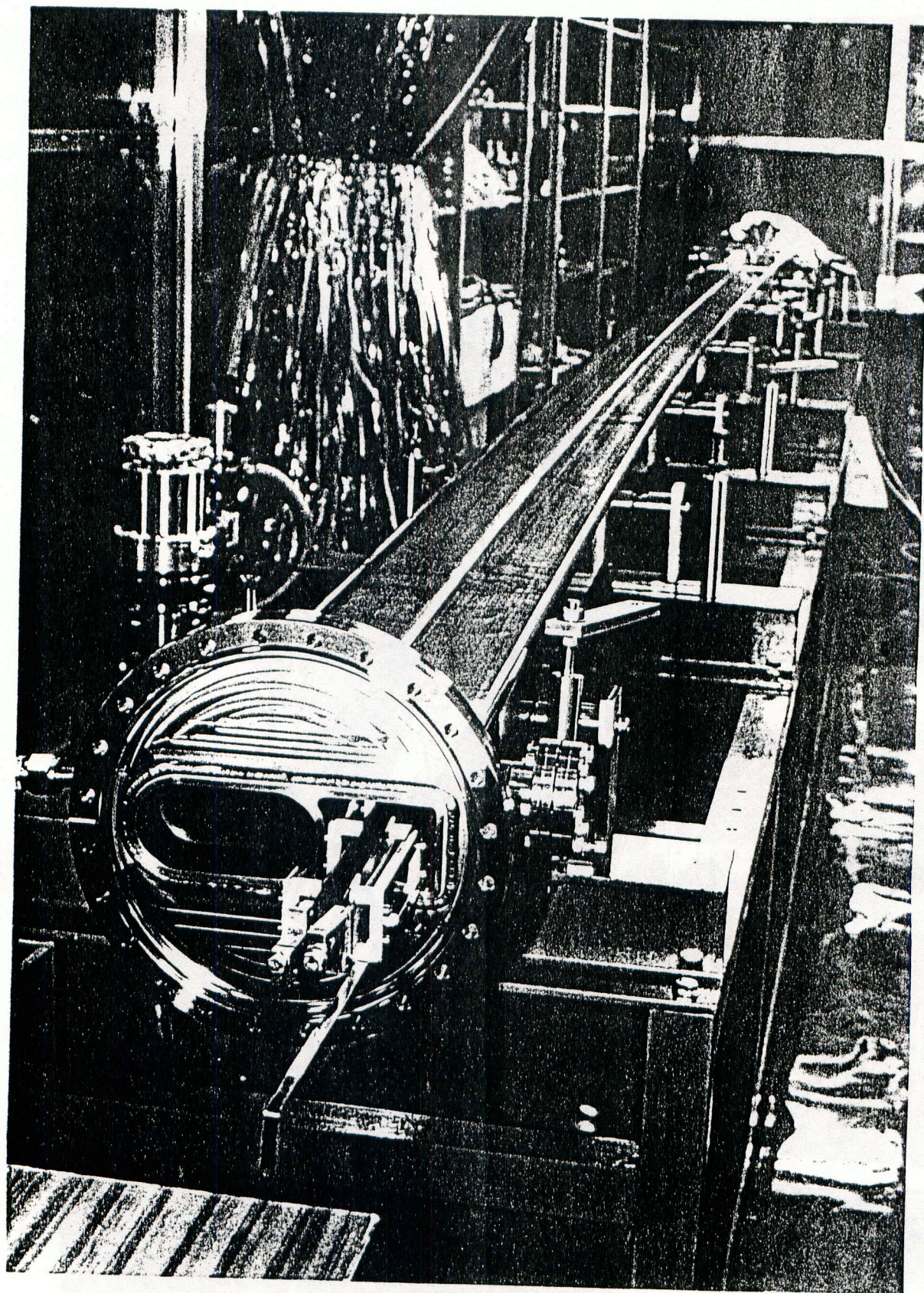




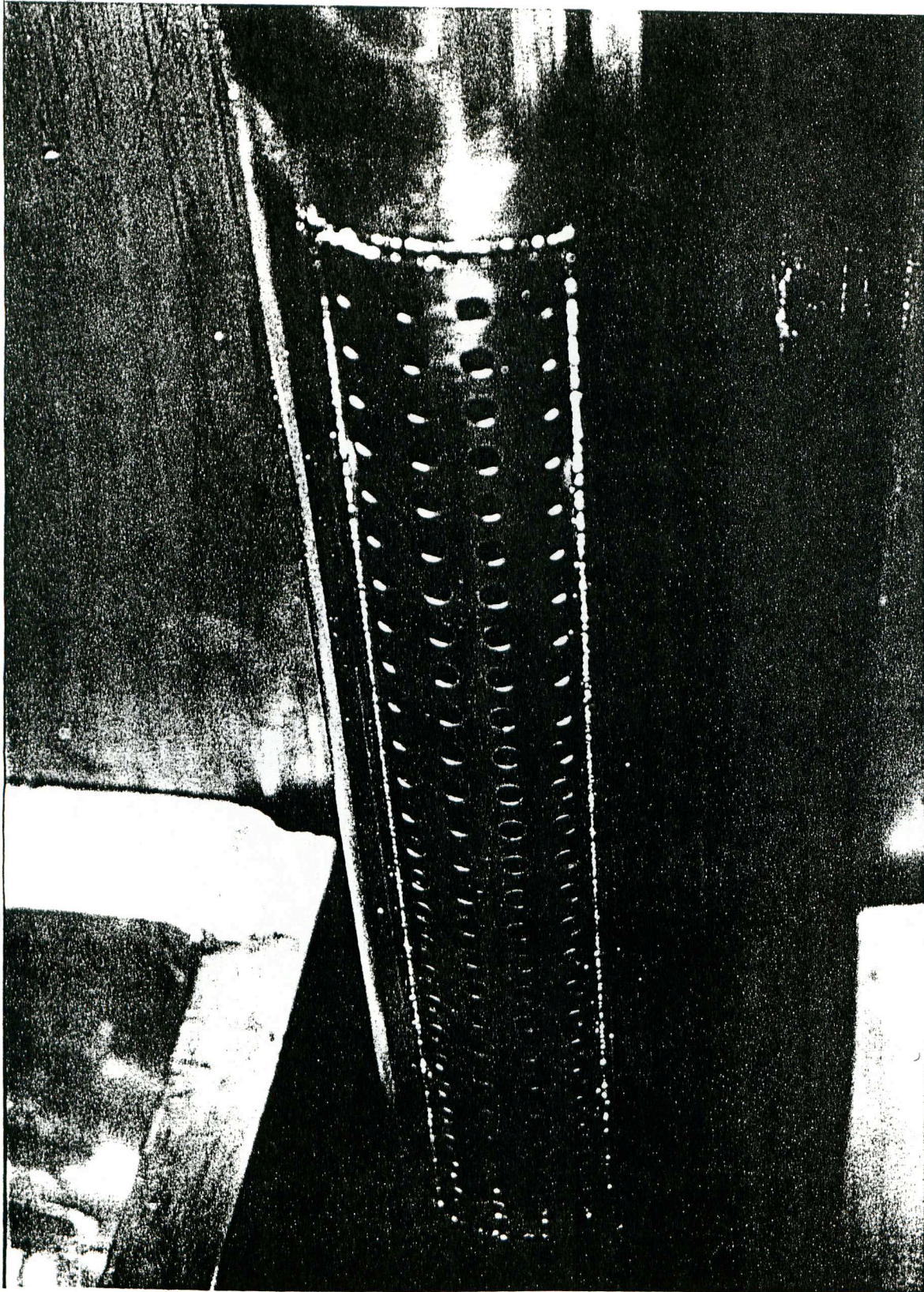
HER Q Chamber (in the tunnel)



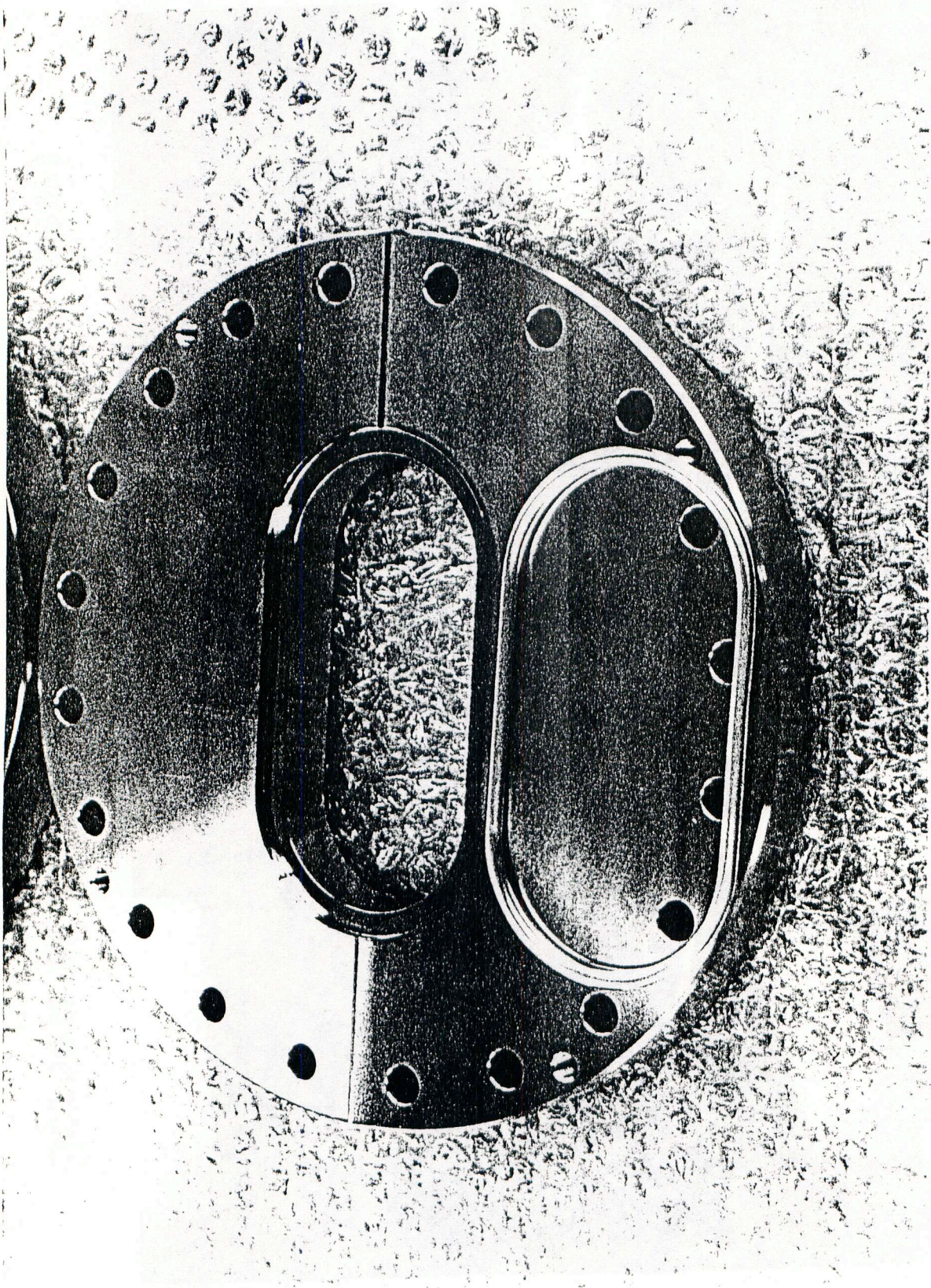
HER S Chamber



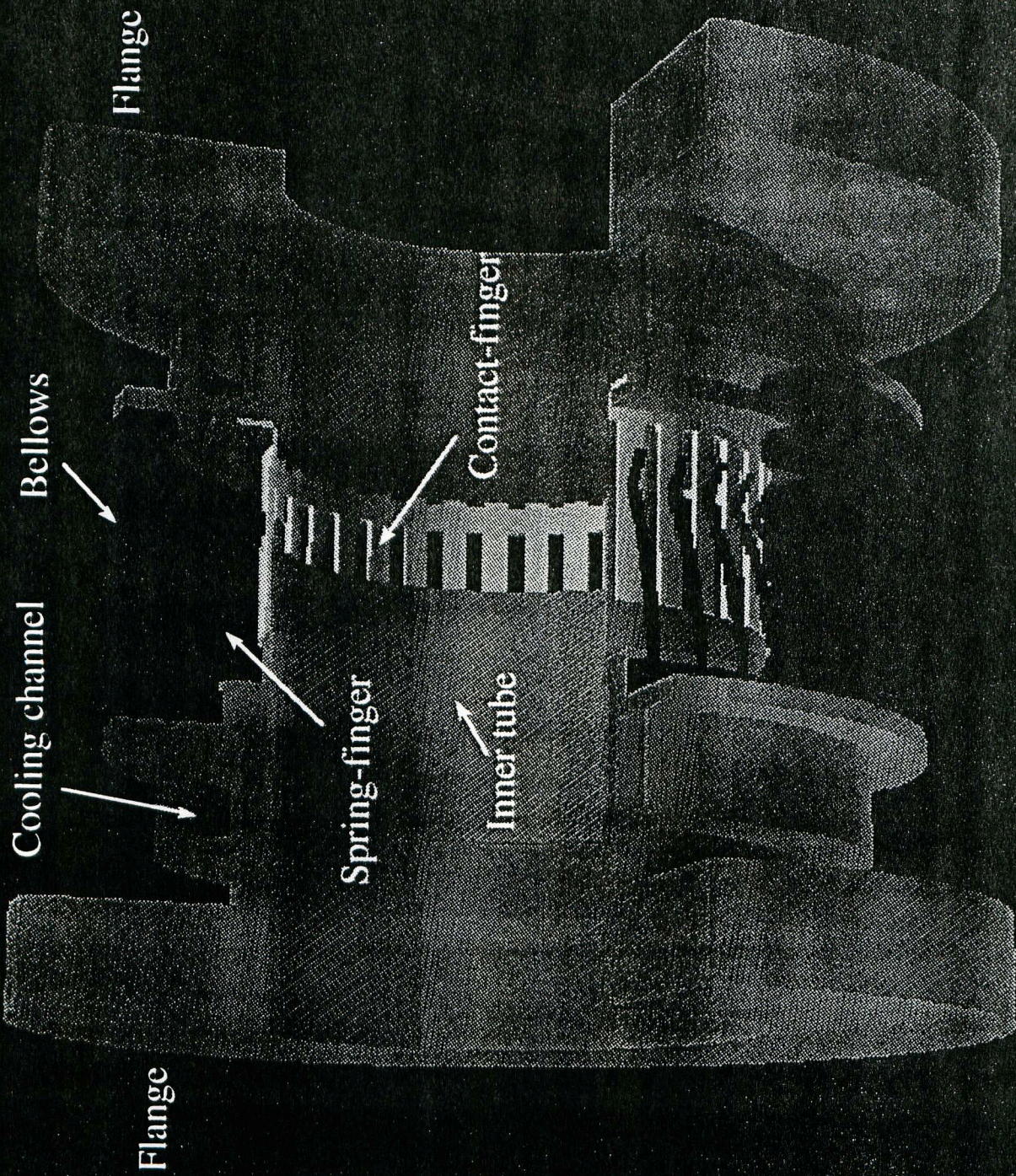
HER B-chamber and NEG strip

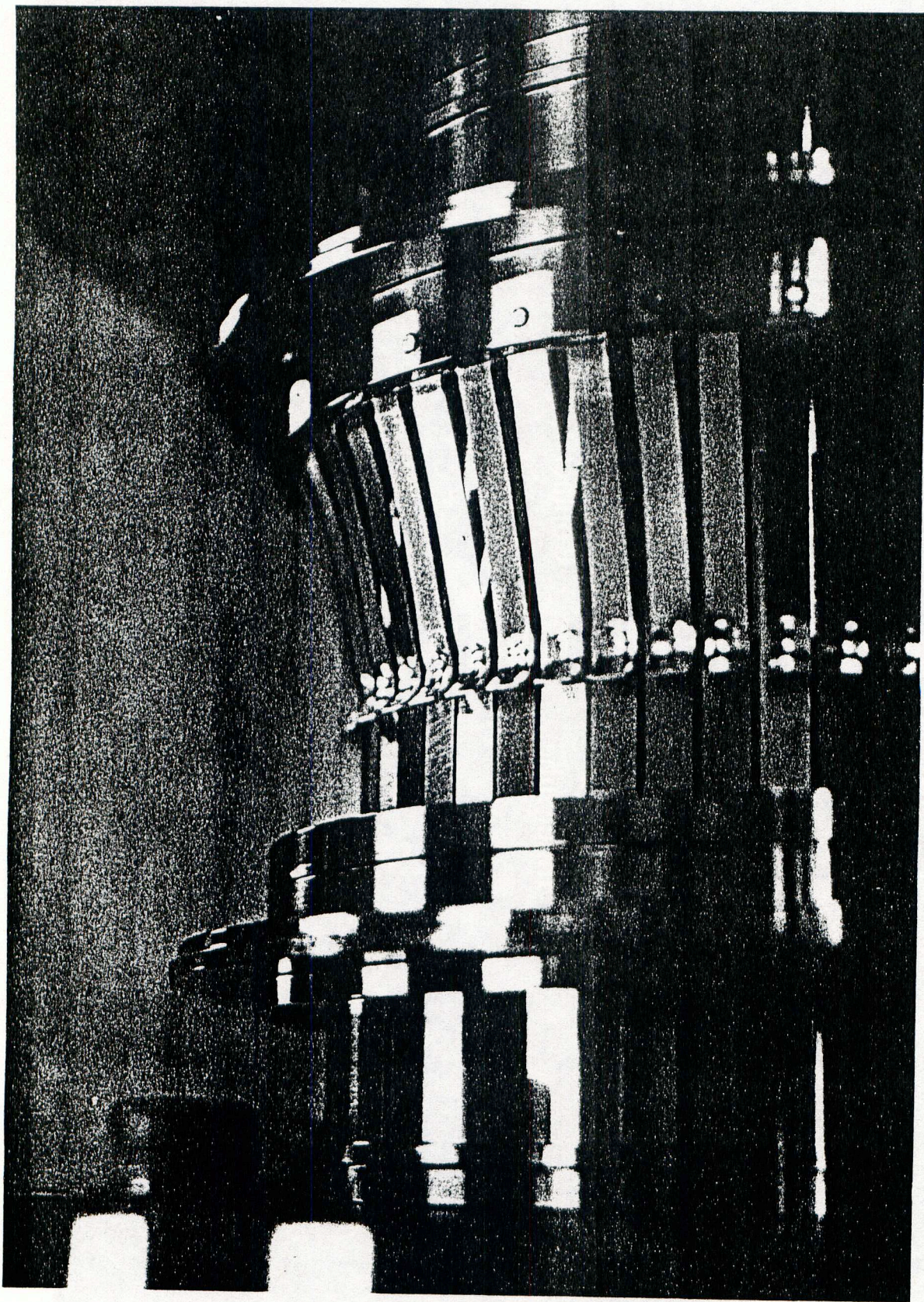


Screen of NEG channel (outside view)

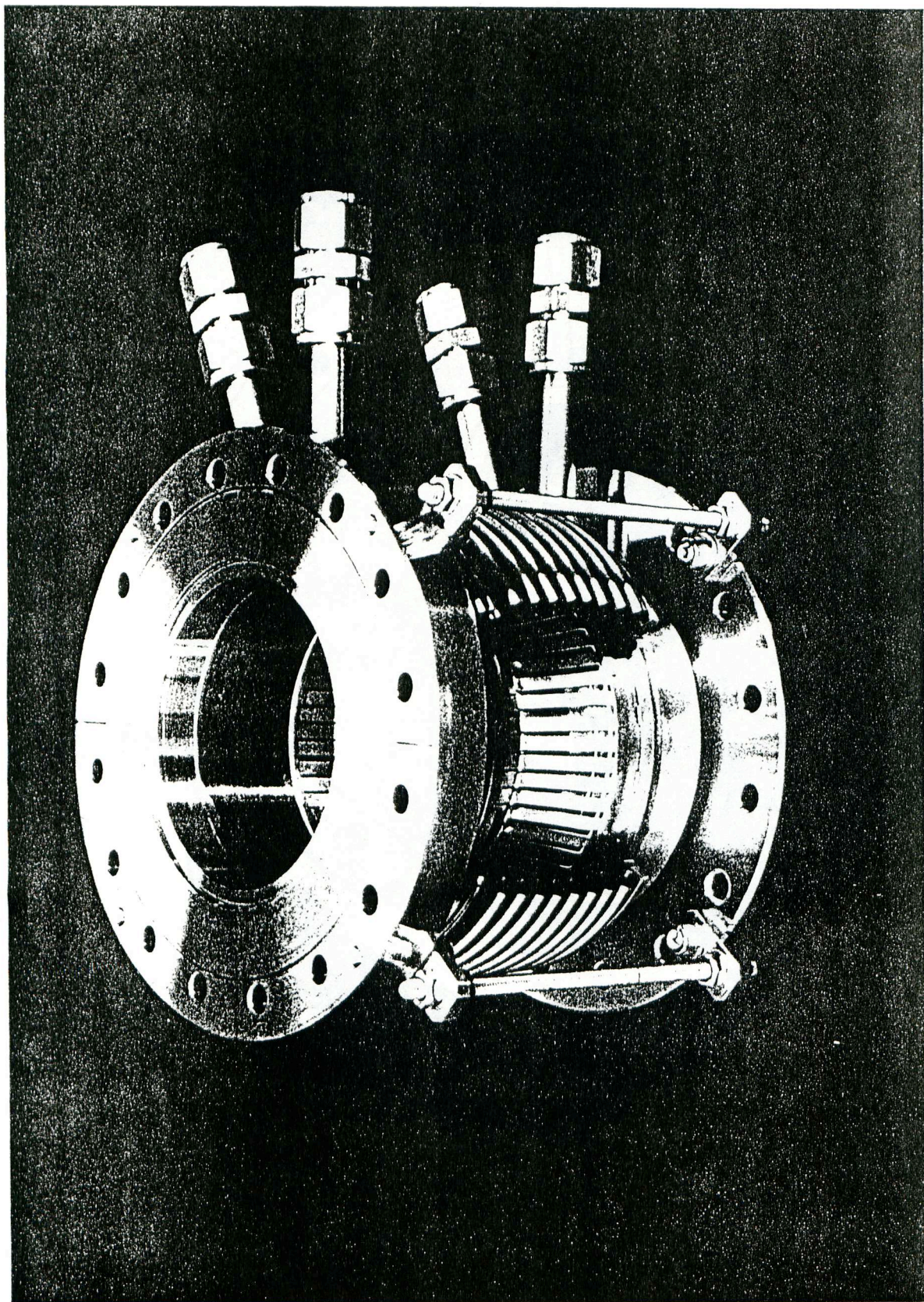


Vacuum seal = Helicoflex (racetrack)

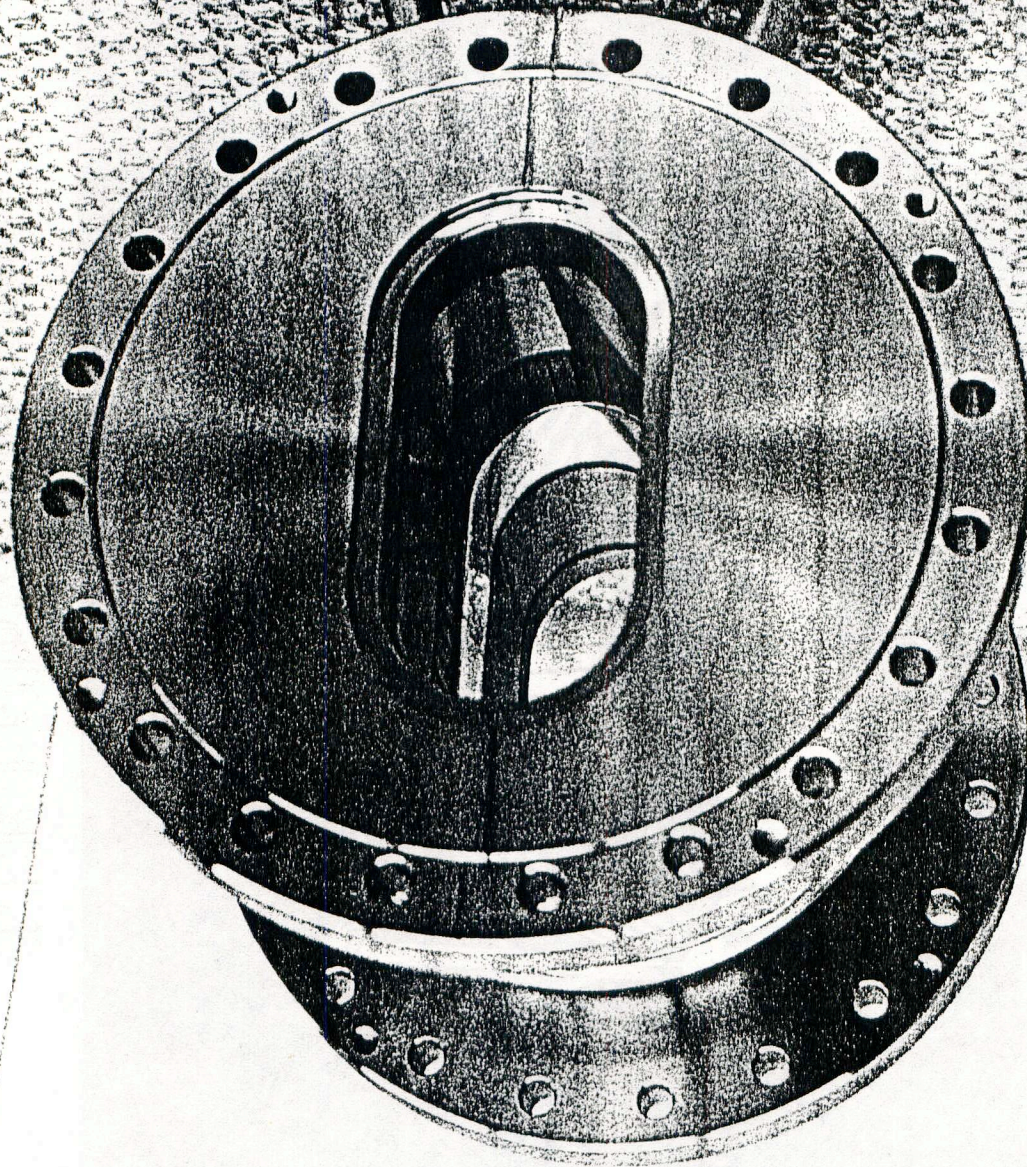




RF-shield fingers inside the bellows chamber



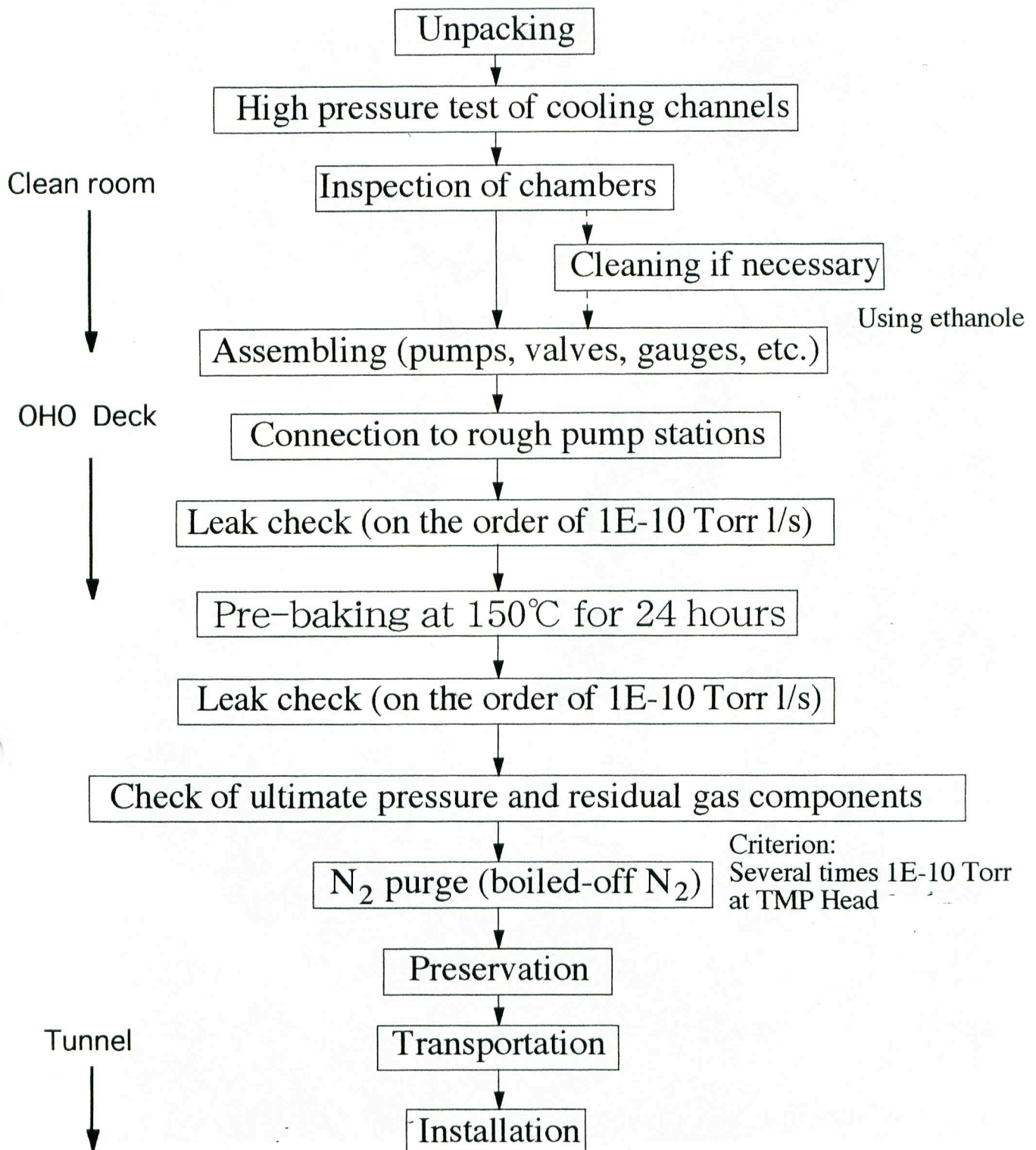
LER bellows chamber

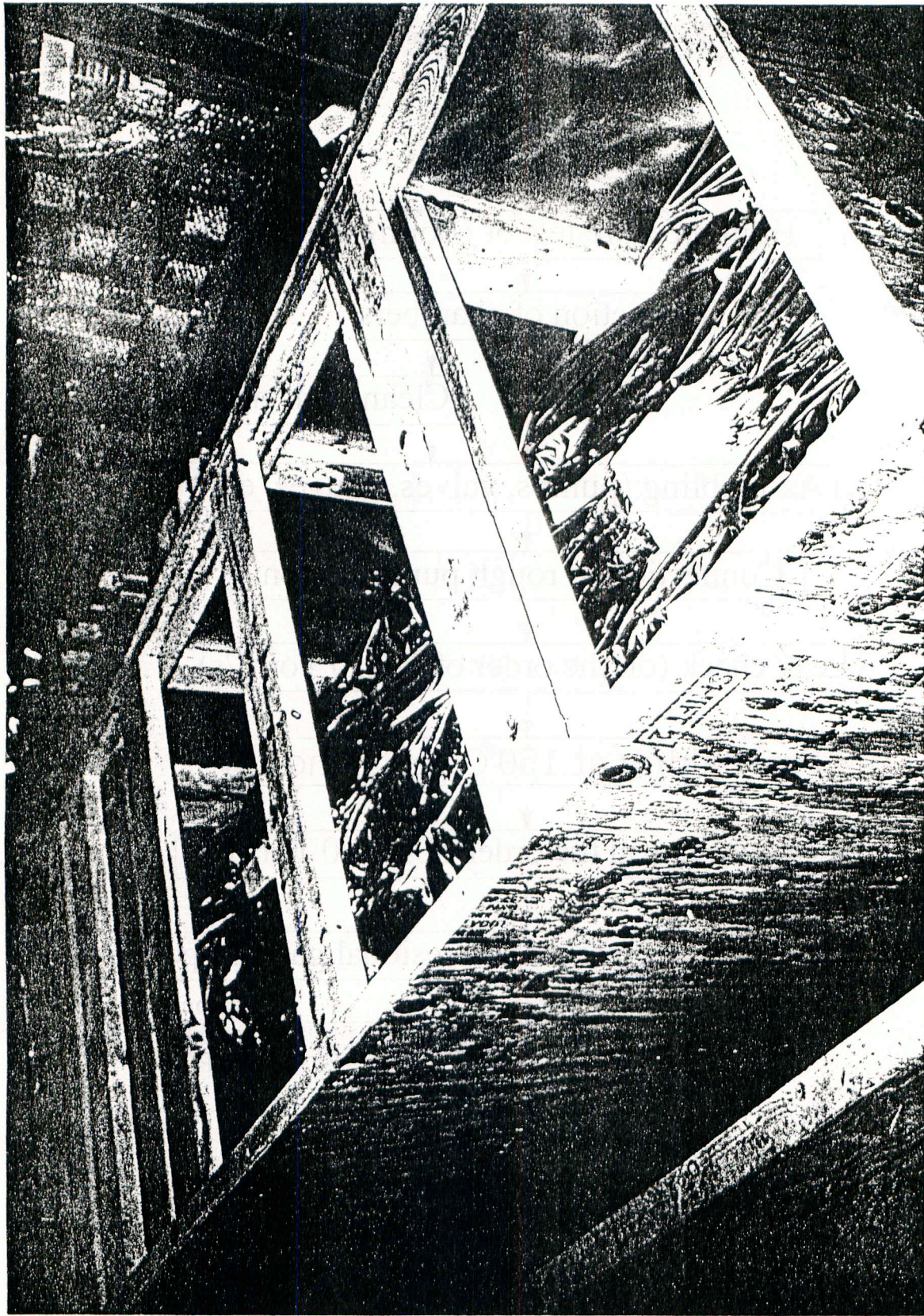


HER bellows chamber

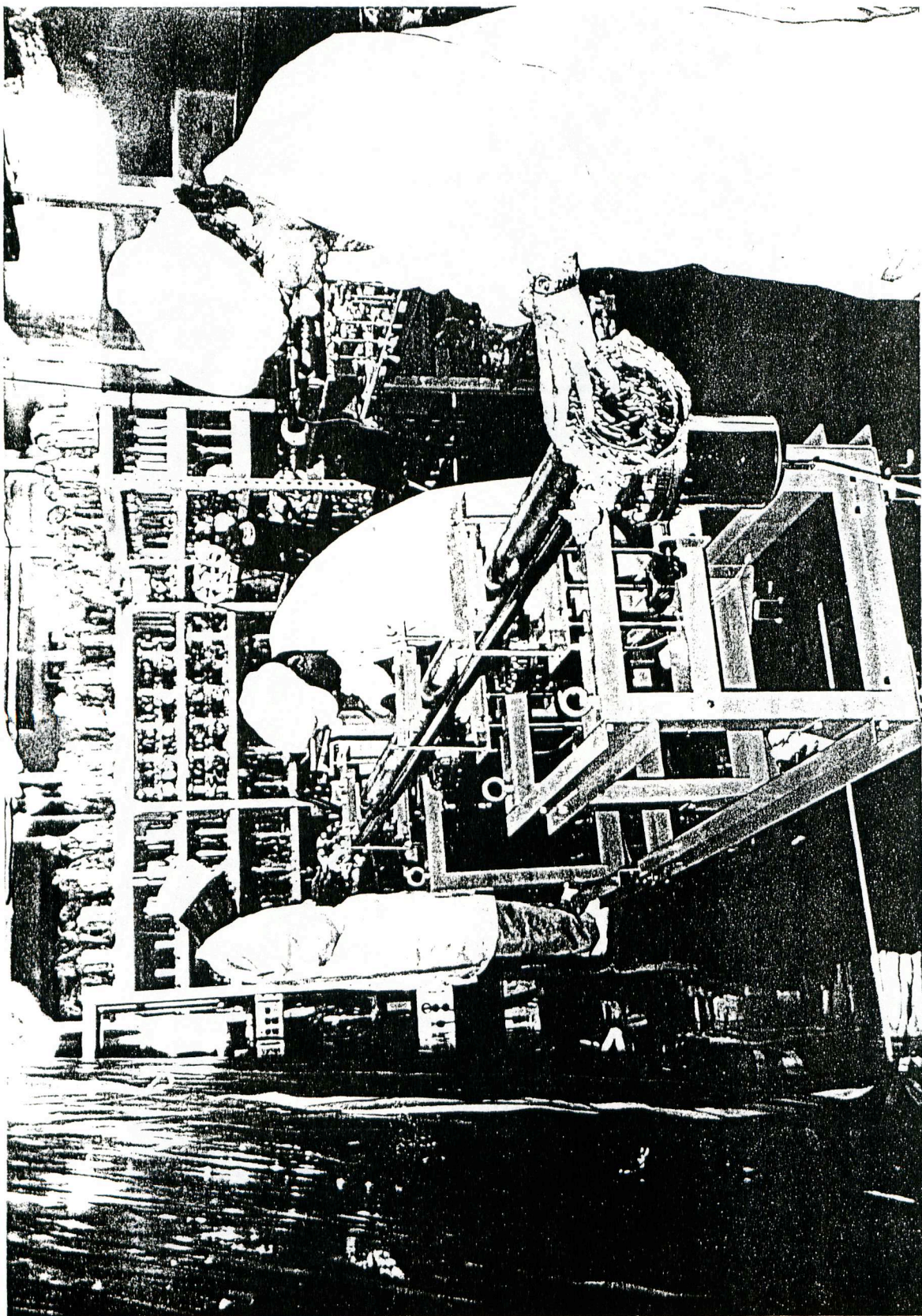
Installation

Basic flow of the receiving work

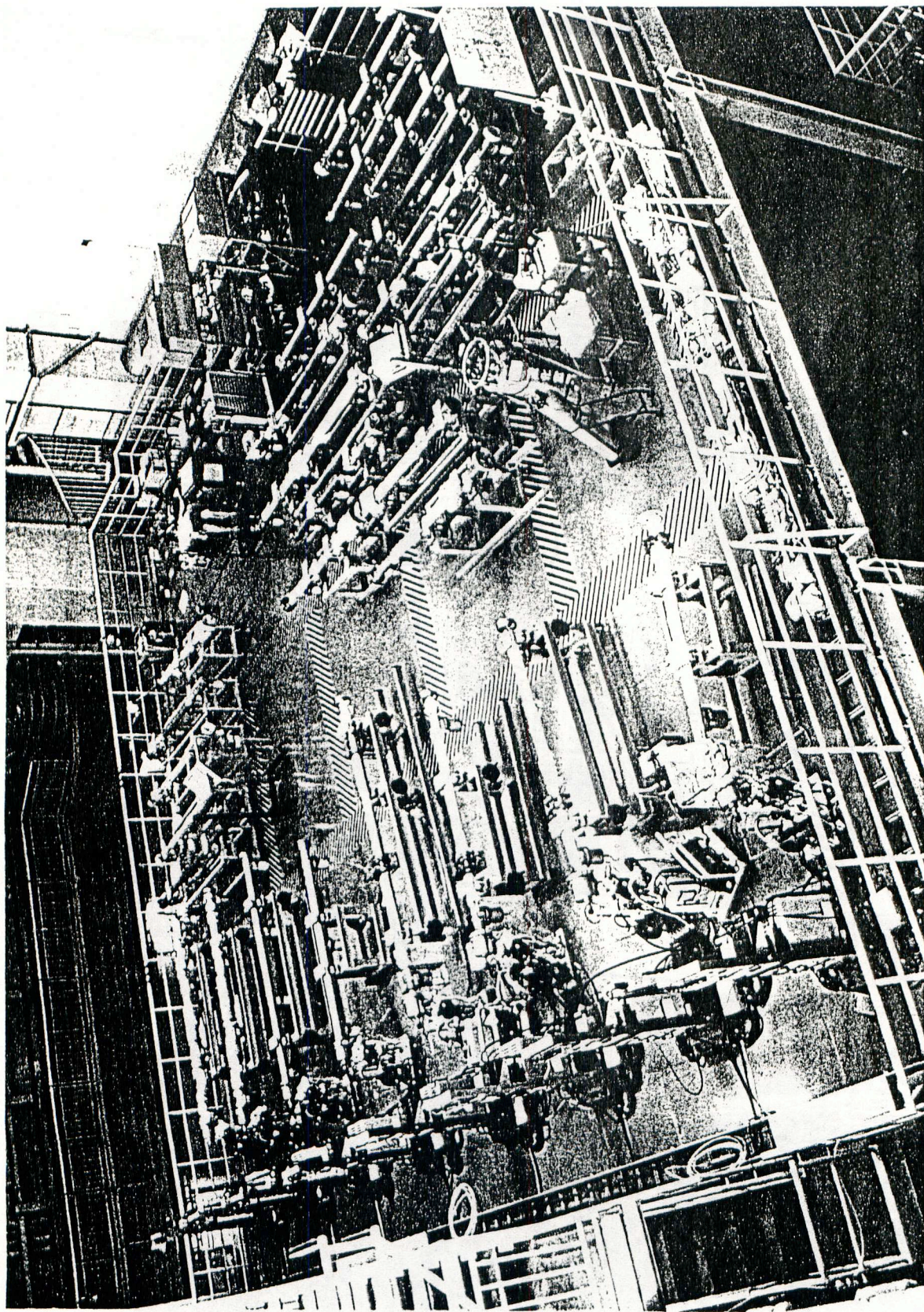




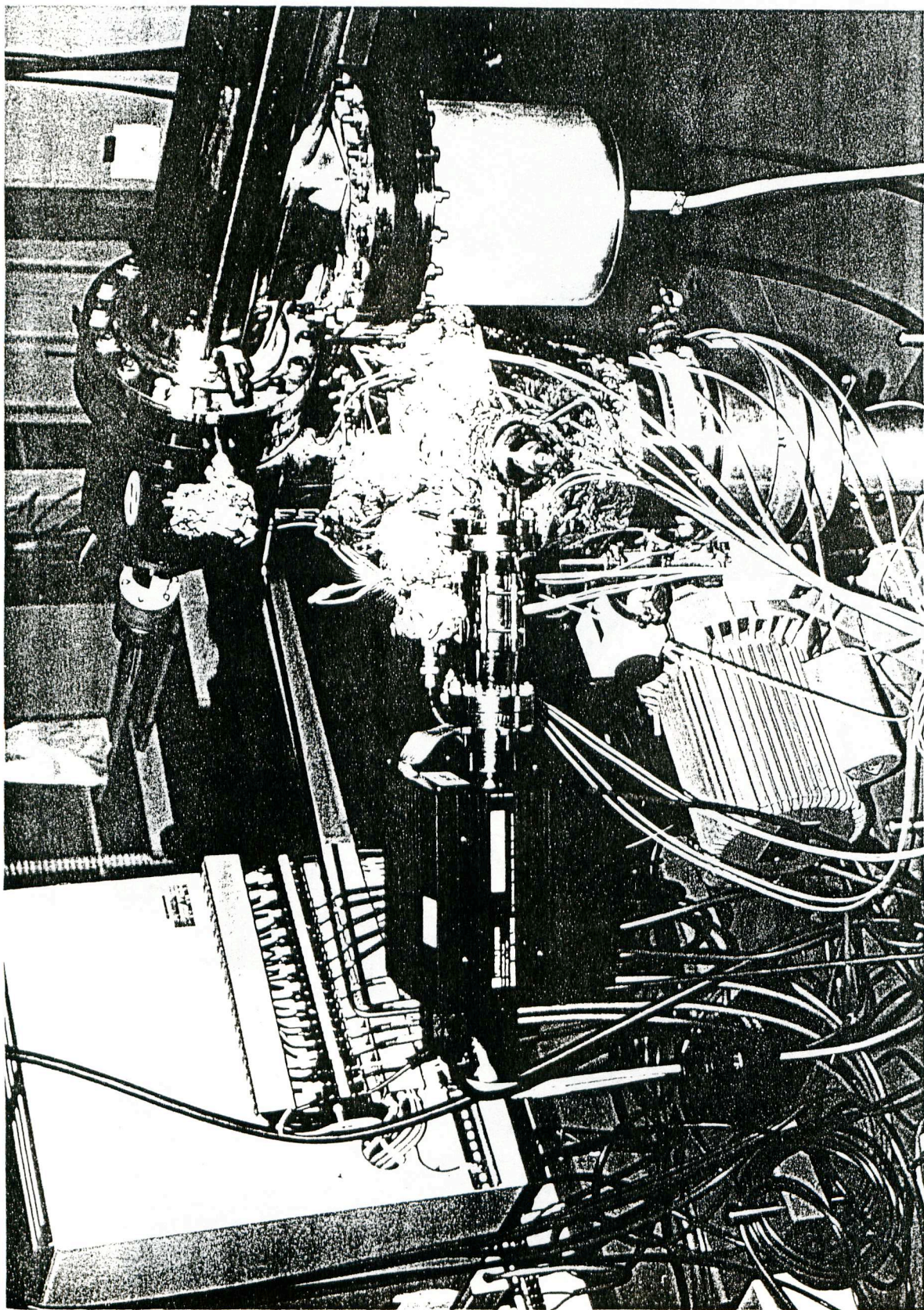
Container for transportation
(Chamber is filled with dry nitrogen)



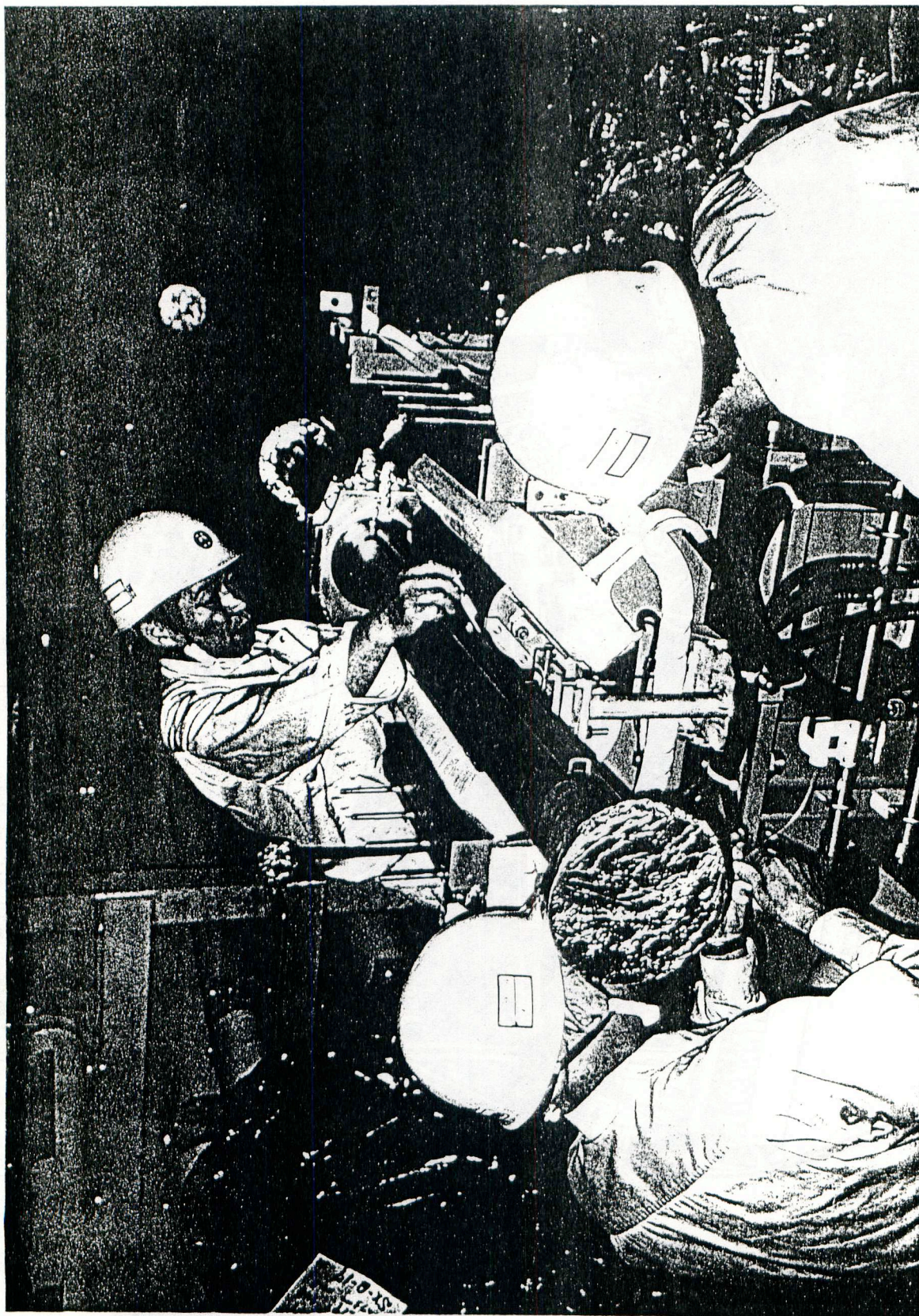
Assembling in the clean room



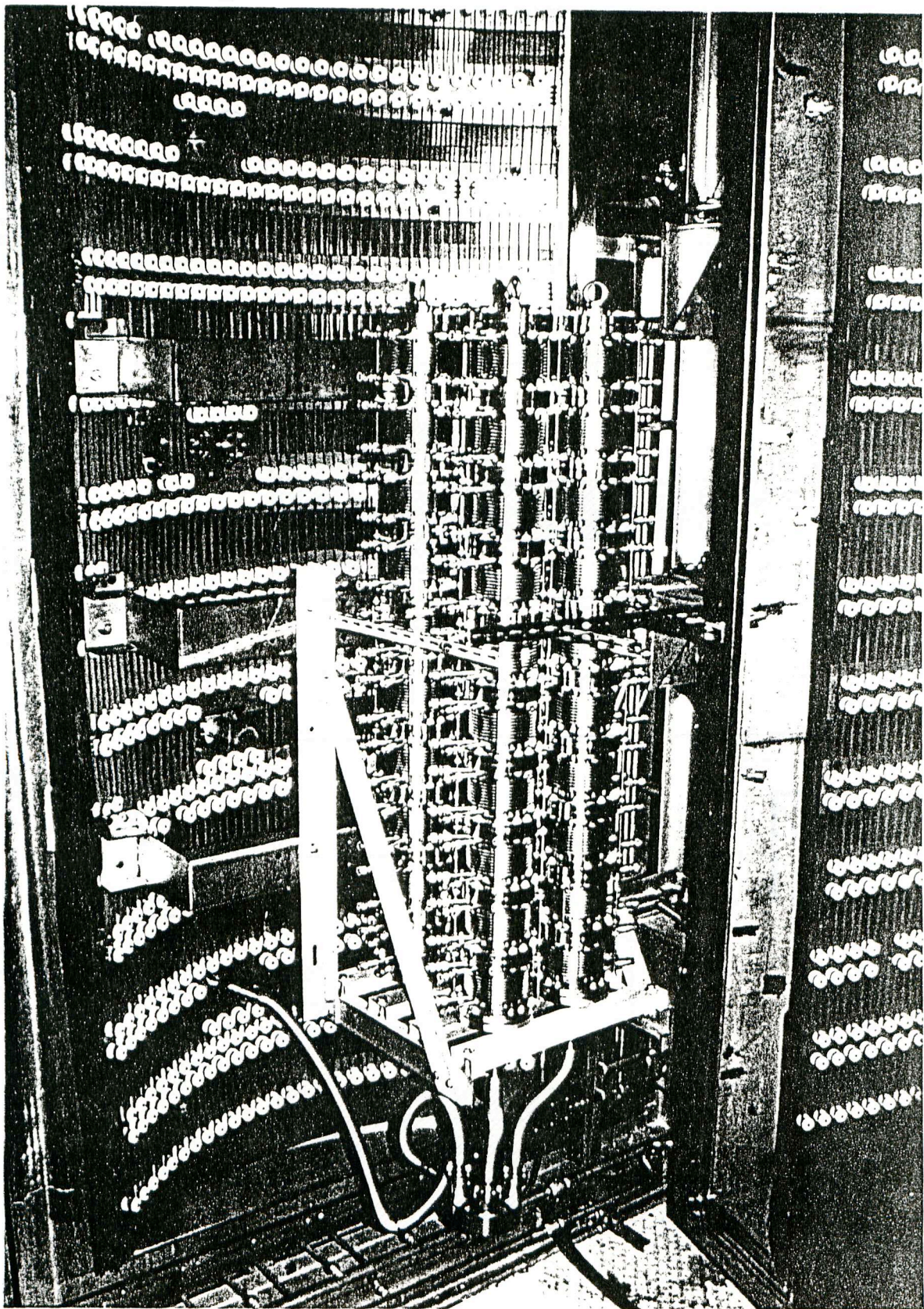
Stations for leak check and pre-bake



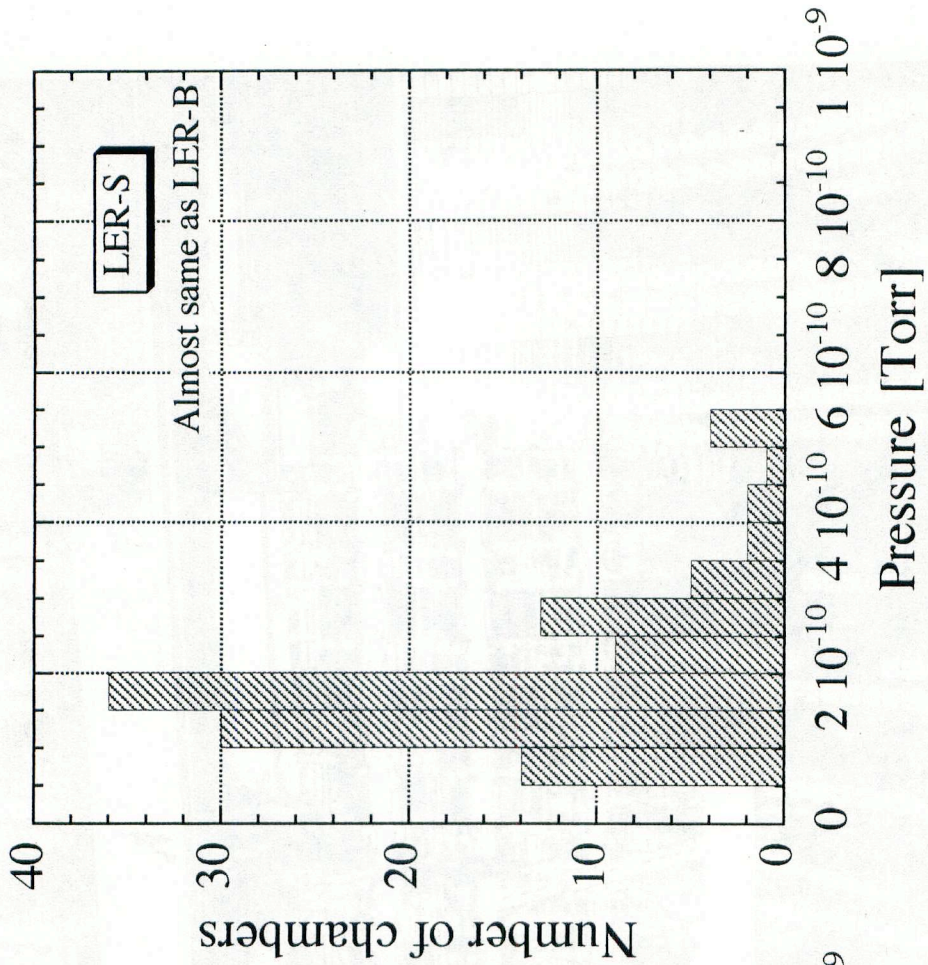
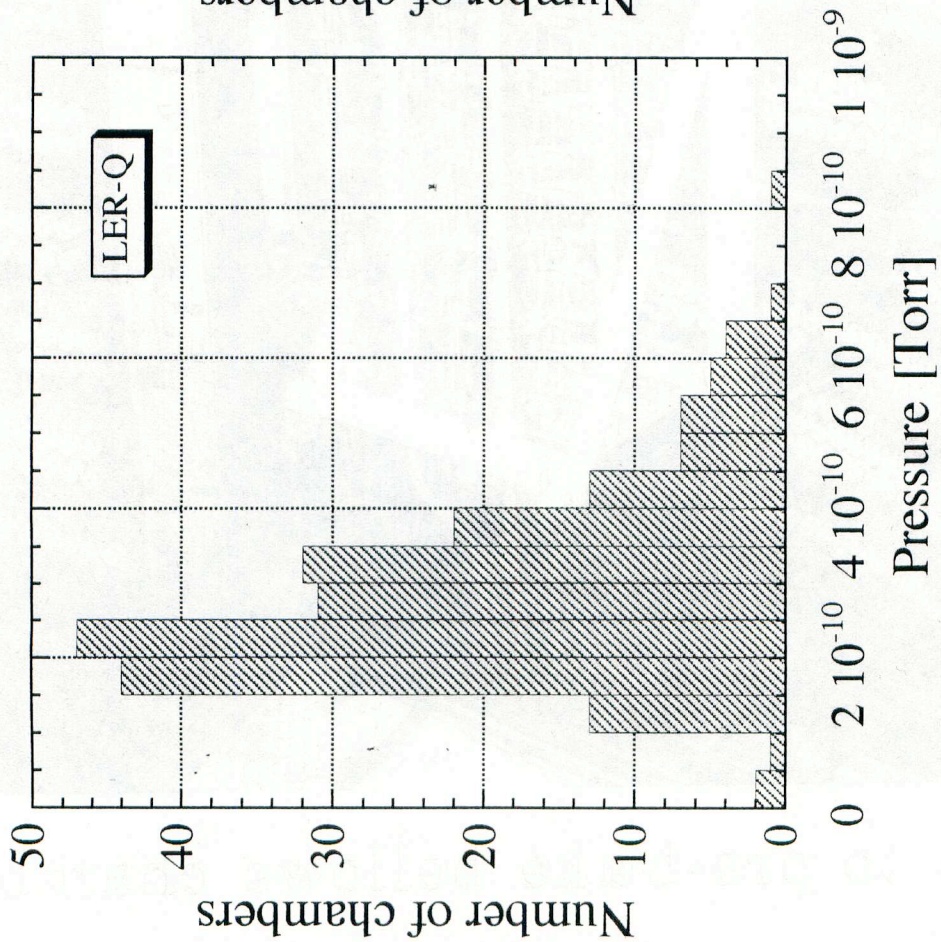
A rough pumping system
Completely oil free



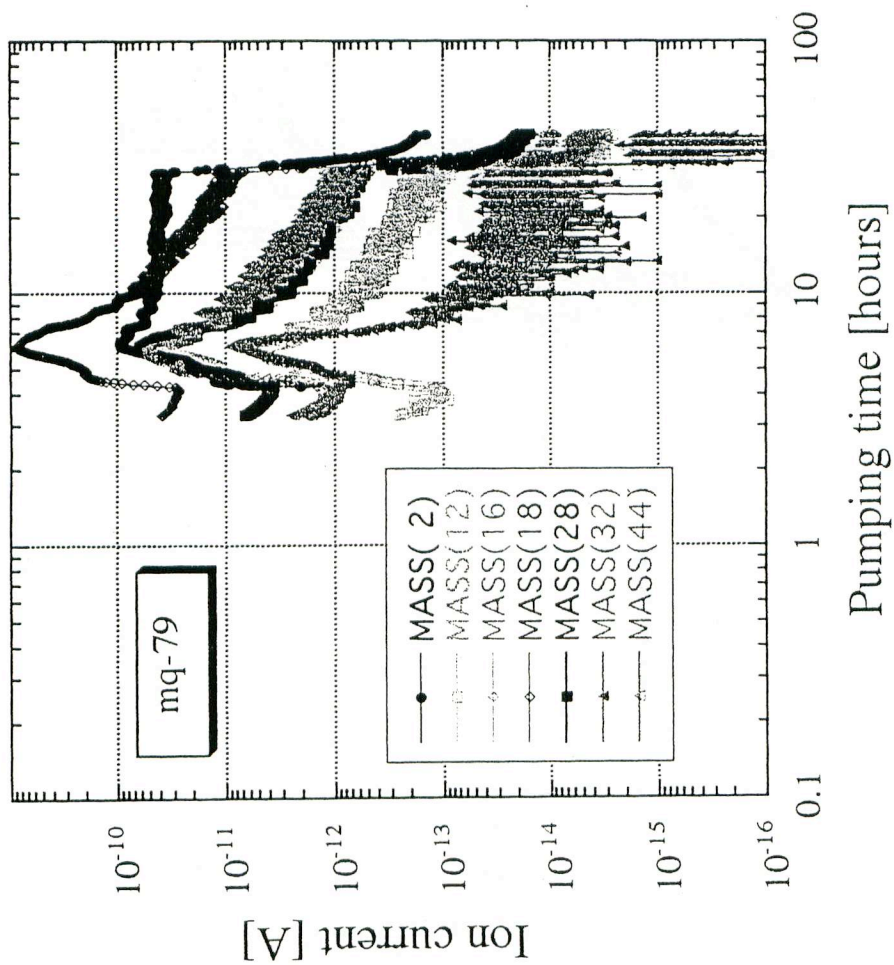
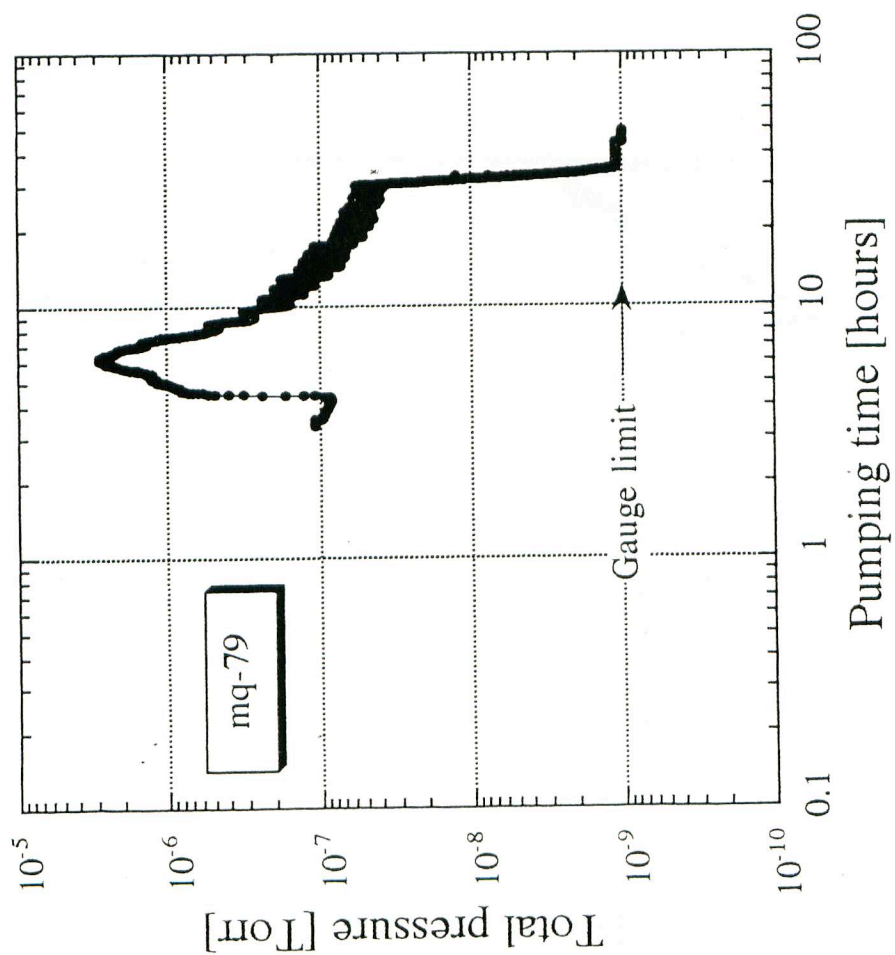
Installation of chamber (Q)



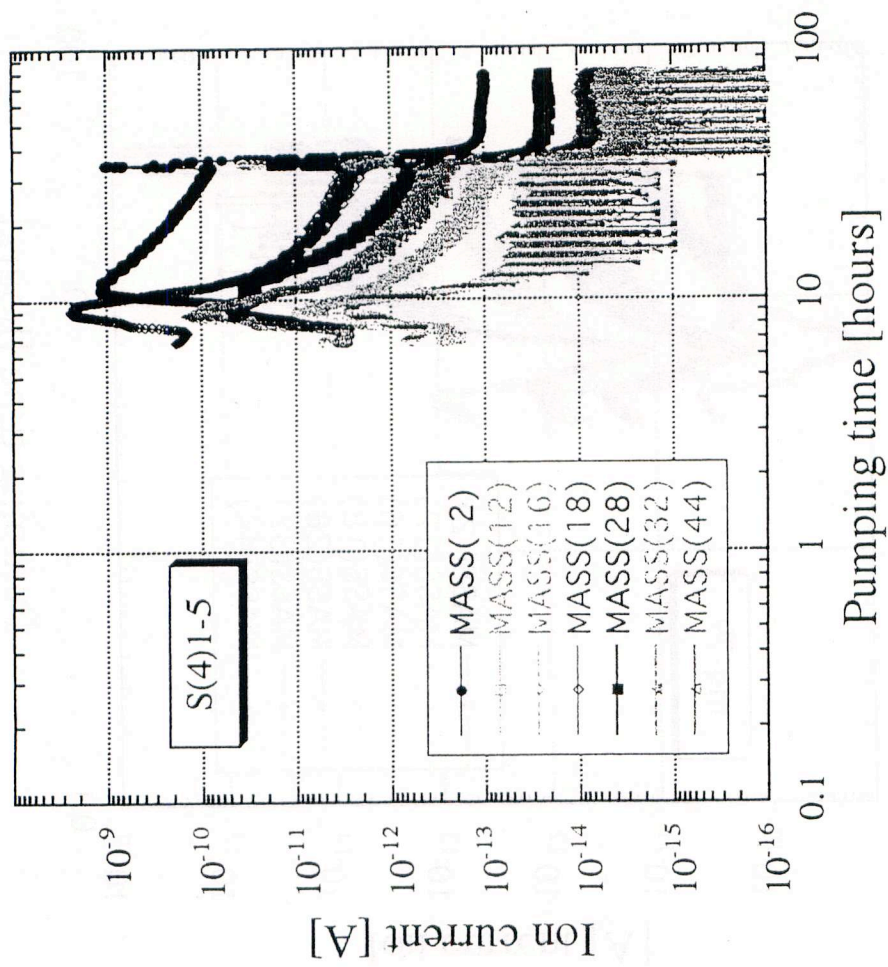
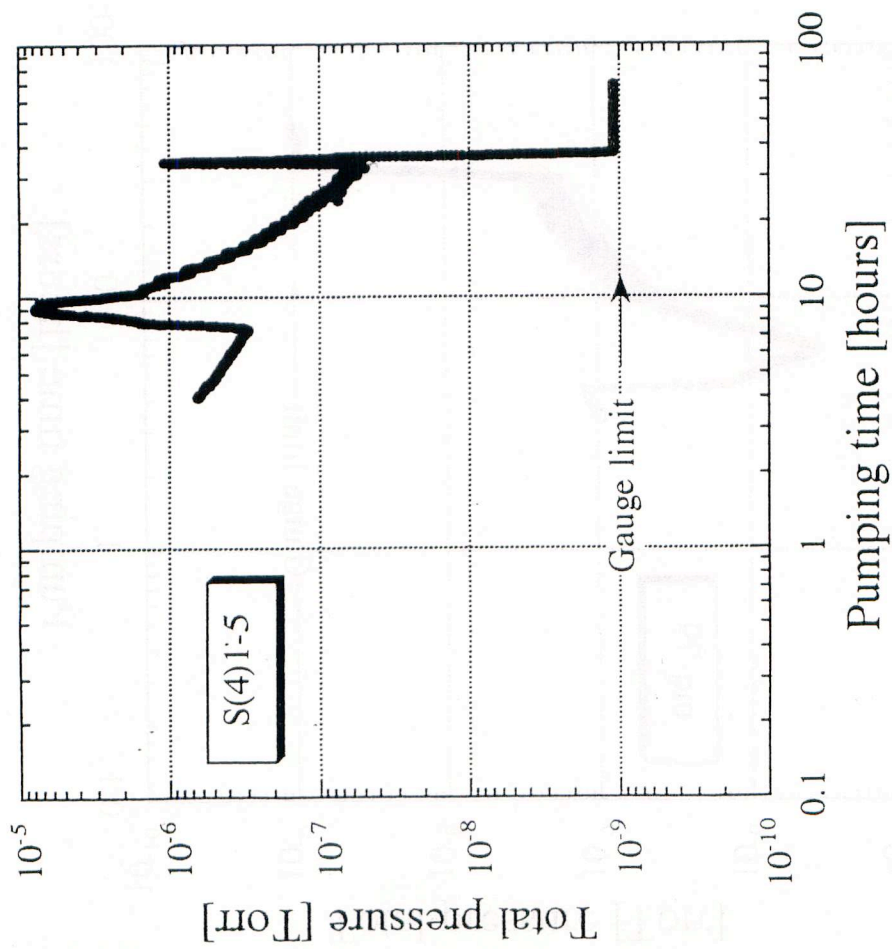
Furnace to pre-bake bellows chambers



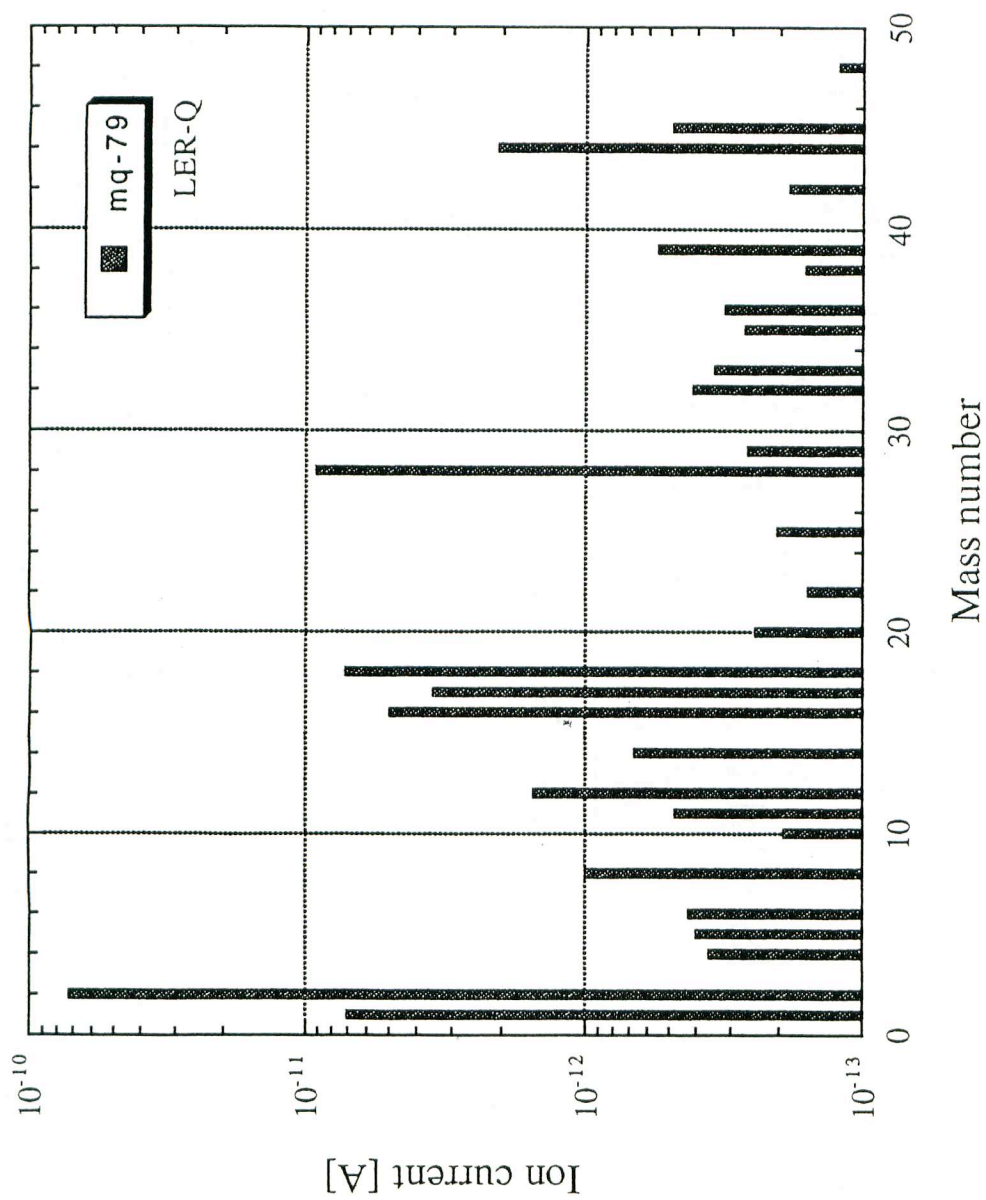
Ultimate pressure after the pre-bake (150deg., 24hours)



Typical pumping down curve of Q chamber



Typical pumping down curve of S chamber



Typical example of residual gas components
after the pre-bake

Present status

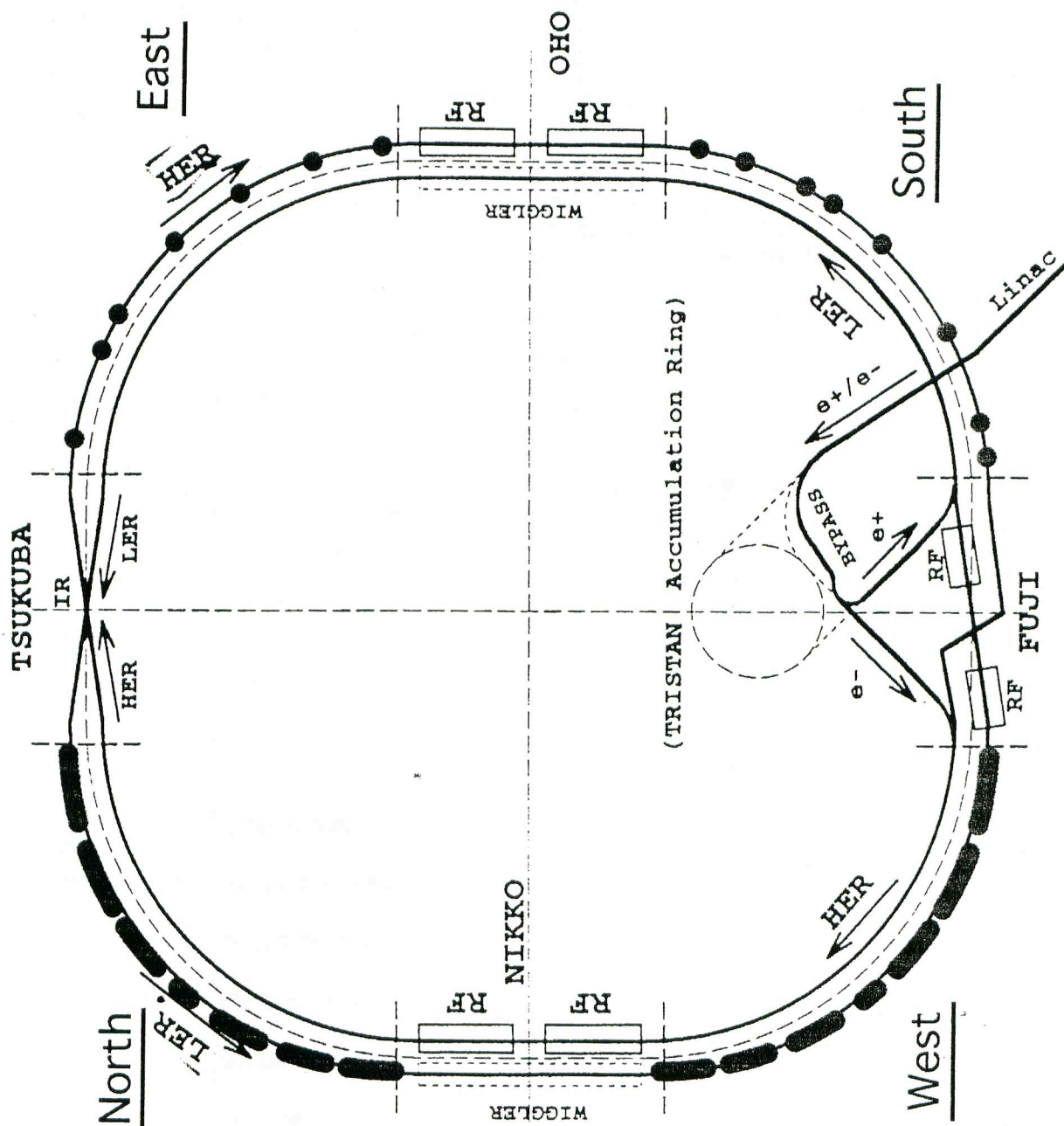
Number of received and Installed chambers

at the end of February .

	Received		Installed	
LER Chambers [Arc]				
Q	338	99%	169	50%
B	52	46%	52	46%
S	170	61%	83	30%
[Straight] ,				
Q	0	0%	0	0%
Others	4	2%	0	0%
HER Chambers [Arc]				
Q	128	37%	15	4%
B	9	8%	0	0%
S	52	22%	0	0%
[Straight]				
Q	0	0%	0	0%
Others	0	0%	0	0%
Total	763	37%	319	15%
Bellows chambers	1800	90%	0	0%

The diagram illustrates the TRISTAN Accelerator Ring, a circular particle accelerator. The ring is divided into four quadrants: North, South, East, and West. Key components and locations are labeled as follows:

- North Quadrant:** Contains two RF (Radio Frequency) cavities and a WIGGLER. The location **NIKKO** is marked.
- South Quadrant:** Contains two RF cavities and a WIGGLER. The location **OHO** is marked.
- East Quadrant:** Contains two RF cavities and a WIGGLER. The location **TSUKUBA** is marked.
- West Quadrant:** Contains two RF cavities and a WIGGLER. The location **FUJI** is marked.
- Central Region:** Labeled **(TRISTAN Accumulation Ring)**, showing a dashed circle representing the accumulation ring and a solid line for the **BRASS** detector.
- Injection and Extraction:** A **Linac** (Linear Accelerator) is shown entering from the top right, with arrows indicating the flow of e^- (electrons) and e^+ (positrons).
- Beam Paths:** Arrows labeled **HER** (High Energy Ring) and **LER** (Low Energy Ring) indicate the direction of the beams.



Sum of received and installed chambers so far

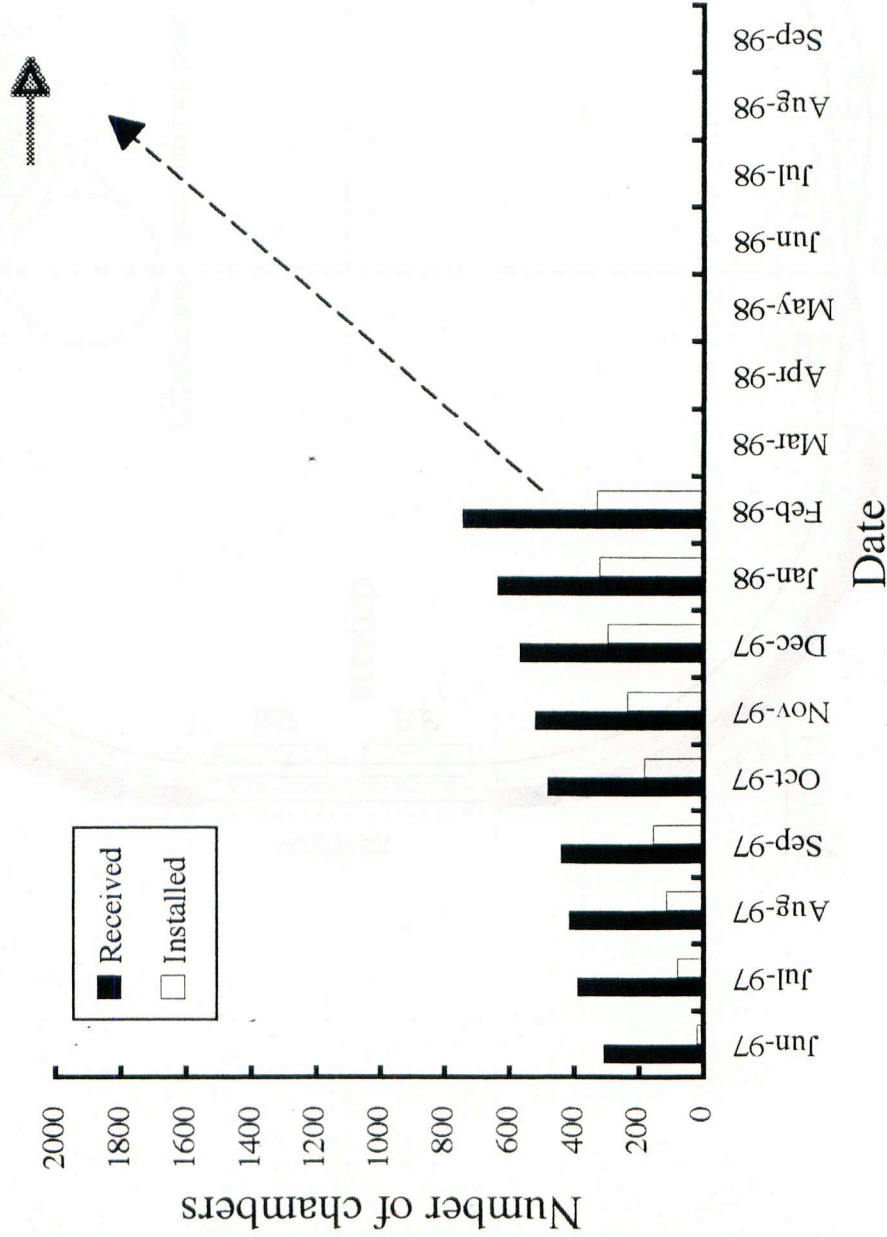
The delay of the delivery schedule is larger than half a year.
The delivery seems to go smoothly at last.

How to deal with about 200 chambers/month?
(about 10 chambers/day)

Most serious problem of the vacuum system at present.

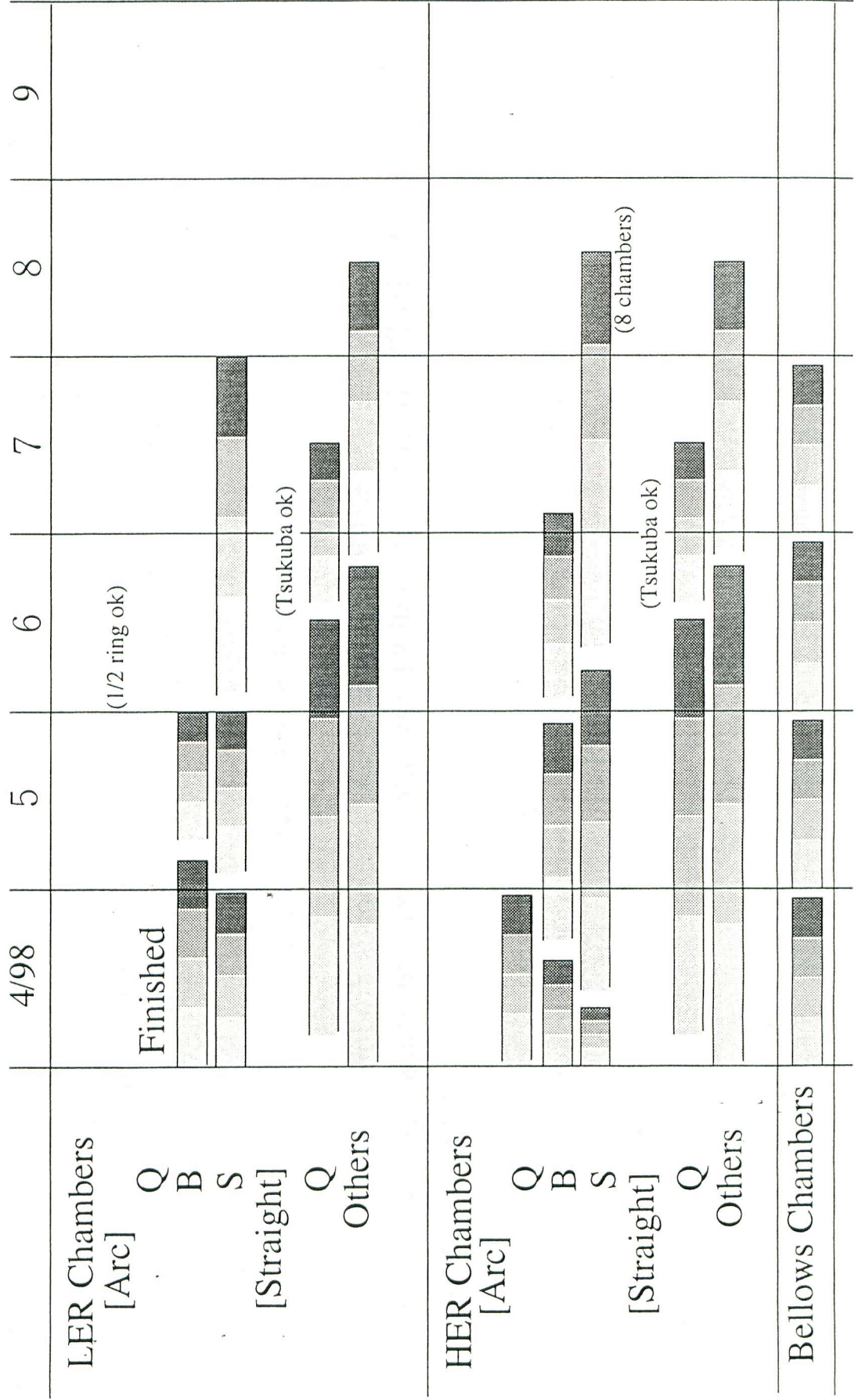
We are now trying to

- Increase the workers.
 - Expand the working area.
 - Raise the efficiency of receiving work.
- ex. Shorten the pre-bake time



Schedule

Delivery schedule

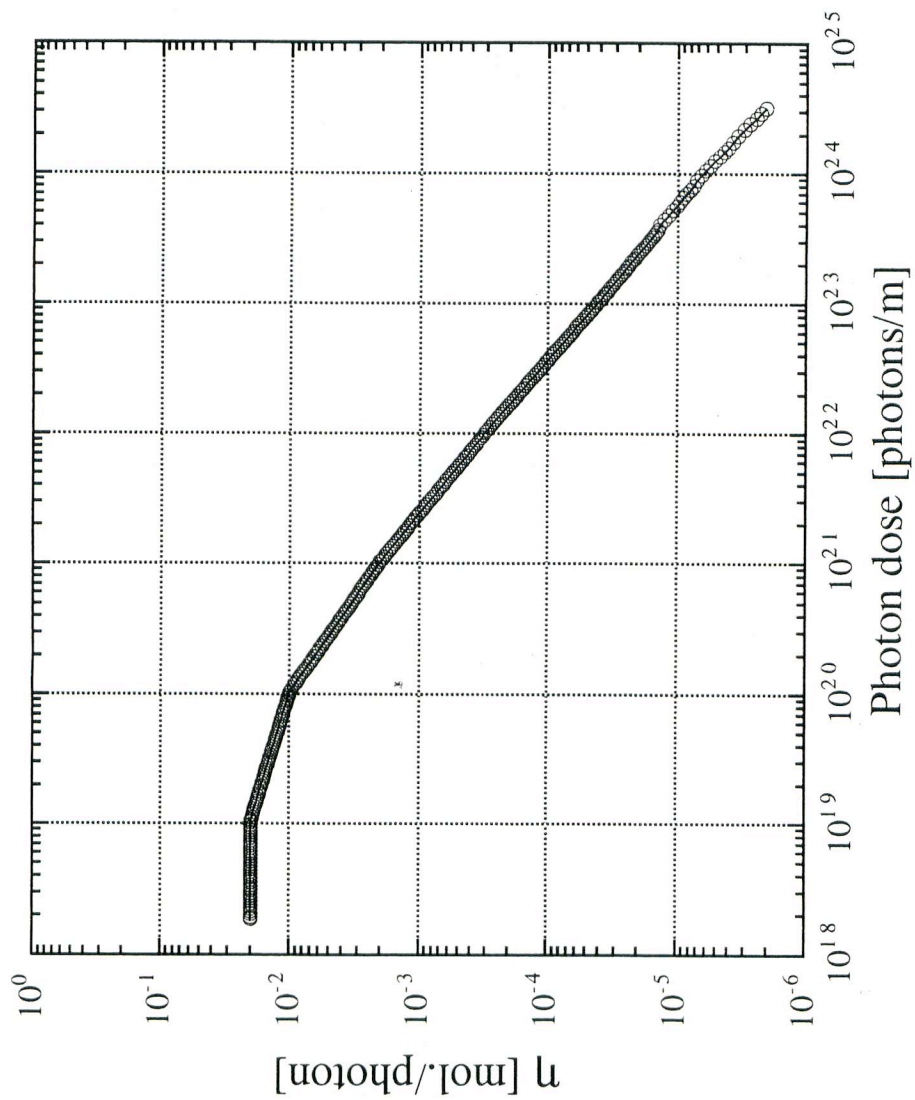


Commissioning of vacuum (simulation)

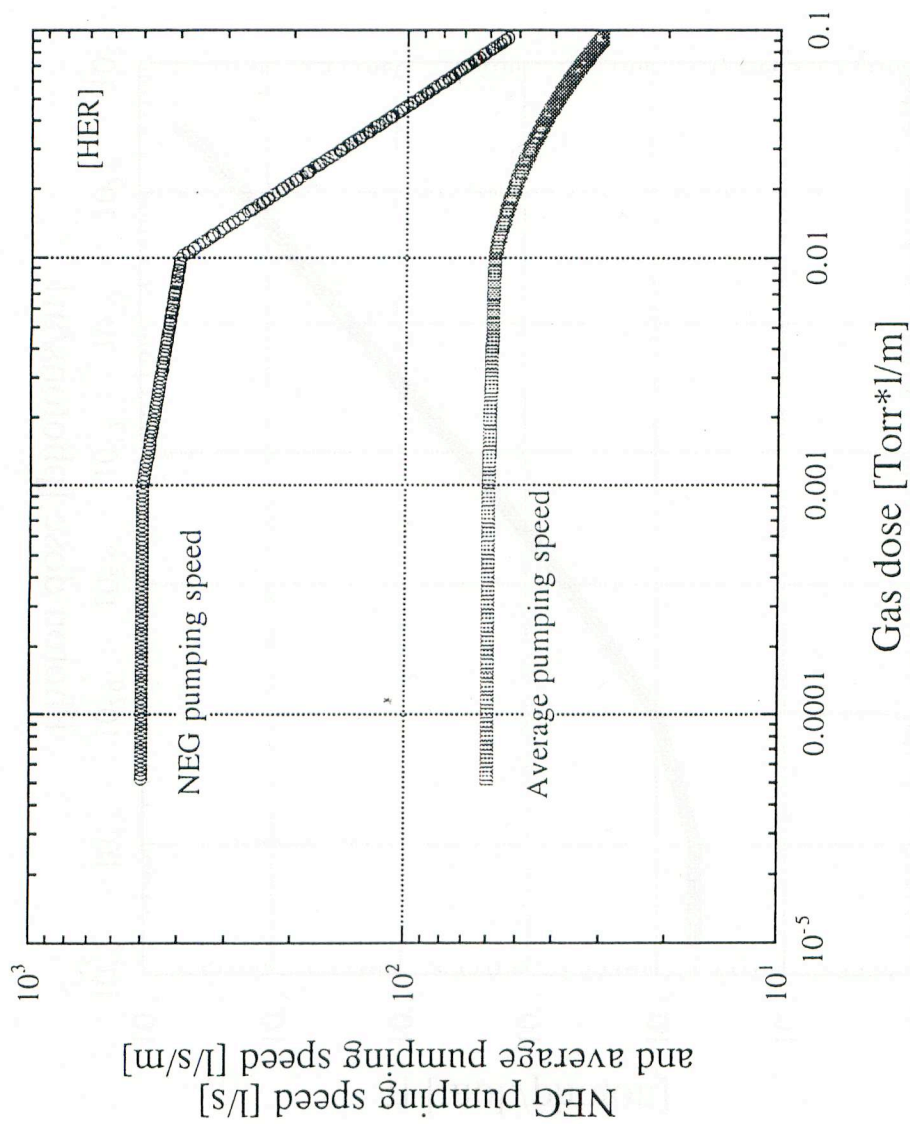
Assumptions

- (1) Photo-desorption coefficient η [molecules/photon]
Based on our experimental results of the R&D of copper chamber performed in Accumulation Ring (KEK)
- (2) NEG pumping speed
Initial pumping speed of NEG in itself : 500 l/s/m (for both LER and HER)
Initial average pumping speed LER: 70 l/s/m
 HER: 60 l/s/m

Activation : When the NEG absorbed gas of about 0.1 Torr l/m.
- (3) Beam current
The beam current starts at 1/5 of the full current. (ex. 520 mA for LER)
The beam current increases by 1/5 of the full current
when the lifetime reaches 10 hours.
- (4) Relation between the beam lifetime and the pressure
Beam lifetime $\times$ Pressure = 4×10^{-8} [Torr $\cdot$ hours]
Main gases are CO and CO₂



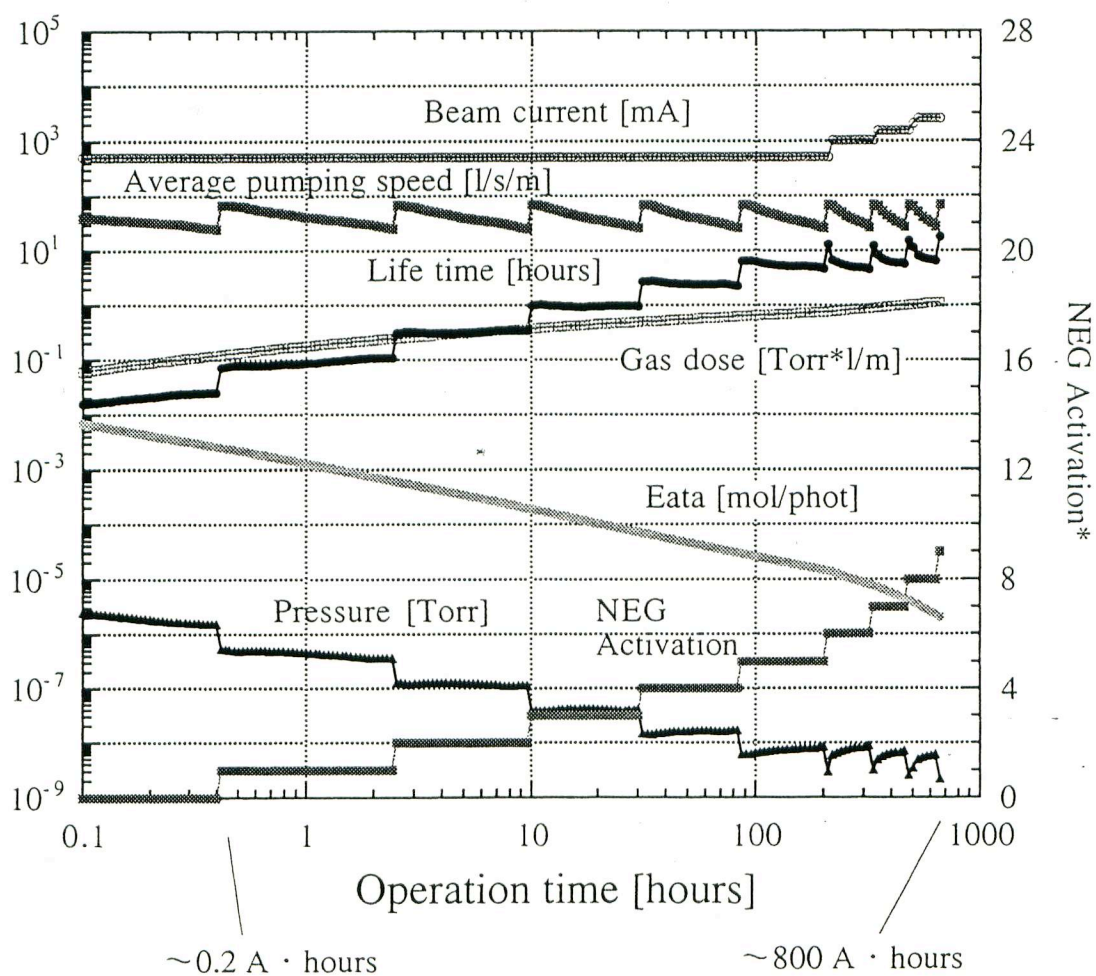
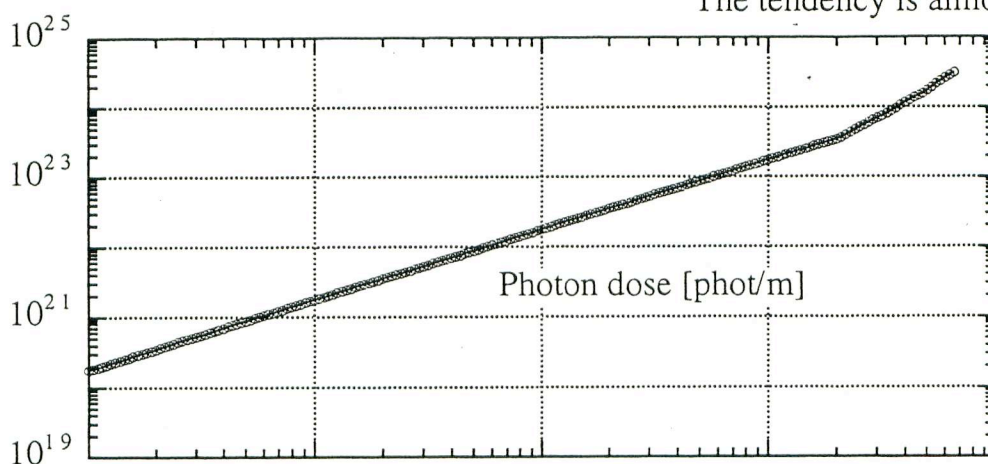
Assumed η [molecules/photon] for the simulation



NEG pumping speed vs absorbed gas used for the simulation.

Result for LER

The tendency is almost same as HER.



*Ion pumps were neglected
Activation was done independent of the life time.