

Overview of KEKB Accelerator system

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March 8, 1999

KEKB Accelerator Review

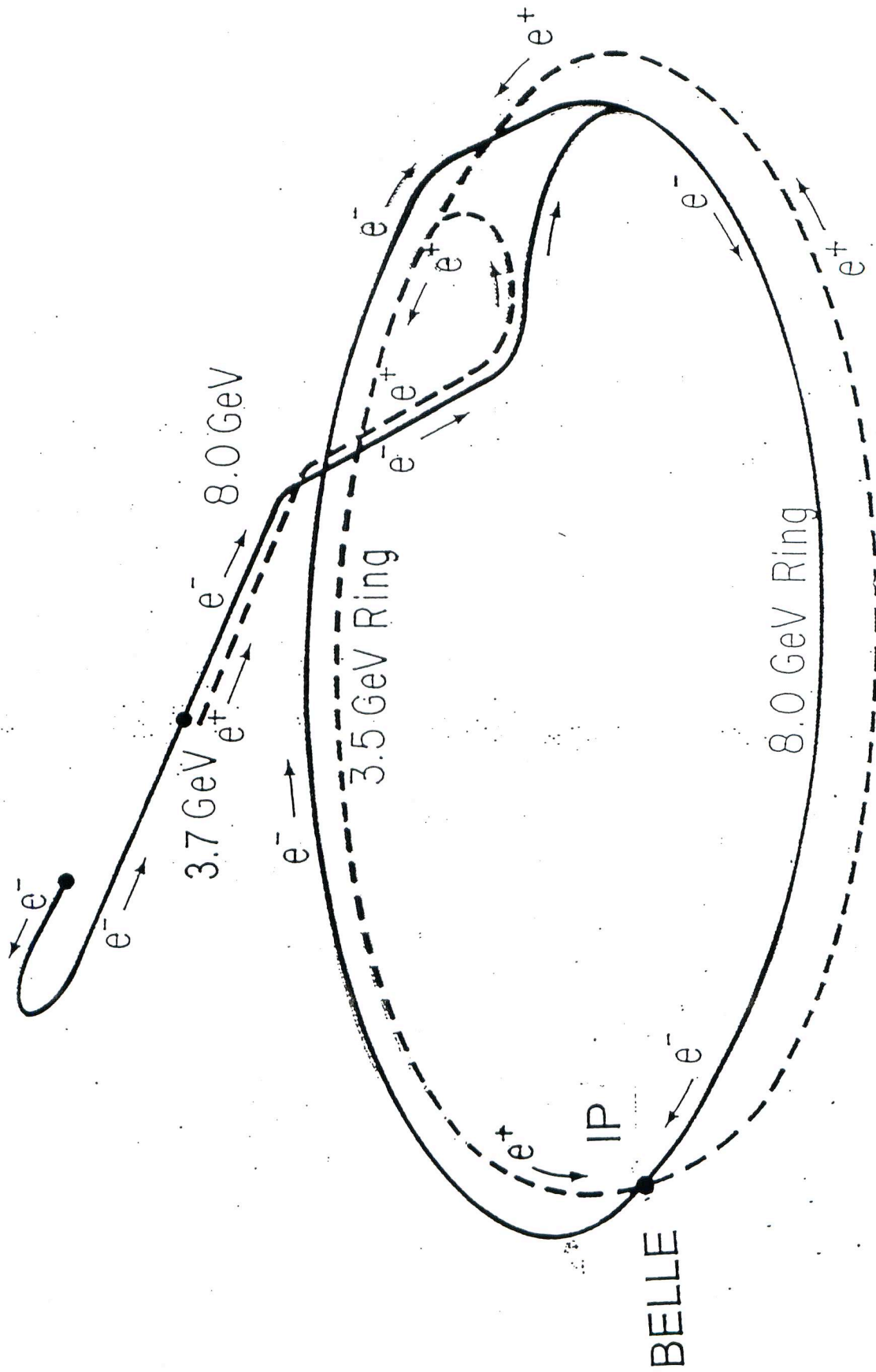
KEK B-Factory(KEKB)

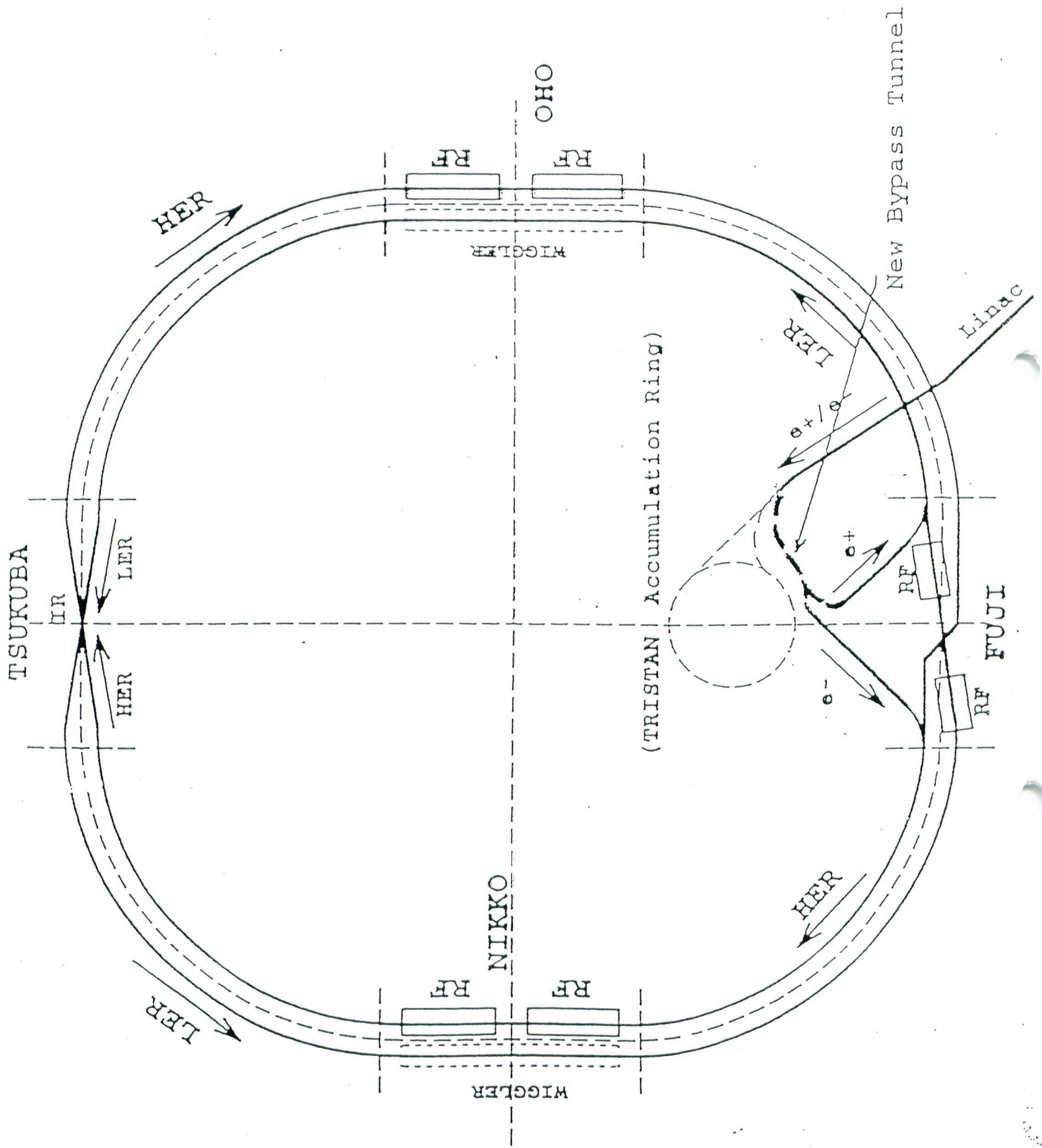
**3.5 GeV(e^+) x 8 GeV(e^-)
2-ring, asymmetric collider**

**design luminosity
 $1 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$**

Features:

- 5-year project (94-98)**
- budget 380×10^8 yen**
- in TRISTAN tunnel**
- BELLE at IP**
- finite-angle crossing of
 2×11 mrad at IP**
- crab crossing scheme (*future*)**



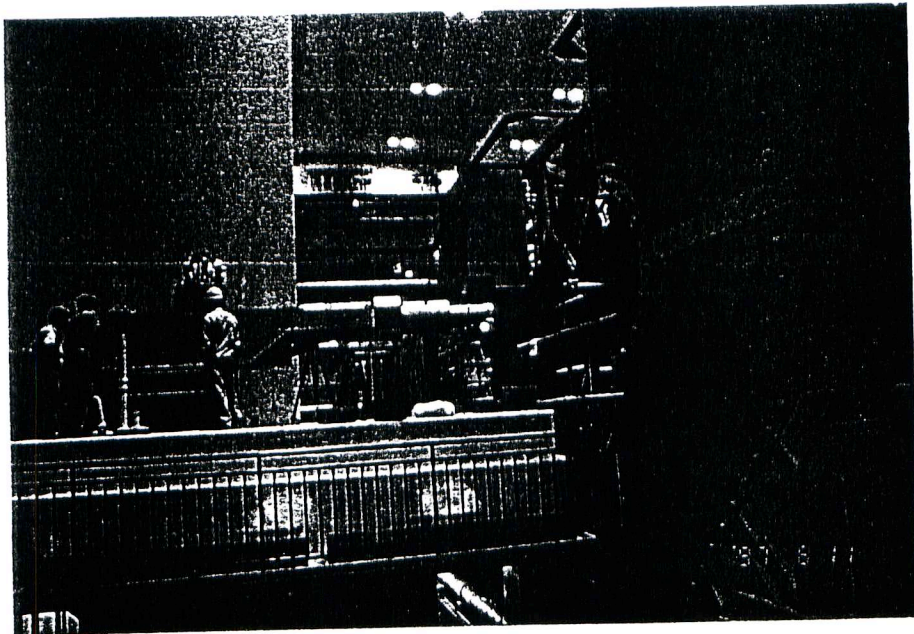


KEKB Parameters

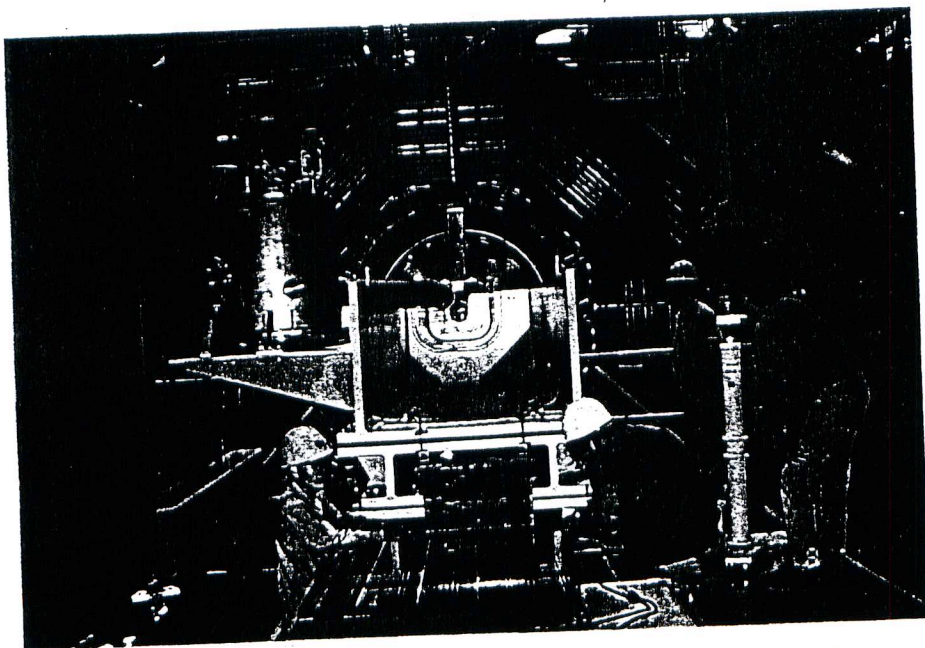
- 3.5 GeV(e^+) x 8 GeV(e^-)
- 3016 m circumference
- Luminosity $10^{34} \text{cm}^{-2} \text{s}^{-1}$
- Beam-beam tuneshift $\xi = 0.05$
- $\beta_y^* = 1 \text{ cm}$
 $\sigma_x = 90 \mu\text{m}, \sigma_y = 1.9 \mu\text{m}$
- Currents 1.1 A(e^-), 2.6 A(e^+)
- 5000 bunches with 0.6 m spacing
- Crossing at $2 \times 11 \text{ mrad}$ at IP

Progresses

- 98/1-3** Superconducting final-focus quads completed and field measurement with BELLE solenoid
- 98/5-6** Commissioning of fully upgraded linac (3.5-GeV e^+ and 8-GeV e^-). 3.5-GeV e^+ transported half-way to KEKB ring
- 98/11/30** HER and LER completed



BELLEとQCS(超伝導収束電磁石)



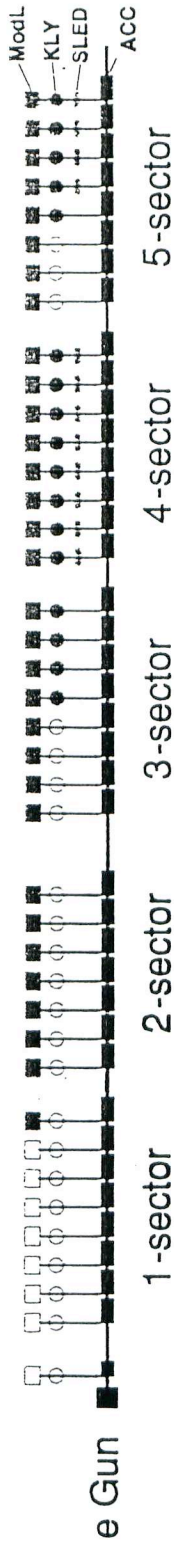
QCSとBELLE超伝導ソレノイド

Linac Upgrade

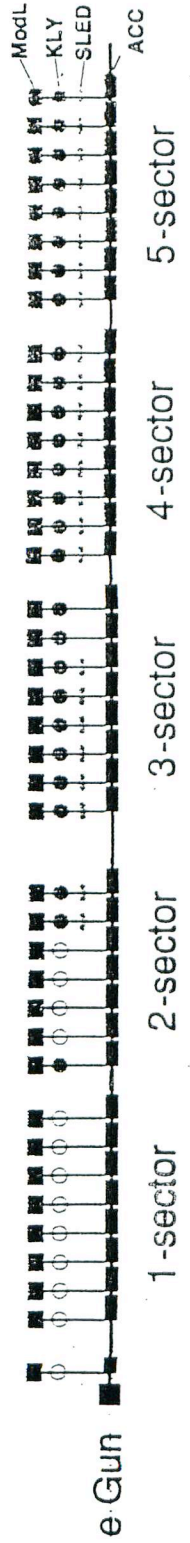
- **2.5 GeV -> 8 GeV**
- **I- linac -> J-linac**
- **Increasing e^+ yield by factor 20 by making the e^- energy at e^+ production target from 0.2 -> 3.7 GeV)**
- **In May-June 1998 fully upgraded linac has been successfully commissioned**
- **Linac is supplying beams to KEKB**

- High Power RF Modulator
- Ordinary RF Modulator
- High Power Klystron
- Ordinary Klystron
- Accelerating Unit
- SLED

1996 Jul.



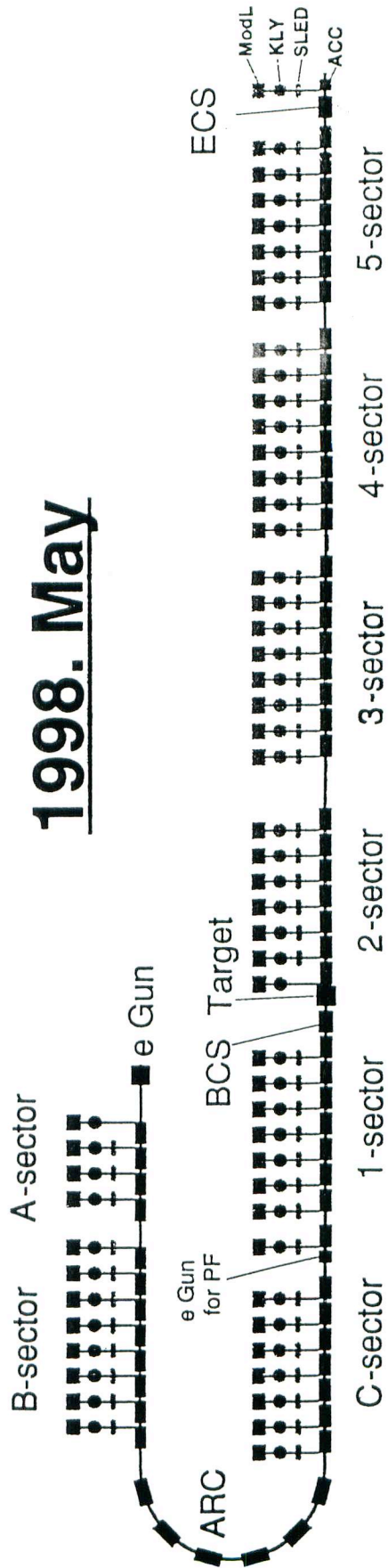
1997 Jan.

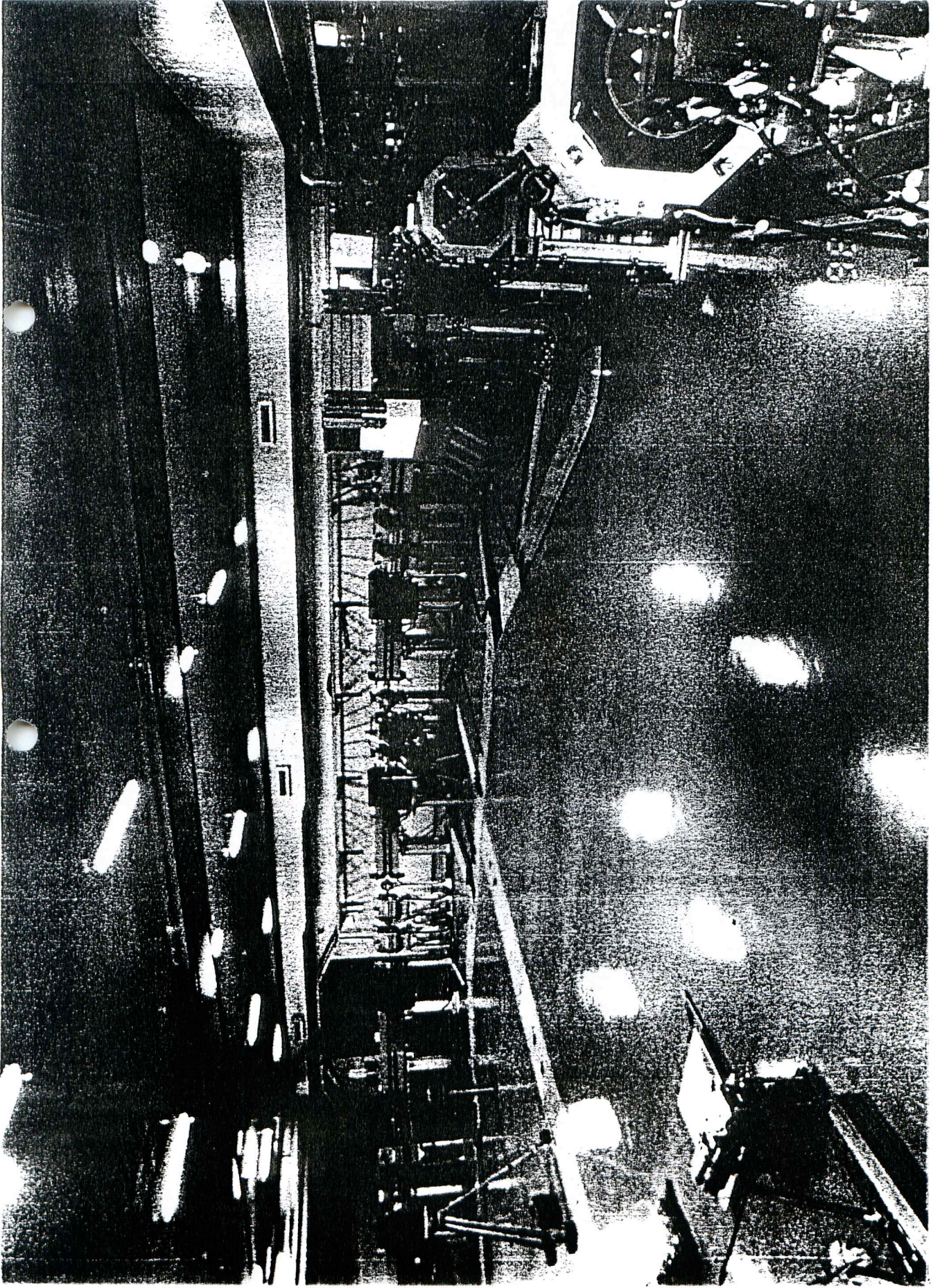


1998. Mar

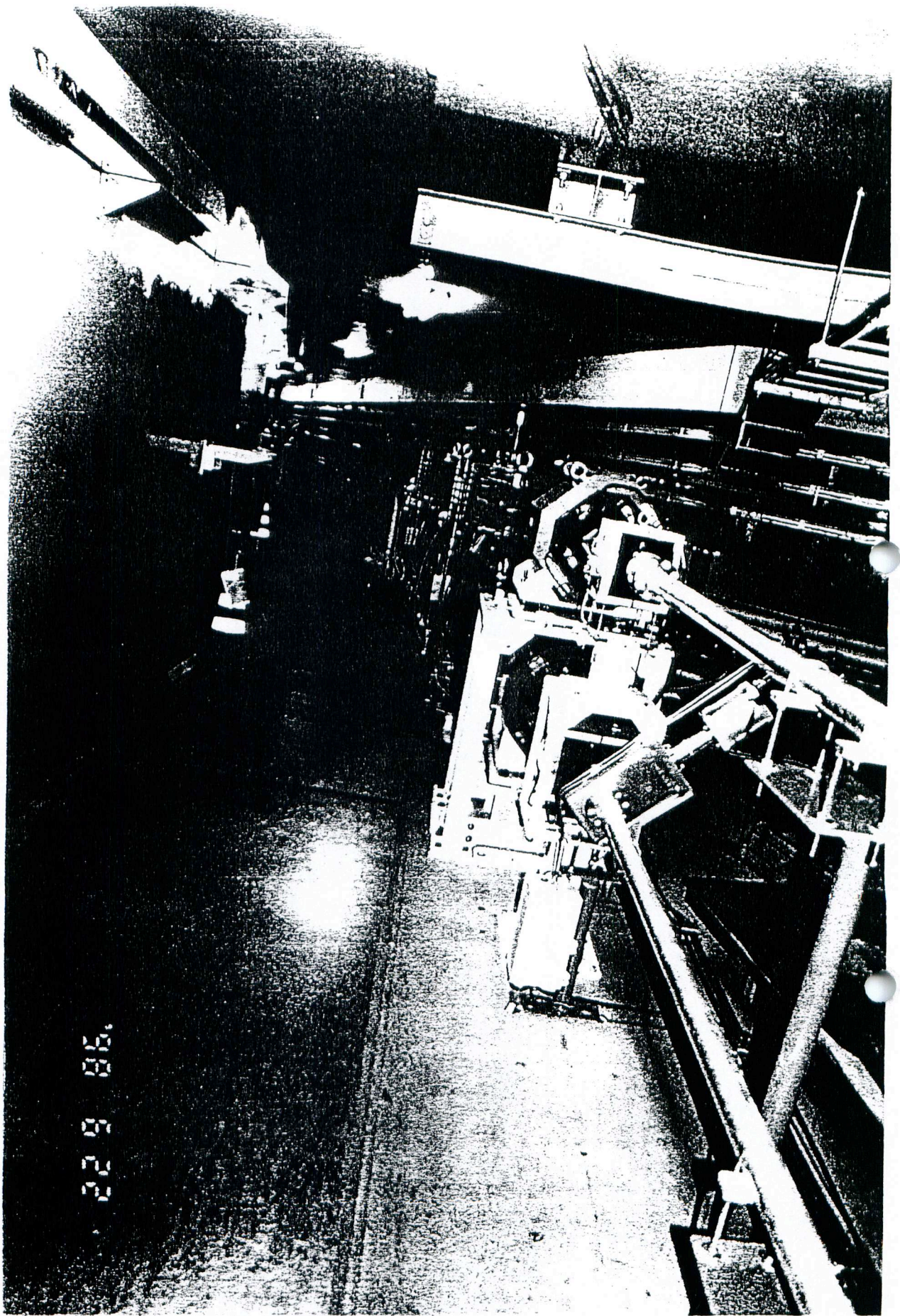


1998. May

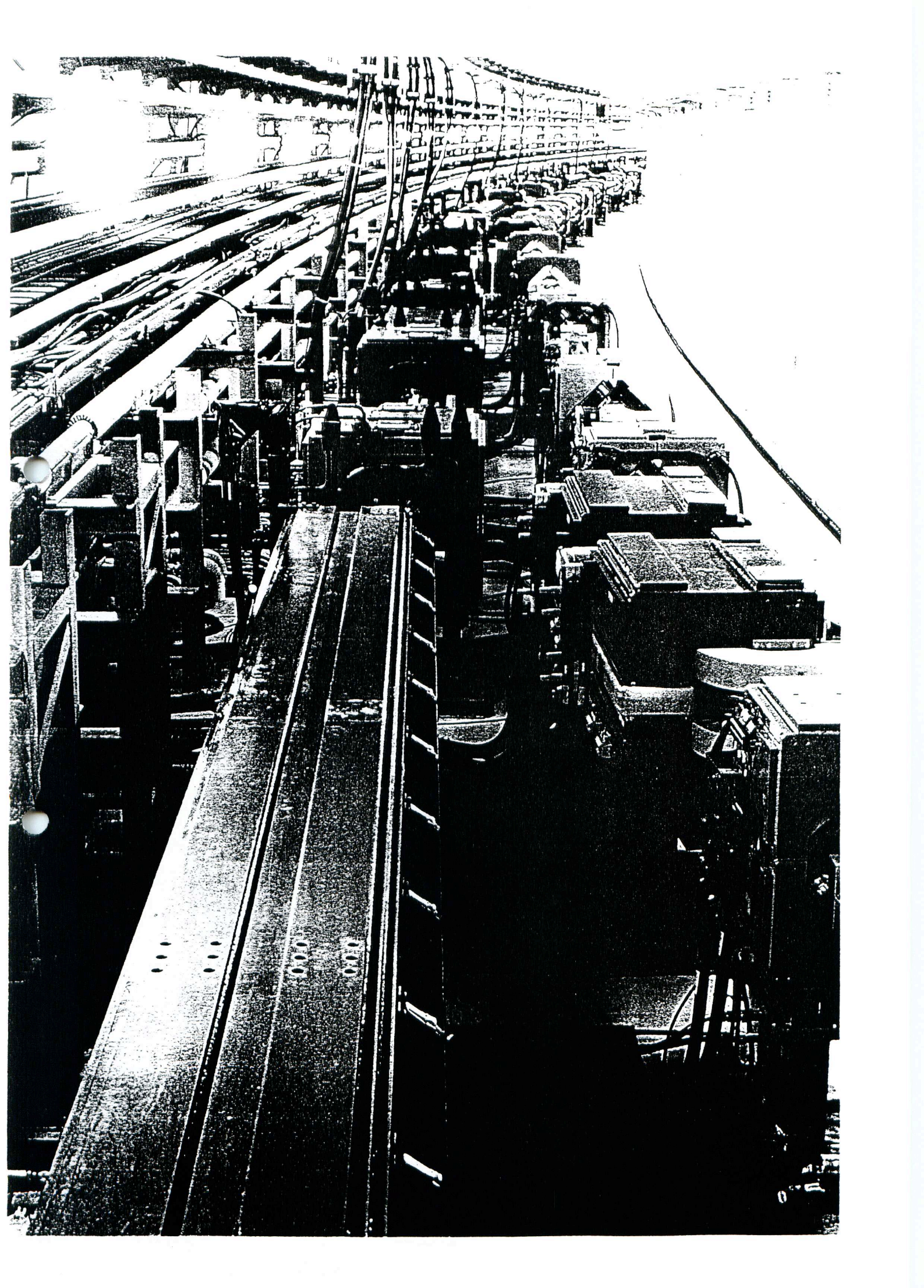


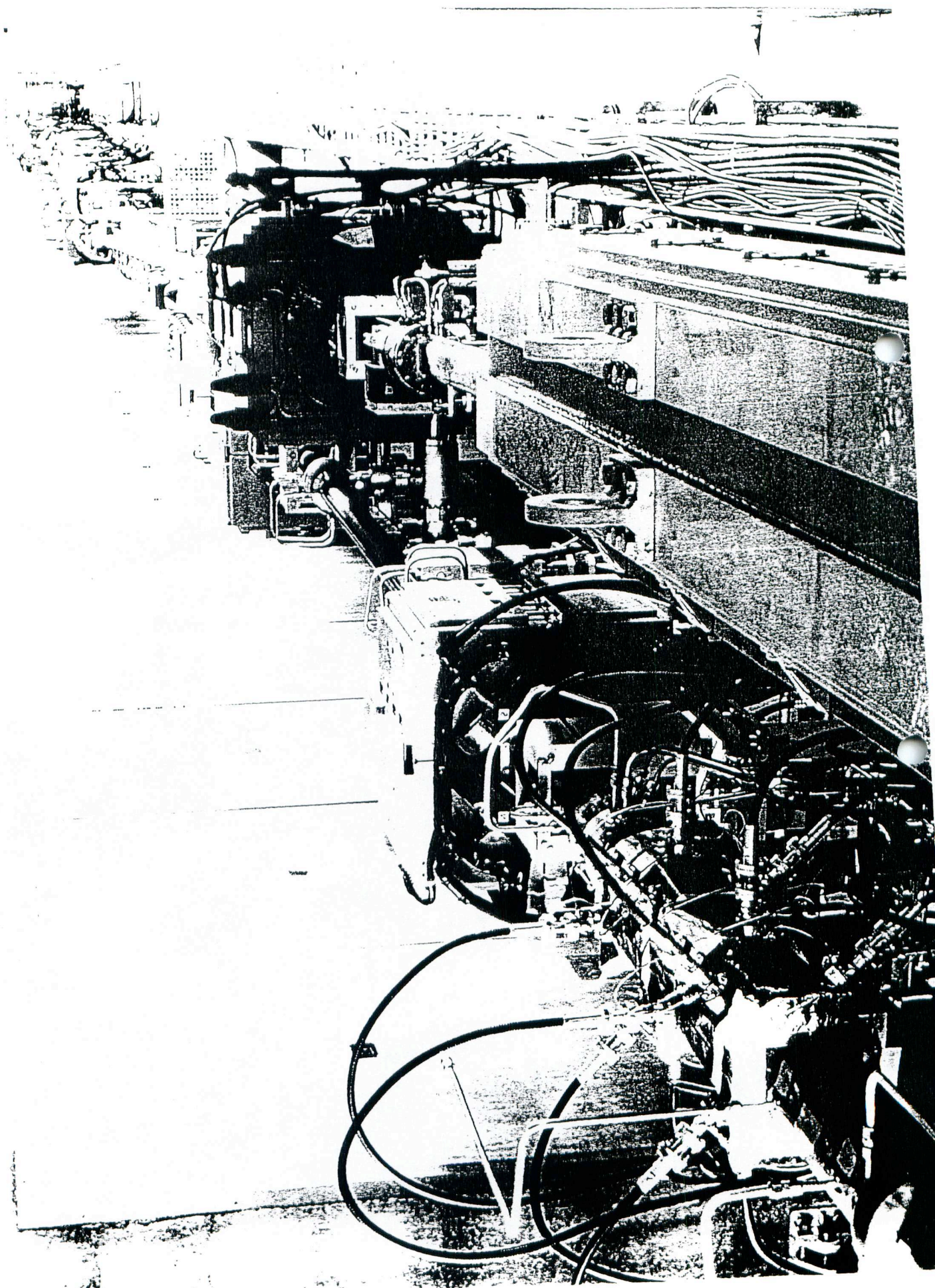


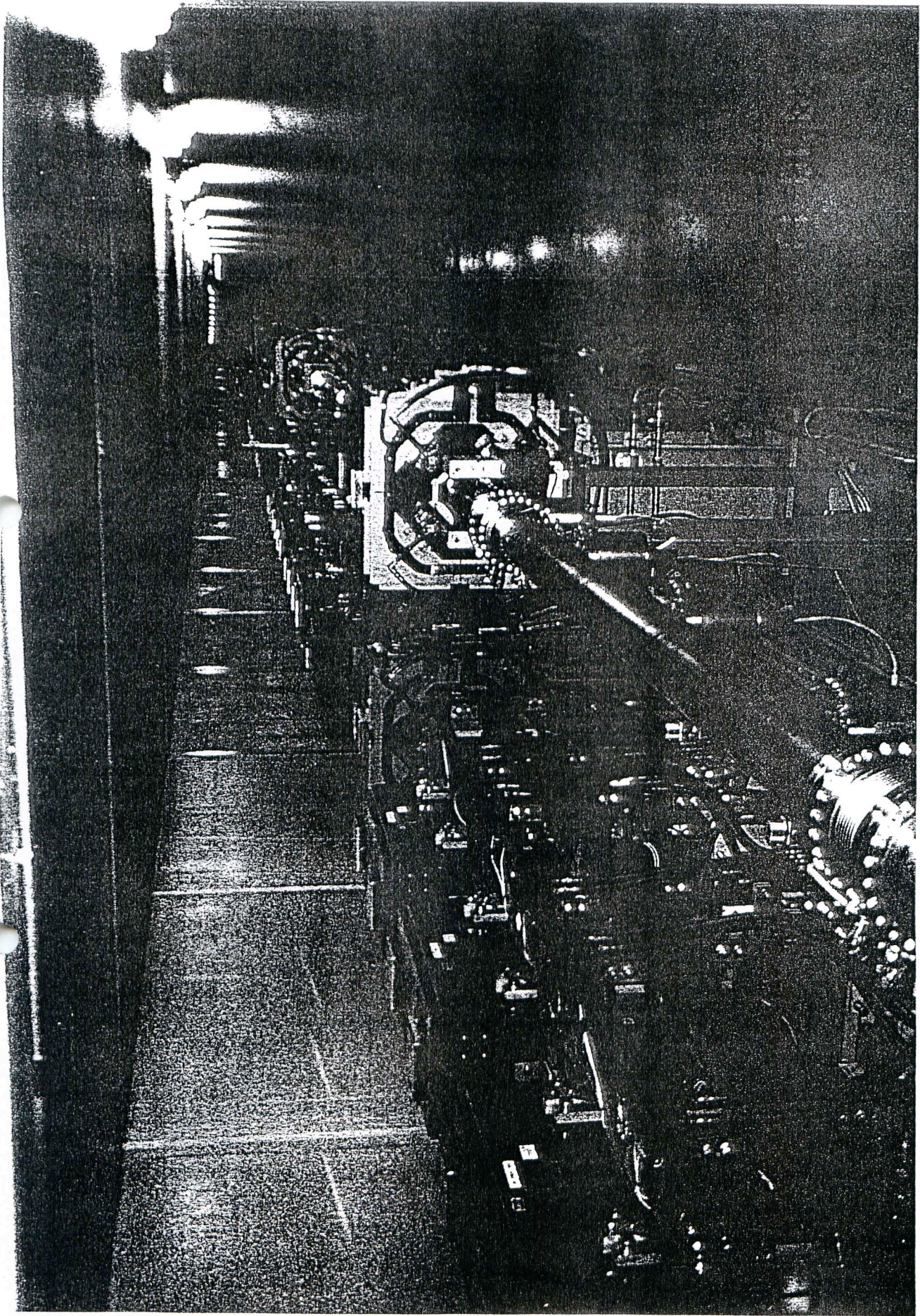
J-arc

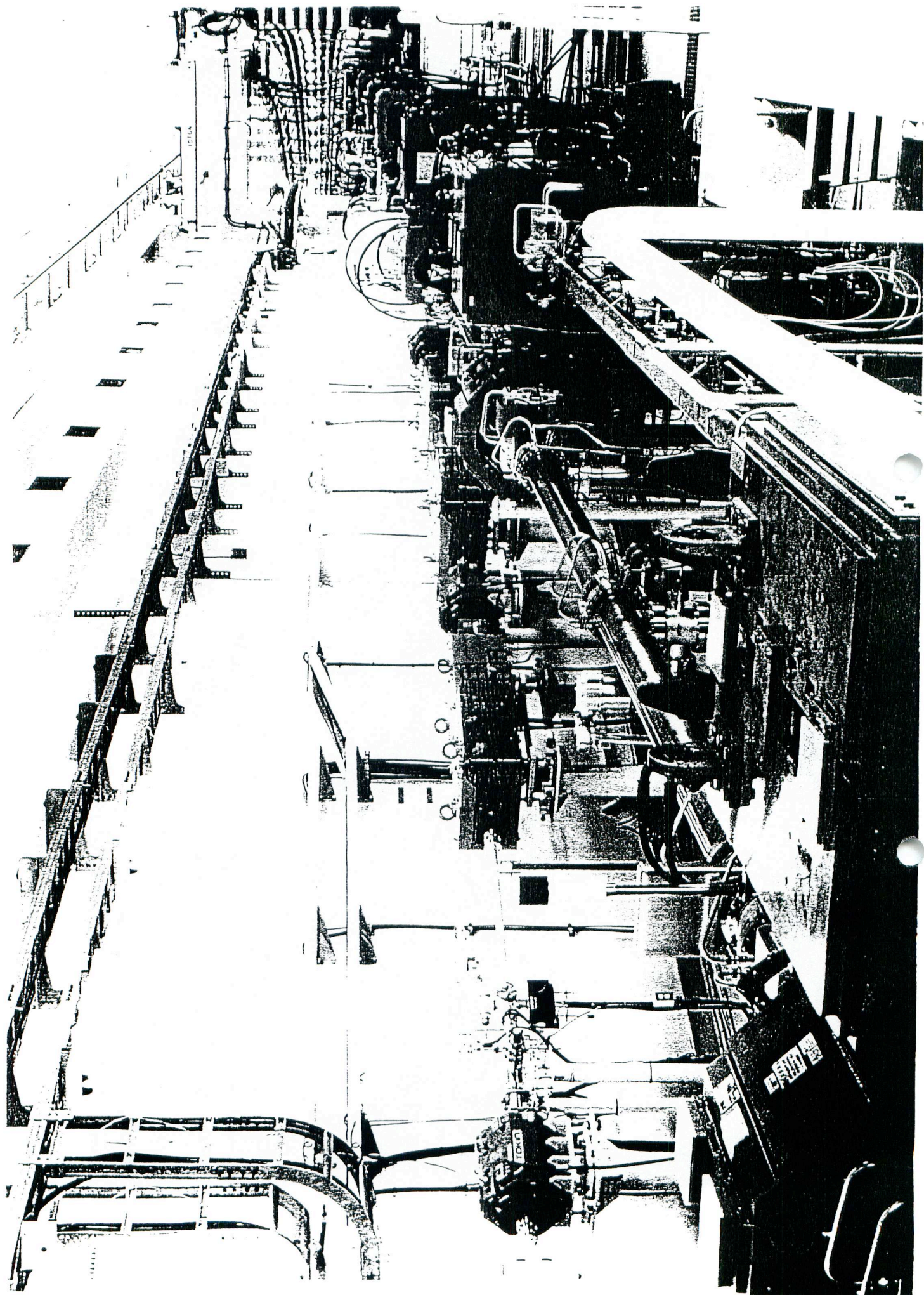


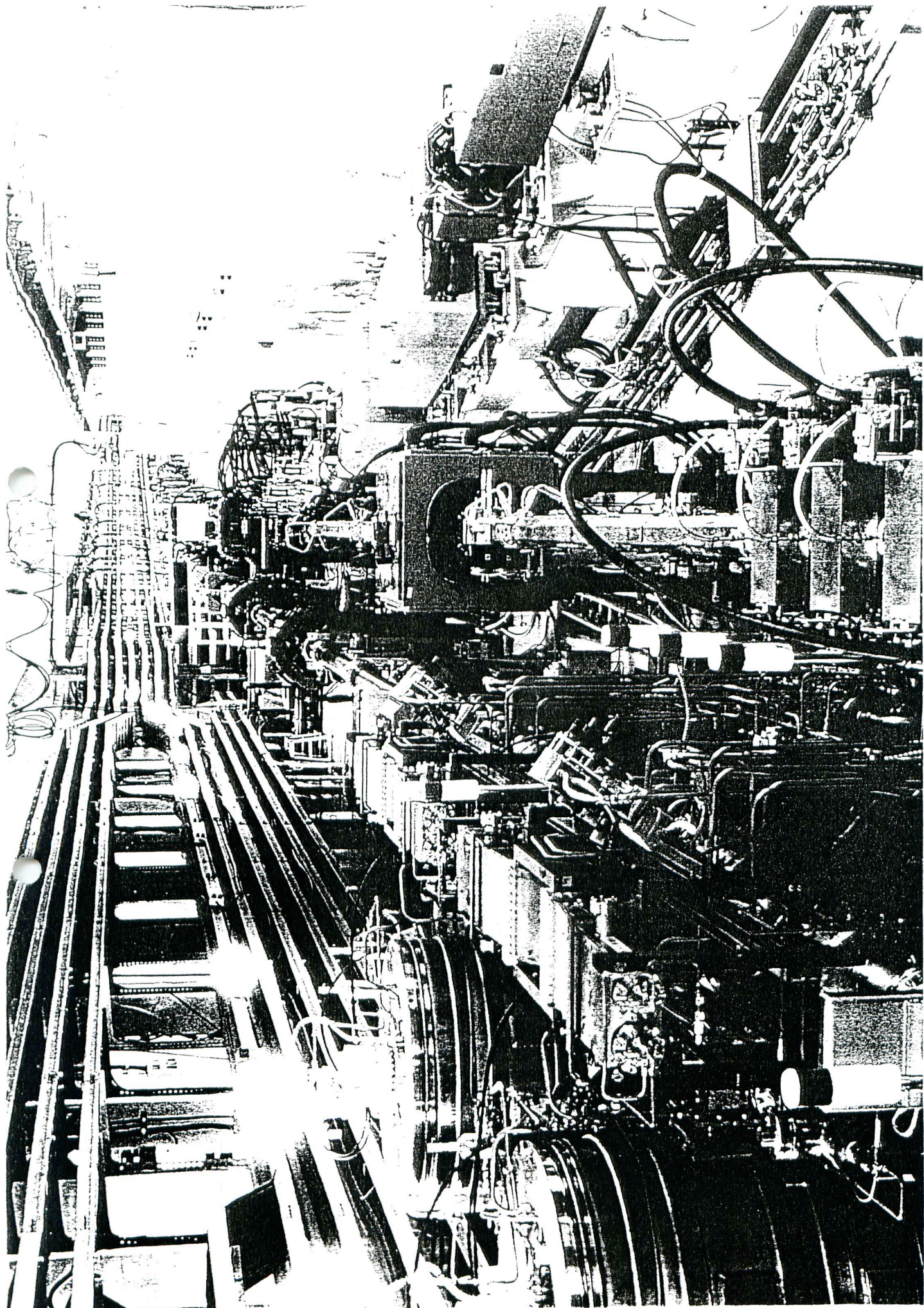
Beam Transport Line











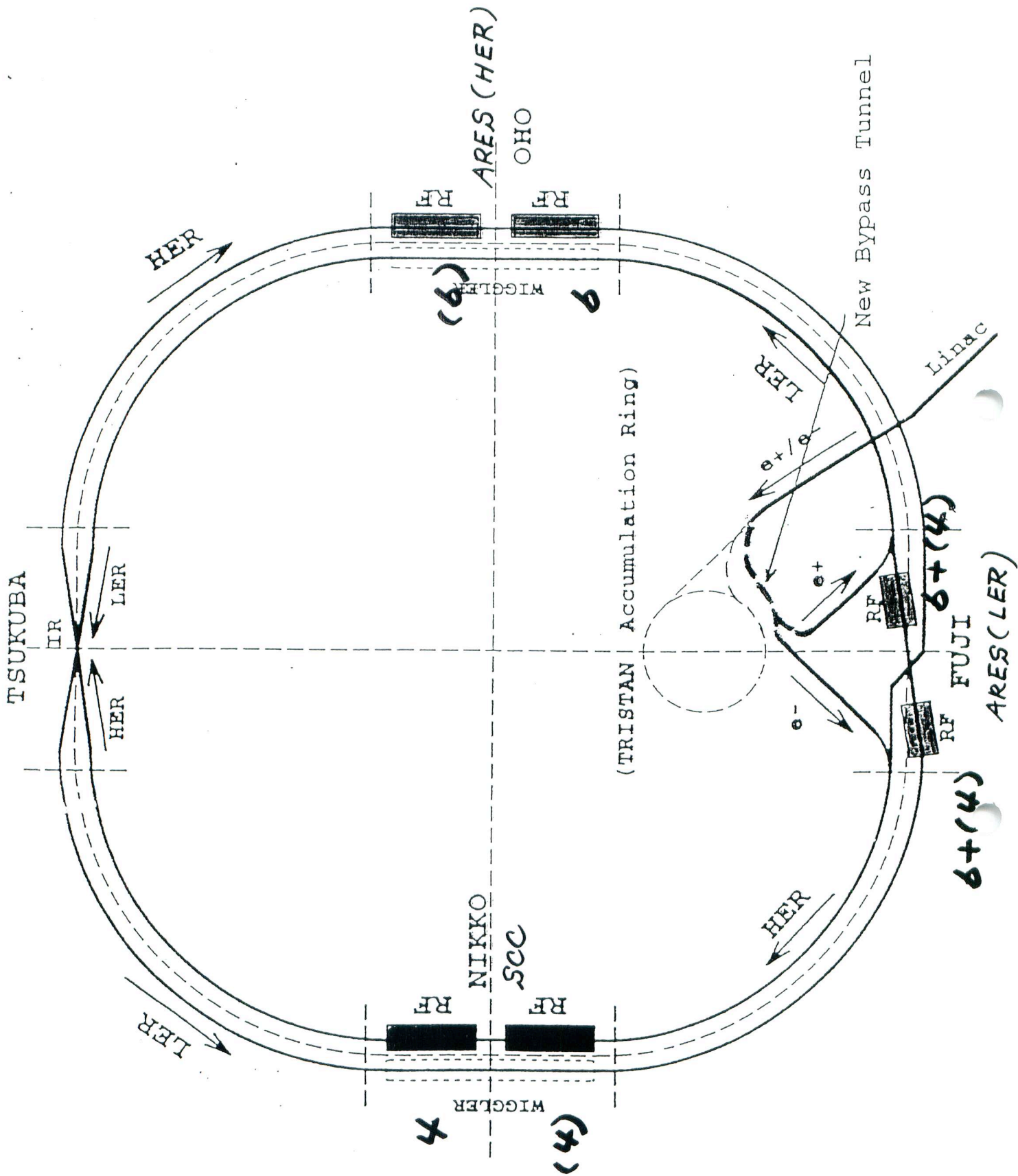
RF System

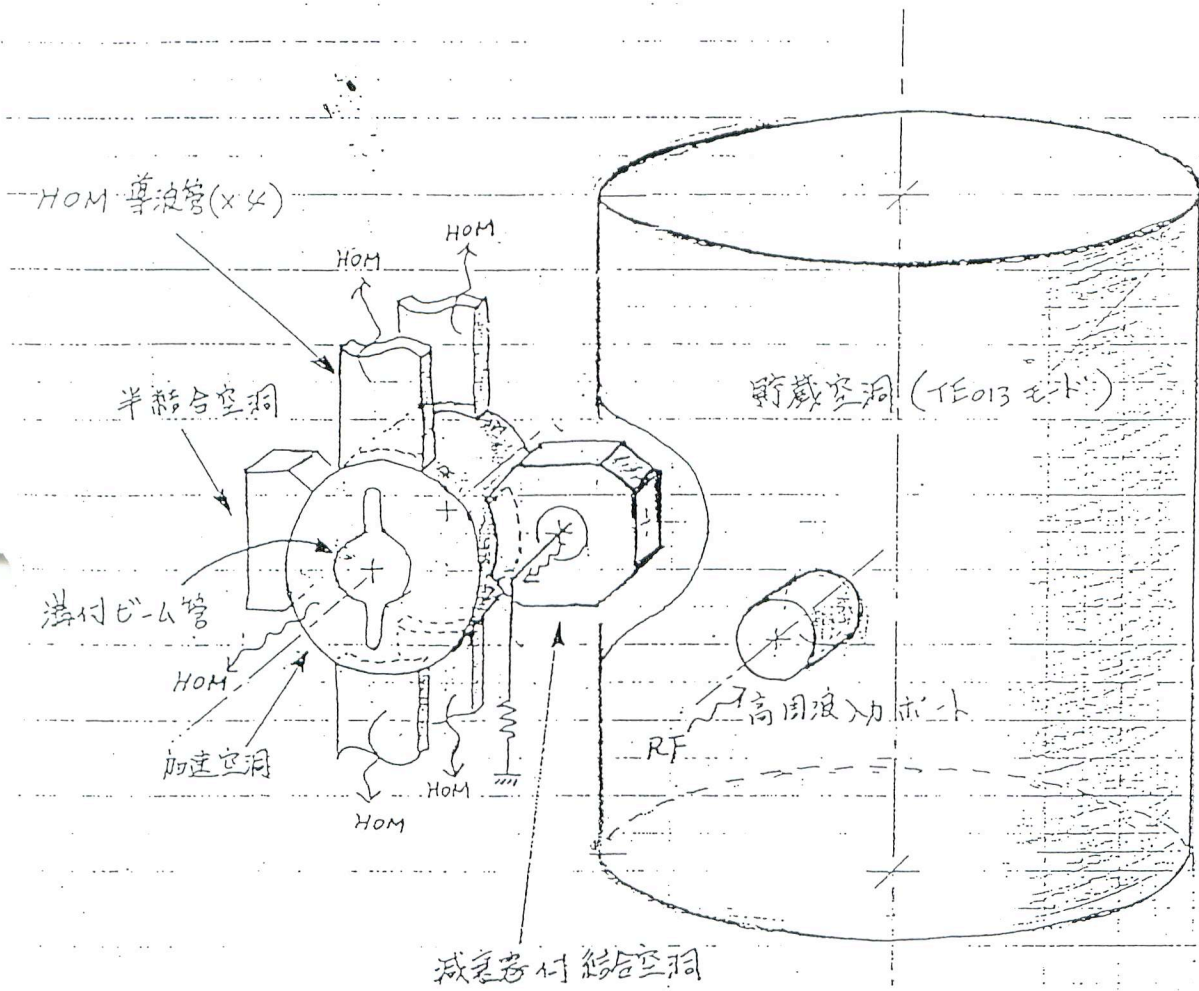
- 1. To combat high beam-loading and prevent coupled-bunch instabilities due to HOMs, HOM-free cavities with a large stored energy should be used at KEKB.**
- 2. Normal conducting cavity, ARES, and superconducting cavity, SCC, are the KEKB solutions.**

3. Number of cavities:

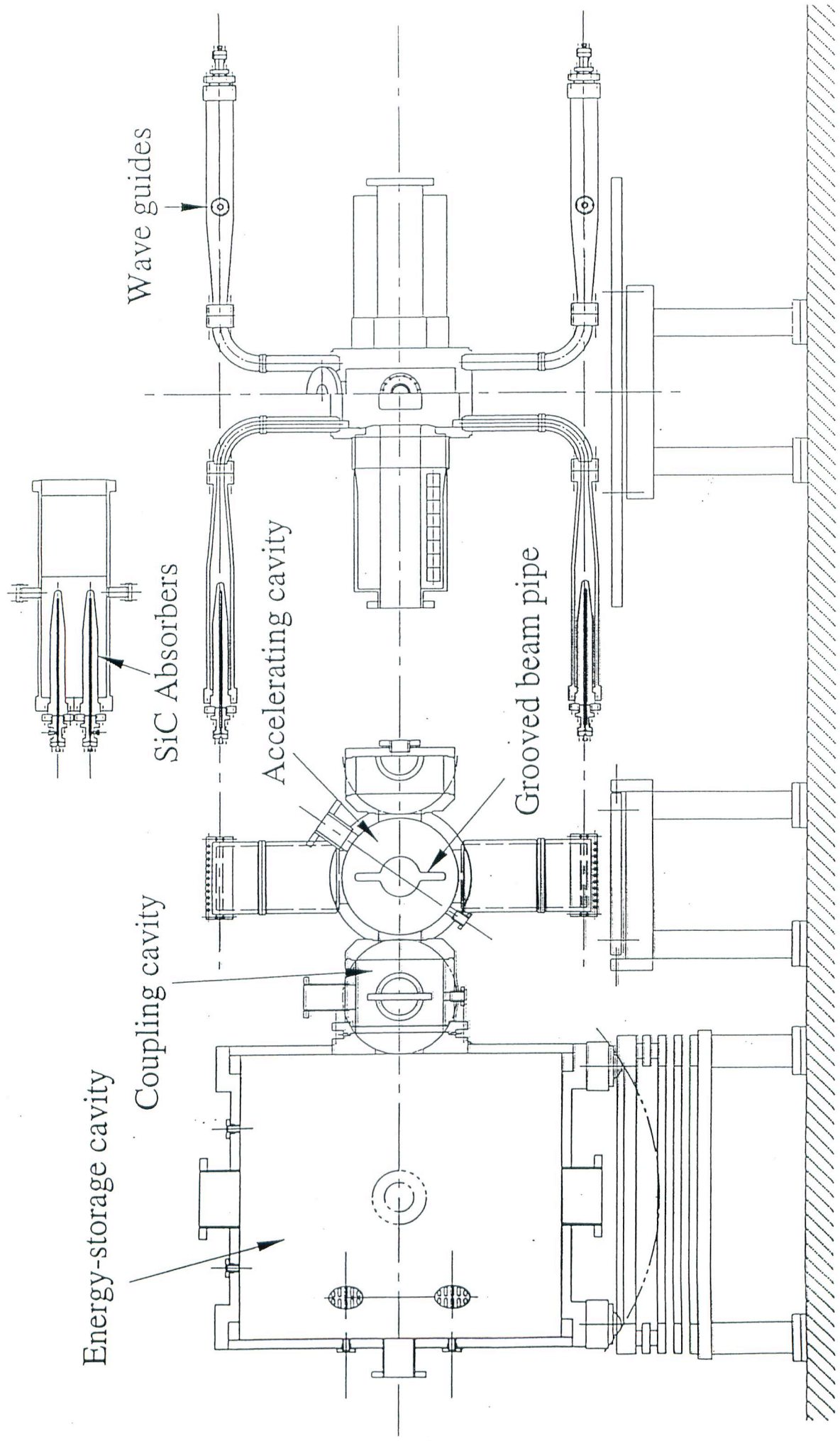
	station	t=0	final
LER	Fuji(ARES)	12	20
HER	Oho(ARES)	6	12
	Nikko(SCC)	4	8

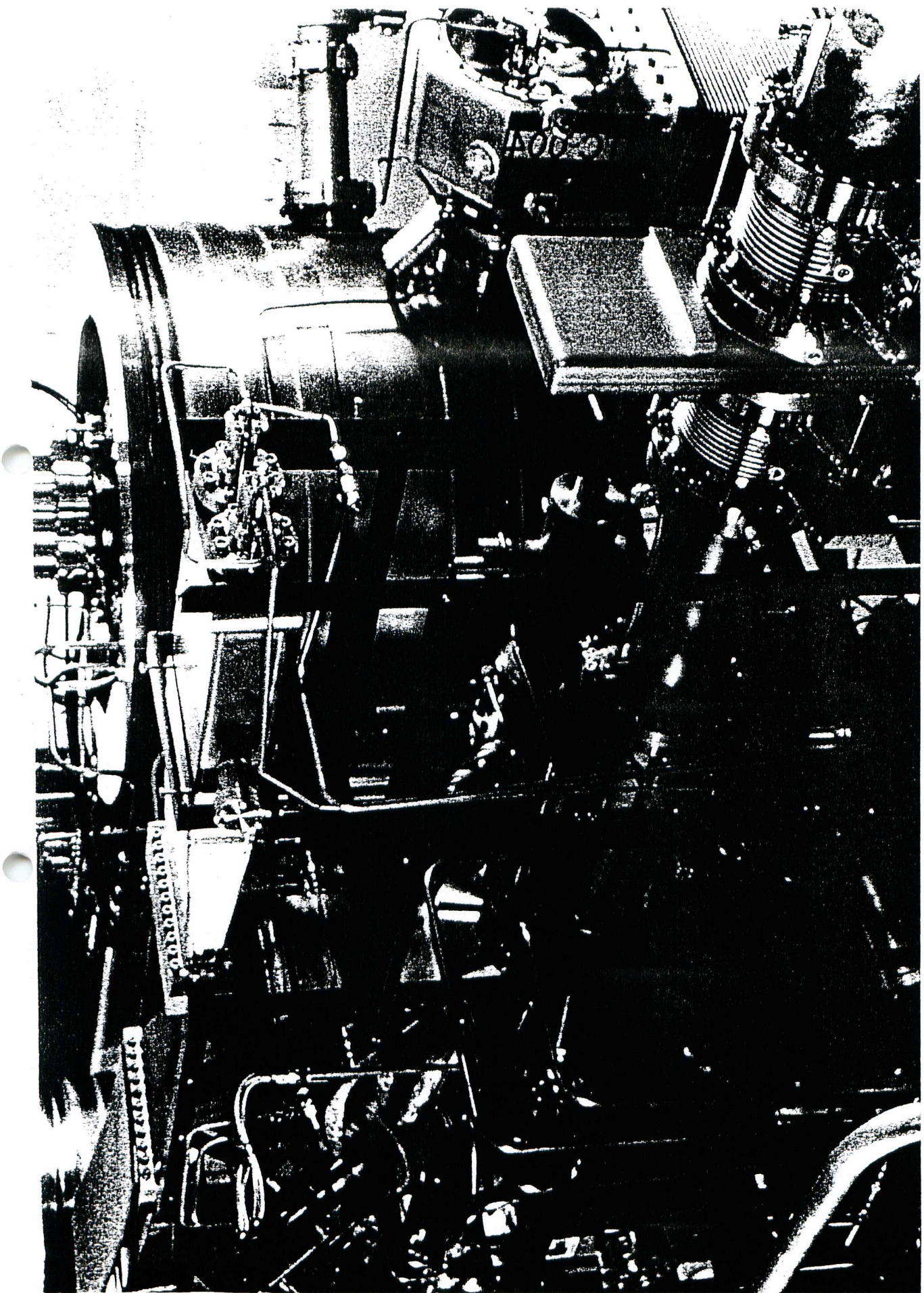
4. ARES and SCC are working without any problems.

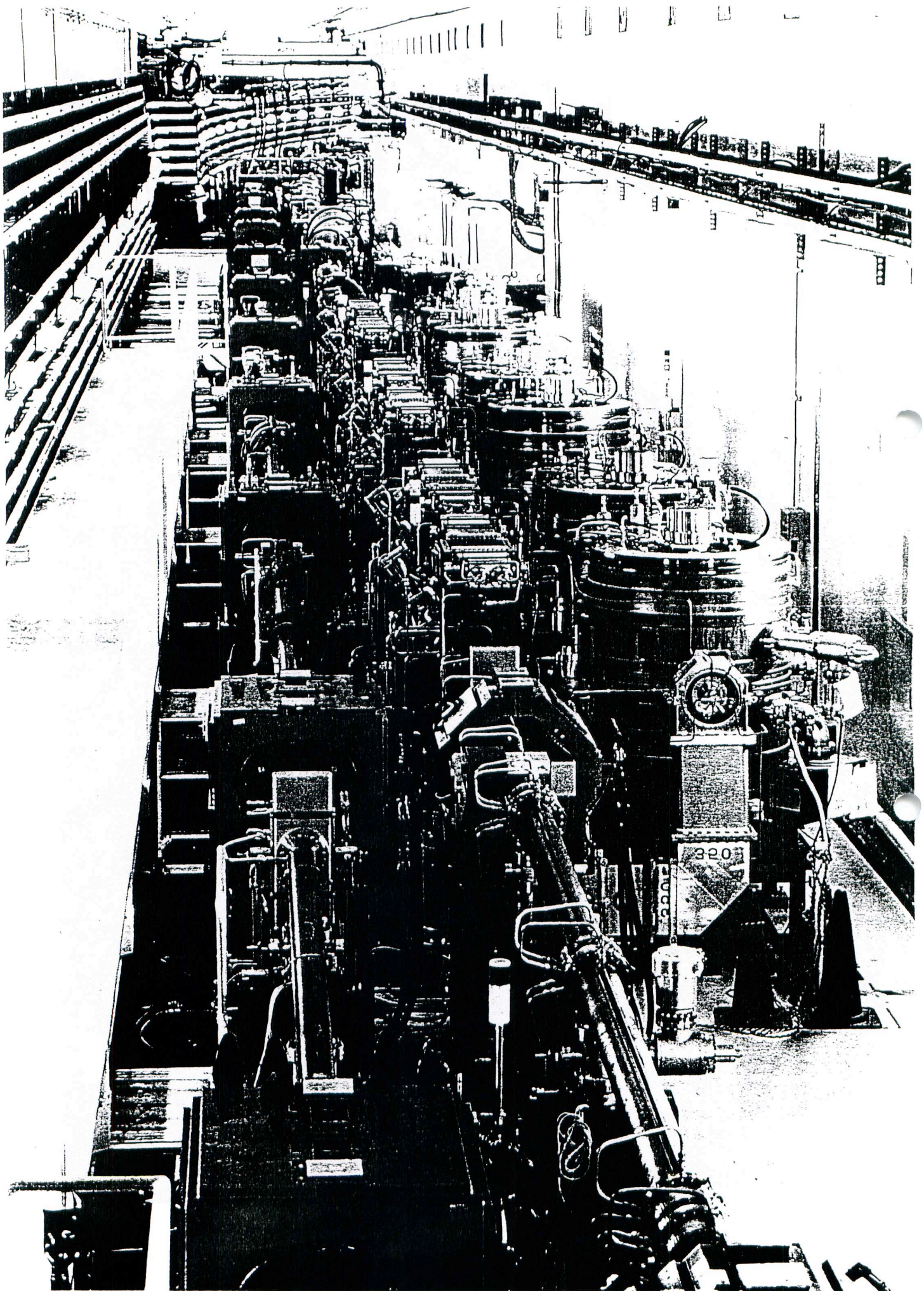




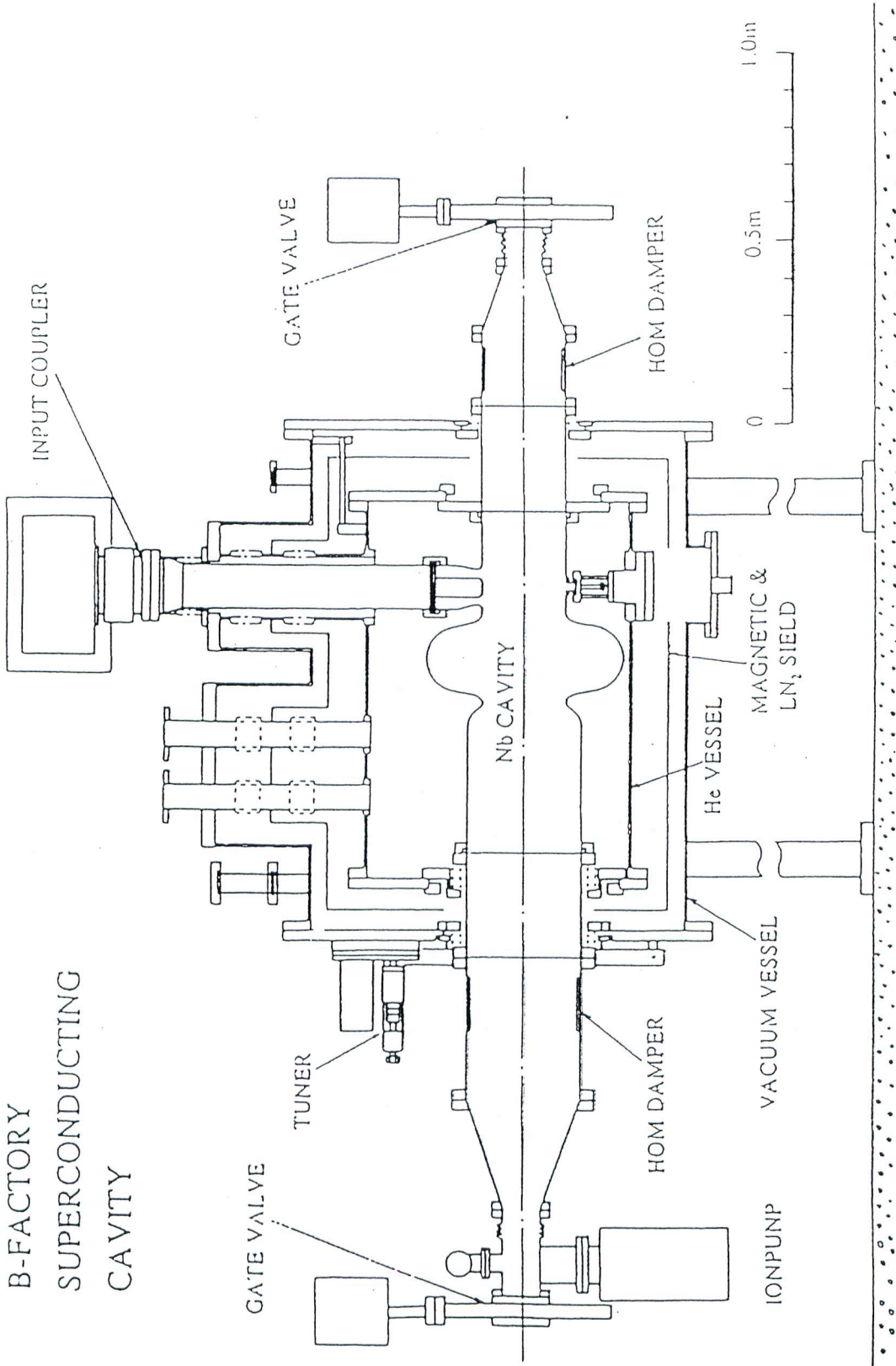
96試 ARES 空洞

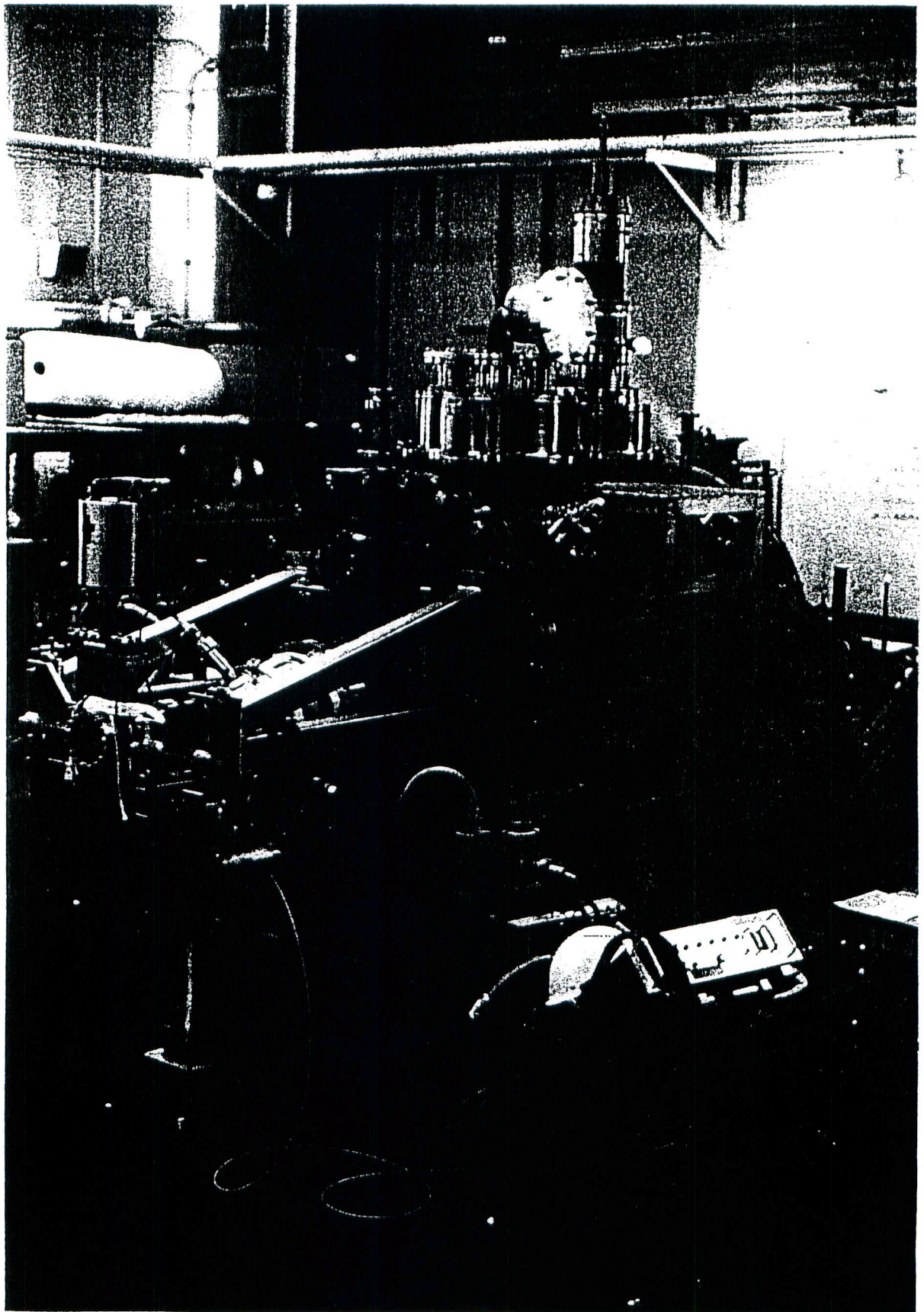






B-FACTORY
SUPERCONDUCTING
CAVITY

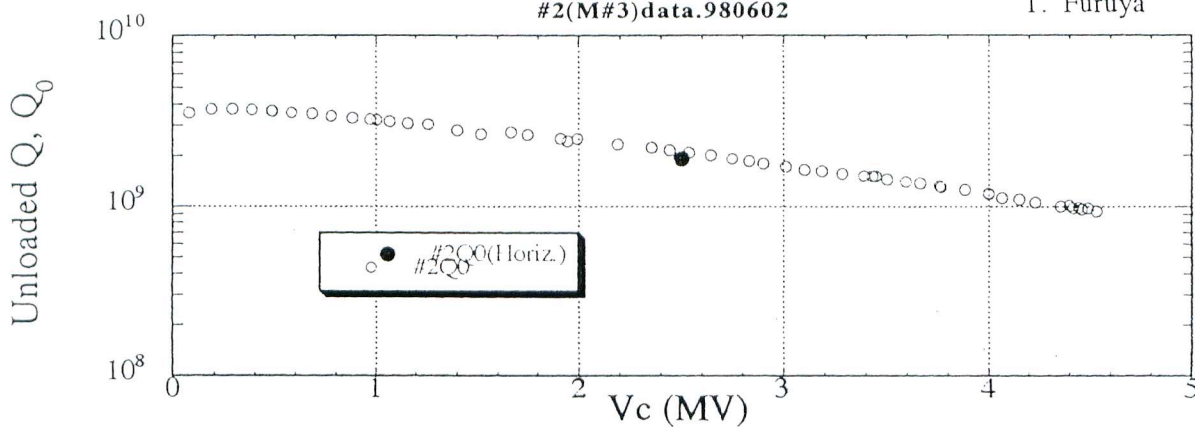




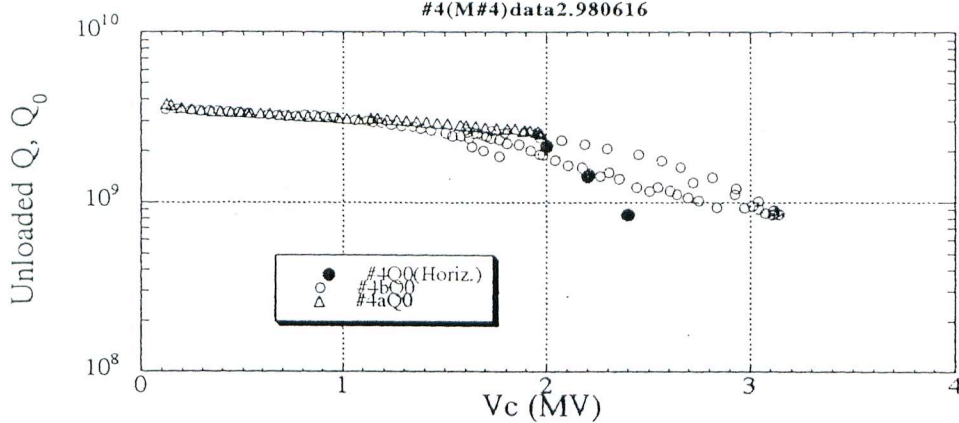
Q_0 vs V_c of KEKB-SC

T. Furuya

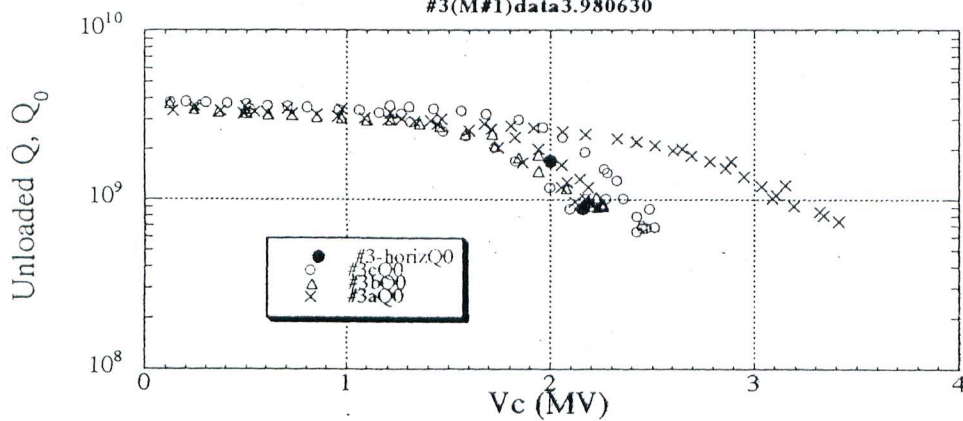
#2(M#3)data.980602



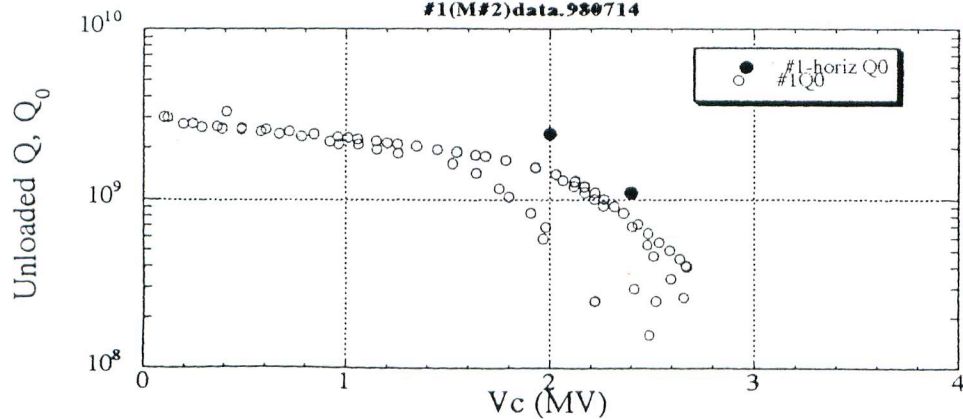
#4(M#4)data2.980616



#3(M#1)data3.980630

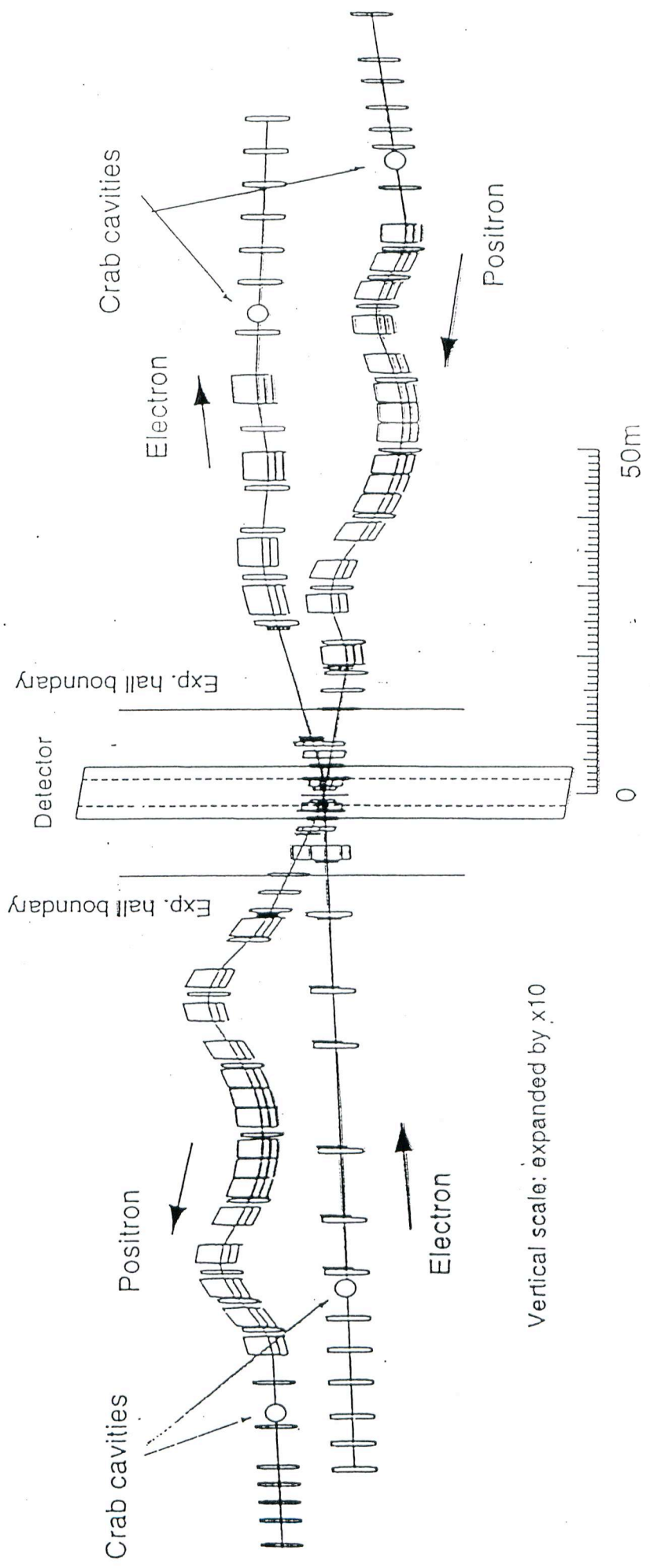


#1(M#2)data.980714

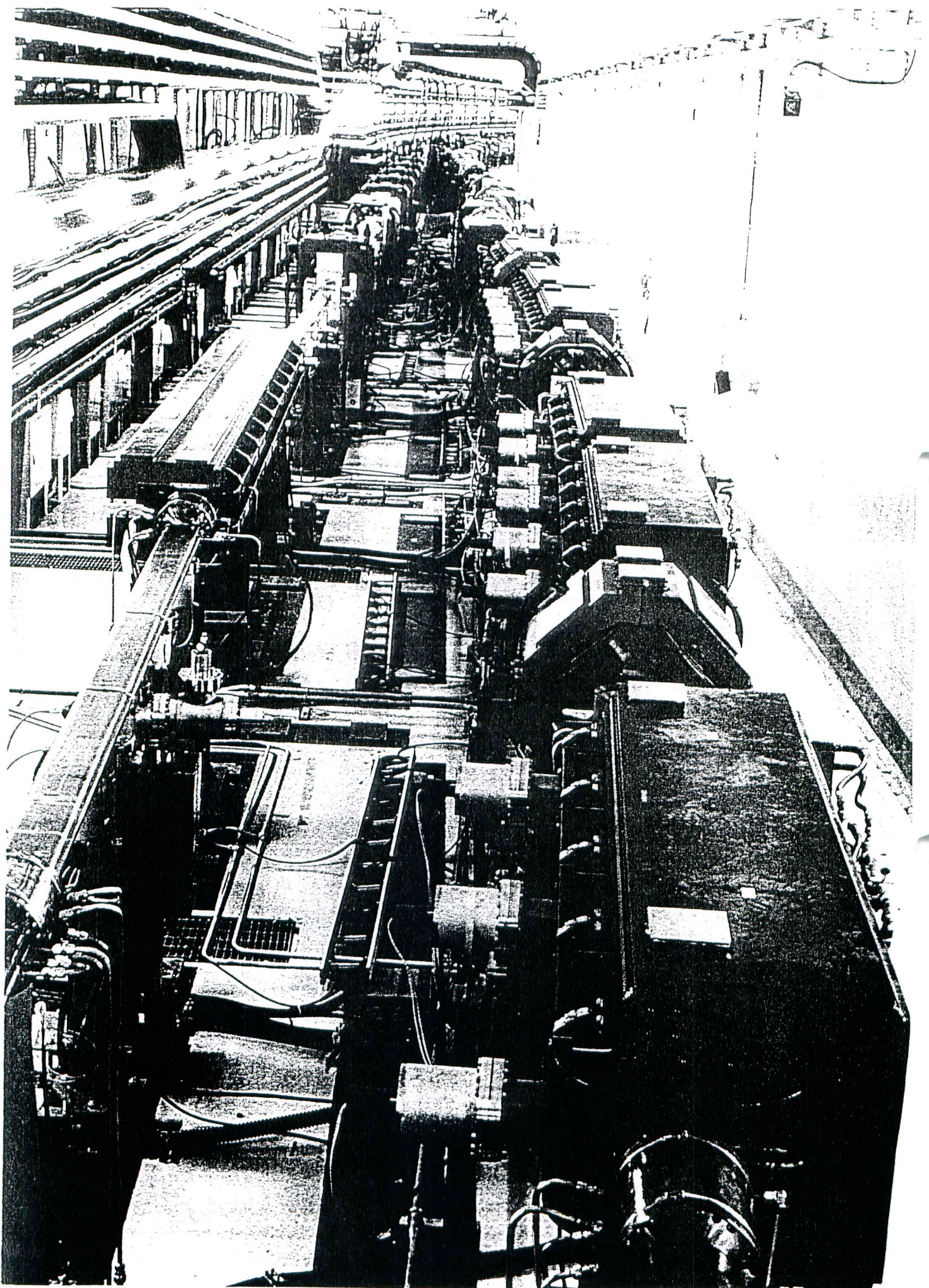


Interaction Region

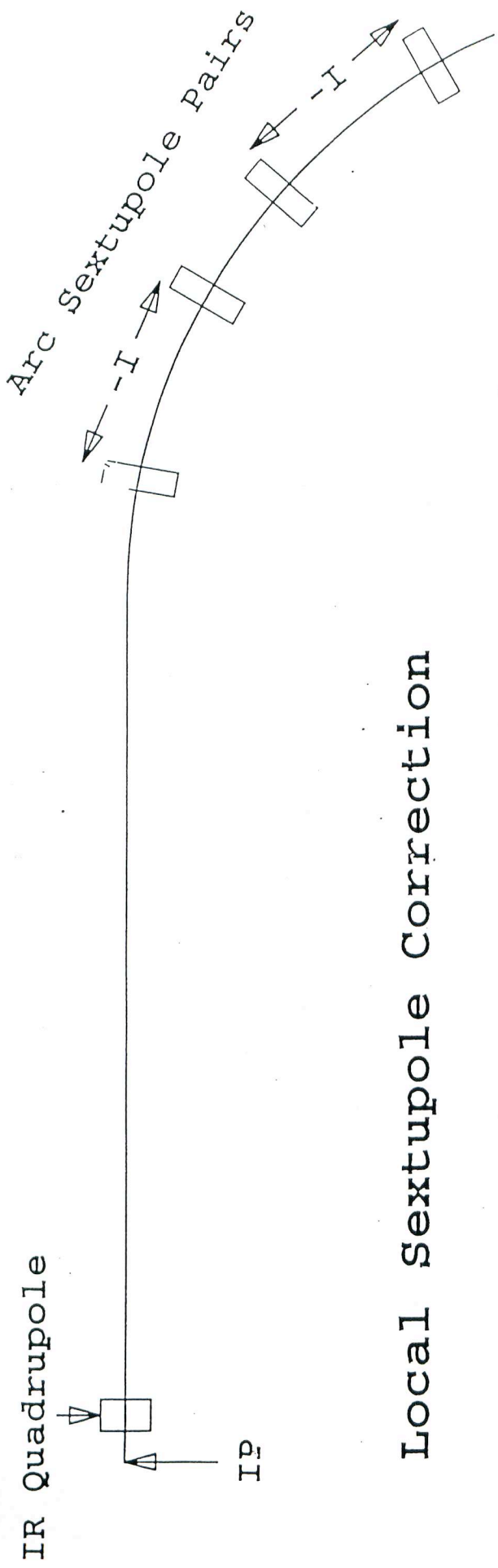
- 1. 2 x 11 mrad finite-angle crossing at IP to simplify IR and fill every bucket with beam.**
- 2. Superconducting final-focus quads and anti-solenoids inside 1.5 Tesla BELLE detector solenoid.**
- 3. Crab-crossing scheme as a fall-back option. Superconducting crab cavities are being developed.**



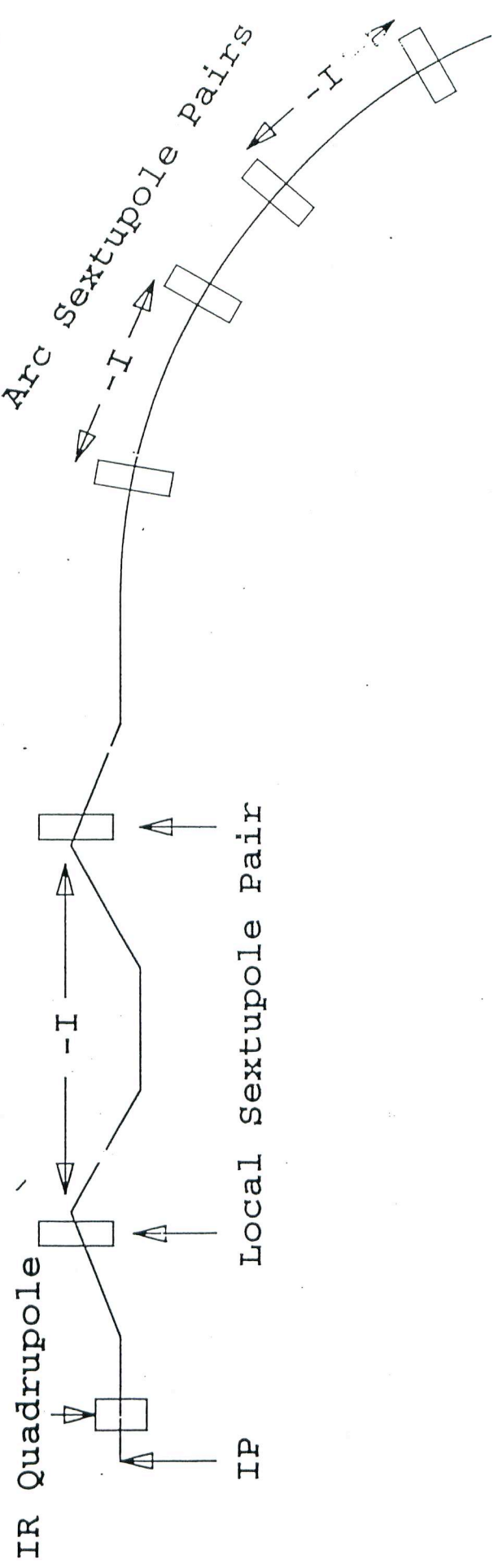
Vertical scale: expanded by x10

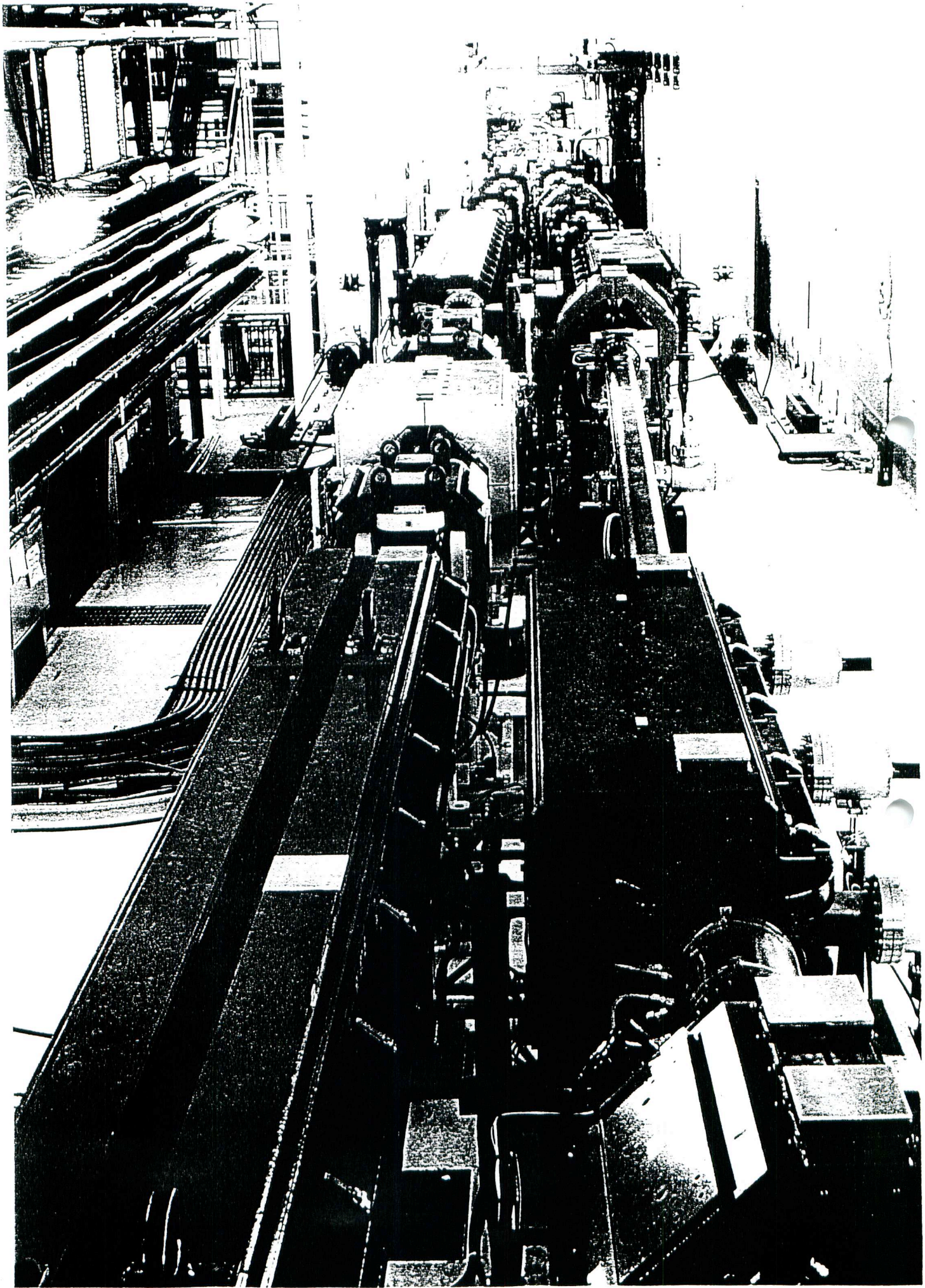


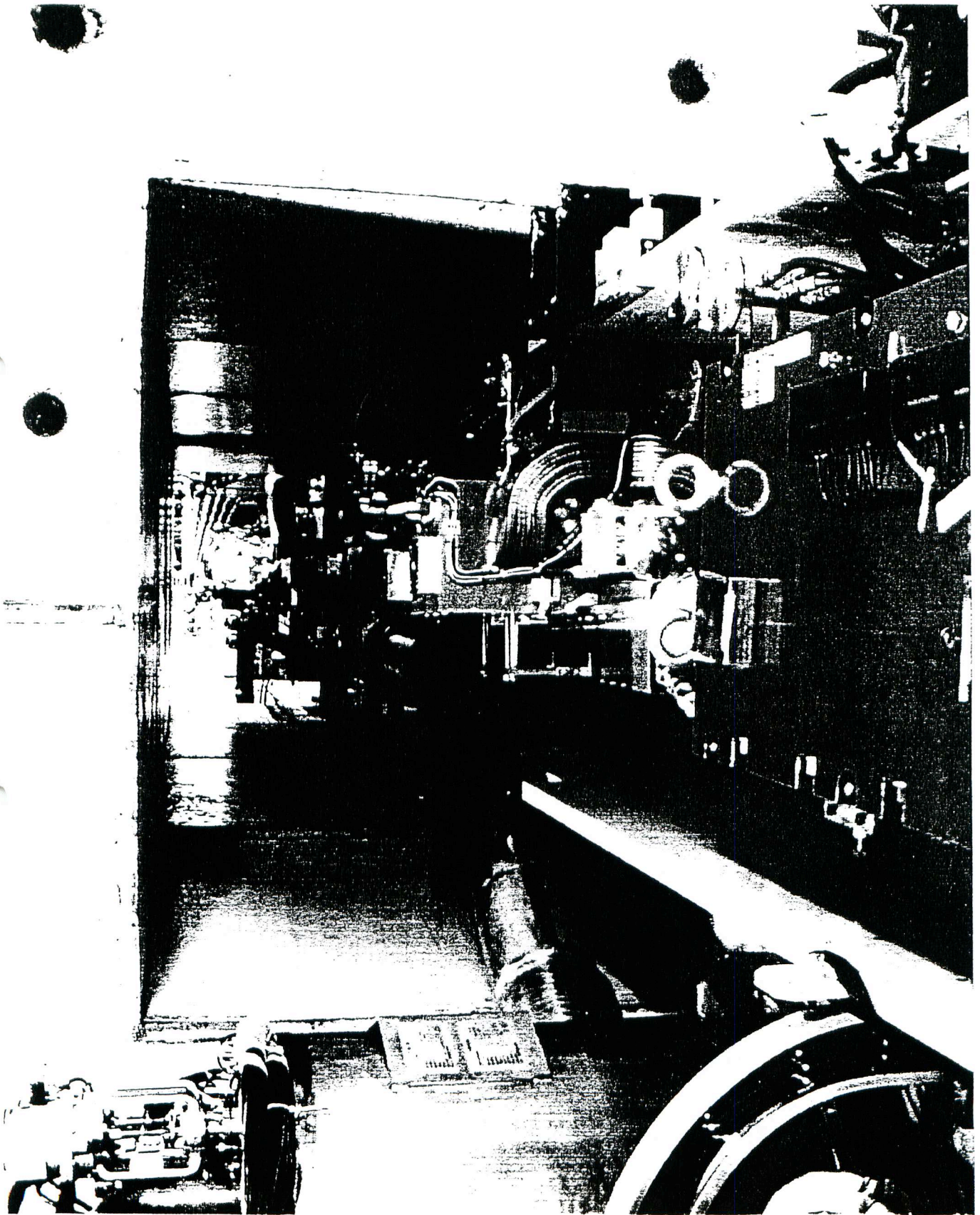
Non-local Sextupole Correction

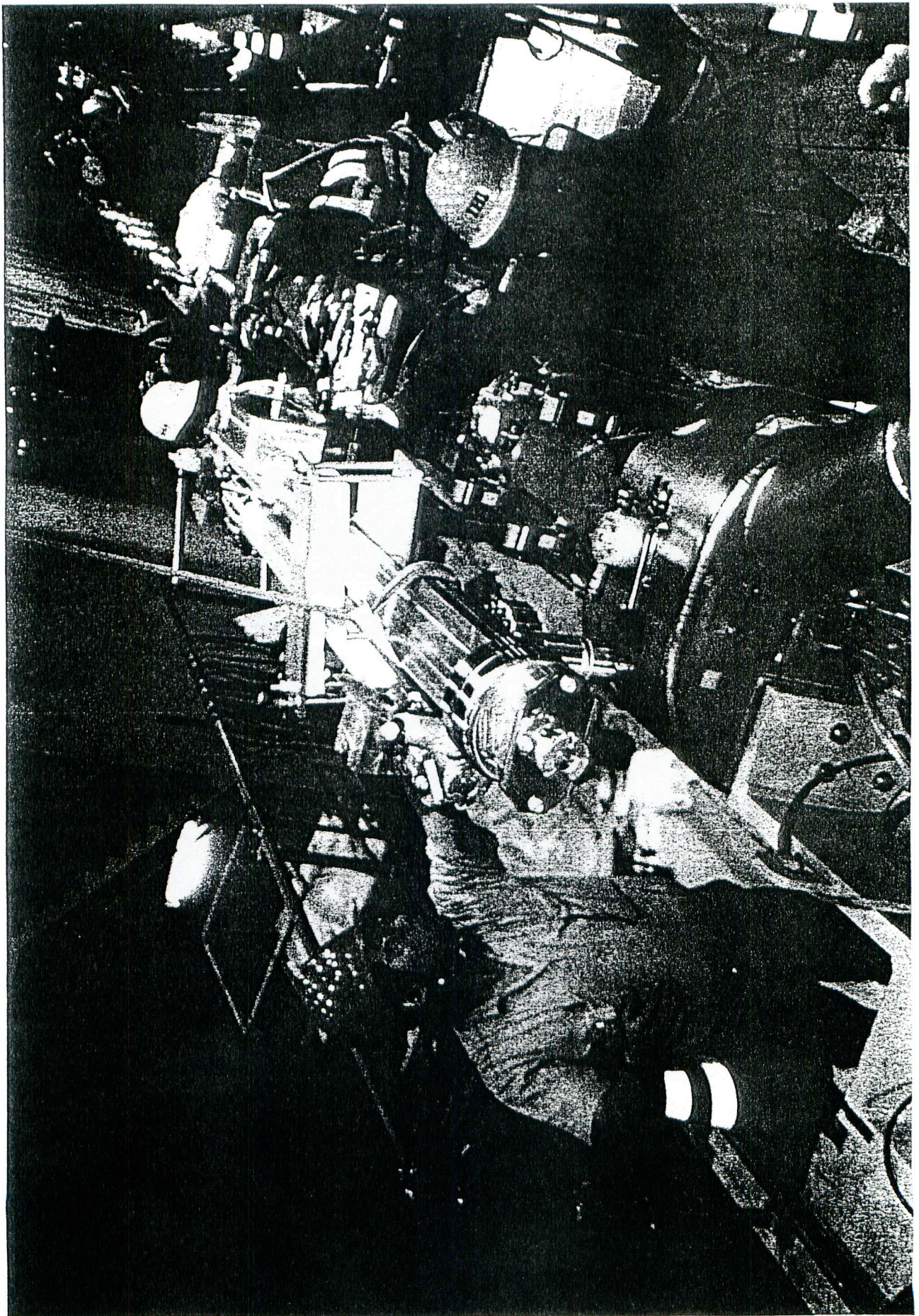


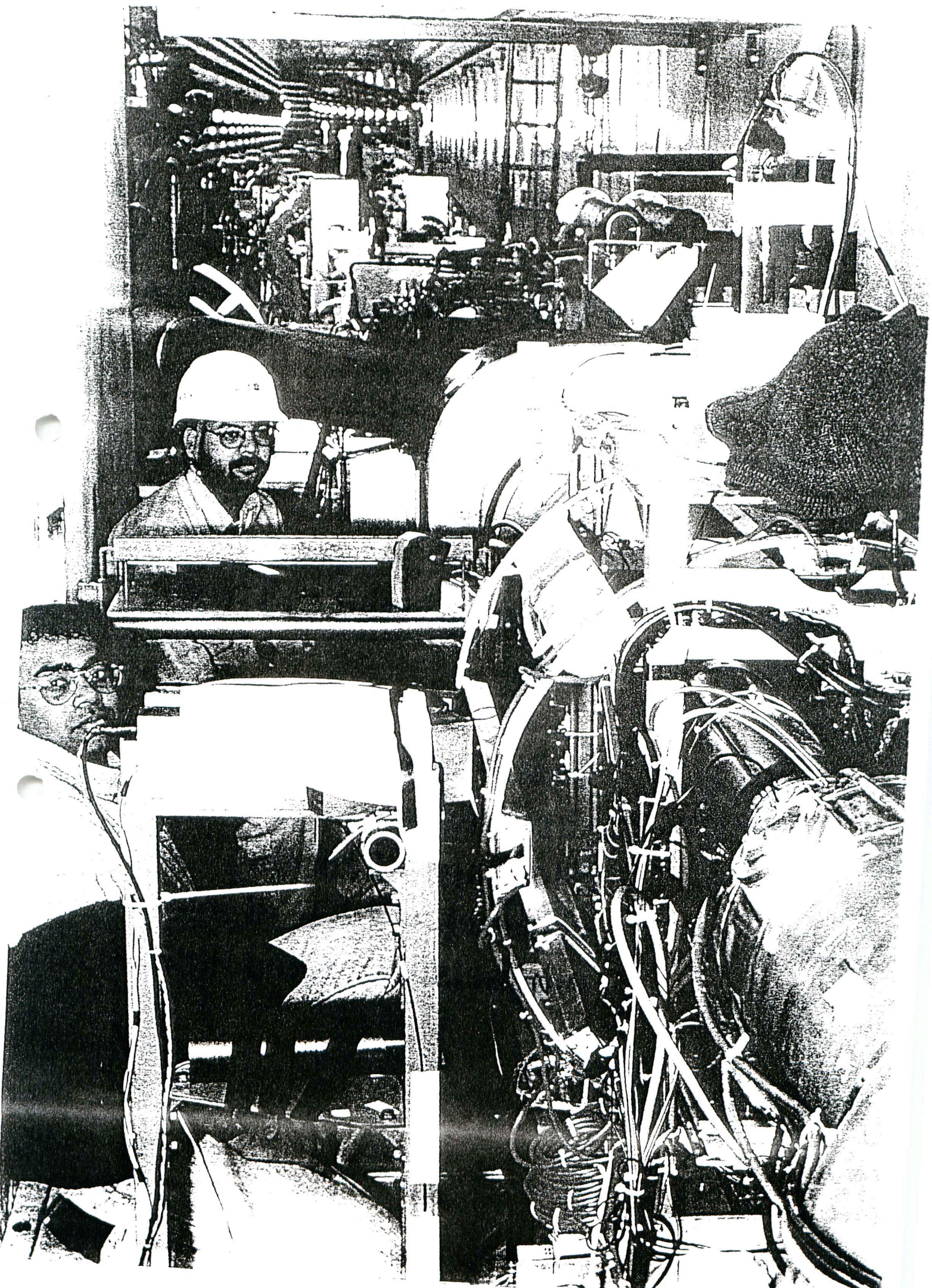
Local Sextupole Correction











- 98/12/1** **Commissioning of HER started**
- 98/12/11** **First circulation of beam in HER**
- 98/12/13** **First beam storage in HER**
- 98/12/27** **e⁺ transported to KEKB ring**
- 98/12/27** **Year-end and new-year shutdown**
-99/1/7 **Blockage of cooling channel of LER dipole magnets was fixed**

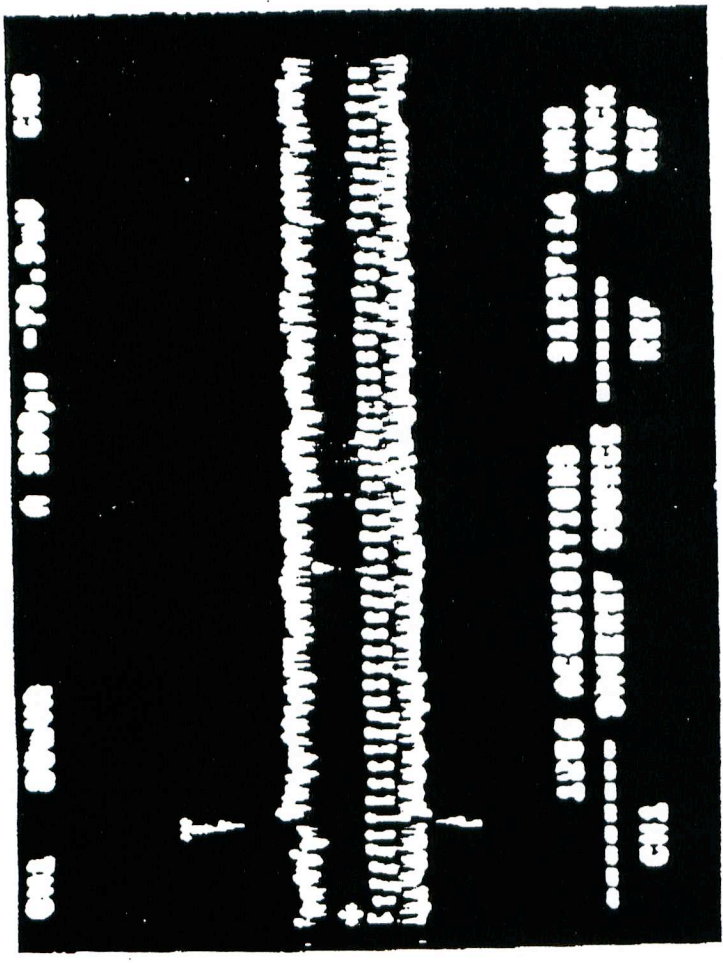
Commissioning Group

- 1. KEKB has single commissioning group that commissions linac, beam transport lines and KEKB rings on 24-hour basis.**
- 2. This group is led by Katsunobu Oide and has 38 members.**
- 3. Good exchange of information between this group and BEAST group.**
- 4. Everyday at 9:00 regular meeting is held for commissioning.**

Controls

- 1. Both linac and KEKB rings are controlled from the KEKB control room. This has increased the efficiency of commissioning tremendously.**
- 2. The control system suffers from frequent stops of IOCs. We have not understood why they stop.**
- 3. Software has been continuously improved.**

227-199 MHz
 ← 571.199 MHz
 変え [c]



227-199 MHz } 変え [c] (by 末武)

3 = 26

3 = 30

3 = 32

11-7 to 508 . 8865404 } → P113

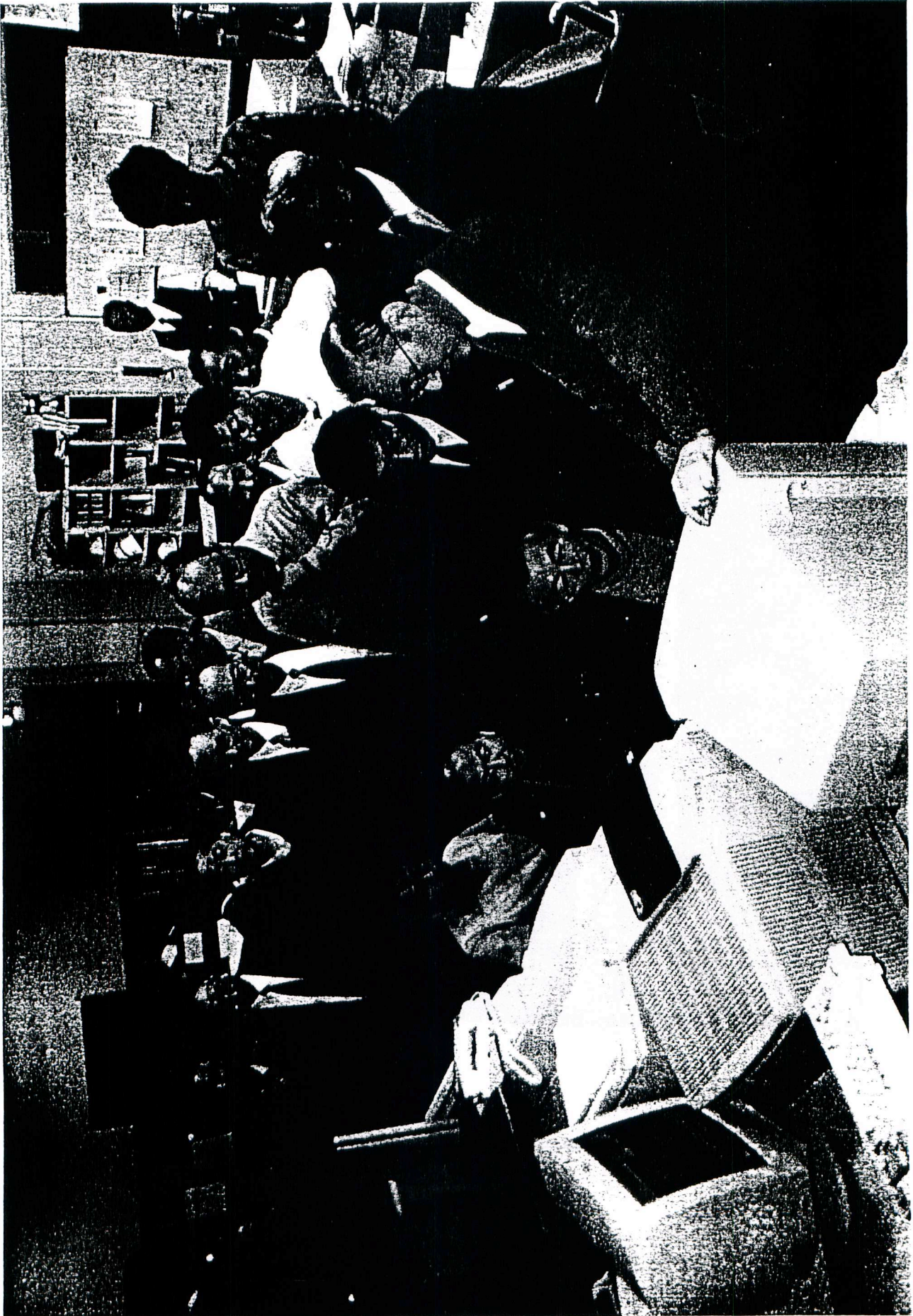
2-11° - Interlock 解除

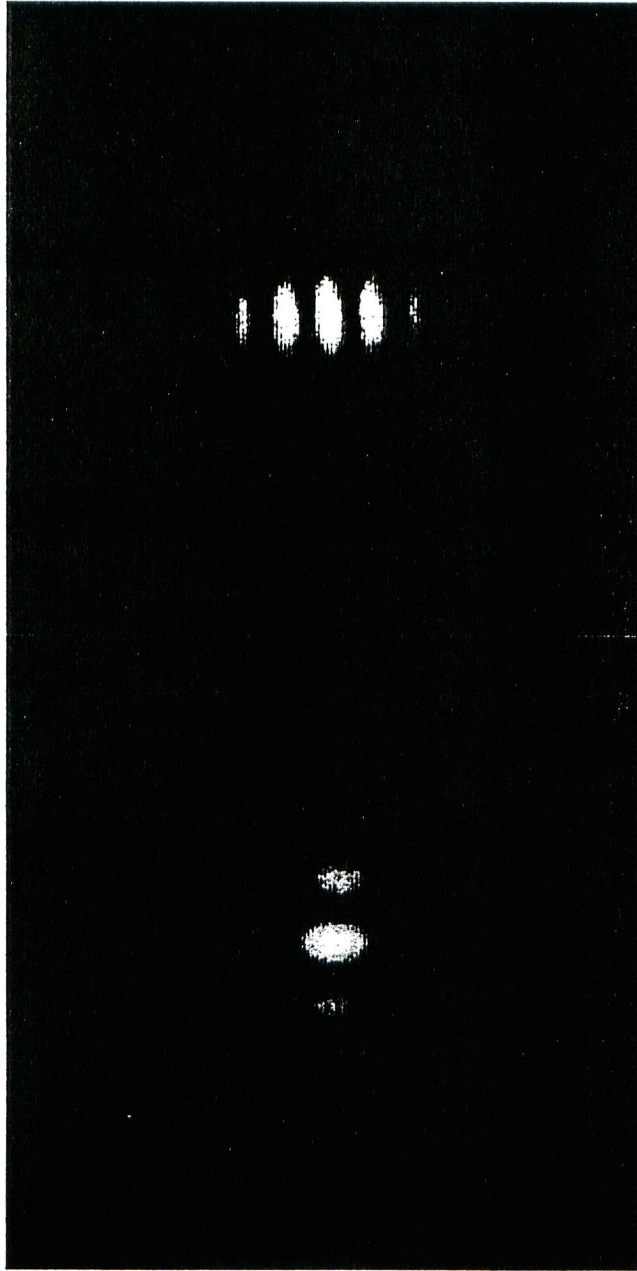
frequency 2 入射 Phase 調整

88° → 93° → 98° → 103° → 83° → 73°

2 系統局 出力

~~73° 50° 80° 40°~~





1/8 **Commissioning resumed**

1/10 **Commissioning of LER
started**

1/13 **First circulation of beam
in LER**

1/14 **First beam storage in
LER**

1/26 **First trial of beam
collision**

1/27-2/3 **Operation being
suspended due to
radiation accident**

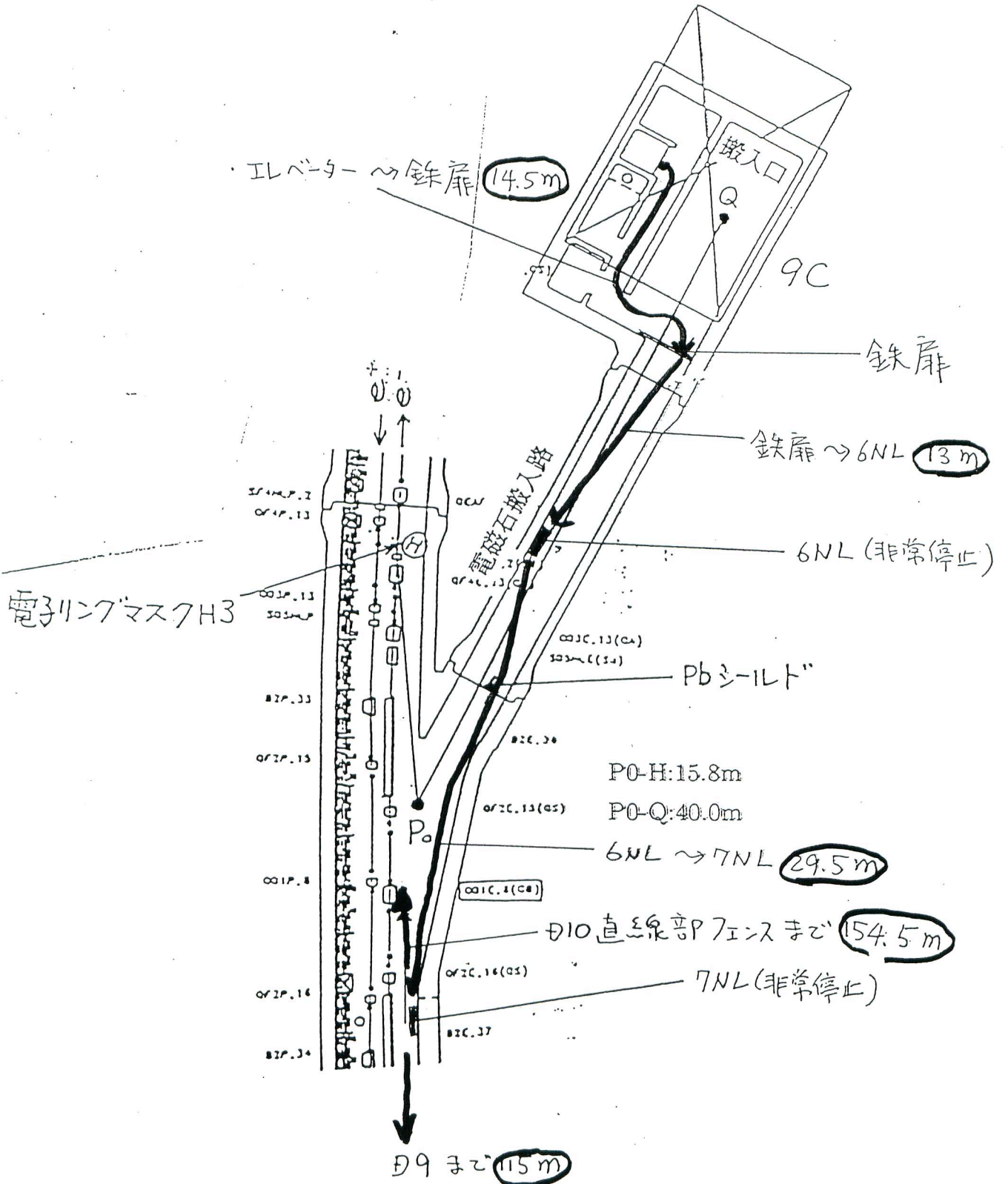
Accident on January 27,1999

- 1. A Fire alarm in the KEKB tunnel worked at 4:44 on January 27.**
- 2. A guard man tried to identify the alarm, scrambled the gate, went down by elevator, and entered the approach tunnel to the KEKB rings.**
- 3. He pushed the first emergency button in the approach and KEKB got stopped. Duration of his stay in the radiation controlled area is 5 minutes.**

4. Radiation dose he got is below the detection level of a film badge he wore.
5. We got inspection by STA on January 27; STA officials pointed out a few drawbacks that should be improved quickly.

We have improved the drawbacks. The second inspection by STA was held on February 2nd. We resumed the operation on February 3rd.

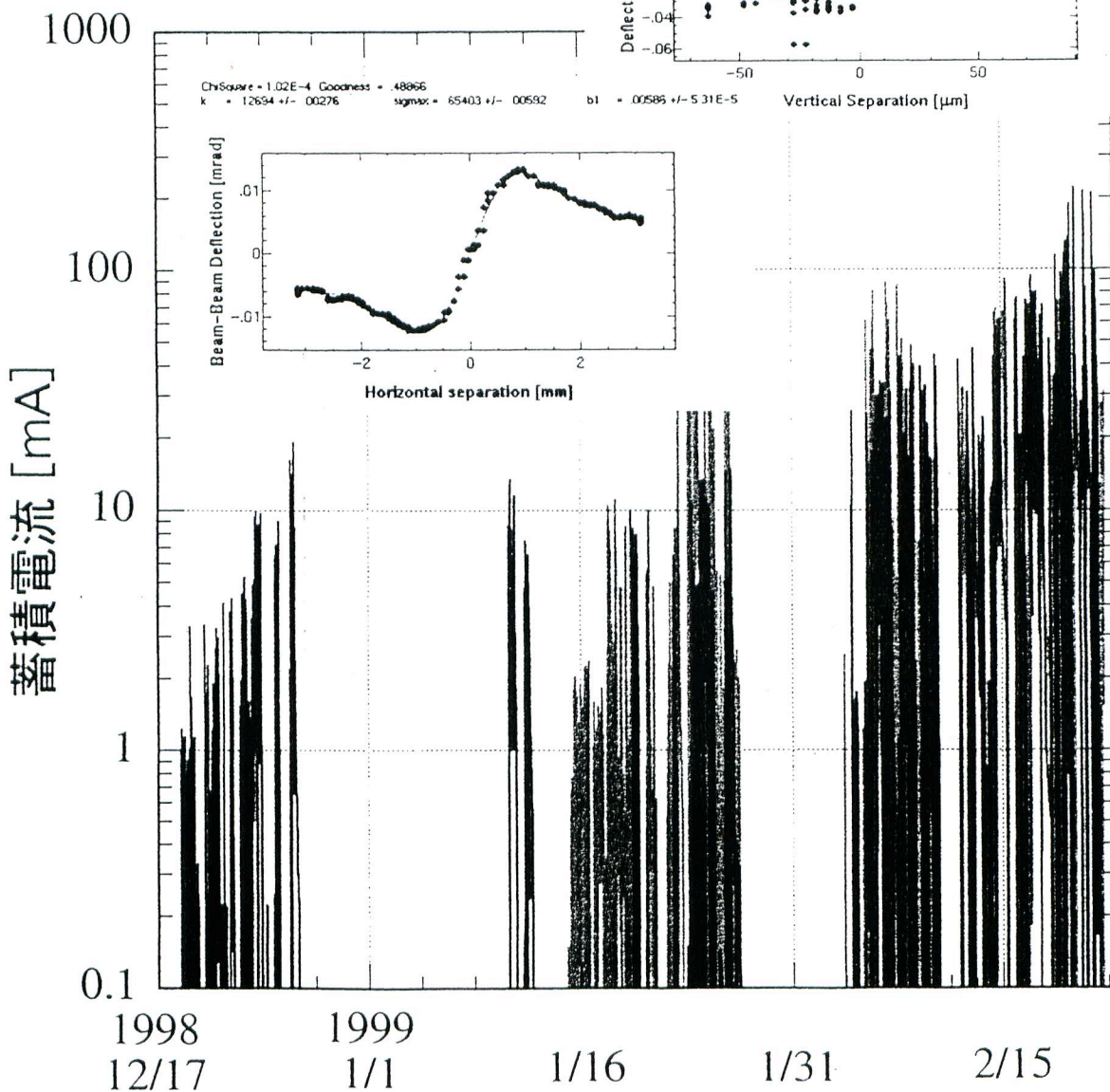
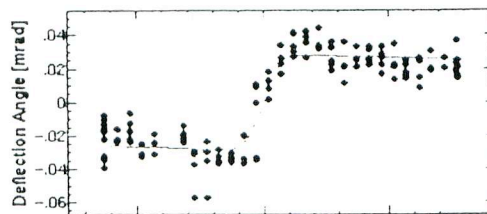
資料 7

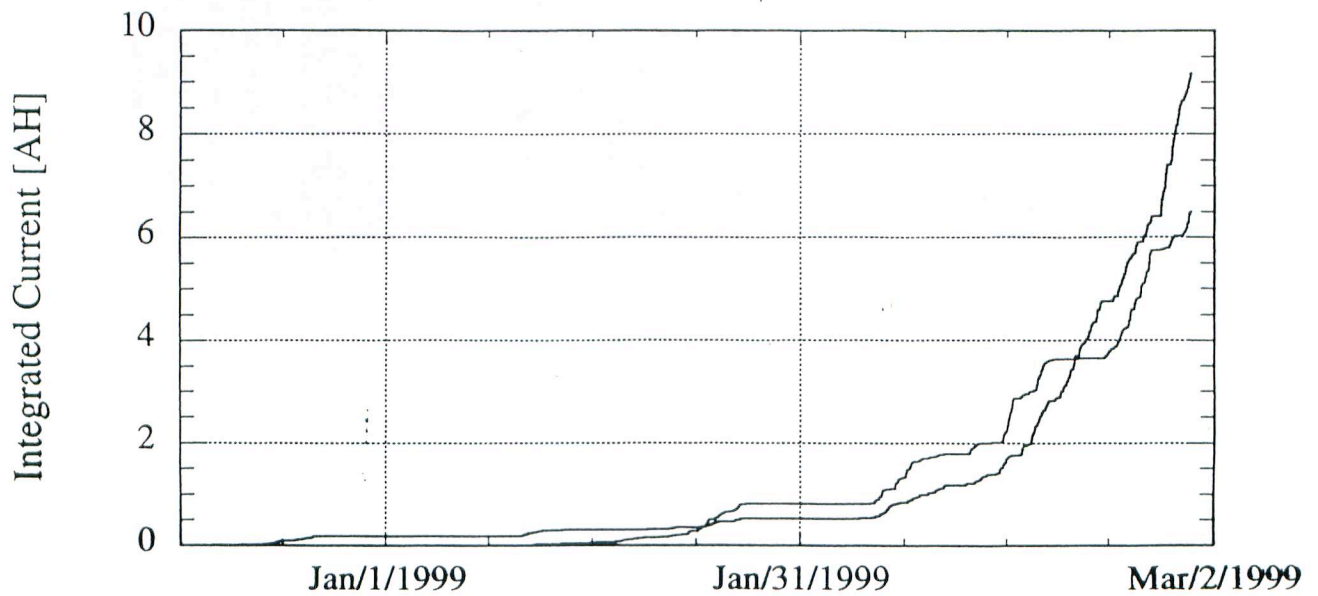
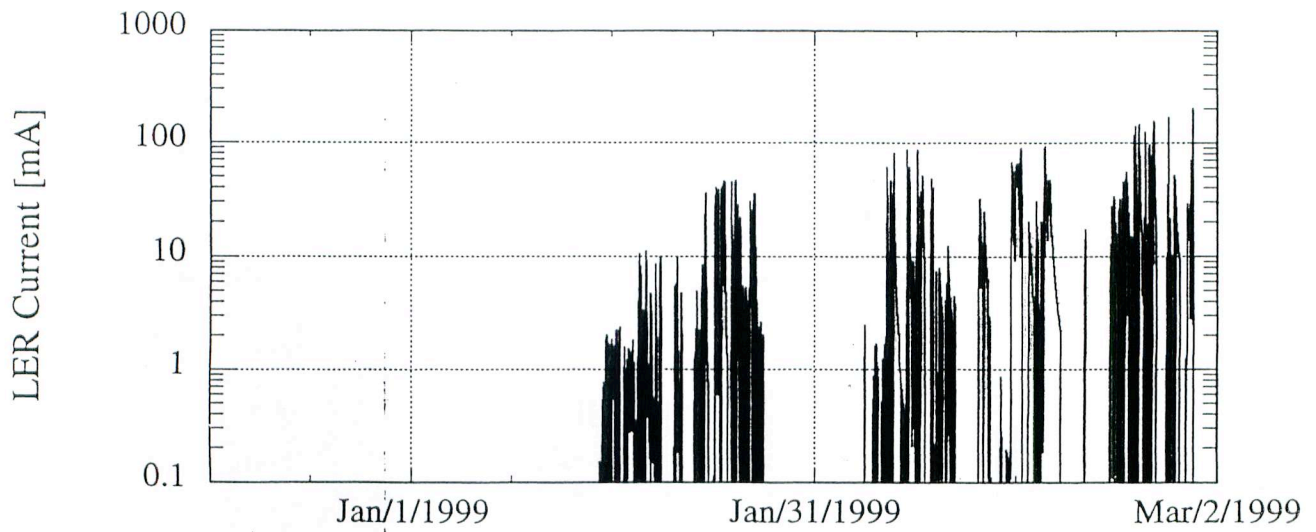
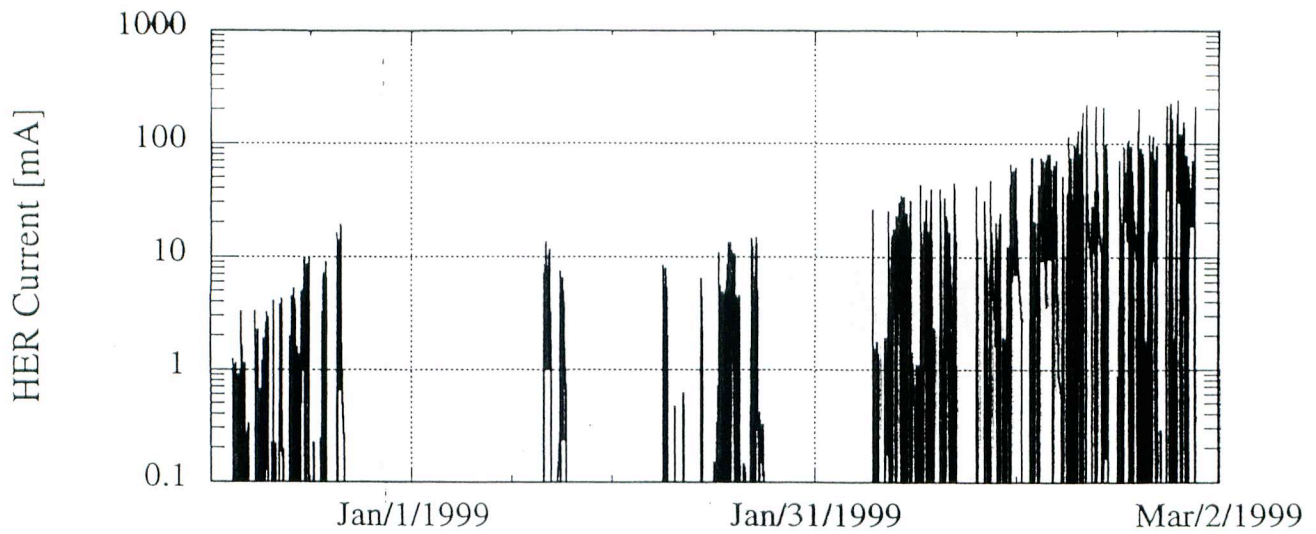


- 2/5** **Observation of beam collision**
- 2/5-2/28** **Tuning of both rings continued: by this day, stored currents in the rings reached 243 mA in LER and 200 mA in HER**
- 2/28** **Operation stop due to vacuum leak at IP**
- 99/3/6** **LER operation resumed**
- 3/8-3/10** **KEKB accelerator review**

KEKB 始動 !!

ChiSquare = 0.2008 Goodness = 43741
 $\beta_2 = 0.1000 \pm 0.0178$ $\gamma_0 = -0.0637 \pm 0.04903$ $\sigma_{max} = 385.055 \pm 10.639$
 $\beta_2 = 0.32E-2 \pm 7.87E-4$

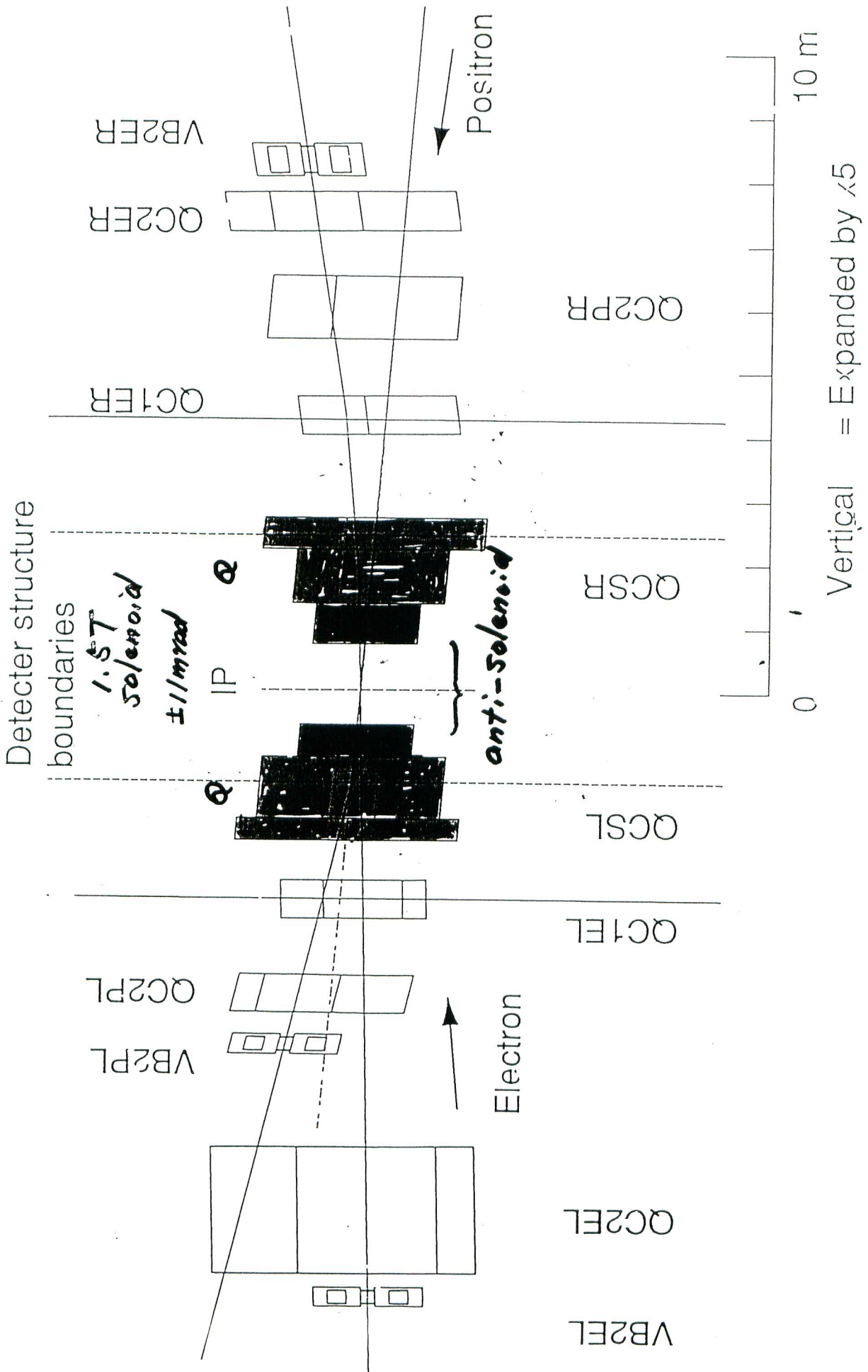


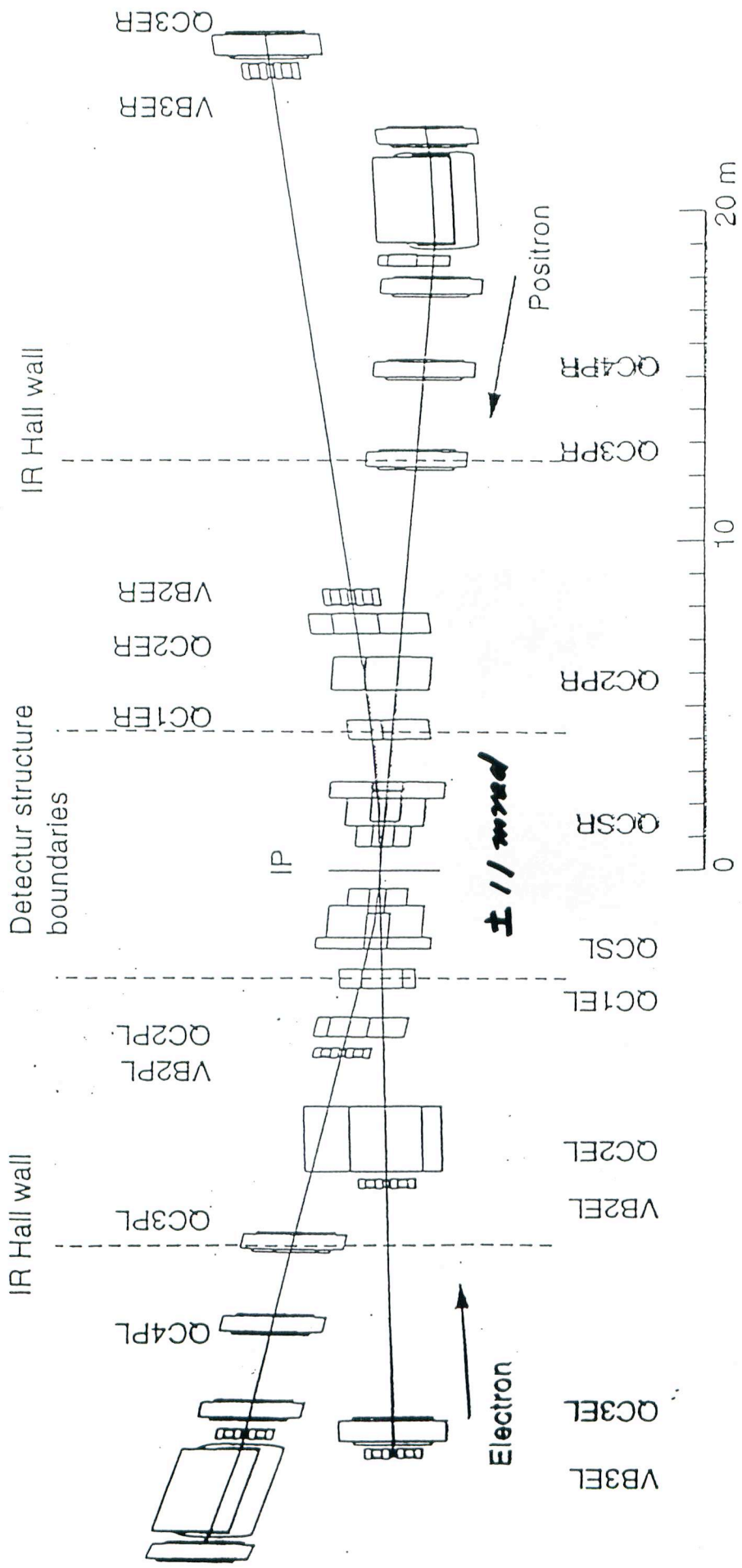


Vacuum leak at IP chamber and radiation shielding near IP

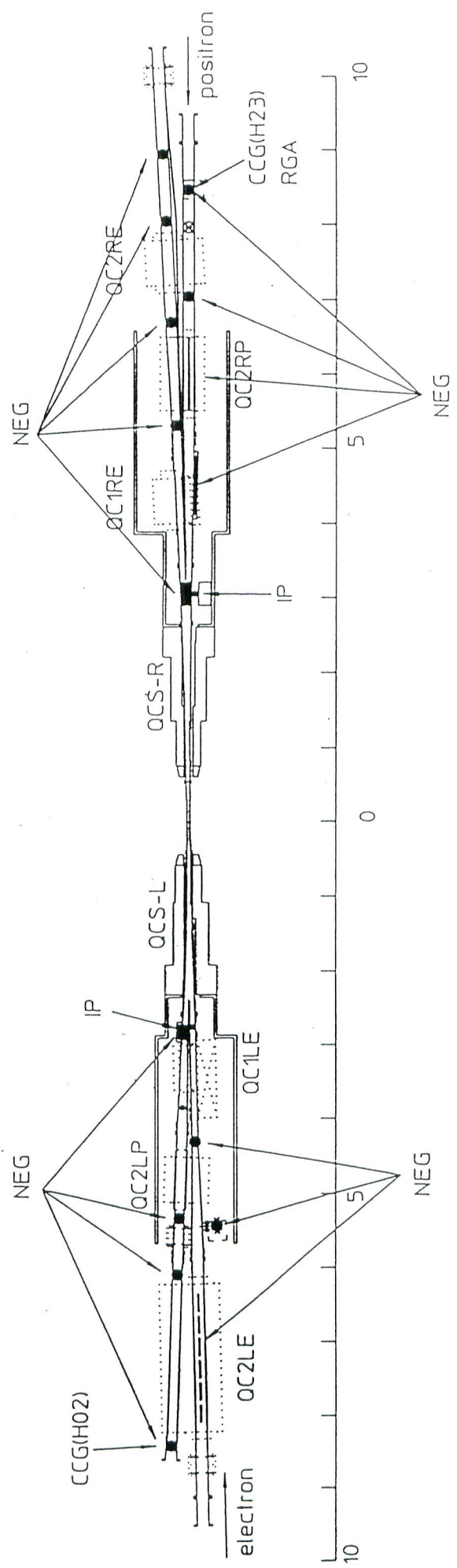
- 1. In the morning of February 28th, we had a sudden vacuum leak at one of the IP chamber. Vacuum of one third of each ring got worse and needed to be restarted from roughing pumping.**
- 2. We suspect that SR light from final-focus superconducting quads or HOMs trapped in the chamber heated up the chamber and made a crack.**

- 3. New chamber with better cooling and simplified shape will be reinstalled during March 15-18 shutdown.**
- 4. We are suffering from high radiation level around IP for HER operation, which sometime limit injection .**
- 5. Lead shielding arround the chamber will be added also during this shutdown, which may alleviate the radiation problem.**
- 6. Concrete shield will be added at the exits of tunnel near IP during March 15-18 shutdown.**



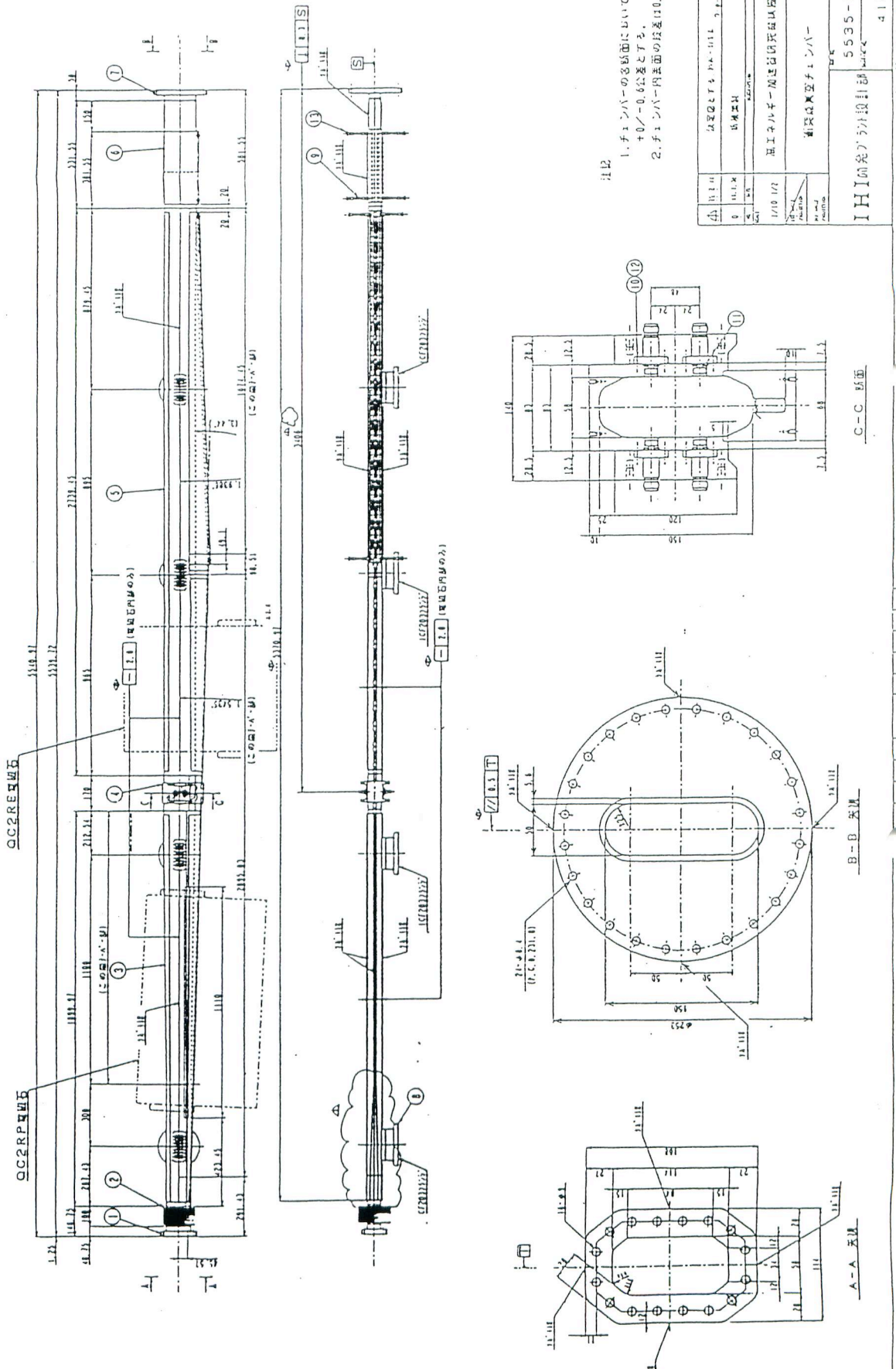


(Vertical scale: Expanded by x5)



品名	数量	単位	材料	規格	備注
1	1	個	鋼板	SPCC	
2	1	個	鋼板	SPCC	
3	1	個	鋼板	SPCC	
4	1	個	鋼板	SPCC	
5	1	個	鋼板	SPCC	
6	1	個	鋼板	SPCC	
7	1	個	鋼板	SPCC	
8	1	個	鋼板	SPCC	
9	1	個	鋼板	SPCC	
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11	1	個	鋼板	SPCC	
12	1	個	鋼板	SPCC	
13	1	個	鋼板	SPCC	
14	1	個	鋼板	SPCC	
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91	1	個	鋼板	SPCC	
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95	1	個	鋼板	SPCC	
96	1	個	鋼板	SPCC	
97	1	個	鋼板	SPCC	
98	1	個	鋼板	SPCC	
99	1	個	鋼板	SPCC	
100	1	個	鋼板	SPCC	

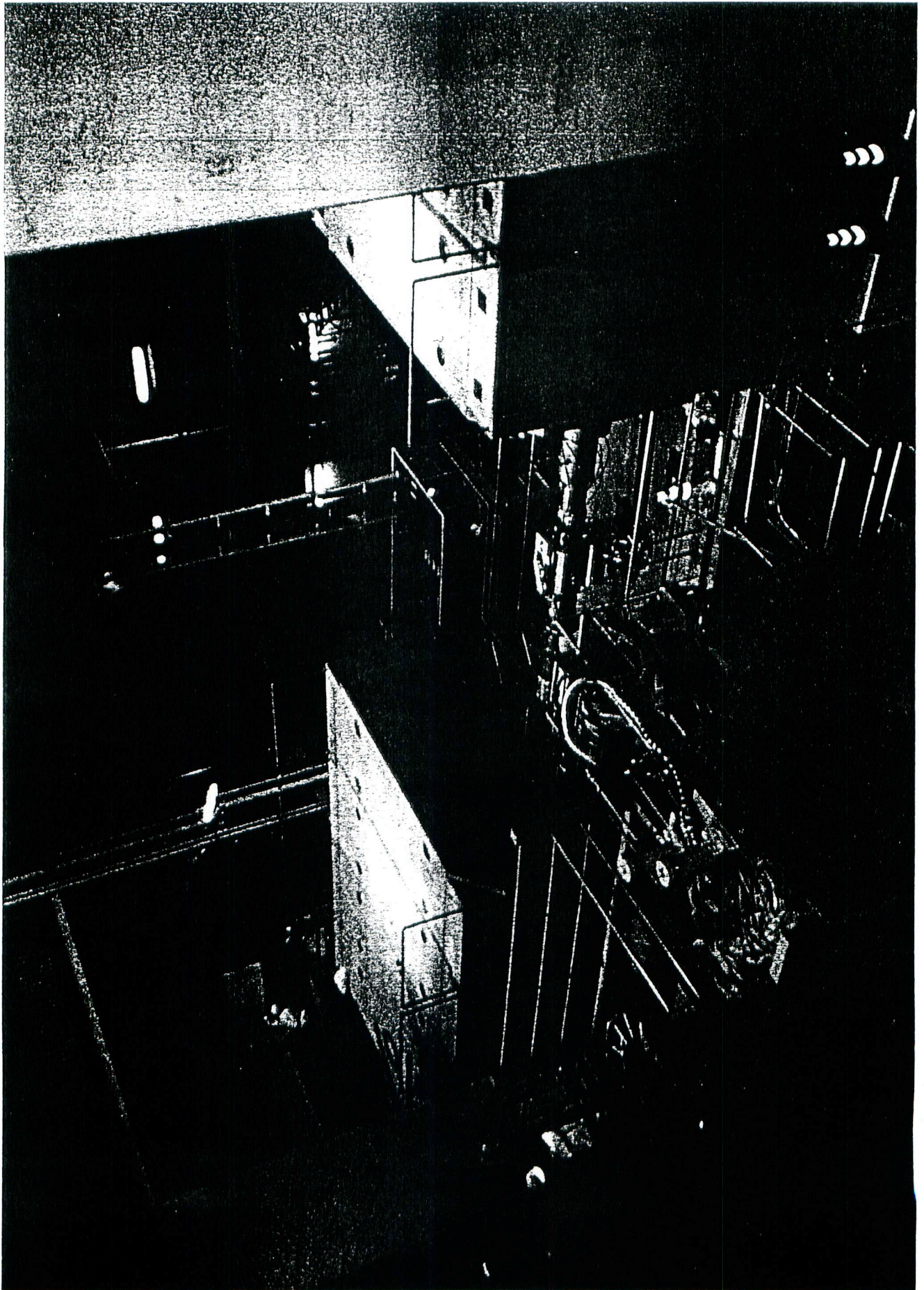
単位: 15



注記
 1. チェンバーの各断面において明記の寸法公差は全て $\pm 0/-0.06$ 公差とする。
 2. チェンバー内表面の公差は 0.3 以下を目標とする。

決定図		承認	
1	設計	承認	承認
2	製造	承認	承認
3	検査	承認	承認
4	出荷	承認	承認
5	納品	承認	承認
6	廃棄	承認	承認
7	修理	承認	承認
8	再検査	承認	承認
9	再製造	承認	承認
10	再出荷	承認	承認
11	再納品	承認	承認
12	再廃棄	承認	承認
13	再修理	承認	承認
14	再再検査	承認	承認
15	再再製造	承認	承認
16	再再出荷	承認	承認
17	再再納品	承認	承認
18	再再廃棄	承認	承認
19	再再修理	承認	承認
20	再再再検査	承認	承認
21	再再再製造	承認	承認
22	再再再出荷	承認	承認
23	再再再納品	承認	承認
24	再再再廃棄	承認	承認
25	再再再修理	承認	承認

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Near Future Schedule

- 3/15-3/18** Reinstallation of a vacuum chamber at IP and strengthen of shielding near IP
- 3/18-4/19** Commissioning of both LER and HER continued
- 4/19-5/24** BELLE roll-in
- 5/24-7/E** Operation with BELLE
- 99/10 (?)** Operation with BELLE
-12
- 00/1-6** Operation with BELLE

Commissioning Plan

Feb 22, '99

	3	4	5	6	7	8	9
PF		4/12 - 4/28	5/10 - 7/1				
AR-v1		4/19 - 5/24	6/4 - 7/10				
AR-v2		4/19 - 5/24	6/10 - 7/20				
KEKB	Beam C'ng -> 4/19	4/19 - 5/24 4/19 : Belle Roll-in	5/24 - 7/31 - 5 w - - 2 w - tuning	5/24 - 7/31 : Experiment			
PEP II	2/22 : Babar Roll-in		5/7 - 8/31 : Experiment				

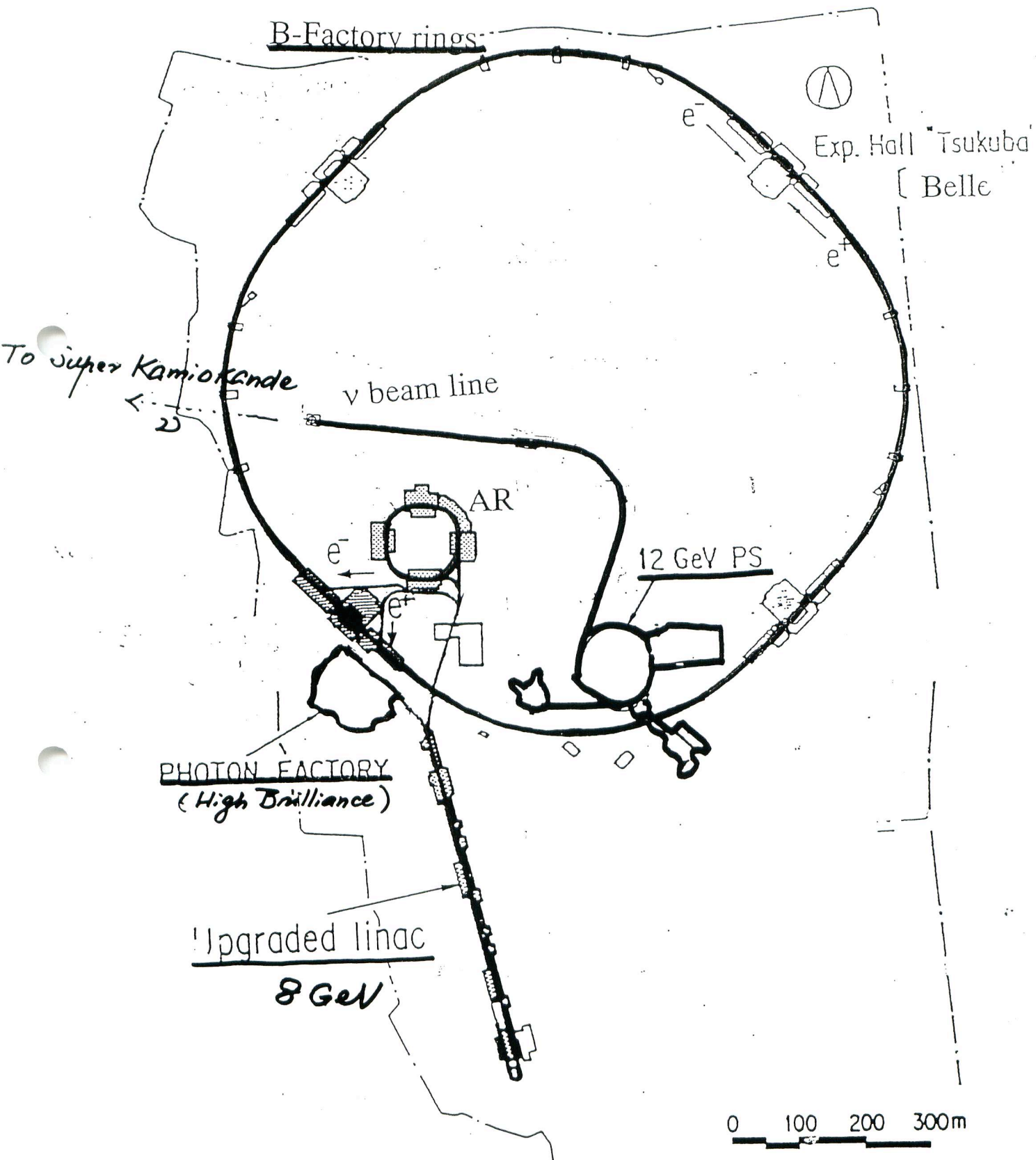
LP-99

Sharing of linac among 4 rings

	e^-/e^+	Energy (GeV)	Inj./ day
HER	e^-	8	~20
LER	e^+	3.5	~20
PF-AR	e^-	2.5	~10
PF-2.5 GeV	e^-	2.5	~2

1. We had a problem of changing linac mode between KEKB and PF-2.5 GeV ring. Sometimes former conditions could not be recovered.
2. From June, the linac should supply beams into 4 rings.

3. Task force led by Prof. Kihara has been established for the issue of sharing linac.



Future Upgrade

1. Summer 1999

Addition of 12-14 ARES cavities in LER (6-8) and HER (6).

Number will be reduced if the summer shutdown is short.

2. Summer 2000

Addition of 4 superconducting cavities in HER.

3. Summer 2001(?)

Addition of 4 superconducting crab cavities in the IP straight section.

Summary

1. **KEKB was completed by the end of November 1998; this is 35 months after the termination of TRISTAN in December 1995 and 2 months behind the schedule set early 1998.**
2. **Commissioning of KEKB started on December 1 and is progressing step by step.**
3. **Though a few problems have yet to be solved, the commissioning shows that basic hardware of KEKB is working well:**

- (1) magnets are correctly measured and alligned
- (2) vacuum has tight enough joints and η is decreasing as designed
- (3) BPM has a good resolution; SR interferometer is working; feedback system is tabilizing the beams
- (4) RF system is quite stable
- (5) Beam tranport system is working well
- (6) Linac is supplying 8 GeV e^- and 3.5 GeV e^+

4. A lot of works should be done before the start of roll-in of BELLE on April 19th.