5

Magnet System in KEK B Factory

Magnet Group

Ryuhei Sugahara

1. Magnets

2. Magnetic Field Measurement

3. Power Supply

4. Installation

5. Schedule

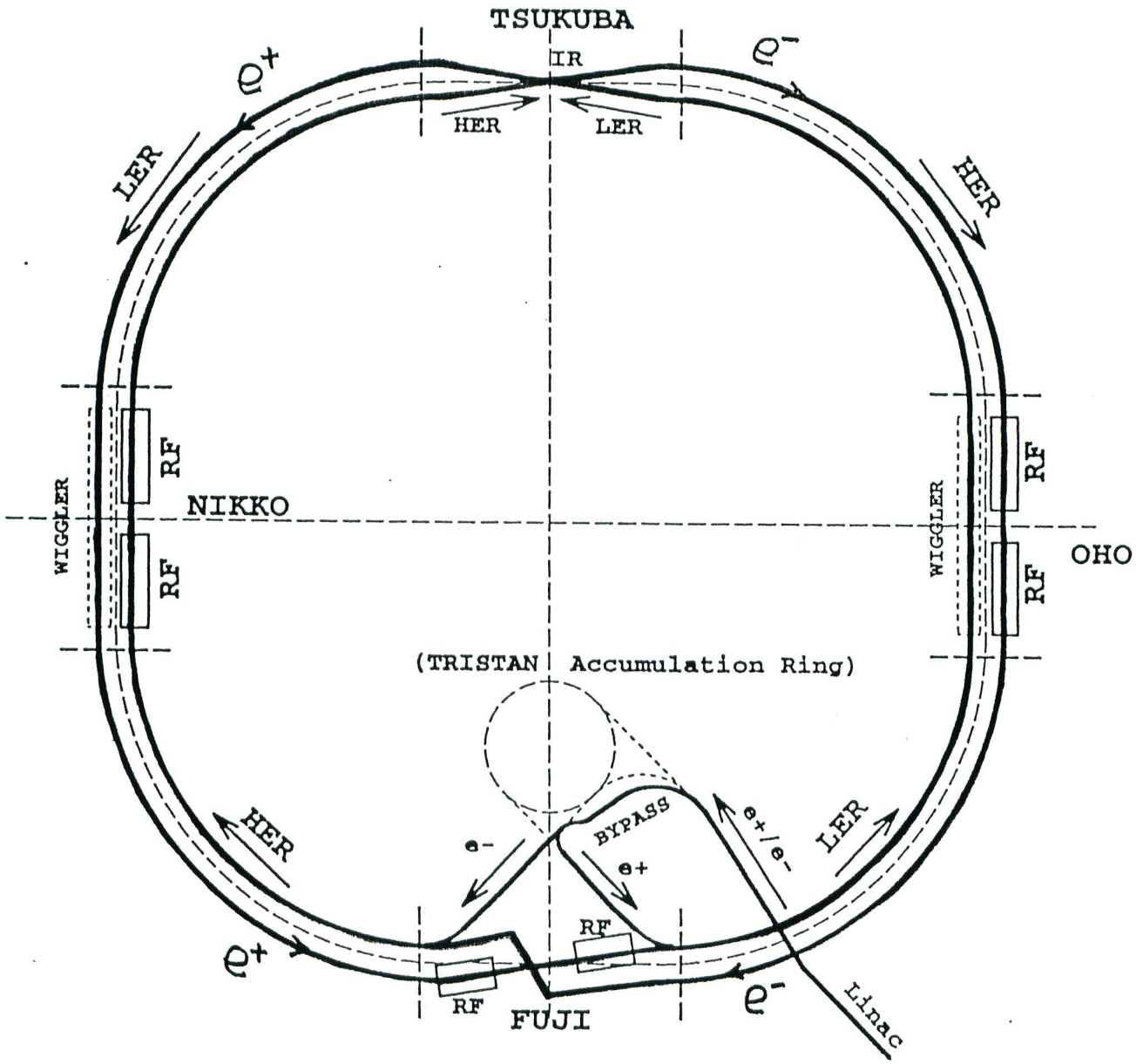
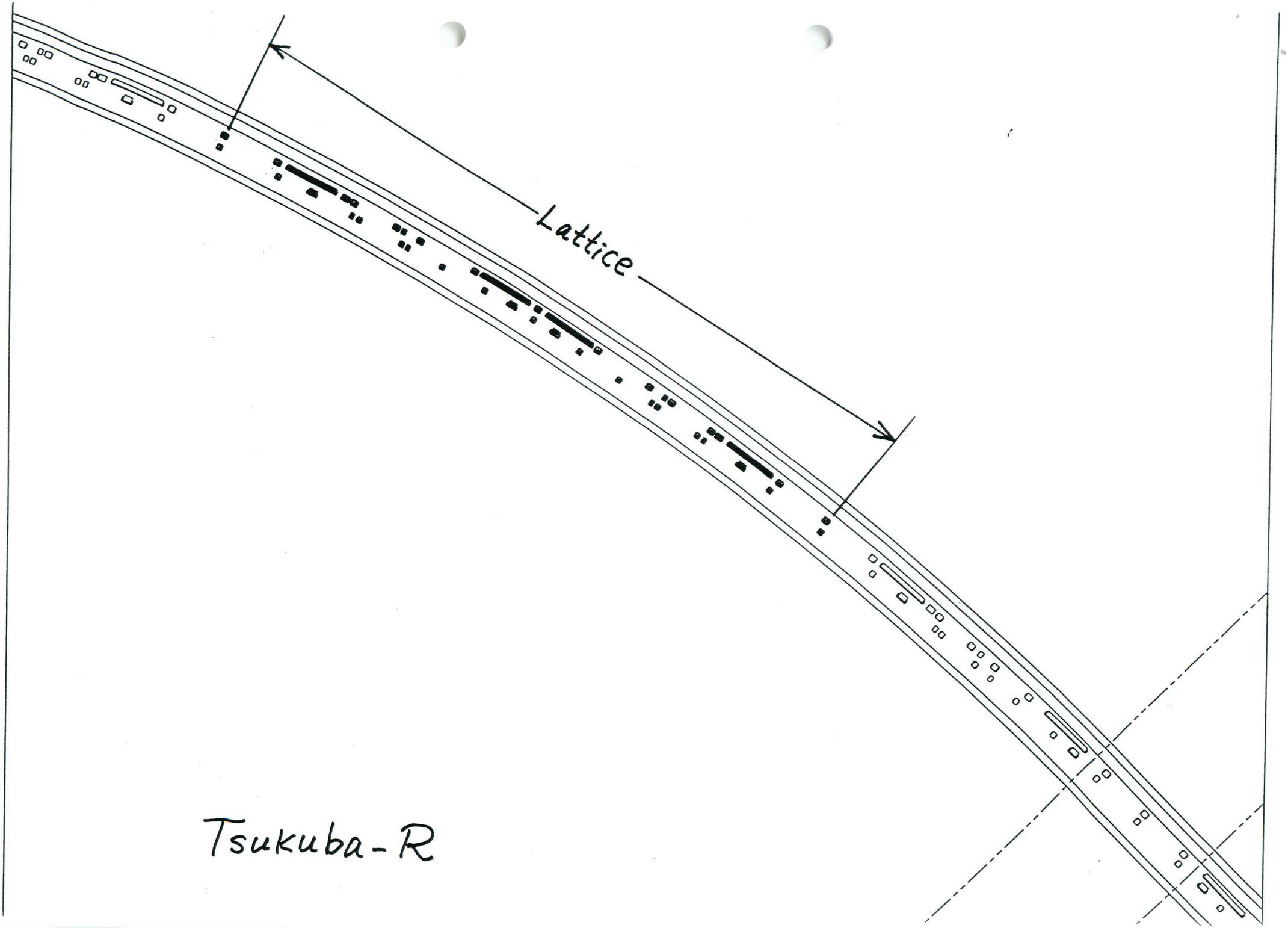
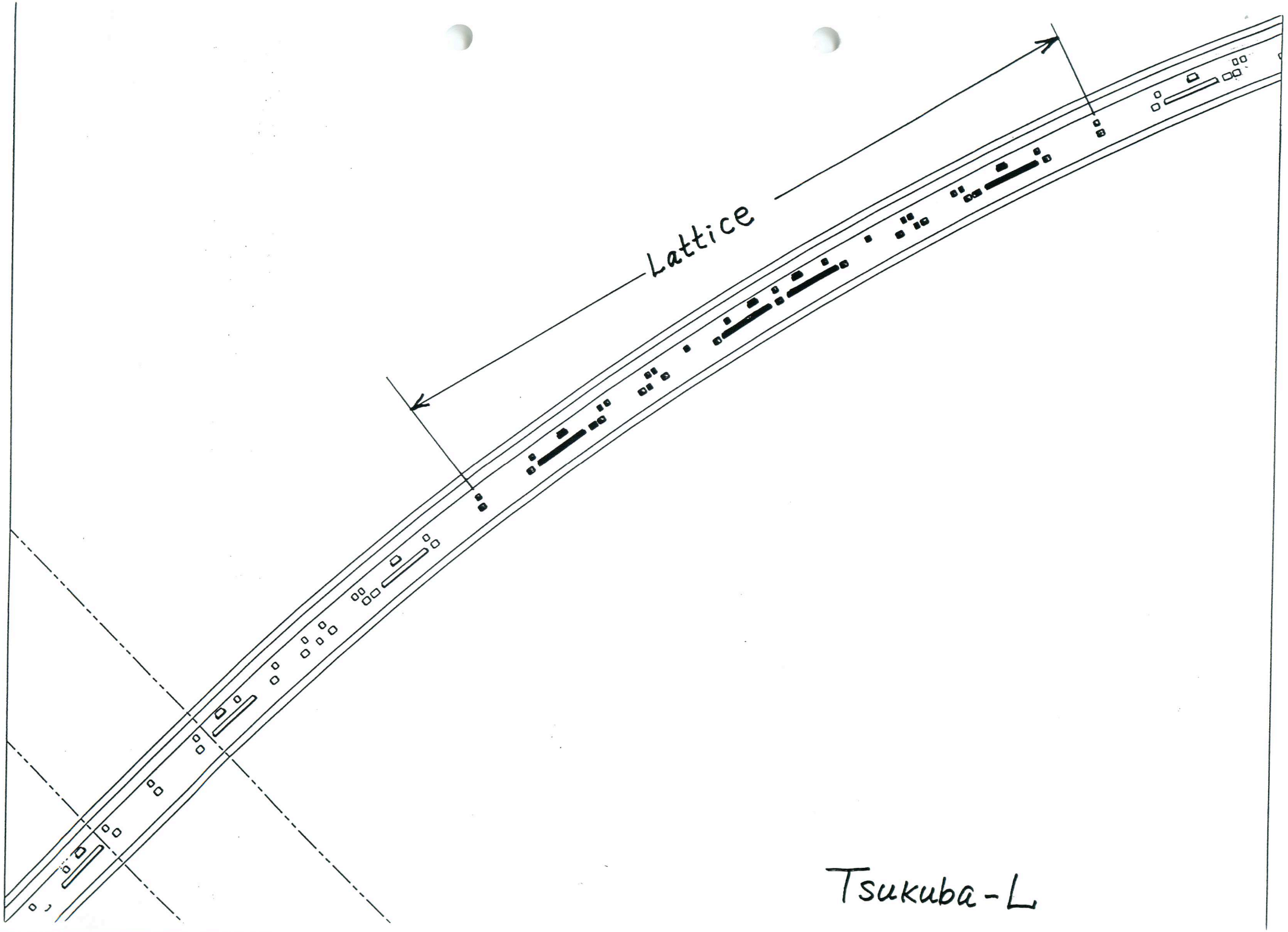
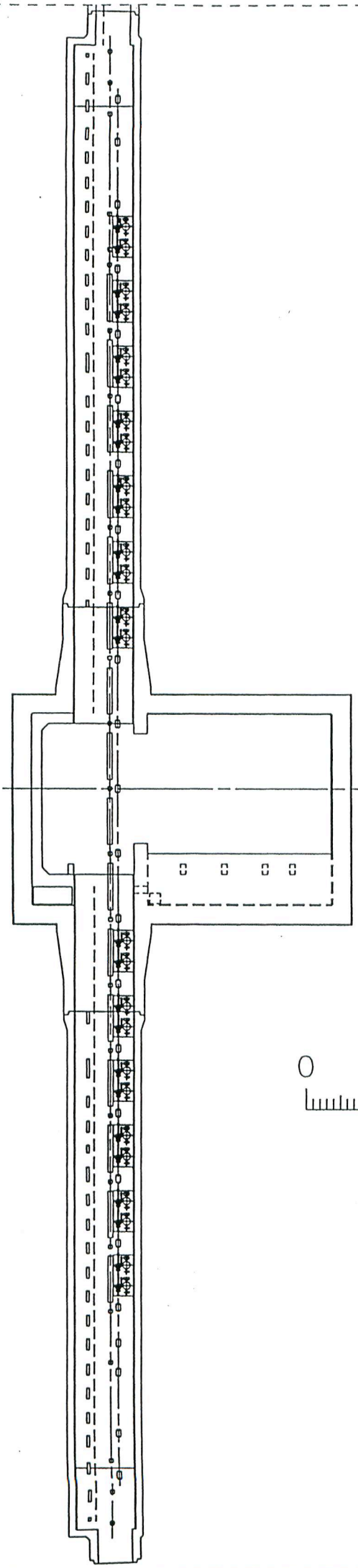


Figure 1: Configuration of KEKB accelerator system.


Lattice
Tsukuba-R


Lattice
Tsukuba-L

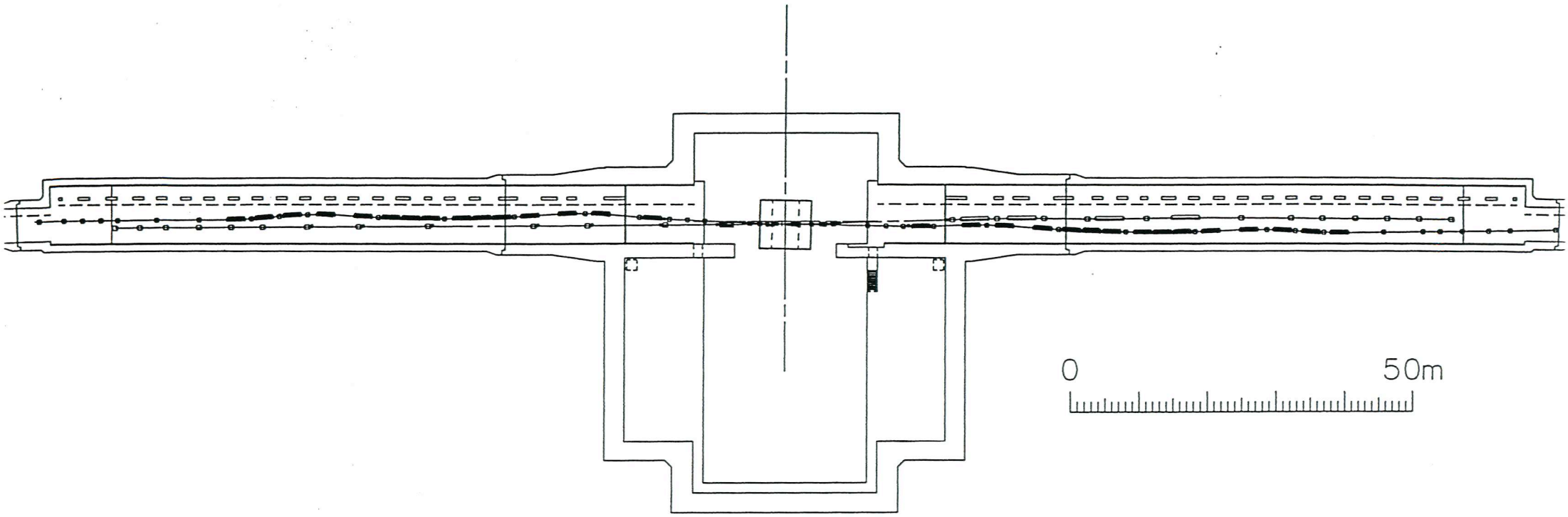


Nikko

0 50m

95-5-1

2-FRONT



Tsukuba

Designation	Half gap or bore radius (mm)	Lamination length (m)	B (T), B' (T/m), or B'' (T/m^2)	Number of magnets	Usage	Comments
Dipole magnets						
Barc	57	0.76	0.848	108	normal bend	new
	57	0.76	0.848	8	half bend	new
	57	0.76	0.08	2	crossing	new
	57	0.76	0.848	16	chicane	new
B_{lc}	57	2.5	0.42	30	local correction	new
B_v	57	1.5	0.2	4	vertical bend	new
B_t	57	0.3	0.65	3	near IR	new
Quadrupole magnets						
Q_{arc}	55	0.4	10.3	436	arc, straight	new
Q_{rf}	80	0.5	6.6	16	RF section	new
Sextupole magnets						
SxF	56	0.39	350	~~52~~ 56	focus	recycle SxF(TR)
SxD.1	56	0.39	350	~~44~~ 40	defocus	recycle SxF(TR)
SxD.2	56	0.54	350	8	defocus	recycle SxD(TR)

Table 9.1: LER Magnet types.

Designation	Half gap or bore radius (mm)	Lamination length (m)	B (T), B' (T/m), or B'' (T/m^2)	Number of magnets	Usage	Comments
Dipole magnets						
B_{arc}	35	5.804	0.3	112	normal bend	recycle
	35	5.804		2	crossing	recycle
Quadrupole magnets						
Q_{arc}	50	0.6	10.9	144	arc, straight	new
Q_{rf}	80	1.0	6.6	32	RF section	new
QA	50	0.762	8.5	184	arc, straight	recycle
QB	50	0.95	8.5	92	arc, straight	recycle
Sextupole magnets						
SxF	56	0.54	350	52	focus	recycle
SxD	56	0.80	350	52	defocus	new

SxD(TR)

Table 9.2: HER Magnet types.

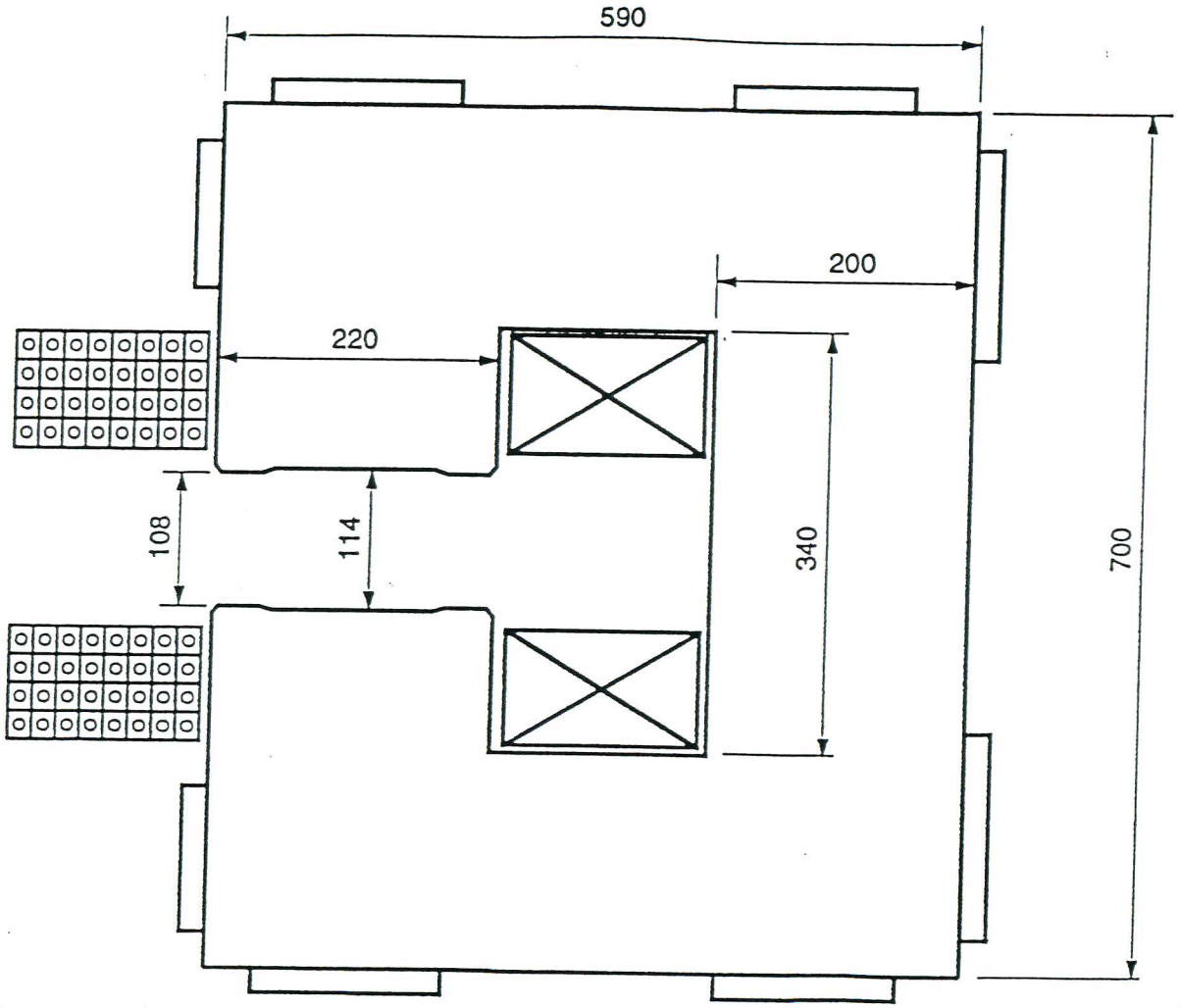


Figure 9.1: A cross section view of the preliminary design of a LER dipole magnet (B_{arc}).

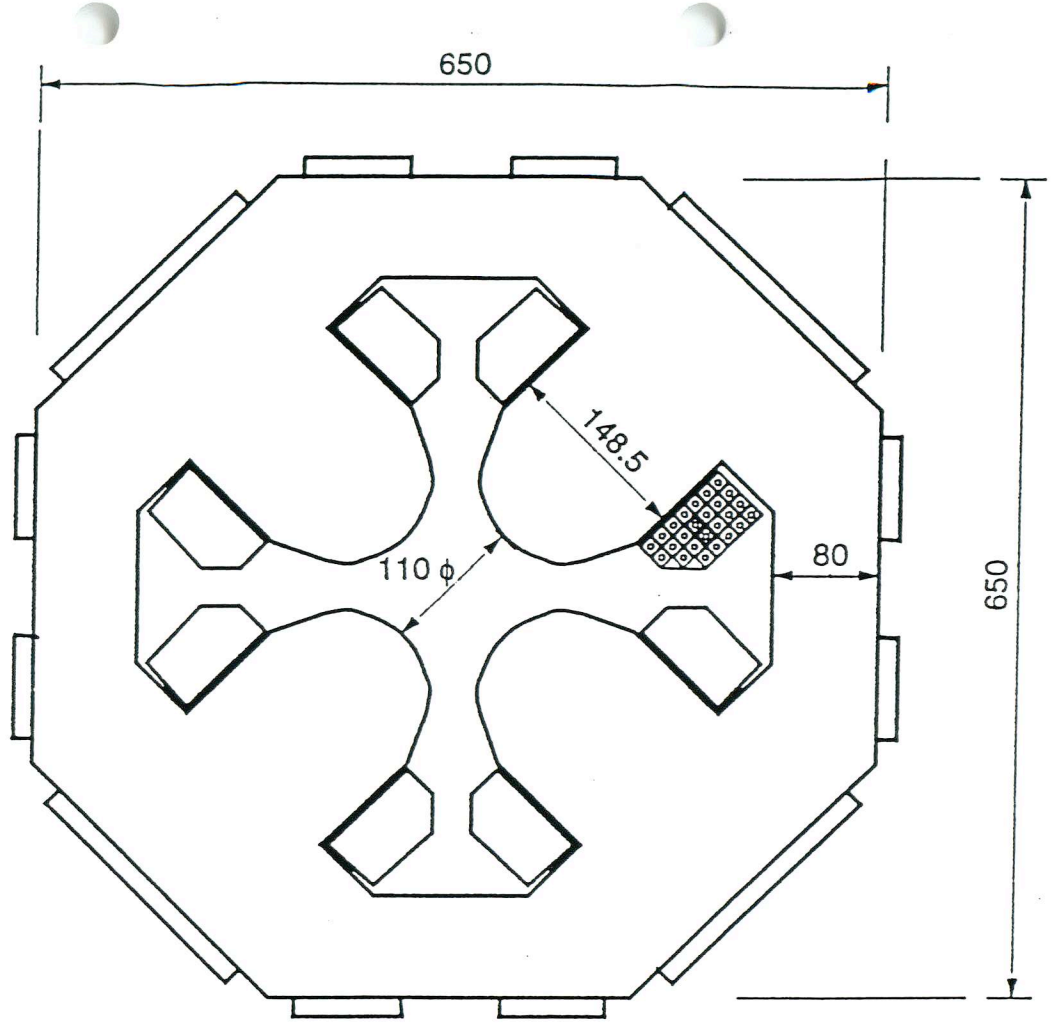


Figure 9.2: A cross section view of the preliminary design of a LER quadrupole magnet (Q_{arc}).

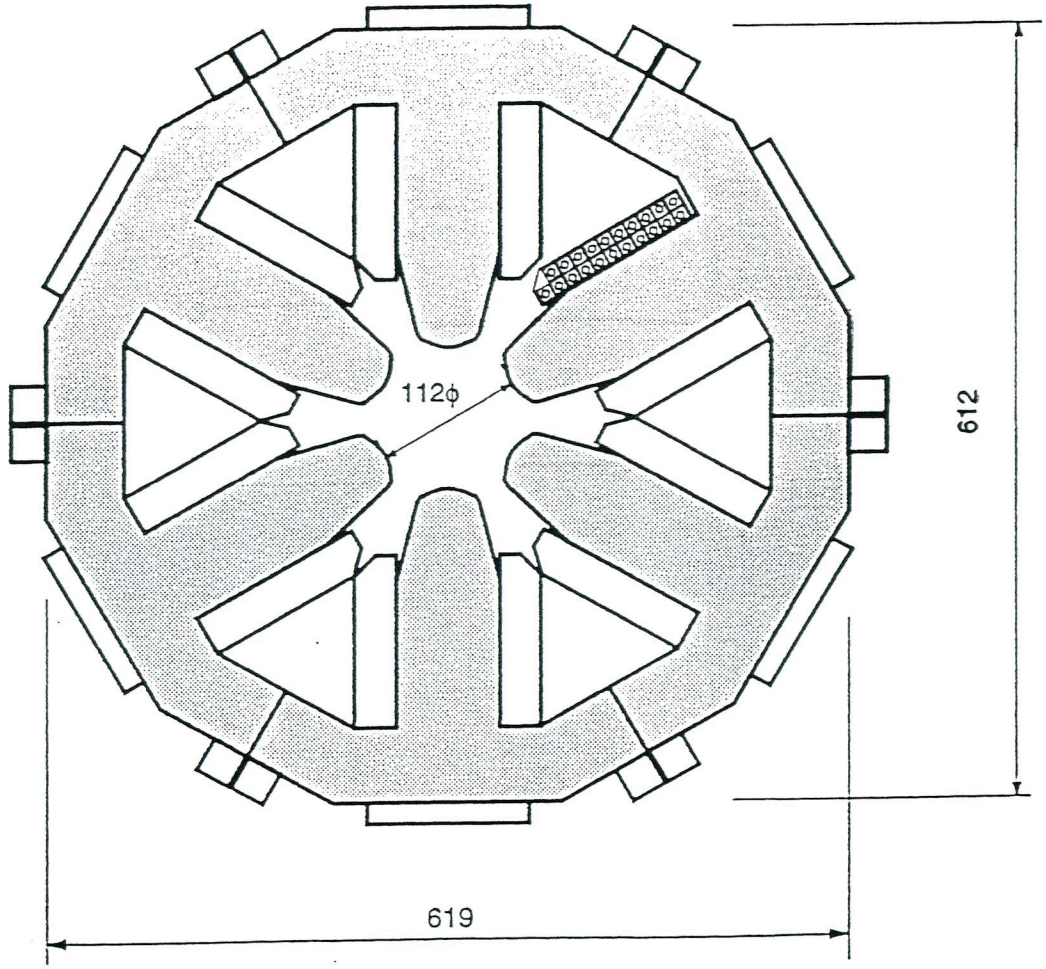
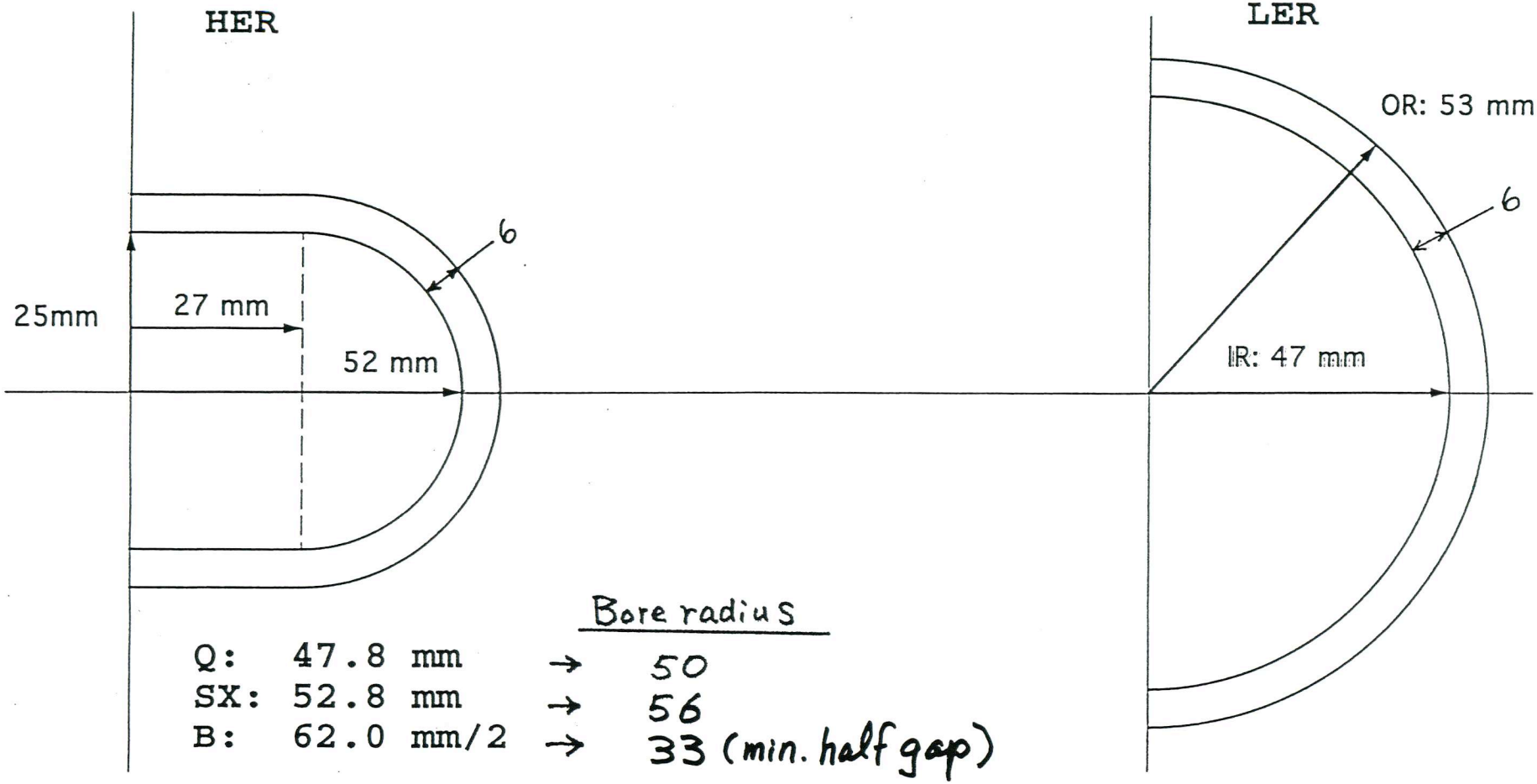


Figure 9.3: A cross section view of the preliminary design of a LER sextupole magnet.



Bore radius

Q: 47.8 mm → 50
SX: 52.8 mm → 56
B: 62.0 mm/2 → 33 (min. half gap)

(※ TRISTAN
MR MG. B: 66.3 mm/2
Q: 50.0 mm
SX: 56.0 mm)

Bore radius

Q : 55
Sx : 56
B : 54 (min. half gap)

	Tolerance at 50 mm radius
Dipole magnets	$B_3/B_1 < 0.12$ %
	$B_5/B_1 < 0.45$ %
Quadrupole magnets	$B_6/B_2 < 0.12$ %
	$B_{10}/B_2 < 0.14$ %

Table 9.3: Tolerances of systematic multipole errors

Dipole		
Field uniformity within the aperture (±60 mm)	$< \pm 2 \times 10^{-4}$	
Integral dipole strength error $\Delta L_B/L_B$	$\sigma = 4.1 \times 10^{-4}$	for $B = 0.97$ kG
	4.0×10^{-4}	4.2
	4.8×10^{-4}	5.2
	0.028	remanent
Gap error $\Delta g/g$	$\sigma = 2.8 \times 10^{-4}$	
Core length error $\Delta L/L$	$\sigma = 0.8 \times 10^{-4}$	
Quadrupole (QA) $\ell = 0.8m$		
High multipoles at aperture / Quadrupole field	$< 2 \times 10^{-4}$	with end shim
Integral quadrupole strength error $\Delta L_q/L_q$	$\sigma = 4.2 \times 10^{-4}$	for $g = 4.7$ T/m
	7.9×10^{-4}	18.2
	9.6×10^{-4}	21.
	0.046	remanent
Bore error $\Delta r/r$	$\sigma = 1.2 \times 10^{-4}$	
Core length error $\Delta L/L$	$\sigma = 1.7 \times 10^{-4}$	
Quadrupole (QB) $\ell = 1m$		
High multipoles	almost the same as QA	
Integral quadrupole strength error $\Delta L_q/L_q$	$\sigma = 4.0 \times 10^{-4}$	for $g = 4.7 \sim 21.7$ T/m
Insertion Quadrupole Magnets		
Integral quadrupole strength error $\Delta L_q/L_q$	$\sigma = 5.0 \times 10^{-4}$	for $g = 3.5 \sim 16$ T/m
Sextupole Magnets		
High multipoles at aperture / Sextupole field	18 poles $< 3 \times 10^{-3}$	
	others $< 1 \times 10^{-3}$	
Integral sextupole strength error $\Delta L_s/L_s$	$\sigma = 2.1 \times 10^{-3}$	for SXF at 350 T/m^2
	2.3×10^{-3}	for SXD

Table 9.4: Performance of the TRISTAN magnets for reference.

	LER	HER
Steering: STV		
Number of Magnets	450	450
Bore radius	80 mm	80 mm
Lamination core length	0.2 m	0.2 m
Total length	< 0.3 m	< 0.35 m
Required kick angle	1 mrad	1 mrad
Current $\times$ turns/pole	5 A $\times$ 760	5 A $\times$ 1700
Steering: STH		
Number of Magnets	450	450
Bore radius	80 mm	80 mm
Lamination core length	0.2 m	0.2 m
Total length	< 0.3 m	< 0.35 m
Required kick angle	1 mrad	1 mrad
Current $\times$ turns/pole	5 A $\times$ 760	5 A $\times$ 1700

Table 9.10: Parameters of the steering correction magnets for the LER and HER.

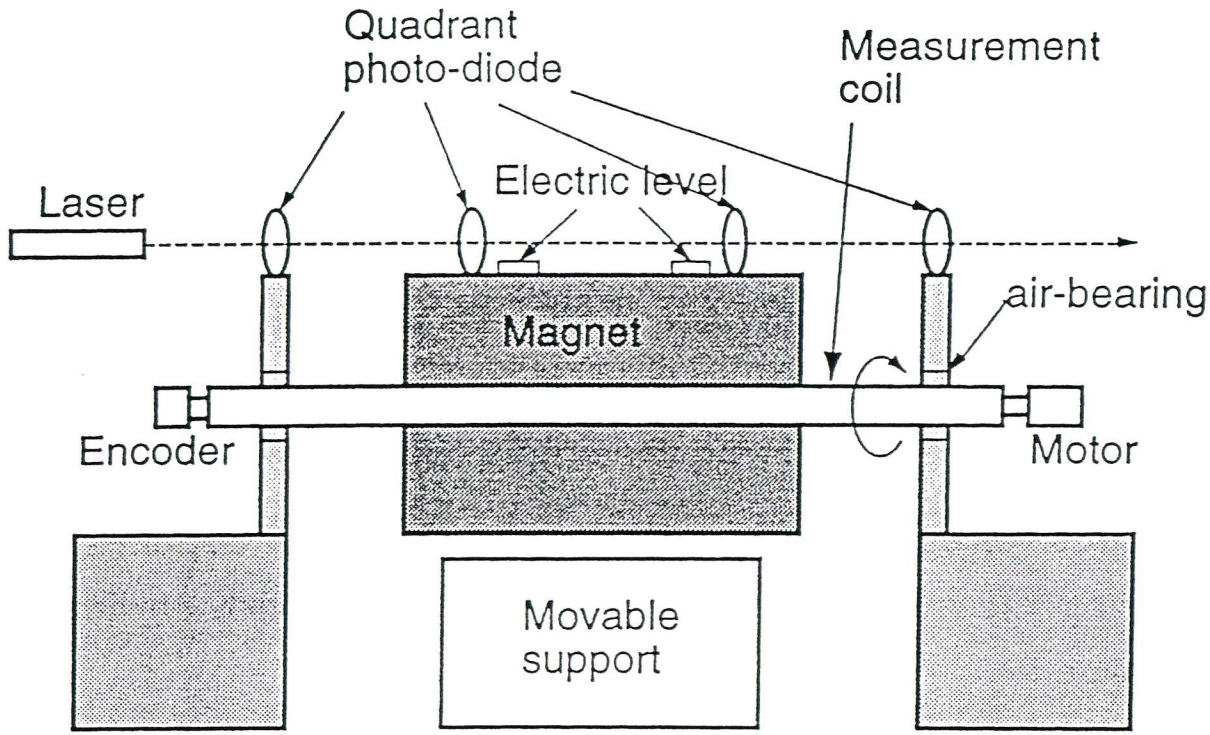


Figure 9.4: A schematic view of the magnetic field measurement system using a rotating coil.

Ring	Magnet type	Voltage (V)	Current (A)	Number of units		Total
LER	Dipole	1400	1250	1 (1	)	
		150	1250	1 (1	)	
		25	1250	3 (3	)	
			1250	4 (	4)	
	Wiggler		1250	8 (	8)	
						17
	Quadupole	800	500	5	5)	
		500	500	2	2)	
		90	500	6		
		40	500	40	(36+64)	
		25	500	36		
				18		
						107
	Sextupole	40	425	52	52	52
	Steering			886	886	886
HER	Dipole	1400	840	1 (1	)	
		25	840	2 (	2)	
			840	2 (	2)	
						5
	Quadrupole	900	500	5 (4	1)	
		500	500	2 (	2)	
		130	500	4		
		90	500	2		
		45	500	40	(36+63)	
		30	500	37		
				16		
						106
	Sextupole	65	425	24 (	24)	
		40	425	28 (	28)	
						52
	Steering			886 (	886)	886

Preliminary

Table 9.11: The list of magnet power supplies required at KEKB.

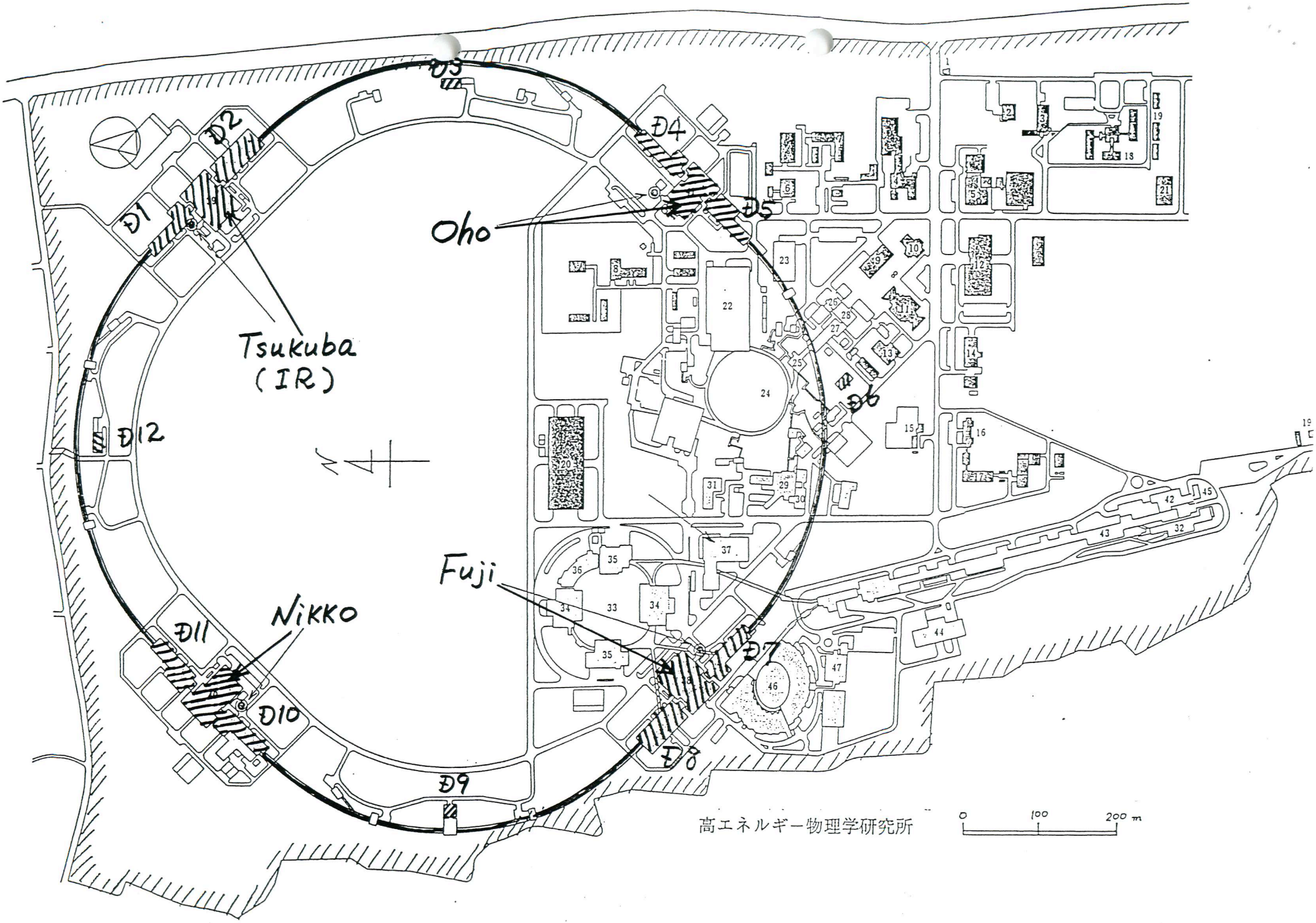
recycled

new PS

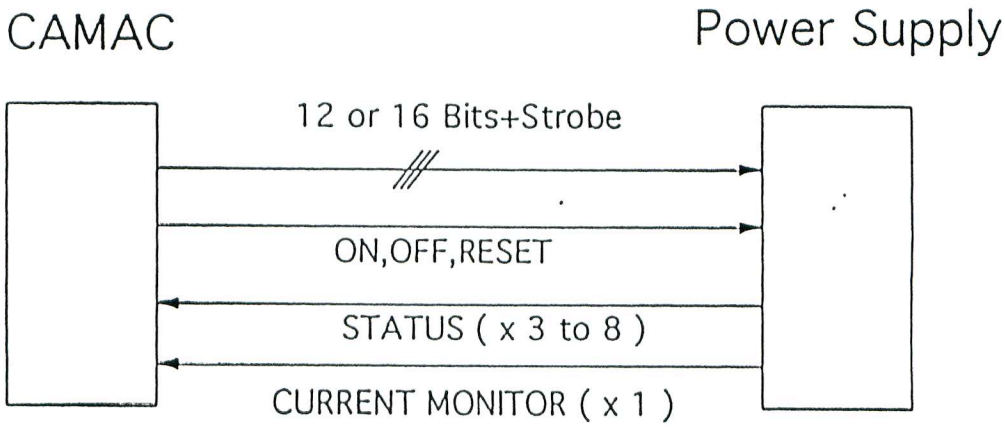
Number of Power Supplies

I (A)	VI (VA)	KEKB Recycled	KEKB New	TRISTAN
> 1000	> 1M	1		8
	1M - 500k			
	500k - 100k	1		44
	< 100k	3	12	32
1000 - 400	> 1M	1		
	1M - 500k			
	500k - 100k	4	10	6
	< 100k	72	235	
< 400	< 20k			21
Total Number		82	257	111
Steering mag.			900 (+900*)	520

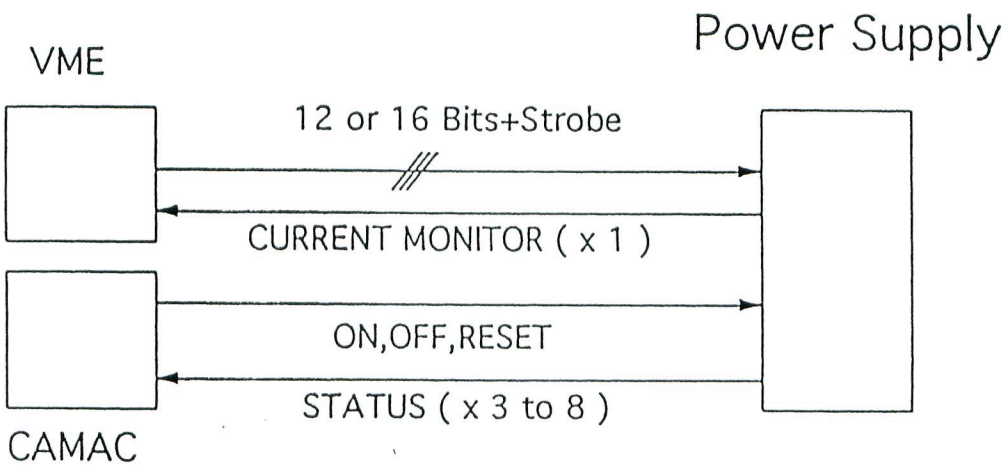
* Those may not exist at the first stage.


D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
Oho
Tsukuba
(IR)
Fuji
Nikko
高エネルギー物理学研究所
0
100
200 m

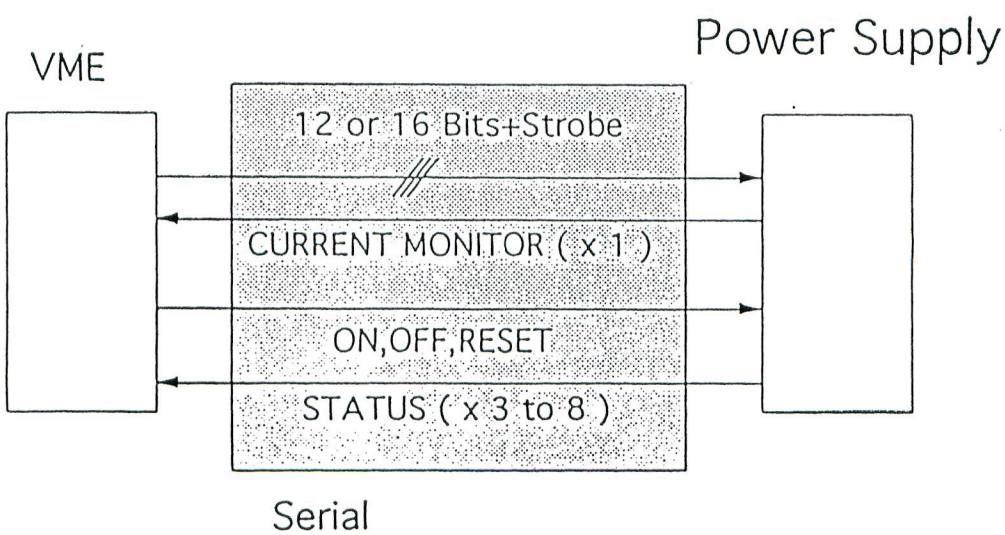
TRISTAN

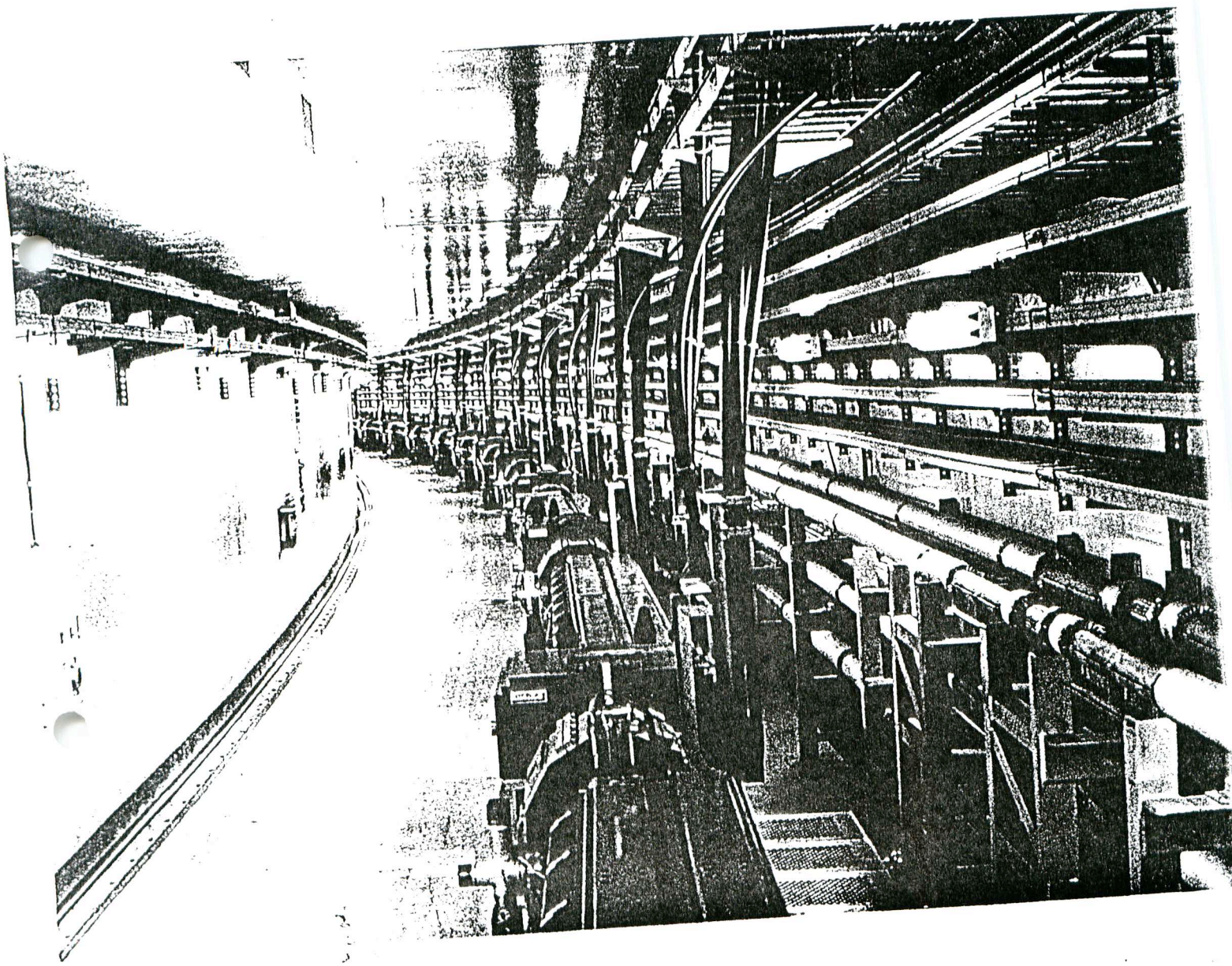


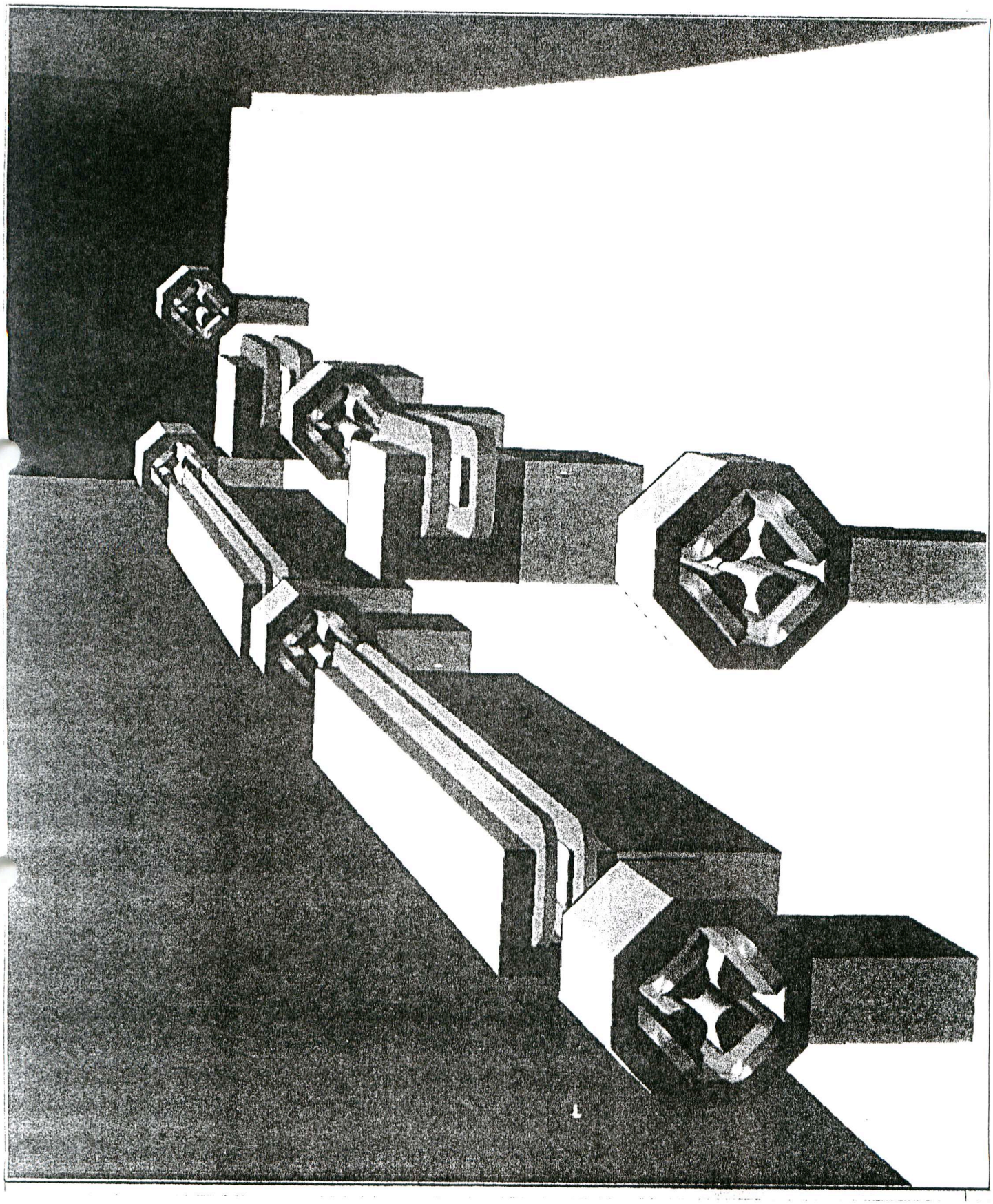
B-factory

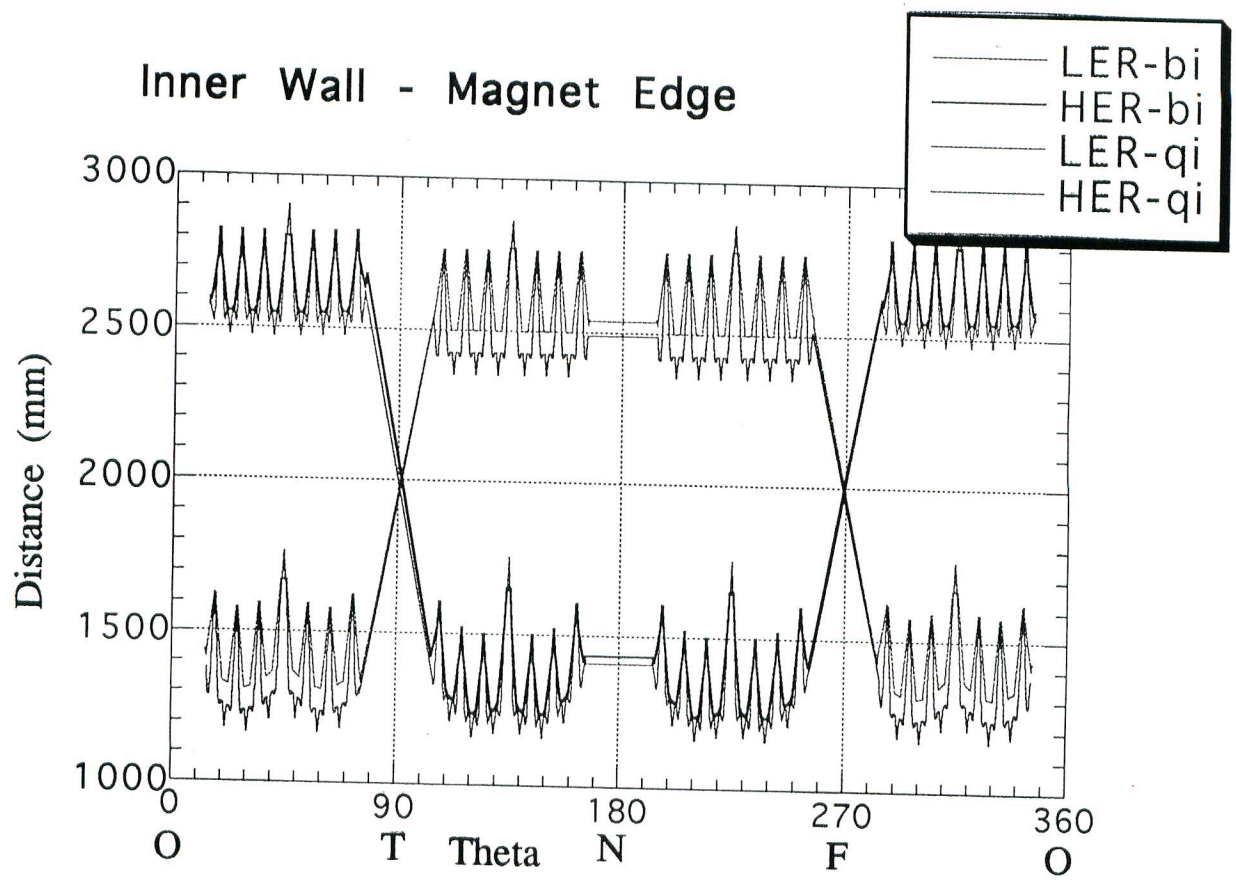


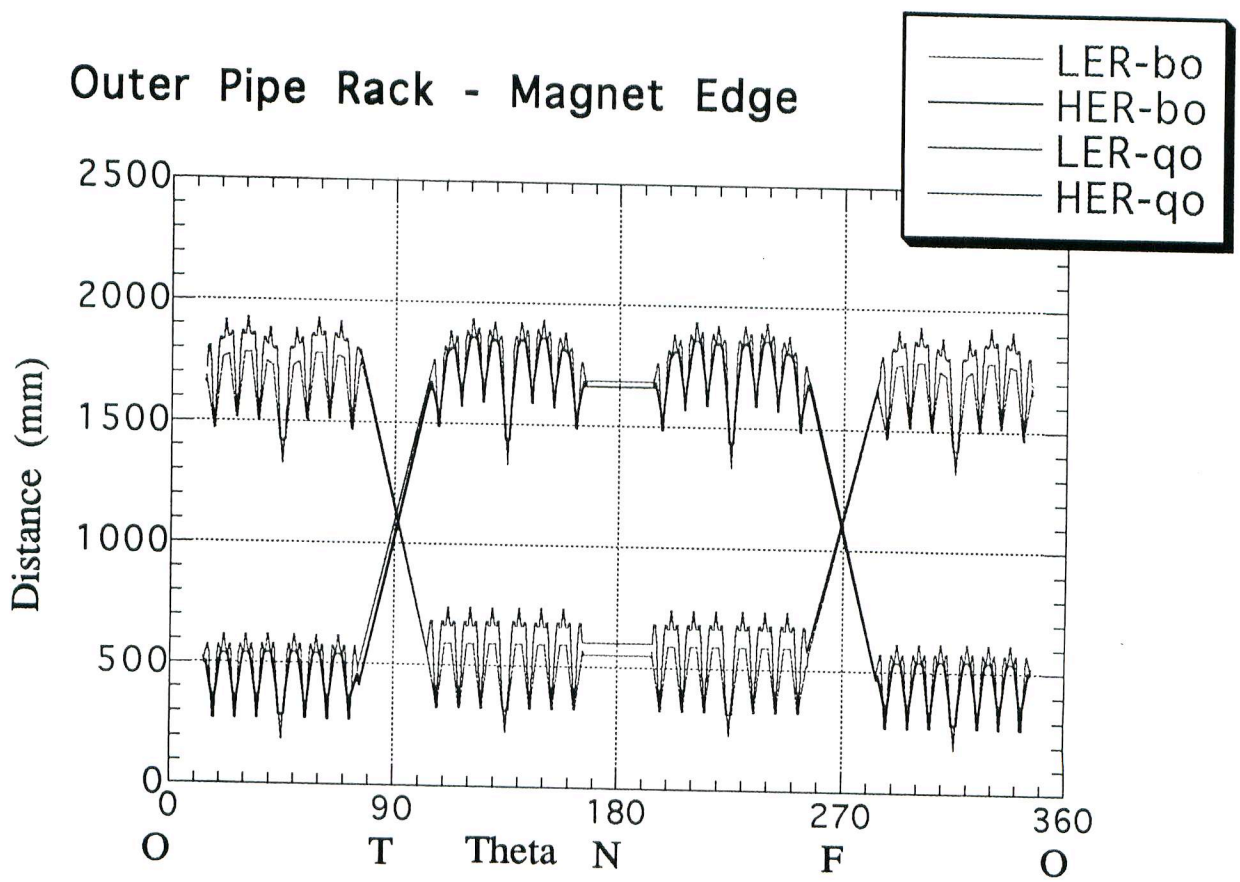
or

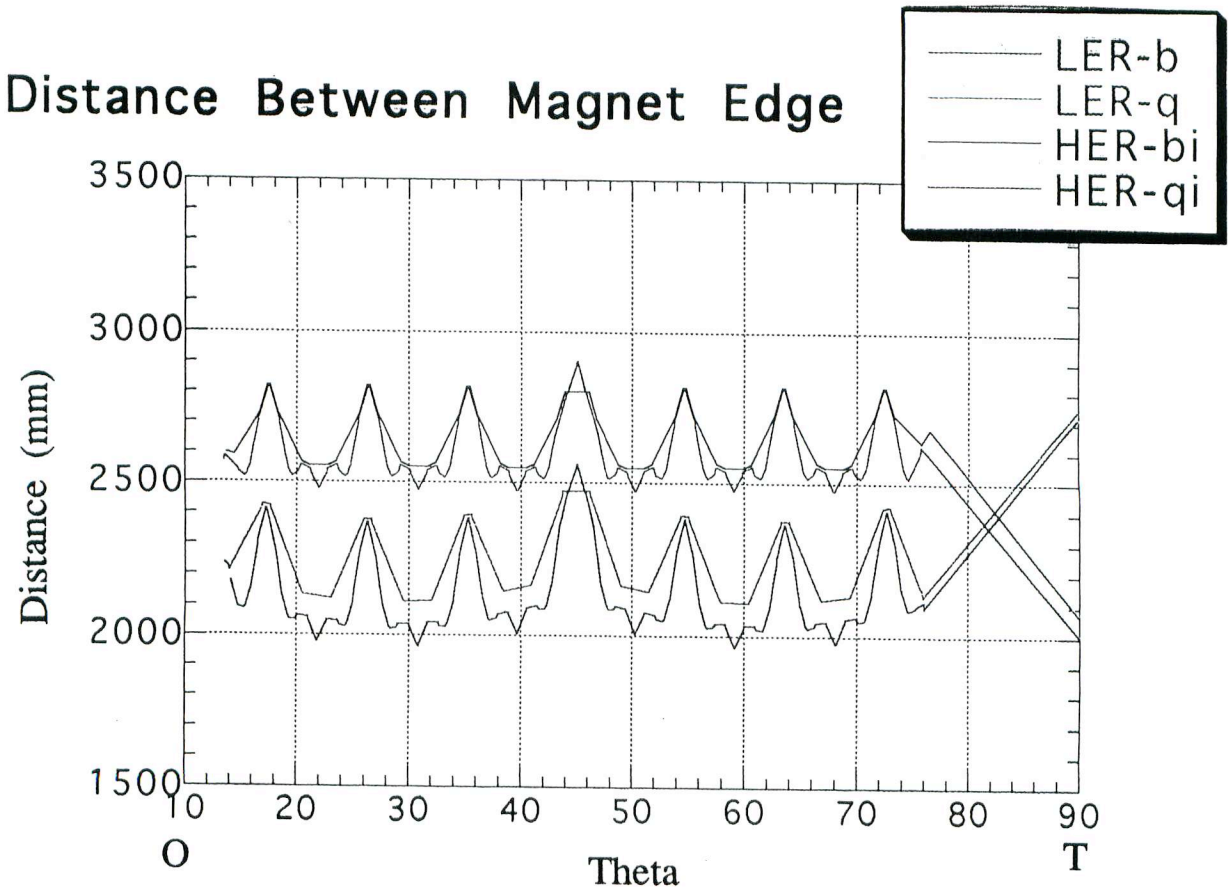


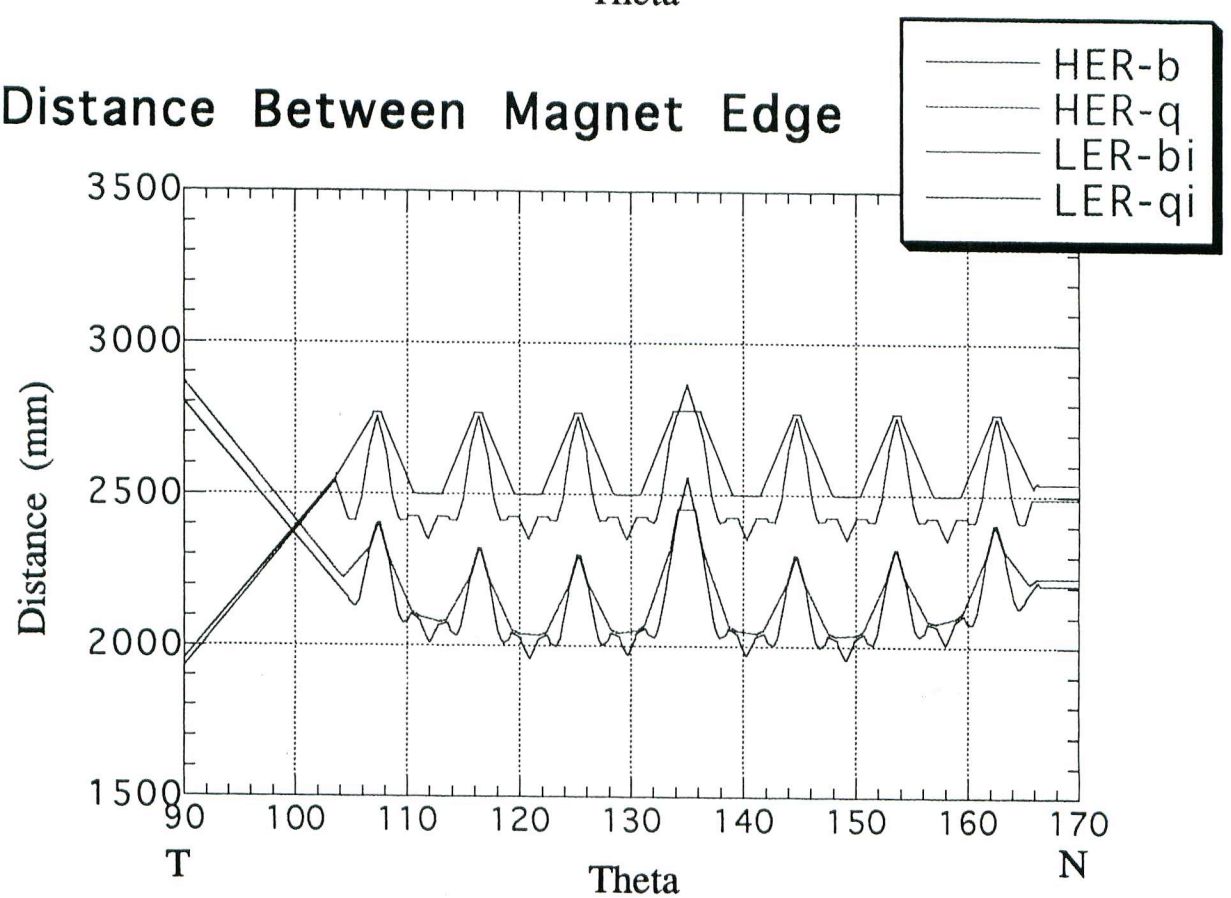





Inner Wall - Magnet Edge
LER-bi
HER-bi
LER-qi
HER-qi
Distance (mm)
3000
2500
2000
1500
1000
0
90
180
270
360
O
T
Theta
N
F
O

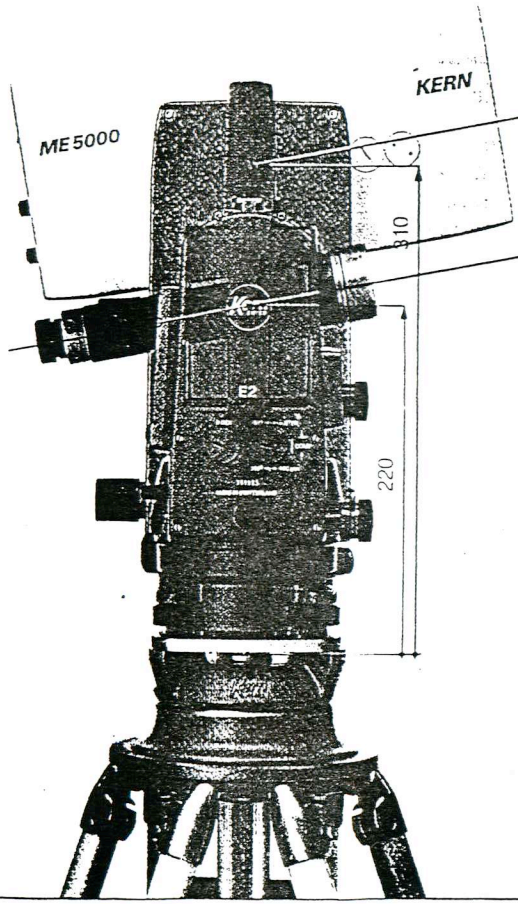

Outer Pipe Rack - Magnet Edge
LER-bo
HER-bo
LER-qo
HER-qo
Distance (mm)
2500
2000
1500
1000
500
0
0
90
180
270
360
O
T
Theta
N
F
O


Distance Between Magnet Edge
LER-b
LER-q
HER-bi
HER-qi
3500
3000
2500
2000
1500
Distance (mm)
10
20
30
40
50
60
70
80
90
O
Theta
T


Distance Between Magnet Edge
HER-b
HER-q
LER-bi
LER-qi
3500
3000
2500
2000
1500
Distance (mm)
90
100
110
120
130
140
150
160
170
T
Theta
N

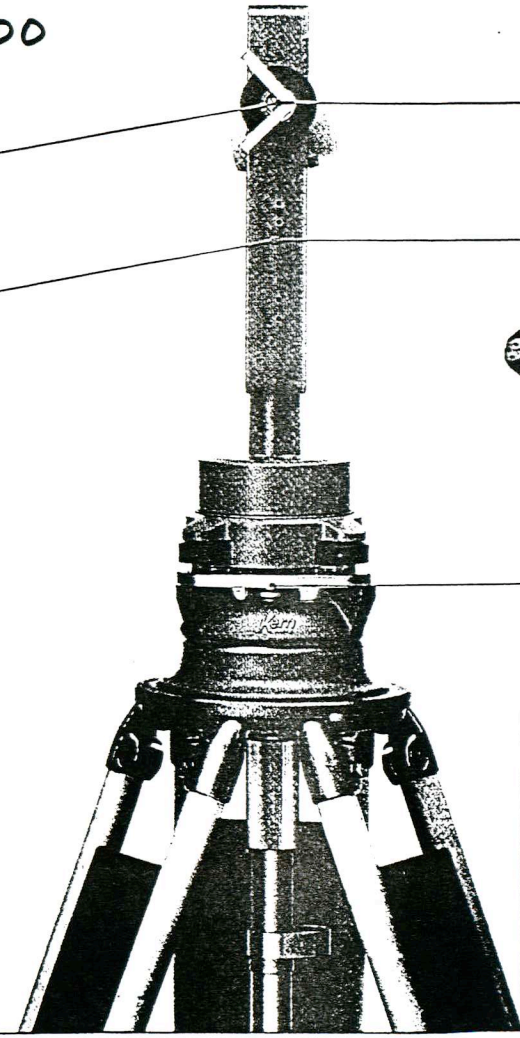
Mekometer

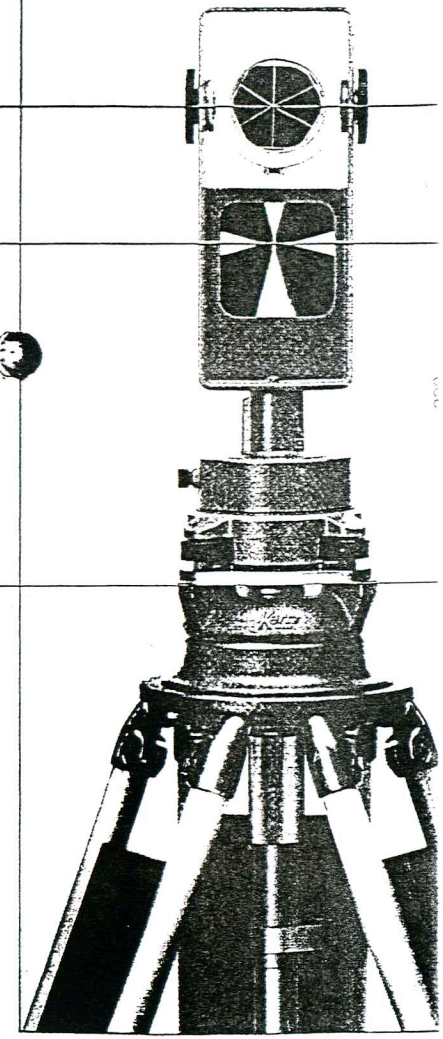
LEICA社 ME5000



Measuring Axis

Target Axis





レーザー測距儀 Mekometer

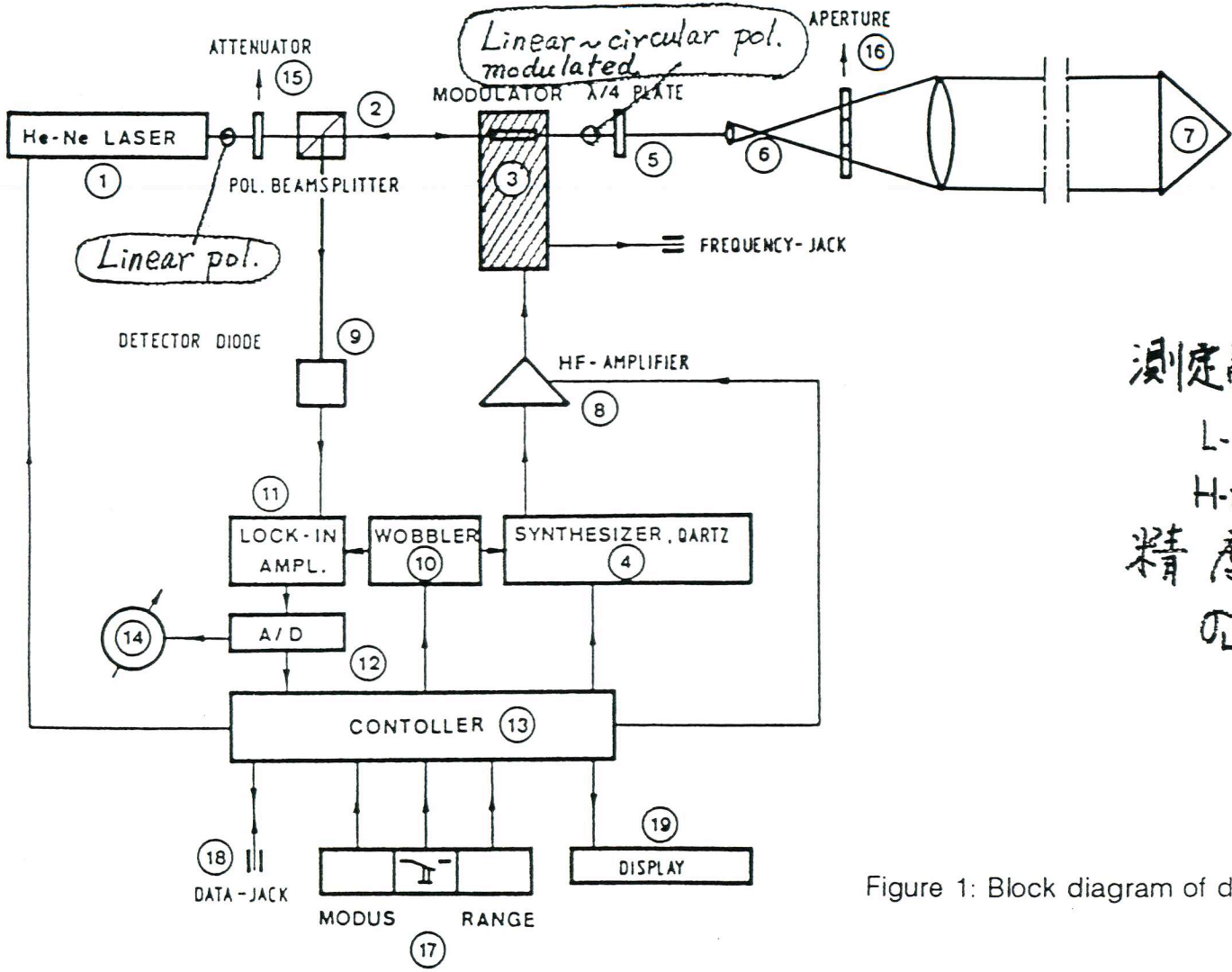


Figure 1: Block diagram of distance meter

測定範囲

L-range 20 m ~ 1 km

H-range 50 m ~ 8 km

精度

$\sigma_L = 0.2\,mm + f_z \cdot L$

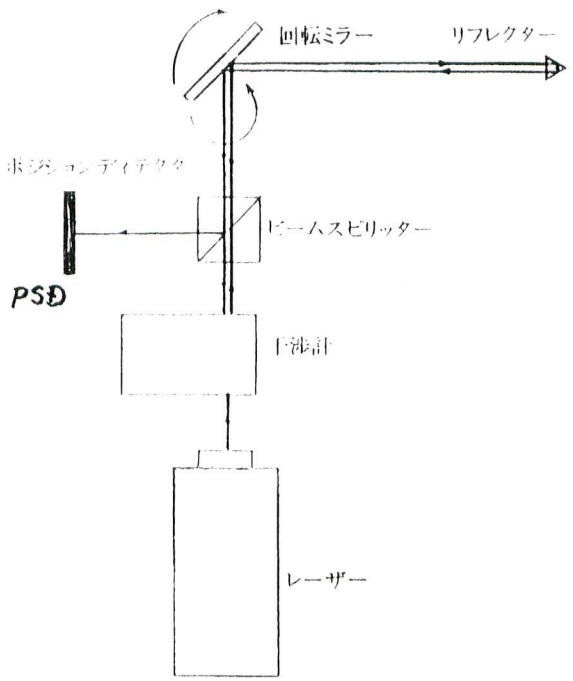
($f_z = 20\,\mu m/100\,m$)

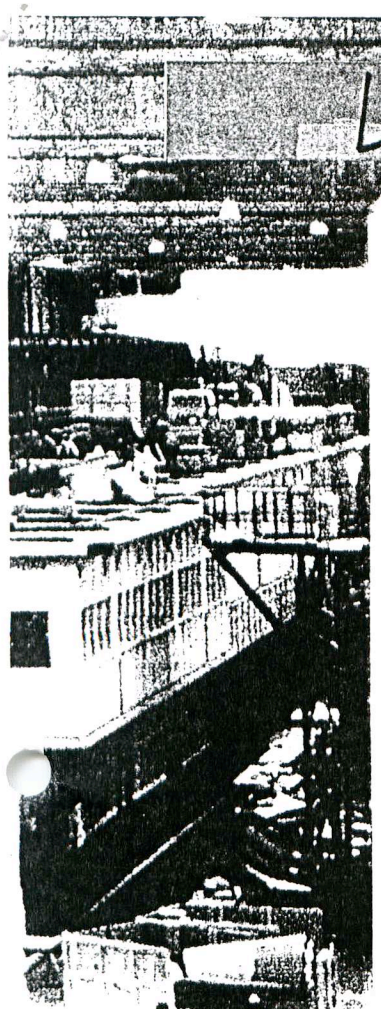
Leica ME5000

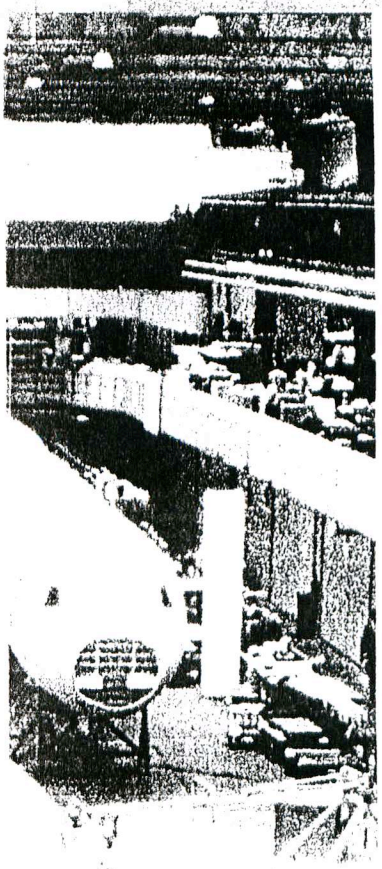
レーザートラッカー

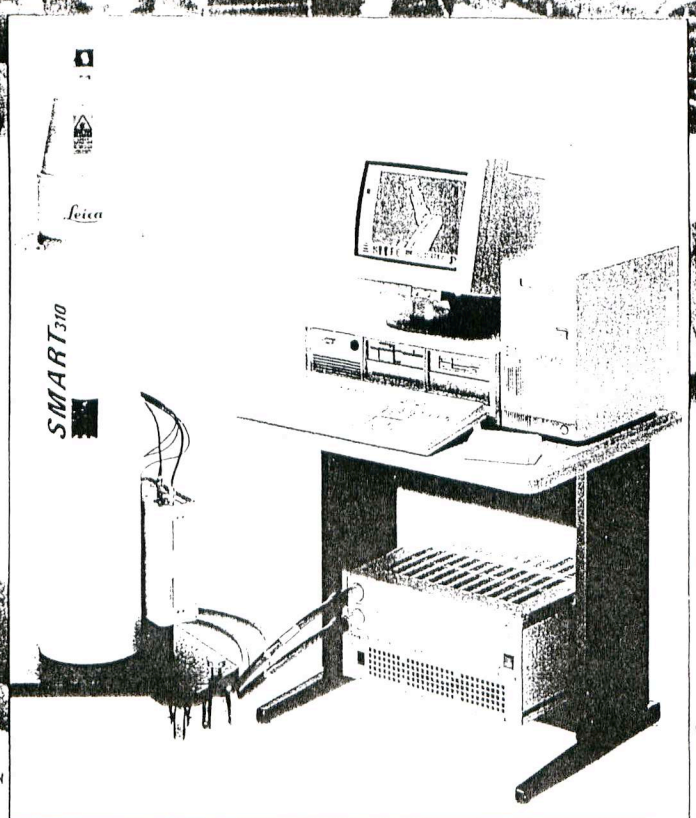
SMART 310

原　理









Leica社
SMART 310
Chesapeake社
CMS-3000

$\sigma_d = 1\,ppm$; $\sigma_\phi, \sigma_\theta = 10\,ppm \rightarrow 3\,\mu rad$

レーザートラッキングシステム測定可能距離 $\lesssim 20\,m$

Leica

Movers

1. For Sx-magnets

Two axis movers (X and Y)

Range = ± 3 mm

σ =

2. For Q-magnets around IR

Three axis movers
(X, Y and θ_{roll})

Range =

σ =

Schedule for Magnet Fabrication and Installation

1995.2.4