

Jan.24, 1997

# **KEKB MAC 97**

## **Magnets and Installation**

R. Sugahara

### **I. Fabrication of magnets**

### **II. Magnetic field measurement**

**II-1 LER-QA magnets**

**II-2 LER-B magnets**

### **III. Installation and alignment**

### **IV. Schedule**

# List for KEKB Magnets

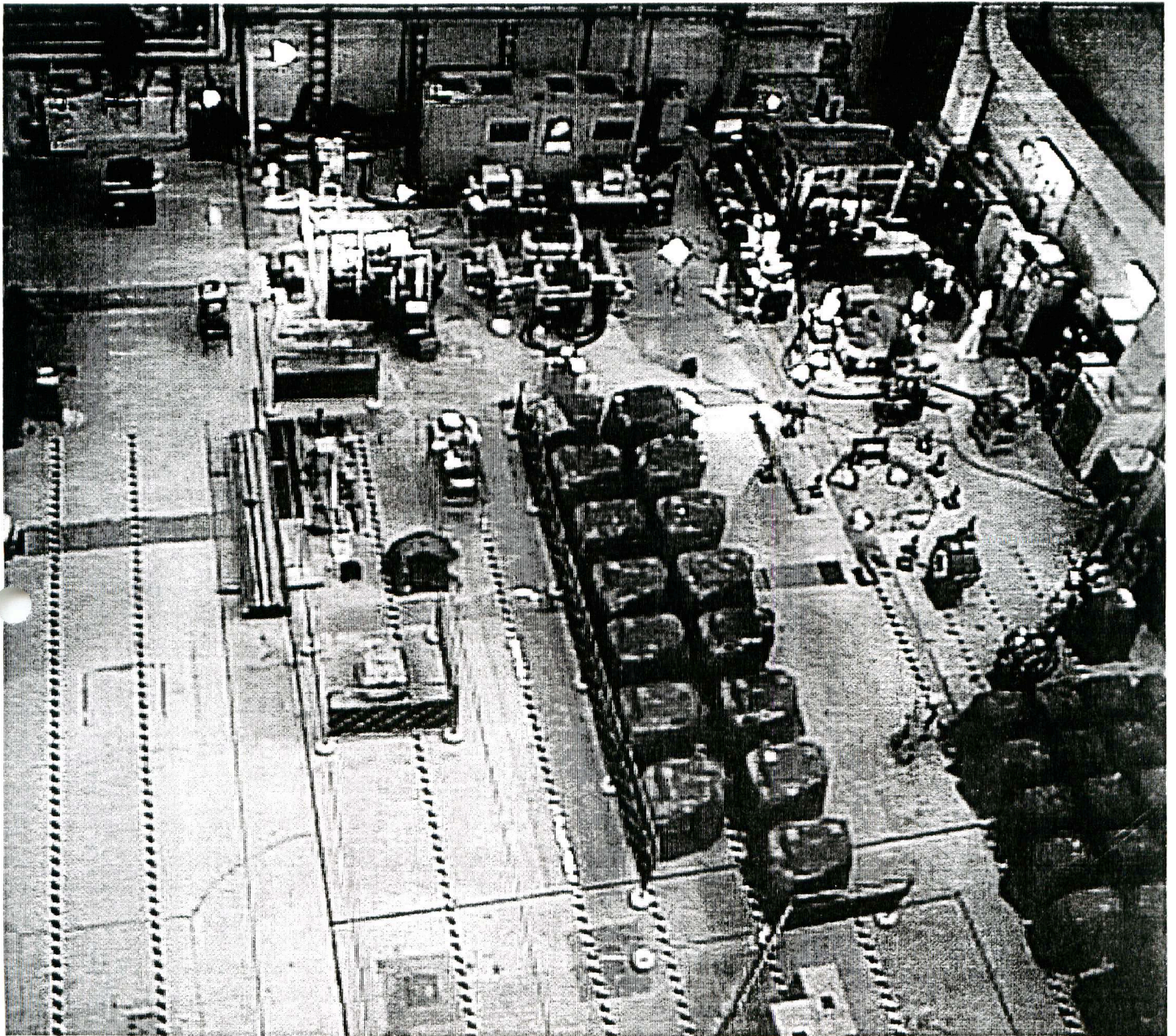
97.1.20

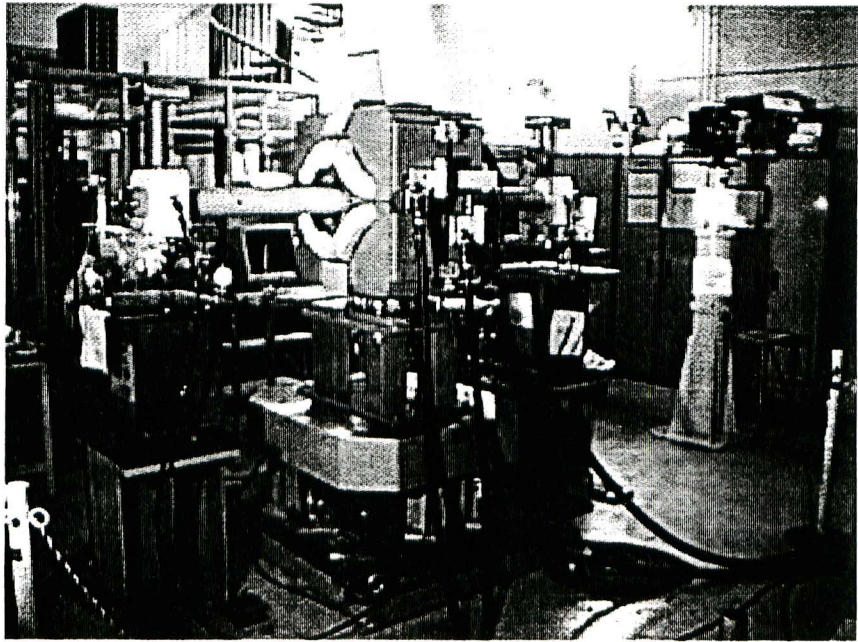
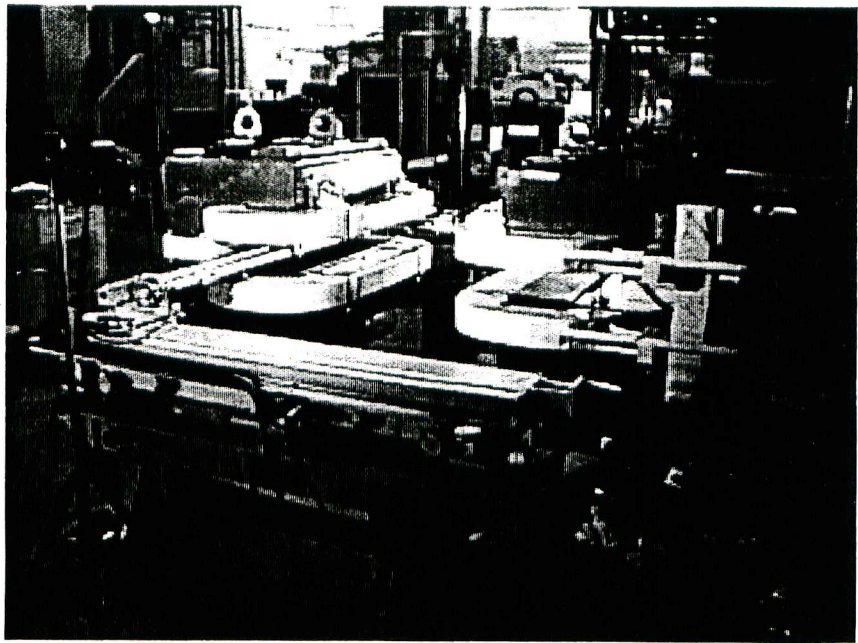
	Number	# delivrd	Length	Weight	Maker	Comment
<LER>			(mm)	(ton)		
B	134+1	20	816	2.8	H	
Blc	26		2,160	6.0	T	for local corr.
BV1	3		~220	0.8		=StVW; for Tsukuba area
BV2	4		~1,310	5.8	M	Vertical B. at Fuji
BS	3		~340	1.4	M	B at Fuji-arc-end and TR
Wig	192+2		800	3.1	M(154)	40 is left to be ordered
QA	414+2	40	444	1.5	H	
Qrf	36+6		540	2.1	T	Large bore Q; RF and LC area
Qk	8		~240	0.9	*	Skew Q
SxF	56+1		340	0.7	H	Sx
SxD	48+1		340	0.7	H	Sx
Sc	4		~540	1.4	H	at IR
StV	414+2	132	~220	0.2	IHEP	Wide gap StV
StVW	36+6		~220		IHEP	Vertical steering
StH	410+2		~220	0.2	BINP	Horizontal steering
StHW	36+2		~220		BINP	Wide gap StH
StHX	4+1		~220		IHEP	StH for beam crossing
StHXW	6+1		~220		IHEP	Wide gap StH for beam crossing
<HER>						
B	117+2		5,860	9.6	M	TR-B
BHL	2		~460	2.0	*	BH at IR-L
BHS	1		~220	0.9		=StHW?; Short BH at IR-L
BV	4		~220	0.9		=StVW?; BV at IR
BS1	6		~2,860	5.0	M	B at arc end(T,N,O)
BS2	1		816	2.8	H	= LER-B; for arc end (FR)
BS3	1		1,200	3.2	Exist	= TR-Bs; for arc end (FL)
QS	80+2		540	1.6	H	Normal Q
Qrf	43+1		~1,040	3.2	H	Large bore Q at RF area
QA	200+2		800	5.0	M	TR-QA
QB	109+2		1,000	5.6	M	TR-QB
Qk	12		~340	1.1	*	SkewQ
QX	4+1		800	2.6	H	for crossing at Fuji
SxF	56		340	0.7	H	Sx
SxD	48+1		~1,040	2.2	H	Long Sx
StV	404+2		~220	0.2	IHEP	Vertical steering
StVW	42+2		~220		IHEP	Wide gap StV
StH	404+2		~220	0.1	BINP	Horizontal steering
StHW	42+2		~220		BINP	Wide gap StH

## Magnetic Field Measuring Equipment

Jan.20, 1997

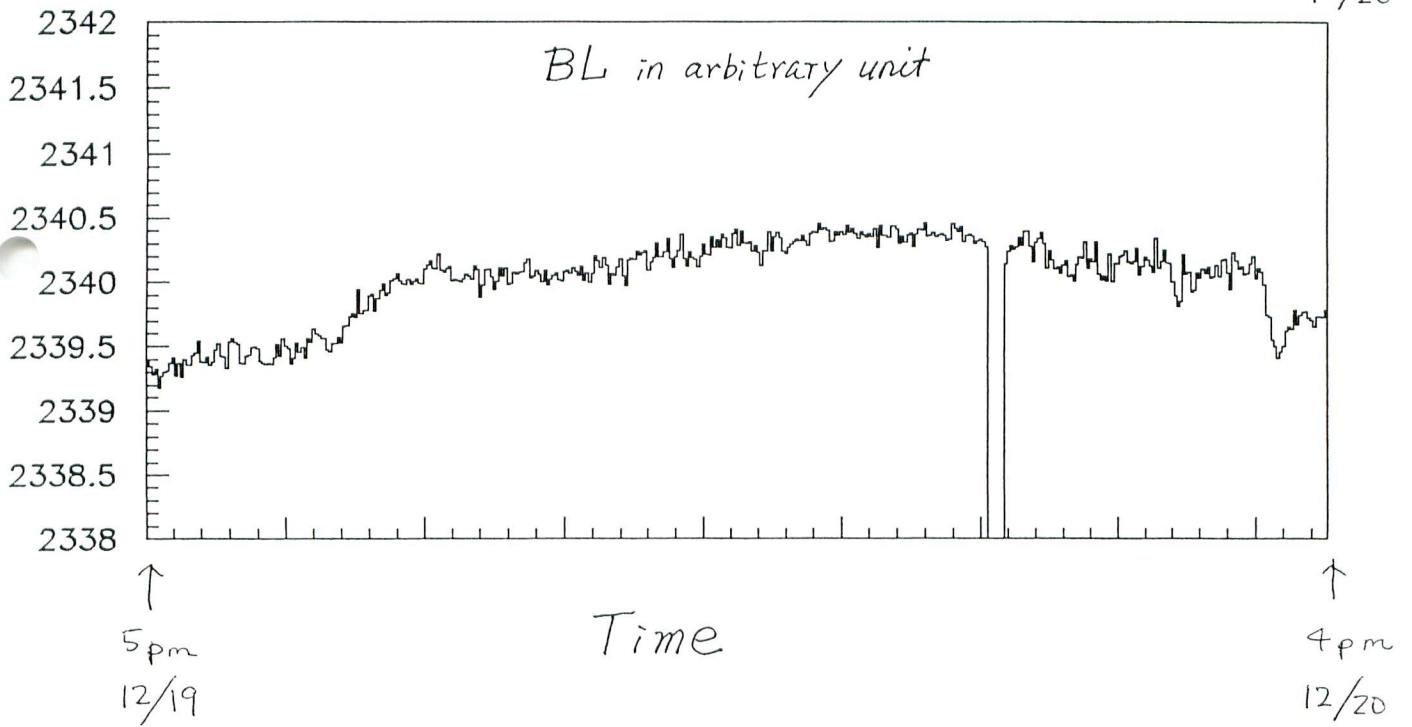
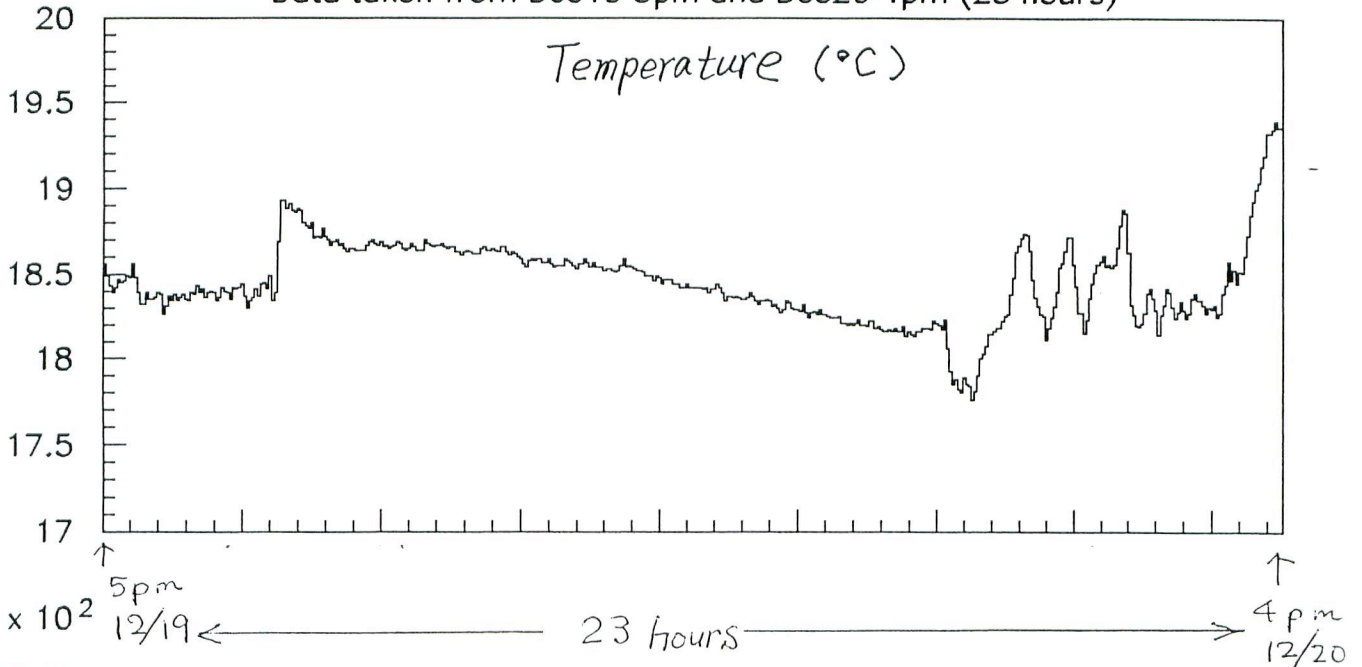
Sensor	Computer	Magnets	Status	Comment
LER harmonic coil	EPICS,(Mac,PC)	LER-QA,Qrt,Sx,SxC	Measuring LER-QA	New
LER flip coil	NEC-PC,(Mac)	LER-B	Measuring LER-B	New
3.5mB flip coil	NEC-PC	LER-B1c	Ready	Overhauled
6.5mB flip coil	NEC-PC	HER-B	Measuring HER-B	Overhauled
HER harmonic coil	EPICS,(Mac,PC)	HER-QA,QB,SxD,Sx	Under preparation	New
		LER-Sx,SxC		
Wigg harmonic coil	NEC-PC	LER-Wiggler	Measuring wigglers	New





# Drift of BL Before air flow adjusted

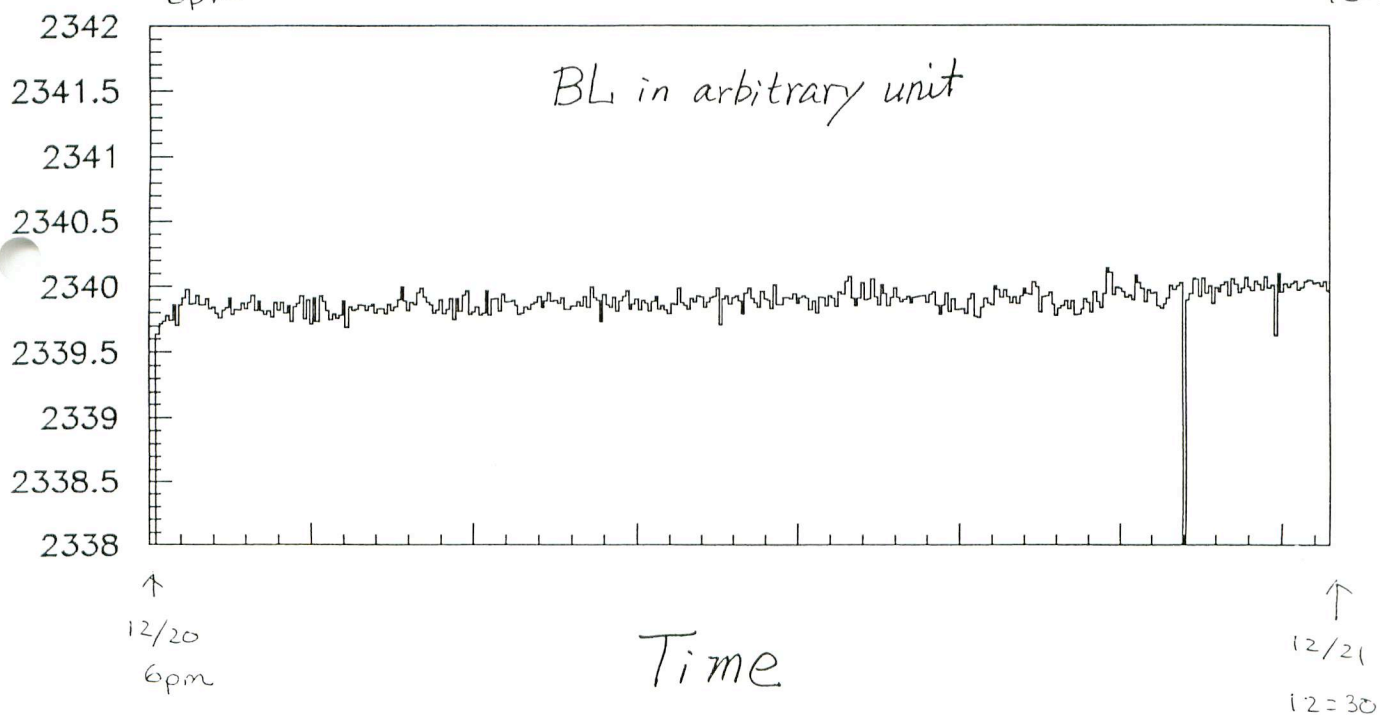
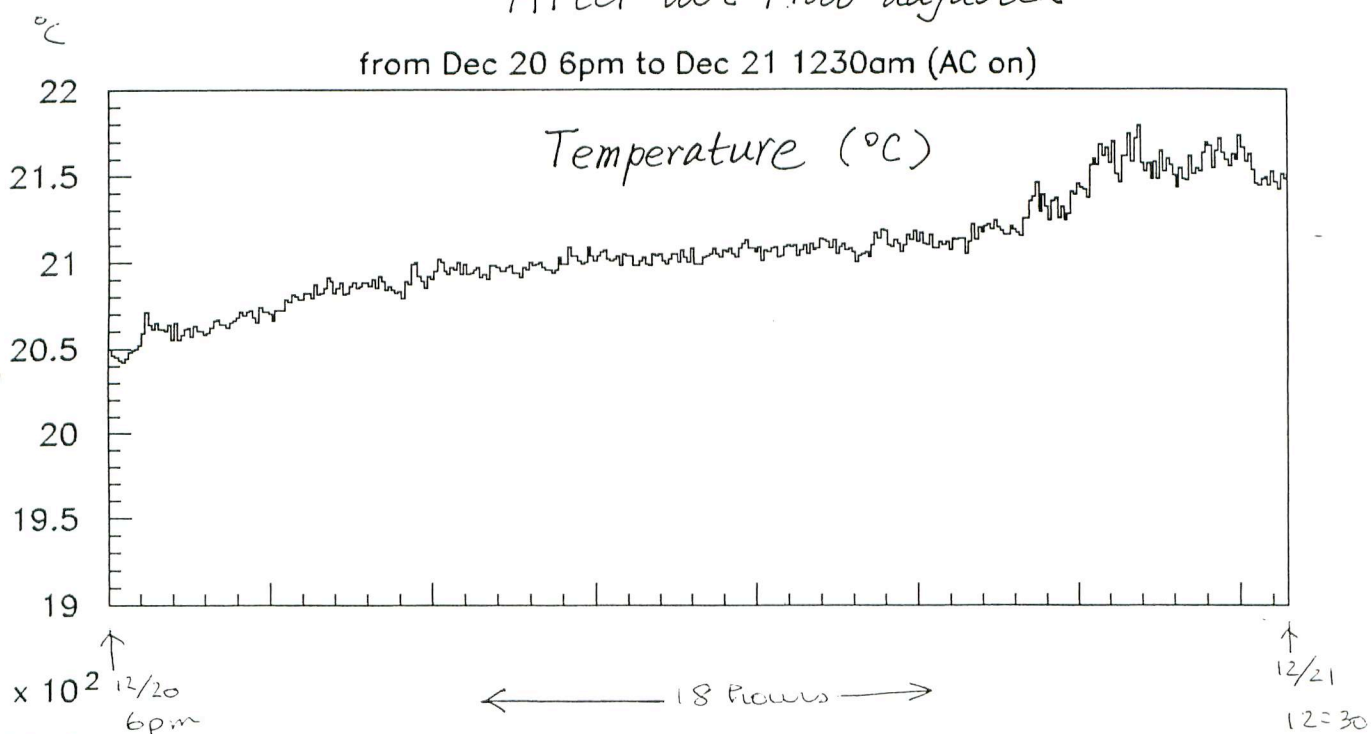
Data taken from Dec19 5pm and Dec20 4pm (23 hours)



# Drift of BL

After air flow adjusted

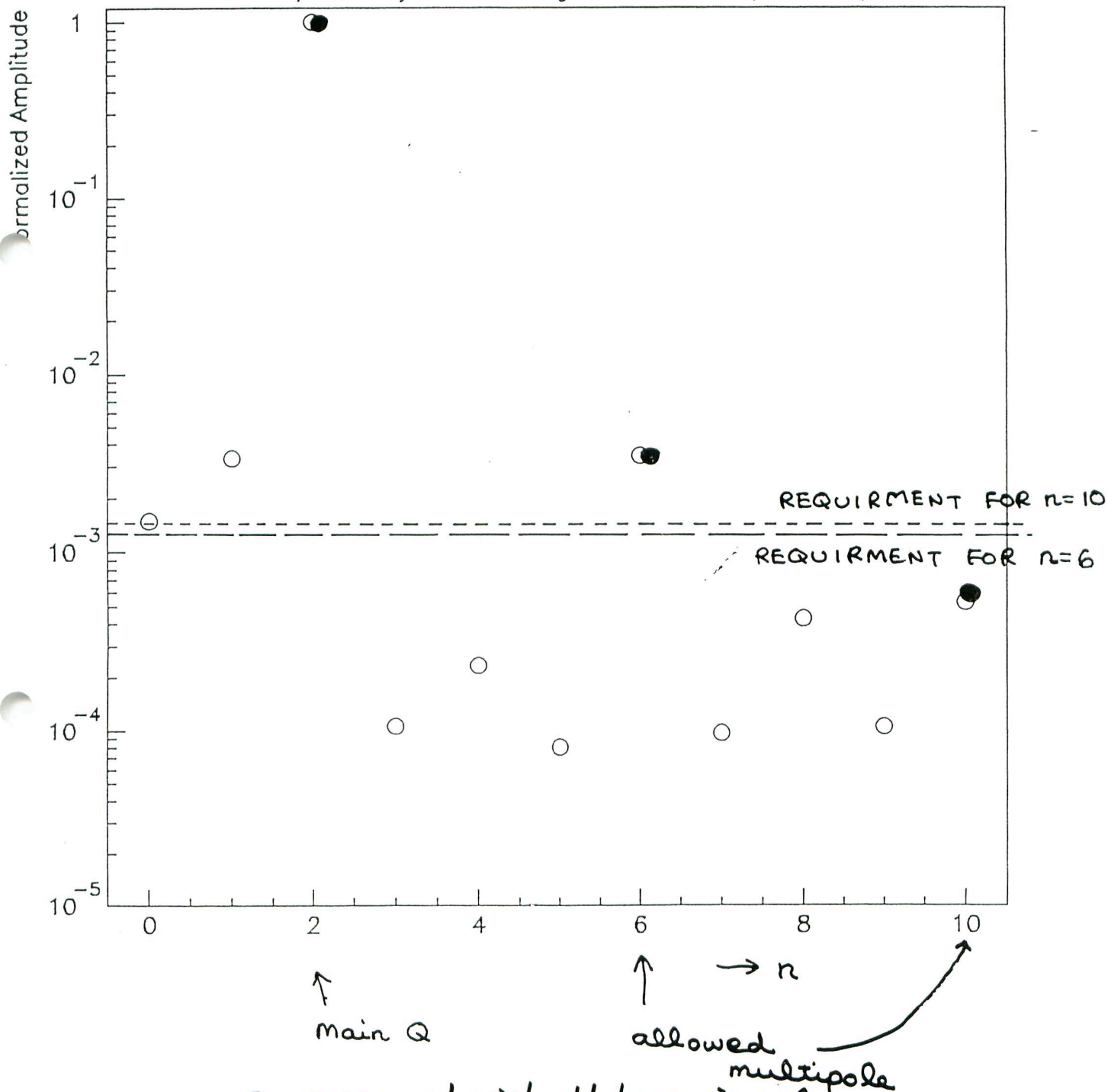
from Dec 20 6pm to Dec 21 1230am (AC on)



# Without shim

96/12/15 03.58

Multipole analysis from Long Coil at I=500A (r=50mm)

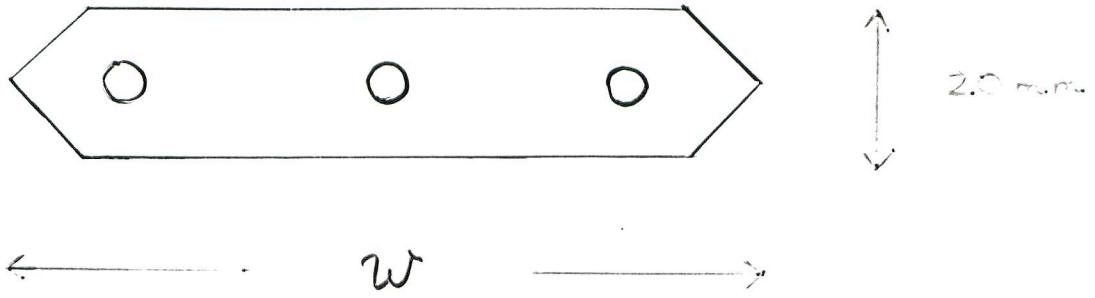


● measured with old harmonic coil

n=6 component has to be reduced by factor 3.  
 n=10 component is small enough.



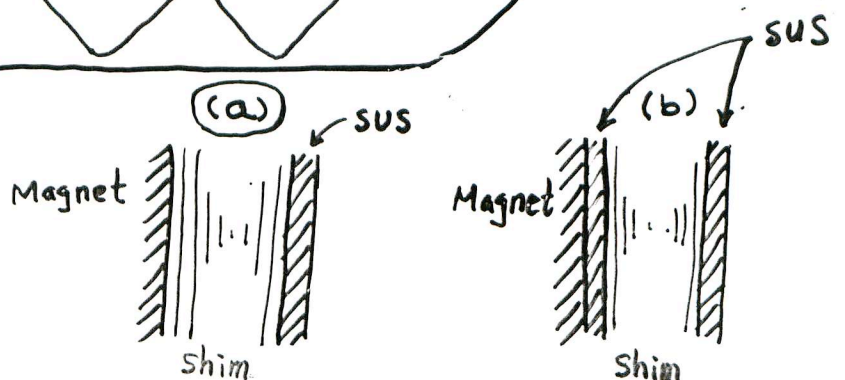
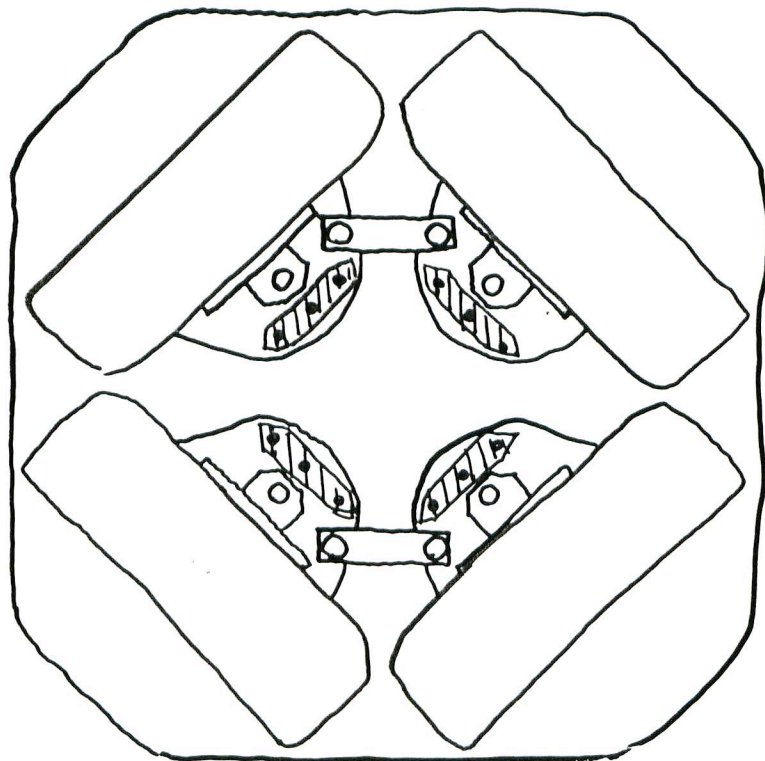
# Shape of shim



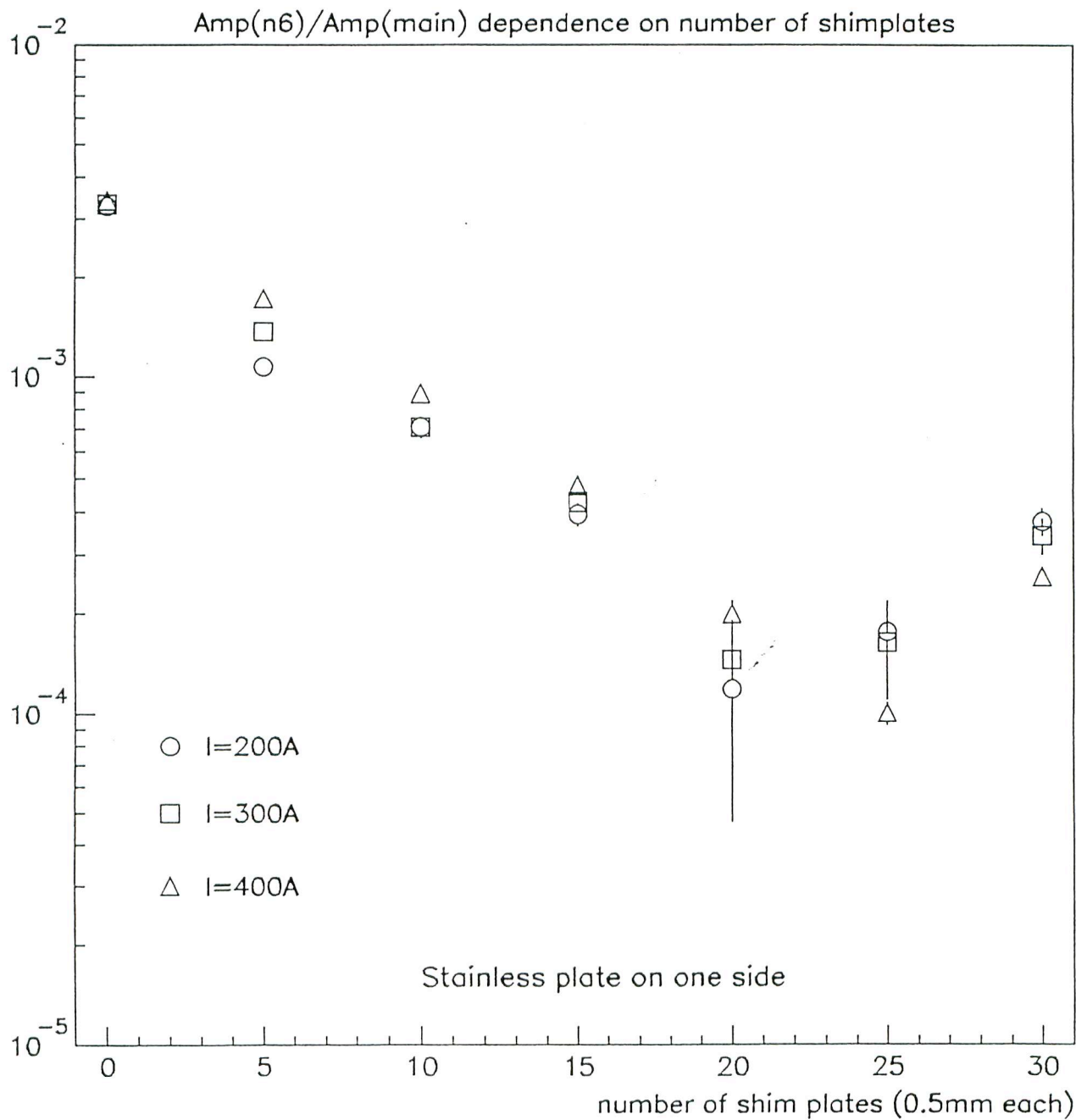
$W = \underline{100}, 105, 110 \text{ mm}$

$t = 0.5 \text{ mm thick}$

Material: iron silicate ... same as core



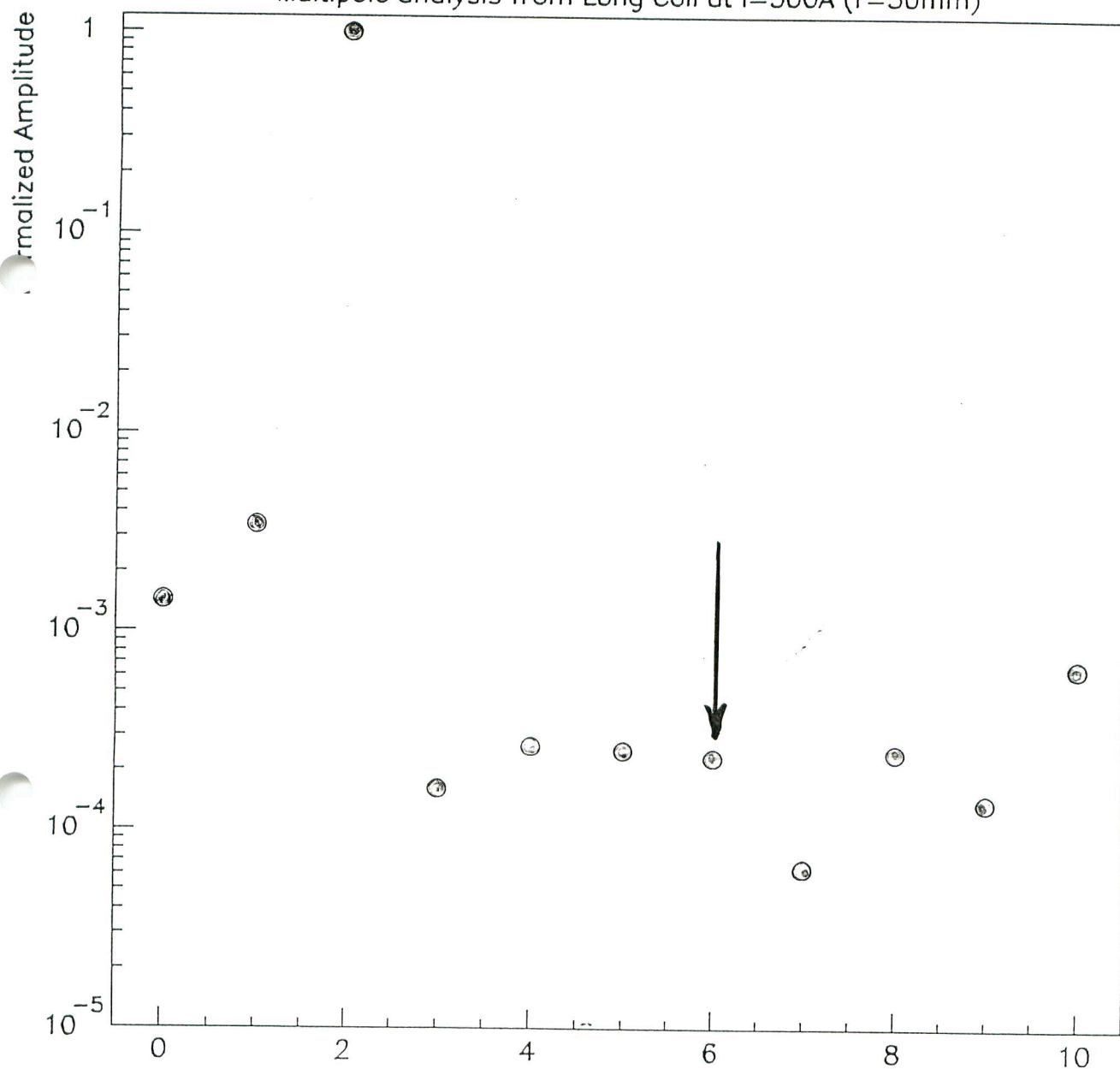
96/12/13 17.23



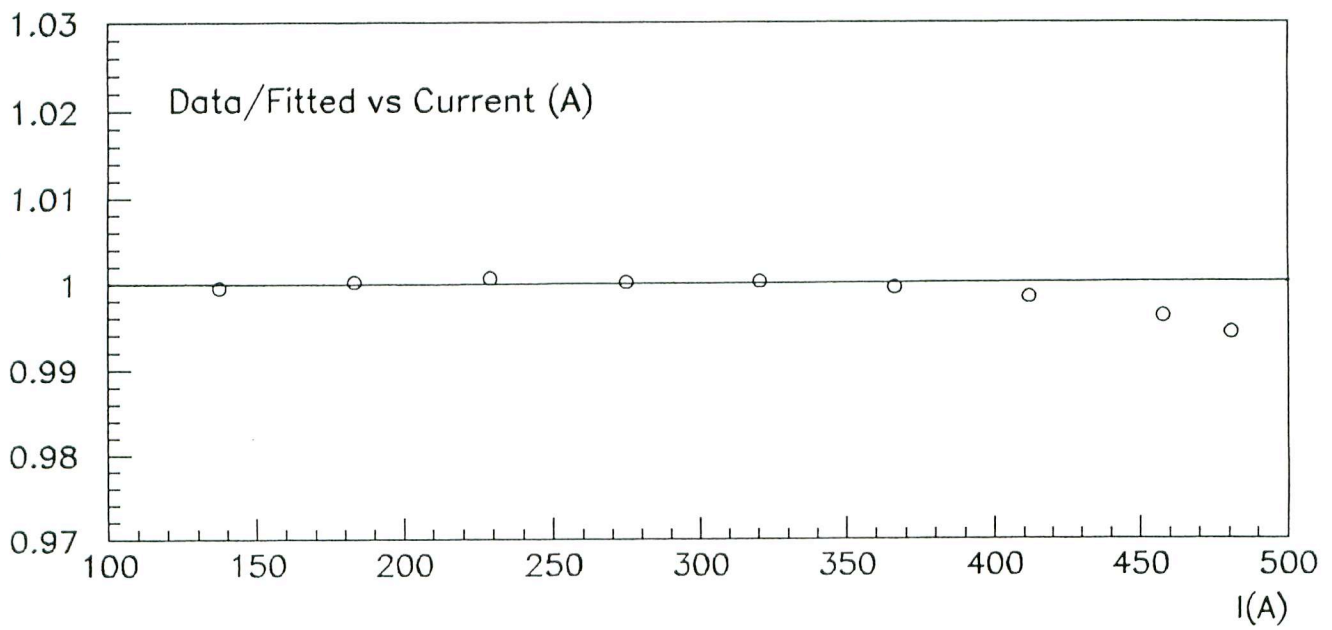
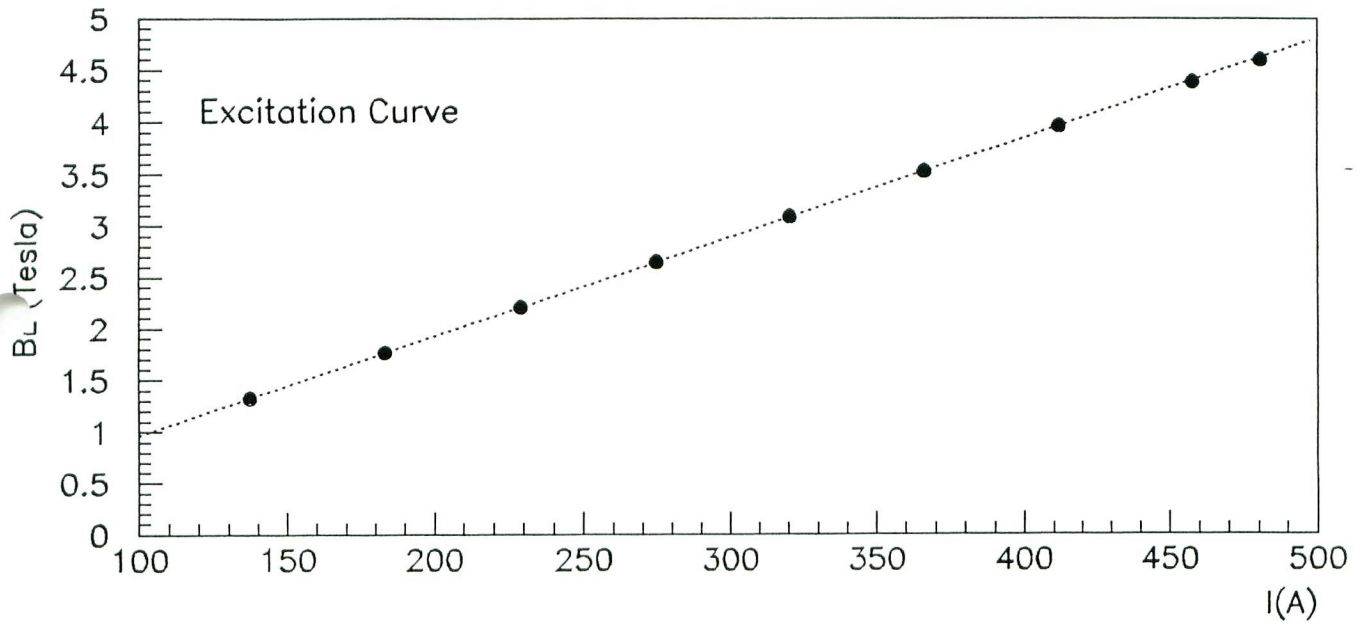
↑  
**Chosen**  
 20 plates = 10 mm  
 (W = 100 mm)

• With shim (10 mm thick)

96/12/15 04.38

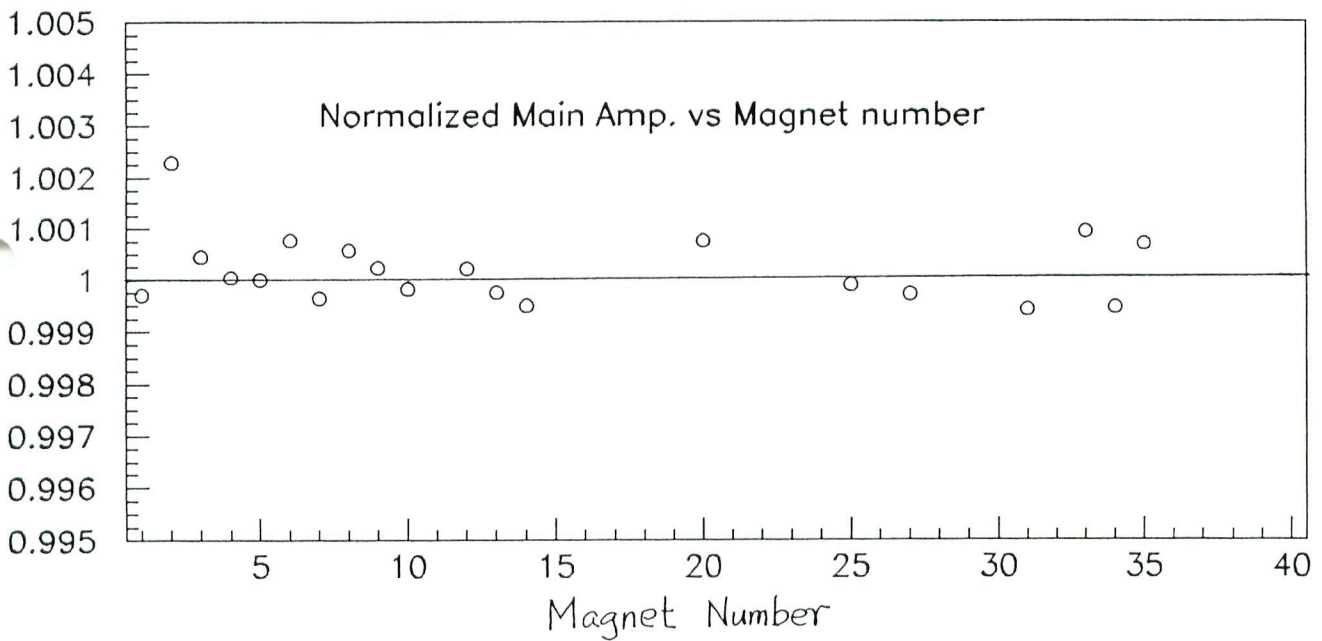
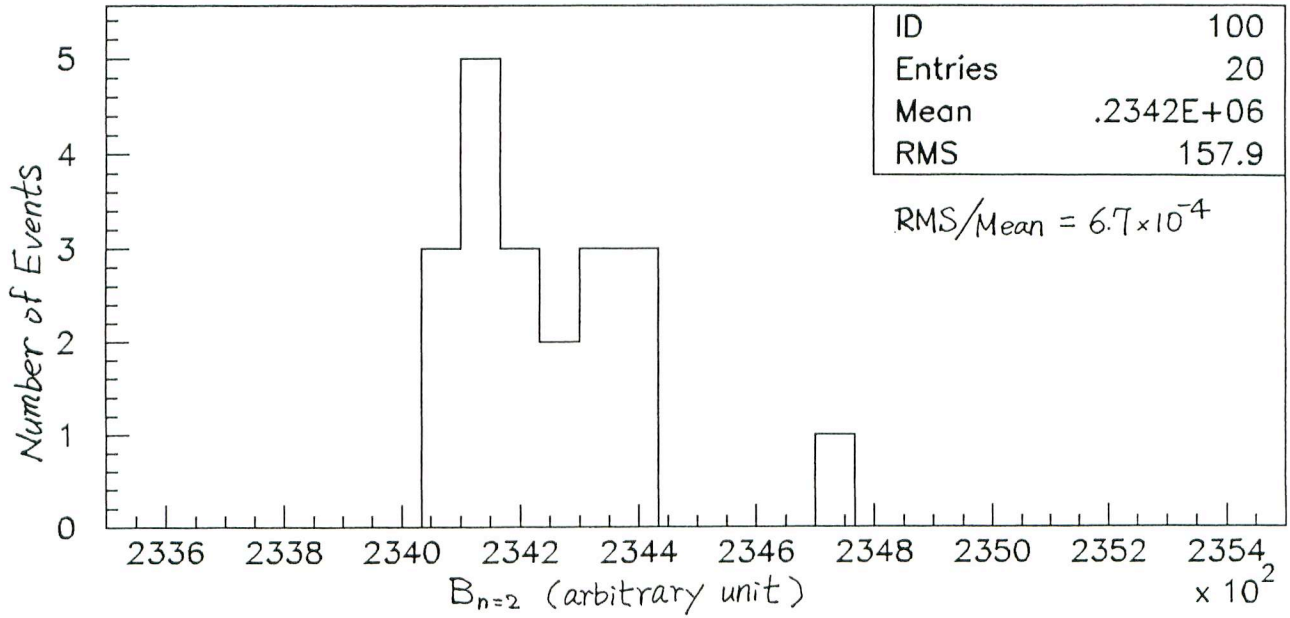
Multipole analysis from Long Coil at  $I=500A$  ( $r=50mm$ )

97/01/21 16.33



97/01/21 16.36

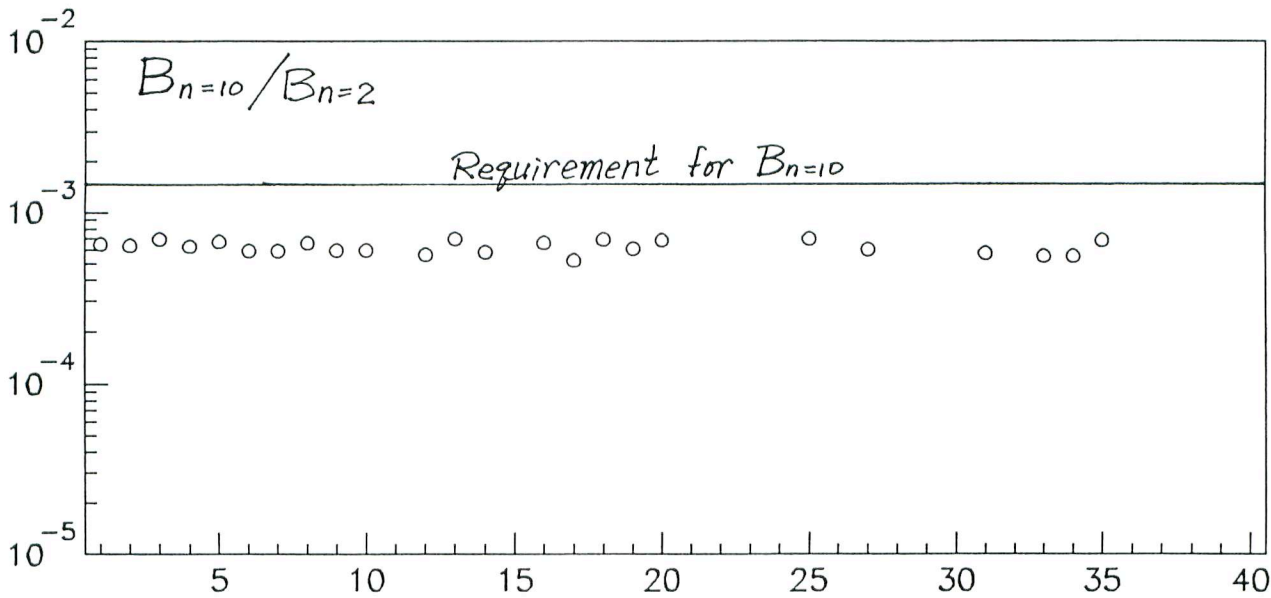
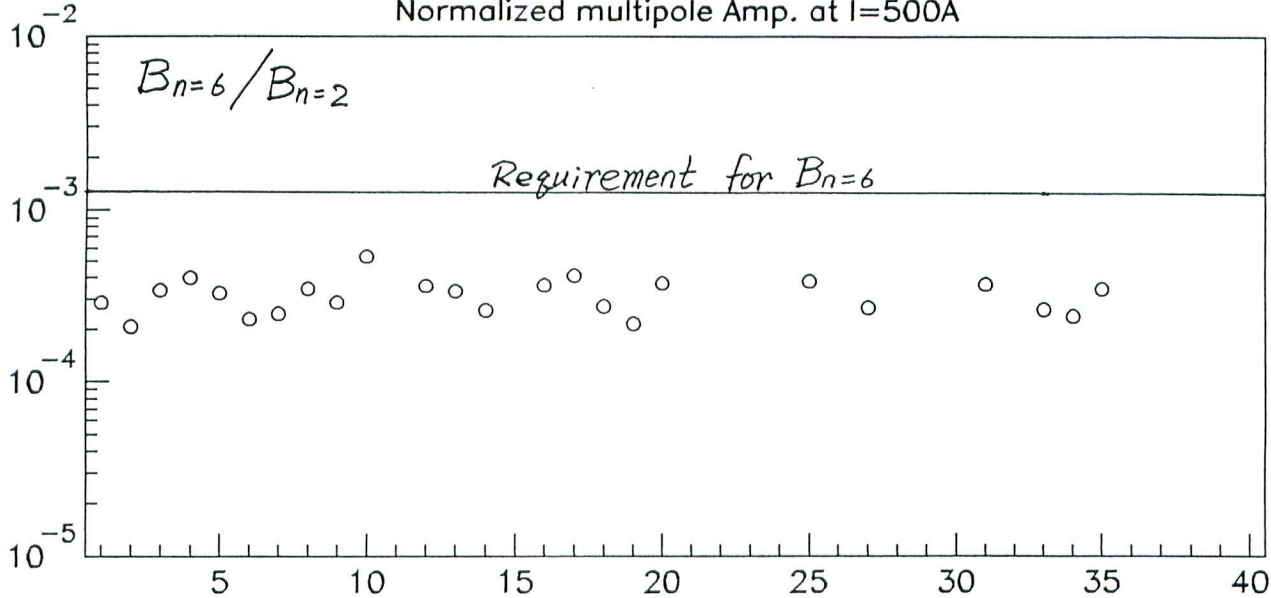
Main Amp. (arbitrary unit) distribution at I=500A



< Allowed component >

97/01/21 13.45

Normalized multipole Amp. at I=500A

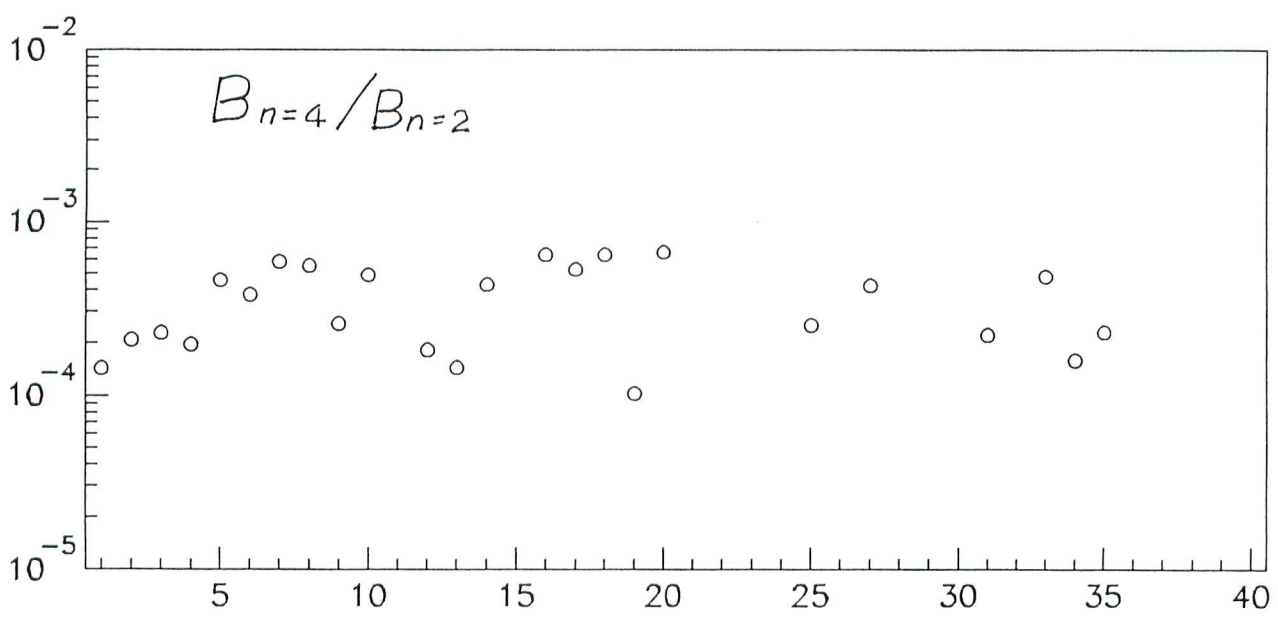
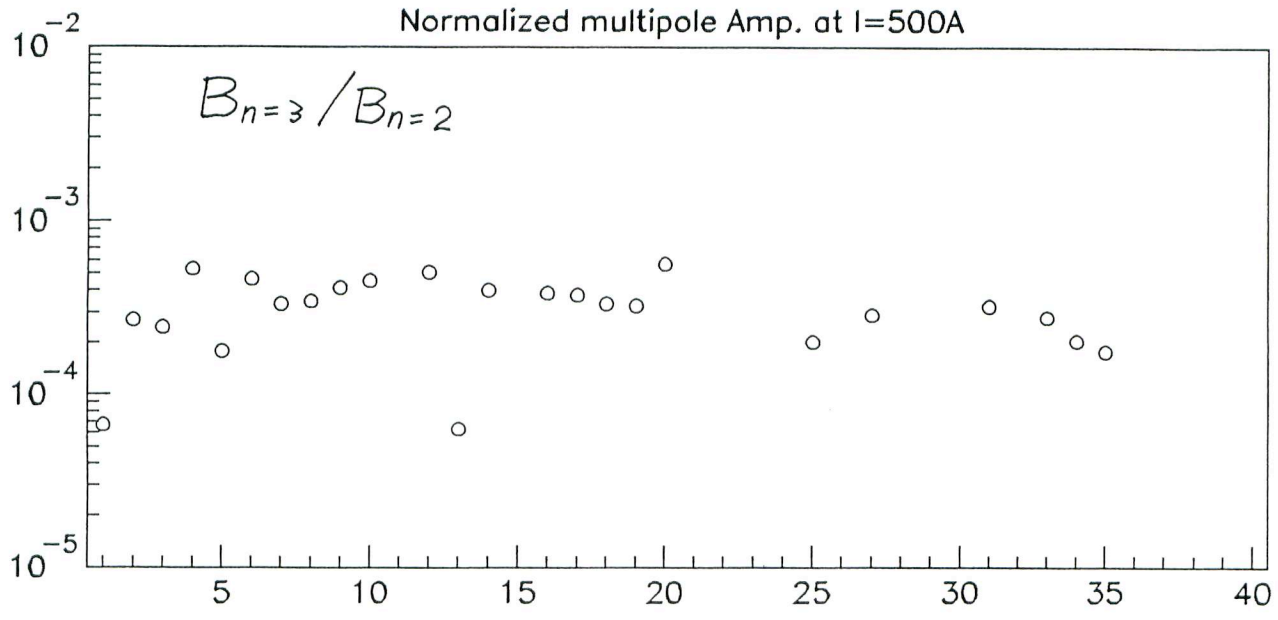


Magnet Number

< Non-allowed component >

97/01/21 13.45

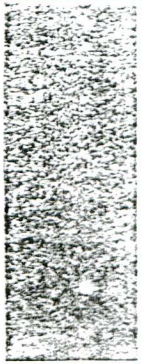
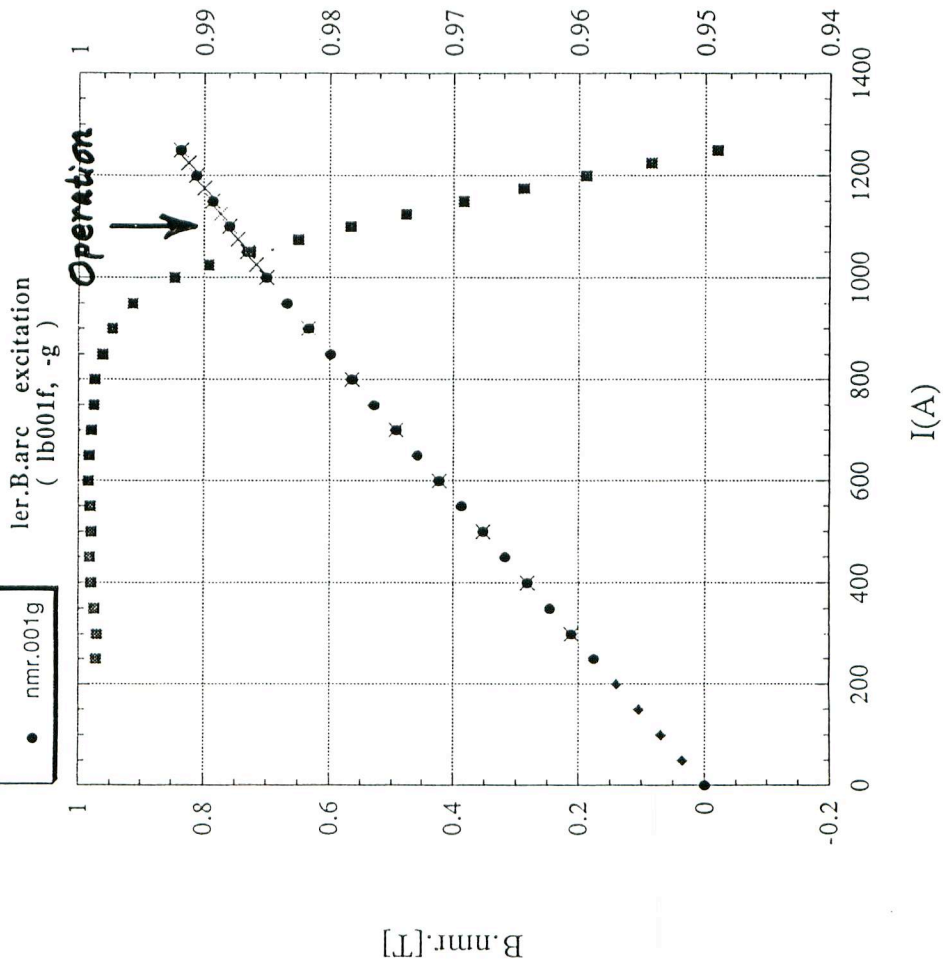
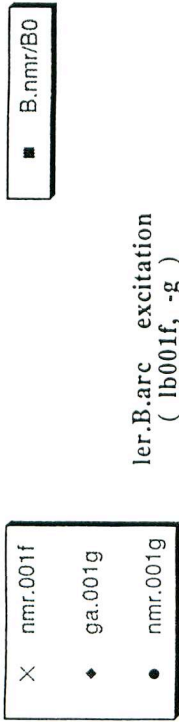
Normalized multipole Amp. at I=500A



Magnet Number

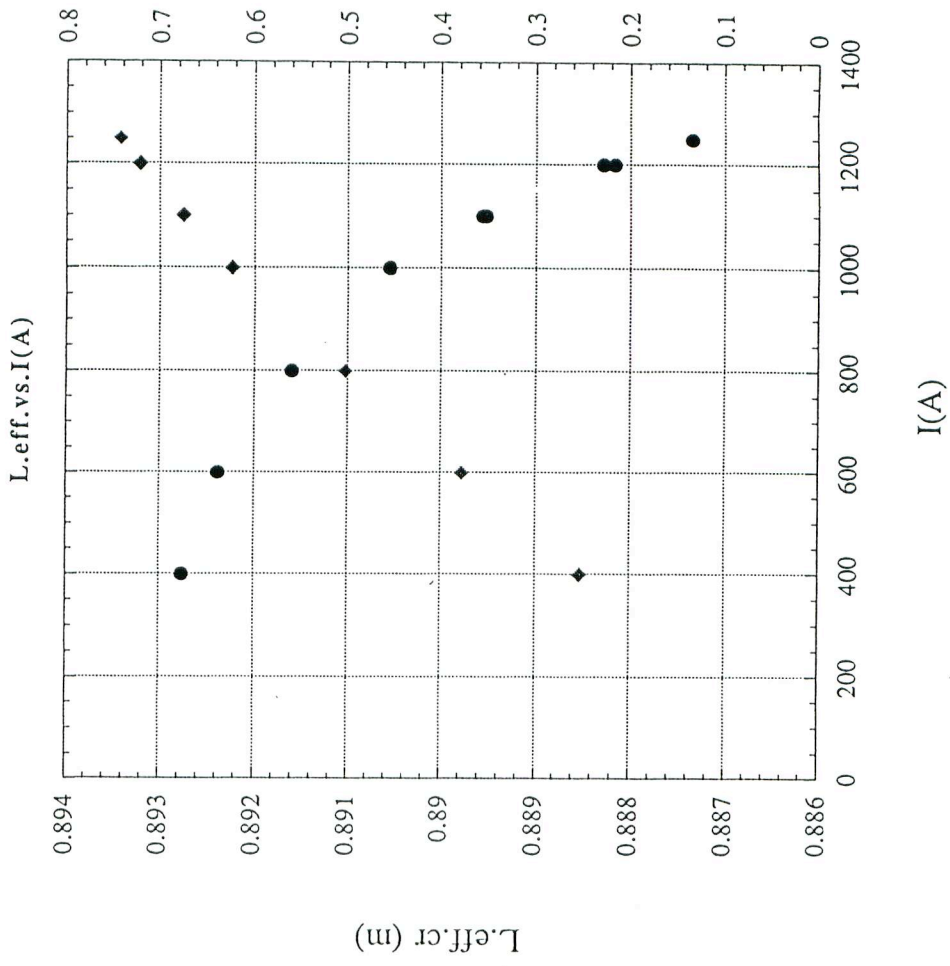
NMR

# ler.Barc excitation by NMR



mapping

# L<sub>eff</sub> & B<sub>eff</sub> by Gauss-meter mapping



LER-B



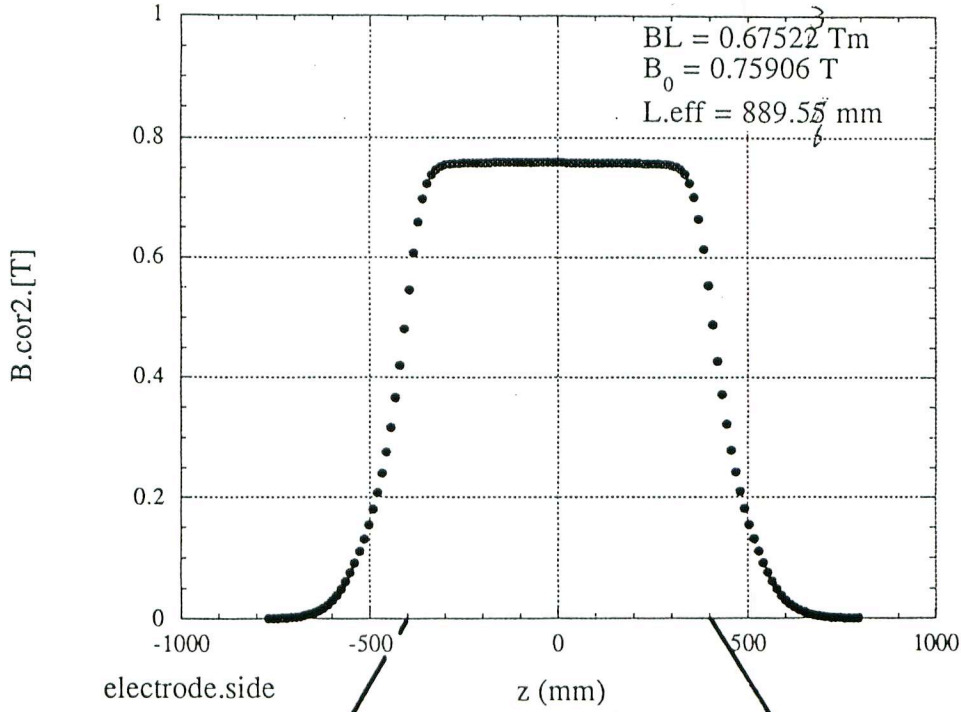
ler. Barc B[z]

• B.cor2.[T]

by mapping

b[z].1100A.p2

1b001b.1100A



• b.cor2

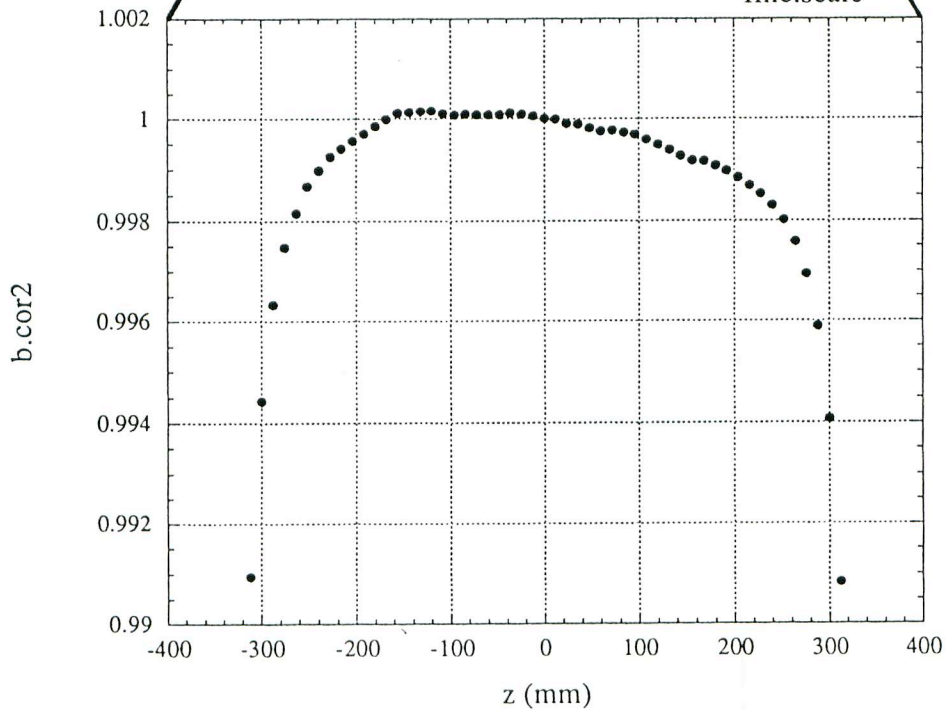
$b[z] \equiv B[z] / B[z=0]$

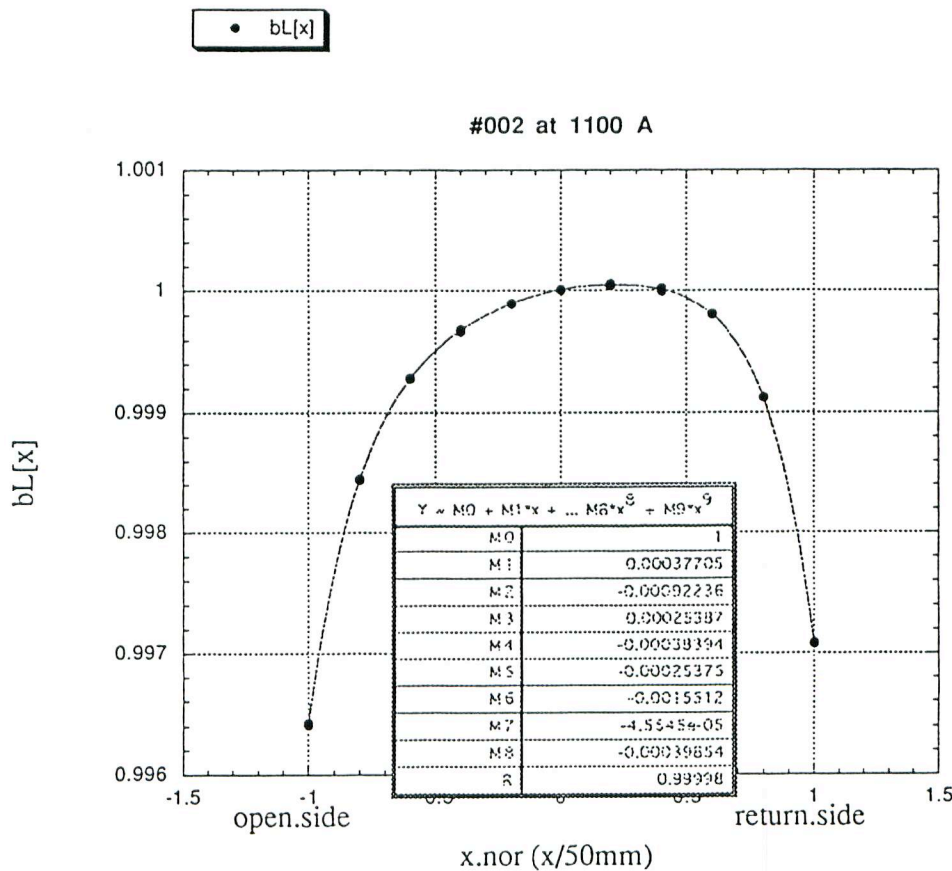
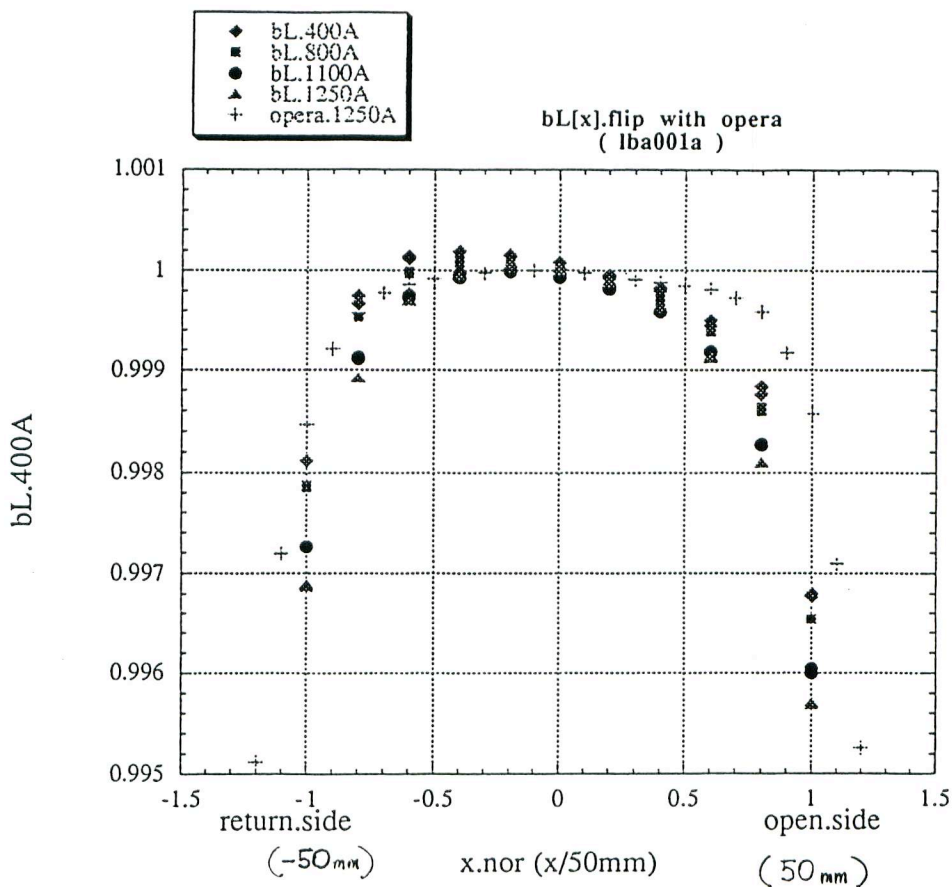
in fine scale

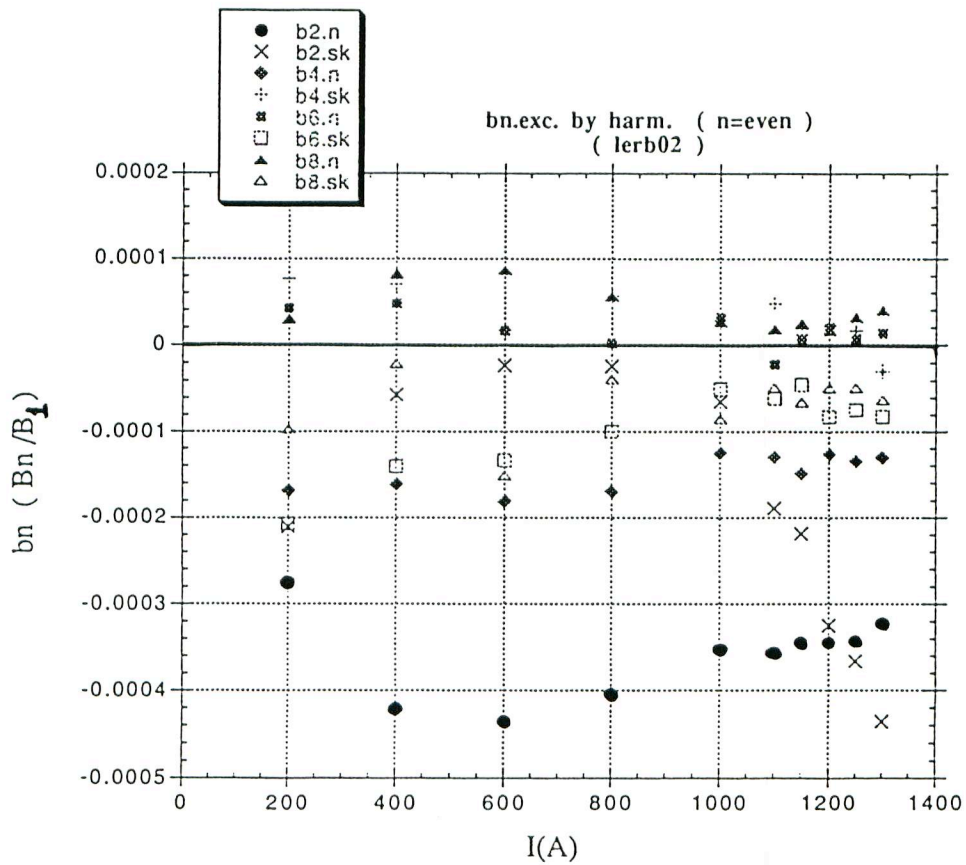
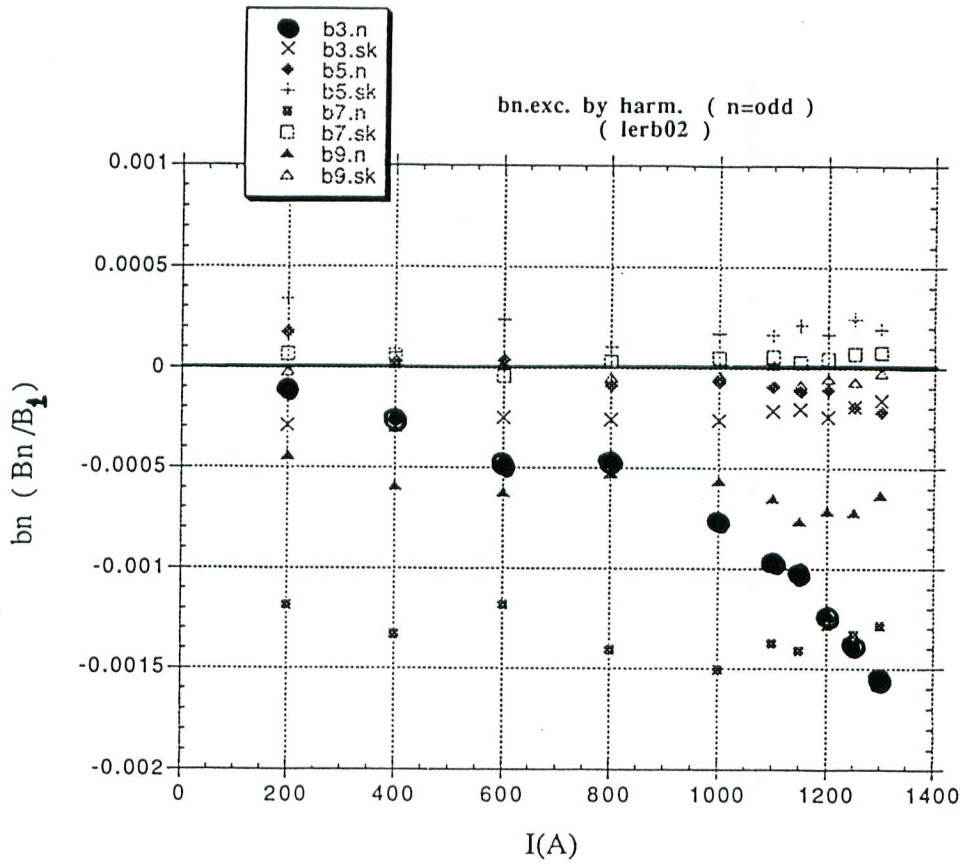
b[z].1100A.p3

b[z].1b001b.1100A

fine.scale

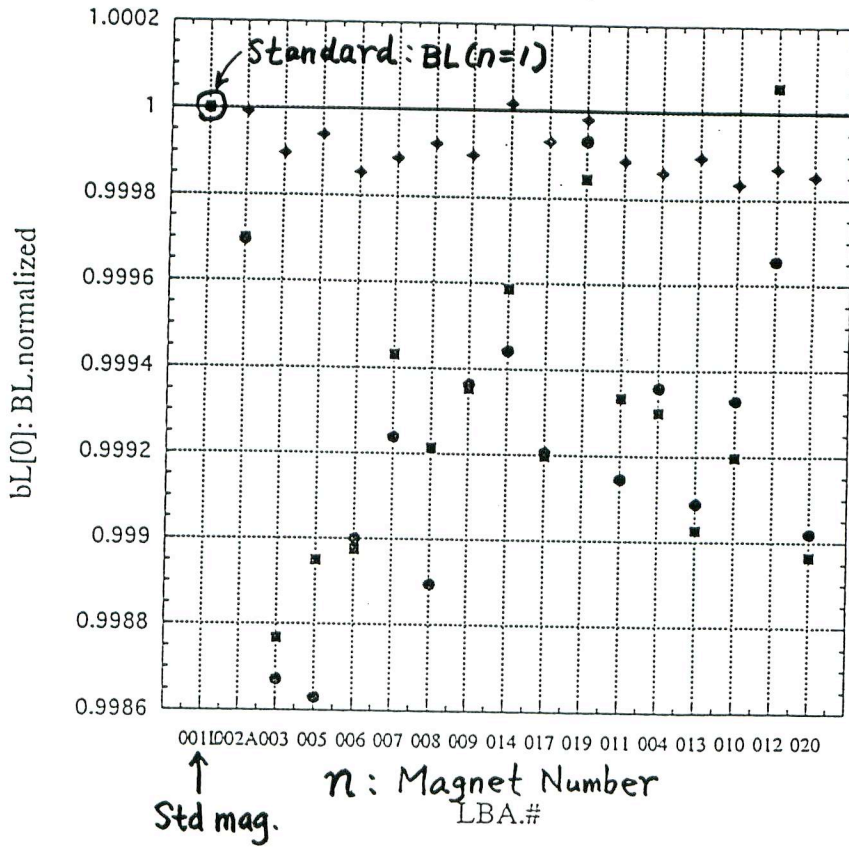






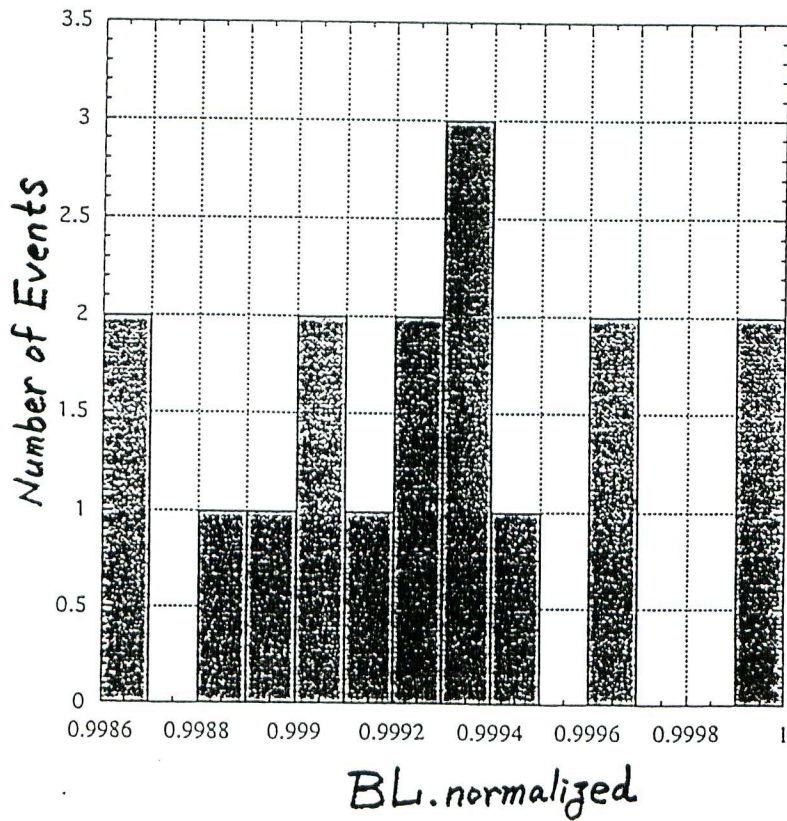
- b.1100A
  - LBA#/st.1200A
  - ◆ d[st]
- $BL(n)/BL(n=1)$  at 1100A  
 $BL(n)/BL(n=1)$  at 1250A  
 $BL(Std\ mag)/BL(n=1)$  at 1100A

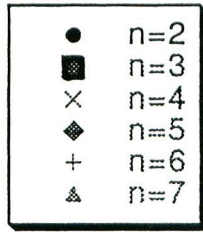
LBA.summary



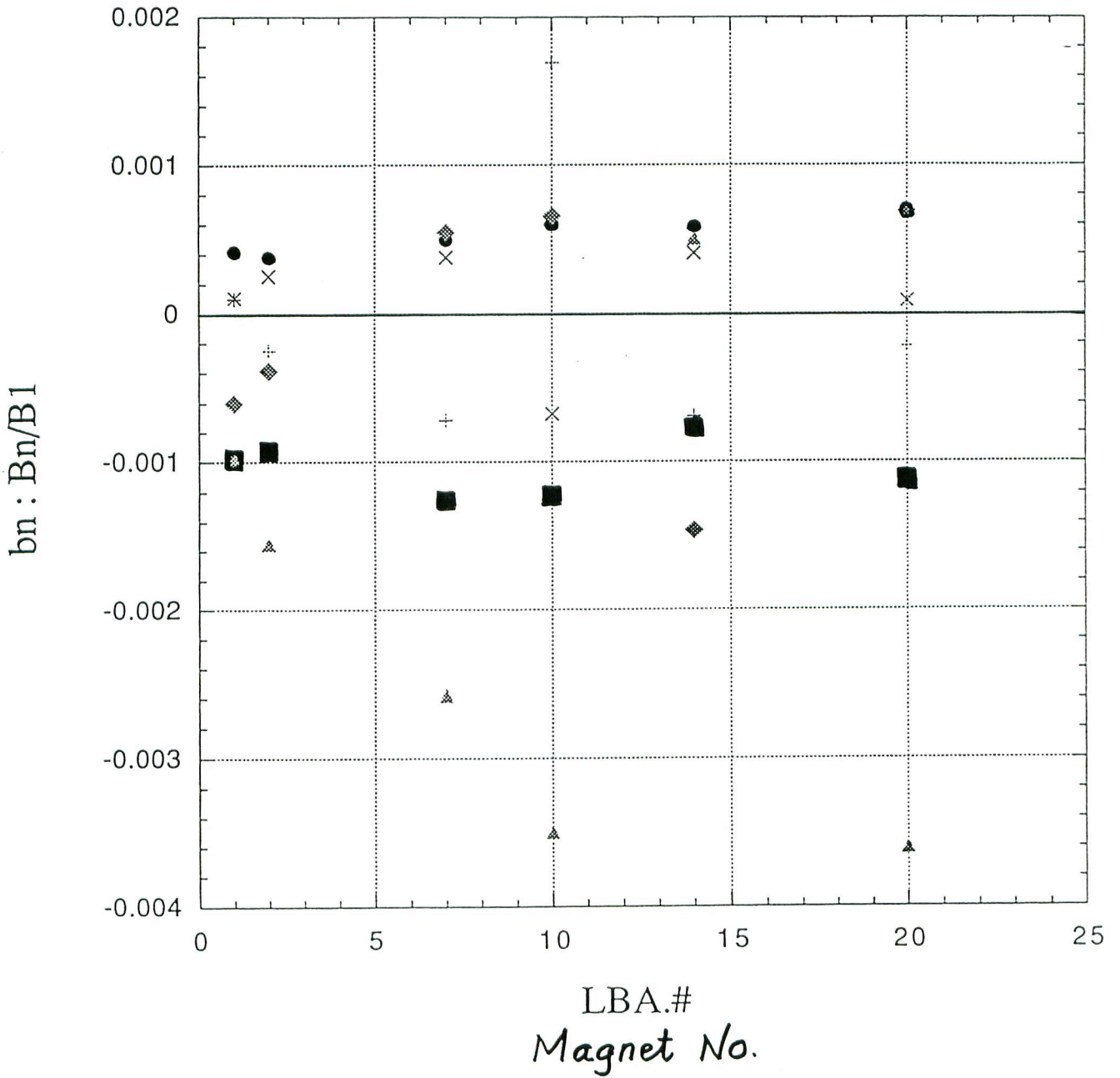
- ⊠ b.1100A

LBA.summary



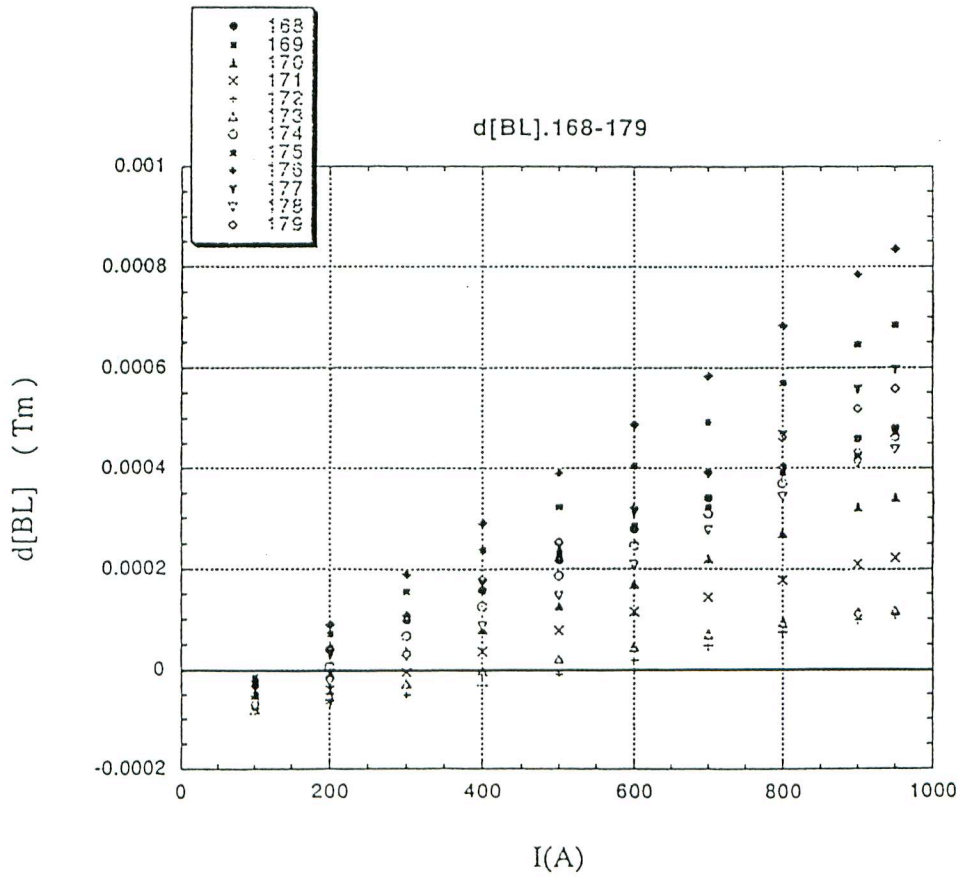
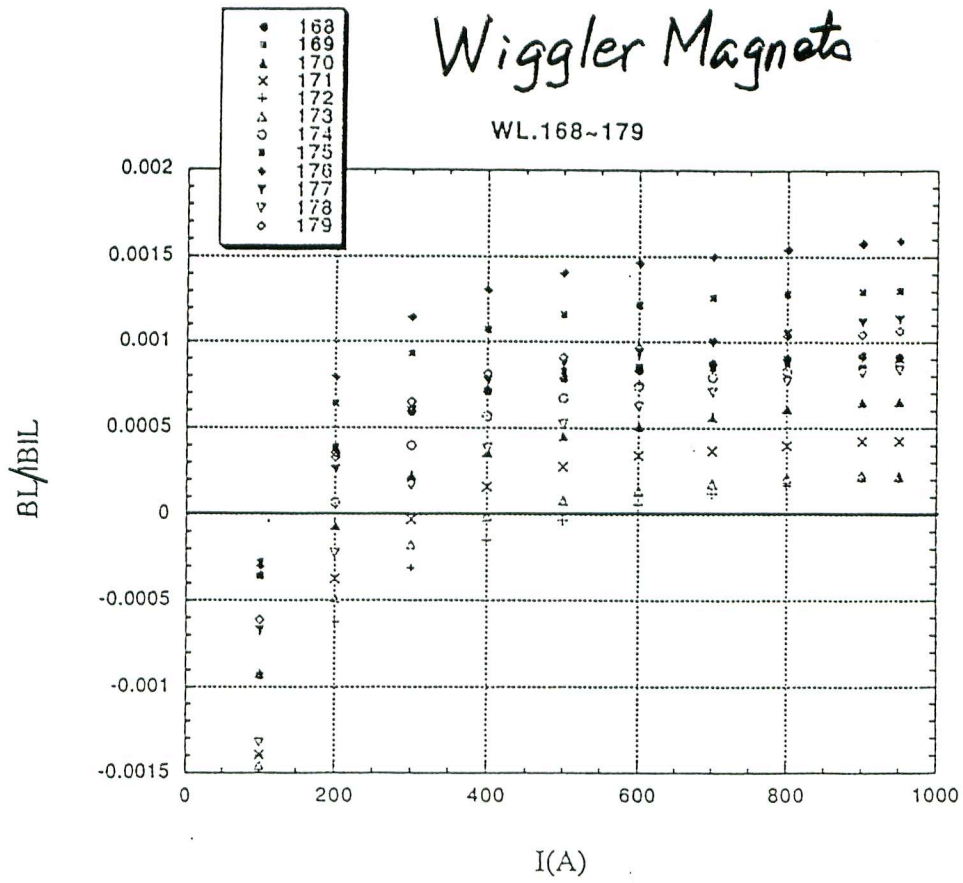


bn : Bn/B1 at 1100 A



# Wiggler Magnets

WL.168-179



## LER-QA: Results of Magnetic Field Measurement

Fabrication #	Magnet ID	No.	R	L	Date delivrd	Date measd	Results
796487-1	*LQA001L	1		1	9/27/96	1/7/97	Reference
796487-2	LQA002R	2	1		12/5/96	1/8/97	
796487-3	LQA003R	3	1		12/5/96	1/13/97	
796487-4	LQA004R	4	1		12/5/96	1/13/97	
796487-5	LQA005R	5	1		12/5/96	1/13/97	
796487-6	LQA006R	6	1		12/5/96	1/14/97	Base-2 is not good in Z
796487-7	LQA007R	7	1		12/5/96	1/14/97	
796487-8	LQA008R	8	1		12/5/96	1/9/97	
796487-9	LQA009R	9	1		12/5/96	1/14/97	
796487-10	LQA010R	10	1		12/5/96	1/14/97	
796487-11	*LQA011R	11	1		12/5/96	1/16/97	Base is bad in Z
796487-12	LQA012R	12	1		12/5/96	1/16/97	Big dipole compo.
796487-13	LQA013R	13	1		12/5/96	1/10/97	
796487-14	*LQA014R	14	1		12/6/96	1/16/97	Bad in dipole compo.
796487-16	*LQA016R	15	1		12/6/96	1/17/97	Base is bad in X
796487-17	LQA017R	16	1		12/6/96	1/17/97	Big dipole compo.
796487-18	LQA018R	17	1		12/6/96	1/20/97	Big dipole compo.
796487-19	*LQA019R	18	1		12/6/96	1/20/97	Base is bad
796487-20	*LQA020R	19	1		12/6/96	1/16/97	Base is bad
796487-21			1		12/6/96		
796487-22			1		12/6/96		
796487-23			1		12/6/96		
796487-24			1		12/6/96		
796487-25	LQA025R	20	1		12/6/96	1/13/97	
796487-26			1		12/6/96		
796487-27	*LQA027R	21	1		12/20/96	1/9/97	Base is bad
796487-28			1		12/20/96		
796487-29			1		12/20/96		
796487-30			1		12/20/96		
796487-31	LQA031R	22	1		12/20/96	1/8/97	
796487-32			1		12/20/96		
796487-33	*LQA033R	23	1		12/20/96	1/8/97	Bad in dipole compo.
796487-34	*LQA034R	24	1		12/20/96	1/10/97	Bad in dipole compo.
796487-35	*LQA035R	25	1		12/20/96	1/10/97	Bad in dipole compo.
796487-36			1		12/20/96		

Note: Magnets with \* mark are unusable !

**LER-B; Results of Magnetic Field Measurement**

Fabrication#	Magnet ID	No.	Date delivrd	Date measd	Results
796486-1	LBA001	1	7/0/1996	Reference	
796486-2	LBA002	2	12/3/96	1/8/97	
796486-3	LBA003	3	12/3/96	1/10/97	
796486-4	LBA004	4	12/3/96	1/14/97	Base is not good
796486-5	LBA005	5	12/3/96	1/10/97	Base is not good
796486-6	*LBA006	6	12/3/96	1/14/97	Base is bad
796486-7	LBA007	7	12/3/96	1/13/97	
796486-8	LBA008	8	12/4/96	1/9/97	
796486-9	LBA009	9	12/4/96	1/13/97	Base is not good
796486-10	*LBA010	10	12/4/96	1/16/97	Base is bad
796486-11	LBA011	11	12/4/96	1/14/97	
796486-12	LBA012	12	12/4/96	1/17/97	
796486-13	*LBA013	13	12/4/96	1/16/97	Base is bad
796486-14	*LBA014	14	12/20/96	1/8/97	Base is bad
796486-15	*LBA015	15	12/20/96	1/20/97	Base is bad
796486-16	LBA016	16	12/20/96	1/20/97	
796486-17	LBA017	17	12/20/96	1/9/97	
796486-18			12/20/96		
796486-19	*LBA019	18	12/20/96	1/8/97	Base is bad
796486-20	LBA020	19	12/20/96	1/17/97	

Note: Magnets with \* mark are unusable !



## Installation and Alignment

Jan.21, 1997

### **1. Survey of the beam level**

Oct-Nov,1995 Installed beam level markers referring to the level of TRISTAN Q-magnets.  
Jan-May,1996 First survey of level markers  
June,1996 Second survey of level markers  
June,1996 Third survey of level markers

### **2. Survey of monuments**

Monuments are the center of TRISTAN Q-magnets.

Apr-Jul,1996 Survey of monuments with the laser tracker:  
N → N → W → E → S → N → 4 IR's

### **3. Installation of magnets**

End of Aug - Nov,1996

Marked the magnet position with the laser tracker: position for both ends of B-magnets in the arc section, and that for all magnets in the straight section.

Nov.,1996 Started to mark the base plate position.

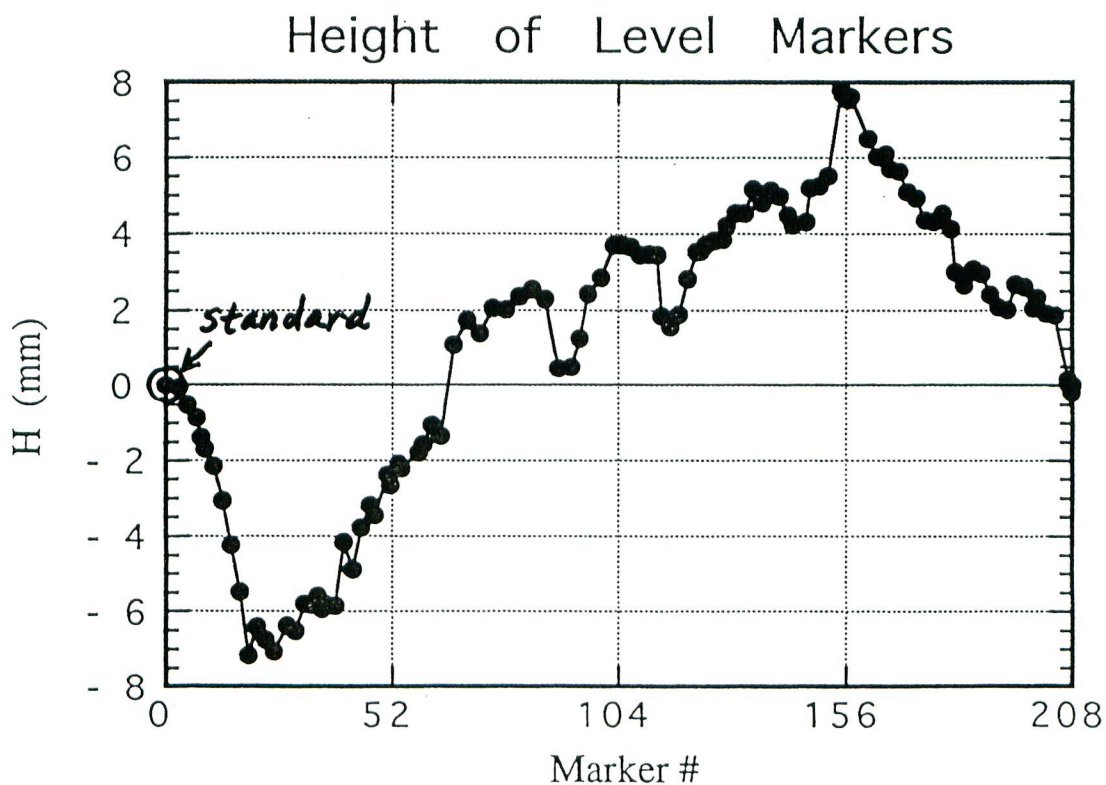
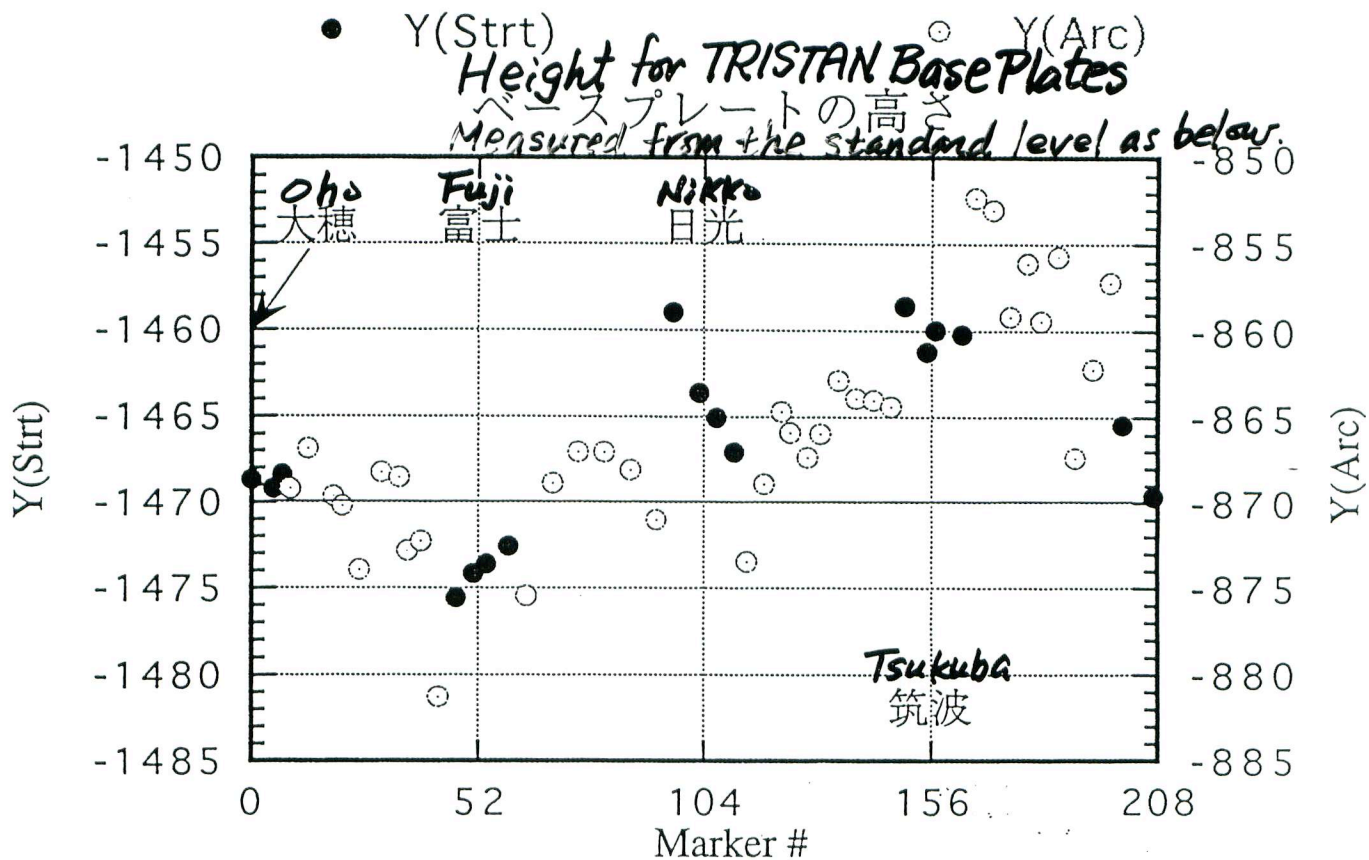
Dec.,1996 Started to install base plates.

Finished in the west arc on Jan.14,1997.

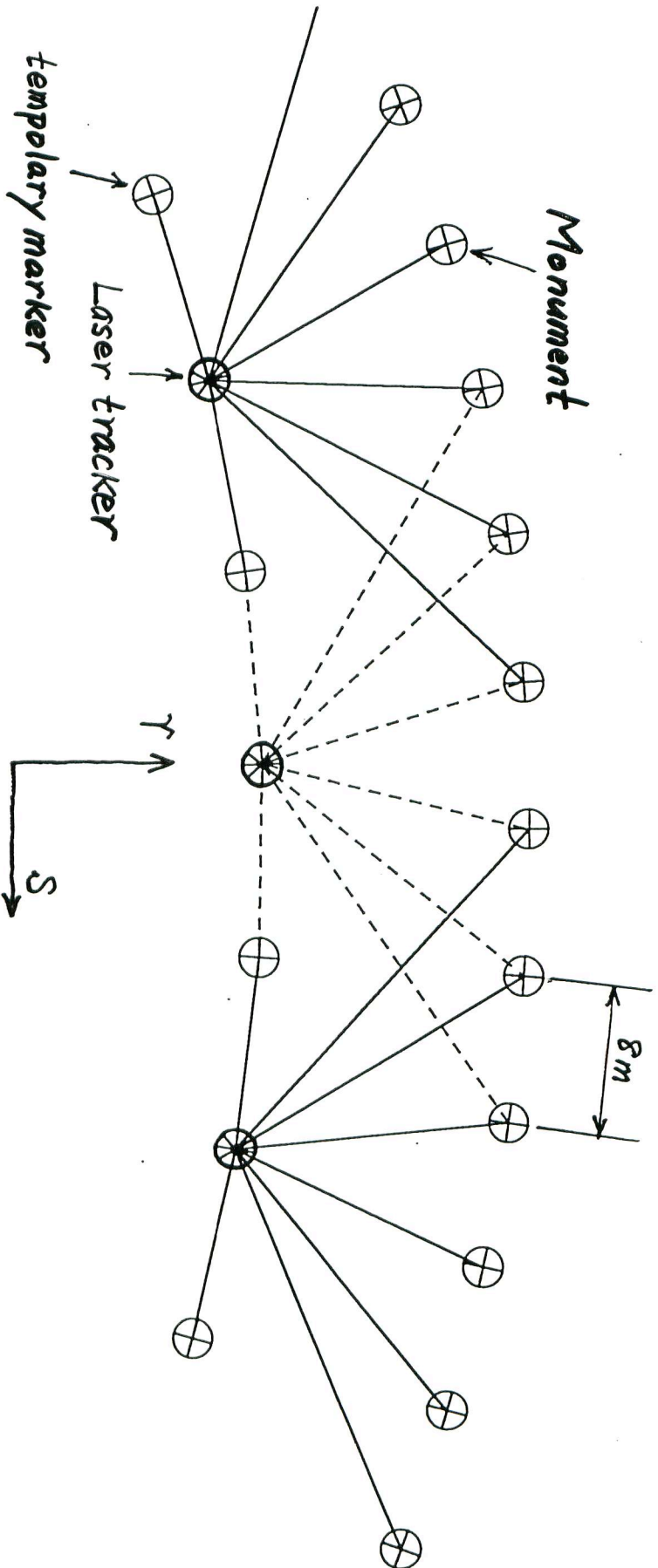
Will complete in March, 1997.

Jan.16,1996 A set of magnet carrier was delivered.

Installation of magnets will start in February.



# Survey of monuments with the Laser Tracker '96.7.30 R.S.



$$\Delta S (\text{tracker}) = R \Delta \phi \approx 20\text{m} \times 3\mu\text{rad} = 60\mu\text{m}$$

$$\Delta S (\text{target setting}) \approx 100\mu\text{m}$$

$$\therefore \Delta S \approx 0.12 \text{ mm}$$

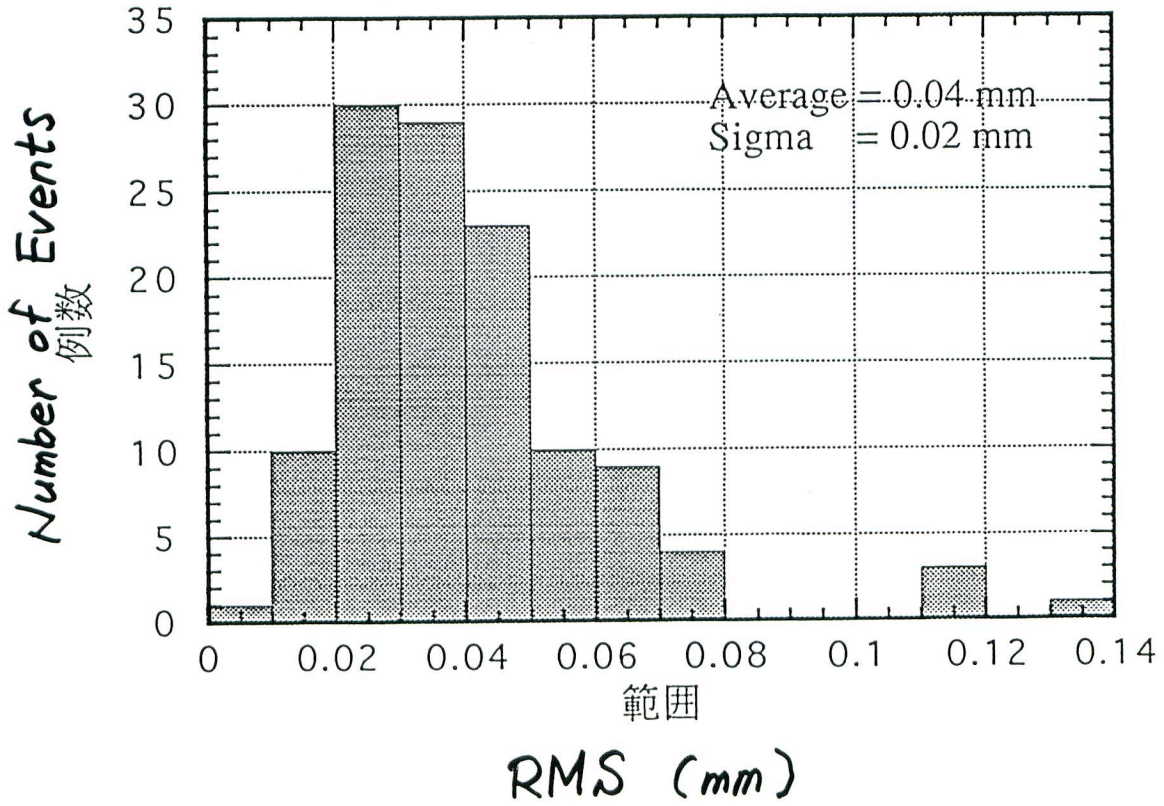
$$N_{\text{meas}} = 3000\text{m} / 24\text{m} = 125$$

$$\Delta l_{\text{arc}} \approx \Delta S \cdot \sqrt{N_{\text{meas}}} = 1.3 \text{ mm}$$

$$\Delta r \approx 0.1 \text{ mm}$$

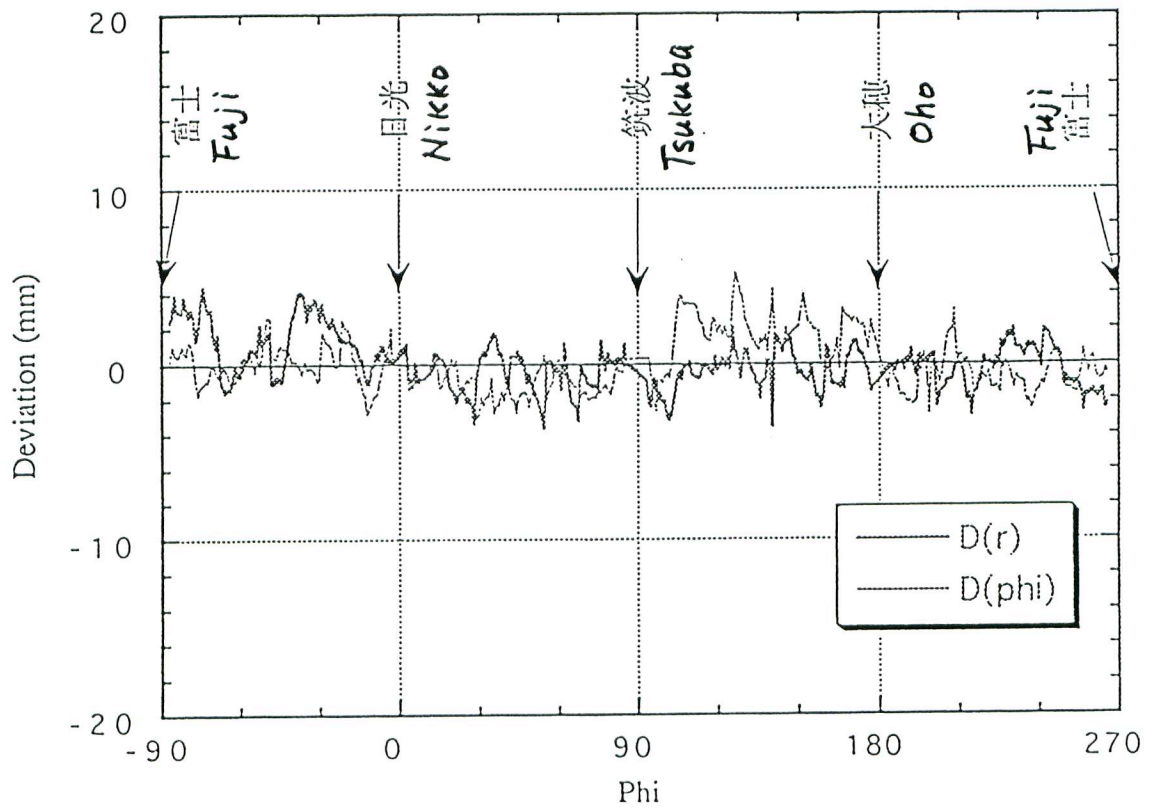
# RMS for overlapping points

オーバーラップ測定点の重なり具合 (RMS)

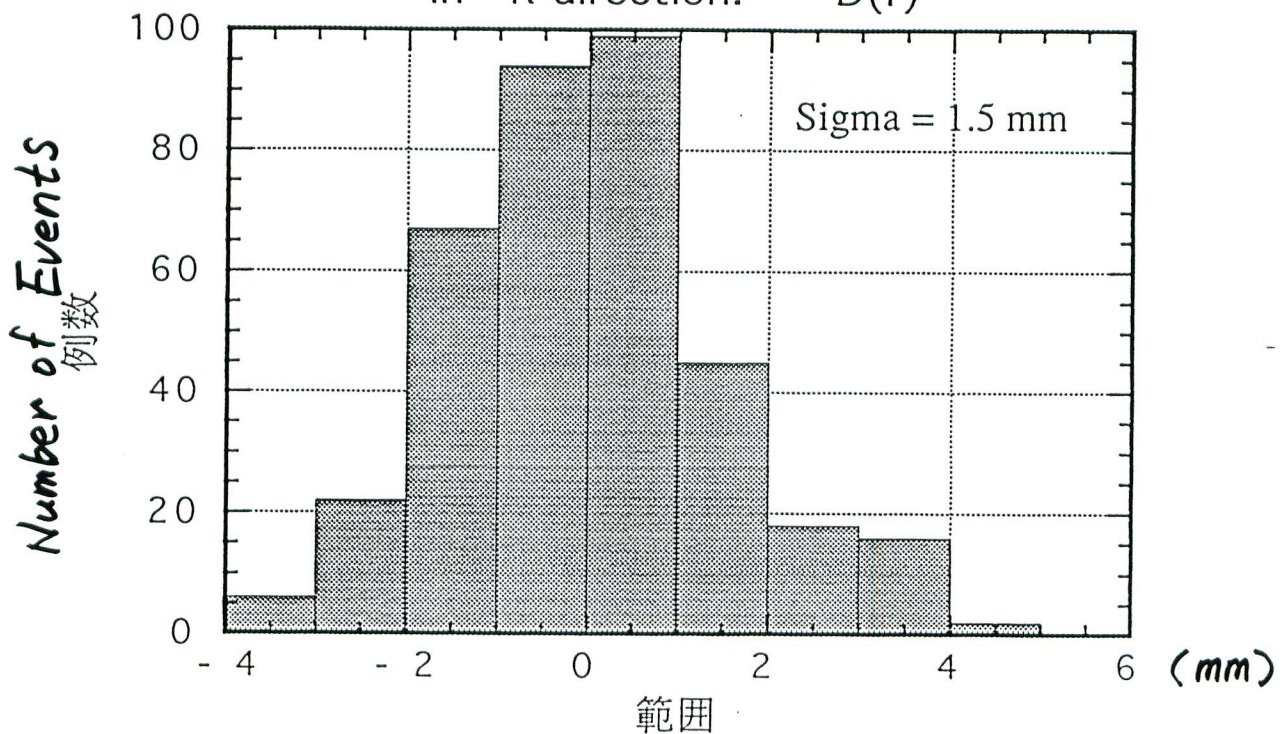


Coord. for TRISTAN-Q Monument

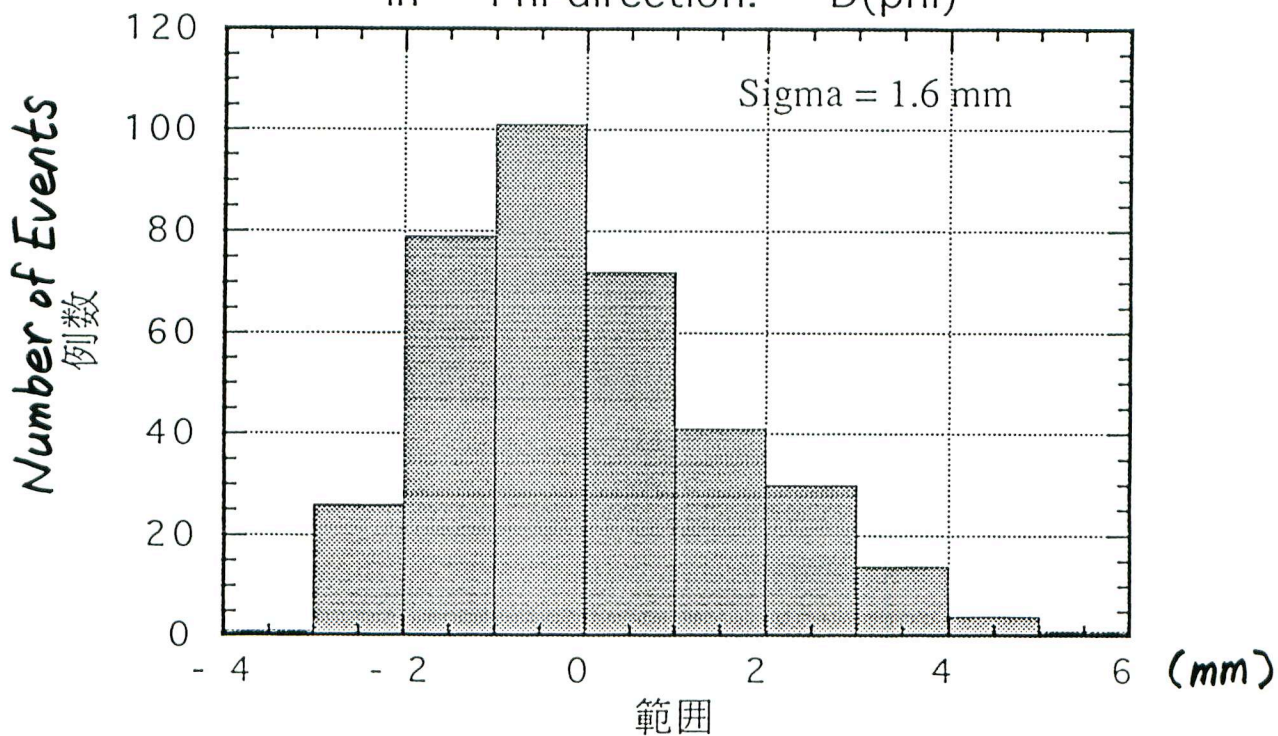
Difference : Measurement - Lattice Coord.

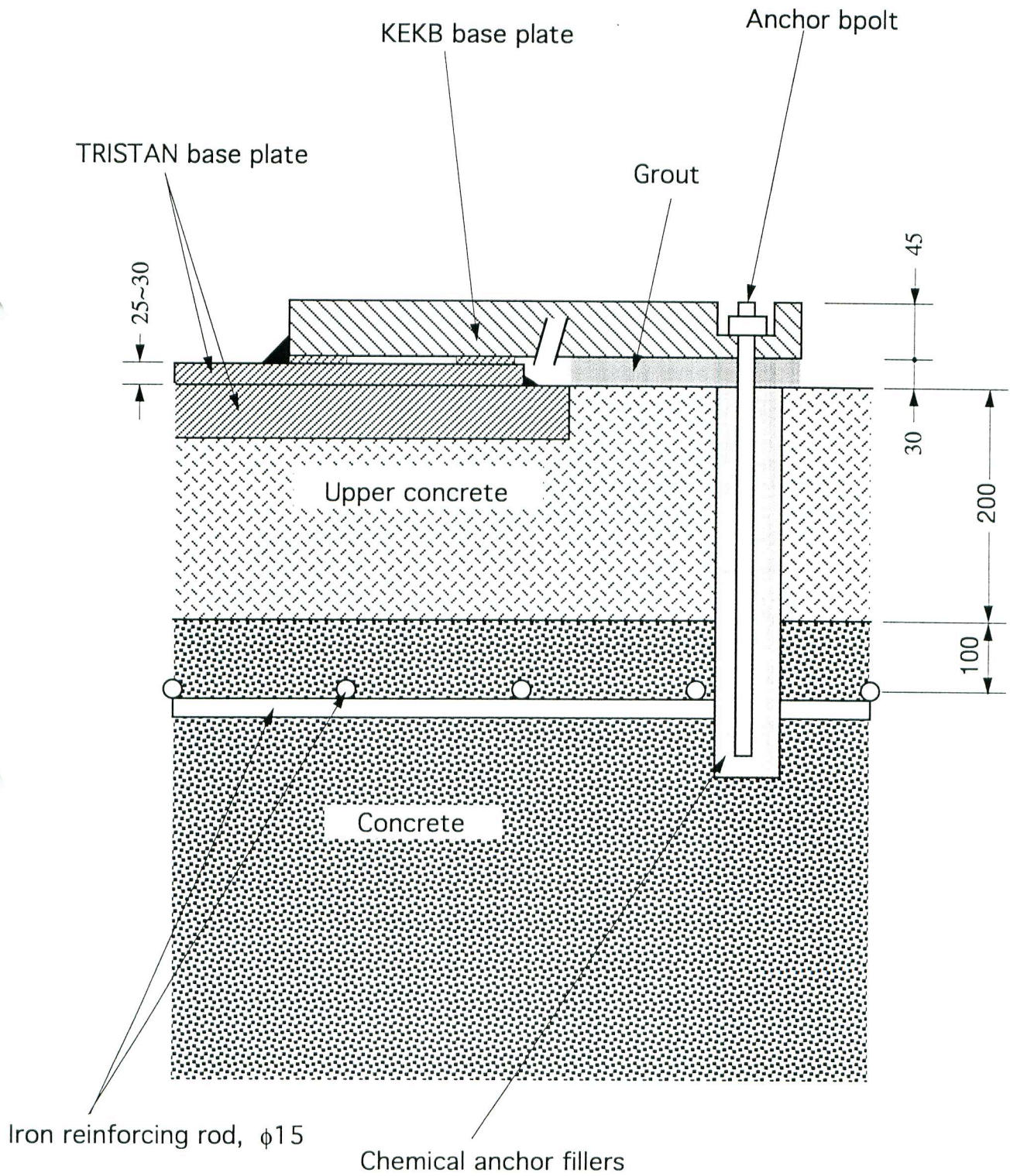


Deviation from TRISTAN Coord.  
in R-direction:  $D(r)$

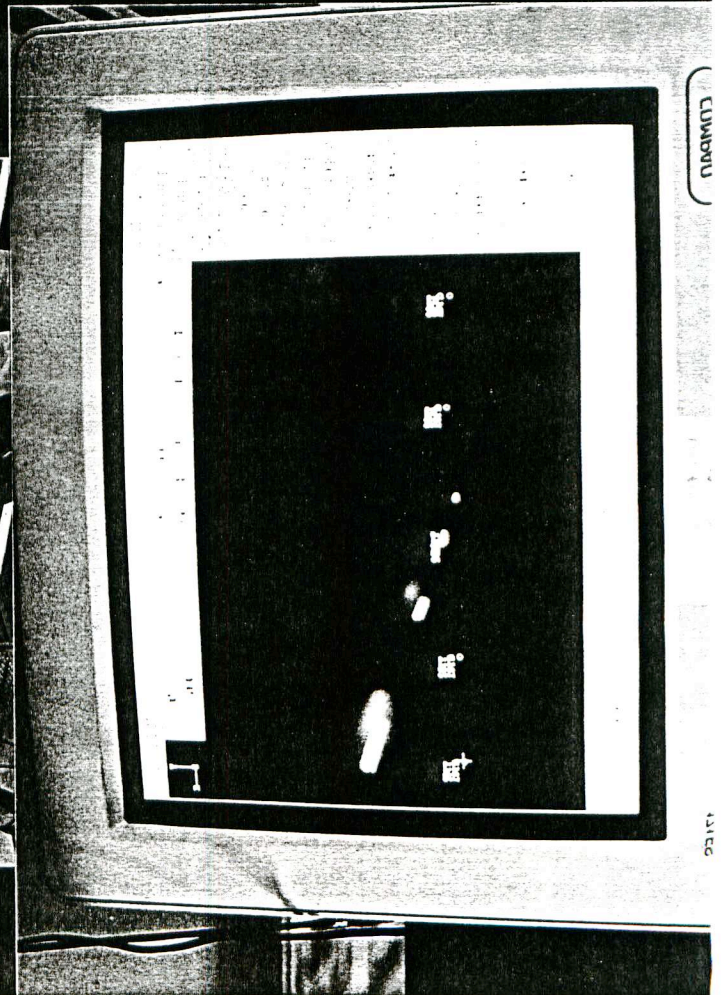
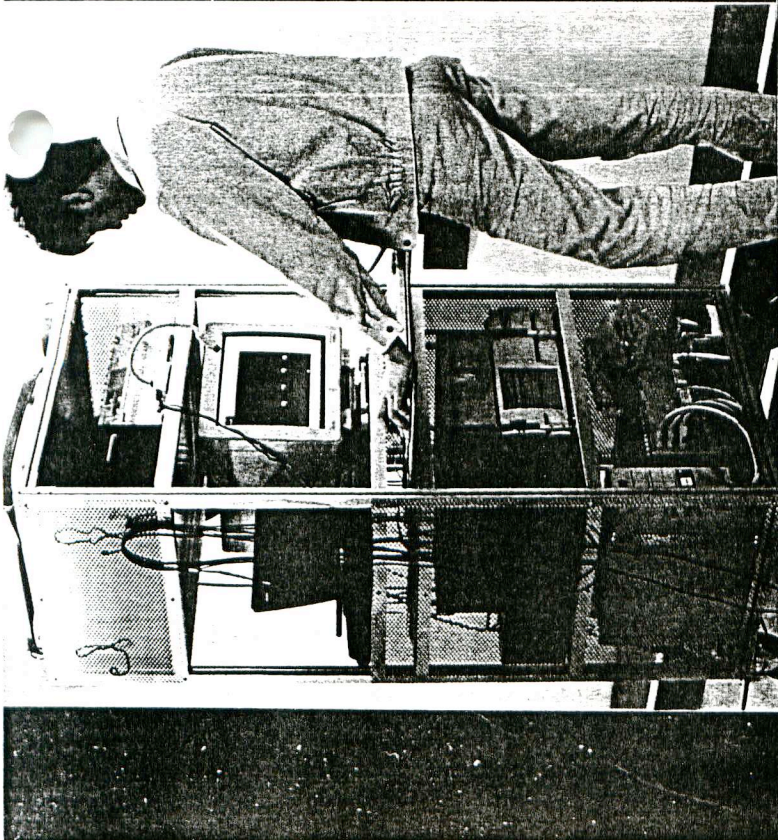
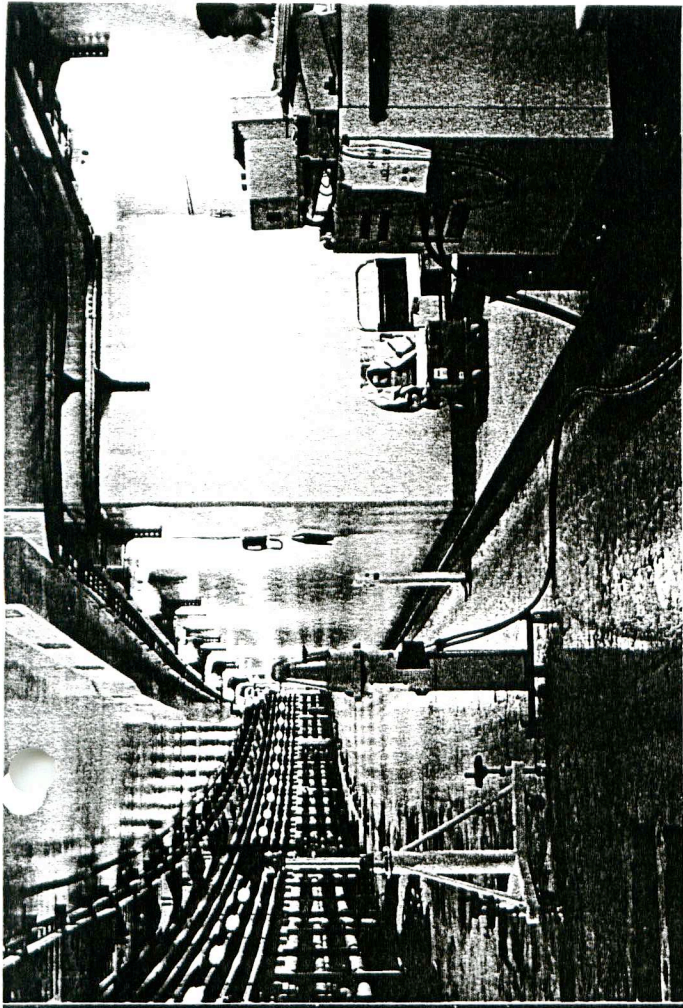


Deviation from TRISTAN Coord.  
in Phi-direction:  $D(\phi)$

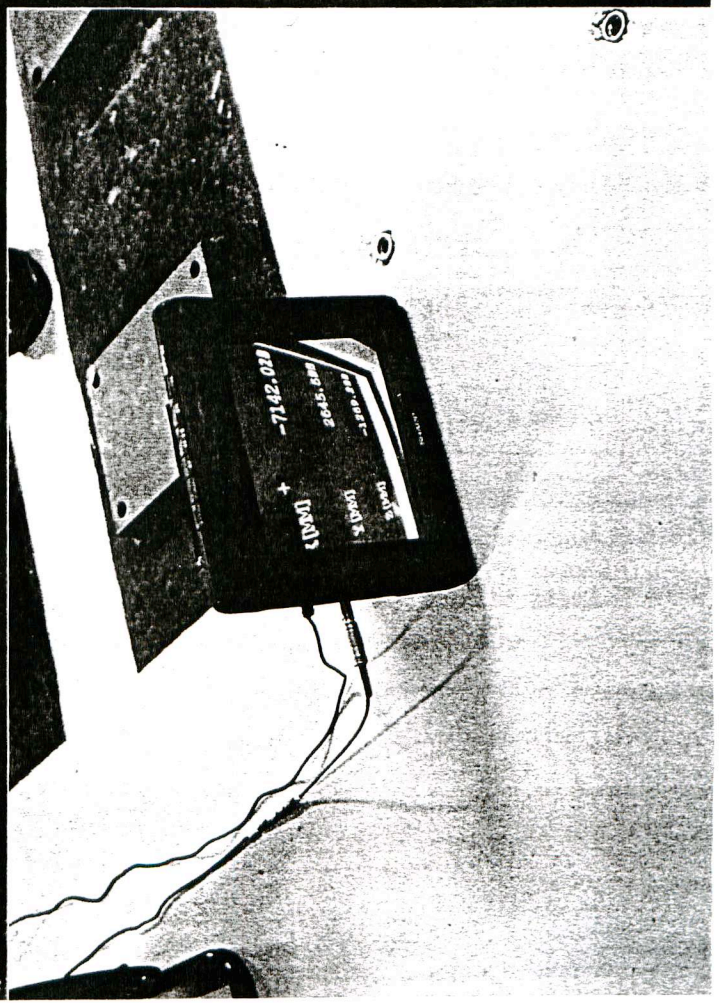
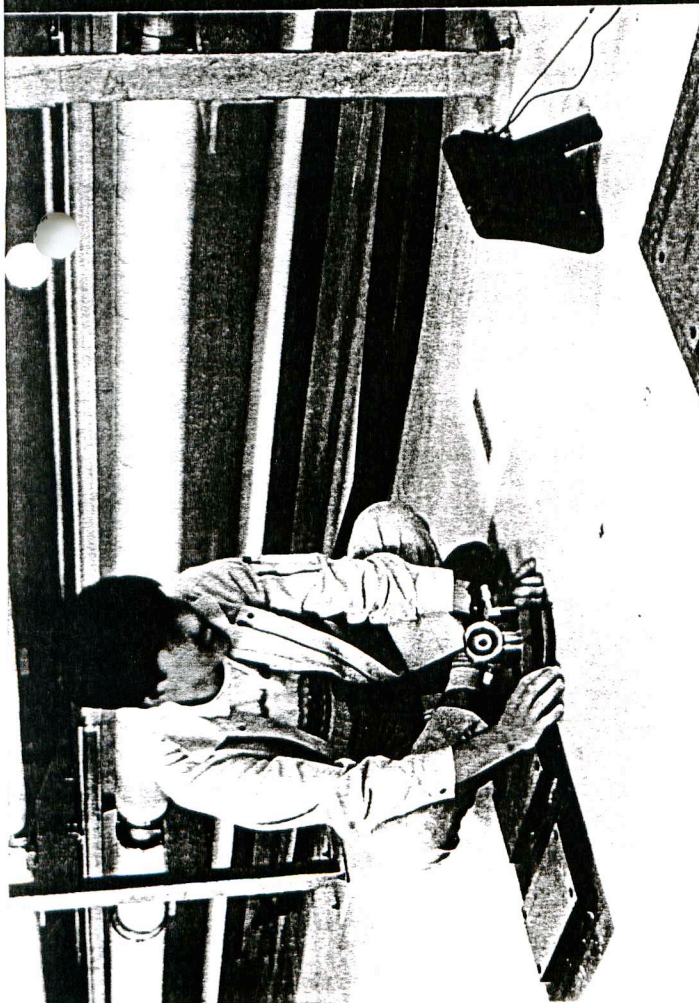
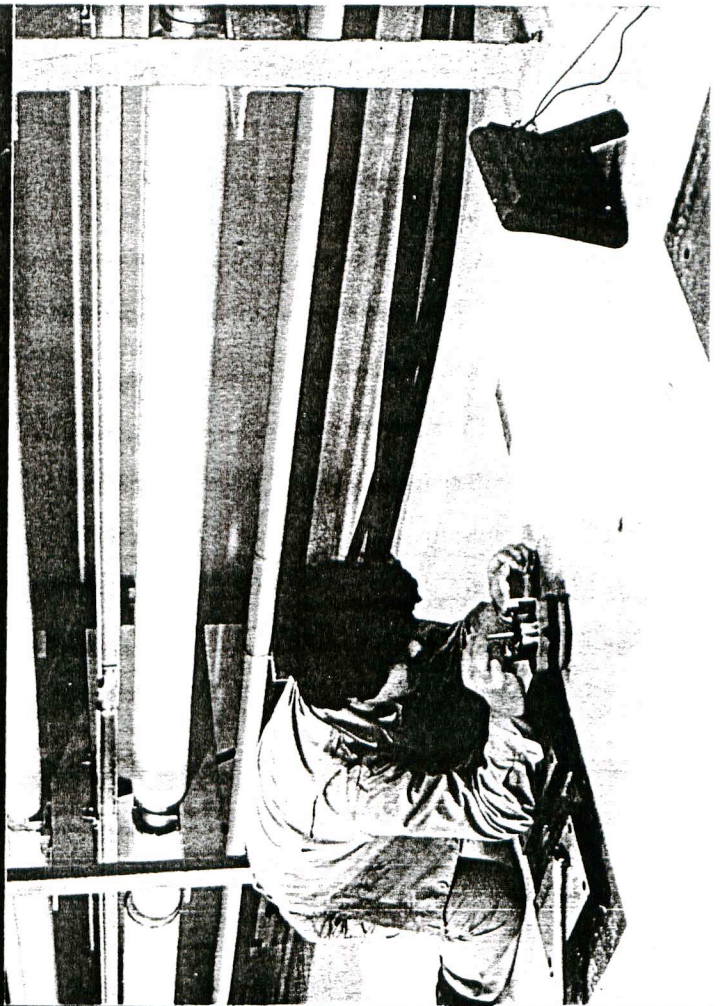
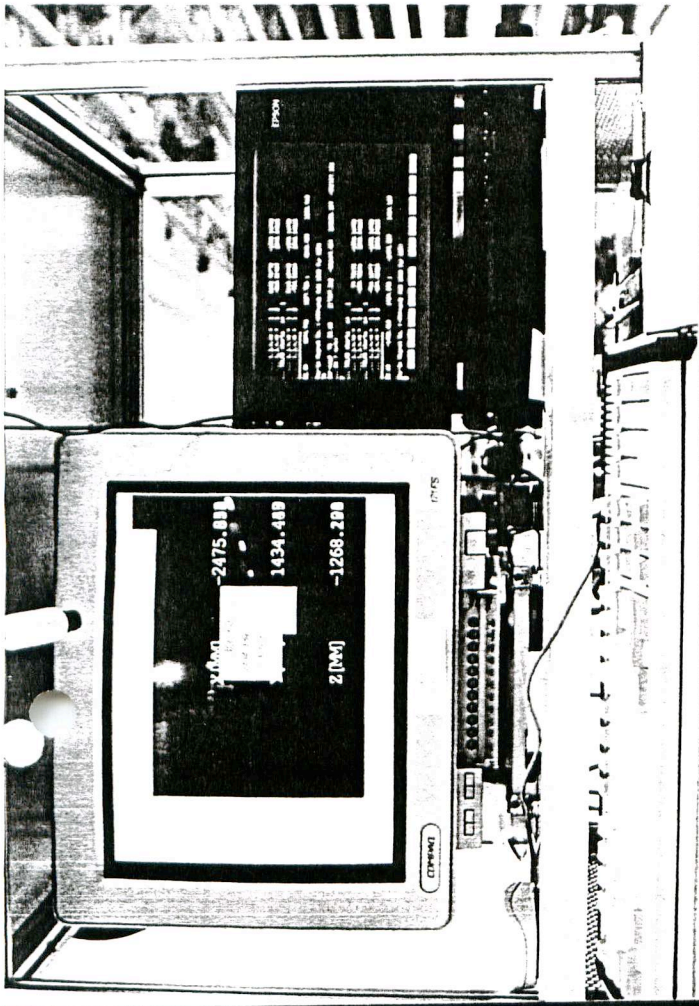


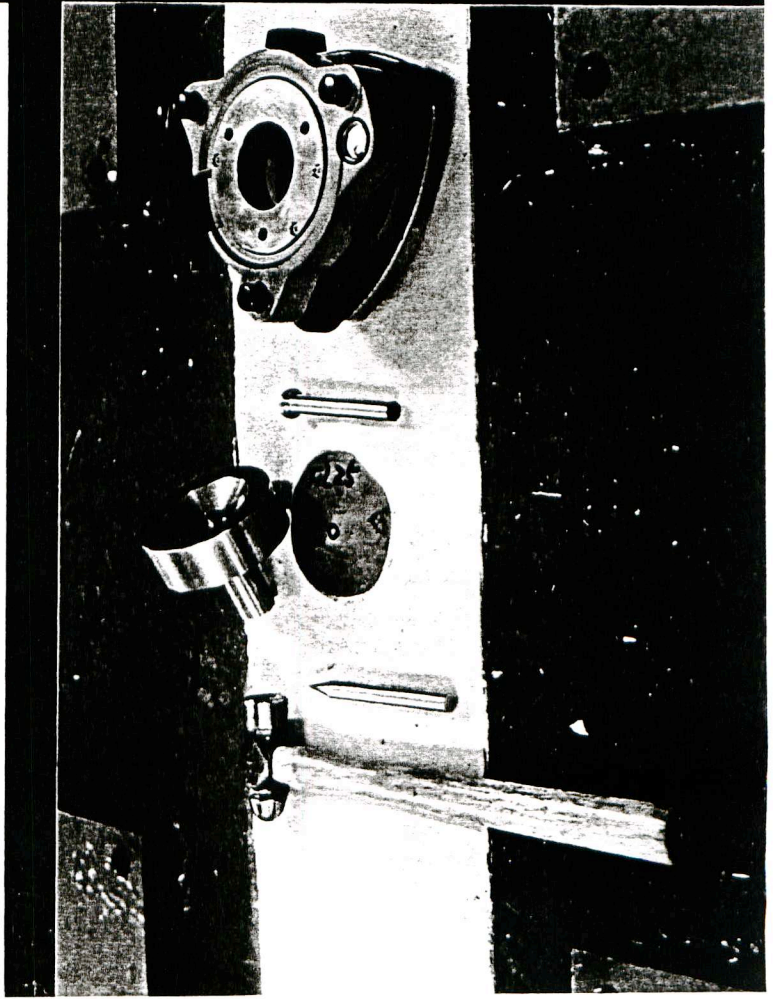
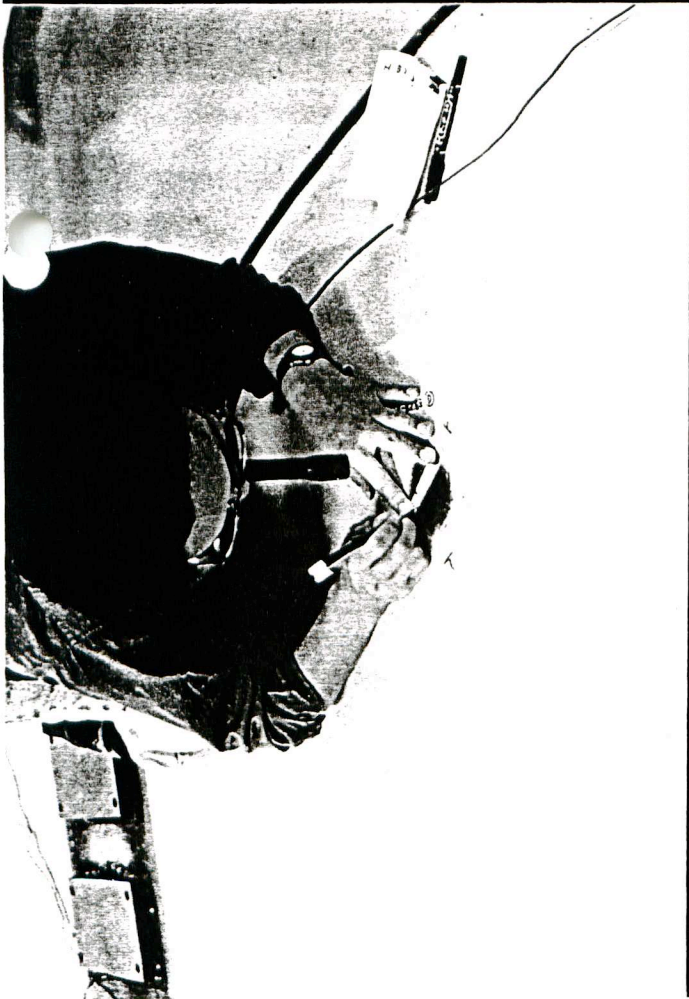
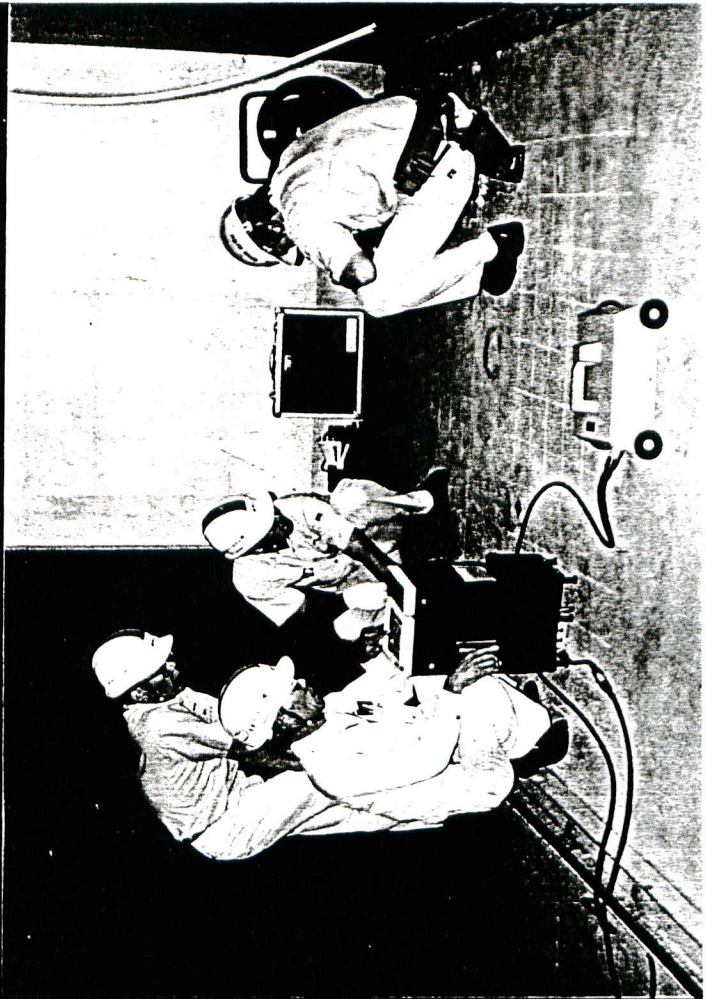
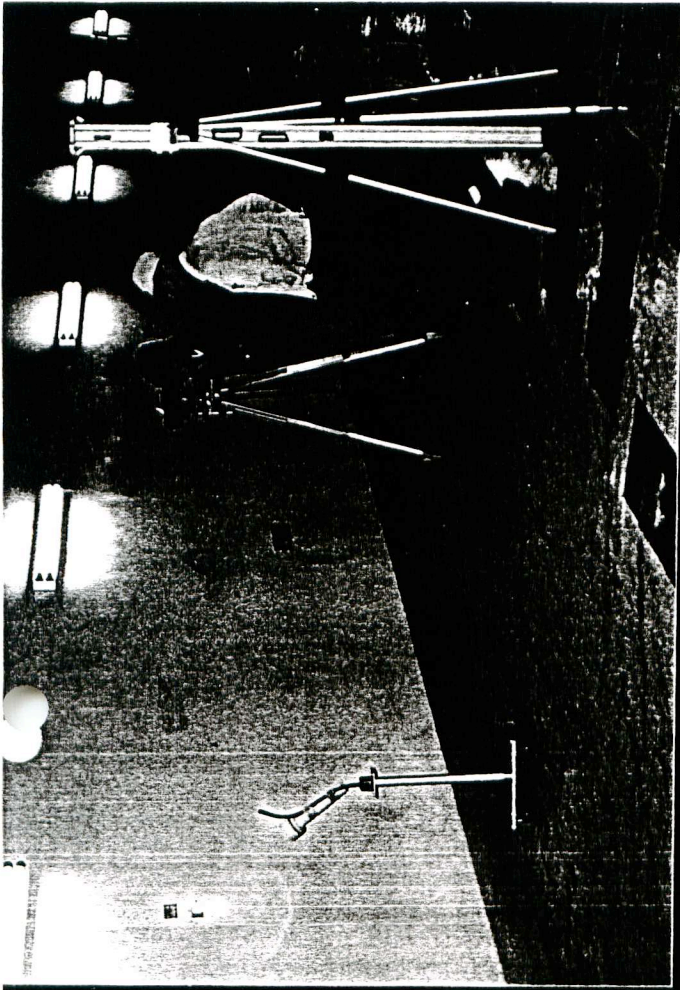


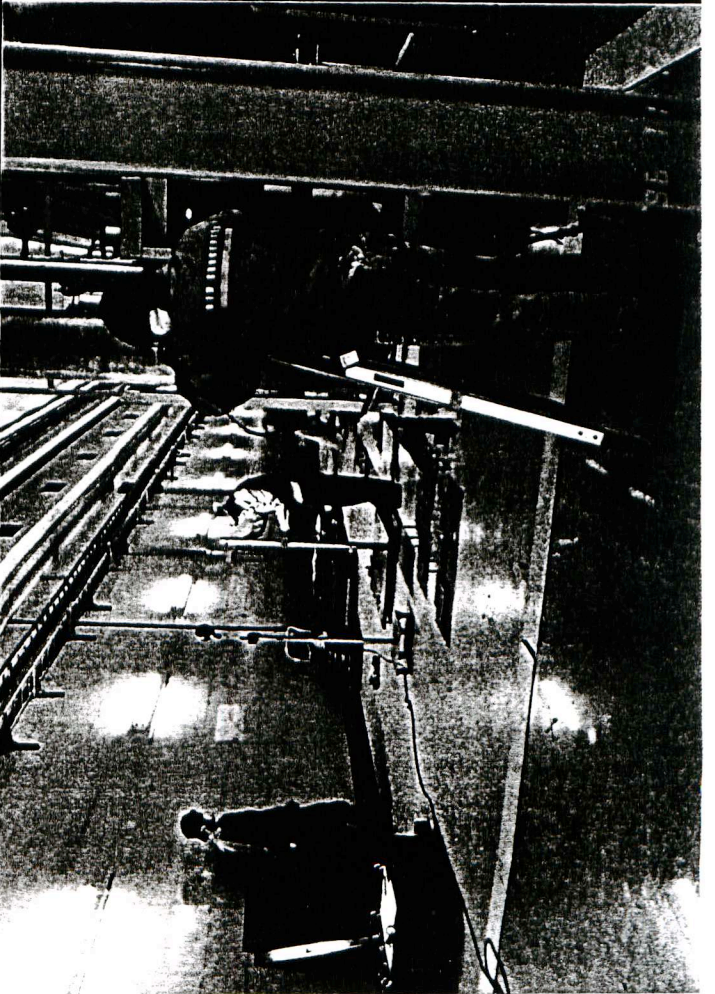
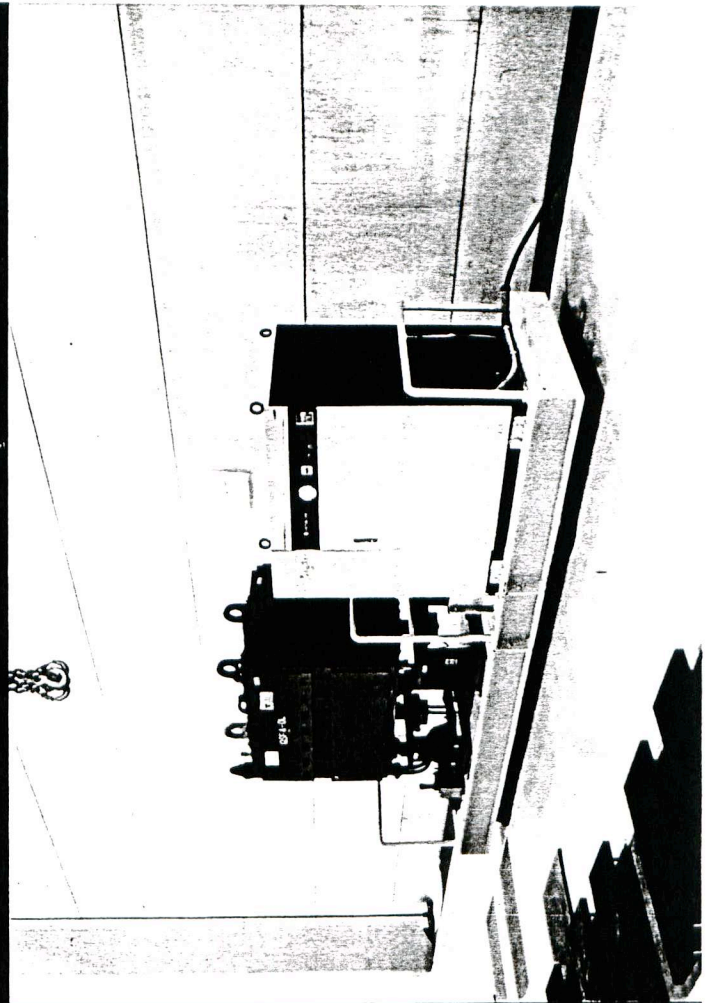
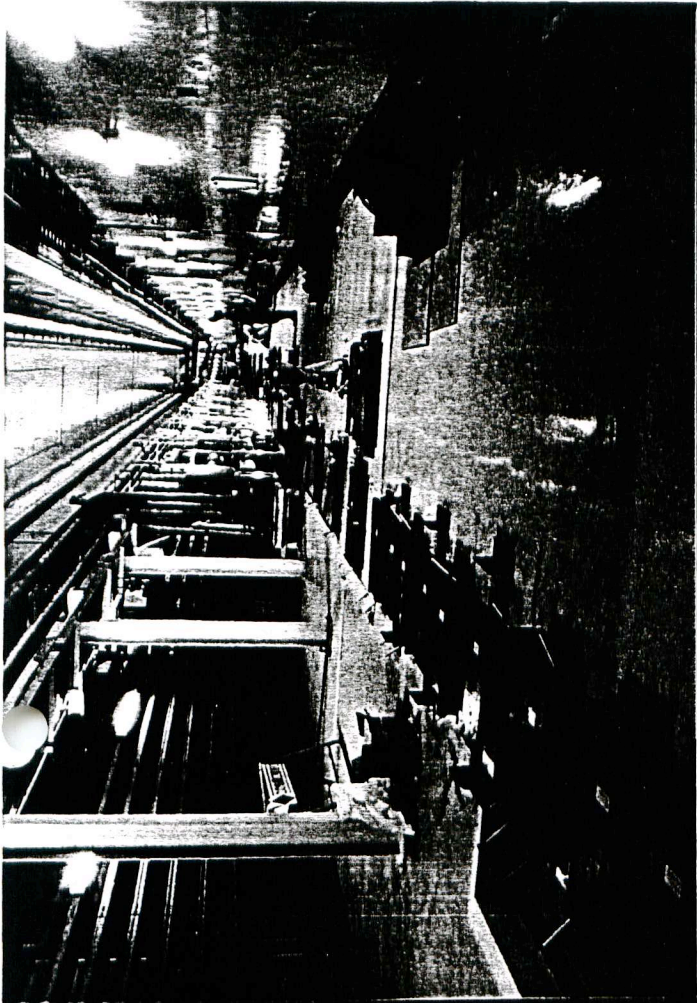
Base plate for KEKB  
1997.1.21 R.S.

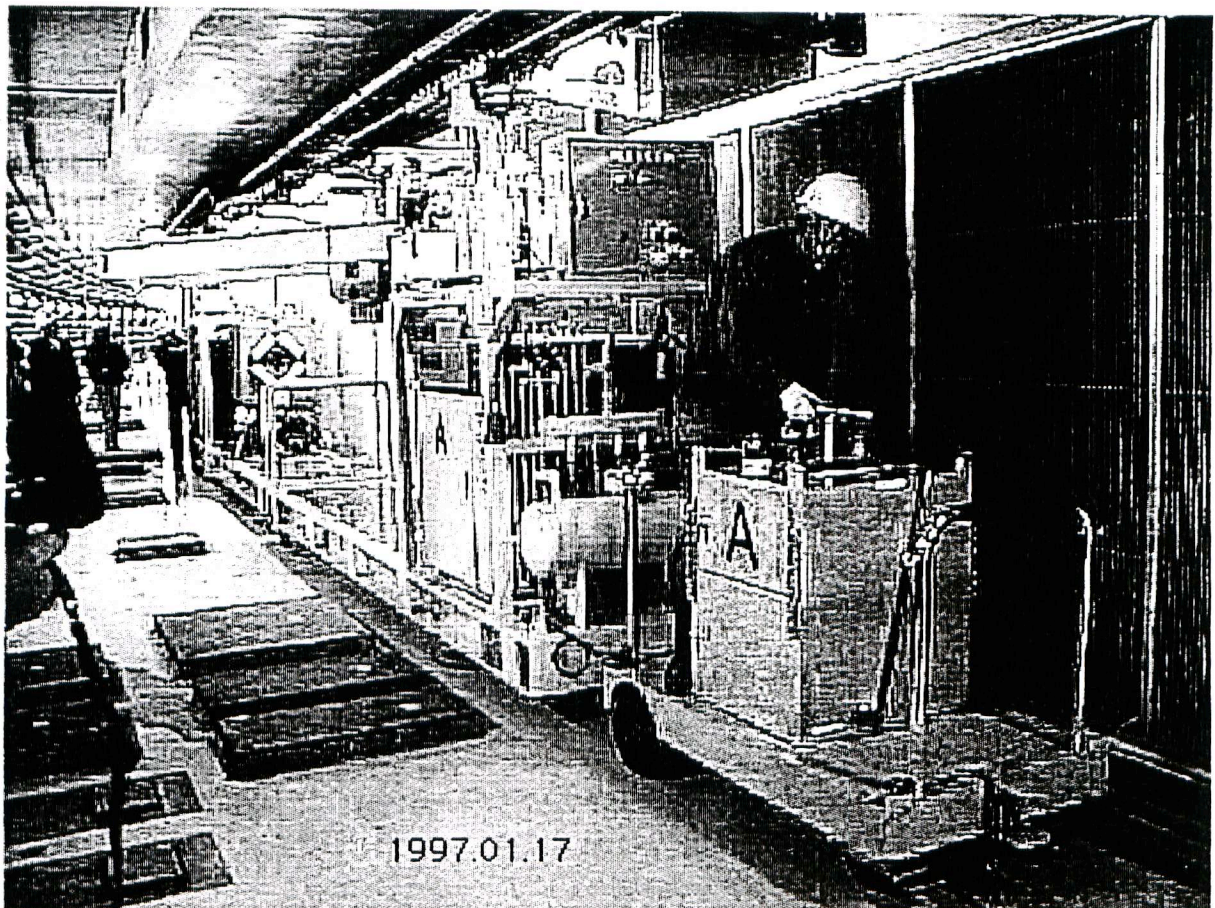












1997.01.17

A set of magnet carrier was delivered on Jan.16,  
and tested successfully!

Two carriers are hauled by <sup>a</sup>batteried electric car.  
The carrier is made of air pallet.

The compressor require electric power :  $2 \times 15 \text{ kW}$ ,  
which is supplied by the trolley cable.

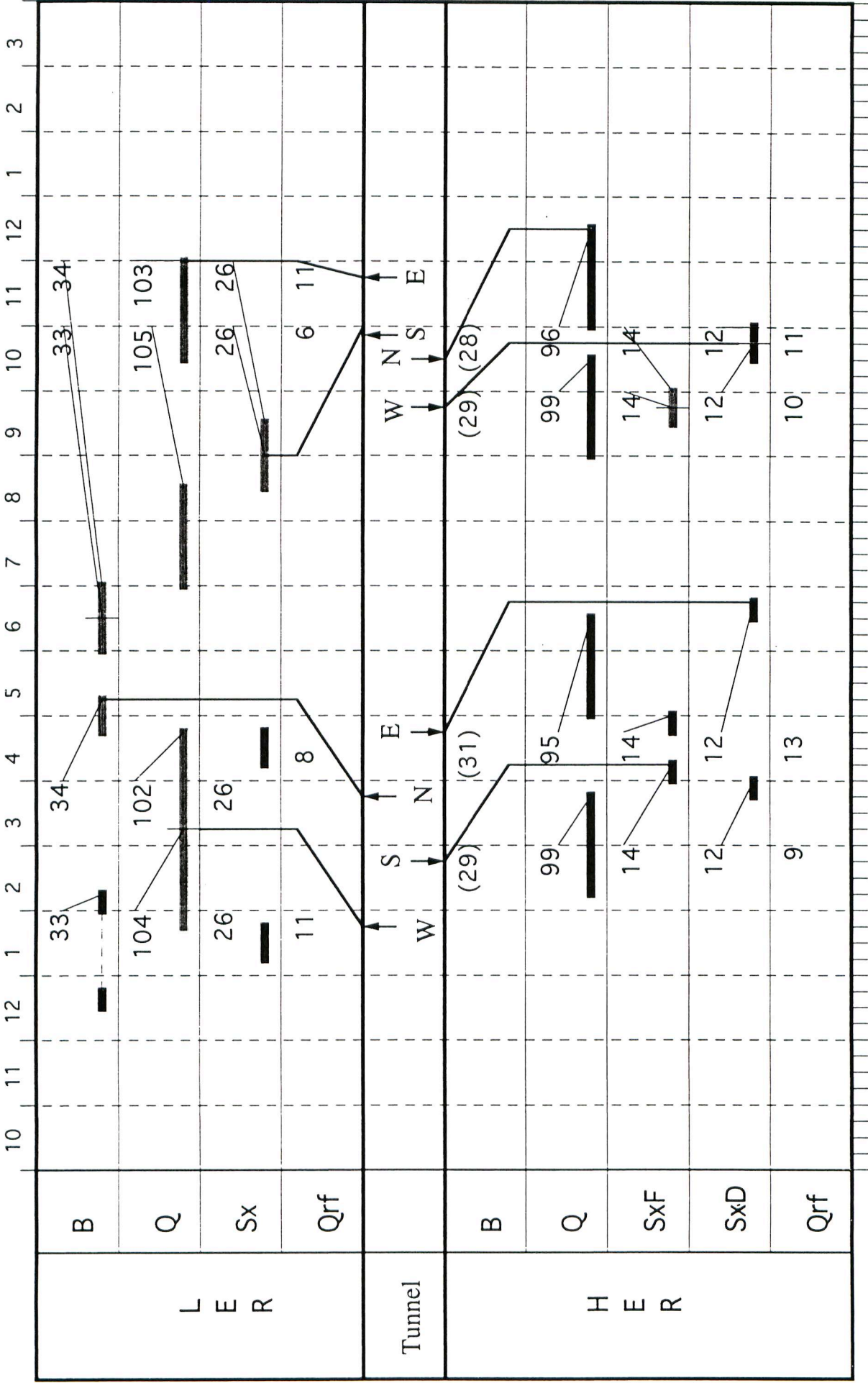
A carrier can handle 6 ton magnet.

Two carrier can handle 6m long HER-B magnet.

Max. speed is 3 km/H, a bit less than walking  
speed.

1997

1998



Schedule for Magnetic Field Measurement and the Number of Magnets Required for Installation

Magnetic field measurement: 16 magnets/week/line

Installation: 10/day for LER-B; 5/day for HER-B; 5/day for Q & Sx (Opening of magnets iare ncluded)

Plan #1 No beam operation in spring, 1998

Updated on Jun.25,96

	FY1996 (H8)			FY1997 (H9)			FY1998 (H10)					
	4	7	10	1	4	7	10	1	4	7	10	1
West tunnel (N - F)	Outer (LER)			B	Ins	Clis (A)	A	M				
	Inner (HER)			B			Ins	A	Opn	Ins	Cts	M
North tunnel (T - N)	Outer (LER)			B	Ins	Clis (A)	A	M				
	Inner (HER)			B			Ins	Opn	Clis	Ins	M	
South tunnel (F - O)	Outer (HER)			B	Ins	Inb	Clis			A	M	
	Inner (LER)			B			Ins	Ins	Cs	A	M	
East tunnel (O - T)	Outer (HER)			B	Ins	Clis				A	M	
	Inner (LER)			B			Ins	Ins	Clis	Ins	A	M

<Magnet related>

- B Install base plates
- Ins Install magnets (and open them)
- Clis Close magnets
- A Align magnets
- Opn Open magnets

<Vacuum and BPM related>

- Ins Install vacuum chambers
- Bring vacuum and power supply system into operation
- M Align BPM

Schedule for Installation of Magnets, Vacuum Chambers and BPMs

# Plan #2 Beam operation in spring, 1998

Updated on Dec.12, 1996

	FY1996 (H8)				FY1997 (H9)				FY1998 (H10)			
	4	7	10	1	4	7	10	1	4	7	10	1
West tunnel (N - F)	Outer (LER)			Ins	Ins	Clis (A)		A	M			
	Inner (HER)							A	Opn	Ins	Clis	M
North tunnel (T - N)	Outer (LER)			B	Ins	Ins	Clis (A)		A			
	Inner (HER)			B				Ins		A	Opn	Ins
South tunnel (F - O)	Outer (HER)			B	Ins	Ins	Clis					
	Inner (LER)			B				Ins	Clis	A	M	
East tunnel (O - T)	Outer (HER)			B				Ins	Clis			
	Inner (LER)			B				Ins	Clis	A	M	

Beam operation

<Vacuum and BPM related>

<Magnet related>

- B Install base plates
- Ins Install vacuum chambers
- Clis Close magnets
- A Align magnets
- Opn Open magnets
- Ins Install magnets (and open them)
- M Bring vacuum and power supply stem into operation
- Align BPM

## Schedule for Installation of Magnets, Vacuum Chambers and BPMs