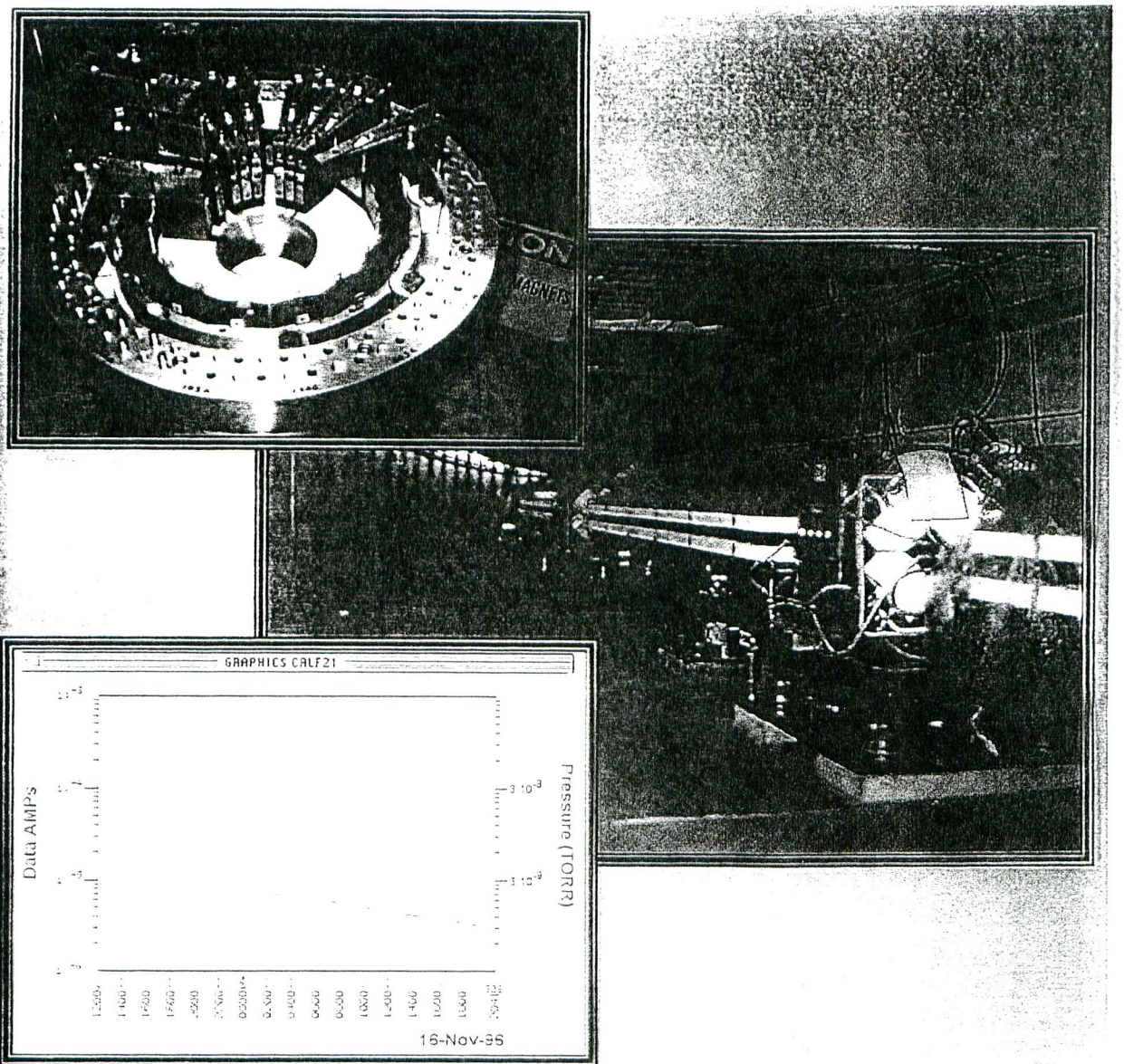
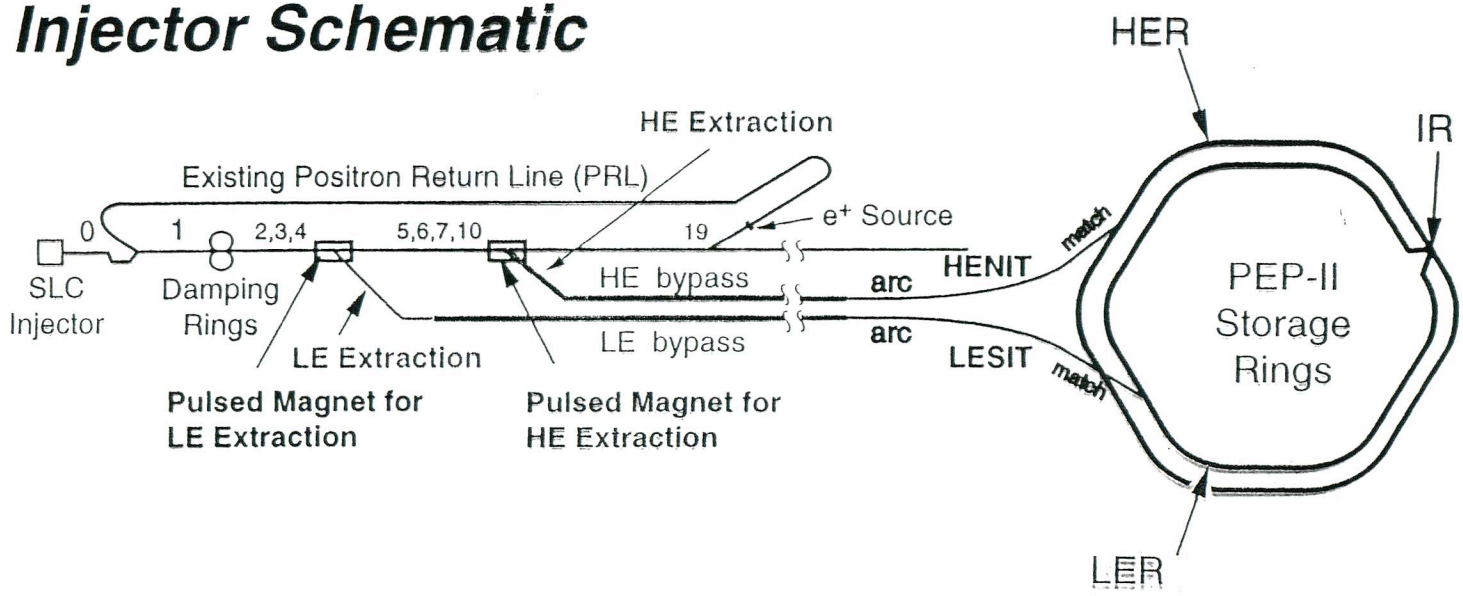


PEP-II Machine Advisory Committee Meeting

January 6-8, 1997

Injector Schematic



03/13/96
7701A4

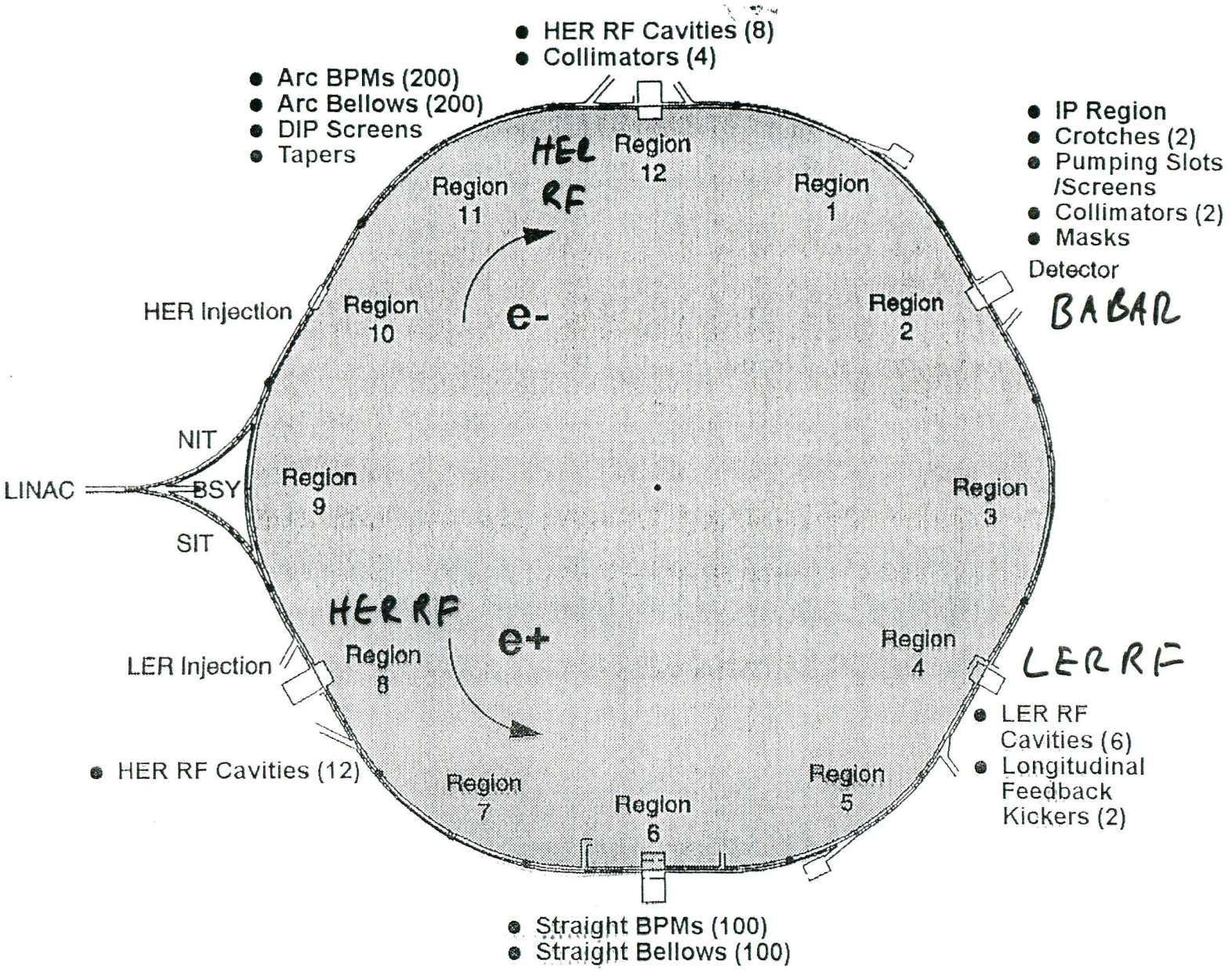
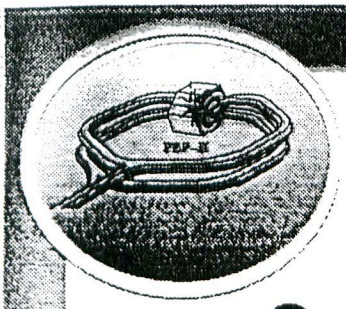


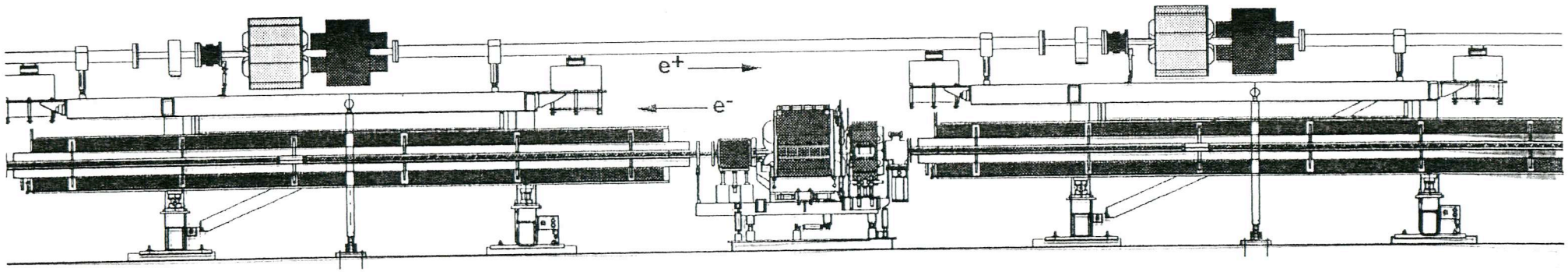
Figure 1 Overview of the PEP-II Rings



Several PEP-II Parameters

	e^+	e^-
Beam energy (GeV)	3.1	9
Beam current (A)	2.14	0.98
β^*_y (cm)	1.5	2.0
ε_x (ε_y) (nm)	64(2.6)	48 (1.9)
σ_x (μm at IP)	155	
σ_y (μm at IP)	6.2	
σ_z (cm)	1.0	1.15
Luminosity	3×10^{33} cm^{-2} s^{-1}	
Tune shift	0.03	
Beam aspect ratio (v / h at IP)	0.04	
Number of beam bunches	1658	
Bunch spacing (m)	1.26	
Beam crossing angle	0 (head-on)	

PEP-II *B*-Factory

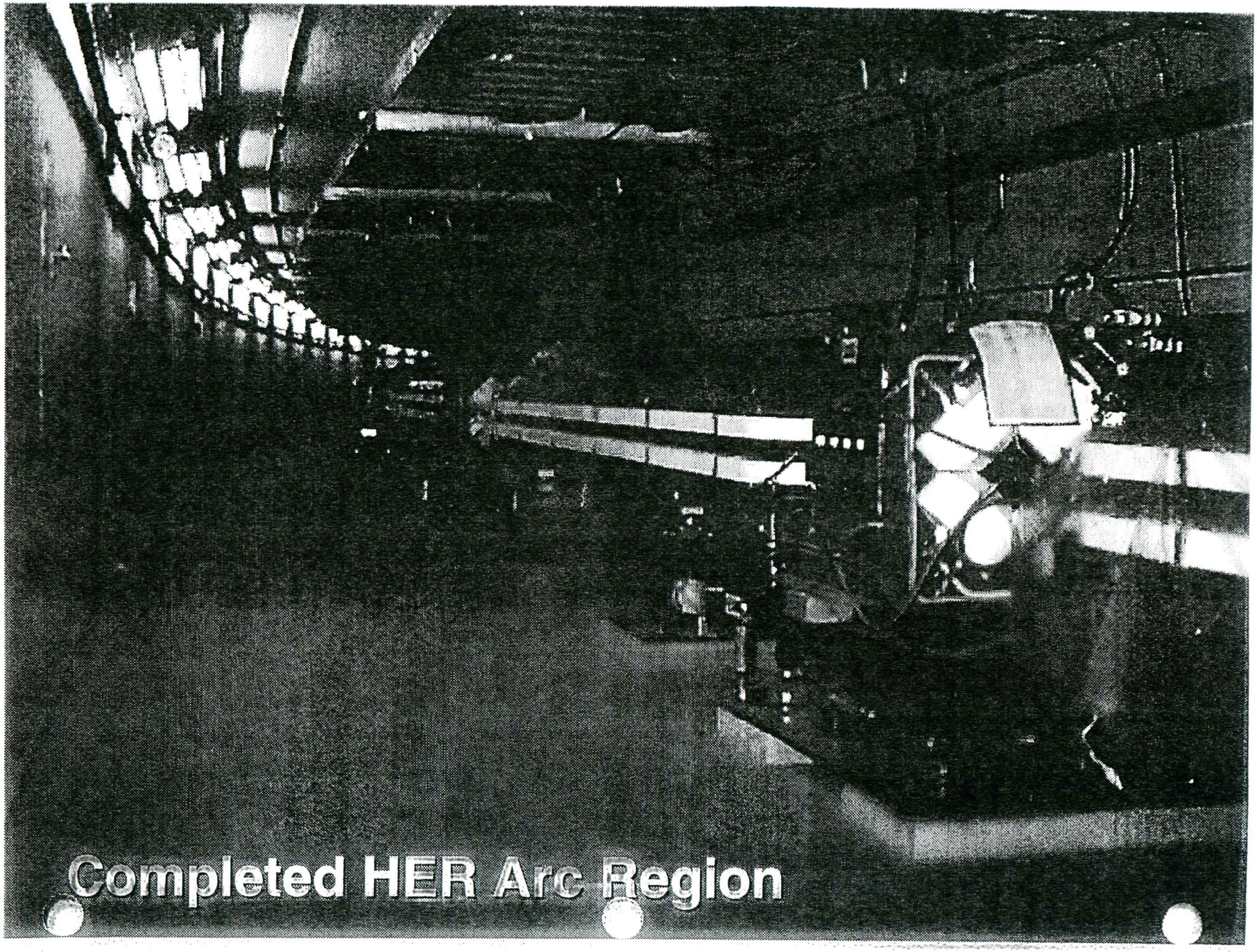


The two Storage Rings are vertically stacked

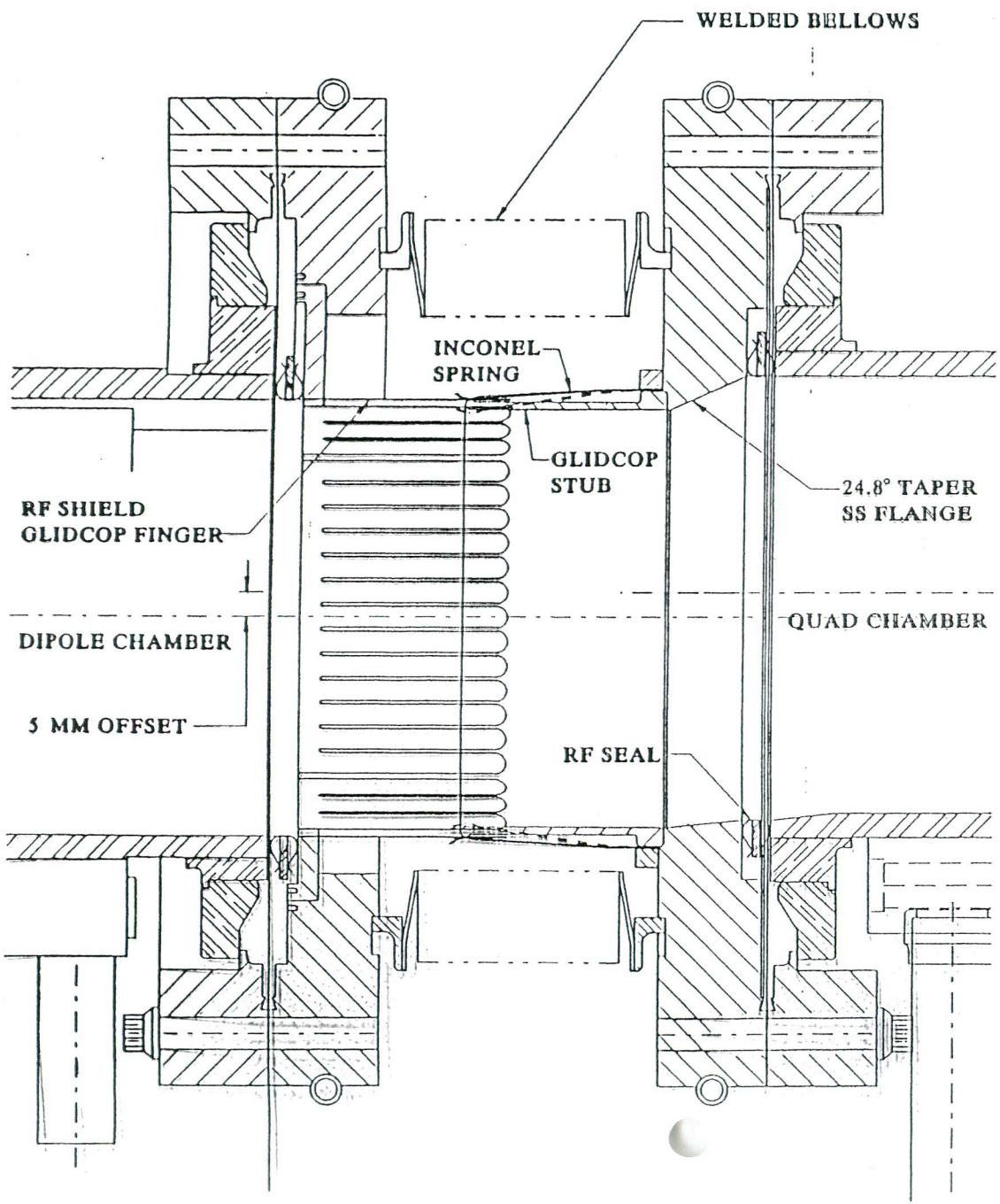
Table 1: **Nominal PEP-II Parameters**

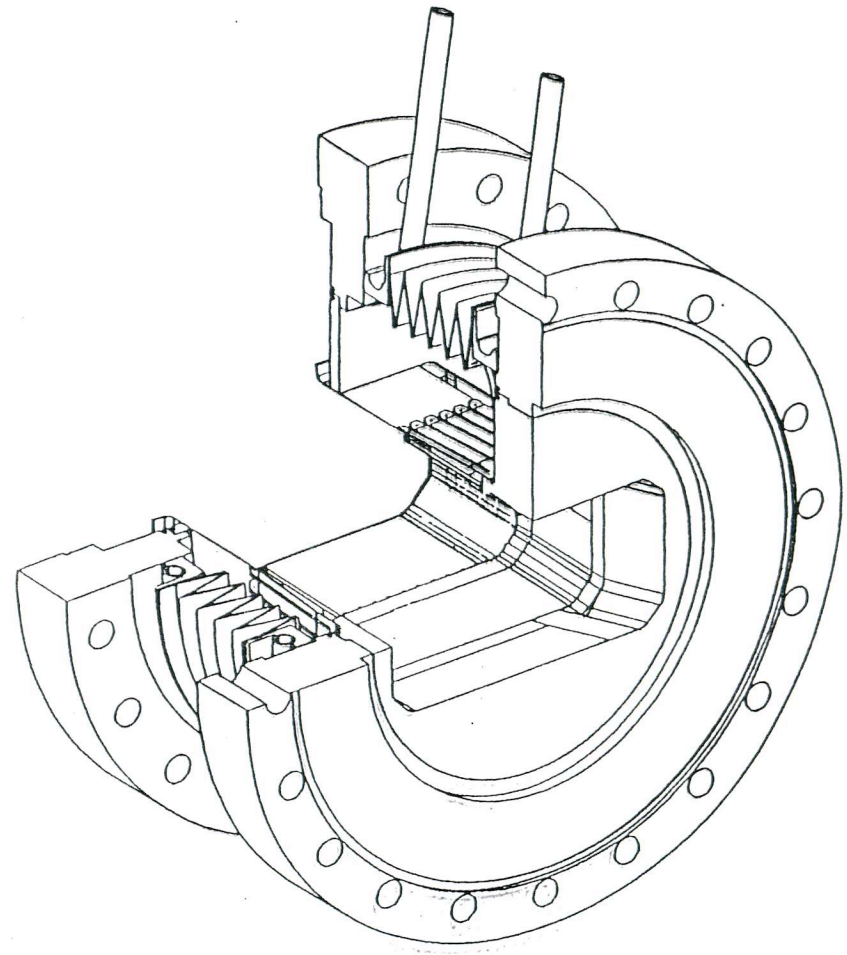
Parameter	Symbol	Units	LER	HER
Energy / particle	E	GeV	3.109 / e^+	9.0 / e^-
Lorentz factor	γ		6084.2	17612.6
CM Energy	E_{CM}	GeV	10.579	
Circumference	C	m	2199.318	
Revolution frequency	f_{rev}	kHz	136.312	
Revolution time	T_{rev}	μs	7.336	
IP beta functions	$\beta_x^*\|\beta_y^*$	m	0.500 / 0.015	0.667 / 0.020
Max beta functions	$\beta_x^{max}\|\beta_y^{max}$	m	105.4 / 170.1	400.7 / 325.5
Betatron tunes	$Q_x\|Q_y$		38.570 / 36.642	24.618 / 23.638
Transverse emittances	$\epsilon_x\|\epsilon_y$	nm-rad	65.61 / 1.97	49.18 / 1.48
IP rms sizes	$\sigma_x^*\|\sigma_y^*$	μm	181.1 / 5.43	
IP rms divergences	$\sigma_x'^*\|\sigma_y'^*$	μrad	362.2 / 271.7	
IP aspect ratio	$r = \sigma_y^*/\sigma_x^*$		3%	
Optimum coupling	$\kappa = \epsilon_y/\epsilon_x$		3%	
Beam-beam tune shift	$\xi_{0,x}\|\xi_{0,y}$		0.03/0.03	
Momentum compaction	α_c	10^{-3}	1.23	2.41
Partition numbers	J_x/J_E		0.974 / 2.026	0.995 / 2.005
Damping times	$\tau_x\|\tau_y\|\tau_E$	ms	62.5 / 60.8 / 30.0	37.0 / 36.8 / 18.3
Damping constants	$(\tau_x\|\tau_y\|\tau_E)^{-1}$	s^{-1}	16.0 / 16.4 / 33.3	27.0 / 27.2 / 54.5
RF frequency	f_{RF}	MHz	476.0	
Harmonic number	h		3492	
RF cavities	N_C		6	20
RF voltage	V_{RF}	MV	5.1	14.0
S.R. energy loss/turn	U_0	MeV	0.75	3.59
S.R. power	P_{SR}	MW	1.62	3.58
RF power	P_{RF}	MW	1.85	3.73
Longitudinal emittance	ϵ_s	μm-rad	7.641	7.034
Synchrotron tune	Q_s		0.0334	0.0449
Synchrotron frequency	f_s	kHz	4.553	6.127
Turns/Synch. period	Q_s^{-1}		29.94	22.25
Relative energy spread	σ_E/E	10^{-3}	0.77	0.61
Absolute energy spread	σ_E	MeV	2.40	5.52
Bunch length	σ_s	mm (ps)	9.94 (33.2)	11.5 (38.3)
Bunch separation	s_b	m (ns)	1.26 (4.2)	
Colliding bunches	k_b		1658	
Bunch population	N^+, N^-	10^{10}/bunch	5.971	2.750
Bunch current	I_b^+, I_b^-	mA/bunch	1.304	0.601
Beam current	I^+, I^-	A	2.162	0.996
Beam energy	E_B	kJ	49.3	65.7
Beam power	P_B	GW	6.72	8.96
Luminosity/interaction	L^*	cm^{-2}	1.33×10^{25}	
Luminosity	L	$cm^{-2}s^{-1}$	3×10^{33}	

(updated March 16, 1996)



Completed HER Arc Region


WELDED BELLOWS
INCONEL SPRING
GLIDCOP STUB
24.8° TAPER SS FLANGE
RF SHIELD GLIDCOP FINGER
QUAD CHAMBER
DIPOLE CHAMBER
5 MM OFFSET
RF SEAL



HER

1) ~825/850 magnets installed

2) ~ 70% under vacuum

3) Injection & collision straights left

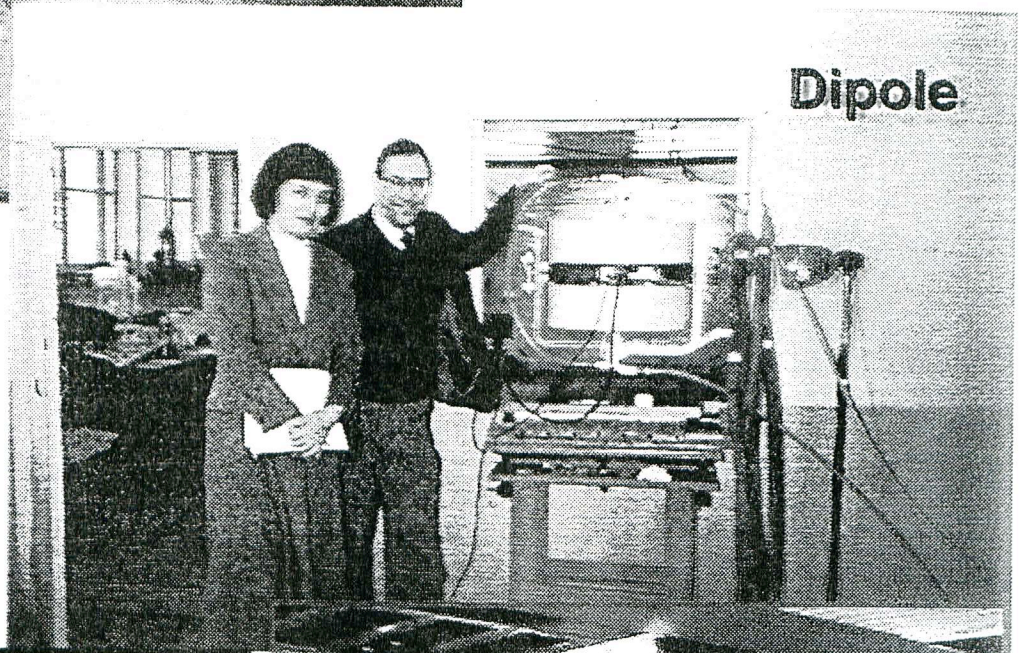
2 RF stations in April (~200 mA)
June

5 RF stations in September (500-1000 mA

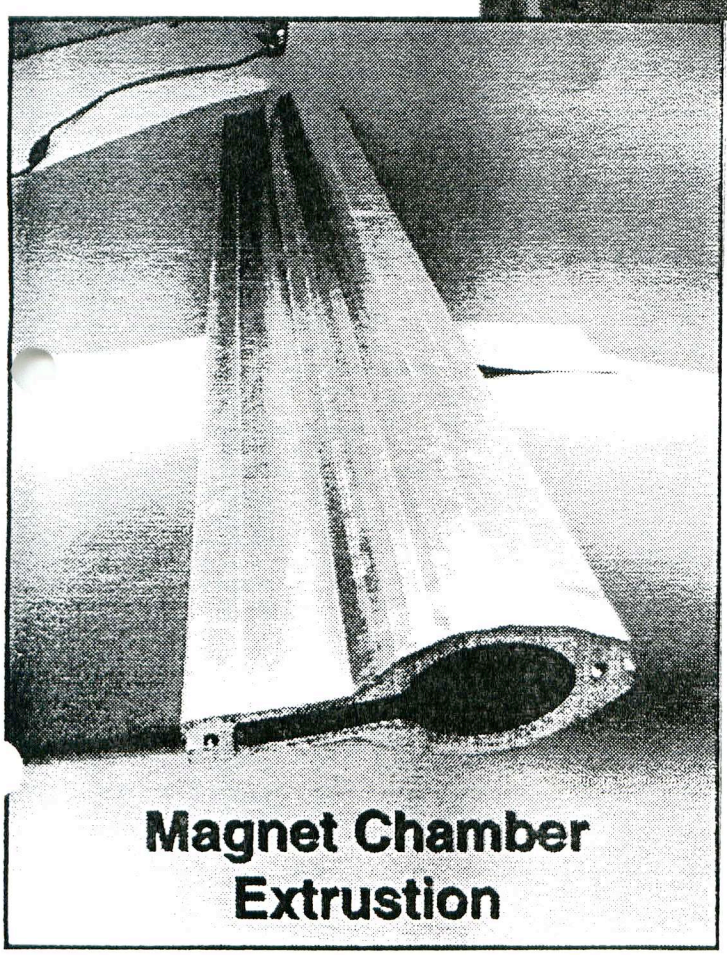
Low Energy Ring

Quadrupoles

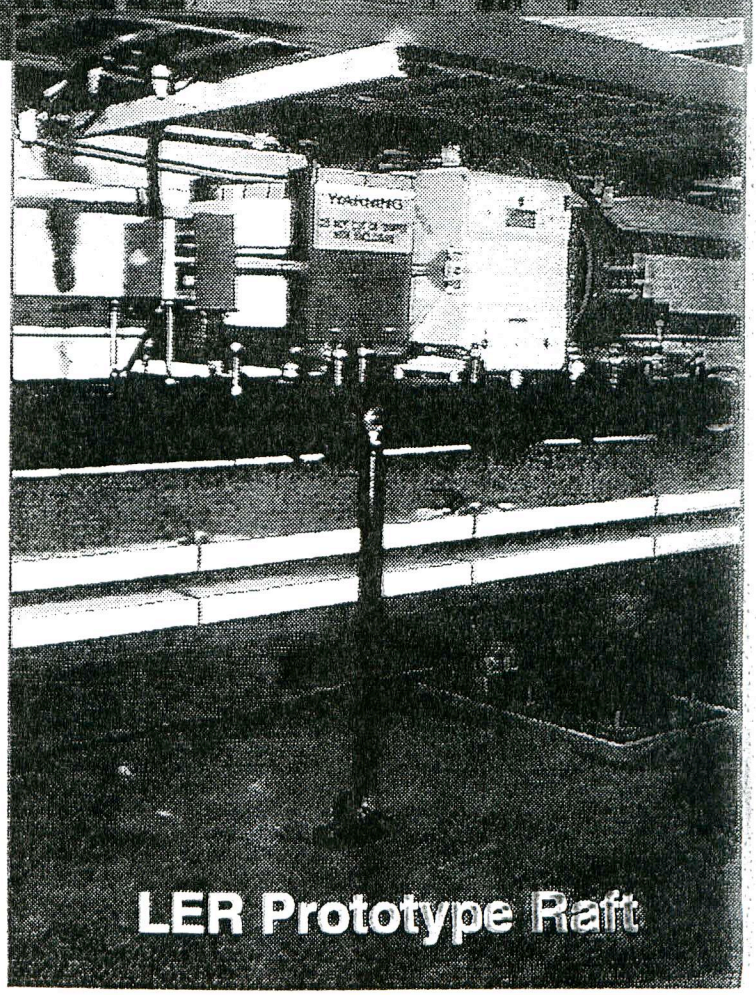
Dipole



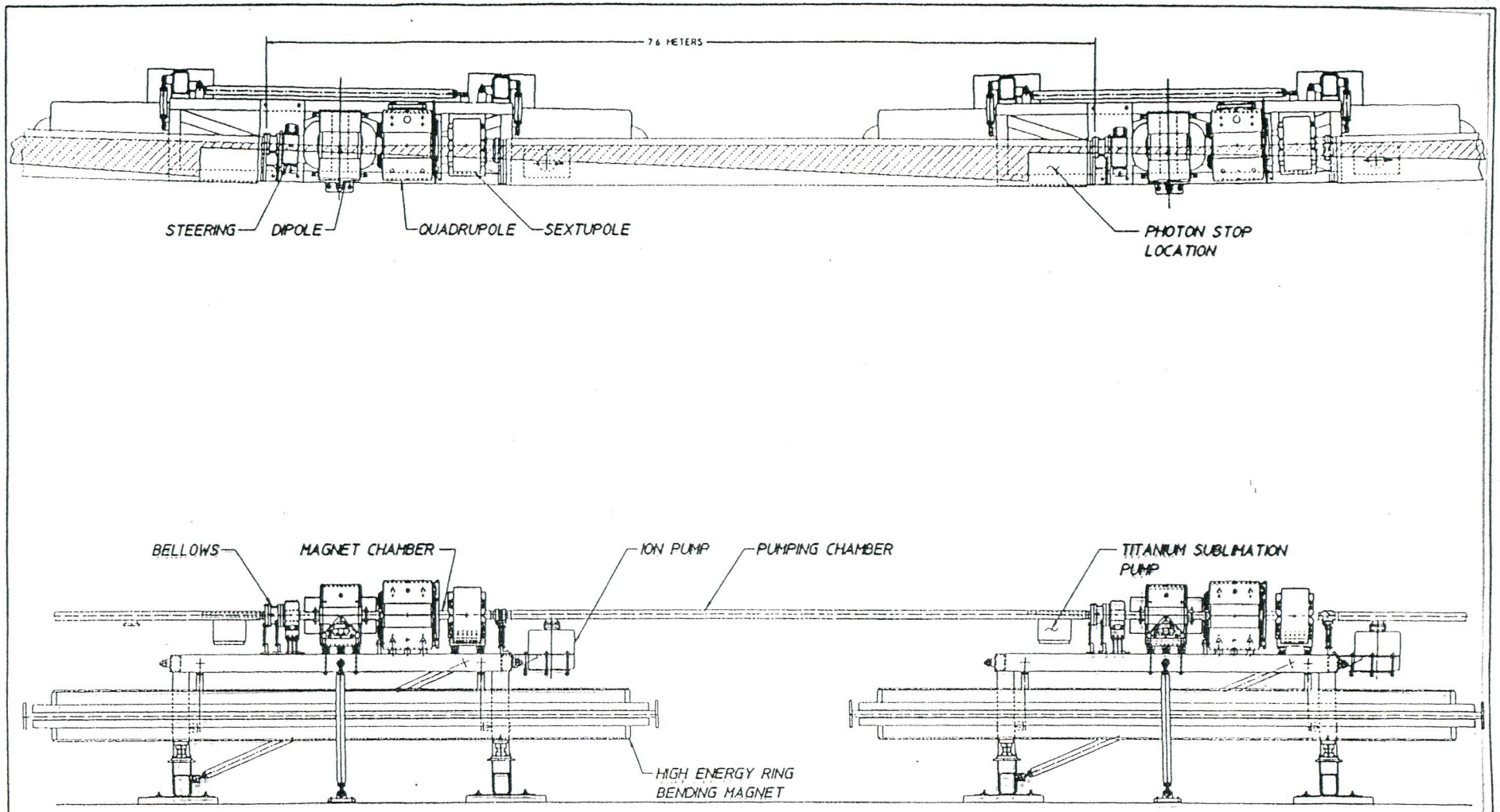
Fabrication Highlights



Magnet Chamber Extrustion

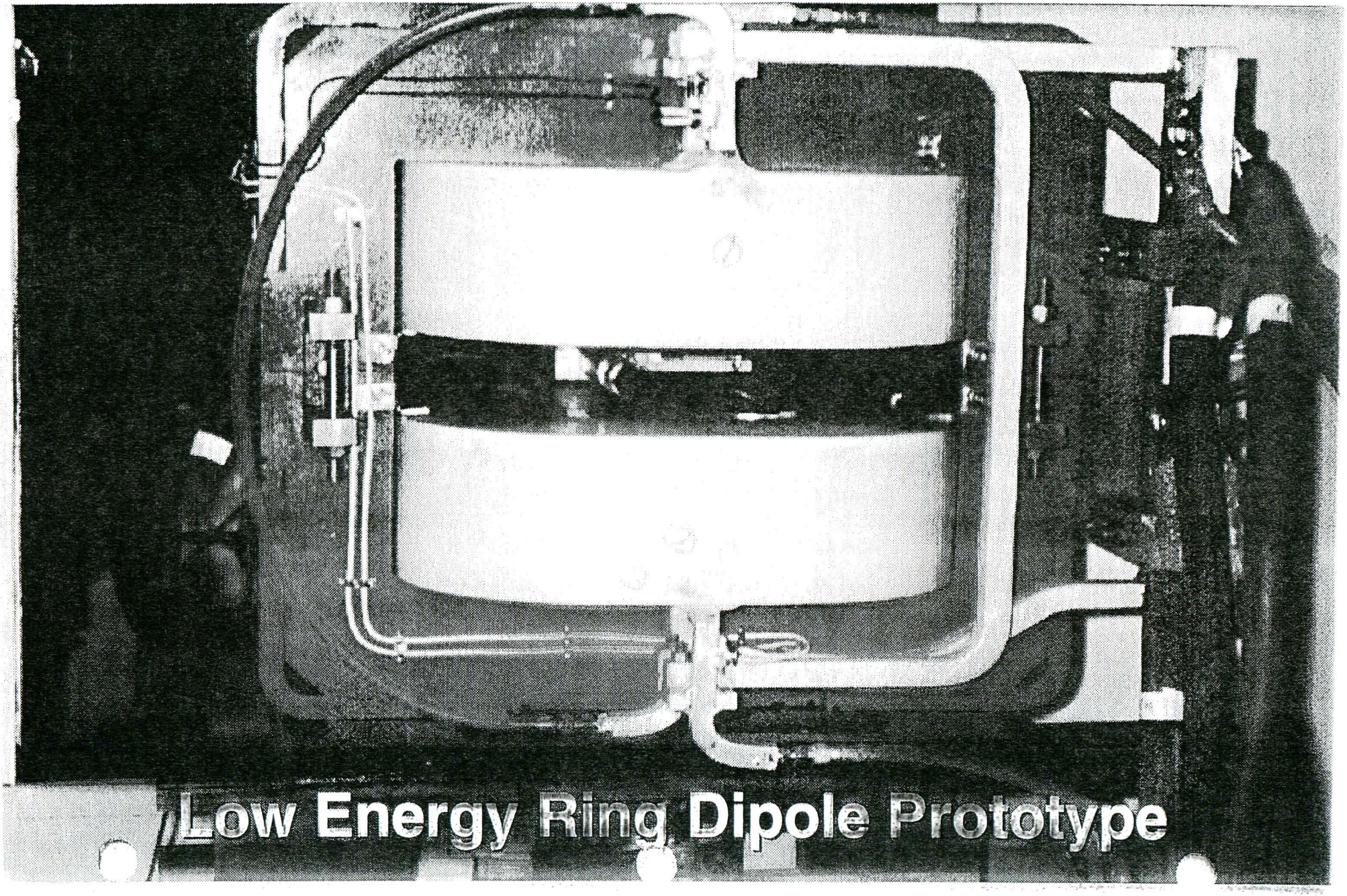


LER Prototype Raft

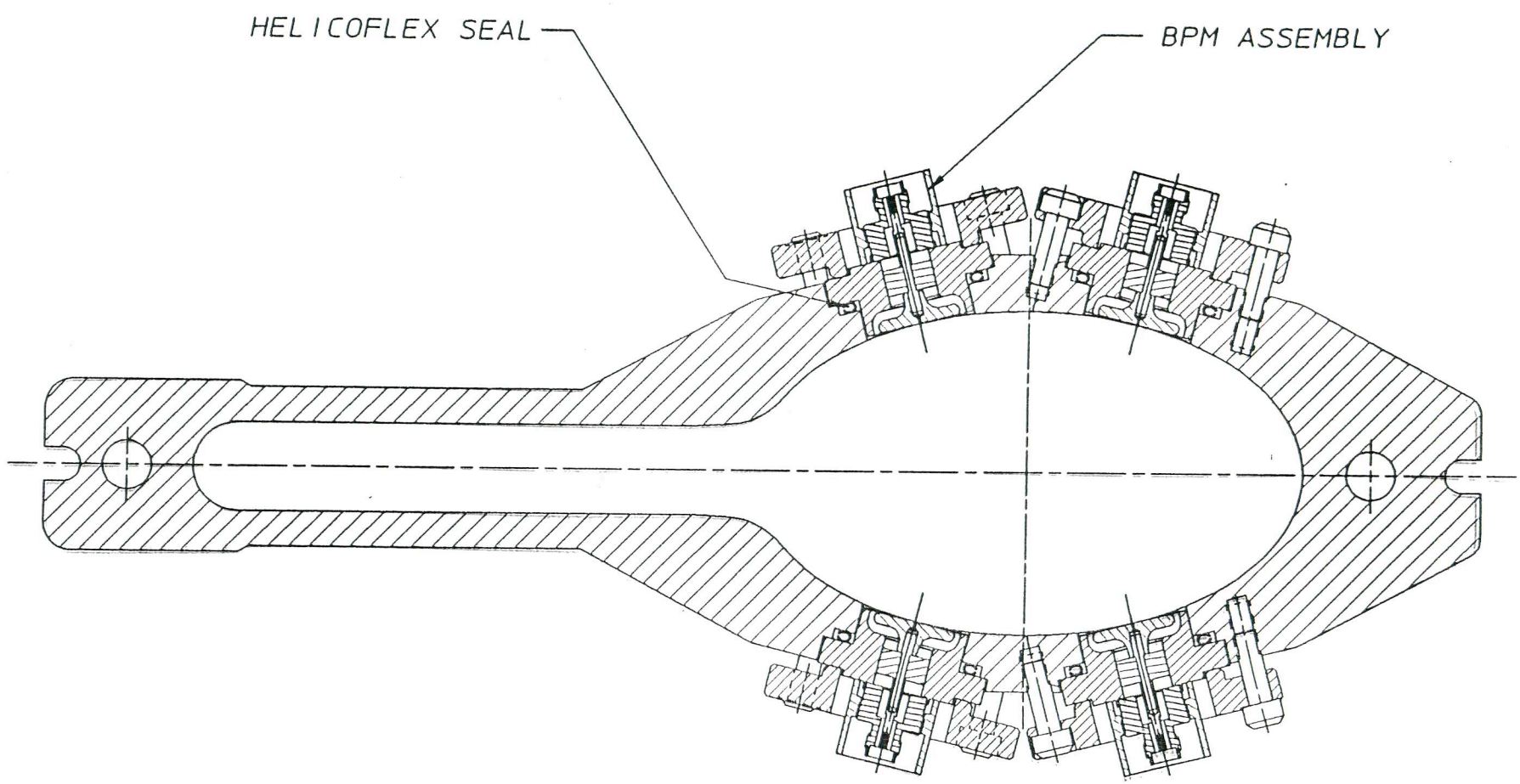


LOW ENERGY RING ARC HALF CELL

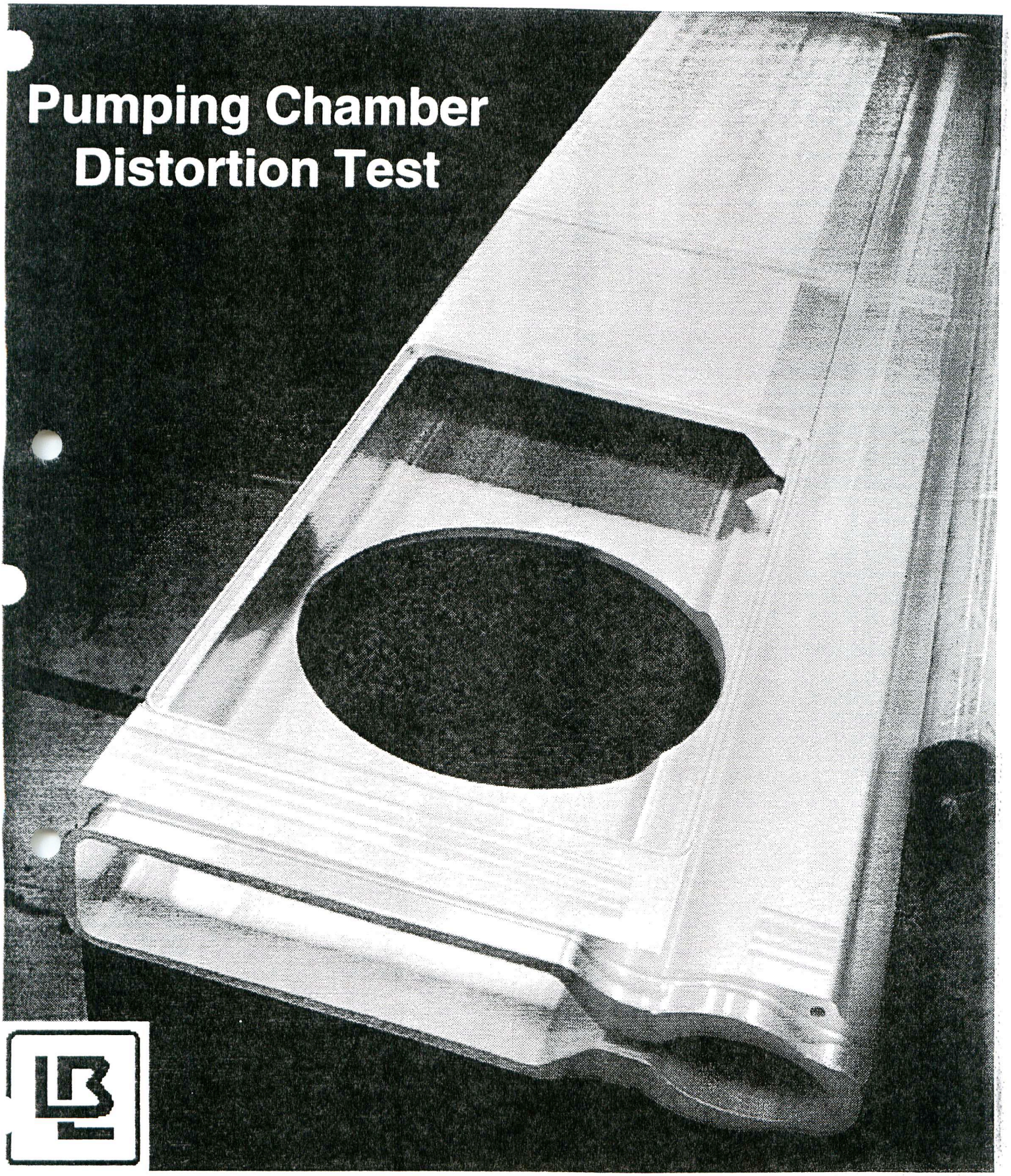
AUG 15, 1995

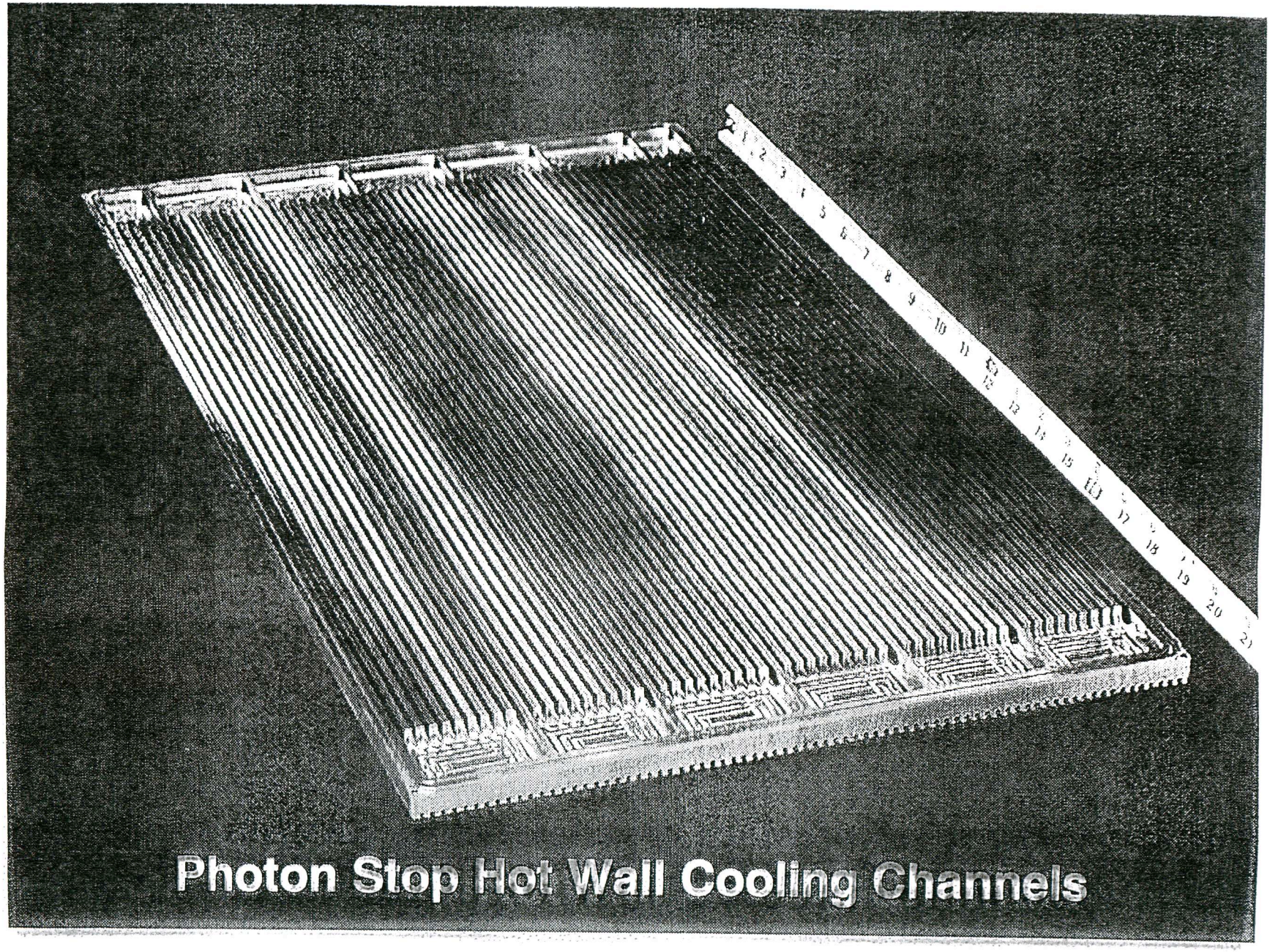


Low Energy Ring Dipole Prototype


HELICOFLEX SEAL
BPM ASSEMBLY

Pumping Chamber Distortion Test





Photon Stop Hot Wall Cooling Channels

LER

~ 210/330 Quads built (IHEP)

~ 60/200 Dipoles built (IHEP/Kelin)

All correctors done

Vacuum in manufacture (start)

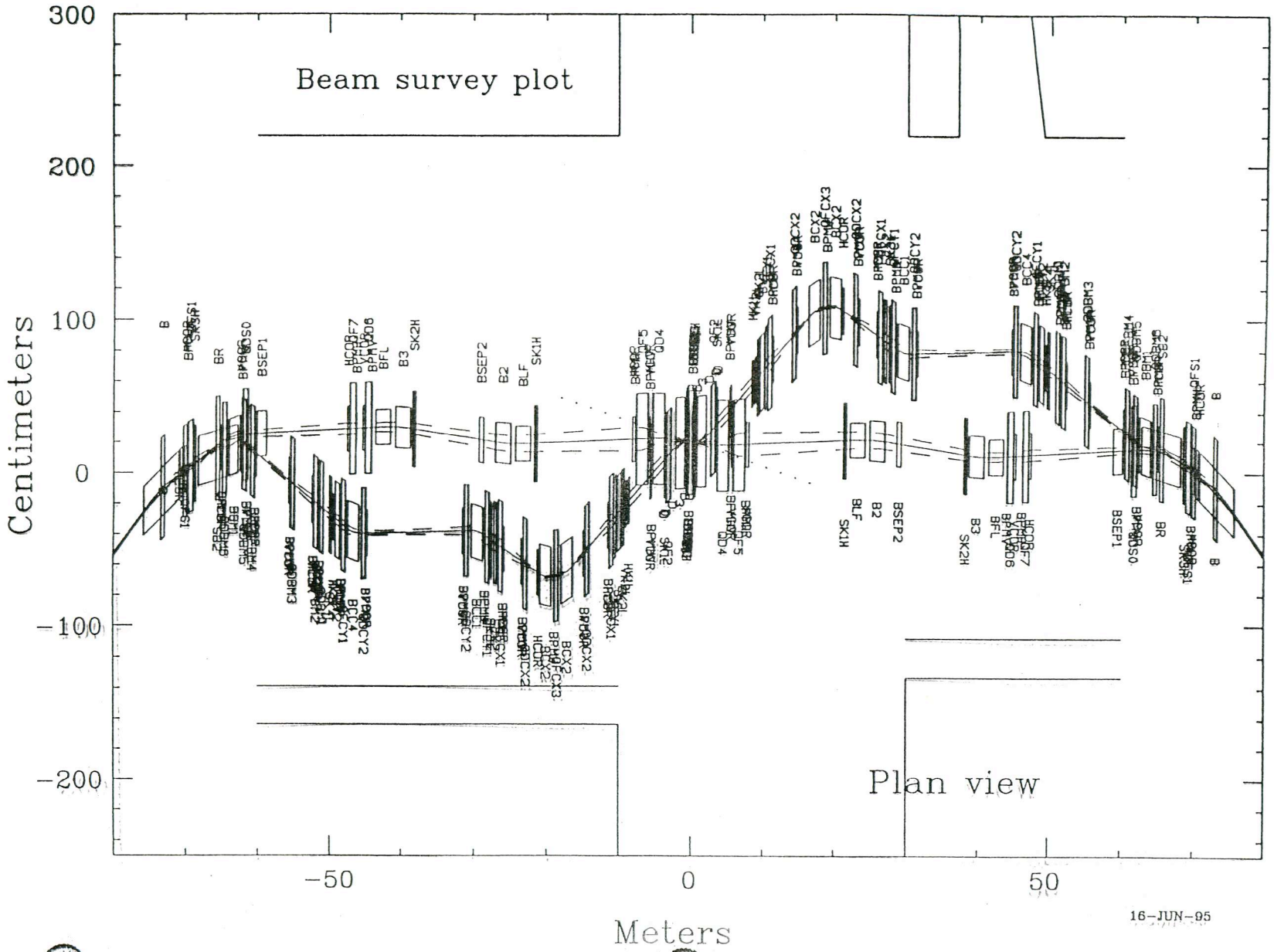
80% supports installed

Cables installed

Controls ready in March 97

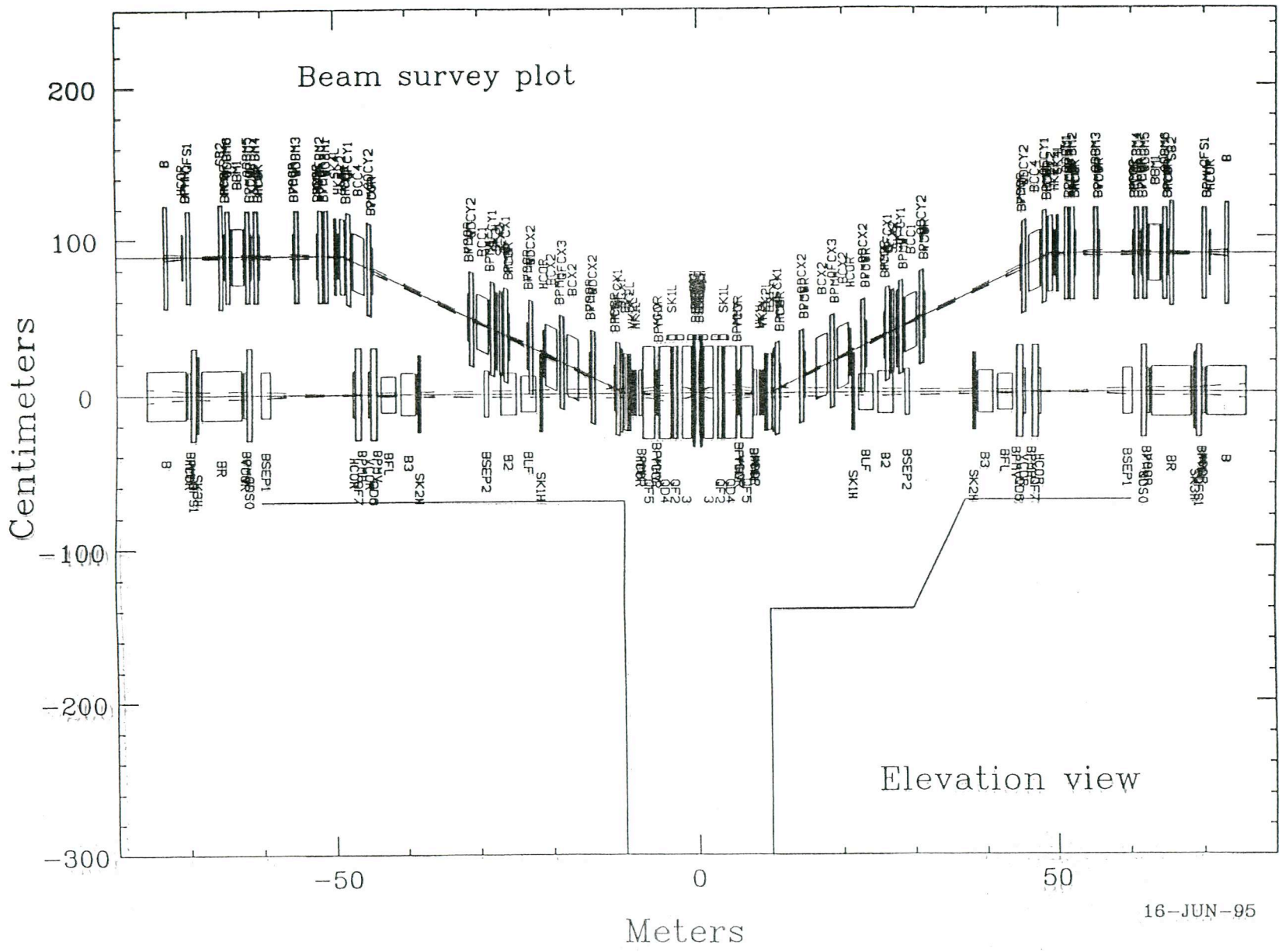
IR
(x)

Interaction Region

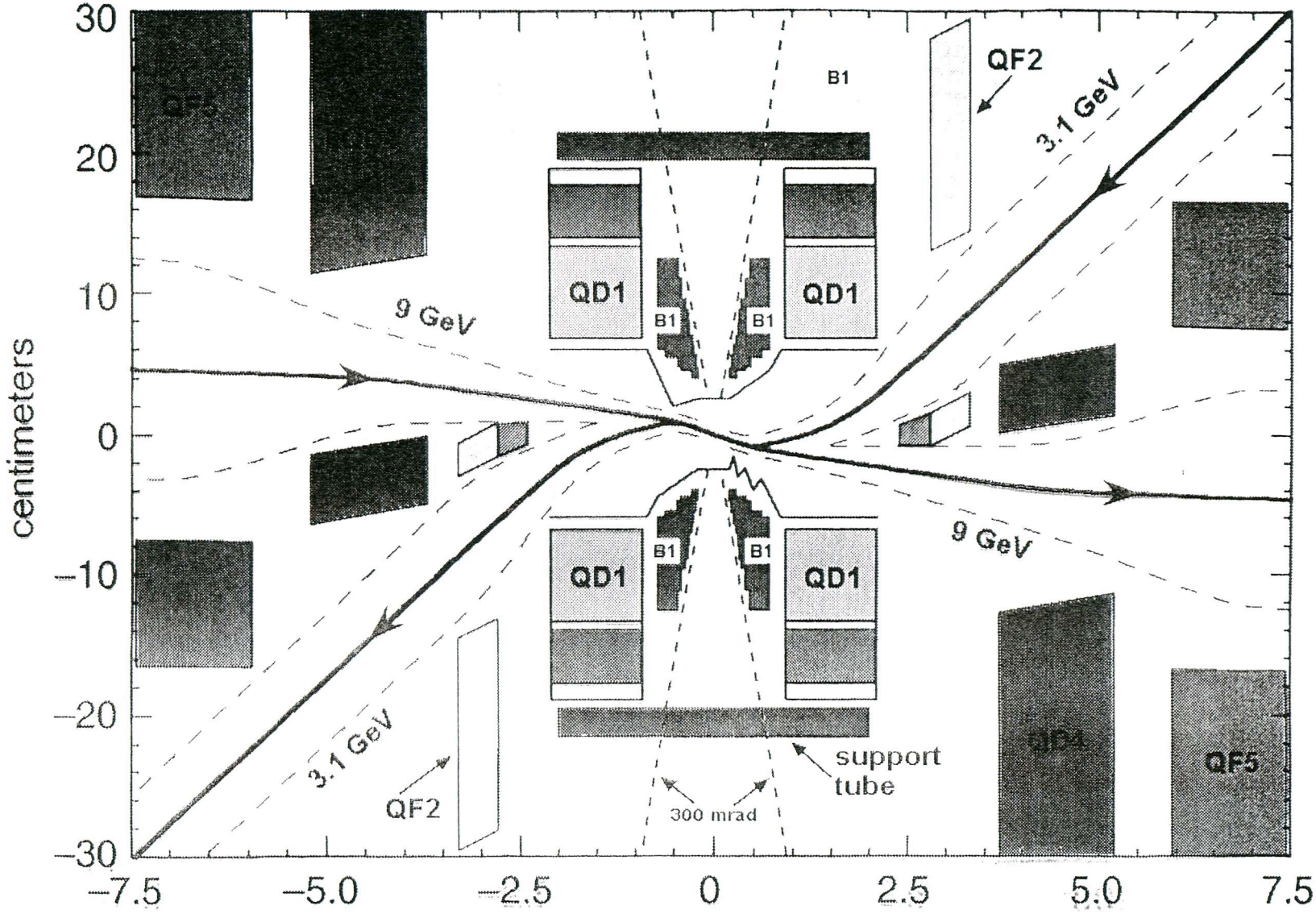


IR
(Vert)

Interaction Region



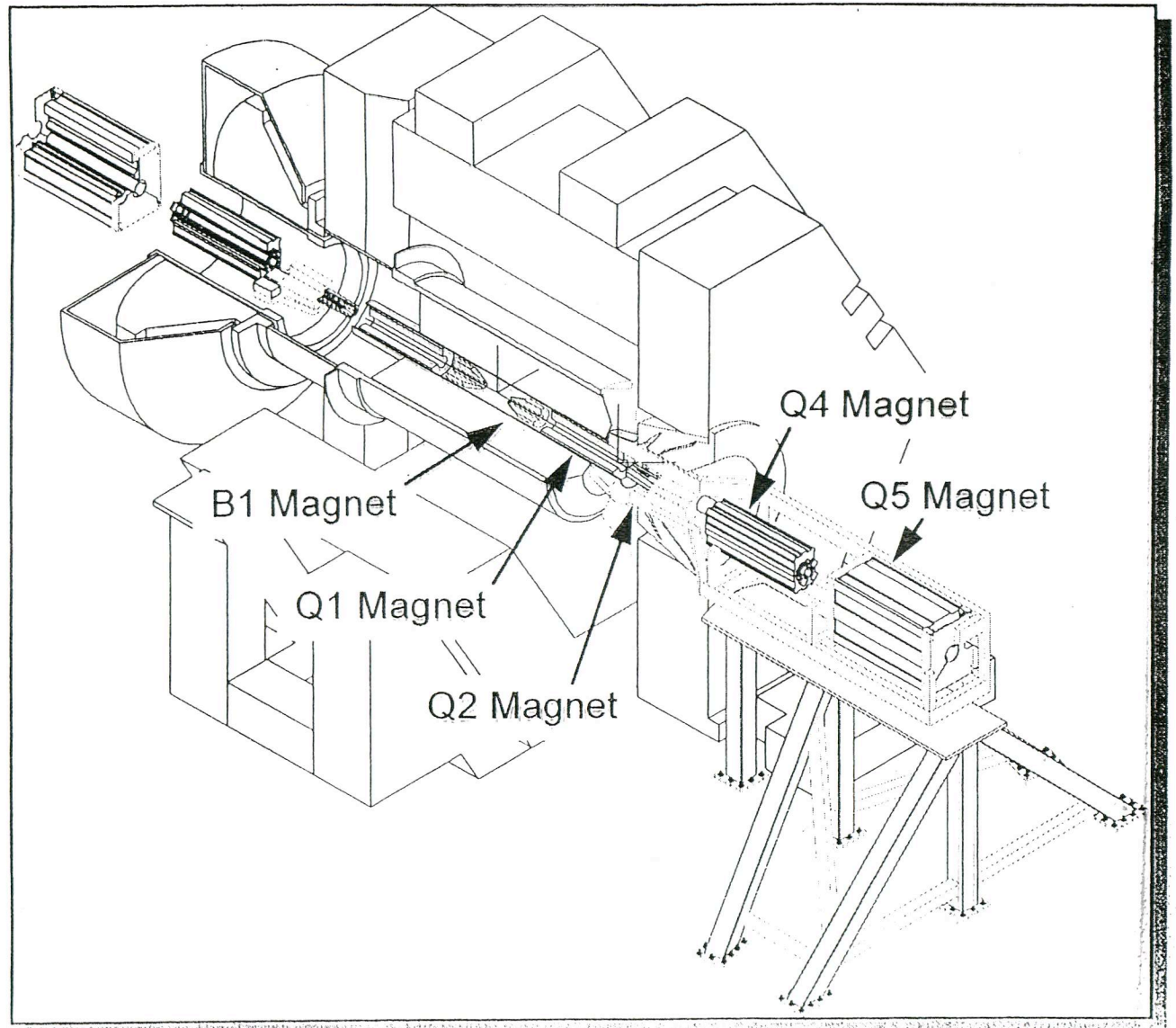
Interaction Region



IR WBS
(± 3m)

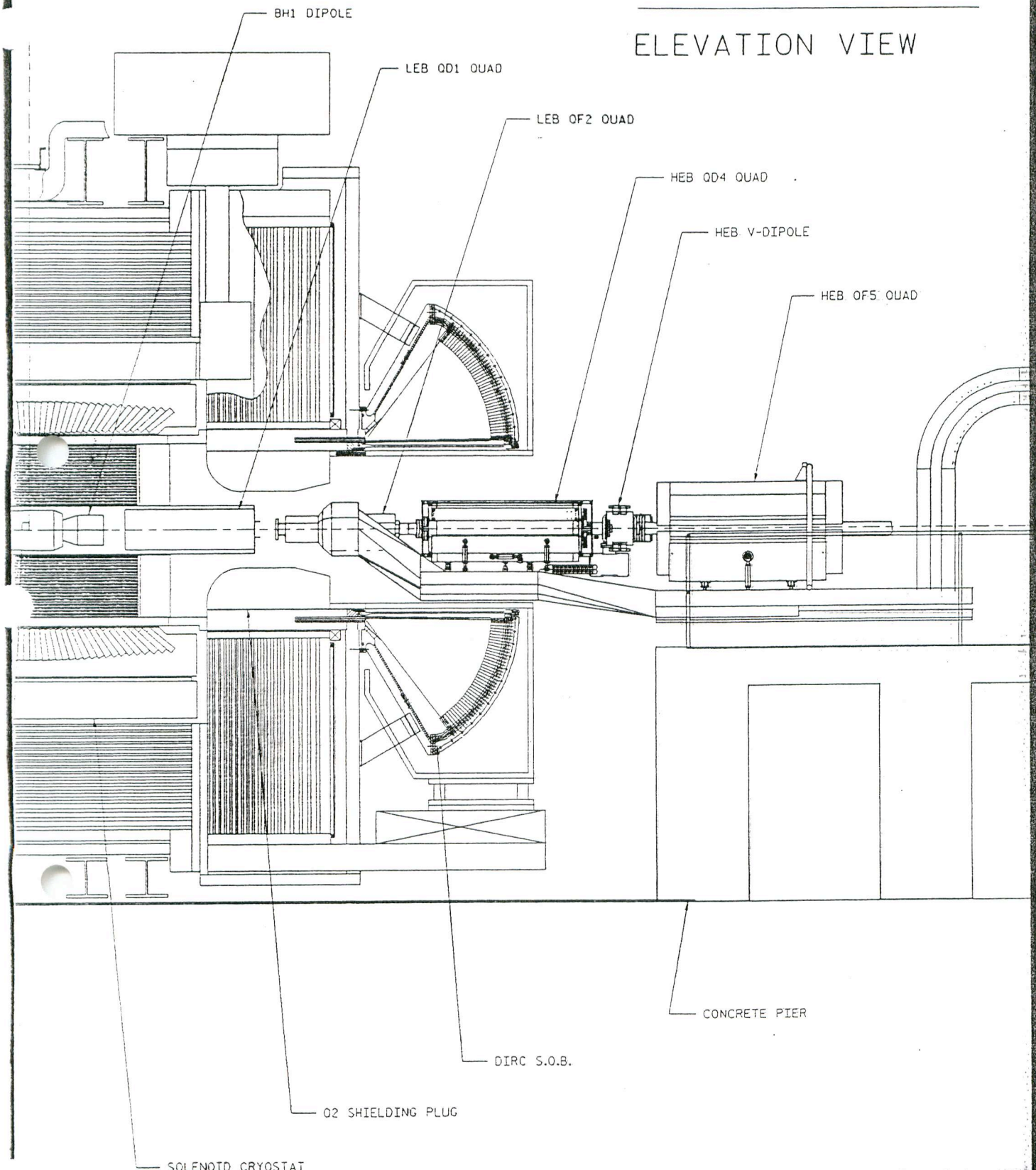
Apiary 8.6C
M. Sullivan
Jun. 21, 1995

Magnet Design



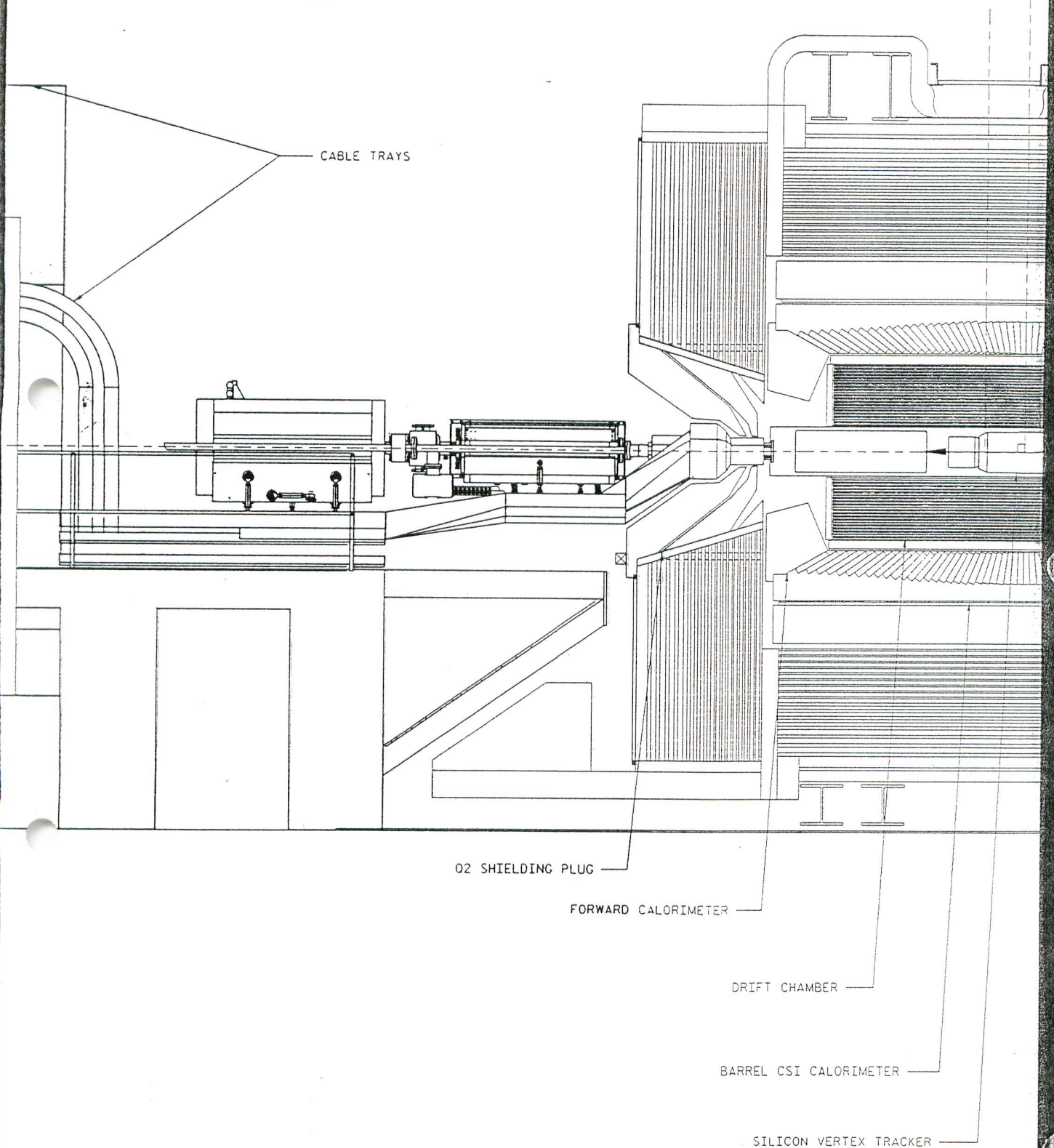
IR-2 BACKWARD END

ELEVATION VIEW

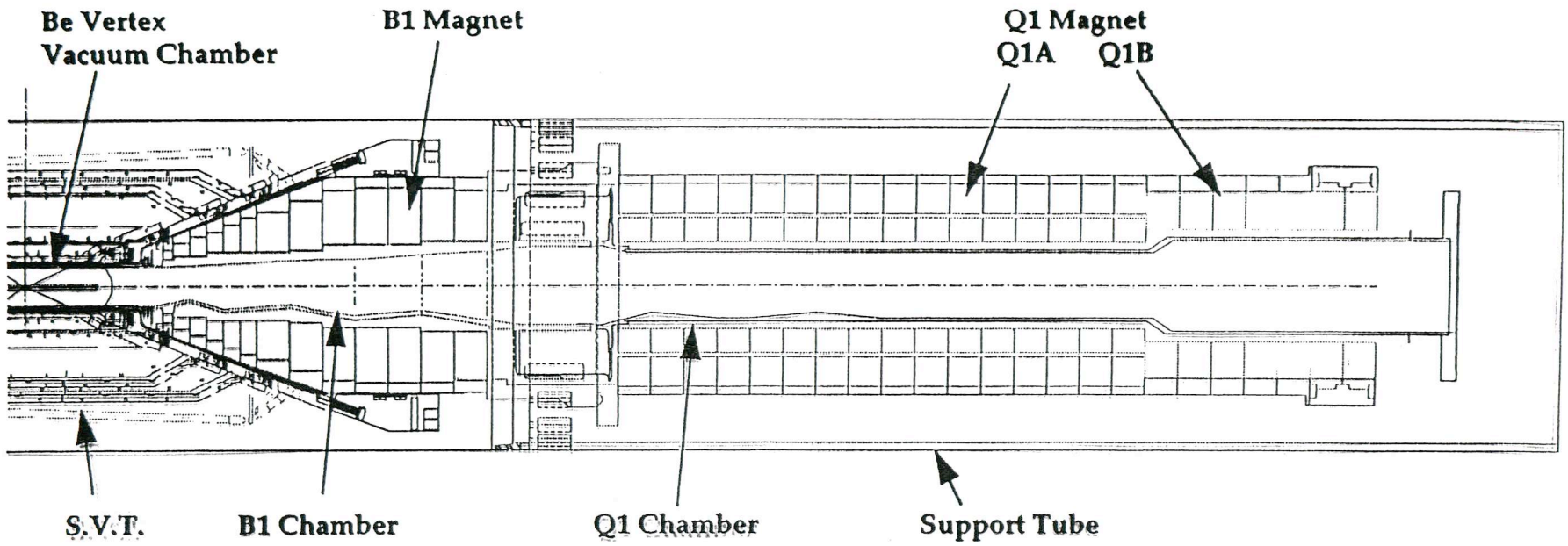


IR-2 FORWARD END

ELEVATION VIEW



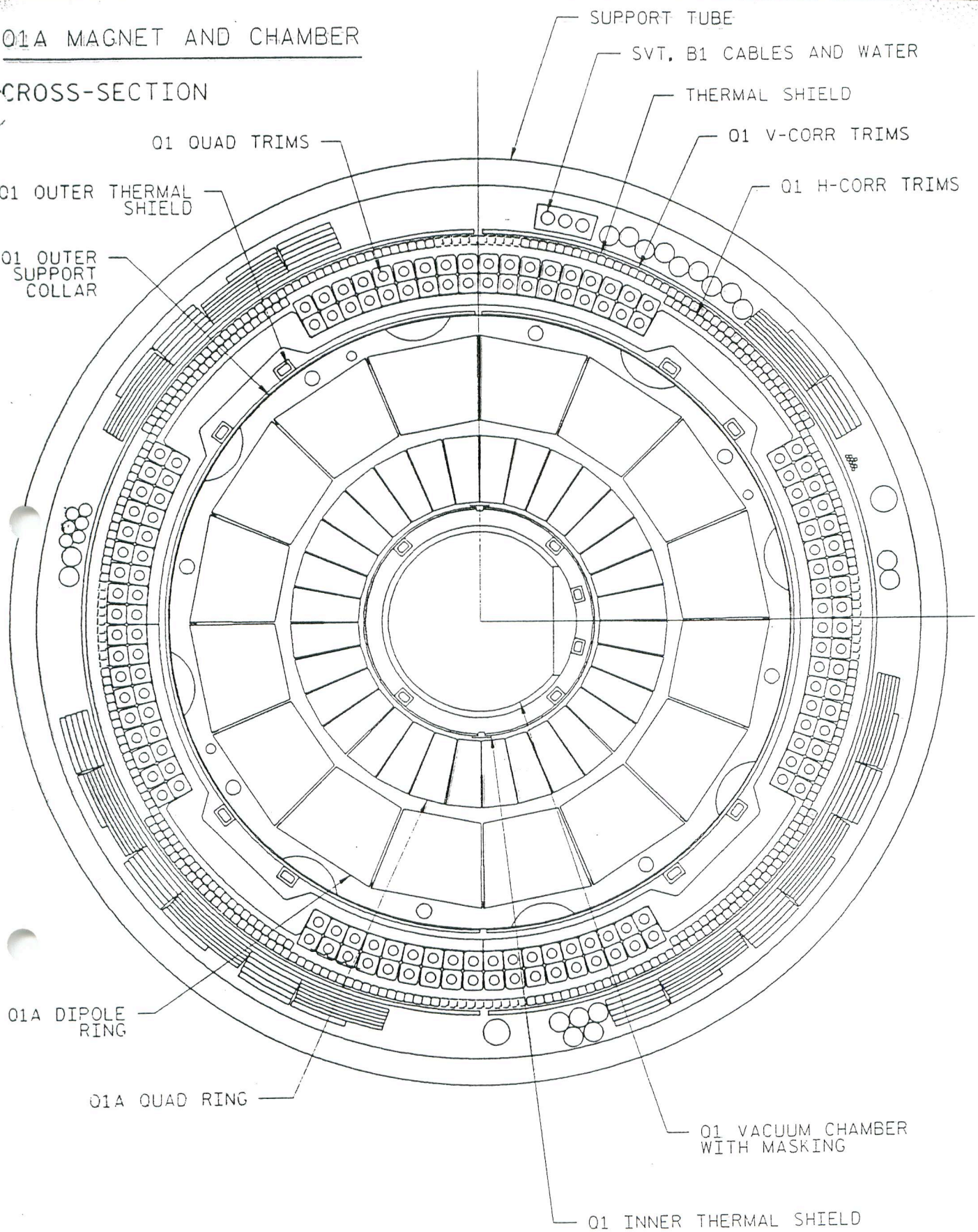
Plan View of Near I.R. Components



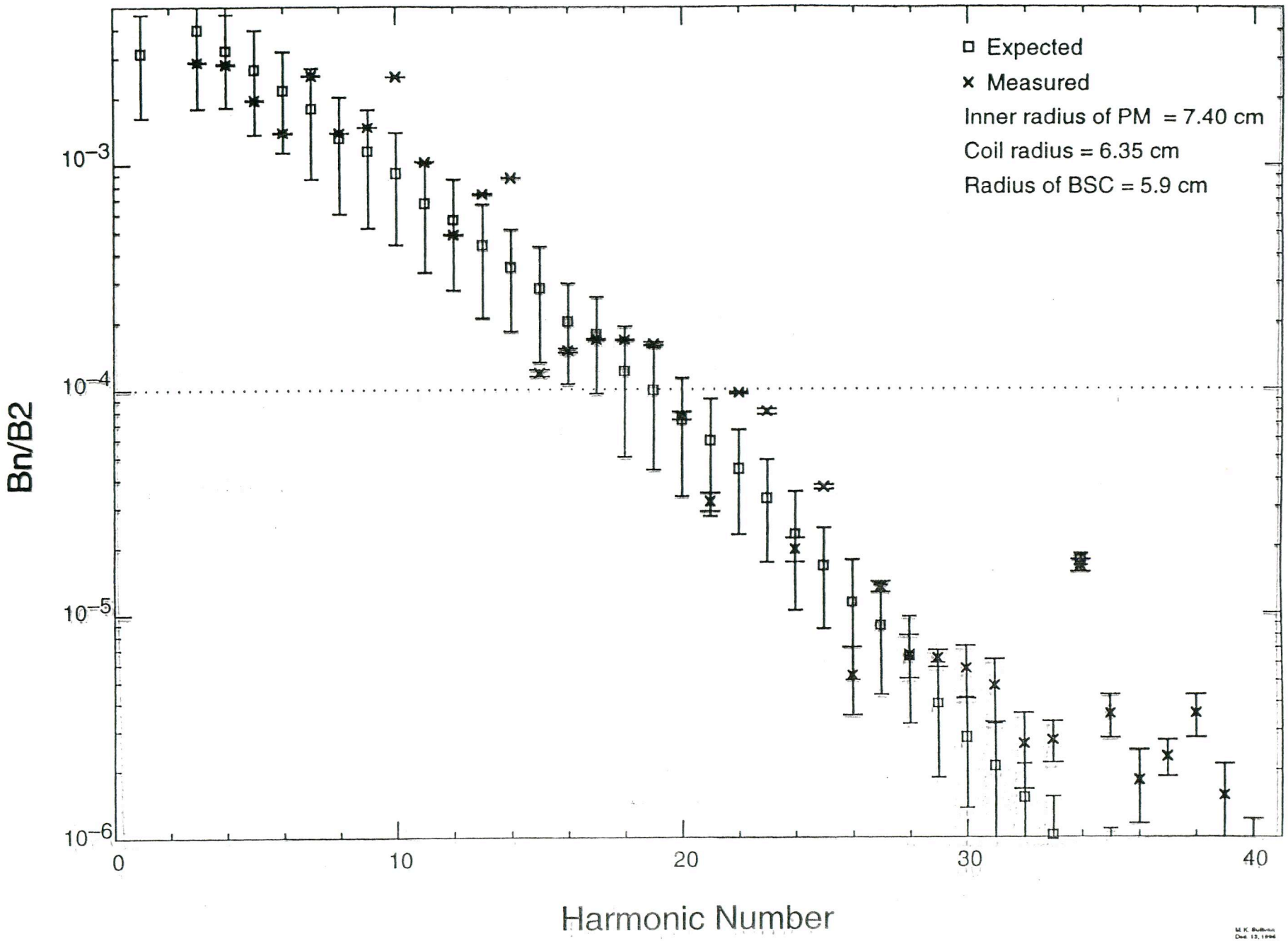
- Magnets are buried inside Support Tube, inside BaBar
- Immersed in 15 kG BaBar solenoid field
- B1 is surrounded by BaBar SVT

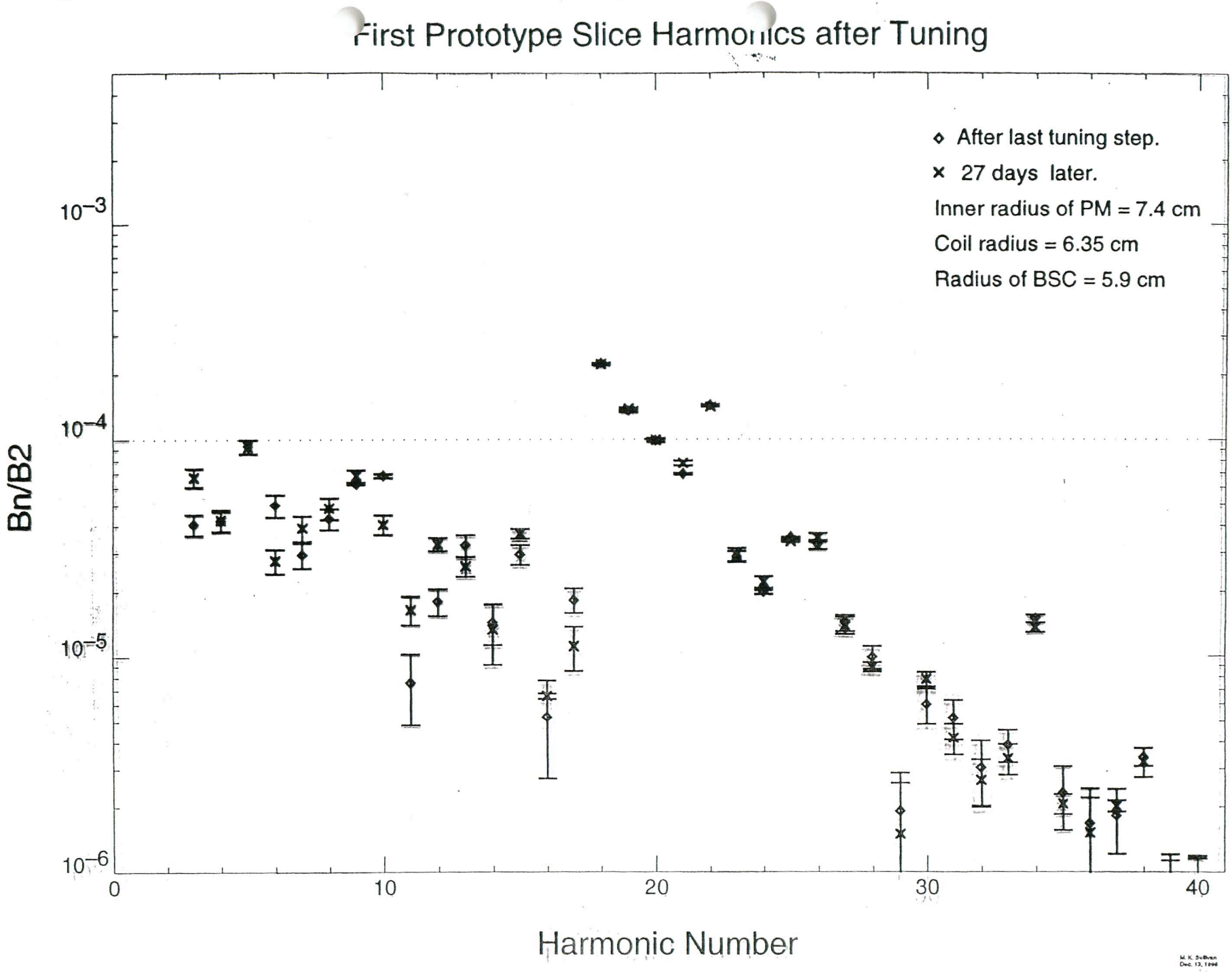
Q1A MAGNET AND CHAMBER

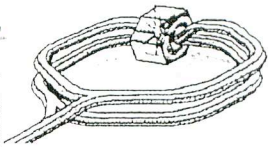
CROSS-SECTION



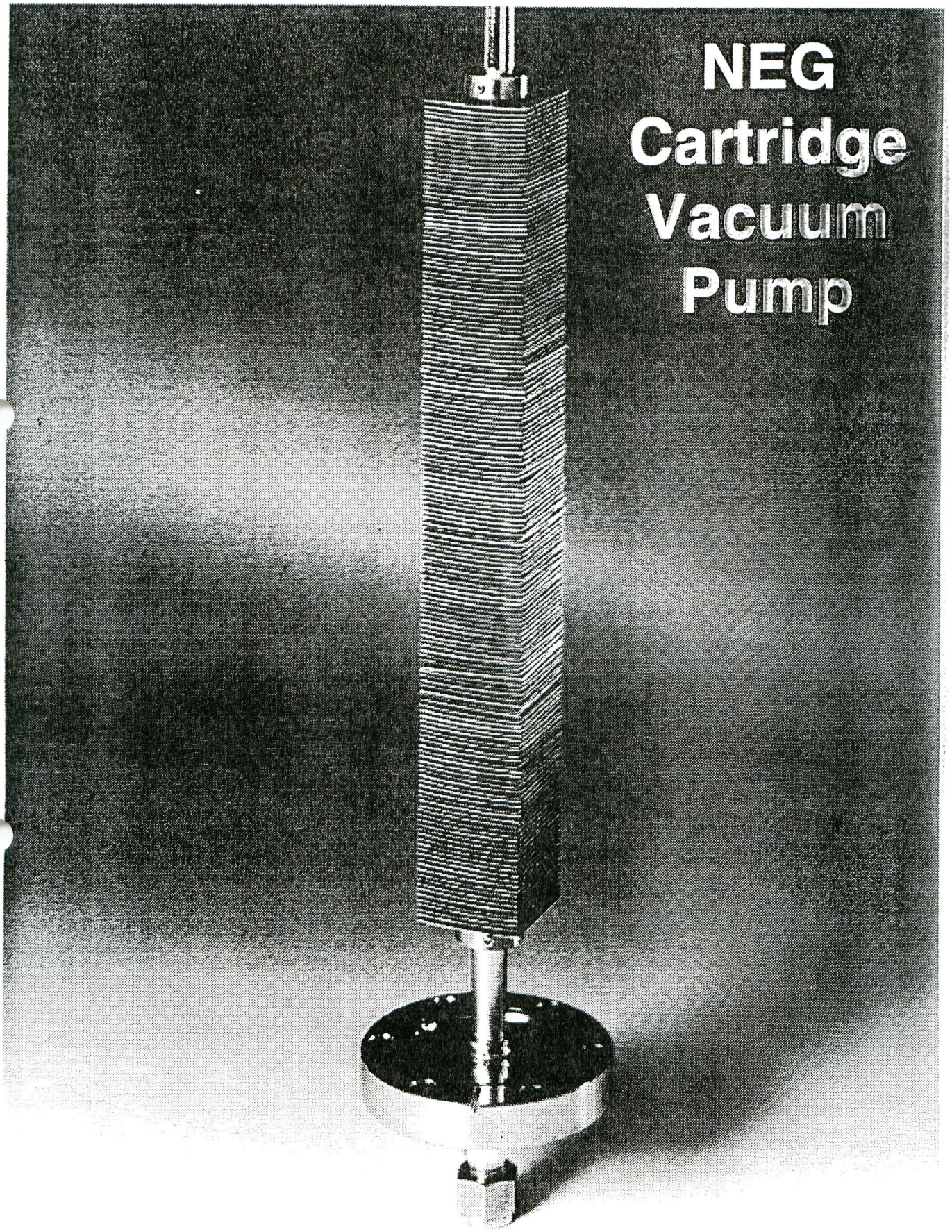
Expected and Measured Harmonics from the First Prototype Slice



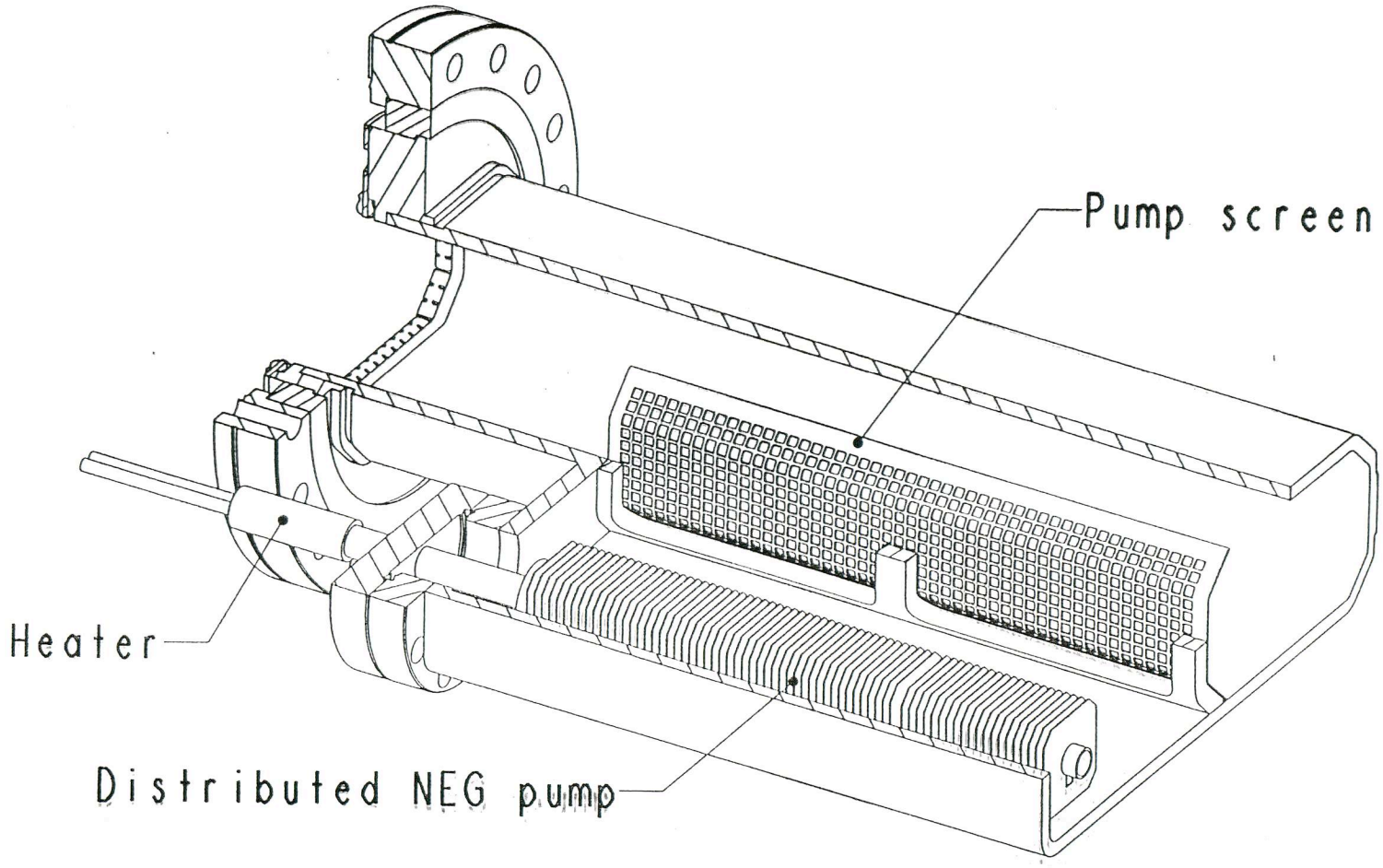

First Prototype Slice Harmonics after Tuning
After last tuning step.
27 days later.
Inner radius of PM = 7.4 cm
Coil radius = 6.35 cm
Radius of BSC = 5.9 cm
Bn/B2
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0
10
20
30
40
Harmonic Number



NEG Cartridge Vacuum Pump



LER IR-2



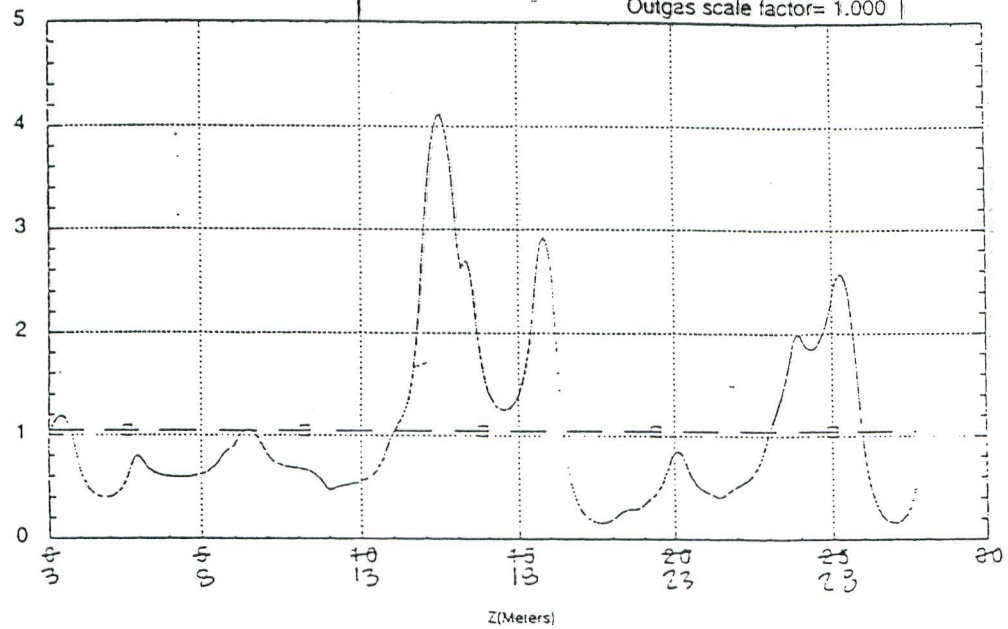
Model of B-Factory IR-2 Beam Pipes

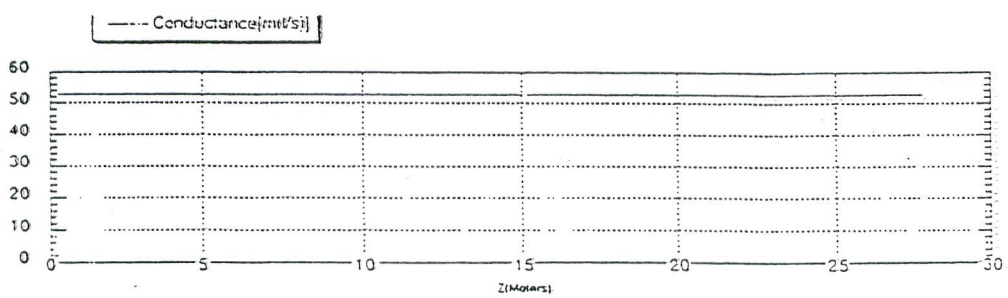
LER Upstream expected vacuum pressure

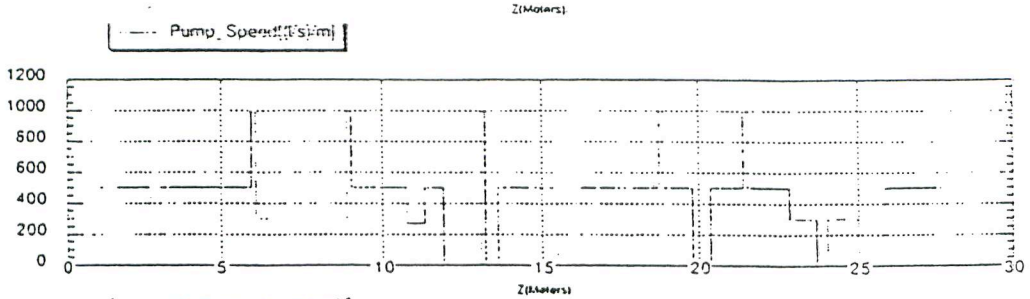
PRESSURE[nTorr]
Paverage[nTorr]

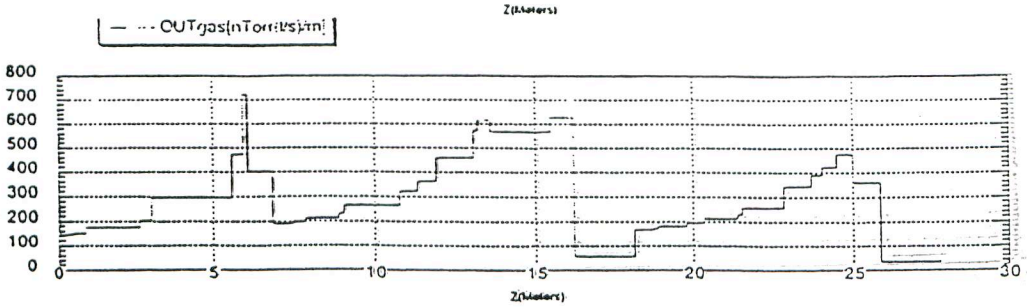
LEB Mid Upstream Beam Pipe (Press. N2 Equiv.)			
	START	END	AVE
Pressure (nTorr)	.986	.677	1.043
Flow (nTorr(l/s))	-55.855	-97.711	.574
Outgas scale factor= 1.000			

Direction of Positive Flow —>









t = 40 A-hrs

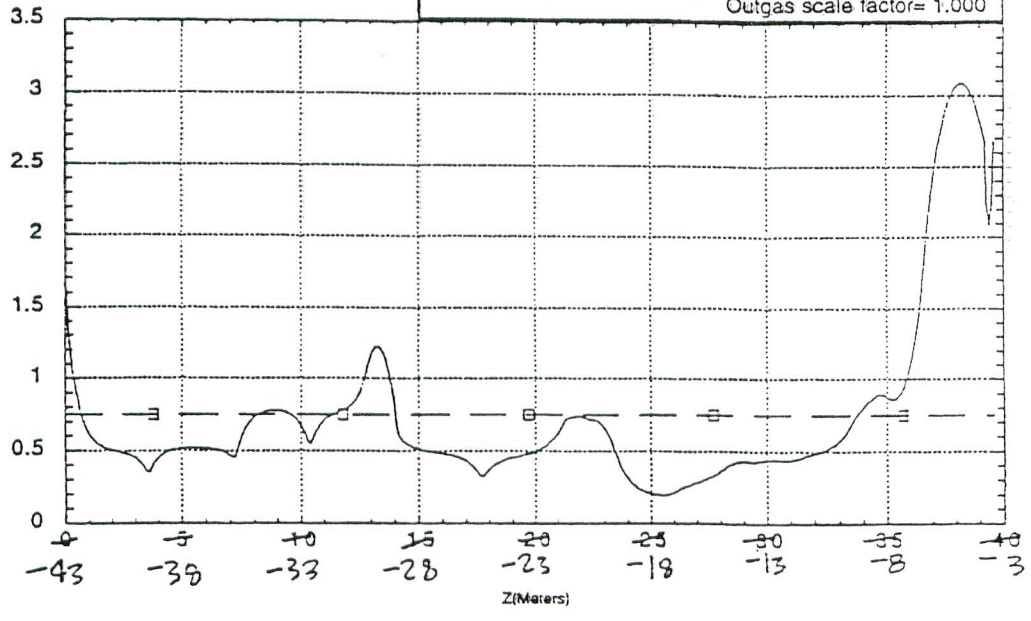
Model of B-Factory IR-2 Beam Pipes

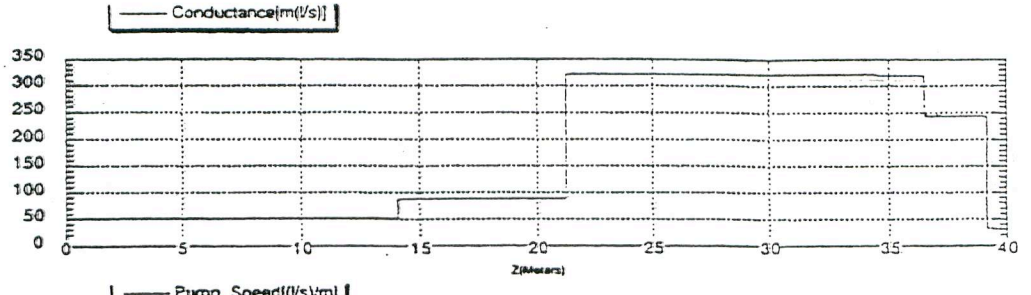
HER Upstream expected vacuum pressure

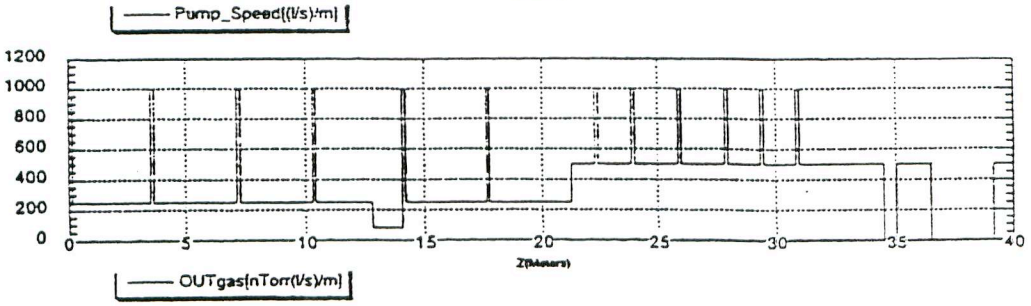
HEB Mid Upstream Beam Pipe (Press. N2 Equiv.)			
	START	END	AVE
Pressure (nTorr)	1.772	3.462	.747
Flow (nTorr(l/s))	286.157	-325.068	-13.164
		Outgas scale factor= 1.000	

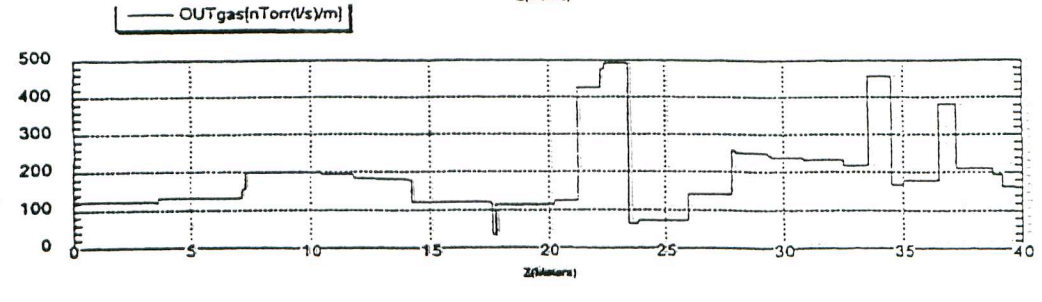
PRESSURE[nTorr]
Paverage[nTorr]

Direction of Positive Flow -->

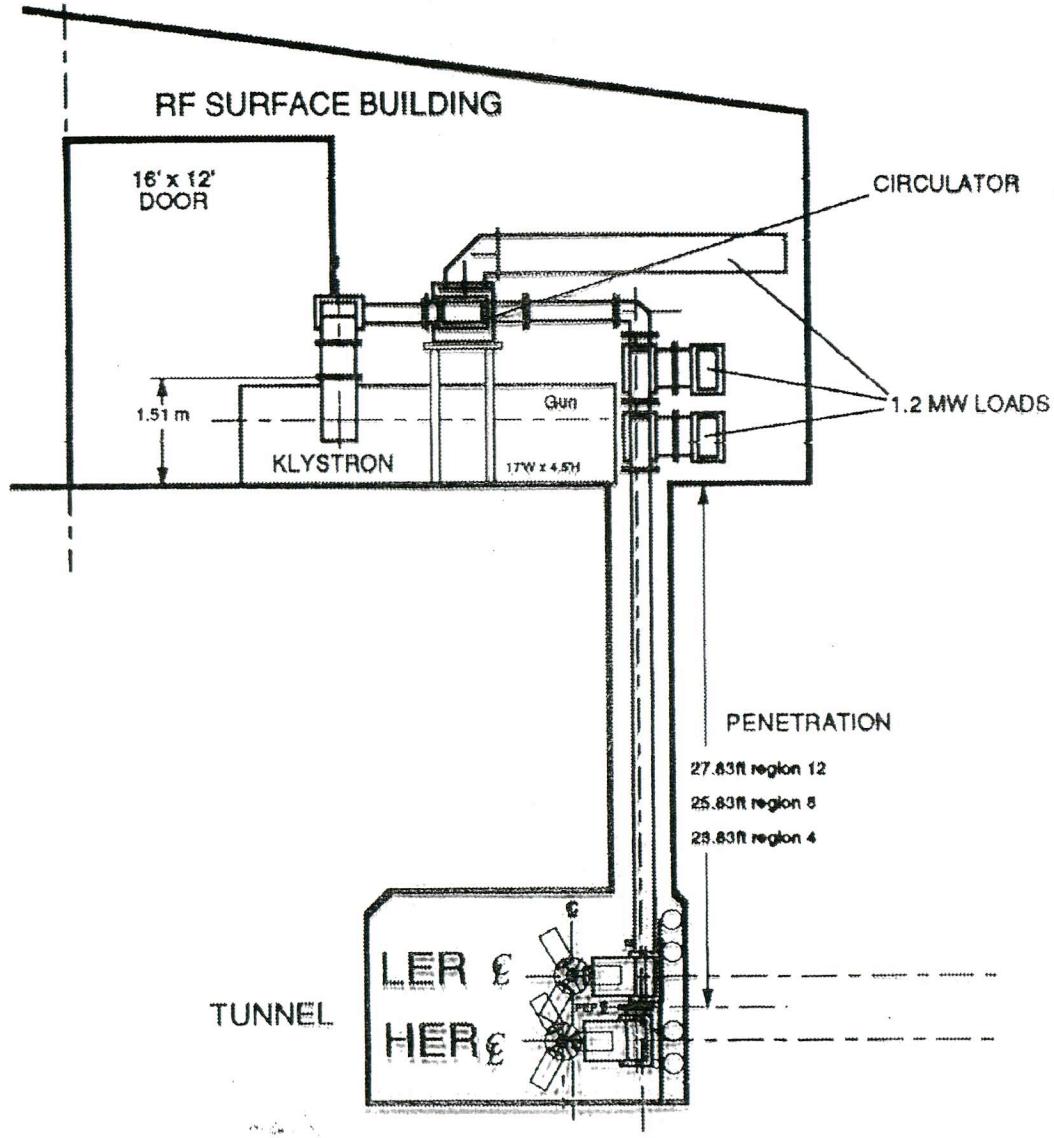




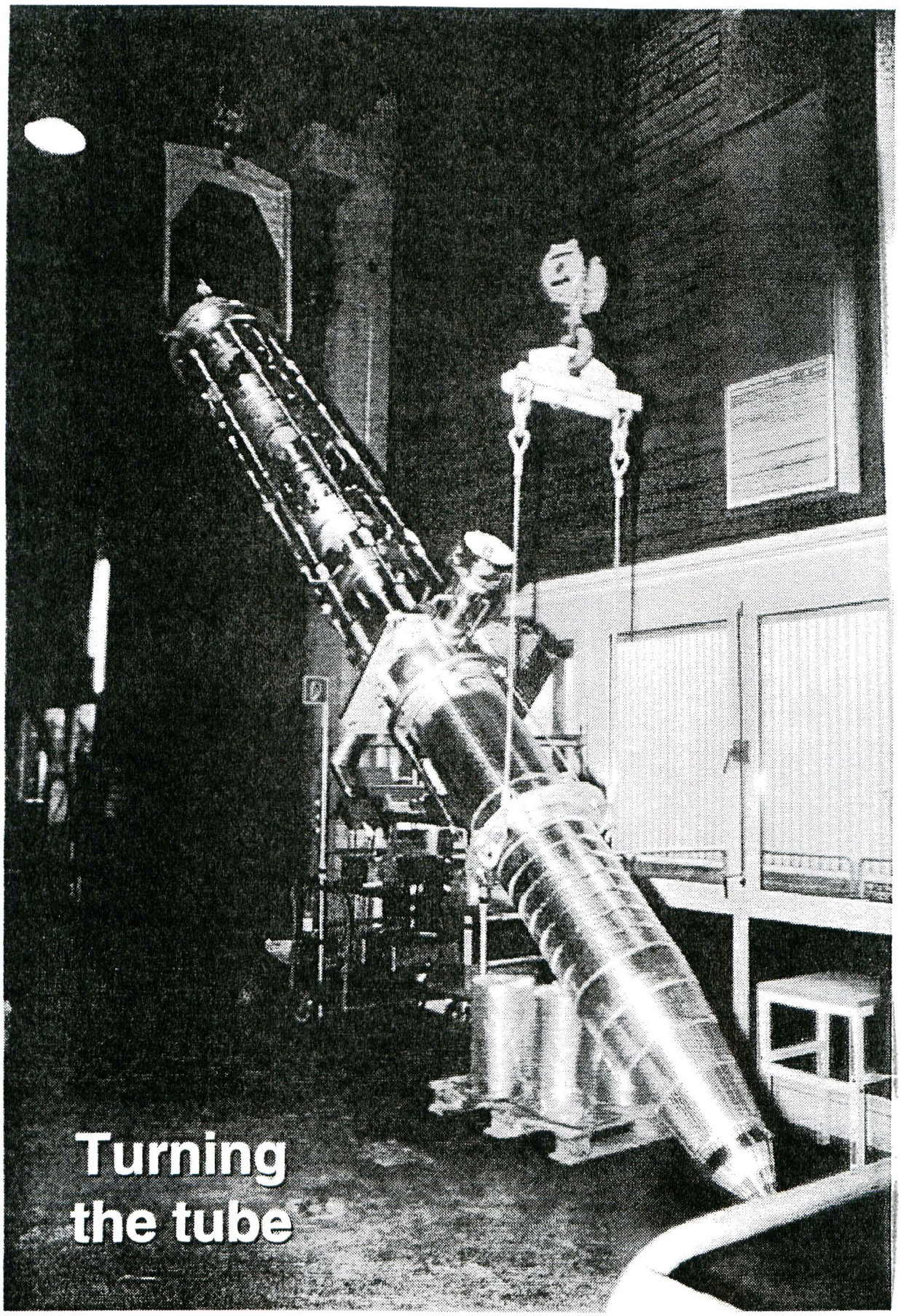




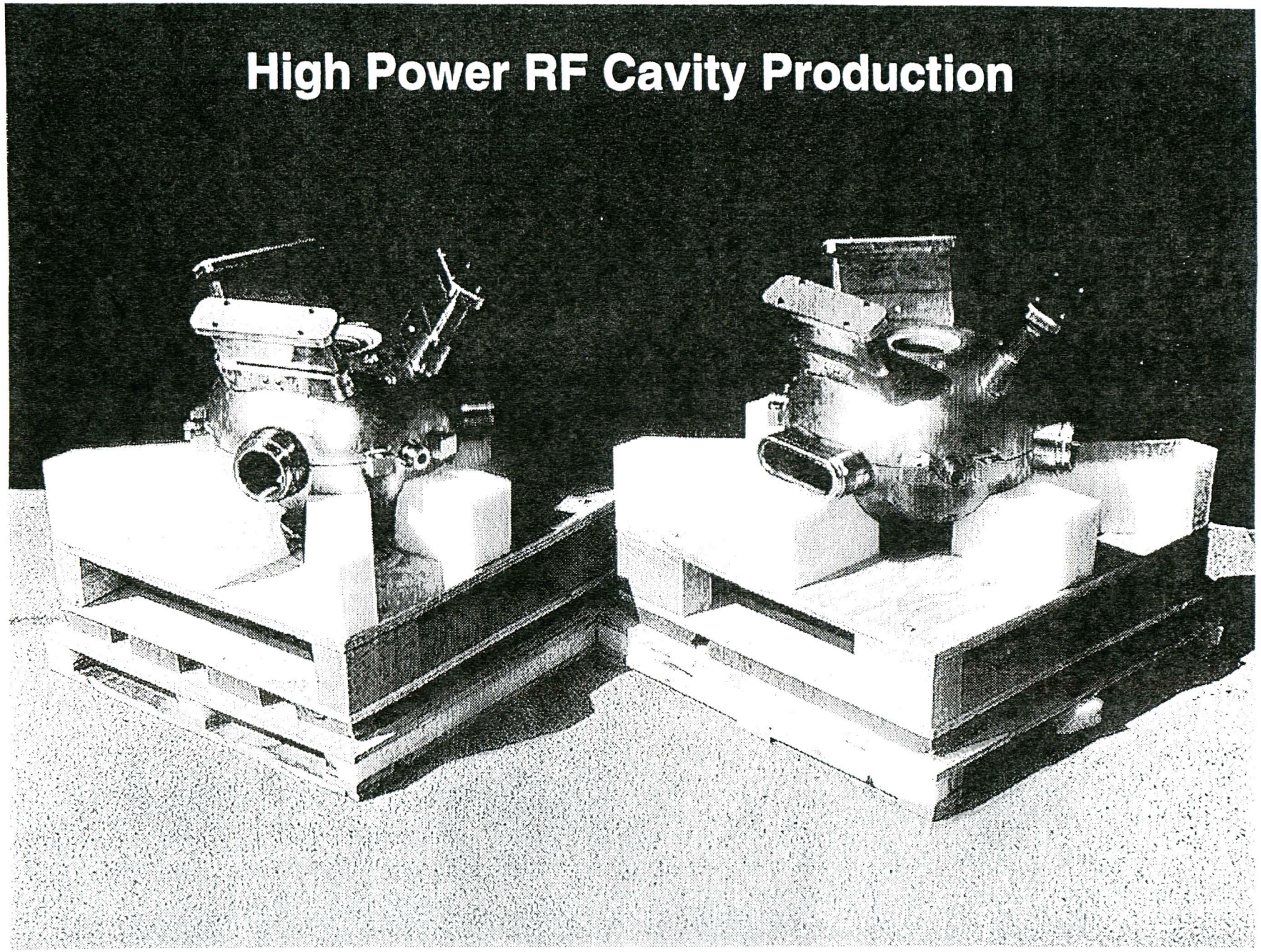
Typical Cross Section Layout

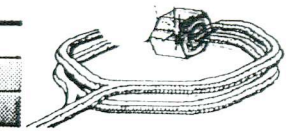


YK 1360 - Tube #1



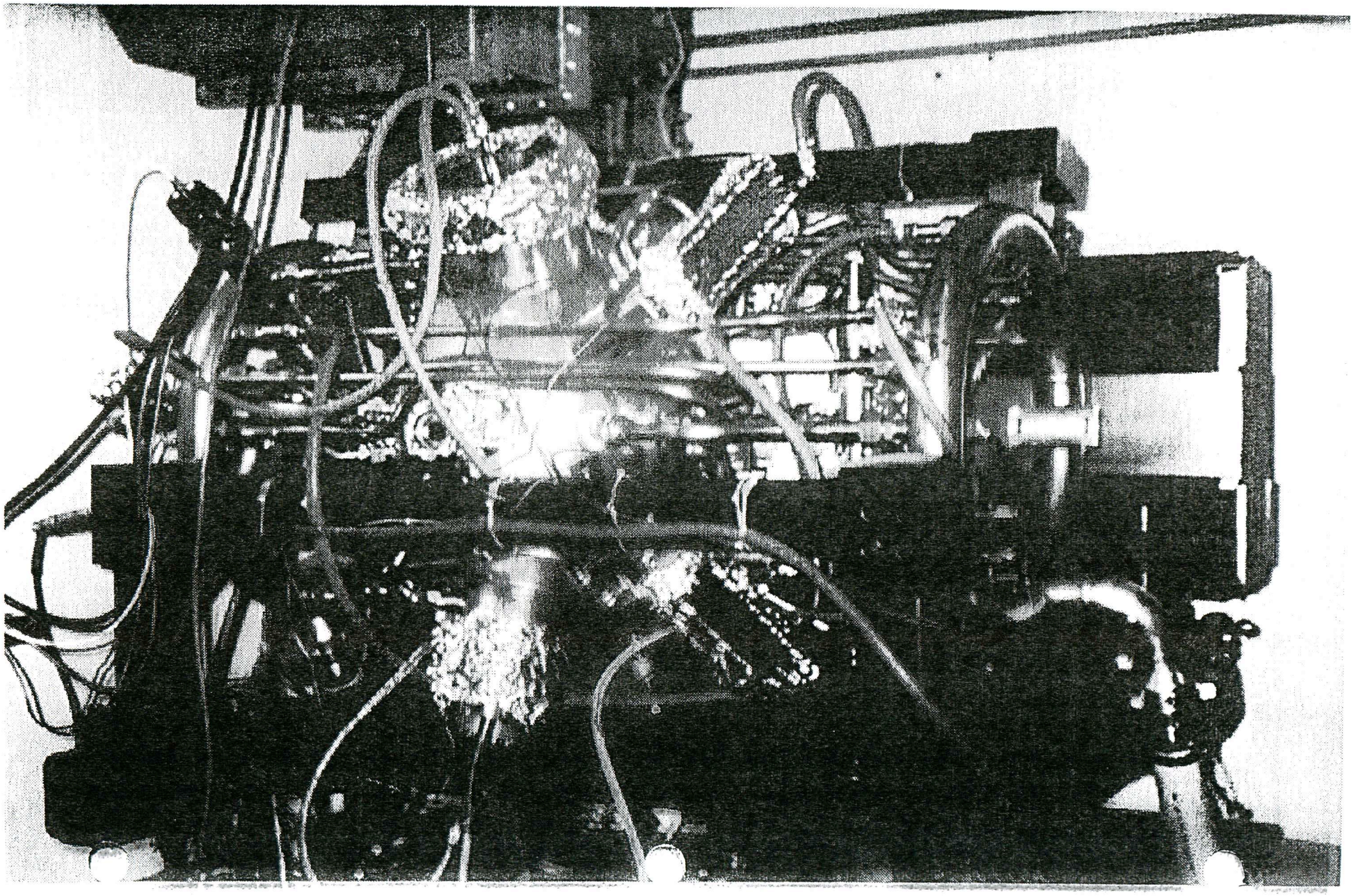
Turning the tube

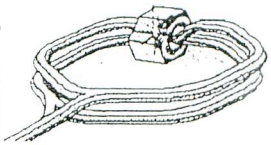

High Power RF Cavity Production

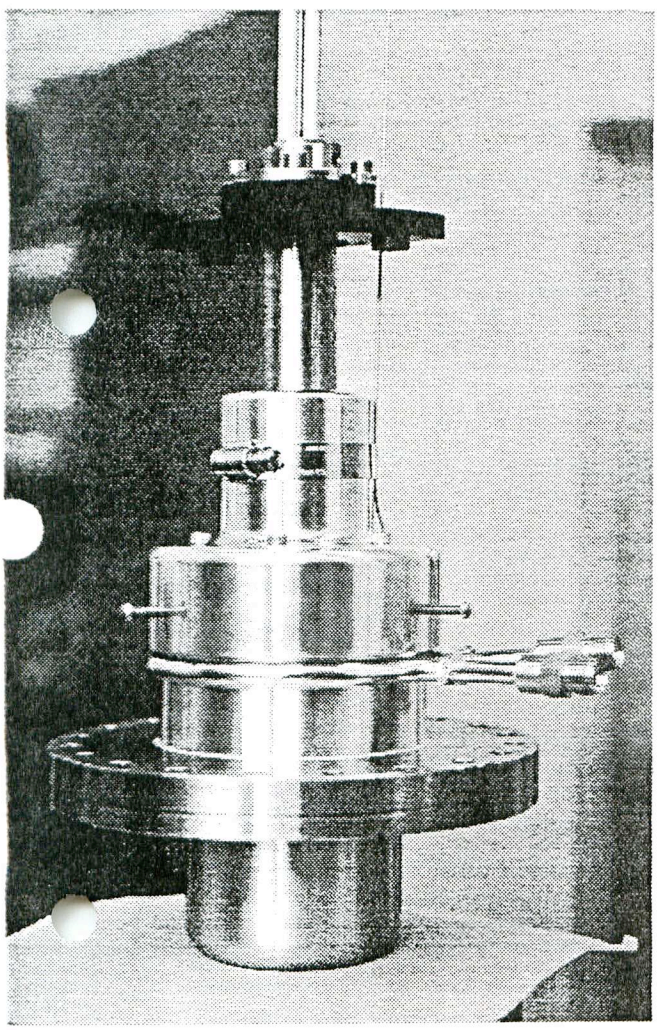


Production HOM Load Tile Assembly
(AlN + 40% SiC)

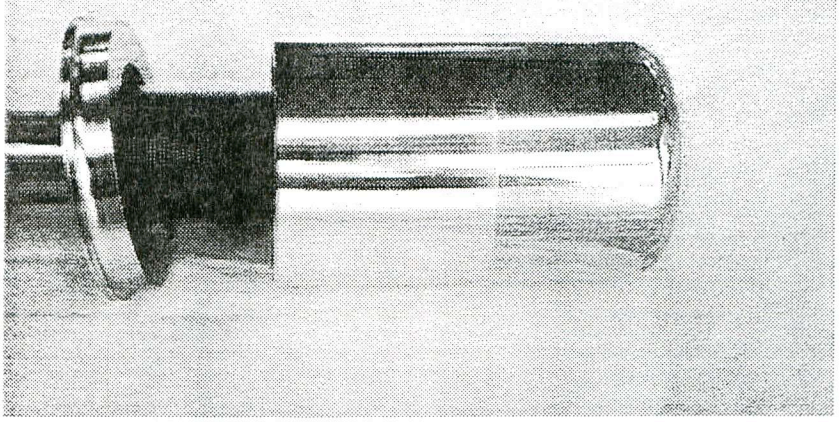
PEP-II RF Cavity in Raft



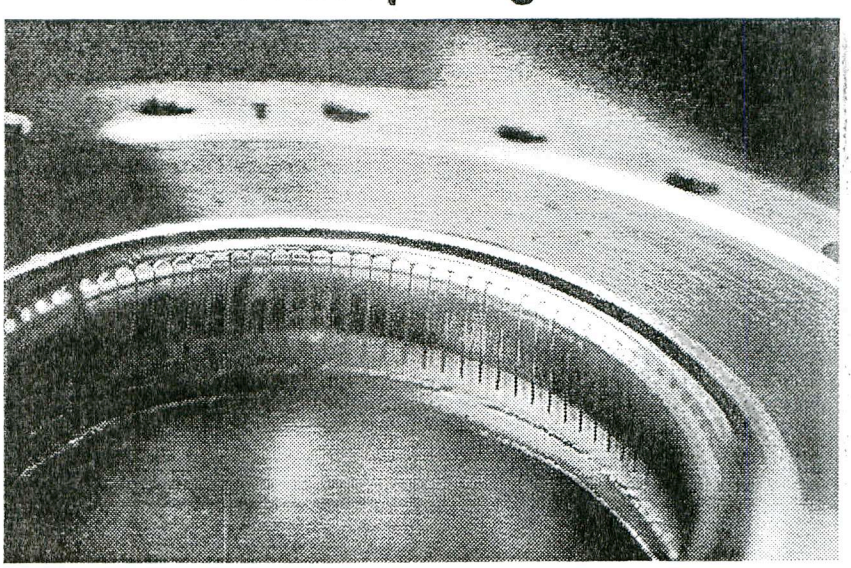




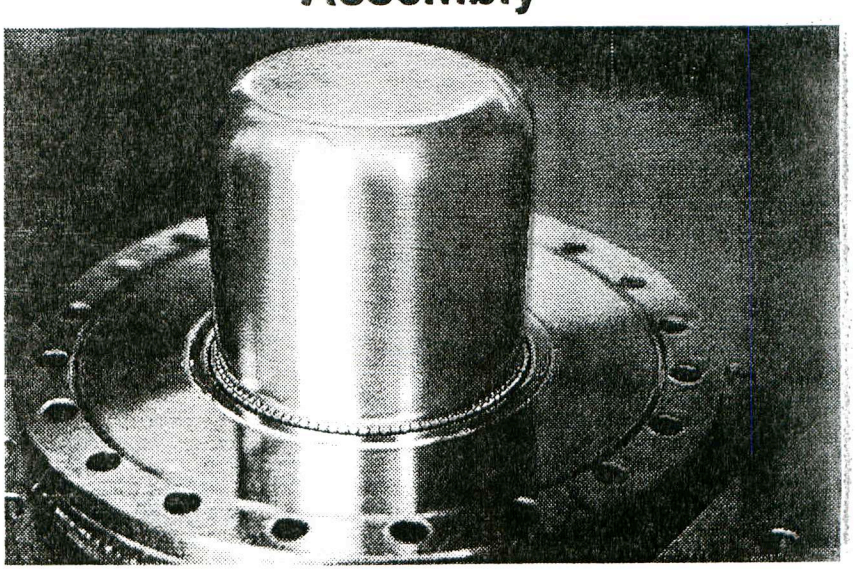
Tunner Plunger with Rhodium



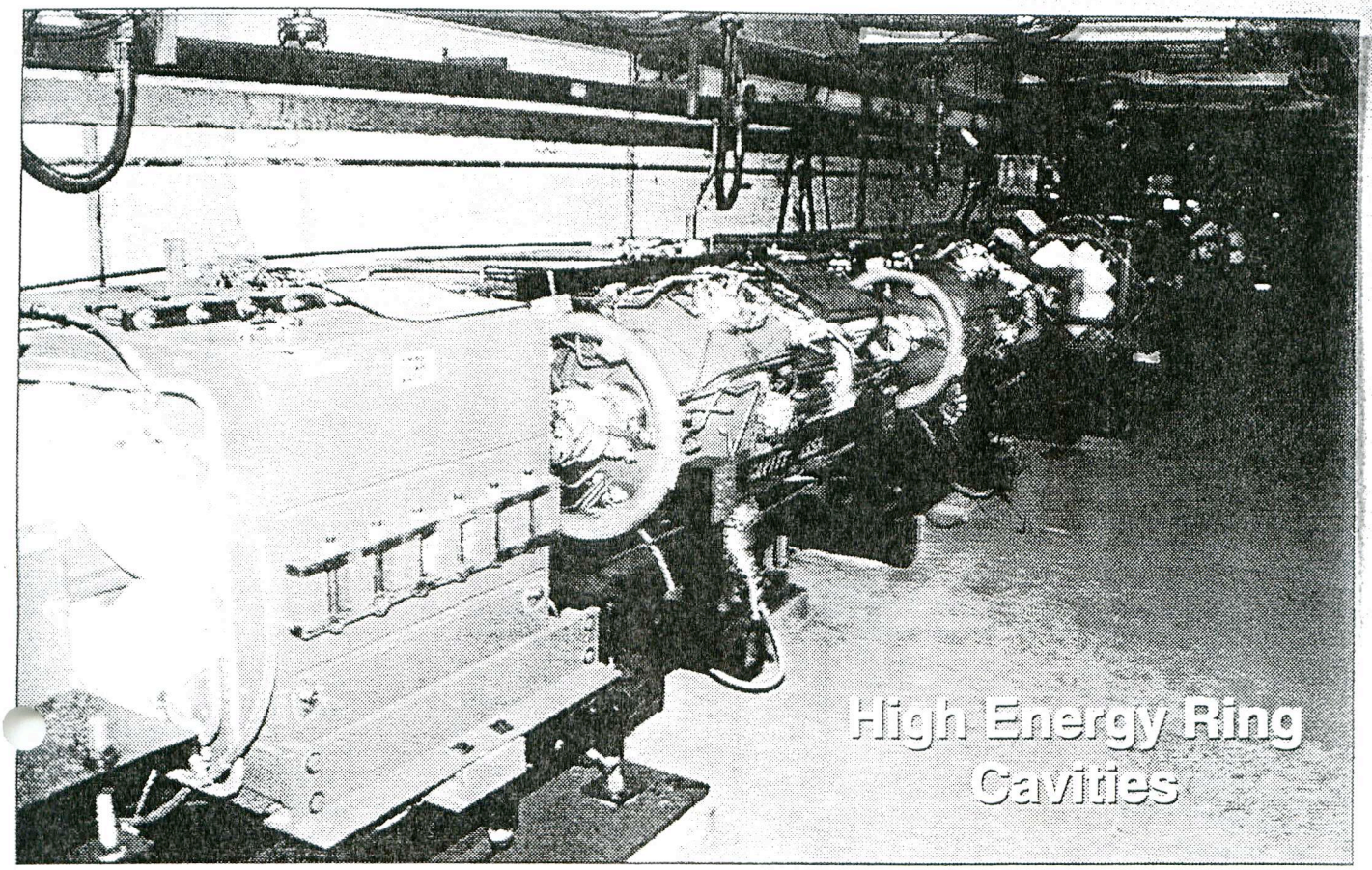
Glidcop Fingers



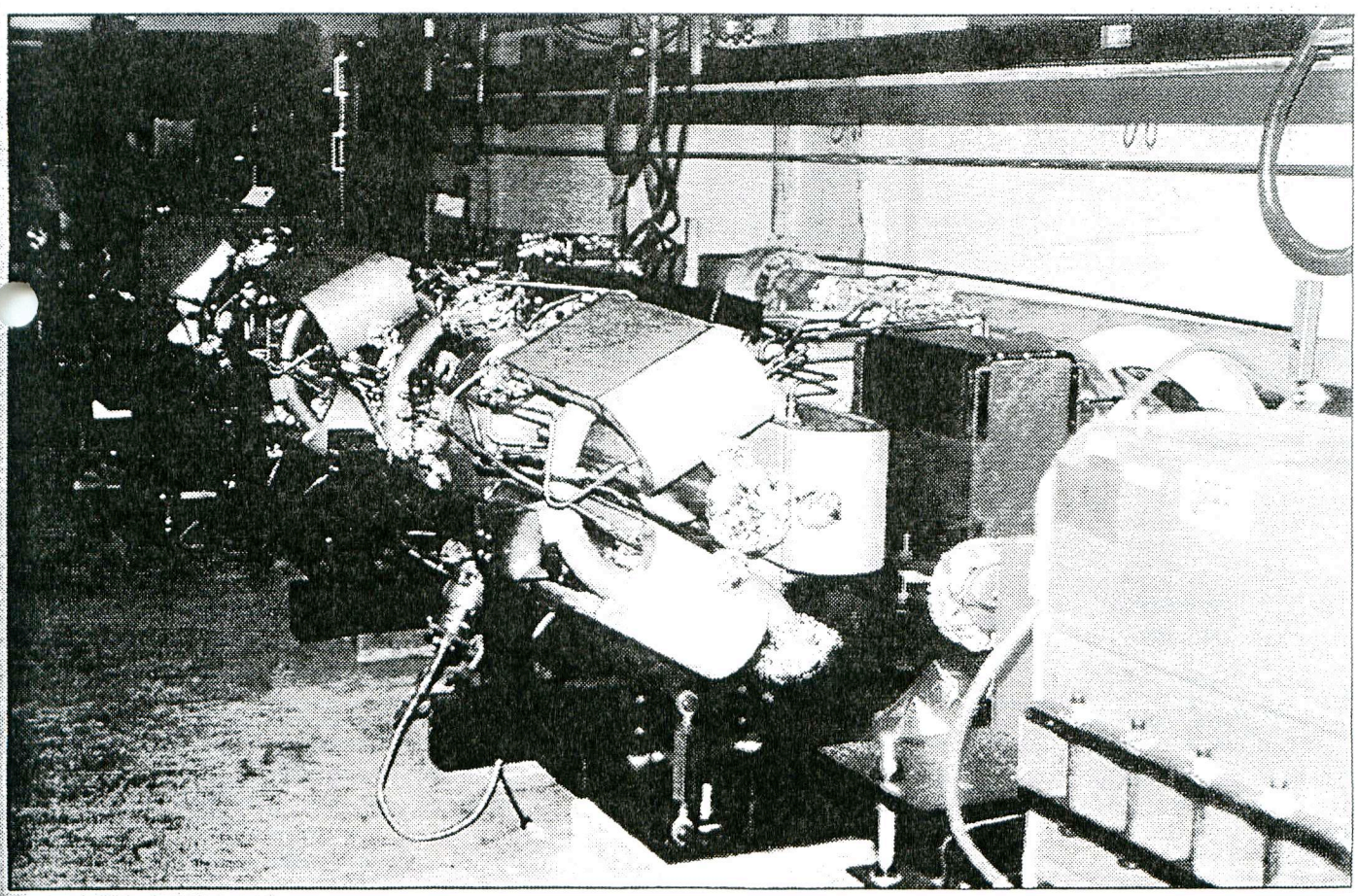
Assembly



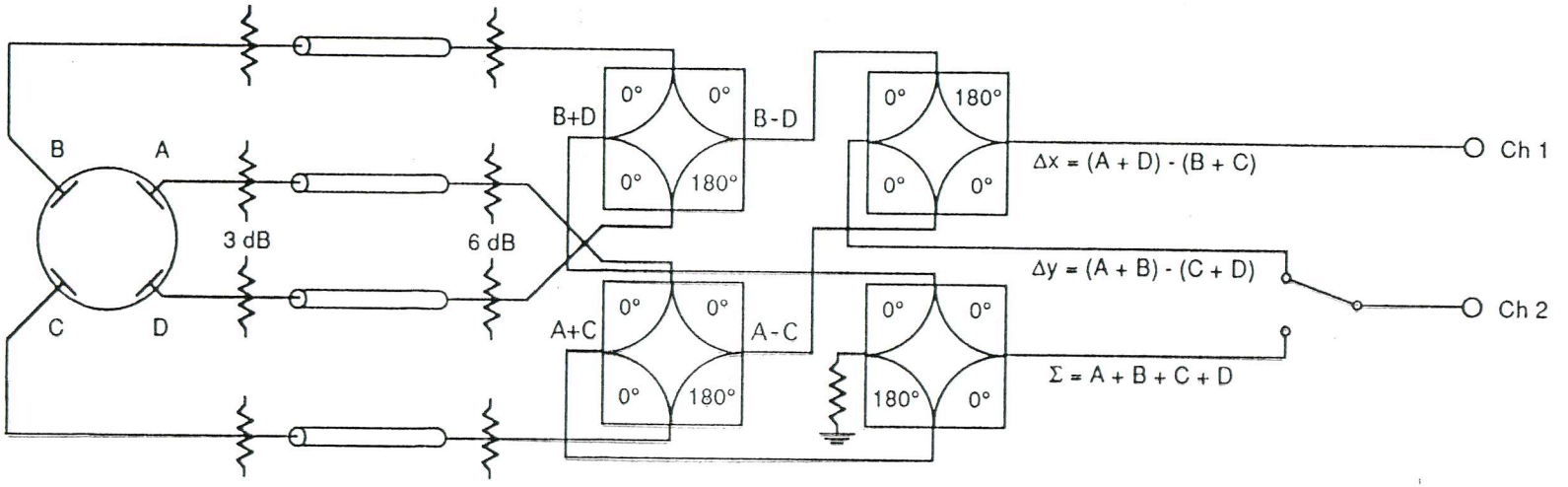
PEP-II RF Cavity Tuner

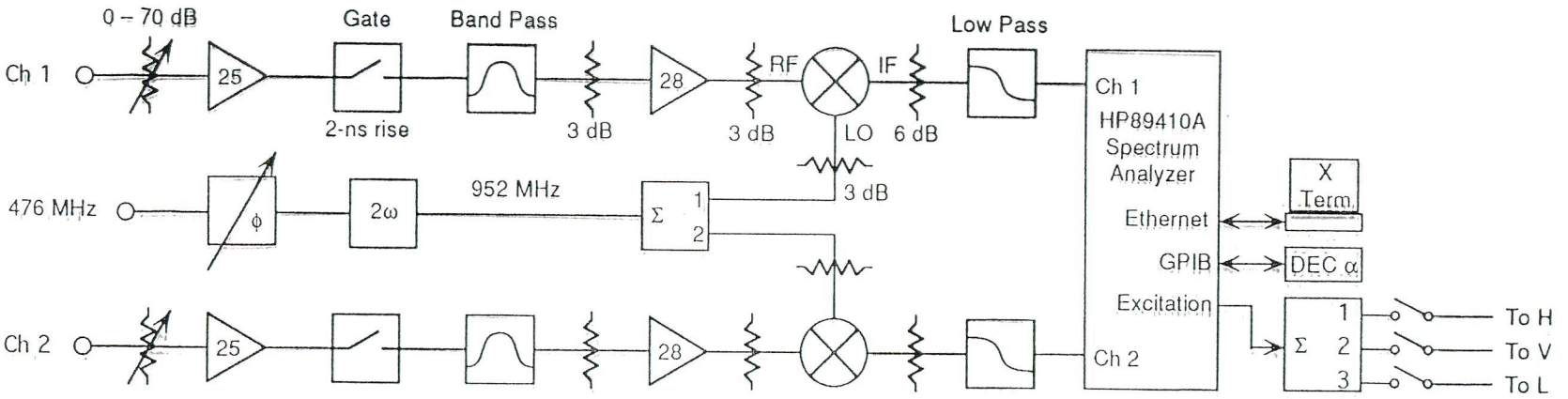


Installation in PEP-II Tunnel



PEP-II Tune Monitor





PEP-II Ring Beam Position Monitor Requirements

Steve Smith

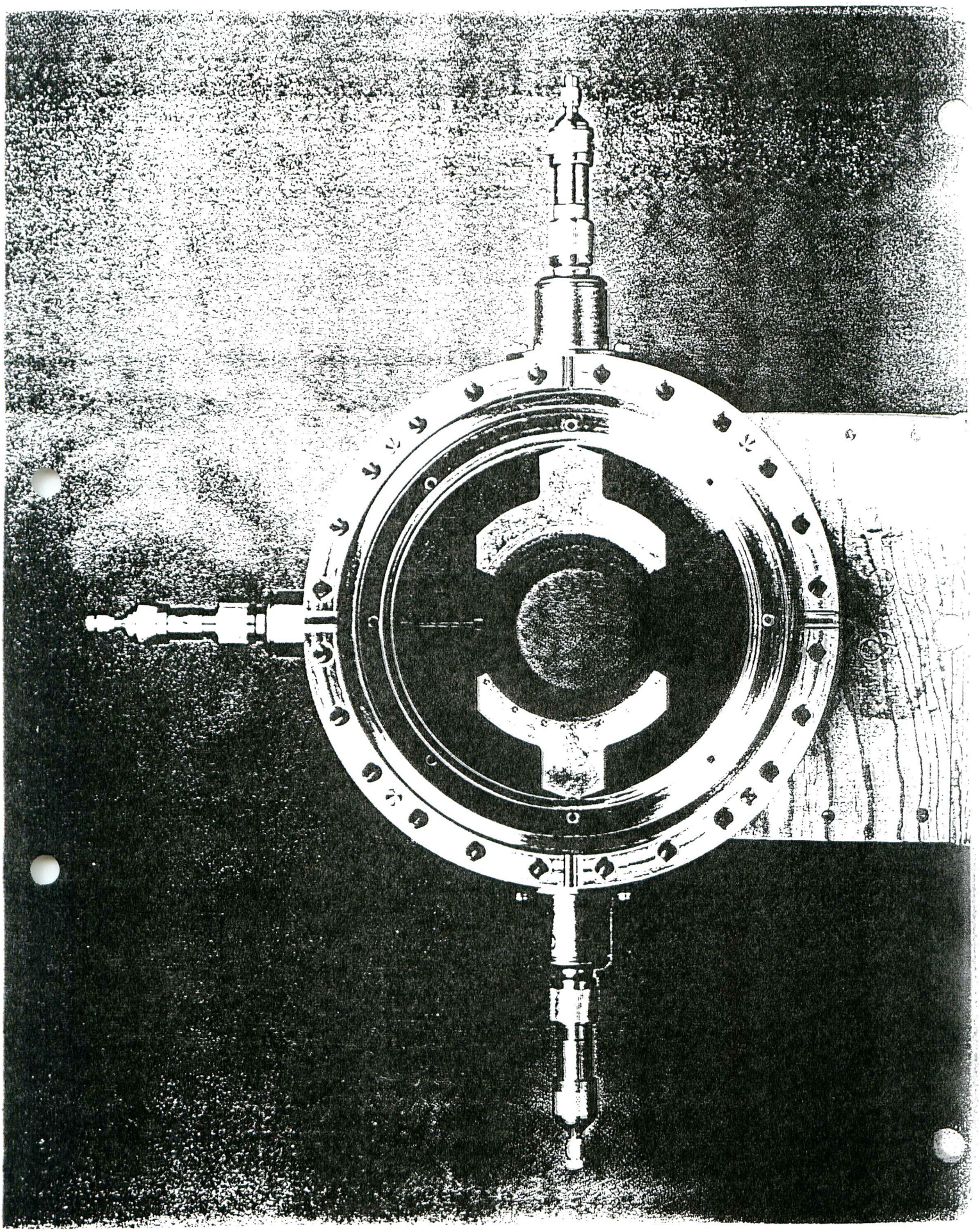
September 19, 1994

Measurements of Prototype Processor, Dec. 1996

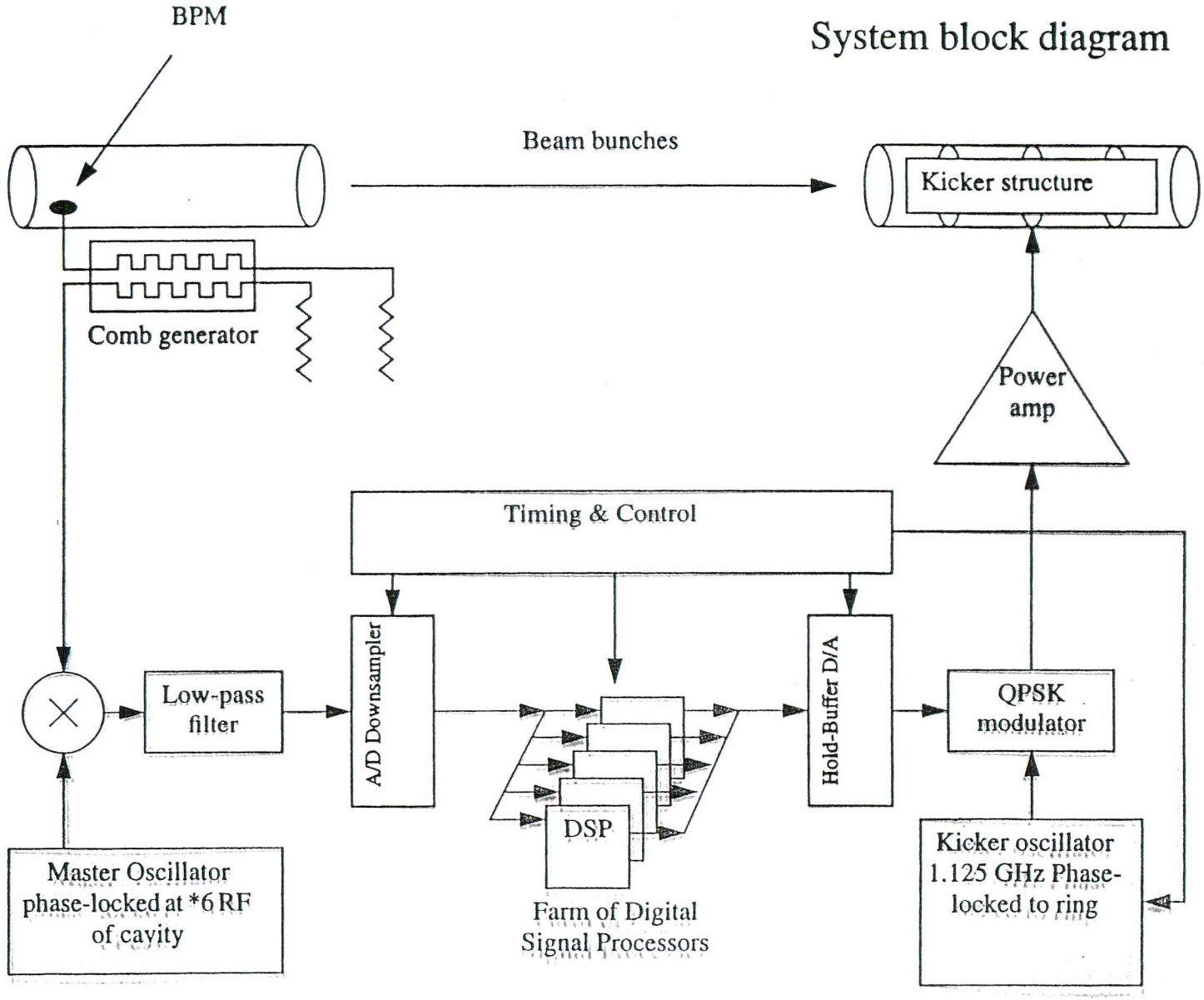
Summary of Requirements:

Parameter	Requirement	Measurement	Conditions
Quantity and location of BPM's	Approximately 288 BPM's in each ring, one in each quad, with each processor individually switchable between HER & LER		Most measure either X-only or Y-only, about 50 (X,Y) BPM's
Time resolution of position measurement	A single measurement represents the average position of fewer than 10 consecutive bunches.		
Measurement Rate	Up to one measurement per machine turn, unless the cost is prohibitive.		
History	When not otherwise occupied, BPM processors will maintain a FIFO buffer of the last 1000 turns or more, if undersampled.		For fault analysis
Resolution @ Current	1.0 mm @ 5×10^8 e^- in one turn	$< 100\ \mu m$	Single bunch, single turn
	100 µm @ 1×10^{10} e^- in one turn	$< 20\ \mu m$	Single bunch, single turn
	15 µm @ 1×10^{10} e^-	$< 1\ \mu m$	averaged over 10^3 turns
Reproducibility over a one hour period	15 µm electronic plus 15 µm mechanical	$< 5\ \mu m$	To re-establish orbit after a shutdown
Accuracy of measured beam position with respect to quad magnetic center	± 1 mm σ < 0.5 mm	< 0.3 mm	Full width RMS before beam-based alignment (see below for accuracy budget)
Dynamic range, (position)	Meet the above resolution & accuracy specs. Resolution not to exceed10% of displacement		For (x,y) within 1 cm of center. For displacement > 1 cm of center
Dynamic range (current)	No damage or channel saturation for R < 1 cm @ I < 3 Amp		
X-Y Coupling	≤ 30% for r = 1cm, "pincushion distortion" ≤ 3% for r < 1 cm,		X-only or Y-only BPM's X-Y BPM's
Precision of current measurement	10%		
Accuracy of current measurement	Initially 50%, 10% after normalization with beam		

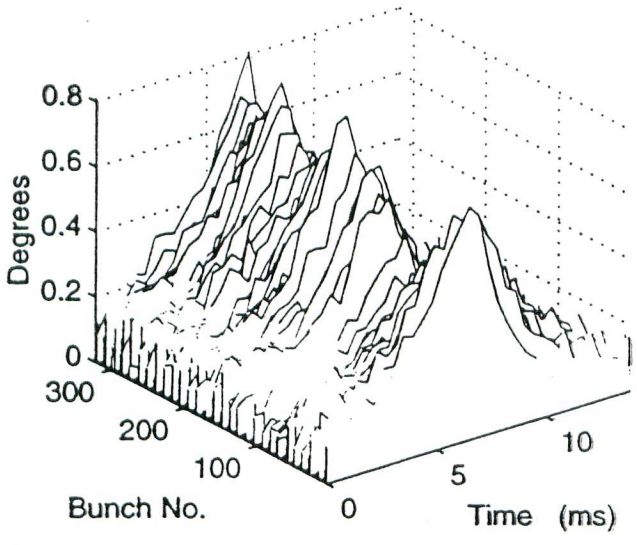
HER-LER isolation	< -86 dB	-74 dB worst channel, -80 dB median
Processor input reflection (S_{11})	< -20 dB	-17 dB worst channel, -19 dB typical



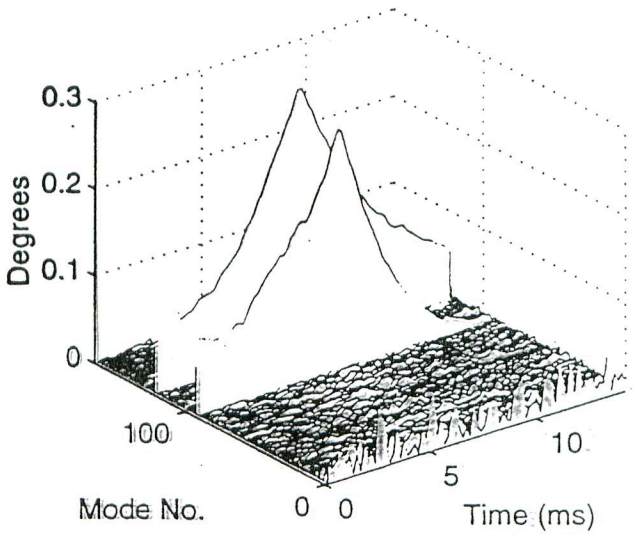
System block diagram



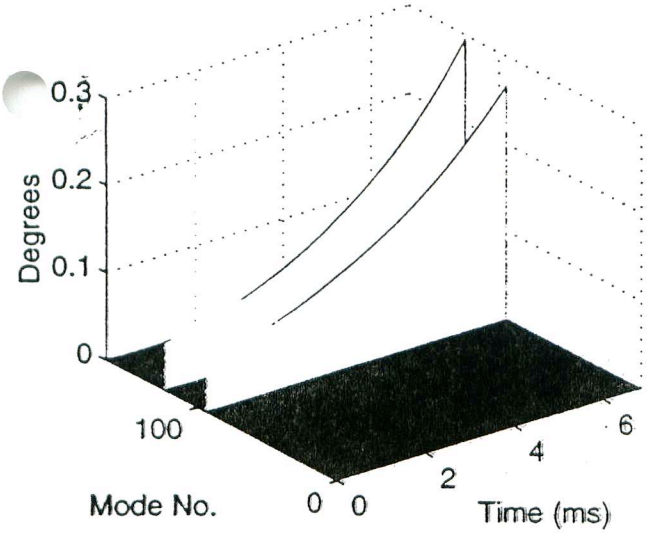
a) Oscill. Envelopes in Time Domain



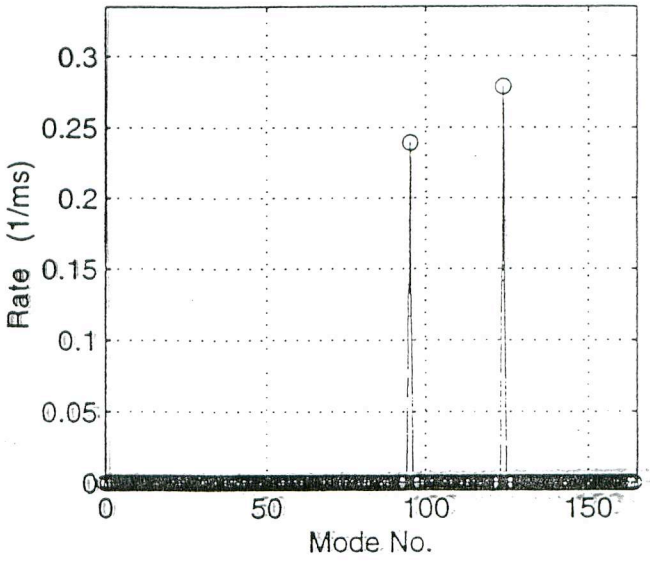
b) Evolution of Modes



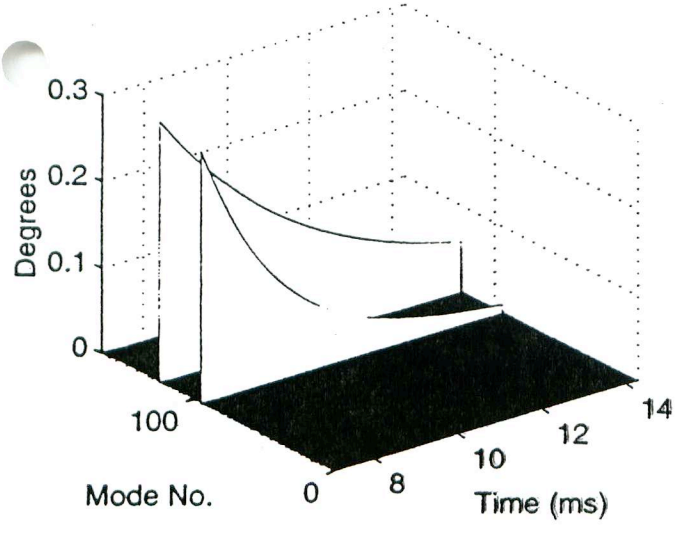
c) Exp. Fit to Modes (pre–brkpt)



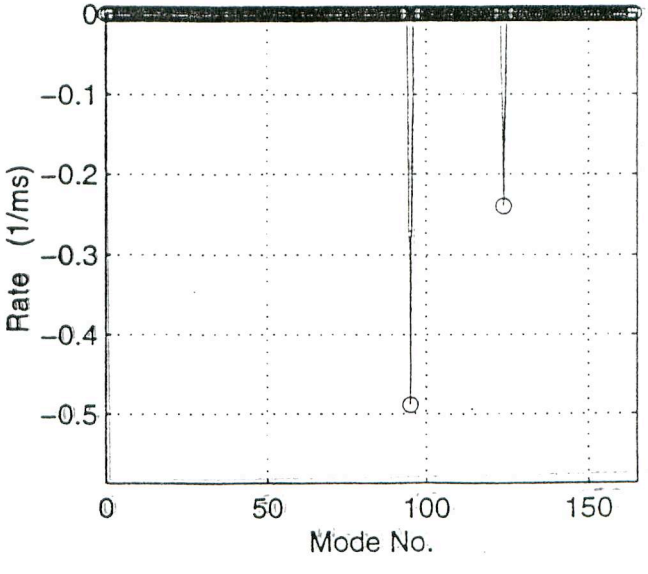
d) Growth Rates (pre–brkpt)



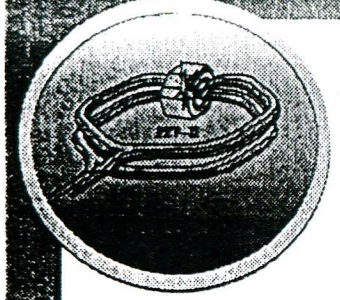
e) Exp. Fit to Modes (post–brkpt)



f) Growth Rates (post–brkpt)



apr0996/2303: Io= 127mA, Dsamp= 22, Shift Gain= 3, Nbun= 320, Gain1= 0, Gain2= 1, Phase1= −200, Phase2= −200, Brkpt= 480, Calib= 21.2 cnts/mA–deg.



PEP II Commissioning Plans

Phased commissioning:

Extraction / beam transport tests: **Fall 1995-->**
Parasitic "few" Hz extraction

HER injection / stored beam: **Spring 1997-->**
Work towards stored beam and high I

LER injection / stored beam: **Spring 1998-->**
Work towards stored beam and high I

PEP II collisions: **Summer 1998**
Detect beam-beam collisions

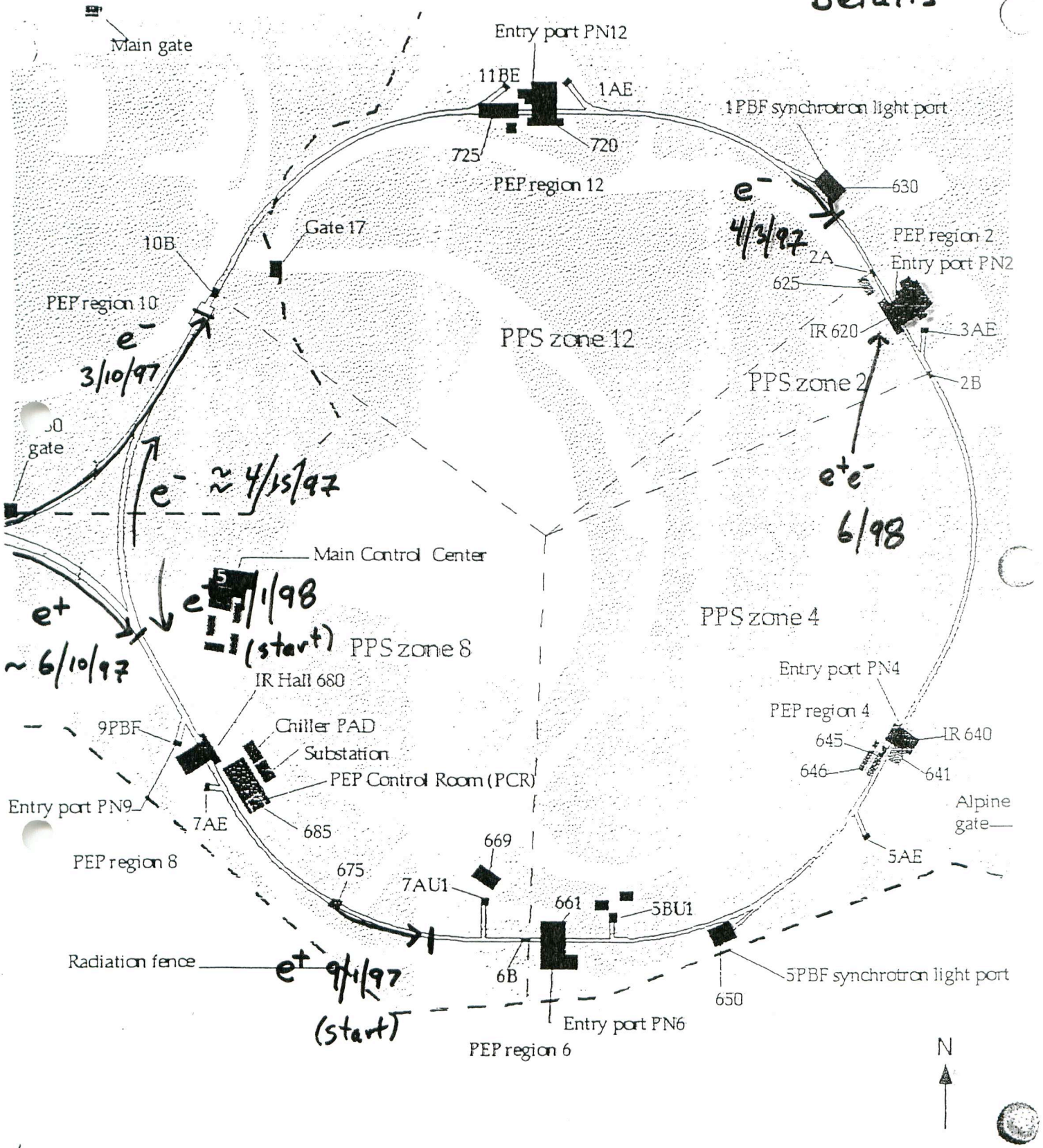
BABAR collisions: **Summer 1999**

Commissioning Strategy for HER

- **Mostly Parasitic with SLC running**
  $\Rightarrow$ ~ 2-4 Hz e^-
- **Some dedicated running at 60 Hz**
- **Install for 4 days (M-Th), commission for 3 days**
- **Important to recognize that we are installing a relatively small number of components during this time**
  - LER Stands are already in place
  - Full Cable Plant will be complete by end of 1996
  - LER components are modular
- **To the largest degree possible, we will only "break" the PPS in one zone per week.**
- **Schedule**
  - Midnight Thursday - 8 am Friday: Secure the tunnel
  - 8 am Friday - 4 pm Friday: Reestablish stored beam
  - 4 pm Friday - 5 am Monday: Commission HER
  - 7 am Monday: Open tunnel

11.1 PEP PPS Zones and Entry Ports

Commissioning Details



PEP-II Status: Conclusions

- Technical progress on all fronts has been excellent
- We have experienced major schedule slippage in LER Vacuum production. We have moved aggressively to resolve this situation
- PEP-II remains on schedule to complete the High Energy Ring by March 1997 and the rest of the machine by April 1998. Anticipate first collisions June 1998
- Funds are tight. We will have to manage the expenses with care