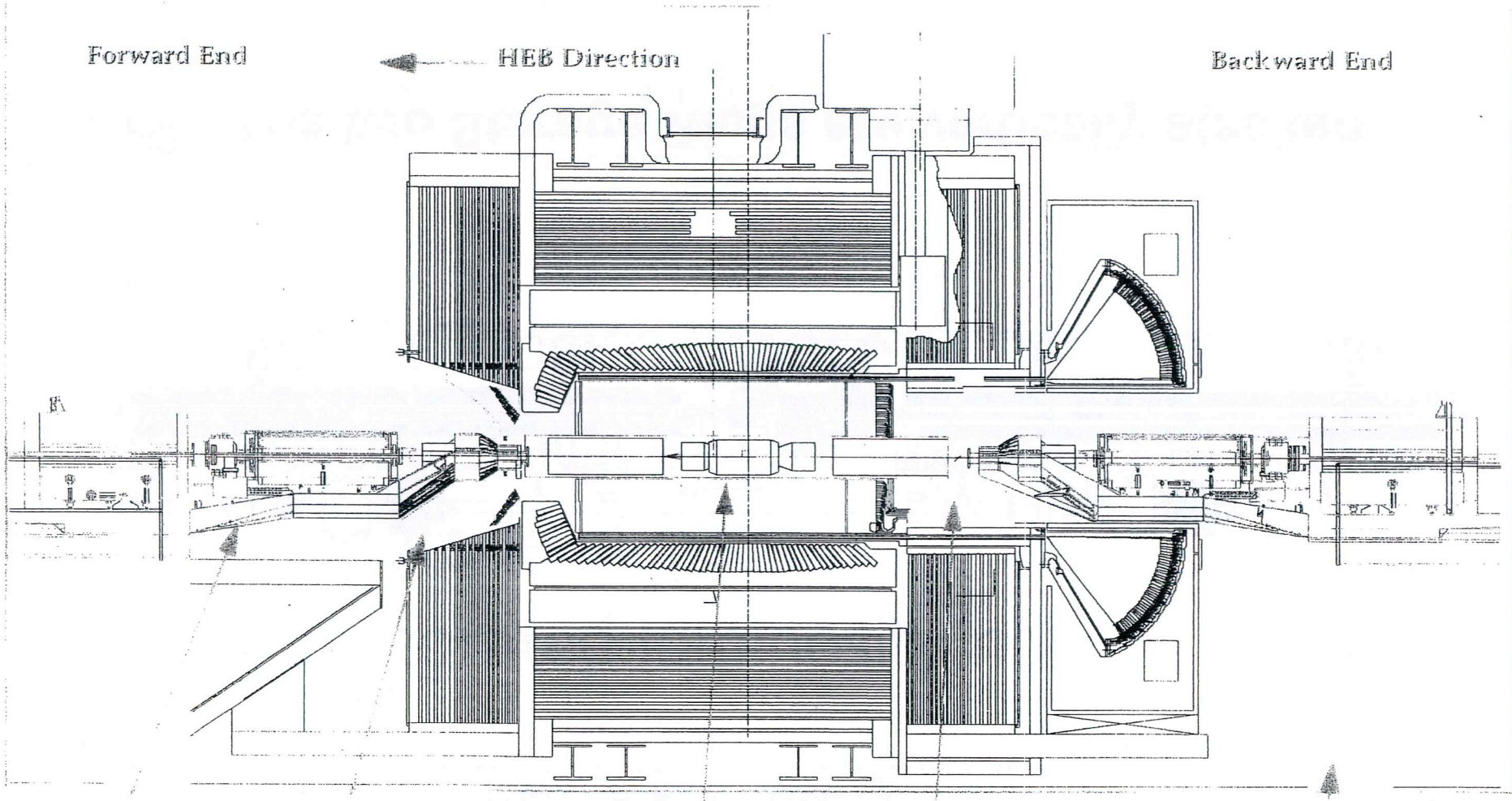
PEPII Status

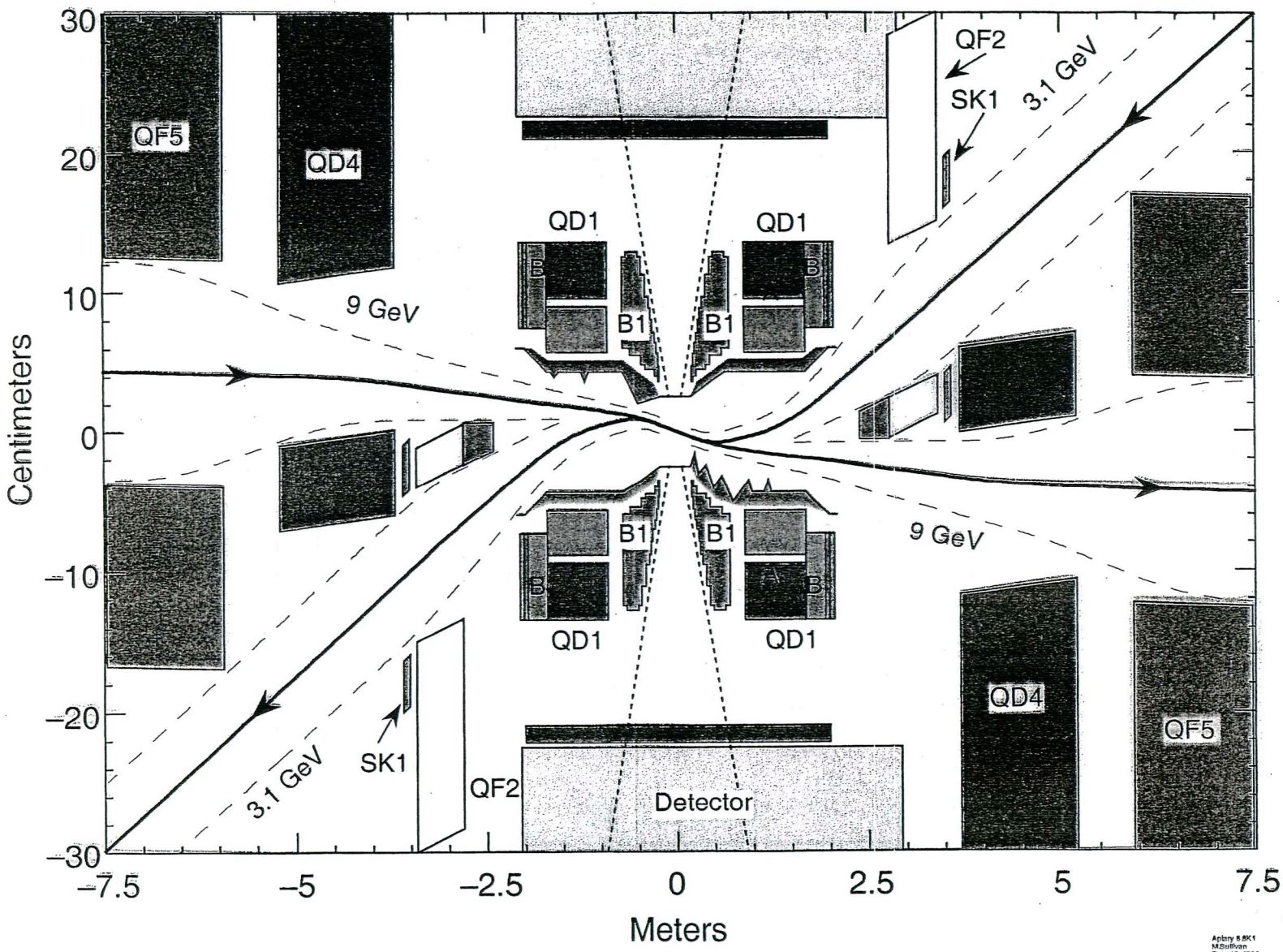
(Feb.26　10:00-11:00　J.Seeman)

PEP-II I.R. and BaBar Detector in IR-2

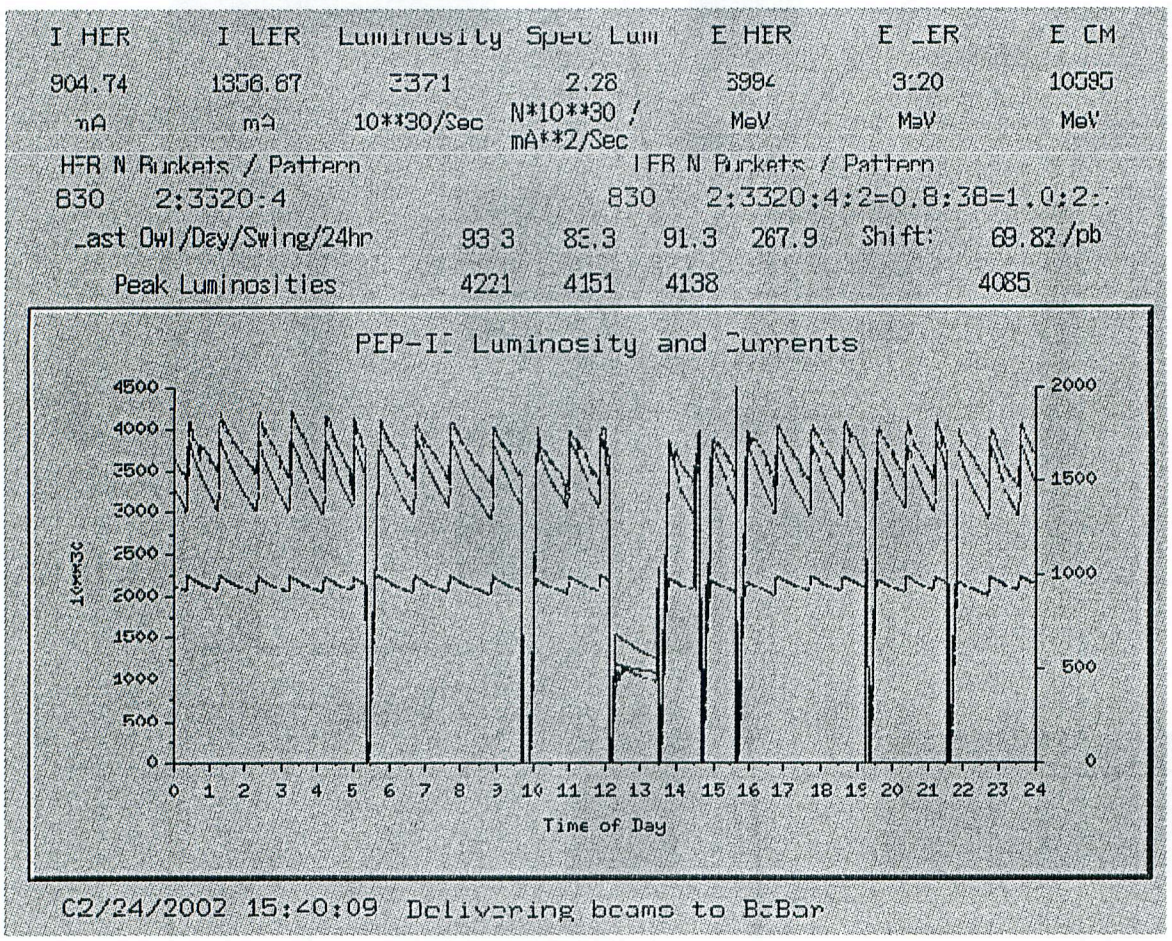


Elevation View of PEP-II I.R. and BaBar

PEP-II Interaction Region



Apbny 8.8K1
M.Sullivan
Dec. 16, 1996



This image is a snapshot of the control room luminosity and currents display taken every ten minutes. The display runs from midnight to midnight with the current time (dimly) marked by a vertical line. The

Recent PEP-II Luminosity Increase

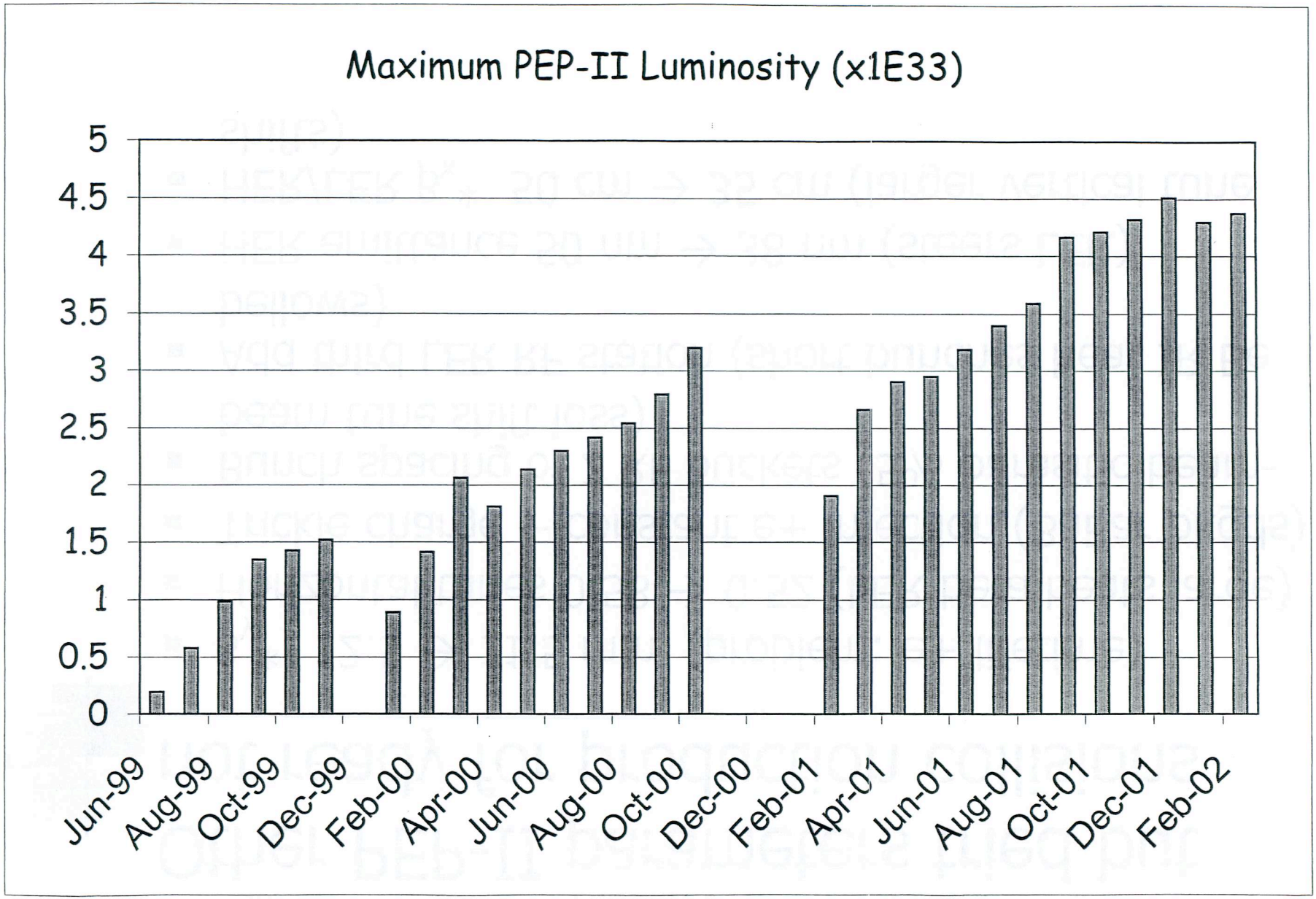
- From June '01 through January '02, the PEP-II luminosity increased from 3.3 to 4.5 $x10^{33}$ and the integrated luminosity from 175 to 309 pb^{-1}/day.
- Reasons for increase:
  - Number of bunches: 692→ 796
  - LER vert. dispersion: 250 mm rms → 50 mm rms
  - HER current: 800 mA →1005 mA
  - LER current: 1550 → 1758 mA
  - HER β_x*: 60 cm → 50 cm

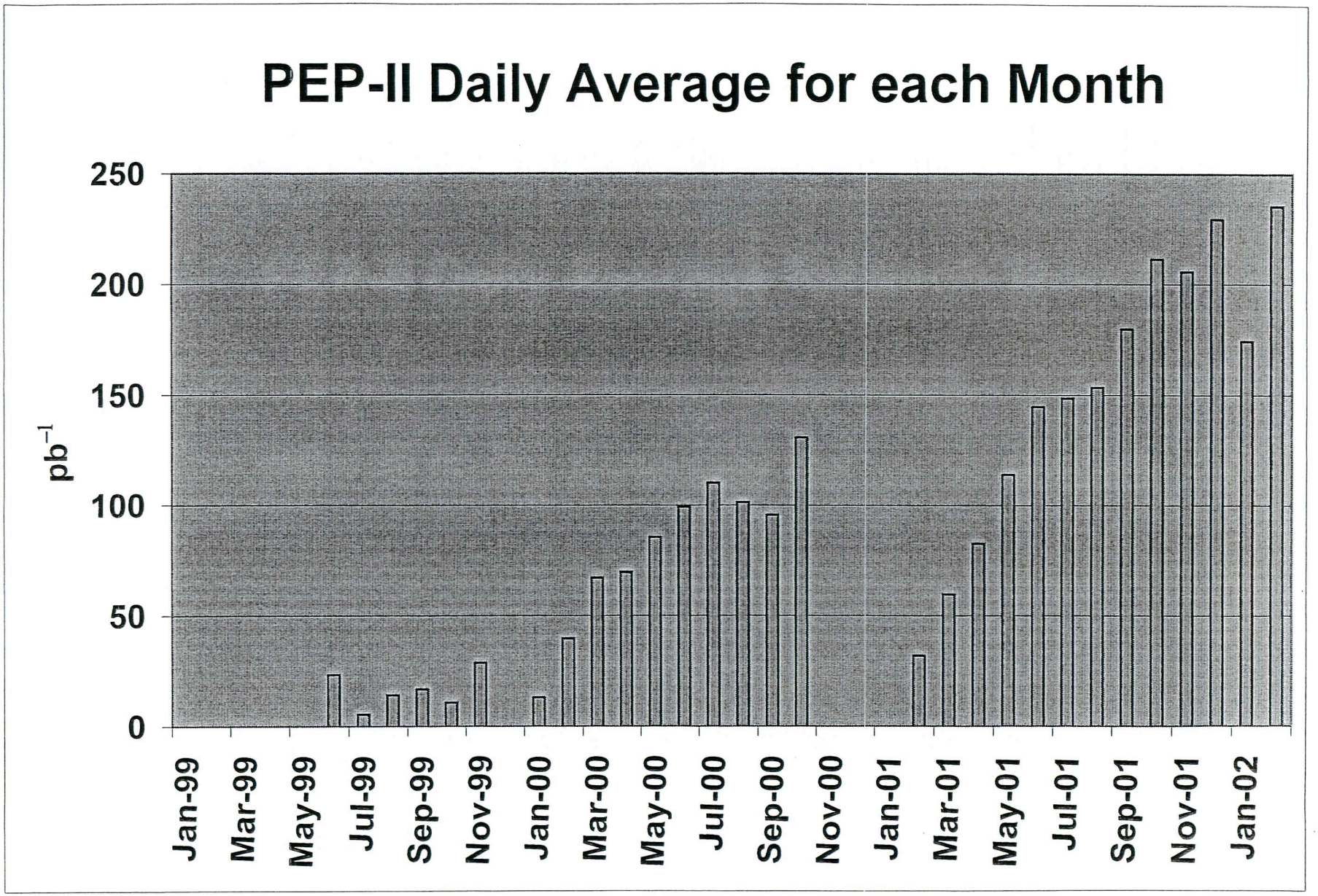
PEP-II Luminosity Parameters

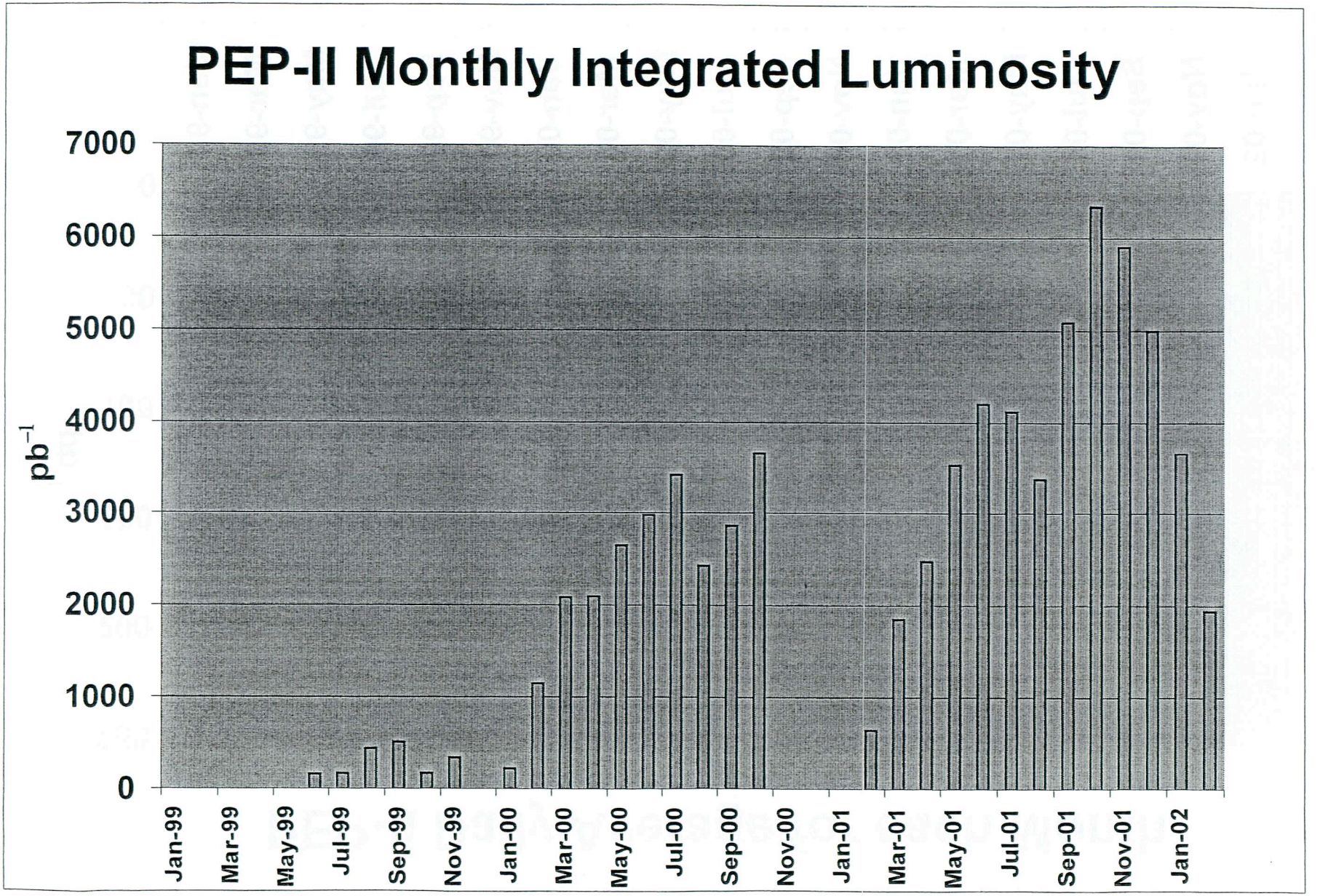
- Luminosity = 4.51 x 10^{33} /cm^2/s
- Positron current = 1758 mA
- Electron current = 1005 mA
- Number of bunches = 796
- IP beam sizes (ave) = 147 x 5 microns
- $\Sigma_{x,y}$ = 190 μm, 8 μm at low I
- Tune shifts:
  - Horizontal (e-,e+) 0.06, 0.07
  - Vertical (e-,e+): 0.03, 0.05

Other PEP-II parameters tried but not ready for production collisions

- β_y*: 12.5 → 11.5 mm (problem: e+ lifetime)
- Horizontal tunes 0.58 → 0.52 (LER beta beats large)
- Trickle charge -- constant e+ injection (BaBar bkgds)
- Bunch spacing of 2 RF buckets (5% parasitic beam-beam tune shift loss)
- Add third LER RF station (short bunches heat IR Be bellows)
- HER emittance 50 nm → 38 nm (steers LER)
- HER/LER β_x* 50 cm → 35 cm (larger vertical tune shifts)


Maximum PEP-II Luminosity (x1E33)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Jun-99
Aug-99
Oct-99
Dec-99
Feb-00
Apr-00
Jun-00
Aug-00
Oct-00
Dec-00
Feb-01
Apr-01
Jun-01
Aug-01
Oct-01
Dec-01
Feb-02


PEP-II Daily Average for each Month
250
200
150
100
50
0
pb^{-1}
Jan-99
Mar-99
May-99
Jul-99
Sep-99
Nov-99
Jan-00
Mar-00
May-00
Jul-00
Sep-00
Nov-00
Jan-01
Mar-01
May-01
Jul-01
Sep-01
Nov-01
Jan-02


PEP-II Monthly Integrated Luminosity
7000
6000
5000
4000
3000
2000
1000
0
pb⁻¹
Jan-99
Mar-99
May-99
Jul-99
Sep-99
Nov-99
Jan-00
Mar-00
May-00
Jul-00
Sep-00
Nov-00
Jan-01
Mar-01
May-01
Jul-01
Sep-01
Nov-01
Jan-02

PEP-II Records

Last update:
Dec 23, 2001

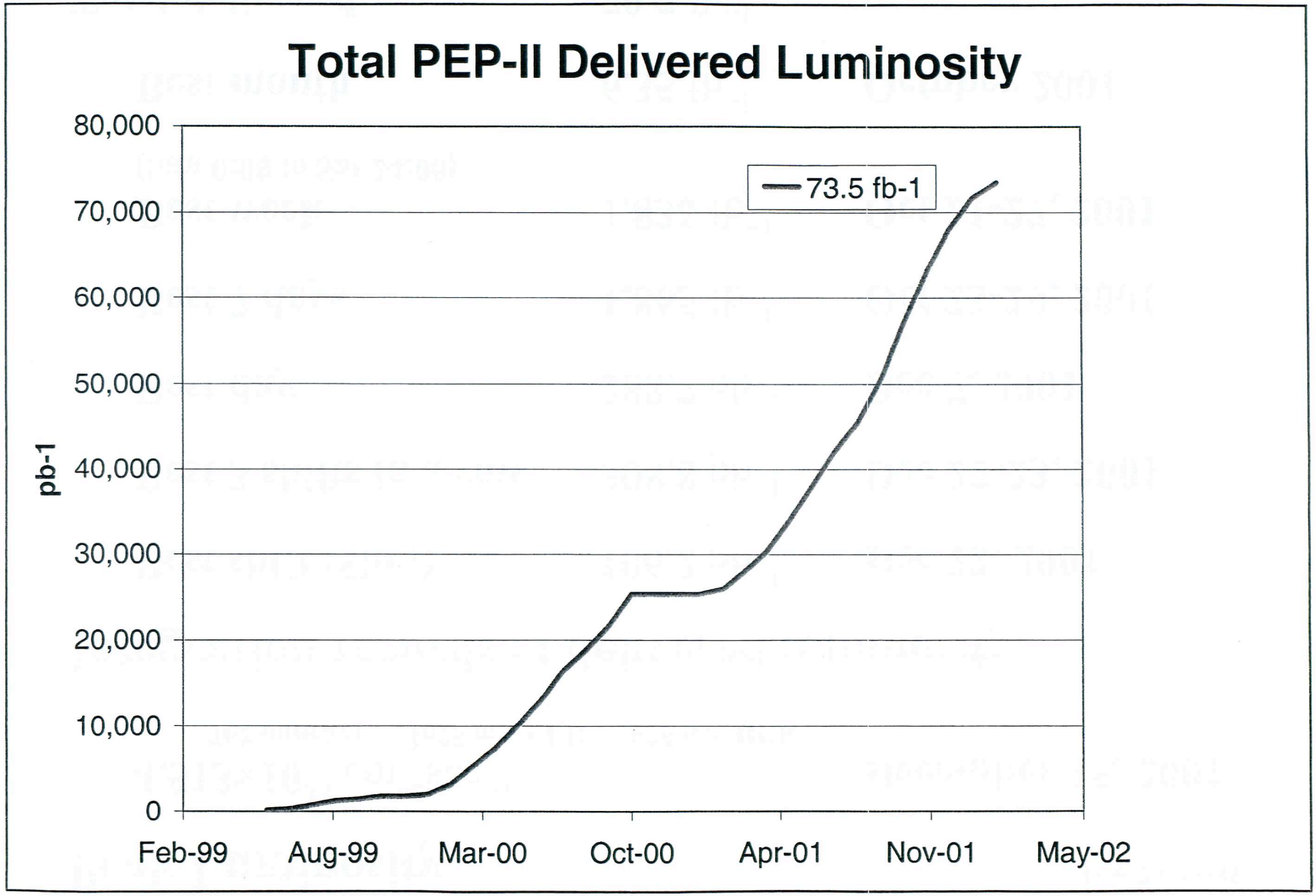
Peak Luminosity

4.513×10^{33} cm^{-2}sec^{-1} — **December 15, 2001**

762 bunches 1675 mA LER 975 mA HER

Integration records of delivered luminosity

Best shift (8hrs)	**106.2** pb^{-1}	**Dec 22, 2001**
Best 3 shifts in a row	**308.8** pb^{-1}	**Dec 22-23, 2001**
Best day	**288.7** pb^{-1}	**Dec 7, 2001**
Best 7 days	**1.865** fb^{-1}	**Oct 23-29, 2001**
Best week (Sun 0:00 to Sat 24:00)	**1.836** fb^{-1}	**Oct 21-27, 2001**
Best month	**6.35** fb^{-1}	**October 2001**
Total delivered	**70.7** fb^{-1}	

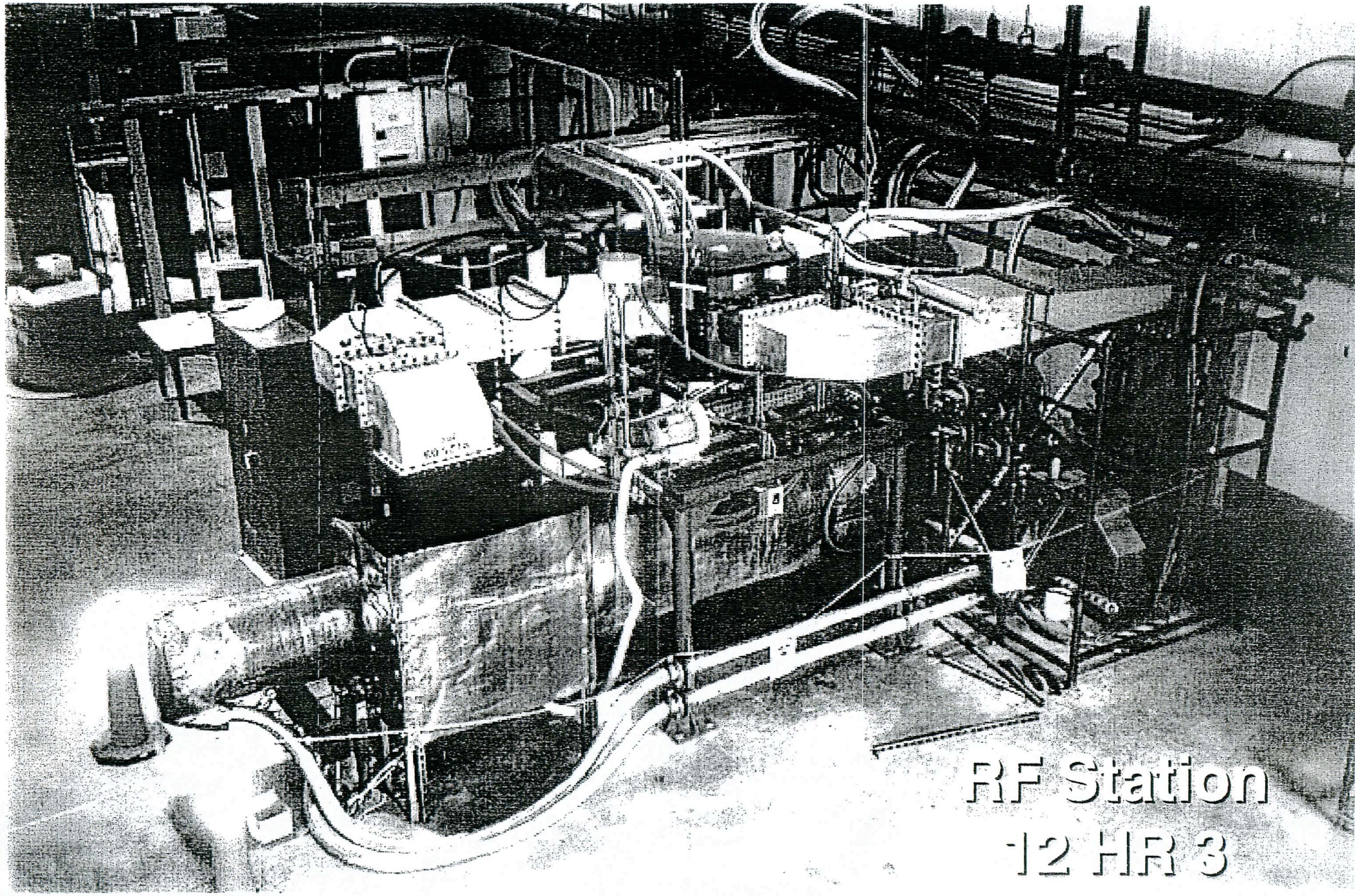

Total PEP-II Delivered Luminosity
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
pb-1
73.5 fb-1
Feb-99
Aug-99
Mar-00
Oct-00
Apr-01
Nov-01
May-02

Path to higher luminosity

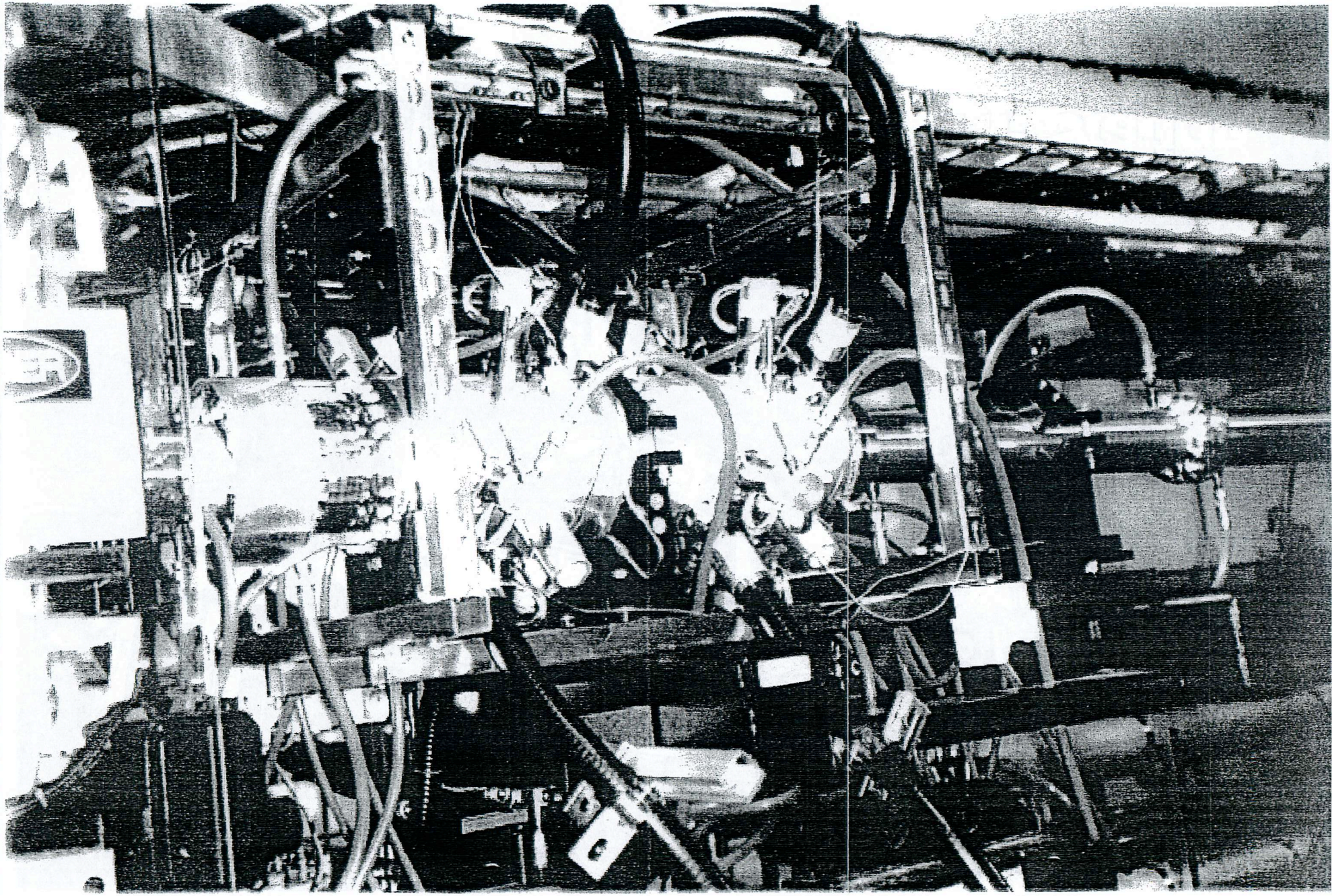
Lumi	4E33	5E33	20E33	
I+	1600	1750	4000	mA
I-	950	1000	1400	mA
Beta y*	1.25	1.05	0.70	cm
Beta x*	50	50	35	cm
Bun. Length	1.3	1.1	0.8	cm
# bunches	728	750	1658	
Vert emit	2-5	2-3	0.8	nm

Present PEP-II Issues

- RF system stability: reduce trips, higher currents
- Feedback kicker heating: Extra cooling, new cooled couplers, new kicker design
- LER Electron Could Instability: New bunch patterns and Arc solenoids or transverse fields
- IR Be vacuum chamber heating: Bunch patterns and air cooling, water cooling in FY2002
- More luminosity: Better specific luminosity (coupling), more bunches, lower beta*s and higher currents



RF Station
12 HR 3



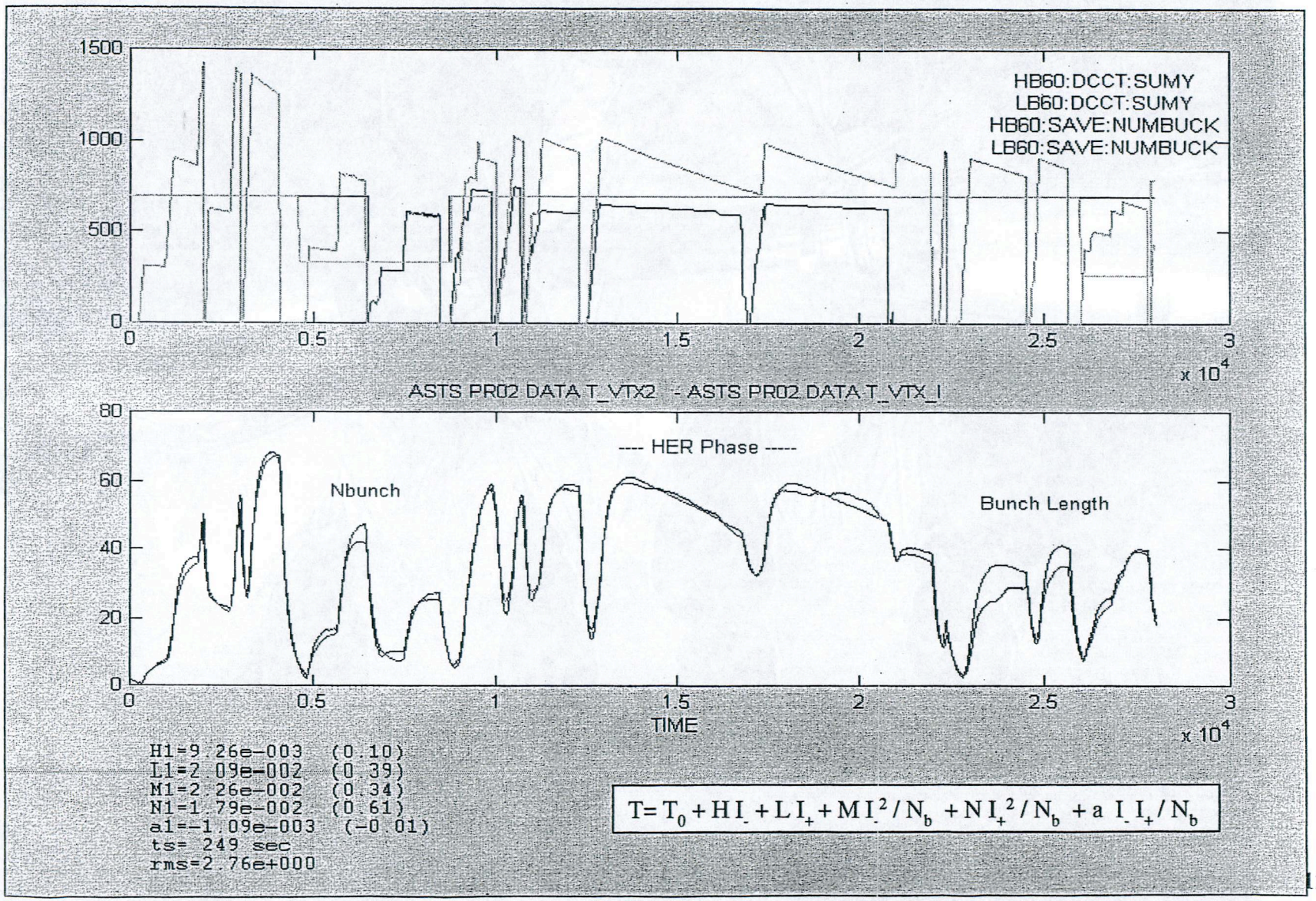
Low Energy Ring Longitudinal Kicker

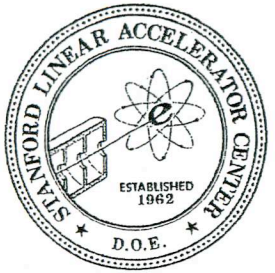
U:\r\rogers\pub\PEP_II\ma_od\ms_108.jpg

MS_108

05/27/98

Machine Development Study



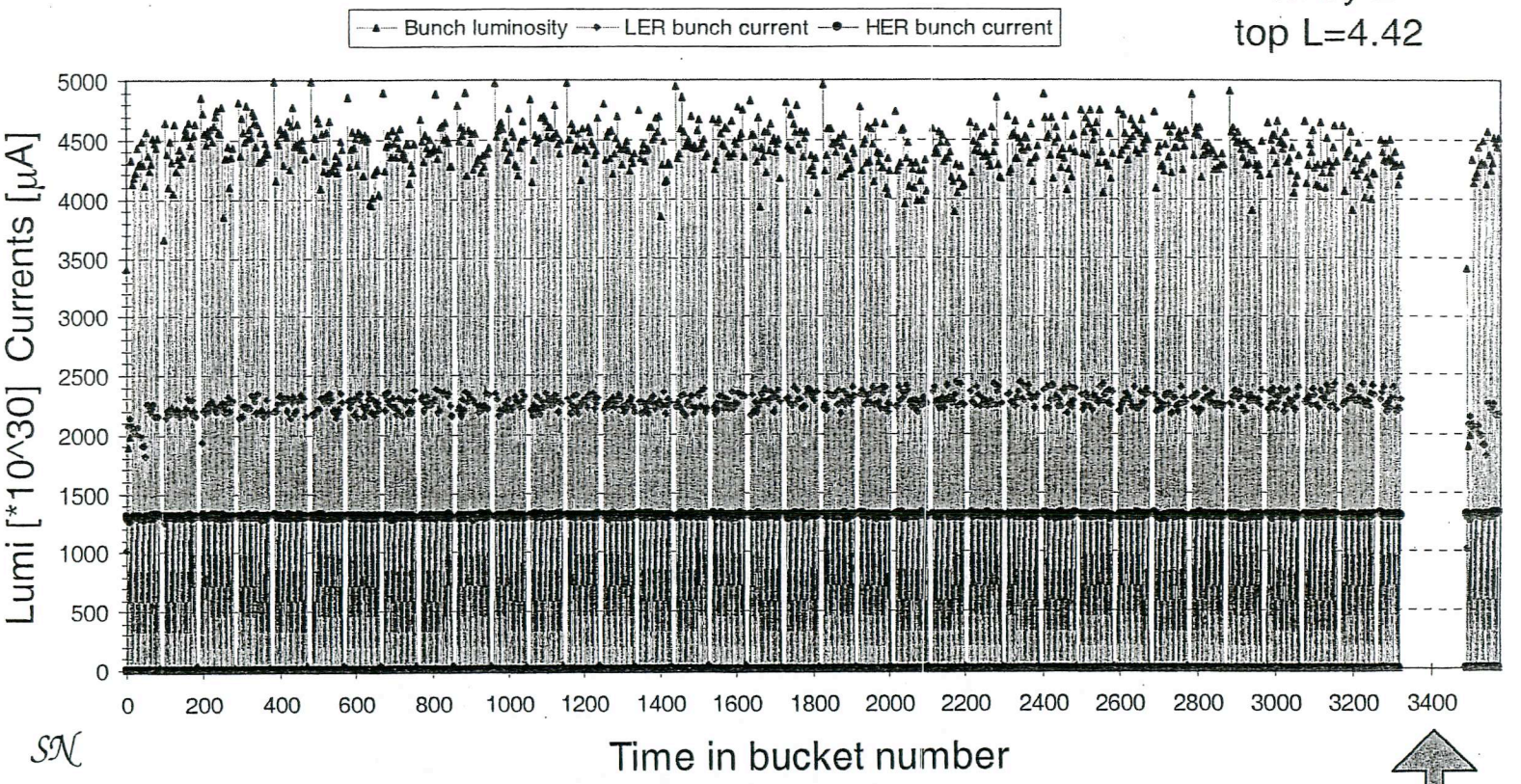


Time Gap for Spectrum Measurement

A. Novokhatski
"Spectrum at IP"

12/12/01 16:00

by 4 trains of 21
off by 2
top L=4.42

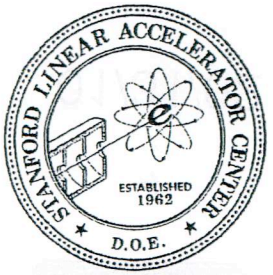


4

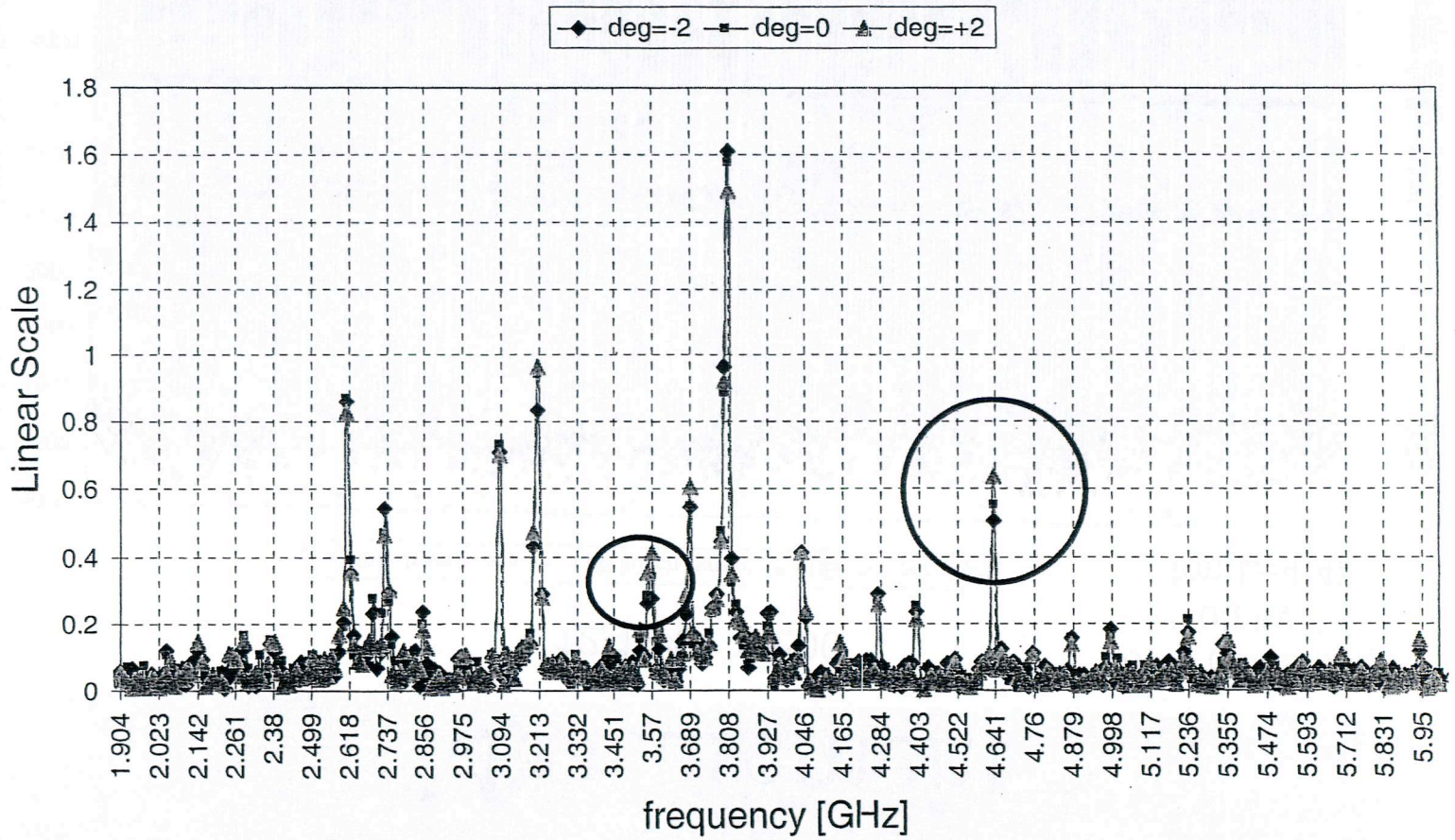
SN

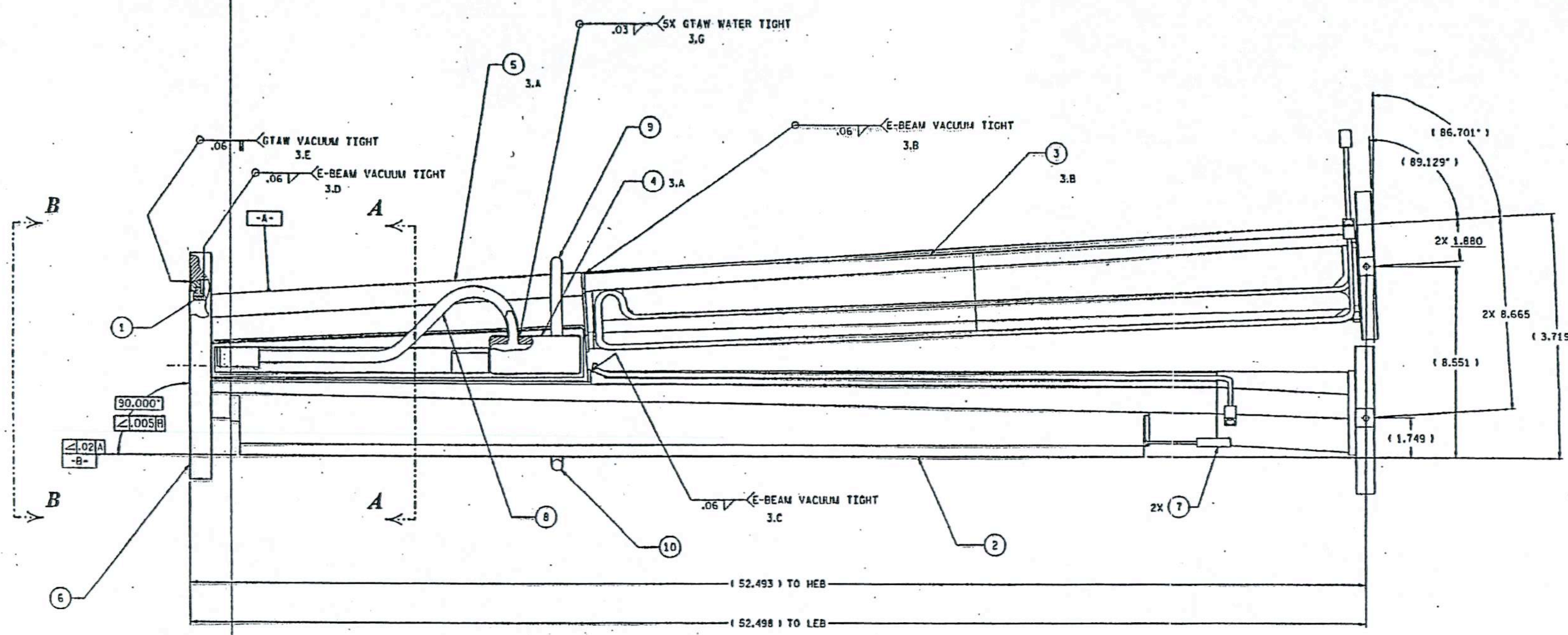
01/31/02

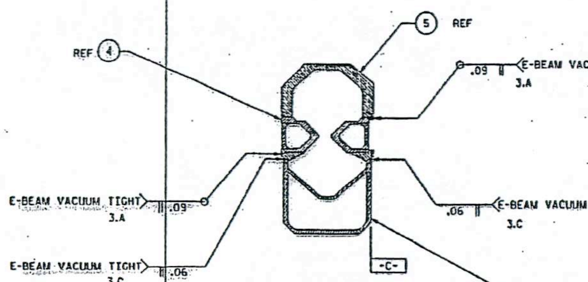
350 ns ion gap



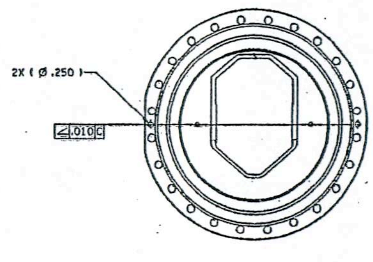
Spectrum of the "gap"



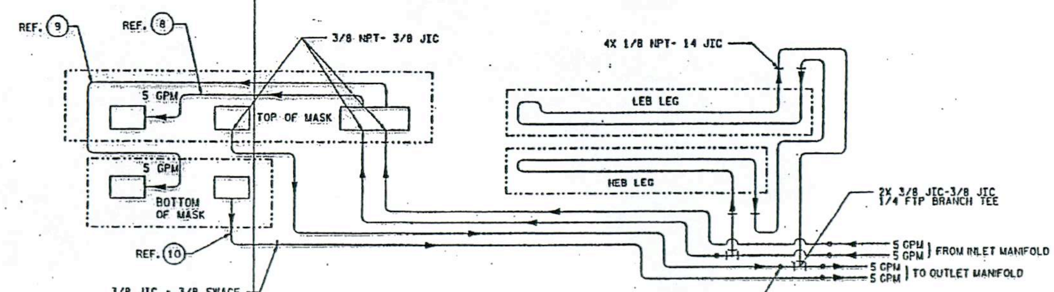




SECTION *A-A*
DETAILS OMITTED FOR CLARITY



VIEW *B-B*
DETAILS OMITTED FOR CLARITY



WATER PLUMBING SCHEMATIC

NOTES:

1 UHV HANDLING: HANDLE UHV-CLEAN PARTS WITH CLEAN POLYETHYLENE AND NYLON GLOVES, IN/ON A CLEAN ROOM AND SURFACE. FOR STORAGE OR SHIPPING, WRAP PARTS IN LINT-FREE TISSUE AND FOOD-GRADE ALUMINUM FOIL; STORE IN CLEAN TOTE BOXES.

2 LEAK TESTING: USE A HELIUM MASS-SPECTROMETER LEAK DETECTOR, CALIBRATED TO 2 X 10 STD CC/SEC. PROBE WITH HELIUM FOR 1 MIN AND REJECT ANY PART WITH A LEAK RATE OF 2 X 10 STD CC/SEC ABOVE BACKGROUND. USE OF SILICONE GREASE IS PROHIBITED.

3 ASSEMBLY SEQUENCE.
FOR ALL WELDS, USE SA 343-452-20 CHAMBER ASSEMBLY FIXTURE.

3.A WELD (ITEM 4), MASK ASSEMBLY INTO (ITEM 5) SEPTUM BLOCK ASSEMBLY.
3.B INSERT (ITEM 3), LEB CHAMBER ASSEMBLY INTO (ITEM 5), SEPTUM BLOCK ASSEMBLY AND WELD.
3.C ALIGN INBOARD EDGE OF (ITEM 2), HEB CHAMBER ASSEMBLY WITH INBOARD EDGE OF (ITEM 5), SEPTUM BLOCK ASSEMBLY, CHECKING FIT IN CROTCH AREA AND WELD.
3.D WELD (ITEM 1), INBOARD TRANSITION TO (ITEMS 2), HEB CHAMBER ASSEMBLY, AND (5), SEPTUM BLOCK ASSEMBLY.
3.E WELD (ITEM 6) INBOARD FLANGE TO (ITEM 1), INBOARD TRANSITION ASSEMBLY.
3.F VACUUM LEAK CHECK ASSEMBLY PER NOTE 2.
3.G WELD (ITEMS 8,9 AND 10) TUBES TO (ITEM 4), MASK ASSEMBLY.
3.H VACUUM LEAK CHECK TUBE WELDS PER NOTE 2.
3.J PRESSURE TEST TUBES TO 300 PSI, WATER AND HOLD FOR 15 MINUTES.
3.K FLOW TEST WATER CIRCUITS ON MASK; PLUMB PER SCHEMATIC. THEN FLOW 10 GPM (5 GPM / INLET LINE), RECORD PRESSURE DROP.

PEP-II VACUUM
UHV PART
SEE NOTES

ITEM NO	PREF	BASE	SUFF	TITLE OR DESCRIPTION	QTY
10	PF	343-450	55	MASK WATER TUBE #3	1
9	PF	343-450	54	MASK WATER TUBE #2	1
8	PF	343-450	53	MASK WATER TUBE #1	1
7		BXX09839:1.5T		AERDROD HTR, 63W/IN^2 HI-TEMP	2
6	PF	343-450	05	INBOARD FLANGE MACHINING	1
5	SA	343-450	59	FORWARD SEPTUM BLOCK ASSY	1
4	SA	343-450	32	FORWARD MASK ASSEMBLY	1
3	SA	343-450	40	FORWARD LEB CHAMBER ASSY	1
2	SA	343-450	10	HEB CHAMBER ASSEMBLY	1
1	SA	343-450	06	INBOARD TRANSITION ASSEMBLY	1
REF	AD	343-450	03	SOLID MODEL OF PART	-

STOCK OR PART NO

NEXT ASSEMBLIES

SCALE: 1:2
DO NOT SCALE DRAWING
CAD FILE NAME: ad34345003.e0

STANFORD LINEAR ACCELERATOR CENTER
STANFORD UNIVERSITY STANFORD, CALIFORNIA

S. METCALFE
S. METCALFE
N. STILES

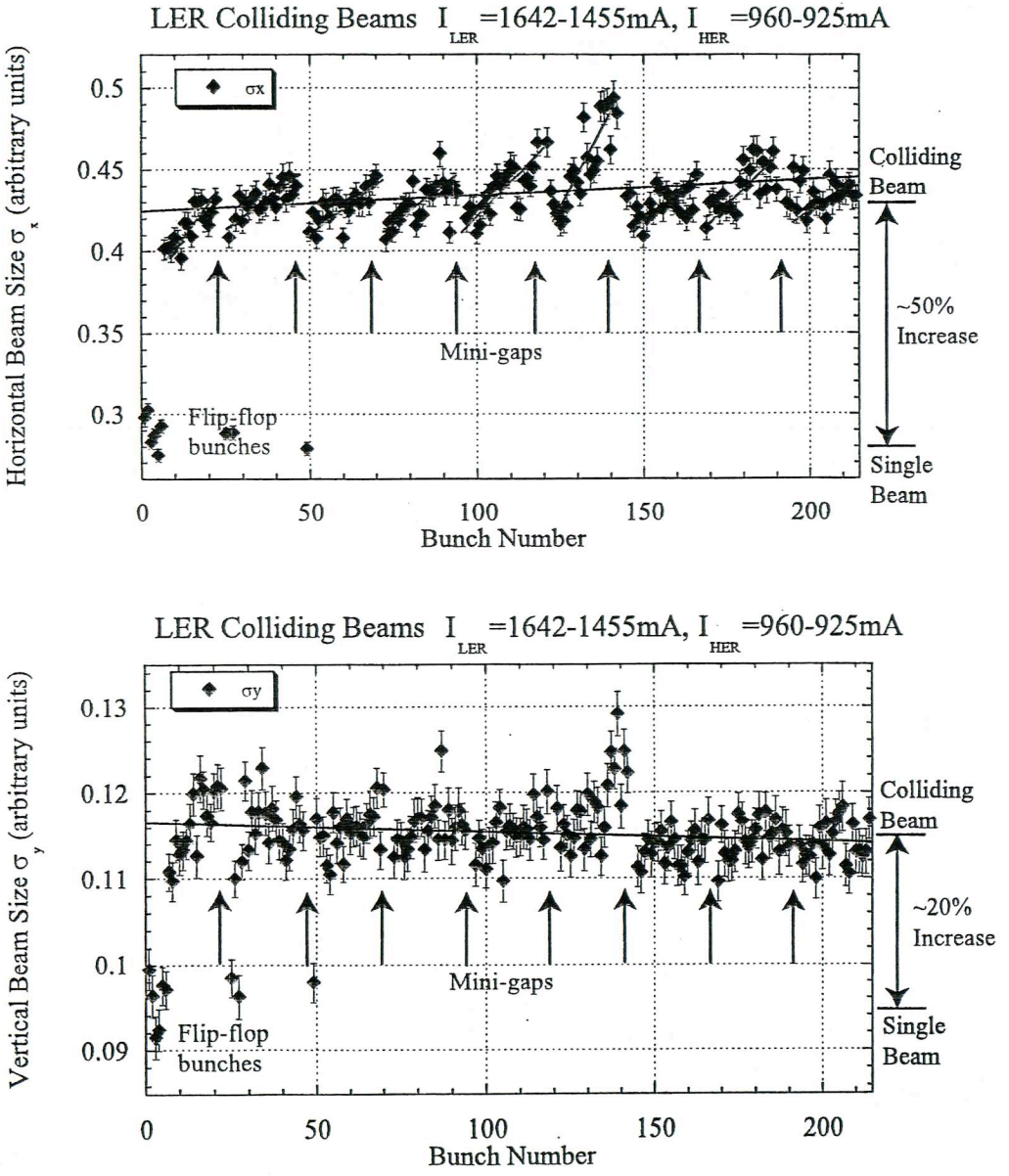
PEP II 02 C-CHMBR
NEW FORWARD CHAMBER
ASSEMBLY

AD-343-450-03 E0 | E

SH 1 OF 1

REV | DESCRIPTION

Colliding Beam Measurements

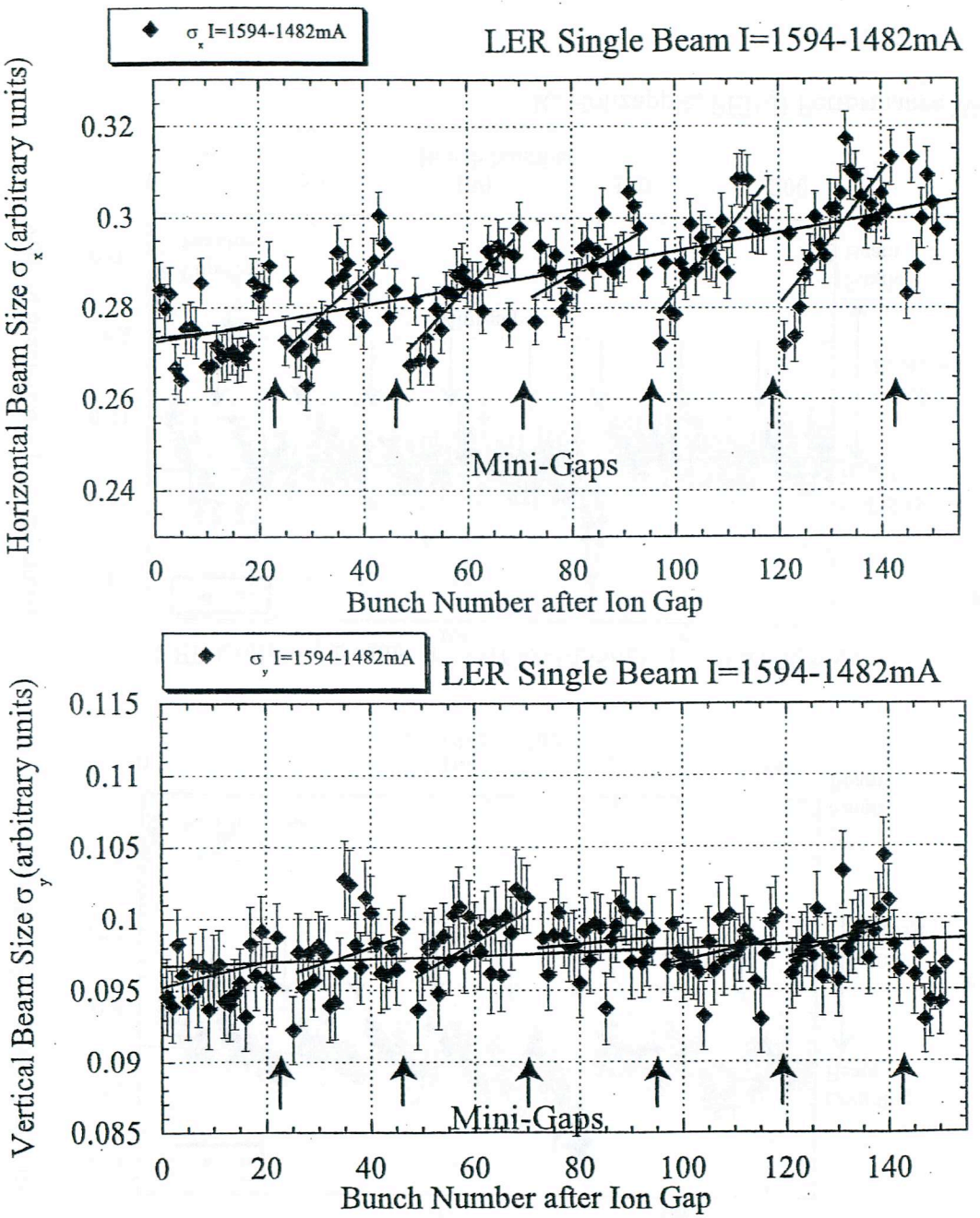


σ_x, σ_y during collisions:

- 4 by 22 pattern with $I_{bLer/Her}$=2.0/1.25mA
- Two components of beam size growth:

  1) Beam-beam (~50% compared to single bunch)

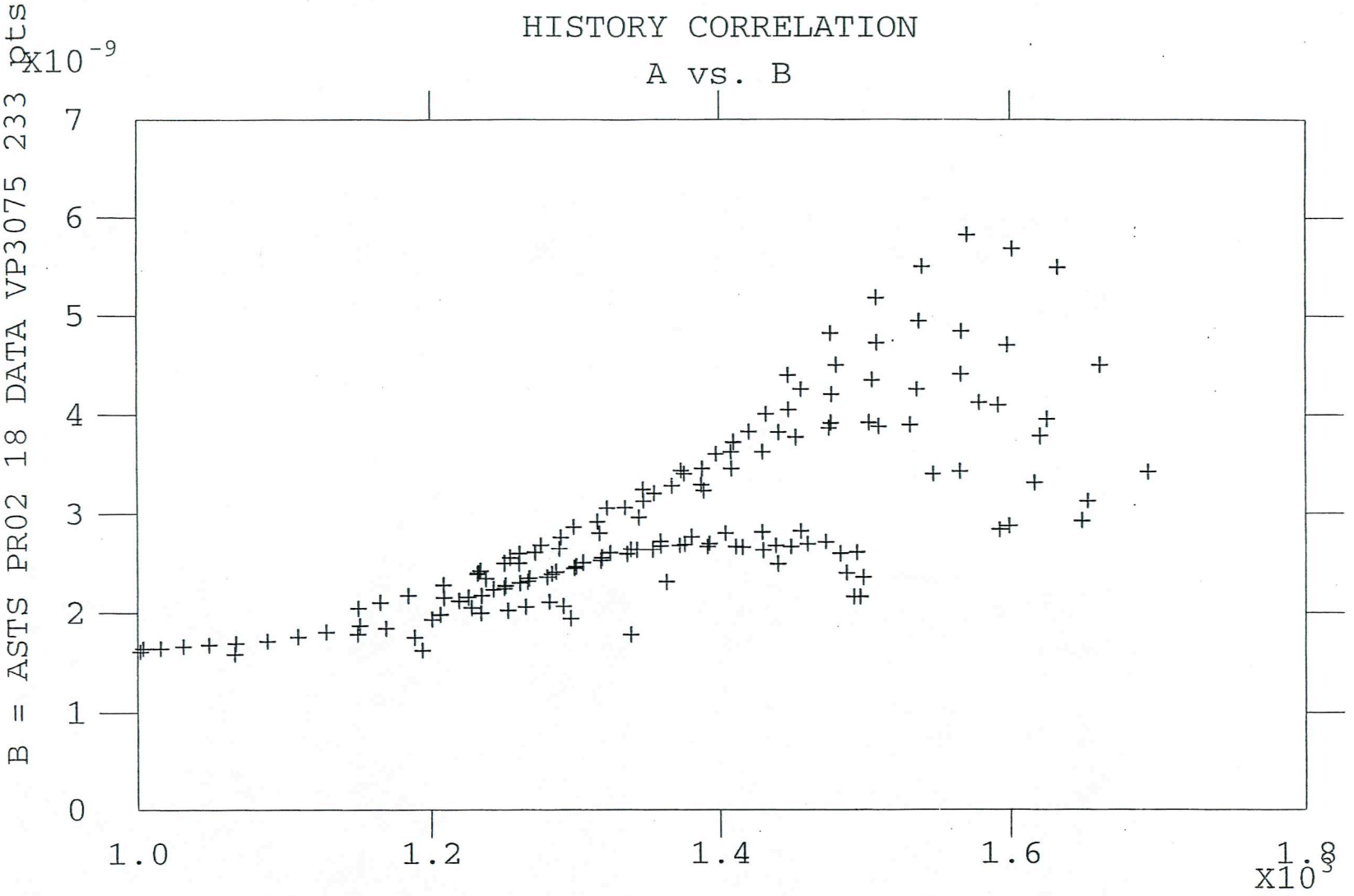
  2) Electron cloud (growth within the train).
- Luminosity drop-out for the early bunches in the first few trains.



High I Measurement

Single beam size growth at high current?

- Single Beam at high current I_{bunch}~2.0mA (4 by 22 pattern).
- Electron cloud beam size growth is evident in the horizontal plane (long range and within each train).
- Slight evidence of growth in the vertical plane-manly within each train.
- Electron cloud decays quickly!

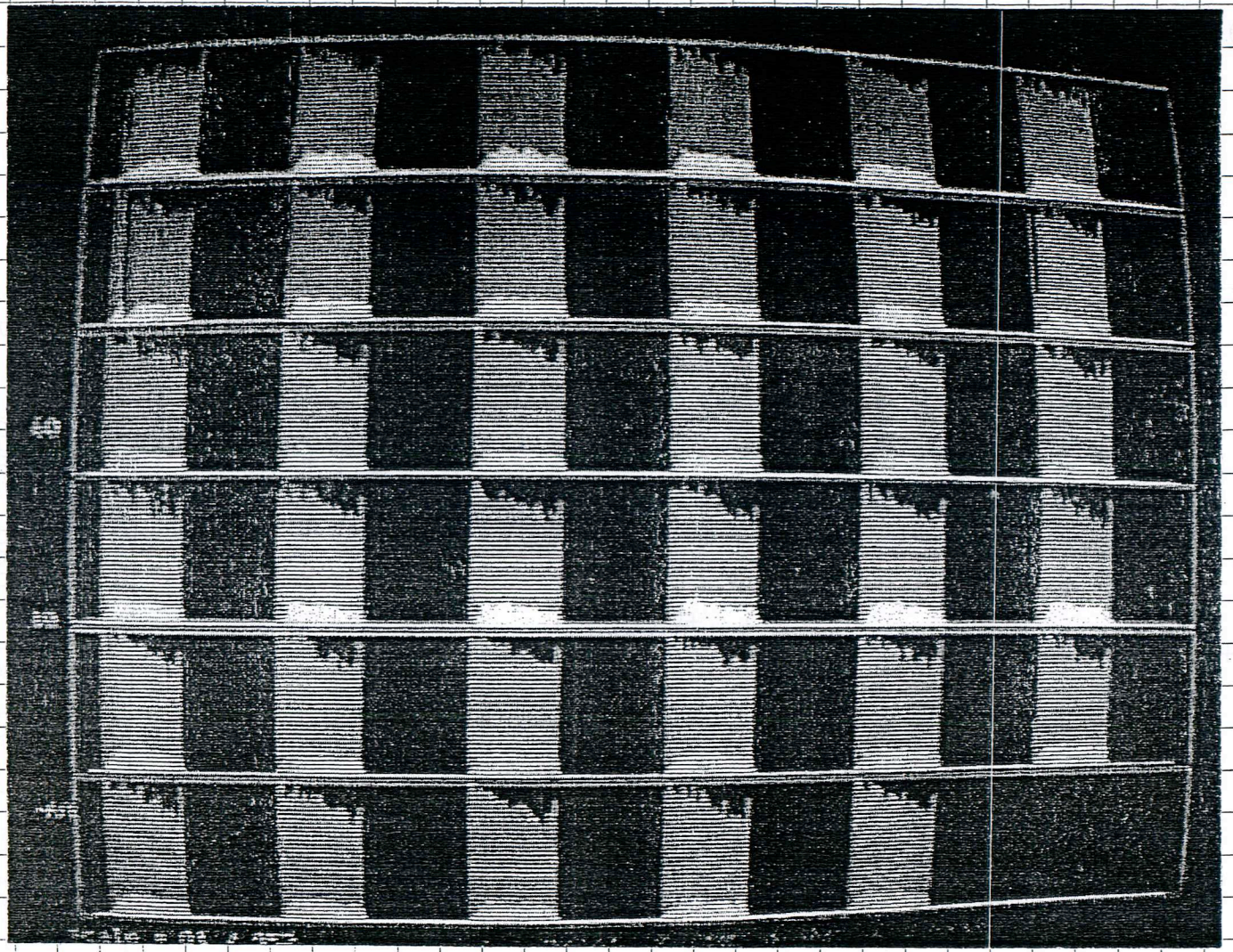


A = LB60:DCCT:SUMY 470 pts

Linear corr. coeff. (r) = .8214571
2-sided signf. of r = 0.000000
Time Range: 6-FEB-2002 07:58:15. - 7-FEB-2002 07:58:15.

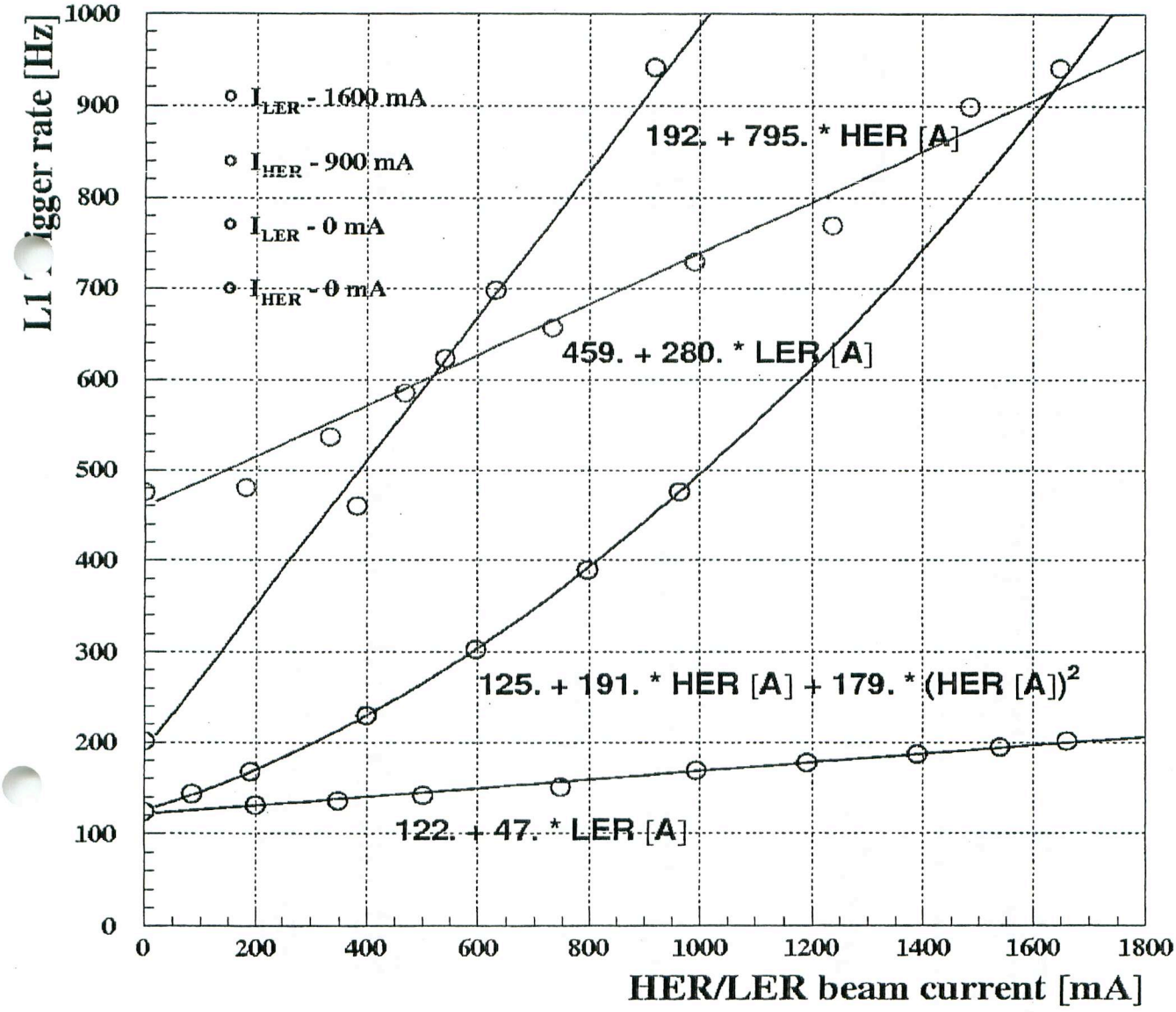
7-FEB-02 07:58:15

2220 1300 × 800 trying to jump resonances with tunes.



Luminosity for by 2 pulse (2 by 22). Notice the last bunch (and 1st bunch) in each train is higher in luminosity due to the lack of

Background Study, 10-Feb-2002



PEP-II Schedule

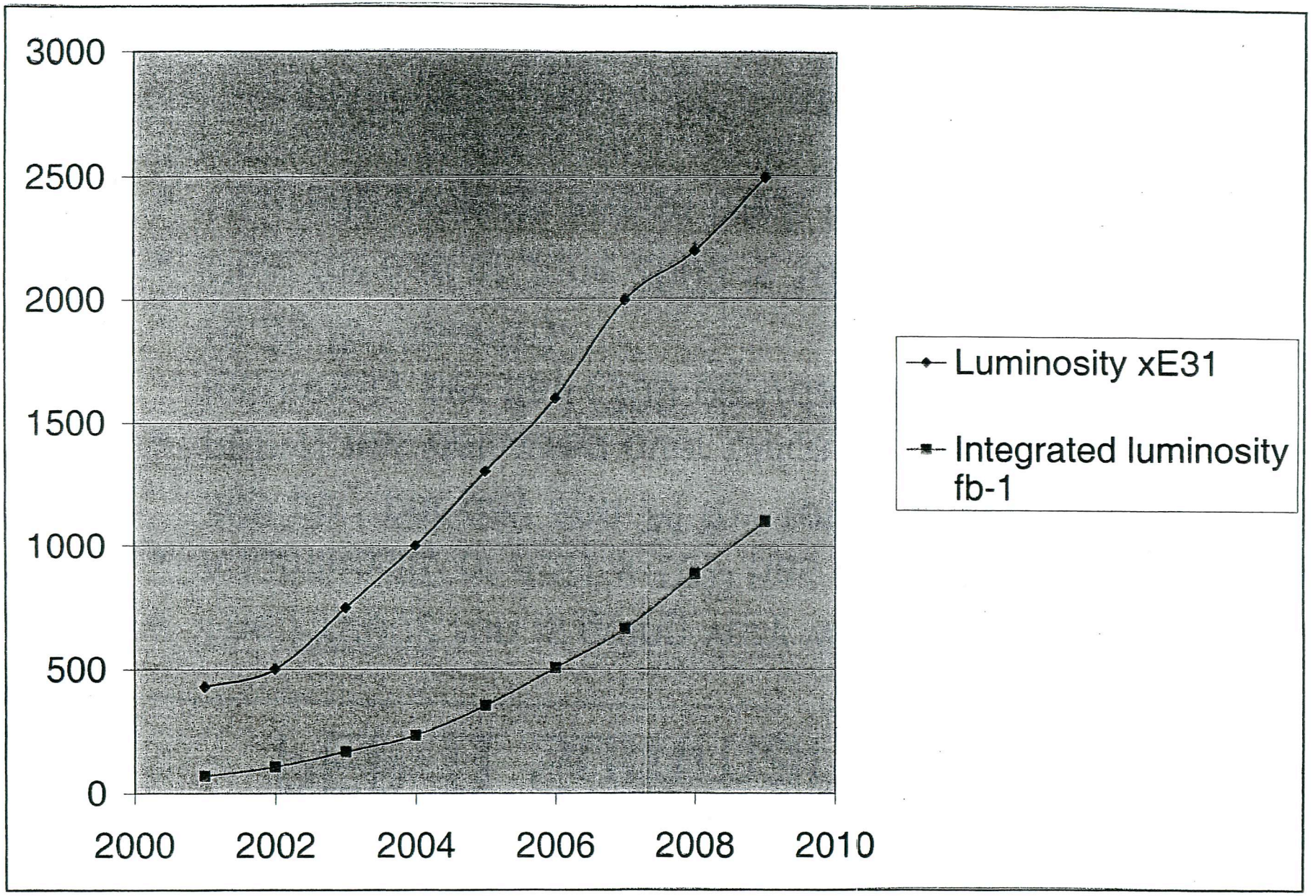
Accelerator:	PEP-II
Winter shut down	Dec 23
Winter turn on	Jan 11
Summer shut down	July 1
Fall turn on	Nov 1

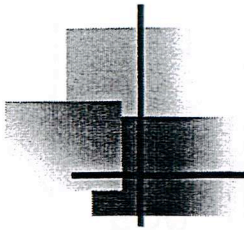
PEP-II Summer Projects

- Two new HER RF stations (+ 400 mA)
- New Q2 chamber and bellows in IR2 (currents x 1.5)
- New HER collimator (30 m upstream)
- Longitudinal feedback kickers feedthrus (heating)
- Transverse feedback kickers feedthrus (heating)
- New IR2 vacuum valve RF seals (heating)
- New abort kickers HER/LER (shorter gap, ΔRF phase)
- New low level RF feedback circuits (higher I)
- More shielding near IR2 upstream LER (BaBar IFR)
- x-y BPMs at HER/LER sextupoles (emittance control)
- Stronger LER injection bump dipoles

PEP-II Near Term Plans

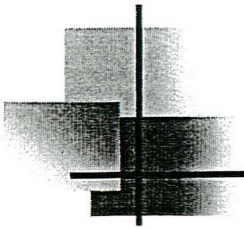
- Present run starts January 11, 2002.
- Present run will end July 1, 2002.
- Luminosity goal by June 2001
- is 5×10^{33}
- Total integrated luminosity of 100 pb-1 in June 2002 (30 pb^{-1} to go or 5 pb^{-1} / month)
- Followed by a four month down.
  - Two HER RF stations, New Q2 chamber
  - New kicker feedthrus, HER upstream collimator


3000
2500
2000
1500
1000
500
0
2000
2002
2004
2006
2008
2010
Luminosity xE31
Integrated luminosity fb-1



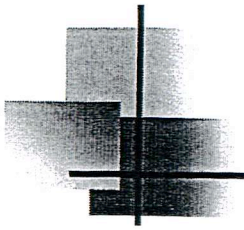
PEP-II Summary

- The FY2002 run is going very well, as you know.
- A luminosity of 4.51×10^{33} has been achieved with 309 pb^{-1} per day and 74 fb^{-1} total delivered so far.
- PEP-II has delivered over twice the design integrated luminosity per day (309 pb^{-1}/day) and per month (6.35 fb^{-1}/month).
- Goal for end of June 2002 is 100 fb^{-1}.
- Upgrade projects are on track for Summer 2002



Super-B- Factory

- A small group of PEP-II accelerator physicists are working on the design of a Super-B-Factory SBF with a luminosity approaching 10^{36}.
- There was a workshop on PEP-II performance on January 30-31 and a SBF on February 1, 2002.
- The goal is to have the next round parameter set in spring 2002.
- This effort is not to interfere with PEP-II performance.



Issues for a Super B-Factory

- Choice of beam energy
- How to make the luminosity
- High beam currents
- Beam lifetimes
- Injection
- Interaction region
- Vacuum system

How to get the Luminosity?

- $\mathcal{L} = 2.17 \times 10^{34} (1+r) \xi_y E I / \beta_y$

E =	3.0	3.0	3.0	GeV
I =	3	10	25.	A
β_y =	8	4	1.5	mm
ξ_y =	0.05	0.07	0.11	
r =	0.02	0.02	0.02	
$\mathcal{L}$ =	10^{34}	10^{35}	10^{36}	/cm^{-2}/s

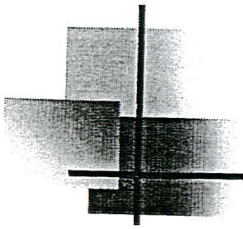
New technologies

- Short beam lifetimes: inject continuously
- Small β^*_y: reduced dynamic aperture (ok)
- High beam current: Massive RF systems (costly)
- Flangeless vacuum system: low impedance, reliable
- Low α lattice for short bunch lengths
- Larger energy asymmetry: IR separation and particle physics
- IP crossing angle: many bunches (3000 to 7000)
- e^+ is high energy beam: Cures electron cloud issues

PEP-II Luminosity with SBF IR Layout			J. Seeman	24-Jan-02
Parameter	Units	RF = 476 MHz	RF = 476 MHz	RF = 476 MHz
		1.00E+34	1.00E+35	10**36 SBF
E+	GeV	3.1	3.1	3.1
E-	GeV	9	9	9
Beta x +	cm	50	30	15
Beta y +	cm	0.8	0.4	0.15
Emit x +	nm	40	50	75
Emit y +	nm	0.7	0.63	0.75
Bunch length	cm	0.8	0.4	0.18
Beta x -	cm	50	30	15
Beta y -	cm	0.8	0.4	0.15
Emit x -	nm	40	50	75
Emit y -	nm	0.7	0.63	0.75
Bunch length	cm	0.8	0.4	0.18
Num Bunch		1700	3400	3400
I+	mA	3000	10000	24500
I-	mA	1033	3444	8439
N+		8.11E+10	1.35E+11	3.31E+11
N-		2.79E+10	4.66E+10	1.14E+11
Sig x +	microns	141.4	122.5	106.1
Sig y +	microns	2.4	1.6	1.1
Sig x -	microns	141.4	122.5	106.1
Sig y -	microns	2.4	1.6	1.1
r0	cm	2.83E-13	2.83E-13	2.83E-13
fc	Hz	1.36E+05	1.36E+05	1.36E+05
Cap Sig X	microns	200.0	173.2	150.0
Cap Sig Y	microns	3.3	2.2	1.5
Uy (~betay/sigz)		1.00	1.00	0.83
R (hourglass factor)		0.850	0.850	0.830
Lum calc	/cm2/s	1.06E+34	1.01E+35	1.03E+36
Lum spec calc	/cm2/s/l2	5.81E+30	9.99E+30	1.69E+31
Tune shift x+		0.0510	0.0683	0.1119
Tune shift y +		0.0488	0.0702	0.1119
Tune shift x-		0.0510	0.0683	0.1119
Tune shift y -		0.0488	0.0702	0.1119

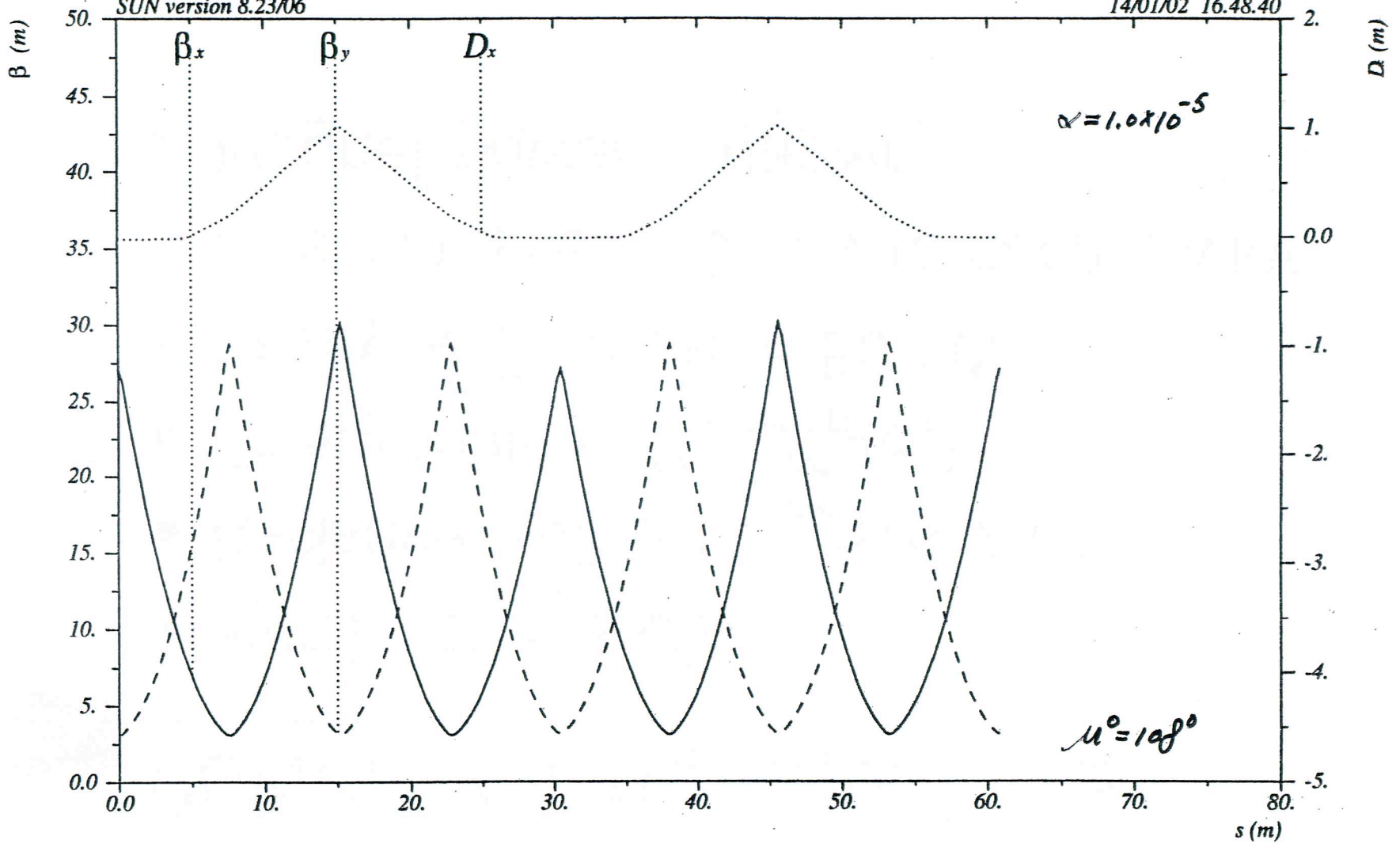
Initial Parameters for 1E36 (using PEP-II Tunnel)

Beam particle	e+		e-
Beam energy(GeV)	9.0		3.1
Circumference (m)		2200	
Number of bunches		3400	
Bunch length (mm)		1.8	
Beam lifetime (min)	5		5
Beam current (A)	8.4		24.5
Beta * (x/y) (mm)		15/1.5	
IP beam sizes (microns x/y)		106/1.1	
Beam-beam tune shifts		0.11	
RF Frequency		476 MHz	
Luminosity (/cm^2/s)		10^{36}	



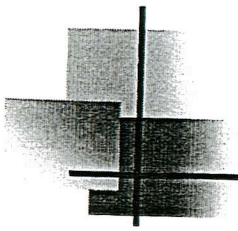
Power Scaling Equations

- Synch rad ~ $I\ E^4/\rho$
- Resistive wall ~ $I^2_{total}/r_1/f_{rf}/\sigma_z^{3/2}$
- Cavity HOM ~ $I^2_{total}/f_{rf}/\sigma_z^{1/2}$
- Cavity wall power = 50 kW
- Klystron gives 0.5 MW to each cavity
- Magnet power ~ gap~r_1



$\delta_E / p_0 c = 0.$

Table name = TWISS



Conclusions

- The accelerator for a 10^{36} e^+e^- collider has definite possibilities.
- The detector will need a very different design than BaBar, BELLE, or CLEO.
- The particle physics case for this accelerator is being developed to fully compete with LHCb and *B* TeV.