

# **PEP-II Status and Plans**

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***for the PEP-II Team***

***DOE High Energy Physics Program Review***

***June 2-4, 2004***

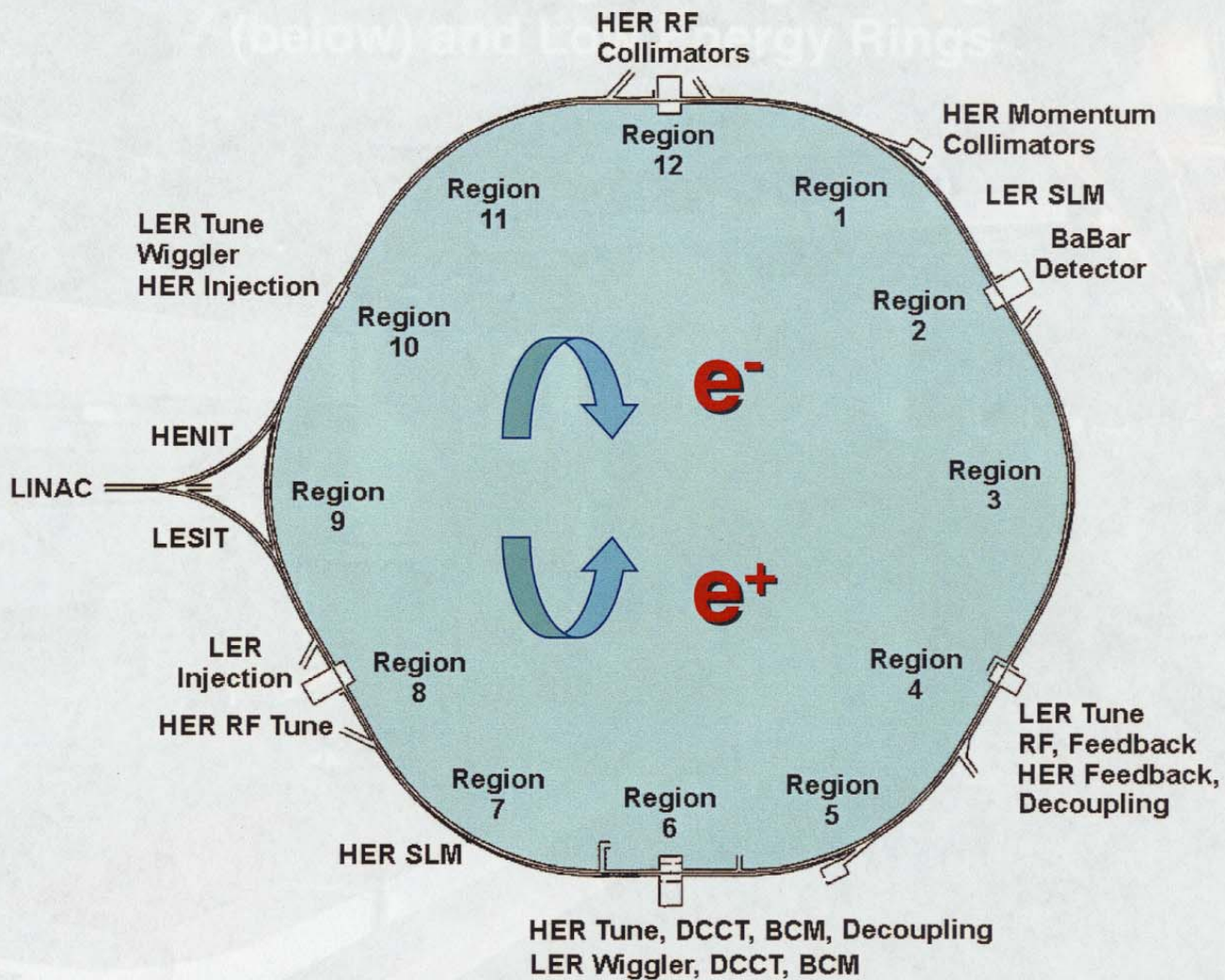
# Outline

- **Improvements over the last year**
- **Present Status**
- **Plans for the present run (Run 4)**
- **Plans for summer 2004**
- **Luminosity improvements and upgrade plans**

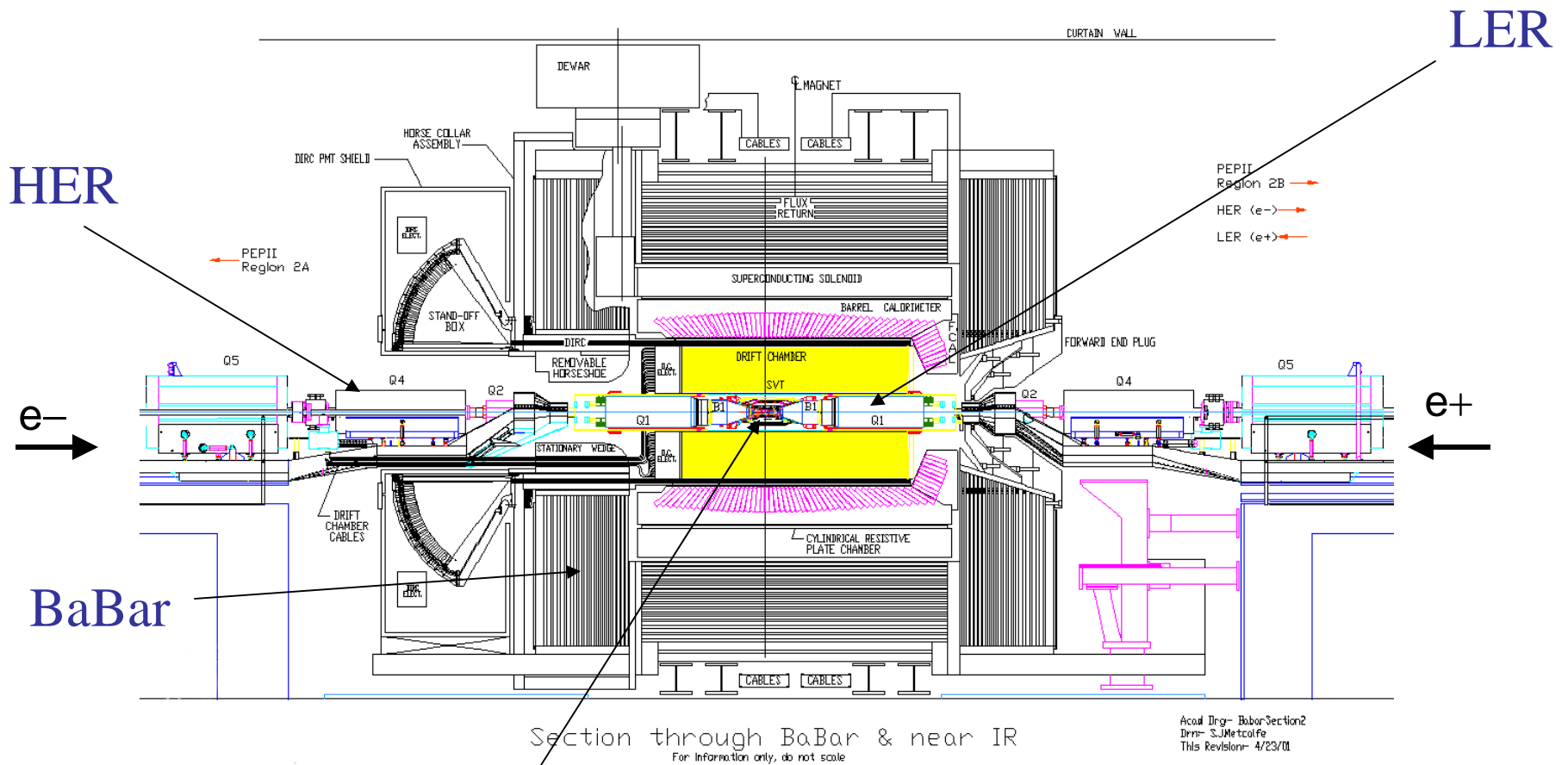
## The PEP-II $e^+e^-$ asymmetric collider



# PEP-II ring layout



# PEP-II Interaction Region and the BaBar Detector



Collision point

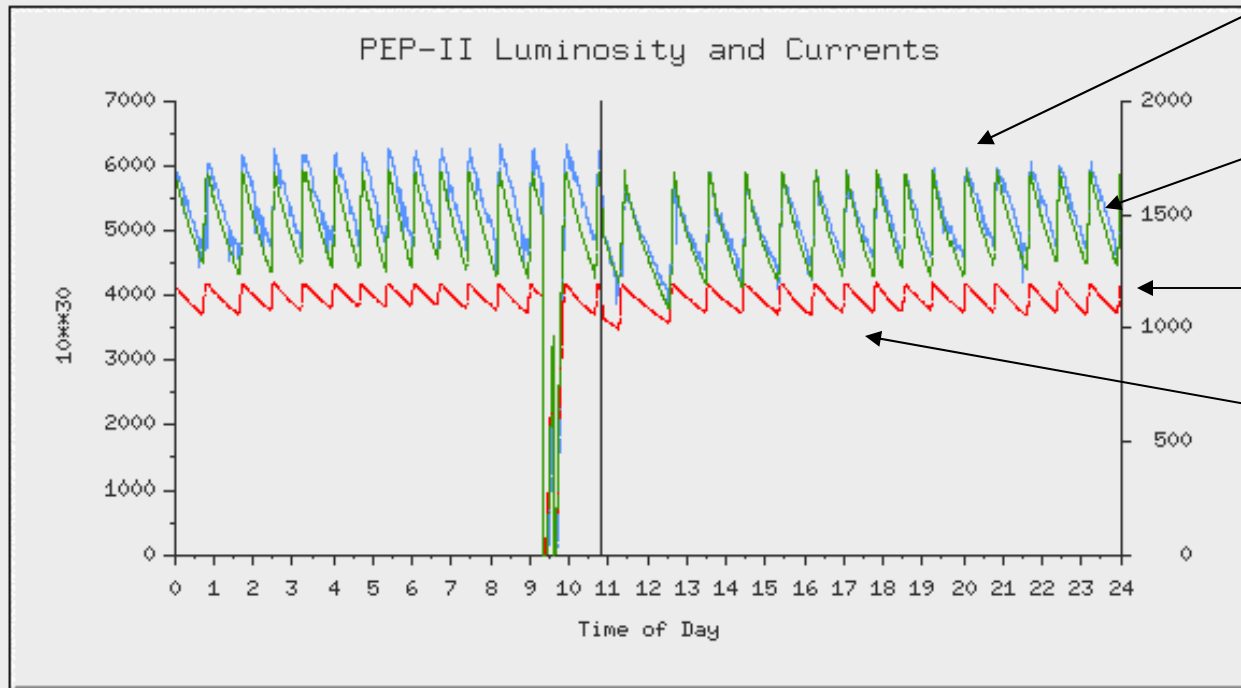
# Improvements last year

- **Status last June**
  - Peak luminosity:  $6.6 \times 10^{33}$
  - Number of bunches: 1034 (by3 pattern)
  - $I^+$  current 1550 mA (3 RF stations)
  - $I^-$  current 1175 mA (7 RF stations)
  - Fill and coast both beams
  - $\beta_y^*$  of 12 mm
- **Status now:**
  - Peak luminosity:  $9.2 \times 10^{33}$
  - Number of bunches: 1588 bunches in the by2 (24 long trains)
  - Parasitic collision effects seen (<5%), ECI effects small (<2%)
  - $I^+$  current 2450 mA (3 RF stations)
  - $I^-$  current 1550 mA (8 RF stations)
  - All data now taken in trickle charge mode (both beams)
  - $\beta_y^*$  of 10.5 mm

# “Typical” running day in November 2003 at PEP-II Before Continuous Injection

I HER	I LER	Luminosity	Spec Lum	E HER	E LER	E CM
1157.25	1627.11	6088	3.98	8927	3118	10552
mA	mA	10**30/Sec	N*10**30 / mA**2/Sec	MeV	MeV	MeV
HER N Buckets / Pattern			LER N Buckets / Pattern			
1230 by2_t13_her_no_fb			1230 by2_t13_ler_no_fb			
Last Owl/Day/Swing/24hr		141.1	110.3	133.6	384.9	Shift: 40.52 /pb
Peak Luminosities		6326	6034	6137		6386

Luminosity is over twice design at  $6.78 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$



LER current is about 1750 mA

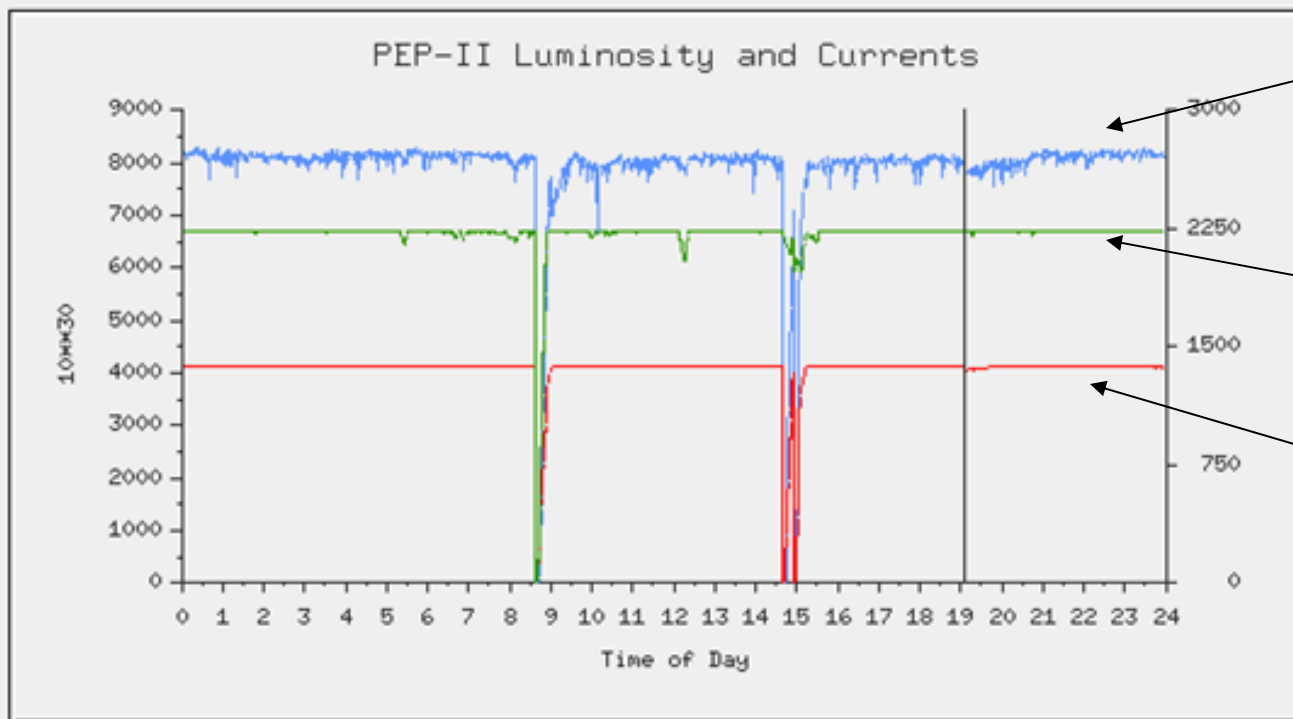
HER current is about 1200 mA

Fill and coast every 50 minutes

11/28/2003 10:50:19

# Continuous Injection (Trickle Charge) Both Beams

I HER	I LER	Luminosity	Spec Lum	E HER	E LER	E CM
1380.18	2230.68	8007	4.05	8992	3119	10592
mA	mA	10**30/Sec	N*10**30 / mA**2/Sec	MeV	MeV	MeV
HER N Buckets / Pattern			LER N Buckets / Pattern			
1556	by2_t33_her_midp	1	1554	by2_t33_ler_midp		11
Last Owl/Day/Swing/24hr		233.8	210.1	194.6	638.5	Shift: 89.40 /pb
Peak Luminosities		8339	8258	8316		8216



Luminosity

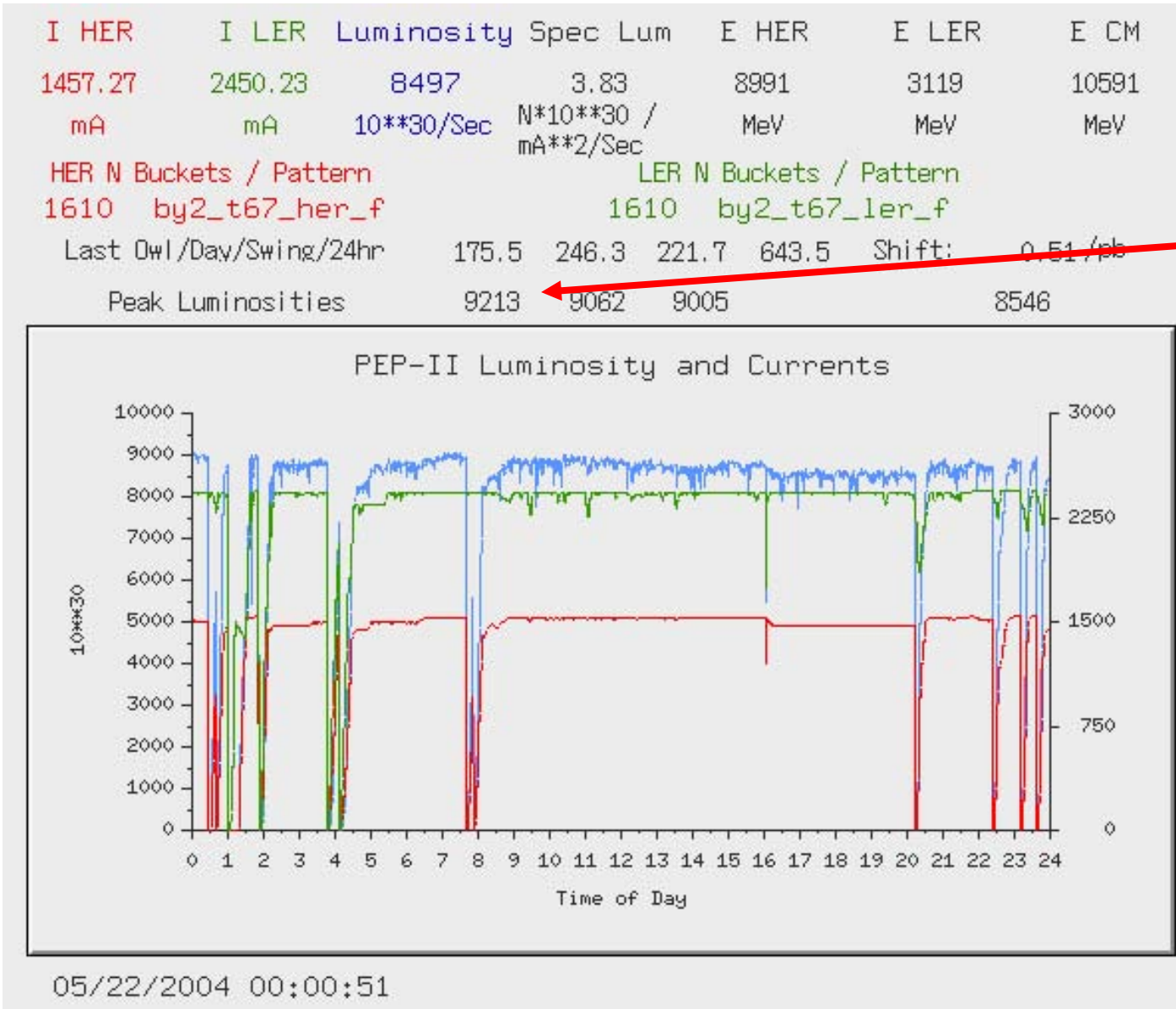
LER I+

HER I-

04/06/2004 19:05:21



# Peak luminosity of $9.21 \times 10^{33}$

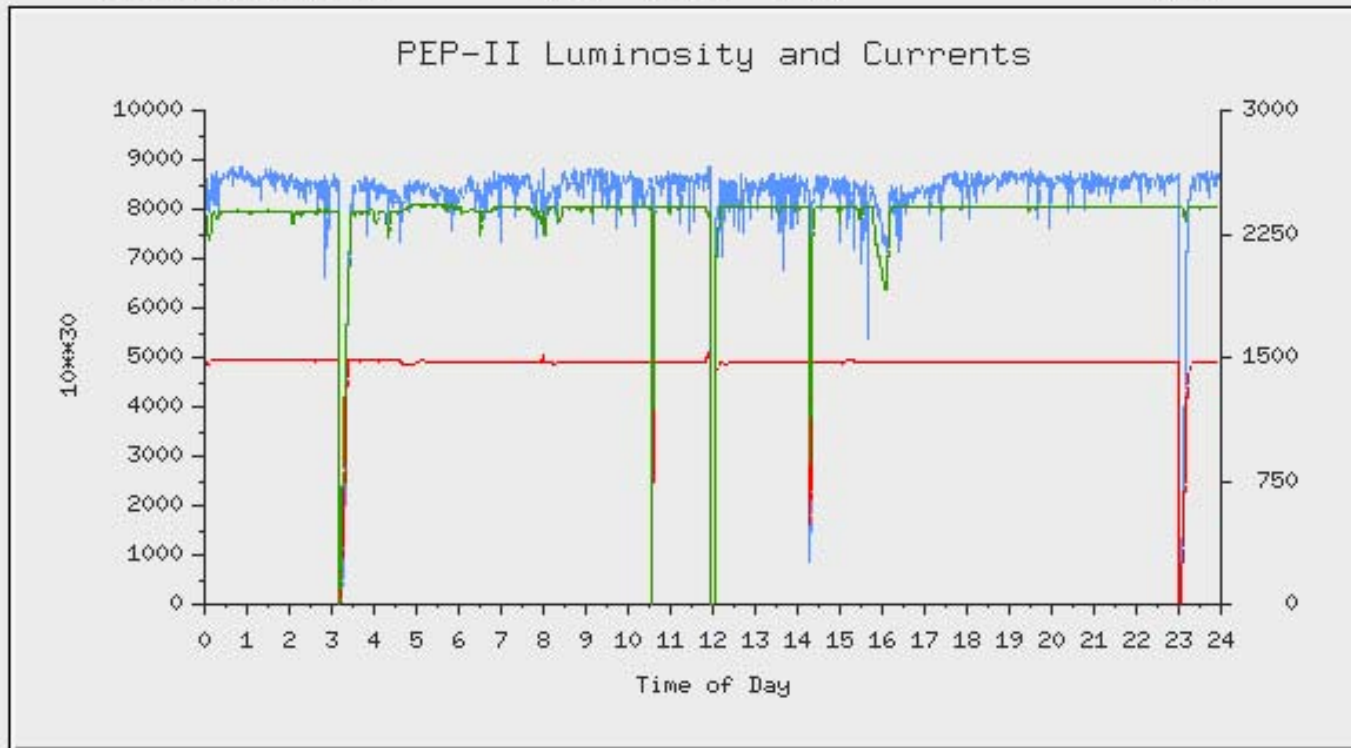


**Record  
Peak  
Luminosity**

# Daily Integration Record

I HER	I LER	Luminosity	Spec Lum	E HER	E LER	E CM
1478.62	2419.39	8726	3.87	8991	3119	10591
mA	mA	10**30/Sec	N*10**30 / mA**2/Sec	MeV	MeV	MeV
HER N Buckets / Pattern			LER N Buckets / Pattern			
1588 by2_t66_her_f			1588 by2_t66_ler_f			
Last Owl/Day/Swing/24hr		235.5	233.6	238.1	707.2	Shift: 0.52 /pb
Peak Luminosities		8940	8911	8878	8839	

710/pb



05/25/2004 00:00:57

# PEP-II Records

Last update:  
June 1, 2004

## Peak Luminosity

**$9.213 \times 10^{33}$**  cm<sup>-2</sup>sec<sup>-1</sup>

1588 bunches    2450 mA LER    1550 mA HER

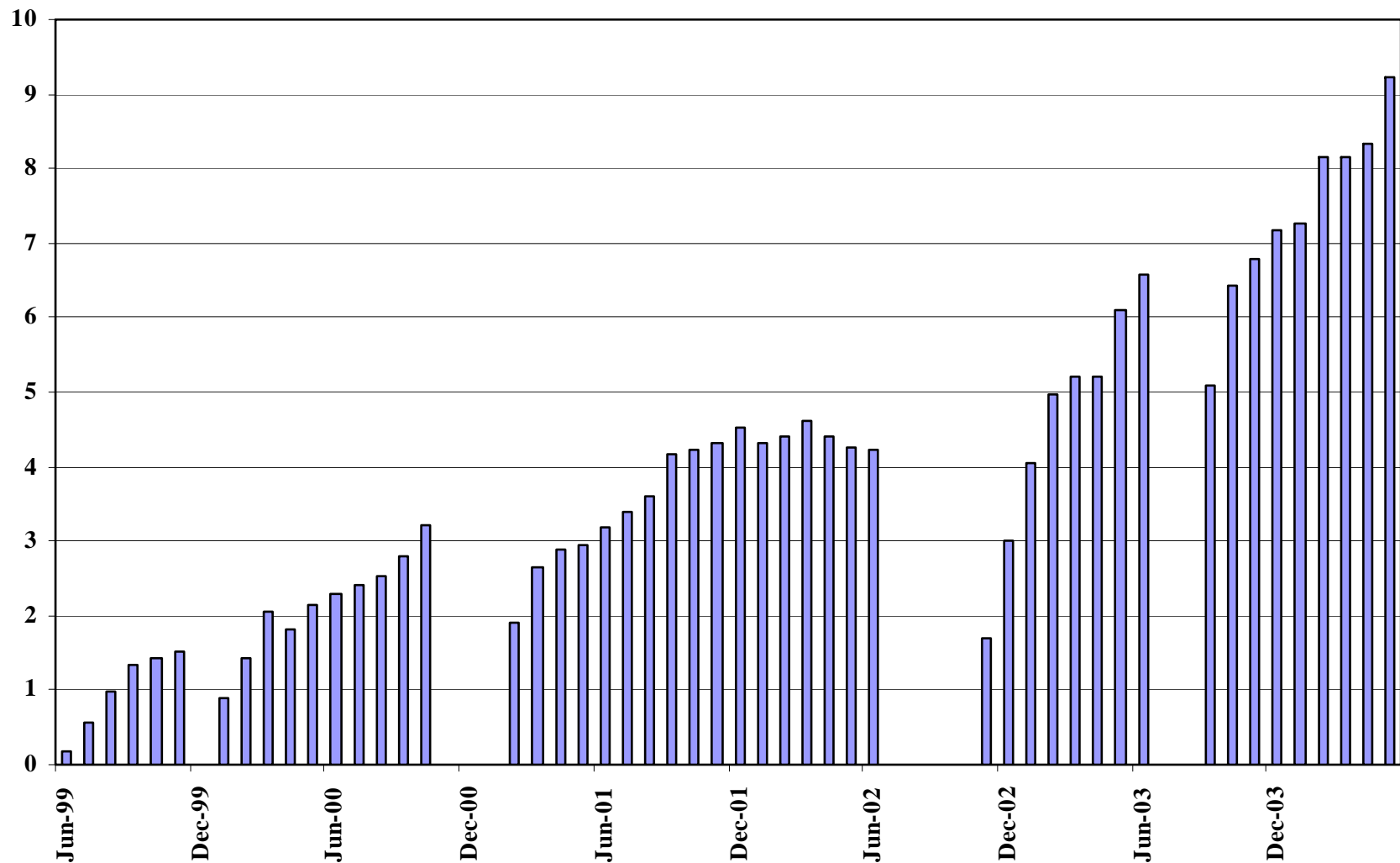
**May 21, 2004**

## Integration records of delivered luminosity

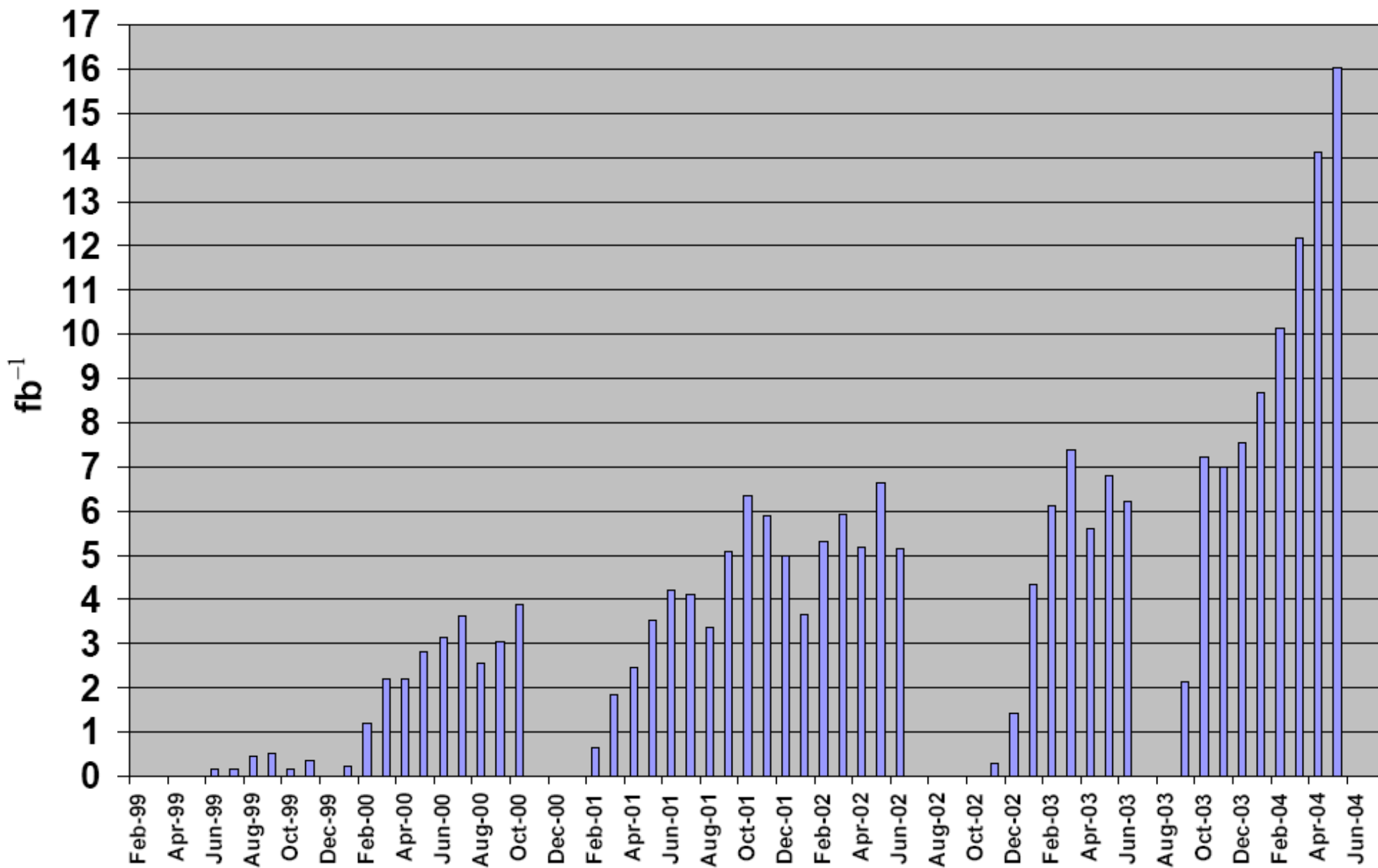
<b>Best shift</b> (8 hrs, 0:00, 08:00, 16:00)	<b>246.3</b> pb <sup>-1</sup>	<b>May 21, 2004</b>
<b>Best 3 shifts in a row</b>	<b>710.5</b> pb <sup>-1</sup>	<b>May 24, 2004</b>
<b>Best day</b>	<b>710.5</b> pb <sup>-1</sup>	<b>May 24, 2004</b>
<b>Best 7 days</b> (0:00 to 0:00)	<b>4.258</b> fb <sup>-1</sup>	<b>May 14-May 20, 2004</b>
<b>Best week</b> (Sun 0:00 to Sat 24:00)	<b>4.194</b> fb <sup>-1</sup>	<b>May 16-May 22, 2004</b>
<b>Peak Ave Lum</b>	<b><math>8.705 \times 10^{33}</math></b>	<b>May 14, 2004</b>
<b>Best 30 days</b>	<b>16.045</b> fb <sup>-1</sup>	<b>Apr 28 – May 27, 2004</b>
<b>Best month</b>	<b>16.019</b> fb <sup>-1</sup>	<b>May 2004</b>
<b>Total delivered</b>	<b>225</b> fb <sup>-1</sup>	

<http://www.slac.stanford.edu/grp/ad/pep-ii/stats/stats.html>

## Peak PEP-II Luminosity (x1E33) per Month

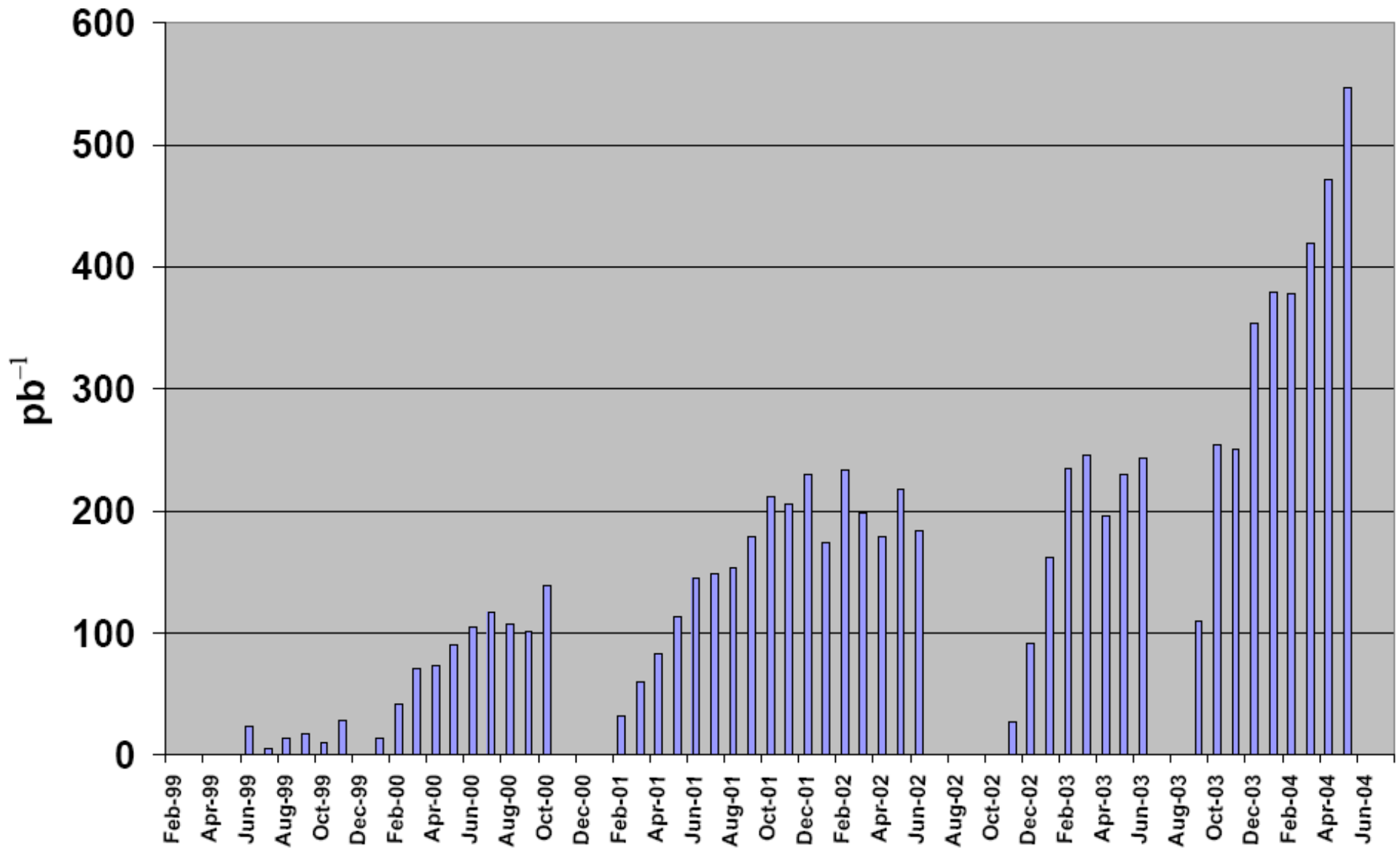


# PEP-II Monthly Integrated Luminosity



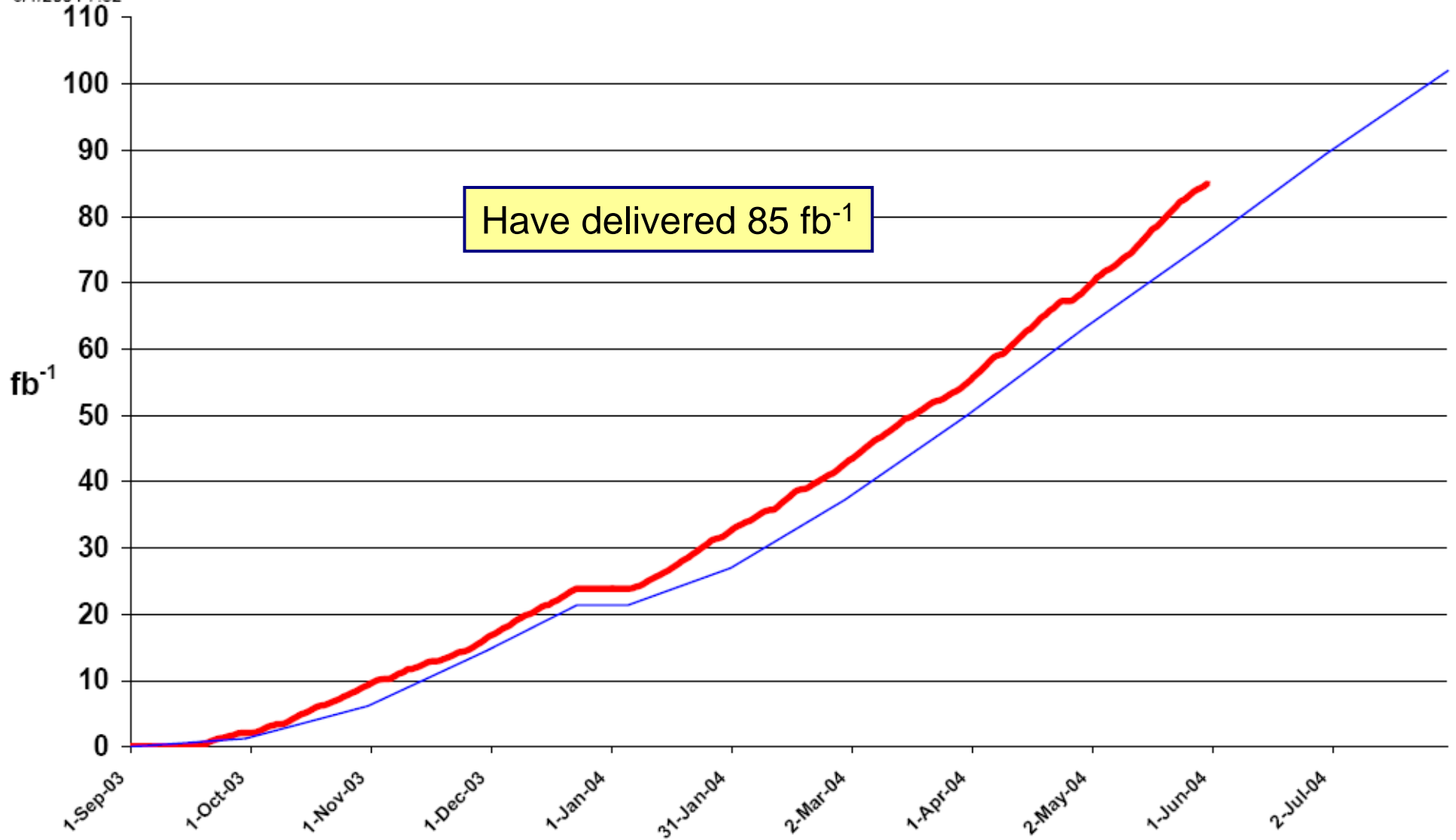
Last Updated:  
6/1/2004 7:32

# PEP-II Daily Average for each Month



# PEP-II Run 4 Delivered Luminosity in 2003-2004

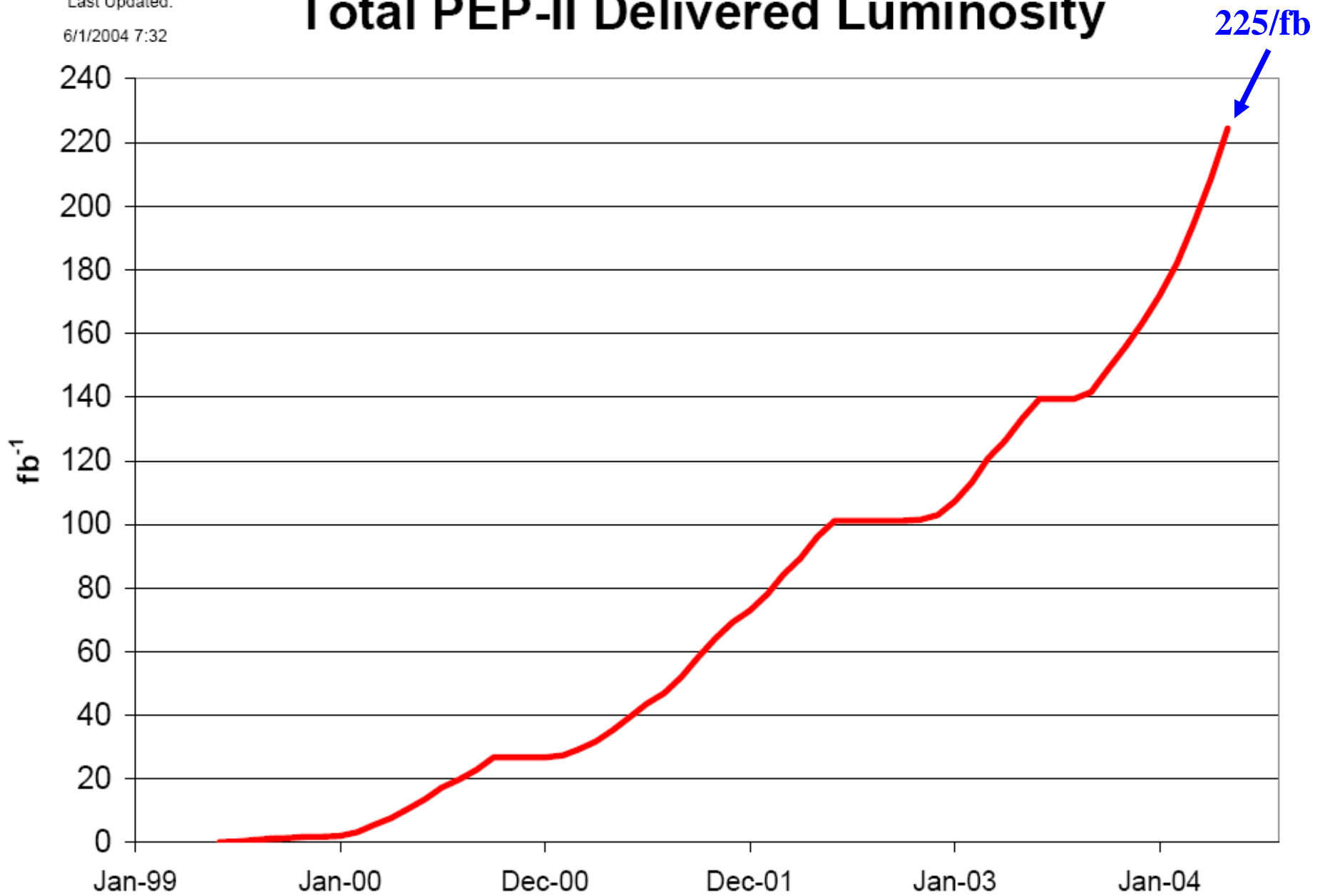
Last updated:  
6/1/2004 7:32



Last Updated:

6/1/2004 7:32

# Total PEP-II Delivered Luminosity





# Improvements in run 4

- Lower LER  $\beta_y^*$  from 11 to 10 mm (is down to 10.5 mm)
- Lower HER  $\beta_y^*$  from 11 to 10 mm (is down to 10.5 mm)
- Commission new HER RF woofer
- Increase HER current to 1480 mA (have gotten to 1550 mA)
- Increase LER current to 2500 mA (have gotten to 2450 mA)
- Shorten HER bunch length by raising HER RF voltage
- Shorten LER bunch length by raising LER RF voltage
- Fix HER beta beat
- Lower LER  $\beta_x^*$
- Online model updates and online correction tools
- Use HER/LER octupoles
- Improve lattice corrections (orbit, dispersion ...)

# Overall Parameters and Goals

Twice design

Parameter	Units	Design	Best in collision	Future 2007 goal
I+	mA	2140	2450	4500
I-	mA	750	1550	2200
Number bunches		1658	1588	1715
$\beta_y^*$	cm	15-20	11	8
$\xi_y$		0.03	0.05, 0.08	0.055-0.08
Luminosity	$\times 10^{33}$	3.0	9.2	24
Integrated lumi / day	$\text{pb}^{-1}$	130	710	1800

Over three times design

Over five times design!

## Near Term Goals for Run 4

- This run's near term goal is to deliver at another  $15 \text{ fb}^{-1}$  and reach  $1 \times 10^{34}$  before the summer shutdown (end of July 2004).
- We also want to demonstrate the capability for delivering  $850 \text{ pb}^{-1}$  per day.

# Summer 2004 PEP-II Improvements

- IR2 south forward shield wall
- Add another new LER RF station
- Add a HER RF station by splitting up a current 4 cavity station into two 2 cavity stations
- Two new “Frascati” longitudinal kickers in LER
- New electrodes for transverse kickers **Shorter bunches**
- Add fans to all HER bellows
- Alignment work (quadrupole rolls)
- New LER synchrotron light monitor
- IR NEG pump HOM reduction
- New Support Tube Chiller

# New transverse kicker electrodes



## New Longitudinal Feedback Kicker Assembly



# PEP-II Long Range Upgrade Plans

- Lower  $\beta_y^*$  from 11 to 8mm
  - Raise LER beam current from 2.4 to 4.5 A
  - Raise HER beam current to 1.4 to 2.2 A
  - Increase number of bunches to 1715+
  - Complete hardware by Fall 2006
  - Reach peak luminosity by Summer 2007
- 
- **Increase luminosity to  $2.4 \times 10^{34} \text{ cm}^{-2} \text{ sec}^{-1}$**

# PEP-II Future Luminosity Parameters

	$\beta_x$	$\beta_y$	$\epsilon_x$	$\epsilon_y$	n	I	$\sigma_x^*$	$\sigma_y^*$	Lumi	$\xi_x$	$\xi_y$
<b>Units</b>	<b>cm</b>	<b>mm</b>	<b>nm</b>	<b>nm</b>		<b>mA</b>	$\mu\text{m}$	$\mu\text{m}$	<b>x1E33</b>		
<b>LER now</b>	<b>43</b>	<b>11</b>	<b>30</b>	<b>1.3</b>	<b>1588</b>	<b>2450</b>	<b>114</b>	<b>3.8</b>	<b>9.21</b>	<b>0.065</b>	<b>0.069</b>
<b>LER 2007</b>	<b>28</b>	<b>8</b>	<b>60</b>	<b>1.35</b>	<b>1715</b>	<b>4500</b>	<b>130</b>	<b>3.3</b>	<b>24.0</b>	<b>0.071</b>	<b>0.078</b>
<b>HER now</b>	<b>33</b>	<b>11</b>	<b>60</b>	<b>1.4</b>	<b>1588</b>	<b>1450</b>	<b>141</b>	<b>3.9</b>	<b>9.21</b>	<b>0.045</b>	<b>0.045</b>
<b>HER 2007</b>	<b>28</b>	<b>8</b>	<b>60</b>	<b>1.4</b>	<b>1715</b>	<b>2200</b>	<b>130</b>	<b>3.3</b>	<b>24.0</b>	<b>0.050</b>	<b>0.056</b>



# Future luminosity increase factors

Parameter	Present	Future	Luminosity gain ratio	Hardware and work needed
LER current	2450 mA	4500 mA		Two RF stations, new vacuum chambers
HER current	1550 mA	2200 mA	1.61	Two RF stations, new vacuum chambers
$\beta_y^*$	11 mm	8 mm	1.38	HER higher tunes, RF & power supplies work
$\xi_y$	0.068 L 0.045 H	0.079 L 0.053 H	1.16	Tune plane, coupling, & IR work
Parasitic $\Delta x$	3.22 mm	3.80 mm	1.08	B1 magnet change
<b>Total</b>			<b>x 2.78</b>	

# PEP-II Long Range Beam Parameters Goals

- April 2004: 2.3A x 1.4 A  $\beta_y^*=11$  mm 1555 bunches L=8.4E33
  - July 2004: 2.5A x 1.6 A  $\beta_y^*=10$  mm 1600 bunches L=10E33
  - June 2005: 3.3A x 1.8 A  $\beta_y^*=9$  mm 1700 bunches L=15E33
  - July 2006: 3.9A x 2.0 A  $\beta_y^*=8$  mm 1720 bunches L=20E33
  - July 2007: 4.5A x 2.2 A  $\beta_y^*=8$  mm 1720 bunches L=24E33
- 
- With good integration reliability and trickle injection:
  - 115 fb<sup>-1</sup> more integrated from Summer 2003 to Summer 2004.
  - 530 fb<sup>-1</sup> total integrated by Fall 2006.
  - About 1.7- to 2.0 ab<sup>-1</sup> integrated by Fall 2010.

# Summer-Fall 2005 PEP-II Shut-Down Activities

- Install LER-5 RF station
- Install HER-10 RF station
- Remove support tube for SVT work
- Increase beam separation with stronger B1 permanent magnet
- Upgrade several high-power IR vacuum chambers (Be bellows, Q4, Q5, high power dump, Q2 bellows, LER abort window, radial ion pump, luminosity chamber, ...)
- HER lattice upgrade for low momentum compaction
- LER quadrupole power supply upgrades for lower  $\beta_y^*$
- New RF comb filters

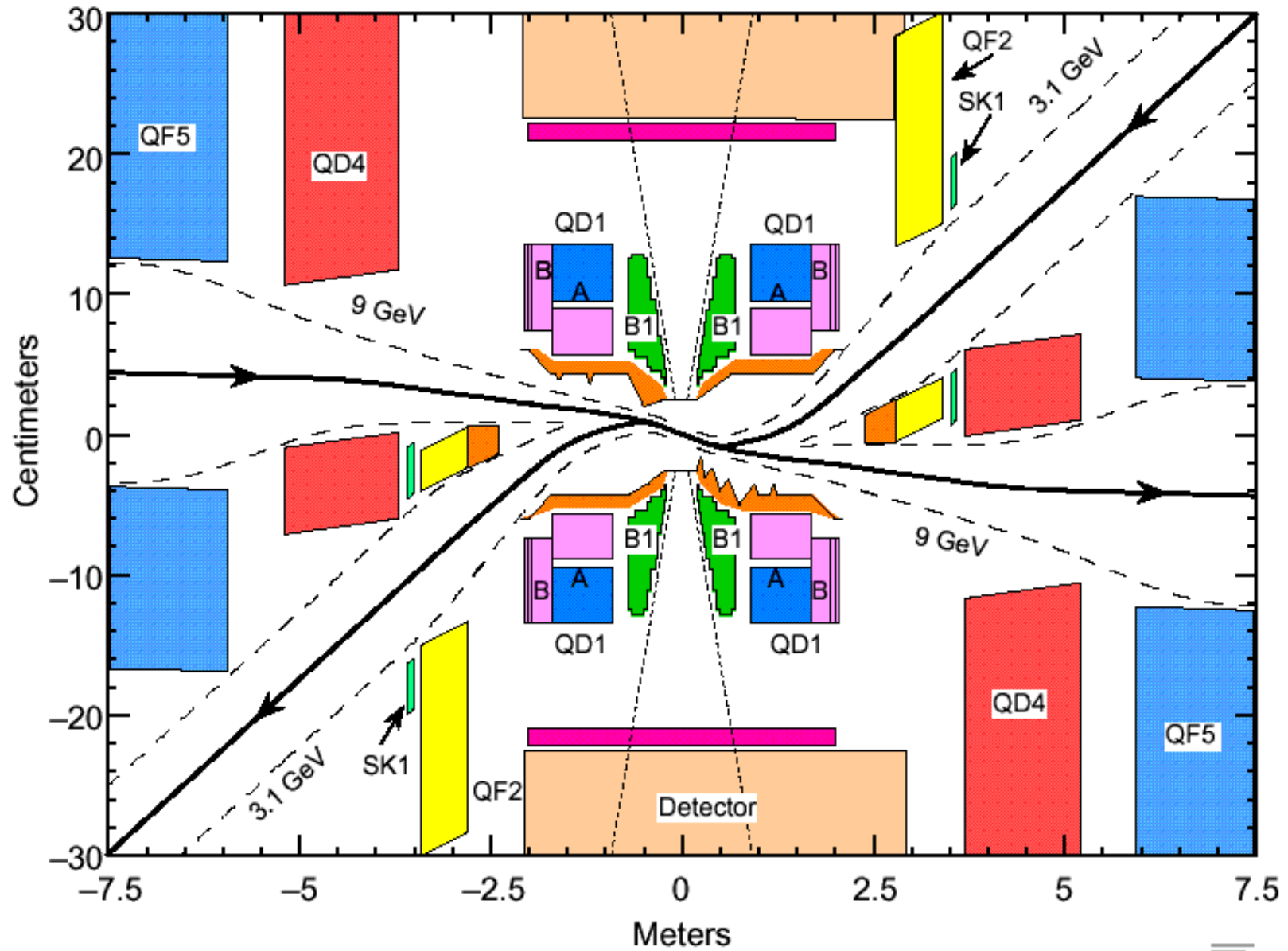
# IR Modifications

- We think we can get to 8 mm  $\beta_y^*$  without any major hardware changes in the near IR
- Vacuum chamber heating from SR power at the higher beam currents looks OK so far
- SR masking for detector backgrounds is OK
- We presently see beam effects from the 1<sup>st</sup> parasitic crossing in the by2 pattern. Presently, we can correct most of this effect and get back the lost lumi. The parasitic crossing effect is made worse with lower  $\beta_y^*$ s. Can we still compensate?

# IR modifications (cont.)

- Looking at upgrading B1 magnets to improve the 1<sup>st</sup> parasitic crossing effect
- Keep the B·dl the same. Strengthen the inside magnetic slices and weaken or remove some of the outside slices.
- Need a rad hard magnetic material with a higher field strength
- Build new radial ion pumps
- Build new Q4 and Q5 HER beam pipes

# PEP-II Interaction Region



# Conclusions

- **PEP-II has reached a luminosity of  $9.2 \times 10^{33}$ . It has delivered to BaBar 710/pb in one day.**
- **BaBar has collected well over 200 fb<sup>-1</sup>**
- **We trickle inject into both rings all of the time now**
- **We plan to deliver another 15 fb<sup>-1</sup> and reach  $1 \times 10^{34}$  before the summer shutdown**
- **We have a new challenge from the director – 850 pb<sup>-1</sup> per day capability before the summer shutdown**
- **Near term upgrades are going well**
- **Planned upgrades toward  $2.4 \times 10^{34}$  are on track**
- **Need to complete specifications for a few items over the next two months for the 2004 and 2005 downs:**
  - **Several IR vacuum chambers**
  - **HER lattice upgrade path**
  - **B1 magnet upgrade path**
  - **NEG pump upgrade**