

PEP-II Status and Future Plans

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February 22, 2005



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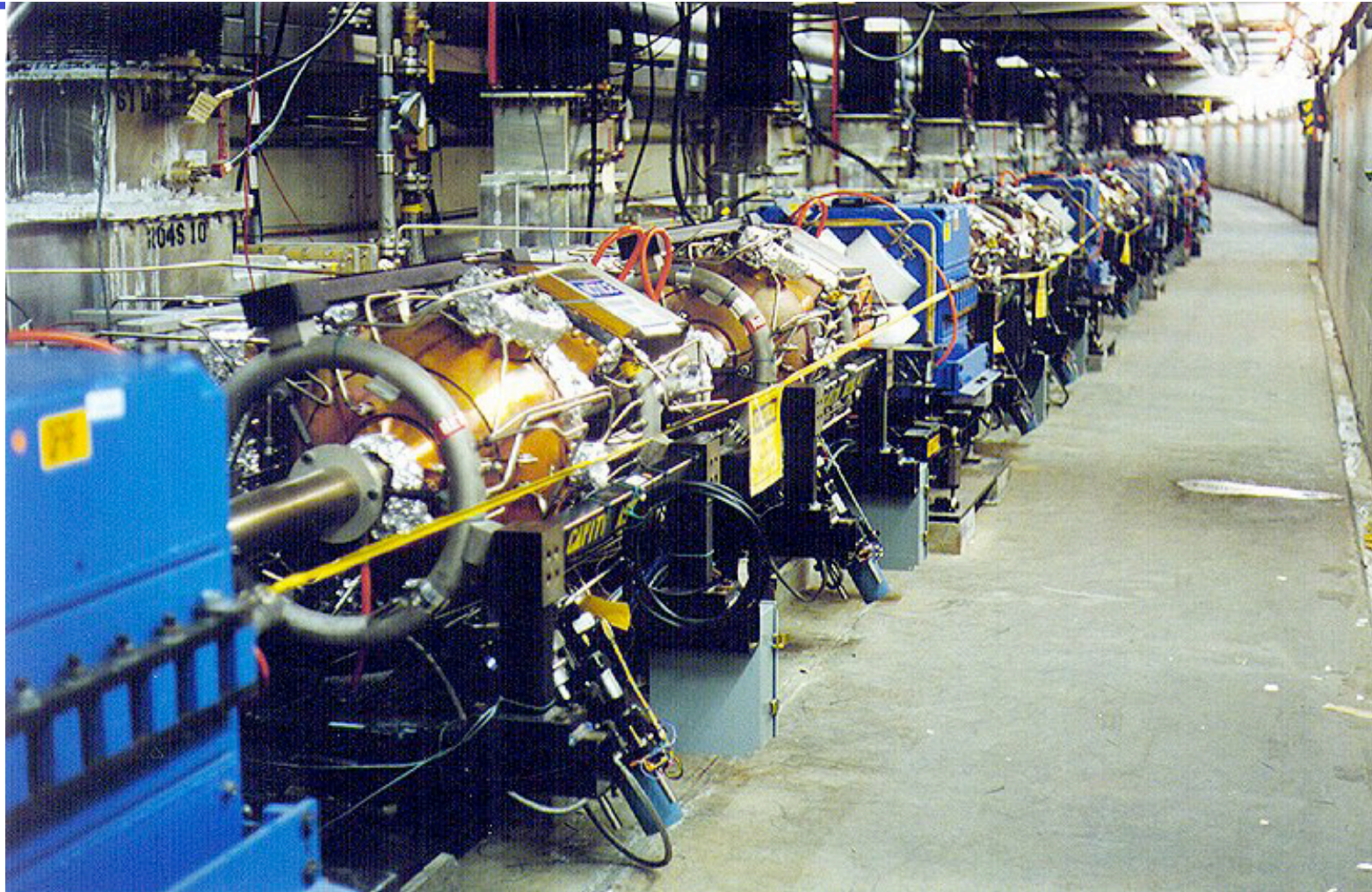


PEP-II arc section





PEP-II HER RF cavities



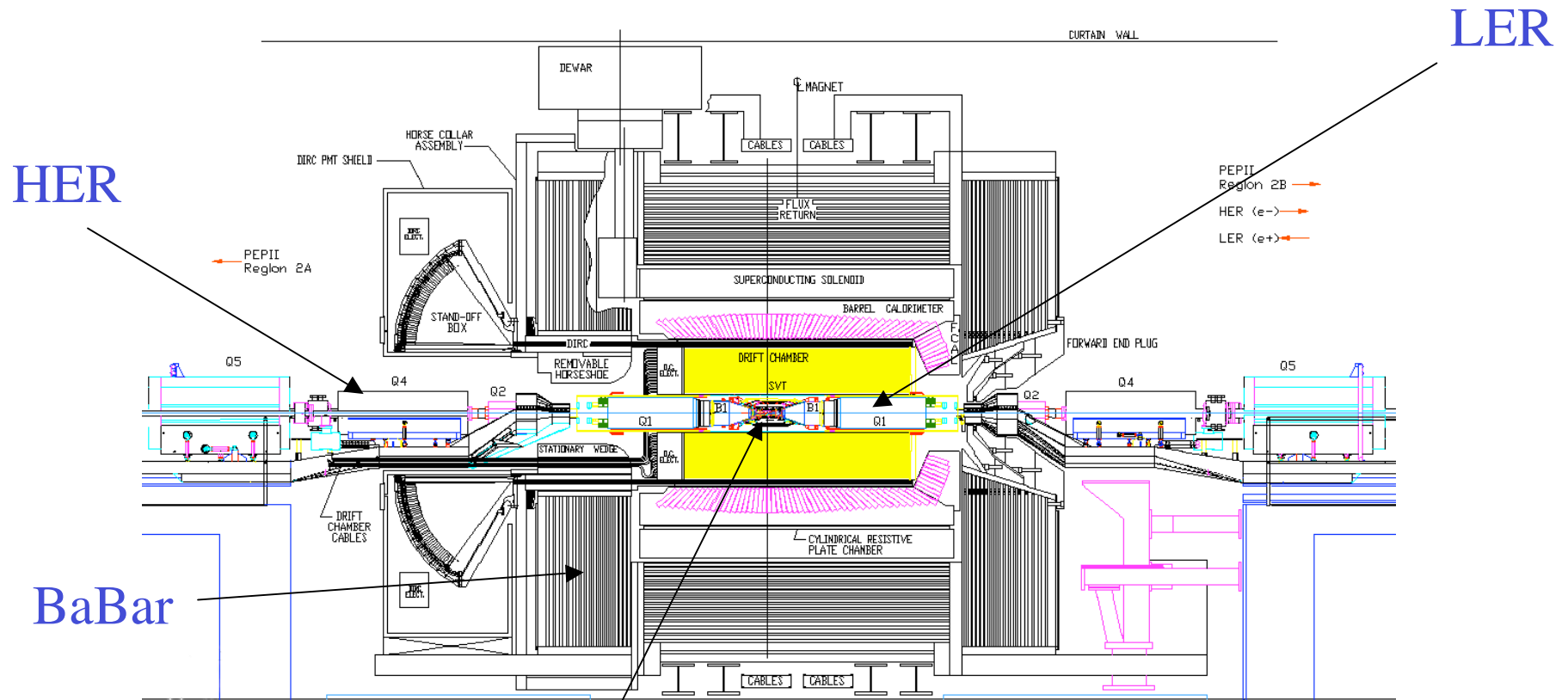
BR_049

HER Cavities Region 12

8-19-97



PEP-II Interaction Region Components near BaBar



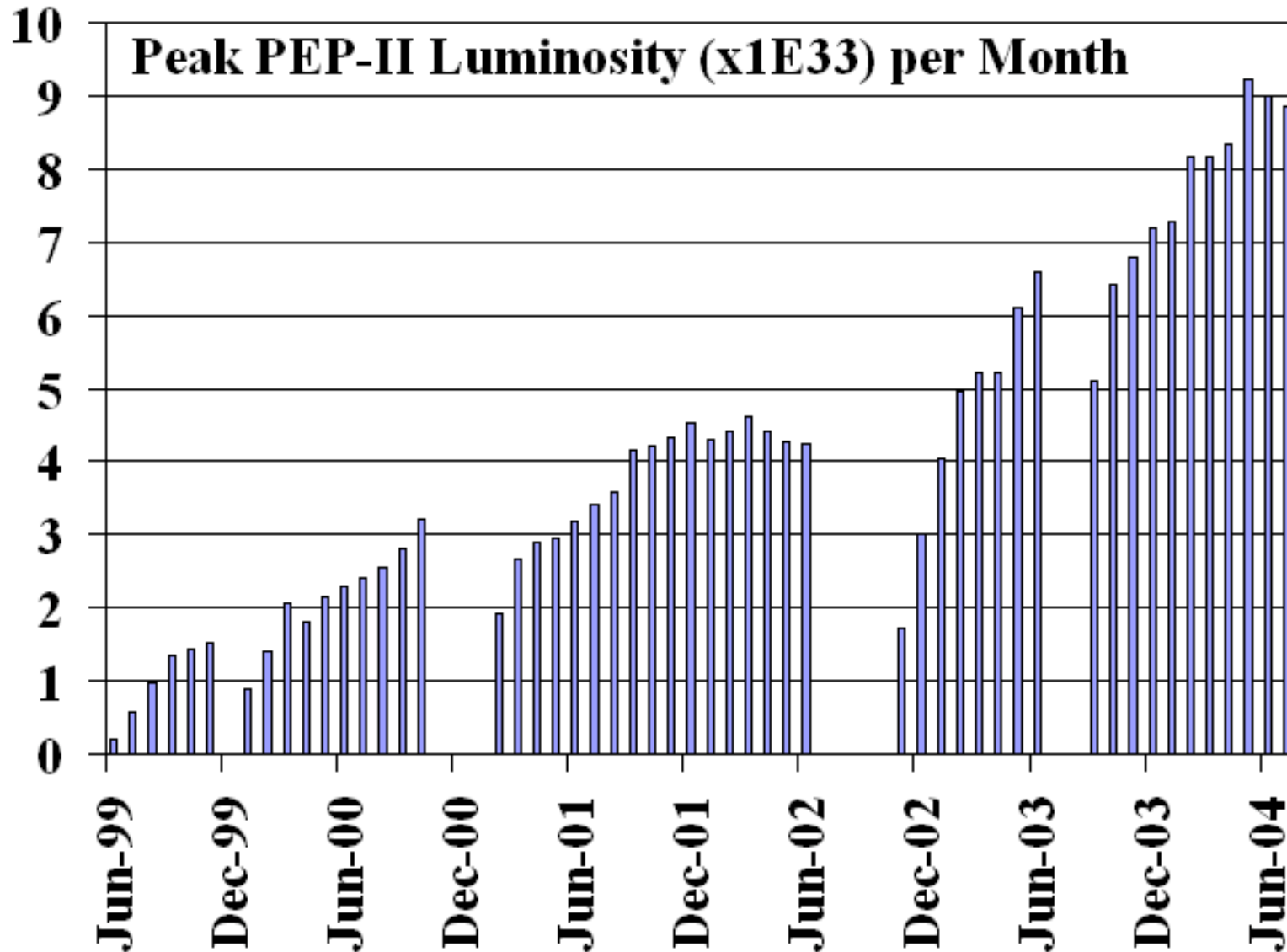
Section through BaBar & near IR
For information only, do not scale

Acad Dwg- BabarSection2
Dwn- S.J.Metcalf
This Revision- 4/23/01

Collision point



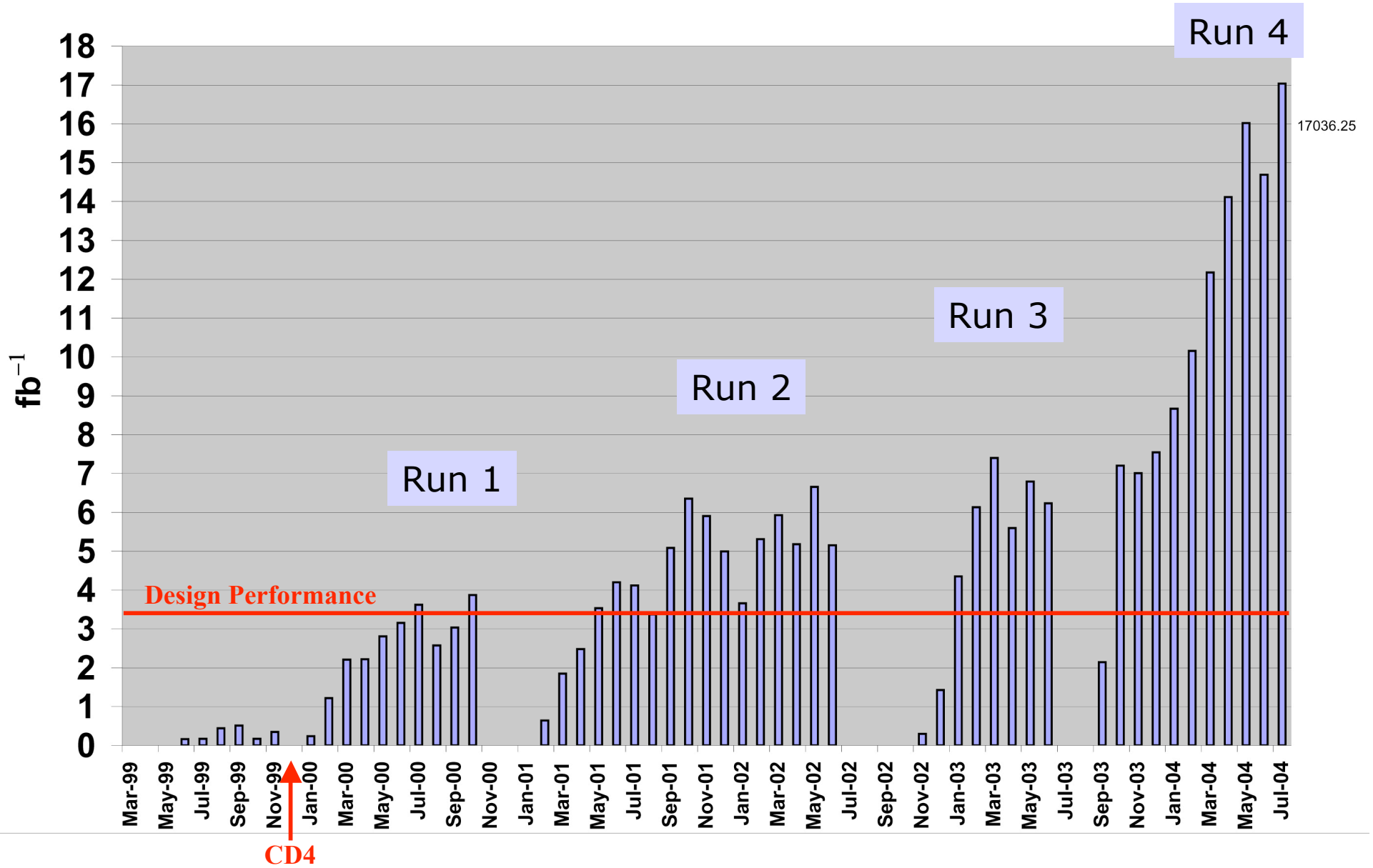
PEP-II Performance Measure: Peak Luminosity





Last updated:
7/31/2004
02:04

PEP-II Monthly Integrated Luminosity





PEP-II Records

Last update:
July 31, 2004

Peak Luminosity

9.213×10^{33} cm⁻²sec⁻¹

May 21, 2004

1588 bunches 2450 mA LER 1550 mA HER

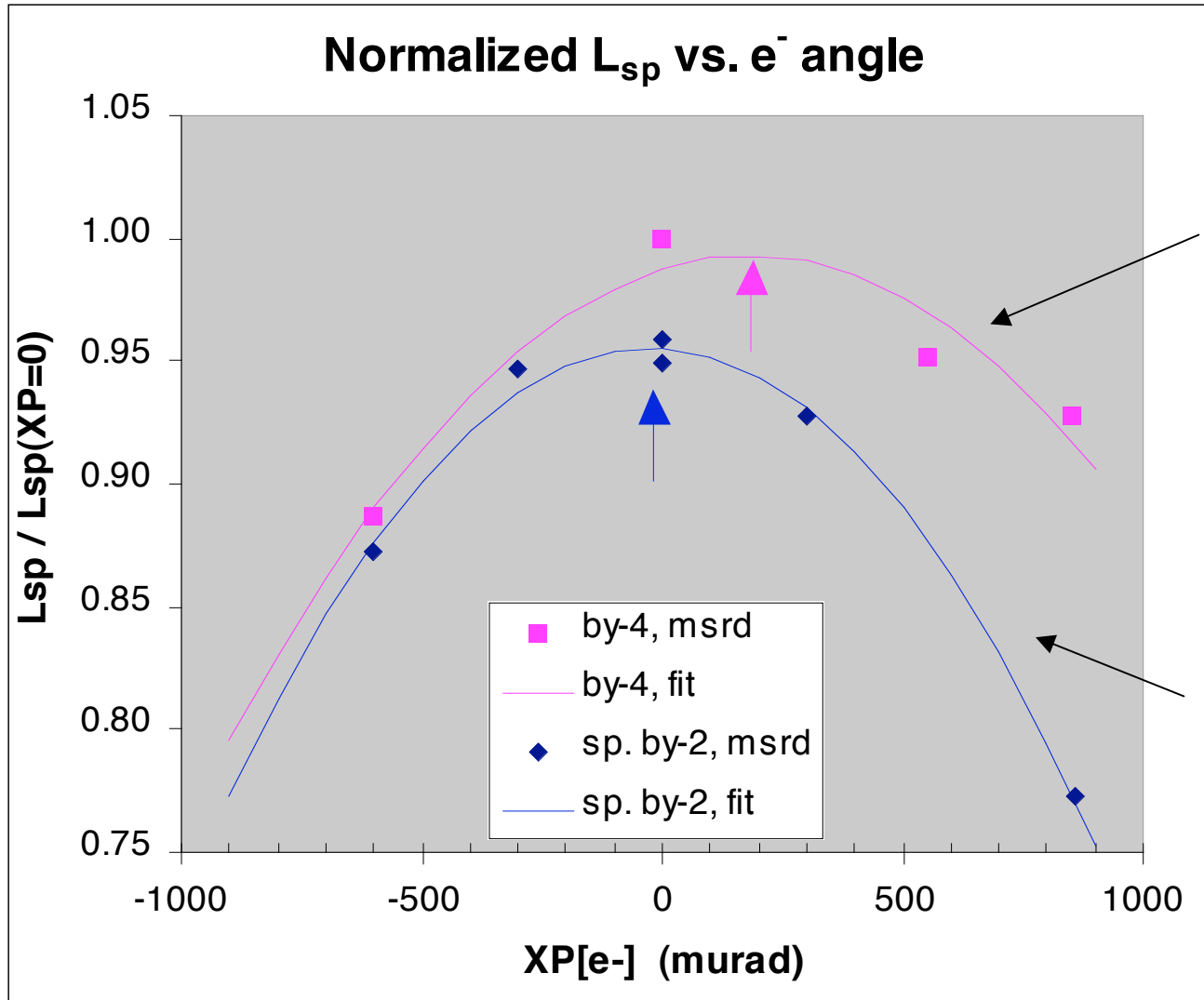
Integration records of delivered luminosity

Best shift (8 hrs, 0:00, 08:00, 16:00)	246.3 pb ⁻¹	May 21, 2004
Best 3 shifts in a row	710.5 pb ⁻¹	May 24, 2004
Best day	710.5 pb ⁻¹	May 24, 2004
Best 7 days (0:00 to 0:00)	4.464 fb ⁻¹	Jul 25-Jul 31, 2004
Best week (Sun 0:00 to Sat 24:00)	4.464 fb ⁻¹	Jul 25-Jul 31, 2004
Peak Ave Lum	8.705×10^{33}	May 14, 2004
Best 30 days	16.720 fb ⁻¹	Jul 2 – Jul 31, 2004
Best month	17.036 fb ⁻¹	July 2004
Total delivered	256 fb ⁻¹	



Luminosity versus Crossing Angle

•
Kozanecki
Sullivan
Cai





Operational Improvements in FY2004

- Peak luminosity: $6.6 \rightarrow 9.2 \times 10^{33}$
- Number of bunches: 1050 \rightarrow 1588 bunches
 - by-2 pattern (24 long mini-trains) with 2% ion gap
- Parasitic collision effects seen but small (<5%)
- Electron Cloud (ECI) effects are small (<2%)
- I+ current 1500 \rightarrow 2450 mA (3 RF stations)
- I- current 1050 \rightarrow 1550 mA (8 RF stations)
- β_y^* of 12 \rightarrow 10.5 mm
- All data now taken in trickle charge mode
 - Both beams: LER in November, HER in March

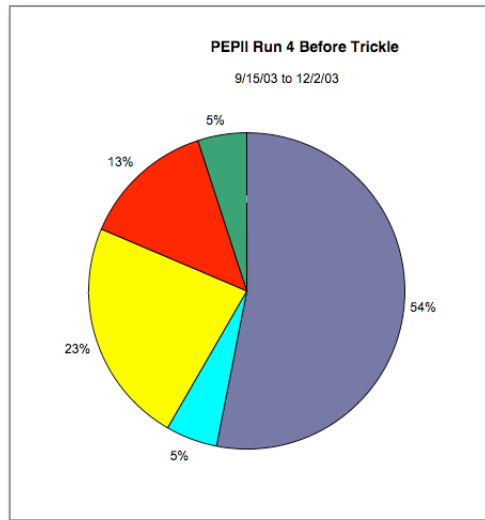


PEP-II Run Time Dist. FY 04

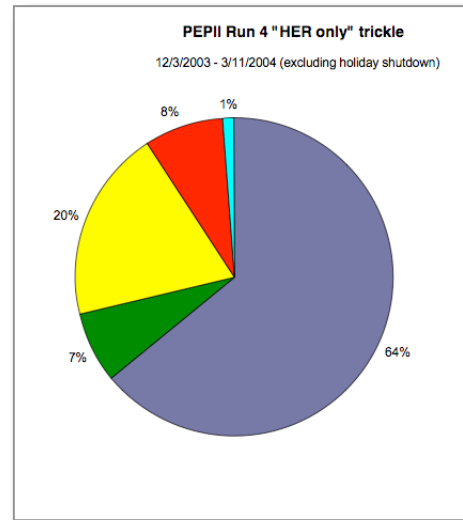
- Average delivery: 65%
- Average tuning+injection: 17%

M. Stanek

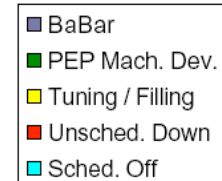
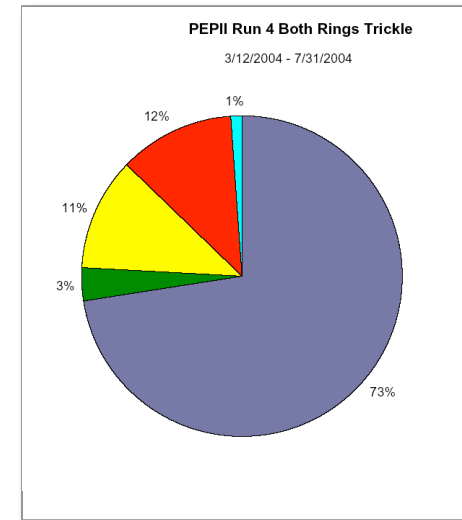
Pre-trickle



LER-trickle



Double-trickle





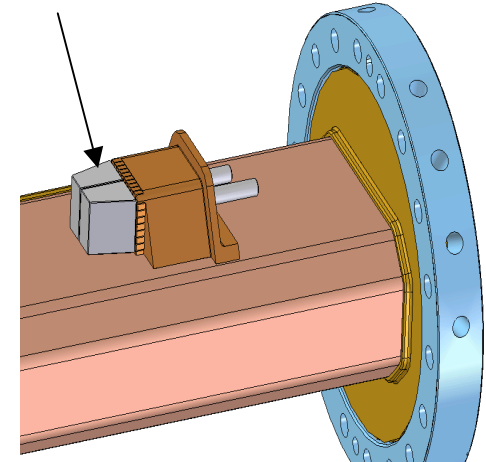
Major Contributors to Performance

- Trickle Charge raised the average luminosity
 - with little doubt the single biggest success...
- Rf/LFB Improvements raised current & pk lum
 - 6-station -> 8 station running in HER
 - Increased HER current to 1550 mA
 - Increased LER current to 2450 mA
 - Shorten HER bunch length by raising HER RF voltage (14.6 to 16.8 MV)
 - Shorten LER bunch length by raising LER RF voltage (HOM heating)
 - Commissioned LGD Woofer in HER
- By-2 Pattern Commissioning: more bunches
- Lattice Improvement
 - HER steering: lower y dispersion
 - β_y^* reduction from 12 mm to 10 mm in both rings
 - Improve online tools and lattice corrections (orbit, dispersion ...)

Run 4 Major Issues

- IR 2 vacuum-related problems/HOM heating
 - VAT vacuum gate valve failed, replaced by spool
 - NEG heating
 - Limited LER beam current
 - Limited LER bunch length
- HER longitudinal instabilities
 - fixed with LGD Woofer
- Beam currents limited by RF stability
 - Mostly in the HER
 - Also in the LER because we were not able to raise the RF voltage

SiC HOM absorber



plenum not shown for clarity





LER upstream NEG work

- This summer:
 - We took out the nine NEG's with “c type” screens and installed a small HOM absorber in each cavity
 - The total length of NEG pumping that was removed is 5.5 m out of a total of 40.4 m
 - We removed the two movable collimators
 - We removed the Q4 NEG and have replaced it with a HOM absorber (another 1.6 m of pumping)
 - We have added extra pumping at the port between the upstream LER Q4 and Q5 chambers
 - In addition, we have added extra screening to the ion pumps in this region



Summer 2004 PEP-II Improvements

- IR2 south forward shield wall: Backgrounds
- Added another new LER RF station: Higher current
- Add a HER RF station by splitting up a current 4 cavity station into two 2 cavity stations: Higher current
- Two new “Frascati” longitudinal kickers in LER: More stability
- New electrodes for transverse kickers: More stability
- Add fans to all HER bellows: Cool Higher Order Modes (HOMs)
- Alignment work (quadrupole rolls): Smaller vertical emittance
- New LER synchrotron light monitor: Smaller vertical emittance
- IR NEG pump HOM reduction: Better lifetime and backgrounds
- New Support Tube Chiller: Higher currents



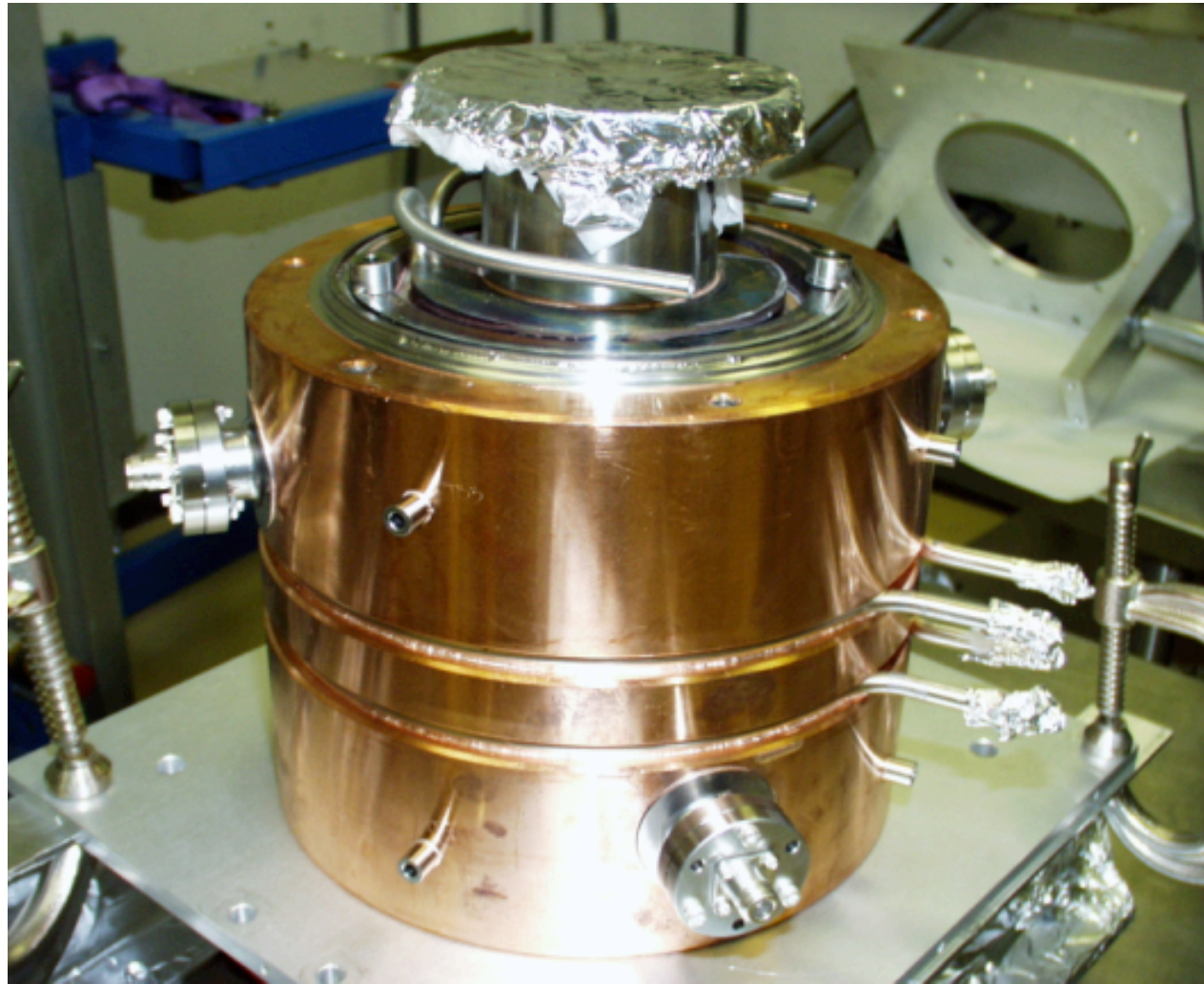
Windings finished for ECI reduction





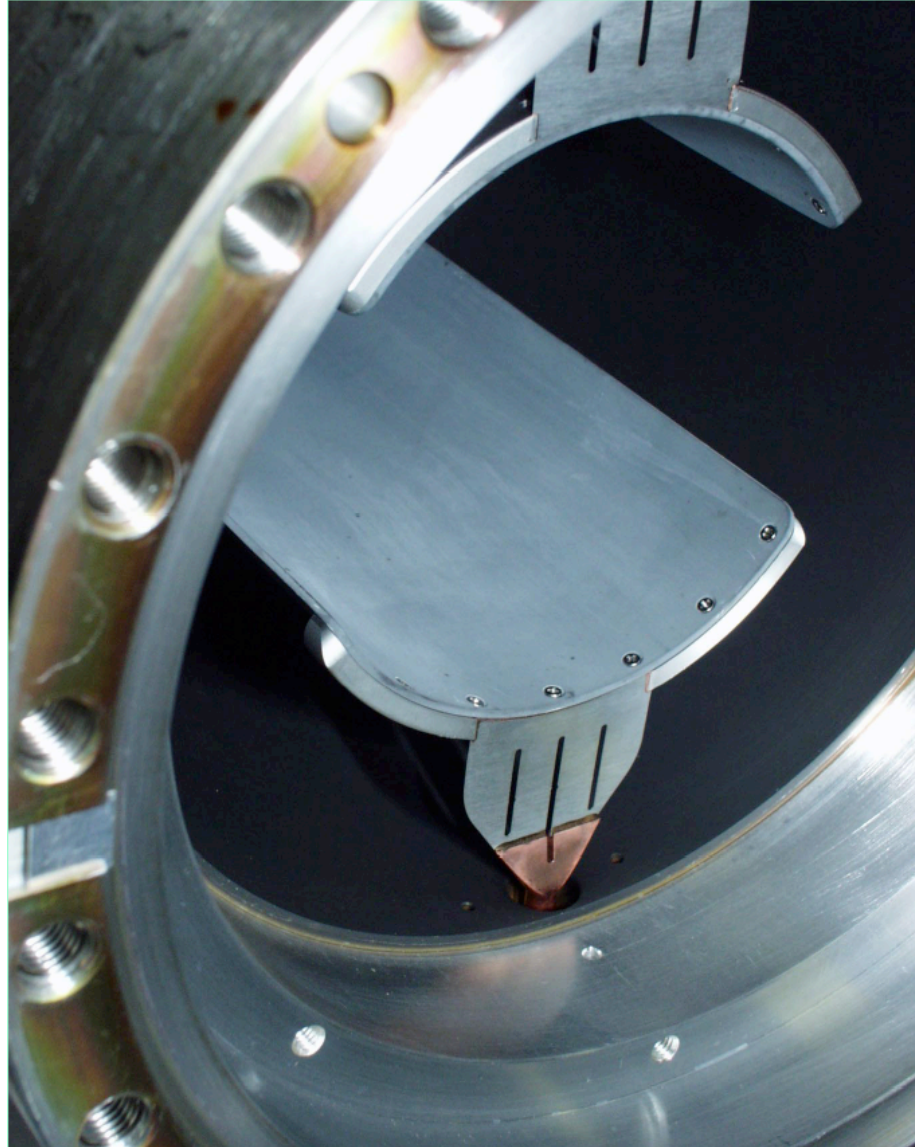
SLAC Accelerator Department

New Longitudinal Feedback Kicker





New transverse kicker electrodes





Run 5 Status

- PEP was within 5 days of final lockup when work at SLAC was halted by our Director.
- SLAC has been working hard on re-evaluating and adapting our safety procedures.
- PEP-II Validation complete by February 24.
- Turn on in March.
- Run through the summer with a 1 month down.
 - Goal: Double our total integrated luminosity.



Validation Process

- A serious electrical accident occurred on October 11, 2004 (arc-flash).
- Time period October 2004 through February 2005 used for employee training and safety procedure upgrades.
- Type A Investigation Report completed December 2004.
- Corrective Action Plan produced (draft in January and final in February).
- Linac and PEP-II Proposed Restart Plan produced for the Restart Validation Team January 20, 2005.
- Validation process started January 24, 2005.
- Validation process closeout February 24, 2005.
- There will be some additional hardware and procedure rework needed following the closeout taking a few weeks.



Validation Team Sub-Topics in Review

- “Safety Comes First” Training
- Implementation of New Electrical Bulletins
- BaBar User Safety
- Radiation Safety
- Electrical Safety
- Detector Operation Procedures
- Hoisting and Rigging
- Accelerator Operations and Maintenance
- Integrated Safety Management System (ISMS) Implementation
- Other Departments Management
- Training Accelerator Personnel
- OSHA Audit Issues
- 1999 Linac Safety Review
- 2000 PEP-II Accelerator Audit
- 2004 BaBar Operations Review
- 2004 Linac Safety Review



Run 5 Strategy

- Most luminosity will come from higher currents
 - 3.3 A on 1.8 A by summer 2005 in 1720 bunches
- We will be pushing the rf voltages both rings
 - Reduce bunch length but also increase stability margins
- We will further reduce β_y^* in both rings
 - Presently we have 10.5 mm,
 - Would like to go towards 9 mm
 - Worthwhile even at present bunch length
- We will raise the bunch currents
 - Only way to increase beam current after filling by-2 pattern
 - This may well require us to turn on the LER wiggler

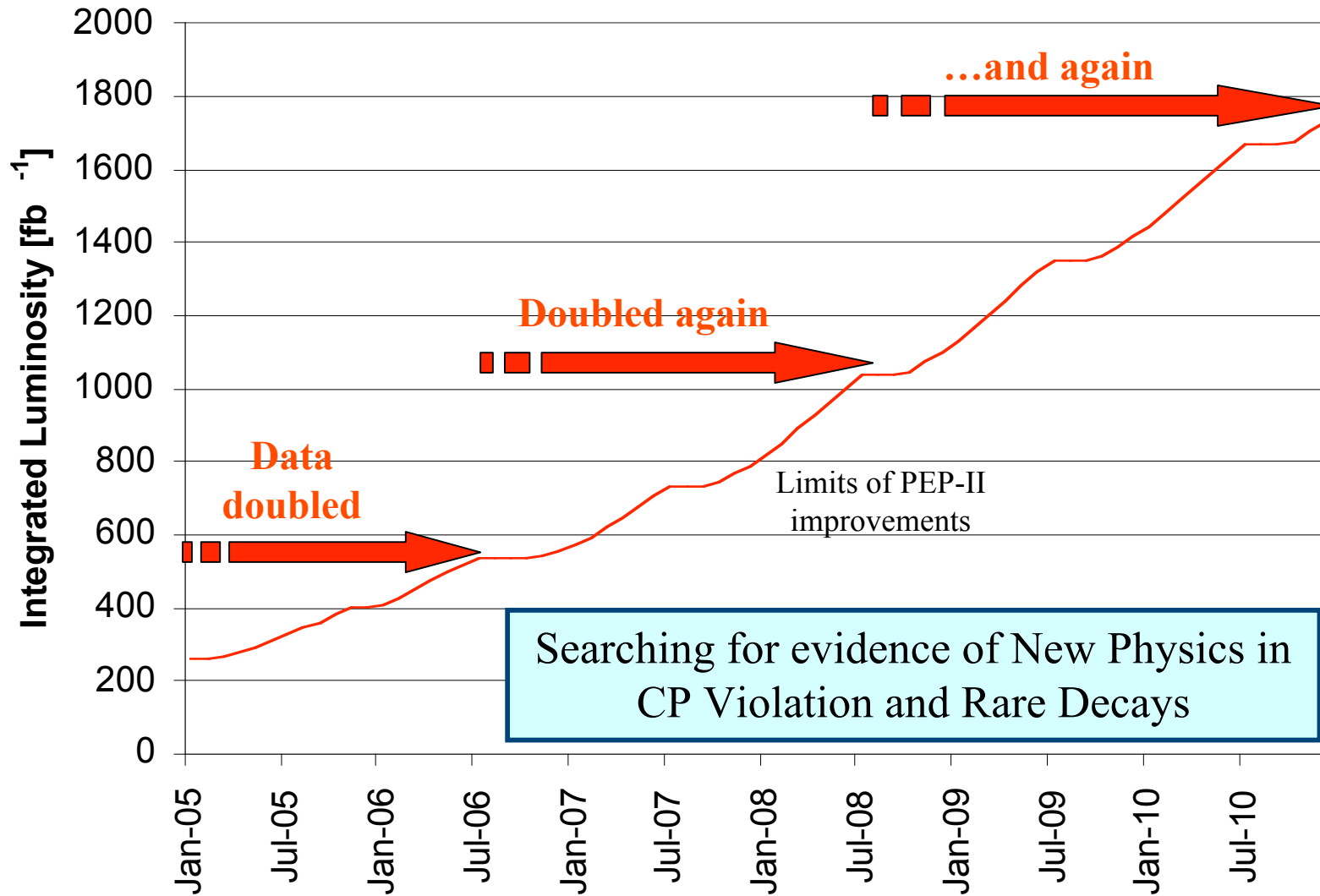


PEP-II Long Range Beam Parameters Goals

- 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=9.2E33
 - 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:
 - 117 fb⁻¹ more integrated from Summer 2003 to Summer 2004.
 - 530 fb⁻¹ total integrated by Fall 2006.
 - 1000 fb⁻¹ total integrated by Fall 2008



Projected PEP-II Integrated Luminosity (fb^{-1})





Overall Parameters and Goals

Parameter	Units	Design	Best in collision	Future 2007 goal
I+	mA	2140	2450	4500
I-	mA	750	1550	2200
Number bunches		1658	1588	1720
β_y^*	mm	15-20	11	8.5
ξ_y		0.03	0.045, 0.06	0.055-0.07
Bunch length	mm	12	10-12	8.5
Luminosity	$\times 10^{33}$	3.0	9.2	23
Integrated lumi / day	pb^{-1}	130	710	1600

Twice design

Over three times design

Over five times design!



Future luminosity increase factors

Parameter	Present	Future	Luminosity gain ratio	Hardware and work needed
LER current	2450 mA	4500 mA	1.61	Two RF stations, new IR vacuum chambers
HER current	1550 mA	2200 mA		Two RF stations, new IR vacuum chambers
β_y^*	10.5 mm	8.5 mm	1.24	HER higher tunes, RF & power supplies work
ξ_y	0.06 L 0.045 H	0.070 L 0.055 H	1.17	Tune plane, coupling, & IR work, vertical emittance
Parasitic Δx	3.22 mm	3.80 mm	1.08	B1 magnet change (?)
Total			x 2.52	



Expected PEP-II Delivered Integrated Luminosity

Delivered as of end of fiscal year	PEP-II Projection	“Delta”	
FY2004	256/fb	117/fb	
FY2005	387	131	
FY2006	528	141	
FY2007	821	293	
FY2008	1156	335	
FY2009	1501	345	
FY2010	1847	346	

Five month down



Major Future Maintenance Down Activities

- Install LER-5 RF station
- Install HER-10 RF station
- Remove support tube for SVT work to fix radial ion pump, add an IR BPM, new Be bellows (TBD)
- Upgrade several high-power vacuum chambers (Q4, Q5, Q2 bellows, LER abort window, absorber bellows)
- HER lattice upgrade for lower momentum compaction and shorter bunches
- New RF comb filters
- New klystron linearizer
- New transverse digital feedback processors



Conclusions

- PEP-II has reached a luminosity of $9.2 \times 10^{33} / \text{cm}^2 / \text{s}$.
- PEP-II has delivered 710 pb^{-1} in one day.
- PEP-II has delivered 117 fb^{-1} in Run 4!
- PEP-II has delivered 256 fb^{-1} since May 1999.
- Trickle injection in both rings all of the time.
- Near term upgrades are going well.
- Planned upgrades toward 2.3×10^{34} are on track.

End of Presentation