

Accelerator Systems Division



PEP-II Accelerator Status

John Seeman
Particle and Particle-Astrophysics Directorate
Stanford Linear Accelerator Center

KEKB ARC Meeting

March 20, 2007

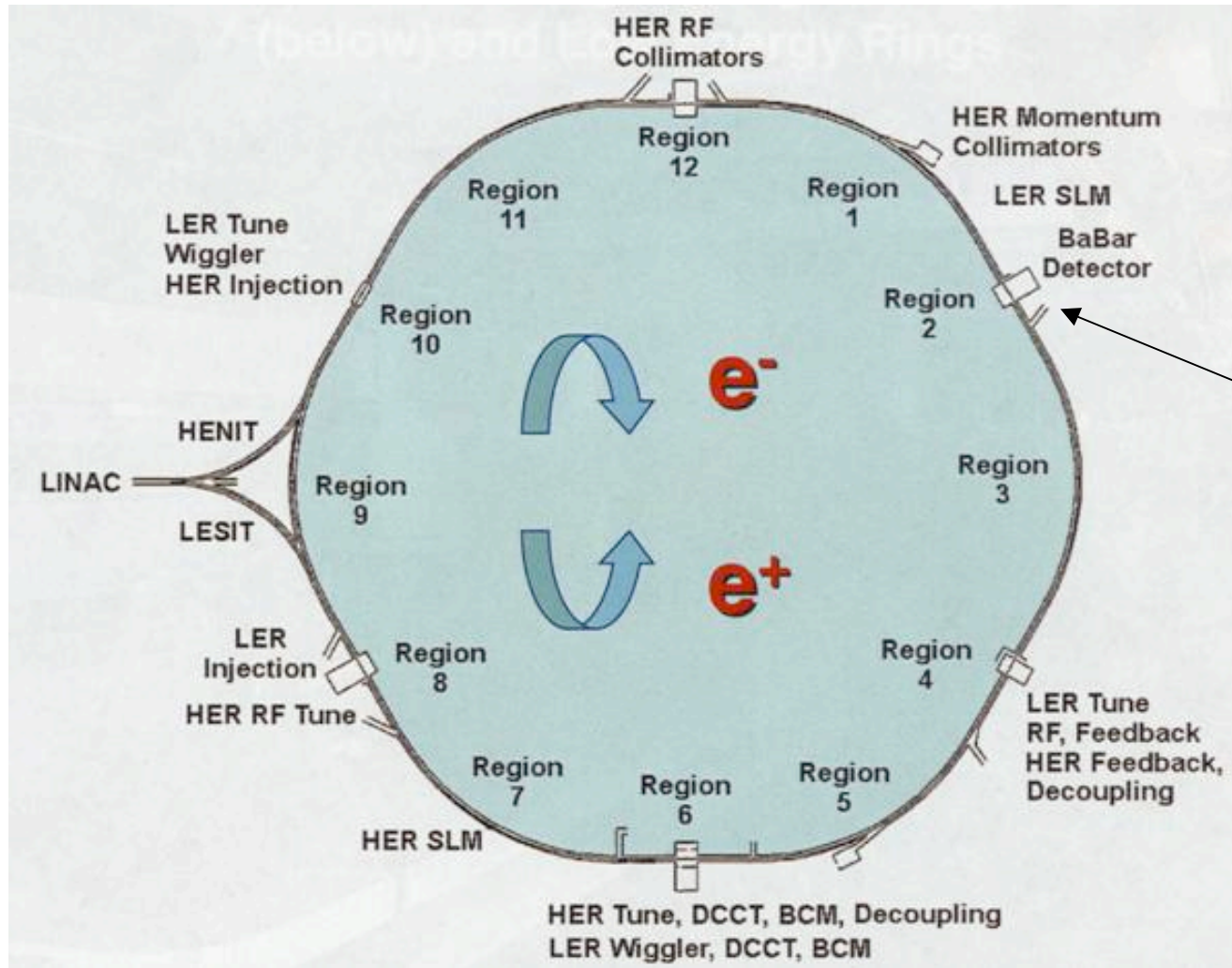


Topics

- Major new hardware items from Fall 2006 down.
- Accelerator issues in January to March.
- Present luminosity plots
- Schedule for Run 6
- Activities for Fall 2007 down
- Turn off PEP-II September 30, 2008



PEP-II e^+e^- Collider Overview



BaBar
Detector



Accelerator Systems Division

The PEP-II Team

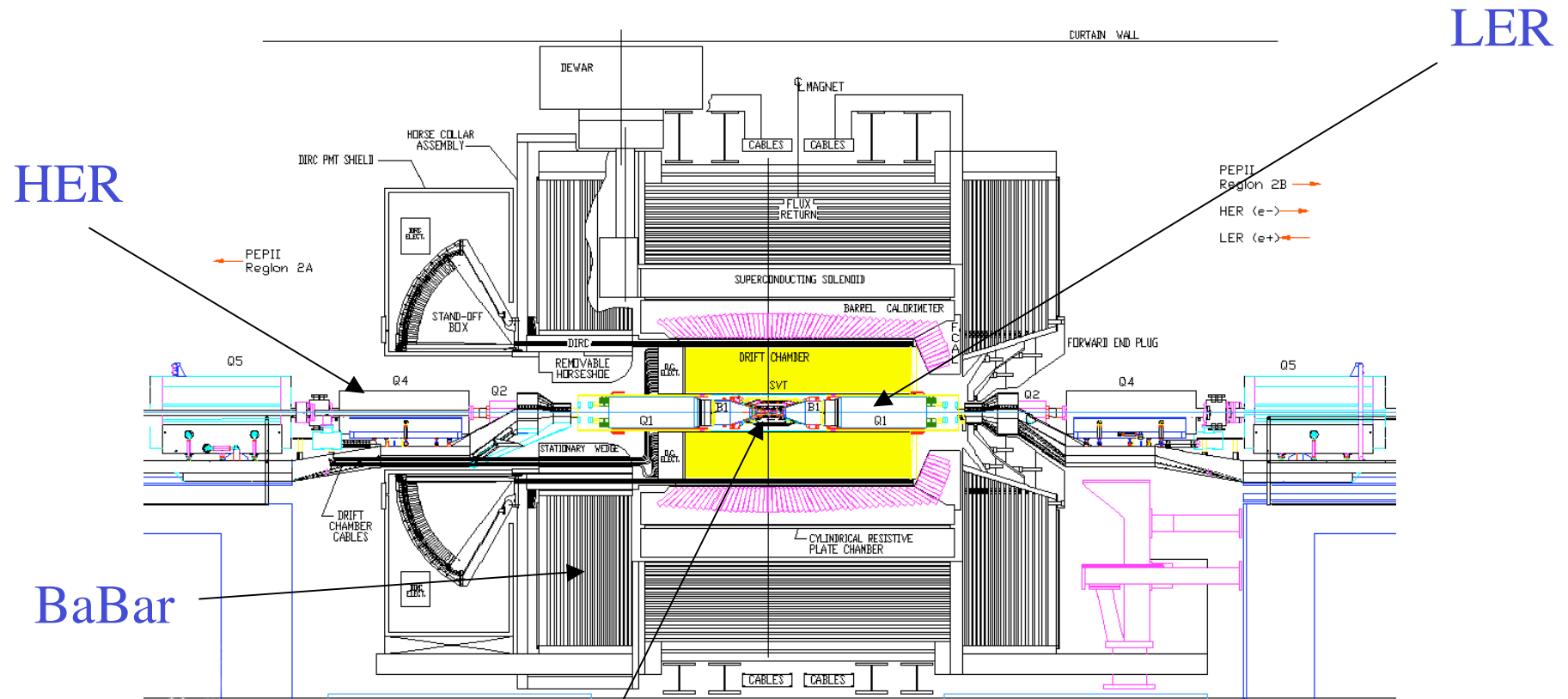


Accelerator Systems Division
SLAC Support Groups
BaBar
LBNL
ILC
Machine Advisory Committee





PEP-II Interaction Region Components near BaBar



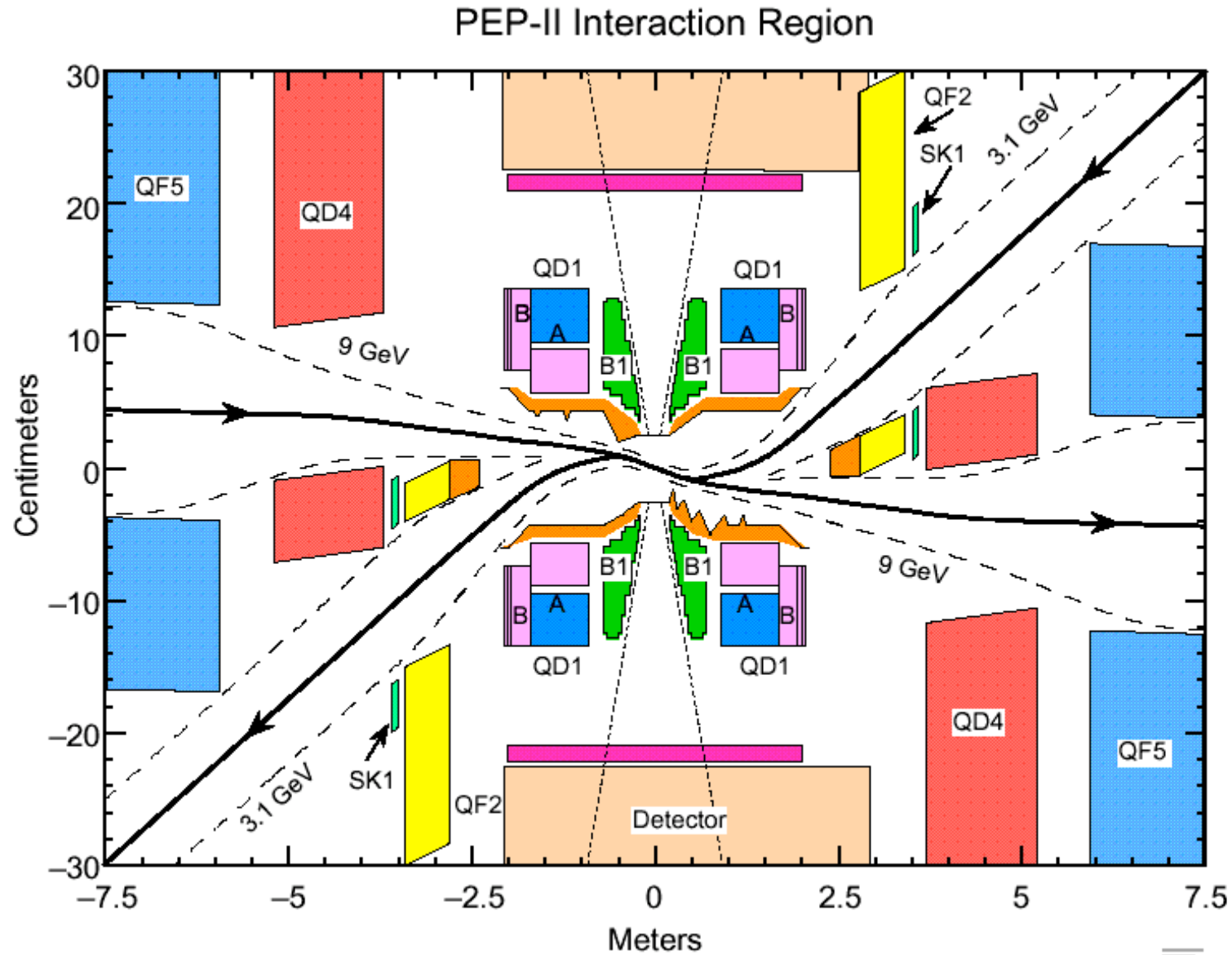
Section through BaBar & near IR
For information only, do not scale

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

Collision point



How the beams enter and exit the PEP-II Interaction Region





Quick update facts for PEP-II for Run 5b and Run 6

- Peak luminosity= $1.00 \rightarrow 1.20 \times 10^{34}$.
- Best integrated shift = $247 \rightarrow 339 \text{ pb}^{-1}$.
- Best integrated 24 hrs = $728 \rightarrow 911 \text{ pb}^{-1}$.
- Specific luminosity at high current $\sim 3.6 \rightarrow 4.1$.
- Fall “2006 down” August 18 to Jan 12
- Run 6 turn-on in January seemed slow but is about “average.”



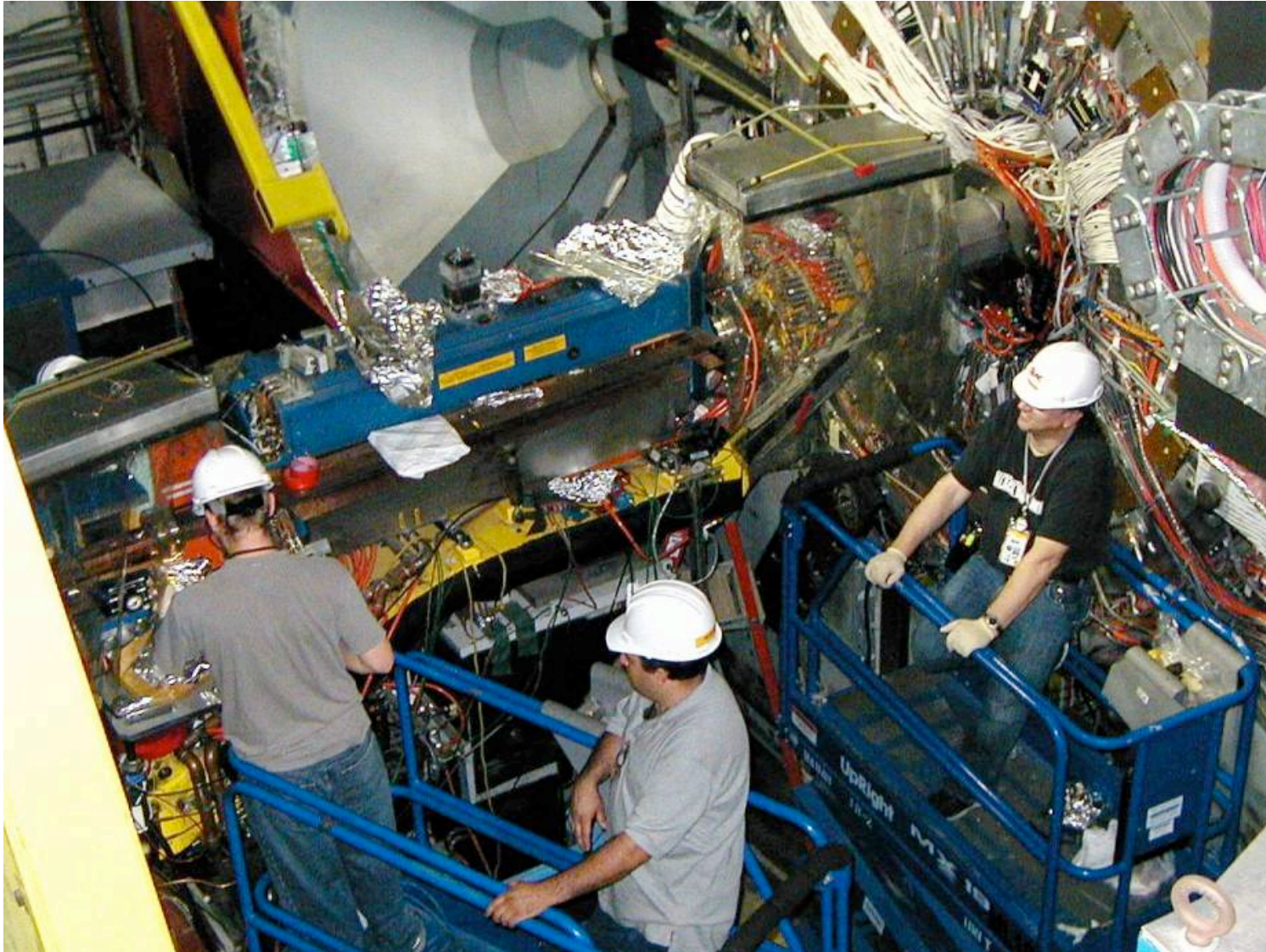
Accelerator Improvement Projects for Fall 2006

- X-Y BPM upgrades 2006 Done
- New HER Q5 vacuum chambers 2006 Done
- HER-10 RF station 2006 Done
- HER-11 RF station 2006 Done
- HER power supply upgrade for higher tunes 2006 Done
- New HER Q4 vacuum chambers 2006 Done
- New IR2 Q2 bellows 2006 ½ done
- LER IR HOM absorber 2006 Done
- HER IR HOM absorber 2006 Done
- LER BPM monitor upgrade 2006 5/6 done
- LER new high power bellows 2006 Done
- LER NEG vacuum chamber upgrade 2006 Done
- New Longitudinal feedback processor 2006 Done



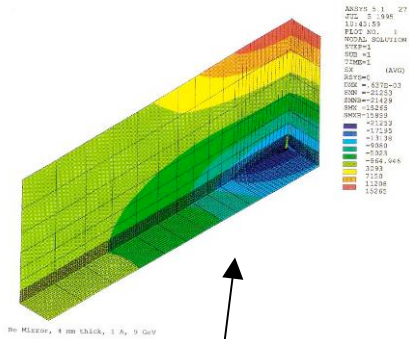
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LER Forward Q4 Location

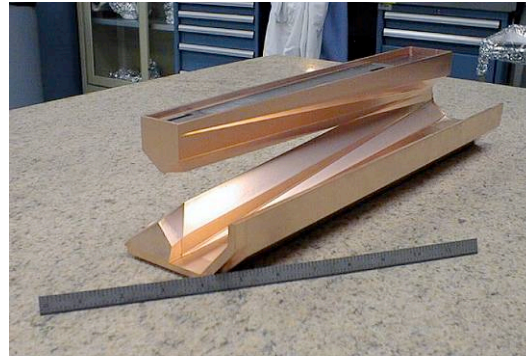




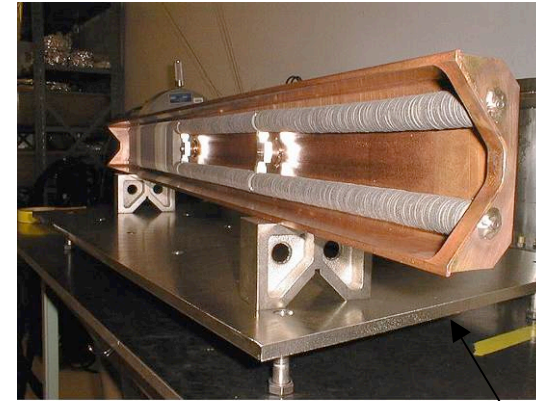
LER/HER Q2 IR Vacuum Chamber (Fall 2006 → March 2006)



Thermal analysis of synchrotron radiation power (~100 W/cm)



MN_043 Q2 Chamber - Back Mask 1 02/03/99

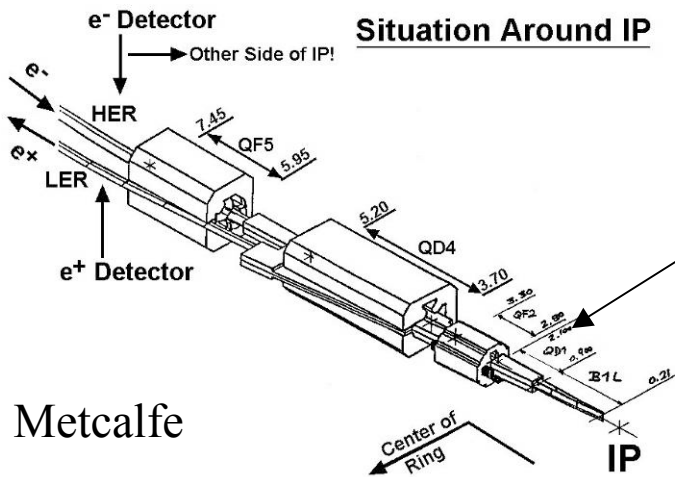


MN_068 Q2 Chamber NEG Pump 02/05/99



New PEP-II forward Q2 vacuum chamber CRW_0415L, S.J.Metcalf, 5/18/02

NEG Vacuum Pump

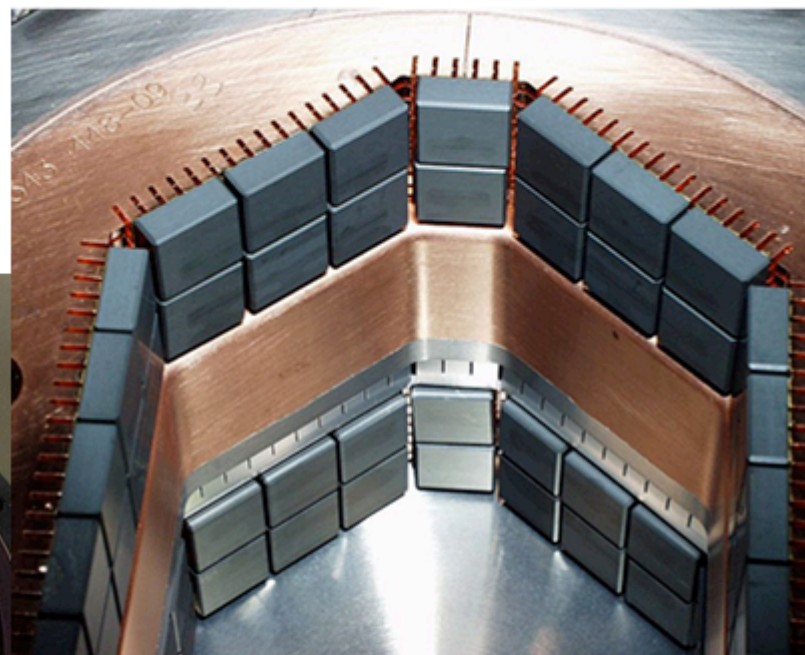
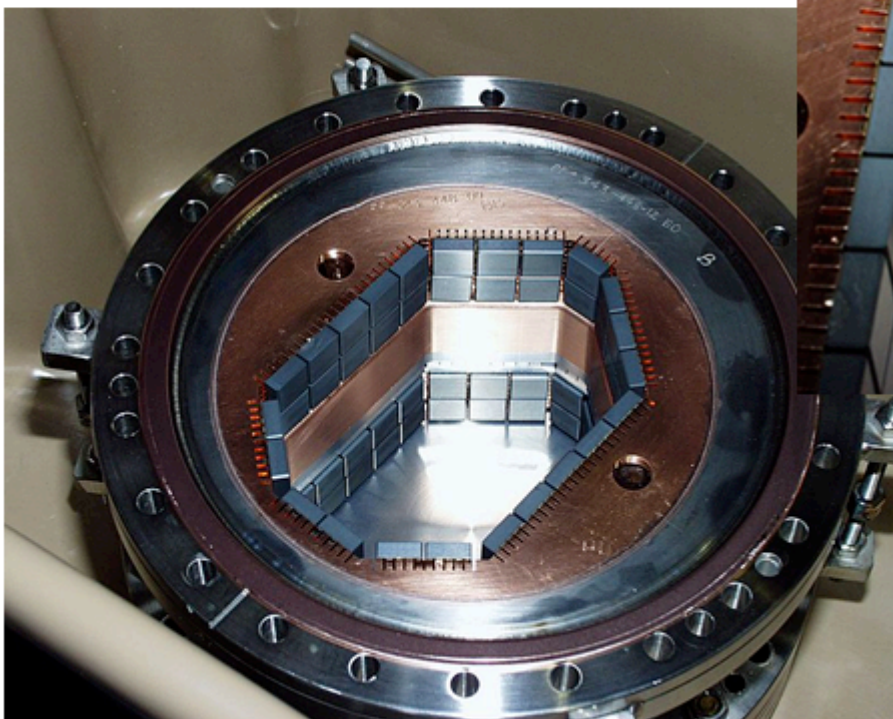


S. Metcalfe

High power separation chamber



Q2 Bellows section



Bellows are fully compressed in pictures



“Discharge” on Absorbing Tile

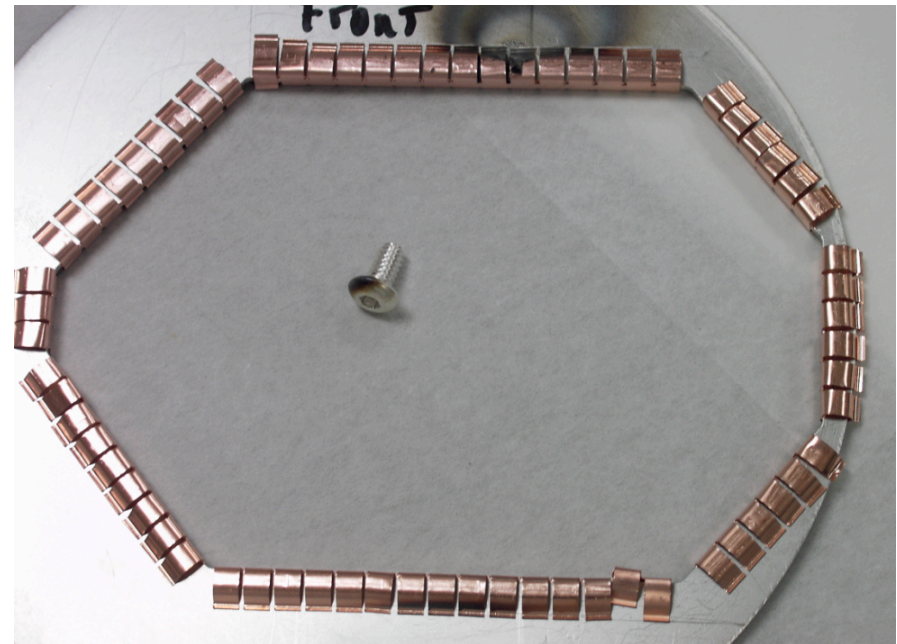
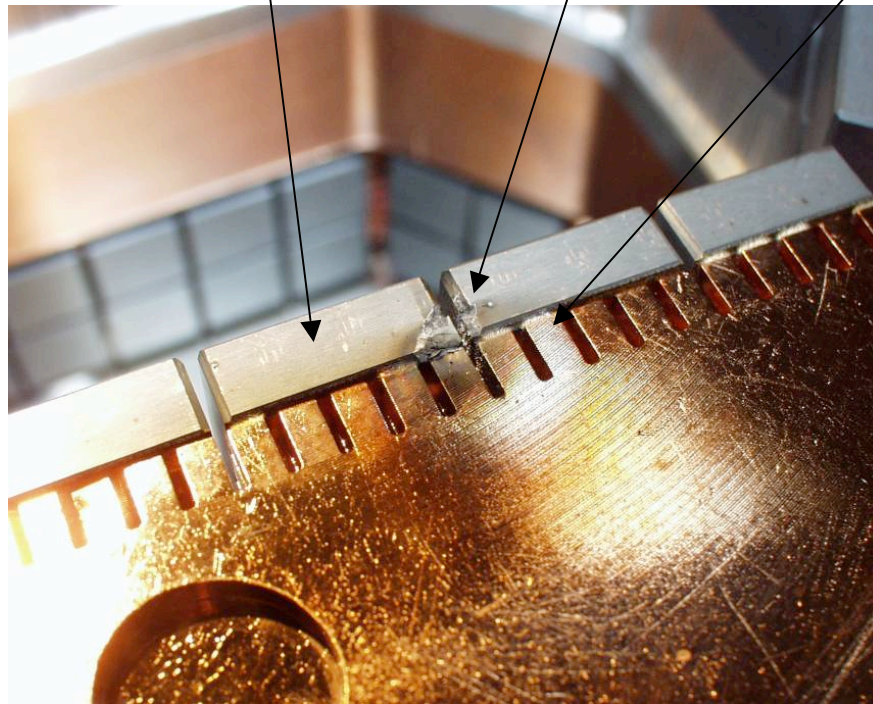
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SiC/AlN
HOM Tile

Arc site

Cu heat sink

RF seal fingers

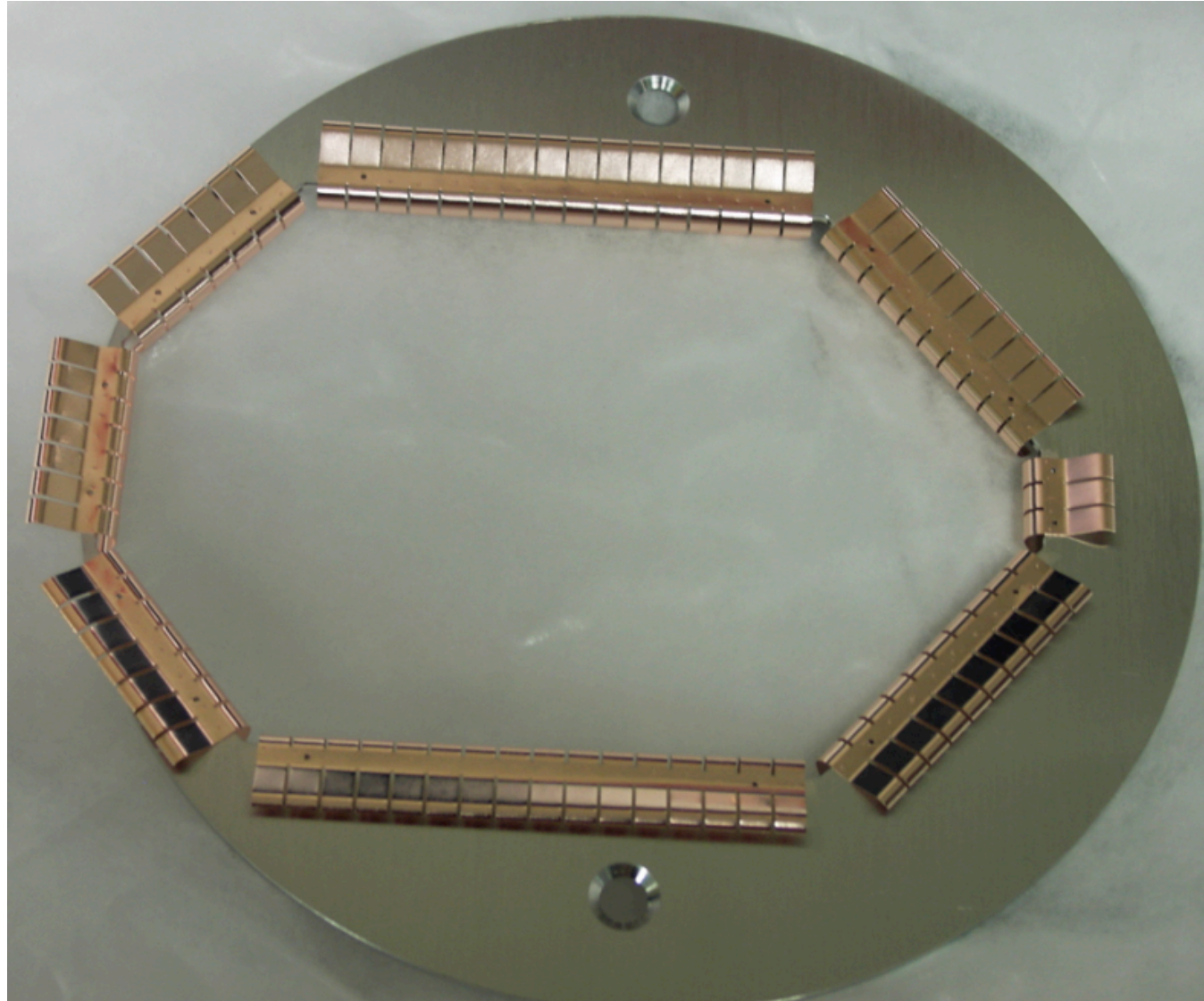




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New RF seal to correct problem: New seat on Cu base not tile

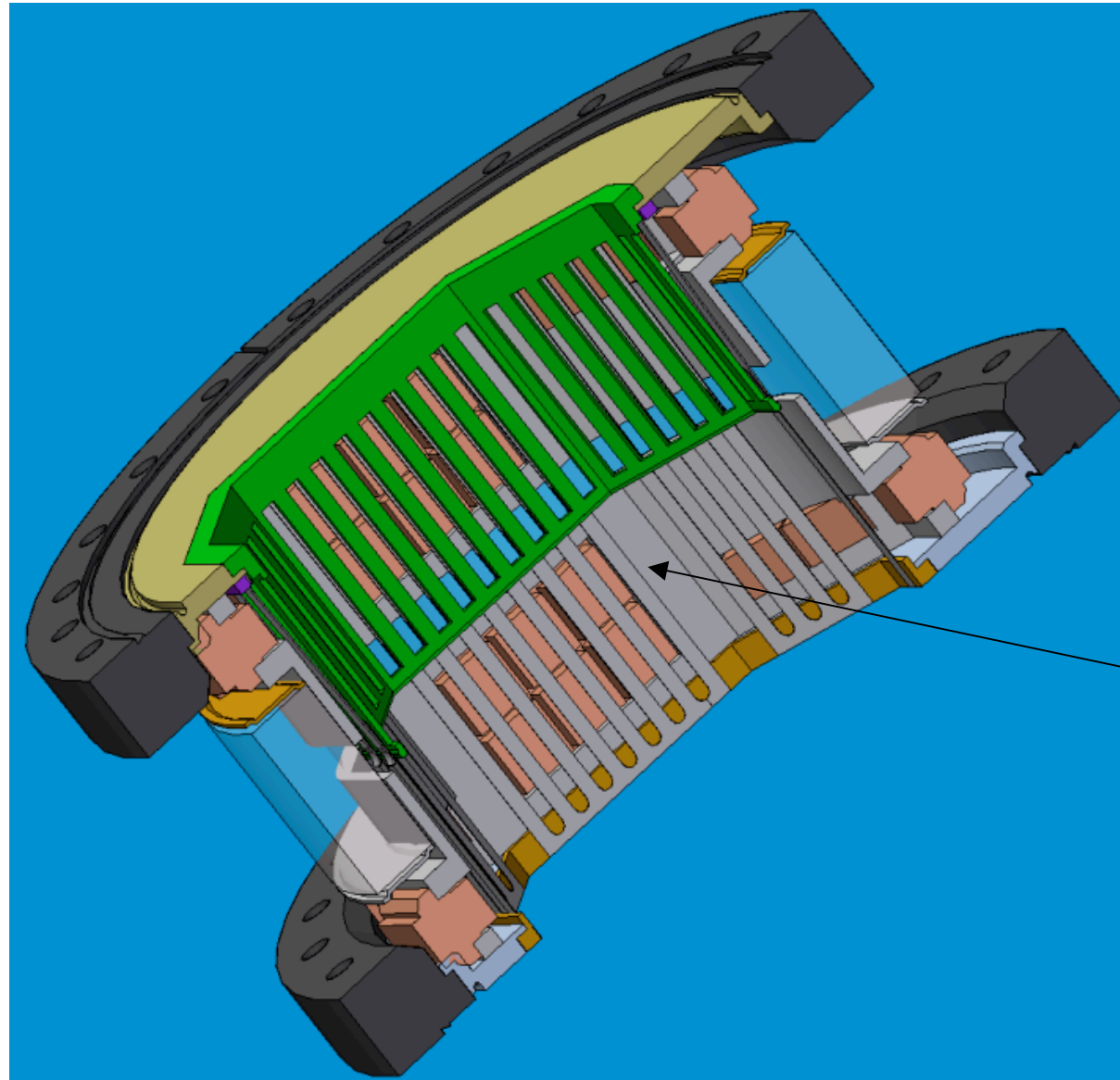
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N. Kurita



New HOM bellows install Fall 2006



Tiles behind
Fingers

N. Kurita
Novokhatski
Weathersby
April 2006



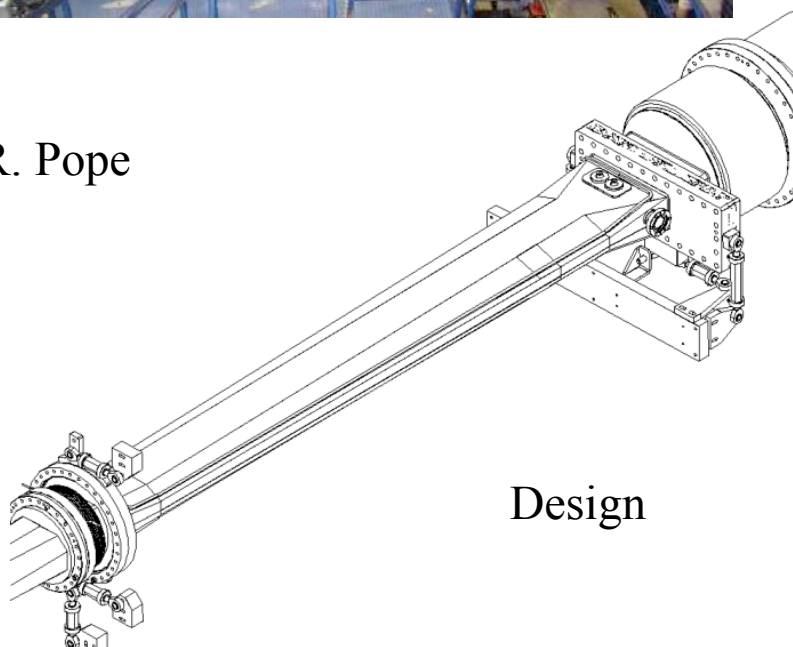
Example: HER QF5R Chamber (Fall 2006)



Specifications

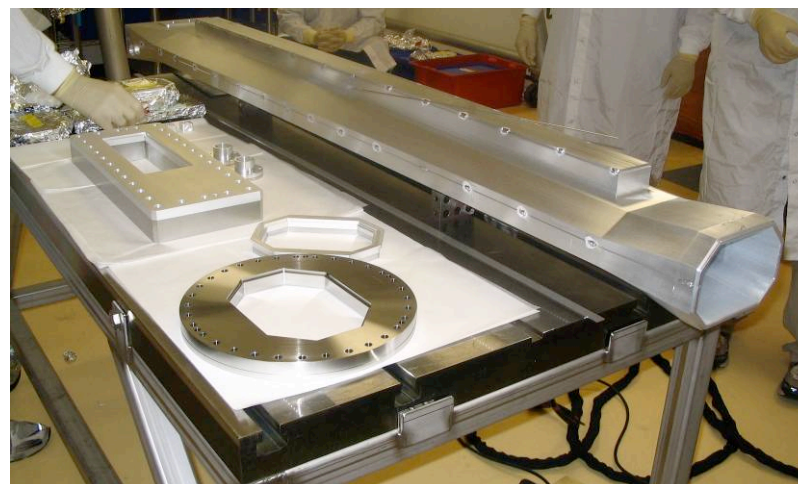
- HER beam current: 2.2 A
 - No LER fans.
 - No SR heating during normal operation.
- HOM and I2R power: 1kw/m, [8 cooling channels required](#).
- BSC: $12 \sigma_x \times 8.7 \sigma_y$, ([Q2R still limiting aperture](#))
- SR [missteering](#) envelope through Q4R-Bellow-Q5R-Frangible Link:
 - x offset : -2 mm / +7 mm, x angular: -0.5 mrad / + 0.5 mrad
 - y offset : -3 mm / +3 mm, y angular: -1 mrad / + 1 mrad
- Vacuum load 14.7 psj.
- Q2R Chamber remains. Aperture is a constraint.
- Chamber-to-magnet clearance: 0.080" (2 mm) to the pole and 0.120" (3 mm) to the coil.
- 1:10 tapers (5.7 degree)
- < 0.5mm (0.02") transverse steps.
- Improve BPM stability
- Improve mechanical reliability.
 - Missteer.
 - Load on Q2

R. Pope



Design

Construction





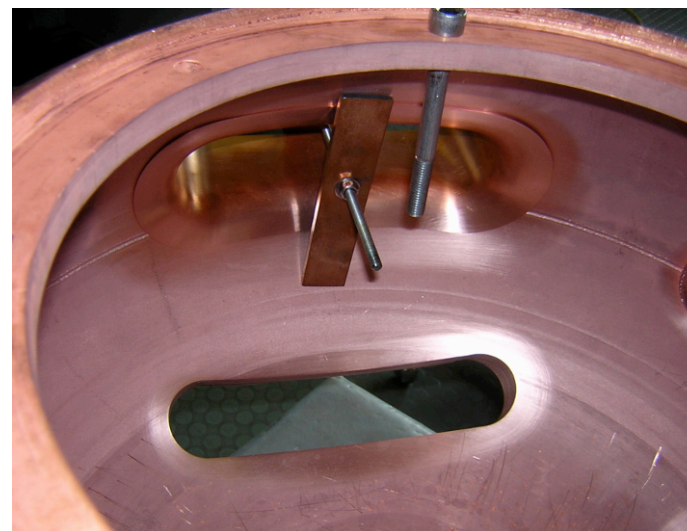
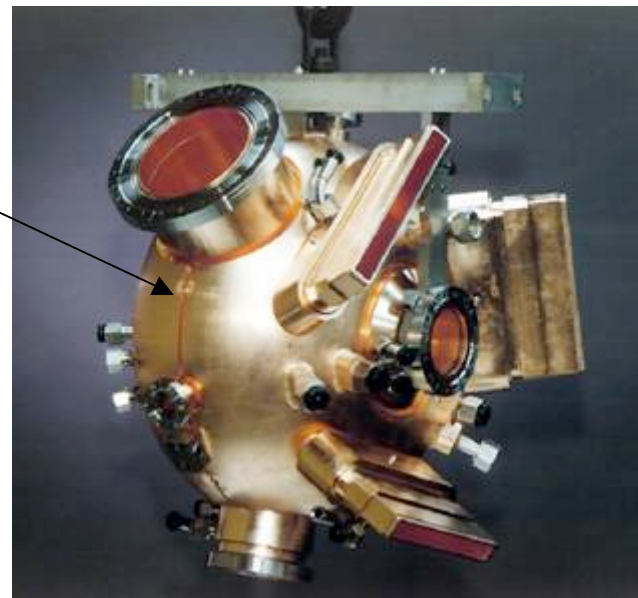
RF Cavity Production

●
ACCEL Germany

Finished cavity

Ports to be welded

Cavity bowls welded together.
Installed in November 2006.



H. Schwarz, A. Hill



B-Factory RF Klystrons (1.2 MW) under construction

-

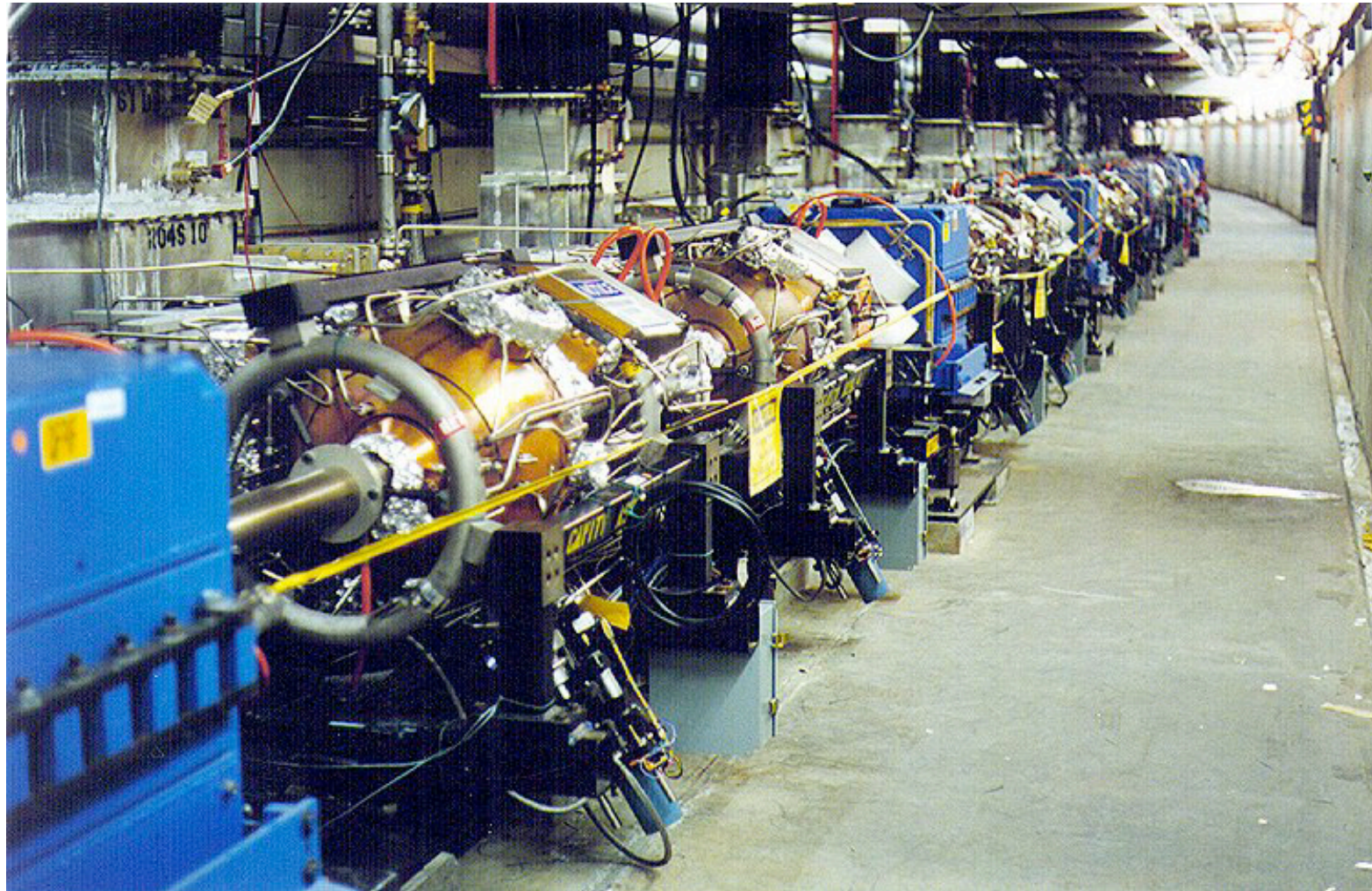


C. Pearson

HER has all SLAC klystrons now!



PEP-II RF Cavities



BR_049

HER Cavities Region 12

8-19-97



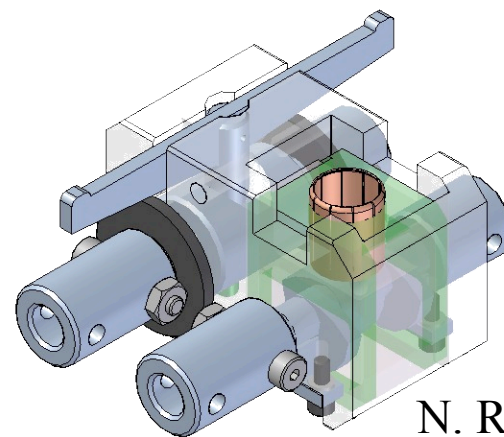
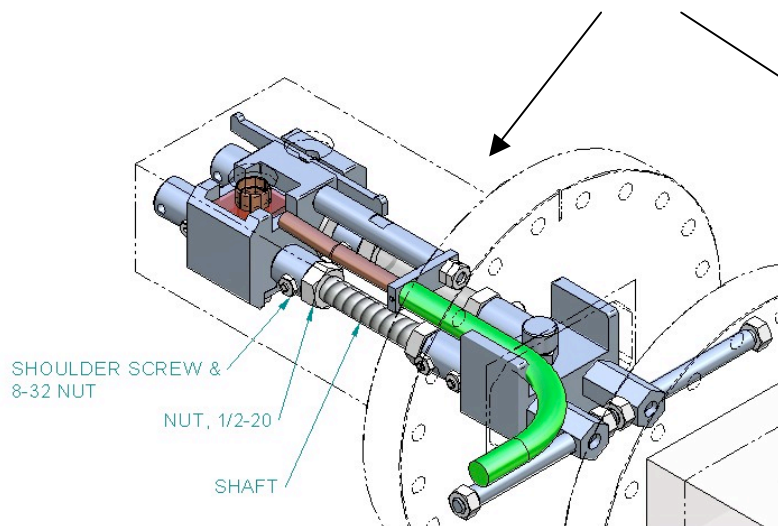
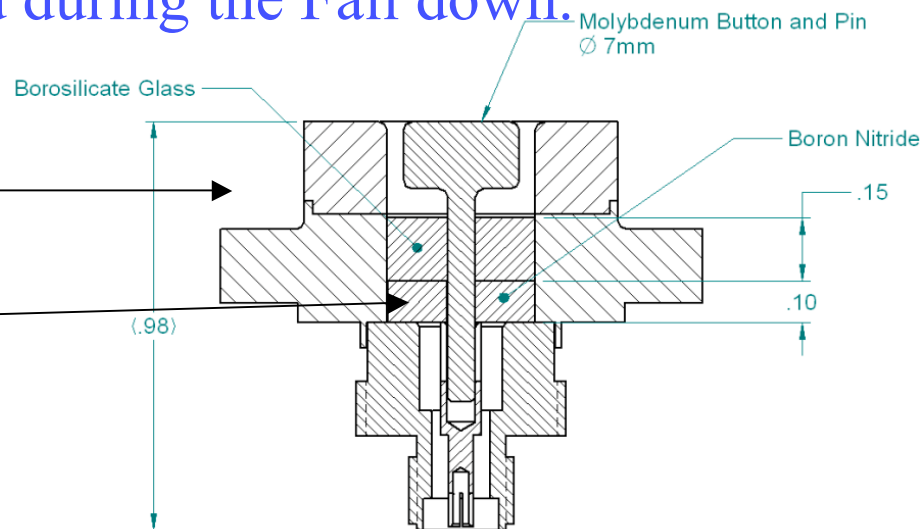
New LER Beam Position Monitors

- ~700 BPM buttons changed during the Fall down.
About 150 to go!

New button design

HOM absorber

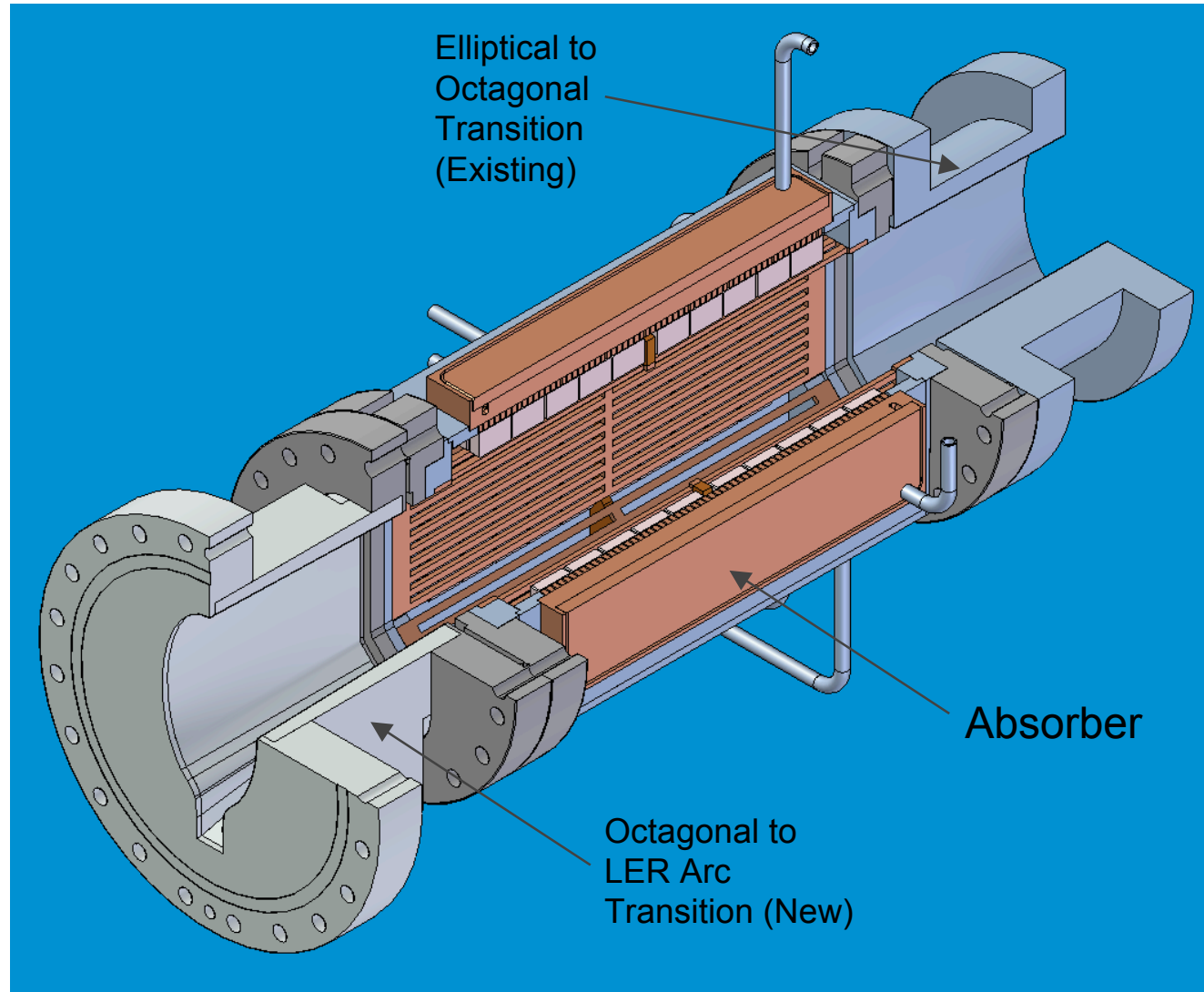
Button puller design



N. Reeck
M. Kosovski
N. Kurita



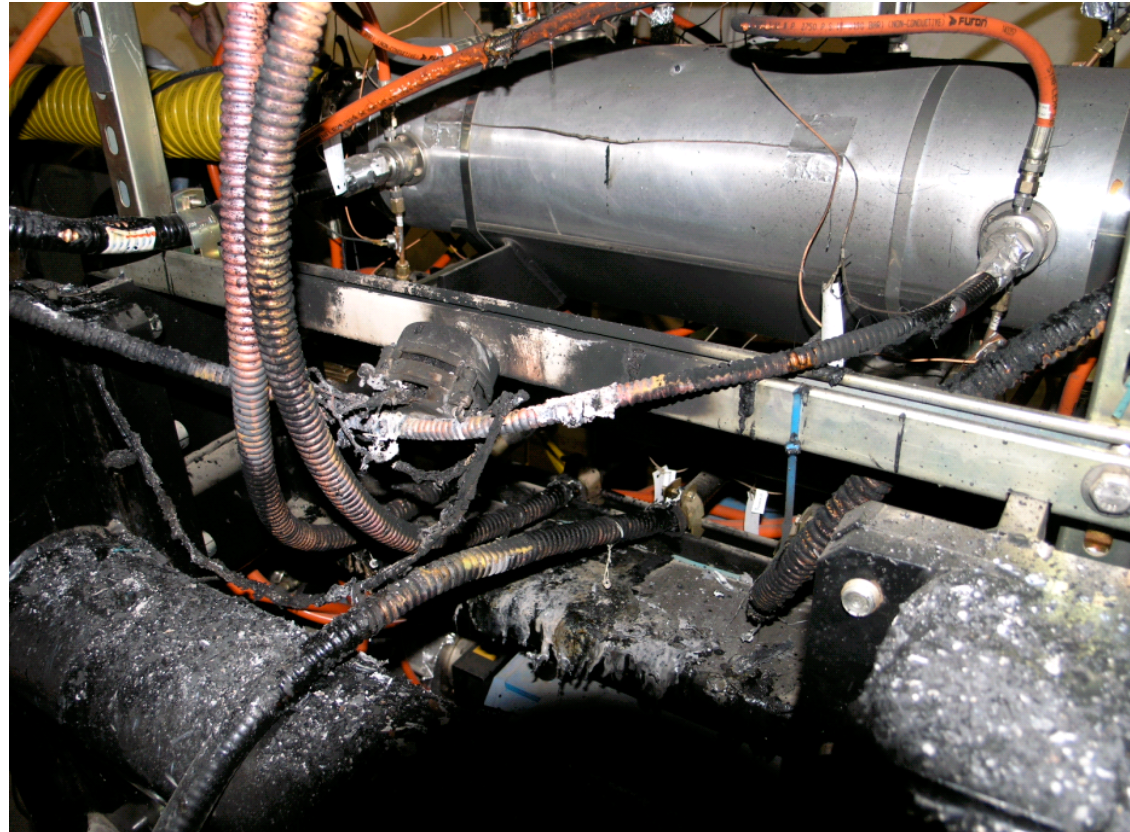
New HOM absorber near IR2 gate valve





Fire Recovery from August 18.

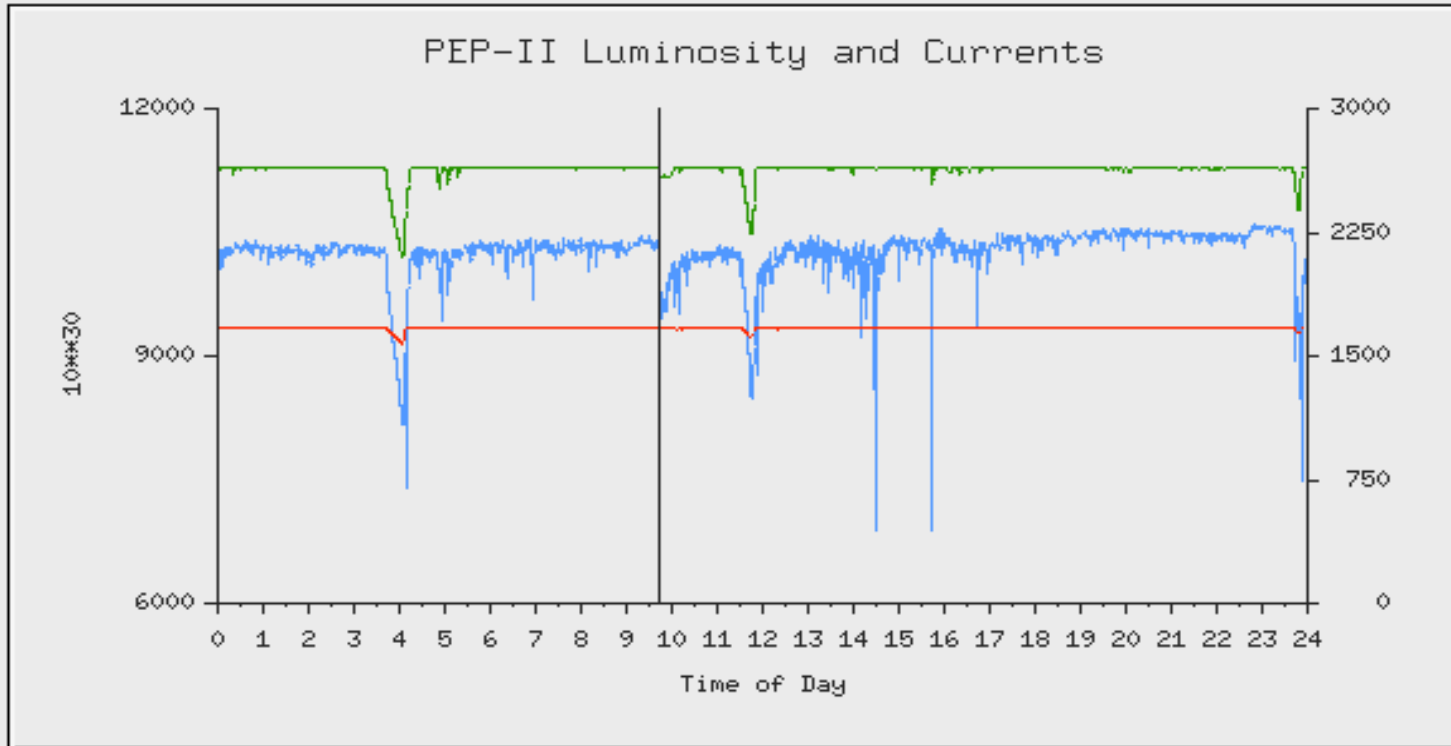
- Fire damaged cables repaired with hard work from Power Conversion and Controls Departments. Preventative measures installed. Should not happen again.





Good day in Summer 2006

I HER	I LER	Luminosity	Spec Lum	E HER	E LER	E CM
1680.41	2649.57	10366	4.01	8917	3120	10549
mA	mA	$10^{30}/\text{Sec}$	$N \cdot 10^{30} / \text{mA}^2 / \text{Sec}$	MeV	MeV	MeV
HER N Buckets / Pattern			LER N Buckets / Pattern			
1722 0=1;3442=0.96;0:3442:2=			1722 0:3442:2			
Last Owl/Day/Swing/24hr		293.9	290.4	299.4	883.7	Shift: 65.85 /pb
Peak Luminosities		10510	10587	10608	10515	



06/12/2006 09:45:16



Future PEP-II Overall Parameters and Goals

Parameter	Units	Design	Present best	2008 goal
I+	mA	2140	2940	4000
I-	mA	750	1940	2200
Number bunches		1658	1722	1732
β_y^*	mm	15-20	10	8
Bunch length	mm	15	11-12	9
ξ_y		0.03	0.047-0.065	0.054-0.07
Luminosity	$\times 10^{33}$	3	12	20
Int lumi / day	pb^{-1}	130	911	1300

4 times design

7 times design



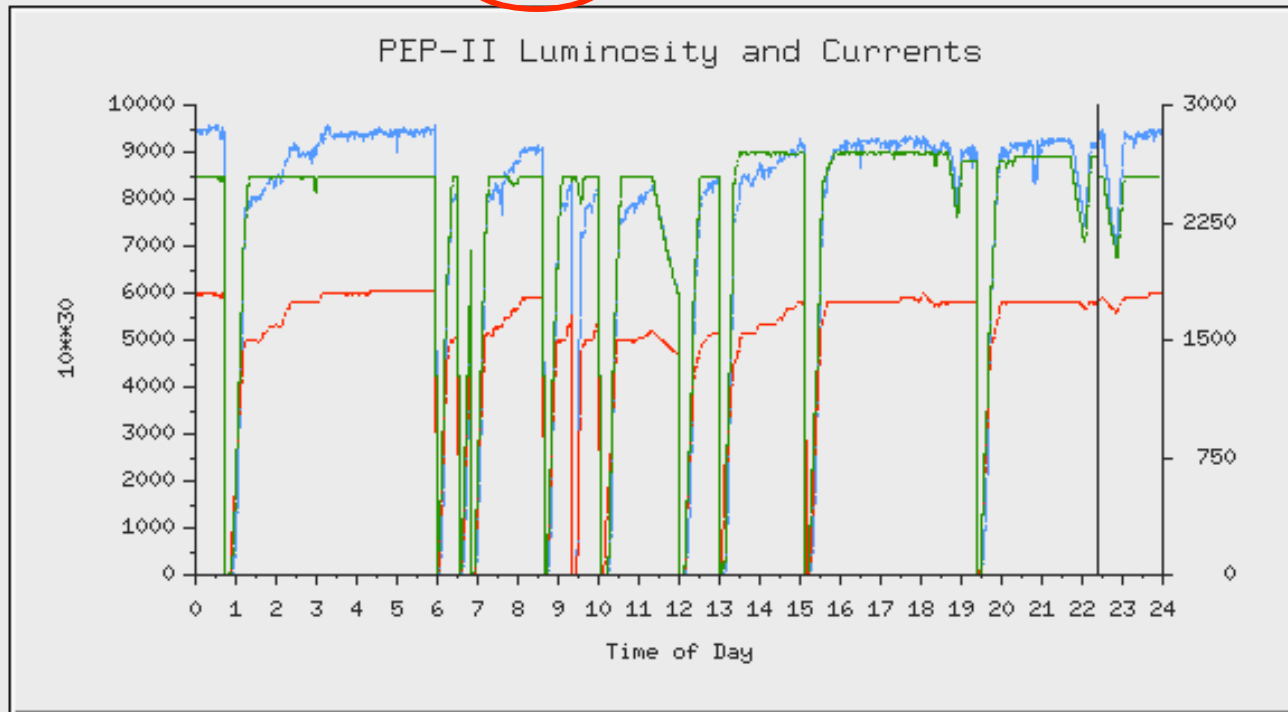
Run 6 January-February Issues

- The shut down extended a week longer to get all items done.
- RF stations were more difficult to turn-on than usual (+ two new ones). Many small items.
- A re-installed gate valve still over heated even with new HOM damping unit nearby and had to be removed.
- Two vacuum leaks in Region 6 had to be fixed.
- Pulled off BPM button heads in IR2 needed new amplifiers installed for ones with “broken pins.”

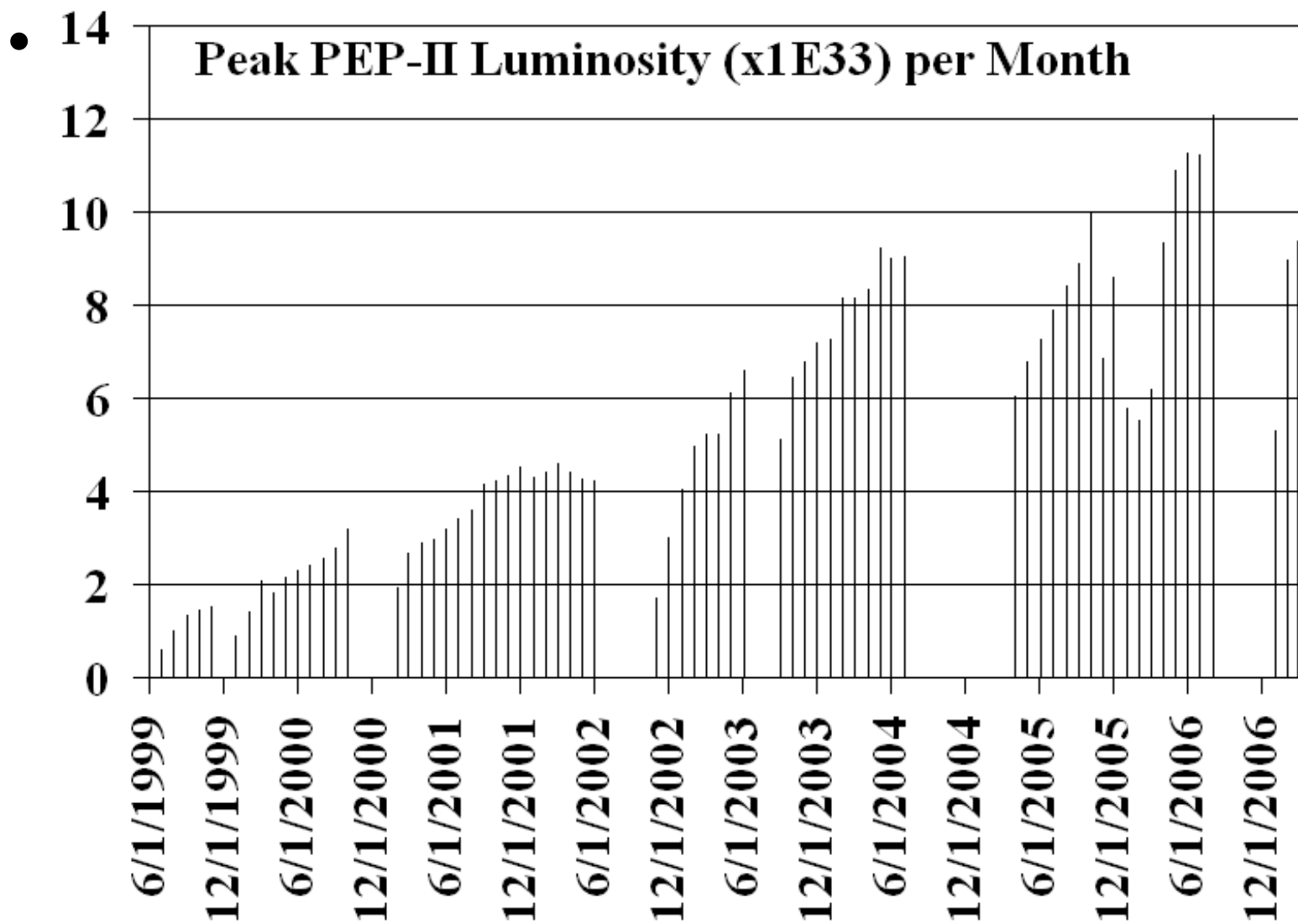


Luminosity March 18, 2007

I HER	I LER	Luminosity	Spec Lum	E HER	E LER	E CM
1750.27	2675.12	9253	3.40	8985	3121	10580
mA	mA	$10^{30}/\text{Sec}$	$N \cdot 10^{30} / \text{mA}^2/\text{Sec}$	MeV	MeV	MeV
HER N Buckets / Pattern			LER N Buckets / Pattern			
1722 0:3442:2			1722 0:3442:2;0=.95			
Last Owl/Day/Swing/24hr		214.4	175.4	205.6	595.3	Shift: 197.92 /pb
Peak Luminosities		9656	9303	9573	9429	



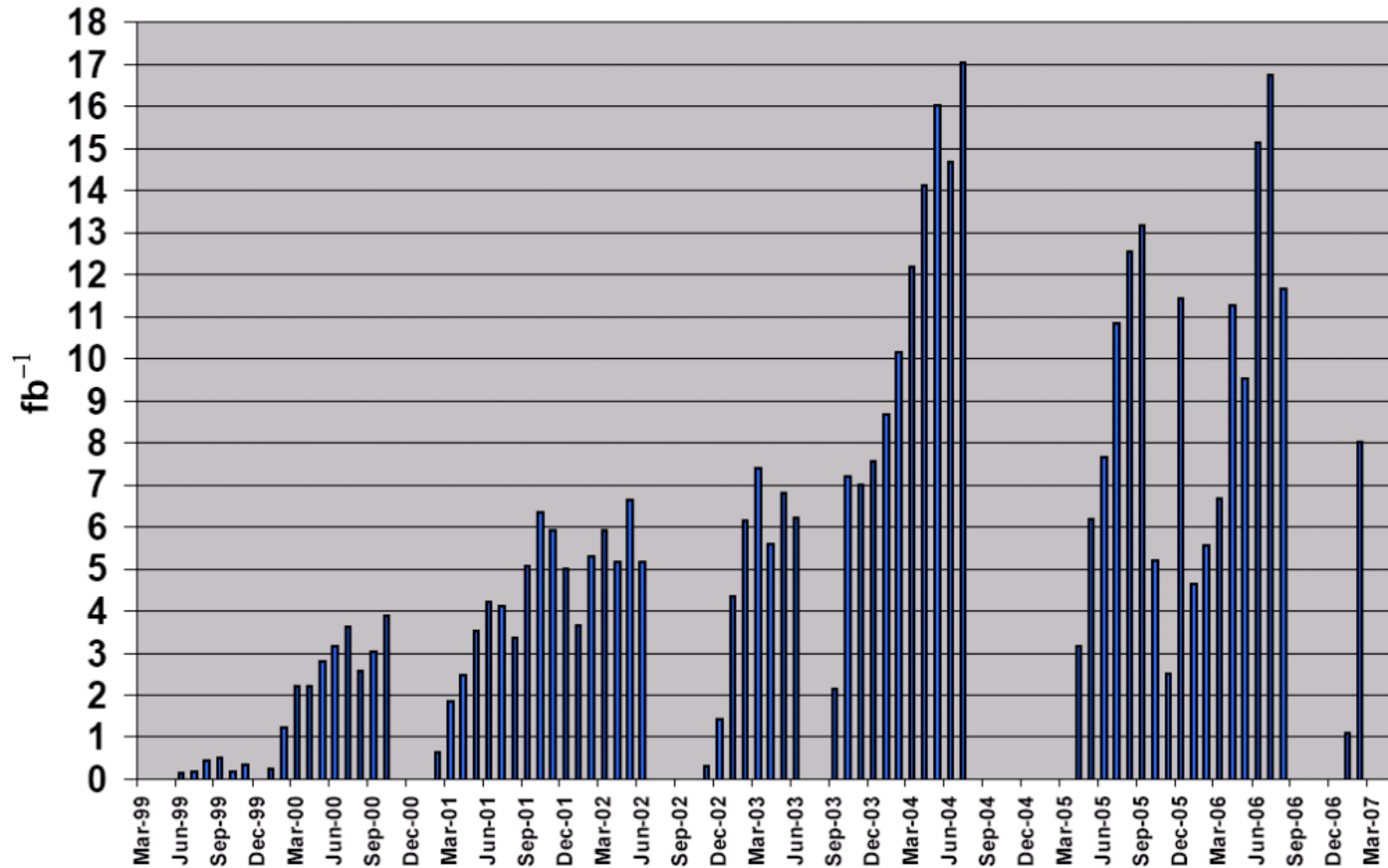
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Last updated:
2/26/2007
17.AE

PEP-II Monthly Integrated Luminosity



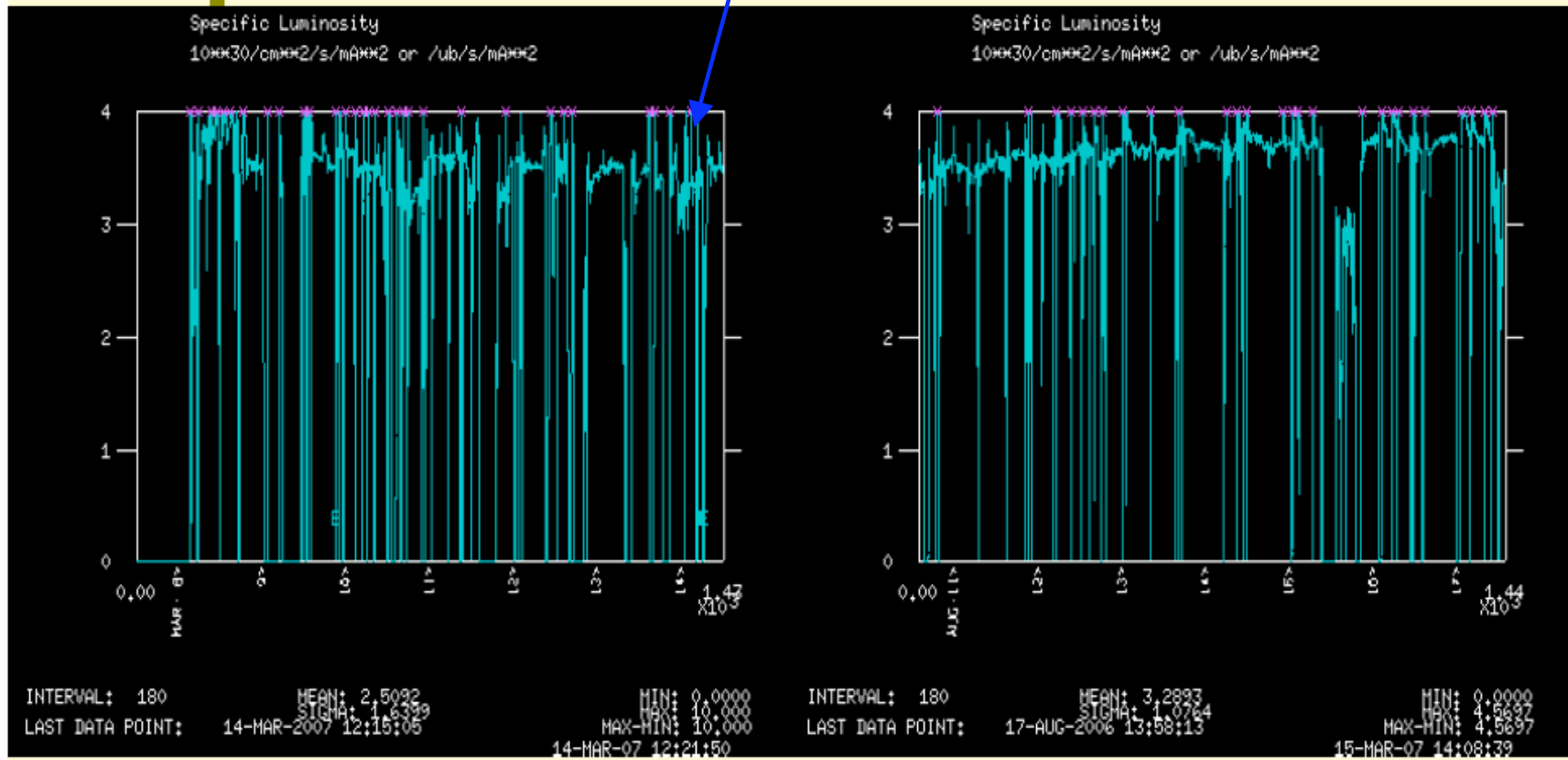


Specific Luminosity March 2007 vs Aug 2006



Sp. Lumi now, 10...17-Aug

Sp. Lum 10% down



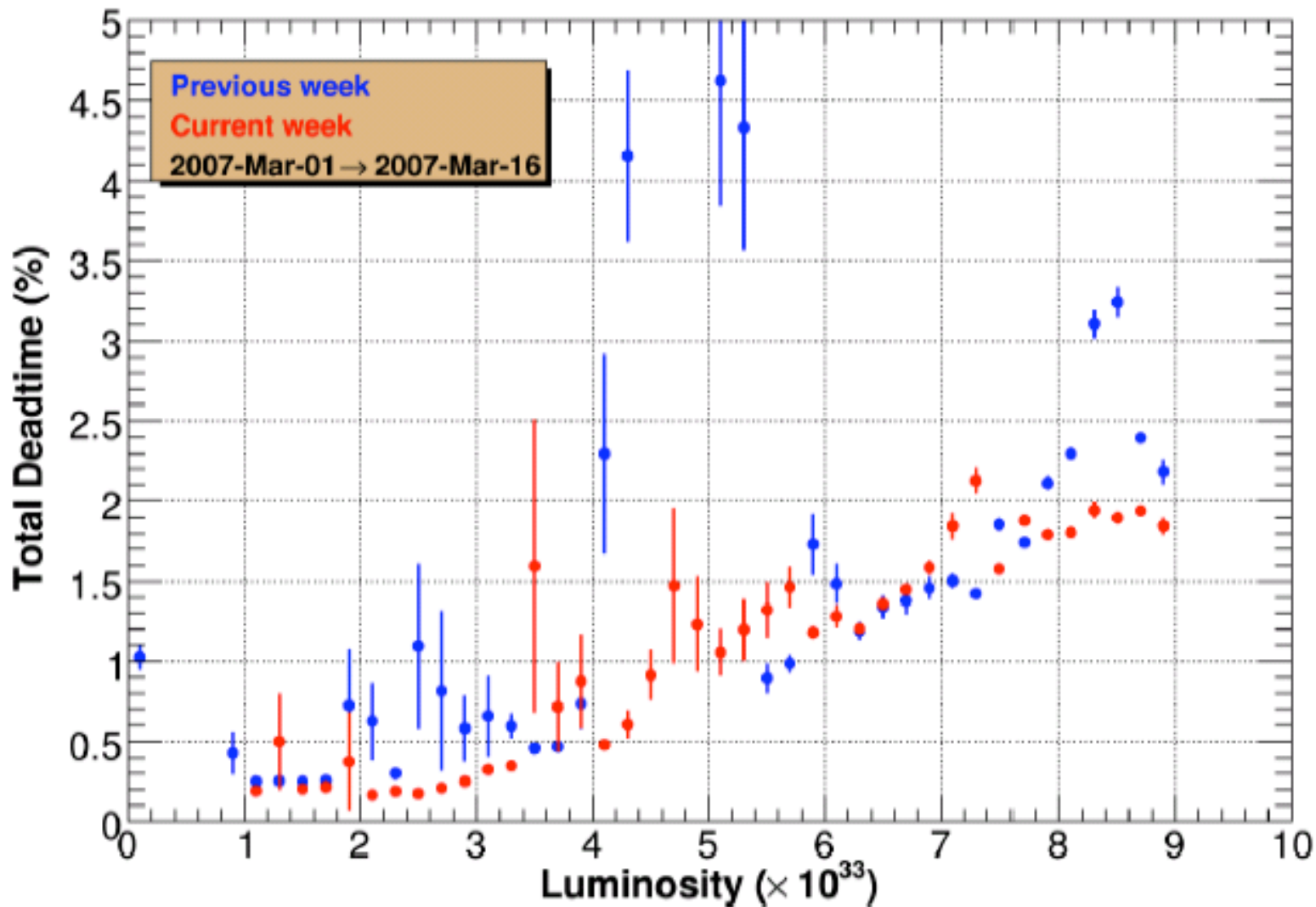


Lattice summary

- β^* values:
 - HER now: x: 42 cm, y: 9.4 mm,
16-Aug: x: 77cm, y: 9.9 mm
 - LER now: x: 34 cm, y: 7 mm,
16-Aug: x: 20 cm, y: 7.3 mm
- β beat:
 - HER **x significantly different**
 - LER, HER y not as much different



Detector Dead Time (~2 %) in Continuous Injection





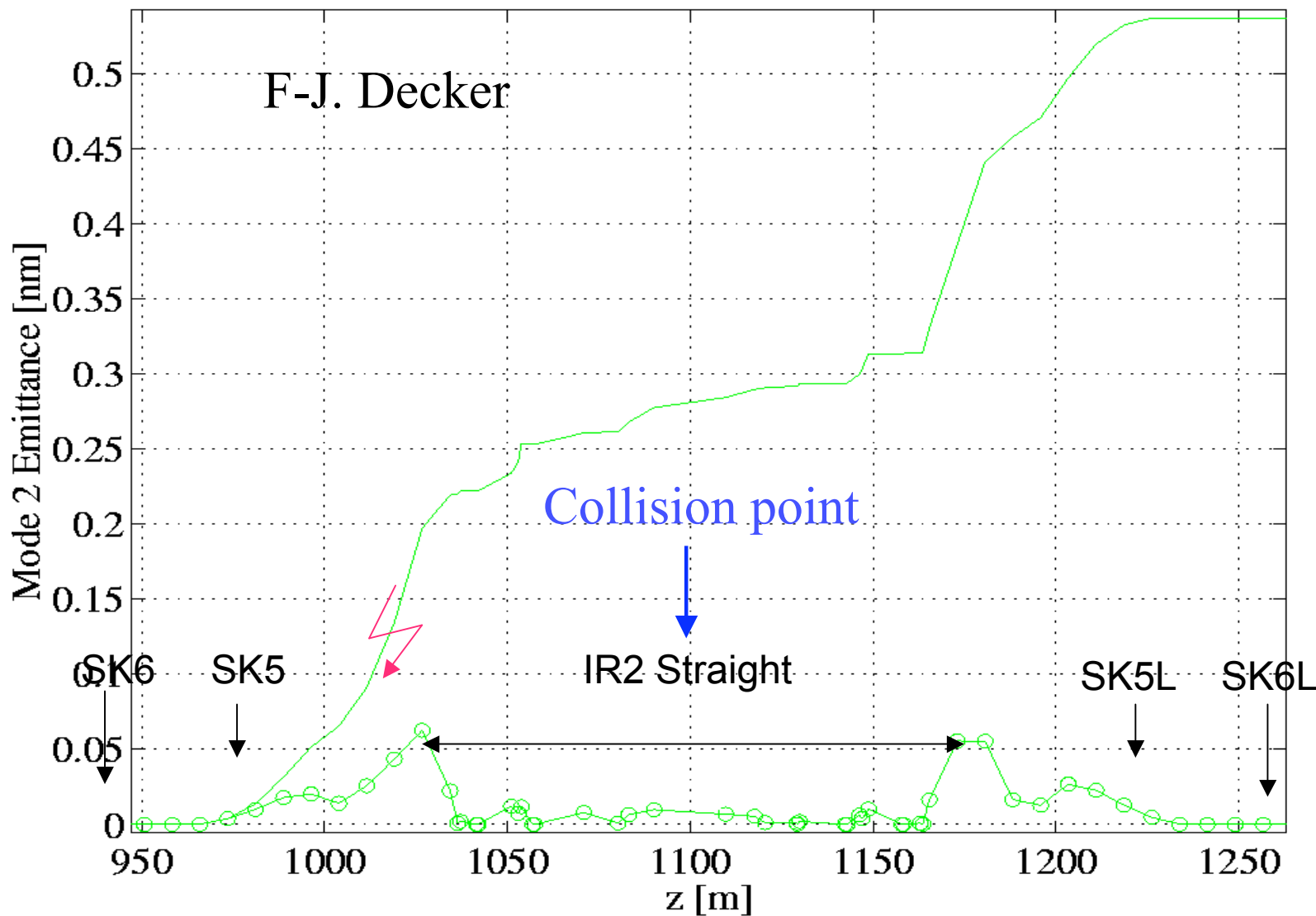
Near term activities

- Reduce number of RF trips
- Raise the beam currents.
- Move LER horizontal tune closer to half integer tune by lowering the “beta beats”
- Introduce the 90 degree lattice HER for shorter bunches
- Lower β_y^*
- Lower LER vertical emittance



PEP-II MAC: Reduce Vertical Emittances → Decker studies

LER Mode 2 Emittance Contribution and Increase along z





Formula used for H_y:

Y. Nosochkov:

$$\varepsilon_{x,y} = 3.84 \cdot 10^{-13} \gamma^2 \frac{\langle H_{x,y} / |\rho^3| \rangle}{J_{x,y} \langle 1/\rho^2 \rangle}, \quad \text{where} \quad H = \beta \eta'^2 + 2\alpha \eta \eta' + \frac{1 + \alpha^2}{\beta} \eta^2.$$

Formula used for H_2:

Valeri Lebedev:

- Then the emittance growth is

$$\frac{d\varepsilon_1}{dt} = \left\langle A_1 \frac{d}{dt} \overline{\left(\frac{\Delta p}{p} \right)^2} \right\rangle_s, \quad \frac{d\varepsilon_2}{dt} = \left\langle A_2 \frac{d}{dt} \overline{\left(\frac{\Delta p}{p} \right)^2} \right\rangle_s$$

Here: $A_{1,2} = \mathbf{D}^T \mathbf{B}_{1,2} \mathbf{D}$, $\mathbf{B}_1 = (\mathbf{V}^{-1})^T \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \mathbf{V}^{-1}$, $\mathbf{B}_2 = (\mathbf{V}^{-1})^T \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \mathbf{V}^{-1}$

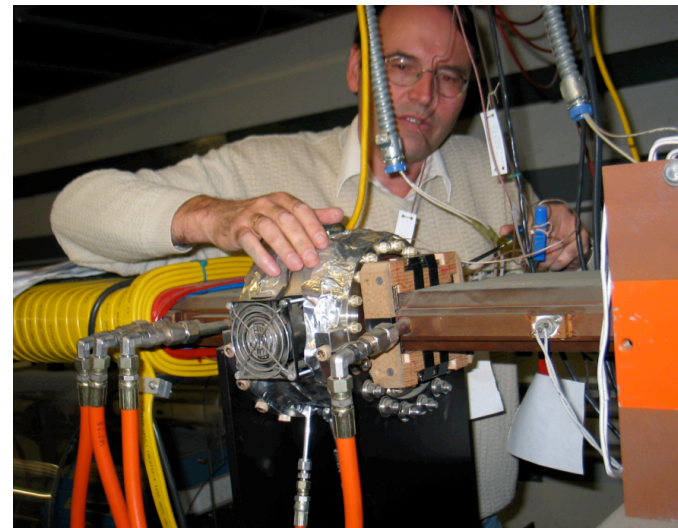
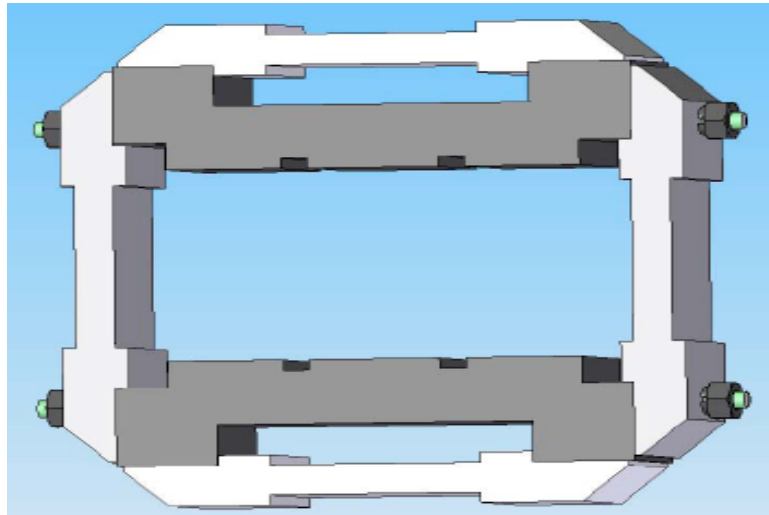
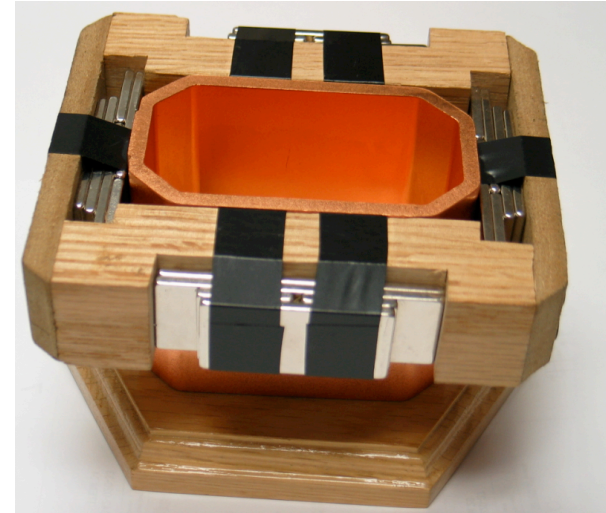


New skew magnets to cure LER Vertical Emittance
→ 10 to 50% gain at fixed currents

Physicist design (F-J. Decker)

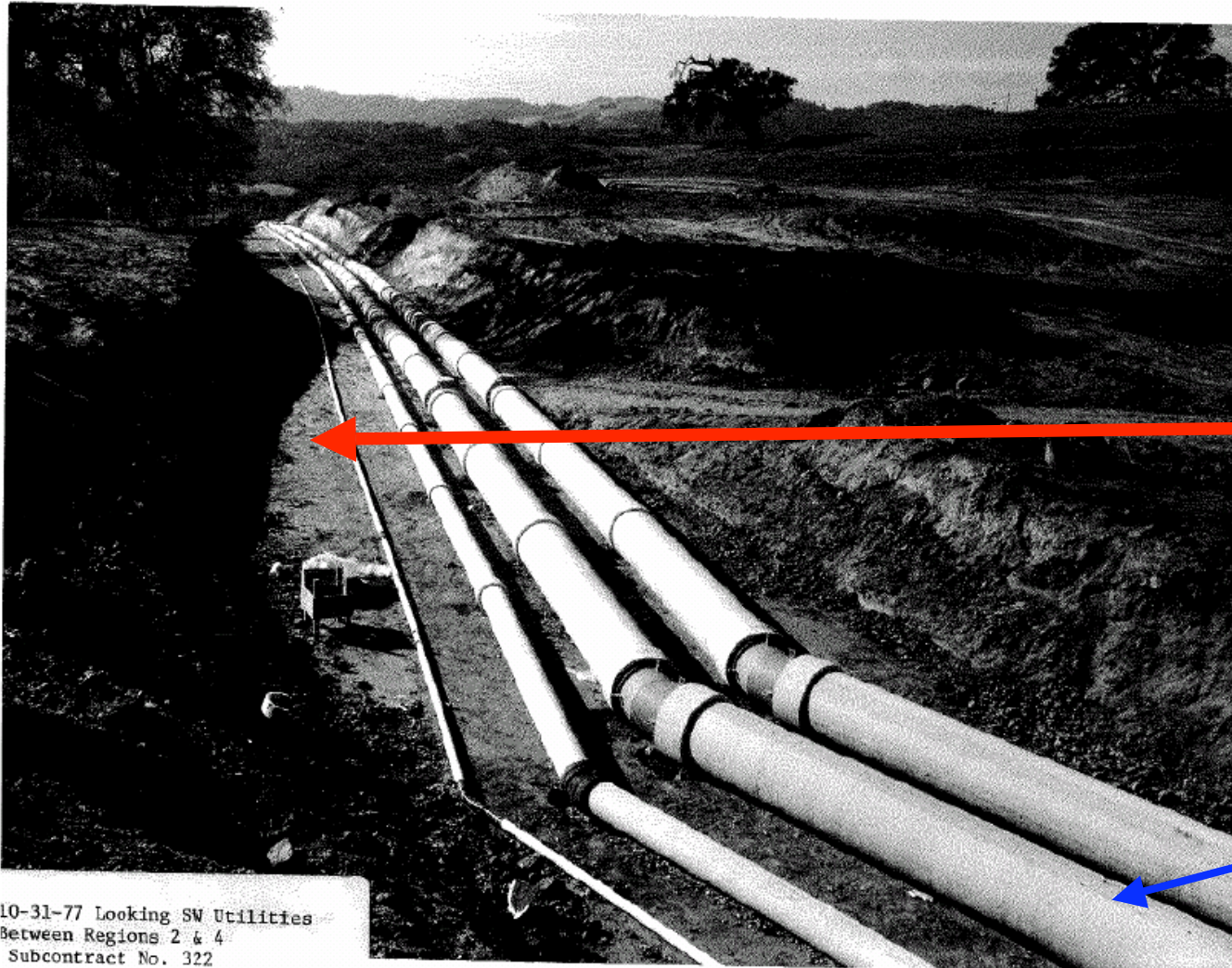
(Ready to go this week!)

Final mechanical design (Kharakh)





PEP-II Utility work in late March 2007 (3 days) for LCLS



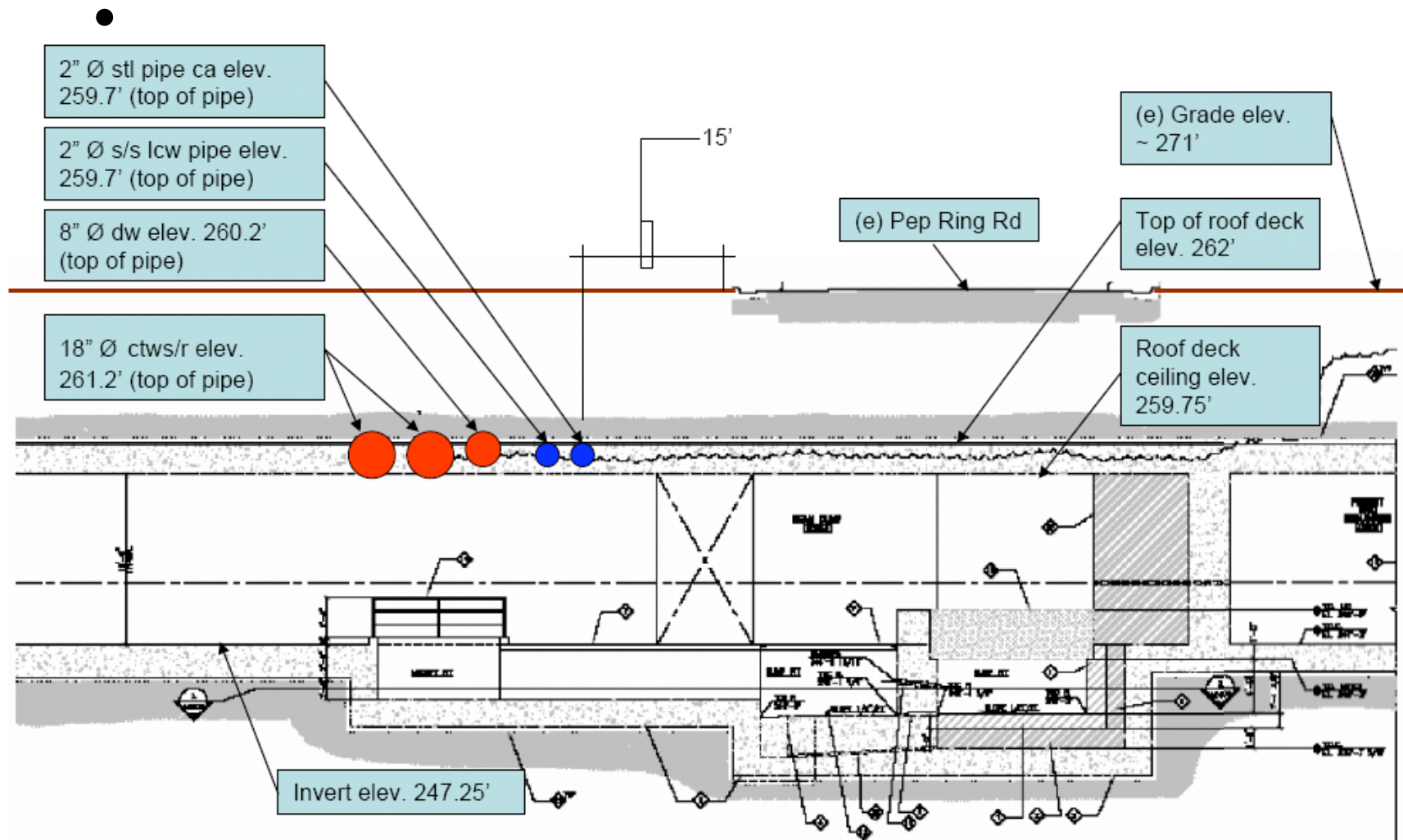
LCLS
tunnel

PEP-II cooling
water and
air lines

10-31-77 Looking SW Utilities
Between Regions 2 & 4
Subcontract No. 322



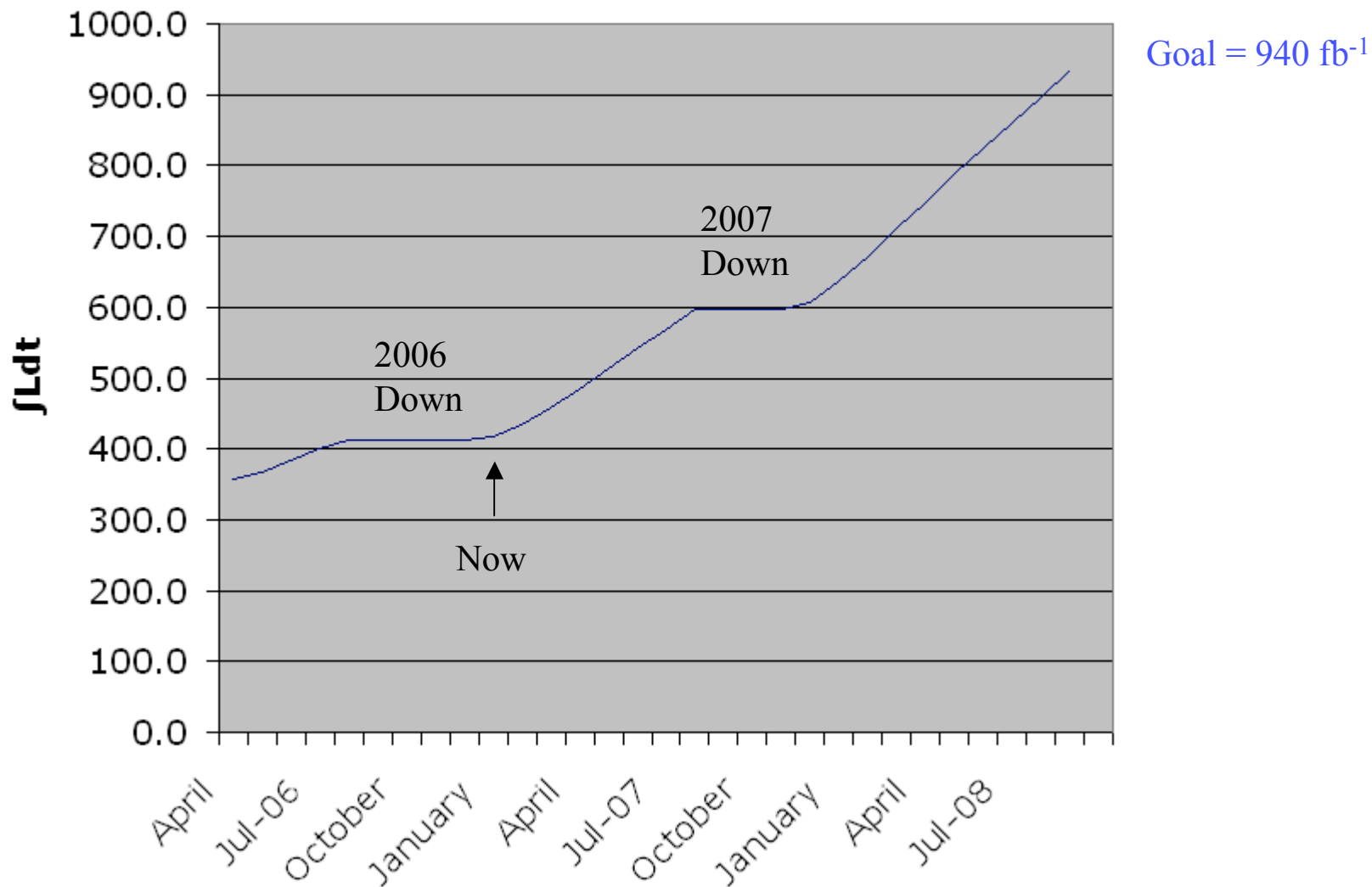
LCLS Tunnel Elevation View





Integrated Luminosity Projection from Summer 2006

- PEP II Integrated Luminosity (1/fb)**





Fall 2007 Down Activities (September 1-November 28)

- Finish LER BPM replacement if not done during Run 6.
- Install IR2 backward Q1-Q2 bellows unit.
- Replace about 10 to 20 HER Arc bellows units
- Replace 10 to 20 HER Arc “Omega Seals”.
- Install collimator in IR2 downstream LER if needed for reduced backgrounds.
- Install several LER higher HOM bellows.
- Install two new LER Q5 chambers in IR2.



Conclusions

PEP-II turn-on for Run 6 is about average historically although it seems more difficult.

The luminosity will be ramped as fast as possible (now 0.97×10^{34}) with the aim of about 1.7 this run.

Integrate-Integrate-Integrate!

Planning for the Fall 2007 down has started.

Upgrades towards $\sim 2 \times 10^{34}$ are mostly done.

Run plans are in place with target of about 1 ab^{-1} at the end of FY2008.

Turn off PEP-II September 30, 2008!