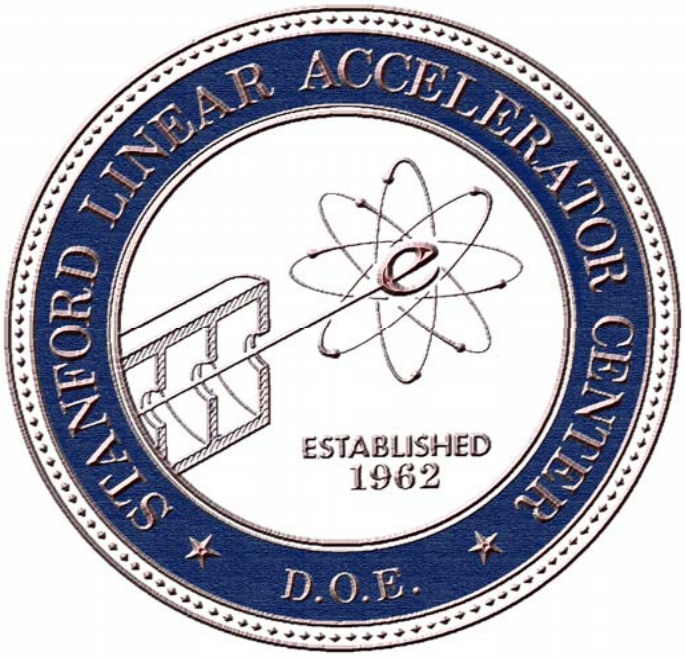
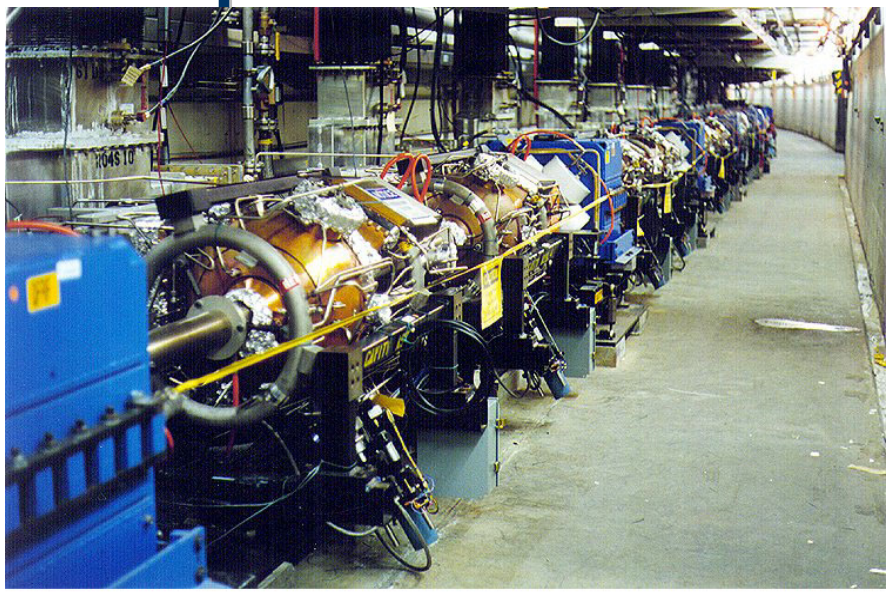
SLAC B Factory Program



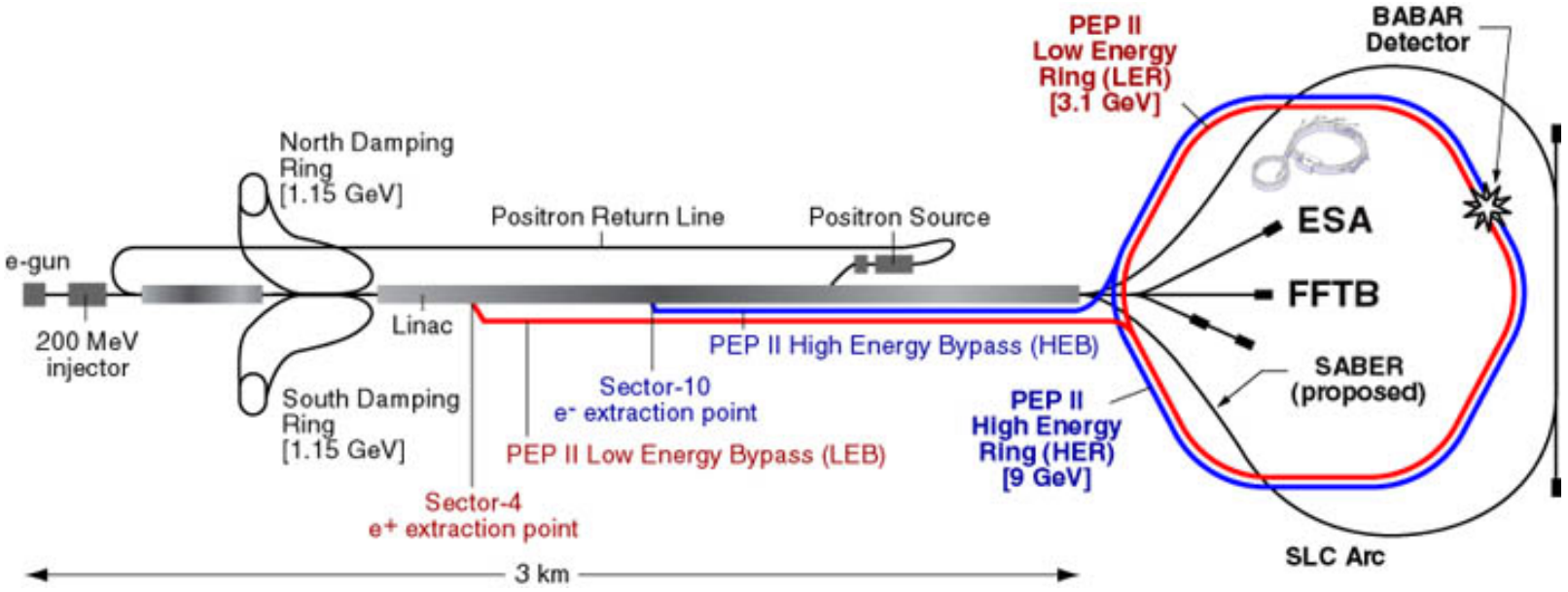
HEPAP Meeting

Washington DC, May 18, 2005

Linac/PEP-II Complex



BR_049 HER Cavities Region 12 8-19-97



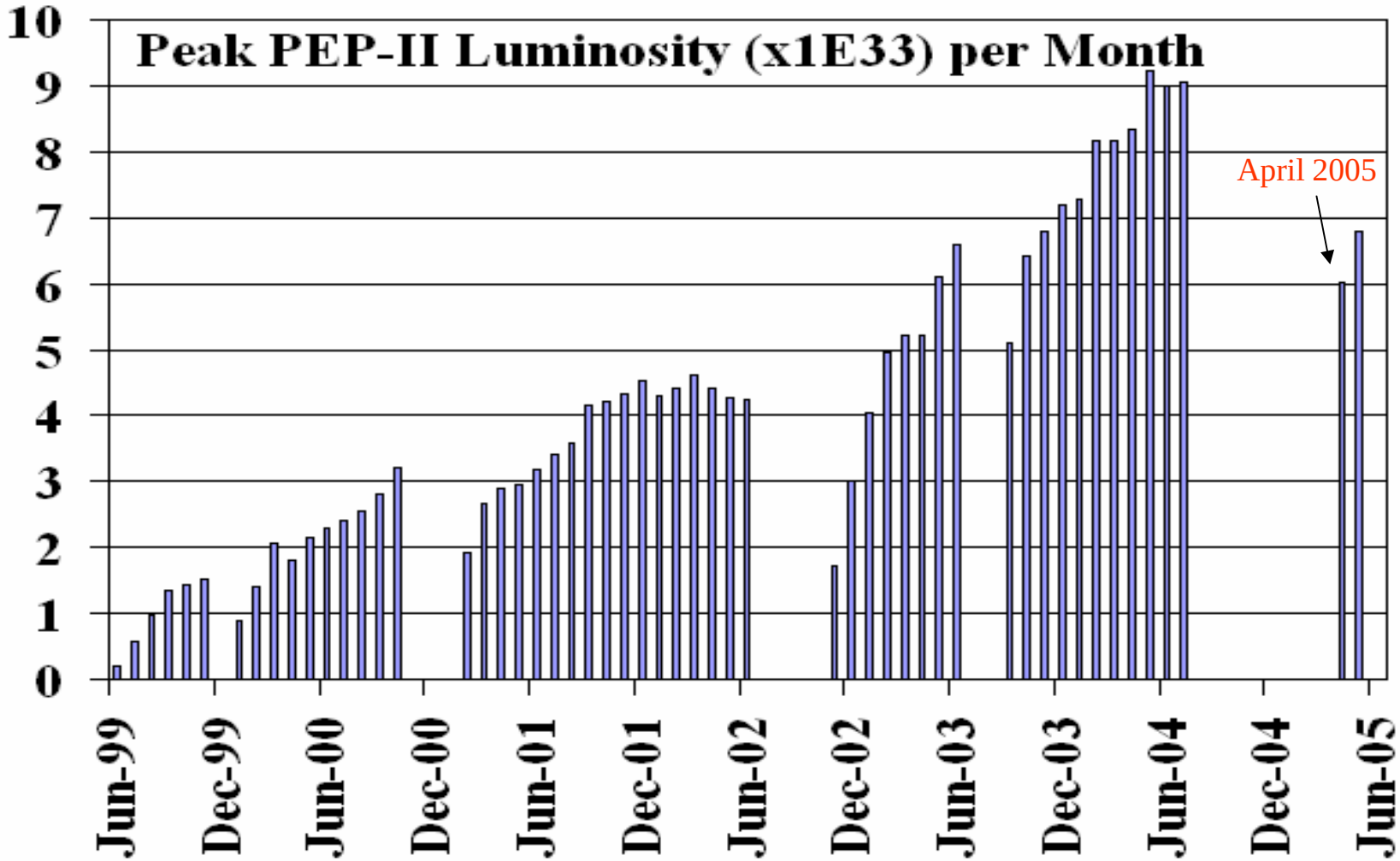
Summer 2004 PEP-II Improvements

- **IR2 south forward shield wall: Backgrounds**
- **Add another new Low Energy Ring (LER) RF station: Higher current**
- **Add a High Energy Ring (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**

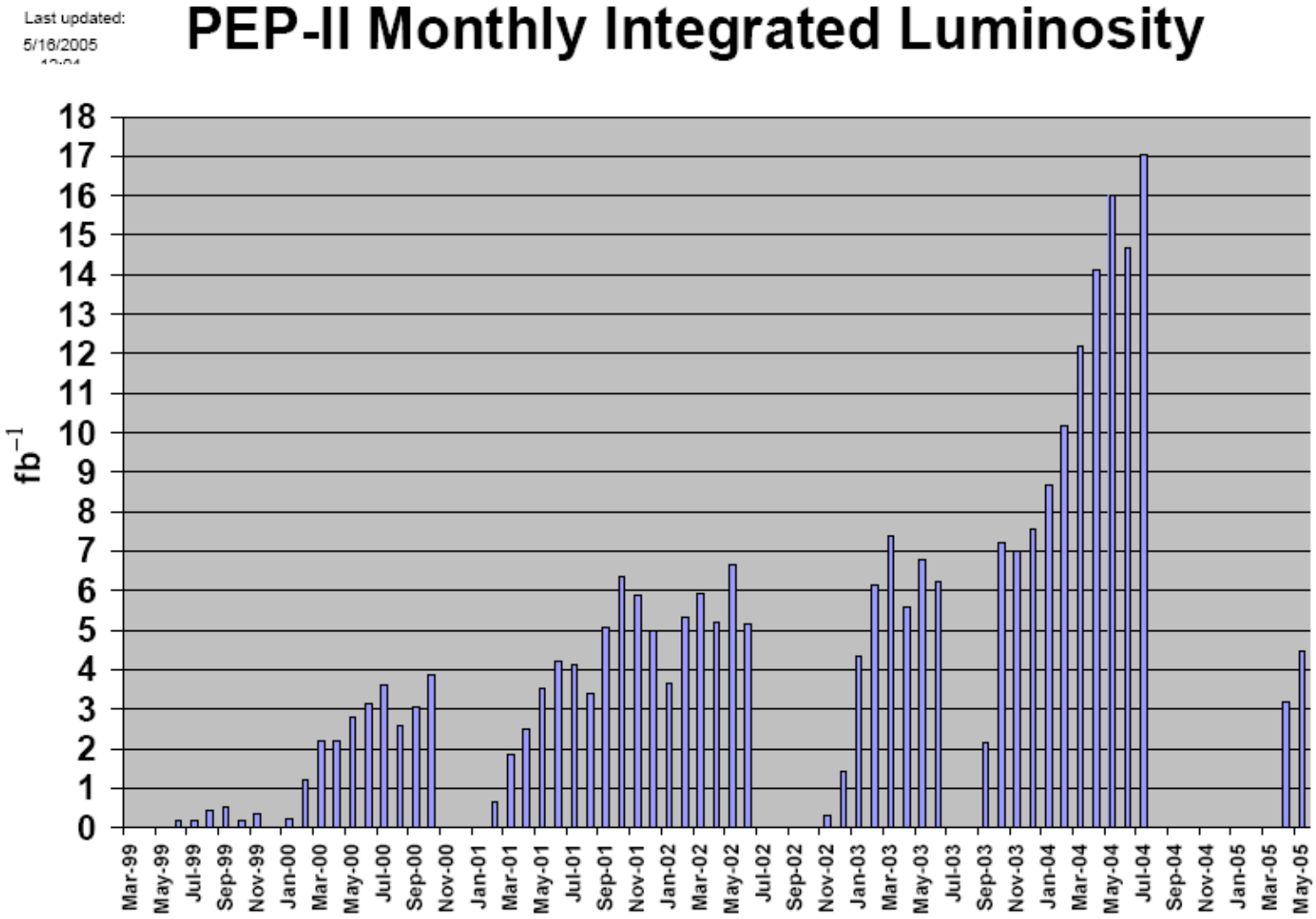
PEP-II Safety Planning and Restart Plan

- Electrical accident at SLAC on October 11, 2004. All running of accelerators suspended
- Type A Investigation October-December, 2004
- Corrective Action team: December 2004 –January 2005
- Safety training with new procedures October 2004 – March 2005
- Linac/PEP-II/BaBar Restart Validation Review: February – March 2005
- Linac and PEP-II operations start up April 2005
- Electron and Positron beams both at PEP-II rings April 14, 2005. Data logging began that weekend

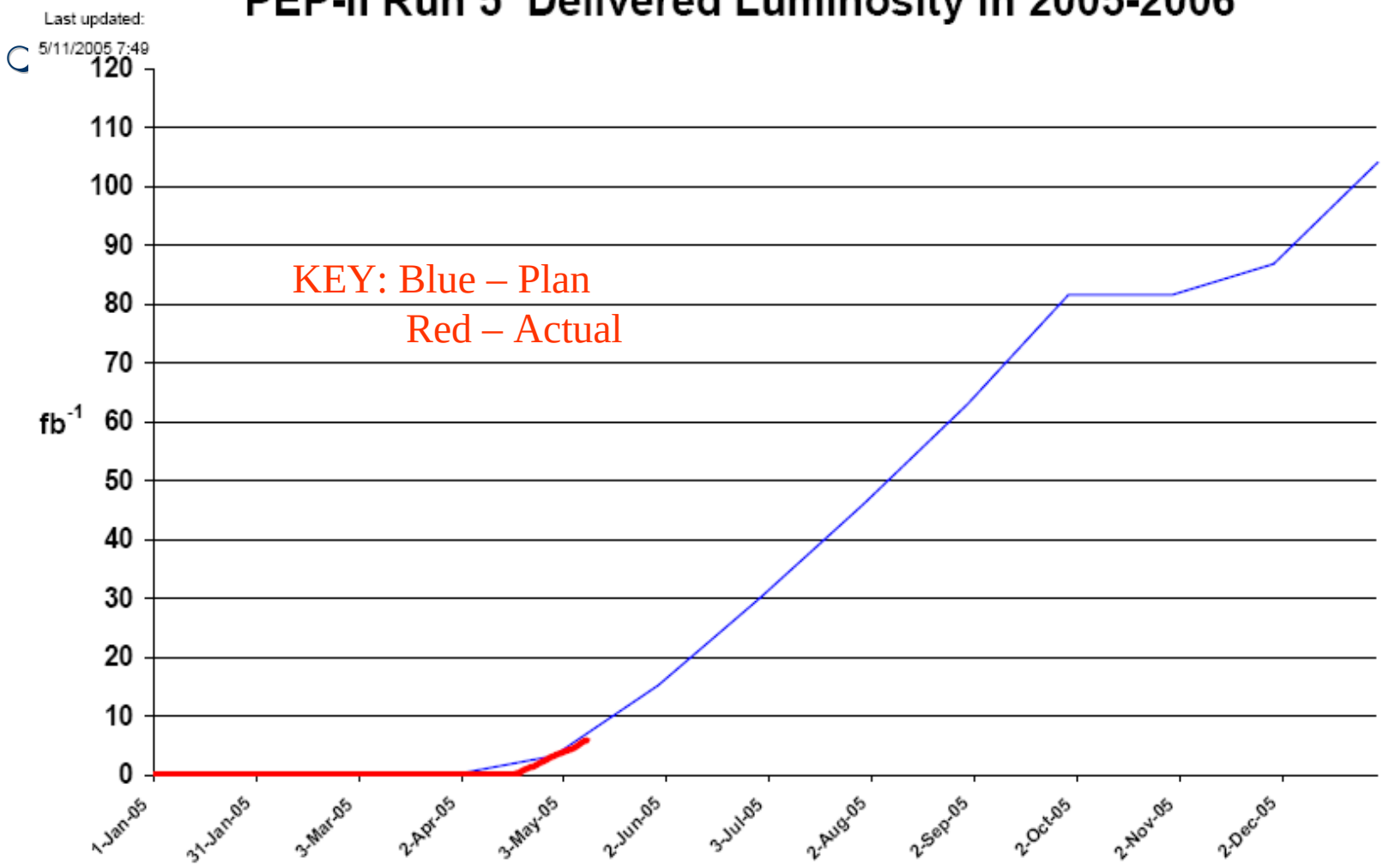
PEP-II Monthly Peak Luminosity



PEP-II/Babar are In Full Data-Taking Mode



Run 5 Data Accumulation Plan



Total Accumulated Data: 264 fb^{-1}

PEP-II Run Schedule

- PEP-II Run 5 started April 15, 2005
- Will collide steadily from April 2005 through July 2006 with a one month break in October 2005
- Down in 2006 August through November for BaBar and PEP-II upgrade work
- Three month down in Summer-Fall 2007
- Collide through September 2008

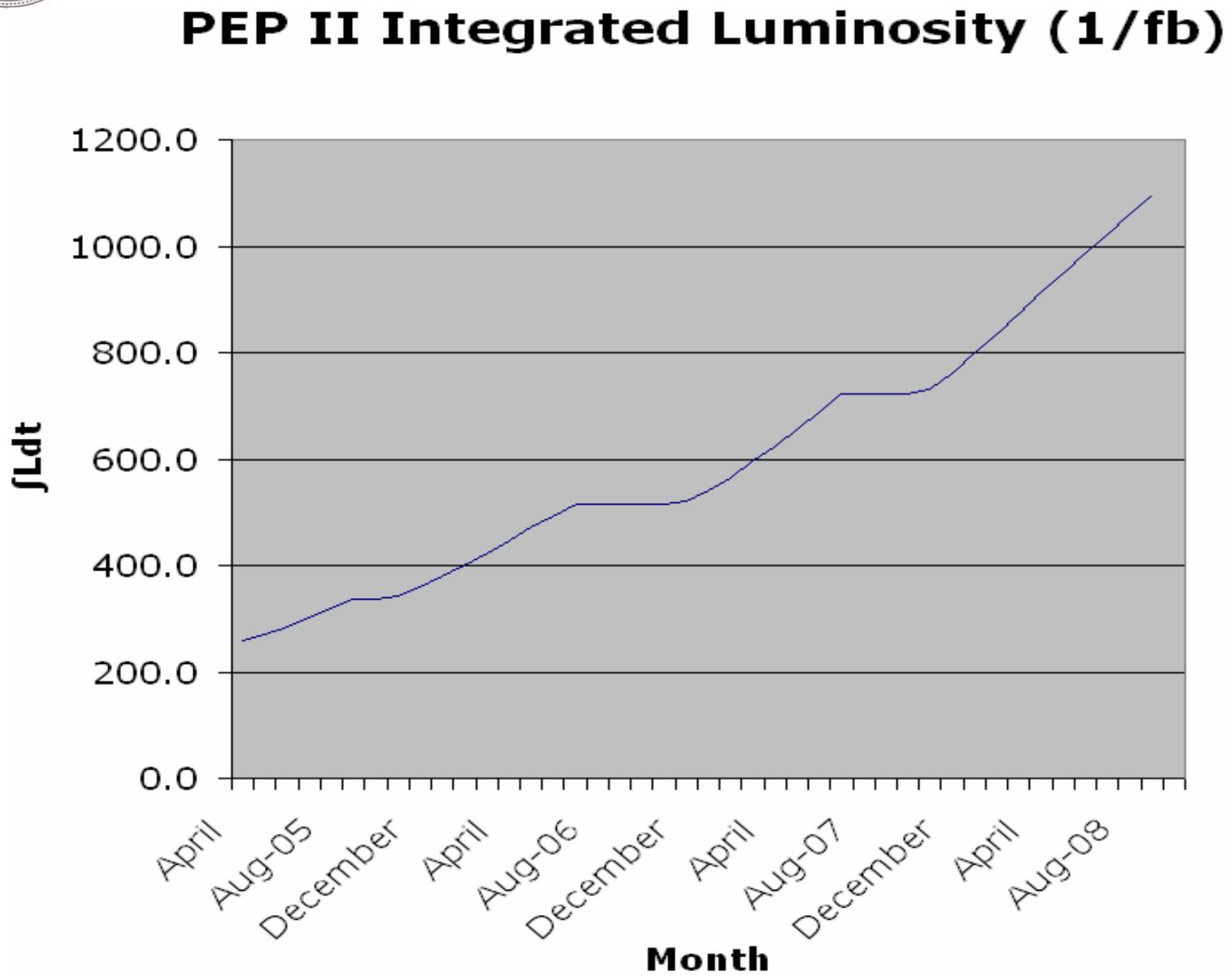
Future PEP-II Improvement Activities

- New transverse digital feedback processors (Summer 2005)
- New RF comb filters (Fall 2005)
- New klystron linearizer (Spring 2006)
- Install LER-5 RF station (Fall 2006)
- Install HER-10 RF station (Fall 2006)
- Upgrade several high-power IR vacuum chambers (Fall 2006)

Future luminosity increase factors

Parameter	Present	Future	Luminosity gain ratio
LER current	2450 mA	4500 mA	
HER current	1550 mA	2200 mA	1.61
β_y^*	10.5 mm	8.5 mm	1.24
ξ_y	0.065 L 0.043 H	0.070 L 0.055H	1.17
Total			x 2.3

Integrated Luminosity Goals



The *BABAR* Collaboration

11 Countries
80 Institutions
623 Physicists

USA [38/311]

California Institute of Technology
UC, Irvine
UC, Los Angeles
UC, Riverside
UC, San Diego
UC, Santa Barbara
UC, Santa Cruz
U of Cincinnati
U of Colorado
Colorado State
Harvard U
U of Iowa
Iowa State U
LBNL
LLNL
U of Louisville
U of Maryland
U of Massachusetts, Amherst
MIT
U of Mississippi
Mount Holyoke College
SUNY, Albany
U of Notre Dame
Ohio State U
U of Oregon
U of Pennsylvania
Prairie View A&M U
Princeton U
SLAC
U of South Carolina
Stanford U
U of Tennessee
U of Texas at Austin
U of Texas at Dallas
Vanderbilt
U of Wisconsin
Yale

Canada [4/24]

U of British Columbia
McGill U
U de Montréal
U of Victoria

China [1/5]

Inst. of High Energy Physics, Beijing

France [5/53]

LAPP, Annecy
LAL Orsay
LPNHE des Universités Paris VI et VII
Ecole Polytechnique, Laboratoire Leprince-Ringuet
CEA, DAPNIA, CE-Saclay

Germany [5/24]

Ruhr U Bochum
U Dortmund
Technische U Dresden
U Heidelberg
U Rostock

Italy [12/99]

INFN, Bari
INFN, Ferrara
Lab. Nazionali di Frascati dell' INFN
INFN, Genova & Univ
INFN, Milano & Univ
INFN, Napoli & Univ
INFN, Padova & Univ
INFN, Pisa & Univ & ScuolaNormaleSuperiore
INFN, Perugia & Univ
INFN, Roma & Univ "La Sapienza"
INFN, Torino & Univ
INFN, Trieste & Univ

The Netherlands [1/4]

NIKHEF, Amsterdam

Norway [1/3]

U of Bergen

Russia [1/13]

Budker Institute, Novosibirsk

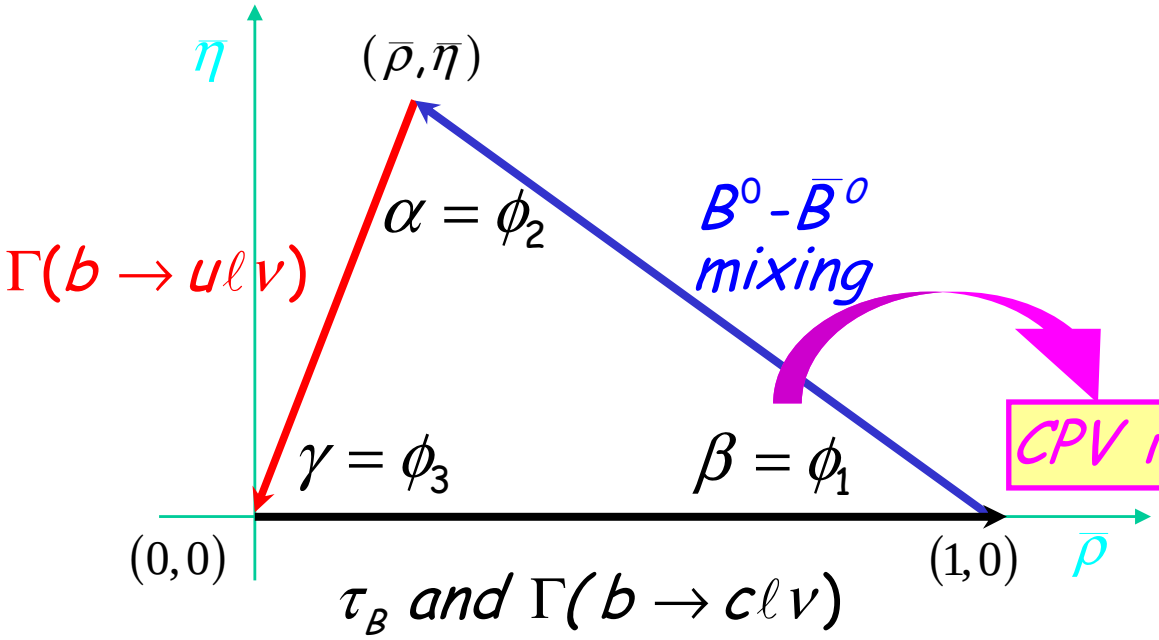
Spain [2/3]

IFAE-Barcelona
IFIC-Valencia

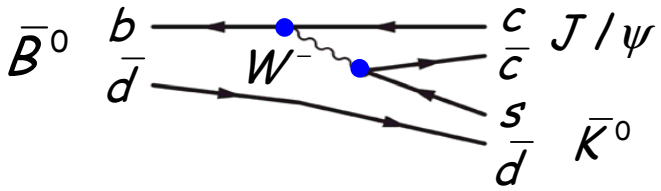
United Kingdom [11/75]

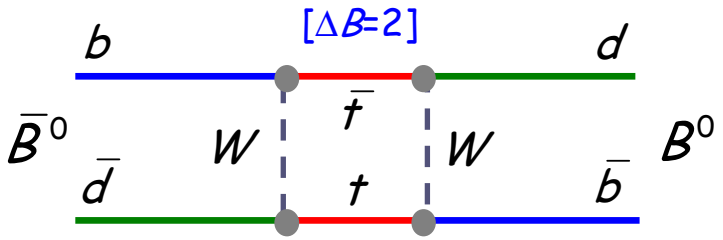
U of Birmingham
U of Bristol
Brunel U
U of Edinburgh
U of Liverpool
Imperial College
Queen Mary , U of London
U of London, Royal Holloway
U of Manchester
Rutherford Appleton Laboratory
U of Warwick

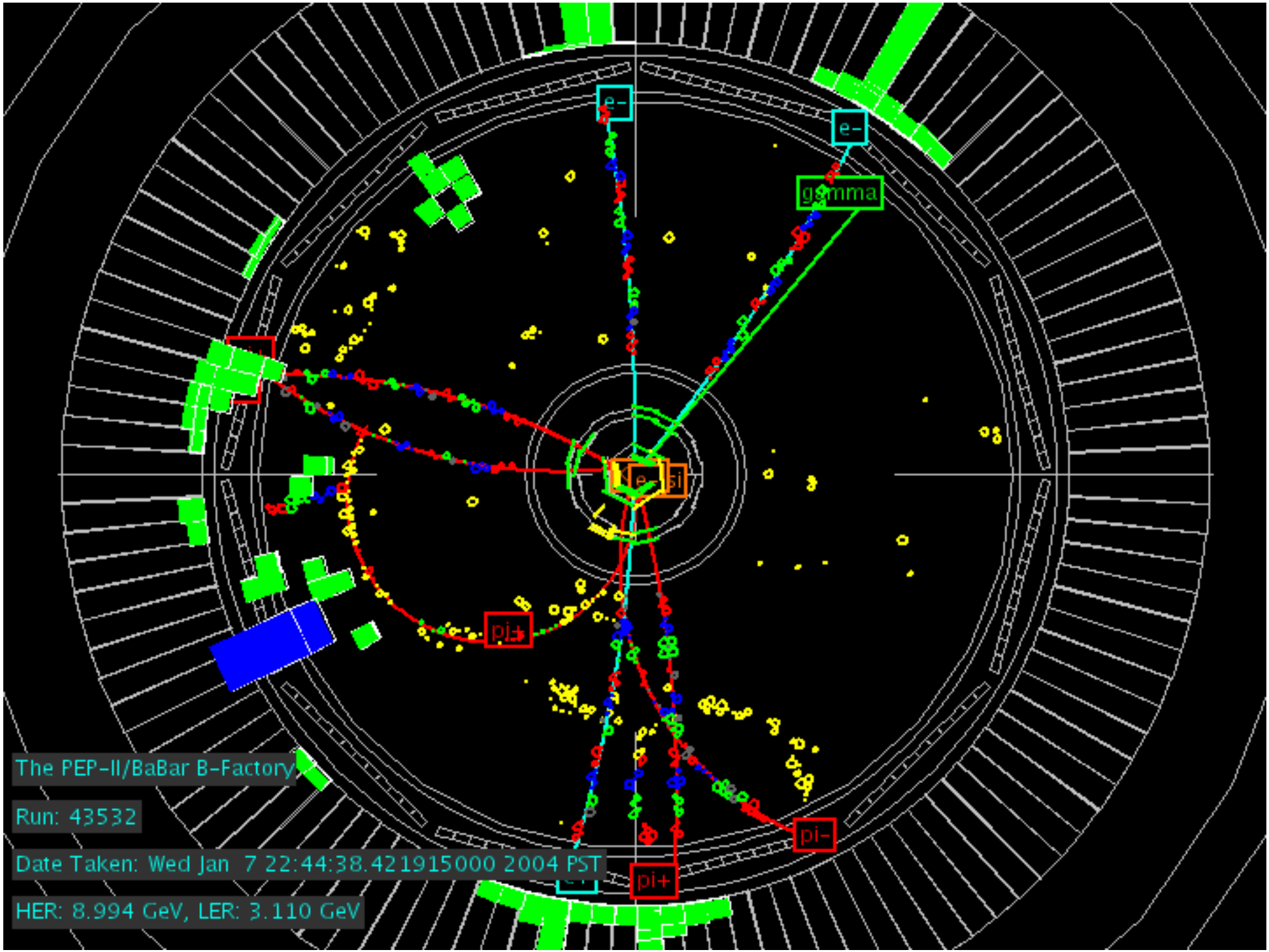
CPV in charmonium modes

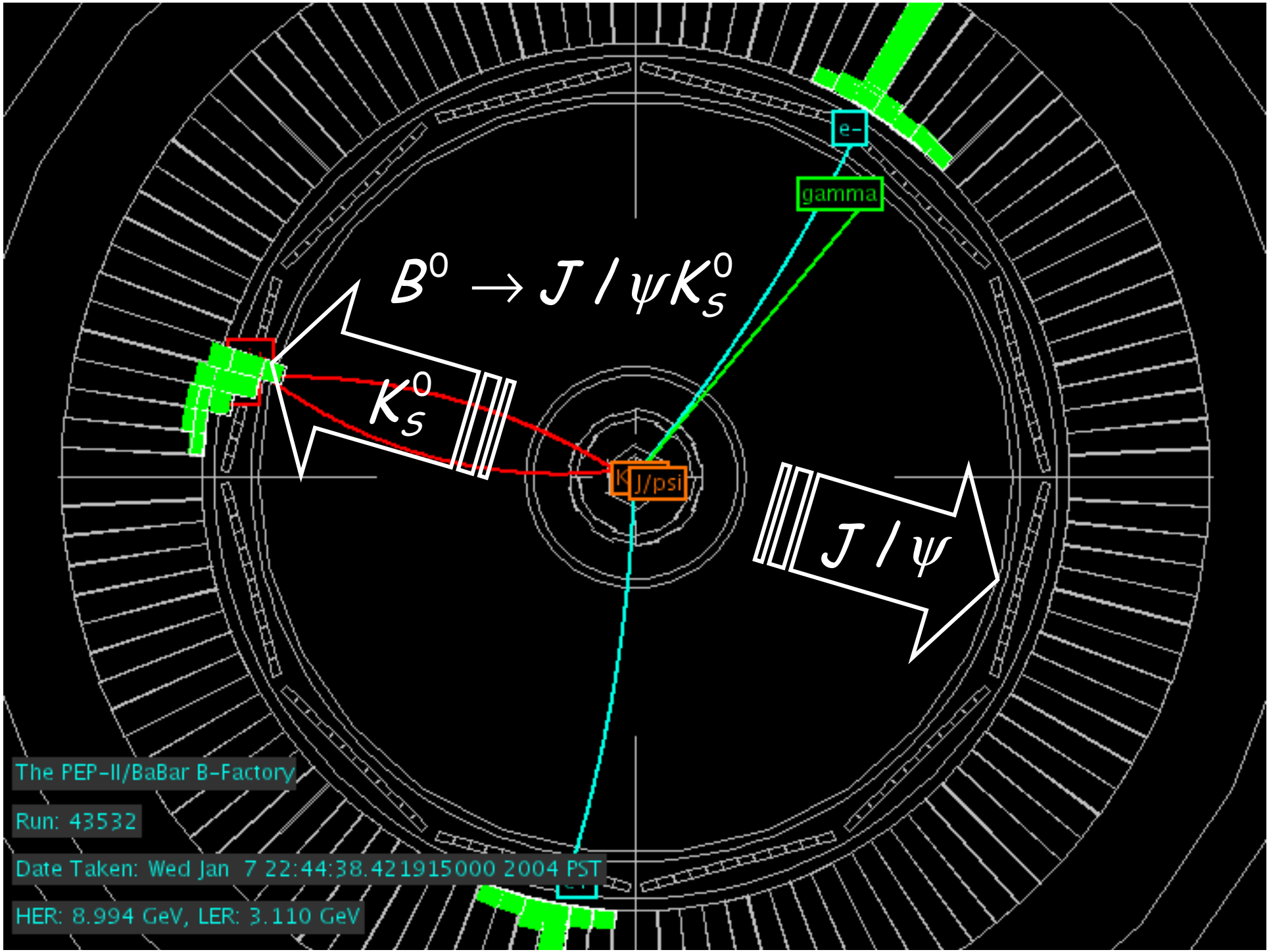


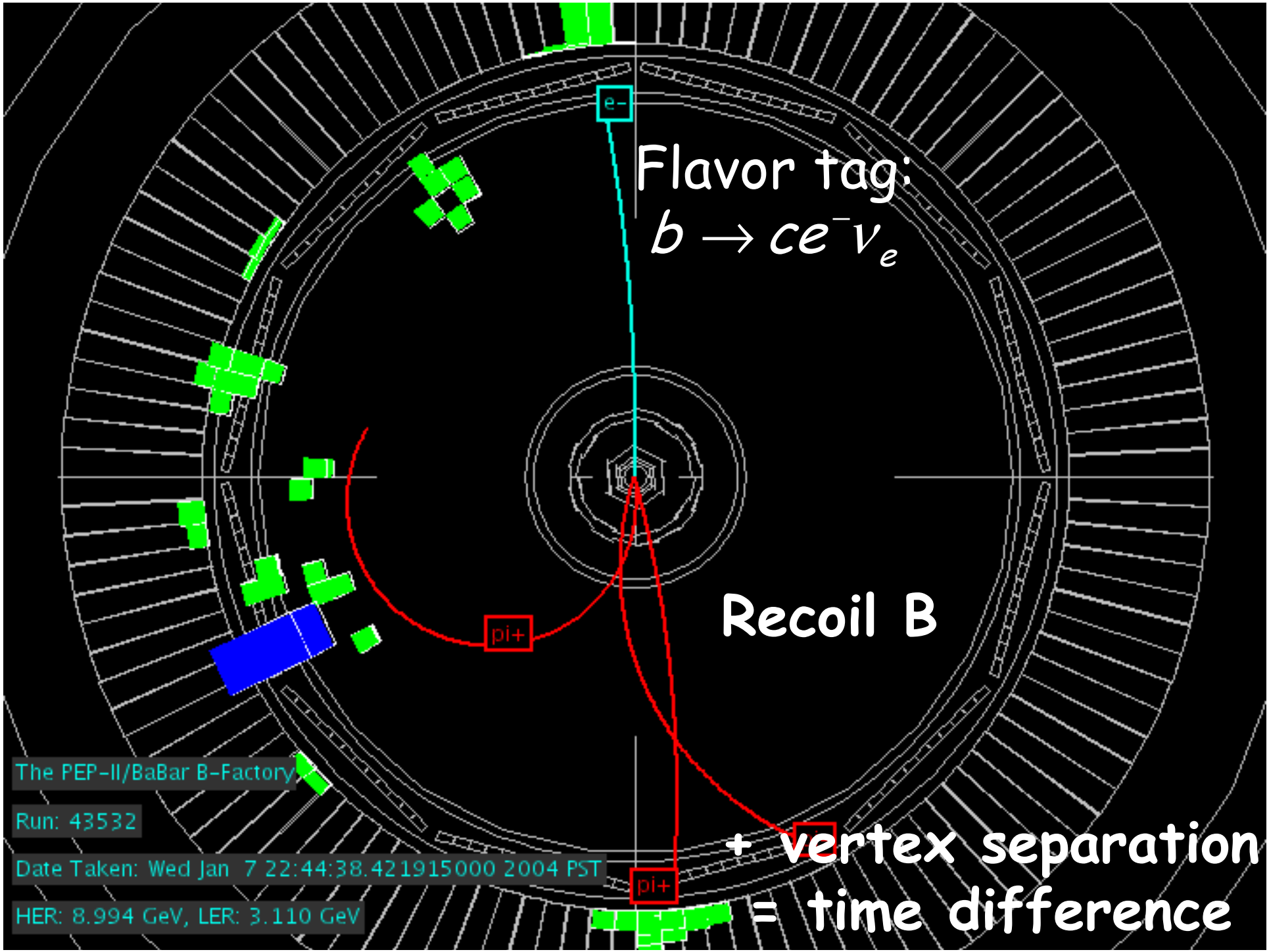
Interference of $b \to c$ tree decay with mixing





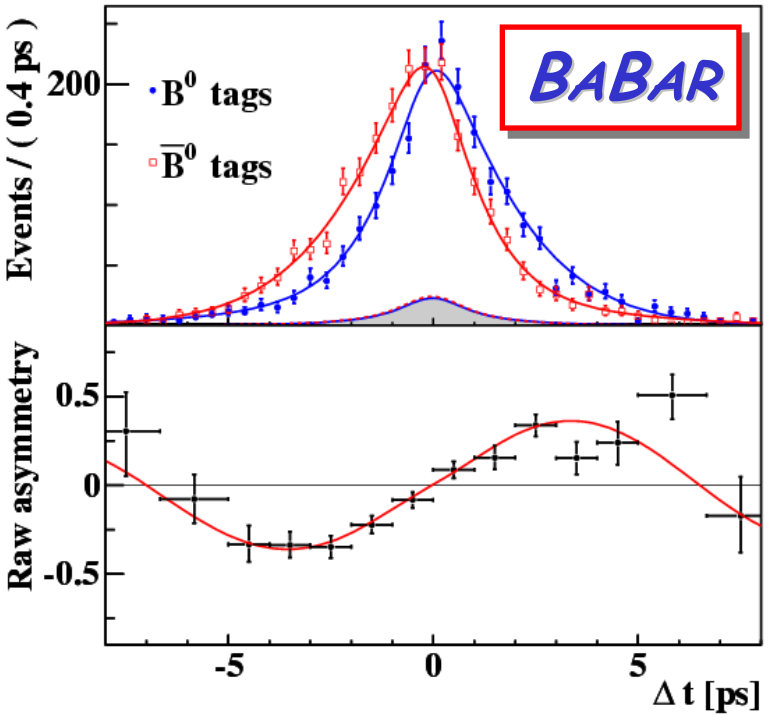

e-
e-
gamma
pi+
pi-
pi+
The PEP-II/BaBar B-Factory
Run: 43532
Date Taken: Wed Jan 7 22:44:38.421915000 2004 PST
HER: 8.994 GeV, LER: 3.110 GeV


e-
gamma
$B^0 \to J/\psi K_S^0$
K_S^0
J/psi
J/ψ
The PEP-II/BaBar B-Factory
Run: 43532
Date Taken: Wed Jan 7 22:44:38.421915000 2004 PST
HER: 8.994 GeV, LER: 3.110 GeV

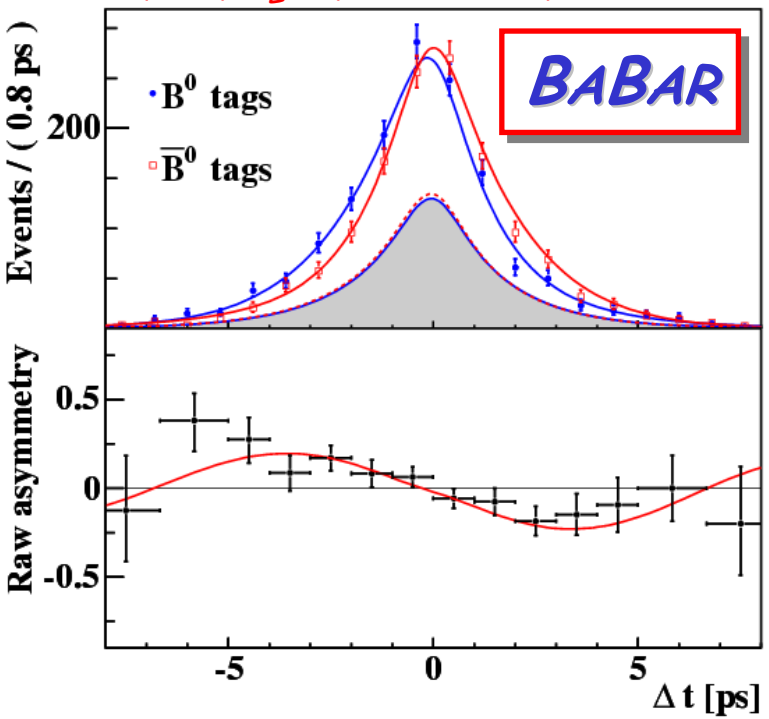

e-
Flavor tag:
$b \to ce^{-}\nu_e$
pi+
Recoil B
The PEP-II/BaBar B-Factory
Run: 43532
Date Taken: Wed Jan 7 22:44:38.421915000 2004 PST
HER: 8.994 GeV, LER: 3.110 GeV
pi+
+ vertex separation
= time difference

sin2β results from charmonium modes

$(c\bar{c})K^0_S$ (CP odd) modes



$(c\bar{c})K^0_L$ (CP even) modes



Update for ICHEP04 *BABAR PUB-04/038*

$$\sin 2\beta = +0.722 \pm 0.040 \pm 0.023$$

$$|\lambda| = |\bar{A}/A| = 0.950 \pm 0.031 \pm 0.013$$

$(c\bar{c})K^0_S +$ $(c\bar{c})K^0_L$

Limit on direct CPV

$205 fb^{-1}$ on peak or $227M$ $B\bar{B}$ pairs
7730 CP events (tagged signal)

Summary of constraints on α

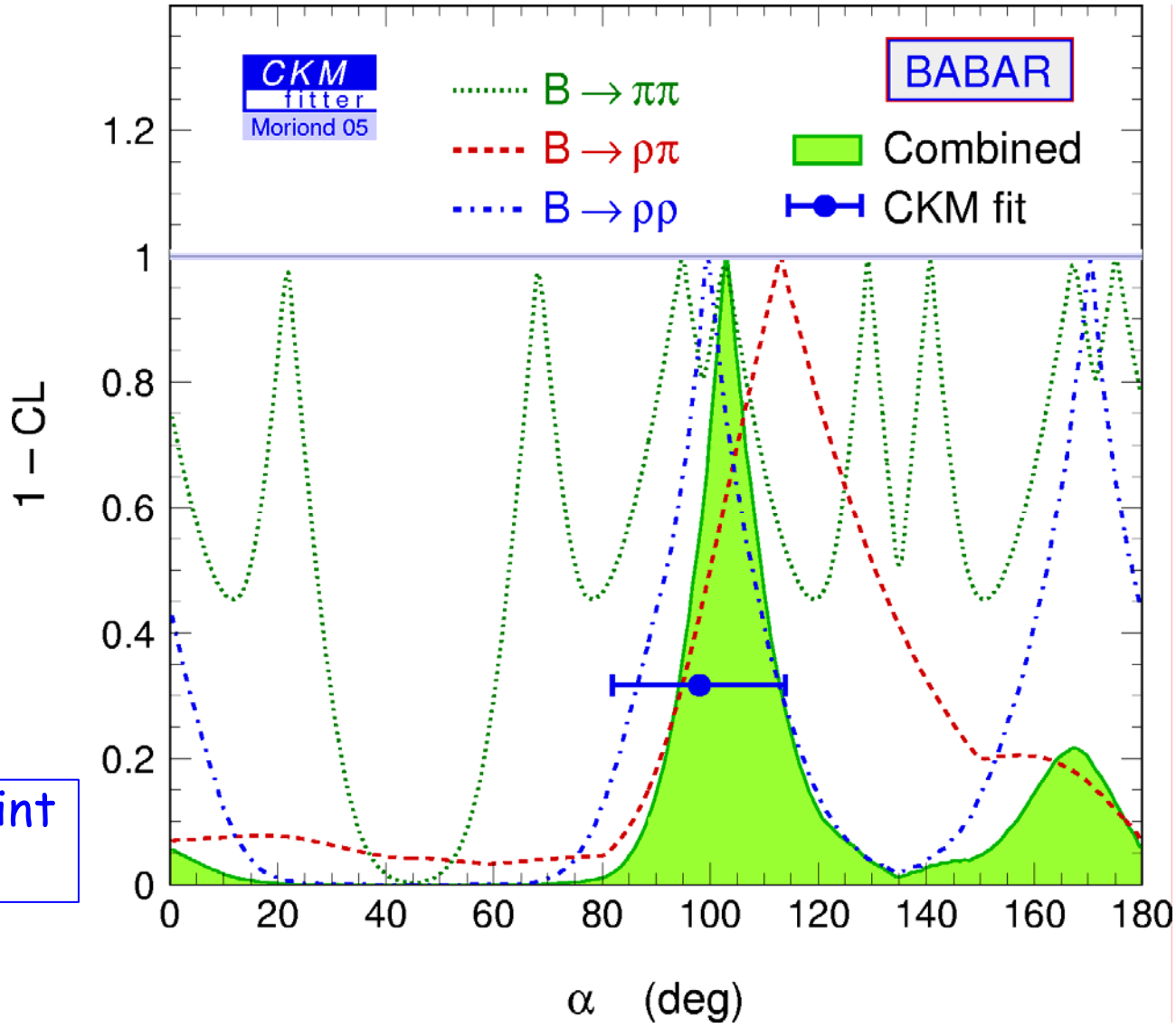
BABAR only

Mirror solutions disfavored

From combined $\pi\pi, \rho\pi, \rho\rho$ results:

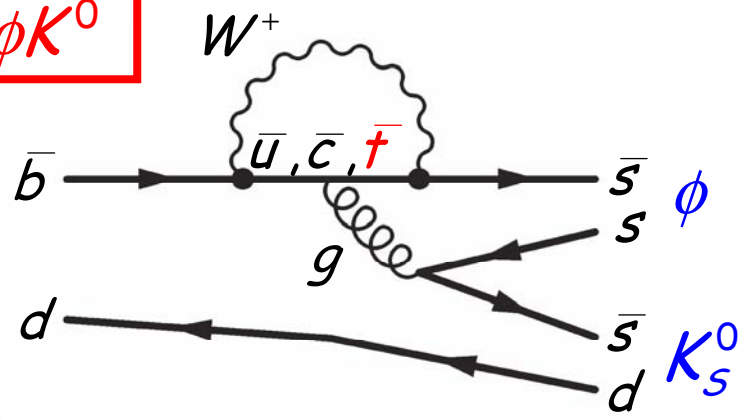
$$\alpha = \left[100\ ^{+9}_{-10}\right]^{\circ}$$

CKM indirect constraint fit: $\alpha = 98 \pm 16^{\circ}$



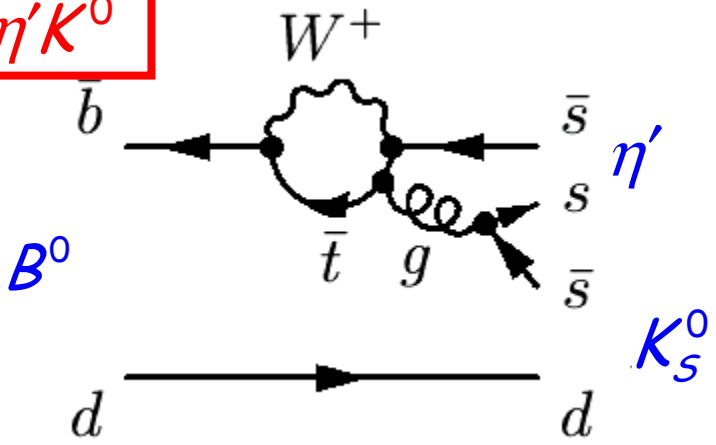
Potential New Physics contributions

$B^0 \to \phi K^0$

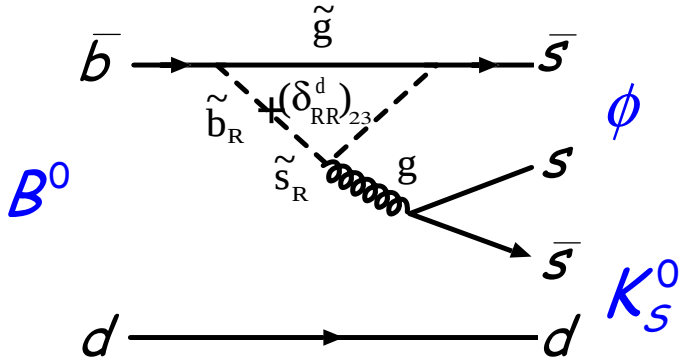


"Internal Penguin"

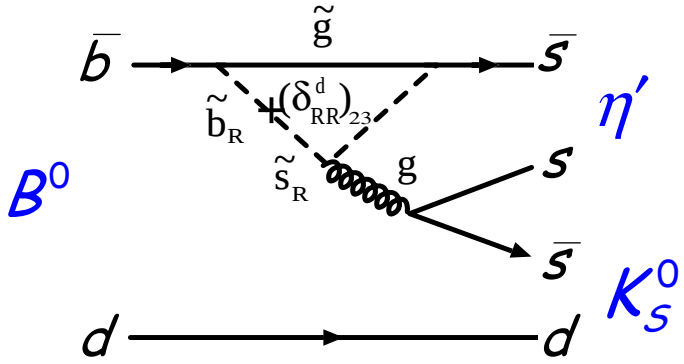
$B^0 \to \eta' K^0$



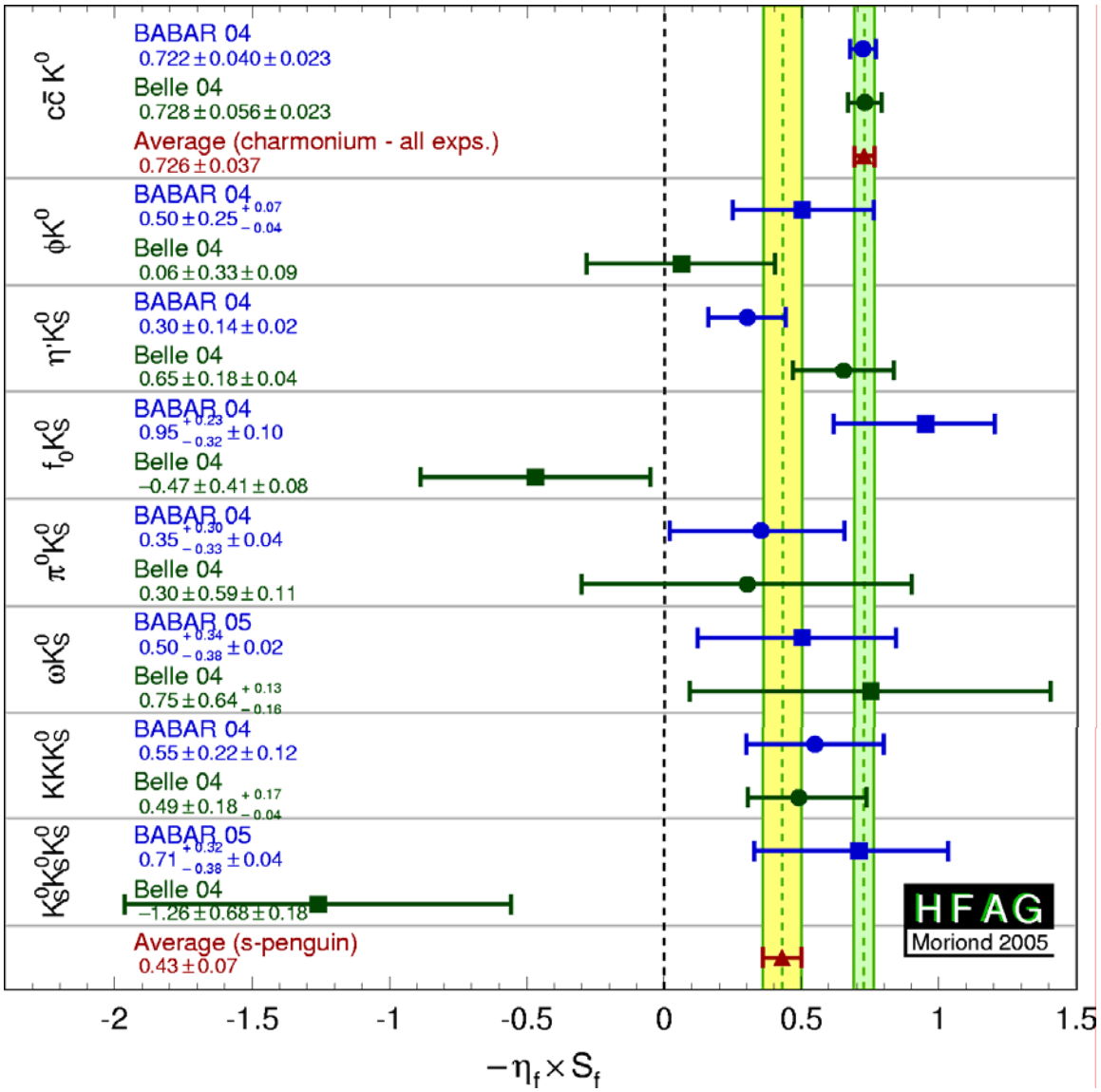
New physics in loops?



SUSY contribution with new phases



CPV in charmonium & s-penguin modes



Charmonium

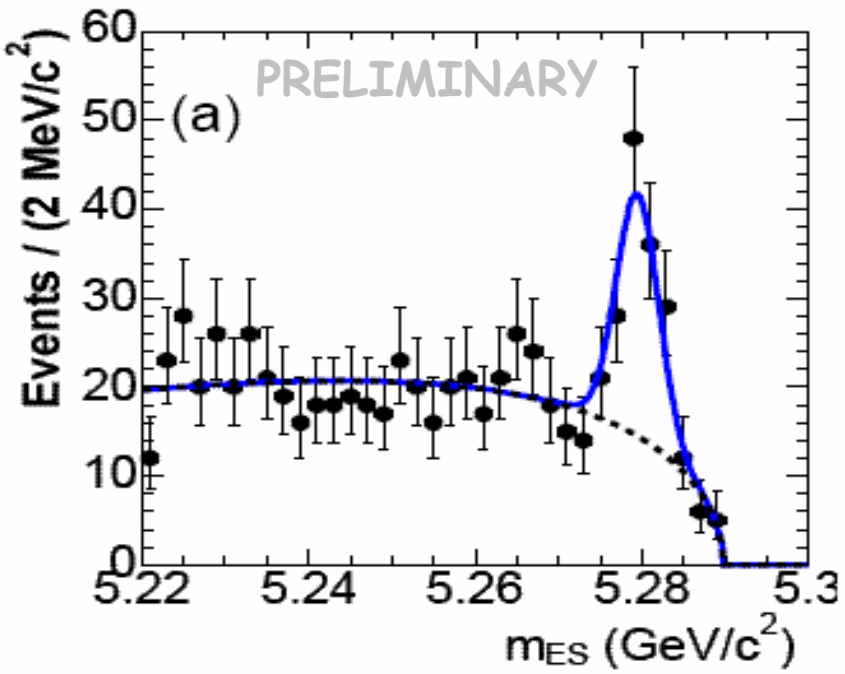
s-Penguins

Good consistency between B Factory experiments

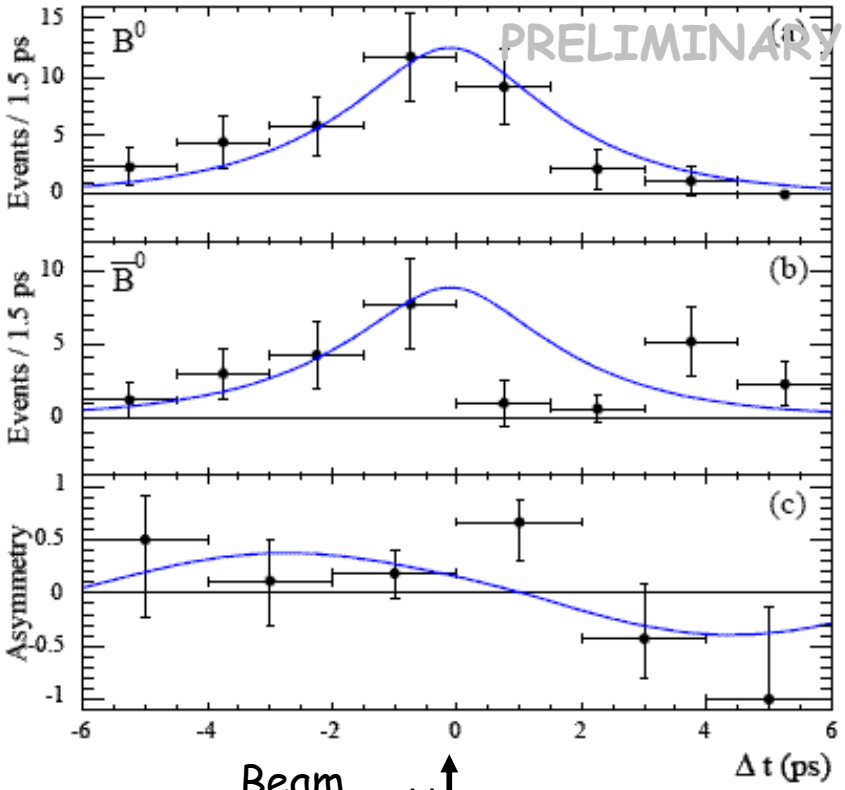
3.7σ between *CP* violation in s-penguin vs sin2β (cc)

No sign of Direct *CP*

New three-body mode: $B \to K_S K_S K_S$



88±10 signal events

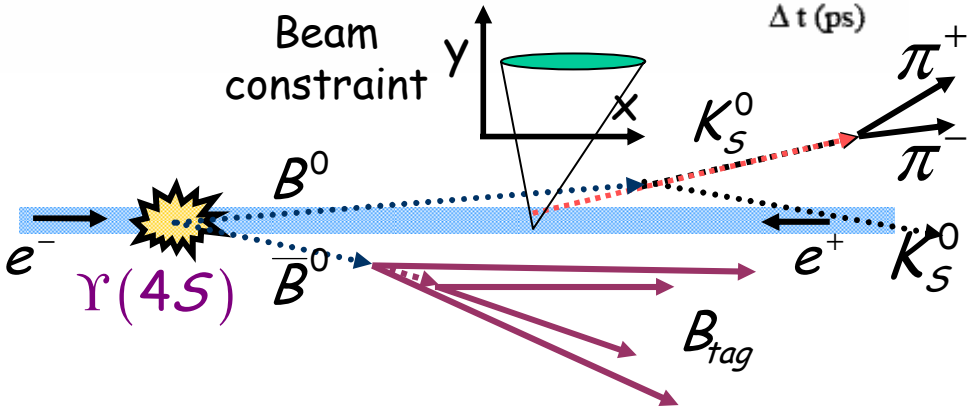


BABAR PUB-04/052

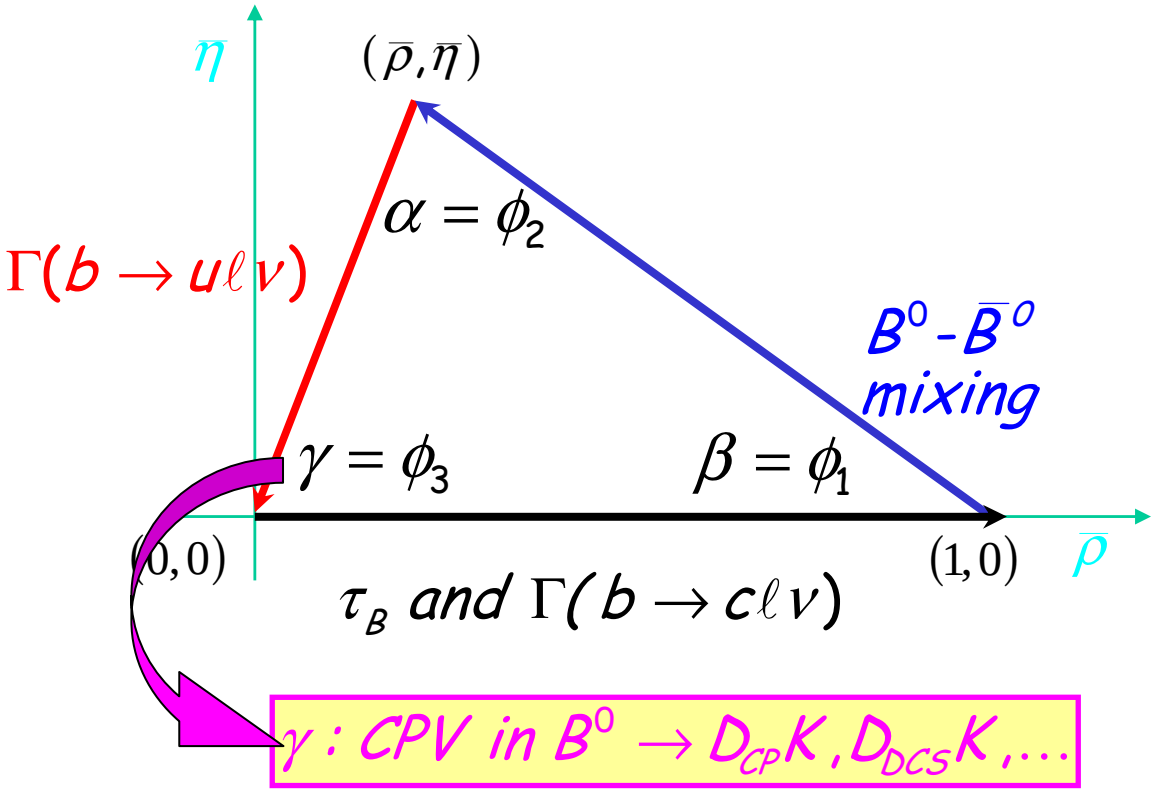
Aspen05

$$-\eta_{CP} \cdot S_{3K_S} = +0.71^{+0.38}_{-0.32} \pm 0.04$$

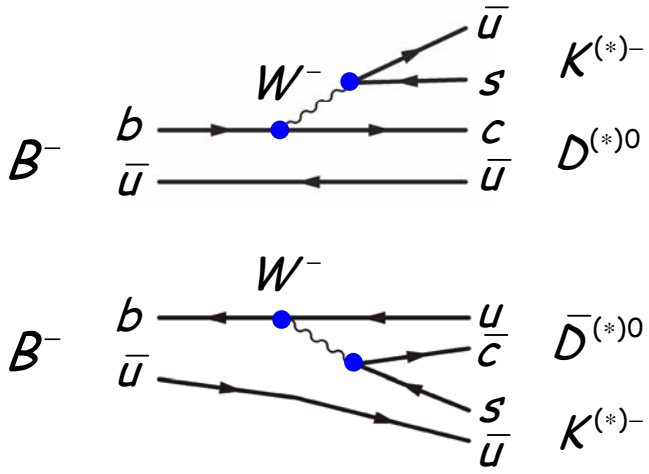
$$C_{3K_S} = -0.34^{+0.28}_{-0.25} \pm 0.05$$



Good progress on gamma

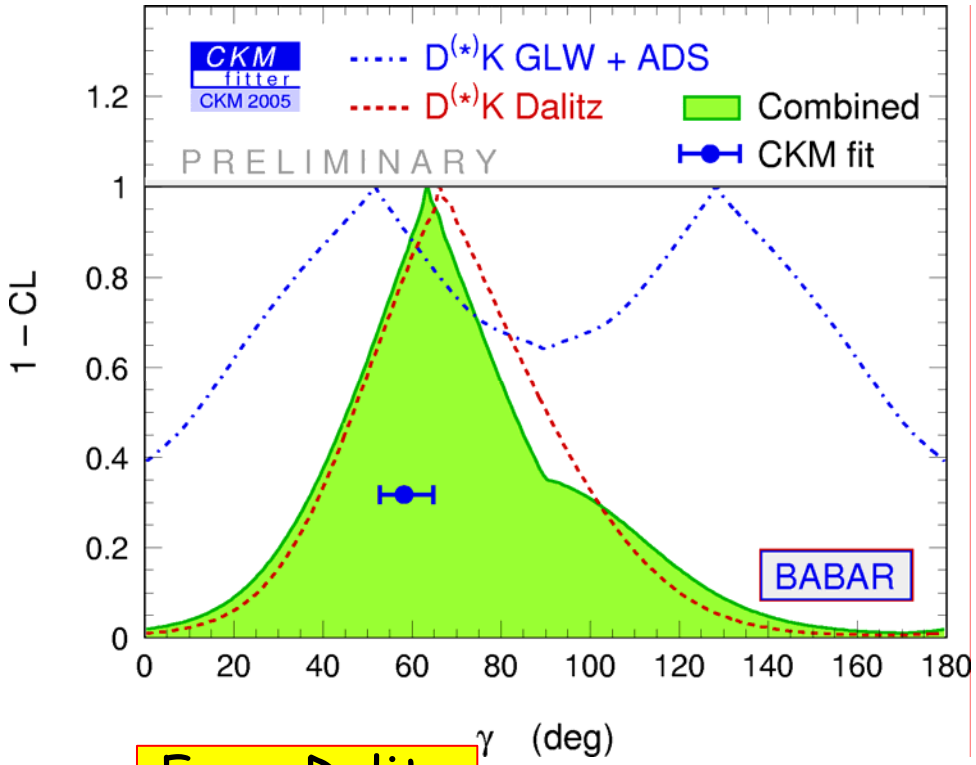


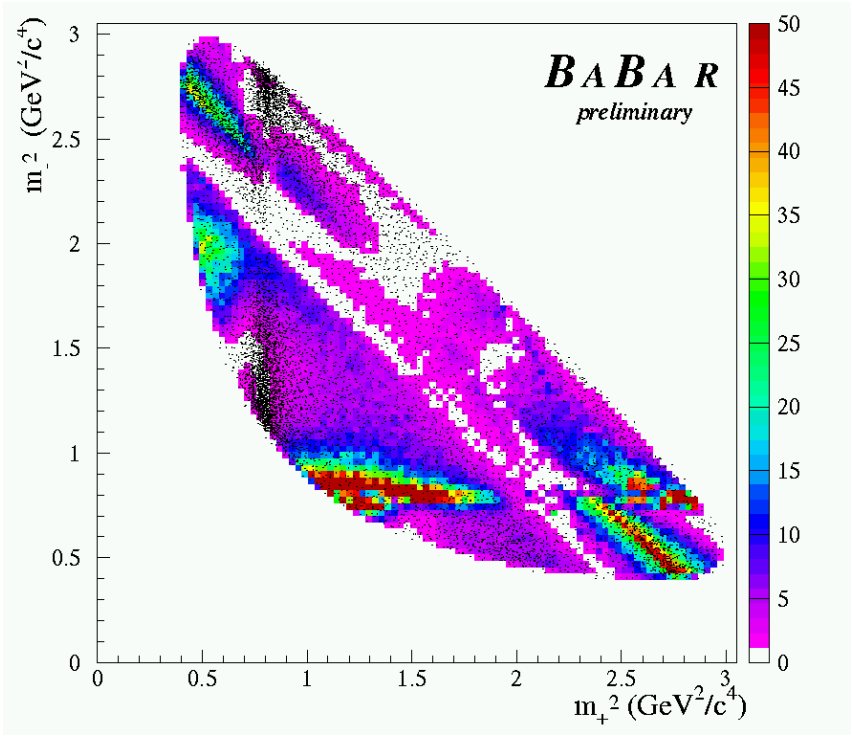
Interference of color-allowed and color-suppressed tree decays



Dalitz plot analysis for gamma

Idea: Increase *B* decay interference through *D* decay Dalitz plot





$B^+ \to D^{(*)0}\left[\to K^0_S\pi^+\pi^-\right]K^+$

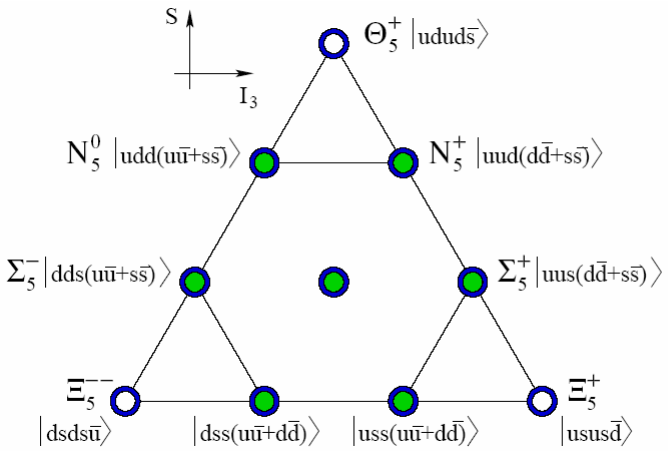
From Dalitz analysis:

$$\gamma = \left[63^{+34}_{-26}\right]^\circ$$

Indirect constraint:

$$\gamma = \left[58^{+8}_{-7}\right]^\circ$$

No Evidence Seen for the Penta Quark



arXiv:hep-ex/0408064 v2 25 Oct 2004

The *BABAR* Collaboration

Search for Strange Pentaquark Production in e^+e^- Annihilations at $\sqrt{s} = 10.58$ GeV and in $\Upsilon(4S)$ Decays

Abstract

We present a preliminary inclusive search for strange pentaquark production in e^+e^- interactions at a center-of-mass energy of 10.58 GeV using 123 fb^{-1} of data collected with the *BABAR* detector. We look for the states that have been reported previously: the $\Theta^+(1540)$, interpreted as a $ududs\bar{}$ state; and the $\Xi^{--}(1860)$ and $\Xi^0(1860)$, candidate $dsds\bar{u}$ and $uss(u\bar{u}+d\bar{d})$ states, respectively. In addition we search for other members of the antidecuplet and corresponding octet to which these states are thought to belong. We find no evidence for the production of such states and set preliminary limits on their production cross sections as functions of c.m. momentum. The corresponding limits on the $\Theta^+(1540)$ and $\Xi^{--}(1860)$ rates per $e^+e^- \to q\bar{q}$ event are well below the rates measured for ordinary baryons of similar mass.

Search for the $\Theta_5^+(1540) \rightarrow pK_s^0$

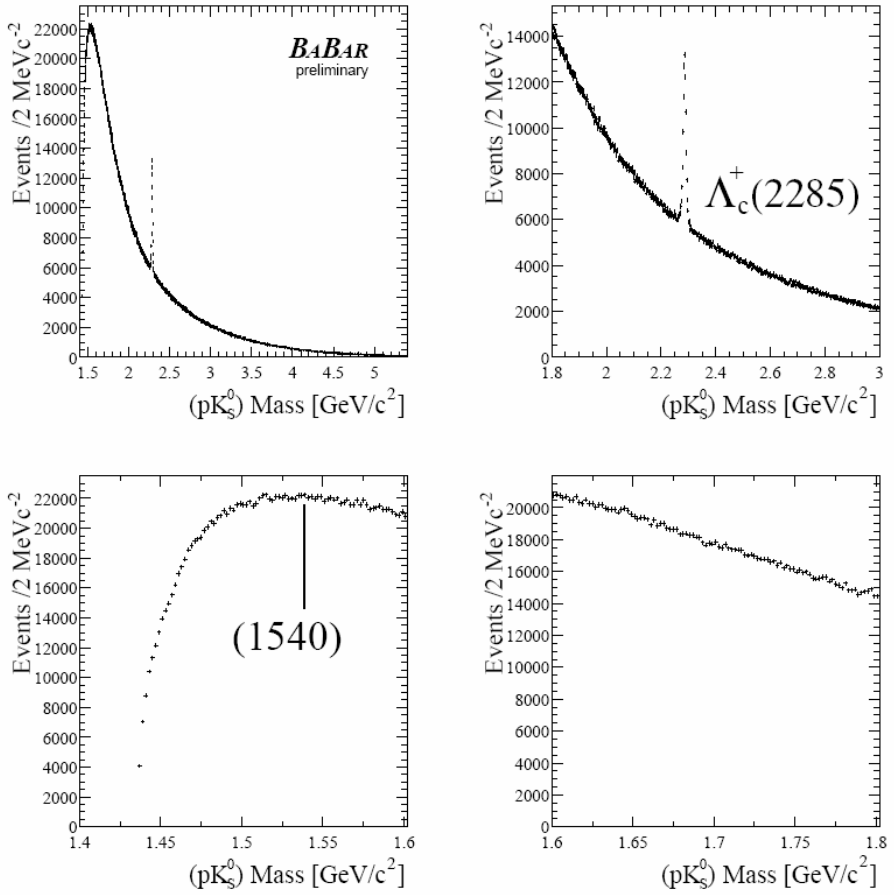


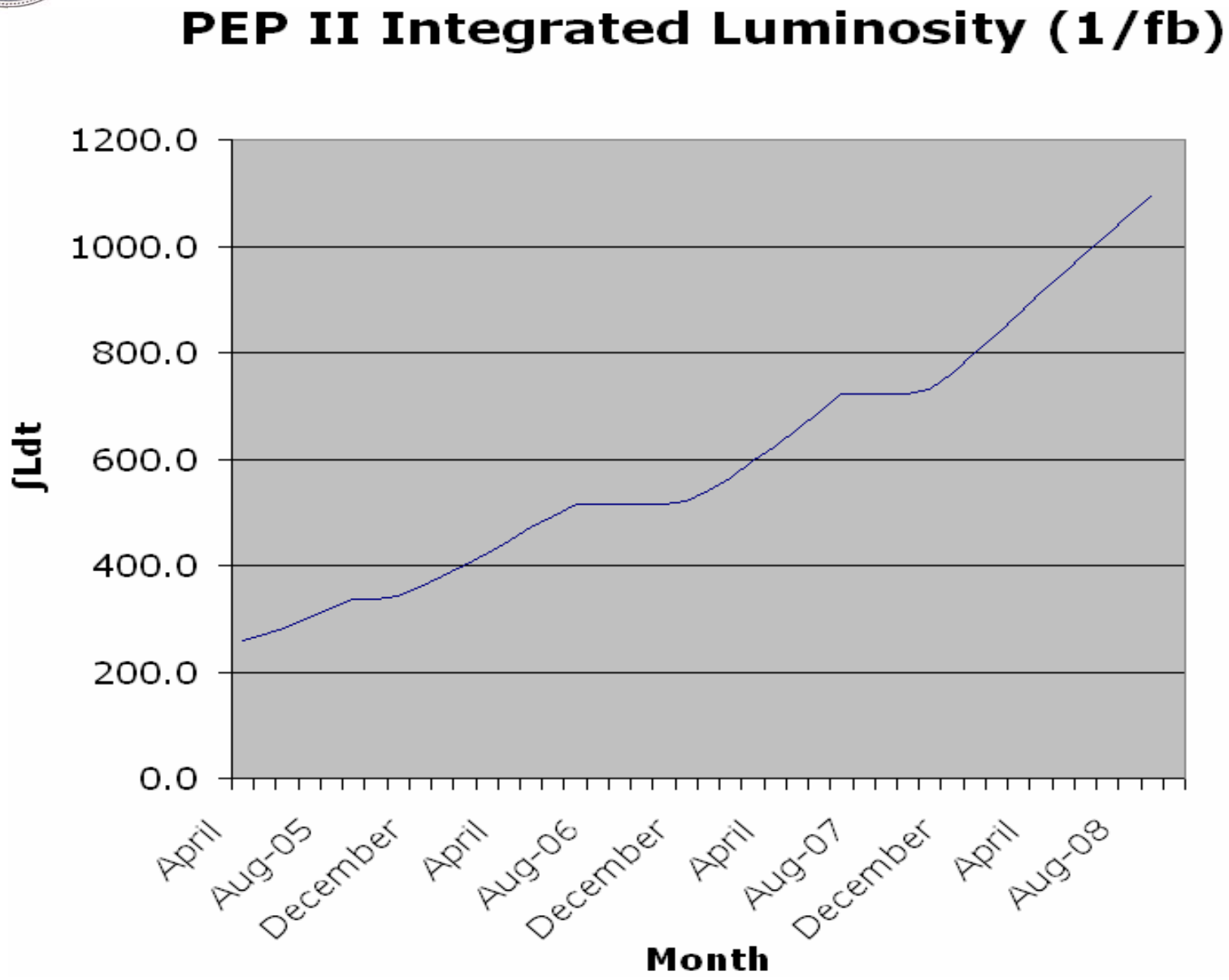
Figure 2: Distribution of the pK_S^0 invariant mass for combinations satisfying all the criteria described in the text. The same data are plotted four times in different pK_S^0 mass regions.

BABAR & Belle physics results

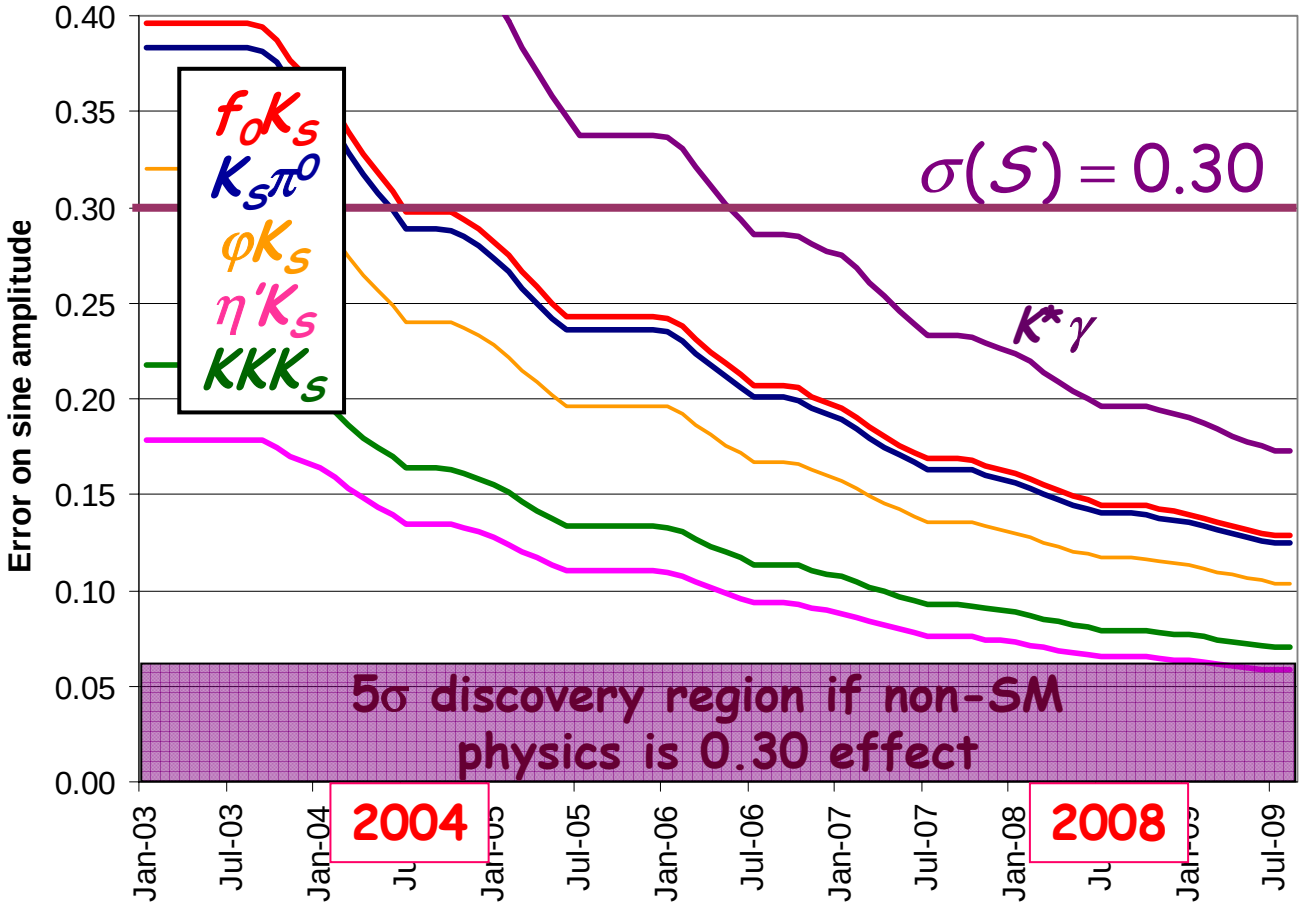
Journal Papers	BABAR	Belle
<2003	32	54
2003	39	28
2004	52	35
May 2005	21	19
Total	144	136

Conference Contributions	BABAR	Belle
Papers submitted to ICHEP04	72	63
Abstracts submitted to LP05	75	73

Integrated Luminosity Goals



Snapshot II: Summer 2008



Luminosity expectations:

2004=240 fb^{-1}
2008=1.1 ab^{-1}

Golden modes reach 5 sigma level

Projections are statistical errors only;
but systematic errors at few percent level

Summary

- **Data taking began in mid April 2005. PEP-II and Babar have made a rapid return to full, safe operation**
- **Goal for 2005-2006: double current data set**
  - **Delay in Run 5 can be overcome by summer 2006 with extended running period, with substantial reduction in errors on *CP* violation asymmetries in rare decay modes**
  - **Error on average of Penguin modes should reach 0.06**
- **Goal for 2007-2008: double again to ~1 ab^{-1}**
  - **Individual Penguin modes with errors in range 0.06-0.12**

  - **Sensitivity to New Physics through rare decays & *CP* violation, with a significant discovery potential**
  - **Rich program of flavor physics/CP violation also pursued**