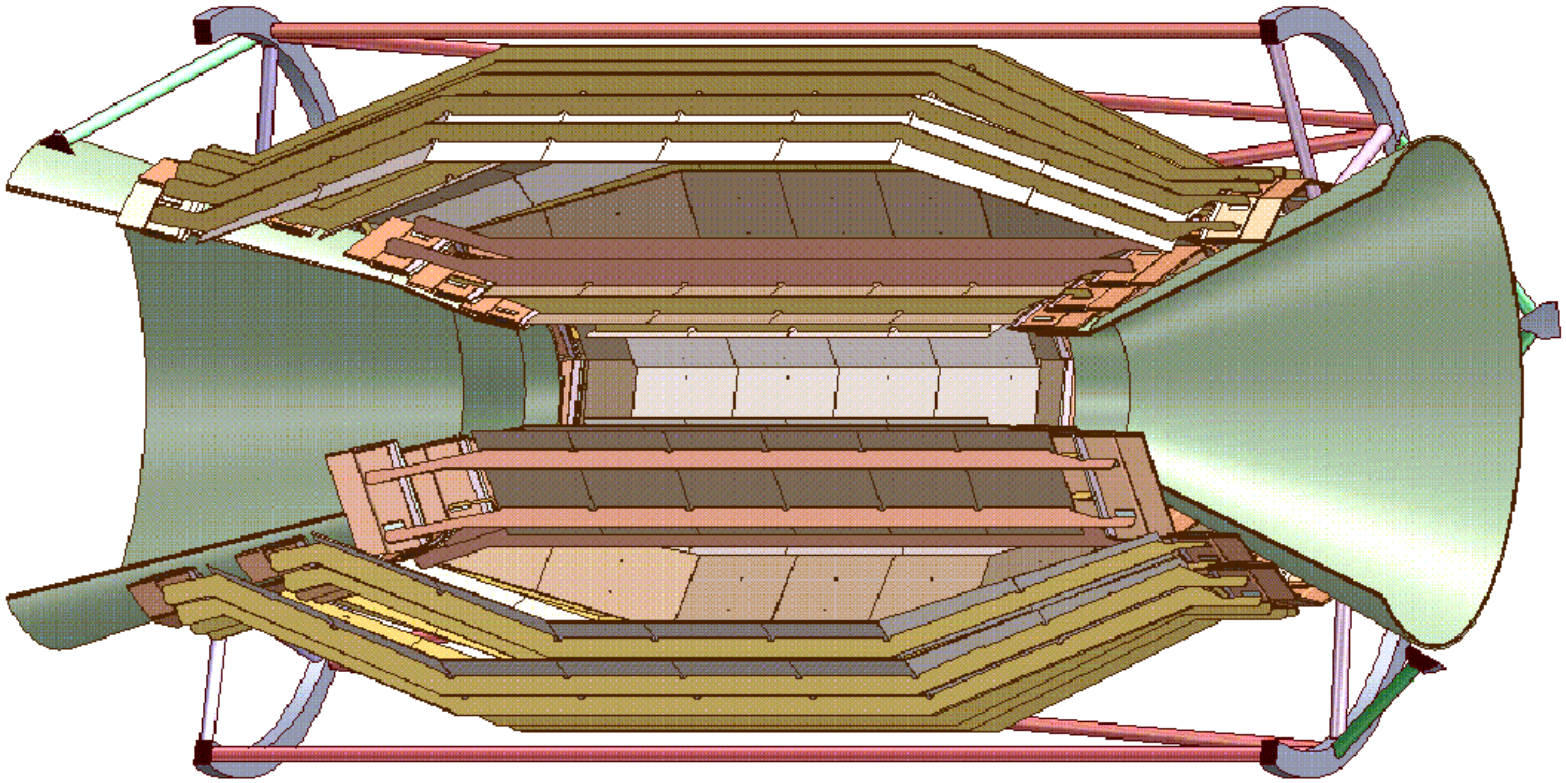
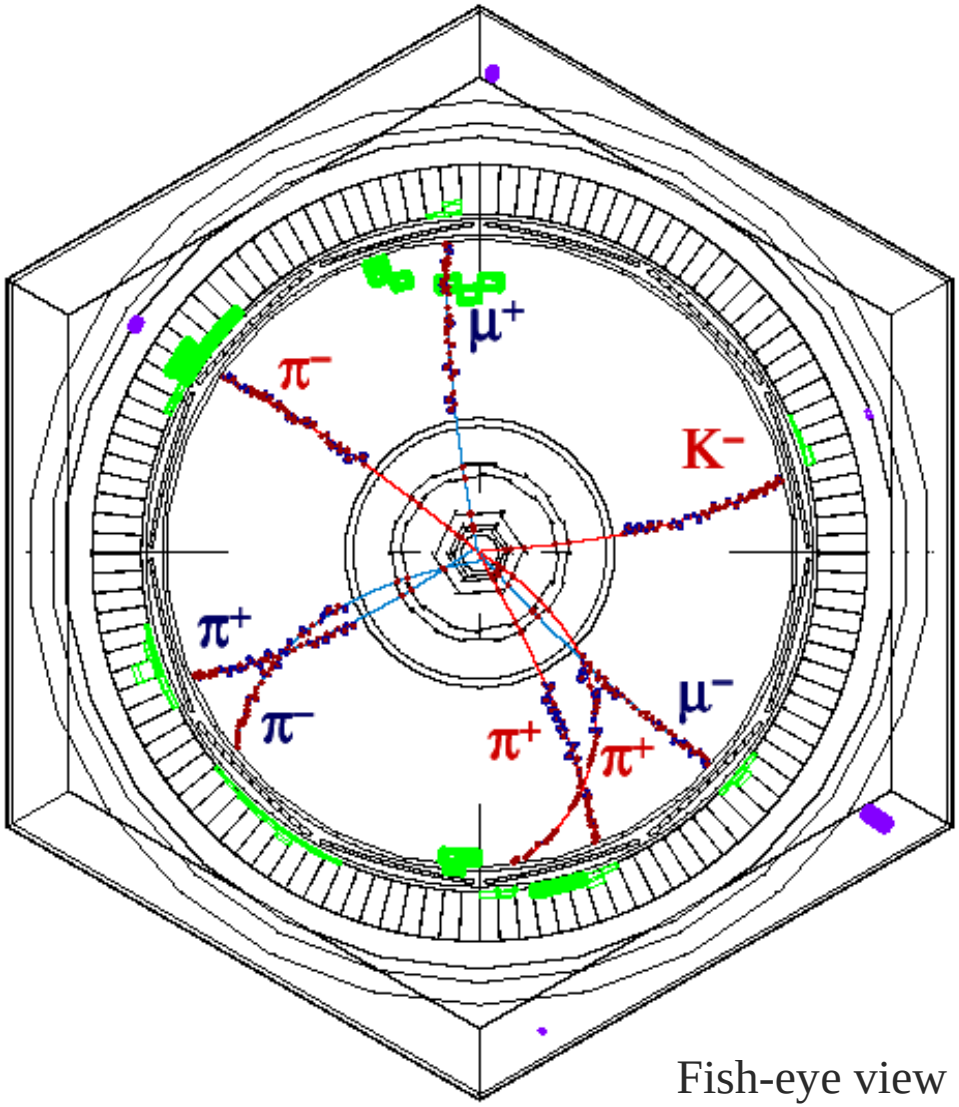
Vertexing is done with a five-layer Silicon Vertex Tracker (SVT)



A Completely-Reconstructed Event



Fish-eye view

A candidate in the mode

$$B^0_{CP} \to \psi(2S)\, K^0_S, \quad K^0_S \to \pi^+\pi^-$$

with: $\psi(2S) \to \mu^+\mu^-$

The other *B* meson is **fully-reconstructed** in the mode:

$$\overline{B}^0 \to D^{*+}\pi^-_f$$

$$D^{*+} \to D^0\pi^-_s$$

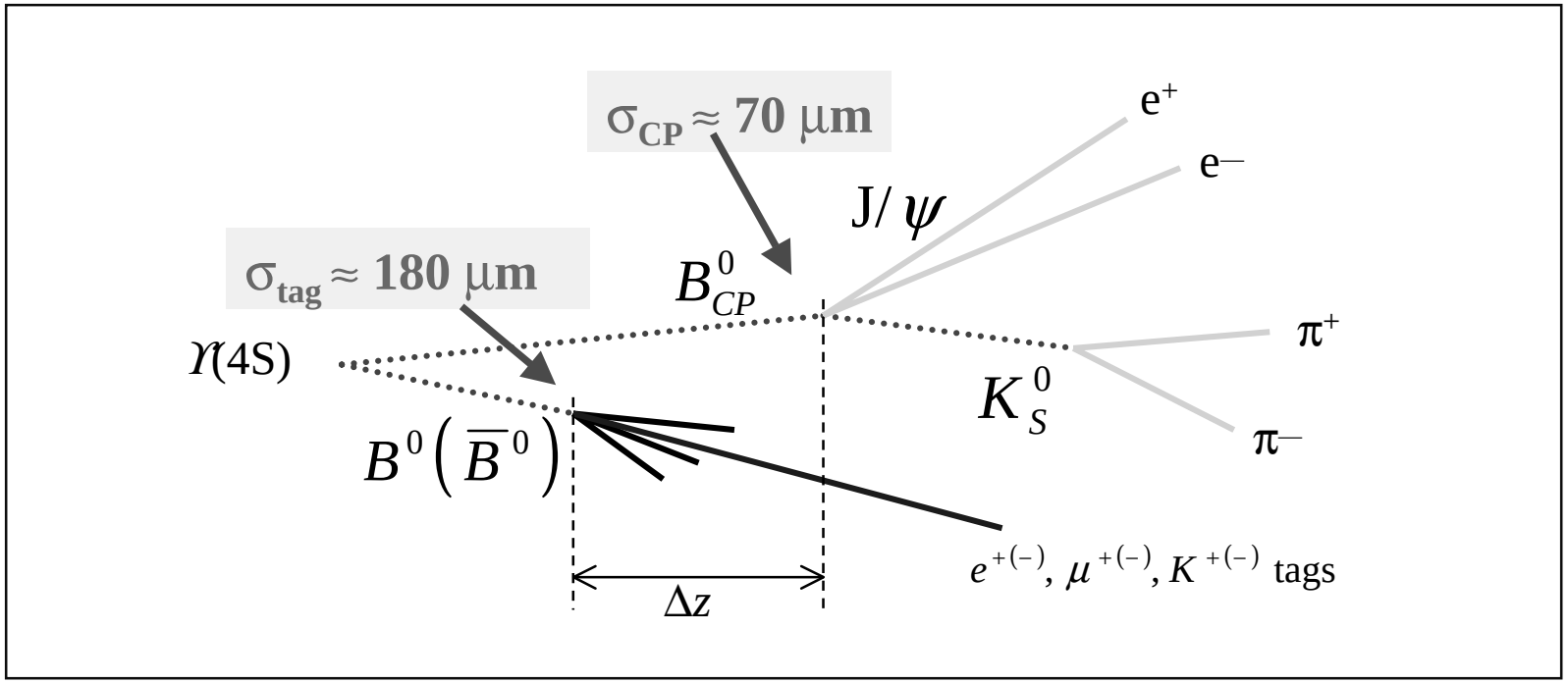
$$D^0 \to K^-\pi^+$$

Measuring Δt at PEPII

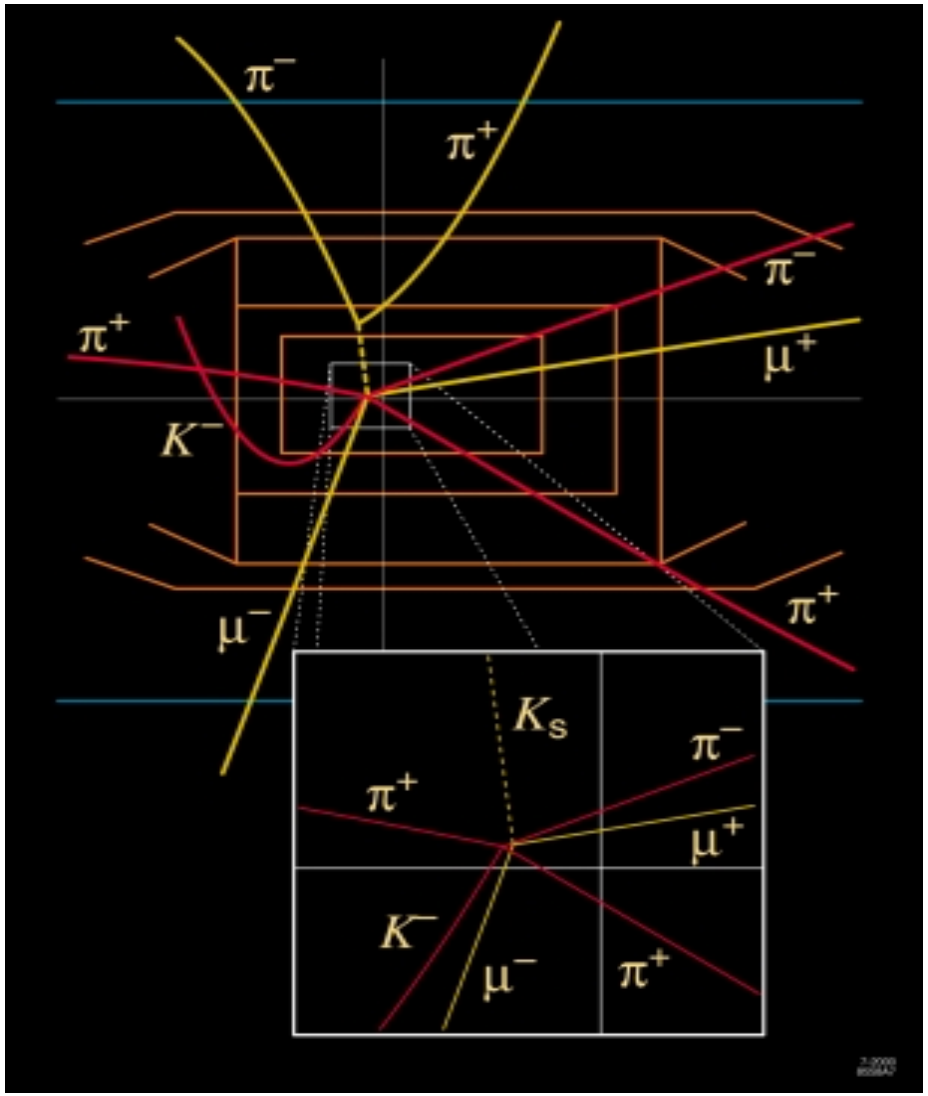
$E^- = 9.0$ GeV; $E^+ = 3.1$ GeV

Lorentz Boost $\Rightarrow$ $\beta\gamma = 0.56$

$$\Delta t \approx \Delta z / \beta \gamma c$$



An Event from the CP Sample



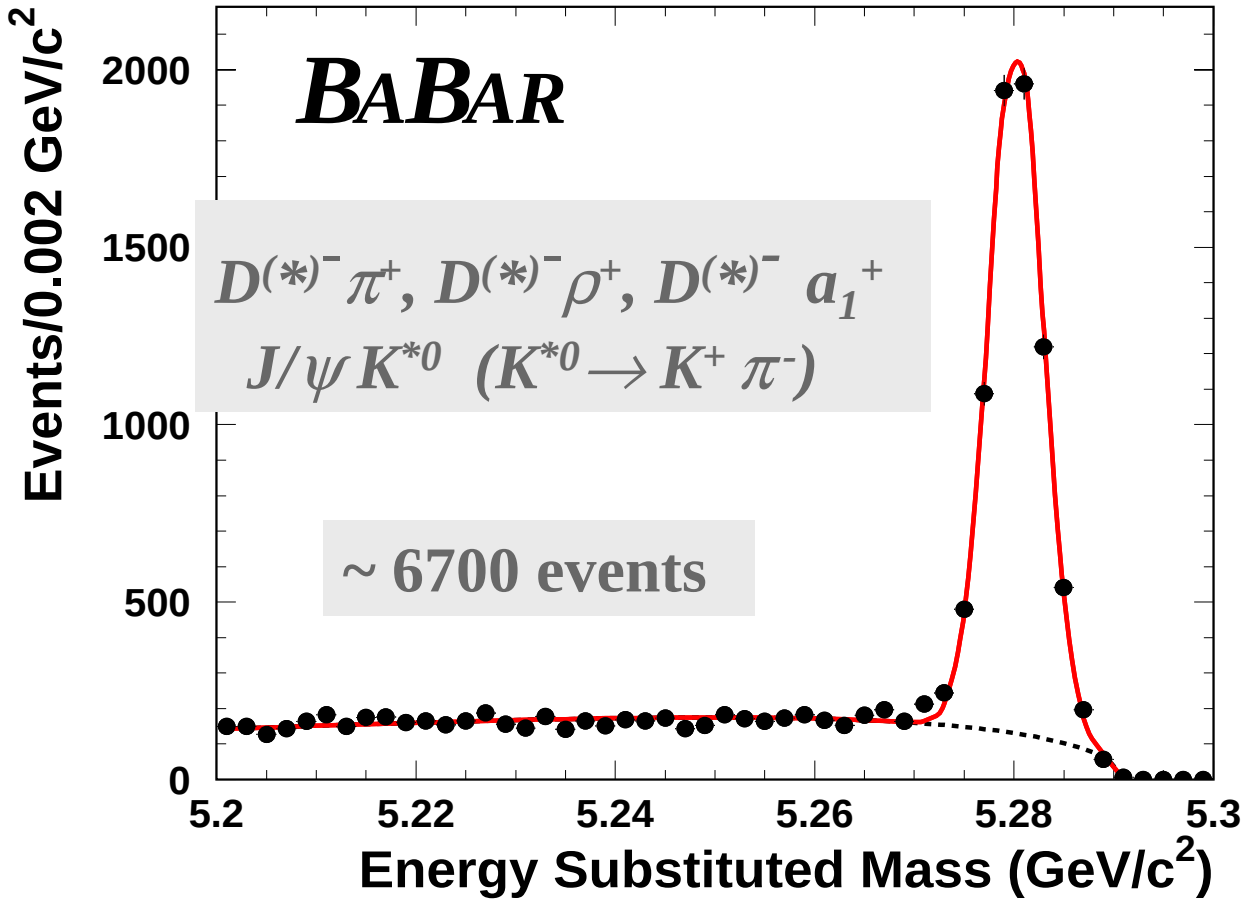
A candidate in the Golden Mode

$$B^0_{CP} \to J/\psi K^0_S, \quad K^0_S \to \pi^+\pi^-$$

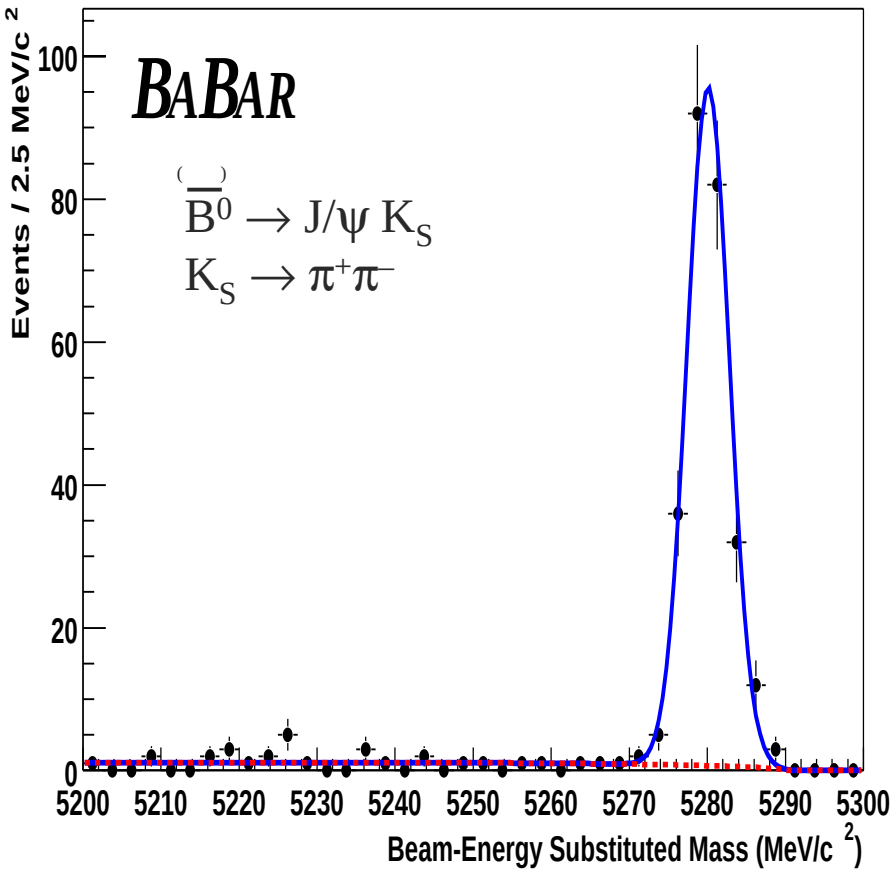
with: $J/\psi \to \mu^+\mu^-$

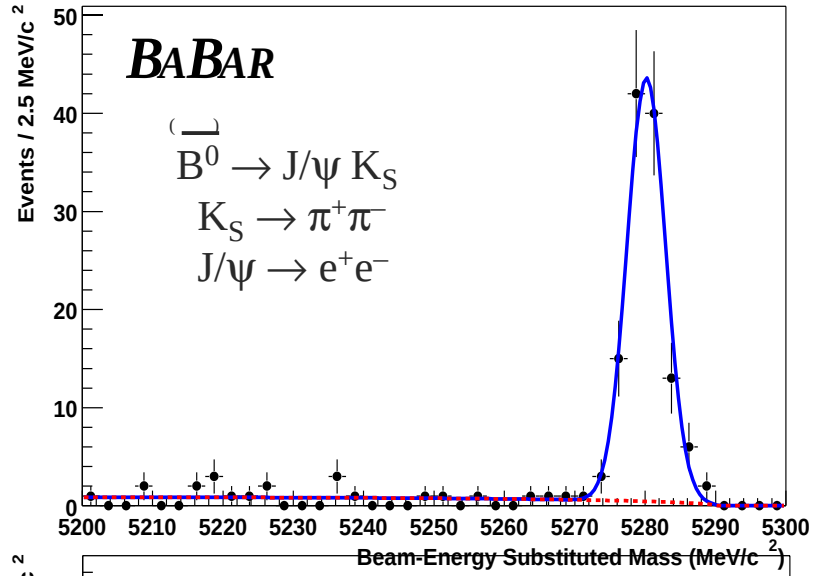
- A negative kaon is found in the decay products of the other *B* meson, which is therefore tagged as a $\overline{B}^0$
- Δz is measured precisely, thanks to the Silicon Vertex Detector

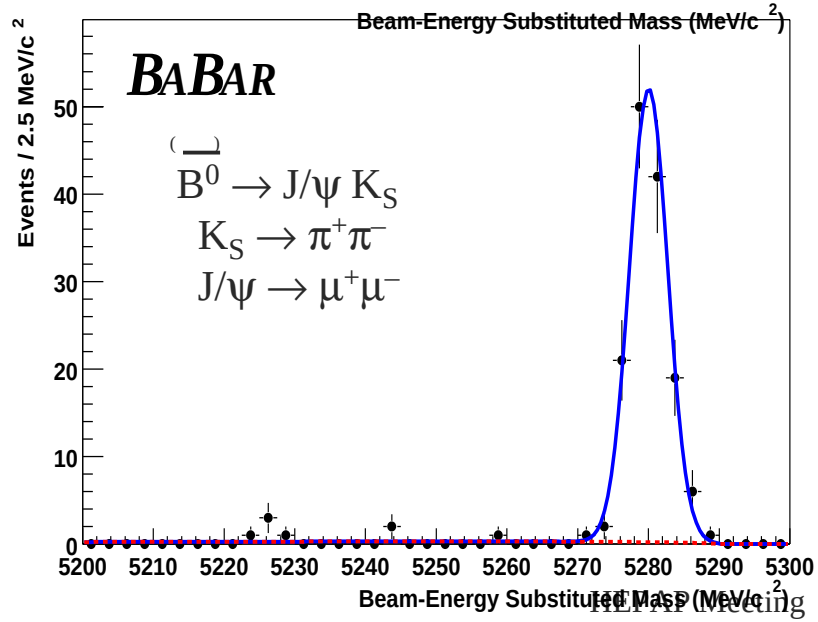
Reconstructed Hadronic *B* events for mixing and fitting (B_{flav} Sample)



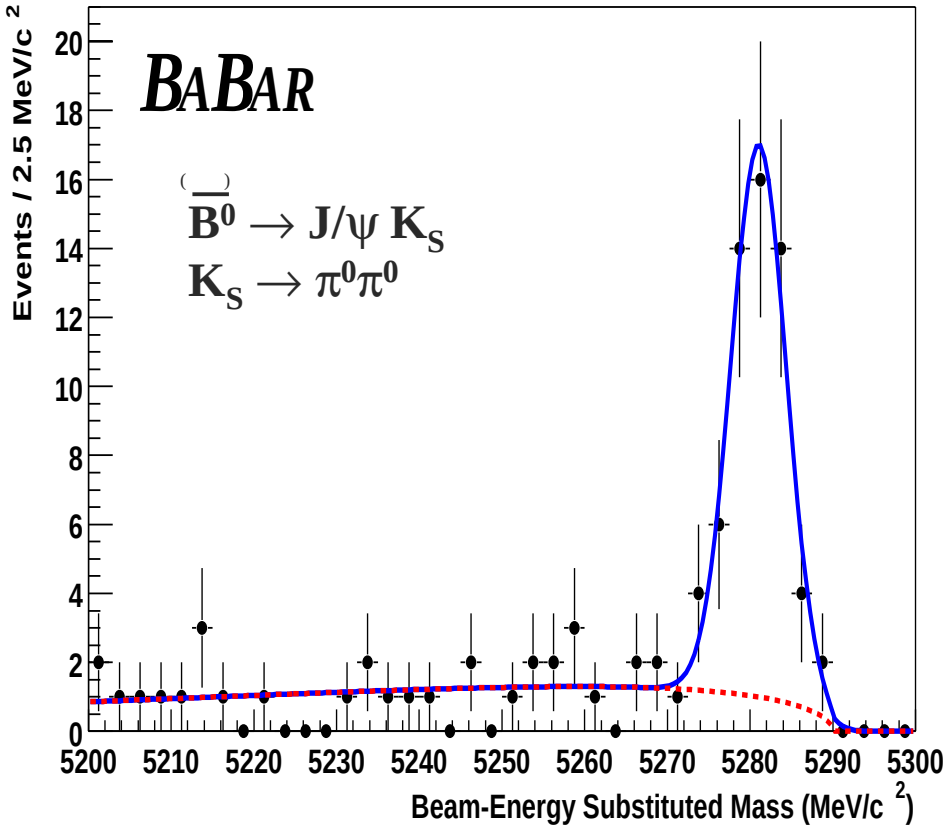
$B^0 \to J/\psi\ (K_s \to \pi^+\pi^-)$

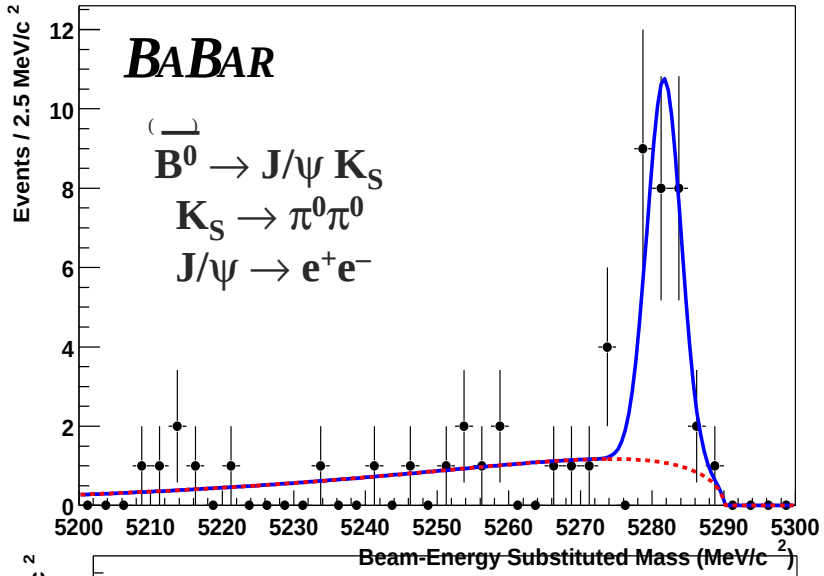


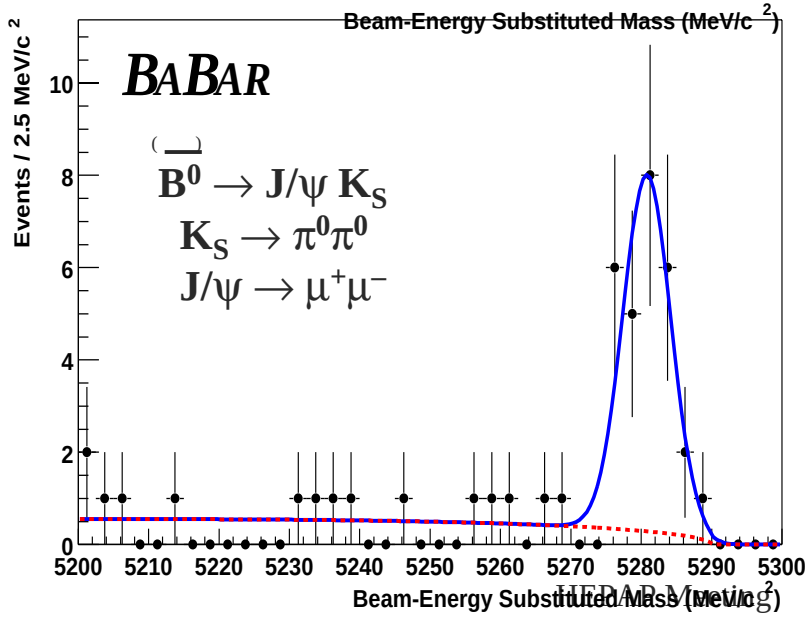




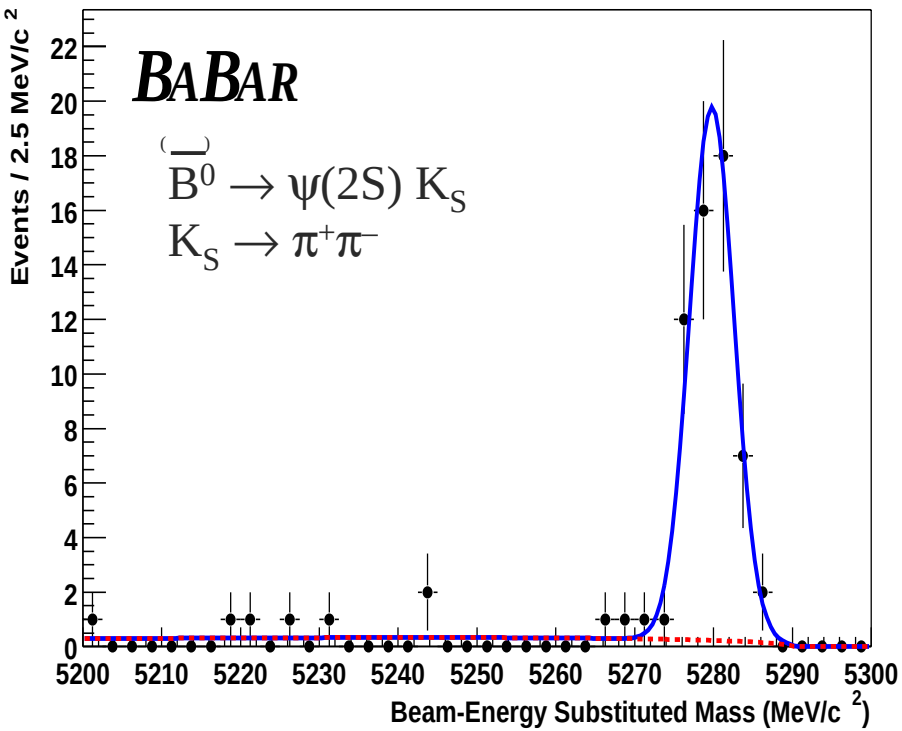
$B^0 \to J/\psi\,(K_s \to \pi^0\pi^0)$

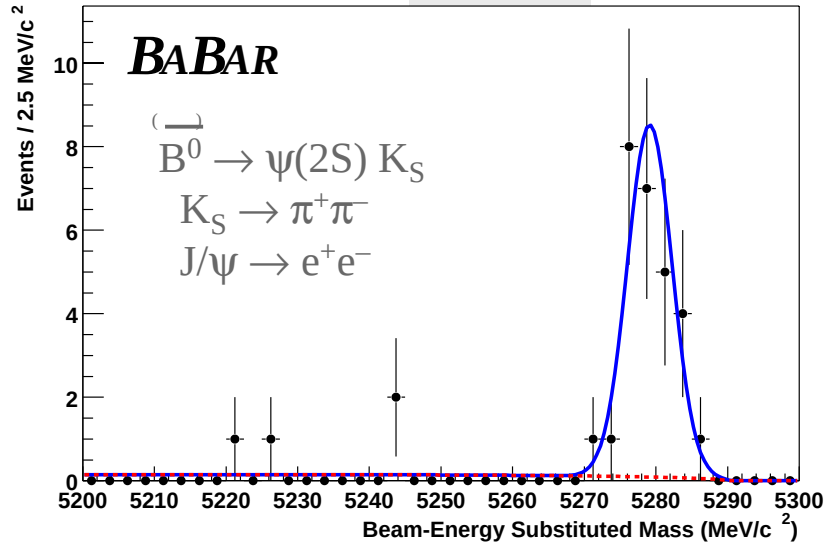


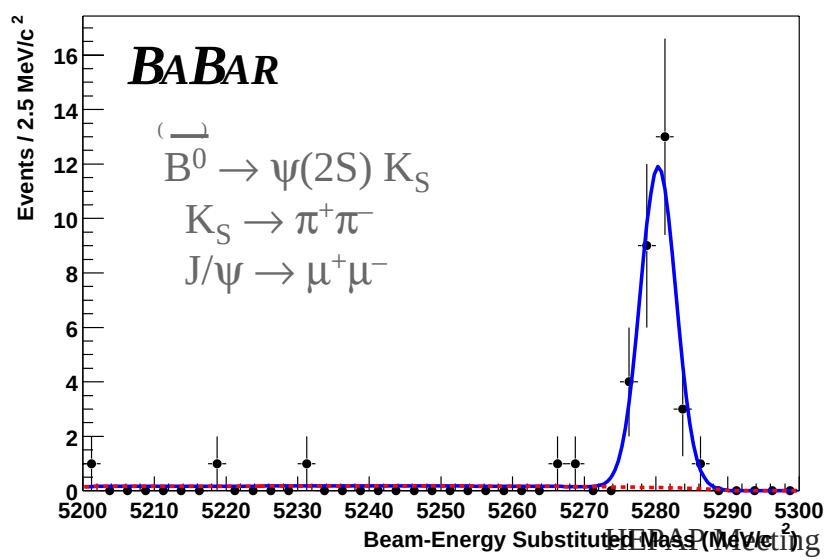




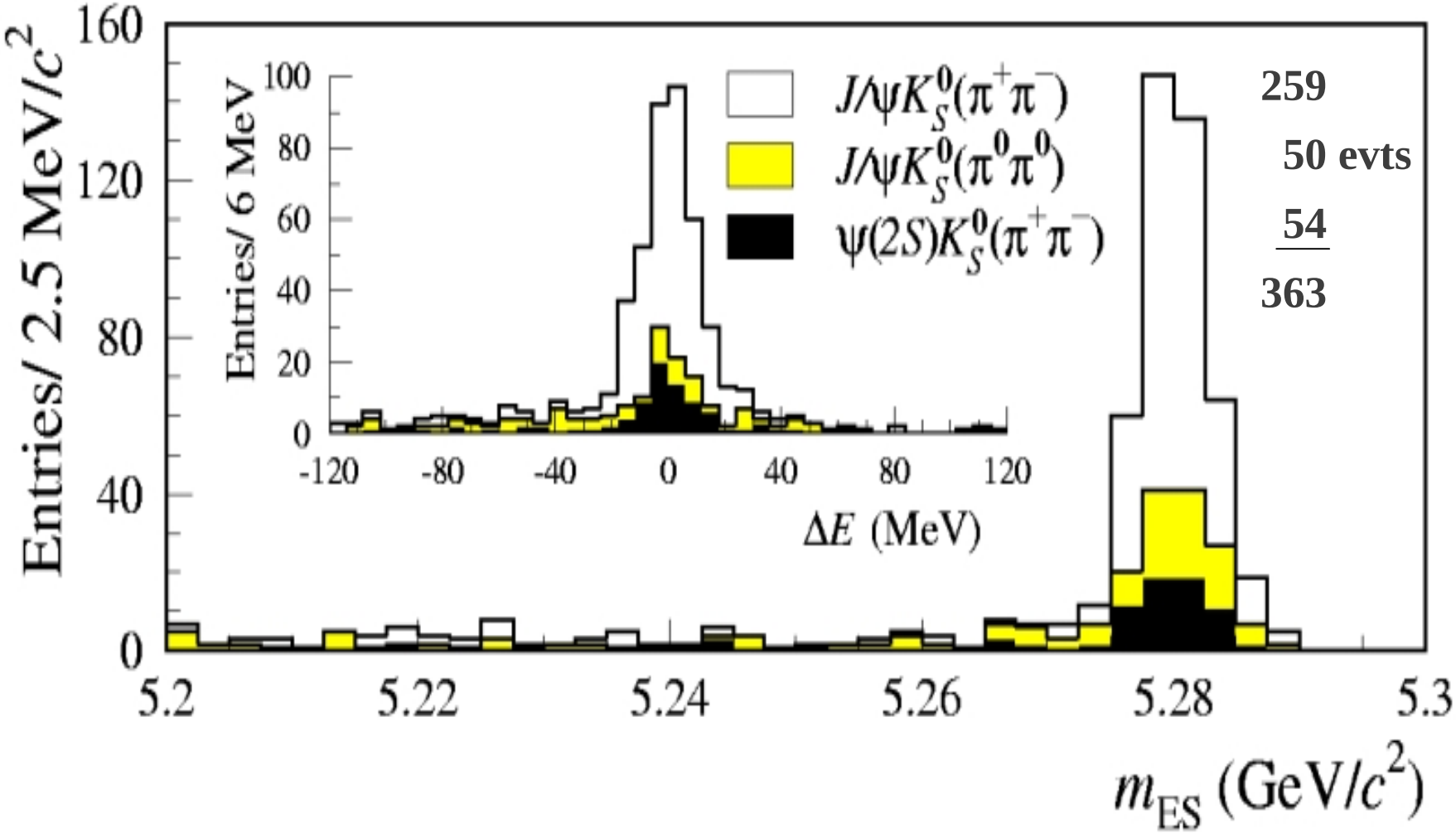
$\psi(2S)$ $(K_S \to \pi^+\pi^-)$





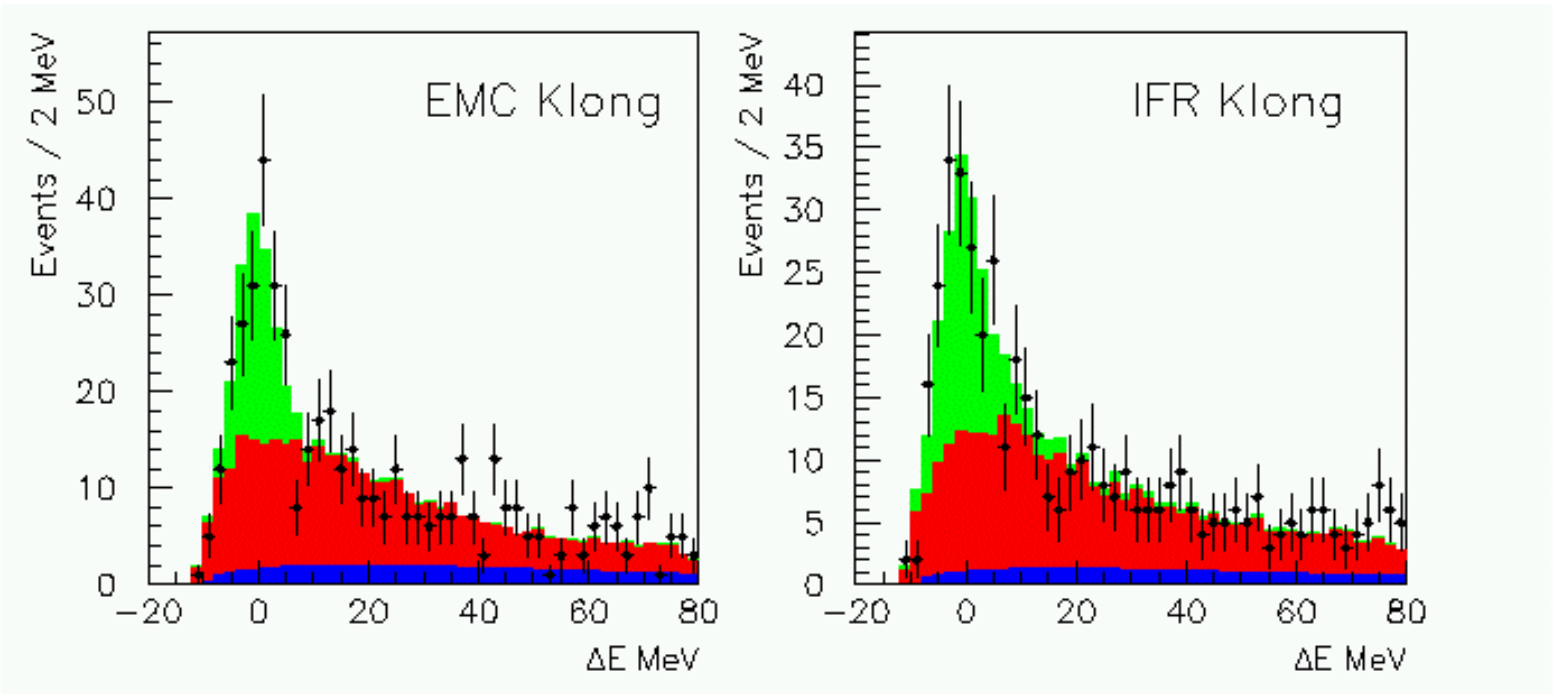


Final *CP* sample of κ^0_s modes



$B^0 \rightarrow J/\psi K^0_L$ events in CY 2000 sample

- K^0_L signaled by isolated clusters in IFR (>1 layer) and/or EMC (>200 MeV)
- K^0_L direction is combined with J/ψ momentum to reconstruct K^0_L energy
- ~ 205 total events above large background before tagging. Background shape, amount, and *CP* structure studied with Monte Carlo. (182 after tagging)



Likelihood analysis – global fit

- **Simultaneous fit to B_{CP} and B_{flav} samples for $\sin 2\beta$ (plus 34 parameters to characterize the detector and the data)**
  - **Signal Δt resolution function (9 parameters)**
  - **Signal dilutions and B^0 $\overline{B}^0$ dilution differences (8 parameters)**
  - **Background Δt structure, resolution function, dilutions and *CP* content (17 parameters)**
- **Correlations between B_{CP} and B_{flav} are small**
- **Extract background parameters from:**
  - **m_{ES} sidebands for golden *CP* modes and B_{flav} modes**
  - **J/ψ sidebands and inclusive $B^0 \rightarrow J/\psi$ monte carlo for K^0_L modes**

Mistag fractions w_i and effective efficiencies Q_i

- **Determined from data via likelihood fit**
- $Q_i = \varepsilon_i (1-2w_i)^2$ **is the effective tagging efficiency**

Tag Category	$\varepsilon(\%)$	$w(\%)$	$Q(\%)$
Lepton	10.9 ± 0.4	11.6 ± 2.0	6.4 ± 0.7
Kaon	36.5 ± 0.7	17.1 ± 1.3	15.8 ± 1.3
NT1	7.7 ± 0.4	21.2 ± 2.9	2.6 ± 0.5
NT2	13.7 ± 0.5	31.7 ± 2.6	1.8 ± 0.5
Total	68.9 ± 1.0		26.7 ± 1.6

Cross checks on mistag fractions

$B^0 \rightarrow D^{*-} l \nu$ **16,000 events**

B_{flav} sample ~5000 events

Parameter	one bin	One bin hadronic	Global likelihood fit
w [Lepton]	0.108 ± 0.013	0.116 ± 0.021	$\mathbf{0.116 \pm 0.020}$
w [Kaon]	0.180 ± 0.009	0.176 ± 0.014	$\mathbf{0.171 \pm 0.013}$
w [NT1]	0.216 ± 0.019	0.197 ± 0.030	$\mathbf{0.212 \pm 0.029}$
w [NT2]	0.364 ± 0.016	0.323 ± 0.027	$\mathbf{0.317 \pm 0.026}$
Q	$\mathbf{0.255 \pm 0.017}$	$\mathbf{0.264 \pm 0.018}$	$\mathbf{0.267 \pm 0.017}$