Final Update on Γ_{ee}

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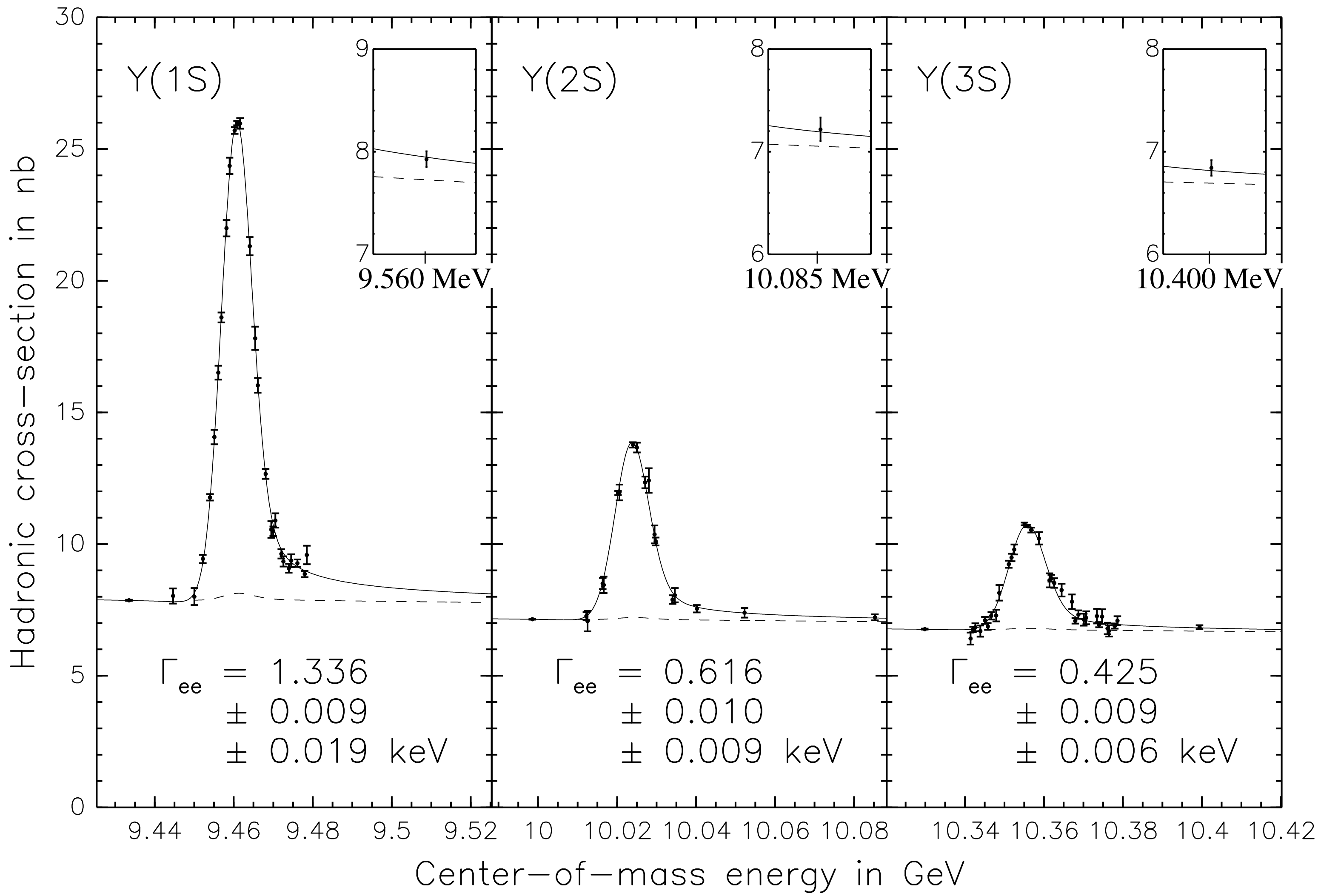
Reminder of Γ_{ee}

$\Gamma_{ee} = \dfrac{M_\Upsilon{}^2}{6\pi^2} \displaystyle\int \sigma(e^+e^- \to \Upsilon)\, dE$, integral from cross-section versus energy fits



This result went to EPS, Lattice05, and will go to PANIC05

What went into this measurement?

- Scan procedures designed to minimize uncertainty from beam energy: $\lesssim 0.2\%$
- Background subtraction with 0.25% uncertainty
- Υ efficiency with 0.7% uncertainty
- Luminosity calibration with 1.3% uncertainty

Luminosity calibration and most of efficiency systematics cancel in ratios of $\Gamma_{ee}(nS)/\Gamma_{ee}(mS)$
Ratios have 2–3% statistical uncertainties

The ratios are also easier for Lattice QCD to predict

Reducing Statistical Uncertainties

Preliminary results used $e^+e^- \to \gamma\gamma$ for point-by-point (relative) luminosity which dominates statistical uncertainty

Improve measurement with $e^+e^- \to e^+e^-$

	$\Gamma_{ee}(2S)/\Gamma_{ee}(1S)$	$\Gamma_{ee}(3S)/\Gamma_{ee}(1S)$	$\Gamma_{ee}(3S)/\Gamma_{ee}(2S)$
$e^+e^- \to \gamma\gamma$	1.7%	2.3%	2.7%
2/3 of $e^+e^- \to e^+e^-$	0.7%	1.0%	1.2%

Issues:

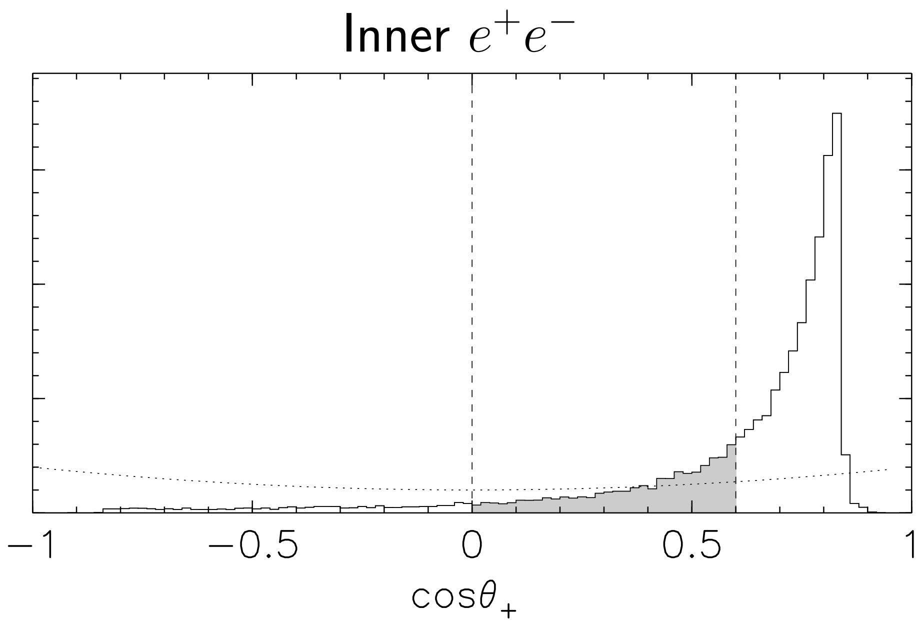
- e^+e^- count is contaminated by $\Upsilon \to e^+e^-$, with energy-dependent interference

"Opportunities":

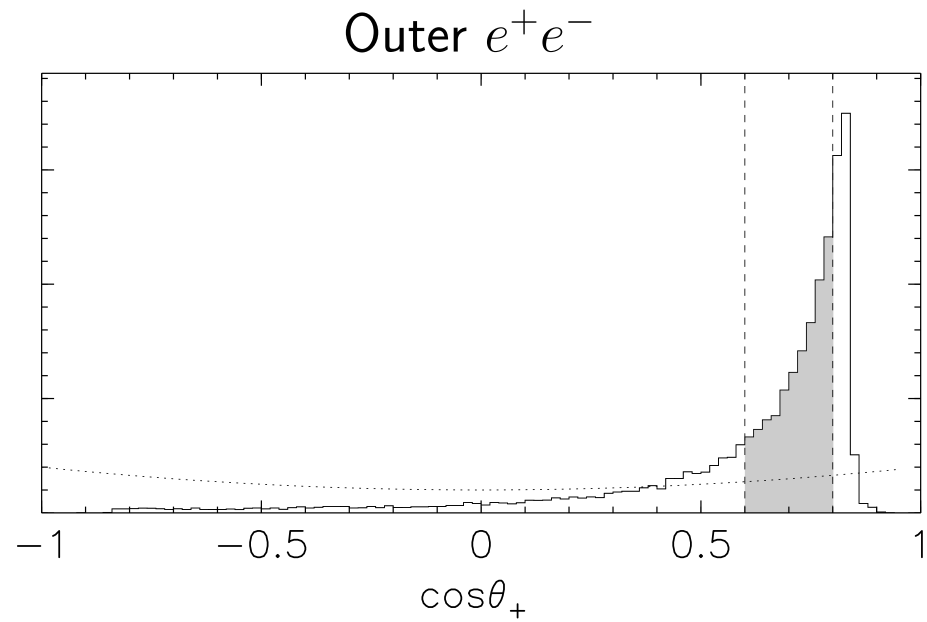
- Higher statistical power resolves additional systematics:
  we see a 1.8% $\pm$ 0.6% narrowing of beam energy spread in April 2002

Issue: Removing $\Upsilon \to e^+e^-$ Contamination

As a check, we divide the e^+e^- sample into two regions:



More contaminated by $\Upsilon \to e^+e^-$



Less contaminated by $\Upsilon \to e^+e^-$

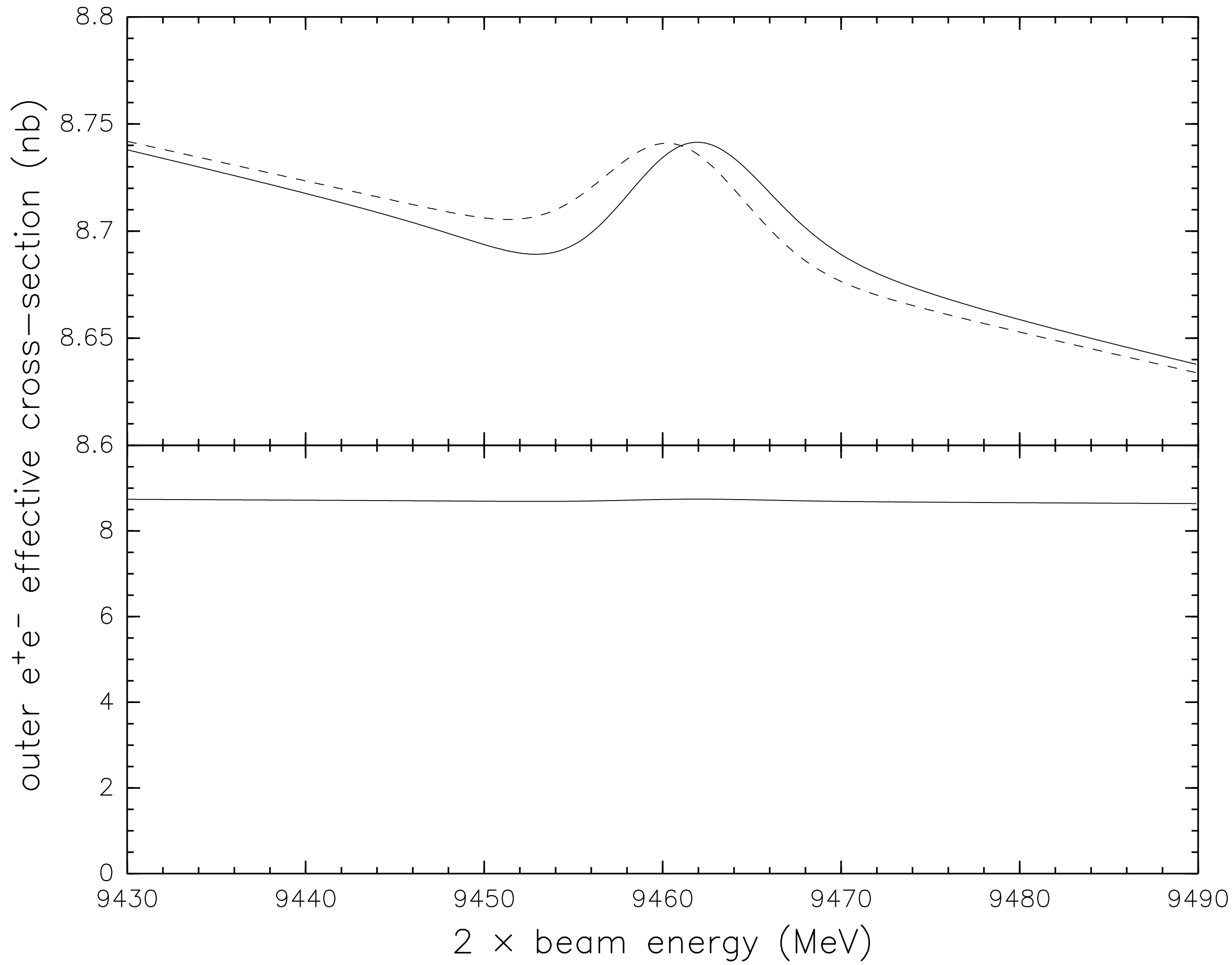
$$\#e^+e^- \text{ to subtract} = \sigma_\Upsilon(E)\ \mathcal{B}_{\mu\mu}\ \frac{\displaystyle\int_{0.6}^{0.8} \cos^2\theta_+\ d(\cos\theta_+)}{\displaystyle\int_{-1}^{+1} \cos^2\theta_+\ d(\cos\theta_+)}\ \mathcal{L}_{\gamma\gamma}$$

where $\sigma_\Upsilon(E)$ is Karl's lineshape function, appropriately normalized

Issue: Removing $\Upsilon \to e^+e^-$ Contamination

$\sigma_\Upsilon(E)$ calculates Breit-Wigner $\otimes$ beam-energy spread $\otimes$ ISR tail

with continuum (Bhabha) interference

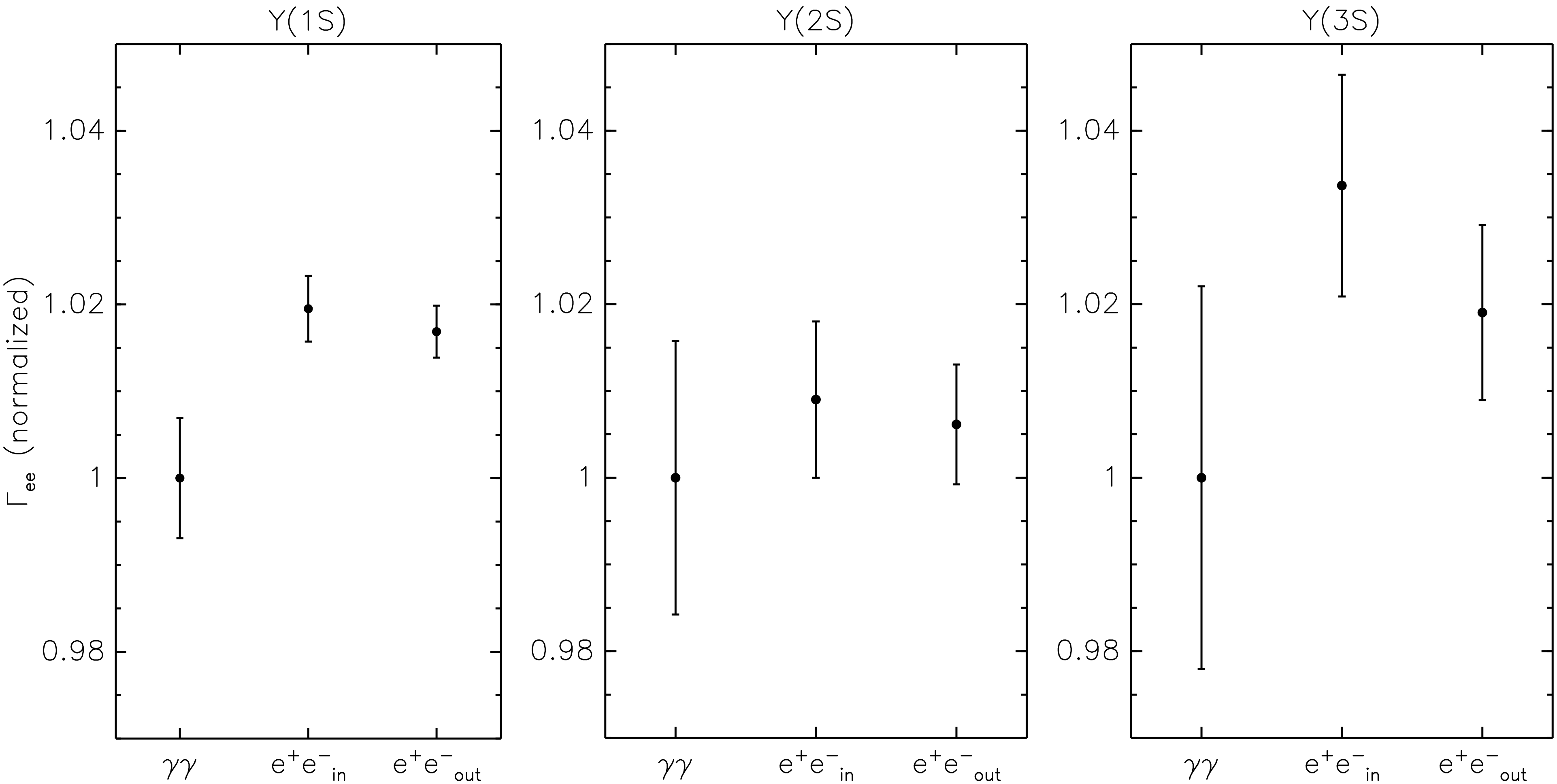


Solid line is e^+e^- effective cross-section, dashed line is without interference

Fit Results

$\surd$ Including/excluding interference is a 0.02% (0.04%) difference for outer (inner) e^+e^-

$\surd$ Outer and inner e^+e^- agree with each other:

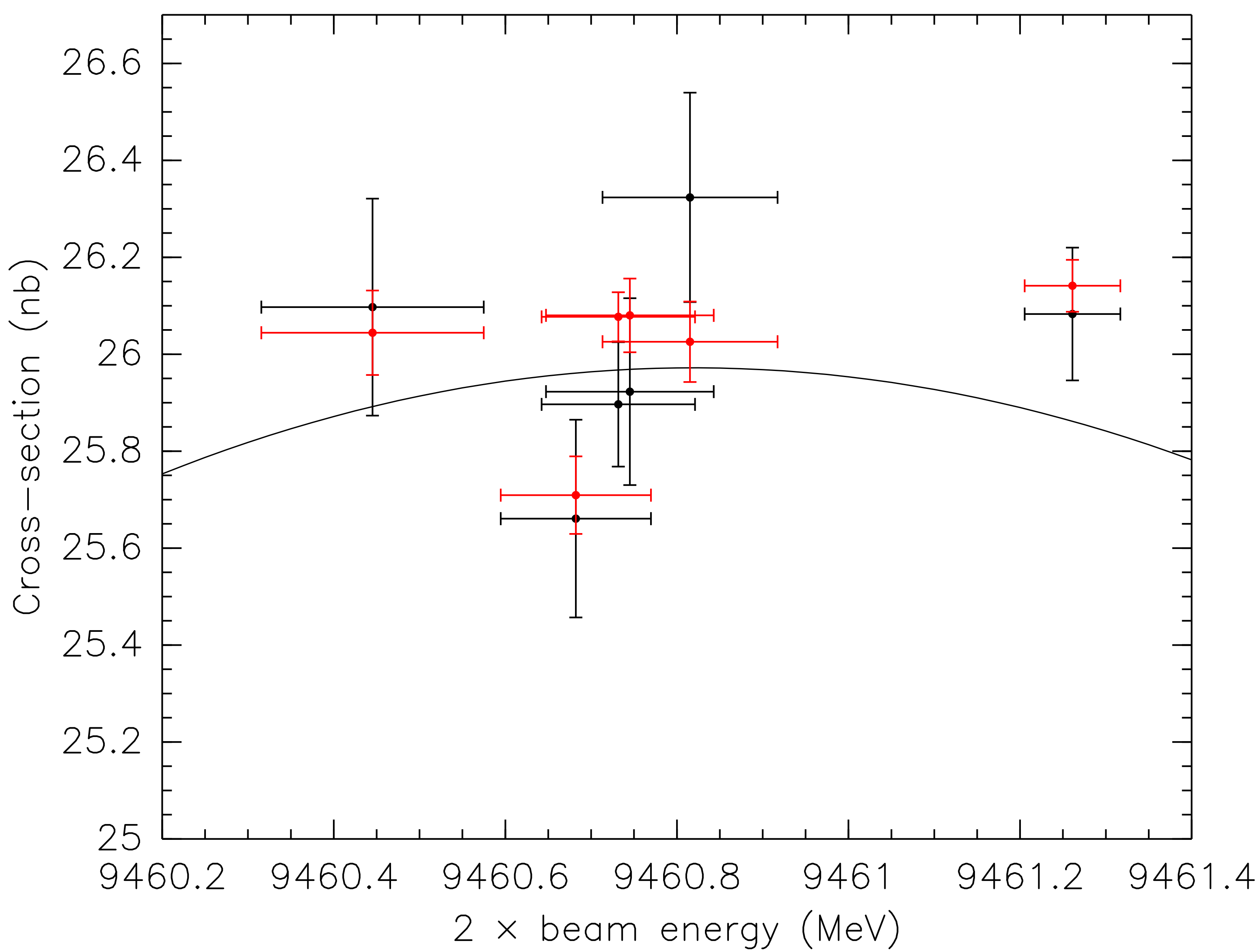


...but not with $\gamma\gamma$? I am investigating this.

New topic: what e^+e^- precision uncovered

What e^+e^- precision uncovered

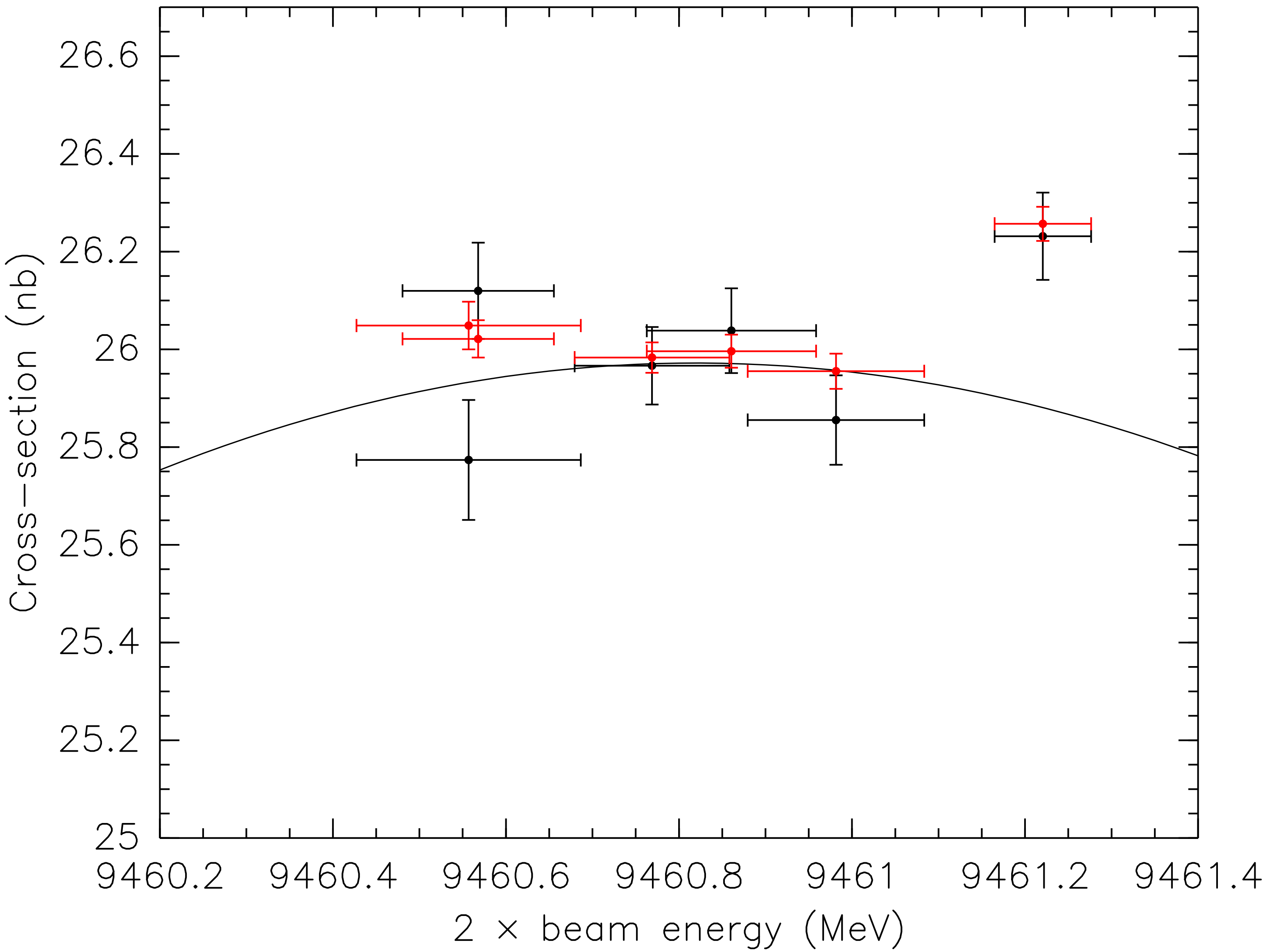
With scan data near the $\Upsilon(1S)$ peak (black = $\gamma\gamma$, red = outer e^+e^-, grouped by week):



we see a 1.8% excess in April 2002 (far right point)

What e^+e^- precision uncovered

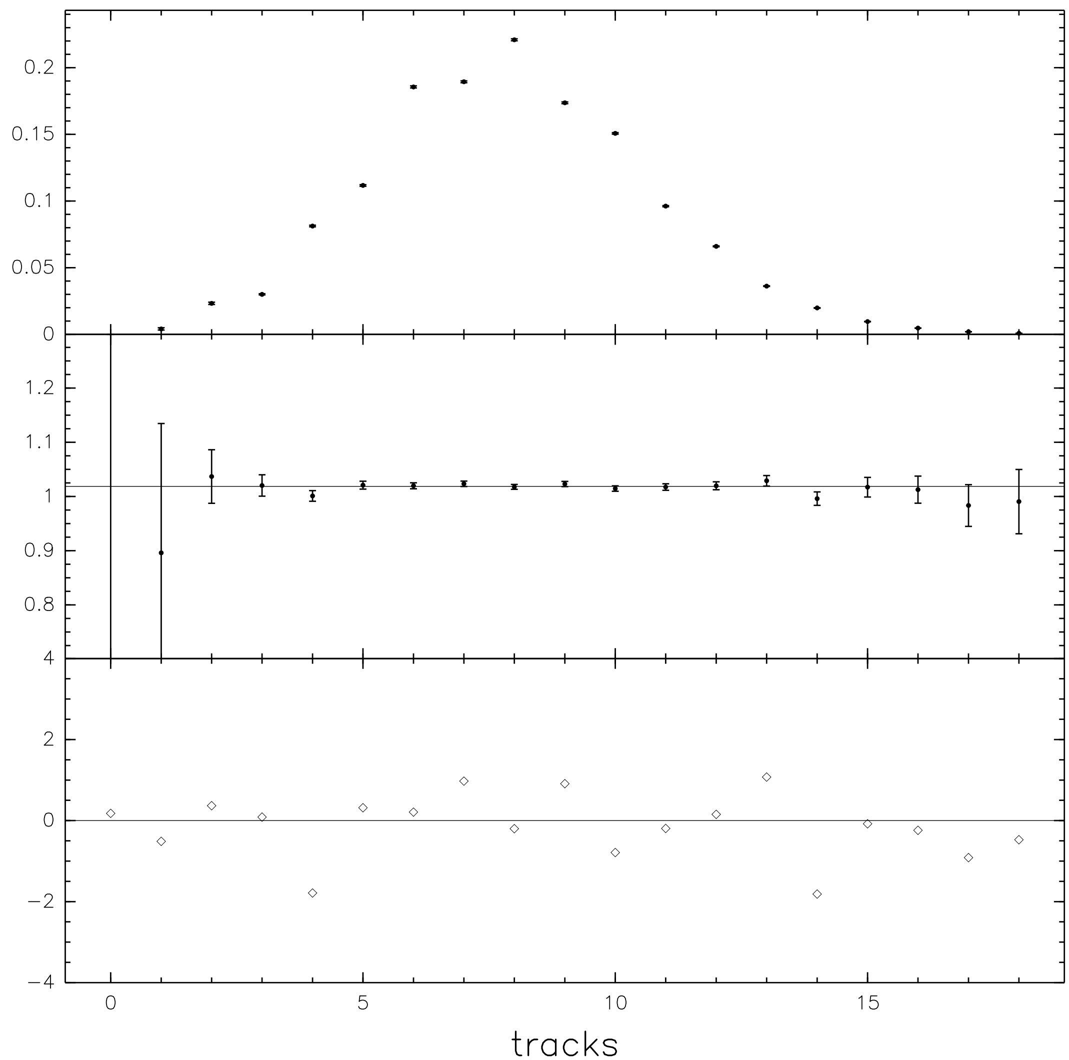
With all available CLEO-III data with the same dates (black $= \gamma\gamma$, red $=$ outer e^+e^-):



we see a clearer 1.8% excess in April 2002 (far right point)

What does this excess look like?

In all distributions, the excess is distributed like Υ events.



$\rightarrow$ not an inefficiency or background

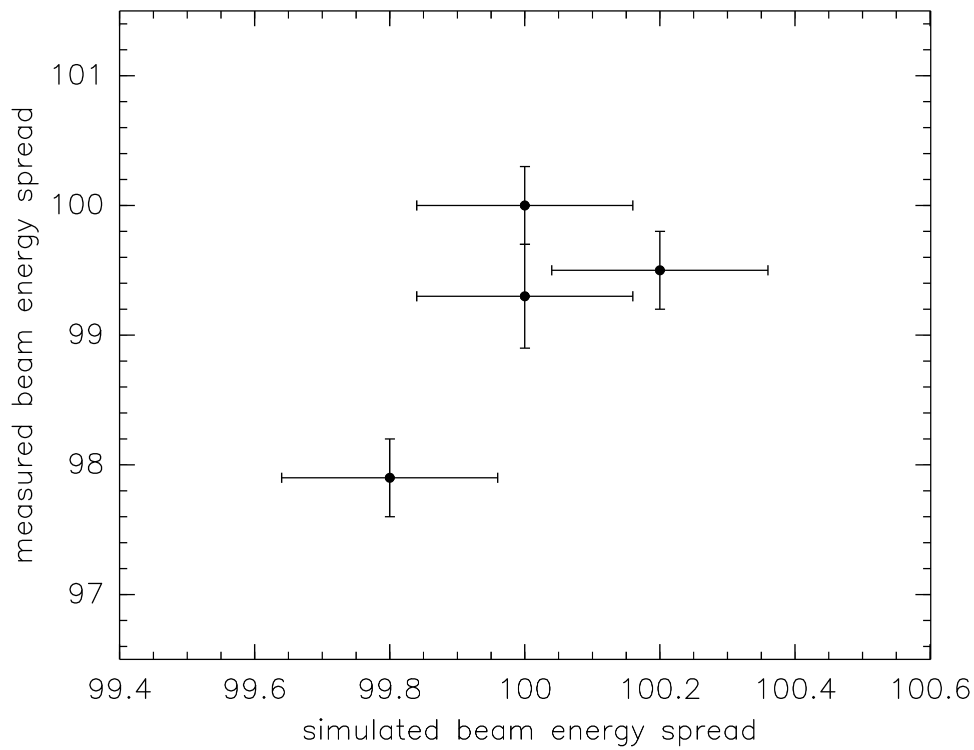
Can Υ beam energy spread fluctuate on this scale?

CESRV simulations

Yes!

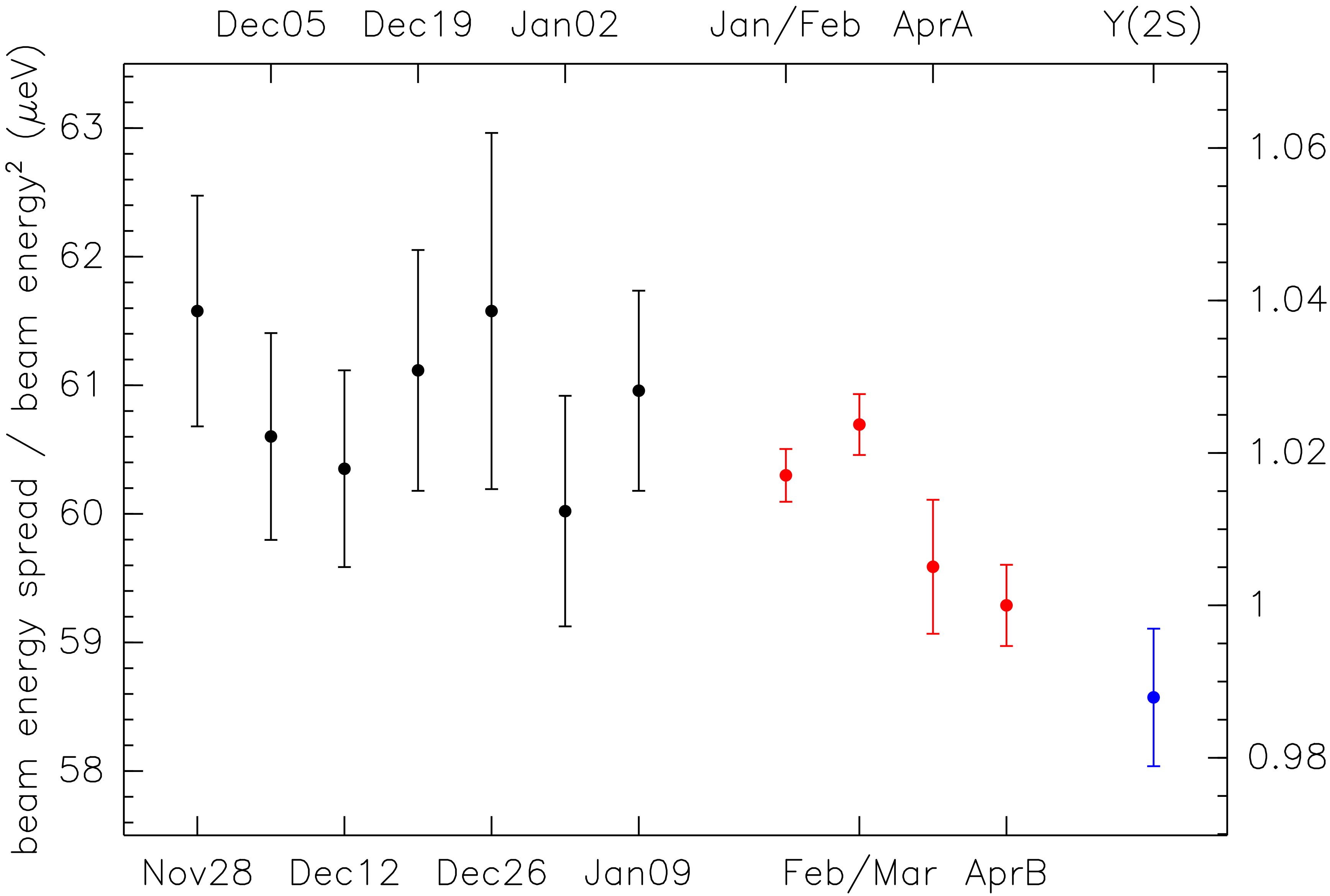
Simulations of an April 2002 beam orbit and a March 2002 beam orbit reveal beam energy spread differences on the order of 1%

Simulations with spring 2002 savesets are correlated with measured beam energy spreads:



Surveyed CESR e-log to find breakpoints;
fits now allow piecewise constant beam energy spread

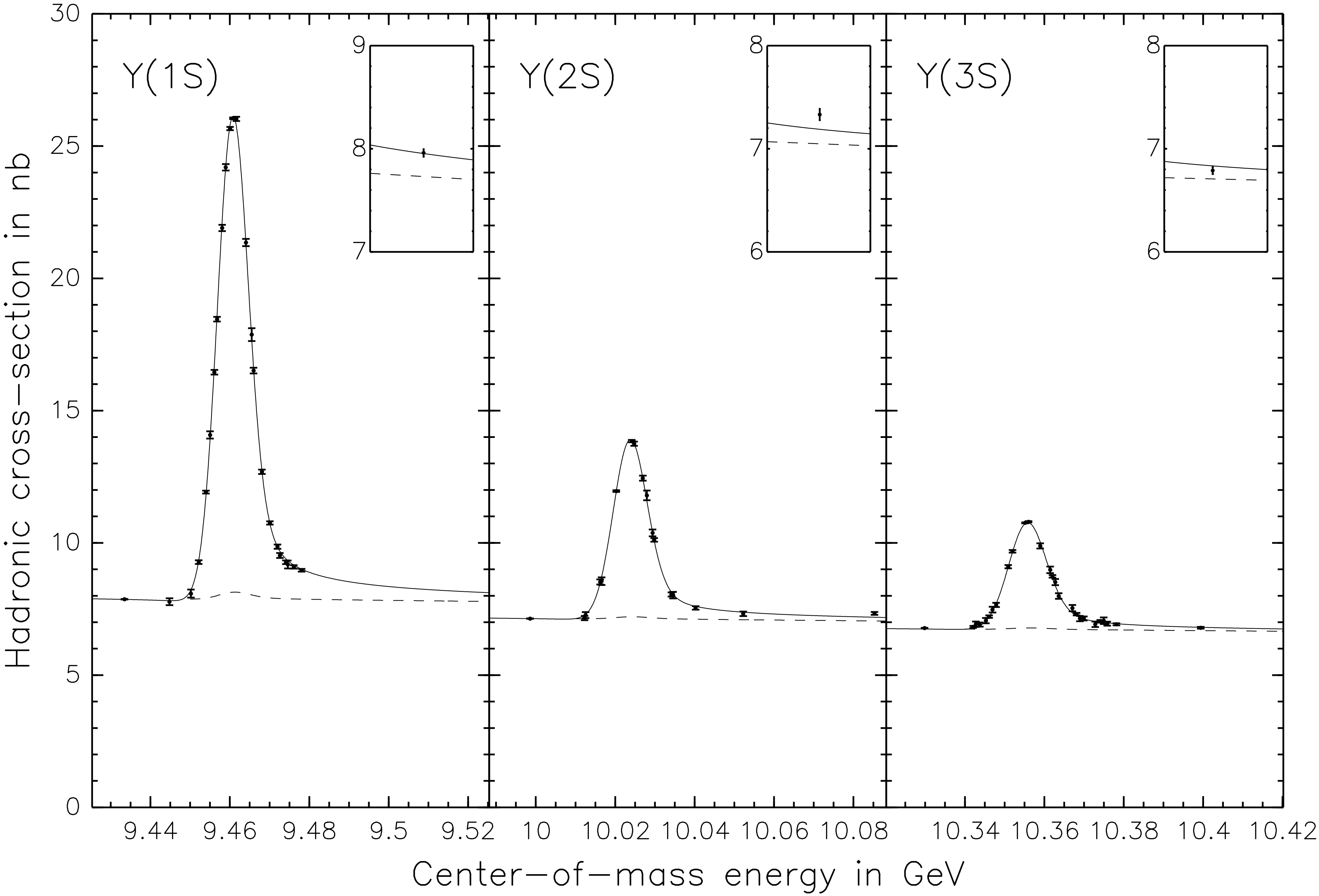
Piecewise constant beam energy spread— Fit Results



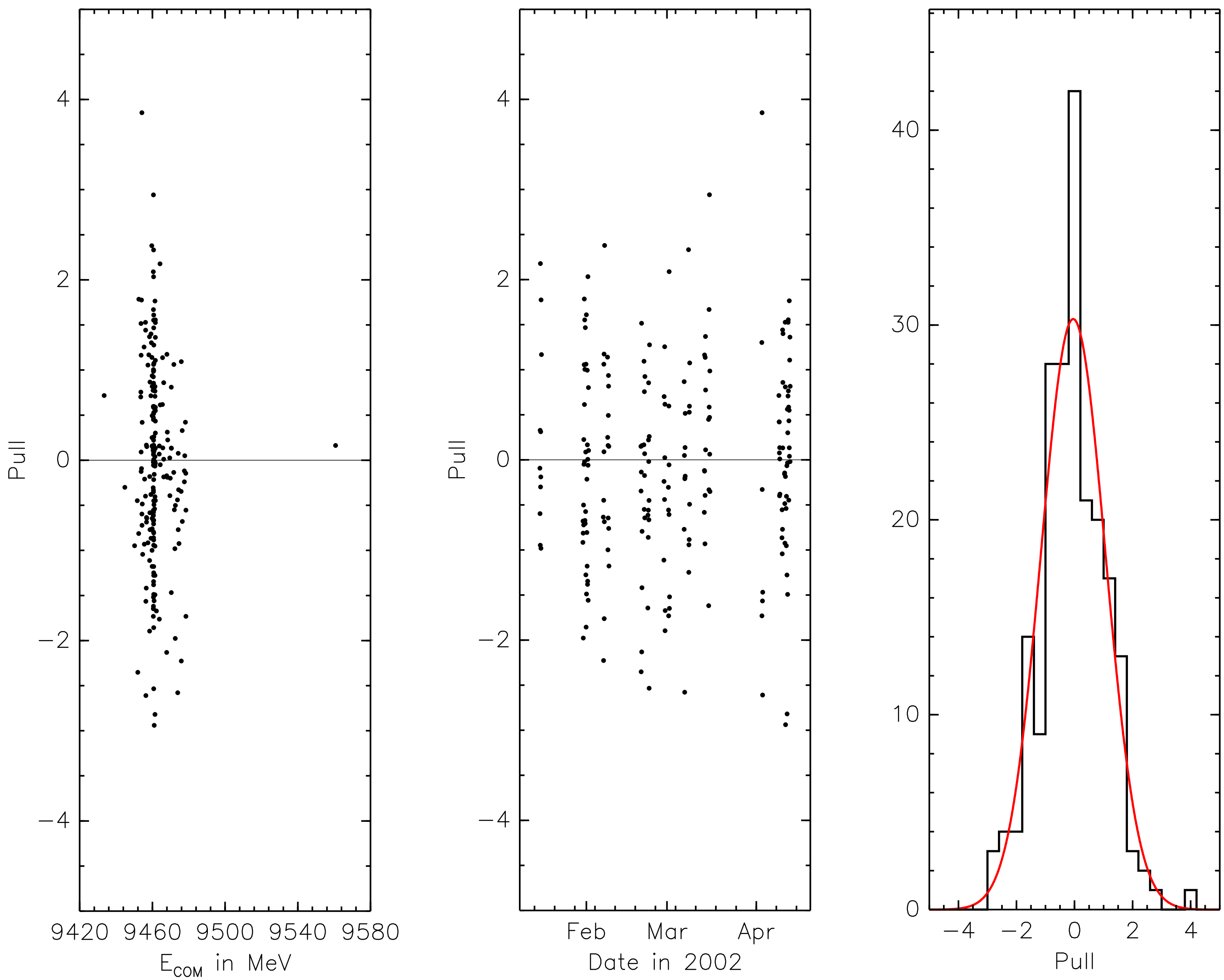
(black = $\Upsilon(3S)$, red = $\Upsilon(1S)$, blue = $\Upsilon(2S)$)

New topic: quality of fits

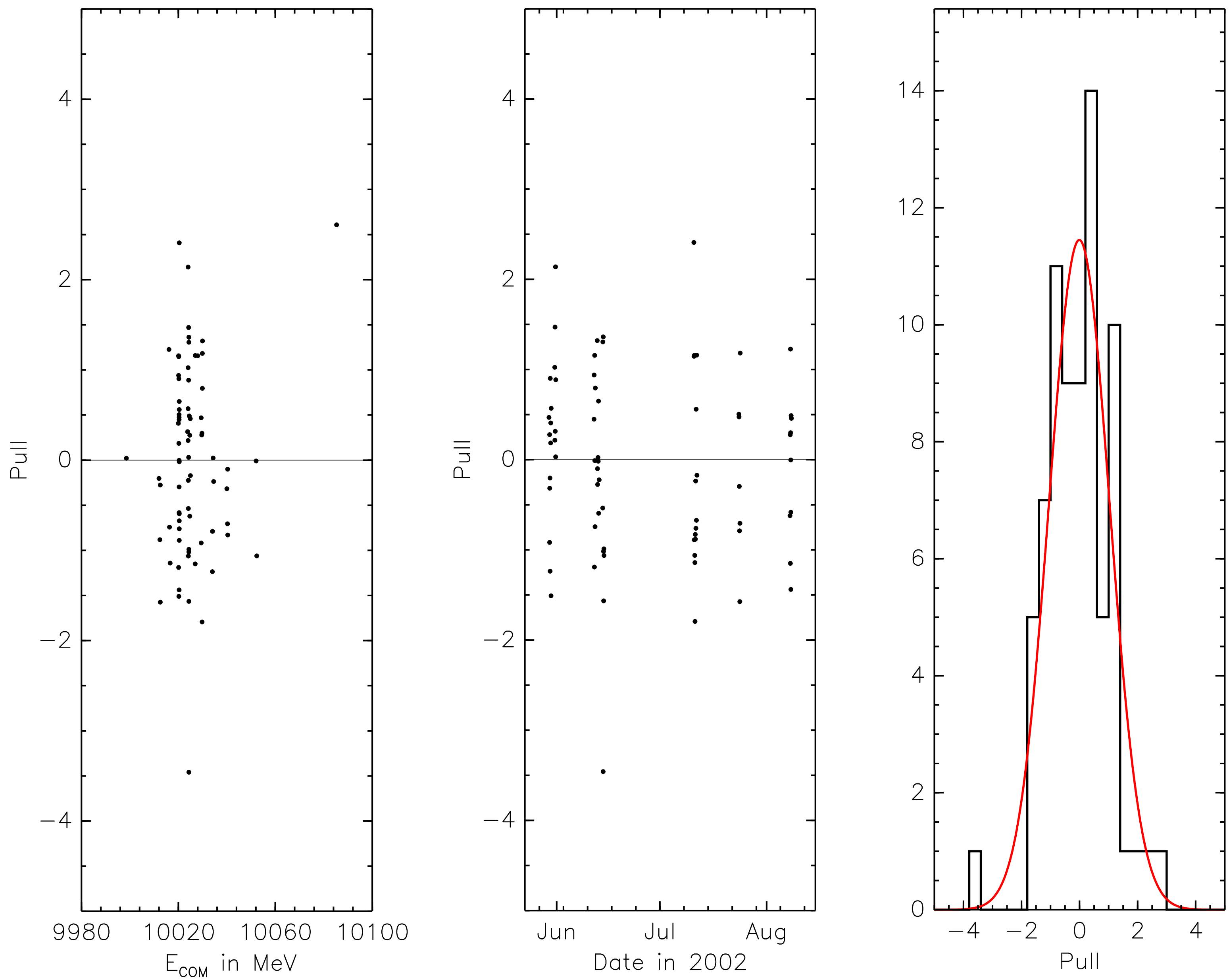
Outer e^+e^- Fit Results



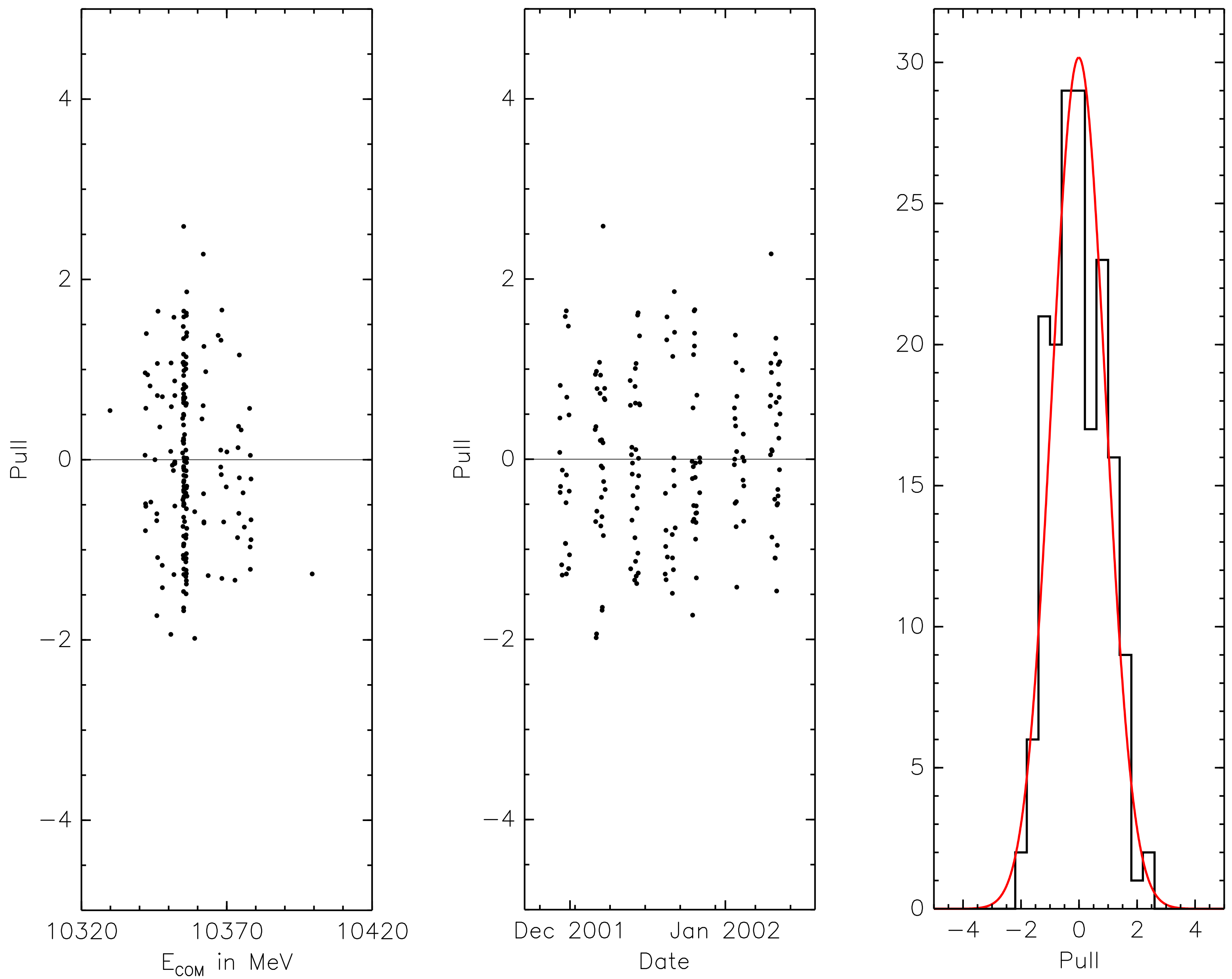
Outer e^+e^- Fit Results: $\Upsilon(1S)$ has $\chi^2/\mathrm{ndf} = 257.2/(210 - 18) = 1.34$



Outer e^+e^- Fit Results: $\Upsilon(2S)$ has $\chi^2/\mathrm{ndf} = 82.0/(75-9) = 1.24$



Outer e^+e^- Fit Results: $\Upsilon(3S)$ has $\chi^2/\mathrm{ndf} = 149.93/(175-16) = 0.94$



Conclusions

- Subtracting $\Upsilon \to e^+e^-$ from e^+e^- luminosity counts is not hard, even with interference
- I will use Brian and Surik's Bhabha cuts (CBX 05-17) instead of "inner" and "outer"
- 2-σ disagreement between $\gamma\gamma$ and e^+e^- fit results? I will check $\frac{\#\gamma\gamma}{\text{Bhabha}}$ vs. E, date

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- We can see one change in beam energy spread and have guarded against bias in the fit

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- Fit pull distributions (reduced χ^2) are a little wide (1.34, 1.24, 0.94)
- Increase "cross-section reproducibility" systematic from 0.1% to 0.4%

- Immediately after PANIC, we start to write the PRL
- Paper vote in December!