Calculating hadronic cross-section for runs at the same energy and getting the same answer

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Previously, I measured hadronic efficiency to high precision

Luminosity measurement in two parts:

1. Calculated luminosity is correct for each run relative to all others (remember, I'm doing scans)
2. Absolute magnitude of luminosity is correct

Today, I focus on #1

Contents:

- Gamgam cuts for luminosity
- Trigger efficiency for gamgams
- Look at hadronic cross-section of $\Upsilon(3S)$ continuum: see fluctuations
- Why? Sensitivity to CC calibration
- Change gamgam *and* hadron cuts to reduce sensitivity
- Will this be a problem for my hadronic efficiency measurement? No.

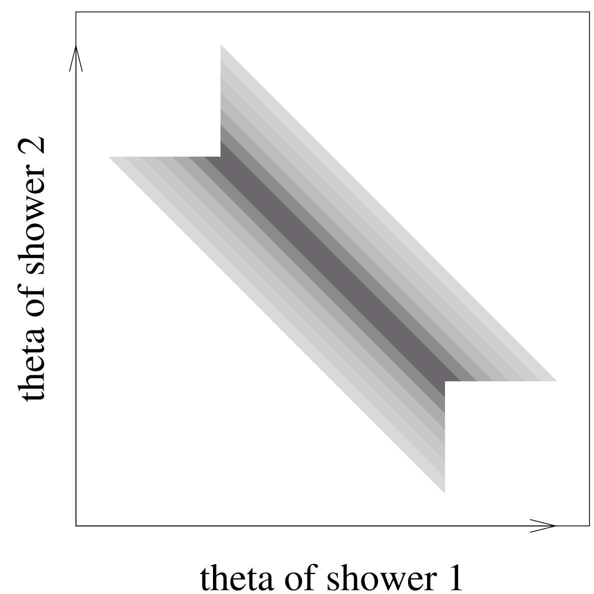
$e^+e^- \to \gamma\gamma$ (gamgam)

(Why use gamgam? e^+e^- and $\mu^+\mu^-$ interfere with Υ across resonance)

Initial cuts:

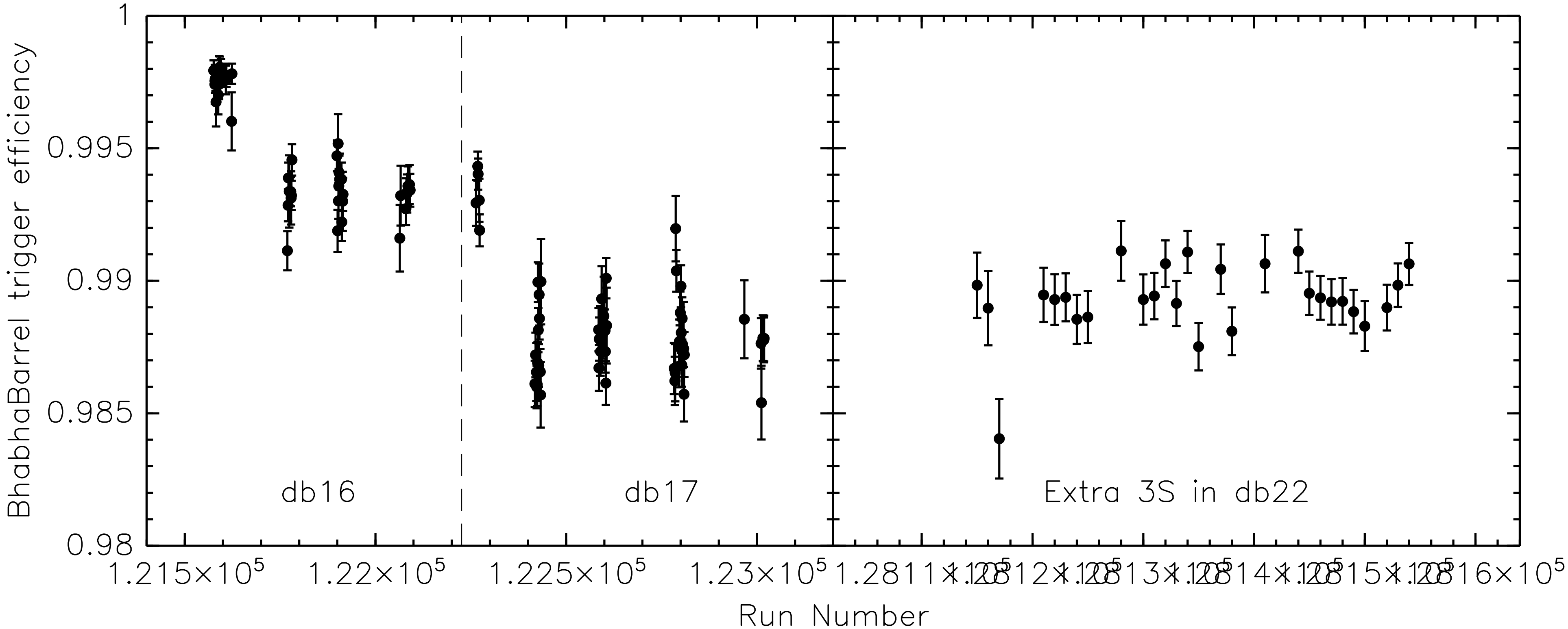
1. BhabhaBarrel trigger line (the only neutral trigger in CLEO-III)
2. Second-biggest shower (E2) $>$ 90% eBeam
3. Zero "quality" tracks
4. $|\cot\theta_1 + \cot\theta_2| < 0.1$ (back-to-back in θ)
5. $|\sin(\phi_1 - \phi_2)| < 0.04$ (back-to-back in ϕ, avoiding bhabhas)
6. asymmetric cut on $\cot\theta$: upper limit of 1.28, 1.18 ($= \cos\theta$ of 0.79 = barrel)
7. asymmetric cut on $\cot\theta$: lower limit of 0.05, 0.15 to avoid trigger inefficiency at the center of the detector

Asymmetric cut:



BarrelBhabha trigger requires two CBHI clusters (> 1.5 GeV each): on opposite sides of the detector (edge effect near $\cos\theta = 0$)

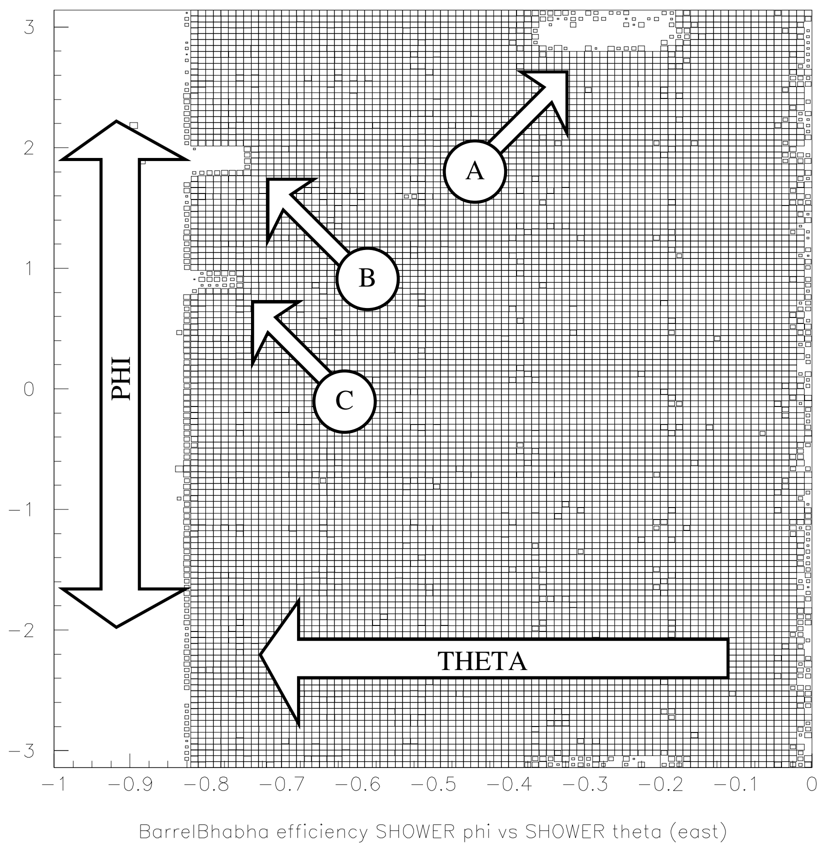
Can be measured by identifying bhabhas with gamgam cuts and $0.04 < |\sin(\phi_1 - \phi_2)| < 0.25$, and asking for BarrelBhabha trigger bit. (Corrected for θ dependence.)

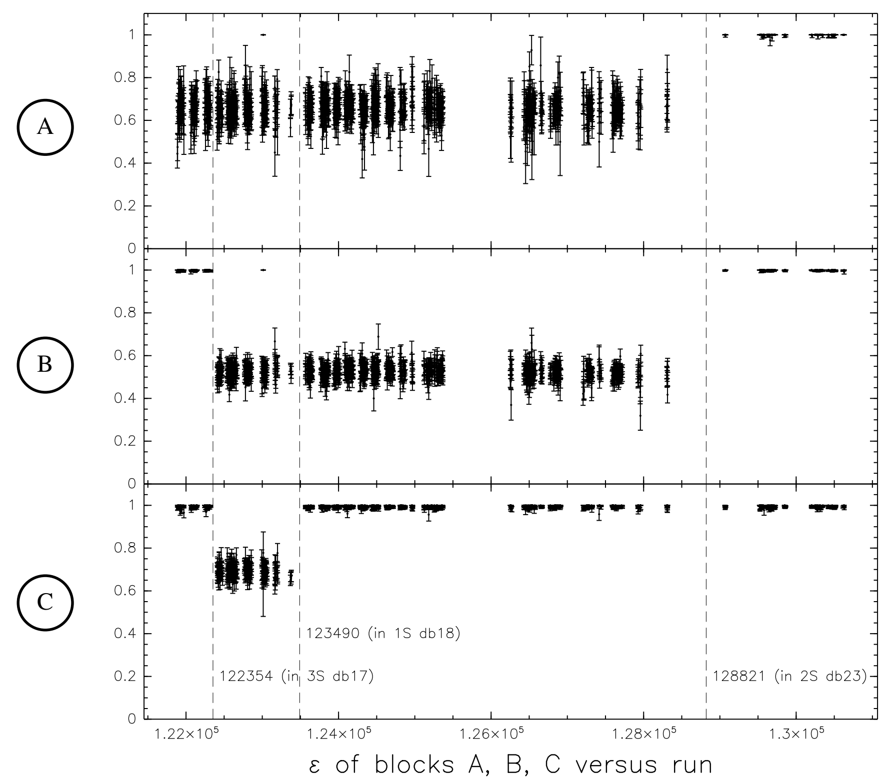


Why does trigger efficiency have steps?

Three tiles become very inefficient at different times during CLEO-III non-4S.

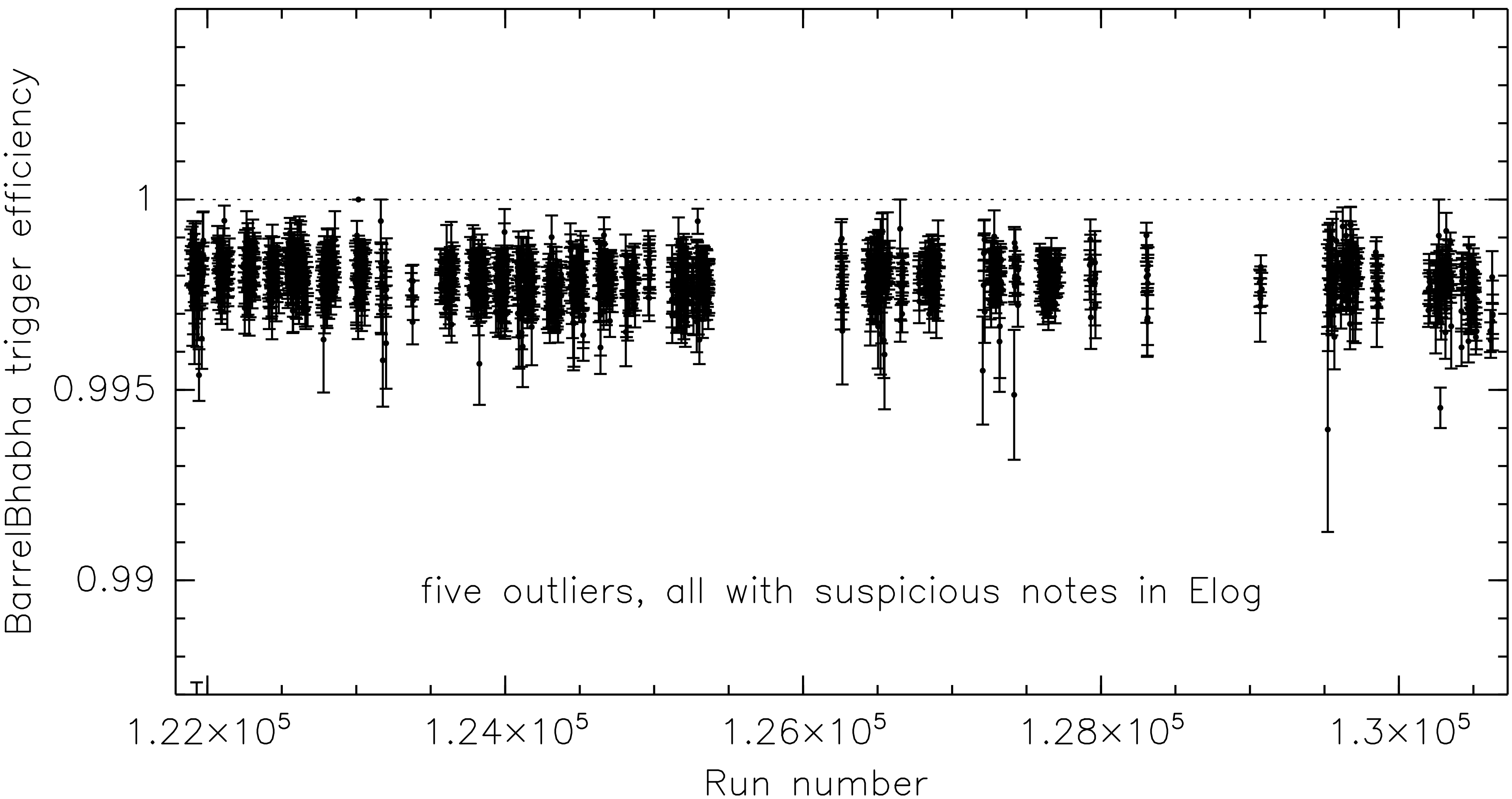
They were all fixed before the end of CLEO-III.





So I additionally exclude these blocks from my gamgam cuts

Trigger efficiency *given* other gamgam cuts is now 99.8%



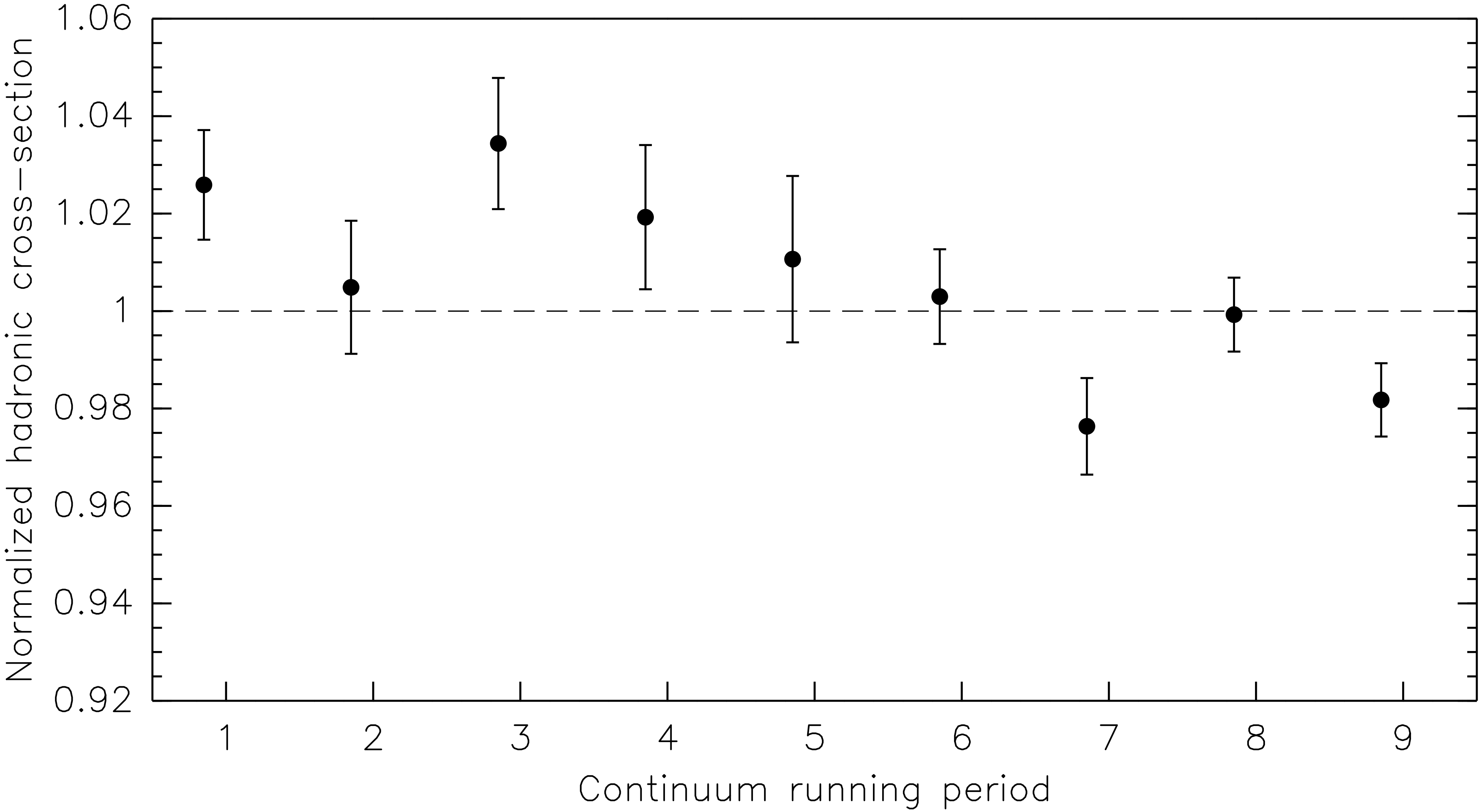
Test the hypothesis that run-by-run luminosity is stable by calculating hadronic cross-section for $\Upsilon(3S)$ continuum (9 running periods)

Caveats:

- Hadronic efficiency that I measured before doesn't apply to continuum—but it should be constant with time
- Other luminosity systematics remain, but none of them depend on time

$\Longrightarrow$ This is hadronic cross-section $\times$ unknown constant

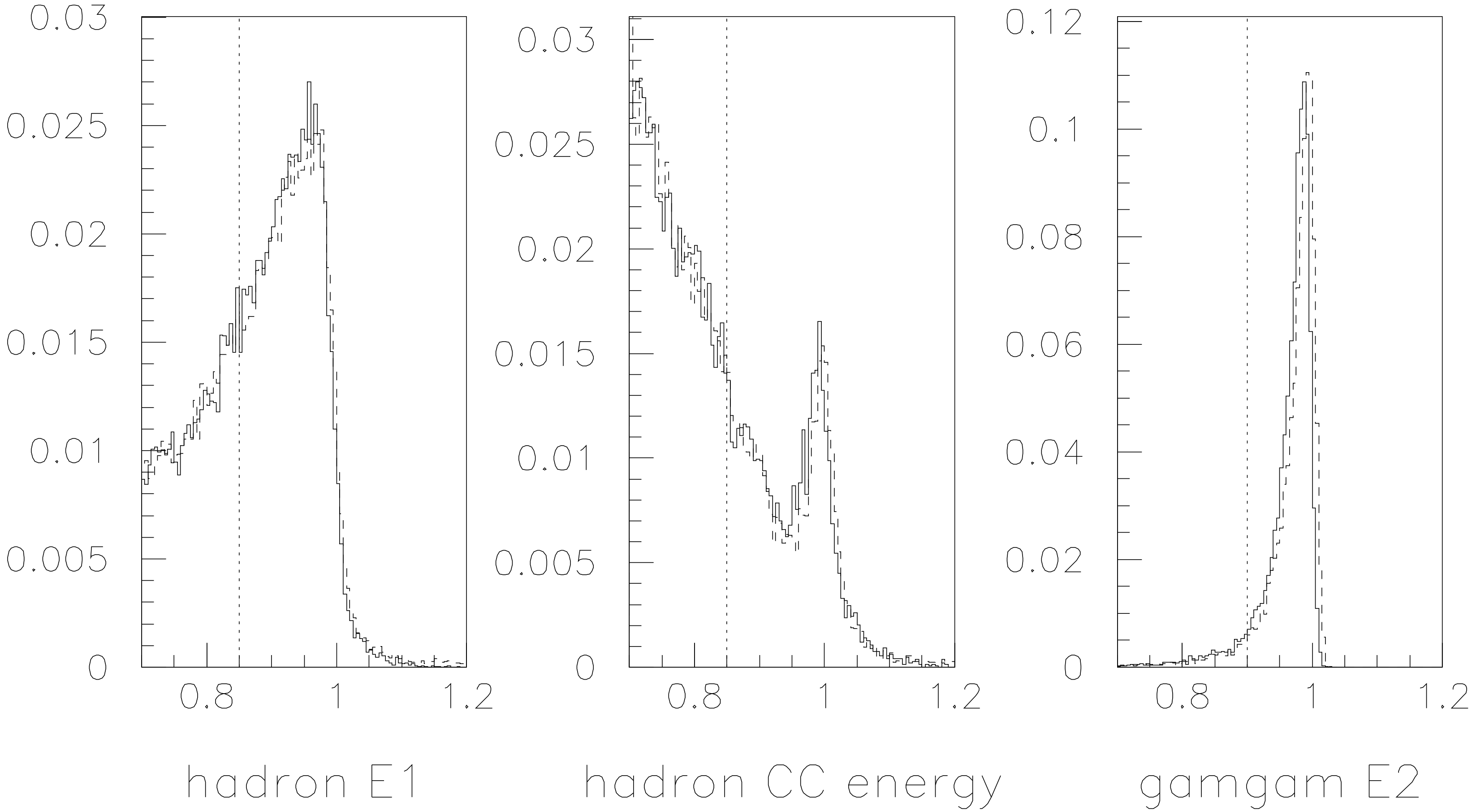
Fluctuations!!! $\chi^2/\mathrm{ndf} = 25.7\ /\ 8 \quad \Rightarrow 0.1\%$ C.L.



Take a closer look at points 3 and 7 (the most extreme)

Cuts most responsible for difference in hadronic cross-section: shower energy cuts

CC calibration drifted 6 MeV between points 3 and 7



Does this matter?

It is the continuum yield which is fluctuating— if drift is slow, I can subtract only “nearby” continuum

But how close is close enough? This problem limits how much on-resonance data I can use in an unknown way

Also, $\Upsilon(2S)$ continuum is not all near on-resonance

Can my cuts be modified to make this safer? YES!

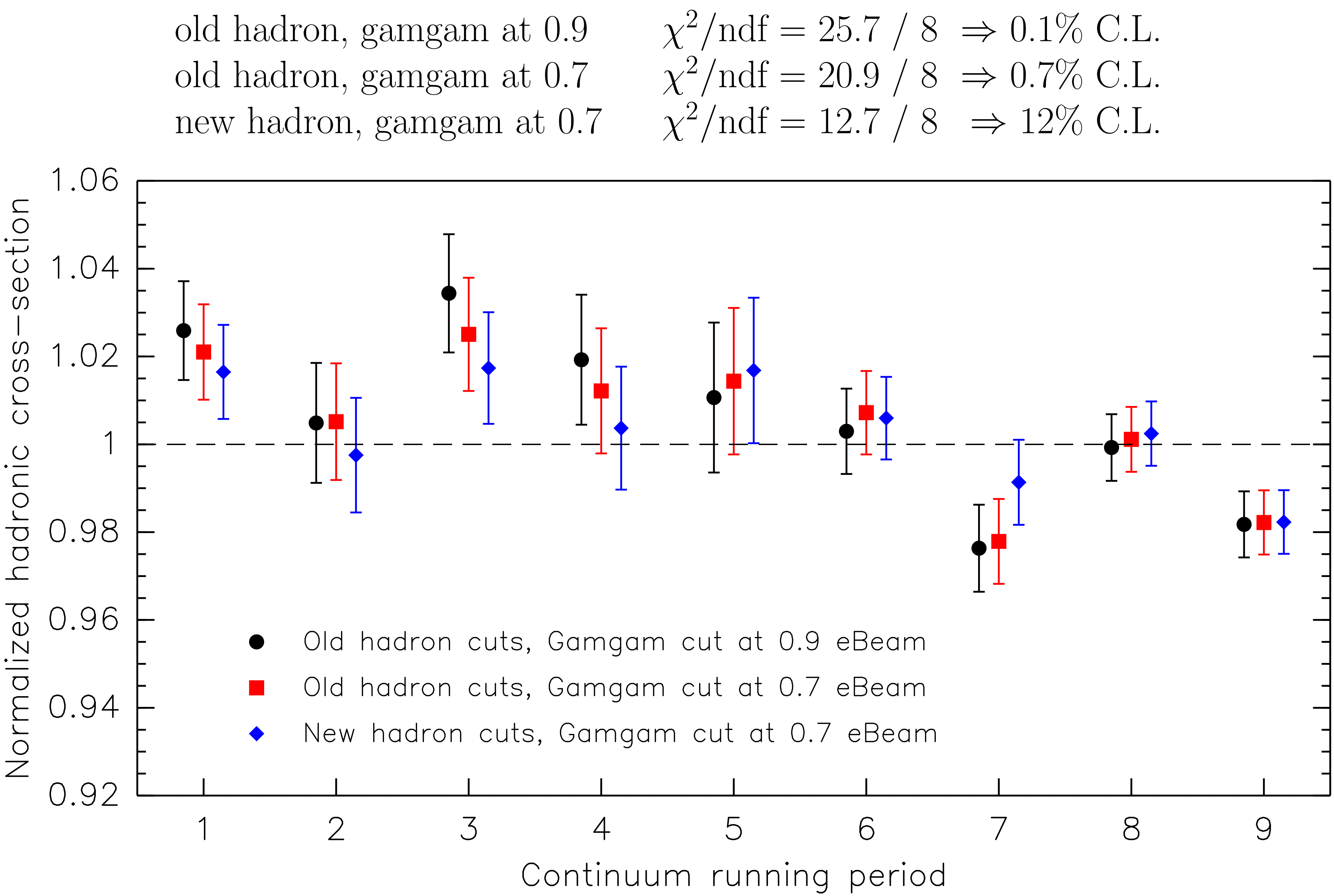
anti-bhabha cuts in hadron

$$\begin{array}{c} \text{E1} < 0.85 \text{ eBeam} \\ \text{P2} < 0.85 \text{ eBeam} \\ \text{CC energy} < 0.85 \text{ eCOM} \end{array} \longrightarrow \text{P1} < 0.8 \text{ eBeam}$$

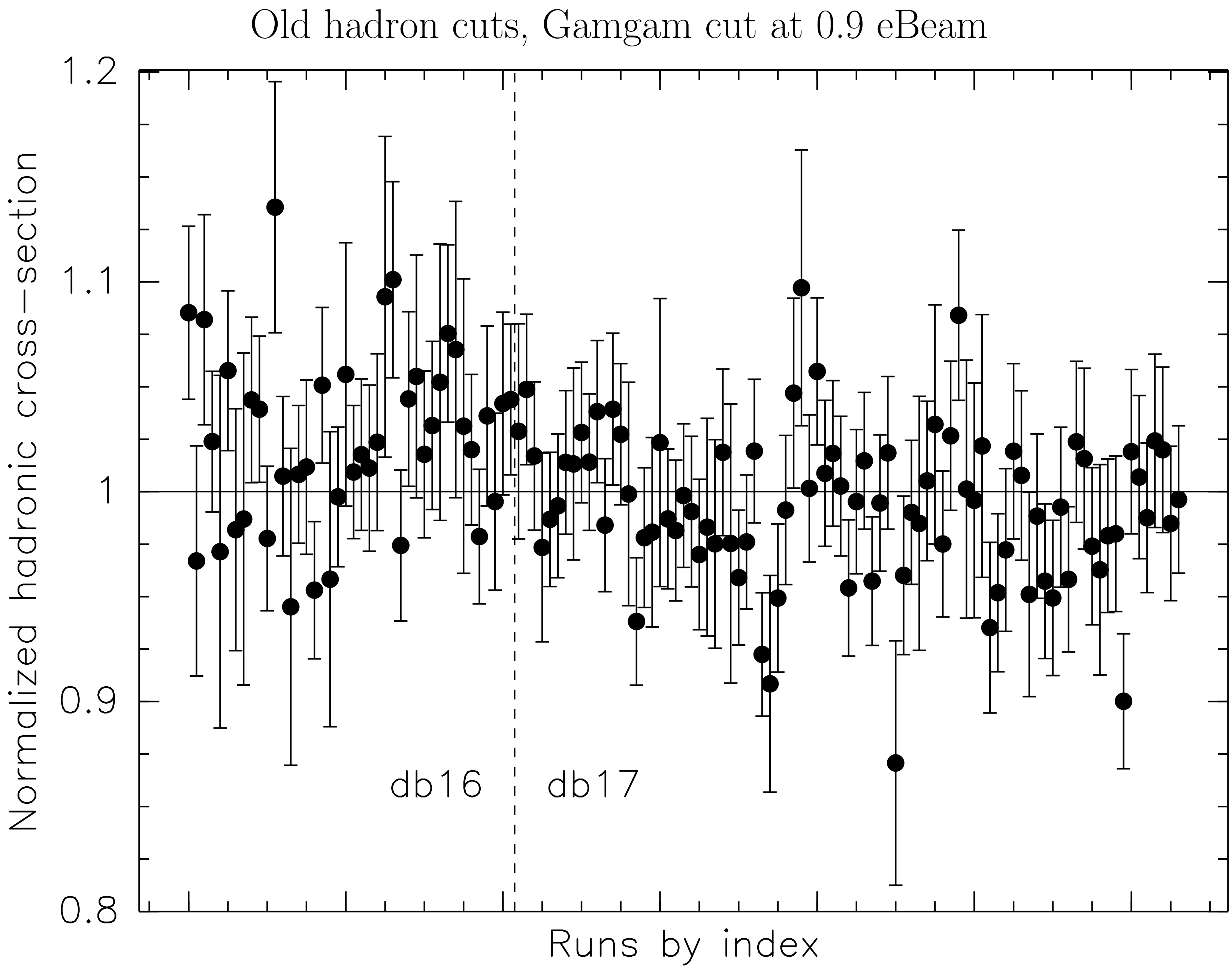
energy cut in gamgam

$$\text{E2} > 0.9 \text{ eBeam} \longrightarrow \text{E2} > 0.7 \text{ eBeam}$$

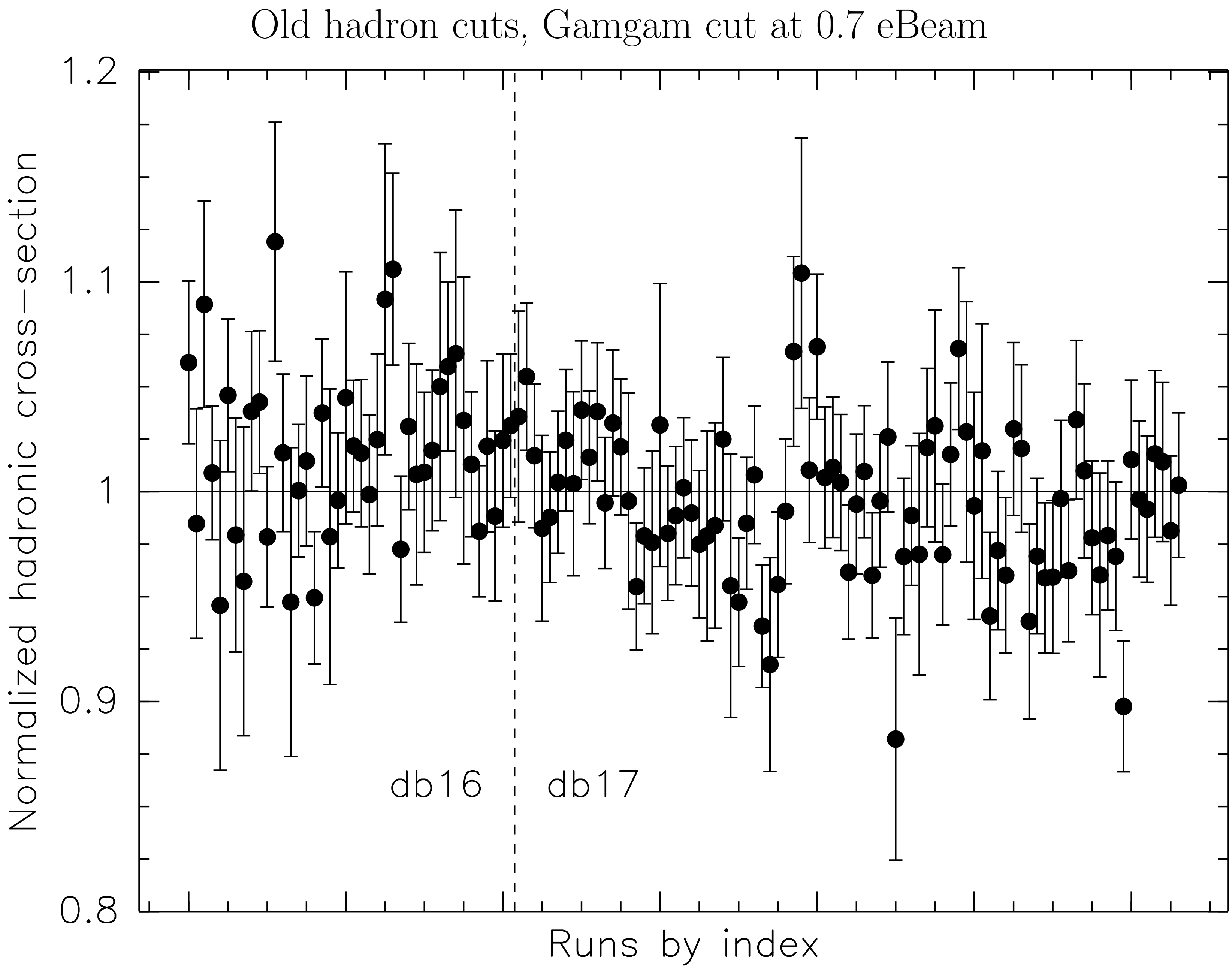
(E1,2 are biggest shower energies, P1,2 are biggest track momenta)



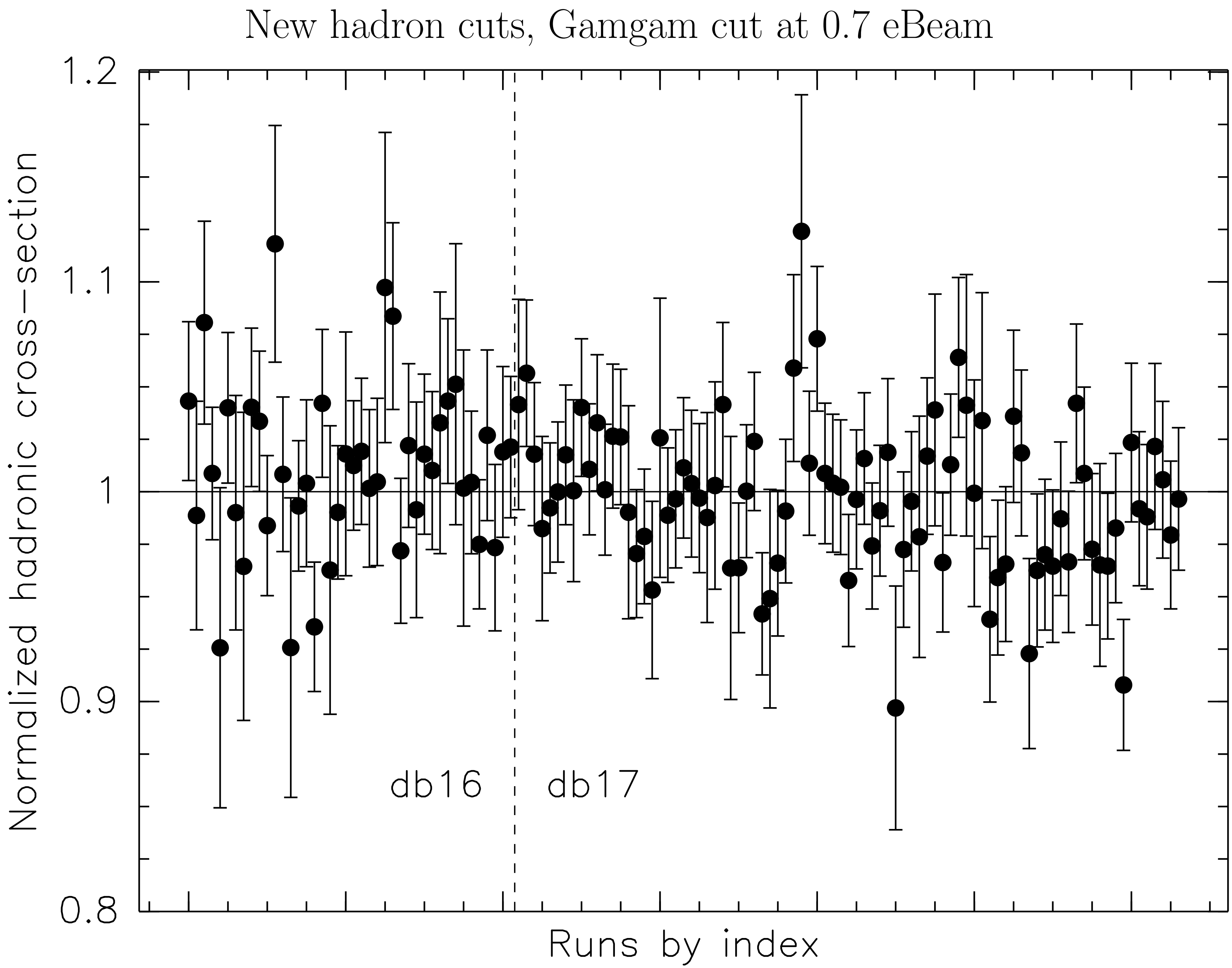
old hadron, gamgam at 0.9 $\chi^2/\mathrm{ndf} = 25.7 / 8 \Rightarrow 0.1\%$ C.L.
old hadron, gamgam at 0.7 $\chi^2/\mathrm{ndf} = 20.9 / 8 \Rightarrow 0.7\%$ C.L.
new hadron, gamgam at 0.7 $\chi^2/\mathrm{ndf} = 12.7 / 8 \Rightarrow 12\%$ C.L.
Normalized hadronic cross-section
Continuum running period
Old hadron cuts, Gamgam cut at 0.9 eBeam
Old hadron cuts, Gamgam cut at 0.7 eBeam
New hadron cuts, Gamgam cut at 0.7 eBeam



Old hadron cuts, Gamgam cut at 0.9 eBeam
1.2
1.1
1
0.9
0.8
Normalized hadronic cross-section
db16
db17
Runs by index



Old hadron cuts, Gamgam cut at 0.7 eBeam
1.2
1.1
1
0.9
0.8
Normalized hadronic cross-section
db16
db17
Runs by index



New hadron cuts, Gamgam cut at 0.7 eBeam
1.2
1.1
1
0.9
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Normalized hadronic cross-section
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Runs by index

Are my new cuts as effective at cutting bhabha backgrounds?

Essentially.

	old cuts	new cuts
fraction of continuum subtraction which is bhabha subtraction*	$\sim 7.3\%$	$\sim 8.4\%$

This means that changes to my draft CBX are minimal: I need to re-create plots and figures.

(*How did I determine that? $E_{\text{COM}} - E_{\text{track 1}} - E_{\text{track 2}} - |\vec{p}_{\text{track 1}} + \vec{p}_{\text{track 2}}| < 0.1$ eCOM is a good definition of a bhabha/mupair. [See plot])

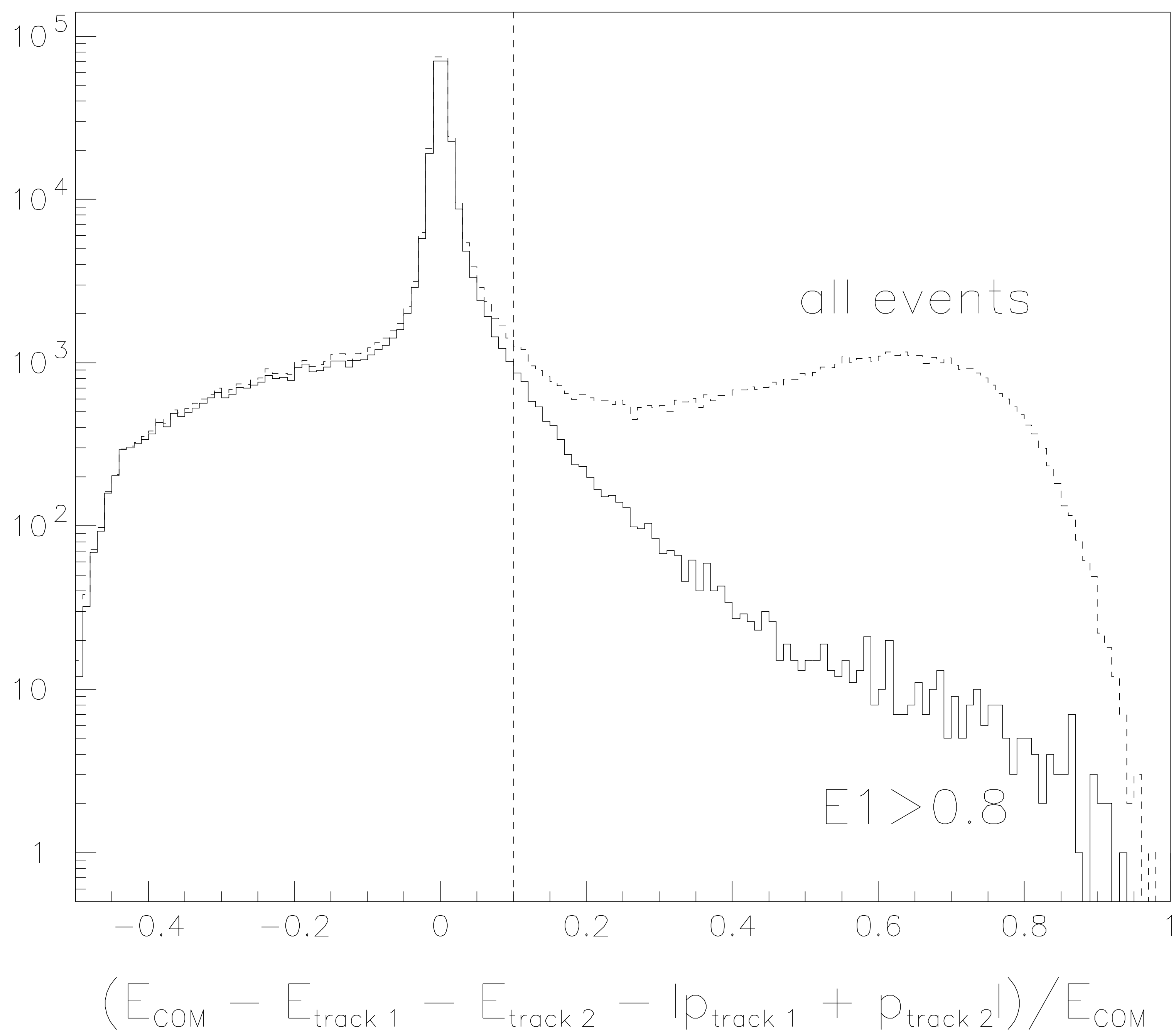
Conclusions: timeline

- Top priority: update draft CBX to include new hadron cuts and relative gamgam luminosities (1–2 weeks)

- While my paper committee reads it, I can work on absolute luminosity issues (How often does a photon convert? How does crystal granularity affect the θ cut-off? OR— plug in Surik's result.)

- and (at the same time) fits of the resonance lineshapes (Does inserting energy calibration jumps make the χ^2 unbelievable? How much Γ_{ee} uncertainty do upper limit jumps incur? Cross-check $\tau^+\tau^-$ interference by tightening number of tracks cut.)

- This is everything that is needed for a summer result.



all events
E1>0.8
10^5
10^4
10^3
10^2
10
1
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
$(E_{COM} - E_{track\,1} - E_{track\,2} - |p_{track\,1} + p_{track\,2}|)/E_{COM}$

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