Search for Exclusive ee and $\gamma\gamma$

- Exclusive Interactions
- Tevatron and CDF II
- Caveat: No Backgrounds Subtracted
- Analysis Methodology
- Candidate Events
- Efficiency and Expectations
- Conclusions and Outlook

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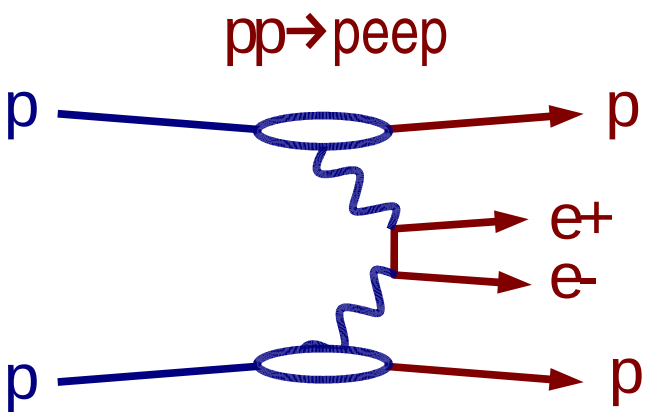
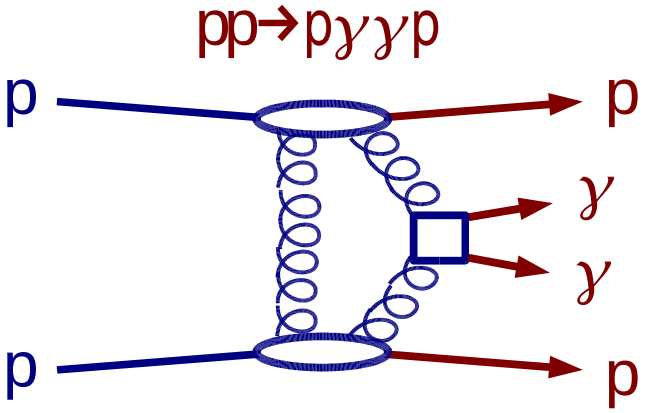
(peeps: Mike Albrow, Bryan Caron, Beate Heinemann, and Jim Pinfold)

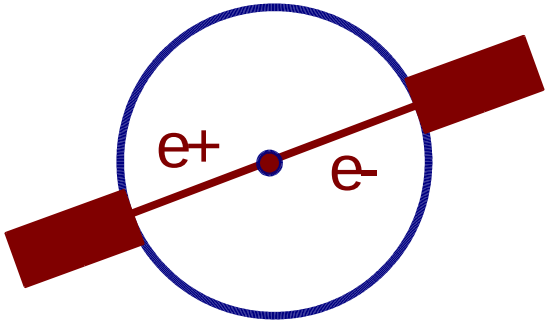
Exclusive Interactions

Exclusive Interaction: An in-elastic interaction in which both proton and (anti-)proton escape without dissociating.

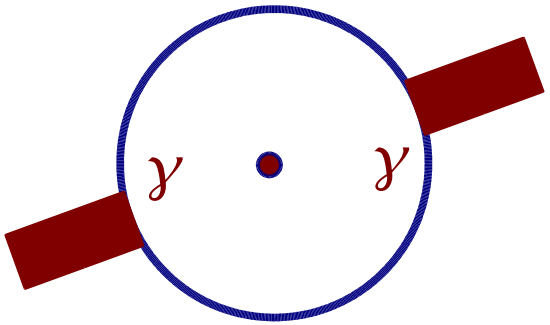




Fundamentally different production mechanisms (QED vs. QCD), yet their detector signatures are nearly identical, *and* easily distinguishable.



CDF rϕ-view



Tevatron

$p\bar{p}$ collisions @ $\sqrt{s} = 1.96 \ TeV$

$\mathscr{L}_{inst} = 20 \text{ to } 160 \times 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$

$\overline{\Delta t}_{bunch} = 580 \text{ ns}$

radius = 1 km
36 bunches

$\sigma_{inel} = 60 \text{ mb}$

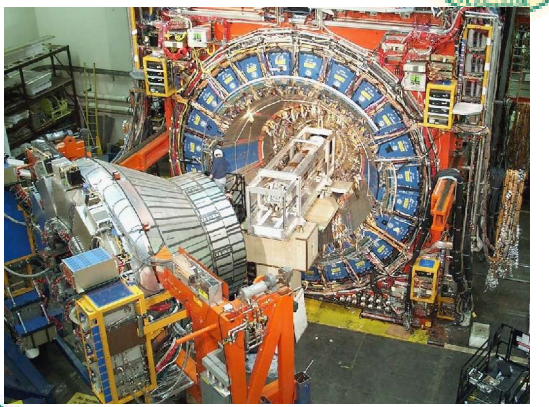
$\overline{n} = \sigma_{inel} \ \mathscr{L}_{inst} \ \overline{\Delta t}_{bunch}$

~ 1 to 6 interactions per crossing

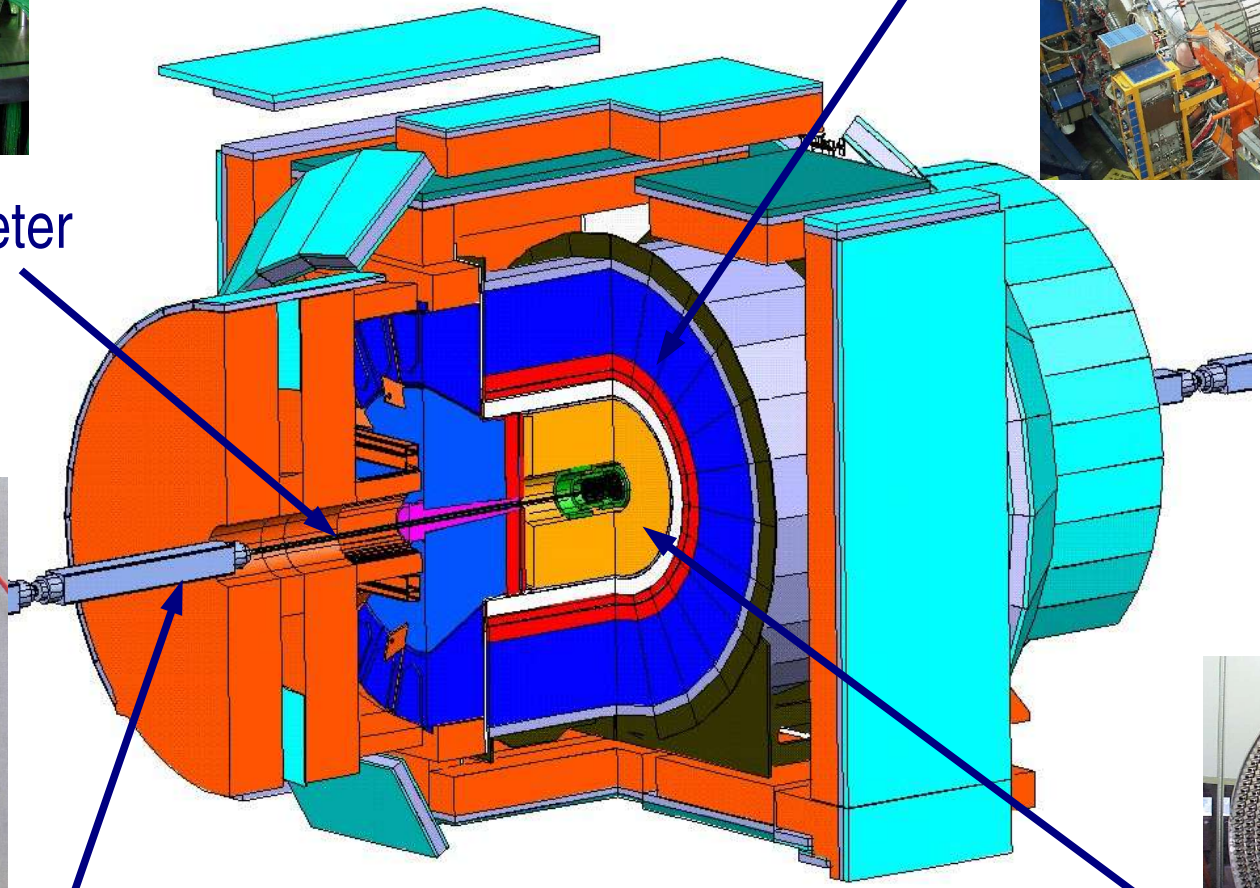
very important when searching for exclusive states without proton taggers

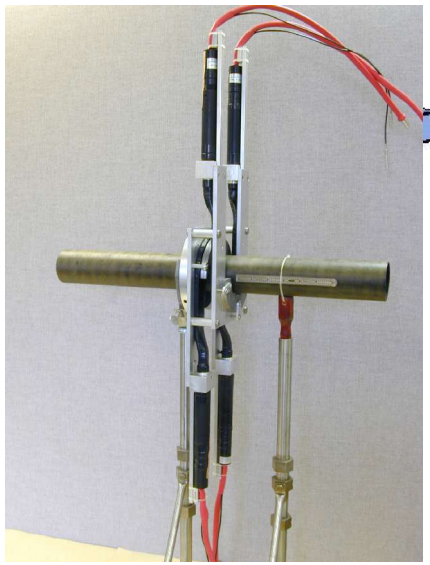
CDF II Detector

Plug and Central Calorimeters
$|\eta| < 3.5$



MiniPlug Calorimeter
$3.5 < |\eta| < 5.5$





COT Tracker
$|\eta| < 1$ (2)

Beam Shower Counter $5.5 < |\eta| < 6$

Caveat: No Background Subtracted

Background studies have not been finalized,
so they are not public yet.

All plots shown have ***no background subtracted***

Background studies in progress include:

- inclusive events faking exclusive events
- hadrons faking electrons and γs

Analysis Methodology

Data Collection:

- Trigger: east+west BSC veto and 2 EM towers with $E_T > 4$ GeV
- Running period: 7 December 2004 to 19 July 2005
- Total luminosity 325 ± 26 pb^{-1}

Event Selection:

- apply EM object cuts (require 2 EM objects)
- apply exclusive cuts to all towers outside EM objects
- apply tracking cuts to EM objects to distinguish e from γ

EM object cuts

- $E_T > 5.0$ GeV
- $|\eta| < 1.0$
- had/em<0.055+0.00045*E
- CES fiducial
- CES $\chi^2 < 20.0$

Exclusive cuts

- Central E_T < 200 MeV
- Low Plug E_T < 100 MeV
- Mid Plug E_T < 100 MeV
- Fwd Plug E_T < 70 MeV
- Mini Plug E_T < 10 MeV
- BSC ADC < 300 counts

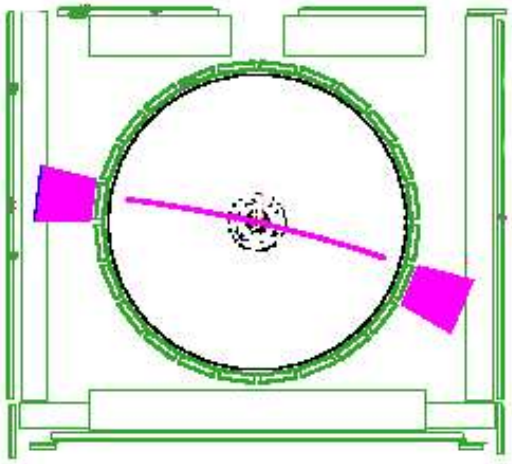
Tracking cuts

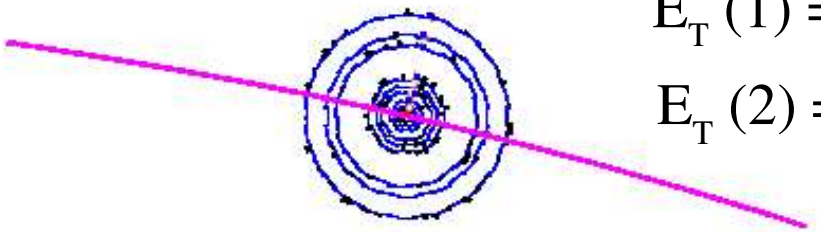
e
- n tracks = 1
- track $p_T > 1.0$

γ
- n tracks = 0

ee Candidate Events

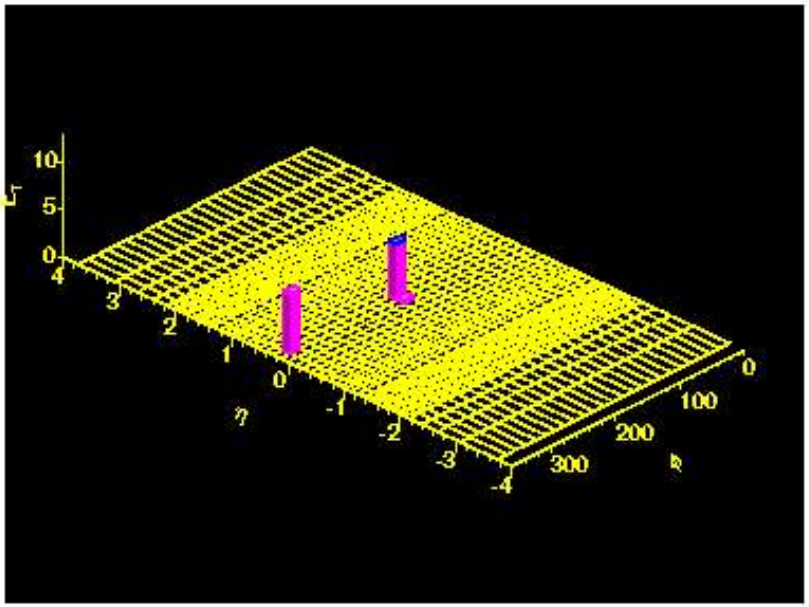
10 ee candidate events

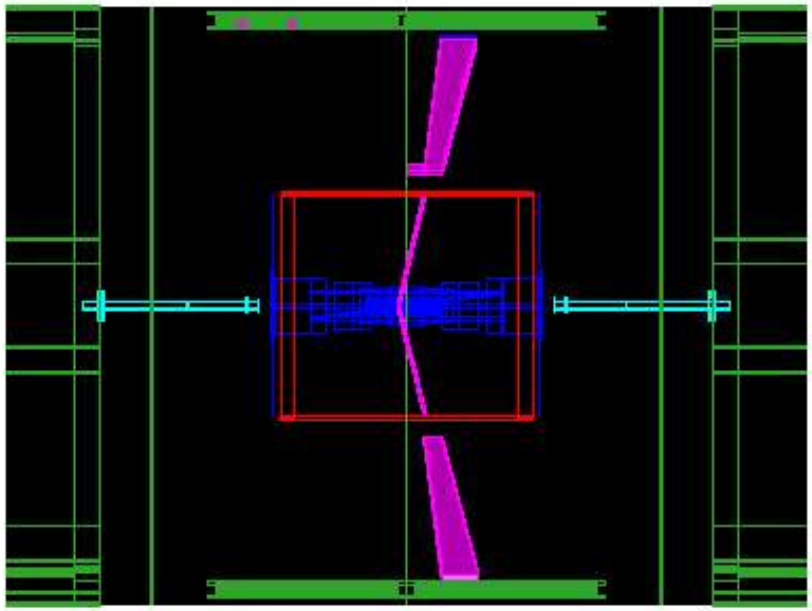




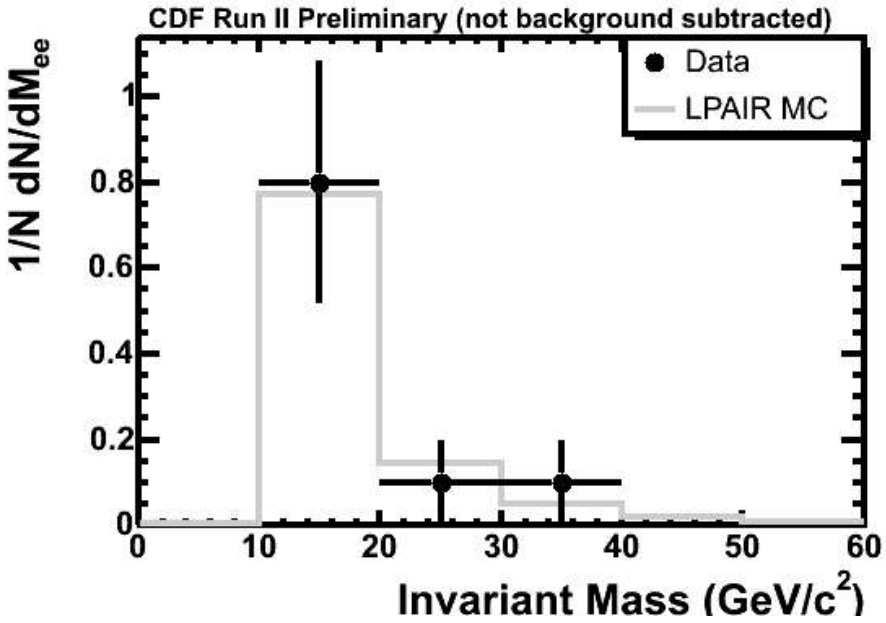
E_T (1) = 6.1 GeV

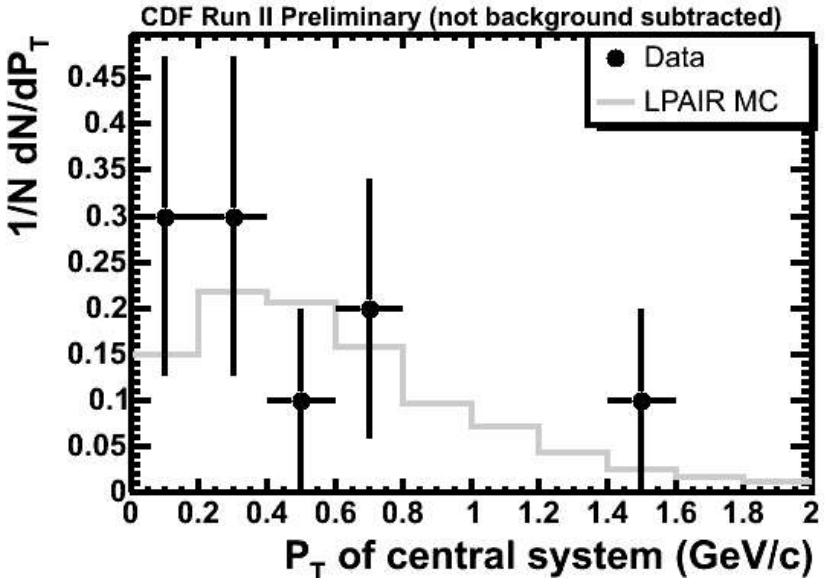
E_T (2) = 6.0 GeV

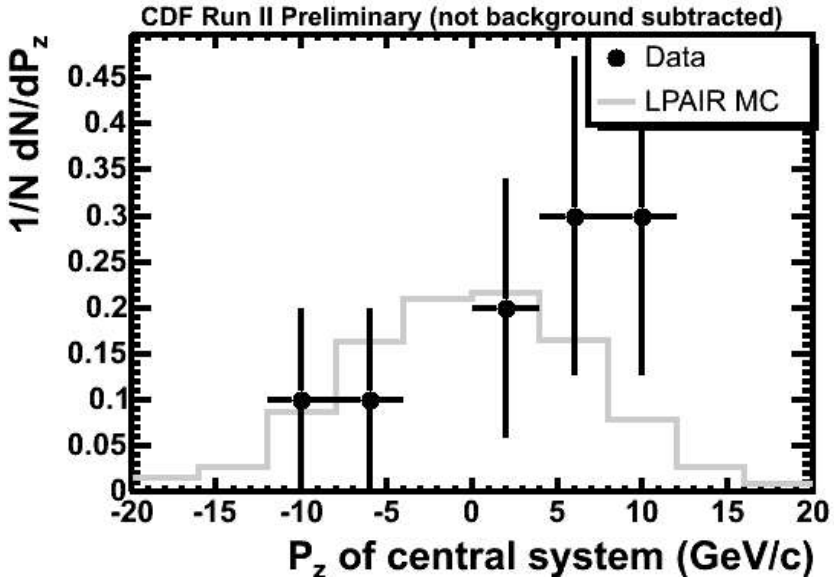




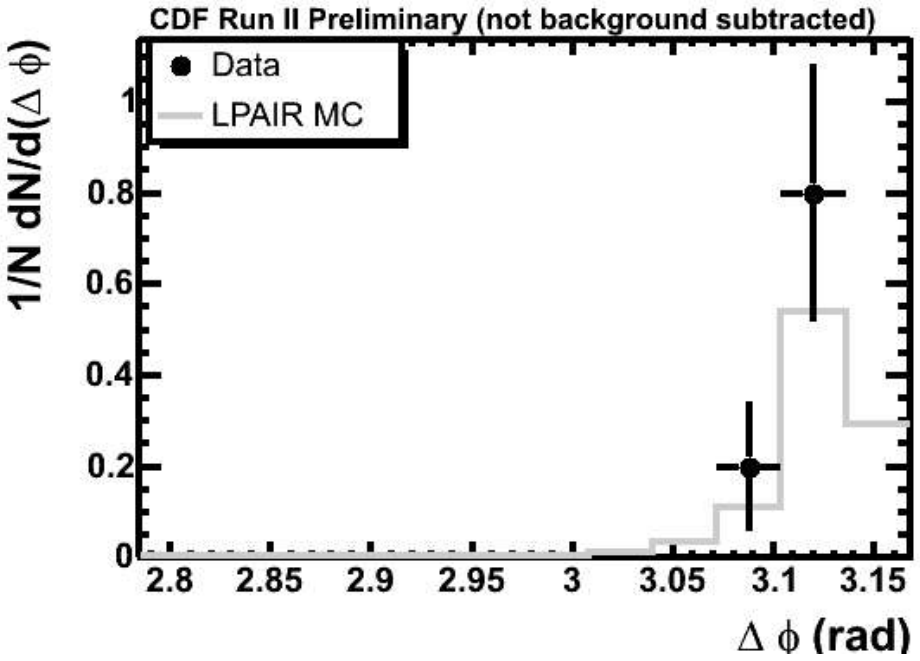
ee Candidates vs. LPAIR MC





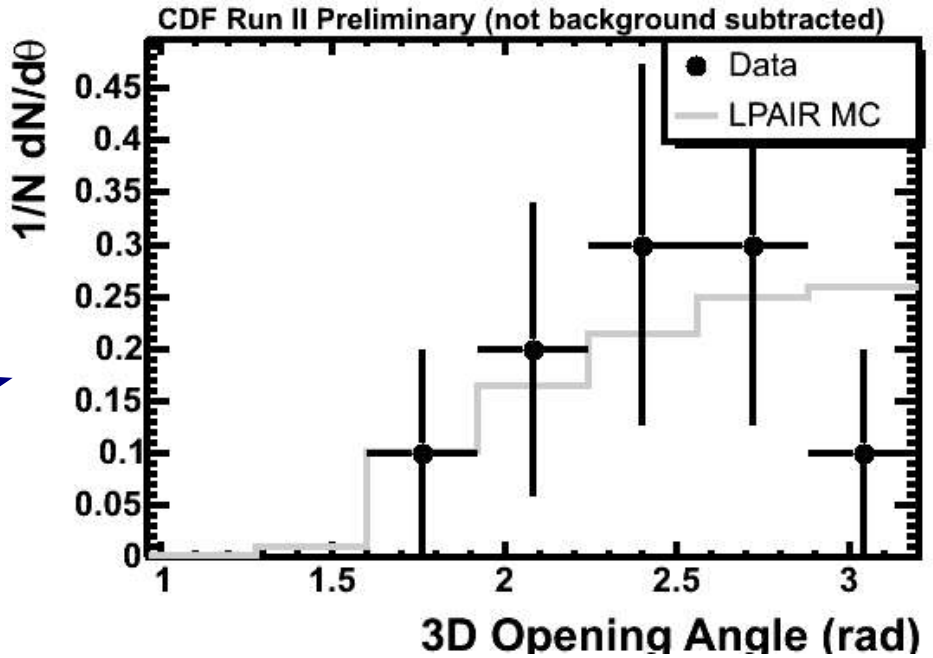


ee Candidates vs. LPAIR MC

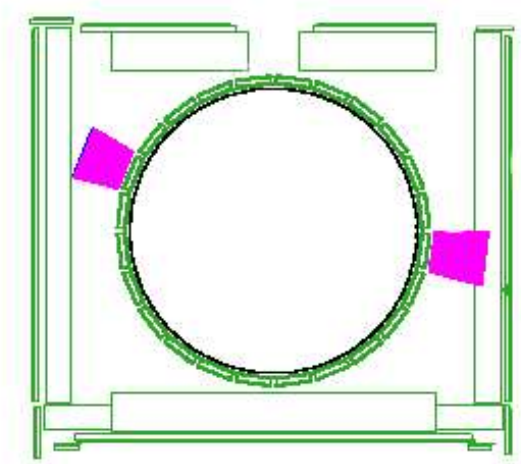


back-to-back in ϕ

not collinear



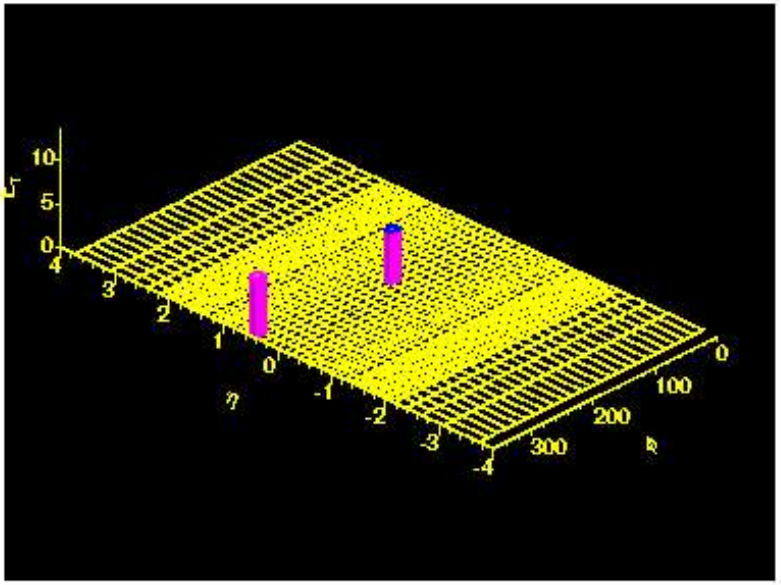
$\gamma\gamma$ Candidate Events

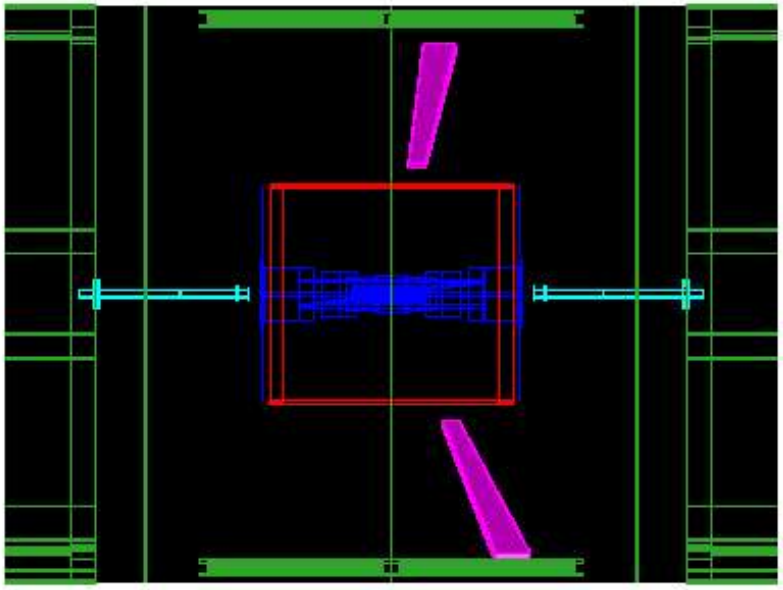


3 $\gamma\gamma$ candidate events

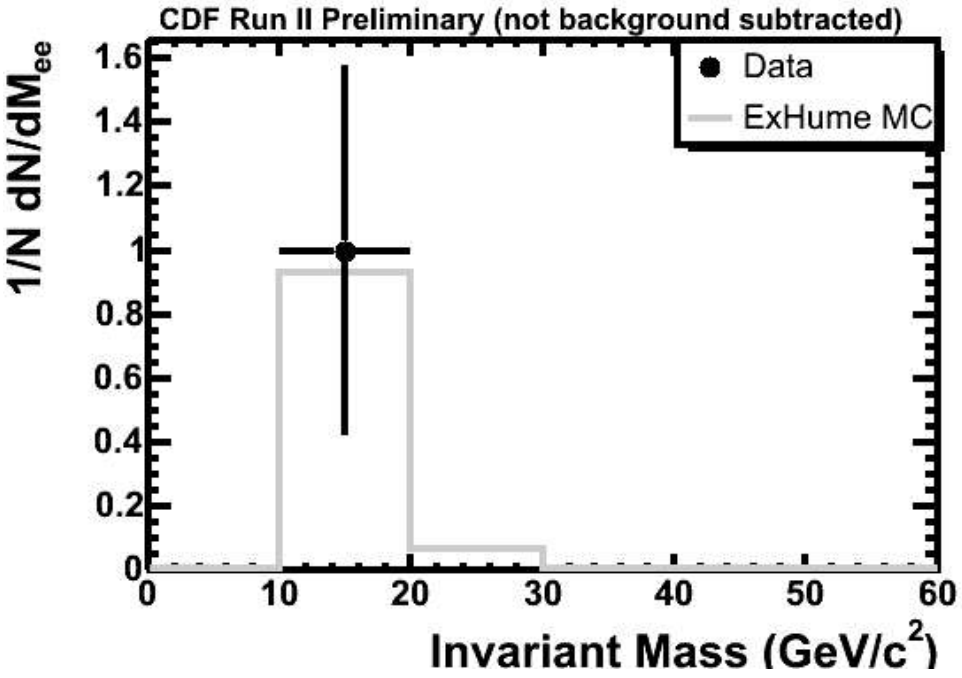
E_T (1) = 6.8 GeV

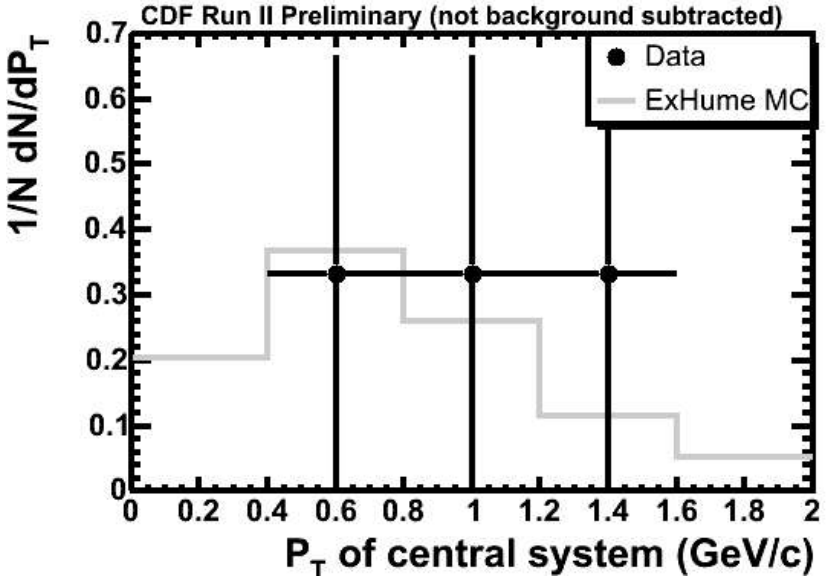
E_T (2) = 5.9 GeV

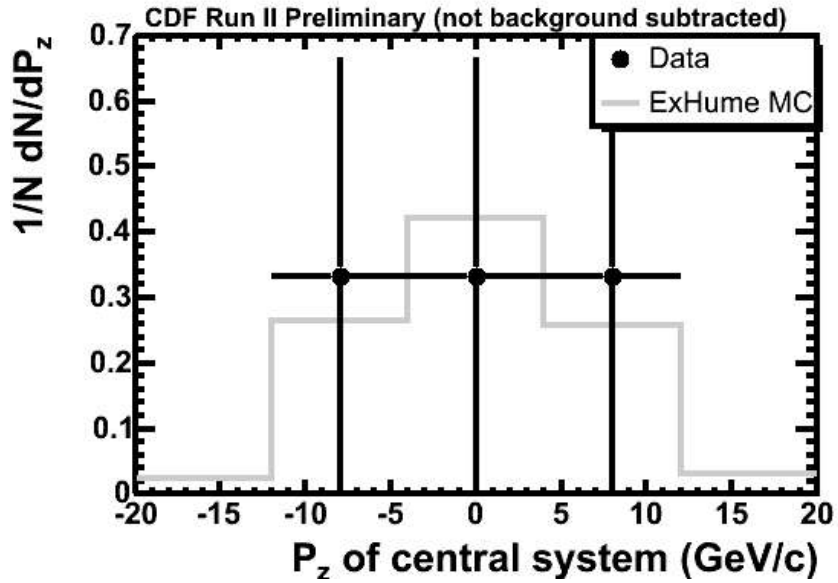




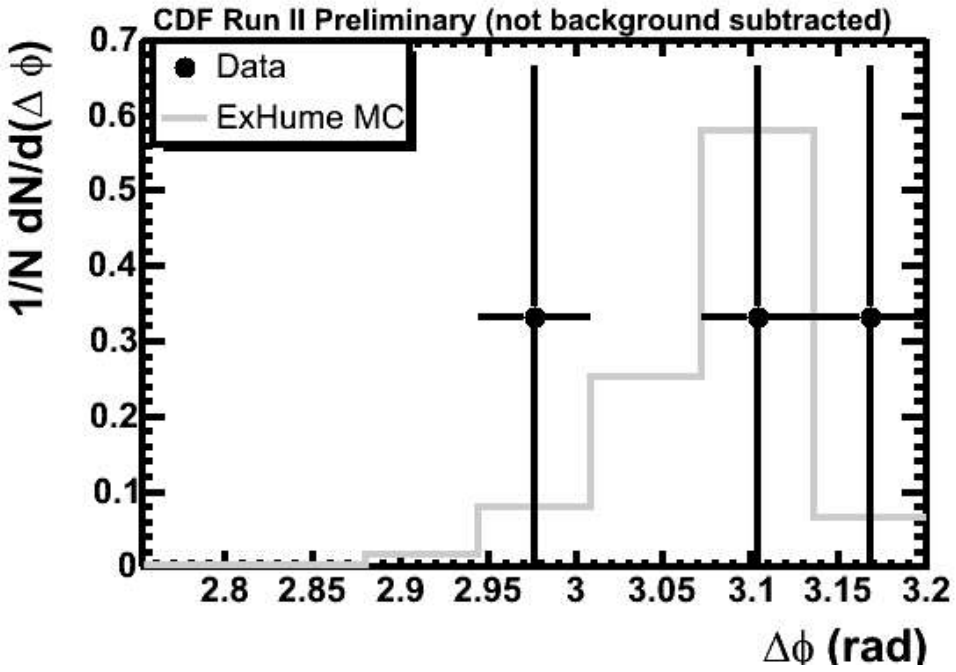
$\gamma\gamma$ Candidates vs. ExHume MC



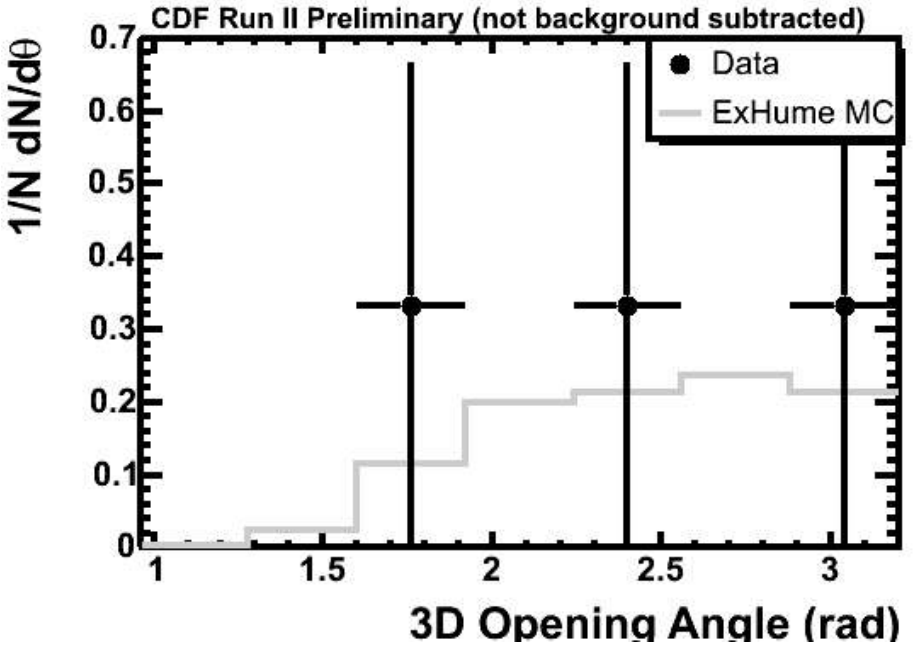




$\gamma\gamma$ Candidates vs. ExHume MC



lower ϕ resolution (no track)



Efficiency

Efficiency to trigger, reconstruct, and identify both e's (or γ's):

$$\varepsilon_{ee/\gamma\gamma} = 0.6 \pm 0.1$$

Efficiency for ee pair to not Bremsstrahlung into 2 separate CDF EM objects:

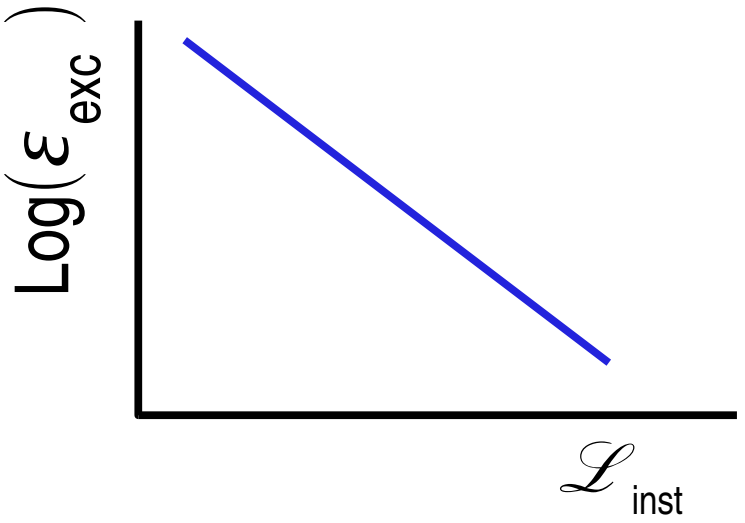
$$\varepsilon_{fsr} = 0.7 \pm 0.1$$

Efficiency for $\gamma\gamma$ pair to not convert into 2 separate CDF EM objects:

$$\varepsilon_{conv} = 0.9 \pm 0.1$$

Effective Luminosity

Concept:



$$\varepsilon_{exc} \simeq e^{-\sigma_{inel}\mathscr{L}}$$

ε_{exc} is the probability that the detector is in a state that can observe an exclusive interaction (no multiple interaction, beam halo, noise etc)

Effective luminosity: $\mathscr{L}_{eff} \equiv \int \varepsilon_{exc}\, \mathscr{L}_{inst}\, dt$

Calculated from data: $\mathscr{L}_{eff} = 40 \pm 10\ pb^{-1}$ ← replaces $\int \mathscr{L}\, dt$

Expected Number of Events

How do the number of candidates compare with expectations?

Do <u>not</u> make a cross section from this!
No backgrounds have been subtracted.

$pp \to peep$: $N_{expected} = 9 \pm 3$ events

$\sigma_{LPAIR} = 582 \pm 4$ fb

$\mathcal{L}_{eff}\ \varepsilon_{ee/\gamma\gamma}\ \varepsilon_{fsr}$

$\sigma_{KMR/ExHume} = 4 \pm (\times 3)$ fb

$\mathcal{L}_{eff}\ \varepsilon_{ee/\gamma\gamma}\ \varepsilon_{conv}$

$pp \to p\gamma\gamma p$: $N_{expected} = 1^{+3}_{-1}$ events

Conclusions and Outlook

Conclusions:

- Found 10 events which appear consistent with pp→peep
- Found 3 events which appear consistent with pp→p$\gamma\gamma$p
- *However, background estimations are not complete*

Outlook:

- We will complete the background estimates
- We will extend analysis into $|\eta| < 1.5$ (maybe 2)
- We will add another 100pb^{-1} (maybe 200pb^{-1})
- We can try to recover the FSR and conversion losses