Update on $\pi^0 \to e^+e^-\gamma$

- Analysis Overview
- Reminder of Systematics Table Status
- Radiative Corrections
- Still To Do

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Analysis Overview

PDG: $\frac{\Gamma(\gamma e^+e^-)}{\Gamma(2\gamma)} = (1.213 \pm .030)\%$

Signal: $K_L \rightarrow 3\pi^0$, where one $\pi^0 \rightarrow e^+e^-\gamma$
TRIGGER 14

Normalization: $K_L \rightarrow 3\pi^0$ with each $\pi^0 \rightarrow \gamma\gamma$
TRIGGER 6 (analysis ps of 10)

Main Selection Criteria

- kaon z: [123.0, 158.0] m
- kaon energy: [40.0, 160.0] GeV
- pairing chi2: [0.0, 75.0]
- min cluster energy: 3.0 GeV
- min track momentum: 4.0 GeV/c
- min cell separation must be greater than 3

$\sim 65,000$ events $\rightarrow$ stat. uncertainty $\sim 0.4\%$

Presented at DPF; preliminary result:
$BR(\pi^0 \rightarrow e^+e^-\gamma)/BR(\pi^0 \rightarrow \gamma\gamma) = (1.1539 \pm 0.0045 \pm 0.0152)\%$
1.38% uncertainty (0.39% stat., 1.32% syst.)

Systematics Table Status

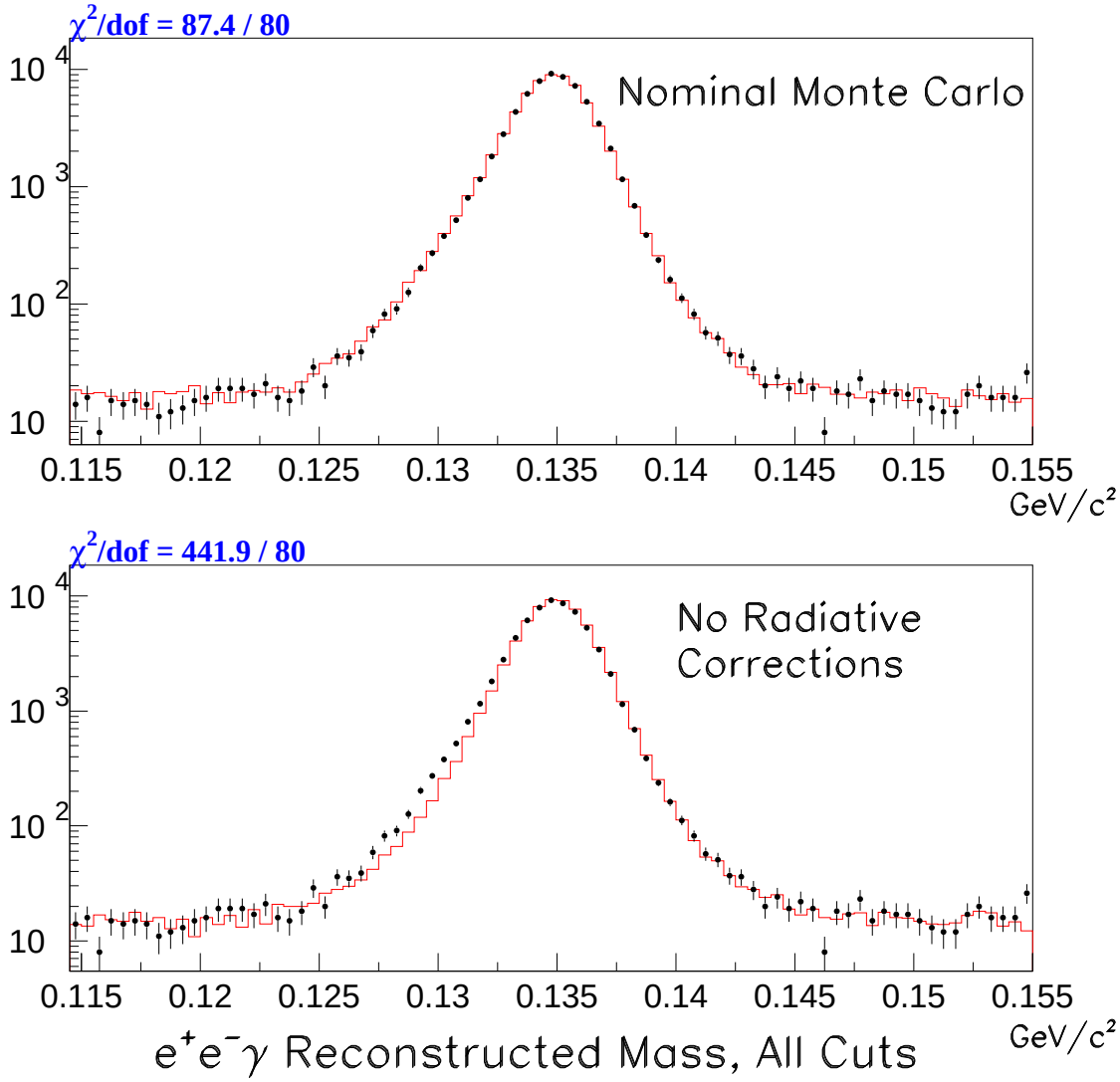
Source of Systematic Error	Uncertainty
Radiative Corrections	1.02%
Tracking Inefficiency	0.68%
Detector Material	0.37%
Accidentals	0.1%
Relative Trigger Inefficiency	0.14%
Trigger 6 Inefficiency	$< 0.01\%$
Trigger 6 Prescale	0.02%
Form Factor	0.07%
Photon Inefficiency	0.01%
Background	$< 0.01\%$
Cut Variations	0.1%
Monte Carlo Statistics	0.19%
Total Systematic Error	1.31%

Recent progress:

Changes since DPF: trigger 6 studies used data from trigger 5 along with latch and trigger mask information.

Radiative Corrections...

Radiative Corrections - preliminary uncertainty of ∼1%



Data - Nominal MC width agrees; with no radiative corrections, the MC width is different by $\sim$ 9 sigma.

Δ acceptance $\sim$ 5.5% when radiative corrections are off.

Uncertainty = Δ accept / (9/2) $>$ 1%

This is a conservative method

Can we do better? part one

Use reconstructed $e^+e^-\gamma$ mass width method with more events:

Since cell separation cross check looks good down to cell sep of 1, can we use events with cell sep greater than 0 to improve the result from this method. → improves statistics by factor of almost 3.

Sample	Cell>3 (nom)	Cell>0
Δ accept. (nrad-nom)	5.59%	5.08%
Width disagreement	8.4 σ	11.6 σ

Uncertainty with this larger sample $\sim$ 0.88%

Can we do better? part two

Idea: separate out events by type of radiative correction: eegg events (real extra photon) and events with virtual corrections.

At generation, 16.18% of events are eegg (eeg with an extra real radiated photon)

Use acceptance from no radiative corrections as a baseline for comparison.

No rad corr: A_{nrad}

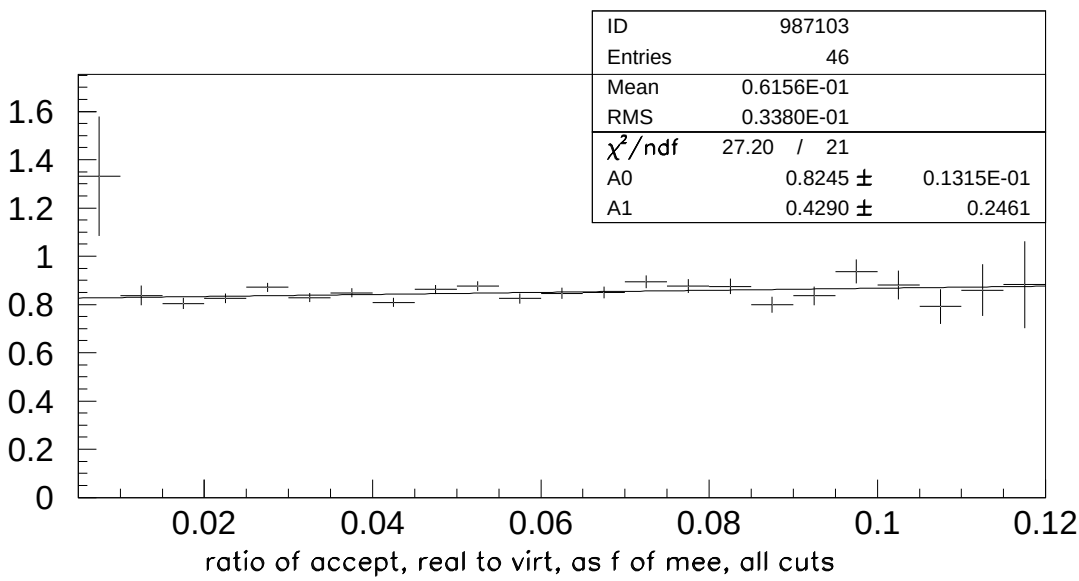
Real corrections only (eegg): $A_{real}/A_{nrad} = 1.37$!!

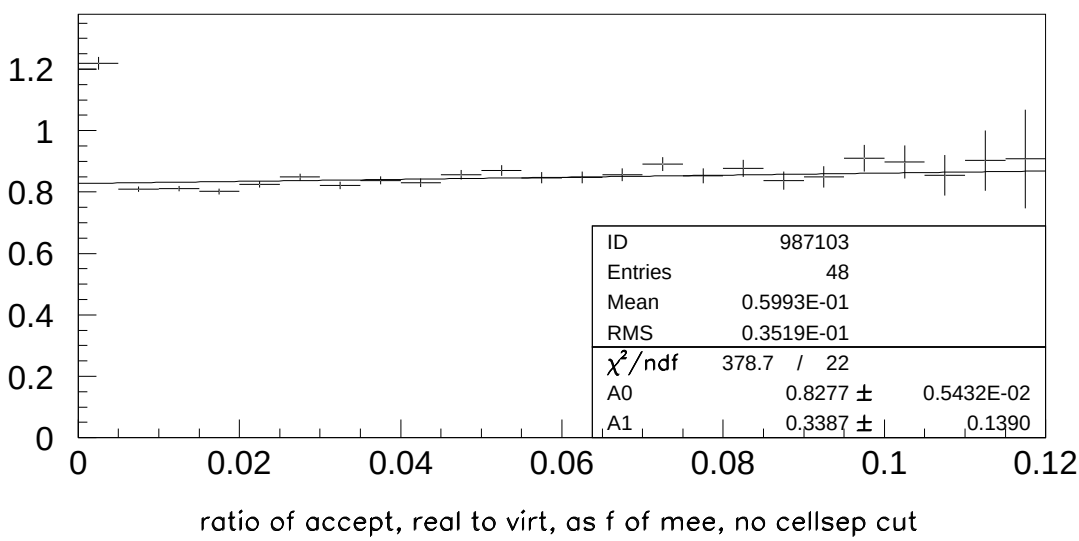
Virtual corrections only: $A_{virt}/A_{nrad} = 0.87$

All rad corrections on (nominal): $A_{nom}/A_{nrad} = 0.95$

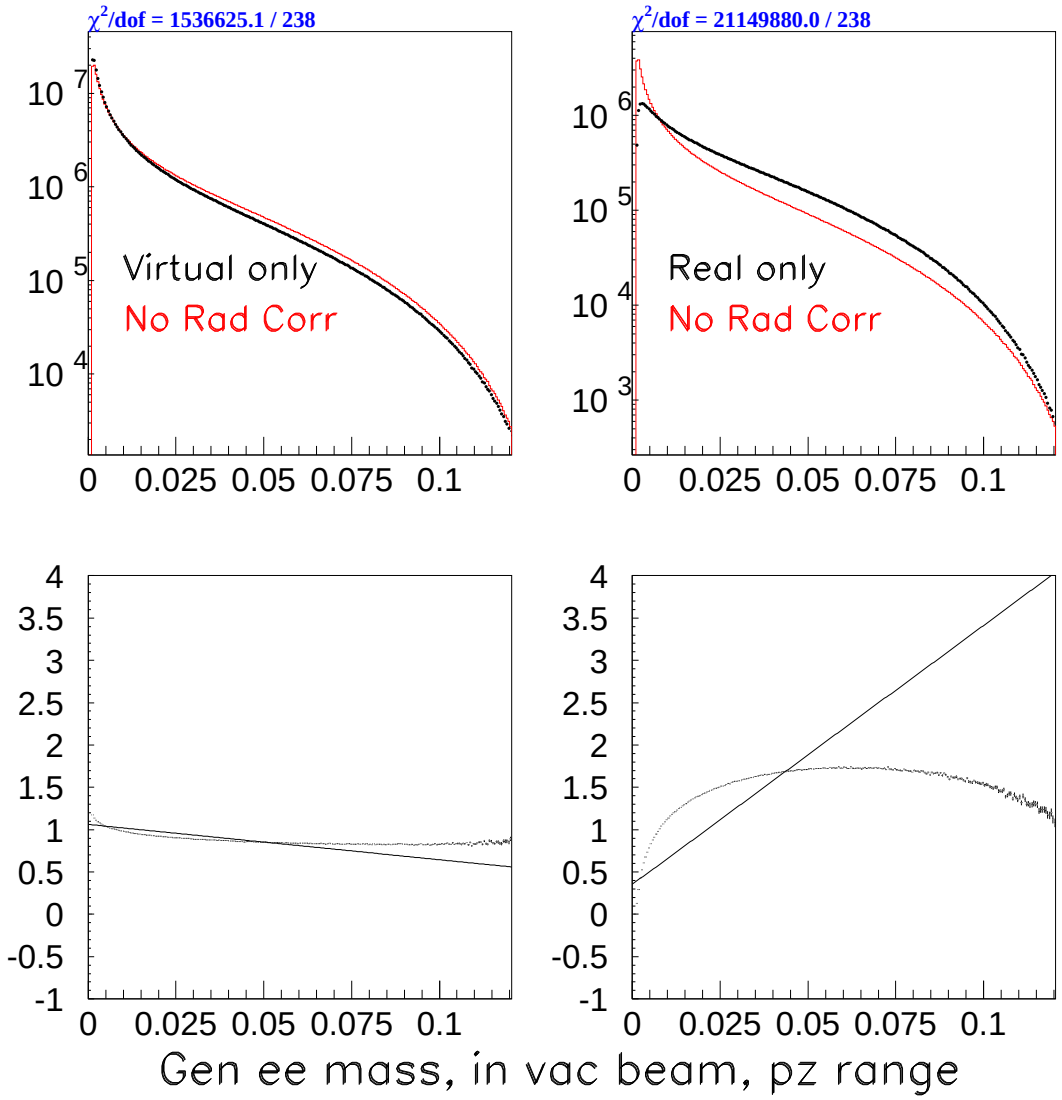
Ratio of Real to Virtual Acceptance vs Generated ee Mass

A_{real}/A_{virt}

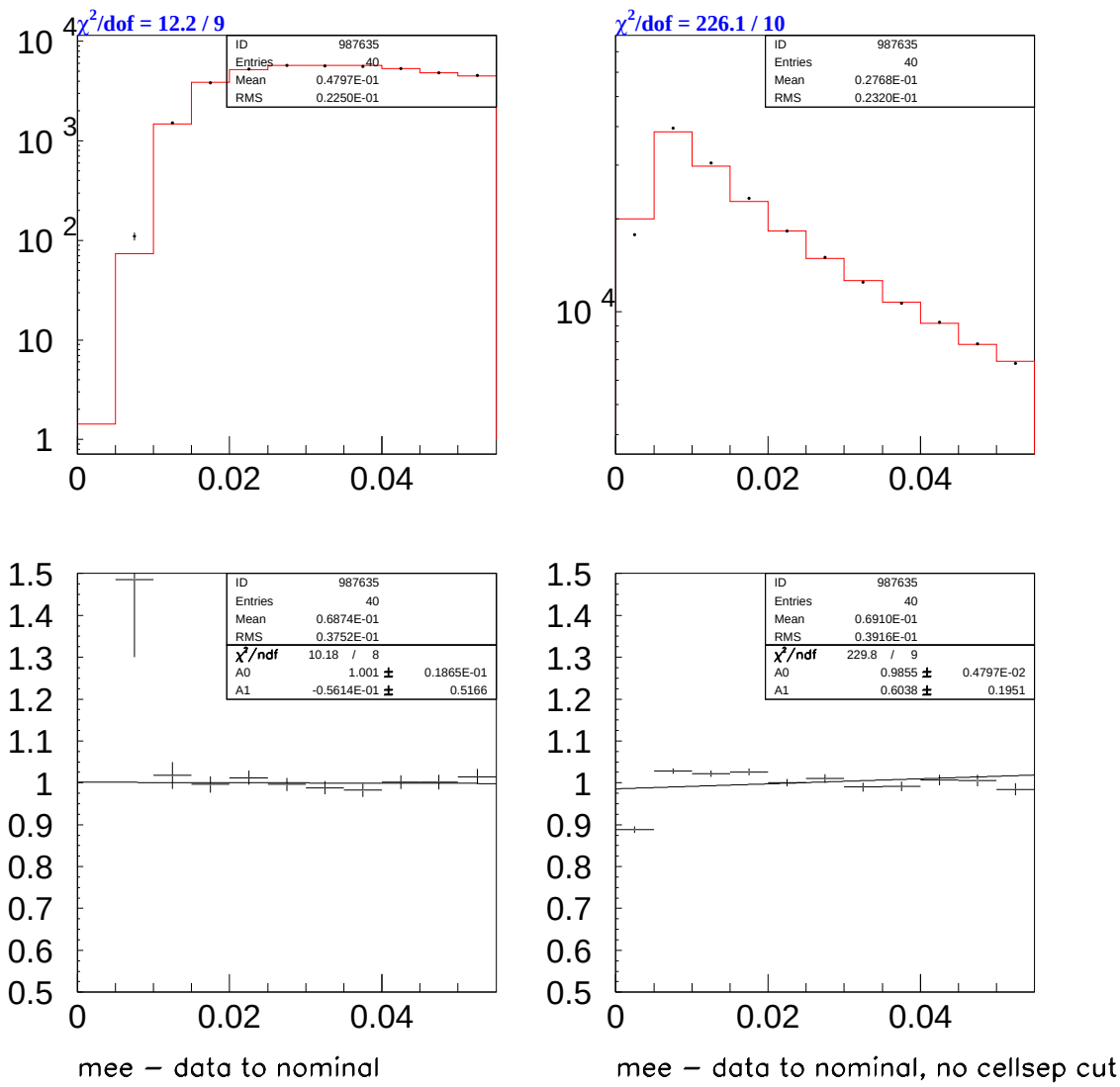




Generated ee Mass: No Rad Corr, Real Only, Virtual Only



Generated ee Mass: Analysis Cuts



No acceptance below ∼ 10 or 15 MeV

The $\sim$5% change in acceptance between nominal and no rad corr is really coming from a cancellation of large changes in acceptances for the 2 different kinds of radiative corrections. (real: up 37% and virtual: down 13%)

Could quote result with ee-mass cutoff, say 15 MeV. Would be much less sensitive to radiative corrections.

Acceptance ($\times 10^{-4}$)

Sample	No Mee cut (% change from nrad)	Mee>15 MeV (% change from nrad)
No Rad Corr	4.304 (0.00%)	12.33 (0.00%)
Virtual Only	3.730 (-13.3%)	12.03 (-2.4%)
Real Only	5.909 (+37.3%)	10.93 (-11.4%)
Nominal	4.083 (-5.1%)	11.75 (-4.7%)

What's left?

Decide what uncertainties to quote for radiative corrections

Finish last cross checks (magnet polarity, inbend/outbend)

Write thesis (in progress)

Write PRD