Neutral Mode Status Report

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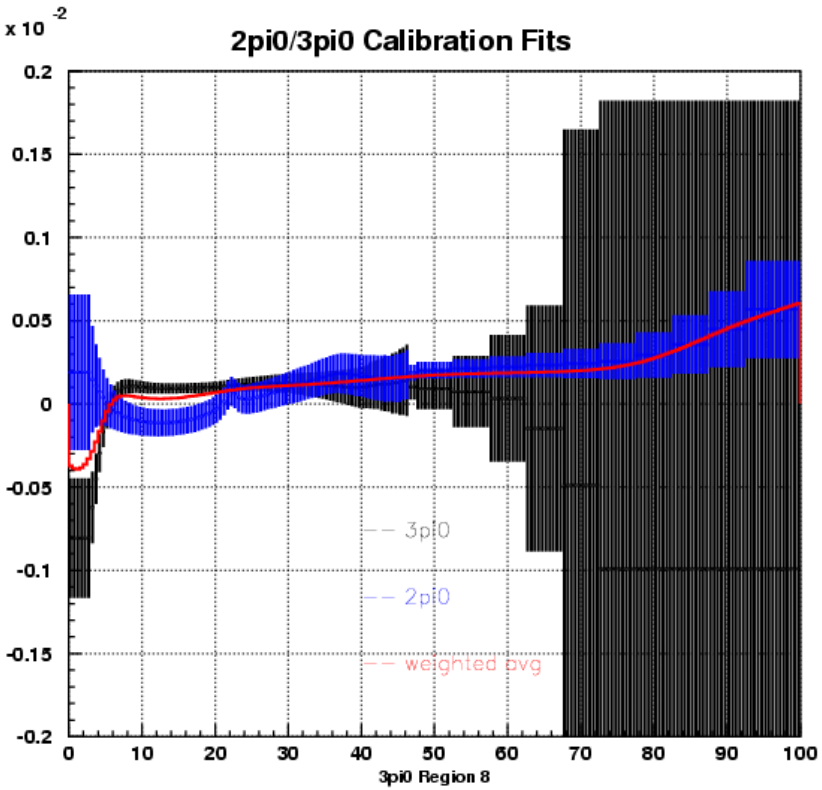
Overview

- Issues from last meeting
  - 1999 energy scale problem
  - 3pi0 calibration fits
- New fits
  - issue with fit chi2 in z binned fits
- 2pi0 z slope
  - vus cuts?
- 3pi0 energy scale and z slope
- Study of systematic from energy non-linearity
- Status of systematics
- To do

Issues from last meeting

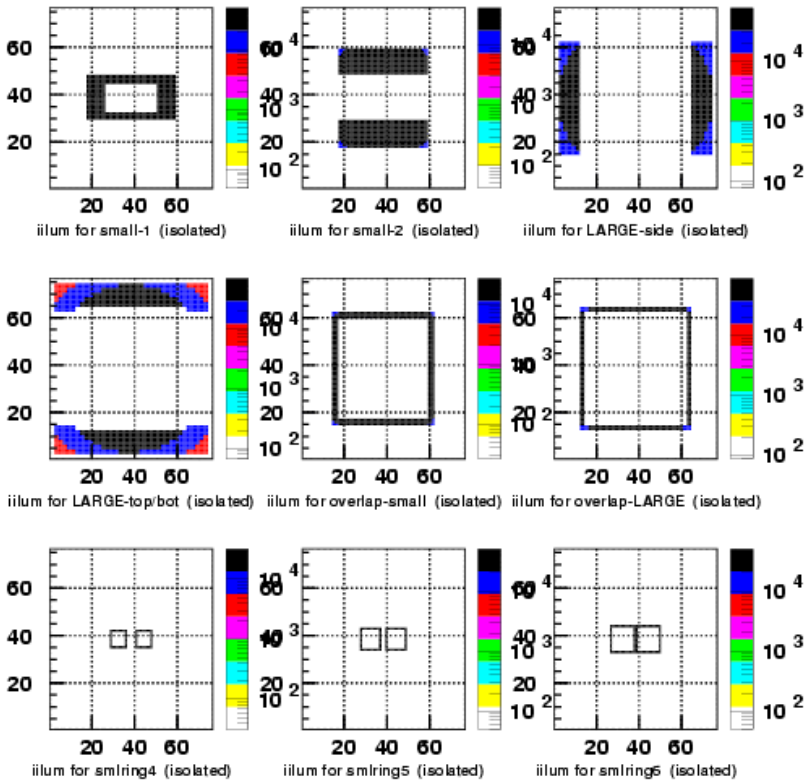
- Mismatch in energy scale between 99 data and MC – appeared in early ’06 after a db update
  - bug in generation of db banks allowed for unreasonably small and large values
  - memory overwriting problem in uniformity correction
  - 1999 data-MC edge match again looks nearly identical to 1997
- 3pi0 calibration fits did not cover full energy range
  - redo fits
  - use weighted average of 2pi0 and 3pi0 data over energy range where data is available
  - correction is sum of 3 fit iterations
  - improvement in 2pi0-3pi0 energy scale agreement

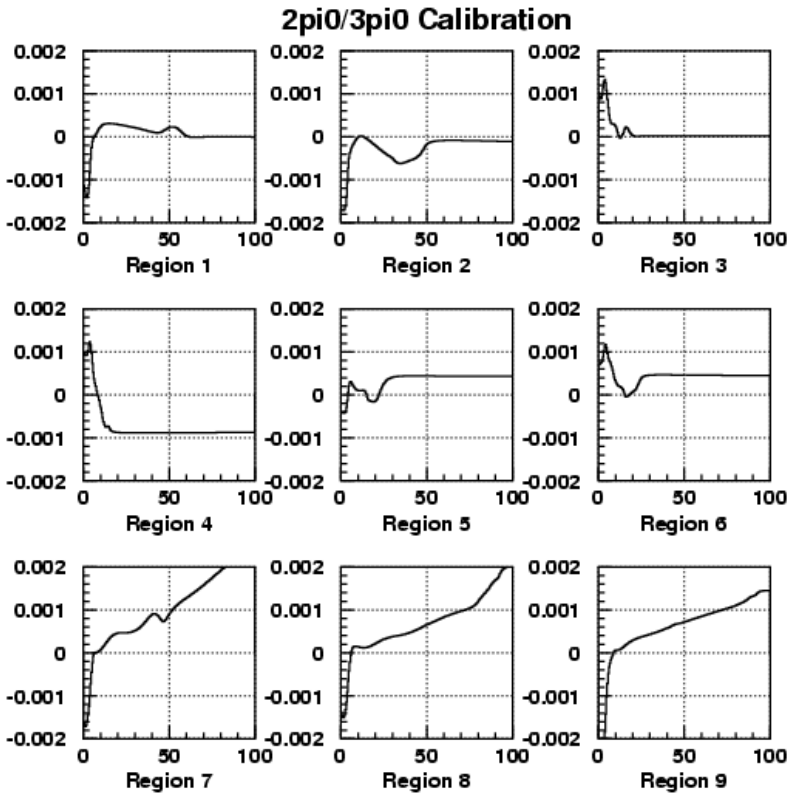
2pi0/3pi0 Calibration Fits



- fits done in 9 calibration regions based on CsI position
- weighted average between corrections measured for 2pi0 and 3pi0
- when one mode runs out of statistics use other mode exclusively
- when both modes run out of statistics correction becomes flat (no extrapolation to higher energies)
- corrections applied to data and fits repeated – 3 iterations

2pi0/3pi0 Calibration Fits





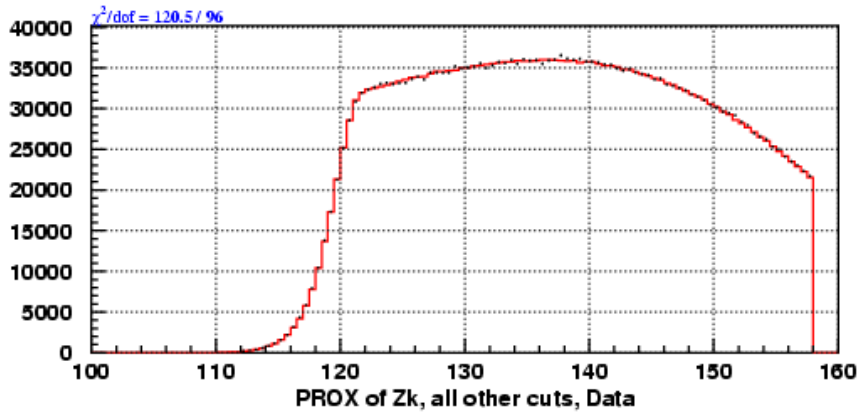
Current Neutral Fits

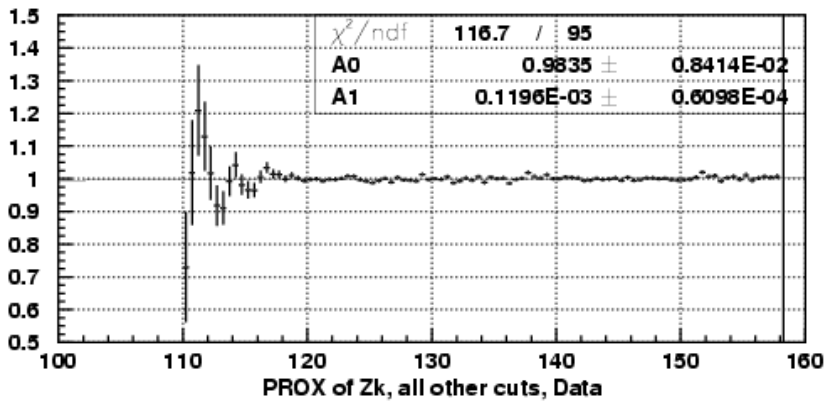
Fit	Chi2/dof	Result
PRD 96/97 Re(ε′/ ε)	27.6/21	Re(ε′/ ε) = (20.71 ± 1.5) E-4
PRD 96/97 neutral $\Delta m, \tau_S$	195/199	Δm = (5237 ± 11) E6 τ_S = (89.64 ± 0.05) E-12
Current 1997 Re(ε′/ ε)	20.56/21	Re(ε′/ ε) = (17.3 ± 1.8) E-4
Current 1997 neutral $\Delta m, \tau_S$	229.4/199	Δm = (5247 ± 13) E6 τ_S = (89.67 ± 0.06) E-12
Current 1999 neutral $\Delta m, \tau_S$	270.3/199	Δm = (5259 ± 11) E6 τ_S = (89.75 ± 0.05) E-12

Improving Chi2 for Z-binned Fits

- Apply regenerator edge scale in 10 GeV energy bins (nominal is 4 parameter fit)
  - improves fit chi2 by ~20 units for 97 and 99
  - no change to fit values
- Include statistical errors from bg subtraction in fitter
  - improves fit chi2 by ~10 units for 97 and 99
- Remove z=124.0-124.5 from fit in regenerator beam
  - improves fit chi2 by ~30 units for 99
- Apply all 3 changes to 99 fit
  - Chi2 = 218.16/199
  - Chi2 (nominal) = 270.3/199

2pi0 Z-Slope



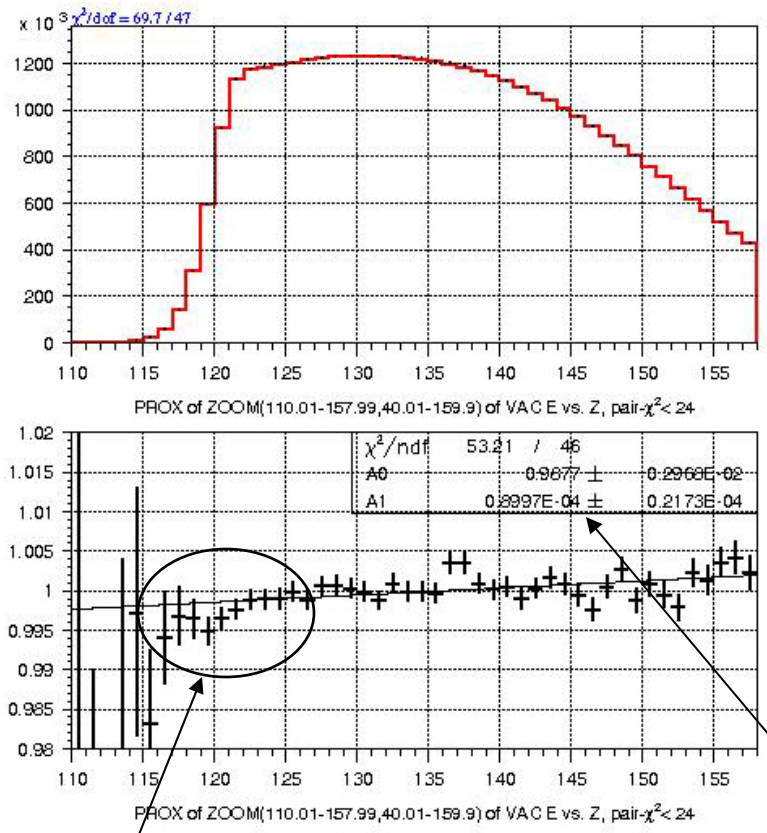


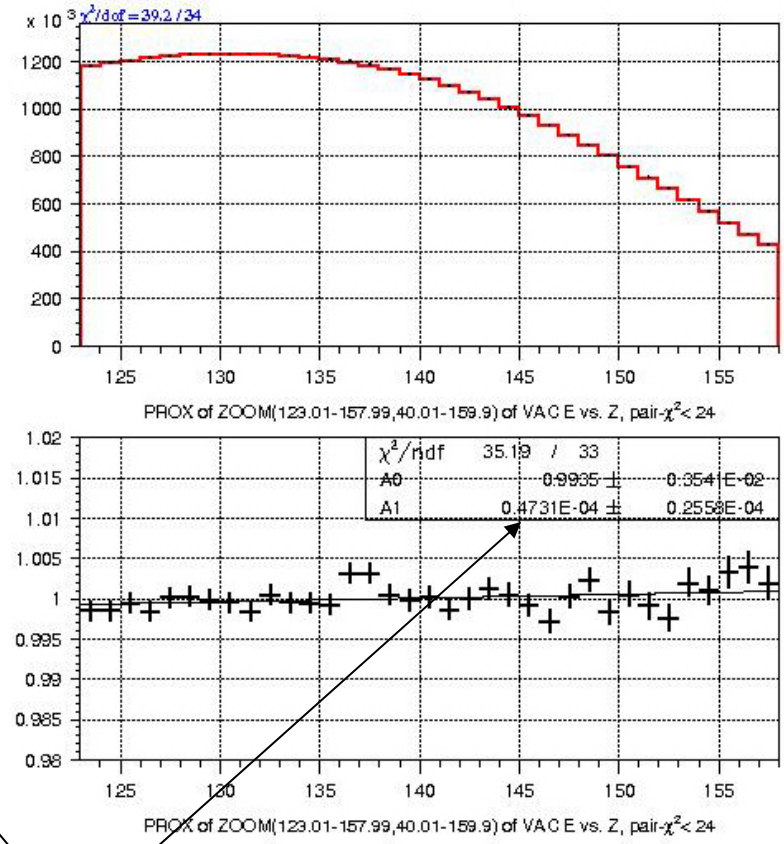
- 97 z-slope ~2σ
- 99 z-slope ~3σ
- removing events with reconstructed position inside the first ring of hole blocks removes 97 z slope
- try moving to “vus cuts”
  - remove hole blocks
  - loosen pairing chi2 cut to 50 (nominal cut is 12)
- study all cut changes on 97 before looking at effect on 99

Vus Cuts

- relaxing pairing chi2 significantly changes bg
- z-slope eliminated for 1997
  - (0.3349 ± 0.6511) E-4
- 1997 neutral $\Delta m, \tau_S$ fit
  - Chi2: 212/199 → 222/198
  - no significant change in fit values
- 1997 Re(ε′/ ε) fit
  - Chi2: 20.8/21 → 21.91/21
  - Re(ε′/ ε): 17.3 → 20.5
    - change in z-slope explains ~1E-4 change in ε′
    - investigating potential change in energy scale, potential problem with bg subtraction

3pi0 Scale/Z-Slope





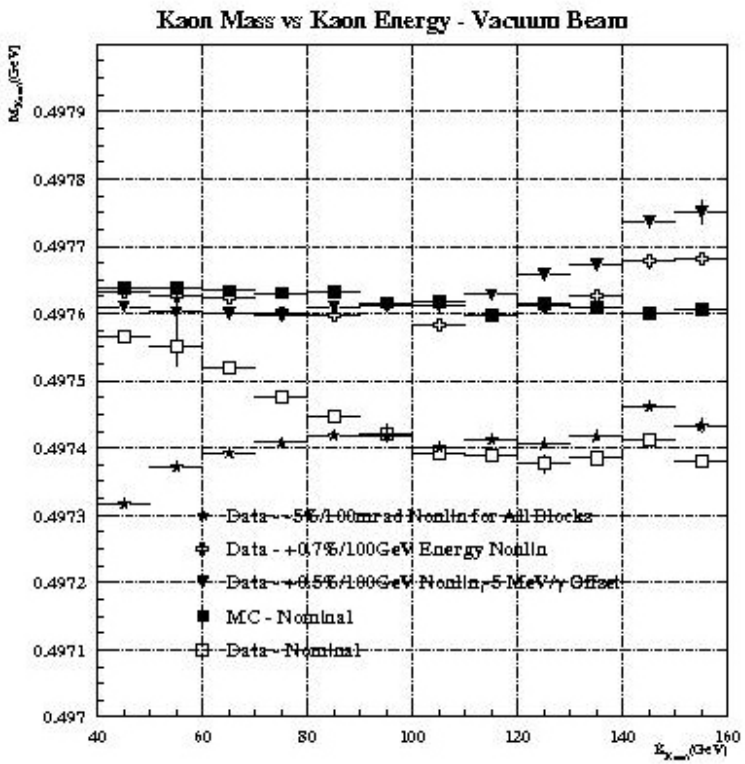
energy scale mismatch much improved

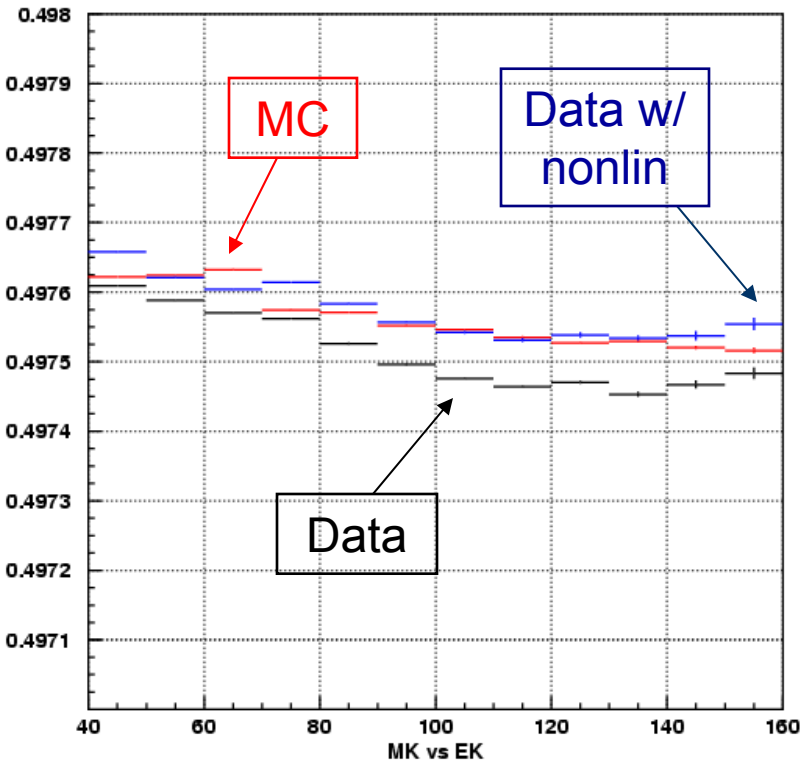
z slope still significant

Energy non-linearity Systematic

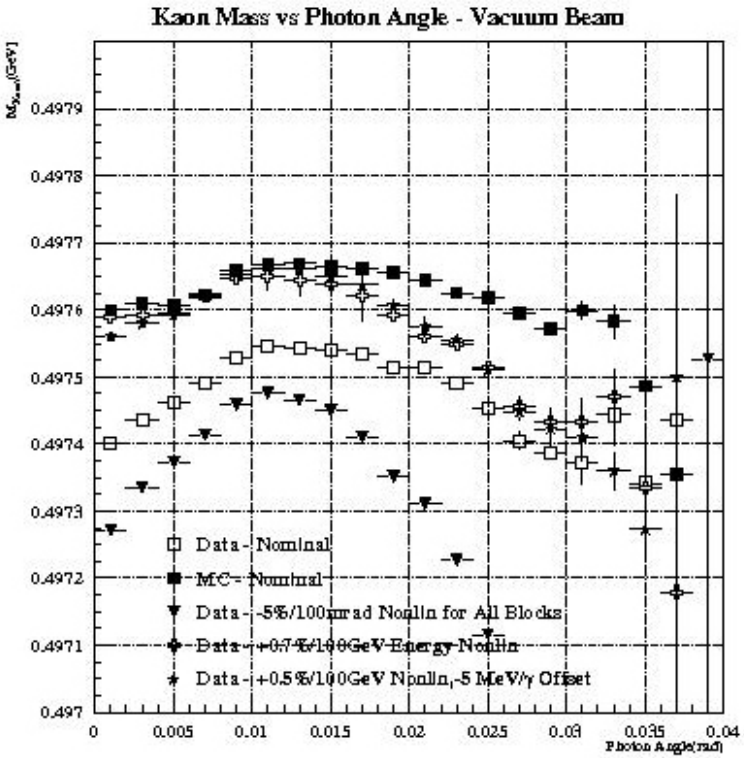
- 1997 PRD
  - systematic determined by applying a variety of corrections to data which improved the data-MC agreement of kaon mass distributions
    - 0.7%/100 GeV nonlin
    - 0.5%/100 GeV nonlin, -5 MeV/photon offset
    - shower mean adjustment + pm0 calibration
    - nearby cluster correction w/ own nonlin and offset
  - final systematic: 0.66E-4
- Current 1997 analysis
  - non-linearity corrections
    - 0.1%/100 GeV nonlin, +3 MeV/photon offset

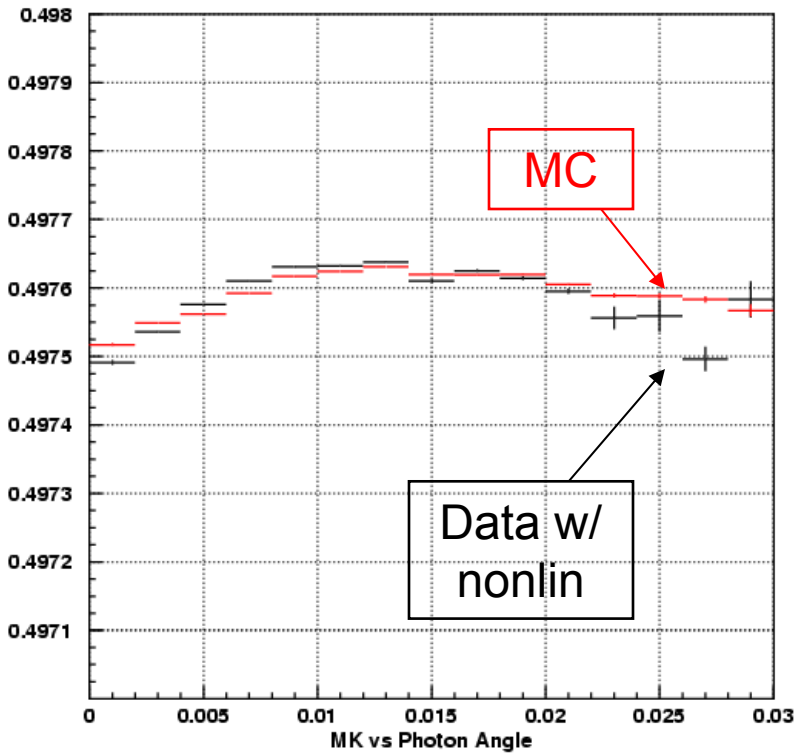
Kaon Mass vs Kaon Energy



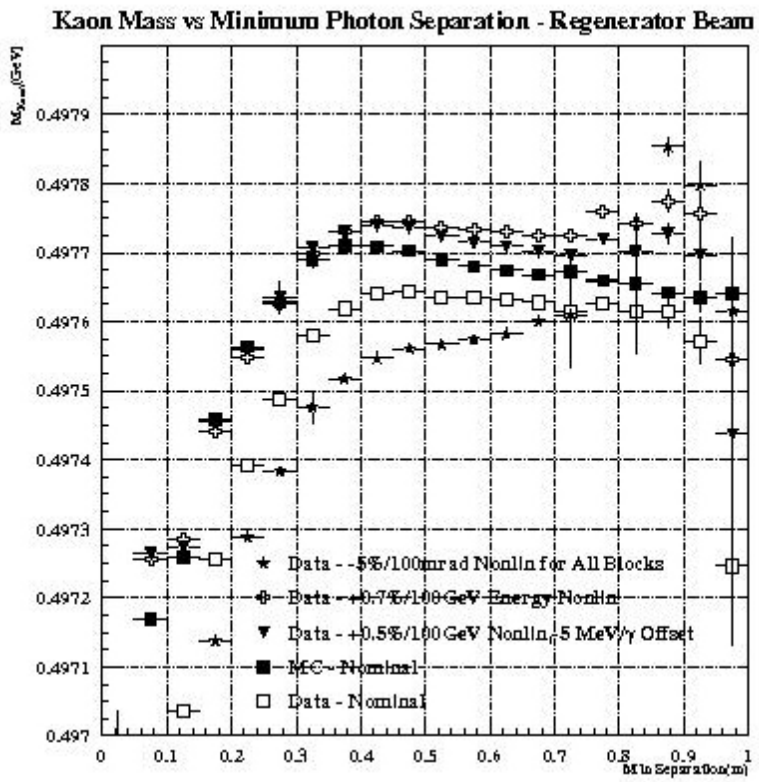


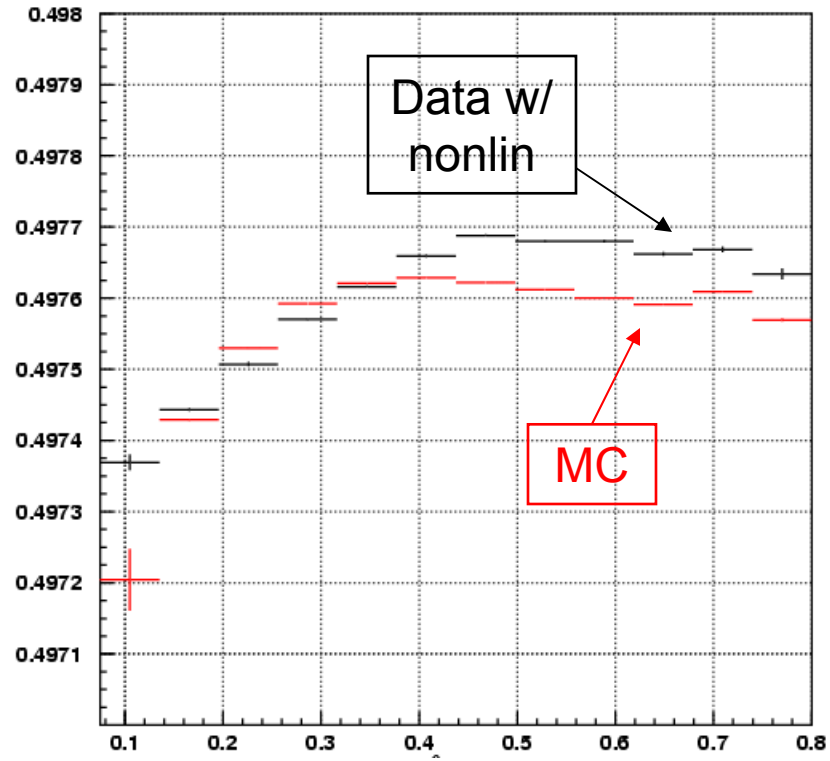
Kaon Mass vs Photon Angle





Kaon Mass vs. Minimum Photon Separation





Energy non-linearity Systematic

- for current best non-linearity
  - change in Re(ε′/ ε) is 0.7 E-4
  - change in z-slope is 1.1 E-4
  - after compensating for change in z-slope there is no systematic for this variation
- agreement between data and MC in MK distributions does not suggest other variations as it did for the PRD
- need to verify some details of his analysis with Val to make sure results are consistent
- final systematic likely to be very small

Current Status of Re(ε′/ε) Systematics

Source	1997 (Val's Thesis)	1997 (Current)	1999 (Current)
L1 trigger	0.19	to do	to do
L2 trigger	0.12	to do	to do
L3 filter	0.05	0.05	0.00
Energy Scale	1.37 (2.5 cm)	1.8 cm	1.0 cm
CsI nonlin	0.66	0.0 ?	to do
Analysis Cuts	0.37	hists exist, fits to do	hists exist, fits to do
Background	1.06	*	*
z-slope	0.26	vus cuts, 2pi0/3pi0?	vus cuts, 2pi0/3pi0?
CA aperture	0.42	*	*
MA aperture	0.18	*	*
CsI size	0.15	*	*
CsI position	0.35	*	*

*no change expected, will take old value

To Do

- finalize cuts
  - move to “vus cuts”?
- get 2pi0/3pi0 z-slope with final cuts
  - decide on 2pi0/3pi0 for z-slope systematic
- finalize neutral fits
  - settle bg issue or remove z=124-124.5?
- finalize various systematics
  - cut variations
  - CsI nonlin
  - energy scale
- L1 and L2 systematic studies
- run 1996 analysis once all is settled
  - calibration is done except resolution matching for MC
- combine all 3 years
- Goal: preliminary result for May 21