Results from BNL E949 on $K^+ \to \pi^+\gamma\gamma$

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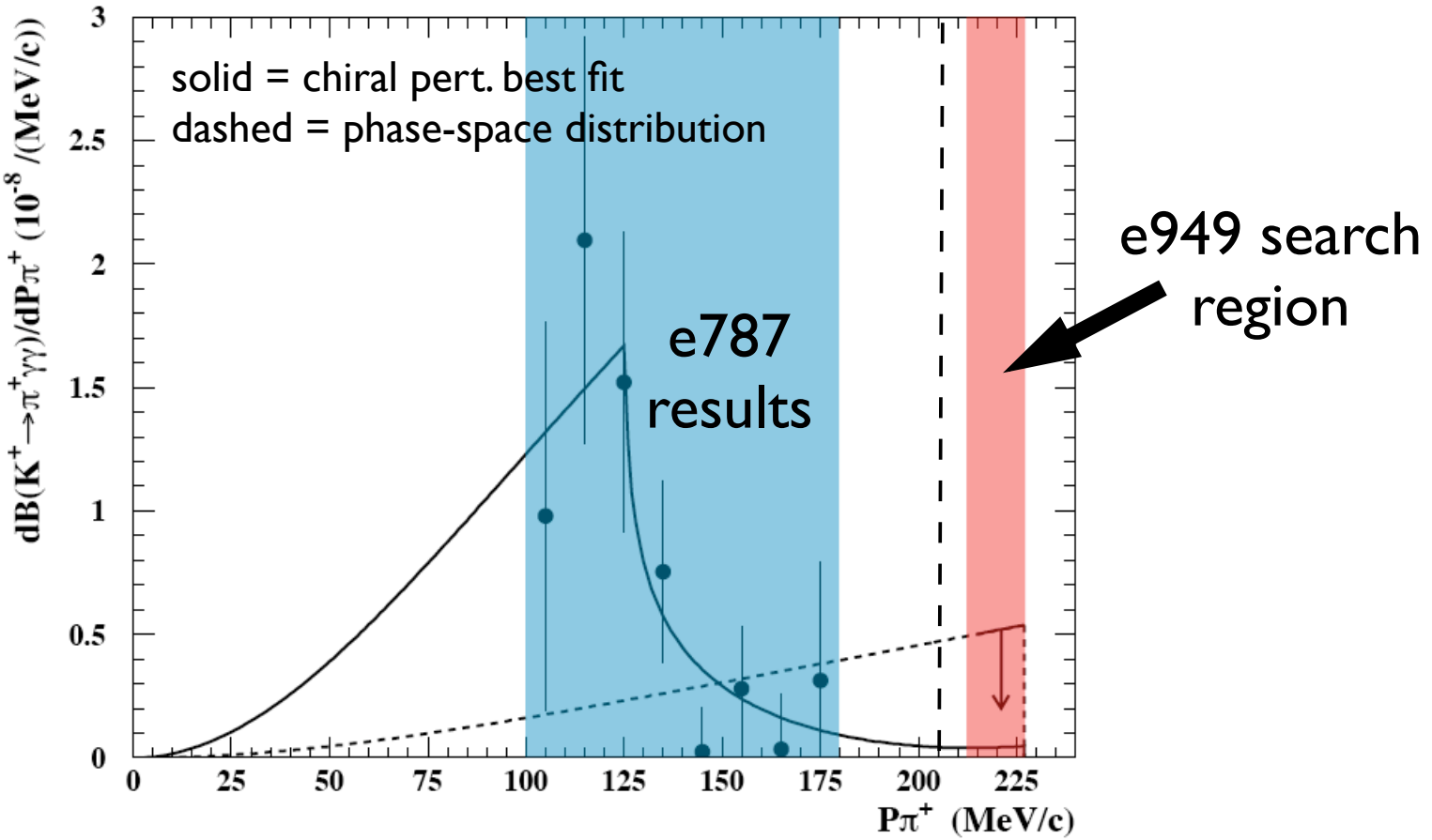
TRIUMF

π^+ Momentum Spectrum for E787

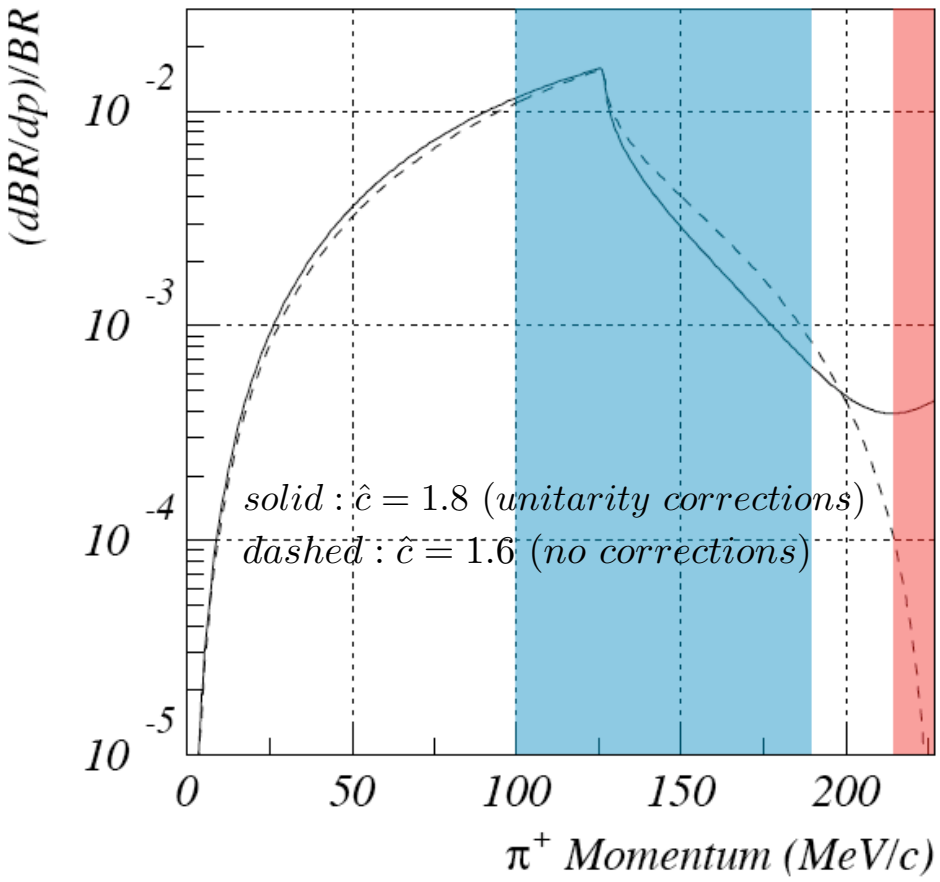
$$\mathcal{B}(K^+ \to \pi^+\gamma\gamma, 100MeV/c < P_{\pi^+} < 180MeV/c) = [6.0 \pm 1.5 \pm 0.7] \times 10^{-7}$$

$$\mathcal{B}(K^+ \to \pi^+\gamma\gamma, P_{\pi^+} > 215MeV/c) < 6.1 \times 10^{-8}$$



P. Kitching *et al.*, Phys. Rev. Lett. **79**, 4079 (1997).

Branching Ratio from ChPT



- Curves similar < 200 MeV/c
- Curves diverge >200 MeV/c
- Finite BR at kinematic end point using unitary corrections.

Values obtained from E787

$$\hat{c}_{No\ corr.} = 1.6 \Longrightarrow \mathcal{B}(P_{\pi^+} > 213 MeV/c) = 4.9 \times 10^{-10}$$

$$\hat{c}_{unitarity\ corr.} = 1.8 \Longrightarrow \mathcal{B}(P_{\pi^+} > 213 MeV/c) = 6.1 \times 10^{-9}$$

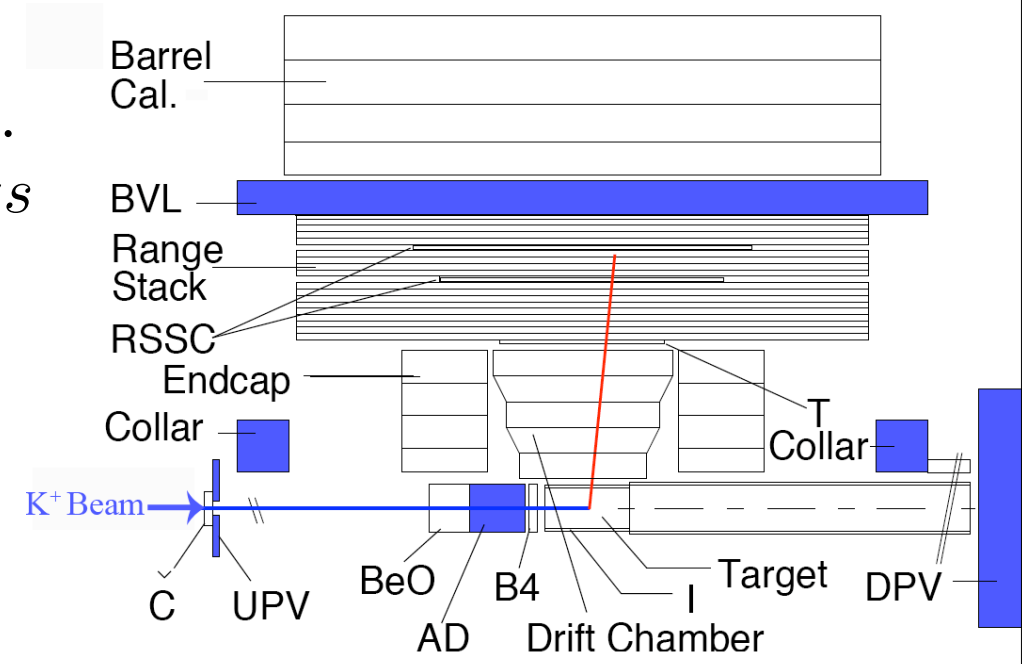
Order of Magnitude Different!

E949 Detector & Trigger

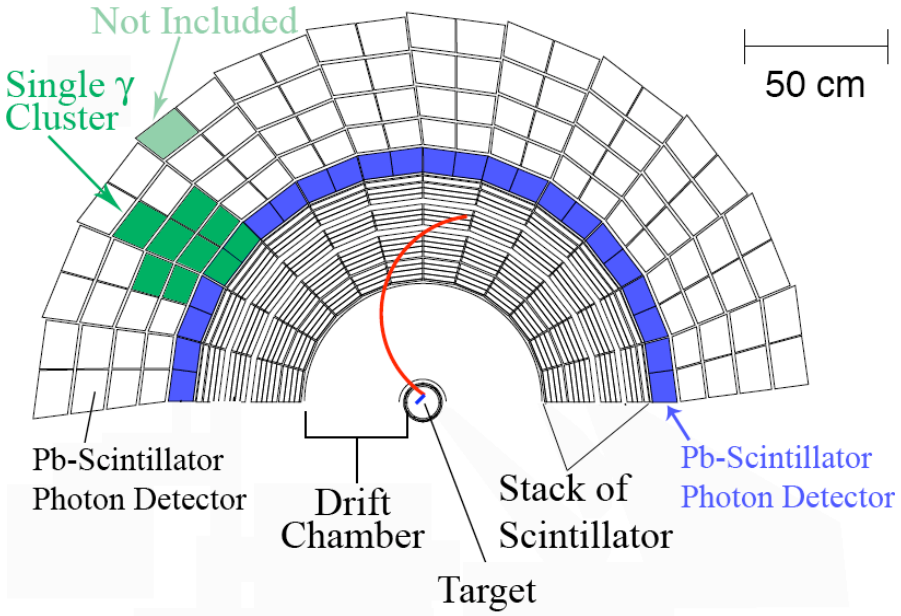
- K^+ *enters detector & stops.*
- K^+ *decays : detect* π^+ *and* γs

Signal Signature

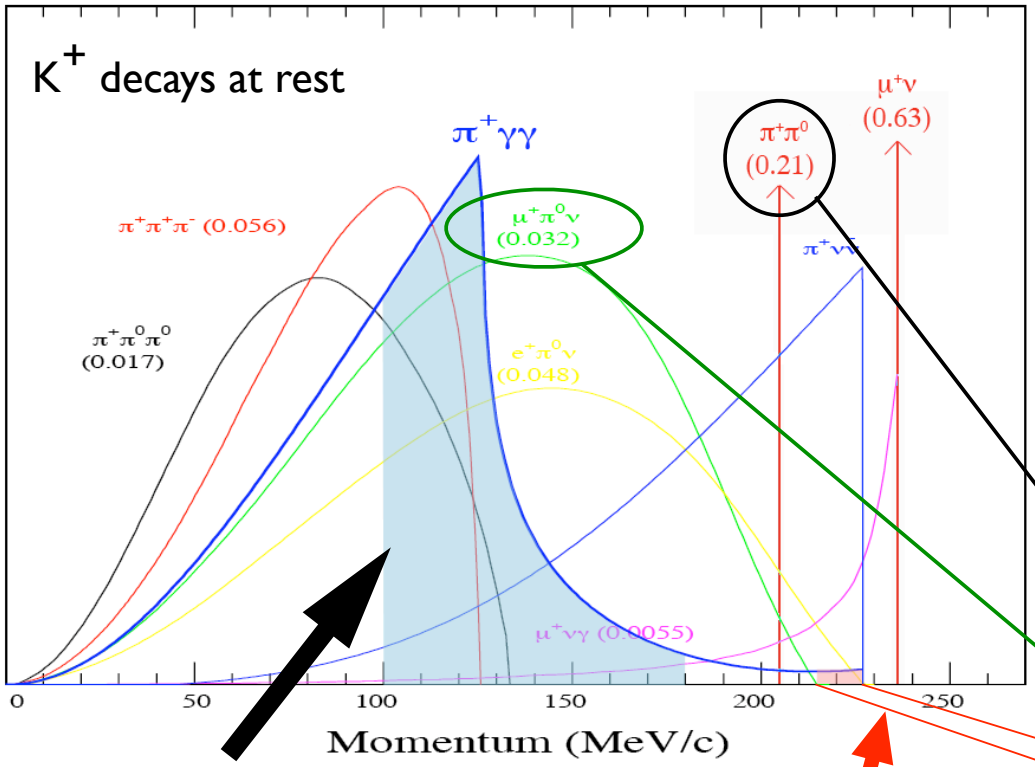
- *Both* γs $\sim$ *collinear*
- *Long range* π^+



- *Trigger on 1 or 2* γ *clusters*
  - γ *in Barrel photon detectors*
  - $2\gamma s \rightarrow 1$ γ*cluster for high mom.* π^+
- *Long range* π^+



Backgrounds & Trigger Events

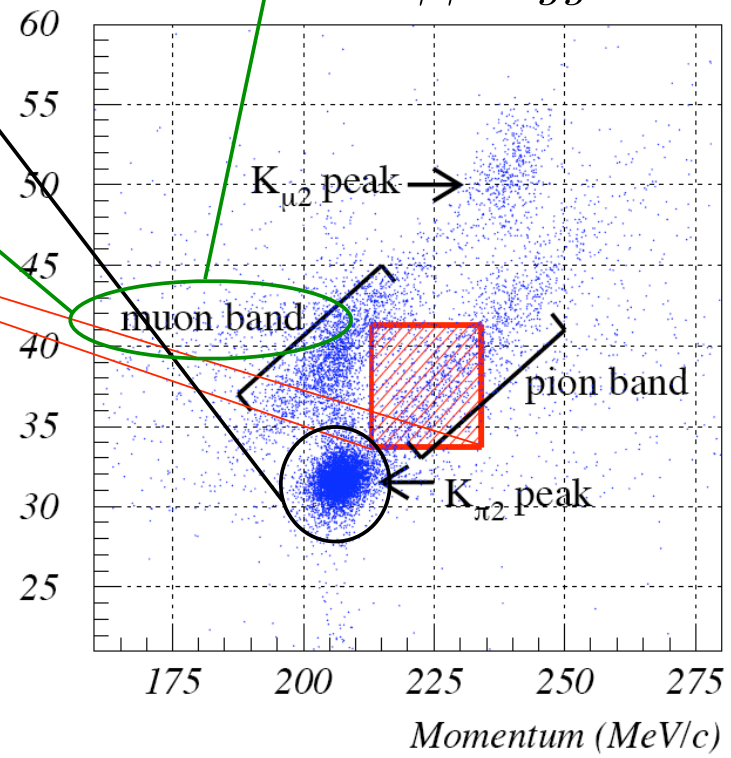


Background from $K^+ \to \pi^+\pi^0$

$K^+ \to \mu^+\nu\gamma$

$K^+ \to \mu^+\pi^0\nu$

$K^+ \to \pi^+\gamma\gamma$ *triggers*



E787 Signal Region

E949 Signal Region

$K^+ \to \pi^+\pi^0; \pi^0 \to \gamma\gamma$

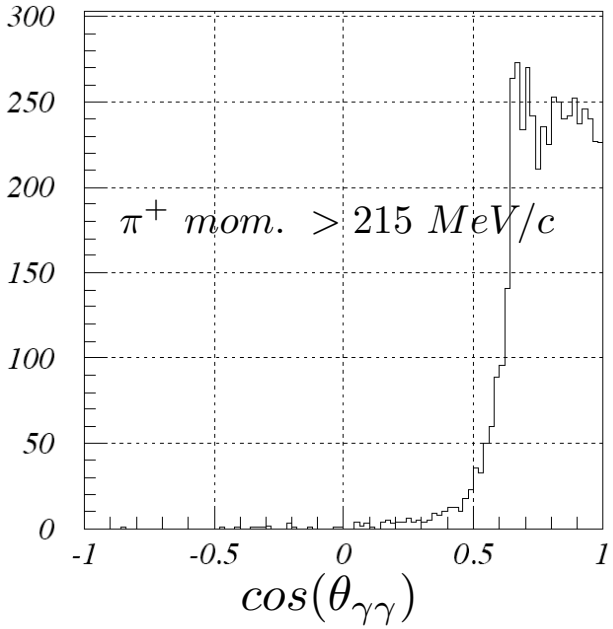
SAME FINAL STATE!

$K^+ \to \pi^+\pi^0$ Background

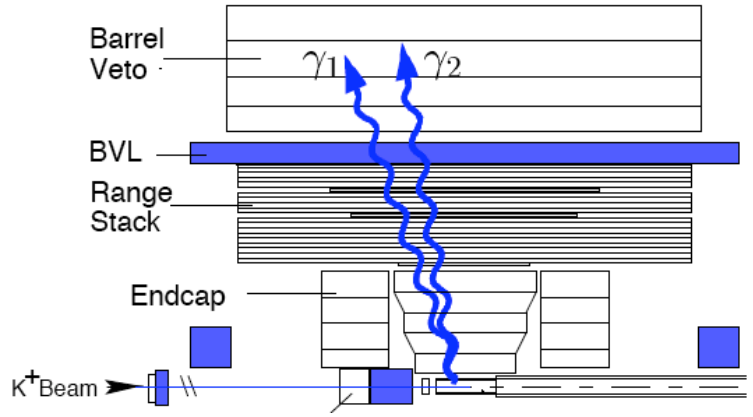
Suppress backgrounds

- *Use π^+ kinematics*
- *Opening angle cut on γs*

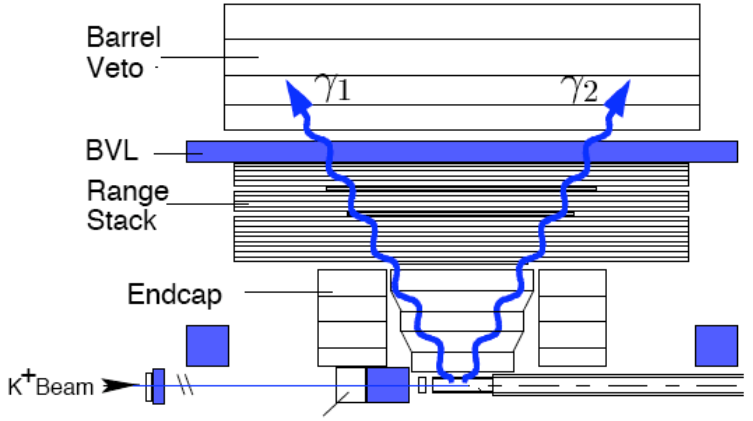
$K^+ \to \pi^+\gamma\gamma$ *Monte Carlo*



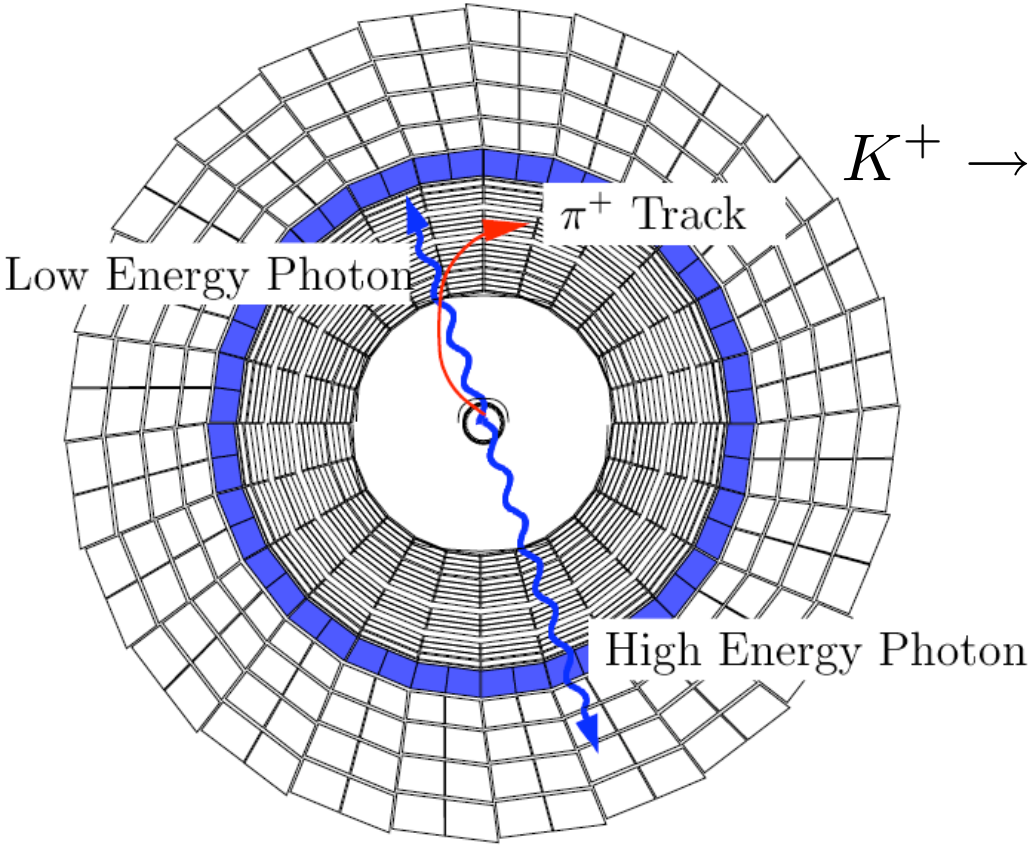
$K^+ \to \pi^+\gamma\gamma$ *signal*



background from $K^+ \to \pi^+\pi^0$



Overlapping γ Background



- *Cut on overlapping γ by observing larger than expected energy*

Results

Background	Background level
$K^+ \to \pi^+\pi^0$	0.017 ± 0.006
$Overlapping\ \gamma$	0.065 ± 0.065
Muon	0.090 ± 0.020
Single Beam	0.025 ± 0.014
Double Beam	$0.006\ (90\%\ C.L.)$
Total	0.197 ± 0.070

Acceptance

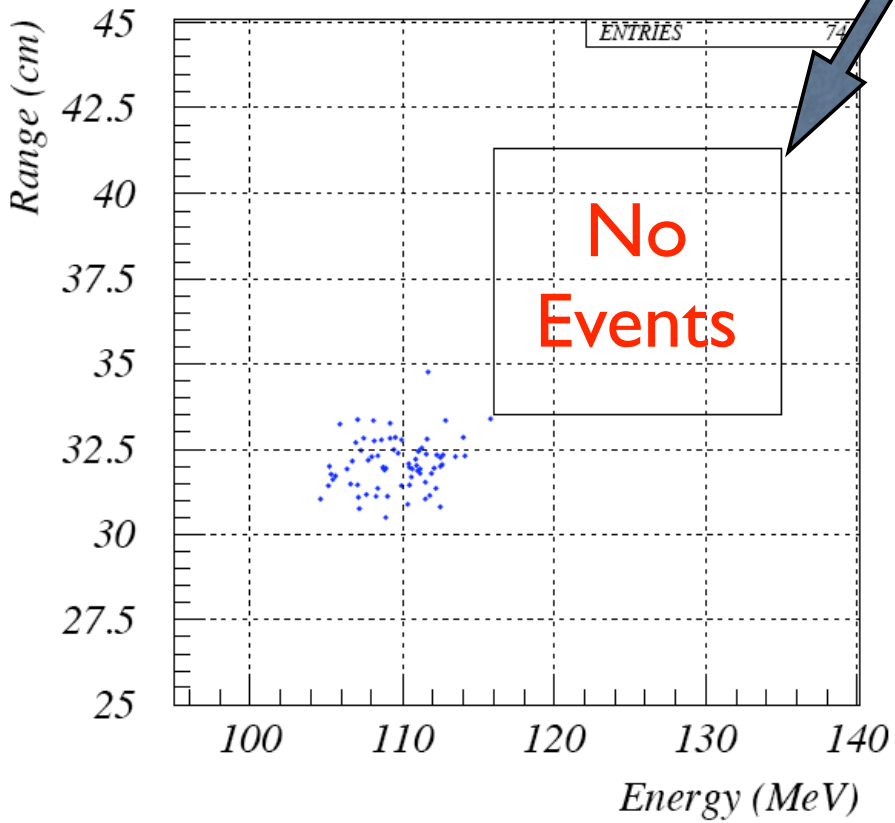
$$A^{\pi^+\gamma\gamma}_{O(p^6)} = 1.550 \pm 0.034 \times 10^{-4}$$

Expected Number of Events

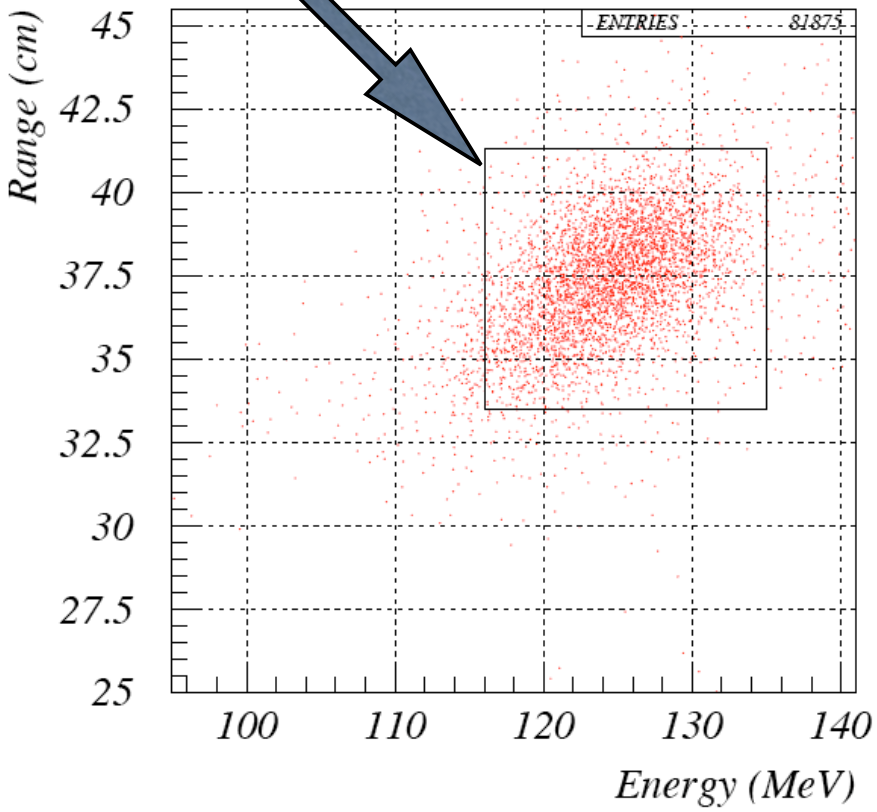
1.6 (assuming unitarity corrections)

Open Box

$K^+ \to \pi^+\gamma\gamma$
Signal Region



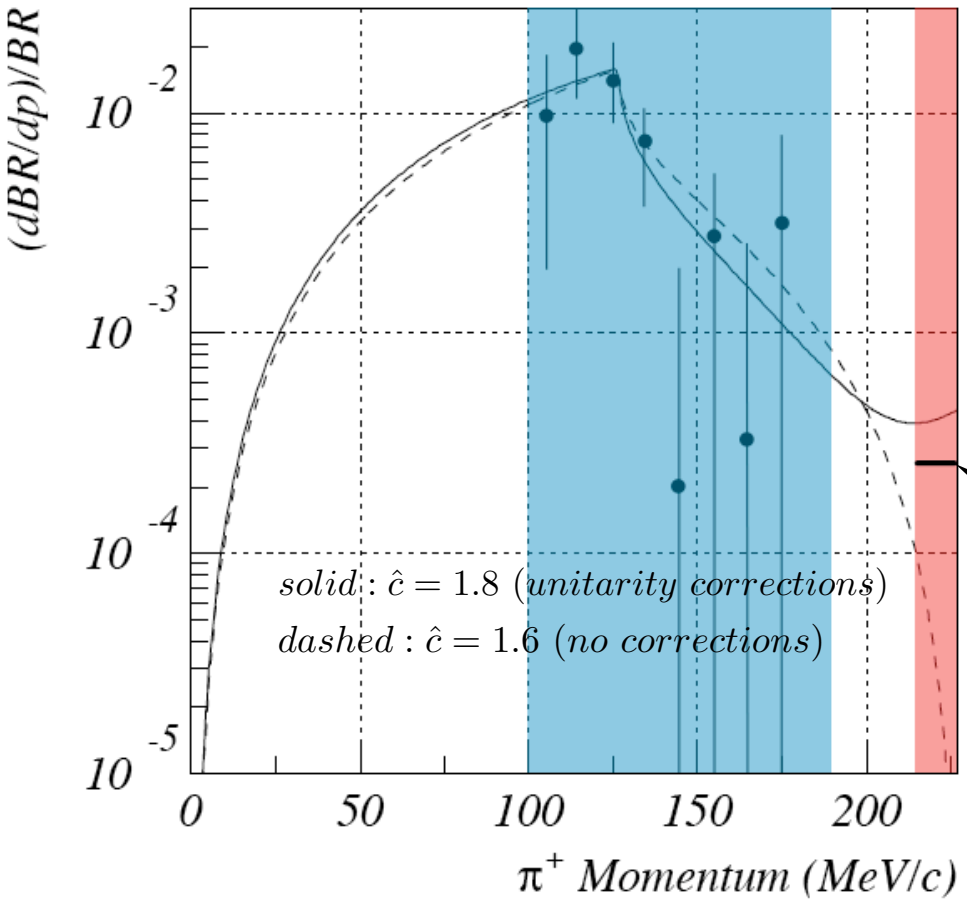
Surviving events
All cuts applied



Simulated distribution
$\hat{c} = 1.8$ unitarity corrections

Conclusions

$$\mathcal{B}(K^+ \to \pi^+\gamma\gamma; P_{\pi^+} > 213 MeV/c) \; < \; 9.1 \times 10^{-9} \quad (90\%\ CL)$$



Single Event Sensitivity

- Upper limit x ~7 improvement
- consistent with and without unitarity corrections
- More data needed.

THANK YOU