Monte Carlo for RICH Kaon Mass Measurement

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What the MC Does

Produce ring radius distributions

- Beam momentum is Gaussian with $sigma_p/p = 2\%$
- Assume beam is composed equally of p,K,pi
- Calculate ring radius

$$r=L*\sin(theta)$$
$$\cos(theta)=1/(n*beta)$$

- Assume number of hits per ring is Gaussian with $\langle N\rangle=26.45$ $sigma_N=6.334$ (PR plots)
- $sig_r=sig_h/N^{1/2}$, $sig_h=5.5$ mm (SELEX) where sig_h is the single hit resolution

Fitting the Radius Distribution

Fit to sum of three Gaussians

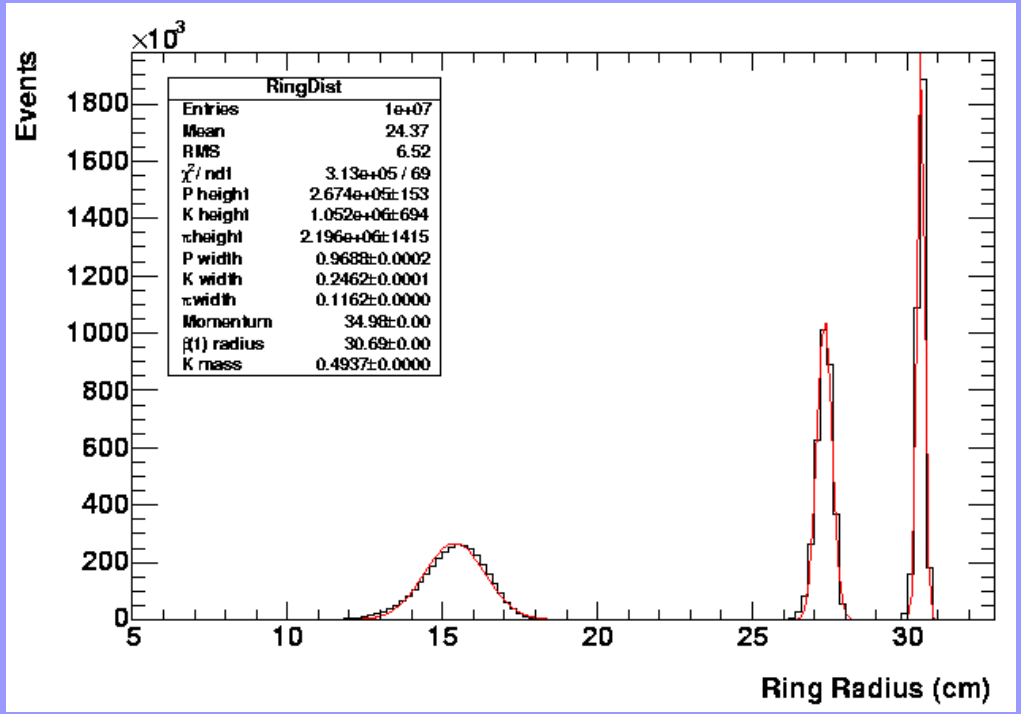
- Centers of Gaussians are correlated:

$$R^2 = R_0^2 - L^2\left[\left(\frac{m}{p}\right)^2 - \frac{1}{4}\left(\frac{m}{p}\right)^4\right]$$

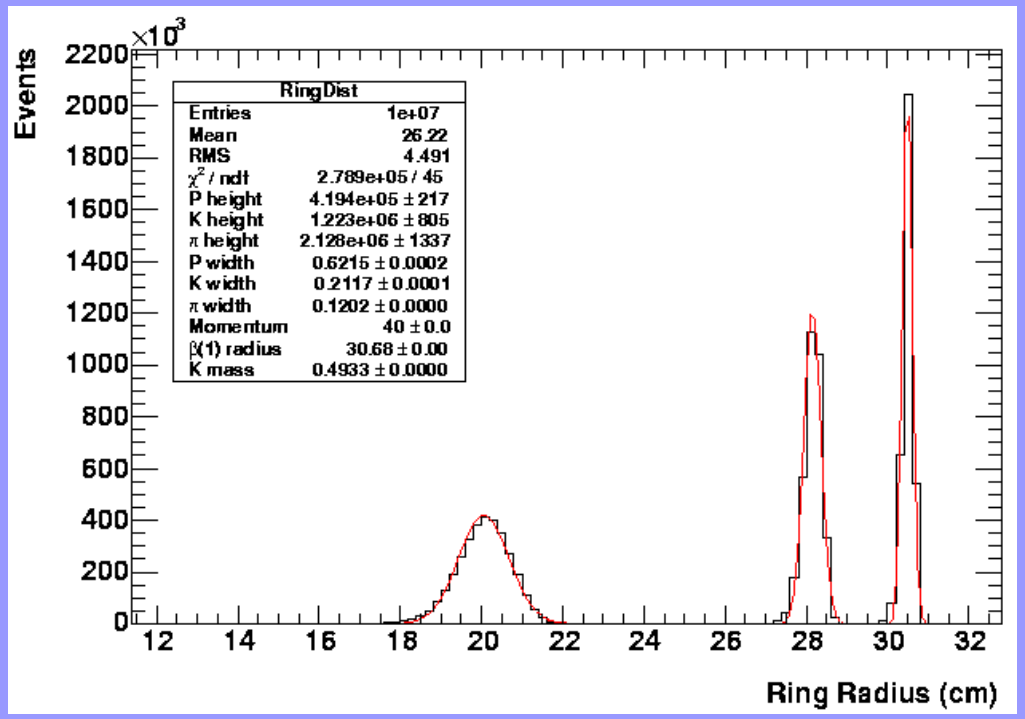
  where R_0 is the radius for a beta=1 particle and L is the length of the RICH

- Vary these parameters:
  - Normalization, sigma for all three
  - R_0 – restrict to within 2 cm of calculated value
  - Momentum – restrict to 2% of nominal
  - Kaon mass

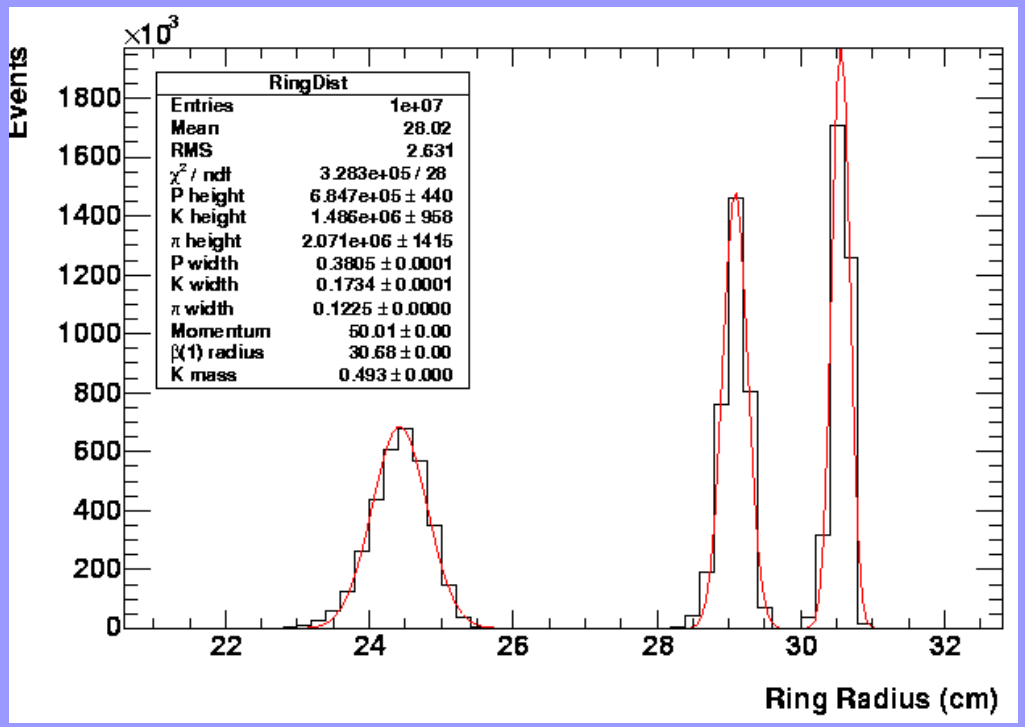
Sample Fits



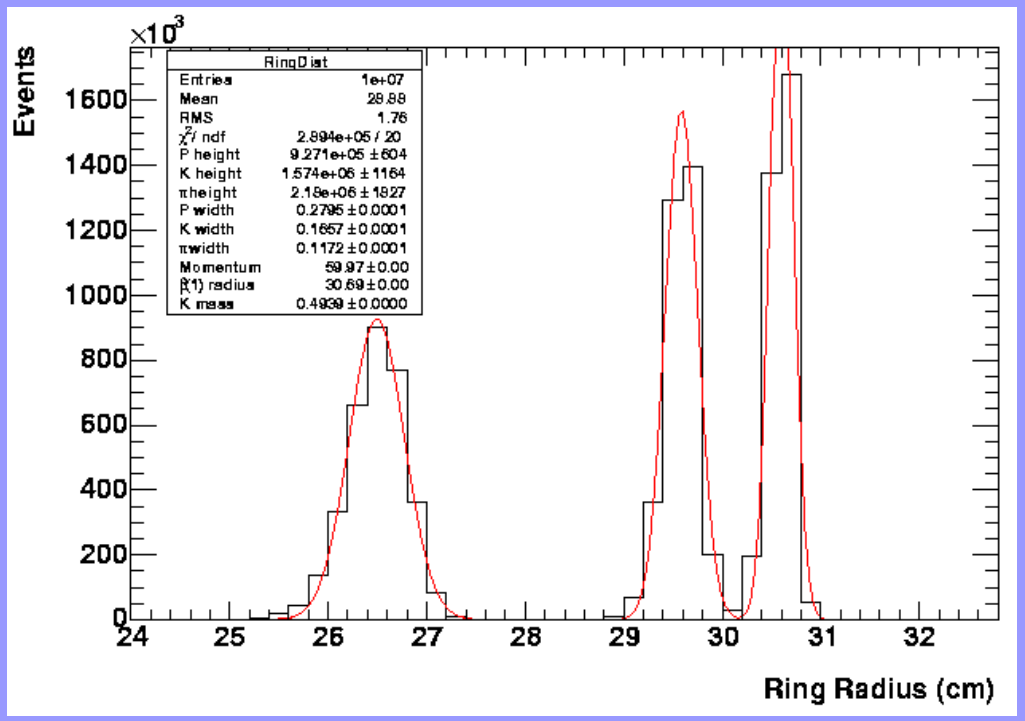
Right: 35 GeV, 10 million events
Below: 40 GeV, 10 million events



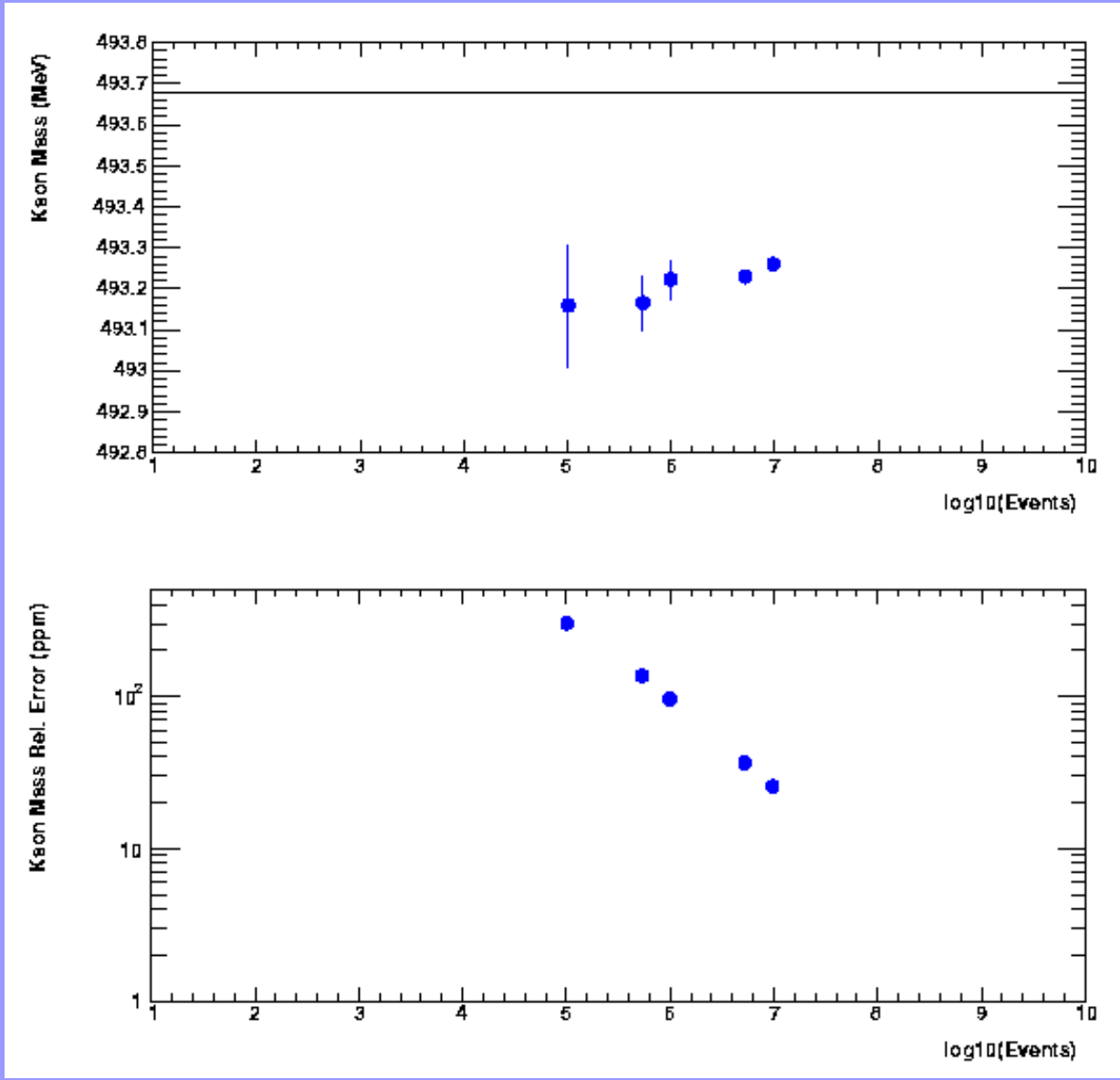
More Sample Fits



Right: 50 GeV, 10 million events
Below: 60 GeV, 10 million events



Some Preliminary Results

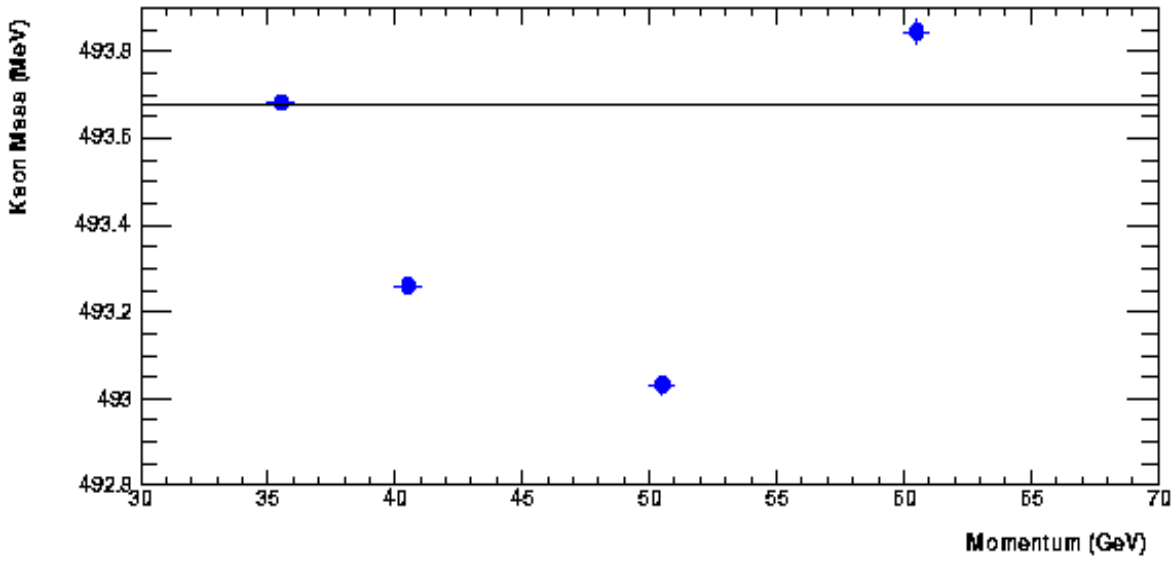


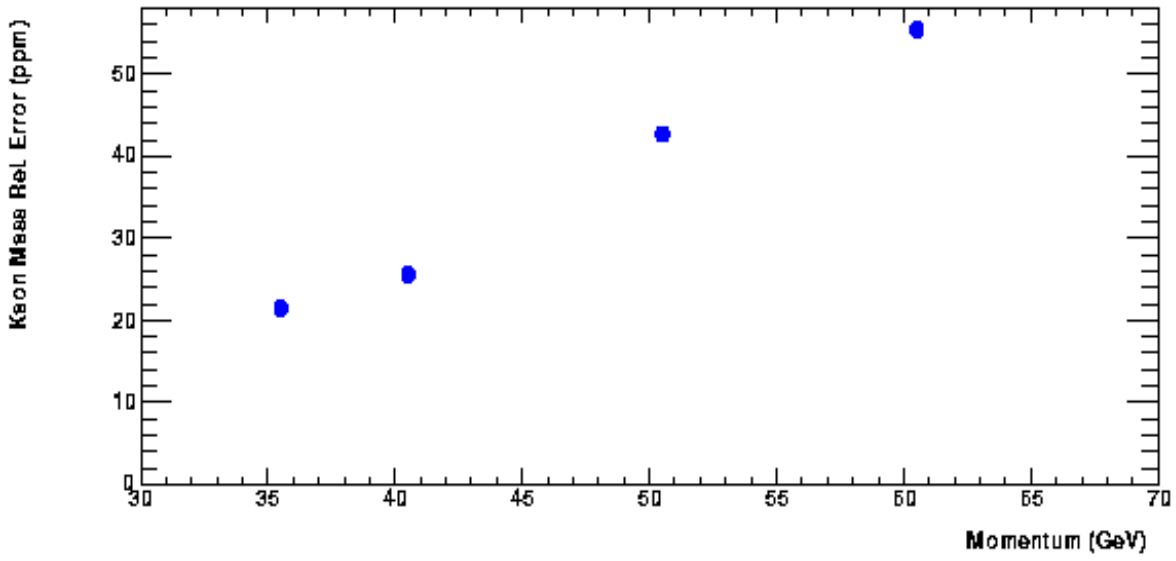
Results from 40 GeV trials

Mk = 493.677 MeV from PDG
Fits do not agree within statistical error

Need ~10 million events to get to 20 ppm

More Results





Lower momentum yields better precision on kaon mass

Reinforces earlier arguments for running at low momentum: ~40 GeV

Conclusions/Further Work

Some preliminary conclusions

- As has been argued, want to run at low momentum (~40 GeV)
- Need about 10 million events. Assuming .5 spill/minute and 50% downtime:
  - -- 2500 spills/week
  - -- Need 4000 events/spill (1 kHz daq rate)

Future improvements

- Let p,pion masses vary within measured errors
- More precise R_0 constraint
- Address differences in production spectrum for p,K,pion
- Include dispersion