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Seeded RICH Ring Fitter

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Motivation

- Calculated RICH likelihoods are not meaningful yet
  - When then will be this can be used as a cross check
- Combination of RICHRadFit/RICHCircFit does not use tracking information, so its efficiency is (perhaps) questionable in busy events
- I wanted to see performance of approach based on
  - DA filter to select the ring hits
  - HERA-B algorithm to share hits among rings

Seeding the Fit

- Select all tracks which
  - Have at least 10 chamber hits
  - Have non-zero path length through CO2
- For each track, scan r to find the minimum of the sum of

$$\chi^2 = \sum \frac{(r - r_{hit})^2}{\sigma^2}$$

except if radius difference is above 2σ, the hit gets a flat weight of 4

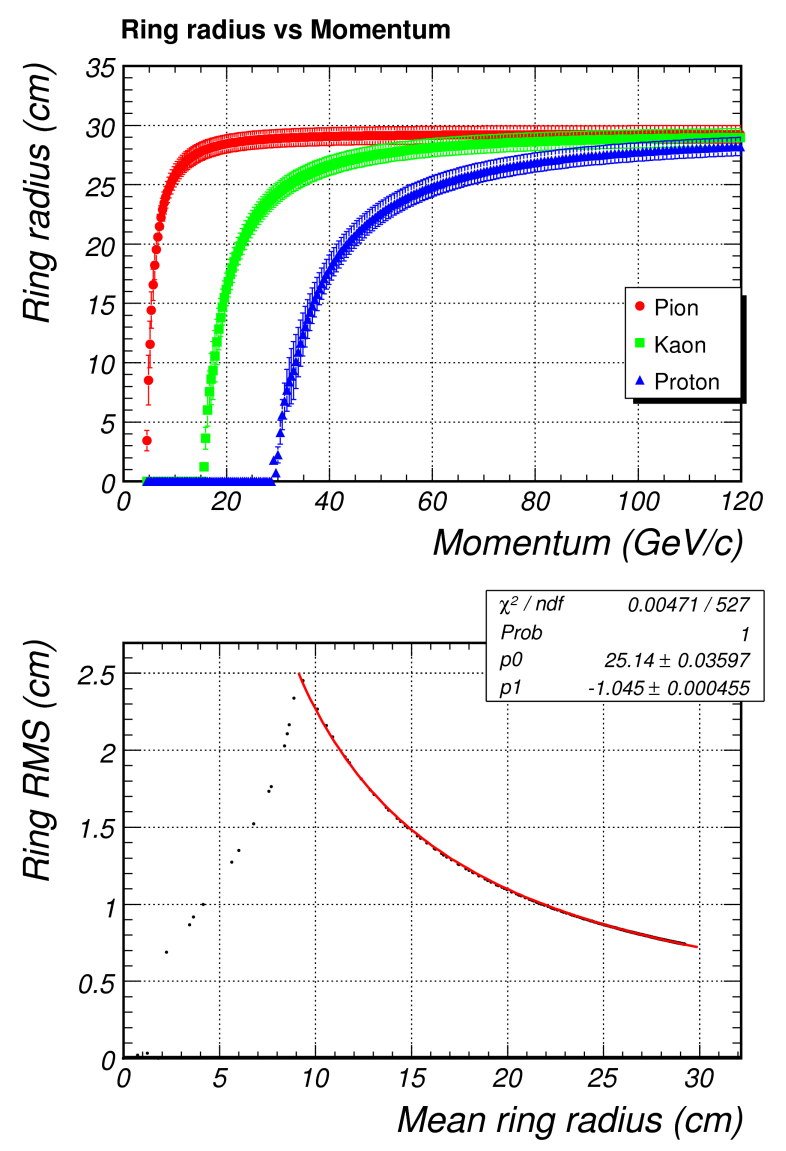
  - Scan is done in steps of 1σ

What is σ?

- Using the light distribution calculated in RICHReco/macros/radiusPlot.C, I plot the RMS of the ring as a function of ring radius, and observe that for r>9 cm, the functional form is

$$r_{RMS} = 25\, r^{-1.025}$$

- Below 9 cm, it's a flat line: there is no Cherenkov light

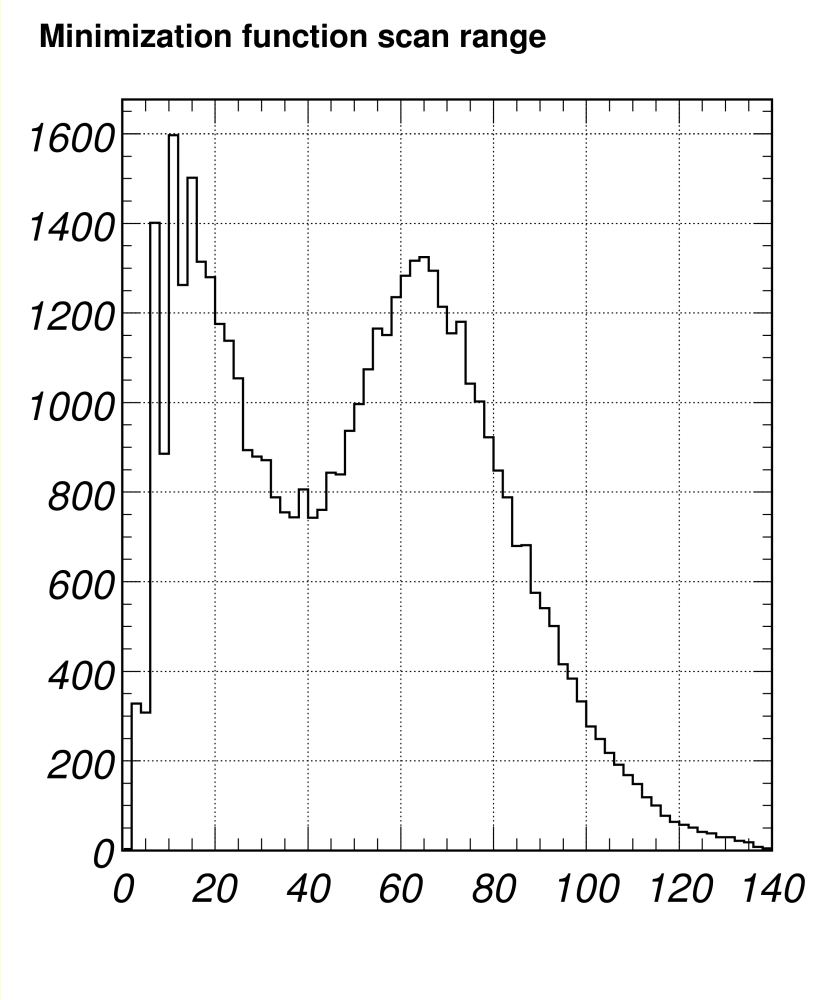


Filtering and Hit Sharing

- Given a DAF temperaturue and ring (x,y,r) hypothesis, I compute hit weights and claim to use hits where the weight is above 10^{-6} (2σ is taken as the critical radius)
- In bins of 0.4σ, I compute the occupancy o_i of each bin, so each hit knows how many other hits of that track are in the same bin
- When TMinuit evaluates the minimization function, each hit weight is adjusted based on DAF weight and if the hit is shared, it is weighed down by $\frac{o_i}{o_1 + o_2 + \ldots}$

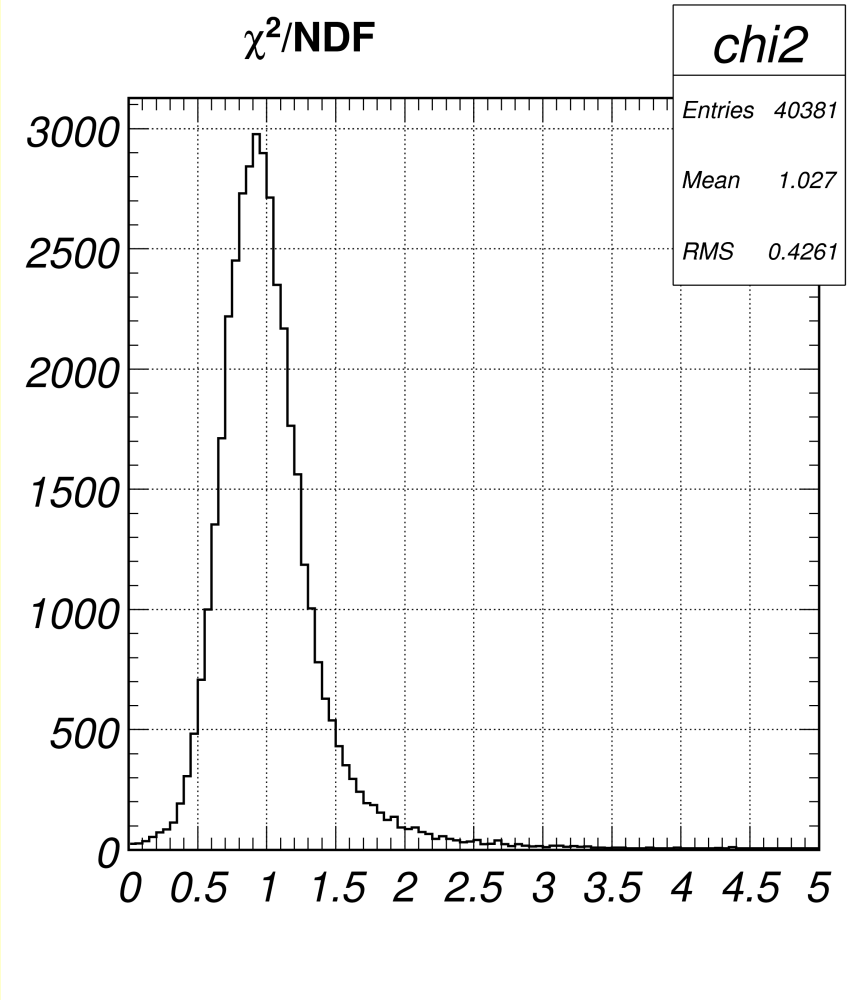
Scanning for seed

- Minimization function scan range can probably be used to weed out some of the nonsensical rings, but at the moment nothing is done
- I do require at least 3 hits on the seed ring – otherwise no fit is done

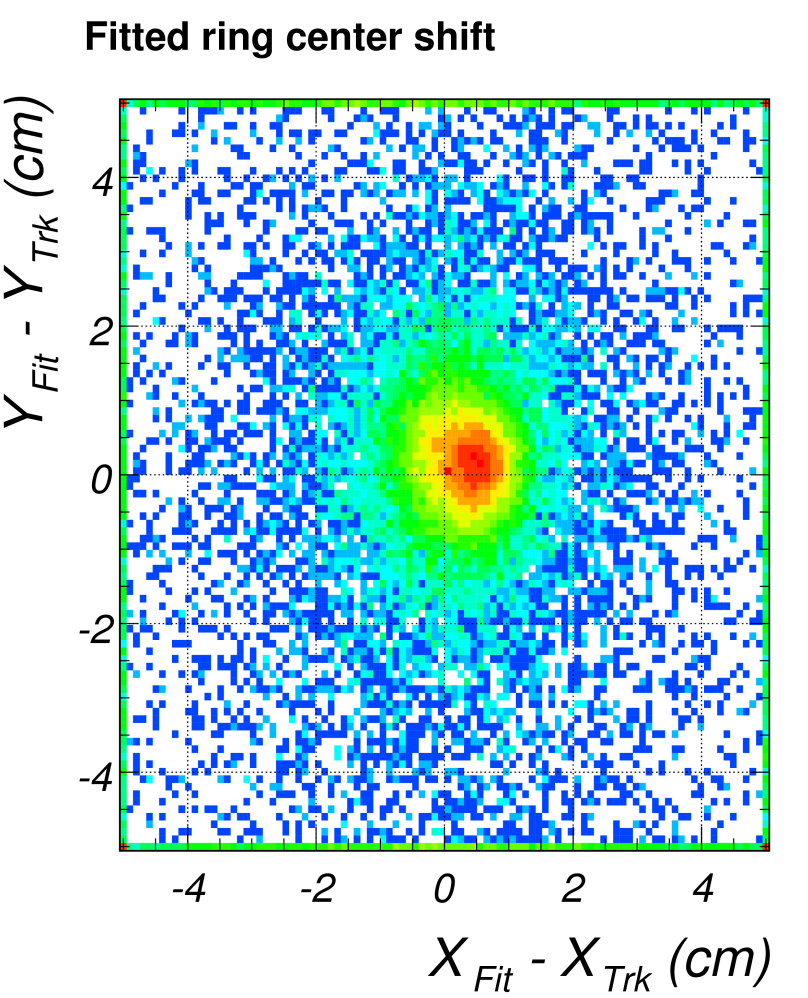


How good is σ?

- Looking at the overall distribution of χ^2 per degree of freedom tells me that my choice of σ is quite good
- The distribution is pulled down a bit because hits above critical radius may get counted in NDF, but contribute little to χ^2



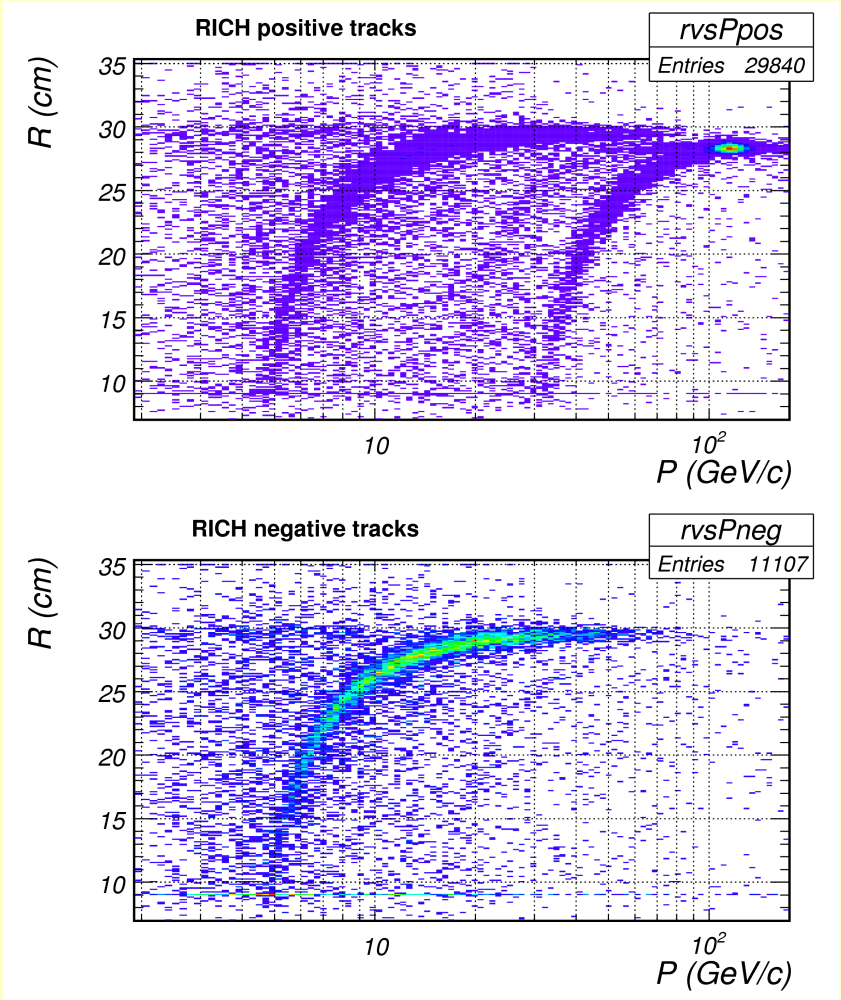
Ring center position



- I allow for ring center to vary within 5 cm of the seed in both X and Y if there are at least 5 hits on the ring
- I do not (yet) use alignment constants, so there is a systematic shift from the origin

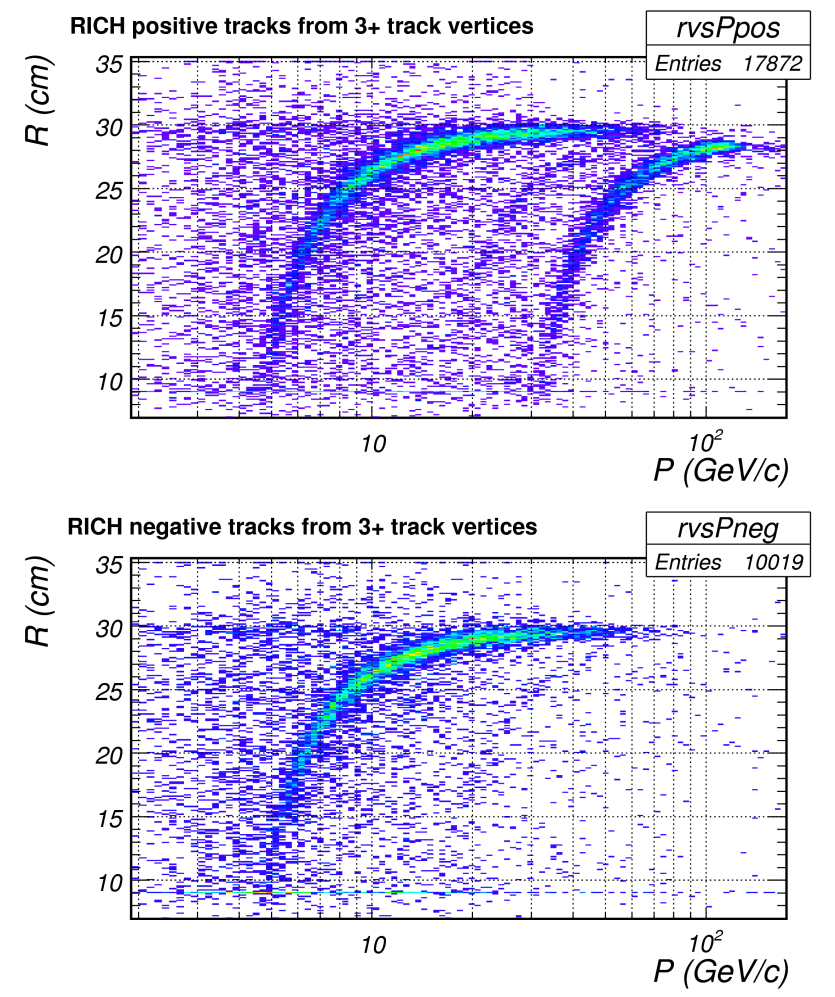
Plotting “everything”

- I processed the first 6 subruns of run 15860 (120GeV C) -- about 30k triggers
- Overall, no surprises, except the bands at r=9cm
- One interesting feature in the positives is that the 120 GeV proton ring goes down to almost 60 GeV/c



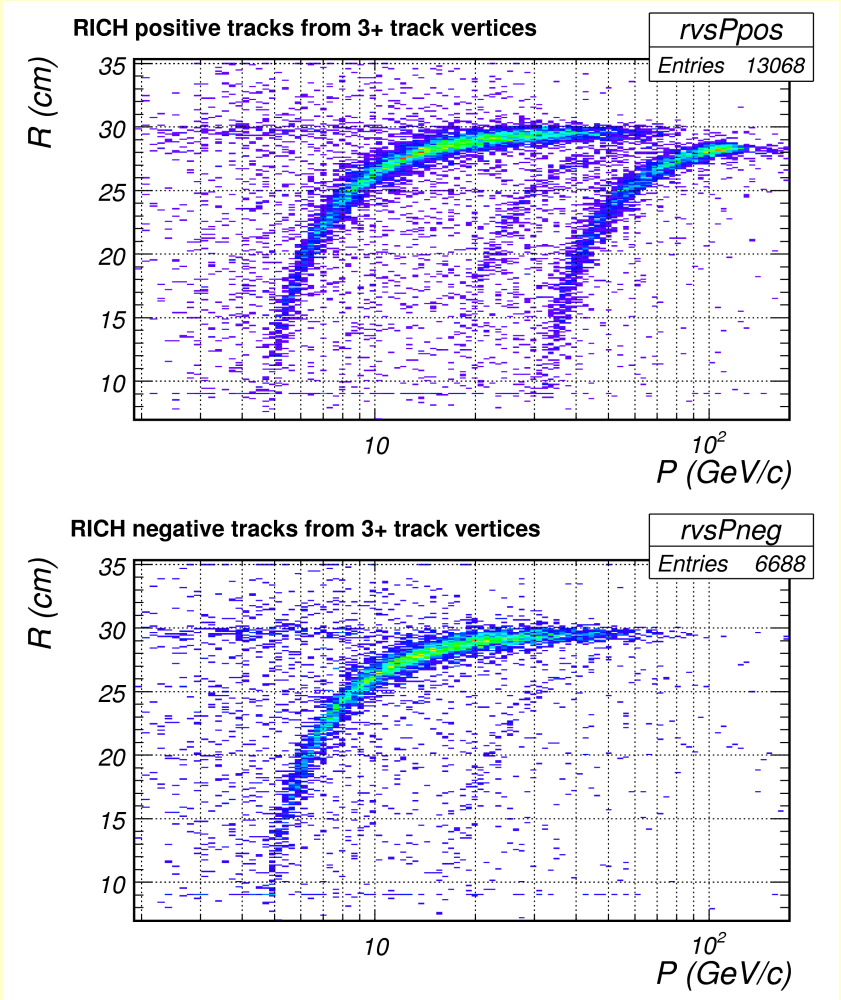
Requiring a 3+ track vertex

- I did not require a target-like vertex, although more than 90% of 3+ track vertices come from the target



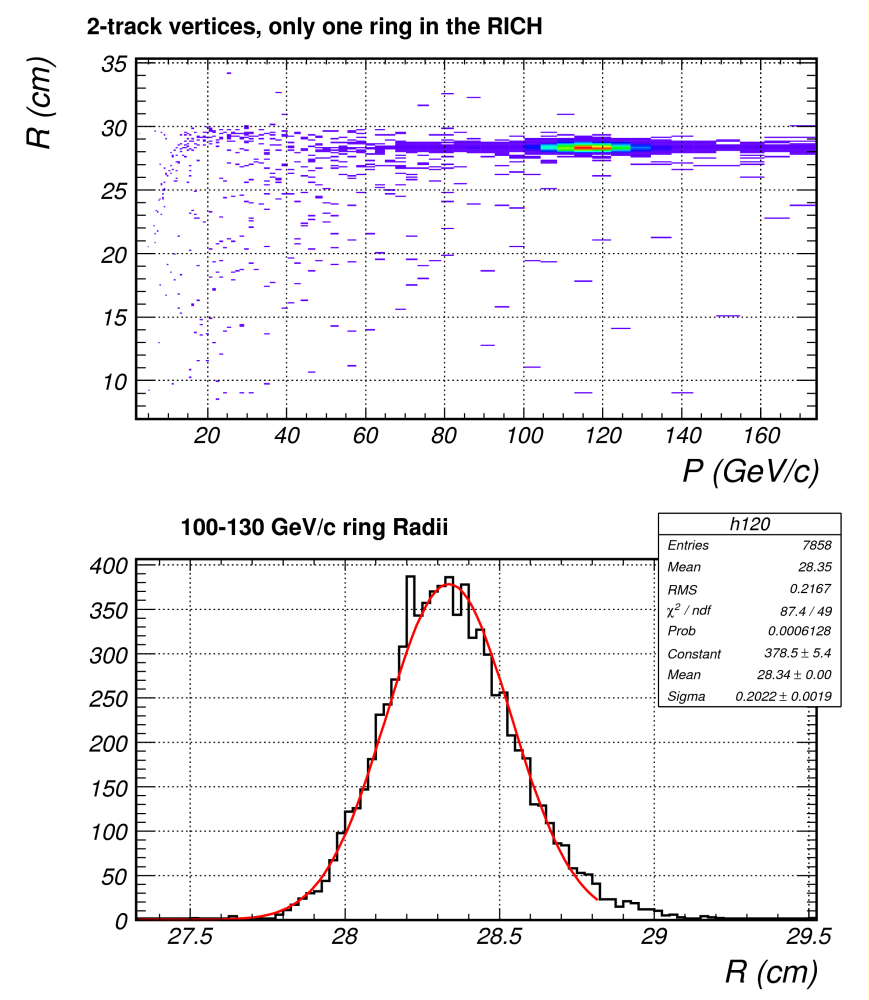
Limit center shift

- To clean the plot up, I require that the center stay at least 0.5 cm away from the 5 cm boundaries
- Almost all particles are below proton threshold!
- This removes a significant fraction of r=9cm rings

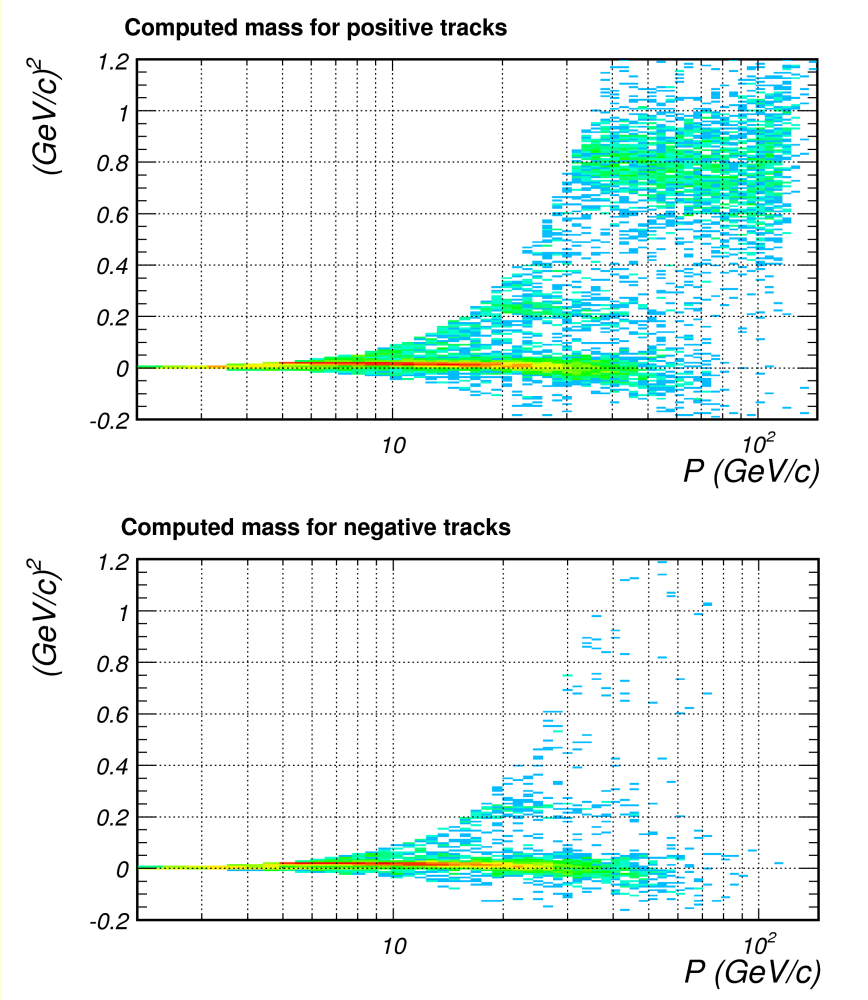


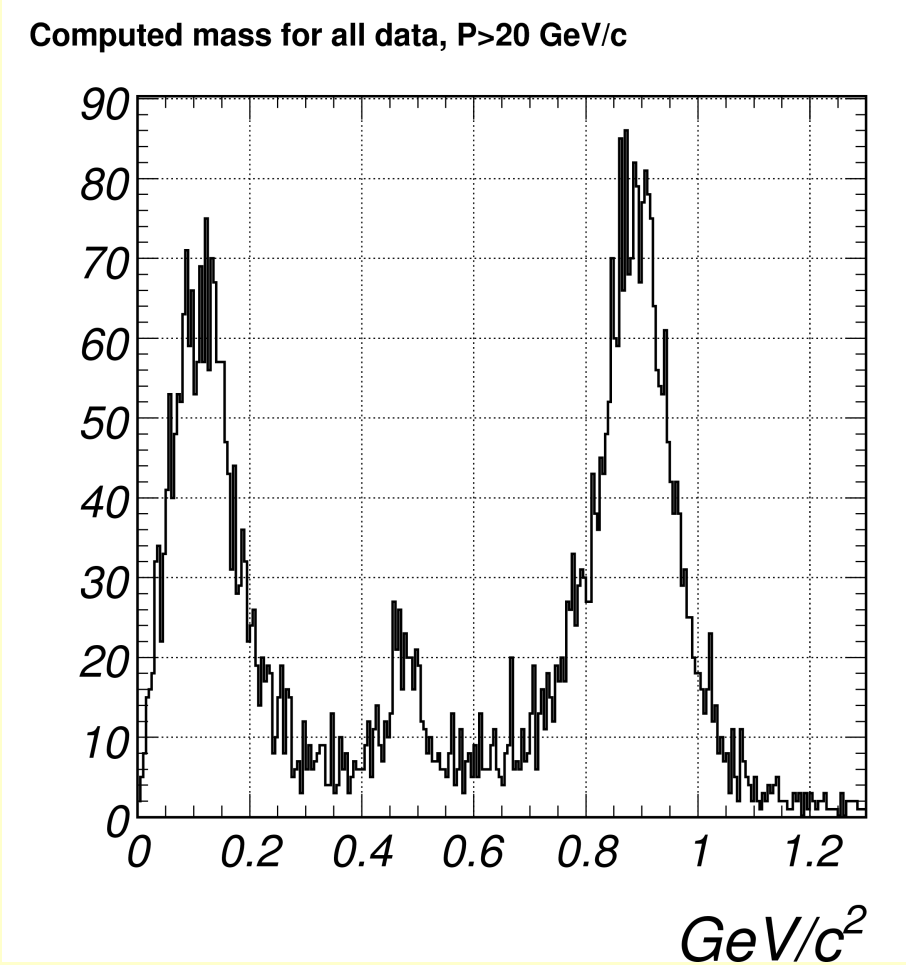
Calibrating R0

- To understand what fitted radius means, you need to calculate R_0 – radius of $\beta=1$ particle
  - In this case $R_0=29.38$ cm
- Once you have that, you can compute particle mass through $m^2 = \frac{R_0^2 - R_i^2}{F^2} p^2$

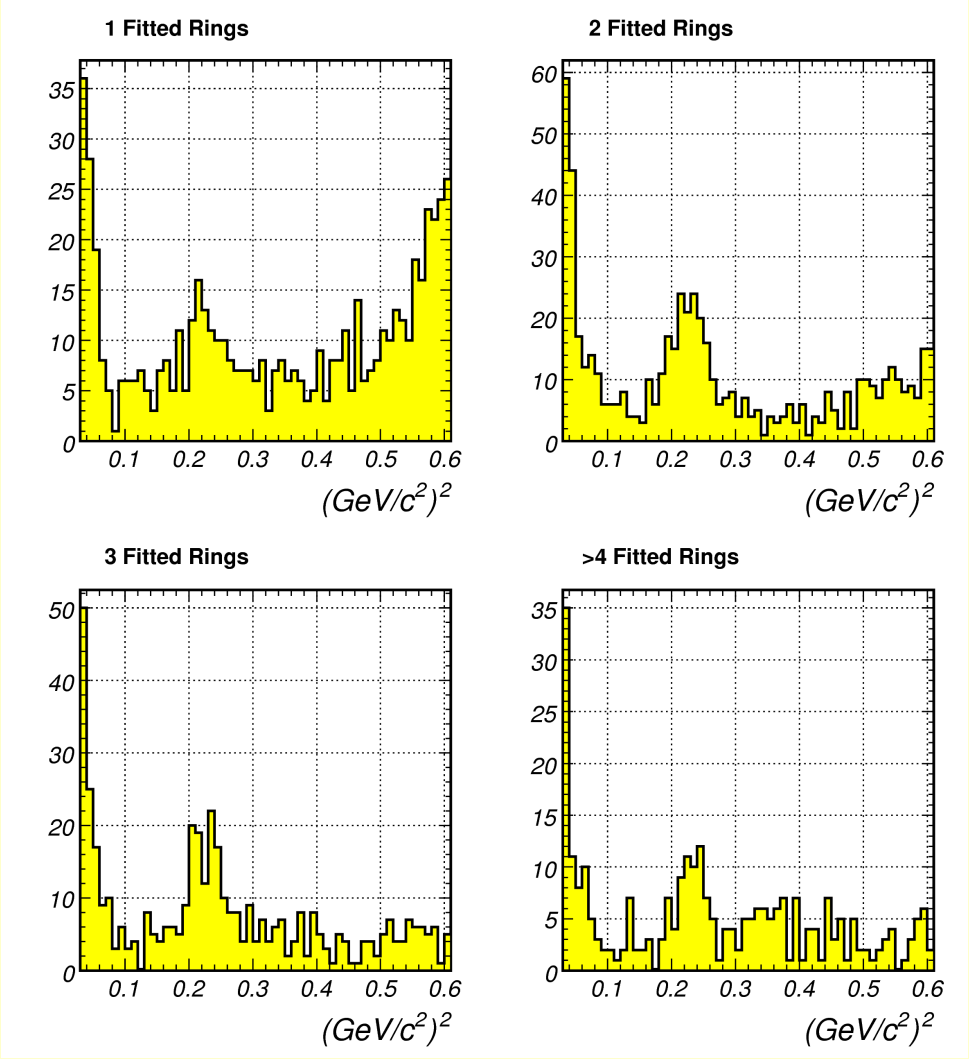


Transforming R vs P curves





Multiple-ring Events, P>20 GeV/c



- Presumably, as we get more rings in the RICH, mis-identification rate will be higher
  - Kaon will be hit hardest as it is minority particle
- One-ring events look bad because of high momentum proton which are dominant

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Summary

- Seeded ring fitter exists
  - Converges on ring hits through deterministic annealing
  - Takes hit sharing into account
  - Allows for ring center to vary – crucial to weed out a large fraction of otherwise mis-identified tracks
- Does not require precise calibration of (n-1) or R0 before DST's are produced
- π/K/p separation above 20 GeV/c looks quite good even in many-ring events