RICH Likelihoods in DST Now

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RICH Reconstruction

The RICH has two modes of reconstruction:

- "Stand alone" (RICHCircFit and RICHRadFit modules)
  - Performs a Hough transform to search the PMT array for rings.
  - Rings which are found are fit to find (x0,y0,r) using a least square statistic
  - After global track fit, rings are matched to tracks (RICHMatch module) and their radii are associated to the track in the DST

- "Predictive" (RICHReco)
  - Takes global track fit as input for (x0,y0)
  - Predicts photon distribution on PMT array using track fit momentum for e/mu/pi/K/p hypothesis
  - Calculates -log(likelihood) for each hypothesis

The predictive method is in principle better but requires good inputs (alignment, PMT efficiencies, etc...) and was not ready for the last production pass. So I quickly put something together to get a reasonable particle ID.

The Method

For a given track I computed the likelihood in the following manner:

- Compute theoretical curves for (Re, Rmu, Rpi, Rk, Rp) as functions of momenta assuming a single index of refraction (see Nick Graf's talk for how good an assumption this is)
- For every particle hypothesis, vary the momentum P from 0 to 120 GeV to find the minimum of the chi^2 statistic:

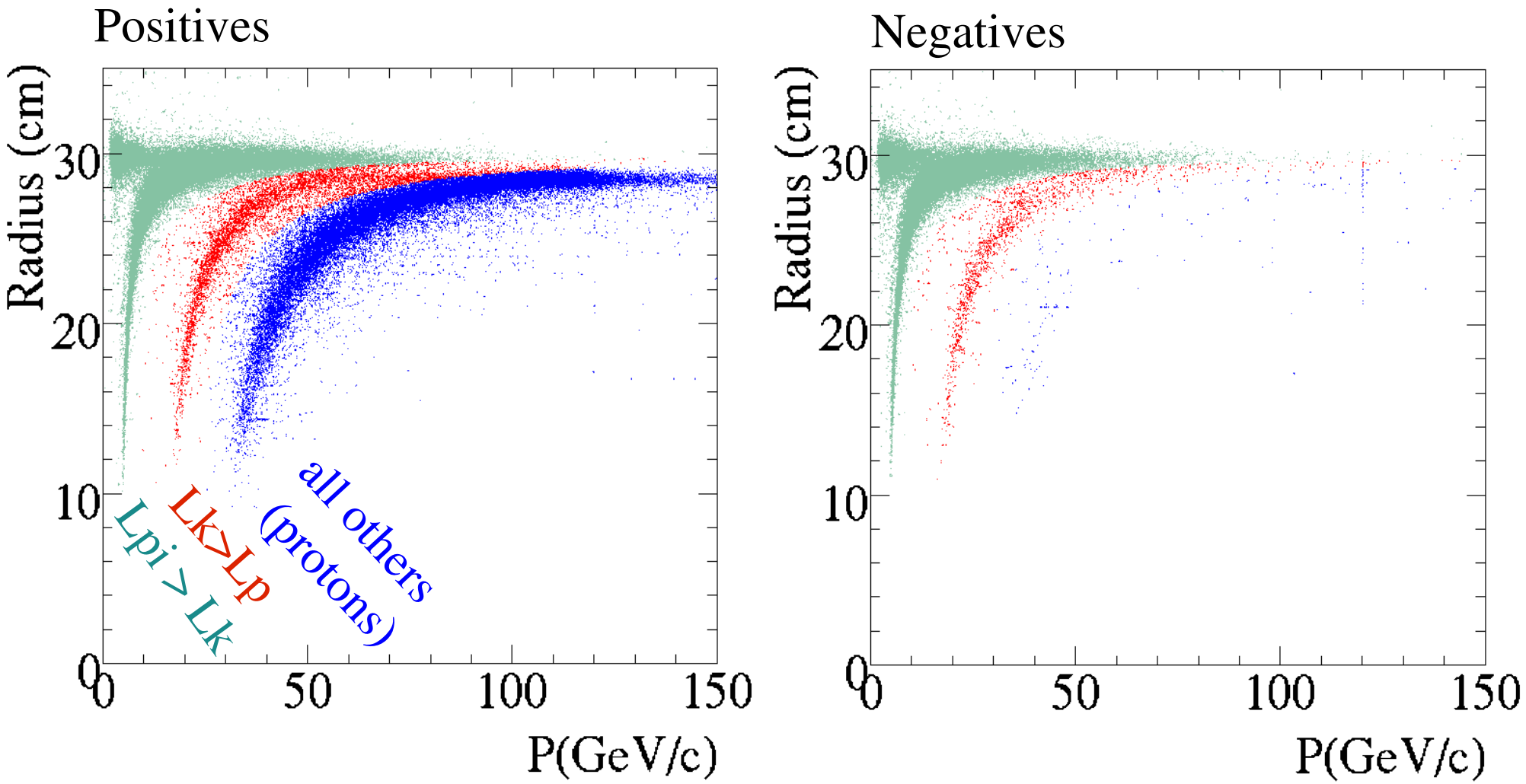
  chi^2 = *(R*predicted-*R*reconstructed*)*^2*/sigma*R^2 + *(P-P*reconstructed*)*^2*/sigma*P^2

  [sigmaR is assumed a constant (3 mm), and sigmaP is assumed to be 5%]

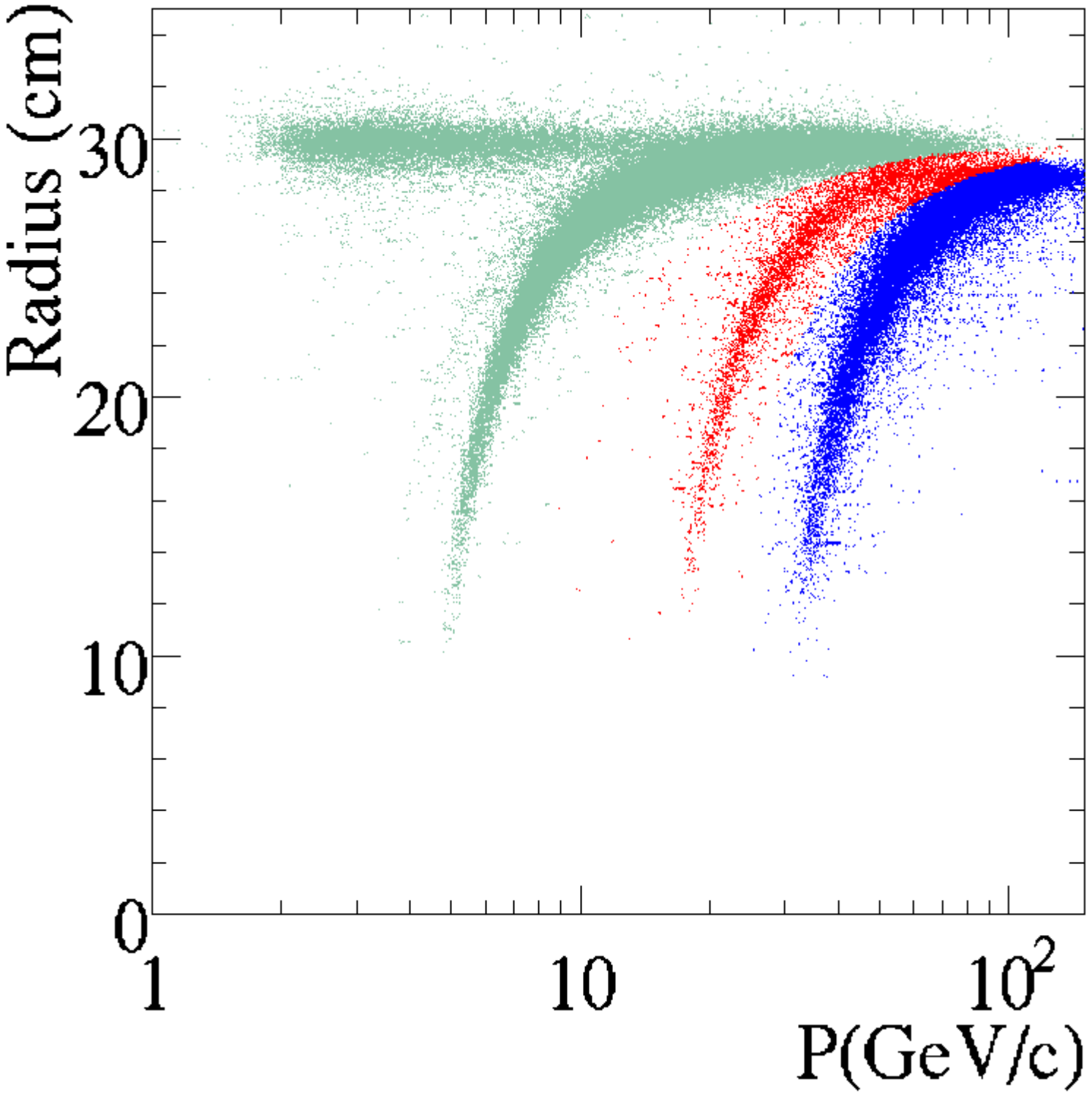
- Report the likelihood for the hypothesis as -0.5*chi^2

- This was not very carefully tuned. *Caveat Emptor!*

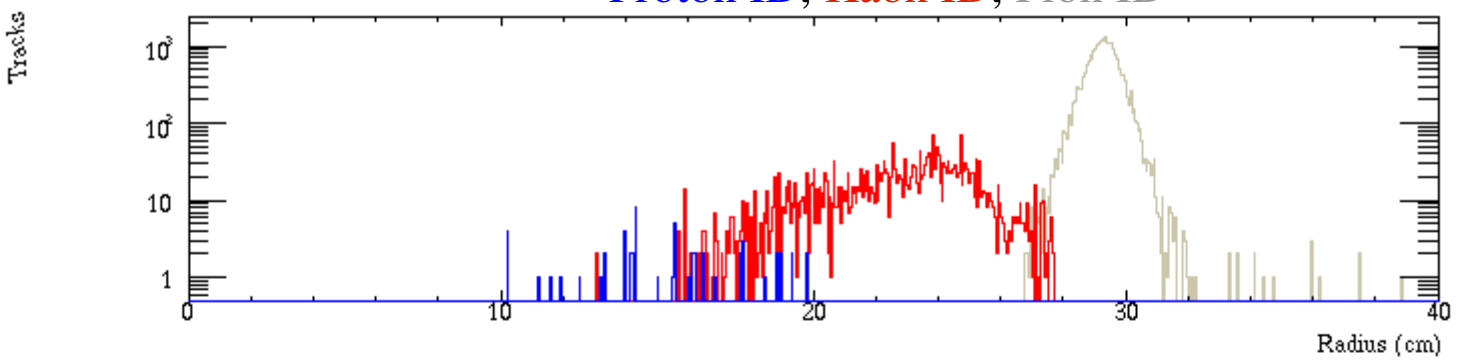
RICH ring radius as function of momentum



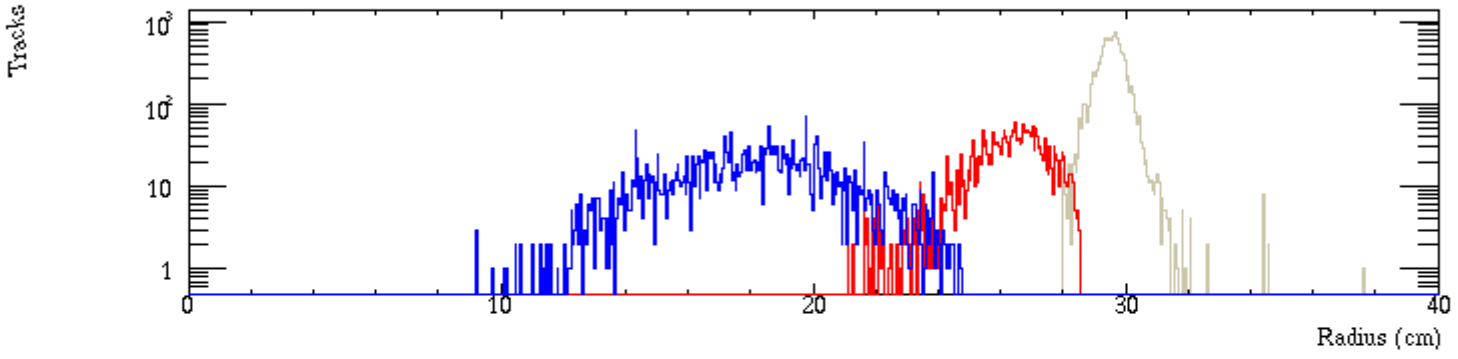
NuMI target data


Radius (cm)
30
20
10
0
1
10
10^2
P(GeV/c)

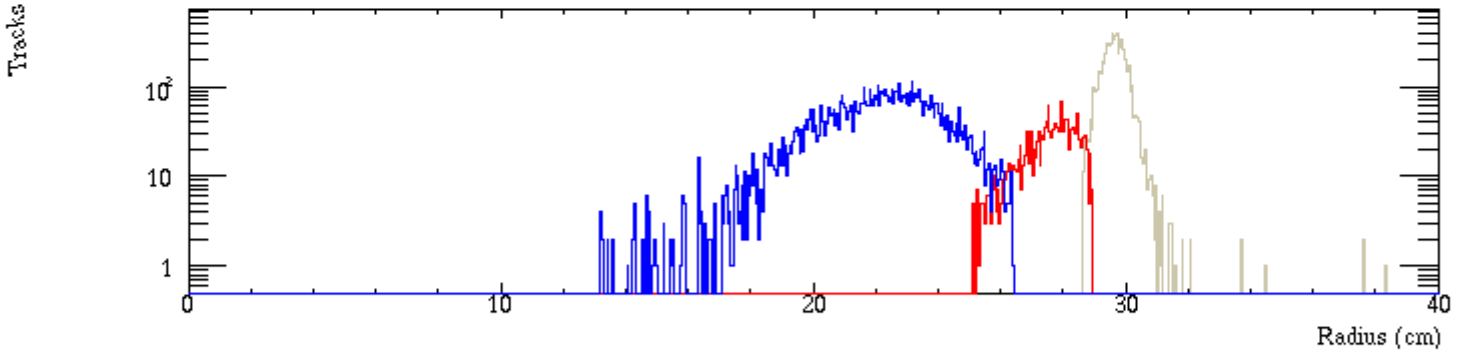
Proton ID, Kaon ID, Pion ID



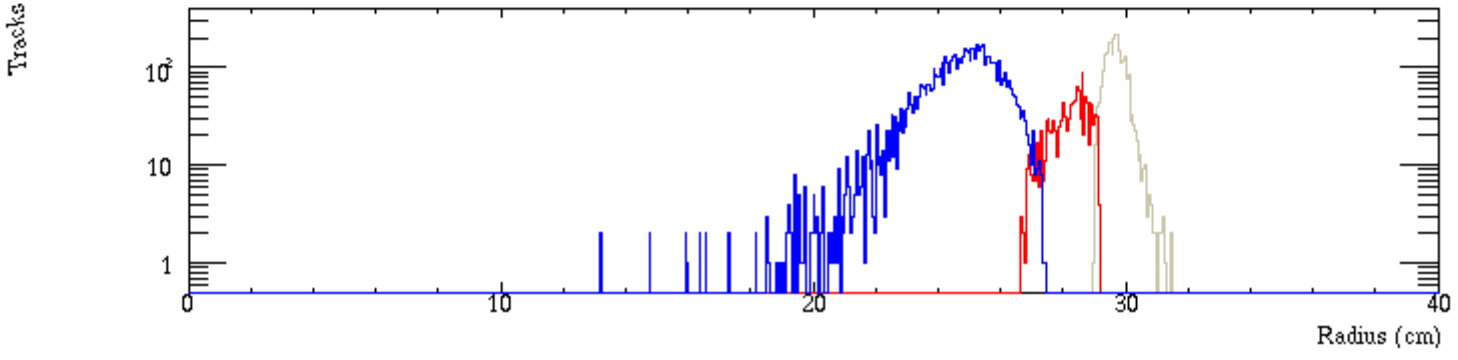
20-30 GeV slice



30-40 GeV

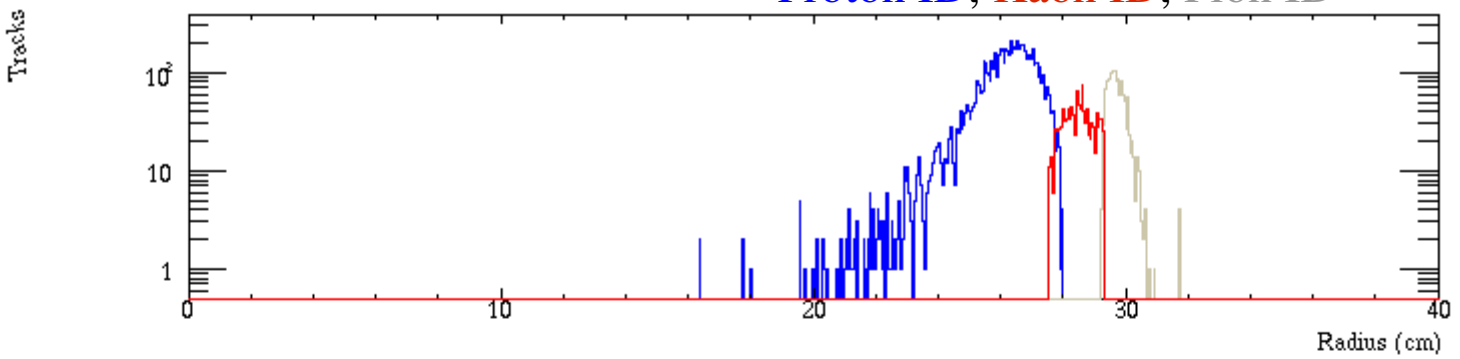


40-50 GeV



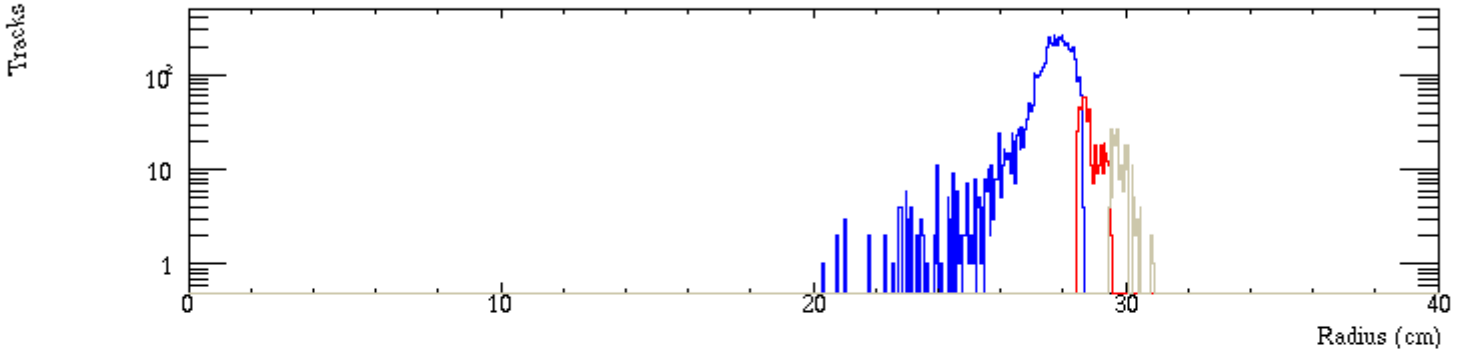
50-60 GeV

Proton ID, Kaon ID, Pion ID

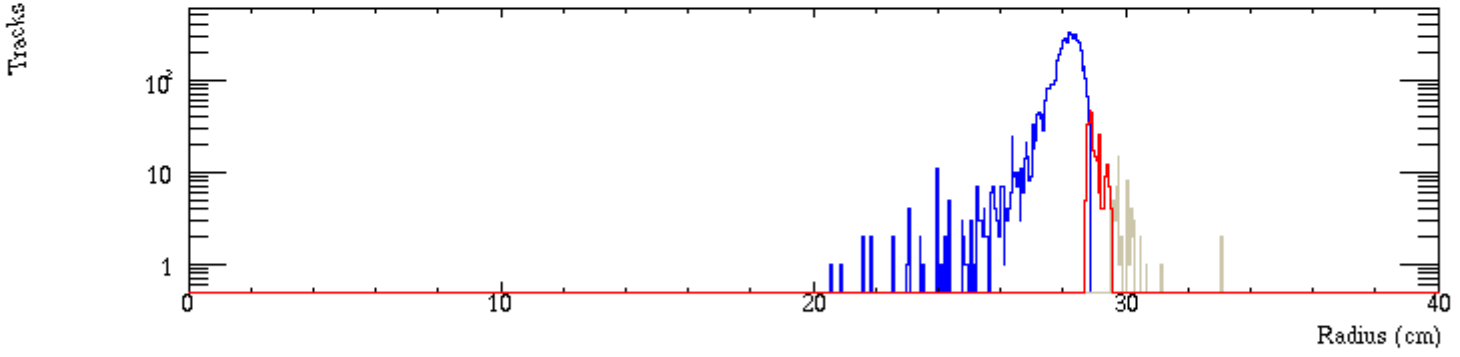


Slices from

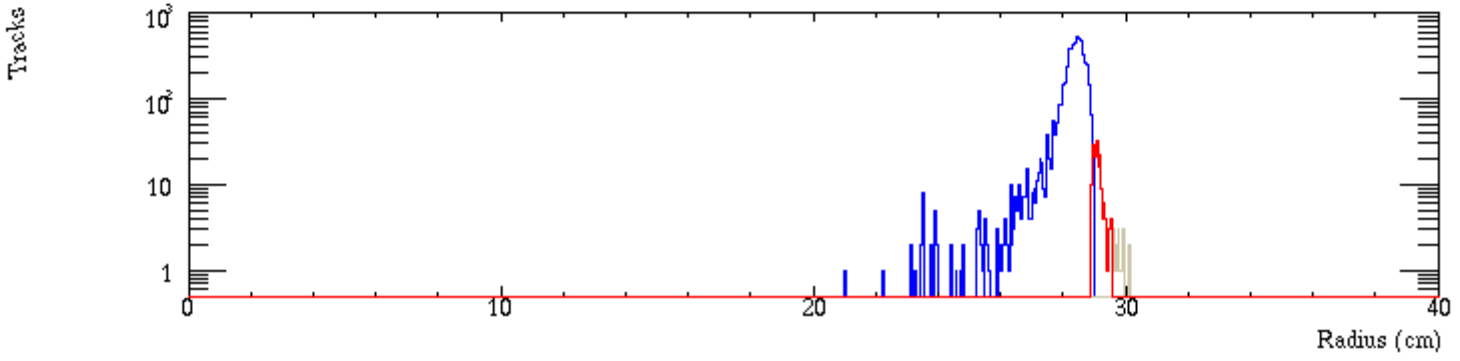
60-70 GeV



80-90 GeV



90-100 GeV



100-110 GeV