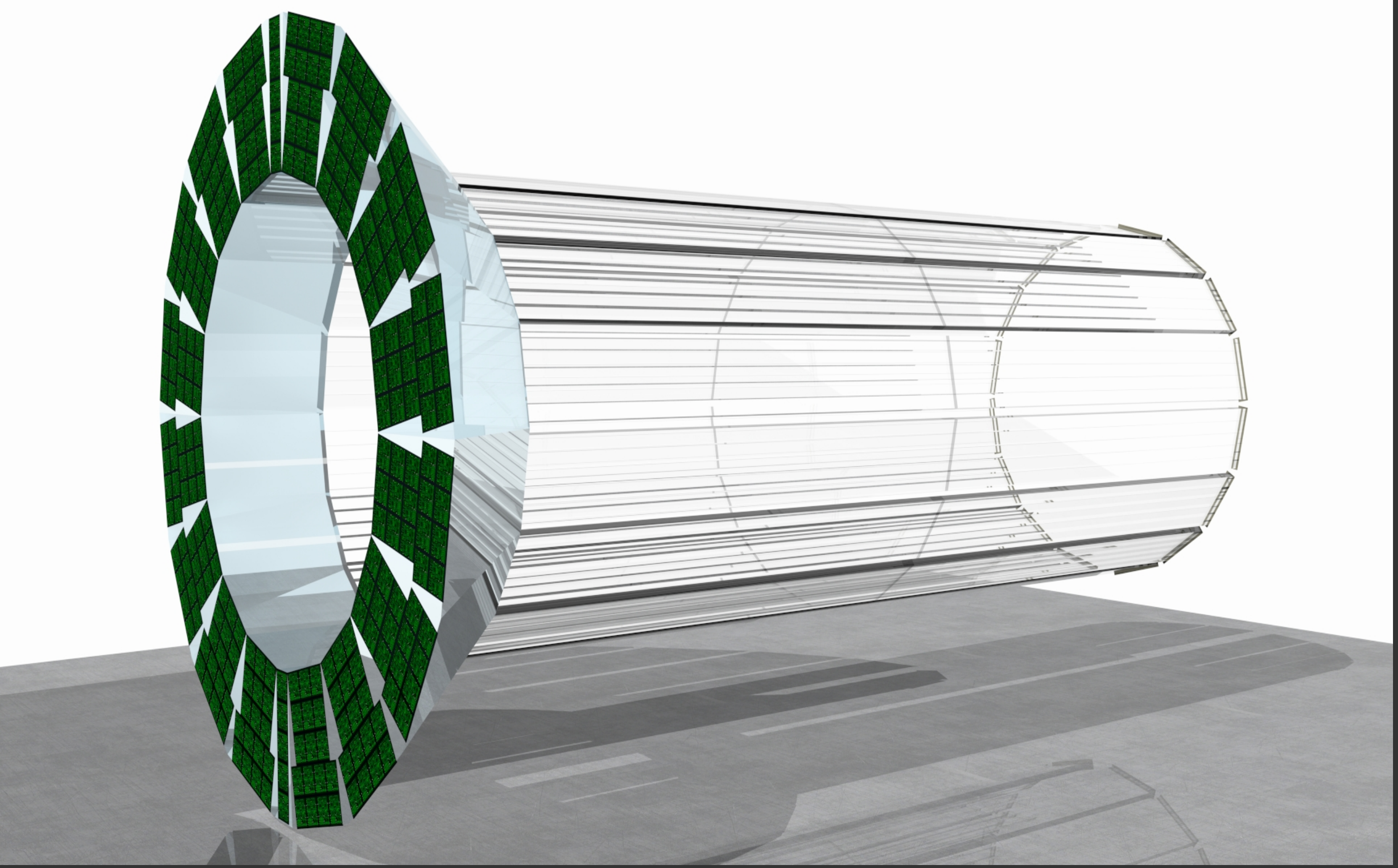


Required PANDA Barrel DIRC resolution

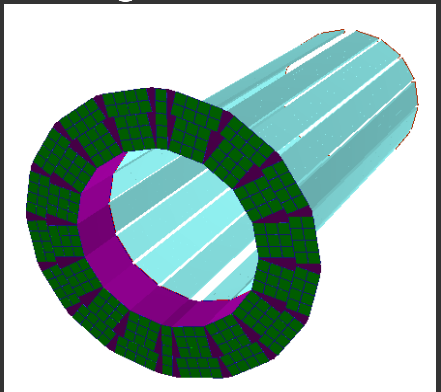
Maria Patsyuk

Approach

- PANDA PID requirement: to have ≥ 3 standard deviations π/K separation in the momentum range 0.5 GeV/c – **3.5** GeV/c
- Use a number of reaction from the PID-TAG report that occupy the most of the Barrel DIRC phase space
- Focus on the positive identification of K
- Study the phase space distribution of K in the final states of different reactions
- Study the impact of the efficiency loss due to the limitation of the PANDA PID requirement
- Translate DIRC PID requirement into max. allowed $\sigma_{\theta C}$
- What is the best detector that can be reasonably built?
  (in terms of technology, budget, reasonable geometry)

DIRC without focusing:

3σ K/π separation up to ~ 3.2 - 3.5 GeV/c



DIRC with focusing:

3σ K/π separation up to ~ 3.5 - 4 GeV/c

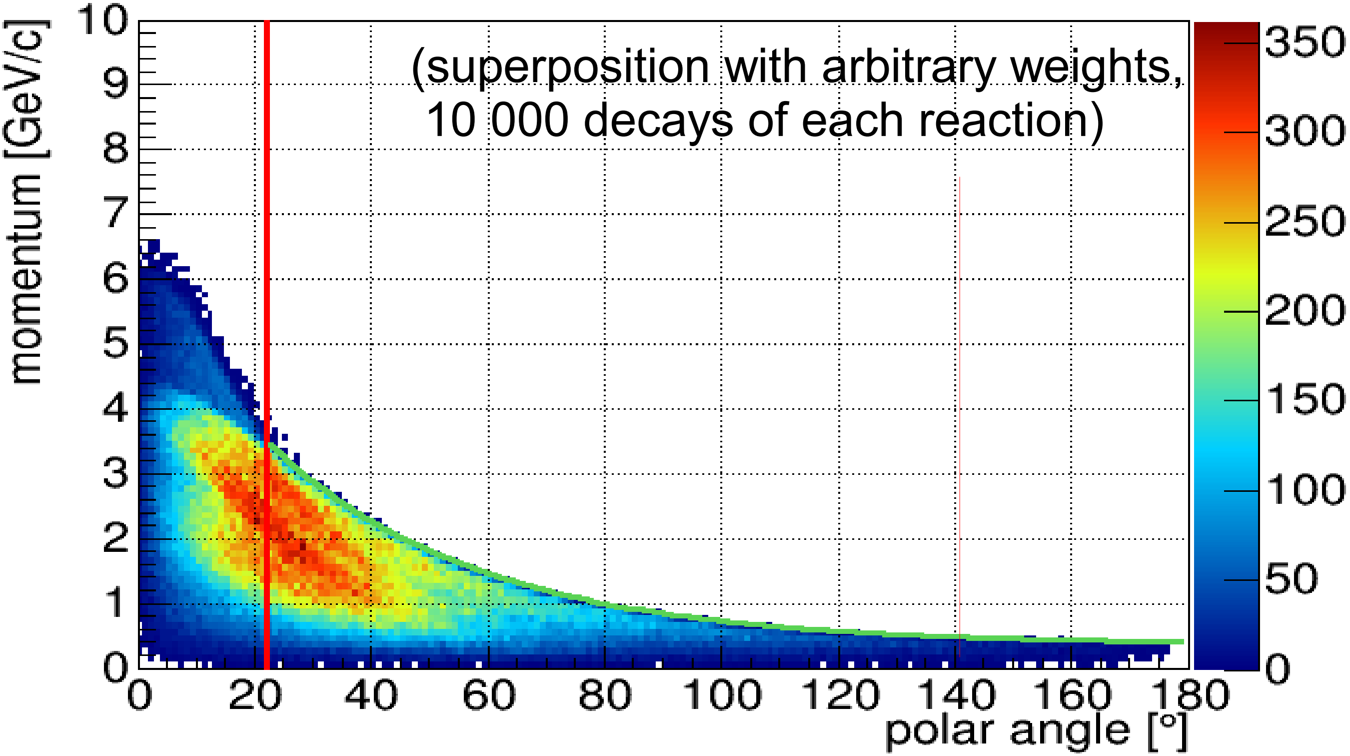
PANDA benchmark reactions

1. $p\bar{p} \to 2K4\pi$ at $6.57 GeV/c$;
2. $p\bar{p} \to D^+D^-$ at $6.57 GeV/c$;
3. $p\bar{p} \to D^{*+}D^{*-}$ at $7.7 GeV/c$;
4. $p\bar{p} \to h_c \to \eta_c\gamma$ at $5.6 GeV/c$;
5. $p\bar{p} \to \Lambda_c\bar{\Lambda}_c$ at $\sqrt{s} = 4.58 GeV/c$;
6. $p\bar{p} \to \phi\phi$ at $10 GeV/c$;
7. $p\bar{p} \to K^+K^-\gamma$ at $10 GeV/c$ (glueball search);
8. $p\bar{p} \to \tilde{\eta_{c1}}\eta \to D^0 D^{0*}\eta$, $D^0 \to K^+\pi^-$ at $15 GeV/c$;

Benchmark channels are taken from the PID-TAG report

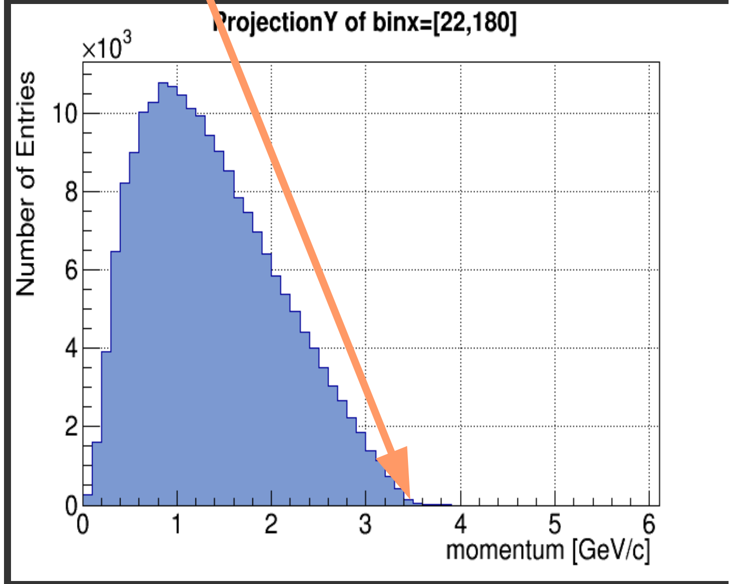
Reactions except of open charm decays at highest momentum, where final state K occupy the most phase space in the Barrel DIRC acceptance

phase space distribution for K resulting from the listed reactions



Projection of the phase space plot on the momentum axis for the DIRC angular acceptance

99.8 % of K lie below 3.5 GeV/c



PANDA benchmark channels

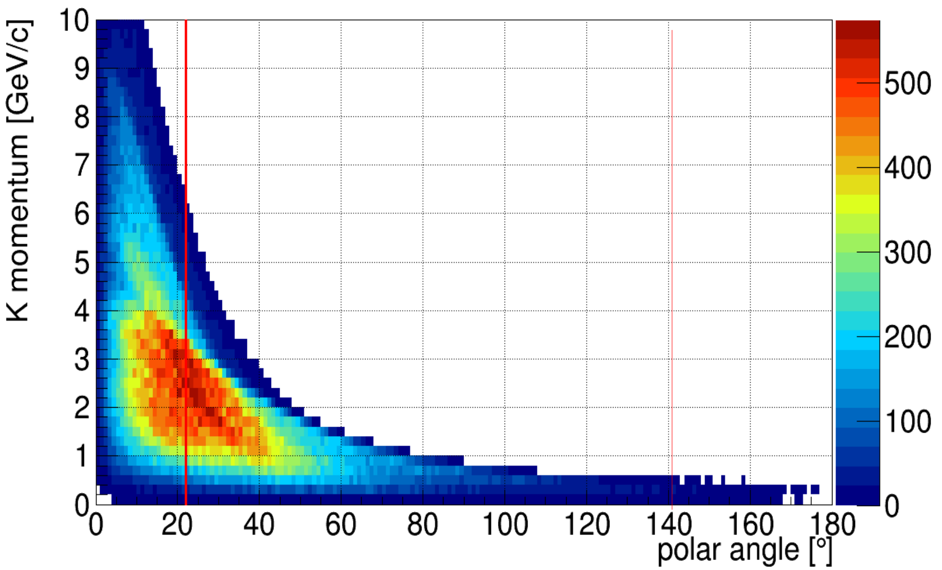
1. $p\bar{p} \to \tilde{\eta_{c1}}\eta \to D^0 D^{0*}\eta$, $D^0 \to K\pi^-\pi^+\pi^+$ at $15GeV/c$;
2. $p\bar{p} \to D^0 D^0 \gamma$ at $15GeV/c$;
3. $p\bar{p} \to D^+ D^- \gamma$ at $15GeV/c$;
4. $p\bar{p} \to D_s^+ D_s^- \gamma$ at $15GeV/c$;
5. $p\bar{p} \to D^{*0} D^{*0} \gamma$ at $15GeV/c$;
6. $p\bar{p} \to D^{*+} D^{*-} \gamma$ at $15GeV/c$;
7. $p\bar{p} \to \phi\phi$ at $15GeV/c$;
8. $p\bar{p} \to D^{*0} \bar{D}^{*0}$ at $15GeV/c$;
9. $p\bar{p} \to D_s^+ \bar{D}_s^-$ at $15GeV/c$;
10. $p\bar{p} \to D^+ D^-$ at $15GeV/c$;
11. $p\bar{p} \to D^0 \bar{D}^0$ at $15GeV/c$.

Open charm reactions at highest energy:
P(p bar) = 15 GeV/c.

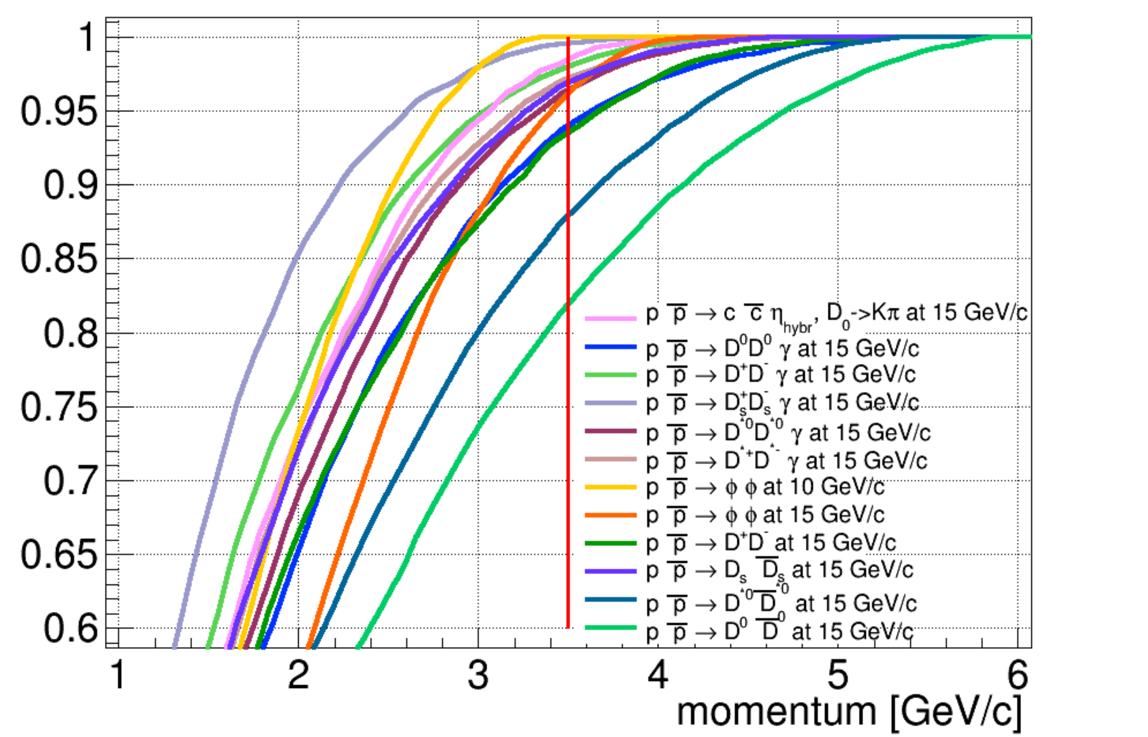
K in the final state go up to 6 GeV/c in the forward region of the Barrel DIRC!

It is not possible to build DIRC operating up to 6 GeV/c
→ study the impact of the K efficiency limit at 3.5 GeV/c

The most challenging reactions, all the others do not have K with p>3.5 GeV/c

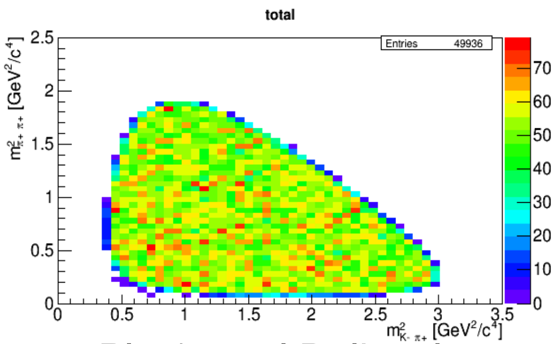


Fraction of K with momentum less than p

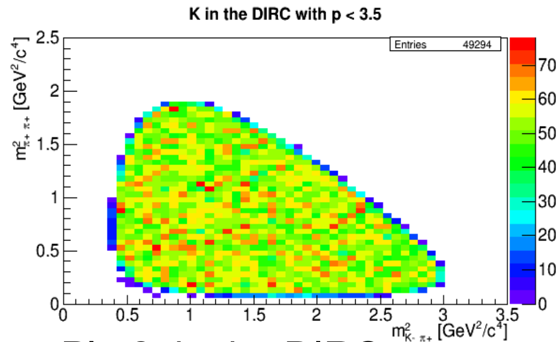


Phase space distributions

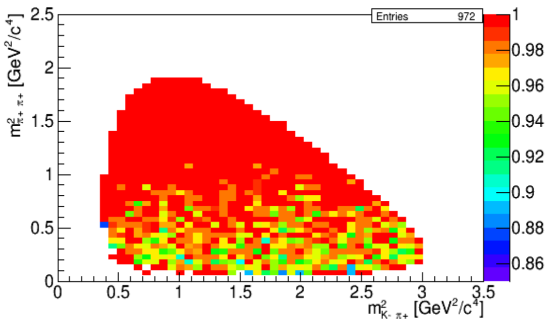
- Decay of D* mesons using PHSP



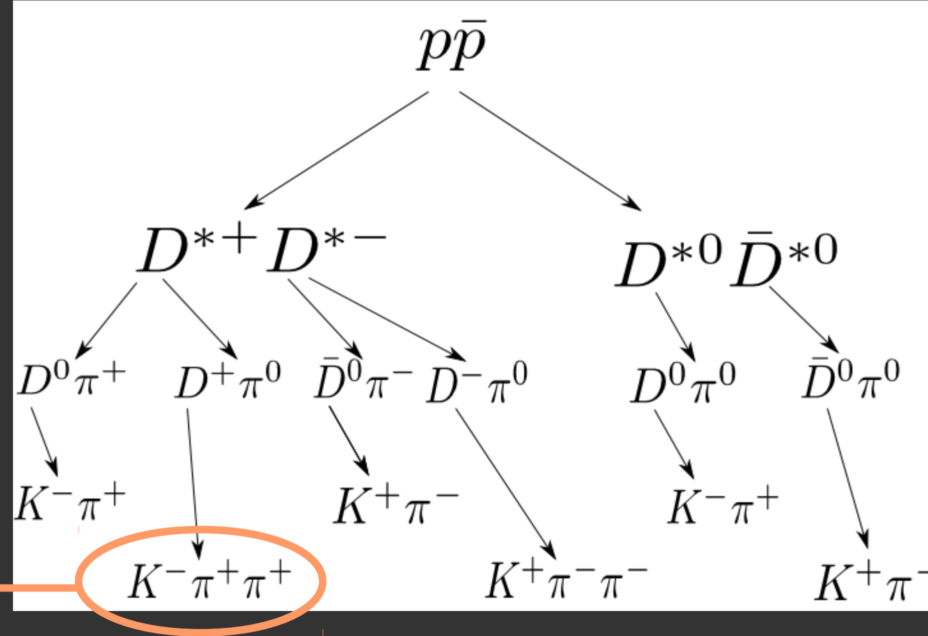
Plot1: total Dalitz plot



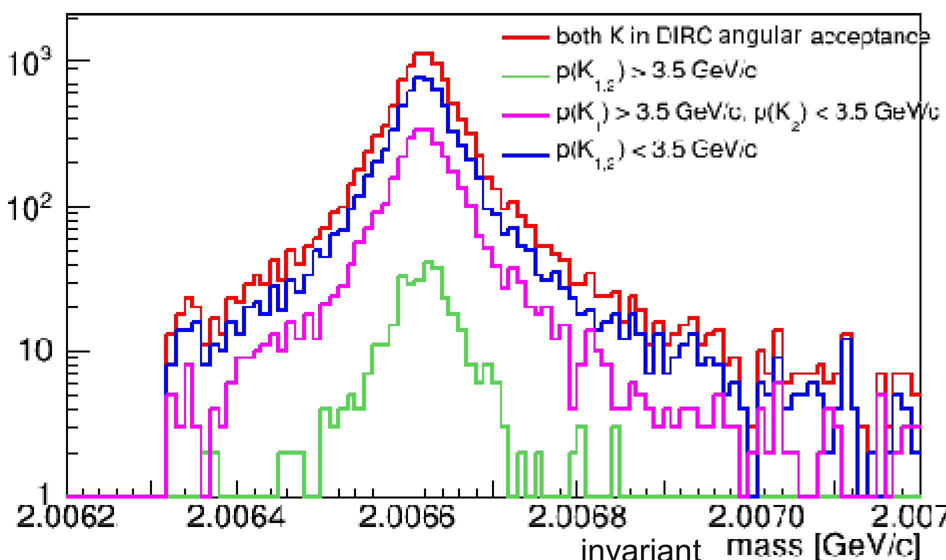
Plot2: in the DIRC acceptance only K with p< 3.5 GeV/c are taken into account



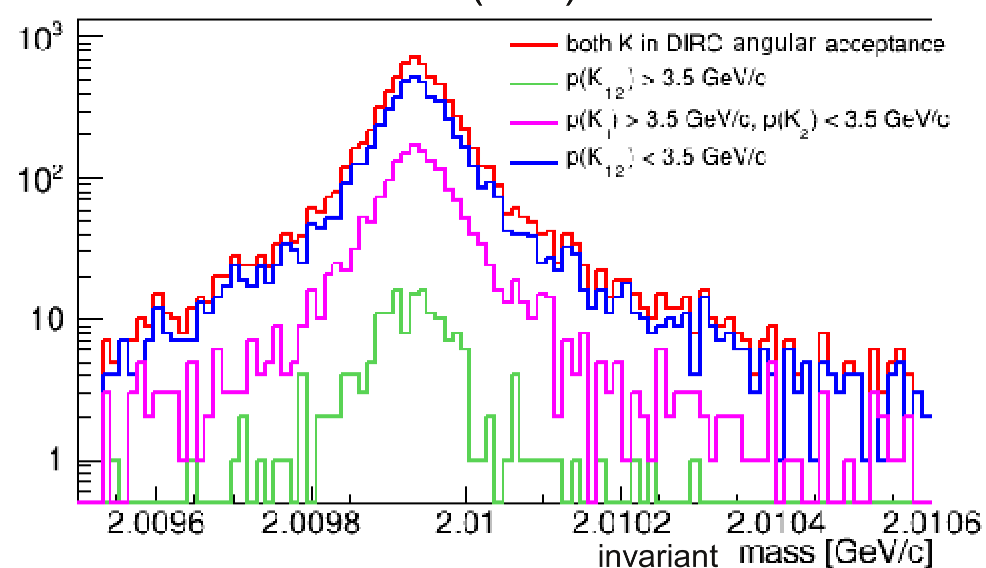
Plot2/Plot1



m(D*⁰)

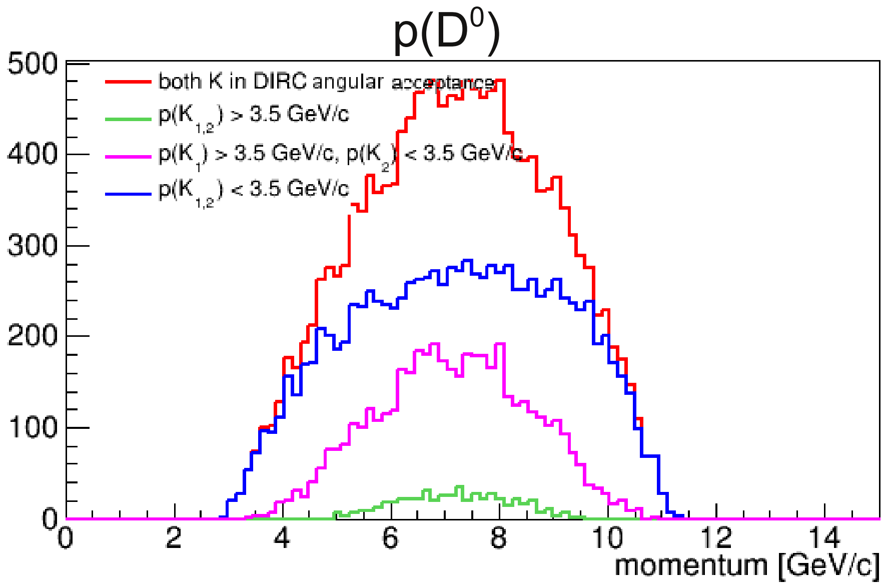


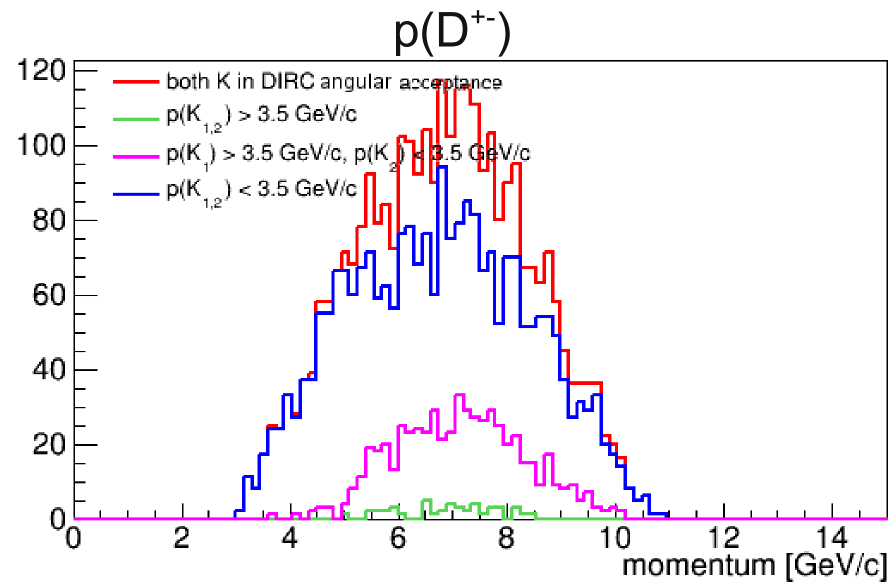
m(D*⁺⁻)

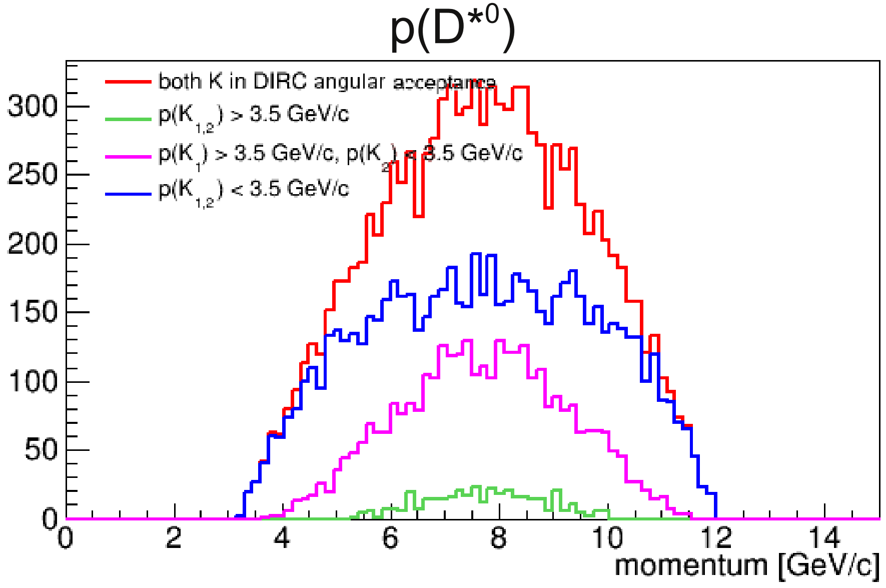


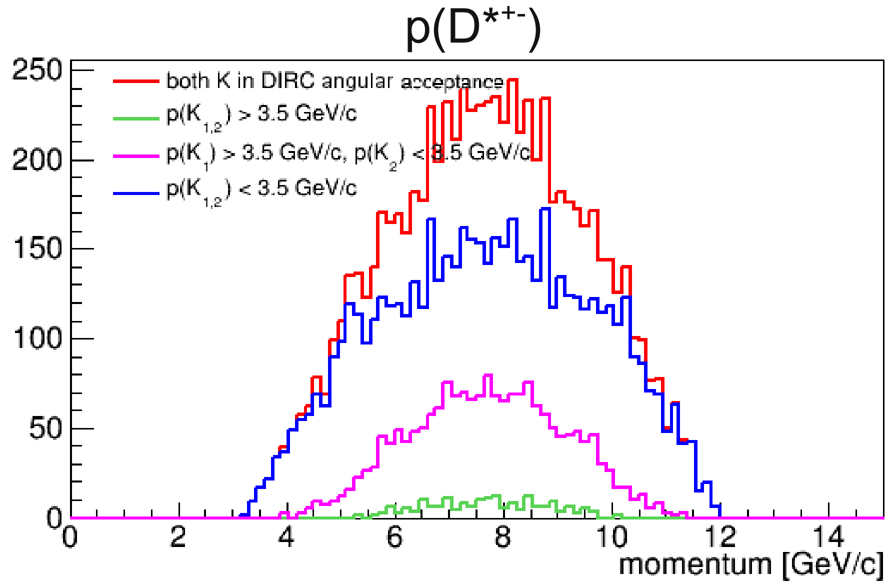
Phase space distributions

- Decay of D* mesons using PHSP model: momentum distributions



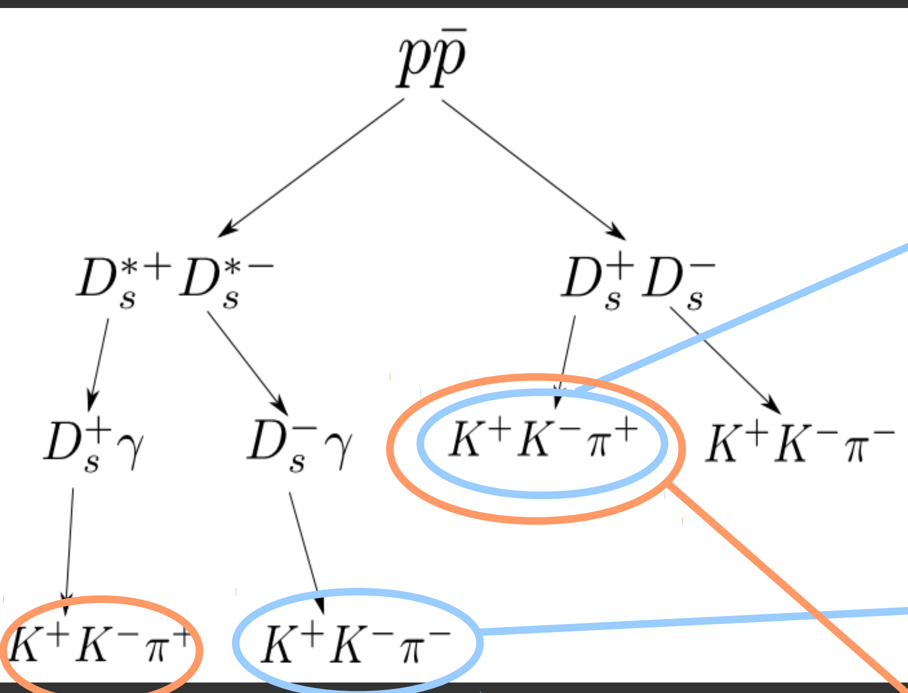


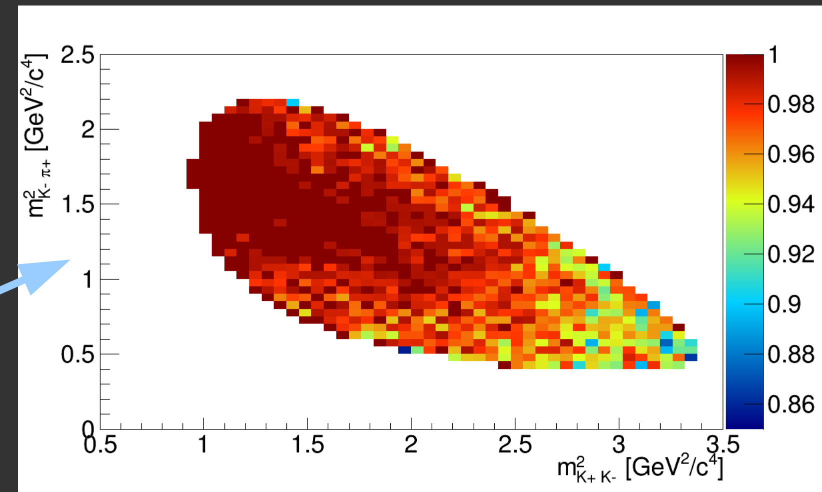


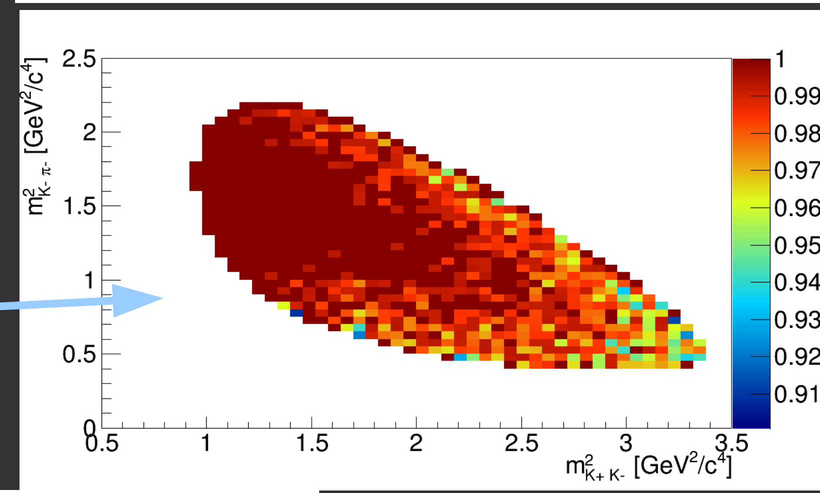


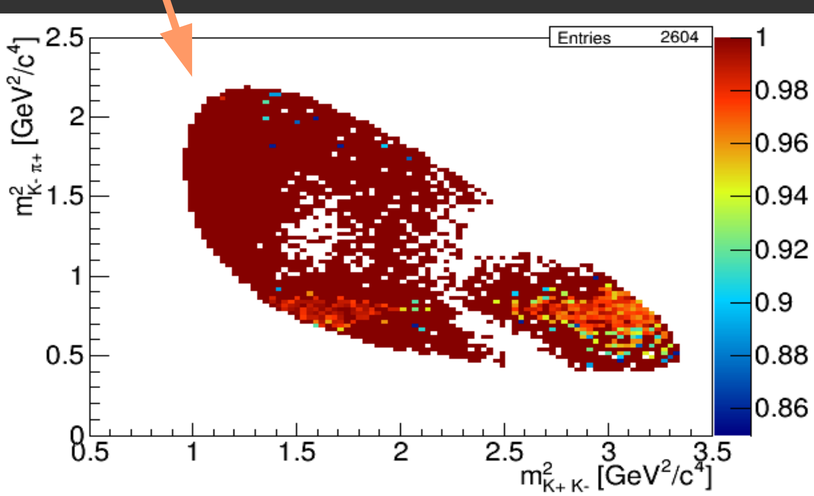
Phase space distributions

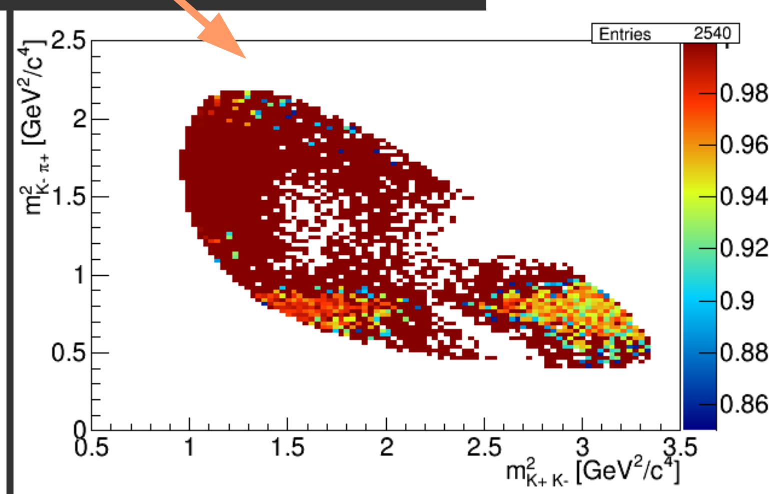
- Decay of Ds mesons using PHSP and DALITZ models:











Phase space plots are not uniformly filled, but the efficiency is still smoothly distributed!

PANDA PID requirement

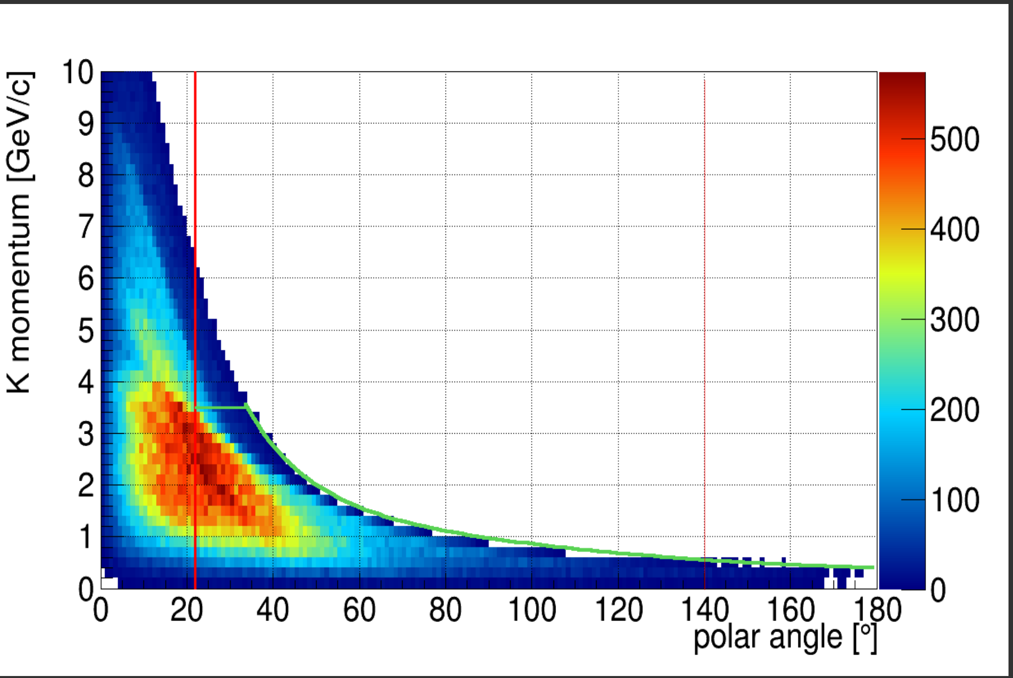
- PANDA particle identification requirement: ≥ 3 standard deviations π/K separation in the momentum range 0.5 GeV/c – 3.5 GeV/c (PID)

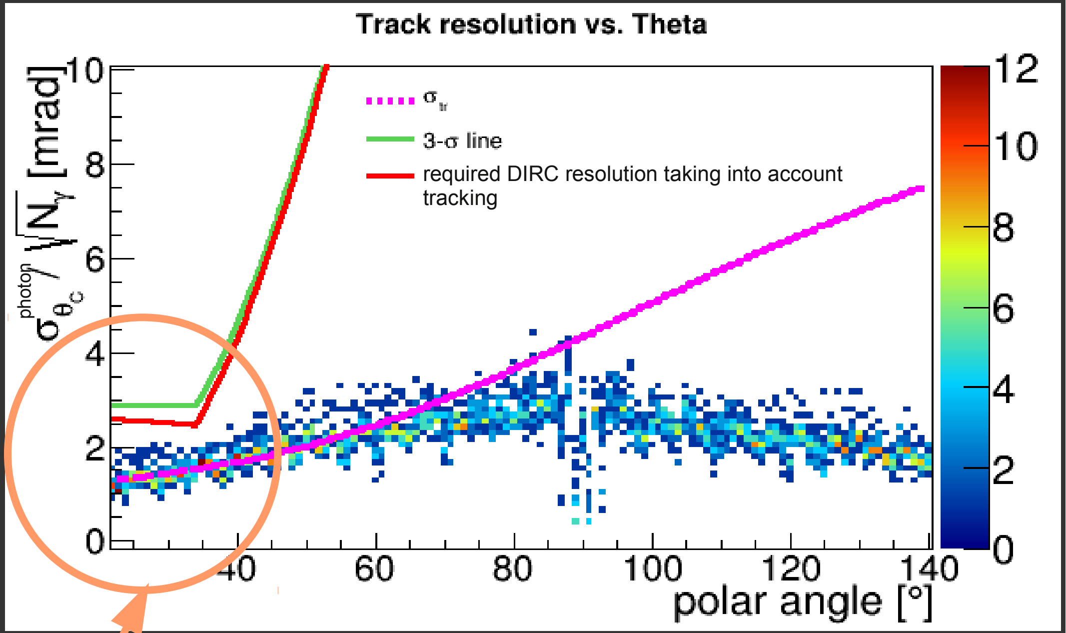
$$\sigma^2_{\theta_C} = \sigma^2_{correlated} + \frac{\sigma^2_{\theta_C^{photon}}}{N_{photons}}$$

Reaction products at PANDA are boosted → maximum K momentum depends strongly on the polar angle

$\sigma_{correlated}$ - tracking, multiple scattering ...

$\sigma^{photon}_{\theta_C}$ – *single photon Cherenkov angle resolution*





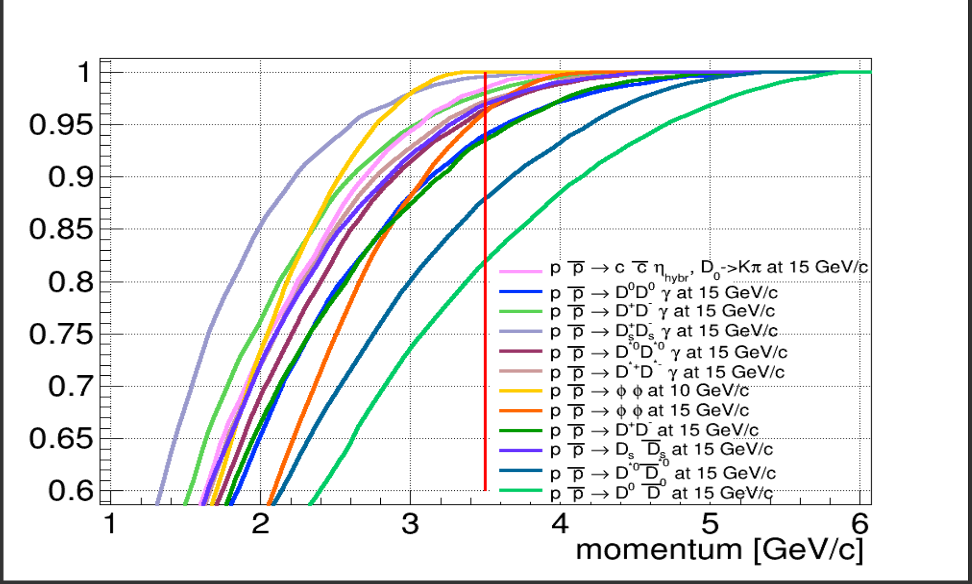
$P_{max\ K}(\theta)$ transforms into 3σ line, which defines the σ_{θ_C}

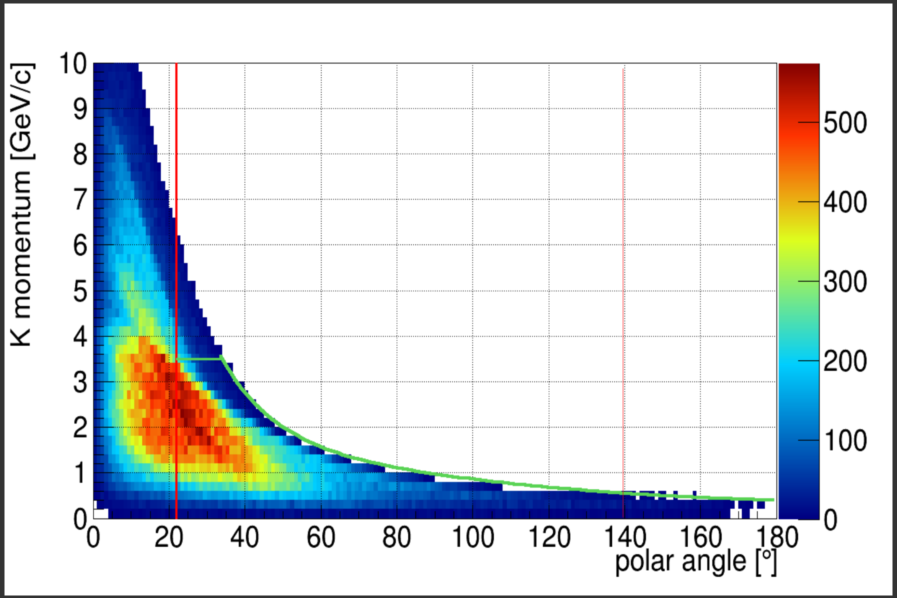
3 σ π/K separation at 3.5 GeV/c requires ≤ 3 mrad Cherenkov angle resolution

Discussion

- For most of the channels to separate π/K with ≥ 3 standard deviations it is enough to claim the upper limit of this requirement = 3.5 GeV/c

- Challenging channels are the open charm decays at 15 GeV/c anti-proton momentum

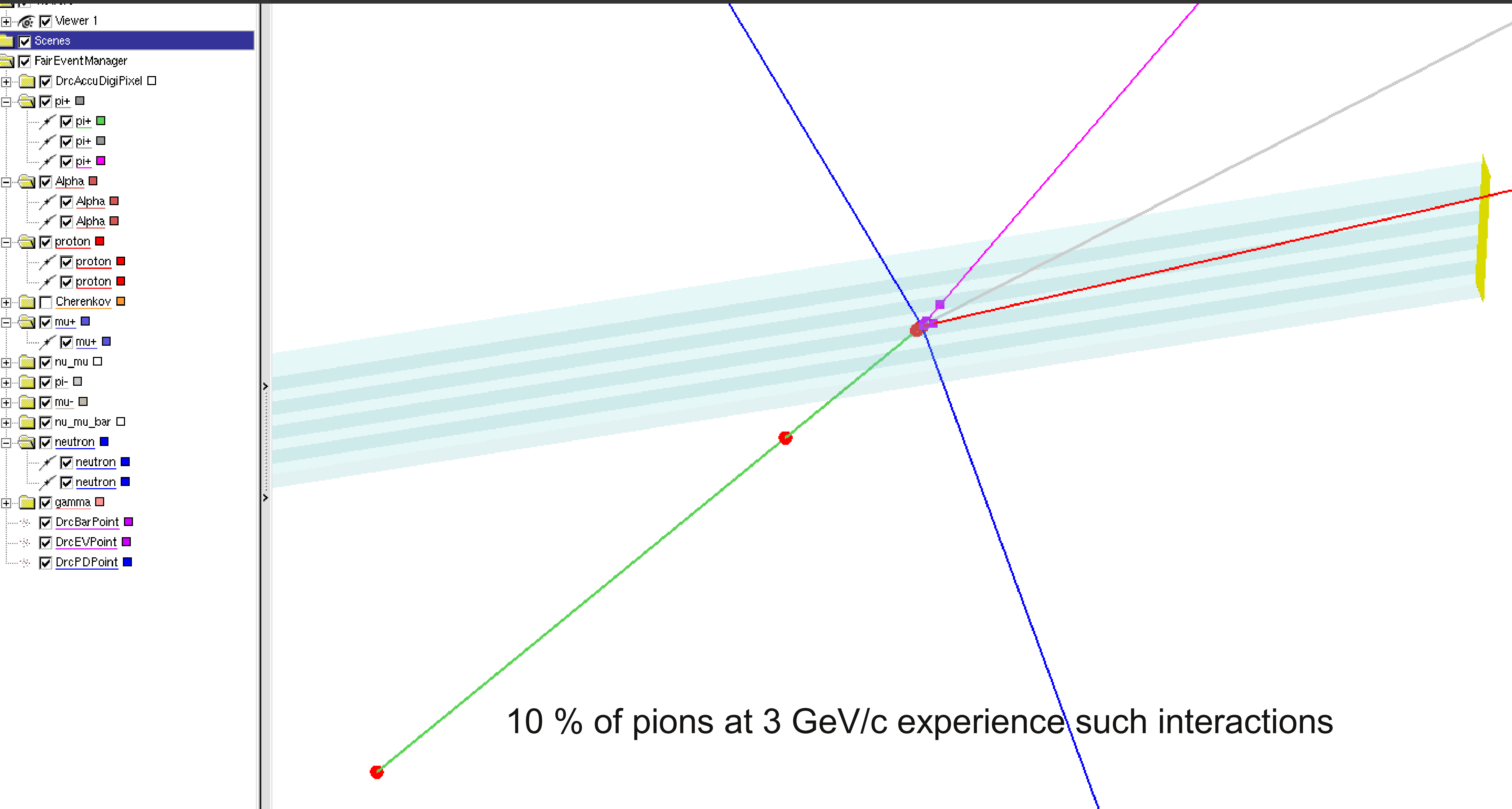




- Using the design with focusing elements the Barrel DIRC can reach up to ~4 GeV/c with 3 standard deviations π/K separation.

Would it lead to a significant gain for the physics analysis?

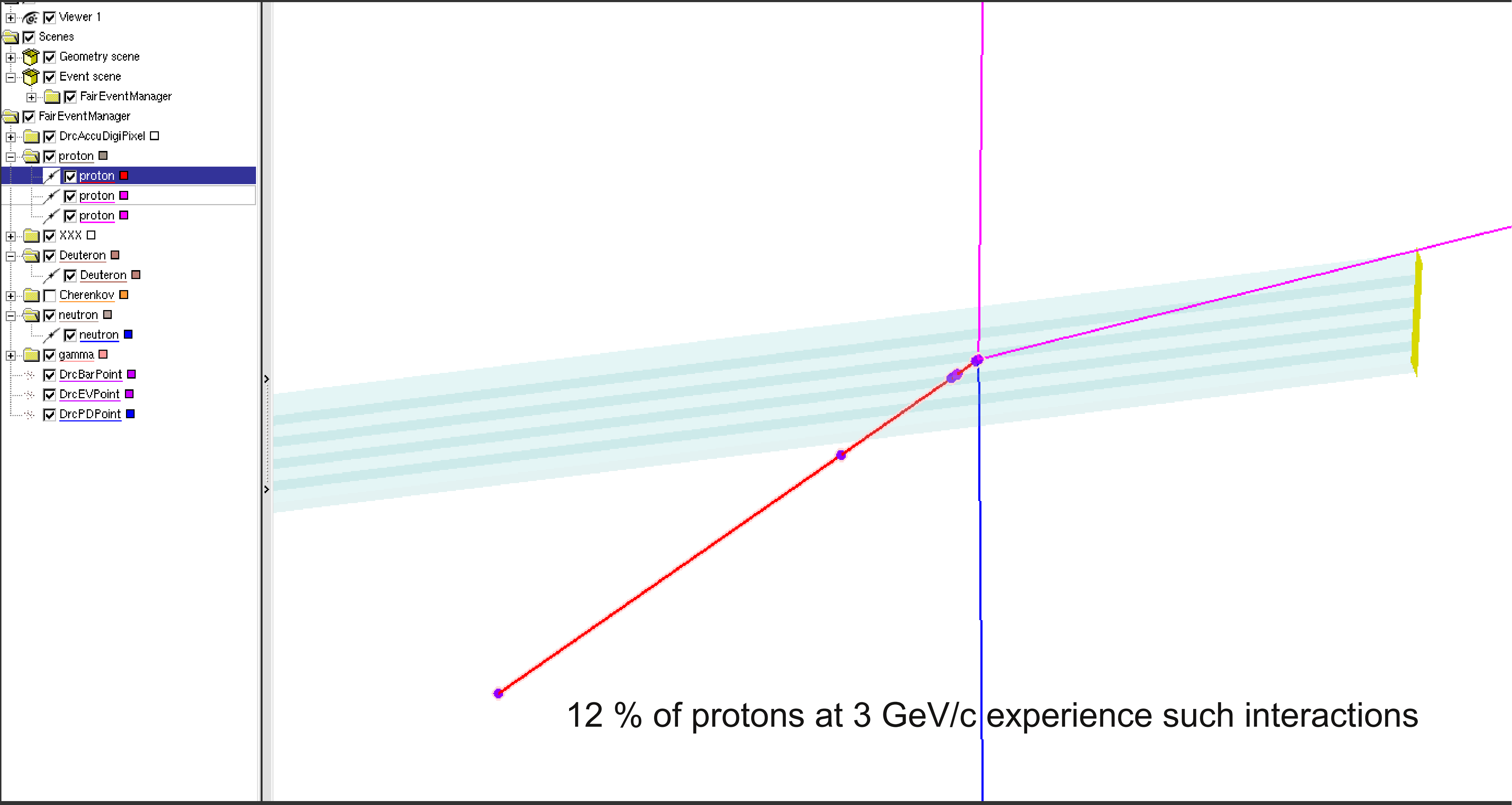
Hadronic inelastic (23)



10 % of pions at 3 GeV/c experience such interactions

Such behavior of particles was not observed at BABAR and for other DIRCs.
Are the probabilities of hadronic inelastic process realistic?
How one can switch off the hadronic inelastic process?
Some special config-settings required?

Hadronic inelastic (23)



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