JÜLICH
FORSCHUNGSZENTRUM

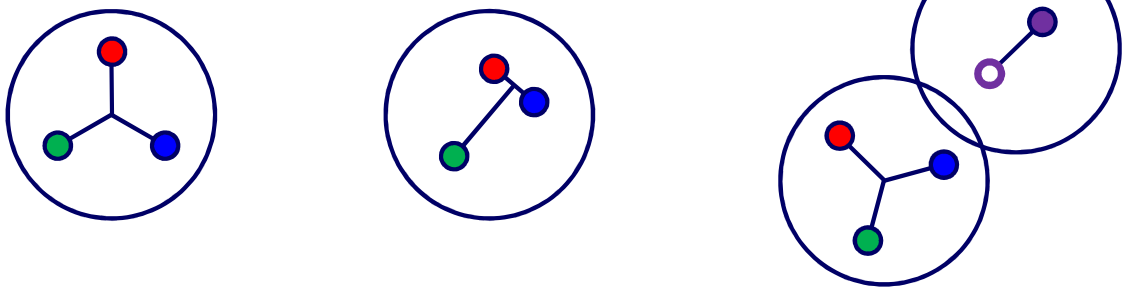
Ξ Spectroscopy and the PANDA ‚Start Setup'

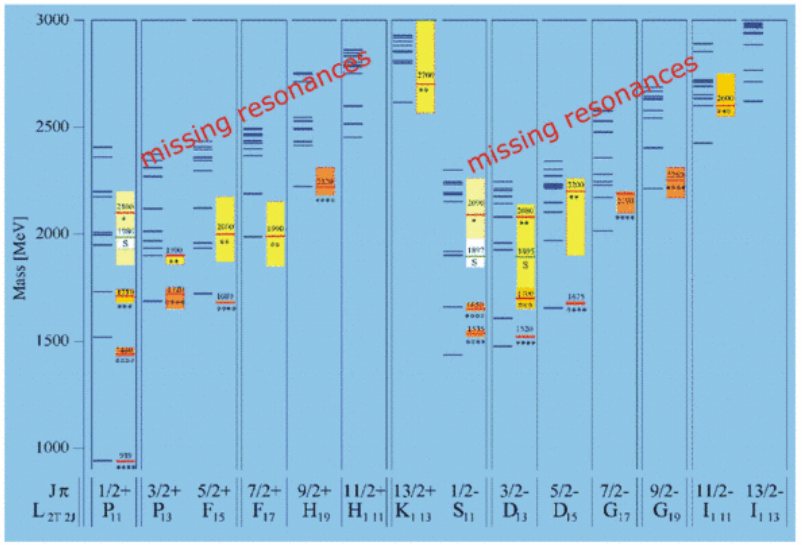
Dec 6, 2016 | Albrecht Gillitzer

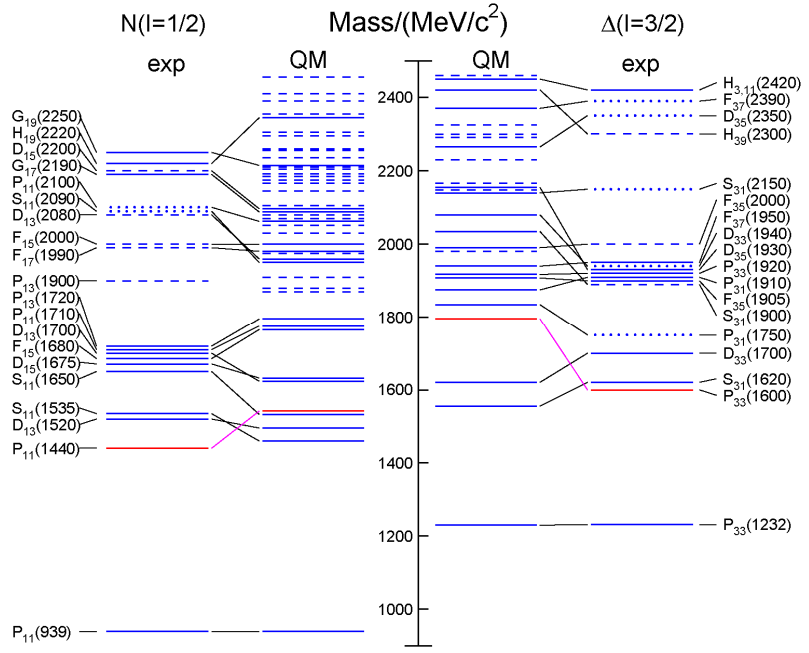
LIX PANDA Collaboration Meeting, GSI Darmstadt, 5-9 Dec 2016

Open Questions

- Missing resonances
- Wrong masses, wrong sequence
- Relevant degrees of freedom?
  - 3-quark?
  - quark-diquark?
  - meson-baryon dynamics



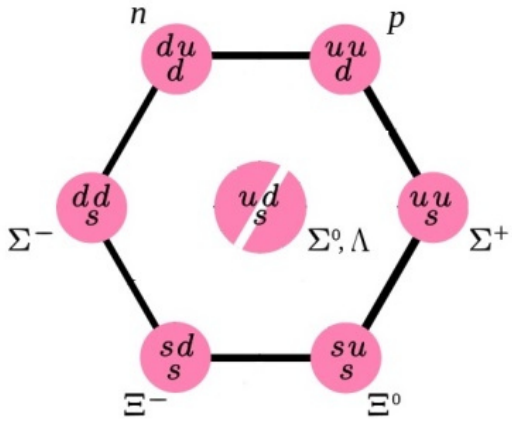


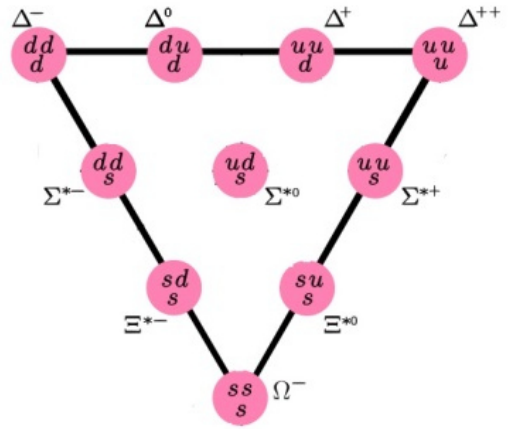


from RPP 2014 / QM: S. Capstick, W. Roberts

Strange Partners

- Approximate SU(3) flavor symmetry
- N* & Δ states have partners in the strange sector
- focus on Ξ and Ω
  - Ξ: as many states as N* & Δ together (1)
  - Ω: as many states as Δ
- scrutinize our understanding of the baryon excitation pattern





(1) in case of SU(3) symmetry !

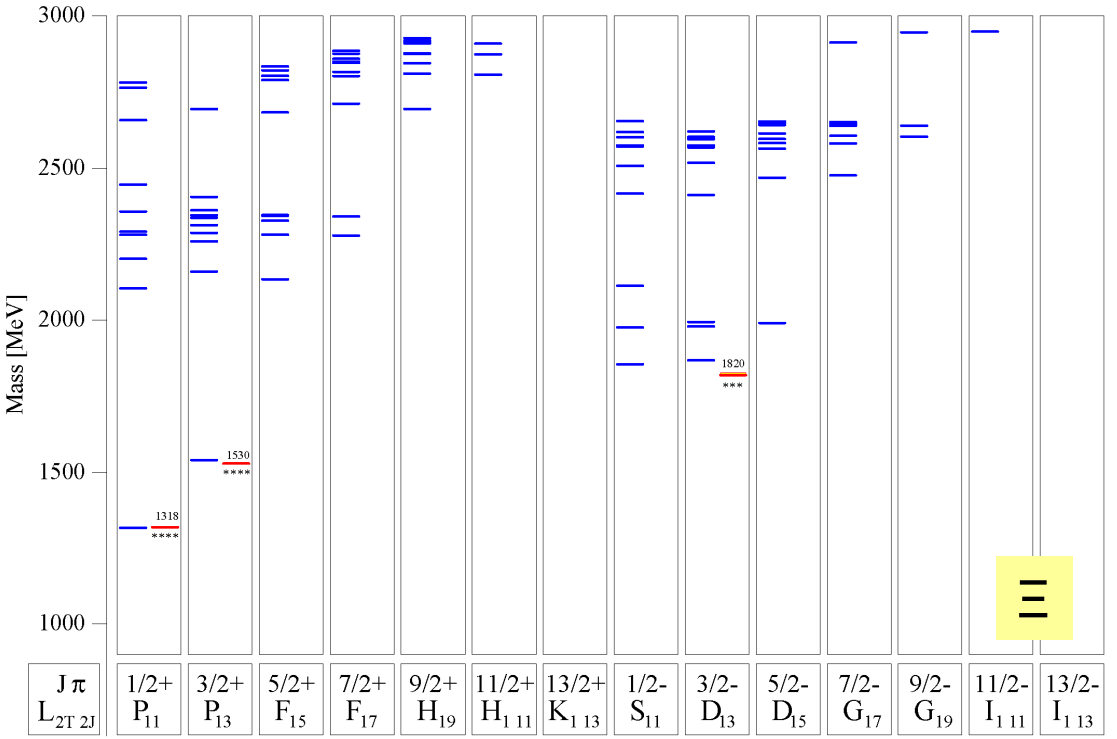
Quark Model for Ξ & Ω

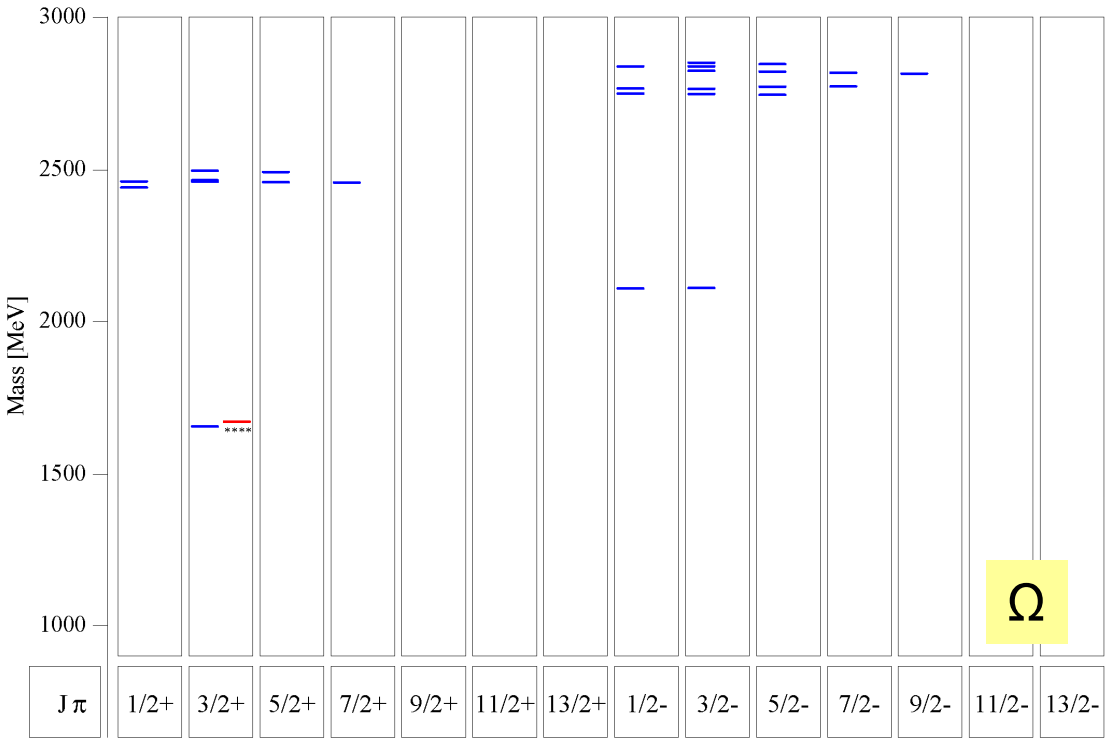
Ξ:

- many states predicted below 3 GeV
- compare $1/2^+$ and $1/2^-$ excitation

Ω:

- several states predicted between 2 GeV and 3 GeV
- compare $3/2^+$ and $3/2^-$ excitation





U. Löring *et al.*, EPJA 10 (2001) 447

s.a.: M. Pervin, W. Roberts, PRC 77 (2008) 025202

Most Promising: Study Ξ Resonances

- very little known ←→ rather high cross section
- find missing resonances
- determine branching to various decay modes:

  $\Xi\pi,\ \Xi\pi^+\pi^-,\ \Xi\pi^0\pi^0,\ \Lambda K^-,\ \Sigma\bar{K},\ \Xi\eta,\ \Xi\eta\pi,\ \Xi\eta',\ \Xi\omega,\ \Xi\phi, \ldots$
- determine J^P quantum numbers if possible

recent progress:
PAWIAN now includes baryons

strategy:
select $\bar{p}$ momentum to produce a specific resonance close to threshold

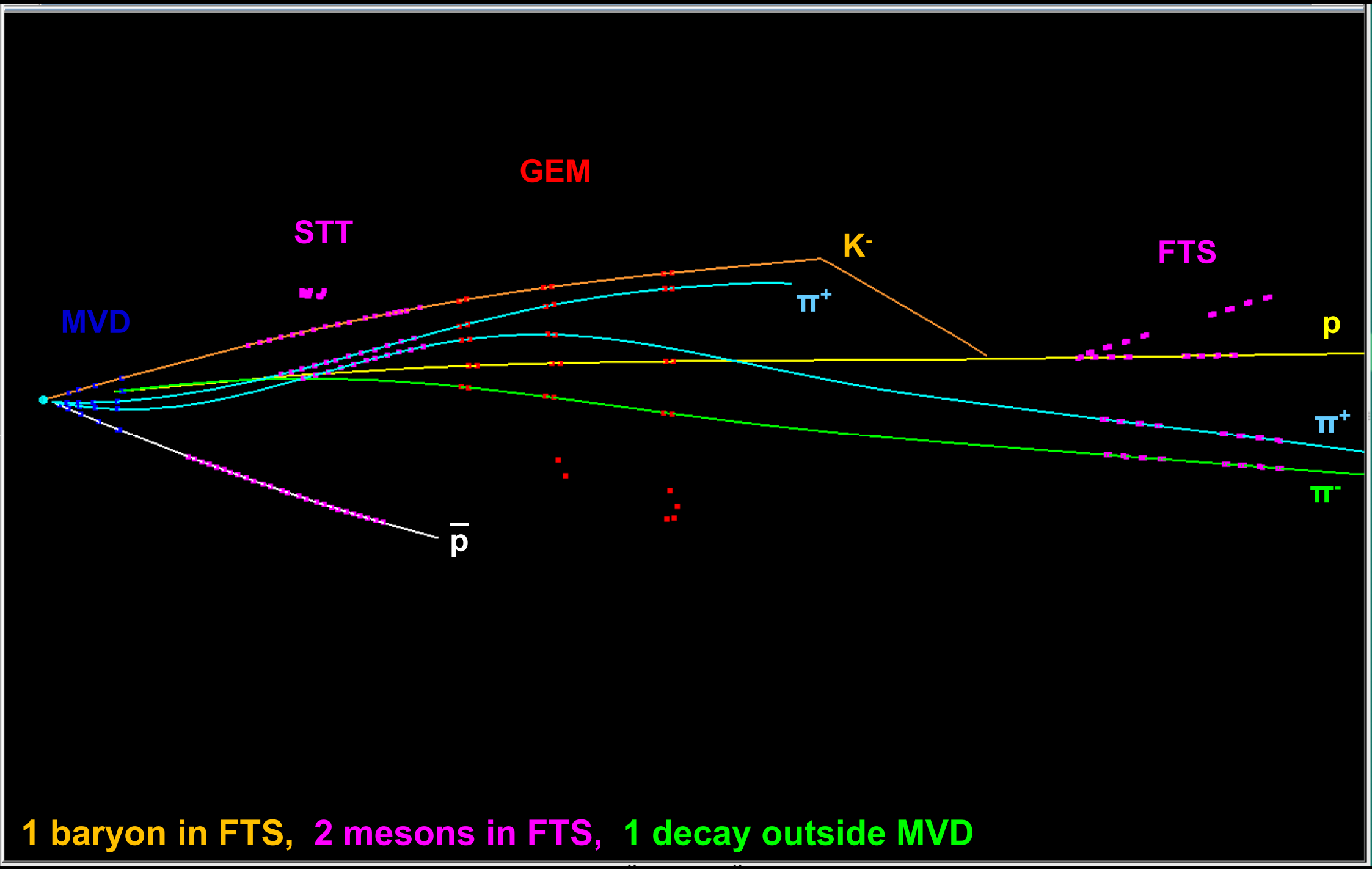
Proposed Version of the PANDA ‚Start Setup'

Day-1 master macros as basis for the physics simulation and analysis studies:

- Cluster Jet Target
- No GEM planes → need MVD or STT_{stereo} for p_z
- No Disc DIRC → no K/π separation
- FTS planes 1 2 3 4 (no 5 6) → poor p resolution
- No RICH

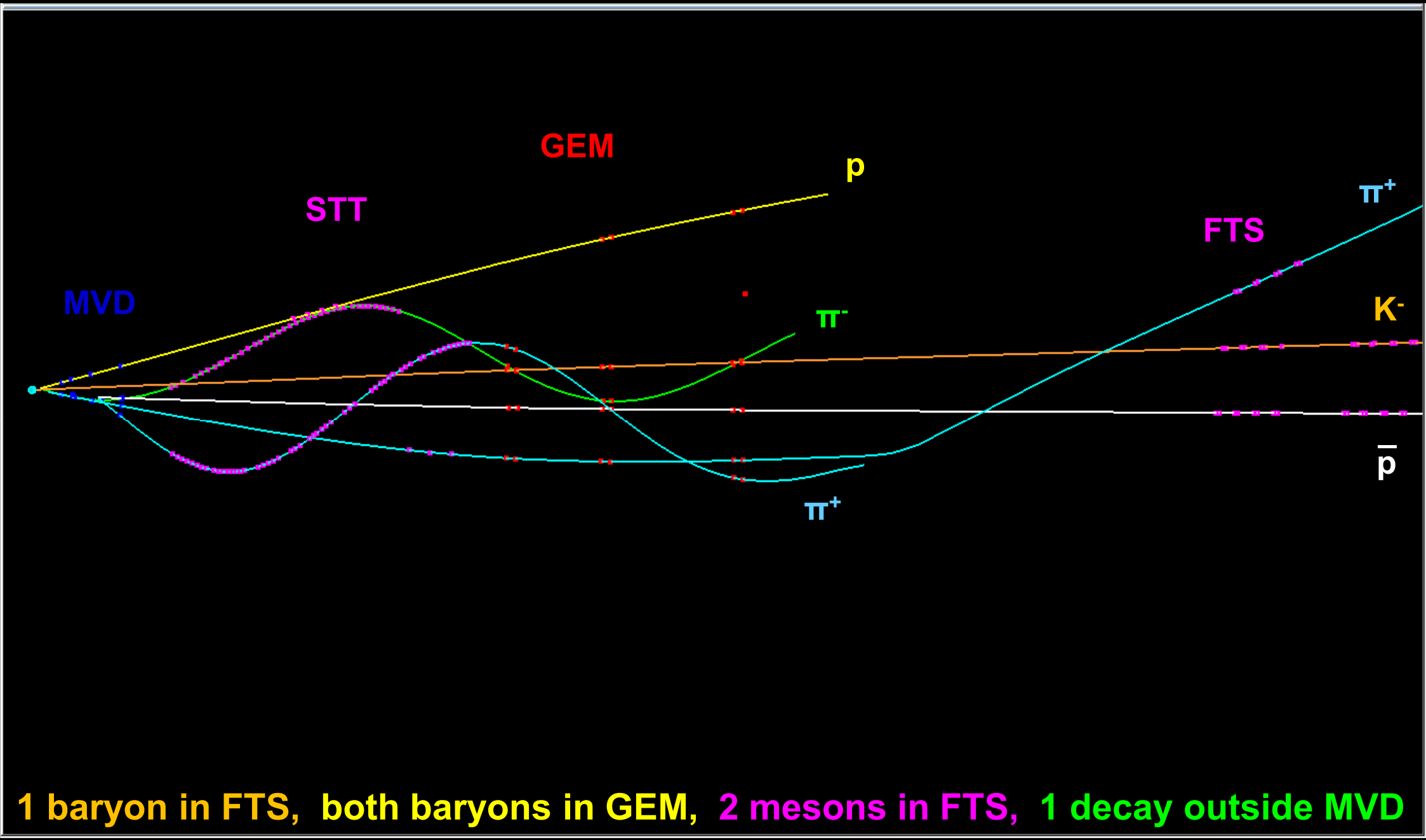
➢ How does this affect Hyperon Spectroscopy & Hyperon Spin Physics?

event #15



1 baryon in FTS, 2 mesons in FTS, 1 decay outside MVD

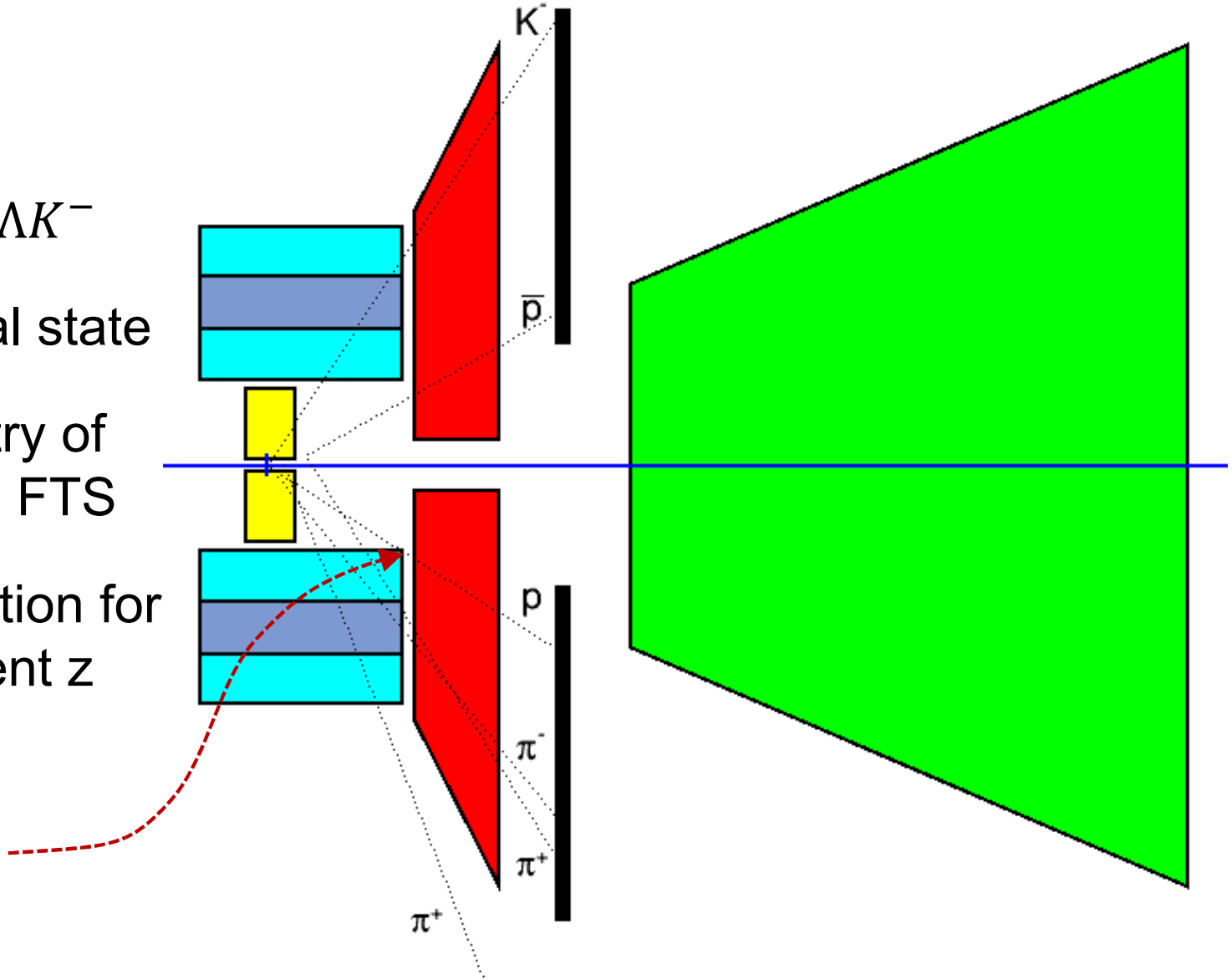
event #34



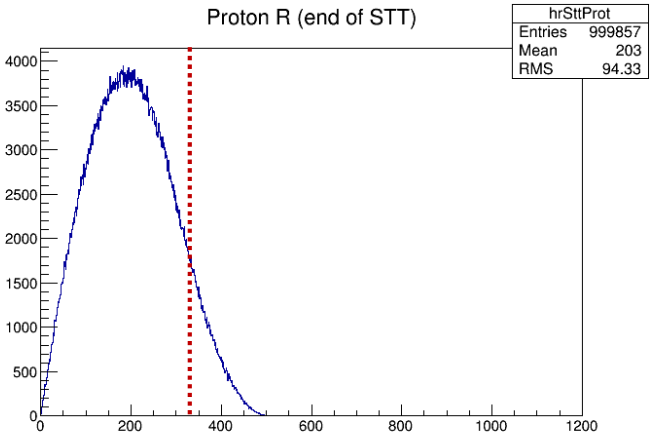
1 baryon in FTS, both baryons in GEM, 2 mesons in FTS, 1 decay outside MVD

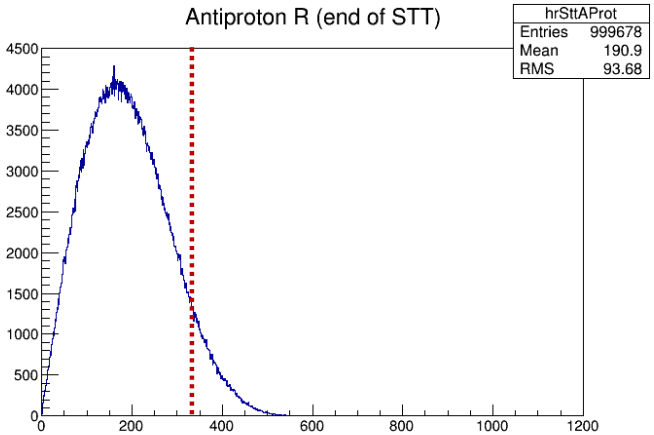
Fast Geometric Analysis: now with Helix Tracks

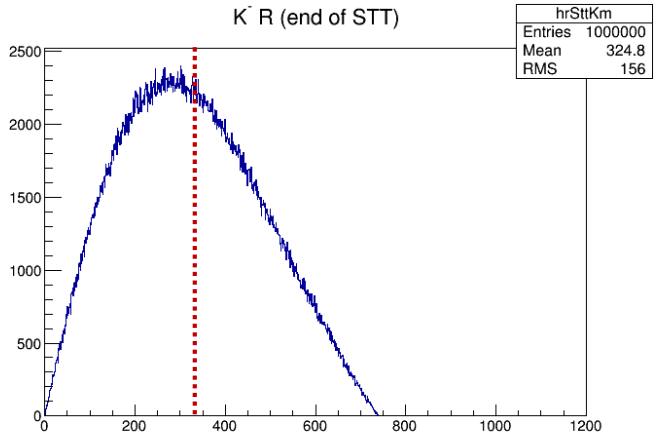
- EvtGen events
- 4.1 GeV $\bar{p}p \rightarrow \bar{\Xi}^{+}\Lambda K^{-}$
- $\bar{p}\pi^{+}\pi^{+}p\pi^{-}K^{-}$ final state
- simplified geometry of MVD, STT, GEM, FTS
- plot xy hit distribution for particles at different z

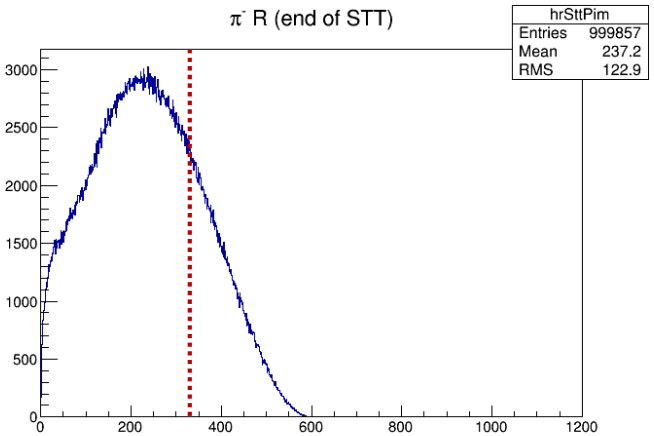


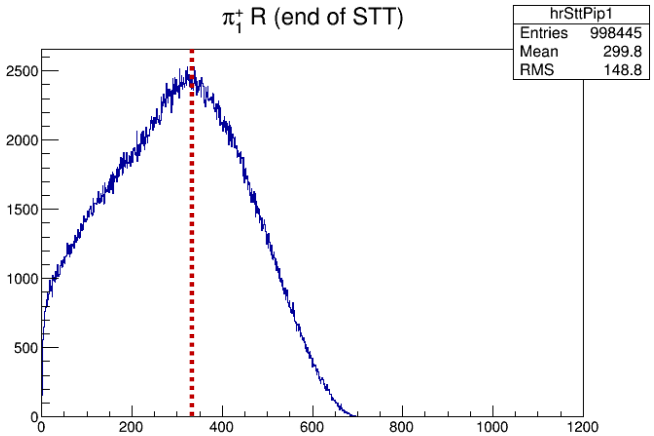
Radial Distribution at STT End Plane, Helix Tracks

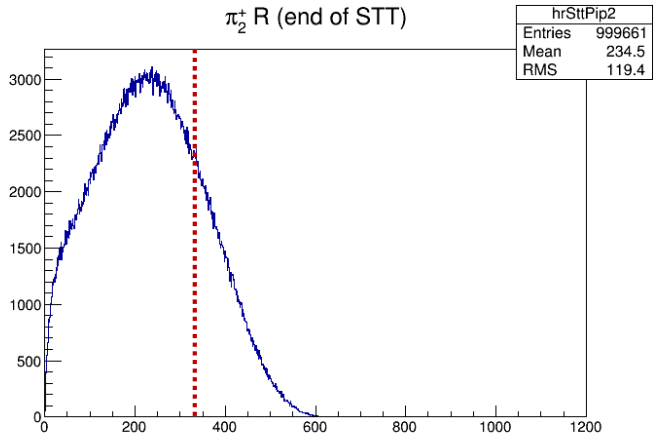




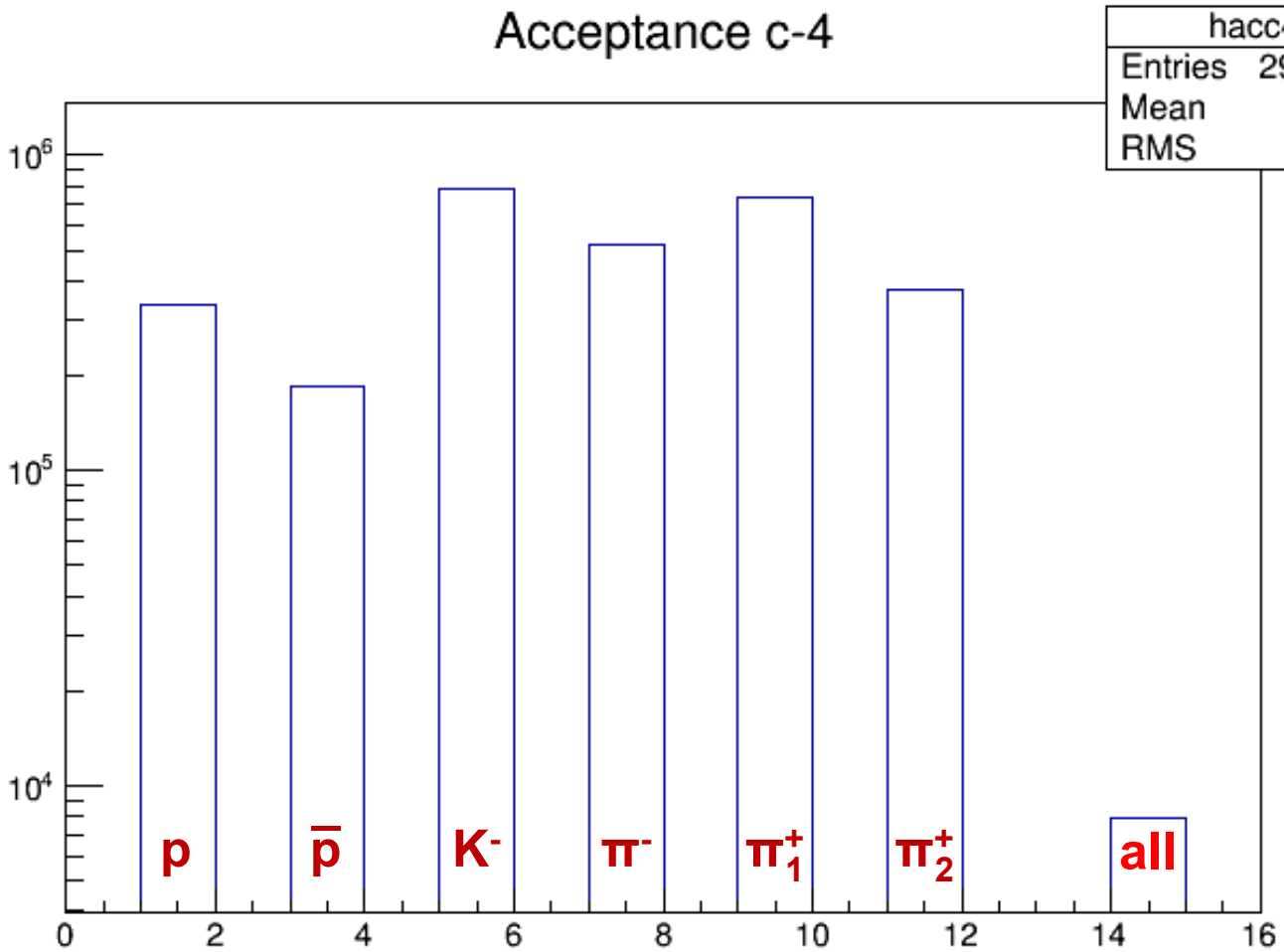








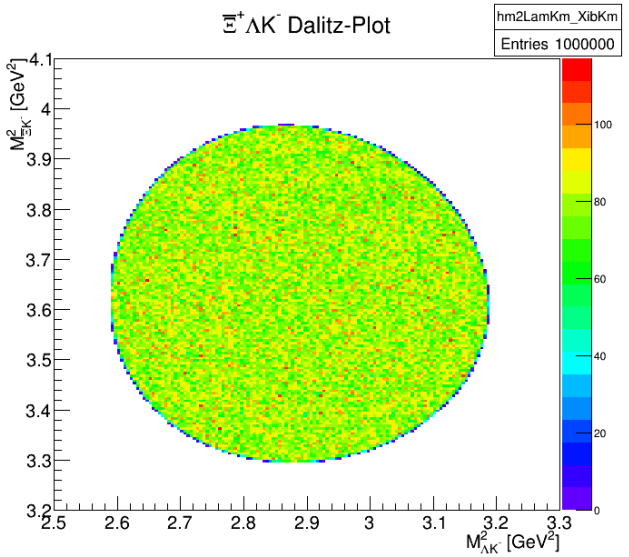
$R_{STT} > 331$ || ($R_{MVD\text{-}70} > 10$) && ($R_{STT} > 190$)

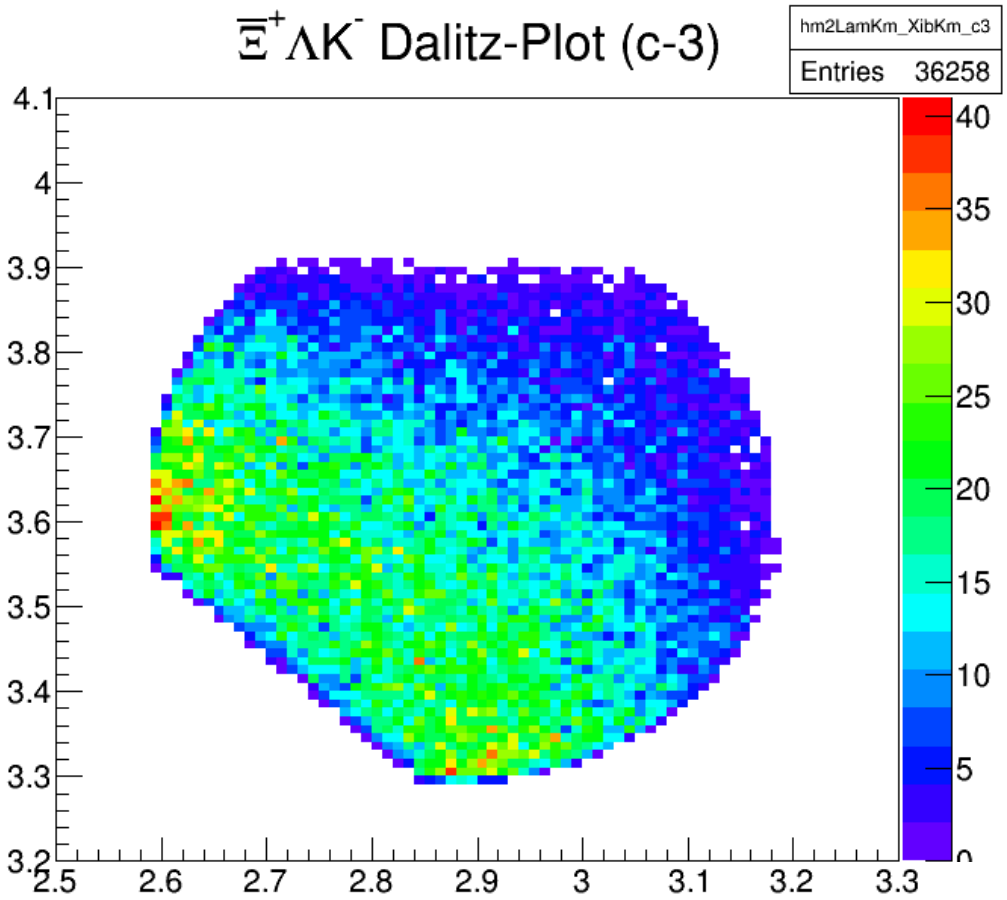


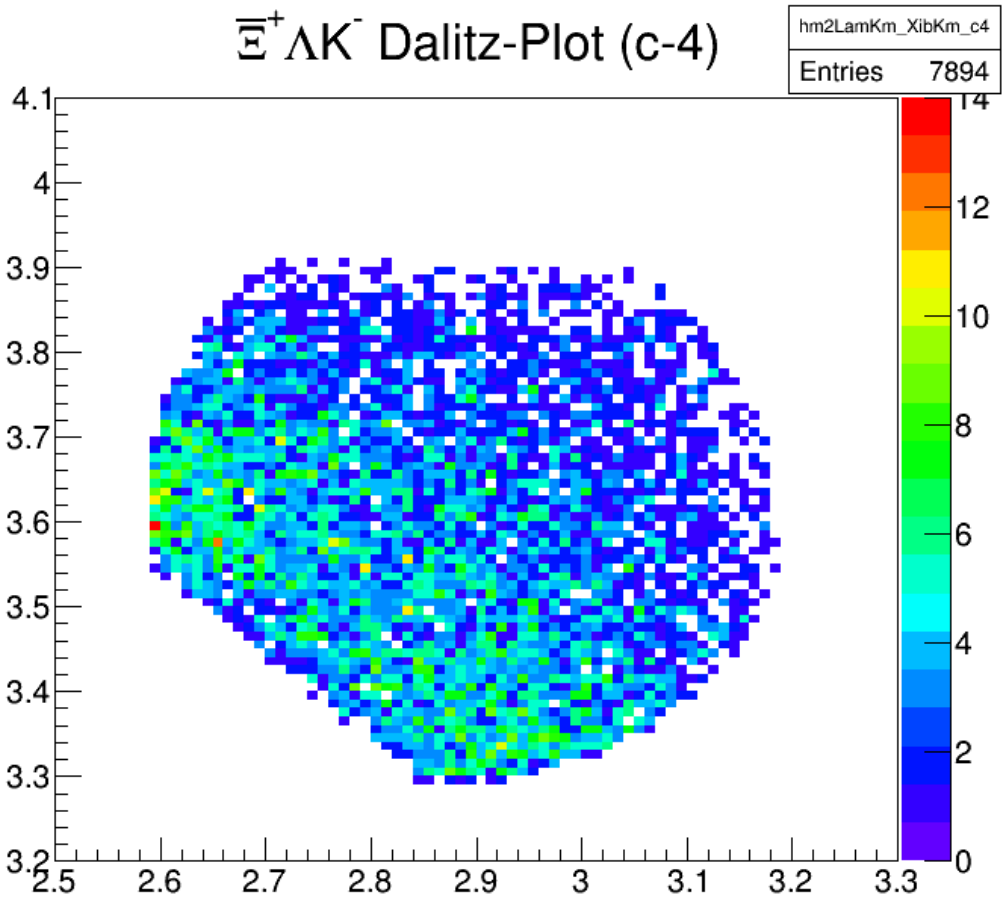
particle	F_{acc}
p	0.334
$\bar{p}$	0.184
K^-	0.778
π^-	0.518
$\pi^+{}_1$	0.738
$\pi^+{}_2$	0.376
all	0.008

i.e. hitting STT stereo layers ***or*** (hitting 2nd-last MVD disc ***and*** STT 2 double layers)

Effect on $\bar{\Xi}^{+}\Lambda K^{-}$ Dalitz Plot

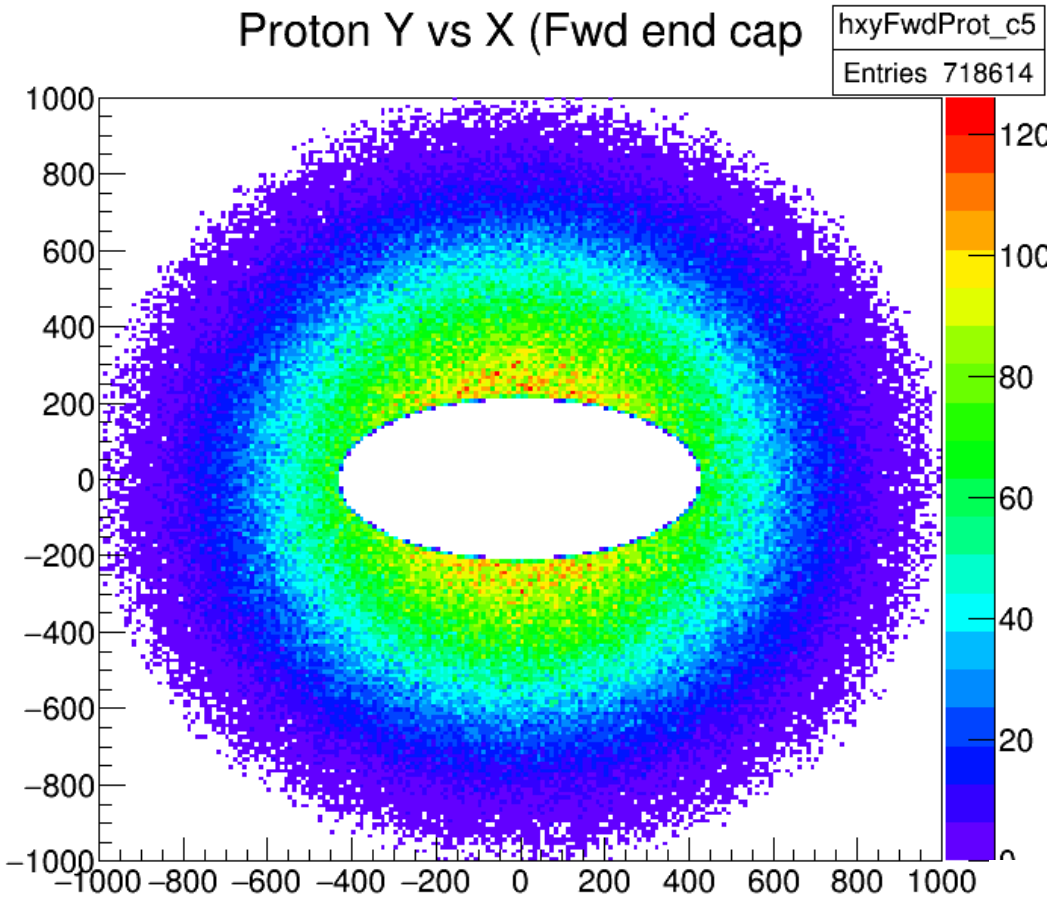


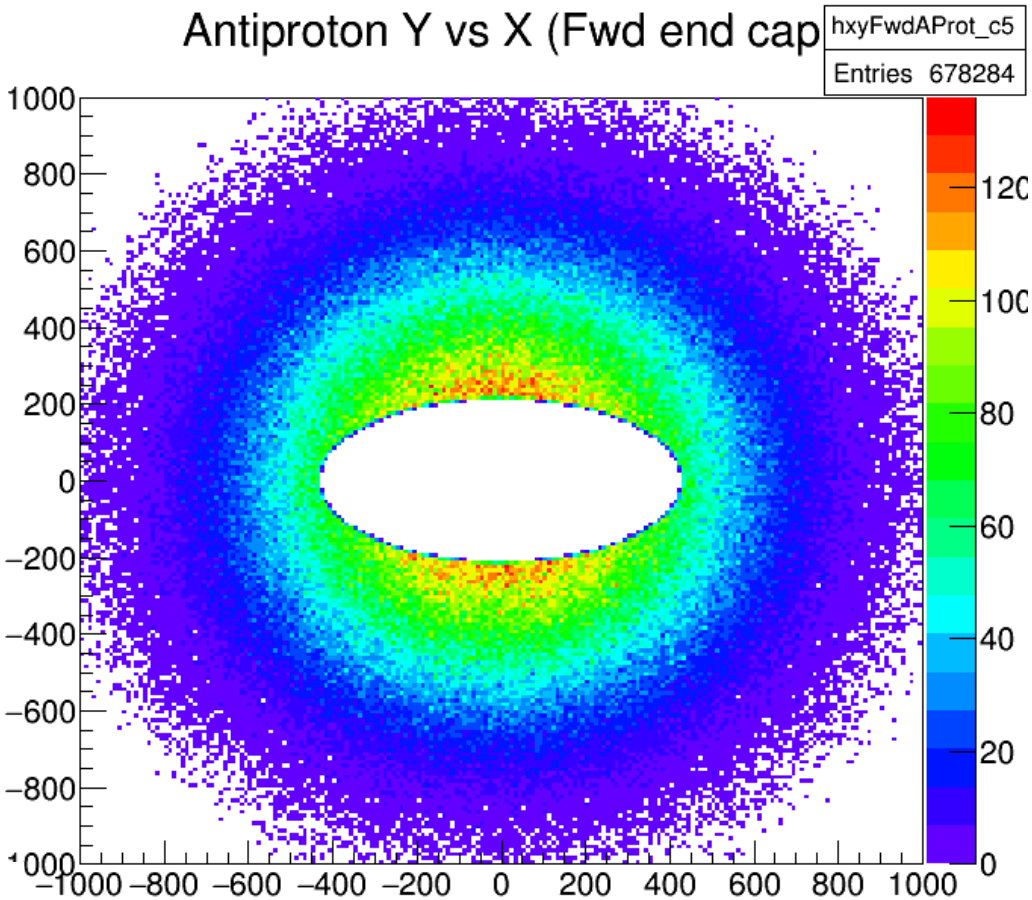




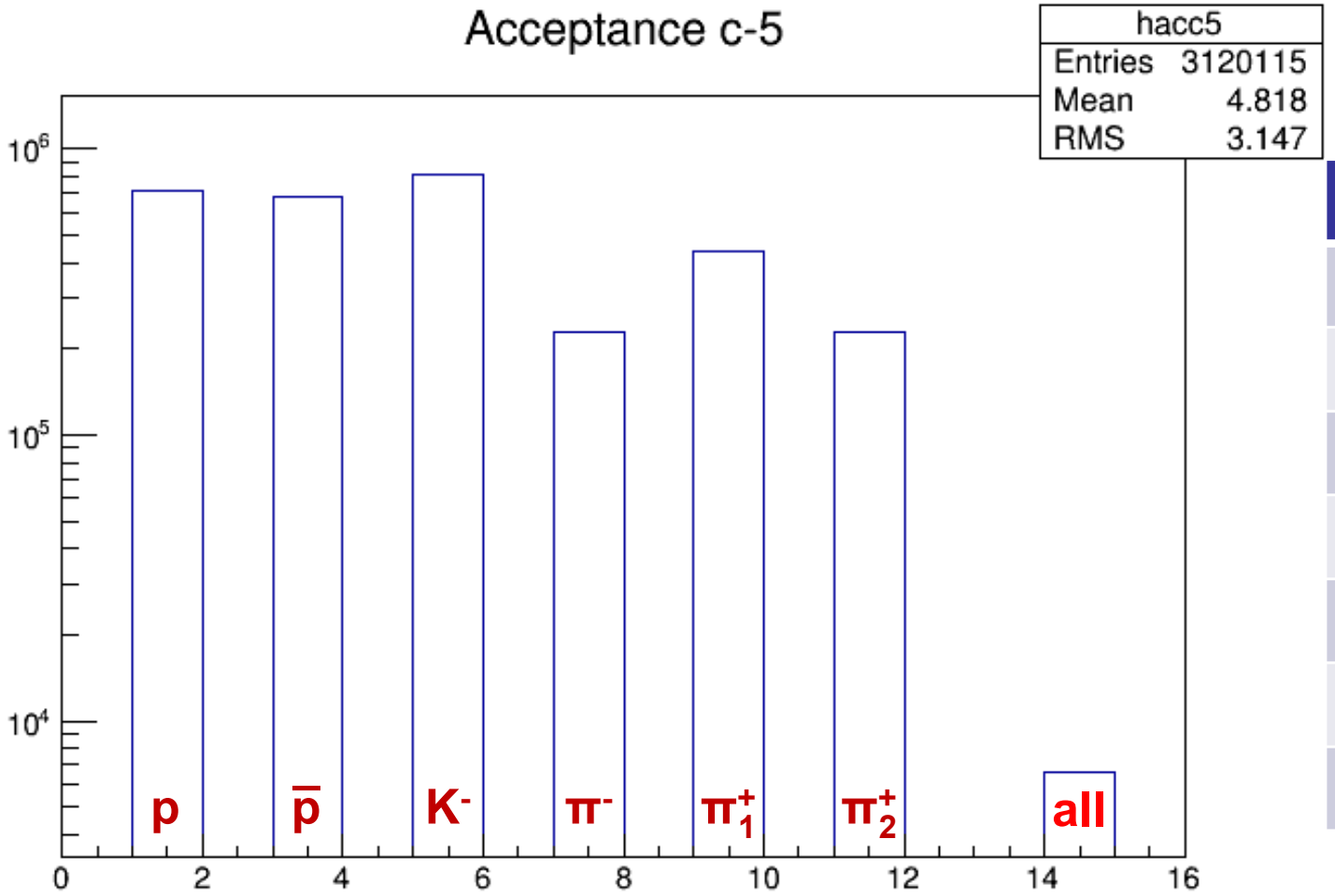
Acceptence of Target Spectrometer

xy hit distribution on Target Spectrometer forward end cap:





$XY_{FwdEndCap}$ inside TS acceptance



particle	F_{acc}
p	0.719
$\bar{p}$	0.678
K^-	0.816
π^-	0.231
$\pi^+{}_1$	0.440
$\pi^+{}_2$	0.230
all	0.007

Conclusion

- Hyperon spectroscopy is an important topic in hadron physics which deserves more attention
- PANDA is the ideal instrument for a comprehensive Ξ and Ω spectroscopy program
- A large part of the program can already be pursued at reduced luminosity

❖ **However:** for these studies the GEM detector and the FTS, including a detector *behind* the dipole, are required