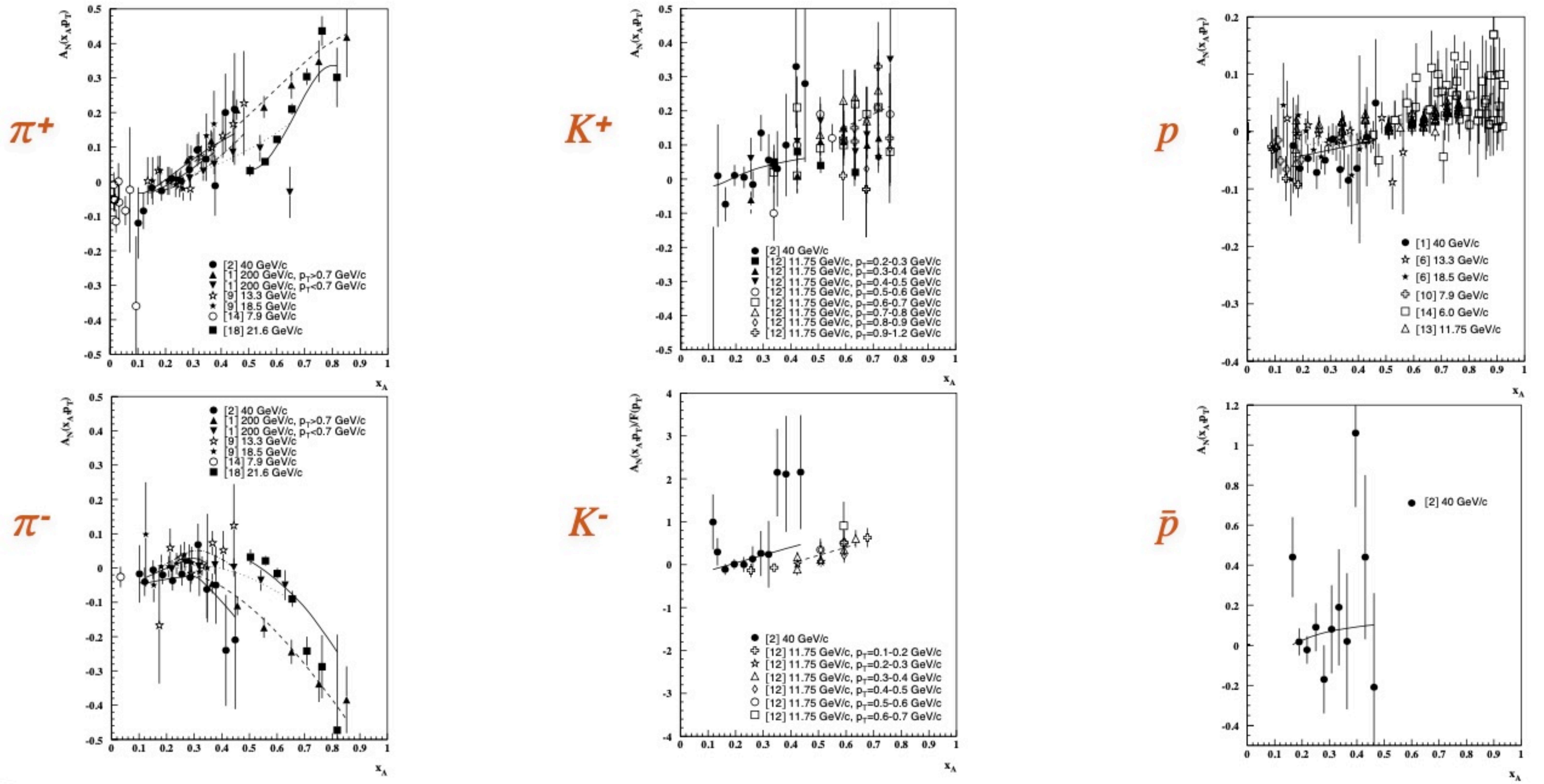
TSSA of charged hadrons in pp @ 13 GeV in the SPD

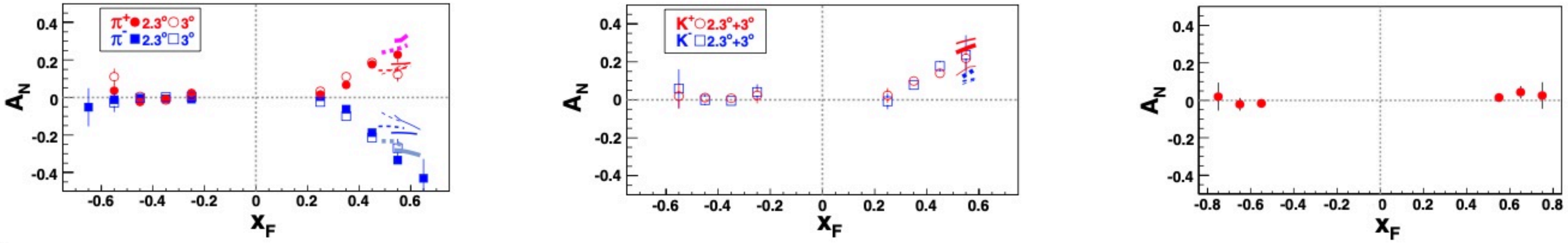
Elena Zemlyanichkina (JINR)

VII SPD Collaboration Meeting
Almaty, 24 May 2024

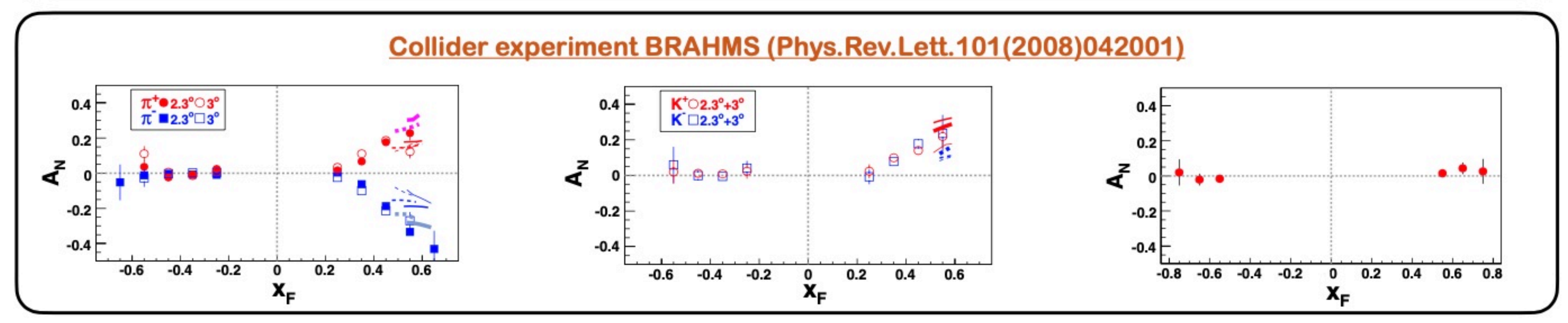
Fixed target experiments (Eur.Phys.J.C14(2000)427)



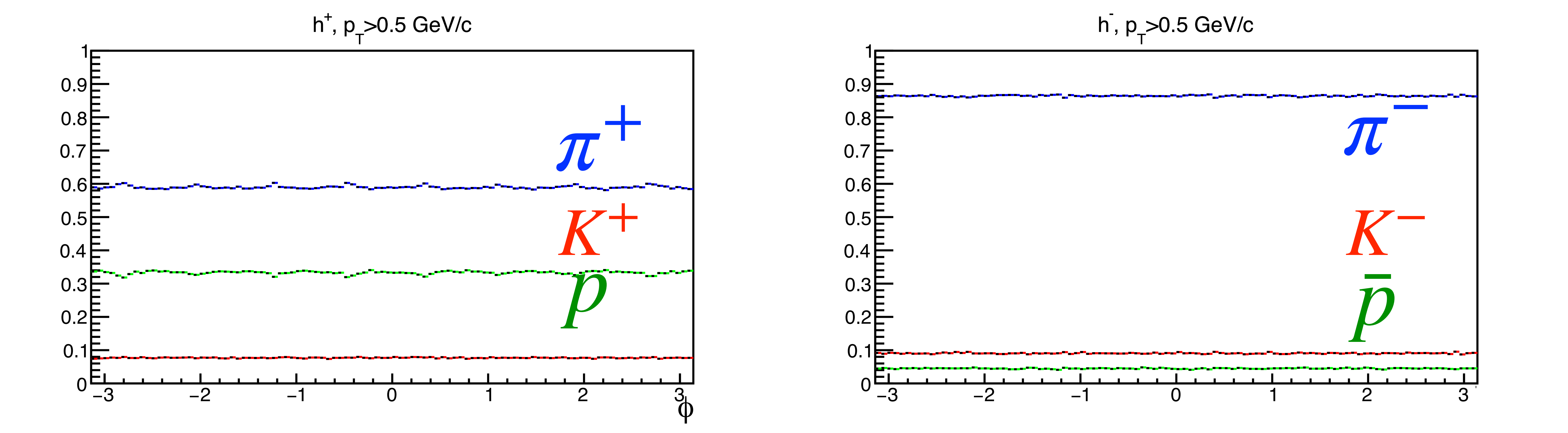
Collider experiment BRAHMS (Phys.Rev.Lett.101(2008)042001)



Motivation



- $A_N^{\pi^+}$, $A_N^{K^+}$, and A_N^p are positive $\Rightarrow A_N^{h^+}$ should be positive @ $x_F > 0.2$



- More than 85% of h^- at $p_T > 0.5\ GeV/c$ are π^- $\Rightarrow A_N^{h^-}$ could be negative @ $x_F > 0.2$

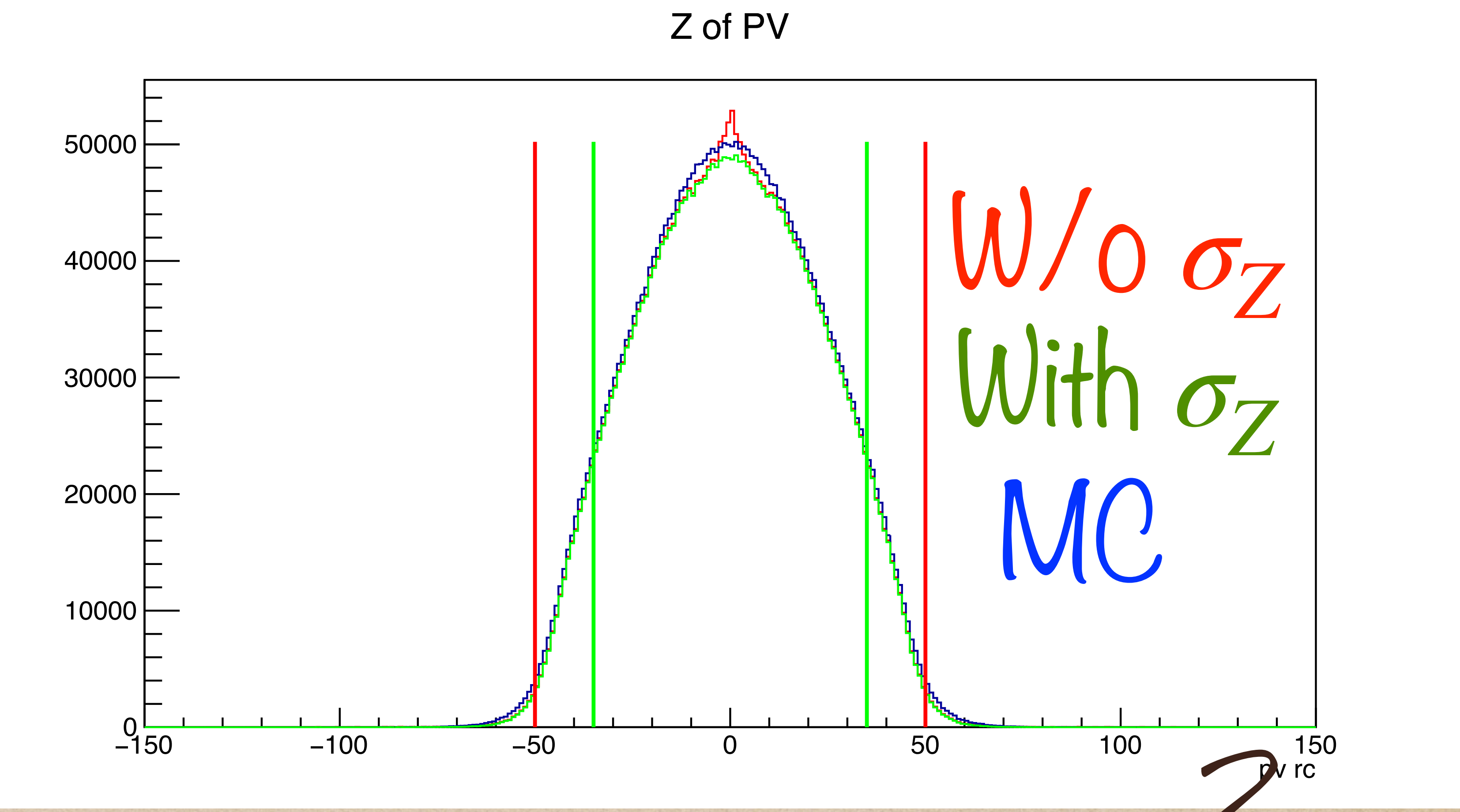
- TSSA $A_N^{h^+}$ and $A_N^{h^-}$ are good tests for polarised measurements with SPD

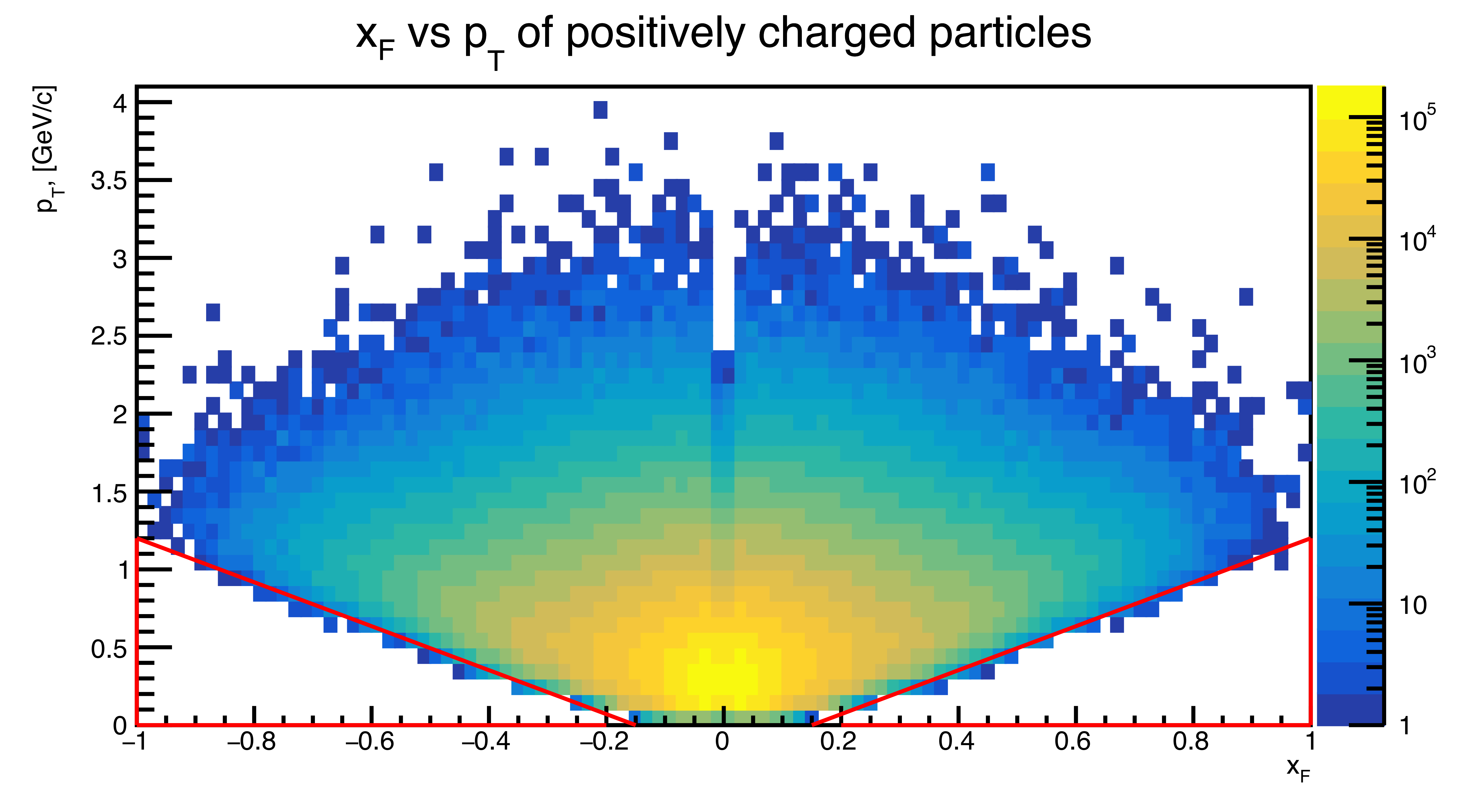
Generation and Reconstruction

- 10 milions soft QCD (w/o elastic) events with Pythia 8 in $pp@\sqrt{s} = 13\ GeV$;
- SPDRoot v. 4.1.6;
- ITS: 1 layer Micromegas-based Central Tracker;
- TS: STRAW detector
- Beam: Event vertex (0,0,0), 30 cm Gaussian z-smearing

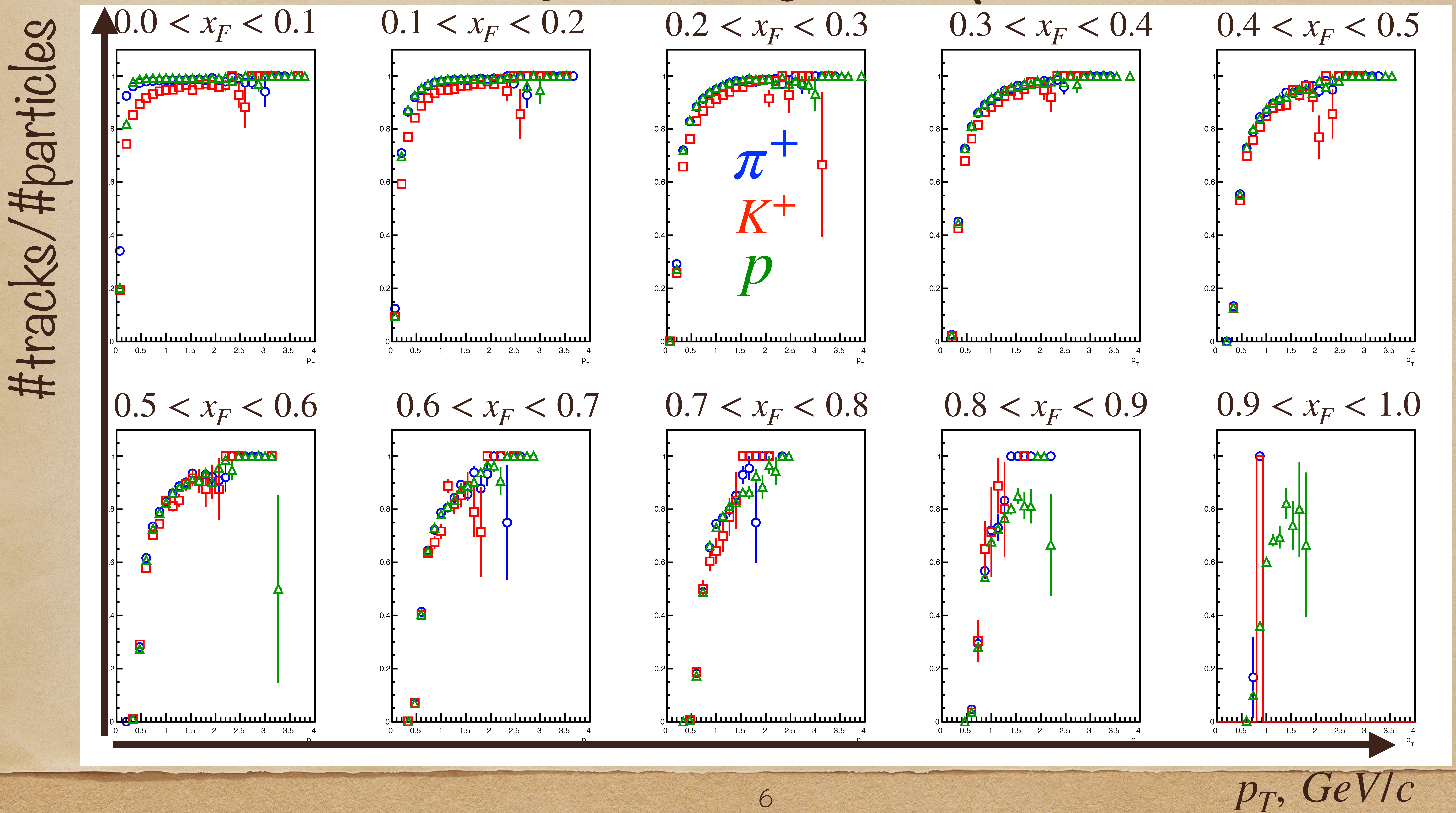
Selection

- Reconstructed Primary Vertex (RCVertex)
- $-35\ cm < Z_{PV} < 35\ cm$
- $\sigma_Z < 4\ cm$
- At least 8 hits in STRAW
- Track fit convergency != 0
- $\sigma_p/p < 0.1$
- $p_T > 0.5\ GeV/c$

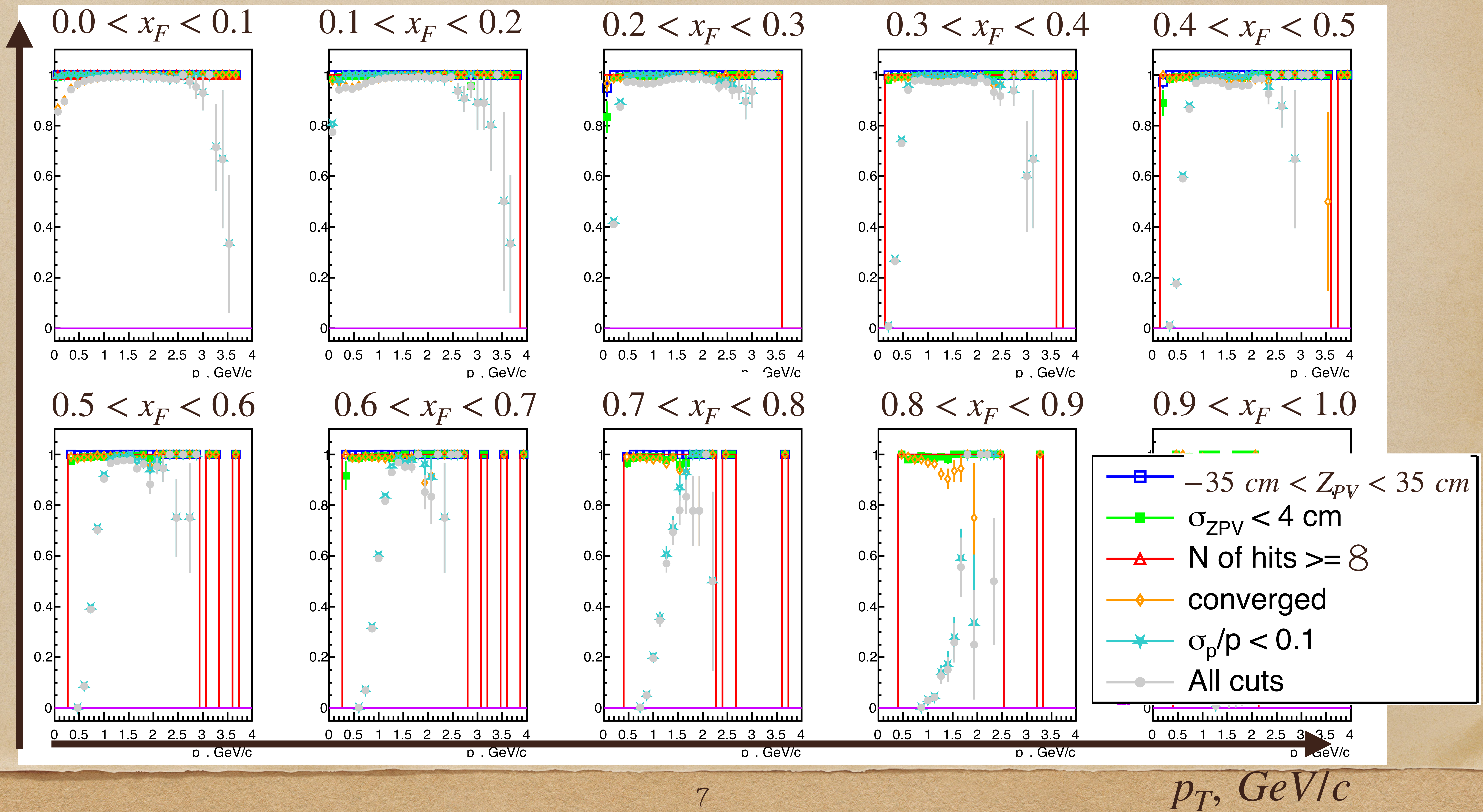




Pure geometry acceptance

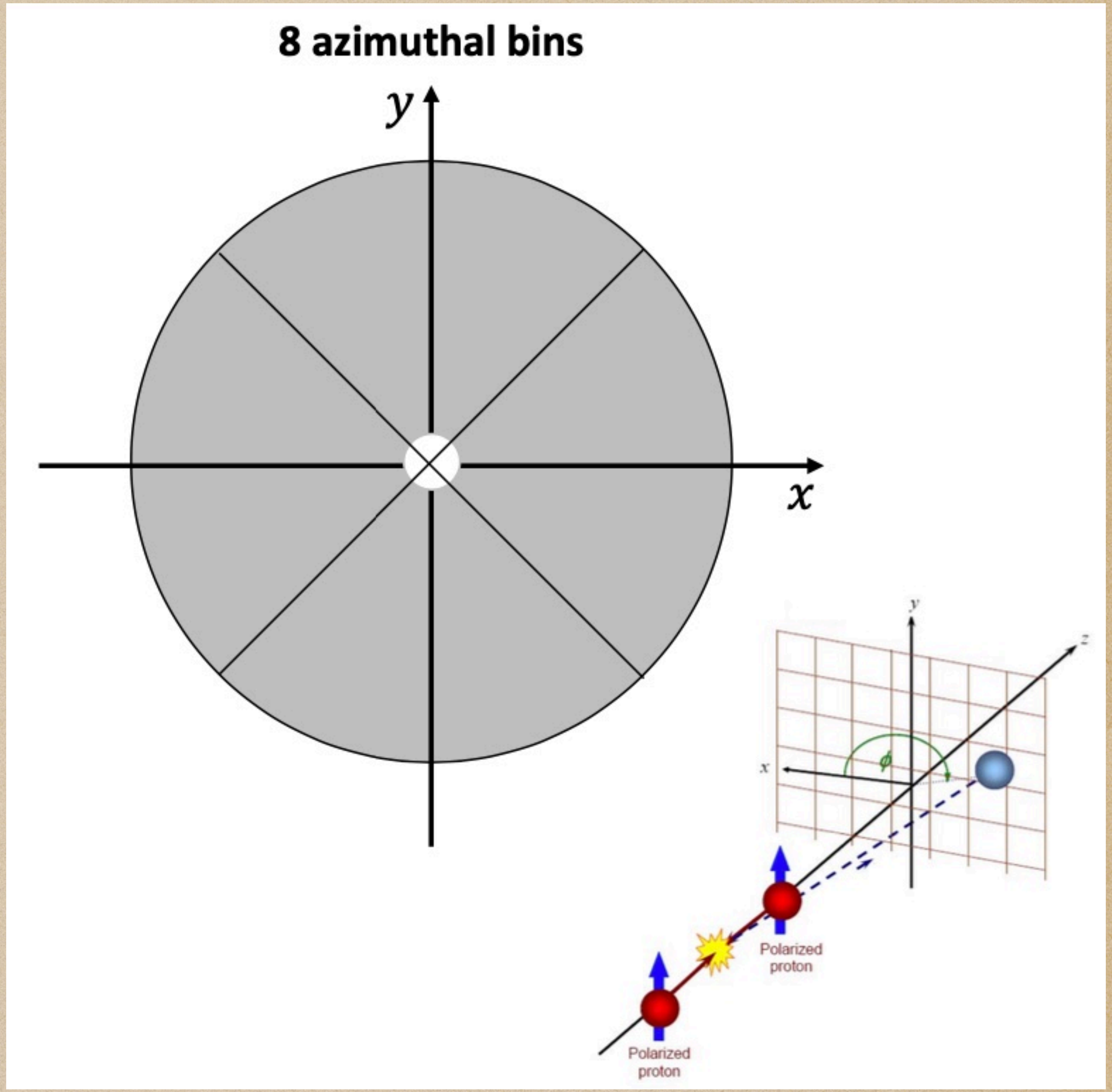


Selection criteria

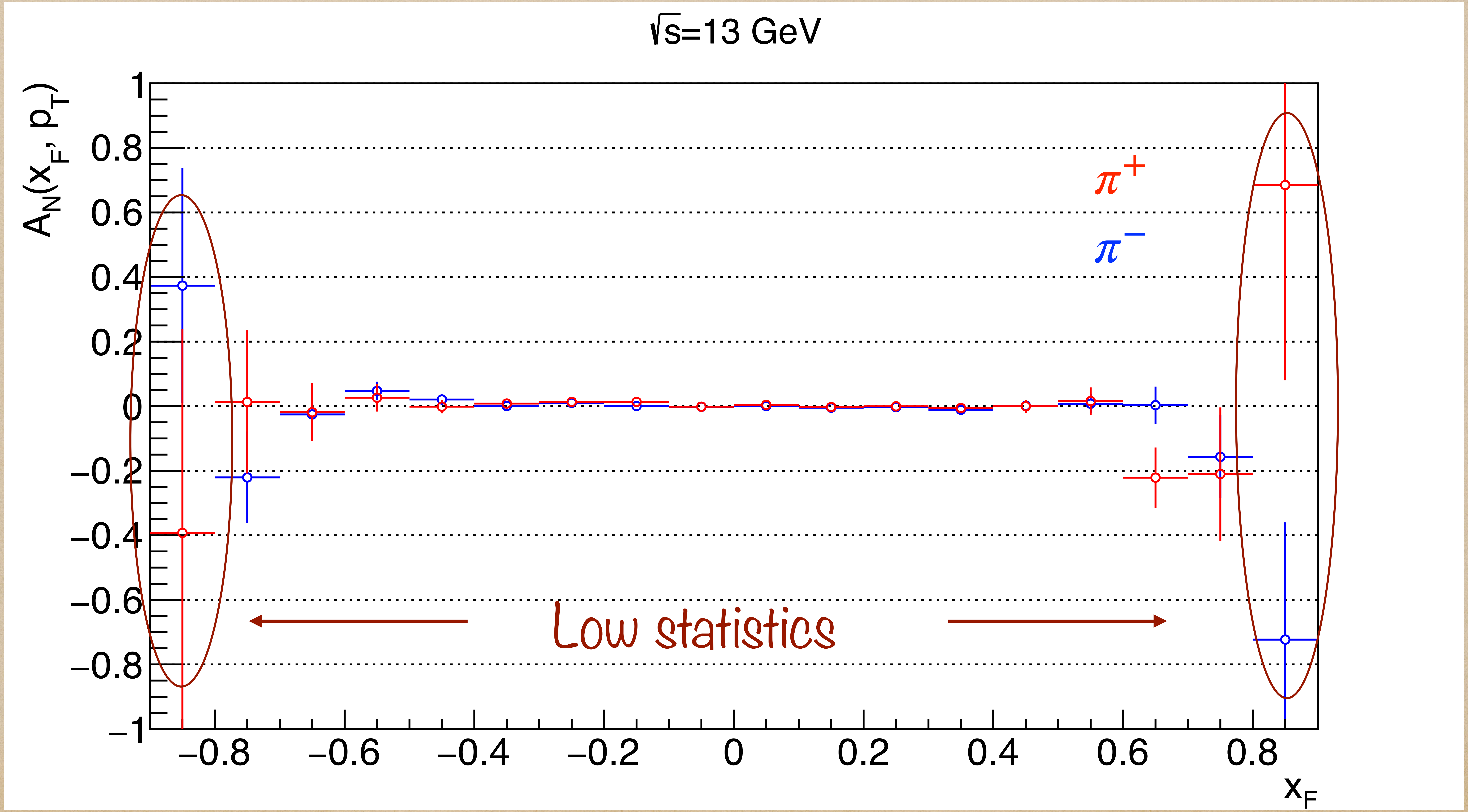


Extraction of TSSA A_N

- $p^{\uparrow} + p \rightarrow \pi^{\pm} + X$
- The cross section of hadron production in polarised $p^{\uparrow} + p$ collisions is modified in azimuth: $\frac{d\sigma}{d\phi} = \frac{d\sigma}{d\phi_0}(1 + P \cdot A_N \cdot \cos\phi)$, where $P \cdot A_N \cdot \cos\phi$ is azimuthal cosine modulation
- $N_{\pi^{\pm}}(\phi) = A(1 + B\cos\phi)$: yield of $\pi^{\pm}$; $A_N = \frac{B}{P}$,
  P : Beam polarisation, $P \sim 0.7$ was assumed
- The spin dependent $\pi^{\pm}$ yields for each bin are extracted in different x_F sub-ranges for each ϕ bin

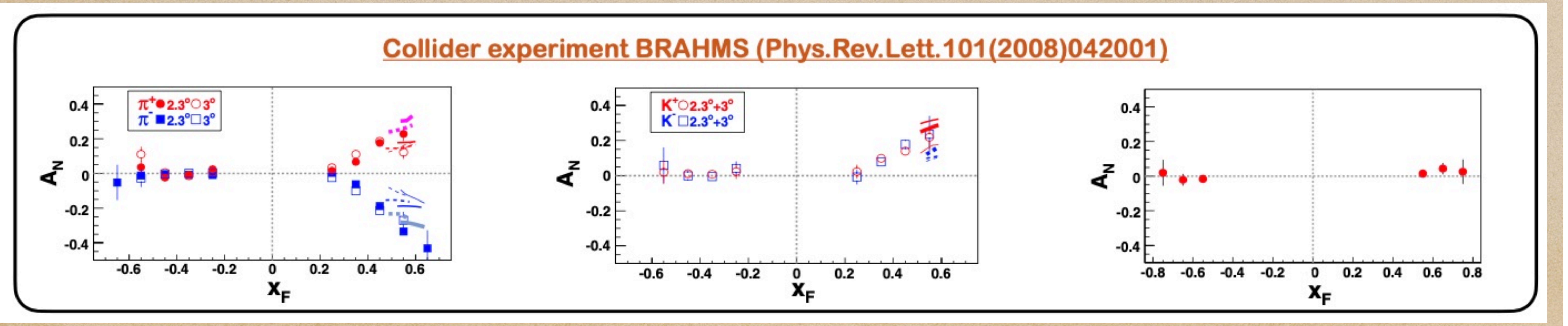


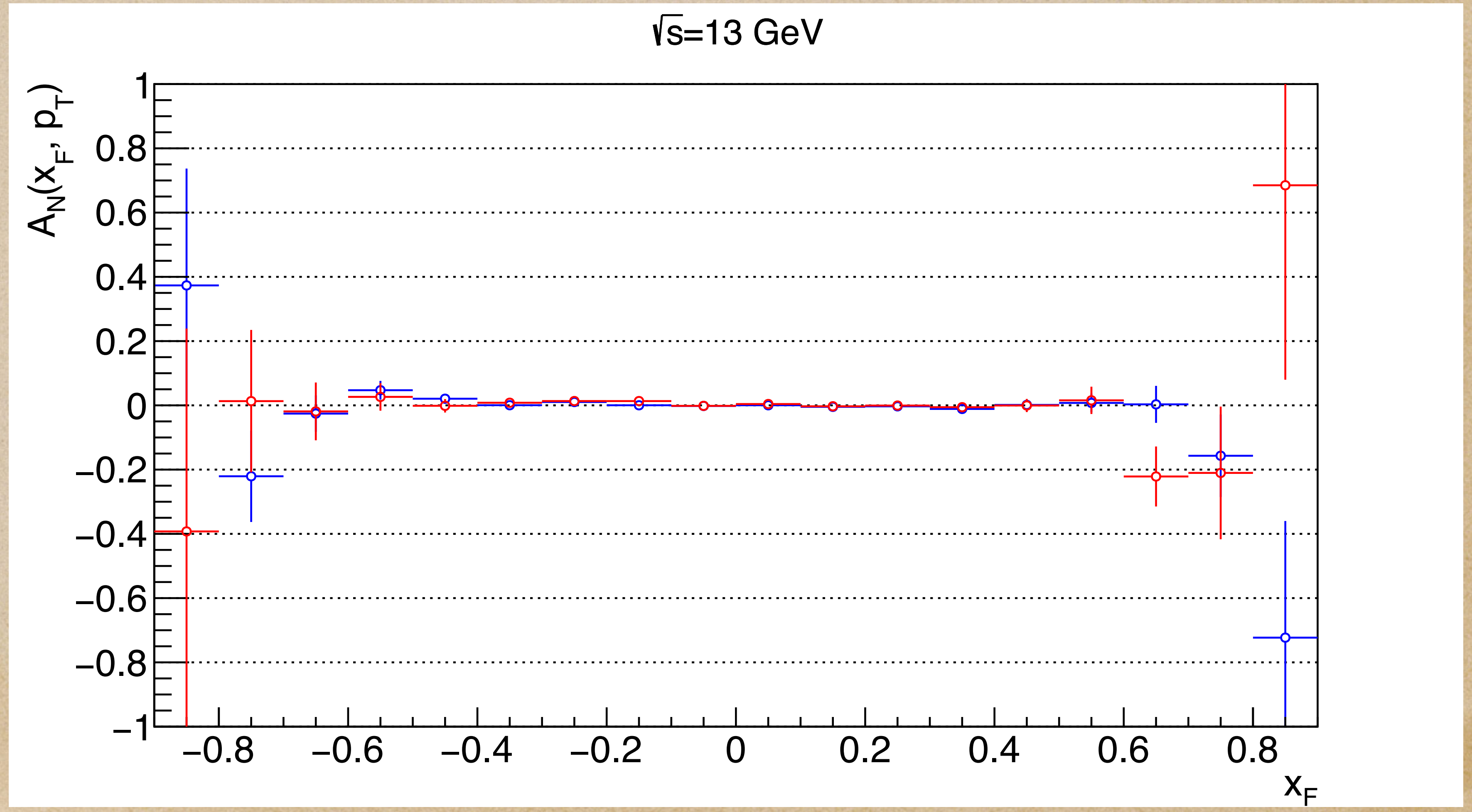
Results: $A_N^{\pi^\pm}$ @ $p_T > 0.5\ GeV/c$, $P_{beam} = 0.7$



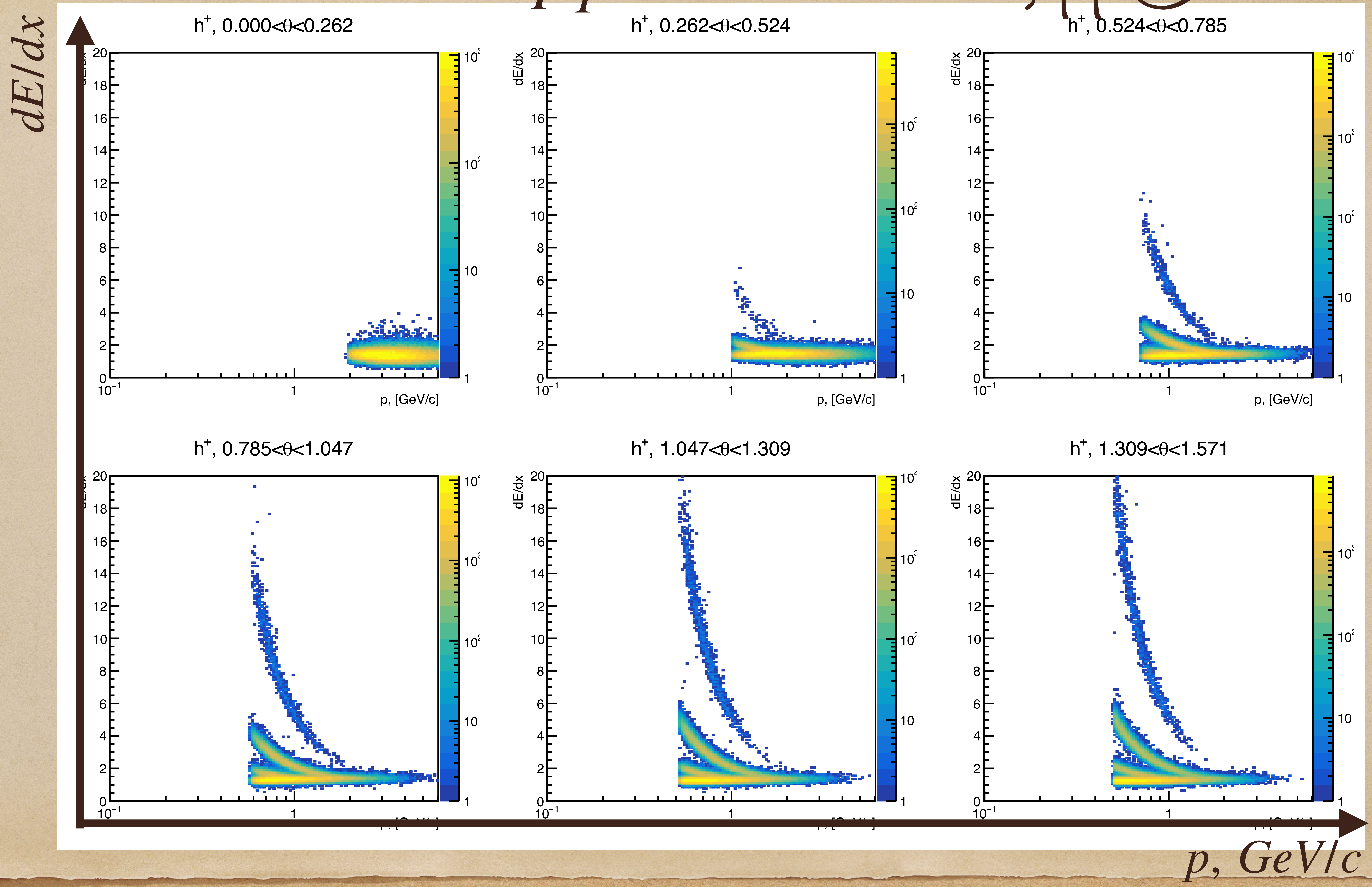
Summary

- We can not identify π^+ @ $p_T > 0.5\ GeV/c$ using STRAW detector alone, but
- Since $A_N^{\pi^+}$, $A_N^{K^+}$, and A_N^p are positive $\Rightarrow A_N^{h^+}$ should be positive @ $x_F > 0.2$
- More than 85% of h^- at $p_T > 0.5\ GeV/c$ are π^- $\Rightarrow A_N^{h^-}$ could be negative @ $x_F > 0.2$
- $A_N^{h^\pm}$ can be a first check of polarised measurements with SPD

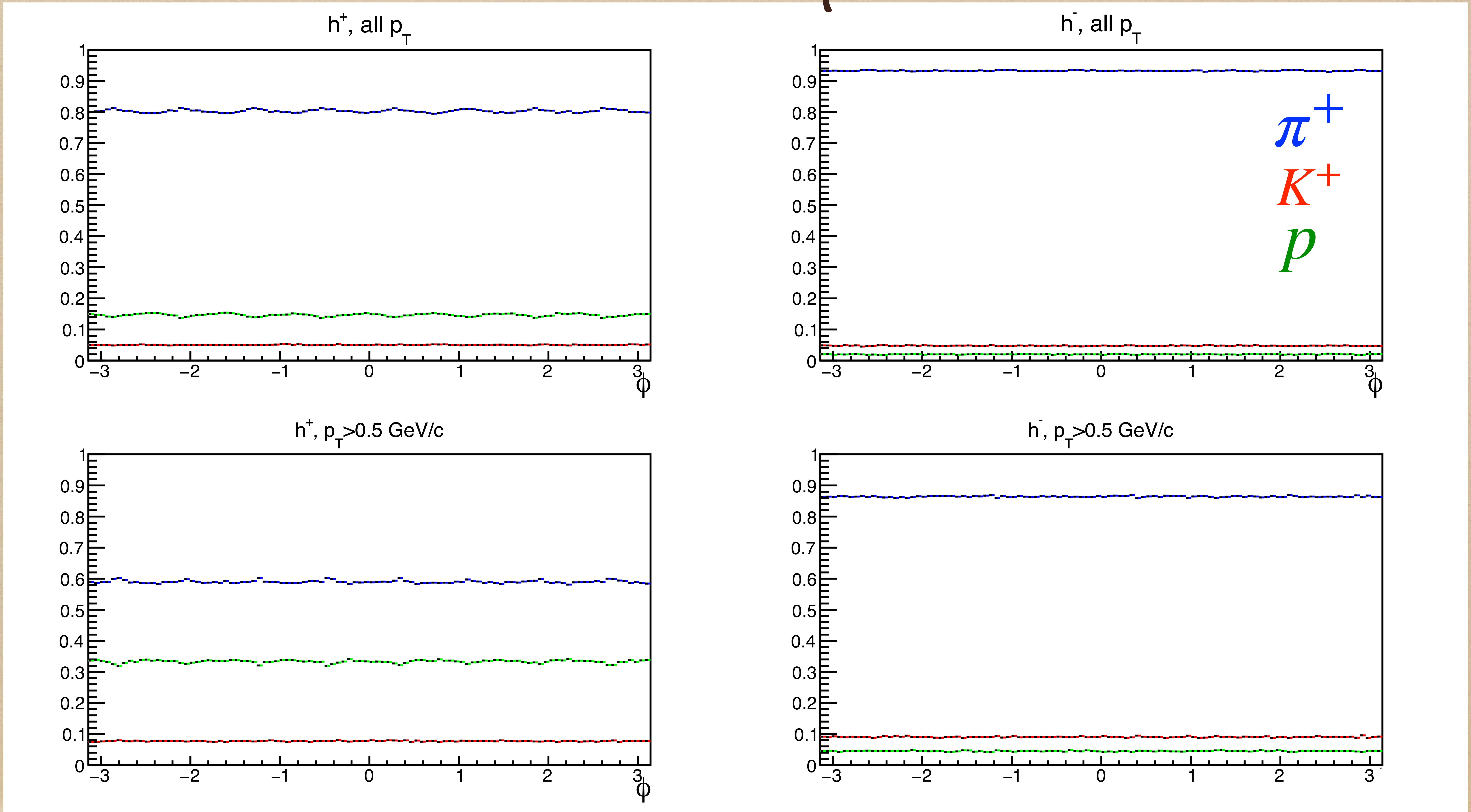




PID with STRAW ($p_T > 0.5\ GeV/c$), pp@27GeV



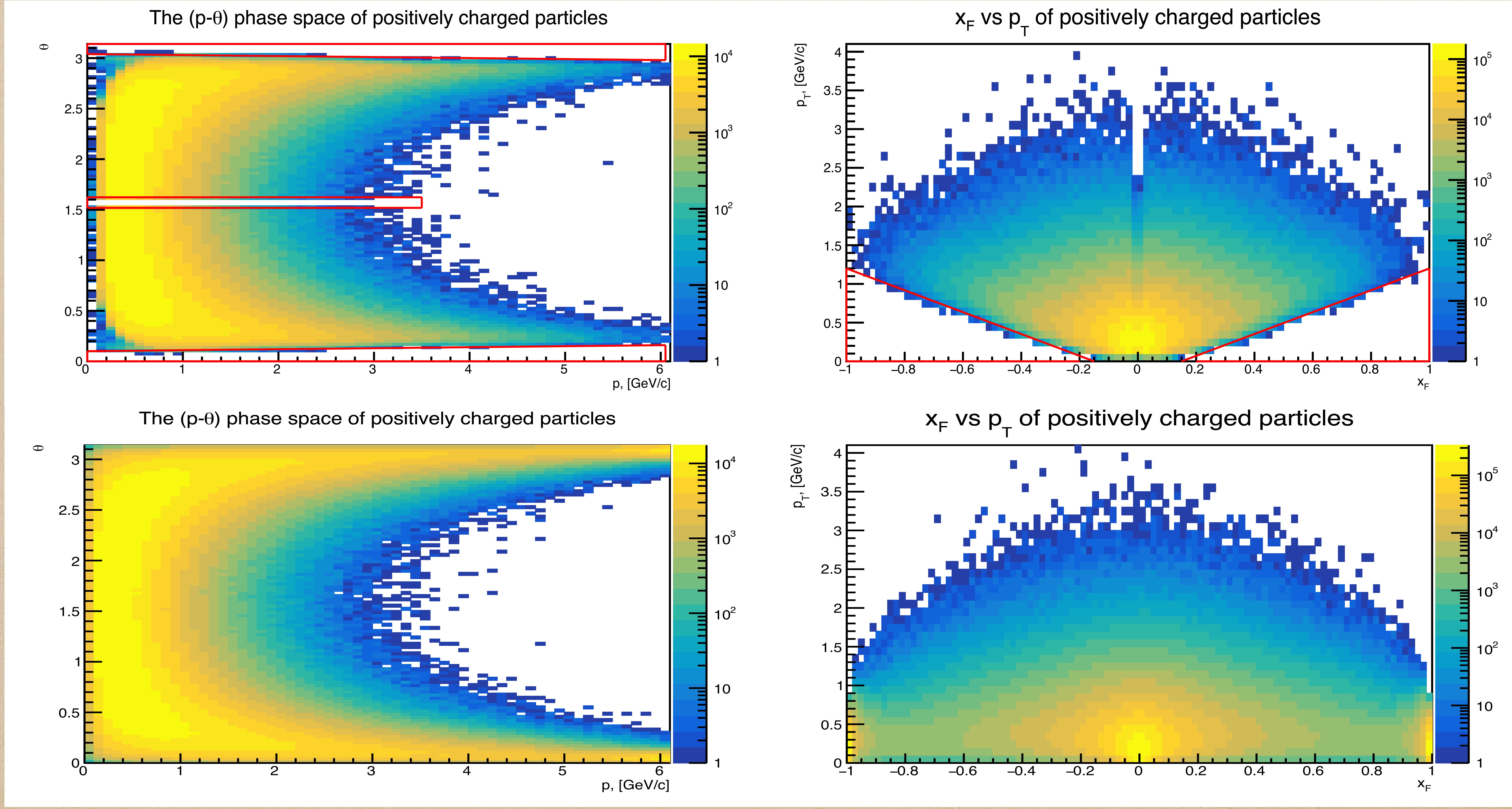
Hadron composition



Charged Hadrons: 2D distributions

Reconstructed in SPDRoot

pure Pythia8



Generation and Reconstruction

- 10 milions soft QCD (w/o elastic) events with Pythia 8 in pp @ 13 GeV;
- SPDRoot v. 4.1.6; ITS: 1 layer Micromegas-based Central Tracker;
- Beam: gRandom->SetSeed(seed);

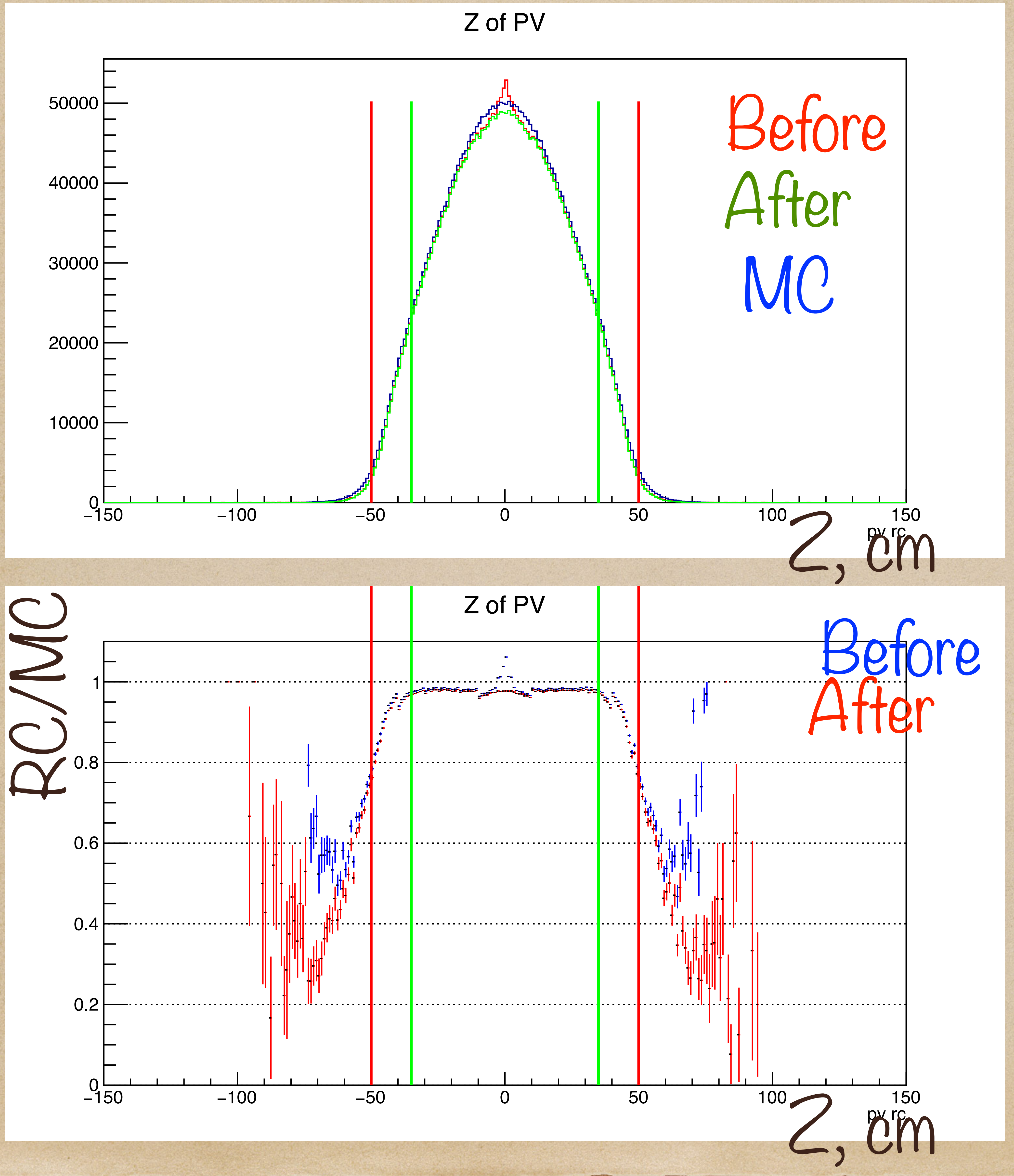
```
primGen->SetBeam(0., 0., 0.025, 0.025);//X0,Y0,Xwidth,Ywidth : 250 microns std. dev.
primGen->SmearGausVertexXY(kTRUE);
//Important : for uniform smearing or SmearVertexXY(kTRUE), give twice the width you want
//uniform smearing is done from -width/2 to width/2
//for Gaussian smearing or SmearGausVertexXY(kTRUE), give sigma or standard deviation you want

primGen->SetTarget(0., 30.);//Z0,Zwidth, 30 cm std. dev.
primGen->SmearGausVertexZ(kTRUE);
//Important : for uniform smearing or SmearVertexZ(kTRUE), give twice the width you want
//uniform smearing is done from -width/2 to width/2
//for Gaussian smearing or SmearGausVertexZ(kTRUE), give sigma or standard deviation you want
```

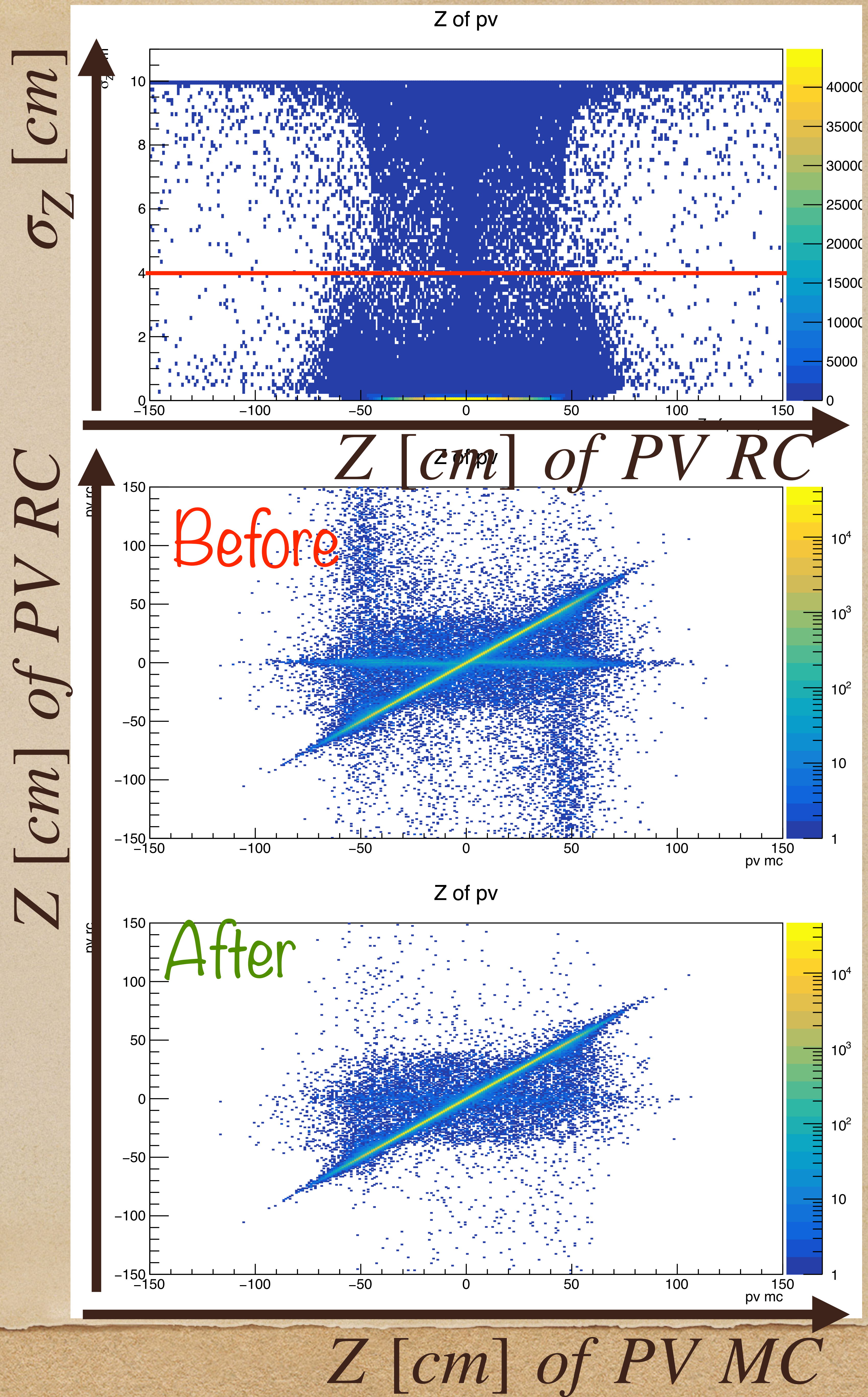
Micromegas-based Central Tracker description

```
//___________________________________________________________________
void CustomMvd(Int_t geo_type)
{
    if (geo_type < 1) return;

    SpdMvdGeoMapper* mapper = SpdMvdGeoMapper::Instance();
    if (geo_type == 1) { mapper->SetGeoType(1); return; }
    if (geo_type == 2) { mapper->SetGeoType(2); return; }
    mapper->SetGeoType(3);
    mapper->ClearGeometry();

    // here we can redefine active material (by default = "argon").
    //mapper->SetActiveMaterial("copper");

    //----------------------------------------
    // BUILD LAYERS

    Int_t l0, l1;
    l0 = mapper->DefineLayer(5.0,80.0);
    mapper->SetLayerActivity(l0,true);
    mapper->AddSublayer(l0,0.01750,"FR4");
    mapper->AddSublayer(l0,0.00190,"copper");
    mapper->AddSublayer(l0,0.01350,"kapton2");
    mapper->AddSublayer(l0,0.40000,"argon");
    mapper->AddSublayer(l0,0.00055,"copper");
    mapper->AddSublayer(l0,0.02400,"kapton2");

    l1 = mapper->DefineLayerCopy(l0,5.5);
    l1 = mapper->DefineLayerCopy(l0,6.0);
}
```

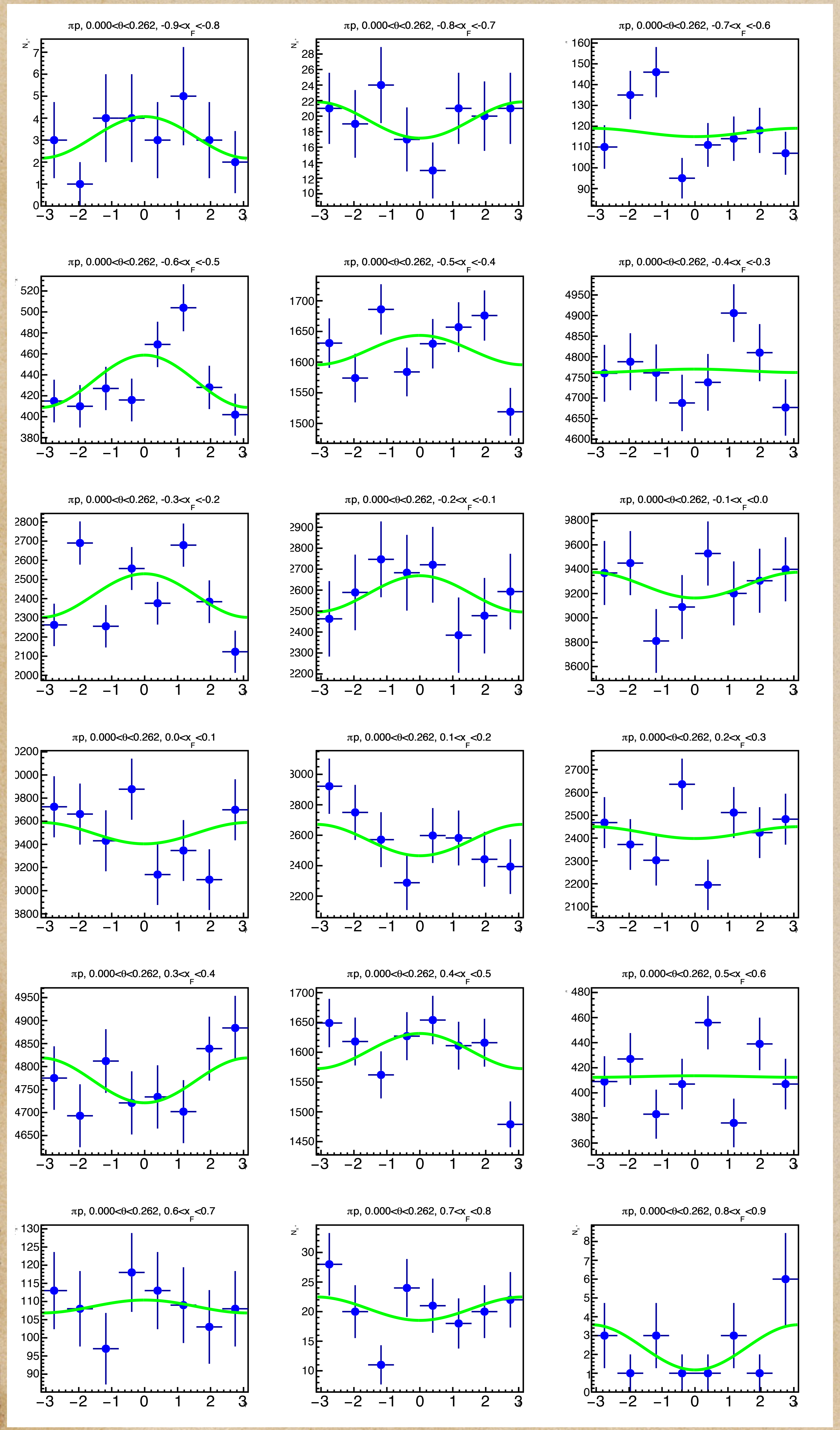
- CustomMvd(3); — 1 layer
- track_fitter->SetFitterMaxIterations(20); — convergency and PV RC

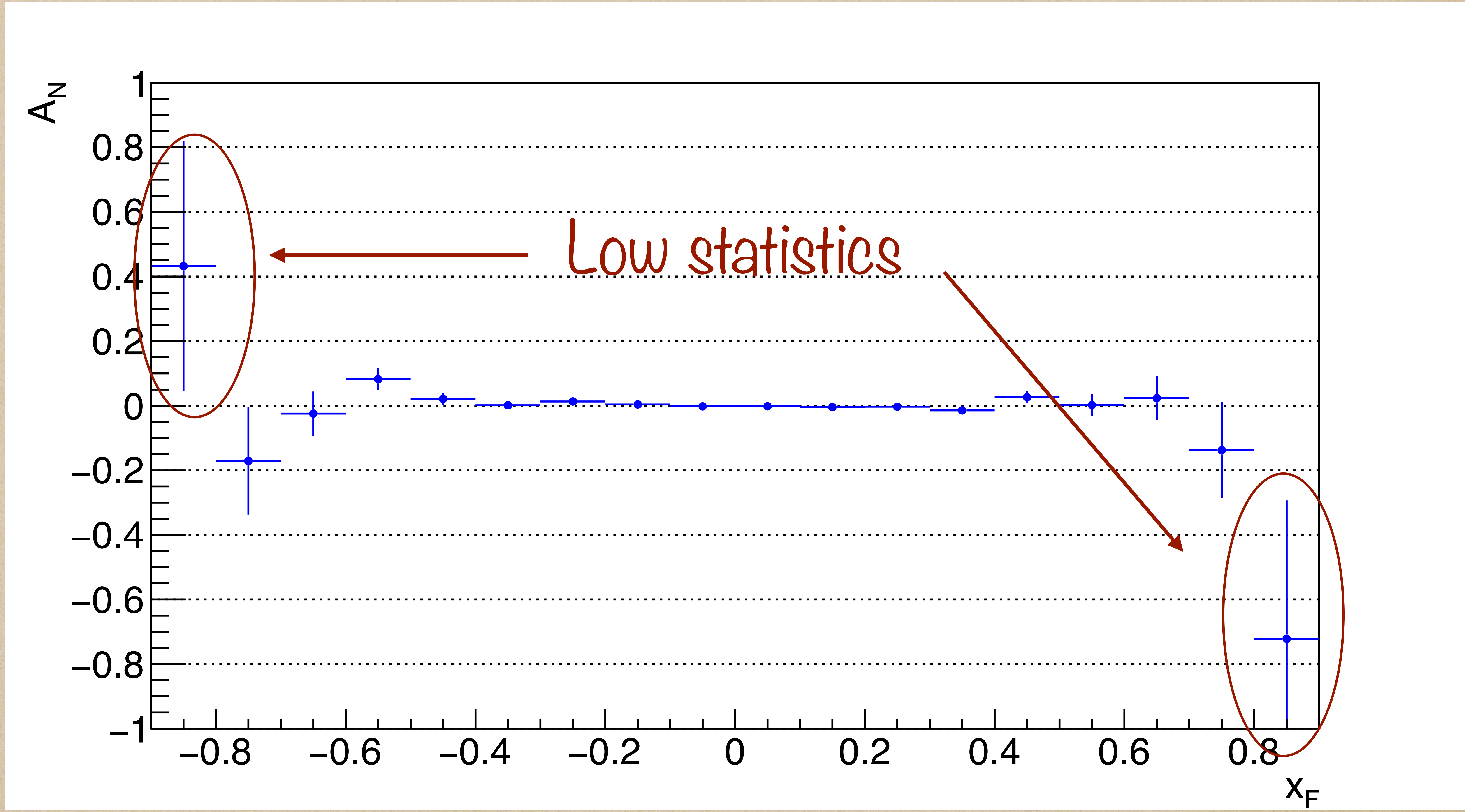
$\sigma_Z < 4\ cm$


Z of PV
Before
After
MC
Z, cm
RC/MC
Before
After


Z of pv
σ_Z [cm]
Z [cm] of PV RC
Before
After
Z [cm] of PV RC
Z [cm] of PV MC

$A_N(\pi^+, p_T > 0.5\ GeV/c, P_{beam} = 0.7)$





Azimuthal cosine modulations