Dependence of Forward π^0 Transverse Single Spin Asymmetries on Roman Pot Triggers from $\sqrt{s} = 200$ GeV pp Collisions at STAR

– Analysis Status –

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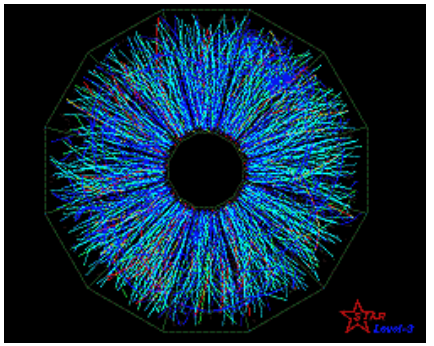
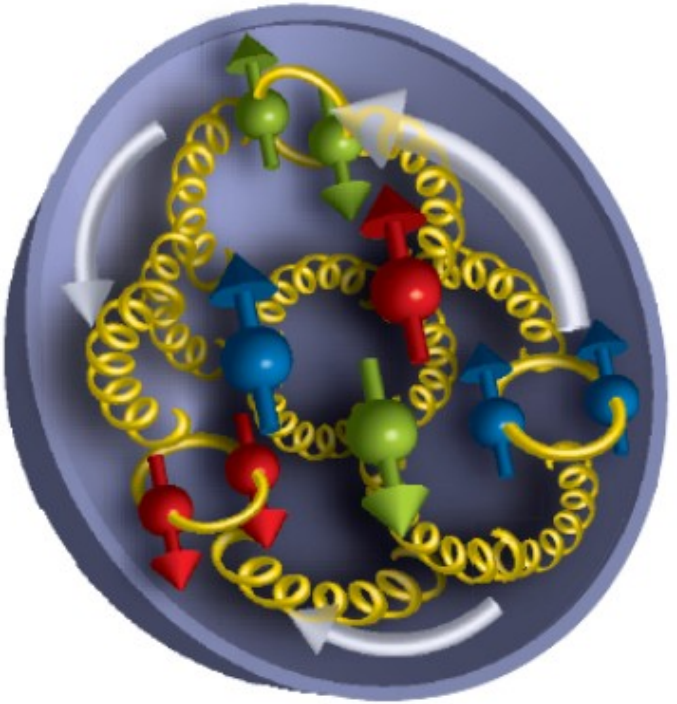
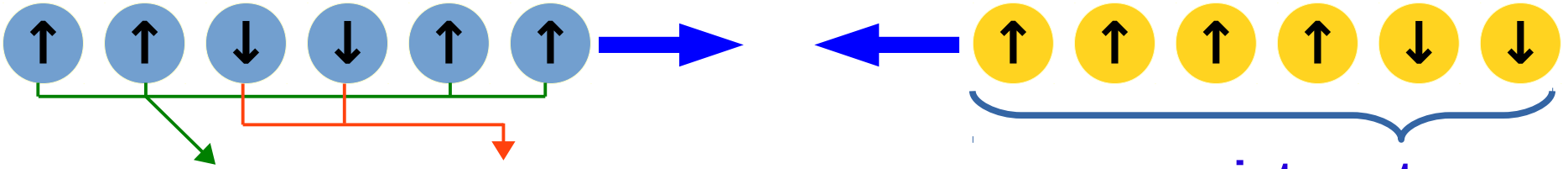


Outline

- Introduction and Motivation
- Calorimetry and Triggers at STAR
- Event Selection
- Asymmetry Projections



Transverse Single Spin Asymmetry



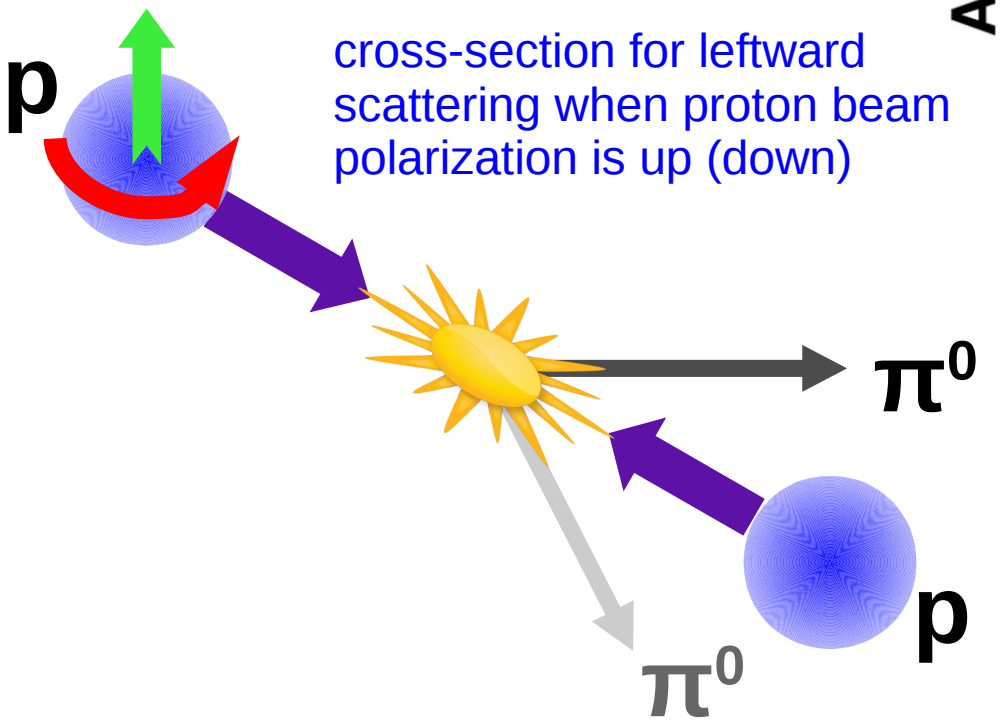
integrate over polarization

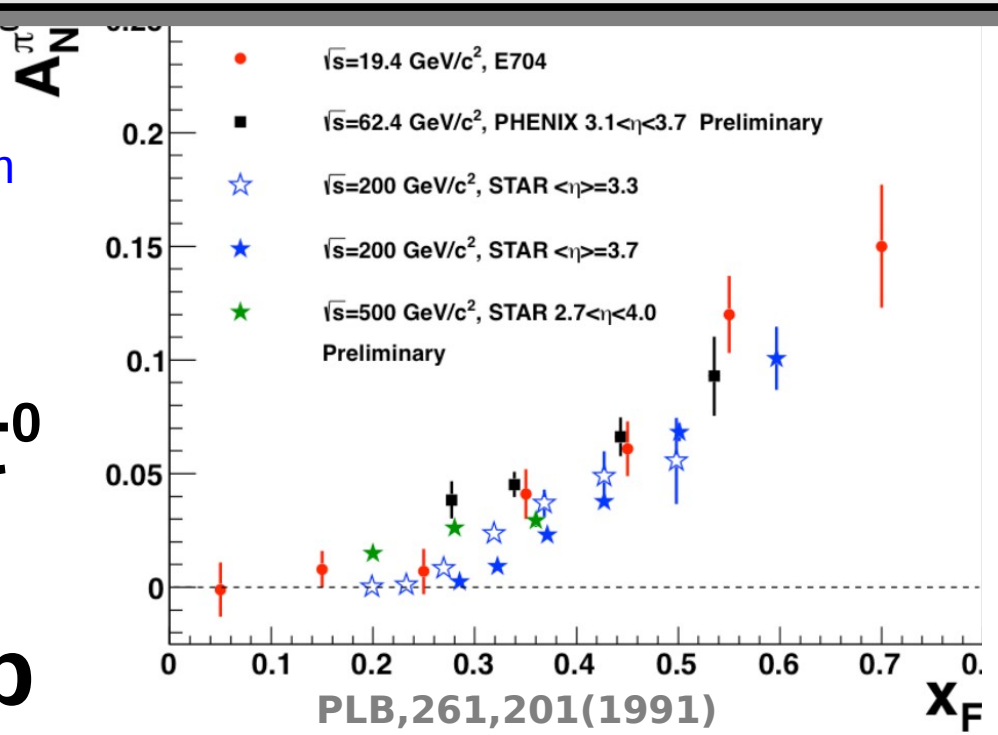
$$A_N = \frac{d\sigma^{\uparrow} - d\sigma^{\downarrow}}{d\sigma^{\uparrow} + d\sigma^{\downarrow}}$$

Large pion A_N, independent of CoM energy and rising with $x_F = 2p_L s^{-1/2}$, observed since 1976

$d\sigma^{\uparrow(\downarrow)}$

cross-section for leftward scattering when proton beam polarization is up (down)





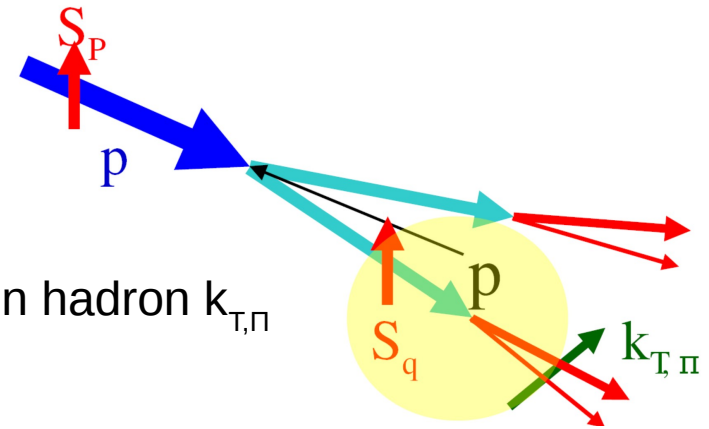
PLB,261,201(1991)
PRL,101,222001(2008)
PRD,90,012006(2014)

pQCD 2→2 Mechanisms for A_N

Collins Mechanism

Azimuthal dependence of hadrons in each jet

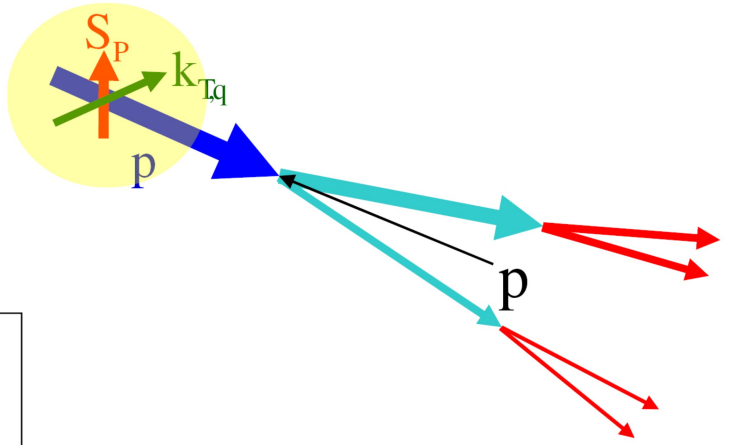
Correlation between struck parton spin and fragmentation hadron $k_{T,\Pi}$

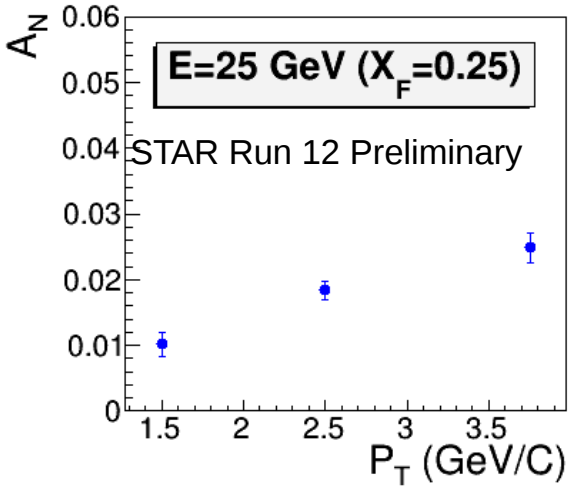


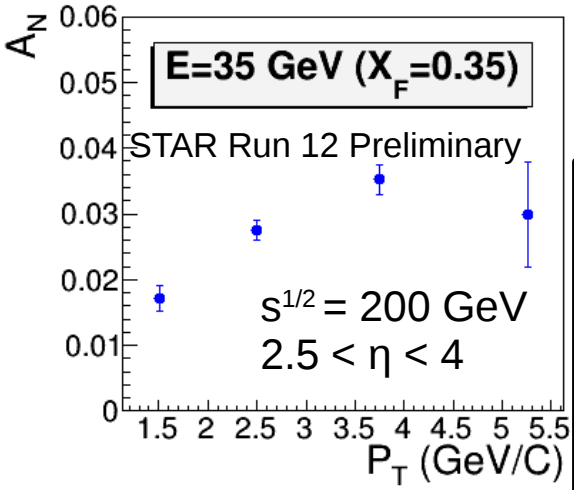
Sivers Mechanism

Azimuthal dependence of jet production

Correlation between initial parton $k_{T,q}$ and proton spin







Collins, Sivers, (and twist-3) models predict $1/p_T$ dependence of A_N

...but A_N appears to rise with p_T (at low x_F)

A_N in Diffractive Processes?

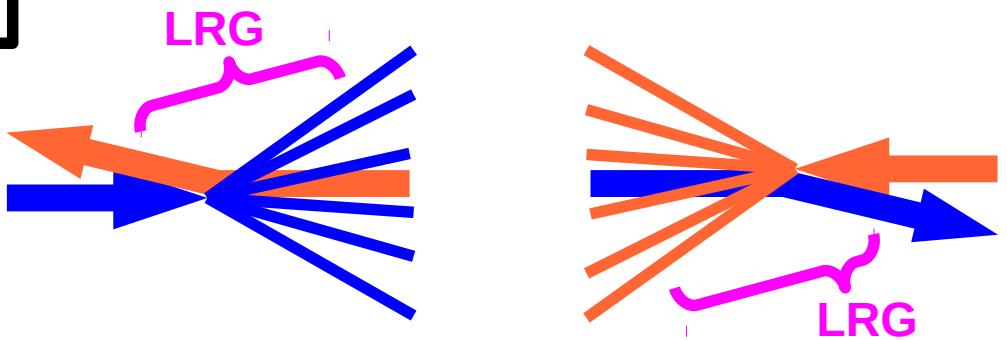
- Large A_N and its p_T dependence unexplained
- Any contributions from diffraction?

Main signatures of diffraction

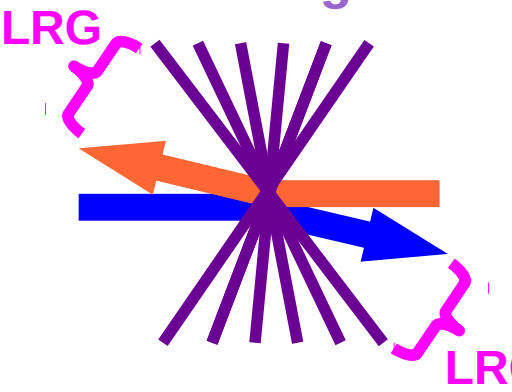
- Projectile proton diffracts around target proton
- One or both protons remain intact and only slightly deflected
  - Deflected protons observable in **Roman Pots**
- Both protons shatter in double-diffraction
- Large pseudorapidity gaps (LRG)
- Modeled in QFT by pomeron exchange

Elastic Scattering

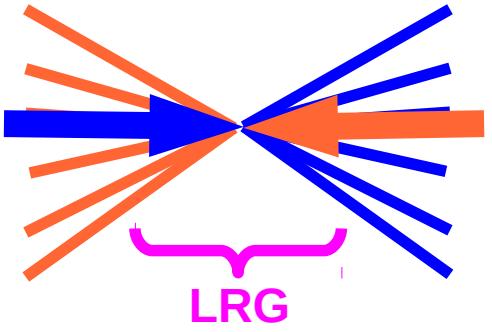
Single Diffractive Dissociation



Double Pomeron Exchange

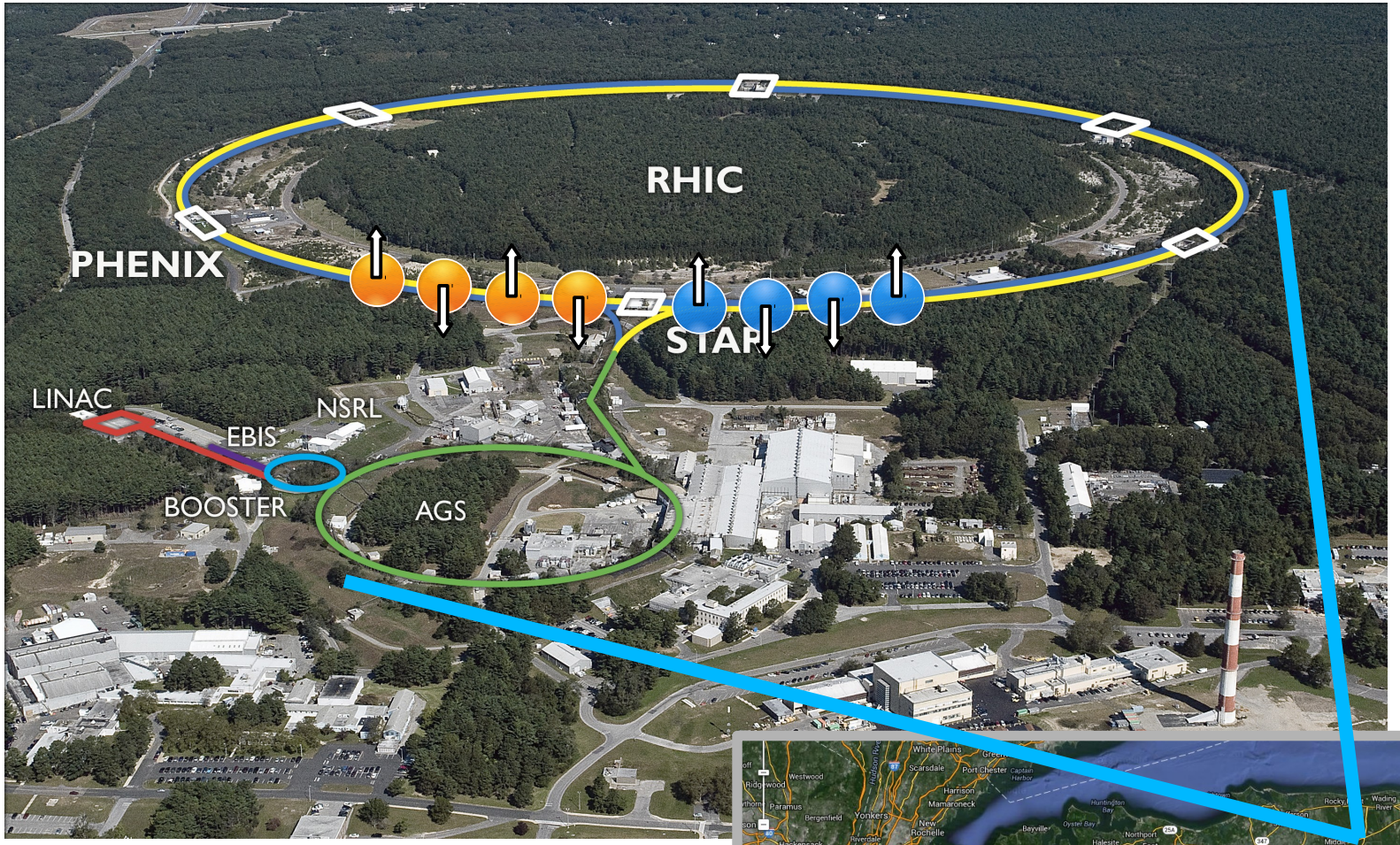


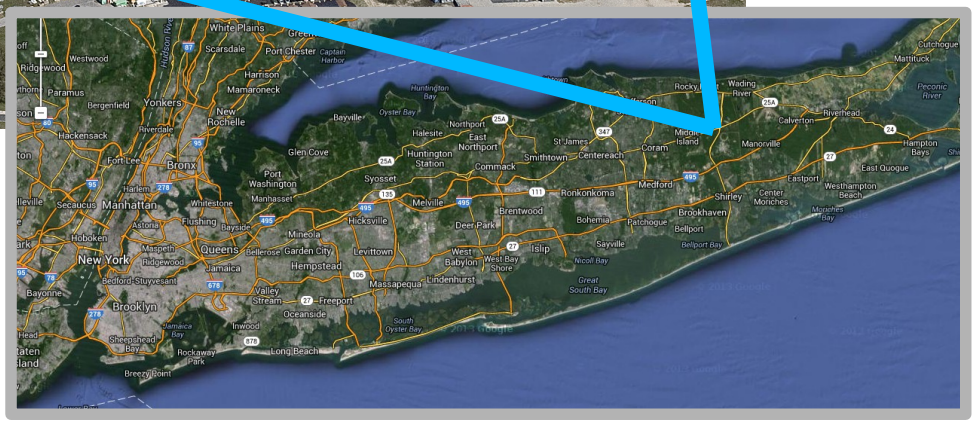
Double Diffractive Dissociation **



** RPs not sensitive to DD

Relativistic Heavy Ion Collider





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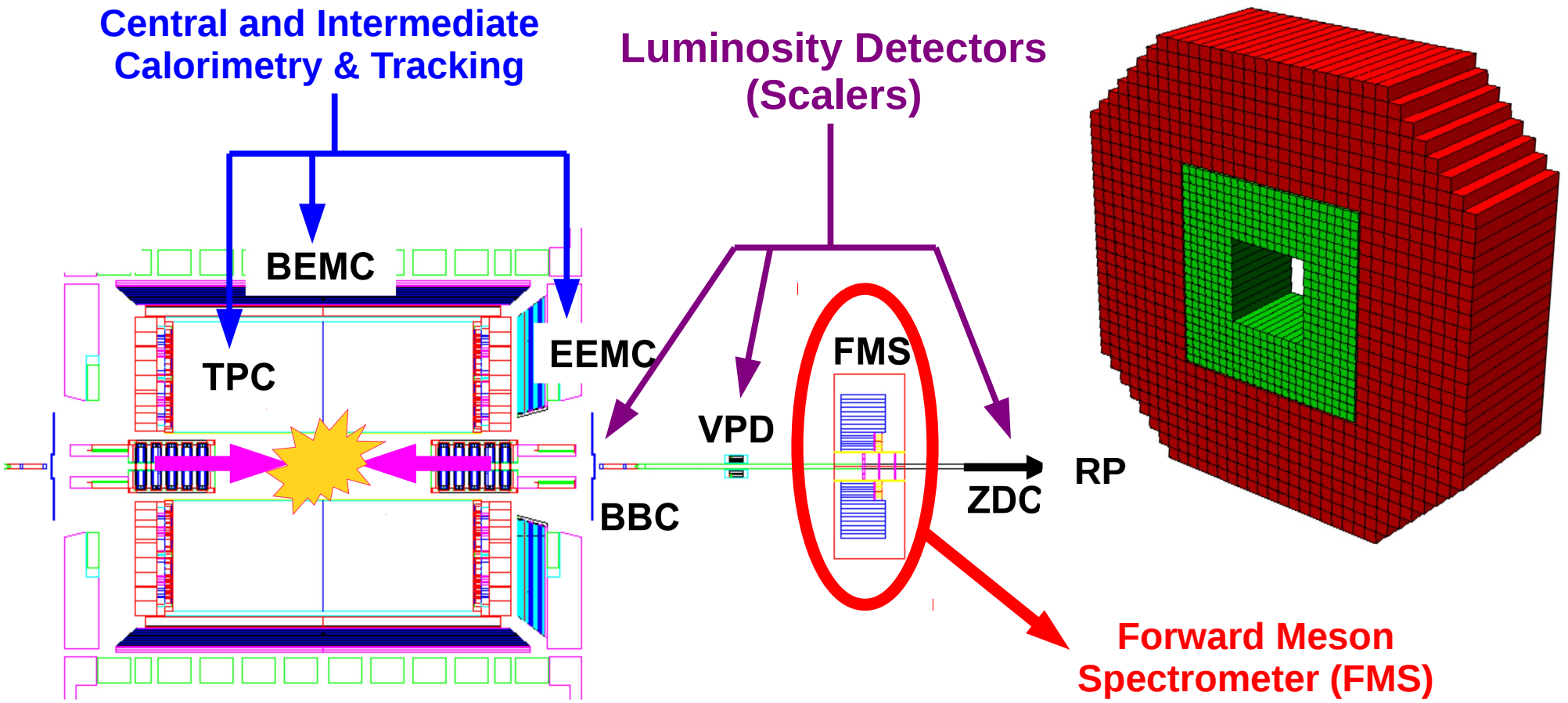
STAR and the FMS

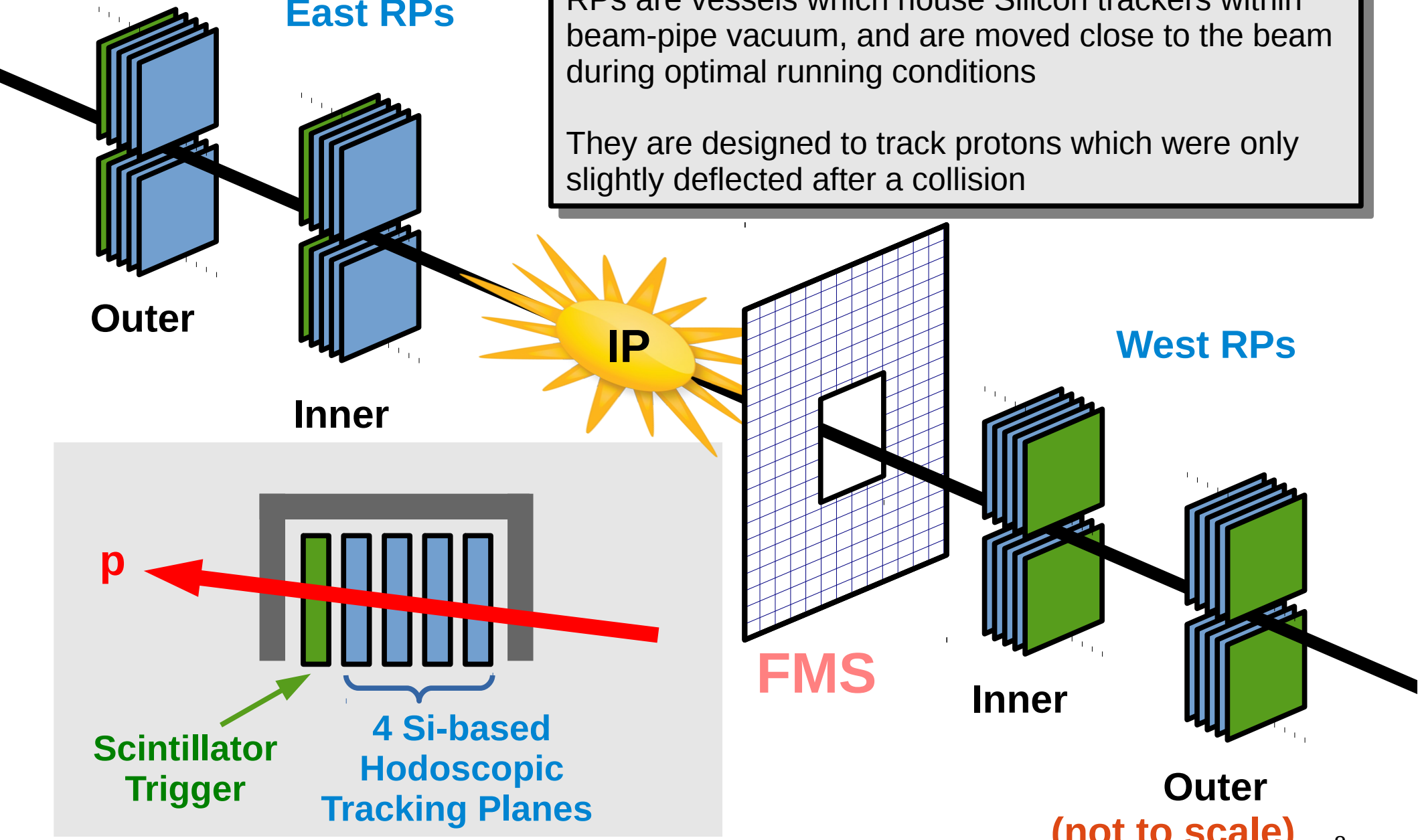


- Forward pseudorapdity: **2.5 < η < 4**
- 1,264 **Lead-glass cells** coupled to photomultiplier tubes
  - Large (5.8 x 5.8 cm) outer cells (red)
  - Small (3.8 x 3.8 cm) inner cells (green)
- Primarily Observes $\pi^0 \rightarrow \gamma+\gamma$ as 2-cluster events

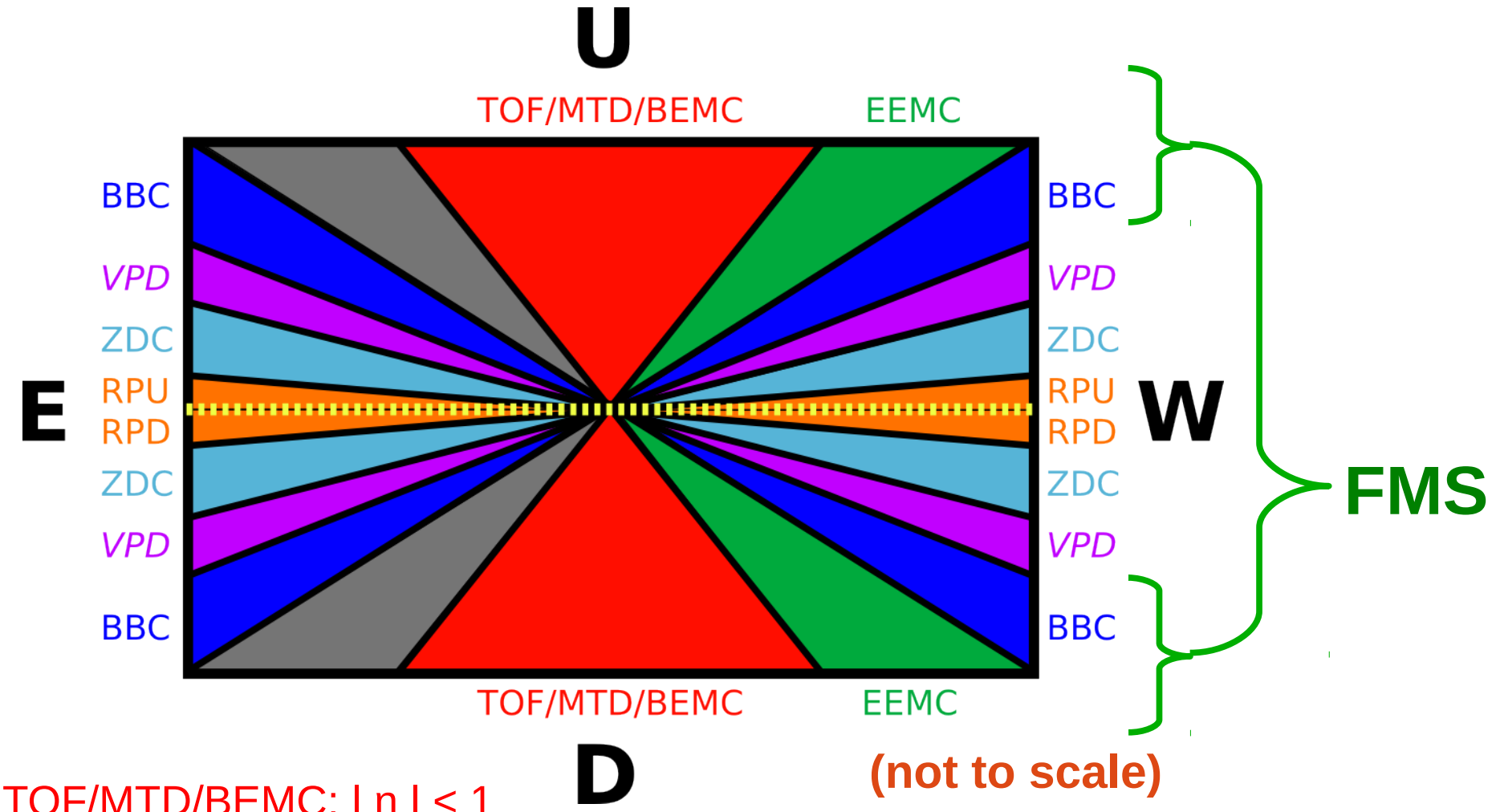
Roman Pots

RPs are vessels which house Silicon trackers within beam-pipe vacuum, and are moved close to the beam during optimal running conditions

They are designed to track protons which were only slightly deflected after a collision

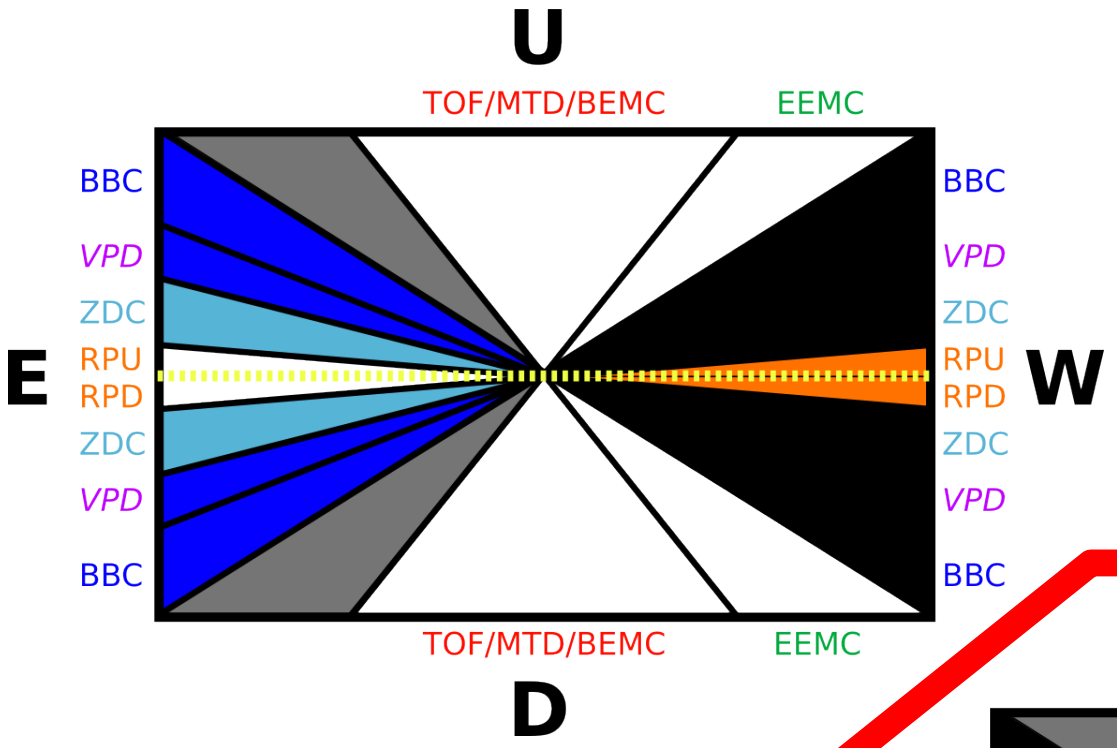


Trigger Detector Pseudorapidities



- TOF/MTD/BEMC: | η | < 1
- EEMC: 1 < η < 2
- BBC small tiles: 3.3 < | η | < 5 (@3.74m) … overlaps with small FMS cells
- VPD: 4.2 < | η | < 5 (@5.68m) … overlaps with BBC
- ZDC: 6.5 < | η | < 7.5 (@18.0m)

Single Dissociation Triggers



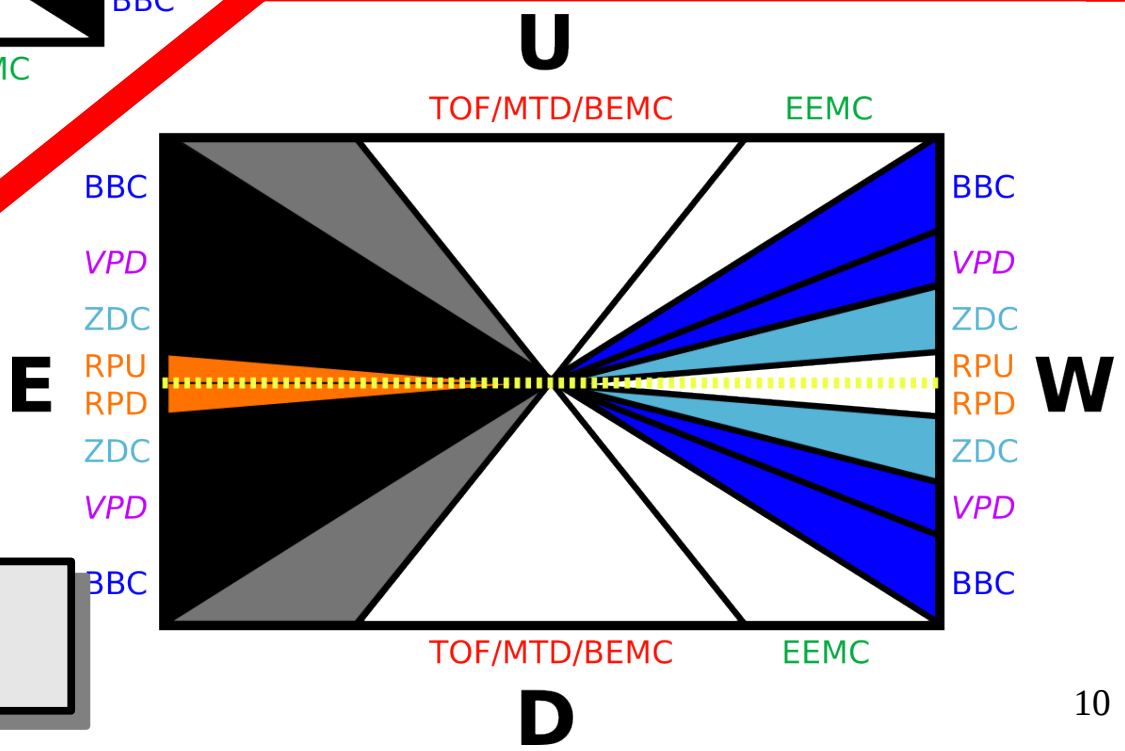
SDW

```
W-RP &
¬BBCW & ¬ZDCW &
( BBCE | ZDCE )
```

* black-colored regions are vetoes

SDE

```
E-RP &
¬BBCE & ¬ZDCE &
( BBCW | ZDCW )
```

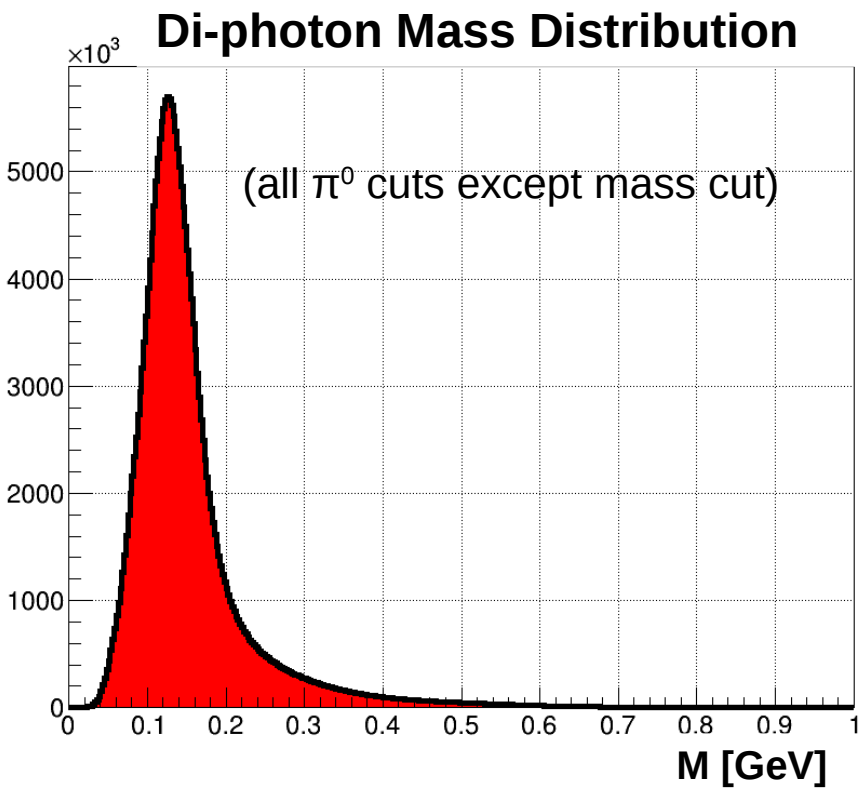


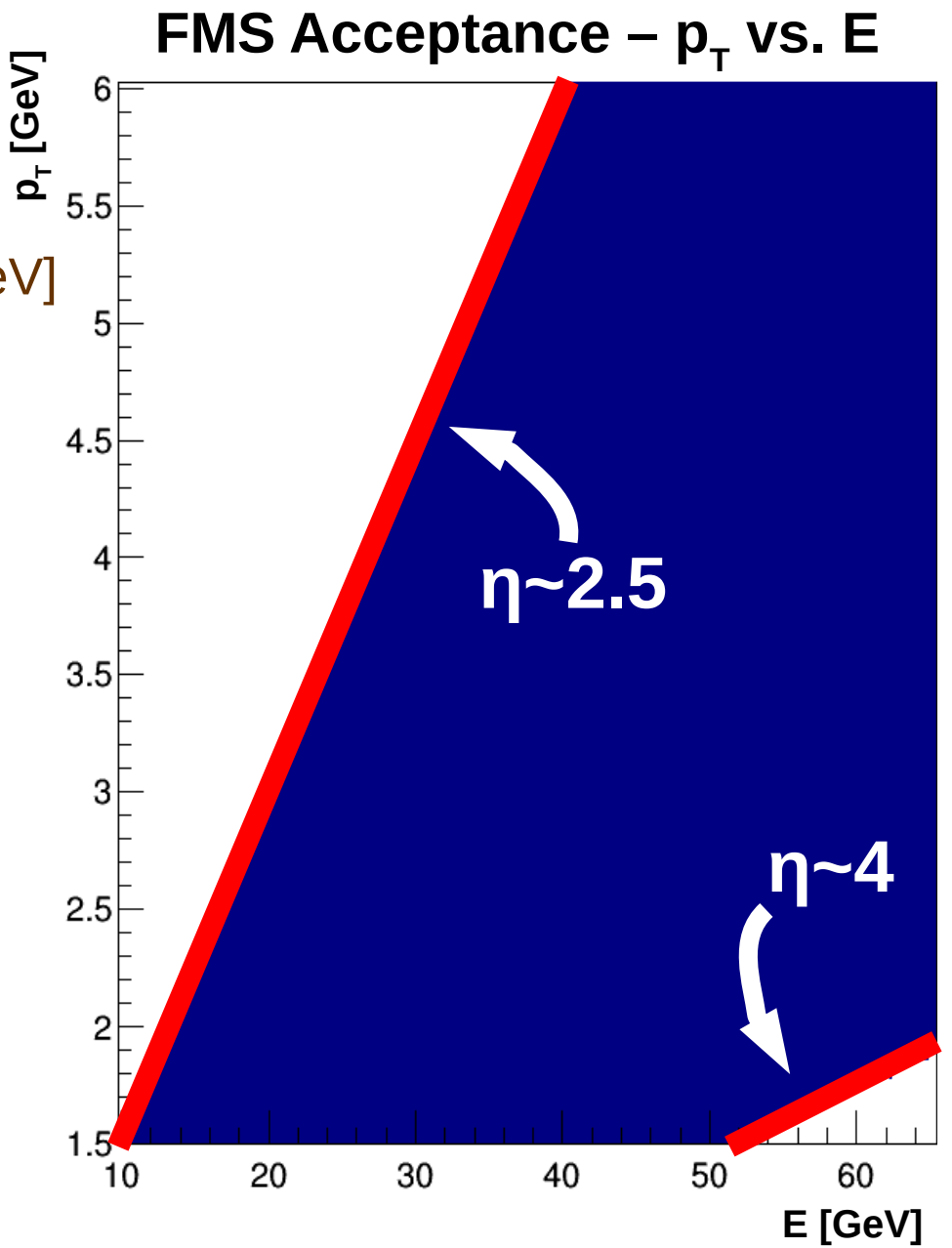
- Reconstruct proton tracks in RPs
- Reconstruct π^0s in the FMS

FMS π^0 Acceptance and Kinematics

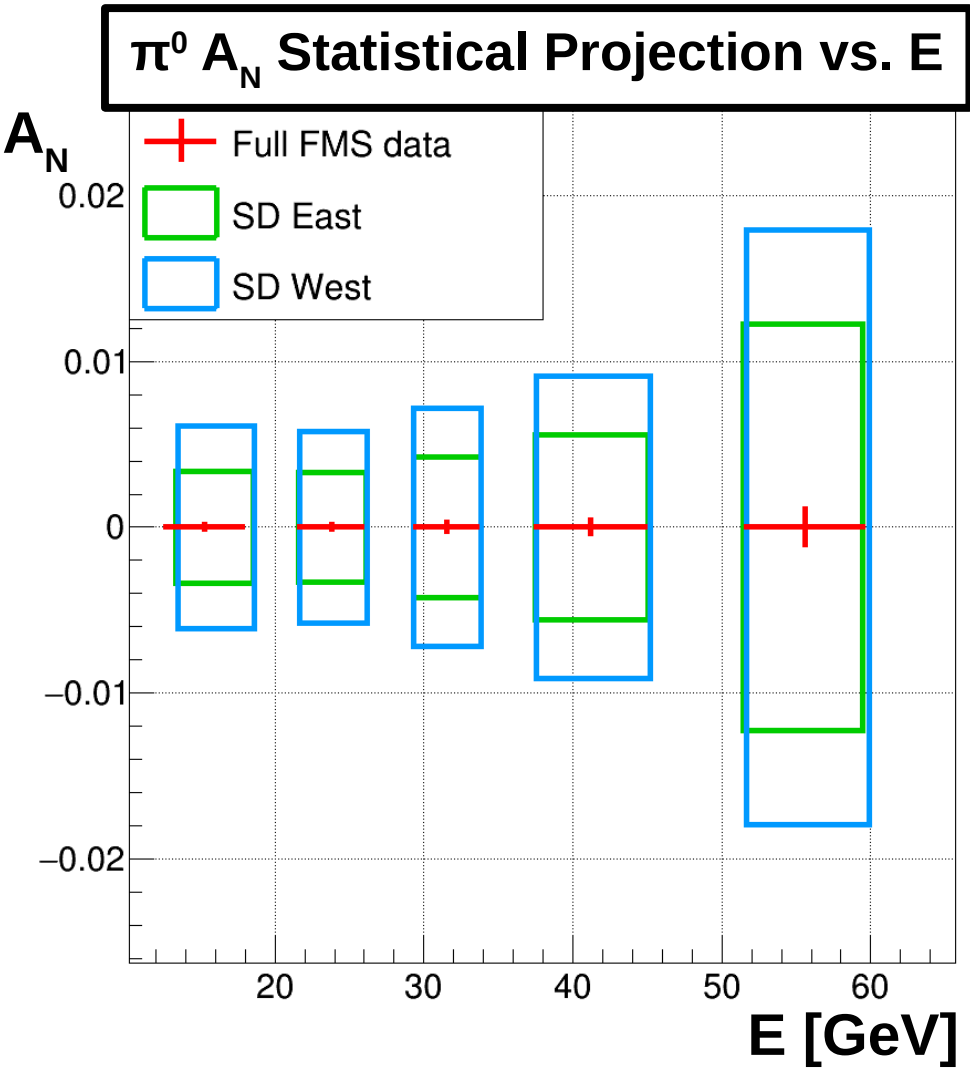
π^0 Event Selection

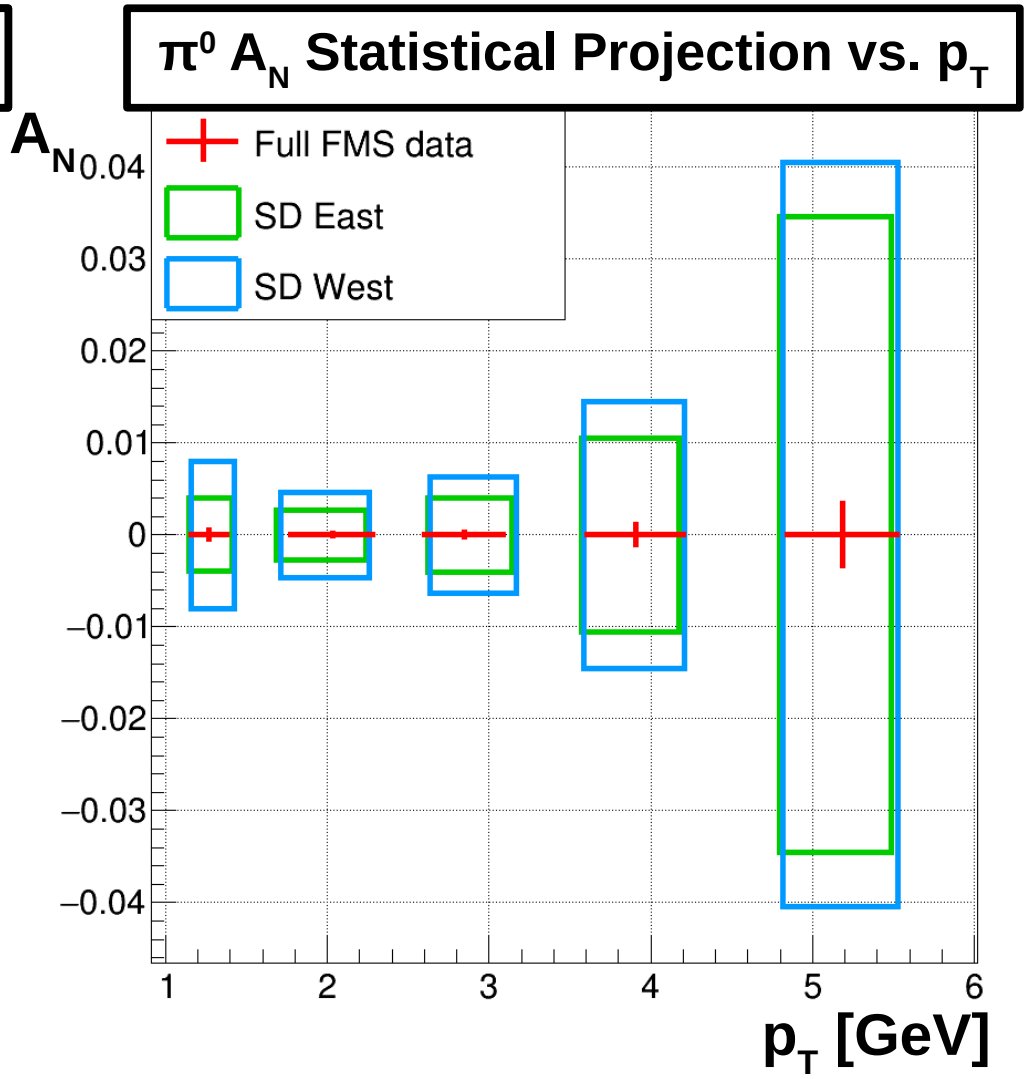
- 2-photon event
- $|E_1-E_2| / E < 0.8$
- $E > 10$ GeV and $p_T > 1$ GeV
- E-dependent mass cut [$M_{\pi 0}$~135 MeV]
- 35 mrad photon isolation cone





Asymmetry Projections

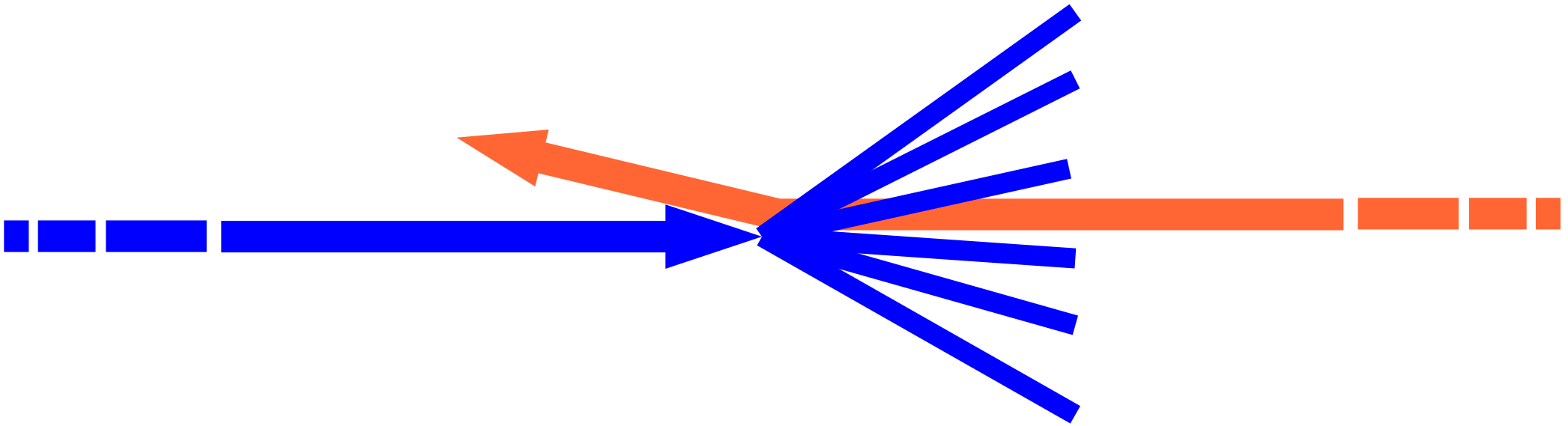




- 95% RP tracking efficiency assumed
- A_N ~3-5% in this kinematic region
- FMS+RP simultaneous trigger ~1.5 times more likely to be from real FMS+RP correlation than from random trigger overlap

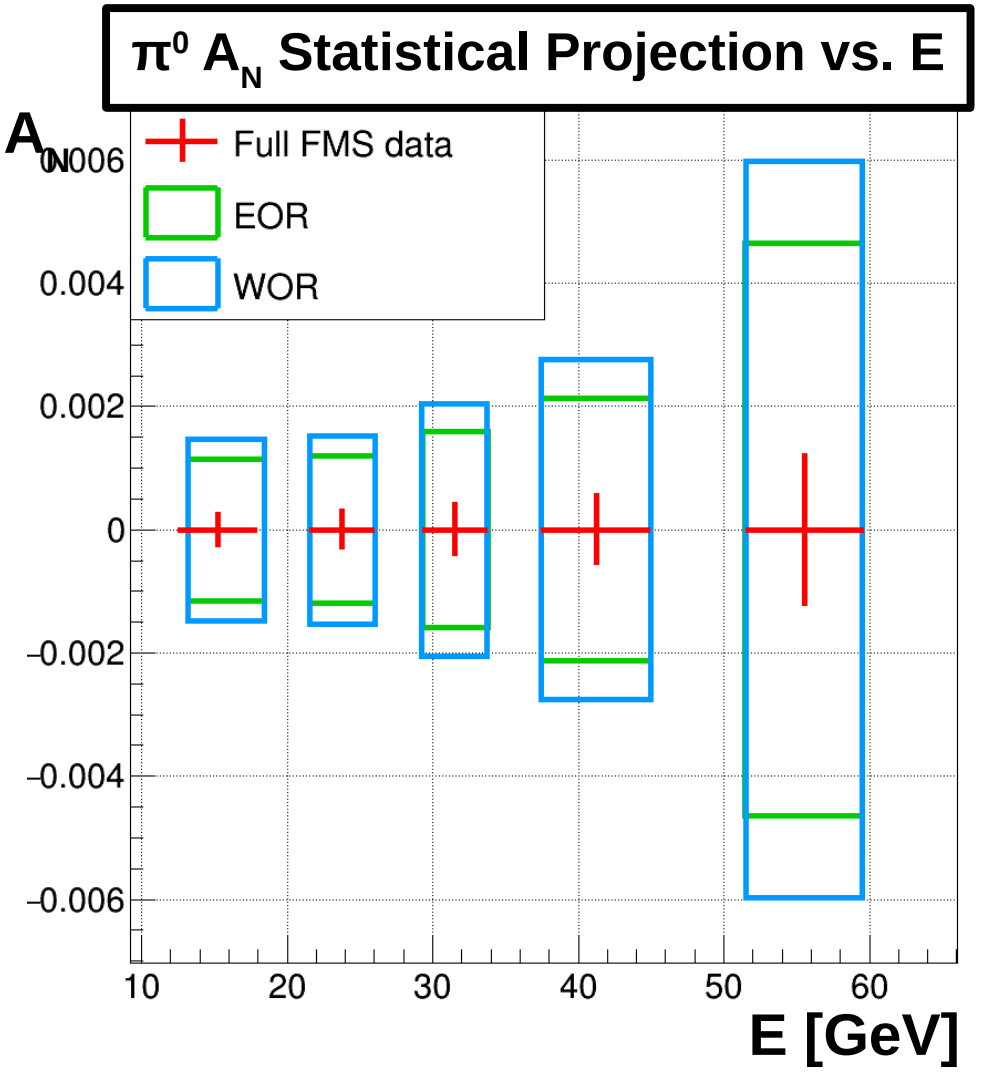
Analysis Status & Outlook

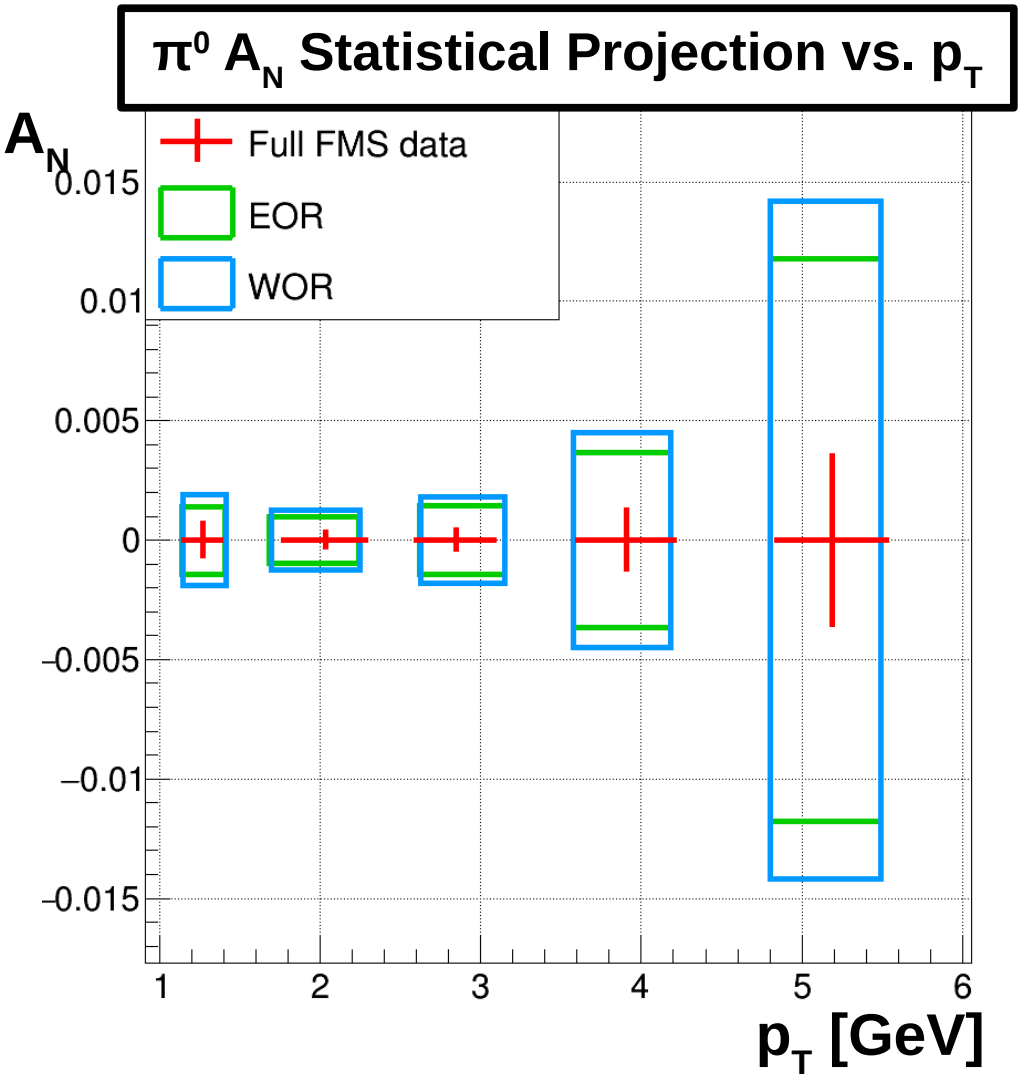
- RP proton track reconstruction algorithm almost complete; data to be processed soon
- RP trigger bit-matching issues to be solved
- Fine-tuning of diffractive-like trigger booleans and interpretation
- Stay tuned!



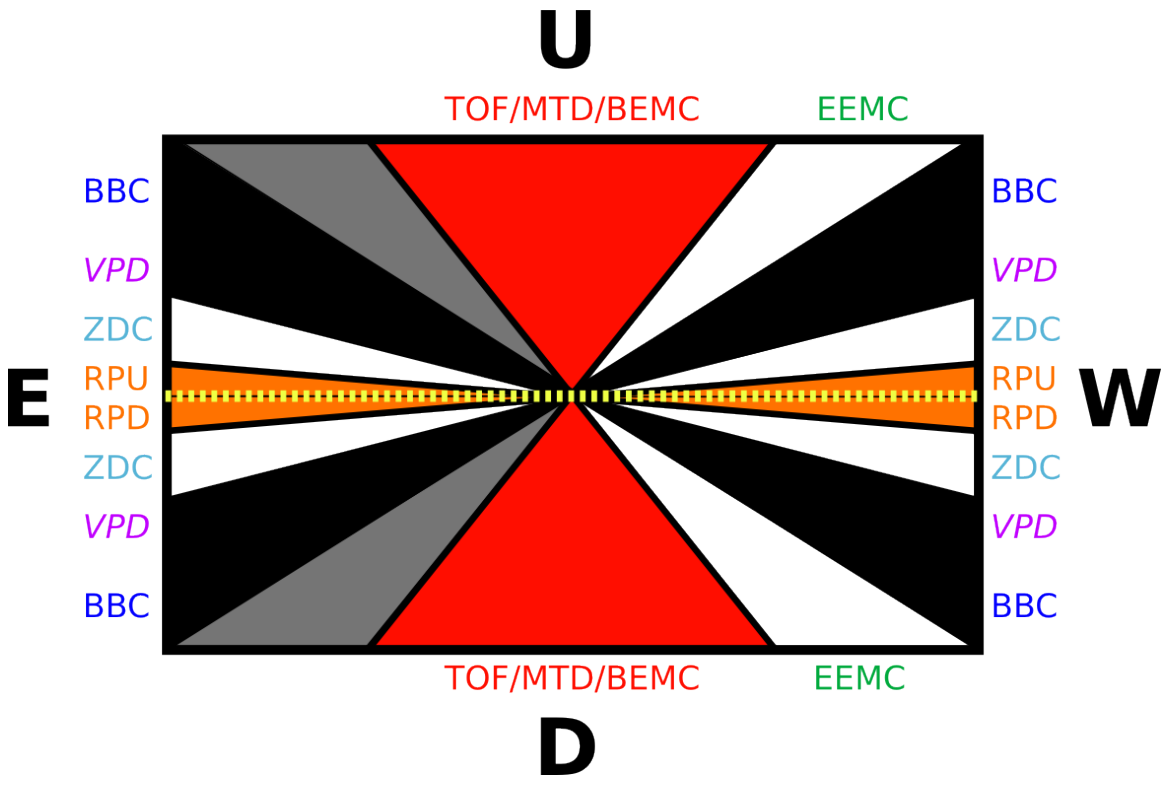
backup

Asym. Projections (EOR / WOR)





Double IP Exchange / Dissociation



Double IP Exchange

`E-RP & W-RP & ¬BBCW & ¬BBCE & TOF`

Double Diffractive Dissociation:

- No protons will appear in RPs
- BBC (and VPD) are inadequate to characterize the sprays of particles
- FMS can characterize spray on West side, but there is nothing comparable on the East side