Two-Particle Correlations in p+p and p+Au Collisions with the MPC+MPC-EX detector at RHIC-PHENIX

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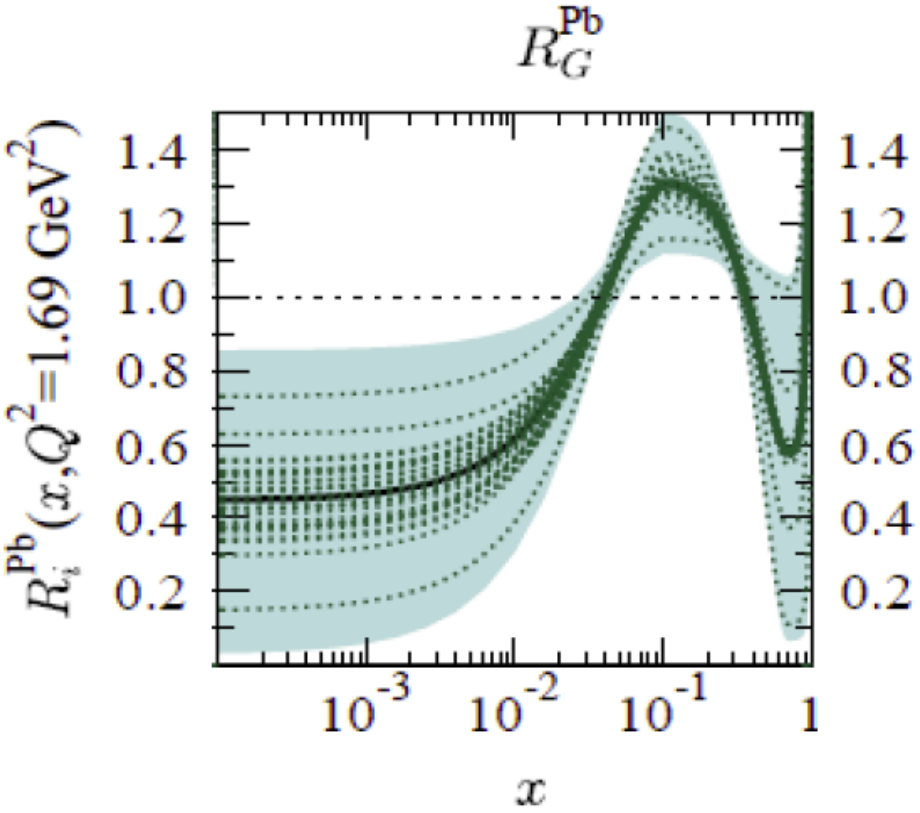
Outline

- Pinning down nuclear parton distribution functions
- Highlights of how PHENIX has addressed this with forward measurements in 2008 d+Au.
- MPC-EX upgrade and expectations of furthering these measurements.

Nuclear Parton Distribution Functions (nPDFs)

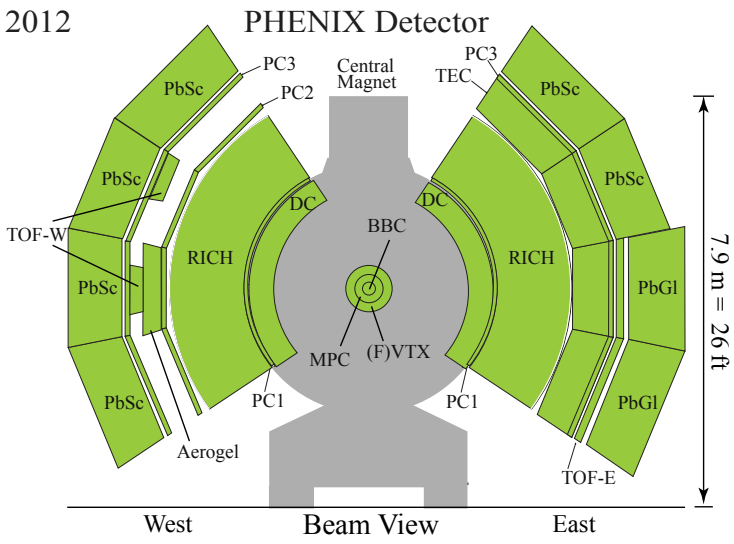
$$R_i^A = \frac{x f_i^A(x)}{A x f_i(x)}$$

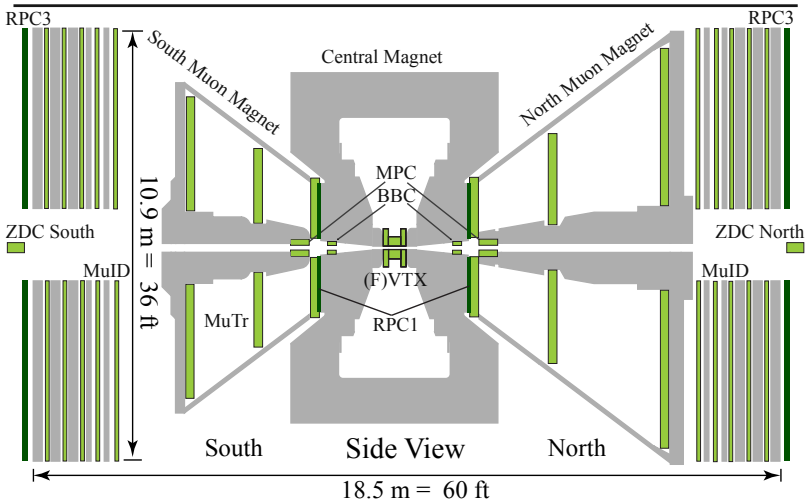
- By unitarity pinning down the location of the curve at any x affects the value at all other x.
- Experimental goals
  - Make measurements throughout this curve
  - Make measurements as a function of impact parameter
  - Look for physics beyond nPDF, i.e. cold nuclear matter energy loss



Ekola, Paukkunen, and Salgado, JHEP 0904:065 (2009)

PHENIX Experiment





- Central spectrometer: charged tracking, EM calorimetry, electron id
- Forward muon spectrometer, $1.2 < |\eta| < 2.2$
- MPC – $PbWO_4$ EM calorimeter, $3 < |\eta| < 3.8$

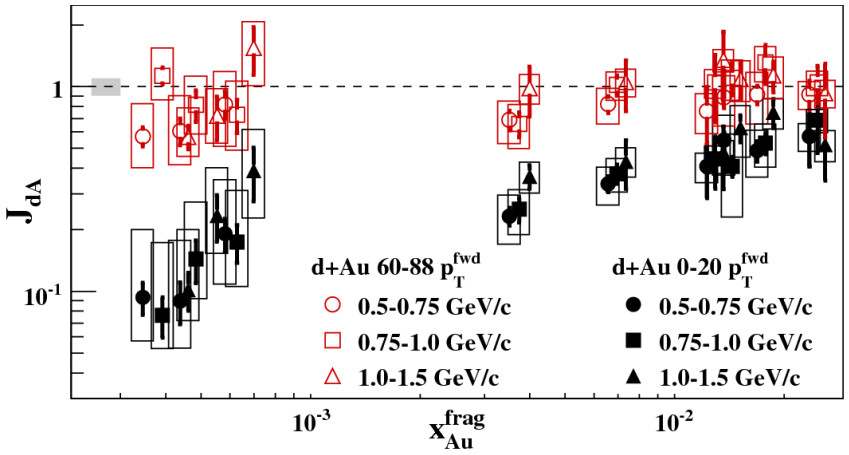
Correlated pairs with forward π^0

- Pair MPC clusters with π^0 identified in central arm or MPC.
- Pair suppression factor

$$J_{dA} = \frac{\mathrm{d+Au\ yield}}{\langle N_{coll} \rangle \times \mathrm{p+p\ yield}}$$

- Measured as a function of an approximation for x

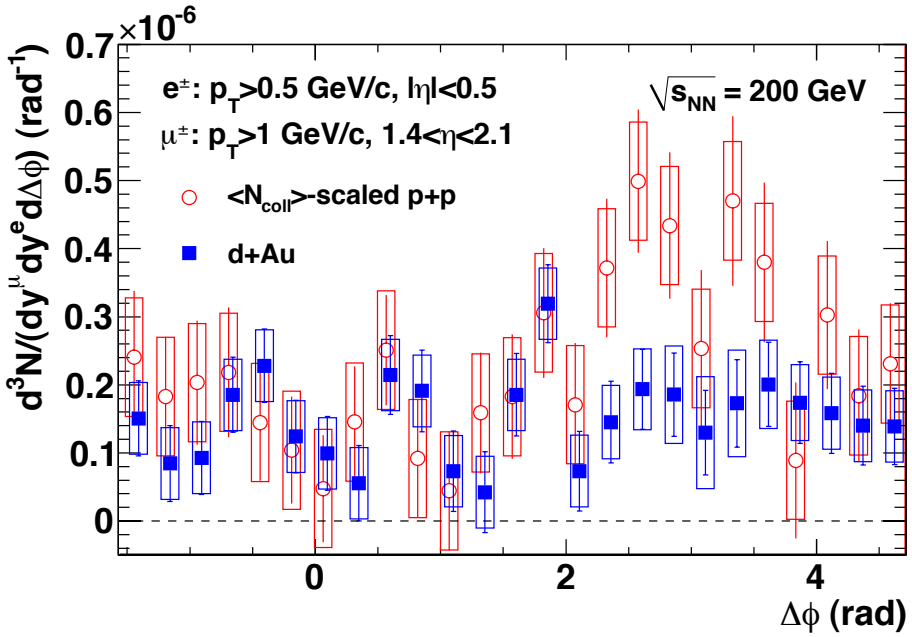
$$x_{\mathrm{Au}}^{frag} = \frac{\langle p_{T1} \rangle e^{-\langle \eta_1 \rangle} + \langle p_{T2} \rangle e^{-\langle \eta_2 \rangle}}{\sqrt{s_{NN}}}$$



A. Adare *et al.* (PHENIX Collaboration) Phys. Rev. Lett. **107**, 172301 (2011)

- Rate of pairs arising from lower-x partons in Au suppressed in central d+Au collisions compared to p+p.

Correlated Heavy Flavor $e - \mu$ Production



A. Adare *et al.* (PHENIX Collaboration) Phys. Rev. C **89**, 034915 (2014) as Editor's Suggestion

$J_{dAu}(2.7 < \Delta\phi < 3.2) = 0.433 \pm 0.087(\text{ stat.}) \pm 0.135\ (\text{syst.})$

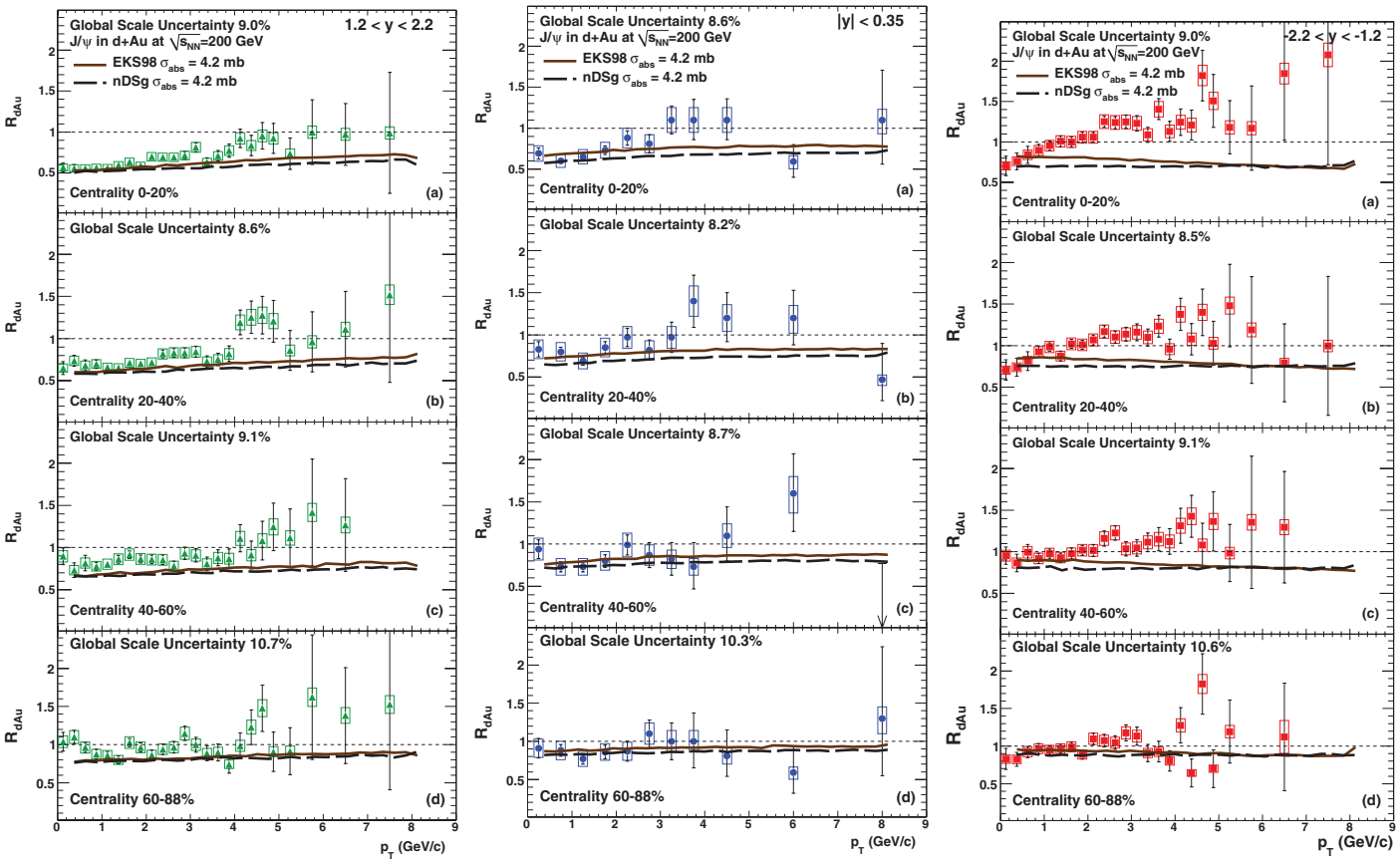
- $e^{\pm}$: $p_T > 0.5$ GeV, $|\eta| < 0.35$
- $\mu^{\pm}$: $p_T > 1.0$ GeV, $1.4 < \eta < 2.1$
  - d-going, probing low-x gluons in Au.
- Like-sign subtraction and other techniques removes all light-hadron backgrounds.
- $x \sim 10^{-2}$ at Q^2 =10 GeV^2, at the edge of the shadowing region.

J/ψ R_{dAu}

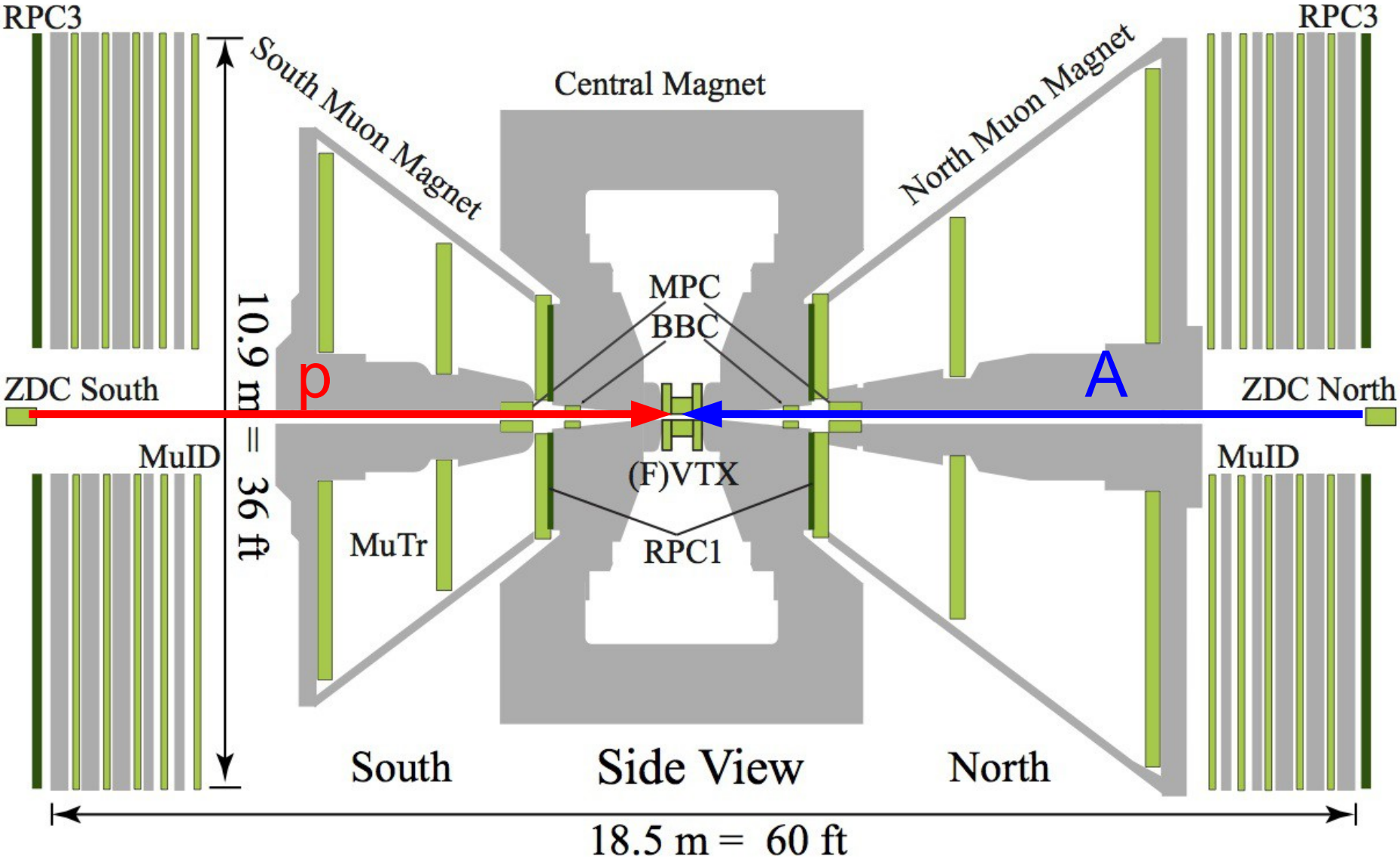
- Full p_T, y and centrality dependence of J/ψ

$$R_{dAu} = \frac{d + \mathrm{Au\ yield}}{\langle N_{coll} \rangle p + p\ \mathrm{yield}}$$

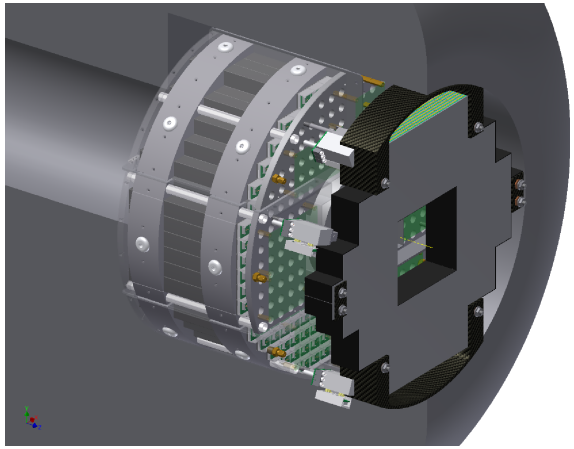
low-x intermediate-x high-x

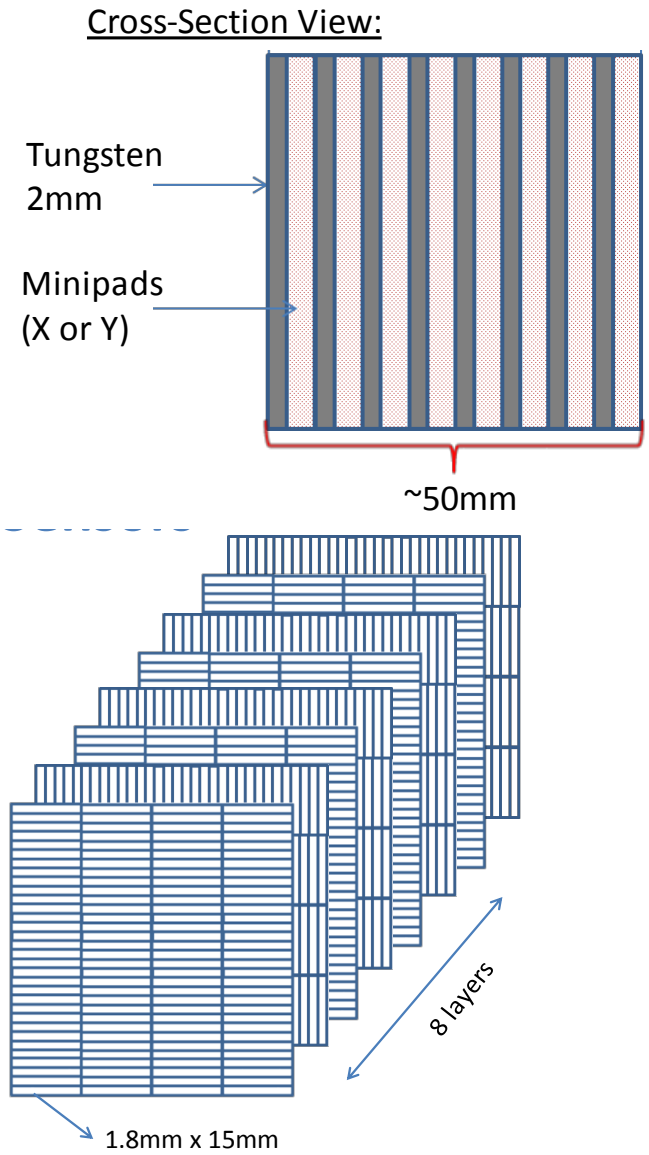


2015 p+A Running



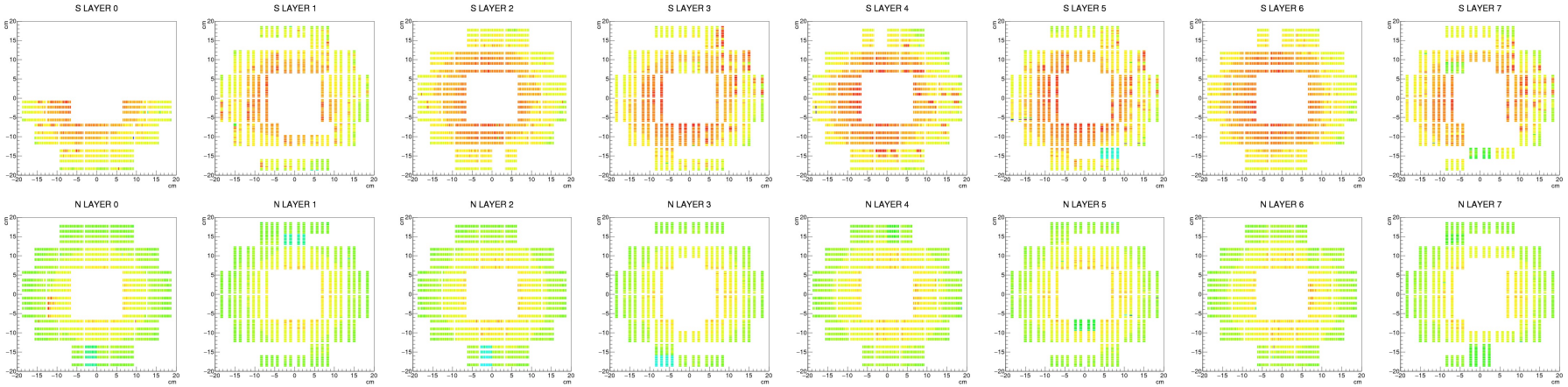
MPC-EX Upgrade





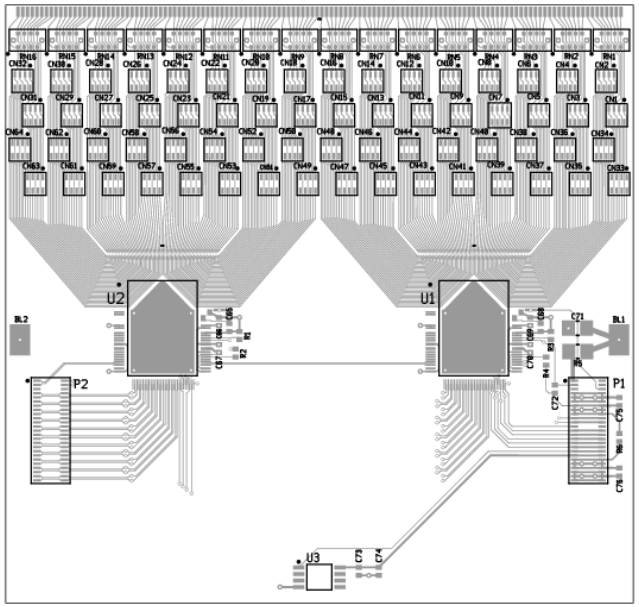
- Si-W pre-shower added in front of MPC
- Separate two photon showers from π^0 decays up to $E = 80$ GeV.
- Installed in Oct-Nov 2014 and taking data.
- Took data during 2015 $p + p$, p+Au and p+Al running at RHIC.

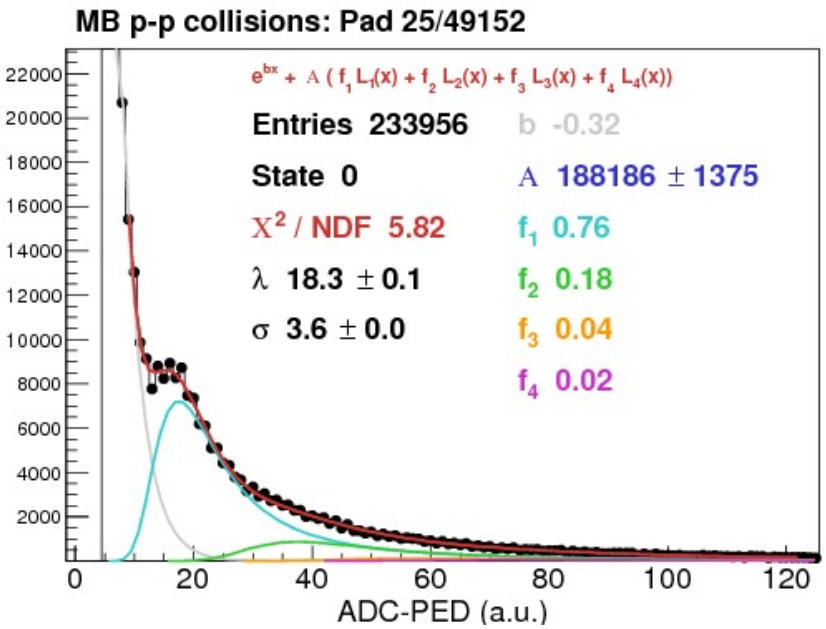
MPC-EX with Data



- Hit distribution in $p + p$ for each layer
- Top: South arm, backward rapidity, probes high-x in Au.
- Bottom: North arm, forward rapidity, probes low-x in Au.
- Left-to-right closest to furthest from the nominal interaction point.

MPC-EX with Data

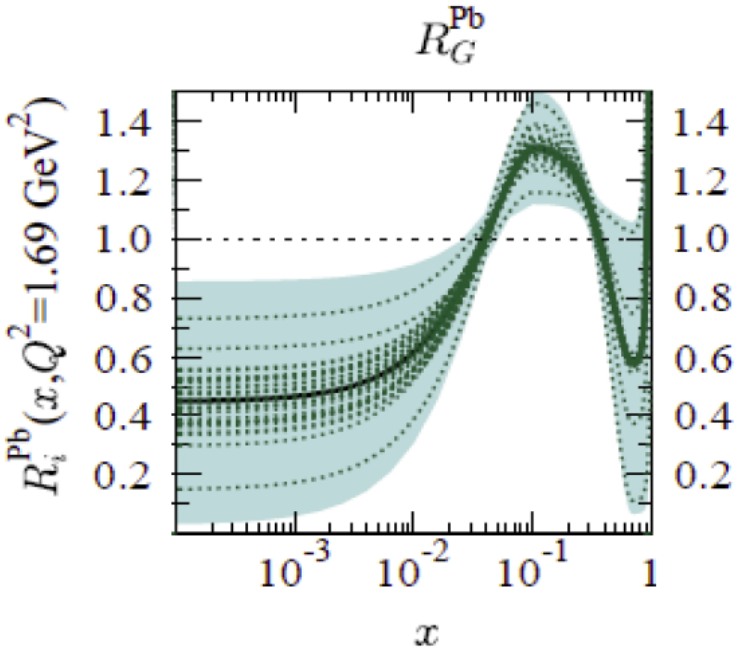


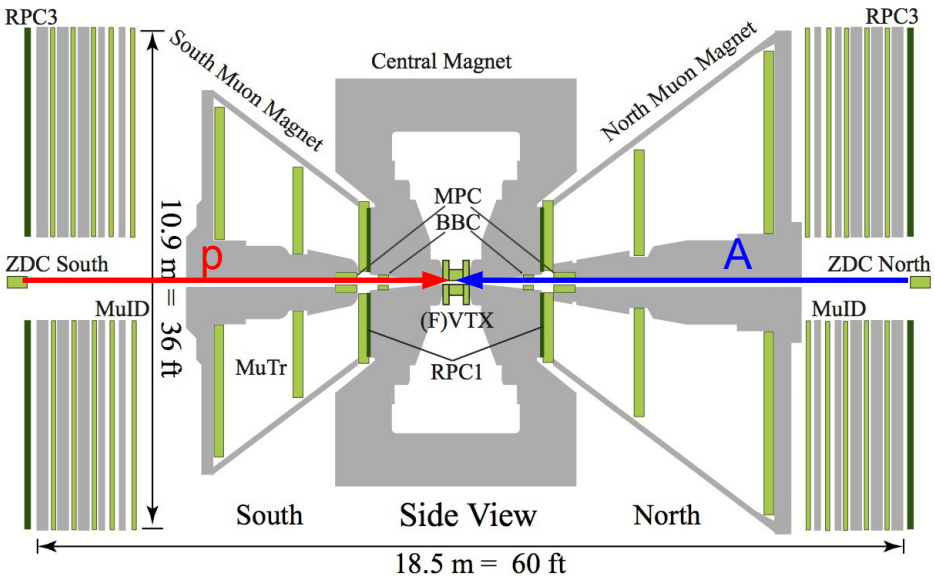


- Dual SVX-4 ADCs per 32x4 minipads
- Each minipad split between two capacitors, high gain/low gain 5.

- MIP visible in low gain channels after pedestal subtraction.
- Energy calibration ongoing.

Future Work





- Measure pairs of particles triggered with high-p_T identified π^0 in MPC+MPC-EX.
- Trigger on both north and south arm to access both low-x and high-x gluons in Au simultaneously.

Conclusions & Acknowledgements

- PHENIX has measured suppressed production of single particles and pairs at forward rapidity.
- No consistent picture from nPDF modification and energy loss can describe all data across p_T, η and centrality.
- MPC-EX upgrade increase the Q^2 range for measurements at forward rapidity.
- High statistics dataset for $p + p$ and p+Au on tape and being analyzed.

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