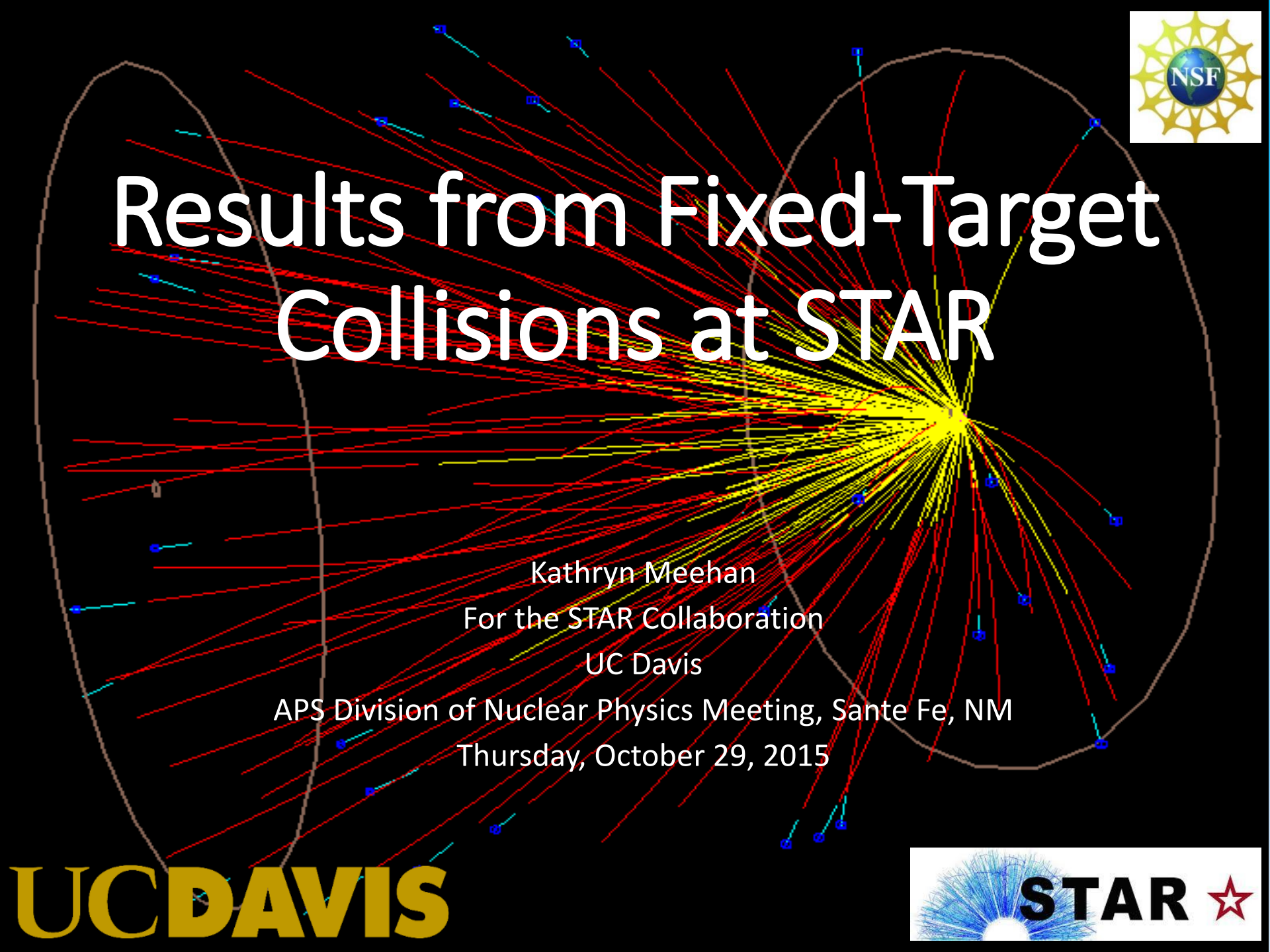


# Results from Fixed-Target Collisions at STAR

Kathryn Meehan
For the STAR Collaboration
UC Davis

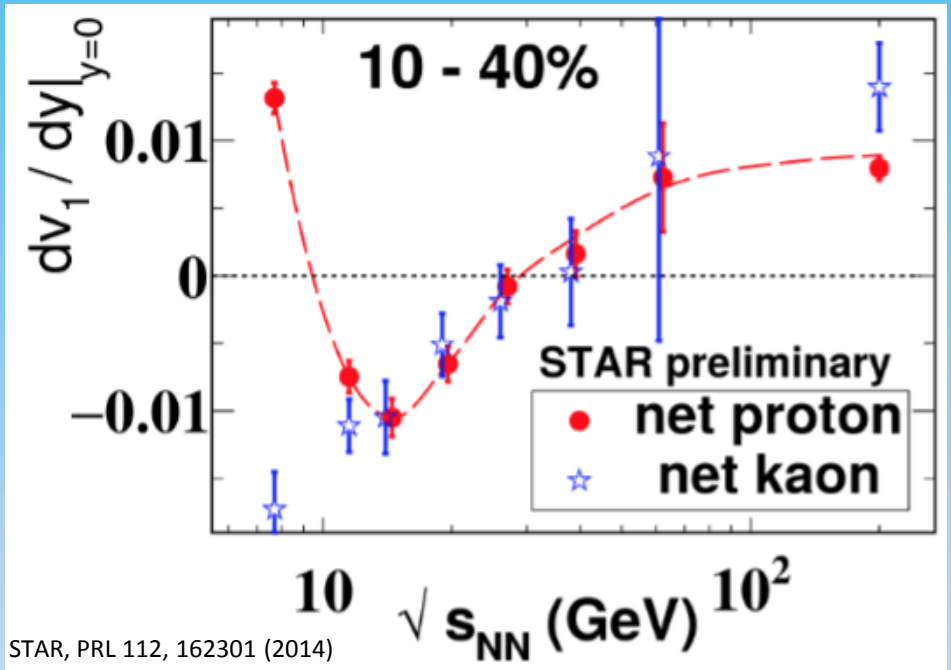
APS Division of Nuclear Physics Meeting, Sante Fe, NM
Thursday, October 29, 2015

# Why a Fixed-Target (FXT) Program?

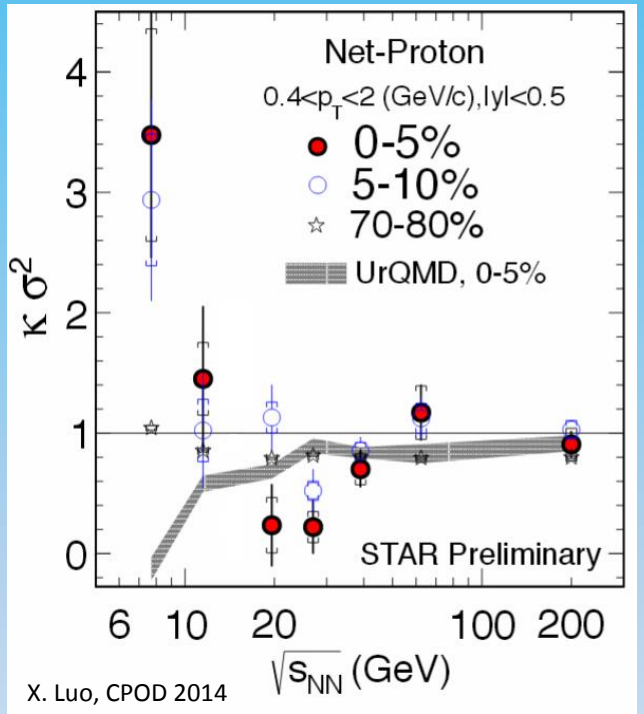
- STAR Beam Energy Scan (BES-I) results suggest a softening of the equation of state (EOS) and hints at critical fluctuations
- To help clarify these hints, STAR needs to access energies below 7.7 GeV where we expect no QGP formation
- At these lower energies the luminosity of RHIC is too low, making it impractical to take data in collider mode

The goals of BES-I:

1) Observe the disappearance of QGP signatures
2) **Find evidence of the first-order phase transition**
3) Find the possible Critical Point



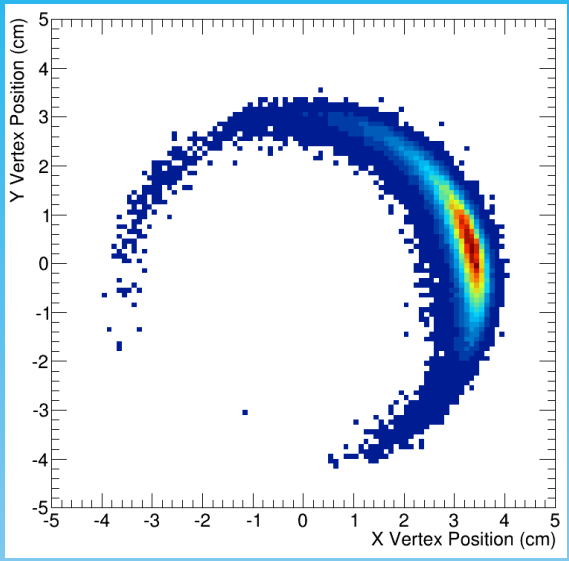

STAR, PRL 112, 162301 (2014)

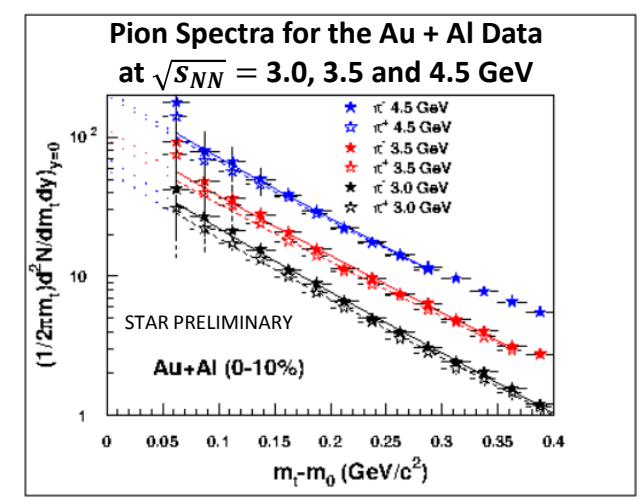


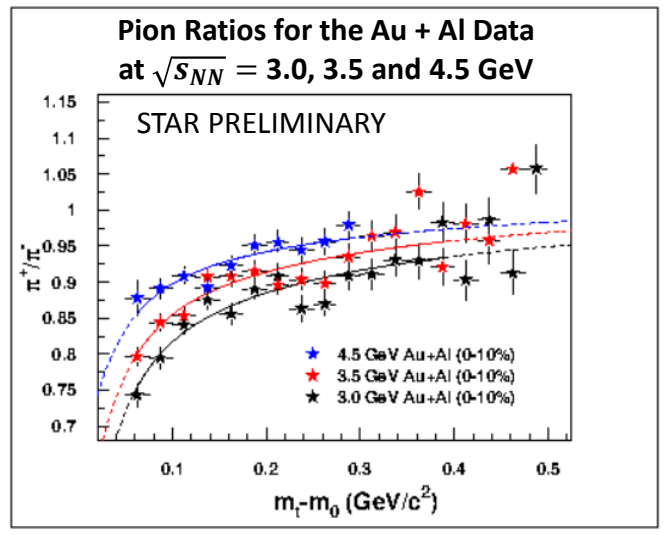

X. Luo, CPOD 2014

# Proof of Principle: Au + Al Beam Pipe Studies

**Vertex Distribution of Au + Al Beam Pipe Events**

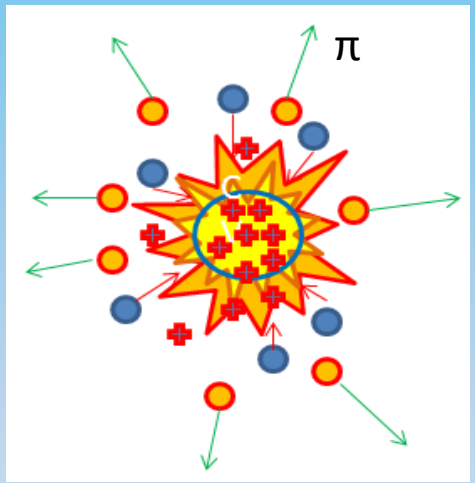


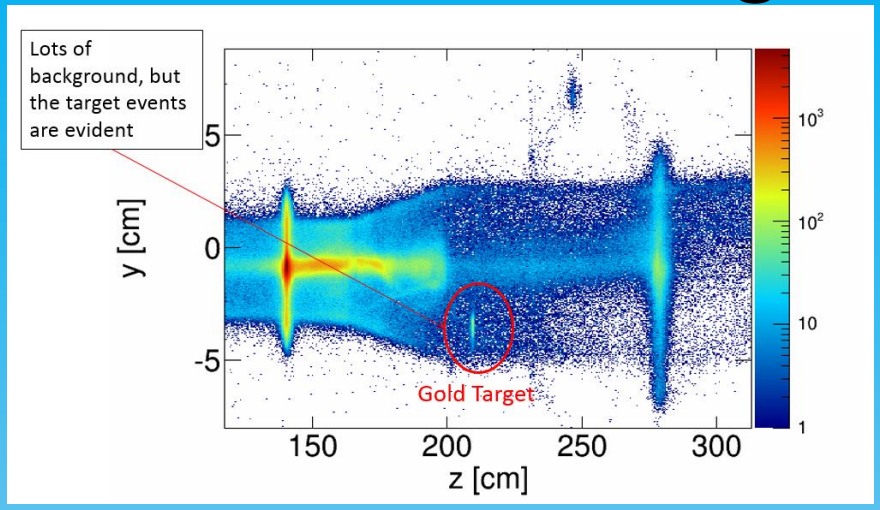




- Coulomb Potential has been extracted and shown to be consistent with previous experiments

- STAR software framework can successfully reconstruct fixed target vertices and has good acceptance and PID capabilities up to mid-rapidity

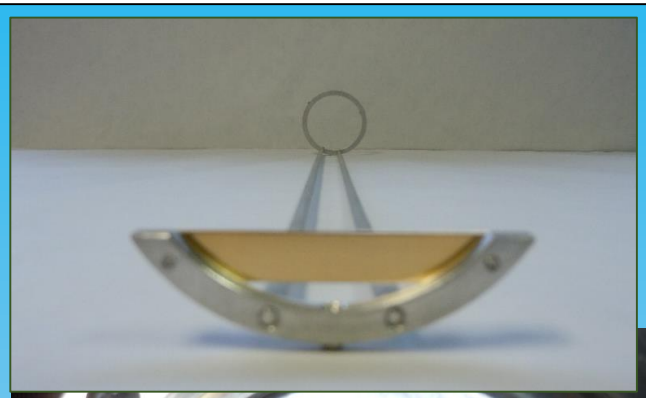


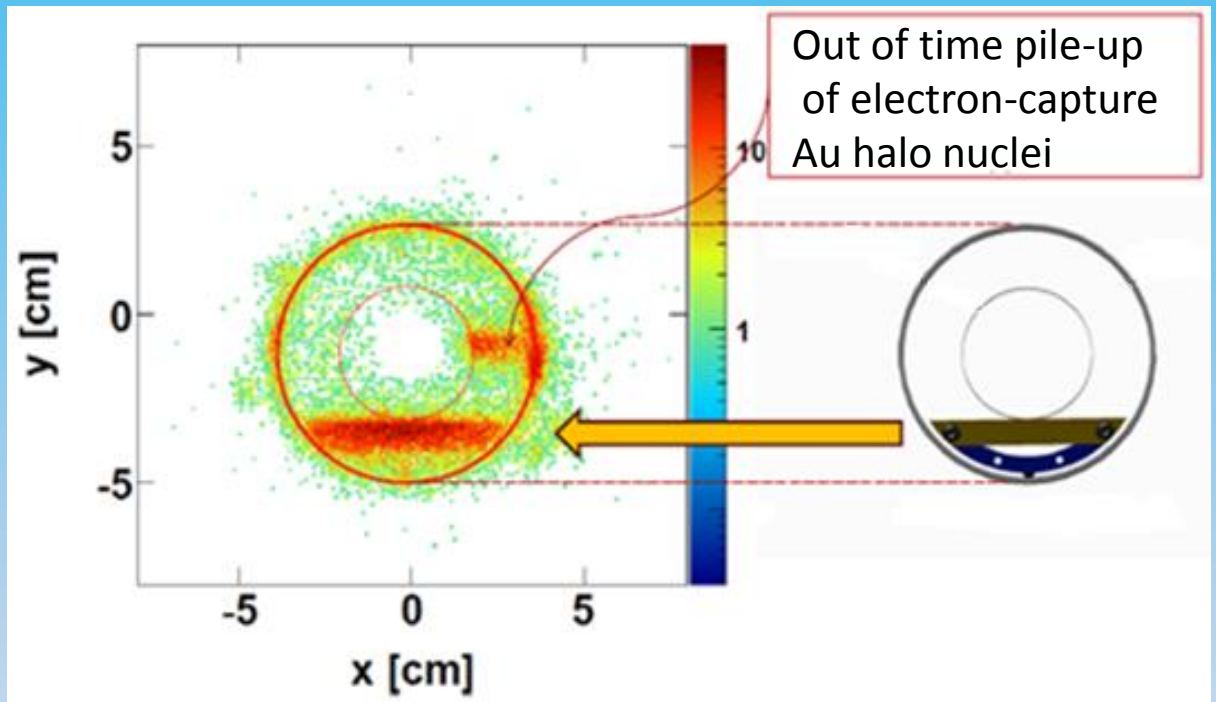
# Gold Target Installed for Run 14

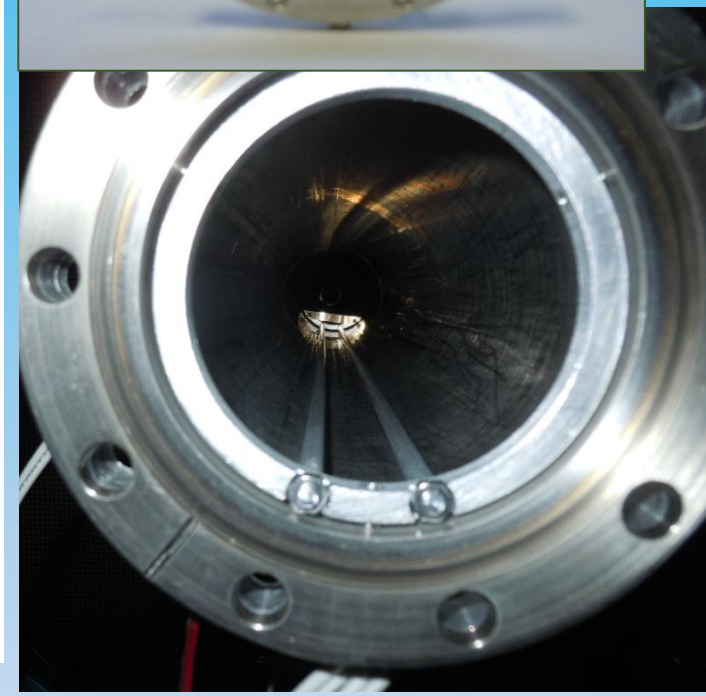



**Run 14 details:**

- Fixed Target 3.9 GeV data taken concurrently with 14.5 GeV Au + Au collider events
- The target foil is held 2 cm below of the beam axis.
- The foil is 1 mm thick (4%).

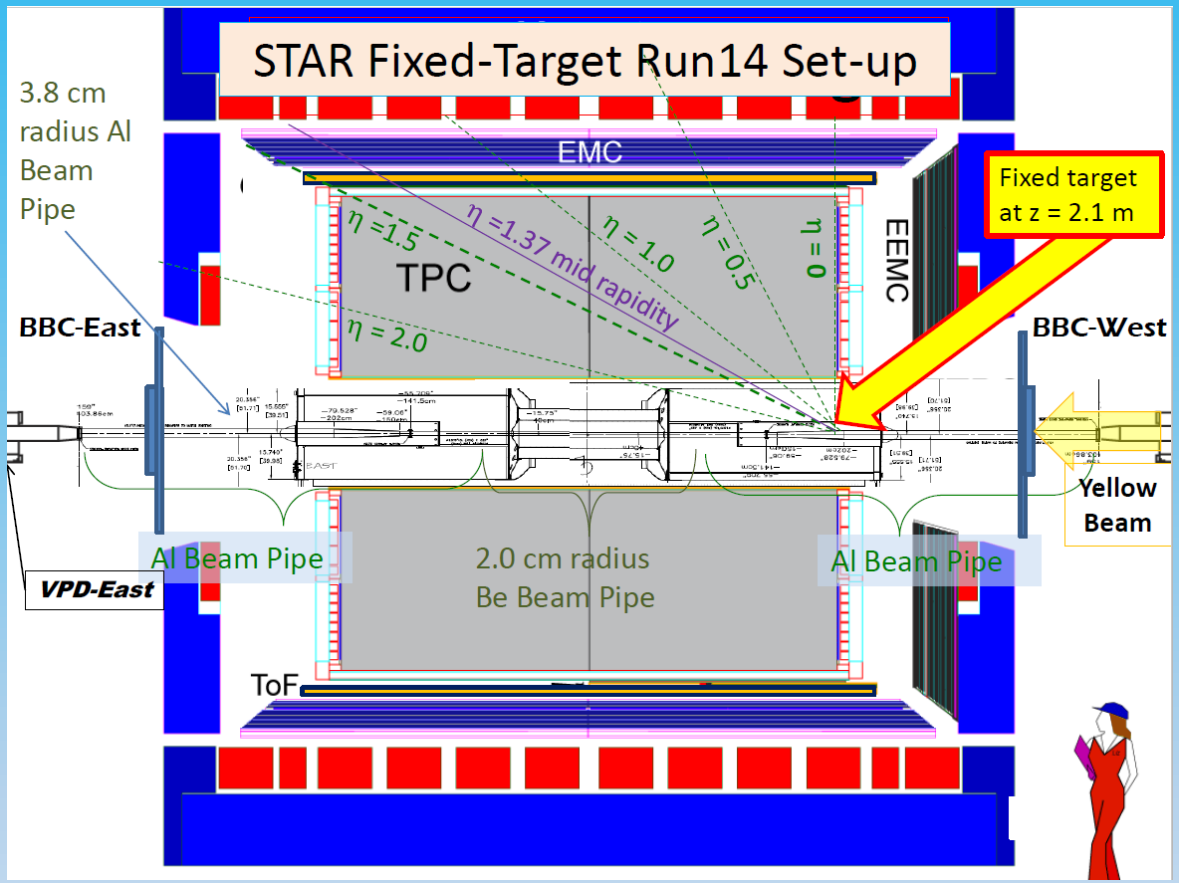


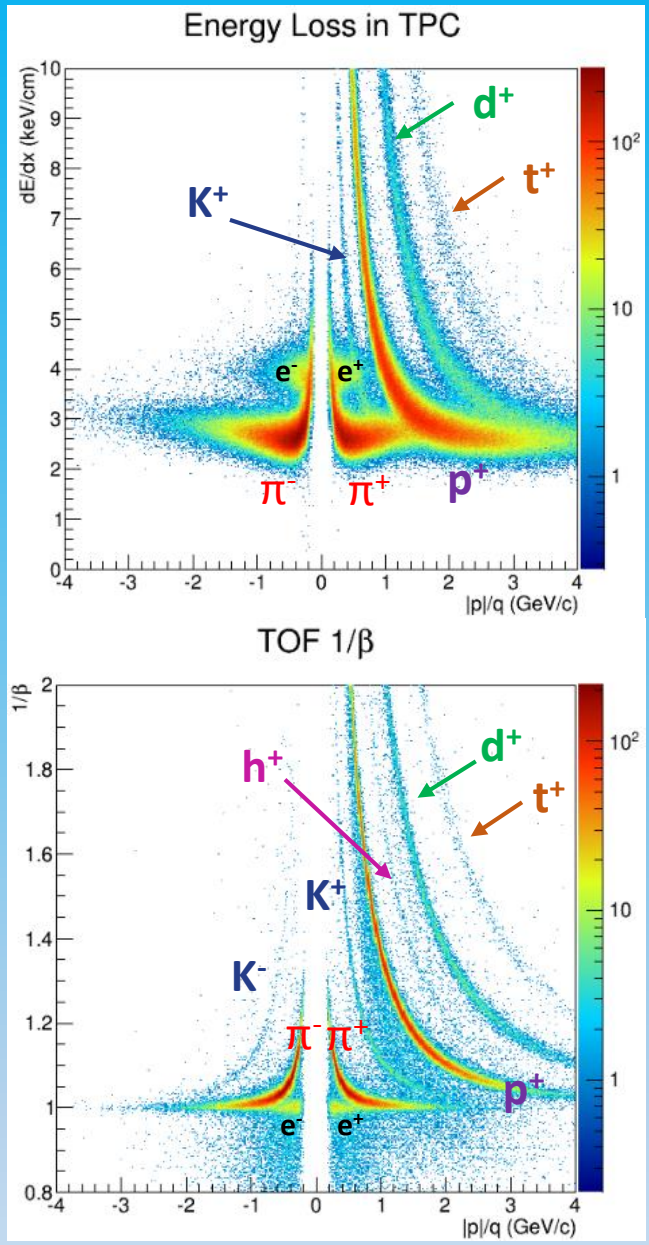


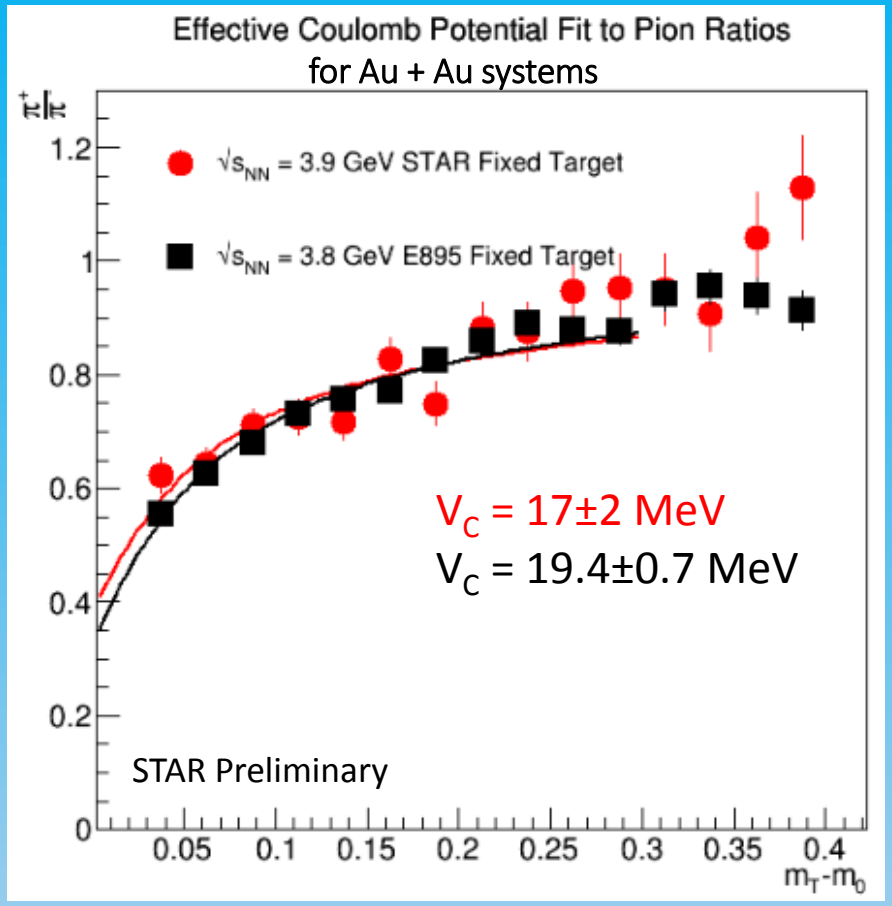
# 3.9 GeV Au + Au Test Run

Excellent PID with Time Projection Chamber (TPC) and Time of Flight (TOF) detectors for fixed target events

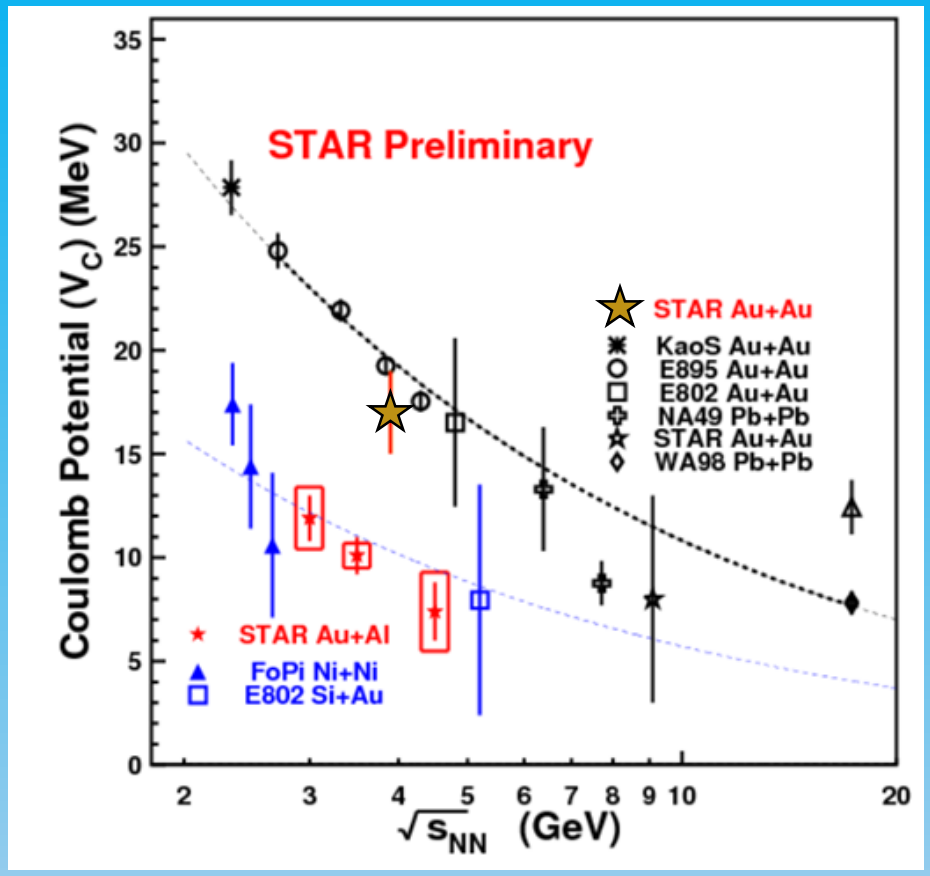


# Coulomb Potential Analysis




J. Klay et al.(E895 Collaboration), Phys. Rev. C 68,054905 (2003)




arXiv:1408.1369

(1) $E_f = E_i \pm V_C$ — Coulomb Potential

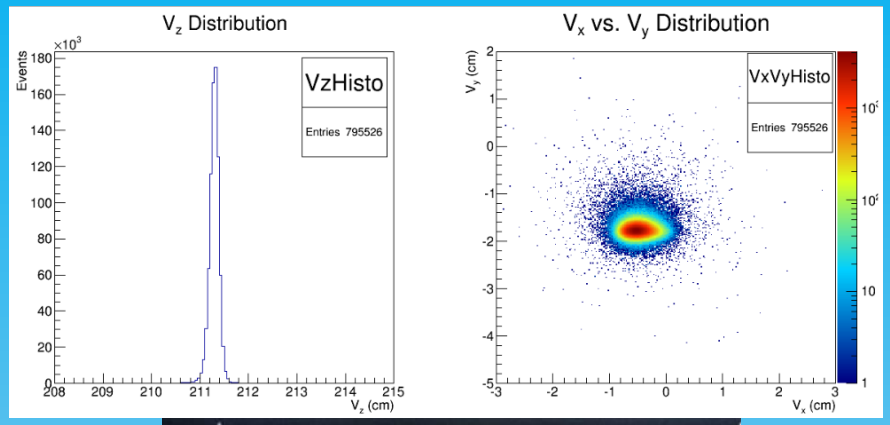
(2) $R_f(E_f) = \frac{E_f - V_C}{E_f + V_C} \frac{\sqrt{(E_f - V_C)^2 - m^2}}{\sqrt{(E_f + V_C)^2 - m^2}} \frac{n^-(E_f - V_C)}{n^-(E_f + V_C)}$ — Jacobian

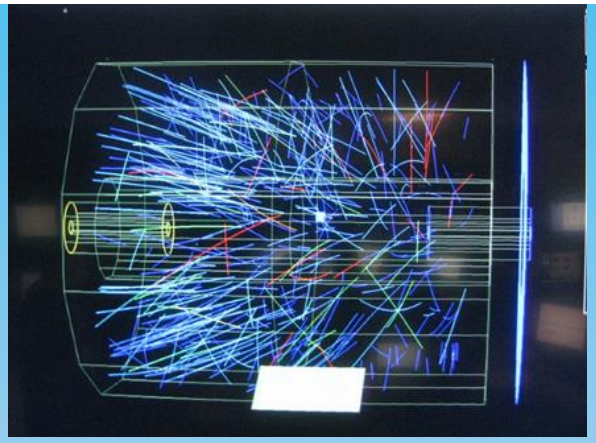
(3) $\frac{n^+(E_f - V_C)}{n^-(E_f + V_C)} = \frac{A^+(e^{(E_f + V_C)/T_+} - 1)}{A^-(e^{(E_f - V_C)/T_-} - 1)}$

- **Our result for Coulomb potential is consistent with previous experiments**
- **Projectile is consistent with gold ion**

# 2015 Test Run Performance

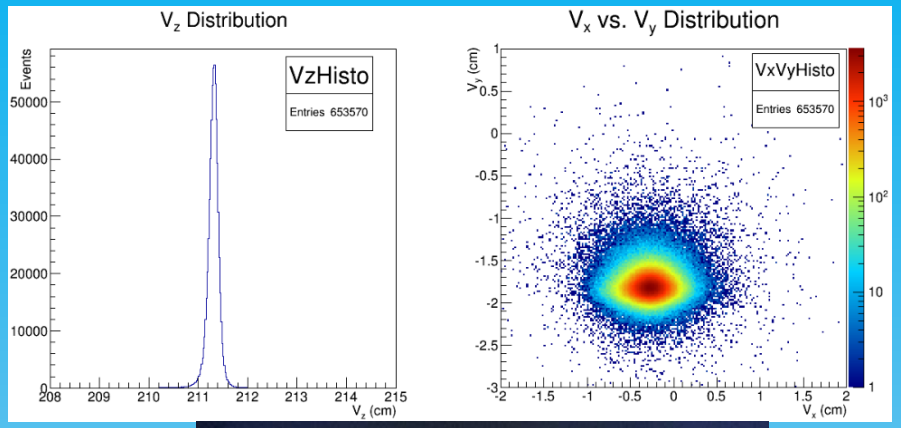
## Au + Au $\sqrt{s_{NN}}$ = 4.5 GeV

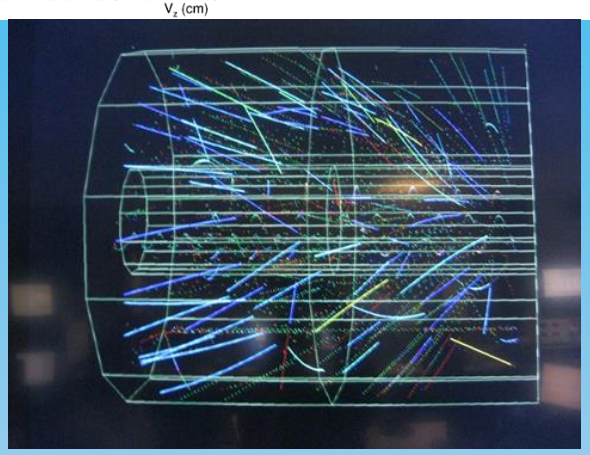


- Can take ~1 million events in half an hour, as opposed to ~5000 events in 3 weeks
- Dedicated fixed target runs are a better conduct of operations than concurrent runs
- Coming soon: HBT, fluctuation, spectra, flow results…

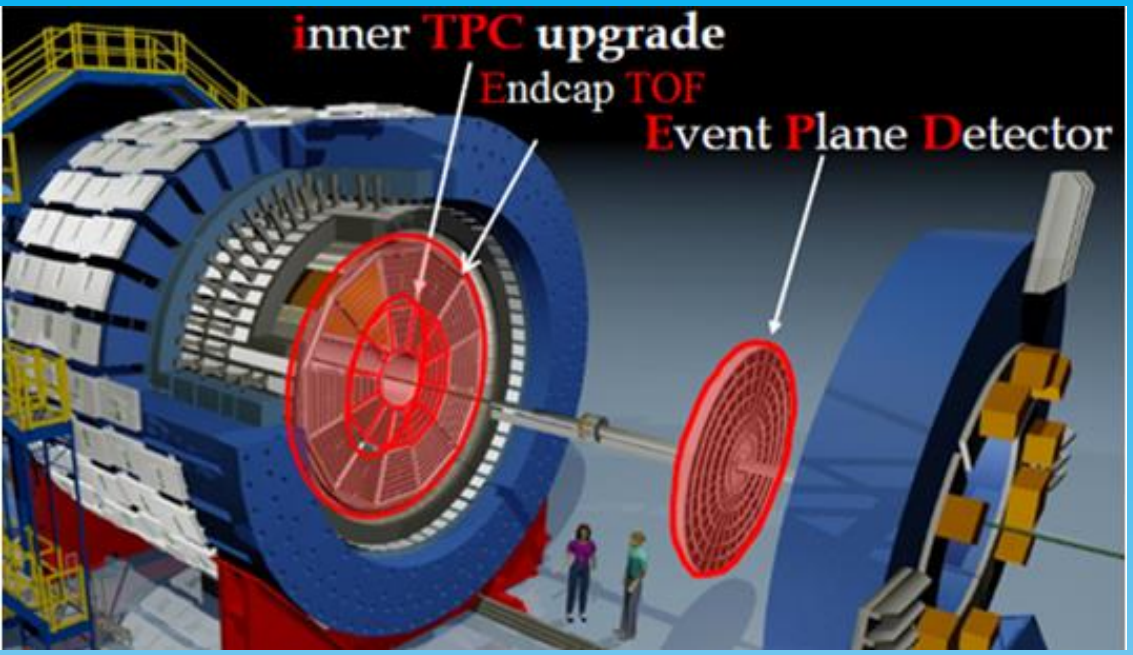
## Al + Au $\sqrt{s_{NN}}$ = 4.9 GeV

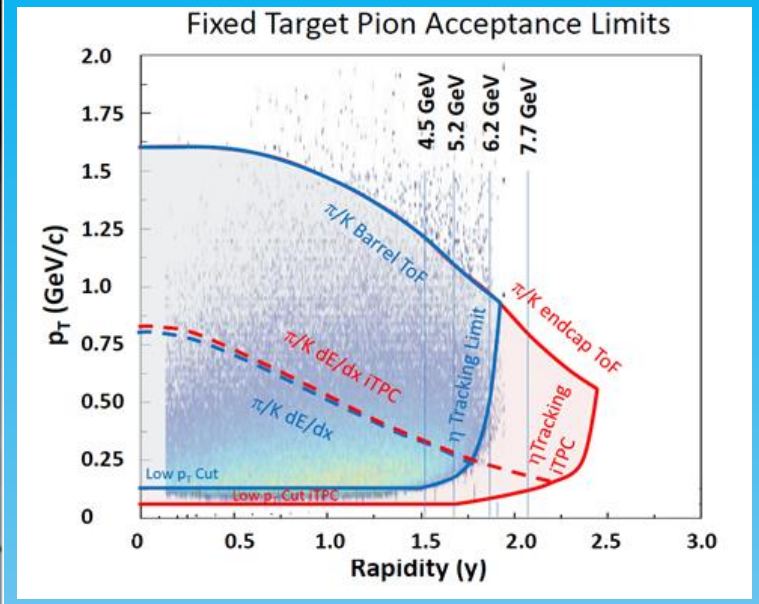


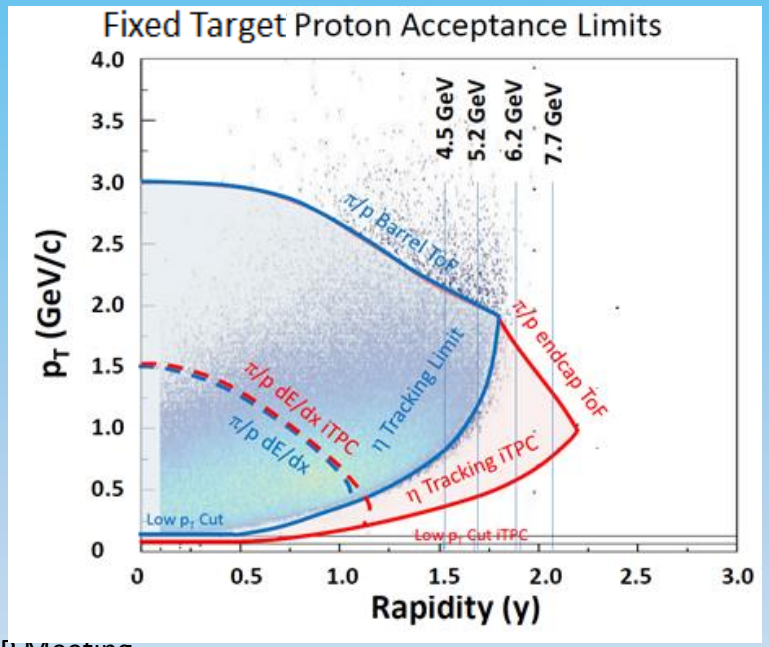



- Can obtain second half of phase space to complement beam pipe studies
- See poster 00012 by Jessica Howard at 2 pm!

# Future: BES-II

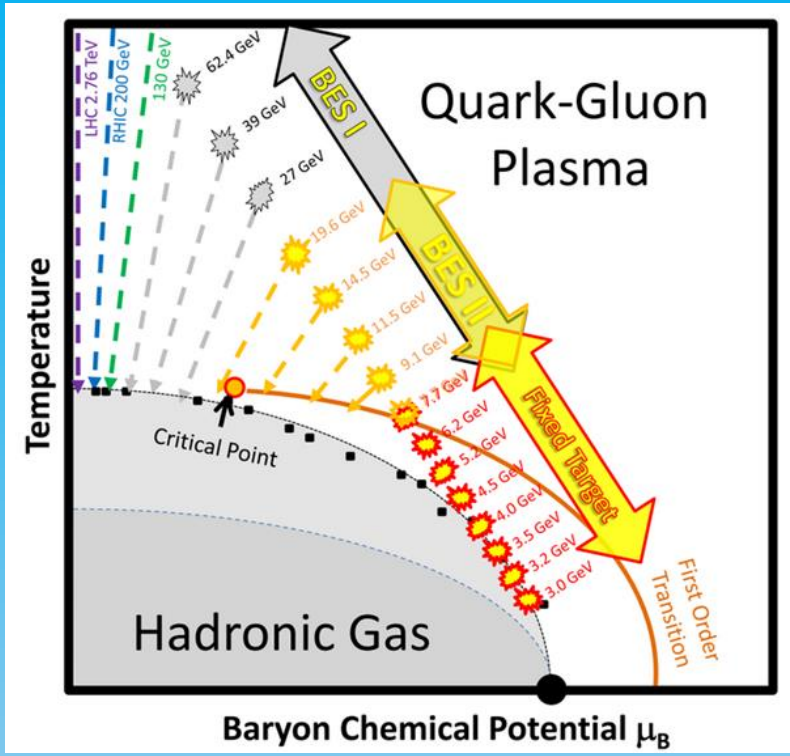



- FXT Program will collect huge statistics up to ~50 million events per day
- 1-2 days of dedicated fixed target running at each energy would collect sufficient statistics to extend BES-II to lower energies
- Detector upgrades would extend our midrapidity acceptance for additional fixed target energies
- Physics goals include looking for a 1st order phase transition (eg. $dv_1/dy$…) and clarifying evidence for a critical point (eg. kurtosis…)

# Conclusions




- Successful FXT test runs demonstrated that dedicated runs are a preferable conduct of operations to concurrent runs
- Coulomb Potentials were also measured and are consistent with previous experiments
- The detector upgrades will extend the FXT program up to 7.7 GeV which will allow for comparison with collider mode analyses at the same energy
- The FXT program will allow us to extend BES-II statistics down to 3.0 GeV

Acknowledgements: This material is based upon work supported by the National Science Foundation under Grant No. 1404281. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily represent the views of the National Science Foundation.