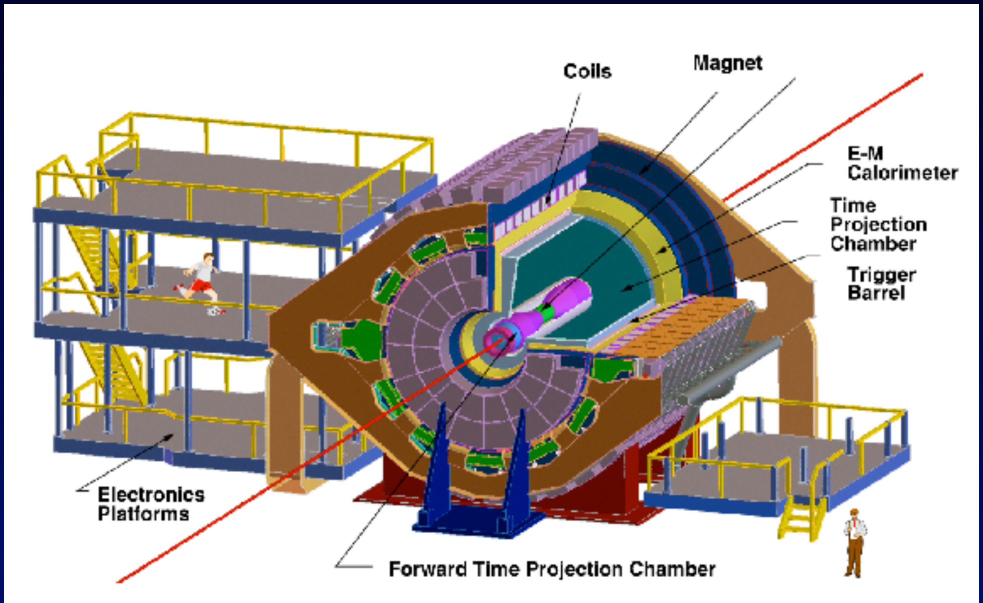
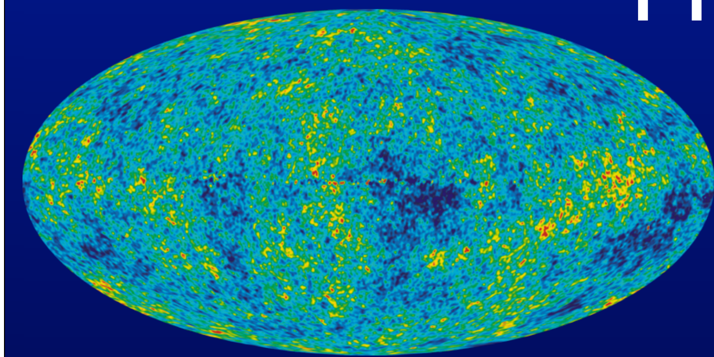
STAR as a Fixed Target Experiment?

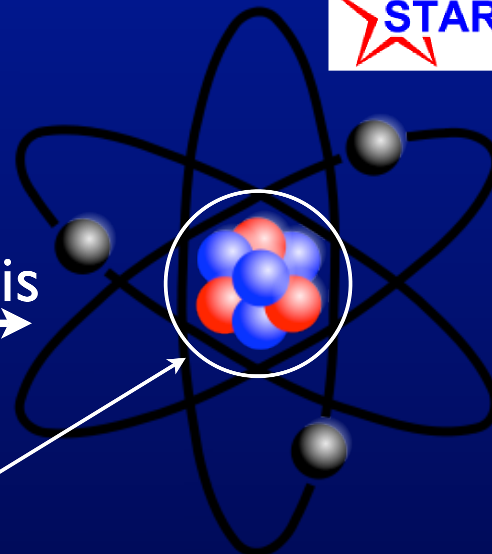


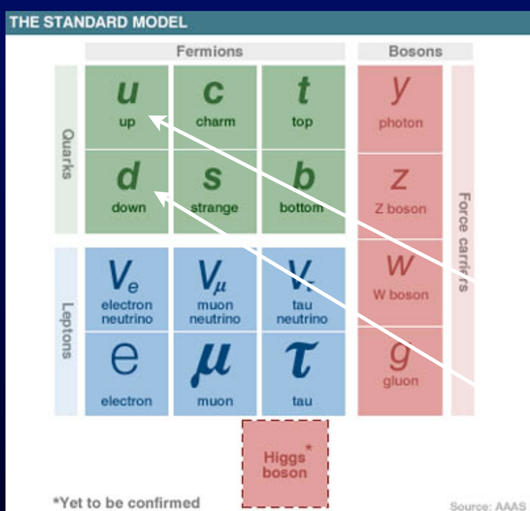
Brooke Haag for the STAR Collaboration
Hartnell College / University of California, Davis
Presented at the Meeting of the California Division of the APS
November 13, 2009

The Basics

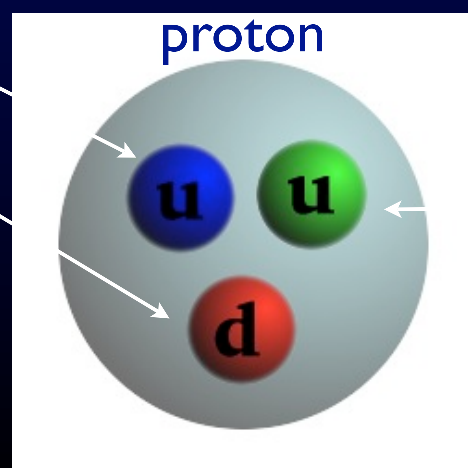


matter in the universe is made of atoms





nucleus = protons + neutrons

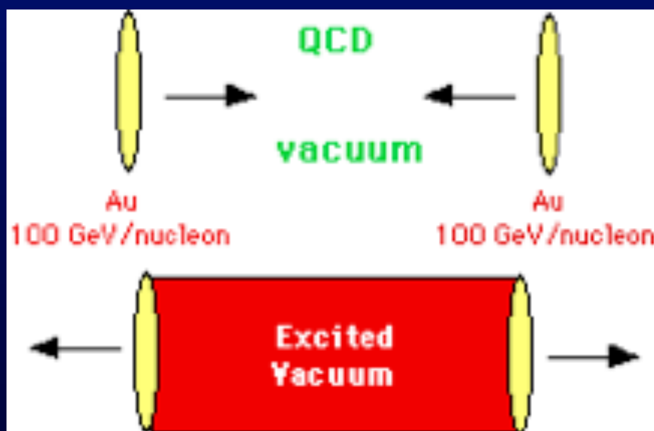


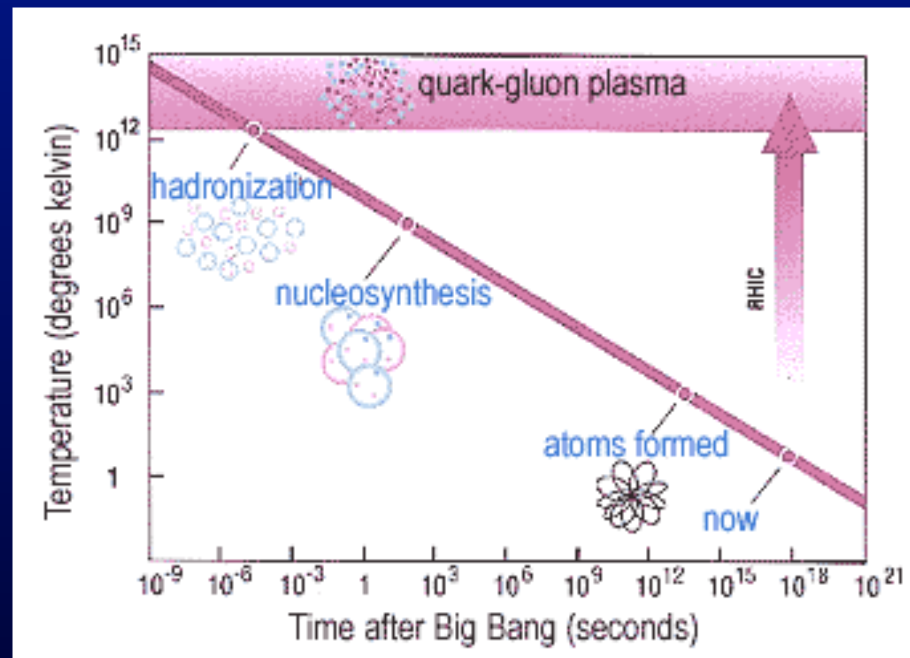
nucleons are hadrons (made of quarks)

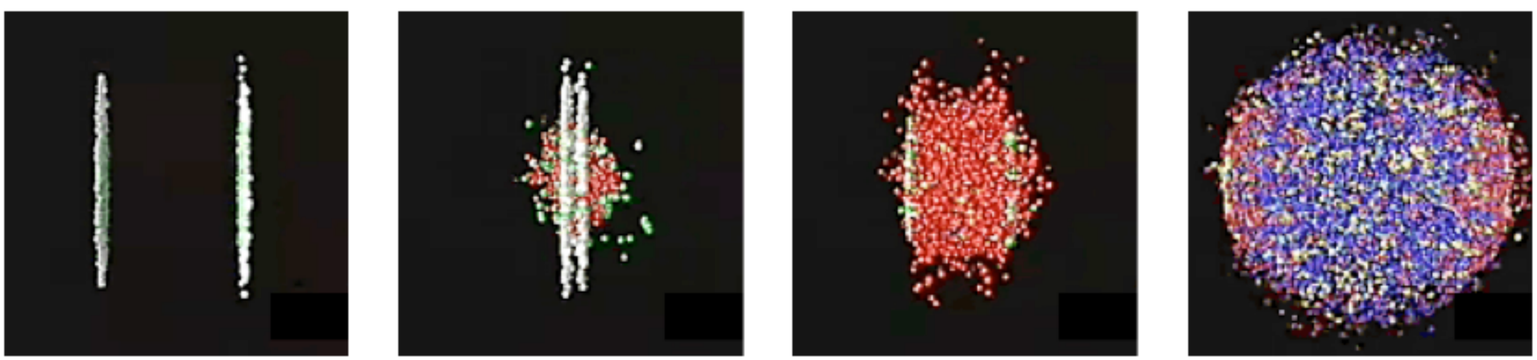
mesons = 2 quarks
baryons = 3 quarks

Creating mini-big bangs in the laboratory

Goal: Use relativistic collisions of nuclei to create hot dense matter which reproduces the earliest stages of the universe

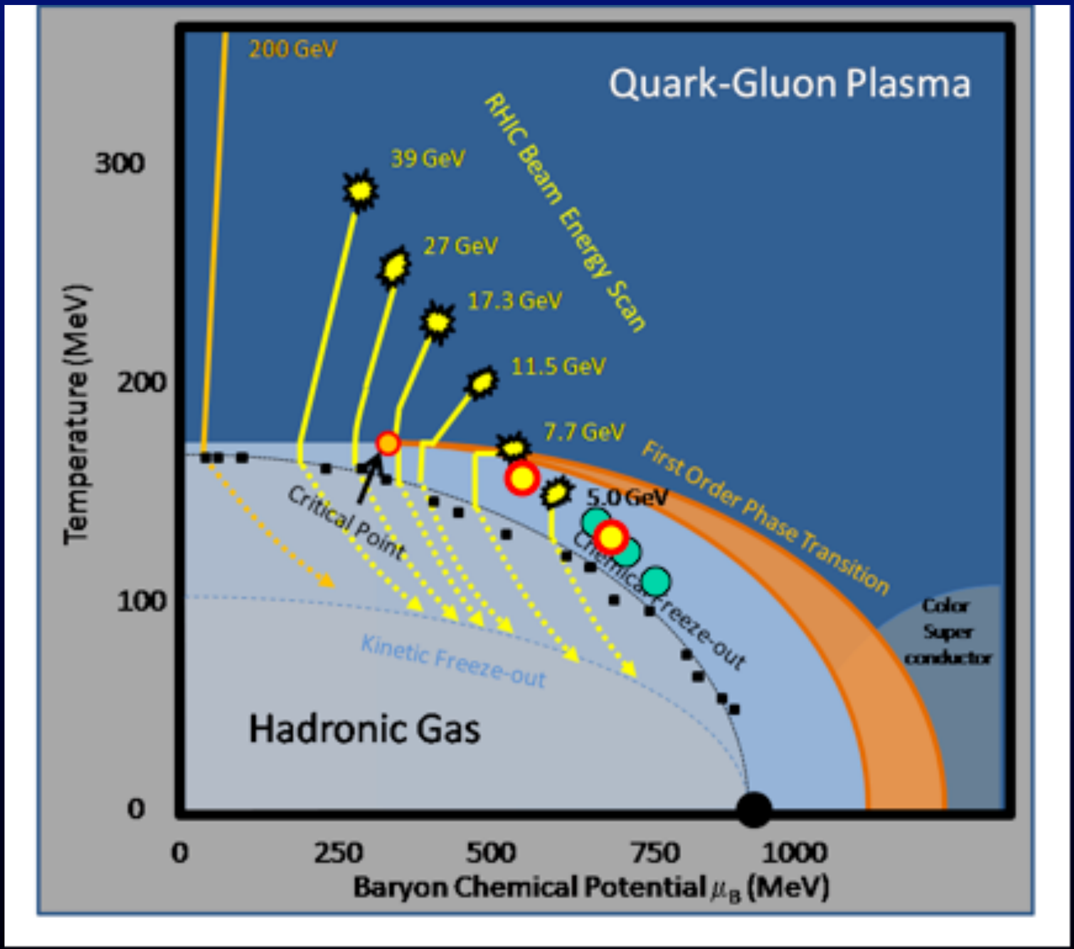






1. Ions about to collide*
2. Ion collision
3. Quarks, gluons freed
4. Plasma created

QCD phase diagram



- We have created a new state of matter consistent with the QGP !
- We have not located the critical point.
- A beam energy scan will explore regions of lower temperature and higher chemical potential to find the critical point.
- Can we extend the physics analysis at lower energies by introducing a target into the STAR detector ?

Kinematic Calculations

Collision Energy (GeV)	Single Beam Energy	Single Beam P_z (GeV/c)	Fixed Target $\sqrt{s}$	Single Beam Rapidity	Center of Mass Rapidity
22.4 Cu+Cu	11.2	11.16	4.66 Cu+Al	3.18	1.59
19.6 Au+Au	9.8	9.76	4.47 Au+Al	3.04	1.52
9.2 Au+Au	4.6	4.50	3.21 Au+Al	2.28	1.14

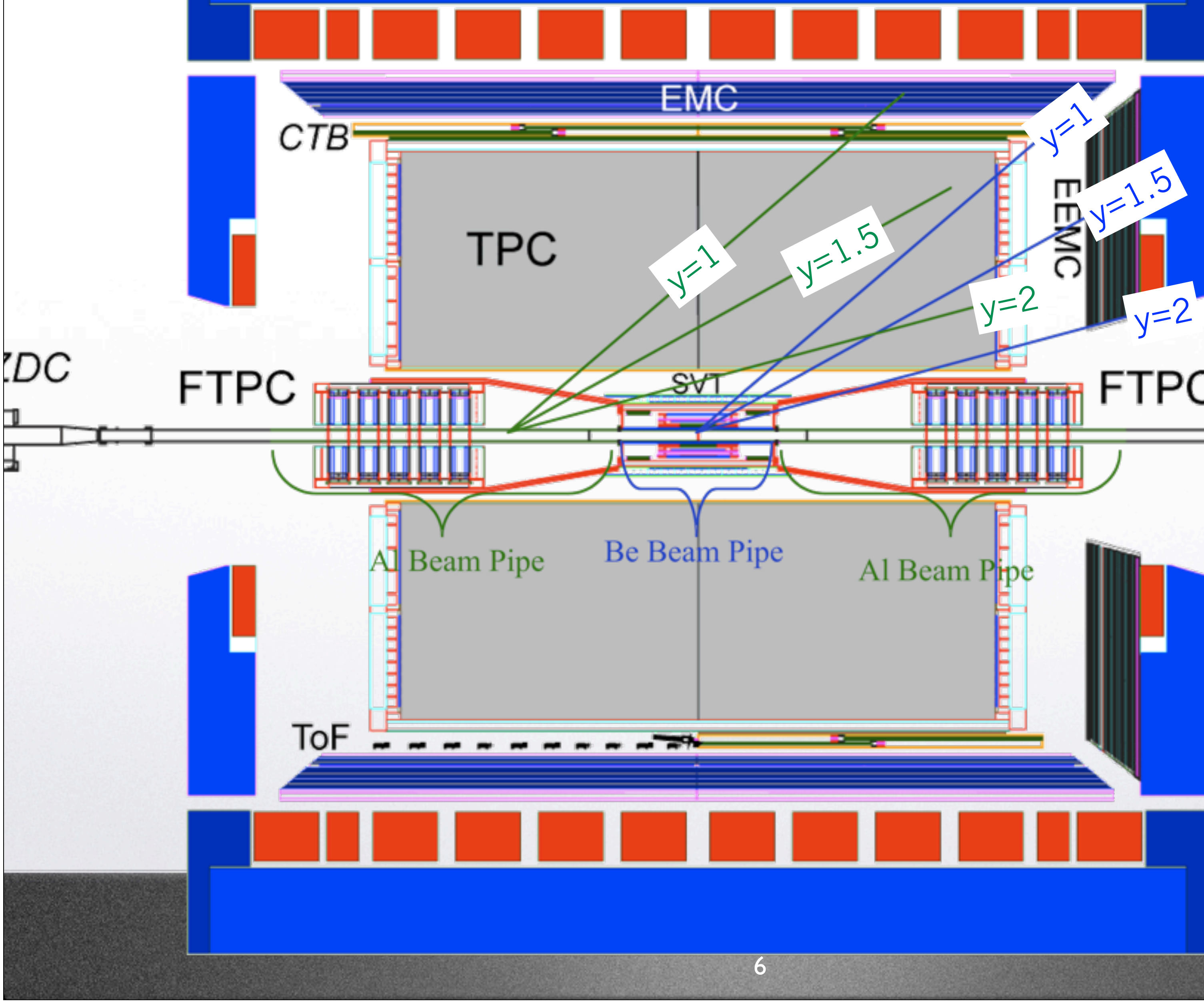
$\sqrt{s_{NN}}$ = center of mass energy

- $\sqrt{s_{NN}} = \sqrt{2m^2 + 2Em}$
  $m = 0.9315$ GeV/c^2 ; $E = 9.8$ GeV
- $\sqrt{s_{NN}} = 4.47$ GeV
- $p_z = \sqrt{E^2 - m^2} = 9.76$ GeV/c

rapidity (y)

- $y_{beam} = 0.5*[\ln(E + p_z)/(E - p_z)]$
- $y_{beam} = 3.0$
- $y_{cm} = 1.5$

STAR detector array



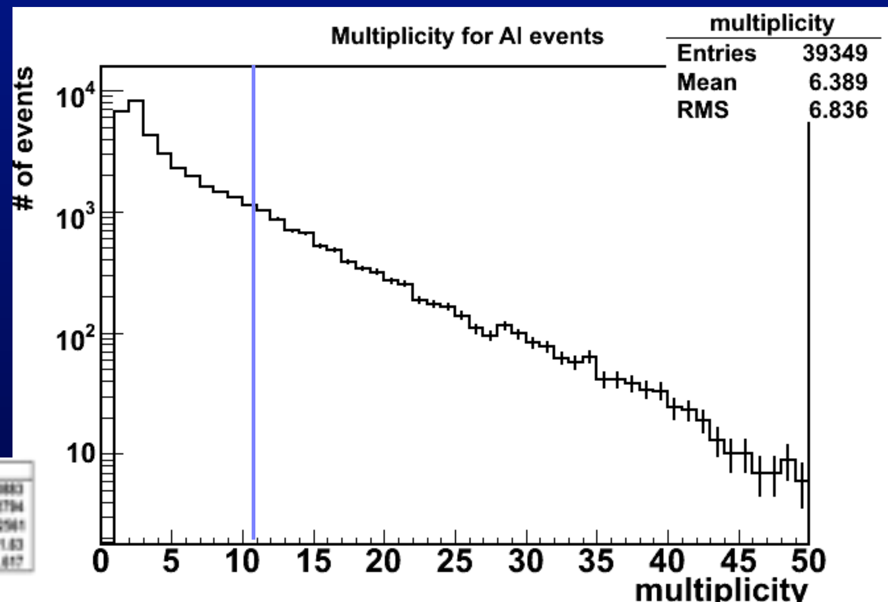
green = non-central beampipe event

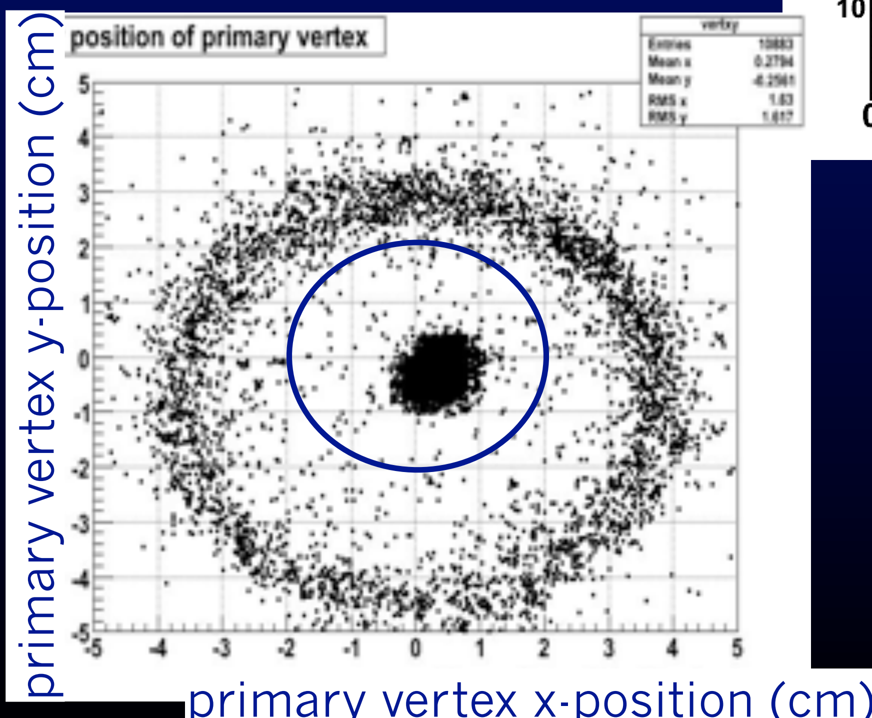
blue = central beampipe event

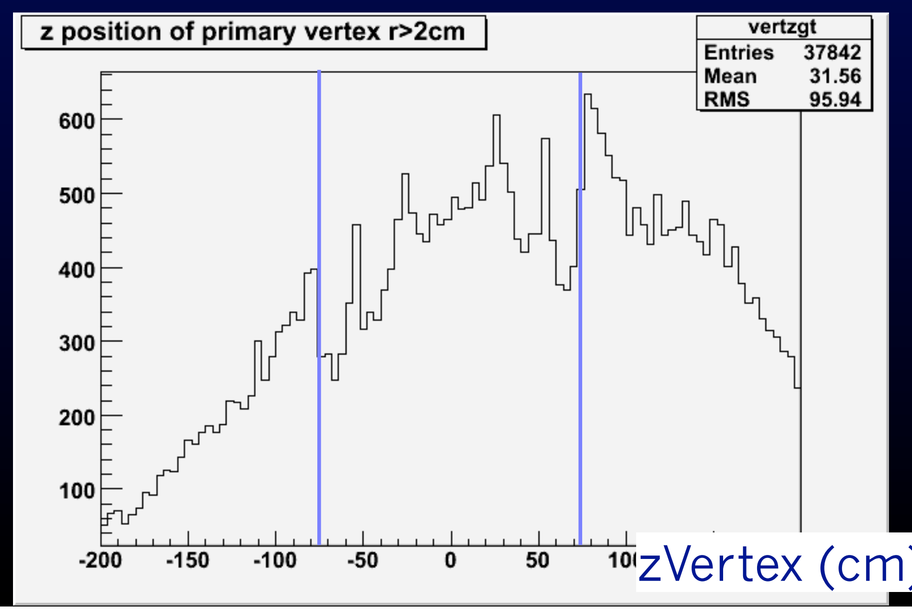
Event Selection

Cu+Al Event Cuts:

- |zVertex| > 75 cm
- rVertex > 2 cm
- multiplicity > 11
- $\Sigma\, p_z$*zVertex < 0

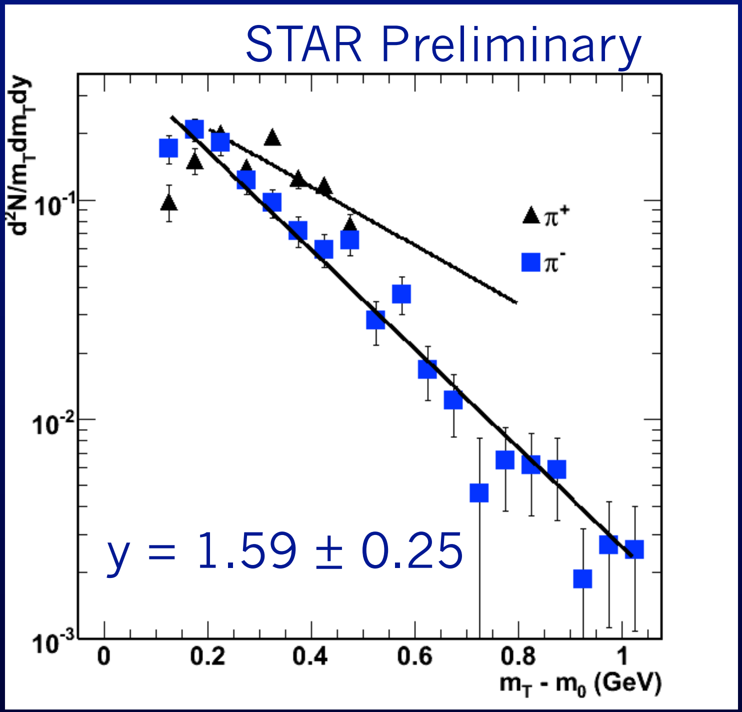


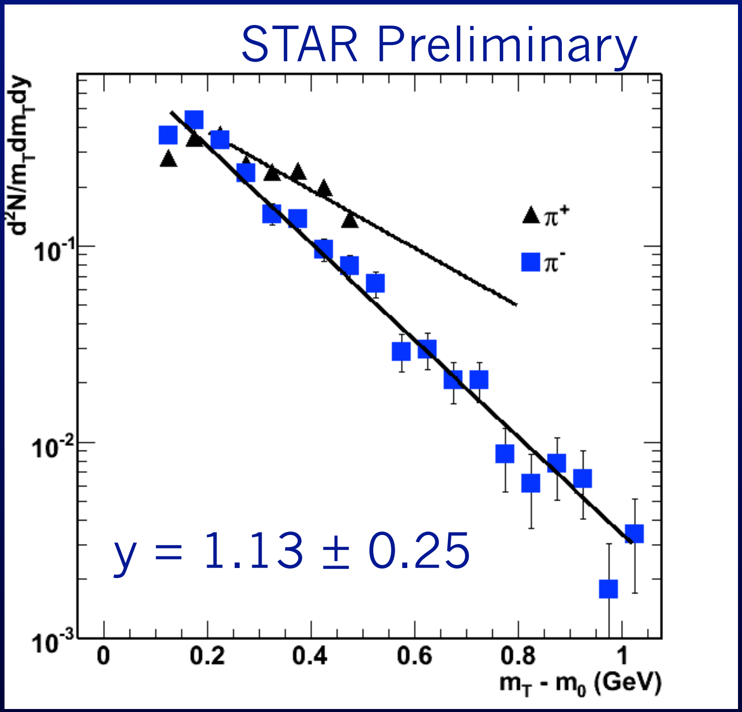




* Spectra not corrected for acceptance and efficiency

Spectra

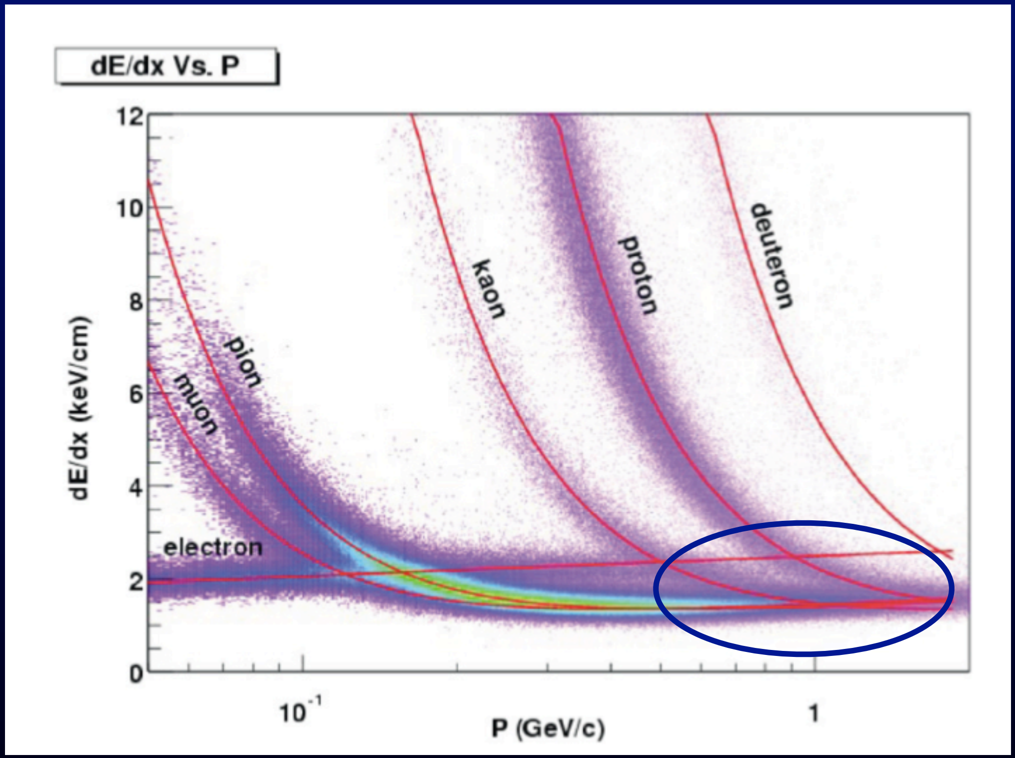




- Fits to spectra assume Boltzmann distributions
- With efficiency corrections we can extract a temperature for comparison with previous measurements by other experiments

Next Steps

- We need to understand the acceptance of the detector in the forward region
- One important issue -- looking in the forward region with the TPC for particle identification



Conclusions and Outlook

- We can do physics with STAR as a fixed target experiment !
  - We have been able to extract spectra from several species for fixed target collisions at lab rapidity
  - Will it contribute to the critical point search?
    - need to understand detector efficiency at high rapidities
    - need much better statistics - this study is a proof of principle
    - want to get yields and slopes which compare favorably with published data in this energy range