Y2004 FTPC Calibration

Some results from München.

STAR FTPC Review

7-19-2004

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Thanks to:

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Lidia Didenko

Eric Hjort

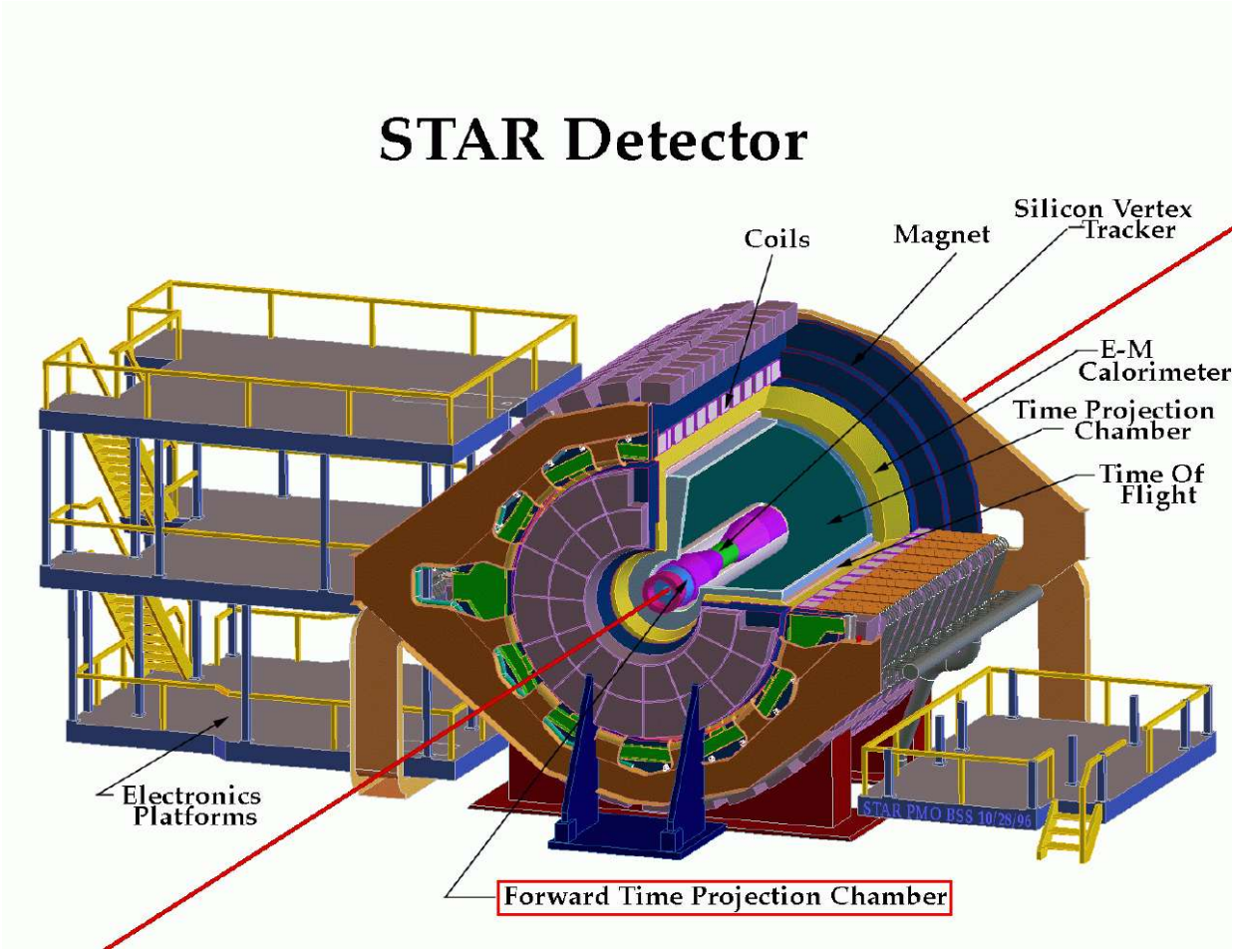
Jerome Lauret

Jeff Porter

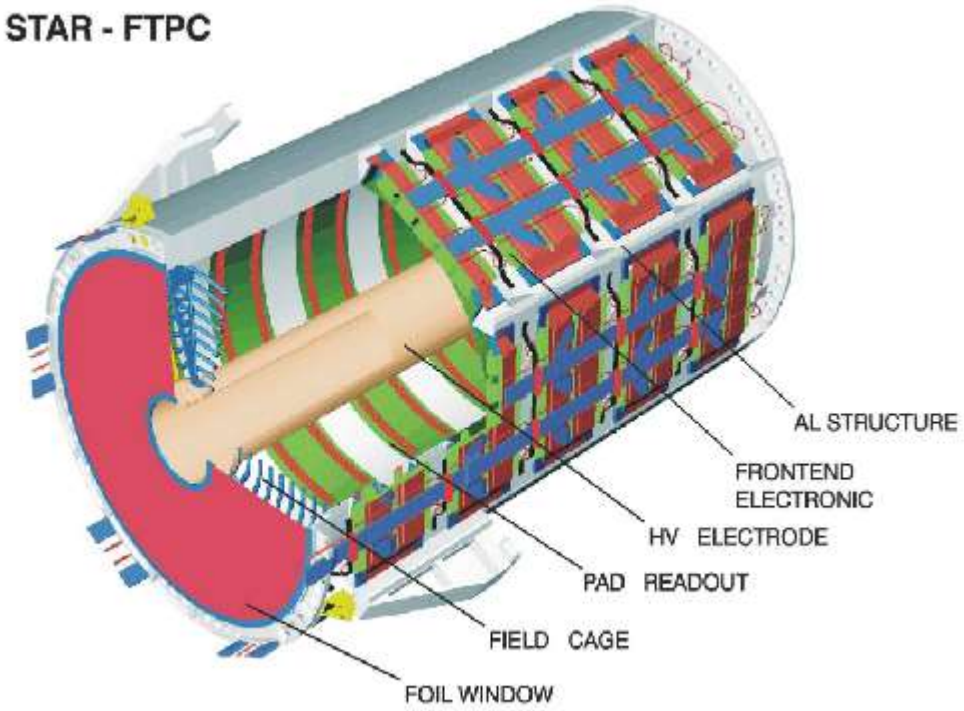
……

For invaluable technical support!

FTPCs at STAR



FTPCs at STAR



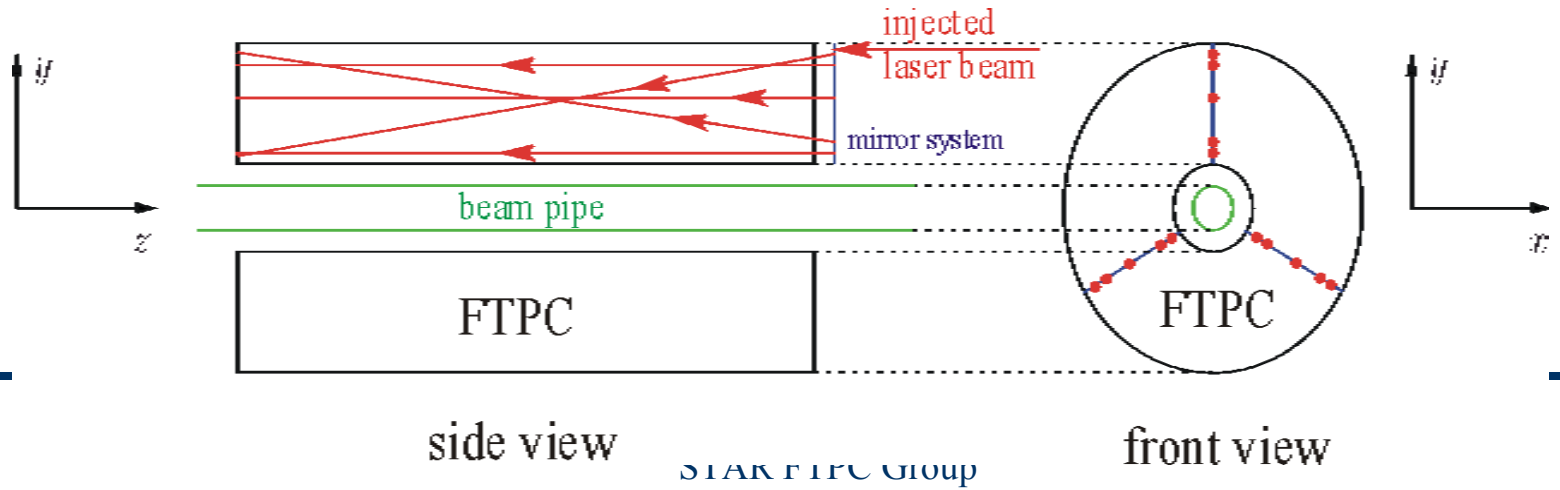
Volume	
inner radius	7.73 cm
outer radius	30.05 cm
chamber length	120 cm ($\|z\|$ = 150 – 270 cm)
acceptance	η=2.5 –4.0 (θ=2° - 9°)
Field properties	
drift cathode voltage	10-15 kV
drift electrical field	240-1400 V/cm (radial, $\perp$ beam)
Solenoid magnetic field	0.5 T ($\|$ beam)
Gas properties	
gas mixture	Ar(50%)-CO_2(50%)
drift velocity	0.3 – 2.0 cm/μs
trans. Diffusion DT	100-130 μ m/$\sqrt{cm}$
long. Diffusion DL	100-130 μ m/$\sqrt{cm}$
Lorentz angle	4 deg.

Y2004 Calibration

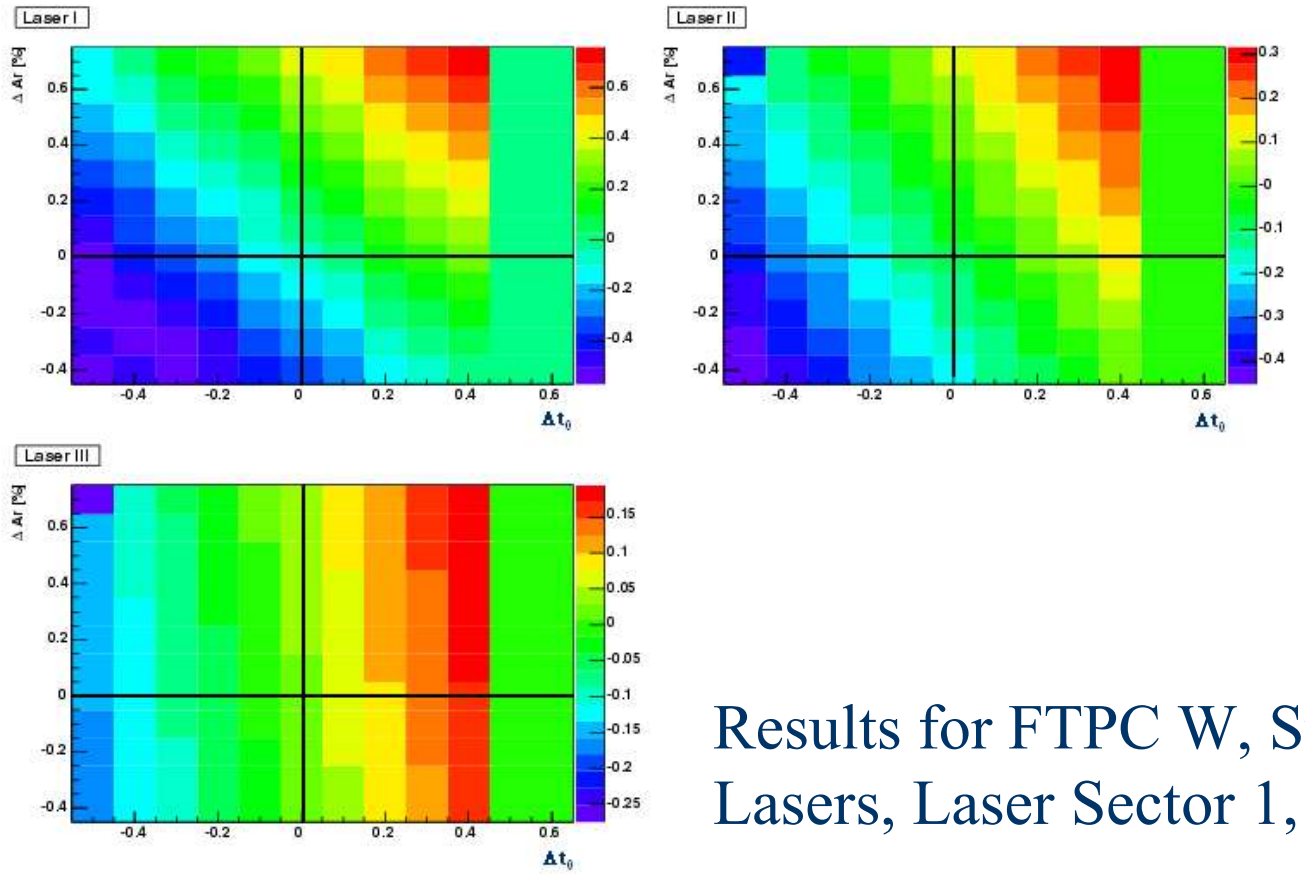
- Steps:
  - Consider internal detector geometry:
    - Inner cathode correction.
  - Utilize information from raw clusters:
    - Position of radial step:
      - » t_0
      - » temperature corrections
    - Gain tables.
  - Information from tracking:
    - x-, y-vertex offset wrt TPC.
    - Laser calibration:
      - » drift velocity, Δt_0
      - » E x B corrections

Laser Calibration

- FTPC laser system used to determine changes in:
  - Gas composition→drift velocity
  - t_0
  - E x B correction



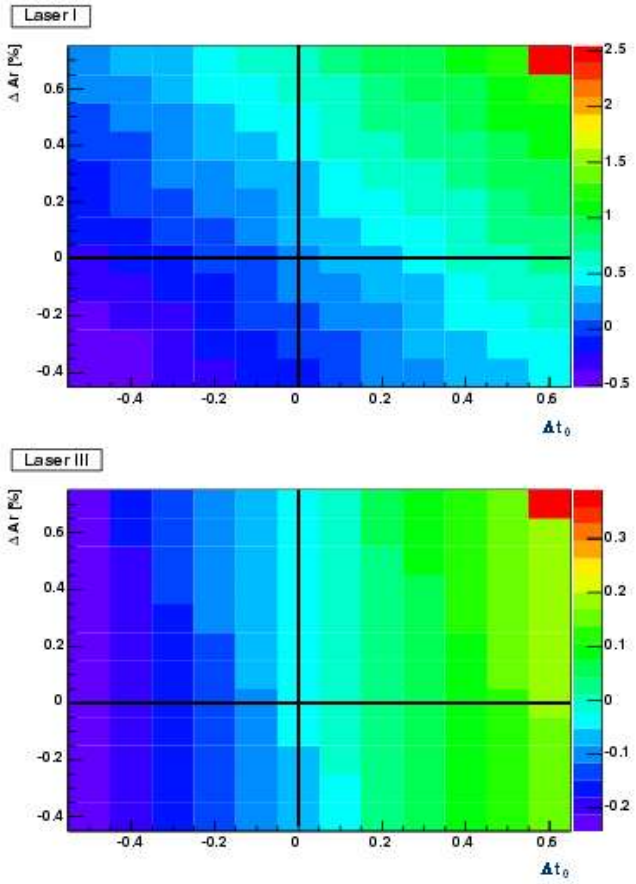
Laser Calibration



Colors represent: (Expected – Reconstructed) radial position.

Results for FTPC W, Straight Lasers, Laser Sector 1, B = -1.

Laser Calibration



Results for FTPC W, Straight Lasers, Laser Sector 2, B = 0.

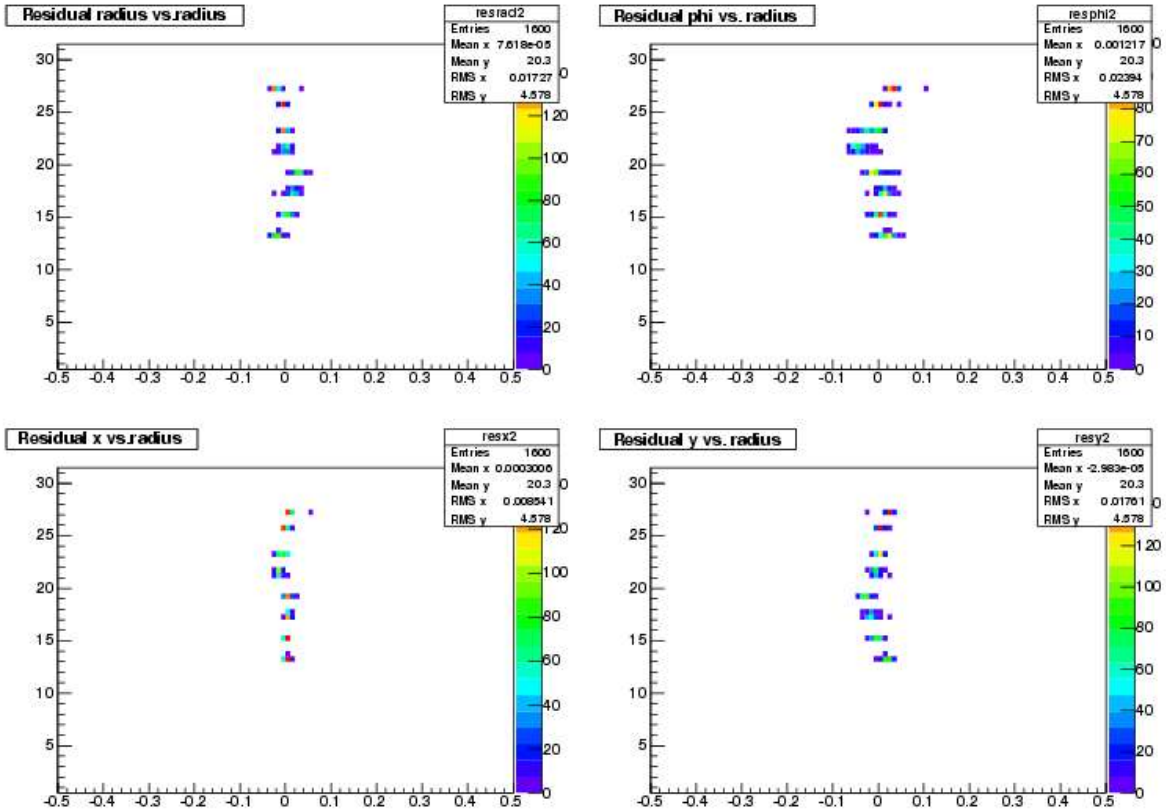
t_0 and drift velocity look correct within measurable limits!

No change in gas composition.

Laser Calibration

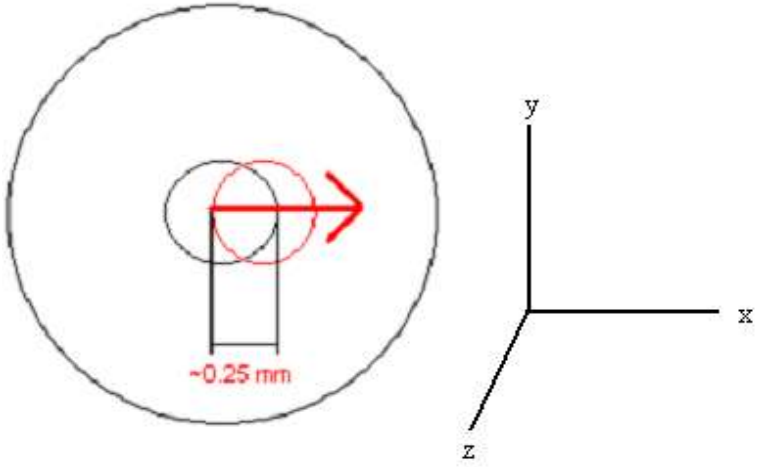
FTPC W, Inclined Lasers, Lsec 1, B = -1

Shows no change in drift velocity or E x B corrections!

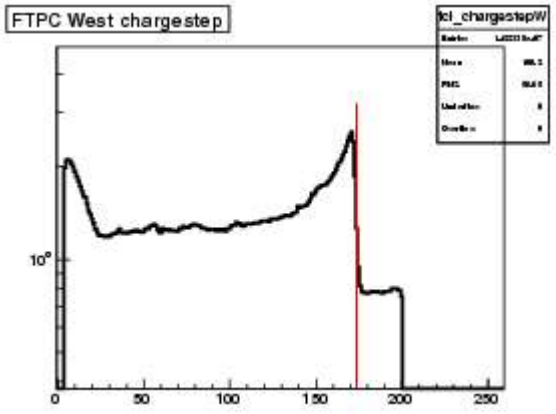


Inner Cathode Correction

- Correction corresponding to small mechanical offset of FTPC inner cathode wrt pad plane.



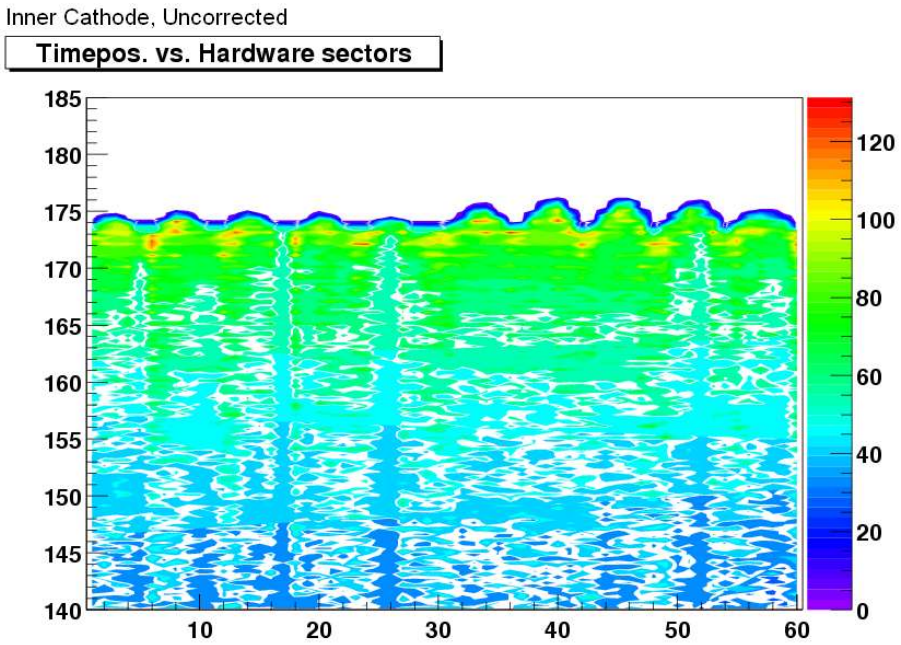
- This shift manifests as an oscillatory structure in the time position of the chargestep.

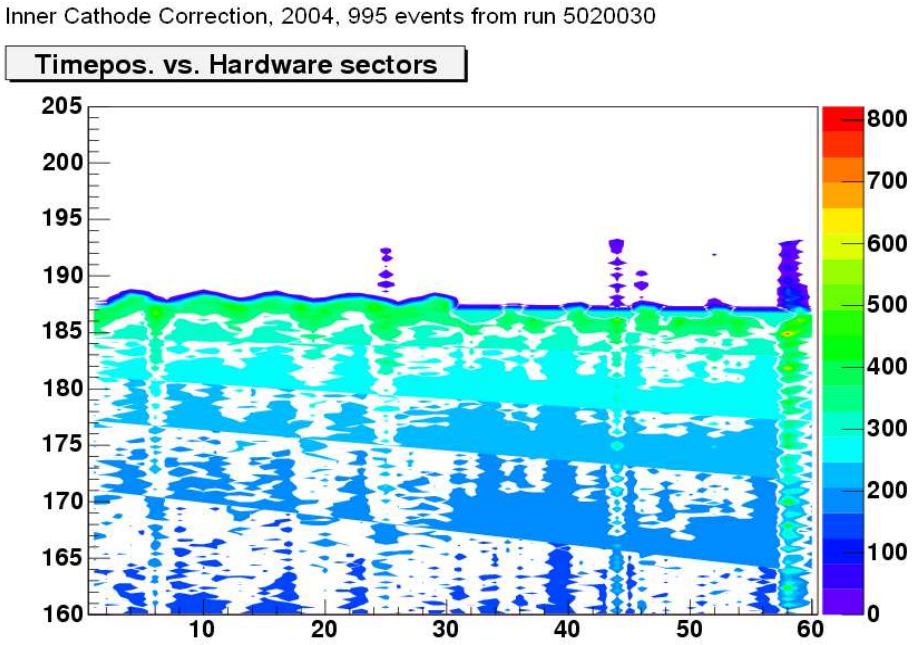


Inner Cathode Correction

- Can correct for the cathode offset.

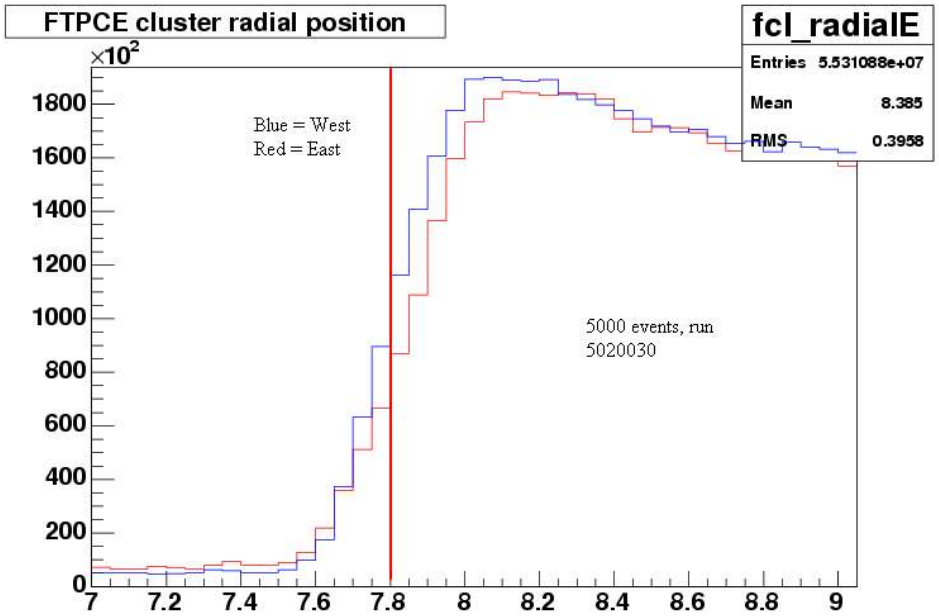
- With more statistics can make the correction more precise (thanks to pad and time information now included in StEvent).





t_0 and Radial Step

- The useable inner volume of the FTPC begins at a radial distance of ~7.75 ± .05 cm.

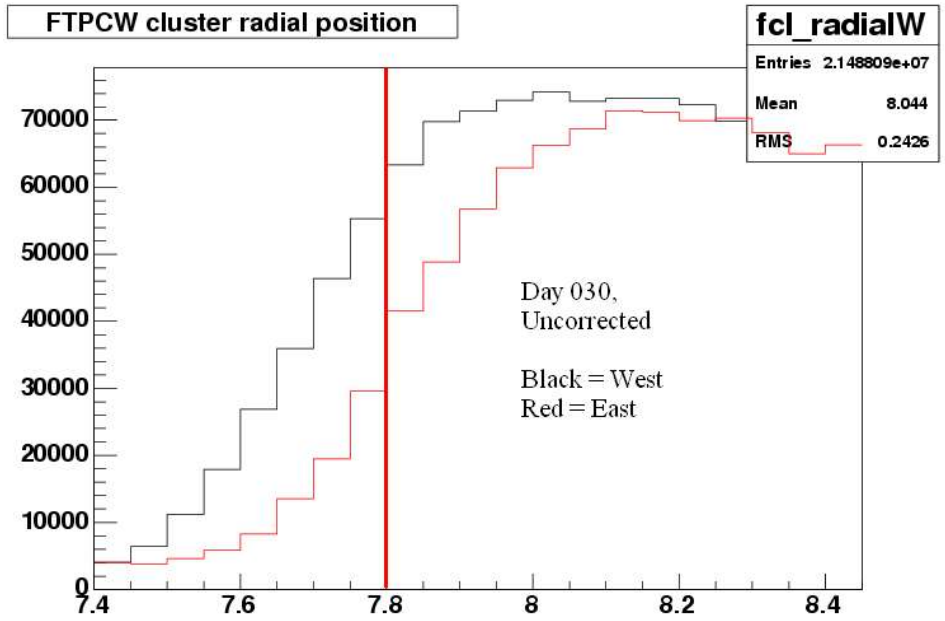


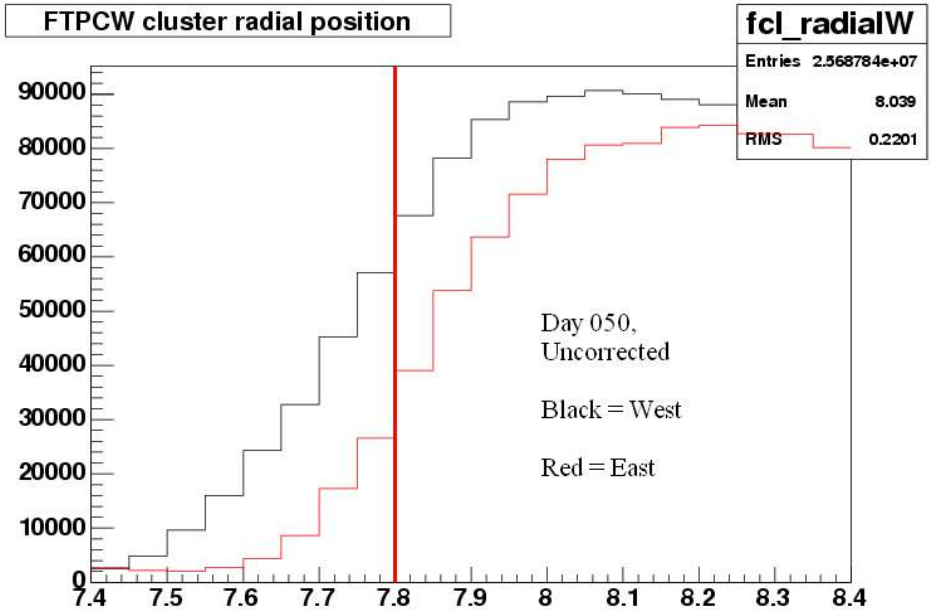
t_0 and Radial Step

- Can use position of radial step as a check on t_0.
- Increasing t_0 will move radial step to smaller radial position, and vice-versa.
- However, temperature measurements are also important for accurate reconstruction.

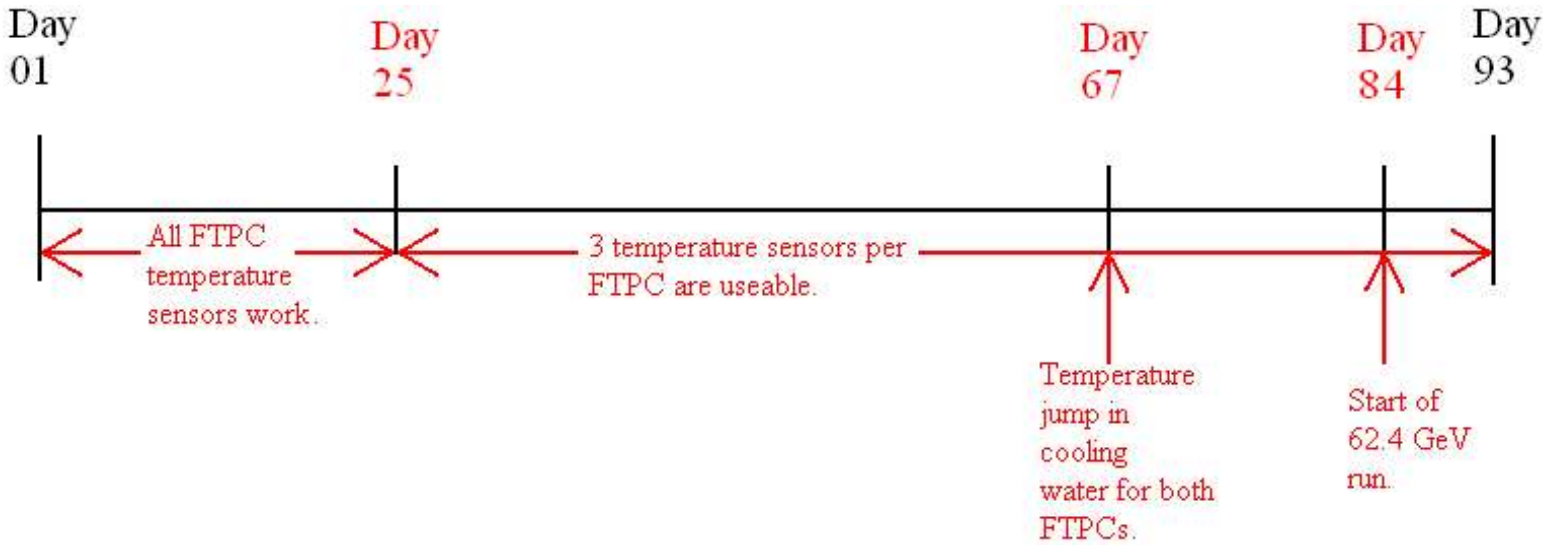
FTPC Temperatures

The relative difference between West & East is due to the temperature differences.





Temperature Jump

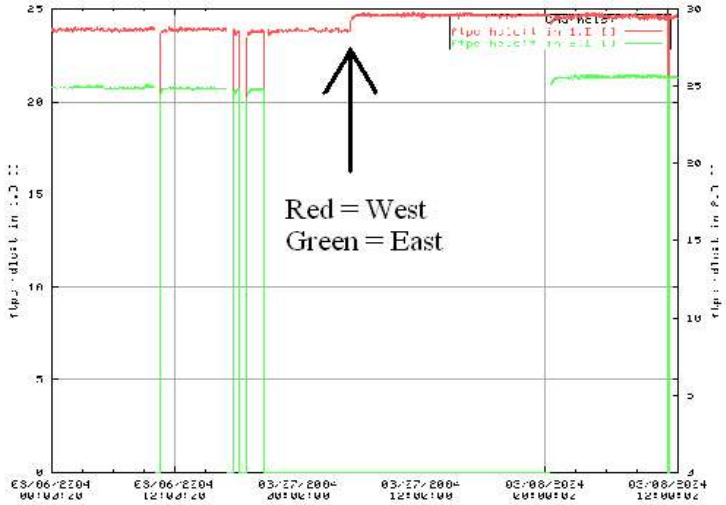


FTPC Temperatures

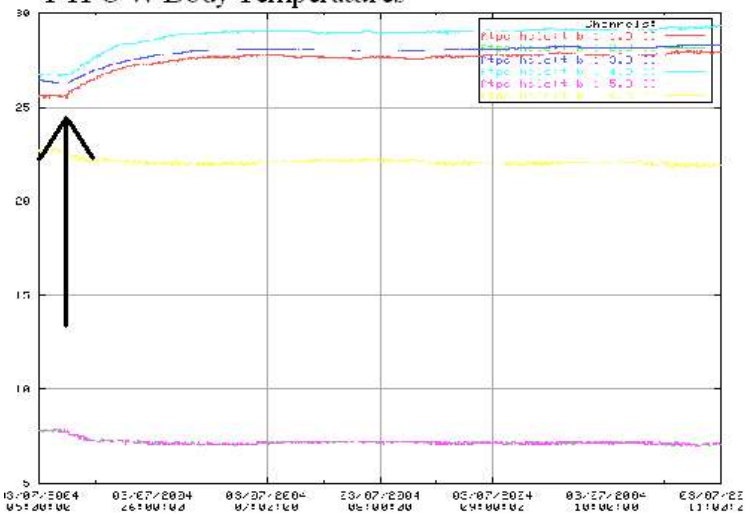
- Will this impact 200 GeV production?
  - The first ~25 days are fine.
  - Studies underway to determine offsets for remainder of run.
    - One offset value may work for data beyond day 25, but before day 67.* (*See next slide.)
    - Will require multiple offsets.

Temperature Jump

FTPC Water In Temperature



FTPC W Body Temperatures



FTPC E Body Temperatures

Gain Tables

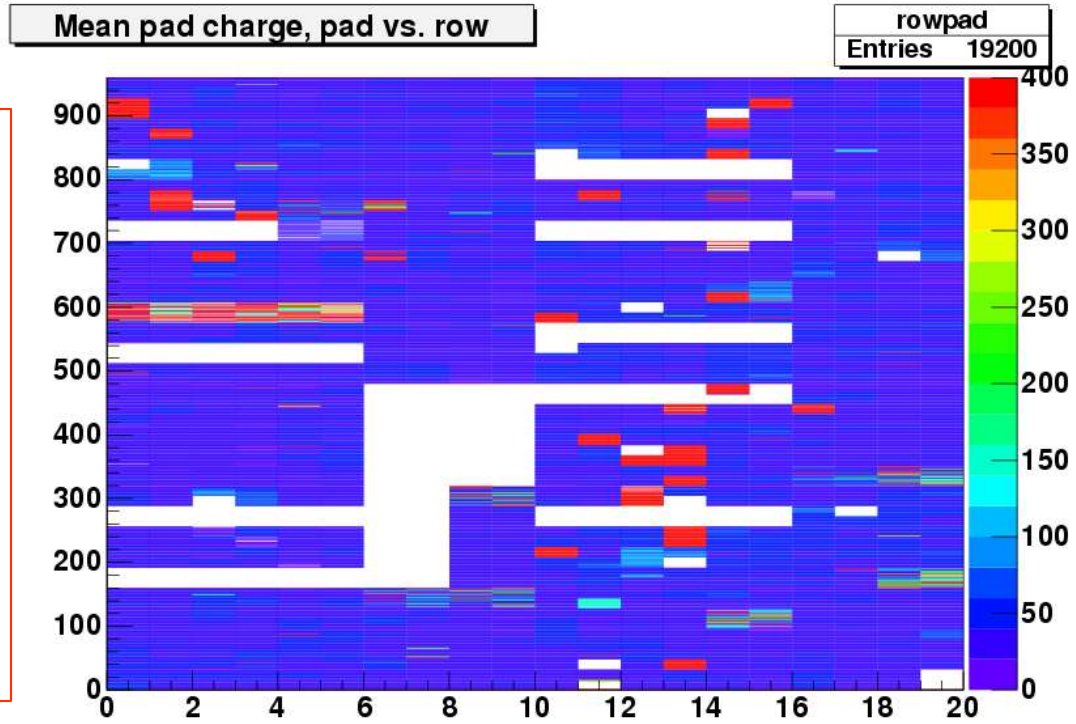
- Required to mask dead/noisy pads.
- Important for proper efficiency studies.

- New gain table needed for every major change in detector state
  - Change in the number of dead or noisy pads.

FTPC Electronics Losses

Efficiency not constant during the run!

Since FTPC utilizes radial drifting, losses could impact phi acceptance.



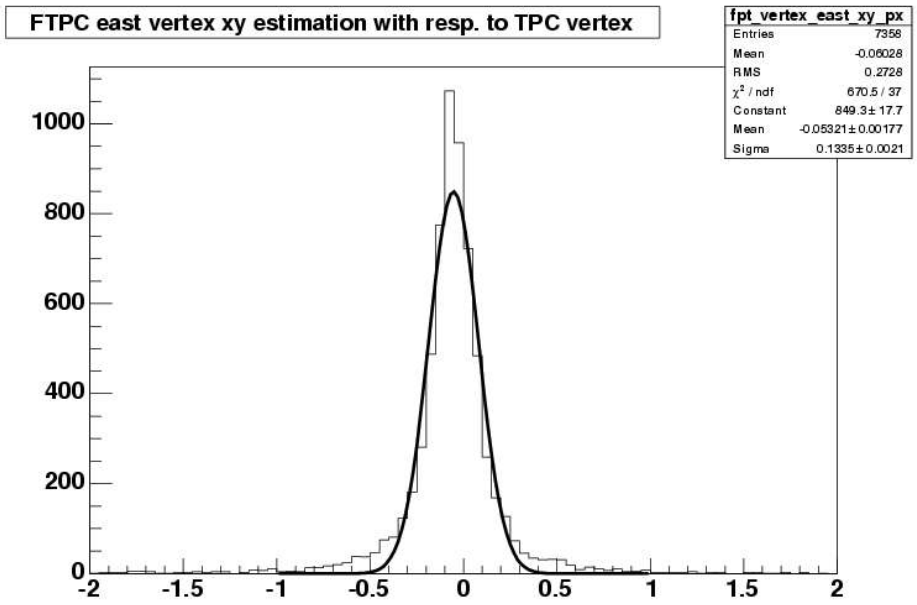
Day 65

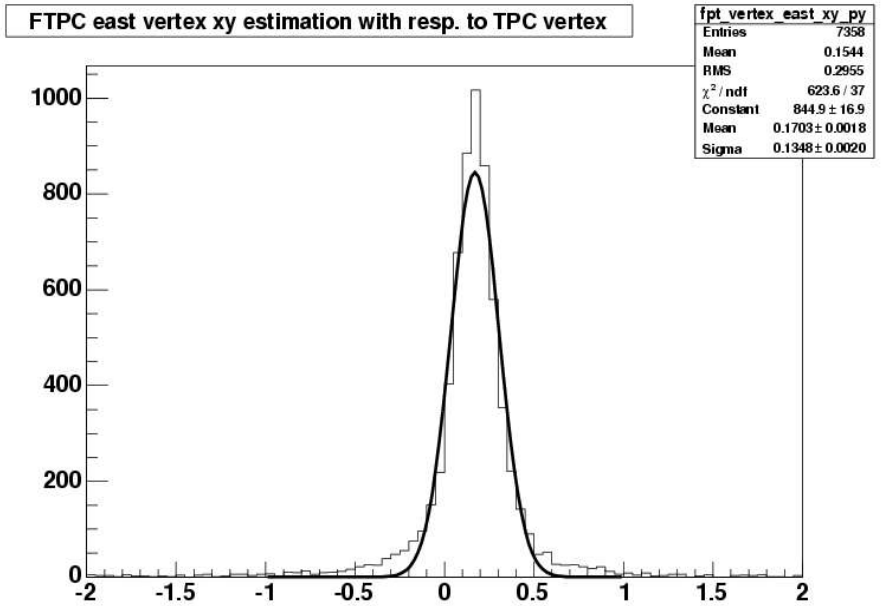
Vertex Offset

- Reconstructed vertex position from FTPC tracks differs slightly from main TPC vertex.
  - Shift due to small rotation of FTPC about mounting points.
  - Correction must be calculated every time FTPC is removed and replaced (or if TPC vertex changes).

Vertex Offset

The mean of a Gaussian fit to the x,y projection of the FTPC vertex position is the offset value.





Vertex Offset

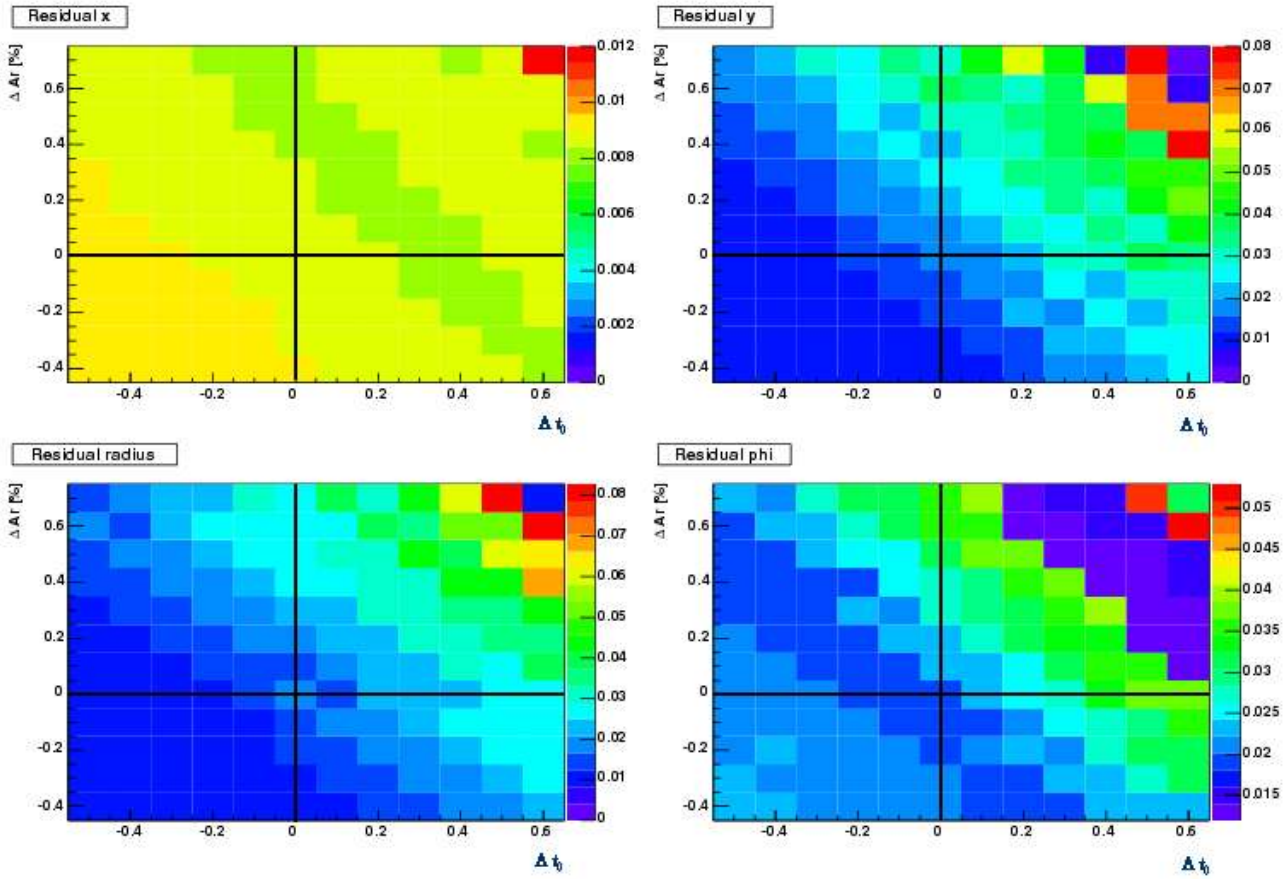
- For 200 GeV production:
  - The values will be rapidly determined as soon as inner cathode correction is fixed.
  - Another test pass will be needed to check the offset values.

Conclusions/To Do

- FTPC will be **ready for physics production.**
  - Temperature problems will not effect track counting and centrality selection.
    - Detector efficiency changes during the run due to electronics losses.
    - Effect on momentum resolution?
  - Improve inner cathode correction?
    - » Small effect once initial correction in place.
  - Lasers verify no change in gas composition (drift velocity) and E x B corrections.
  - Additional detector tuning is possible in the long term, especially for central events.
    - » Answer why # of hits on track decreases with increasing multiplicity.

BACKUP

Laser Calibration

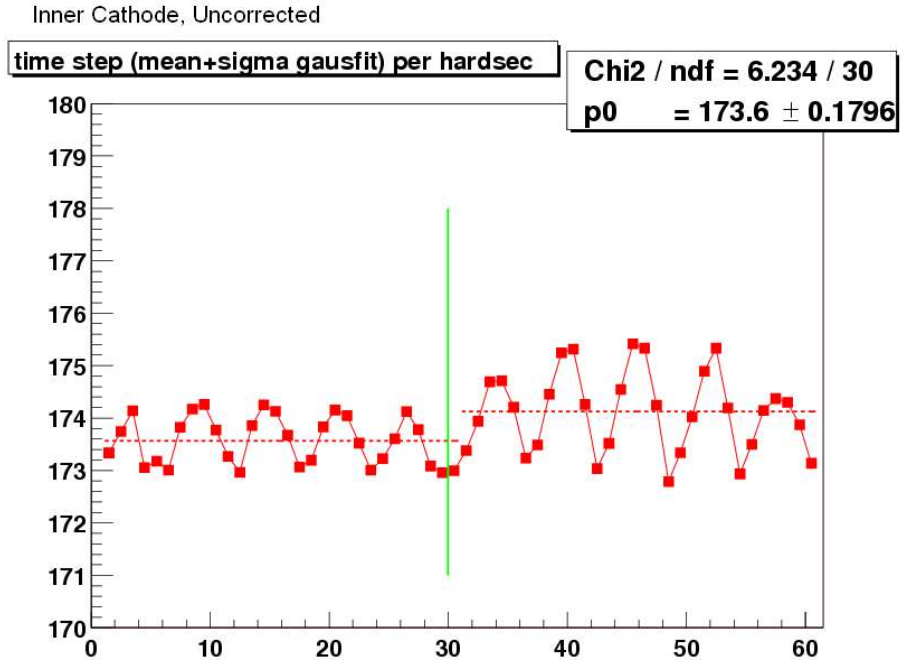


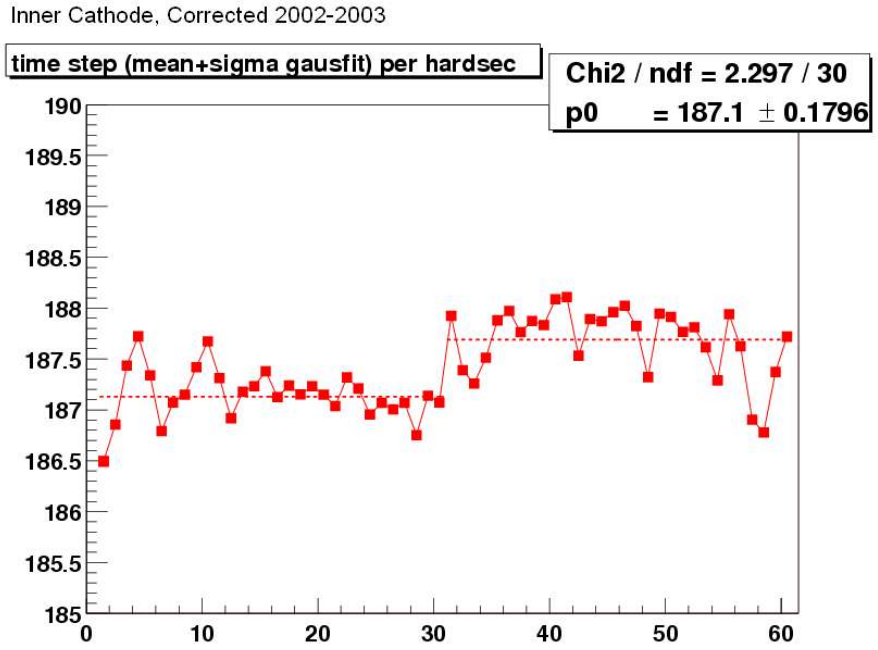
FTPC W, Inclined Lasers, Lsec 1, B = -1

Shows no change in drift velocity or E x B corrections!

Inner Cathode Correction

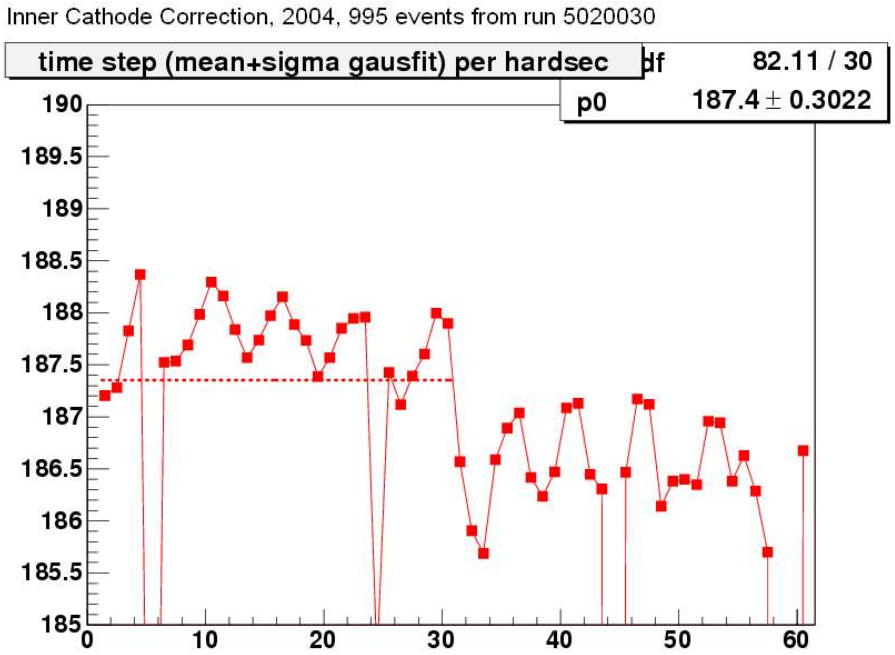
- Question to be answered:
  - Were the corrections reversed? (West ⇔East?)

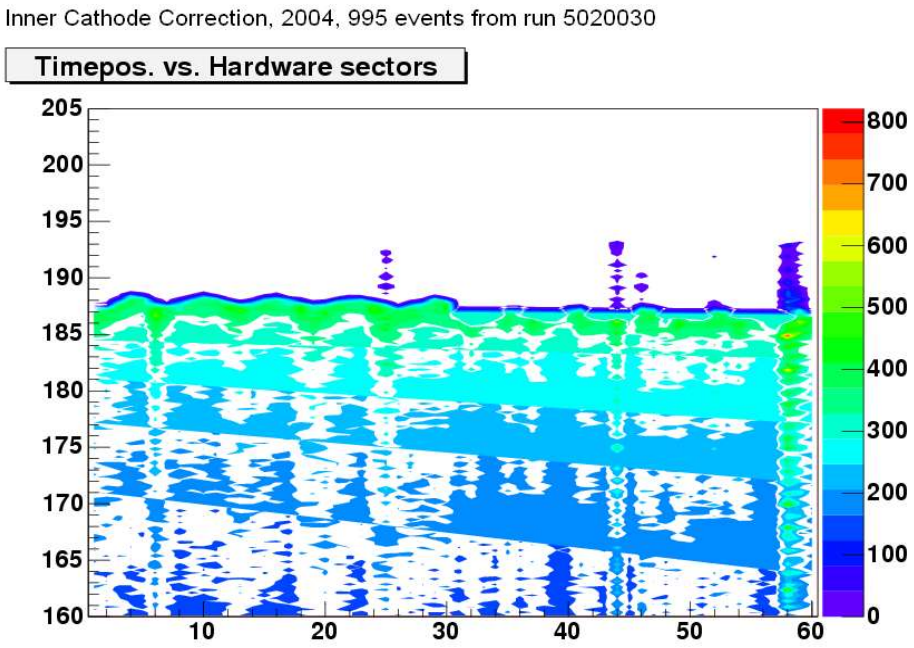




New Inner Cathode Correction

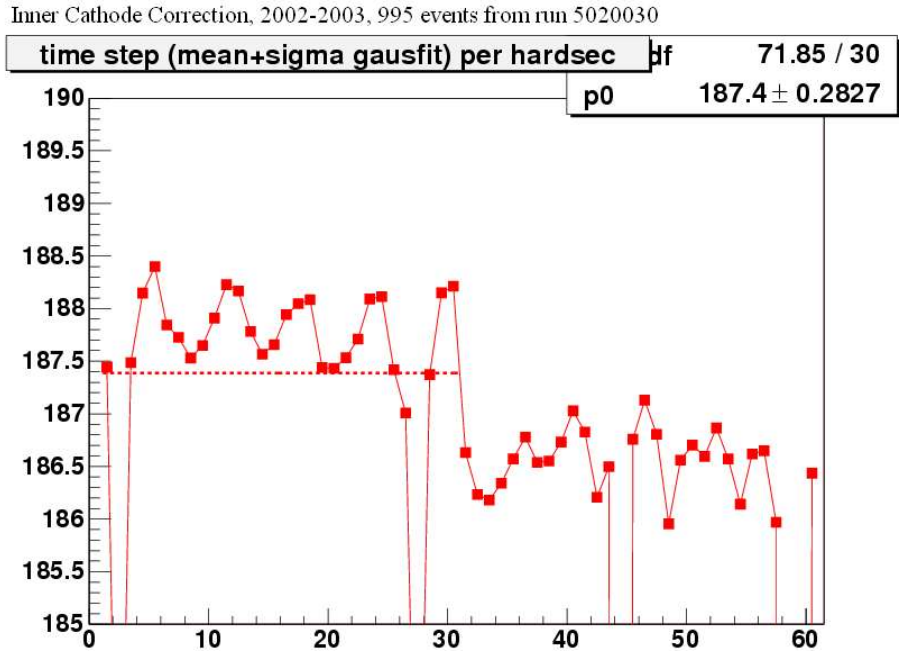
- Exchanged West ⇔ East
  - New values: West = -0.06, East = -0.07

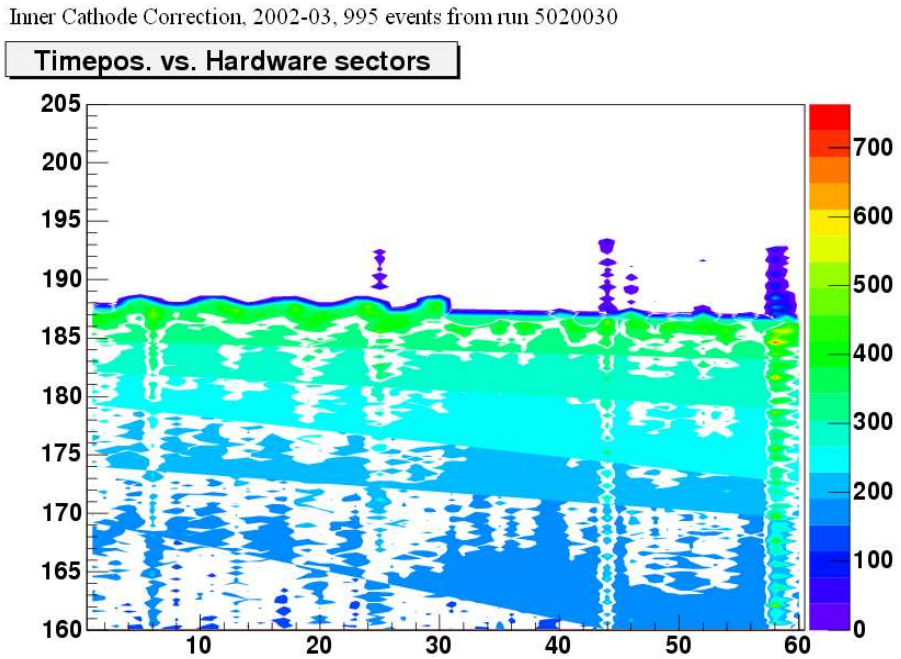




Inner Cathode Correction

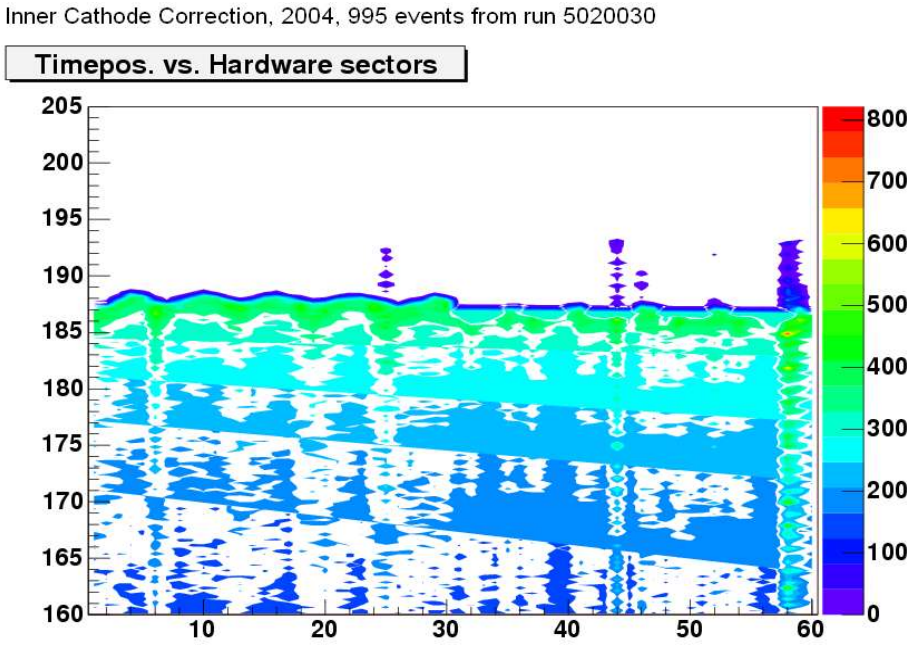
- Compare to old values:
  - West = -0.07, East = -0.06

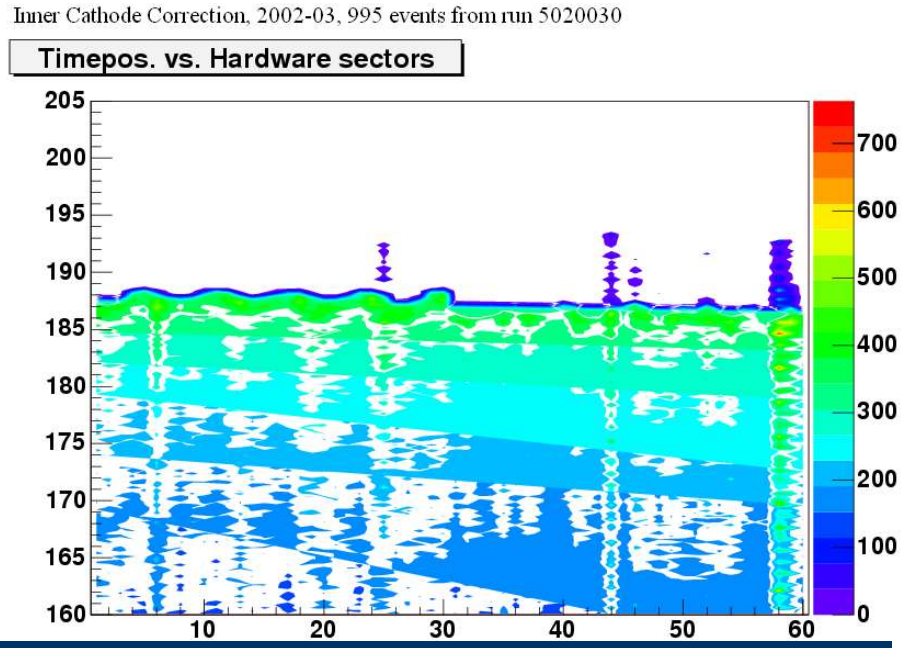




Inner Cathode Correction

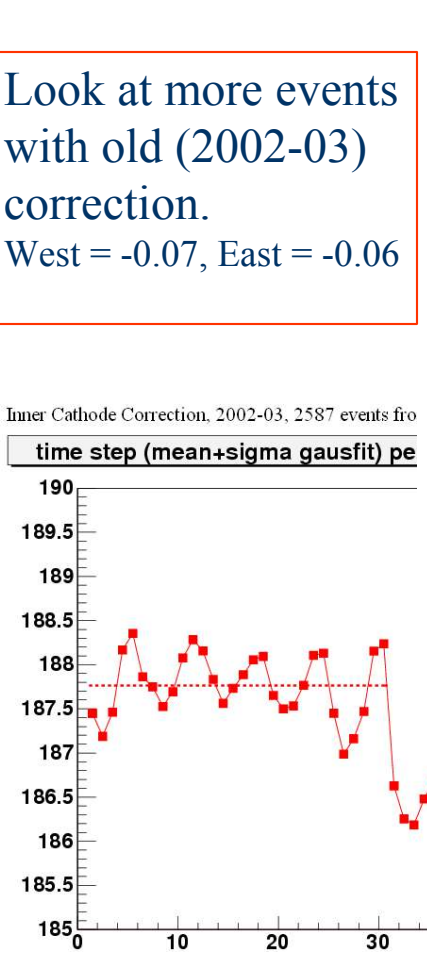
- Conclusion: Little difference between the two corrections!

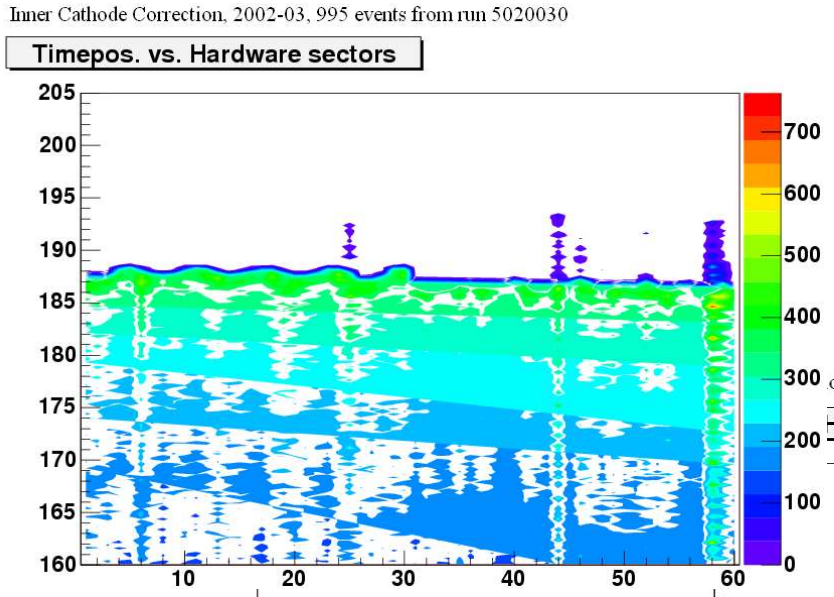




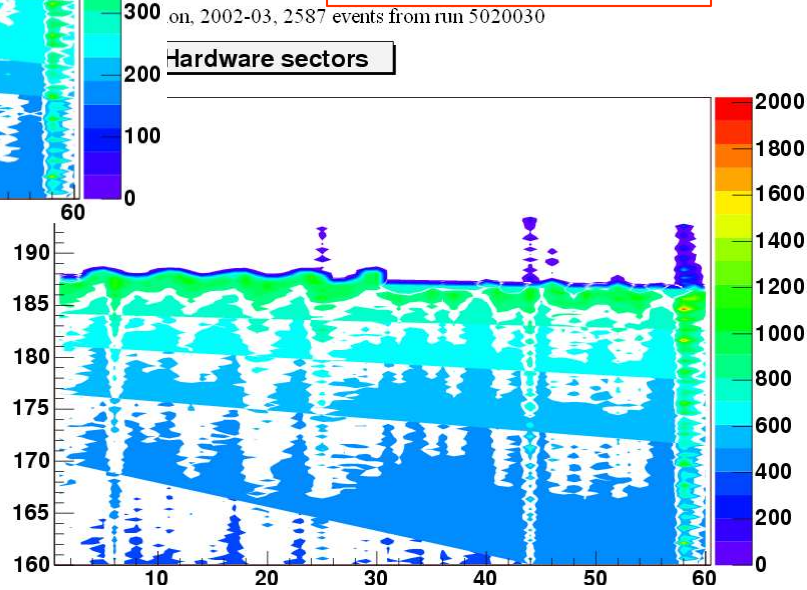
Inner Cathode Correction

Look at more events with old (2002-03) correction.
West = -0.07, East = -0.06





A few points improve. Otherwise, NO CHANGE!

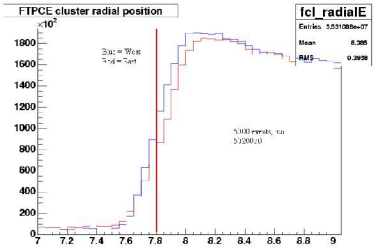


Inner Cathode Correction

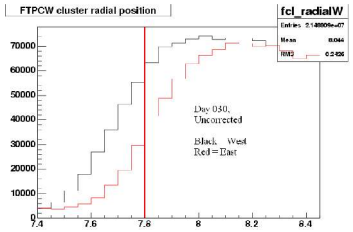
- Why is there such a large variation in the new data?
- Generate plot of

FTPC Temperatures

- Before day 025:
  - 6 body temperature readings/FTPC available to calculate average temperature.



- ~Day 025 and beyond:
  - Several body temperature sensors went bad.
  - Temporary fix:
    - Using 3 body temp sensors per FTPC and a hard-coded offset to correct the reconstructed radial step position.
    - This offset needs to be added to the database.



Temperature Jump

- On 3/7 there was an unexplained increase in the cooling water temperature and a corresponding jump in average FTPC body temperatures (~2-3 ^{o}C).
- The temperatures remained at this elevated level for the remainder of the run.

Gain Tables

- Run gain table program on pulser files:
  - Produce gain factors for all channels.
- Run noise finder program on data (daq) files:
  - Flags out channels with charge sum above certain threshold.
  - Writes final gain table which is then converted into database useable form.

Vertex Offset

- Generate plot of x,y position of FTPC E and W vertex wrt TPC vertex from several thousand events.
- Project x,y onto 1-D distribution.
- The mean of a Gaussian fit is the offset value.
- BOTH offsets for ‘x’ must be reversed in sign before being used:
    - This is due to the way the FTPC coordinate system is set up.

Purdue & the FTPC

- We have taken over the responsibility of the calibration of the FTPC for physics running.
- Y2004 calibration is a collaborative MPI/Purdue effort.

Purdue & FTPC

- Our current capabilities allow us to maintain the detector in a physics useable state for the foreseeable future.
  - As good or better than Y2003 FTPC calibration.
  - This includes handling all the previously mentioned calibration steps (inner cathode, laser, t_0, etc).
- Given current funding and manpower, we do not foresee being able to mount a concerted program to greatly enhance FTPC capabilities in areas such as:
  - Momentum resolution
  - Improved tracking

Future FTPC Physics

- Purdue's interest in the FTPC focuses primarily on the study of the "Quark-Gluon String Fusion" model.

M.A.Braun and C.Pajares
Nucl. Phys. B390,542(1993).

- There is strong interest in charged particle FTPC tracking from the PMD group and their study of disoriented chiral condensate (DCC).

F/B Correlations: Motivation

- The study of correlations among particles produced in different rapidity regions helps to understand the mechanisms of particle production.
- Many experiments show strong positive short-range correlations→clustering of particles over ~1 unit of rapidity.
- Short range correlations dominate at central rapidity. Longer range correlations observed in h-h collisions only at high energies.
- Long range correlations stronger in h-A and A-A than in h-h scattering at the same energy.

String Fusion Model

- Hadronization of color strings stretched between projectile and target particle describes multi-particle production in high energy collisions.
- # of strings increases with increasing energy and # of participating nuclei.
    - Expectation that the interaction between strings becomes essential.
- At RHIC, high energy nuclear ion collisions may produce a Quark-Gluon Plasma (QGP).
    - Interaction between strings will make the system evolve toward a QGP state.

F-B Multiplicity Correlation

Correlation between forward and backward multiplicities (n_f, n_b) of produced charged particles is:

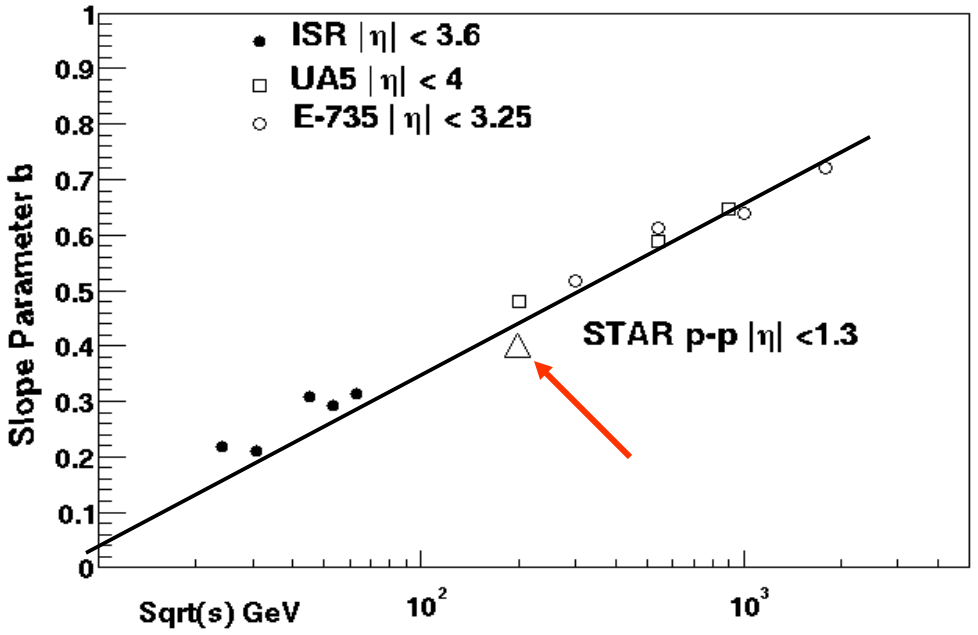
$$\langle n_b \rangle_{n_f} = a + b\, n_f$$

Constant coefficients a, b are determined by minimizing $\langle [n_b - (a + b\, n_f)]^2 \rangle$ (Linear Regression)

$$b = \frac{\langle n_f n_b \rangle - \langle n_f \rangle \langle n_b \rangle}{\langle n_f^2 \rangle - \langle n_f \rangle^2} = \text{Correlation Strength}$$

Measurements of Slope Parameter

Measured at ISR, UA5, and E-735 energies in pp and $p\bar{p}$ collisions.



At STAR:

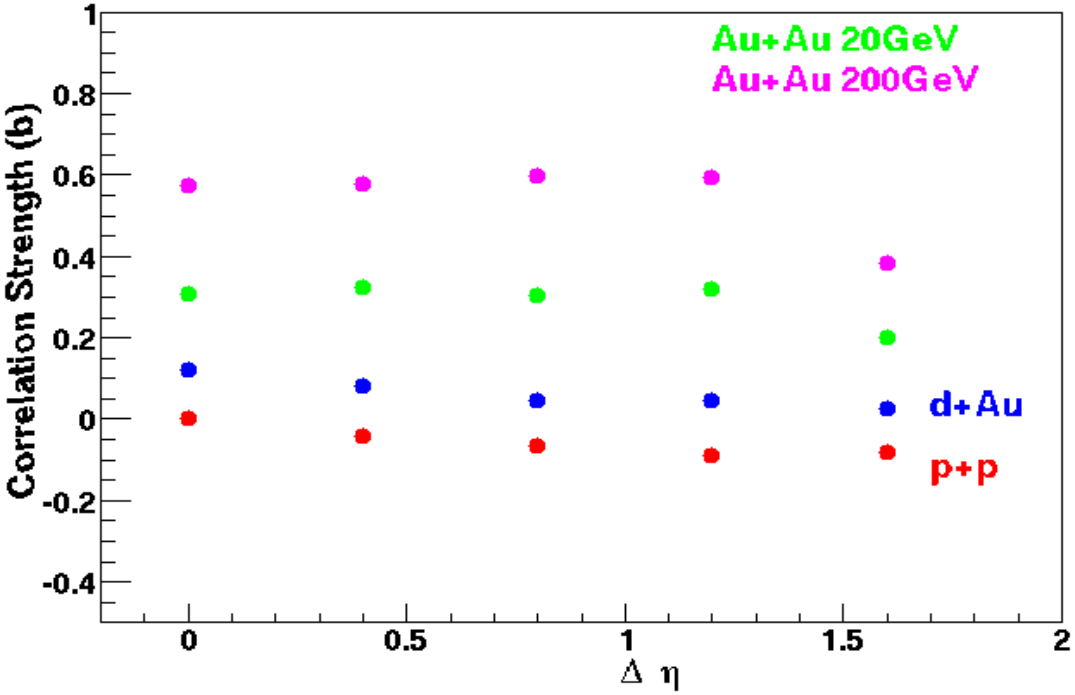
-2.5 M minbias pp events @ $\sqrt{s}$ = 200 GeV.

- $|z| = 25$ cm
- $|\eta| < 1.3$
- $0 < dca < 3$
- # fit points > 25

Correlation strength increases with energy.

STAR data follows the established trend.

Correlation Strength as a function of Δη



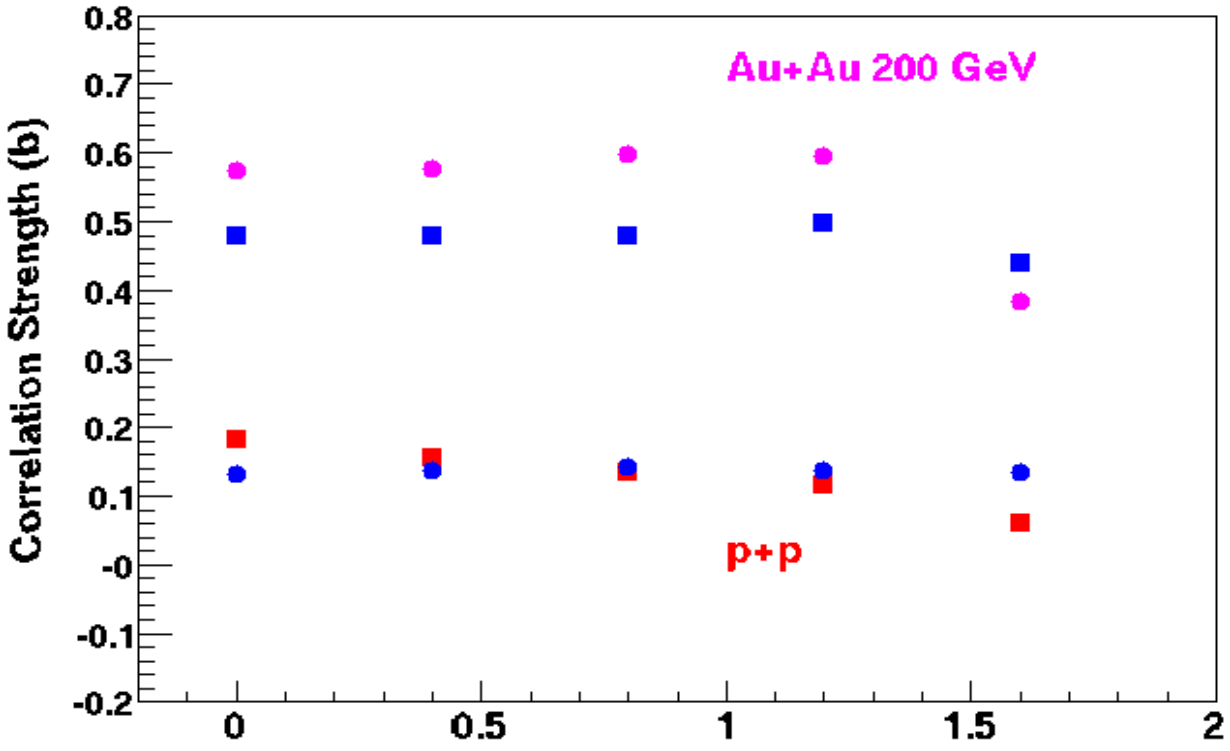
What happens as Δη increases:

- Does correlation strength go to zero?

OR…?

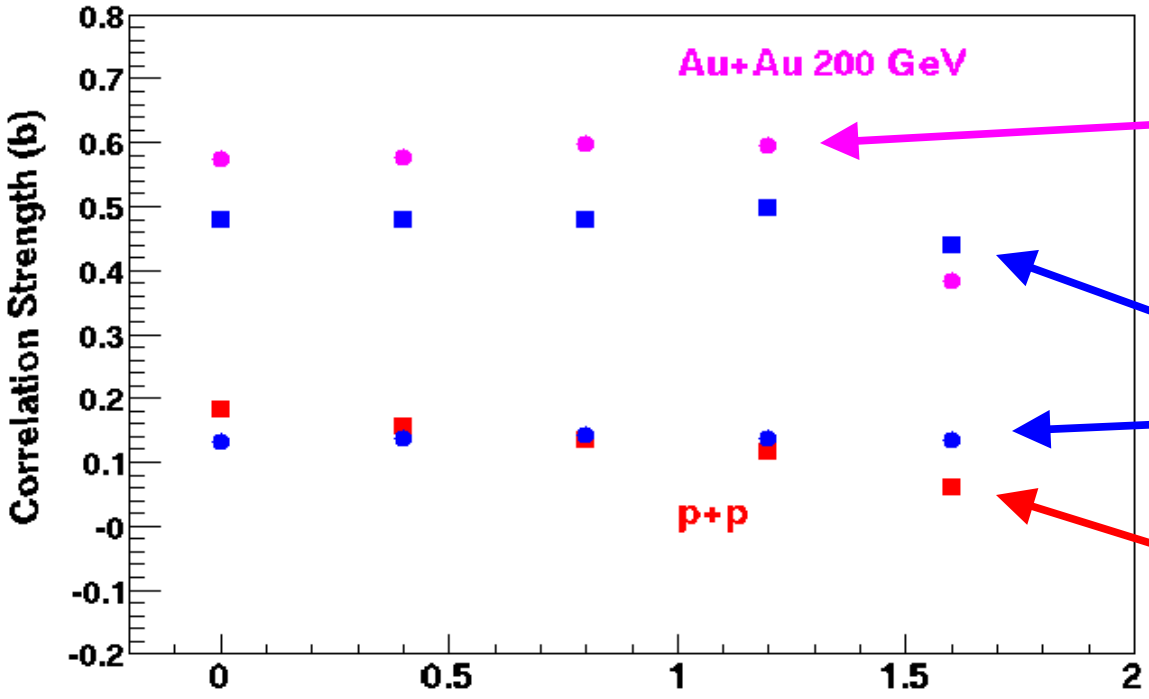
- Is there percolation/string fusion?

SFM @ 200 GeV


Au+Au 200 GeV
p+p
Correlation Strength (b)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
-0
-0.1
-0.2
0
0.5
1
1.5
2

SFM @ 200 GeV

Correlation strength versus Δη for 200 GeV p-p, Au-Au, and SFM.



Au-Au 200 GeV

SFM

p-p 200GeV