# Estimation of TPC Aging Based on dE/dx Measurements

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STAR TPC review

# Outline

- Some details of STAR dE/dx calibration (procedure, corrections,…)
- Previous attempts to observe TPC aging.
- Run IX: pp500 versus pp200
- Conclusions



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# STAR dE/dx Calibration

- The dE/dx calibration is based on a sample of global tracks reconstructed in TPC with momenta in range 0.4 GeV/c < p < 0.5 GeV/c (MIP for pion). For runs with high luminosity (and high rate of pile-up events) these global track sample is restricted to track associated with triggered primary vertex in order to avoid problem with wrong distortion corrections due to poorly defined Z coordinate for pile-up hits.
- dE/dx corrections include:
  - Relative pad gain calibration base on pulser runs (done online and use for online clustering)
  - Restriction cluster sample :

    to non ovelapped clusters, and

    removing clusters near sectors edges where cluster charge significantly drops (5 pads).
  - "ADC Correction" => ADC and Clustering nonlinearity correction, accounting for loss of signal due to:
    - to threshold,
    - ADC saturation, and
    - rounding during cluster charge calculation.

    This correction has been obtained from TPC response simulation. For new TPC electronics this correction has not been obtained yet.
  - Essential part of the calibration is the TPC distortion correction which does effect on the precision of dx measurement.
  - Set of multiplicable factors:
    - SecRow => "Gas gain" correction for sector/row,
    - Oxygen => Correction for Electron Attachment due to O2,
    - Pressure => Dependence of the Gain on Gas Density due to Pressure,
    - …
  - LengthCorrection => Correction for track <dE/dx> (30% truncated mean) variation versus track length used for the track <dE/dx> calculation due to cluster dE/dx dependence on dx.

# STAR dE/dx Calibration (cont.)

The main tool to obtain "multiplicable factors" is fit Z-distributions for cluster binned for variable such as sector, row, pressure, …

$Z = \log((dE/dx)_{measured}/(dE/dx)_{\pi})$, where

$(dE/dx)_{\pi} = F(p/m,dx)$ is prediction of Photo Absorption model (know in STAR as the "Bichel model") for π-mass hypothesis.

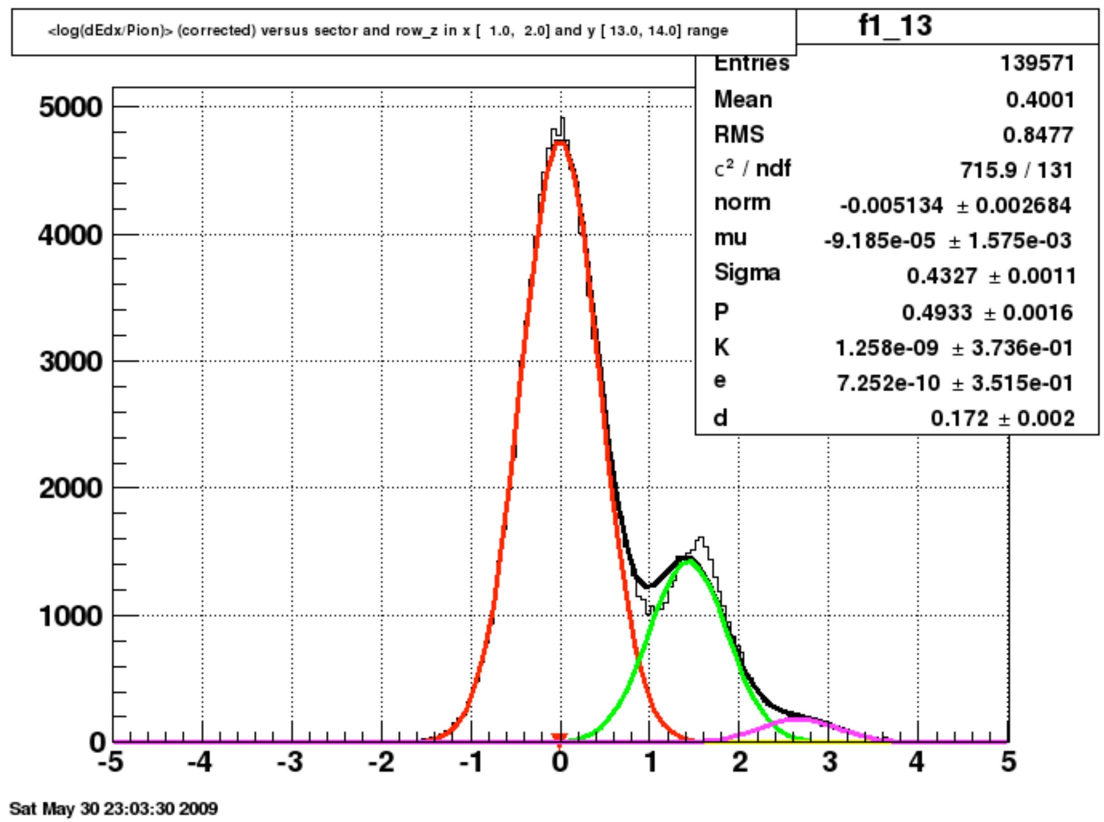
This is an example of such fit of z distribution for clusters in sector 1 and pad row 13. The fit is done with 5 mass hypotheses (represented by Gaussian with the same width) with fixed distance proton, kaon, electron and deuteron hypotheses from π. The fit parameters are:

•Shift π peak from predicted position ("mu"),

•A sigma of all Gaussians, and

•Fraction of all mass hypotheses.

This procedure provides precision better than 1%.



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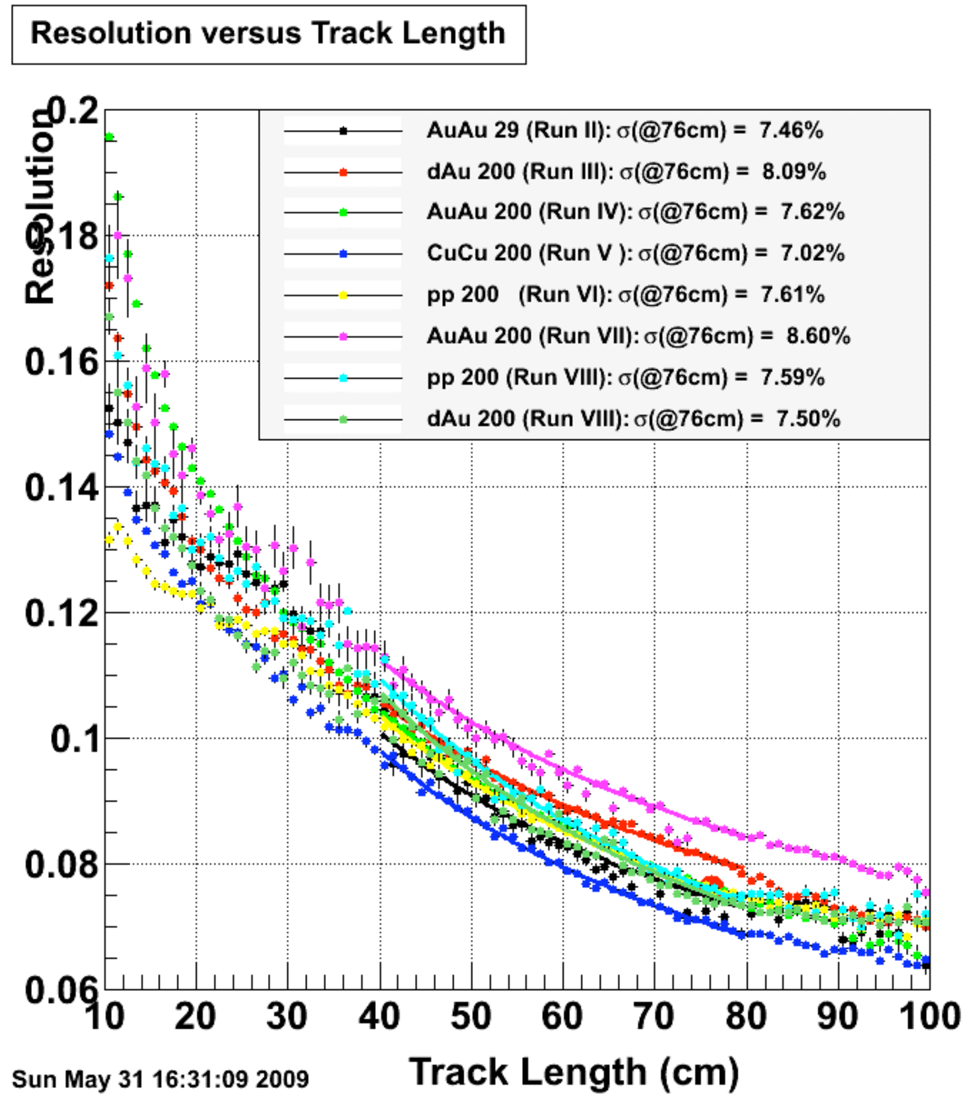
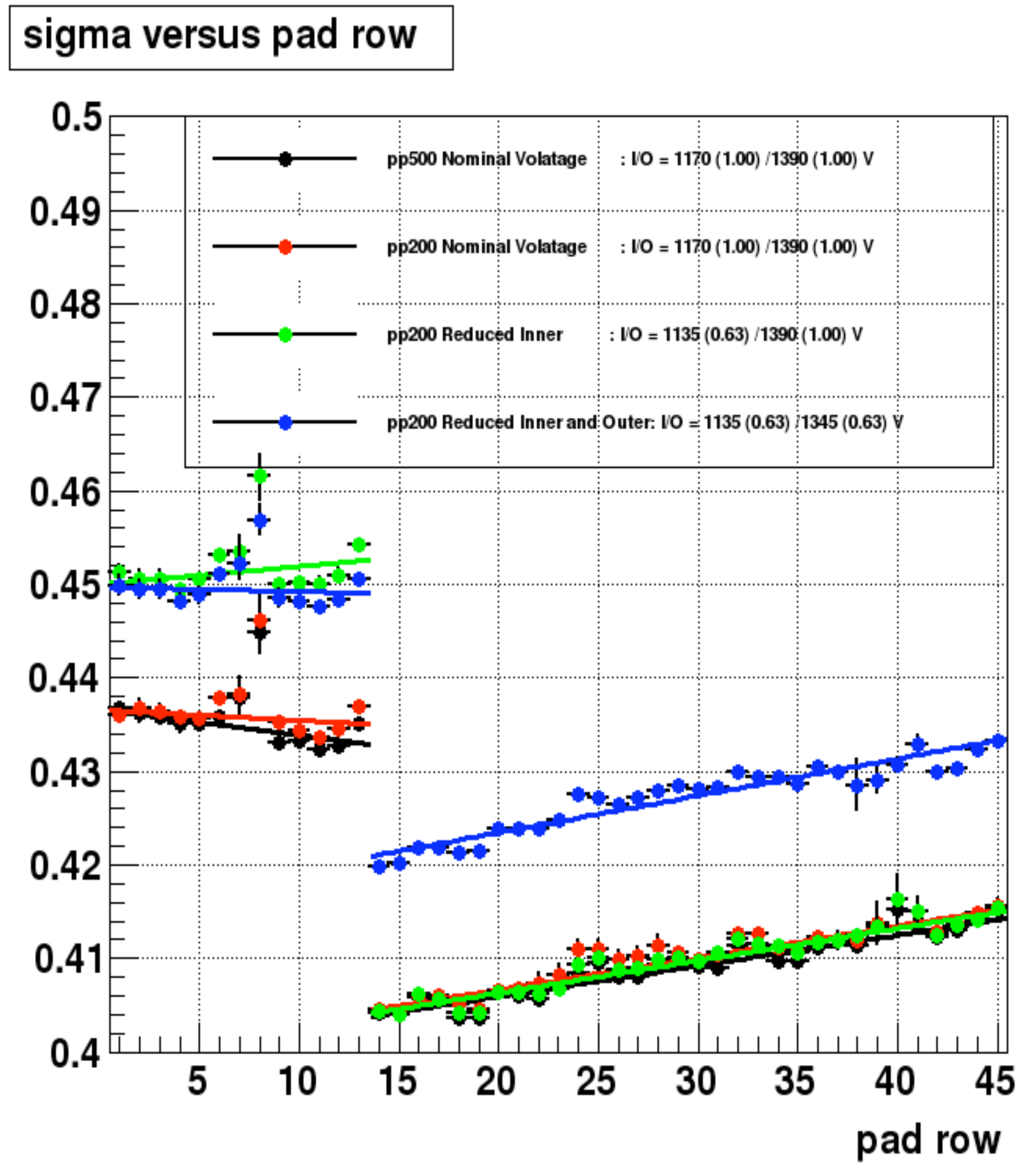
# STAR dE/dx Calibration (cont.)

- On this plot relative dE/dx track resolutions versus the track length used for the dE/dx calculation for different RHIC run are presented.
- The conclusions from this plot are:
  - The resolutions are about “achievable” value 7.6% @ 76 cm track length (Model estimation gives 7.3%).
  - There is no (at least obvious) time dependence.
  - There is a dependence on run conditions (mainly hit occupancies and distortion correction precision).



# Sigma versus row for different gains

- Rough dE/dx resolution estimation:
  - Nominal Voltage:
    - $\sigma_I = 0.435/\sqrt{(0.7\bullet 13)} = 14.4\%$
    - $\sigma_O = 0.41/\sqrt{(0.7\bullet 32)} = 8.7\%$
    - $\sigma = 7.45\%$
  - Reduced Voltage Inner (relative gain 0.63 with respect to nominal)
    - $\sigma_I = 0.45/\sqrt{(0.7\bullet 13)} = 14.9\ \%$
    - $\sigma = 7.51\%$
  - Reduced Voltage Inner and Outer (relative gain 0.63 with respect to nominal)
    - $\sigma_O = 0.425/\sqrt{(0.7\bullet 32)} = 9.0\%$
    - $\sigma = 7.7\%$
- Reduction of gain for Inner sector practically (~0.06%) has no effect on dE/dx resolution but Outer sector gain reduction produces sizeable effect (~0.25%).

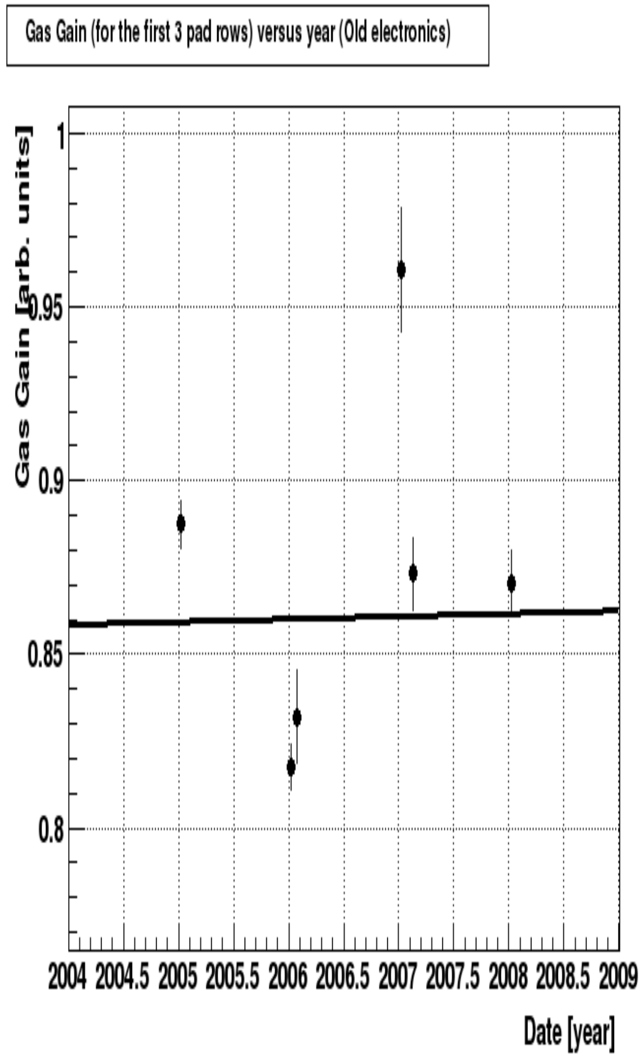


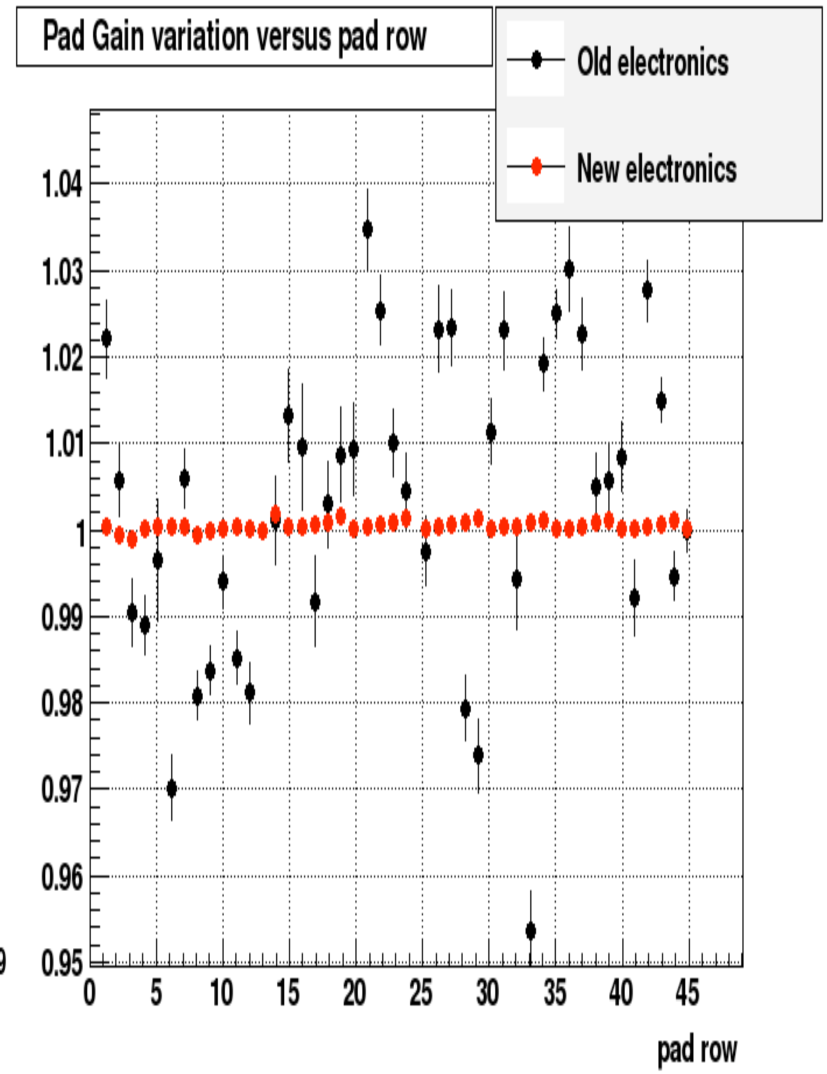
# Aging measurement based on dE/dx

In the past we have tried to estimate TPC aging by comparison "gas gain" correction obtained during dE/dx calibration (recalculated for "standard" gas parameters).

We did not see any statistically significant effect of aging. One of the reason could be a large variation of pad gains.

For the last run we have requested special data sample to try to evaluate aging (with new electronics) with hope that new electronics has much lower (<0.2%) pad variation which will allow to see aging effect on the level of ~1%.



# Comparison low luminosity runs pp500 and pp200 (Run IX data)

Here we compare data obtained at "low luminosity" at the beginning of pp500 (03/24/09) and the beginning of pp200 just after finishing pp500 (04/28/09). For this period it was collected 10 C for all Inner sectors and 10/3.8 = 2.63 C for Outer sectors (A.Lebedev).

Thus accumulated charge per 1 cm of wire:

•I: 10C /1.6 km = 62.5 μC/cm at <r> = 85.2cm (row 6)

•O: 2.63C/3.6km = 7.3 μC/cm at <r> = 157cm (row 29)

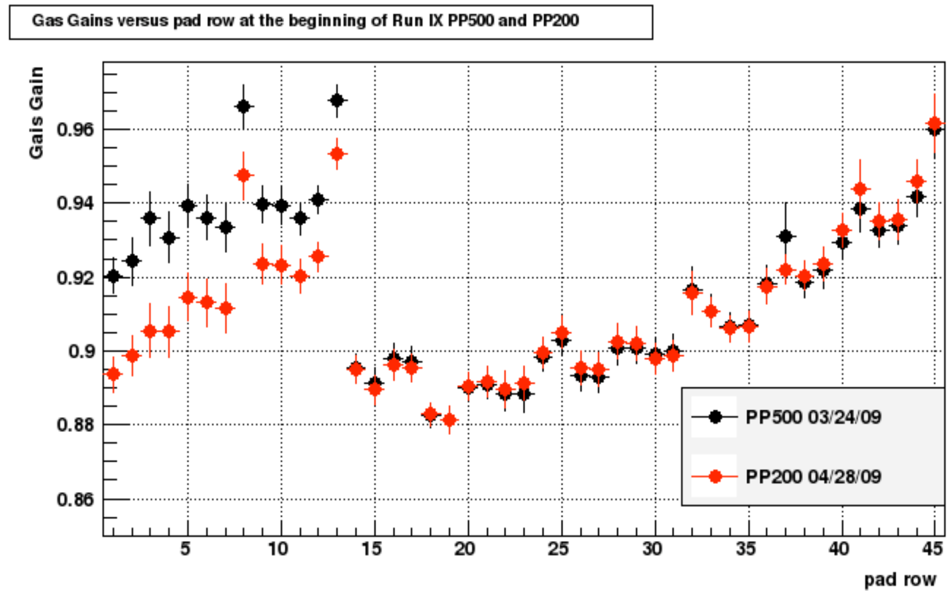
Ratio pp200/pp500 versus pad row shows clear dependence reduction of "gas gain" versus pad row. If we assume

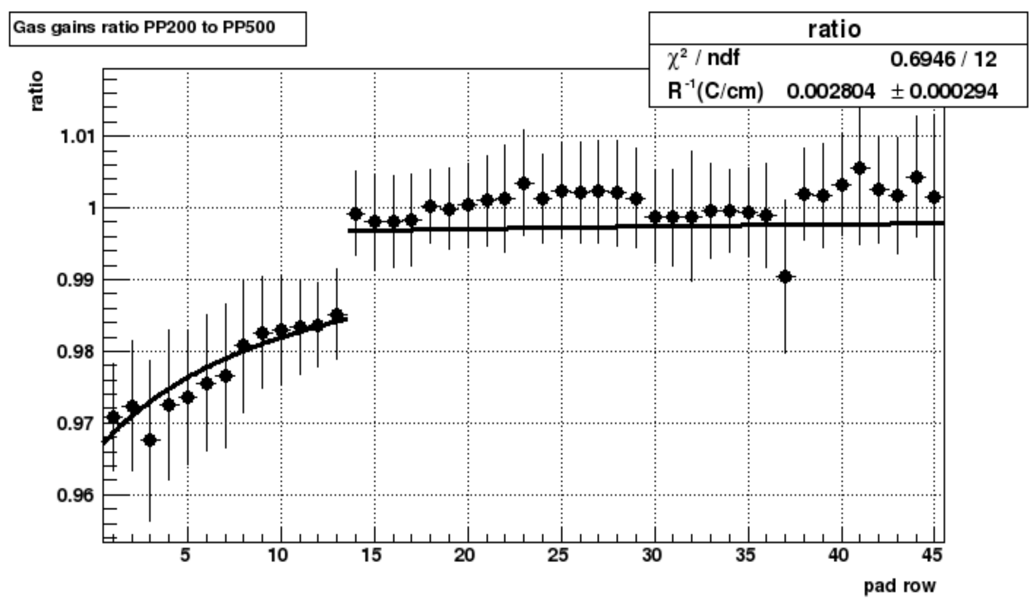
$$R^{-1} = -\ \Delta Q/(\Delta G/G),$$

And reduction at row 6 is $\Delta G/G \sim -2.5\%$ =>

$R^{-1}$= 62.5 [μC/cm] /2.5% = 2.5 [mC/cm].

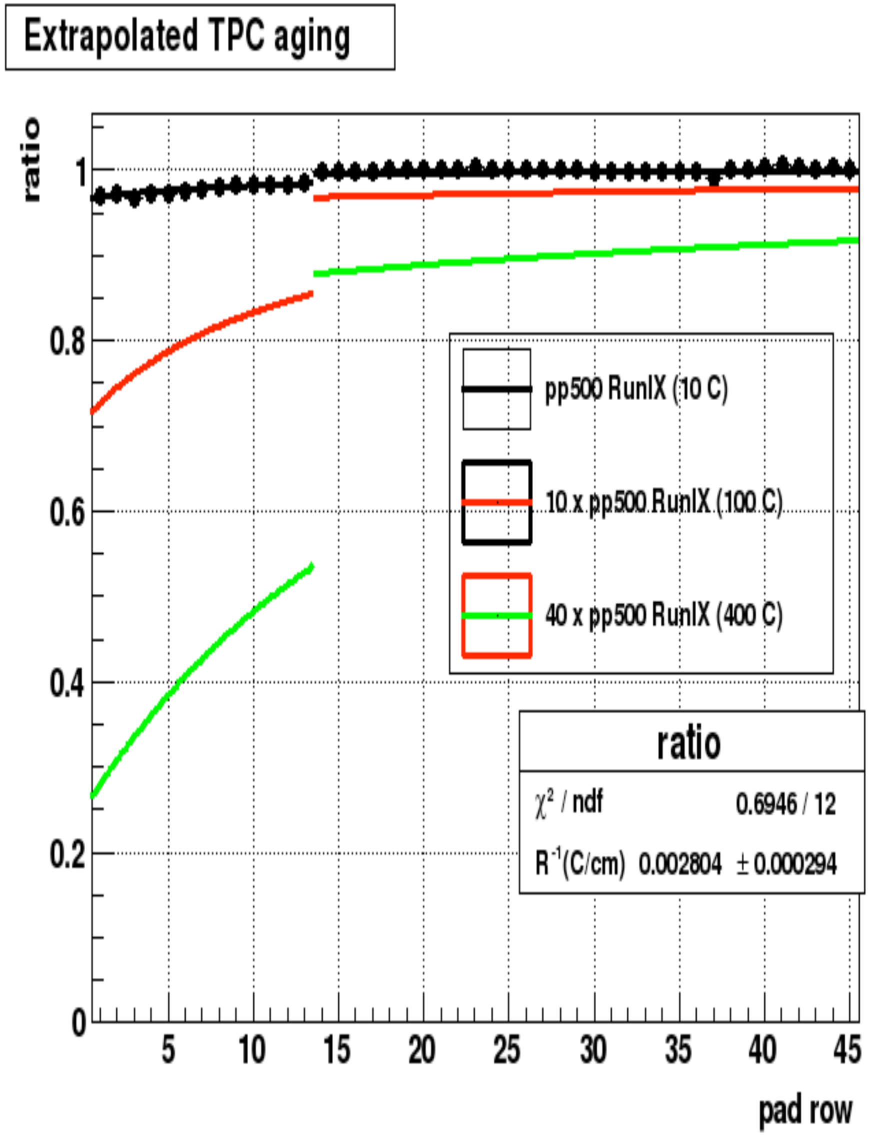
The fit assuming 1/r accumulated charge dependence gives $R^{-1} = 2.8 \pm 0.3$ [mC/cm]. This value is a factor of 35 less usually claimed ~100 [mC/cm].



# Extrapolation to 10 years of running and 10 years of running at RHIC II

- On this plot extrapolations to x10 and x40 accumulated charge are shown.
- The major problems have started with x40 integrated luminosity for Inner Sector.



# Conclusions



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