Status of the dE/dx calibration

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Outlook

- Why did we revisit dE/dx calibration?
- What is the dE/dx calibration?
- Where are we now?
- Conclusions

Why ?

- **Last calibration was done in March, 2002:**
  - **σ(dE/dx)/(dE/dx) = 8.2% for 76 cm track**
  - **STAR CDR (p. 4C-33)**
    - **$\sigma(dE/dx)/(dE/dx) = 0.47\ N^{-0.46}(Ph)^{-0.32}$, P = 1atm**
    - **σ_{Inner} = 14.3%, h = 1.15 cm, N = 12;**
    - **σ_{Outer} = 7.7%, h = 1.95 cm, N = 32;**
    - **σ = 6.8% for 76 cm track in TPC**
  - **H.Bichsel simulation:**
    - **σ = 7.0 % for 13 * 1.2 cm + 32 * 2.0 cm**
  - **I was not happy that ~1% is missing.**
- **H.Bichsel's calculations reproduce the data only qualitatively. Is this due to calibration procedure ?**
- **H.Bichsel claims that we have non linearity in dE measurement. Can we check this ?**
- **Can dE/dx calibration be done in one pass? Can we move it into fast online ?**

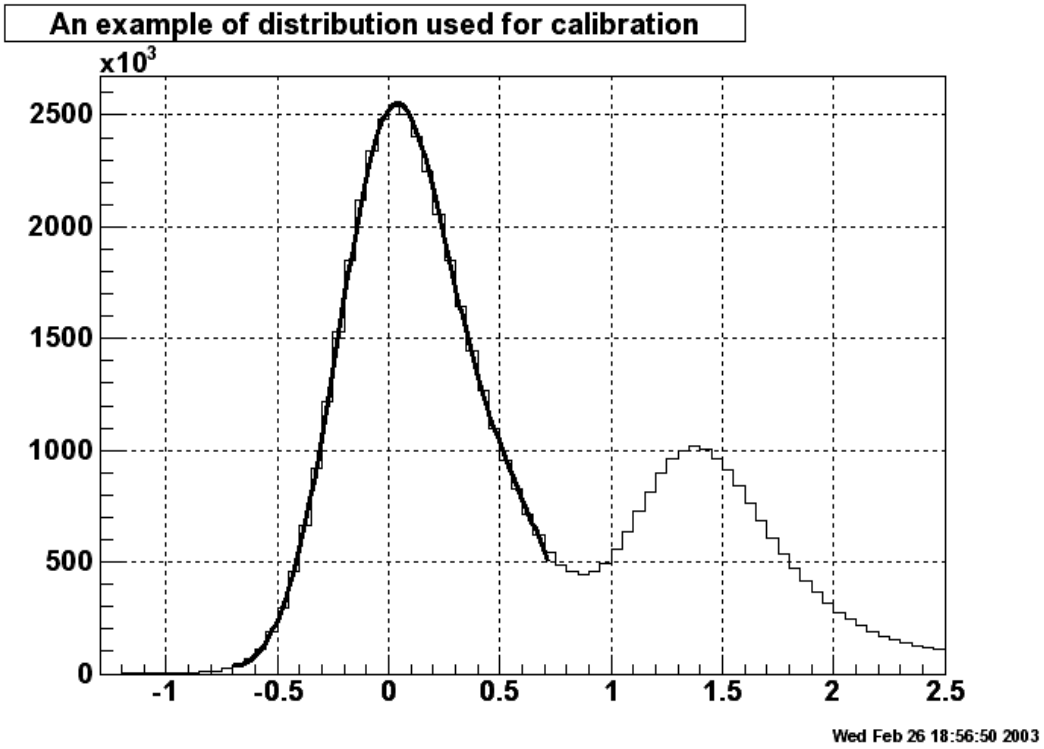
What does calibration include?

- **Applying pad correction obtained from pulser data (Fabrice did this and I will not talk about it)**
- **For good clusters (used in fit, no overlaps)**
- **For good global tracks (No. fit points ≥ 30, Track length in TPC > 40 cm)**
- **$Z = \log[(dE/dx)_{measured}/(dE/dx)_{predicted\ for\ \pi^-}]$**

• Fit Z-distribution with Gauss(μ,σ) + pol3 in +/-3σ range (It is supposed that we have ~80% π.)

• μ => 0 and it should not depend on

- **Time, Pressure**
- **Sector, row**
- **Drift distance, …**



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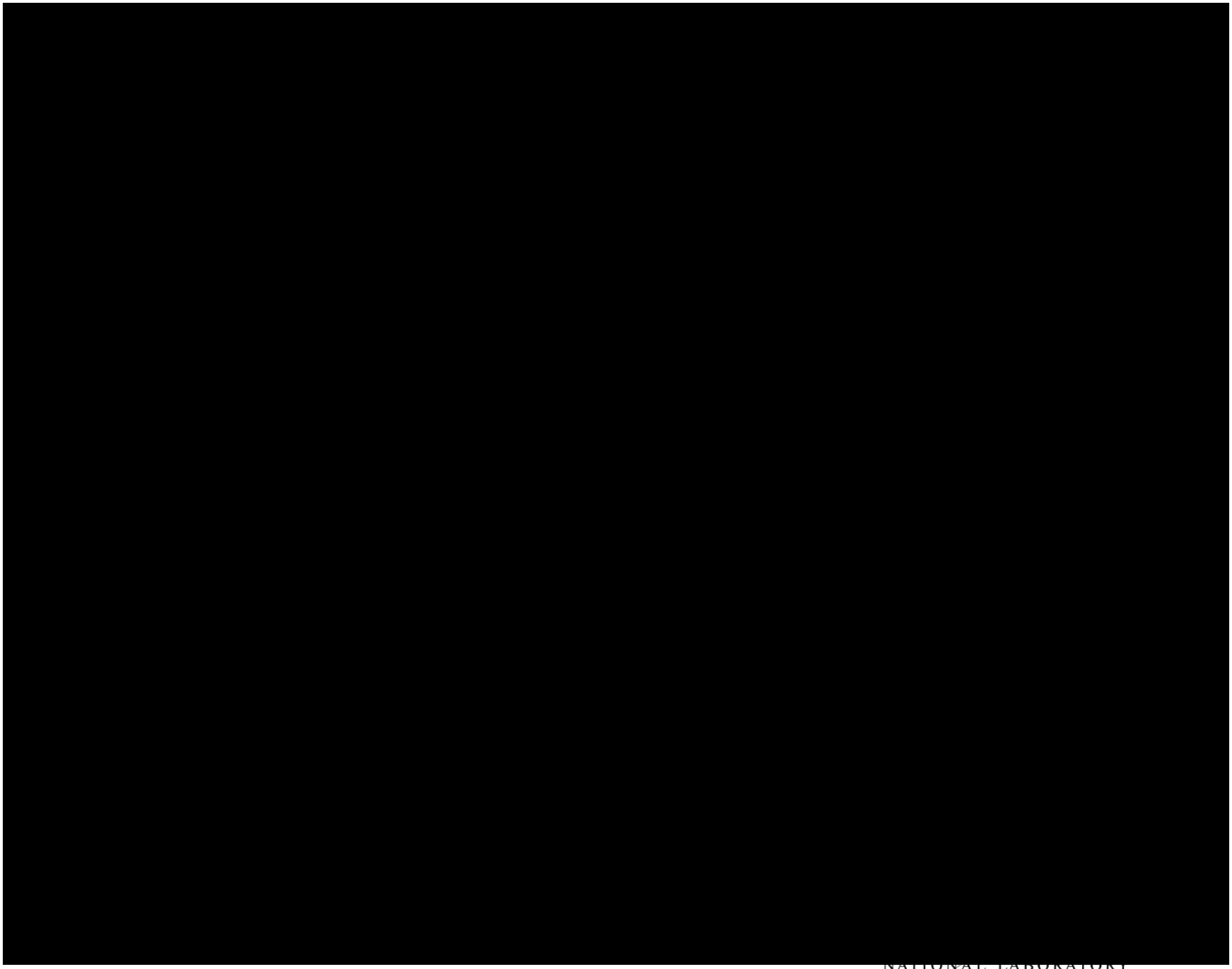
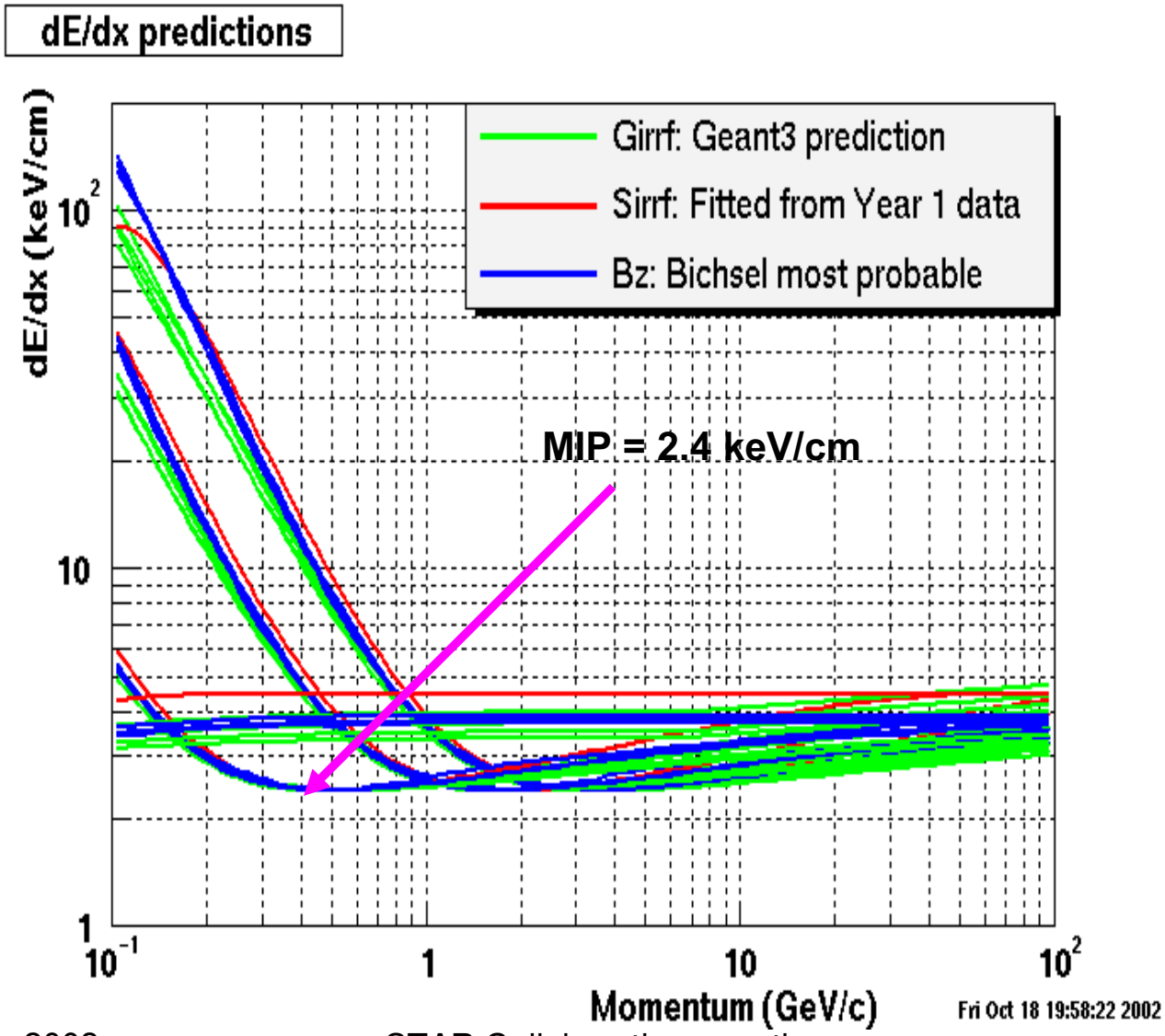


What does prediction mean ?



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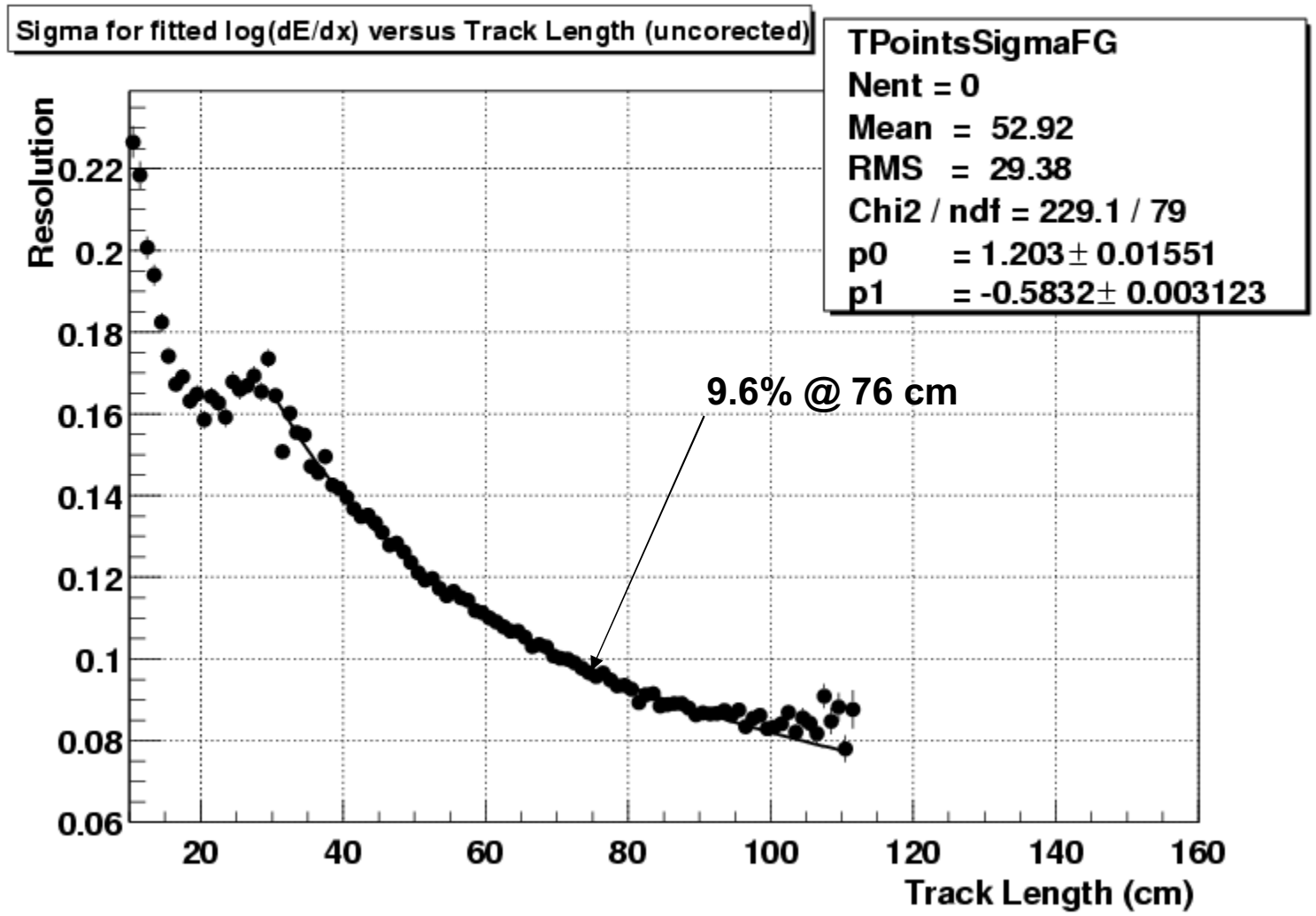
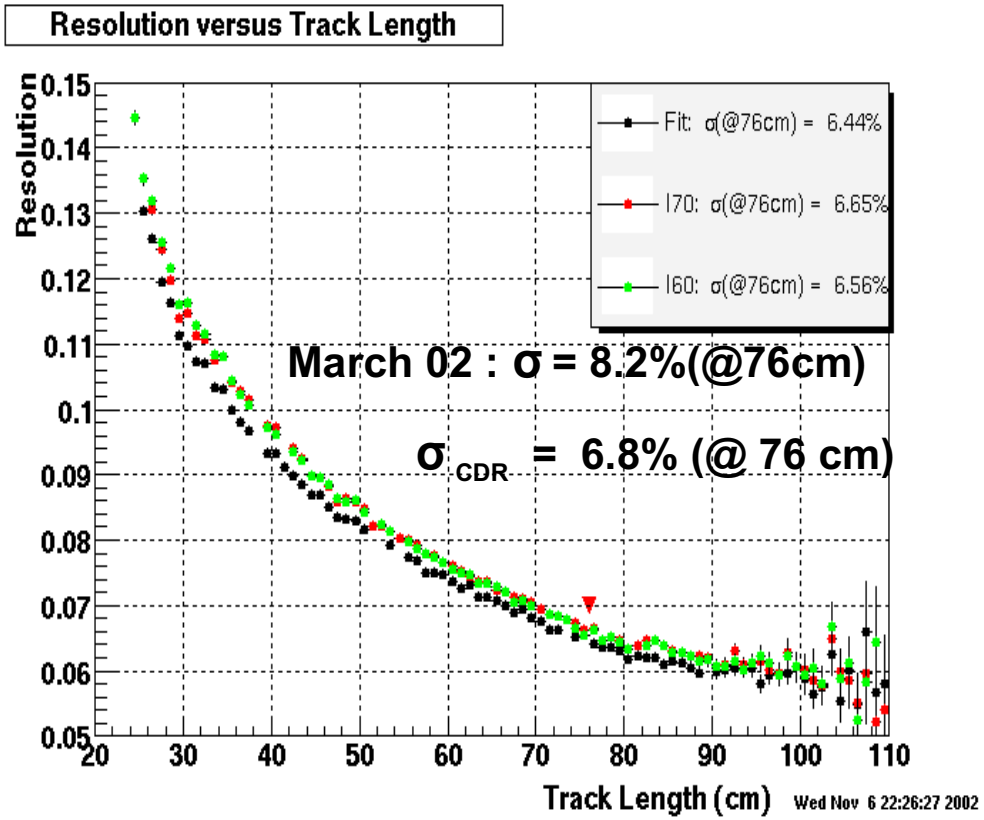
Resolution before calibration



What does March calibration mean?

- **The same procedure as for Year 1 data**
- **Sirrf was used as prediction**
- **Calibration was done for all tracks (no restriction on momentum)**
- **Time dependence : overall gain correction factor each few hours (1-4)**
- **Sector and pad row correction**
- **Drift distance correction**
- **Result : σ = 9.6% → σ = 8.2%**



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New calibration

- Calibration is based on tracks with $0.4 < p < 0.5$ GeV/c (~MIP for pions: $\beta\gamma = p/m = 4$).
- Calibration has been done for new **(daq)** tcl only.
- Bichsel's calculation was used as prediction with dx dependence (see next slides) i.e.

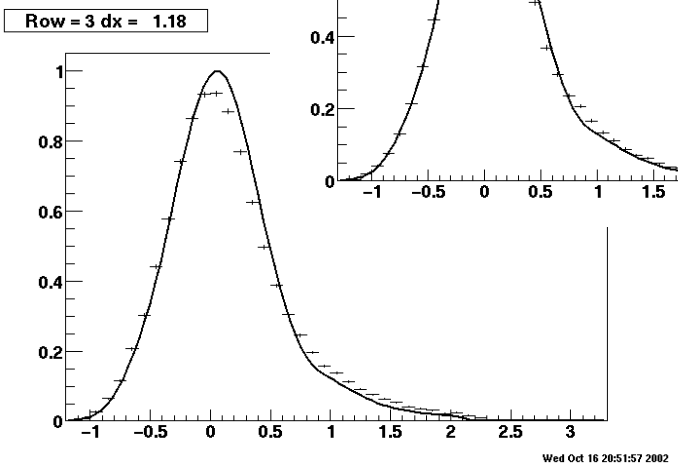
$$\mathbf{Z = \log[(dE/dx)_{measured}/(dE/dx)_{predicted\ for\ \pi}(\beta\gamma, dx)]}$$

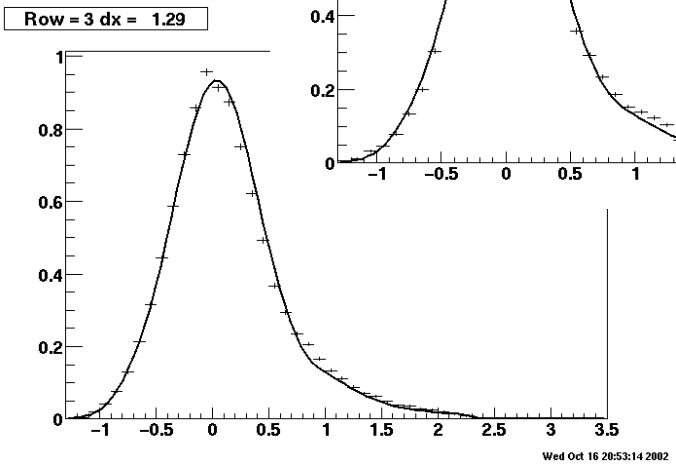
- This calibration gives σ = 8.8% (instead of 8.2% obtained in March because it was done only for $0.4<p<0.5$GeV/c but resolution is obtained for all momenta).

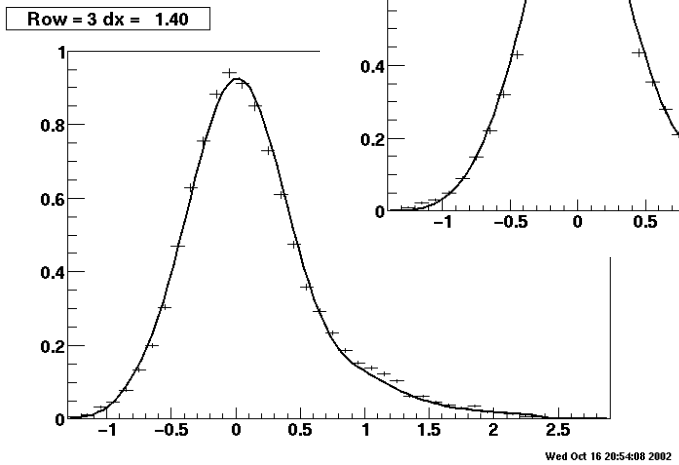
Bichsel shapes

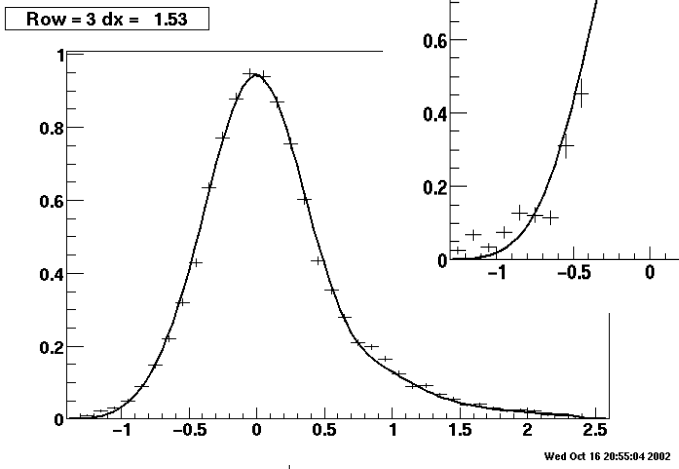
fit by $\varphi(\mu+(1+\sigma)z)$, where
$\varphi(z)$ is Bichsel shape and
$z = \log(dE/dE_{\text{most probable}})$;

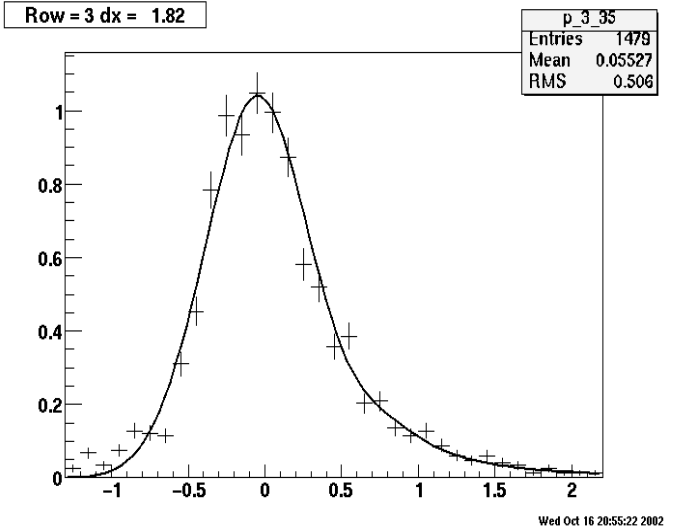
Inner











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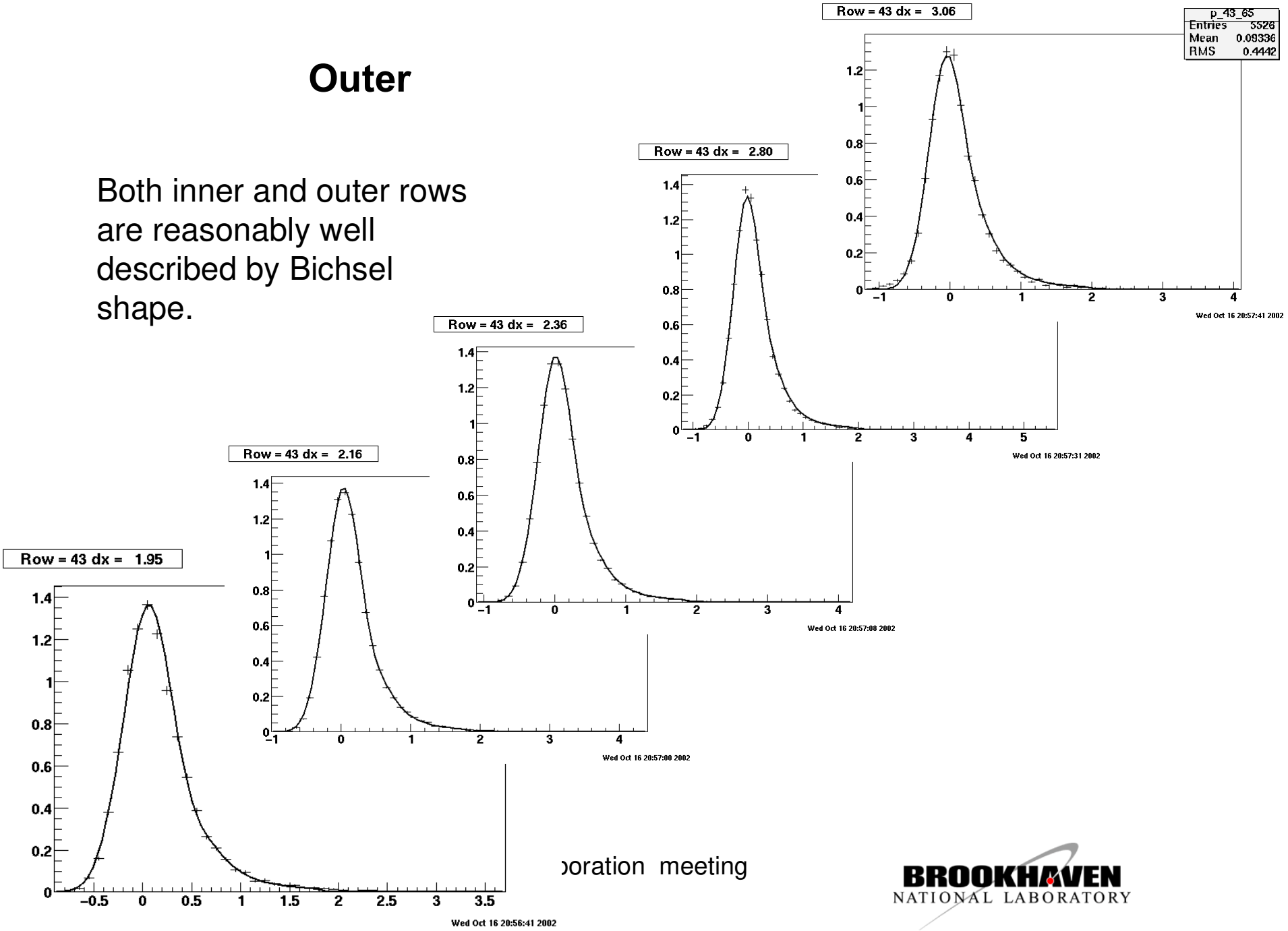
Outer

Both inner and outer rows are reasonably well described by Bichsel shape.



oration meeting

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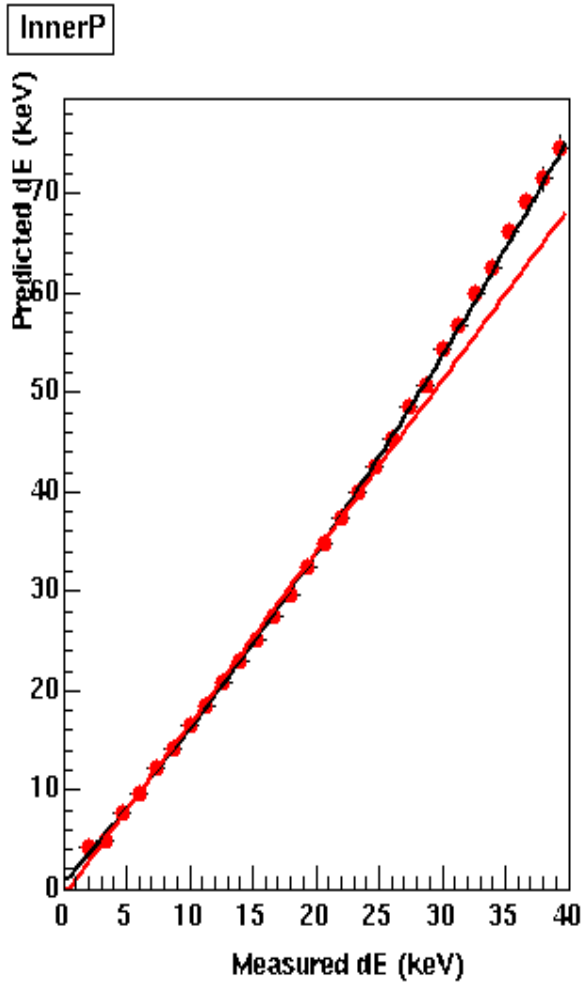
Cluster dE nonlinearity

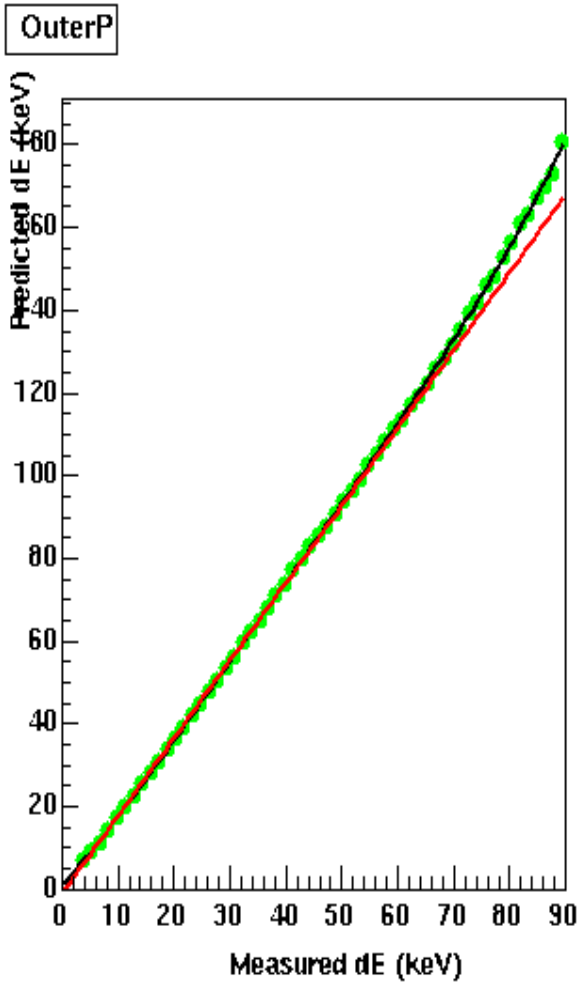
For uniquely identified tracks:

- **σ < 15% and**
- **v=log[(dEdx)/(dE/dx)$_J$], where J = [e,π,K,p,d]**
- **|v| < 3σ for only J, and**
- **|(dE/dx)$_J$ - (dE/dx)$_k$| >5σ, for J≠K**

Plot shows predicted dE versus measured dE

- **The origin of the nonlinearity was not clear:**
  - **ADC ?**
  - **Clustering ?**





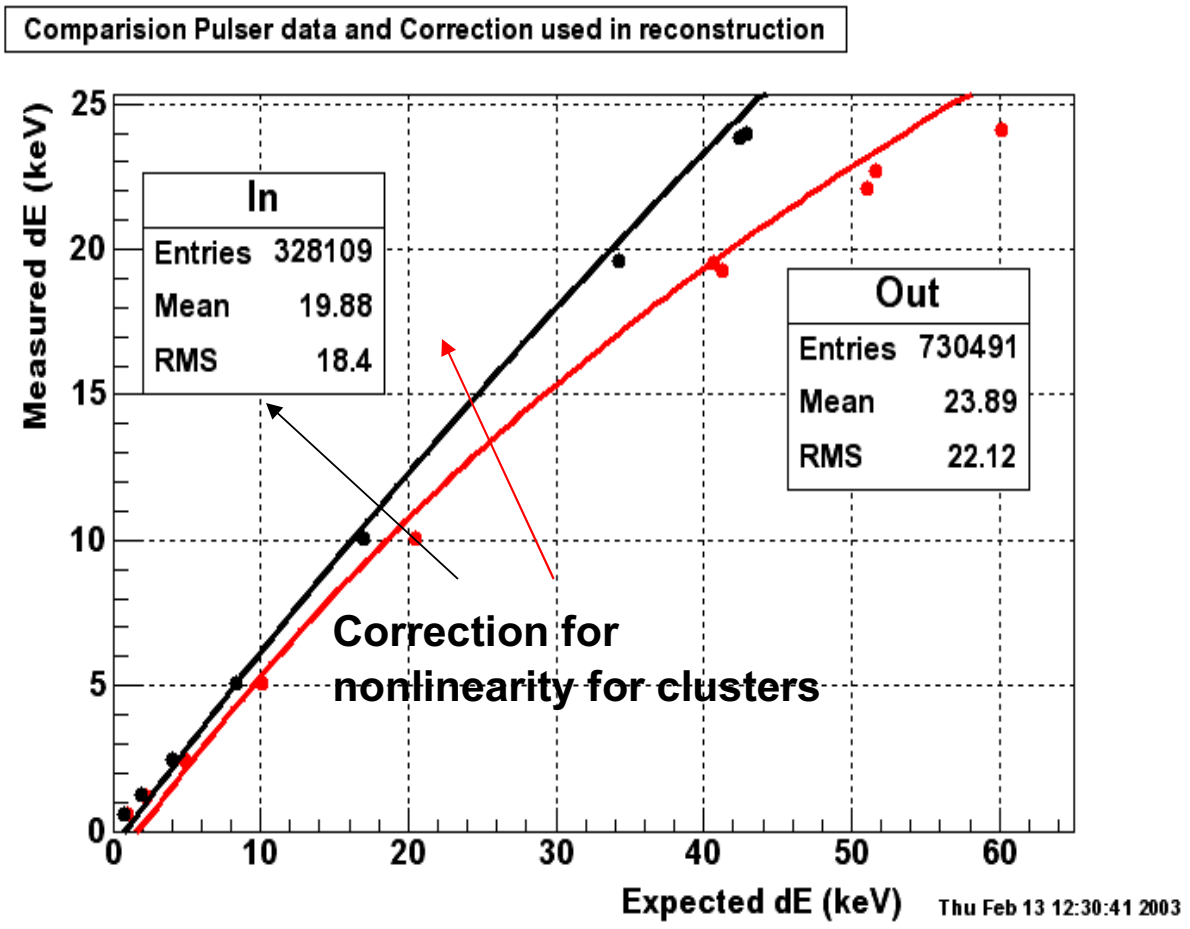
Pulser runs (ADC nonlinearity)

Thanks to Blair and Fabrice !

Pulser runs were done with different signal levels.

ADC response has the same trend as correction obtained for clusters and thus confirm that we have saturation effects seen in the data.

Still there is a question where we have to correct it : daq or offline?



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Y2 Calibration tables

dE/dx corrections: table names (**new**, **used**, **not used**)

- R "ADC" nonlinearity => "TpcAdcCorrection"
- Z Drift distance
  =>"TpcDriftDistOxygen","TpcZCorrection"
- Pressure: => "tpcPressure"
- Time => "TpcTimeGain" **not used any more**

All time dependence is accounted via correction for Pressure and Oxygen contamination

- SecRow => "TpcSecRowB"
  has to be redone after Fabrice's pulser corrections
- dX correction => "TpcdXCorrection"
- TPC track length => "TpcLengthCorrection"
  has to be redone after Fabrice's pulser corrections

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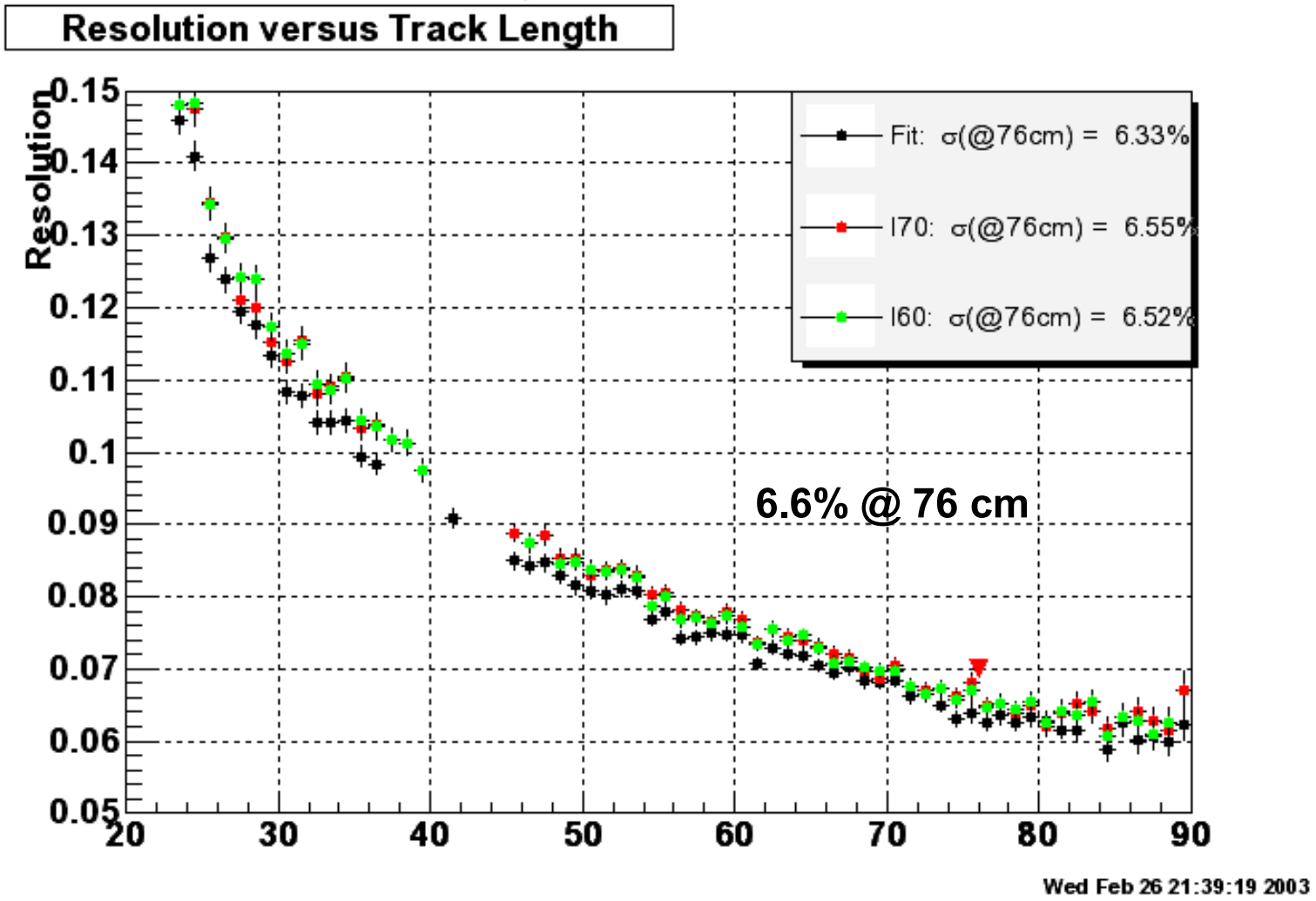
New calibration with new (daq) Clustering for Y2 data



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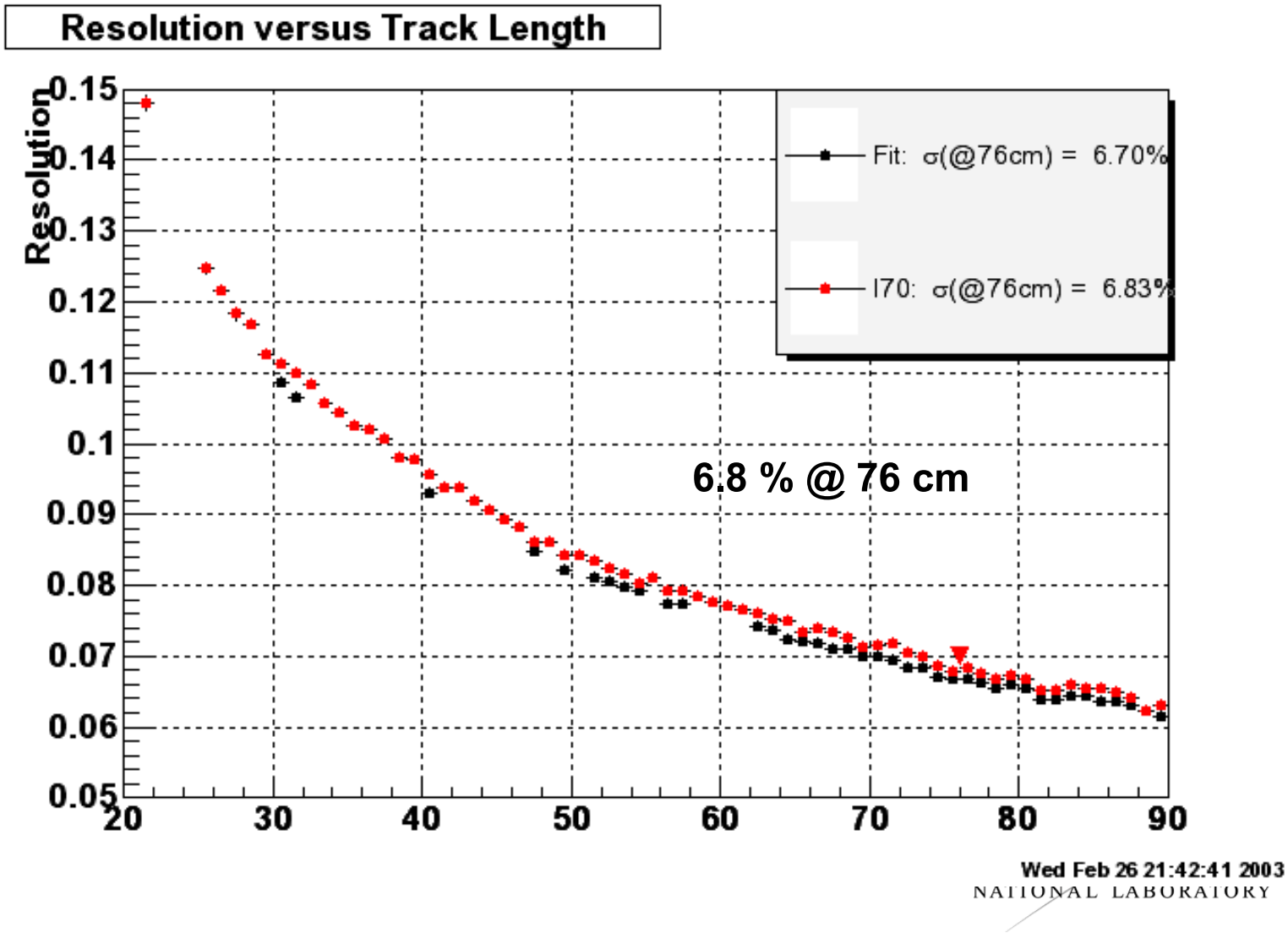
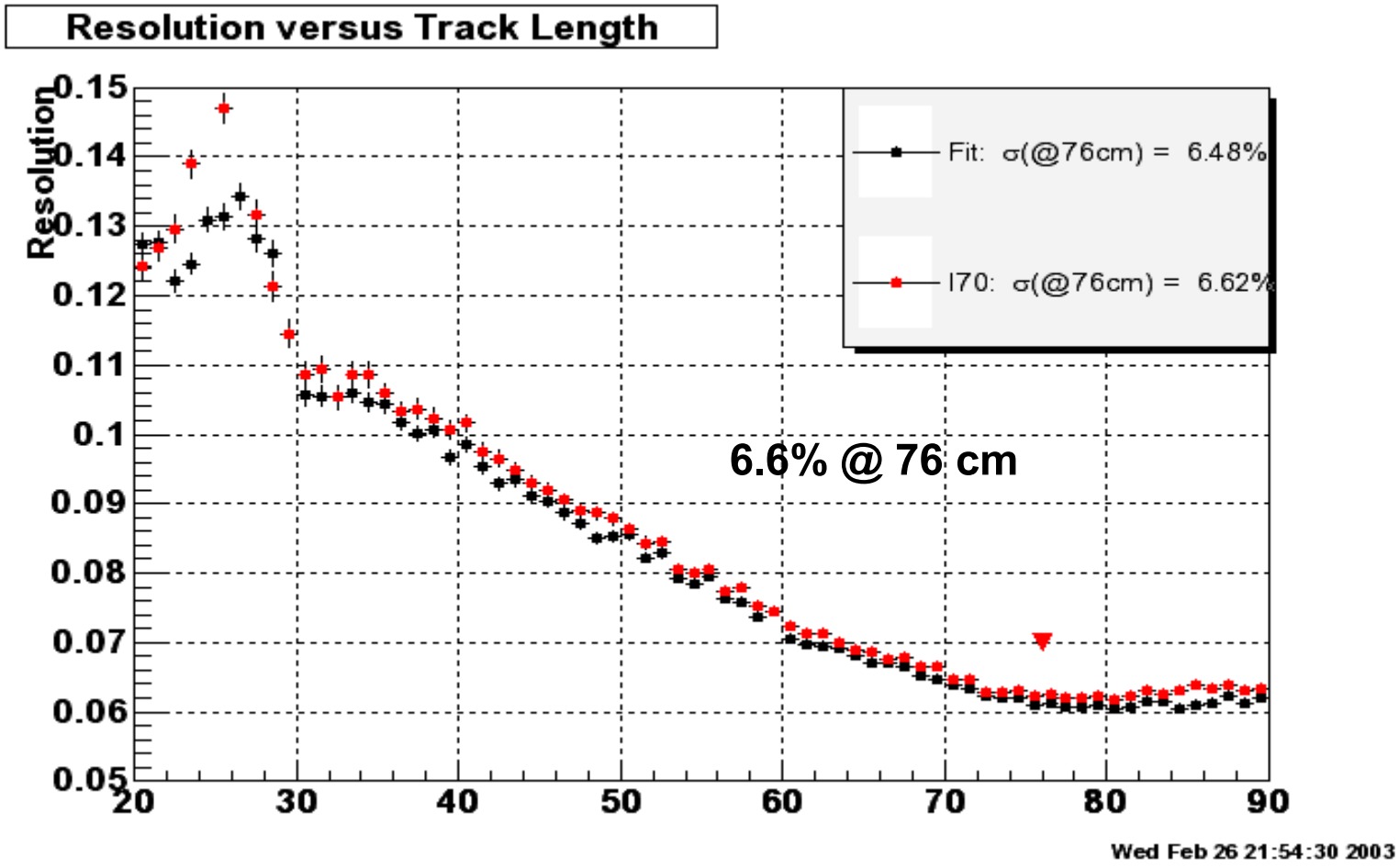
New calibration with old (tcl) Clustering for Y2 data



dAu data with Y2 calibration



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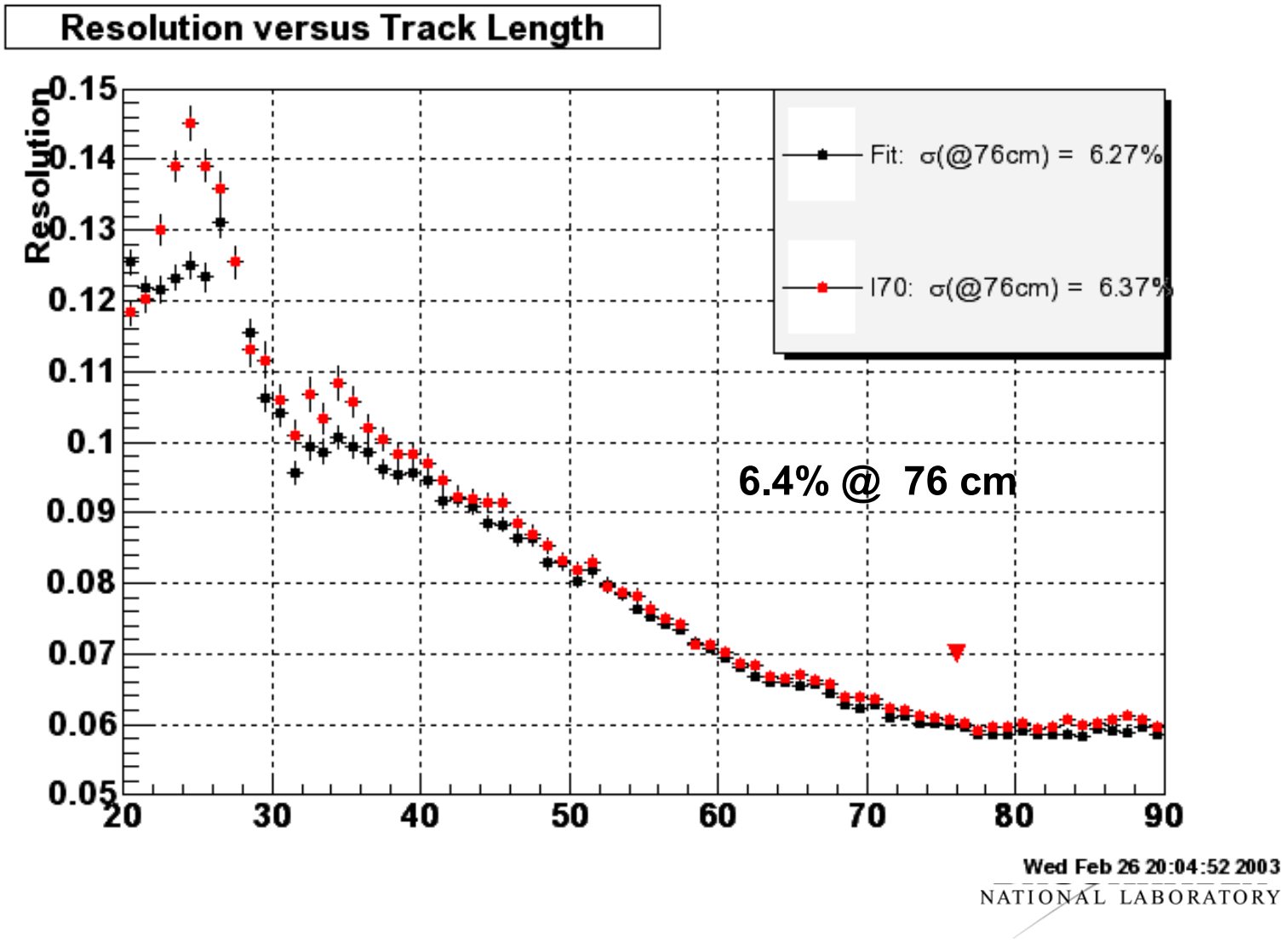
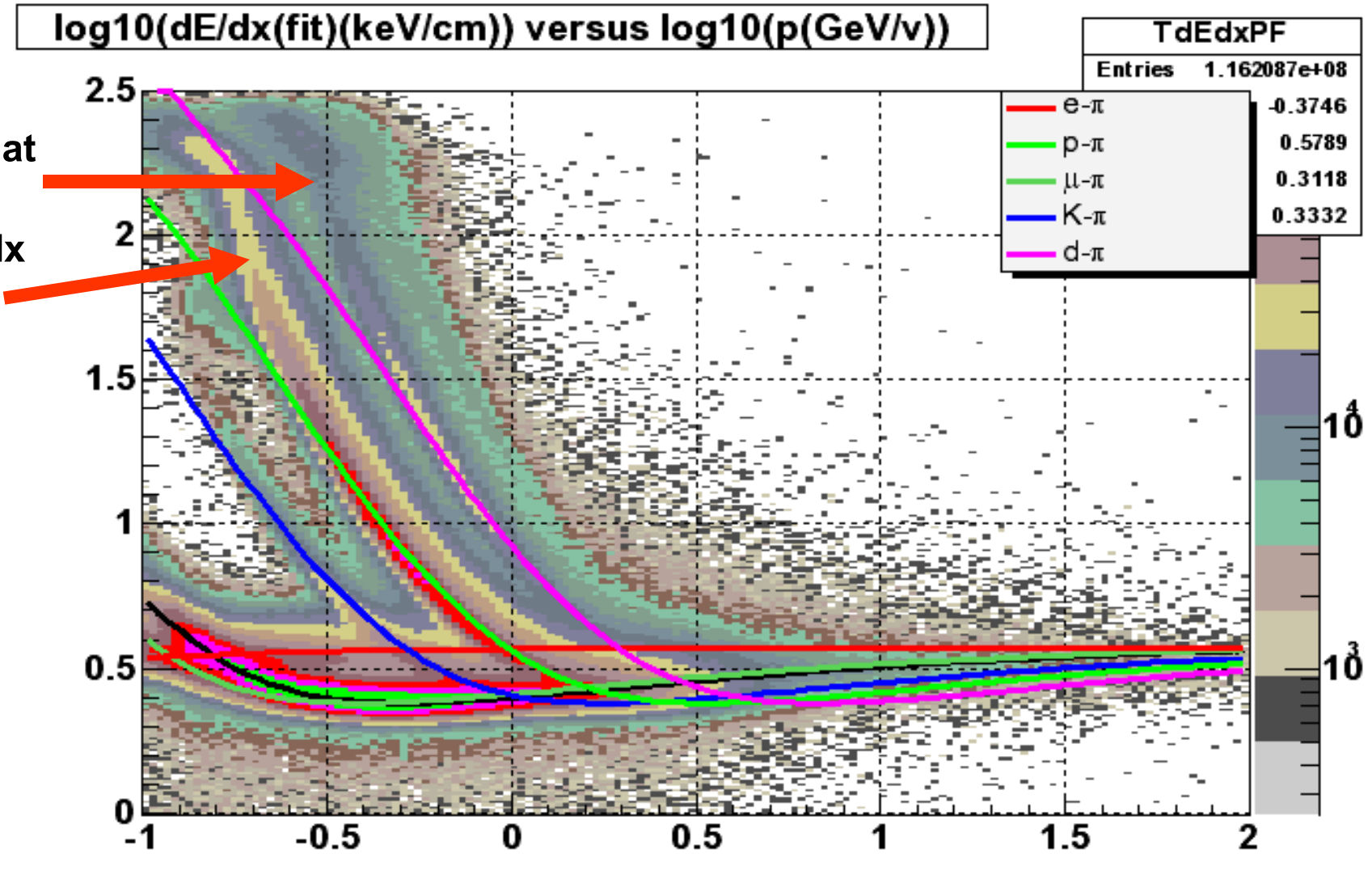
dAu Data after Sector/row correction



dE/dx from dAu with Bichsel's predictions

It appears that in dAu the highest dE/dx (>30keV/cm) are over - corrected.



Conclusions

- **A significant nonlinearity is observed in dE with respect to H.Bichsel's calculations which can be explained by ADC saturation (it might also include nonlinear effects in gas amplification) and offline clustering nonlinearity for low signal.**
- **The new calibration scheme allows to improve significantly dE/dx resolution:**
  - **9.6% (no calibration)**

    ⇒ 8.2 % (Y1 calibration scheme)

    ⇒ 6.8% (Y2 data, new scheme) == 6.8% (STAR CDR)

    ⇒ 6.6 %(dAu data with Y2 calibration)

    ⇒ 6.4% (a first look in dAu data)
- **A fine tuning is still necessary:**
  - **Model calculation for P10 mixture,**
  - **Adjustment of nonlinearity corrections for new data**

Conclusion

1. **In present dE/dx calibration model:**
   - **Only Sector/Row correction has to be updated after pulser correction update.**
   - **The model has to checked => Test Productions**
   - **It is important to understand reason for "ADC" nonlinearity:**
     1. **Pulser (for ADC itself)**
     2. **Detailed simulation of cluster finder**
2. **Time dependence is taken out by Pressure and Drift corrections.**
3. **To make dE/dx calibration in fast offline it is necessary to have:**
   - Access to monitoring tables (tpcGas and might be tpcGainMonitor)
   - A reasonable measurement of track momenta in [0.4,0.5]GeV/c range
   - Statistics : precision ~1% => 24*10K good track (~50%) in momentum range [0.4,0.5] GeV/c (~20%) => 2.4 M tracks. (Now I am using statistics ~50M tracks)