Summary of Data Analysis on MI/TEV Flying Wires

Fermilab March-April 2003

Federico Roncarolo

CERN/University of Lausanne

Contents

MI Photo Tubes Filters

- We spent some shots in studying the new PM filters set up for the MI. (There is an EXCEL file summarizing all the measurements and the conclusions)

Data Analysis

- Conversion of binary archived measurements into ascii with Eugene LabView program
- ROOT analysis of raw data
  - Comparison with on-line results
  - Look for systematic correlations
- For each analyzed profile I stored many quantities (i.e. fit parameters, chisquares, residuals to fit, profile integrals, speeds, pass1-pass2 differences, etc.)
- I will show some of them.

Help

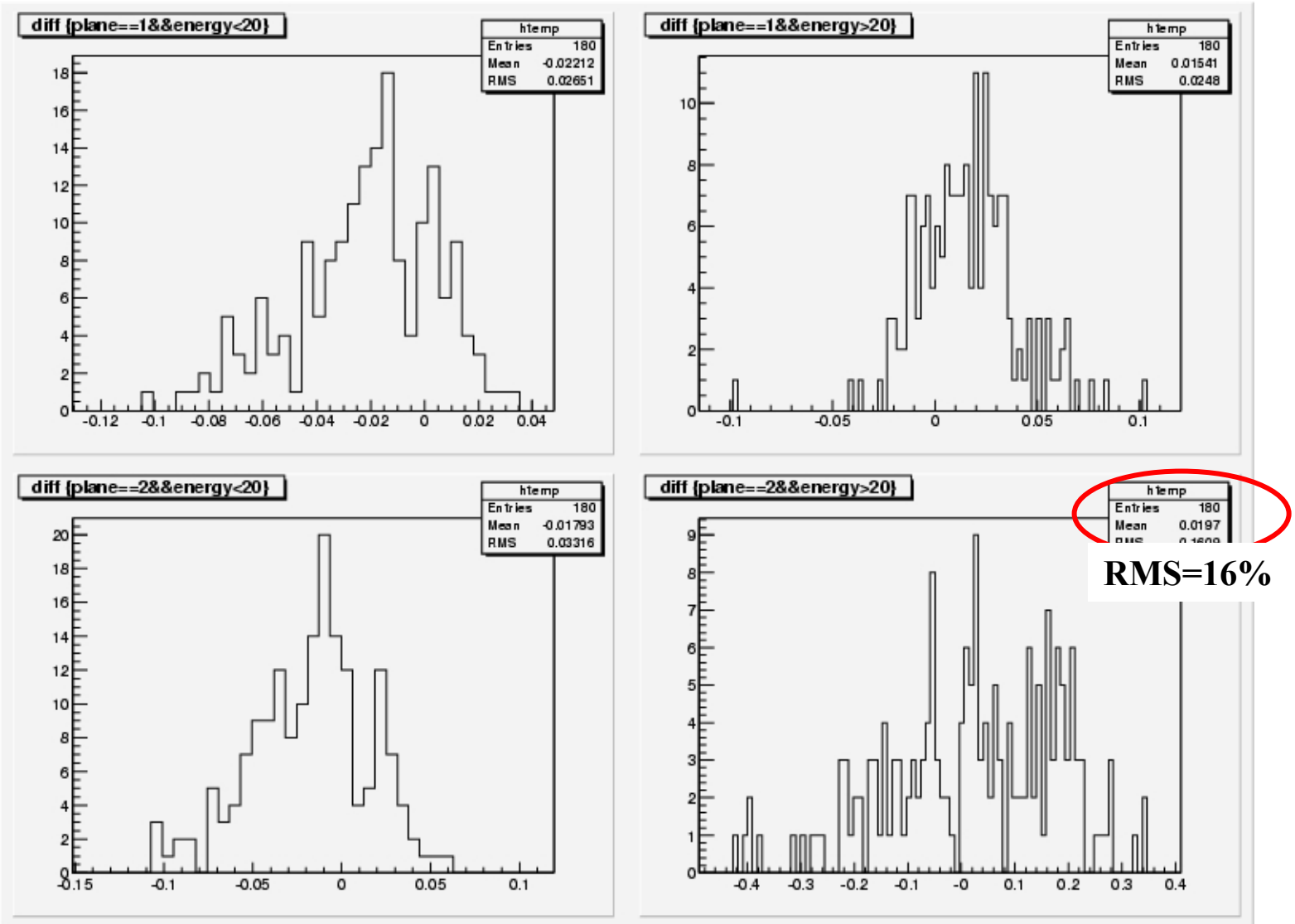
- **Few notes to help in understanding the plots:**
  - **Everytime red dots are results from LabView or SDA, black dots from ROOT analysis on raw data**
  - **The quantity "diff" refers always to pass1-pass2 relative difference in sigmas**
  - **For MI: plane1=horizontal, plane2=vertical**
  - **For TEV:plane1=E11H, plane2=E11V, plane3 E17H**

Main Injector

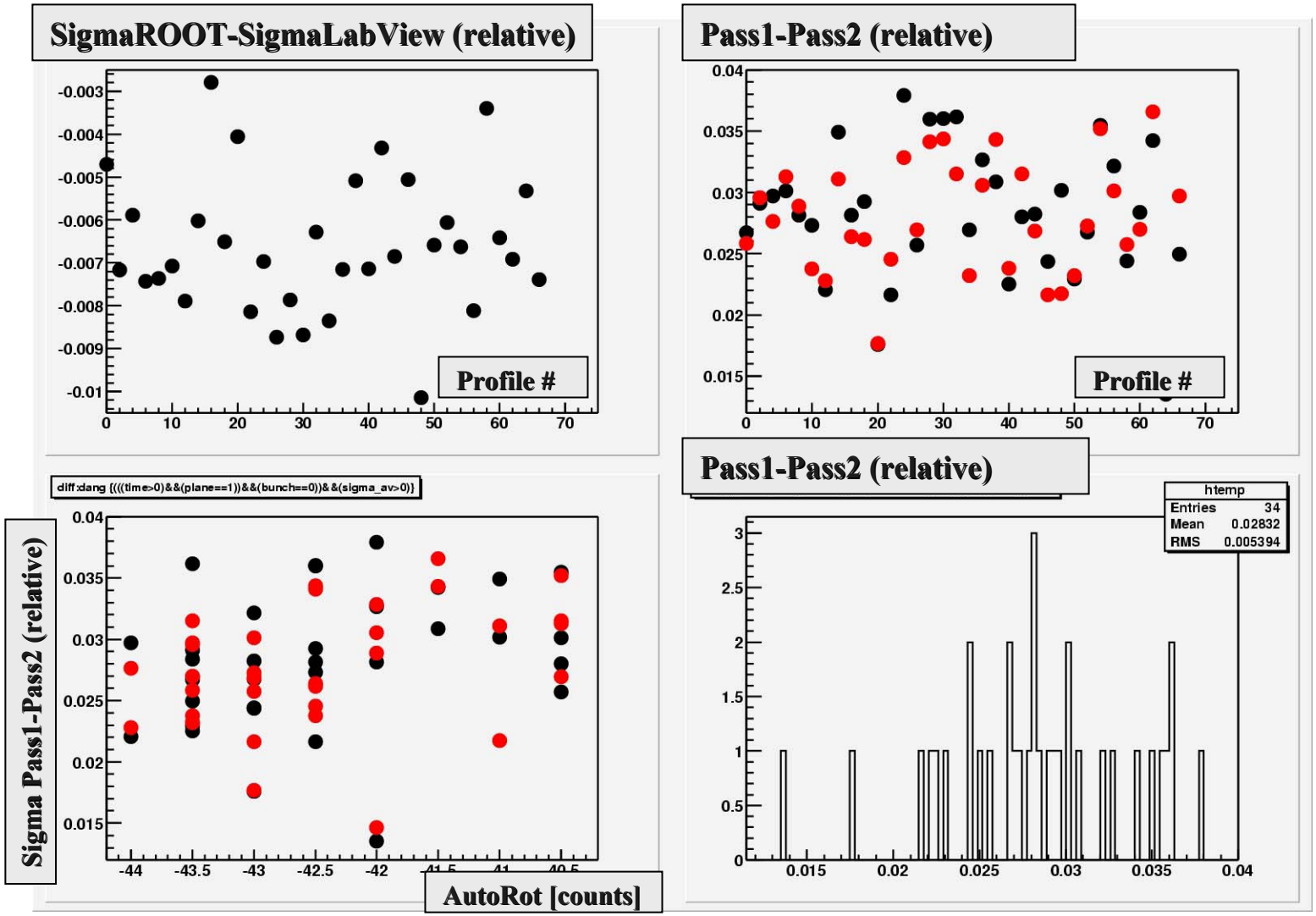
- Shots 2420-2422-2424-2436-2438
- No major problems with horizontal plane wire
- More problems with vertical plane wire
  - There are randomly appearing asymmetric profiles at 150 GeV
  - Sigma differences between pass 1 and pass 2 can go up to 40% at 150 GeV but this is normally not related with asymmetric profiles
  - There is a kind of correlation autorotation vs (pass1-pass2 diff) at 150 GeV
  - However a simple simulation taking a real set of data and changing the autorotation angle shows a linear change of the resulting sigma, but doesn't explain the large differences pass1-pass2
  - Also the ratio of the integrals pass1/pass2 shows a larger spread than in the horizontal plane (~13% for Pbars at 150GeV, ~2.5% in the horizontal plane)
- The speed calculated as $(x_i-x_{i-1})/t_{rev}$ has oscillations in both planes and is very reproducible
- The ROOT analysis on raw data doesn't show large differences from the on-line results

Pbars Pass1-Pass2

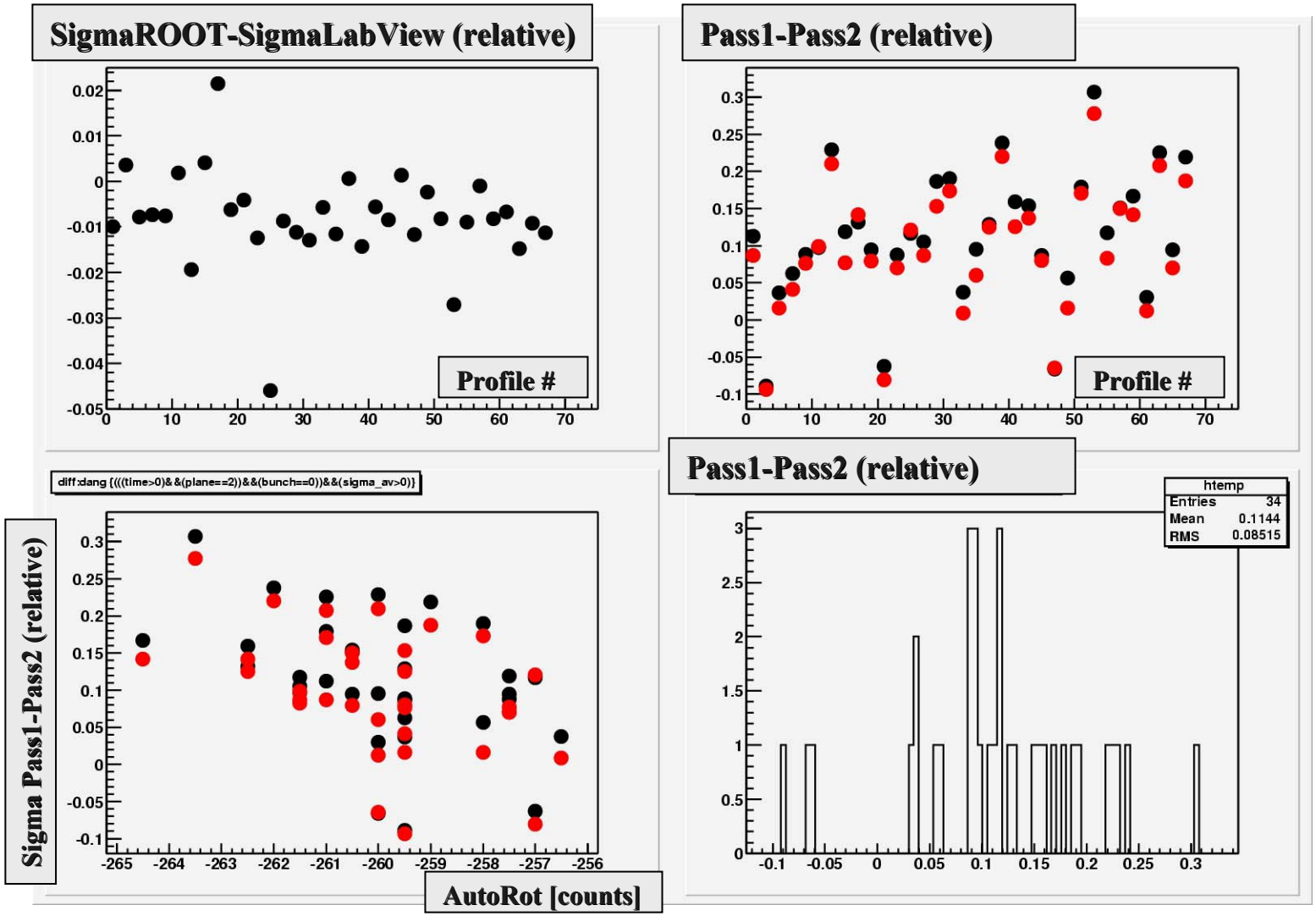
Relative differences between sigmas pass1-pass2



MI Protons Hor 150GeV

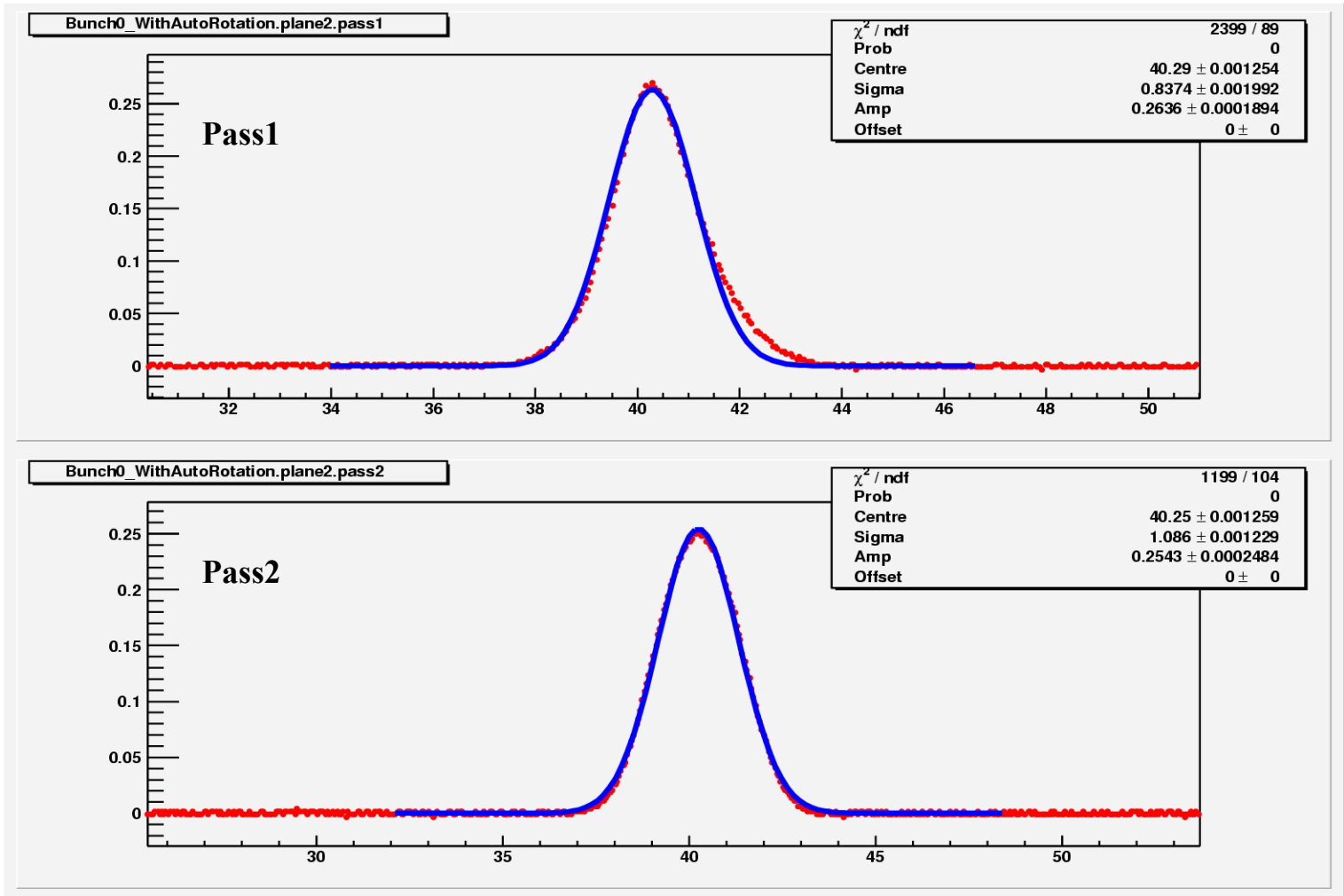


MI Protons Vert 150GeV



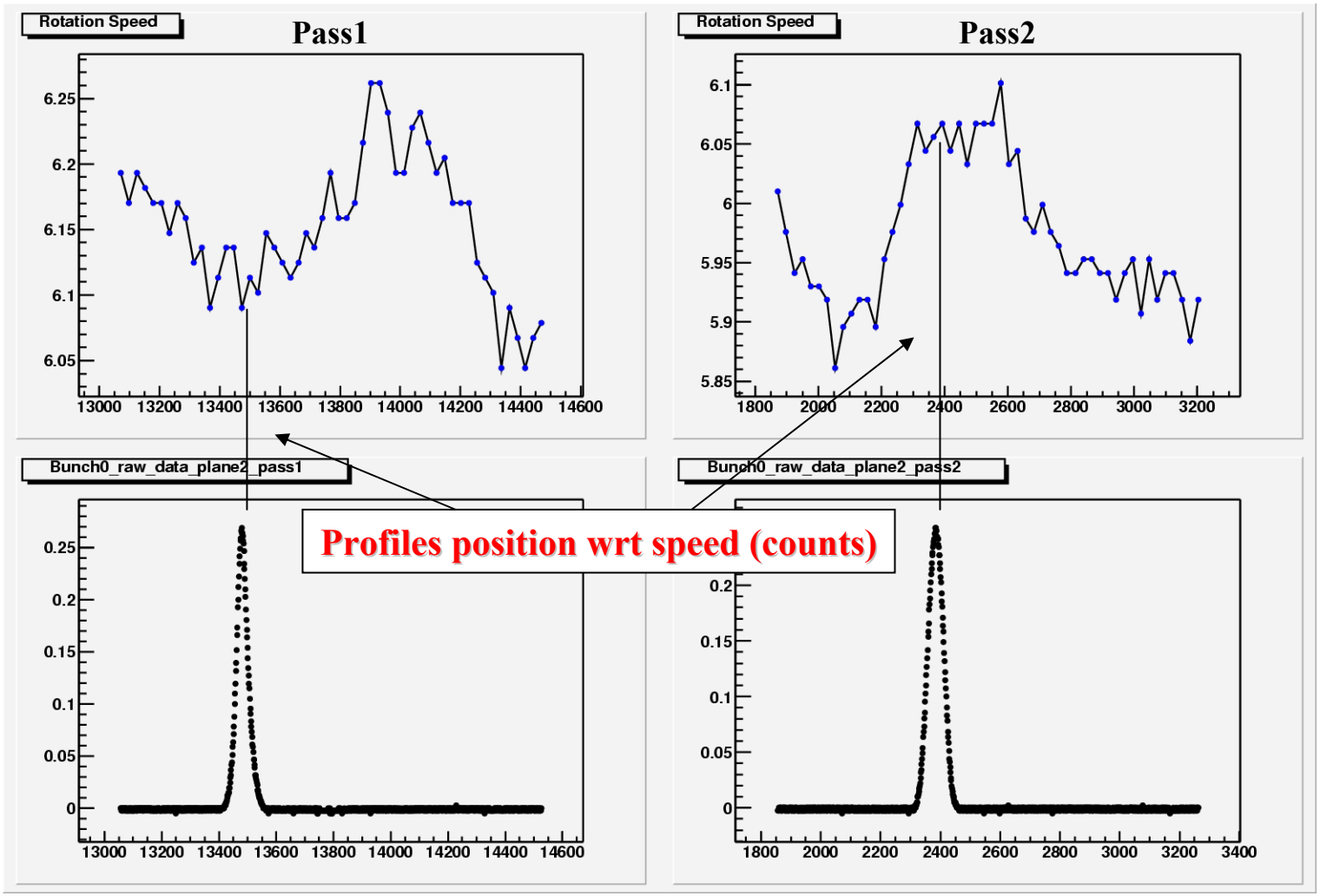
MI Prot Profiles

- **Example Vertical Profiles @ 150 GeV where sigma difference (pass1-pass2) is large**



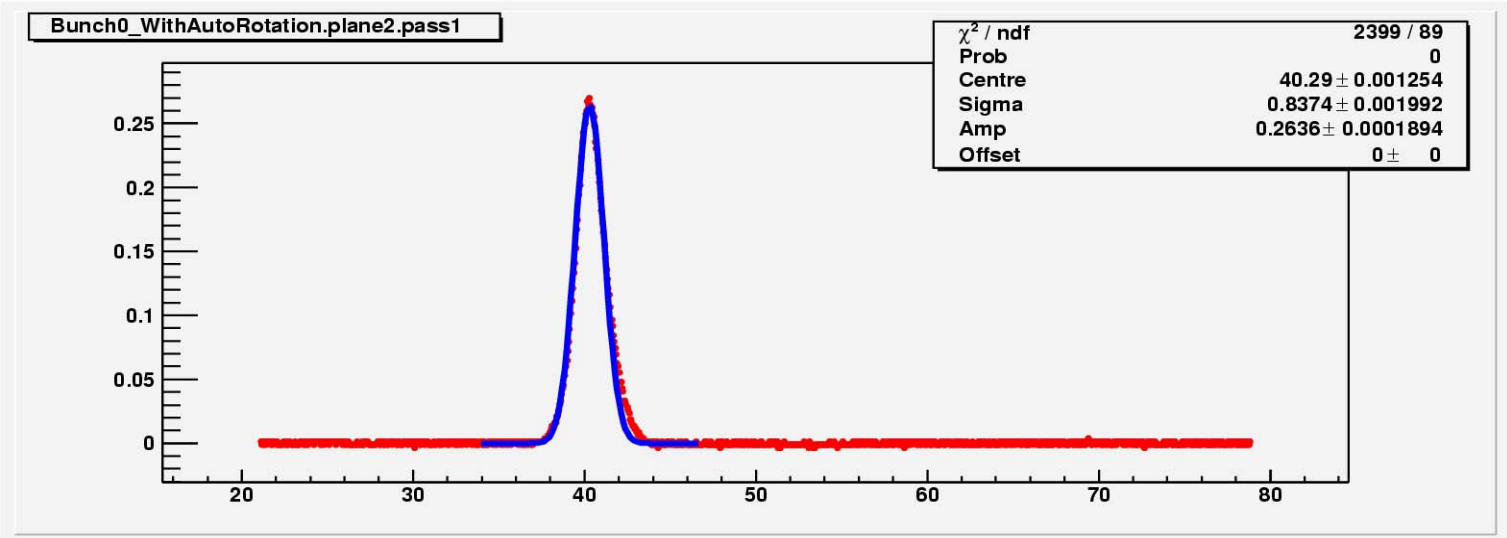
MI Protons Wire Speed

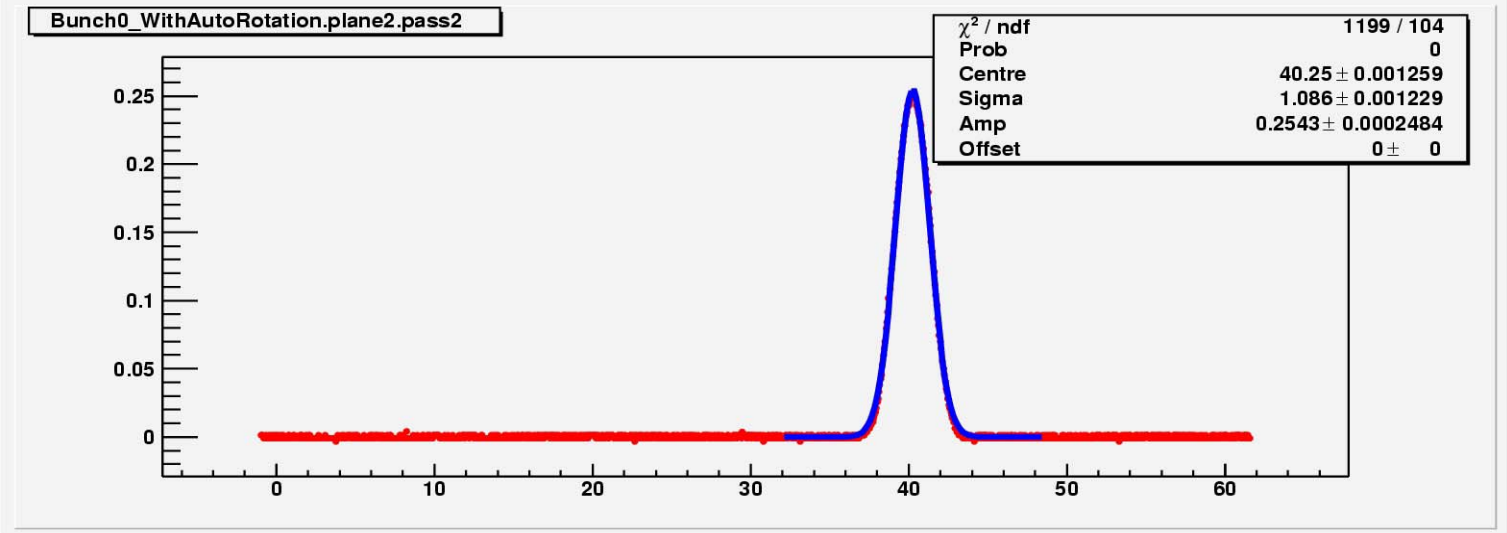
- **Wire speed for the profiles of previous slide (Vertical @ 150GeV)**



MI Prot Profiles (bis for Stephen)

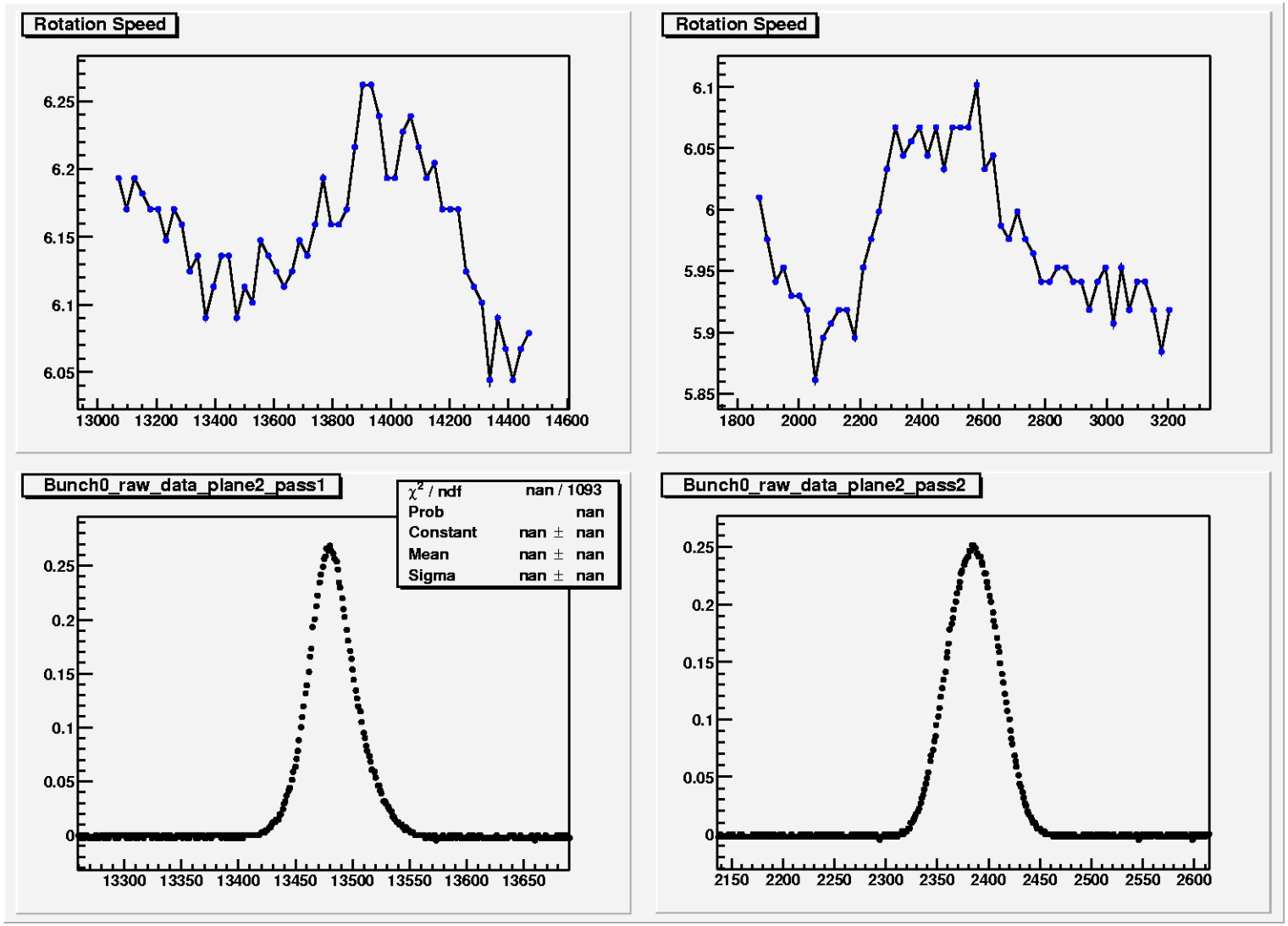
Shot 2441, file 15, Vertical 150GeV





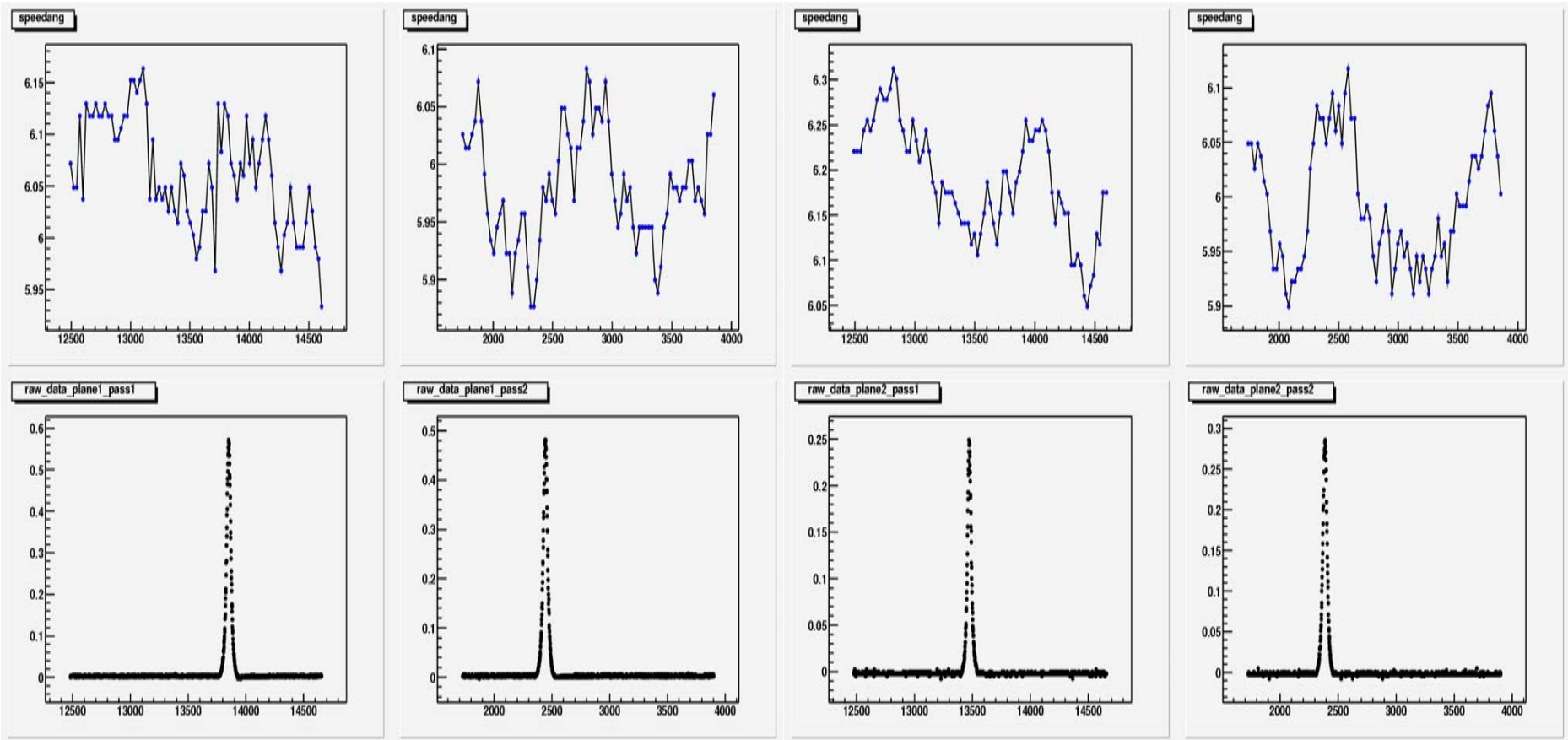
MI Protons Wire Speed (bis for Stephen)

Shot 2441, file 15, Vertical 150GeV



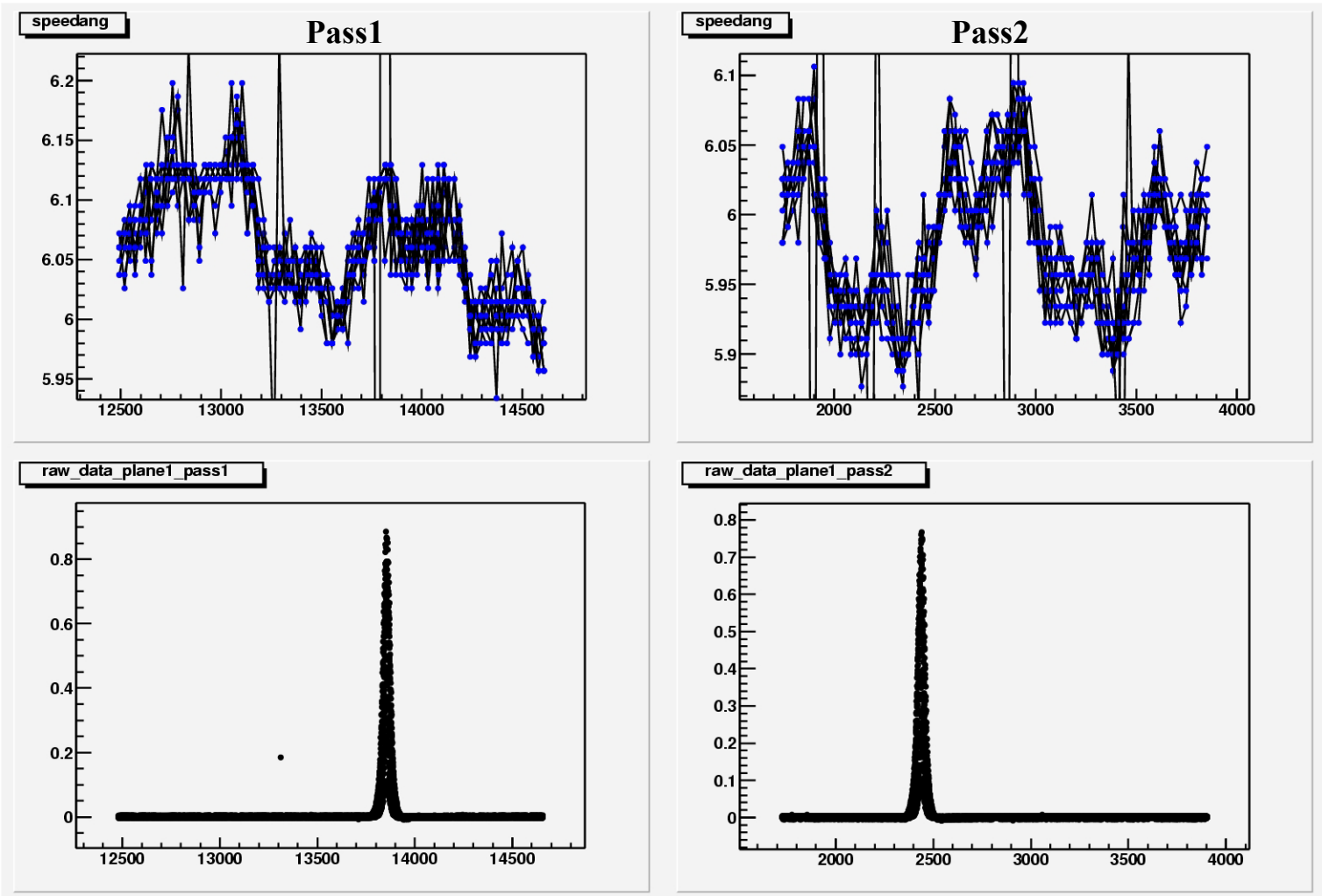
MI Pbars Horiz/Vert Speed

HOR		VERT	
PASS1	PASS2	PASS1	PASS2

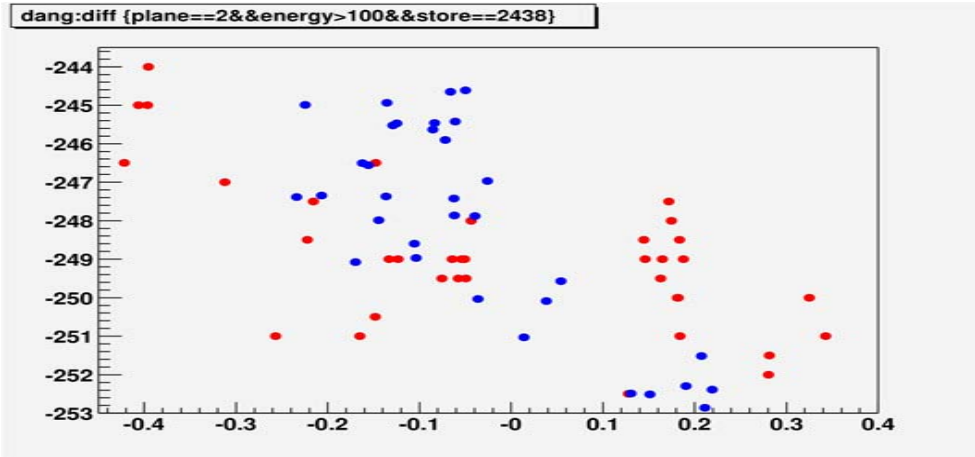


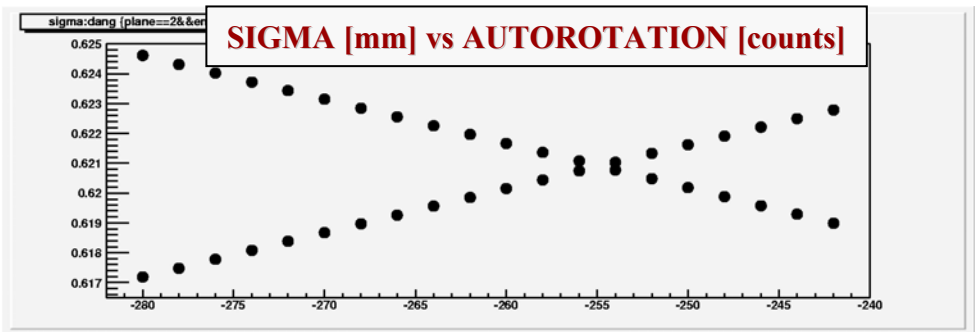
MI Speed Reproducibility

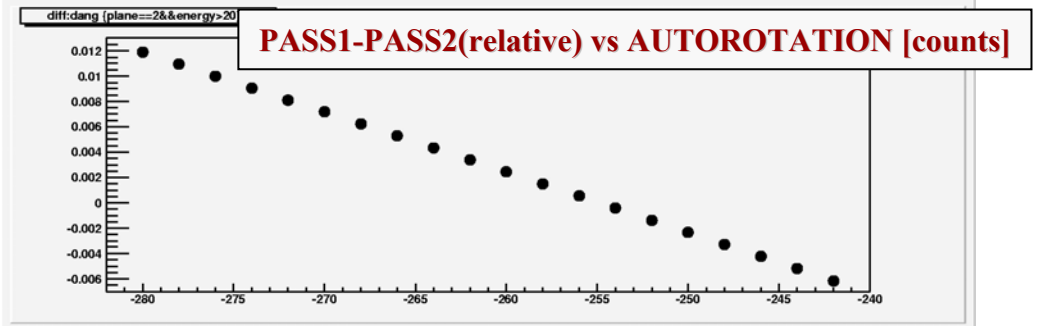
- **Vertical Plane, Pbars, shot 2420, 150GeV**



Autorotation







- **Data: Two Stores,**
- **Autorotation Angle vs (Pass2-Pass1 sigma diff.)**

  - **Store 2438**
  - **Store 2436**

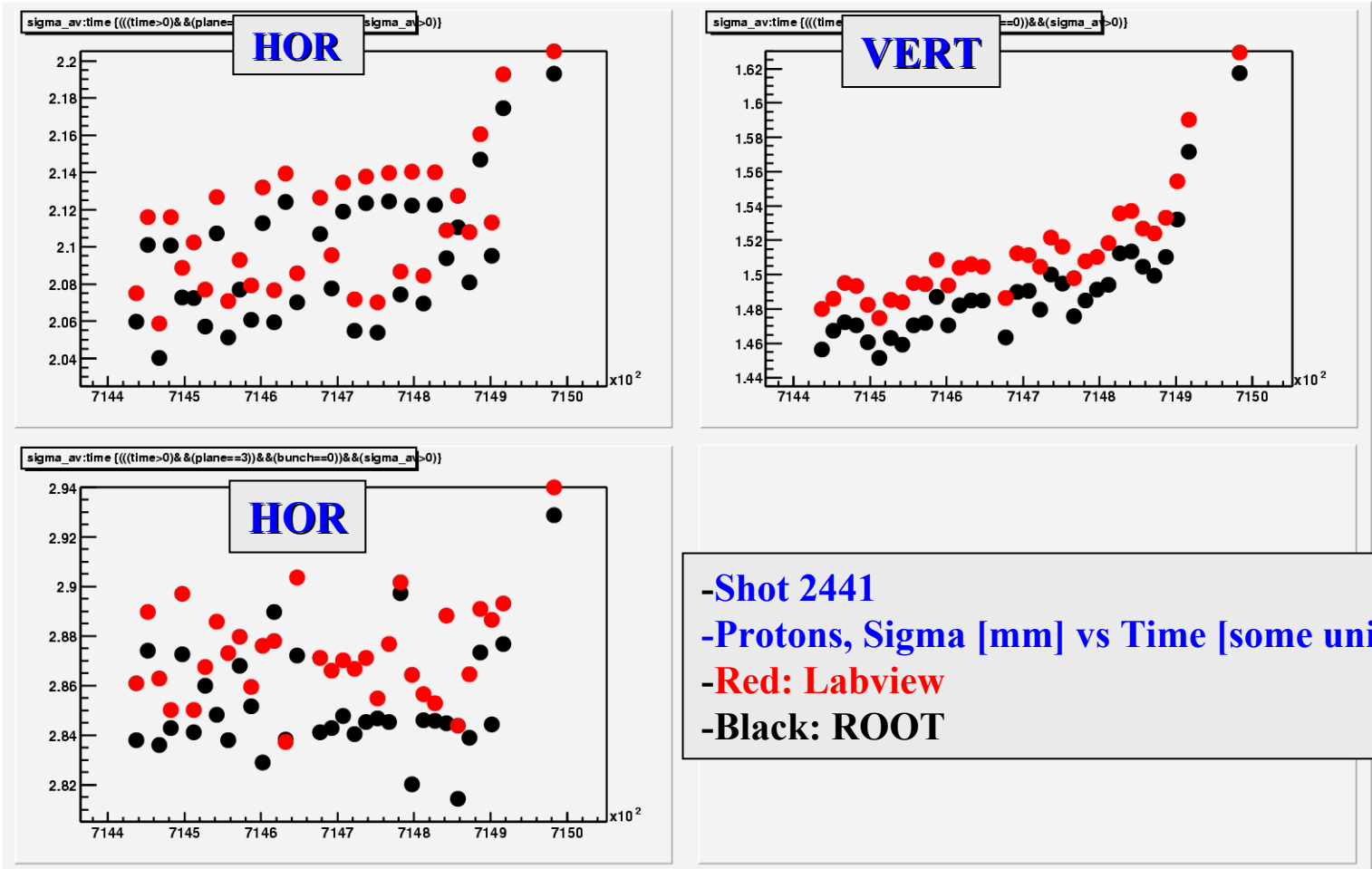
- **Simulation: I forced Autorotation Angle and looked at Sigmas (calculated from real profiles)**
- **It shows a change of 1.8% over a large variation of angle (40 counts ~ 0.9 degrees)**

Tevatron

- Shots 2436-2441, I looked only at protons
- The differences pass1-pass2 are within +/- 5%

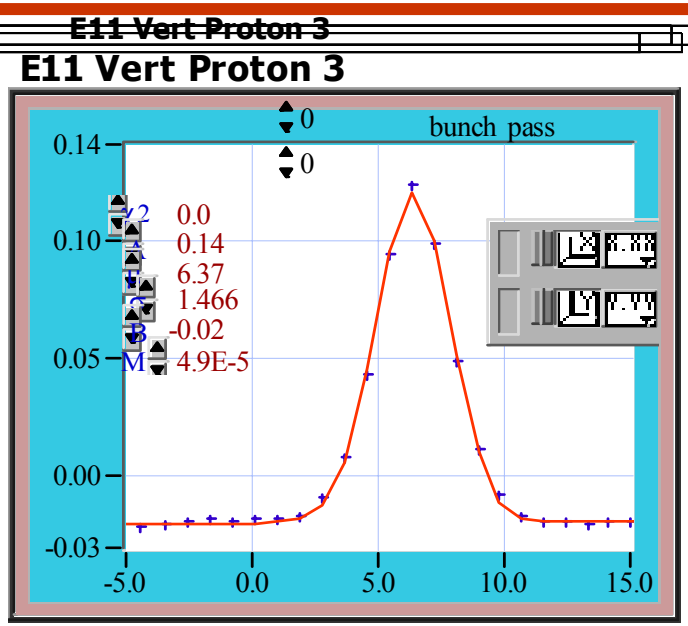
- Systematic difference between Labview and ROOT in the vertical monitor
  - Looking at profiles, it seemed a problem of the decimation
  - A simple test forcing the decimation, offline, with Labview, proved it
- The speed profiles look different from the MI ones
- Looking at the horizontal emittance I found some dependence on the lattice parameters you plug in…

TEV Labview-ROOT



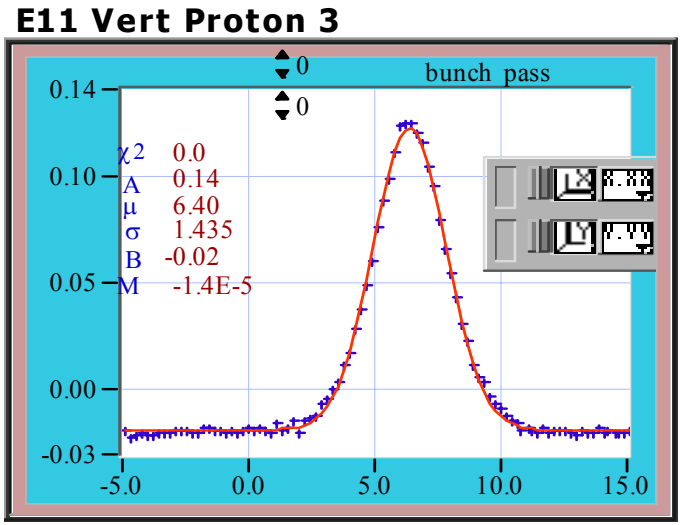
-Shot 2441
-Protons, Sigma [mm] vs Time [some units]
-Red: Labview
-Black: ROOT

TEV Vertical Profiles from LabView



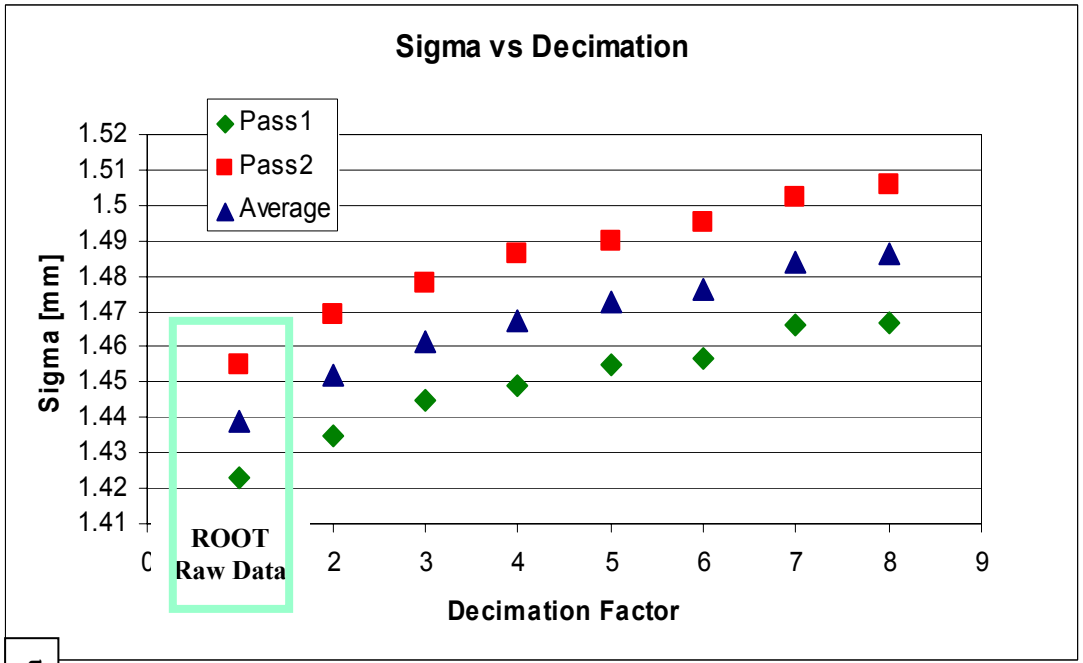
- Profiles from Labview
- Monitor E11, vertical plane

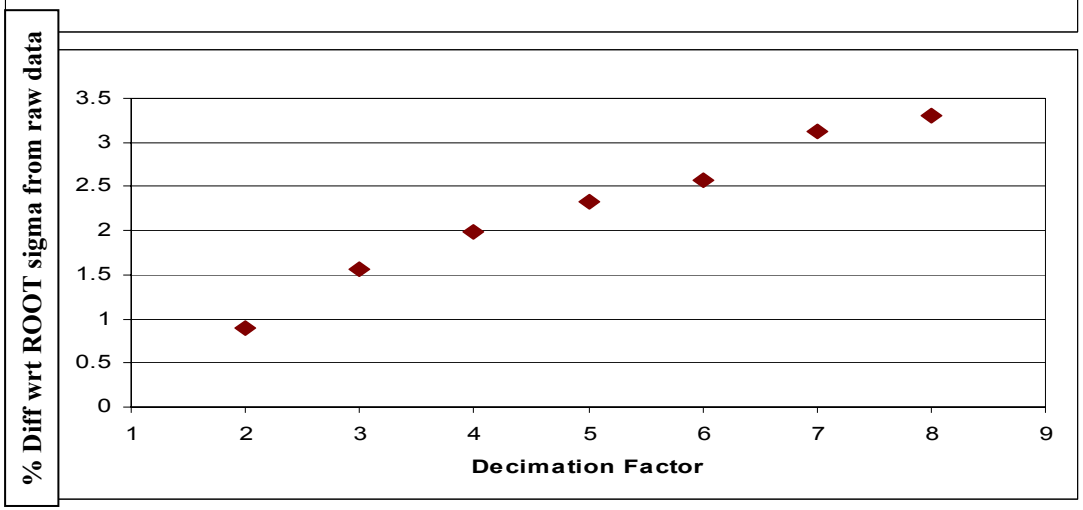
DECIMATION FACTOR = 8
SIGMA = 1.466 mm



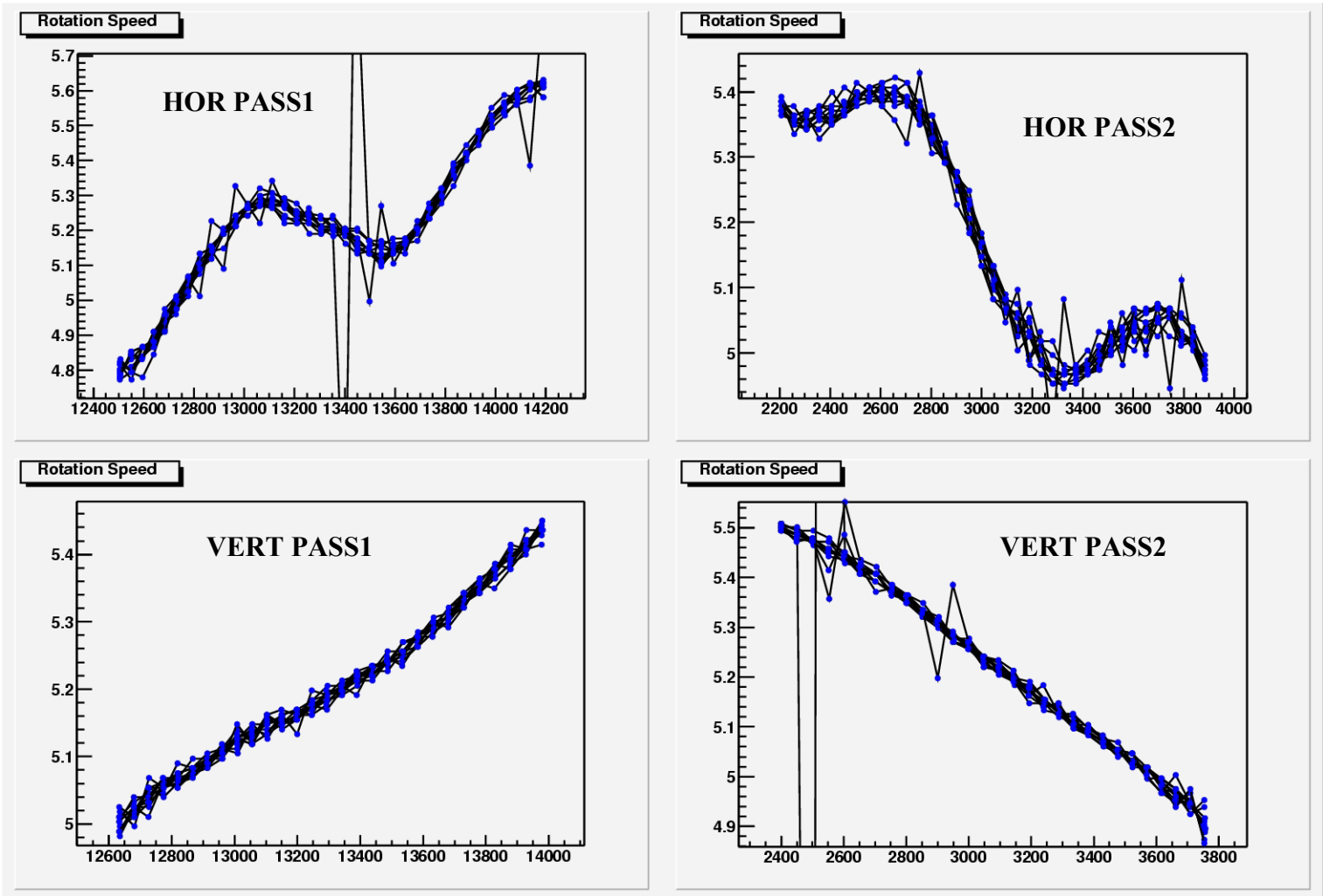
DECIMATION FACTOR = 2
SIGMA = 1.435 mm

TEV Decimation Effect

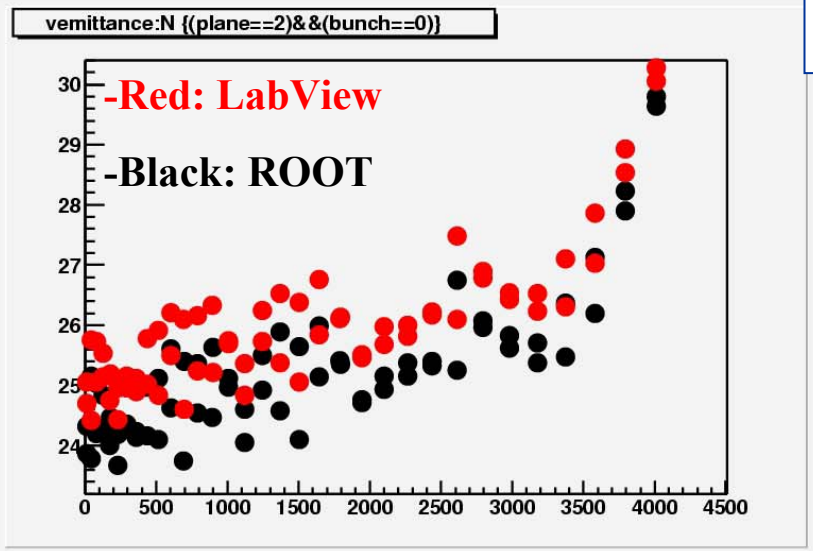




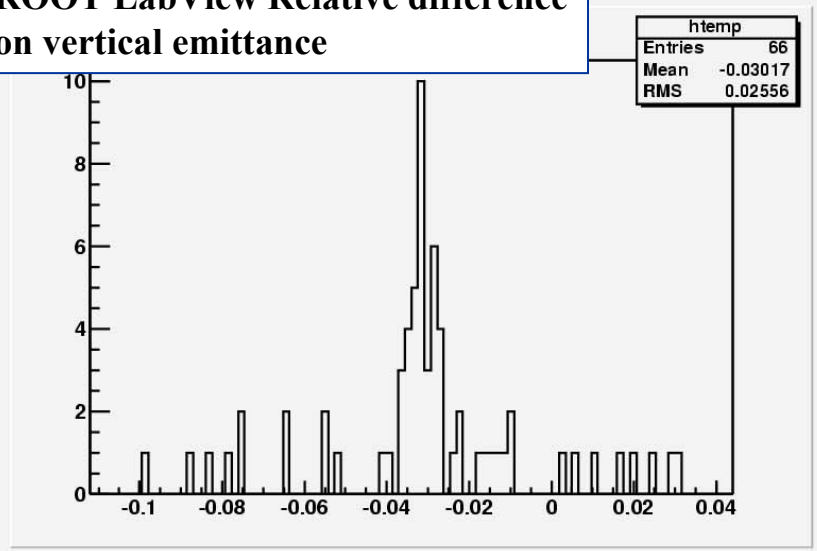
TEV Wire Speed

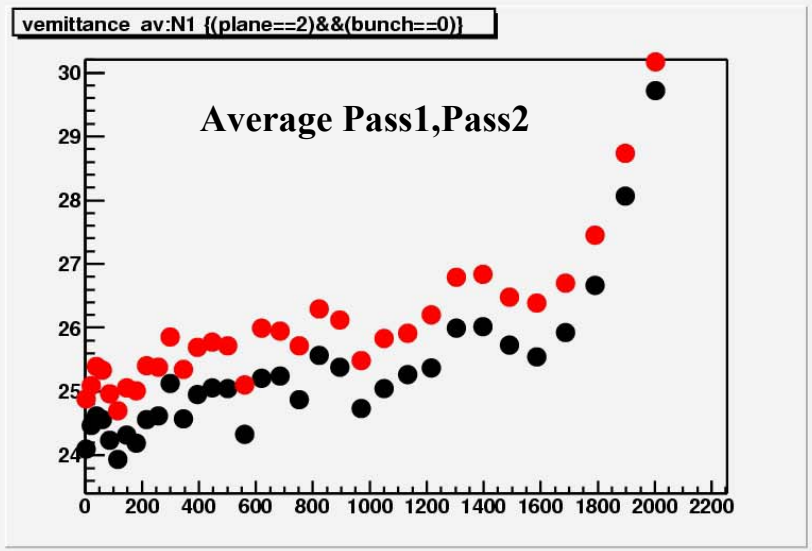


TEV VERT Emittance



ROOT LabView Relative difference on vertical emittance





- **TEV Vertical Emittance evolution of ONE bunch (the first I believe) along 33 scans.**

TEV HOR Emittances

- Calculate Emittances for shot 2441:
  - 33 injections, 66 scans (33pass1+33pass2)
- In a first loop I impose the E11, E17 horizontal emittances (average of pass1 and pass2) to be equal in order to extrapolate the momentum spread
- The values of the momentum spread nicely fit in an histogram , I take the mean value and loop a second time on the emittances plugging in such value as the momentum spread (therefore constant for all the measurements)

$$\varepsilon_x = \frac{6 \cdot (\beta\gamma)_{beam}}{(\beta_x)_{lattice}} \cdot \left[\sigma_x^2 - \left(D_x \frac{dp}{p} \right)^2 \right] = K \cdot \left[\sigma_x^2 - \left(D_x \frac{dp}{p} \right)^2 \right]$$

$$\varepsilon_x^1 \equiv \varepsilon_x^2 \qquad \Rightarrow \left(\frac{dp}{p} \right)^2 = \frac{K_2 \sigma_2^2 - K_1 \sigma_1^2}{K_2 D_2^2 - K_1 D_1^2}$$

- The results are compared with the SDA quantities:
  - TFW Norm Dp/p Emittan
  - TFW Norm Hor Emittance

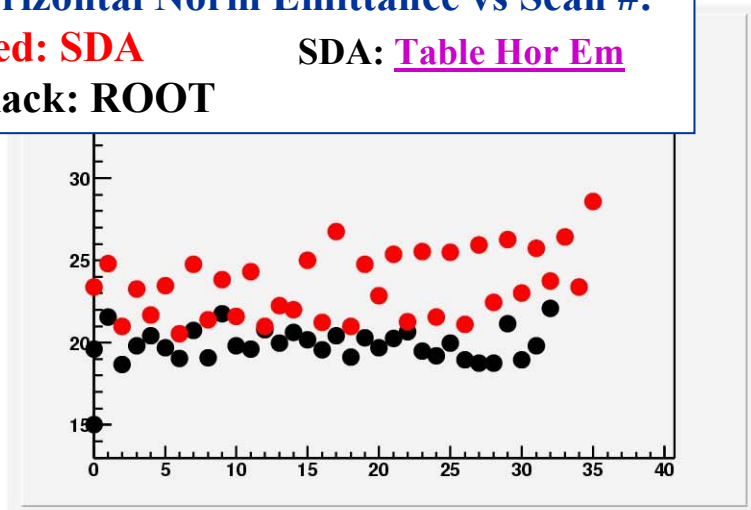
TEV HOR Emittances (I)

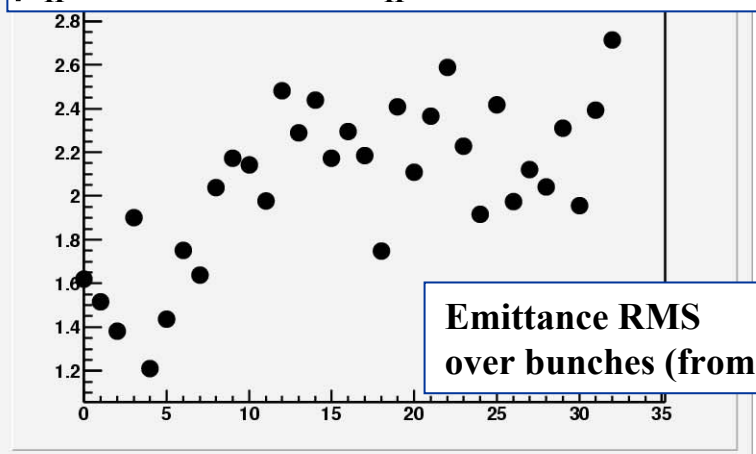
Average
Horizontal Norm Emittance vs Scan #:
-Red: SDA SDA: Table Hor Em
-Black: ROOT

- Nov 18, 2002 - from Val Lebedev -

$\beta_H^{E11} = 83.54\,m \quad D_H^{E11} = 2.82\,m$

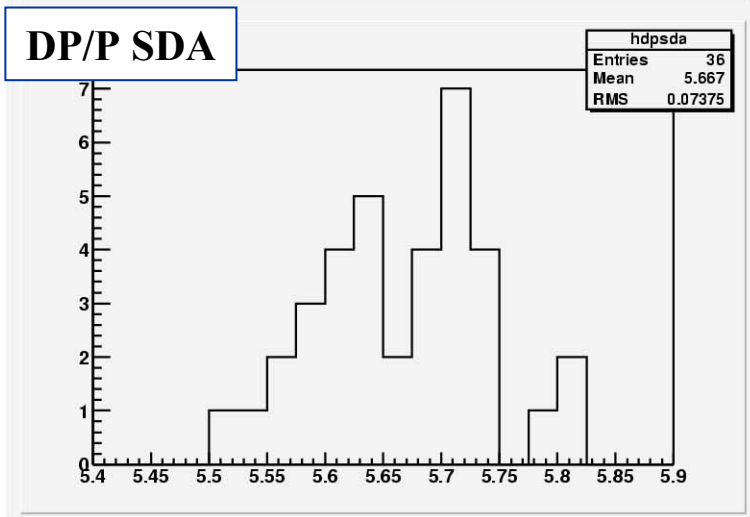
$\beta_H^{E17} = 62.54\,m \quad D_H^{E17} = 4.58\,m$



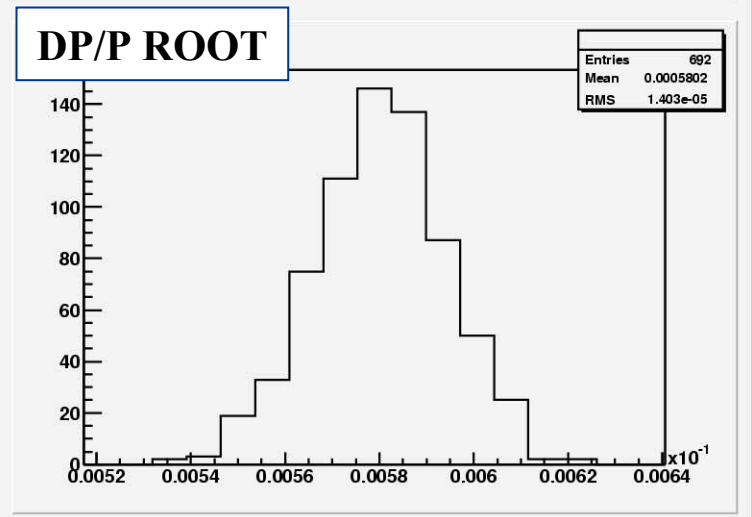


Emittance RMS over bunches (from ROOT)

DP/P SDA



DP/P ROOT



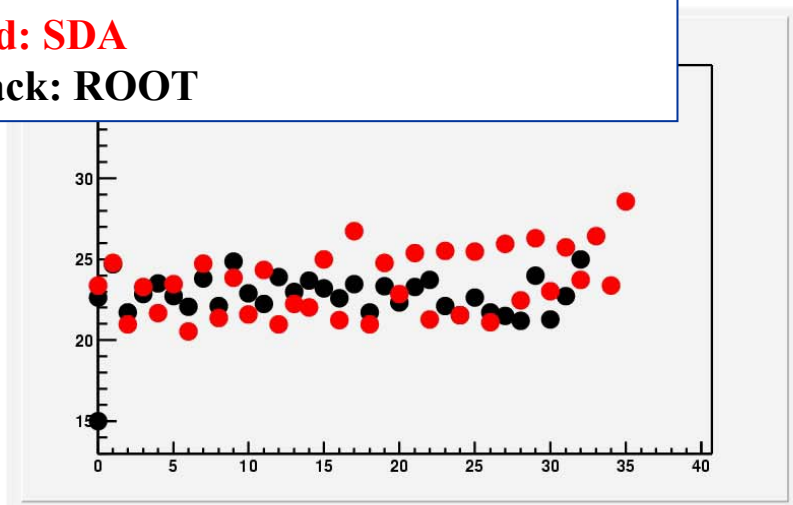
TEV HOR Emittances (II)

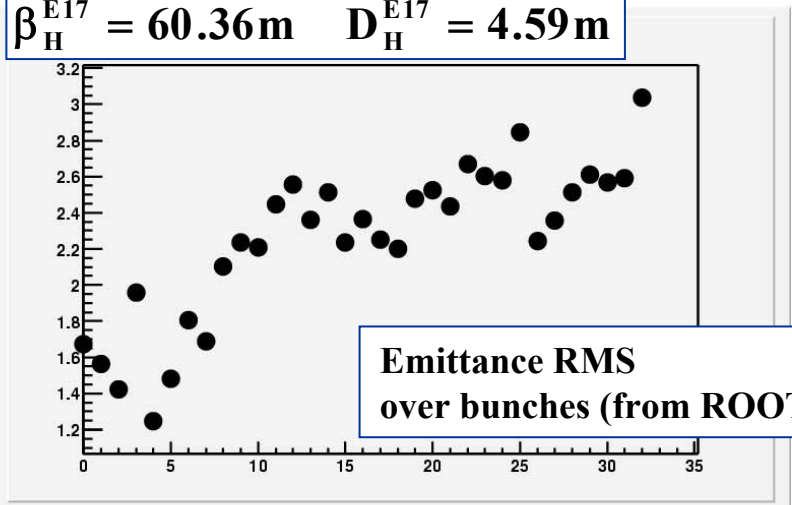
Average
Horizontal Norm Emittance vs Scan #:
-Red: SDA
-Black: ROOT

- Values from Alberto -

$\beta_H^{E11} = 82.59\,m \quad D_H^{E11} = 2.75\,m$

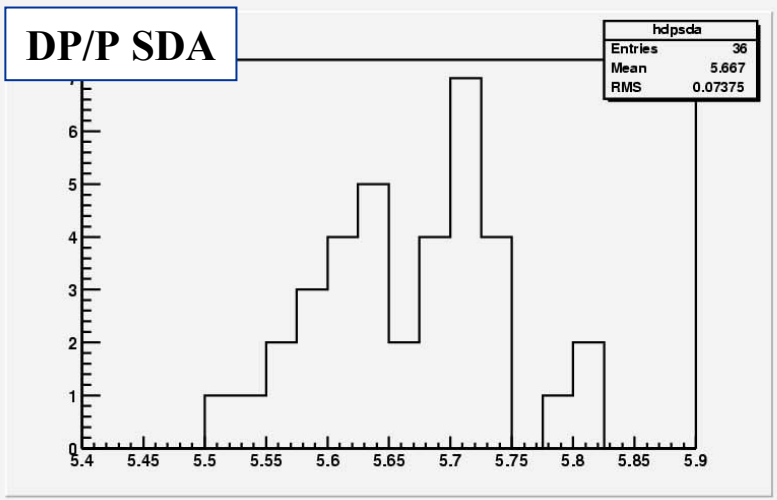
$\beta_H^{E17} = 60.36\,m \quad D_H^{E17} = 4.59\,m$



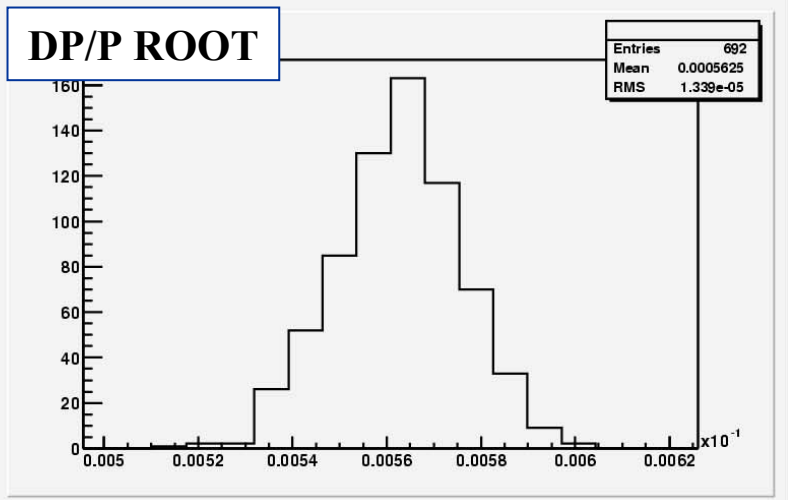


Emittance RMS over bunches (from ROOT)

DP/P SDA



DP/P ROOT



Conclusions

- The problem in the MI vertical flying wire is still not understood, but doesn't look to depend on software
- The speed profiles look different between MI and TEV and may be useful to understand the problem
- No major problems showed up in comparing the fit results between LabView and ROOT, in the TEV
- The horizontal emittance spread could be reduced by taking a constant values of the momentum spread, previously calculated from the profile measurements themselves.