Flying Wire Analysis
Intermediate Report

December 17, 2008

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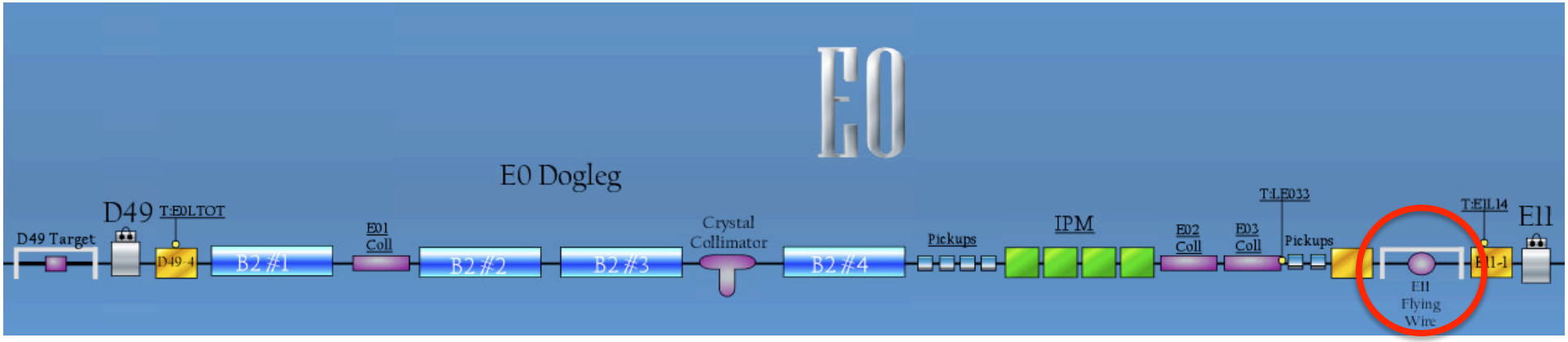
Collaborating with Rick Tesarek

Introduction



Goal:

1. Estimate sensitivity of FW to see channeling or VR beams
2. Align FW with E03 collimator

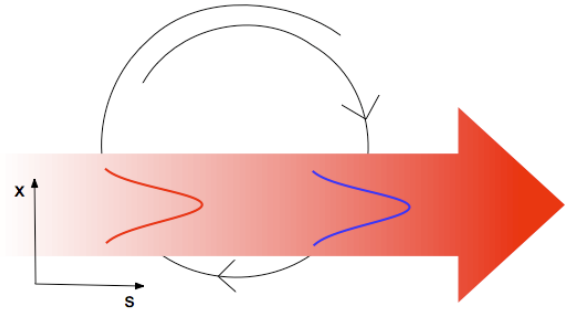
Steps:

1. Understand Low-gain (LG) data
   Separate mechanical effects from physics
2. Calibration of LG data
   → As a by-product of the analysis, we measure growth rate of the beam width
3. Calibration of High-gain (HG) against LG
4. Look at beam halo with HG data

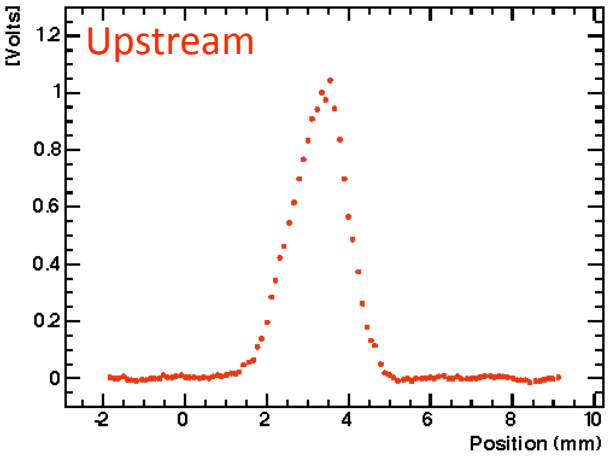
Flying Wire Data

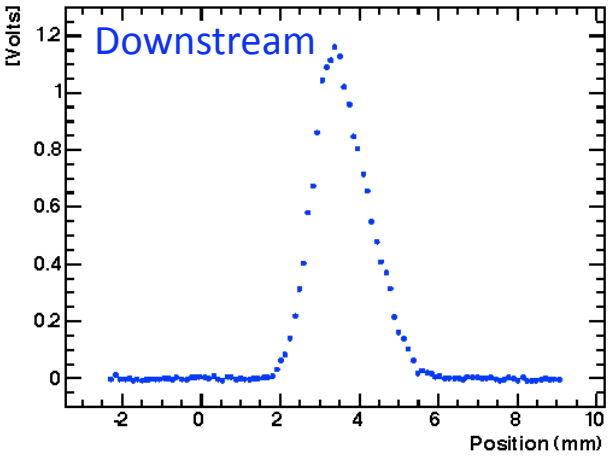
→Two beam profiles (upstream & downstream) for each bunch
→Different mechanical features for CW and CCW flys

Clockwise

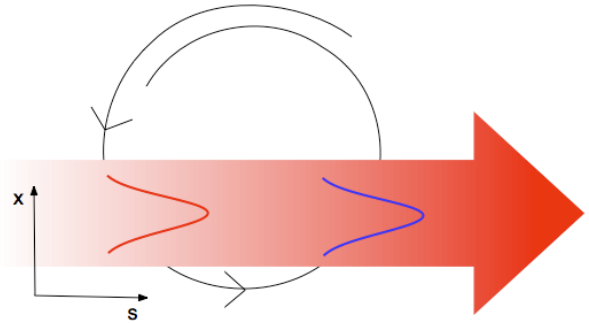


Store 6184 Fly at 7:49 am Bunch 1

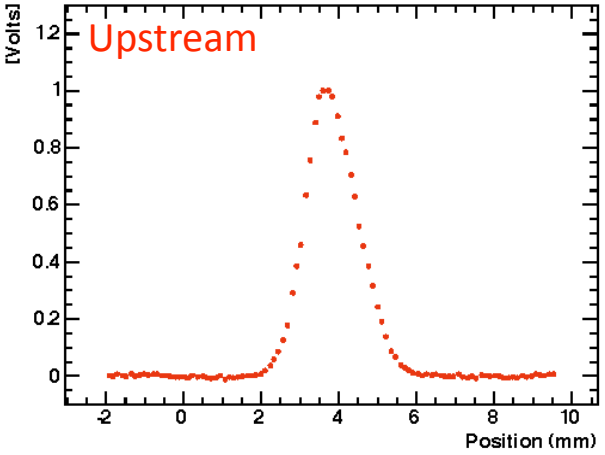


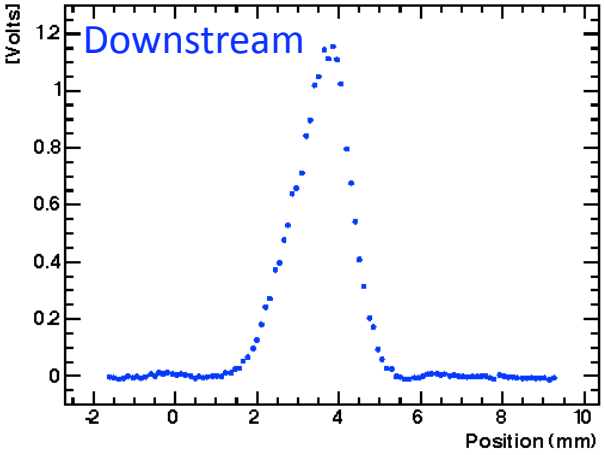


Counter Clockwise



Store 6184 Fly at 6:49 am Bunch 1



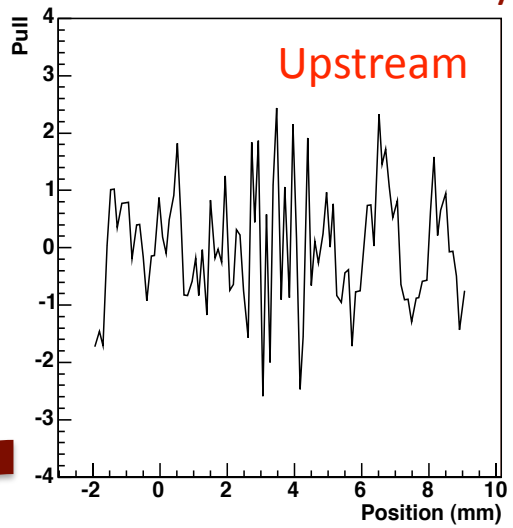


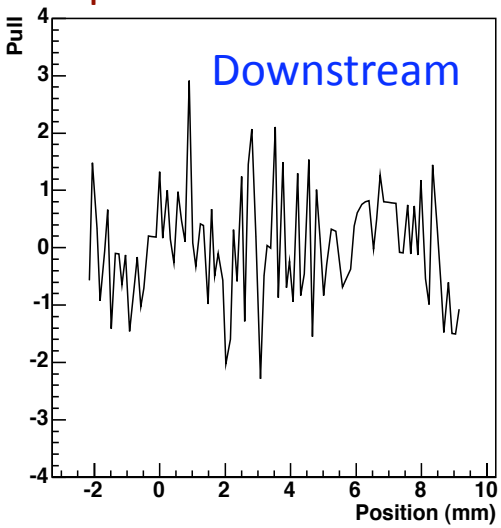
Uncertainty on Each Point

Uncertainty on each point = RMS of pedestal + Const * sqrt(Amplitude)

Uncertainty at each point allows us to evaluate uncertainty on fit to the beam profile.
→ we can propagate uncertainty to evaluate uncertainty in measurements

Store 6203 Fly at 8:45 pm bunch 1

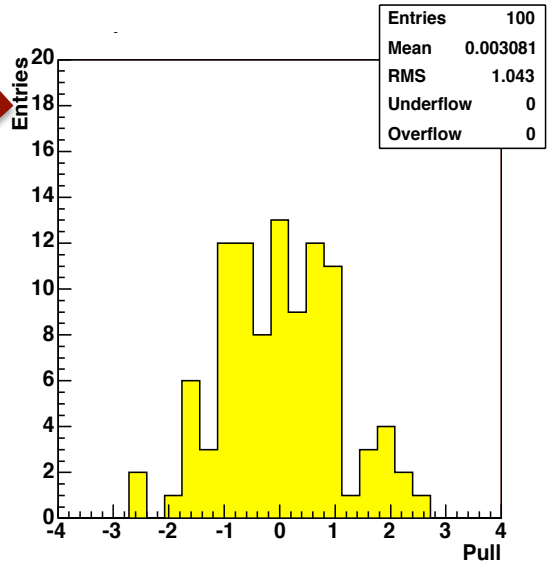


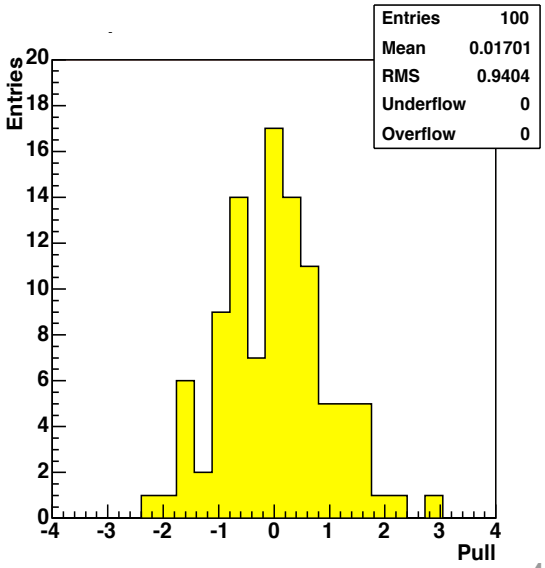


Projection onto Y-axis

Choose the constant by looking at the pull:

Pull(x) =
(data(x) – fit(x))/uncertainty(x)



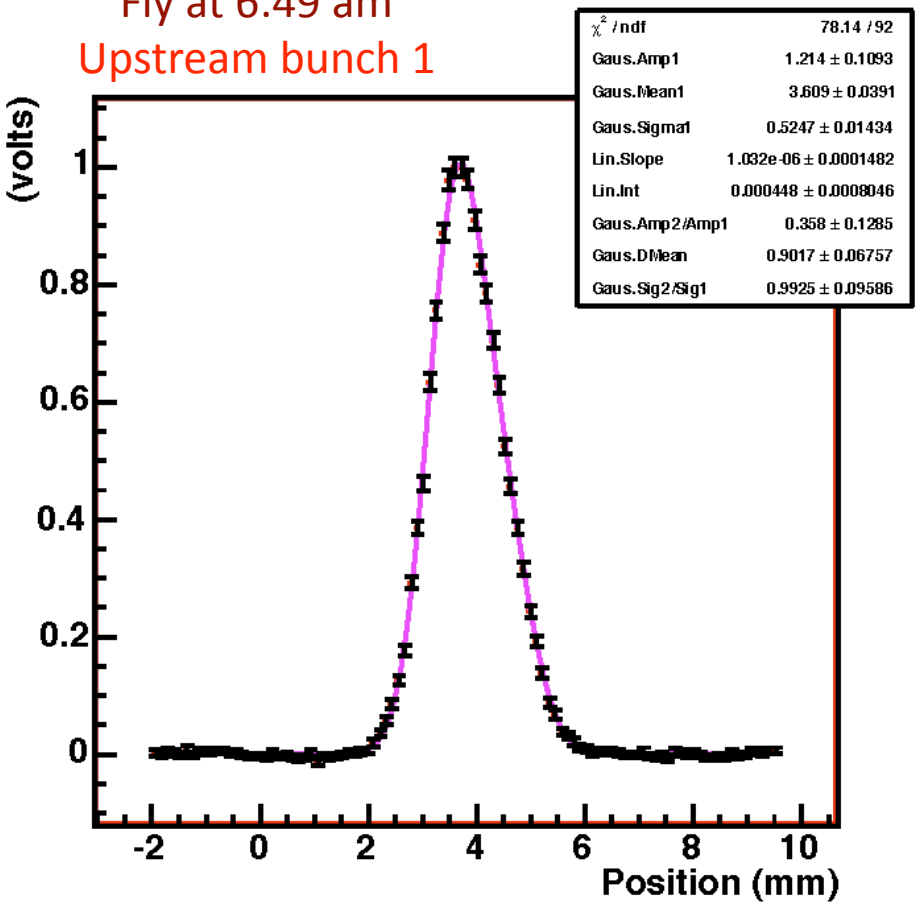


	Constant
Upstream	0.012
Downstream	0.014

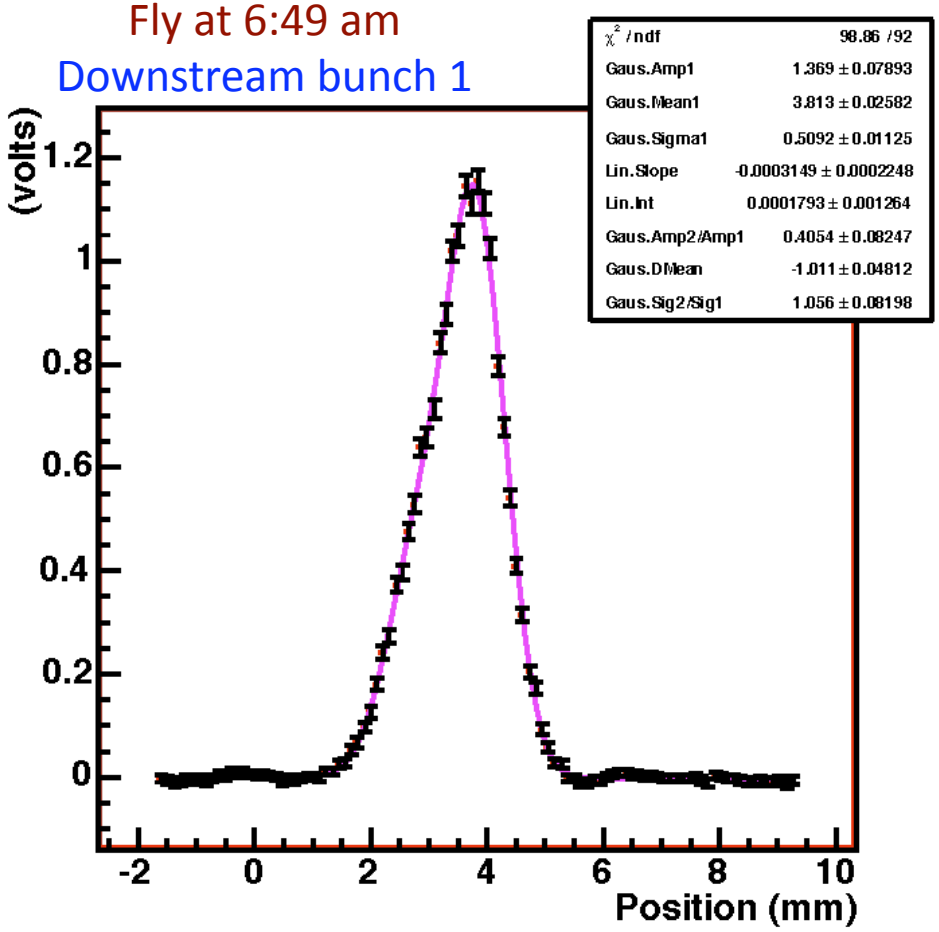
Fit to Beam Profile

Fit function = Gaussian1 + Gaussian2 + linear

Store 6184
Fly at 6:49 am
Upstream bunch 1



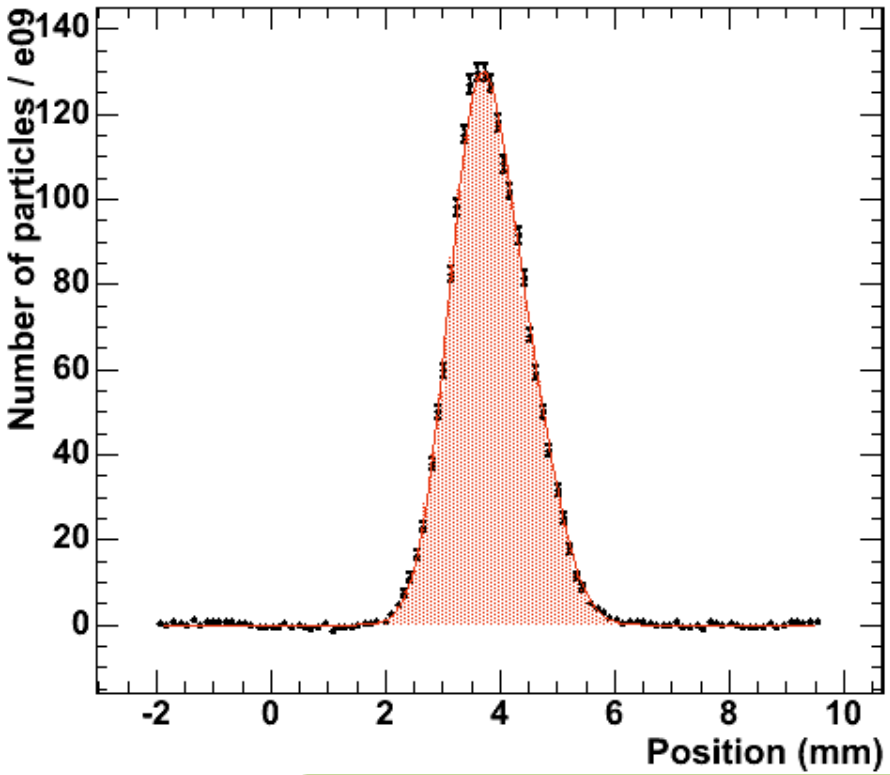
Store 6184
Fly at 6:49 am
Downstream bunch 1

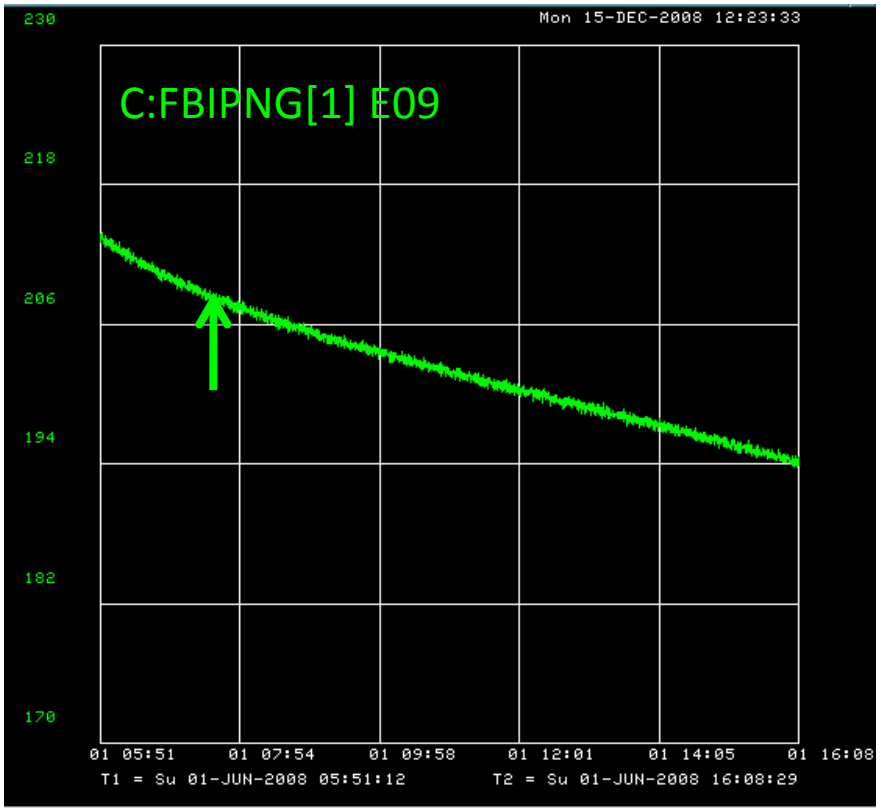


Calibration against FBI

Calibrate the area under the FW beam against Fast Bunch Integrator

Store 6184 Fly at 6:49 am
Upstream bunch 1

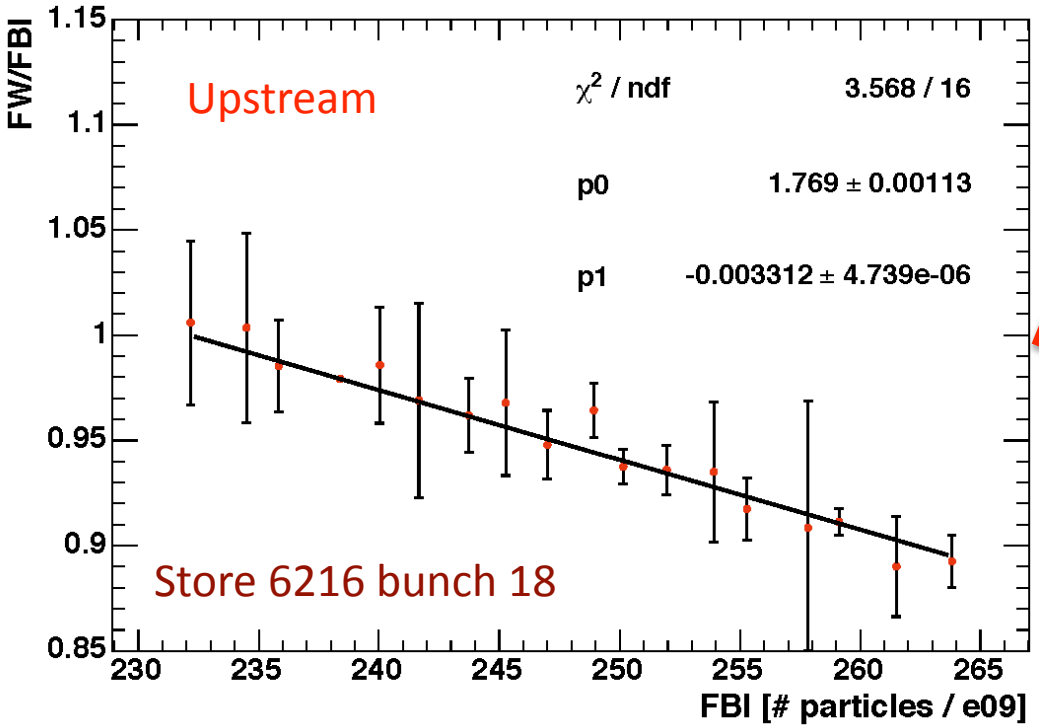




Scaling from volts to number of particles is determined using upstream data. We will take care of the difference between upstream and downstream later.

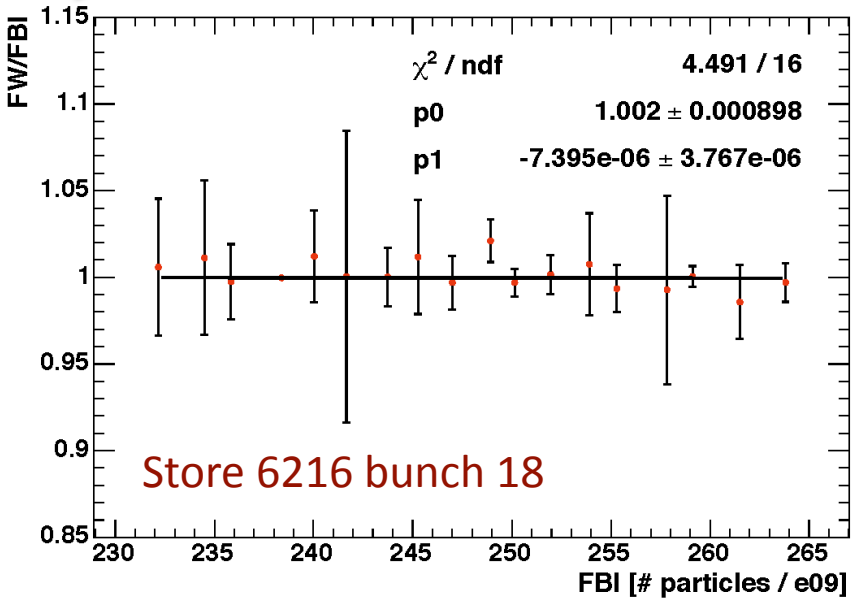
Calibration: Dependency on PMT Current

Assuming FBI data are accurate, we correct for dependence of FW area as a function of FBI



Correction = -0.003312 * FBI + 1.77

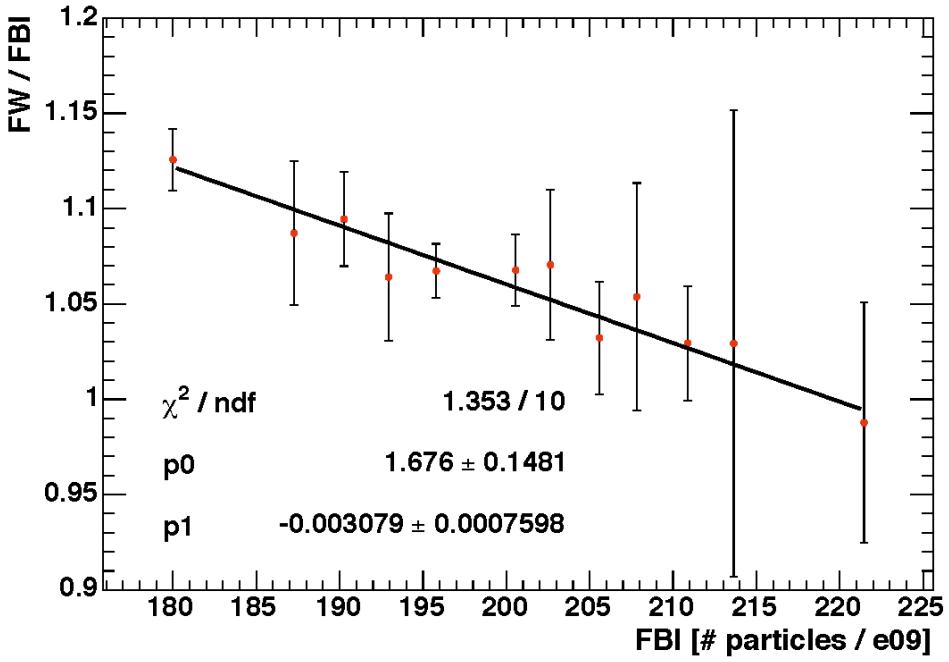
FW area corrected
= FW area initial /Correction

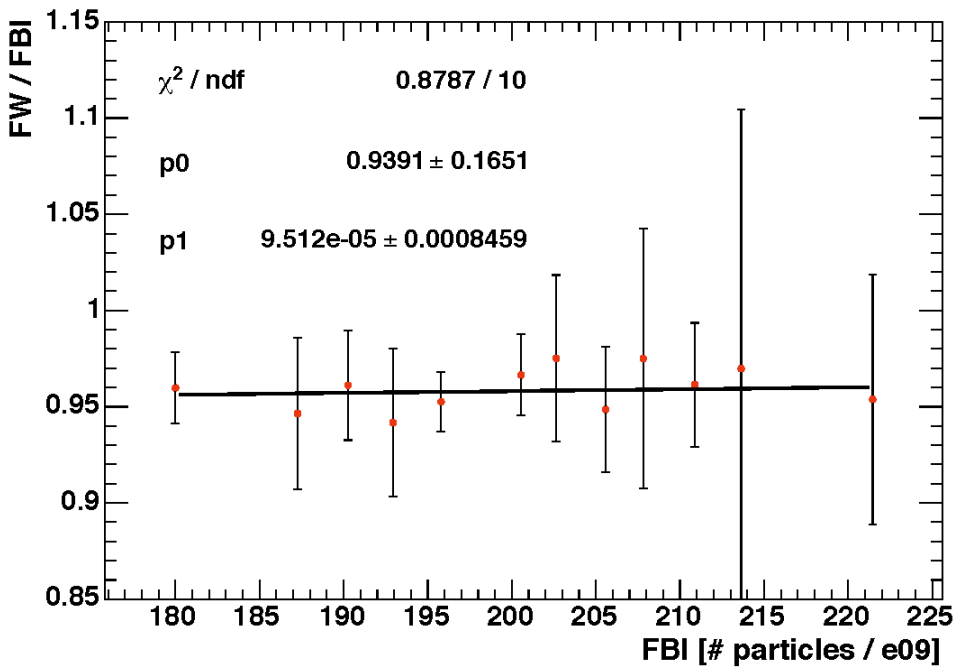


Check with another Store

Before calibration → **After calibration**

Store 6185 bunch 18 Upstream





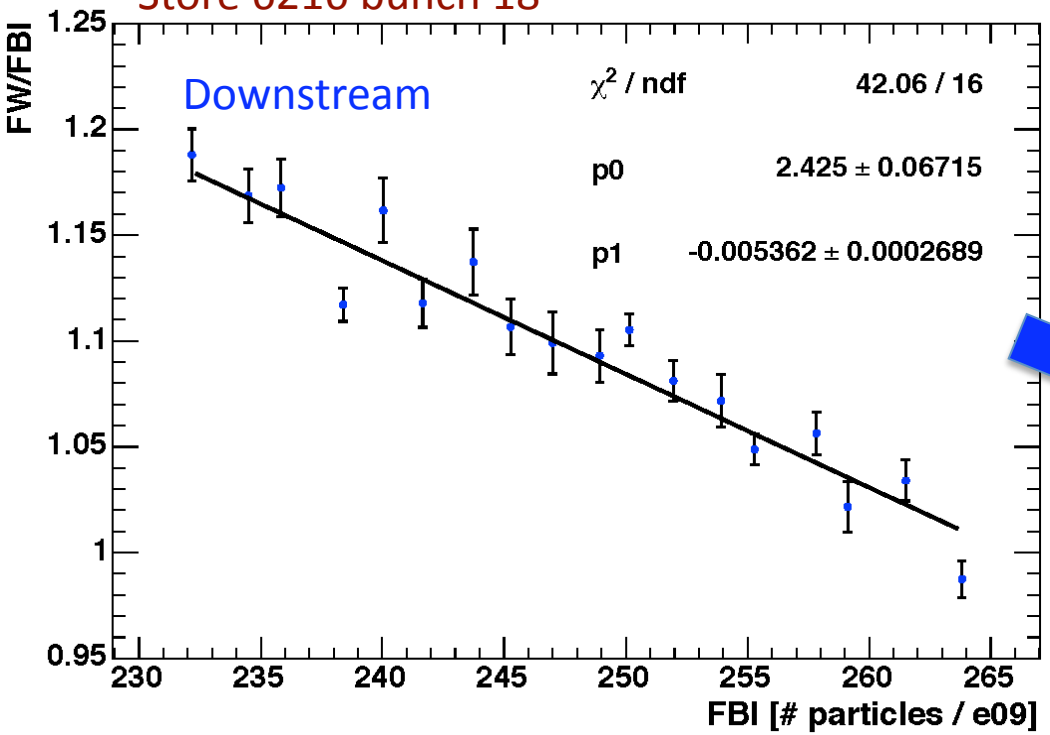
Slope ~ 4 σ

Slope ~ 0.1 σ

Calibration of Acceptance Ratio

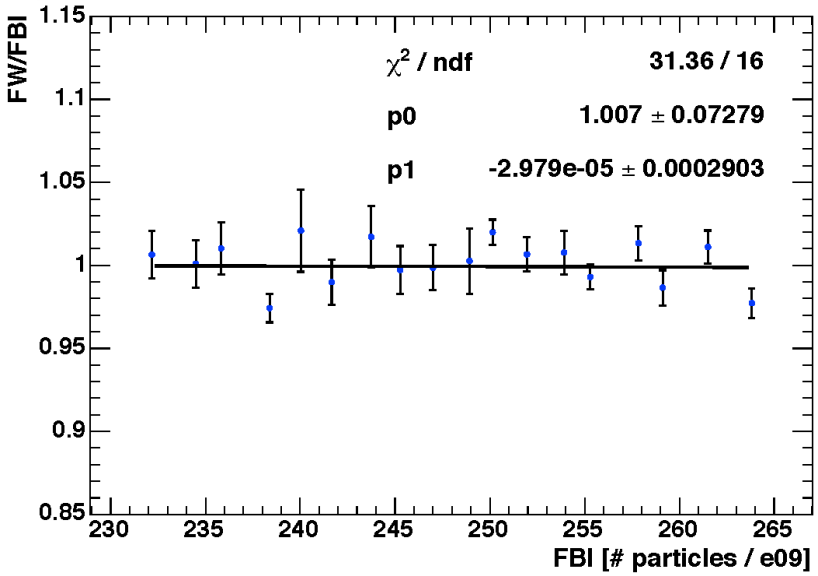
Upstream and downstream have different fraction of scattered particles reaching the detector due to the difference in solid angle

Store 6216 bunch 18



Correction = -0.0053 * FBI + 2.43

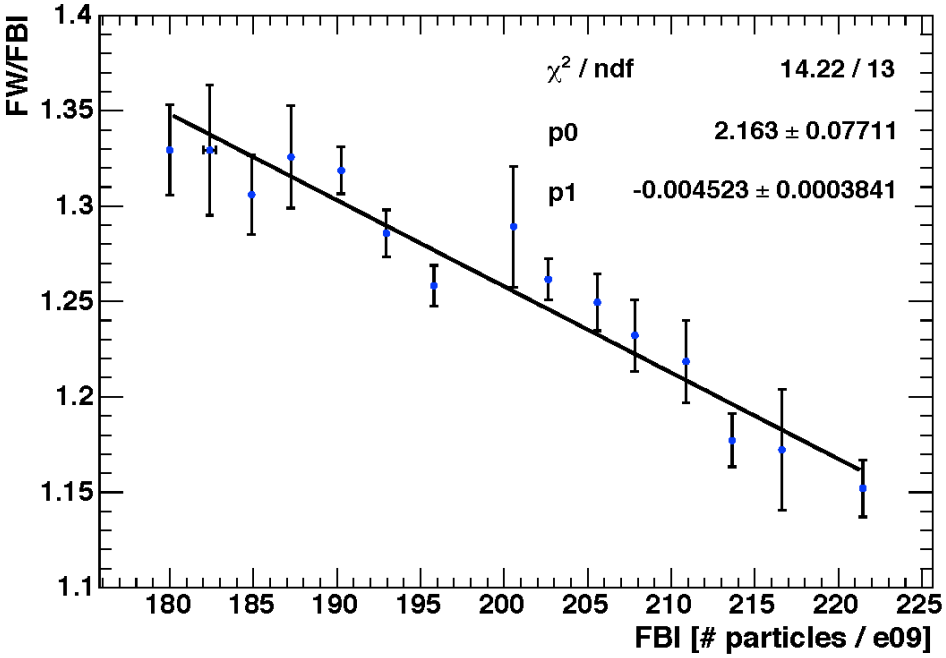
FW area corrected
= FW area before/Correction

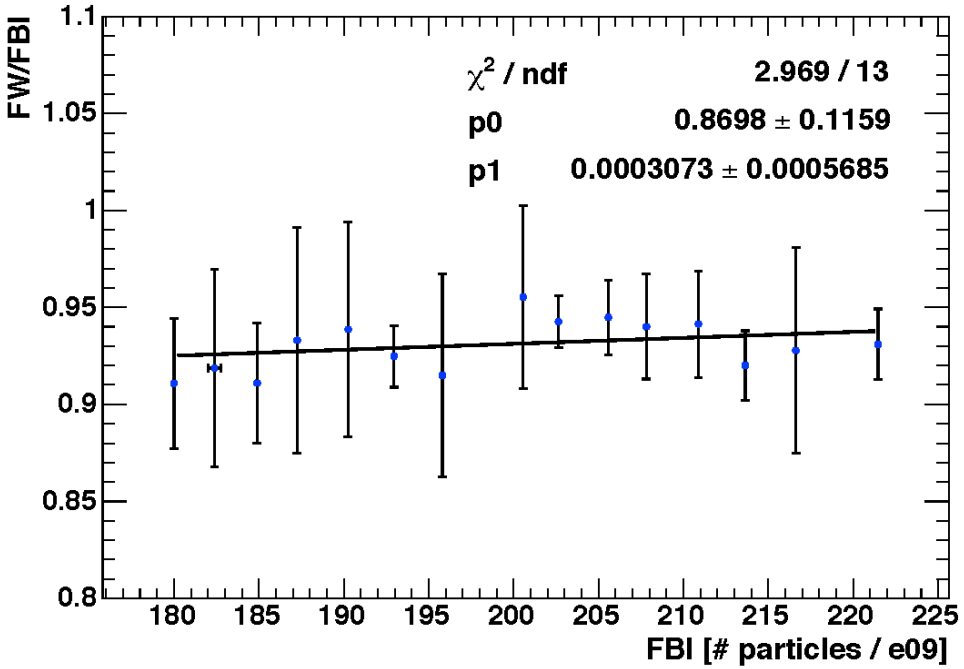


Check with another Store

Before calibration → **After calibration**

Store 6185 bunch 18 Downstream





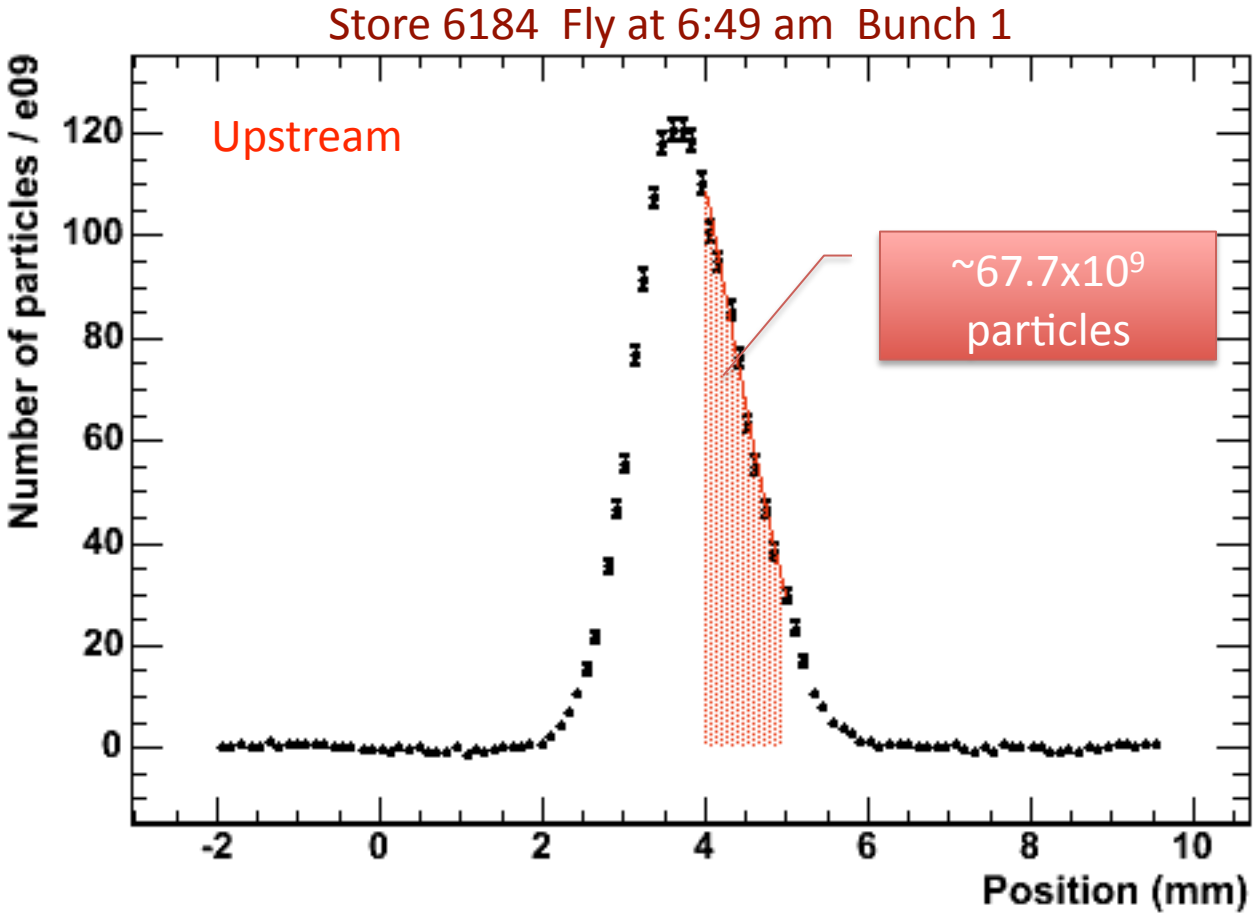
Slope ~ 12 σ

Slope ~ 0.5 σ

Note on Calibration

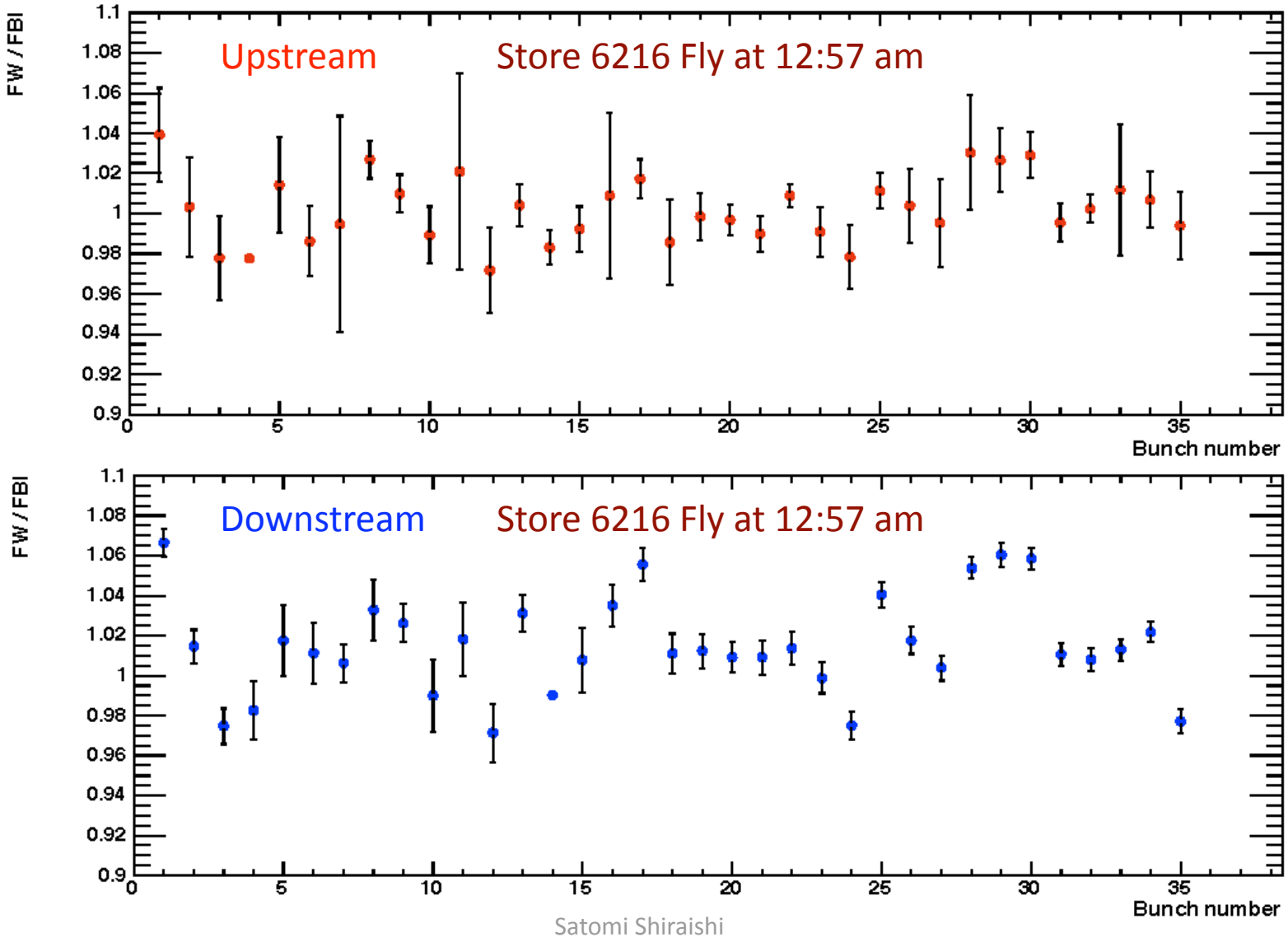
Calibrations are performed on data

→ One can read-off number of particles in a given position from the FW beam profile



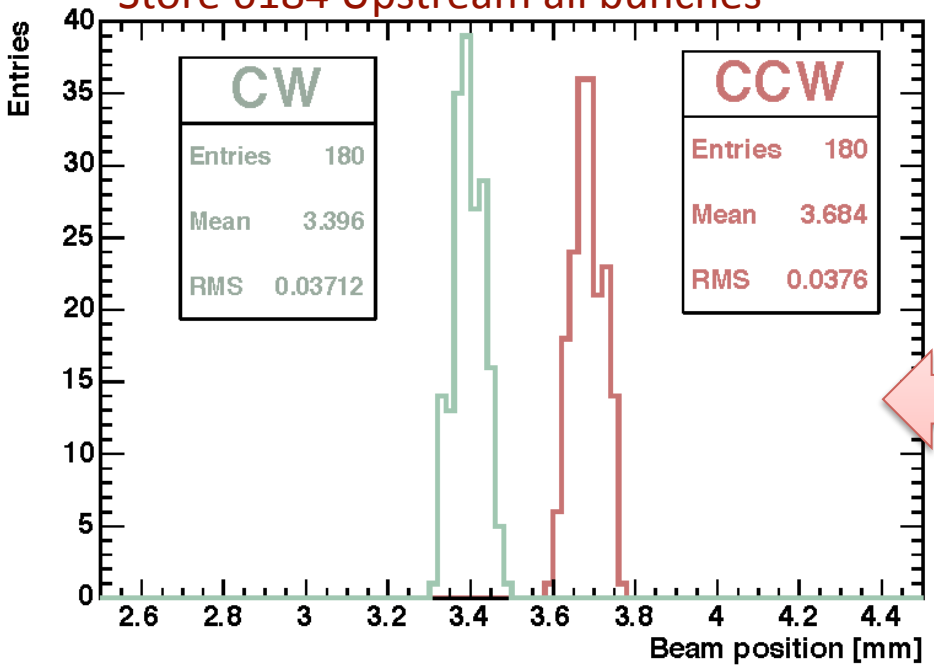
Bunch Dependence

More things to be taken care of…
We need to calibrate things that has ~5% or more effects



Dependence on Direction of Fly

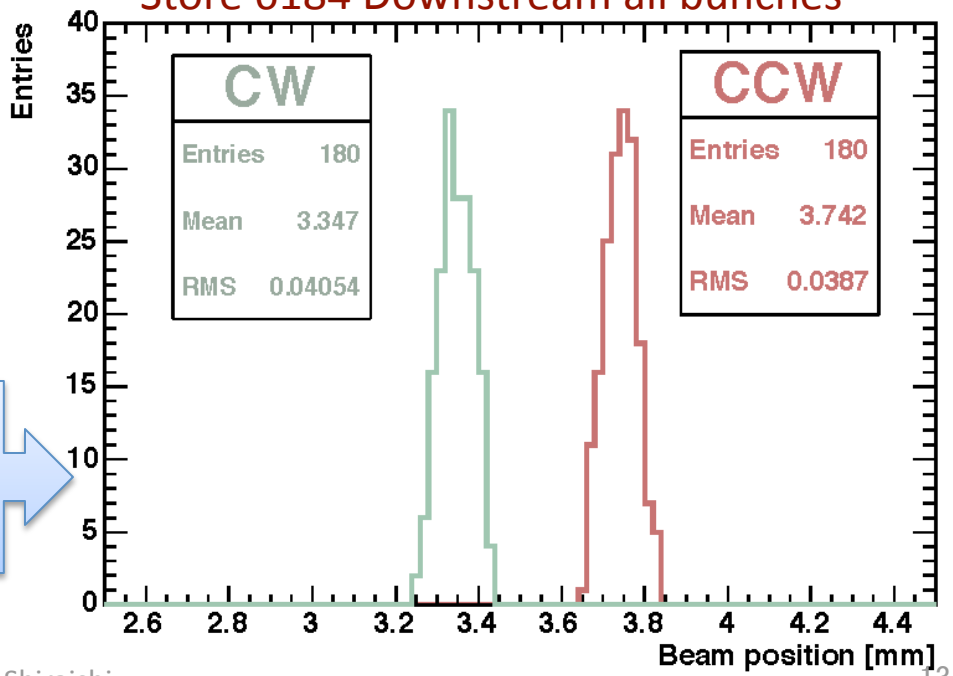
Store 6184 Upstream all bunches



Beam position =
Most probable position in the beam
(i.e. position of maximum amplitude)

CCW – CW =
0.284 +/- 0.004 mm

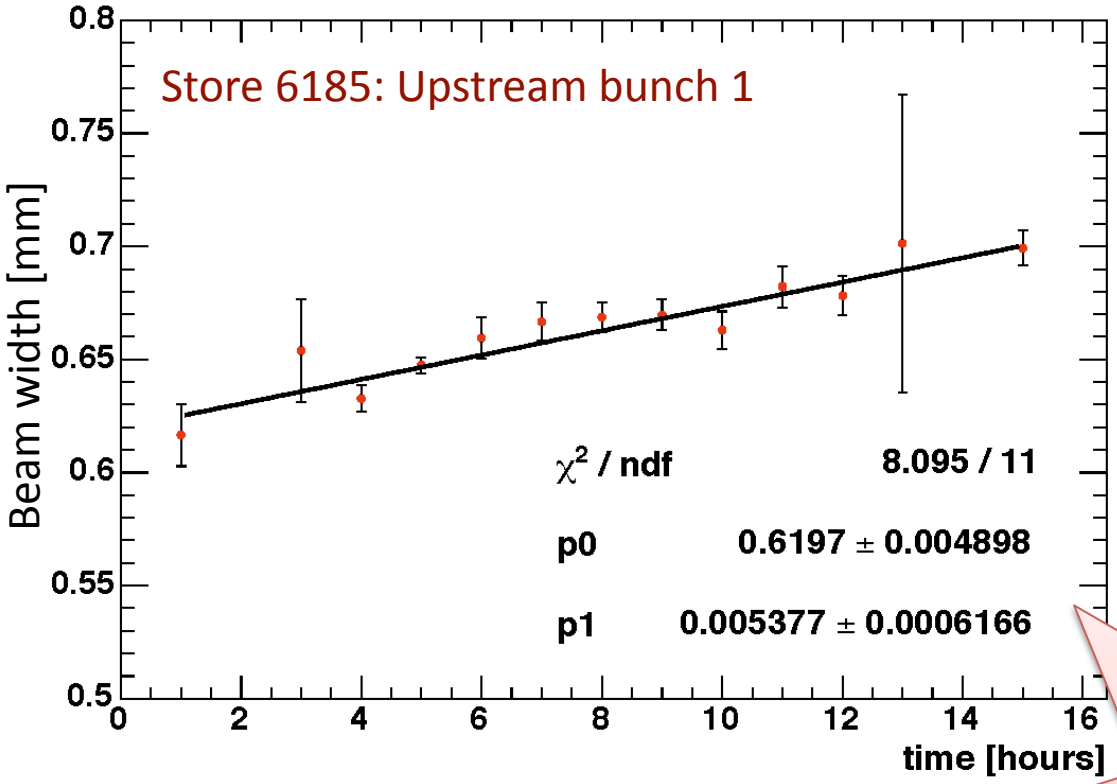
Store 6184 Downstream all bunches



CCW – CW =
0.390 +/- 0.003 mm

In addition…
Beam Width Growth Rate during HEP

(Preliminary)



Beam width =
standard deviation of the two Gaussians in the fit

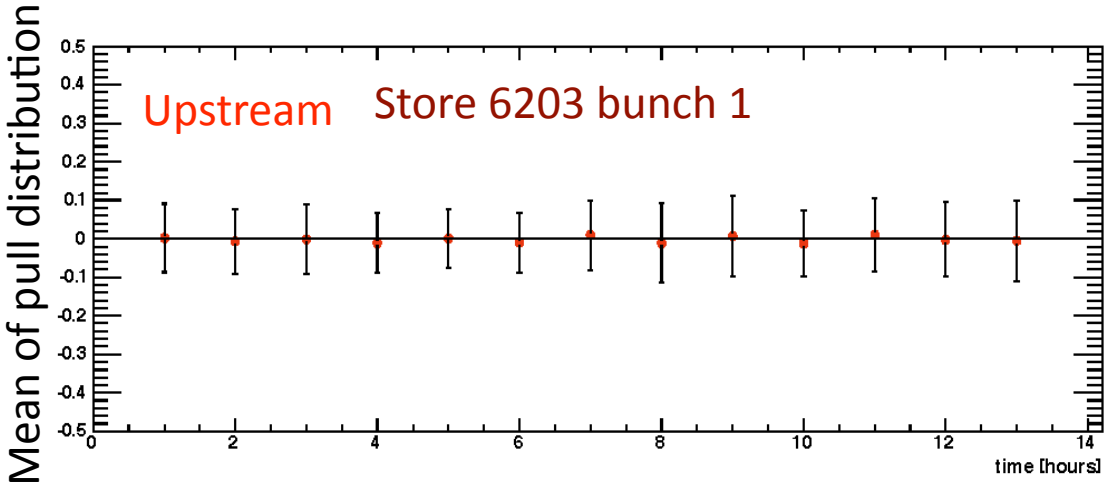
Simple linear fit (at least, for now) to width of the beam as a function of time in store gives 0.0015 +/- 0.0002 μm/sec

Conclusion

- Flying Wire data has various features depending on direction of fly, and whether it is an upstream or downstream profile
- Things that have been done:
  - Assignment of uncertainties on data
  - Fit to data using double Gaussian + linear function
  - Calibration against FBI
  - Calibration of dependence on current in PMT
  - Calibration of acceptation ratio between up and downstream
- Things to be done in future:
  - Remove dependence on bunch
  - Correction of position shift vs fly direction (CW vs CCW)
  - Make fits more robust
  - Compare fit parameters vs time into store
  - Check validity of calibration for multiple stores
  - Calibrate High-gain data against Low-gain data to study sensitivity for channeling/VR particles and to align E03 collimator with FW

Backup

Pull as a function of time in store



Downstream
also looks okay.