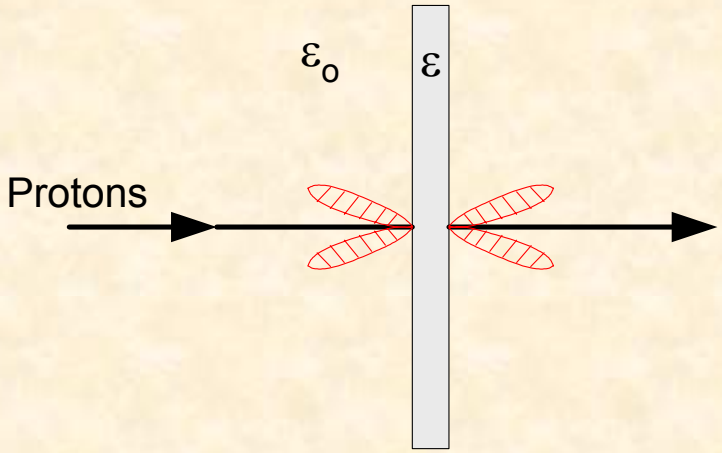
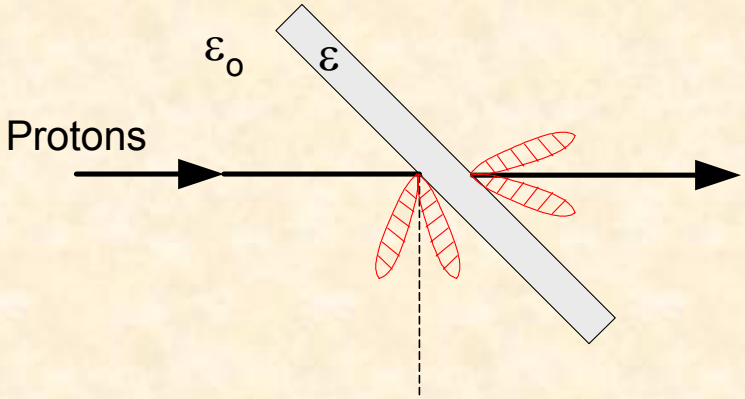
What is Optical Transition Radiation?

Optical Transition Radiation (OTR) is generated when a charged-particle beam transits the interface of two media with different dielectric constants, for example, vacuum to metal



Normal Incidence



Oblique Incidence

Ray Diagram for OTR Imaging

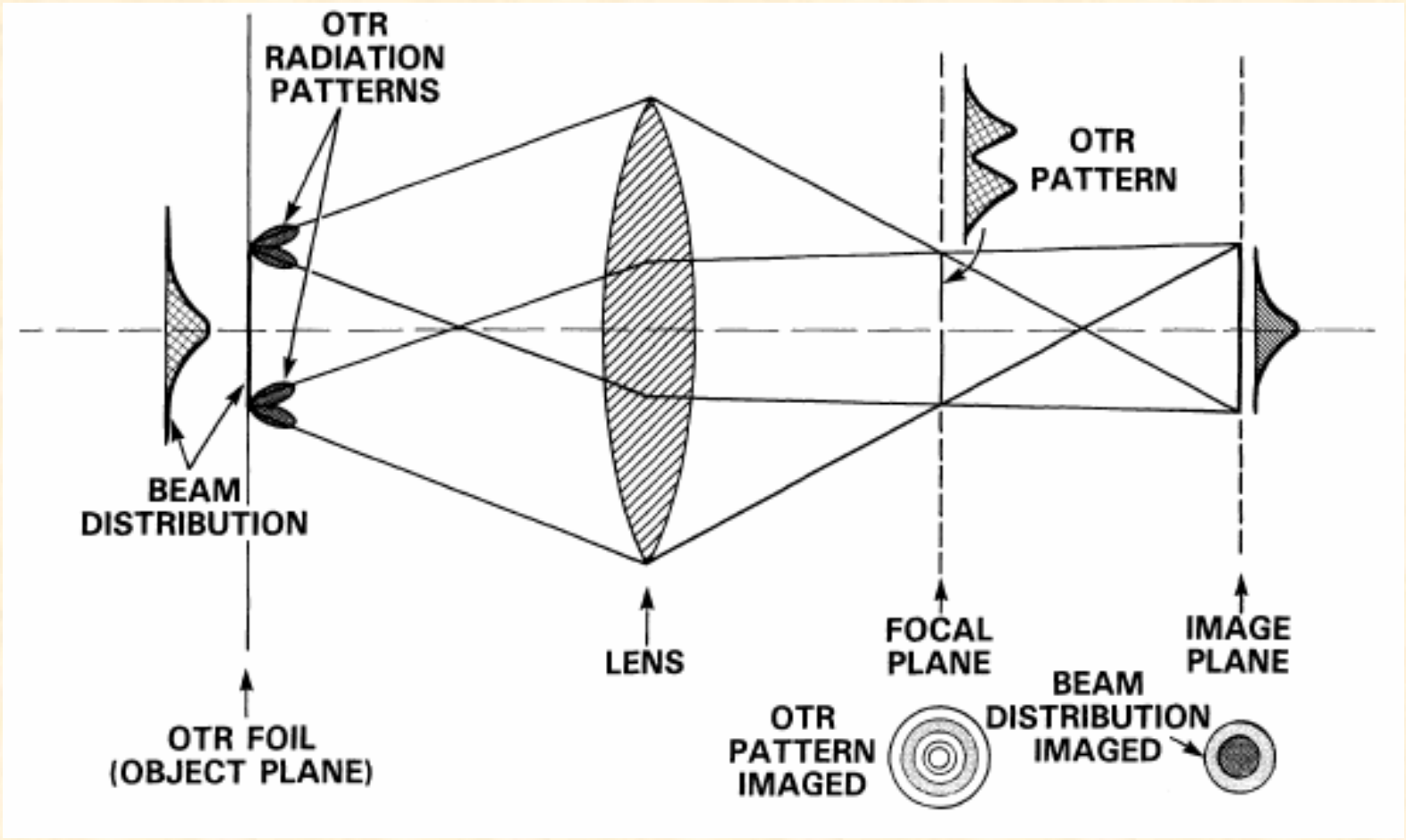
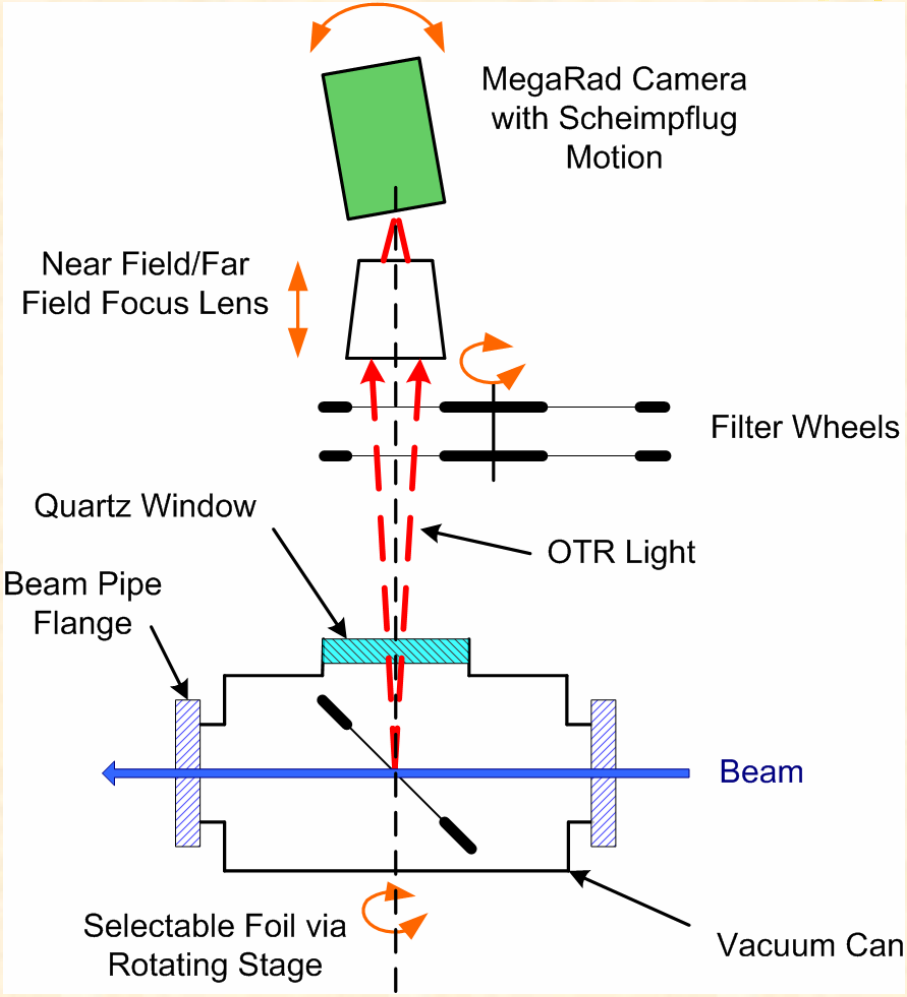


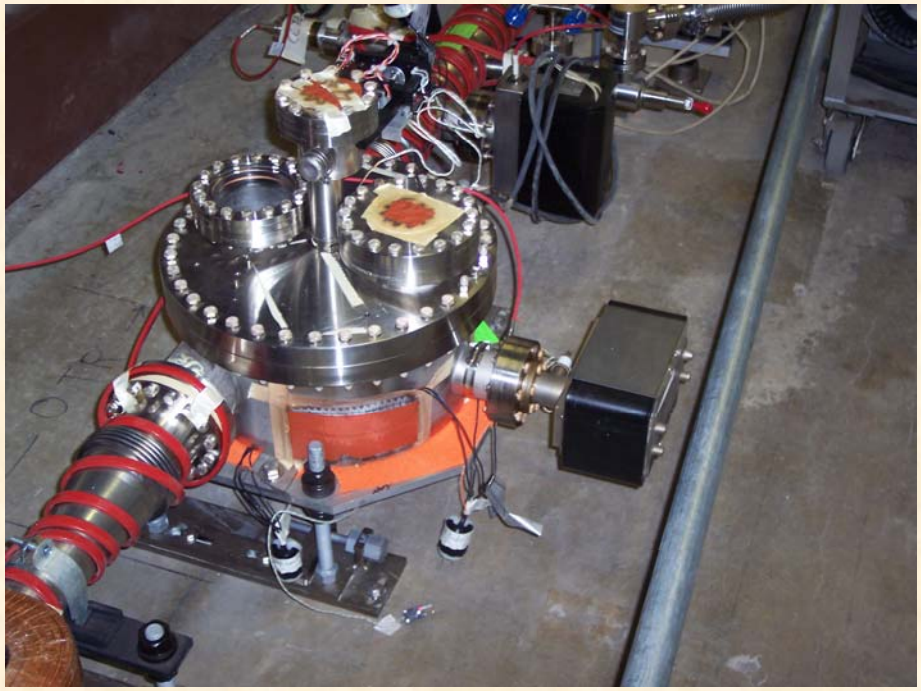
Diagram of OTR detector

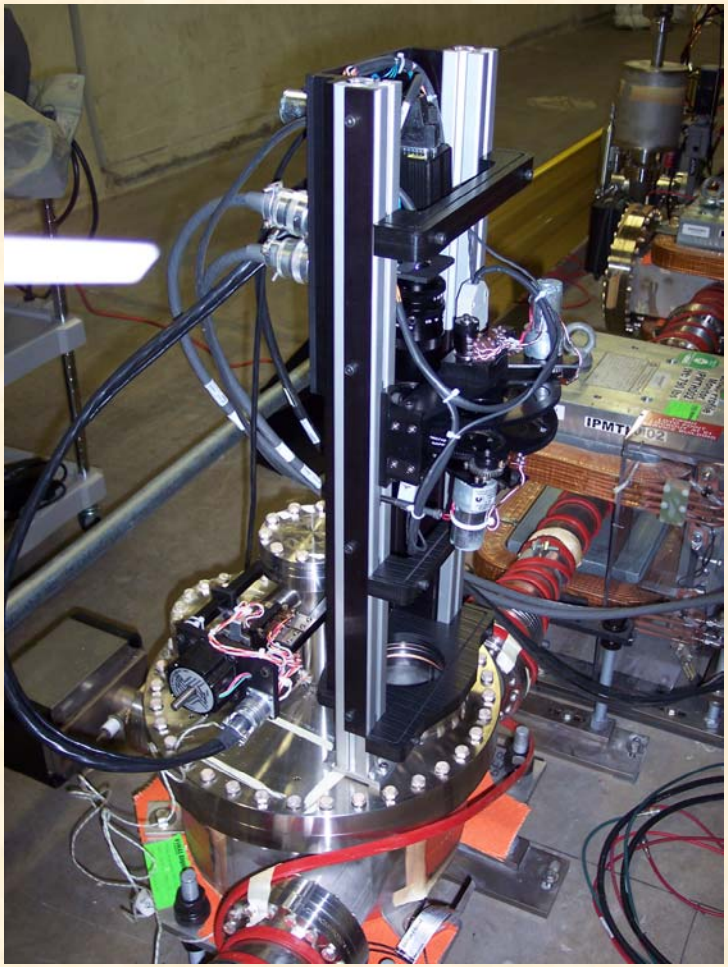


- Radiation hardened CID camera
- Near field/far field focusing
- Neutral density filter wheels with polarizers
- Bidirectional beam measurements with selectable foils
- Vacuum certified to few 10-9

OTR Installed in Tevatron

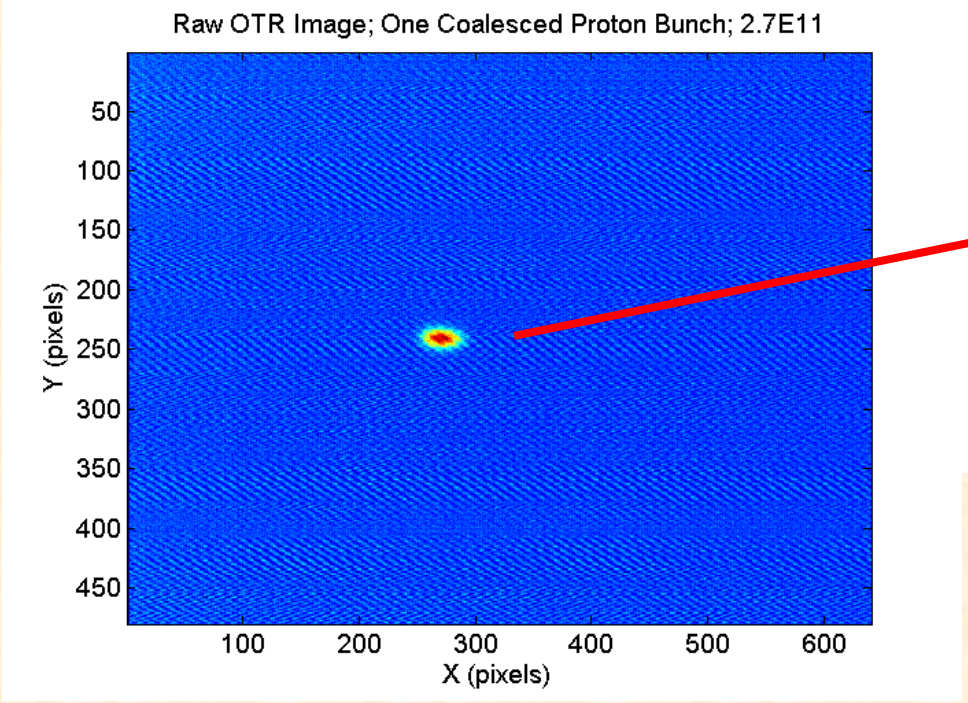
- Installed at E0 next to new IPM
- Used for single turn injection studies
- Proton and pbar foils

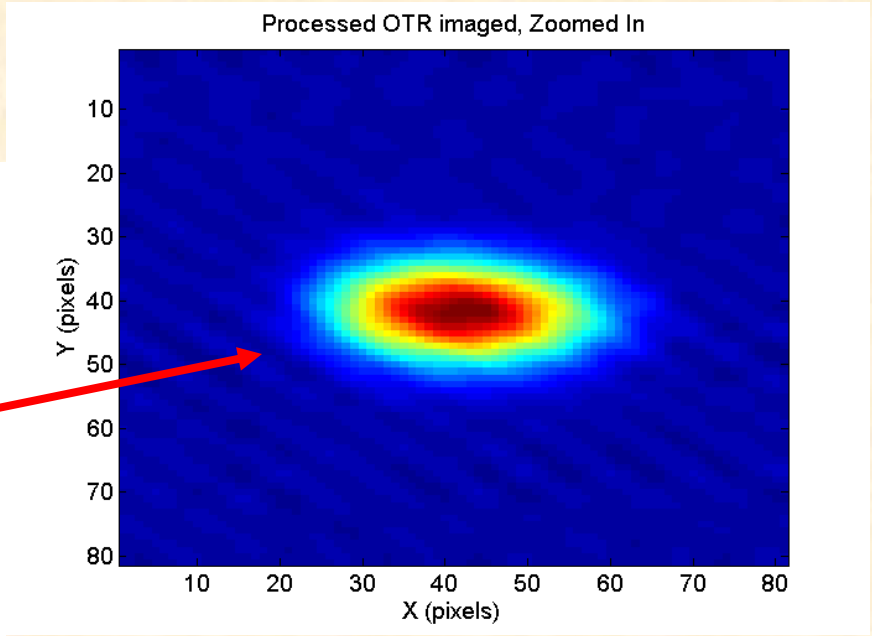




First Images

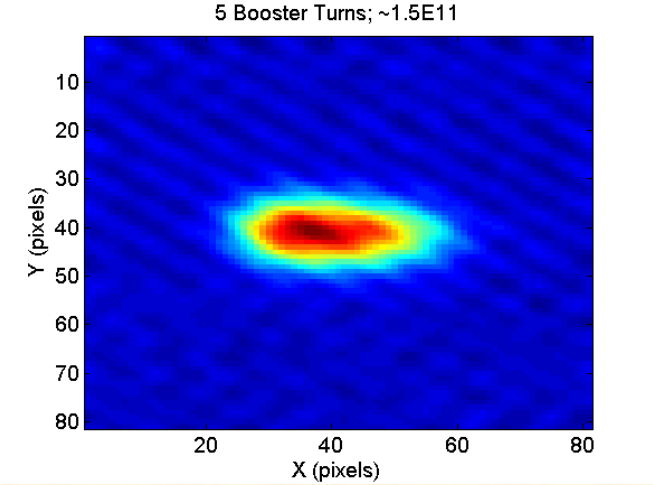
- One coalesced proton bunch ~2.7E11
- Single turn injection
- Ran from ~1E11 to 3.5E11

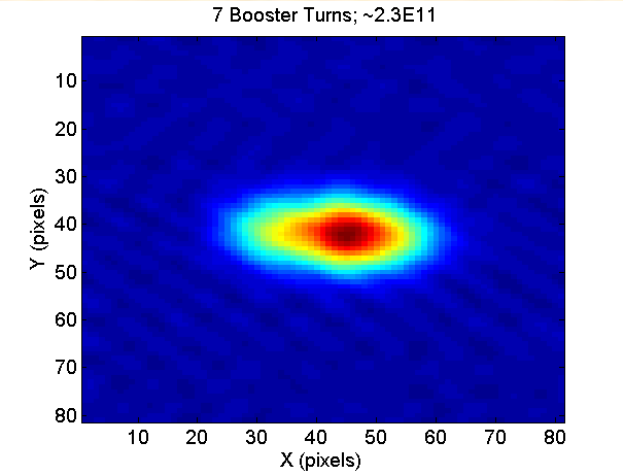


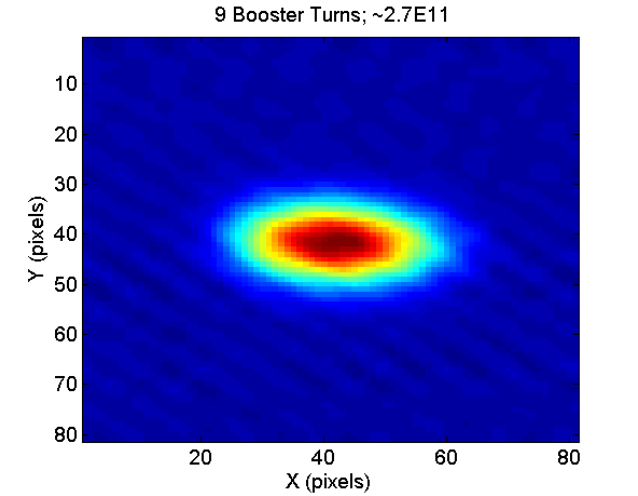


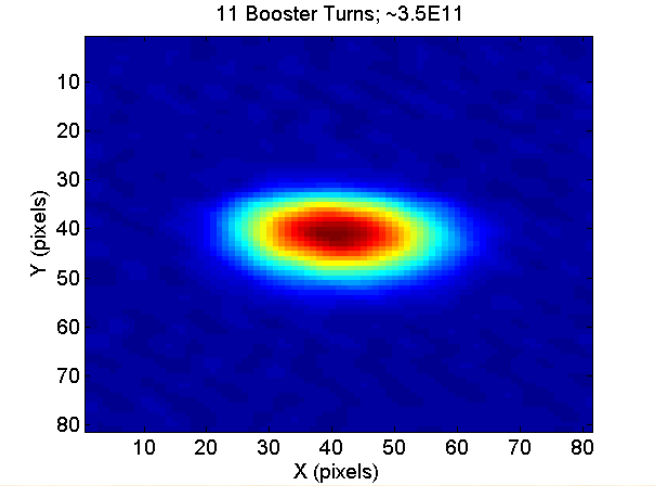
Reprocess image to minimize background

OTR Versus Beam Intensity





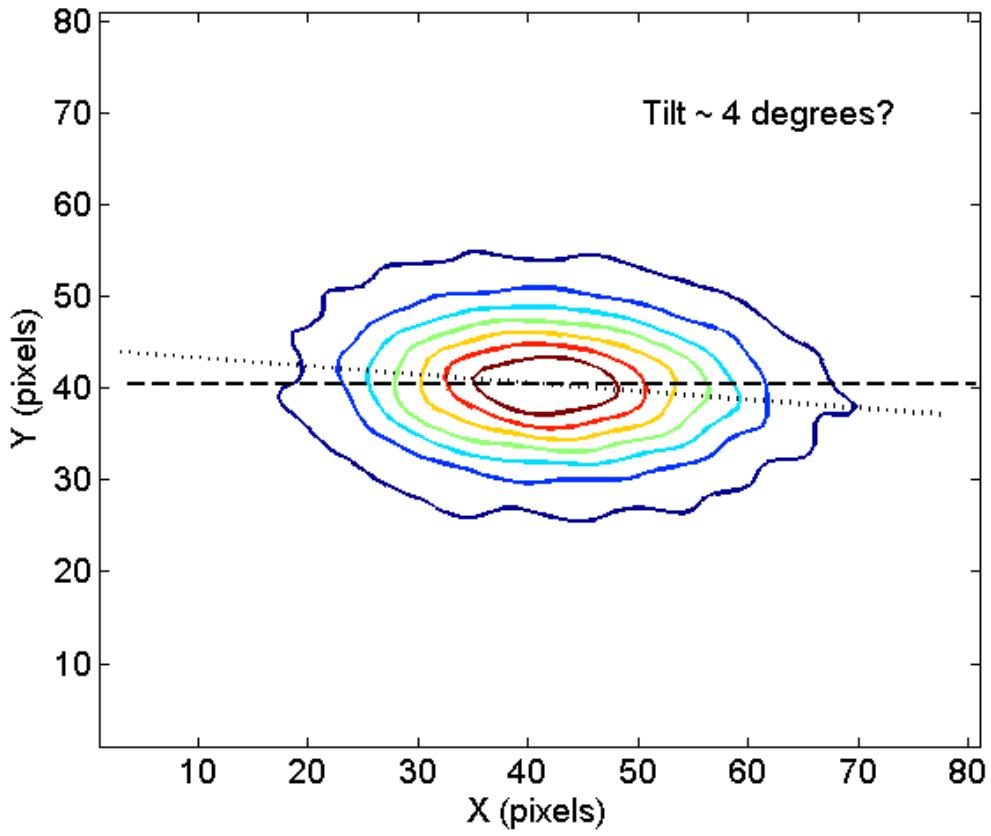




Is Tilt Real or Systematic?

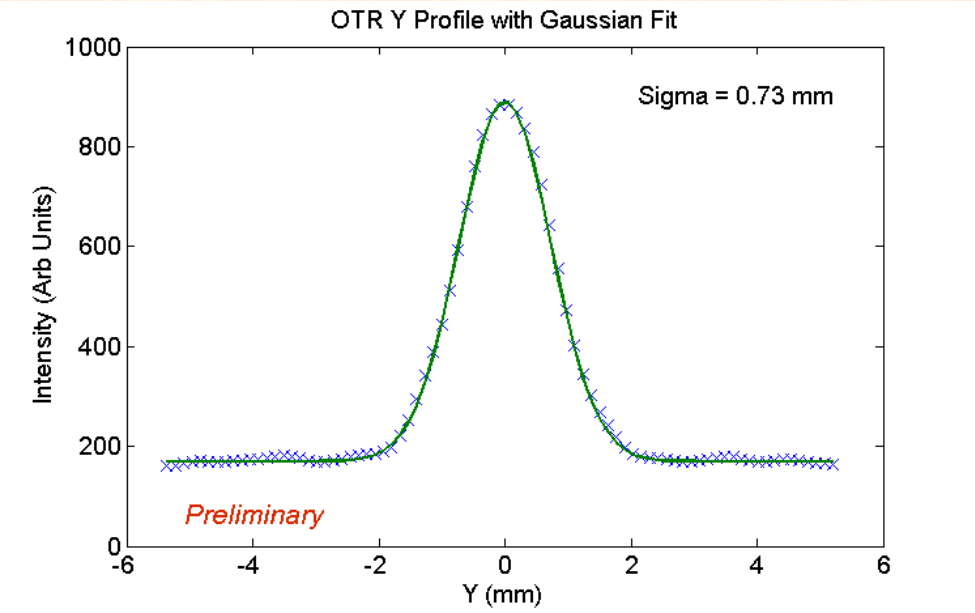
What systematic can cause tilt?

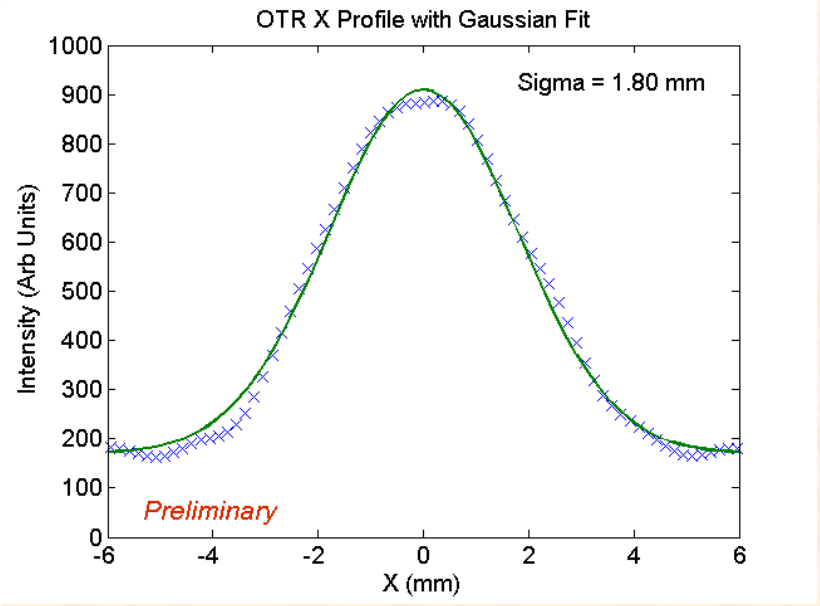
- **Detector roll**
- Combination of pitch and yaw?
- Internal alignment < 1 degree
- Need to put alignment data into analysis to correct image



What is the beam size?

- Use calibration image to go from pixels to mm and remove distortion





Compare to $\sigma^2 = \varepsilon\beta/\pi + D^2 (\delta p/p)^2$

- Typical emittances: H ~ 15 π mm-mr, V ~ 17 π mm-mr *(estimate from previous stores)*
- Beta-Functions: H = 92 m, V = 62 m (@ IPM)
- Dispersion: H = 3 m, V = 0 m (@IPM)
- dp/p: ~1E-3 (estimate from previous stores)

Very Preliminary

	Vertical	Horizontal
Calculated	1.1 mm	3.2 mm
OTR Measured	0.73 mm	1.8 mm

- Get better number for dispersion and beta-functions (@OTR)
- Measure MI dp/p, MI emittance during study
- Double check factors of π, meters, 95%, etc

Conclusion

- Just starting to commission
  - Original intent to cross-check IPM
- Need to integrate calibration/alignment information into acquisition software
  - Some shape artifacts may be to detector alignment
  - These can be corrected
- Need to swap mis-matched video cable
- Future studies: uncoalesced protons, multiple turns (few)
  - Should see betatron oscillation
- No upgrade to hardware planned (need $$$)
- Upgrading camera may allow some sort of turn-by-turn measurement
  - This needs investigation but probably won't be cheap