Quartztof

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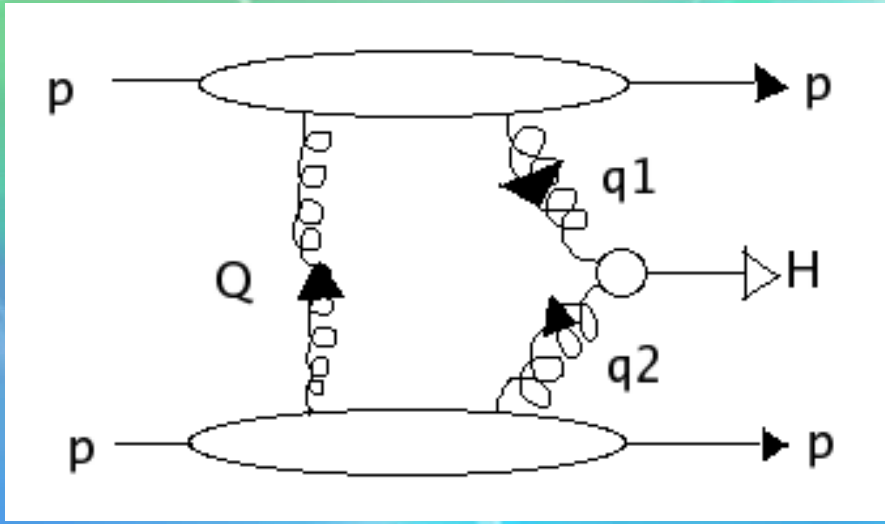
Outline

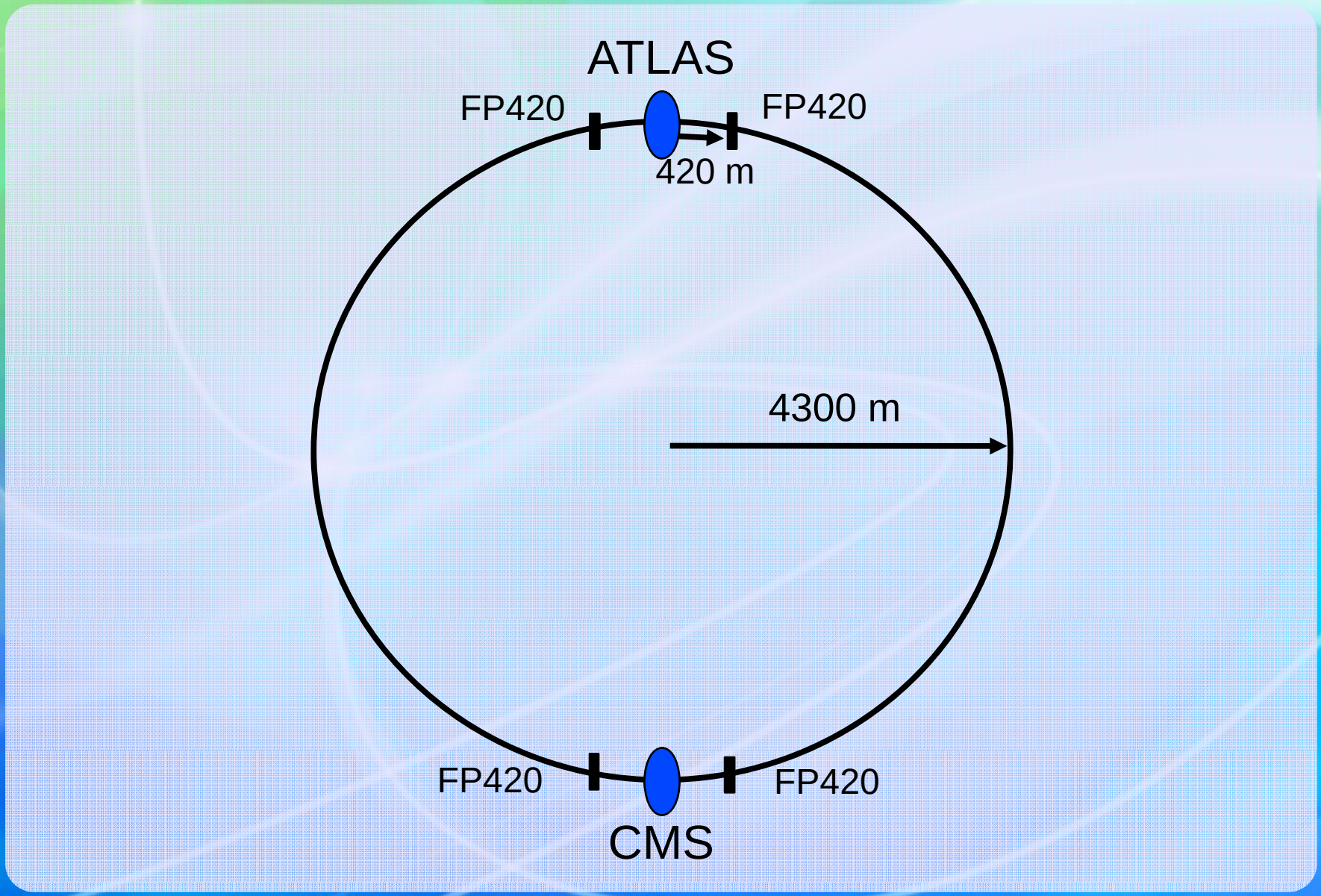
- The idea behind Quartztof
- Geometry of detector
- Simulating the detector
- Results from on-axis proton beam
- Results from off-axis proton beam
- Conclusion

Background: FP420 R&D Project



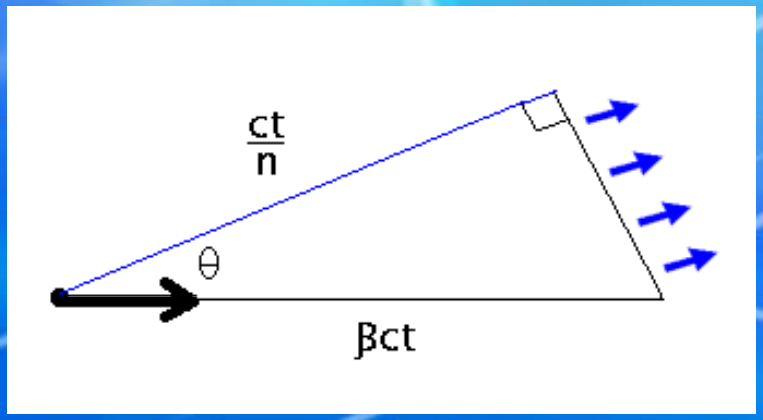
- Hopes to discover or develop...
  - Higgs Boson
  - Quantum chromodynamics
  - Electroweak physics
  - beyond the Standard Model physics

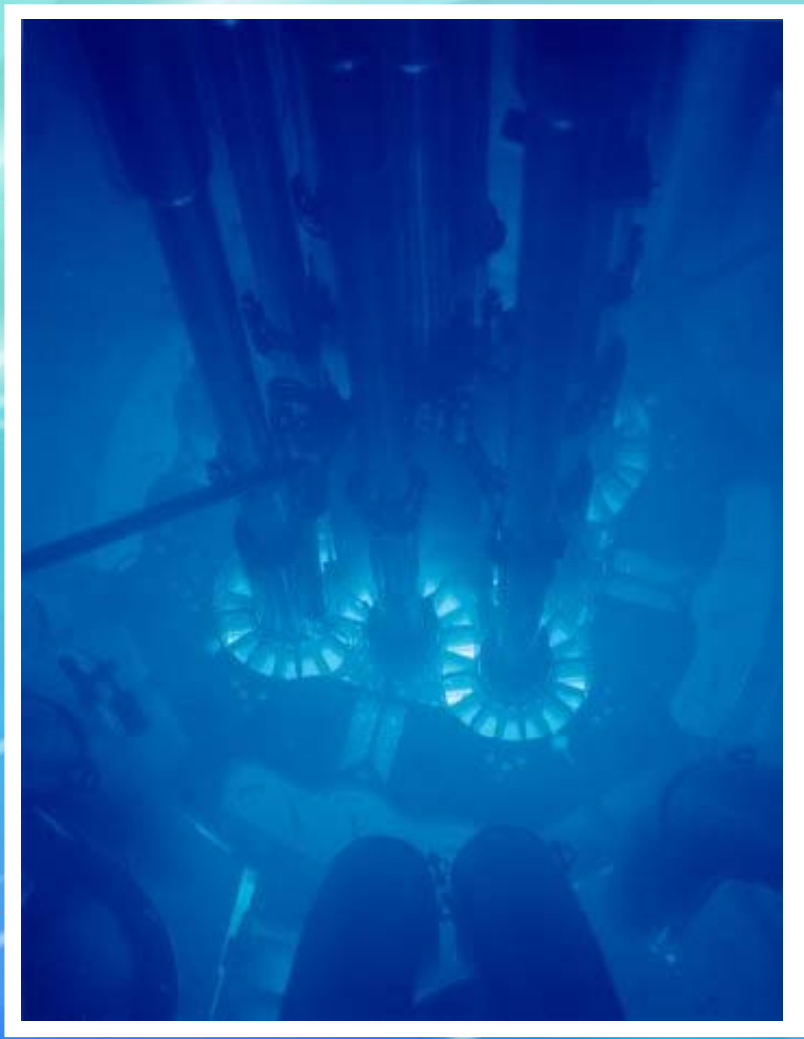
Basic Map of Large Hadron Collider



What is Cerenkov radiation?

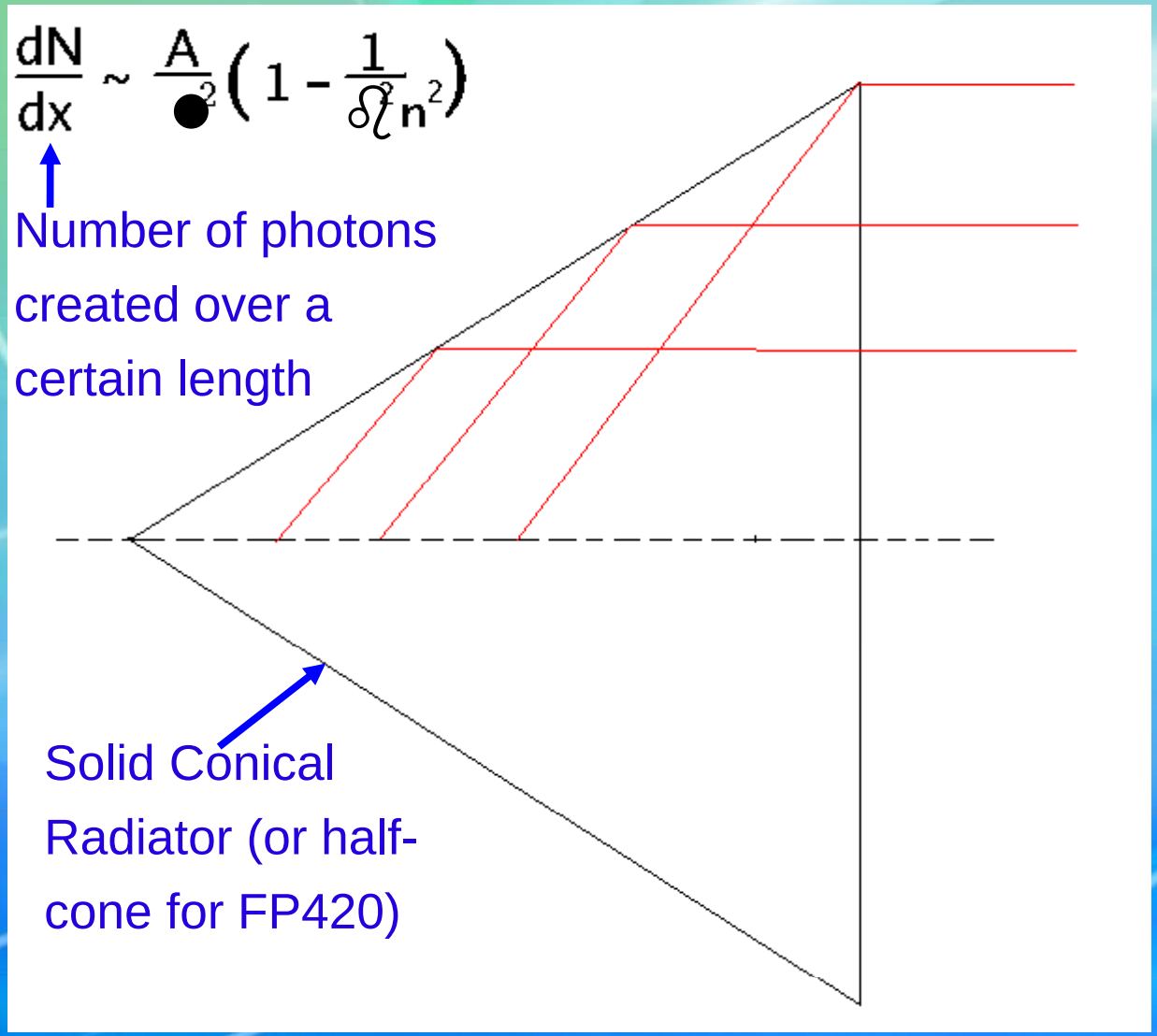
- Radiation created as a charged particle travels through a medium faster than the speed of light in that medium





Picture courtesy of Wikipedia:
http://en.wikipedia.org/wiki/Cherenkov_radiation

Faster timing using Cerenkov radiation

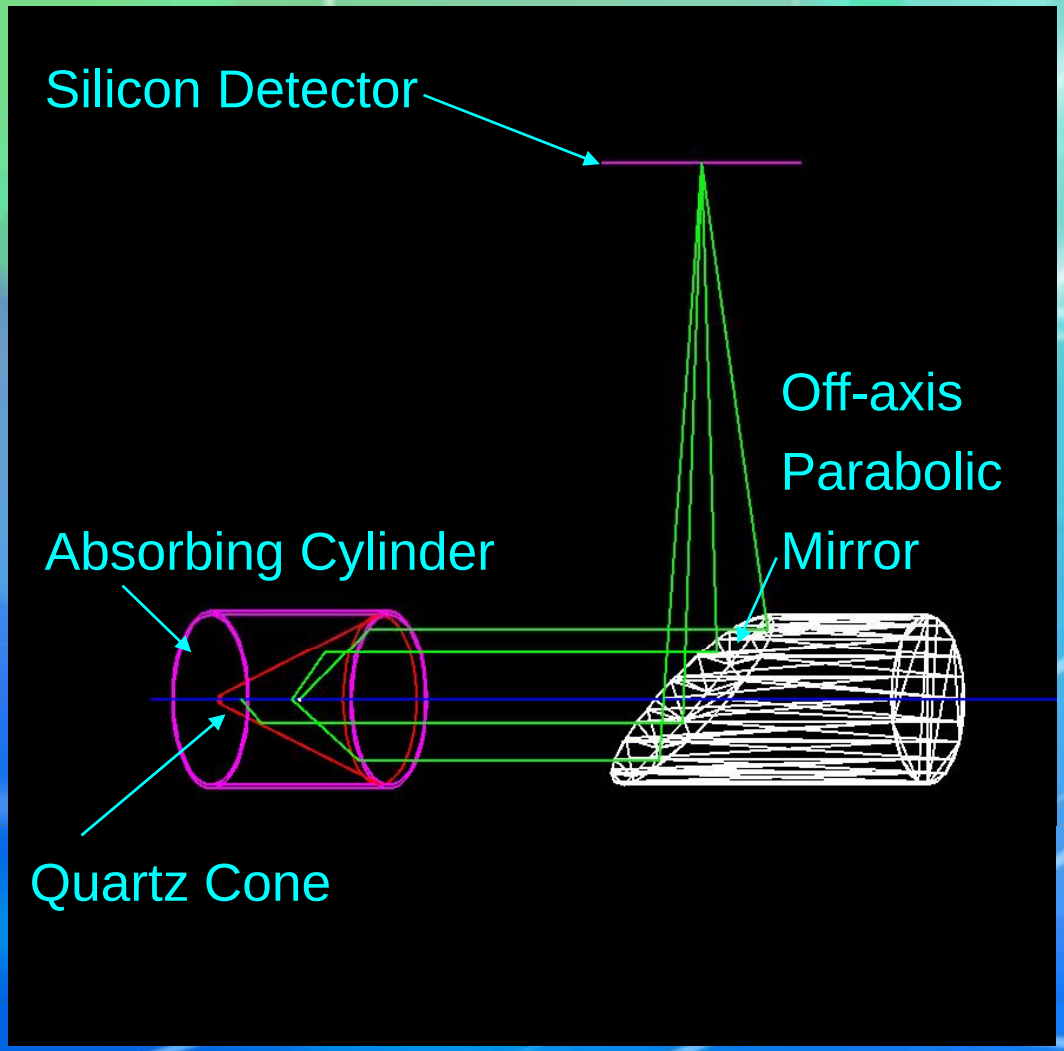


Further info:

$\beta = v/c$

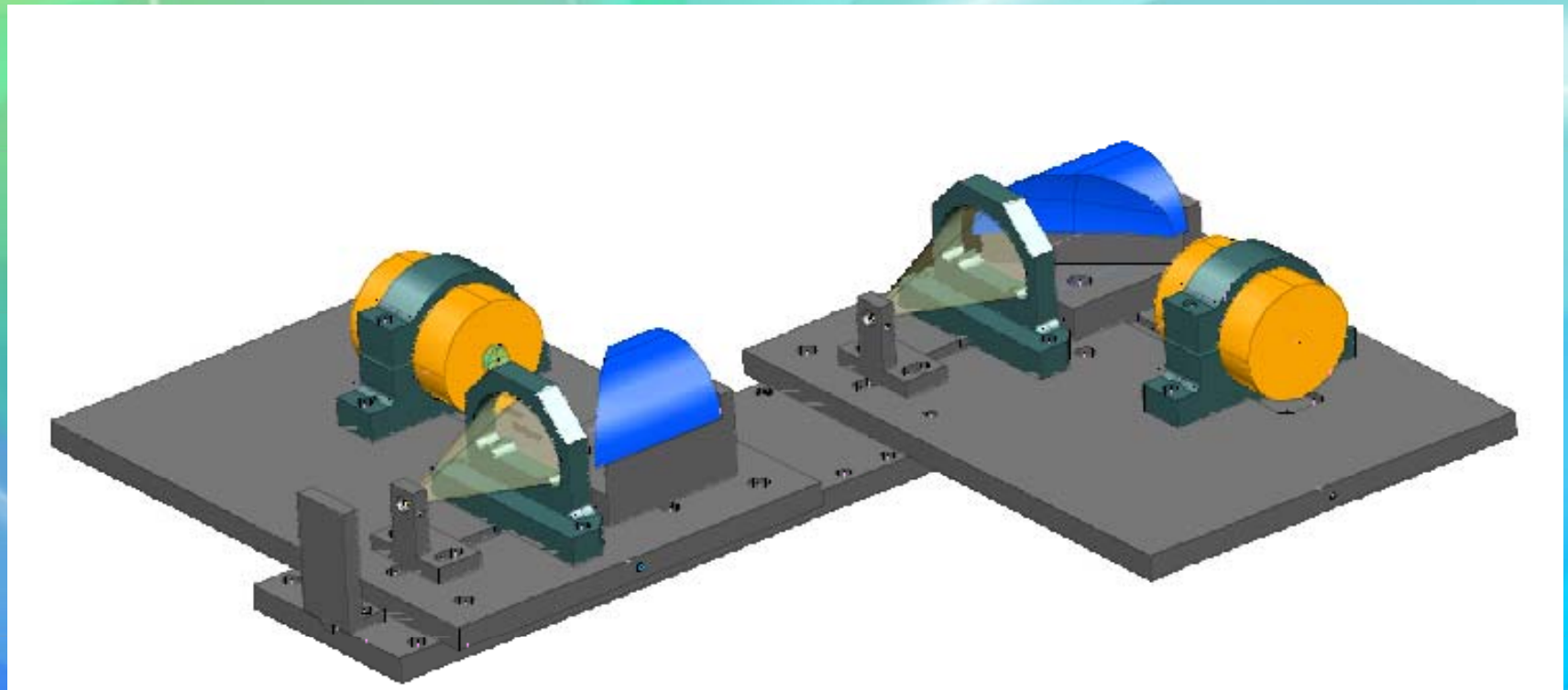
A=constant

Geometry



- Cone optimized for 689 nm (1.8 eV)
  - Cone angle 23.3°
- Off-axis Parabolic mirror
  - Focal Length = 76.2 mm

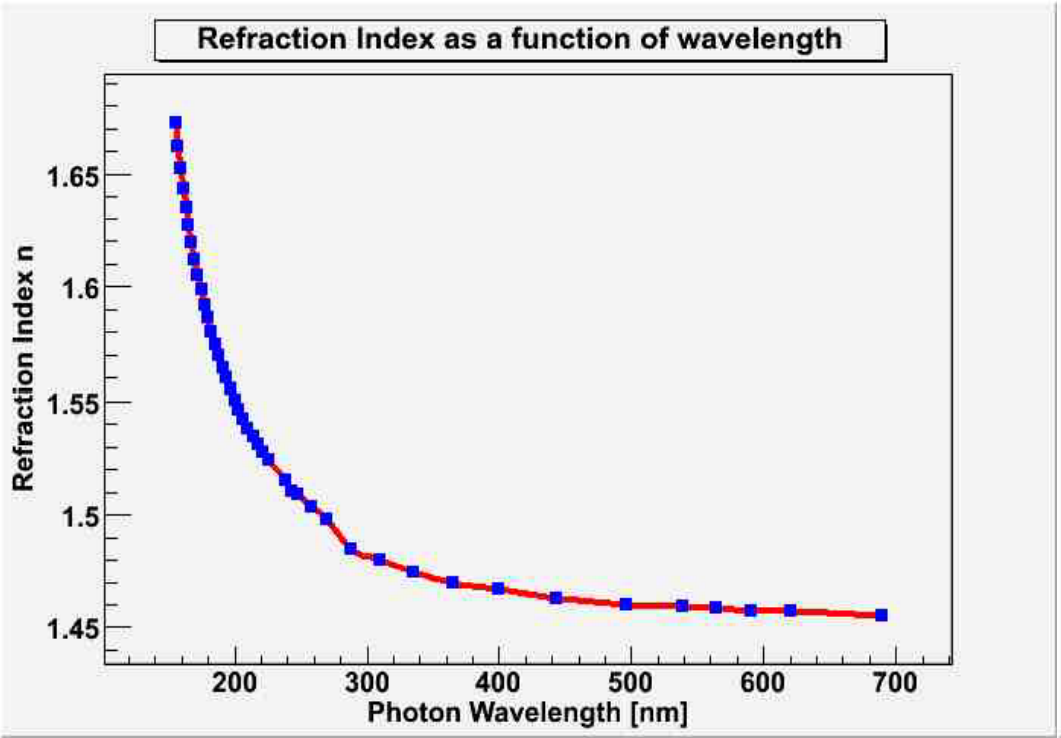
CAD (by John Rauch, FNAL) and Physical Prototype, courtesy of Mike Albrow, FNAL

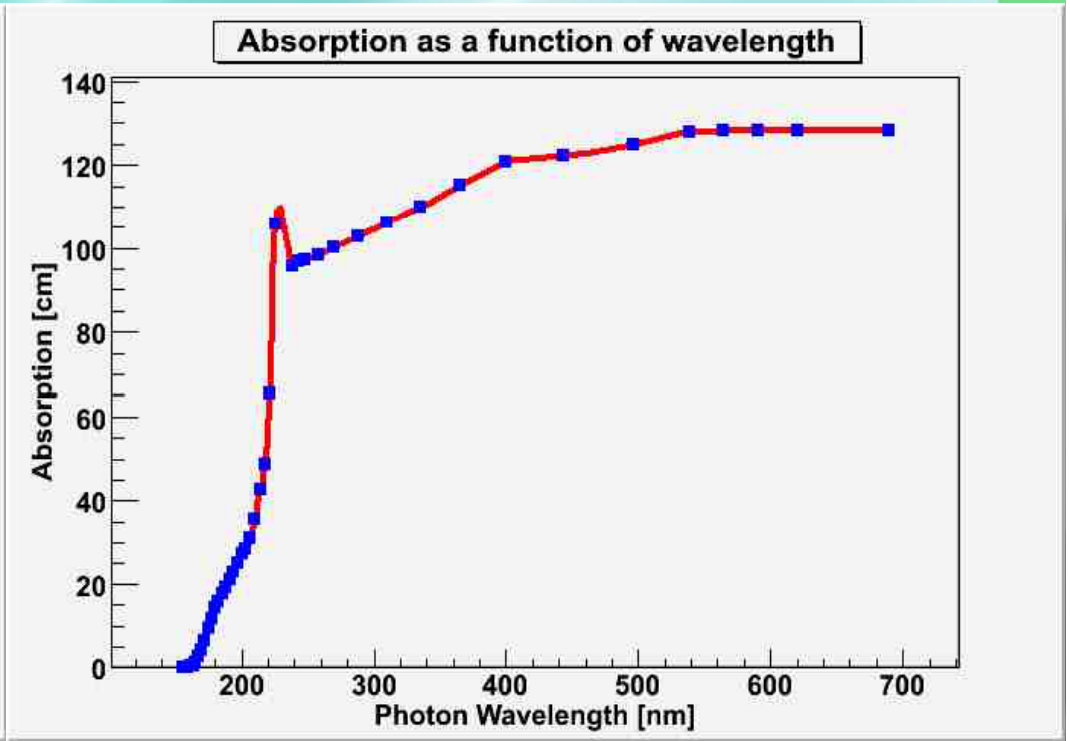


Toolbox

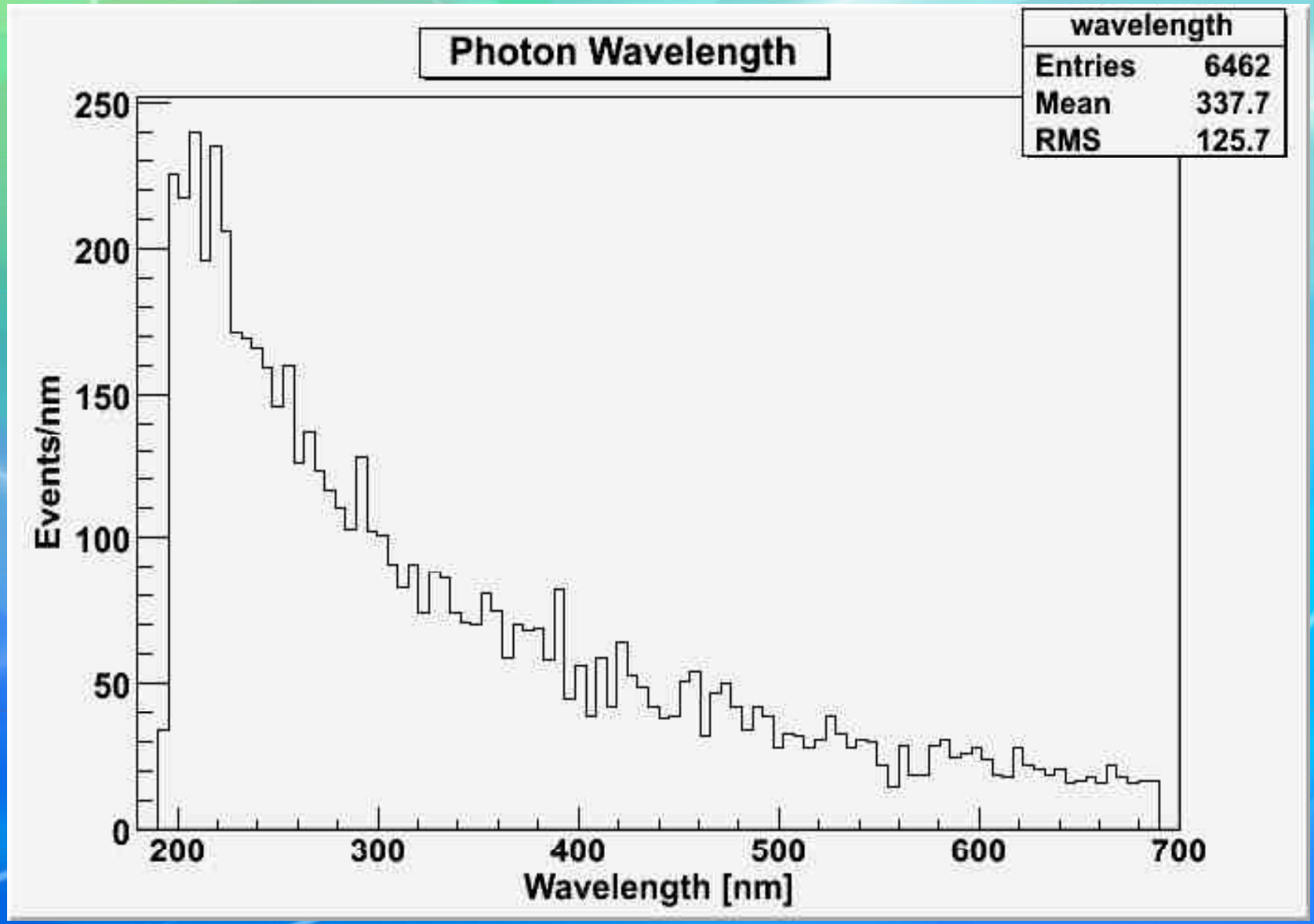
- Simulation Framework= Geant4
- Code Development = Netbeans
- Analysis = Root
- Documentation = CVS

Optical Properties for Quartz

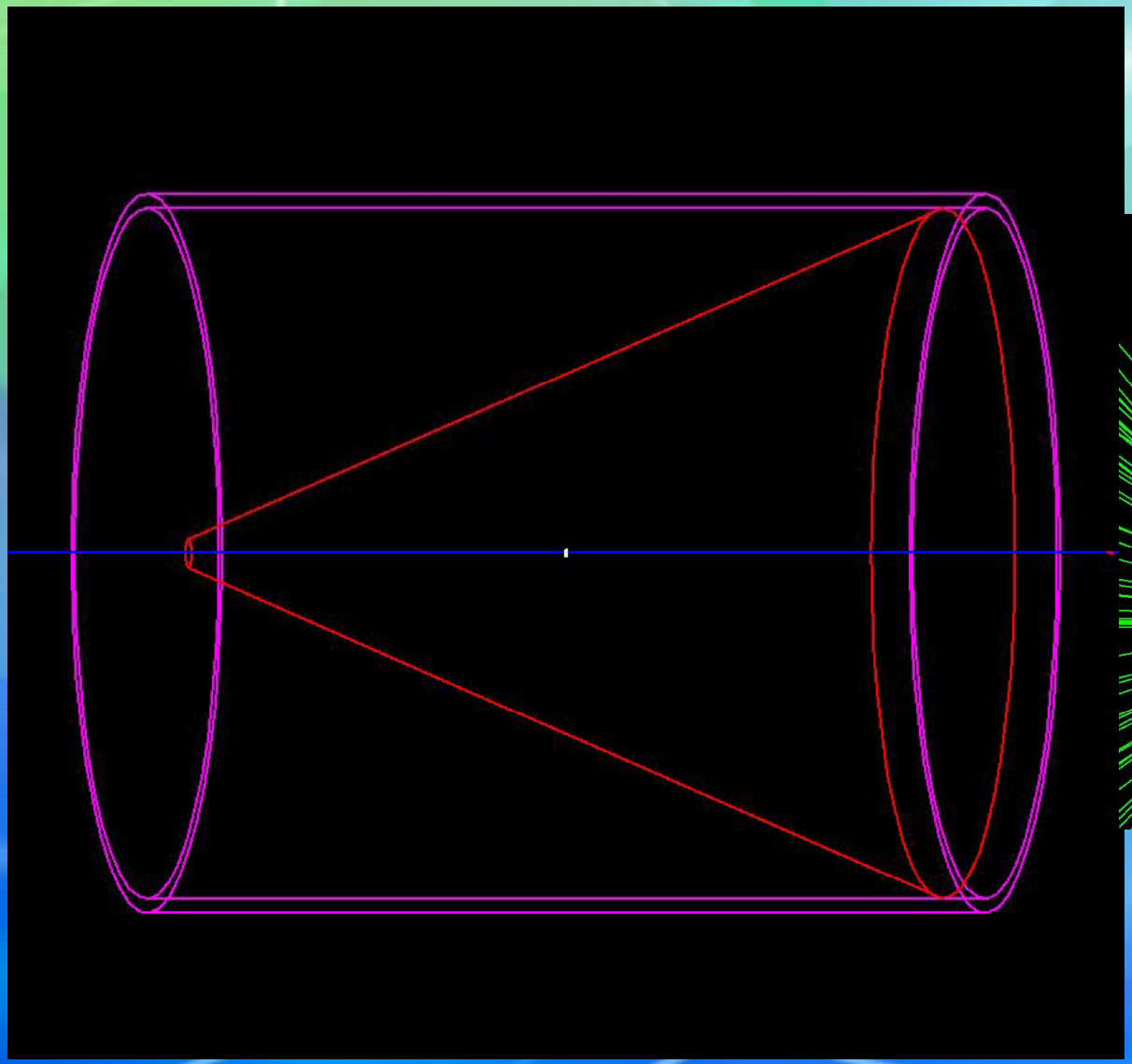


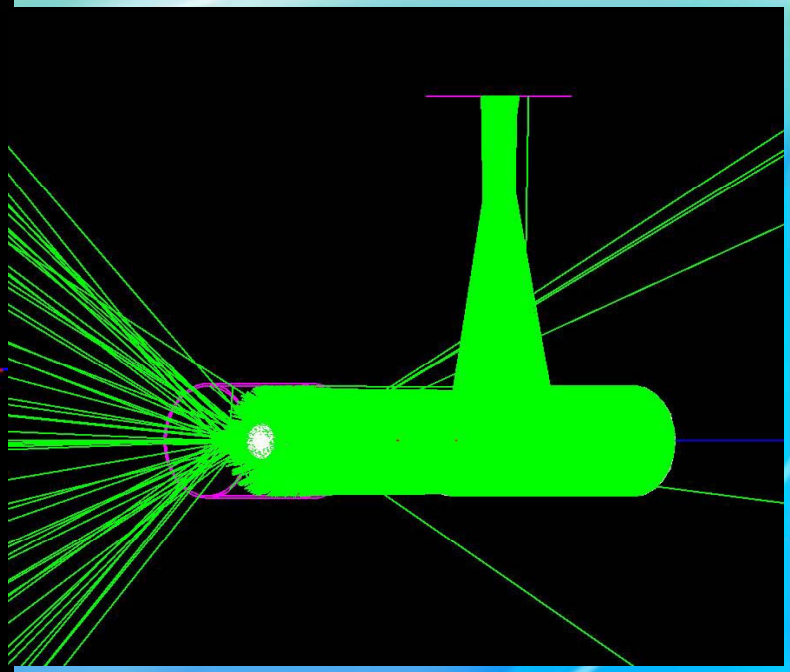


Spectrum of Light Created

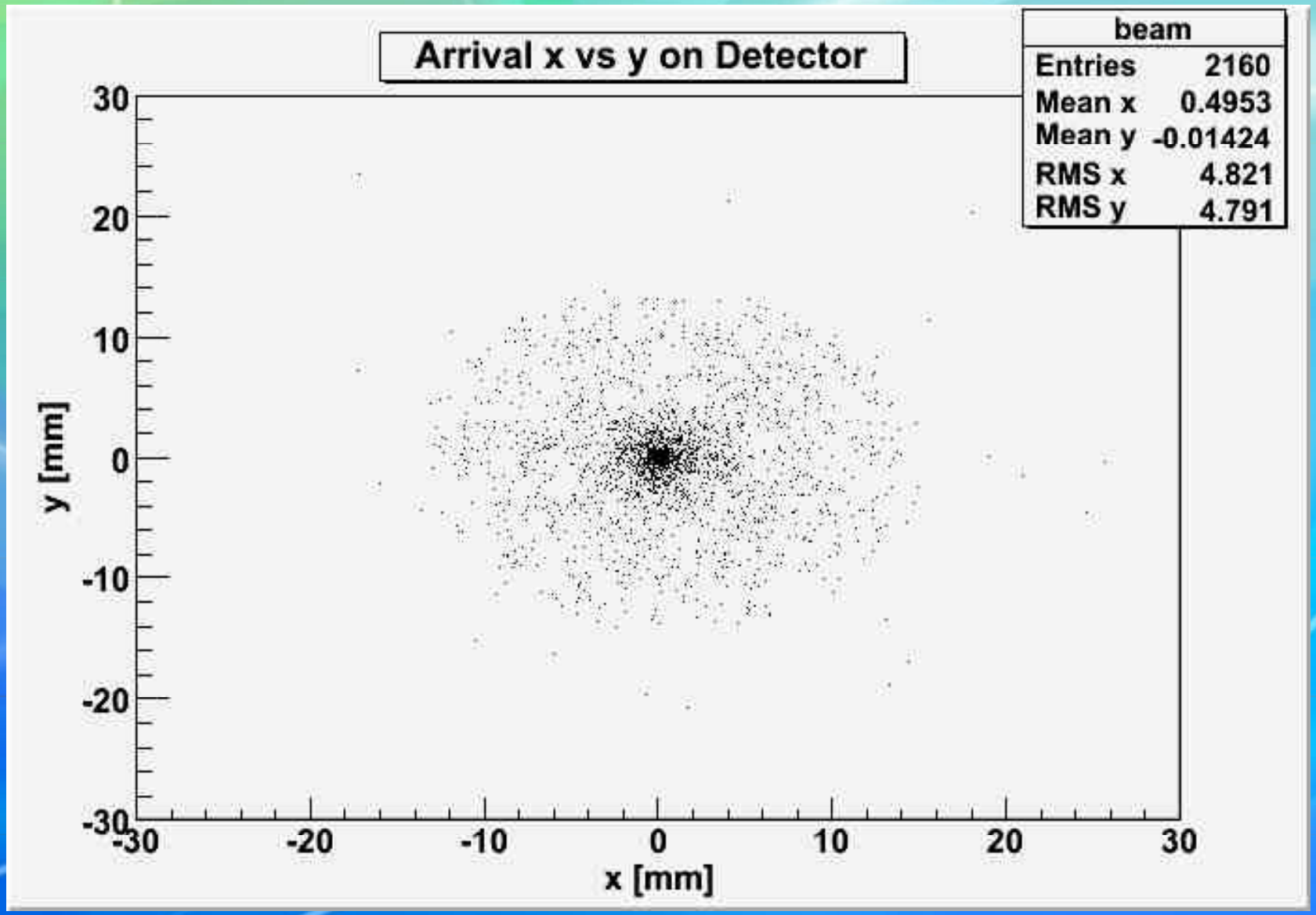


Results using on-axis proton beam

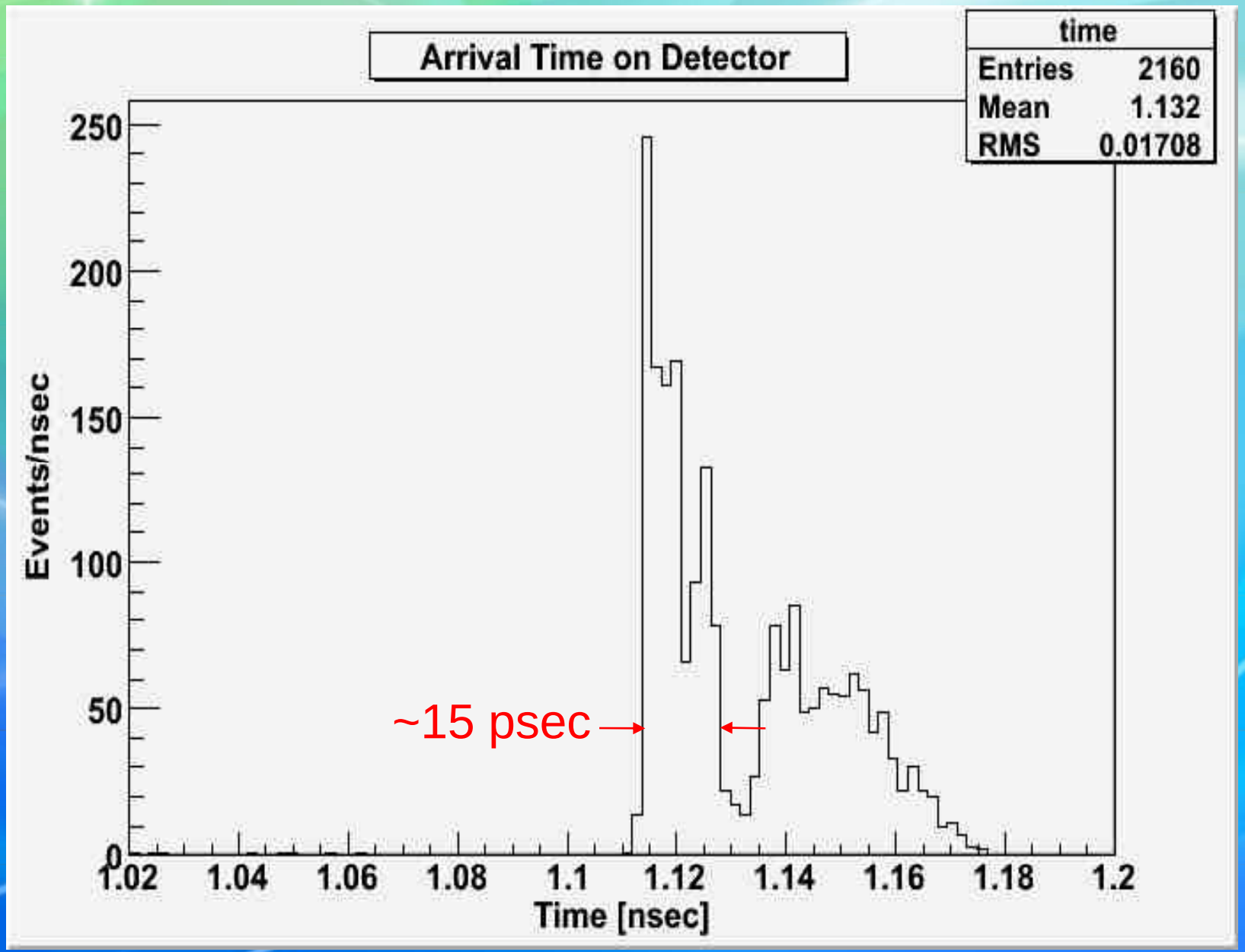




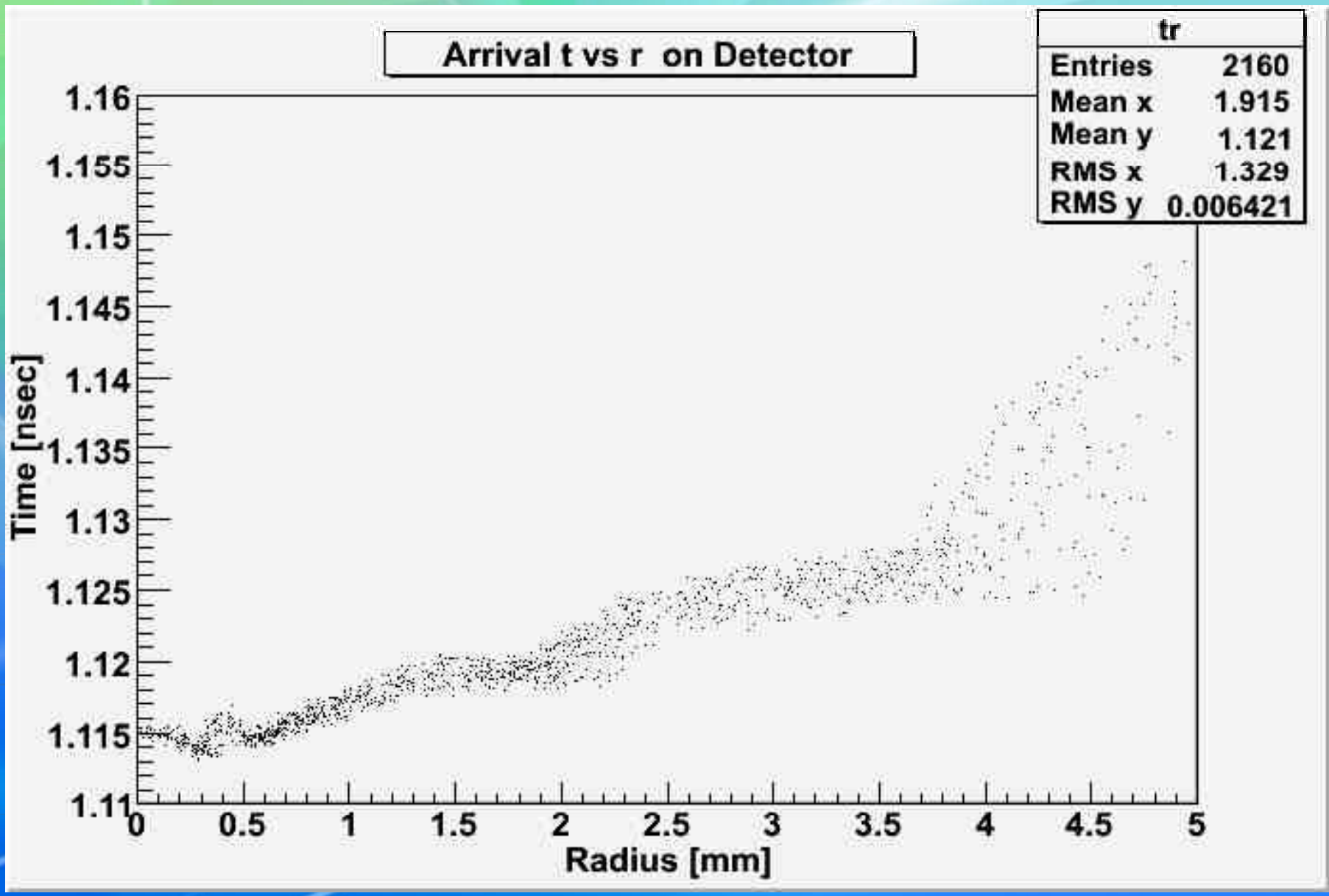
Beam position on Detector



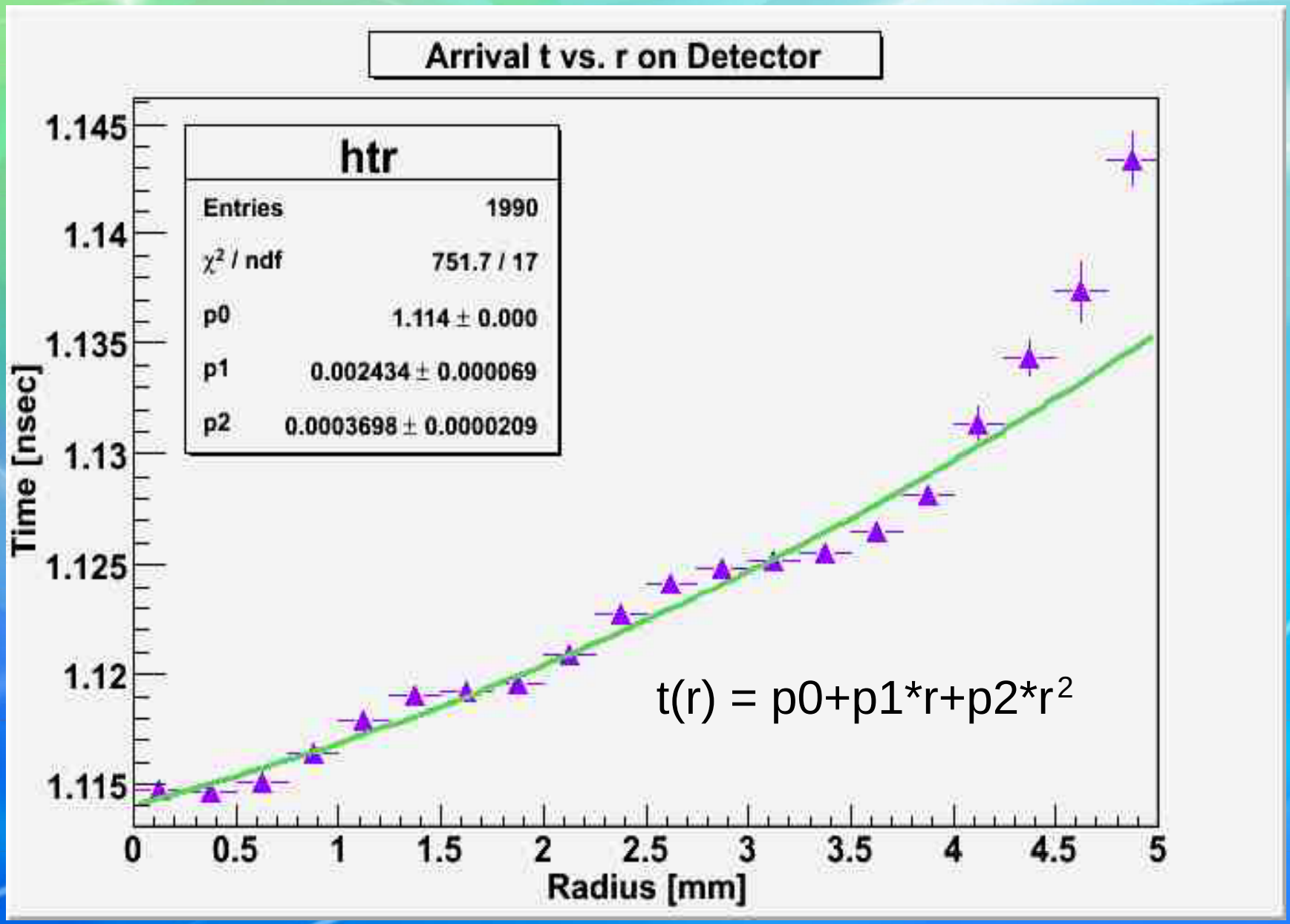
Arrival of Beam on Detector



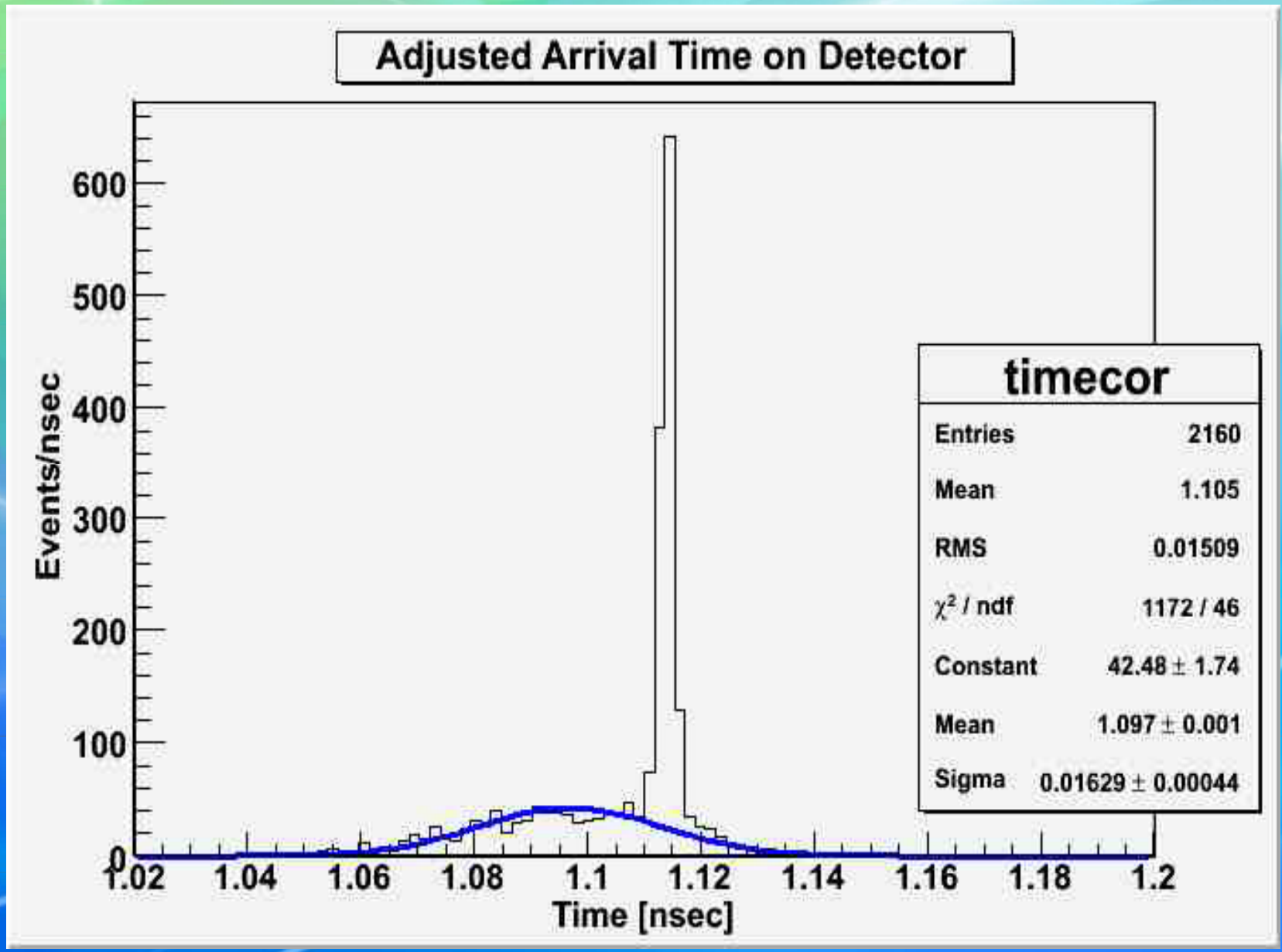
Time as a function of radius



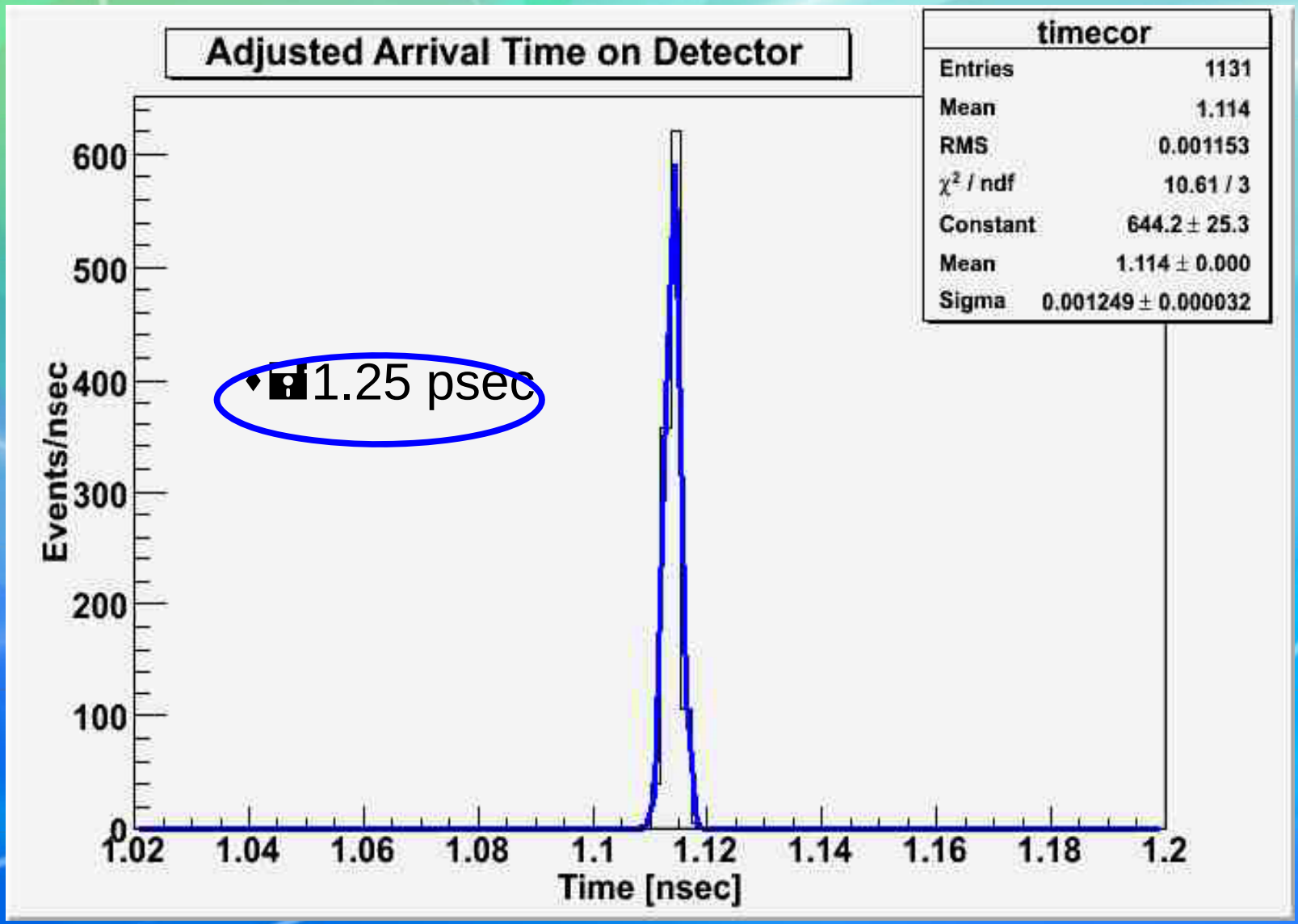
Profile plot w/ fitted quadratic of t(r)



Arrival Time adjusted: t0 = t-p1*r-p2*r²

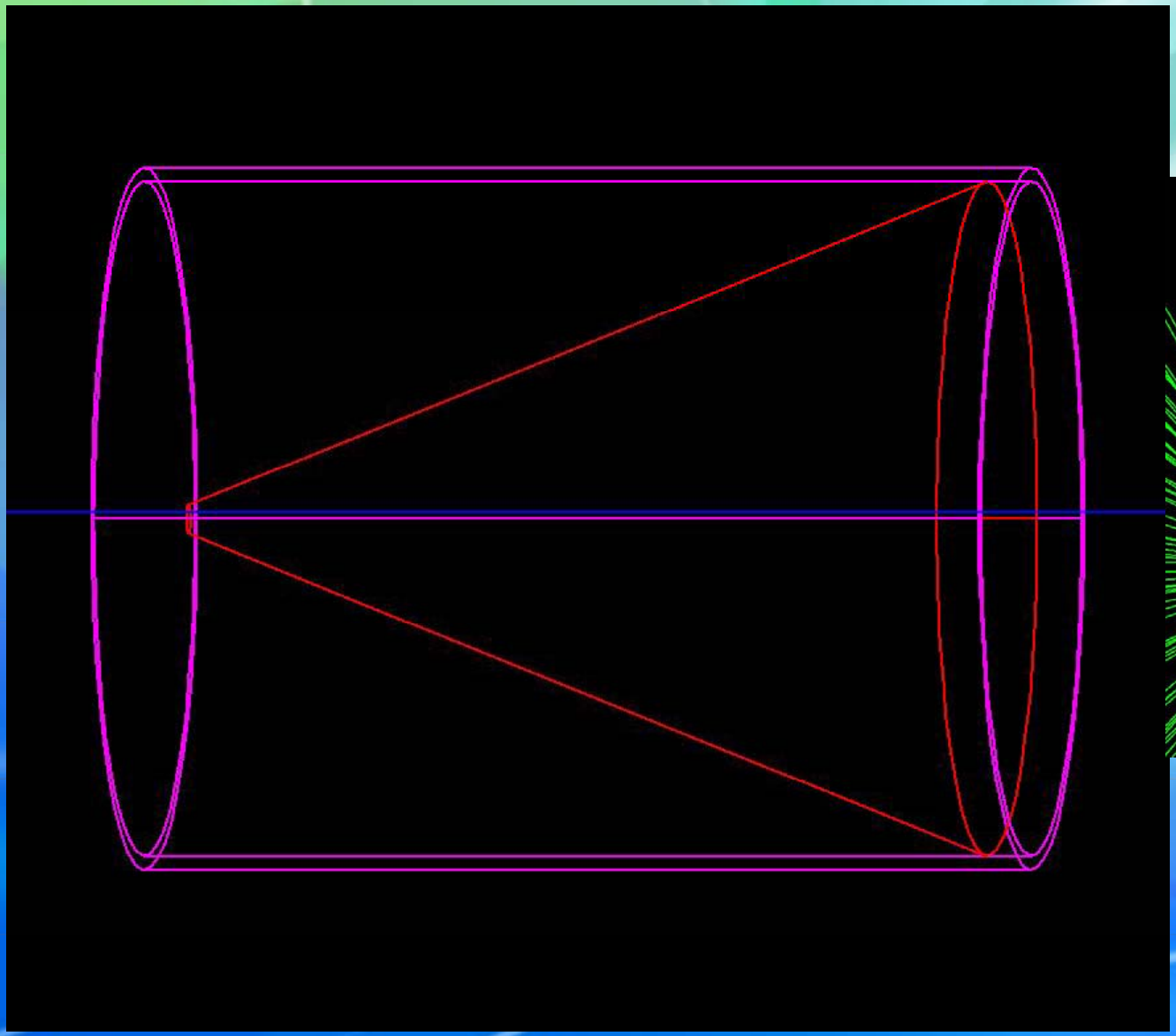


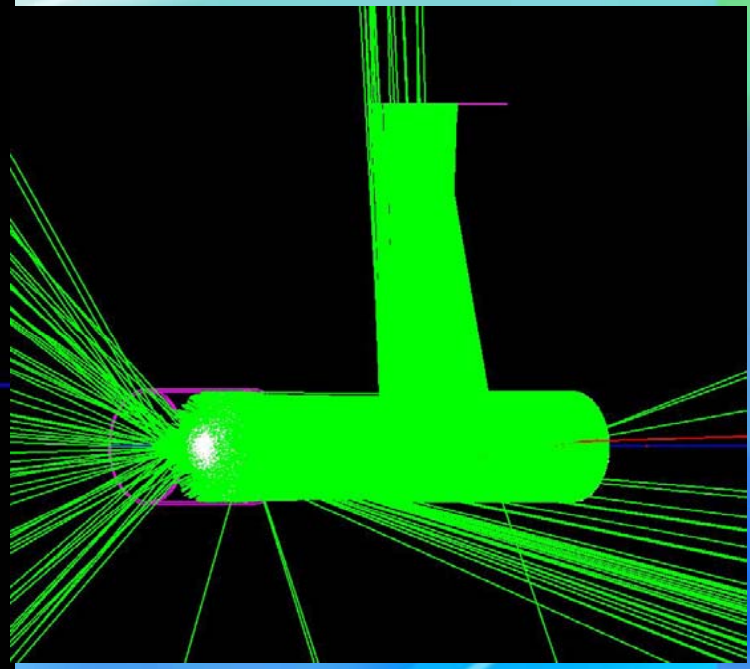
Arrival Time adjusted by t(r), within r=4 mm



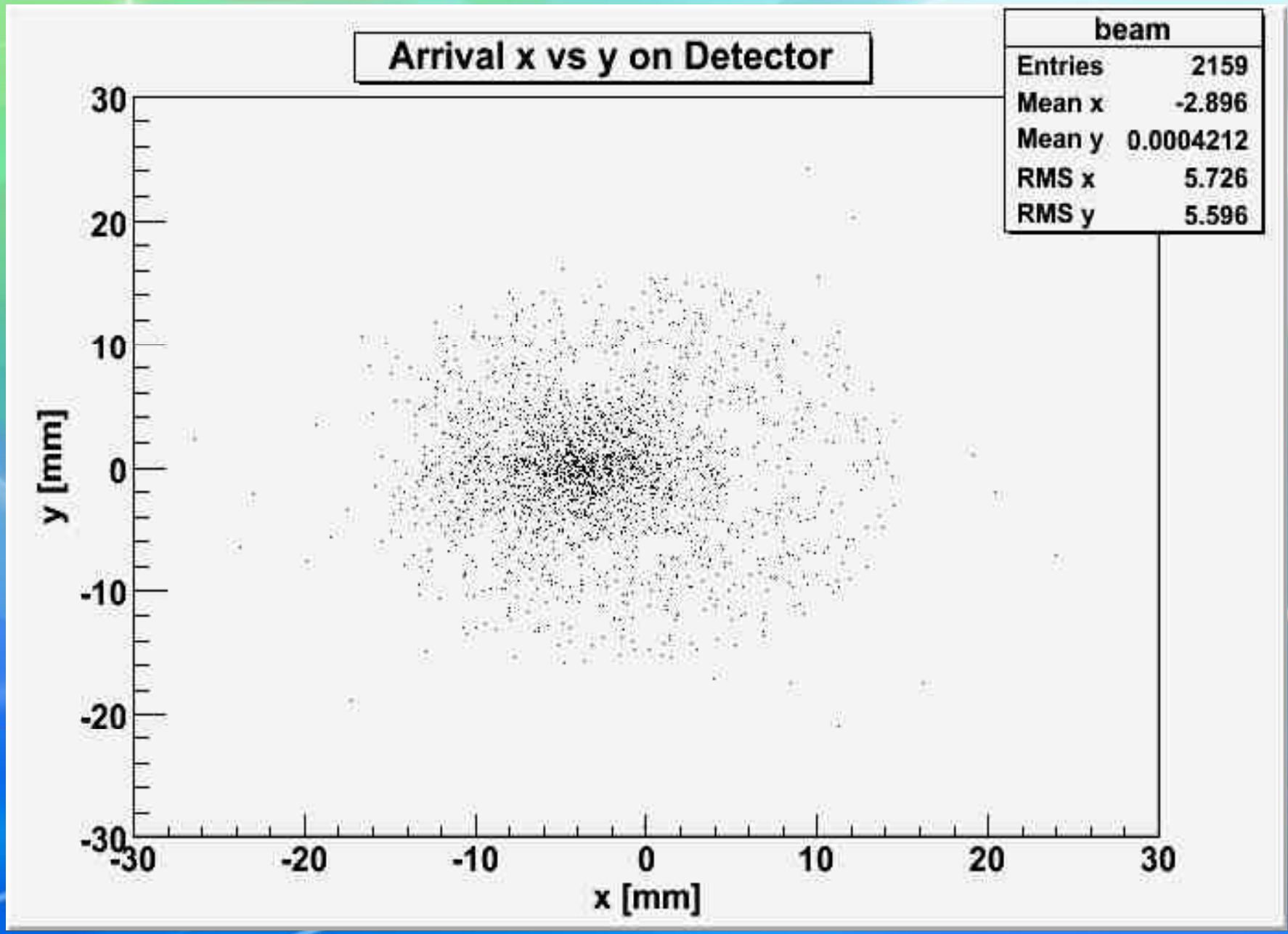
First Results using off-axis beam

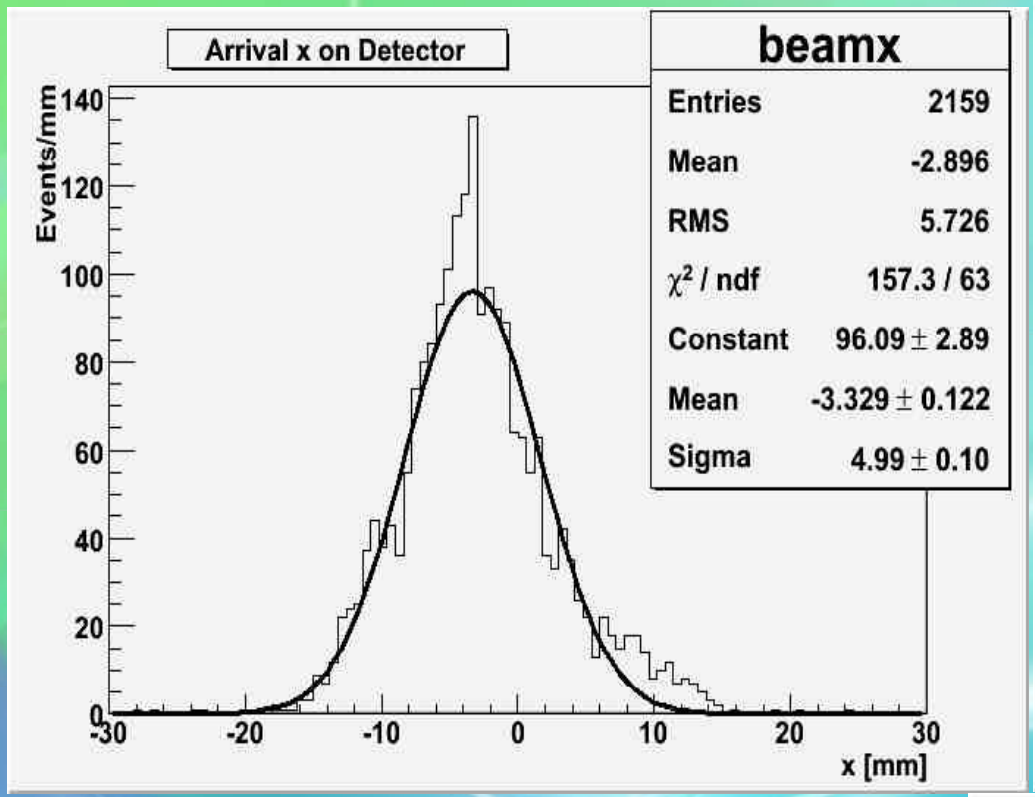
0.5 mm up from origin

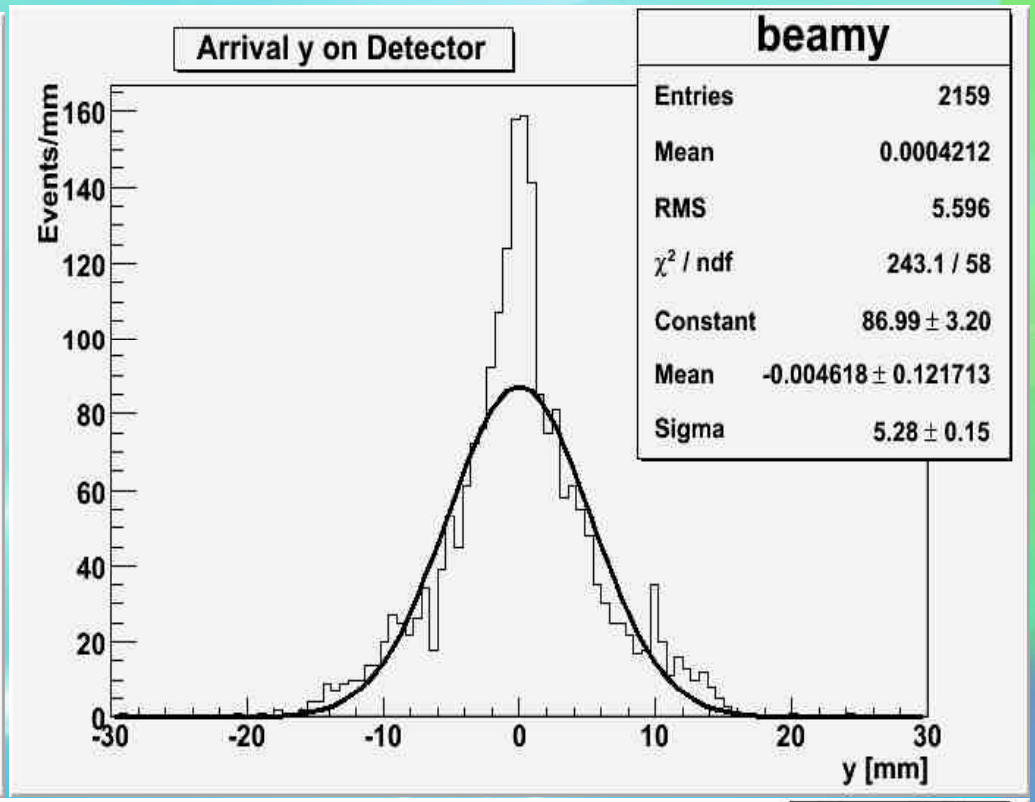




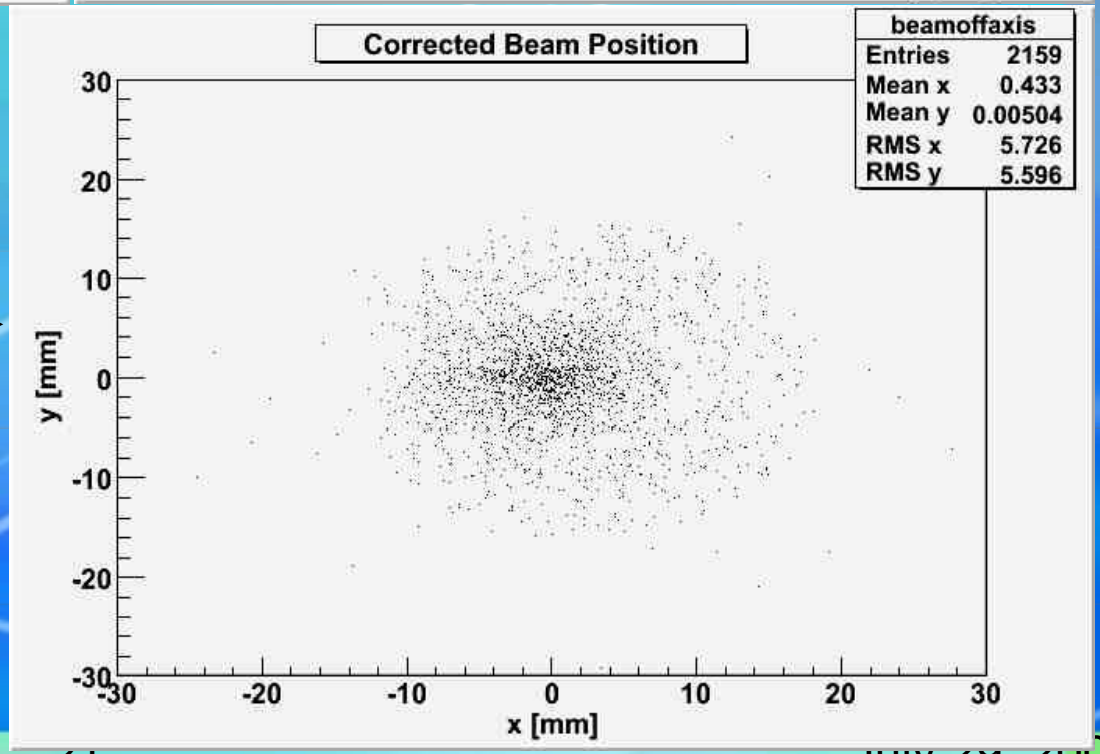
Beam Position on Detector



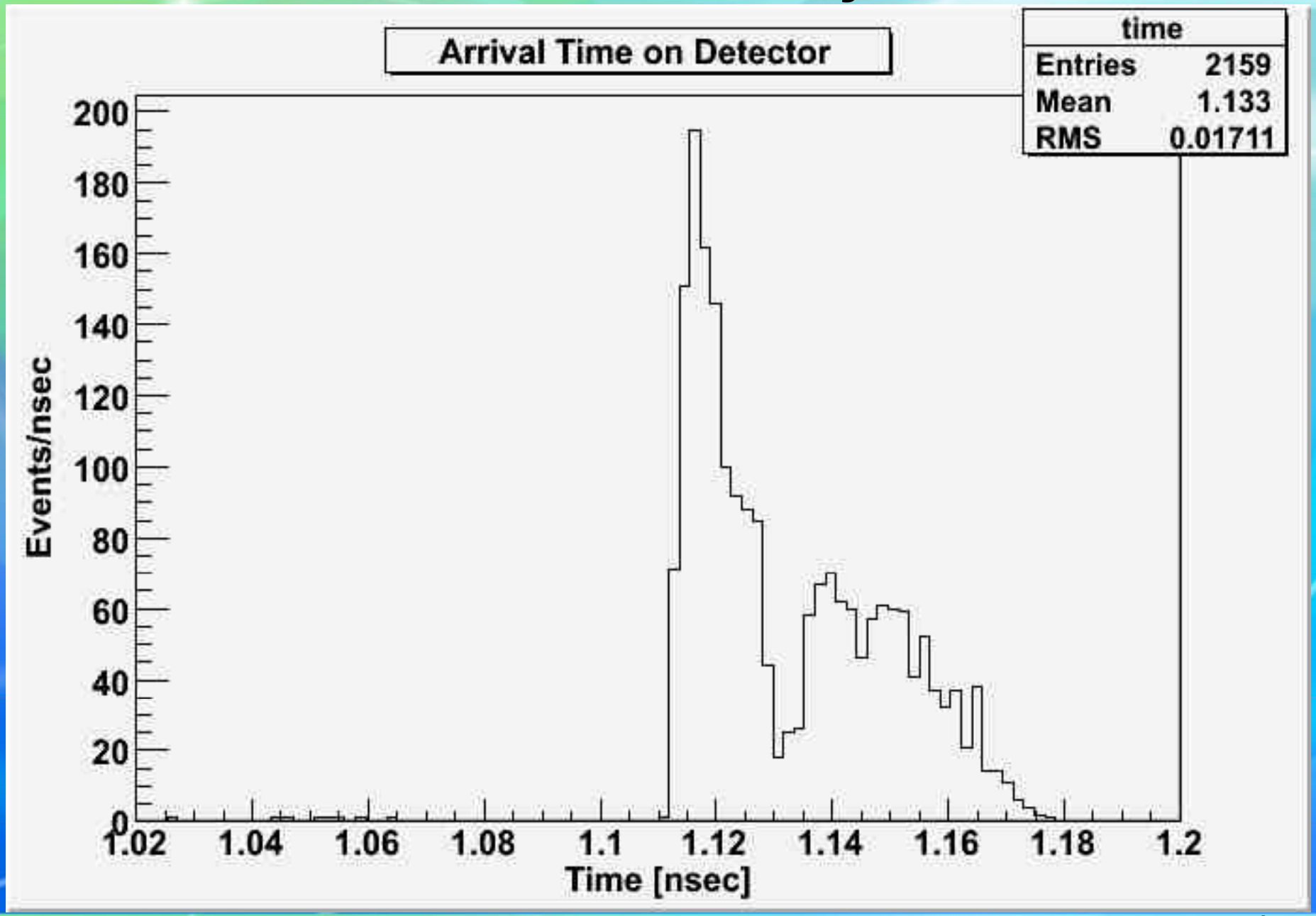




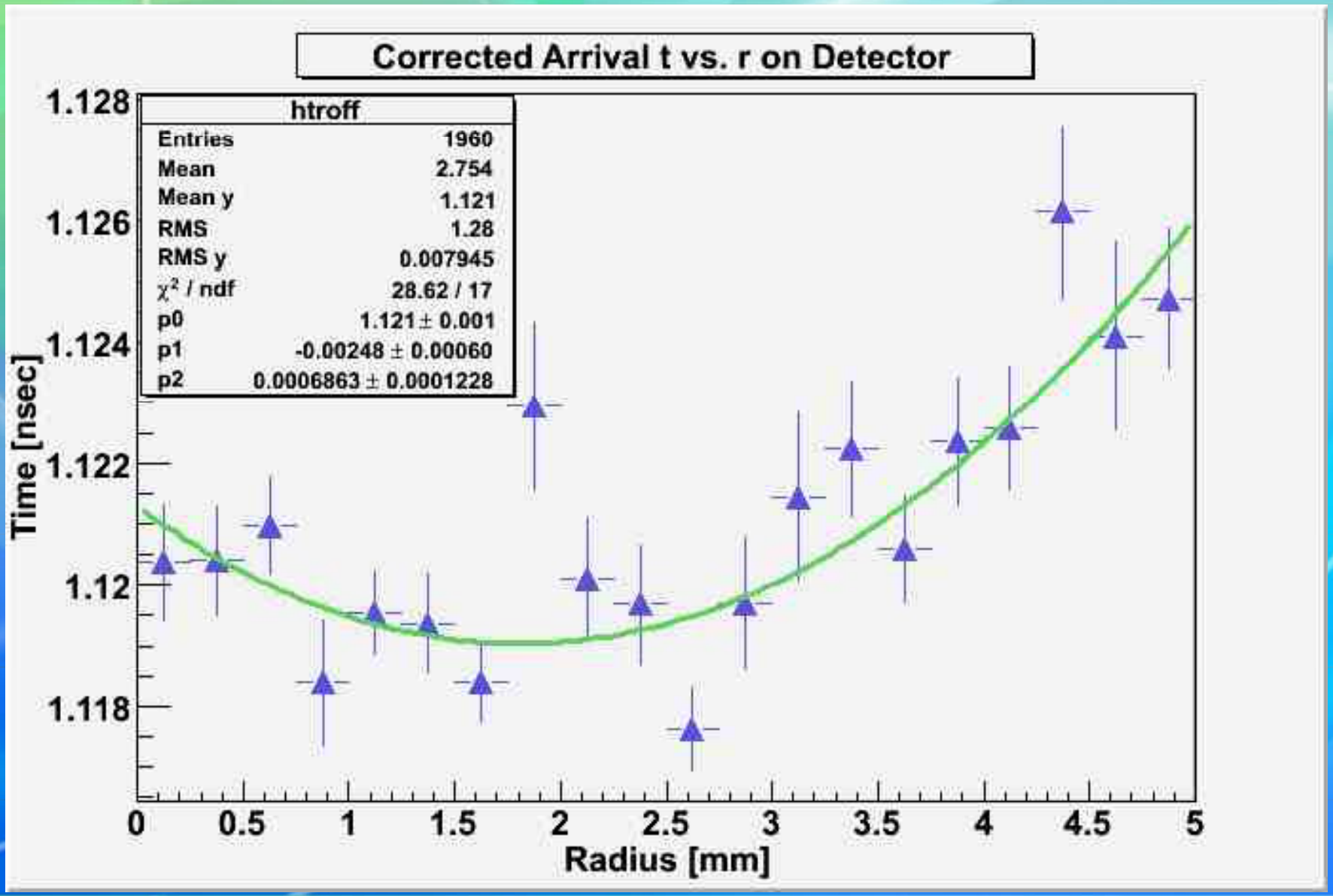
New position = (x,y) - (Gaussian mean of x, Gaussian mean of y)



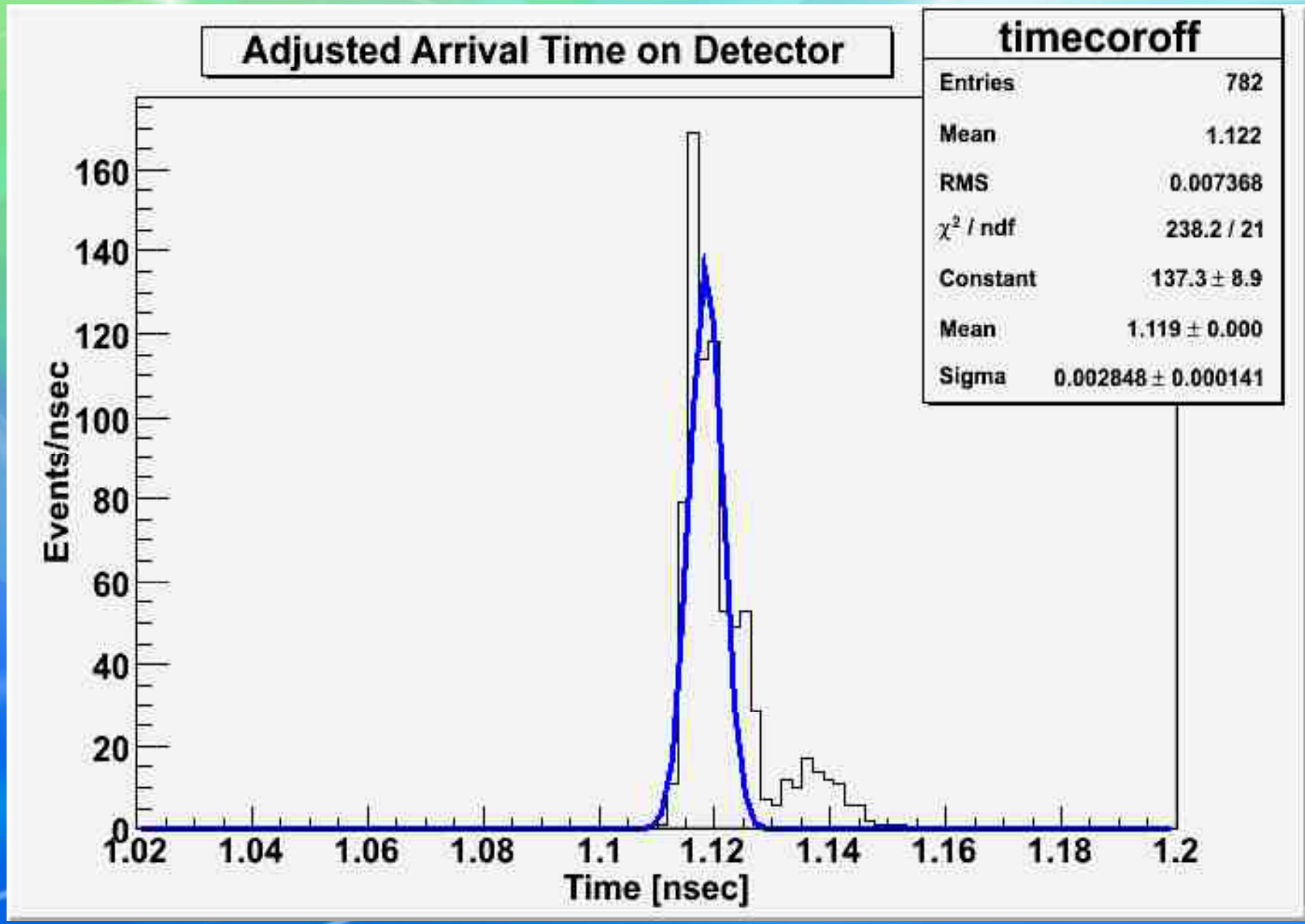
Arrival Time, no adjustments

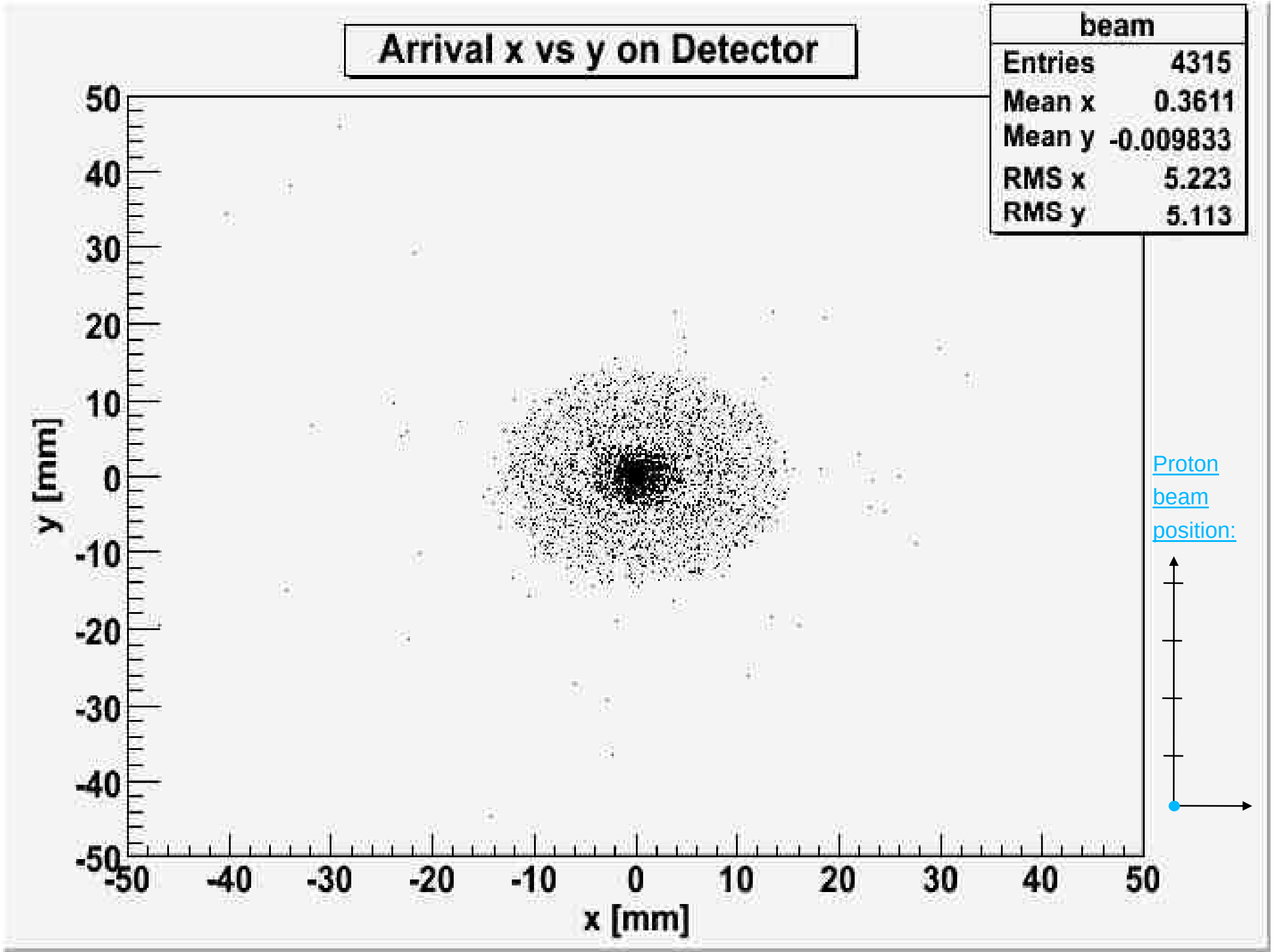


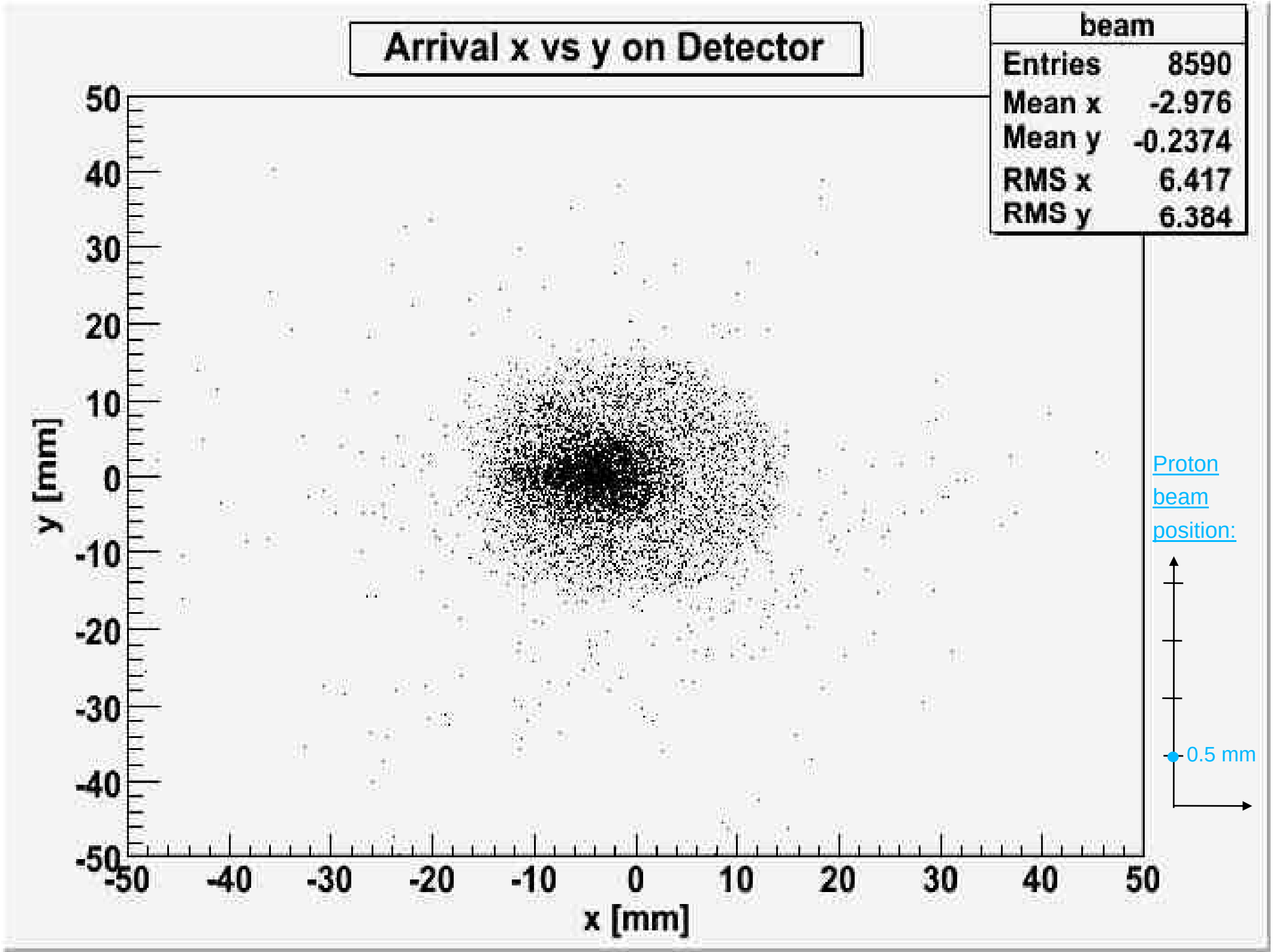
Arrival time as a function of r (radius corrected for beam position)

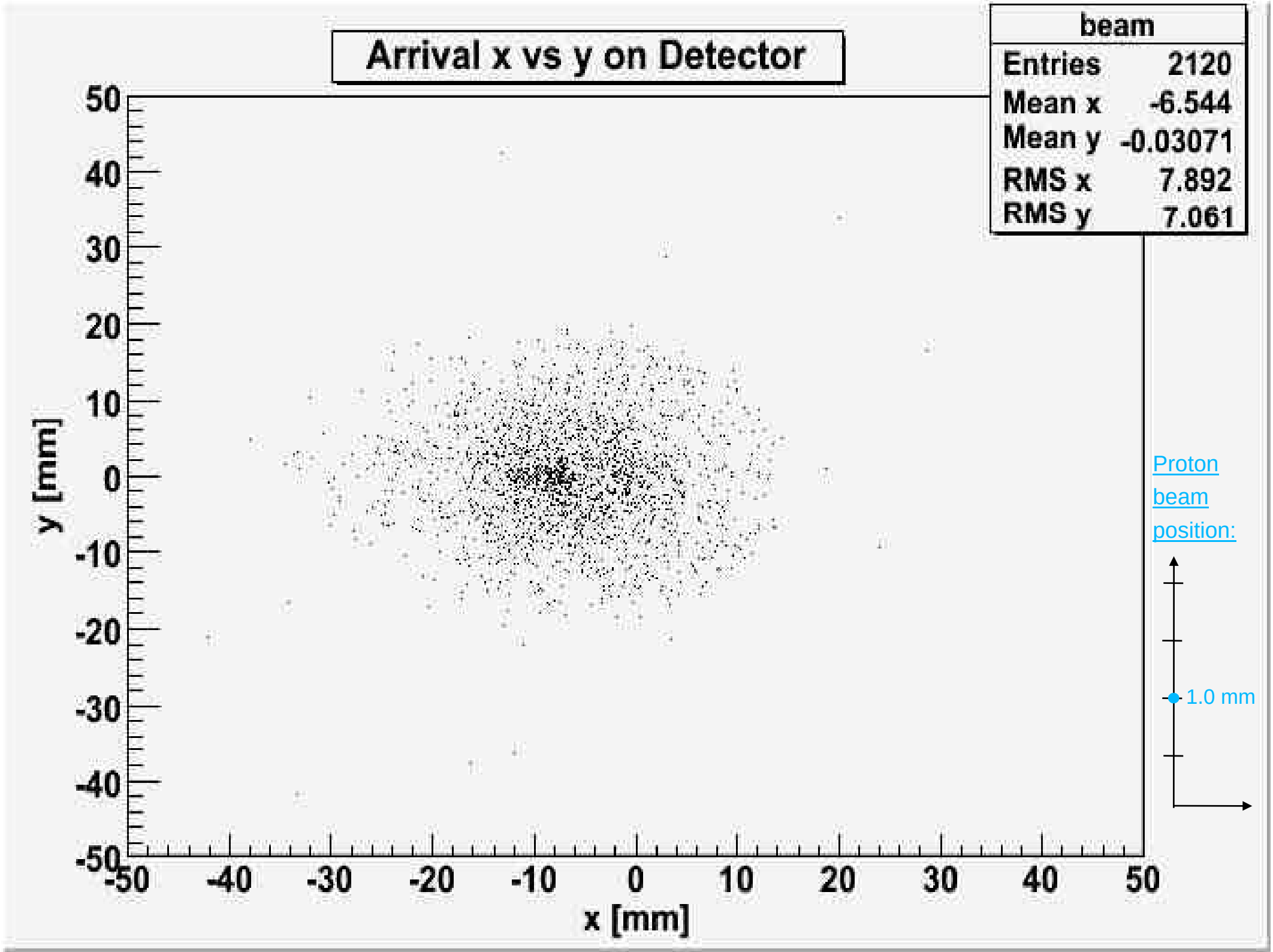


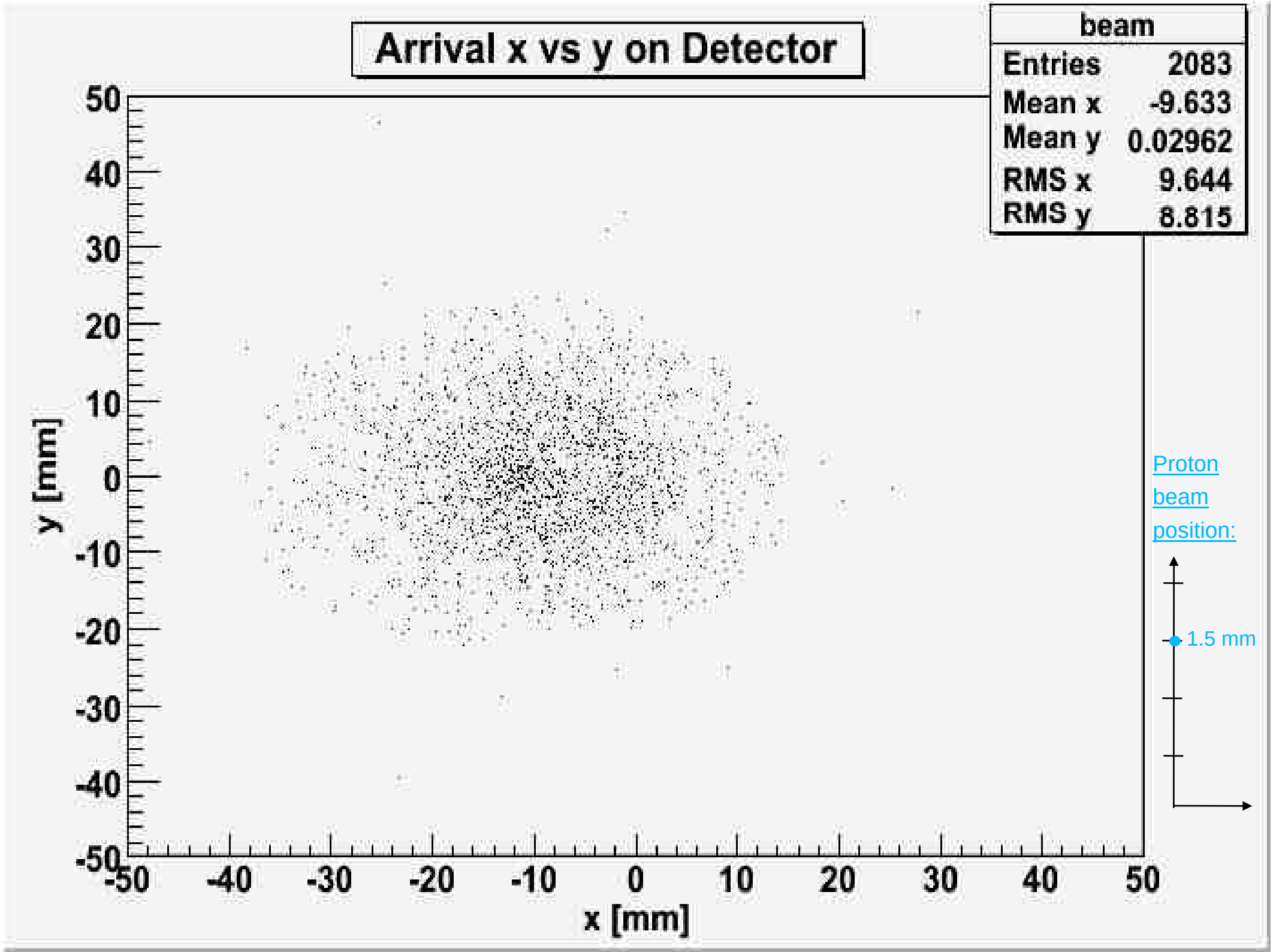
Arrival Time adjusted by t(r)

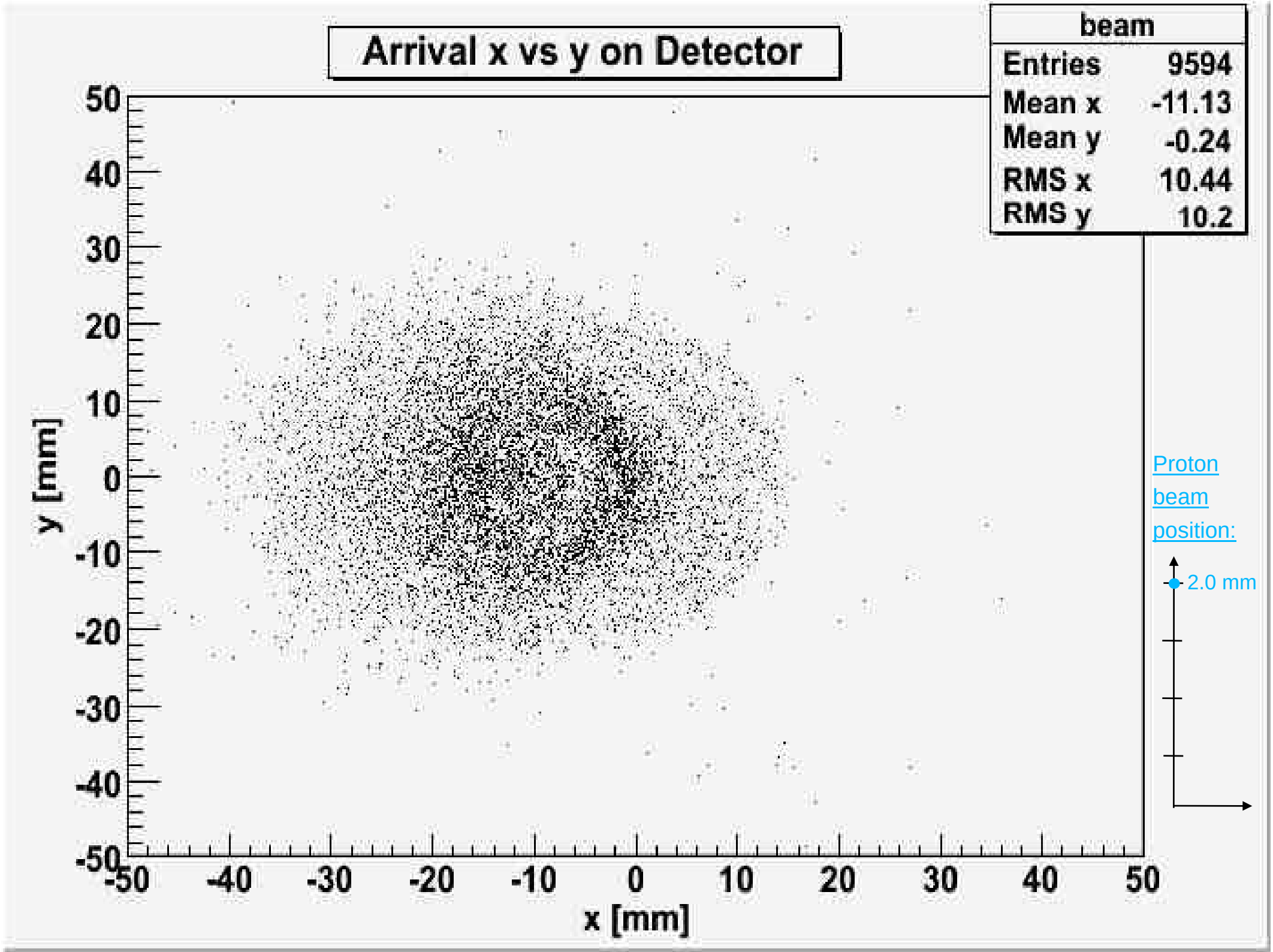



Arrival x vs y on Detector
beam
Entries 4315
Mean x 0.3611
Mean y -0.009833
RMS x 5.223
RMS y 5.113
y [mm]
x [mm]
50
40
30
20
10
0
-10
-20
-30
-40
-50
-50
-40
-30
-20
-10
0
10
20
30
40
50
Proton beam position:


Arrival x vs y on Detector
beam
Entries 8590
Mean x -2.976
Mean y -0.2374
RMS x 6.417
RMS y 6.384
y [mm]
x [mm]
50
40
30
20
10
0
-10
-20
-30
-40
-50
-50
-40
-30
-20
-10
0
10
20
30
40
50
Proton beam position:
0.5 mm


Arrival x vs y on Detector
beam
Entries 2120
Mean x -6.544
Mean y -0.03071
RMS x 7.892
RMS y 7.061
y [mm]
x [mm]
50
40
30
20
10
0
-10
-20
-30
-40
-50
-50
-40
-30
-20
-10
0
10
20
30
40
50
Proton beam position:
1.0 mm


Arrival x vs y on Detector
beam
Entries 2083
Mean x -9.633
Mean y 0.02962
RMS x 9.644
RMS y 8.815
y [mm]
x [mm]
50
40
30
20
10
0
-10
-20
-30
-40
-50
-50
-40
-30
-20
-10
0
10
20
30
40
50
Proton beam position:
1.5 mm


Arrival x vs y on Detector
beam
Entries 9594
Mean x -11.13
Mean y -0.24
RMS x 10.44
RMS y 10.2
y [mm]
x [mm]
50
40
30
20
10
0
-10
-20
-30
-40
-50
-50
-40
-30
-20
-10
0
10
20
30
40
50
Proton beam position:
2.0 mm

In Conclusion

- Quartztof is sensitive to shifts in the beam
  - On-axis protons behave ideally, but more effort must be taken to understand or to correct off-axis behavior
- Verify that half-cone simulations behave as expected

Thanks to...

- Hans Wenzel (Fermilab)
- Mike Albrow (Fermilab)
- Adam Para (Fermilab)
- George Kattawar (Texas A&M University)