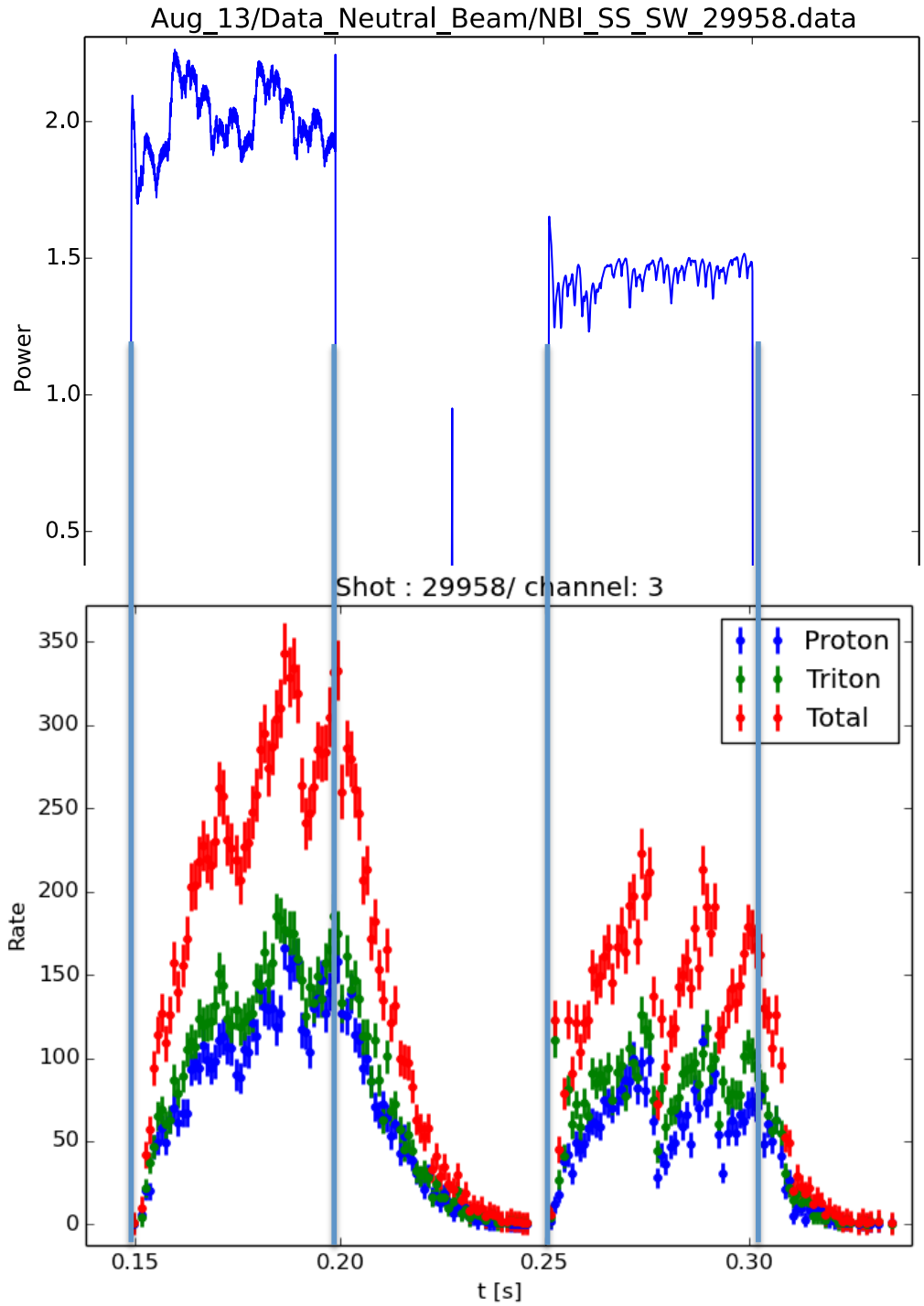
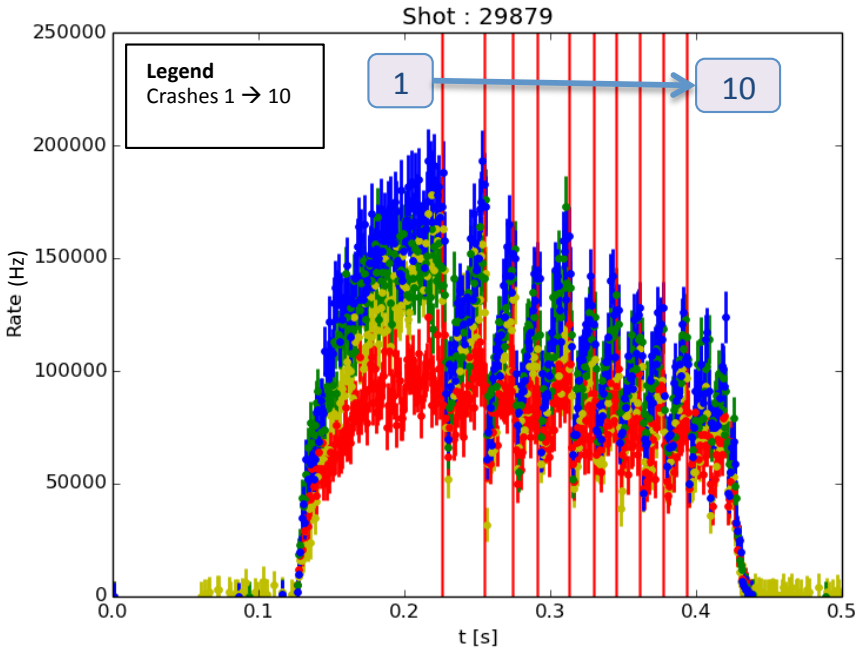
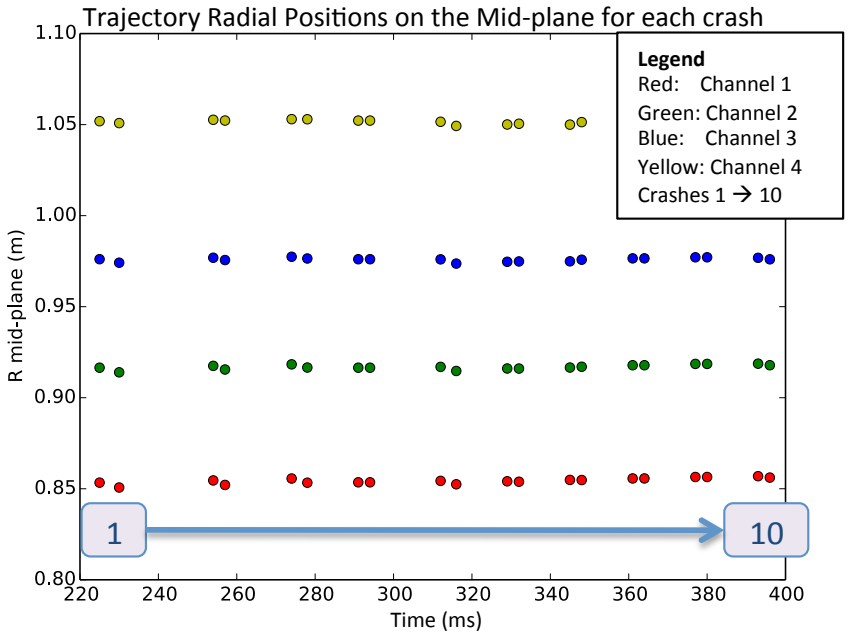
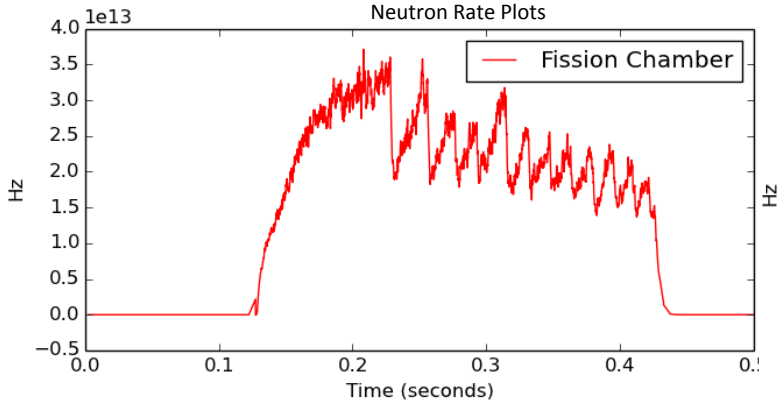

Aug_13/Data_Neutral_Beam/NBI_SS_SW_29958.data
Power
2.0
1.5
1.0
0.5
Shot : 29958/ channel: 3
Proton
Triton
Total
Rate
350
300
250
200
150
100
50
0
0.15
0.20
0.25
0.30
t [s]

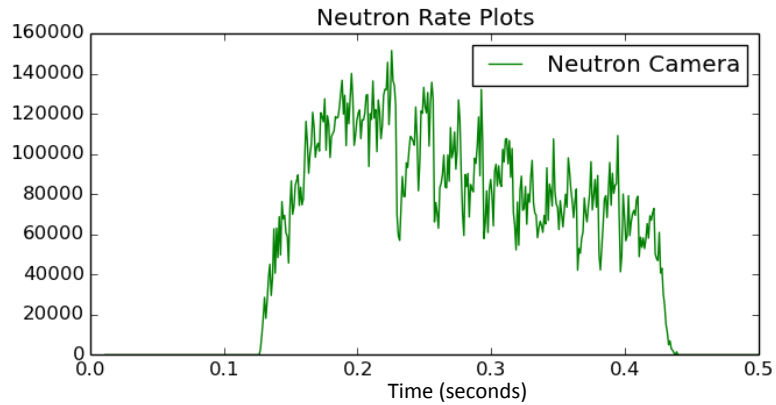
Sawtooth Scenario



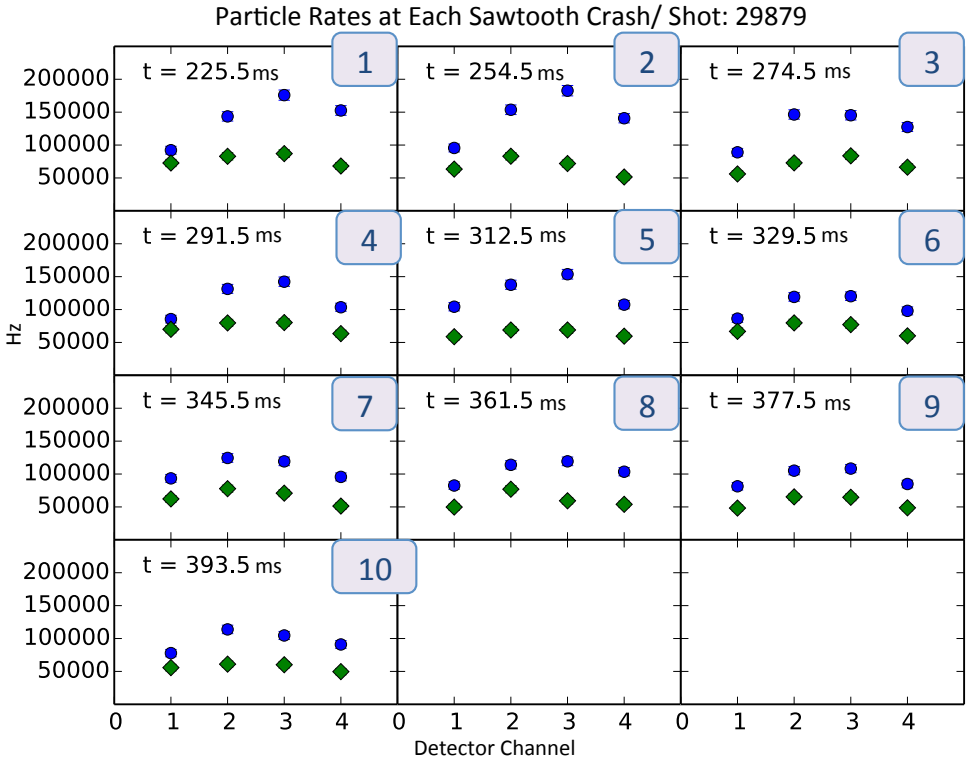


- The PD sawtooth crash rate plot is shown in the above left image. In the above right image, the mid-plane radial position before and after each crash is plotted.



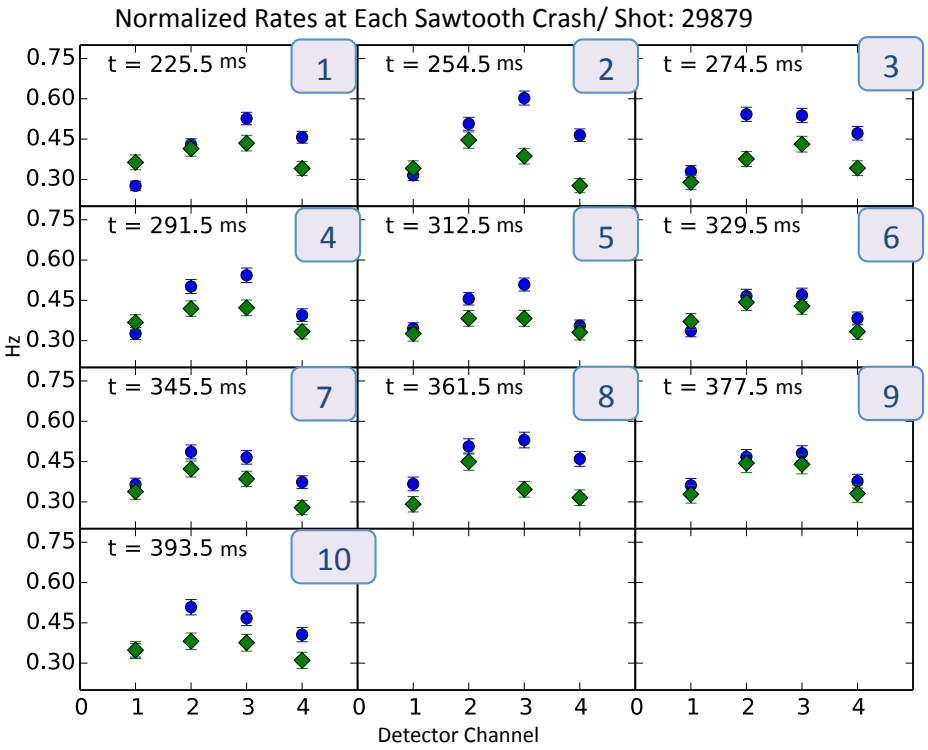


Results: Sawtooth Scenario



Before crash
After crash

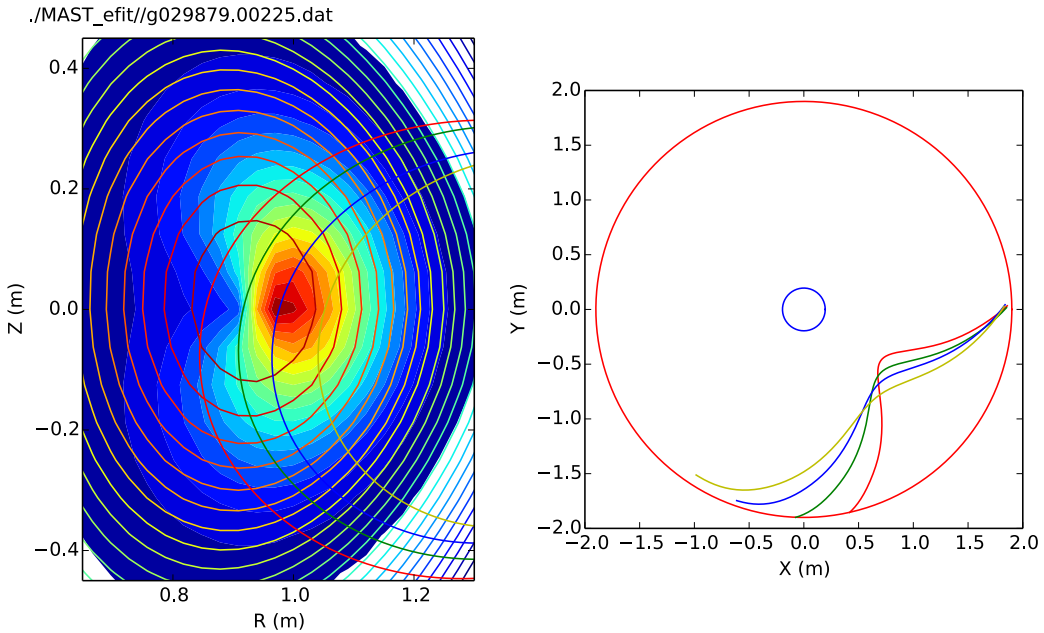
Normalized to Fission Chamber

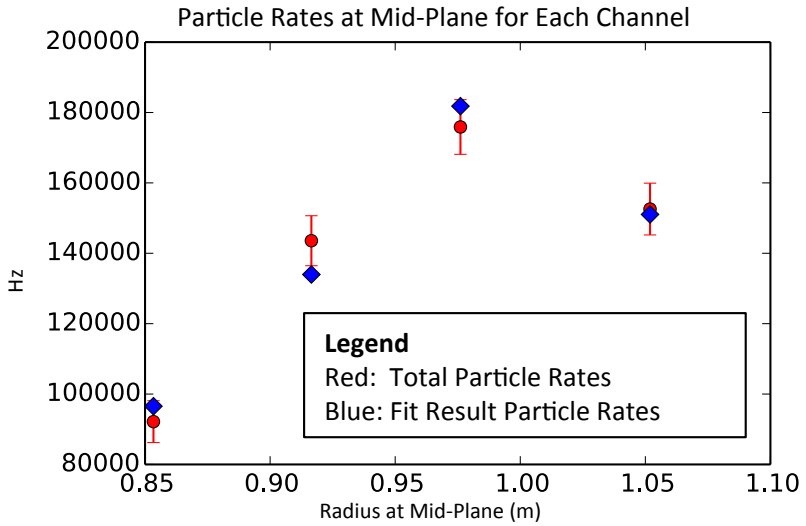


Before crash
After crash

- Combining repeat shots difficult
- Planned: combined analysis PD and neutron camera

Results: Emission Profile 1 Before

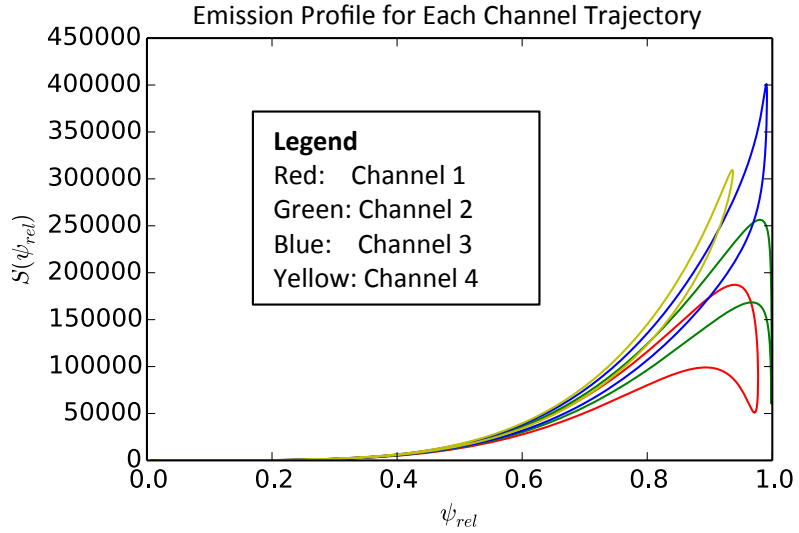




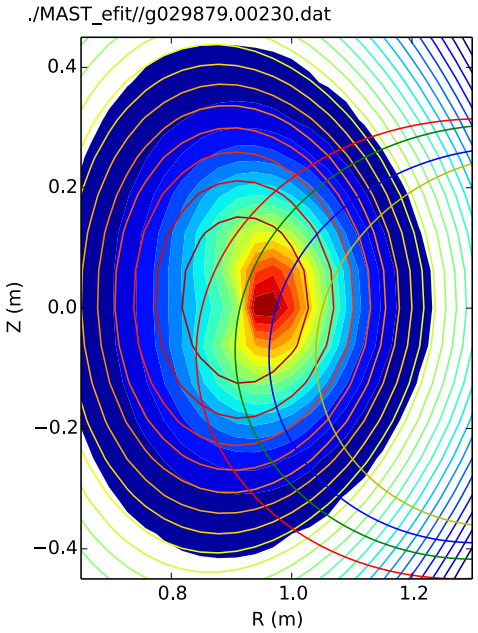
Reconstructed emission profile (particle yield) model function:

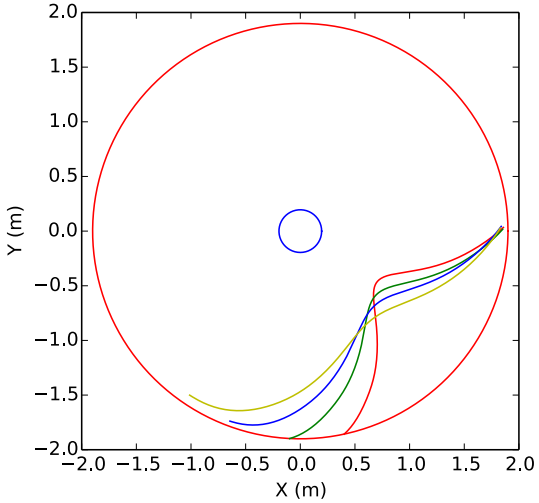
$$S(r, z, \psi_{rel}) = \alpha {\psi_{rel}}^{\lambda}(1 + Acos\theta)$$

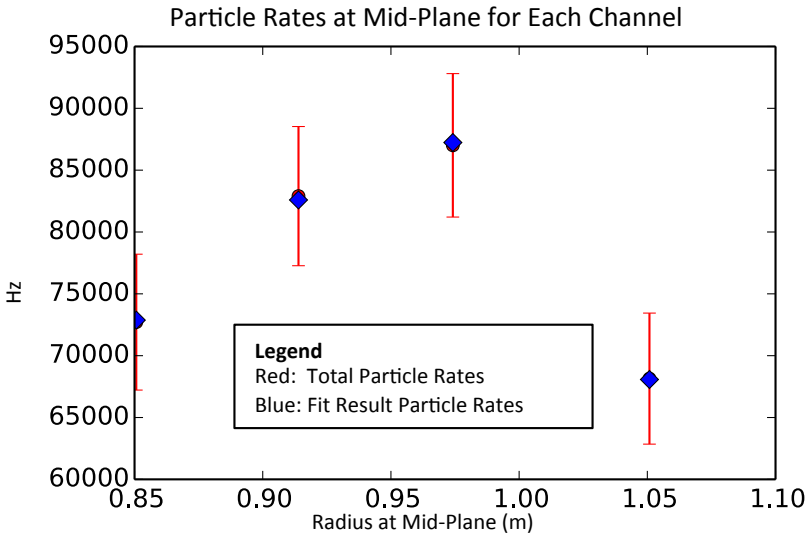
S is integrated along particle orbits and the integral is fitted to the observed rate taking the detector acceptance into account.



Results: Emission Profile 1 After

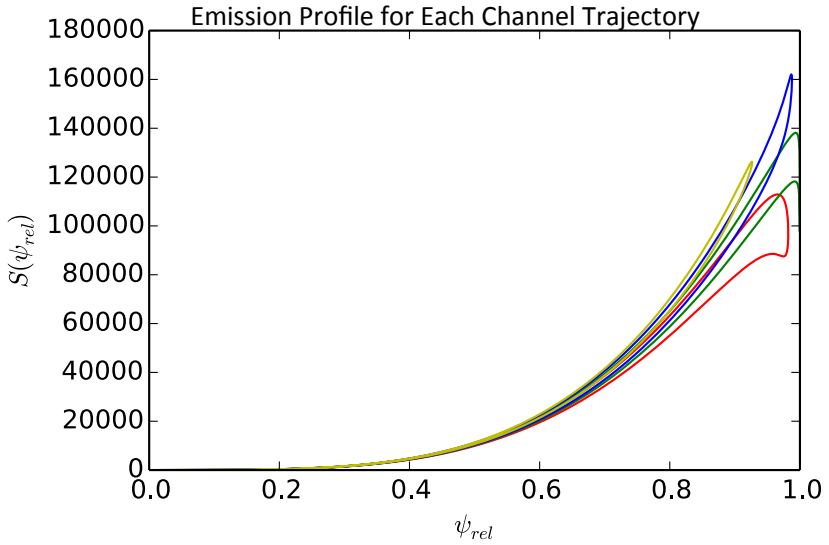




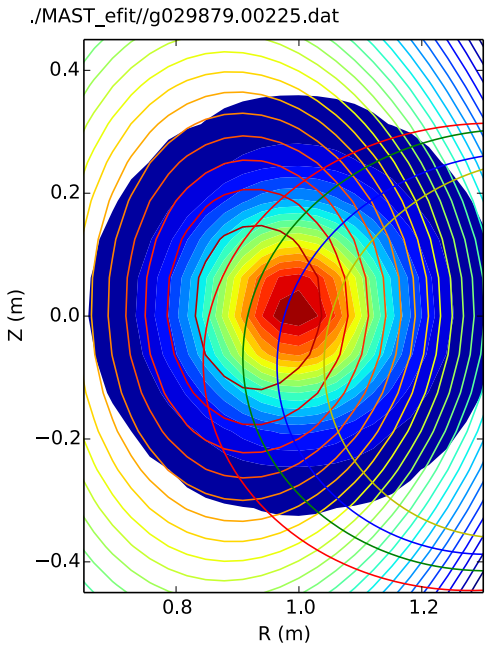


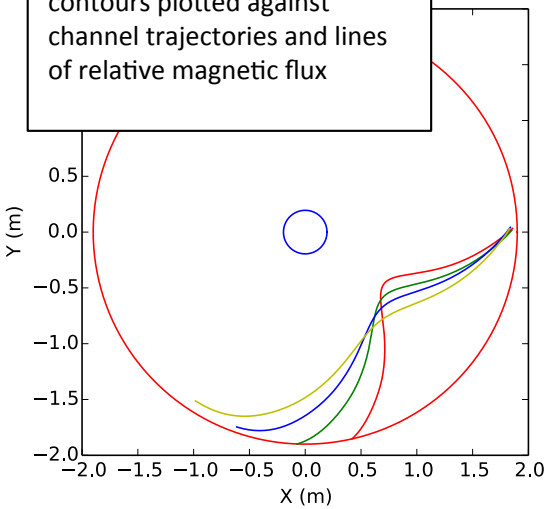
- S not constant on the flux surfaces
- Profile seems to get wider after crash

- Profile has a strong model dependence because there are only 4 channels.

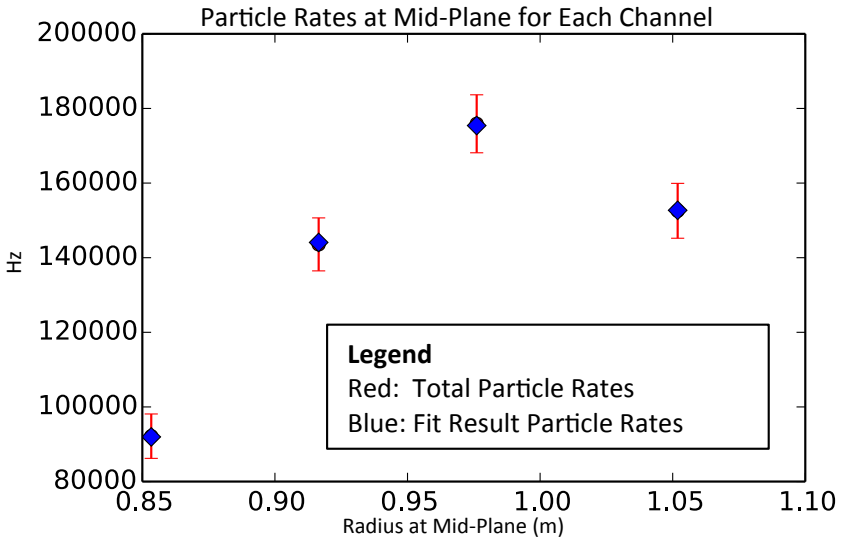


Results: Emission Profile 2 Before



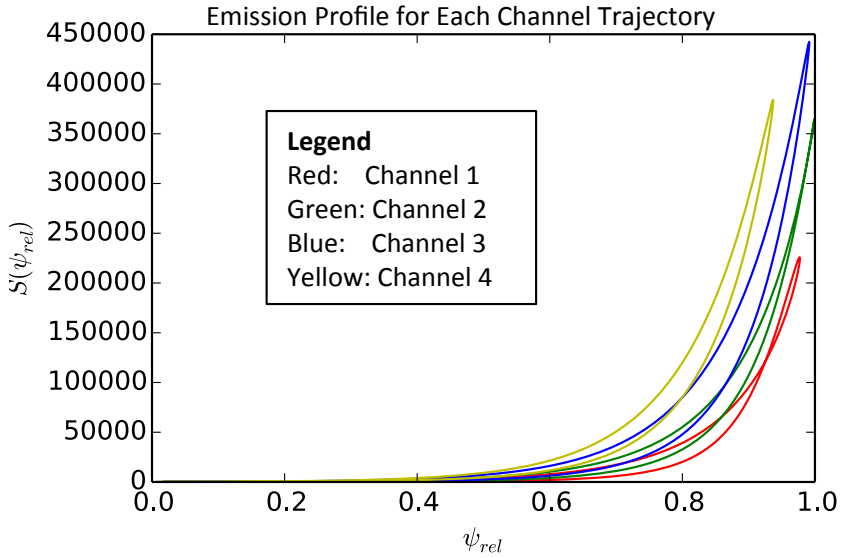


To the left: Particle emission contours plotted against channel trajectories and lines of relative magnetic flux

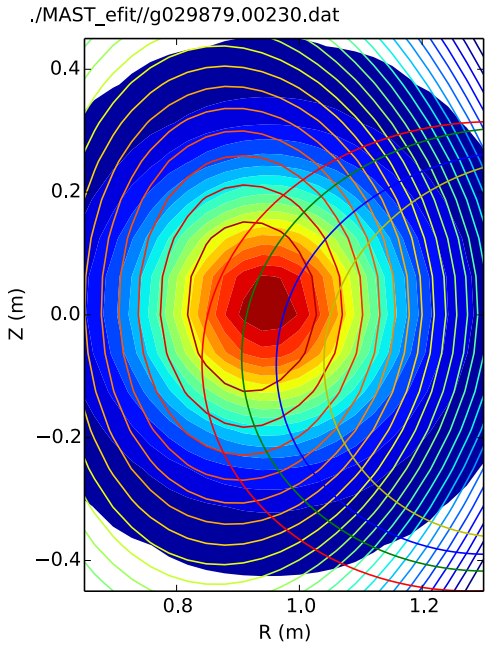


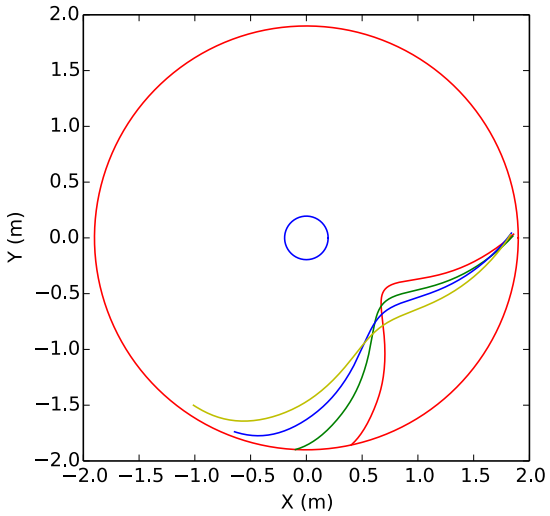
Reconstructed emission profile model function (Gaussian):

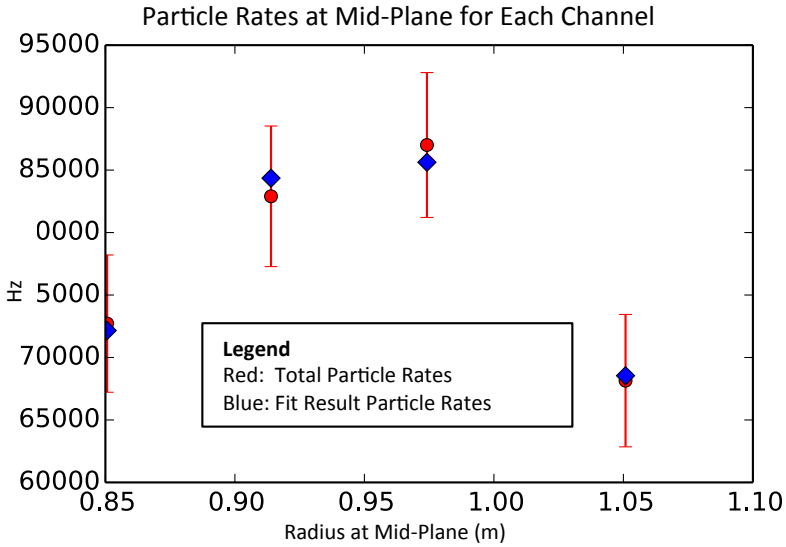
$$S_g(r,z) = Ae^{-\frac{((r-r_0)^2+z^2)}{\sigma^2}}$$



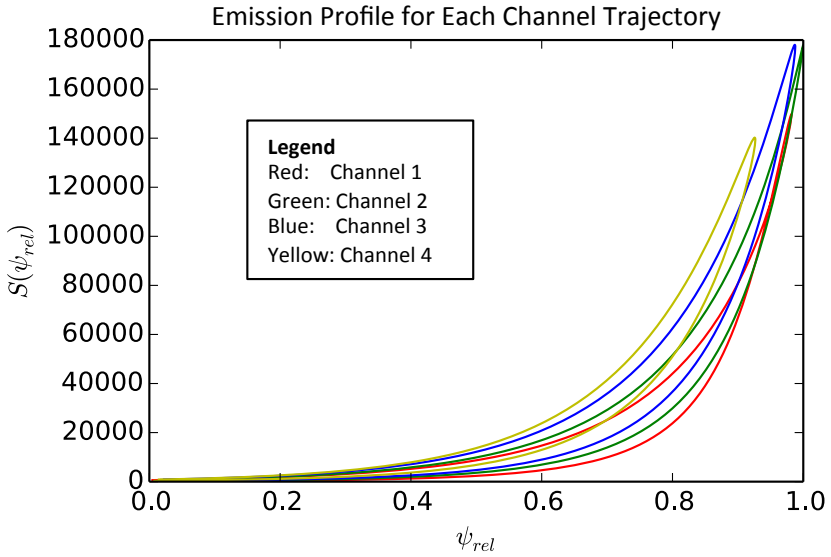
Results: Emission Profile 2 After



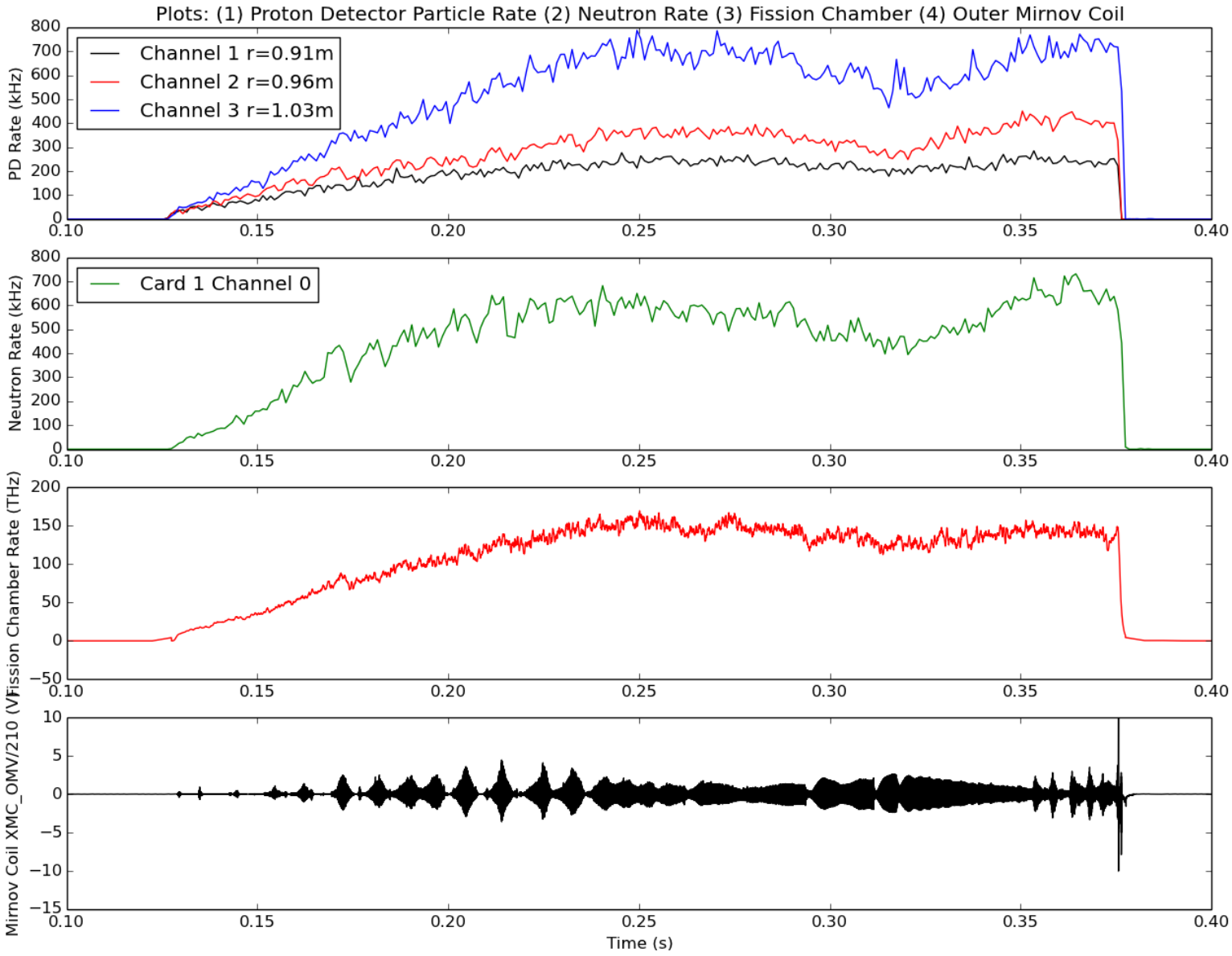


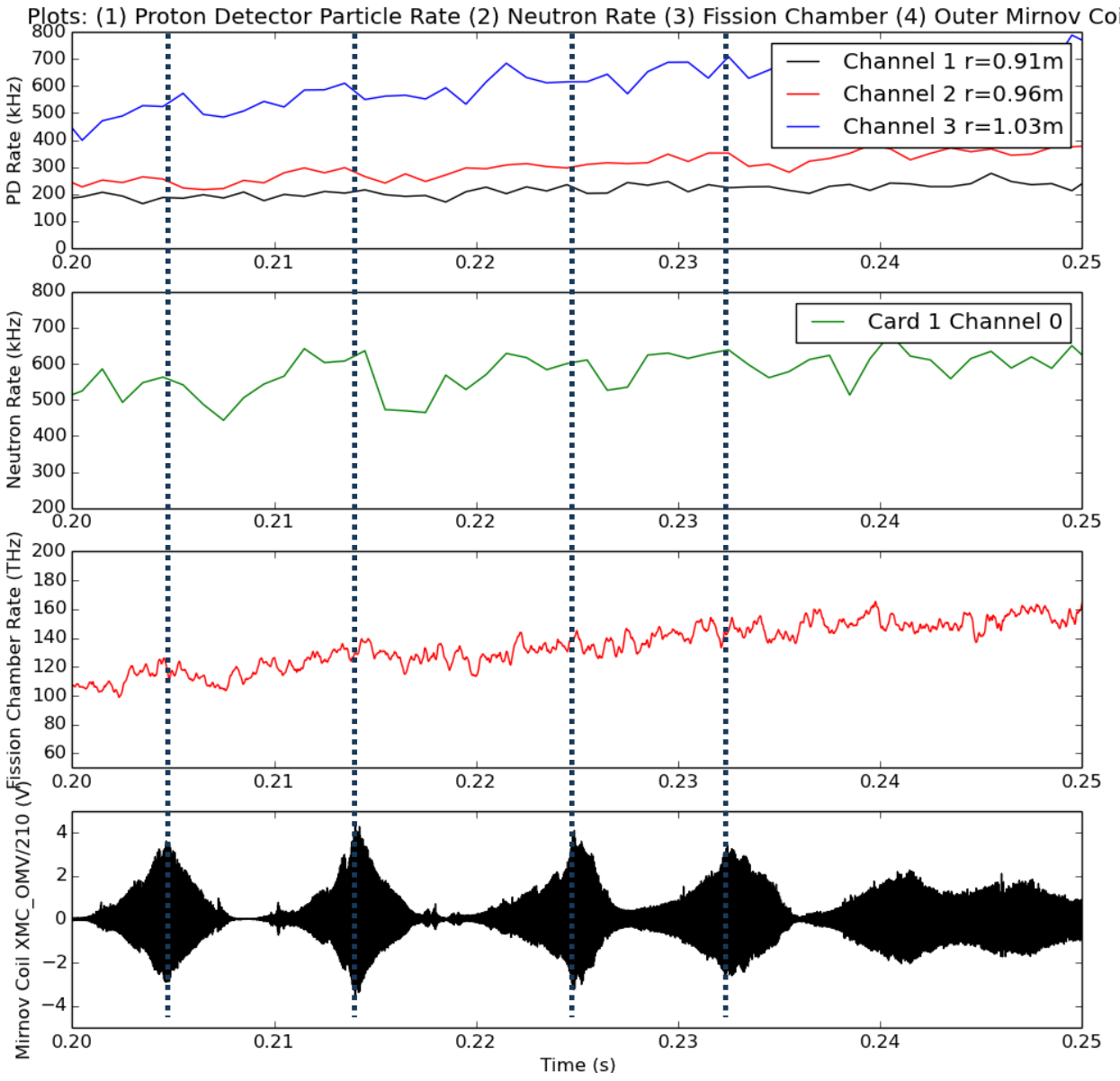


- S shifted to larger R
- S is wider

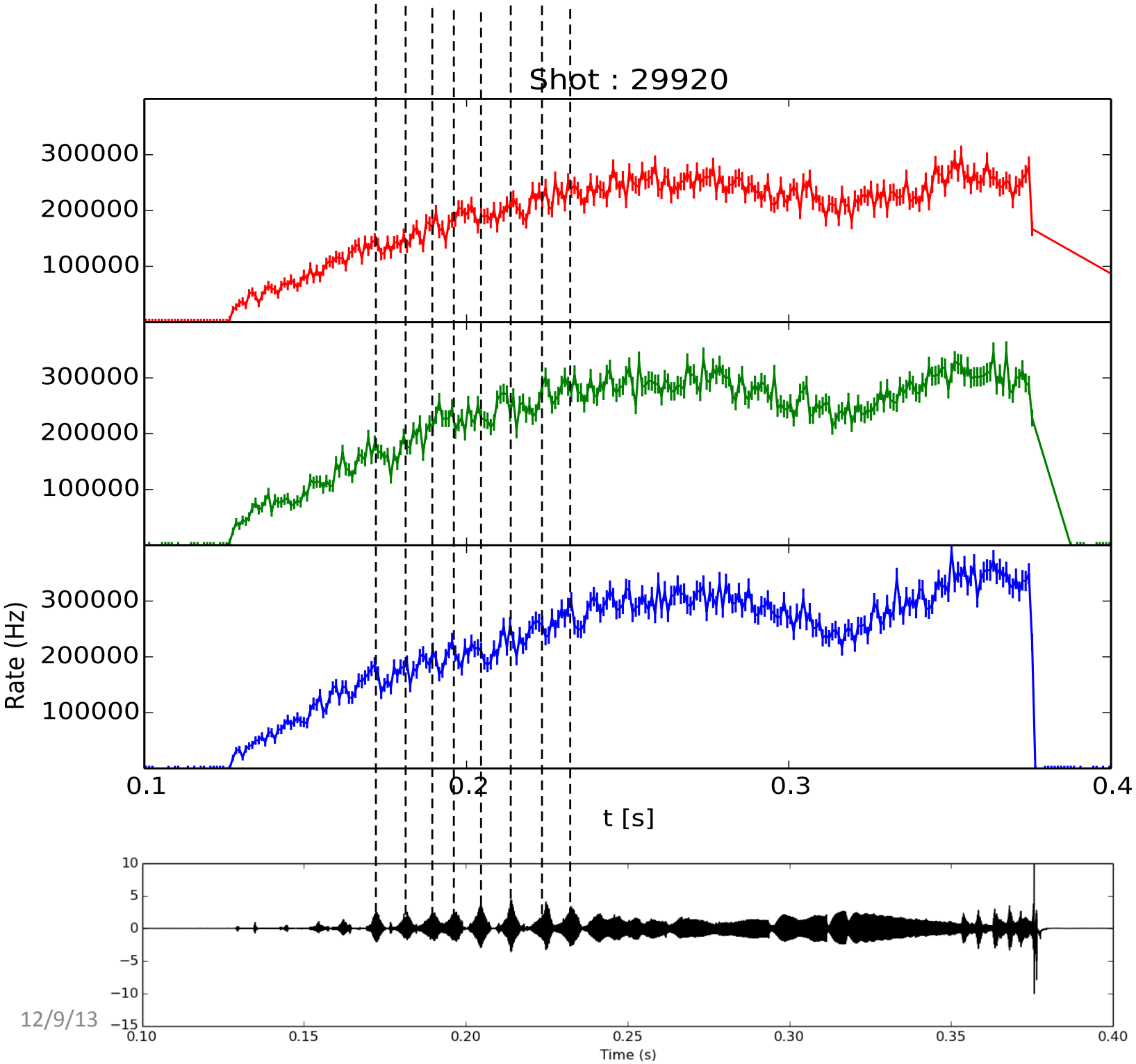


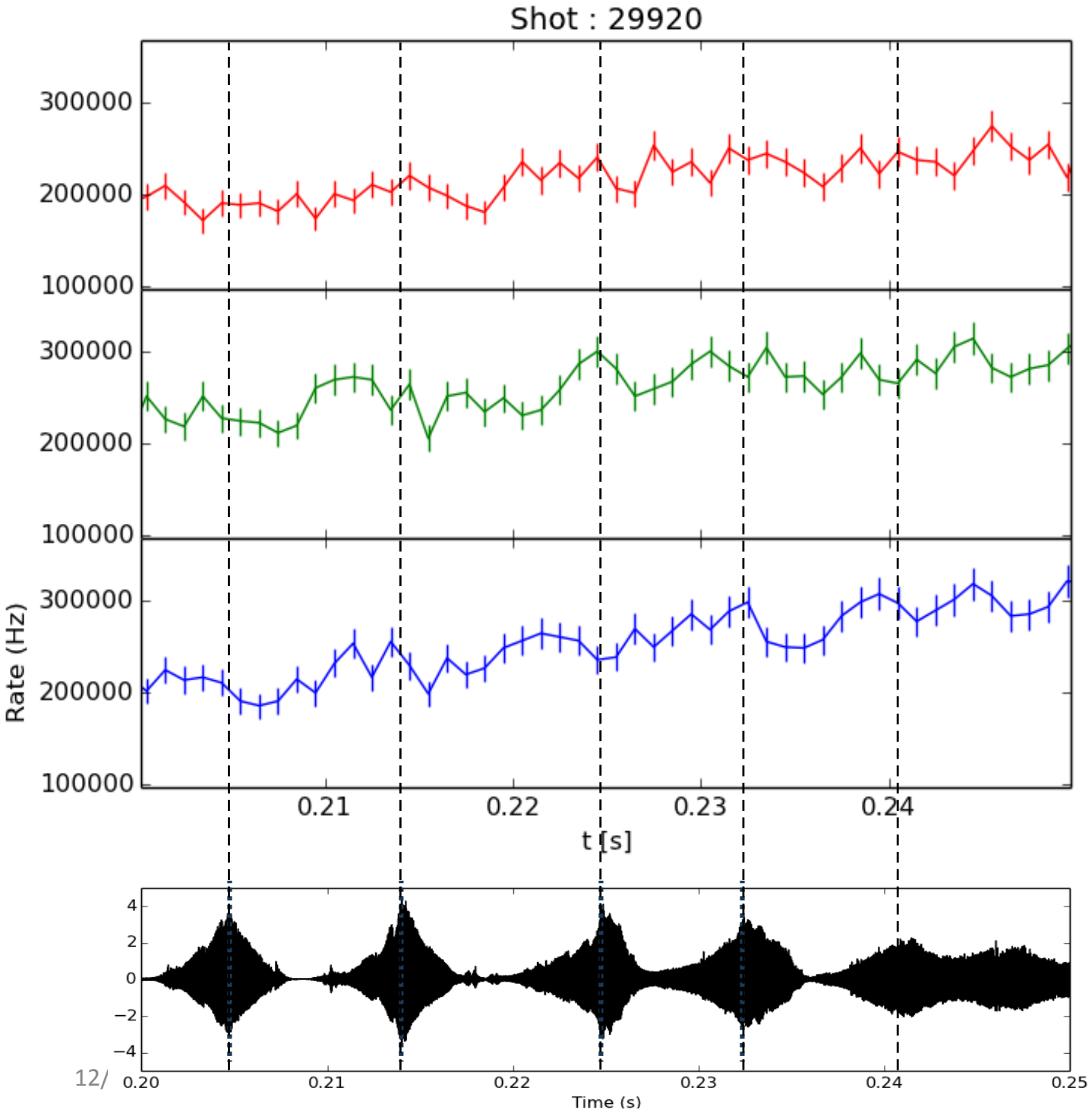
Fishbone Scenario: 29920





- Simple pulse height analysis
- No fitting
- Total rate: protons and tritons


Shot : 29920
Rate (Hz)
300000
200000
100000
0.1
0.2
0.3
0.4
t [s]
10
5
0
−5
−10
−15
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Time (s)



- Good particle identification is needed for detailed information
- Noise suppression is important

Installation in NSTX-U

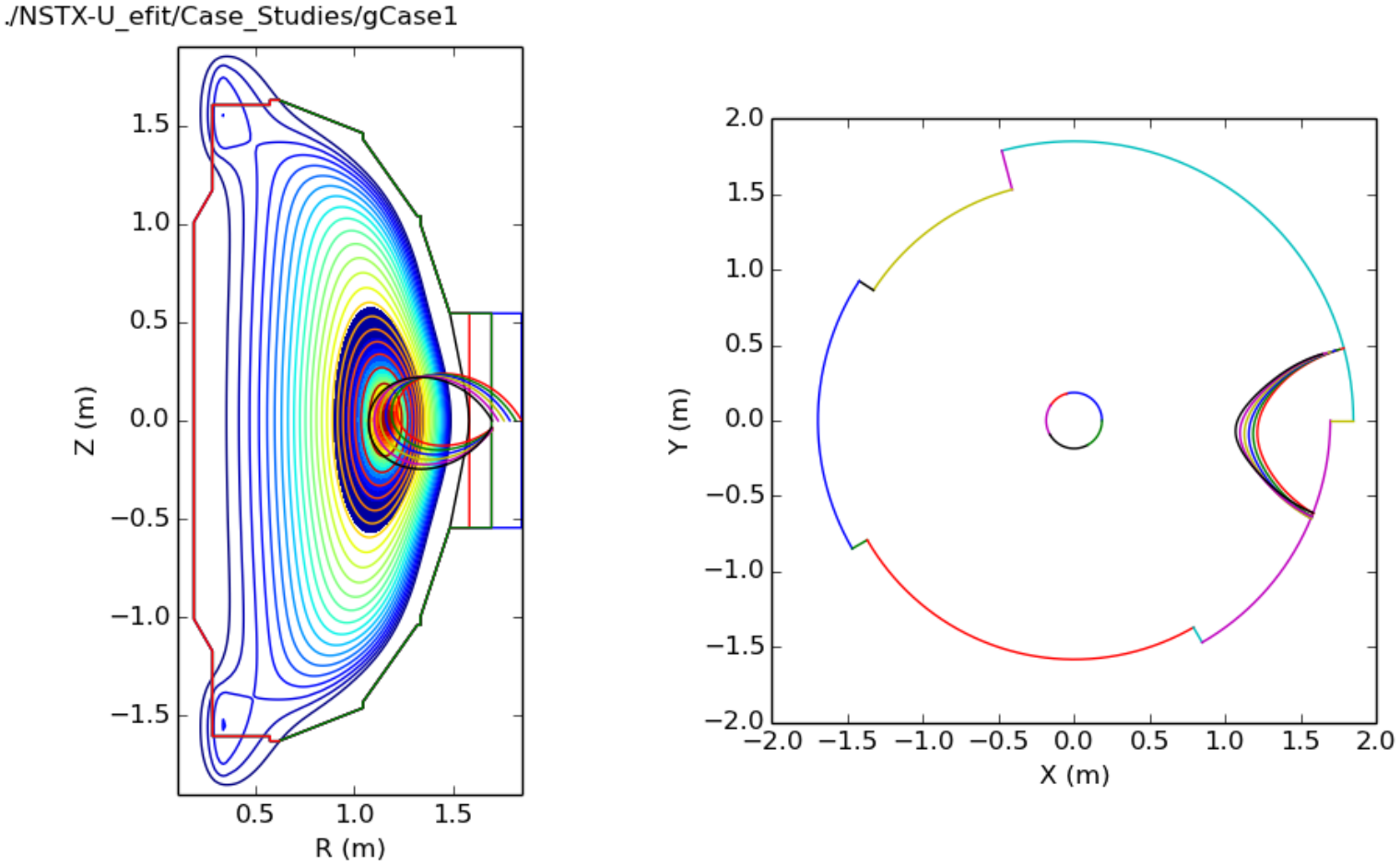
- New high I_p and B_T: very different orbits
- New detector mount is needed
- Fully instrumented 4 channels
- With existing (old) hardware number of channels can be increased to 6
- Mount on probe arm that allows axial rotation is crucial

Potential Orbits in NSTX-U

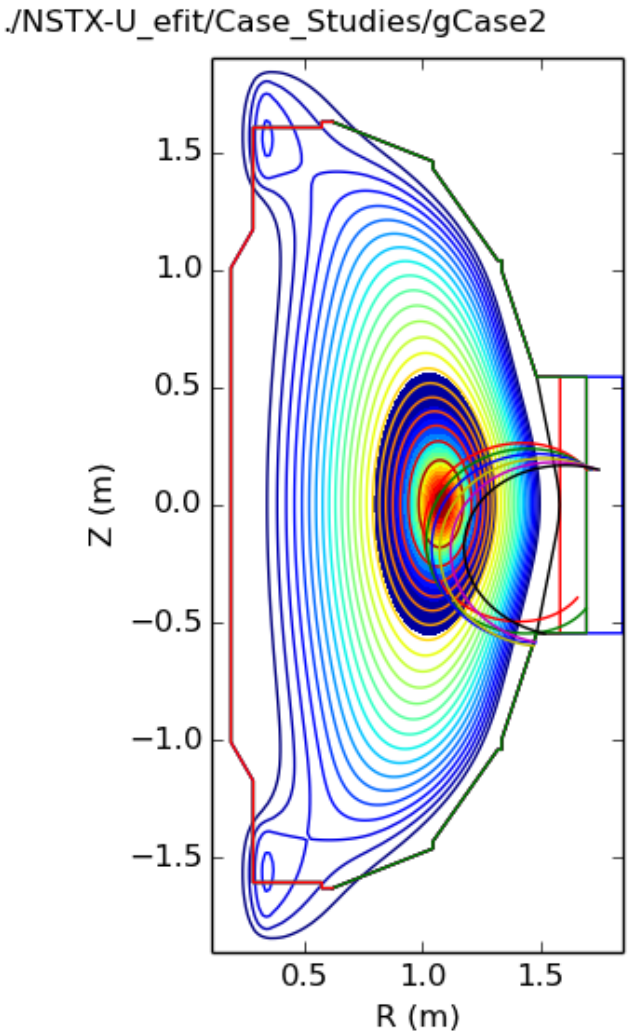
Initial studies on three main configurations

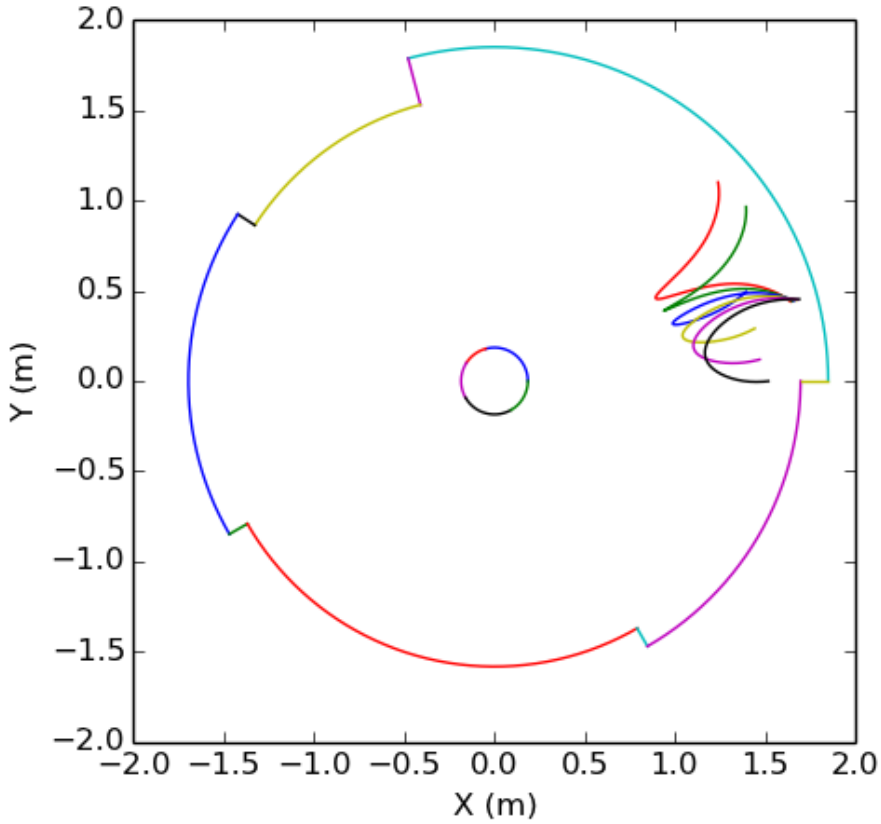
1. $B_T = 0.95T$ $I_P = 1$ MA
2. $B_T = 0.73T$ $I_P = 1.5$MA
3. $B_T = 1.0$ T $I_P = 2.0$MA

B_T = 0.95 T, I_P = 1 MA

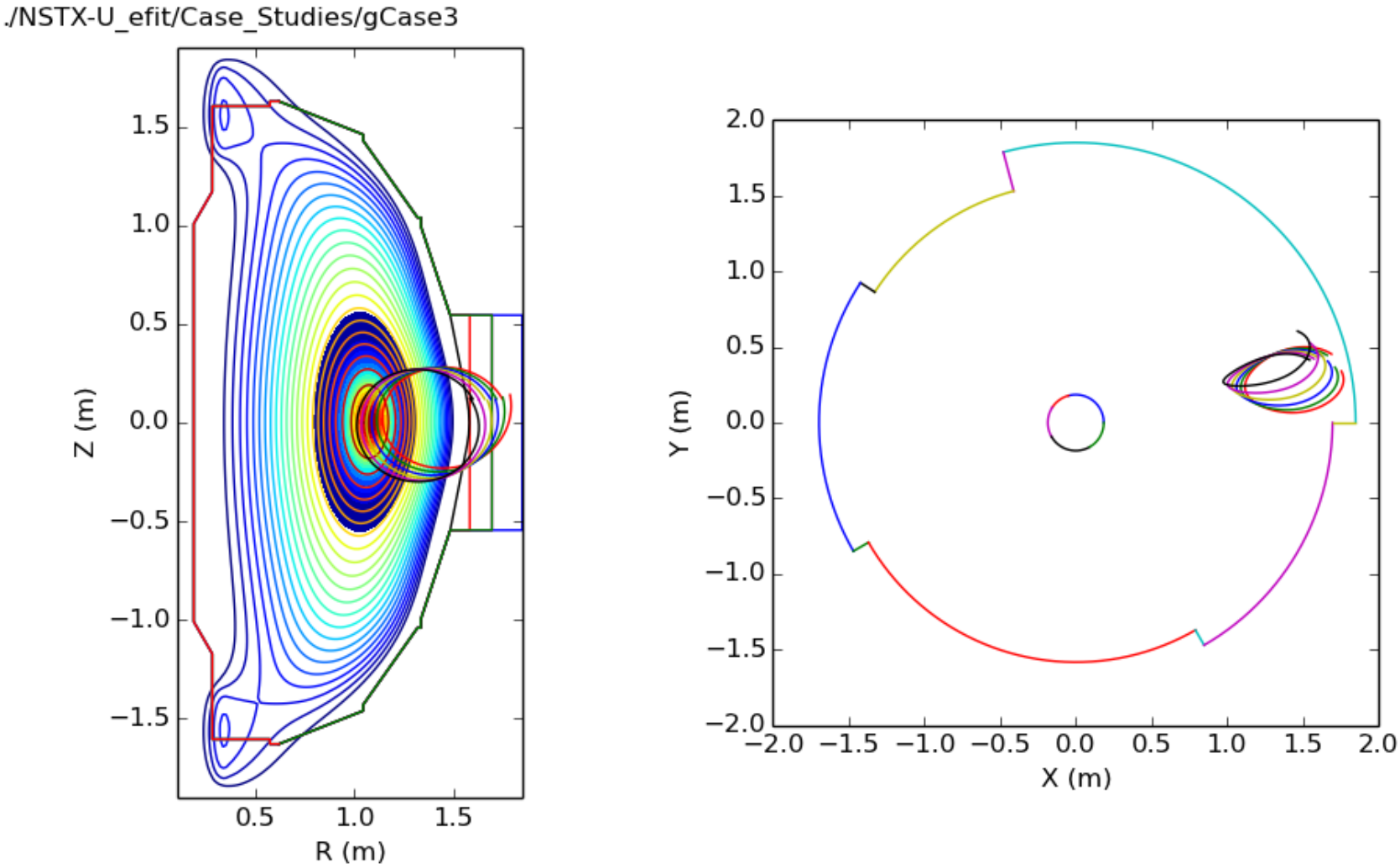


B_T = 0.74 T, I_P = 1.5 MA



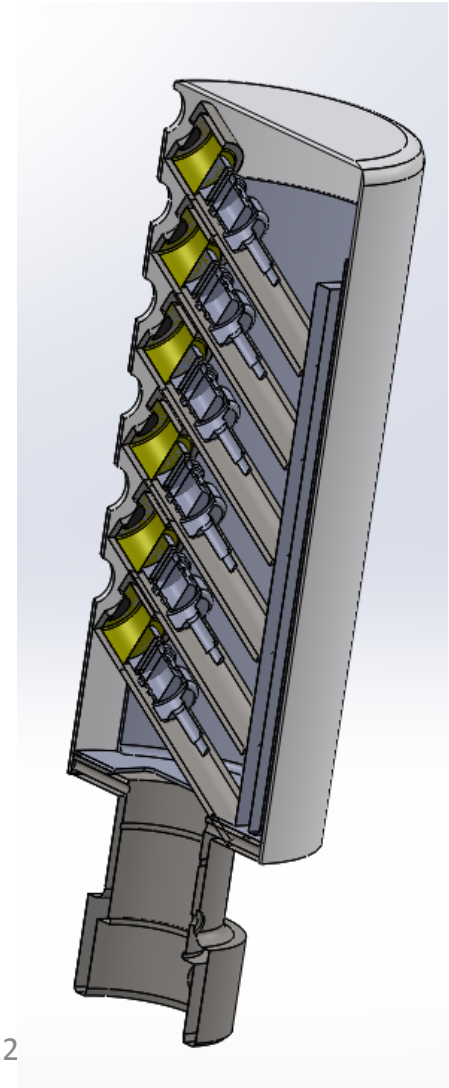


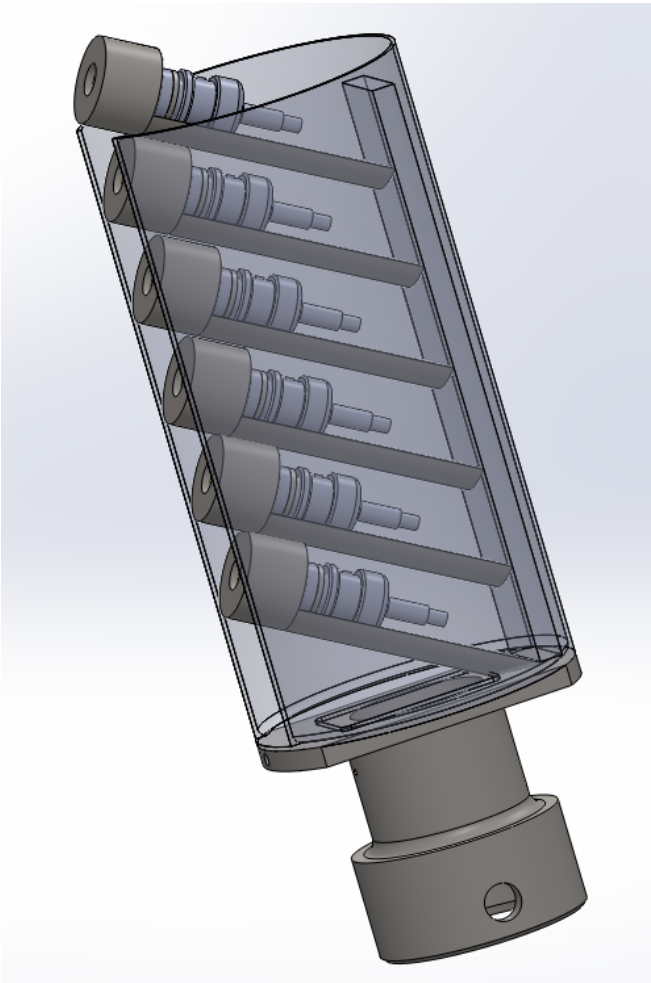
B_T = 0.74 T, I_P = 1.5 MA

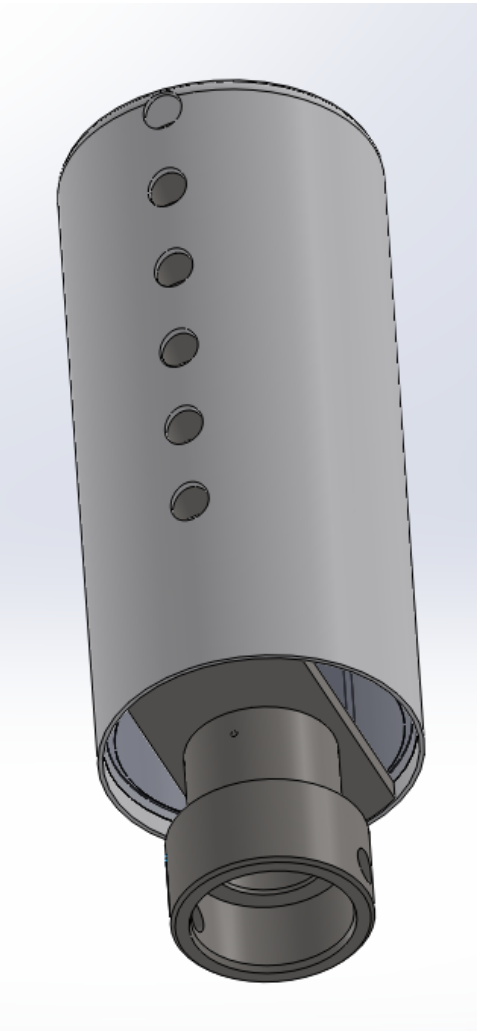


Conceptual Designs for NSTX-U

Linear array fits in 100 mm port opening

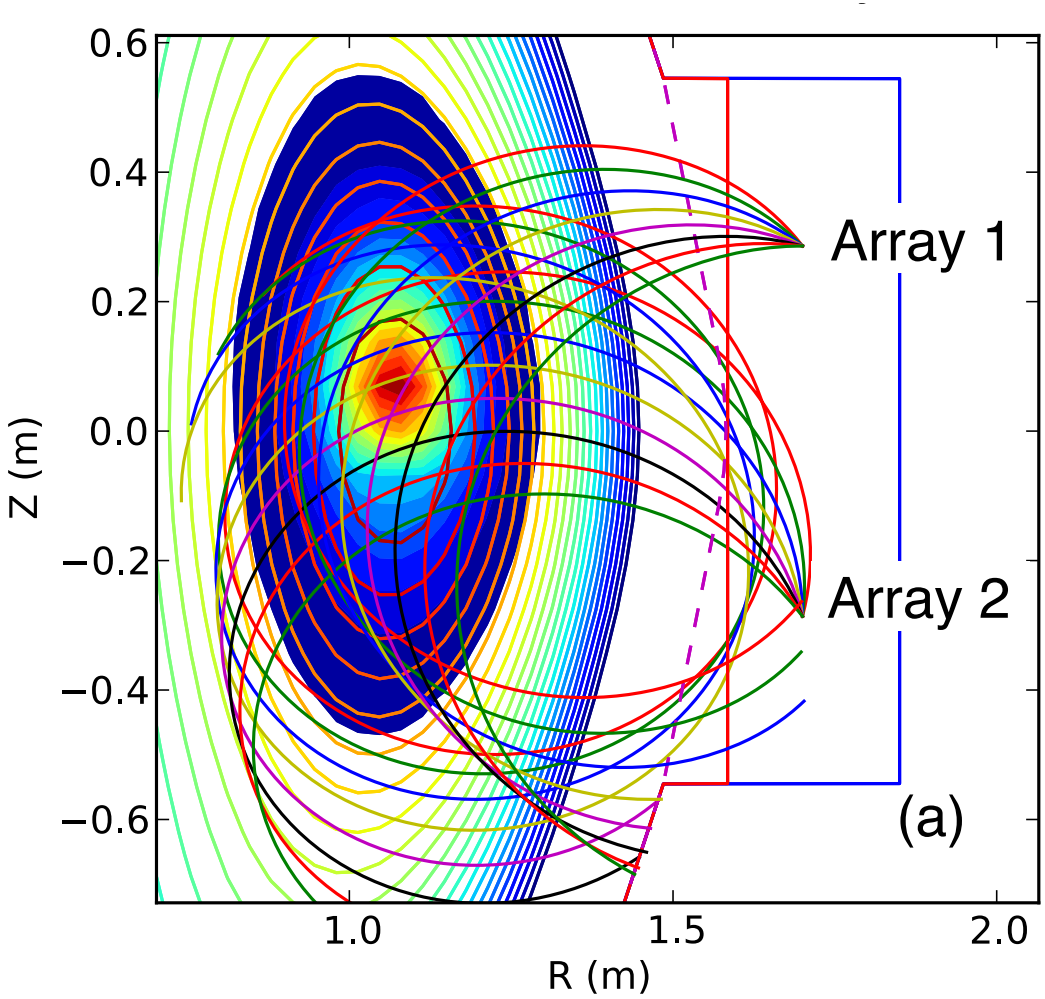




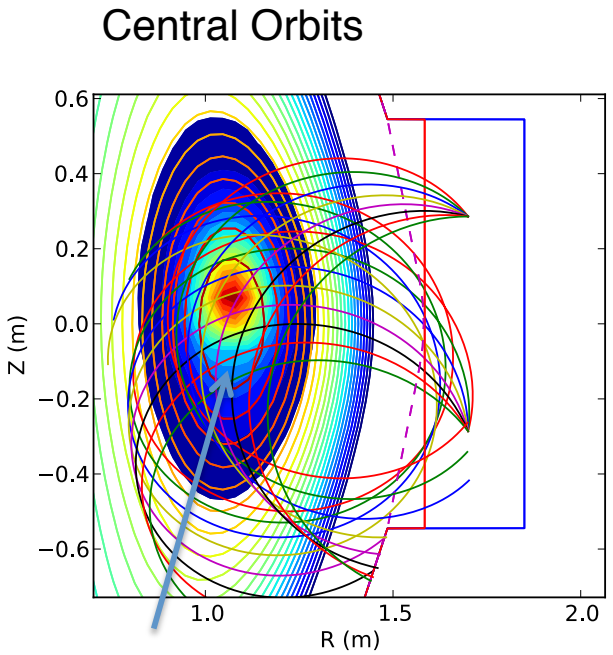


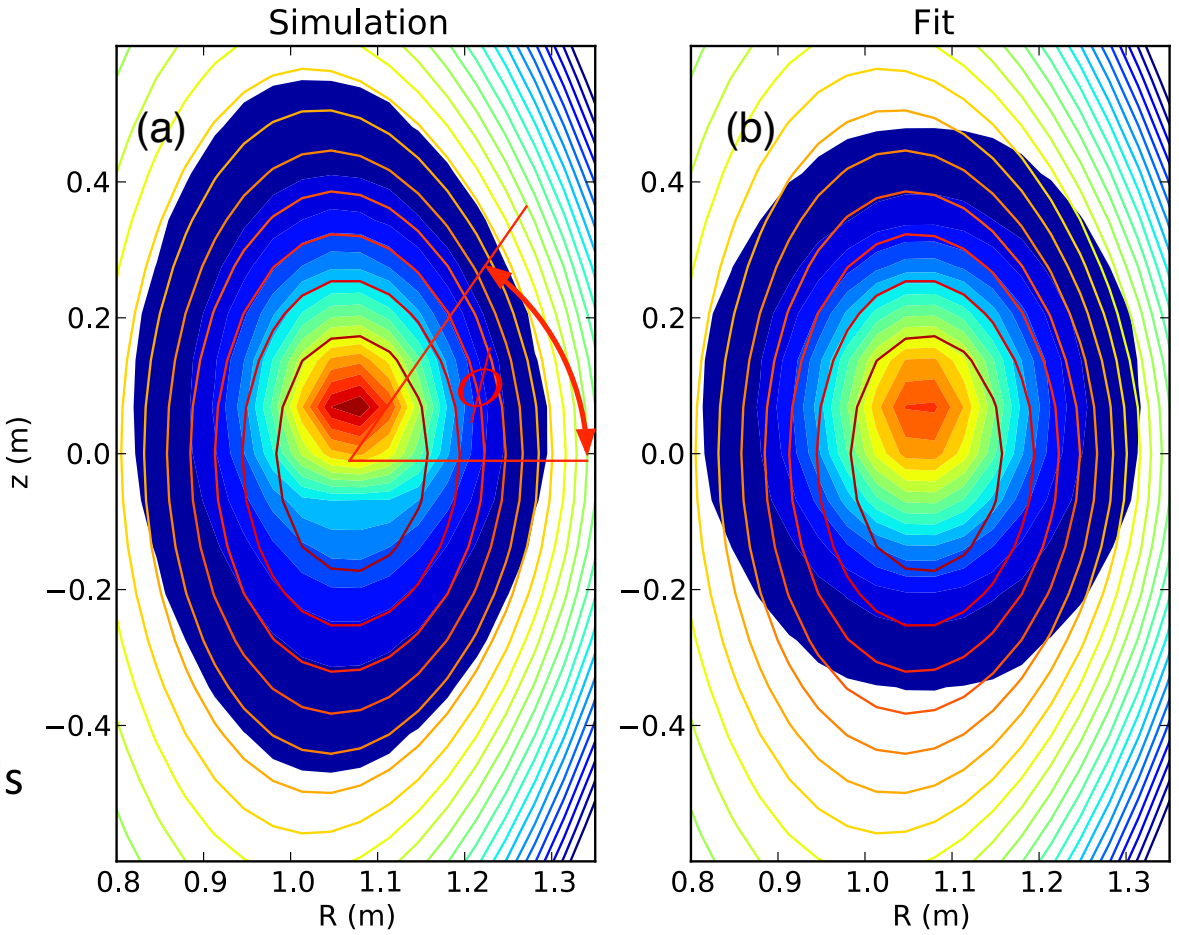
16 Channel System for NSTX-U/MAST

- 2 units of 8 channels each
- 2 fixed units
- One fixed, one on probe drive (with axial rotation)
- Various collimator arrays possible, can be optimized for specific experiments
- Parameters similar to JET neutron camera (19 channels)
- Much more detailed reconstructions possible
- Use custom array detector for compact instrument



Profile Reconstruction





- Orbits cross central plasma region
- Act like 'curved' sight chords in X-ray tomography

Simulation: $S(\psi) = \psi^{\lambda}(1. + Asin(\phi)), \lambda = 11.45, A = 0.5$

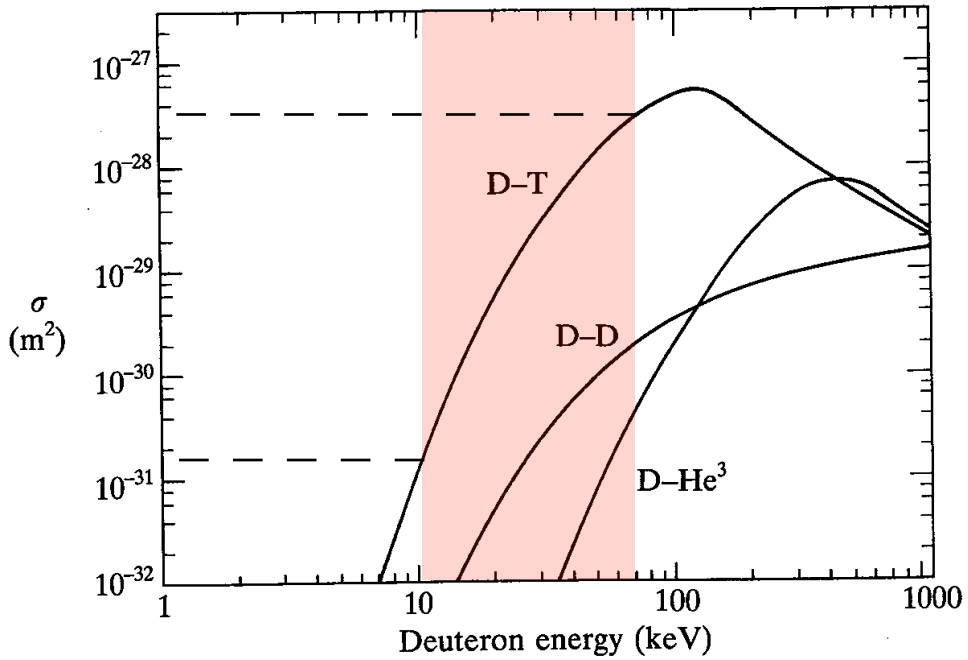
Fit function: $S_{fit}(R,z) = Ae^{-\frac{1}{2}\left(\frac{R-R_0}{\sigma_R}\right)^2} e^{-\frac{1}{2}\left(\frac{z-z_0}{\sigma_z}\right)^2}$

Summary

- Successful data taking at MAST, data comparable to neutron camera
- Noise can be controlled
- Protons can be well identified, ^{3}He difficult with window
- Good time resolution of 1 ms at 10%
- Sawteeth oscillations and Fishbone activities could be observed and studied
- Adaptable to NSTX-U
- More channels are necessary

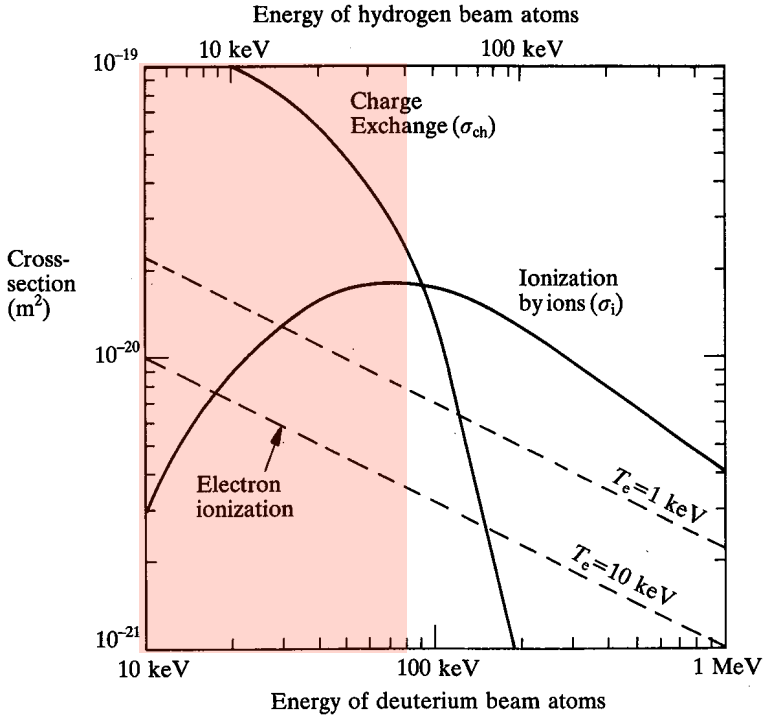
Cross Sections

Nuclear Reaction Cross Sections



Cross section droppes 3 orders of magnitude

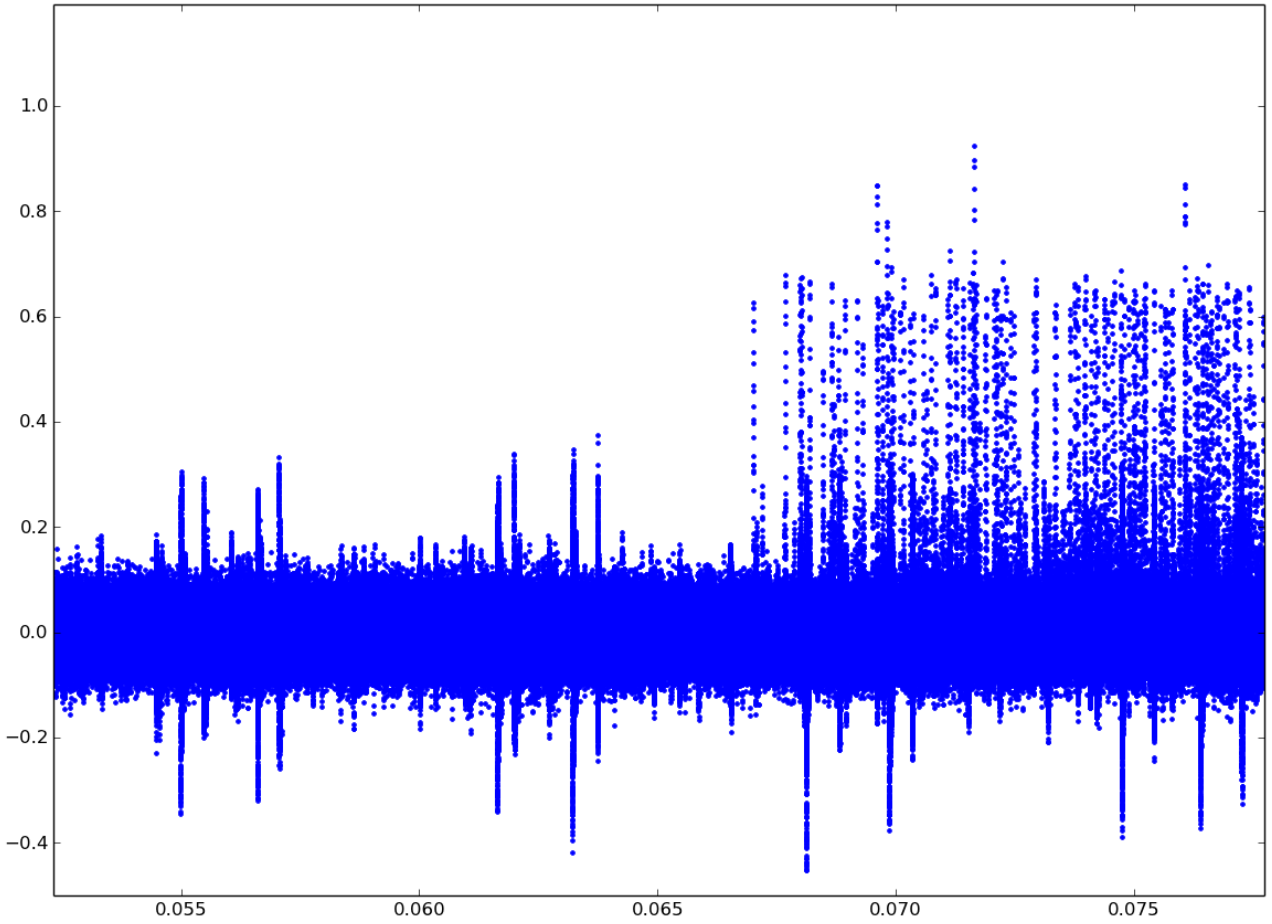
Neutral Atoms Cross Sections



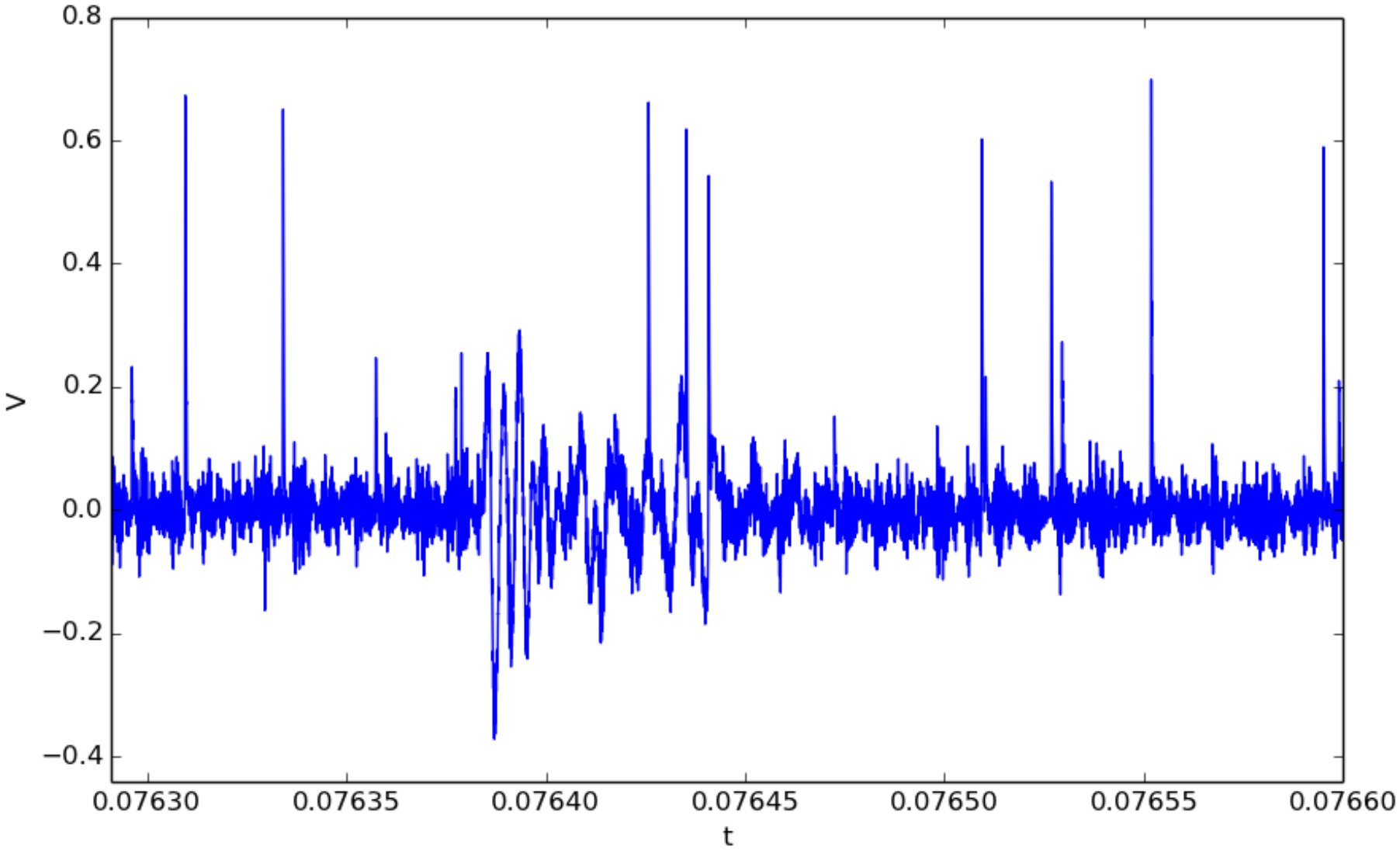
Cross section increases by factor of ~10

(pictures from J. Wesson, Tokamaks)

Noise in Particle Pulses



Noisy Signals (detail)



Backup: DAQ setup