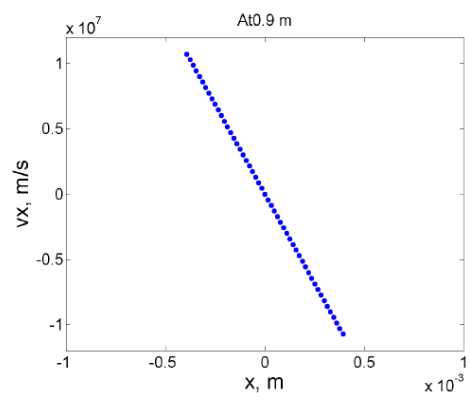
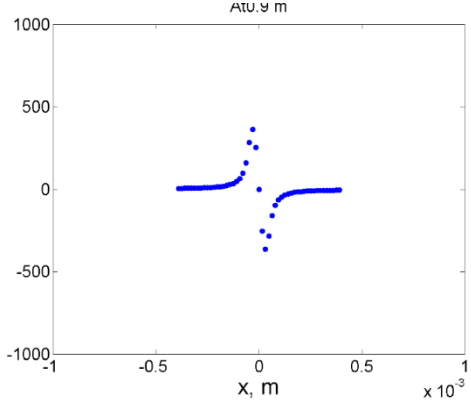
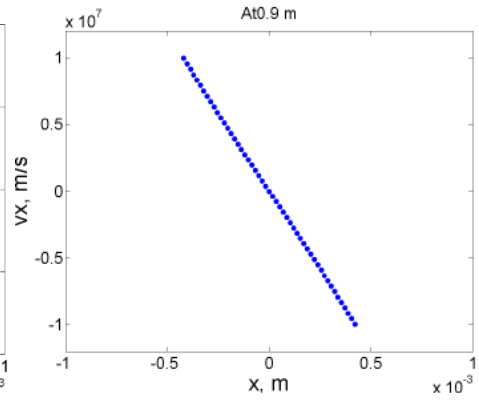
Discussion of Jun’s results

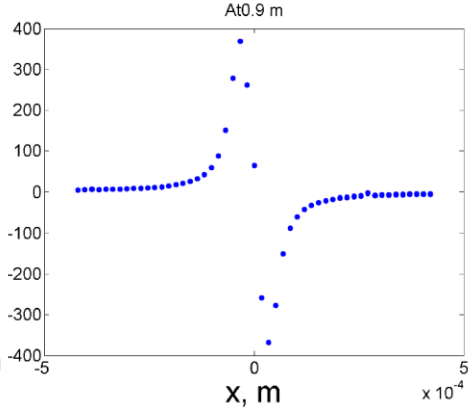
2/9/2017

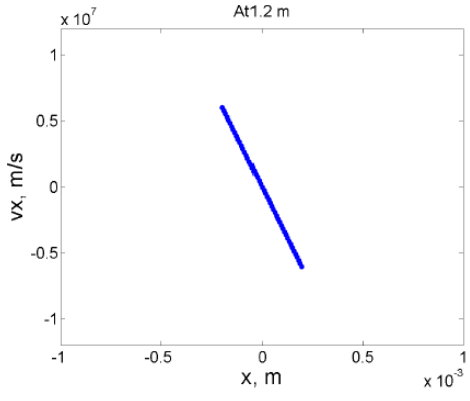
Jun's plots

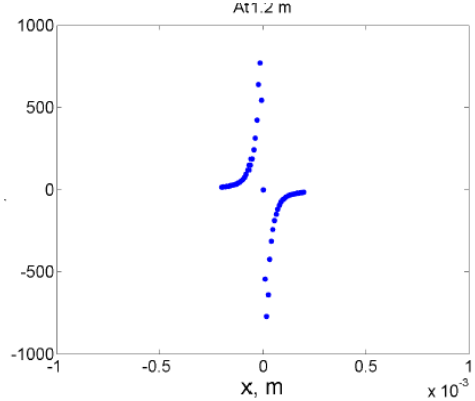

At0.9 m
x 10^7
vx, m/s
x, m
x 10^-3

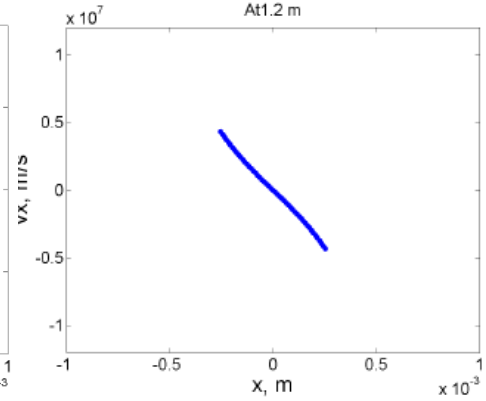

At0.9 m
x, m
x 10^-3

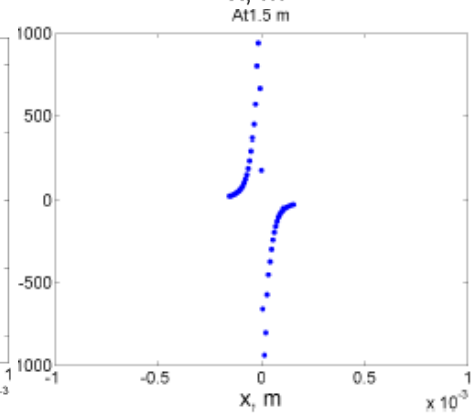

At0.9 m
x 10^7
vx, m/s
x, m
x 10^-3

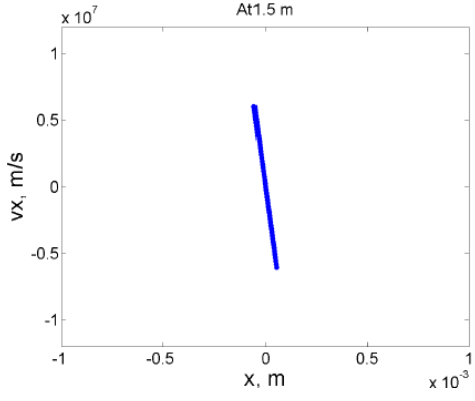

At0.9 m
x, m
x 10^-4

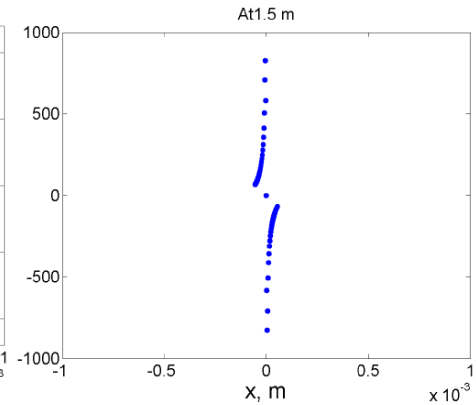

At1.2 m
x 10^7
vx, m/s
x, m
x 10^-3

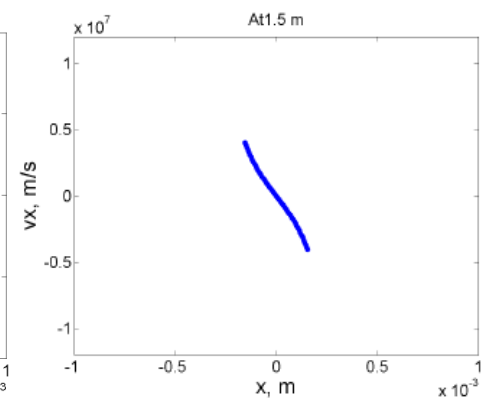

At1.2 m
x, m
x 10^-3

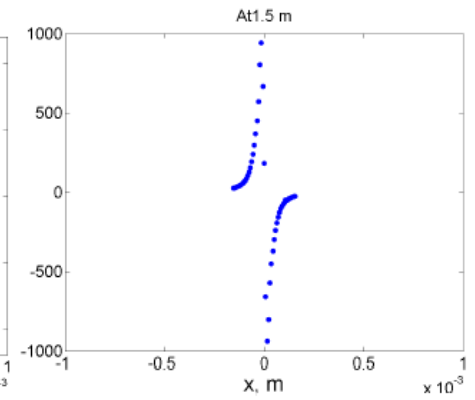

At1.2 m
x 10^7
x, m
x 10^-3


At1.5 m
x, m
x 10^-3

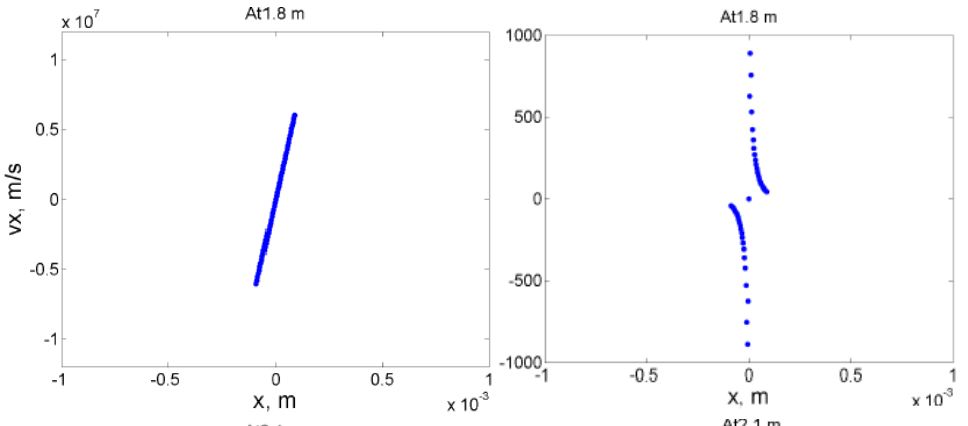

At1.5 m
x 10^7
vx, m/s
x, m
x 10^-3

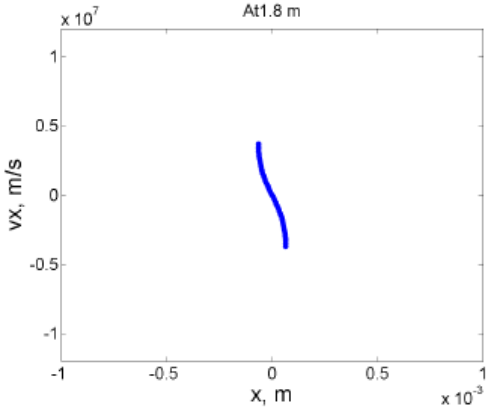

At1.5 m
x, m
x 10^-3

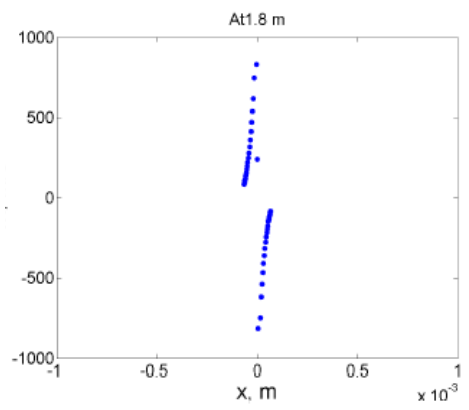

At1.5 m
x 10^7
vx, m/s
x, m
x 10^-3

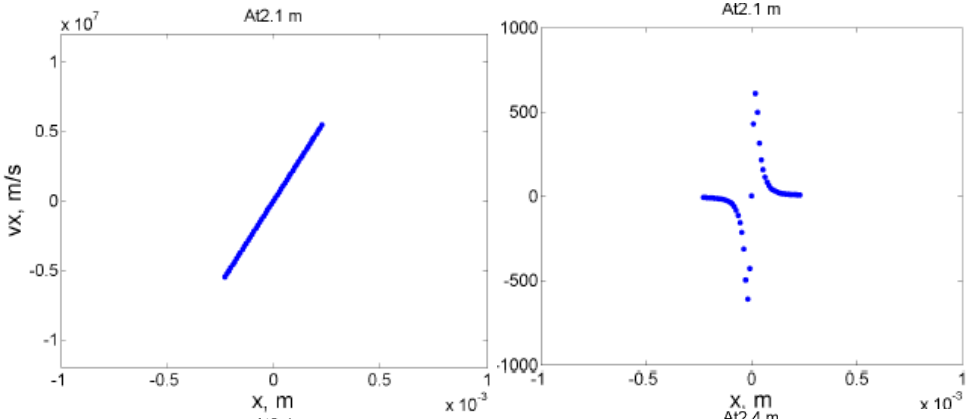

At1.5 m
x, m
x 10^-3

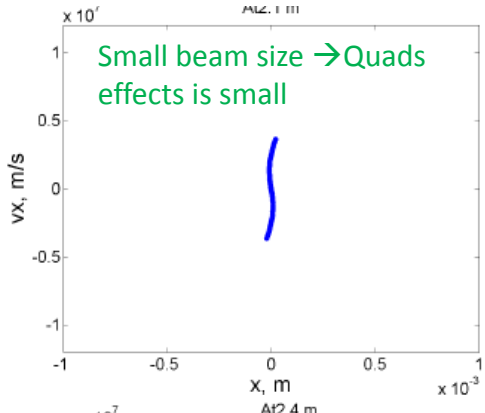
Jun's plots continued



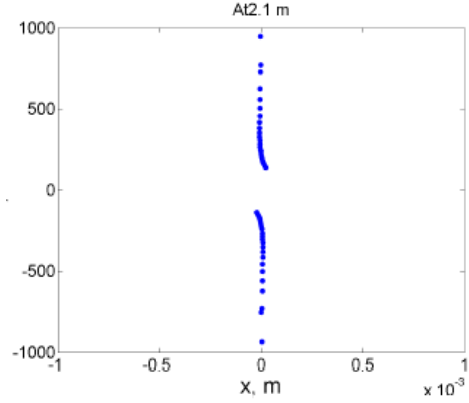


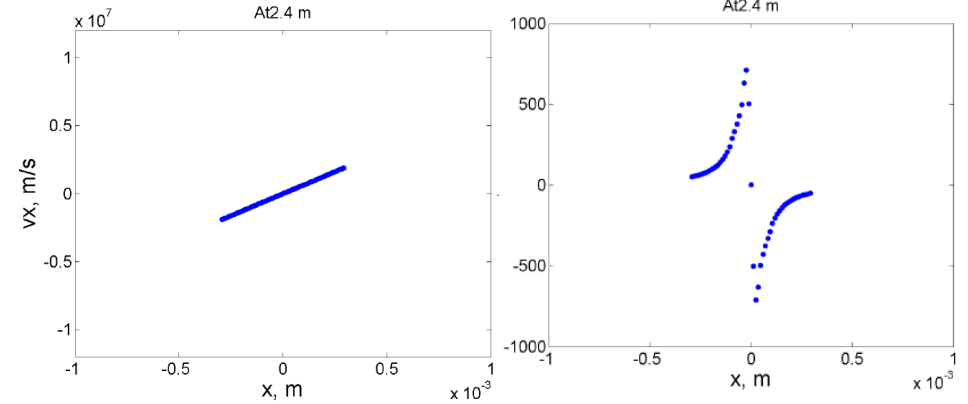


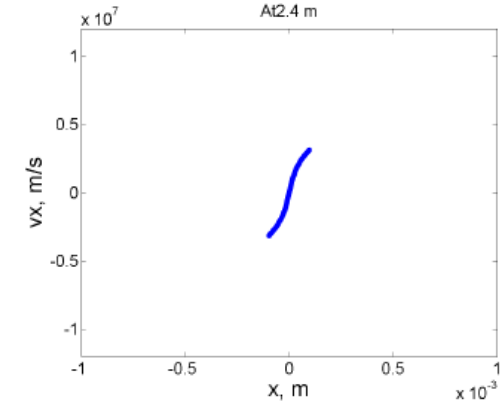


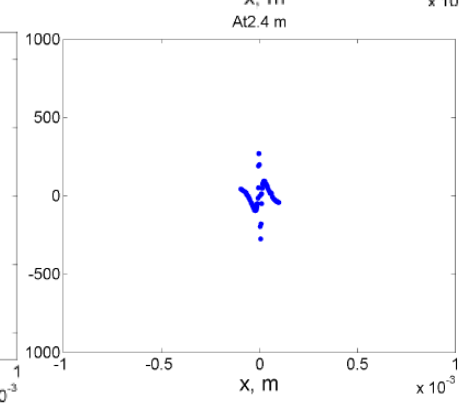


Small beam size →Quads effects is small

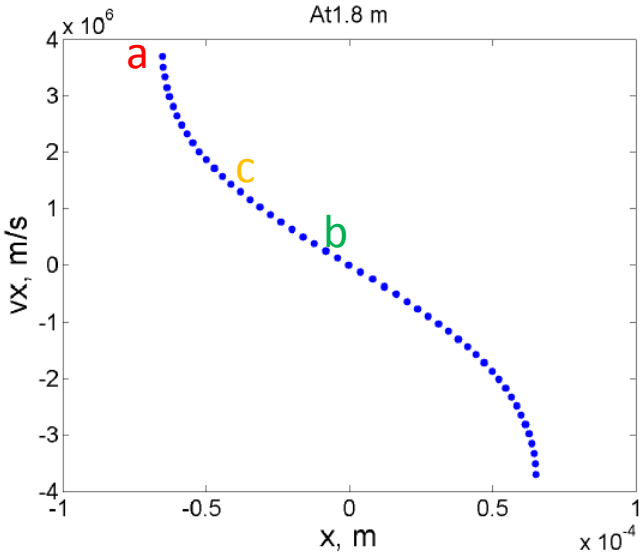


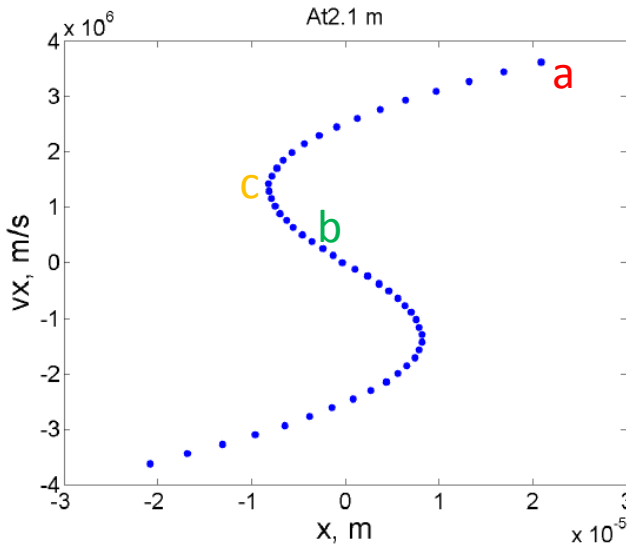


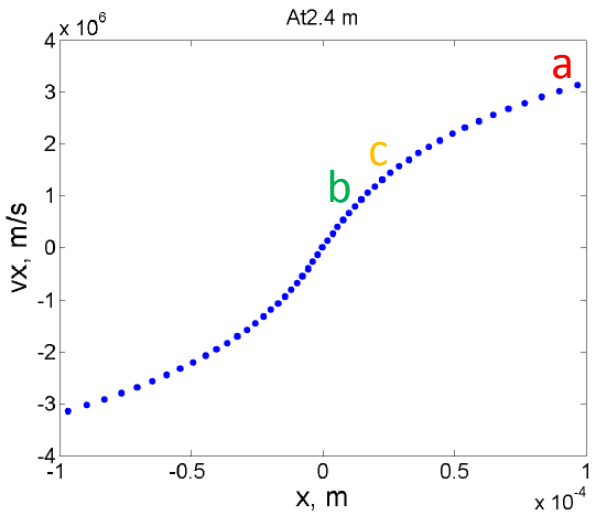


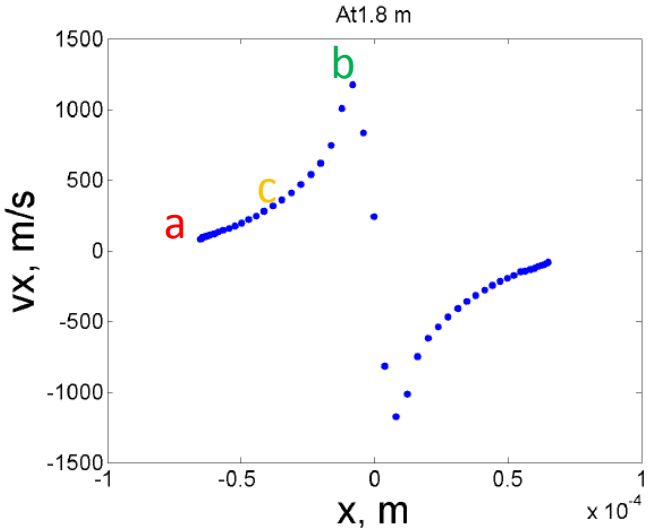


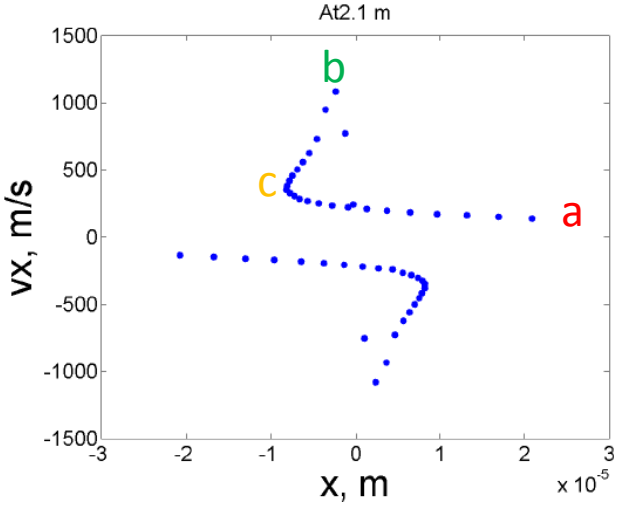
Zoom in plots at 1.8~2.4 m

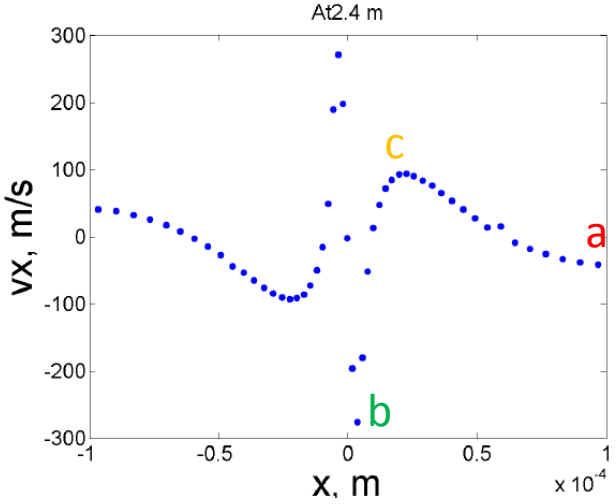






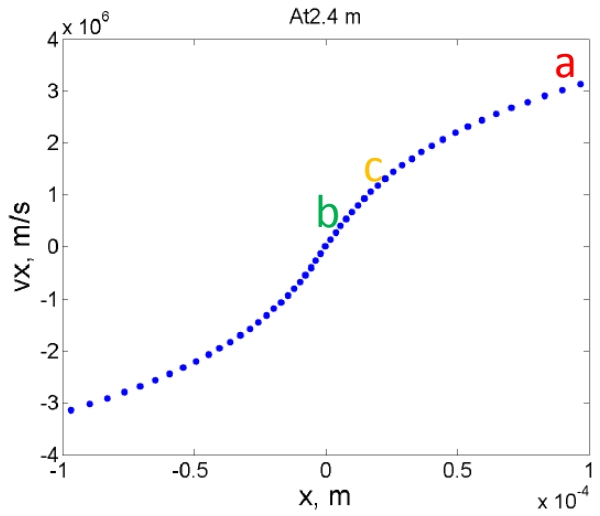


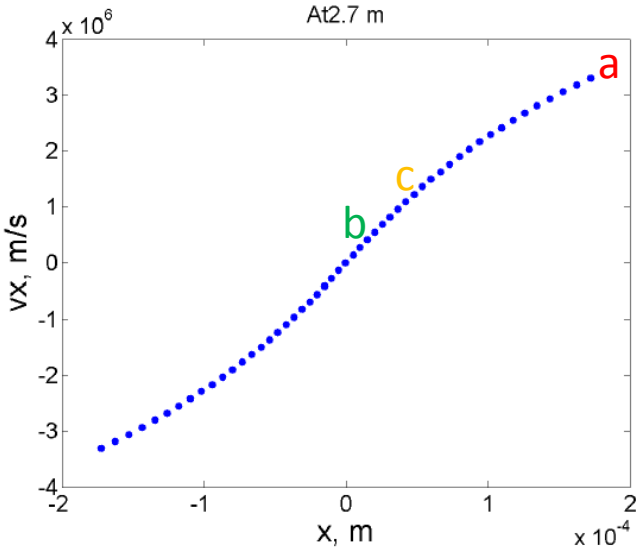


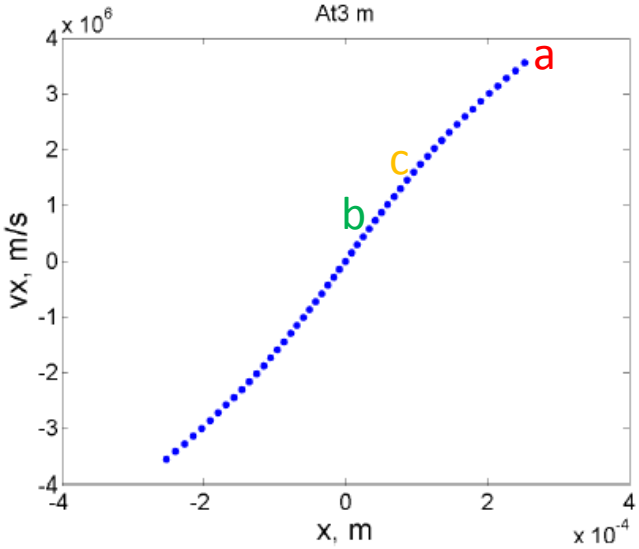


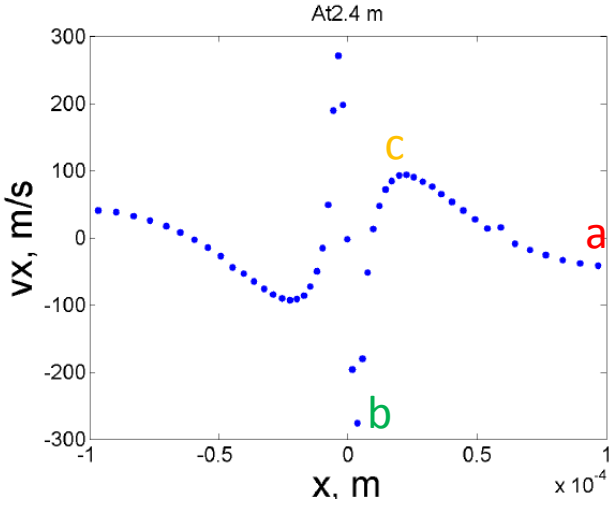
Ion give particle b enough net kick to reverse the sign of its velocity while it passing through the ion. In addition, particle b stays around ion very close, so the net momentum change is large.

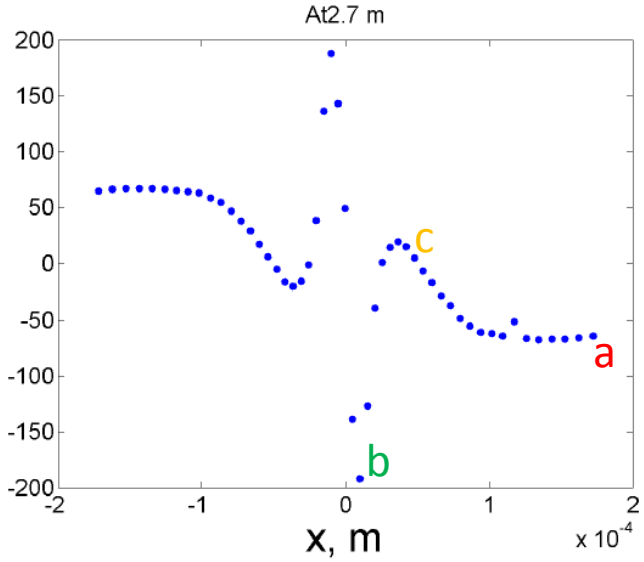
Zoom in plots at 2.7 m to 3 m

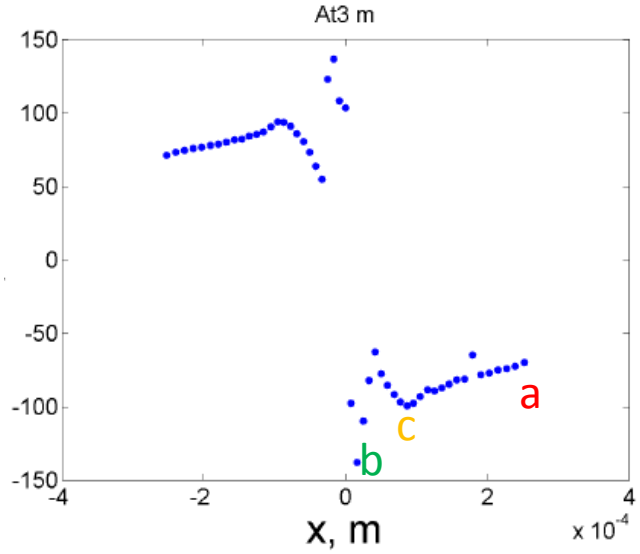












Coordinates of a, b and c

Background	1.8 m		2.1 m		2.4 m	
	X, m	Vx, m/s	X, m	Vx, m/s	X, m	Vx, m/s
a	-6.5e-5	3.7e6	2.1e-5	3.6e6	9.8e-5	3.1e6
c	-4.1e-5	1.4e6	-8.2e-6	1.4e6	2.6e-5	1.4e6
b	-8.1e-6	2.5e5	-2.4e-6	2.5e5	3.8e-6	2.6e5

Signal	1.8 m		2.1 m		2.4 m	
	X, m	Vx, m/s	X, m	Vx, m/s	X, m	Vx, m/s
a	-6.5e-5	8.3e1	2.1e-5	1.4e2	9.8e-5	-4.1e1
c	-4.1e-5	2.8e2	-8.2e-6	3.5e2	2.6e-5	9.1e1
b	-8.1e-6	1.2e3	-2.4e-6	1.1e3	3.8e-6	-2.6e2

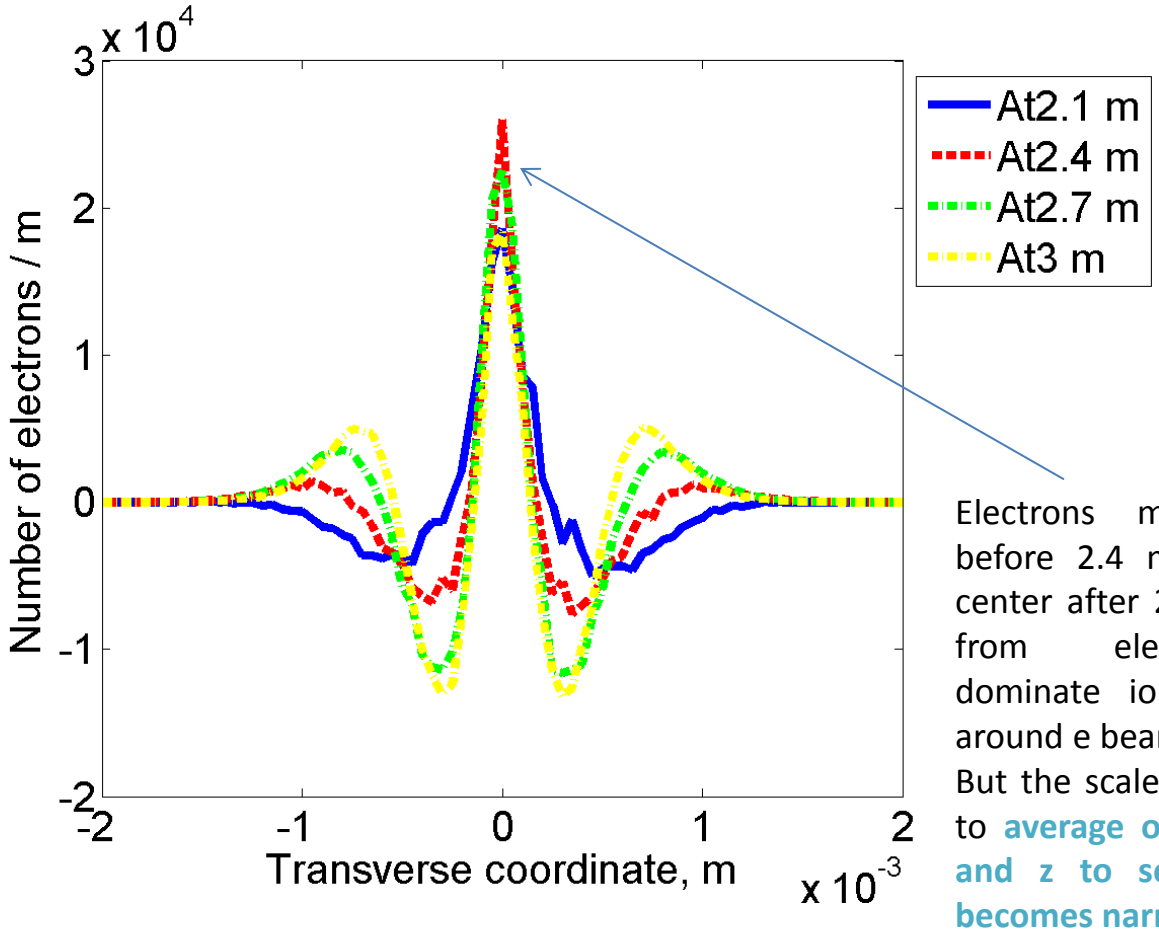
Zoom in plots at 1.8~2.4 m continued

- Particle a moves too fast and hence the net momentum change due to ion is small. But since its initial momentum modulation due to ion is also small and it stays at the right side of the ion longer, it changes its sign as well.
- Particle c has relatively large initial momentum modulation from the ion and it stays at the right side of the ion shorter than particle a. As a result, the net momentum kick from ion is not enough to change its sign.
- Compared with no space charge case, the non-linear space charge force enhances ion's effects towards the center of the beam (since particles around the center stays much longer than the no space charge case), which is responsible for the center peak observed in the vx-x plot.

Explanation

- Nonlinearity of space charge force is responsible for the ‘werid’ shape in x-<vx> plot at 2.1 meters
- Space charge of electrons slows down the phase space rotation and make all particles initially around beam center passing through ion in a much slower speed and hence dp_x=F_x*dt is larger, i.e. much stronger horizontal momentum kick from ion is received by these electrons.
- However, after 2.4 m, the center peak is reducing, which can only be due to density modulation in electrons, i.e. we need to see a very sharp nx peak around x=0 followed by negative peaks so that electrons further away from the center will see a field dominated by the ion.

nx Plot

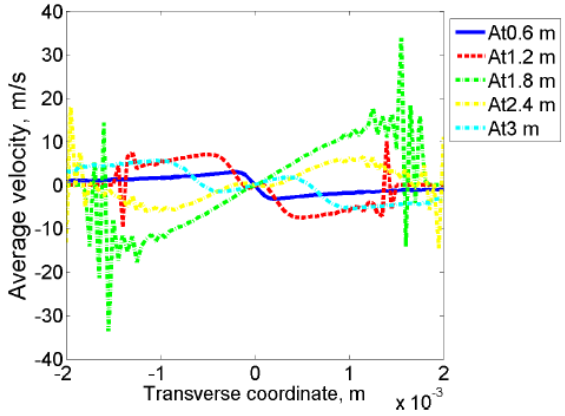


Electrons move towards center before 2.4 m and away from the center after 2.4 m, suggesting fields from electrons' modulation dominate ion's field after 2.4 m around e beam center.

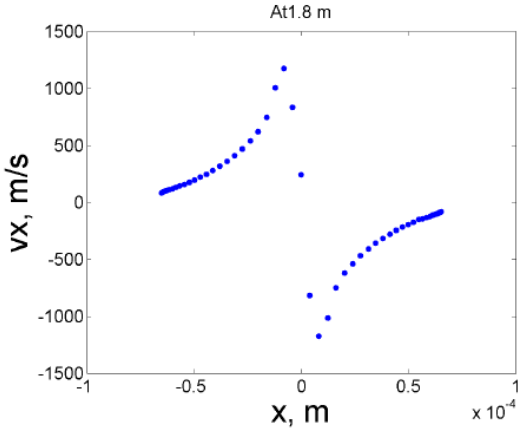
But the scale is not right… We need to **average over smaller range in y and z to see whether the peak becomes narrower locally.**

Backup Slides

Puzzle left

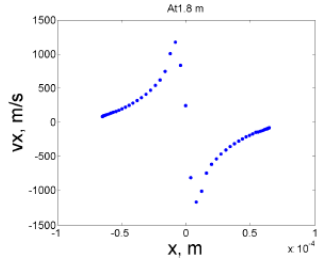


(a) overall v_x

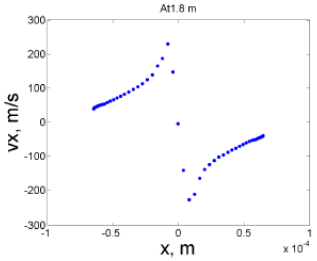


(b) center-line v_x

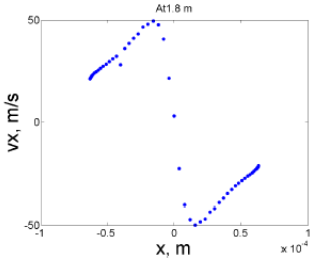
- Other than plot at 1.8 m, other four plots in above figure seems consistent with 'single line' tracking.
- Need to check for location 2.1m and find where the source of the reverse comes from (particles with non-zero initial velocity?).



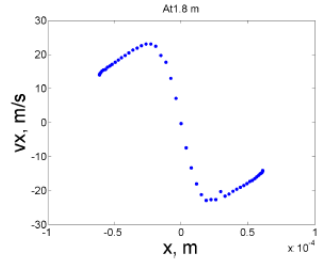
(a) $y = 0.0\sigma$



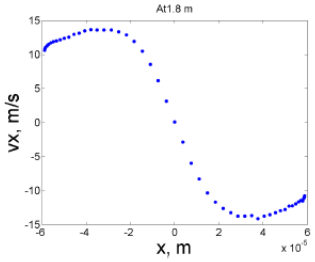
(b) $y = 0.1\sigma$



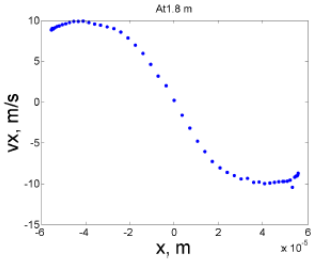
(c) $y = 0.2\sigma$



(d) $y = 0.3\sigma$



(e) $y = 0.4\sigma$



(f) $y = 0.5\sigma$