Modulator with Quadrupoles

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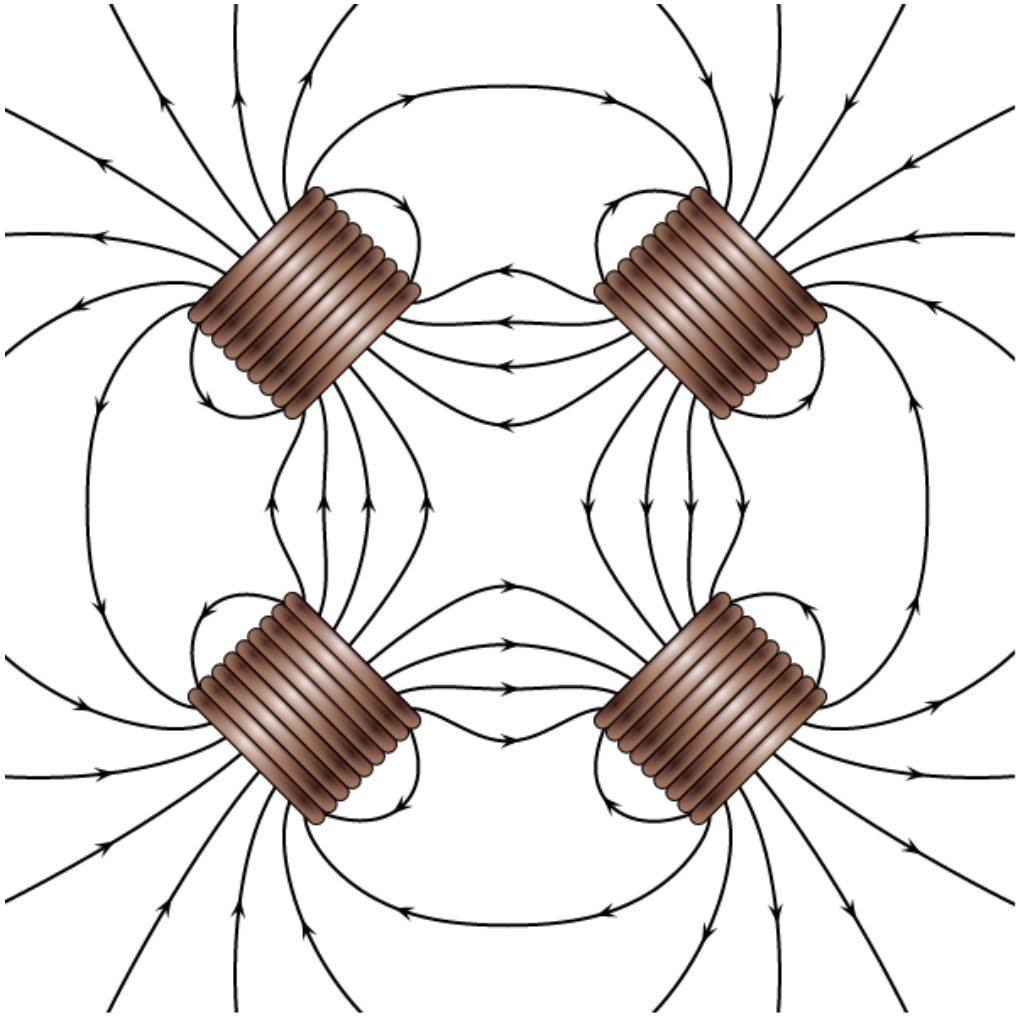
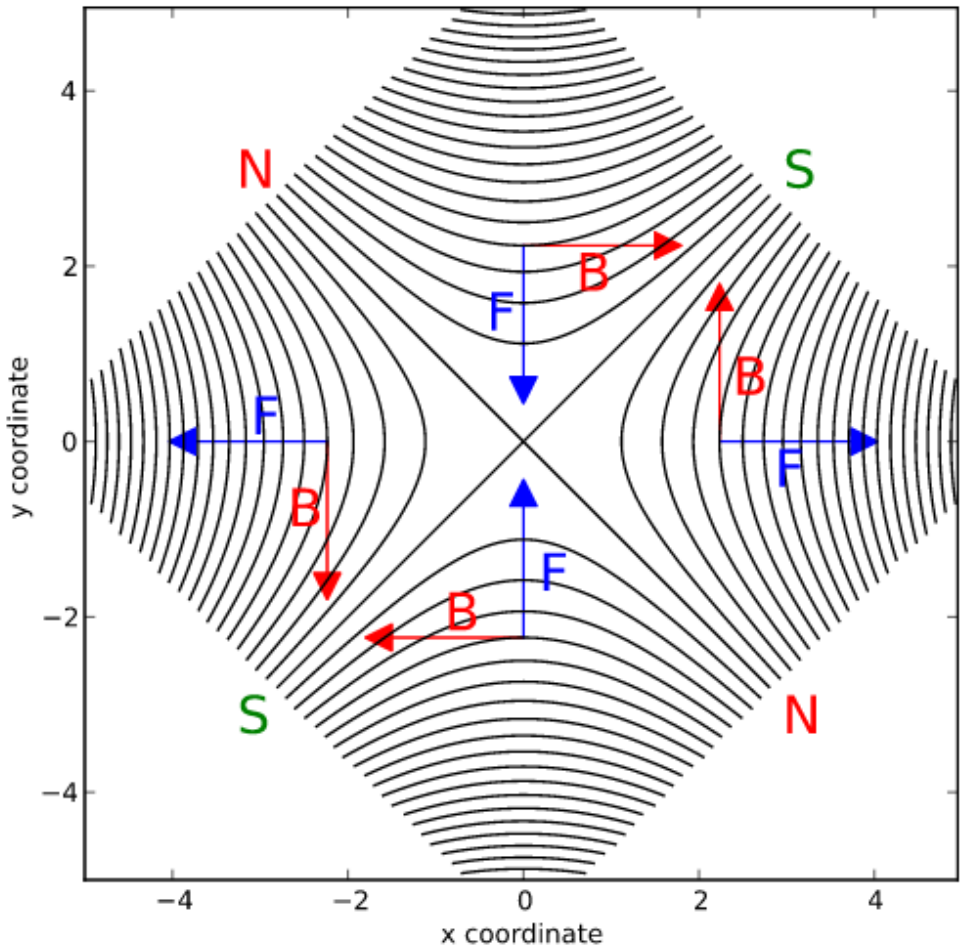
An example of quadrupole



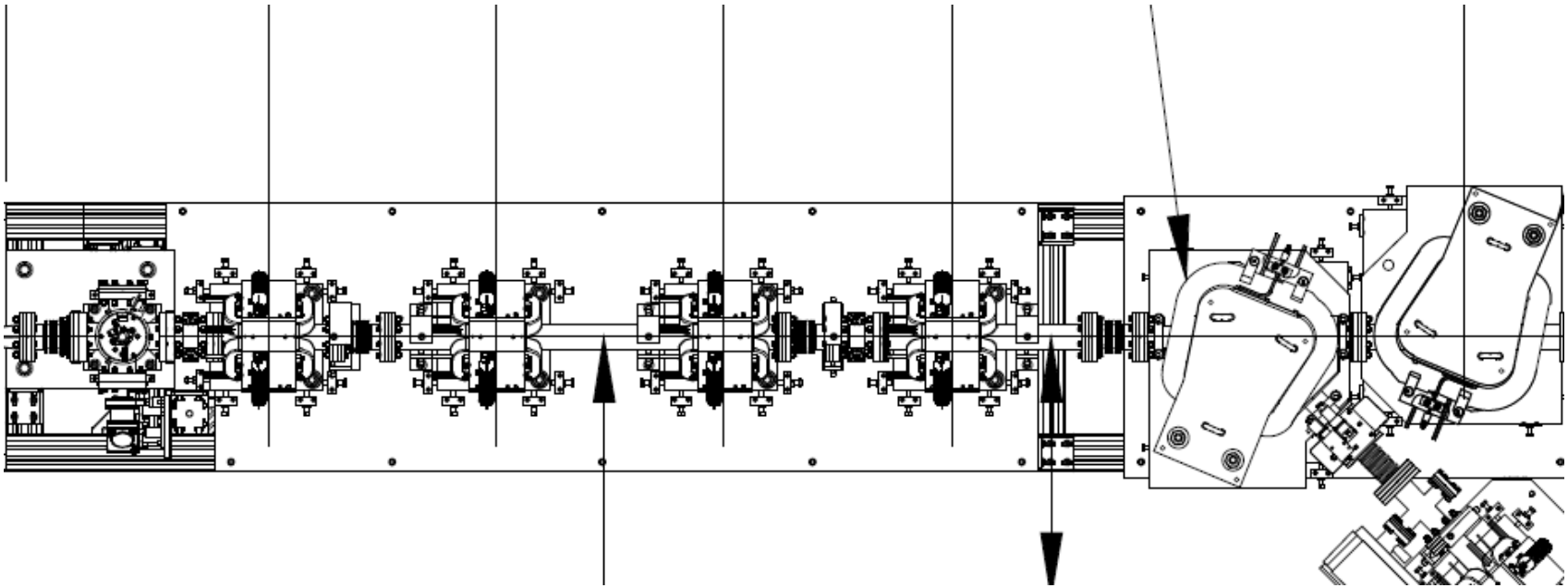
Magnetic field of quadrupole



Magnetic field of quadrupole

$$
\begin{aligned}
B_y &= K \cdot x \\
B_x &= K \cdot y \\
K &= K_1 \cdot B\rho \\
B\rho &= p/q
\end{aligned}
$$

Layout of quadrupoles



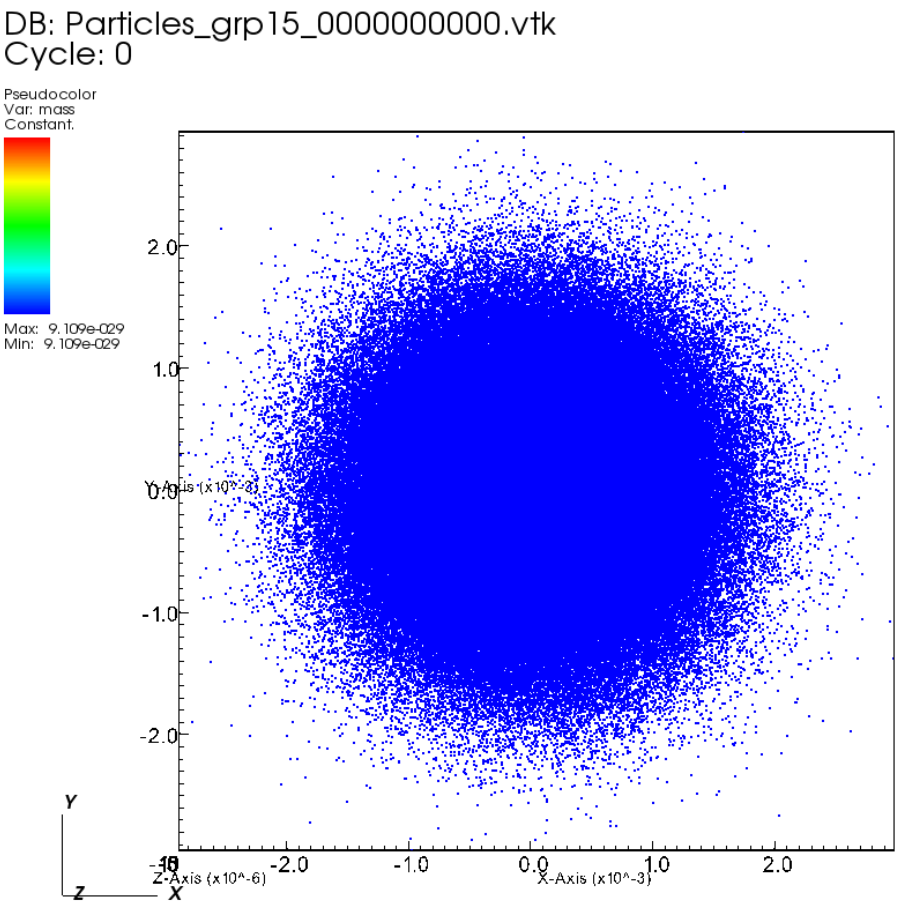
Locations of quadrupoles

- 0m - 0.4715m : Drift
- 0.4715m - 0.6285m : Q1, K1=-2.102
- 0.6285m - 1.0215m : Drift
- 1.0215m - 1.1785m : Q2, K1=6.713
- 1.1785m - 1.5715m : Drift
- 1.5715m - 1.7285m : Q3, K1=-7.661
- 1.7285m - 2.1215m : Drift
- 2.1215m - 2.2785m : Q4, K1=3.383
- 2.2785m - 3.7m : Drift

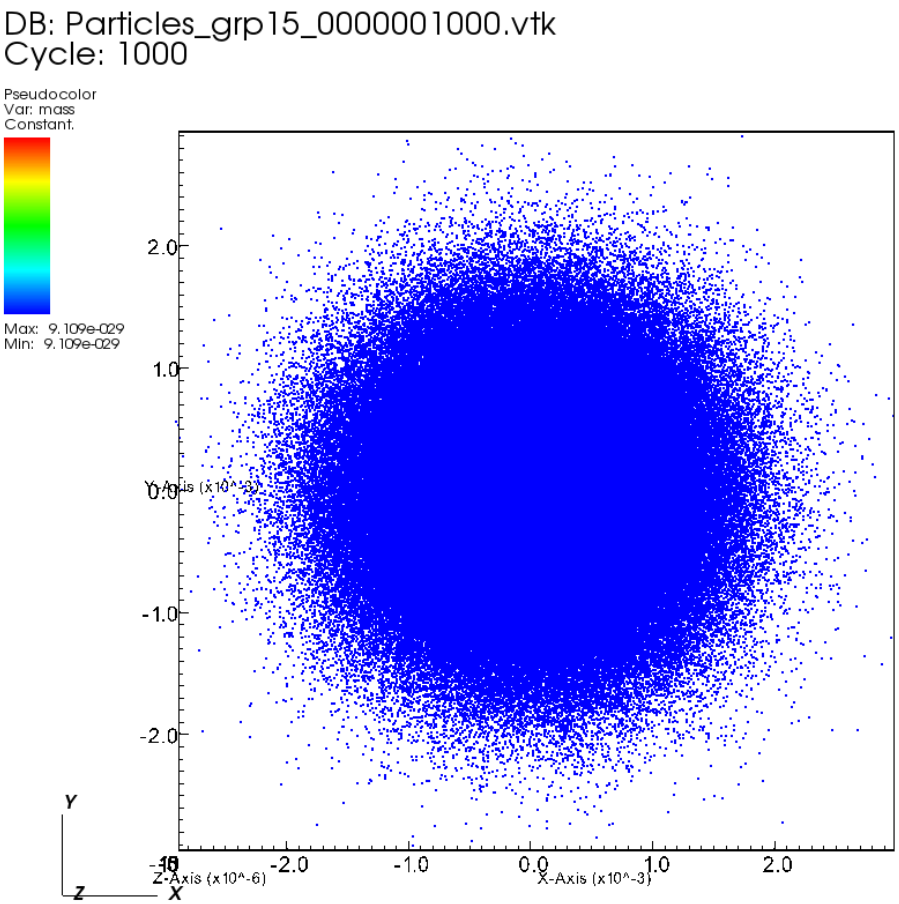
Electron bunch passing through quadrupoles

- Gaussian in x, y
- Uniform in z
- Kappa2 velocity distribution

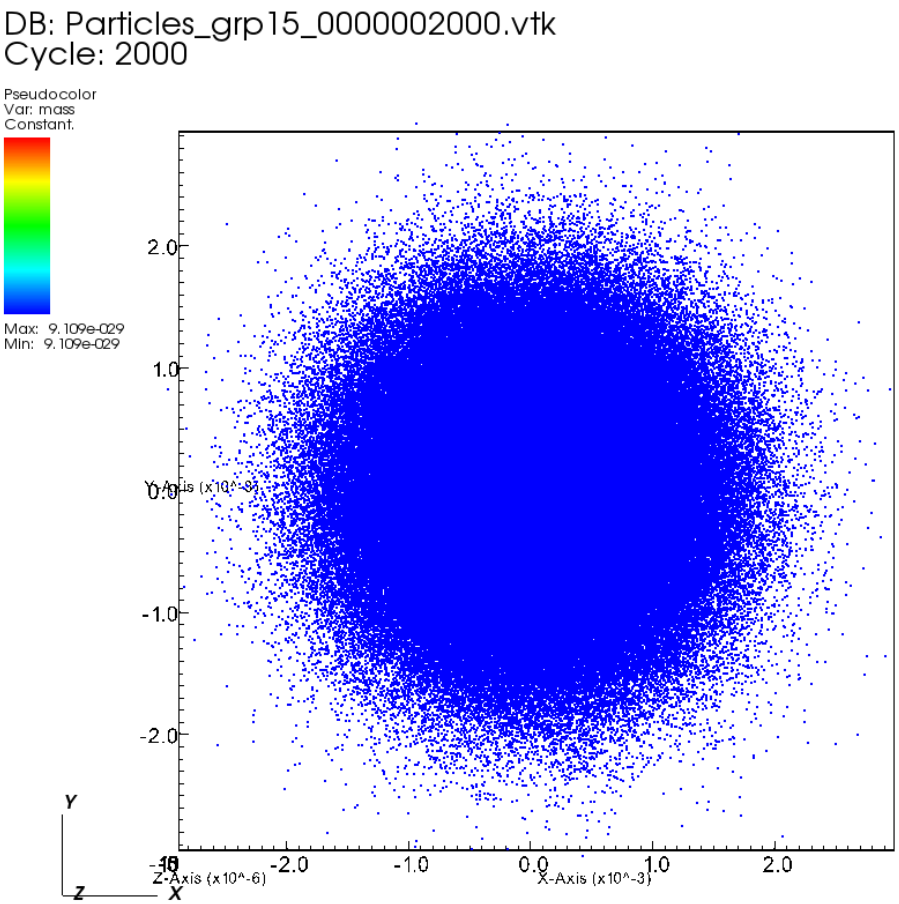
At 0.0 m


DB: Particles_grp15_0000000000.vtk
Cycle: 0
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Y-Axis (x10^-6)
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:36:57 2016

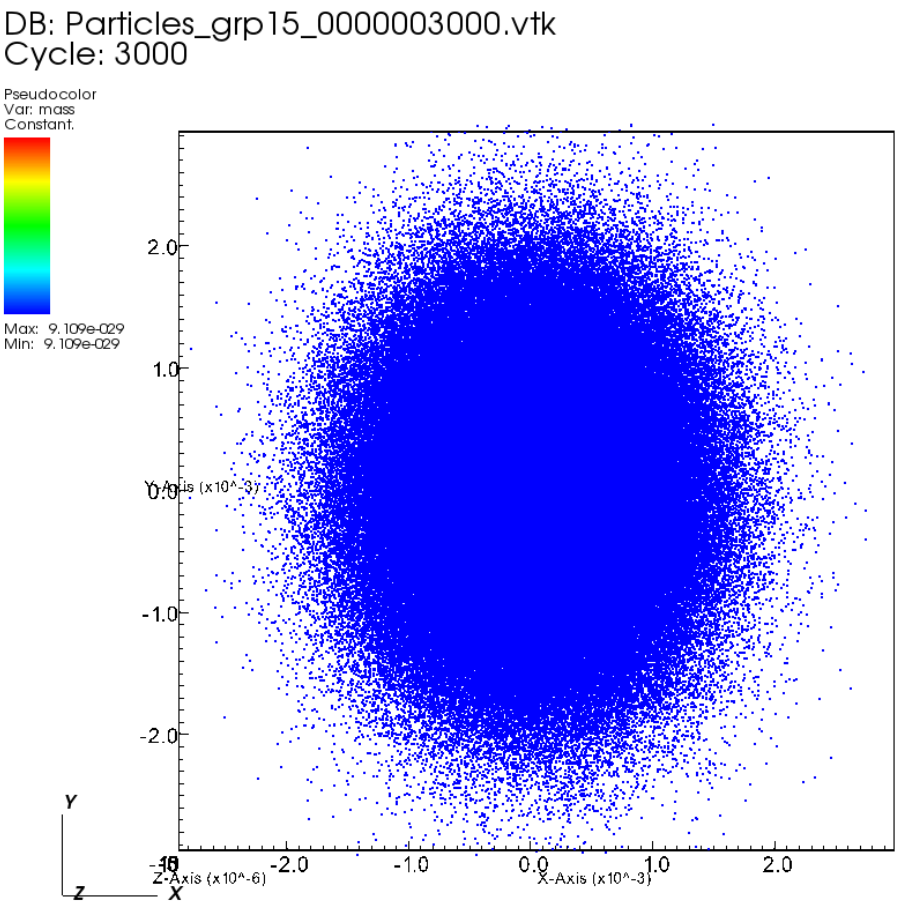
At 0.3 m


DB: Particles_grp15_0000001000.vtk
Cycle: 1000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Y-Axis (x10^-3)
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:37:07 2016

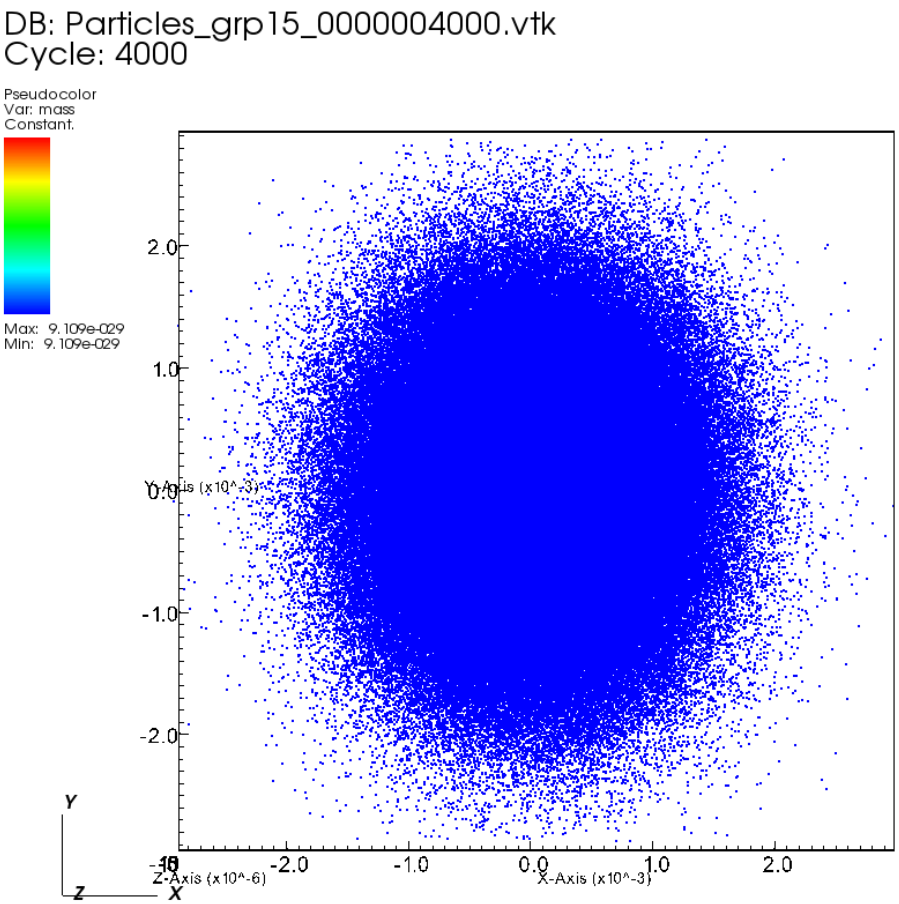
At 0.6 m


DB: Particles_grp15_0000002000.vtk
Cycle: 2000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:37:23 2016

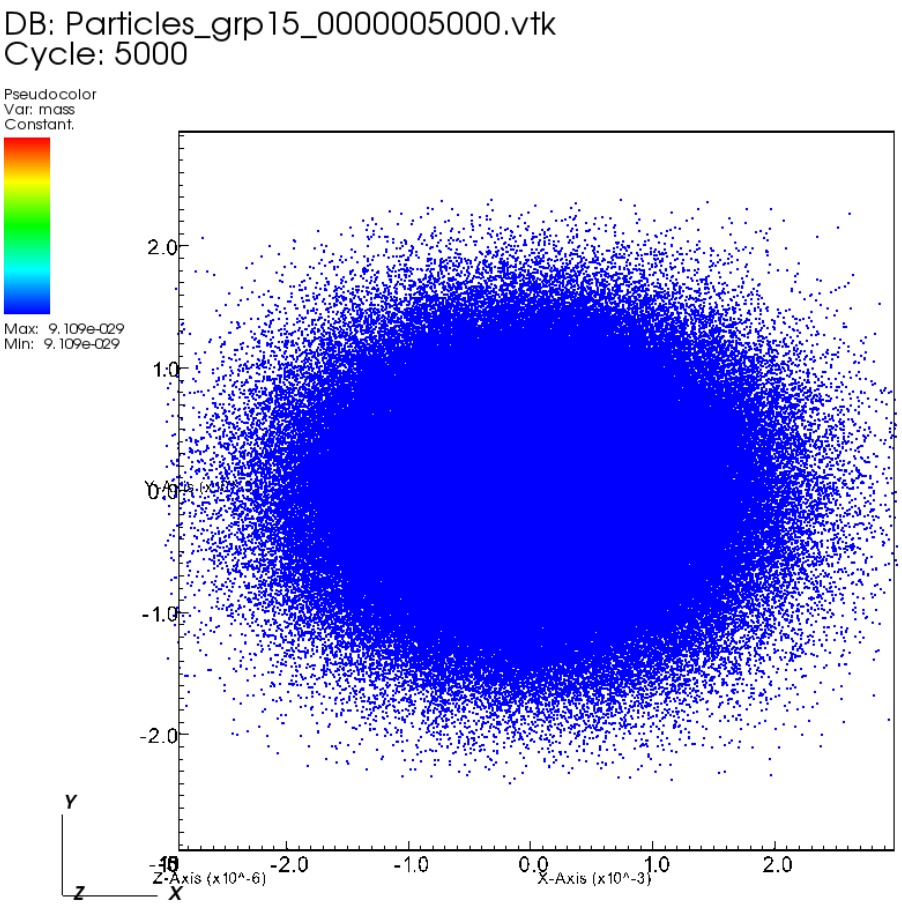
At 0.9 m


DB: Particles_grp15_0000003000.vtk
Cycle: 3000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
Y-Axis (x10^-3)
-2.0
-1.0
0.0
1.0
2.0
X-Axis (x10^-3)
Z-Axis (x10^-6)
Y
Z
X
user: MJ
Wed Mar 30 23:37:31 2016

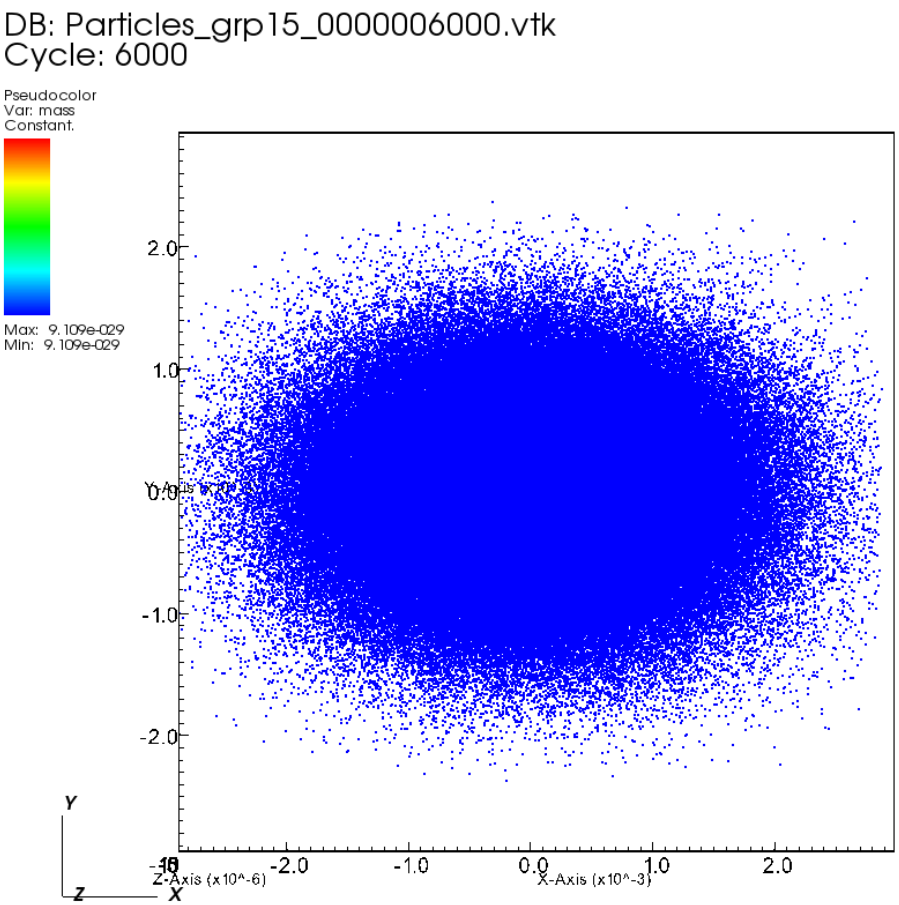
At 1.2 m


DB: Particles_grp15_0000004000.vtk
Cycle: 4000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
Y-Axis (x10^-3)
-2.0
-1.0
0.0
1.0
2.0
X-Axis (x10^-3)
Z-Axis (x10^-6)
Y
Z
X
user: MJ
Wed Mar 30 23:37:40 2016

At 1.5 m


DB: Particles_grp15_0000005000.vtk
Cycle: 5000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:37:47 2016

At 1.8 m


DB: Particles_grp15_0000006000.vtk
Cycle: 6000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
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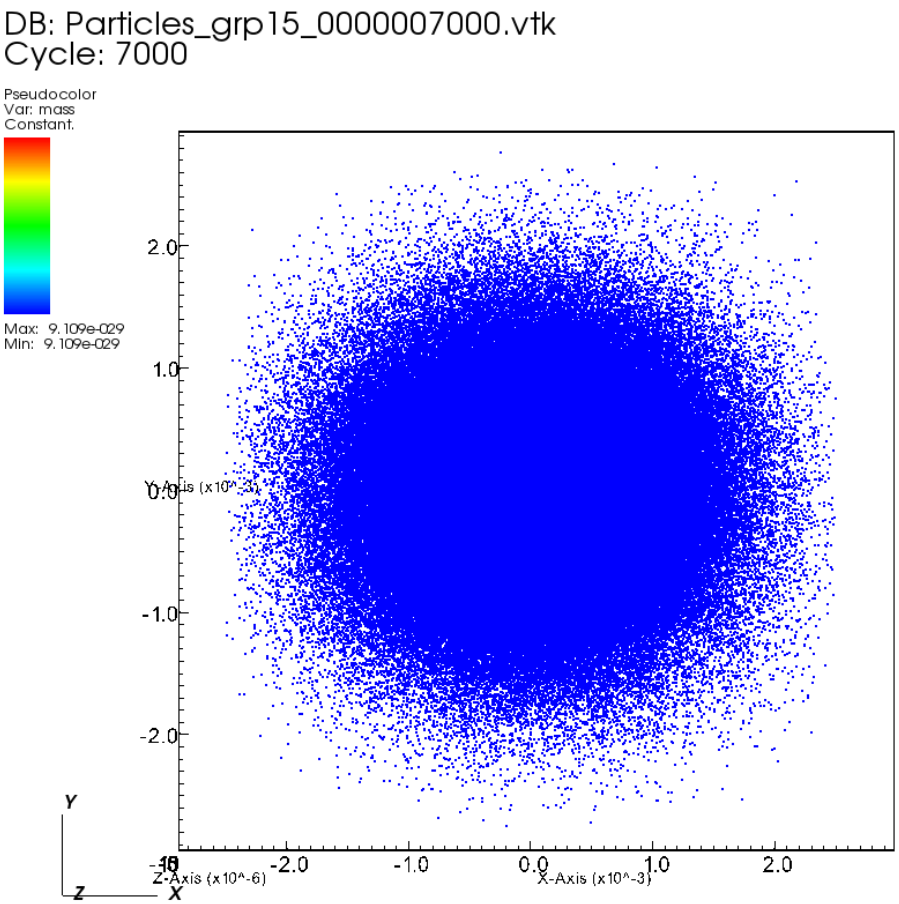
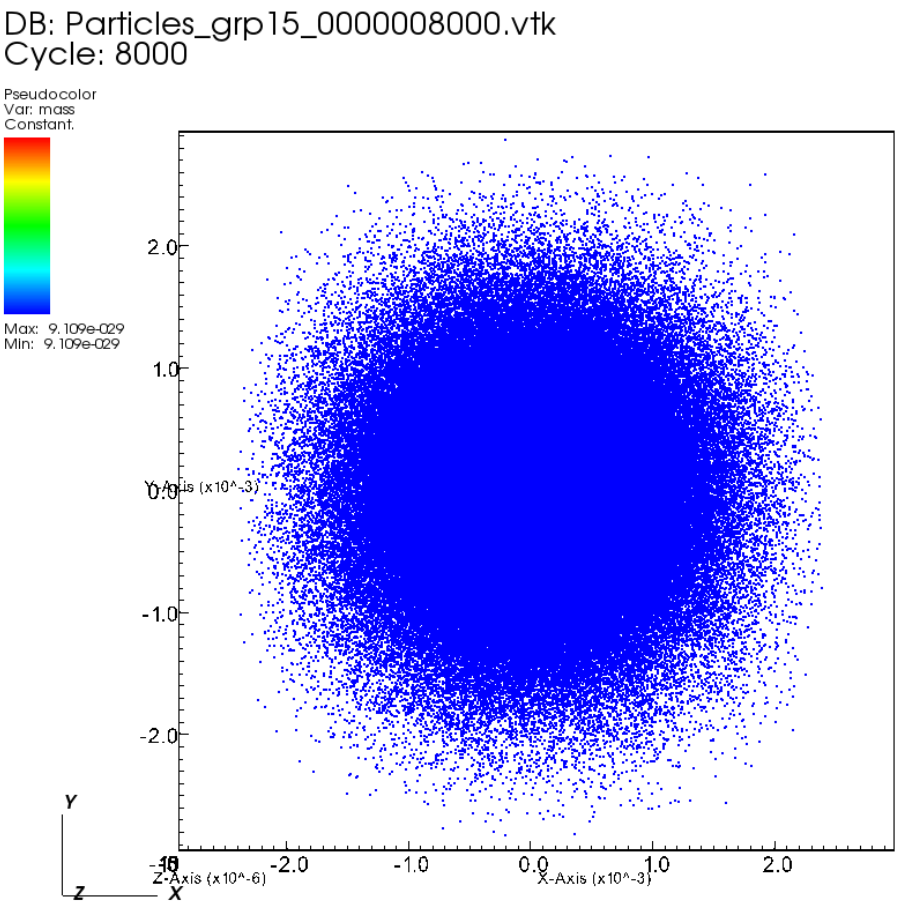
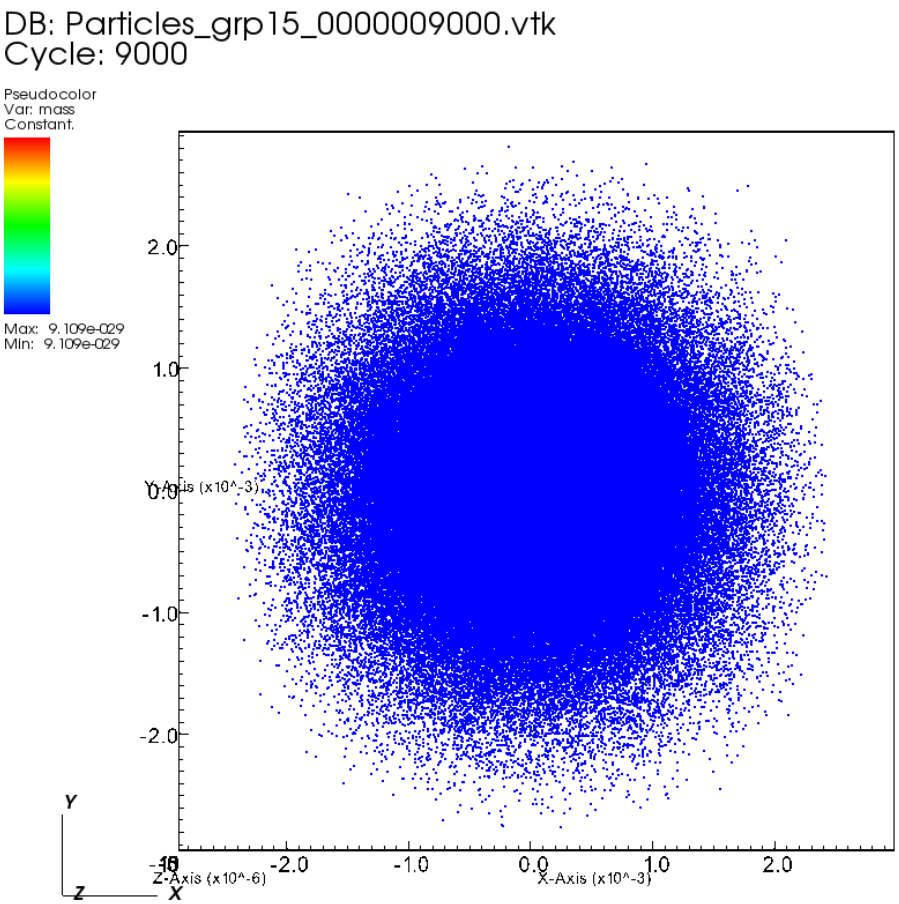
At 2.1 m


DB: Particles_grp15_0000007000.vtk
Cycle: 7000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:38:02 2016

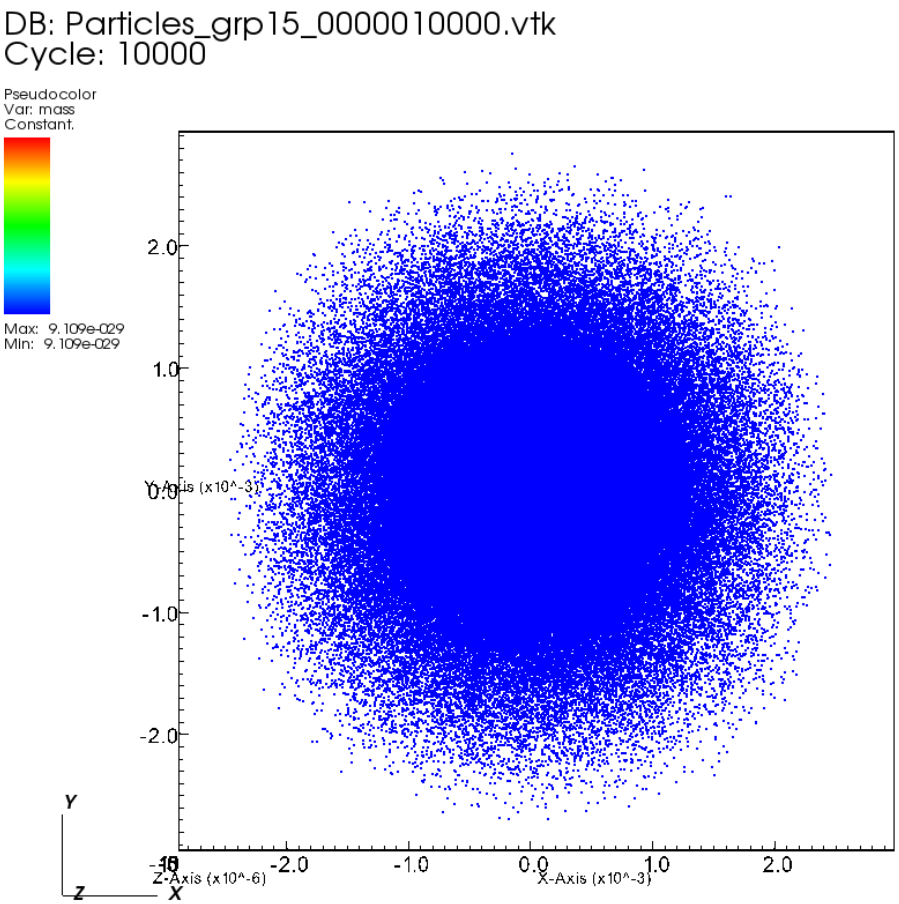
At 2.4 m


DB: Particles_grp15_0000008000.vtk
Cycle: 8000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
Y-Axis (x10^-3)
-2.0
-1.0
0.0
1.0
2.0
X-Axis (x10^-3)
Z-Axis (x10^-6)
Y
Z
X
user: MJ
Wed Mar 30 23:38:09 2016

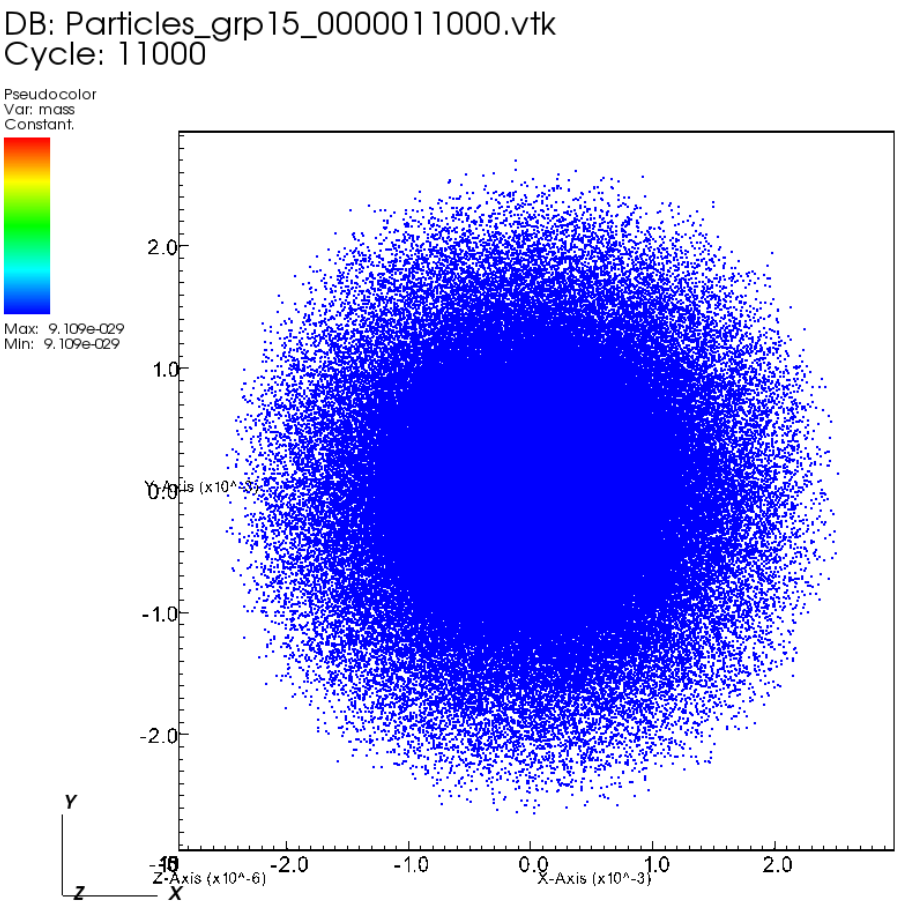
At 2.7 m


DB: Particles_grp15_0000009000.vtk
Cycle: 9000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
Y-Axis (x10^-3)
-2.0
-1.0
0.0
1.0
2.0
X-Axis (x10^-3)
Z-Axis (x10^-6)
Y
Z
X
user: MJ
Wed Mar 30 23:38:17 2016

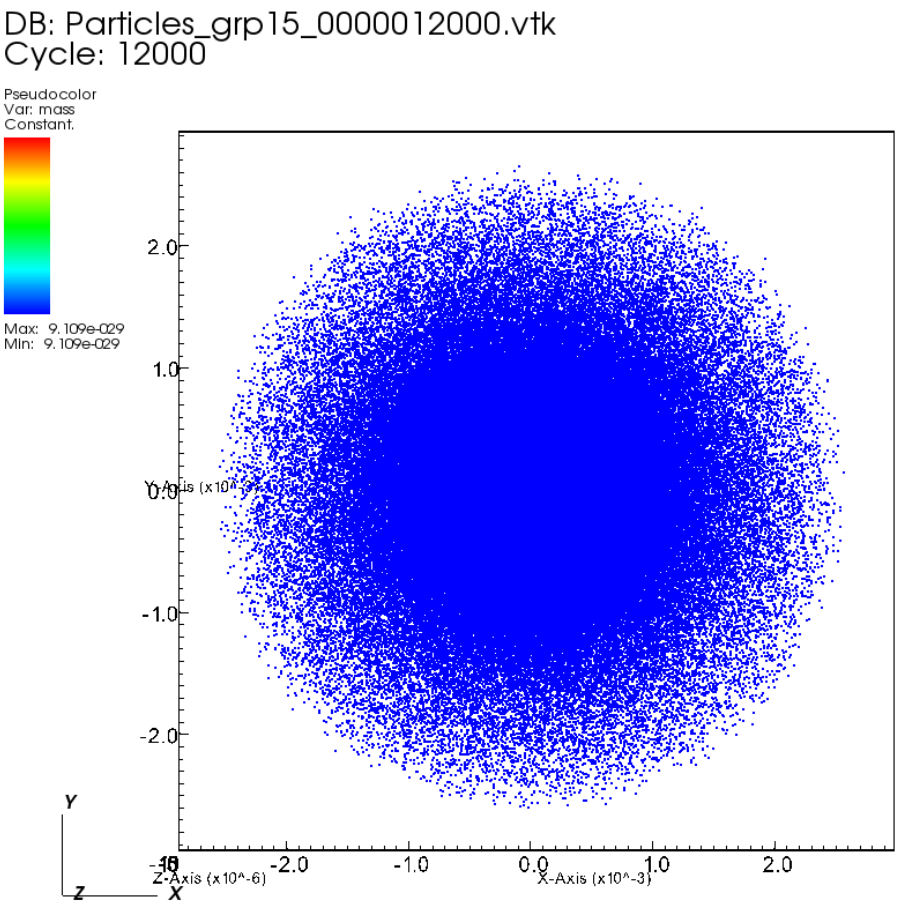
At 3.0 m


DB: Particles_grp15_0000010000.vtk
Cycle: 10000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
Y-Axis (x10^-3)
-2.0
-1.0
0.0
1.0
2.0
X-Axis (x10^-3)
Z-Axis (x10^-6)
Y
Z
X
user: MJ
Wed Mar 30 23:38:24 2016

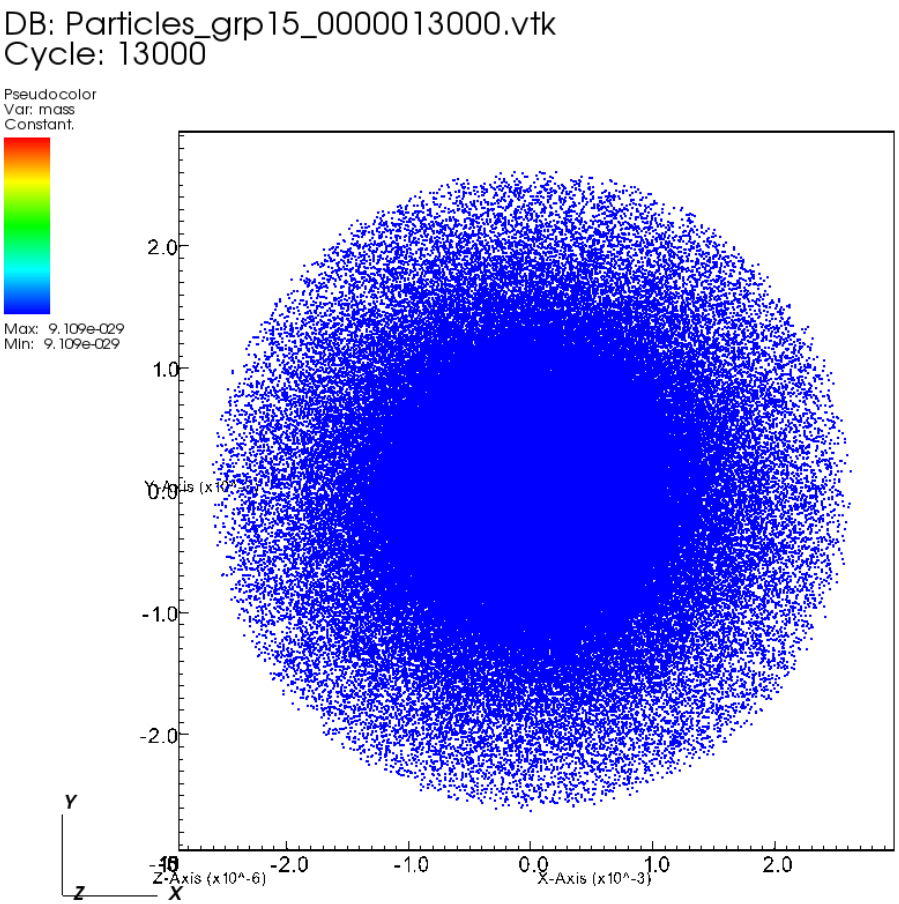
At 3.3 m


DB: Particles_grp15_0000011000.vtk
Cycle: 11000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
Y-Axis (x10^-3)
-2.0
-1.0
0.0
1.0
2.0
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:38:30 2016

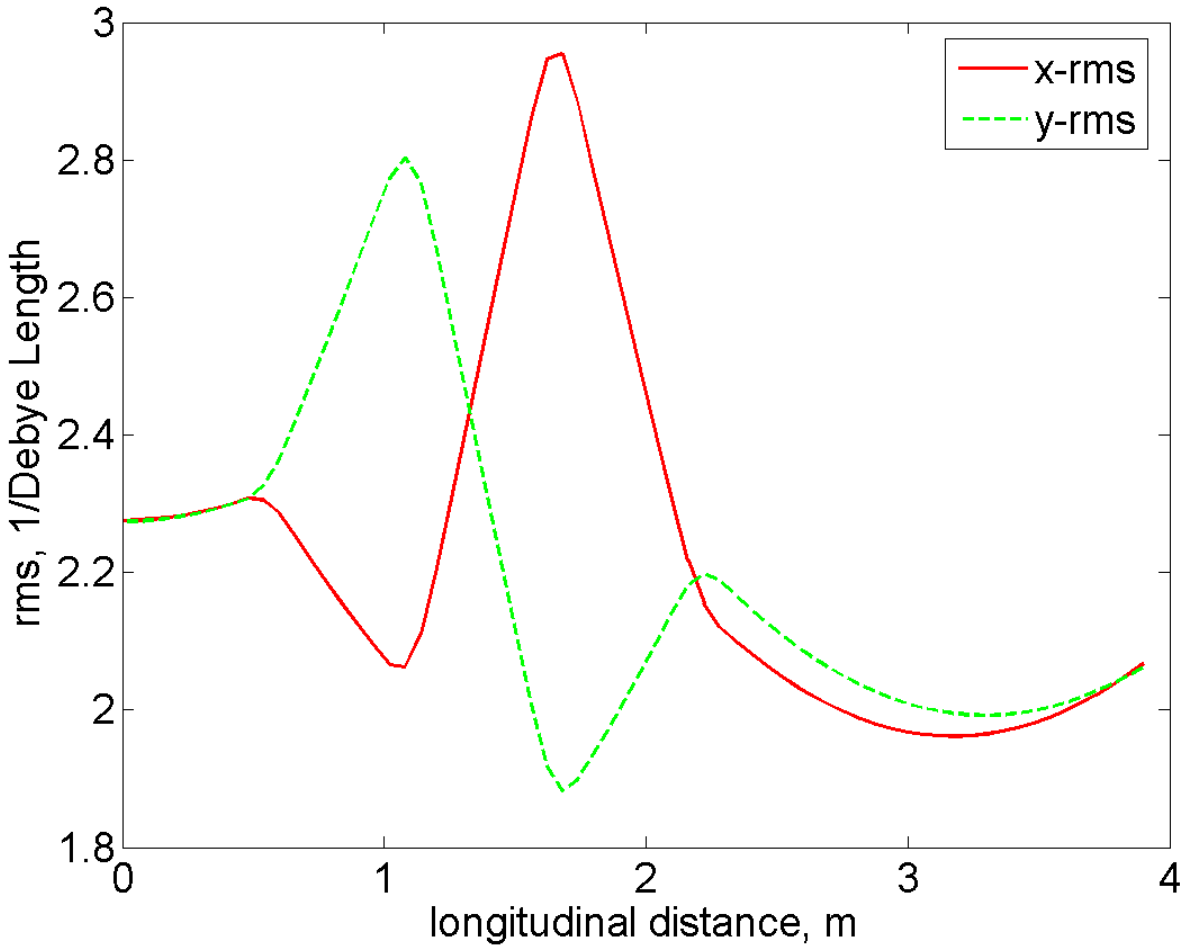
At 3.6 m


DB: Particles_grp15_0000012000.vtk
Cycle: 12000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:38:37 2016

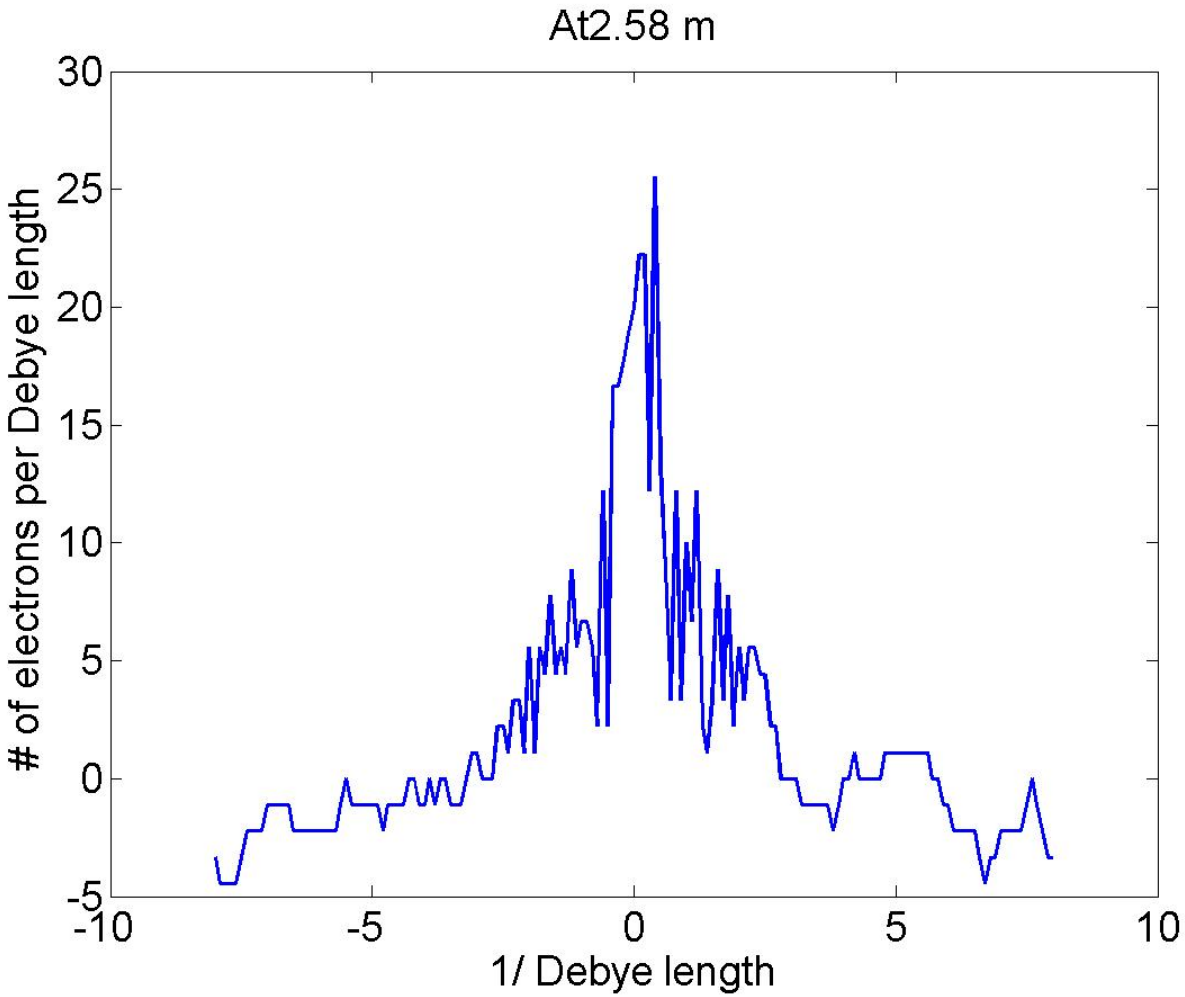
At 3.9 m


DB: Particles_grp15_0000013000.vtk
Cycle: 13000
Pseudocolor
Var: mass
Constant.
Max: 9.109e-029
Min: 9.109e-029
2.0
1.0
0.0
-1.0
-2.0
-2.0
-1.0
0.0
1.0
2.0
Z-Axis (x10^-6)
X-Axis (x10^-3)
Y
Z
X
user: MJ
Wed Mar 30 23:38:44 2016

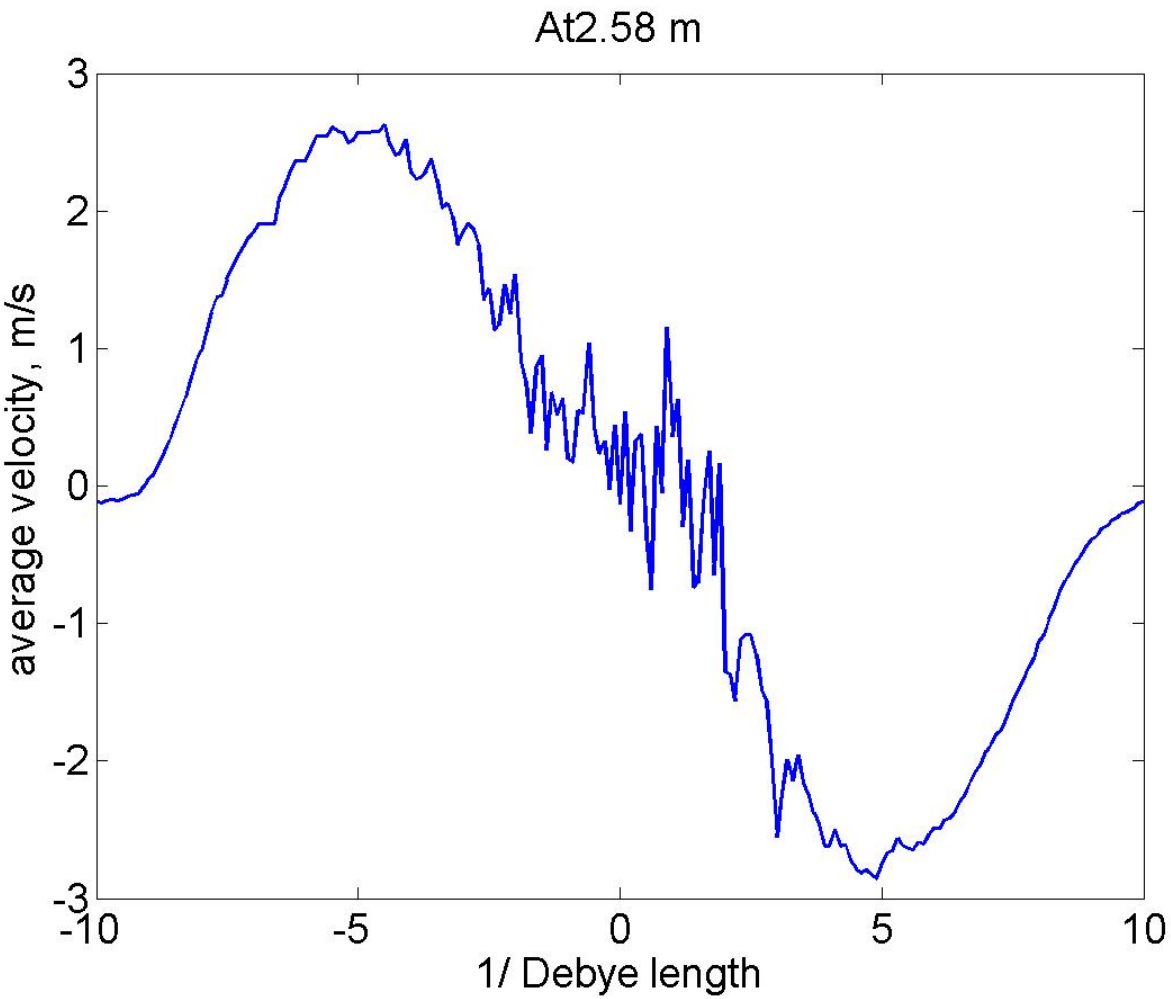
RMS


x-rms
y-rms
rms, 1/Debye Length
longitudinal distance, m
3
2.8
2.6
2.4
2.2
2
1.8
0
1
2
3
4

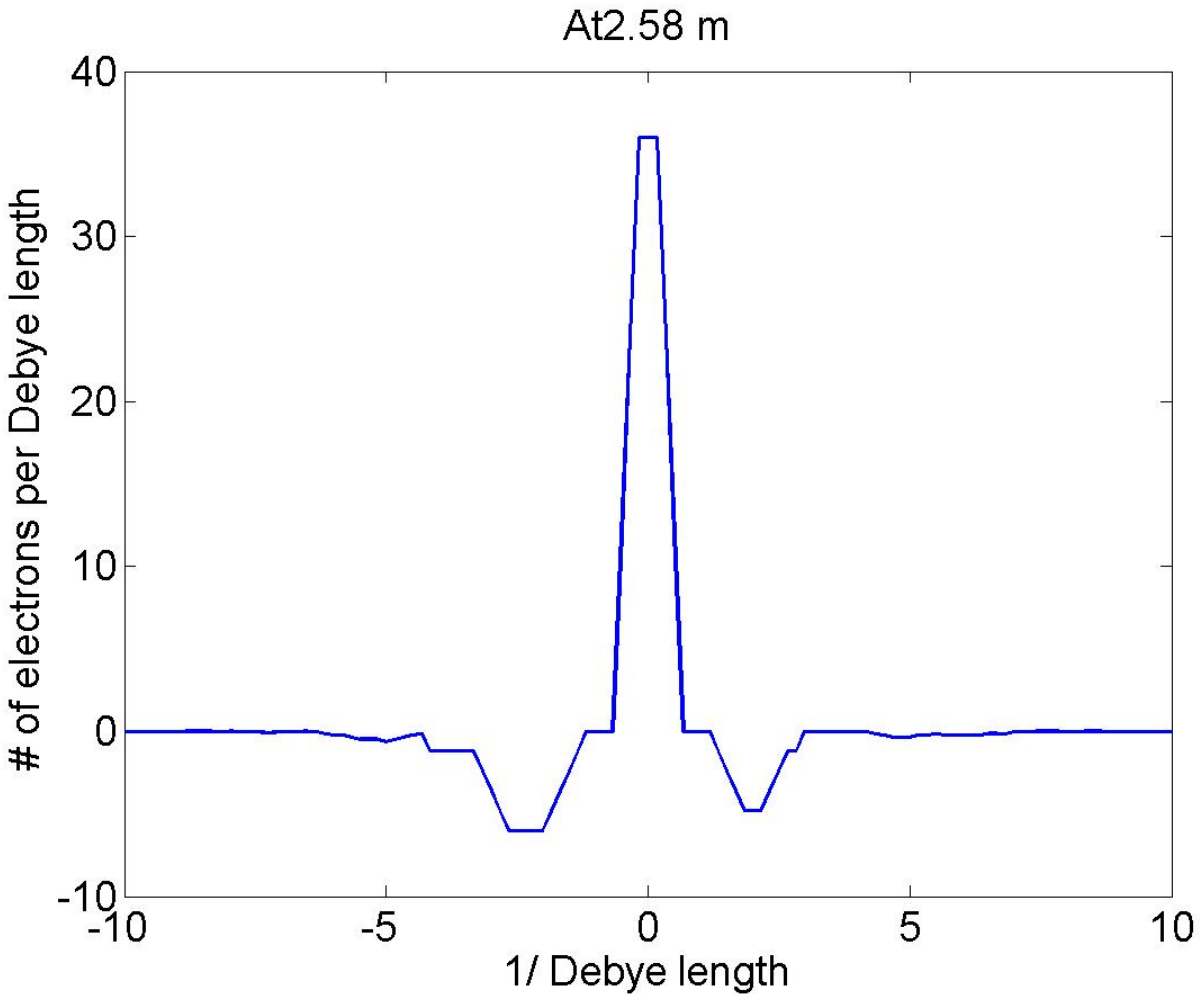
Longitudinal number distribution



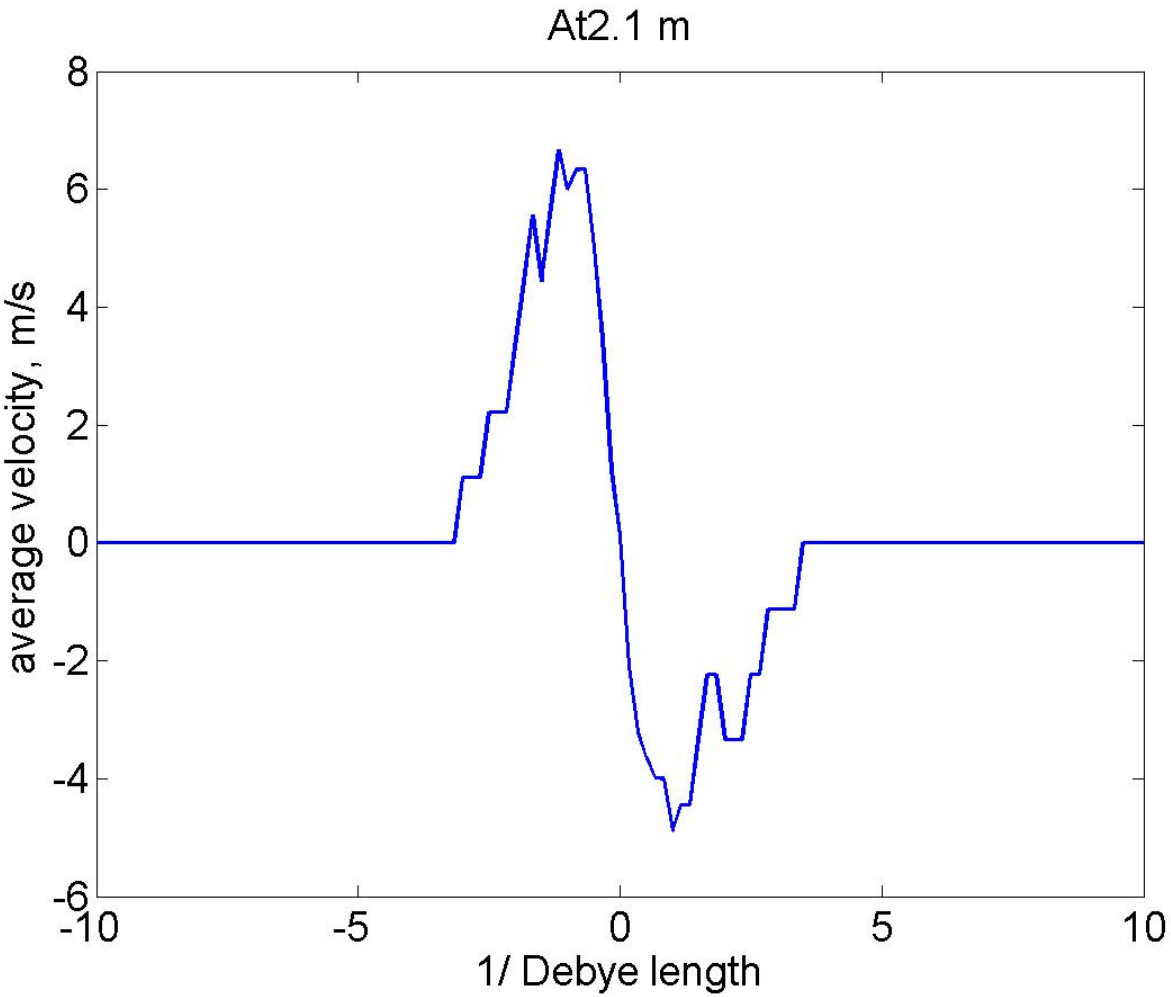
Longitudinal velocity distribution



Transversal number distribution



Transversal velocity distribution



- Ion moves with 1 β_z along longitudinal direction
- In the code, ion stays and electron bunch moves instead

Longitudinal number distribution