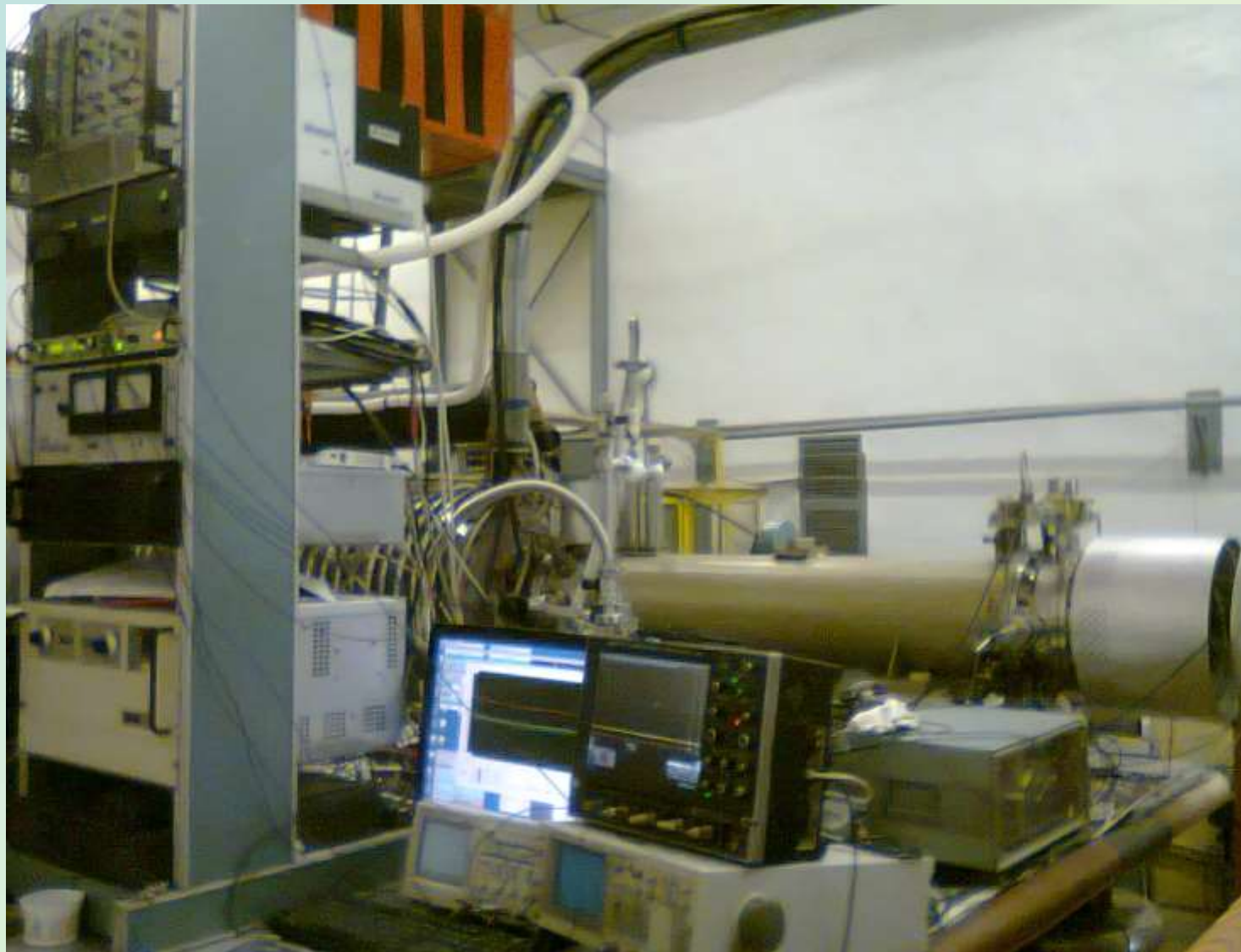


Программное обеспечение для  
физических расчетов методом частиц в  
ячейке

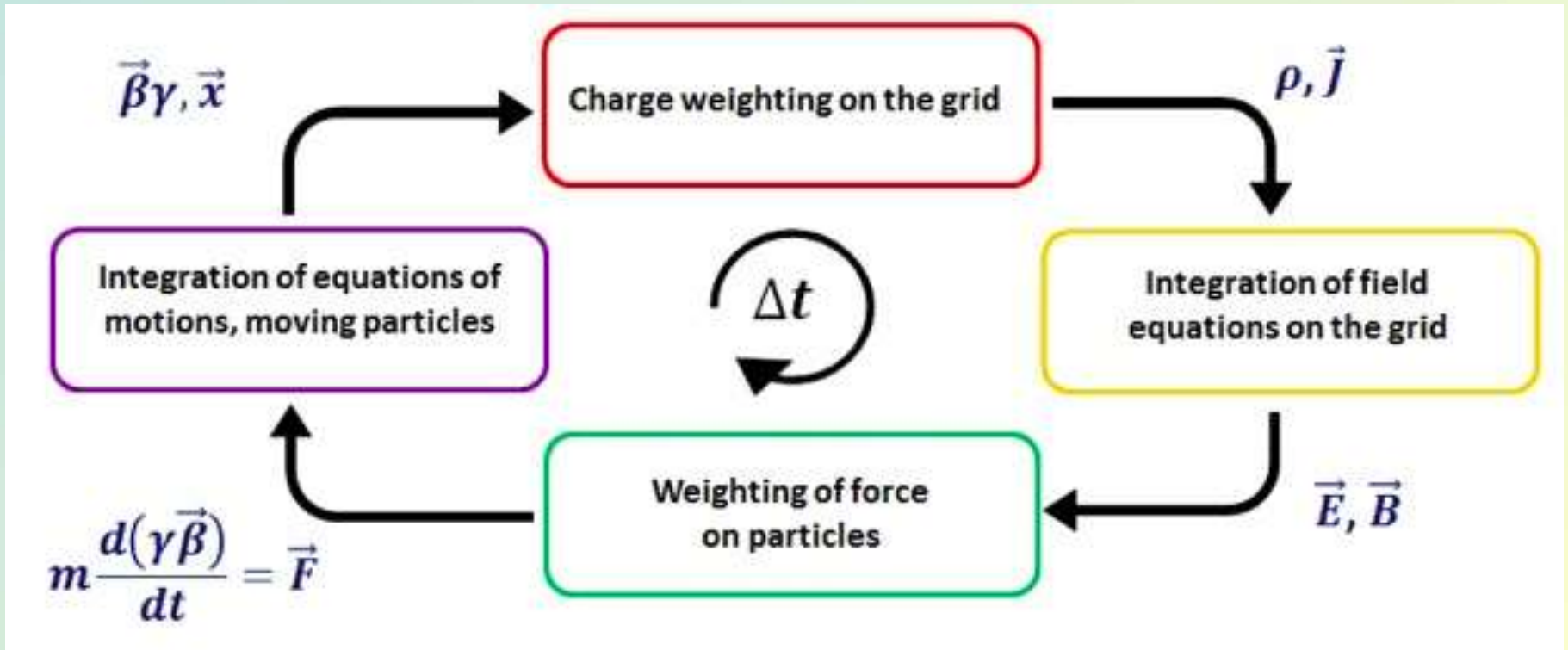
Бойцов А.Ю.

# Krion -6T



# The particle in cell method

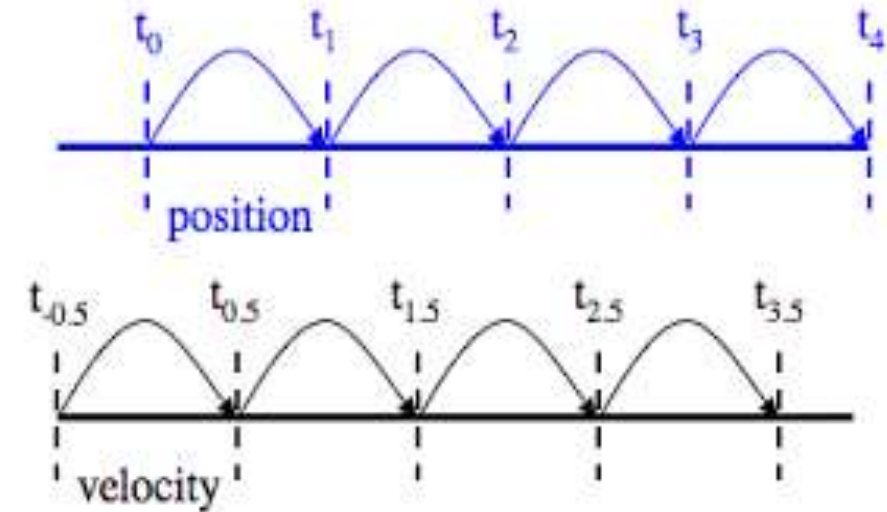
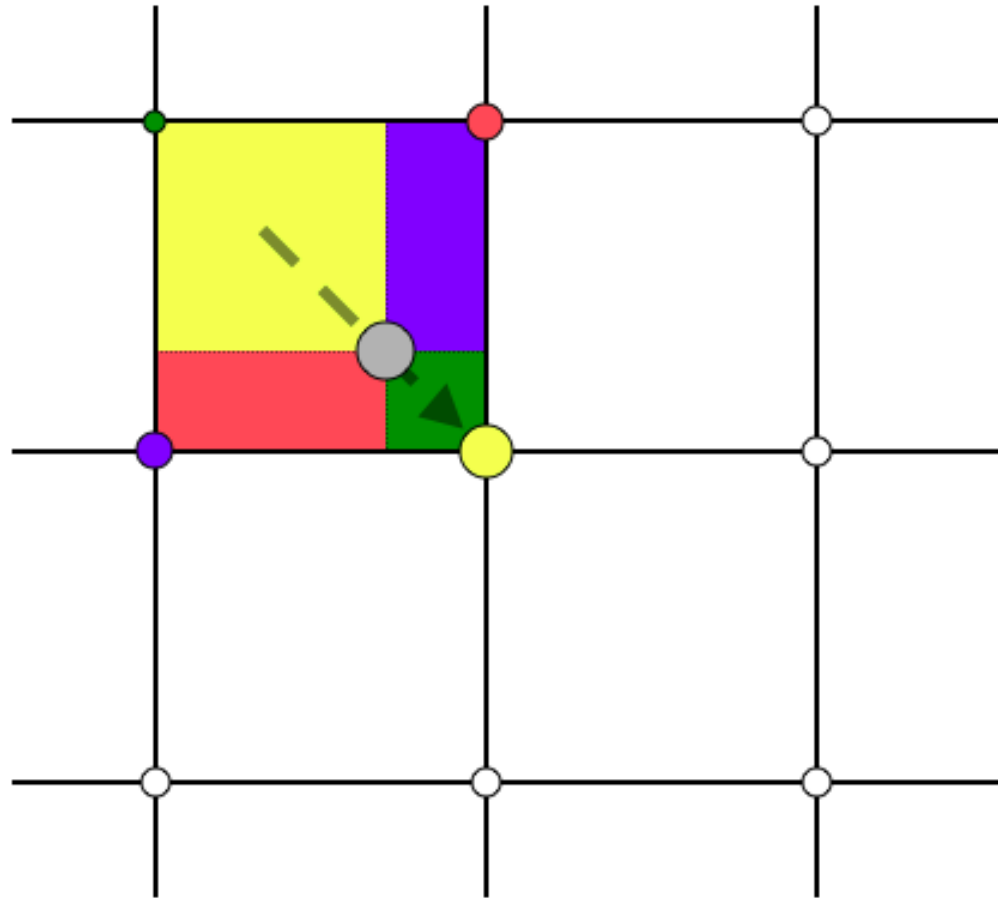
The Particle-In-Cell Method for Hydrodynamic Calculations. Personal Authors: Evans, Martha W.; Harlow, Francis H.; Bromberg, Eleazer Report Date: 08 NOV 1957



[http://gaps.ing2.uniroma1.it/alberto/alberto/PIC\\_files/PICloop.jp](http://gaps.ing2.uniroma1.it/alberto/alberto/PIC_files/PICloop.jp)

# Charge weighting on the grid

# Moving particles



The Leap-Frog method.

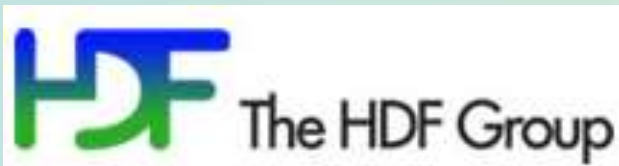
[https://www.particleincell.com/wp-content/uploads/2010/11/pic\\_leapfrog.png](https://www.particleincell.com/wp-content/uploads/2010/11/pic_leapfrog.png)

Schematic of the scatter operation. Charge of the particle (in gray) is distributed among the surrounding nodes. Charge contributed to each node is based on the proximity of the particle to that node  
<https://www.particleincell.com/2010/es-pic-method/>



# Electrostatic Particle In Cell Functions

Libraries:



**PETSc**



Source:



<https://github.com/noooway/epicf>

Computing resource



<http://hybrilit.jinr.ru>

Visualization



About PIC:



<https://www.particleincell.com>

**Main code was  
maid by  
Andrei Bylichev  
(BLTP JINR)**

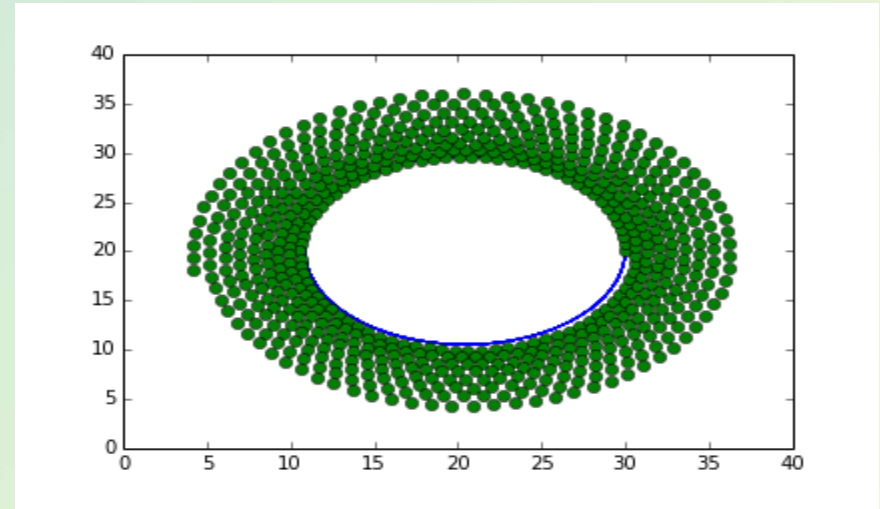
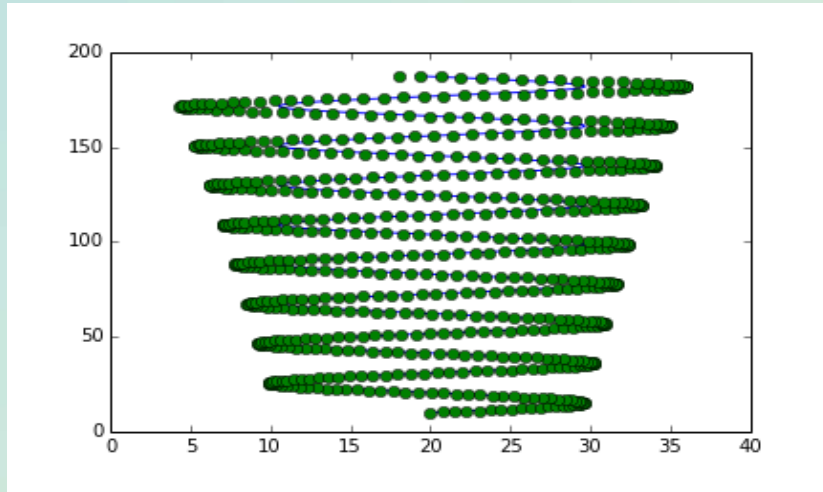
User interface



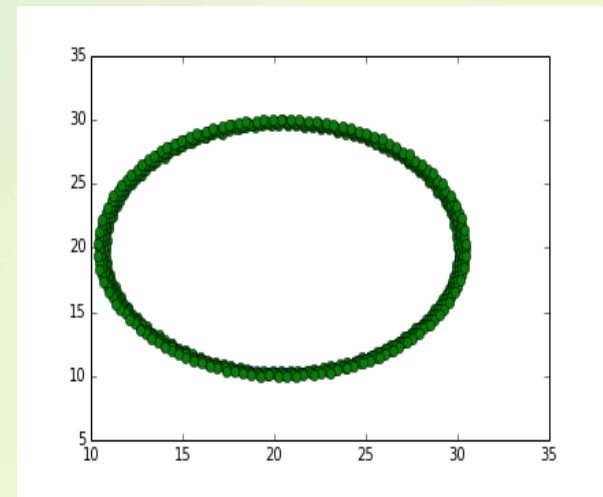
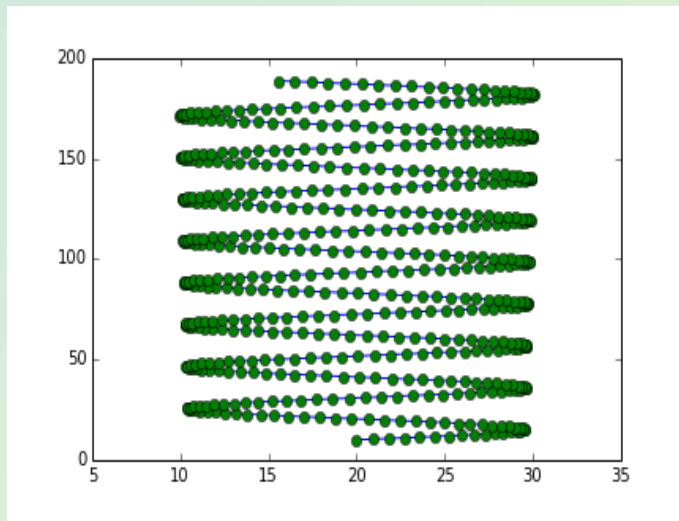
/

# Tests: helix

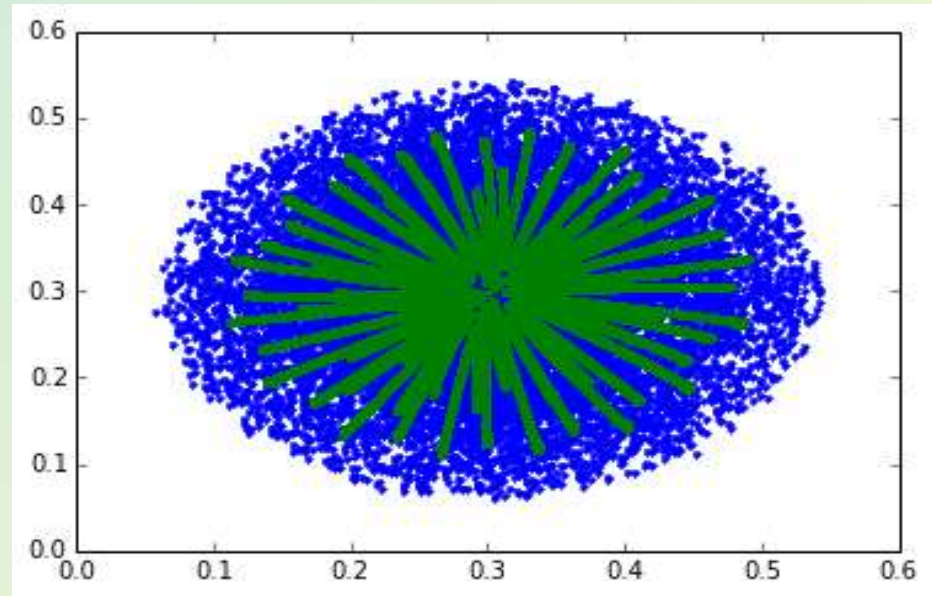
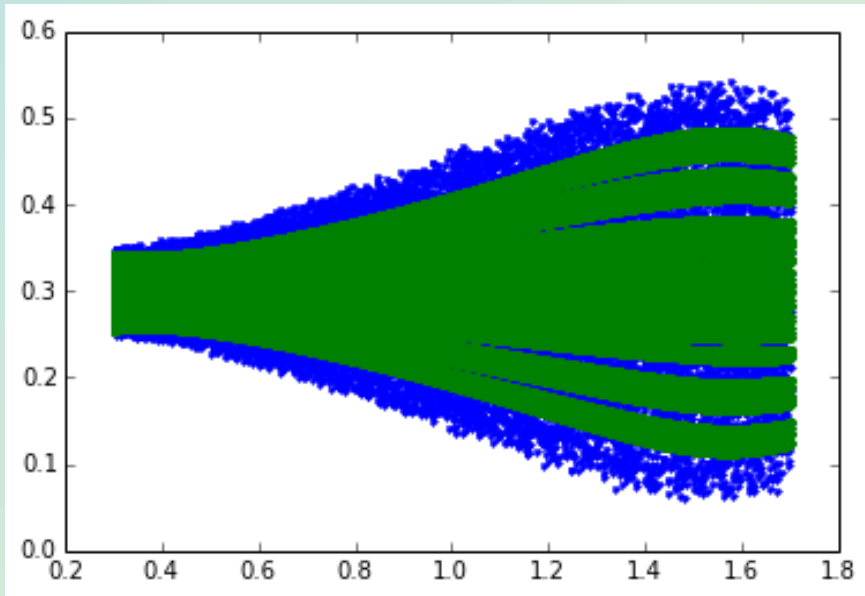
$T = 1e-8s$



$T = 1e-9s$



# Tests: diode

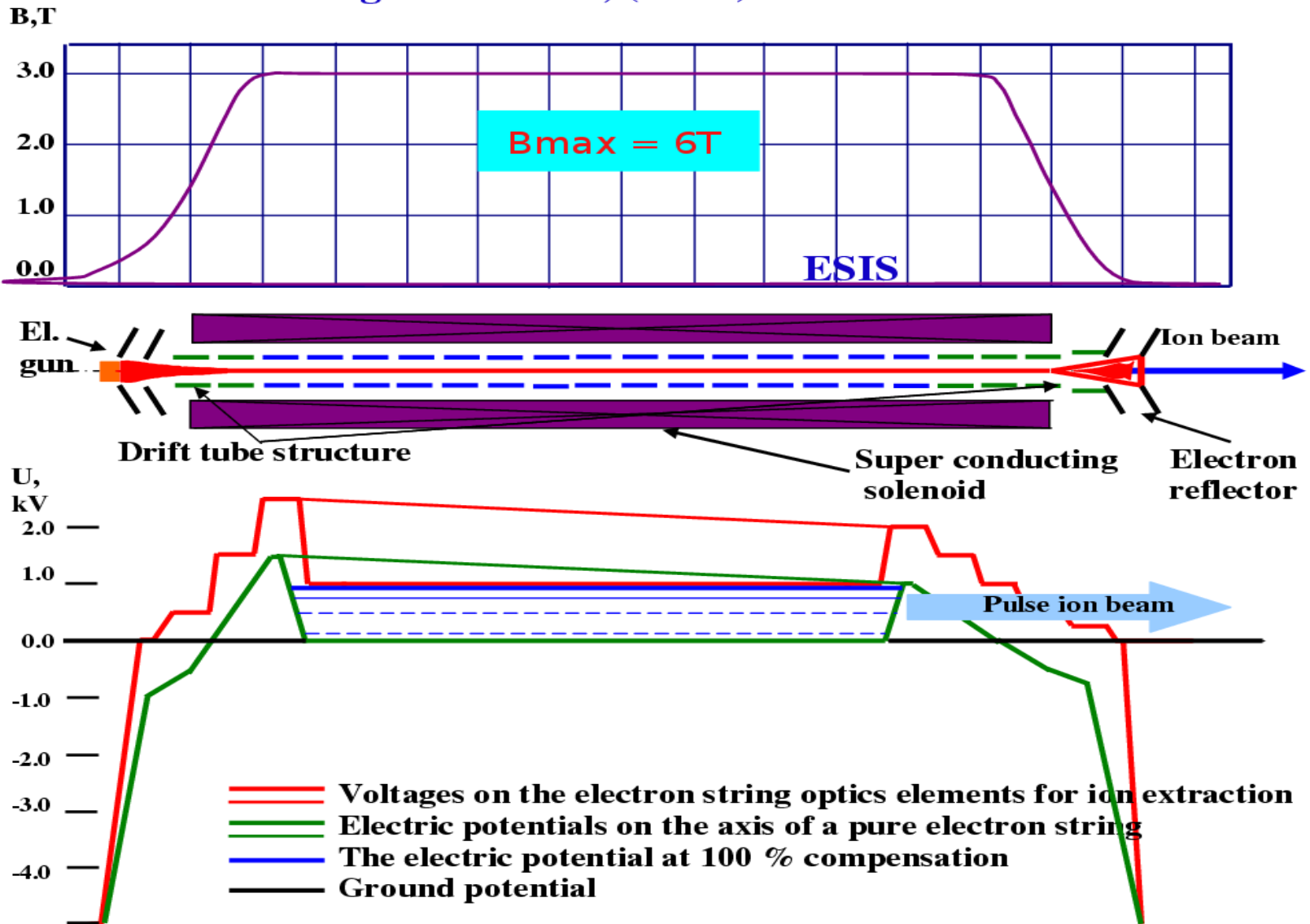


Green: external program

Blue: our program



# Electron String Ion Source, (ESIS)



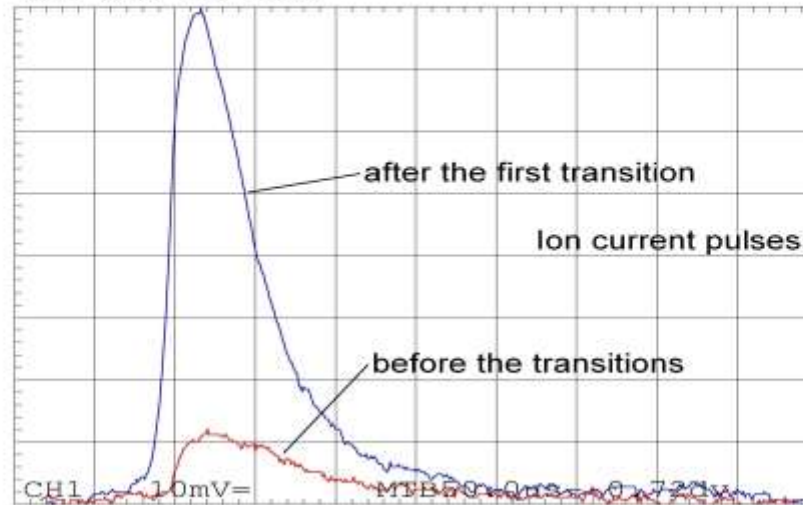
Total ion current pulse before (red),

after 1-st transition (blue)

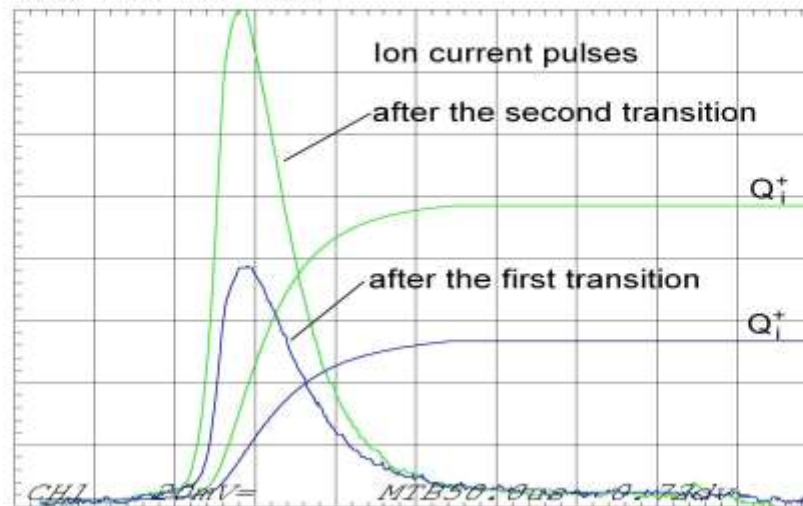
and after 2-nd transition (green)

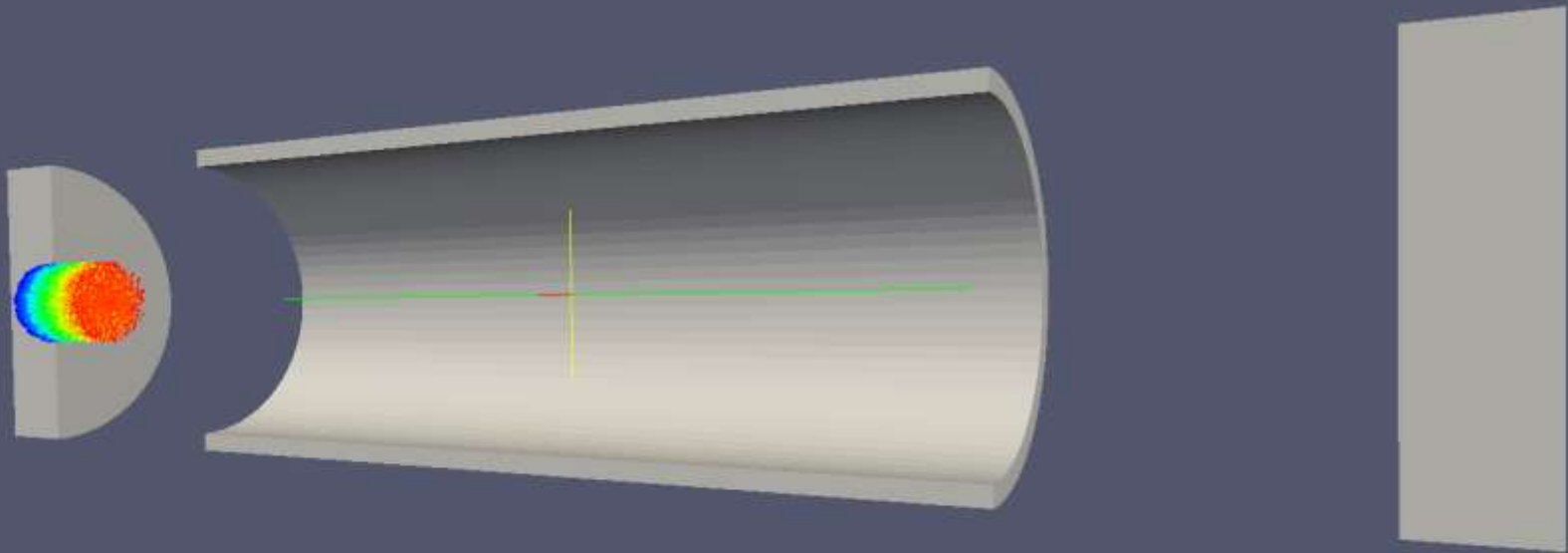
to e-string state

Thu Jul 21 2011

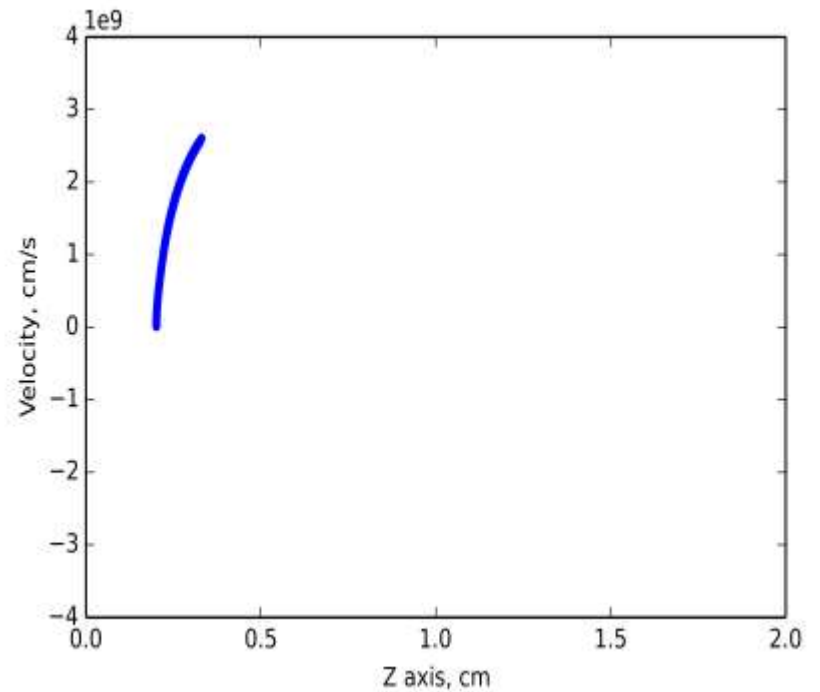
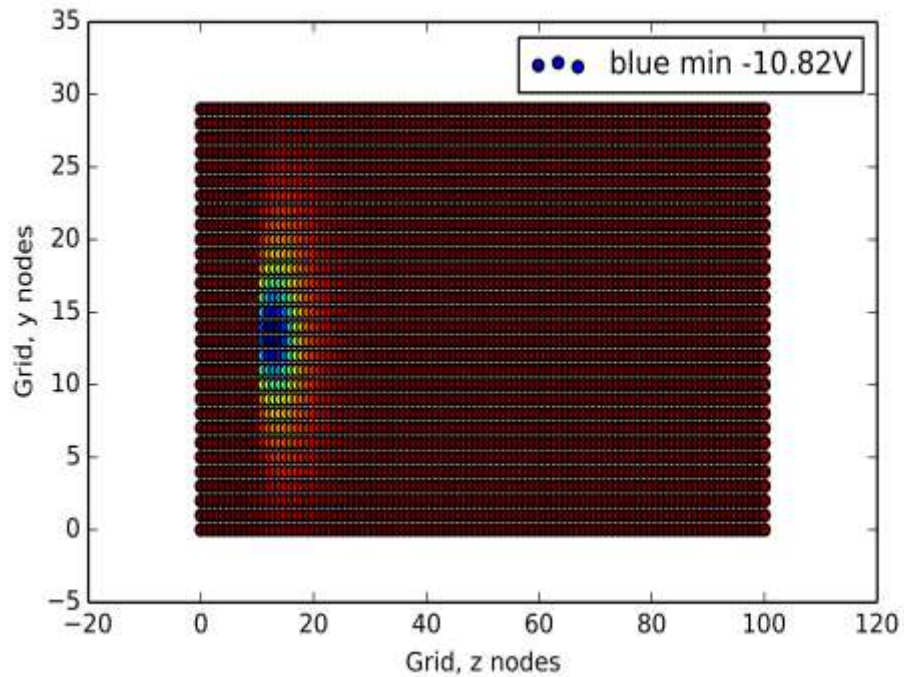


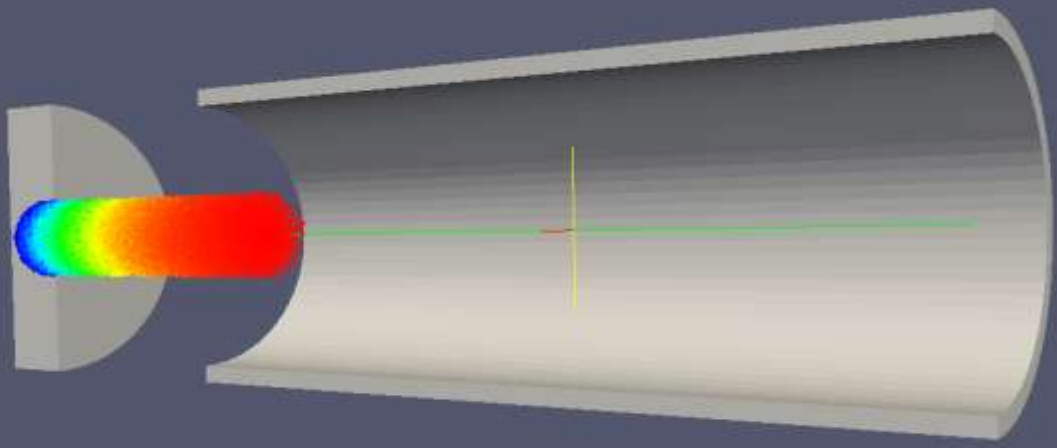
Thu Jul 21 2011



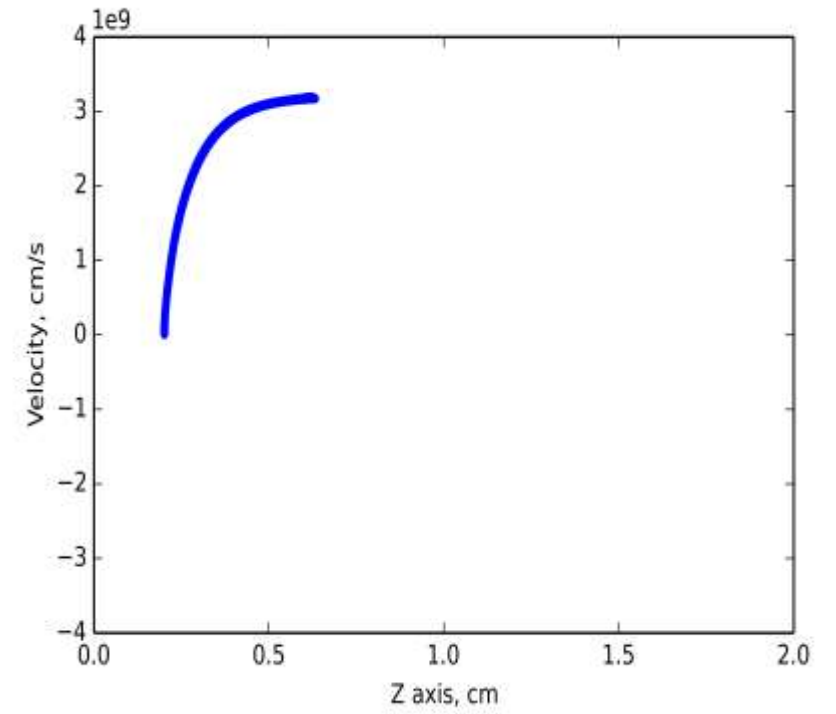
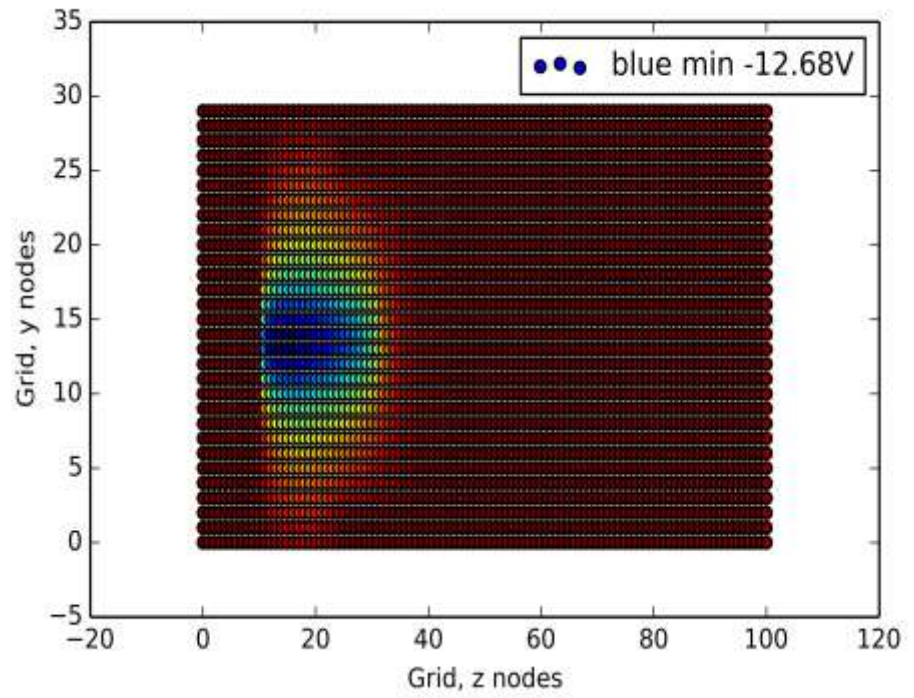


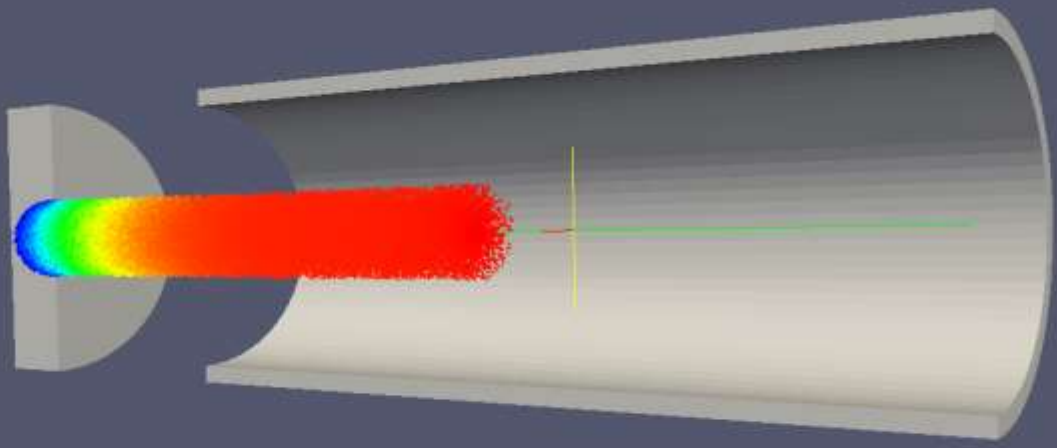
$T = 0.1 \text{ ns}$



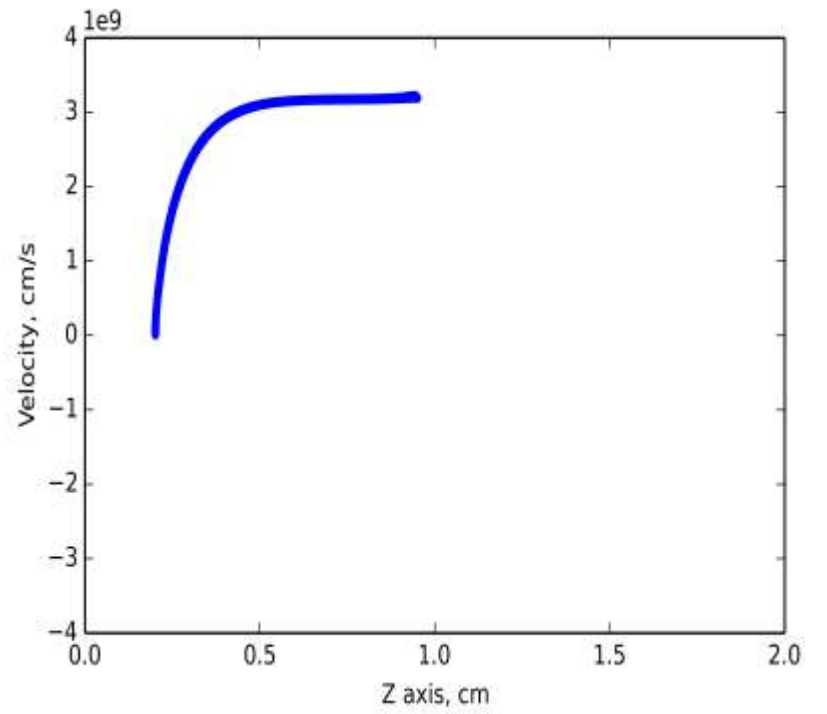
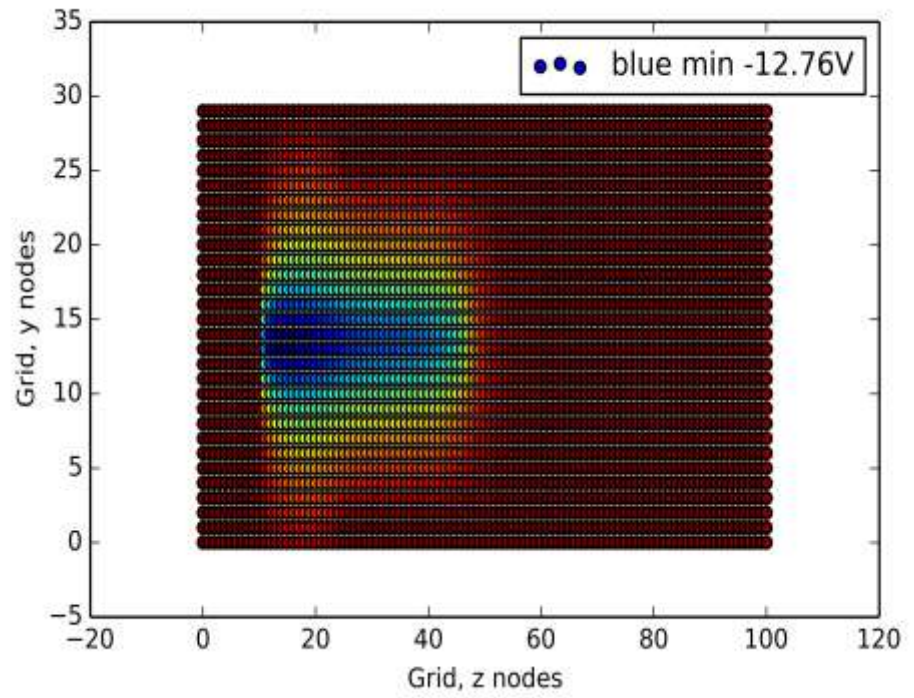


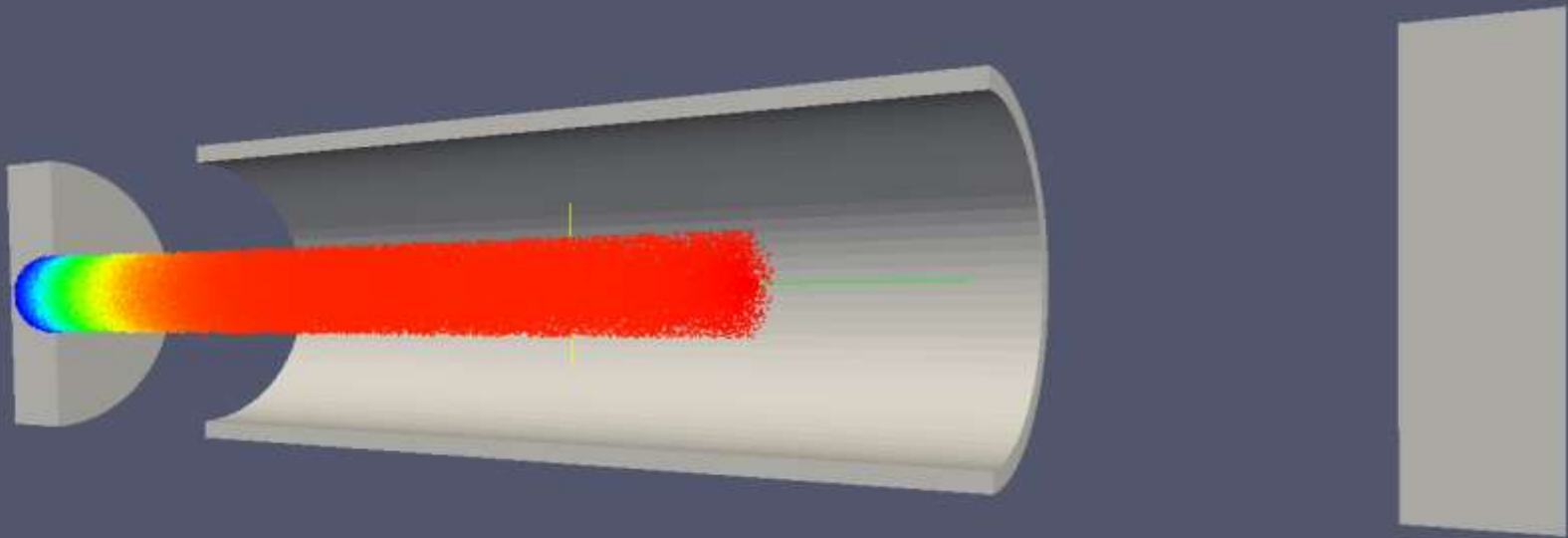
$T = 0.2 \text{ ns}$



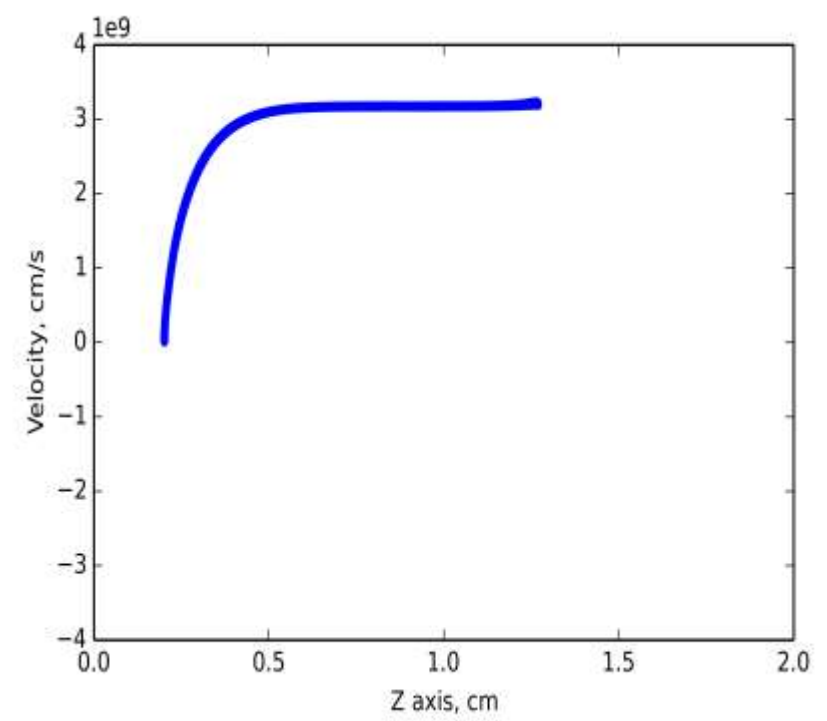
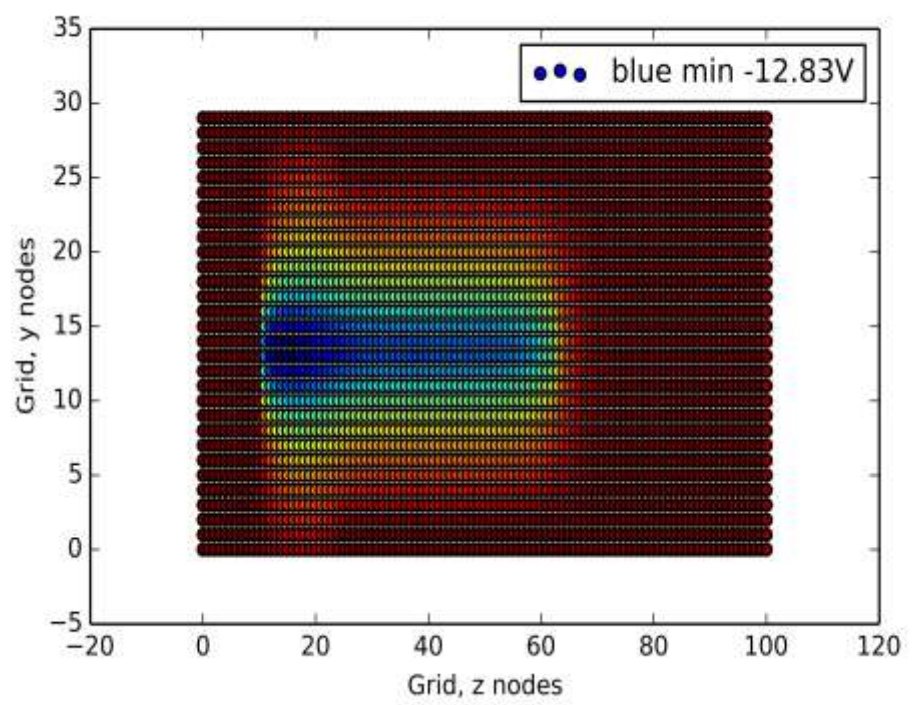


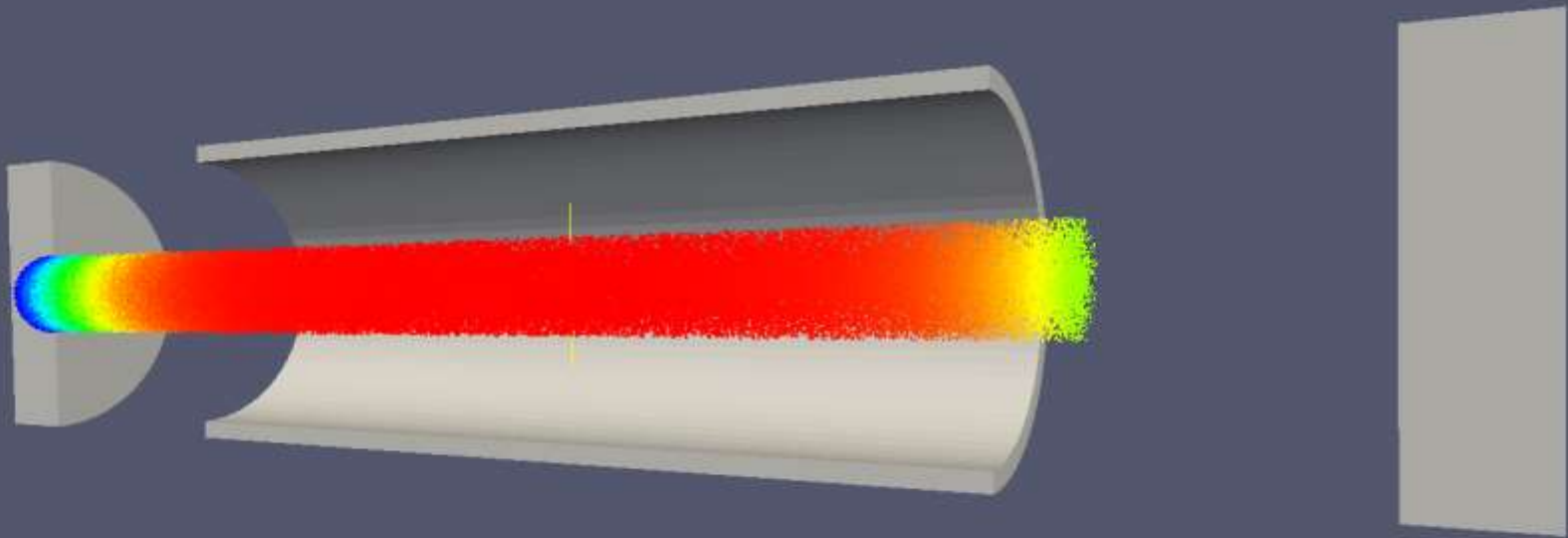
$T = 0.3 \text{ ns}$



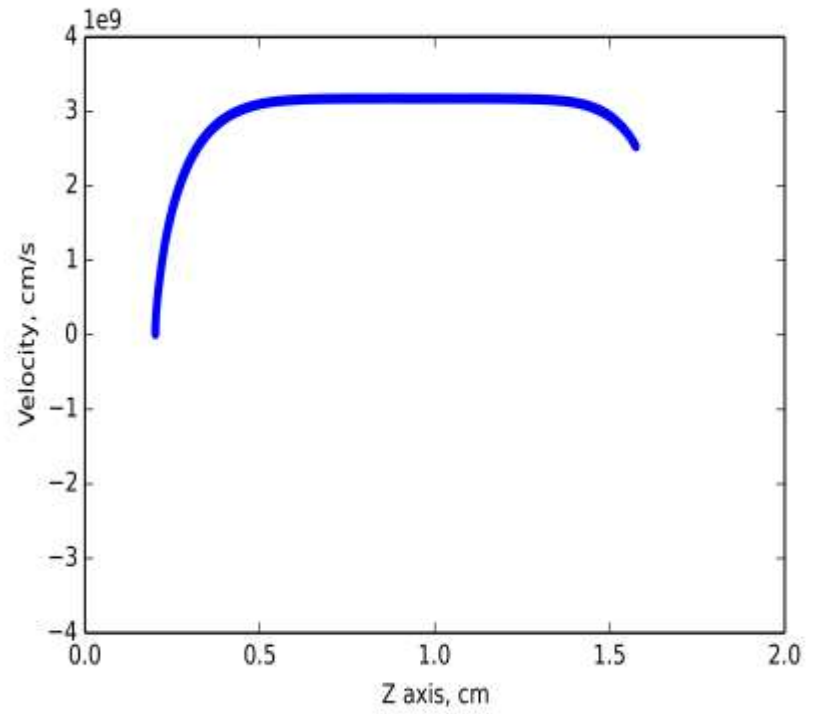
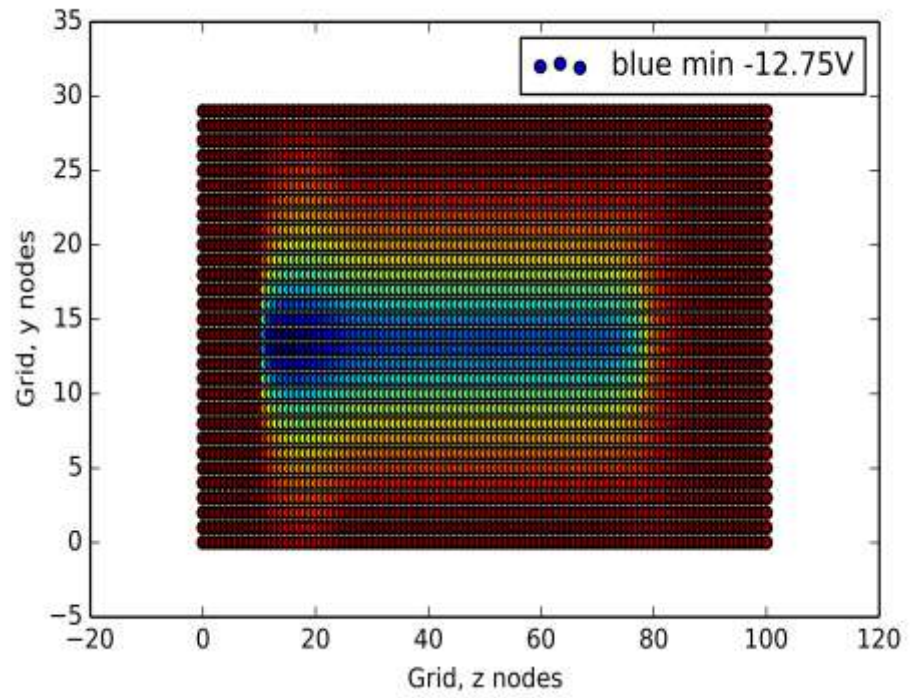


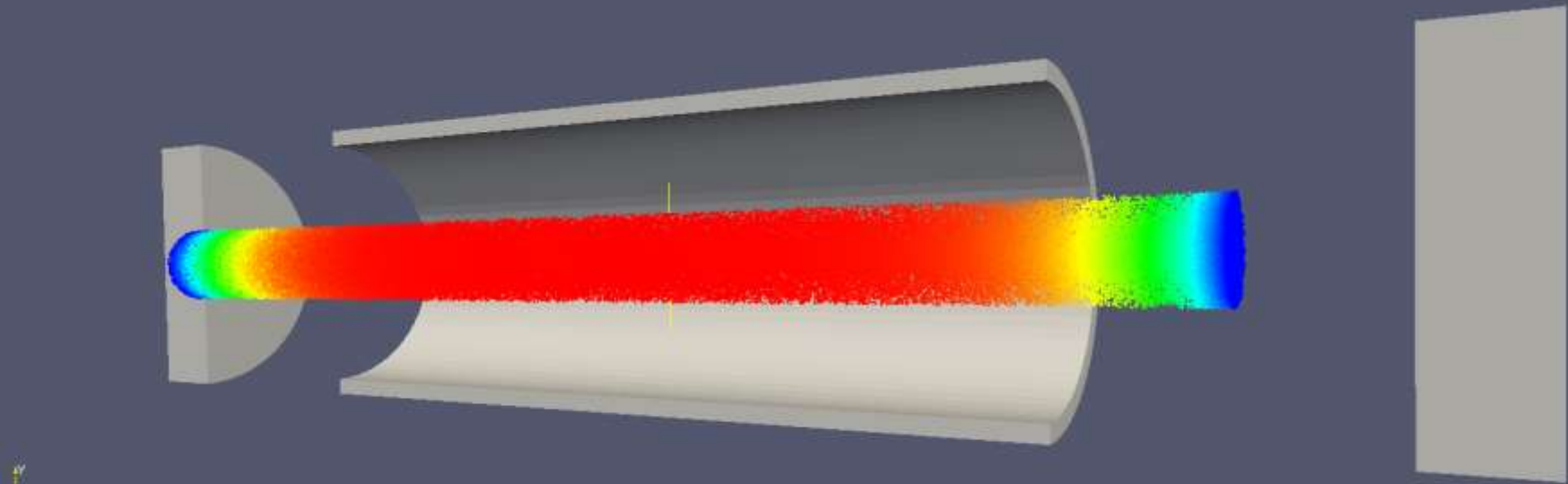
T = 0.4 ns



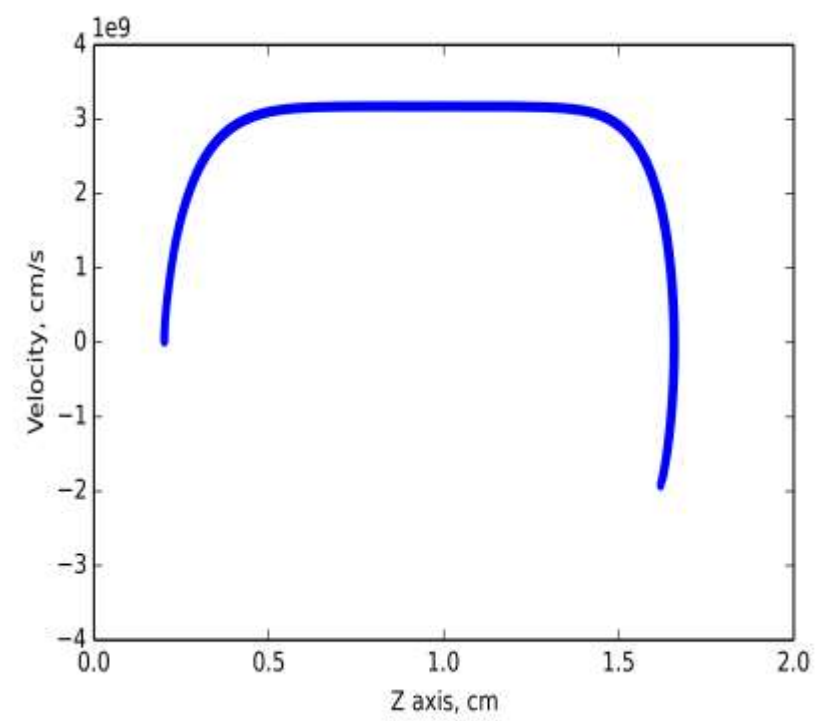
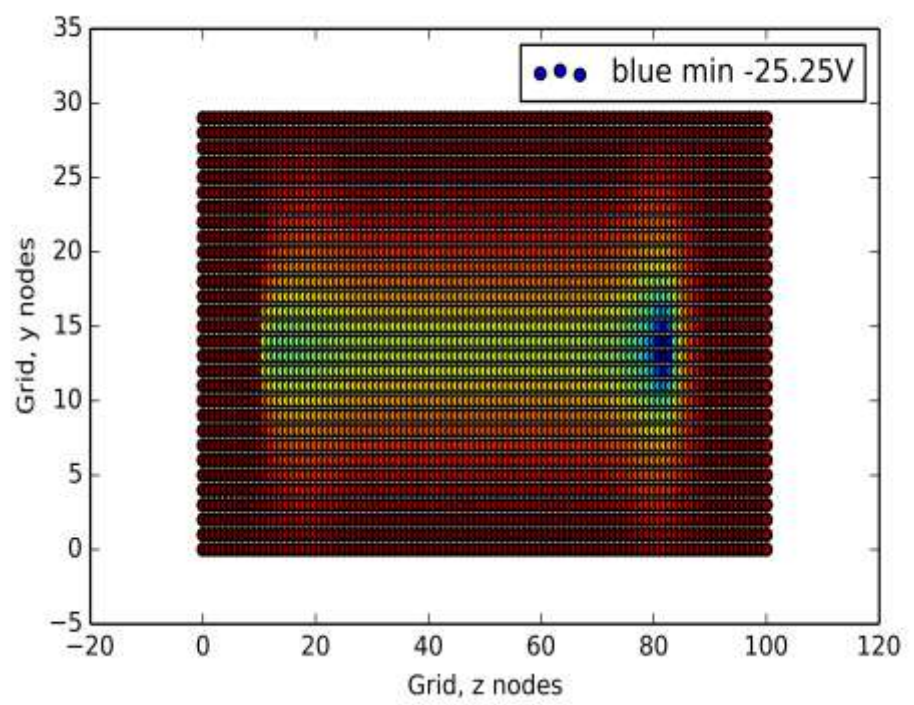


$T = 0.5 \text{ ns}$

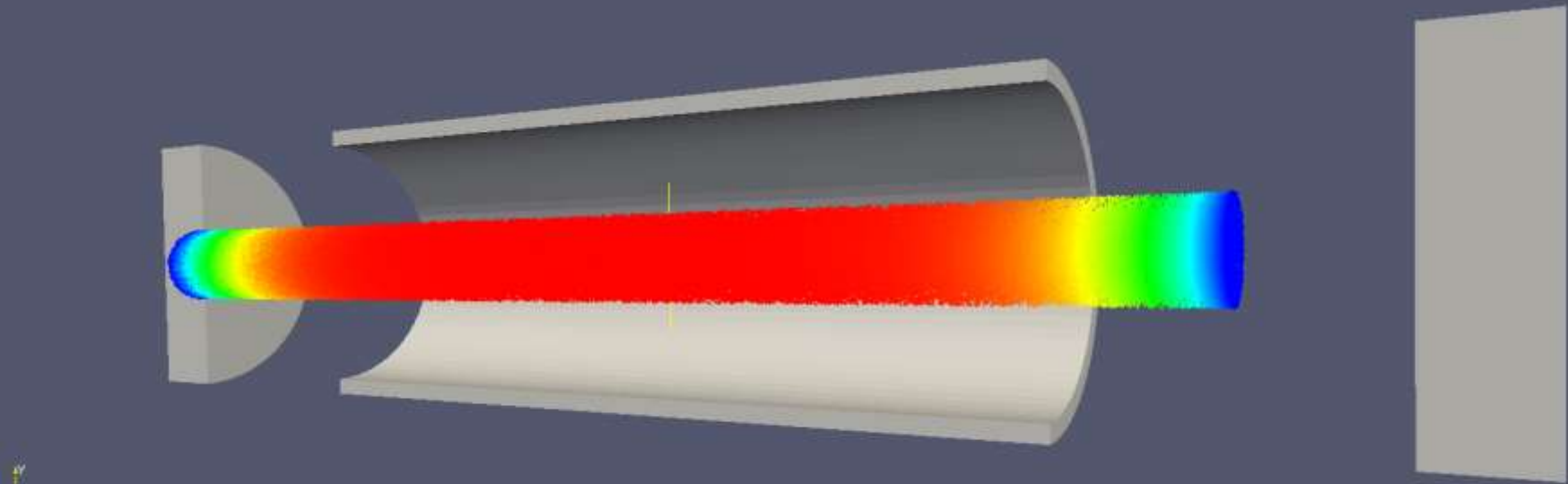




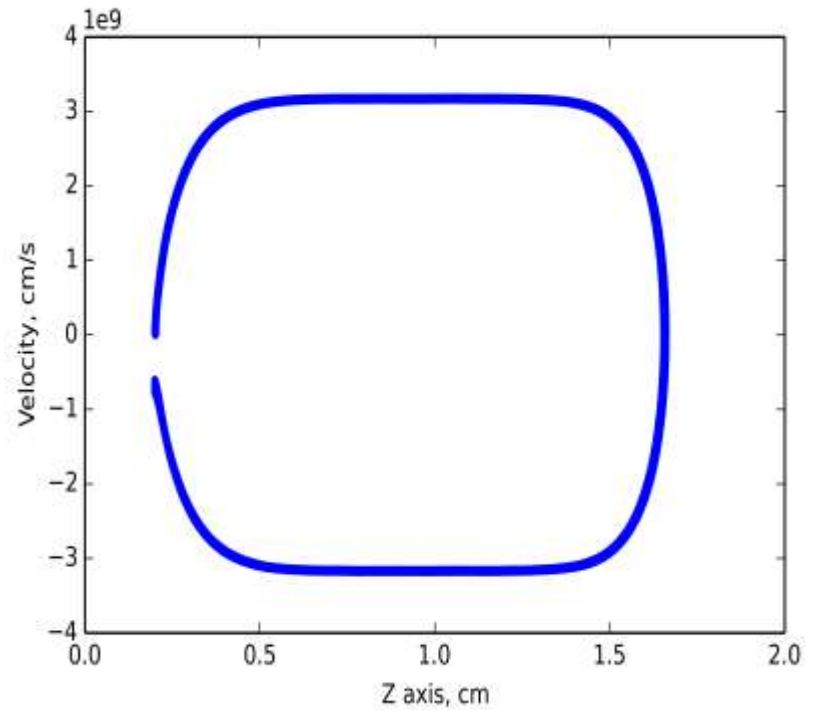
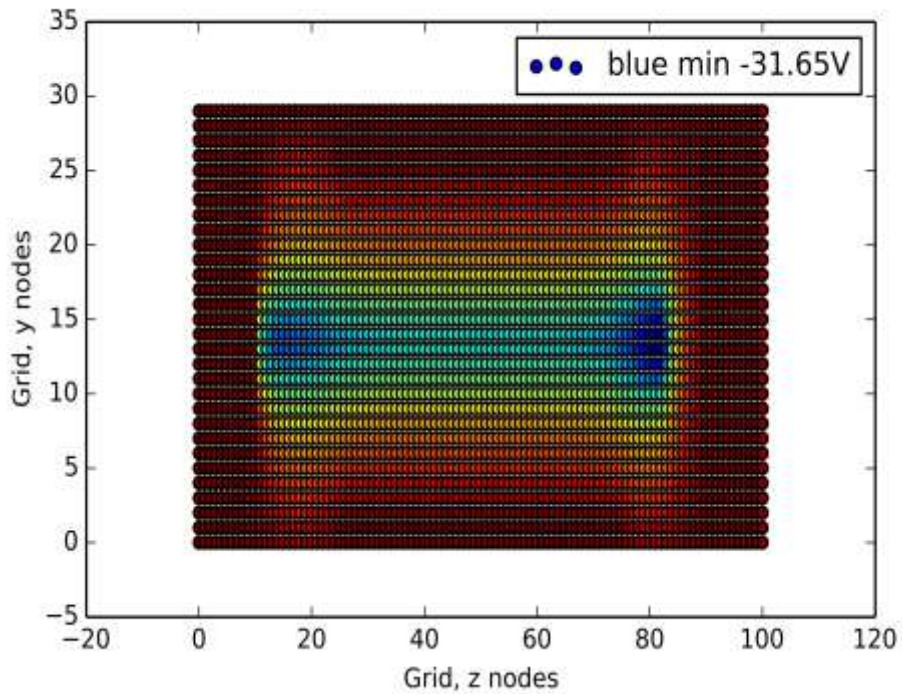
$T = 0.6 \text{ ns}$

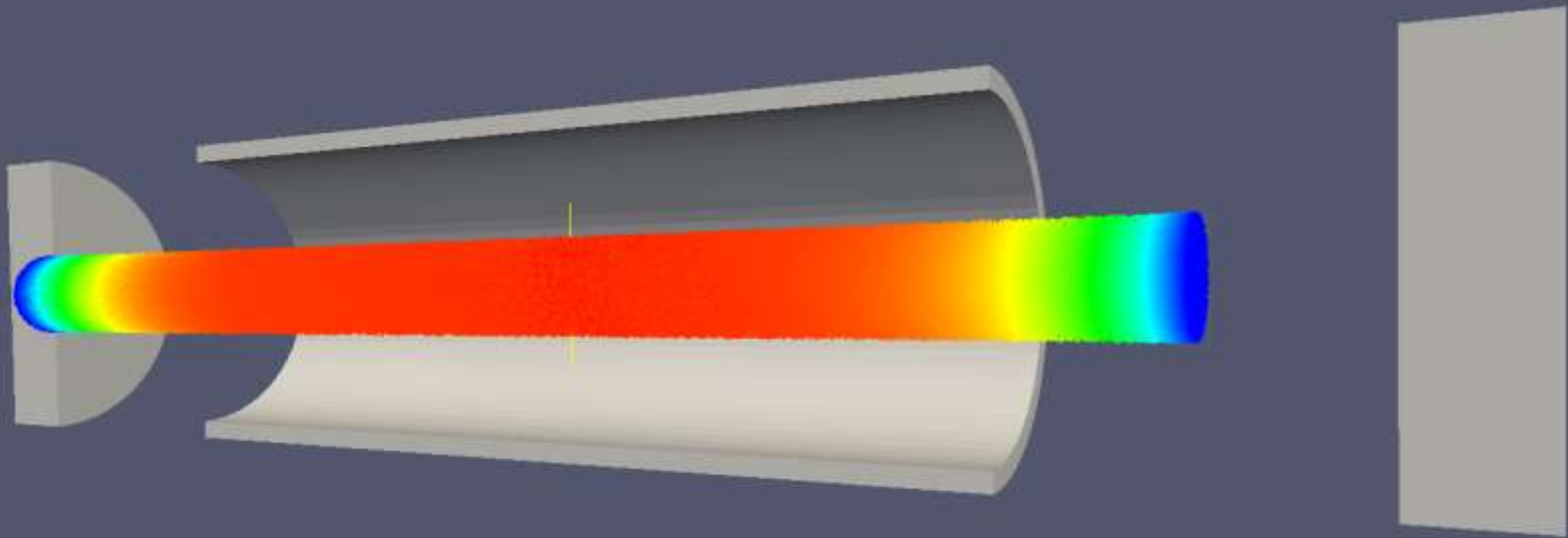




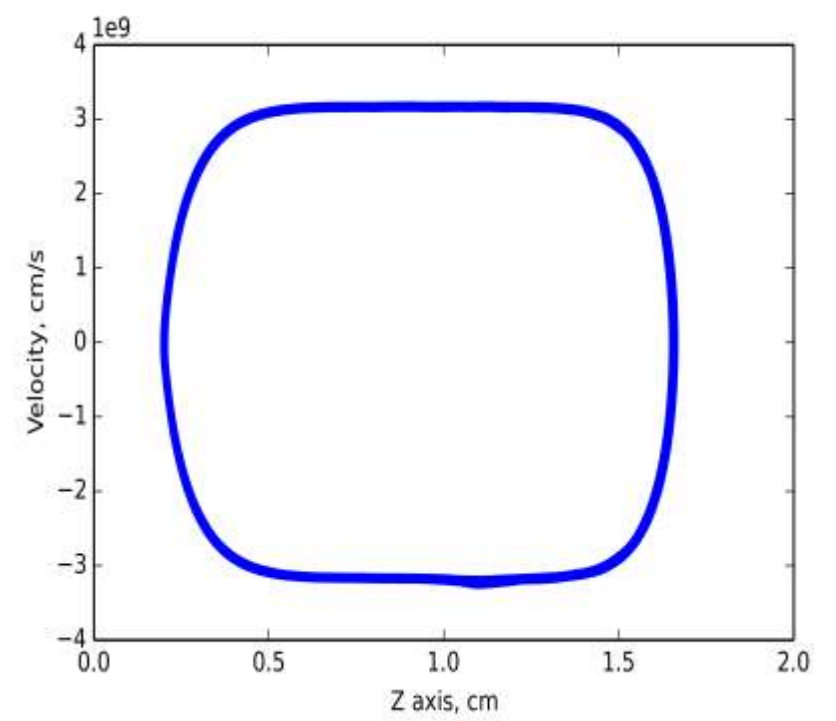
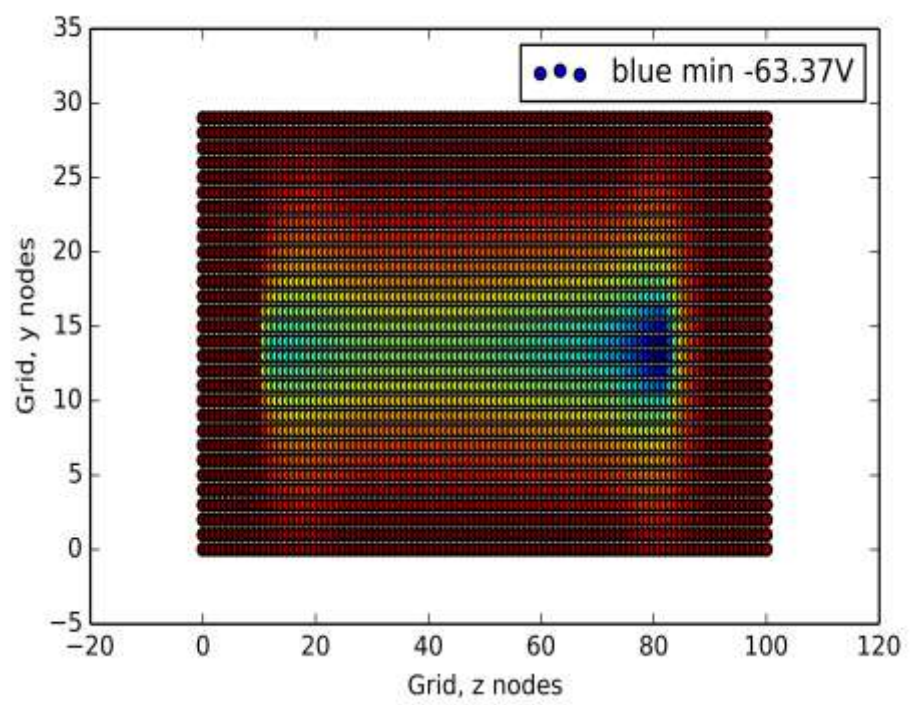


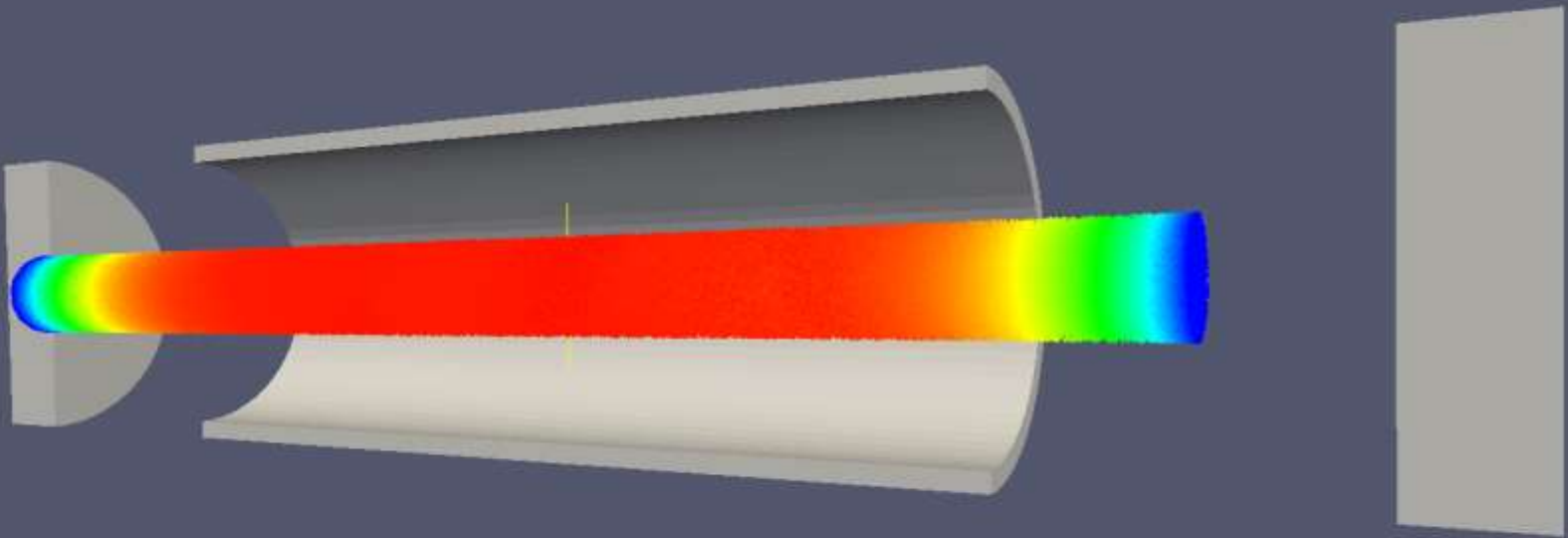
$T = 1.1 \text{ ns}$



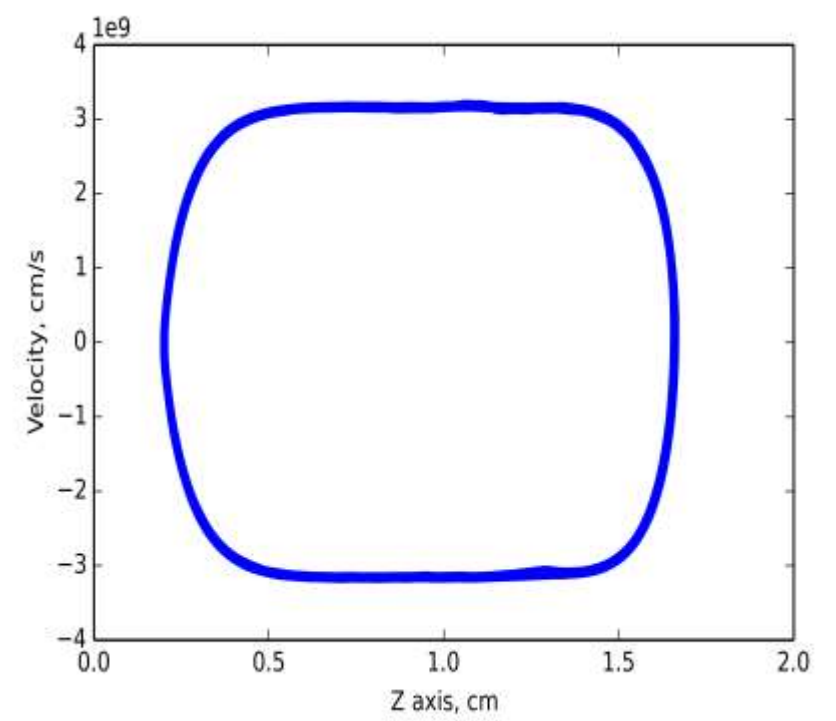
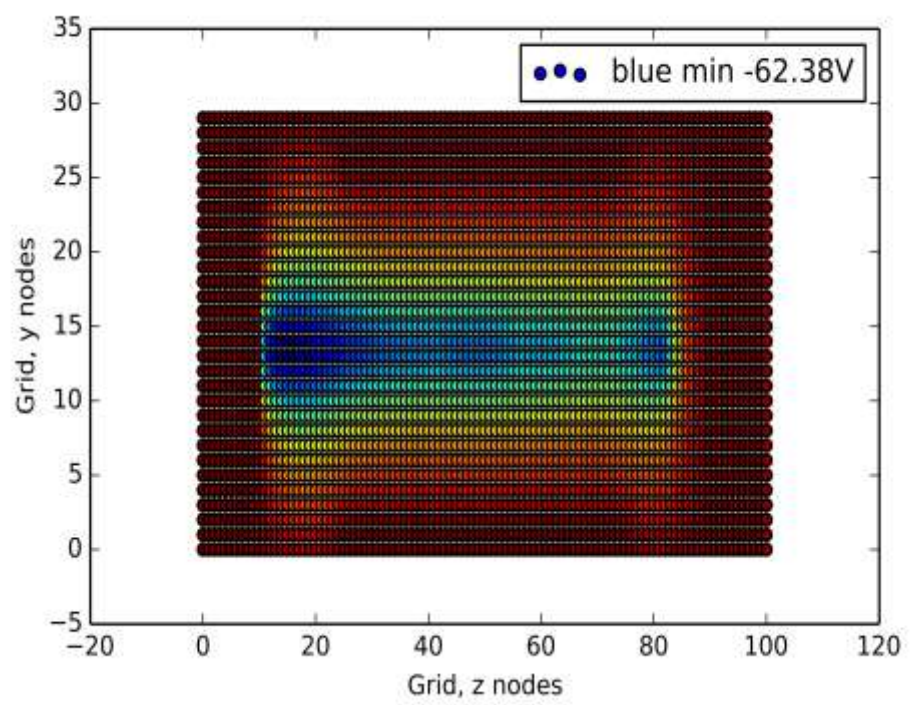


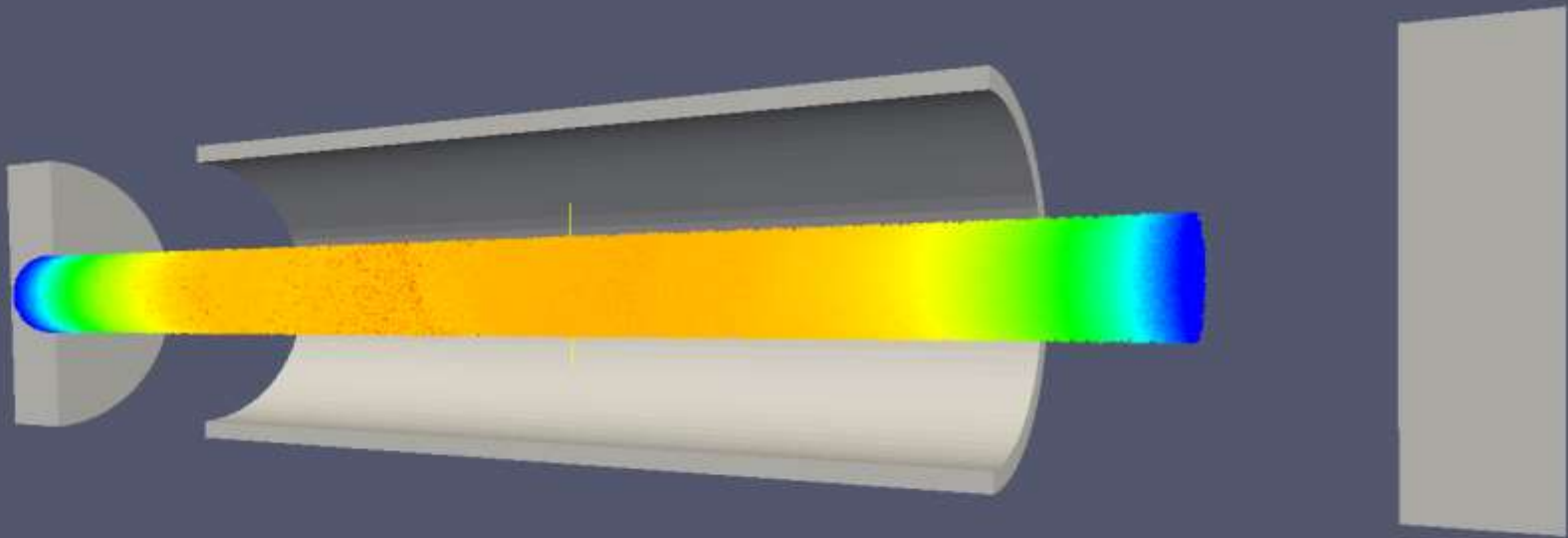
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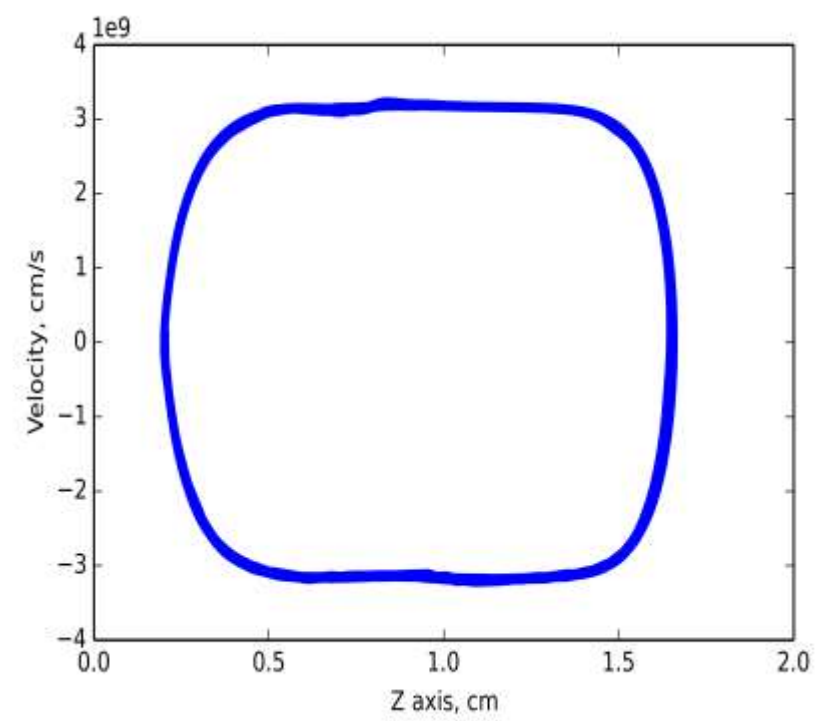
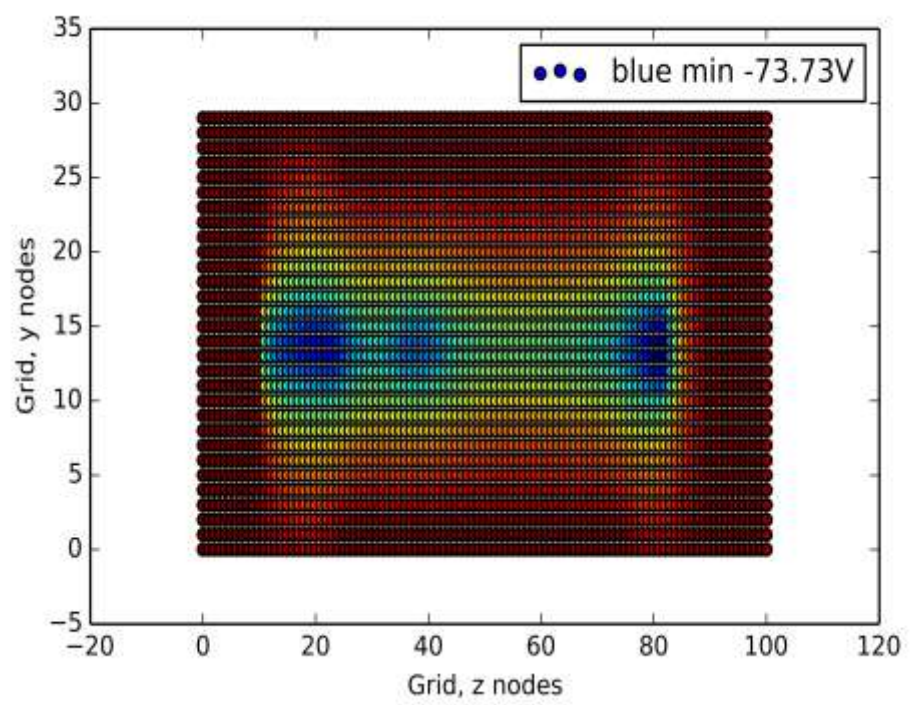


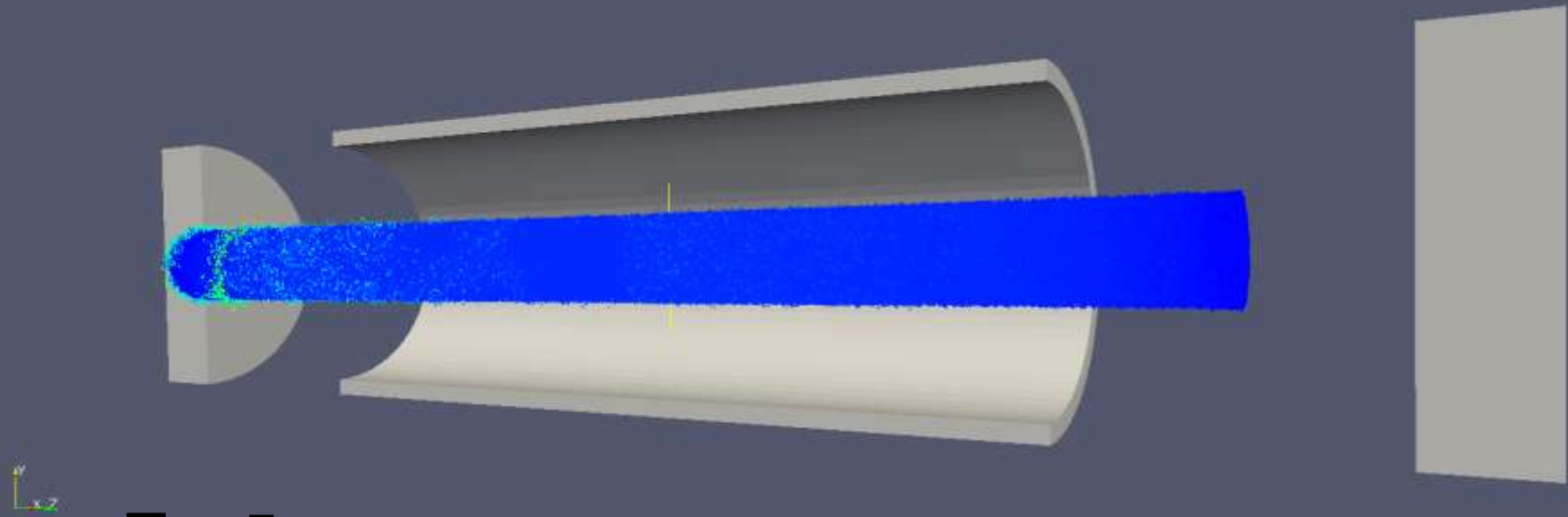
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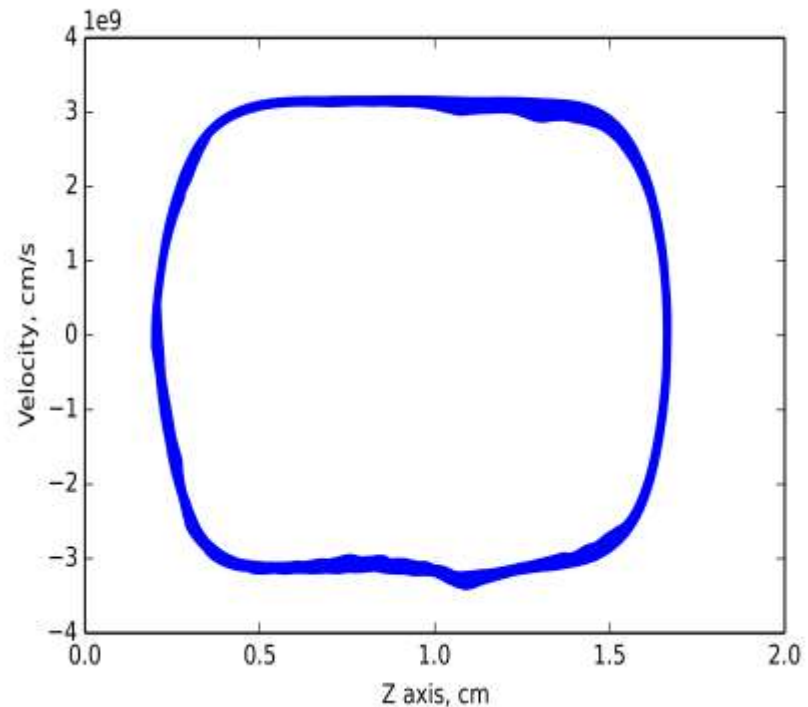
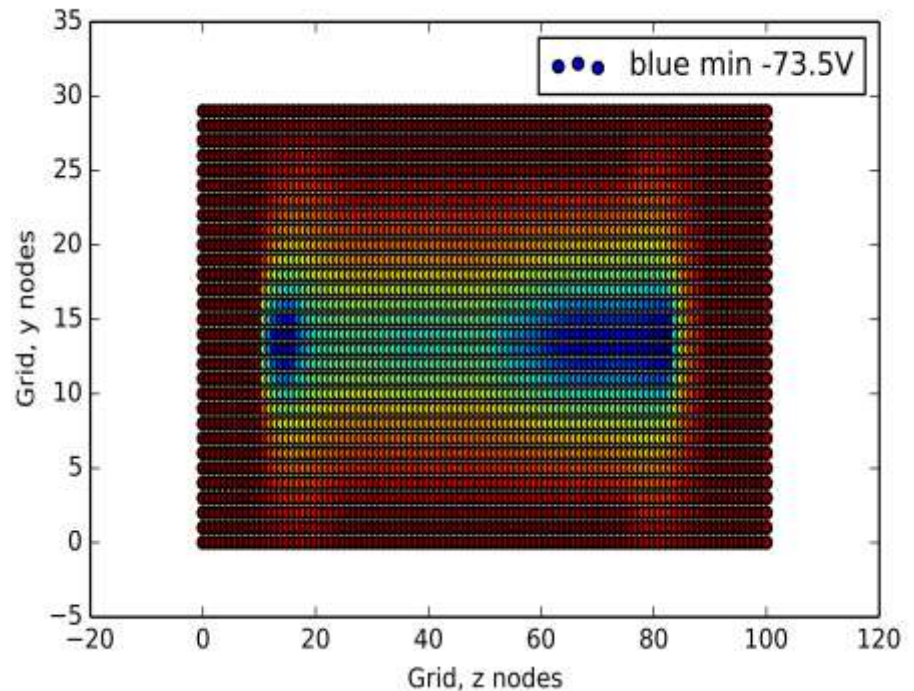


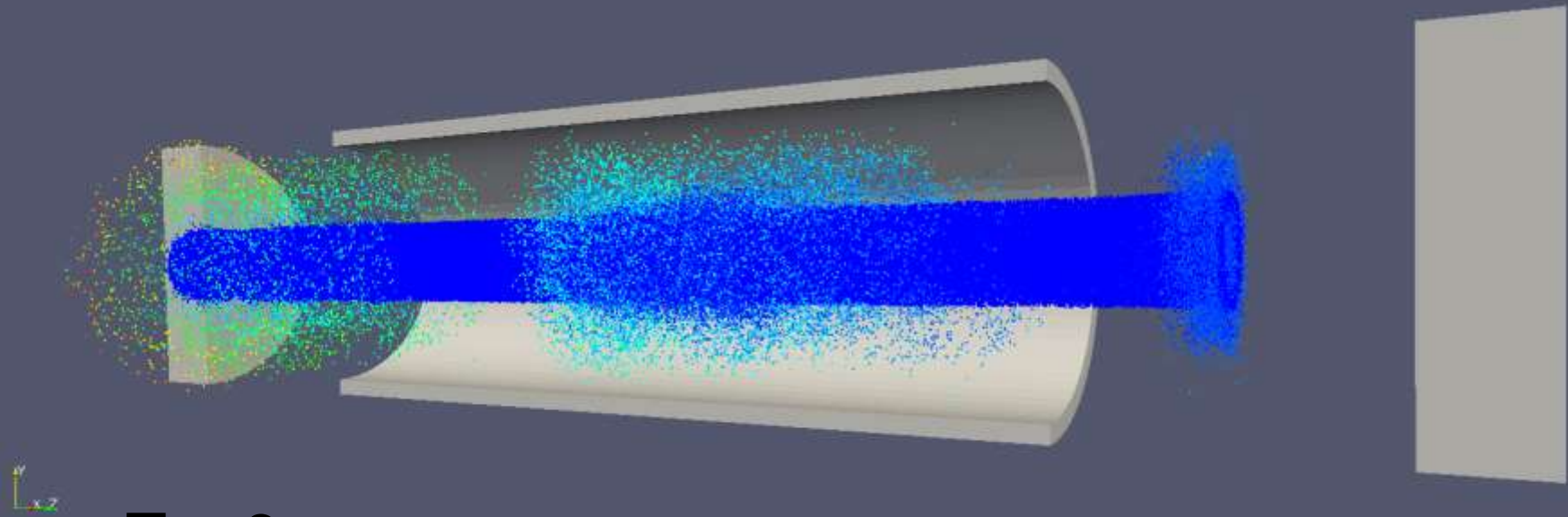
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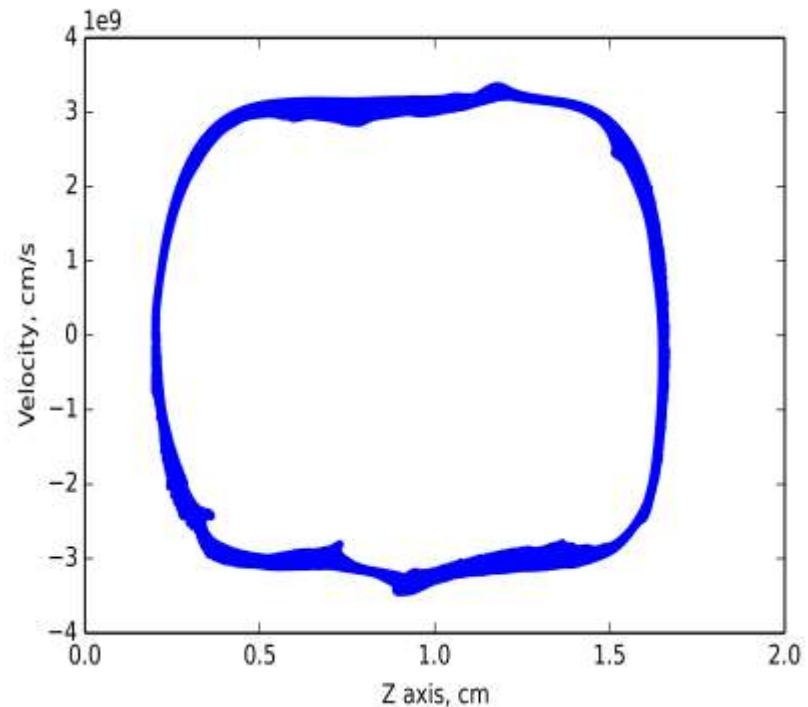
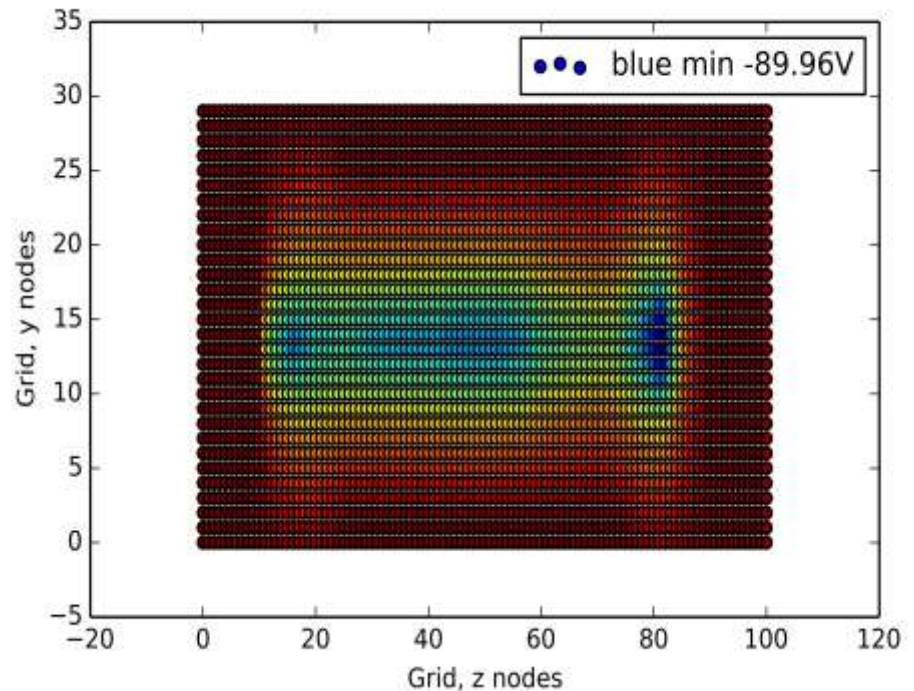


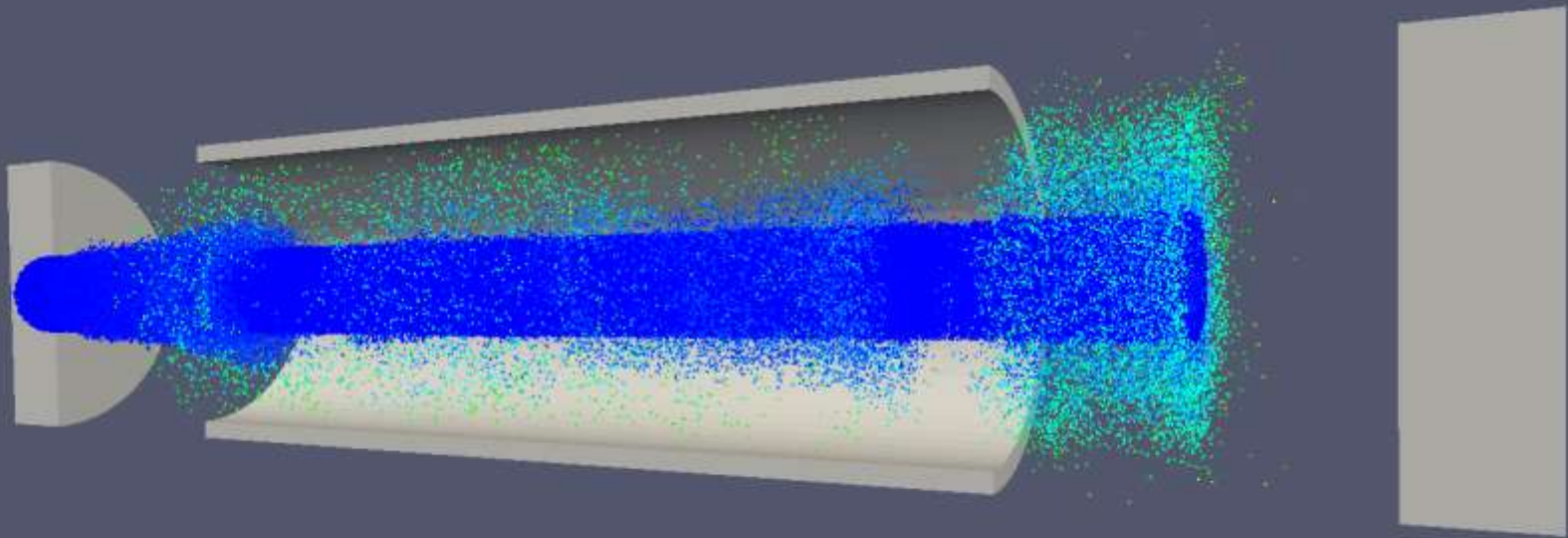
$T = 5 \text{ ns}$



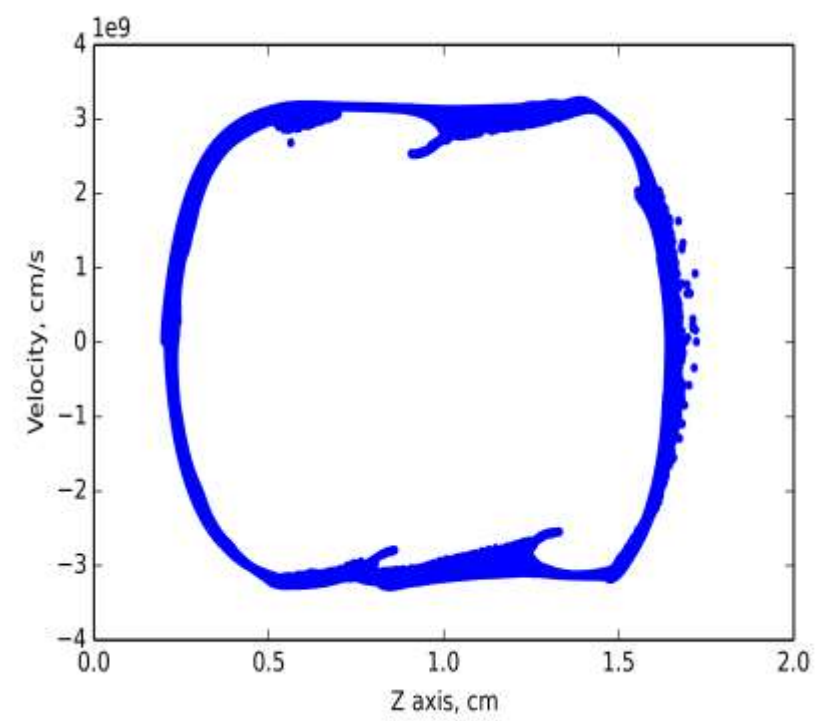
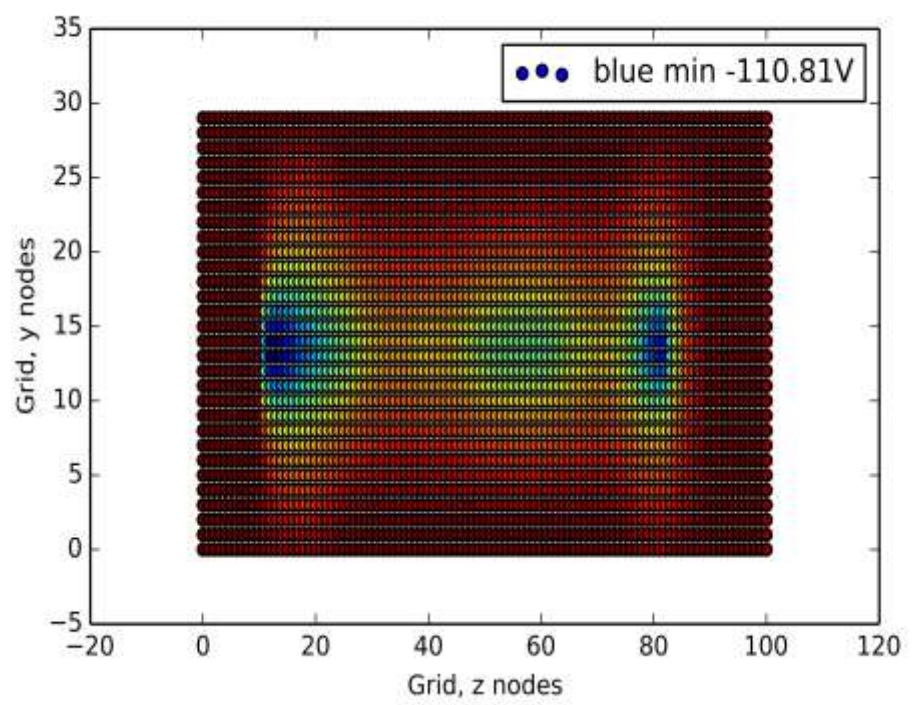


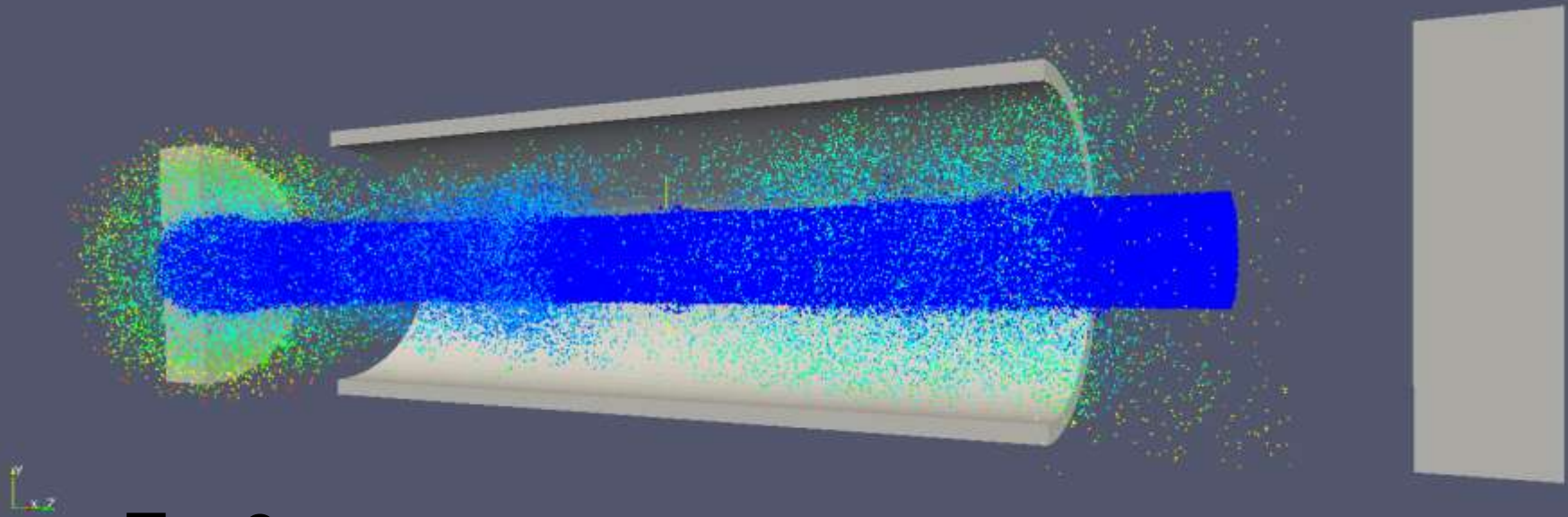
$T = 6 \text{ ns}$



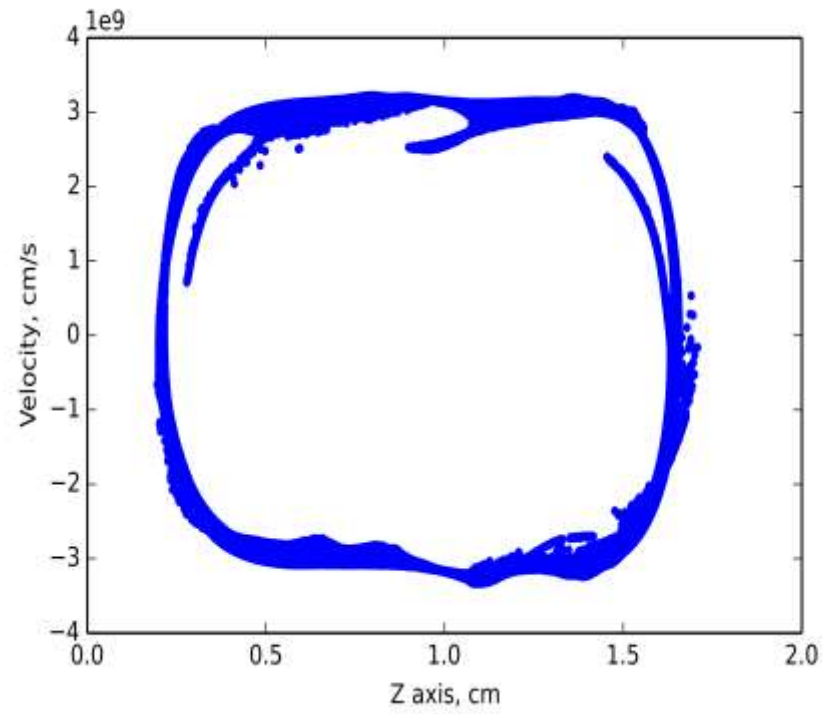
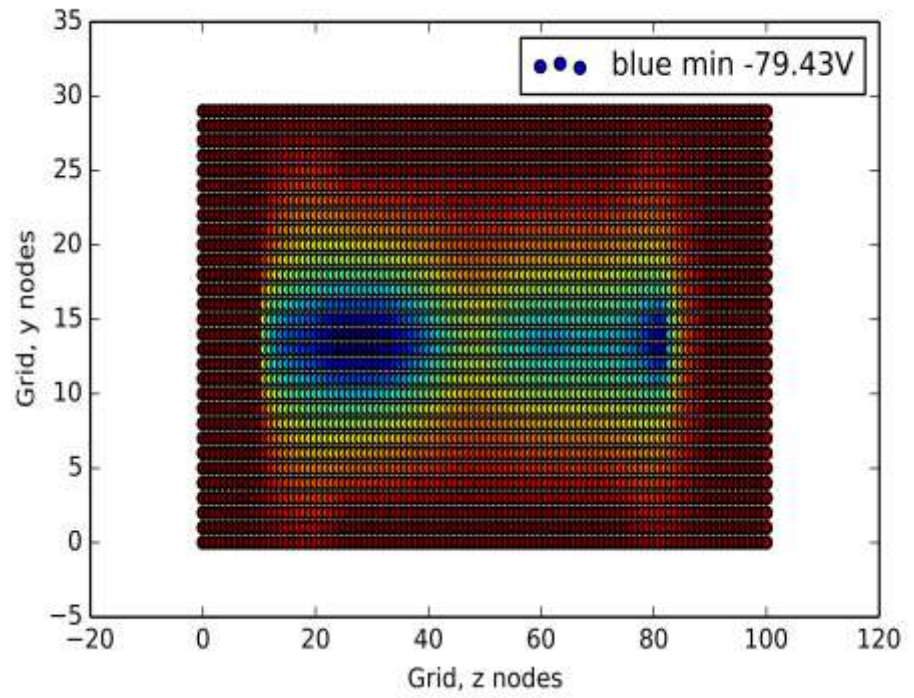


$T = 7 \text{ ns}$

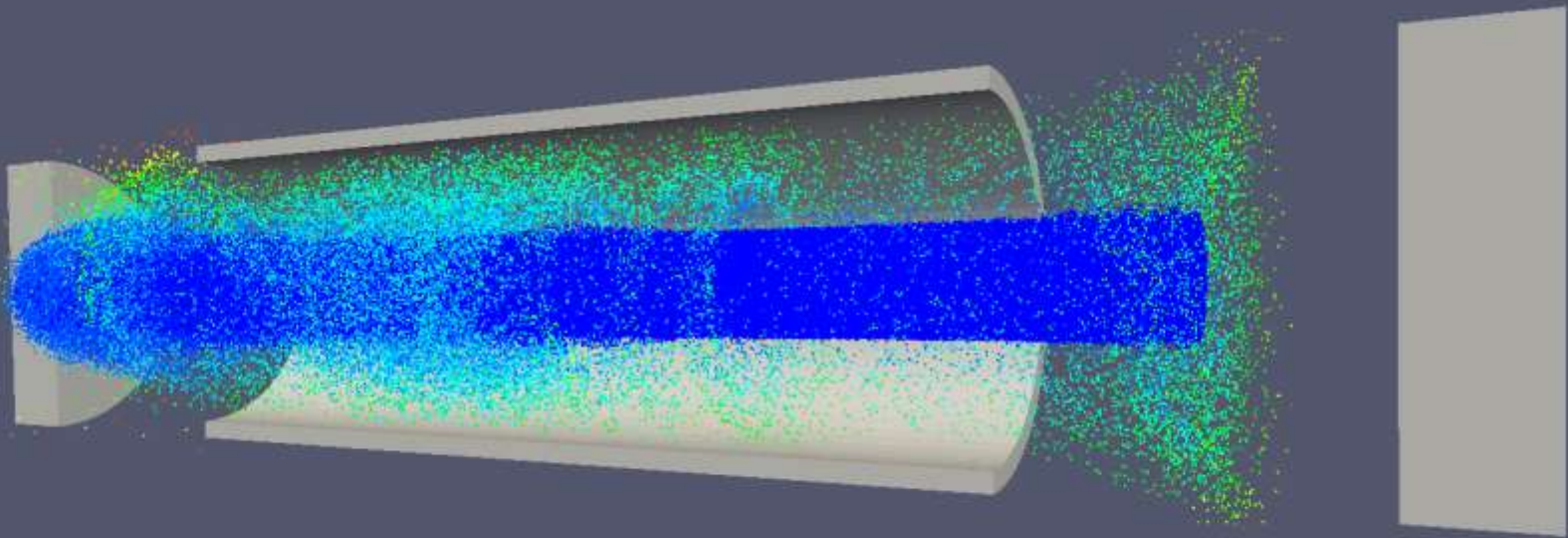




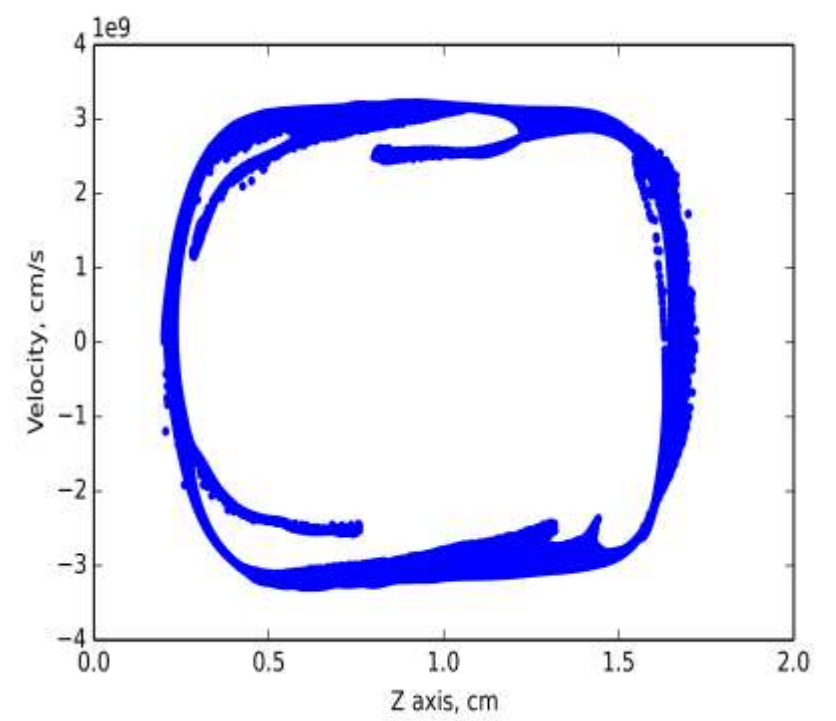
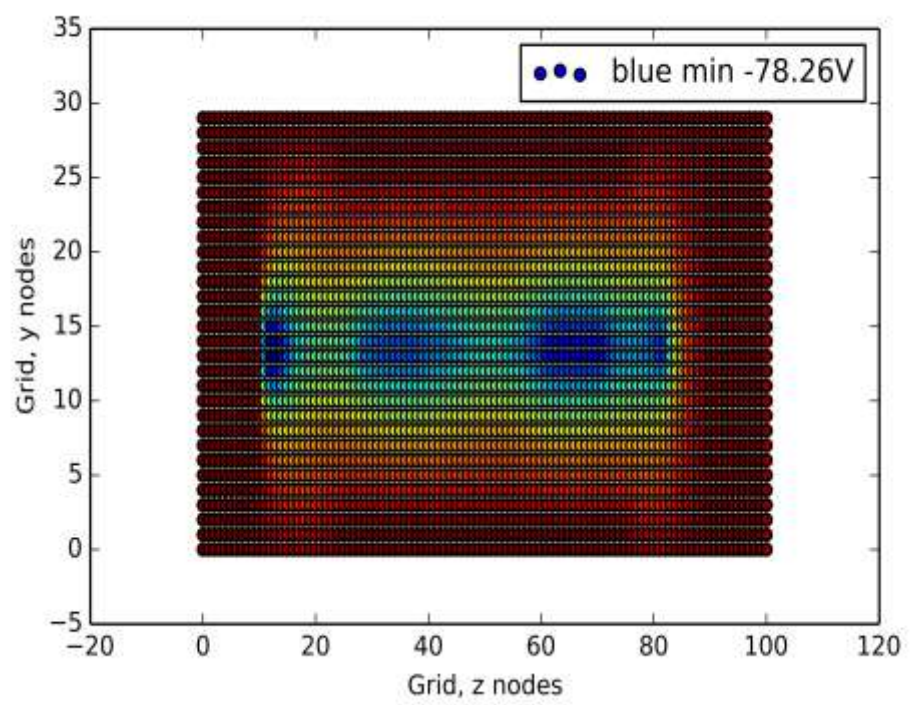
$T = 8 \text{ ns}$

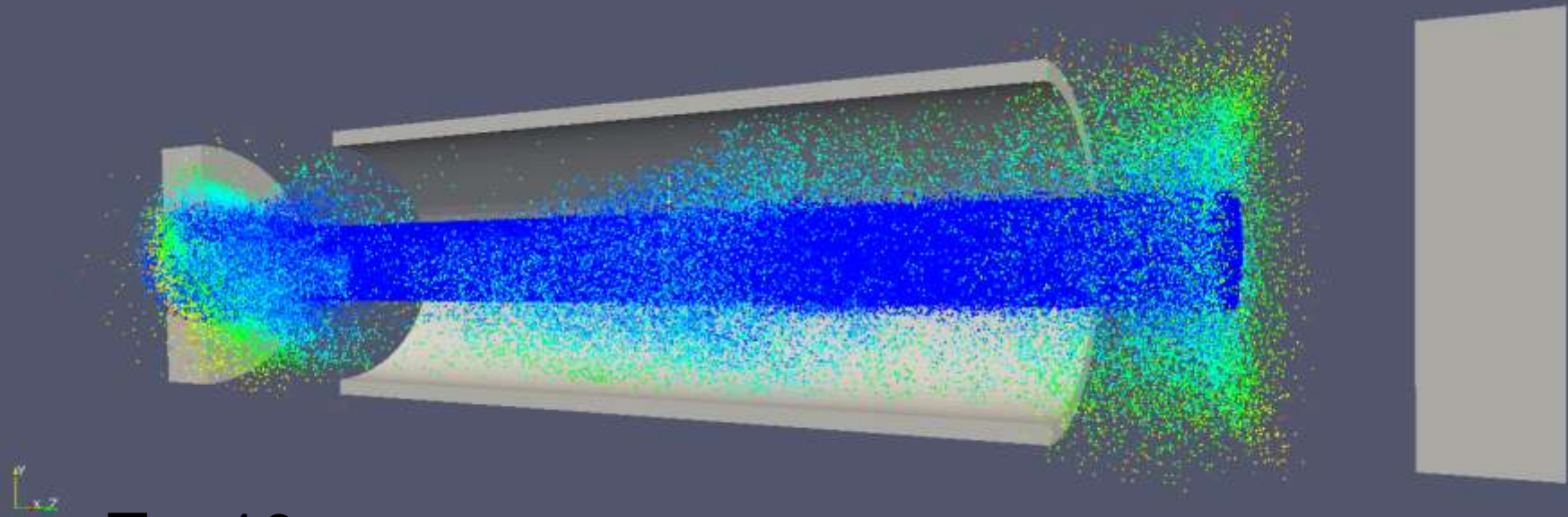




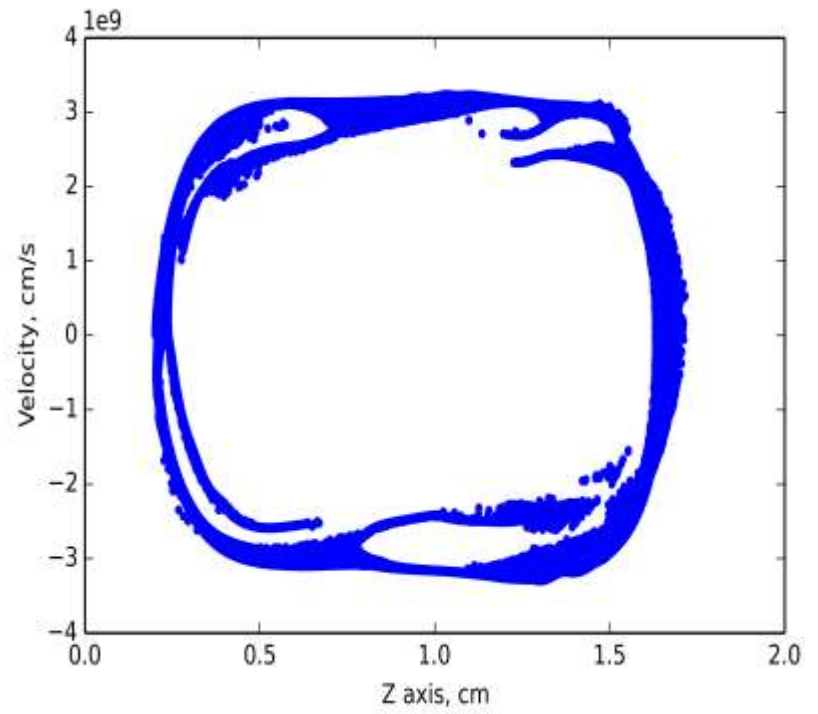
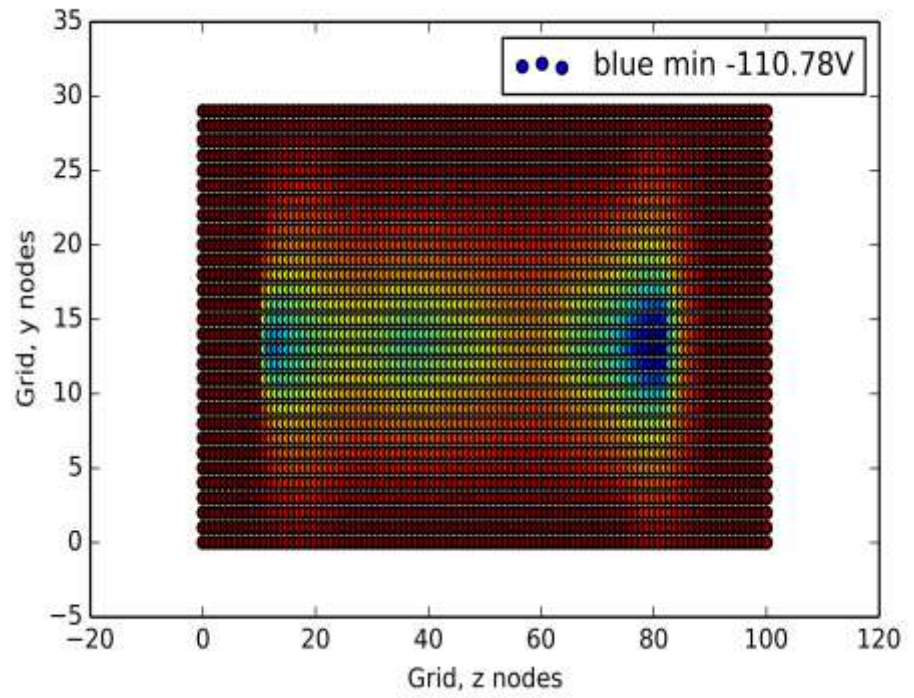


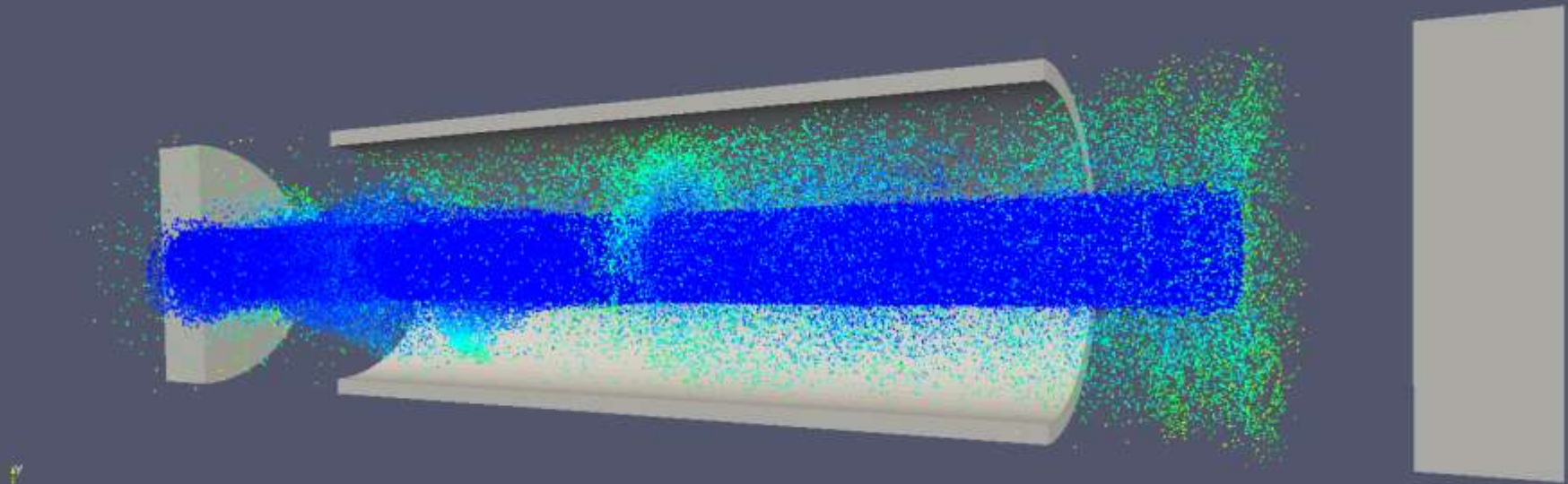
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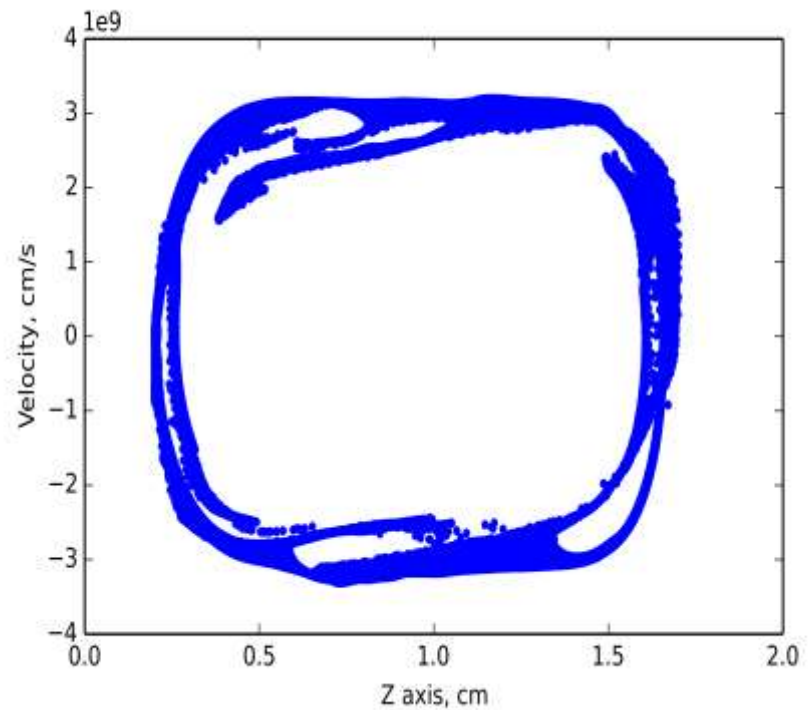
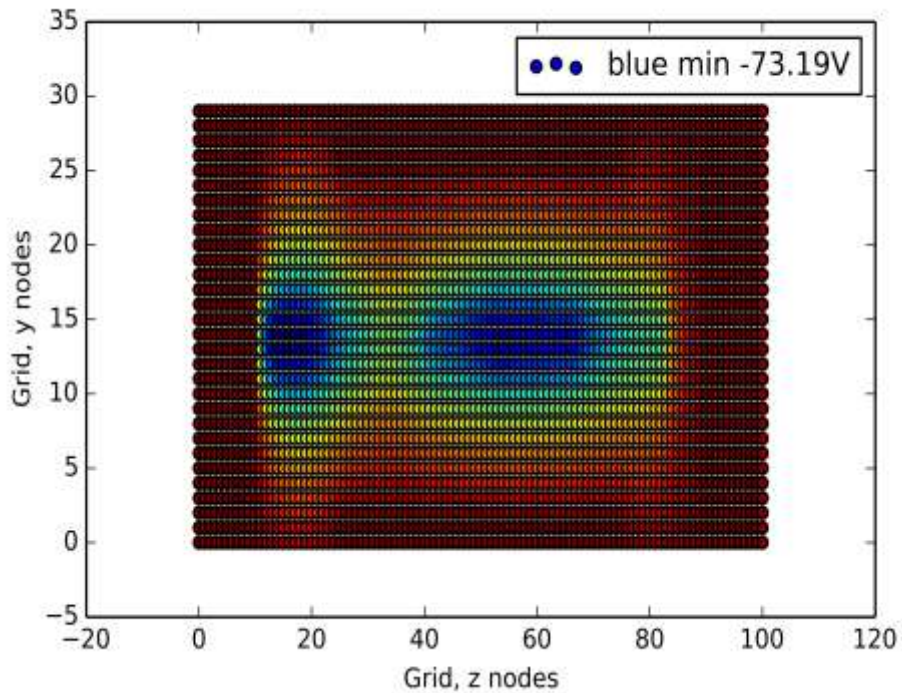


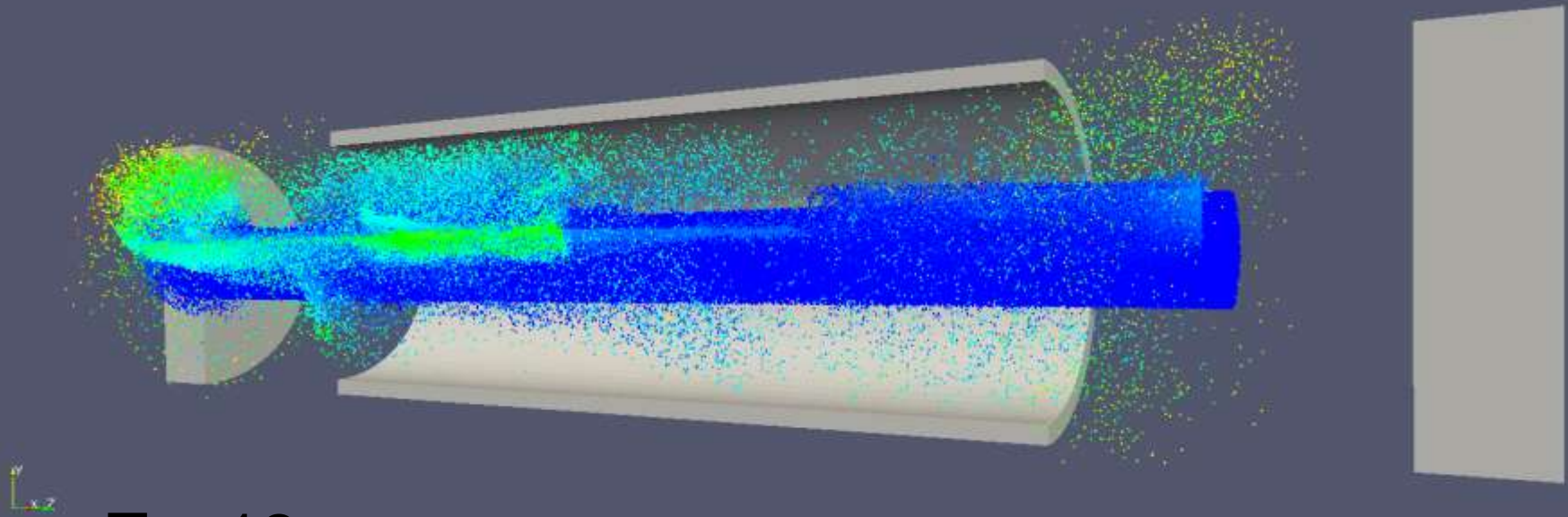
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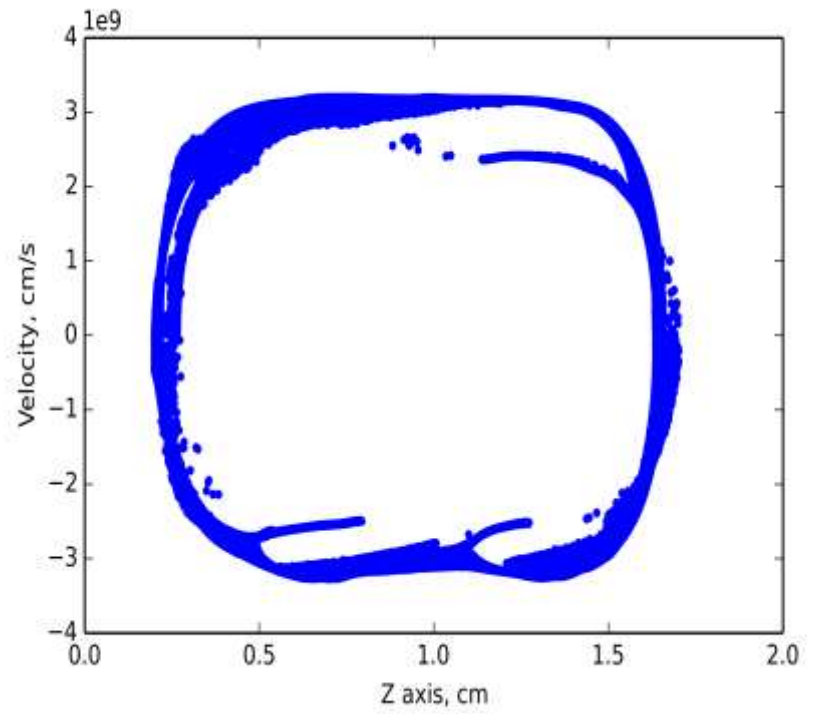
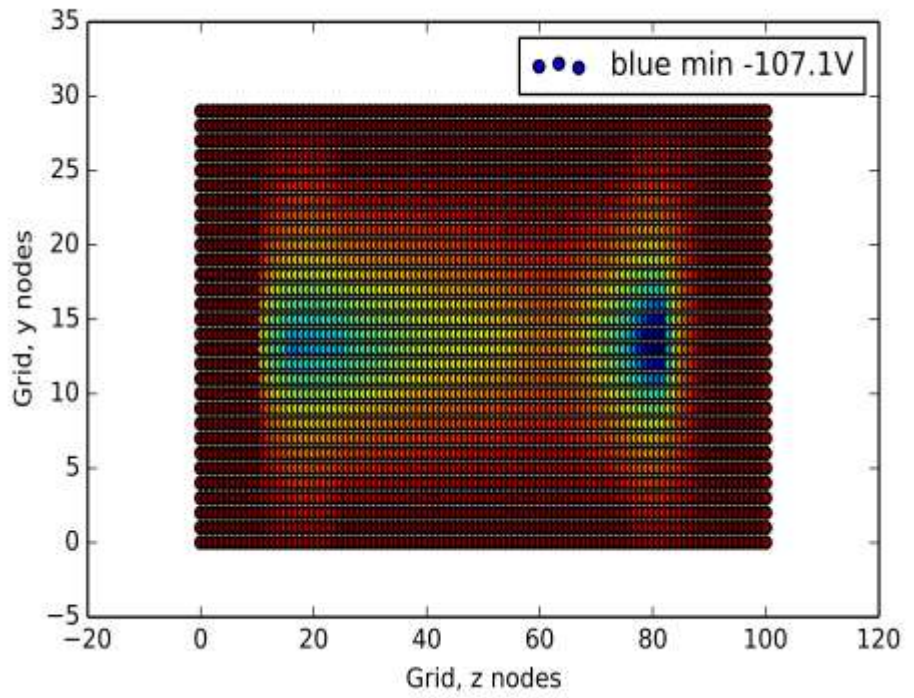


T = 11 ns





T = 12 ns



# Energy spectrum

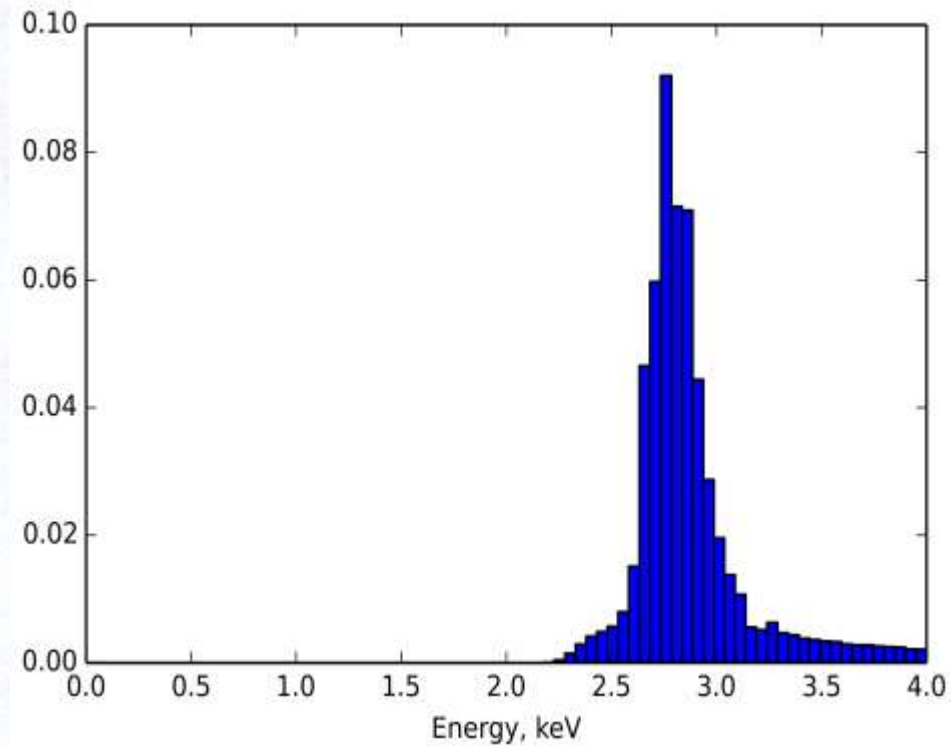
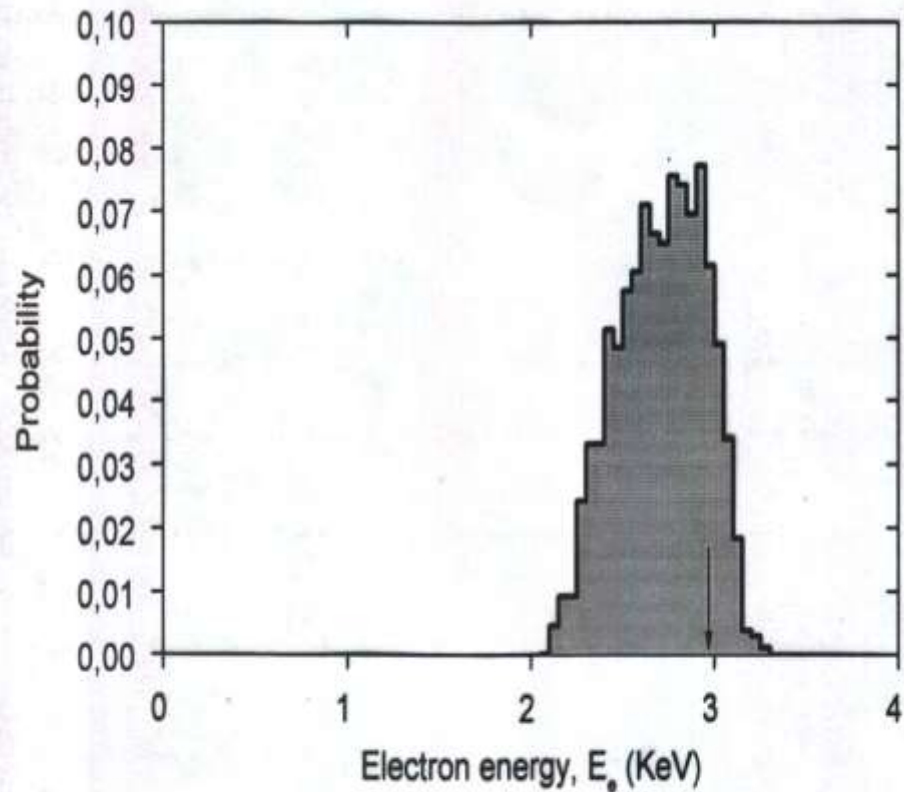
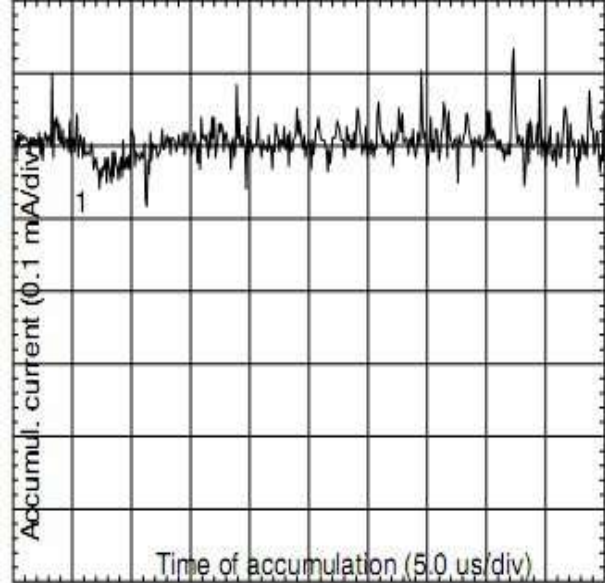
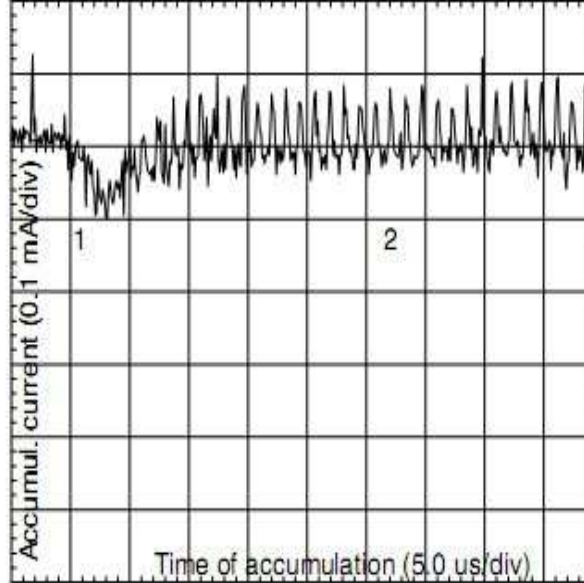


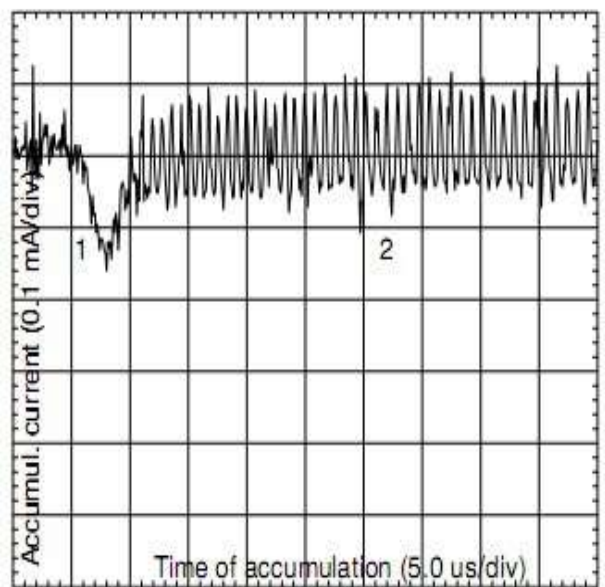
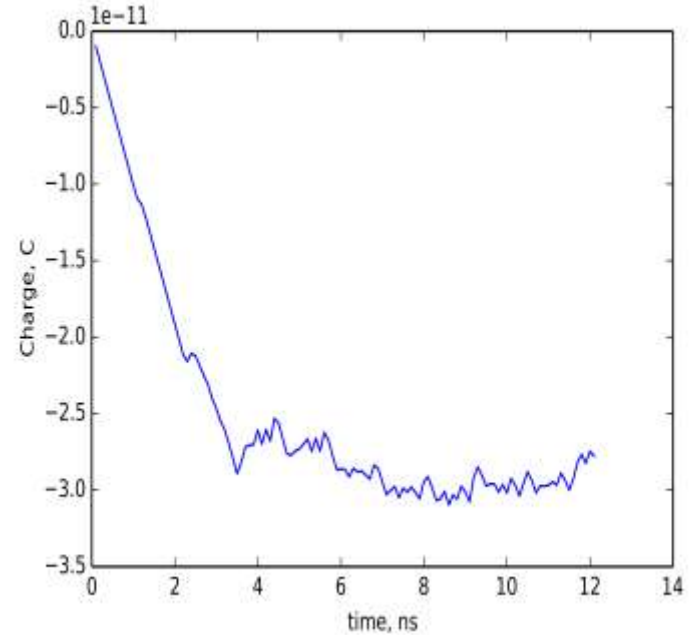
Fig. 8. Electron energy distribution in the string with a feeding electron energy equal to 2.99 KeV.



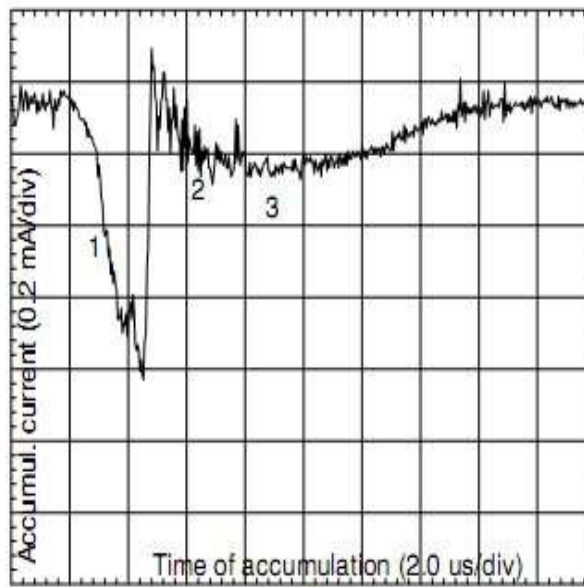
a)



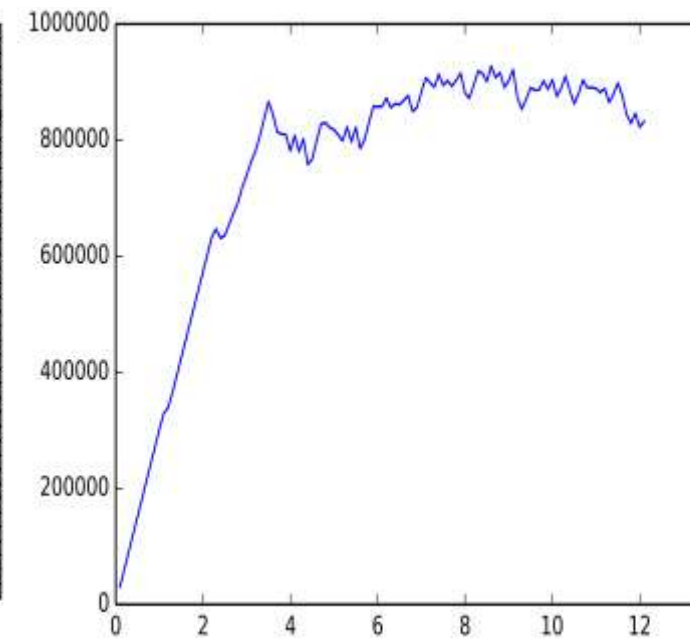
b)

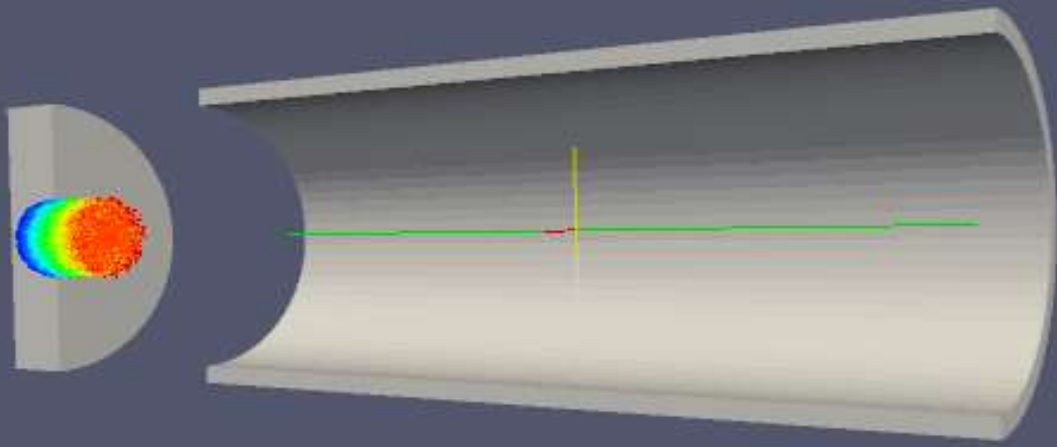


c)



d)





**Спасибо за внимание**