

# Update on VSim simulation

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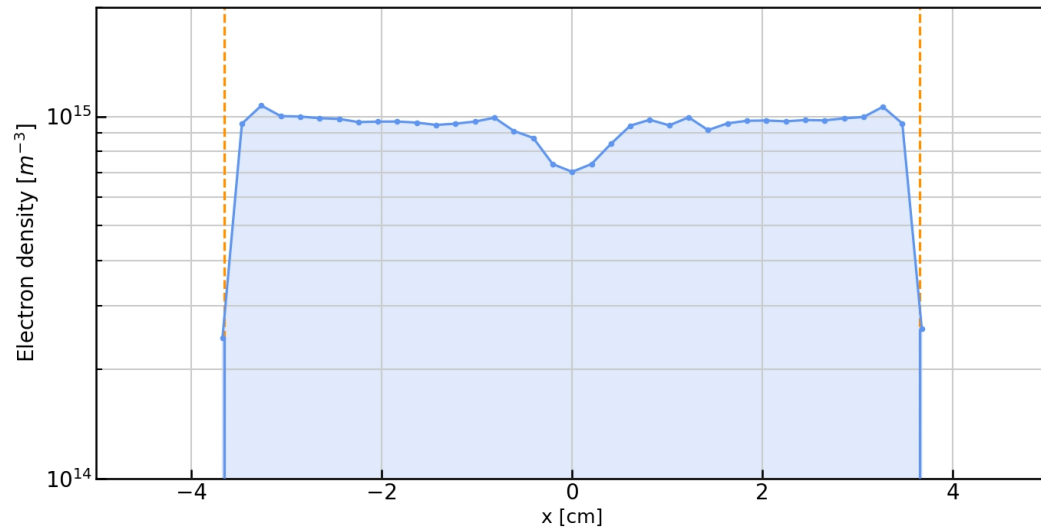
9<sup>th</sup> July 2020

# Simulation #4 (parameters)

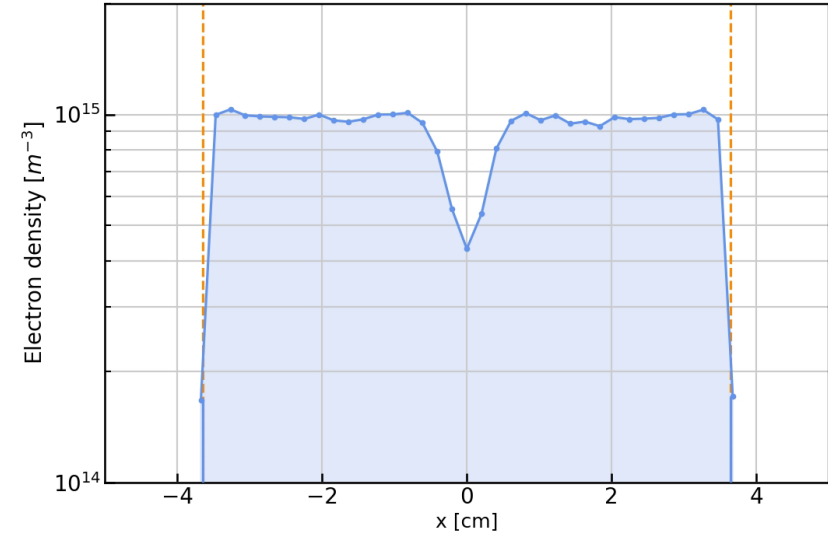
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- Some of the more important parameters:
  - Electron density  $n_e = 10^{15} \text{ m}^{-3}$
  - External B-field (spatially uniform) – 100 mT
  - Time step  $dt = \text{plasma period} / \text{number of steps per plasma period}$
  - Number of steps per plasma period: 10
  - Number of simulation steps: 5000 (1.75  $\mu\text{s}$ )
    - Grid size: 50 x 50 x 500
    - Macroparticles per cell: 10
  - Cathode voltage - set based on  $n_e$  and the longitudinal confinement condition
- At this stage there is no secondary emission included in the simulation or background gas

# Radial electron distribution



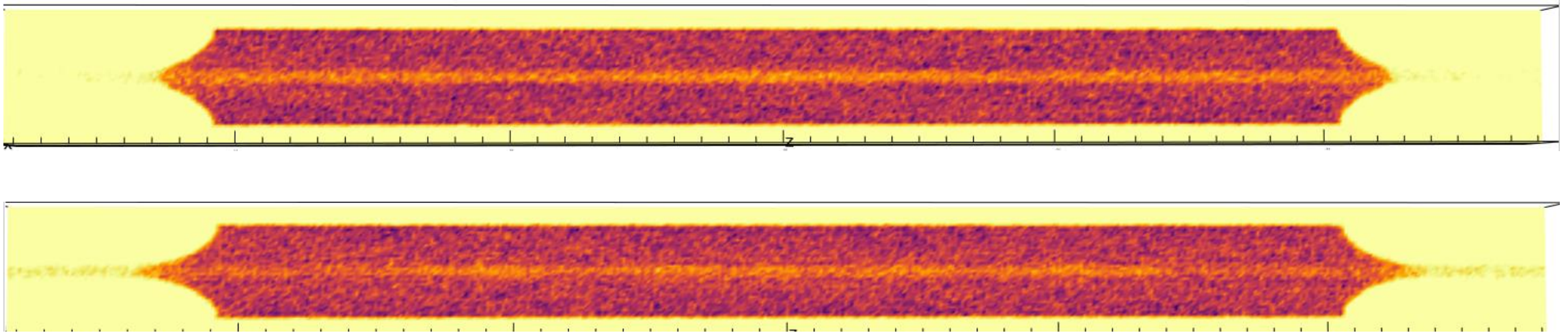
210 ns



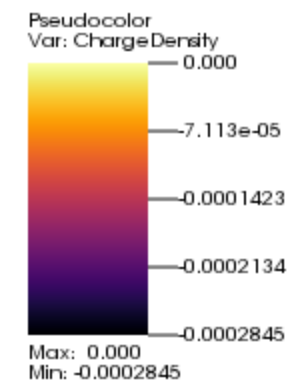
350 ns

- Simulation stopped after  $\sim 350$  ns (72h runtime, 50 cores)
- The density depression at the centre increases significantly
- Need to increase simulation speed (e.g. by reducing the length of the lens)

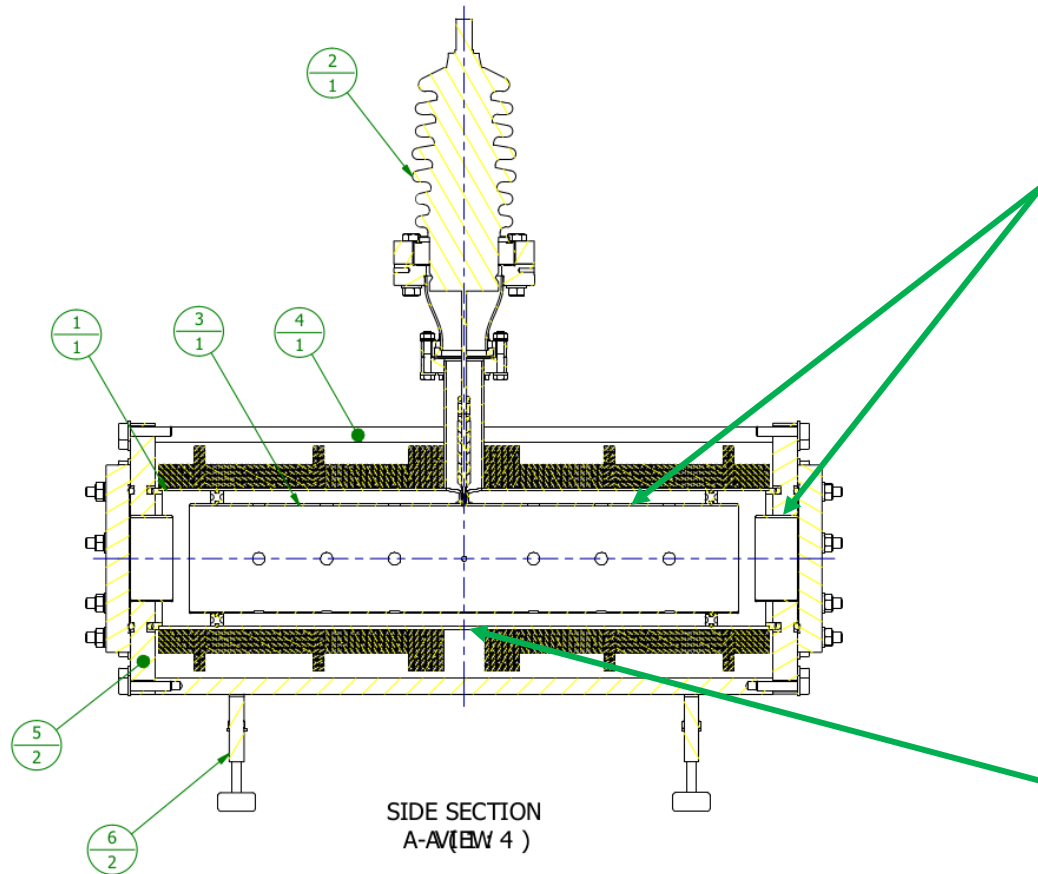
# Longitudinal electron distribution



- The central density depression is longitudinally uniform
- Particles are lost at the two and near the central axis
- There are periodic streams of electrons escaping the plasma

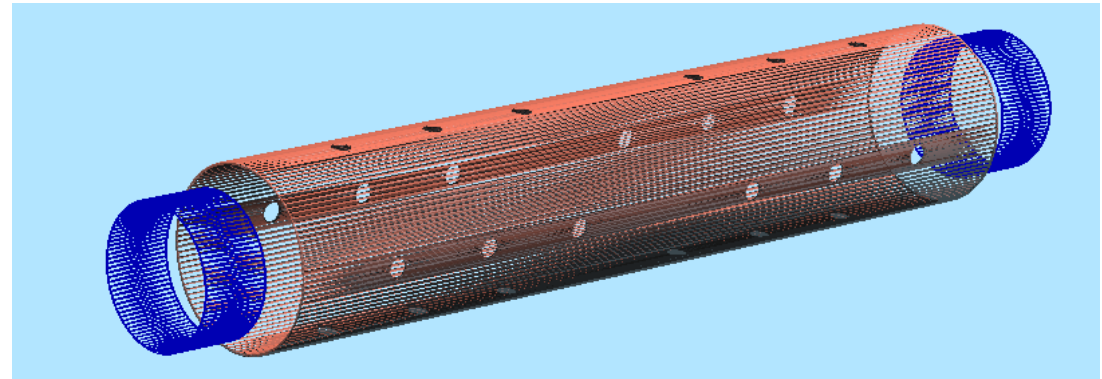


# Previous prototype

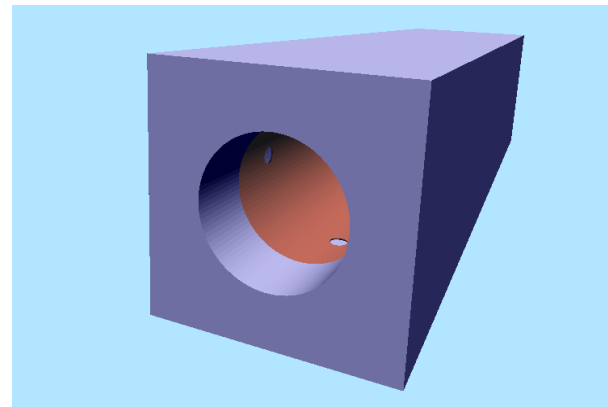


Engineering drawing

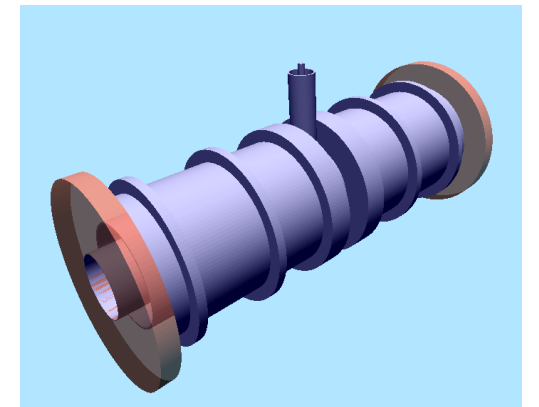
VSim: central electrode & end tubes



VSim: squared-off vacuum tube



VSim: full model with coild and end flanges



# Coils configuration

## Pancake coils

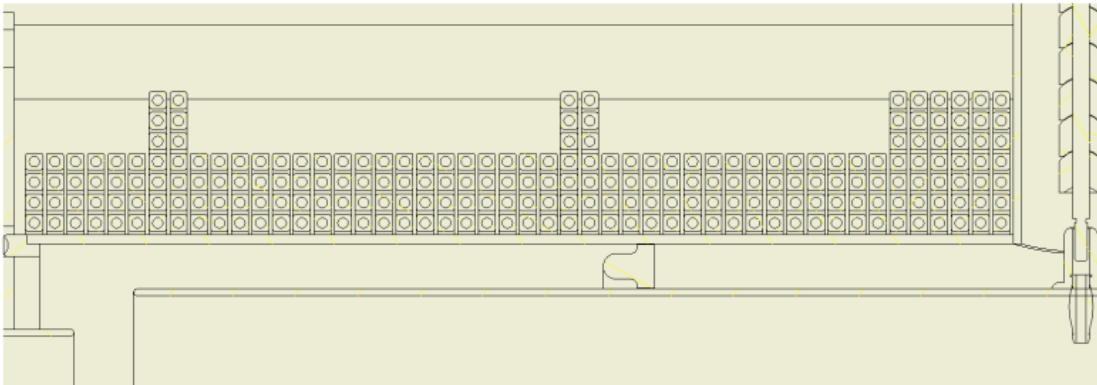
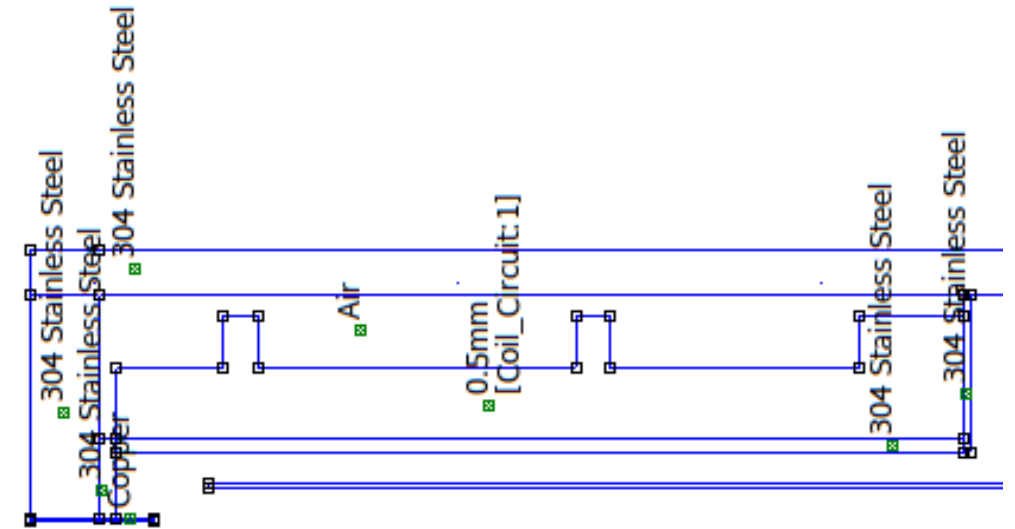


Figure 4: Showing one half, drawing view of pancake coils.

(Production Readiness Review)



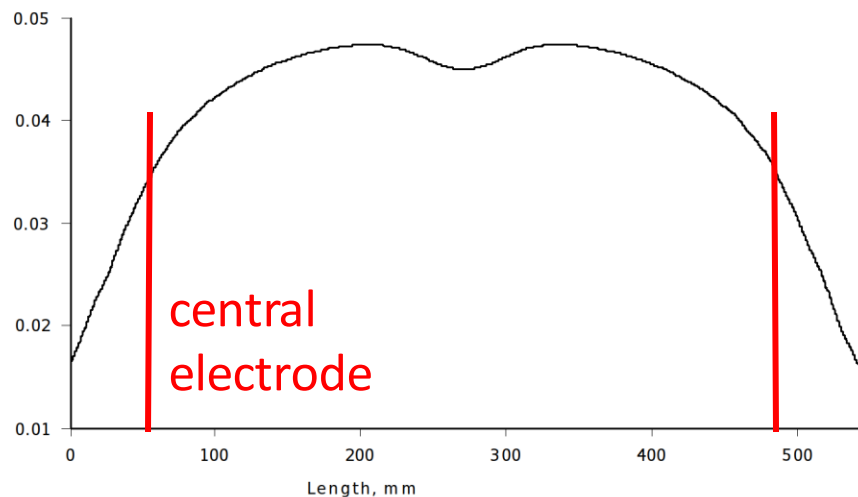
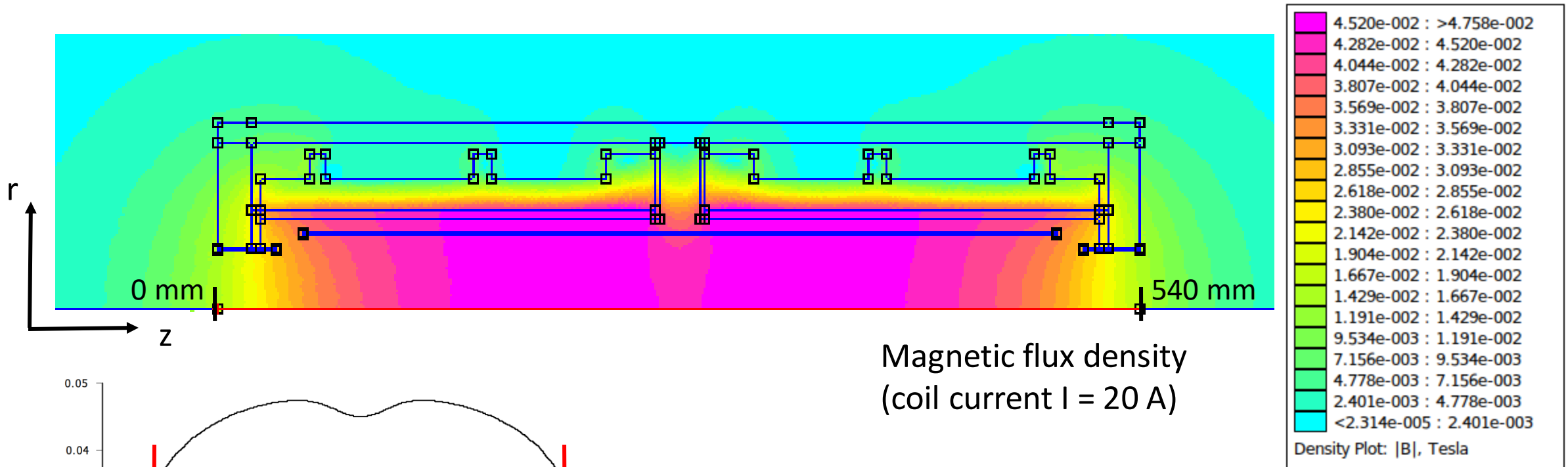
Copper conductor – area  $10.86 \text{ mm}^2$



Coils and metallic surfaces as modeled in FEMM

- Set current in the circuit such that the current density in the coils matches the values used in the experiments

# Magnetic field map

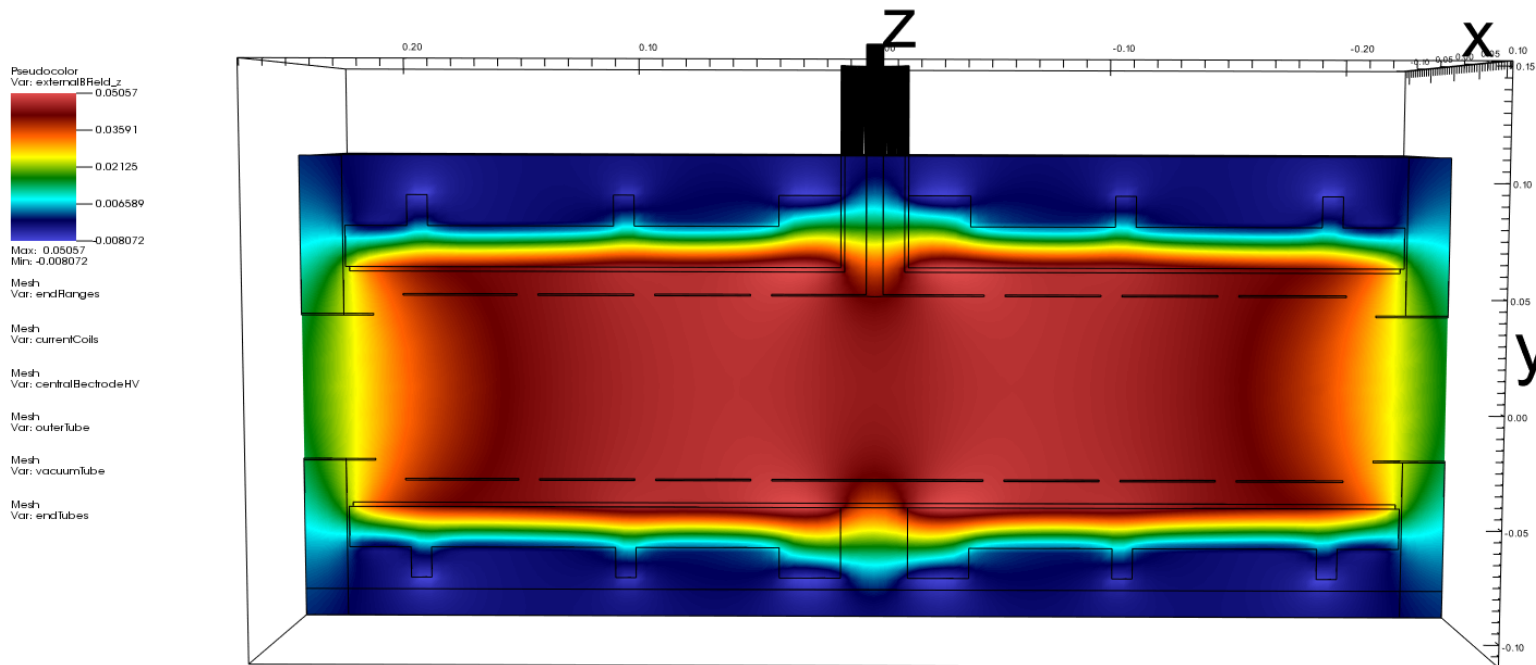


$B_z$  [T] on central axis  
( $B_r \sim 10^{-10}$  T)

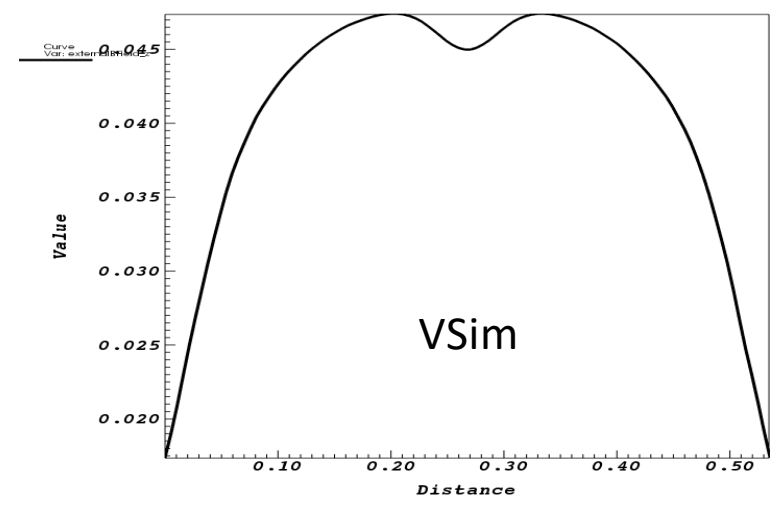
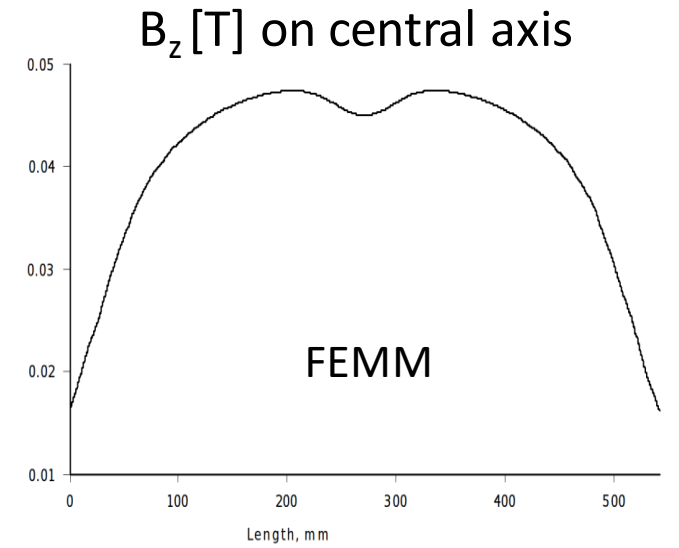
50 mT is enough to confine  
 $\sim 10^{16} \text{ m}^{-3}$  electron density

# Magnetic field map

- Import B-field map into VSim and verify for consistency



VSim: Bz colormap





# Next steps

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- Initialise the electrons into the simulation for the lens prototype
  - Homogeneous density vs. discharge