FLUKA

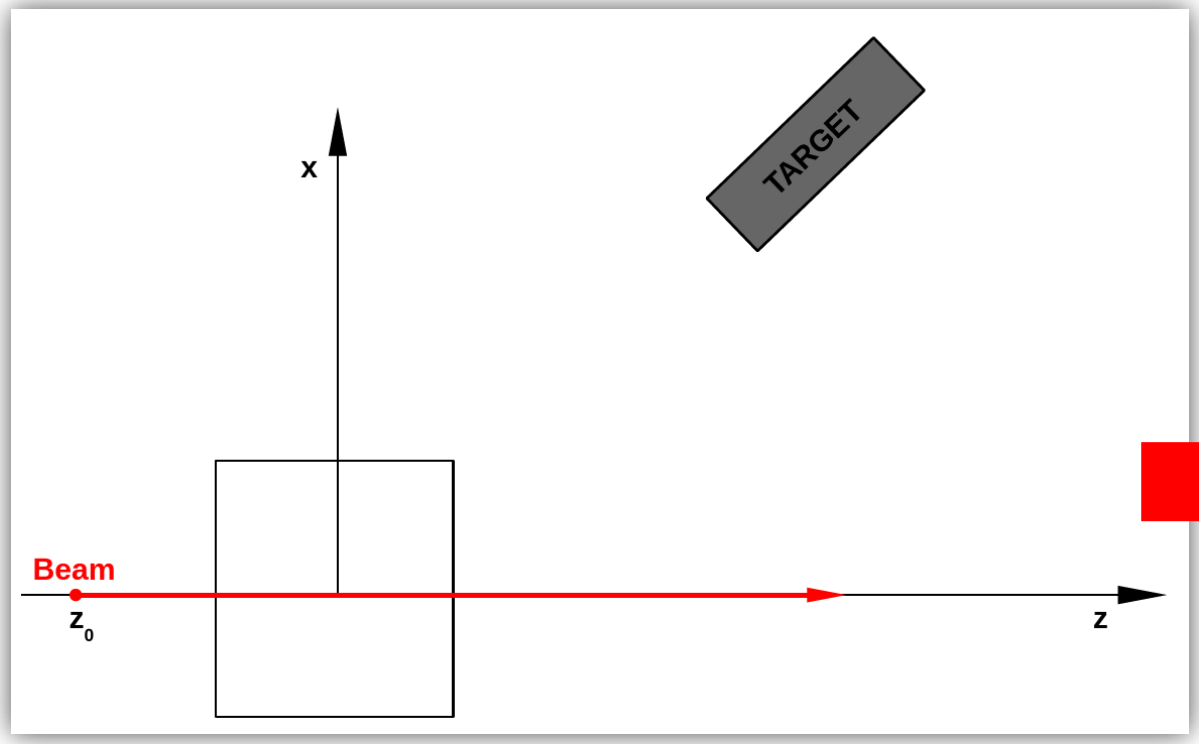
Exercise: Magnetic Field - Solution

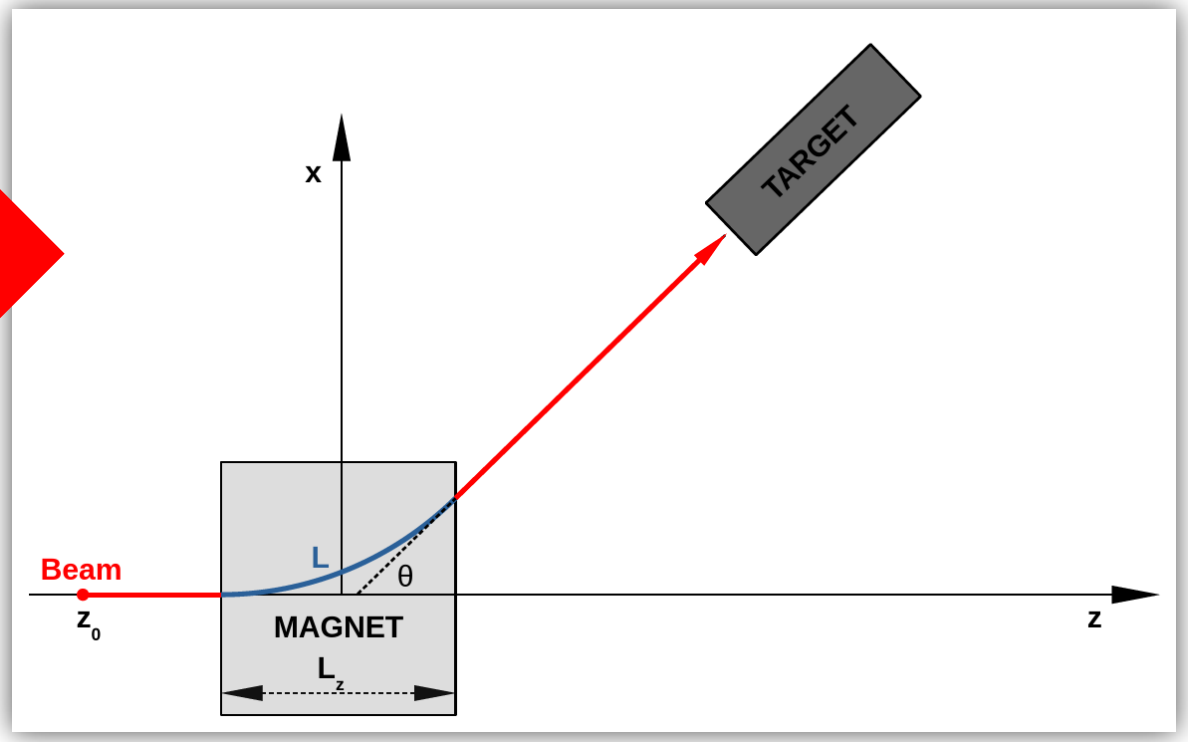
Aim of the exercise:

- Define a dipole field which deviates the beam on a target
- Plot the field
- Visualize the effect of the field on the beam trajectory

Exercise

- Introduce a dipole field in order to deflect a given beam on a pre-defined target





- Proton pencil beam with **600 MeV/c**
- Starts at z_0 **= -50 cm**, in positive **z-direction**

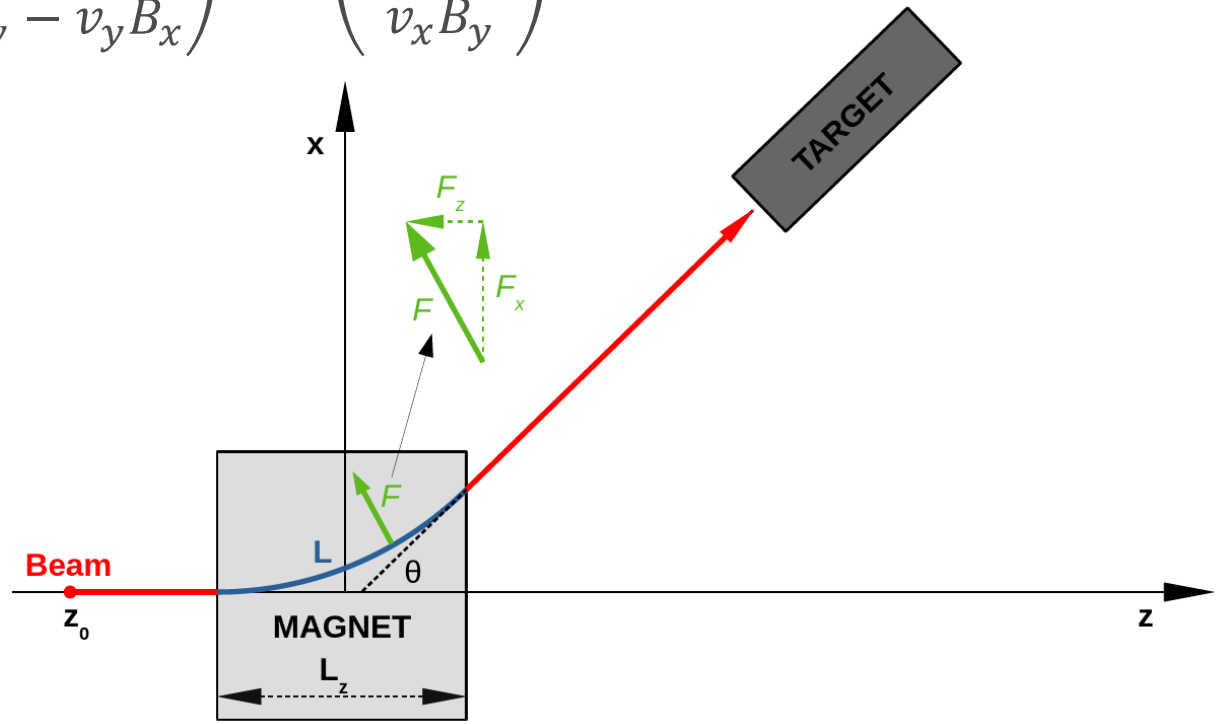
B field direction

- The B field is perpendicular to the plane of movement - hence only B_y can be non-zero if the particle shall move in the x-z plane:

$$\begin{pmatrix} F_x \\ 0 \\ F_z \end{pmatrix} = q \begin{pmatrix} v_x \\ v_y \\ v_z \end{pmatrix} \times \begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix} = q \begin{pmatrix} v_y B_z - v_z B_y \\ v_z B_x - v_x B_z \\ v_x B_y - v_y B_x \end{pmatrix} = q \begin{pmatrix} -v_z B_y \\ 0 \\ v_x B_y \end{pmatrix}$$

  - (F_x, F_y, F_z) = Lorentz force
  - q = Particle charge
  - (v_x, v_y, v_z) = Particle velocity
  - (B_x, B_y, B_z) = Magnetic field components

- Protons are positively charged (q>0):
  - As shown in the figure: $F_x > 0$ and $F_z \leq 0$
  - Since $v_z > 0, v_x \geq 0$, B_y must be negative



Required |*B*|

- Required B field strength of a **50 cm** long dipole to deviate a **600 MeV/c** proton beam by **25 deg**:

$$|B|\ [T] = \frac{0.6\ [GeV/c]}{0.299792\ * 1\ [e] * 0.5\ [m]} \sin\left(\frac{25}{180} * \pi\right) = 1.69164\ [T]$$

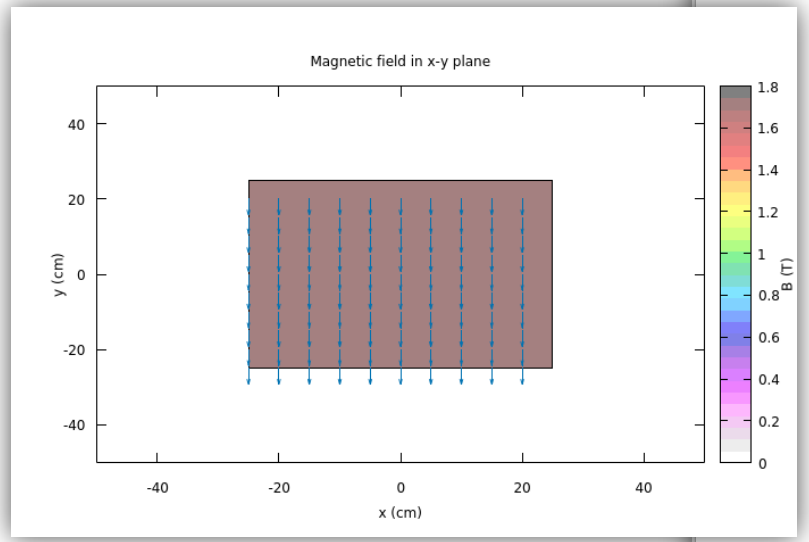
The cards

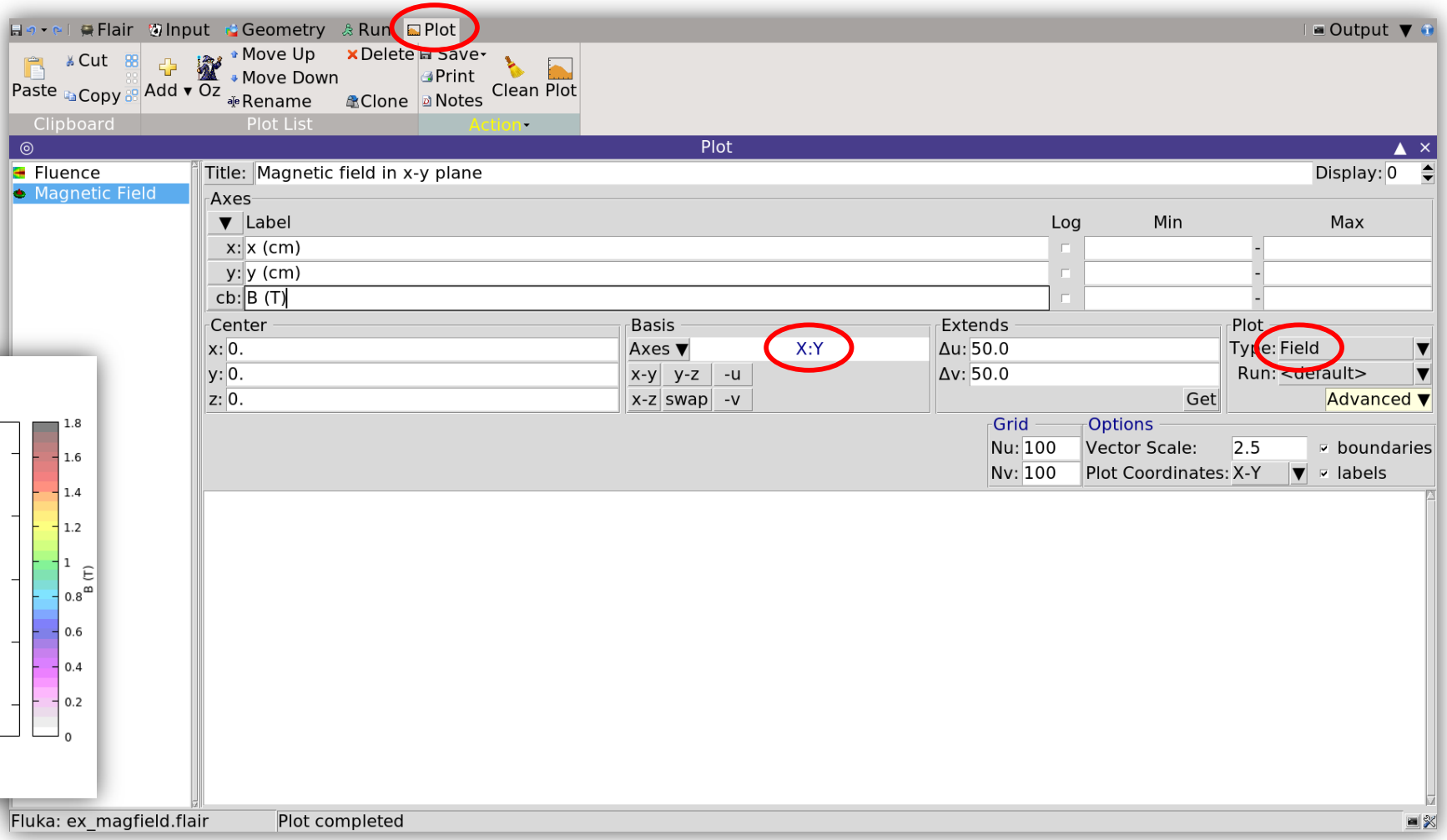
- **ASSIGNMA** (under “Media”):

- **MGNFIELD** (under “Transport”):

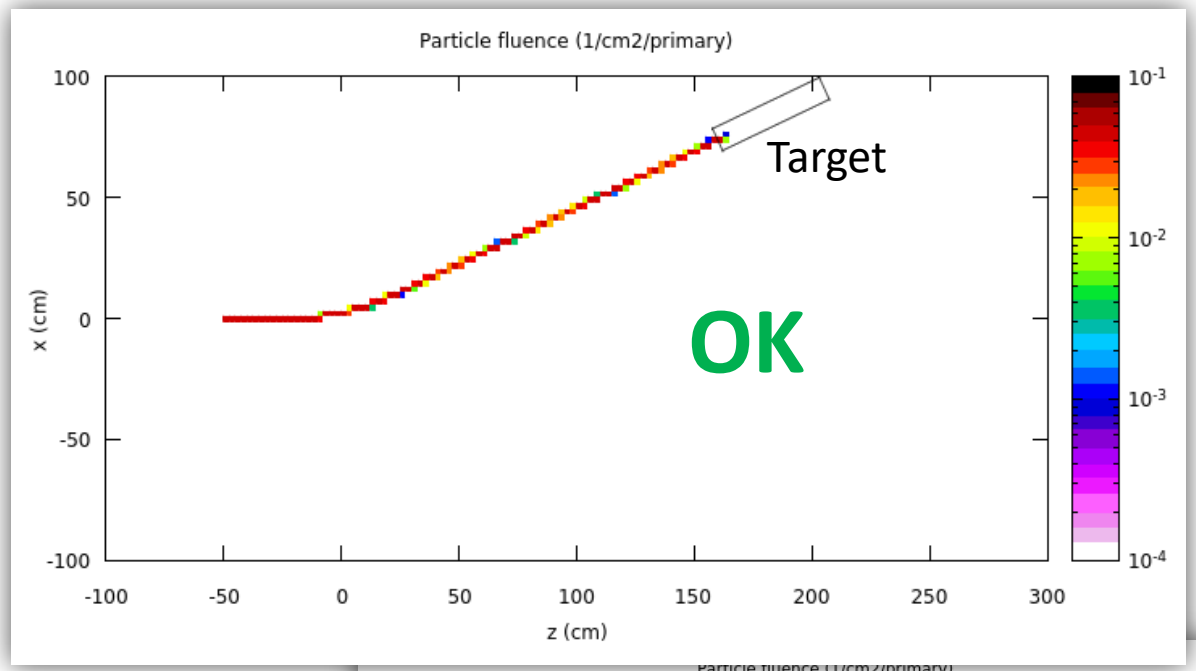
Plotting the field

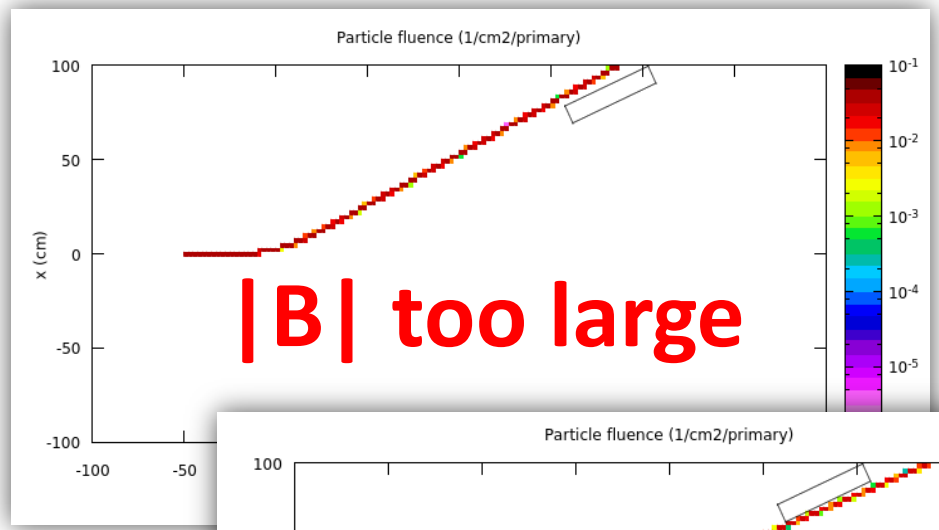
- Since the B-field only has a y component, let's for example chose the x-y plane for plotting:

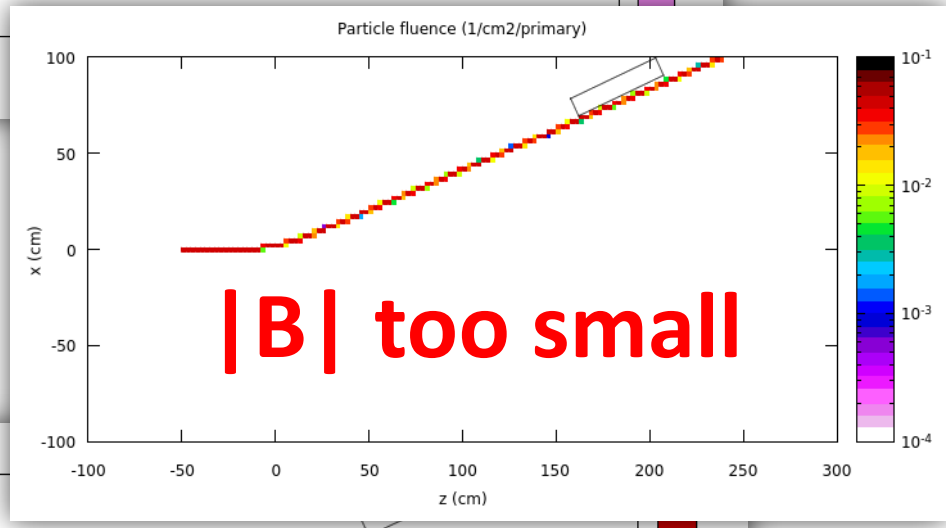


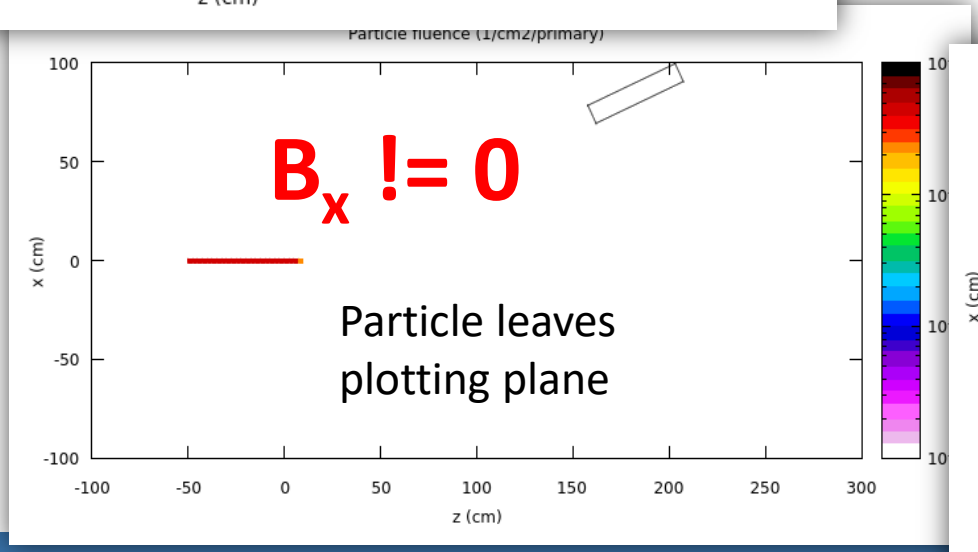


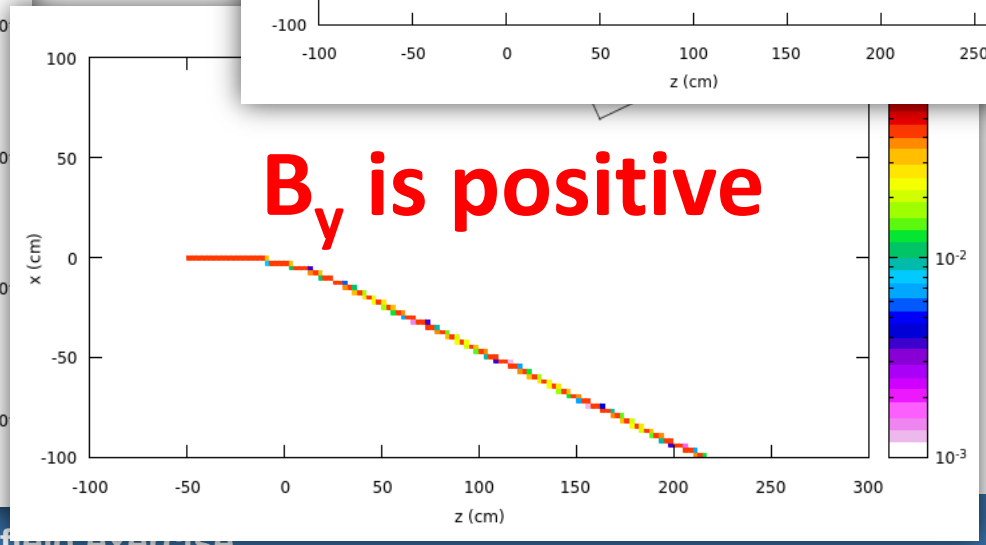
Particle fluence in x-z plane









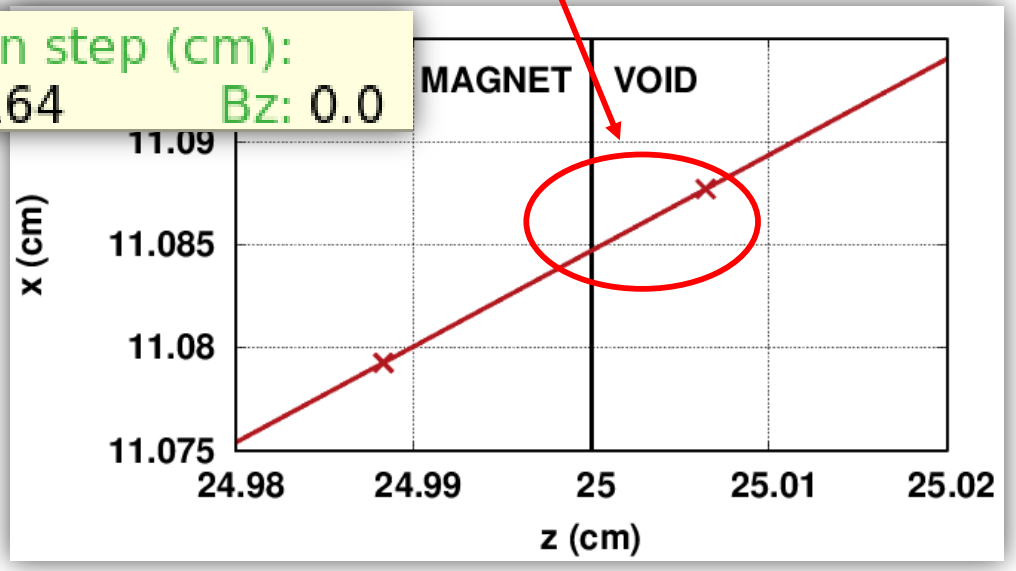


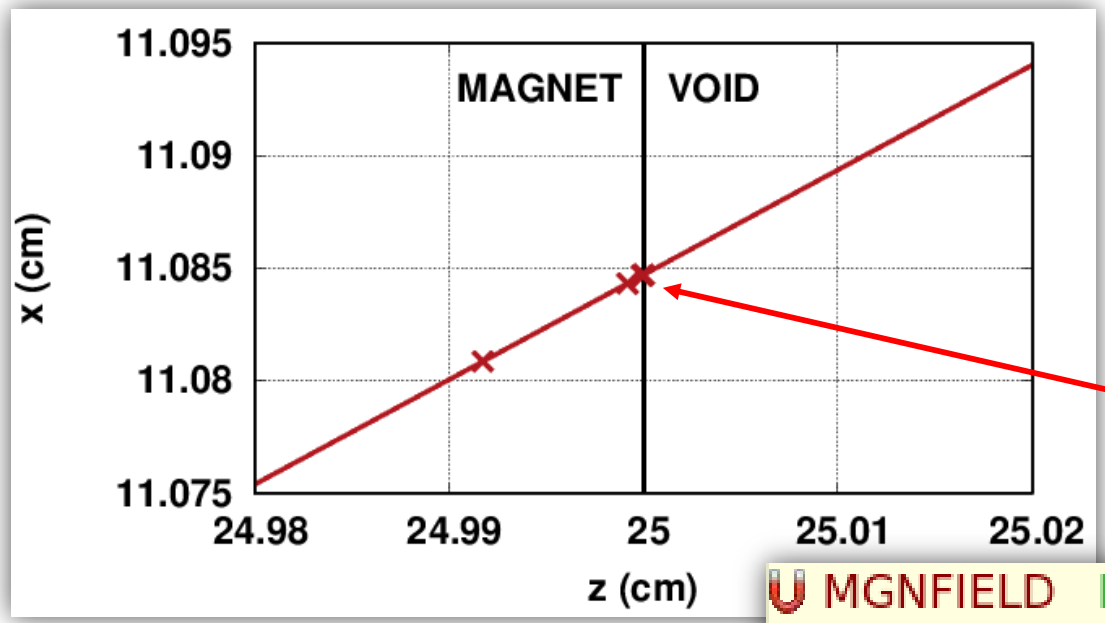
Tracking accuracy (boundary crossing)

- (was not part of the exercise)
- Pay attention to accuracy vs tracking speed

Default settings

MGNFIELD Max Ang (deg): Bound Acc. (cm): Min step (cm):
Bx: 0.0 By: -1.69164 Bz: 0.0





MGNFIELD Max Ang (deg): Bound Acc. (cm): 0.0001 Min step (cm):
Bx: 0.0 By: -1.69164 Bz: 0.0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