## A 90 degree bend calculated in two sections

Basis for the calculations are measured field maps which are used in Astra via the 3D field map option in the namelist Cavity. The calculation is performed in two steps with a 90 degree rotation of the coordinate system in between. In order to avoid large transverse offsets in the Astra output the origin of the rotation is chosen to be at the intersection of the longitudinal axis of the incoming design trajectory and the longitudinal center of the dipole magnet.
The origin of the coordinate system for the magnetic field measurements is shown in the plot below.
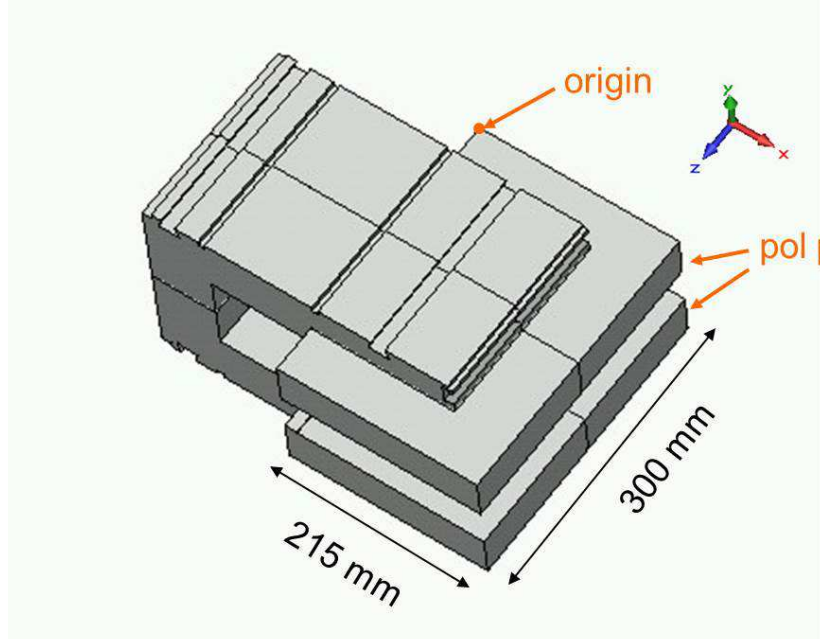
The field maps extent from 10 to 400 mm in x direction and from -150 to 300 mm in z direction. The step size is 10 mm in each direction. The field map is hence asymmetric and covers primarily the area where the beam travels by design.

The Astra field maps generated out of the measured maps uses a shifted coordinate system to simplify rotations. The Astra maps extent from -195 to 195 mm in x and from -225 to 225 mm in z (see the grid definition in the files 3D_Dipole.*). Due to this symmetry the origin of the coordinate system of the field map (which is used by Astra for rotations of the maps) is in the center of the map. The transverse, i.e. x design position of the magnet is 40 mm (in the coordinates of the measurements), i.e. 30 mm relative to the edge of the measured map. For the tracking calculation the origin is thus chosen to be at in the longitudinal center of the magnet and 40 mm off the edge of the pol plate. This requires a magnet position of: C_xoff= 195-30=165mm and C_pos=–(225-(150+150))=-75 mm. For the longitudinal position the asymmetry in the field map (-150 mm) plus half the magnet length (150 mm) needs to be taken into account. The position and extension of the field map can be visualized with fieldplot: Menu 2, x-z B-field, By-component (use next page).

The calculation is performed in two steps. First a beam is started outside of the dipole at -1m and tracked up to the center of the magnet (Input deck: Section1.in). The output distribution (Section1.0100.001) is loaded into postpro, rotated by -90 degree (Menu: phase space manipulations, rotate x-z, postpro rotates around the origin of the coordinate system of the particle distribution, which coincides with the Astra coordinate system) and saved (default file name: Section1_n.0100.001).

The rotated distribution is than tracked with Section2.in up to z=0.54m. In the second input deck the magnet is rotated by -90 degree and the offsets for x and z are exchanged to keep the position of the magnet. (The rotation is performed in Astra around the center of the field map.)

The input distribution 'tets.ini' contains only 7 particles with different momenta. All particles are probe particles thus trajectories can be visualized in lineplot.

Probe Particle Trajectories
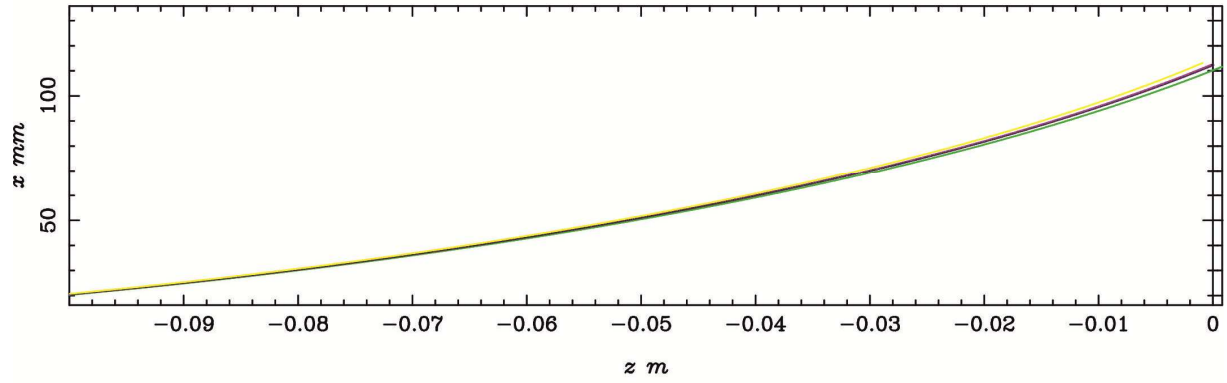
Probe Particle Trajectories
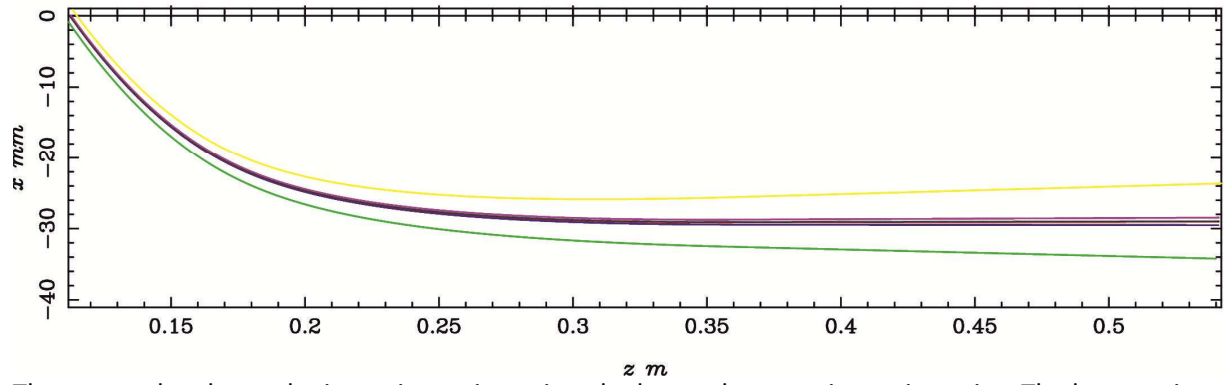
The upper plot shows the incoming trajectories, the lower the outgoing trajectories. The beam exits with ~30 mm offset relative to the longitudinal center of the dipole, the spread in the transvers offsets is due to the energy spread, i.e. it displays the dispersion.