Magnetic field in Geant and DD4hep

Jaroslav Adam

BNL

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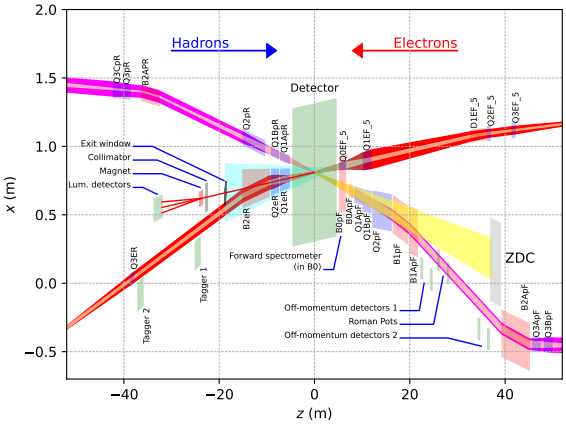
Far-Backward meeting

Beam magnets in far-backward

- Q1eR, Q2eR, B2AeR, B2BeR magnets are simulated in Geant luminosity framework and in DD4hep
- Input is electron beam generated with nominal vertex spread, angular divergence and momentum spread
- The beam is captured at the front of Q3eR after passing through fields of Q1eR, Q2eR, B2AeR, B2BeR
- Shape of the beam is compared to lattice results for the front of Q3eR provided by Charlie Hetzel - thanks:)
- Geant is compatible with lattice results
- DD4hep does not agree with lattice nor with Geant



Magnets location and fields

Name	z_0 (m)	z_1 (m)	d_0 (mm)	d_1 (mm)	B (T or T/m)	x_0 (m)	x_1 (m)	θ_y (mrad
Q1eR	-5.3	-7.1	96	111	13.3153	0	0	0
Q2eR	-7.6	-9	129	129	-12.0595	0	0	0
B2AeR	-9.61	-11.39	140	140	0.192	0	0	0
B2BeR	-11.685	-14.865	196	196	0.238	0	0	0
Q3eR	-37.7	-38.3	100	100		-0.46003	-0.47087	18.08

Table: Start and end position along z is z_0 and z_1. Same convention is used for diameter d and position in x.

Layout in Geant and DD4hep

- Q1eR, Q2eR, B2AeR, B2BeR magnets are shown as cylinders
- Rectangular marker at the front of Q3eR captures the beam

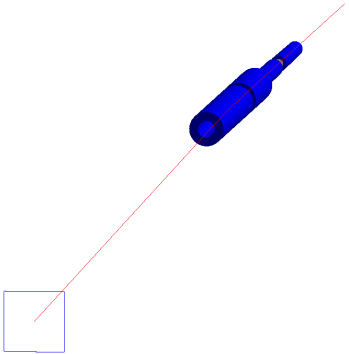


Figure: Geant layout and electron trajectory

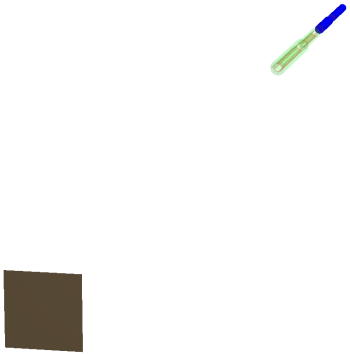


Figure: DD4hep layout

Beam shape at Q3eR from Geant

	μ_x (mm)	μ_y (mm)	$3\sigma_x$ (mm)	$3\sigma_y$ (mm)
Lattice reference	0	0	10.19	0.41
Geant results	-2.733 $\pm$ 0.025	-0.003 $\pm$ 0.001	10.247 $\pm$ 0.062	0.379 $\pm$ 0.003

- Fit to beam position on the front of Q3eR
- Comparison to lattice calculation
- Slight offset in x vs. lattice
- Good agreement for beam width

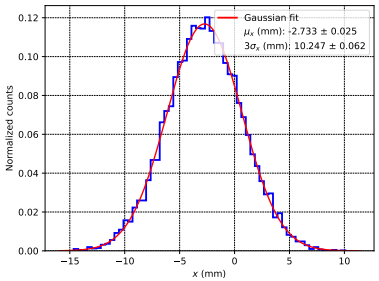


Figure: Beam along x in Geant

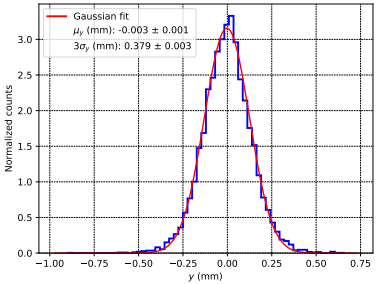


Figure: Beam along y in Geant

Beam shape at Q3eR from DD4hep

	μ_x (mm)	μ_y (mm)	$3\sigma_x$ (mm)	$3\sigma_y$ (mm)
Lattice reference	0	0	10.19	0.41
Geant results	-2.733 $\pm$ 0.025	-0.003 $\pm$ 0.001	10.247 $\pm$ 0.062	0.379 $\pm$ 0.003
DD4hep results	-2.806 $\pm$ 0.046	-0.002 $\pm$ 0.049	11.749 $\pm$ 0.114	2.283 $\pm$ 0.119

- Fit to beam position on the front of Q3eR
- Comparison to lattice calculation and Geant
- Mean and σ_x is consistent with Geant
- Width in y is not a Gaussian, looks like Breit-Wigner
- Not compatible with Geant nor with lattice

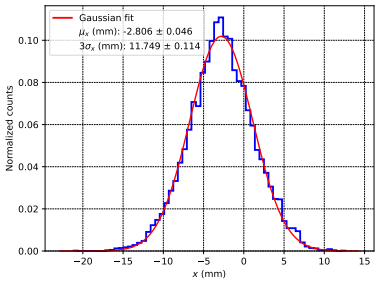


Figure: Beam along x in DD4hep

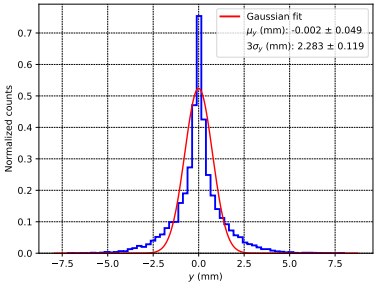


Figure: Beam along y in DD4hep

Summary

- Same hepmc3 input file is used with Geant and DD4hep
- Same physics list (FTFP_BERT) and random seed are set in both simulations
- Identical Geant version (10.7.p01) was used to build the DD4hep (and Athena framework)
- Geant agrees with lattice calculations
- Quadrupoles have to be rotated by 90 degrees along z to get the same convention as comes from lattice
- The rotation is achieved either in magnet placement or by inverting the sign of field gradient
- Beam shape after the magnets from DD4hep is not compatible with expectation from lattice calculations and not compatible with Geant results
- As of now I have no idea about the origin of the disagreement
- Codes used to run DD4hep, including input beam data are provided on indico along these slides