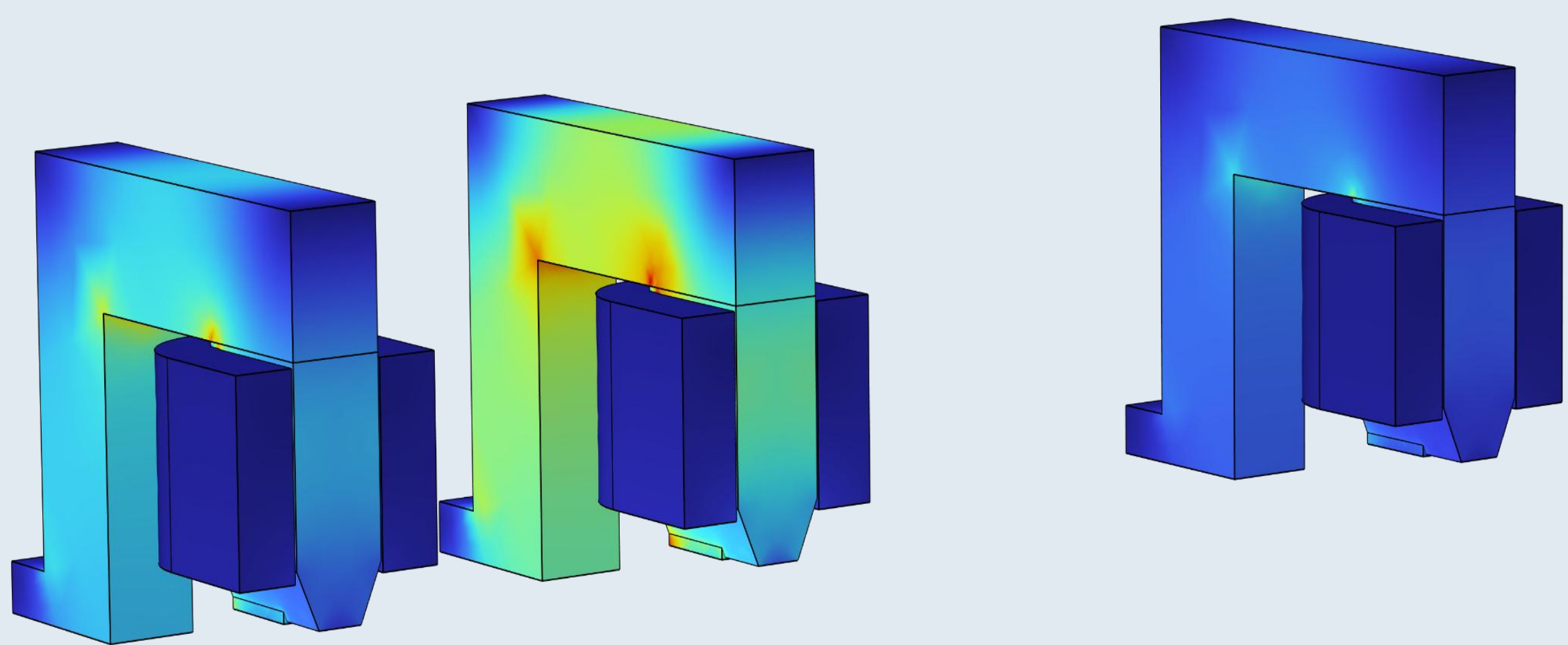


Design of Electromagnetic Canting Magnets and a Hybrid Wiggler for Diamond-II Beamline Sources



COMSOL simulations are performed to evaluate the magnetic-field distribution and key design parameters of the proposed magnetic design configurations, and to verify their compliance with the required beamline specifications.

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Abstract

Diamond Light Source is the UK's national synchrotron facility providing high-brightness X-ray, ultraviolet and infrared beams for multidisciplinary scientific research. The ongoing Diamond-II upgrade [1] aims to enhance the facility's performance through the development of new beamlines and accelerator components. This poster presents COMSOL Multiphysics® simulation studies of the canting magnets and hybrid wiggler required for the K14 and K18 beamlines. The K14 beamline requires a 116 mm period hybrid wiggler, a magnetic device used to generate a

periodic static magnetic field along the electron beam, comprising permanent magnets and low-carbon steel poles, together with three canting magnets, which are used to provide the required horizontal beam offset and restore the electron beam to the nominal orbit. The K18 beamline requires three horizontal and three vertical canting magnets for beam separation and trajectory control. The simulation results confirm that the proposed magnetic designs meet the required specifications of the K14 and K18 beamlines for the Diamond-II upgrade.

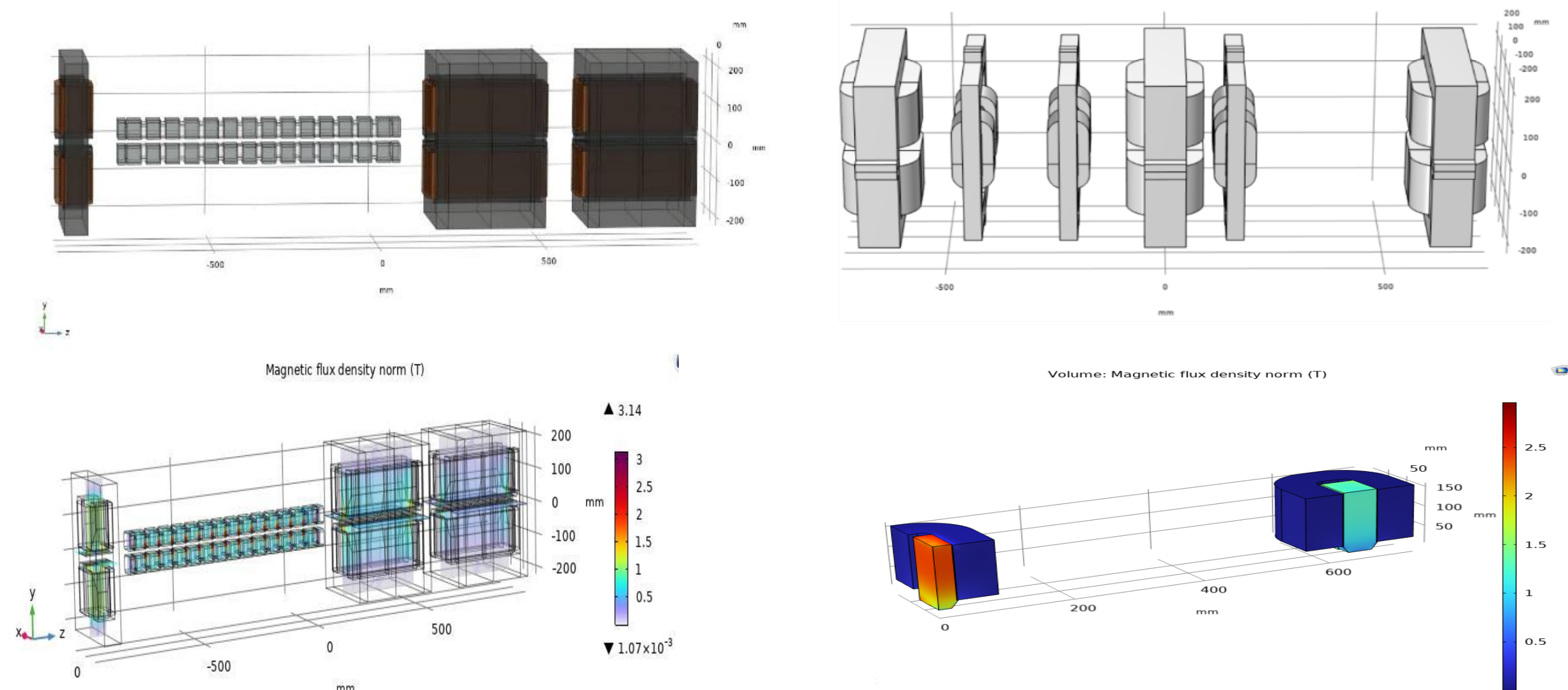


Figure 1. 3D model (top left) and magnetic flux density distribution (bottom left) of K14, 3D model of (top right) and magnetic flux density of H-type magnet (bottom right) for K18.

Numerical Model and Simulation Method

Three-dimensional finite-element simulations of the K14 and K18 magnetic assemblies are performed in COMSOL Multiphysics® using the Magnetic Fields (mf) interface of the AC/DC Module. A stationary formulation is used to obtain the magnetostatic field solution, governed by

$$\nabla \times H = J \text{ and } \nabla \cdot B = 0$$

Nonlinear B-H characteristics are assigned to ferromagnetic components to account for their field-dependent magnetic response.

Results

K14 Parameters [unit]	Chicane 2	Chicane 3
Current density [A/mm ²]	3.81	2.81
Nominal current [A]	39.1	28.8
Temperature change max [°C]	10	10
Pressure drop _{max} [bar]	6	6
Total flow rate [L/min]	0.56	0.55
Water speed [m/s]	0.95	0.95
Copper conductor size [mm x mm]	4 x 4	4 x 4
Hollow diameter [mm]	2.5	2.5
Round edge [mm]	1	1
Voltage [V]	10.3	7.6
Number of turns per coil	79	79
Total heat load per magnet [Watt]	401.1	217.1

K18 Parameters [unit]	Strongest H-magnet	Strongest V-magnet
Current density [A/mm ²]	2.99	3.11
Nominal current [A]	67.6	59.8
Temperature change max [°C]	10	10
Pressure drop max [bar]	6	6
Water speed [m/s]	1	1.56
Copper conductor size [mm x mm]	6 x 6	5 x 5
Hollow diameter [mm]	4	2.5
Round edge [mm]	1	1
Voltage [V]	12.7	3.3
Number of turns	198	75

The magnet geometry, longitudinal positions, pole gap, wiggler parameters, and excitation current are iteratively optimized in COMSOL. The magnetic-field profile and electron-beam trajectory are evaluated for each configuration, with the final design selected based on the required field strength, magnetic field profile, and bending angle. Iron nonlinearities are included to assess saturation regions [2].

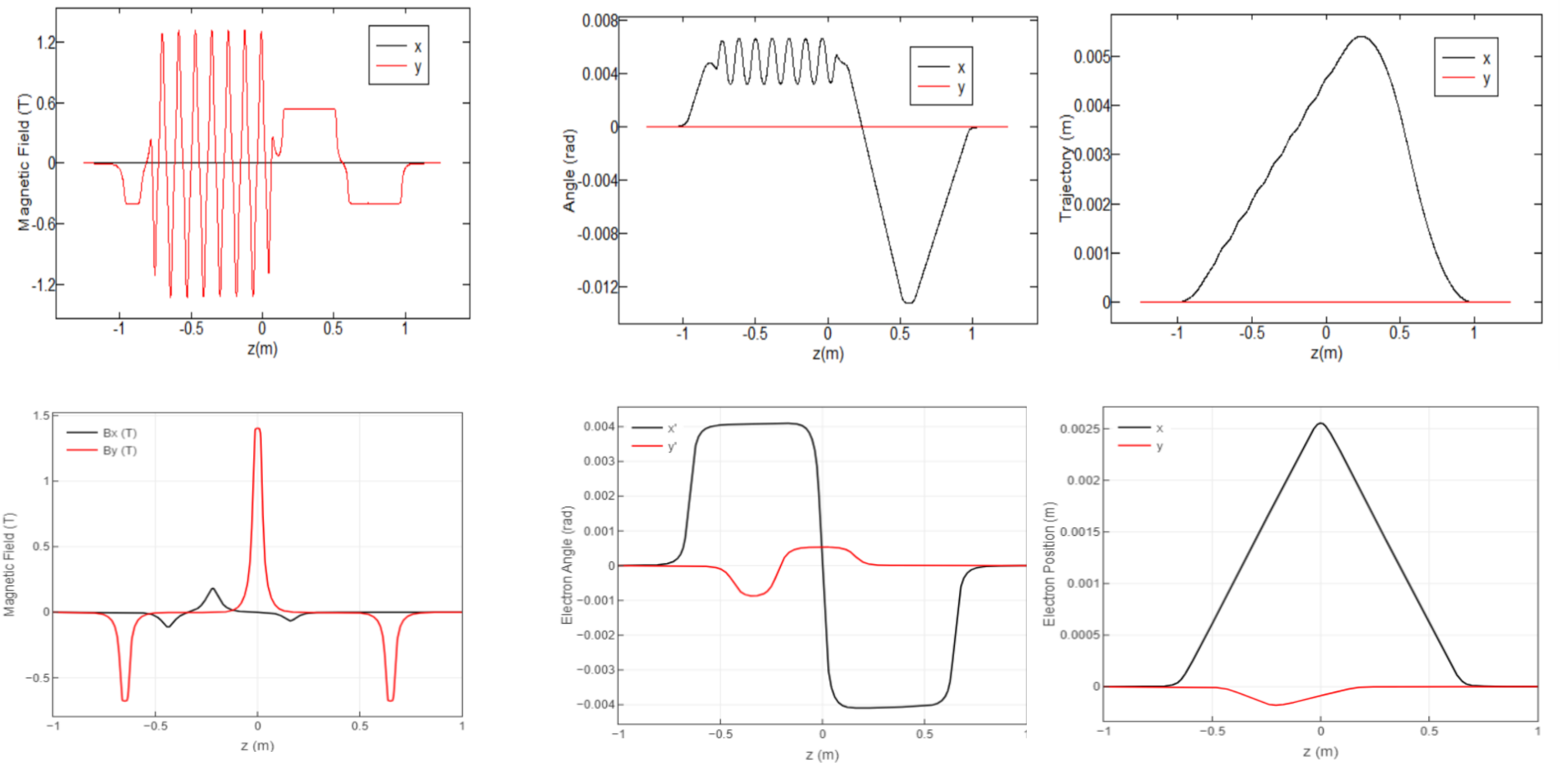


Figure 2. Magnetic field profile, electron beam angle and electron position for K14 (top), Magnetic field profile, electron beam angle and electron position for K18 (bottom)

REFERENCES

[1] Diamond-II Technical Design Report, 2022.
[2] G Sharma, Z Patel, "Design of Electromagnetic Canting Magnets and a Hybrid Wiggler for Diamond-II Beamline Sources", proc of COMSOL conference 2026.



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