Magnet design
FFA physics review

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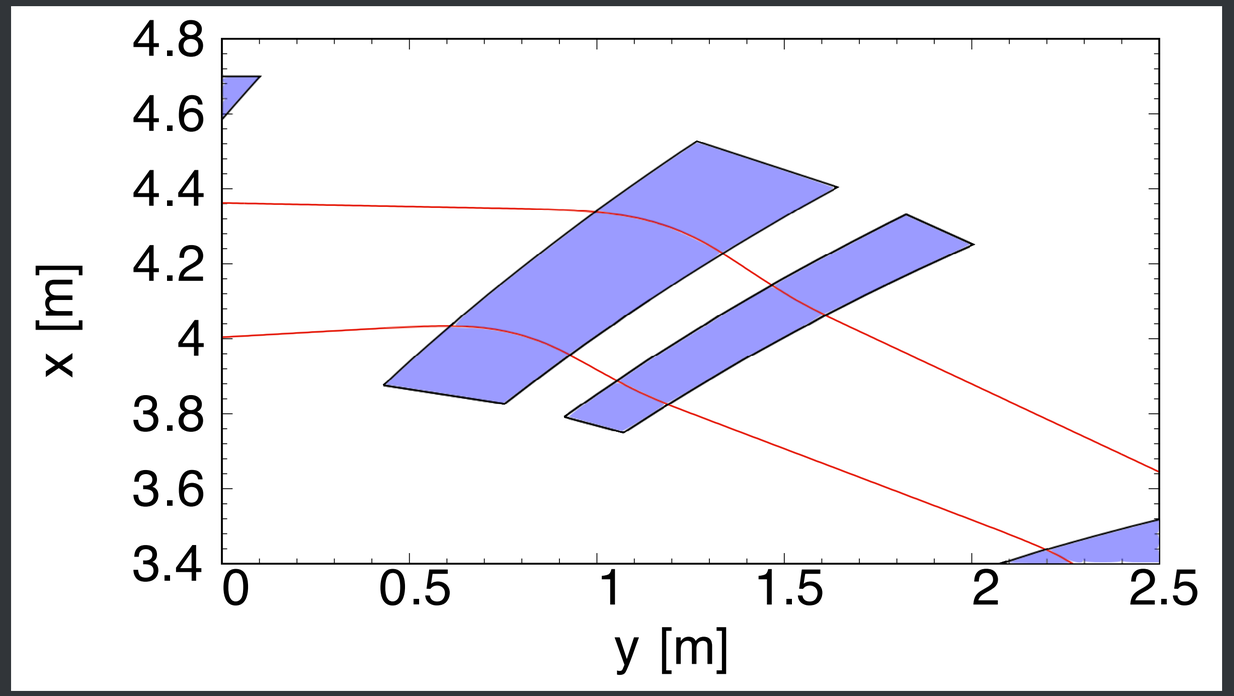
Spiral FFA

- Fixed Field alternating gradient Accelerator option for ISIS-II
- Low-cost operation (DC magnets)
- High longitudinal dynamics flexibility (repetition rate, several target stations)
- FETS-FFA ring: proof of principle for high power pulsed operation



Scaling FFA field law:

$$B = B_0 \left(\frac{r}{r_0}\right)^k \mathcal{F}\left(\theta - \tan\xi \ln\left(\frac{r}{r_0}\right)\right)$$

with $B_0=B(r_0)$, k: geom. field index, ξ: spiral angle

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Magnet prototype scope

- Develop skills internally to design and build FFA magnet
- Design and build spiral hFFA magnet suitable for high intensity operation:

  → zero-chromatic operation (tune constant during acceleration)

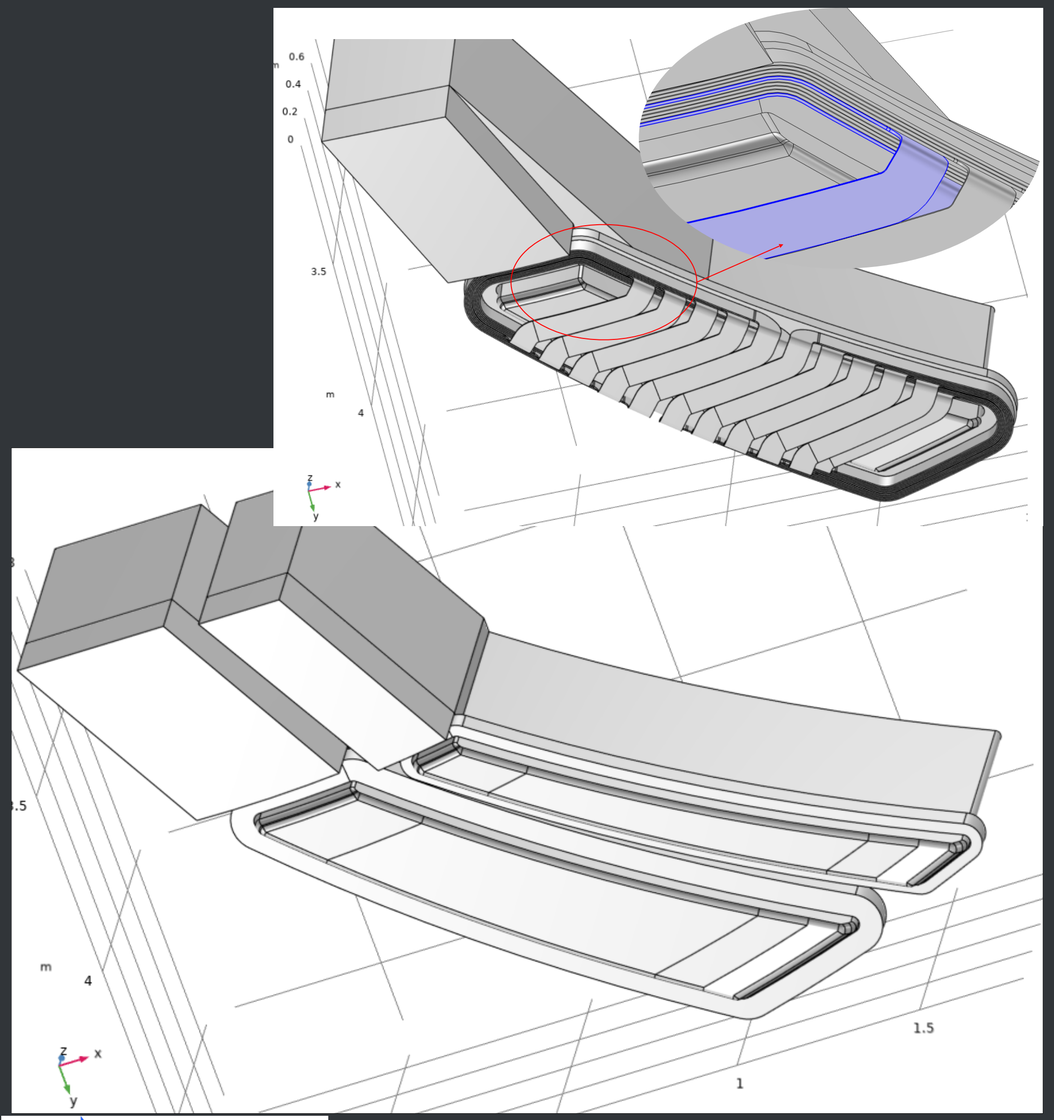
  → adjustable tune as a function of intensity (FD structure with adjustable k-value)

  → Large gap with large dynamic aperture to accommodate beam without uncontrolled losses
- Investigate SC to improve sustainability for ISIS-II

Project tasks

1. Manufacturing options: 2D study ✓✓
2. Fringe field requirements: preliminary 3D model ✓✓
3. Manufacturing contracts options
4. Magnetic modelling of chosen design ✓
5. SC coil investigation
6. Mechanical design
7. Prototype manufacture
8. Magnetic measurements of prototype
9. Analysis of measurements and publication

Magnet specifications



Cell type	FD spiral
Number of cells in the ring	16
Cell opening angle	22.5 deg.
spiral angle	45 deg
k-value range	6 – 11
Injection, Extraction proton energy	3, 12 MeV
F Magnet opening angle	4.5 deg. (31 cm at r=4 m)
D Magnet opening angle	2.25 deg. (16 cm at r=4 m)
Short drift opening angle	2.25 deg.(16 cm at r=4 m)
Full gap size (include vacuum chamber)	80 mm
Good field region excursion	580 mm
Maximum vertical field in good field region	1 T
Fixed average injection/extraction radius	4.0 m/4.42 m

C-type magnet to fit in R9 at RAL

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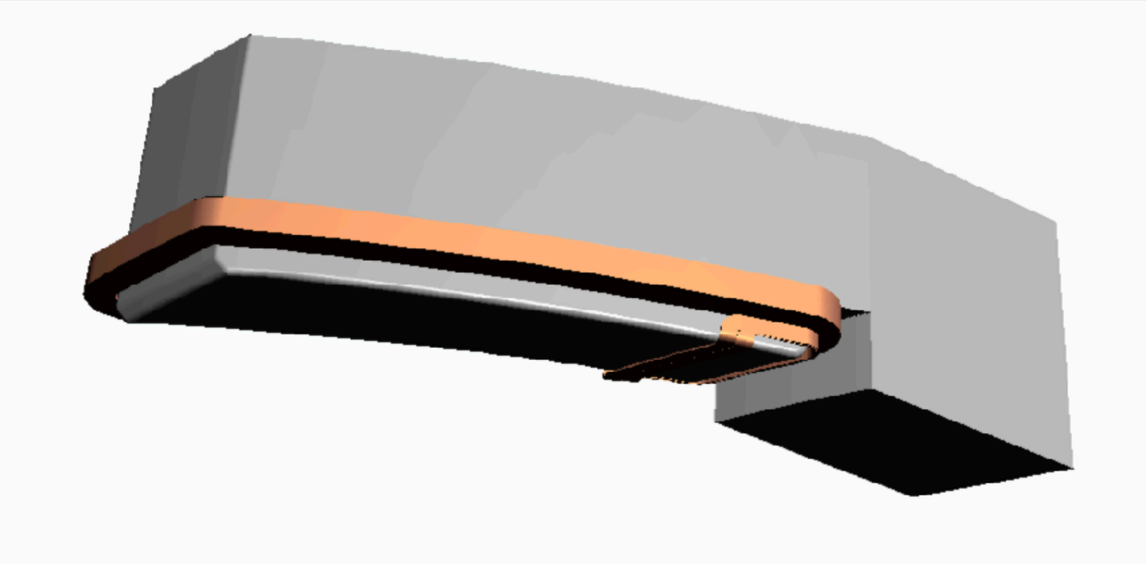
3D preliminary model in Comsol



F magnet with 2 trim coils

- Doublet (with 40 trim coils) may be impossible to solve with 128 GB RAM in Comsol.
- Implementation of model in Opera 3D with field clamps in progress.
- Aim to have reasonably optimised model for central scenario by end of September 2023.

Remaining critical tasks

- Magnetic 3D design (field clamps, currents optimisation) → Sept. 2023
- Mechanical design → Nov. 2023
- Tender for manufacturing → Dec. 2023
- Prototype manufacturing → Dec. 2024
- March 2025 Deadline for deliverables
- Magnetic measurements (in 2025)
- Analysis and publication (in 2025)