Advanced SND@LHC magnet: newer ‘minimal’ design

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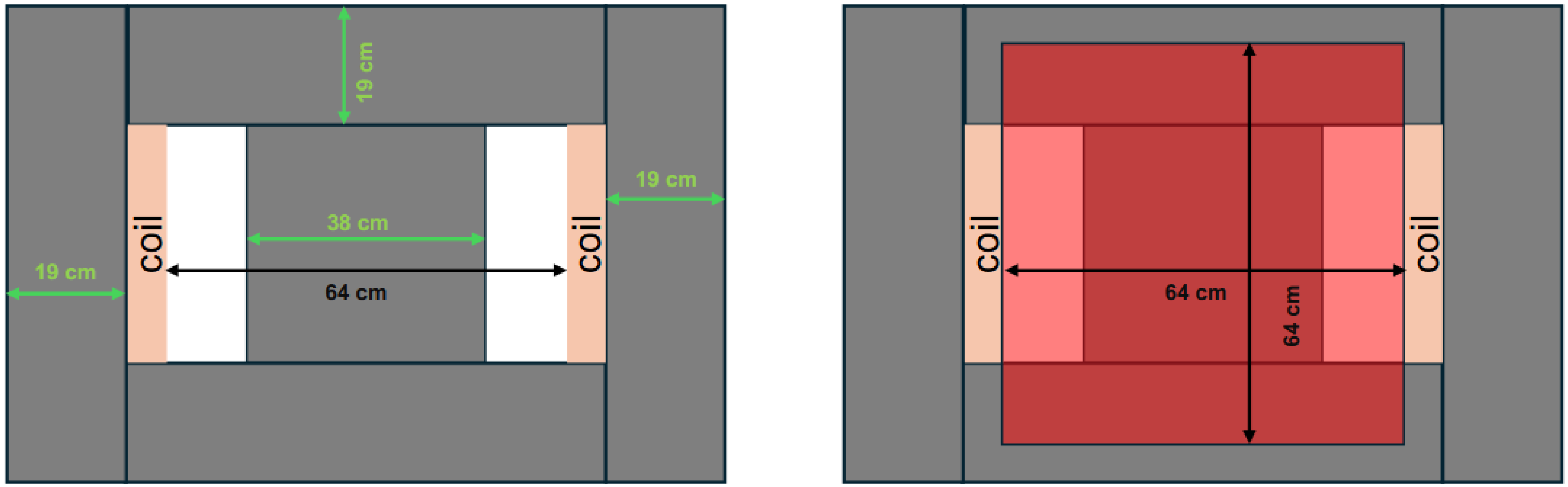
Summary

- Newer ‘minimal’ design (detectors follow up)
- Detailed 3-D FEM analyses
- Stray field evaluation
- Cost estimate
- Preliminary milestones schedule

The HCL calorimeter magnet: newer 'minimal' design [1/4]

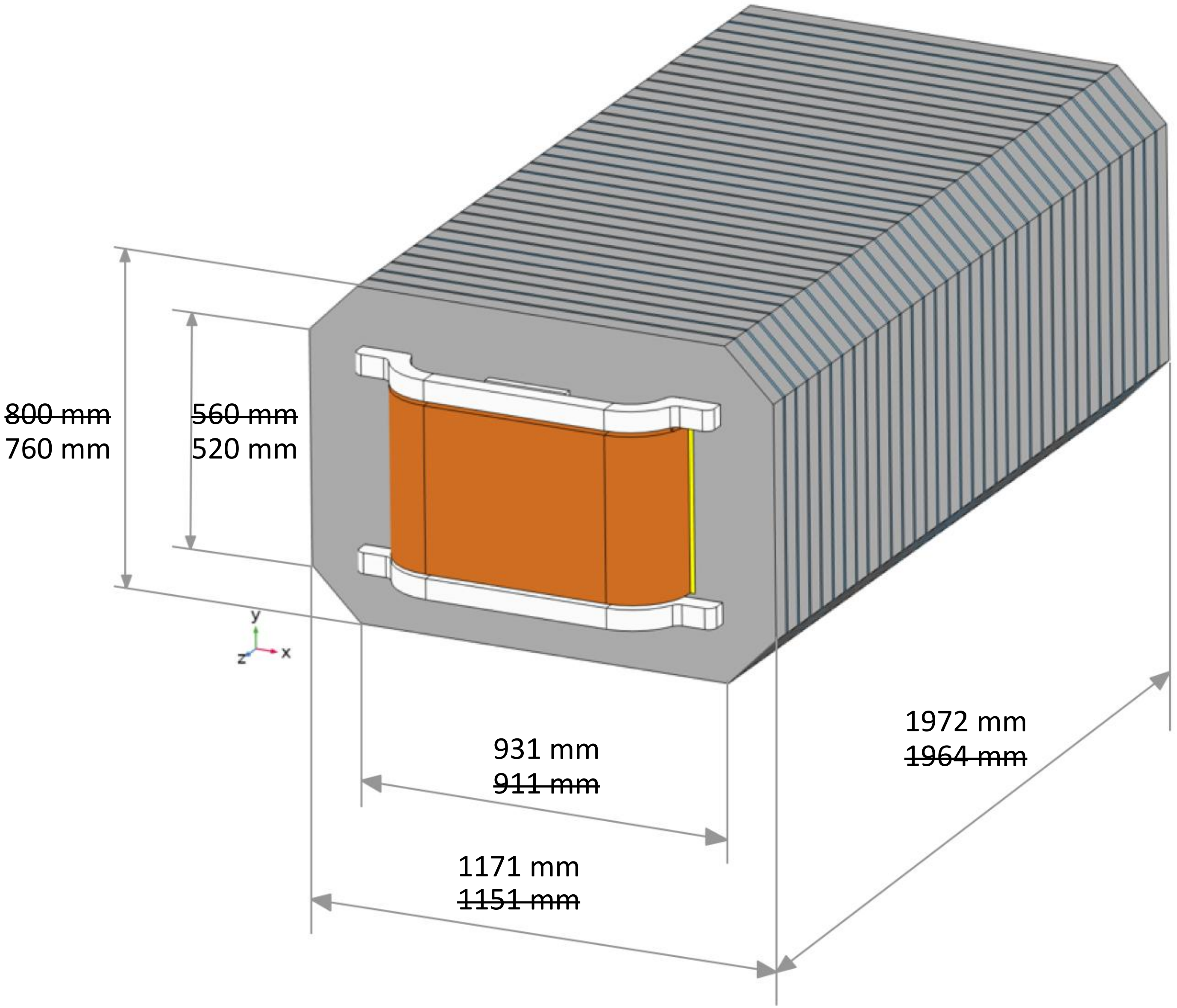
- Newer 'minimal' design following detectors follow up (communication by D Abbaneo)

The iron dimensions can be optimized considering an instrumented area of $38\times38\ cm^2$ while leaving the required surface of $64\times64\ cm^2$ for the implementation of modules and ROBs



Total height of the iron: 38 + 19 + 19 cm
Total width of the iron: 64 + 19 + 19 cm + space for the coil

The HCL calorimeter magnet: newer 'minimal' design [2/4]

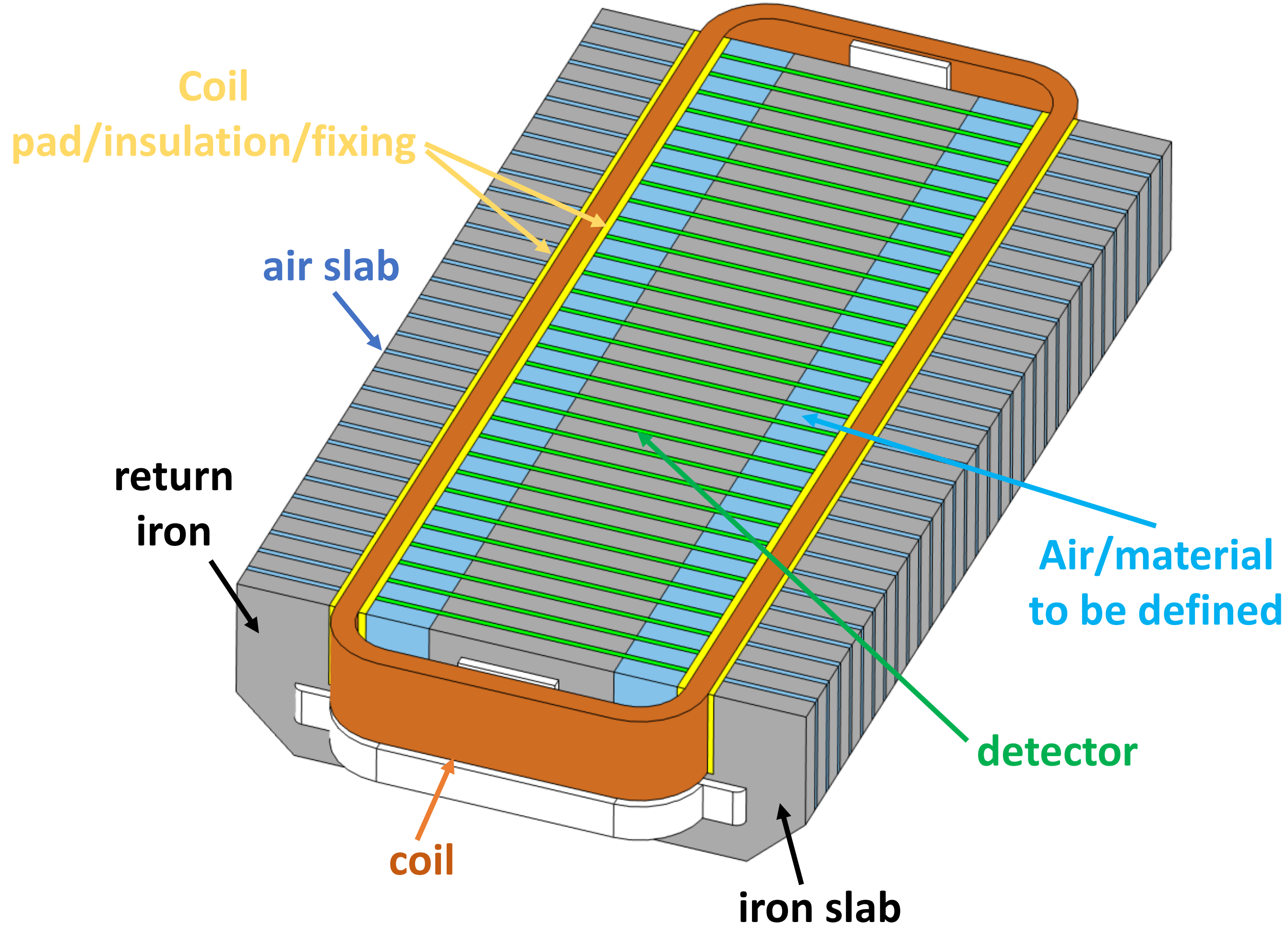


Main features (June 2025 design)

- ~~400x400~~ 380*380 mm^2 active area
- ~~34~~ 32 iron slabs (each 50 mm thick)
- ~~8~~ 12 mm distance between two subsequent slabs (to fit detectors)
- ~~100+100 mm side inox bricks~~ – rails / other structures to be defined
- truncated edges (chamfer side length is 12 cm)
- single air-cooled coil (< 1 ton)
- 'minimalistic' coil fixing (slide 12)

The HCL calorimeter magnet: newer ‘minimal’ design [3/4]

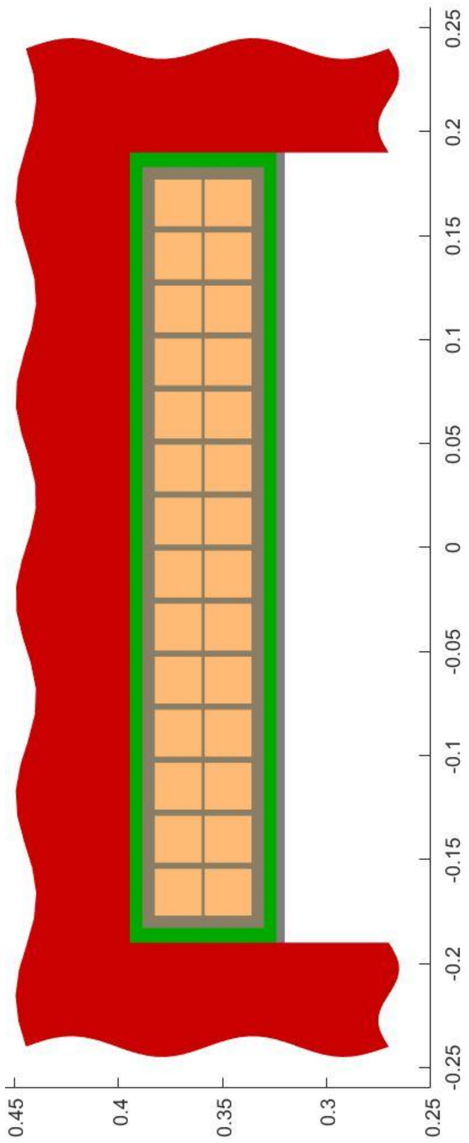
Half view



Hadron Calorimeter Magnet
newer ‘minimal’ design
main parameters (June 2025)

	HCM
Total cross section (without cabling) [m^2]	1.171 x 0.76
Iron length [m]	1.972
Total length (including coil) [m]	2.275
Reference magnetic flux density [T]	1.75
Current density [A/mm^2]	0.93
Electrical power [kW]	1.27
Coil mass (copper + resin) [ton]	0.84
Iron – single slab [ton]	0.28
Overall mass (iron + coil) [ton]	9.7

The HCL calorimeter magnet: newer ‘minimal’ design [4/4]

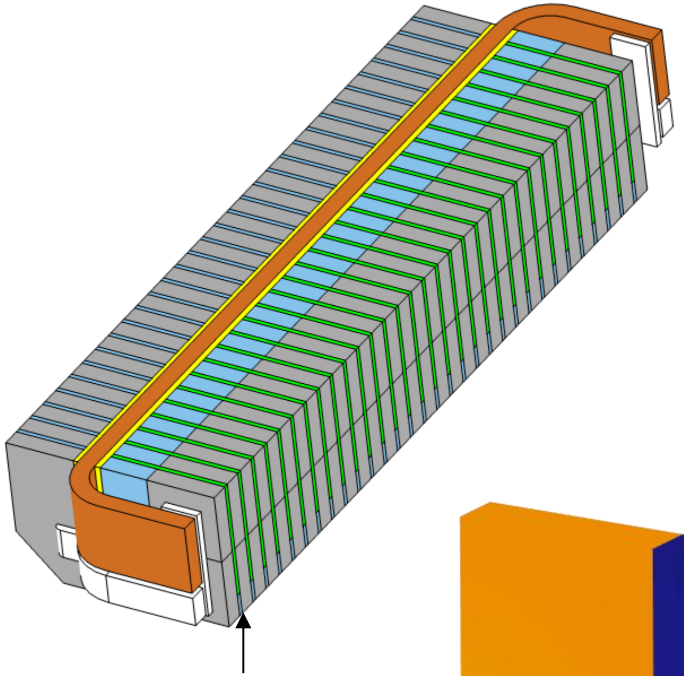


HCM newer ‘minimal’ design

main coil parameters (June 2025)

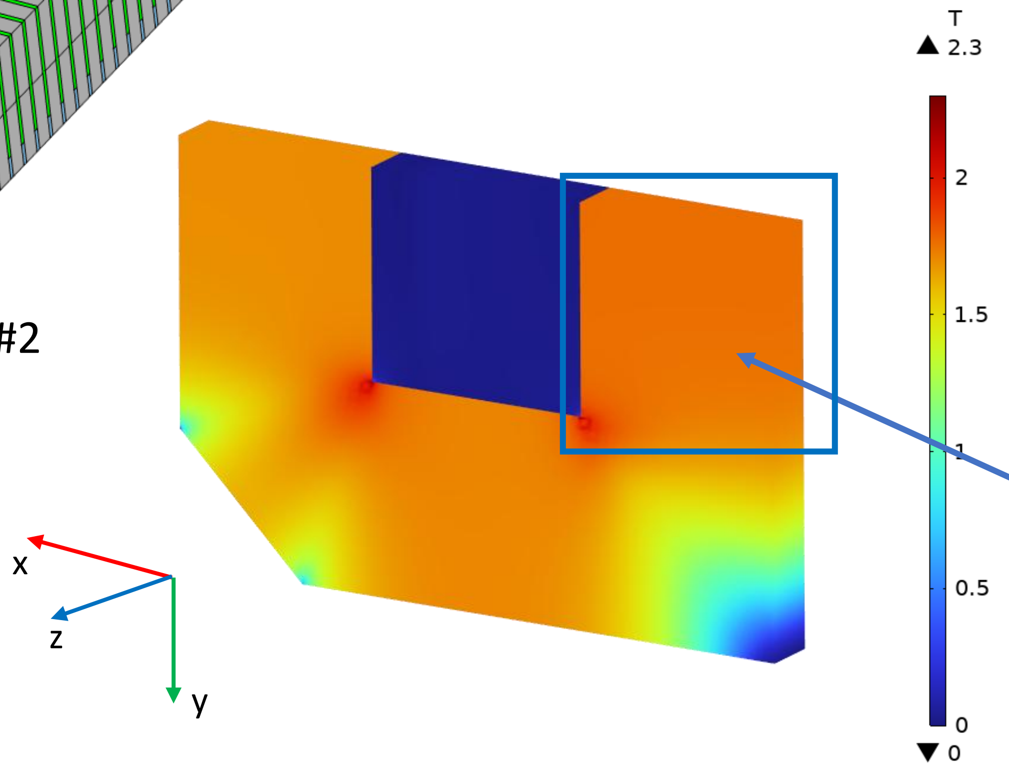
bar material	Cu
total turns	28
bar cross section [mm^2]	22.5 x 22.5
bare coil cross section (Cu + resin) [mm^2]	366 x 58.5
total coil cross section (Cu + resin + pad/insulators/fixing) [mm^2]	380 x 74.5
average turns length [m]	5.7
total winding length [m]	159
total bar mass [ton]	0.71
total coil mass (Cu + resin) [ton]	0.84
voltage [V]	2.7
current [A]	464
current density [A/mm^2]	0.93
total resistance (@40°C) [mΩ]	5.9
magnetomotive force [kA]	13.0
electrical power [kW]	1.27

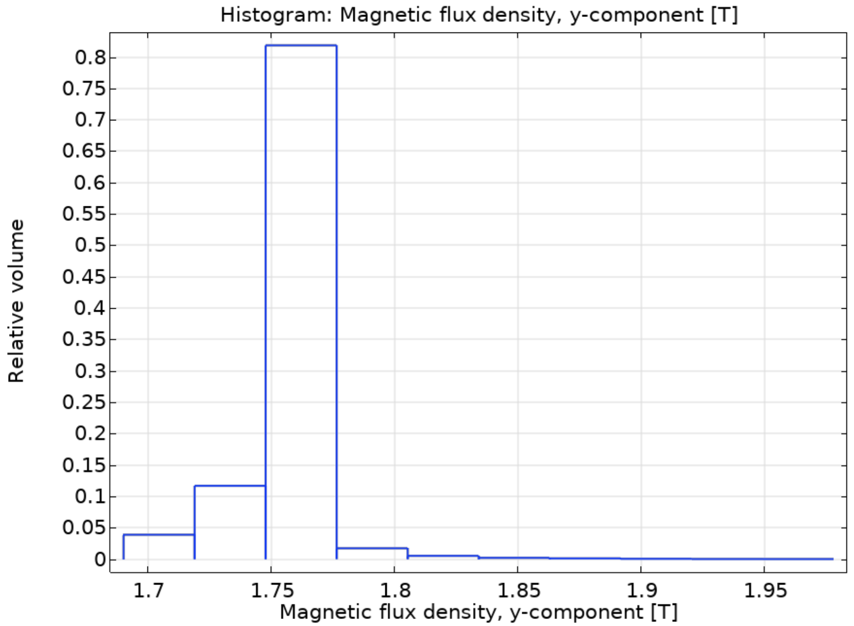
HCM 3D FEM simulations (slab #2) [1/2]



Simulations on one/quarter

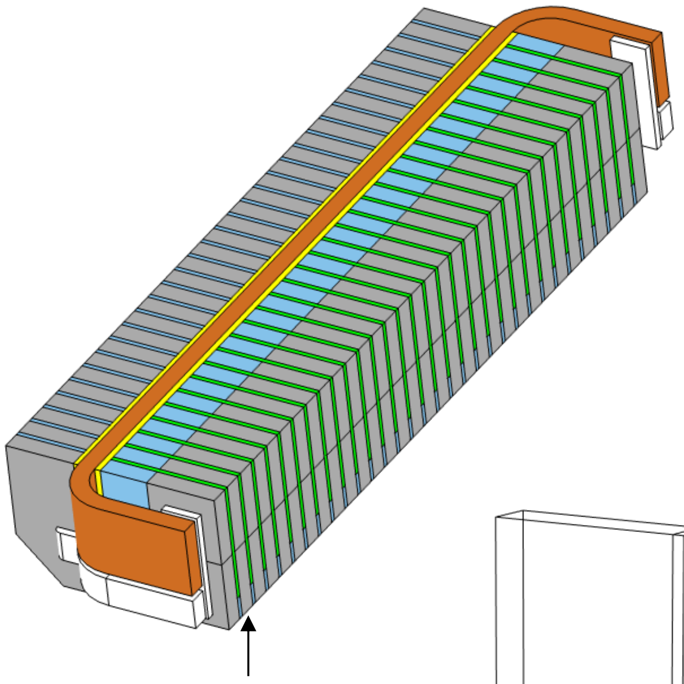
Quarter view





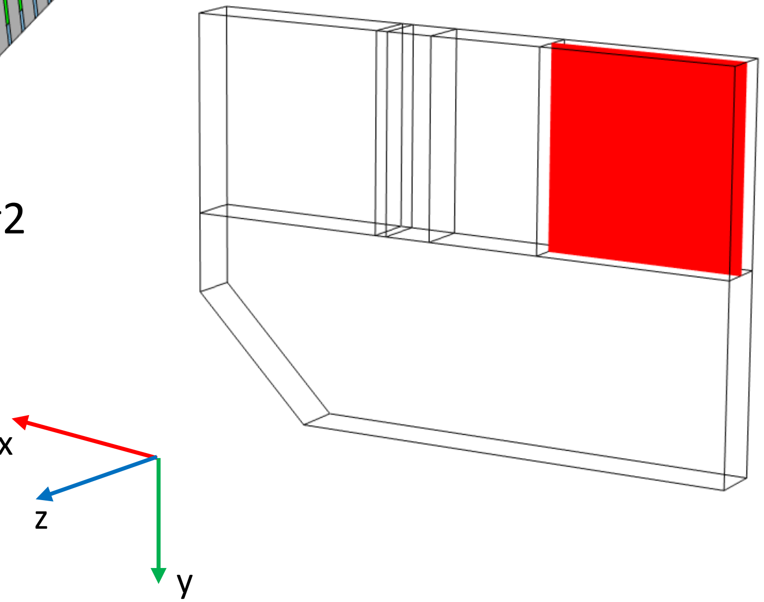
The above histogram is related to the magnetic flux density distribution (y-component, i.e. B_y) in the sole core detector's region

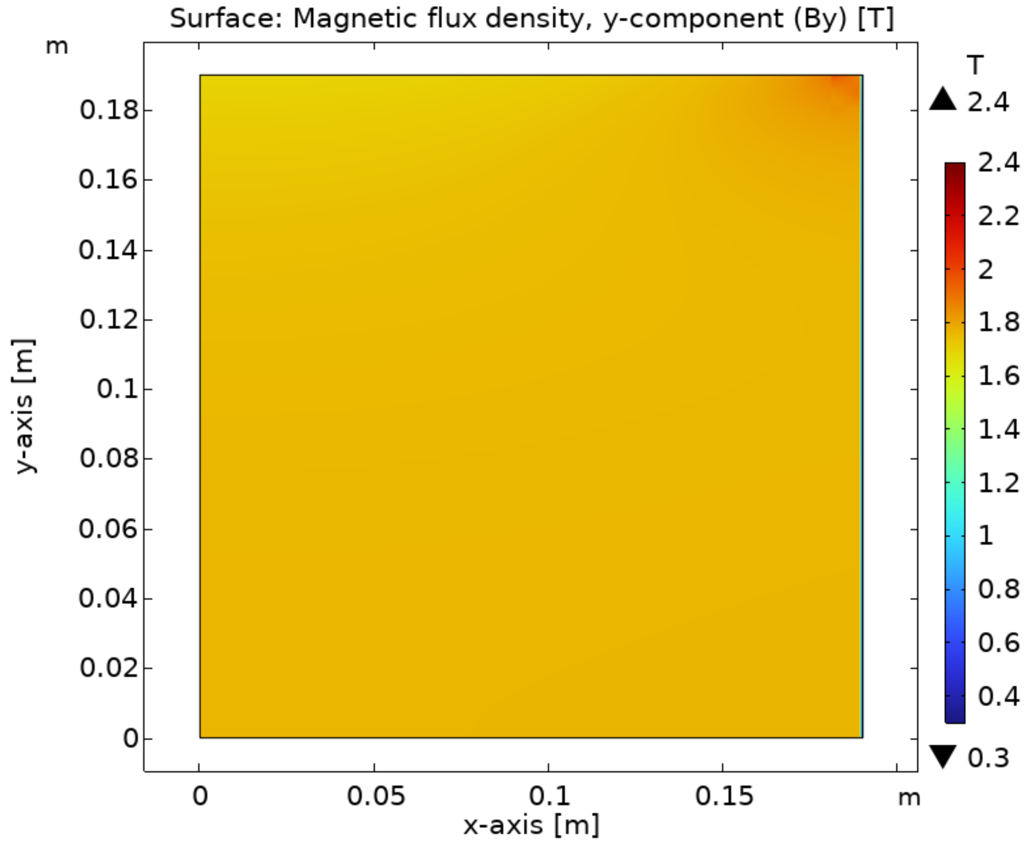
HCM 3D FEM simulations (slab #2) [2/2]



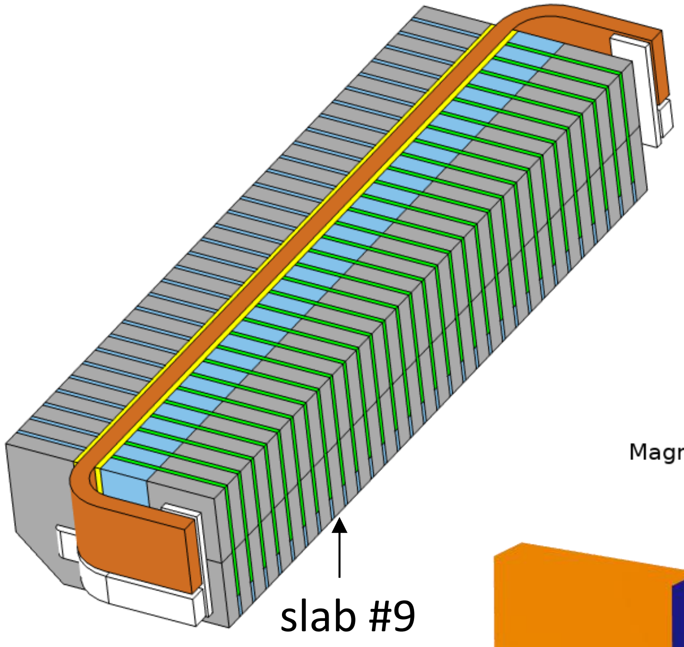
slab #2

Quarter view

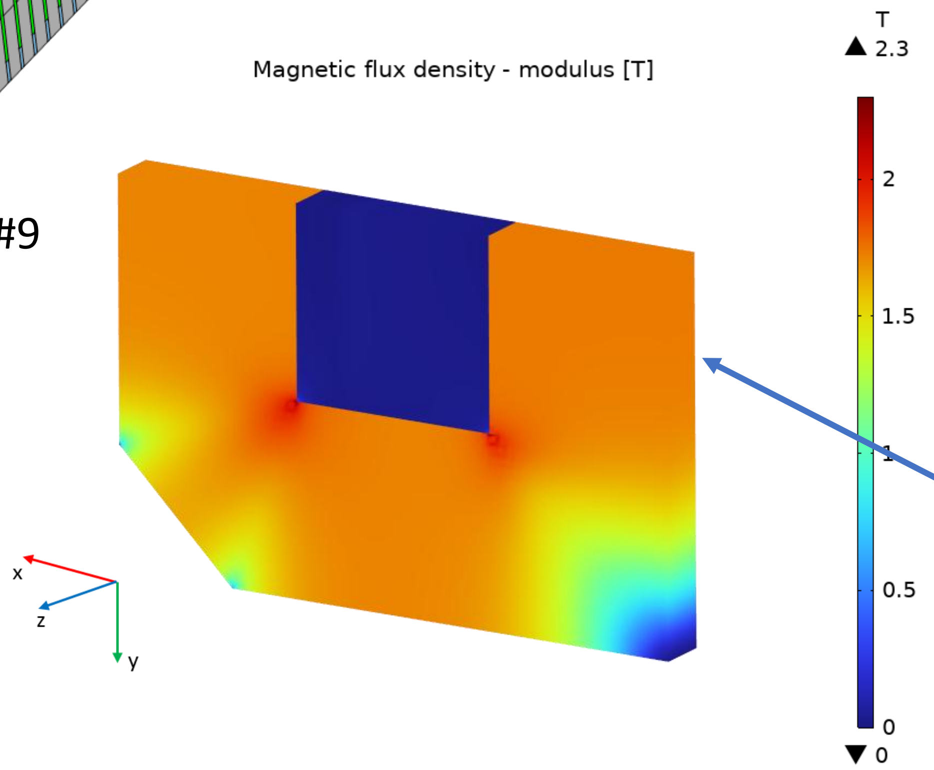


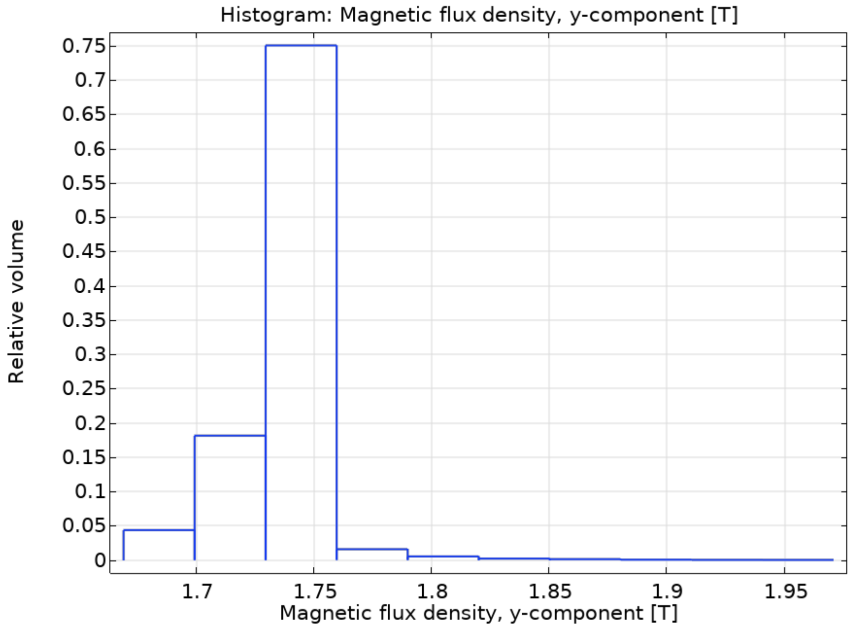


HCM 3D FEM simulations (slab #9)



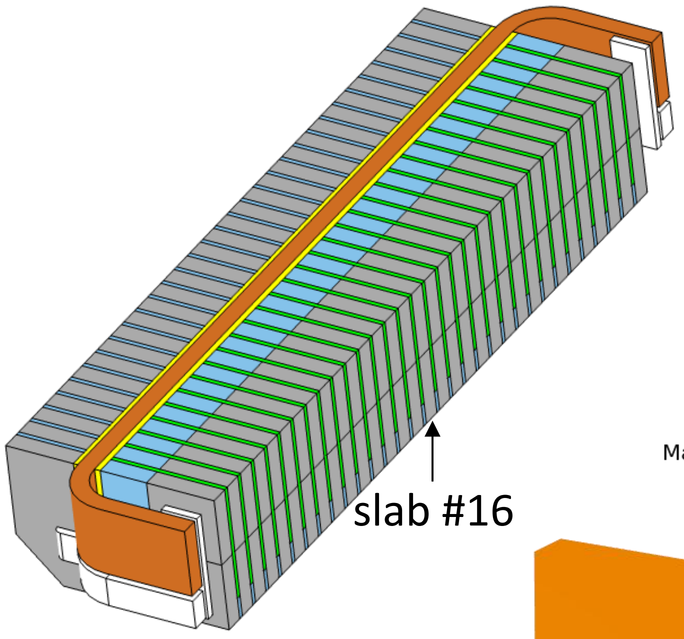
Quarter view



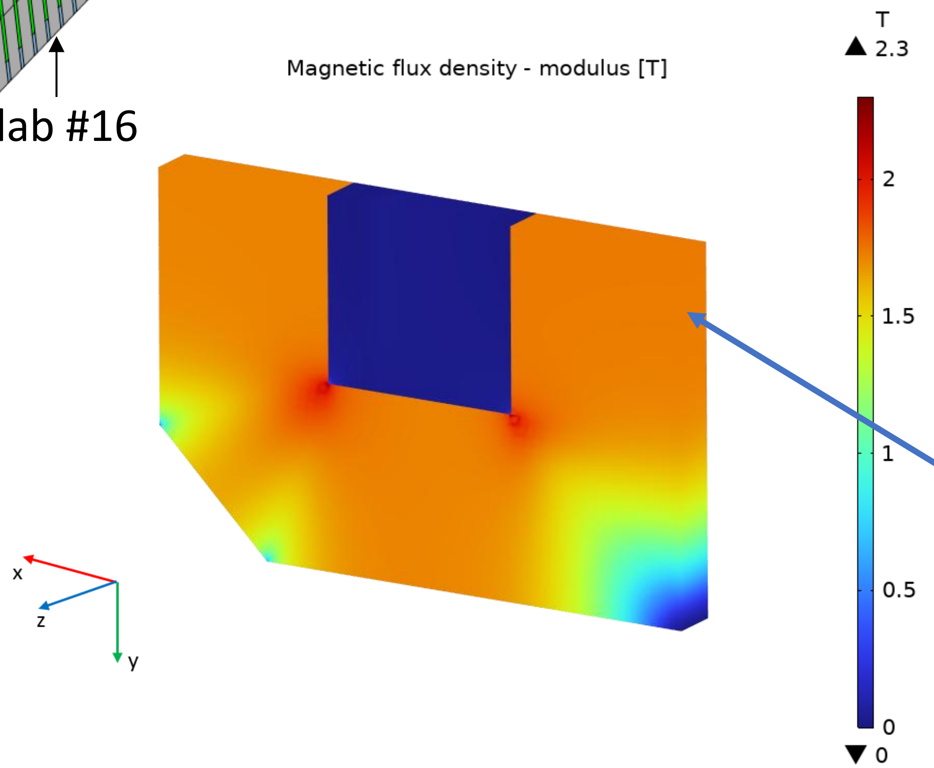


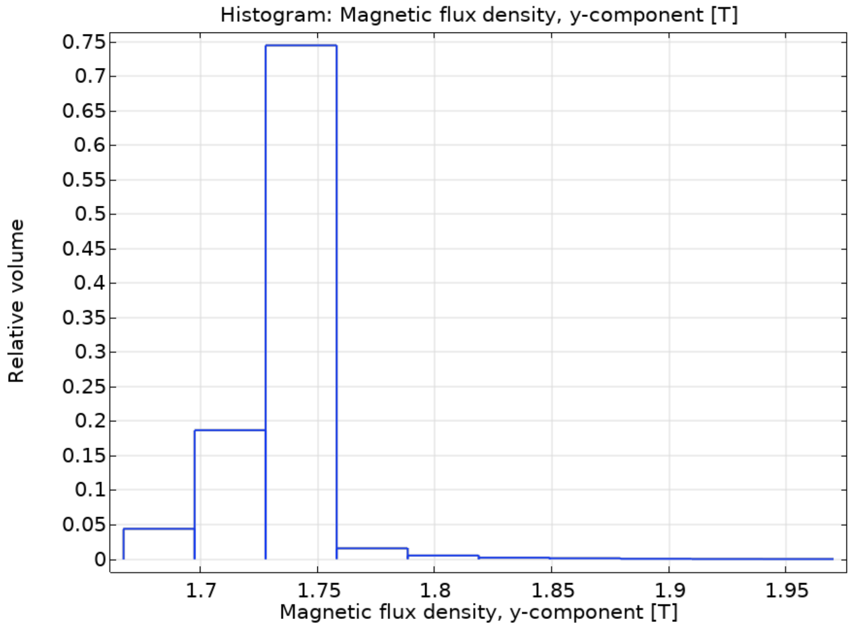
Histogram related to the magnetic flux density distribution (y-component, i.e. B_y) in the sole active region

HCM 3D FEM simulations (slab #16)



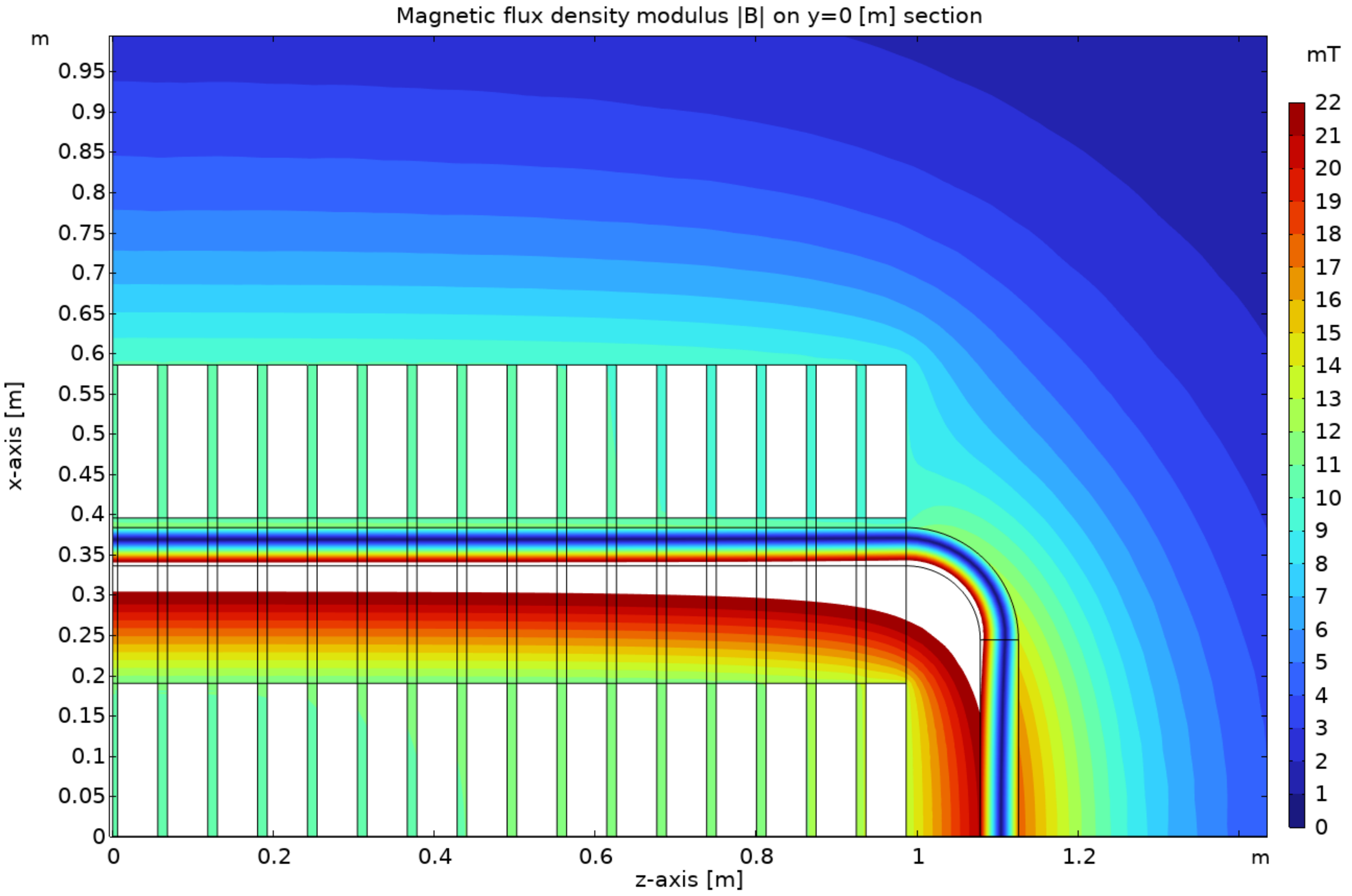
Quarter view



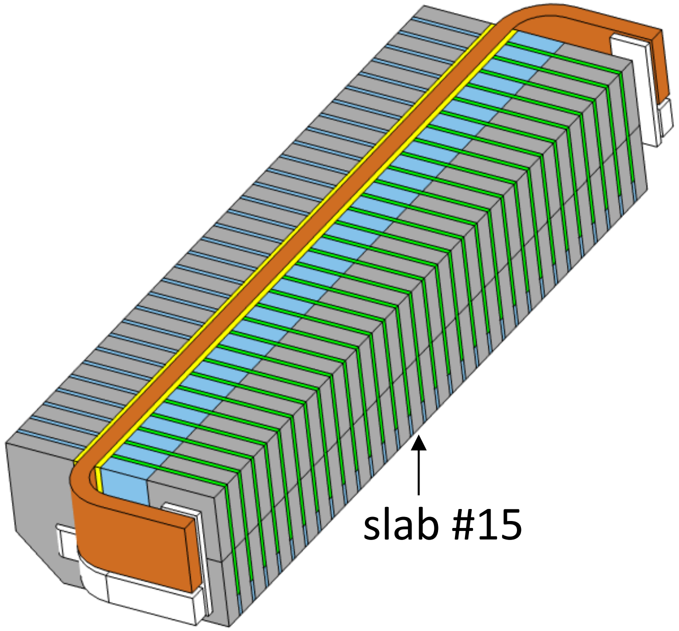


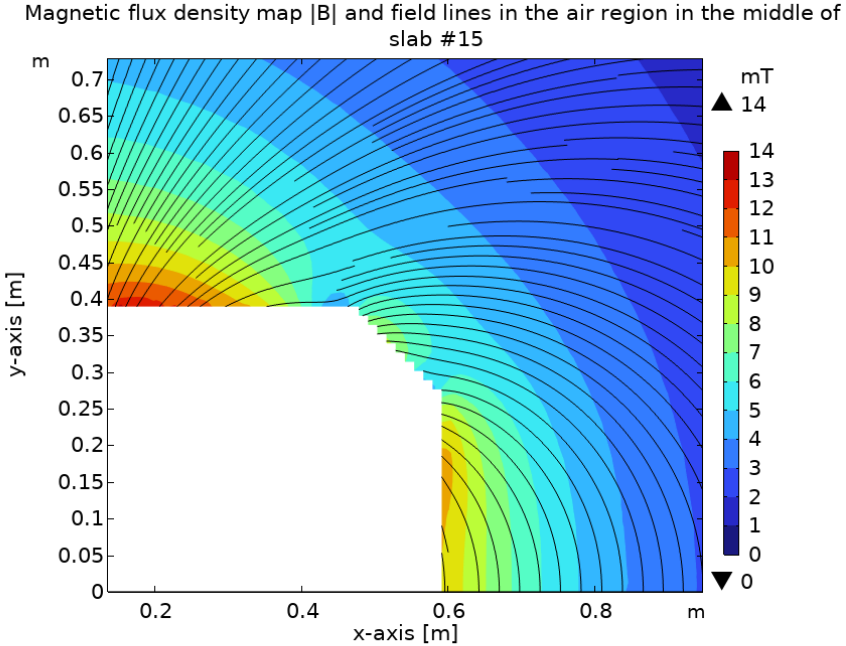
Histogram related to the magnetic flux density distribution (y-component, i.e. B_y) in the sole active region

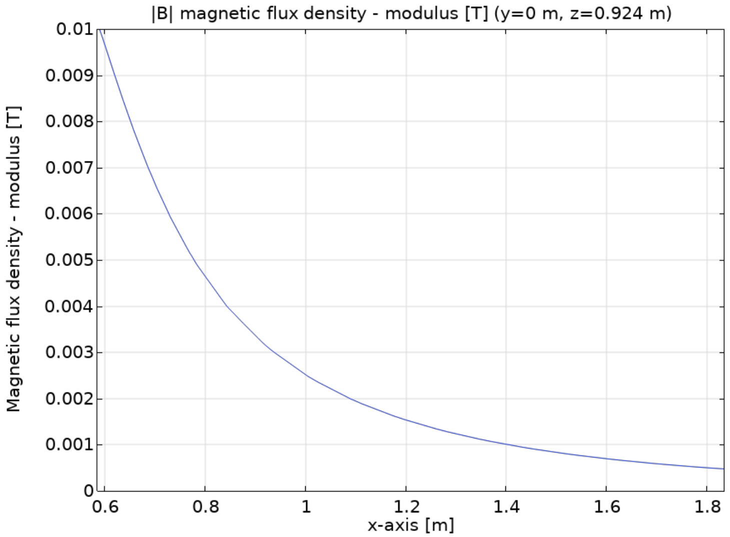
HCM 3D FEM simulations: stray field [1/2]



HCM 3D FEM simulations: stray field [2/2]

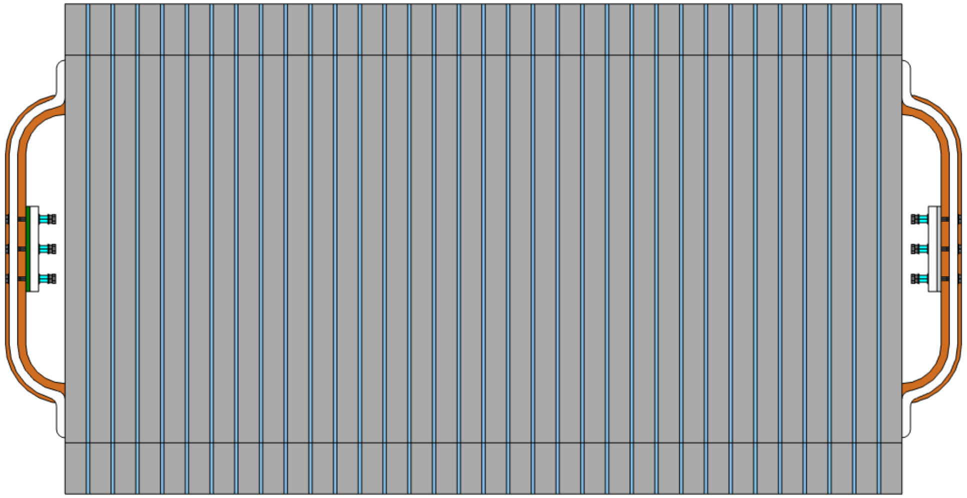


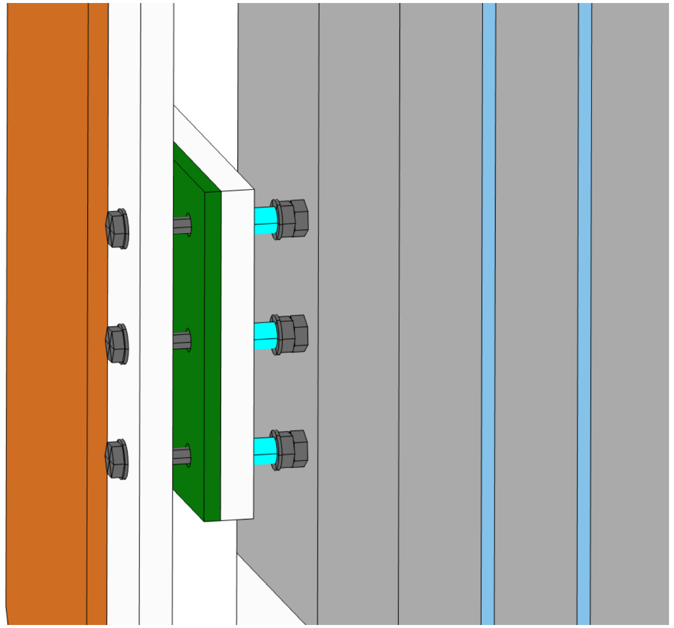


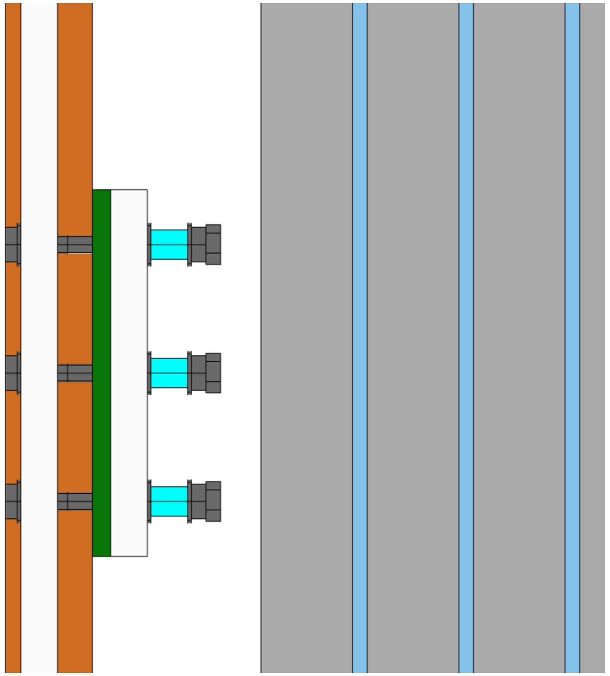


Possible 'minimalistic' mechanical coil fixing

- upstream and downstream spring-loaded coil fixing setup located on the inner side to reduce total longitudinal length
- no internal coil fixing mechanisms to reduce total width







Cost estimate

	Unit cost [kCHF/t]	Weight [t]	Manifacturing factor	Cost [kCHF]
Coil (made with Cu)	9,0	0,7	3,0	18,9
Magnetic structure (iron)	1,6	8,9	5,0	71,2
Power converters				12,0
Contingency		15,0%		15,3
Prototyping & installation				?
Total				117,4

Budget distribution		
2026	2027	2028
mechanical prototype	coil and iron procurement	Installation and testing
10%	80%	10%

Preliminary milestones schedule

Market survey to identify potential coil manufacturers completed	Dec 2025
Iron type chosen (AISI 1010, S235 JR, …)	Dec 2025
EM and thermal design towards PDR (preliminary design review) completed	Feb 2026
Mechanical design towards PDR completed	Apr 2026
Mechanical prototype (made of two iron slabs) completed	Oct 2026
PDR meeting	Dec 2026
FDR (final design review) meeting	Apr 2027
Coil procurement call completed	Jun 2027
Iron machining+annealing / Iron procurement call completed	Nov 2027
Concession requests and MDR (manufacturing design review) completed	Jan 2028
Procurement completed	Mar 2028
Installation completed	Jul 2028

this schedule has to be reviewed and coordinated with that foreseen for the detectors and acquisition electronics (for integrating the magnetic measurements too) and discussed/interfaced with all other involved actors

Thanks for your attention