



ATLAS+ Design Concepts

- FCC-hh detector magnet -

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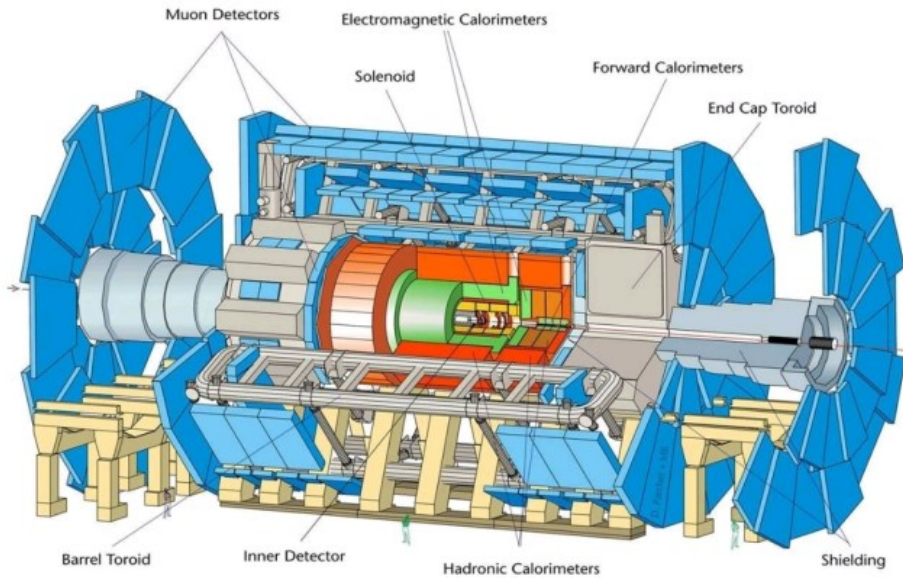
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Overview

- Introduction
- Scaled up ATLAS concept
- Angled concept
- Extended End Cap Toroid concept
- Conclusion

Introduction

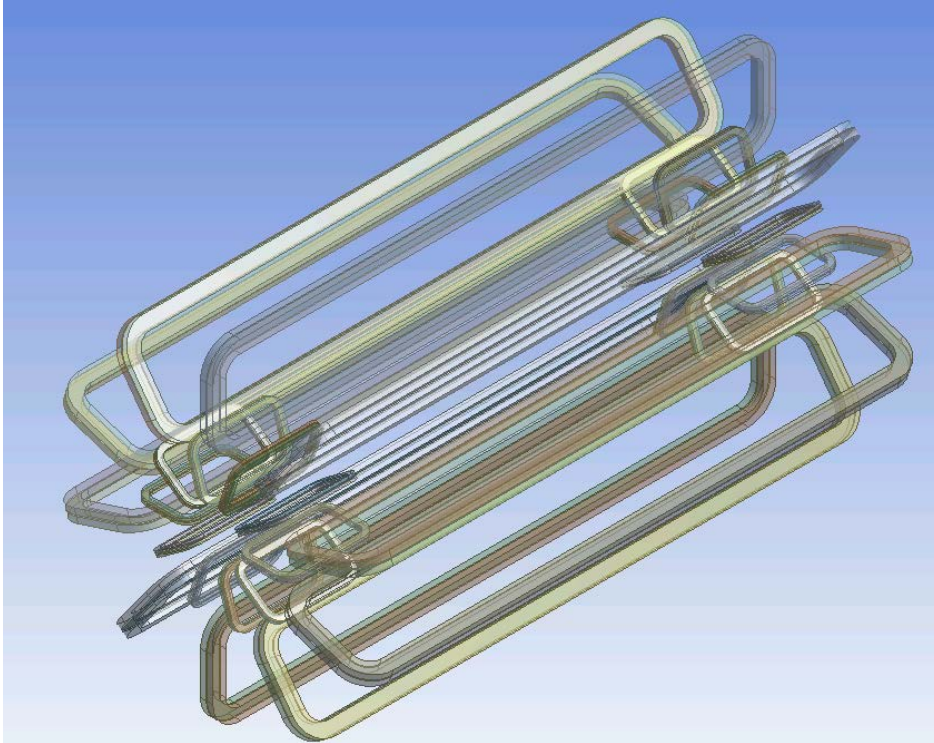


Atlas toroidal field for muon detection:

- Barrel Toroid (BT): open structure
- End Cap Toroids: 8 coils in single cryostat

Property	Value
Stored energy	1.5 GJ (1.1 GJ BT + 2x 220 MJ ECT)
Conductor mass	120 t BT + 2x 20 t ECT
Length BT [m]	25
Inner radius BT [m]	4.7
Outer radius BT [m]	10
Length ECT [m]	5
Inner radius ECT [m]	1.65
Outer radius ECT [m]	4.7
Field integral $\eta = 0$ [Tm] (between conductors)	4
Field integral $\eta = 2.44$ [Tm] (between conductors)	9

ATLAS+, a Scaled up ATLAS Concept



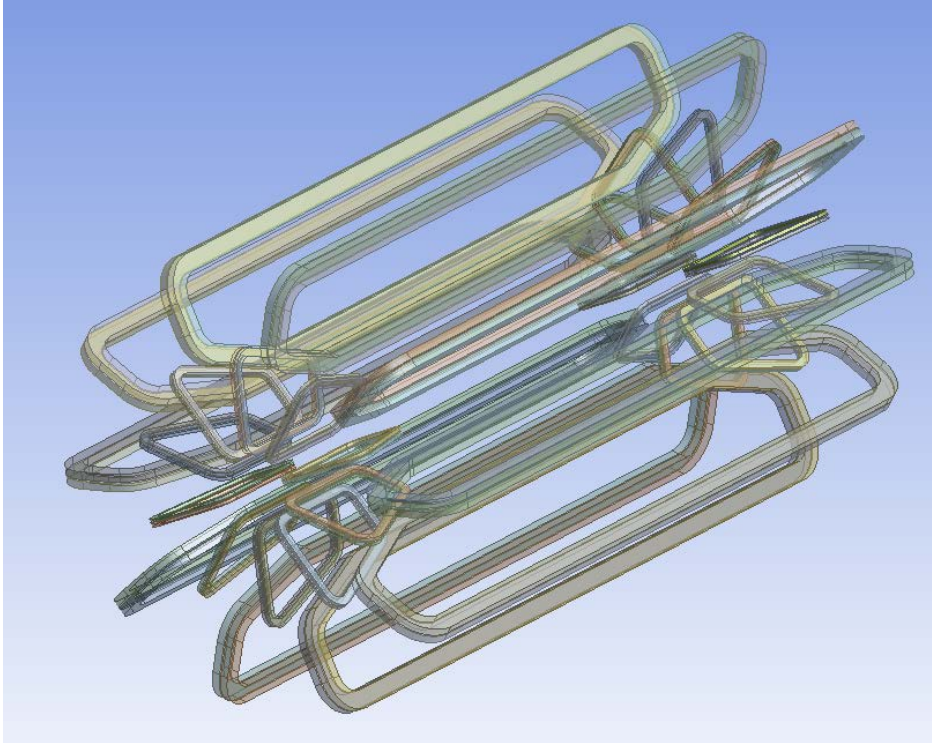
Same concept as ATLAS, but higher field and more volume → More stored energy.

Individual cryostats for barrel toroids.

Possibility of single cryostat for each end cap toroid.

Property	Value
Stored energy	51 GJ (48 GJ BT + 2x 1.6 GJ ECT)
Conductor mass	4.3 kt (10x 400 t BT modules + 2x 140 t ECT)
Length BT [m]	52
Inner radius BT [m]	7
Outer radius BT [m]	15
Length ECT [m]	8
Inner radius ECT [m]	2.5
Outer radius ECT [m]	7
Field integral $\eta = 0$ [Tm] (between conductors)	16
Field integral $\eta = 2.44$ [Tm] (between conductors)	16

ATLAS+ variant - Angled Concept



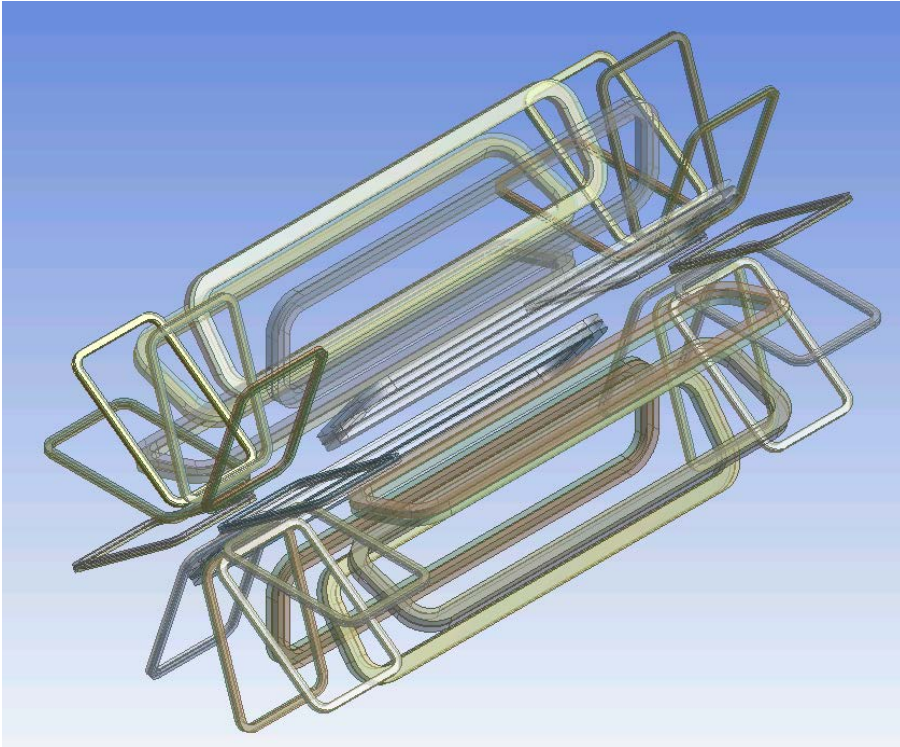
Reduction in peak field on conductor.

Less complicated muon chamber placement, but...

Blind spots at inclination angle (20°)

Property	Value
Stored energy	52 GJ (48 GJ BT + 2x 2.1 GJ ECT)
Conductor mass	4.3 kt (10x 400 t BT modules + 2x 170 t ECT)
Length BT [m]	52
Inner radius BT [m]	7
Outer radius BT [m]	15
ECT inclination angle ($^\circ$)	20
Field integral $\eta = 0$ (between conductors) [Tm]	16
Field integral $\eta = 2.44$ (between conductors) [Tm]	16

ATLAS+ variant - Extended End Cap Toroid Concept



Reduction in magnetic field at edges:

→ Reduction in stored energy and total mass

→ More homogeneous field integral as function of η

Reduced mass and length of BT modules.

Property	Value
Stored energy	40 GJ (34 GJ BT + 2x 3 GJ ECT)
Conductor mass	3.3 kt (10x 280 t BT modules + 20x 25 t ECT modules)
Length BT [m]	36
Inner radius BT [m]	7
Outer radius BT [m]	15
Length ECT [m]	8
Inner radius ECT [m]	2.5
Outer radius ECT [m]	15
Field integral $\eta = 0$ [Tm] (between conductors)	16
Field integral $\eta = 2.44$ [Tm] (between conductors)	16

Conclusion

ATLAS+ concepts:

- Scaled up ATLAS concept:
 - ✓ a proven design, we know how to make it.....
- Angled ATLAS concept:
 - ✓ significant reduction in peak magnetic field in the conductor.
- Extended End Cap Concept featuring:
 - ✓ Open coil structure for both the Barrel Toroid and End Cap Toroids enabling better positioning of muon chambers around the toroids.
 - ✓ More homogeneous field integral \rightarrow Reduced stored energy for the same field integral at $\eta = 0$.
 - ✓ Reduction in Barrel Toroid coil length and mass, but larger ECT coils.
 - ✓ Coil units smaller, easier assembly, smaller crane loads.....

