Future Collider R&D – MPI Munich Plans – ATLAS Group

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Expertise and Ongoing Projects

ATLAS Muon Detector projects:

- Concept for the ATLAS muon spectrometer.
- Design and construction of 100 Muon Drift Tube (MDT) chambers for ATLAS@LHC.

- Concept for the Phase-2 upgrade of the ATLAS muon system and first-level muon track trigger.
- Design and construction of 126 small-diameter Muon Drift Tube (sMDT) chambers for ATLAS@HL-LHC, 22 already installed in LS1 and LS2, construction for LS3 installation started end of 2020.
- Design and construction of 96 thin-gap RPC triplet chambers for ATLAS@HL-LHC, final prototypes in 2021. Integration in the existing ATLAS detector.

- Design and production of the new FEE electronics including design of the ASD and TDC chips (130 nm CMOS) for the ATLAS (s)MDT chambers at HL-LHC.

- Design and production of the (s)MDT based first-level muon track trigger processors for ATLAS@HL-LHC.

- Industrialization of RPC detector production for HL-LHC, Future ee and hh Colliders and large area detectors (Methusla, Anubis, cosmic ray arrays…).

- High-rate performance studies of (s)MDT and RPC detectors at GIF++.

Future Colliders, HL-LHC and beyond R&D projects:

- Development of a next-generation ASD chip (65 nm CMOS) for gas detectors at very high rates at HL-LHC and FCChh. Full exploitation of the rate capability of the sMDT detectors.

- Optimisation of RPC detectors for high-rate, long lifetime operation with eco-friendly gases.

- Design and performance simulation of the muon detector and first-level muon trigger for the FCChh reference detector CDR. Design of a demo FCChh precision muon track and trigger detector.

Detector R&D Interests for Future ee and Hadron Colliders

ee Colliders:

- Conceptual detector design and performance simulation.
- RPC design for muon and ToF systems and for calorimeters. Exploitation of the high RPC time resolution over large areas. Optimisation of RPC performance with eco-friendly gases.
- Development of front-end ASICs for gas detectors and calorimeters.
- Track trigger algorithms and implementation on FPGAs.
- Industrialization of RPC production.

Hadron Colliders:

- Conceptual detector design and performance simulation.
- Track and muon trigger algorithms and implementation on FPGAs.
- RPC design for muon and ToF systems and for calorimeters. Exploitation of the high RPC time resolution.
- Design and demonstration of precision muon tracking and trigger detectors for very high background rates (based on sMDT and RPC/micro-pattern gas detectors). High-rate perfomance tests.
- Development of front-end ASICs for muon detectors at very high rates (sMDT, RPC, micro-pattern gas detectors).
- Track and muon trigger algorithms and implementation on FPGAs.

Physics Studies for ee Colliders

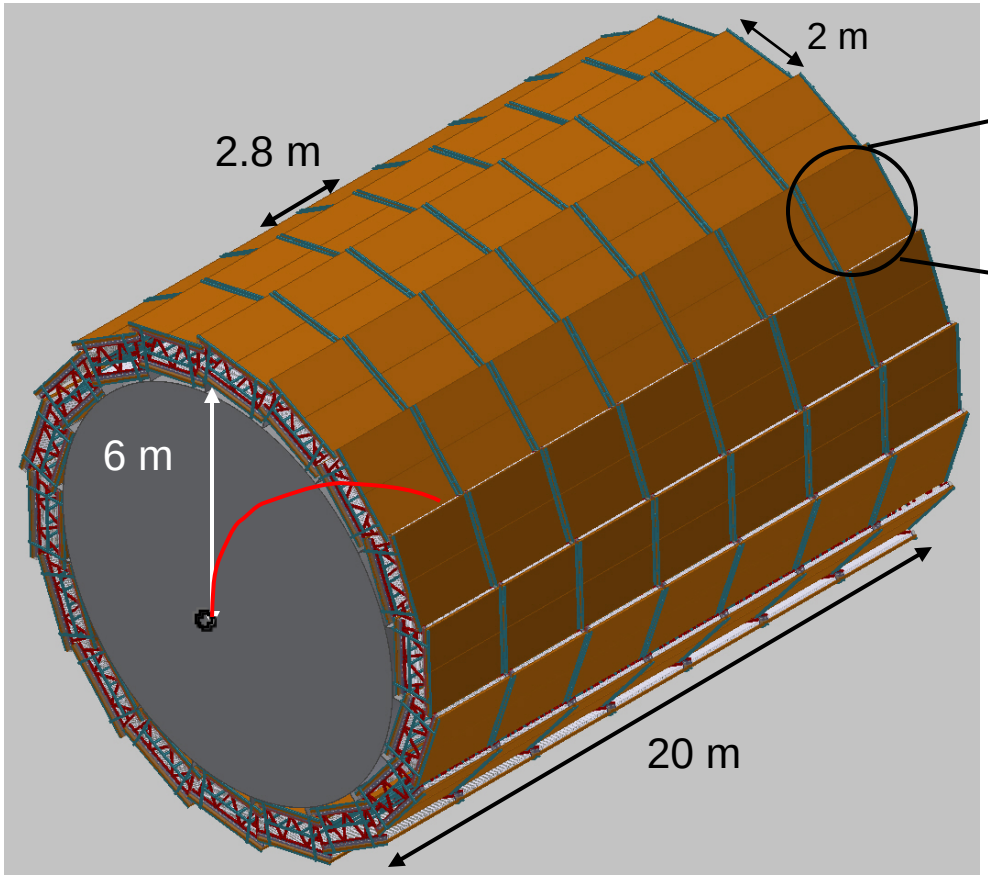
Main interest in Higgs physics and BSM searches (like present ATLAS engagement) with the following priorities:

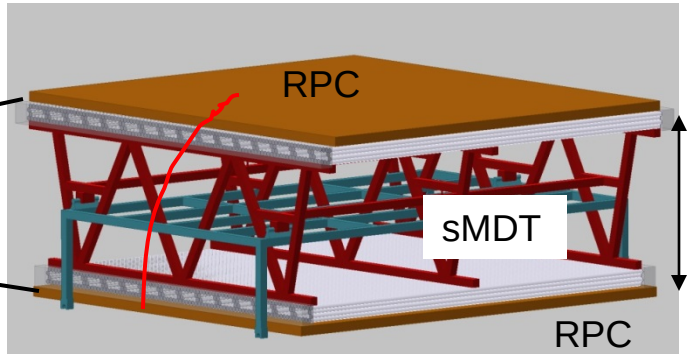
1. $H \rightarrow ZZ$, WW (anomalous) coupling measurement,
   interpretation in EFT frameworks
   (interplay between theory and experiment from current experience in ATLAS)
2. Measurement of CP violating interactions from kinematic distributions
3. Higgs total width measurement
4. Higgs self coupling measurement
5. SUSY, Dark Matter, BSM Higgs searches

Combination with detector simulation studies.

Backup

Baseline instrumentation of the FCChh reference detector muon system for the CDR





sMDT chamber: precision track angle measurement in the bending plane (60 µrad resolution) for high-resolution first-level trigger (like ATLAS@HL-LHC)
RPC: measurement of bunch crossing time, and RoI with 2nd coordinate.

Monolithic sMDT chamber with 20 µm precision over 1.4 m feasible.
10 x higher rate capability than MDTs, sufficient for FCChh!