ATLAS

A Toroidal LHC ApparatuS

ATLAS is a general-purpose detector that will exploit the full potential of the LHC proton-proton collision programme. LHC will provide 10 times higher centre-of-mass energy and 100 times higher proton-proton collision rates than previous colliders. This opens up a **new frontier of physics**. ATLAS will explore this great potential, which can be exemplified both within today's theoretical framework and using extrapolations and guesses of what might lie beyond it.

The **Standard Model**, which is the established theoretical description of the basic building blocks of matter and of the fundamental interactions, has several unexplored aspects, all well within the reach of ATLAS:

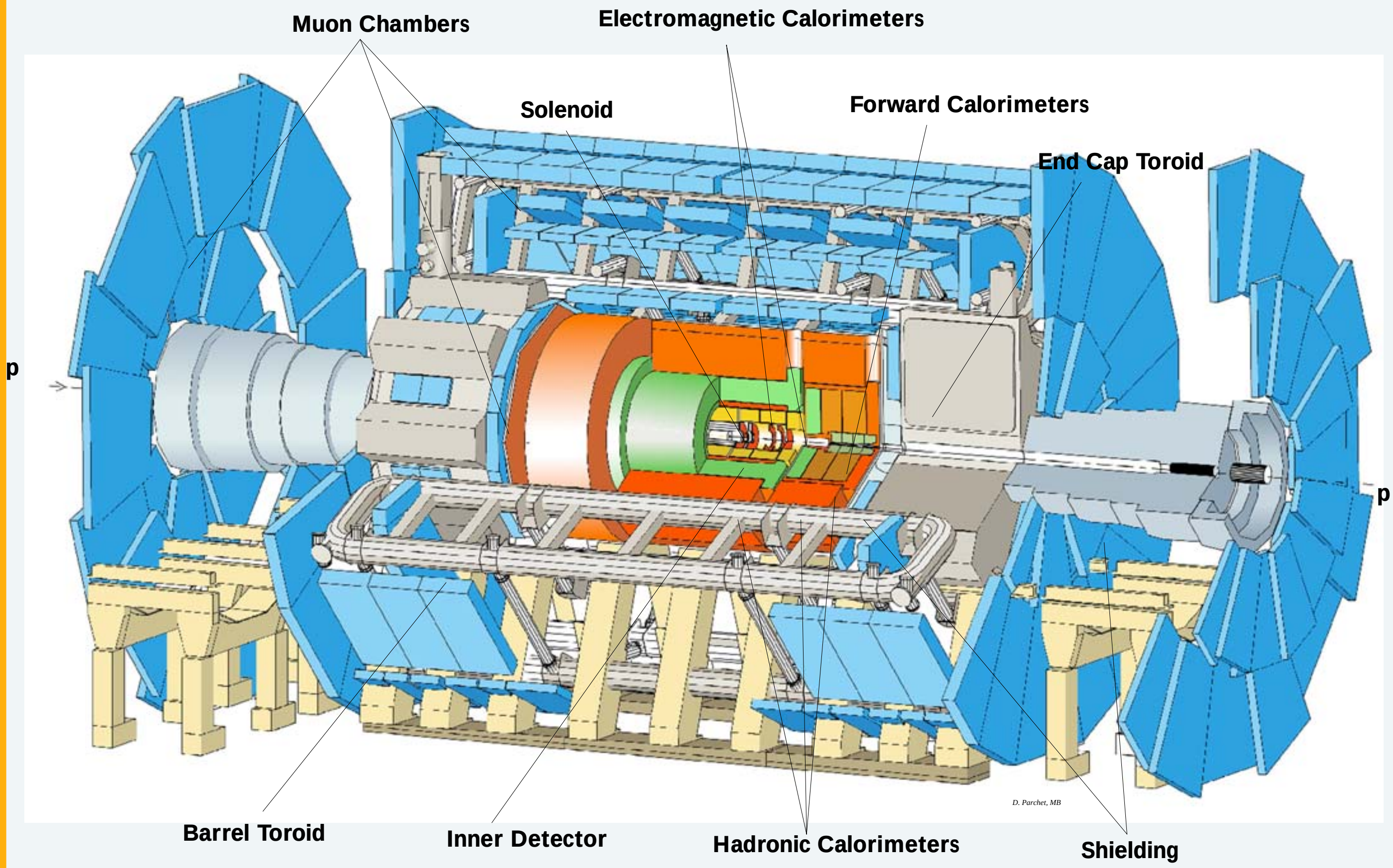
- The mass-generating mechanism or spontaneous symmetry breaking, which predicts the existence of a scalar particle, the **Higgs boson.**
- The decay modes of the **top quark** and the precise determination of its mass.
- The origin of matter/antimatter asymmetry, **CP-violation**, which is expected to be observable in many decays involving the bottom quark.

Theoretical developments indicate the possible existence of a more general framework for the building blocks of matter and the fundamental interactions, **Supersymmetry**. This leads to two important predictions:

- The existence of at least five different Higgs bosons, most often within the mass range accessible to ATLAS.
- A large spectrum of new particles produced at a mass scale that ATLAS will be able to establish and measure with high precision in most cases.

ATLAS at LHC will greatly increase the resolving power with which the size of the building blocks of matter, the quarks and leptons, can be measured. Good sensitivity to a possible **substructure** of the fundamental fermions will be achieved up to a scale of ~ 30 TeV.

The discovery of the Z and W particles was a large step forward in the understanding of fundamental interactions. ATLAS will be able to discover and measure particles with similar properties but with masses up to 50 times larger than those of the W and Z.



ATLAS is designed for a large discovery potential and for precision measurements. Experience and theoretical knowledge tell us that an experiment with this ambition should detect clean signals and perform accurate measurements of:

- Charged leptons
- Photons
- Non-interacting particles such as neutrinos through missing energy measurements.
- Hadronic jets.
- Bottom quarks.

In addition ATLAS should provide reconstruction of complete final states, such as the decay products of B-hadrons at low luminosity.

The basic design concept to achieve these goals includes three detector systems:

- A **tracker** with semi-conductor pixel and strip detectors for very high accuracy measurements of the charged particle trajectories, followed by a straw-tube detector giving a bubble chamber like image of the event and independent electron identification. A thin superconducting solenoid coil provides a 2 T magnetic field for the tracker.
- A **calorimeter** with an inner cylinder in liquid-argon technology with its well-known high resolution, calibration precision and stability, followed at large radius by an iron-scintillator calorimeter providing good resolution in a very cost-effective manner.
- A high-precision stand-alone **muon spectrometer**, instrumented with detectors optimised for the requirements and environment at LHC, surrounding the calorimeter. A superconducting air-core toroidal magnet system provides the magnetic field for the muon spectrometer.

All systems have a large solid-angle coverage to optimise the efficiency for detecting low-rate signals from multi-particle decays. In particular, precision measurements will be performed down to angles as small as 9 degrees from the beam line.

The detector designs are based on extensive R&D within the collaboration and display many innovative features. Over a period of six years, prototypes of progressively increasing scale, together with simulations, have been used to optimise the performance to meet the ATLAS requirements.

The initial information flow from the ATLAS detectors is reduced by a dedicated selection system, the **trigger**. It is based on hierarchical decision-making, where the lowest level is based on coarse calorimeter and muon-spectrometer information, while higher levels use data from the full experiment. A **data-acquisition** system merges the information from the different systems and stores it for further processing and analysis.

An object-oriented **software** system will reconstruct the stored detector signals, so as to access the physical properties of the produced particles. It will also simulate ATLAS in all relevant details, in order to correct for the small distortions on the measurements induced by the apparatus and to estimate the expected levels of background.