The ATLAS “lab”: from CERN to home institute

Daniela Salvatore - LTL 2015 - 8 June 2015 - Unical

About CERN

- At CERN, the European Organization for Nuclear Research, physicists and engineers are probing the fundamental structure of the universe. They use the world's largest and most complex scientific instruments to study the basic constituents of matter – the fundamental particles.

- The particles are made to collide together at close to the speed of light. The process gives the physicists clues about how the particles interact, and provides insights into the fundamental laws of nature.

- The instruments used at CERN are purpose-built particle accelerators and detectors. Accelerators boost beams of particles to high energies before the beams are made to collide with each other or with stationary targets. Detectors observe and record the results of these collisions.

- Founded in 1954, the CERN laboratory sits astride the Franco-Swiss border near Geneva. It was one of Europe's first joint ventures and now has 21 member states.

CERN - © 1954

CERN today

- Meyrin (CH) and Prevessin (F) sites host experimental areas, offices, meeting rooms, auditorium, restaurants, hostel, kindergarten, bank, post-office…

- International community of:

  - **21 member states:** have special duties and privileges. They make a contribution to the capital and operating costs of CERN's programmes, and are represented in the council, responsible for all important decisions about the organization and its activities.

  - **Over 600 institutes and universities around the world** use CERN's facilities. Funding agencies from both member and non-member states are responsible for the financing, construction and operation of the experiments on which they collaborate.

  - CERN employs just over **2400 people**.

  - Some **10,000 visiting scientists from over 113 countries** – half of the world's particle physicists – come to CERN for their research.

The ATLAS Collaboration (1)

- 38 countries, 177 institutes, 3000 members (physicists, engineers, software developers, technicians)
- Italian institutes: Udine, Milano, Pavia, Bologna, Genova, Pisa, Roma La Sapienza, Roma Tor Vergata, Roma Tre, Frascati, Napoli, Lecce, Cosenza
- ~3000 authors for ~500 papers from Run 1 activities
- Very democratic collaboration:
  - from full professors to master degree students
  - each member contributes to physics analysis, data taking operations (i.e. control room shifts), software or hardware development
  - each member is entitled to represent the whole ATLAS Collaboration at international conferences
    - talks assigned through a speakers' committee
    - young researchers are supported and put first

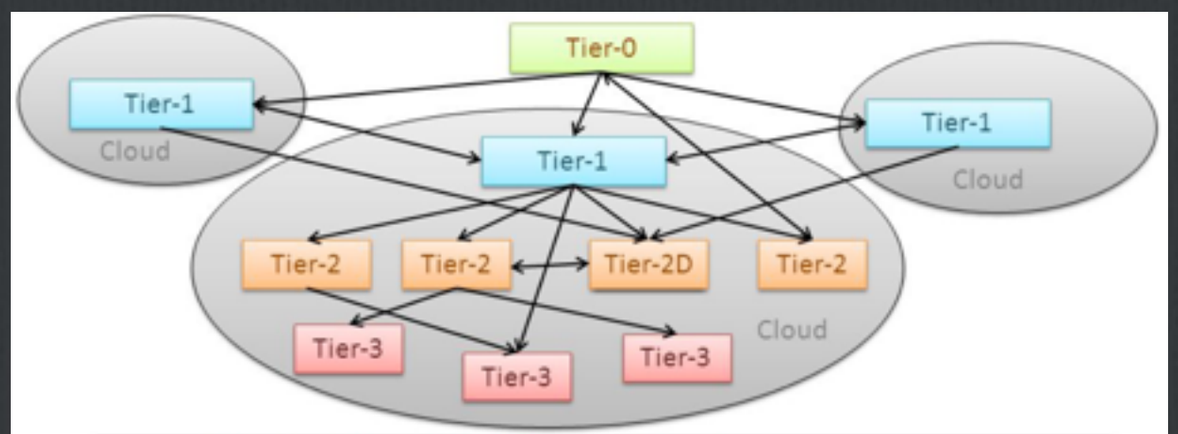
The ATLAS Collaboration (2)

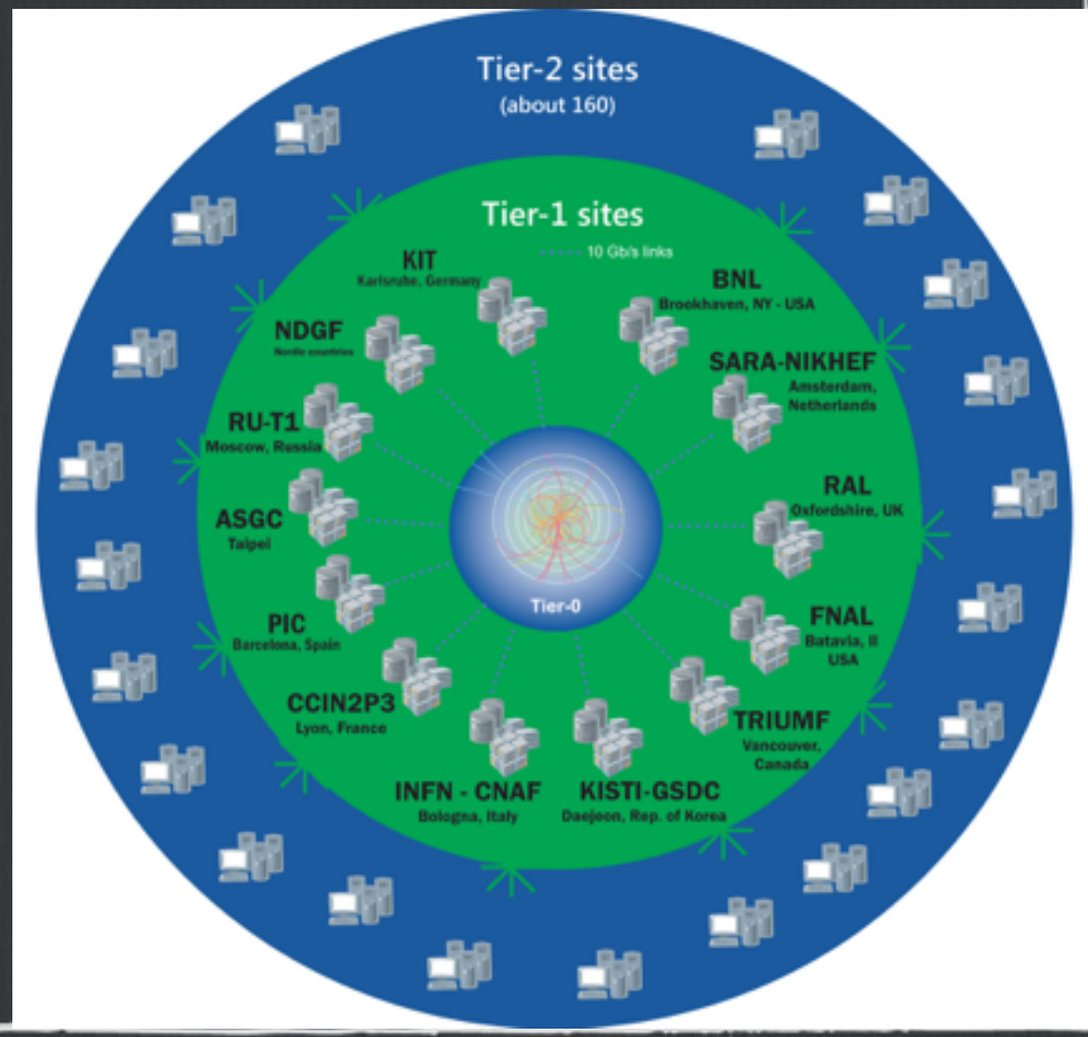
The ATLAS (in-situ) experimental area

- Located on the Meyrin (CH) site
- ATLAS detector is 100 m underground: height 22 m, length 45 m, weight 7000 tons
  - more details on dedicated seminar (10/06/2015)
- Control Room, test area, visitors center on surface

The ATLAS (spread around the world) experimental area (1)

- 177 institutes involved
- many of them host laboratories where the ATLAS sub-detectors have been designed, prototype developed, assembled, tested and commissioned
  - the High Energy Physics Laboratory at Università della Calabria were involved in the production of drift tubes for the ATLAS MDT
- Computing centres spread around the world (the GRID)
  - From Tier-0 to Tier-3
    (UNICAL / INFN Cosenza laboratories host a Tier3)





The ATLAS (spread around the world) experimental area (2)

- **Tier0**
  - CERN Data Centre, **located in Geneva** and also at the Wigner Research Centre for Physics **in Budapest**, (over 1200 km away). Connected by two dedicated 100 Gbit/s data links. **All data from the LHC passes through the central CERN hub**, but CERN provides less than 20% of the total compute capacity.
  - Responsible for the **safe-keeping of the raw data (first copy)**, first pass reconstruction, distribution of raw data and reconstruction output to the Tier 1s, and reprocessing of data during LHC down-times.

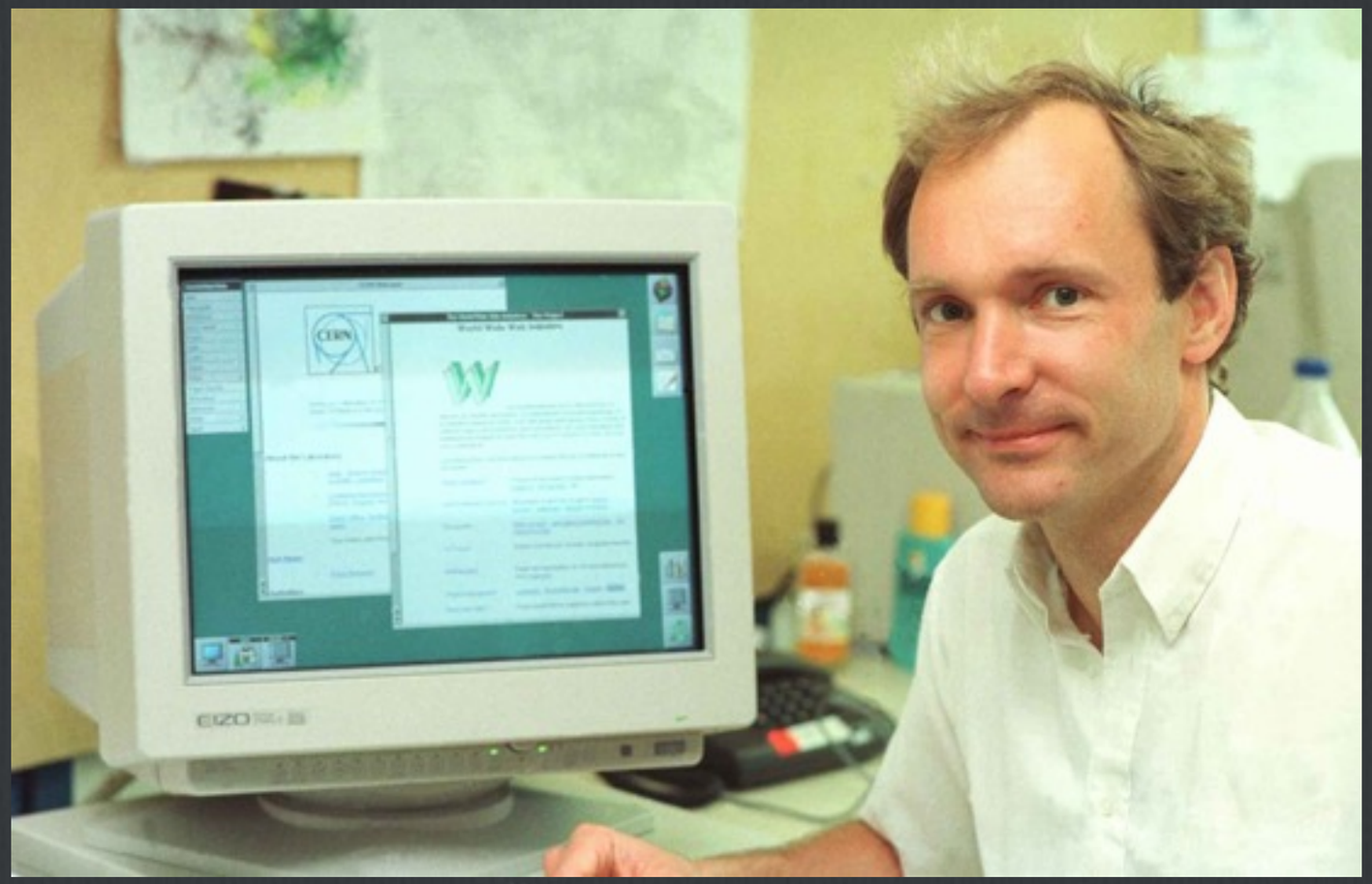
- **Tier 1**
  - Responsible for the safe-keeping of a proportional share of raw and reconstructed data, large-scale reprocessing and safe-keeping of corresponding output, distribution of data to Tier 2s and safe-keeping of a share of simulated data produced at these Tier2s **(13 large computer centres)**

- **Tier 2**
  - **Typically universities and other scientific institutes**, which can store sufficient data and provide adequate computing power for specific analysis tasks. They handle analysis requirements and proportional share of simulated event production and reconstruction **(currently around 160 Tier 2 sites covering most of the globe)**

- **Tier 3**
  - Individual scientists will access these facilities through **local computing resources**, which can consist of local clusters in a University Department or even just an individual PC. **177 institutes involved**

WWW: Where the Web Was born!!!

The GRID: the natural evolution of WWW



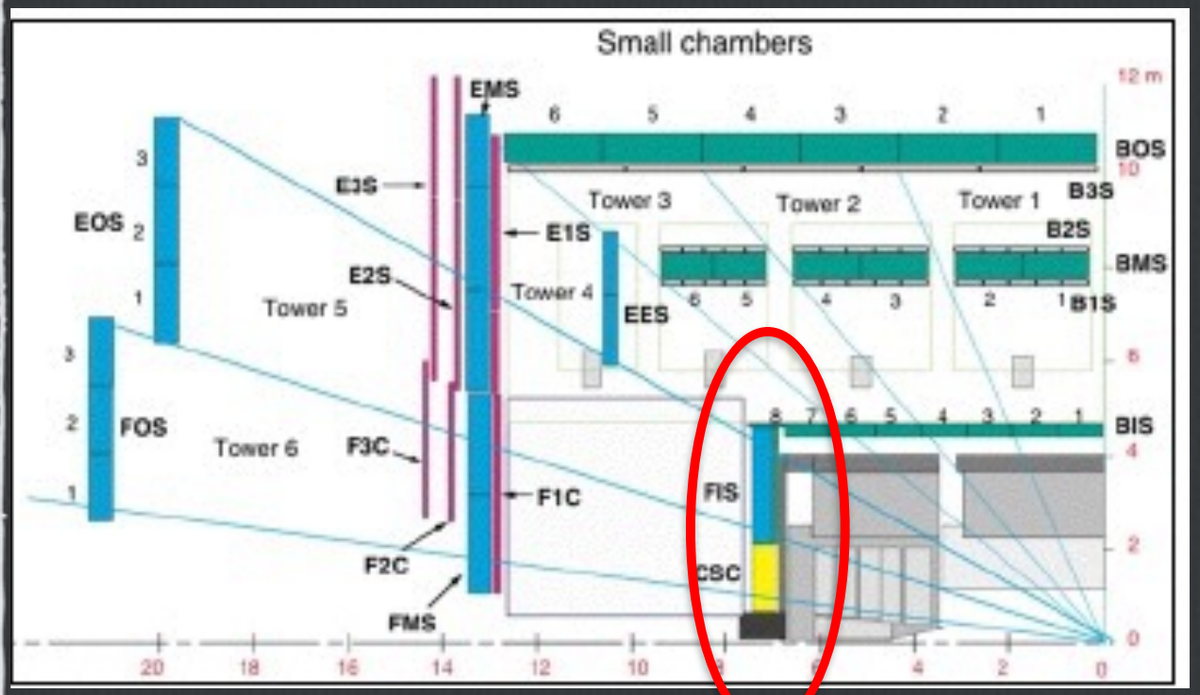
Tim Berners-Lee, a British scientist at CERN, invented the World Wide Web (WWW) in 1989. The web was originally conceived and developed to meet the demand for automatic information-sharing between scientists in universities and institutes around the world.

The basic idea of the WWW was to merge the technologies of personal computers, computer networking and hypertext into a powerful and easy to use global information system.

ATLAS upgrade

- Run 2 data taking has already started
- Some improvements wrt Run 1:
  - New detectors (IBL in the Inner Detector), new selection algorithms, reviewed analysis software
- Upgrade Muon Spectrometer for next years and Inner Tracker

New Small Wheel Upgrade



Present SW Technologies:

CSC (Very Forward Tracking)
MDT (Tracking)
TGC (Second coordinate for MDT)

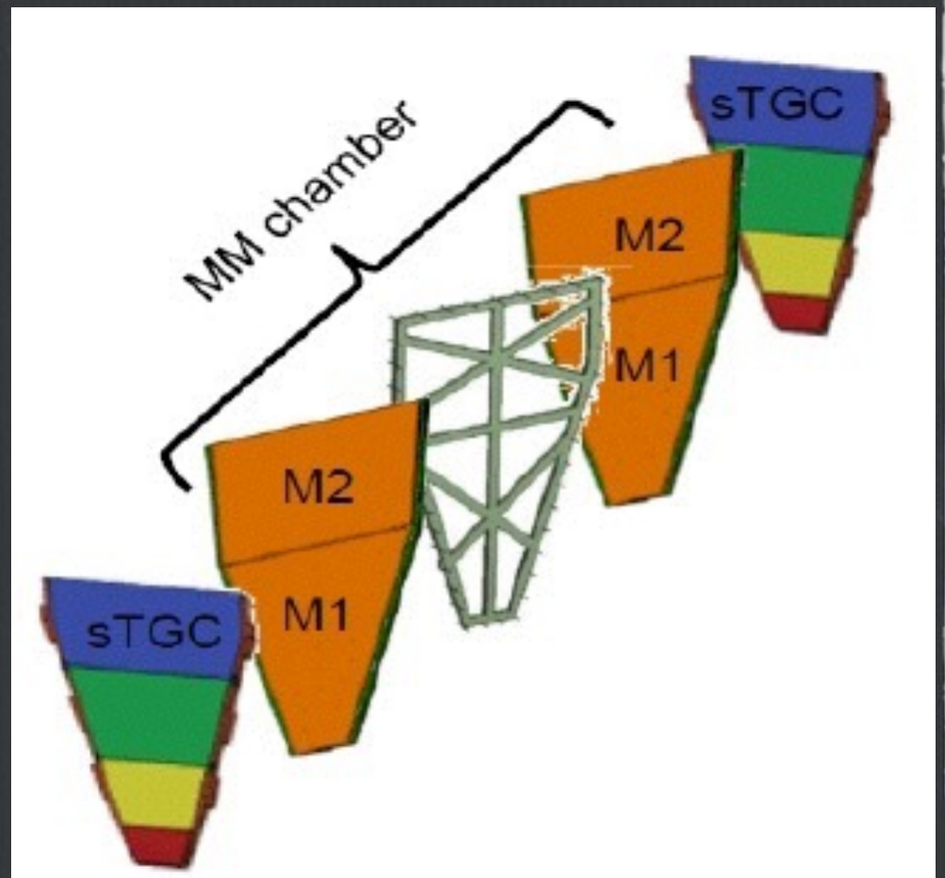
Why change it?

- **MDTs rate limit is reached at ~300 kHz/tube**
- **We see degradation of tube performances on both efficiency and resolution.**

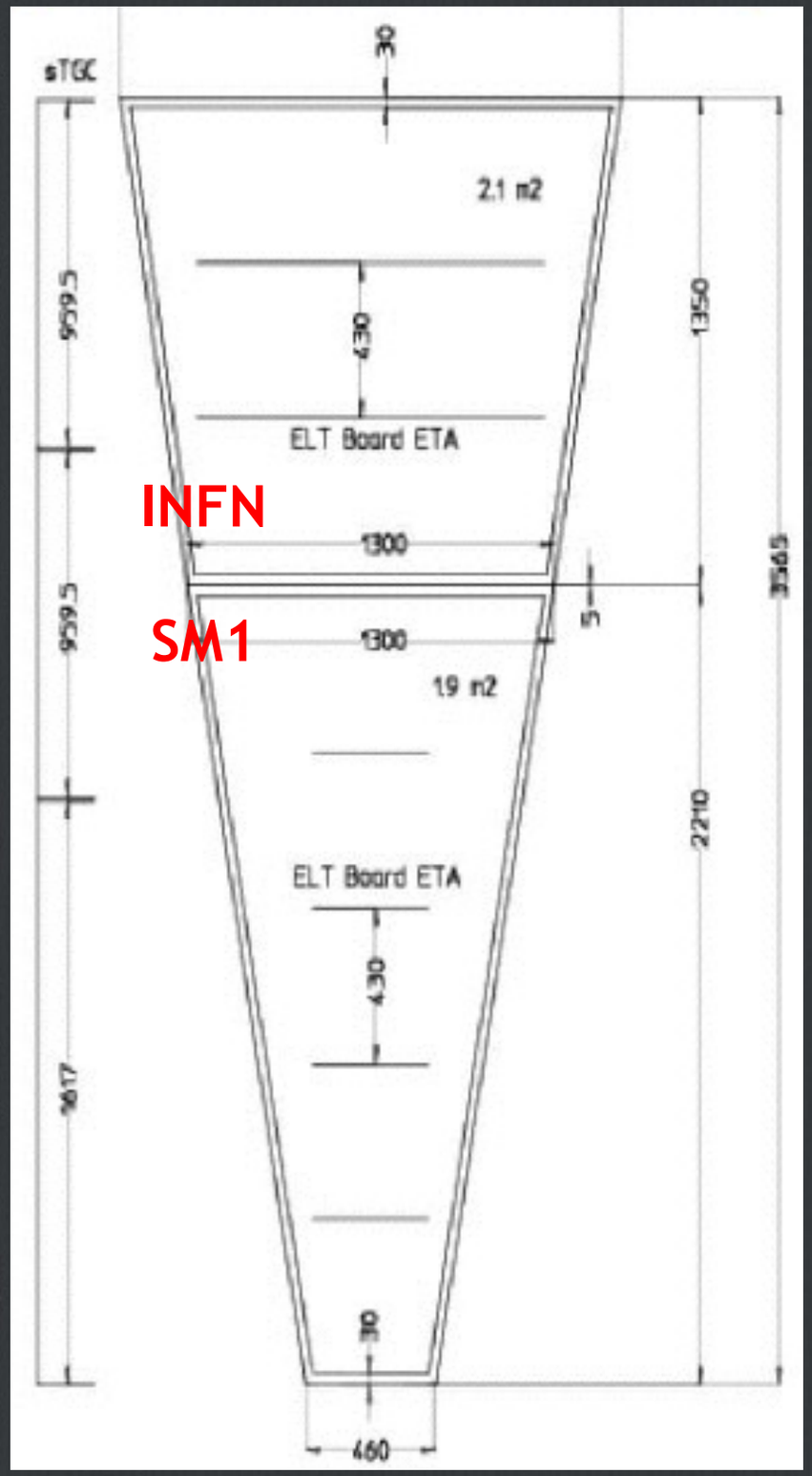
New Detector:

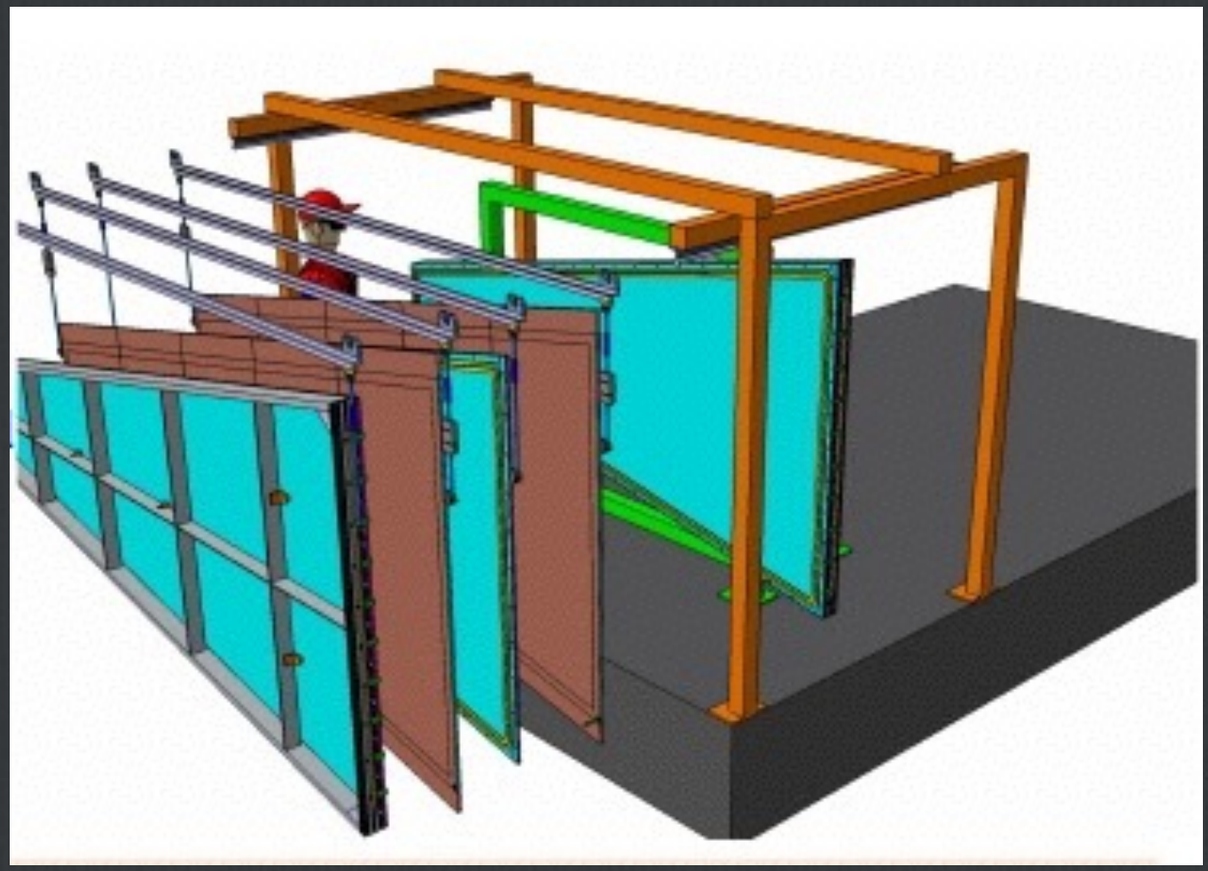
- **Small strip Thin Gap Chambers (sTGC) mainly for Triggering**
- **MicroMegas (MM) mainly for Tracking**

Redundancy of tracking and triggering against failure in a detector plane or element, limited accessibility



New Small Wheel: the Italian contribution





The SM1 chambers are on charge of the Italian Muon ATLAS collaboration.

The work has started two years ago and will be completed end of 2017.

Many prototypes have been assembled to study all the construction procedures and then tested at CERN SPS beam lines.

The first module will be assembled during this summer.

At LTL...

- We will review:
  - basics of particle physics
  - principle of operation of different detectors
- We will build and test a small RPC chamber
- We will learn:
  - Basics of C++ programming and the ROOT analysis framework
  - How to make an analysis in ATLAS
  - How to present results

July, 4th, 2012

ATLAS and CMS Collaborations announcement

of *(the observation of a particle compatible with)* the Higgs boson