



Organization and governance of the large LHC experimental collaborations

Pippa Wells, June 2022

Accelerators & Experiments

Convention for the Establishment of a European Organization for Nuclear Research of 1953 stipulates the operation of particle accelerators and the necessary ancillary apparatus for use in the research programmes

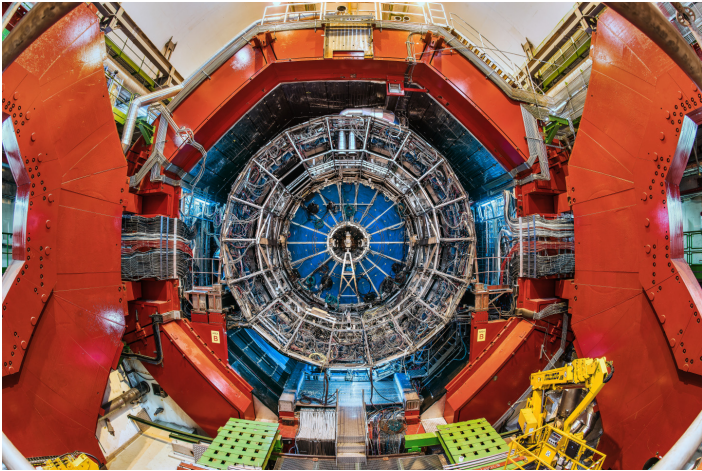
Since the days of LEP (1980s)

- the accelerators are funded from the CERN budget (from Member States) and project contributions from non-member states (NMS)
- the experiments are predominantly constructed by (in-kind) contributions of the institutes from Members States and non-Member States; this may be supplemented by a cash contribution to a Common Fund for construction for the joint procurement of infrastructure
- the experiments are operated jointly by the collaborating institutes and supported by a Maintenance and Operations Budget financed by all participating institutes (through their funding agencies), of which CERN is typically one

LHC Experiments at CERN

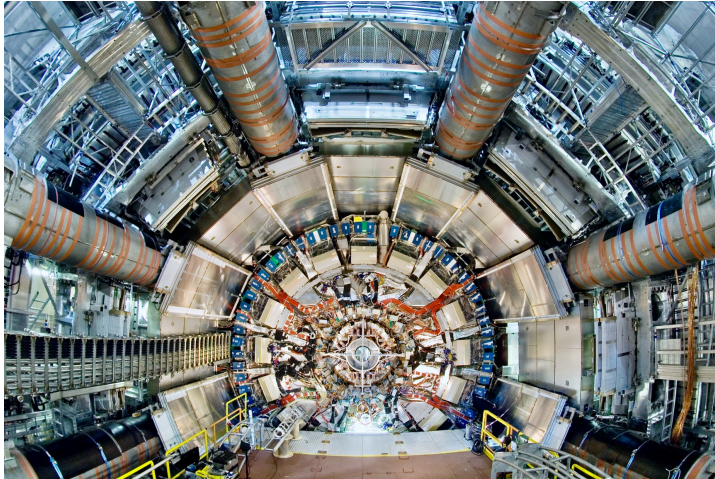
ALICE

~2000 members



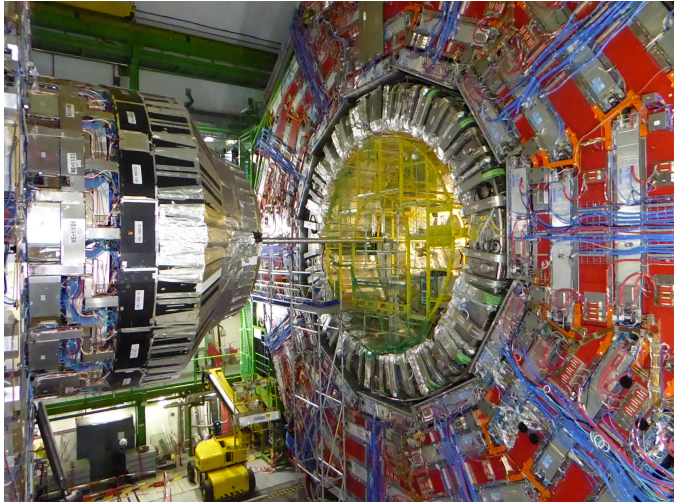
ATLAS

>3000 members



CMS

>3000 members



LHCb

>1400 members



Experimental Collaborations

- Interested physicists form a proto-Collaboration and propose an experimental set-up that is deemed capable of carrying out a measurement programme of interest using infrastructure at CERN
- Once approved the physicists constitute a formal Collaboration with the aim to build and operate the apparatus and to analyse and publish the data recorded jointly
 - their home institute commits to support their activity
 - the results are published under the name of the Collaboration
- Collaborations are open - new institutes may join following a well-defined procedure

Approval and Review by Competent Scientific Committee

- The competent Scientific Committee (LHCC) is called by the Director responsible for research. These committees are constituted by international and independent experts that peer-review the proposals and progress reports
- Progress is compared to milestones set at the approval of the experiment (or its upgrades)
- Deviations are flagged and reported back to the experiments, CERN management and funding agencies to allow for counter measures
- Research Board receives the concise reports of the Committee

Research Board

- The Research Board (RB) is chaired by the Director General of CERN and consists of the Directors, the CERN Department Heads and the chairs of the competent Scientific Committees
- The RB approves the experiment – or not – based on
 - scientific recommendations of the competent Scientific Committee
 - assessment of the financial situation of the experiment and
 - resource implication at CERN (support, services, technical installation, technology requirements). The Department Heads of the relevant technical groups at CERN assess the implications beforehand
- Final decision is taken by Council through the approval of the Medium Term Plan

Participation in Experiments at CERN

- General Conditions (GC) are the legally binding basis for participation in a CERN hosted experiment
 - GC set out the rules for users and describe the host lab responsibilities
- The particular engagement for an experiment is concluded by a Memorandum of Understanding (MoU) between the collaborating institute (funding agency) and CERN, signed by the Director responsible for research as the legal responsible for the CERN hosted experiment
 - MoUs describe the responsibilities for the construction of the experiments, the operation of the apparatus and its dismantling
 - Funding Agencies have direct oversight of their funds via the Resources Review Board

GC last update Dec 2020:

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

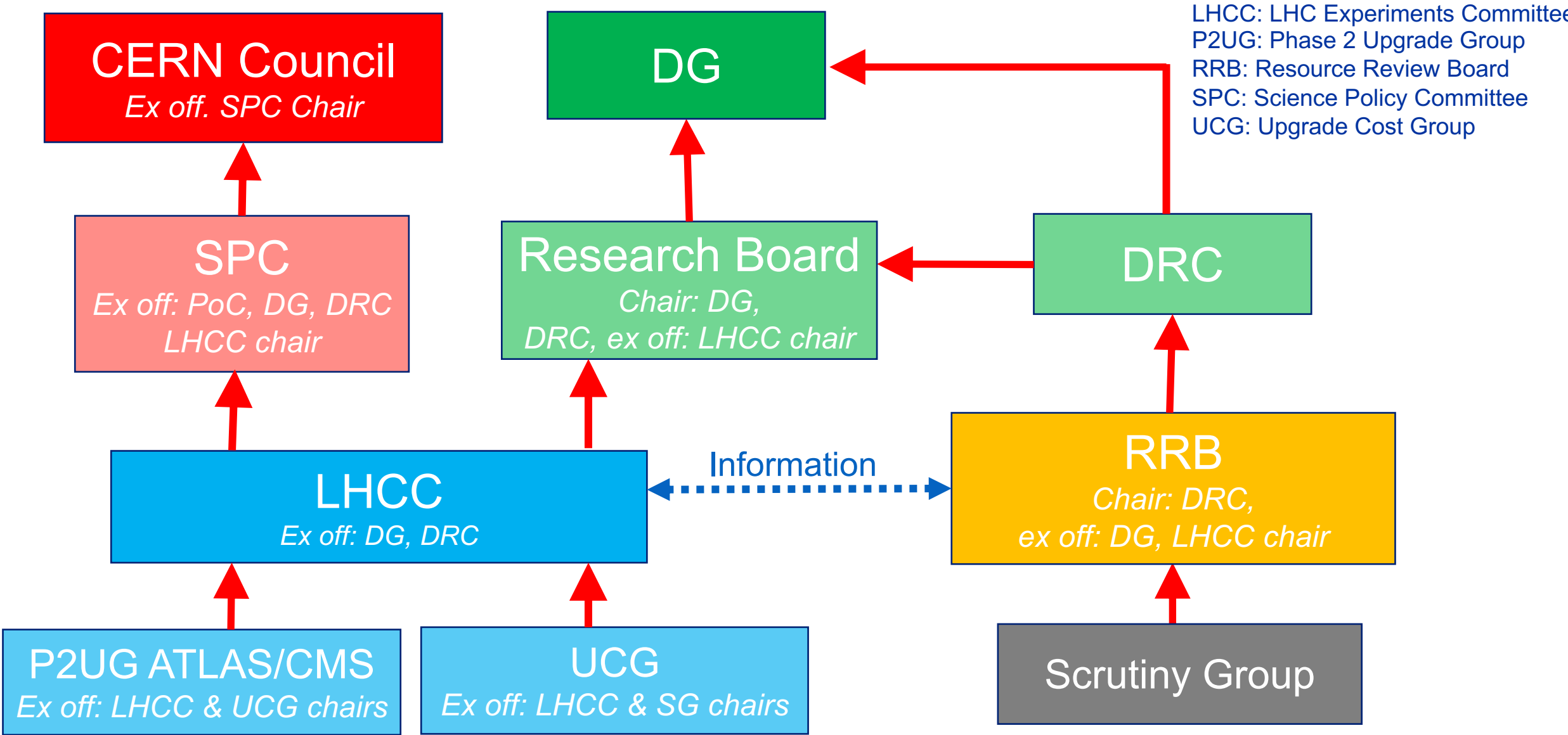
CERN GENERAL CONDITIONS

APPLICABLE TO THE EXECUTION OF
EXPERIMENTS

Memoranda of Understanding

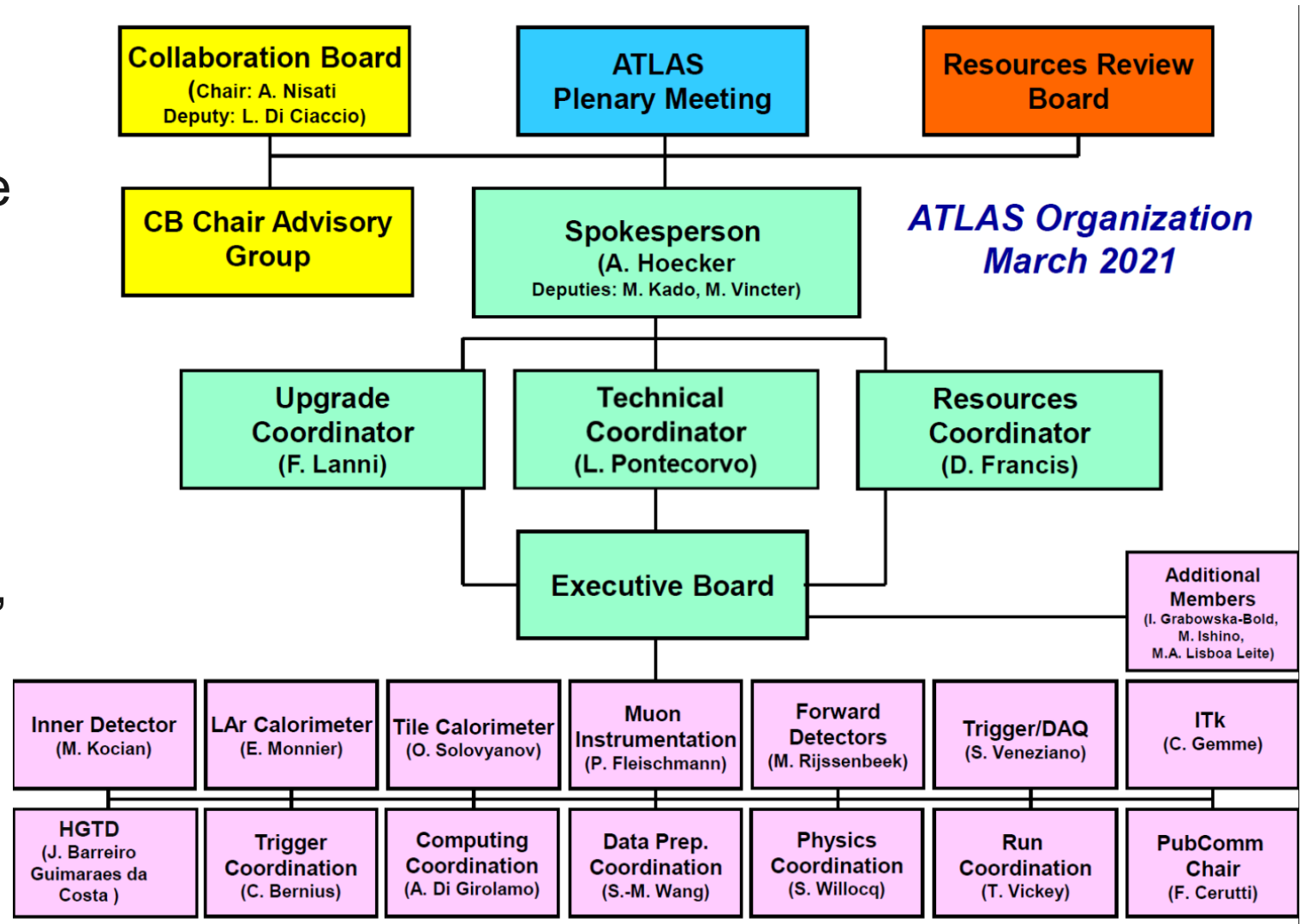
- The MoUs describe the **core** contributions (deliverables) of the institutes to the construction of experiments
- Core contribution is the value of components purchased and the external labour. Internal (institutional) labour is not included.
 - Depending on the salary scale and overheads the **full** cost may be considerably higher than core cost
- Collaborating institutions are expected to contribute core cost at the level of their share in the experiment, e.g. by authors or other agreed scheme
 - (This also defines their fair share contribution to the **Common Fund** for joint purchases of some infrastructure and to the annual **Maintenance and Operation** costs)

Sketch on Reporting on LHC experiments



Example: ATLAS

- Broad engagement of the participating institutes
- Groups of institutes build parts of the apparatus
- The data are available to all physicists for analysis, organised in dedicated working groups



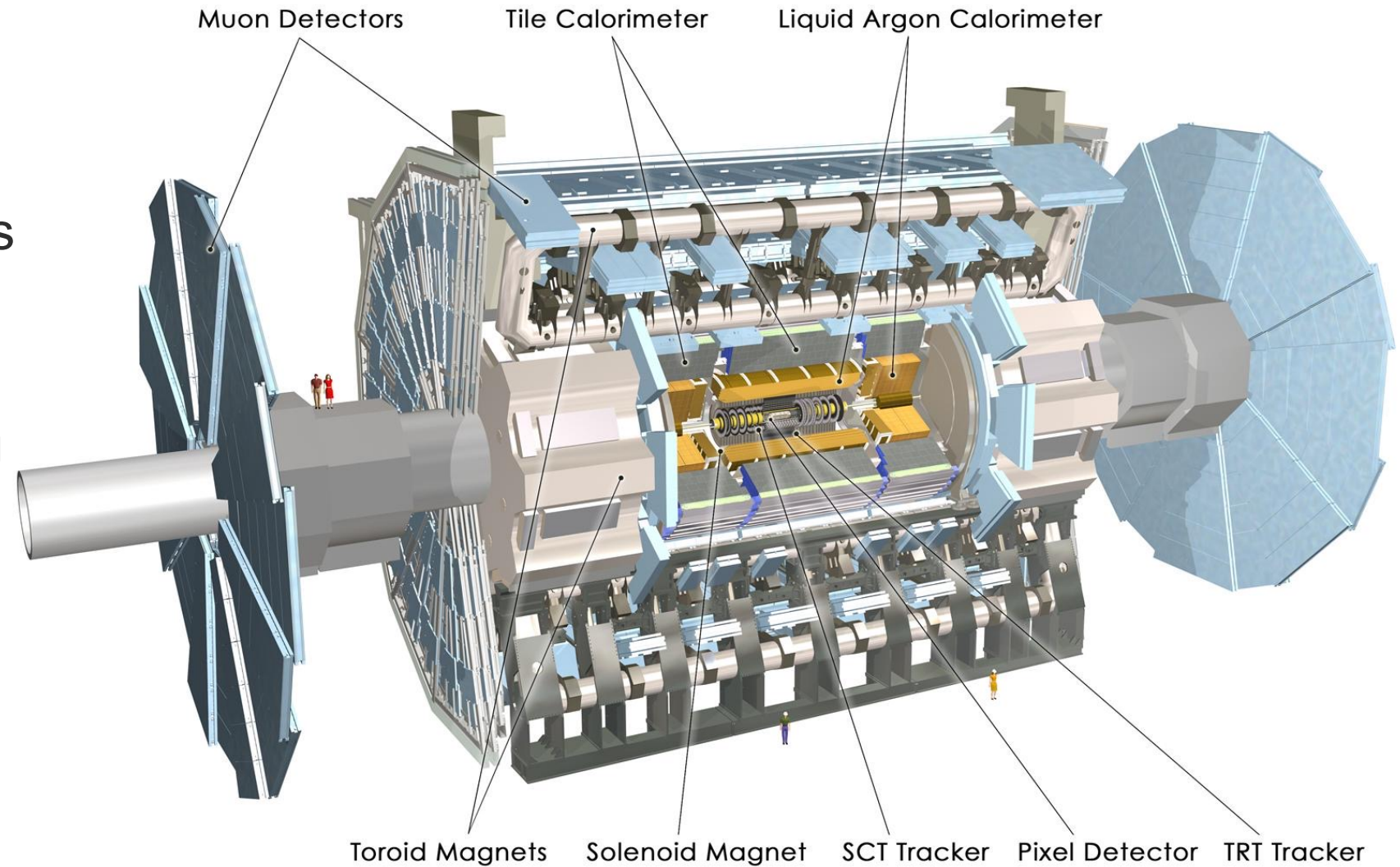
ATLAS detector

25m high, 44m long

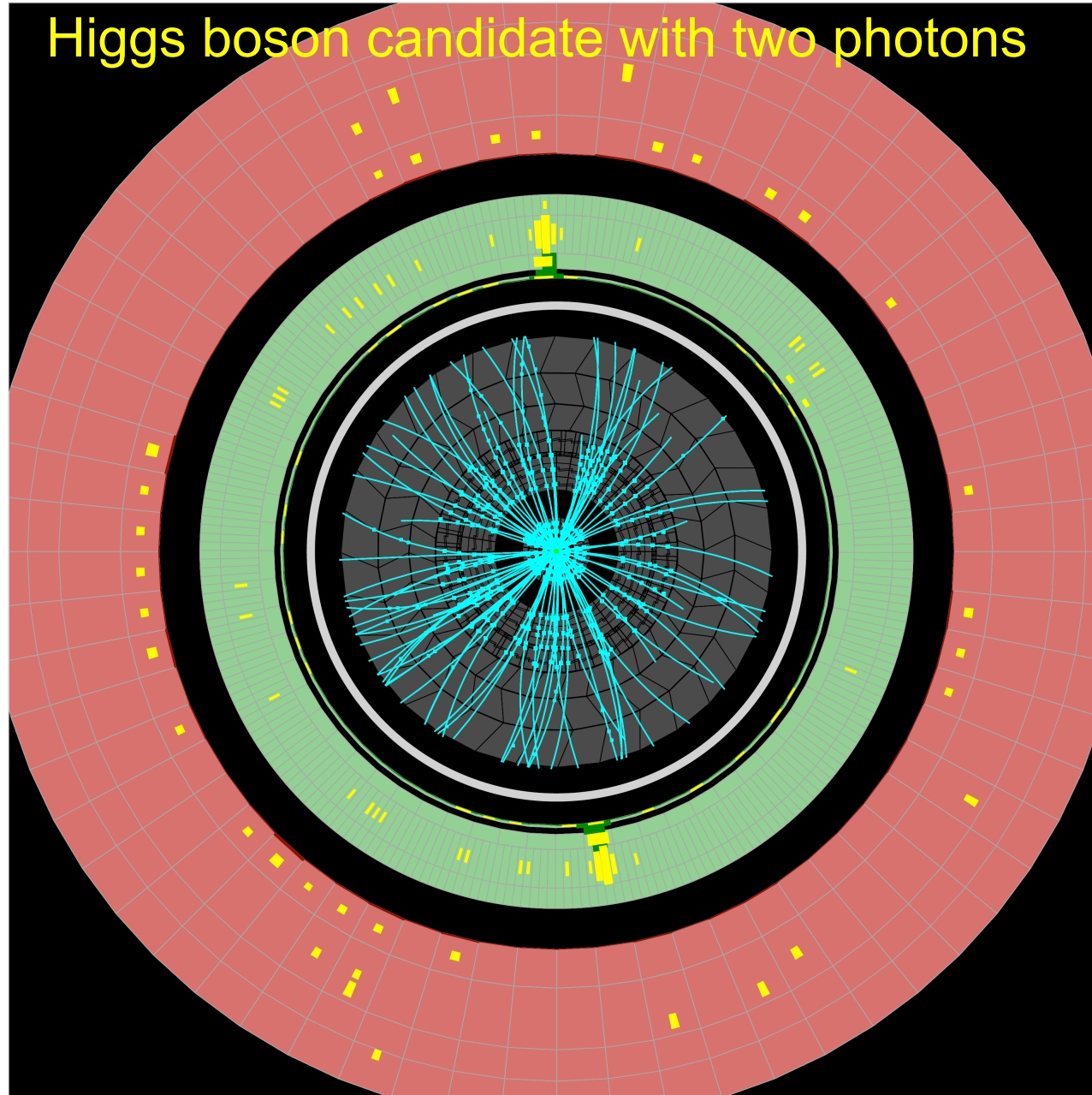
Total weight 7000 tonnes

100 million “pixels” per picture.

3000 scientists including 1000 students

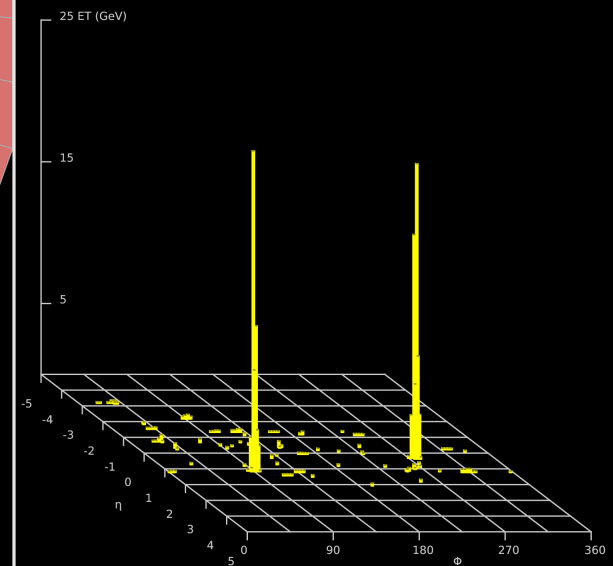


Higgs boson candidate with two photons



Run Number: 203779, Event Number: 56662314

Date: 2012-05-23 22:19:29 CEST



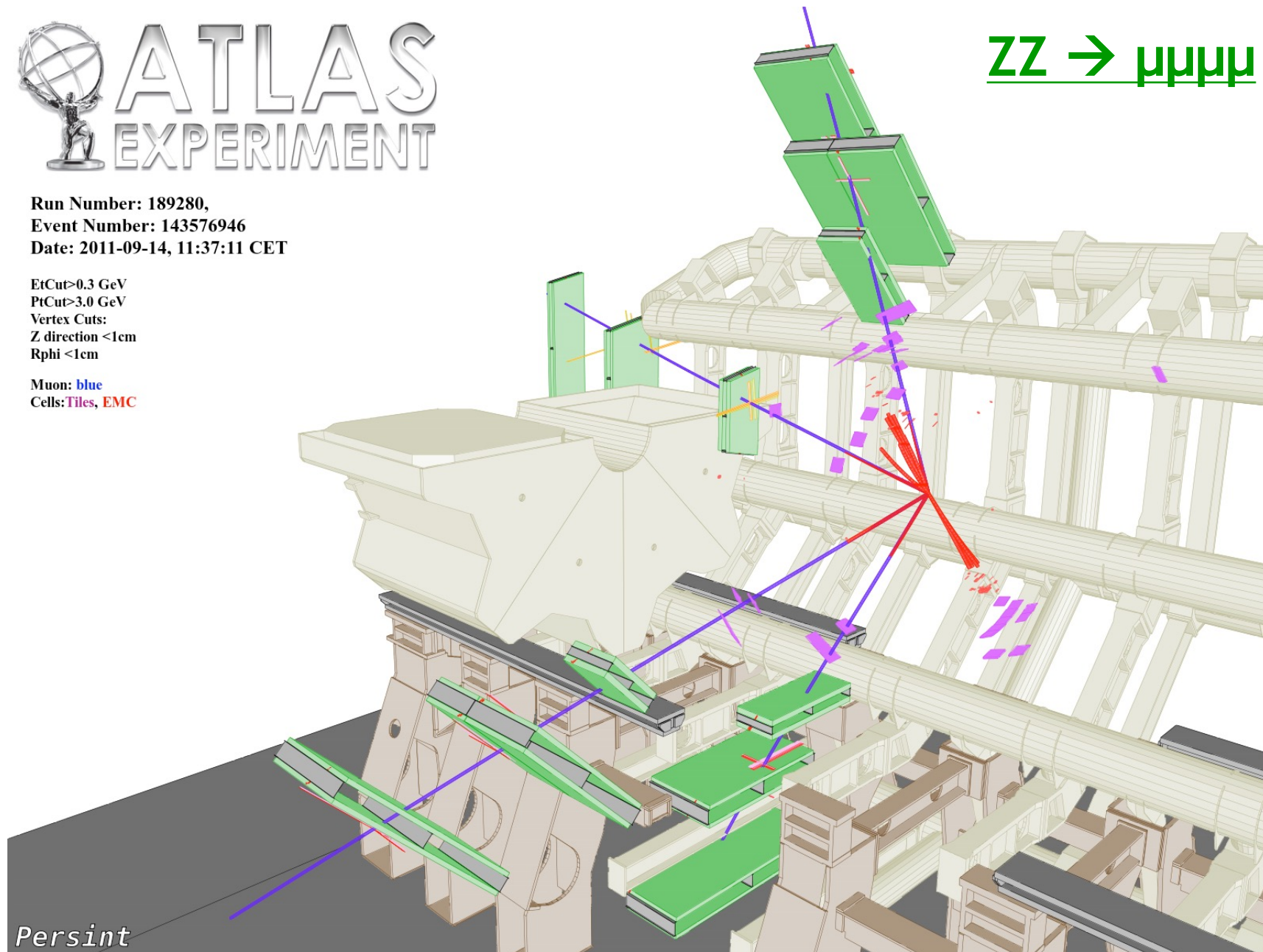
ATLAS EXPERIMENT

Run Number: 189280,
Event Number: 143576946
Date: 2011-09-14, 11:37:11 CET

EtCut>0.3 GeV
PtCut>3.0 GeV
Vertex Cuts:
Z direction <1cm
Rphi <1cm

Muon: blue
Cells: Tiles, EMC

ZZ → μμμμ



Persint

Summary

- The governance of experiments at CERN has a long and highly successful tradition
 - it has grown from small experiments of some ten people in the 1960s to the large collaborations comprising more than 3000 members today
- It is built on fair sharing, on a joint (physics) goal and the determination to succeed
- Risks are transparently and well managed
- The monitoring of the scientific success and the efficient use of resources involves committees with international experts
- The experiment results and data are available in the spirit of Open Science

Backup

Project Follow-up

- Experiments put in place a project management
- In case of technical difficulties in a component
 - internal review identifies origin and initiates mitigation actions (by Technical Coordinator or Spokesperson)
 - competent review committee signals failure and exposes problem
 - milestone tracking
 - spokesperson negotiates new solutions and reports to Resource Review Board
- Schedule changes
 - agreed upon with the Spokesperson, the Technical Groups at CERN and the CERN directorate

Common Fund

- The construction of the experiment necessitates joint purchases of some infrastructure
 - support structures that hold the detector in place
 - specific cooling, heating, distribution systems, ...
 - components not covered by the host laboratory responsibilities, since they are specific to the experiment

which is financed through the Common Fund

- financed by funding agencies
- monitored by RRB
- Host lab responsibilities cover the cost to enable an experiment in the first place: experimental cavern, radiation protection, supply of services such as electricity, cooling and gas; provision of transport of components to the site...

Maintenance and Operation

- The experiment (Technical and Resource Coordinators) presents on an annual basis a budget for Maintenance and Operation (M&O) of the experiment to the **Resource Review Board (RRB)** and its subordinate expert body, the **Scrutiny Group**.
 - before submission to the RRB the M&O requests are scrutinized internally by the experiments
- The M&O budget is used for (M&O A)
 - maintenance of detector components
 - replacement of broken or obsolete equipment
 - maintenance of online system (typical useful life time of CPUs ~4 years)
- Detector specific Maintenance and Operation budget (M&O B)
 - institutes that contribute to a specific detector
- The **RRB** is composed of members of the **funding agencies** contributing to the experiments and meets twice a year
- M&O sharing is based on the number of authors with PhD, updated every year