Three Decades of Greek Contribution to the ATLAS Experiment

Dimitris Fassouliotis, NKUA
On behalf of:

National Technical University of Athens

HELLENIC REPUBLIC
National and Kapodistrian University of Athens
EST. 1837

ARISTOTLE UNIVERSITY OF THESSALONIKI

DEMOKRITOS
NATIONAL CENTRE FOR SCIENTIFIC RESEARCH

HELLENIC OPEN UNIVERSITY

UNIVERSITY OF THE AEGEAN

UNIVERSITY OF WEST ATTICA
ΠΑΝΕΠΙΣΤΗΜΙΟ ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ

Why LHC and ATLAS ?

Why LHC and ATLAS ?

CERN/LHCC/92-4
LHCC/I 2
1 October 1992

ATLAS

Letter of Intent
for a
General-Purpose pp Experiment
at the
Large Hadron Collider at CERN

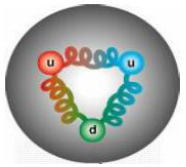
Abstract

The ATLAS collaboration proposes to build a general purpose proton–proton detector for the Large Hadron Collider, capable of exploring the new energy regime which will become accessible. The detector would be fully operational at the startup of the new accelerator. The detector concept, the research and development work under way to optimize the detector design, and its proposed implementation are described, together with examples of its discovery potential.

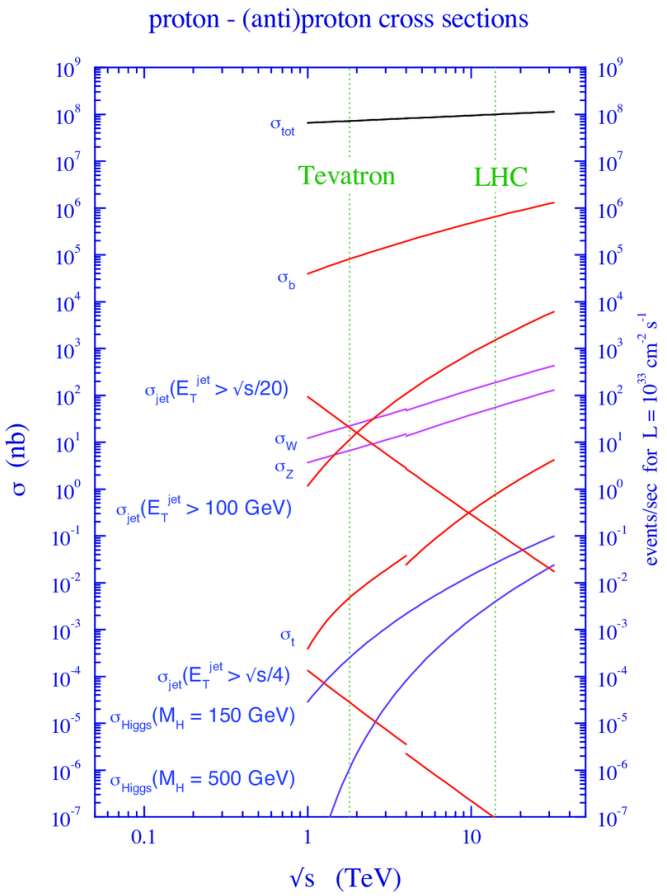
- **Higgs boson discovery**
- **Supersymmetry**
- **Find new physics via**
- Direct searches
- Precision measurements

LHC and ATLAS

$$E^2 = P^2 + M^2$$



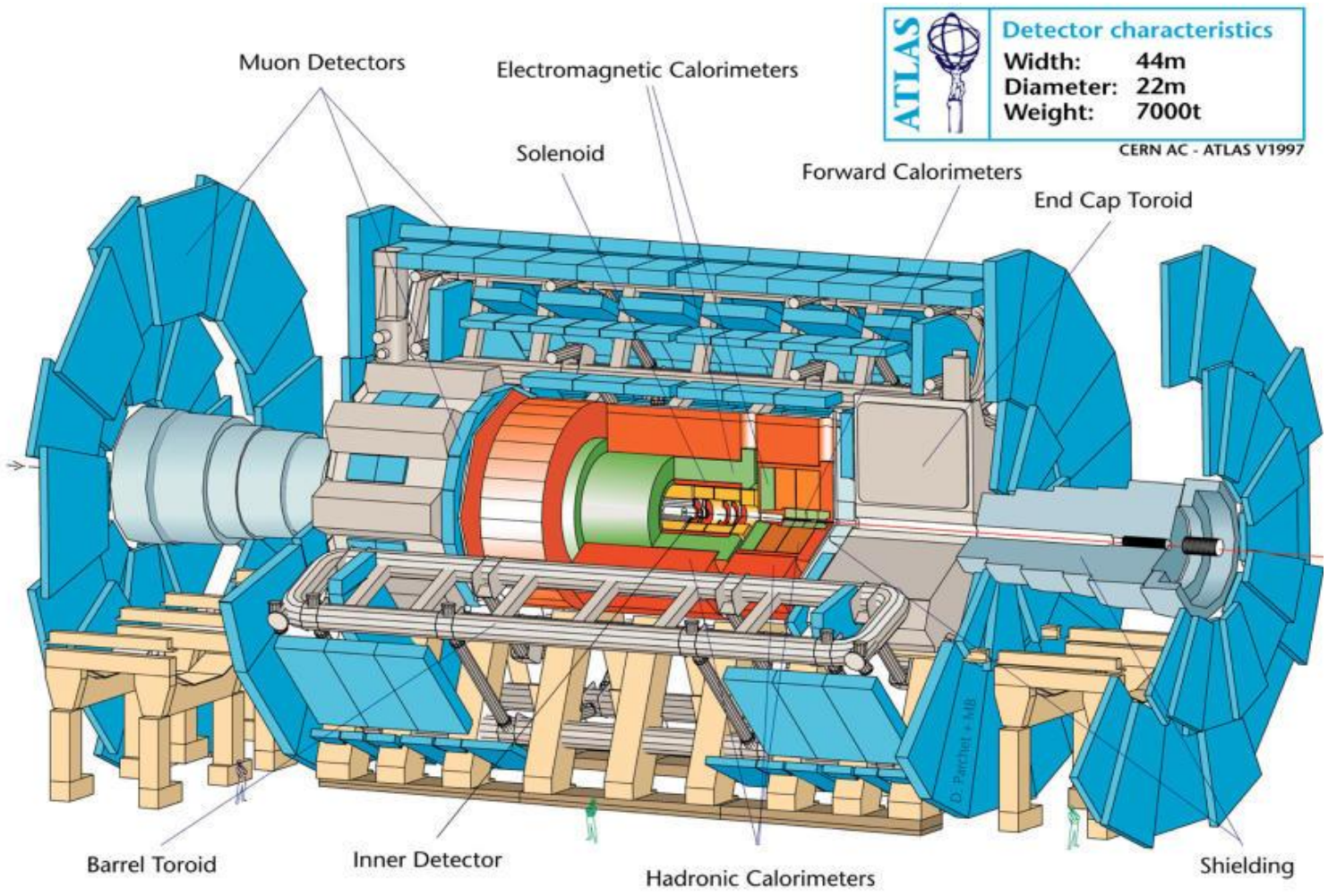
E_b = 6.8 TeV

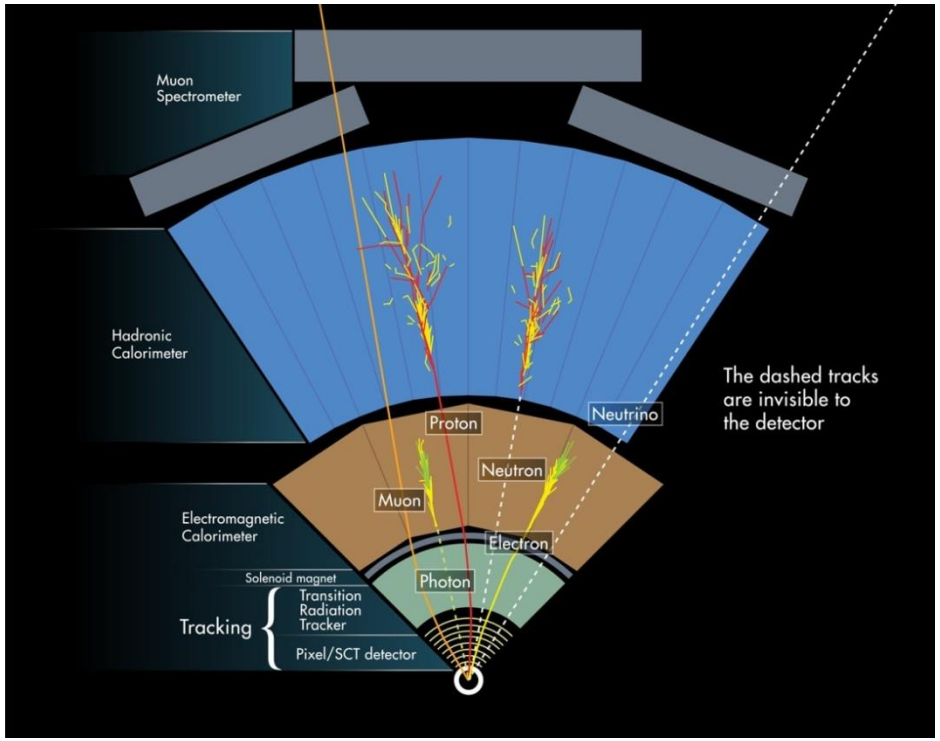


10 orders

40.000.000 bunch crossings / s

LHC and ATLAS





Fast, precise, hermetic detector to measure
E, ***P***, charge, flavor of "stable" particles

… and reconstruct
all decaying particles

Main contributions of the Greek Institutes

Detector development, construction, operation and validation

- MDT BIS chambers construction and integration
- Micromegas development, construction, integration, commissioning
- Electronics design, manufacture and validation
- Detector Control System (DCS)
- Muon system Operation
- Muon reconstruction and performance studies

Physics analysis

- Higgs boson discovery and measurements of its properties
- SM precision measurements
- Searches for BSM (new) physics

Personnel of the Greek Institutes

Faculty members

AUTh +HOU

C. Petridou, Prof. Emeritus,
D. Sampsonidis, Prof.
K. Kordas, Prof. AUTh
S. Tzamarias, Prof.
S. Argyropoulos, Assoc. Prof.
C. Lampoudis, Assist. Prof.
A. Leisos, Assoc. Prof., HOU
K. Bachas, Assoc. Prof., Auth, Lamia

NCSR Democritos

G. Fanourakis, Emeritus
T. Geralis, Director of Research
G. Stavropoulos, Dir. of Research
A. Psallidas, Researcher

NKUA + U. of Aegean

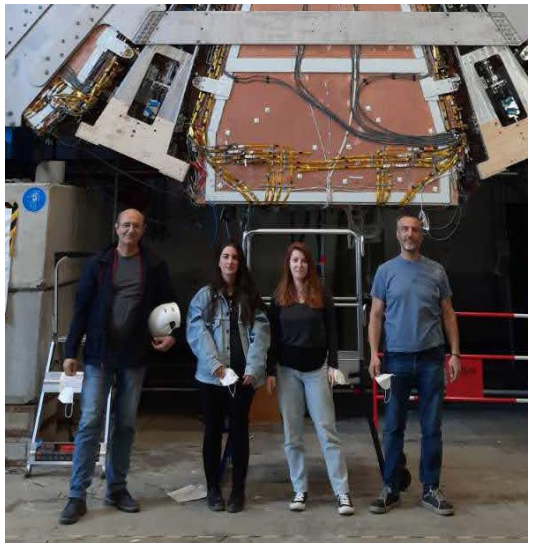
C. Kourkoumelis, Prof. Emeritus
D. Fassouliotis, Prof.
I. Gkialas, Prof. Univ. of Aegean

NTUA

T. Alexopoulos, Prof.
E. Gazis, Prof. Emeritus
Y. Kopsalis, Assist. Prof.
S. Maltezos Prof. Emeritus

UniWA

S. Kyriakis-Bitzaros, Prof.
K. Zachariadou, Prof.



Post doctoral researchers

S. Angelidakis, NKUA
A. Tsirigotis, HOU, Patras
D. Iliadis, HOU, Patras
M. Tsopoulou, AUTh
E. Kasimi, AUTh

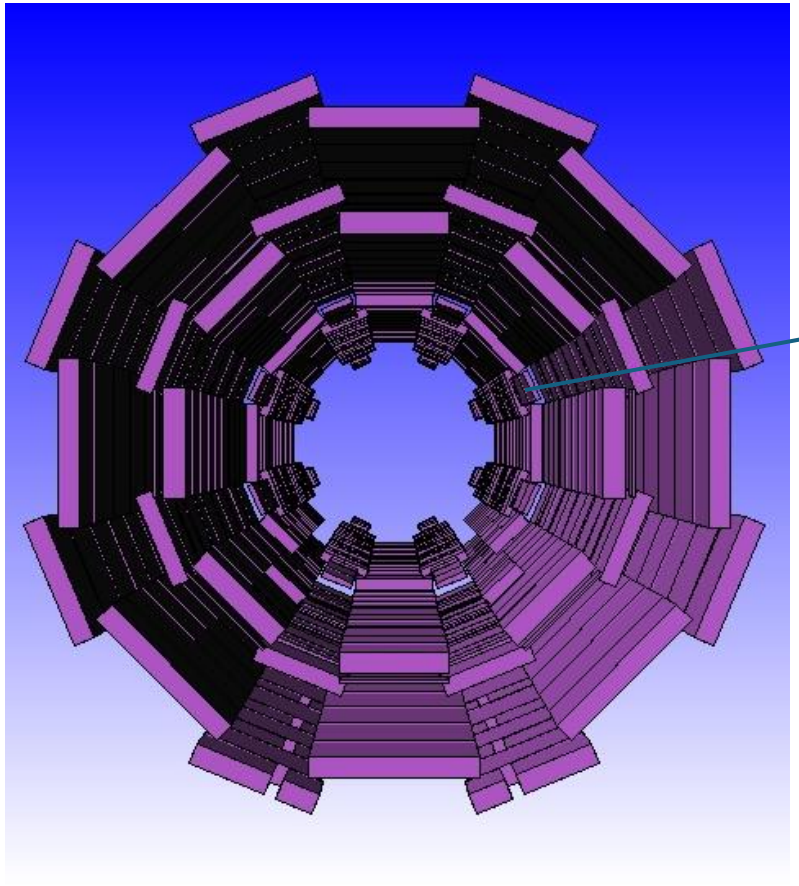
Currently:

- **16 PhD candidates**
- **Similar amount of MSc students**
- **Several undergraduate students**

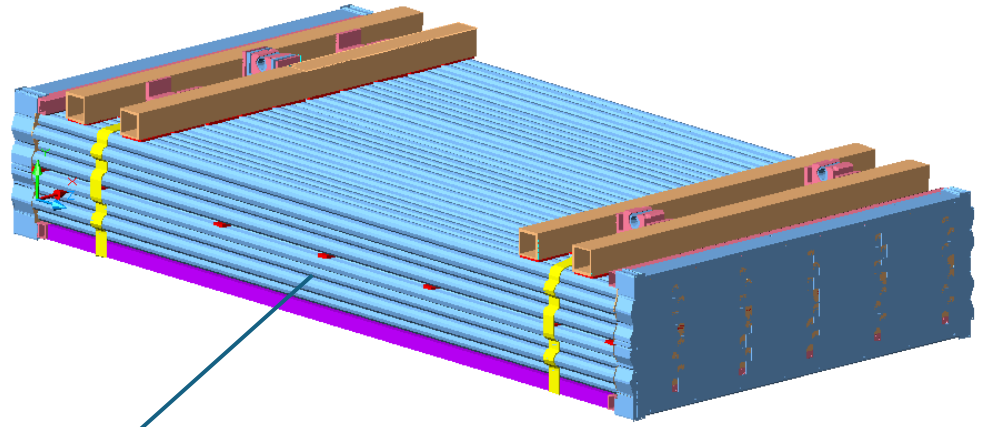
Previous years:

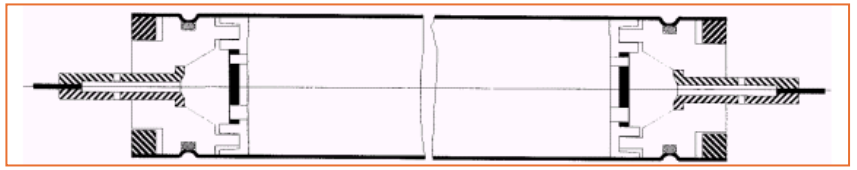
- **45 PhD and ~60 MSc theses completed within ATLAS**
- **Dozens of undergraduate students had their first contact with research**

MDT BIS chambers construction and integration



Transverse view of the Muon Spectrometer





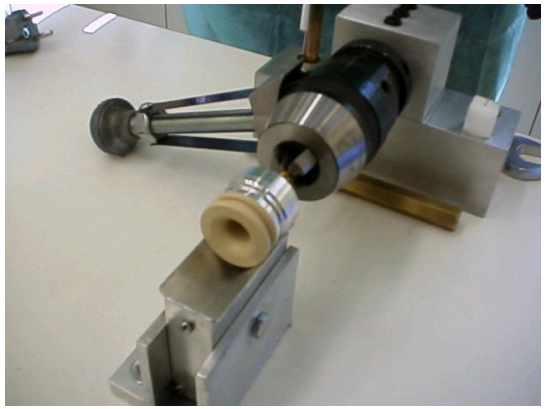
MDT tube with the end-plugs and the wire

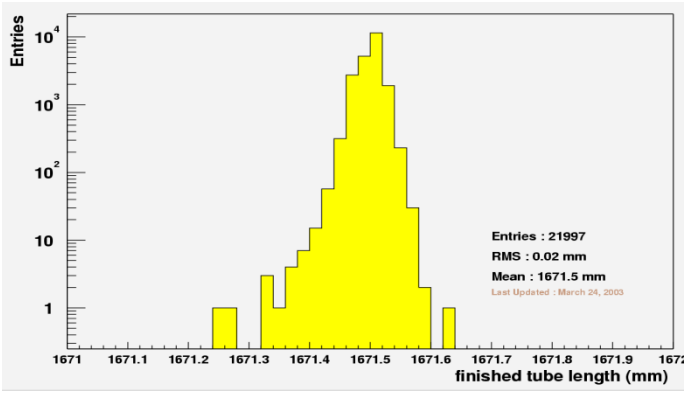
NKUA	*MDT tube assembly*
NTUA	*Quality Assurance of MDT tubes*
AUTh	*MDT chamber assembly*

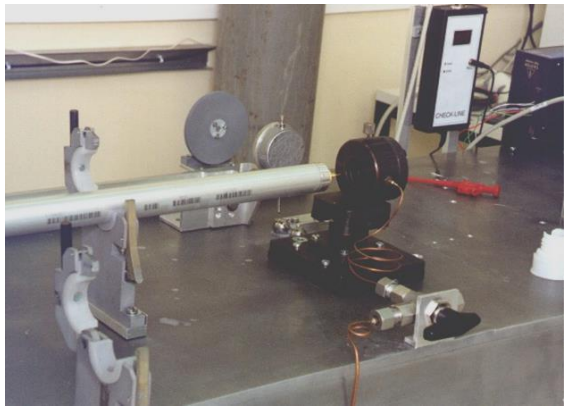
30000 tubes
112 chambers

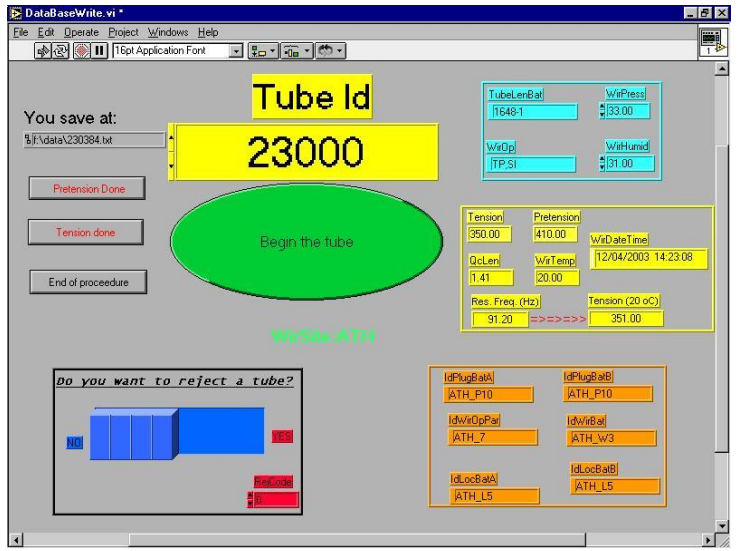
Very tight specifications!

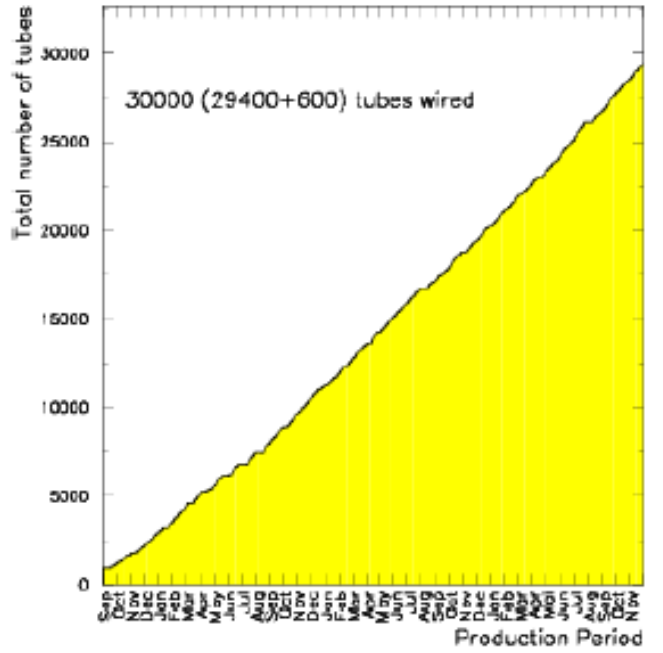
MDT BIS chambers construction: Tube assembly









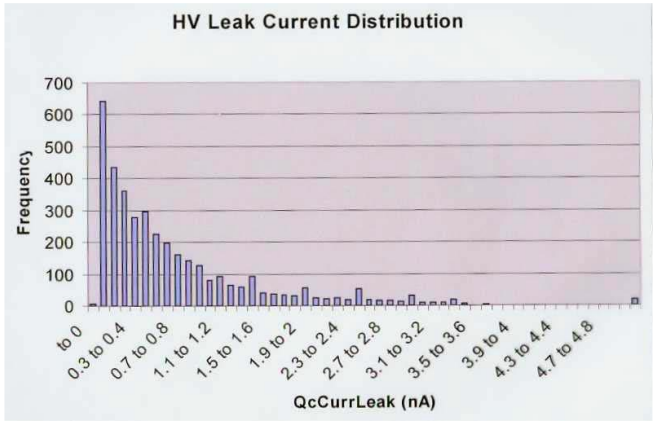


30,000 tubes finished December 2003

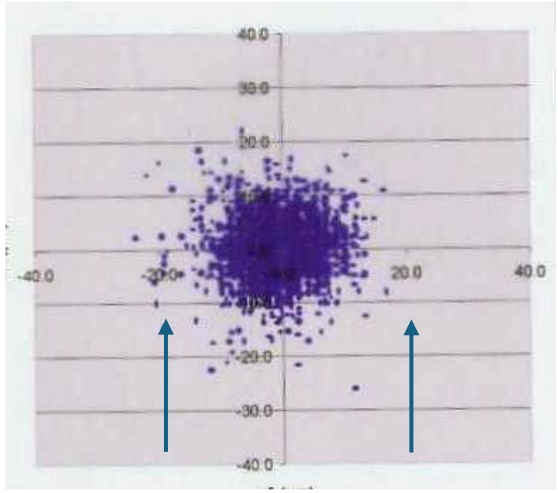
99.2% passed all quality criteria

MDT BIS chambers construction: Tube quality assurance

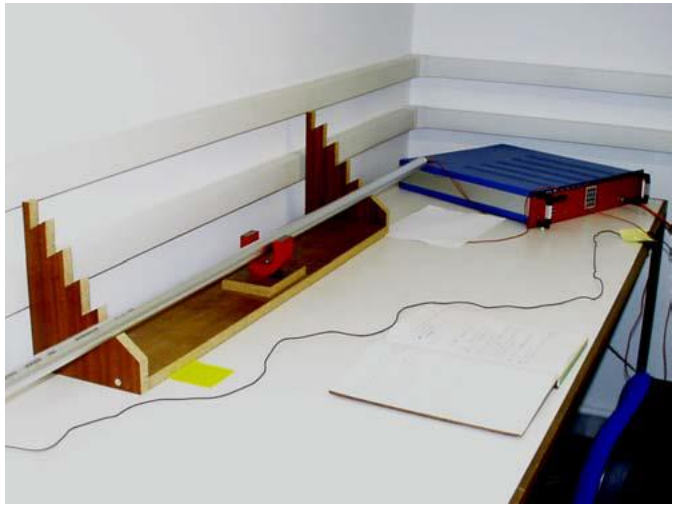
Wire position measurement



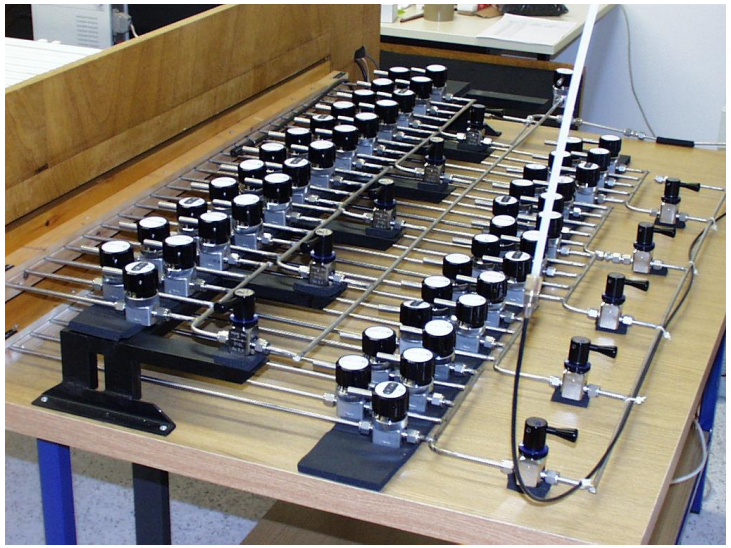
σ=4.3μm

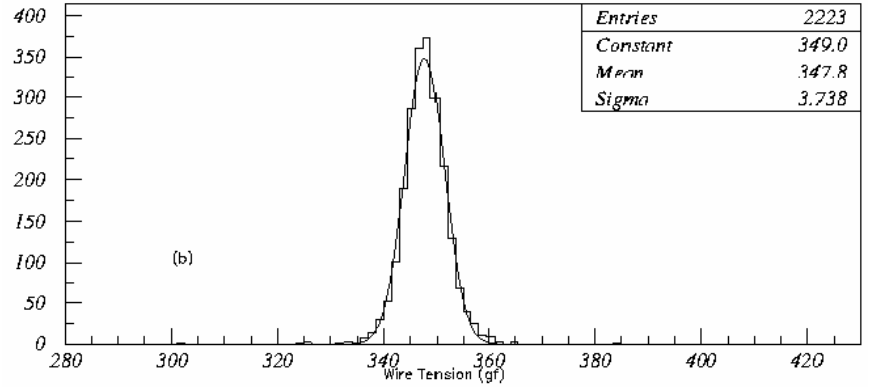


Wire tension measurement



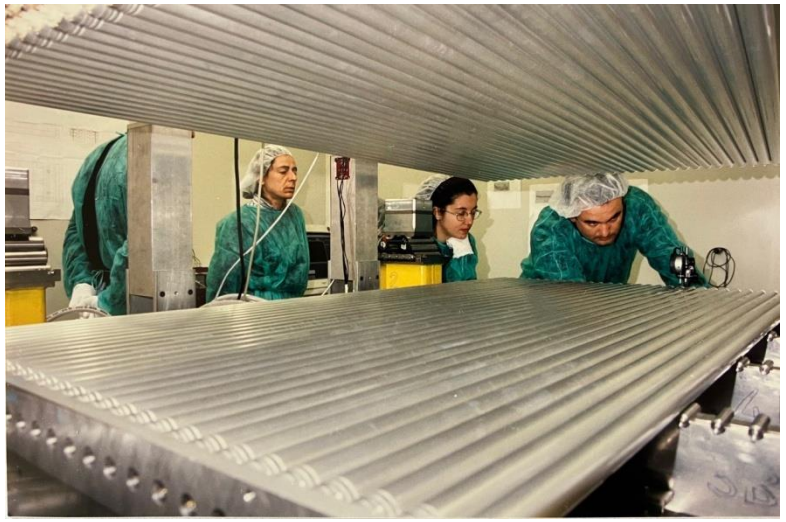
Gas leak measurement

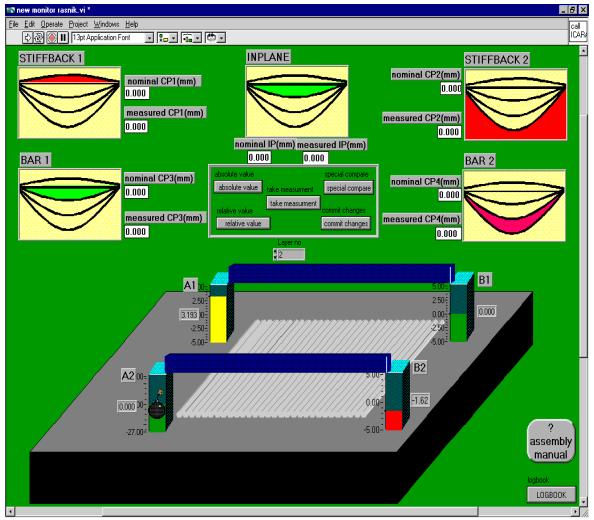


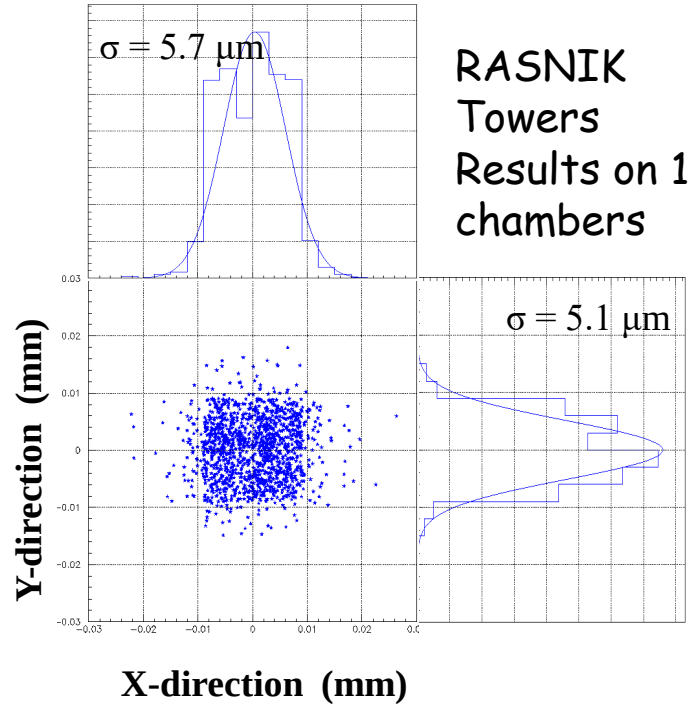


30,000 tubes finished March 2004

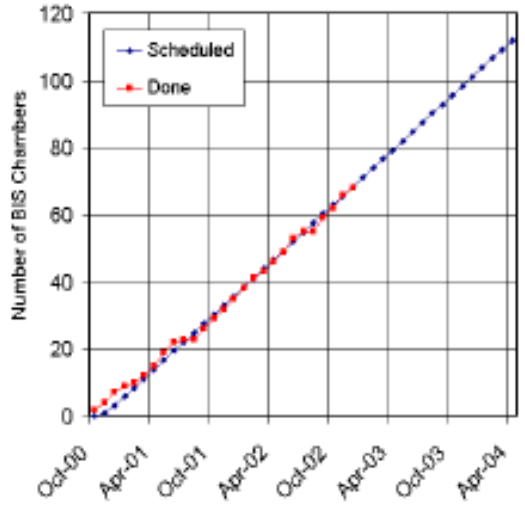
MDT BIS chambers construction: Chamber assembly







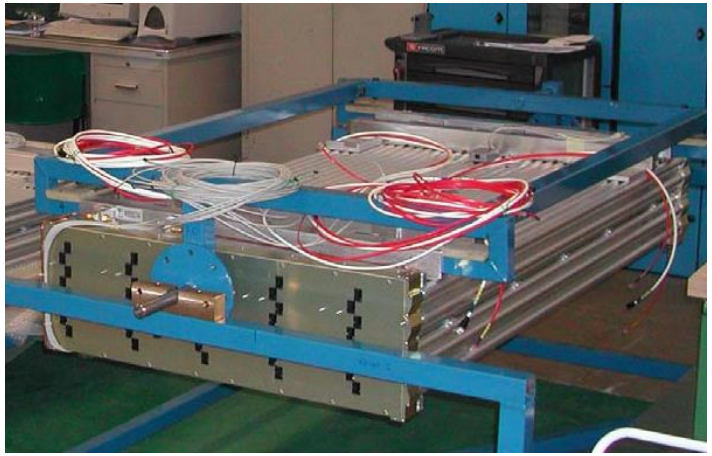
RASNIK Towers Results on 112 chambers

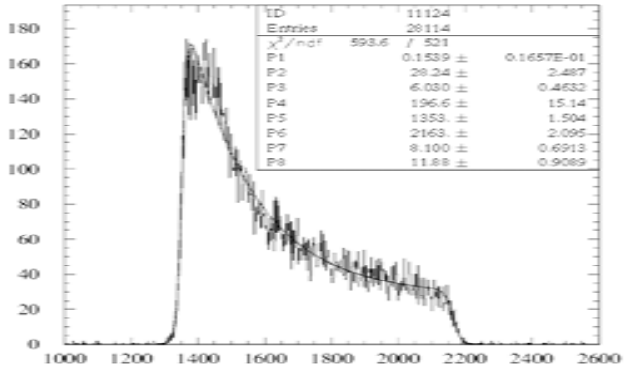


112 chambers finished April 2004

MDT BIS chambers integration

- Preparatory Activities
- Integration phase I – Mechanic components
- Gas Leak Test
- Integration phase II - Electronic components
- Noise test
- Cosmic ray test
- Final qualification and insertion in Data Base





MDT BIS chambers integration

First MDT chamber to arrive at CERN

bulletin

Dernier délai pour soumission des articles : mardi 12.00 h
Les articles du Bulletin se trouvent également sous http://Bulletin.cern.ch/News/

Deadline for submission of articles : Tuesday 12.00 hrs
Bulletin articles can also be found at http://Bulletin.cern.ch/News/

Semaine du lundi 16 août — no 33/99 — Week Monday 16 August

La première chambre à muons d'ATLAS arrive de la chaîne de production grecque

Il est bien loin le temps où un institut pouvait construire tout seul de A à Z un détecteur pour une grande expérience de physique des particules. Dans le cas du LHC, certains sous-ensembles de détection sont si grands et si complexes que la construction de leurs éléments doit être répartie dans le monde entier. Le détecteur de muons d'ATLAS est l'un de ces systèmes : 46 institutions en Europe, en Chine, aux Etats-Unis d'Amérique, en Israël, au Japon et en Russie participent à sa construction. Après la fabrication de plusieurs prototypes en Allemagne, aux Etats-Unis, en Italie, aux Pays-Bas et en Russie, la première chambre de précision à sortir d'une chaîne de production est le fruit de la collaboration de trois universités grecques. Elle est arrivée au CERN le 5 août en provenance de Thessalonique. Cette chambre est le premier modèle complet d'une série de 1200 qui seront construites de par le monde dans les prochaines années.

Le système de détection des muons d'ATLAS sera un énorme dispositif d'un volume d'environ 17 000 m³. A l'intérieur de ce volume, les éléments de détection de précision couvriront une surface de 5500 m² et contiendront quelque 400 000 éléments actifs. Des chambres de déclenchement sur les muons, d'une superficie identique, sont également en construction. Le contrôle de qualité d'un dispositif aussi complexe serait déjà ardu si la construction était centralisée. La participation de 46 instituts ajoute une difficulté supplémentaire. La précision est capitale pour le détecteur de muons d'ATLAS et l'uniformité des modules provenant de différentes régions

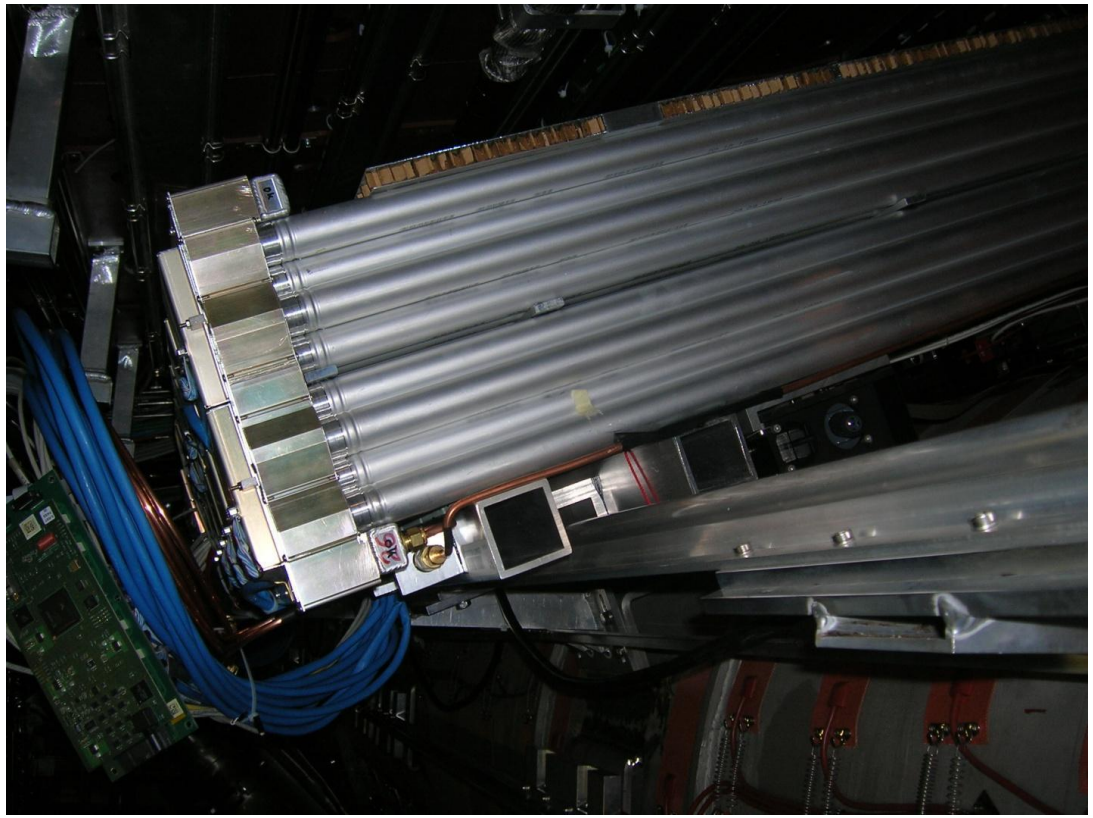
Le délégué de la Grèce au Conseil, le professeur Emmanuel Floratos (au centre), accompagné par des membres de l'équipe grecque, auprès de la première chambre à muons d'ATLAS construite en Grèce installée dans le tomographe à rayons X au CERN.

First ATLAS muon chamber arrives from Greek production line

Gone are the days when a single institute could build an entire particle detector for a large particle physics experiment single handed. With the arrival of the LHC even some sub-detector systems are so big and complex that their construction has to be shared around the world. One such system is the ATLAS muon detector which is being constructed in 46 institutions in Europe, China, Israel, Japan, Russia and the United States. Following the construction of a number of prototypes in Germany, Italy, the Netherlands, Russia and the USA the first precision chamber to come off a production line was built by a collaboration of three Greek universities and it arrived at CERN from Thessaloniki on 5 August. This chamber is the first complete model of 1200 that will be built around the world over the next few years.

The ATLAS muon detection system will be an enormous device covering a volume of some 17 000 cubic metres. Within this volume the precision detector elements will have a surface of 5500 square metres and contain some 400 000 active elements. Another 5500 square metres of muon trigger chambers are also under construction. Quality control for such a complex device would be challenging even if it were being built in one place. Having 46 institutes involved adds an extra dimension to an already complex task. Precision is paramount for the ATLAS muon detector and uniformity between the modules coming from different parts the world has to be carefully controlled. To this end, the collaboration has established a stringent quality control process, and it is a great

Greek delegate to CERN Council, Professor Emmanuel Floratos (front, centre), accompanied by members of the Greek team, with the first ATLAS muon chamber built in Greece installed in the x-ray tomograph at CERN.



~7 years from the start of the effort

A Greek Collaboration can participate & contribute to a very big scale experiment!

Greek Institutes contributions to ATLAS physics potential studies

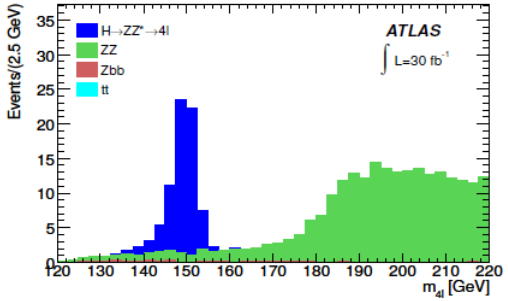
CERN-OPEN-2008-020
December 2008

Expected Performance of the ATLAS Experiment

Detector, Trigger and Physics

The ATLAS Collaboration

A detailed study is presented of the expected performance of the ATLAS detector. The reconstruction of tracks, leptons, photons, missing energy and jets is investigated, together with the performance of *b*-tagging and the trigger. The physics potential for a variety of interesting physics processes, within the Standard Model and beyond, is examined. The study comprises a series of notes based on simulations of the detector and physics processes, with particular emphasis given to the data expected from the first years of operation of the LHC at CERN.



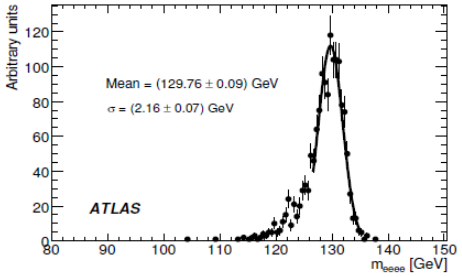


Figure 18: Reconstructed H(130 GeV)→ 4e mass after application of the Z-mass constraint fit.

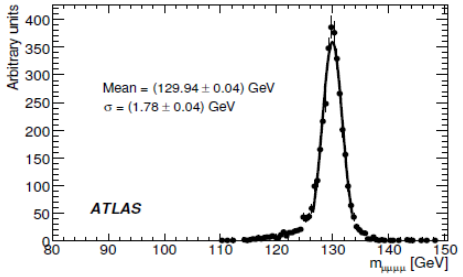


Figure 19: Reconstructed H(130 GeV)→ 4μ mass after application of the Z-mass constraint fit.

- Muons
- Diboson Studies
- H→ZZ(*)→4ℓ
- H/A/h→$\mu^+\mu^-$
- W'→$\mu\,\nu$
- Z'→$\mu^+\mu^-$

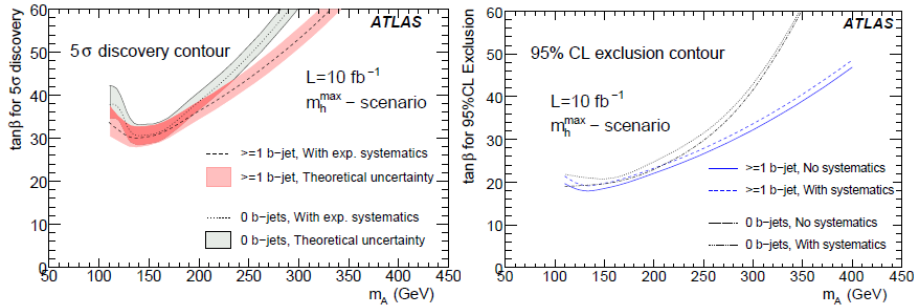


Figure 24: tanβ values needed for the 5σ-discovery (left) and for the 95% CL exclusion of the signal hypothesis (right), shown in dependence on the A boson mass.

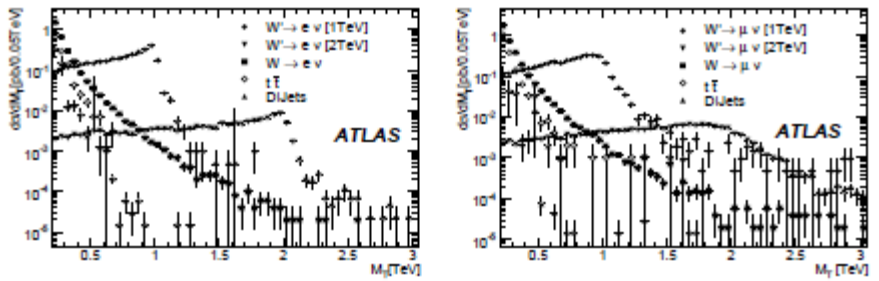
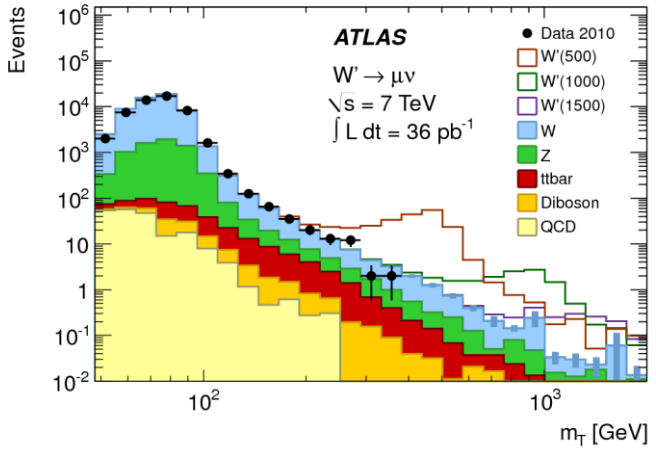
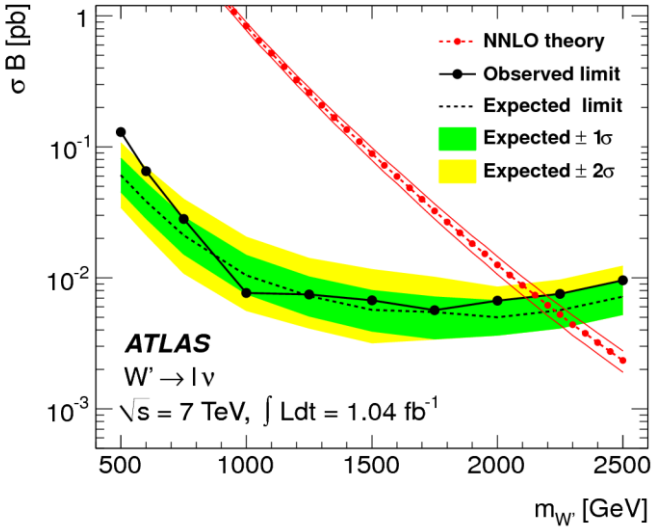


Figure 14: Transverse mass spectrum after the basic kinematic requirements for background and signal ($m_{W'} = 1$ and 2 TeV). Left: electron mode; right: muon mode.

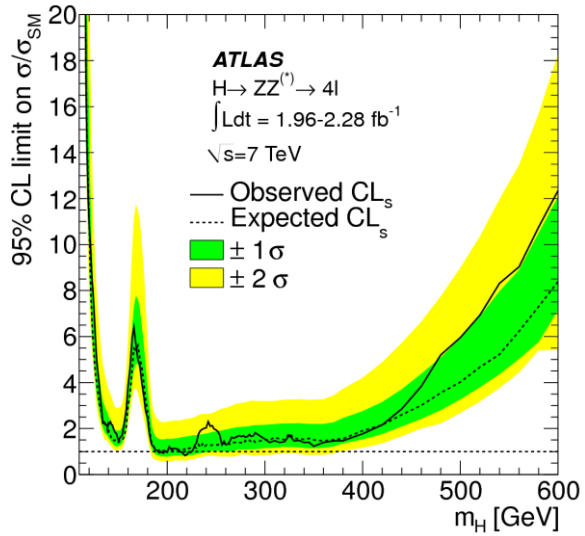
Run 1 Physics (highlights)

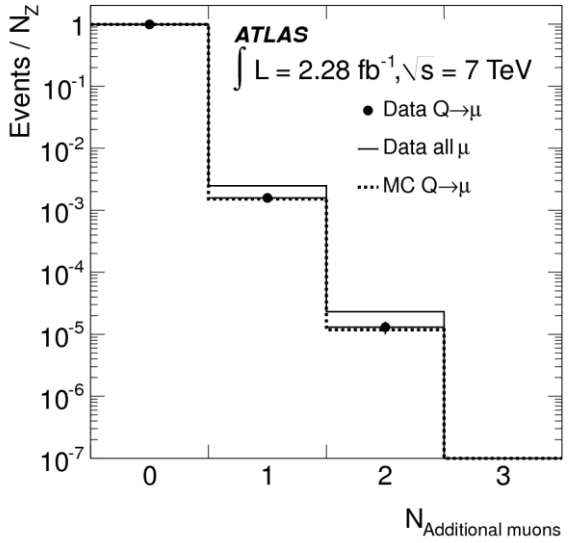
Search for W'→ℓν



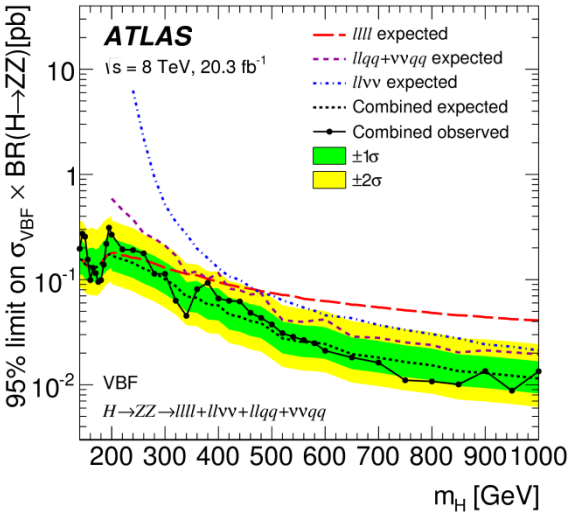


Search for H→ZZ(*)→4ℓ

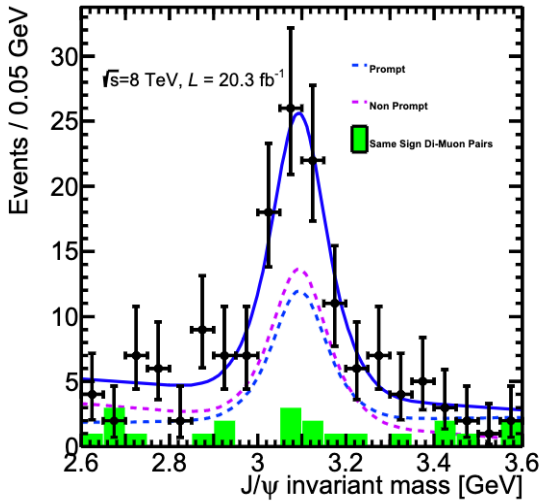




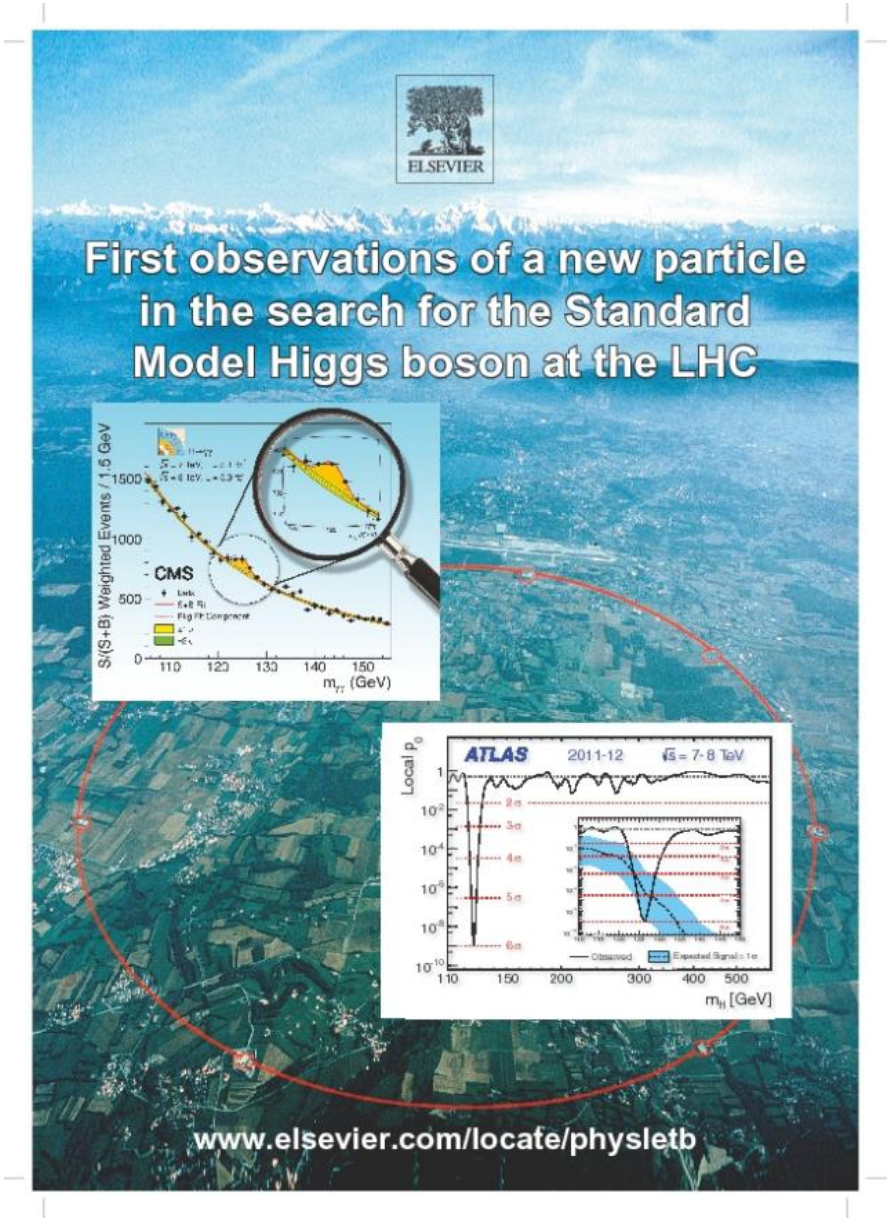
Search for heavy H→ZZ

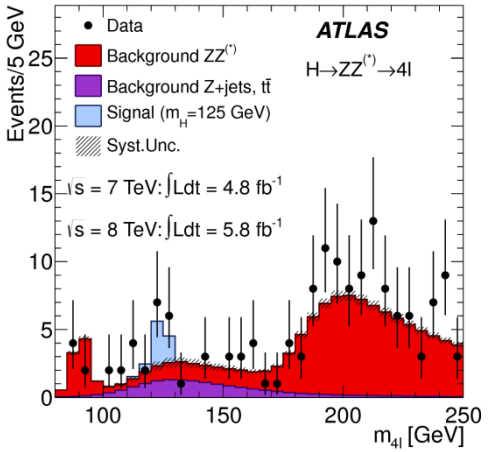


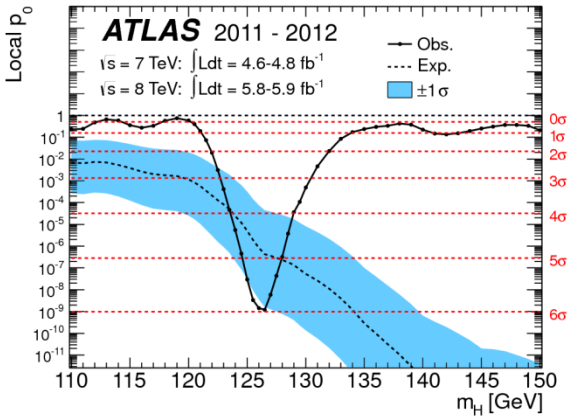
First observation of the associated production of Z boson with prompt and non-prompt J/ψ



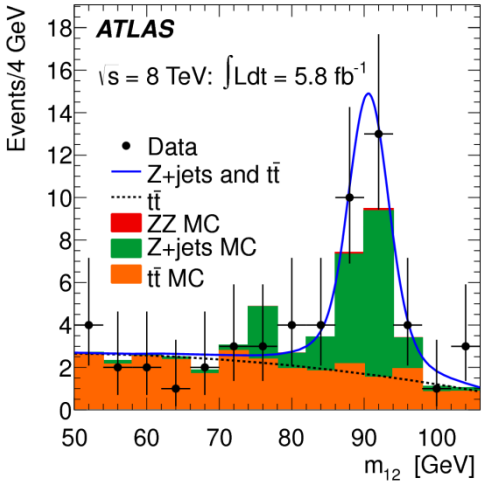
Run 1 Discovery of the Higgs boson by ATLAS and CMS







Data driven reducible background estimation



2013

2 PhD students from Greek Institutes in the H→ZZ(*)→4ℓ analysis

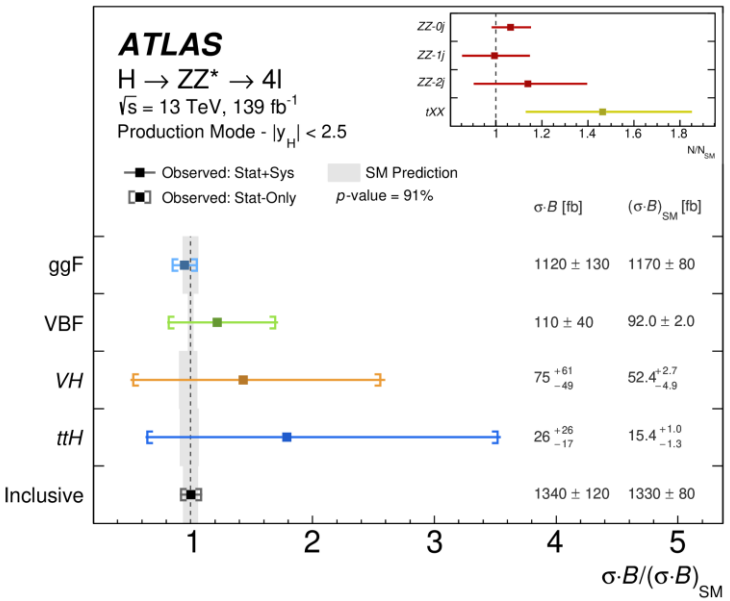
2012 ATLAS Thesis Award

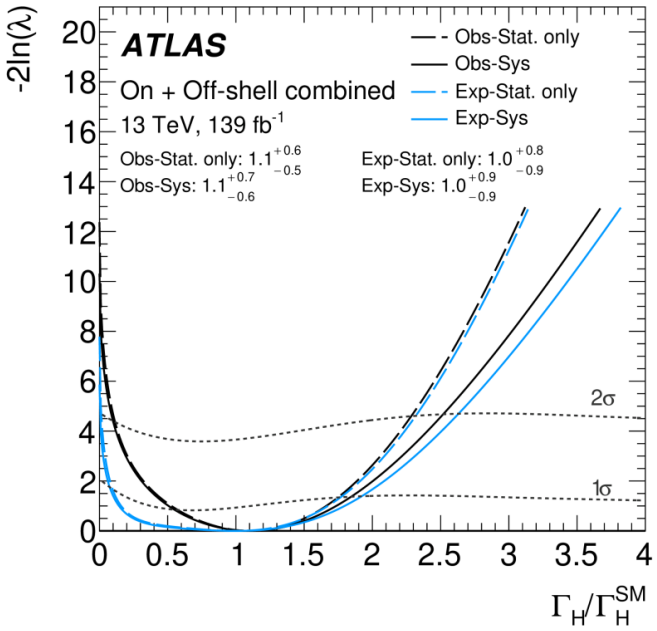
Several researchers originating from Greek institutes

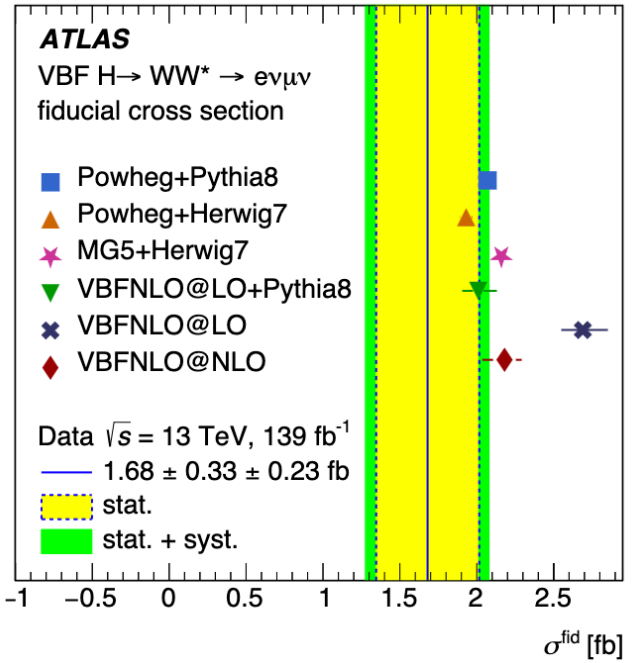
Run 2 Physics (highlights) : Measurement of Higgs boson properties

… After one week of celebrations … focus was put to study the newly discovered boson properties mass, spin, couplings, width, …

This continued in Run 2

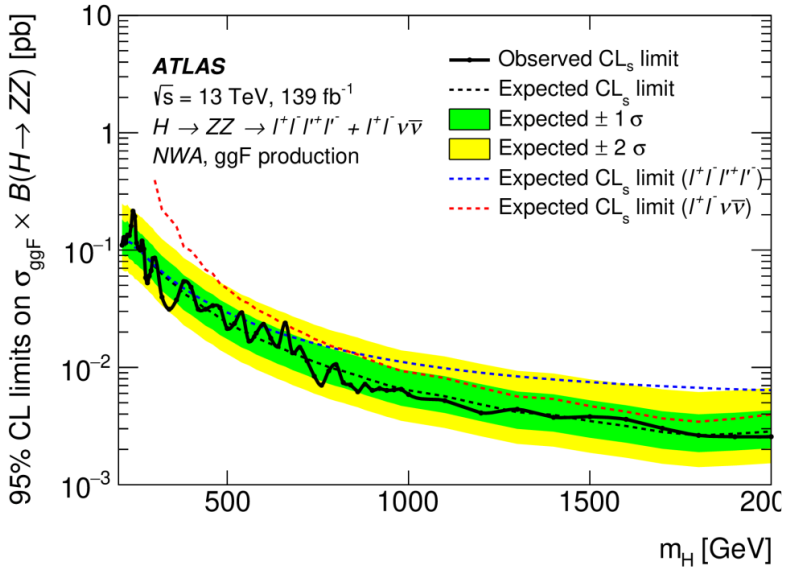




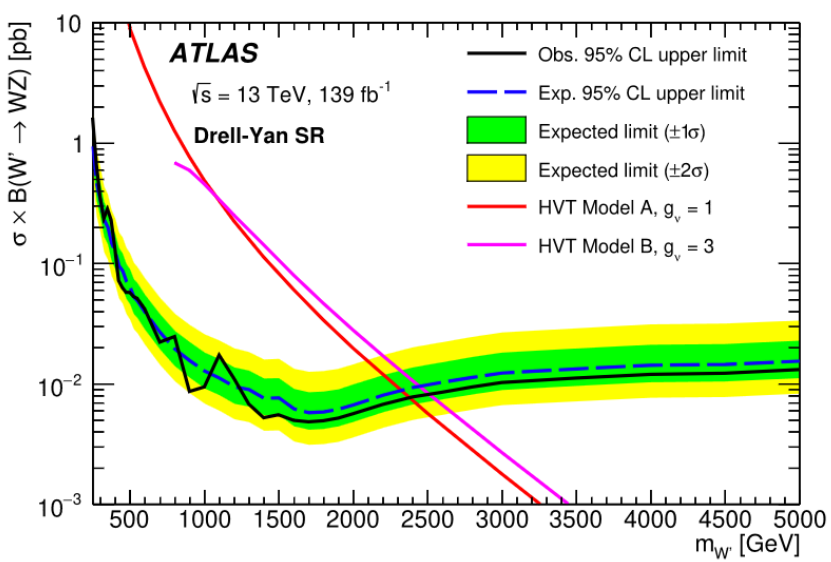


Run 2 Physics (highlights): Direct Searches

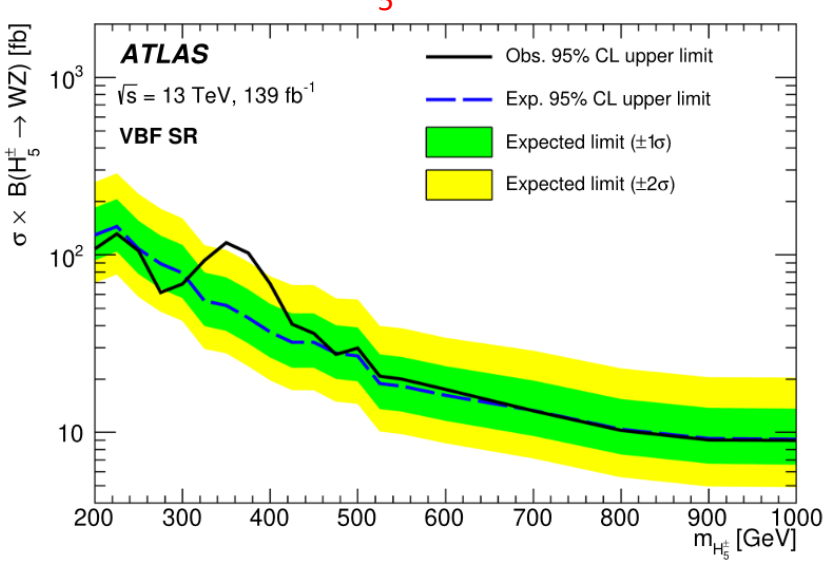
Heavy H→ZZ



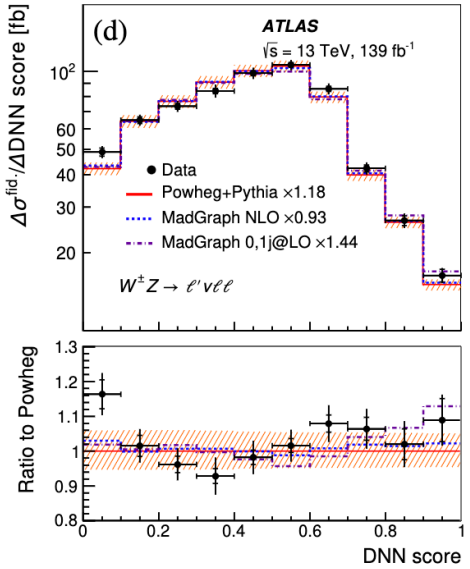
W' → WZ

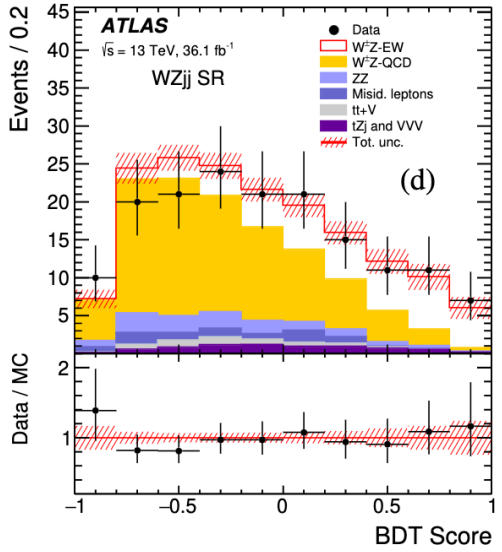


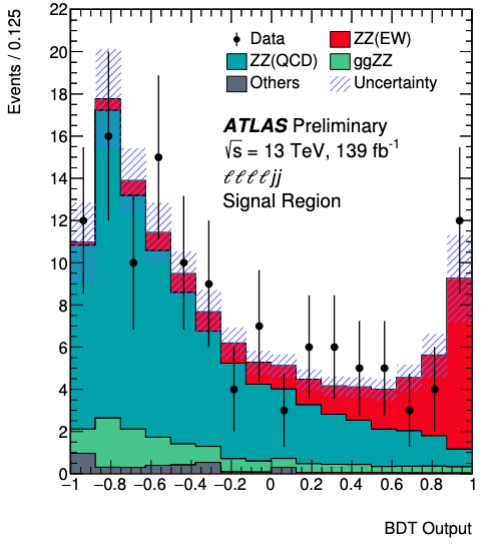
$H_5^{\pm}$ →WZ



Run 2 Physics (highlights): Precision measurements

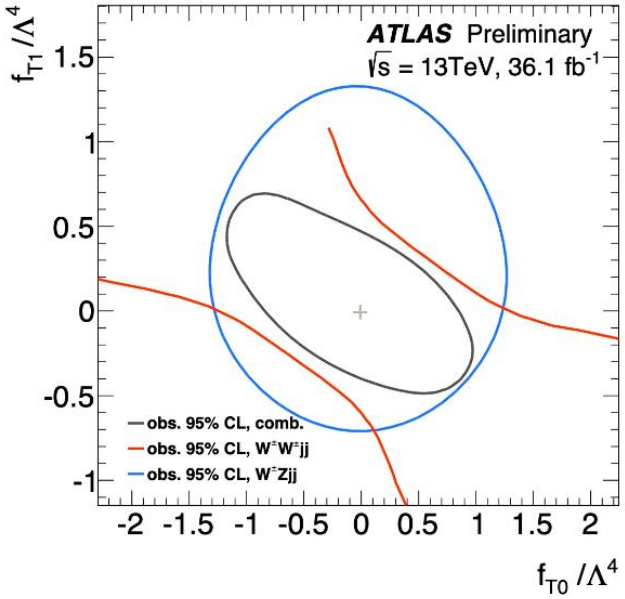






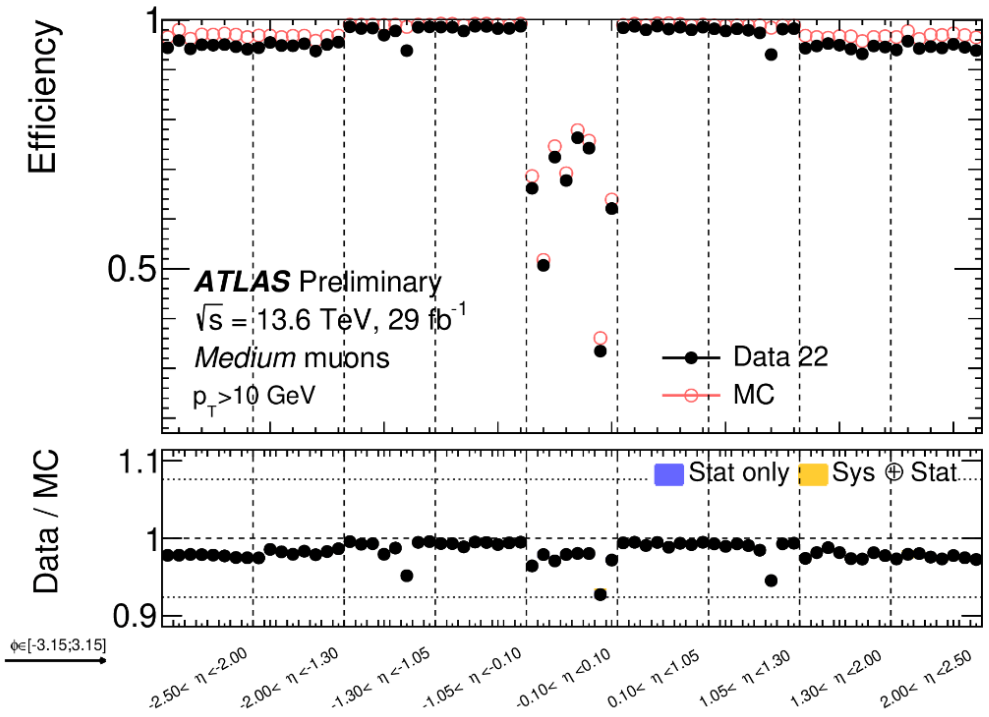
- The presence of a W boson and a Z boson with a simultaneous longitudinal polarization observed with significance of **7.1 standard deviations**
- EWK production of W± Z bosons in association with two jets is measured with observed significance of **5.3 standard deviations**
- EWK production of ZZ bosons in association with two jets is measured with observed significance of **5.5 standard deviations**

Interpretation in terms of NP

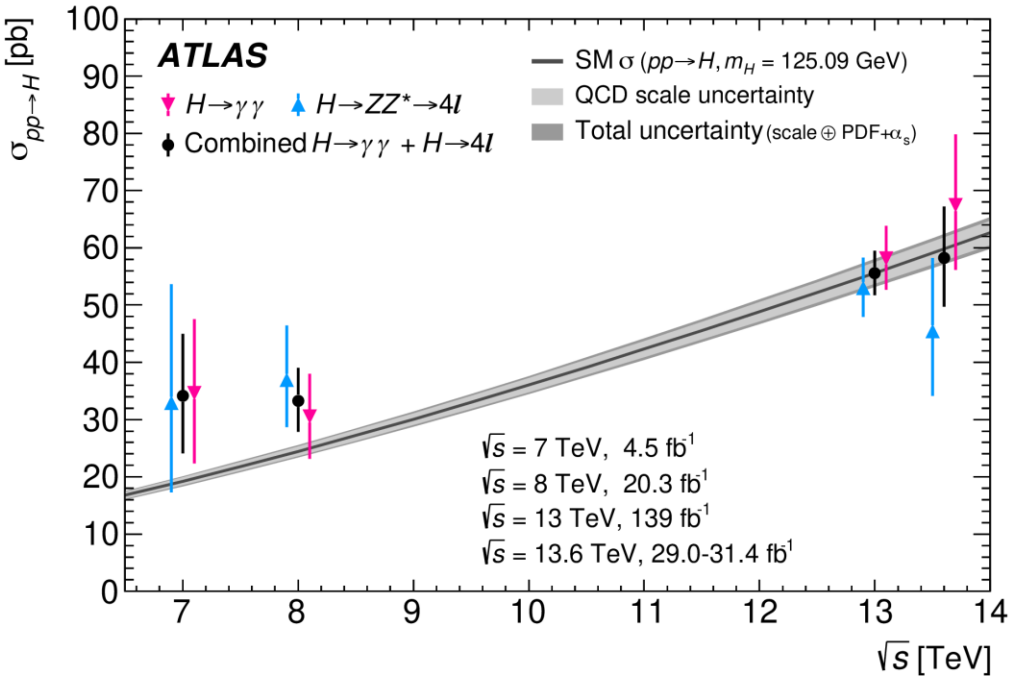


Run 3 Physics (highlights):

Muon efficiency measurements
& identification quality studies

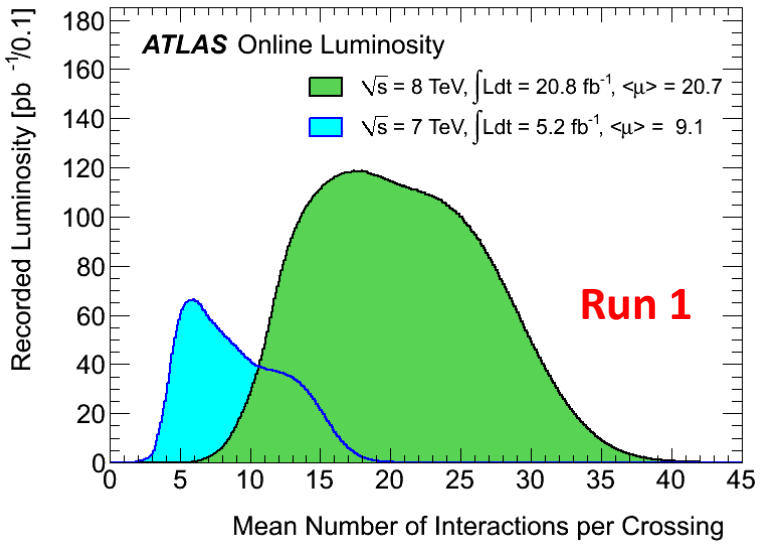


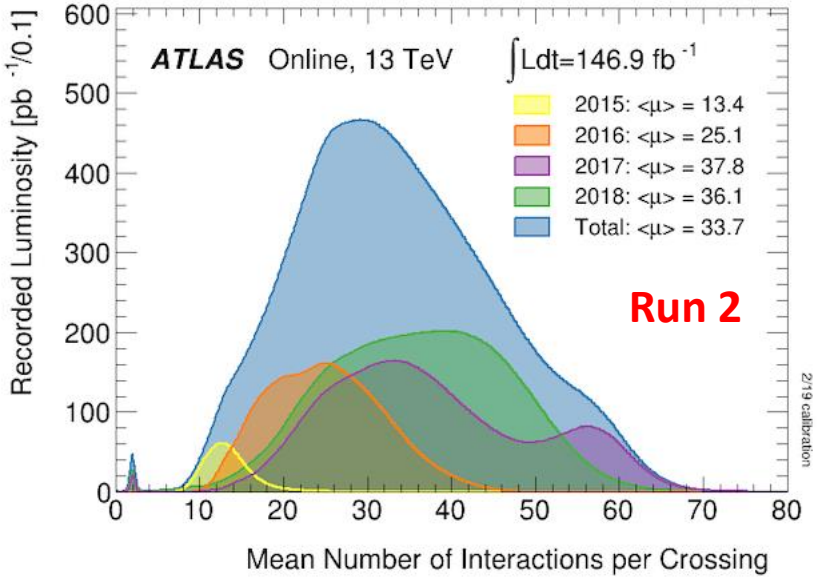
Measurement of the Higgs-boson
cross-section @ 13.6 TeV

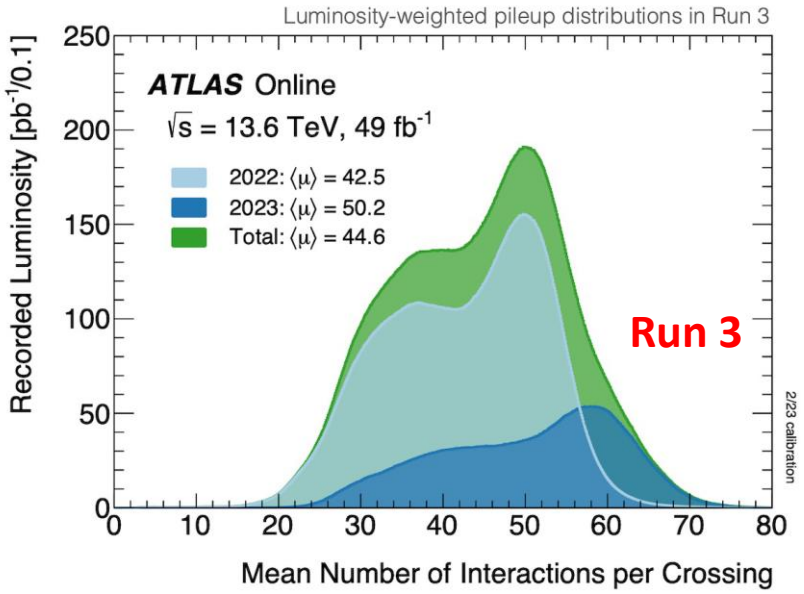


Several other analyses are in progress

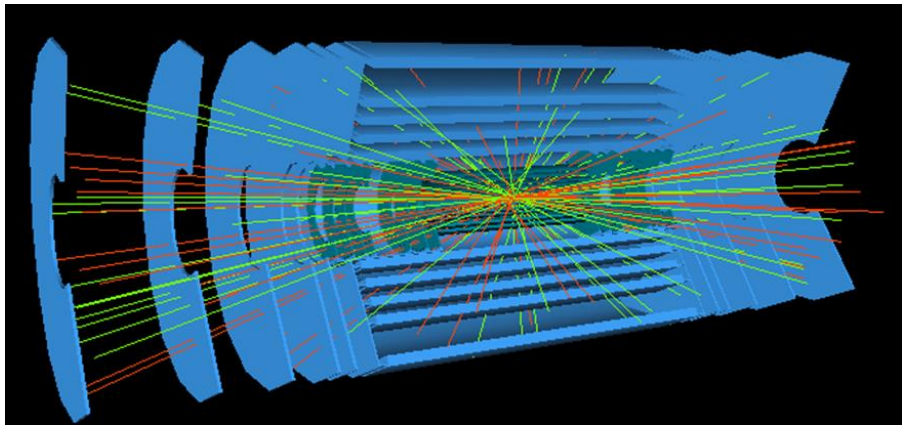
… moving from Run 1 ATLAS detector towards ATLAS at HL-LHC

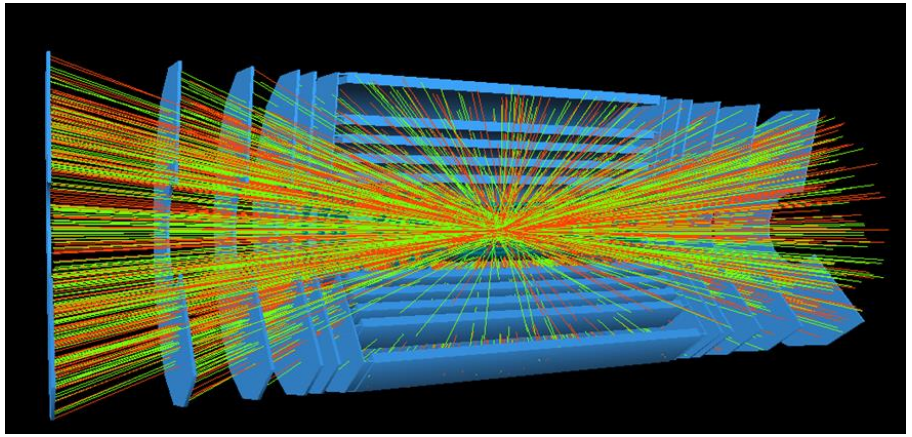






Run 1 …… Run 2 …… Run 3 …… HL-LHC



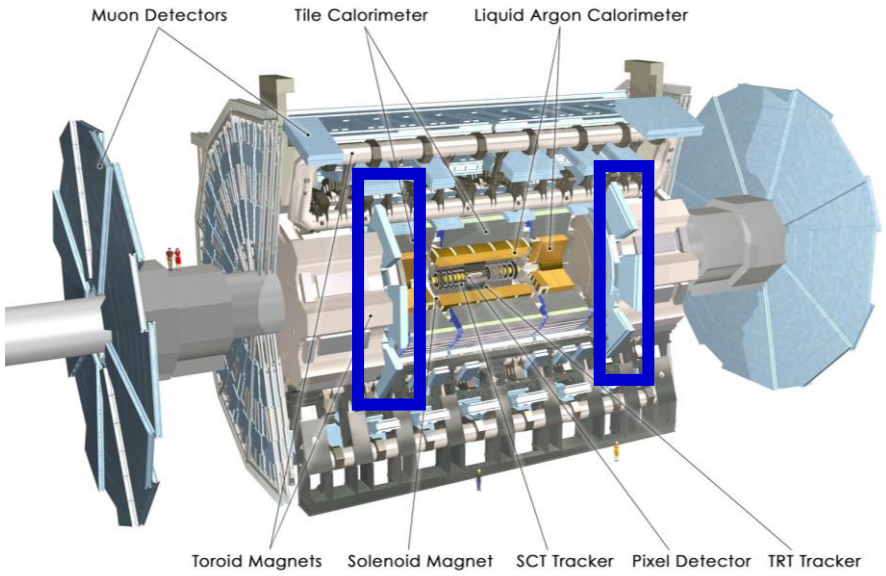


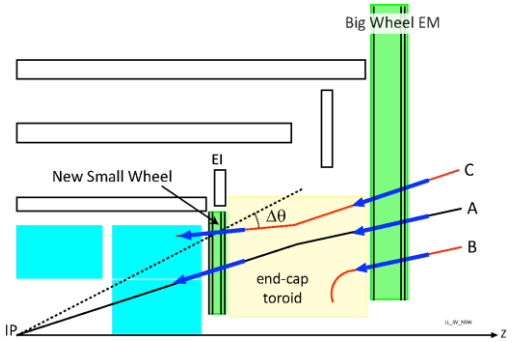
Detector upgrades Phase 1 – NSW

NSW

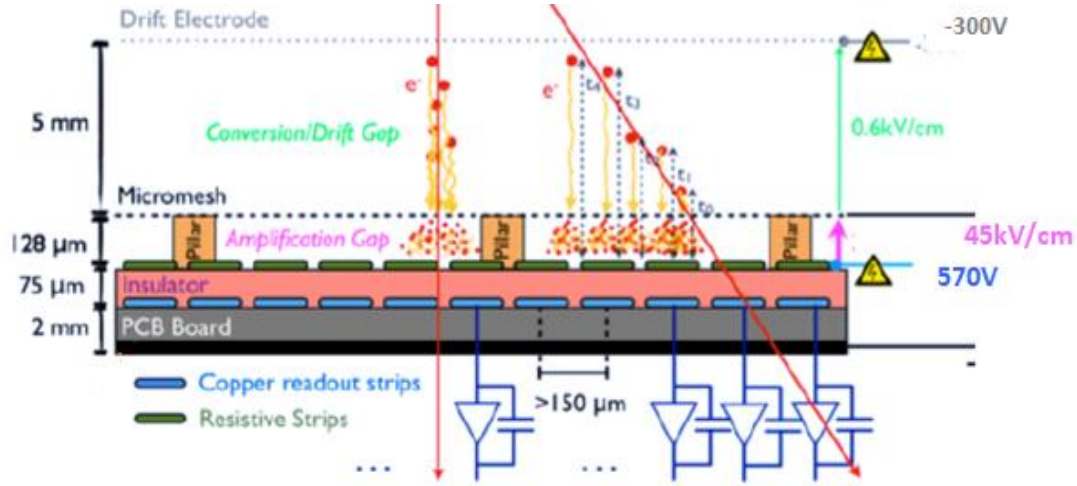
Operation up to 15 kHz/cm^2

- Reduce substantially single muon trigger fake rate
- Maintain excellent efficiency and resolution of tracking at very high rates
- 16 active layers → redundancy for tracking and pattern recognition

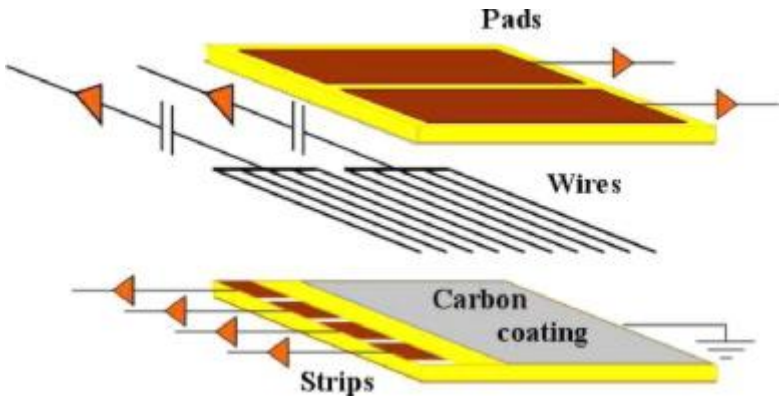




Micromegas



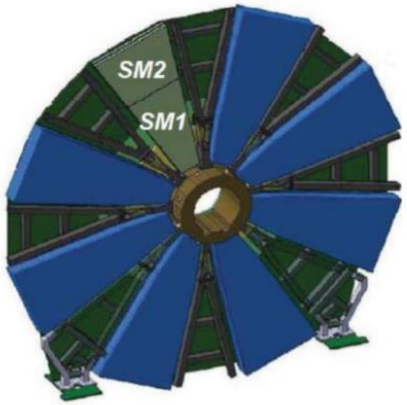
sTGC



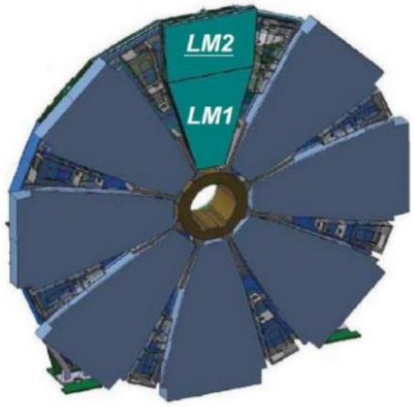
1 mrad + 100 µm (single hit) resolution needed

~2.5 M read-out channels

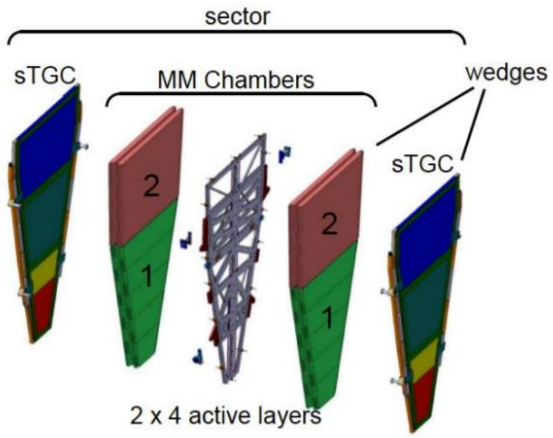
NSW



Small sectors



Large sectors



2013 TDR

2017 Construction Start

Dec 2018 MM+sTGC integration

Dec 2019 First sector Installation on JD

Aug 2021 Side A wheel completion

Oct 2021 Side C wheel completion

Taking Data

NSW Contribution

The Greek teams played a major role in several aspects of NSW upgrate:

- **MM R&D program (started in 2008, continues up to now)**
- **MM Construction**
- **MM Integration and Commissioning**
- **sTGC Integration and Commissioning**
- **NSW Integration and Commissioning**
- **NSW Trigger Commissioning**
- **Design RO Electronics**
- **NSW installation in P1**
- **Validating NSW in the pit**
- **NSW incorporation in software and performance studies**

- Electronics cards designed, fabricate assembled and tested by the Greek institutes and Greek industry.
- NSW services and Micromegas Services design.
- Design of the NSW micromegas gas system.
- Design of the NSW Detector Control System (DCS).
- Gas leak validation of the micromegas modules and sectors
- Micromegas integration in BB5
- Micromegas Commissioning in Bat191

NSW involved personnel from Greek institutes

NTUA
NSW integrations & Commisioning
T. Alexopoulos
E.Gazis
S.Maltezos
K. Iakovidis
N. Agapiou
G. Athanasiadis
C. Bakalis
A. Vgenopoulos
C. Kitsaki
I. Fragkos
A. Giokaris
P. Gkountoumis
N. Karagianopoulos
E. Karentzos
E. Koulouris
C. Kourkoutis
E. Lampardaki
P. Lopez Macia
M. Natsios
C. Paraskevopoulos
M. Perganti
P. Tzanis
S. Tzanos
G. Statharas
K. Patrinos
Y. Drivas-Koulouris

AUTH
LM2 Construction Team :
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C. Lampoudis,
S. Kompogiannis,
I. Manthos,
I. Maniatis,
I. Karkanias,
T. Koutsosimos,
M.Tsopoulou,
L.Didi,
A.Kallitsopoulou,
P.Paschalias,
I.Maznas,
I.Kalaitzidou,
T.Argysis,
C.Petridou
S.Tzamarias
K.Kordas

NKUA
NSW Wedge Integration and Micromegas commissioning :
D. Fassouliotis,
C.Kourkoumelis
I.Gkialas,
S. Angelidakis,
L. Fountas,
P. Bellos,
V. Lefkovits

Demokritos
sTGC Wedge Integration Team:
T.Geralis,
O. Zormpa,
M. Prapa,
K. Damanakis,
Y. Kiskiras,
A. Kerezis,
I. Alexopoulos,

UNIWA (Technical Associate Institute)
NSW Micromegas Integration and commissioning :
S. Kyriakis-Bitzaros
K. Zachariadou
I.Mesolongitis
F. Kolitsi
N. Stouras,
G. Stamoulos,
N. Politis
D. Bita

Most of the names listed here were young PhD, MSc or undergraduate students

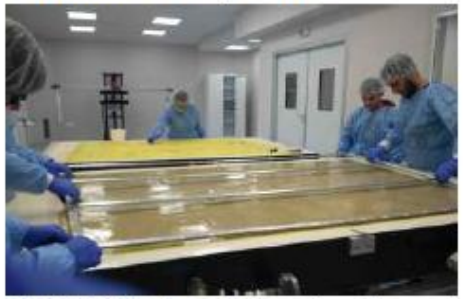
NSW: Drift panel LM2 production at AUTh - Precision

MM LM2 Production: Thessaloniki, Dubna and CERN
Thessaloniki: Delivery of 96+spares Drift panels equipped with mesh,
Dubna: 64 RO panels and chambers assembly.

- New Laboratory for detector construction established (360 m^2) based in the Center of Interdisciplinary Research and Innovation of AUTH
- New Clean Room (145 m^2), 2 preparation rooms, a small workshop
- Site was reviewed (May 2017), Production Readiness Review (June 2017)
- QA/QC Procedure : All parts (bars, honeycomb) for the panel were checked.
- Panel QA measurements: Planarity, thickness, Gas tightness, Mesh tension

All Drift panels have shipped to Dubna (Russia) where the LM2 modules were assembled.


Site Review May 2017

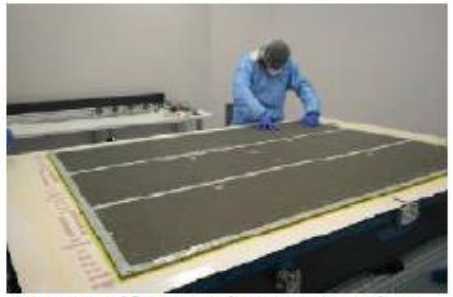

LM2 Drift Panel Construction


Drift Panel Cleaning


Drift Panel QA measurements


Mesh Stretching


Drift Panel equipped with Mesh


LM2 Drift Panel Construction


Drift Panel Cleaning


The Team,

NSW: Electronics Design at NTUA

L1DDC roadmap

512 sTGC, 512 MM L1DDC,
32 rim-L1DDC boards
512 LVDB installed in the NSW
2 x Rim-L1DDC prototypes
4 x MM-L1DDC prototypes
5 x sTGC-L1DDC prototypes
3 x reviews


MM prototype-2 (5 boards)


sTGC prototype-2 (5 boards)


MM prototype-3 (5 boards)


RIM prototype-2 (4 boards)


Prototype-1 (5 boards)


RIM prototype-1 (3 boards)


sTGC prototype-3 (5 boards)

09/2014 02/2015 01/2017 09/2017 10/2017 3/2018 09/2018 10/2018 10/2018 1/2019 03/2019 04/2019

Technical Design Review

Final Design Review

MM Production Readiness Review

MM Production 522 boards

sTGC/RIM Production Readiness Review


Prototype-4 (5 boards)


MM pre-production (50 boards)


sTGC pre-production (50 boards)

NSW: Electronics design cont… and QAQC

sTGC Trigger Repeaters boards

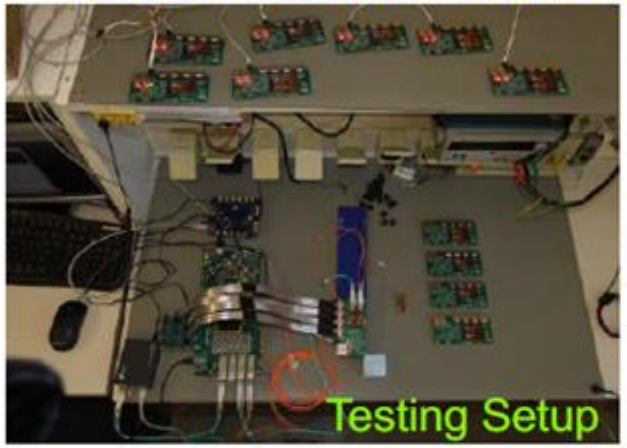
Restoring attenuated trigger signals **Demokritos**

- Repeaters design, construction and testing
- Commissioning and integration on detector
- ***880 Serial* and *150 LVDS repeater boards*** build in collaboration with the **Greek industry**
- Cooling/Faraday cages by Greek industry
- Development of test bench (VC707) – yield 99.5%

Operating in ATLAS since
Jan. 2022 without any problems

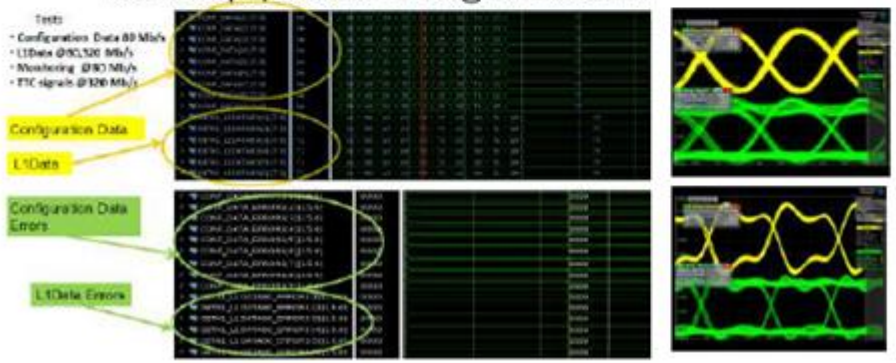
L1DDC Quality Control

NTUA – UNIWA – NKUA – Demokritos



1024 L1DDC cards for Micromegas and sTGC were tested and quality assured in 2019

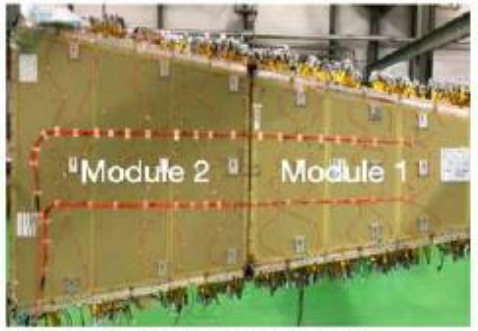
Results for preproduction boards @ ECTLab UNIWA



NSW: Micromegas integration commissioning at BB5 - Complexity

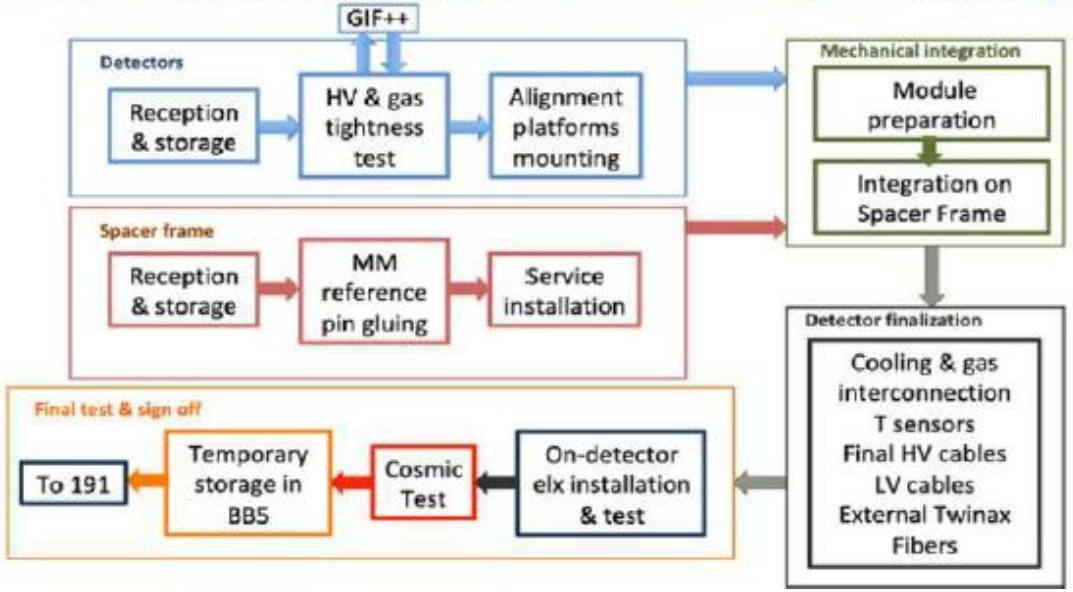
← Integration chambers onto the spacer frame

Cooling interconnections



Optical fibres for alignment system

Install electronics cards

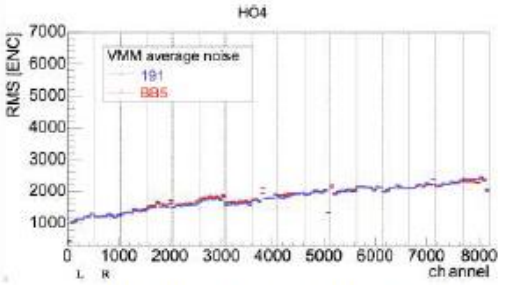


- **Assemble the MM modules into wedges, install services and electronics, validate the performance of the wedge with cosmic rays (@CERN)**
  - Wedge production line : About 20 people occupied daily, distributed to the different tasks
- **Optimised throughput for integration and testing of 1 sector every 10 days**
  - Activity parallelisation and testing automation

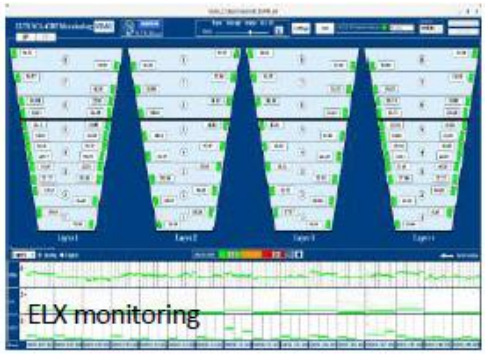
NSW: Micromegas installation – commissioning at b 191 - Accuracy

Micromegas surface commissioning

- Installation, verification of infrastructure
- Definition of commissioning protocol
- Problem identification, solution proposal
- Connections and sectors verification



Example of the RMS of a baseline in ENC for a sector layer (Blue B191, Red BB5)



Pre-installation connections and tests

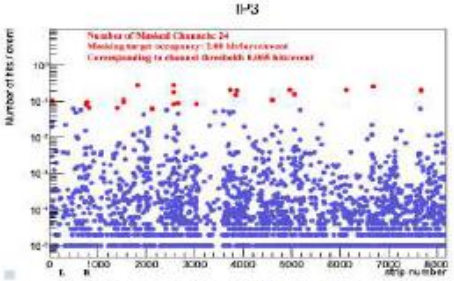
- *On the wheel*
- *On the mm quadruplets*

Post-installation parallel work stream 1

- *Gas flushing*
- *HV connection*
- *HV operation*

Post-installation parallel work stream 2

- *Sensor connections*
- *Temperature reading*
- *Cooling operation*
- *Read out connection*
- *LV operation*
- *Configuration of electronics*
- *DCS monitoring of electronics*



Example of noisy channel mapping

Working in very dense conditions … often w/o visual contact … facing and resolving a variety of challenges

Data taking and sign-off at B 191

- *Baselines - threshold estimation*
- *Pulsing electronics*
- *Dead and Noisy channel mapping*
- *Trigger path validation*

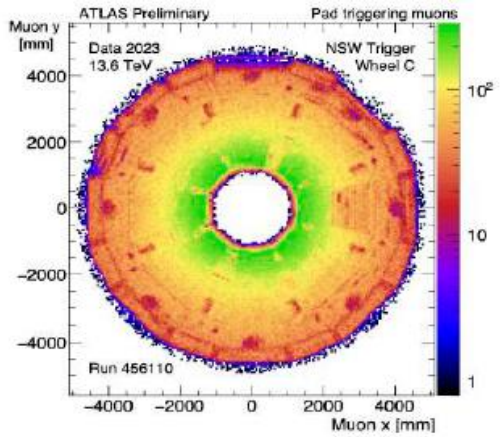
NSW: Trigger

2023: sTGC Pad trigger included
2024: Micromegas trigger included

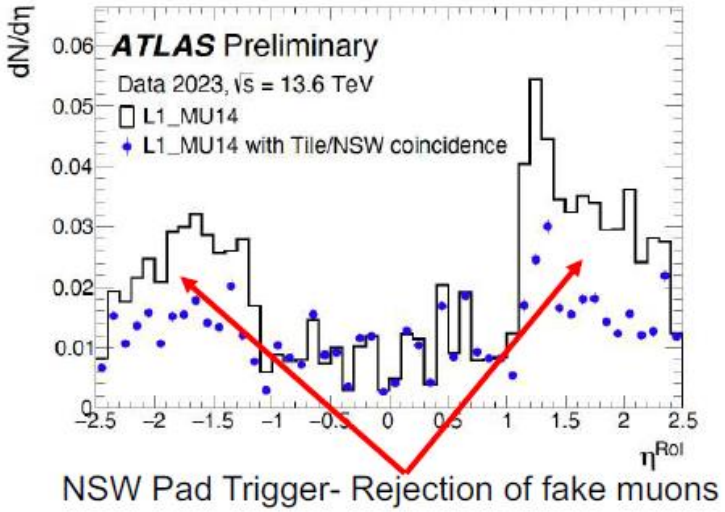
Muon trigger rate decreased by 14 kHz

sTGC Pad Trigger: Demokritos (Coordination), Univ. of West Attica

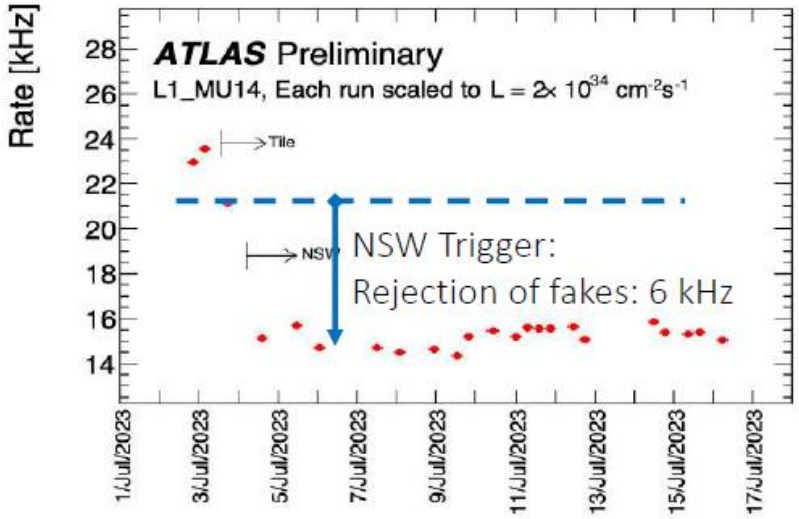
- Commisioning of the sTGC Trigger on all 32 sectors on surface (2020 – 2021) and in P1 after NSW integration to ATLAS (2022)
- Integration of NSW sTGC Trigger in ATLAS
- Successful integration of the NSW Pad Trigger into ATLAS
- 4th of July 2023: NSW in ATLAS trigger ➔ Rejection of 6 kHz fakes
- Allowed low deadtime readout in ATLAS



NSW Pad Trigger Hitmap



NSW Pad Trigger- Rejection of fake muons



Contribution to software, performance and Phase II upgrade

Muon software development

NSW readout geometry, alignment, cabling map
NSW simulation
Multi-Threaded (MT) migration
MT Muon reconstruction & validation
Tracking implementation in ACTS

Muon performance for physics analyses

Phase II upgrade

MS: RPC DCT QAQC
MS: MDT Mezzanine QAQC / production
TDAQ: Trigger Processor Phase II

Summary

The journey of Greek Institutes in ATLAS started in 1994 with the ATLAS technical proposal

Twice it was possible for us to have major contributions to this fascinating and extremely complex detector, with

1) The construction and integration of the **MDT BIS chambers**
2) Several contributions to the **NSW phase I upgrade**

We hope that we have fairly contributed to exploit the potential of the detector and helped in extracting significant physics results with the highlight up to now, being **the discovery of the Higgs boson**

Despite the very limited funding, we hope that we'll be able to fulfill in a similar way our commitments to the collaboration in the very interesting years to come

We have achieved a very successful collaboration with Greek industry and made the liaison towards technology transfer from CERN

We would like also to invite warmly students and young researchers to join us, since there is no better place than ATLAS to learn deeply about science and technology

We would like to thank warmly ATLAS and MUON management for their support and all our ATLAS colleagues for the fruitful collaboration

Special thanks to

Peter Jenni for his catalytic role in the formation of Greek ATLAS

M. Dris, M. Floratos, G. Antonopoulos, M. Zamani, M. Dermitzakis, I. Drakopoulos, A. Andreopoulos, S. Simopoulos, A. Boutouvis

Back up Slides

Responsibilities - Coordination positions

- Outreach Coordinator (*C. Kourkoumelis 2012 - 2014*)
- Muon Speakers Committee Member (*C. Kourkoumelis 2015 - 2021*)
- MM (NSW) surface commissioning (D. Fassouliotis 2019 - 2020)
- Muon Detector Performance Group sub-Coordinator for the integration of the NSW geometry and alignment (*S. Angelidakis 2021 - today*)
- Co-convener of the Efficiency subgroup of ATLAS MCP (*S. Angelidakis 2022-2023*)
- Co-convener of the ATLAS MCP (*S. Angelidakis 2023 - today*)
- ATLAS Muon Software Coordinator (*G. Stavropoulos 2021 - today*)
- ATLAS Muon Steering group (*G. Stavropoulos 2021 - today*)
- NSW Trigger Coordinator (*T. Geralis 2021 - today*)
- NSW Electronics Steering group (*T. Geralis 2017 - today*)
- Vertical Slice Laboratory responsible (*T. Geralis 2022 - today*)
- Speakers Committee Member (*K. Kordas 2020 - 2022*)
- SCAB Member (*C. Petridou 2019 - 2021*)
- International Computing Board Member (*D. Sampsonidis, 2012 - today*)
- Collaboration Advisor Group Member (*C. Kourkoumelis 2006 - 2010*)
- B-Physics Convener (*C. Petridou 2008 - 2010*)
- PubCom Member (*C. Petridou 2008 - 2010*)

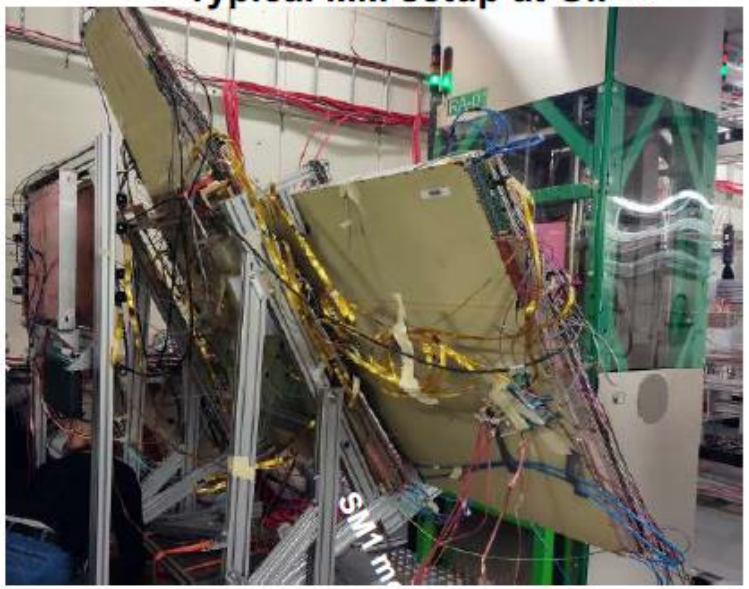
- National Contact Physicist (*D. Samsonidis, 2023 - today*)
- National Contact Physicist (*E. Gazis, 2005 - 2023*)
- Upgrade Advisory Board Member (*D. Samsonidis, 2023 - today*)
- Upgrade Advisory Board Member (*E. Gazis, 2015 - 2023*)

- NSW Electronics Steering (*T. Alexopoulos 2017 - 2023*)
- Muon DCS coordinator (*T. Alexopoulos 2016 - 2019*)
- Muon DCS coordinator (*C. Paraskevopoulos 2022 - today*)
- NSW DCS coordinator (*T. Alexopoulos 2016 - 2020*)
- NSW DCS coordinator (*P. Tzanis 2021 - 2022*)
- NSW commissioning coordination (*E. Koulouris 2019-2022*)
- Micromegas integration co-coordinator (*T. Alexopoulos 2015 - 2022*)
- Micromegas Analysis co-coordinator (*T. Alexopoulos 2016 - 2019*)
- Micromegas represetative in Muon SG (*T. Alexopoulos 2022 - today*)
- Micromegas testbeam co-coordinator (*T. Alexopoulos 2015 - 2019*)
- NSW services coordinator in commission (*K. Iakovidis 2019 - 2022*)
- NSW Steering group (*T. Alexopoulos 2017 - 2023*)

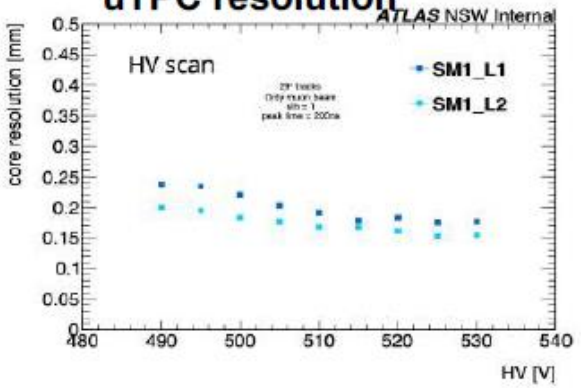
NSW: Micromegas R&D (started well before TDR - continues up to now)

- Long R&D program (under ATLAS experiment) on micromegas technology **started in 2008** extending **up to date**.
- Greek participation from the beginning at the level of co-coordination (T. Alexopoulos, NTUA) and analyzing data from the various testbeam periods, in average three periods per year.
- Long irradiation periods at GIF++ facility of spare NSW-ATLAS micromegas modules for longevity studies.
- Performance studies of micromegas using muon beam in a high gamma radiation enviroment.
- Several years of HL-LHC equivalent have been accumulated so far for all the types of sectors (>20y for LM2); no general “decease” in performance was observed.
- The results of this detector R&D program have been documented in six PhD thesis and in more than 60 journal papers.

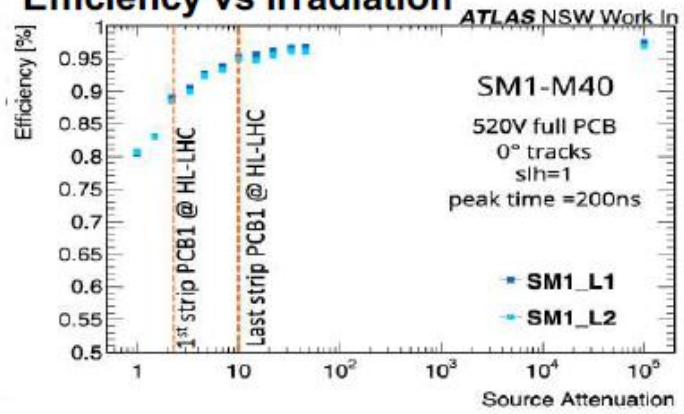
Typical MM setup at GIF++



uTPC resolution



Efficiency vs irradiation



Type of cards used in NSW designed fabricated by NTUA

sTGC-L1DDC prototype-II

sTGC-L1DDC prototype-III

sTGC-L1DDC prototype-IV

sTGC-L1DDC pre-production

mu2e prototype-I

mu2e prototype-II

BBALA

Rim-L1DDC prototype-I

Rim-L1DDC prototype-II

L1DDC prototype-I

GPVMM

Twinax tester

ESD tester

miniSAS FMC

miniSAS to SMA

MDT 436

MDT 446

MMFE1

MMFE1 WB

BBAA

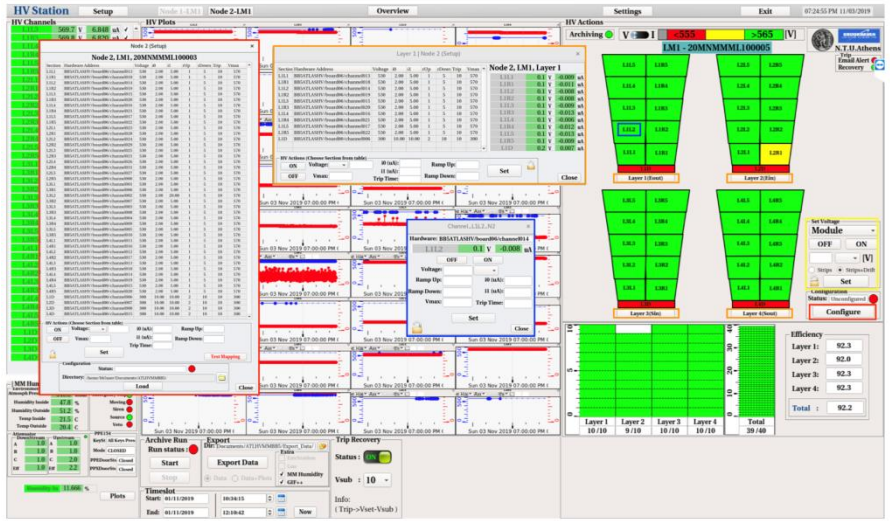
LVDB prototype-2

MM-L1DDC prototype-II

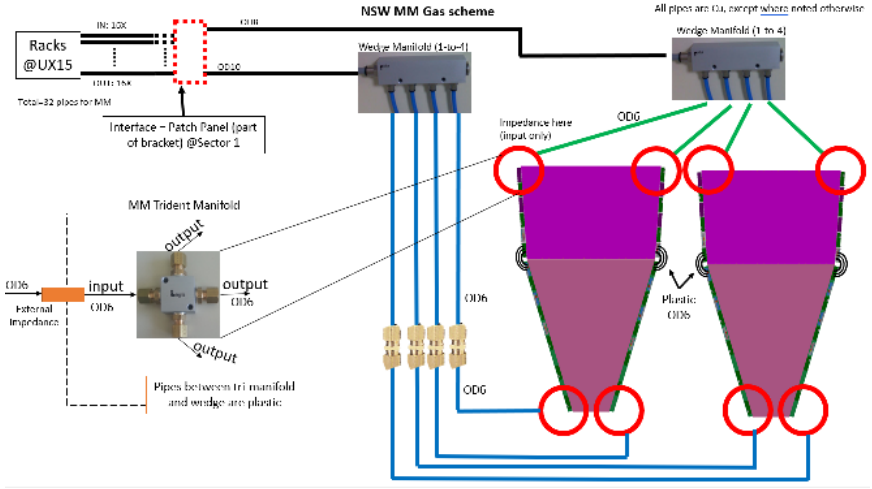
MM-L1DDC prototype-III

MM-L1DDC pre-production

NSW: Design and implementation of DCS and MM gas system/gas leak measurement (NTUA)



MM gas system scheme



NSW: sTGC assembly and integration – Vertical Slice





sTGC Trigger Slice system in B180

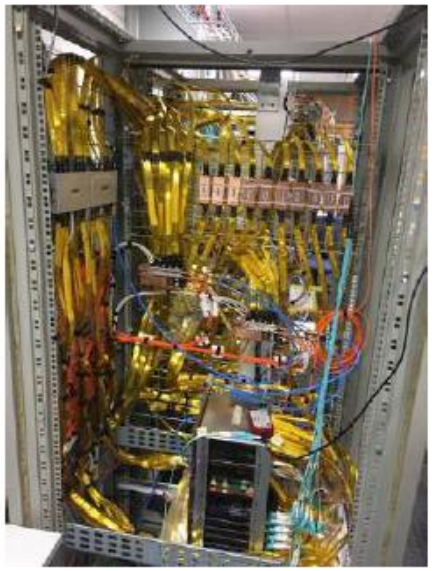
Build by the Demokritos group (Feb. 2020)

Complete autonomous Trigger Slice ➔ 1 Sector wedge

- Complete FE, Trigger (Pad, strips and Trigger processor) and DAQ system.
- Connections as on the ATLAS detector for proper timing
- Proper cooling

Used for NSW Trigger developments remotely.

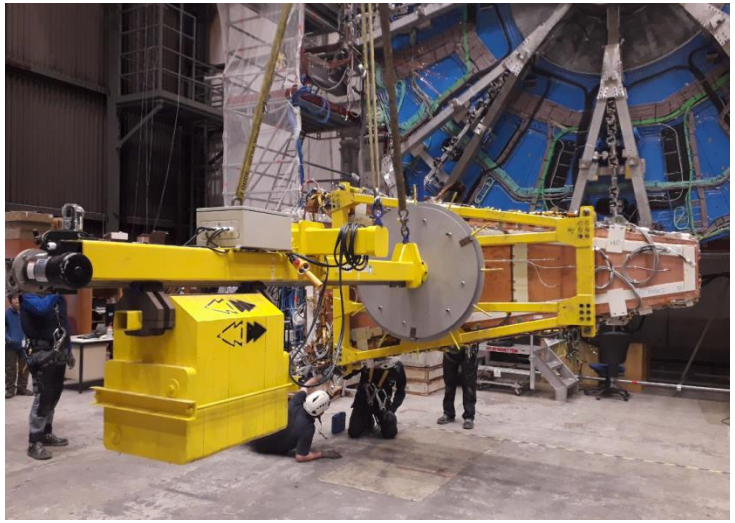
Particularly useful during Covid pandemic

NSW: First sector installation 12/2019

Grabbing of the sector

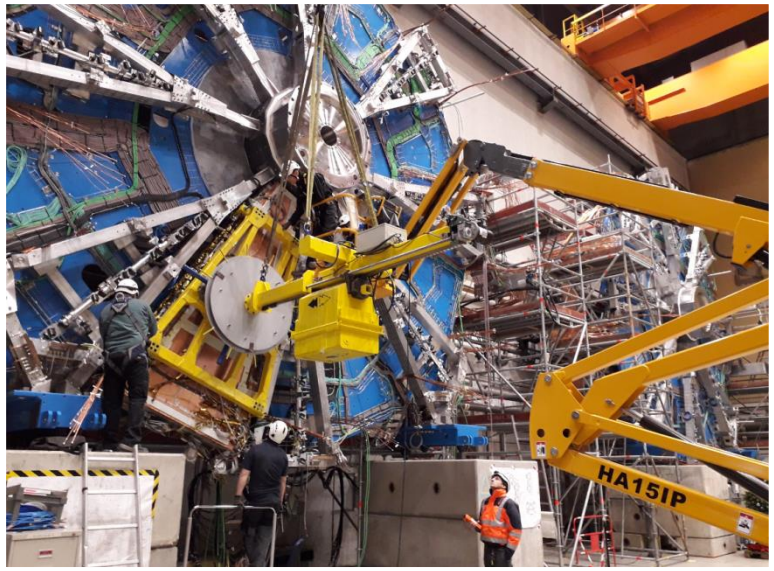
Adjusting center of gravity



Moving towards the wheel

Set orientation to 22.5 deg

Installation Fixation on NSW A



Ready for survey