TRIUMF

New Small Wheel Upgrade of the ATLAS Detector

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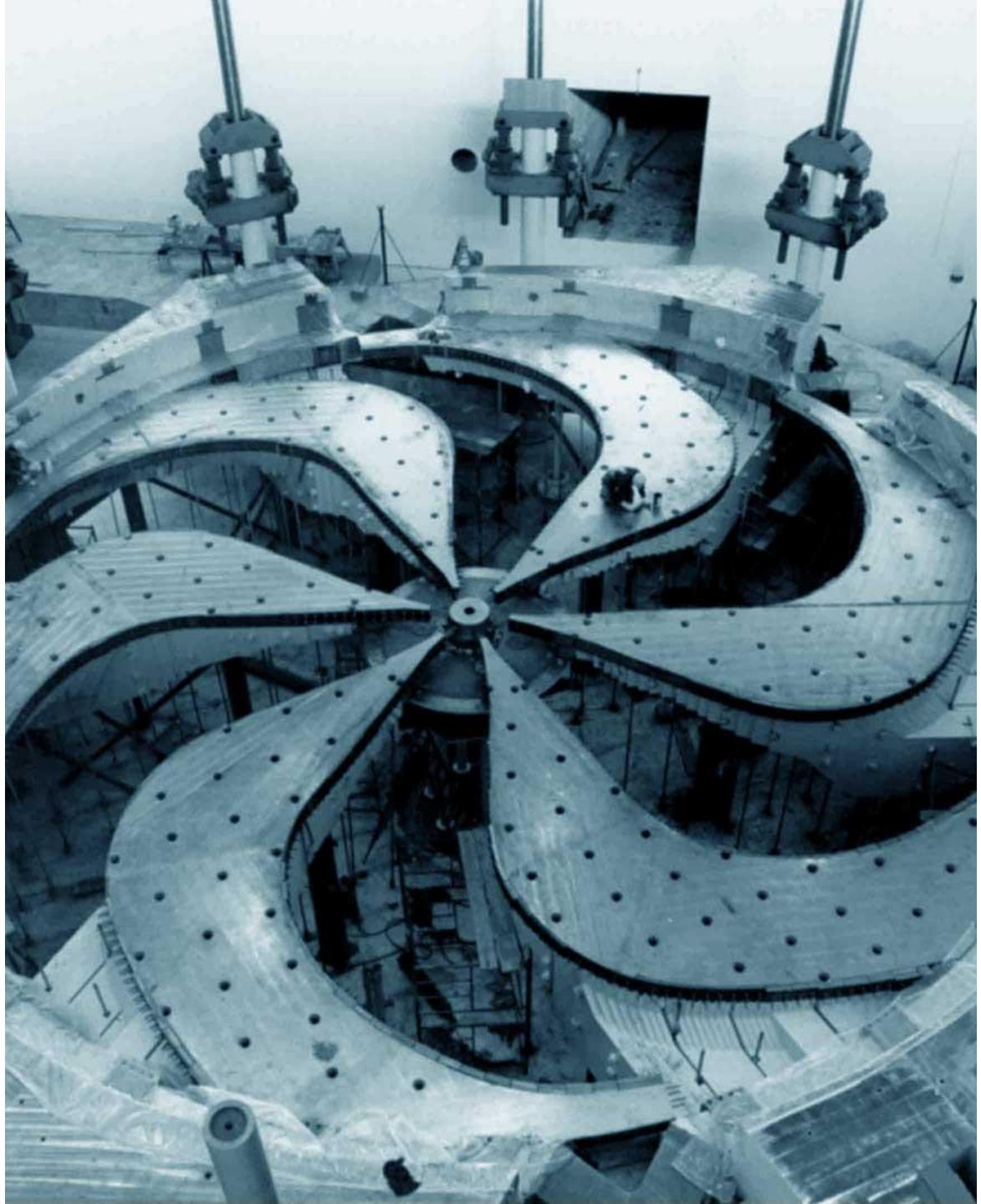
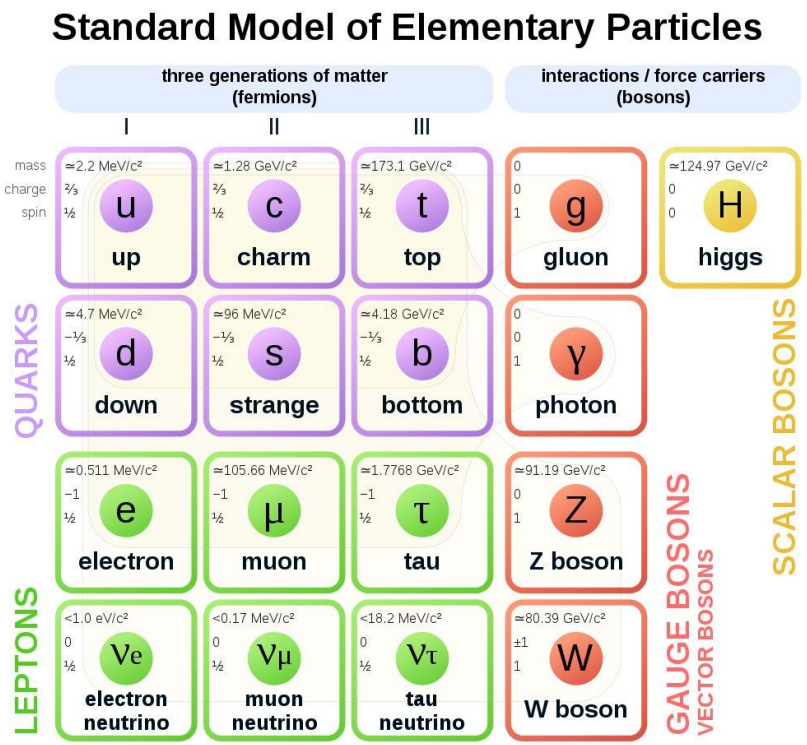
February 15, 2022

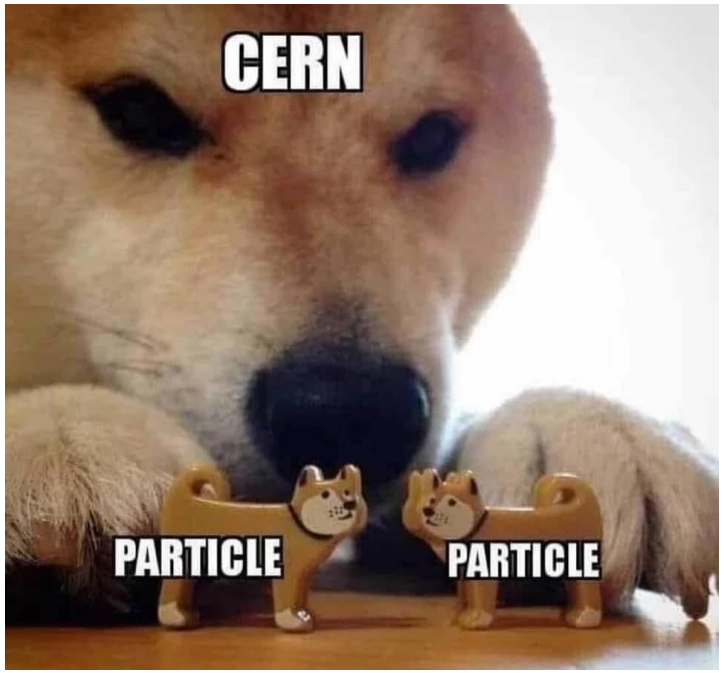


Discovery, accelerated

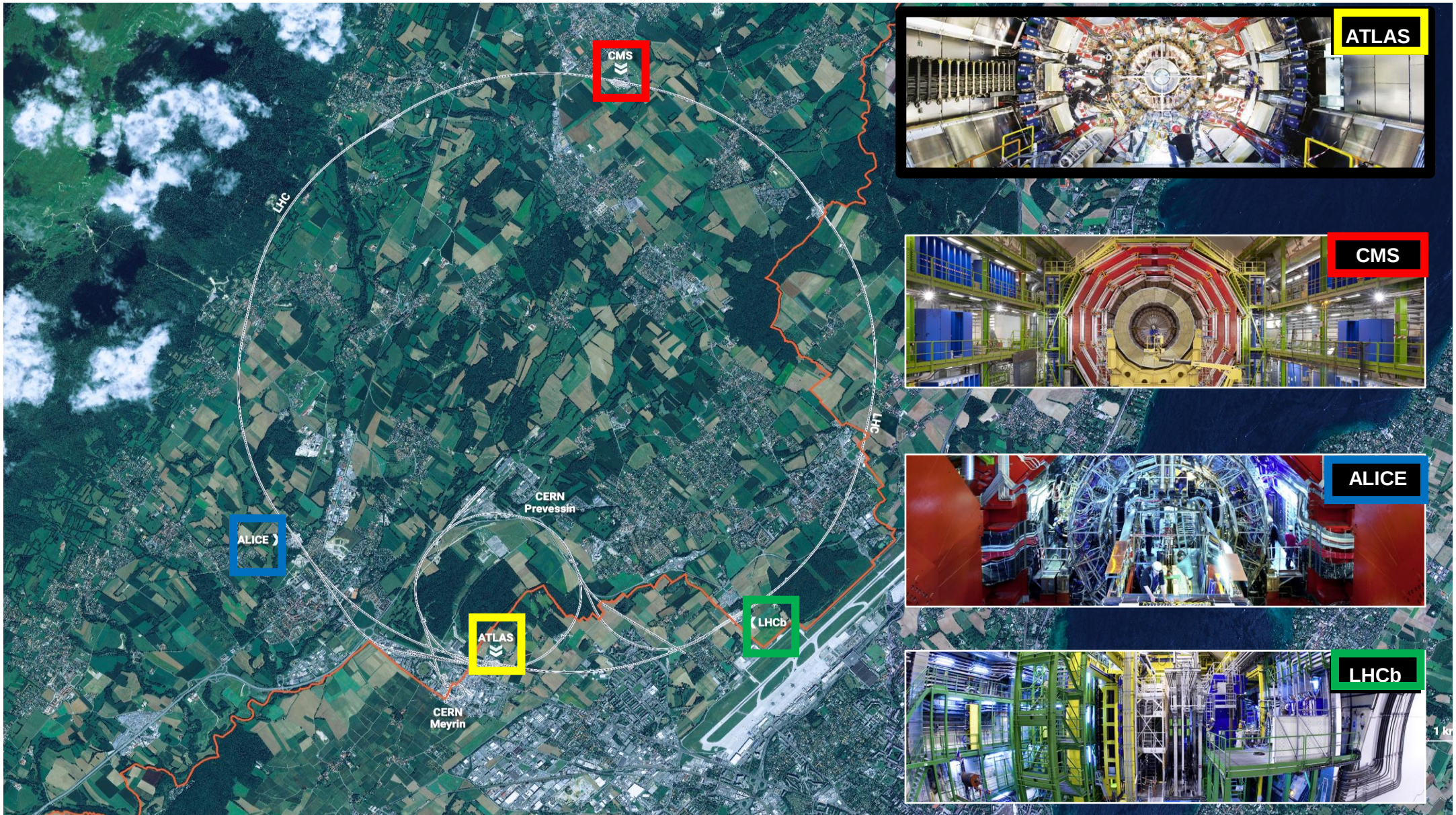
CERN and the Standard Model

- CERN was originally established in 1954 as European Organization for Nuclear Research
- Frontier of high energy physics (HEP) and home to largest particle accelerator in the world
- Has been very successful at describing the Standard Model (SM) through experimentation

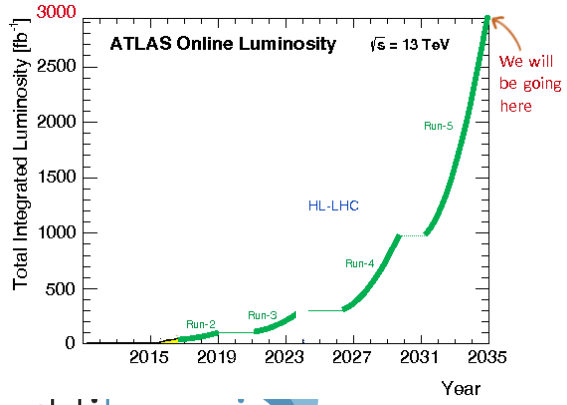




The Large Hadron Collider & its Experiments

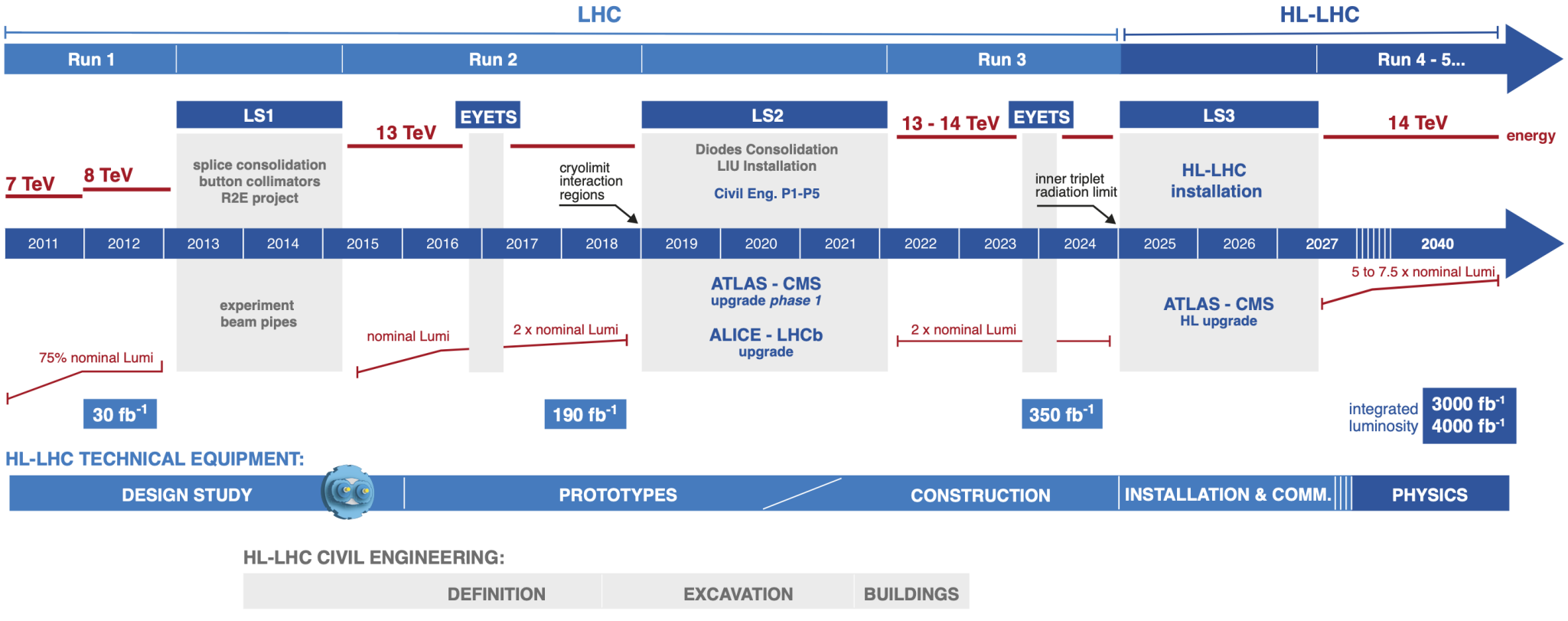


Upgrade to the High Luminosity LHC



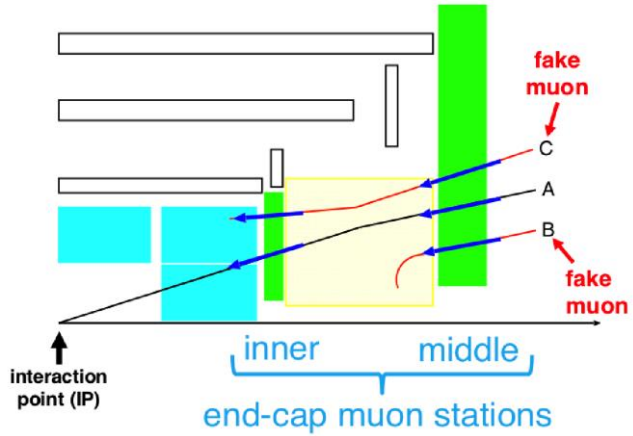
HiLumi LARGE HADRON COLLIDER

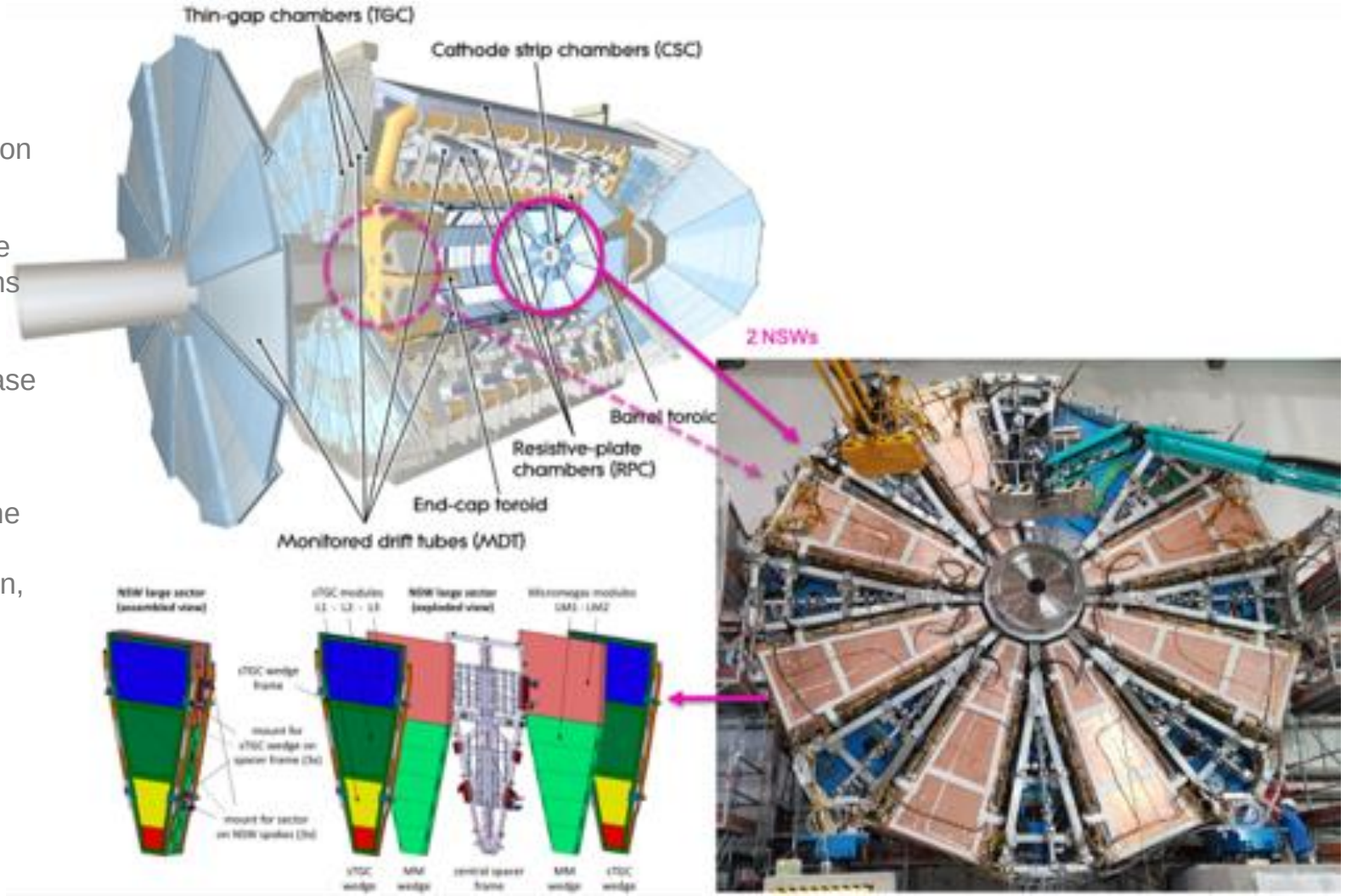
LHC / HL-LHC Plan



What is the New Small Wheel

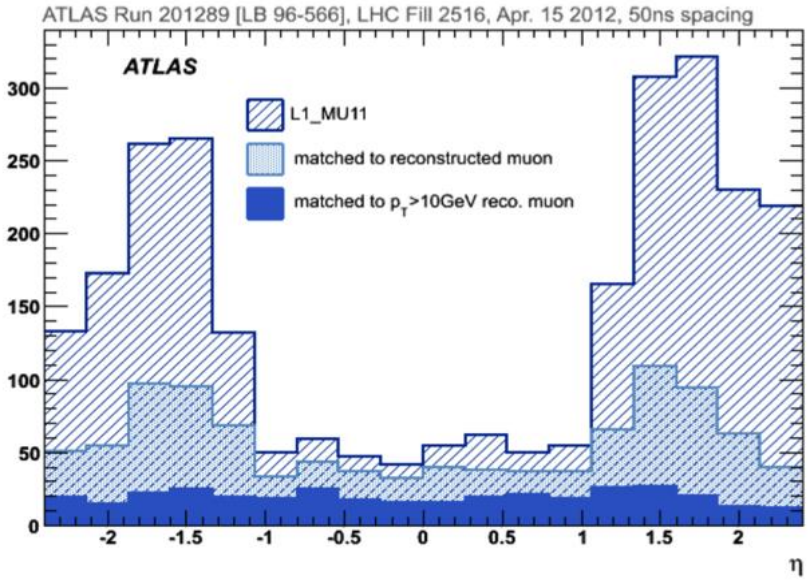
- **Small Wheels:** Innermost station of the muon detection system
- **Fakes:** Currently, 90% of L1 trigger rate due to things which are not muons from collisions
- **High-Luminosity LHC:** Over the next decade the luminosity of the LHC will increase 5-7.5x from $2 \cdot 10^{34}$ $cm^{-2}s^{-1}$ (Run II value) making the fake problem worse.
- **Requirements:** reduce L1 fakes, 95% online muon track reconstruction efficiency, <~100um resolution for offline reconstruction, <1mrad for online matching with Big Wheel



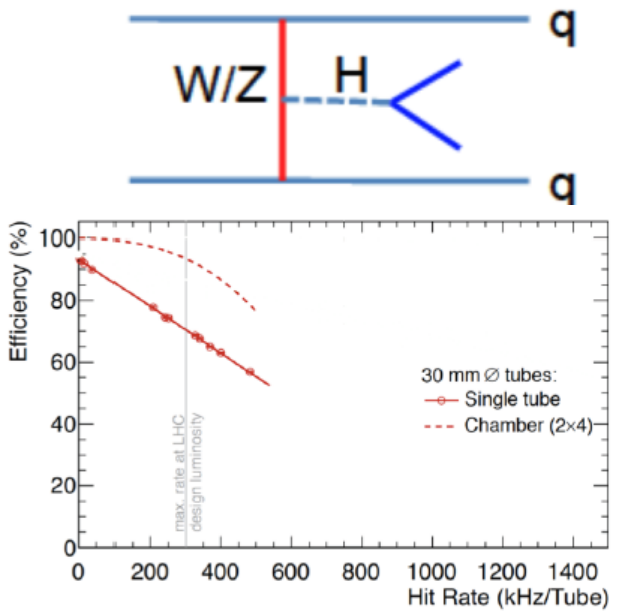


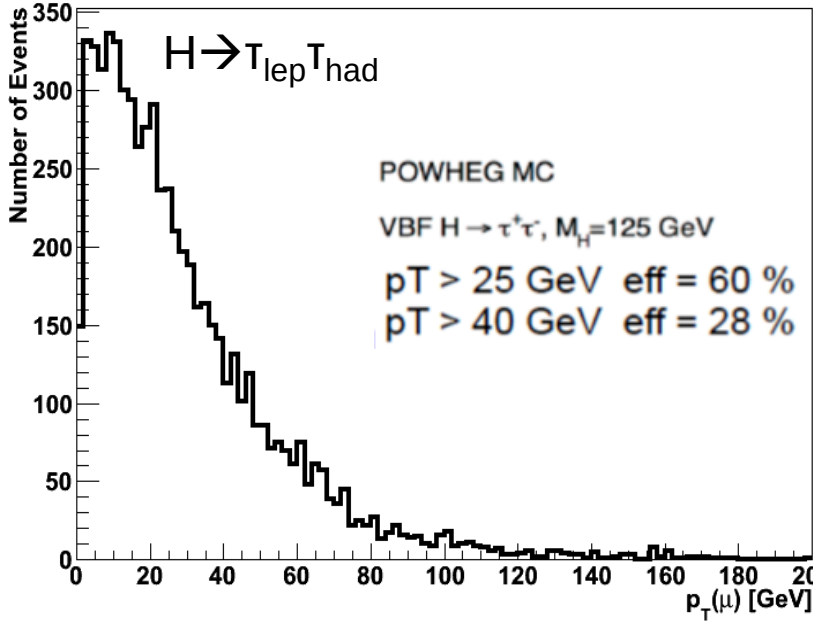
Why can’t we use old SW forever?

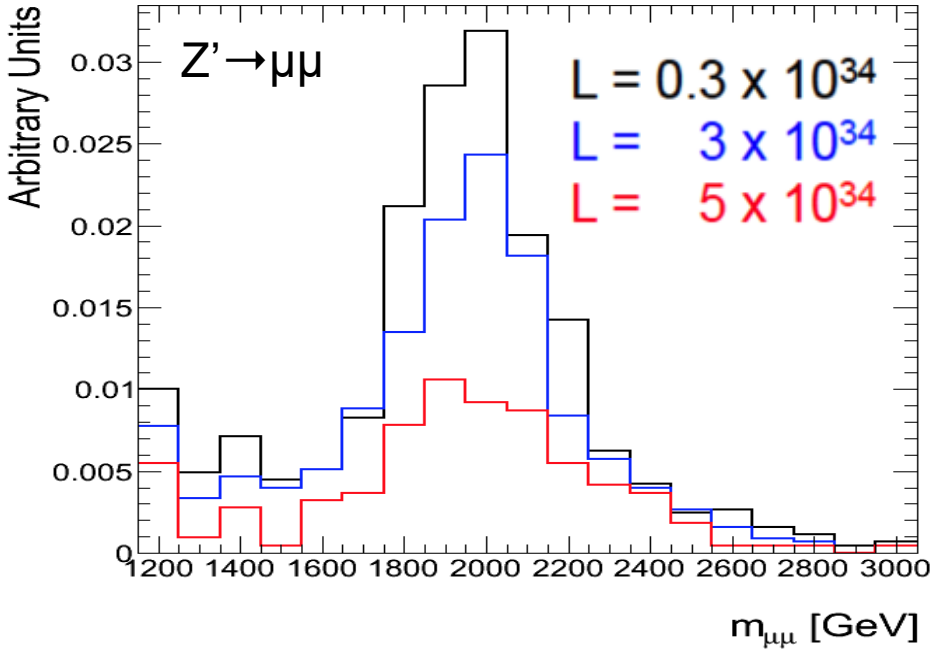
- With old small wheels, increasing the trigger requirements (p_T) of the muon trigger will reduce the fake trigger results
  - Problem: This will also exclude significant physics results as a result
- For HL-LHC the increase in luminosity will increase the number of fakes thus even greater losses to significant physics



Sample of single lepton trigger

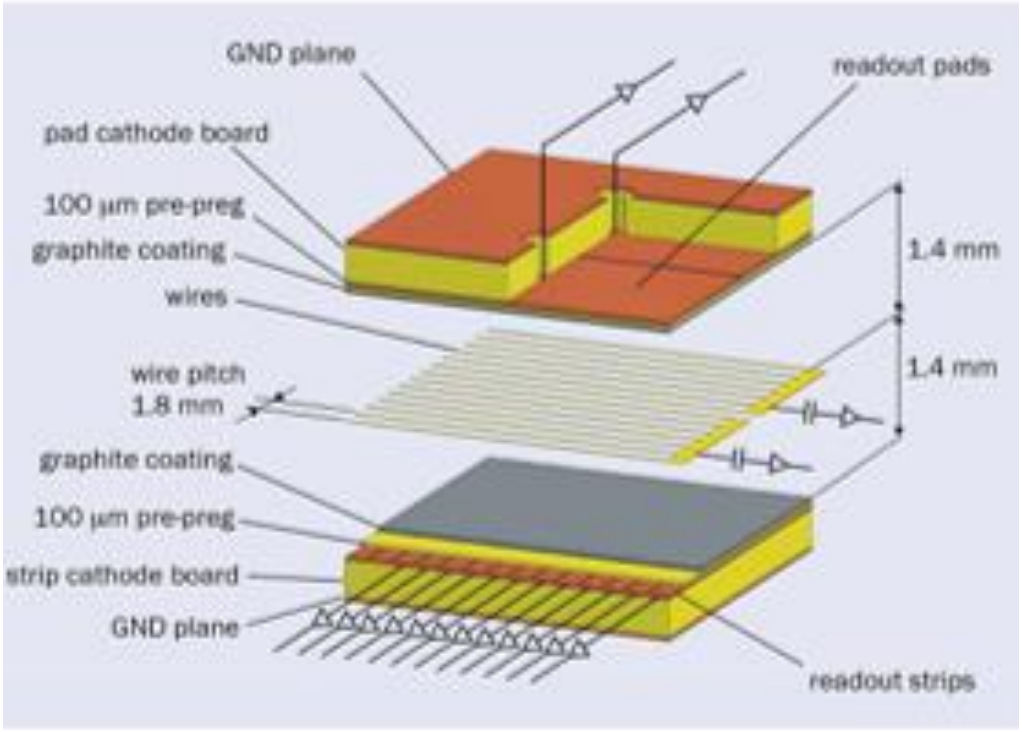


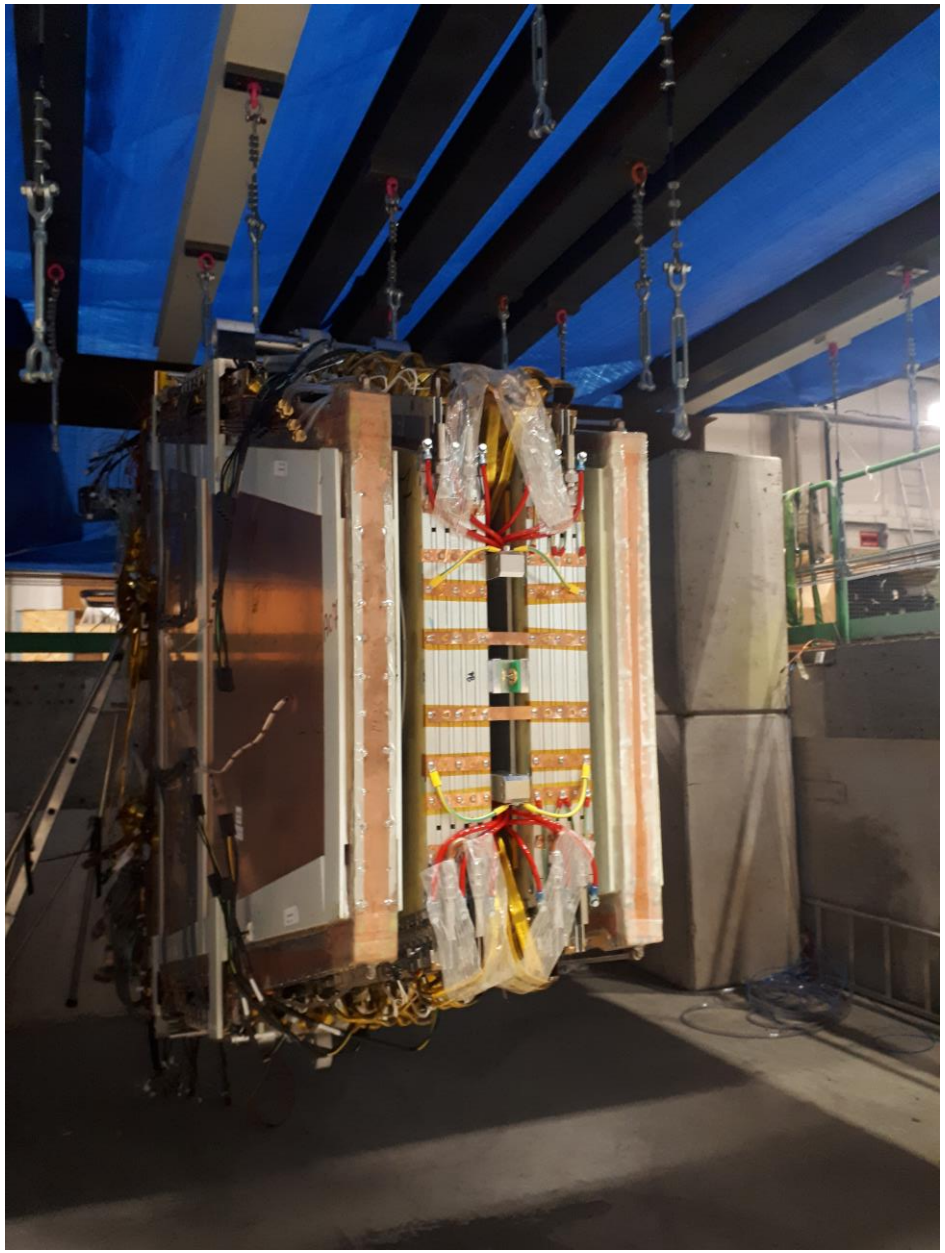




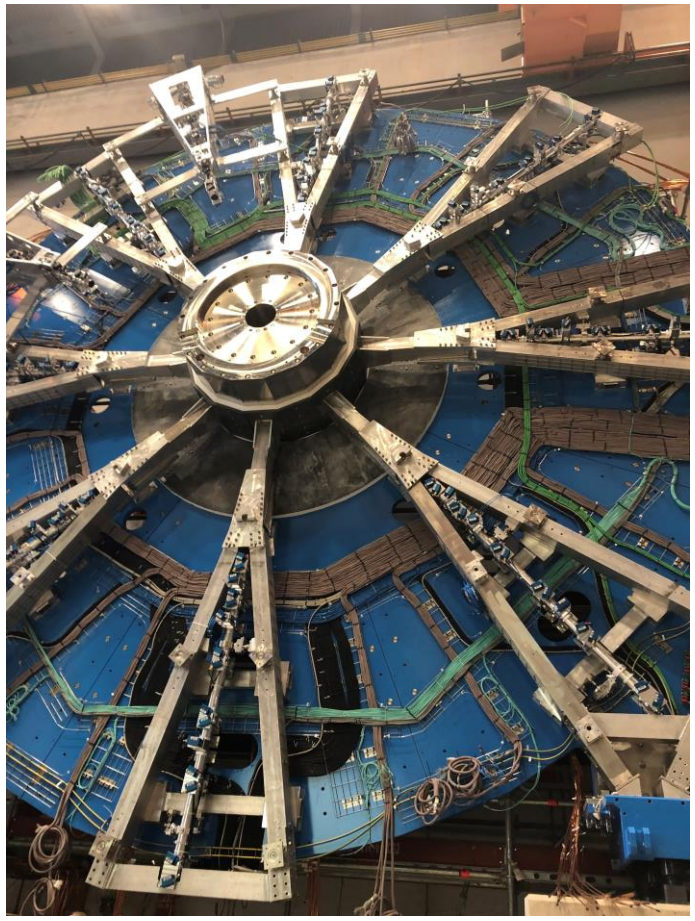
How the NSW detects Muons

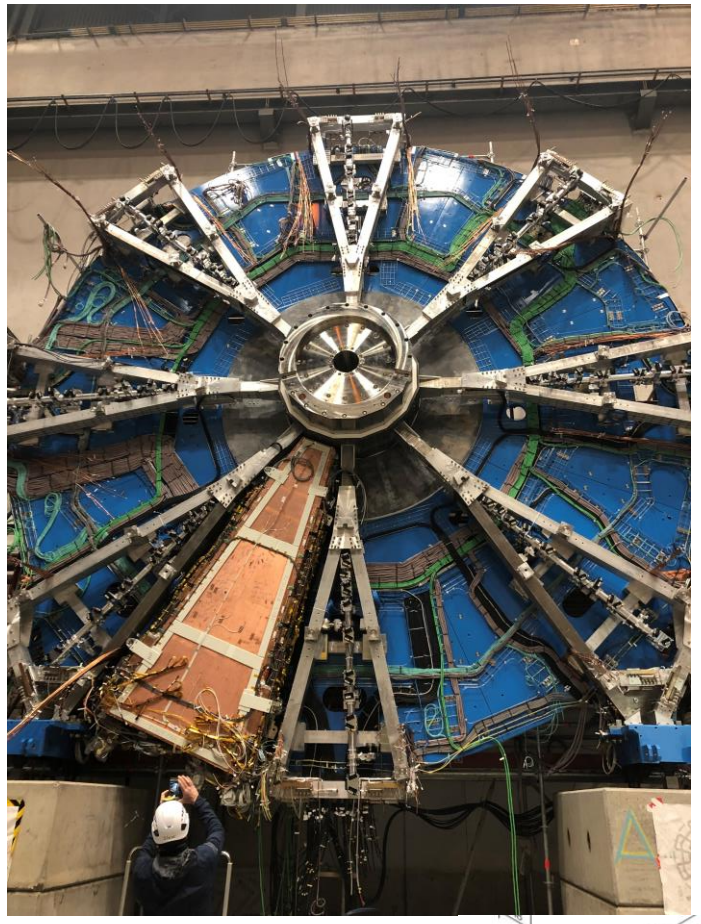
- **Gaseous Ionization Detectors:** muons pass through gas, knock off electrons, which allow us to read out a current pulse
- **Two complementary detector systems, sTGC** primarily used for trigger **and MicroMegas** primarily used for tracking

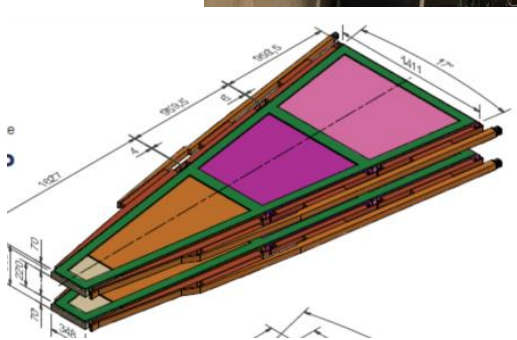


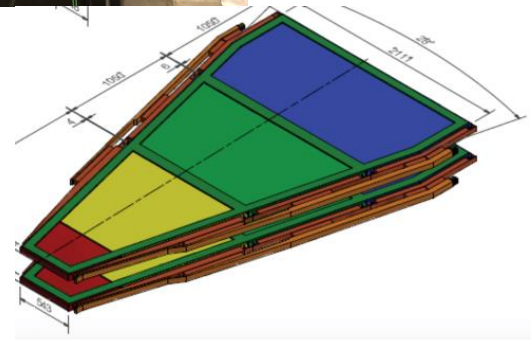


How are the NSW built?









How are the NSW built?

Single Cathode Boards

Doublet

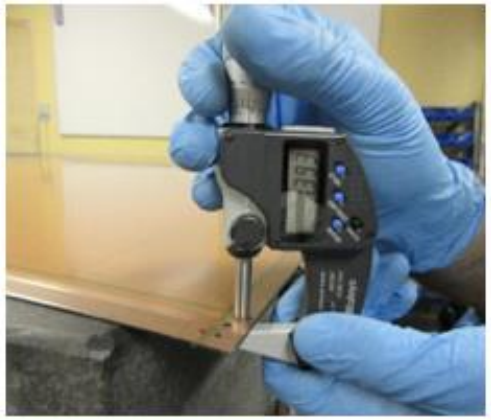
Quadruplet

Wedge

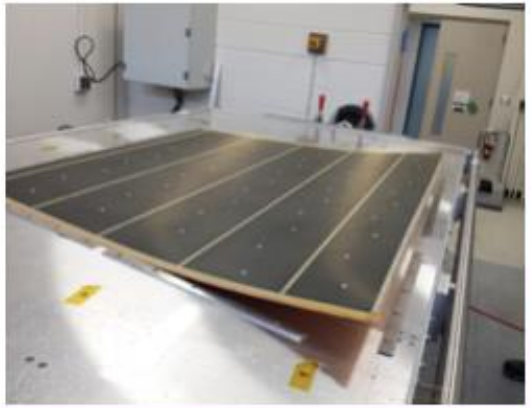
Sector

How are the NSW built?

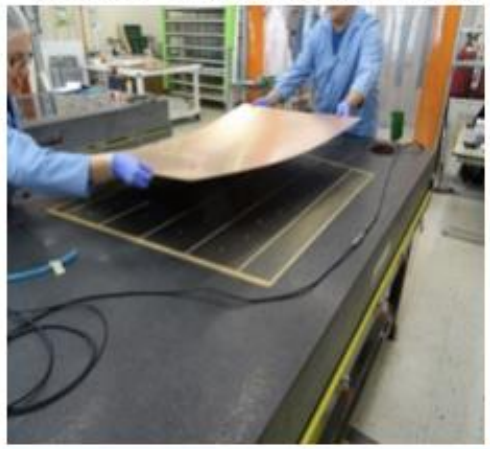
boards thickness, planarity, check for electrical shorts



1/2 chamber folding under wires tension



Lowering a strip board onto a pad board



Single Cathode Boards

Doublet

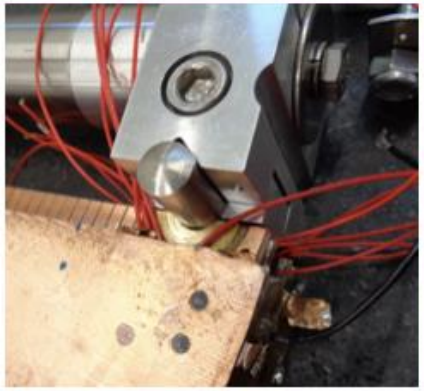
Quadruplet

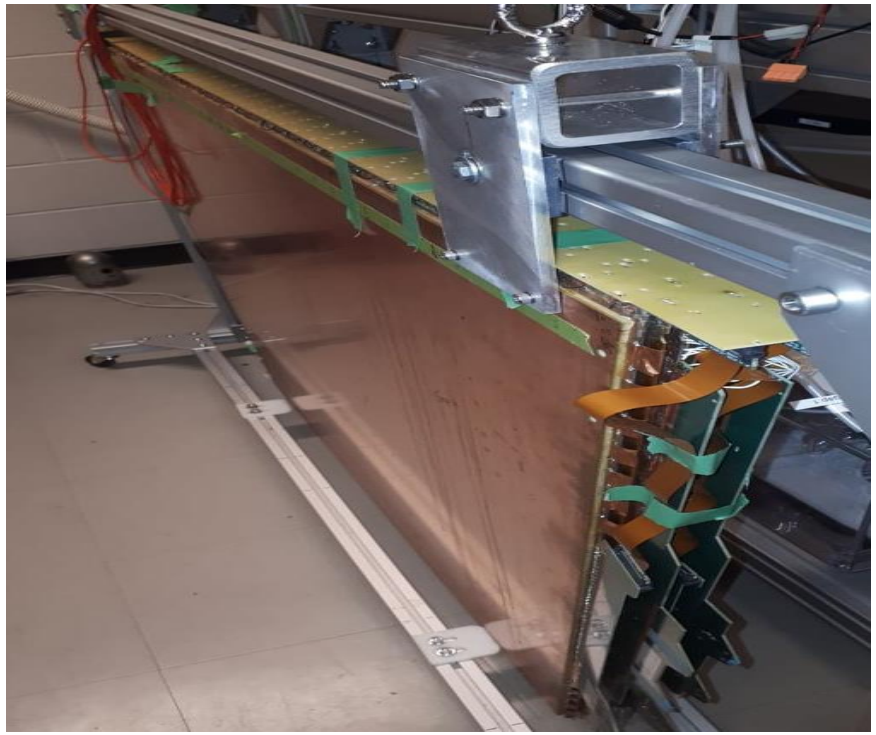
Wedge

Sector

How are the NSW built?

one doublet lowered over another doublet while pushing against the alignment pins





Single Cathode Boards

Doublet

Quadruplet

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Sector

How are the NSW built?

Single Cathode Boards

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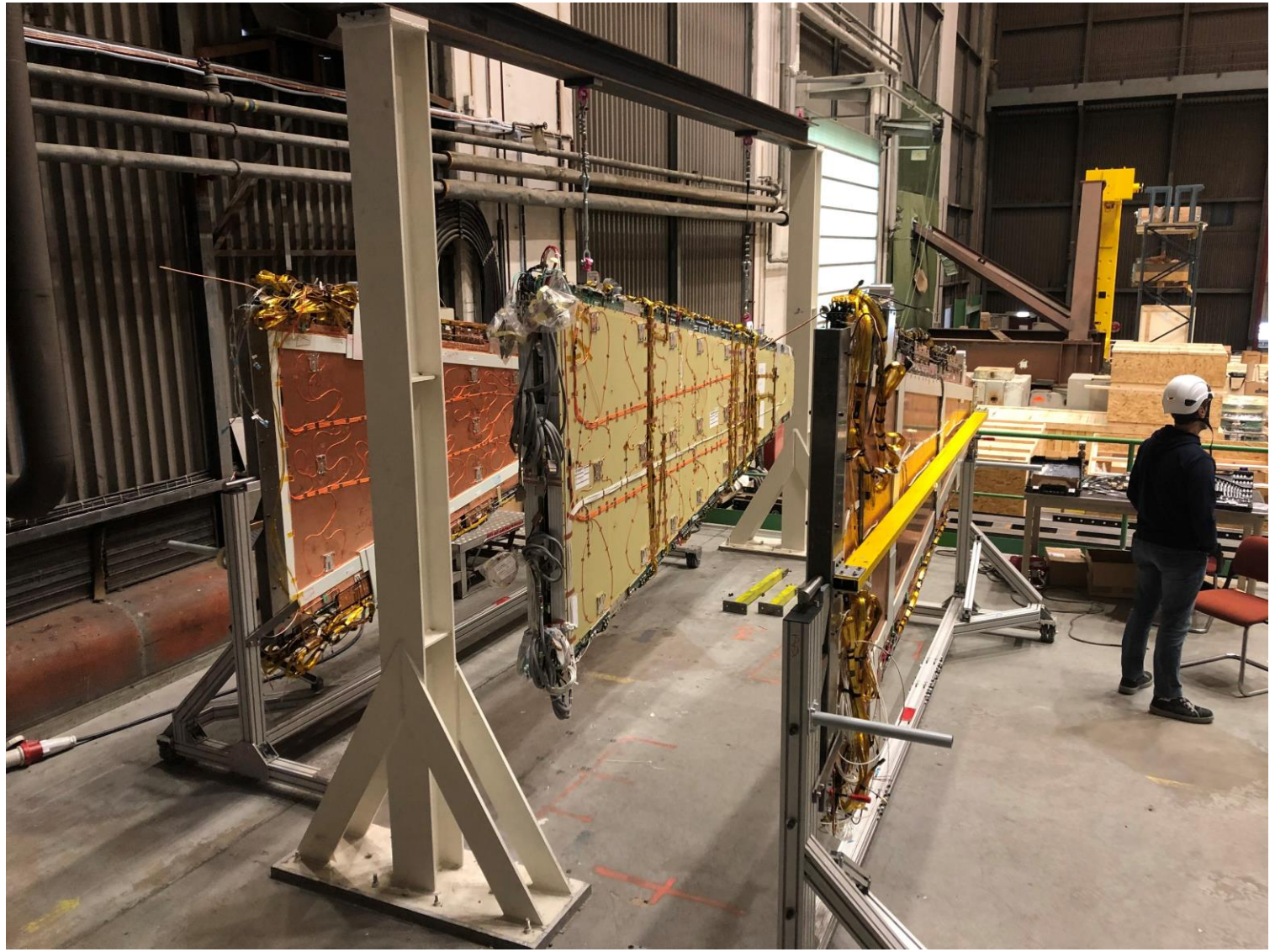
How are the NSW built?



Single Cathode Boards

Doublet

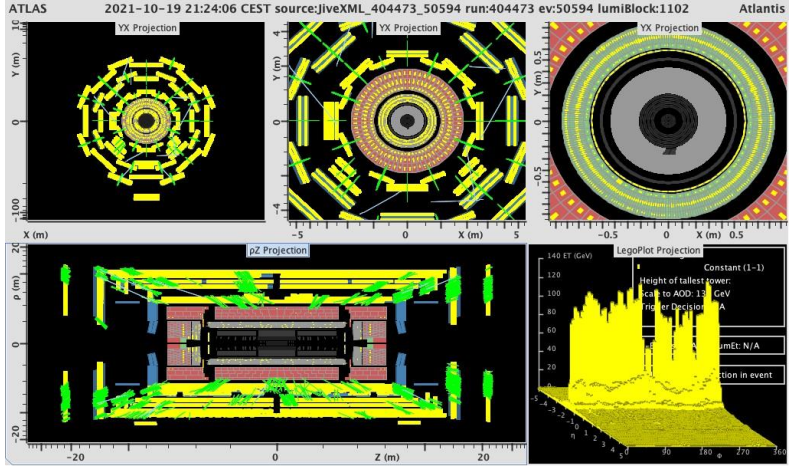
Quadruplet

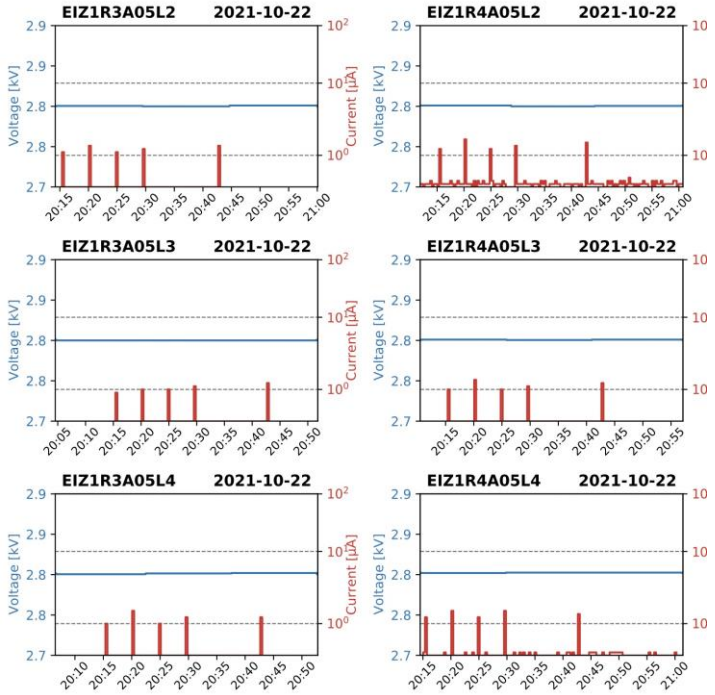
Wedge

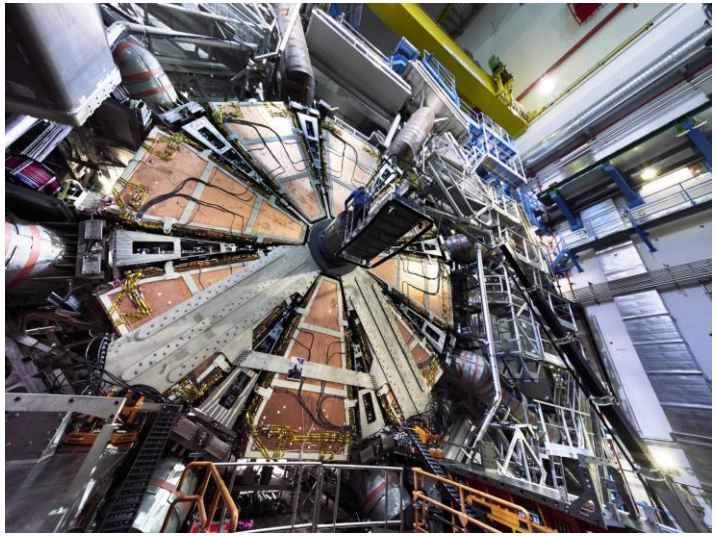
Sector

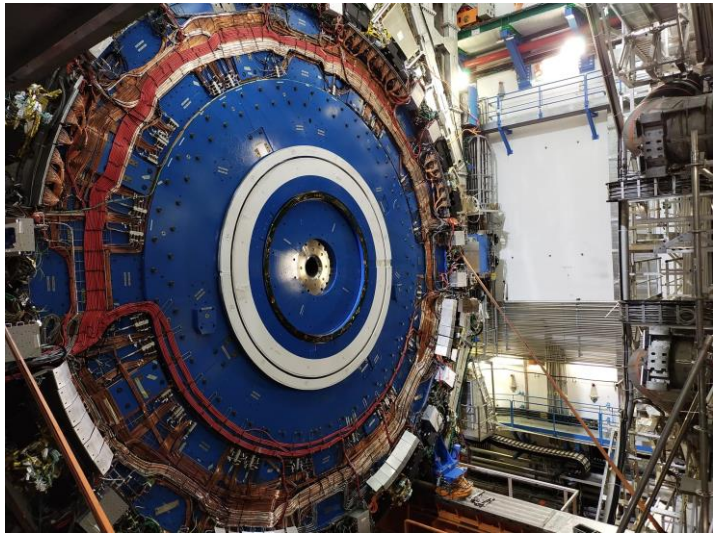
Status of Project

- Wheel A lowered and installed into ATLAS cavern July 2021
- Wheel C lowered and installed into ATLAS cavern November 2021
- Recorded pilot beam splashes November 2021 in both MM and sTGC technologies
- Additional talks about the NSW
  - Leesa Brown: commissioning efforts and pad efficiency of NSW's



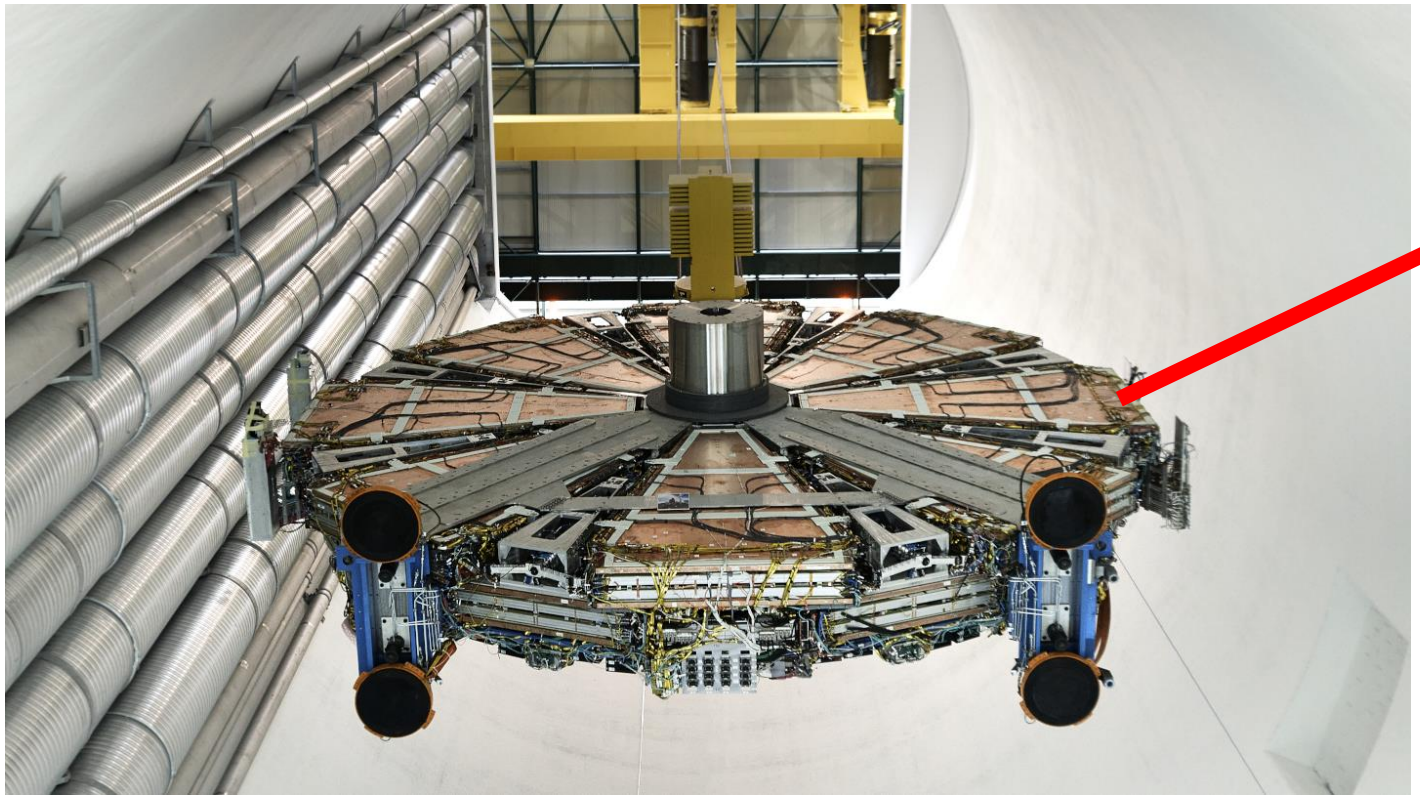


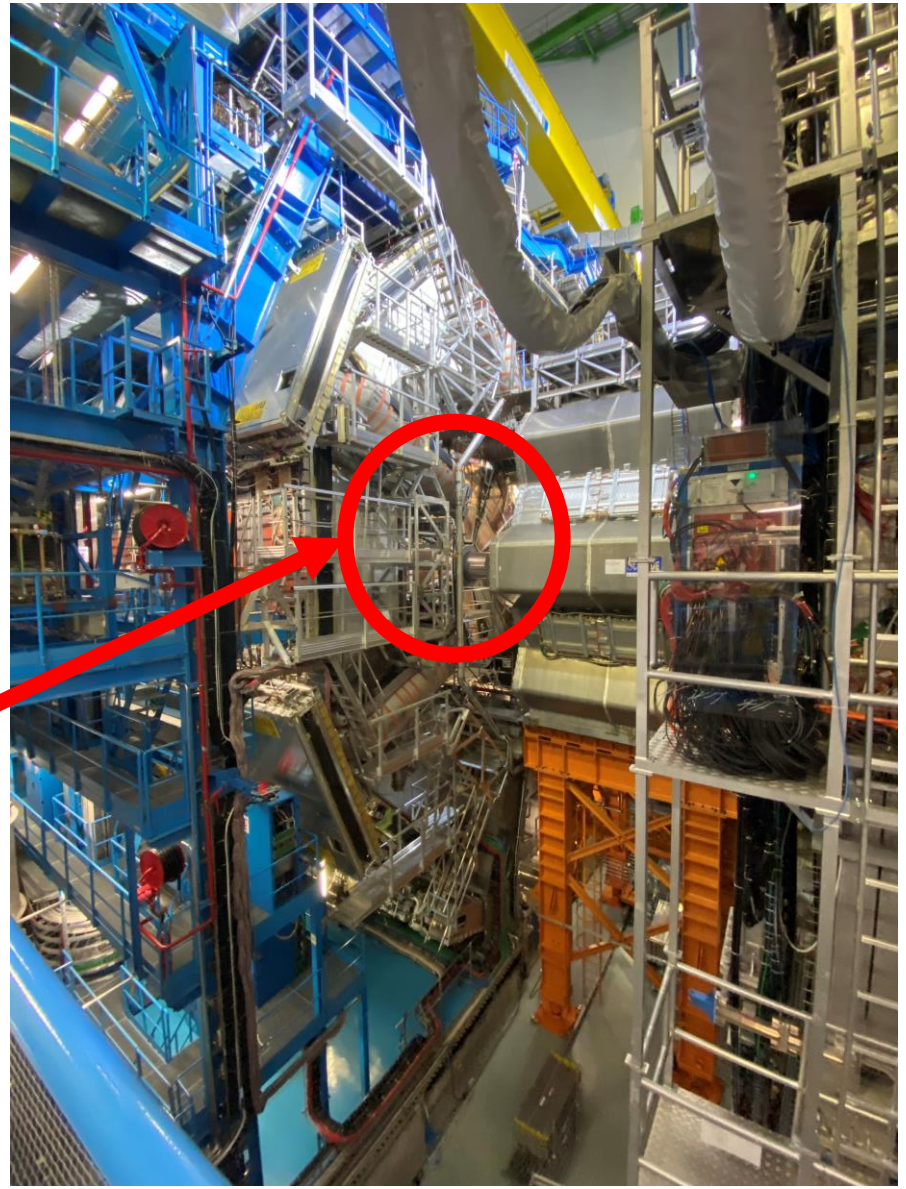




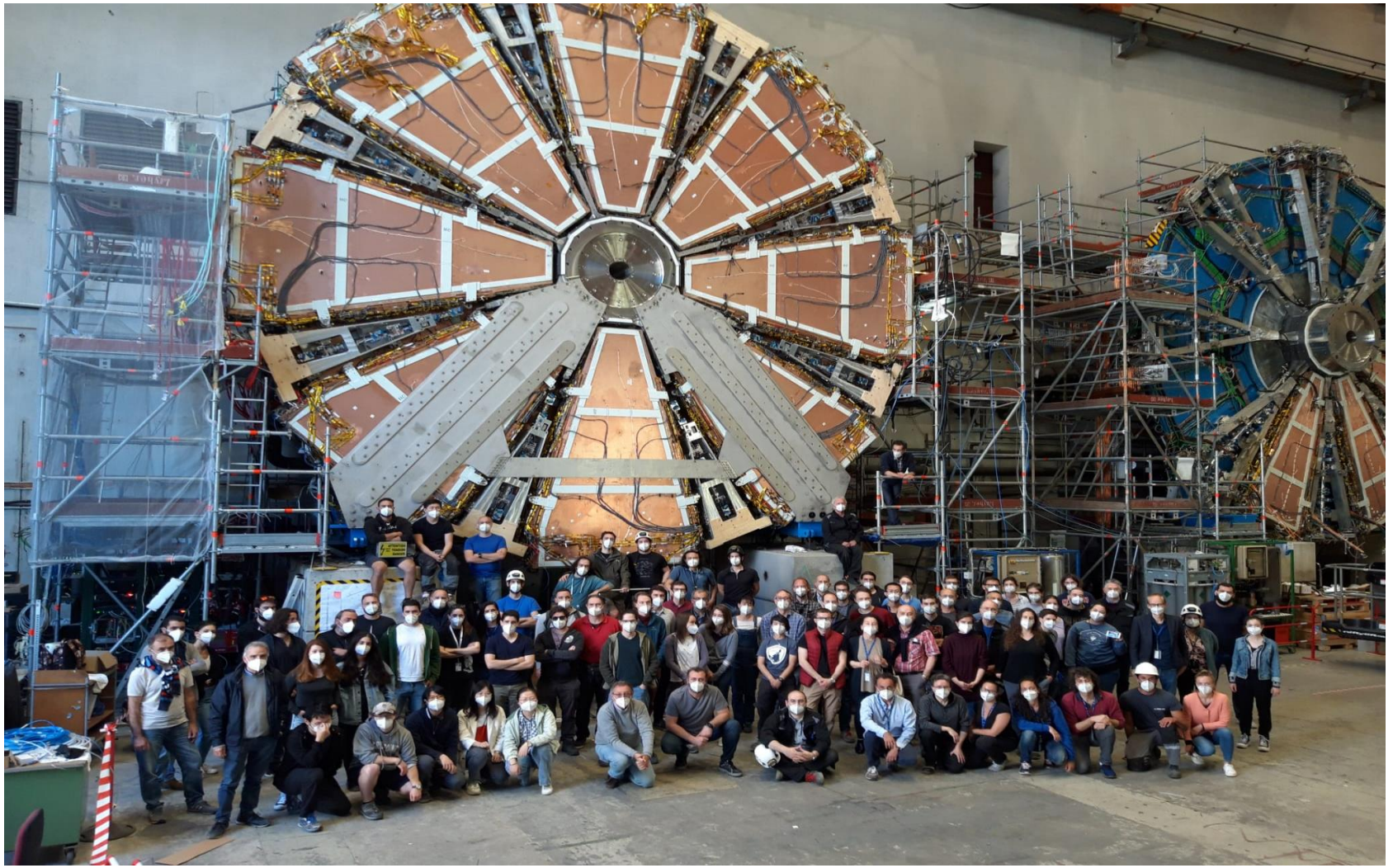
What's Next

- Run III beams will be accelerated into the LHC at 6.8 TeV and center of mass energy of 13.6 TeV in March 2022
- Commissioning of the NSWs in the ATLAS cavern
- Continued Run II analysis and transition into analysis for Run III data
- Continued upgrades to improve detection and data collection for the LHC and its experiments (ITK upgrade with large Canadian involvement, HL-LHC)





Thank you
Merci



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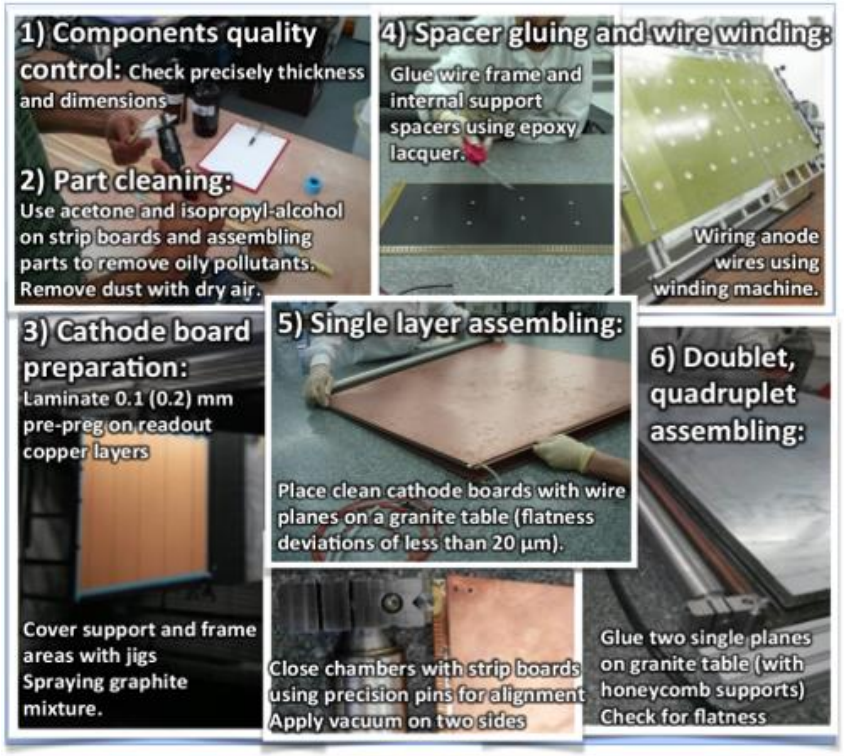
Discovery, accelerated

Additional Slides and Extra Material

NSW Integration and Quality Assurance

- **During assembly of the sectors.**
  - **Pre inspection testing.**
    Physical damages, leak test,
  - **Electrical and mechanical testing.**
    Electrical shorts, pulser test,
  - **Long term testing.**
    High Voltage, High Radiation Test (Cs 137 isotope)



- **During assembly of the wheel.**
  - **Conductivity test**
  - **RIM crate assembly**
  - **Fibre attenuation measurements**
  - **Temperature and magnetic field sensor installation and testing**
  - **LV/HV to power the sectors and readout boards**