



SAHAL YACOOB

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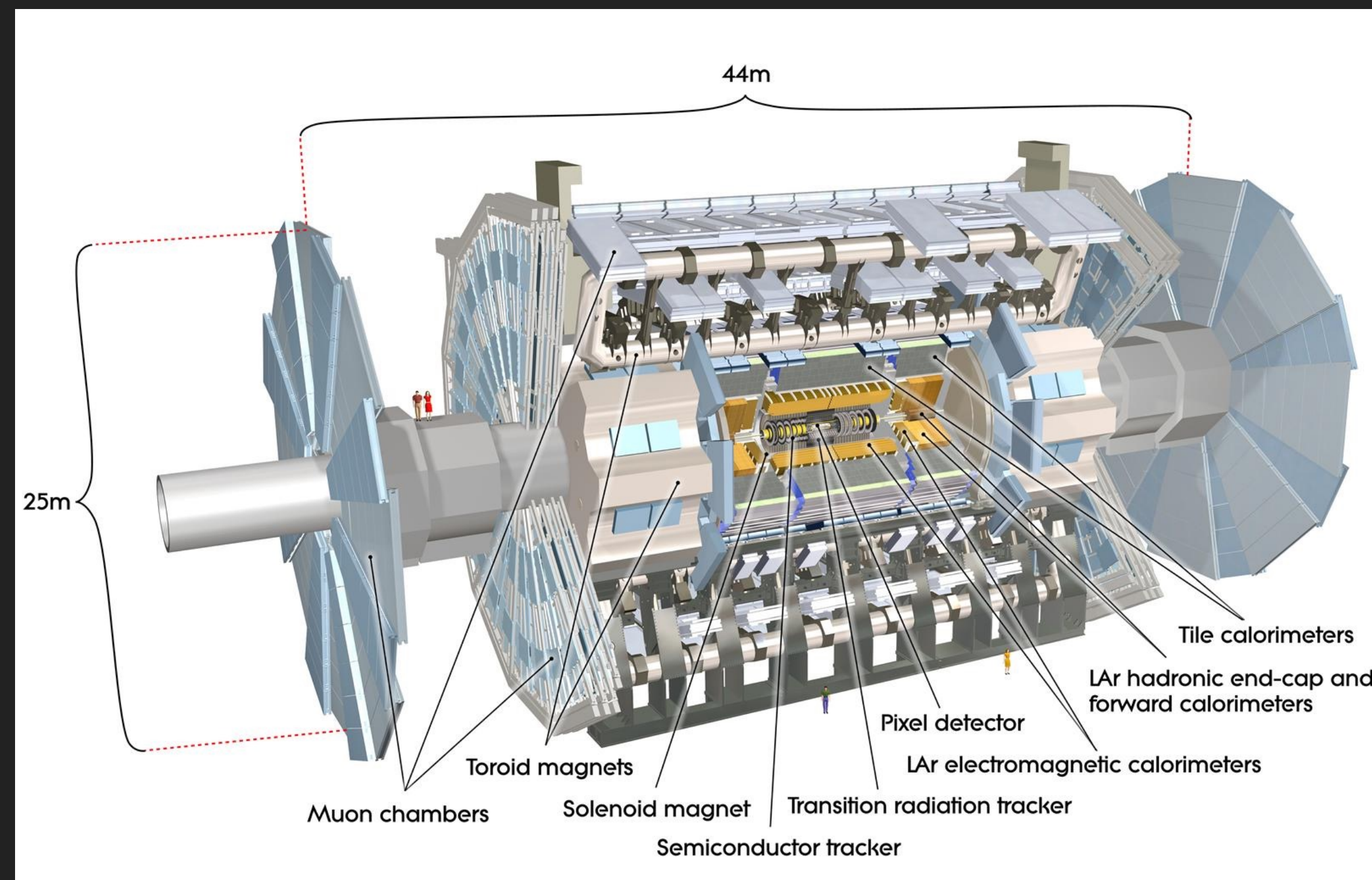
**ATLAS@UCT**



**UNIVERSITY OF CAPE TOWN**  
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

## WHAT IS ATLAS ?

- ▶ The ATLAS experiment at CERN is a Multi-purpose particle Physics detector and collaboration which collect and analyse data from high energy proton and nuclear collisions produced by the Large Hadron Collider



## A SHORT HISTORY OF UCT INVOLVEMENT WITH ATLAS

- ▶ Started by Andrew Hamilton in 2011 (no longer an ATLAS member)
- ▶ Sahal Yacoob joined in 2015
- ▶ James Keaveney joined in 2019 Currently top quark cross-sections group co-convenor

A relatively small group



Andrew



Sahal

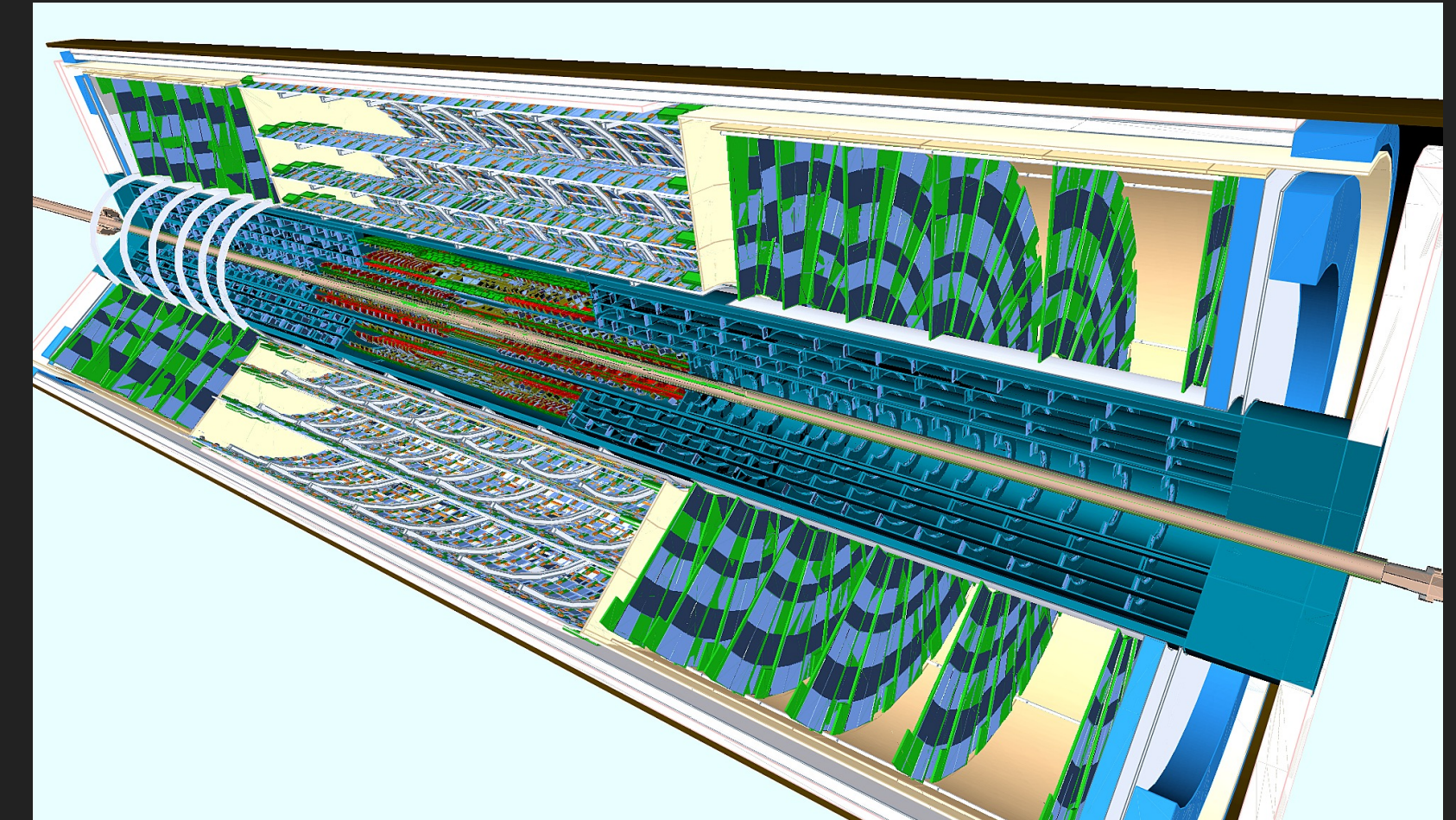


James



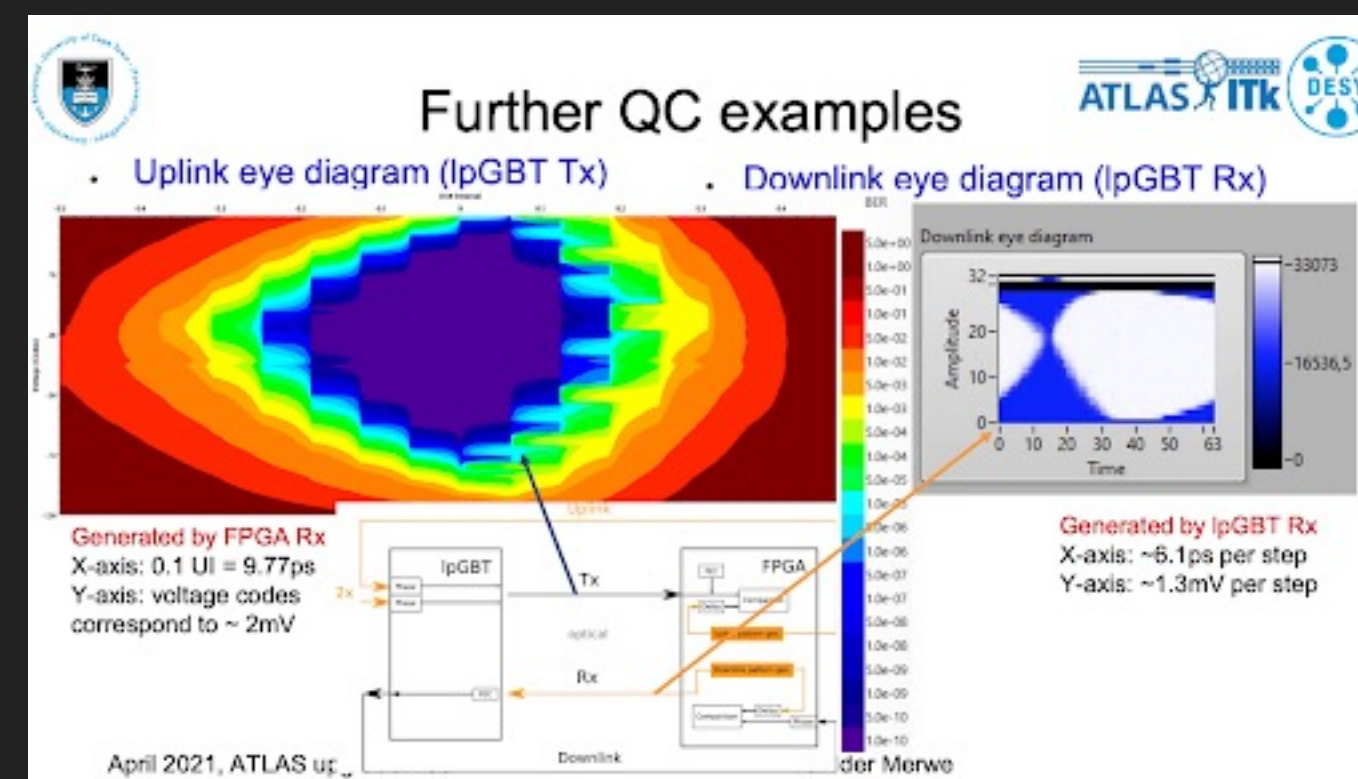
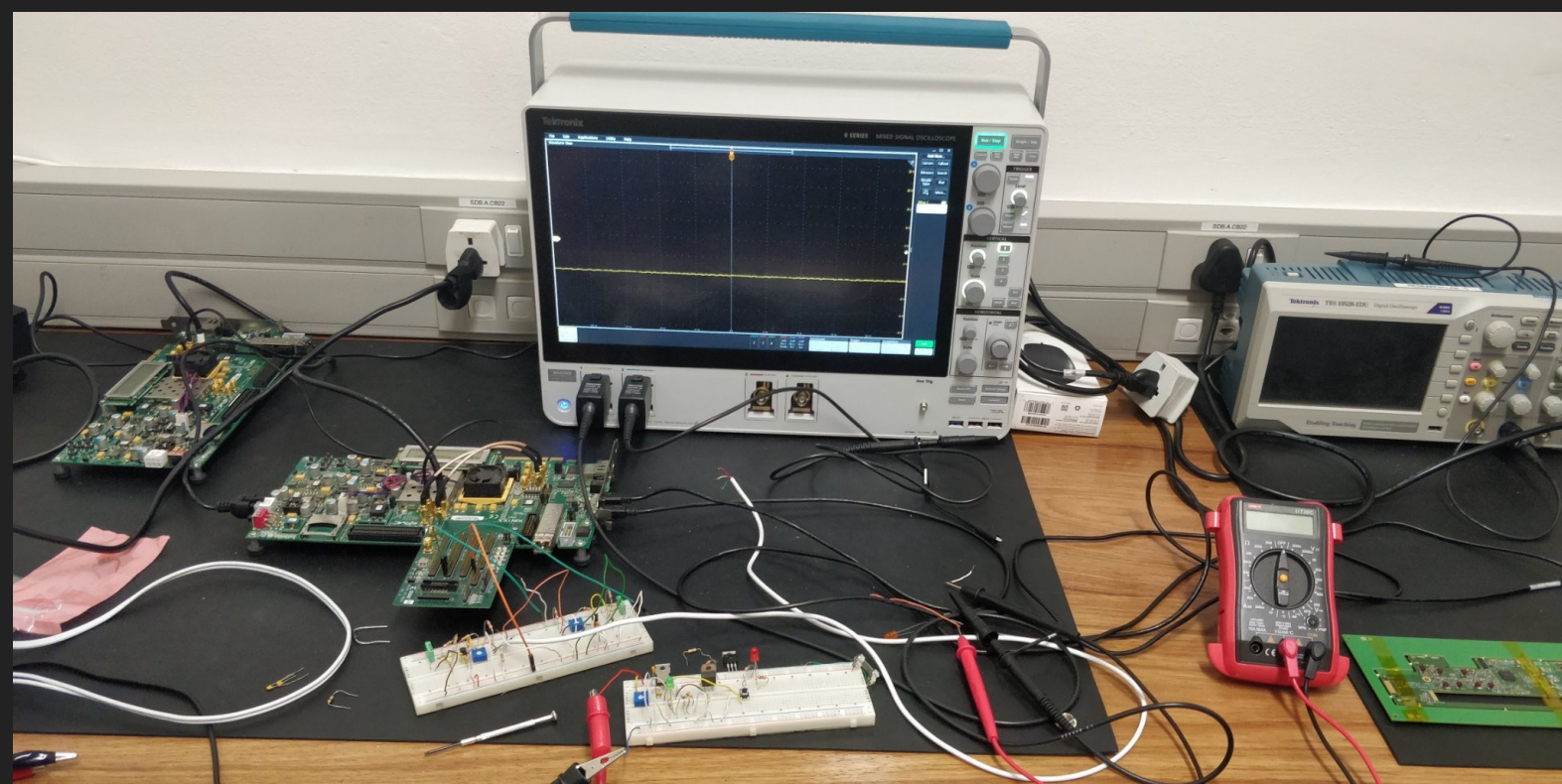
# SILICON DETECTOR DEVELOPMENT

- ▶ SCT
  - ▶ Data acquisition development
- ▶ ITk
  - ▶ Evaporative cooling development
  - ▶ Material Description in simulation and related studies
  - ▶ QC for readout electronics - more on next slide
  - ▶ Polymoderator design and procurement



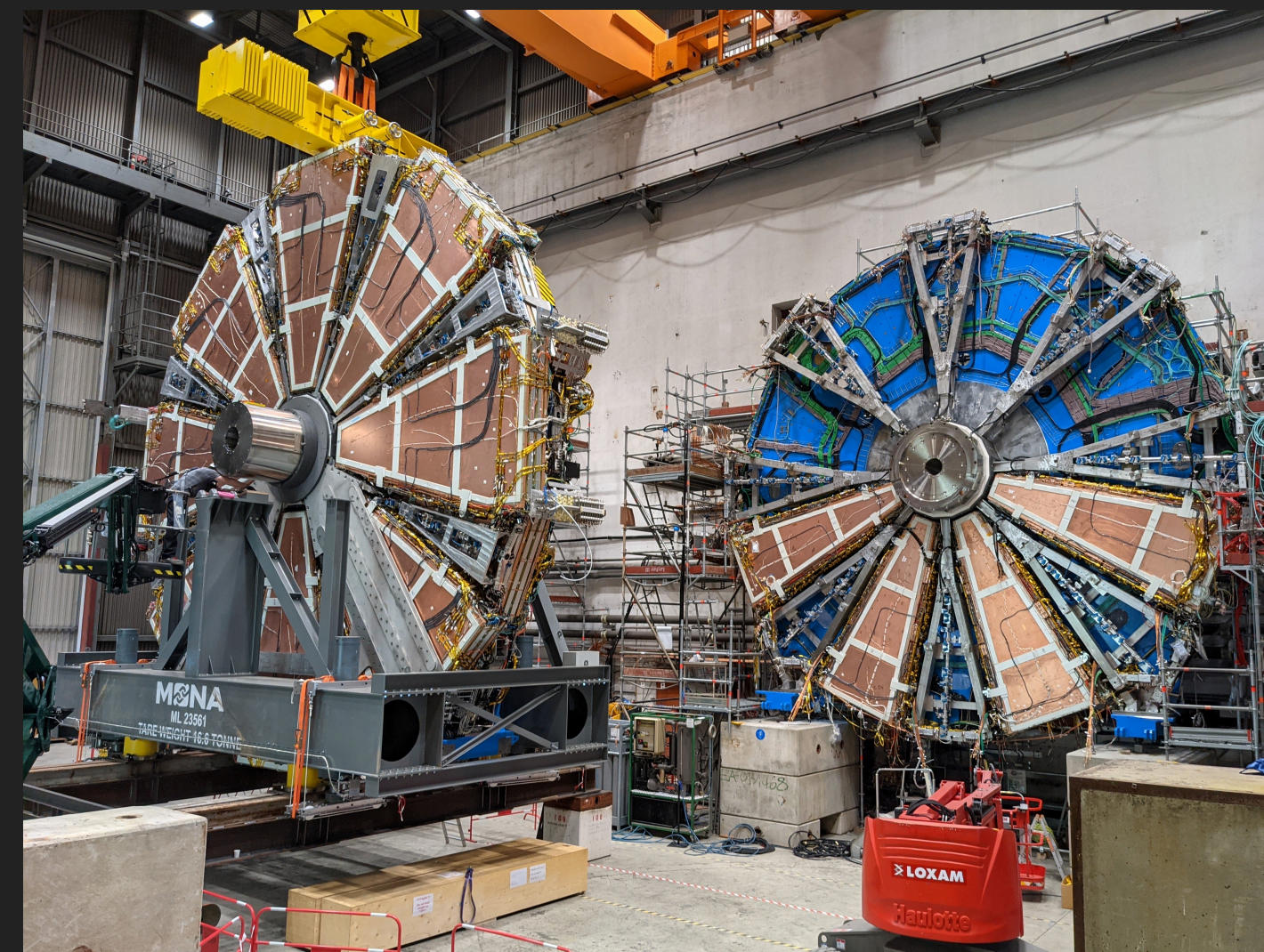
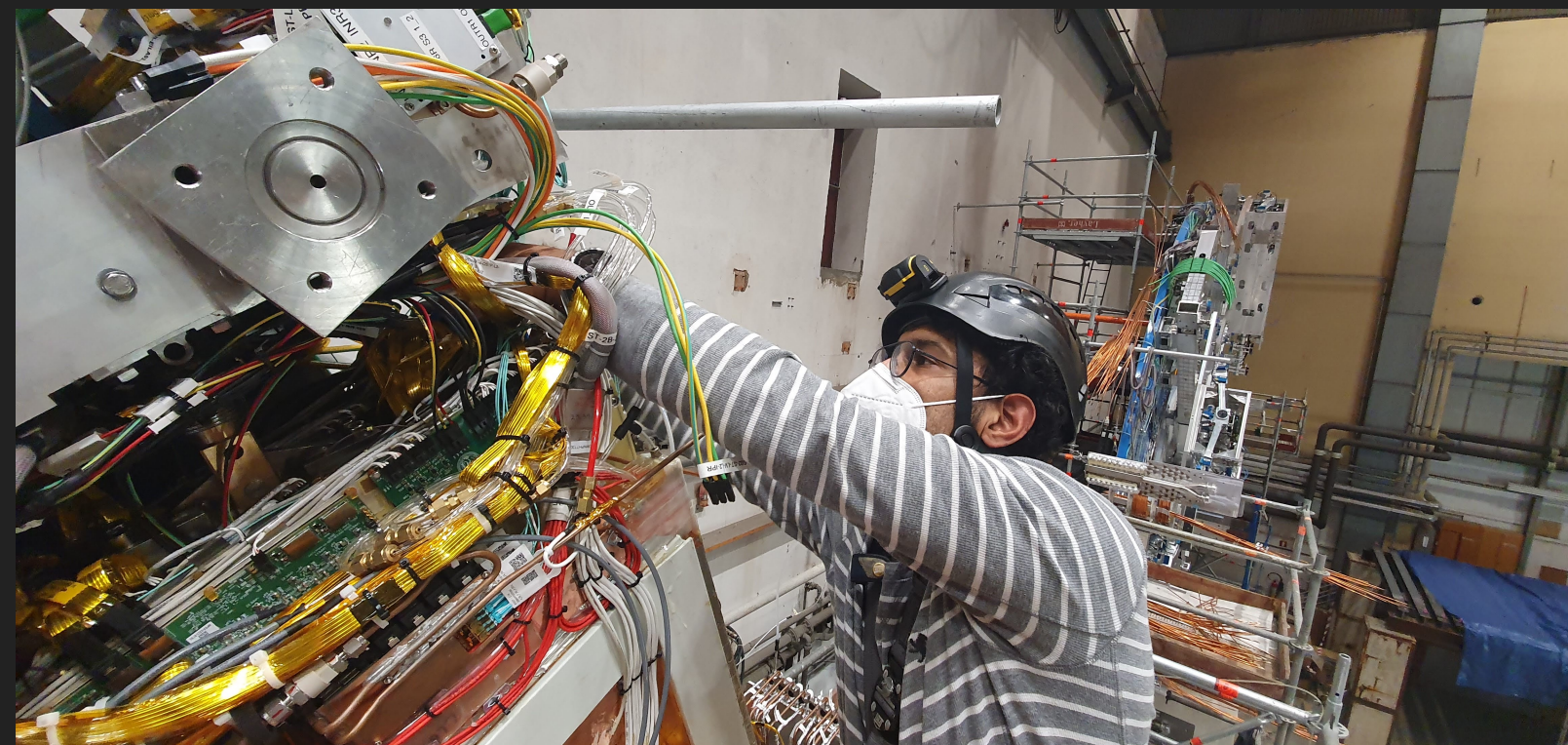
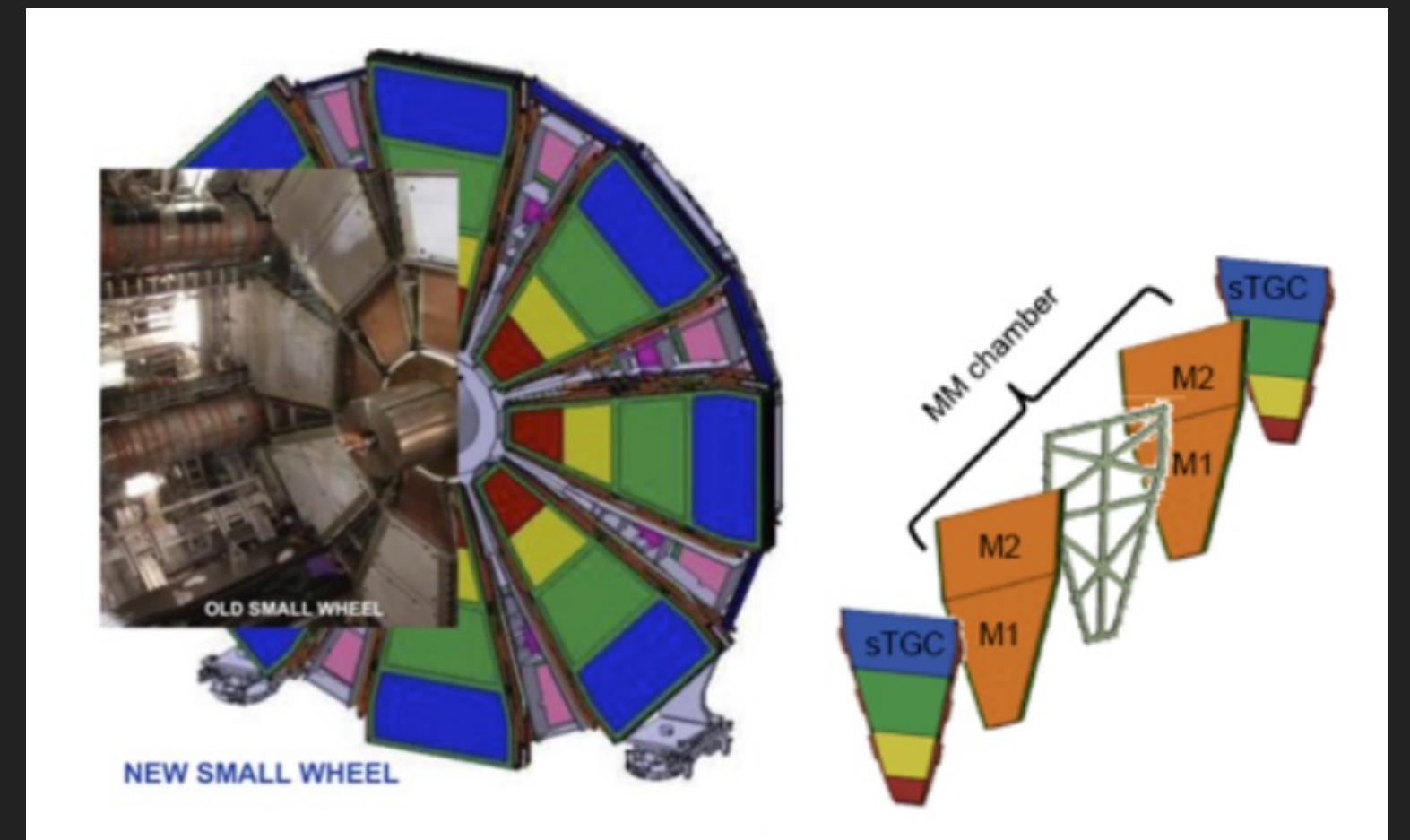
# ITK END OF SUBSTRUCTURE (EOS) CARDS

- ▶ Collaborating with DESY to produce and qualify ~2000 EoS cards for ITk
- ▶ EOS prototypes @ UCT, dedicated lab space and equipment (photos) to develop QC procedures
- ▶ Collaborations between UCT physicists and Engineers.



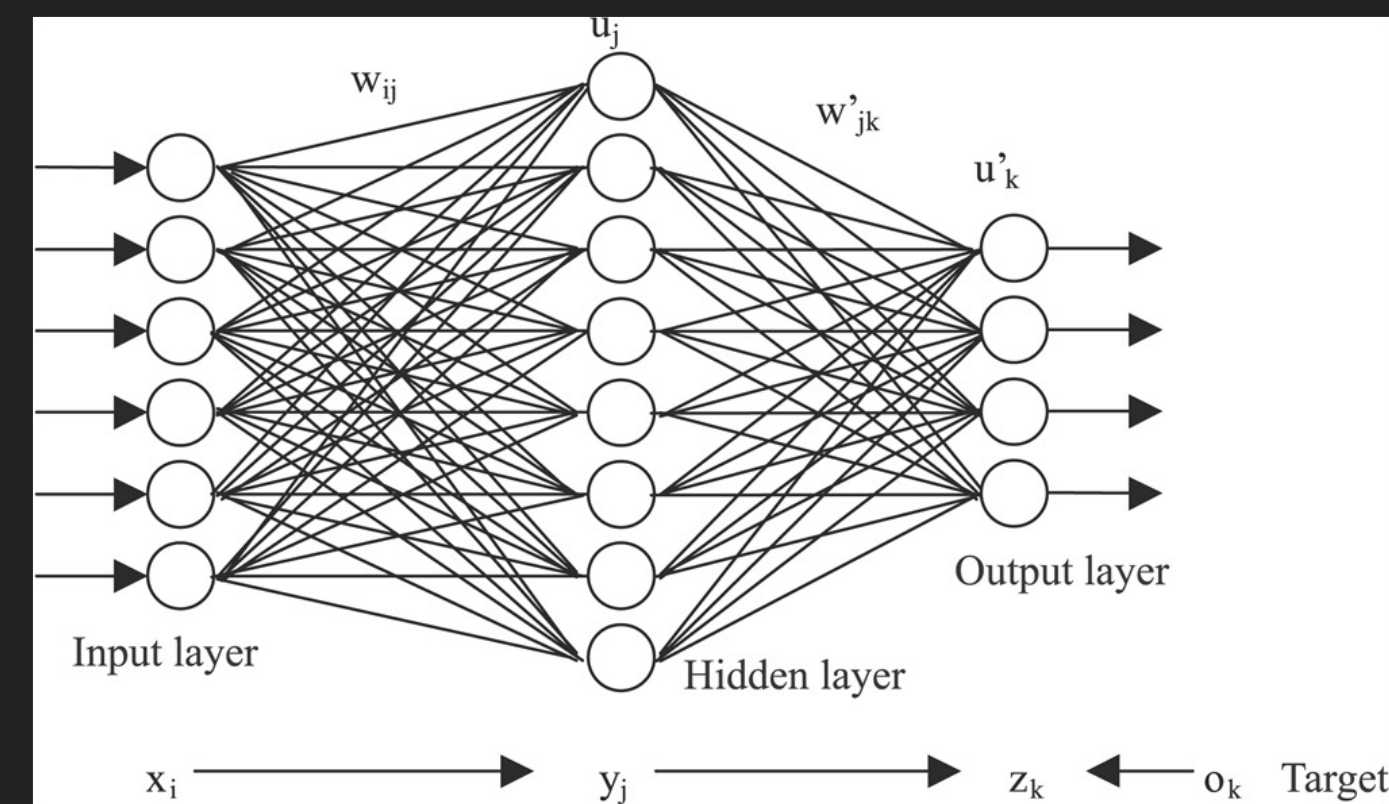
## MORE DETECTOR DEVELOPMENT

- ▶ Muon New Small Wheel
  - ▶ Material description in simulation
  - ▶ Manufacturing and assembly of components and installation tools
  - ▶ Commissioning



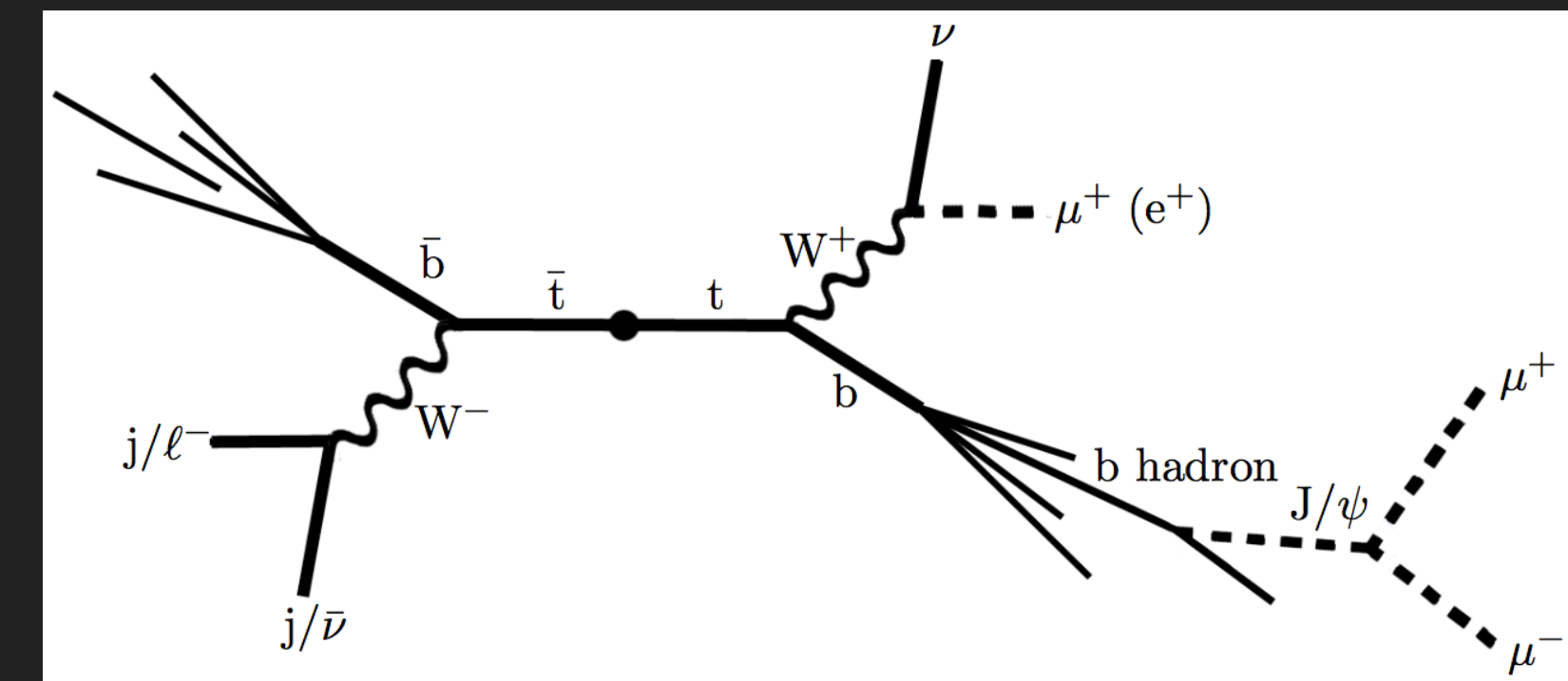
## OTHER DATA VALIDATION TASKS

- ▶ Developing a model for missing transverse momentum determination using neural nets
- ▶ Determining the low- $p_T$  muon fake rates
- ▶ Developing an automated online data quality monitoring algorithm (using machine learning)



# TOP QUARK MASS USING LEPTONS

- ▶ Measuring the mass of the top quark
  - ▶ Current PDG value:  $m_T = 172.9 \pm 0.4 \text{ GeV}$
- ▶ Precision measurement of  $m_t$ ,  $m_W$ , and  $m_H$  combine to form a precision test of the SM
- ▶ Important for SM determination of stability of the vacuum
- ▶ Method should be competitive with large LHC run 3 datasets

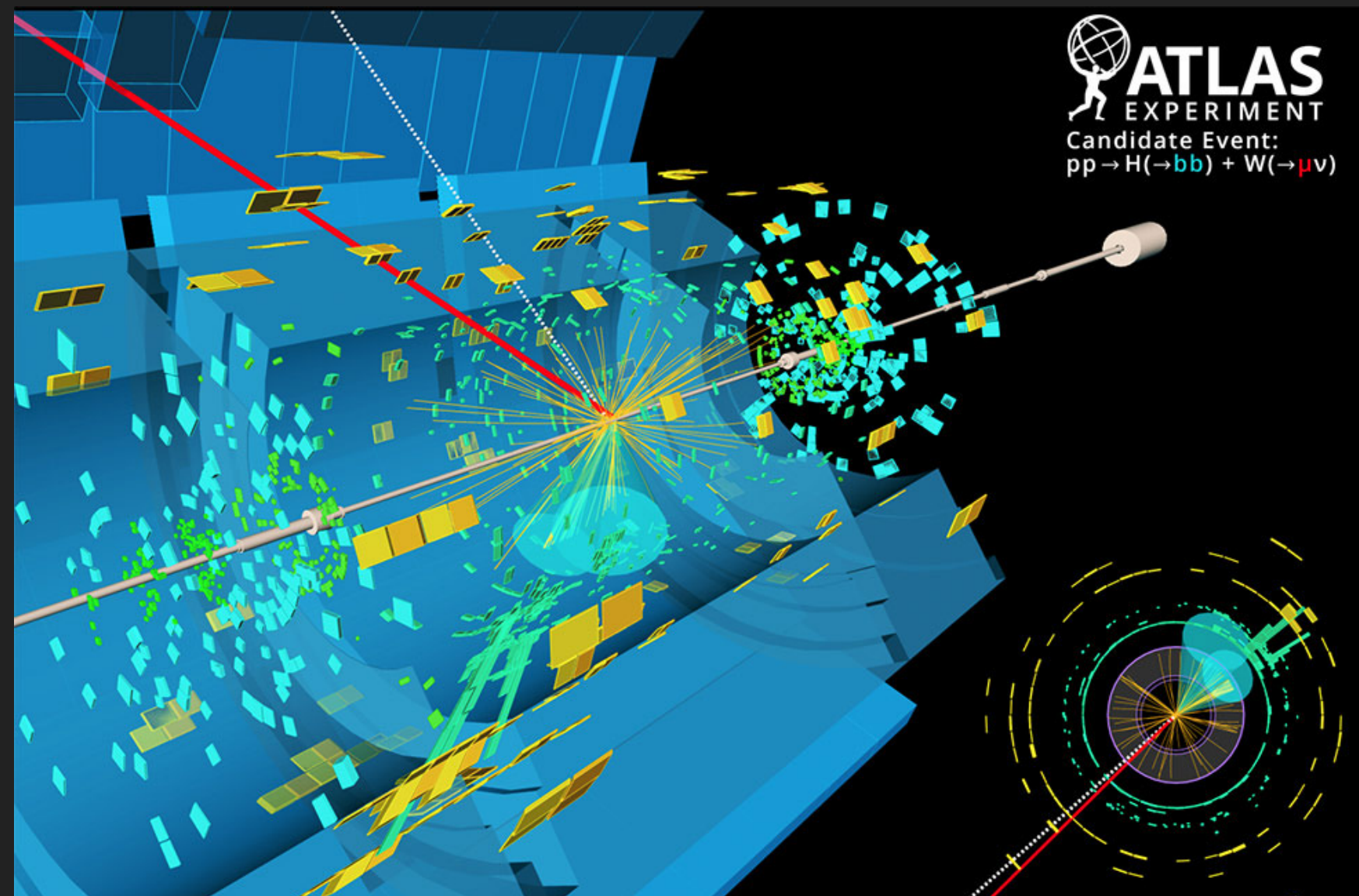
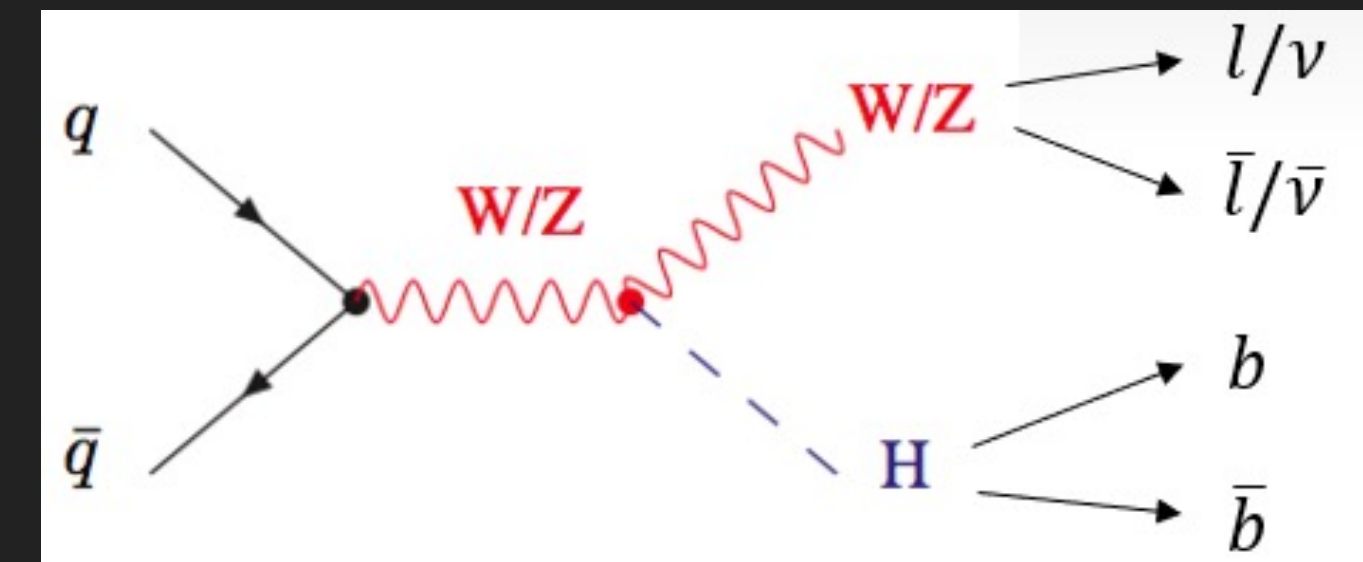


Not Yet Public



## MEASURING HIGGS PRODUCTION

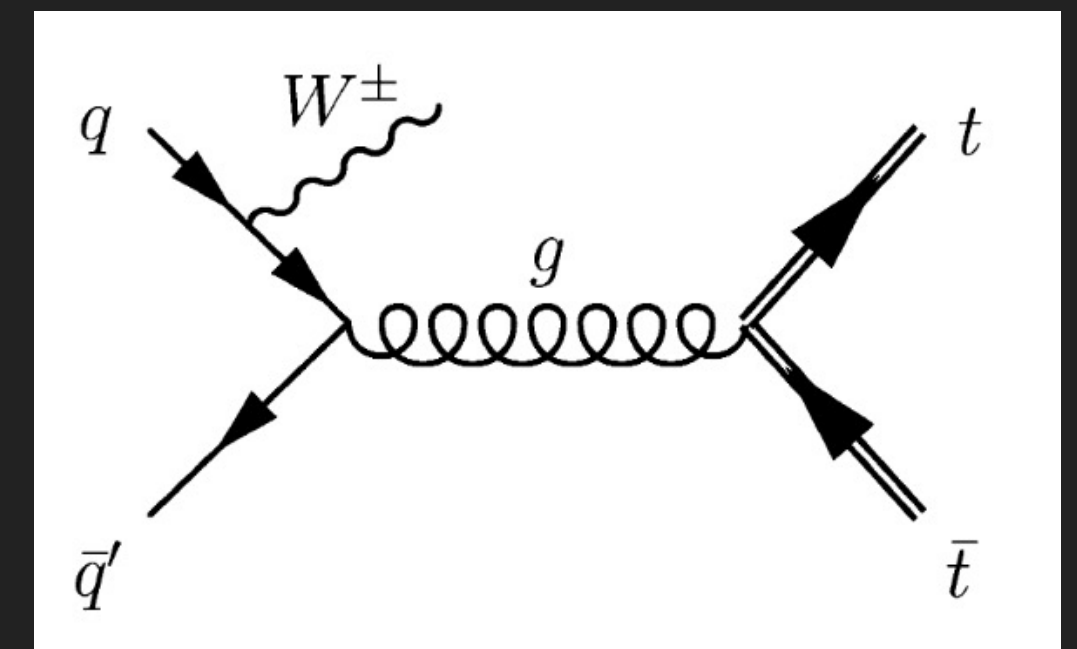
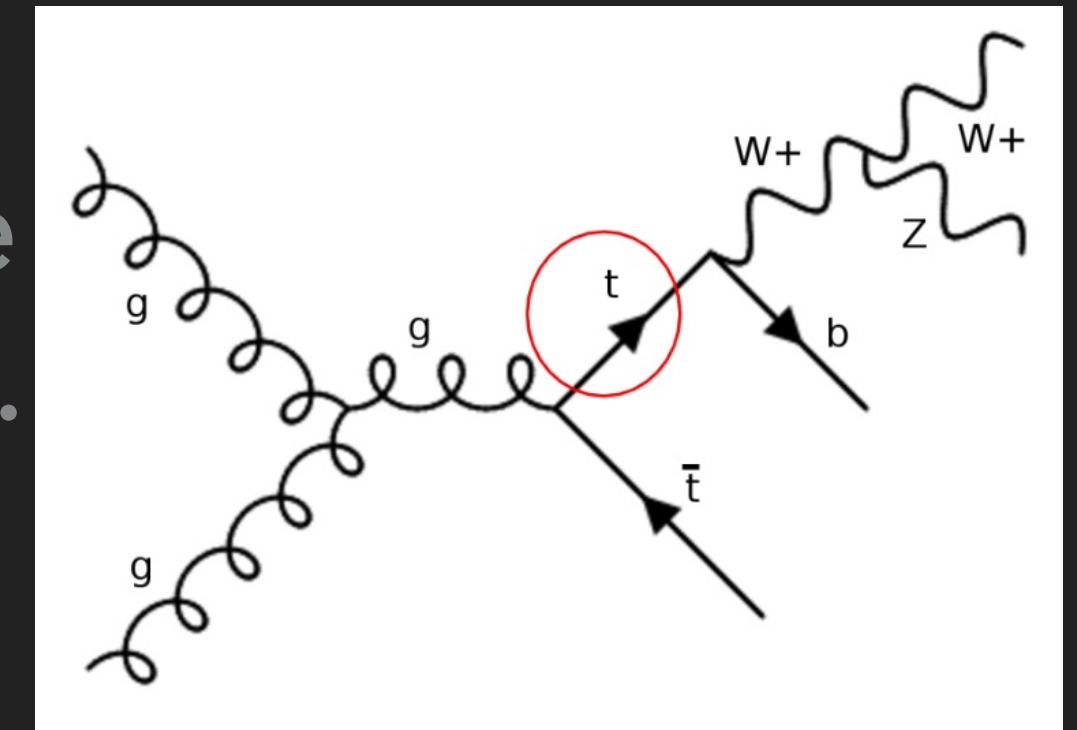
- ▶ Higgs boson production in association with a W/Z boson, with the Higgs decaying to two bottom quarks.



- ▶ Best way to directly measure Higgs boson's ElectroWeak couplings as part of understanding the Higgs.

## NEW PHYSICS VIA TOP EW COUPLINGS

- ▶  $tWZ$  cross section: UCT-led analysis on course to place a novel constraint on a previously unexplored process.
- ▶ Leptonic Charge asymmetry in  $ttW$  production
  - ▶ collaboration between UCT and IFIC Valencia on previously unexplored observable sensitive to new physics
- ▶ Phenomenological work on the top quark EFT to support and inspire these measurements (arXiv:2107.01053)



## WORK BY GRADUATED STUDENTS

- ▶ TWZ production cross section
  - ▶ Tetra and tri-lepton channels
- ▶ Same-sign WW production cross section
- ▶ tH(bb) feasibility study
- ▶ Exclusive dimuon production cross-section
- ▶ QCD backgrounds to W-boson measurements
- ▶ Running ATLAS software on ARM processors
- ▶ Study of susceptibility of EOS cards to SEUs using neutron sources at UCT

# STUDENTS

- ▶ Students Graduated:
  - ▶ 16 MSc (including engineers)
    - ▶ Most continued in academia
  - ▶ 1 PhD
    - ▶ Currently a post-doc on ATLAS
- ▶ Current Students
  - ▶ 4 MSc
  - ▶ 3 PhD



## OUTREACH AND INCLUSION

- ▶ Hosted Particle Physics Masterclasses with High Schools
- ▶ Support for the Beamlines for Schools program
- ▶ Working with the International Particle Physics Outreach Group in expanding Particle Physics to new countries
- ▶ Working within ATLAS and in Particle Physics generally to improve Diversity and Inclusion

## IN SUMMARY

- ▶ Due to the funding available from the SA-CERN program we have been active within the ATLAS collaboration in all aspects:
  - ▶ Detector development, simulation, operations, commissioning, and construction
  - ▶ Interesting and intellectually challenging physics analyses
  - ▶ Exposing students to world-class research and an international network
  - ▶ Impactful on ATLAS and locally --- a good win win

