



ATLAS Activities in Morocco: Current Status

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On behalf the ATLAS Moroccan Group



Moroccan Cluster Evolution since 2013

- ATLAS Moroccan Cluster : 6 universities && 1 research center :

- Univ. Casablanca

- Mohamed VI Polytechnic
University (since 2021)

- Univ. Rabat

- Univ. Kénitra : since 2019

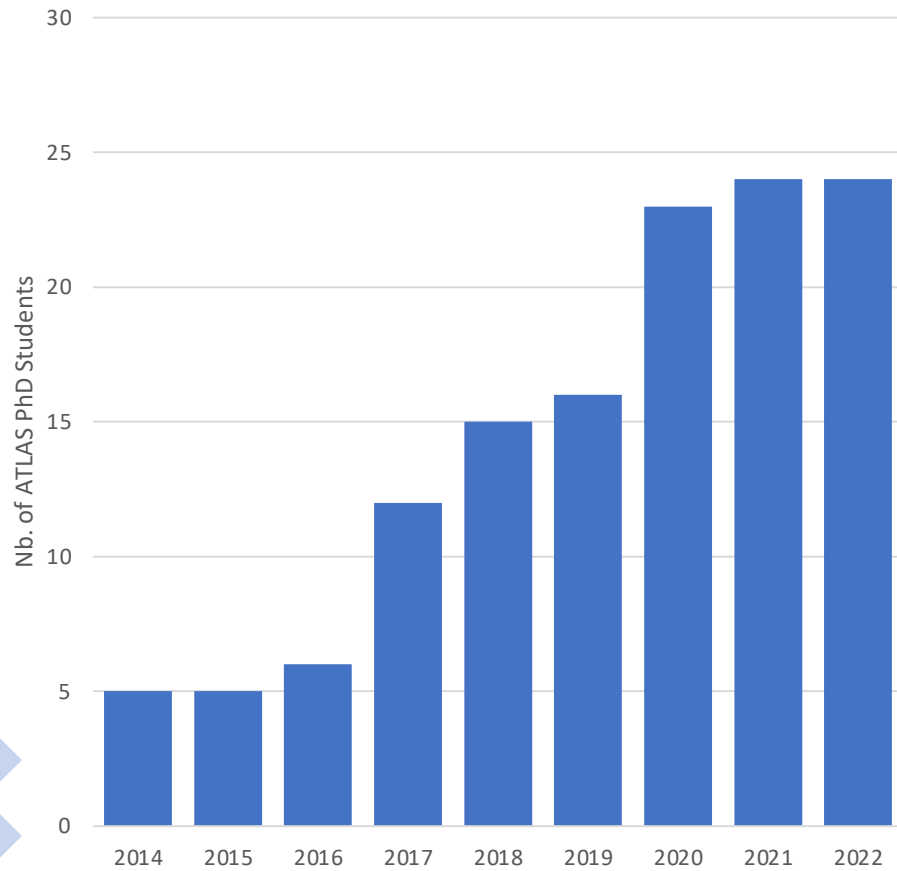
- MAScIR : Moroccan foundation for
Advanced Science,
Innovation and Research
Technical Associate
Institute since 2020

- Univ. Oujda

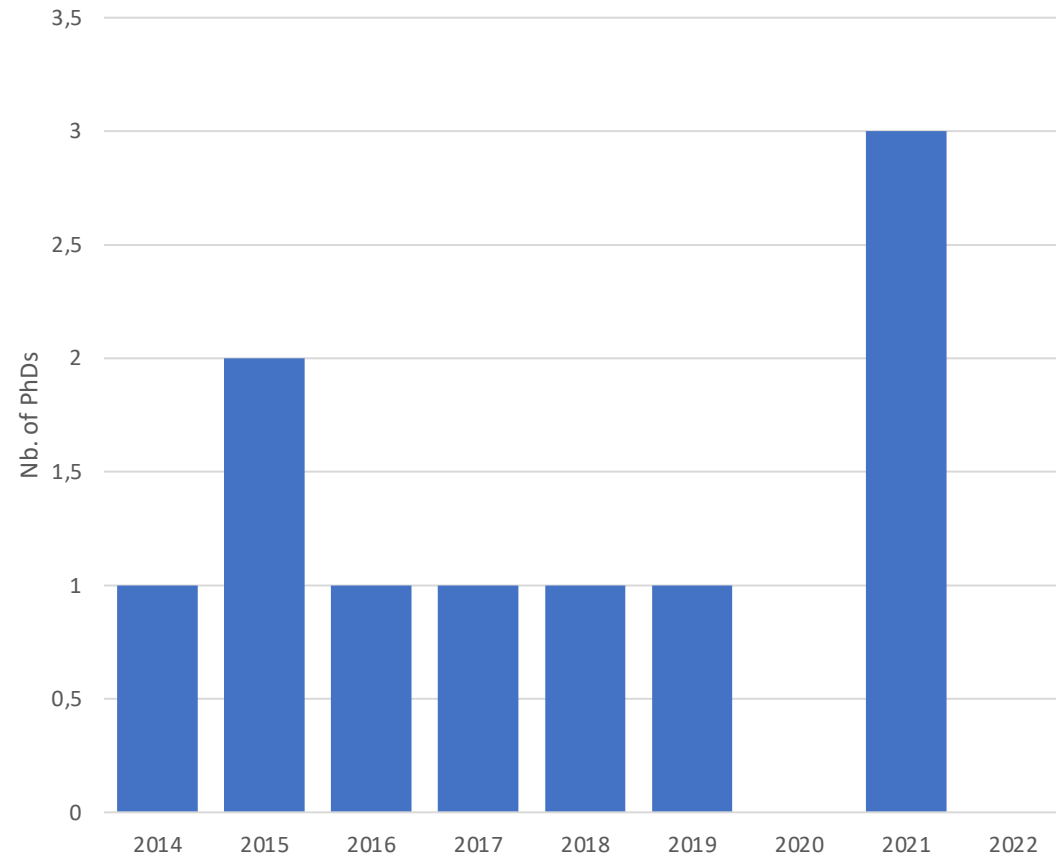
- Univ. Marrakech

Interest of PhD Students to ATLAS Activities

Clear increase of PhD students

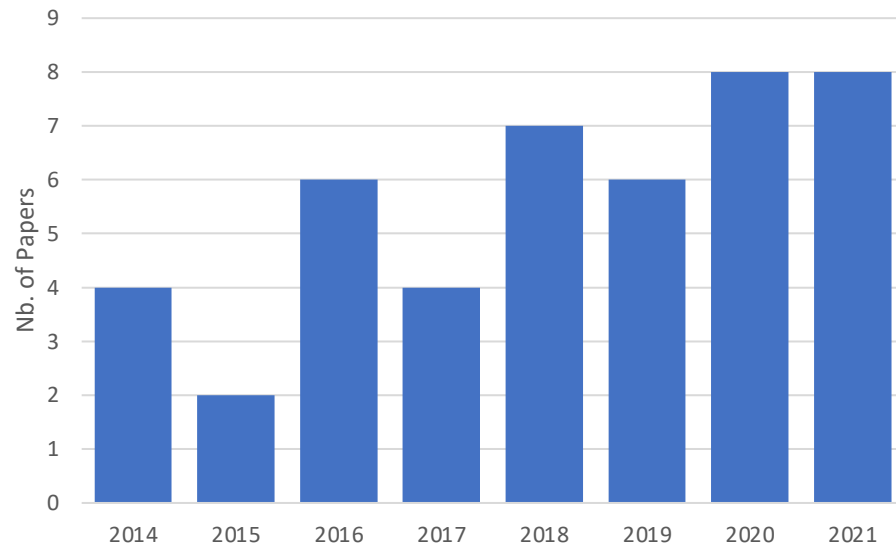


At least 1 or 2 PhD /year



Phenomenology Studies

- Higgs discovery → new challenges for a new physics discovery
- Increase of the interaction between exp. and pheno. Communities of the cluster

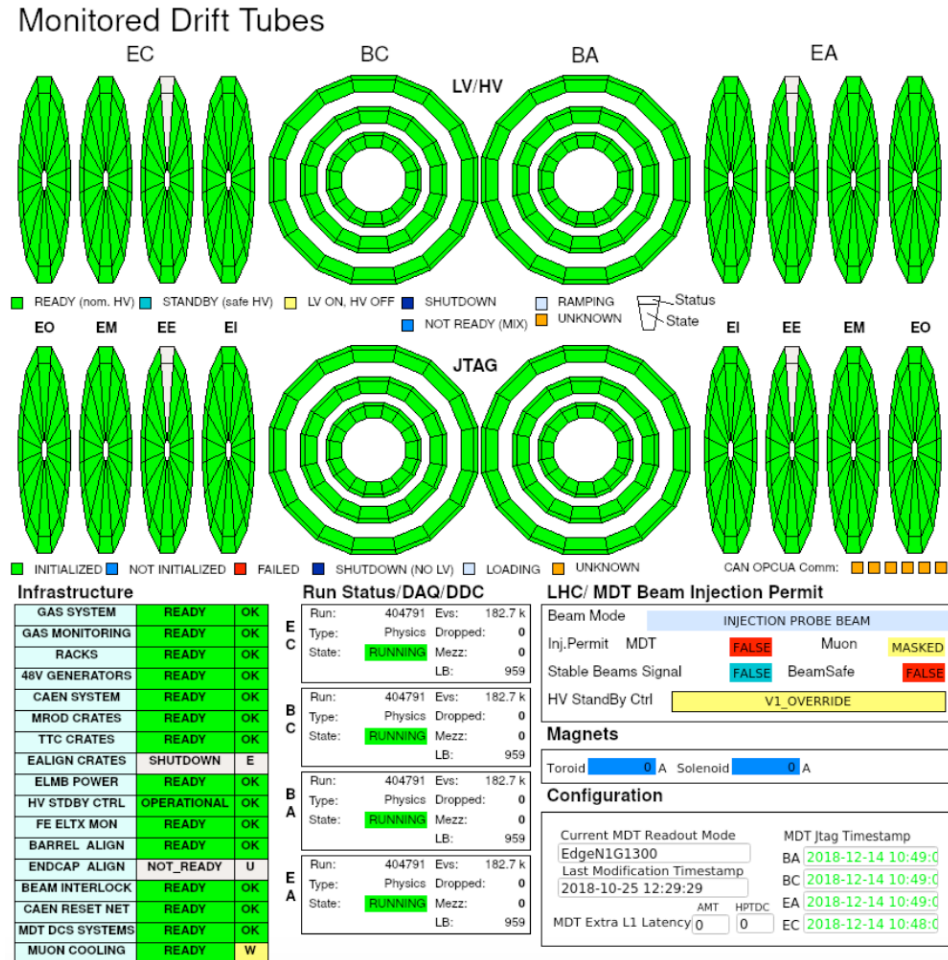


**Publications on Pheno.
Studies about new physics
search at LHC**

Current activities

Phase-I upgrade :MDT upgrade for Run3

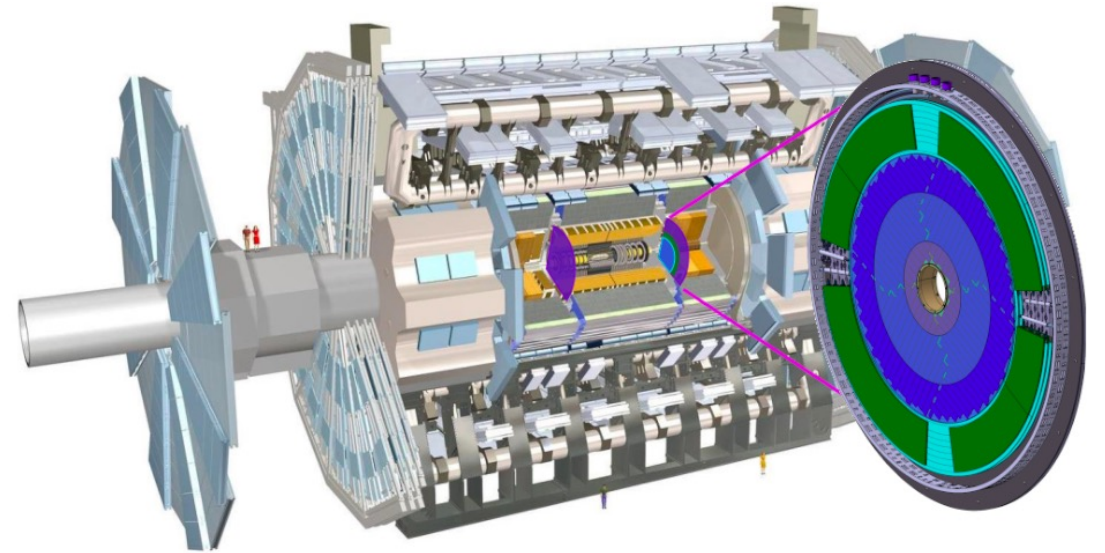
- Decommissioning of the old MDT chambers and installation, commissioning of the new BIS7 sMDT chambers
- Tests of the MDT system and bring up non-working chambers for RUN3
- 1 PhD student at CERN since 2020 (3 years) : financial support from ATLAS Muon group



Upgrade for HL-LHC

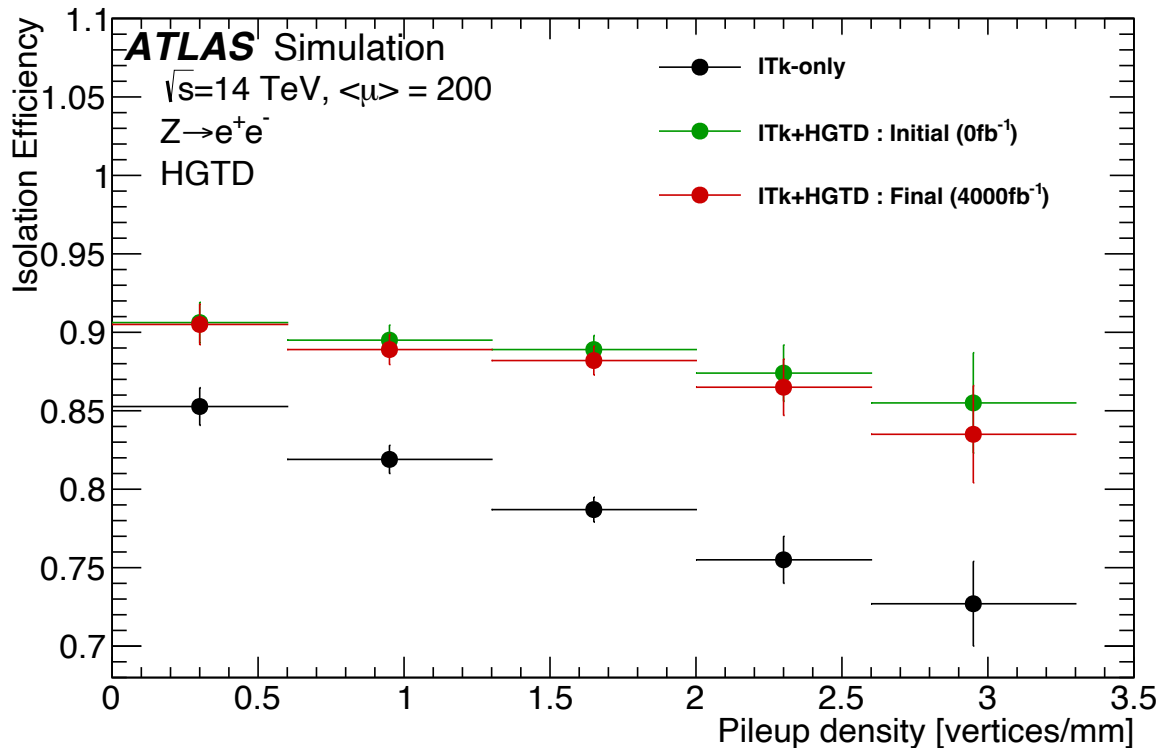
HGTD activities

- Large increase of pileup interactions for HL-LHC
- High-Granularity Timing Detector (HGTD) proposed for the ATLAS Phase-II upgrade, complementing the capabilities of the upgraded Inner Tracker (ITk) in the forward regions
- Use a high-precision timing information (30 ps) to distinguish between collisions occurring close in space but well-separated in time in the region of $\eta \in [2.4, 4]$



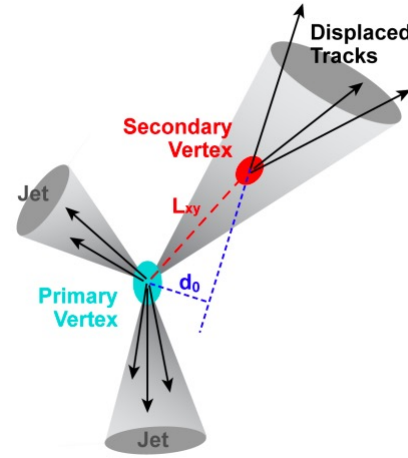
HGTD Physics Performance Studies

Lepton Isolation



b-tagging Performance

- Tagging b-jets is particularly sensitive to pileup track contamination
- ⇒ The performance of the b-tagging is significantly improved
- ⇒ Ongoing studies are based on the Generic BDT and self-tagging



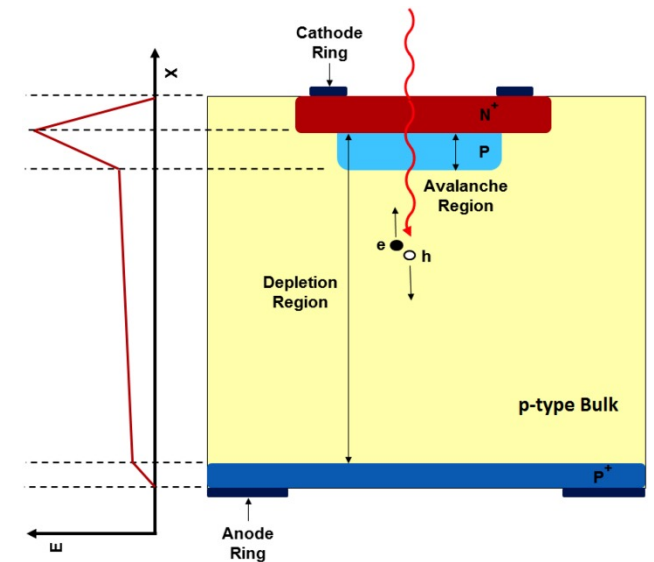
Object Reconstruction & Performance

- Improve the jet energy resolution in the forward region
- Use of particle-flow reconstruction & HGTD impact

Test beam activities

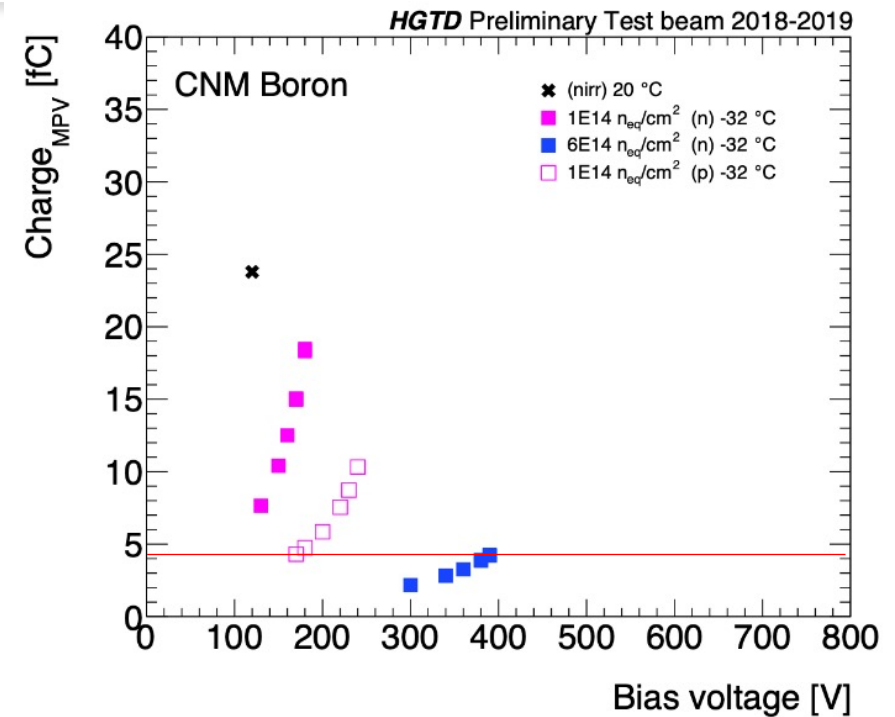
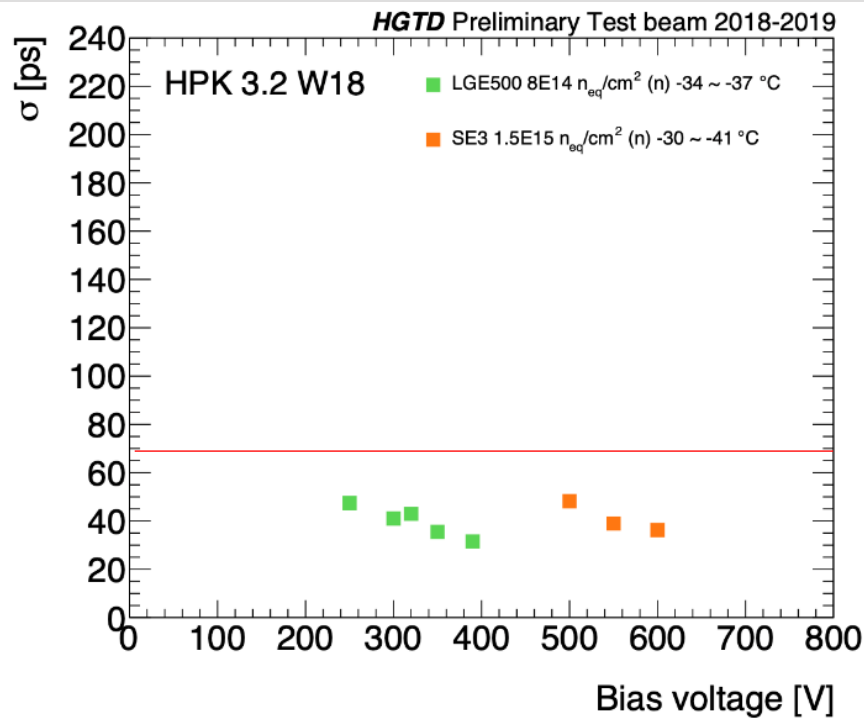
Choice of Low Gain Avalanche Detector (LGAD) :

- ❖ HGTD needs to achieve 70 ps/mip/sensor resolution: technology beyond standard silicon devices
- ❖ Fast signal and excellent S/N
 - The avalanche region increases signal slope
 - Timewalk contribution negligible with CFD
- ❖ Thin sensors ($50\ \mu\text{m}$) to reduce intrinsic Landau contribution to resolution



Test beam campaigns

- ❖ Study LGAD performances : collected charge, time resolution, efficiency ...
- ❖ Sensors provided by different manufacturers, with different doping and irradiated at different fluences up to $3 \times 10^{15} n_{eq}/cm^2$



HGTD Modules Assembly

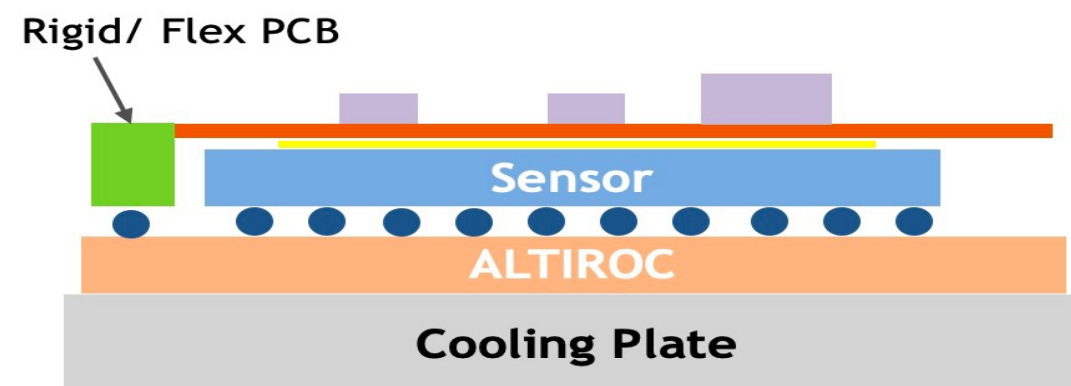
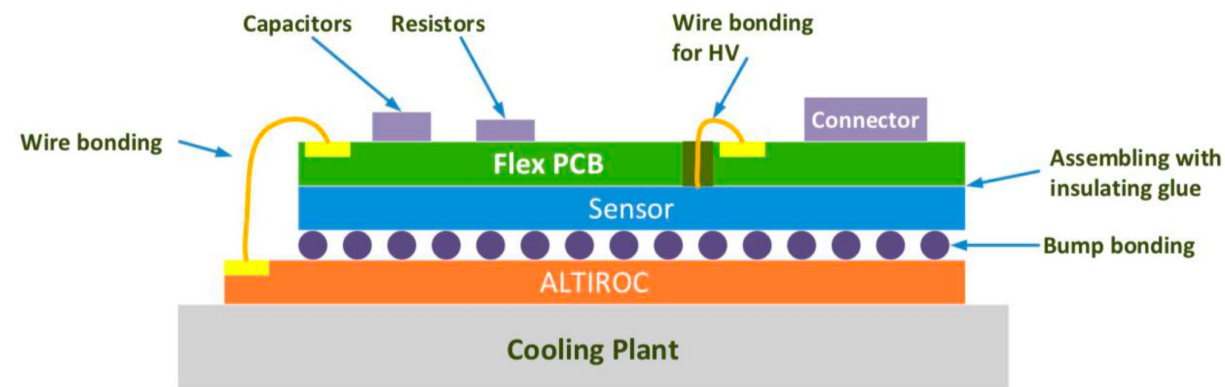
Activity locally coordinated by MAScIR, selected as one of the six assembly centers

Baseline for Module Assembly :

- Dummy modules to share with all assembly sites (for training)
- Prepare the assembly and test of the module
- Contribution on SPR Document

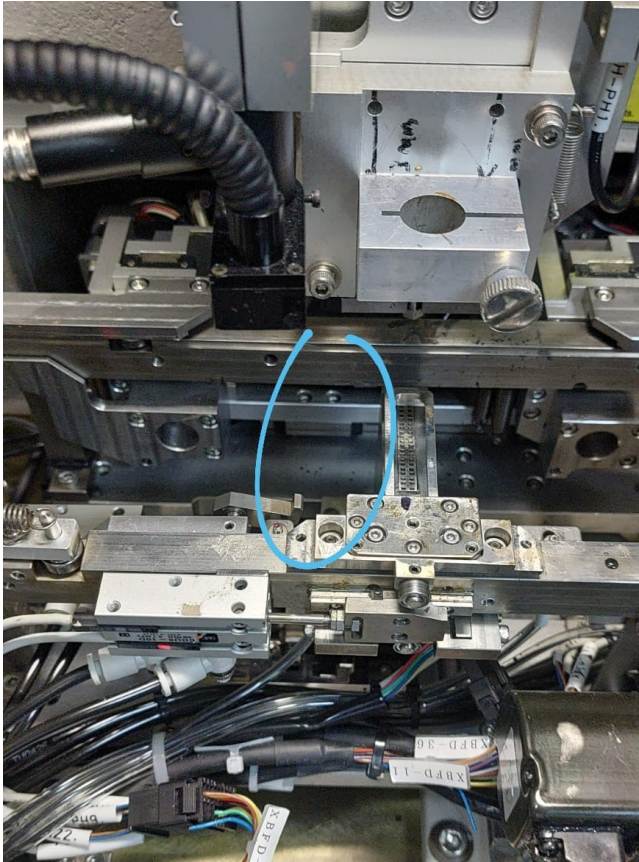
Alternative Module Design R&D:

- Altiroc Bumping Solution
- Process Flow
- Rigid Flex Attachment



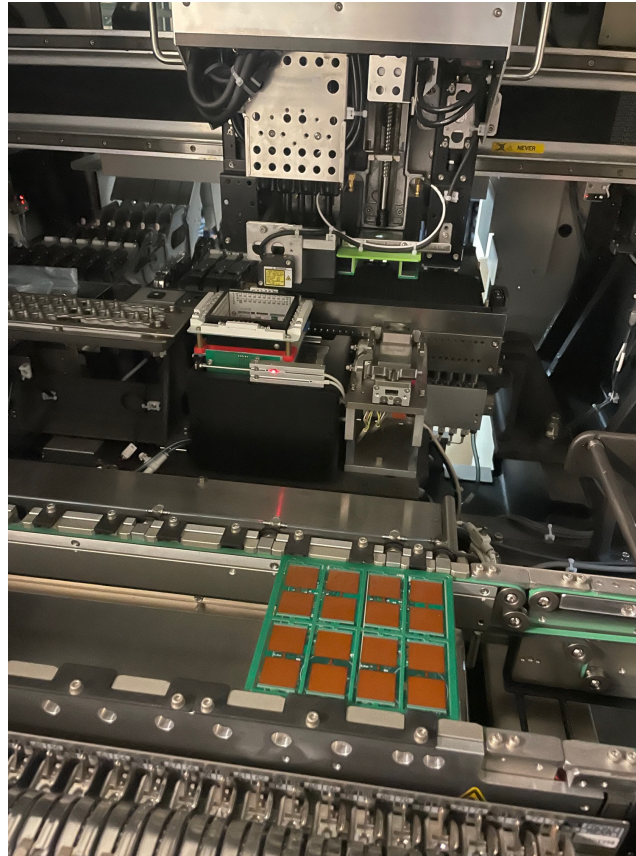
• Placement Options. (I. Azzouzi, HGTD week, 27 June -1 July, 2022)

Flip Chip Bonder



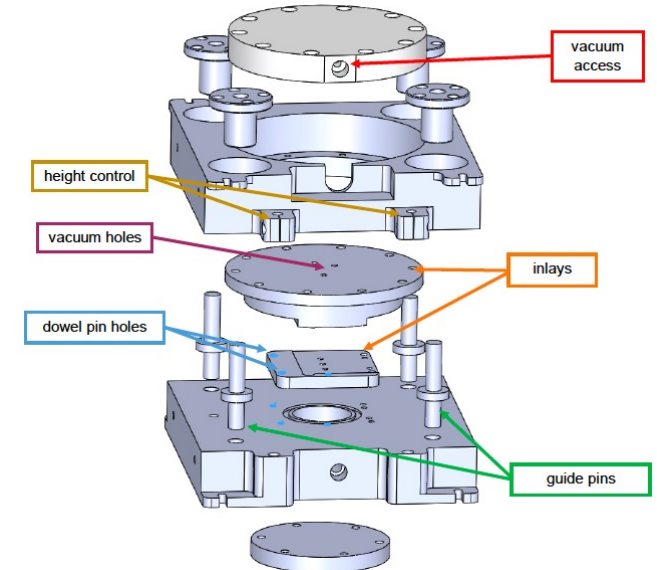
- Limitation of indexer width (PCB too large)

Pick and Place



- Setup just Completed
 - Placement and accuracy under evaluation

Manual Placement with Jig



- Manually using the Gluing Jig
 - Not yet received

Benefits for PhD students :

- Take part in the R&D phase of module assembly
- Use of new technologies in microelectronics

→ 2 PhD students actually at CERN :

- Since 2020 (PhD Grant) : TB activities
- SKF support 2022: Demonstrator

Other activities

Computing & Software

- HGTD GeoModelXML Description
- Pseudo Tracking and Simulation Fast Chain
- Grid & Computing : DAST Cordination

Non-Collision Background studies

- Background not coming from p-p collisions
- Study of the beam-induced background (BIB) as a kind of NCB
 - Test the main available flags
 - Identify the working flags and their efficiency
- Study of parasitic collisions :
 - Collisions that happen with other bunches outside the main colliding ones.
 - Study of minimum bias events with vertex displaced from the middle of the detector

Physics Analysis

Some ongoing studies

- **Search for a BSM resonance at the top quark sector**
- **Search for Invisible Higgs decays**
- **Search for charged Higgs in $H^+ \rightarrow tb$ channel :**
- **Diboson resonances in semi-leptonic final states**
- **Dihiggs HH resonant and non-resonant production : $bbll$ and $bbVV$ channels**

Computing resources

- HPC in the National Center for Scientific Research (CNRST)
- Mohamed VI Polytechnic University (UM6P) : Toubkal, most powerful HPC in Africa



- Commissioned to run ATLAS workloads
- Possible evolution to WLGCC Tier status

Cluster Masters

- Instrumentation and Scientific Computing in High Energy Physics – IISPHE (Casablanca Univ.)
 - ➔ **Master Mixing HEP , Instrumentation and Computing**
 - High Energy, Astronomy and Computational Physics : UCA Marrakech
 - Mathematical Physics – Radiation Physics : Rabat University
- ➔ **Thanks to dedicated schools (ASP, ESIPAP ...) for additional formation**
- ➔ **Need schools in computing**

Funding Agency Involvement

- 2017 : CERN visit of the funding agency (CNRST)
- 2018 : new agreement signed to recover the Moroccan debt
- 2020 : total debt fully cleared
- 2021 : Upgrade MoU signed by CNRST
- Actually : full support from funding agency



CNRST DG – 18 Dec. 2017



UM6P President – 30 Sep. 2021

MAScIR DG – 11 May 2022



D. Benchekroun, Higgs Discovery Celebration

Conclusion && Perspectives

- **Clear evolution of our activities since the Higgs discovery**
- **Increase of the number of students, activities**
- **A special effort given to the phase-2 upgrade**
→ **Increase involvement in hardware activities**
- **Continuous support from our funding agency : taking into account the potential of technology transfer and possibilities for young scientists**
- **Need for new positions at universities dedicated to ATLAS activities**