ATLAS Activities in Morocco

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**On behalf the ATLAS Moroccan Group**

Introduction

- Morocco is member of ATLAS collaboration since 1997

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

- Univ. Casablanca   - Mohamed VI Polytechnic University (since 2021)
- Univ. Rabat
- Univ. Kénitra   - MAScIR : Moroccan foundation for Advanced Science,
- Univ. Oujda   Innovation and Research
- Univ. Marrakech   Technical Associate Institute since 2020

- ~20 defended theses : 1 /year

- ~ 20 ongoing theses on ATLAS

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 η ∈ [2.4,4]
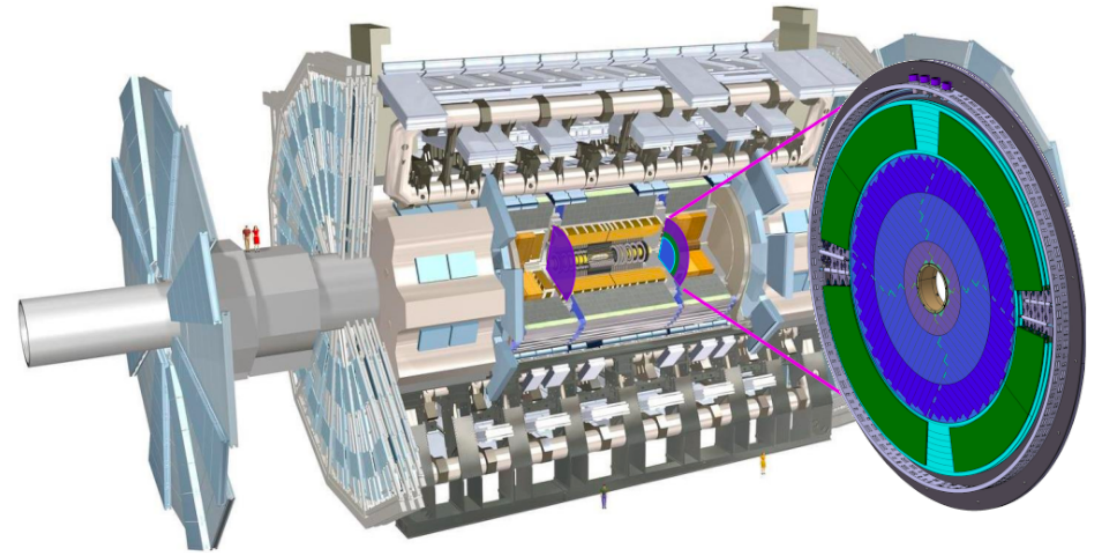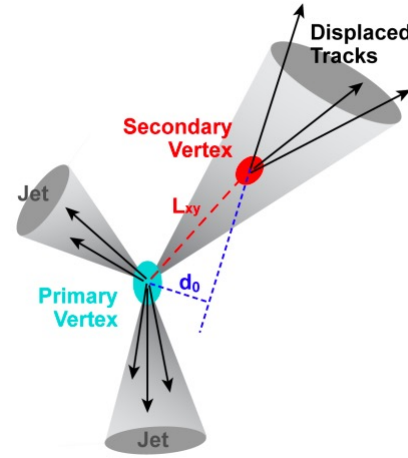
HGTD Physics Performance Studies

Lepton Isolation
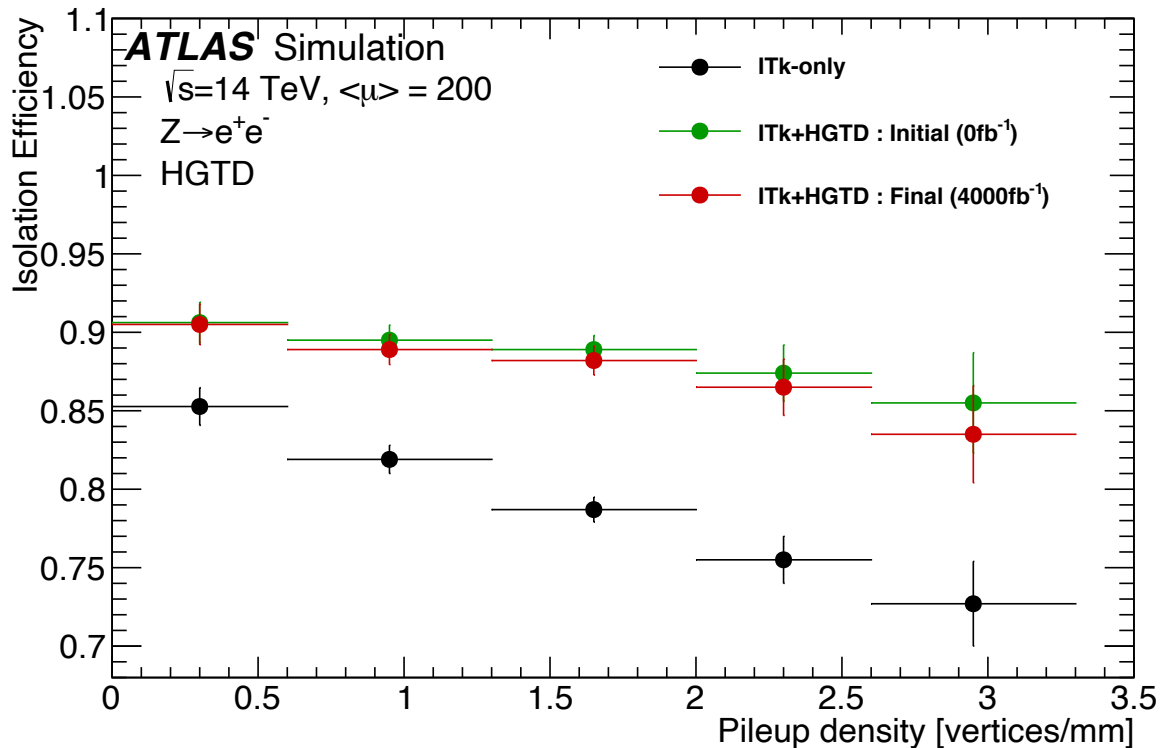
b-tagging Performance

- 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 μm) to reduce intrinsic Landau contribution to resolution
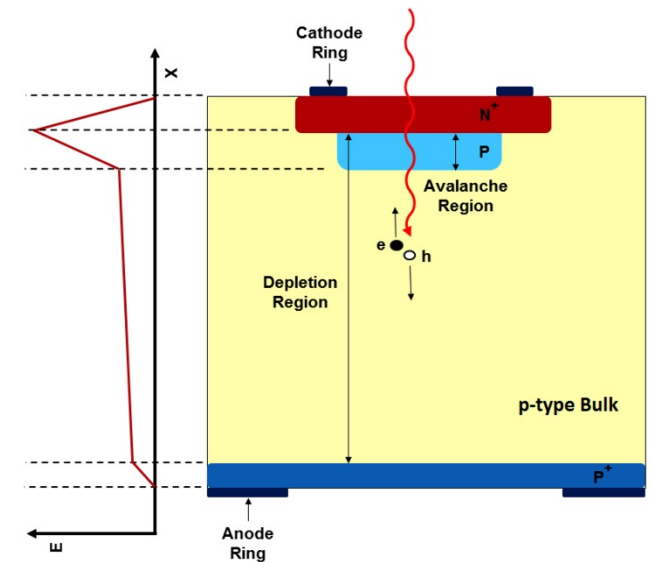
Test beam campaigns

❖ Study LGAD performances : collected charge, time resolution, efficiency ...

❖ Sensors provided by different manufacturers, with different doping and irradiated at different fluences up to $3 \times 10^{15} n_{eq}/cm^2$
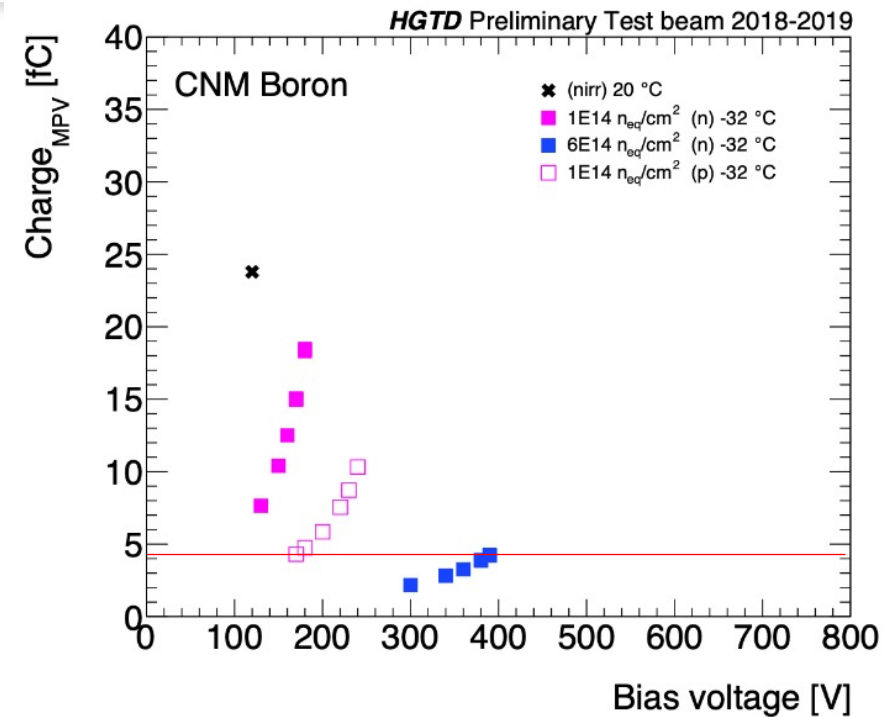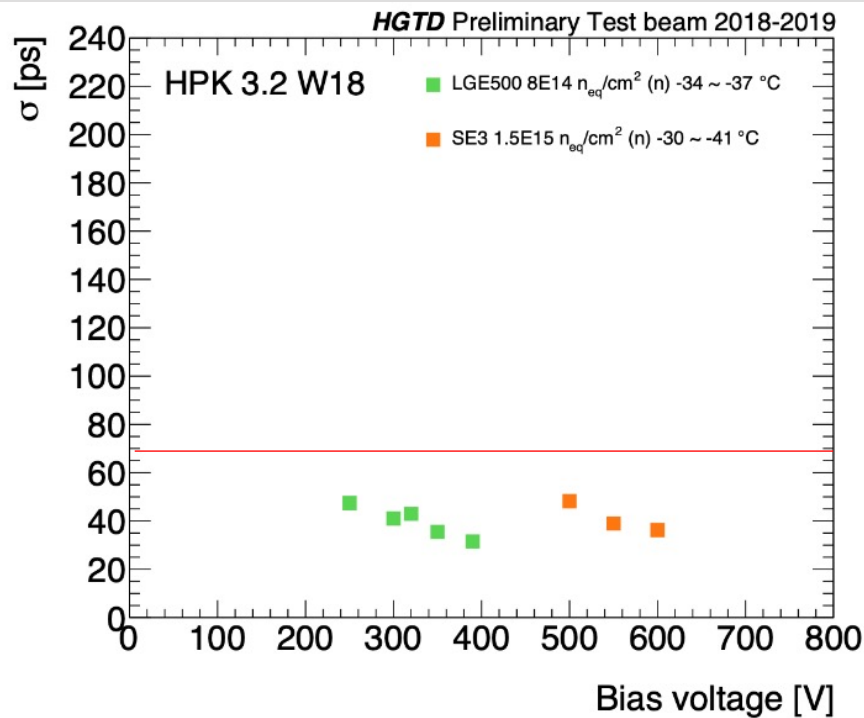
HGTD Modules Assembly

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
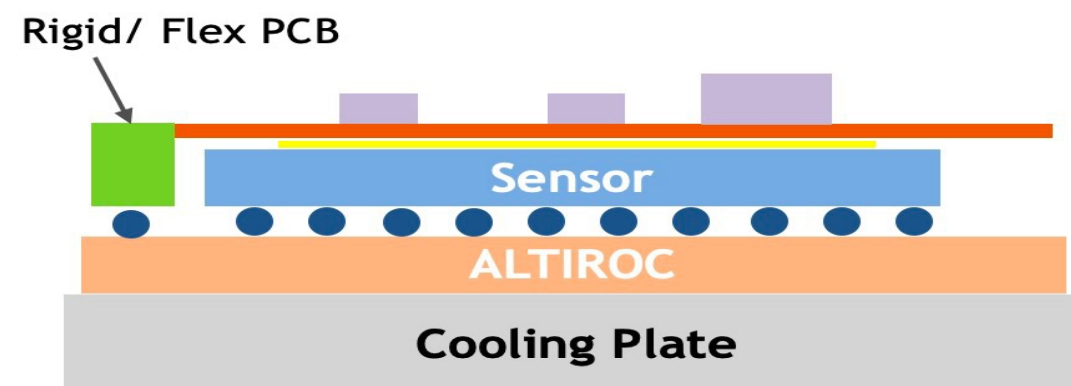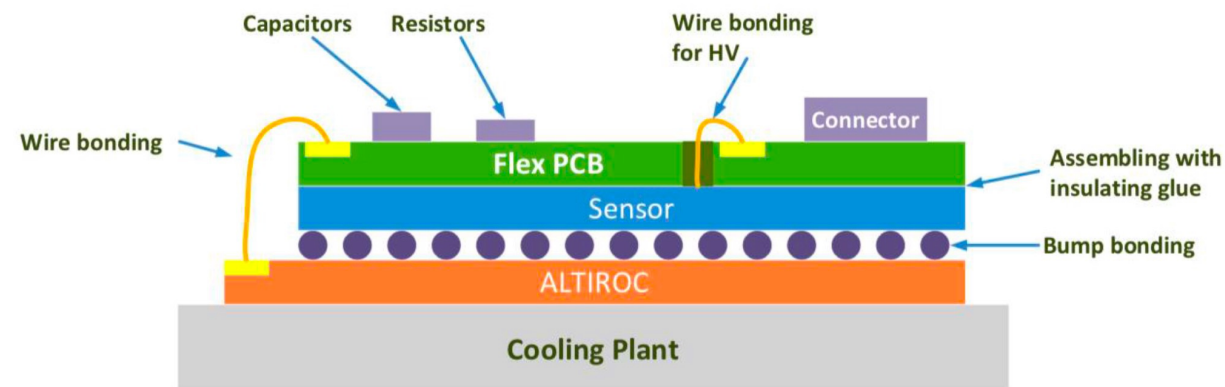
Main activities :

➢ Prepare BOM/ Tooling for Module assembly using available Gold Bond Bonder:
- • Glue
- • Assembly Jig

➢ Prepare material for Module Test:
- • Xilinx Zynq-7000 SoC ZC706
- • Cables
- • Interface Board

Benefits for PhD students :

➢ Take part in the R&D phase of module assembly

➢ Use of new technologies in microelectronics

➢ LGAD use in medical physics (beam monitoring)
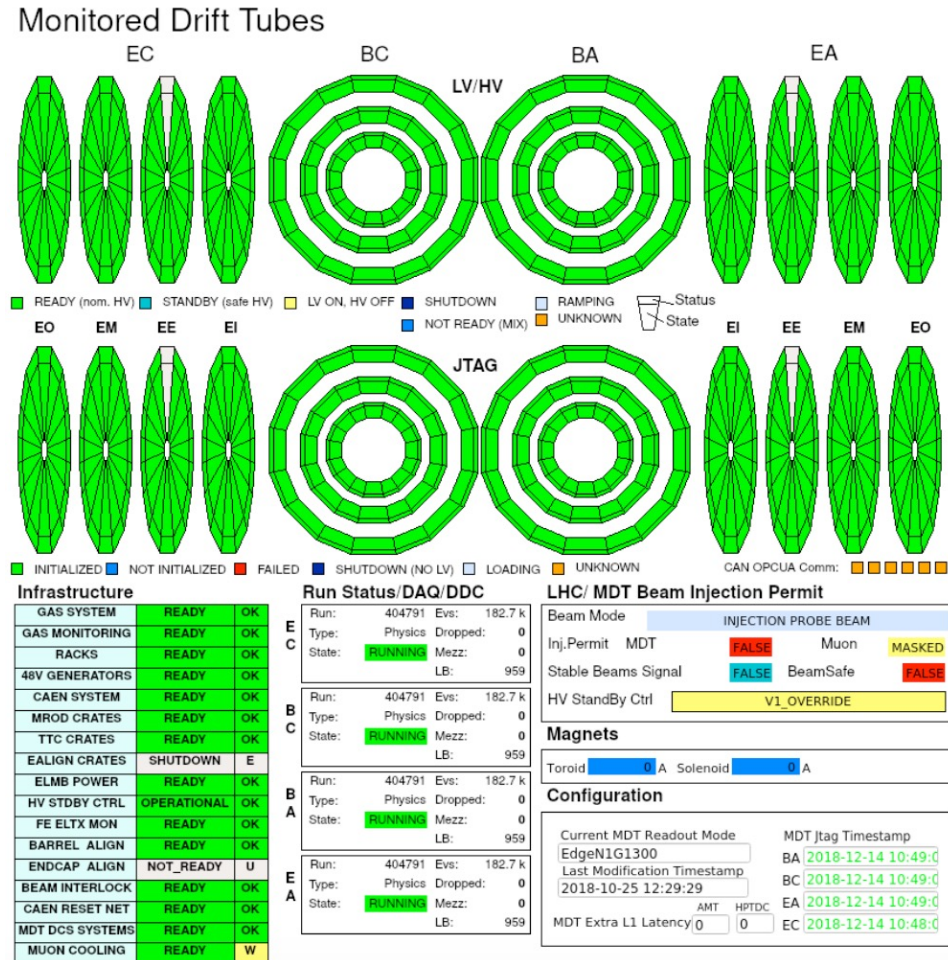
Other activities
Computing & Software

- HGTD GeoModelXML Description

- Pseudo Tracking and Simulation Fast Chain

- Grid & Computing : DAST Cordination

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

Non-Collision Background studies

➢ Background not coming from p-p collisions

➢ Study of the beam-induced background (BIB) as a kink of NCB
- o Test the main available flags
- o Identify the working flags and their efficiency

➢ Study of parasitic collisions :
- o Collisions that happen with other bunches outside the main colliding ones.
- o 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**

- Analysis framework development and validation
- Events selection and reconstruction using Chi2 method
- DATA/MC comparison
- QCD estimation using Matrix Method
- Limit setting

➢ **Search for Invisible Higgs**

- Search for invisible Higgs bosons produced via vector boson fusion
  - Scale uncertainties
- Combination of searches for invisible Higgs boson
- Higgs portal vector dark matter interpretation
  - WIMP interpretation

➢ **Search for Hidden Higgs or dark Sector**

- The search for "exotic" decays, i.e. decays that involve new light states beyond the SM

- Exotic Higgs interpretation for AS, HM and LM searches

- Search for Exotic Higgs Decays to 2 leptons and 2 neutrinos final state using Machine Learning

- Search interpretation using 2HDM+S model . **In addition to ILC projections**

➢ **Search for charged Higgs in H$^+$ ➔ tb chanel :**

- **Search H$^+$,** in the H+ mass range from 200 to 2000 GeV, **in the channel :** pp → tbH+ → tbtb

  1 paper published && 1 in progress

➢ **Diboson resonances in semi-leptonic final states**

   Z', KK ….. - 3 published papers

➢ **Dihiggs HH resonant and non-resonant production : bbll and bbVV channels**

- Study of both VBF and ggF production modes   - Common subject for # institutes

- Use of NN to separate VBF, ggF and background events   - Possible collaboration with

- Implement systematics for VBF analysis   Pheno. people (see A. Arhrib) talk)

Computing resources

- Most of physicists are working from their ATLAS accounts

- Some institutes have local machines with ATLAS software and useful tools installed : possibility for simulation tuning before production

- Aim : have at least tier3 centers : local MC production && data analysis

- HPC in the National Center for Scientific Research (CNRST)

- Possible solution with Mohamed VI Polytechnic University (UM6P) : HPC Toubkal

https://www.datacenterdynamics.com/en/news/university-morocco-africa-supercomputer-toubkal/

→ Tier3 center of ATLAS, with the possibility of upgrading to a tier2
&& skills in machine learning and applications (useful for data analysis)

➔ **Need students with a good knowledge in :**

❖ HEP Phenomenology

❖ Radiation interaction with matter

❖ Advanced programming Languages

❖ HEP Instrumentation

❖ Grid Computing – Machine learning

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**

Conclusion

- **Our activity in ATLAS covers a large field of studies**

- **Contribution to ATLAS papers and talks**

- **A special effort given to the phase-2 upgrade && Run3 preparation**

- **Need to continuously adapt our training to the project evolution**
  → not trivial !!

- **Invest in computing resources and improve the connectivity**
  → need of dedicated manpower