Semiconductor sensors development and applications WG-5.2

First General Meeting

Part I - Status Report

FAPESP Thematic 2020/04867-2

March 3rd 2023

WG-5.2.1 & WG-5.2.2 : Recap

- WG-5.2.1 : ATLAS High Granularity Timing Detector (HGTD)
- WG-5.2.2 : Low Gain Avalanche Detectors (LGADs) for low energy applications

Details on August kick-off meeting

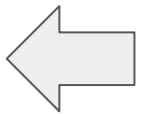
WG 5.2.1: People and Action Items (Recap)

1. Current Team
   - 1.1. M. Leite (Physicist)
   - 1.2. G. Saito (MS,PhD)
   - 1.3. R. Menegasso (TS)
   - 1.4. M. Kuriyama (TS)
   - 1.5. DD (Dedicated)
   - 1.6. DD (Sharing with PA)
   - 1.7. PD (Sharing with PA)
   - 1.8. IC (TT-2 ?)
   - 1.9. TT-4

DD–4: *Ultra-fast semiconductor sensors and associated instrumentation for radiation detection*

1. Deliverables
   - 1.1. LGAD Characterization Lab.
   - 1.2. Characterization of LGAD sensors (on-going)
   - 1.3. Performance studies on irradiated arrays (on-going)
   - 1.4. PEB test stand system
   - 1.5. Participation in HGTD assembly facility construction @ CERN (on-going)
   - 1.6. Demonstrator construction @ CERN (on-going)
   - 1.7. HGTD installation
   - 1.8. HGTD commissioning

1. Action items
   - 1.1. Equipment availability (importation)
   - 1.2. Preparing civil infrastructure for Lab
   - 1.3. Lab installation
   - 1.4. PD, DD, TT hiring
   - 1.5. Start testing sensors
   - **1.6. Significant work to commission local infrastructure (EMU FAPESP)**
   - 1.7. **Significant commitment of people on @CERN activities**



Almost zero float on these items !

WG 5.2.1 : ATLAS HGTD - Infrastructure @CERN

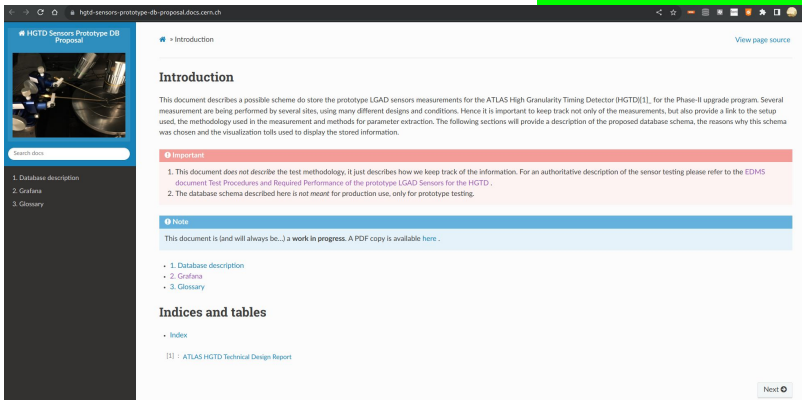
Done (2022)

- **R. Menegasso & M. Kuriyama** @ CERN (3 Months)
  - Clean room and metrology setup for HGTD assembly @ B180
  - Demonstrator construction and thermal test system support
- Effort will intensify during construction and integration years !

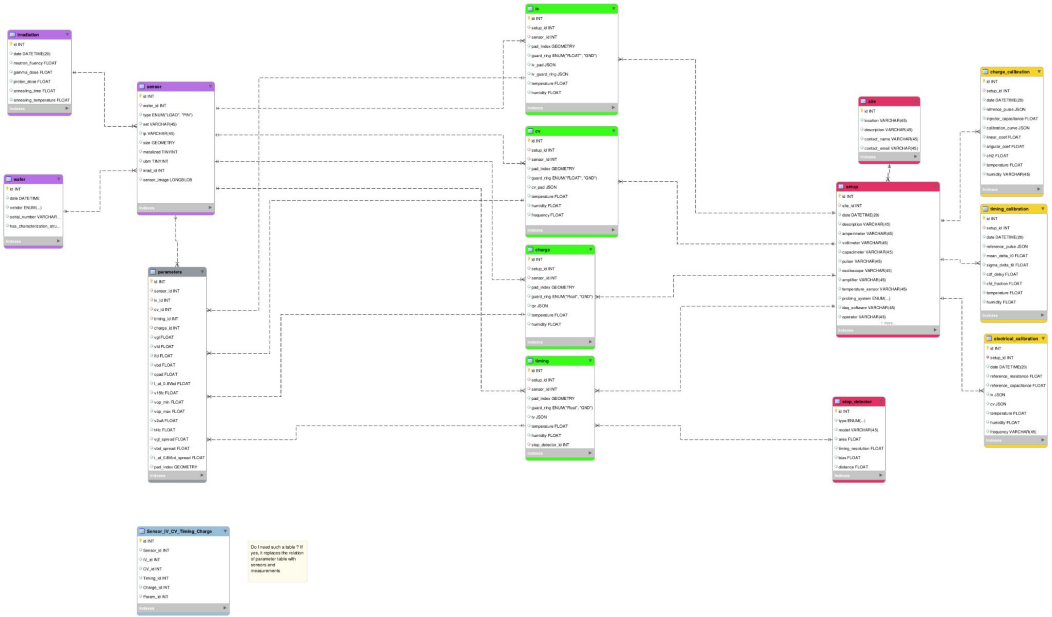
WG 5.2.1 : ATLAS HGTD - Sensor test and Database

- **M. Leite, G. Saito - collaboration in HGTD DB group**
  - Documentation (Sphinx, gitlab pages)
  - Sensor database (MySQL)
  - Plot (Grafana)
- Concludes in 2023, updates after that

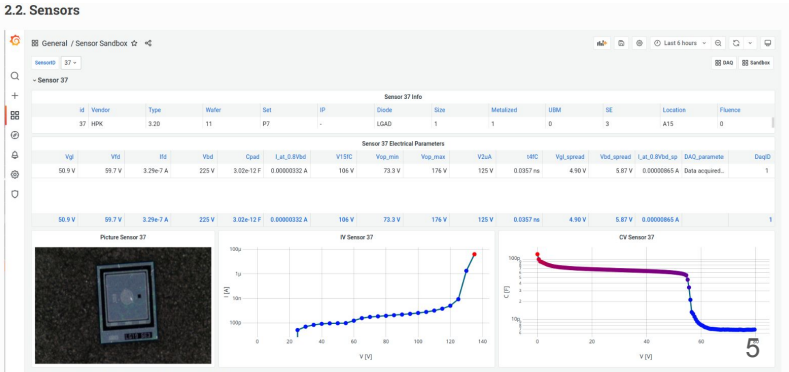
On Track



DB Schema



DB Query and plot in Grafana

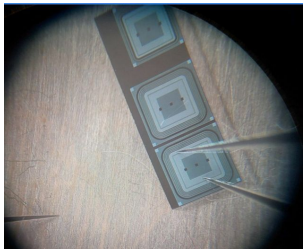


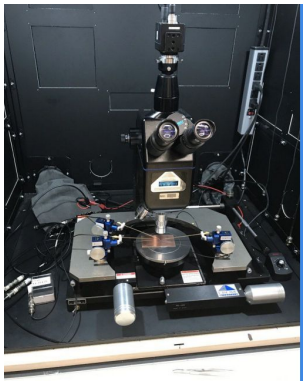
Example of a grafana dashboard showing information about sensors.

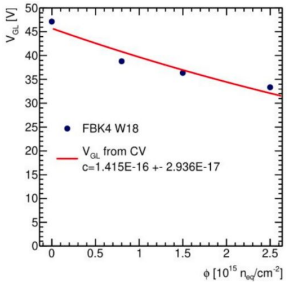
WG 5.2.1 : ATLAS HGTD - Sensor tests and Database

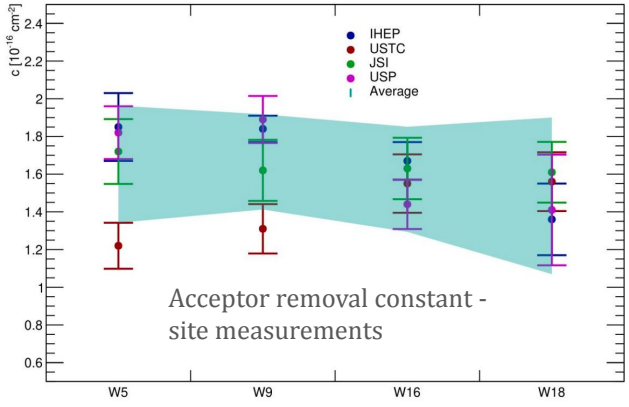
On Track

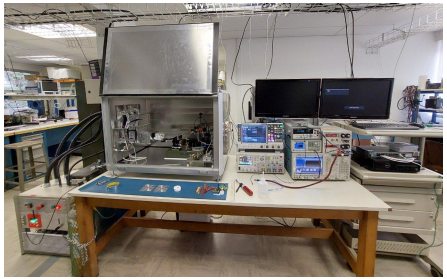
- **M. Leite, G. Saito - ongoing sensor testing**
  - Sensor tests at USP and FEI (M. Pavanello)
  - New laser system in 2023 …
- Part of the commitments for HGTD (forever …)

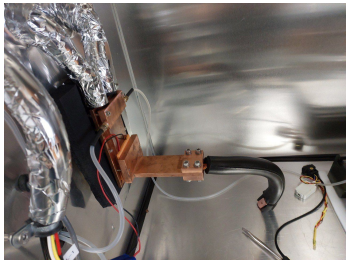










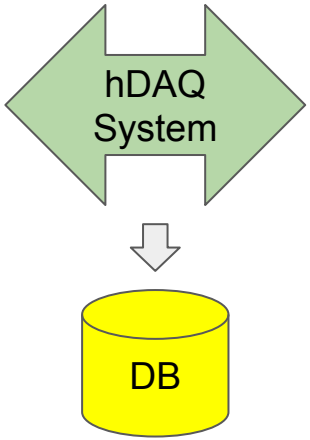


WG 5.2.1 : ATLAS HGTD - Infrastrucutre @USP

- We need to be ready by ~~March 2023~~ as soon as possible
- Importation in several advanced stages by FAPESP and/or acquired in local distrib. (but support for other equip. across institutes)
- Bias tee, low noise conexion boxes and matrix switch being assembled



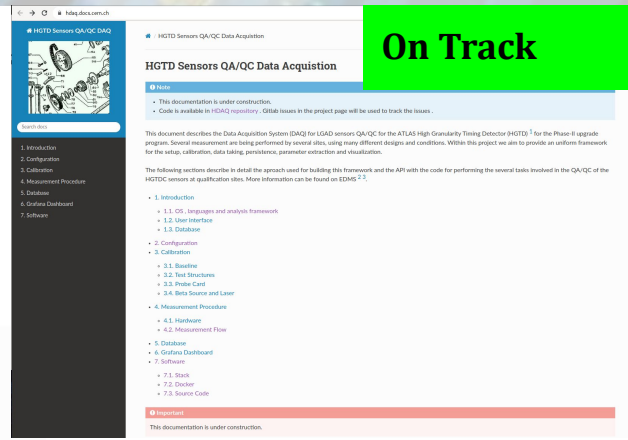


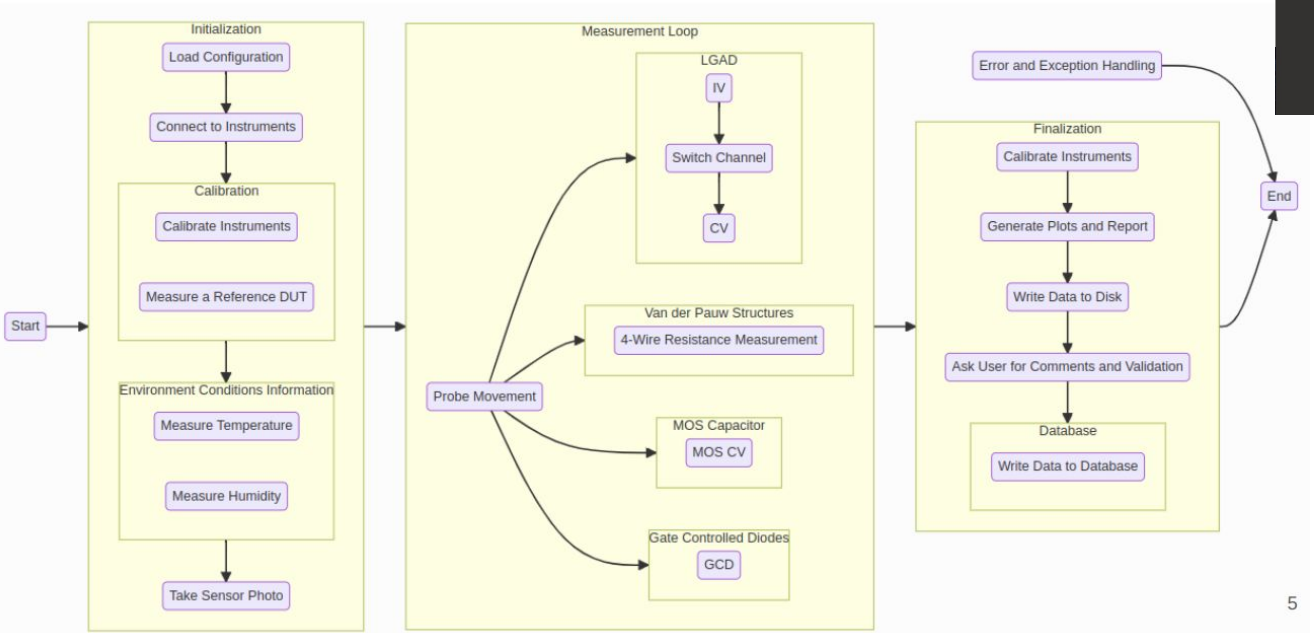
Watch ➡ **On Track**

WG 5.2.1 : ATLAS HGTD - hDAQ

- Integrated DAQ System for Sensor QC
- Sensor and control structures
- MySQL DB integration
- Part of the commitments for HGTD (forever …)
- https://hdaq.docs.cern.ch
- https://gitlab.cern.ch/ATLAS_USP/HGTD/Sensors/QAQC/HDAQ



On Track



WG 5.2.2 : WBS and Deliverables

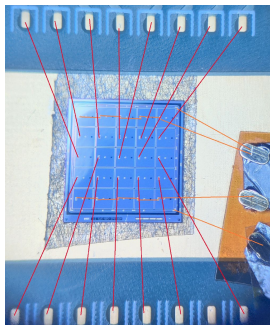
LGADs/AC-LGADS for picosecond time-resolved X-ray testing

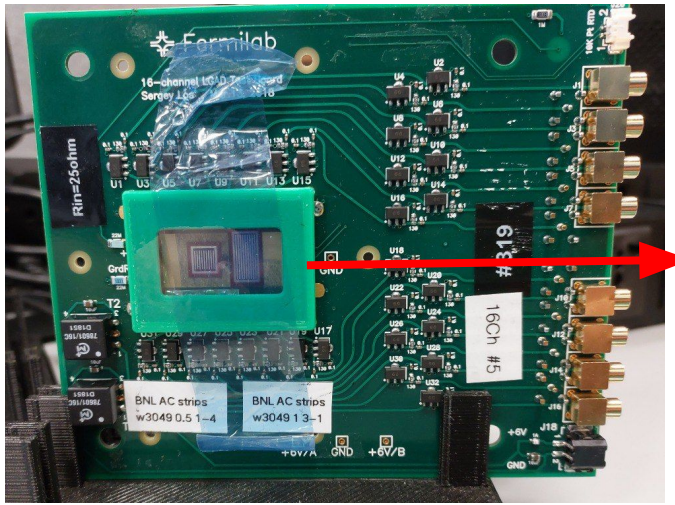
On Track

4. Radiation testing of *available* LGAD, AC-LGAD
   - 4.1. X-Ray testing
   - 4.2. Charged particle testing (electrons, protons, ions)
   - 4.3. Time Resolved X-Ray testing (**M. Leite & UCSC**)

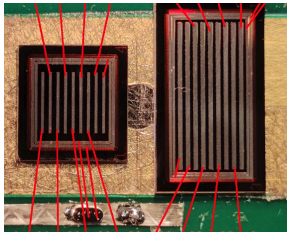
Tested at Stanford SLAC SSRL test beam with UC Santa Cruz in November 2022

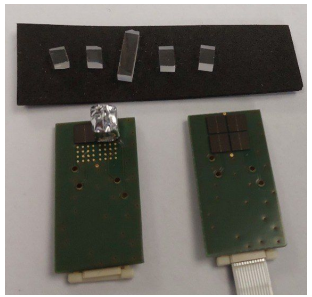
- Energies from 5keV to 53 keV (70 keV with harmonics)
- "Flat" beam (BL 11.2) : 12.6mm x 2.14mm
- Several intensities and bias voltages
- LGADs :
  - HPK 3.1 Single (1.3mm)
  - HPK 3.2 single (1.3mm)
  - HPK 3.2 5x5 (1.3mm)
  - BNL 20μm Single (1mm)
- AC-LGADs :
  - BNL strips

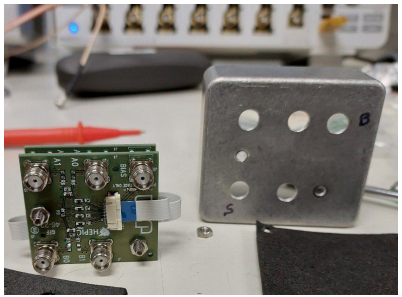




Strips
AC-LGAD







Compton Box
(SiPM + LYSO)

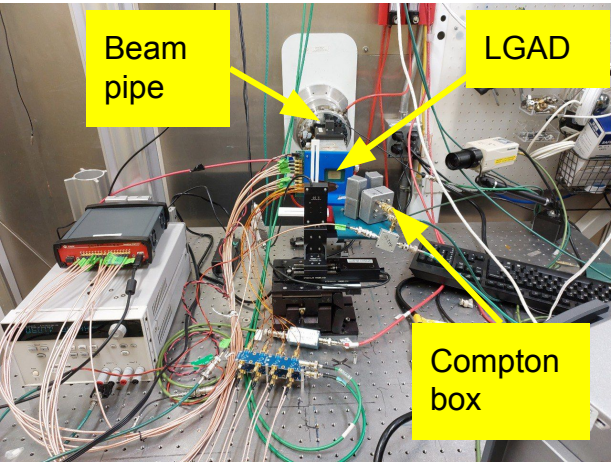
Long range and continuous effort - also discussion with Sirius detector group

WG 5.2.2 : WBS and Deliverables

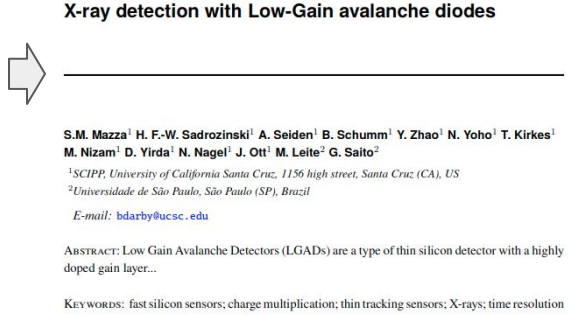
Part-I - LGADS for picosecond time resolved X-ray testing

On Track

SSRL BL 11-2



- Significant amount of work since Dec. 2022
- Analysis almost completed, paper in preparation (JINST) to be submitted next month or so



X-ray detection with Low-Gain avalanche diodes

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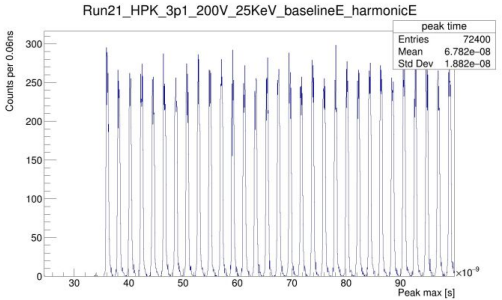
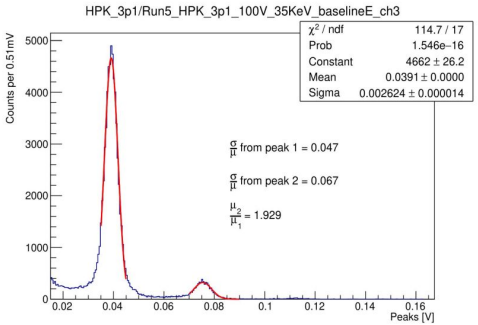
Abstract: Low Gain Avalanche Detectors (LGADs) are a type of thin silicon detector with a highly doped gain layer...

Keywords: fast silicon sensors; charge multiplication; thin tracking sensors; X-rays; time resolution

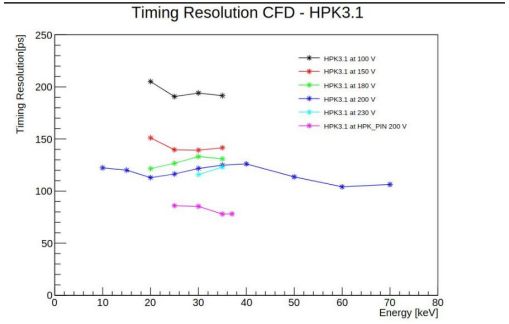


Bunch structure

Energy resolution



Timing resolution



WG 5.2.1 & WG 5.2.2 : **ACTION ITEMS FOR NEXT MONTHS**

on track
critical
new

ATLAS HGTD

- Move ahead with USP infrastructure
  - Most critical item
  - Involves space, import and equipment purchase
  - Needs to prepare lab infrastructure while space discussion is on-going
- DAQ development and DB integration @ USP (in sync with CERN/IHEP/USTC/JSI)
- Infrastructure (baby demo and mockup) @ CERN
- Build the laser system with motorized stages + position measurement

New applications

- Validate first functional TCAD and Geant4 simulation
- Add Ad-hoc simulation code for multiplication mechanism
- Analyze data from TB @SLAC, resume discussion with Sirius (more people involved…)
- Understand irradiation needs and prepare infrastructure/tests at local facilities
- Explore/Converge designs for fabrication (WG 5.2.3 - see next presentation)

WG5.2 Workshop early 2023 (January ?)

- All members with EOI in project will have the opportunity to present their plans/schedule
- follow up through indico working meetings during 1st term of 2023 as preparation for the 1st report to FAPESP