ASP short-term visits for research

Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

Summer 2019 BNL

@BrookhavenLab

January 24, 2023

Kétévi A. Assamagan

ASP Alumni at BNL 2019-2023

June-December 2019. From left

In front: **Christelle Ekosso** (Cameroon), Dr. Mounia Laassiri (Morocco); Standing: **Diallo Boye** (Senegal), Dr. Somiealo Azote (Togo), Jesutofunmi Fajemisin (Nigeria), **Hassnae El Jarrari** (Morocco), Dr. Kétévi A. Assamagan, Raymond Yogo (Kenya), and Yves Kini (Burkina Faso). **Heba Sami Abdulrahman (Egypt), not in the figure, arrived in September 2019.**

July 2022 – February 2023. From left:
Asmaa Aboulhorma (Morocco),
Zainab Soumaimi (Morocco),
Dr. Kétévi A. Assamagan,
Antalia Rabarisoa (Madagascar),
Xola Mapekula (South Africa),
Dr. Kayode Dada (Nigeria),
Rado Fanantenana (Madagascar)

Brookhaven National Laboratory

Acknowledgements

- **DOE Office of Science**
- **BNL DEI Office, NPP Diversity Council**
- **US-ATLAS**
- **Departments that hosted African students**
  - Physics, Collider Accelerator, Center for Functional Nanomaterials, NSLS-II
- **Physics groups & advisors that hosted students**
  - Electronic Detector Group, Omega Group, Medical Isotope Research and Production, CFN Soft and Bio Nanomaterials, Physics Theory Group, Astro & Cosmology Group, ATLAS Software & Computing, **all the Advisors & Mentors**
- **Administration**
  - Linda Feierabend, Eileen Morello, Tracy Trent, Menzel Smith-Jones, Grace Webster, Office of International Services
- **Folks who went beyond for quality of life at BNL**
  - M. Bishai, S. Snyder, C. Weber, R. Pisarski, P. Ramohlouoane

Today, we will hear from the cohort of 2022

Indentation Technique for the Examination of Nanomechanical Properties of Human Tissues

Kayode A. Dada, Ph.D. (Medical Physics)

Centre for Energy Research and Development,

Obafemi Awolowo University, Nigeria

01/24/2023

Brookhaven National Laboratory

@BrookhavenLab

Outline

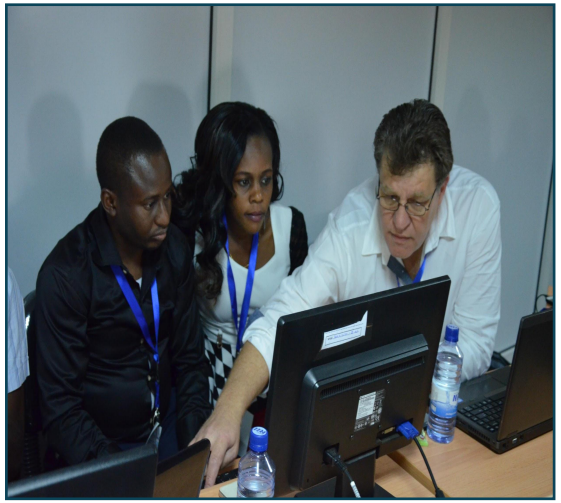
- Short synopsis of my academic path.
- The ASP that I attended.
- My arrival at and departure from BNL.
- The group that I have been working with at BNL.
- A brief description of the work I have been doing at BNL. and results.
- Prospects and outlook for my academic career, and continuation of the work
- Acknowledgements.

Short synopsis of academic path

- Bachelor of Technology, *Pure and Applied Physics*, Ladoke Akintola University of Technology
- Master of Science, *Medical Physics*, Obafemi Awolowo University, Nigeria: ***Protection against effects of radiation***
- Doctor of Philosophy, *Medical Physics*, Obafemi Awolowo University (2021): ***Understanding the biomechanics of irradiated brain cells using established cell lines***
- Challenges encountered include access to requisite research facilities, funding, academic strikes, etc.

ASP attendance - Kigali, 2016





Geant4, fundamental physics, ROOT analysis, mentorship, etc

BNL arrival and accommodation

- Arrived on August 29, 2022
- Expected departure date: February 18, 2023
- Hosted by the Center for Functional Nanomaterials
- Major tool used: Atomic force microscope (Cypher AR)
- Research group: Soft and Bio nanomaterials
- Activities supervised by Dr. Dmytro Nykypanchuk

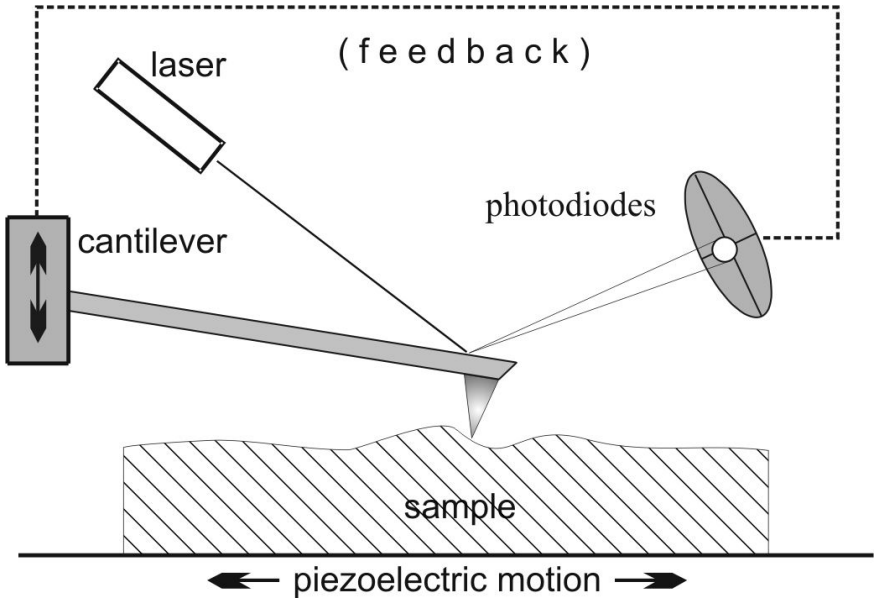
Research Group: main goal

Soft and Bio Nanomaterials:

"Development methods for assembly of hybrid nanoscale systems from organic and inorganic nanoscale components, understanding phenomena driving structure formation and energy-conversion properties of these materials. Our approach for system assembly is based on the unique properties of macromolecules, such as the recognition, re-configurability, and reversibility of interactions, which are used to direct and regulated self-assembly of nano-objects into functional materials with optical, electrical, magnetic and bio-sensing functions."

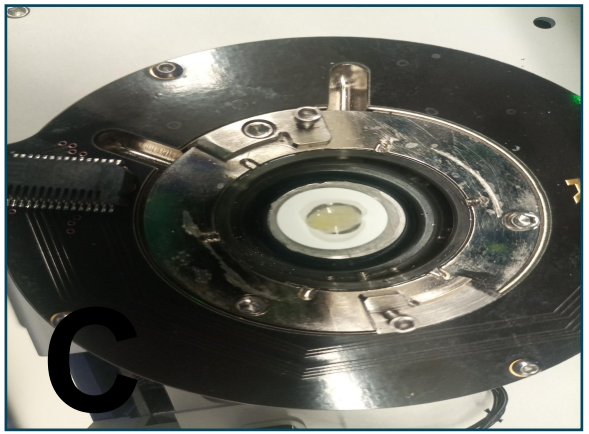
BNL Research Activities and results…

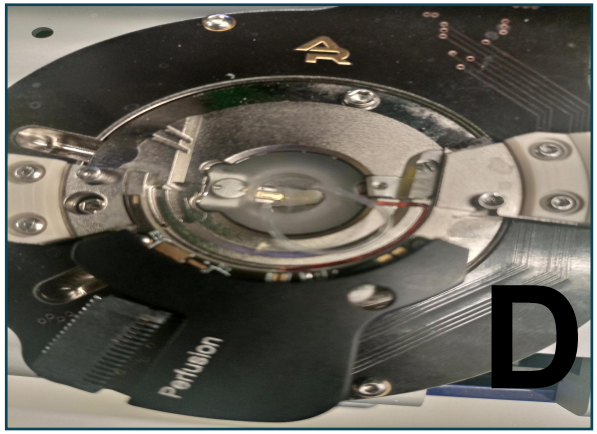
The detection techniques used for cancer management range from molecular assays to radiodiagnosis. Although these methods provide clinical information on the presence of cancer, limited information on the metastatic potential of the cancer cells are usually available before commencement of therapy.

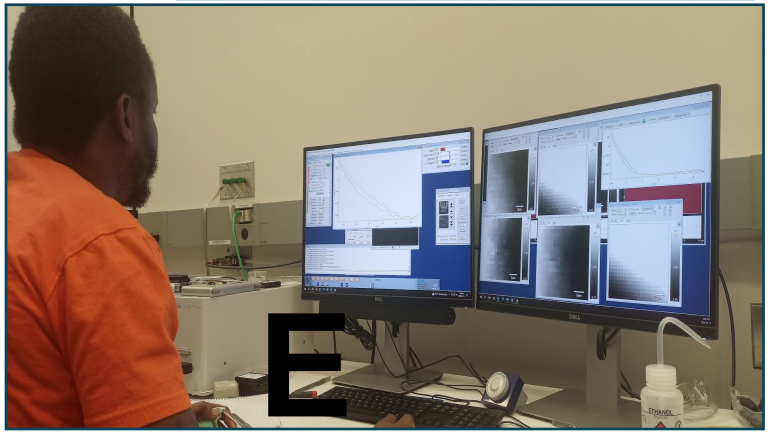


Basic principle of tool used:
atomic force microscope (AFM)

Details of the facility…





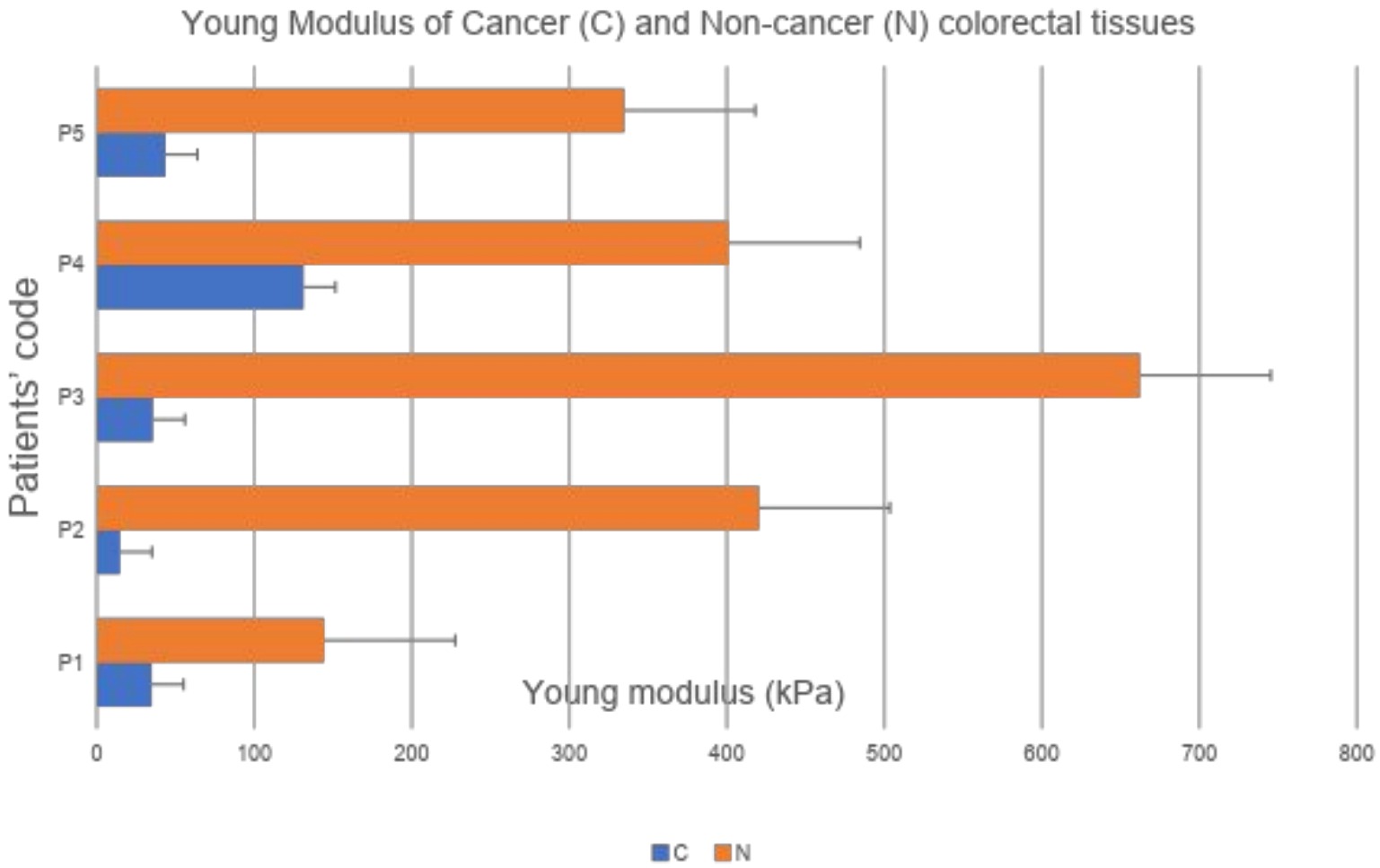


Brookhaven National Laboratory

Summarized workflow used

- Resected colorectal normal/cancer tissues were used.
- Specimens preserved in formaldehyde until use.
- Calibrated the AFM cantilever. Sneddon model for spheres probes.
- Para: Ss = 5-20 µm, setpoint 1 V, f = 64.5 kHz, k = 0.1 – 2 N/m
- About 1 mm cut from each specimen was glued to a coverslip and then attached to metal disc.
- Placed the disc on the AFM stage and added about 50 µl of PBS on sample and 20 µl on cantilever. A water column was then created between the cantilever and specimen.

Summarized results/findings …



Brookhaven National Laboratory

Challenges encountered…

- Liquid medium for imaging: Has not been possible so far
- Very soft specimens: Technically difficult to cut
- Technical complexities: Repeated problems sometimes need new approach for solution
- Specimen status: Measurements best taken within hours of surgery

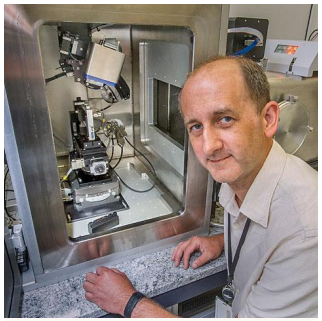
Prospects and outlook: academic career, and continuation of the work

- Presently seeking for a postdoctoral position in biophysics/ radiation biology (radiobiology)/ mechanobiology (cell mechanics)
- Effects of radiation on mechanical properties of cells and tissues
- Effects of preservation on mechanical characterization
- Relationship between structural architecture of the cells and stiffness for better understanding of the metastasis of cancer cells.

Acknowledgements

PROF. F.A. BALOGUN
CERD, NIGERIA

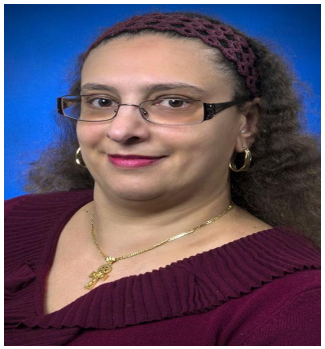
DR. K.A. ASSAMAGAN
ASP/ PHYSICS, BNL



DR. D. NYKYPANCHUK
CFN, BNL

GRACE WEBSTER
CFN USER PROGRAM
ADMINISTRATOR

NOEL BLACKBURN
DEI, BNL

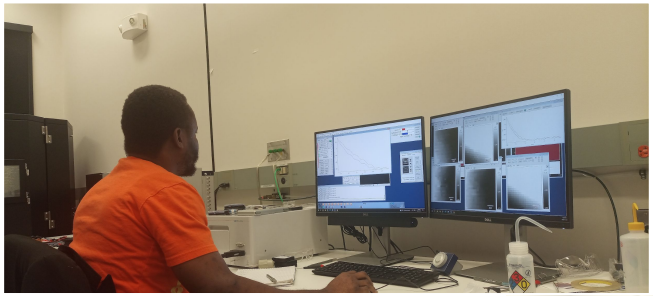


DR. MARY BISHAI
PHYSICS, BNL

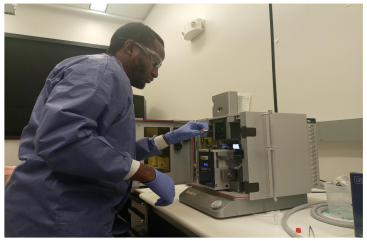
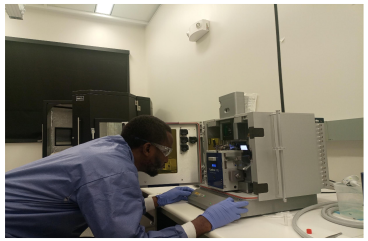
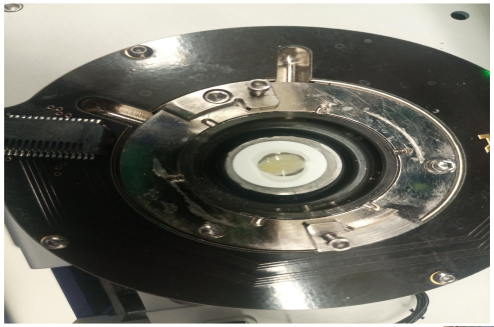
African School of Fundamental Physics and Applications

Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY







Brookhaven National Laboratory

Photo-captions

Thank you for your attention

Universal performance analysis of the DUNE Front-End Motherboards for quality control(QC)

Rado Fanantenana, Razakamiandra

University of Antananarivo, Madagascar

01/24/2023

Brookhaven National Laboratory

@BrookhavenLab

Outline

- Academic path
- My work at BNL
- Summary and Next steps
- Acknowledgements

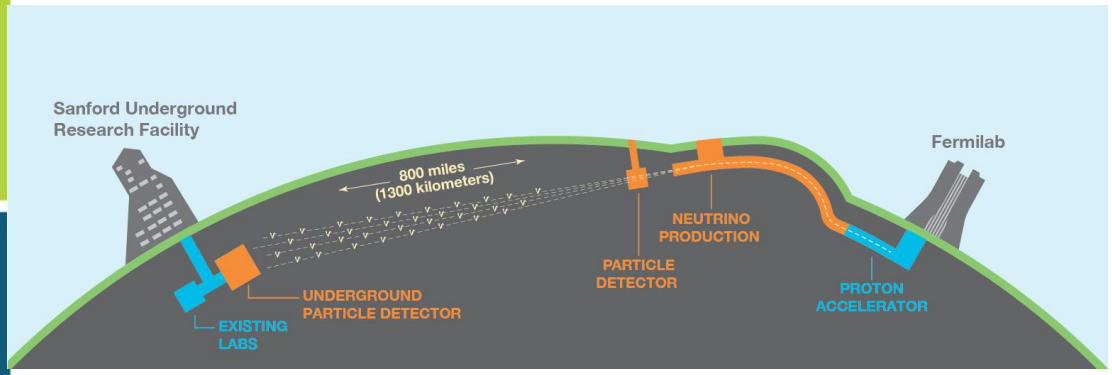
Academic path

- 2014 - 2017: Bachelor's degree in Physics (University of Antananarivo)
- 2018 - 2022: Masters degree in High Energy Physics (University of Antananarivo)

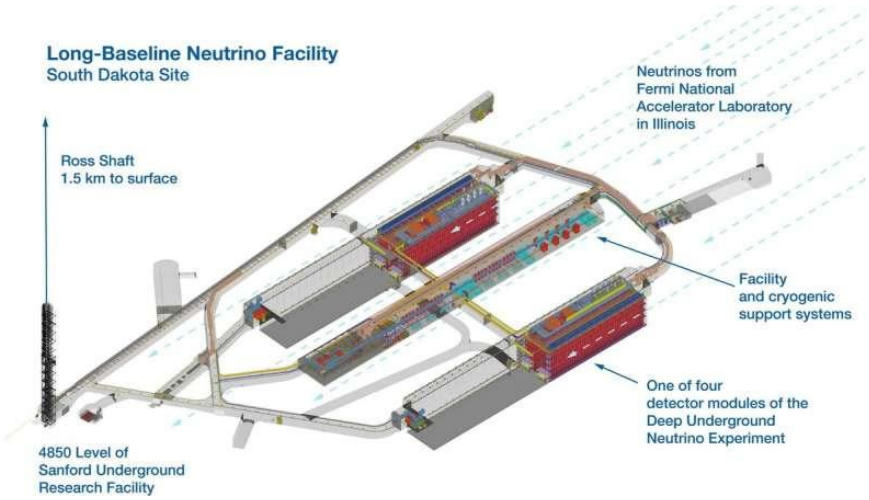
- Since 2019: volunteer based in Madagascar for the Deep Underground Neutrino Experiment(DUNE) working with Dr. David Martinez, Professor Assistant at South Dakota School of Mines & Technology

- ASP 2020/2021 alumni: online event
- Intern at BNL from August 15, 2022 to February 14, 2023 working with the Electronic Detector Group, Cold Electronics

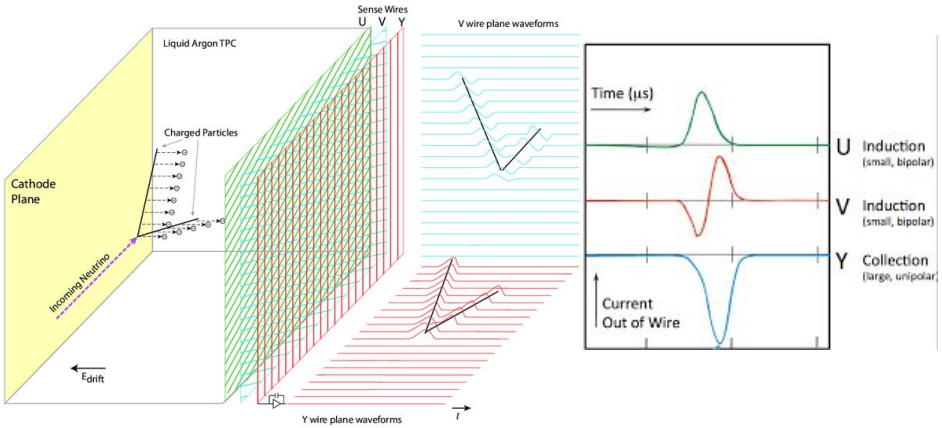
The Deep Underground Neutrino Experiment (DUNE)



- International neutrino experiments based in the United States of America
- Goal:
  - neutrino oscillations
  - proton decay
  - detecting neutrinos from supernova
- Will have near and far detectors



Liquid Argon Time Projection Chamber(LArTPC):



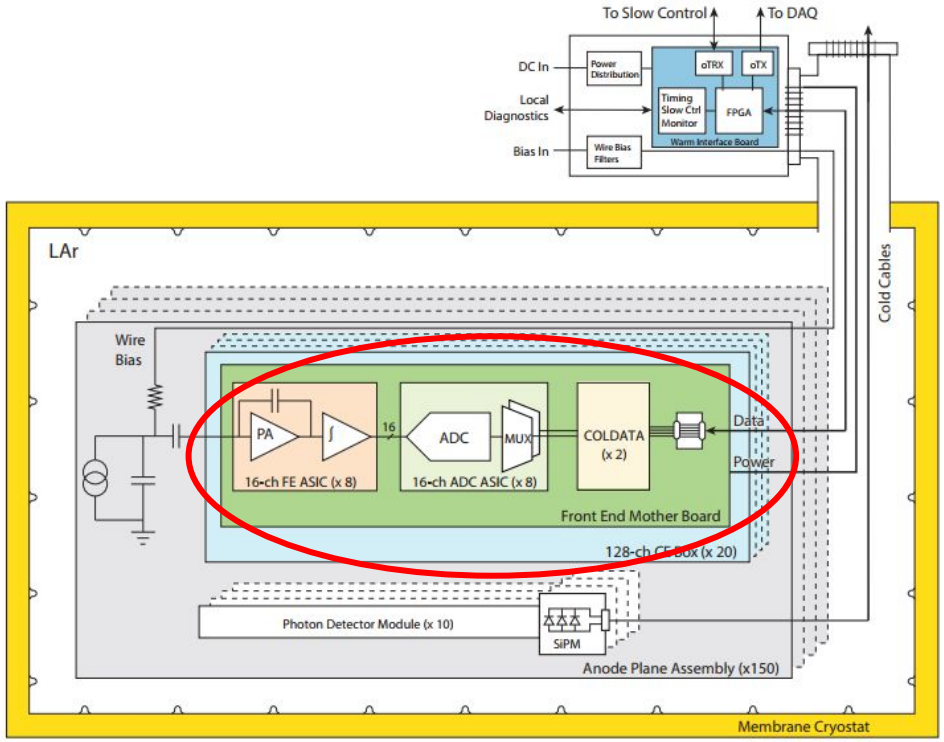
- Wire planes: mounted on the anode plane assembly (APA)
- Ionization electron will induce bipolar and unipolar signals on the wire planes
- signals: read by cold electronics mounted at the end of an APA

Brookhaven National Laboratory

Why Cold Electronics (CE) ?

- Best Signal to Noise Ratio (SNR)
- Freedom to choose the optimum configurations

CE schematic block diagram



DUNE 10kt far detector module 1(HD):

- 384,000 channels
- 24,000 FE ASICs
- 24,000 ADC ASICs
- 6,000 ColDATA ASICs
- 3,000 FEMBs

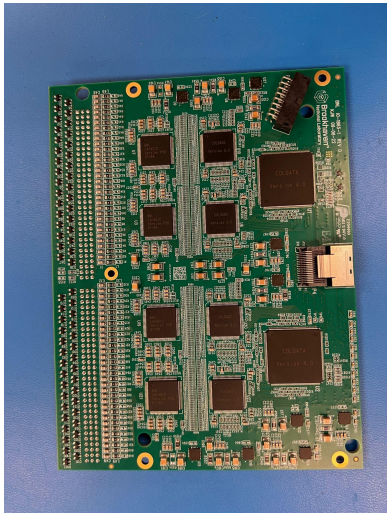
Brookhaven National Laboratory

Cold Electronics(CE) and their requirements

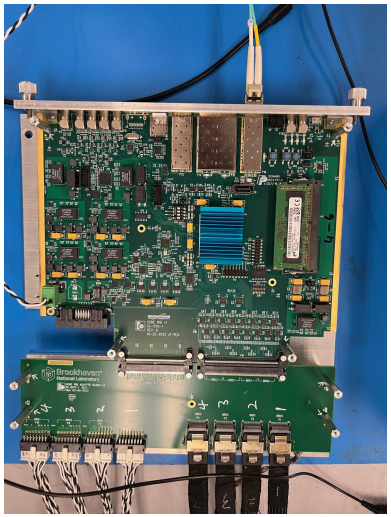
- **Requirements of the cold side:**
  - able to operate in Liquid Argon (87K)
  - long lifetime ~30 years
  - dead channels < 1%

Requires dedicated Quality Control(QC)

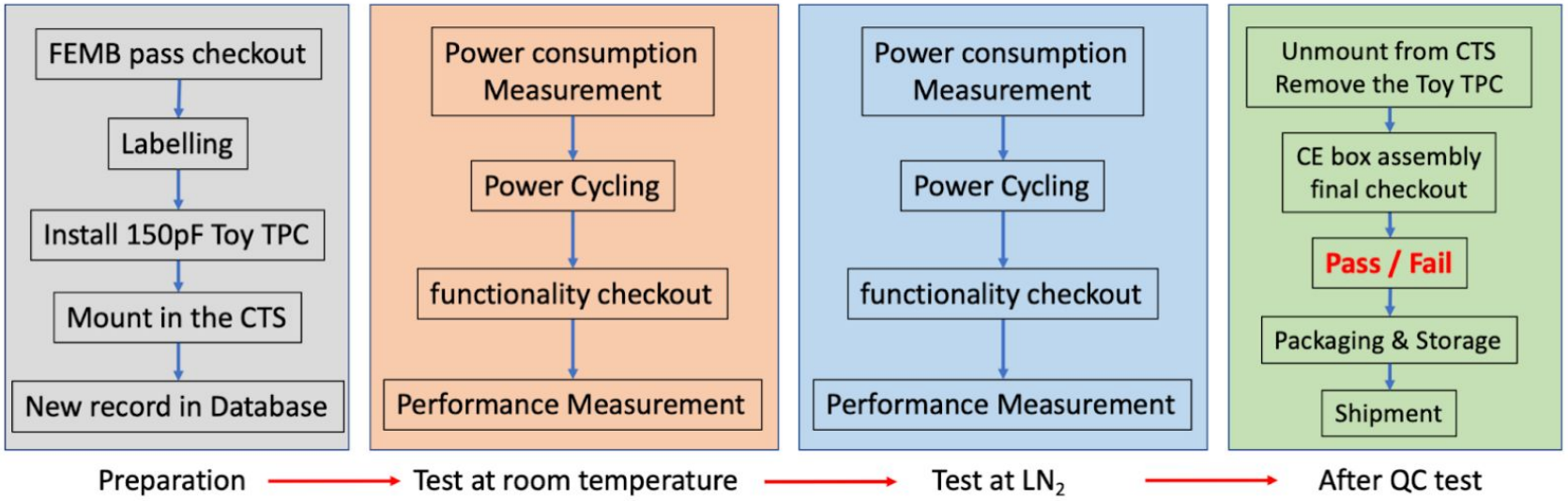
- **Components:**
  - Cold side : immersed in LAr and directly mounted on APA
    - Front-end motherboard (FEMB)
    - Cold Cables



  - Warm side: WIB (Warm Interface Board), PTC(Power and Timing Card), PTB (Power and Timing Backplane)

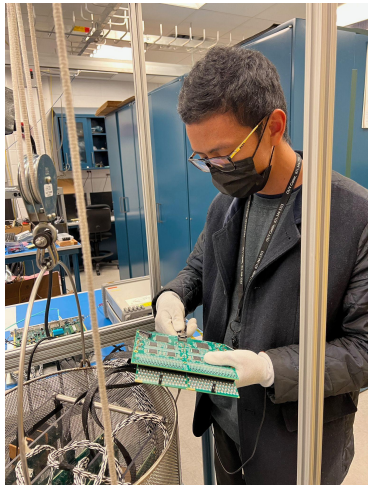


FEMB QC procedures

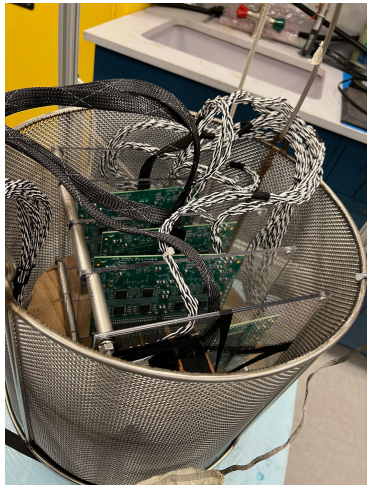


installing the Toy TPC

plug-in the cables



4 FEMBs ready for the QC test



immerse the FEMBs in LN2

Test finished, remove the FEMBs from LN2

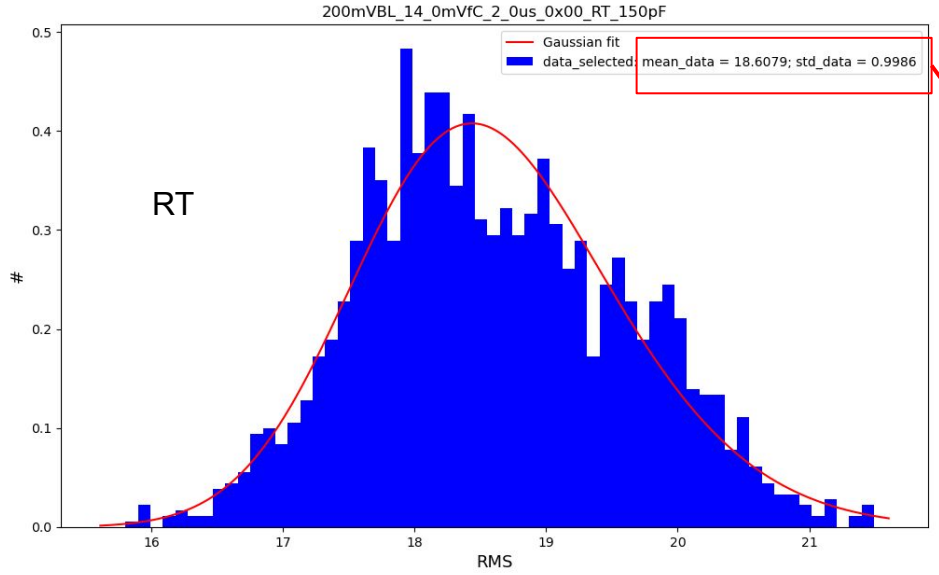
Brookhaven National Laboratory

Goal of this study

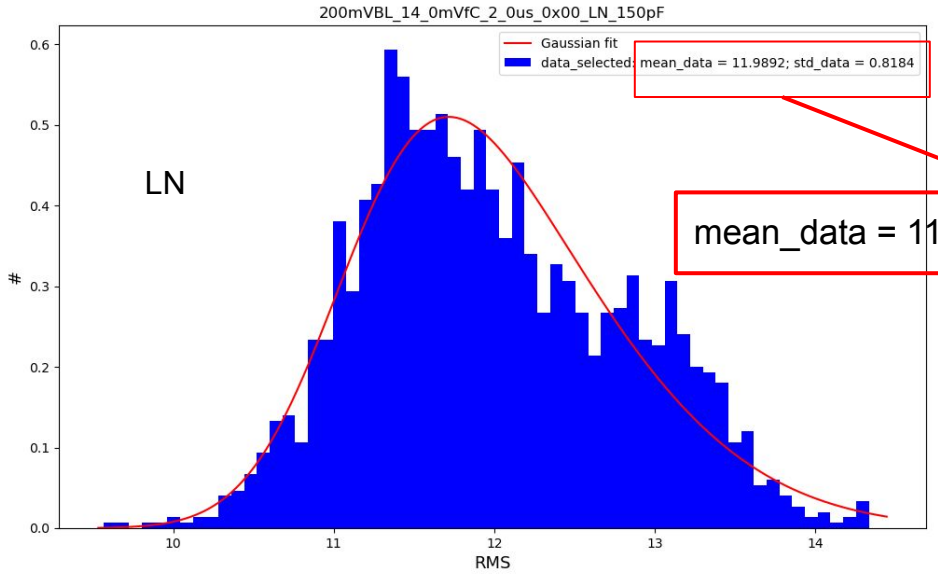
- Analyze the data of the FEMBs that passed the QC: statistical analysis

- Set an acceptance range on the FEMB parameters

Some results: Noise measurement



mean_data = 18.6079, std_data = 0.9986

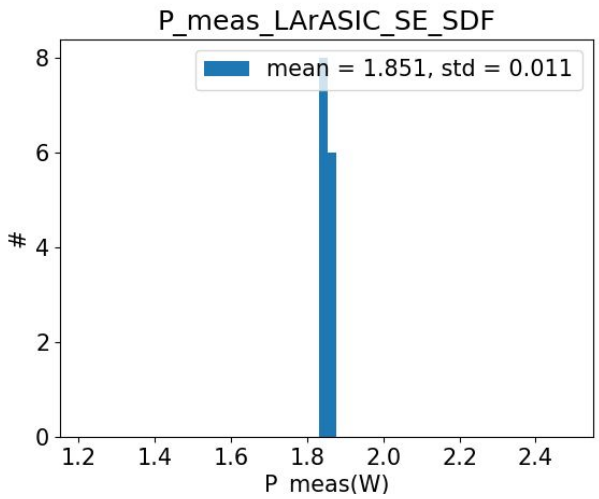


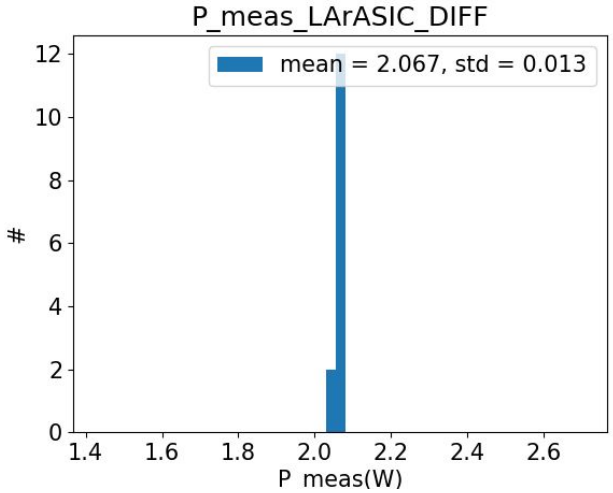
mean_data = 11.9892, std_data = 0.8184

- We expect low noise at LN
- RMS is defined as the standard deviation of the baseline of the signal
- Noise at RT > noise at LN

Some results: Power Measurement of LArASIC

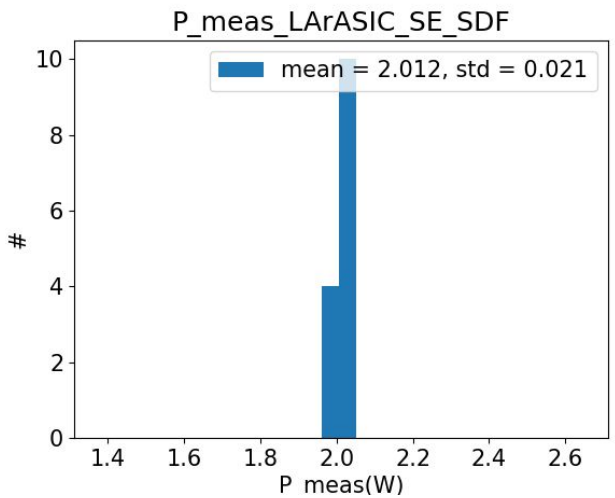
RT

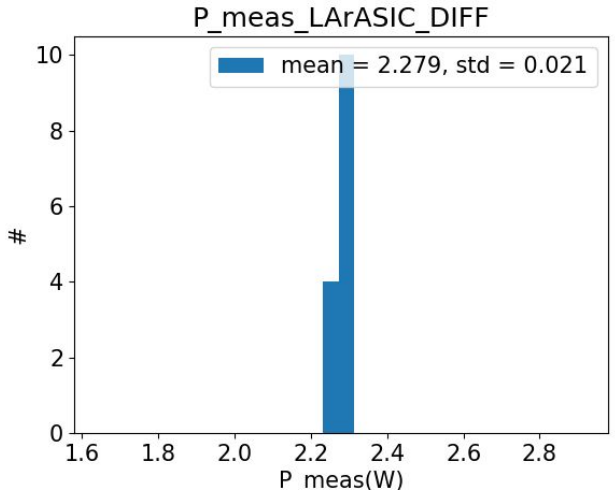




- SE: single-ended
- SE_SDF: single-ended output buffer is enabled
- DIFF: single-ended to differential buffer is enabled

LN

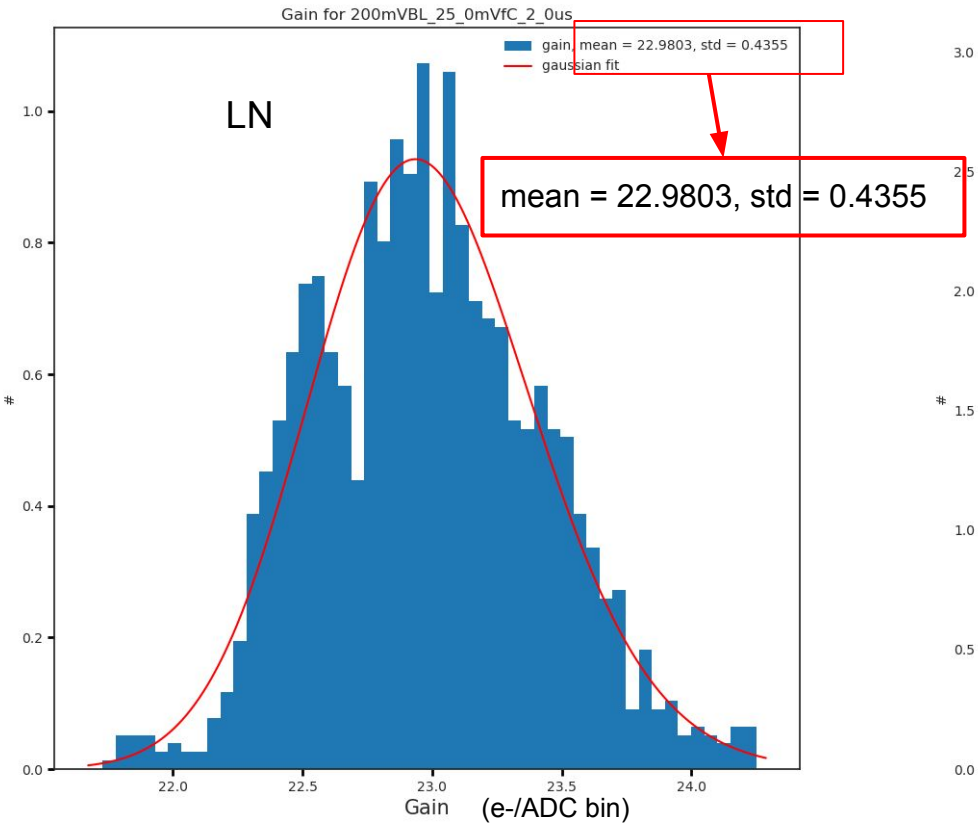


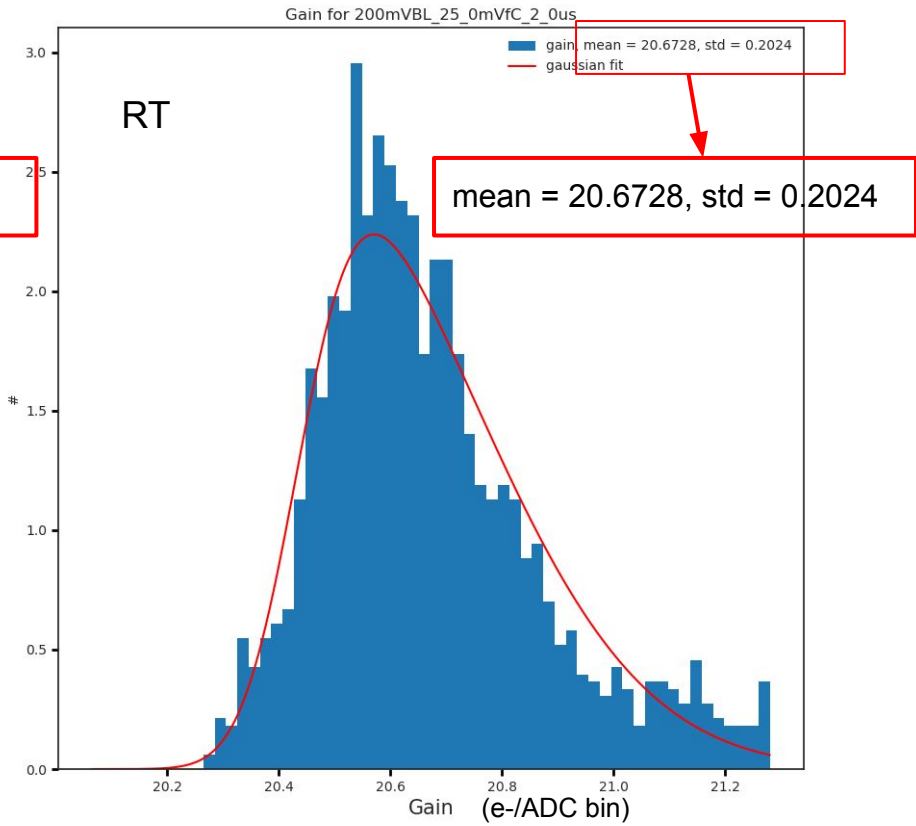


- Power consumption at LN > RT if SE_SDF or DIFF output is enabled

Brookhaven National Laboratory

Some results: Gain of the FEMBs





- Gain of the FEMBs at LN : slightly higher than at RT

Summary and Next steps

- Large quantity of FEMBs will be produced in the future.
- This statistical analysis of the performance of the current FEMBs can help performing the QC in the future.
- More data and parameters will be included in this analysis

→ we can set an acceptance range whether a FEMB passed or failed the QC.

- **Current works:**
  - Analysis of the performance of the dune convolutional visual network on tau neutrino
  - Lifetime study of the LArASIC chips

- **What's next ?**
  - Looking for a graduate program in particle physics

Brookhaven National Laboratory

Acknowledgements

- Dr Laza Rakotondravohitra and Pr. David Martinez: opened the door for me to join the DUNE collaboration
- ASP organizers: opportunity to do this short-term visit and research work
- Electronic Detector Group and Cold Electronics Team: to allow me to work with them
- Family: for their support

Thank you !

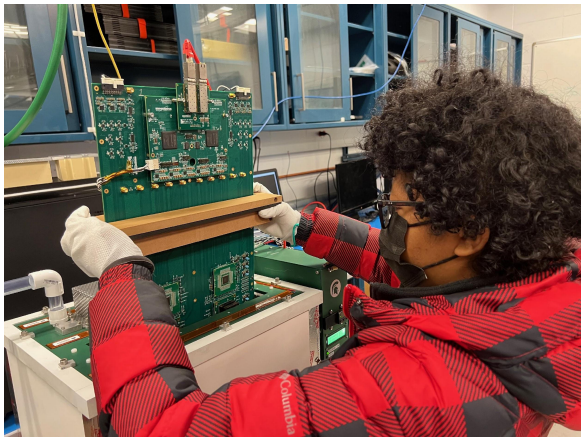
Brookhaven National Laboratory

Thank you for your attention

Analysis of QC results from the DUNE LArASIC chip testing

Antalia Ariel Rabarisoa

University of Antananarivo - Madagascar



01/24/2023

Brookhaven National Laboratory

@BrookhavenLab

Academic path

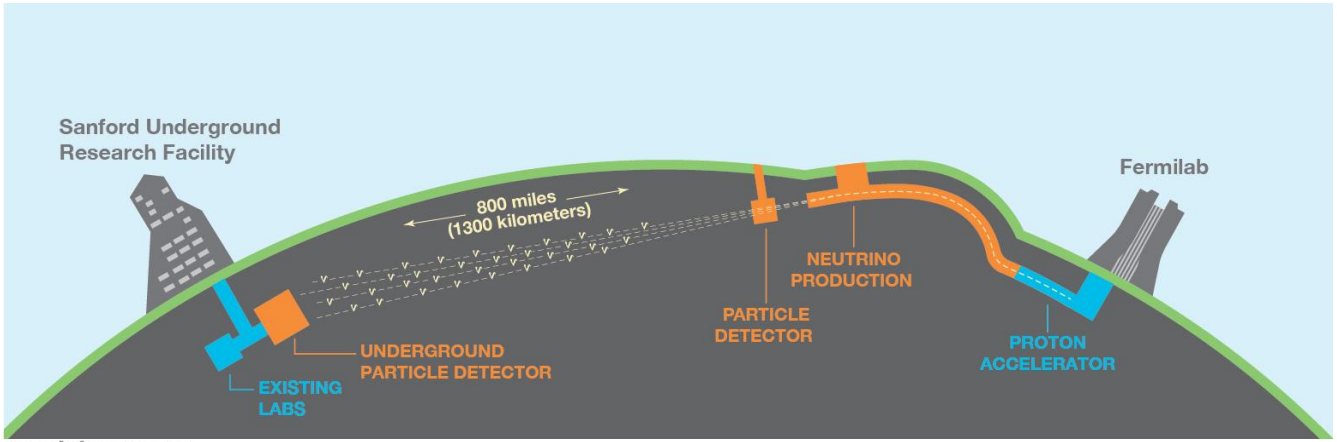
- April 2015 – September 2018: Bachelor degree in Physics and Applications
- October 2019 – September 2020: Master I graduation at the university of Antananarivo
- July 2021 – November 2021: participation in the Cern Online Summer Student program
- October 2020 – March 2022: Master II graduation at the Institute of High Energy Physics of Madagascar (HEPMAD)
- August 2022 – February 2023: Internship at the Brookhaven National Laboratory

ASP program

- The ASP I attended was about the energy sustainability of particle accelerators
- My arrival at BNL was on August 14th 2022 and I will leave on February 14th 2023
- I have been working with the Electronic Detector Group (EDG): the Cold Electronics in the Deep Underground Neutrino Experiment

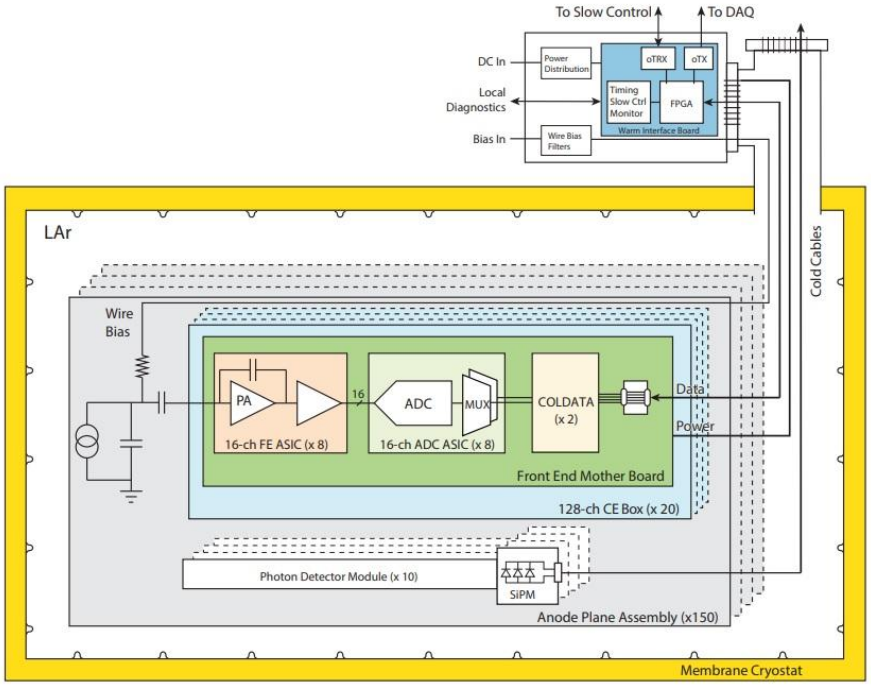
Deep Underground Neutrino Experiment

- The DUNE Experiment is designed to answer fundamental questions and searching for :
  - the origin of matter: neutrino/antineutrino oscillations
  - Supernova neutrino burst
  - The unification of forces: proton decay
- It uses a near detector located at Fermilab and a far detector 1300km away at Sanford Unferground Reseacrh Facility, with LArTPC technologies



Cold Electronics (CE)

- The Cold Electronics are the read out components of the TPC operating at cryogenic temperatures and constitute an important interface for the APAs (Anode Plane Assemblies)
- The Front End Motherboards (FEMB) contain an analog motherboard assembled with eight 16-channel FE ASICs and eight 16-channel Analog to Digital Converter ASICs



Architecture of the TPC Electronics

Brookhaven National Laboratory

LArASIC design and requirements

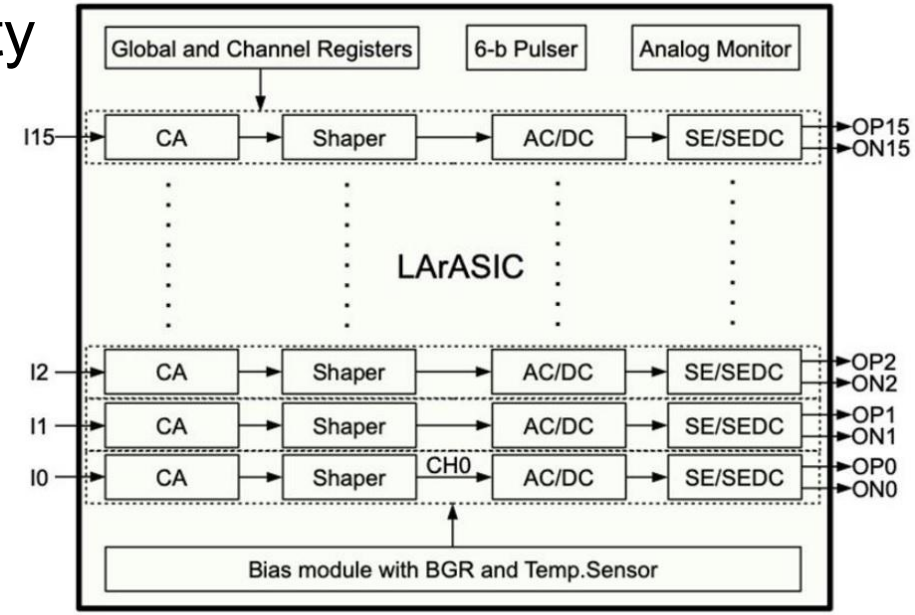
- 16- channel front-end ASIC for the amplification and pulse shaping of signals
- It is designed to operate in the liquid argon (LAr) at the cryogenic temperature of 87K
- It integrates a band gap reference to generate all the internal bias voltage and currents

- It was used to instrument the APAs in the Protodune-SP and will be used to instrument APAs in ProtoDUNE-HD/FD1-HD and CRPs in ProtoDUNE-VD/FD2-VD.
- Each channel has:
  - a dual stage amplifier and shaper and has a programmable gain, peaking time and baseline
  - a built-in charge calibration capacitor

LArASIC design and requirements

- Each LArASIC chip has 3 power rails of which voltage and current are recorded. Noise measurements are performed with different peaking time and buffer configuration

- To ensure that the LArASIC will operate at minimal loss of channels, appropriate design rules are used: noise performance, good linearity

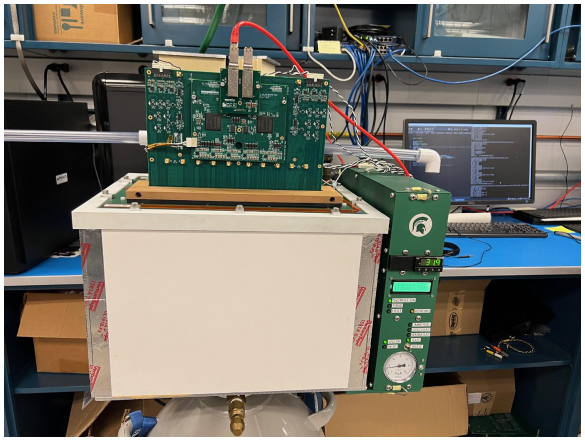


Simplified block diagram of LArASIC

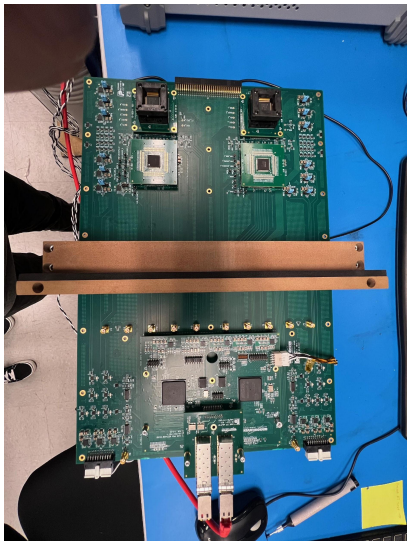
LArASIC chip QC procedure

- The chip that passed the warm test will be tested at the Liquid nitrogen temperature to measure the cold yield
- The Dual-DUT test board is used to characterize the LArASIC

- The data is readout through the interface of the Dual FPGA mezzanine
- The cold test stand(CTS) is used for the test setup



Cold test stand

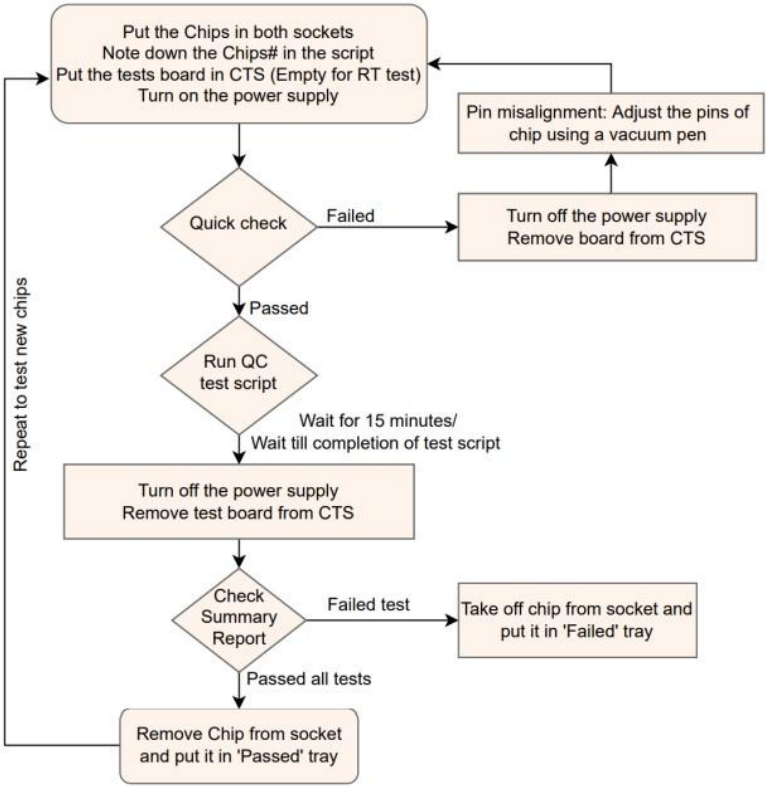


Dual DUT Board

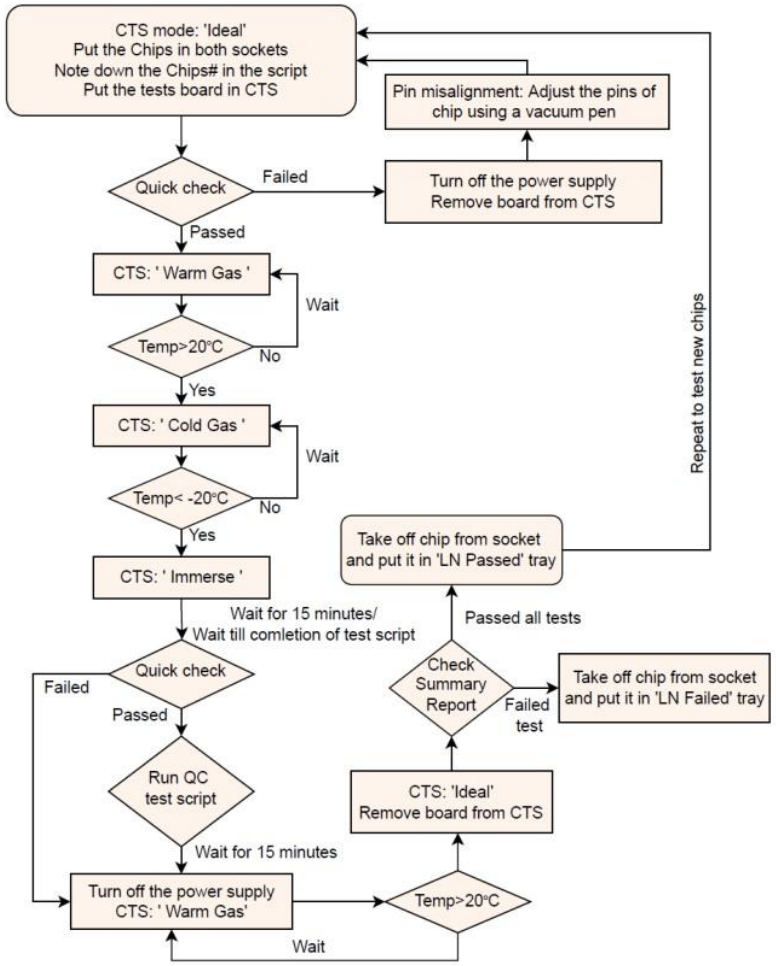
Brookhaven National Laboratory

LArASIC chip QC procedure

RT Test



Cold Test



Brookhaven National Laboratory

LArASIC chip QC test procedure

RT test

2 LArASIC chips are put in both sockets,

LN2/Cold test

Filling the CTS till the appropriate level

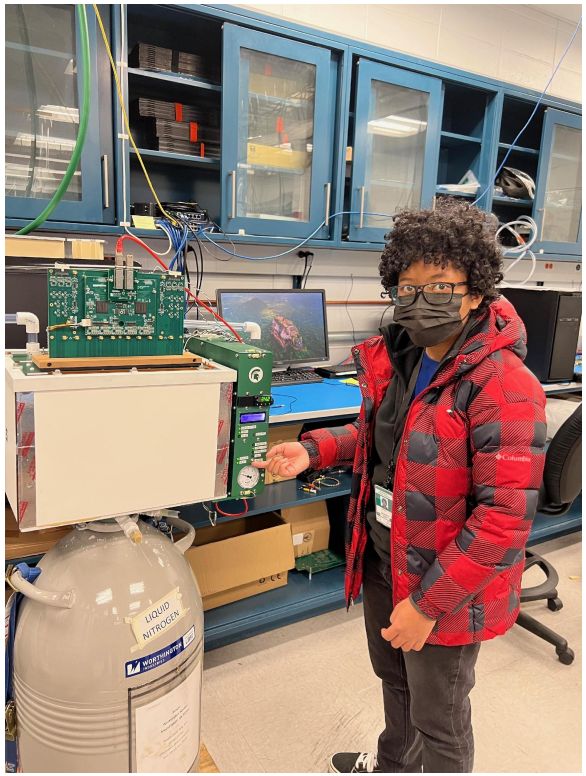
Brookhaven National Laboratory

LArASIC chip QC test procedure

RT test

Test board put in CTS

LN2/Cold test

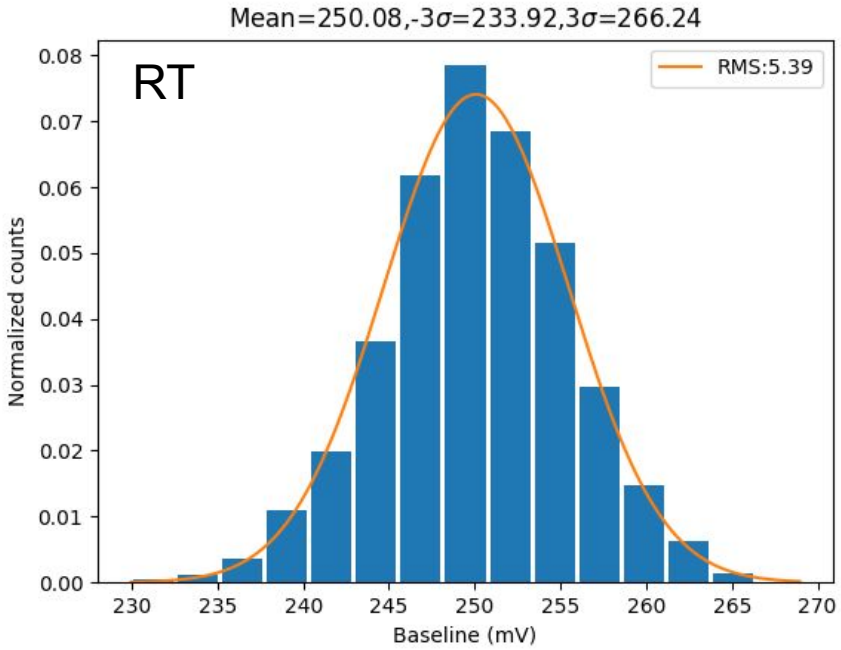


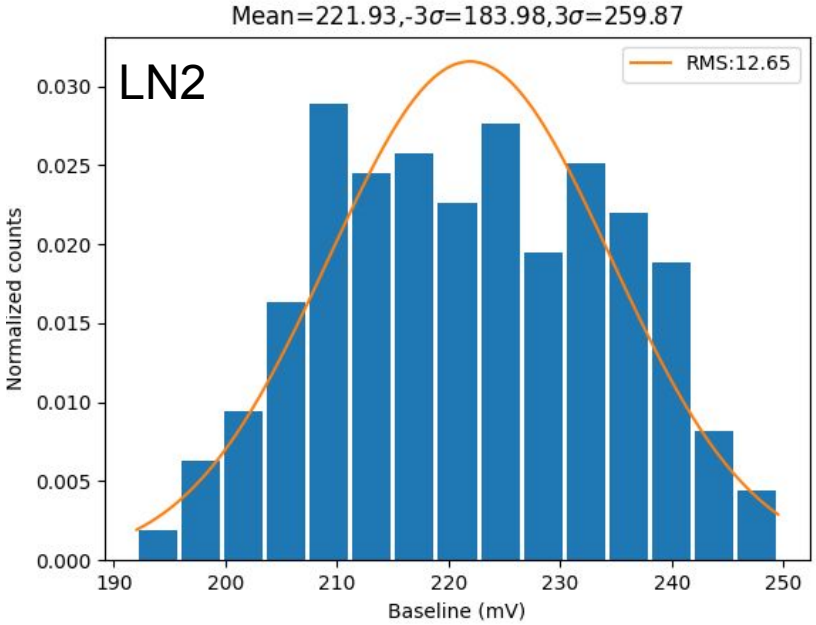
Setting the CTS

Brookhaven National Laboratory

QC LArASIC chip analysis results

- Baseline measurement (200mV)



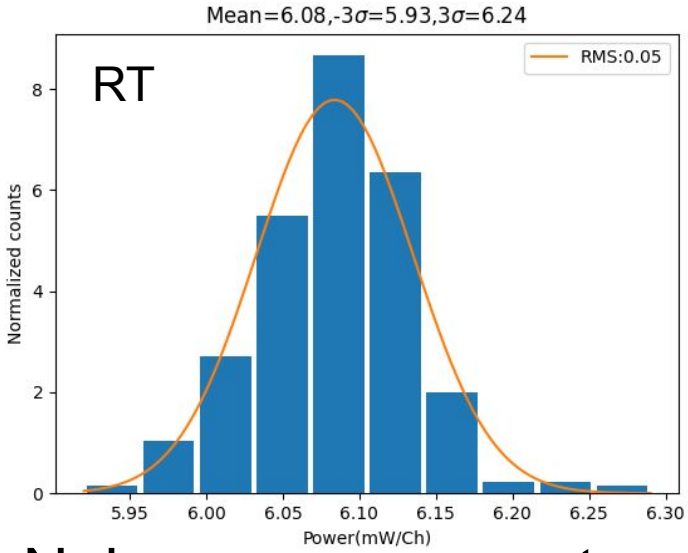


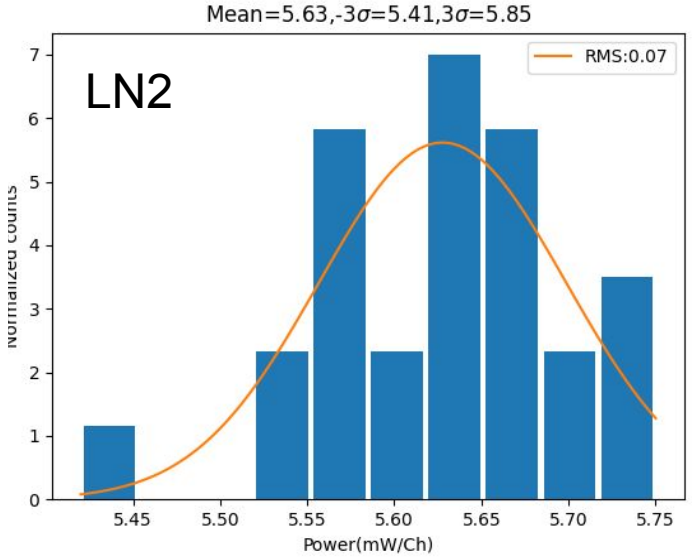
Tested channels:
At RT: 5440
At LN: 432

The baseline is measured from the LArASIC monitoring pin for all channels

Brookhaven National Laboratory

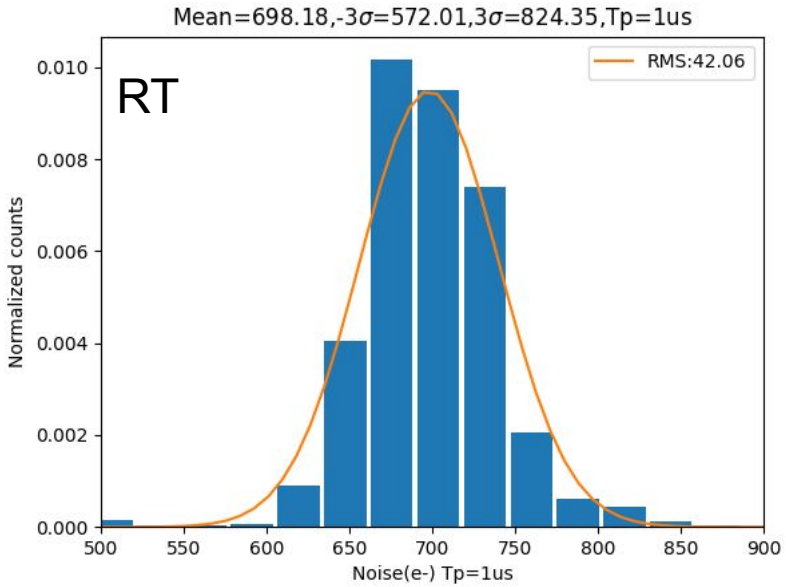
- Power Measurement (200mV)

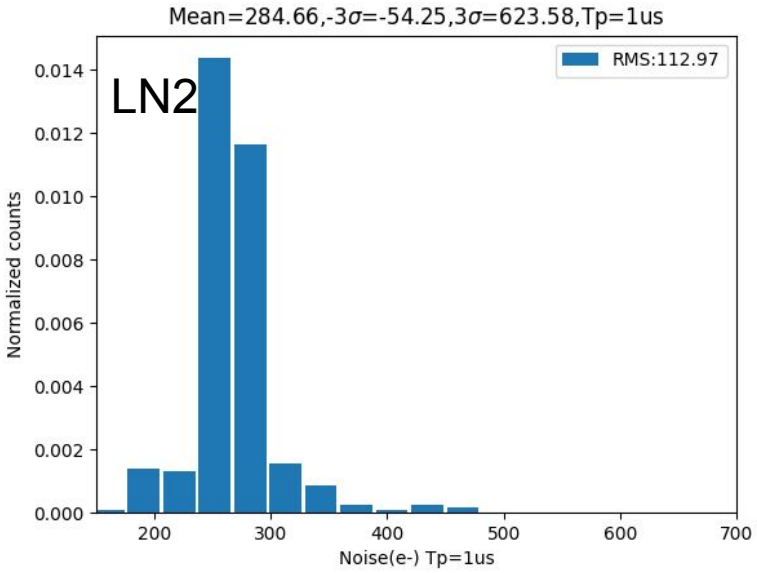




Tested chips:
At RT: 340
At LN: 27

- Noise measurement



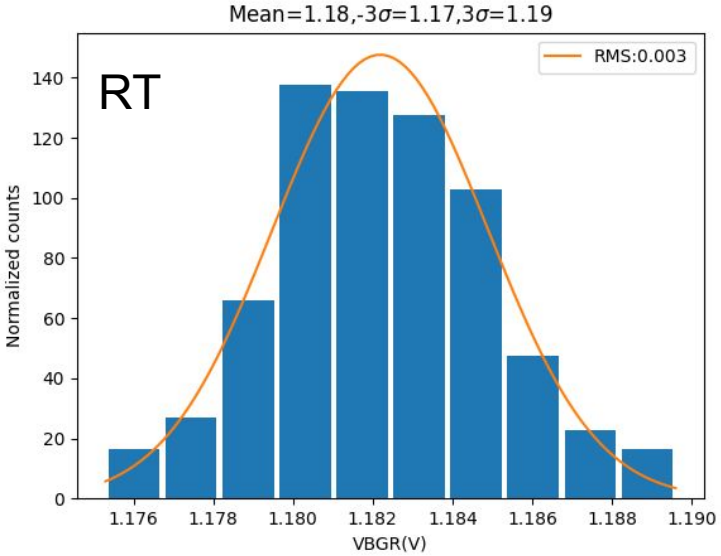


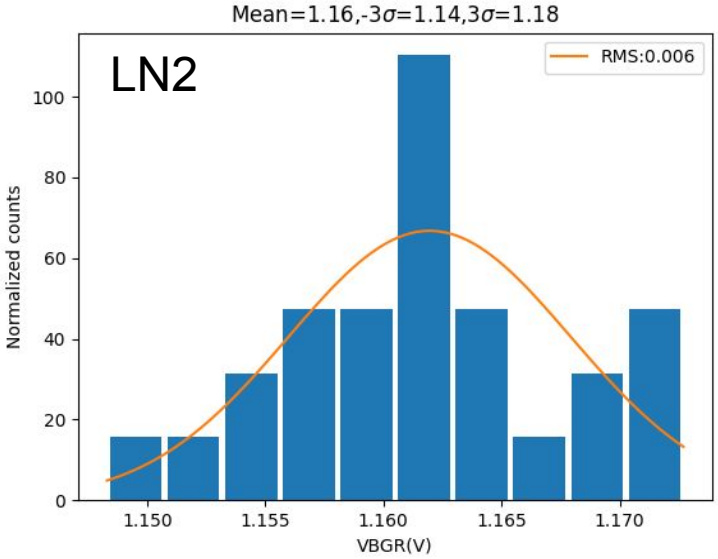
Tested channels:
At RT: 5440
At LN: 432

Brookhaven National Laboratory

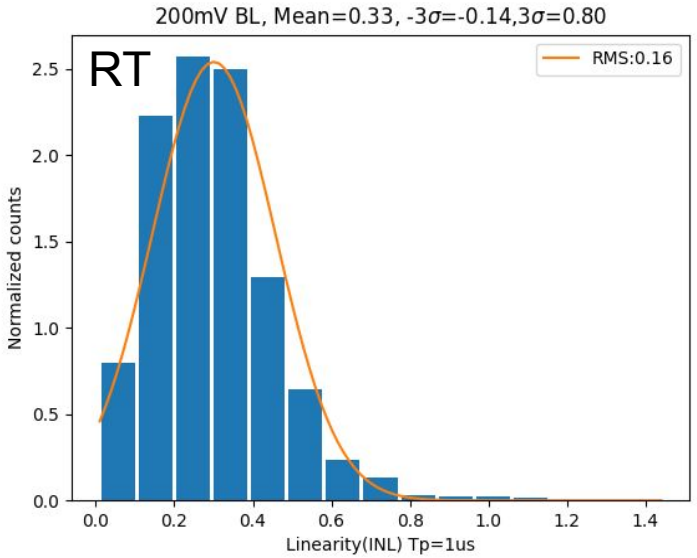
The power consumption is measured through a power monitoring device

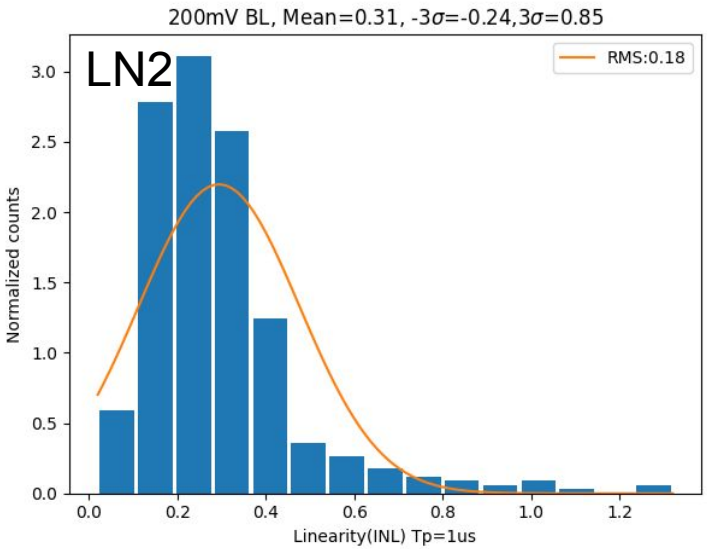
- Bang gap voltage reference (VBGR)





- Linearity measurement





Brookhaven National Laboratory

Summary

- The baseline is more dispersed at LN2 temperature than at RT
- There is less of power consumption in LN2 compared to RT

LArASIC parameter	Mean (RT/LN)		SD(RT/LN2)		#chips outside 3 SD(RT/LN2)	
BL, 200mV	250	221	5.39	12.65	4.11%	0%
BL, 900mV	932	902	3.79	7.57	3.82%	3.7%
Noise, Tp=1us (e-)	698	284	42.06	112.97	20.58%	33.33%
VBGR(V)	1.18	1.16	0.003	0.006	0%	0%
Power(mW/Ch)	6.08	5.63	0.05	0.07	0.88%	0%
Linearity, Tp=1us (%)	0.33	0.31	0.16	0.18	12.35%	33

- The performance acceptance range for future 50k LArASIC chips will be determined by the universal study based on a thousand chips

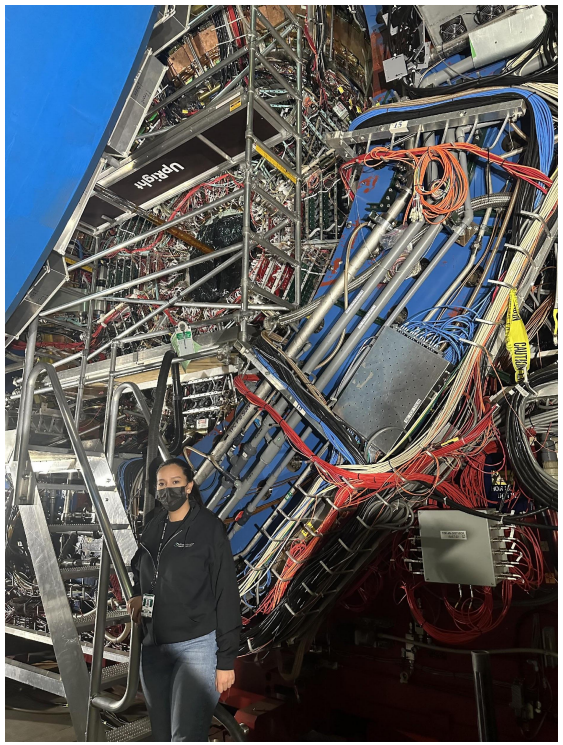
Prospects and acknowledgements

- I am looking for a graduate program in physics
- Acknowledgements:
  - My advisors at BNL
  - My academic advisors at the university of Antananarivo
  - My family and colleagues

Search for Beyond Standard Model Scalar decay in the 2l2j final state with the ATLAS detector at the LHC

Asmaa Aboulhorma

Mohammed V University in Rabat, Faculty of Sciences



01/24/2023

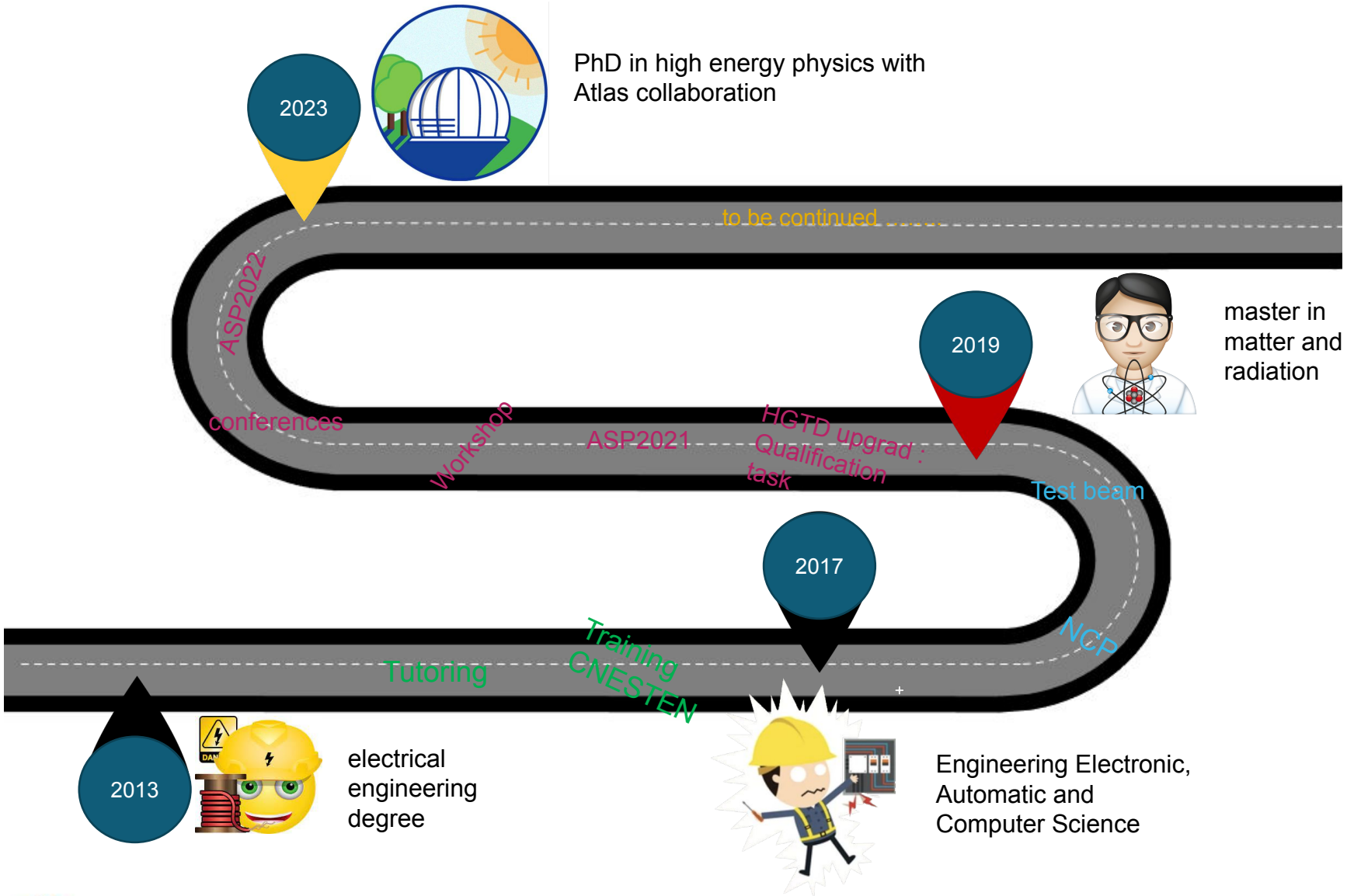
Brookhaven National Laboratory

@BrookhavenLab

Outline

- Short Synopsis of my academic path
- The African Schools of Physics that I attended
- Journey at BNL
- Motivation for the Beyond Standard Model (BSM) Scalar search
- Truth Analysis, quadruplet studies
- Efficiency high-mass
- Update of analysis Software
- Object and event selection
- Timeline

Short synopsis of academic path

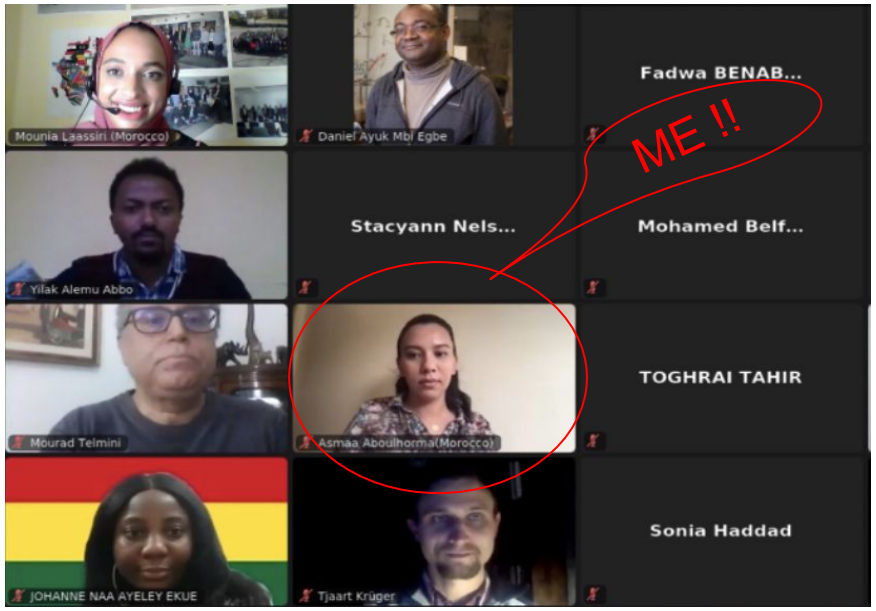


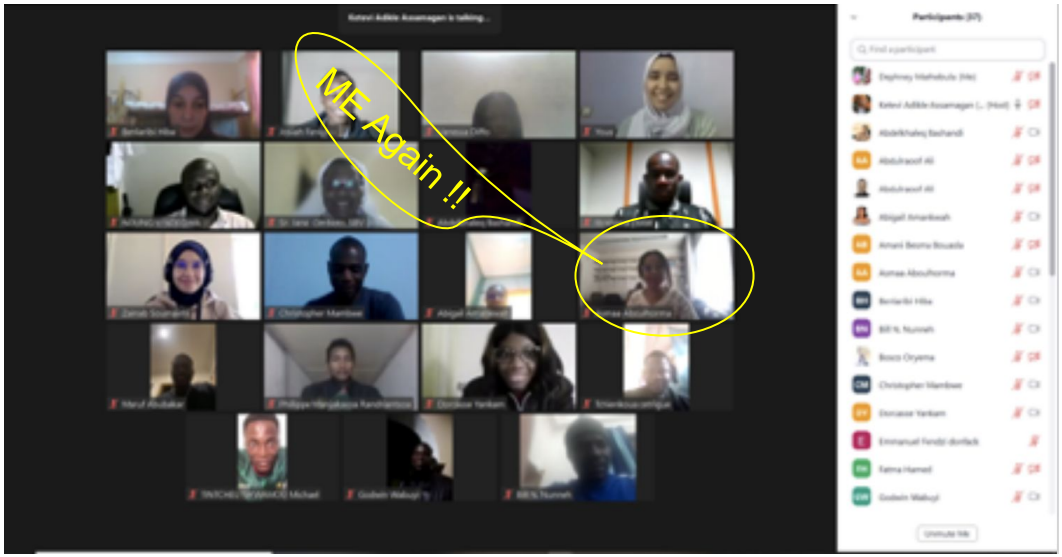
Brookhaven National Laboratory

ASP I attended

2021: Where everything started

- Event rescheduled online
- A very successful edition, considering the difficulties caused by the covid 19





2022:

- I followed this edition from BNL
- hybrid event, took place at Nelson Mandela University in Gqeberha, South Africa, on November 28 – December 9, 2022

Brookhaven National Laboratory

Journey at BNL

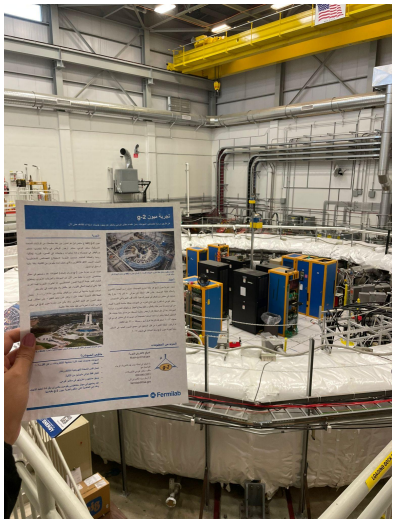
Arive at BNL : 17 August 2022 leave BNL : 01 February 2023

Omega Group

ITK Group

Slow control system development for the thermal cycle of the ITk Strip staves

Fermilab visit



Z_dZ_d Group

Search for Beyond Standard Model Scalar decay in the 2l2j final state with the ATLAS detector at the LHC

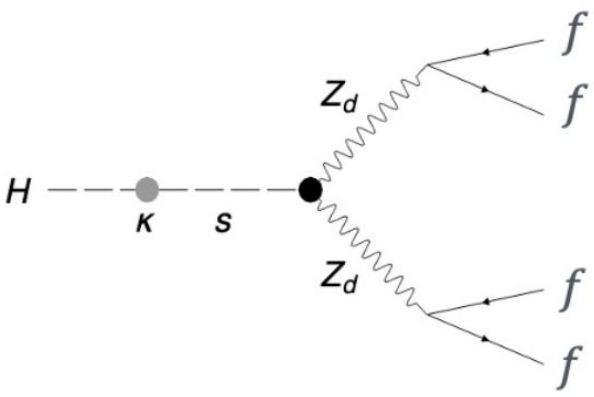
Brookhaven National Laboratory

Motivation for BSM Scalar search

The Higgs boson exists and and was discovered in 2012
→ scrutinize its properties and the Higgs sector nature.

zero spin, no electric charge and no strong force interaction

new window into possible BSM phenomena



- proposing a specific candidate for Dark Matter (DM) in the universe
- Good signal sensitivity in 4l final state
- Choose to investigate $S \rightarrow Z_d Z_d \rightarrow 2\ell 2j$
- $2\ell 2j$: Expect more background compared to 4l final state, but model predicts also higher branching ratio

Brookhaven National Laboratory

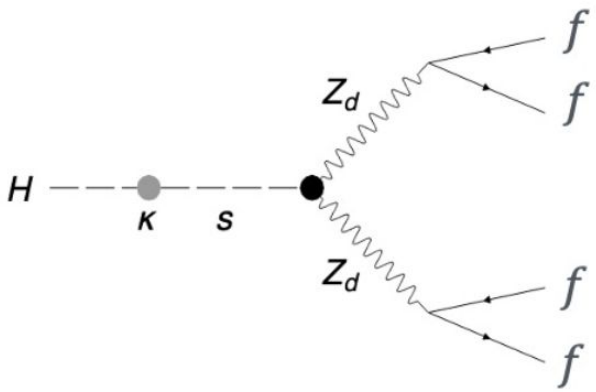
Truth Analysis, quadruplet studies

The main purpose of the truth analysis was to investigate the optimal algorithm for the selection of 2l2j quadruplet

The lepton selected based on leading and sub-leading lepton

The jet selection

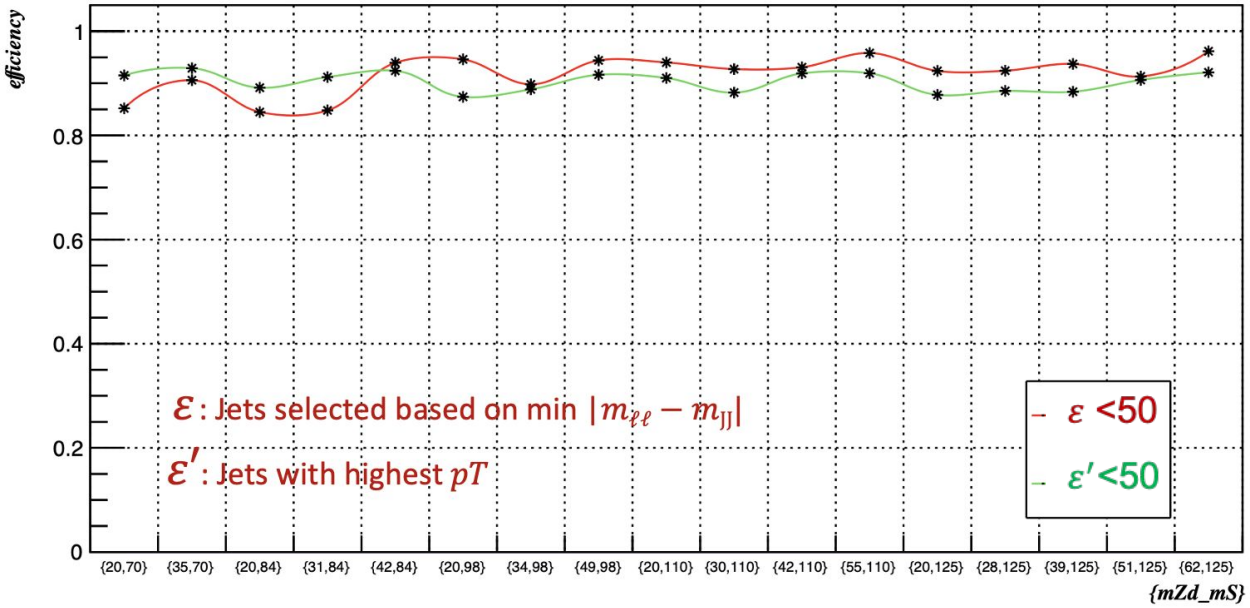
- The ZdZd have the same mass
- Dilepton and dijet need to be consistante
- Using dileptons selected as a reference for selecting the two jets

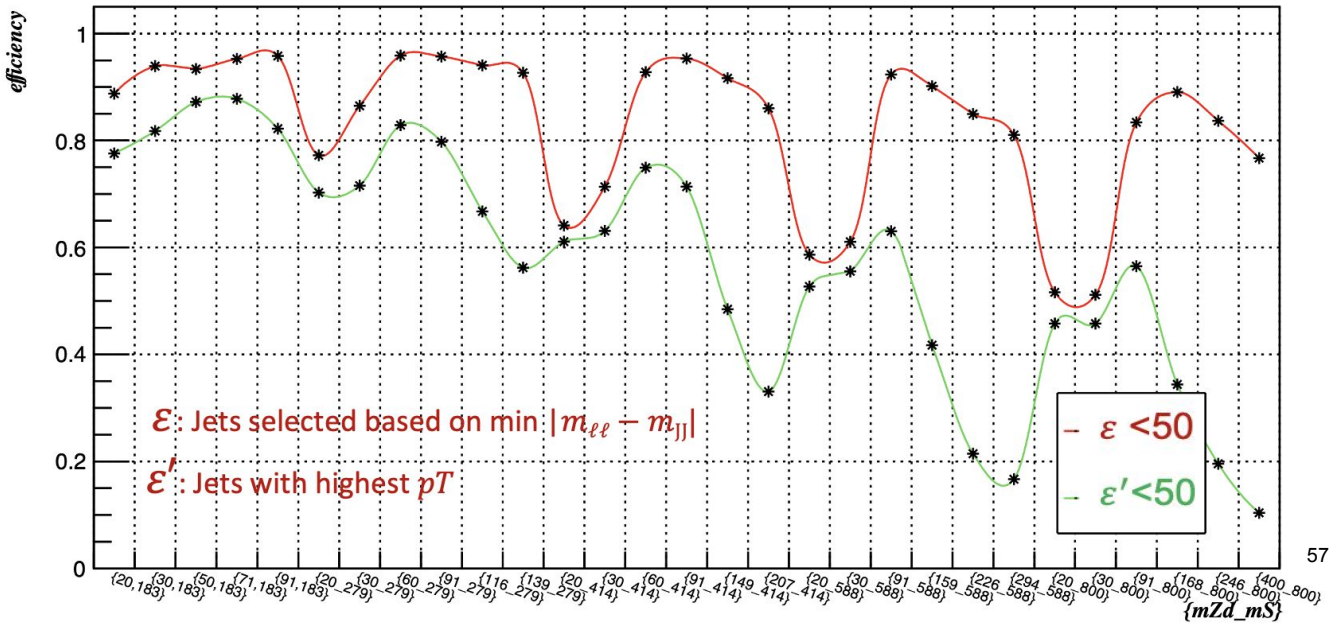


$$\mathcal{E} = \min |m_{ll} - m_{jj}|$$

Another way of selecting jet is using leading and sub-leading $p_T$jets.

Efficiency high-mass

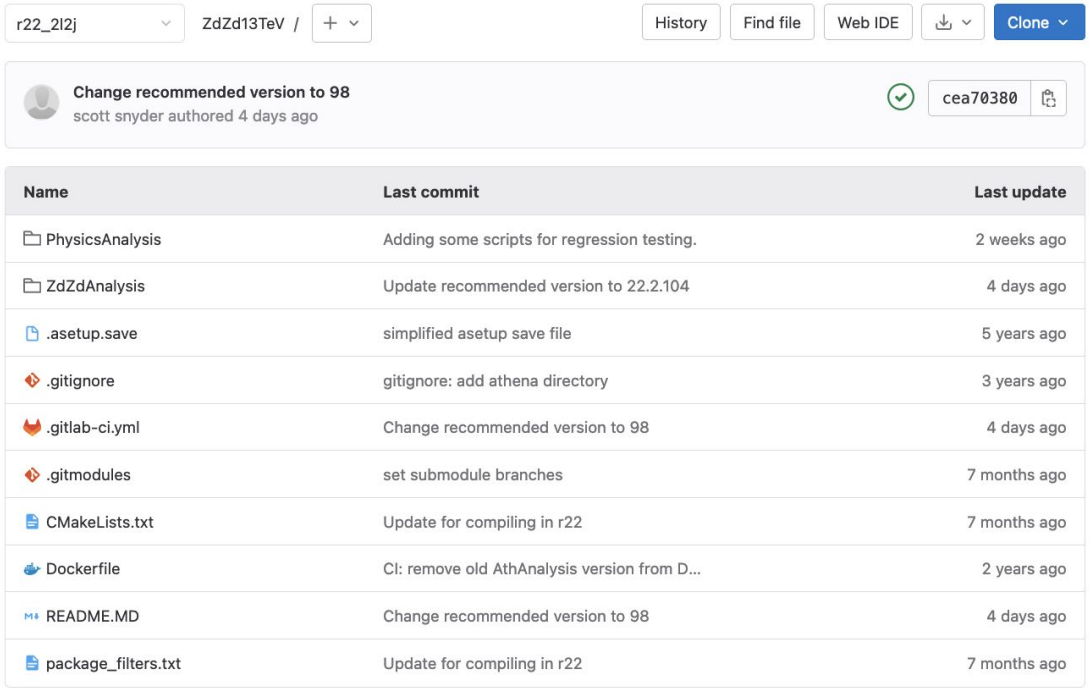




Brookhaven National Laboratory

Update of analysis Software

- ATLAS software is ever evolving
- In addition to that, there is our analysis specific Software which I'm in part in charge of
- Addition active development is needed to maintained compatibility with courant ATLAS software
- Make the new analysis software include the additional final states, i.e. jets



Brookhaven National Laboratory

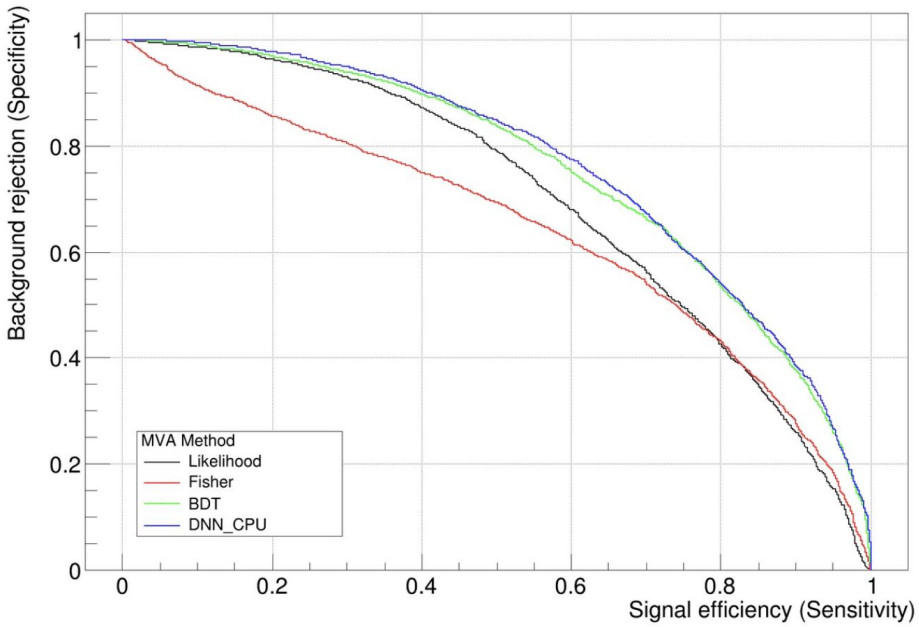
Object and event selection

- Identification of leptons and jets and the formation of ‘quadruplets’ of 2l2j.

→ preliminary result based on a sequence of selection is ready

Prepared for TMVA Signal Region optimization

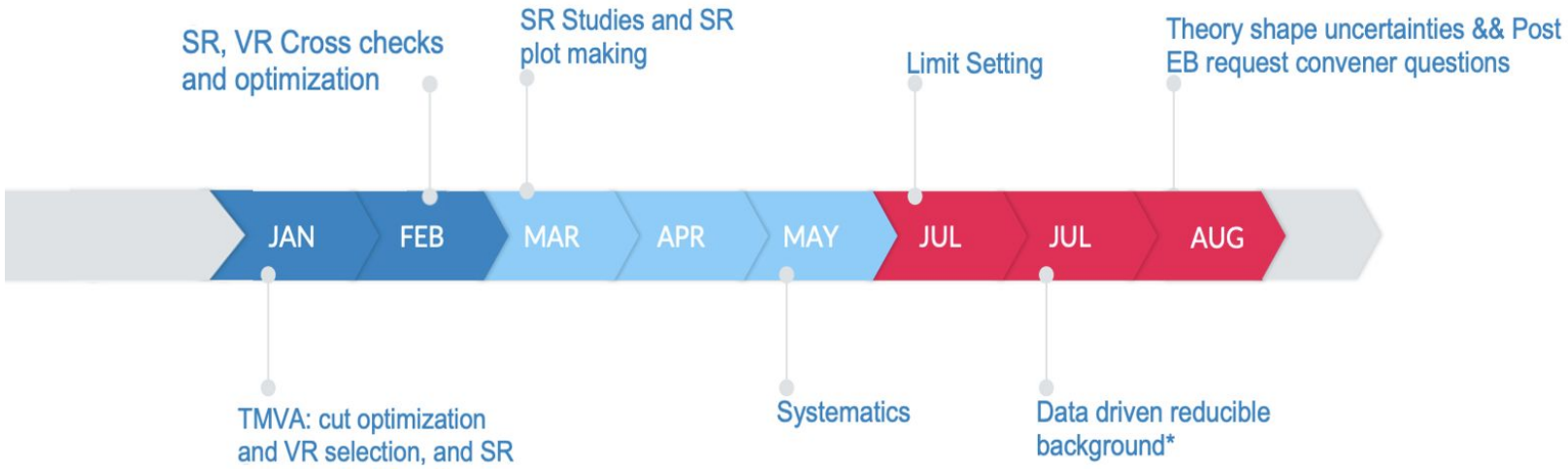
- Use the TMVA to improve the selection of di-jet
- Select the correct di-jet from the HS based on the truth information
- Train the BDT to get the same selection over background and data



Brookhaven National Laboratory

Conclusion & Timeline

- Performant jets pairing algorithm identified
- Updated successfully the analysis software
- Signal and Background data sets are available, having been processed using the updated analysis software
- Preliminary signal selection defined under study
- Moving on to explore multivariate analysis techniques



شكرا

Thank You

Brookhaven National Laboratory

Improving discovery potential of Beyond Standard Model Physics through detector innovation

Xola Mapekula – University of Johannesburg

01/24/2023

Brookhaven National Laboratory

@BrookhavenLab

Outline

- Short synopsis of academic path
- Description of the experiment I conducted at the Omega group in the Physics Department and the Instrumentation lab
  - Experimental setup
  - Methodology
  - Results
  - Conclusion
- Prospects and outlook for my academic career, and continuation of the work

My academic career so far

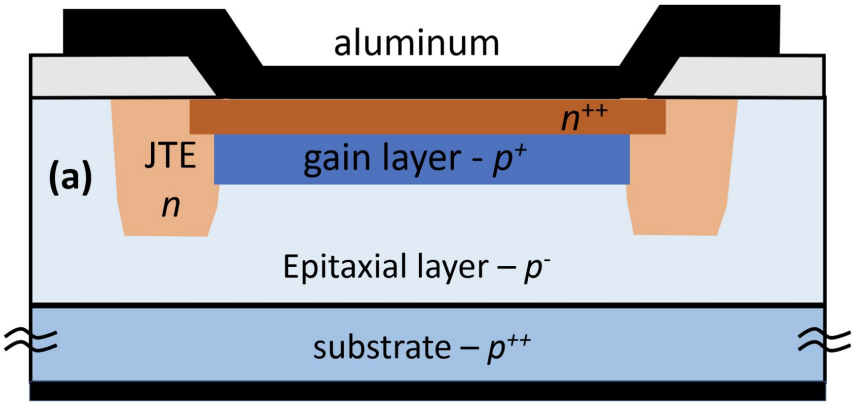
- Got introduced to High energy physics when I was doing my undergrad in Mechanical engineering
- Followed up by doing my Master in High energy physics where I worked on the fringes of the H(S)->ZdZd->4l analysis and ported the limit setting code to GPU
- I am now doing my PhD in High Energy Physics where we will be looking for the H(S)->ZdZd->4l + MET final state

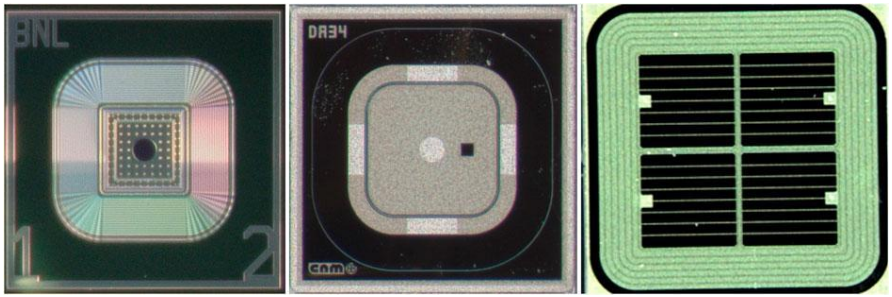
How did I get to BNL?

- I was one of the 65 students that we accepted out ~450 applicants for the sixth edition of the African School of Fundamental and Applied Physics (ASP2020):
- I am one of the four ASP alumni selected for the short-term visit for research program at BNL where I am on a six month program. While at BNL, besides physics analysis and computing work, I have also been working detector performance on the LGAD

Low Gain Avalanche Diode

- Used to extract spatial and timing information of minimum ionizing particles (MIPS) in a detector
- Based in p-n junction semiconductor technology

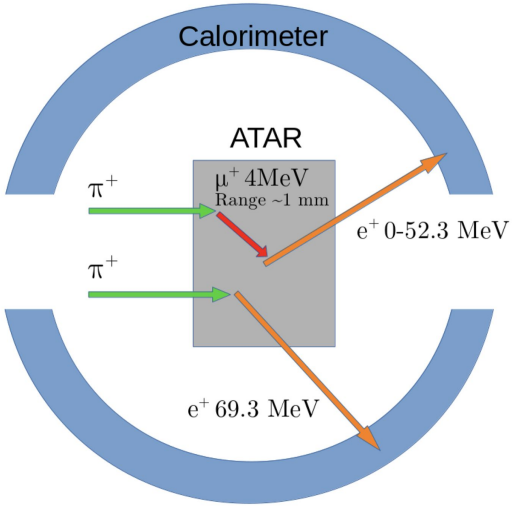




- MIPS generate electron/hole pairs in substrate along their tracks
- Holes drift towards the p-electrode while electrons drift towards the n-electrode
- Ionization coefficient higher for drifting electrons than for holes -> electrons are responsible for amplification of the signal
- This is achieved by making them cross a high enough electric field in which they undergo impact ionization

Brookhaven National Laboratory

LGAD Energy response measurements



Aim

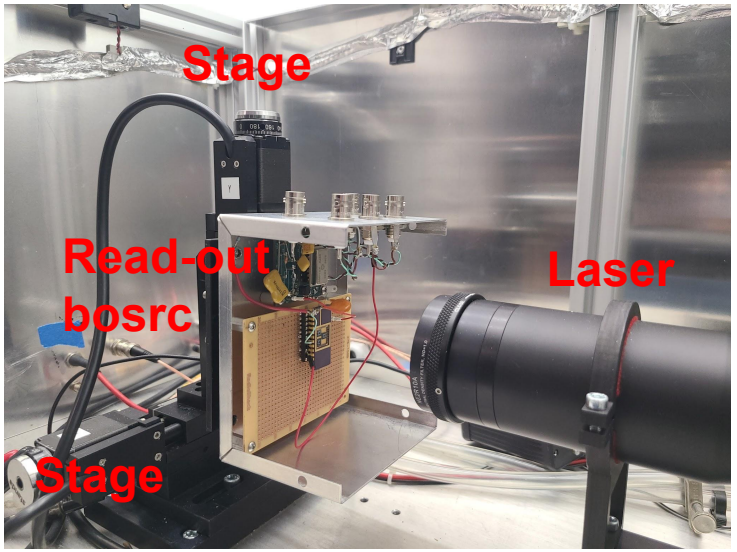
- To see if the LGAD's can be used to measure the energy of particles in the PIONEER detector
- PIONEER is a next-generation experiment to measure the charged pion branching ratios to electrons vs. muons

Goal

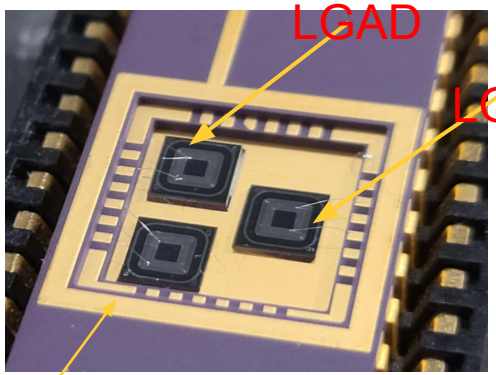
- Use pulsed infrared laser to simulate a minimal ionizing particle
- Compare the response of a diode to an LGAD when interacting with an IR laser
- Measure the gain obtained by the LGAD
- Characterize the response of non-minimum ionizing particle

LGAD Energy response measurements

Experimental setup



Devices



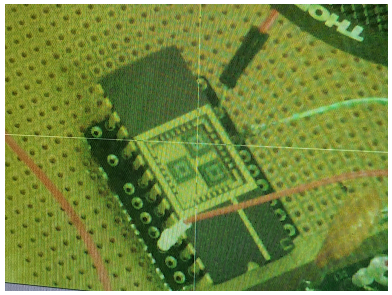
- Board containing devices is mounted onto the readout board
  - A250 Amplifier used to amplify signal from device
  - High voltage power supply channel input across LGAD
  - Output channel that goes to the oscilloscope

- Laser positioned so that it points to one of the devices using the stage motors
- Use the metal box to shield the devices from noise

Brookhaven National Laboratory

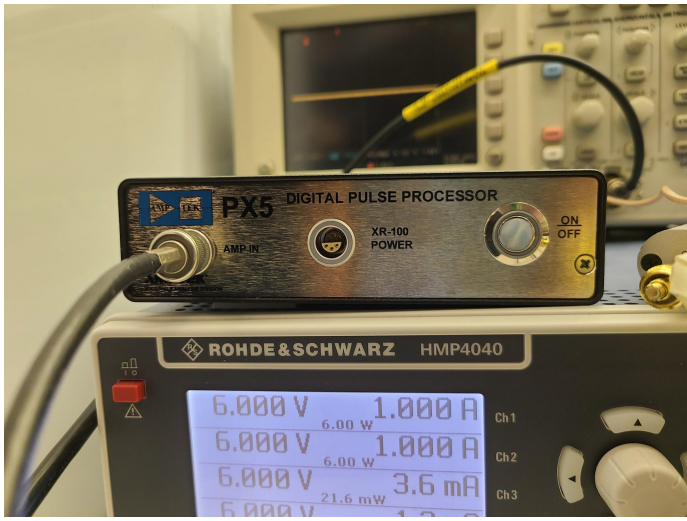
Methodology

1. Obtain interaction response of LGAD with laser
2. Construct a pixel map to get LGAD position
3. Get response of LGAD for varying z-axis position and to get smallest FWHM
4. Use this z-axis position run scan of LGAD
5. Use the same position to get response for different laser intensity thresholds
6. Calculate the FHWM of the gaussian curve formed by multiple counts of the digital response
7. Plot the gain for different laser intensity thresholds between 50% - 72%
8. Plot the gain for different radioactive sources



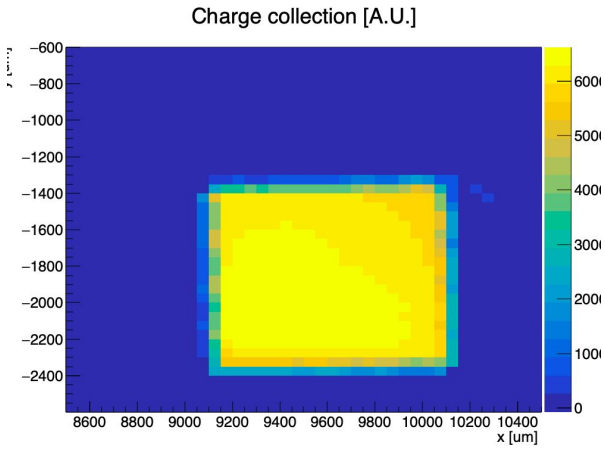
Position laser

PX5 digital processor

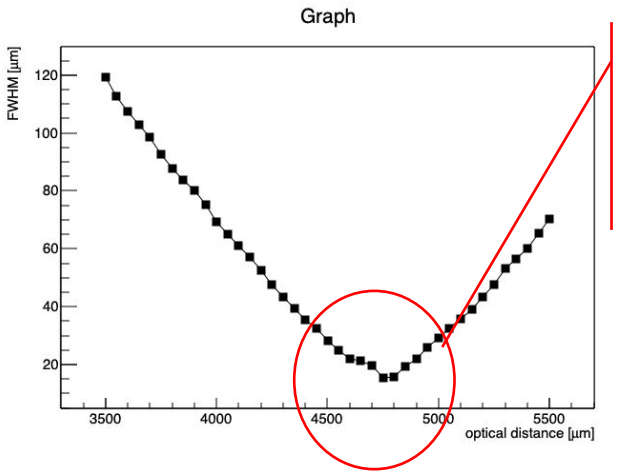


Results

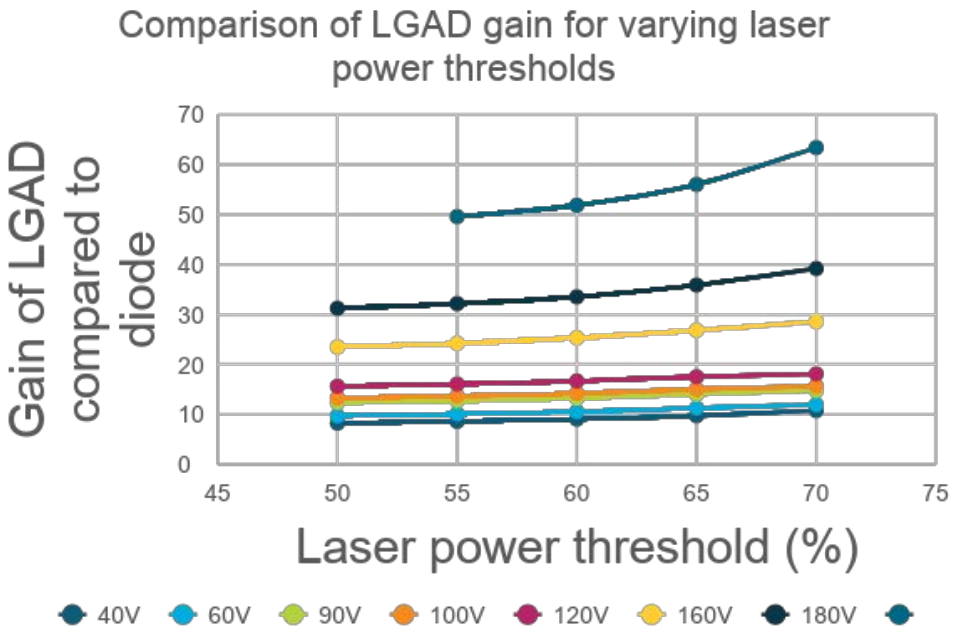
Pixel map of LGAD

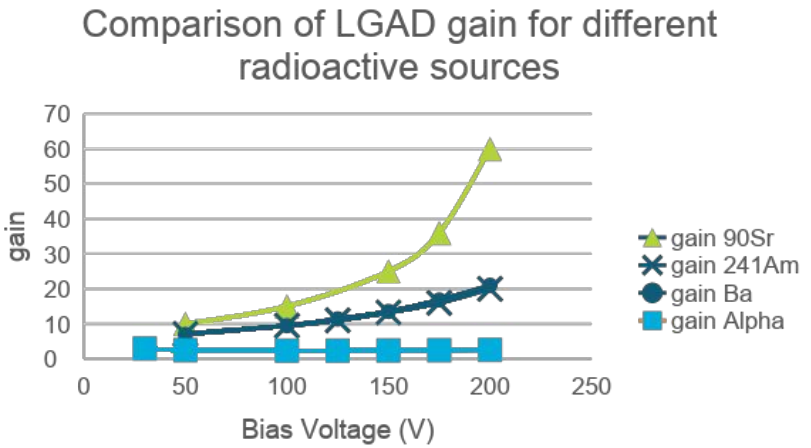


Pixel map of LGAD



Obtained FWHM = 15 µm





Brookhaven National Laboratory

Conclusion

- Conducted an experiment to see if the LGADs can be used for measuring energy of MIPS
- Used infrared laser to simulate how MIPS and non-MIPS would interact with the LGAD's
- Obtained the gain of the LGAD for varying input voltages and laser intensity thresholds
- Next step is to measure the energy resolution of the LGAD
- We will need to repeat the experiment to obtain results for similar ambient conditions and ensure we test the LGAD performance in the lab at the conditions expected in PIONEER, e.g., particle types, energies etc.

Outlook

- Be on my way to becoming GPU and machine learning expert
- Find out if higher luminosity will increase the significance of the S -> ZdZd -> 4l
- Continue to collaborate with BNL in physics analysis instrumentation studies
- Collaborate with the computing group for GPU software projects at ATLAS

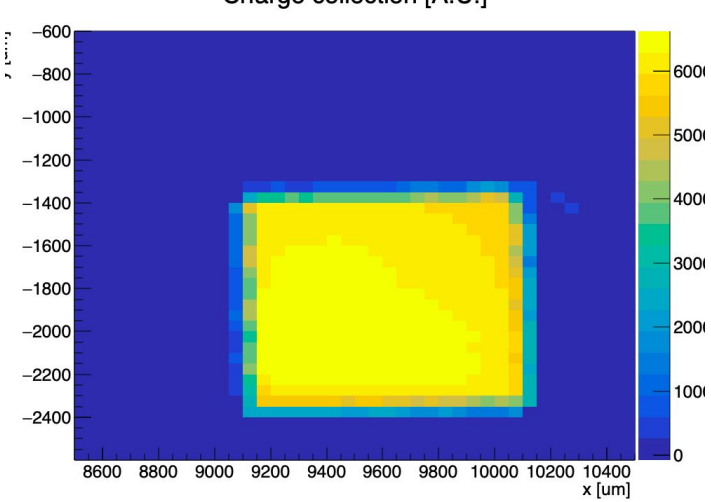
Ngiyabonga

Ketevi Assamagan
Alessandro Tricoli
Enrico Rossi
Gabriel Giacomini
Christian Weber
Gabriele D'Amen

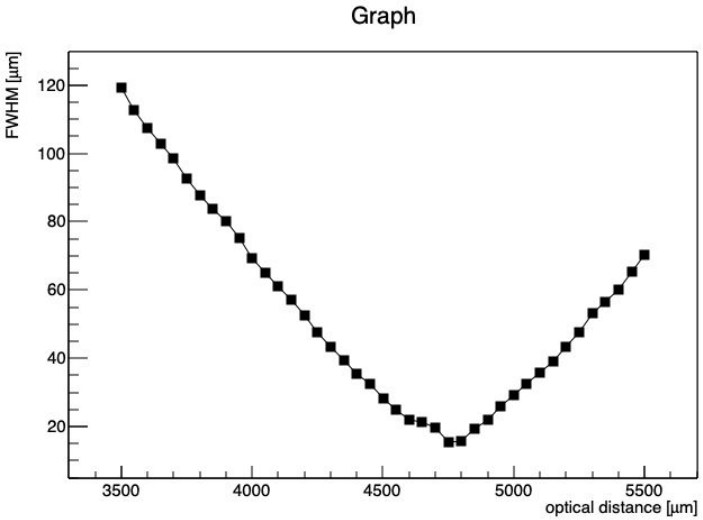
Backup

Results

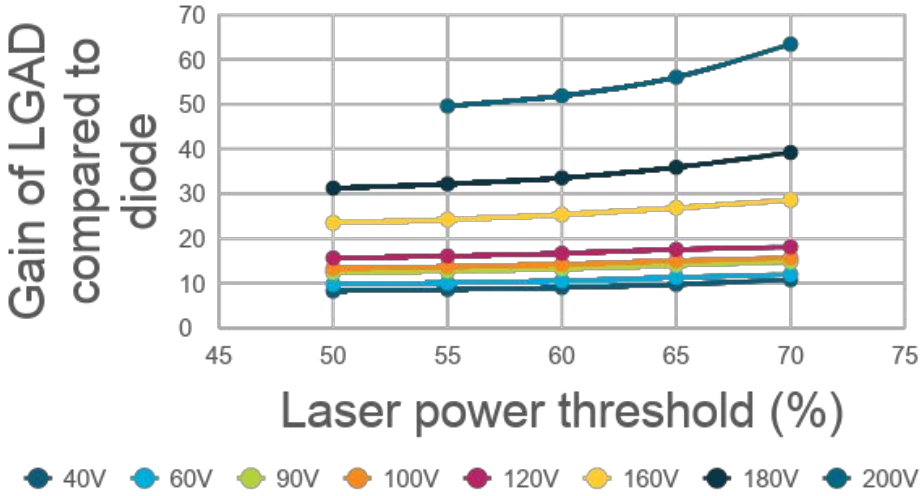
Pixel map of LGAD



Pixel map of LGAD



Comparison of LGAD gain for varying laser power thresholds

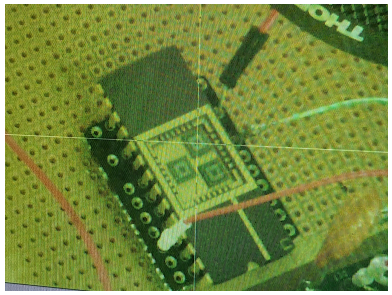


- Gain seems to be constant for lower voltages but increase for values above 180V
- Could be due to external nuisance parameter i.e. temperature increase

Brookhaven National Laboratory

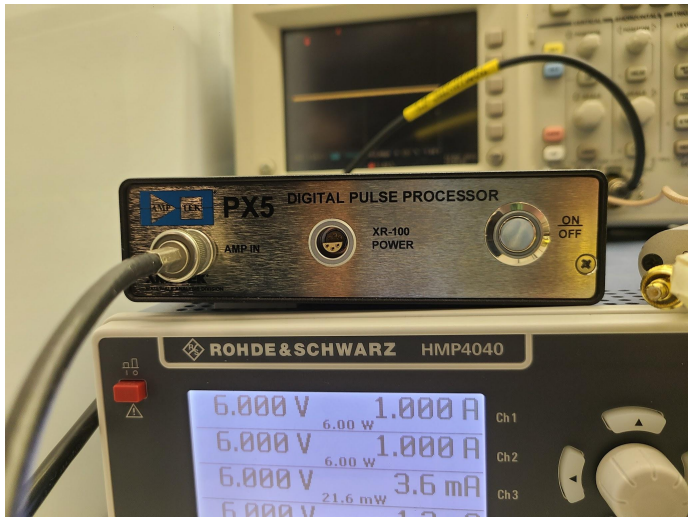
Methodology

1. Obtain response of the laser interacting with each pixel of the LGAD
2. Construct a pixel map of the response of the LGAD to get the exact position of the device
3. Run a horizontal sweep across the LGAD while varying position of the laser in the z-axis to obtain the minimum FHWM of the laser response
4. Use this z-axis position at the minimum FWHM to run a full sweep of the device response of the laser to obtain a pixel map
5. Fix the position of the laser to obtain response of the LGAD for different intensity thresholds of the laser using the PX5 digital processor. The response is an analogue triangular wave form that is integrated to obtain a discrete digital response
6. Calculate the FHWM of the gaussian curve formed by multiple counts of the digital response
7. Plot the gain for different laser intensity thresholds between 50% - 72%
8. Plot the gain for radioactive sources



Position laser

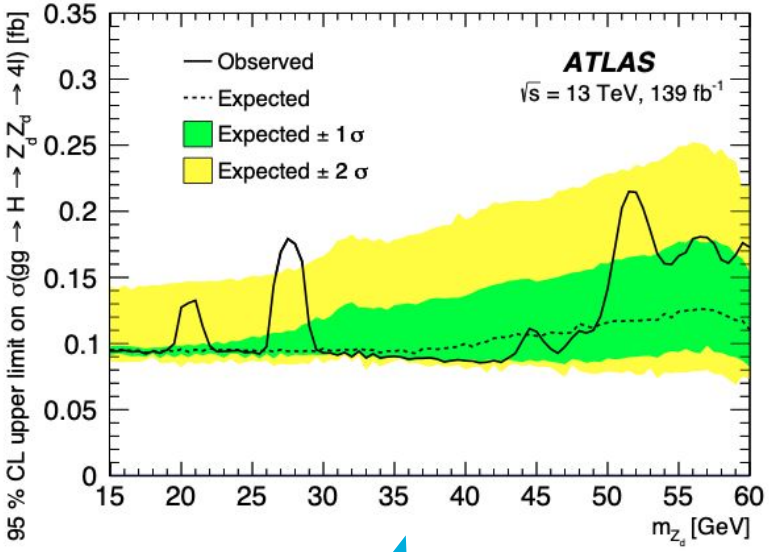
PX5 digital processor

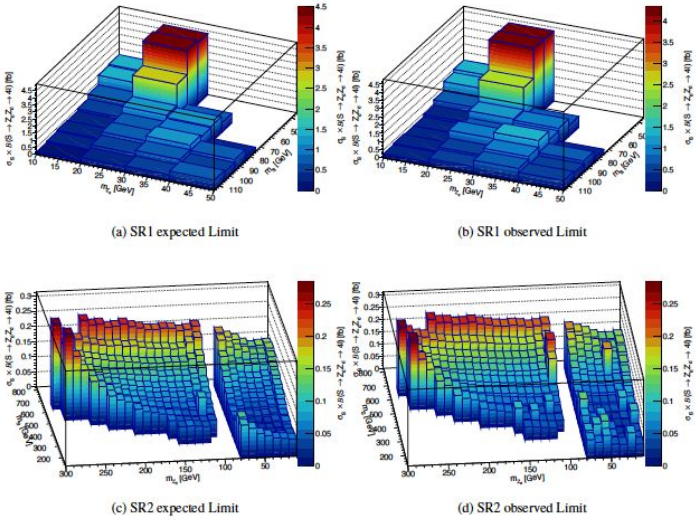


Brookhaven National Laboratory

Physics Analysis

- The High Mass and Additional Scalar analyses produced significant bumps aroun 30 GeV.
- In addition, CMS analysis similar to the HM analysis also showed bumps around 30 GeV.





High mass limits

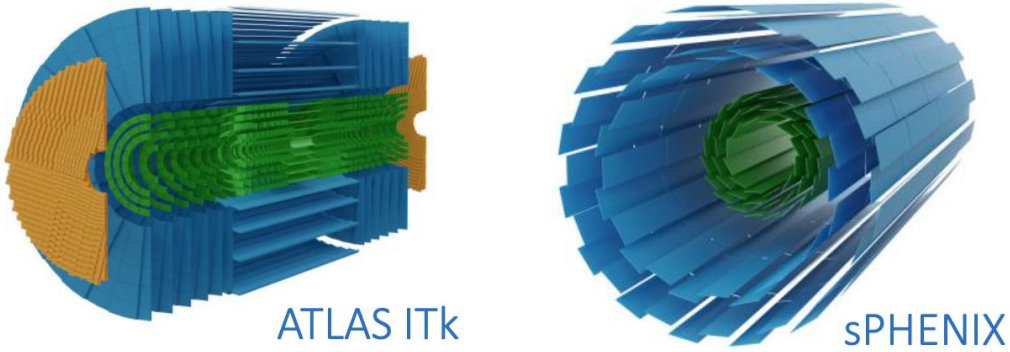
Additional scalar limits

Brookhaven National Laboratory

ATLAS Qualification task

A Common Tracking Software

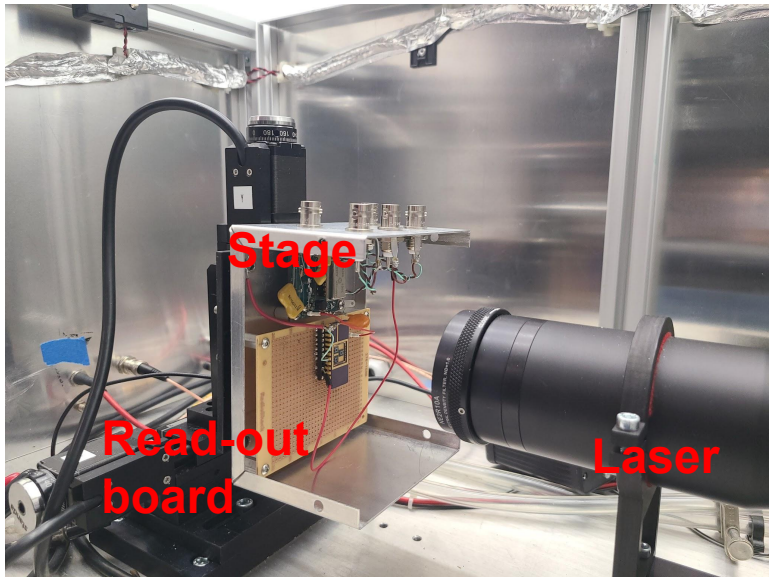
- Modern open source HEP tracking toolkit
  - Based on C++17
  - Experiment independent design
- R&D platform to explore new techniques
  - GPU parallelization
  - Machine Learning



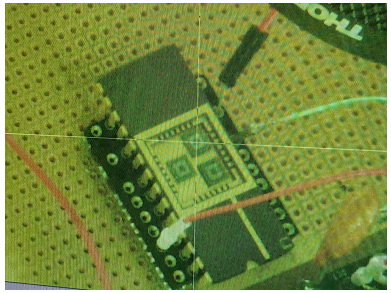
Brookhaven National Laboratory

Methodology

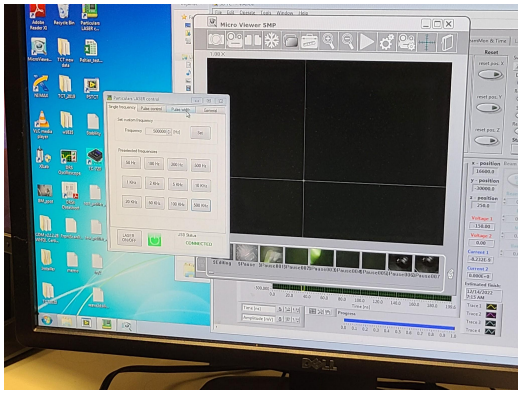
1. Power the A250 amplifier to -6V on one channel and +6V on the other channel
2. Connect high voltage to the LGAD/diode using a power supply so as to create an electric field across the LGAD/diode
3. Connect the output to an oscilloscope to obtain output waveforms
4. Adjust the laser so that it point more or less to the position of the LGAD/diode
5. Use an infrared camera to point the laser to the exact position of the LGAD/diode
6. Close the lid of the enclosure and focus the laser



Stage

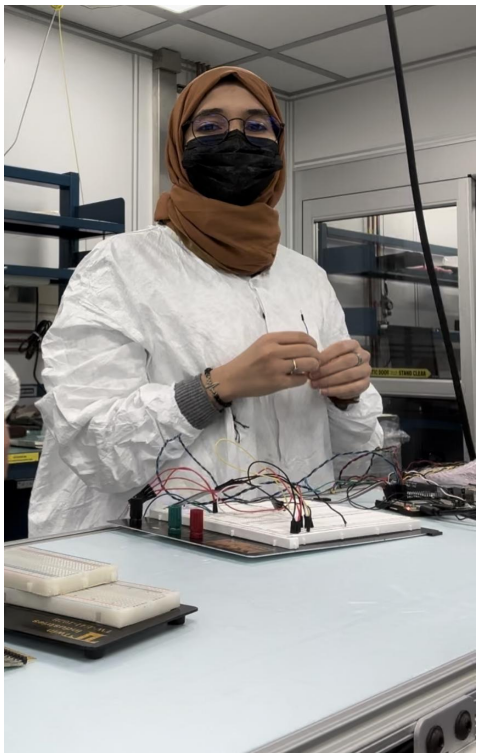


Position laser



Focus laser

Slow control system development for the thermal cycle of the ITk Strip staves



Zainab SOUMAIMI & Asmaa ABOULHORMA

Mohammed V University in Rabat, faculty of science, Morocco

01/24/2023

Brookhaven National Laboratory

Outline

- My Academic path
- The ASP editions that I attended – BNL arrival and affiliation
- A glance at my thesis work
- Motivation
- All-Silicon Inner Tracker
- ITk Strip staves testing
- Stave testing setup
- Results and Outlook
- Acknowledgements

Academic path

- Bachelor in energetics in Sultan Moulay Slimane university, polydisciplinary faculty in Khouribga, Morocco.
- Master in High Energy physics, Astronomy, and Computational Physics (HEPAC), Cadi Ayad University, faculty of Semlalia in Marrakech, Morocco
- Ph.D. student in Particle Physics in Mohammed V University in Rabat, faculty of science, Morocco

ASP2021 and ASP2022 alumni

BNL short term research program
15 August-1 February 2023

Working with the Omega Group under the supervision of Dr. Kétévi A. Assamagan and Dr. Stefania Stucci

Brookhaven National Laboratory

A glance at my thesis work

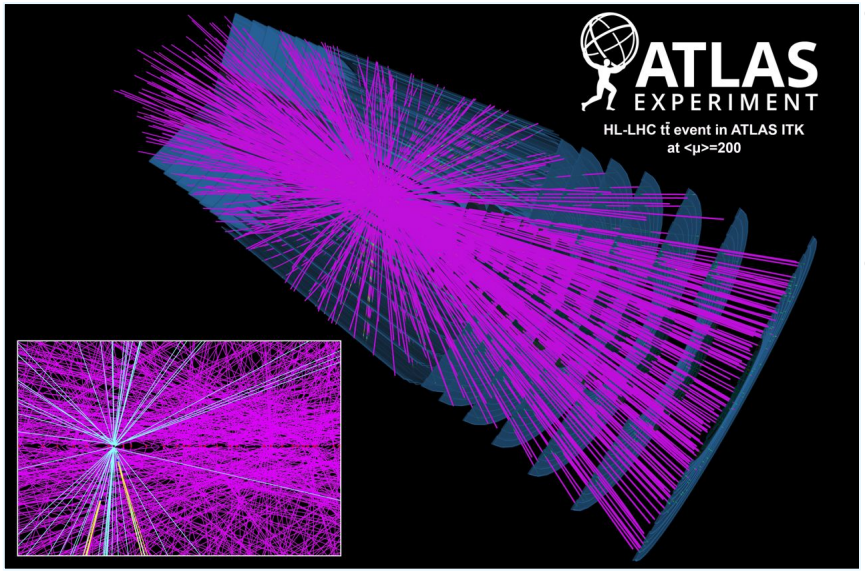
- Working on the decay of the dark Higgs boson, S, to four leptons (e, μ) in the final state through two dark matter mediators, the Z dark bosons; Z_d.
- My contribution to the analysis includes the interpretation of the results in extended sectors beyond the Standard Model.
- My visit to BNL helped me to dedicate more time to finish my thesis writing with the major help and guidance of DR.

Motivation

- The upgrade of the LHC to the High Luminosity phase (HL-LHC).

  Centre of mass energy: 14 TeV
  Ultimate Instantaneous Luminosity: 7.5 × 10^{34} cm^{-2} s^{-1}
  Ultimate Integrated Luminosity: 4000 fb^{-1}

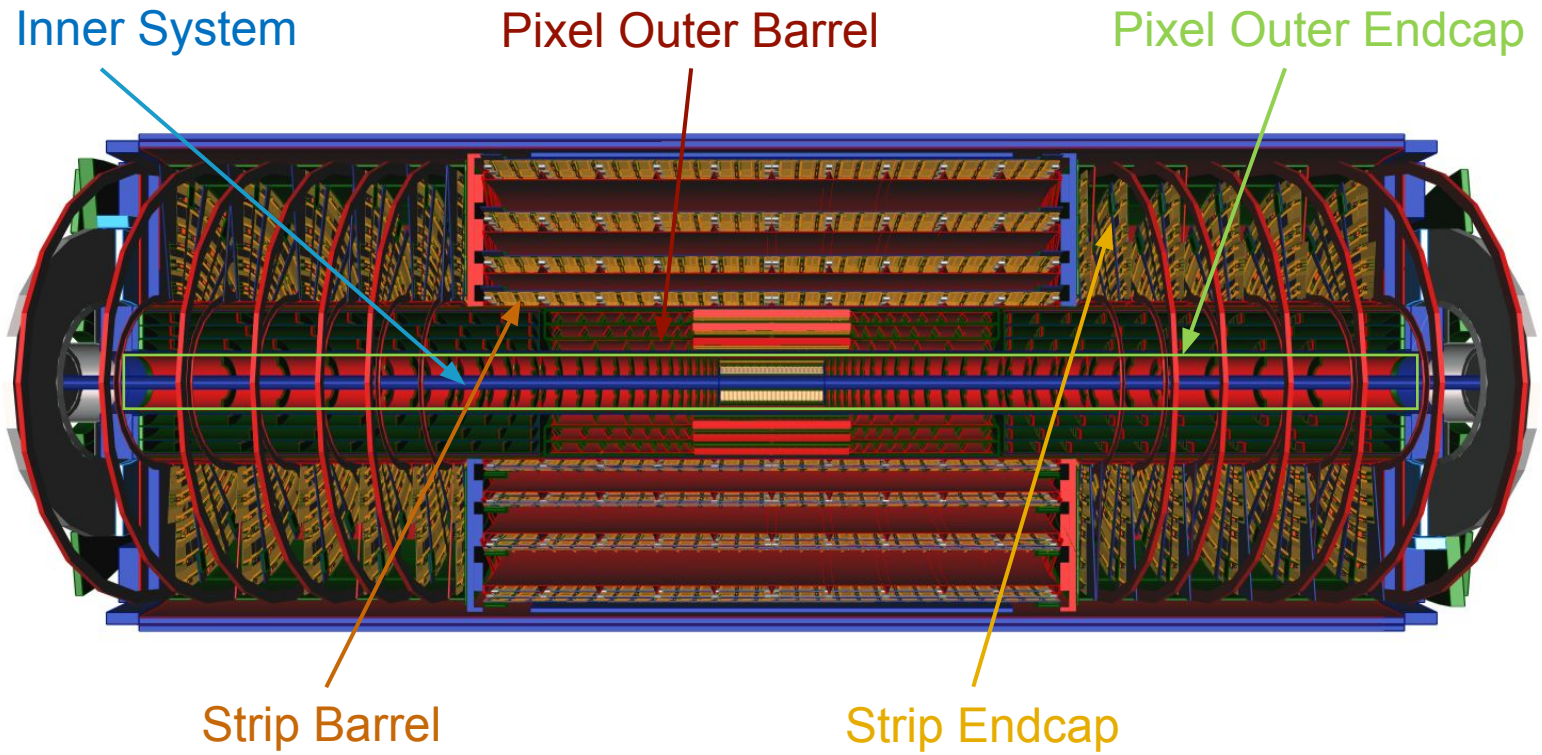
- Larger event sizes, more particles fluxes, higher radiation damages, increased pileups …



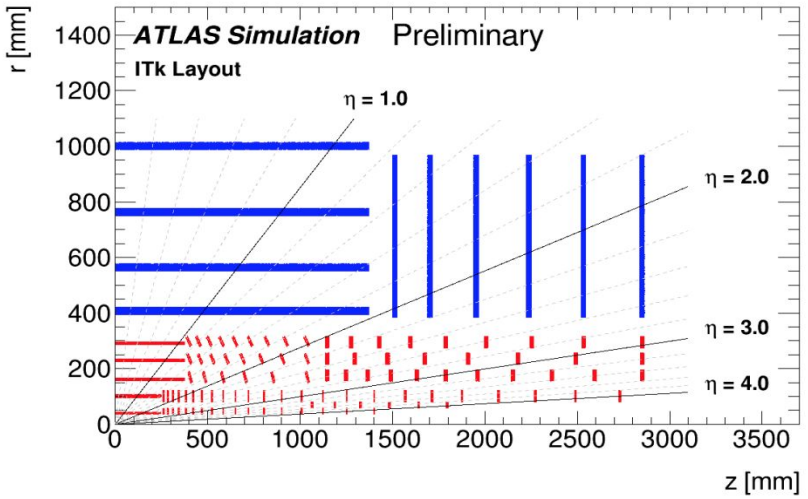
- Many critical components of the ATLAS detector will reach the end of their lifetime.
- Some modification and replacement will affect some of the detector components: Forward calorimeter, forward muon wheels and the ID...

- An All-Silicon Inner Tracker will replace the Inner Detector: ITk

All-Silicon Inner Tracker



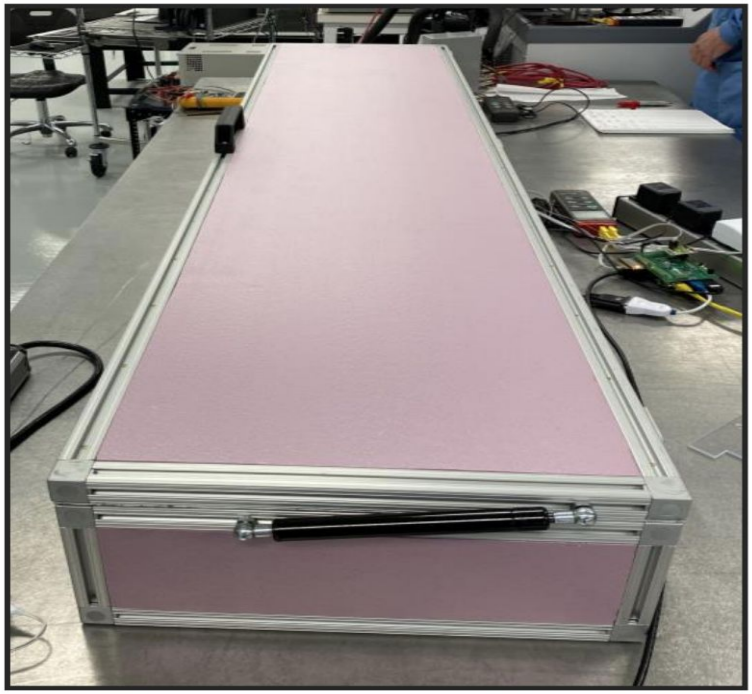
- Pixels: 5 barrel layers and new pixel ring structure.
- Strips: 4 barrels + 6 disks each side.
- Large coverage of the acceptance: $|\eta|<4$.
- Will provide a minimum of **9** hits-on-track in the barrel, and **13** hits-on-track in the forward, for particles with p_T > 1 GeV/c and $|z_{vtx}|$ < 15 mm

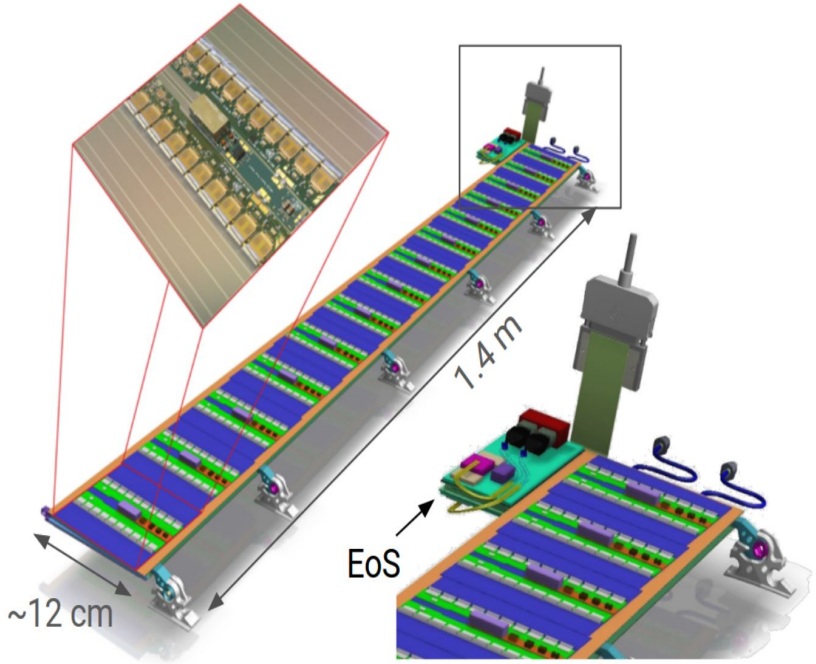


Brookhaven National Laboratory

ITk Strip staves testing

- BNL is responsible for assembling half of the ITk strip detector.
- The mechanical building blocks of the barrel are the staves which host the electrical and cooling services as well as 28 silicon modules, 14 in each side.
- To cope with radiation damages, the detector must be operated at cold temperature.
- A thermal cycle testing is performed to test the reliability of the staves at very low temperature (-45°C).

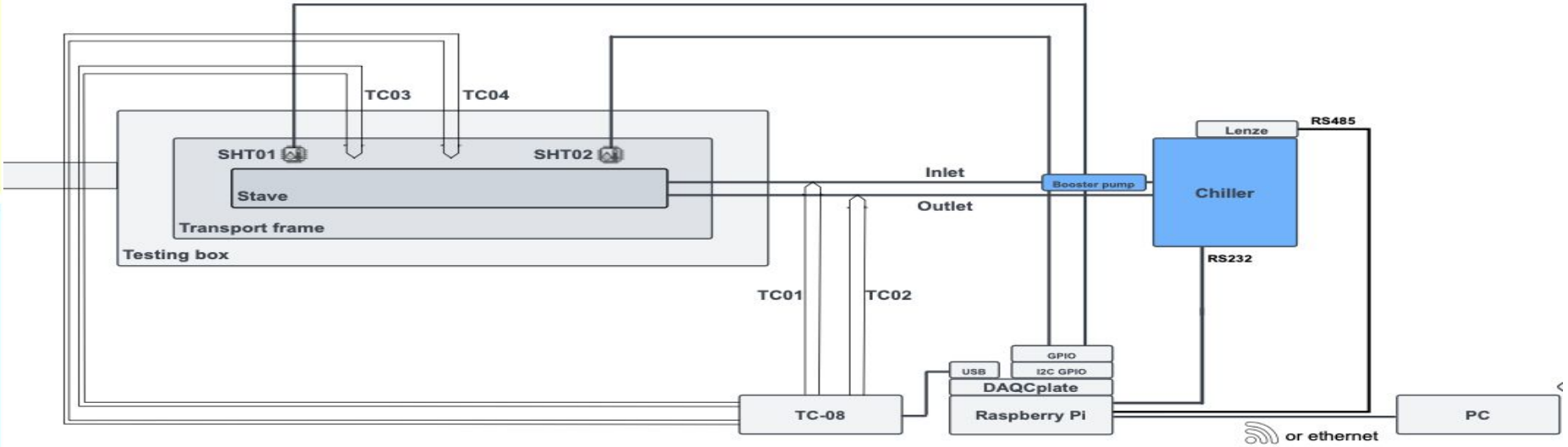




- A chiller, temperature logger and humidity sensors are installed in a coldbox to perform the necessary measurements for the thermal testing.

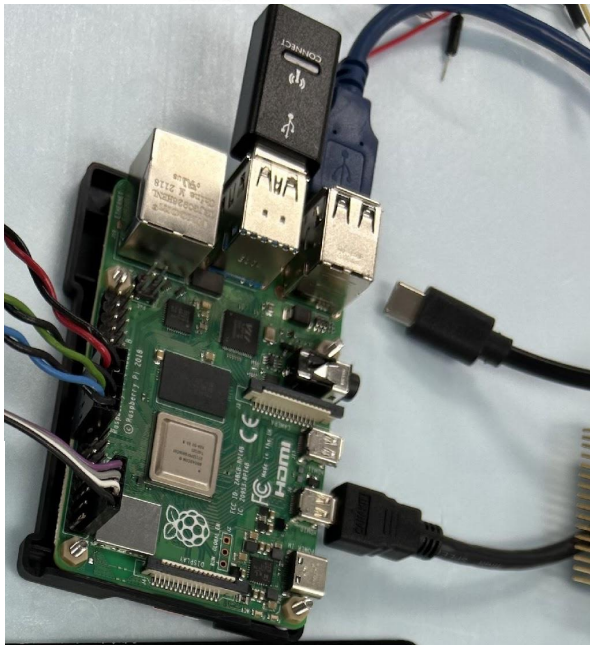
Brookhaven National Laboratory

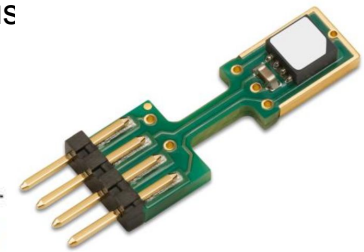
Stave testing setup



The box is equipped with:

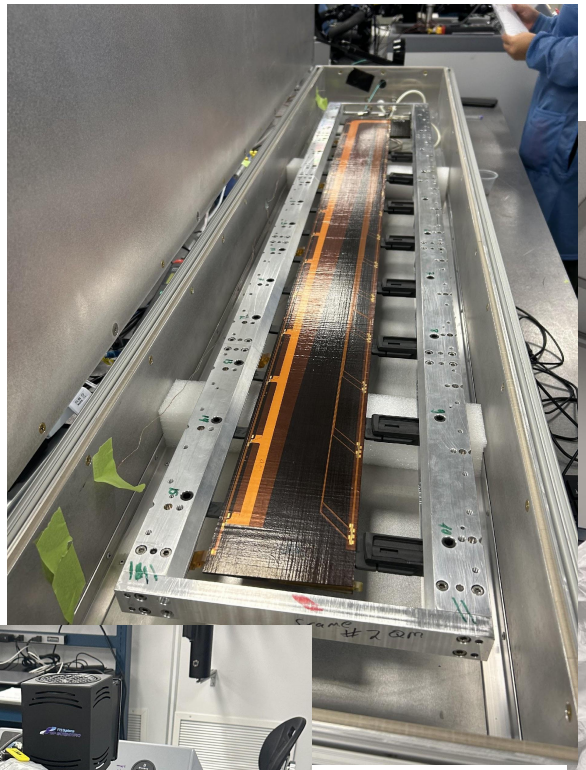
- Chiller: to cool the stave to lower temperature degrees.
- Booster pump: Boost the cooling to the distant modules.
- TC08: USB logger to measure the temperature of the chiller pipes and the box using thermocouples.
- SHT85 sensors: Measure the humidity of the box.
- Raspberry Pi4: us ensor rea

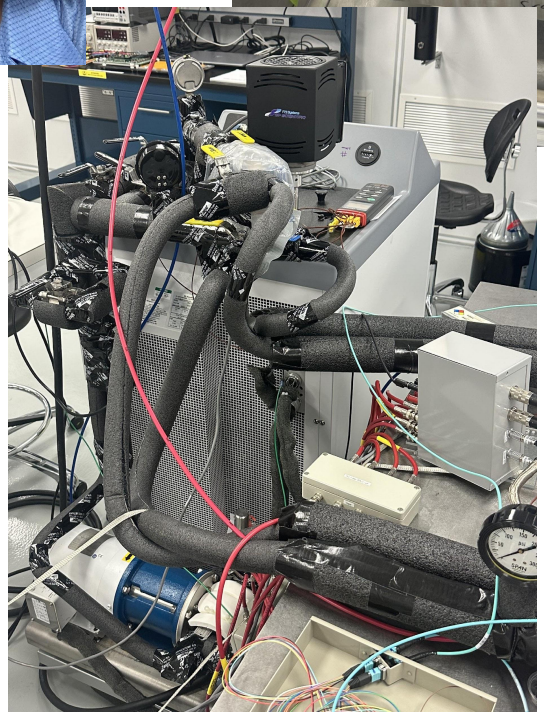


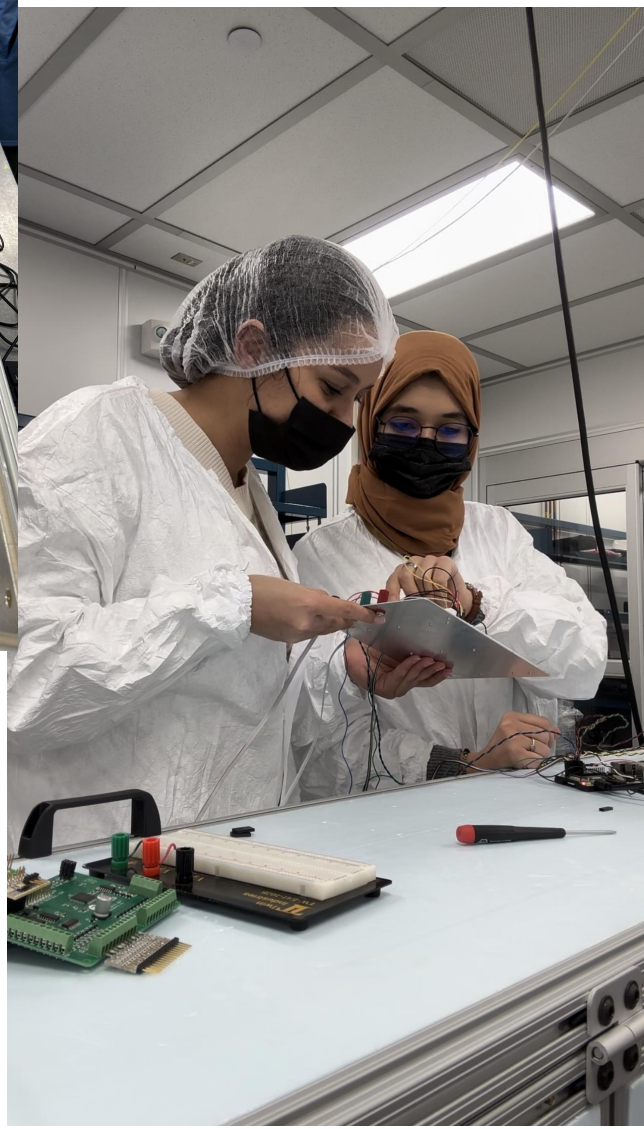


Brookhaven National Laboratory

Cleanroom at BNL



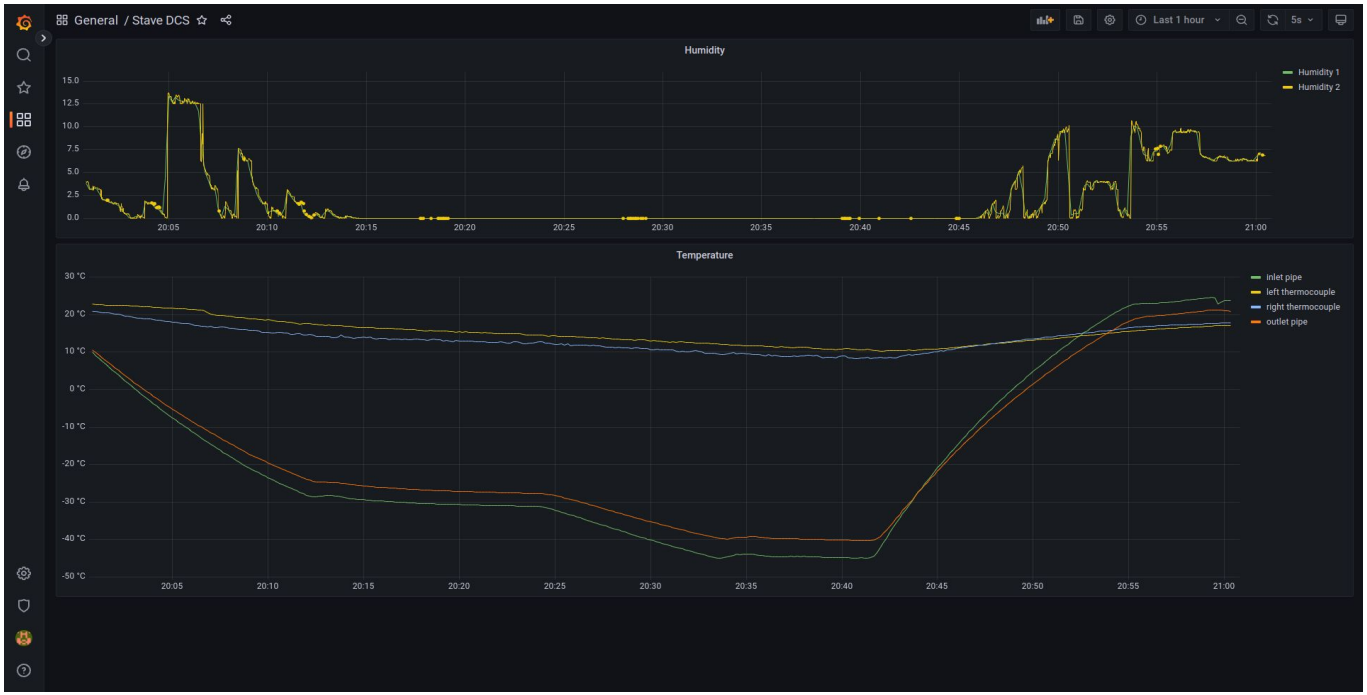




Brookhaven National Laboratory

Results

- An algorithm has been developed to measure the temperature and the humidity of the stave during the thermal cycling.
- The data are stored and retrieved in InfluxDB database and visualized with the Grafana open source software.



Brookhaven National Laboratory

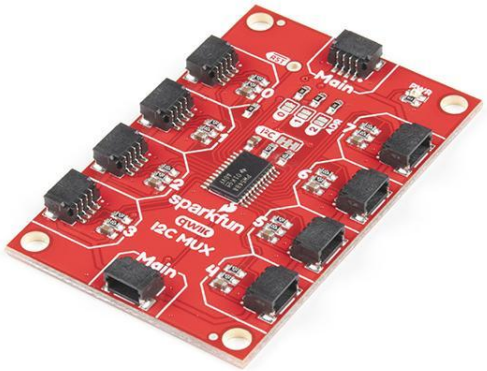
1. Outlet pipe temperature is warmer than inlet due to stave core thermal mass
2. Here, we turned the dry air off and the humidity increased inside the box.
3. Once chiller is set back to RT, the air gets warmer as well. Humidity trend under investigation, one possible cause could be trapped water that is evaporating.

Brookhaven National Laboratory

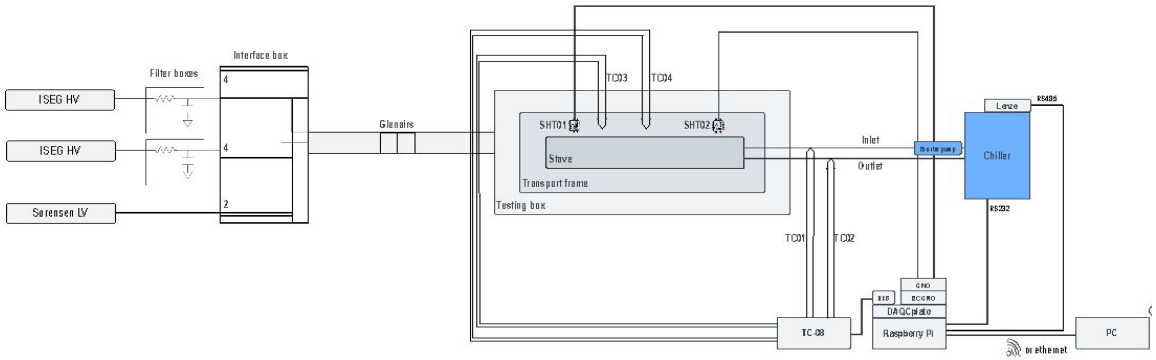
Outlook - ITk

The next steps are:

- Add an I2C multiplexer to monitor two boxes in parallel
- Include booster pump and power supplies control
- Implement interlock functionality
- Add data analyses



BNL stave test setup: DCS



Acknowledgements

- We are deeply grateful for being among the BNL community and getting the privilege of working with its experts.
- We express our sincere gratitude to our mentor and supervisor, DR. Kétévi A. Assamagan, for allowing us to be between you today.
- We extend our appreciation to DR. Stefania Stucci for guiding us and for being cooperative and understanding.
- We want to thank DR. David Lynn, for sacrificing some of his time to enlighten our knowledge about the ITk by giving some lessons.
- We cherish every moment spent here and look forward to seeing you again.

Brookhaven National Laboratory