PIRE GEMADARC

NSF

AUGUST 2019 NEWSLETTER – SPECIAL ISSUE

2019 STUDENT EXCHANGE PROGRAM

Summary of the Student Exchange Program

During the summer of 2019, PIRE-GEMADARC enabled three graduate students to engage in an international research experience. Those students are William Baker from Texas A&M University, David Hervas from the University of North Carolina at Chapel Hill, and Rajendra Panth from the University of South Dakota. Rajendra and David visited Max Plank Institute (MPI) for Physics in Munich, Germany. William visited University Paris Sud in Orsay, France. In accordance with the GEMADARC mentorship plan, all three graduate students received mentorship before their departure and were assigned two on-site mentors: a peer mentor and an experienced mentor.

In addition, a senior undergraduate student, Mukund R. B. from India joined the USD team for two months to work on the study of charge trapping processes in germanium detectors. Mukund R.B., majors in Physics at ISERC, Visva-Bharati University in India. He won the INSPIRE scholarship given by the Indian Government. Mukund was supervised by a young member, Wenzhao Wei, in the PIRE-GEMADARC collaboration for his research at USD. *---Provided by Profs. Christina Keller and Dongming Mei from the University of South Dakota in the U.S.A.*

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Submit news or ideas to:
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Experience from Exchange Students

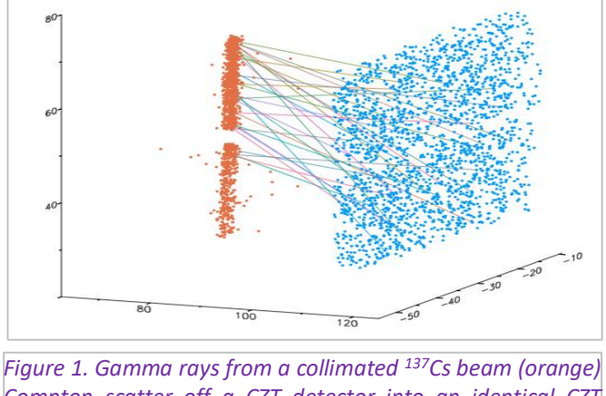


Figure 1. Gamma rays from a collimated ^{137}Cs beam (orange) Compton scatter off a CZT detector into an identical CZT (blue)

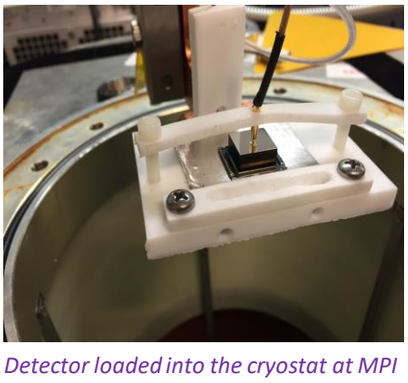
Figure 2. Taking first data with the Ge detector Compton scanner.

David Hervas – University of North Carolina at Chapel Hill, USA

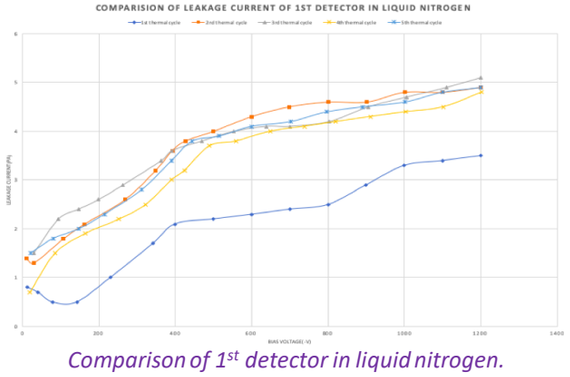
I am currently finishing a research exchange at the Max Plank Institute for Physics (MPI) in Munich, Germany as part of the Partnerships for International Research and Education Program (PIRE). To date, we have finished commissioning of a Compton scanner where we scatter from a target CZT pixel detector to another CZT using a collimated ^{137}Cs source. The setup is being used to validate the target hit position reconstruction code from just the hits on the CZT we scatter into. In an identical setup, we replaced the target CZT with a segmented BEGe (Broad Energy Germanium Detector). BEGe hit positions can be reconstructed by CZT data alone and will be correlated to the detector's pulse-shapes and segment response. The set-up allows for the scan of any in-cryostat Ge detector.

Many undergraduate students participated in the commissioning of the CZT-to-CZT Compton scanner, and I was able to instruct them on the physics behind the setup in addition to many software routines, including the use of containers and introductory programming in ROOT for data analysis. Additionally, the program included many cultural exchange activities that I had the fortune to participate in. As part of the PIRE summer school I joined 2 enriching excursions to Benediktbeuern and historical Munich. Additionally, I participated in the MPI outing to the English Garden and visited the Deutsches Museum and many local festivals with my local cultural advisor Martin Schuster. *---Written by David Hervas from University of North Carolina at Chapel Hill in the U.S.A.*

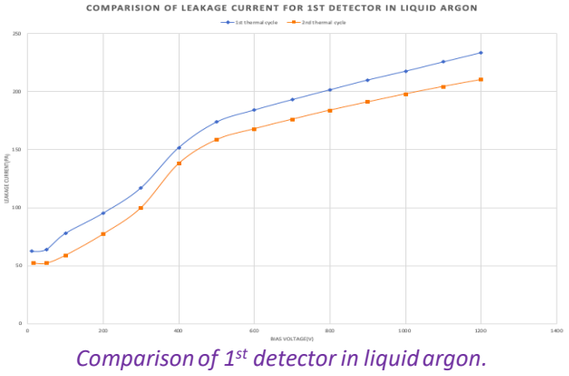
Rajendra Panth – University of South Dakota, U.S.A.



Detector loaded into the cryostat at MPI

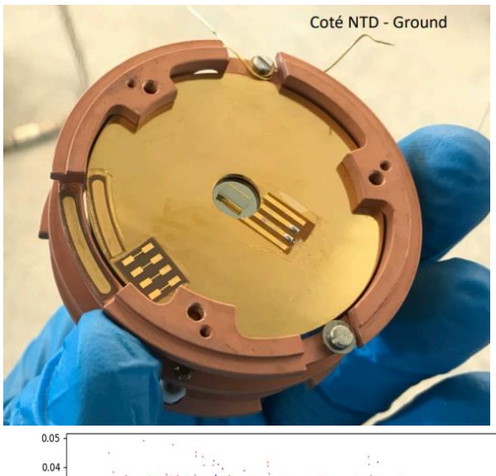


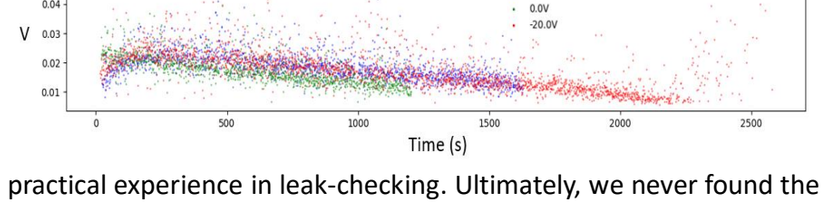
Comparison of 1st detector in liquid nitrogen.



Comparison of 1st detector in liquid argon.

I was involved in the research at MPI in Dr. Iris Abt's group for two months. I participated in summer school and PIRE-GEMADARC collaboration meeting during the stay. I got opportunity to give a presentation on "amorphous contact planar germanium detector in liquid nitrogen/liquid argon". The enjoyable part of the summer school was working in groups involving students from different universities. A few detectors were fabricated using crystals grown at USD and tested before going to MPI. I-V, C-V and energy spectrum measurements were tested using a vacuum cryostat at different temperatures. Dr. Jing Liu and I set up our detector characterization at MPI. Detectors were then directly immersed into the liquid nitrogen and liquid argon to study the stability of the contacts. Measurements show that a-Ge contact detector can survive several thermal cycles without a significant change in leakage current. The setup for the noise was not optimized, therefore there is large uncertainty in energy resolution. We plan to measure the leakage current and energy resolution of these detectors at USD again to compare with the measurements we made before directly immersing in the liquid. The size of the detector is 2.5 cm×2.5 cm×10.7 cm and the detector was fully depleted at 400 V with an impurity concentration of $1\times10^{10}/cm^3$. I am thankful to all the group members of Dr. Iris Abt for their help and suggestions. *---Written by Rajendra Panth from the University of South Dakota in the U.S.A.*





William Baker – Texas A&M University, USA

The research exchange with University Paris Sud in Orsay, just 20 minutes south of Paris, began with a practical demonstration of the cryogenic hazards in a condensed matter physics lab - that is, one of our advising colleagues displayed the creation of a cloud by spilling liquid nitrogen into a basin of water. Fun aside, after the area-specific safety training, work began with some hands-on troubleshooting of a partially-functional pulse-tube cryostat with the purpose of testing a new Ge detector design focused on preventing leakage current. The fridge had been demonstrating a not insignificant leak from the manifold containing the He3-He4 mixture into the detector/sample space, which was preventing the system from reaching its nominal base-temperature of ~20 mK. This troubleshooting provided a close look at and deeper understanding of the inner-workings of a dilution refrigerator, as well as some practical experience in leak-checking. Ultimately, we never found the leak, and so we were forced to solve the issue by installing a "basket" of charcoal on one of the lower stages, to act as an absorber for any gas that leaked into the sample vacuum. We cooled the system down twice without success - the base temperature never went below 80 mK. After this we resorted to using a wet-fridge in an adjacent lab. Liquid He was provided by some colleagues of our French partners, and we were able to cool down to ~30 mK. The requirement of low temperature was critical for operation because the bolometer used for thermometry (Neutron Transmutation Doped Germanium) has a Resistance-Temperature profile which provides exponentially greater sensitivity with lower temperature. In the second cryostat we were able to see distinct pulses on our charge and heat channels and were able to positively identify and calibrate to signals from an Am-241 source which was installed with the detector. The data collected was exciting enough that analysis is still underway and future collaboration has already been planned. For our last few days, we left Paris to visit another group in Lyon and while we didn't accomplish much in the way of research, we were able to bring them up to speed on the work we had already done and discuss their possible role in our future collaboration.

Given the amount of time required for cooling these cryostats, work was regularly punctuated with visits to the city. We spent a day in the Louvre, and another visiting cultural icons like Notre Dame, Sacre Cour, and Tour Eiffel. We ate crepes and croissants nearly every day and found out that burgers are the same in every country. Ryan, Paige and I stayed in the heart of Paris for the majority of our visit at Cite Universitaire, where the dorms are purposefully filled half-way with French students, so that students can make friends with "locals". Our location also made it easy for us to venture out and experience the city by foot or by electric scooter. During our short stay in Lyon, we were able to see the free zoo and the Basilica on the hill after we had Bouchon, a Lyon specialty. We had all started learning French basics before we even began travel, so this provided the foundation to begin learning the language in an immersive experience. One of the first lunches we had, I suggested that our French colleagues speak only in French every other day. This didn't last long, but it was fun for a moment. *---Written by William Baker from Texas A&M University in the U.S.A.*

Mukund was working with Dr. Wenzhao Wei at the University of South Dakota.

Mukund R. B. – Visva-Bharati University, India

I am Mukund.R.B, a final year student pursuing a 5 year integrated M.Sc. course, majoring in Physics at ISERC, Visva-Bharati University in India. Being a recipient of the INSPIRE scholarship given by the Government of India, we are constantly encouraged to apply for internships every summer so as to help us to progress forward in our preferred areas of interest right from our first year of studies. This unique structure has enabled me to work at a variety of research labs and institutes in my preferred areas of interest which have gravitated towards the field of Dark Matter studies and detection during the course of my study over the past 4 years. In order to get a better understanding of the exact fabrication and characterization techniques that are used in the development of highly sensitive HPGe detectors for use in dark matter detection studies, I decided to work under Prof. Dongming Mei's guidance at their research lab at the University of South Dakota, USA for the summer of 2019.

During my time here, my main goal was to carry out charge trapping studies of various planar detectors which had been developed at USD by using a model which was based off of the Shockley-Ramo theorem and use it to estimate various parameters like the trapping length, charge collection efficiency and the trapping cross-sections by using MATLAB for corresponding spectral analysis and related calculations. We expect the observations and results to be converted into a research paper with the aim of publishing it in the Journal of Astroparticle Physics in the near future. I also had a chance to learn the entire process involved in the development of planar HPGe detectors with a-Ge contacts, beginning with the initial zone refining steps and ending with the testing of the fabricated detectors carried out at liquid Nitrogen temperatures. The use of amorphous germanium contacts and their benefits over the traditional lithium and boron contacts was particularly fascinating as I learned that such technologies have a tremendous potential in the quest for developing ton-scale Germanium detectors sensitive to both position measurements and energy resolution. Additionally, all my labmates have been extremely helpful (especially Dr. Wenzhao Wei) in clearing out every single one of my doubts along the way, no matter how trivial they seemed. Weekends were equally enjoyable with trips to the Missouri River nearby providing a pleasant and calm backdrop to wind down from the exciting and fast-paced weekdays. This balance ensured that it created an ideal learning platform for me to gain a lot of important methodologies and procedures, and understanding where and how to adapt these efficient problem-solving methodologies in order to better explain the obtained results.

To sum it all up, these 2 months spent here have been a very wholesome experience in its truest sense and it has left me with an unforgettable "taste" of the kind of research being done at the PIRE-GEMADARC Collaboration and a burning desire to further increase my knowledge base in this area. I eagerly look forward to being a part of this collaborative effort as a hopeful Doctorate candidate next year! *---Written by Mukund R. B. from the Visva-Bharati University in India.*

UPCOMING EVENTS

1. PIRE-GEMADARC Analysis Workshop, November/December 2019.
2. PIRE-GEMADARC 2020 Sumer School and Collaboration Meeting in Taiwan, May 20 – May 30, 2020.

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