

Development of the Most Sensitive Dark Matter Detector with Liquid Argon

Azam Zabihi

Group leader: Prof. Wada
ASTROCENT/CAMK PAN

Annual Meeting- 5th February 2026



ASTROCENT



Funded by
the European Union



NATIONAL SCIENCE CENTRE
POLAND

DarkSide-20k Mockup Assembly at LNGS

Location: Gran Sasso National Laboratory (LNGS), Italy
January- February 2025, on site



Personal Involvement:

- ❖ Participated in full assembly and commissioning cycle
- ❖ Worked closely with cryo/electronics experts
- ❖ **Remote monitoring (March-May):** cooldown, LAr filling, HV testing, gas pocket formation
- ❖ Documentation: Technical note



Scientific Stay at IHEP (Institute of High Energy Physics)

Beijing, China - July 2025



Assembling the TPC



data-taking, SiPM readout



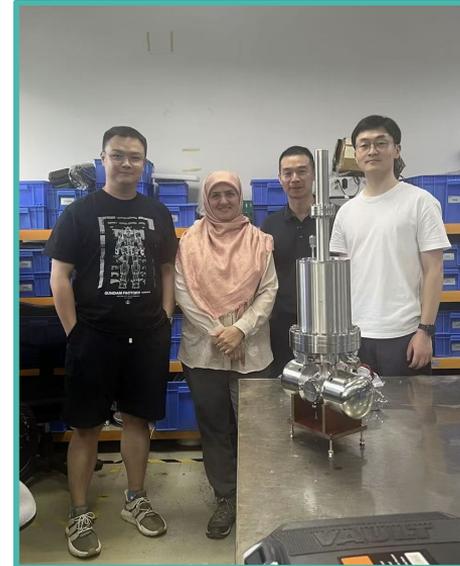
Experimental Physics Division Seminar, July 16

Hands-on Work

- ❖ **Cryogenic system setup** & troubleshooting using Siemens Lab Monitoring & PID Control
- ❖ Assembly & integration of Time Projection Chamber (TPC)
- ❖ Testing and characterization of SiPM-based cryogenic readout electronics (4th-gen VUV-MPPCs)

Scientific Stay at IHEP (Institute of High Energy Physics)

Shenzhen (2 days)



Assembling the Cryocooler
+ a customized heat exchanger

Cryogenic System & TPC Leadership

Almost Ready for Assembly in the New Lab!

Notion page

Thanks to our team: Vladyslav, Clea, Rita, Maciej, Andre, and Prof. Wada

TPC LAr - SONATA BIS NCN

This workspace is meant to organize the efforts to design, construct, commission, and run the TPC and its cryogenic system.

For any questions, feel free to reach out to @AzamZabihi or @Masa

Documents and Data

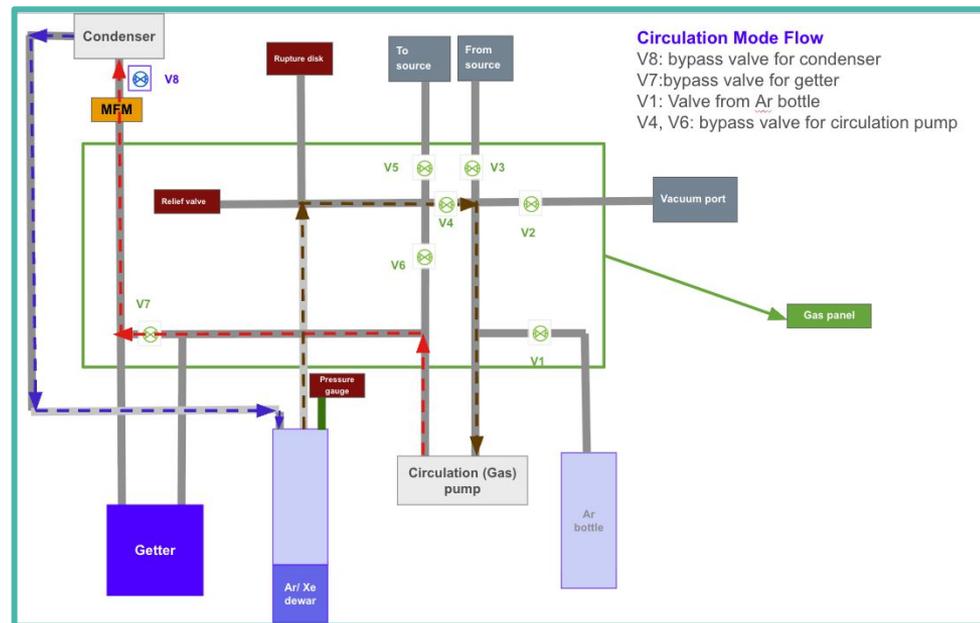
People

- Equipment List
- TPC-Cryostat
- Cryogenic System
- ✓ To-Do
- Cryogenic System Inventory & Task Tracker
- Purchase To Buy

Hardware

- Equipment Control
- Raspberry Pi 5: installation influxDBV1 and Grafana
- Raspberry Pi 5: pressure measuring
- Raspberry Pi 5: Mass Flow Meter (HFM301)

Our system schematic



veto Photo Detector Units (vPDUs) Test

Hands-on work



A Few Shifts ... (more info in Marcin, Samuel, Diego, .. talk)

3DPi PET Project

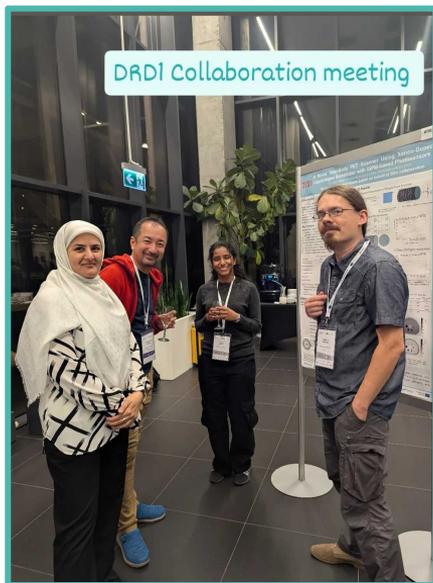
- Paper published in *Physics in Medicine & Biology* (02/2025), as a *first and corresponding author*
- Submitted research grants:
 - **Miniature-9, NCN:** Qualified for financing (2025/11 - 2026/11)
 - **SONATA 21, NCN:** Under eligibility check
 - **Scholarship for an outstanding young scientist:** Under eligibility check
 - **ERC Synergy:** Contribution with my group leader (Prof. Wada & 2 PIs from the DarkSide collaboration)
 - **First Team, FNP:** rejected!

Publication (DarkSide)

- **Flow and thermal modelling of the argon volume in the DarkSide-20k TPC**, Journal of Instrumentation 20 (06), P06046
- **Quality assurance and quality control of the SiPM production for the DarkSide-20k dark matter experiment**, The European Physical Journal C 85 (5), 534
- **Benchmarking the design of the cryogenics system for the underground argon in DarkSide-20k**, Journal of Instrumentation 20 (02), P02016

6th DRD1 Collaboration Meeting

- **Poster:** A Novel Total-Body PET Scanner Using Xenon-Doped Liquid Argon Scintillator with SiPM-based Photosensors
- **Contribution:** Assisted in organizing the meeting.



MuoTech (Muon tomography and radiography detectors)

subcontract

First contract: Muography for non-destructive testing feasibility study; 200 hours, November 2025

Second contract: CMOS (Complementary Metal-Oxide-Semiconductor, standard webcam) Cosmic Ray Detector (CCRD); 80 hours, December 2025-February 2026

Third contract: Coming soon (March...)

Outreach

Wednesday Colloquium
April 16, 2025

Advances in Dark Matter Detection and 3D π PET Imaging Technology

Azam Zabihi
Group leader: Dr. Masayuki Wada
ASTROCENT/CAMK PAN
Wednesday Colloquium, April 16th 2025



ASTROCENT

NATIONAL SCIENCE CENTRE
POLAND

Funded by
the European Union

Science Picnic
May 10, 2025



CAMK Open Day
September 21, 2025



Academic Engagement And Plane for 2026

Grant Evaluation:

- Evaluated a grant proposal submitted to the Swiss National Science Foundation (SNSF)

Paper Reviews:

- Reviewed several research papers for academic journals

Geant4 Monte Carlo Support a Ph.D. student (Electromagnetic Showers at the Large Hadron Collider)

- Center for Nuclear Research, Warsaw, Poland, (Supervisors: Dr Trojanowski. & Prof.Roszkowski)

Contributions to the Iranian Scientific Community

- **Advisor:** One PhD student, already defended her thesis, and a second one will do this month.
- **Publication:** (27 January 2026): Protective effects of selenium nanoparticles against X-ray-induced testicular damage in rats: An integrated experimental and Monte Carlo simulation study, *International Journal of Reproductive BioMedicine*

Plan for 2026

Upgrading cryogenic infrastructure for xenon doping in LAr-based scintillation studies (MINIATURA 9 grant)

Development of the Most Sensitive Dark Matter Detector with Liquid Argon (SONATA-BIS)

- Measurement of delayed electron emission due to chemical impurities in liquid argon.
- Reducing backgrounds from photoelectronics

Development 3DPi PET Project

- Transition from simulation to experimental phase (MAB FNP grant and upcoming grant approval).



Thank you

azabihi@camk.edu.pl