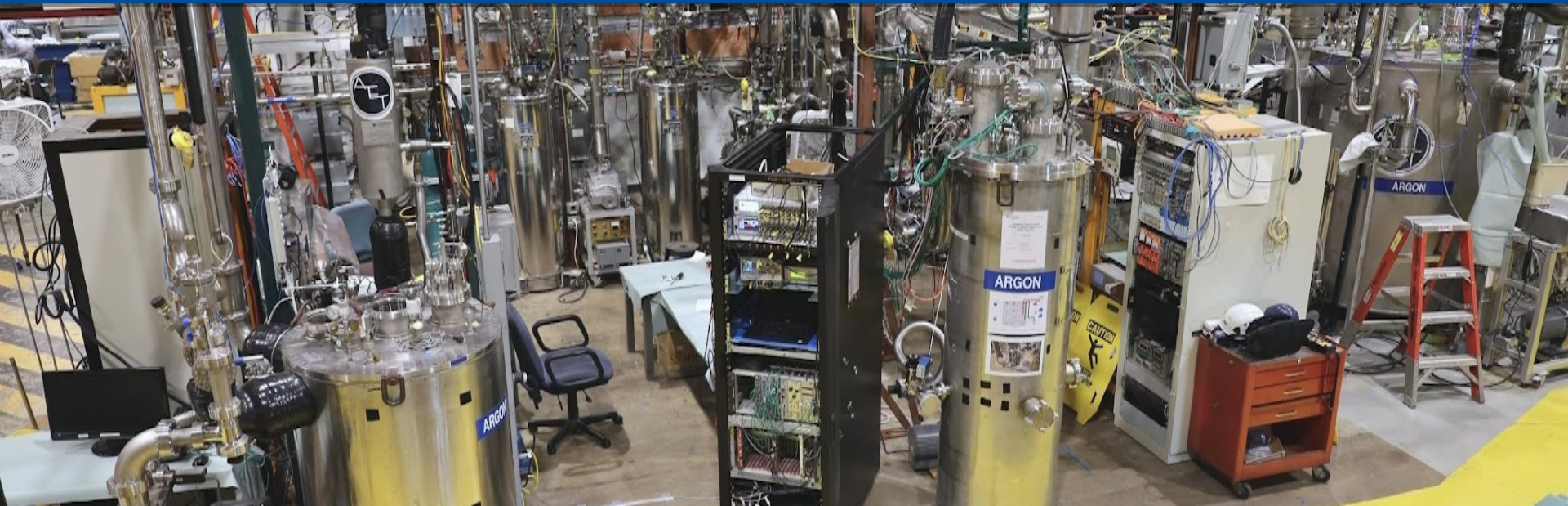




The Noble Liquid Test Facility at Fermilab

Flor de María Blaszczyk

CPAD

October 2026

Outline

- Noble Liquid Test Facility
 - Overview of the facility
 - Main test stands description
 - Community resources and safety
 - Facility upgrades

Noble Liquid Test Facility overview

NLTF is a facility for liquid argon detector development, supporting small scale R&D projects aligned with P5/HEP as well as large scale projects such as DUNE and SBN, similar to the Fermilab Test Beam Facility.

- 4 permanent test stands + workspace for bench testing and open dewars tests
 - Recently added an optical test stand facility.
- **Open to the community, both national and international.**
 - Interested parties send a request to the facility manager:
Flor de Maria Blaszczyk - fblaszcz@fnal.gov
 - Discuss about goals, requirements and resources needed.
 - Submit a technical scope of work form (TSW) to formalize the request.



Collaboration between Fermilab and UNICAMP
to test new filter media in Iceberg

In an era of increasingly constrained budgets, maximizing our collective scientific output means making the most of existing infrastructure and shared expertise. NLTF provides established infrastructure, specialized expertise, and proven safety systems to support our shared research goals.

Why purity matters?

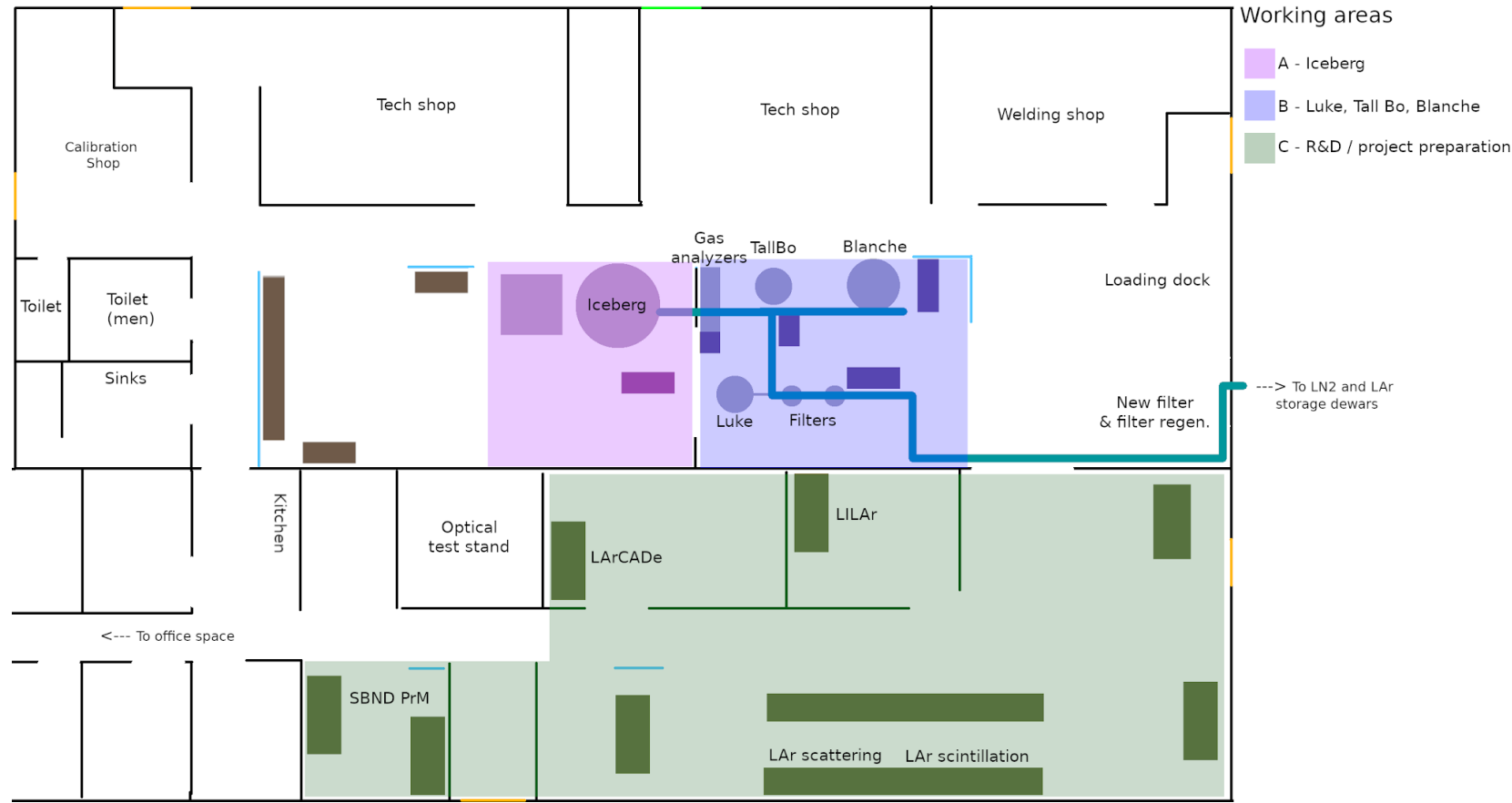
NLTF can provide ultra-pure LAr for all of its test-stands as well as live monitoring of the contamination down to ppb level.

- Charged particles crossing a time-projection chamber (TPC) produce 2 types of signal:
 - Ionization charge, no charge amplification in LAr, oxygen and water impurities capture the electrons (on top of recombination)
 - Scintillation light (128nm), which can be quenched by nitrogen impurities (~20% of light lost at 1ppm nitrogen, [JINST 5 \(2010\) P06003](#))
- Commercial LAr suppliers don't meet the physics standards since the argon has ppm level of contaminants:
 - **Need < 1ppb O₂ and H₂O for O(ms) electron lifetime:** typical drift O(5ms) for DUNE and SBN TPCs (depends on TPC drift length)
 - combination of mol. sieve and copper media used to filter both contaminants by factor 1000.
 - **Need < 1 ppm N₂.** We were unable to filter it but recent test has demonstrated the N₂ absorbing capabilities of Li-FAU, a new filter media.
 - [Technical Note CRYOFRABR#0122024 | CERN EDMS doc. 3121951\(v.1\)](#)



Inline filters and gas analyzer system

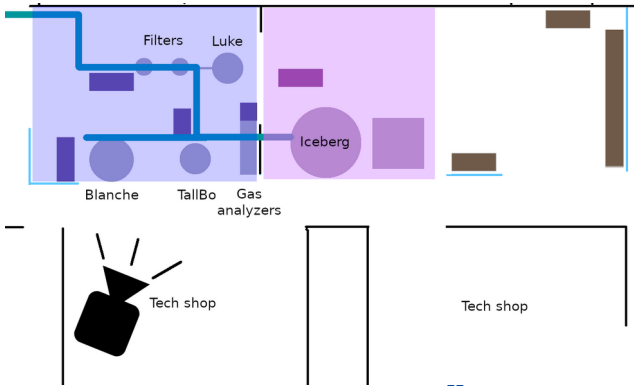
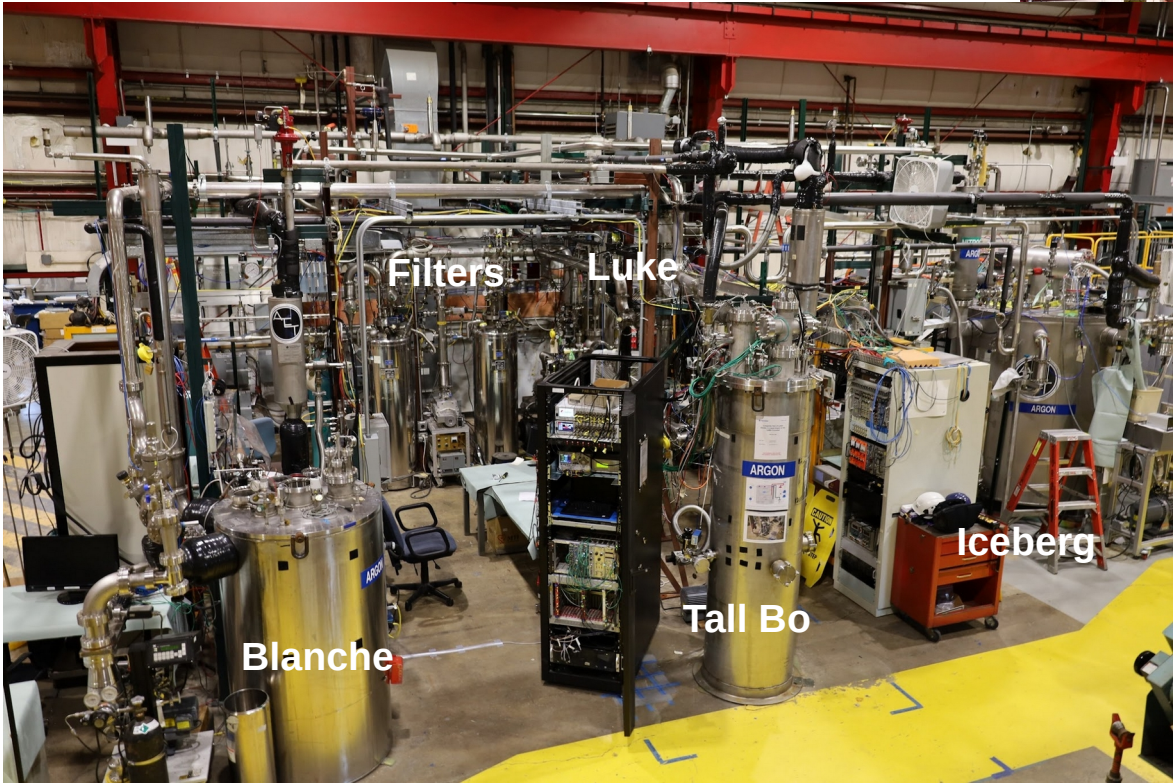
Noble Liquid Test Facility overview (not to scale)



Noble Liquid Test Facility overview

Aerial view of the facility

Current facility layout

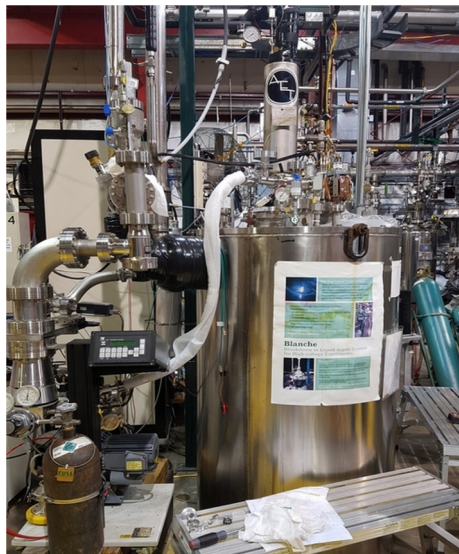


Recent R&D and tests @NLTF



Luke / MTS (250L)

*Small detector tests
Xe doping studies
Material tests*



Blanche (450L)

*HV studies
SBND PrM
Doping studies
TinyTPC
LArCAdE
OSCAR*



Tall Bo (450L)

*NIR/VUV
LAr prop. scintillation
LILAr
LArS
DUNE VD laser diode test
ACCBAR*



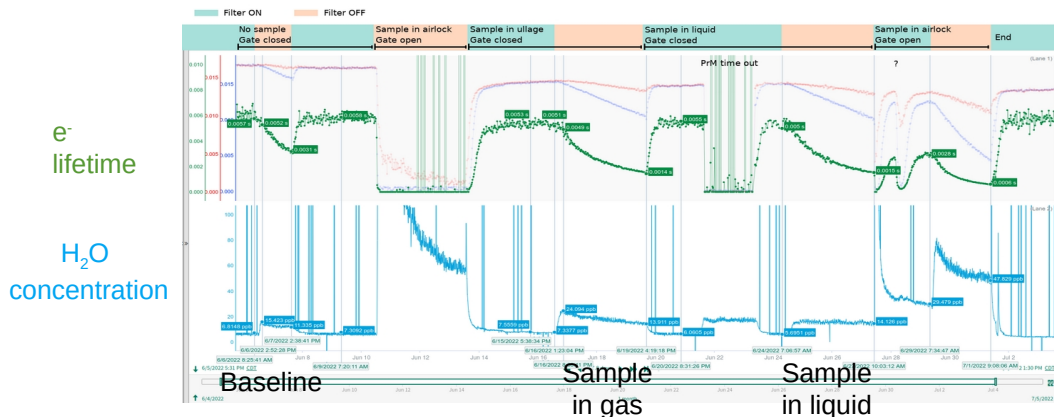
Iceberg (3000L)

*DUNE cold electronics & HV
DUNE VD photon detector
POF/SOF R&D
Filtration tests
AI/ML
DUNE slow controls/DPS*

Luke / MTS (250L – 22" Ø – 37" H – max LAr level 25")

- Features: Purity monitor, internal filter, airlock mechanism to insert materials into the cryostat, elevator to lower the materials into the gas and liquid space, ~10 lemo cables for powering/reading-out small detectors.
- Purpose: Mainly for testing materials in GAr or LAr (impact on electron lifetime and water outgassing). Can be used to test small setups.
 - **Material testing is a service provided to the community.**
- Current status: material tests on-going
 - testing samples for DUNE FD, LBNF recirculation pumps, etc.

Example of material test (~2 weeks long)



Tall Bo (450L – 22" Ø – 79" H – nominal LAr level 60")

- Features: Manual elevator platform, tall vessel.
- Purpose: Mainly used for light collection studies (no lifetime measurement nor internal filtration).
- Current status: last used by ACCBAR, novel calorimeter approach to trap long lived particles (publication soon)
- Recent uses:
 - NIR: Typically light in LAr is UV, but studies show there's also emissions in IR.
 - LILAr: pixel detector coated with amorphous Selenium to develop detector that can collect both charge and light or for very large surface area photon detection.
 - LArS: study of light scattering properties in LAr.
 - Test longevity of laser diodes for the DUNE VD power-over-fiber/signal-over-fiber (POF/SOF) photon-detector system.



Blanche (450L– 30" Ø – 58" H – nominal LAr level 35")

- Features: Purity monitor, recirculation filter (on-going upgrade).
- Purpose: Originally designed for high-voltage tests, multi-purpose cryostat.
- Current status: currently in use by OSCAR (e⁻ transverse diffusion in LAr using a segmented anode TPC)
- Recent uses:
 - SBND high-voltage feedthrough and purity monitor tests
 - TinyTPC: optimize pixel TPC for low energy event detection using photo-ionizing dopants (CPAD2025)
 - Doping studies: light collection optimization with Xe doping and effects of combined doping with photo-ionizing dopants
 - LArCADE: charge amplification in LAr via thin needles on anode (CPAD2026)



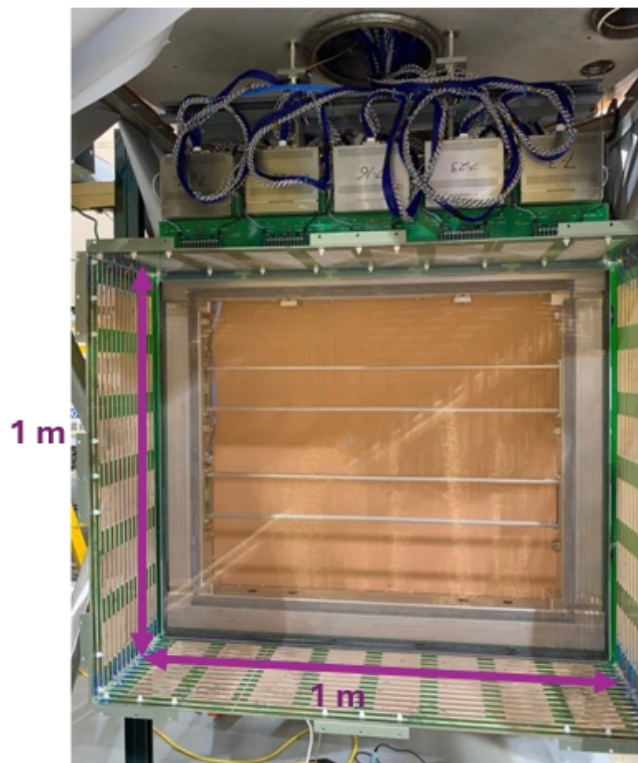
Iceberg (3000L – 60" Ø – 72" H – max LAr level 60")

- Features: Purity monitor, internal filter, large enough volume for TPC, external cosmic ray tagger, **clean power** (separated from building ground,).
 - internal filter will be swapped with recirculation filter
- Purpose: Originally built for DUNE cold electronics testing, multipurpose cryostat, low noise tests.
- Current status: on stand-by, waiting for new transfer LAr line commissioning then will be used for AI/ML R&D.
- Recent past uses:
 - ProtoDUNE single phase high-voltage feedthrough test
 - DUNE vertical drift POF/SOF full X-ARAPUCA tile
 - New filter media Li-FAU, capable of absorbing N₂ from LAr

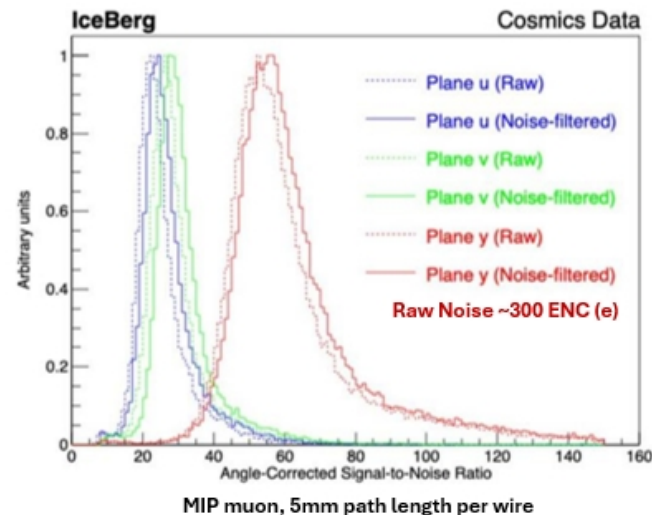


Iceberg TPC (~1m³):
wires planes in the middle, 2 drift volumes

ICEBERG LArTPC

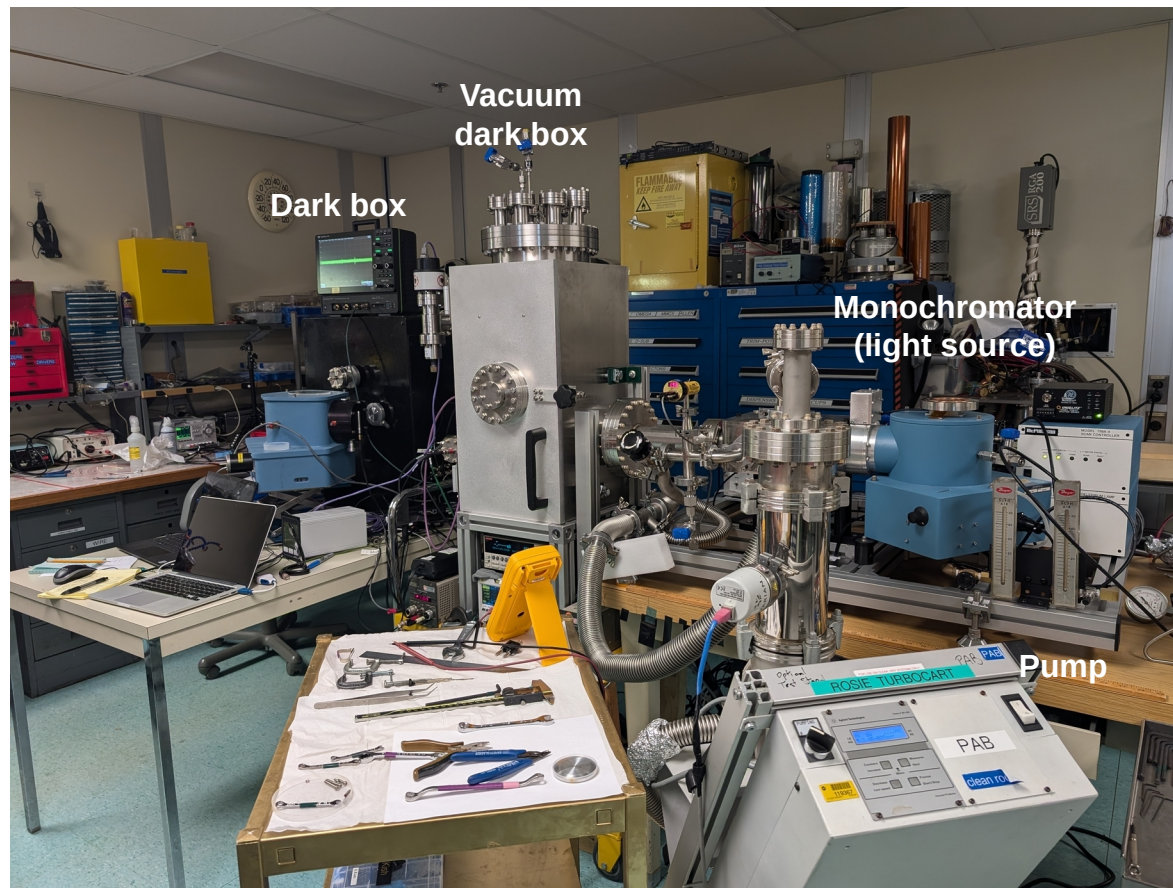


- Active volume $1\text{ m} \times 1\text{ m} \times 0.3+0.3\text{ m}$
- 500 V/cm drift field
- Two cathodes and a central dual anode, 30 cm drift each side
- Each anode side has 3 instrumented wire planes and a grid plan each side
- DUNE-FD-HD low noise cold/warm electronics
- Cryostat and detector isolation from building and cryogenic power enables low noise operations



NLTF optical test stand overview

- Run by Alex Kish
- Features:
 - Light source range VUV to visible (110 nm to 550 nm)
 - Optical table with 7 degrees of freedom (2 rotational, 5 linear)
- Purpose: measuring optical properties of materials (transmission, reflectivity), photosensor quantum efficiency, imaging with $\sim 1\ \mu\text{m}$ resolution.
- Will be upgraded with a coldhead and helium compressor for cryogenic tests.

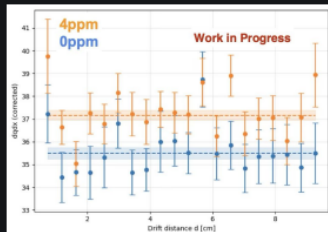


Recent R&D highlights (A. Fava, Fermilab PAC Sep. 2026)

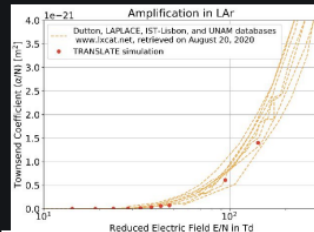
Charge Collection R&D

Aimed at lowering the energy thresholds from O(MeV) to O(10-100keV) to expand physics reach

- 5% charge enhancement observed with 4 ppm photo-ionizing dopants (**TinyTPC**); (H. McCright, CPAD2025)
- developed first microphysics simulation (**TRANSLATE**) towards exploration of secondary ionization in LAr via locally enhanced electric fields at the anode (**LArCADE**).



CPAD2025 highlights

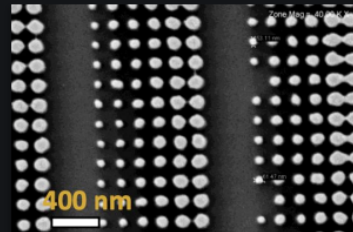


Neutrino 2026 best poster award
and [CPC 297 \(2024\) 109056](#)

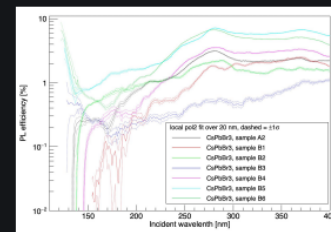
Light Collection R&D

Aimed at improving efficiency of 128 nm scintillation light collection in LAr:

- First transmissive **metalens** for VUV (175 nm) for direct detection without wavelength shifting; (A. Kish, CPAD2023)
- first VUV photoluminescent coating based on halide **perovskite** nano-crystals (CsPbBr_3), developed in collaboration with material scientists from NLR, to increase wavelength shifting efficiency..



Nat. Photon. 19, 1286



-> talk by S. Dey, Noble elements RDC, 10/20

Community engagement

- Monthly meetings where all NLTF users meet to share their results, discuss progress and schedule, and seek advice.
 - facility manager always available as needed
- Multiple tools at the disposal of the community:
 - Online document database and wiki page
 - Electronic log book
 - Webpage: <https://neutrino.physics.fnal.gov/facilities/liquid-argon-facilities/>

NLTF/PAB meeting

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Full Title: NLTF/PAB monthly users meeting
Date & Time: 31 Jan 2024 at 09:30
Event Location: Zoom or PAB conference room
Event Topic(s): [Monthly Meeting](#)
Event Moderator(s): [Elior Blaszczyk](#)

LArTPC

[LArTPC Analysis Summit](#)
[LArTPC Analysis Summit](#)
[NLTF/PAB meeting](#)
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Start	Title	Author(s)	Topic(s)	File(s)	Length	Edit
09:30	NLTF status	Elior Blaszczyk	PAB status	Schedule_Jan2024.pdf	00:10	Edit
09:40	NLTF crystalen upgrade presentation	Sergey Kostalev	Cherenkov Tallies LArTPC Blanchet ICERBERG	2024-01-31-NLTF.pdf 2024-01-31-NLTF.pdf	00:20	Edit
10:00	ICERBERG Status and Plan	Shashvat Mishra	Detectors ICERBERG	ICERBERG Status.pdf	00:15	Edit
10:15	LArTPC Status and Plans	Jacob Zeffernover	Blanchet	ProgressOnLAG.pdf	00:10	Edit

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Typical monthly meeting, with presentations of multiple users

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Neutrino Physics

Noble Liquid Test Facility (NLTF)

The main liquid argon testing facility, the Noble Liquid Test Facility, is located at the Proton Assembly Building and consists of four liquid argon cryostats, three of which can be booked for general RAD tests. It also offers working areas for smaller temporary setups, including several open dewars. The four test stands are:

- LArTPC, also known as the Material Test Stand, mainly used to study the impact of materials on the electron lifetime.
- Tallies, mainly used for developing scintillation light collection techniques.
- Blanchet, multipurpose cryostat mainly used for studying high voltage breakdown in noble liquids and/or small to medium size experimental setups.
- Isotring, a 300L cryostat, mainly used for DUNE related tests.

Please contact the facility coordinator ([Elior de Maria Blaszczyk](#)) if you have any questions about the facility, how to become a user, and what procedures need to be followed to make a request. Please make sure you contact the facility manager before submitting a TSW to make sure the facility does meet your needs. Requests for time on any of these test stands may be made following these [instructions](#).

How to get to the NLTF

The NLTF is located inside the the Proton Assembly Building also known as PAB. See map below.

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0205-x1	LArTPC-0205	Blanchet	LArTPC	29 Jun 2024
0204-x1	NLTF status update June 2024	Elior Blaszczyk	Schedules	29 Jun 2024
0203-x1	JGS Field Status and Review Simulation	Suzana Blazovickovic et al	Workshop LArTPC	24 Jun 2024

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Top: NLTF webpage
Bottom: LArTPC document database

Safety at NLTF

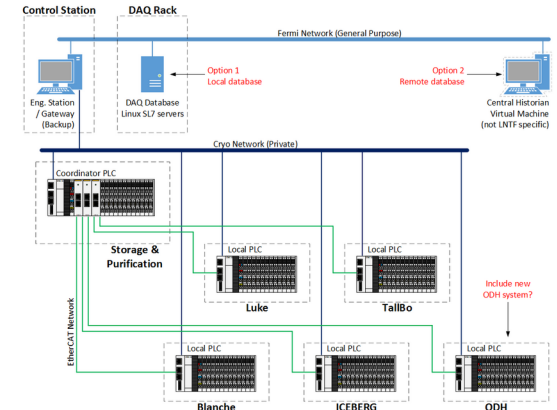
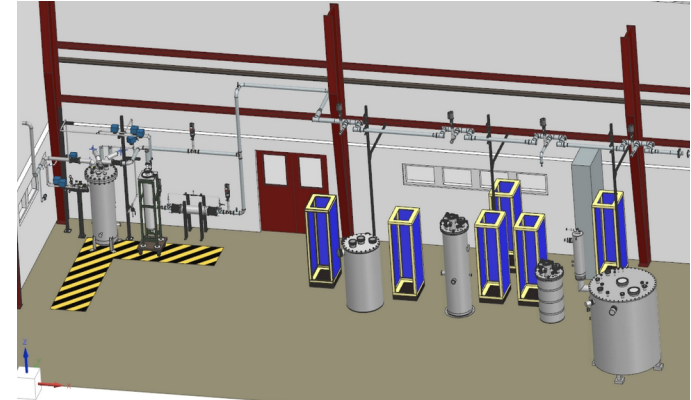
NLTF follows all the Fermilab safety rules and recommendations, no exceptions made.

- Access to the building is restricted to people working in the facility on a regular basis, and requires completion of the NLTF hazard awareness training.
- The facility is an engineered ODH 0 facility: constant oxygen monitoring and special ventilation, alarms if $O_2 < 19.5\%$
 - mandatory evacuation, followed by investigation.
- Every project goes through a multiple stage Operational Readiness Check (ORC) process:
 - Detailed documentation describing the setup and standard operating procedures are submitted to the ORC committee.
 - Depending on the equipment used and potential hazards, an ORC for bench testing might be required.
 - A first ORC walkthrough is done once the setup is installed in its chosen test-stand while the cryostat is still open.
 - what goes inside the vessel, mostly practical recommendations
 - A final review once the cryostat is closed and all the equipment is in its final configuration, ready to be turned on.

NLTF upgrades

NLTF is 15+ years old so the different systems need upgrades and modernization.

- Upgrade plan in multiple phases, while maintaining operations
- Rehaul and expand existing cryogenic infrastructure and cryogenic controls:
 - larger inline filter + N₂ filtering
 - new LAr & LN2 transfer lines
 - cryo controls IFIX → Ignition, individual PLCs
- New floor plan, address known limitations on each individual test-stand
- Modernize available equipment for R&D
- Clean power and basic slow controls for all test stands.



Thank you! Hope to see you soon (?)