

ARTIE-II/MArEX

Argon Resonant Transport Interaction Experiment
Multiple Argon Experiments Initiative

CALCI Meeting (03/21/2024)

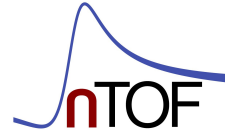
Presented by *Nicholas Carrara* on behalf of the **ARTIE Collaboration*** at **UC Davis, LIP, South Dakota School of Mines, Los Alamos National Laboratory** and the **n_TOF Collaboration†**:

Michael Mulhearn, Emilija Pantic, Robert Svoboda, Jingbo Wang

Yashwanth Bezawada, Junying Huang, Walker Johnson, Tianyu Zhu

*Jan Boissevain, **Sowjanya Gollapinni***, Paul Koehler, Eric Renner, David Rivera, Thanos Stomatopolous, John Ullmann*

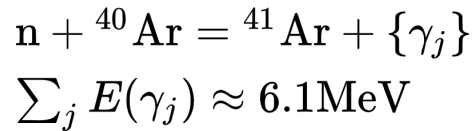
*Sofia Andringa, Michael Bacak, Daniel Cano-Ott, Emilio Mendoza, **Alberto Mengoni†**, Nikolas Patronis*



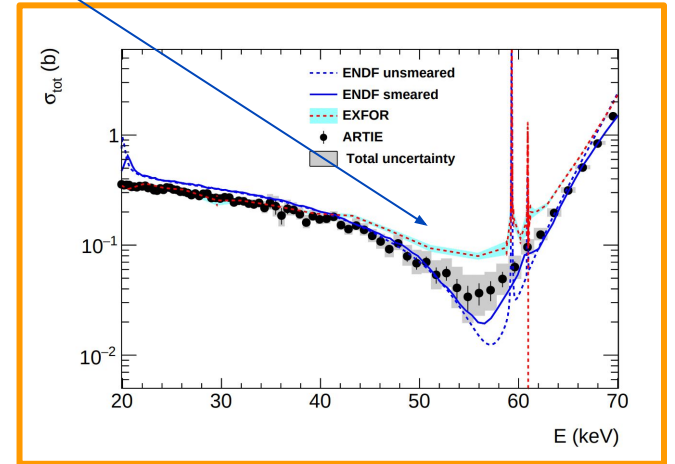
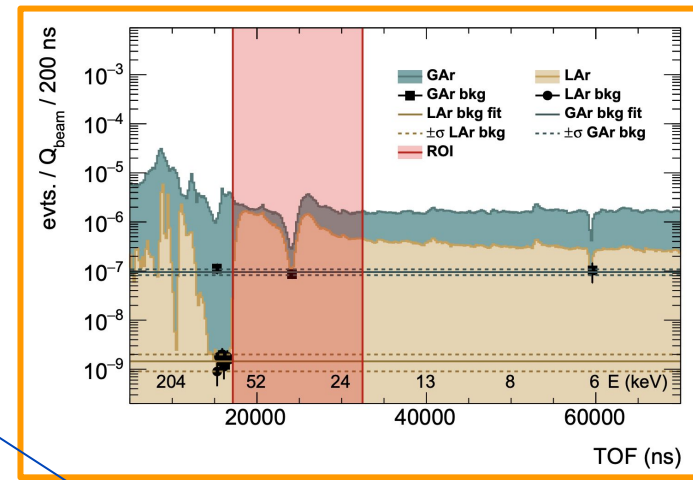
Neutron Calibration

Benefits of low-energy neutrons for calibration:

- **Scattering Length** - Some percentage of neutrons above 57 keV will fall into the cross-section dip.
 - Average fractional energy loss is ~4.8%.
 - The effective scattering length is ~30 m.
 - The resonance well has been measured by the ARTIE¹ experiment at LANL, with a **higher precision follow-up** planned for this year.
- **Standard Candle** - Neutron captures on Ar-40 emit a 6.1 MeV gamma cascade.



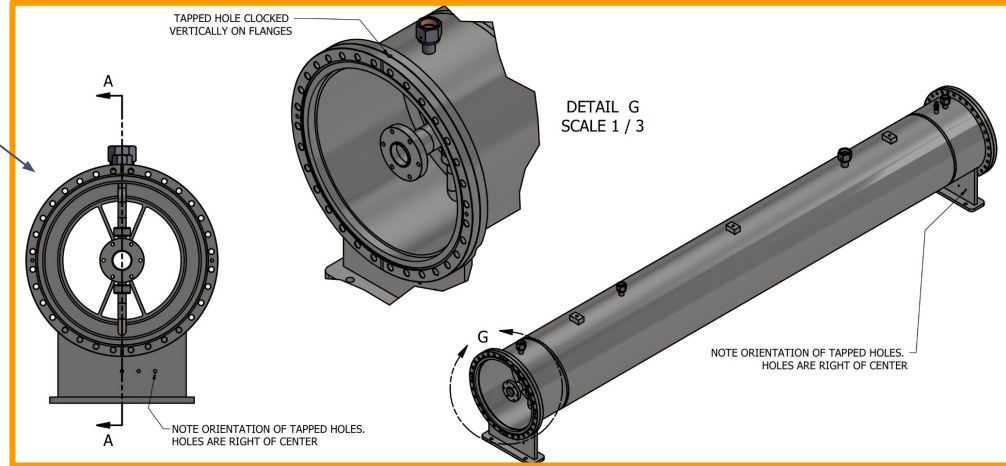
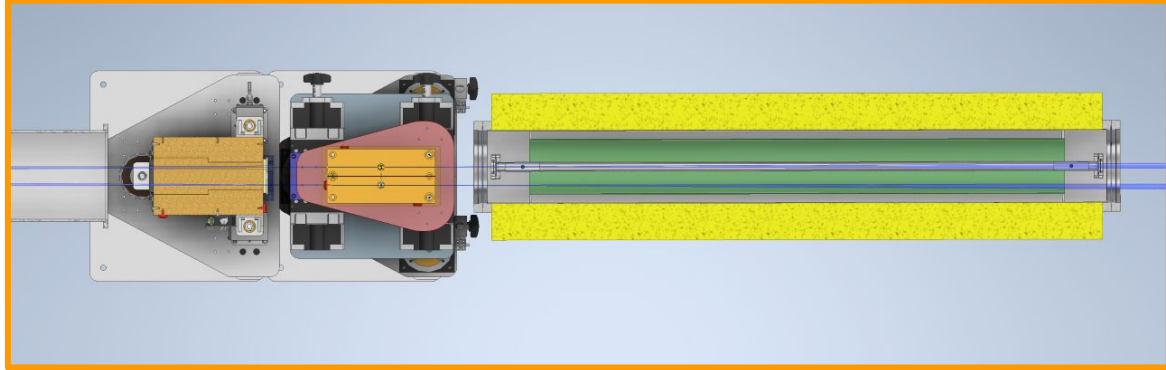
¹ Measurement of the total neutron cross section on argon in the 20 to 70 keV energy range, The ARTIE Collaboration, In review at PRL, 2023, (<https://arxiv.org/abs/2212.05448>).



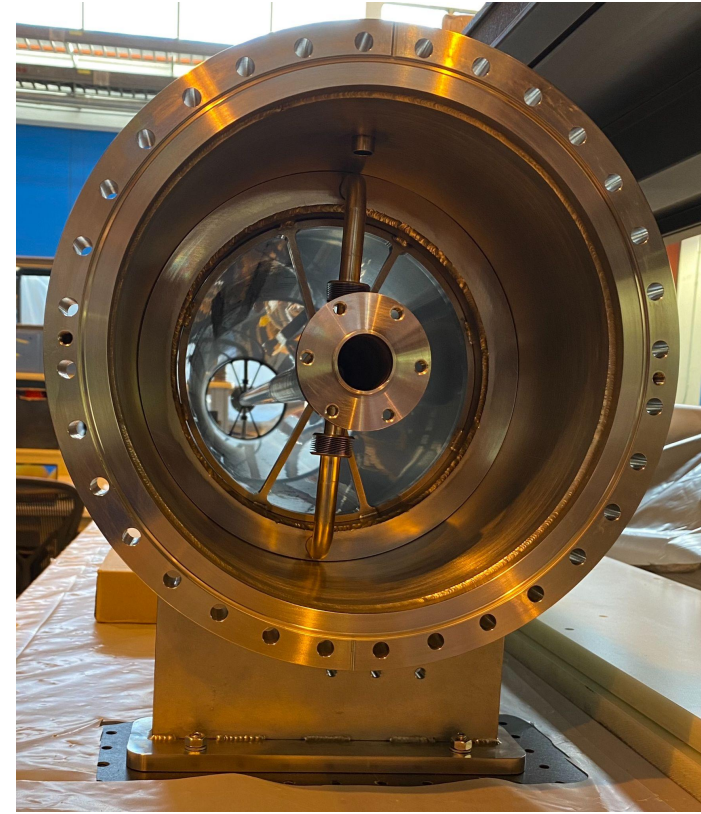
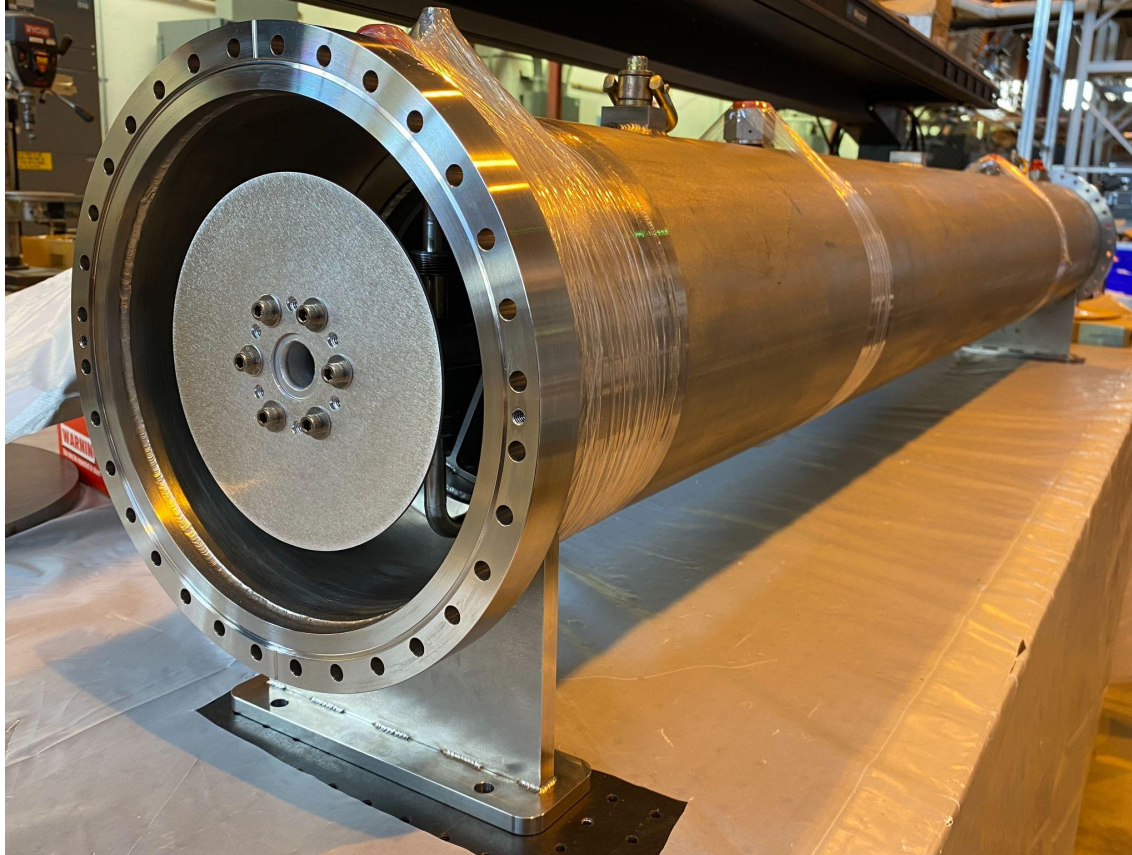
ARTIE-II Target Status

ARTIE-II will use the DICER instrument at LANSCE.

- Simultaneous **target-in/target-out** measurements.
- Annulus design by **LANL** engineers **reduces ARTIE-I heat load** by order of magnitude.
- **30 meter** time of flight.
- 200 cm long target for sensitivity to **anti-resonance well**.
- Additional “short” target (15 cm) for measuring larger cross-sections/energies to compare with previous experiments (Winters).



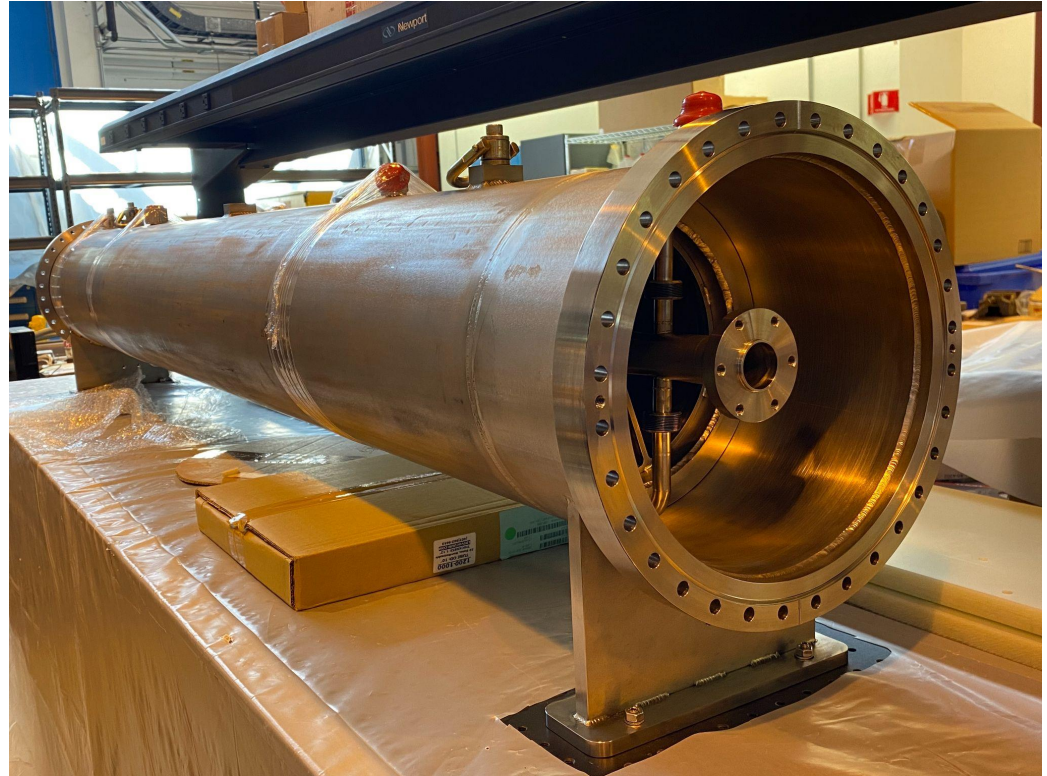
ARTIE-II Target Status



ARTIE-II Target Status

Lujan calls for proposals not out yet, but should be soon.

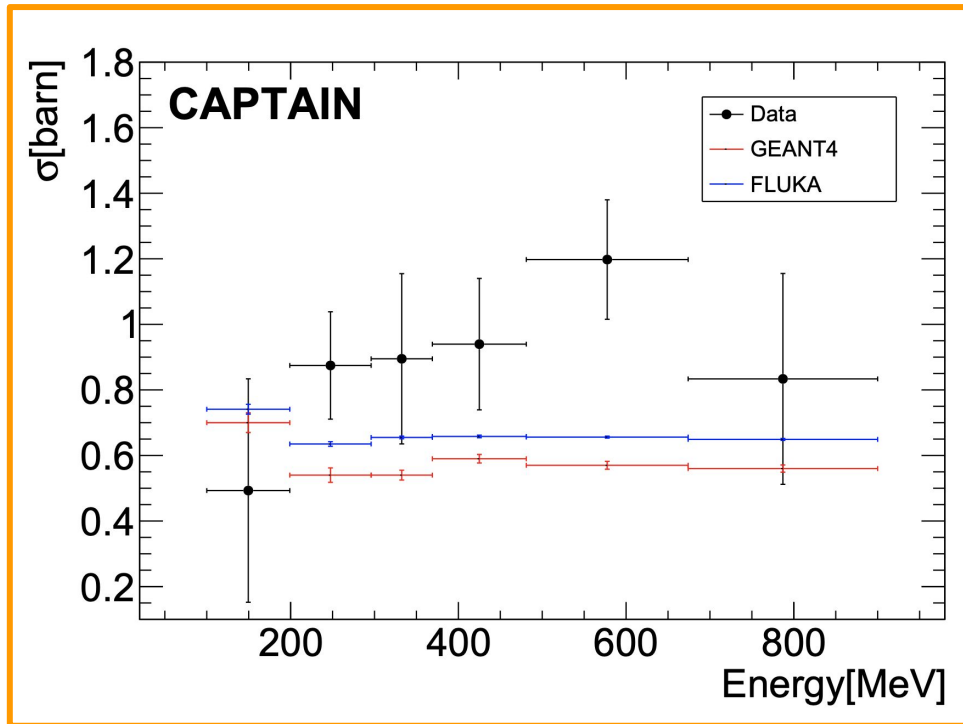
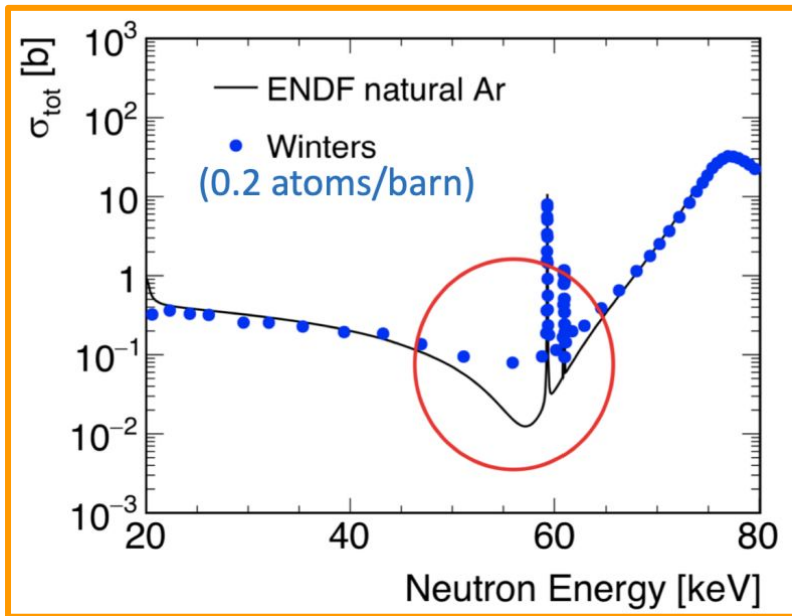
- Resubmitting our proposal from 2023 with some updates.
- We've begun vacuum/cryogenic testing of the target.
- Planning on an engineering run in the next couple of months once upgrades to DICER have been completed.



Backup Slides

Previous measurements on nat-Ar

- Winters et al.¹ [ORNL] (1991) - 7 keV - 50 MeV. (insensitive to ROI resonance well).
- **mini-CAPTAIN**² [LANL] (2019) - 100 MeV - 800 MeV. (large error bars, factor of two discrepancy from ENDF.)

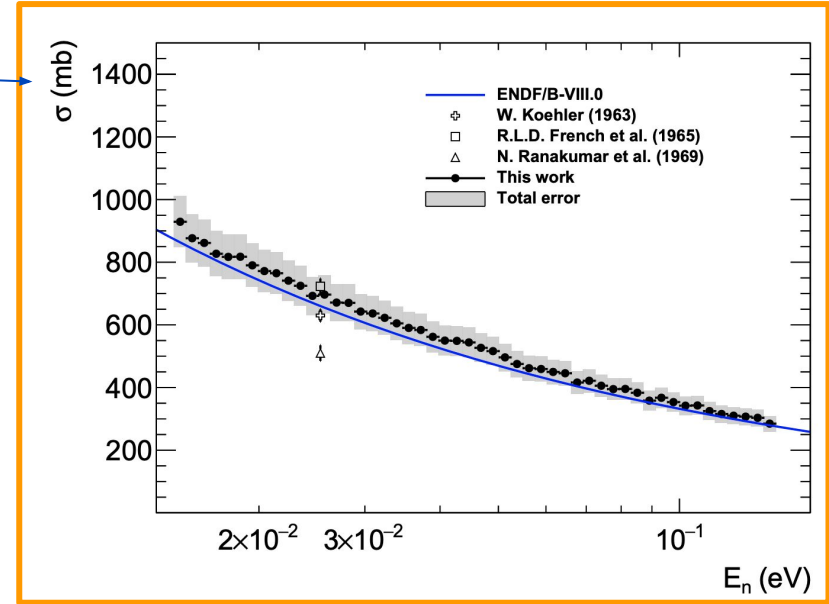
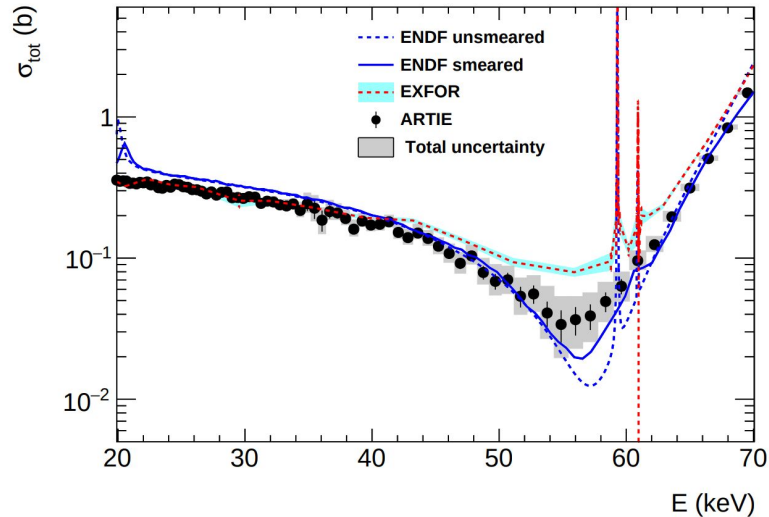


¹ Total cross section and neutron resonance spectroscopy for $n + {}^{40}\text{Ar}$, R. R. Winters et al., Physical Review C, 43 (2), 1991.

² First Measurement of the Total Neutron Cross Section on Argon Between 100 and 800 MeV, B. Bhandari et al., Phys. Rev. Lett. 123, (2019).

Other measurements by Davis, LANL and LIP groups

- **ACED¹** [LANL] - (2018) - capture cross section in the 0.015 eV - 0.15 eV range.
- **ARTIE-I²** [LANL] (2019) - total cross section in the 20 keV - 70 keV range (cross-section dip).



1 Measurement of the neutron capture cross section on argon, V. Fischer et al., *Phys. Rev. D* (2019).

2 Measurement of the total neutron cross section on argon in the 20 to 70 keV energy range, S. Andriga et al., *arxiv:2212.05448*, (2023).

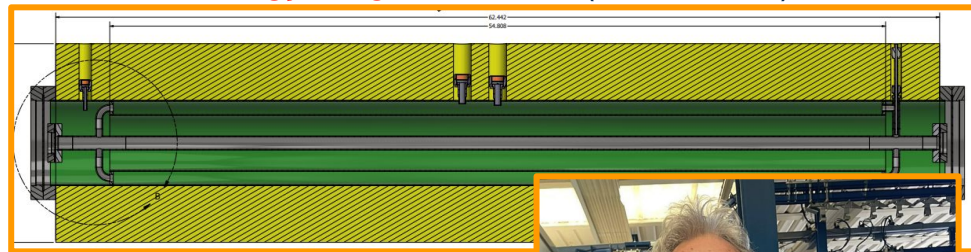
MARx + ARTIE Initiative

Several experiments at **LANL** and **nTOF** to complete the neutron total/capture cross section over all energy ranges.

Total cross section:

- **20 keV - 70 keV** - ARTIE-I large systematics.
- **70 keV - 50 MeV** (Winters et al.)
- **50 MeV - 100 MeV** missing.
- **100 MeV - 800 MeV** - large error bars/factor of two ENDF difference (mini-CAPTAIN).
- **> 800 MeV** missing.

ARTIE-II target design for **LANL** (2023) - **total energy range uncertain (~ 200 keV?)**



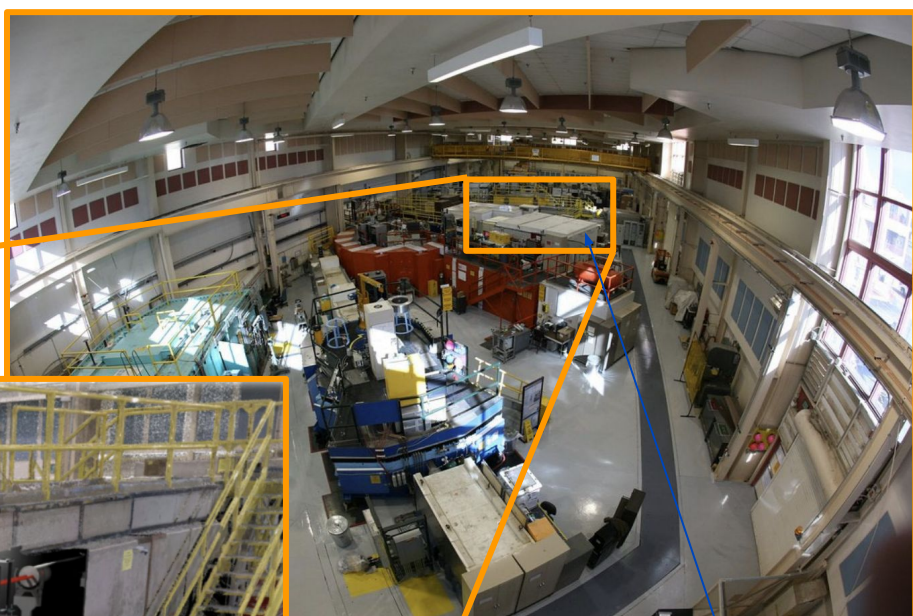
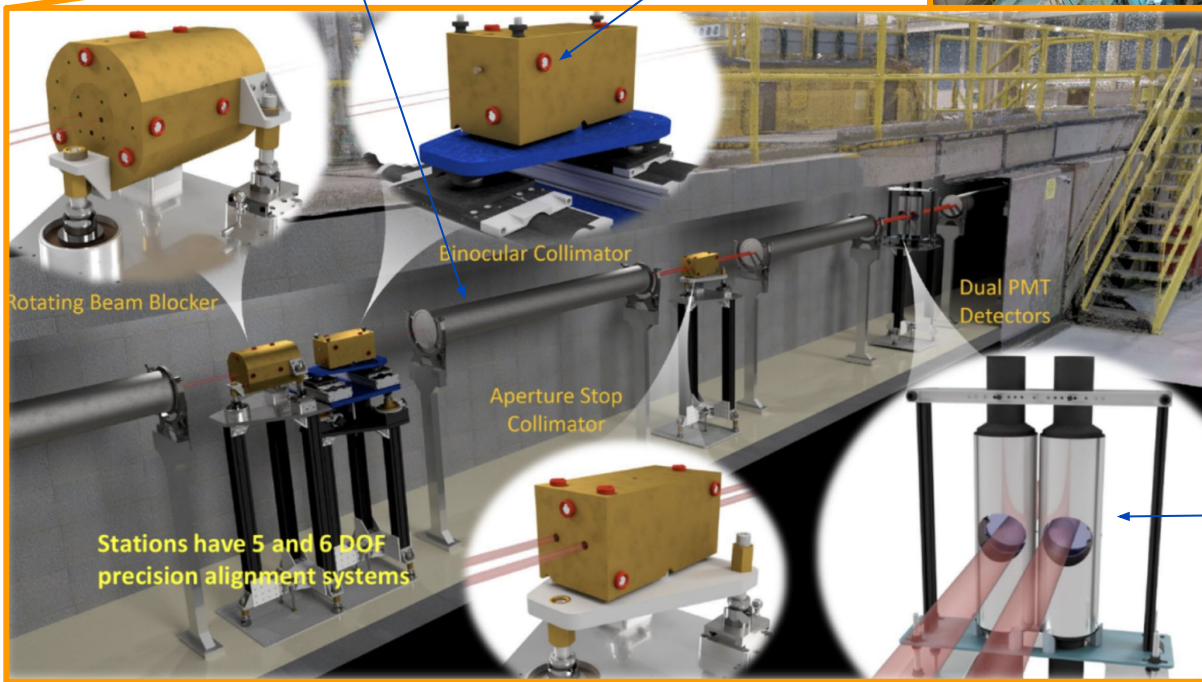
capture tank



DICER Instrument

target location

fiducials



Flight Path 13
(Lujan Center)

Lithium glass
detectors

UC DAVIS

MAReX Demonstrator

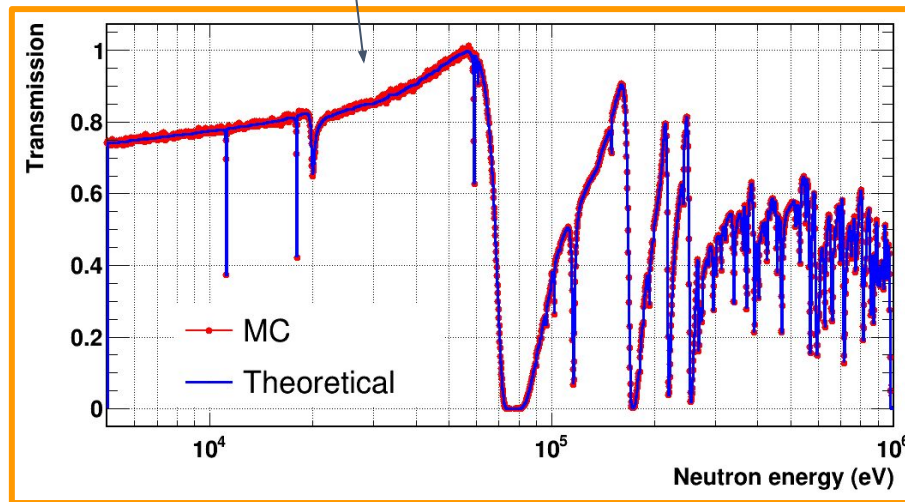
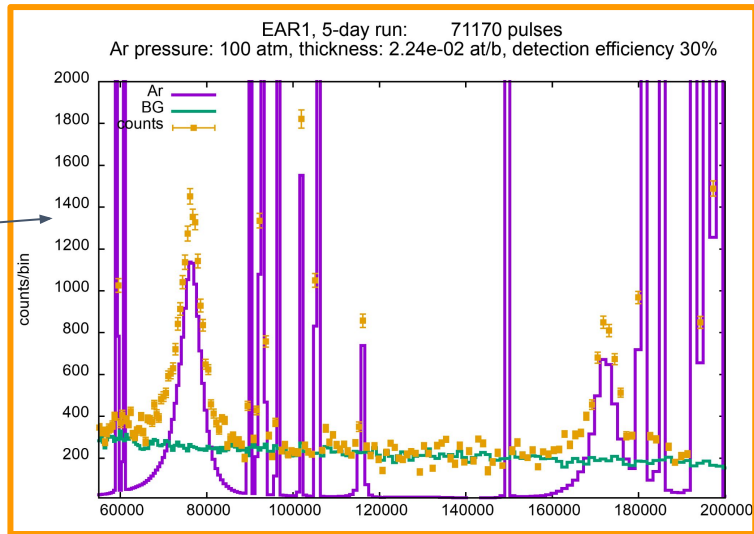
MAReX Initiative will conduct two feasibility measurements at n_TOF this year.

- **Carbon Fiber SCUBA** tanks (pressurized Ar gas up to 300 atm) (carbon cross-section is flat in ROI).
- **200 meter** time of flight.
- Requested one month of running at both EAR1/EAR2 experimental areas.

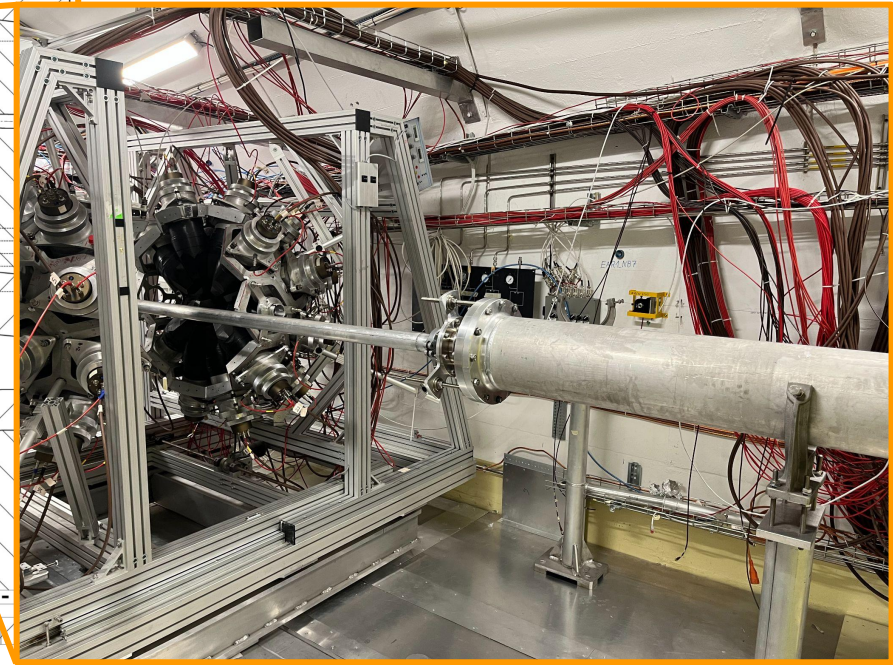
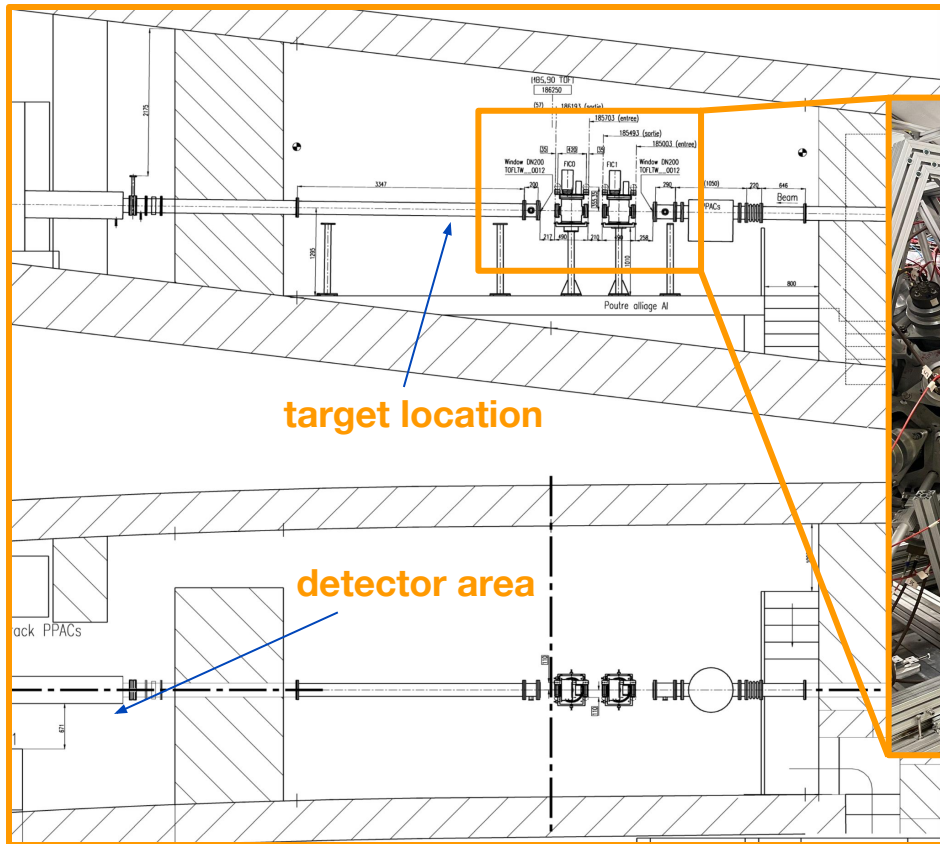
simulations by **E. Mendoza** and **A. Mengoni**

capture measurement

transmission measurement



EAR1 (Experimental Area 1)



Status Updates

ARTIE-II

- Submitted proposal for 2023 run (3/13).
- Received several quotes for procurement of the target (~18K - 80K).
- Order for target procurement will be placed end of this month!
- Nick, Yash and Junying are set to help with beam-line commissioning at FP13 (~July).
- Ongoing effort of background/black-resonance/detector simulations (<https://github.com/ARTIE-II>).

MAReX

- Submitted LOI for 2023 run (04/19).
- Testing various detector setups:

Detector	Converter reaction	Converter density ($\mu\text{g}/\text{cm}^2$)	(at/barn)	detector efficiency	Dimension (diameter)
μmegas	$^{235}\text{U}(n,f)$	469.2	1.2E-6	0.9	70 mm
μmegas	$^{10}\text{B}(n,\alpha)$	19.6 ($^{10}\text{B}_4\text{C}$)	1.5E-5	0.9	100 mm
SiMon	$^6\text{Li}(n,t)$	600 (^6LiF)	1.4E-5	0.2	60 x 60 mm ²
Li-glass	$^6\text{Li}(n,t)$	6.4 mm (LiG)	1.1E-2	1.0	76 x 76 x 6.4 mm ³
MCP	$^{10}\text{B}(n,\alpha)$	1 mm (B-Glass)	2.0E-4	1.0	28 x 28 x 1 mm ³

- Procuring demonstrator SCUBA tanks.
- Ongoing effort of background/black-resonance/detector simulations.
- Planning LAr setup for 2024 and beyond (nuclear recoil scintillation/recombination studies?)

ARTIE-II: Argon Resonant Transport Interaction Experiment

LANSCE Proposal 9433

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January 2023

**ARTIE-II will measure the total
cross-section between 20 keV - 200 keV.**

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Letter of Intent to the ISOLDE and Neutron Time-of-Flight Committee

Multiple Argon Experiments at n_TOF (the MArEX initiative)

May 17, 2023

S. Andringa¹, M. Bacak², Y. Bezawada⁴, J. Boissevain⁵, D. Cano-Ott³, N. Carrara⁴, A. Casanovas², S. Gollapinni⁵, J. Huang⁴, W. Johnson¹⁰, A. Junghans¹¹, A. Losko¹², V. Lozza¹, A. Manna^{6,7}, P. Mastinu⁸, E. Mendoza³, A. Mengoni^{9,7}, M. Mulhearn⁴, E. Pantic⁴, E. Renner⁵, D. Rivera⁵, T. Stamatopolous⁵, R. Svoboda⁴, A. S. Tremsin¹³, J. Ullmann⁵, J. Wang¹⁰, T. Zhu⁴ and The n_TOF Collaboration

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¹²Forschungs-Neutronenquelle Heinz Maier-Leibnitz, 85748, Garching, Germany

¹³University of California at Berkeley, Berkeley, CA, USA

n_TOF Protons Requested

- EAR1 transmission : **15 x 10¹⁷**
- EAR1 capture : **7 x 10¹⁷**
- EAR2 capture : **7 x 10¹⁷**

(final numbers TBC)

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