

# ARTIE-II/MArEX

Argon Resonant Transport Interaction Experiment  
Multiple Argon Experiments Initiative

**DUNE Collaboration Meeting: FNAL (05/21/2023)**

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†:**

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*Yashwanth Bezawada, Junying Huang, Walker Johnson, Tianyu Zhu*

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

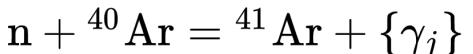
*Sofia Andringa, Michael Bacak, Daniel Cano-Ott, Emilio Mendoza, Alberto Mengoni†, Nikolas Patronis*



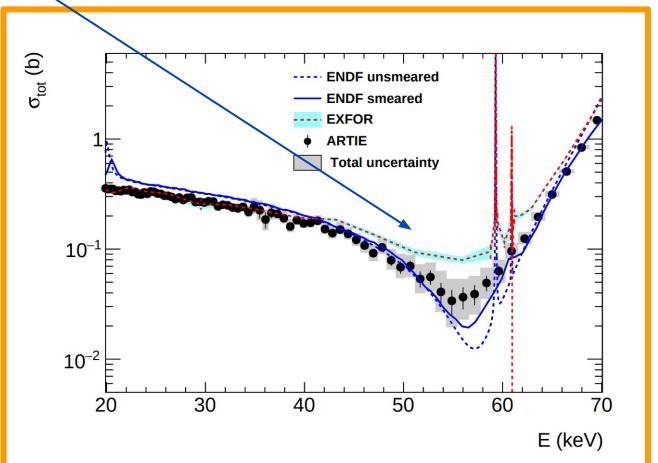
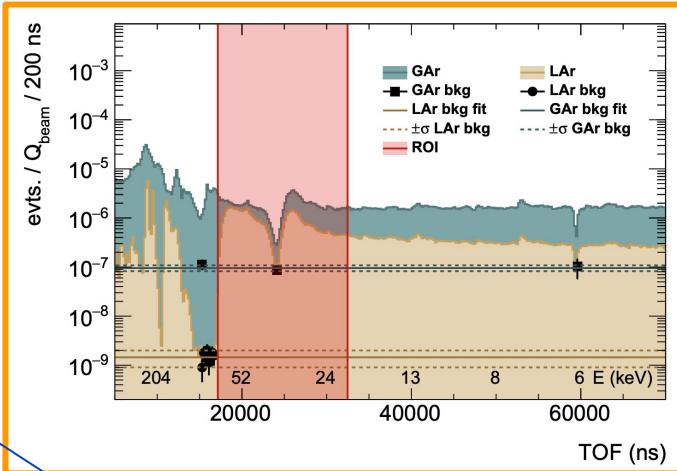
# Neutron Calibration

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 ARTIE<sup>1</sup> 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.



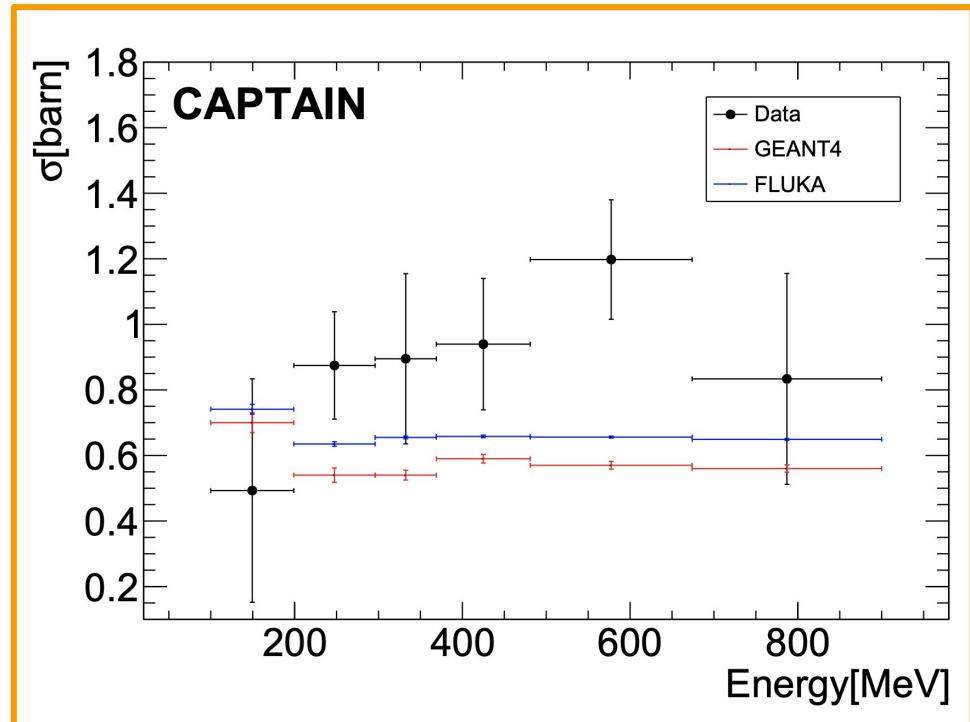
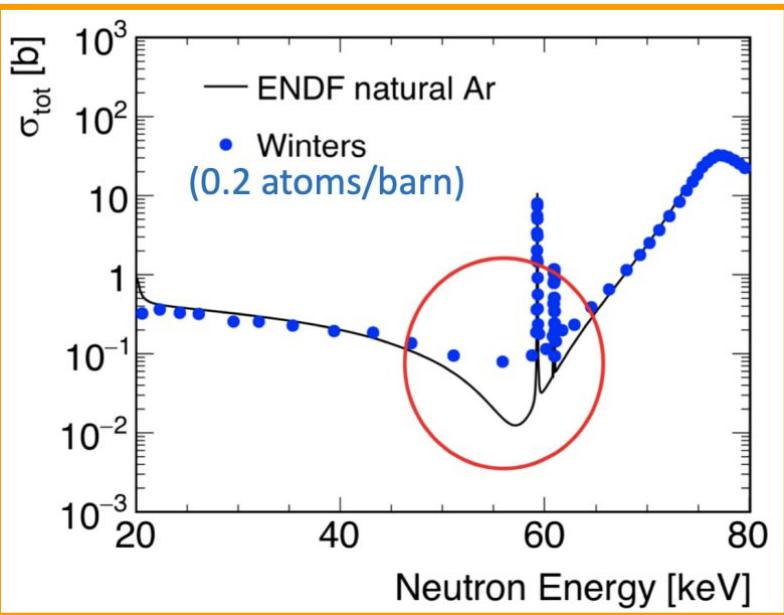
$$\sum_j E(\gamma_j) \approx 6.1\text{MeV}$$



<sup>1</sup> 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>).

# Previous measurements on nat-Ar

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

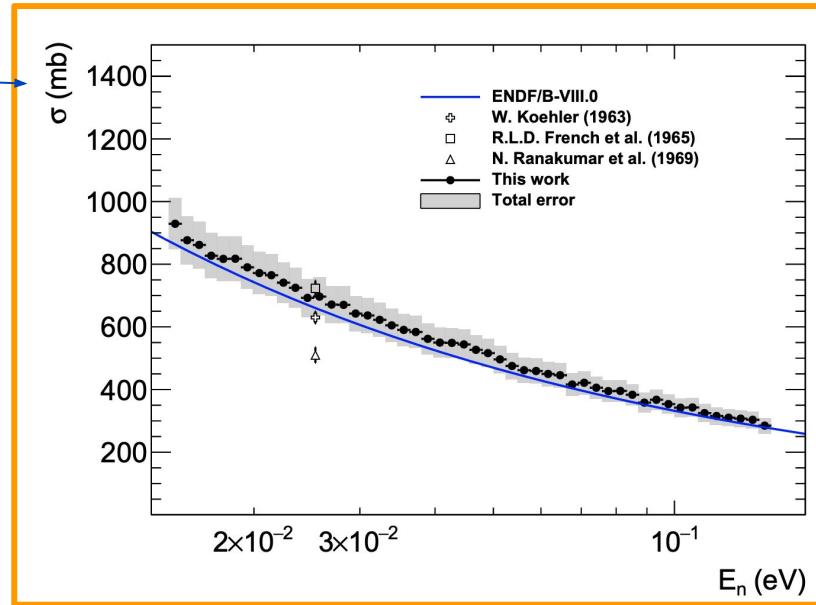
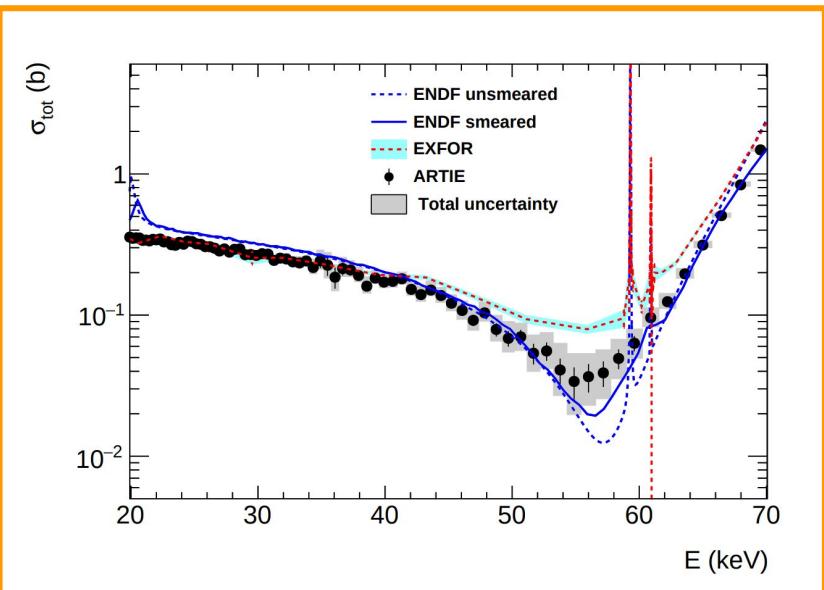


1 Total cross section and neutron resonance spectroscopy for  $n + {}^{40}\text{Ar}$ , R. R. Winters et al., Physical Review C, 43 (2), 1991.

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

- ACED<sup>1</sup> [LANL] - (2018) - capture cross section in the 0.015 eV - 0.15 eV range.
- ARTIE-I<sup>2</sup> [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).

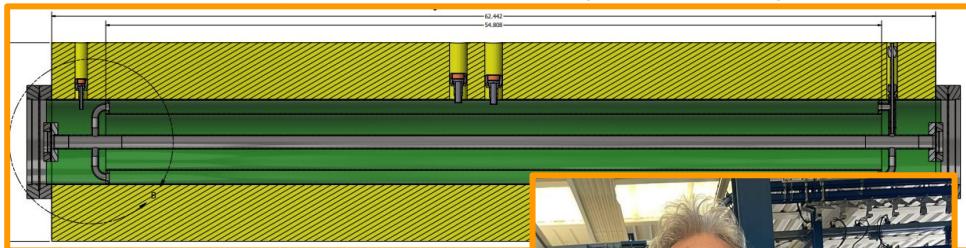
# MArEX + ARTIE Initiative

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?)**

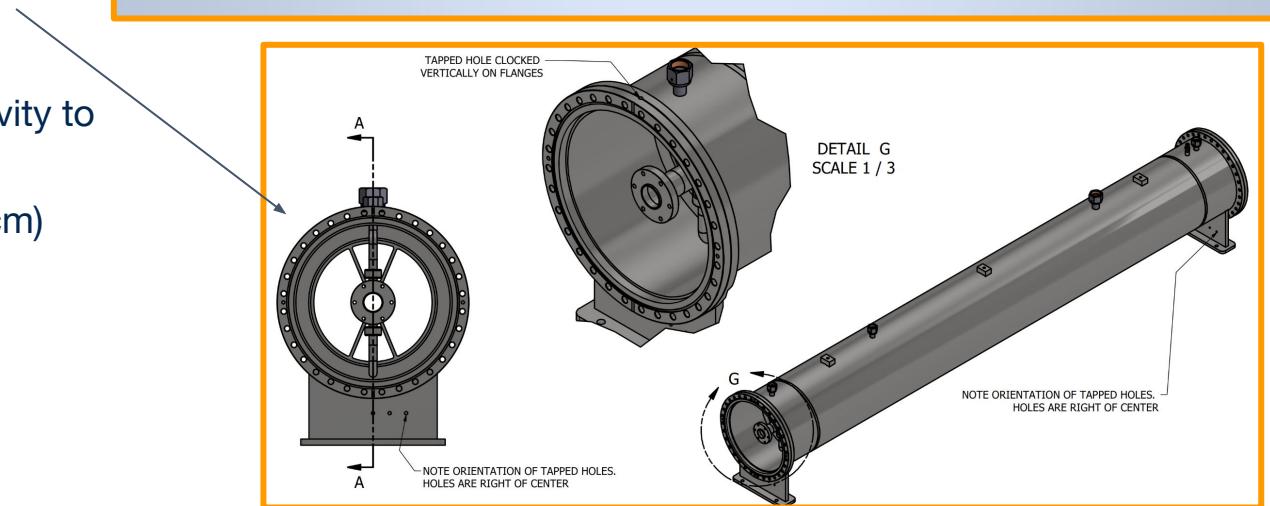
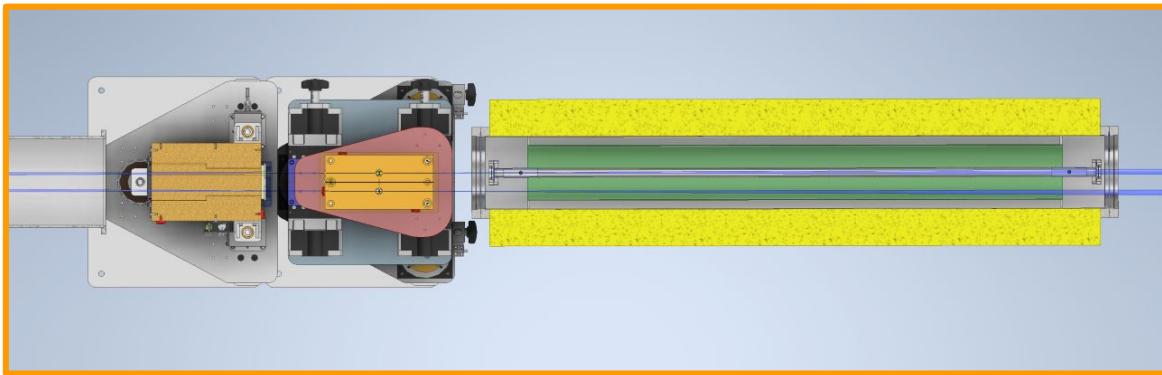


capture tank

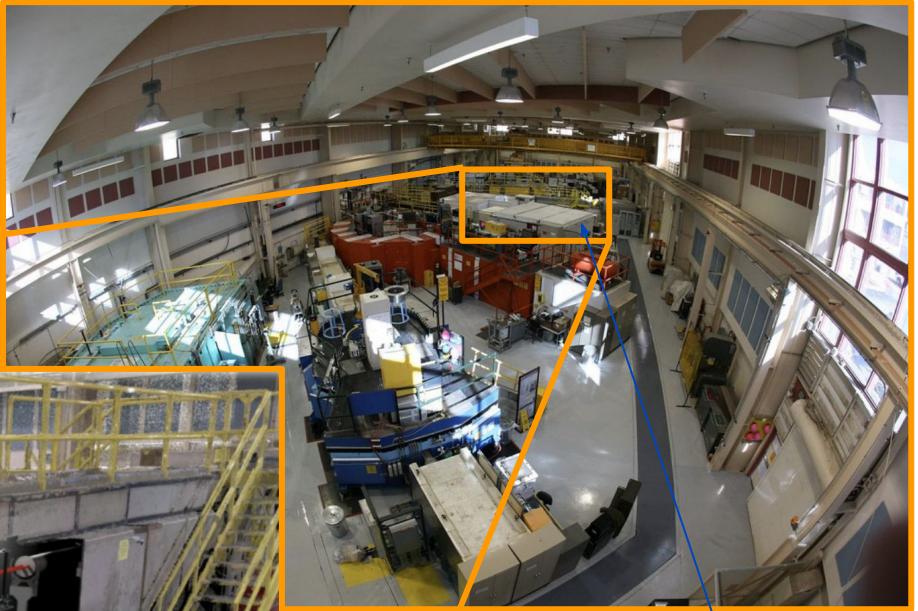
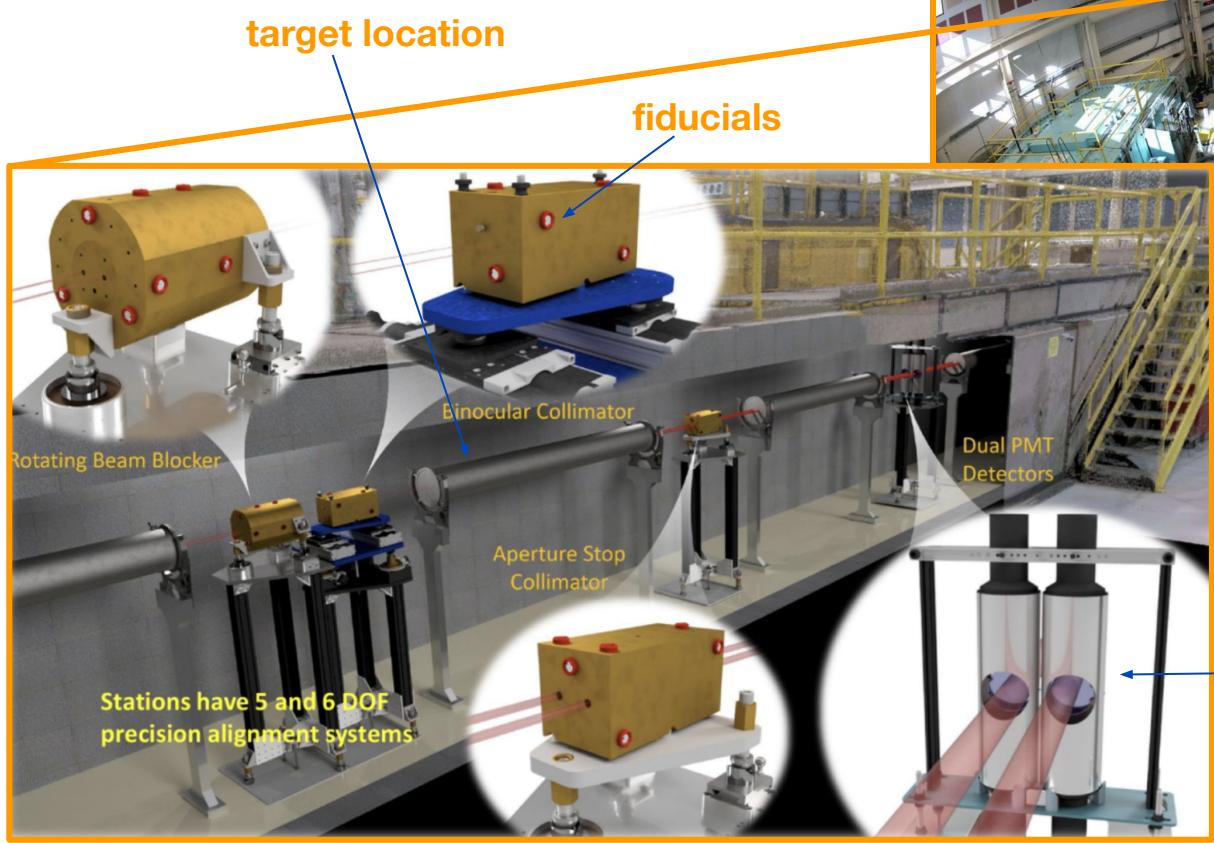
# ARTIE-II Target Status

ARTIE-II will use the DICER instrument at LANSCE.

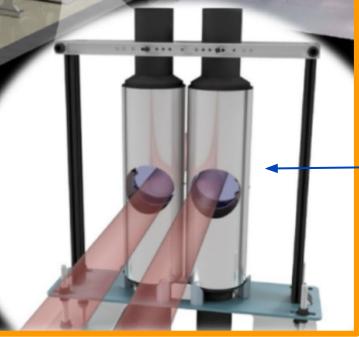
- Simultaneous **target-in/target-out** measurements.
- Annulus design by **LANL** engineers **reduces ARTIE-I heat load by** order of magnitude.
- **30 meter** time of flight.
- 200 cm long target for sensitivity to **anti-resonance well**.
- Additional “short” target (15 cm) for measuring larger cross-sections/energies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



# DICER Instrument



Flight Path 13  
(Lujan Center)



# MArEX Demonstrator

MArEX Initiative will conduct two feasibility measurements at n\_TOF this year.

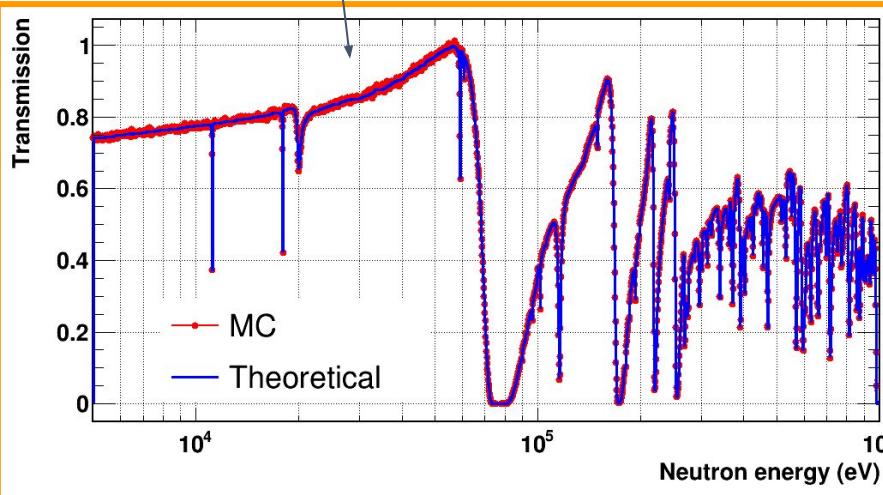
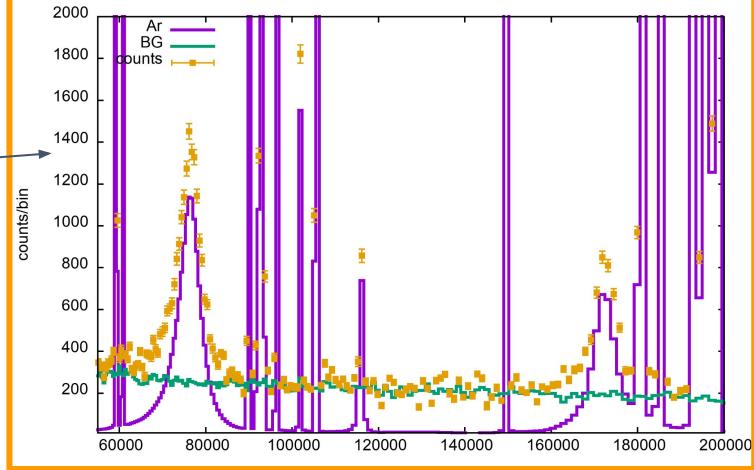
- **Carbon Fiber SCUBA tanks** (pressurized Ar gas up to 300 atm) (carbon cross-section is flat in ROI).
- **200 meter time of flight.**
- Requested one month of running at both EAR1/EAR2 experimental areas.

simulations by E. Mendoza and A. Mengoni

capture measurement

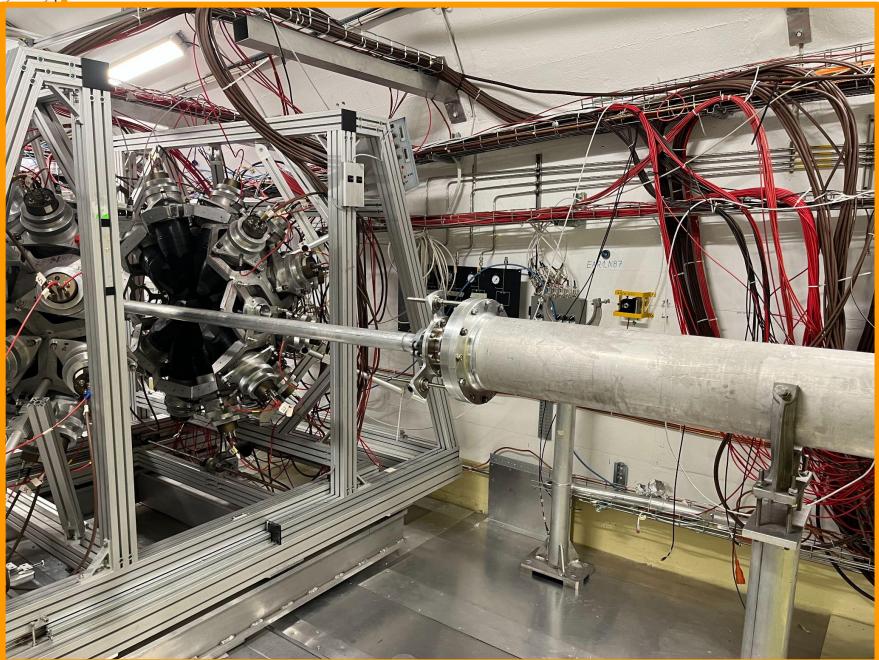
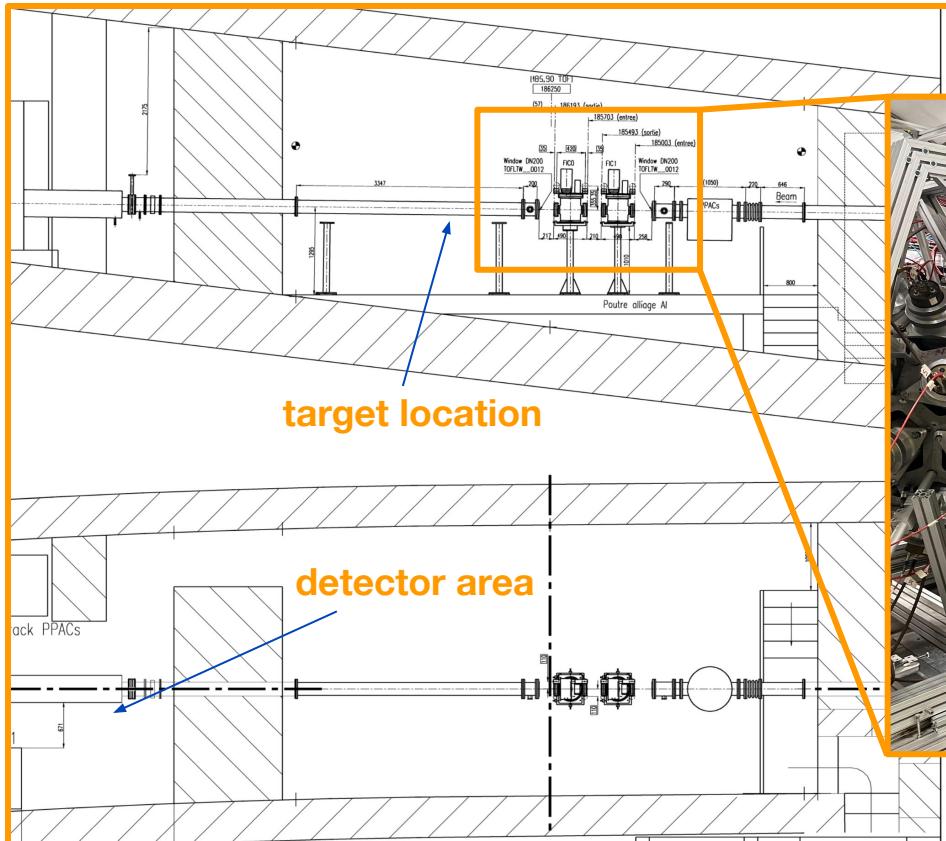
transmission measurement

EAR1, 5-day run: 71170 pulses  
Ar pressure: 100 atm, thickness: 2.24e-02 at/b, detection efficiency 30%



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# EAR1 (Experimental Area 1)



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

- 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. Andringa<sup>1</sup>, M. Bacak<sup>2</sup>, Y. Bezawada<sup>4</sup>, J. Boissevain<sup>5</sup>, D. Cano-Ott<sup>3</sup>, N. Carrara<sup>4</sup>, A. Casanovas<sup>2</sup>, S. Gollapinni<sup>5</sup>, J. Huang<sup>4</sup>, W. Johnson<sup>10</sup>, A. Junghans<sup>11</sup>, A. Losko<sup>12</sup>, V. Lozza<sup>1</sup>, A. Manna<sup>6,7</sup>, P. Mastinu<sup>8</sup>, E. Mendoza<sup>3</sup>, A. Mengoni<sup>9,7</sup>, M. Mulhearn<sup>4</sup>, E. Pantic<sup>4</sup>, E. Renner<sup>5</sup>, D. Rivera<sup>5</sup>, T. Stamatopolous<sup>5</sup>, R. Svoboda<sup>4</sup>, A. S. Tremsin<sup>13</sup>, J. Ullmann<sup>5</sup>, J. Wang<sup>10</sup>, T. Zhu<sup>4</sup> and The n\_TOF Collaboration

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### n\_TOF Protons Requested

- EAR1 transmission :  $15 \times 10^{17}$
  - EAR1 capture :  $7 \times 10^{17}$
  - EAR2 capture :  $7 \times 10^{17}$
- (final numbers TBC)

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