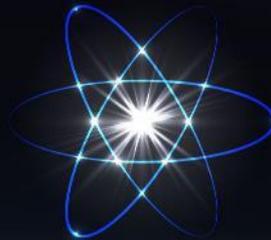




NCSP Related Nuclear Data Research at RPI

Y. Danon

February 15-17, 2022



Presented by:

Y. Danon

Rensselaer Polytechnic Institute, Troy, NY, 12180

NCSP TPR, February 15-17 2022, remote.

RPI Nuclear Data Group



RPI Faculty

Prof. Yaron Danon - LINAC Director

LINAC Technical Staff

Peter Brand - Director, Operations

Michael A. Bretti - Research Support Engineer

John Fava - Research Support Engineer

Matt Gray - Sr. Research Support Technician

Azeddine Kerdoun - Sr. Research Support Technician

Edwin Frank - Research Support Technician

Brian Martindale - Research Support Technician

Graduate Students

Adam Ney (PhD)

Dominik Fritz (PhD)

Sukhjinder Singh (PhD)

Peter Brain (PhD)

Katelyn Cook (PhD)

Benjamin Wang (PhD)

Gregory Siemers (PhD)

Alec Golas (PhD)

NNL

Dr. Tim Trumbull

Dr. Devin Barry

Dr. Michael Rapp

Mr. Brian Epping

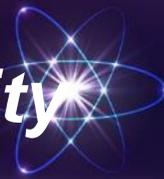
Dr. Adam Daskalakis

Dr. Amanda Lewis

BOLD = staff, researchers, or graduate students partially supported by NCSP

Orange = NCSP related work (to be funded)

Overview of 2021 activity



- **ND1 – Cross section measurements (\$471K+\$71K)**

- Measurements in preparation/progress ([Appendix-B](#))
 - Fe-54 capture measurement completed.
 - Fe-54 transmission was needed and completed
 - Fe-54 data analysis and resonance fitting in progress.
 - **Technical Talk by Sukhjinder Singh**

Chromium (⁵³ Cr)	RPI	
Iron (⁵⁴ Fe)	RPI	RPI
	IRSN	IRSN

- **Evaluation work on Zr isotopes (Gregory Siemers)**
- **Improvement to SAMMY URR capabilities (Alec Golas)**
- **Lead isotopes evaluation (Peter Brain)**

Lead (^{204,206,207,208} Pb)	ORNL	ORNL	ORNL
	RPI	RPI	RPI
	BNL	BNL	BNL
	NNL	NNL	NNL
	IRSN	IRSN	IRSN

- **ND2 –Thermal region cross section measurements (\$0K+\$12.9K)**

- [Appendix-B thermal scattering](#)
 - Completed transmission measurements of:
 - Polyethylene, Lucite, Polystyrene, and YHx,
 - **Technical Talk by Dominik Fritz**

Polystyrene (C ₈ H ₈)	ORNL	
	RPI	
Polyethylene (C ₂ H ₄)	RPI	
Yttrium Hydride (YH _x)	RPI	RPI

- **ND3 – LINAC refurbishment (\$0K+\$30.4K)**

- [Improve NCSP and NR nuclear data measurement capabilities](#)
 - Major purchases completed or in progress, some delivered (Klystrons, Modulators, Accelerator Sections)
 - Working on onsite testing and deployment.
 - Current completion date is projected to the end of 2024
- **A short update will be given**

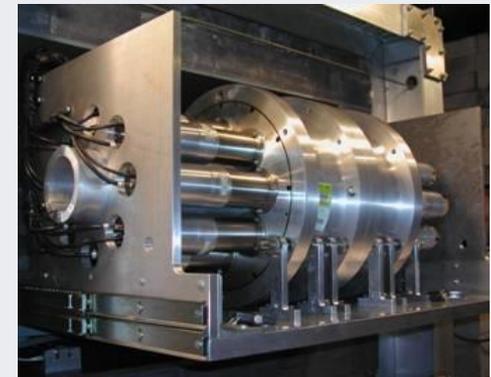
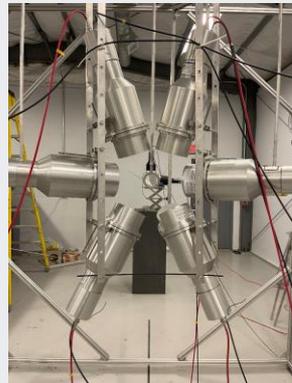
RPI ND-Group Research



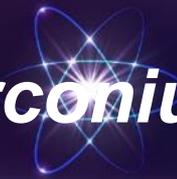
Research topic	Student	Degree
Development of high efficiency (alpha,n) neutron detector	Adam Ney	Ph.D.
Improvements of nuclear data evaluations for lead isotopes in support of next generation lead-cooled fast systems	Peter Brain	Ph.D.
Development of a cold neutron moderator and total cross section measurements	Dominik Fritz	Ph.D.
Neutron Capture Measurements in the keV energy range (Cr-53, Fe-54)	Sukhjinder Singh	Ph.D.
Neutron die away experiments	Benjamin Wang	Ph.D.
Neutron induced gamma production measurements in the RRR and URR	Katelyn Cook	PhD.
Evaluation of Zirconium isotopes	Gregory Siemers	PhD.
Improvement to SAMMY for URR evaluation methods	Alec Golas	PhD.

NCSP funded

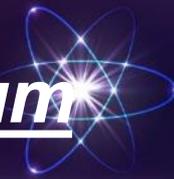
NCSP related



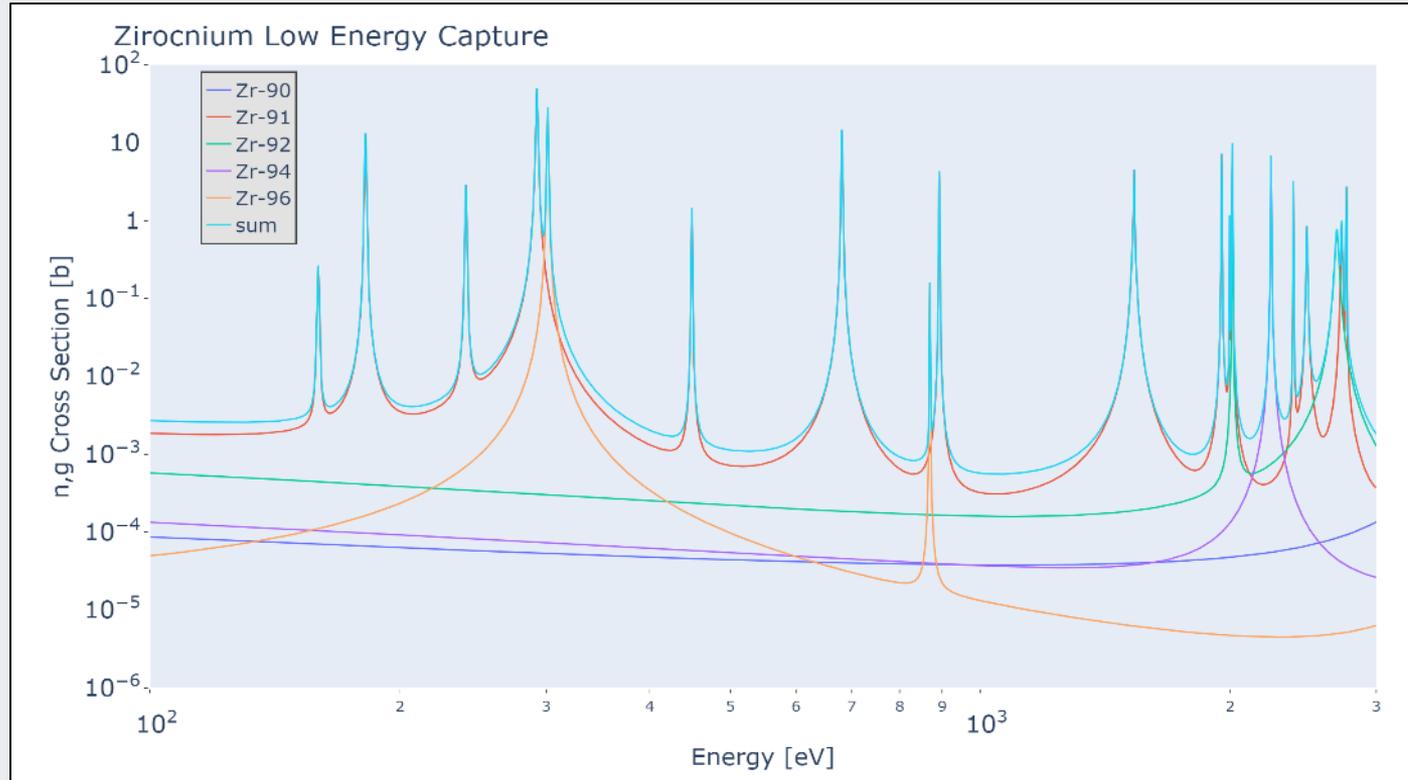
Motivation For New Zirconium Evaluations



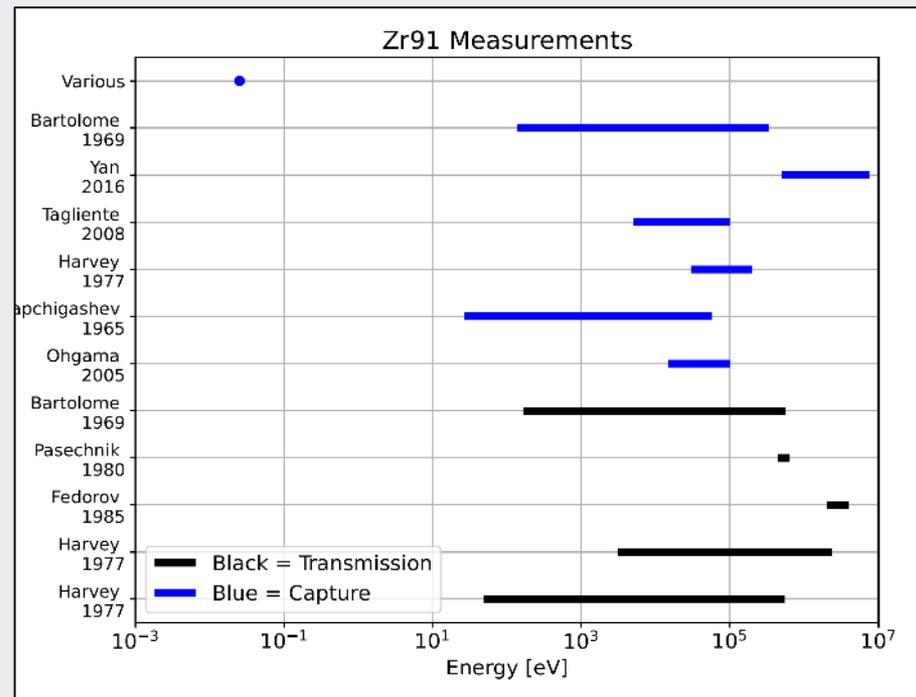
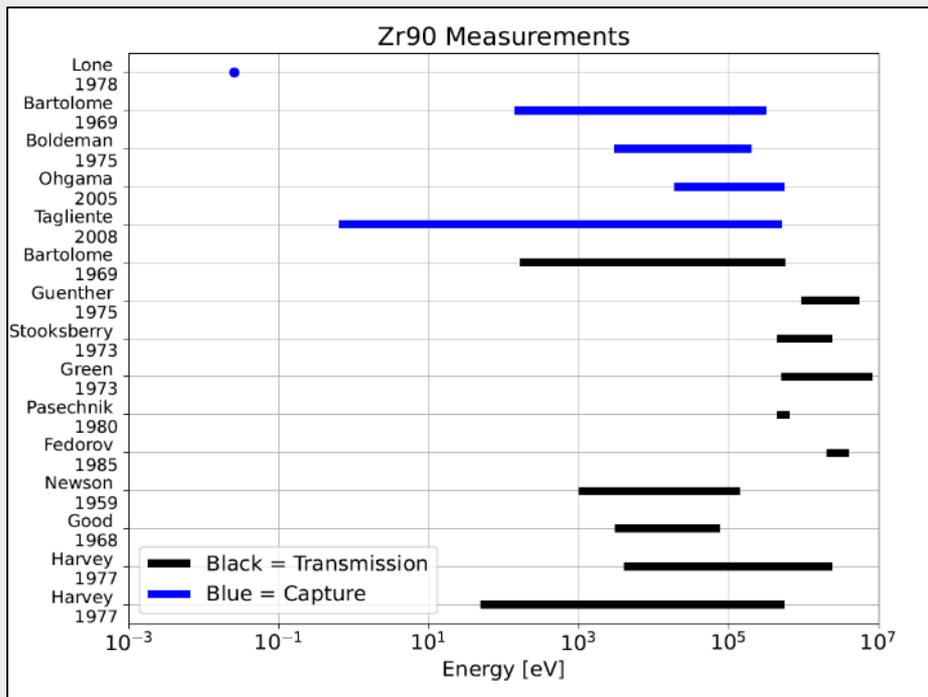
- Work of Gregory Siemers (PhD student)
- In collaboration with ORNL and NNL
- Primary Zirconium Applications:
 - Zircalloys for nearly all thermal reactor fuel cladding
 - Zr hydride for in advanced fuels
- Shortcomings of Current Zr Evaluations:
 - Resonance parameters and region contradictions between three major evaluations for all Zr isotopes
 - ENDF/B-VIII.0 evaluation does not utilize R-Matrix (SAMMY) resonance analysis
 - Previous measurements used in evaluations possess unquantifiable issues
 - No thermal nuclear data for Zr isotopes + inconsistent natural data



- RPI has recognized Zr-90 and Zr-91 as the most important isotopes of Zr for current applications due to:
 - Zr-90 ~50% natural abundance and Zr-91 primary capture isotope

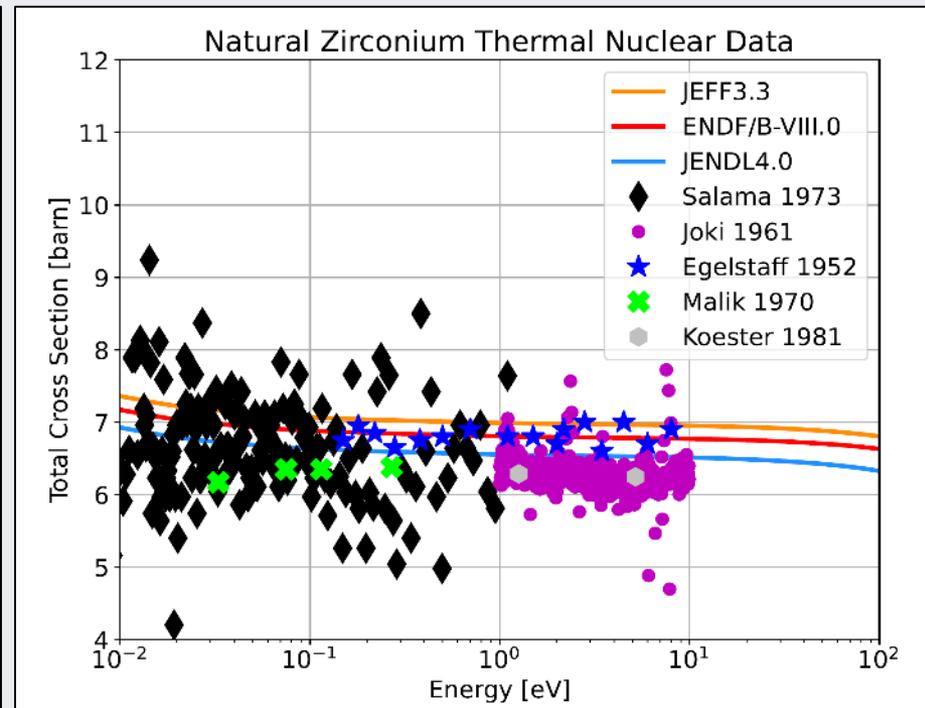
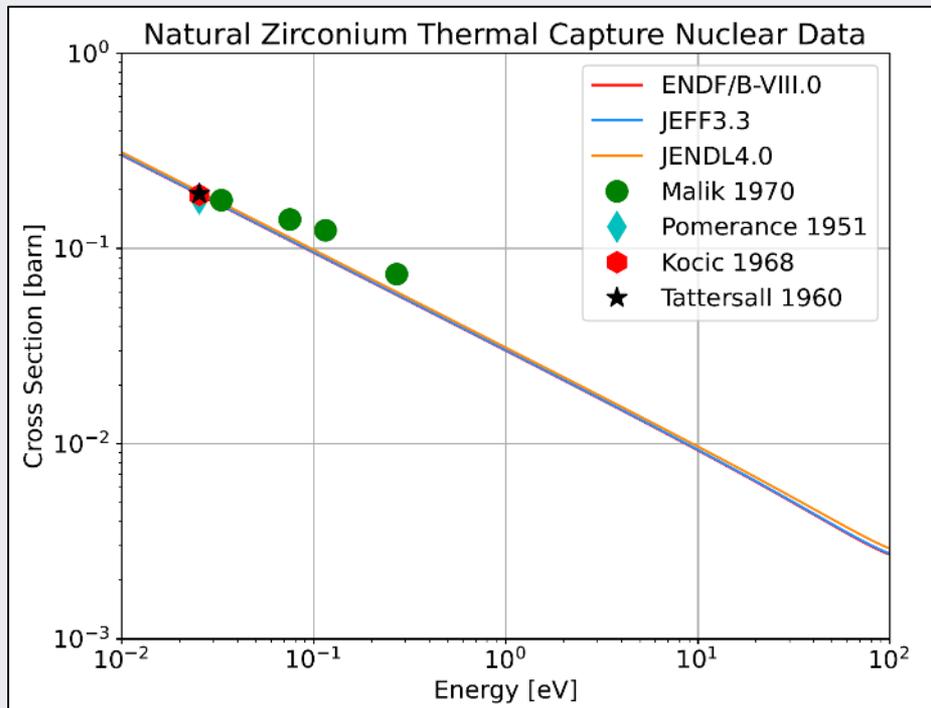


Current Zr-90/Zr-91 Experimental Data



Need For Zr Isotopic Thermal Data

- No Enriched Zr Data in Thermal Region
- Shape of isotopic thermal cross sections needed for accurate evaluation



RPI Resonance Region Evaluation Plan



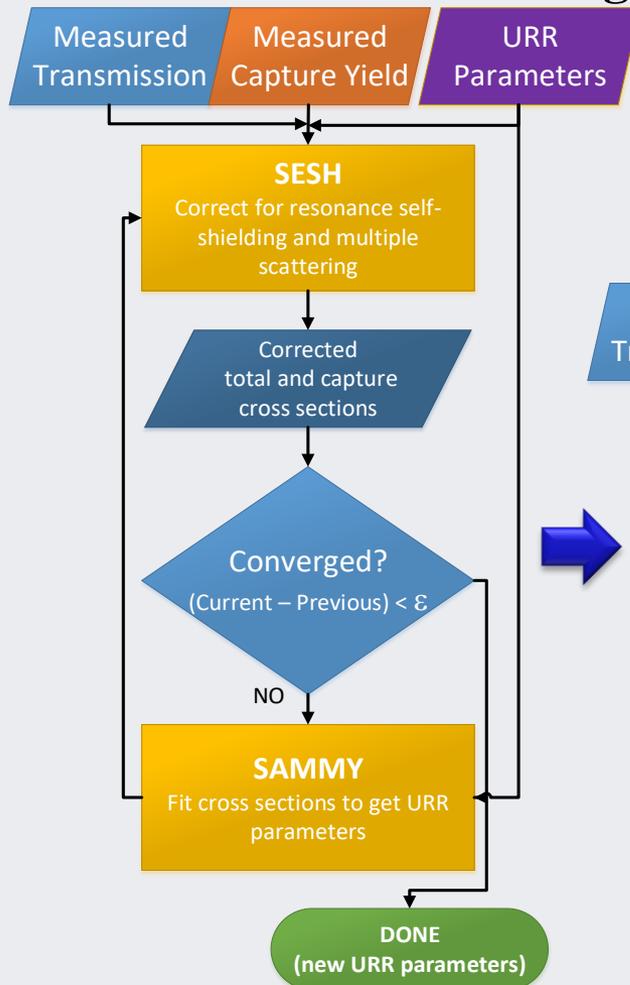
- RPI to perform resonance (resolved and unresolved) region evaluations on Zr-90, Zr-91, and potentially Zr-92
- The evaluation plan is based on availability of measured data from ORNL
- Some data were and other will be measured by ORNL at Geel

Sample	Transmission Data Received?	Capture Data Received?	Data Reduced?	Resonance Region Evaluators	Timeline
Zr-Nat	Yes	Yes	No	-	-
Zr-90	No	No	No	G. Siemers/NNL	Spring 2022
Zr-91	N/A	N/A	N/A	G. Siemers/NNL	2022-2023
Zr-92	N/A	N/A	N/A	G. Siemers/ ORNL/NNL	FY 23-24

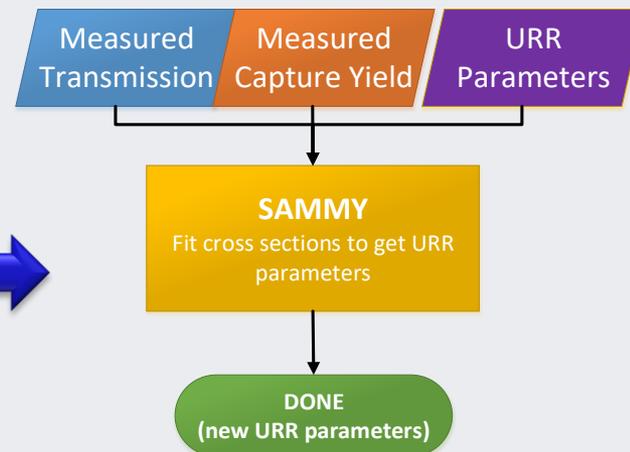
SAMMY SESH Integration

- PhD student thesis
- Collaboration with ORNL/NNL
- Help modernize SAMMY URR analysis
- Integration of a SESH like code into SAMMY
- Eliminate external iterations
- Directly fit transmission and capture yields like SAMMY can do in the RRR
- SAMMY capabilities like the RRR in the URR
 - Include multiple isotopes and samples in one fit
 - Mix transmission and capture yield in one fit

Current URR methodology

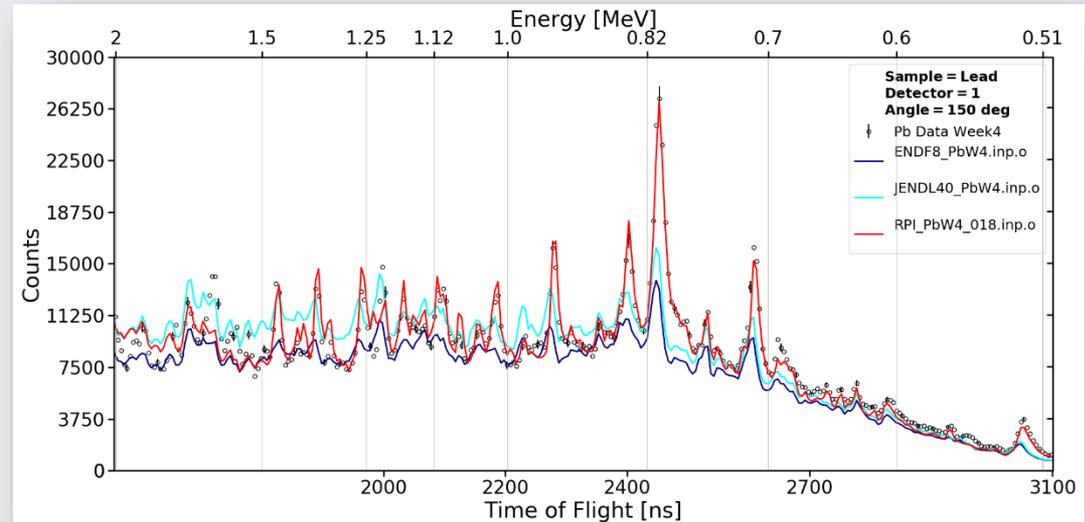


New SAMMY



Pb Evaluation (NEUP supported)

- Preliminary Benchmarking concluded that we need to address issues with angular distributions
 - RPI Quasi-Differential Scattering Experiment
 - Critical and Shielding Benchmarks
 - LSDS Simulations
- Resolved Resonance Region (Finished Pb-206/7/8):
 - Pb-206/7 RPs refit with capture and transmission experiments
 - Pb-208 evaluated with transmission data and MACS (30 keV) and direct capture
 - RRR extension for Pb-208 up to 1.5 MeV
 - New ESAD calculated for all three isotopes
- LANL fast region and RPI RRR evaluations merged to yield best performing Pb-208 evaluation
- Final Benchmarking
 - Improved agreement with RPI scattering experiments and critical benchmarks



Update on LINAC refurbishment (ND3)

- Presentation was given in 2021 ANS Winter Meeting
- Important Dates: Current LINAC shutdown date 9/2022. Complete upgrade end of 2024.
- Currently solving issues with RF windows test that resulted in a cracked window:
 - This test is a critical path for completion of accelerator section acceptance test and proceeding with the manufacturing of the remaining sections.
 - Created a new test setup (shown on right)
 - Solved problems with vacuum seals.
- RPI facilities:
 - Installed a new high power electrical line to the (new) modulator building
 - Removed old TP storage building and cooling tower to make room for a new one
 - Starting construction of a new storage building to house accelerator components removed during LINAC demolition.



Acknowledgments



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