UNIVERSIDAD TECNICA
FEDERICO SANTA MARIA

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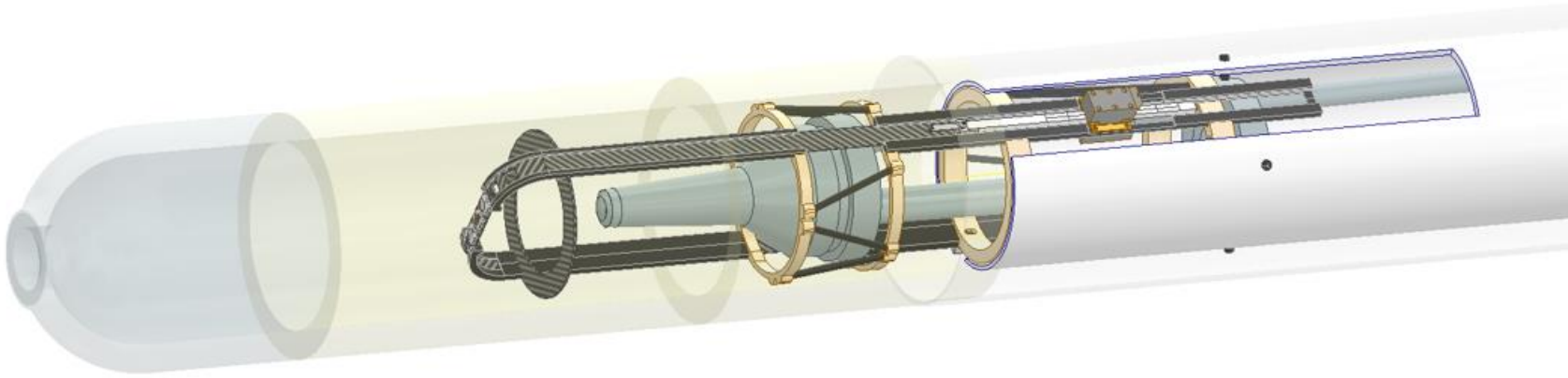
Jefferson Lab

CLAS Collaboration meeting

Update on RG-E Experiment



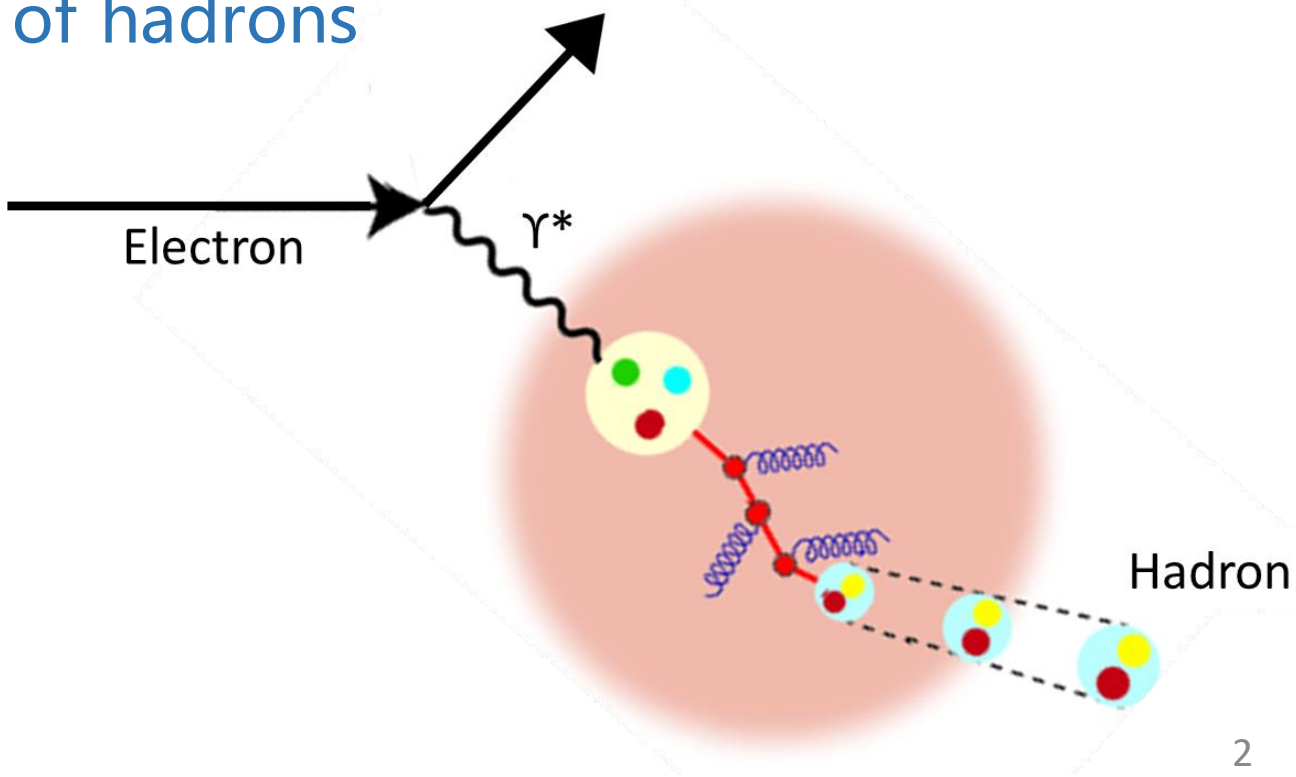
Milan Ungerer M.

November 8th, 2023

Motivation

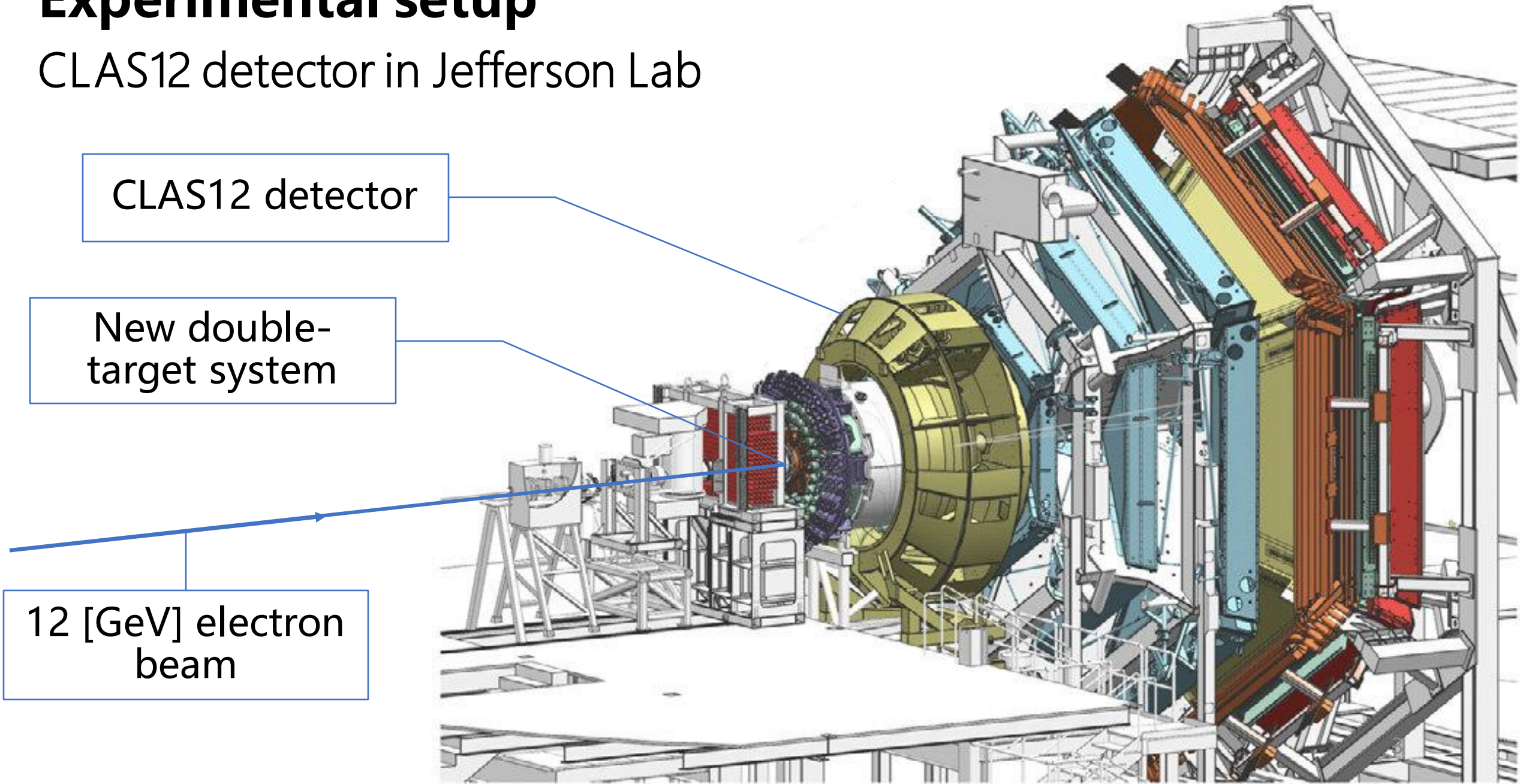
Deep inelastic scattering

RGE will provide a comprehensive study of the impact of the nuclear medium on quark hadronization. A multidimensional kinematical analysis of a variety of hadrons is required.



Experimental setup

CLAS12 detector in Jefferson Lab



Experimental setup

RG-E 2024 schedule

Target	Areal density [g/cm2]	Physical length [mm]	Radiation length [cm]	Luminosity [1/cm2s]	Beam current [nA]	PAC days
Deuterium (LD2)	0.51	30.00	769.10	-	-	**4**
Carbon (C12)	0.48	2.22	19.32	1.E+35	54.19	**6**
Aluminum (Al27)	0.49	1.82	8.90	1.E+35	54.10	**7**
Copper (Cu63)	0.32	0.36	1.43	1.E+35	81.44	**8**
Tin (Sn118)	0.22	0.30	1.21	6.E+34	71.81	**15**
Lead (Pb208)	0.16	0.14	0.56	6.E+34	99.84	**18**

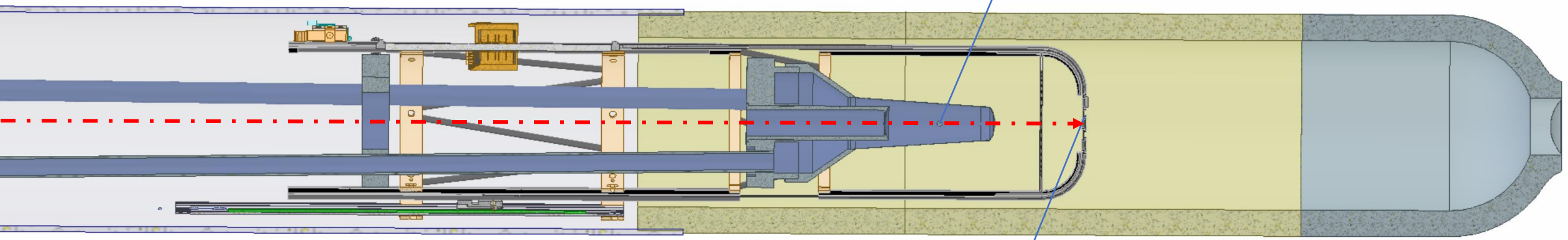
The acquisition of the targets is being coordinated with the Hall B group

RG-E experiment already scheduled from March 11th to May 19th, 2024
(50% of PAC days)

Experimental setup

Double target system

3 [cm] **LD2 target**



- **Carbon** (C-12)
- **Aluminum** (Al-27)
- **Copper** (Cu-63)
- **Tin** (Sn-120)
- **Lead** (Pb-208)

Challenge: extreme conditions

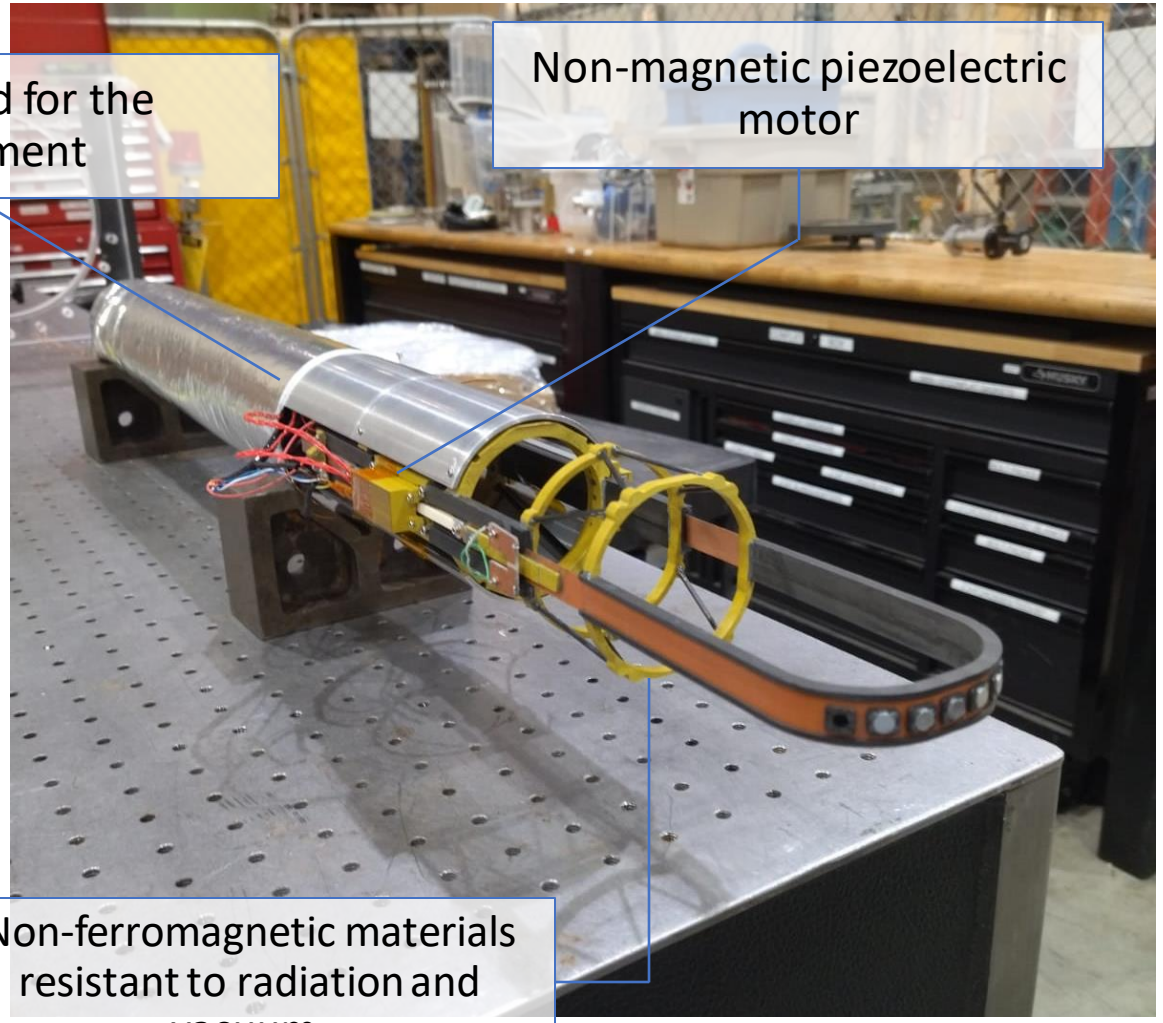
- Ionizing Radiation*: $Neutron\ 3{,}780\ [rem]$
- Magnetic field: $5\ [T]$
- Cryogenic temperatures: $20\ [K]$
- High vacuum: $6 \times 10^{-6}\ [mbar]$)
- Restricted space: tolerances $< 1[mm]$

How can we generate precise movement (to exchange each target) remotely under the extreme conditions of the experiment?

*Lorenzo Zana (Radcon) simulations

Double target system

Glued targets onto composite ribbon (G10 + copper)



Heat shield for the experiment

Non-magnetic piezoelectric motor

Non-ferromagnetic materials resistant to radiation and vacuum.

Double target testing

1. Radiation hardness test (JLab 2019) ✔
2. Heat dissipation test (USM 2022) ✔
3. Precision and accuracy of movement test in high vacuum and LN2 temperatures (USM 2023) ✔
4. Magnetic field test (JLab August 2023) ✔
5. Low temperature test (JLab October 2023) ✔

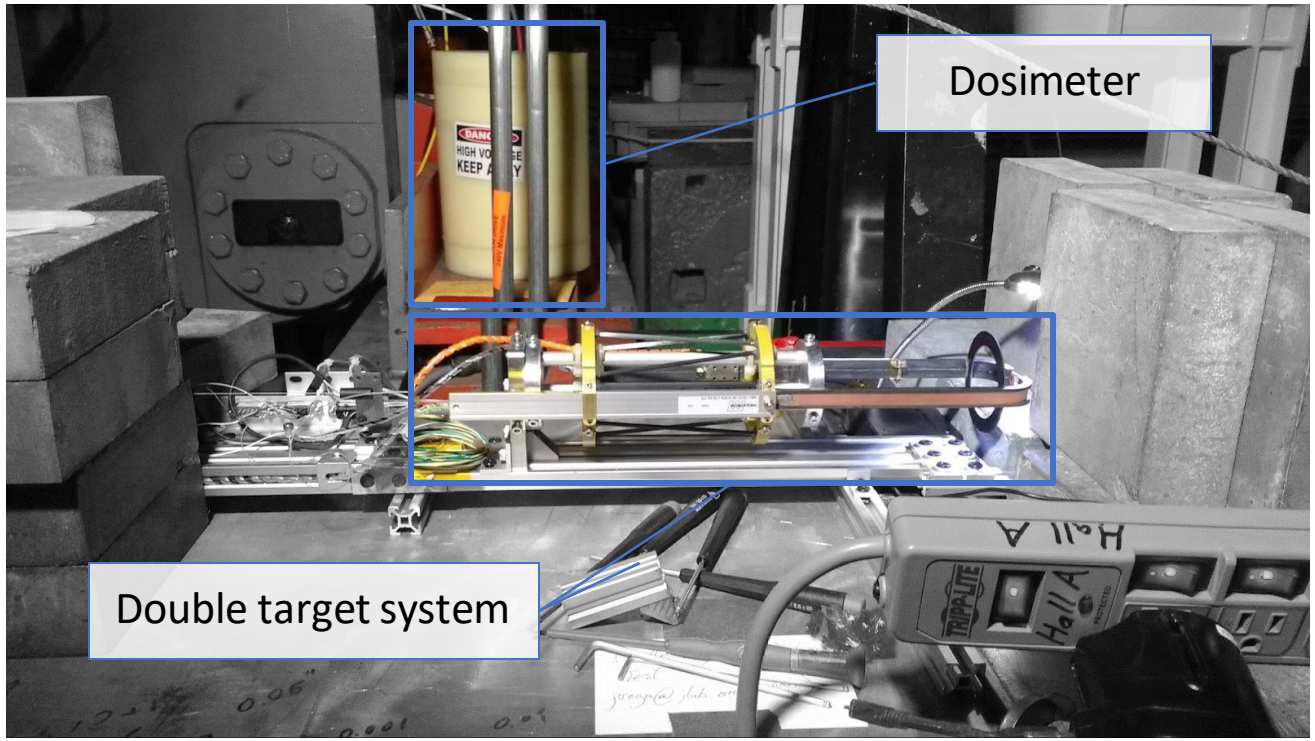
*Updated

Radiation hardness test

Jefferson Lab's Hall A provides an ideal environment for conducting radiation resistance tests due to its **accessibility** to high radiation rates and **constant monitoring.**

Estimation of accumulated dose through **simulations***:

- **Neutron: 3,780 [rem]**
- Photon: 367 [rem]
- Proton: 92 [rem]
- Electron: 3,958 [rem]



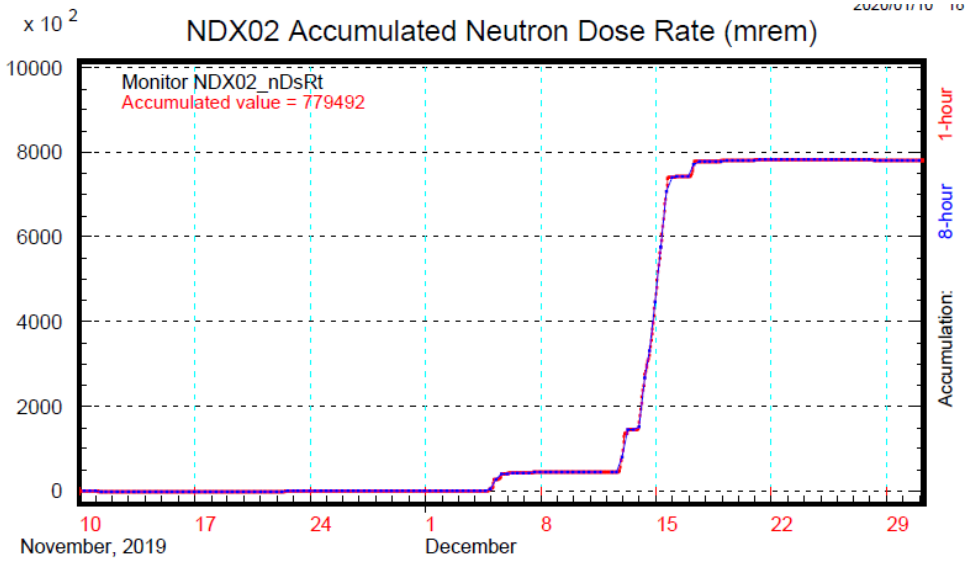
*Lorenzo Zana (Radcon) simulations

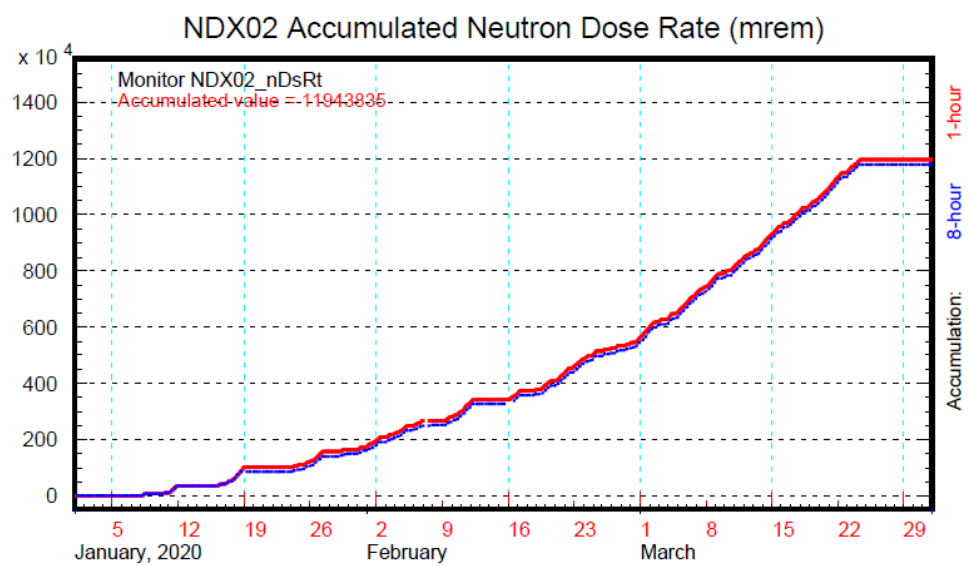
Accumulated dose during 4 months of testing

Neutron dose

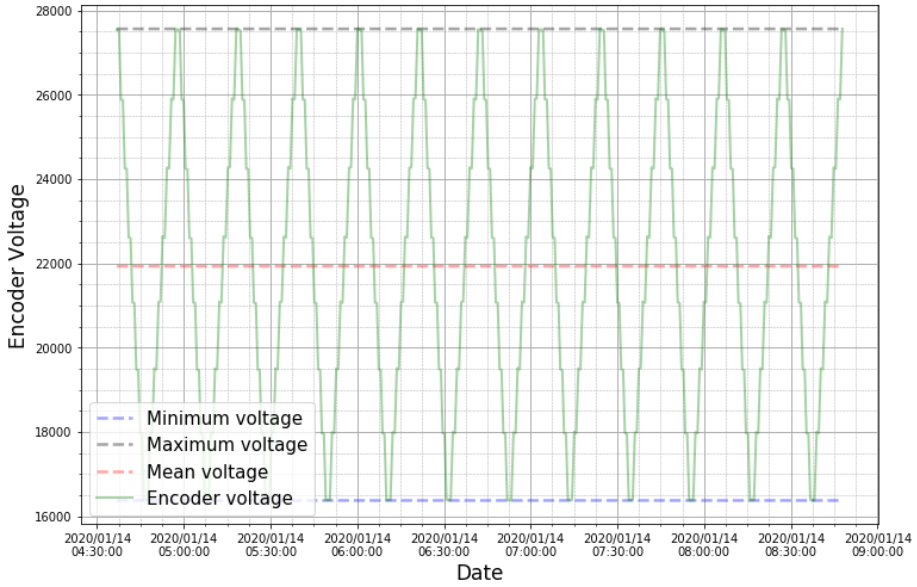
12,723 [rem]

337%!



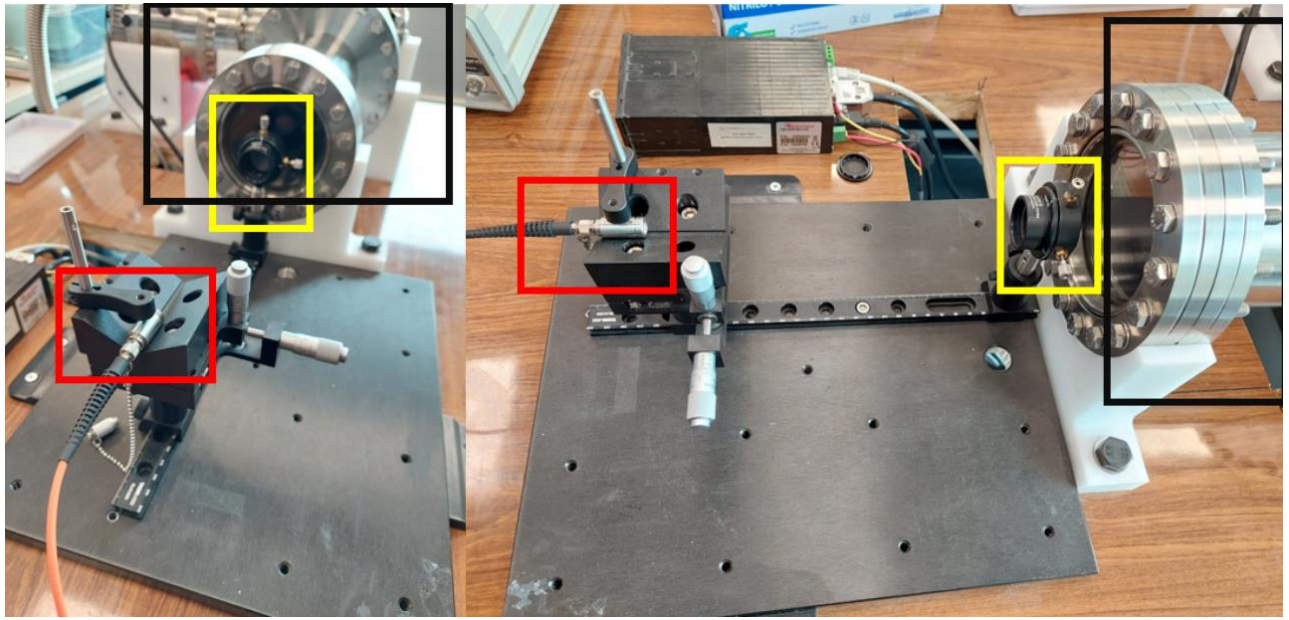


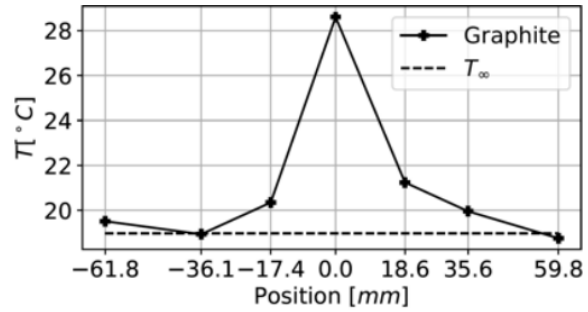
Measurement of position for **125 days without appreciable changes.**

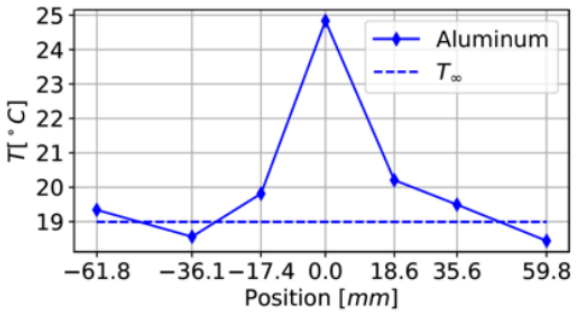


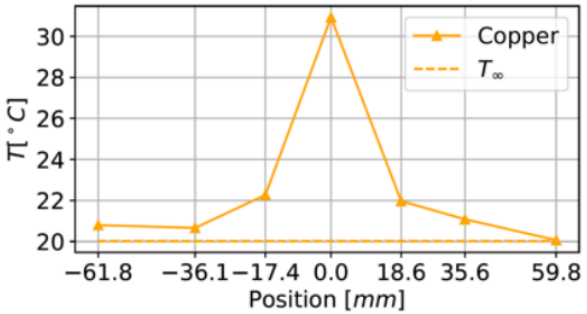
Heat dissipation test

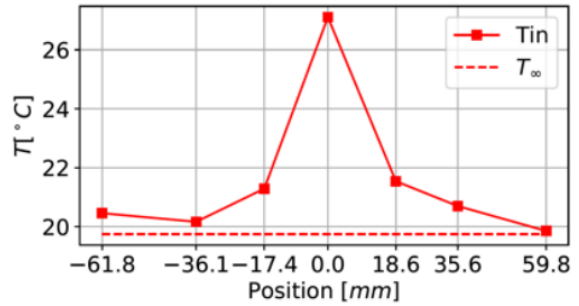
Heat extraction capacities of the Double-Target

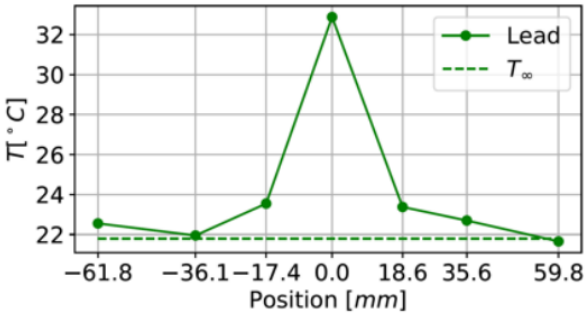






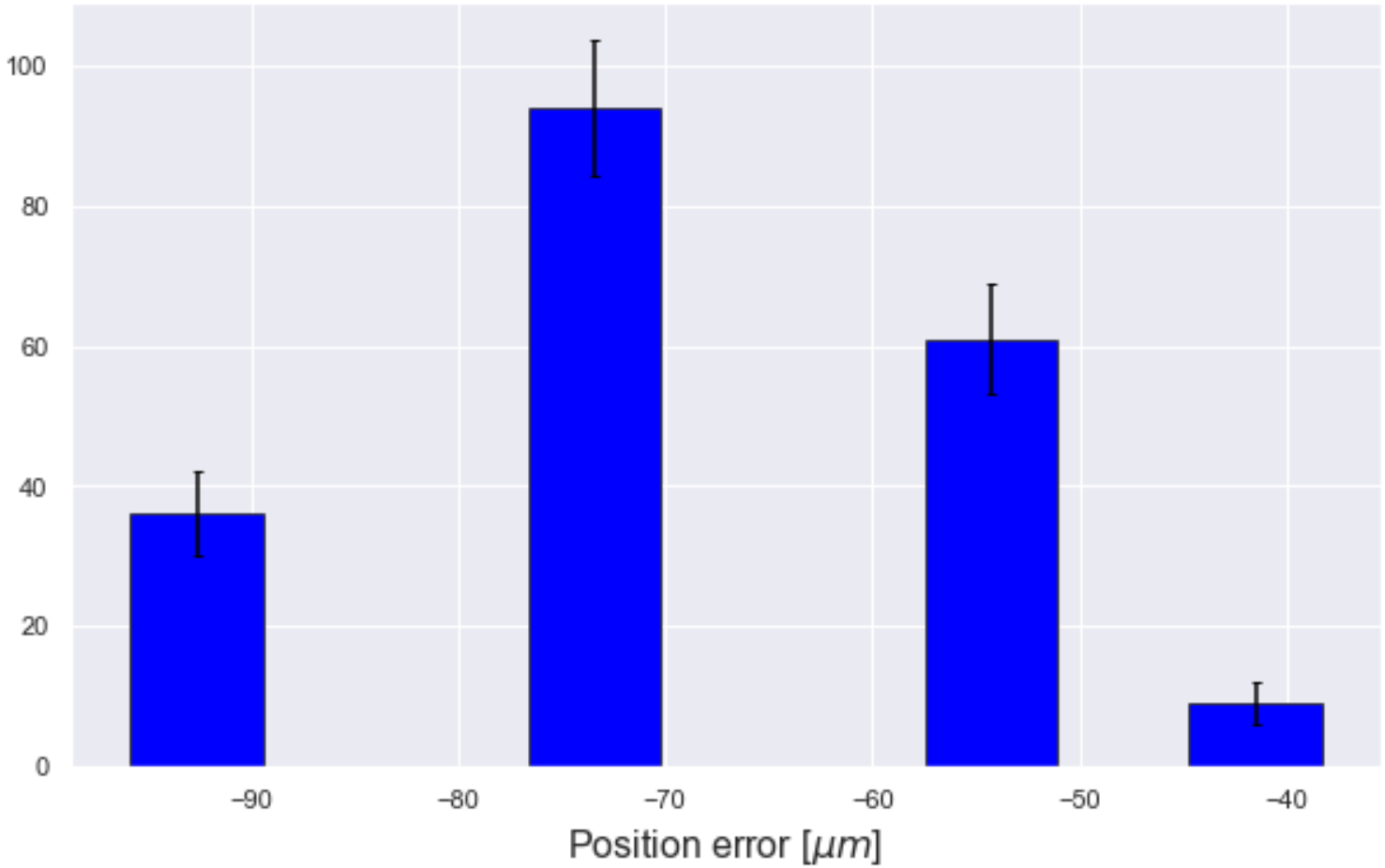






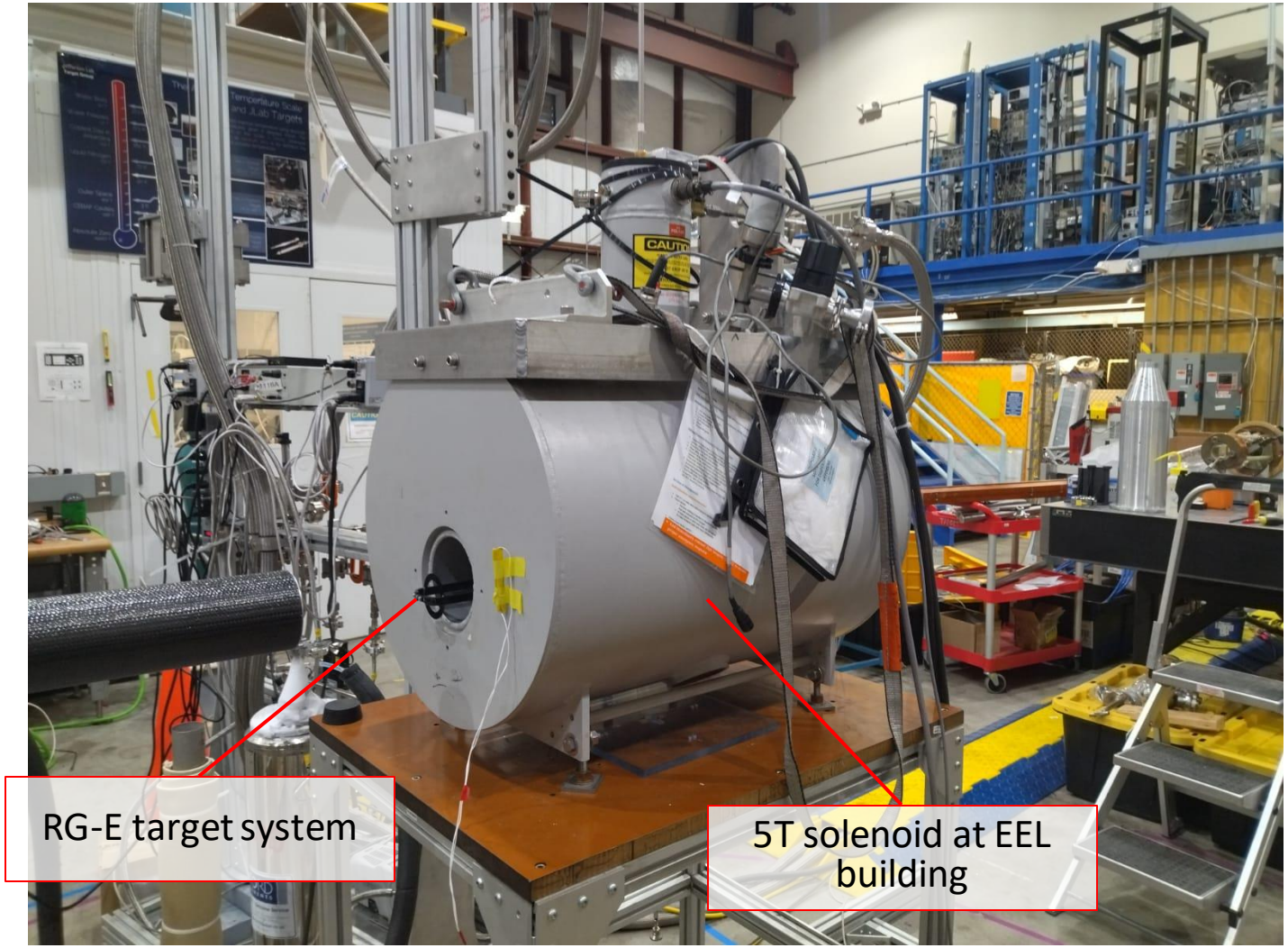
The experimental setup consists of a laser with sufficient power to **deposit 60 [mW]** on each target under vacuum conditions and a measurement of temperature at various points near the heat flow. The objective is to ensure that the solid targets **do not reach their melting point.**

Precision and accuracy of movement in high vacuum conditions



- Measurement instrument resolution: 20 [μm]
- Number of samples: 200
- 3σ (99.7%) = ± 70 [μm]

High magnetic field test at Jlab (August 2023)



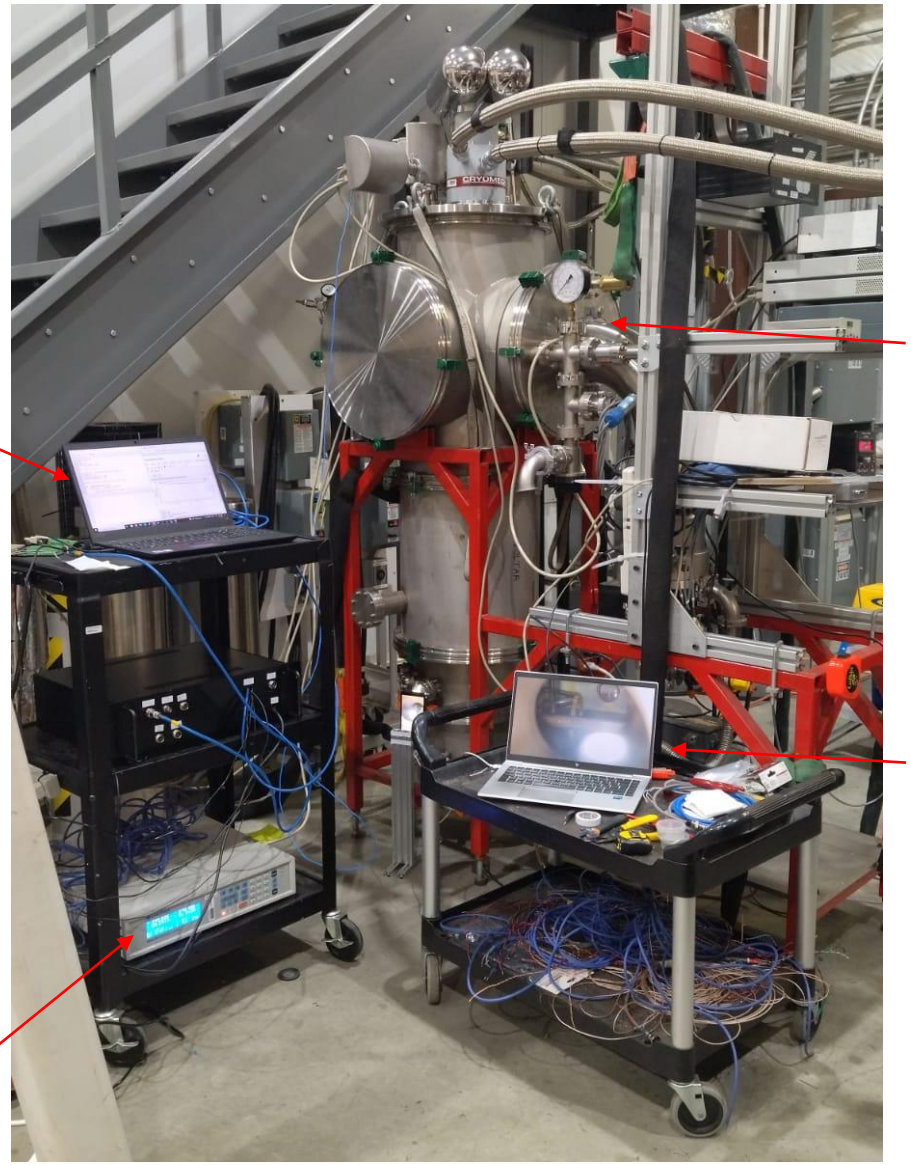
The movement system worked under **5T magentic field without any problem**

Low temperature test at Jlab (October 2023)

Movement control system

Target ready to be installed

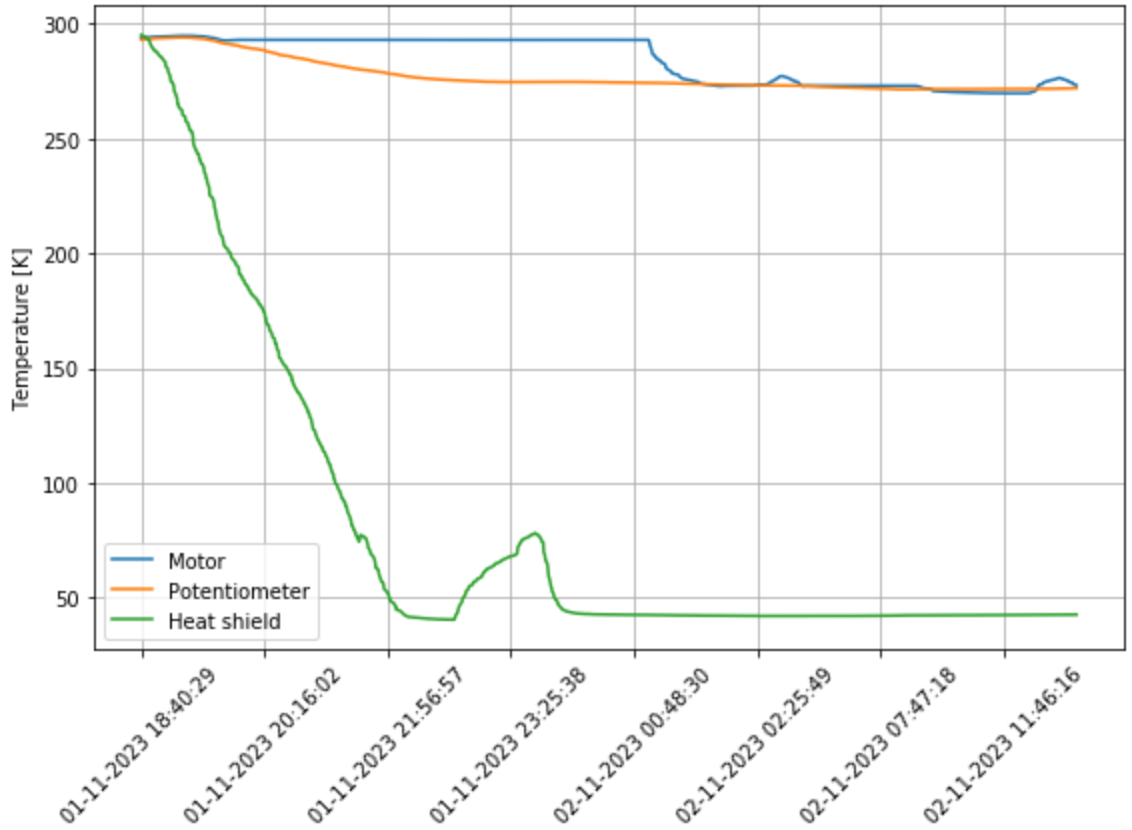
Temperature control system



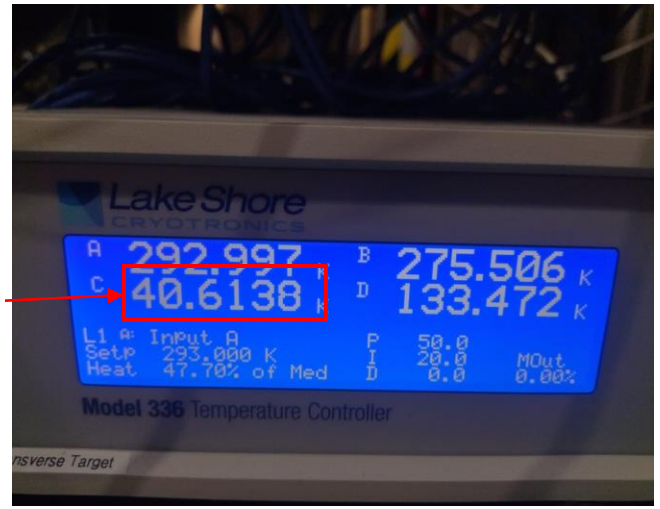
Pulse tube – Cryogenic equipment capable to achieve below 40 K

Visual inspection

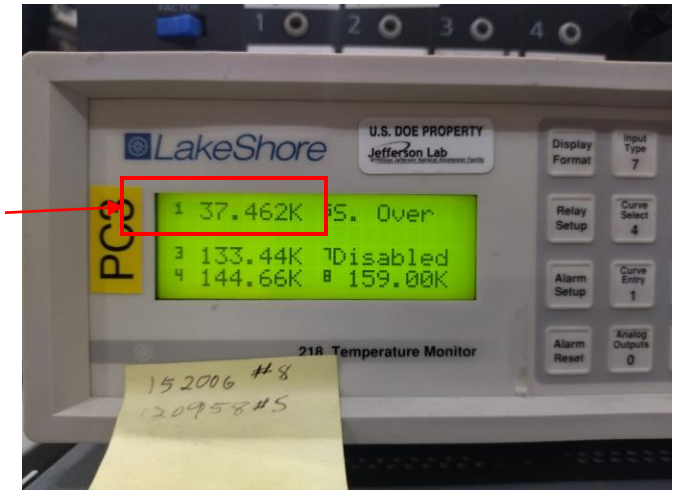
Low temperature test at Jlab (October 2023)



Heat shield temperature



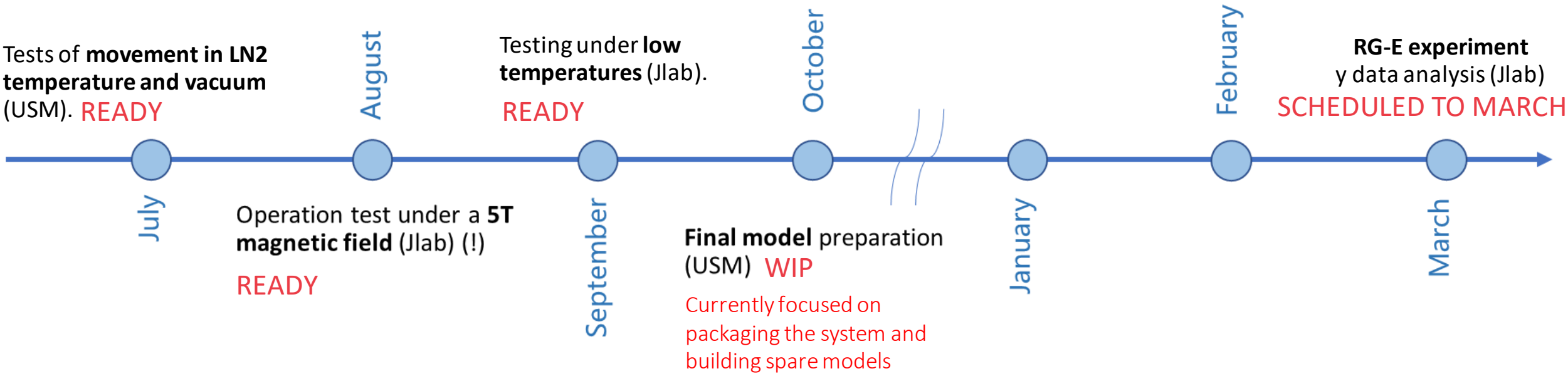
Pulse Tube temperature



The heating power of the system is less than 500 mW

The movement system worked properly during the whole test

Double target schedule



*Updated

Final remarks

- The target system **passed all the tests**.
- The target system design and testing is **ready.** Currently focused on packaging the system and building spare models
- **Help from the target group** during the low-temperature test was crucial. **Thanks for all the support!**

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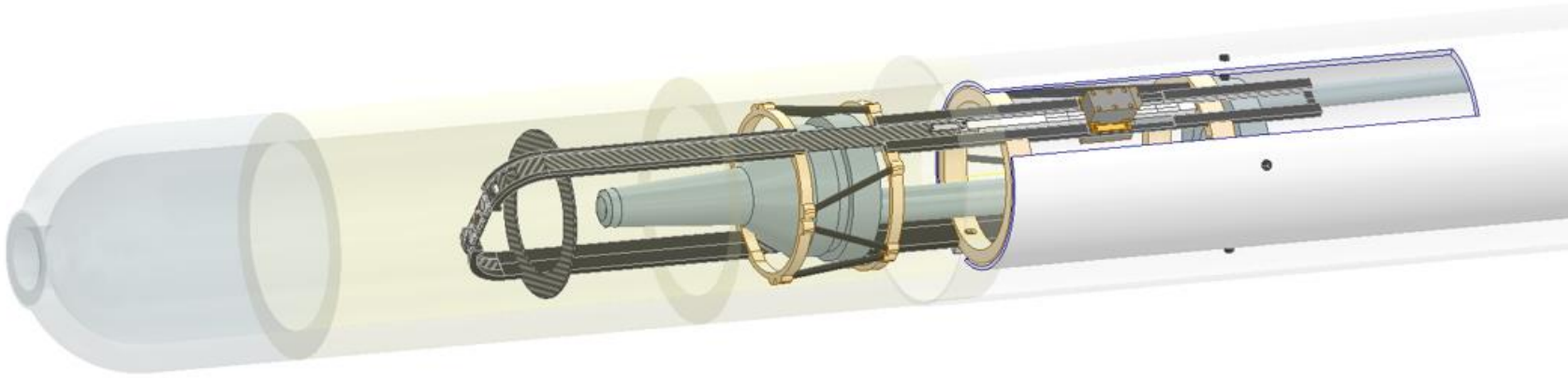

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