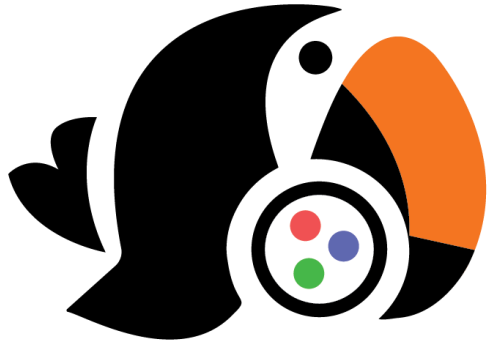




**TUCAN**

TRIUMF Ultra Cold  
Advanced  
Neutron source

# Ultracold neutron storage test at J-PARC

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2026 TRIUMF-KEK Symposium  
September 29<sup>th</sup>, 2026  
Vancouver

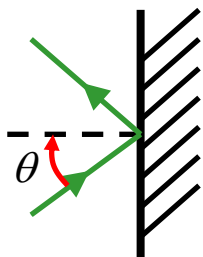
Ultracold neutrons are free neutrons **reflected** from some material surface under **all angles of incidence**.  
They can be stored using:

## Strong force

$$V_F(\vec{r}) = \frac{4\pi\hbar^2}{2m} \sum_i a_i \delta(\vec{r} - \vec{r}_i')$$

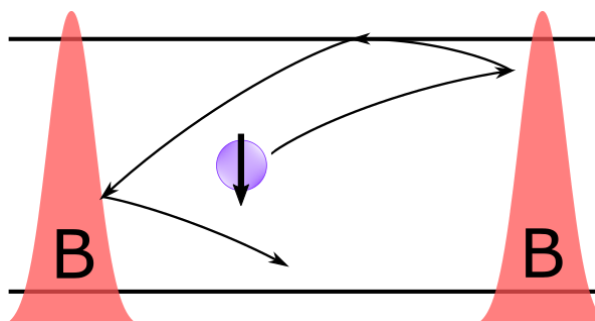
| Material         | $V_F$ (neV) | $v$ (m/s) |
|------------------|-------------|-----------|
| Al               | 54          | 3.2       |
| $^{58}\text{Ni}$ | 350         | 8.2       |
| Graphite         | 180         | 5.9       |
| Stainless Steel  | 188         | 6         |
| DLC              | 282         | 7.3       |

$$E_{kin} < V_F :$$



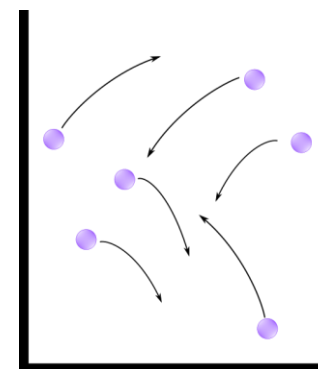
## Magnetic field

$$\mu_N = 60.3 \frac{\text{neV}}{\text{T}}$$



## Gravity

$$V_g = m_n g z = \left( 102.5 \frac{\text{neV}}{\text{m}} \right) z$$



They have very low kinetic energy, about **300 neV** corresponding to ~3.5 mK.

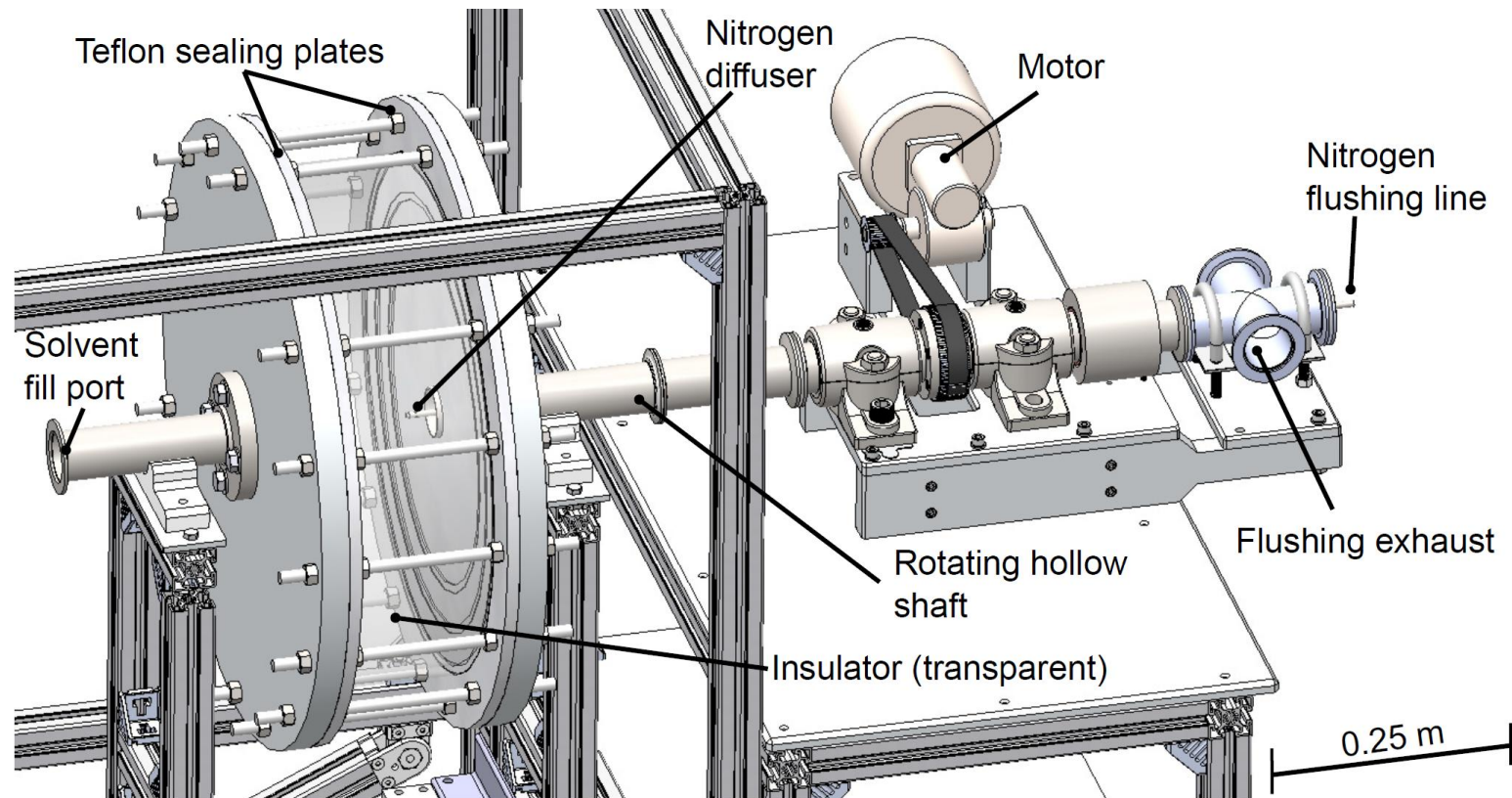
The TUCAN collaboration aims for nEDM measurement based on Ramsey's method of separated oscillatory fields.

$$\sigma_d \propto \frac{1}{T \sqrt{N(T)}}$$

- $N$ : Number of neutron detected, needs for high efficiency at few 100 kHz detection rate
- $T$ : Free precession time, must be optimized considering neutron decay, absorption, storage lifetime, de-polarization...

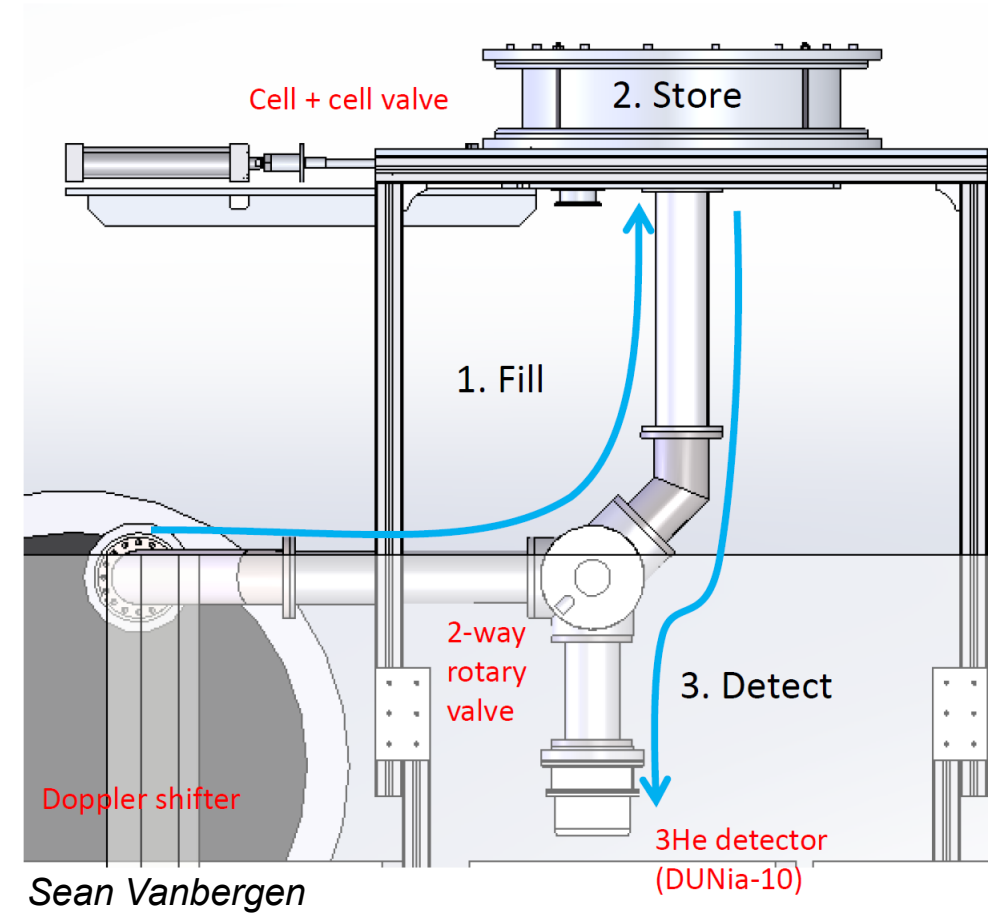
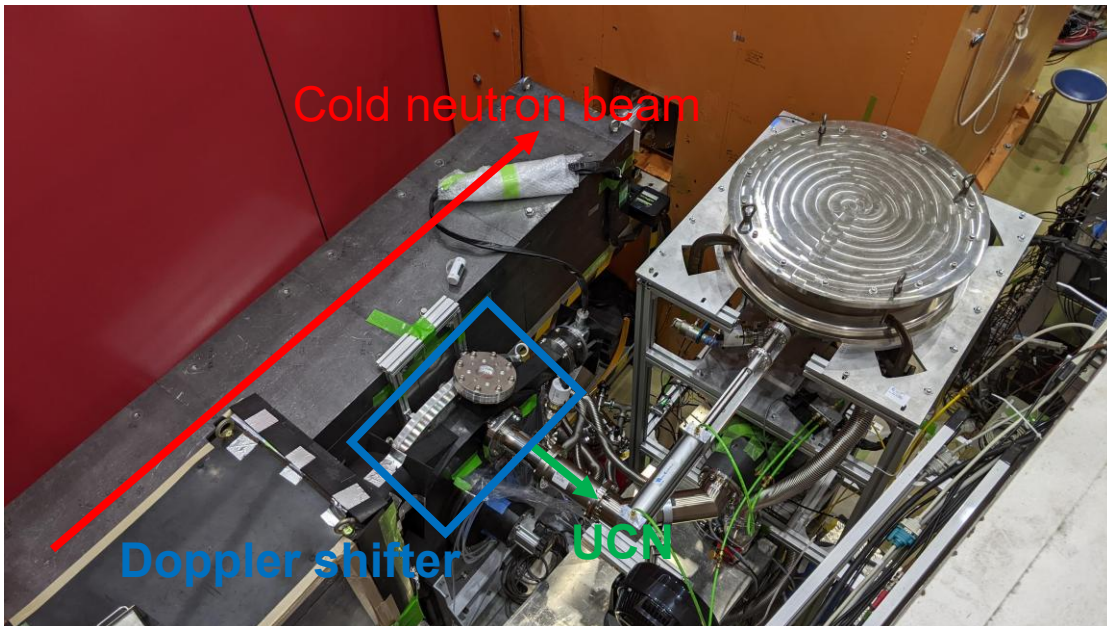
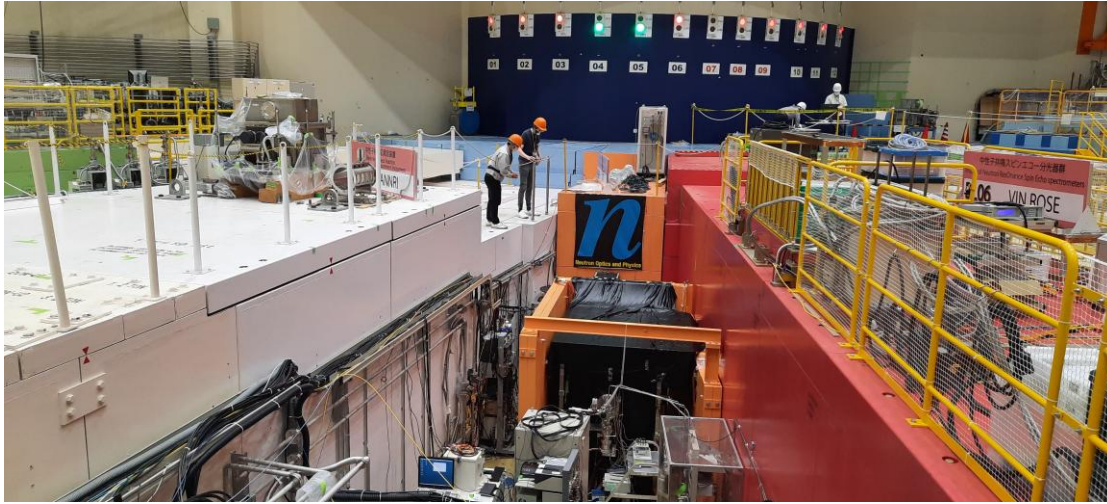
**The experiment requires to store a large number of neutrons, for long period of time.**

Sean Vanbergen developed a coating machine and method for plastic coating.



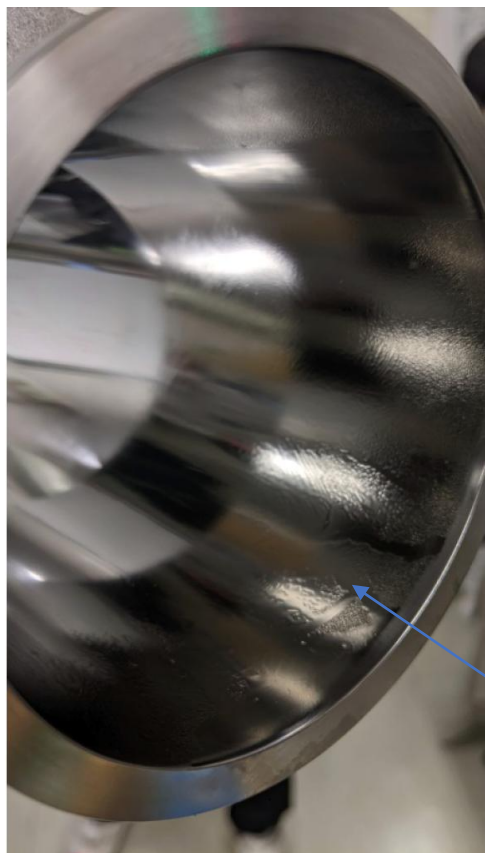
Studies of ultracold neutron dynamics and systematic effects for the TUCAN EDM experiment: 10.14288/1.0448591

## J-PARC MLF



Two cell walls to be tested, Nickel-Phosphorus (NiP) and Deuterated-Polystyrene (dPs).

First NiP measurement was not very good, we decided to bake the cell, storage time then dropped to 0, no UCN were detected anymore. After intensive cleaning, the storage lifetime recovered to still bad value.



| Configuration                | Storage lifetime [s] |
|------------------------------|----------------------|
| NiP Ring                     | $64.9 \pm 2.5$       |
| NiP Ring + Baking            | no neutron           |
| NiP Ring + Baking + Cleaning | $54.1 \pm 1.5$       |
| dPs                          | $72.2 \pm 1.5$       |

Oil deposition on the surface of a 95 mm diameter guide.

From the 2022 campaign, we learned that surface cleaning is crucial for neutron storage.

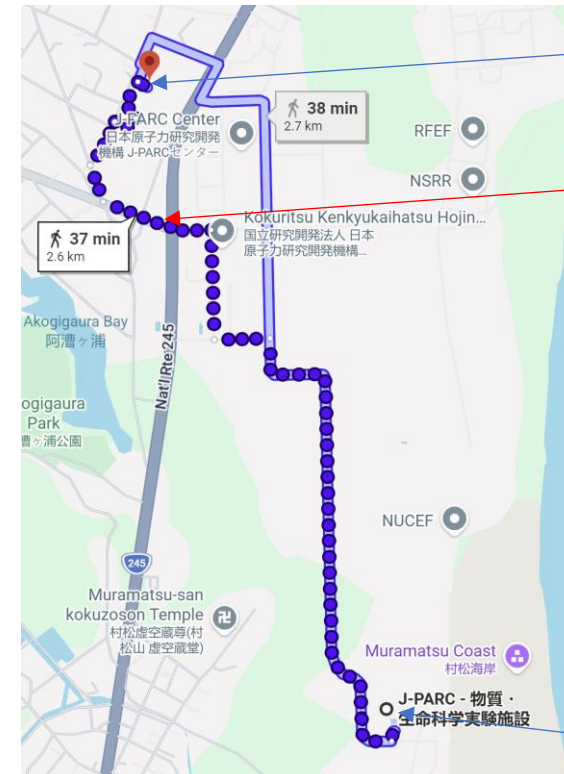
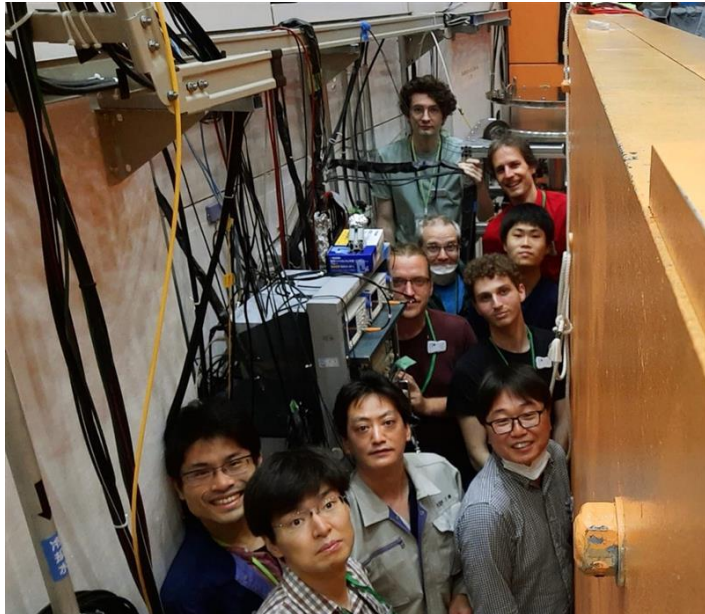
For the 2023 campaign a new cleaning procedure was developed, we cleaned all components UCN could see with a degreaser and isopropanol, in clean room.

|      | NiP             | dPs             |
|------|-----------------|-----------------|
| 2022 | $64.9 \pm 2.5$  | $72.2 \pm 1.5$  |
| 2023 | $137.5 \pm 4.7$ | $111.3 \pm 3.6$ |

The 2023 campaign allowed to validate a cleaning procedure crucial for the future nEDM experiment.

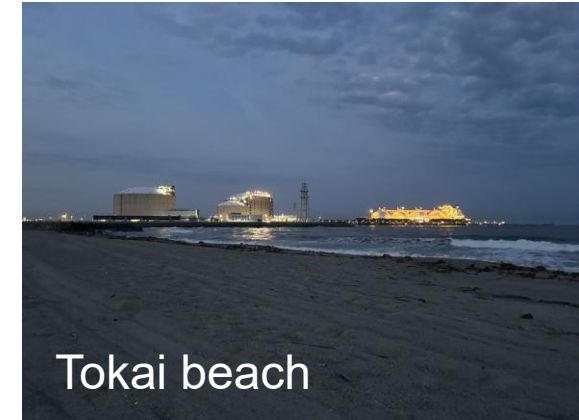
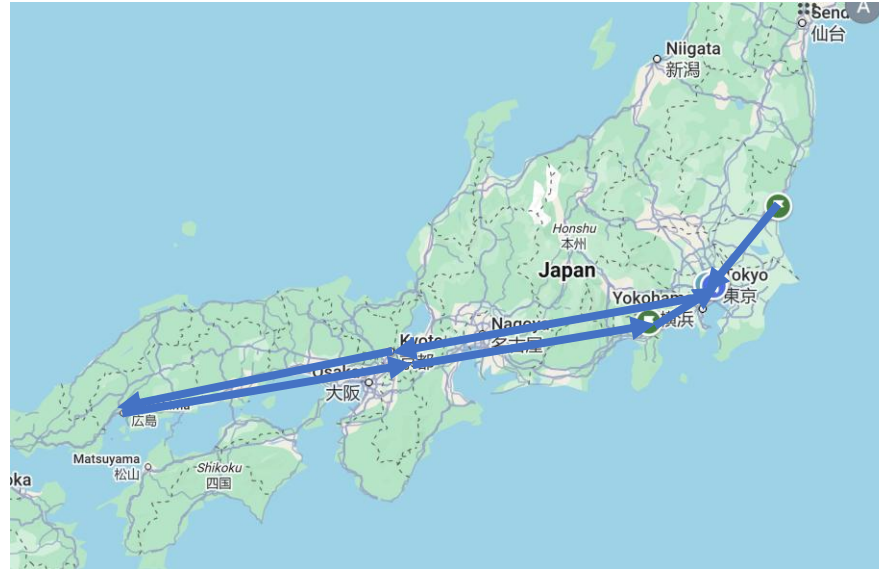
## Lesson learned:

- These campaigns demonstrated the importance of thorough cleaning performed according to a strict and well-defined procedure.
- I learned what beam experiment campaign requires (The experiment decide your sleeping schedule).



- Dormitory
- Best 7-Eleven worldwide ever with always fresh very good.
- J-PARC MLF

After ~3 weeks beam experiment at J-PARC MLF BL05, 5 days off with a Japan Rail pass:



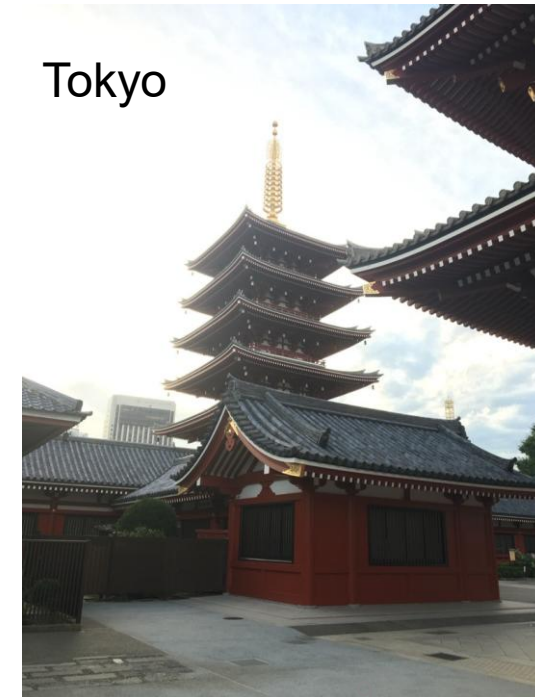
Tokai beach

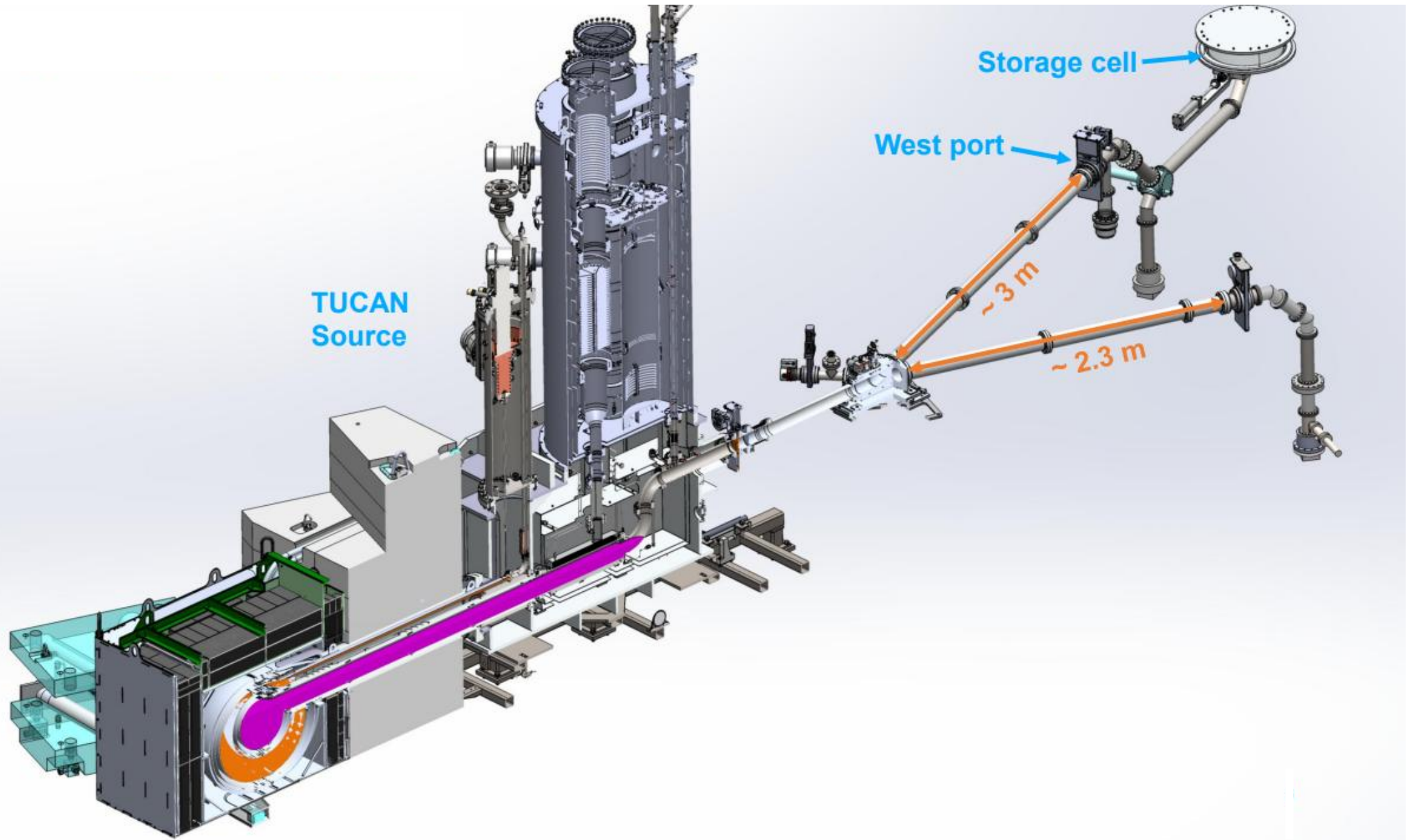
Tokyo

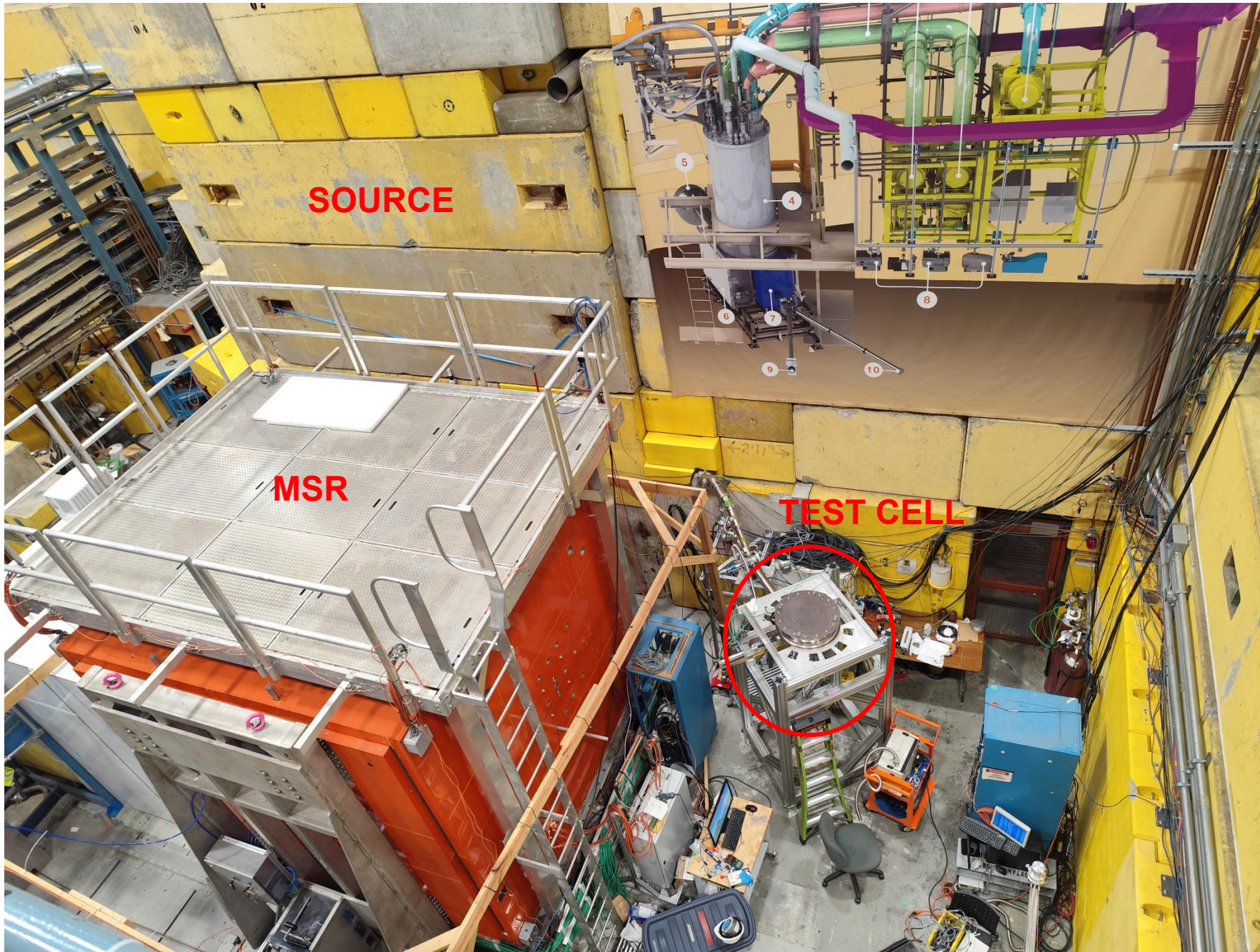
Hiroshima peace memorial



Kyoto



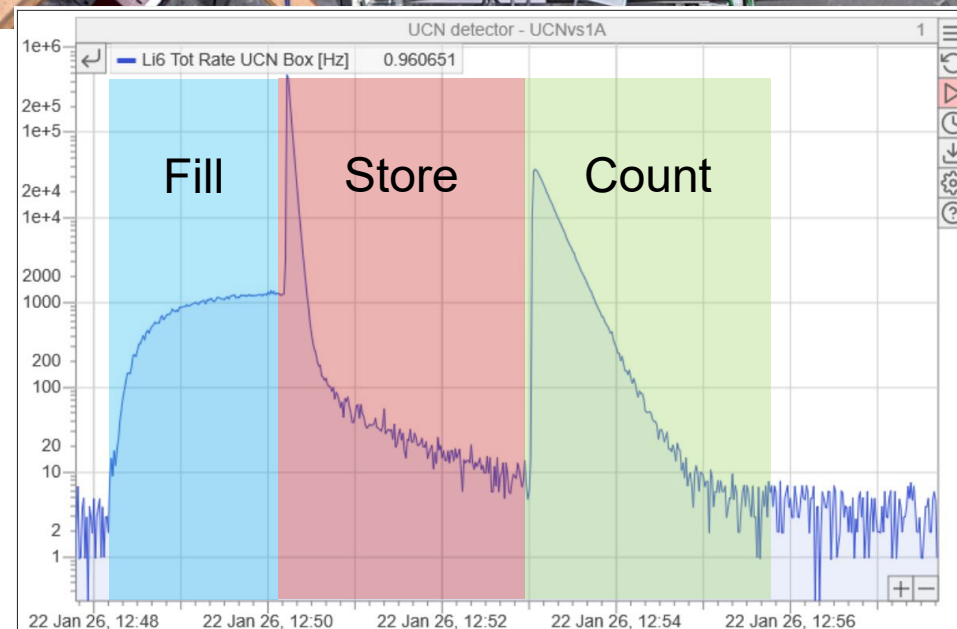
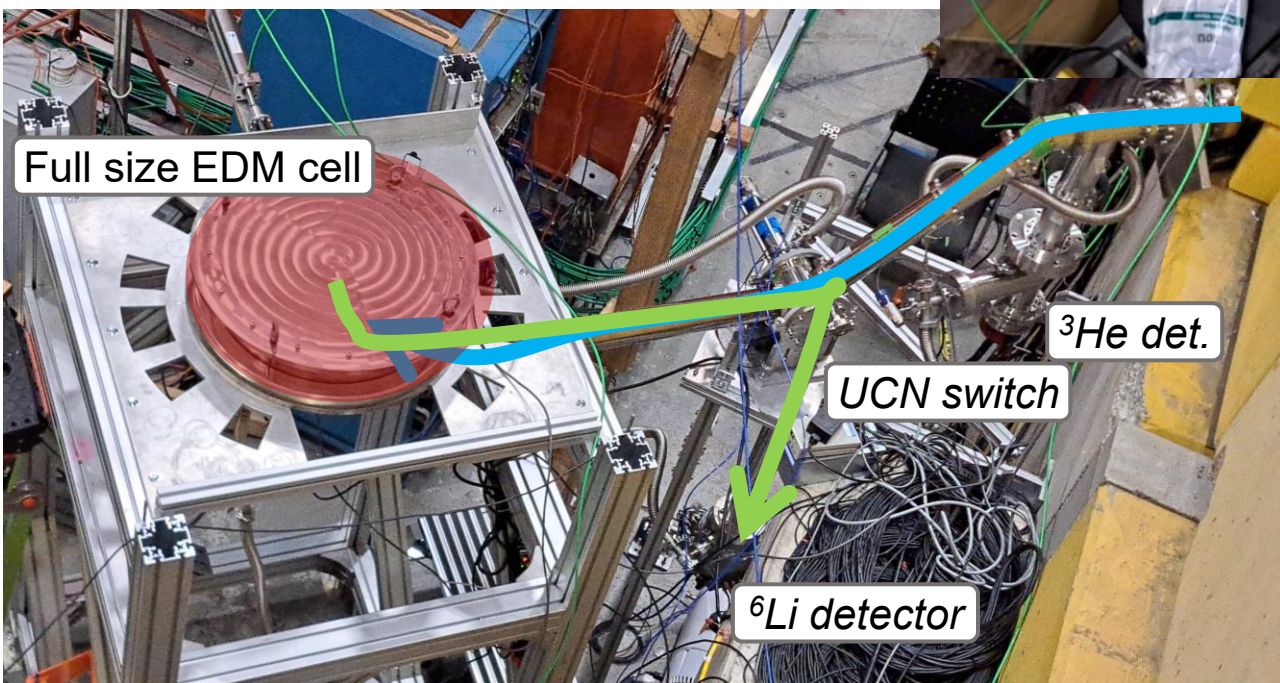
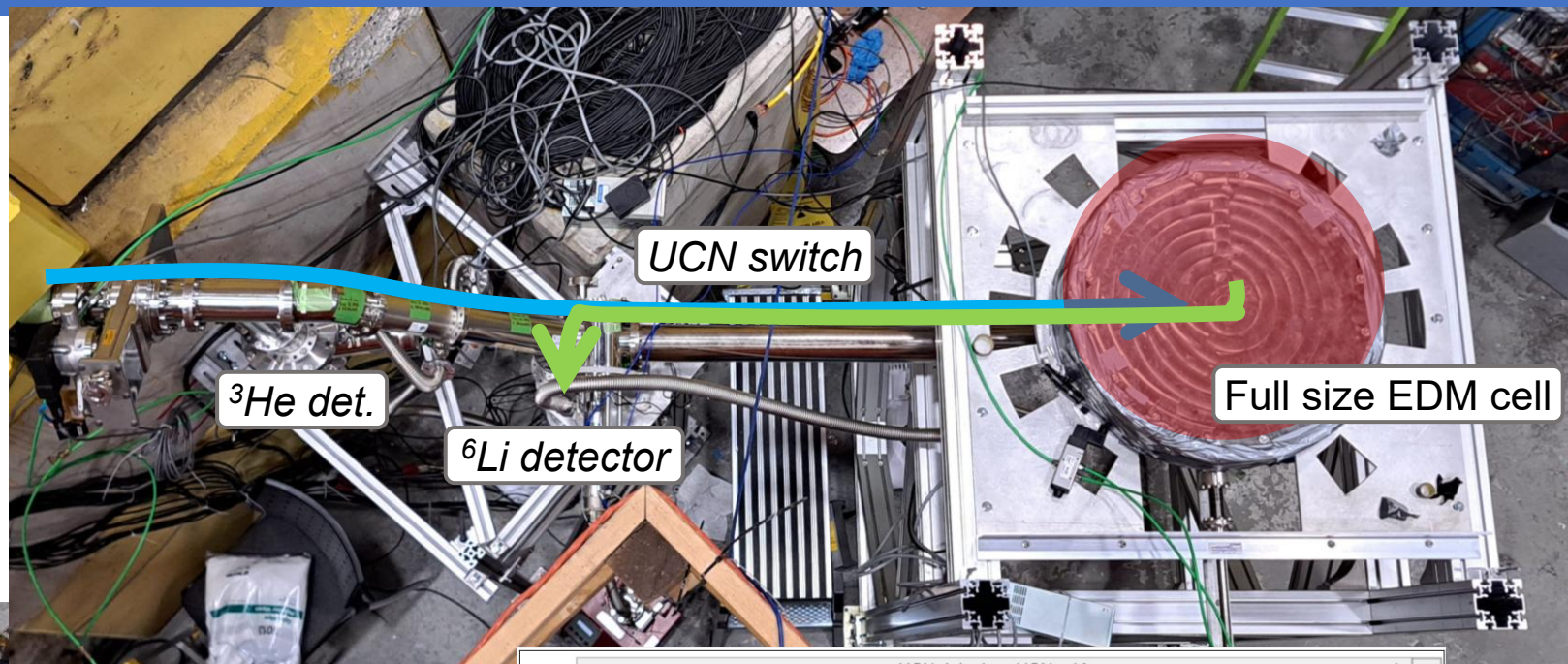




## Prototype EDM measurement:

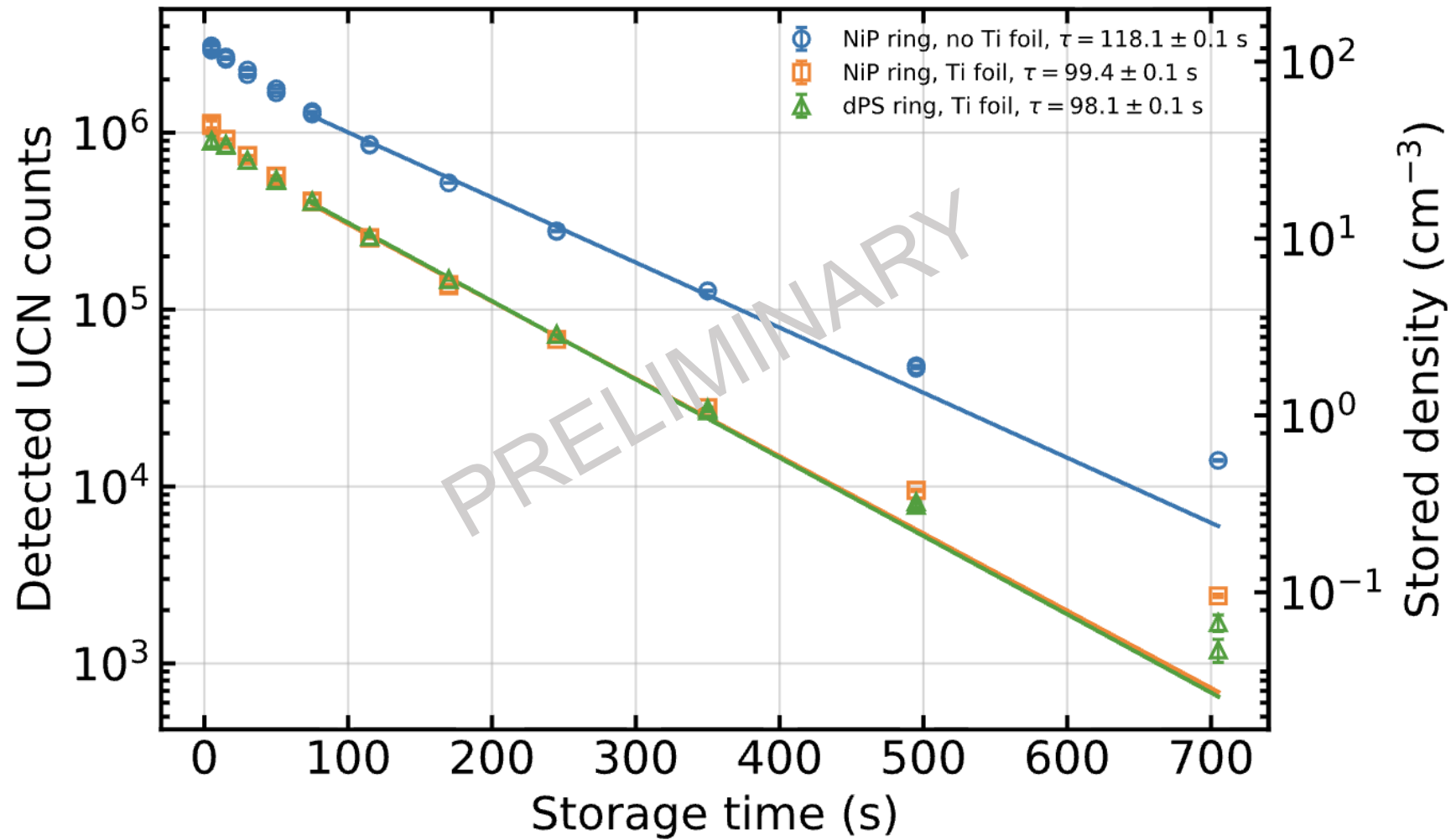
Sequence:

1. Fill UCN into cell 120 s
2. Store in cell 0 - 700 s
3. Count in detector 200 s





## Prototype EDM measurement:







## CONCLUSION:

- The J-PARC UCN source allowed us to test key components during the development of the TRIUMF UCN source.
- The dPs cell, first successfully tested at J-PARC, achieved a record UCN density after being connected to the TRIUMF UCN source.
- The success of the TUCAN collaboration relies on the Canadian-Japanese partnership, the EPECR program is a key part of it.



**TUCAN**  
TRIUMF Ultracold  
Advanced Neutron  
Collaboration



February 2026 collaboration meeting



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JSPS