

*Institut
Ruđer
Bošković*



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The T114 Experiment

Bruno Kovač

Supervisor: Budimir Kliček



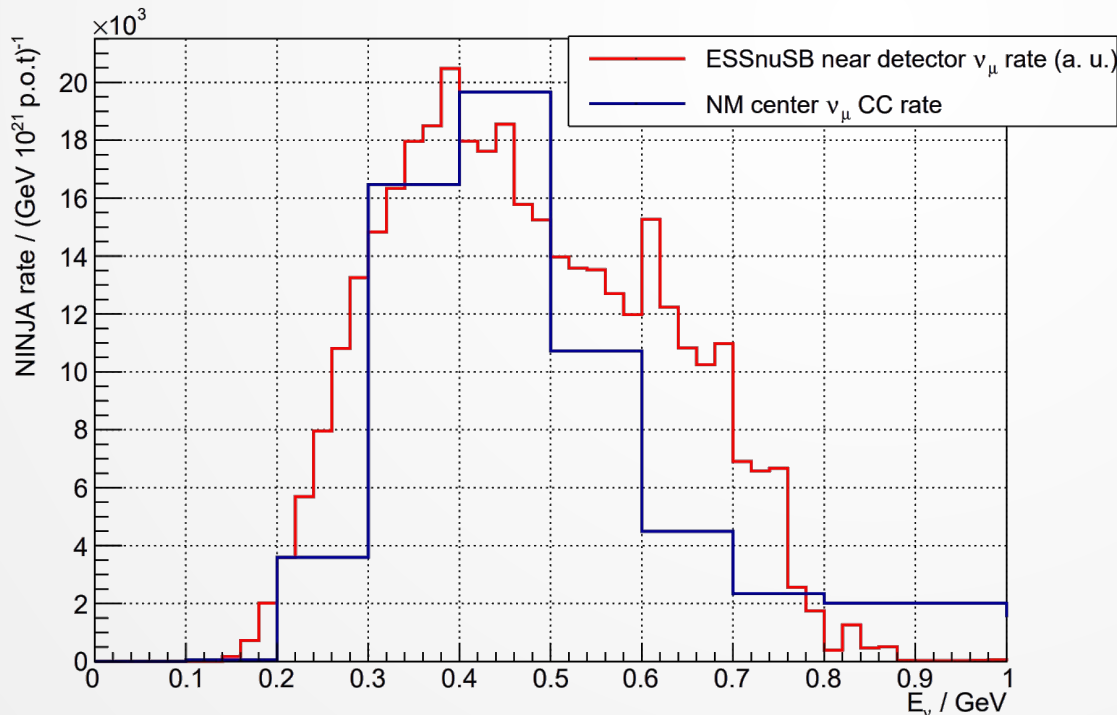
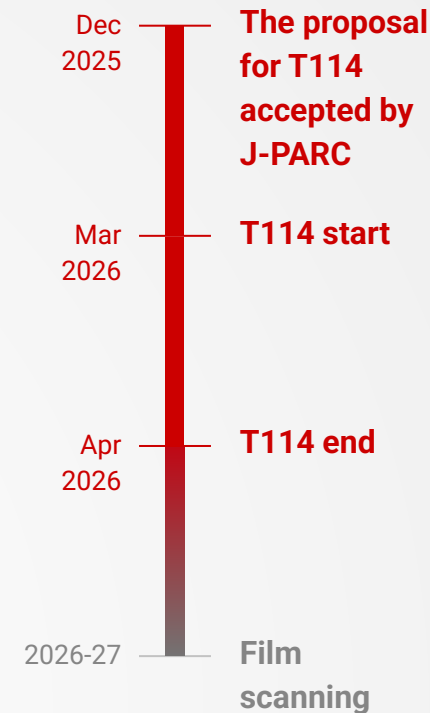
6 October 2026, ESSnuSB+ 4th Annual Meeting in Vik Castle, Sweden

Outline

1. The T114 surface test experiment
2. Test goals
3. Experimental setup
4. Film development
5. Test schedule
6. Summary

1. The T114 test experiment

The NINJA collaboration plans a very off-axis measurement at ground floor (ND280). Increasing the off-axis angle lowers the energy peak, resulting in a narrower flux.

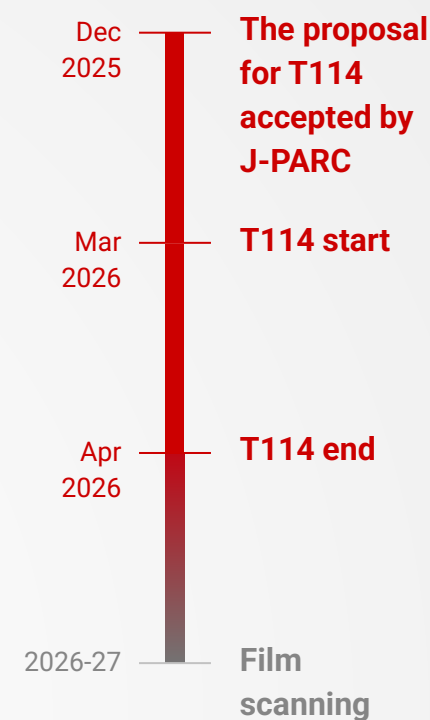


The energy range at the surface will be comparable to the range expected for ESSnuSB.

1. The T114 test experiment

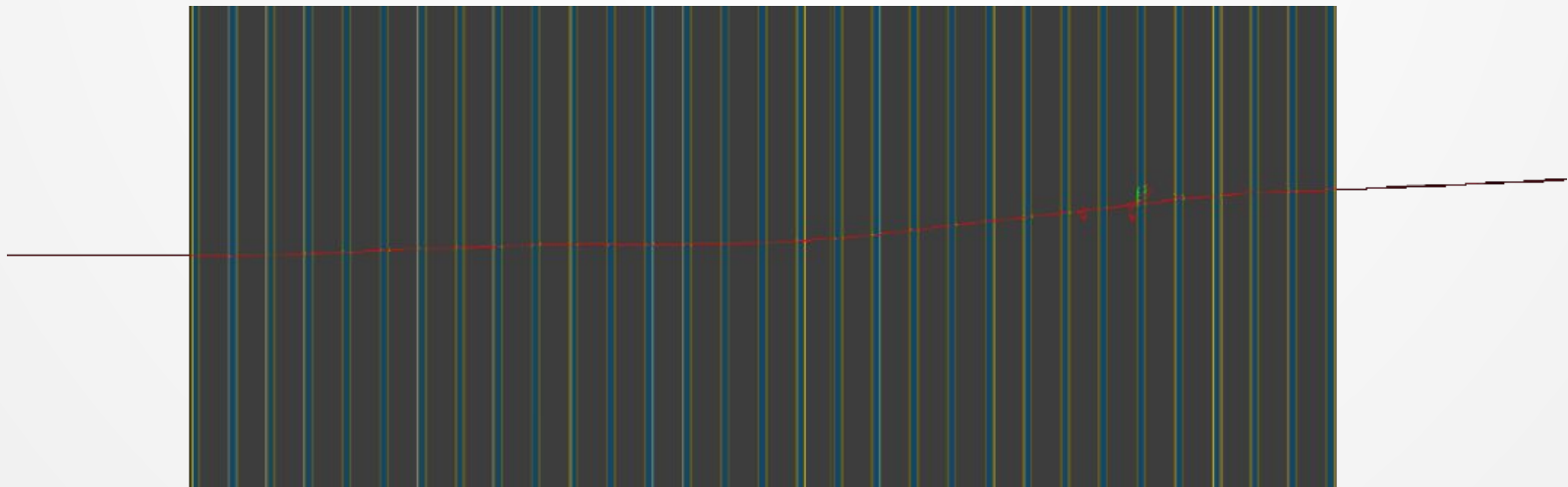
To prepare, the IRB's neutrino group proposed and conducted a test experiment to **characterize backgrounds** to our neutrino signal (μ , γ , sky-shine).

It was important to collect emulsion data at ground level to develop our MC and improve understanding of backgrounds for a potential future NINJA site.



2. Test goals

- **Measure cosmic-ray flux** at ND280 ground level using an emulsion–lead detector:
 - determine muon momentum as a function of zenith angle,
 - validate μ counting efficiency with a scintillator counter;
- **investigate beam induced backgrounds.**

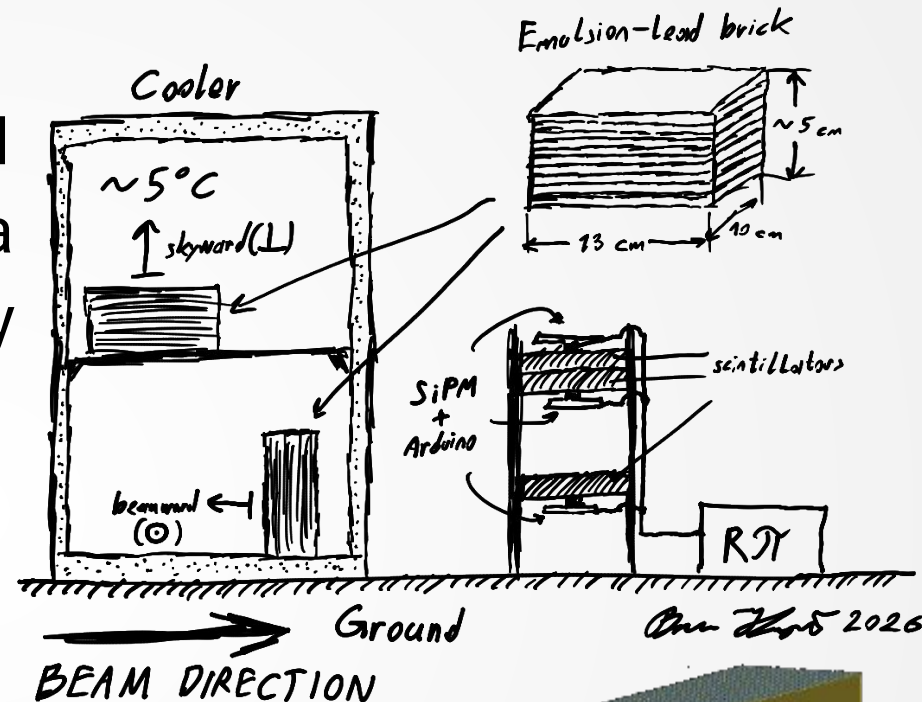


3. Experimental setup

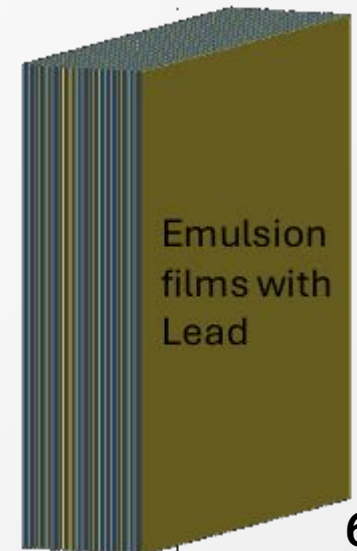
The setup for each run included **two emulsion bricks** placed in a cooler, one oriented horizontally and the other vertically.

Each brick consisted of 30 lead plates (1 mm thick) and 31 emulsion films ($13 \times 10 \text{ cm}^2$).

Bricks were **exposed for two weeks** in two separate runs: once during the T2K neutrino **beam-on** period and once during the **beam-off** period.

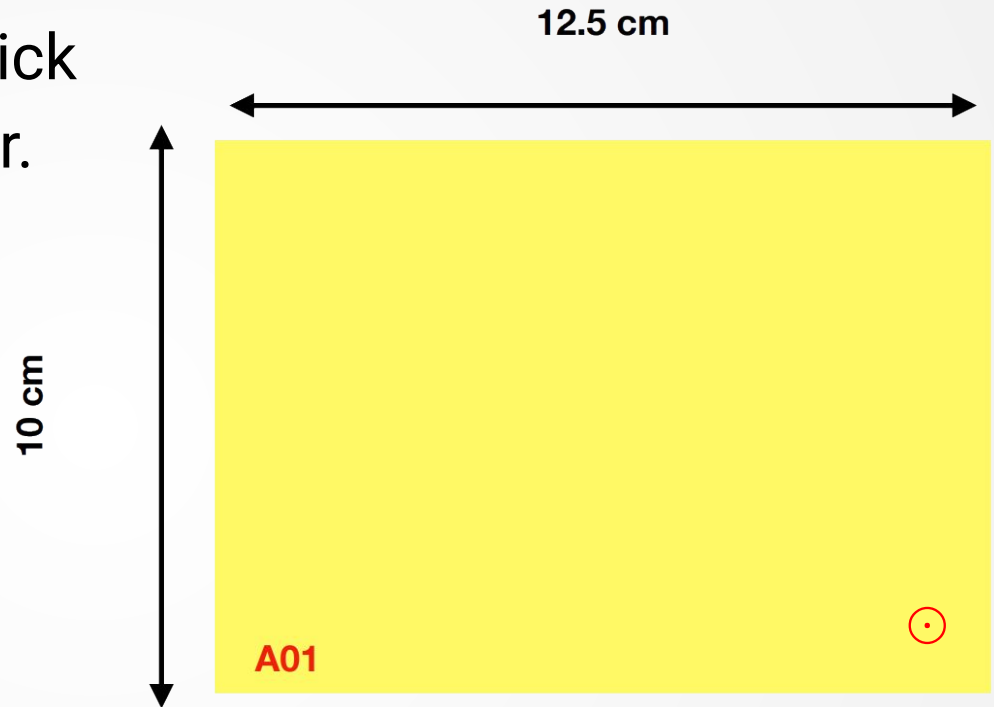


Alternating
lead plates and
emulsion films
form the brick.



3. Experimental setup

Each film had an ID with brick letter and emulsion number.



Run #	Brick ID	Brick orientation	Films in the brick	Exposure [dd/m/yy]	Status
1	A	⊙ beamward	A01 – A031	12-25/3/26 (13 days)	fully scanned
1	B	⊥ skyward	B01 – B31	12-16/3/26 (4 days)	pending scan
2	C	⊙ beamward	C01 – C31	27/3-09/4/26 (13 days)	pending scan
2	D	⊥ skyward	D01 – D31	27-31/3/26 (4 days)	fully scanned

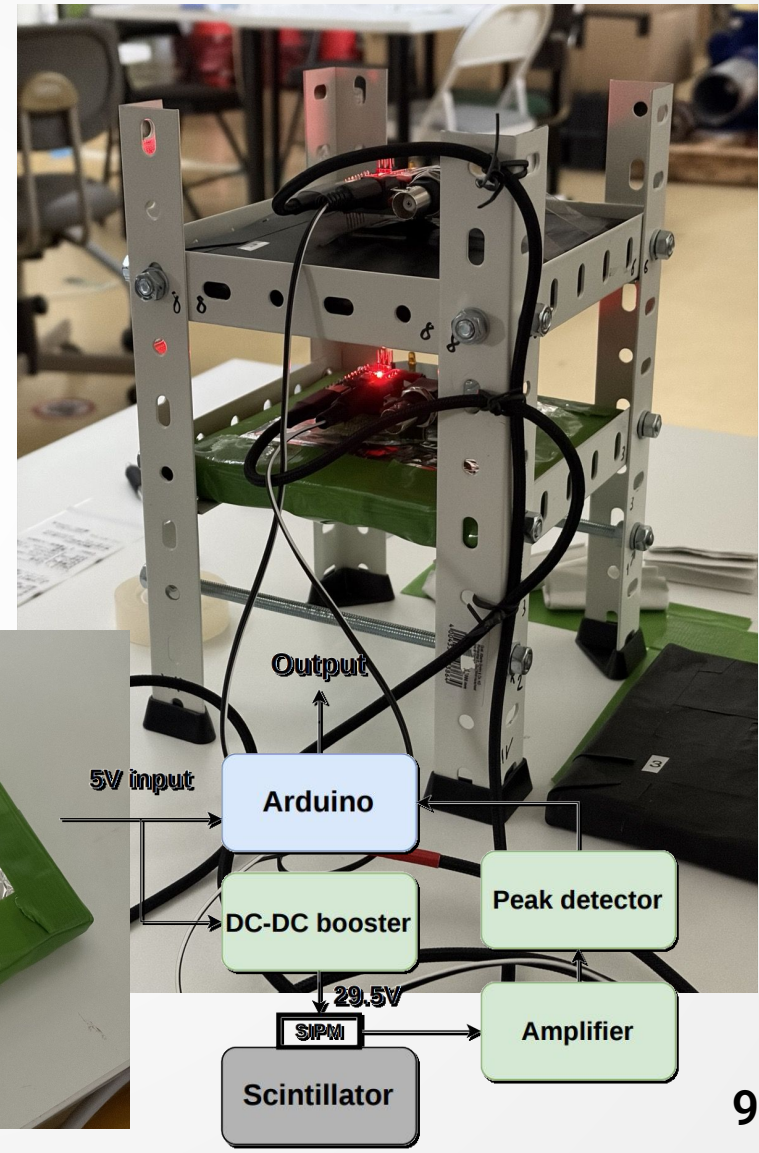
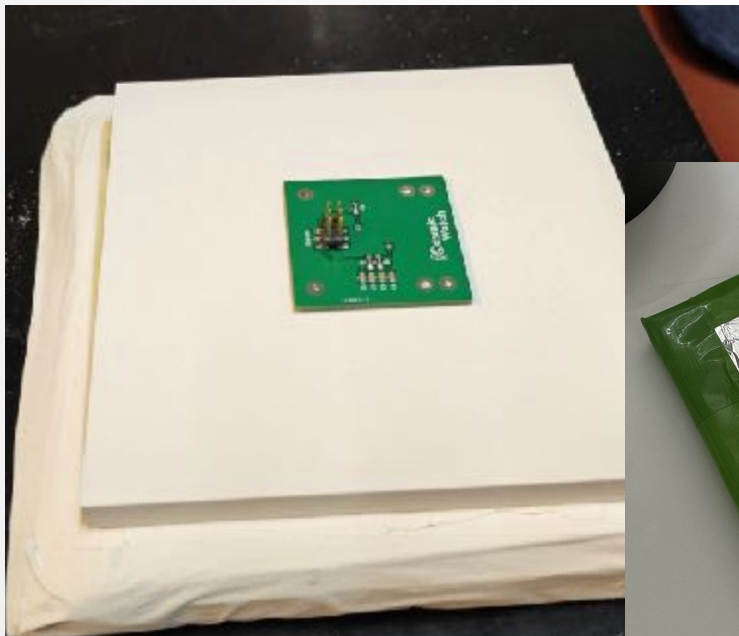
3. Experimental setup

A realized setup inside a J-PARC's Neutrino Assembly building.



3. Experimental setup

A **muon counter** made of 13 x 13 cm² acrylic scintillator plates with SiPM glued onto them was used to cross-check the tracks recorded in the emulsion bricks.



4. Film development

Emulsion films were developed in a dark room by immersing them in a series of chemical solutions:

1. developer (30 min)
2. stopper (10 min)
3. fixer (90 min),

followed by washing under running tap water for at least 60 minutes.



4.1. Drying

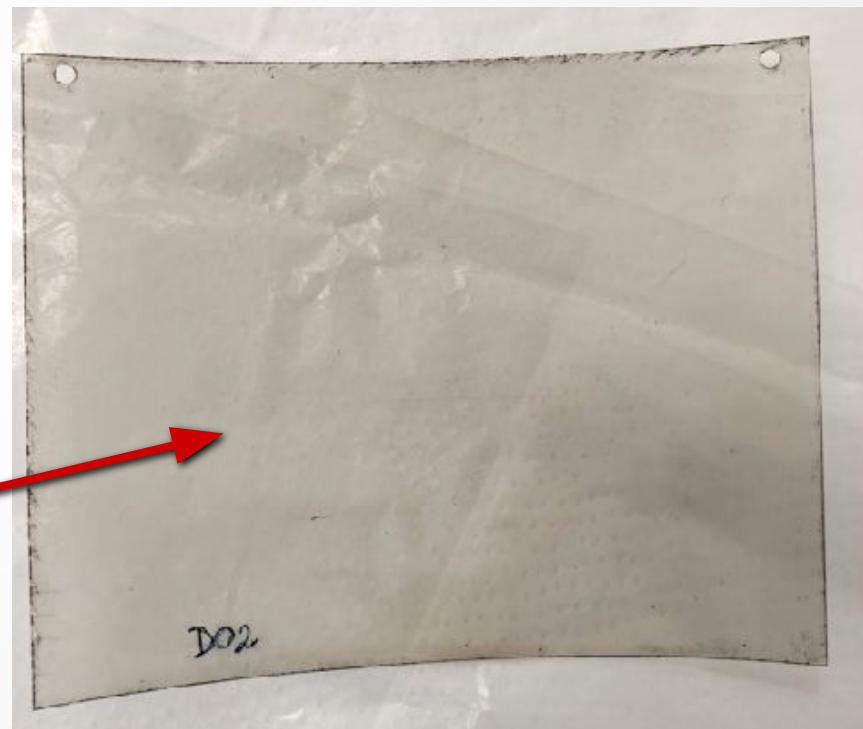
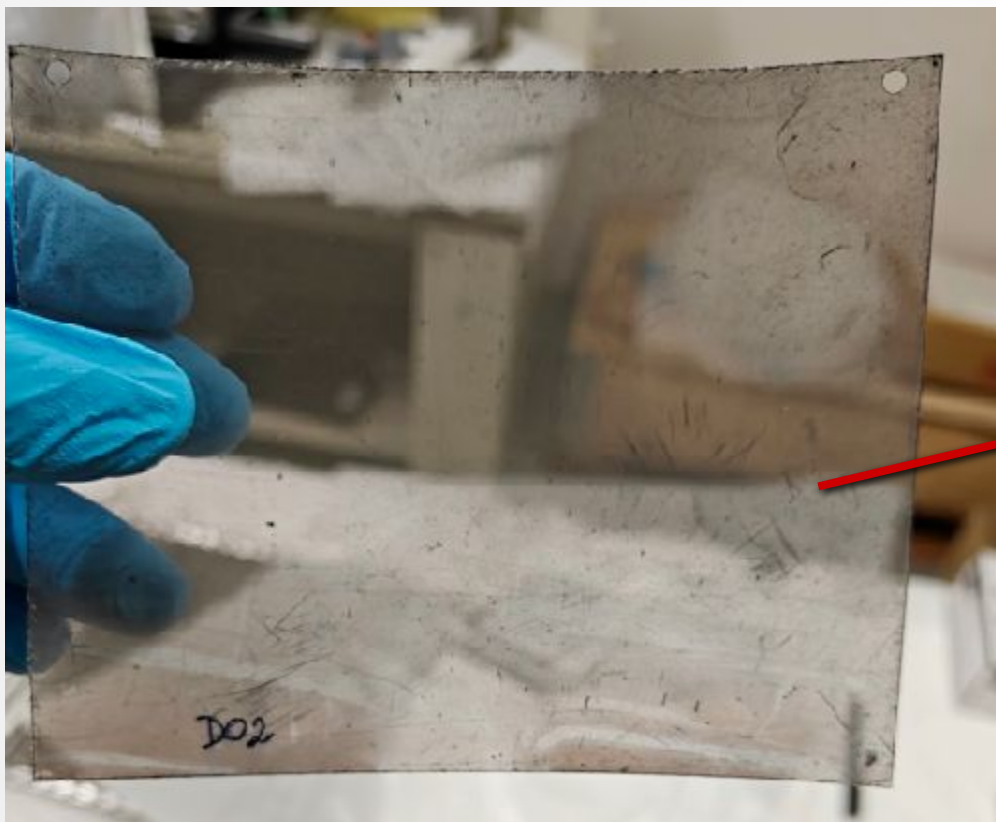
Films from the first brick were dried in the development rack, causing some of them to stick together and sustain mutual damage. Low humidity during drying also led to uneven drying and edge damage.

The remaining films were subsequently hung to dry under appropriate humidity conditions, ensuring uniform drying.



4.2. Silver removal

Worst part.

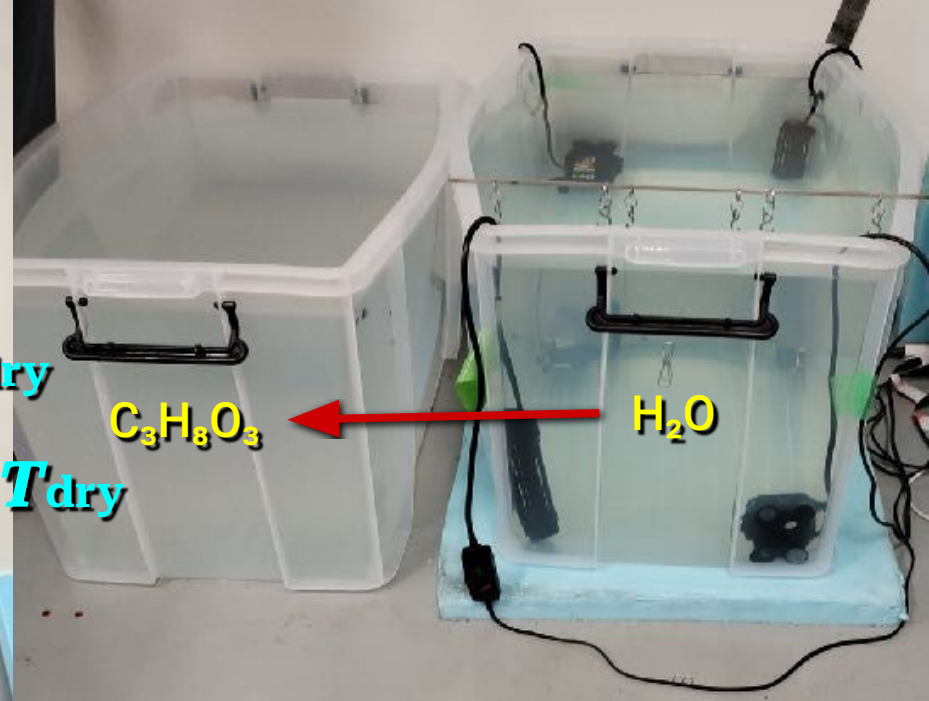


4.3. Swelling

$$T_{\text{aim}} = (T_{\text{gly}} - T_{\text{dry}}) \times 0.3 + T_{\text{dry}}$$

$$\Rightarrow T_{\text{gly}} = (T_{\text{aim}} - T_{\text{dry}}) / 0.3 + T_{\text{dry}}$$

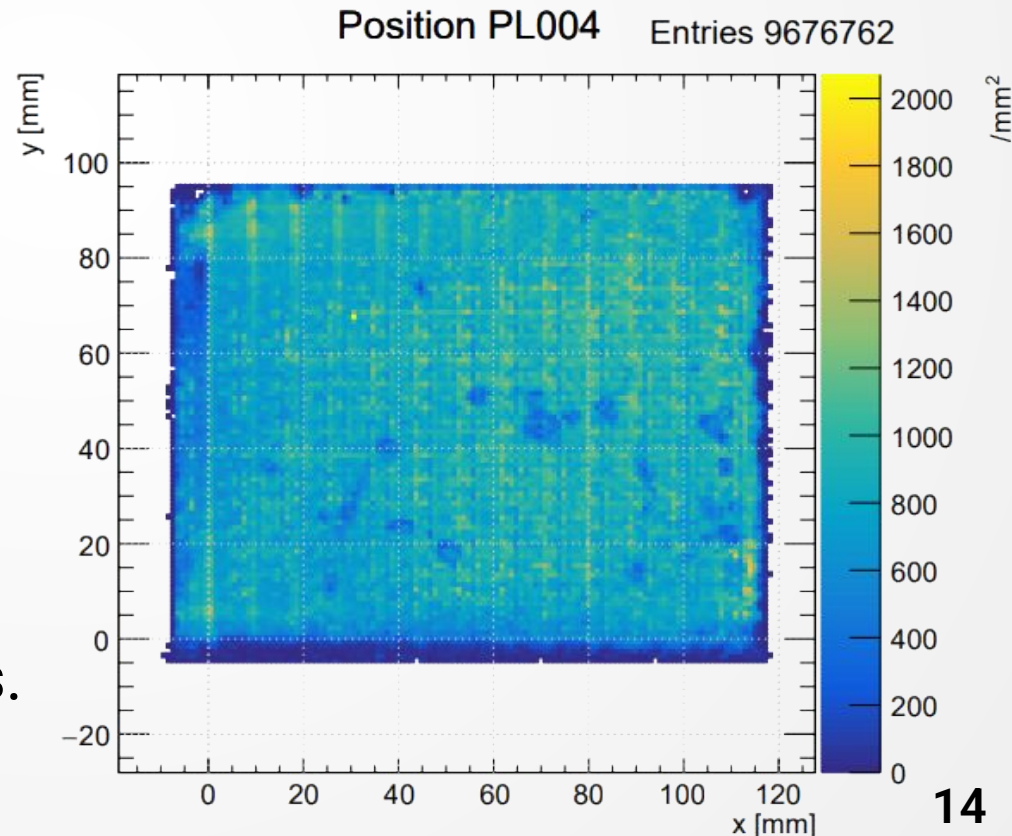
T_{aim} → thickness before development,
 T_{dry} → thickness after silver removal,
 $T_{\text{gly}} - 30$ → target thickness in water prior to glycerol dipping.



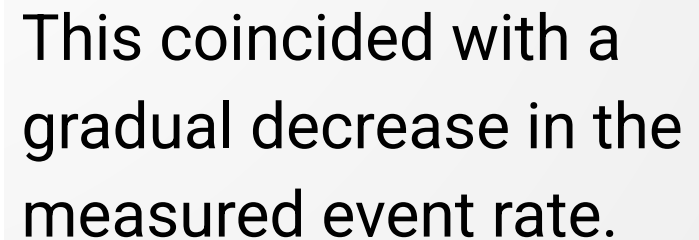
5. Test schedule

The test was originally planned for **Nov–Dec 2025**, but delays in obtaining onsite permissions pushed it to **Mar–Apr 2026**, when data-taking runs were successfully completed.

The current stage of the experiment involves **film scanning** and preliminary **data analysis**. It will be followed by a full analysis, with a focus on **cosmic muons, gamma rays, and beam-induced backgrounds**.



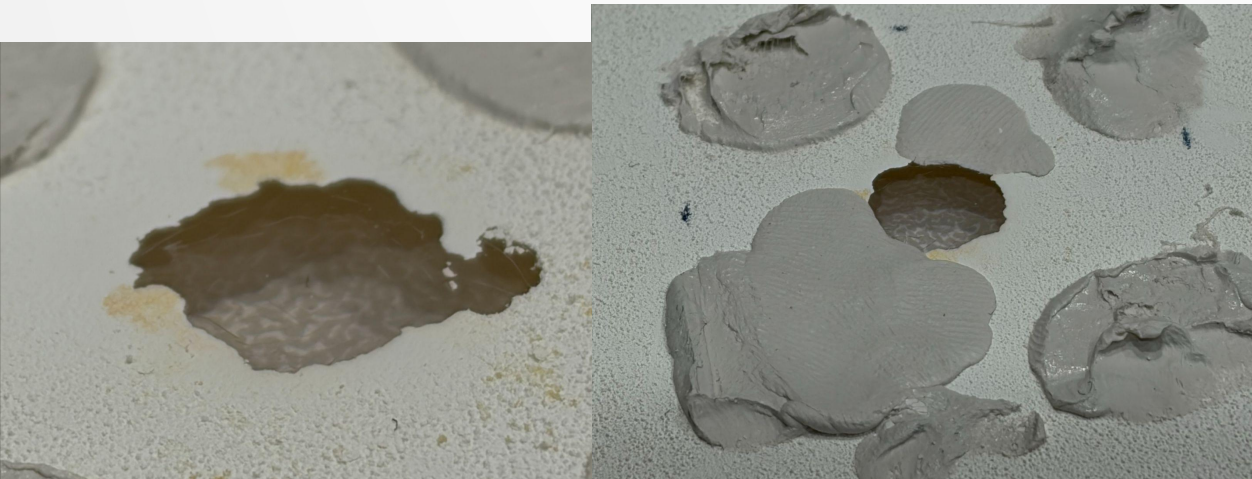
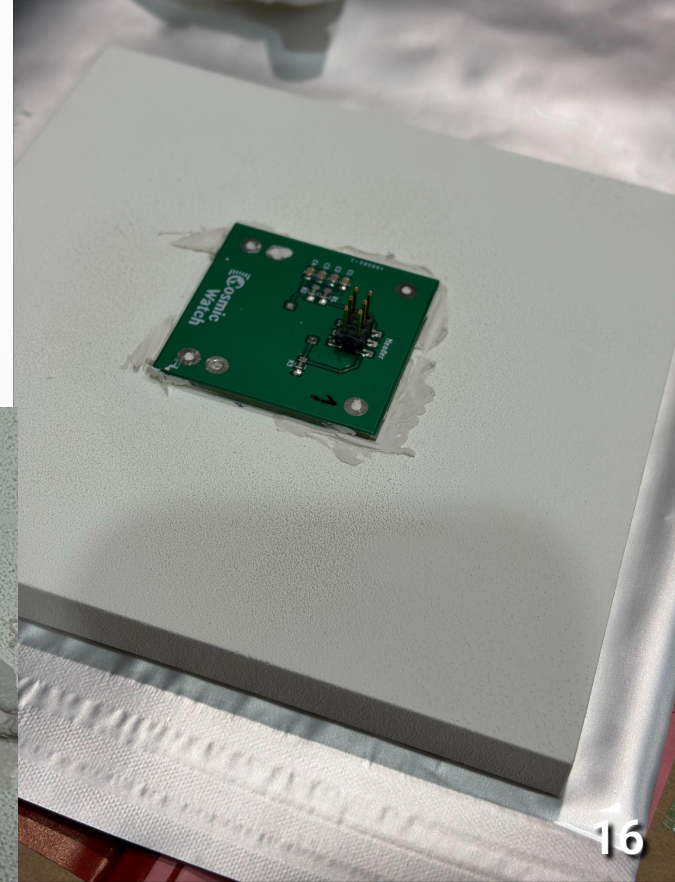
This composite image illustrates the assembly process. The top-left inset shows a close-up of a microchip being inserted into a carrier. The main image shows the carrier, which has a green PCB and a silver heat spreader, being mounted onto a larger PCB. The carrier is secured by four screws. A small square hole is visible in the PCB above the carrier.



Muon counter troubles

With EJ-500 optical cement provided by NINJA's Kyoto group, the SiPM was reattached for the second run.

The scintillator was flipped so the SiPM sat on top, reducing coincidence due to increased separation, which can be corrected via angular acceptance.



6. Summary



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The T114 test experiment successfully completed two emulsion film exposure runs at J-PARC's NA building.

The 62 films from the two exposed bricks have already been scanned, and data analysis is underway.

The muon counter operated near the bricks throughout both runs; although the SiPM detached midway during the first run, it was repaired in time for the second.

T114 provides a potential stepping stone toward ESSnuSB cross-section measurements at J-PARC, while also serving as a precursor to the viking detector.

