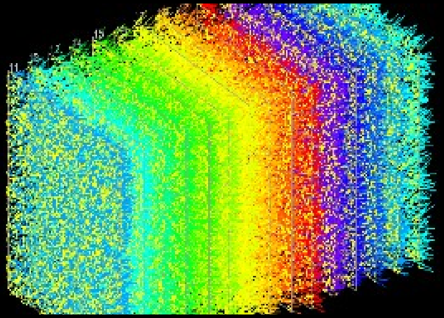
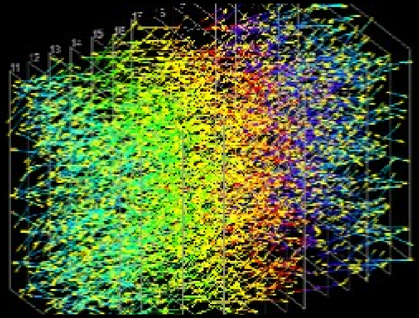
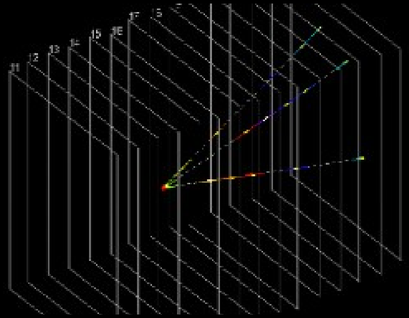
Probing the unseen

Prospects for sterile neutrino searches using the NINJA detector



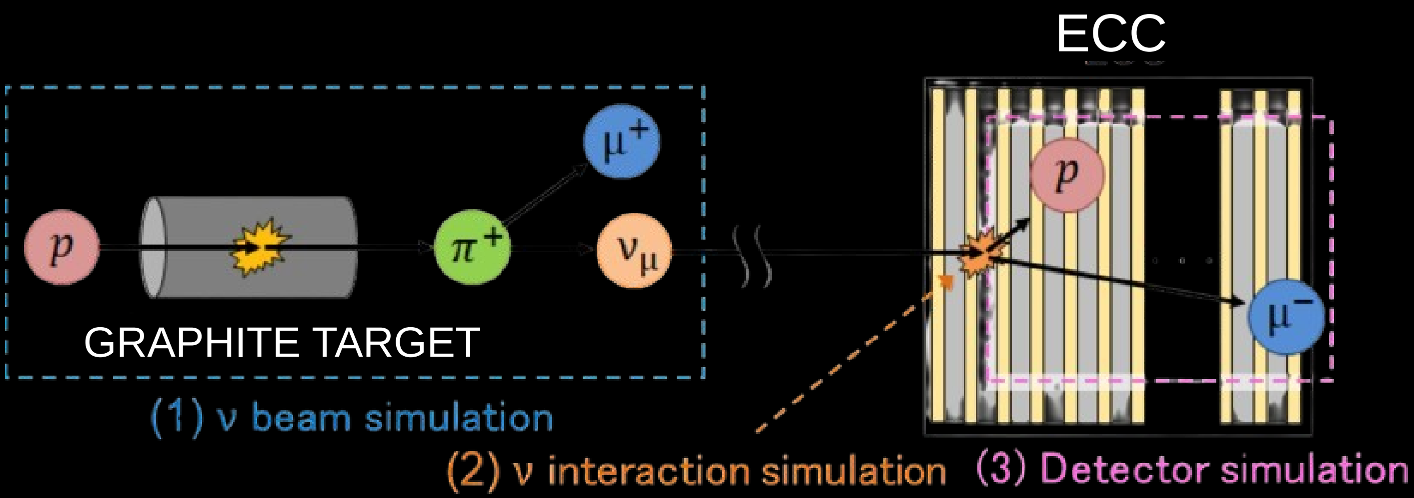


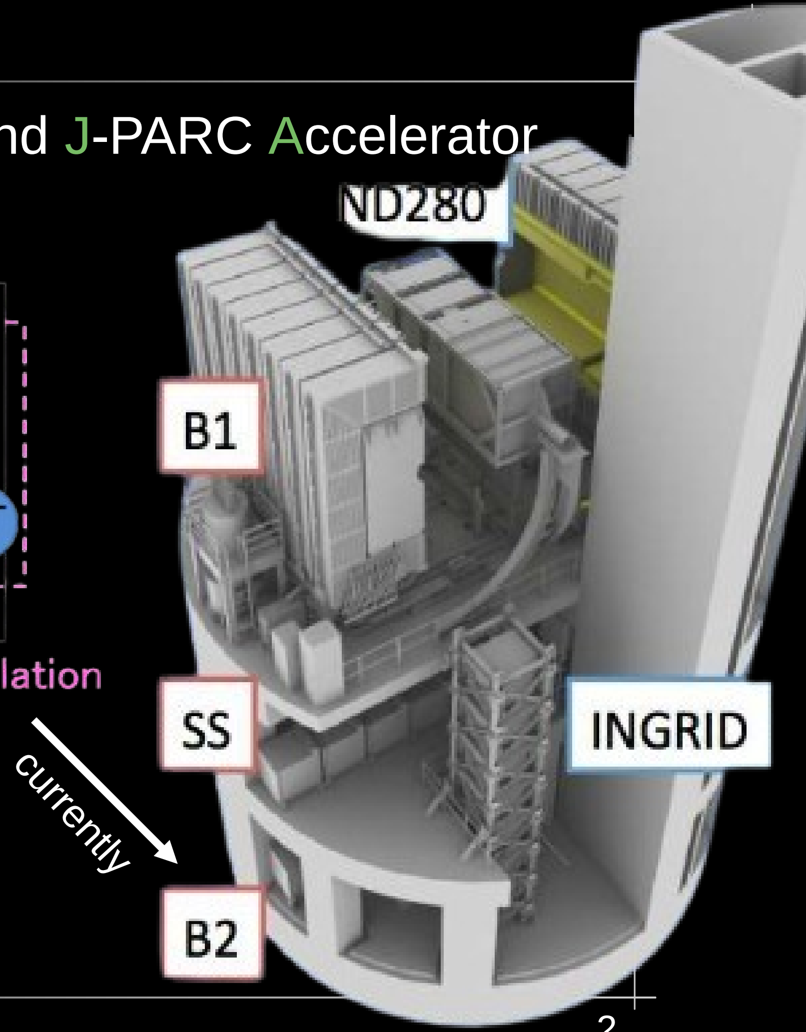


Doris Barčot, Ruđer Bošković Institute, Croatia
on behalf of the **NINJA** colaboration

Not the stealthy kind of NINJA… but a precision emulsion detector at J-PARC

Neutrino Interaction research with Nuclear emulsion and J-PARC Accelerator





Precision measurements of neutrino interactions using nuclear emulsion detectors to provide crucial inputs for long-baseline neutrino oscillation experiments (T2K, HK, ESSνSB)

13 Institutes, ~50 researchers

Can we probe 3+1 sterile neutrino using a high-resolution emulsion detector at 280 m?

- **Light sterile neutrino**: explain anomalies (LSND, MiniBooNE → Δm^2_{41} ~1eV^2)

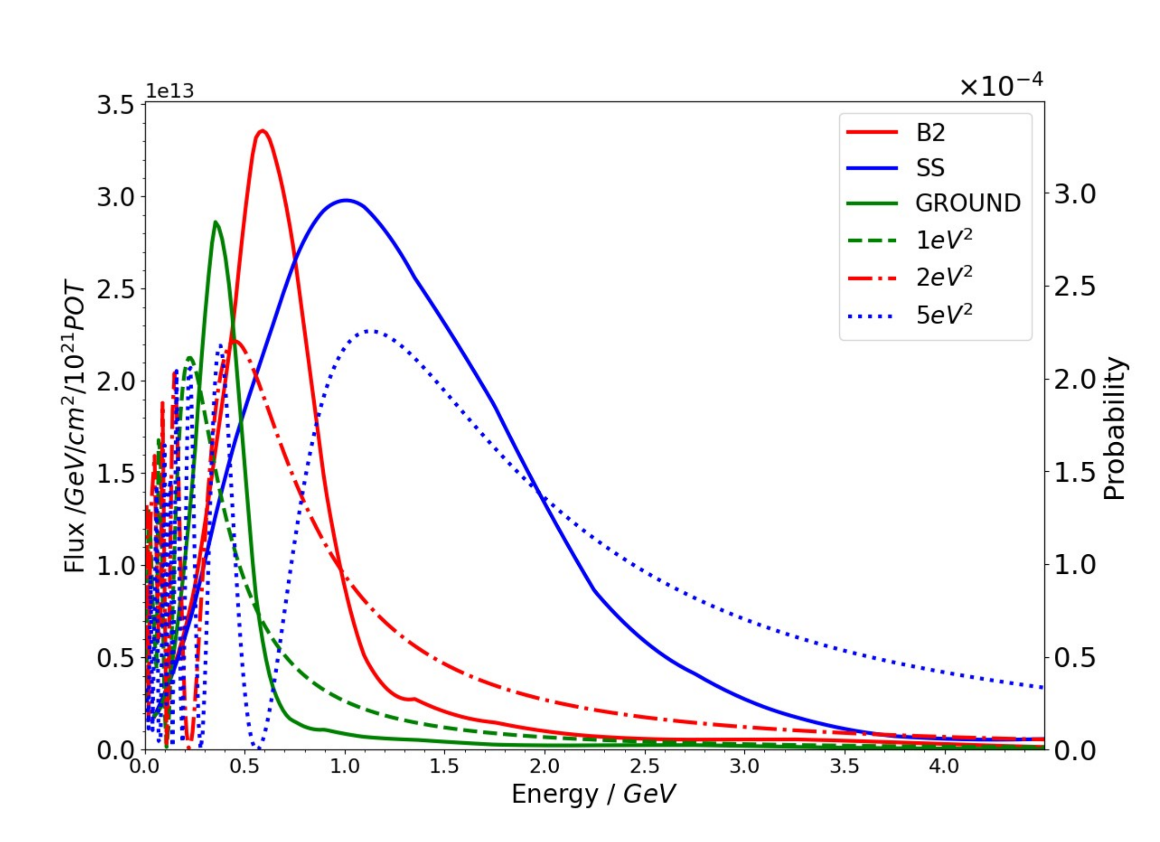


Fig. 1: Probability (right), presented with dashed lines, and flux (left), presented with solid lines, relevant for NINJA.

L= 280 m

10^{21} POT/year

$$P_{\mu e} = \sin^2 2\theta_{\mu e} \sin^2\left(\frac{\Delta m^2_{41} L}{4E_\nu}\right)$$

Can we probe 3+1 sterile neutrino using a high-resolution emulsion detector at 280 m?

This study: Sensitivity to 3+1 oscillations in future NINJA runs w/ Pb target (10 ty).

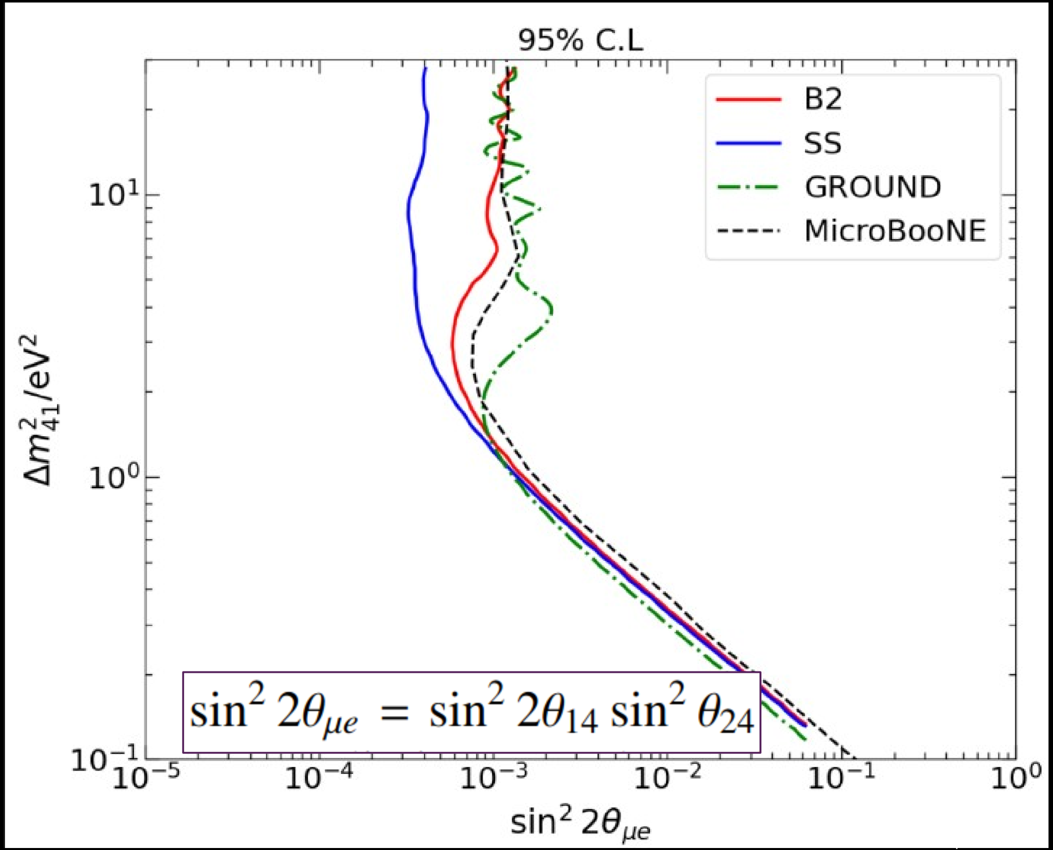


Fig. 3: Bounds on sterile parameters for three detector locations with 10 ty exposure.

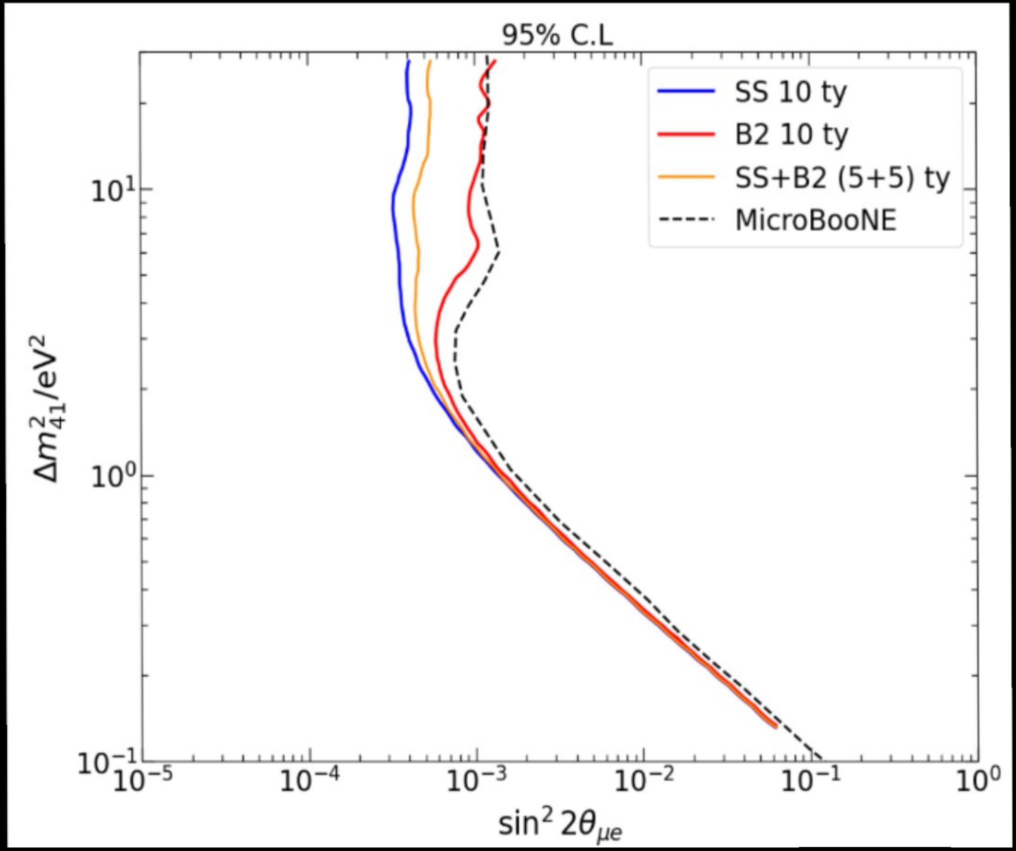


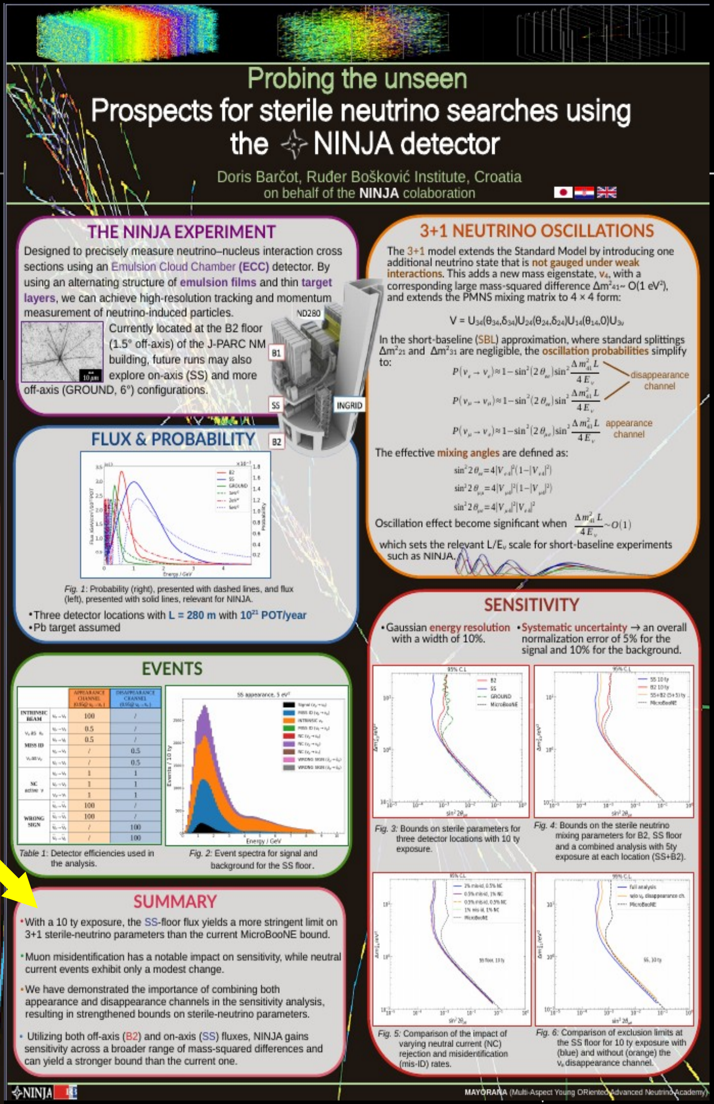
Fig. 4: Bounds on the sterile neutrino mixing parameters for B2, SS floor and a combined analysis with 5ty exposure at each location.

What can we conclude from this?

...that you should come and see my poster to conclude this:

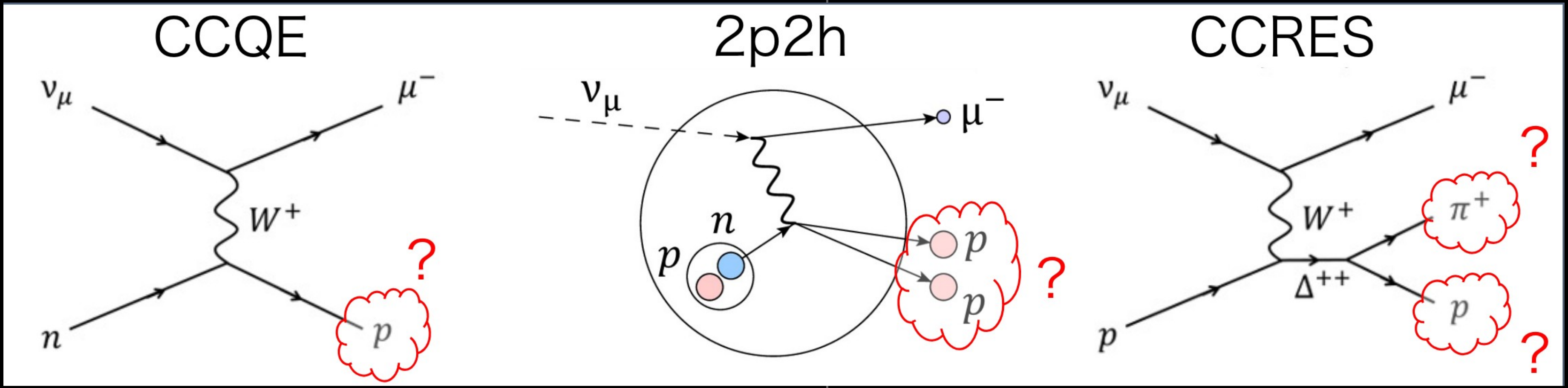
SUMMARY

- With a 10 ty exposure, the SS-floor flux yields a more stringent limit on 3+1 sterile-neutrino parameters than the current MicroBooNE bound.
- Muon misidentification has a notable impact on sensitivity, while neutral current events exhibit only a modest change.
- We have demonstrated the importance of combining both appearance and disappearance channels in the sensitivity analysis, resulting in strengthened bounds on sterile-neutrino parameters.
- Utilizing both off-axis (B2) and on-axis (SS) fluxes, NINJA gains sensitivity across a broader range of mass-squared differences and can yield a stronger bound than the current one.



Back up

- Neutrino interaction uncertainty due to nuclear effects (e.g. nucleon-nucleon correlation and FSI)



- It is hard to separate each interaction mode because the FSIs generate or hide particles.
  → Therefore, it is important to measure low-momentum protons and pions to understand neutrino– nucleus interactions, including nuclear effects.

Back up

A) 2kg iron target run @ SS (2015, $\bar{\nu}$: 1.38×10^{20} POT)

B-1) 65kg iron target run @ SS (2016, ν : 0.4×10^{20} POT, $\bar{\nu}$: 3.5×10^{20} POT)

B-2) 3kg water target run @ SS (2017-2018, $\bar{\nu}$: 7.0×10^{20} POT)

B-3) 9kg heavy water target run @ B2 (2021, ν : 1.8×10^{20} POT)

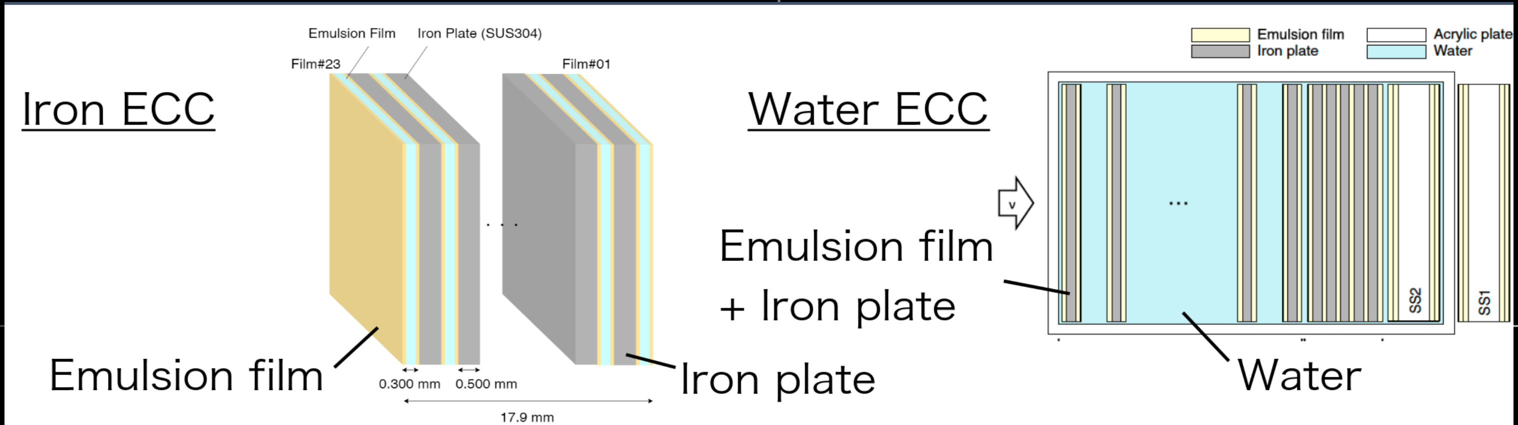
C) Physics run E71-a @ B2 (2019-2020, ν : 4.8×10^{20} POT)

(75kg H2O, 130kg Fe, and 15kg CH targets)

Physics run E71-b @ B2 (2023-2024, ν : 3.12x10^{20} POT)

(75kg H2O)

NEXT RUN: autumn of 2025 to the spring of 2026 (130 kg H2O)



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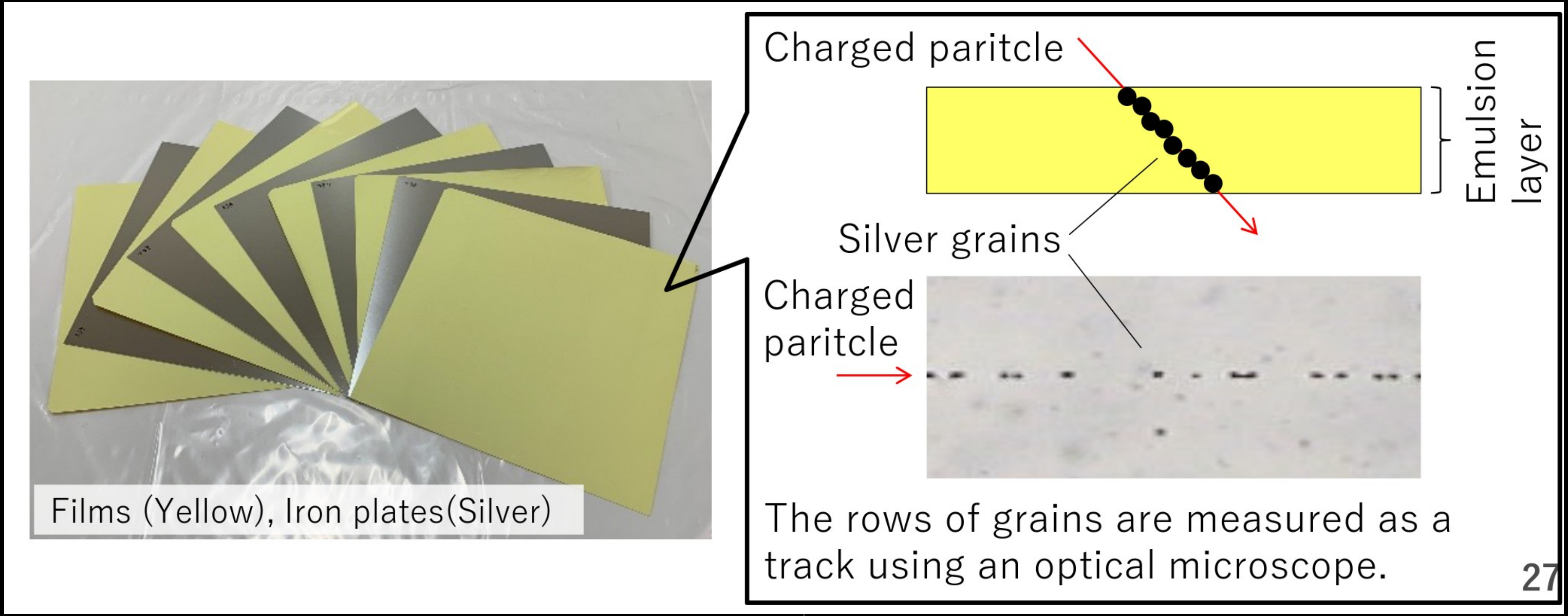

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ICRR, the University of Tokyo

Back up

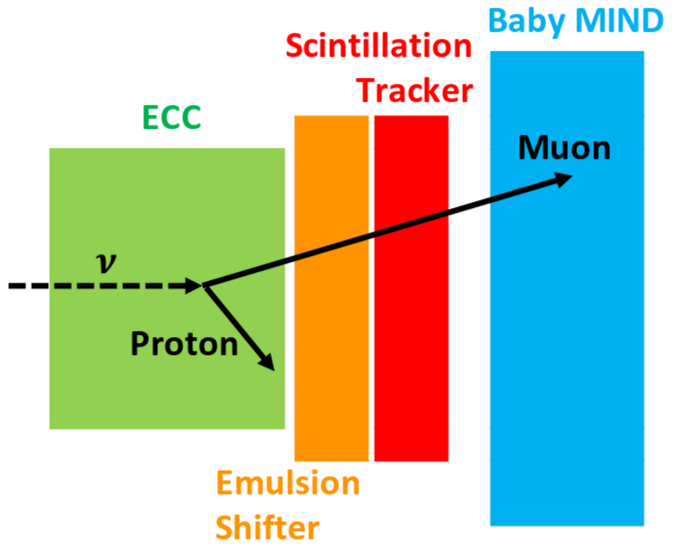

Figure 1: The setup of the detectors

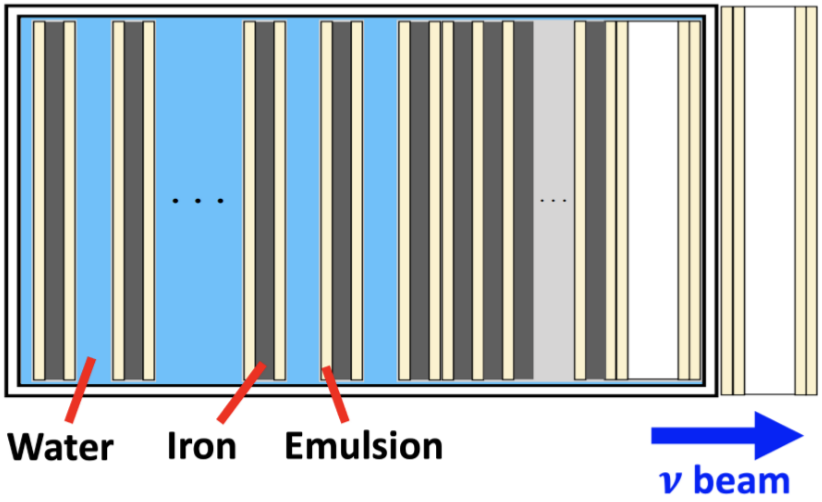

Figure 2: The structure of the ECC