Status and prospects of NINJA experiment

Hiiragi Inamoto
Nagoya-Univ
and NINJA collaboration

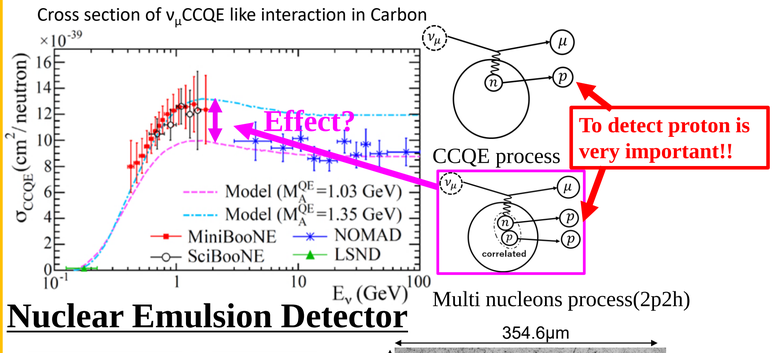
NINJA experiment

Neutrino **I**nteraction research with **N**uclear emulsion and **J**-PARC **A**ccelerator

- Precise neutrino-nucleus interaction measurement from Sub GeV to Multi GeV region is essential to reduce the systematic uncertainty in future neutrino oscillation experiments.

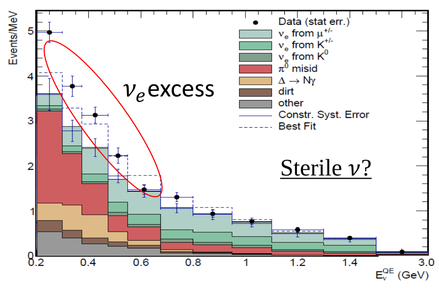
①To understand of neutrino nucleus interactions in this energy region.

Cross section of ν_μCCQE like interaction in Carbon

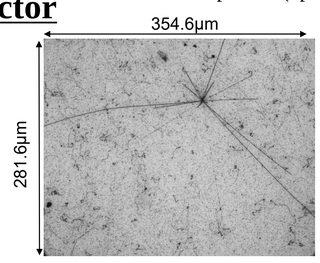


To detect proton is very important!!

② $\nu_e$excess in short baseline neutrino experiment.



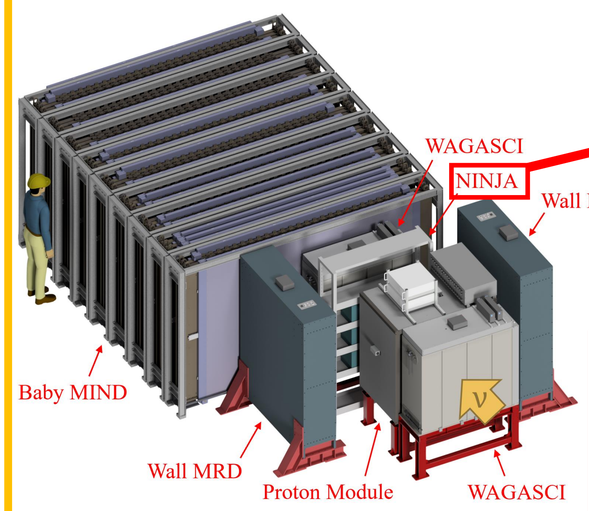
Nuclear Emulsion Detector

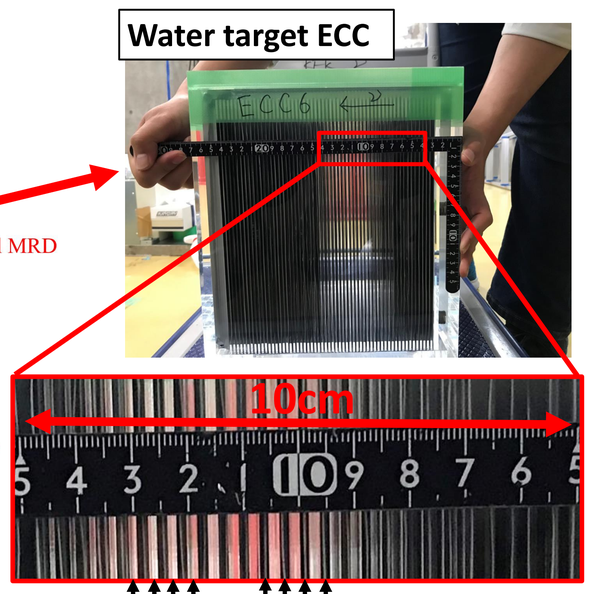


- High position resolution(sub micron)
- We can use various target material(H_2O,Fe, D_2O,etc…)
- Low energy threshold
  →slow proton detectable(>200MeV/c)
- Detectable $\pi^0 \rightarrow 2\gamma$
  →low background for ν_eCC interaction

Physics Run (E71)

Detector





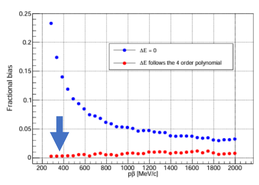
Water target ECC

Target mass:H_2O 75kg, Fe 130kg
CH 15kg, emulsion 30kg

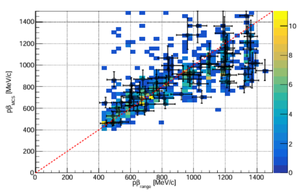
Thin target & sensitive layer
➔can detect short track(p mom>200MeV/c)

Analysis of Physics Run a (E71a)

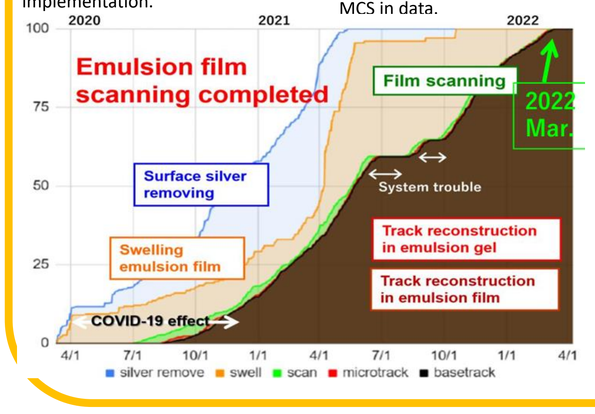
Momentum reconstruction



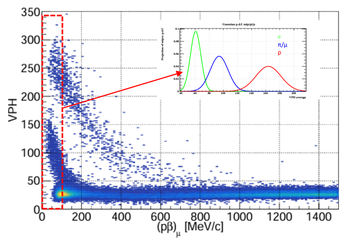
Fractional bias of the relativeresi dualdistribution of 1/pβ as a function of the momentum with and without the energy deposit implementation.



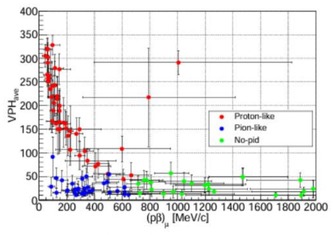
Two-dimensional correlation between the momenta reconstructed using the BabyMIND track range and ECC MCS in data.



Particle identification

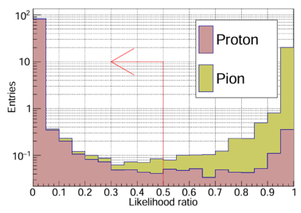


Two-dimensional distribution of VPH and $(p\beta)_\mu$of all the accumulated tracks in the ECC

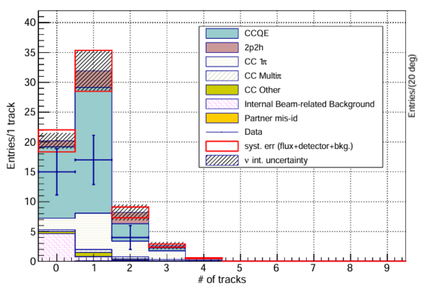


Result of PID for hadron

Proton selection efficiency::99%~
Proton purity:99%~

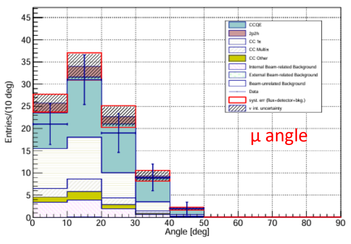


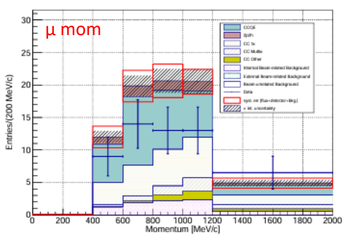
π/p likelihood ratio in MC

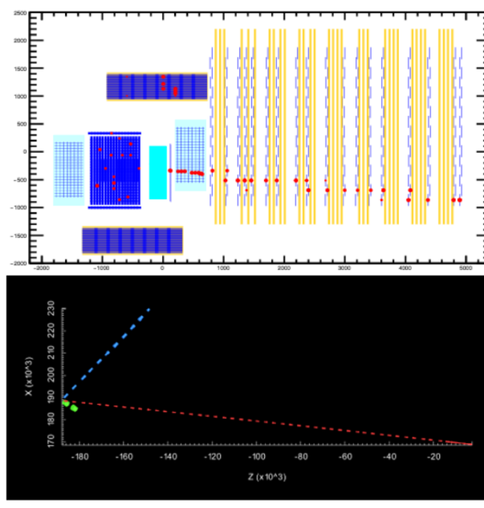


Multiplicity of protons for CC0π

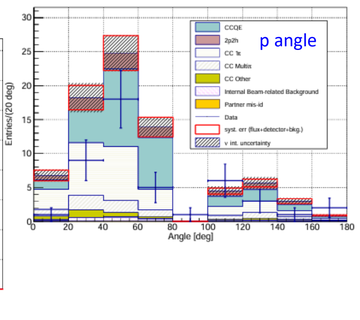
Result of one ECC

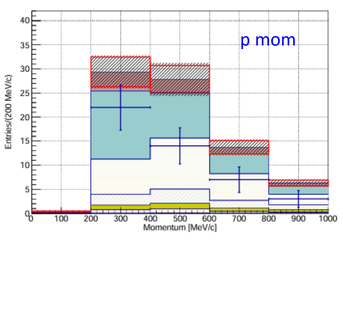






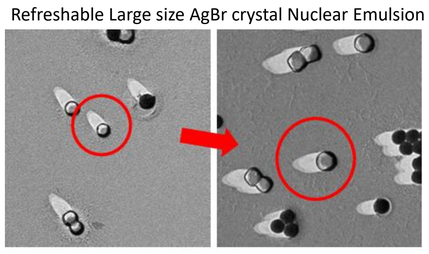
Example of the event display of a CC0π2p event

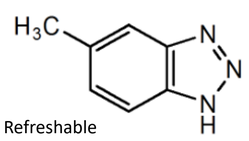




Status of Physics Run b (E71b)

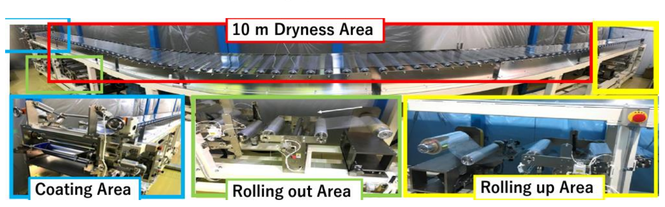
Refreshable Large size AgBr crystal Nuclear Emulsion

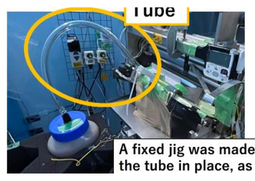




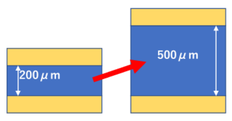
Refreshable
→erasing accumulated noise track before beam exposure

Automatic emulsion pouring system



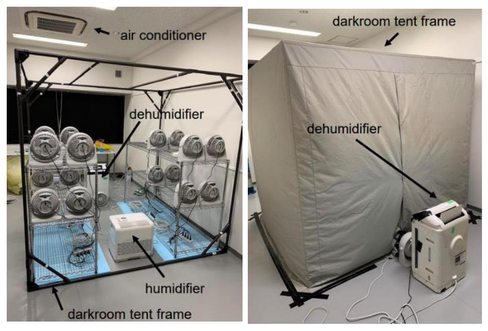


Introducing Automatic Pumping to Automating Coating System

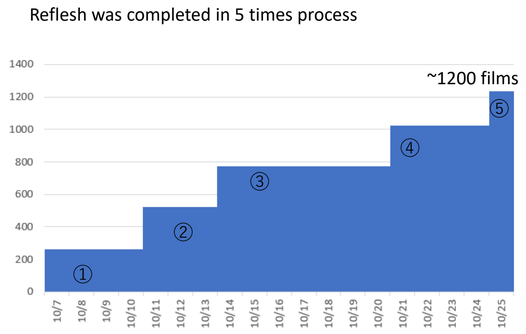


Thicker base Emulsion Film for shifter to improve Angle resolution

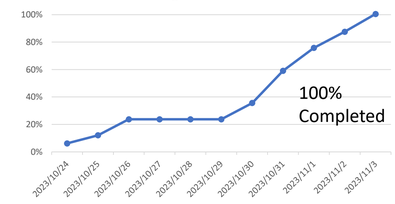
Massive film refresh in October

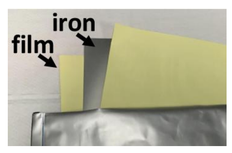


Refresh status
Reflesh was completed in 5 times process



Packing water ECC status

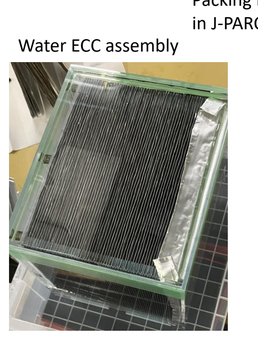


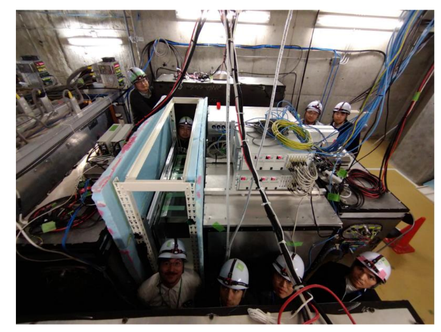


Packing film

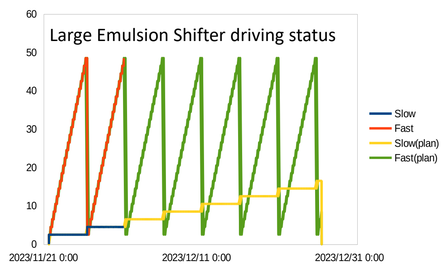
Packing machine in J-PARC dark room

Water ECC assembly





Installed NINJA detector



Beam exposure started on November 21st

Future Physics Run

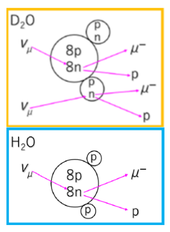
- Continue to accumulate water-neutrino interactions on the B2 floor and proceed with high-statistics muon-neutrino analysis.
- Change the target material to iron or lead and perform electron neutrino interaction cross-section measurements and sterile neutrino search at higher statistics on the B2 floor
- ECCs for water and heavy water (D_2O) target will be placed in front of INGRID on the SS floor to measure neutrino-nucleon interaction cross-sections and sand-muon momentum.
  →D_2O ECC was produced in RUN9(T81) test experiment. We are developing a method to study ν-nucleon interactions by analyzing the subtraction between a heavy water events.
- Install a large number of ECCs on the ground to measure lower energy (200-400 MeV) neutrino interaction cross-sections. (need to be developed low energy muon identification technique)

High precision ν-water interctions

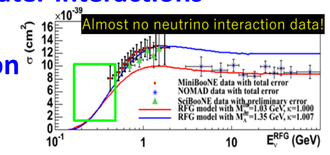
ν_e interactions and sterile ν search

ν-nucleon interaction

Conceptual principle:
(ν -D_2O) – (ν –H_2O) → (ν –n)



Lower energy ν-water interactions Requested from ESSνSB Collablation



Conclusion

・The NINJA experiment is a precise measurement experiment of neutrino nuclear interaction and aims to extract hadron information using nuclear emulsion film.
・Precise measurement of neutrino-water interactions is important for future neutrino oscillation analysis (especially, CC2p2h and ν_eCC)
・Physical run a is being analyzed. all scans have been completed, and the remaining ECCs are being analyzed.
・Physical run b has been installed and start to be exposured neutrino beam.
・Future run is planed and discussed. New detectors are also being tested