Measurement of charged-current interactions on water using a nuclear emulsion detector in the NINJA experiment

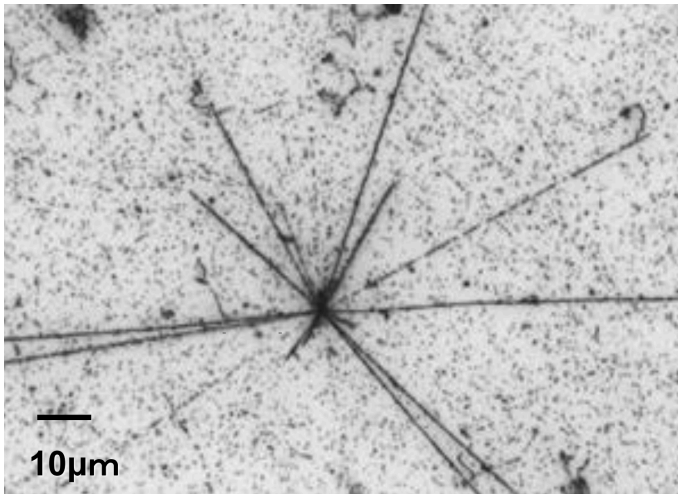
Ayami Hiramoto, Yosuke Suzuki
and the NINJA Collaboration

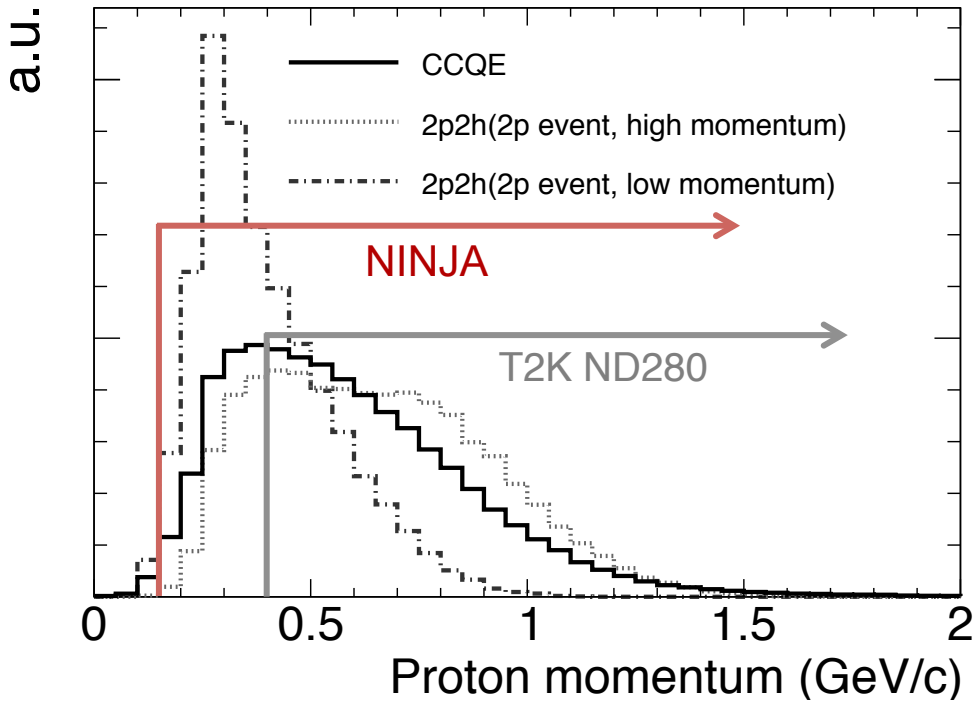
NINJA experiment

- NINJA: Neutrino Interaction research with Nuclear emulsion and J-PARC Accelerator
- Low momentum hadrons can be detected by nuclear emulsion

  => A powerful way to probe nuclear effects

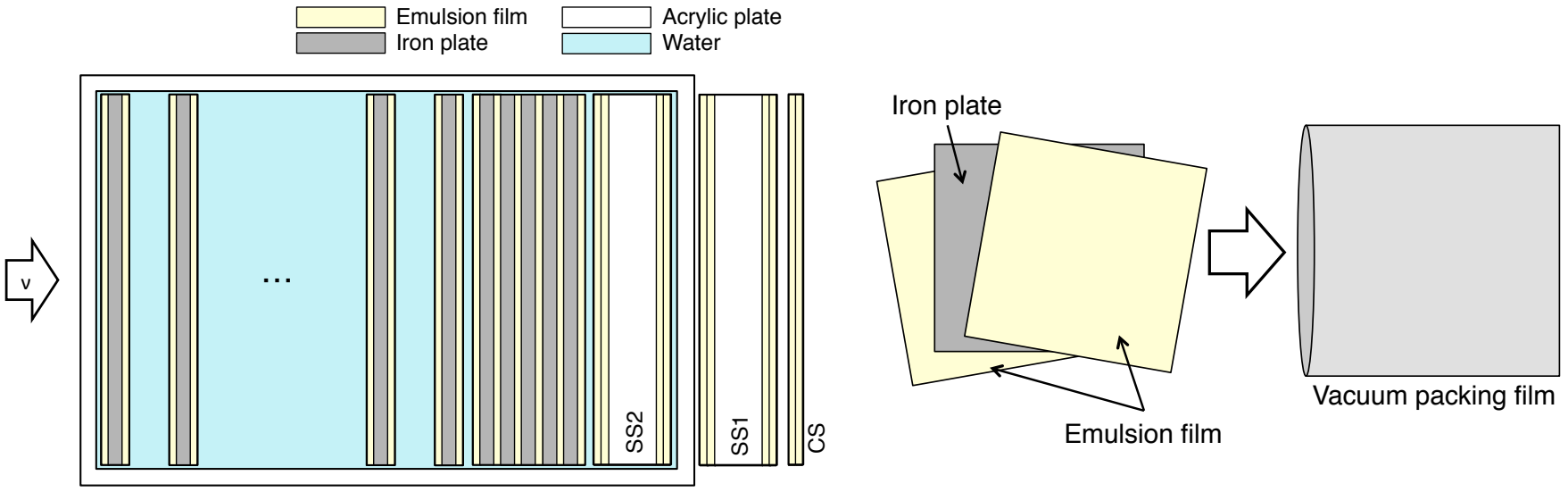
Nuclear emulsion





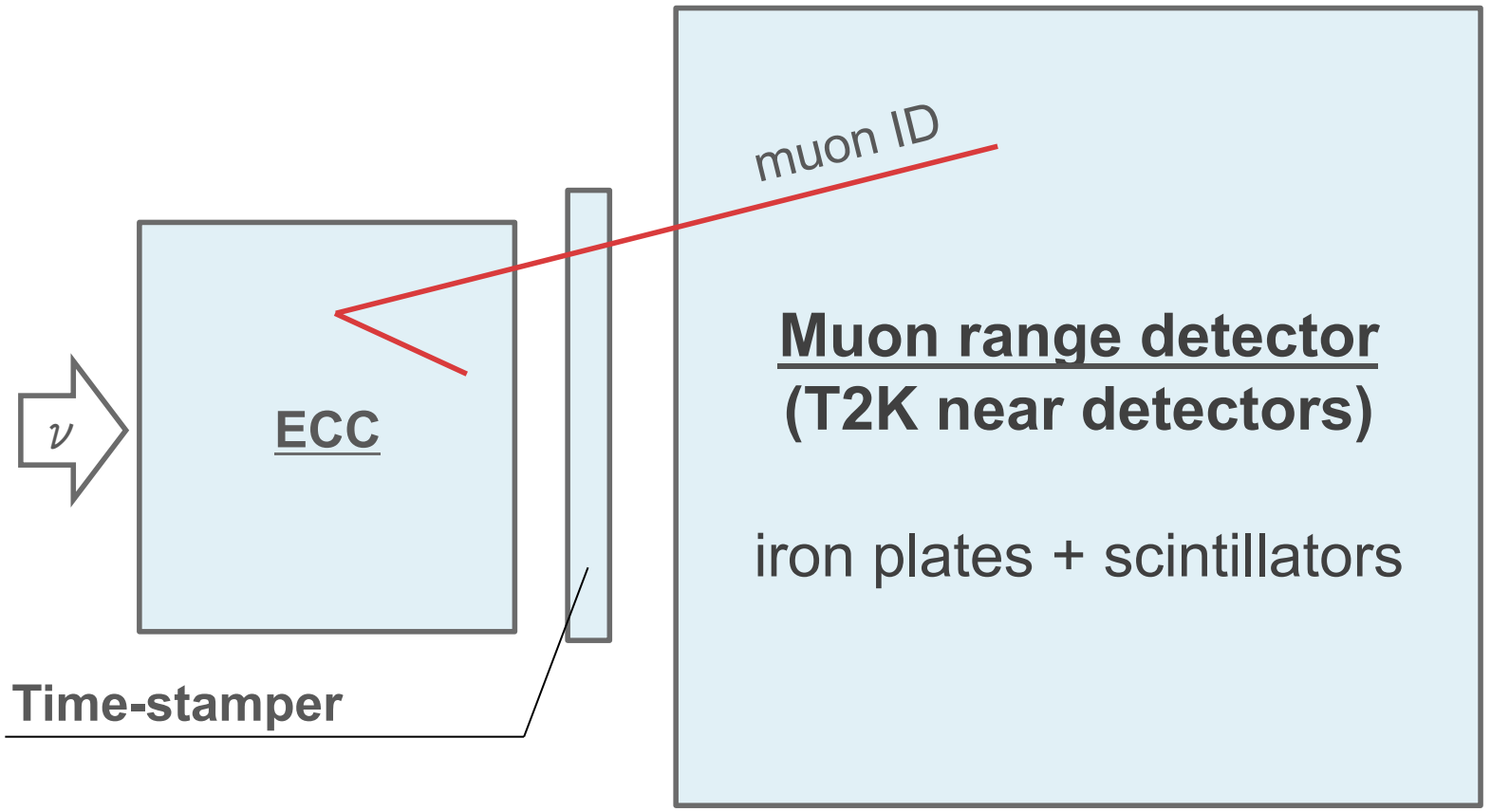
Nuclear emulsion detector

- ECC (Emulsion Cloud Chamber):
  Alternating layers of emulsion films and targets (e.g. 2mm water)
  => Low momentum threshold
- Momentum measurement by multiple Coulomb scattering / range



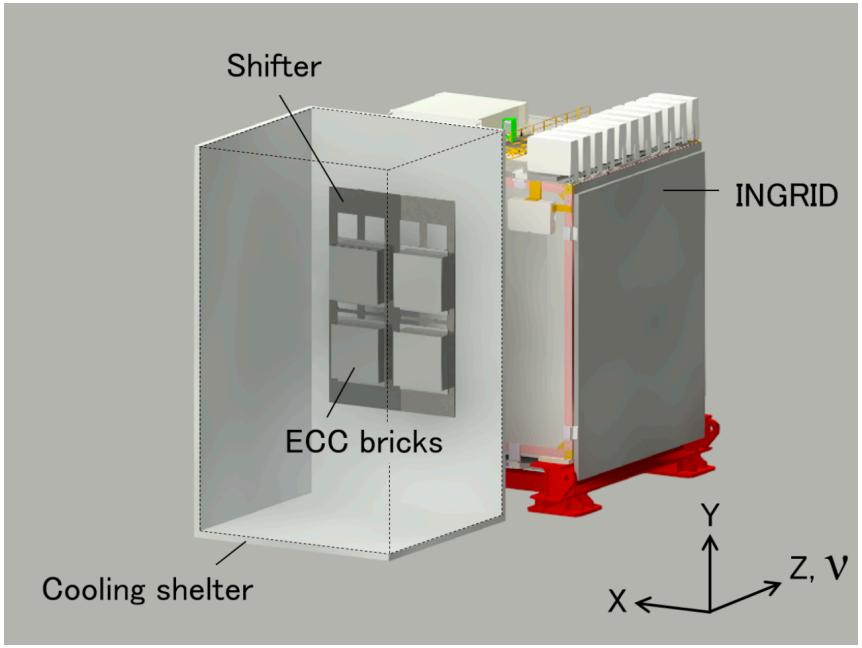
Pilot runs

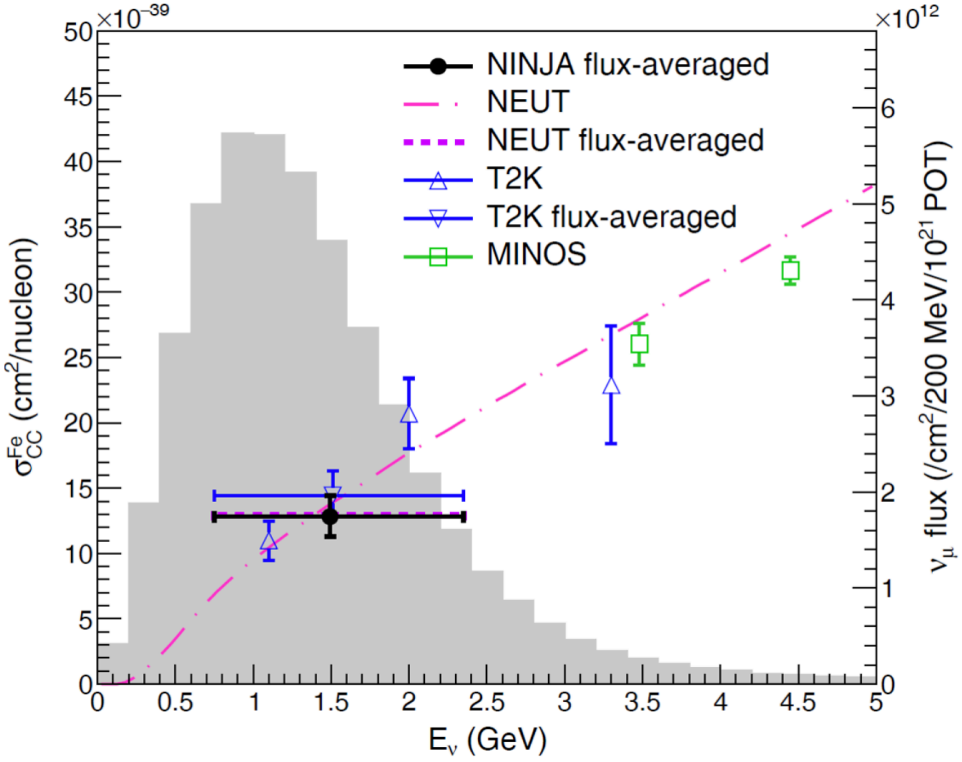
- Iron target run: 60-kg iron target ECC (2016) accepted by PTEP
- Water target run: 3-kg water target ECC (2017-2018) PRD 102, 072006 (2020)



Iron target result

- 60-kg iron target, neutrino mode
- Flux-averaged charged-current inclusive cross section
- Kinematics results paper is in preparation

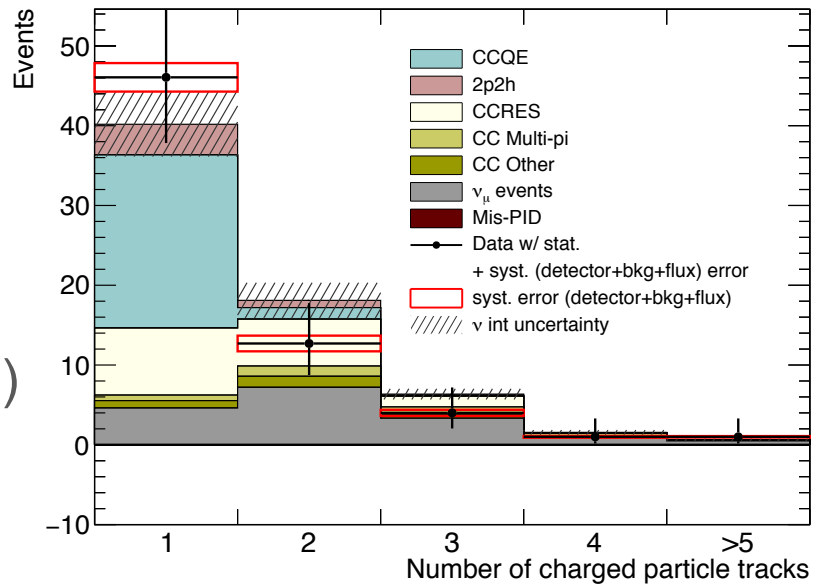




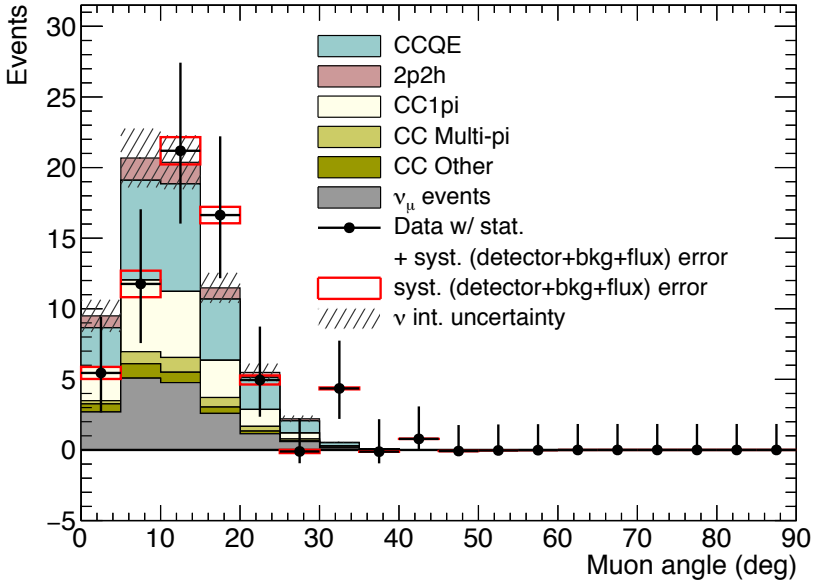
Water target results

- 3-kg water target
- Antineutrino mode
- Backgrounds (mainly cosmic rays) are subtracted

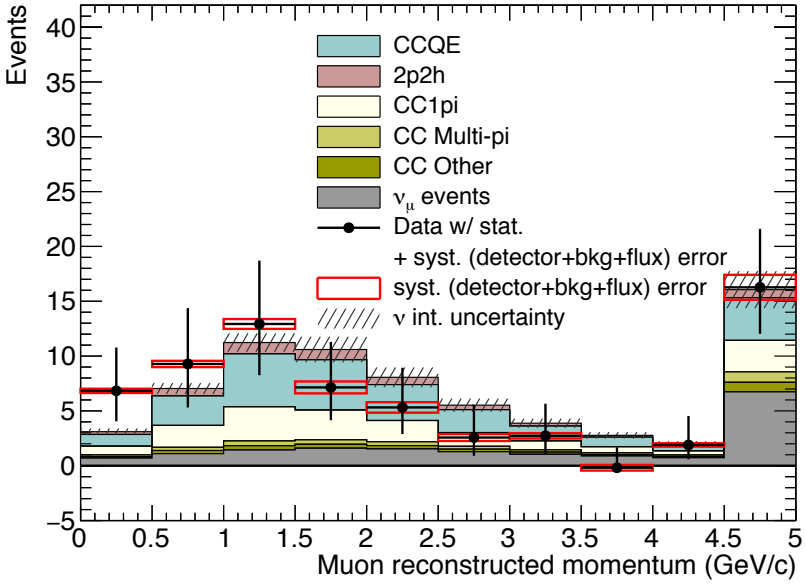
Track multiplicity



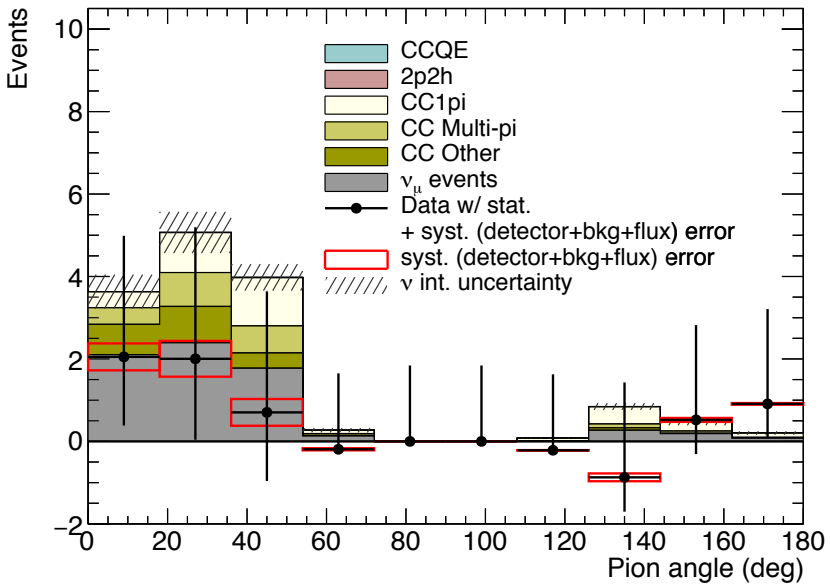
Muon angle



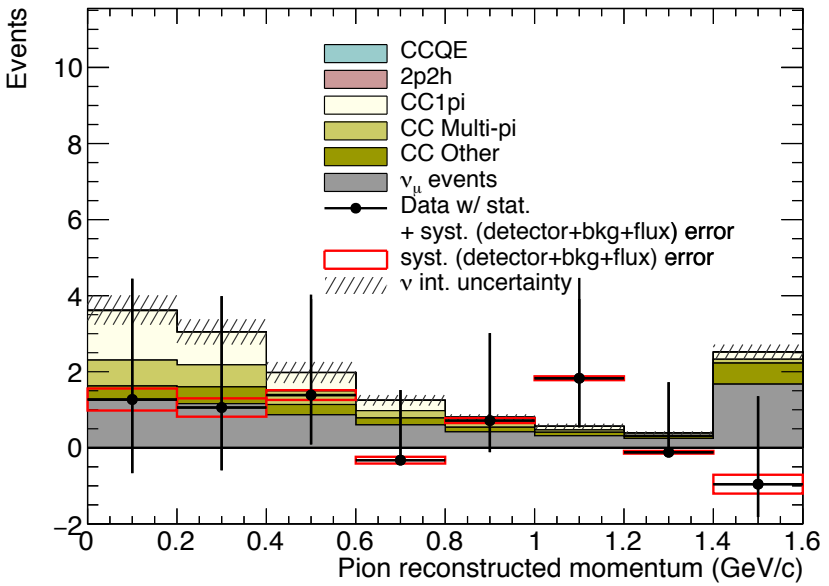
Muon momentum



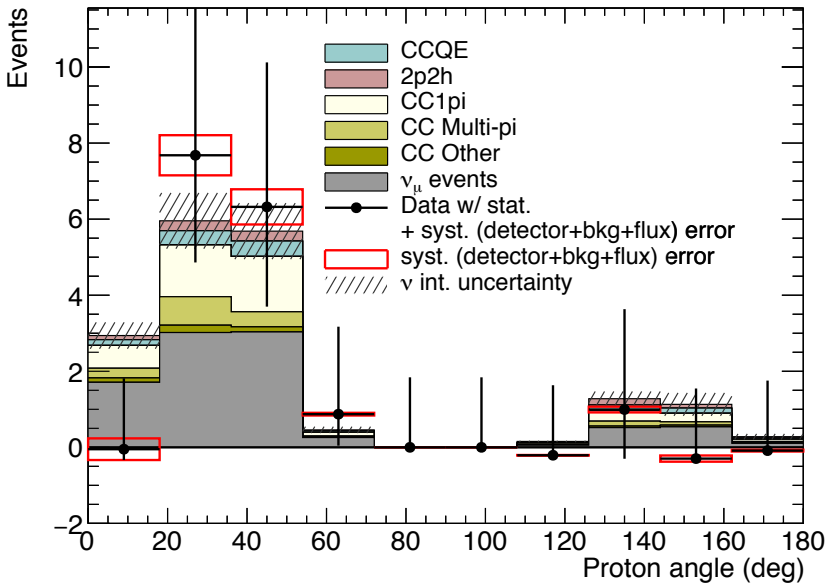
Charged pion angle



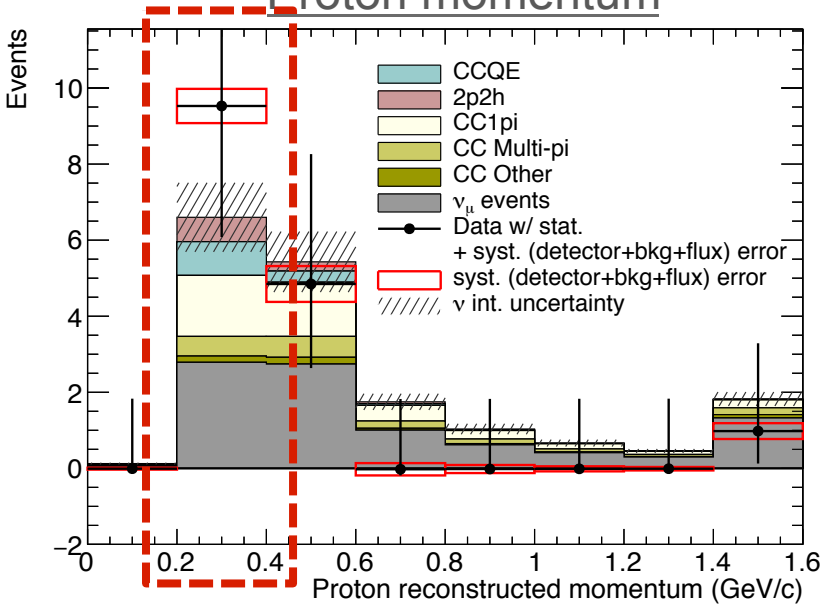
Charged pion momentum



Proton angle



Proton momentum



Physics run & other activities

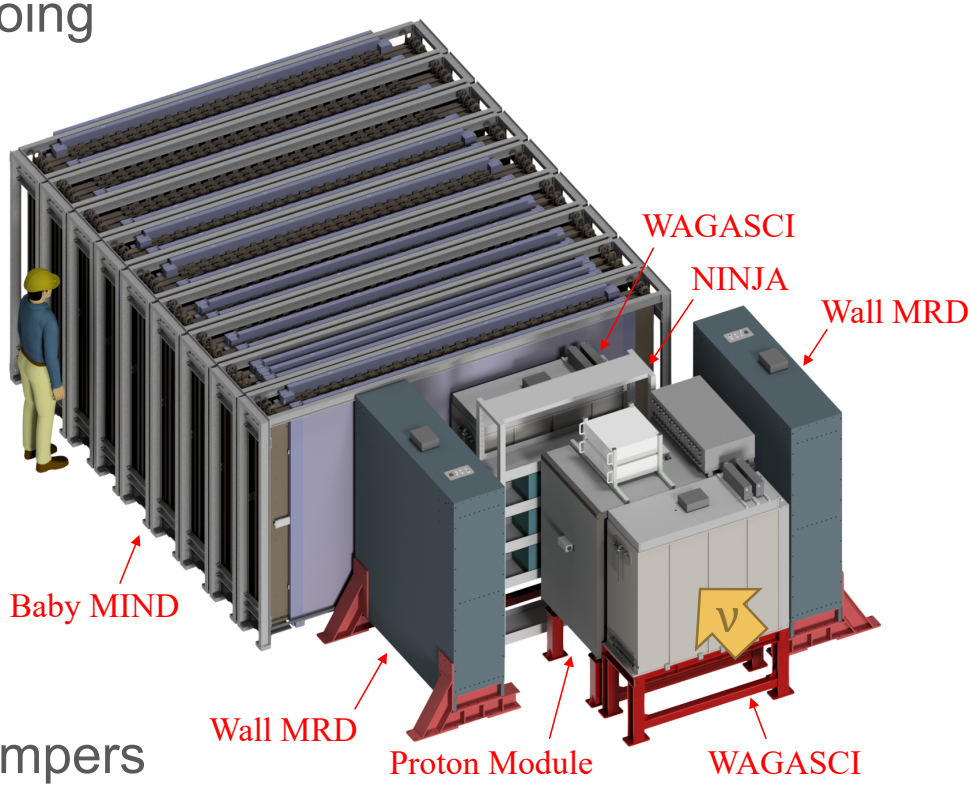
- 2019/2020:

  First physics run, analysis ongoing

- 2022:

  Second physics run

  => ×30 stat data in total !!



Other activities

- Heavy water run
  (Pilot run in ongoing)
- Developments of new time stampers
- Studies for ν_e detection (for a sterile search)

Summary

- The NINJA experiment measures neutrino interactions (especially on water) using nuclear emulsion.
- We can achieve a 200 MeV/c proton momentum threshold to probe nuclear effects.
- The pilot run results demonstrated the capability of our detectors.
- Results from the physics run and other activities are coming soon !!