Performance evaluation of Cylindrical Neutron Counter for J-PARC E80 at K1.8BR

Yuto Kimura (ELPH, Tohoku univ.) , SNP School 2023 YRS

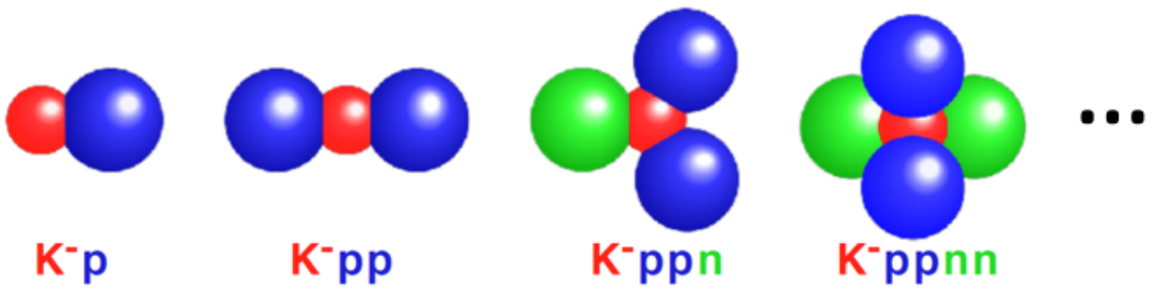
Contents

1. Introduction
   - Kaonic nuclei
   - New spectrometer for further research
2. Beam test at ELPH
3. Result
4. Summary and Outlook

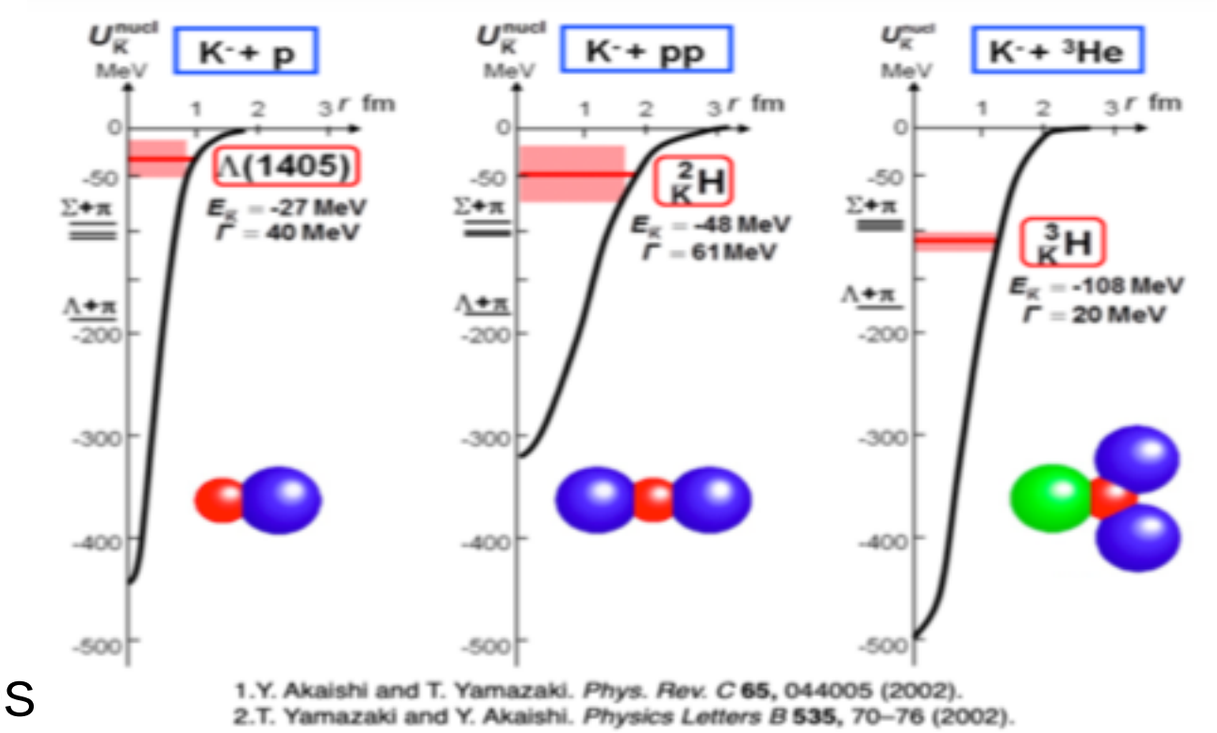
Research center of Electron and Photon

Kaonic nuclei

・What is “Kaonic nuclei” ?



Kaonic nuclei = $\bar{K}$ - $NN\ldots$ bound states



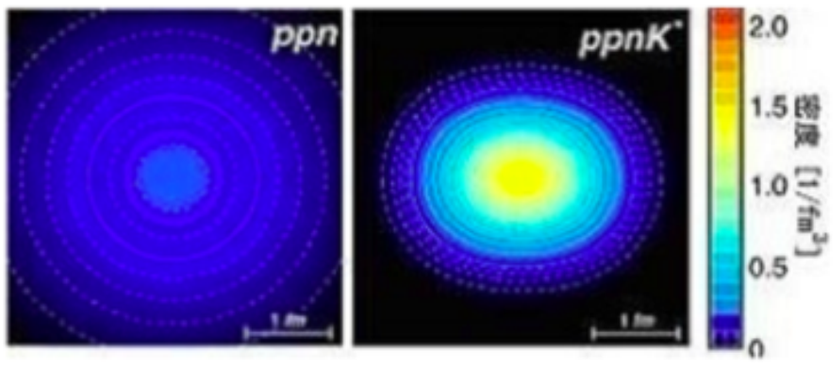
1.Y. Akaishi and T. Yamazaki. *Phys. Rev. C* **65,** 044005 (2002).
2.T. Yamazaki and Y. Akaishi. *Physics Letters B* **535,** 70–76 (2002).

Predicted from strong attractive $\bar{K}N$ interaction in $I = 0$ channel

・What is interesting about “Kaonic nuclei” ?

1. High density state

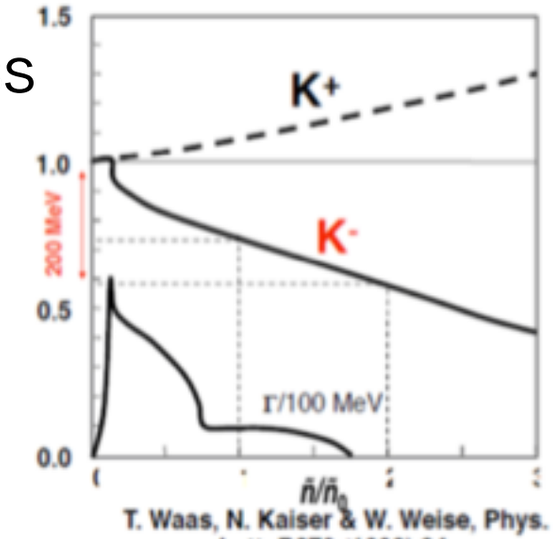
→ Inside a neutron star



Phys. Rev. C70, 044313 (2004).

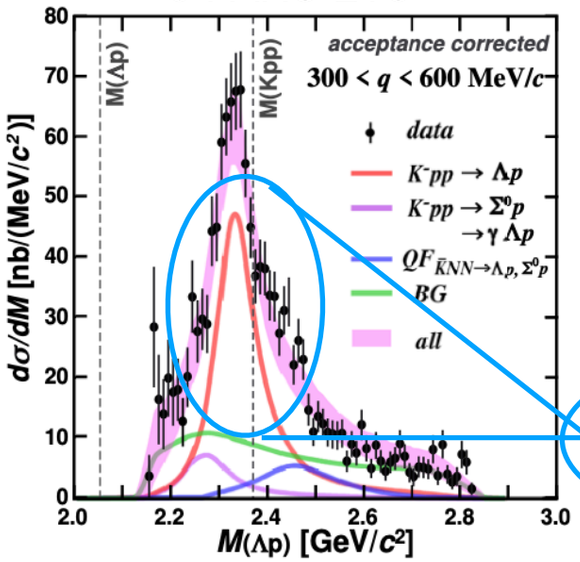
2. Mass of meson in nuclear media

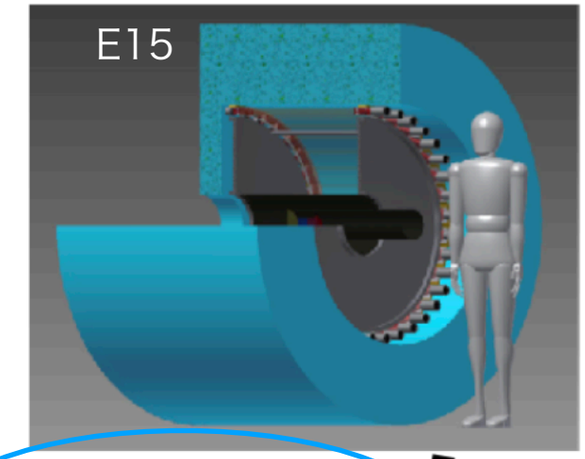
→ Origin of mass



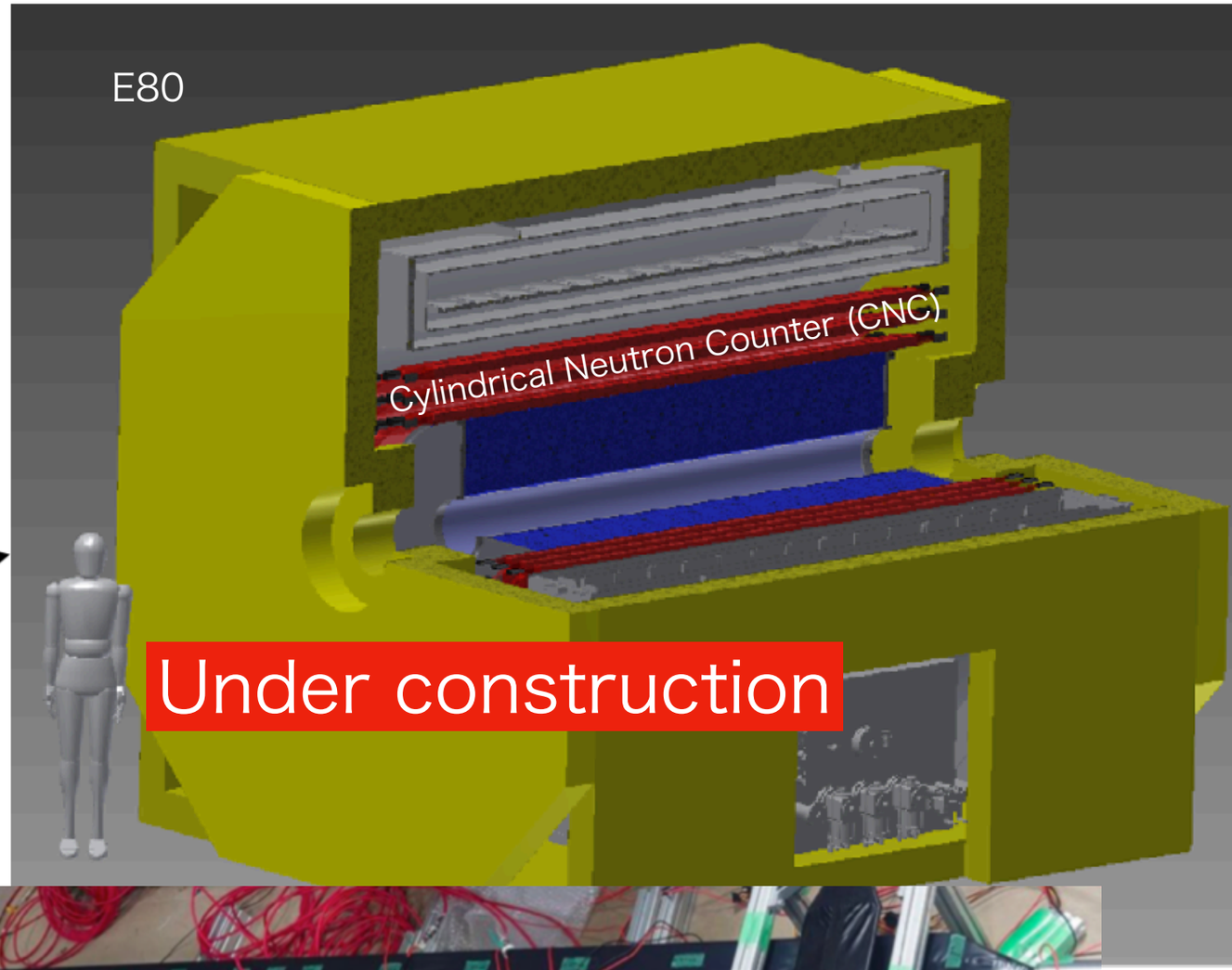
T. Waas, N. Kaiser & W. Weise, Phys. Lett. B379 (1996) 34.

New spectrometer for further research





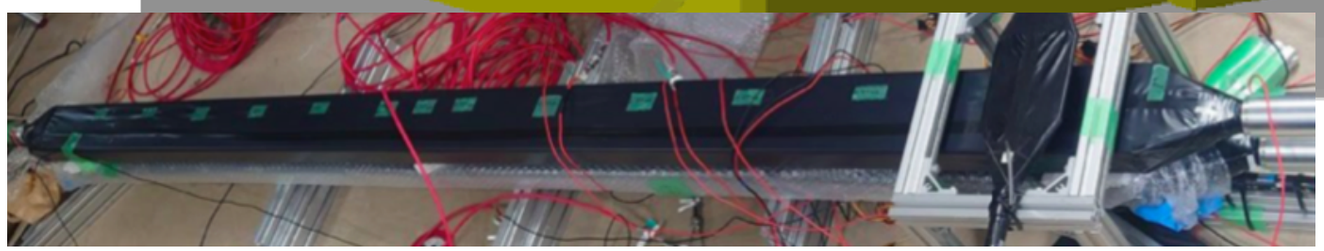
The existence of bound state "K^-pp"

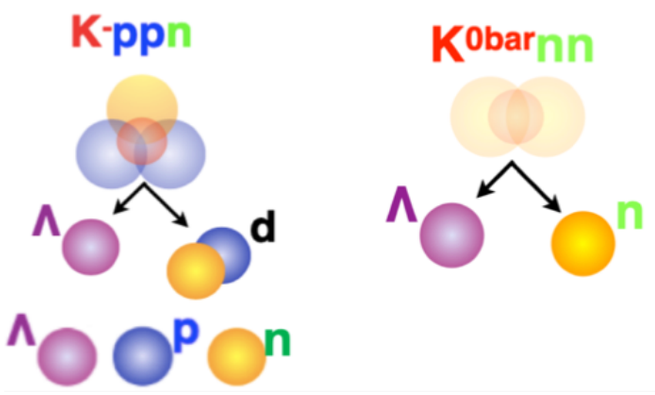


- Larger acceptance (59% —> 93%)
- higher capability of detecting neutron (~3% —> 15~45%)

Cylindrical Neutron Counter (CNC)

- trigger
- particle identification by TOF
- detect neutron

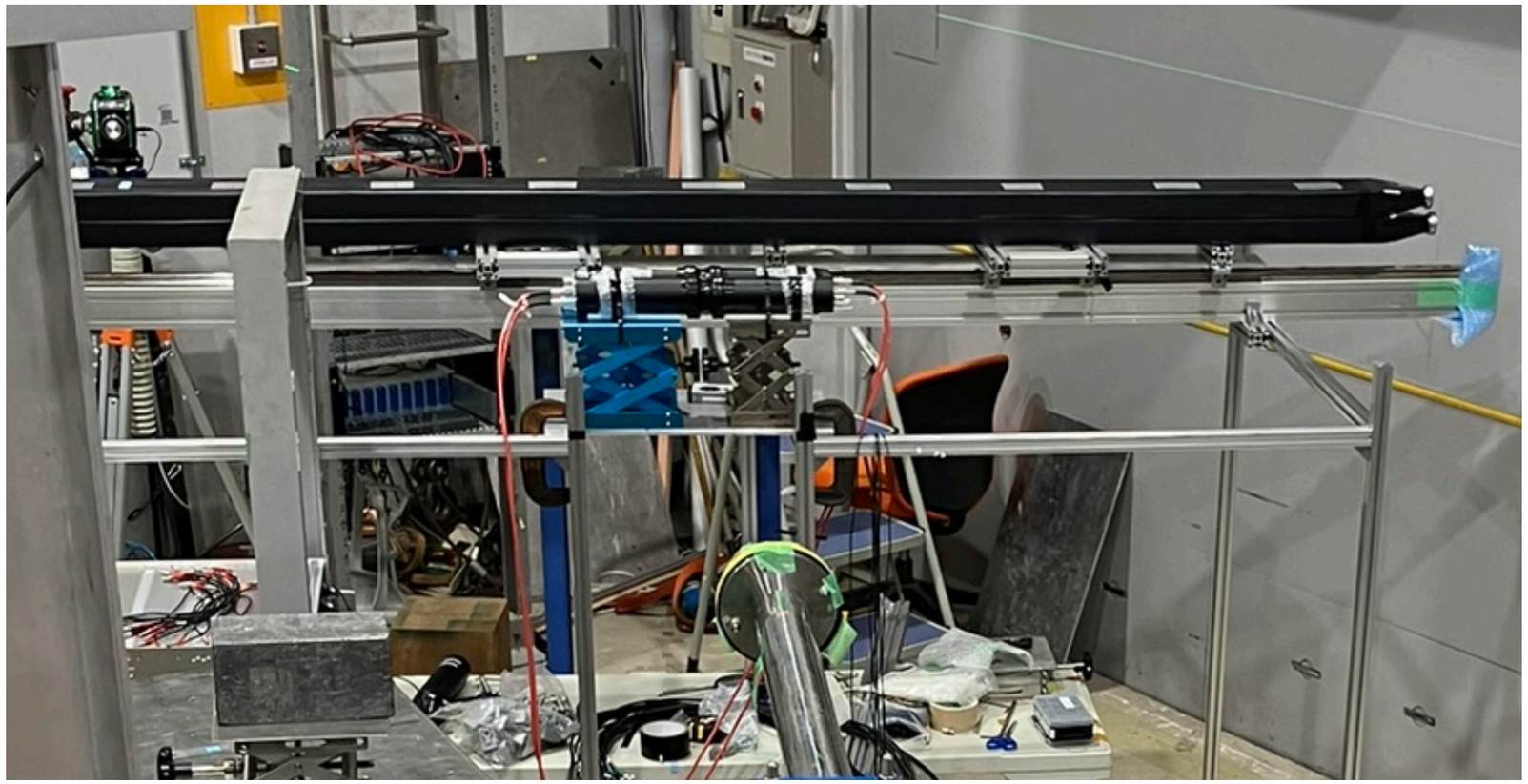




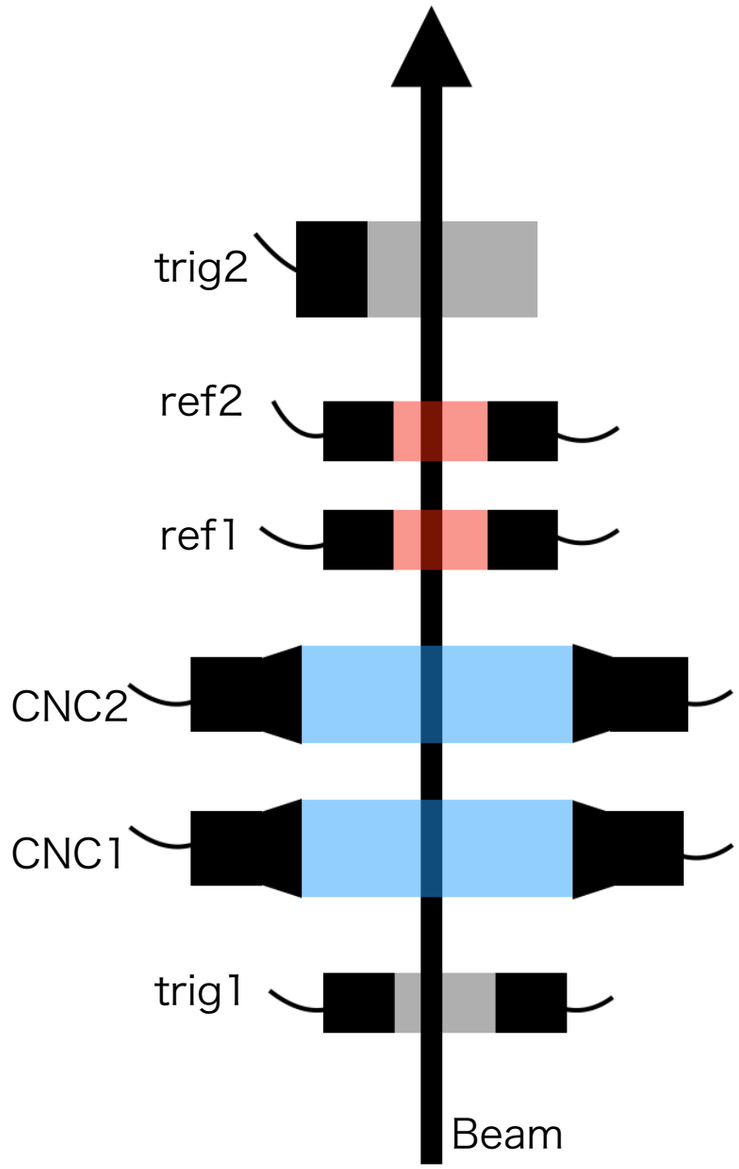
	E15	E80
Scintillator (Ellen EJ-200)	790 * 98 * 30 (mm)	2600 * 120 * 50 (mm)
Length of Light Guide	83 (mm)	115 (mm)
PMT	fine-mesh 19-dynode	
time resolution	σ ~ 80 ps	σ ~ ?

CNC beam test at ELPH in October 2023

Beam (e^+) momentum : 584 MeV/c



@ GeV-γ irradiation room in ELPH

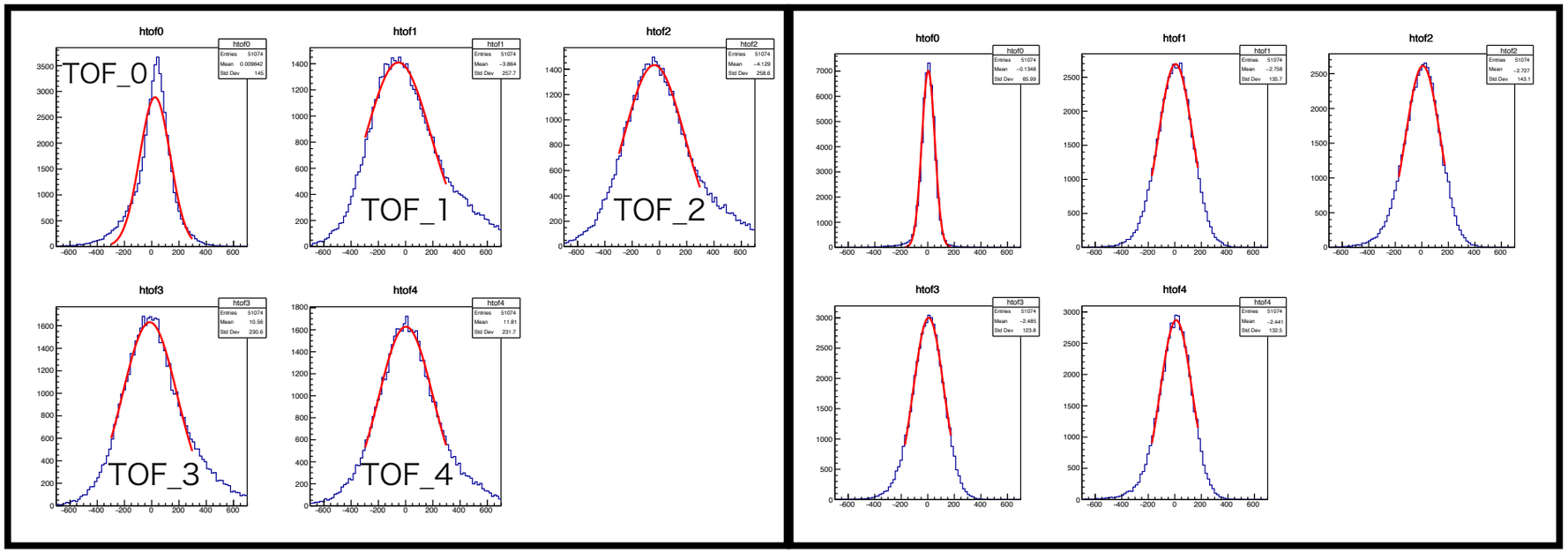


Purpose of this experiment

- Measurement of the time resolution of CNC
- Is there position dependence of it ?

Result

Slewing correction



Define of TOF

TOF_0 = Ref1 - Ref2

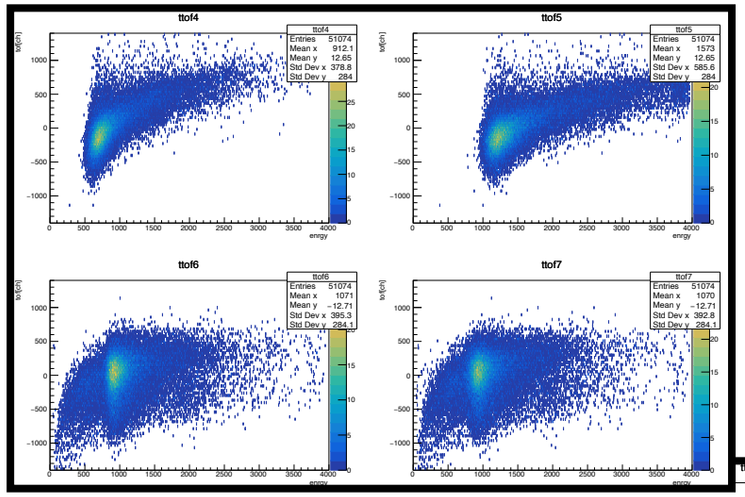
TOF_1 = CNC1 - Ref1

TOF_2 = CNC1 - Ref2

TOF_3 = CNC2 - Ref1

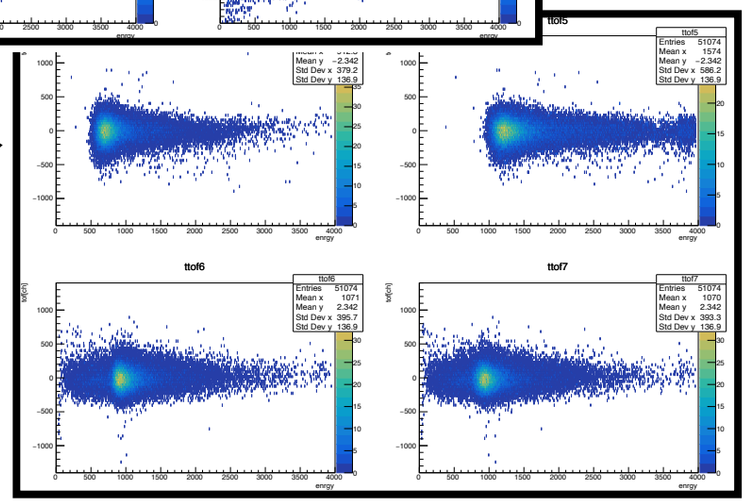
TOF_4 = CNC2 - Ref2

Slewing correction (2D plot)

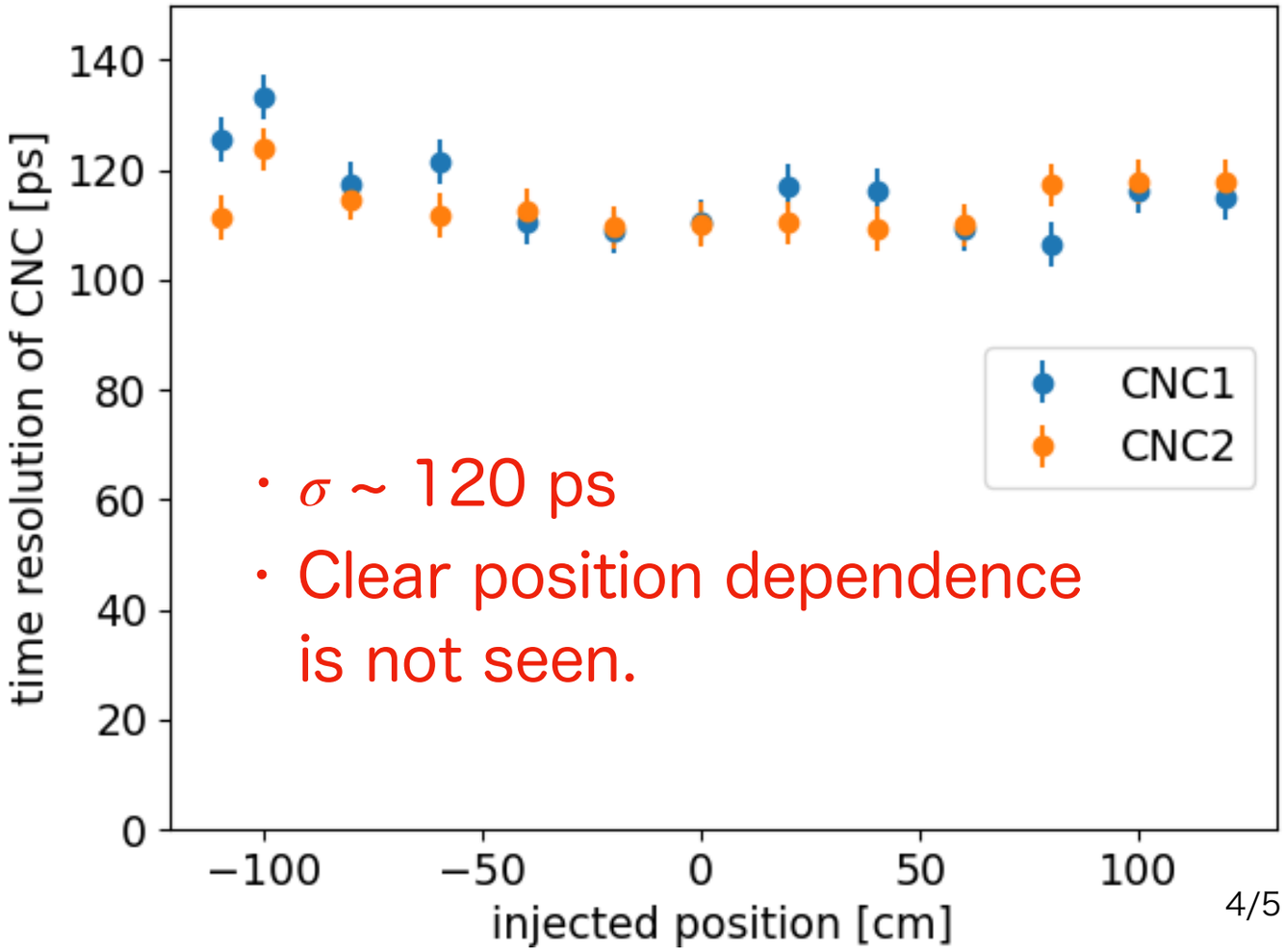


e.g.

Figure of TOF_0



time resolution - position CNC



Summary

- To study Kaonic nuclei with larger mass number and neutrons as decay particles, new detector system, especially CNC is needed.
- Test experiment was conducted at ELPH to measure the time resolution of the CNC and its position dependence.
- The result is σ ~ 120 ps , not seen clear position dependence of the time resolution.

Outlook

- How does changing the length of the light guide change the time resolution, and what happens when MPPC is used instead of PMT ? (currently analyzing)
- I will be running simulations to see how the 120 ps time resolution affects the final results of the E80 experiment.

→ **In 2026, $\bar{K}NNN$ measurement via $^4He(K^-, N)$ reactions !**

Thank you for listening .