Study of Light Kaonic Nuclei

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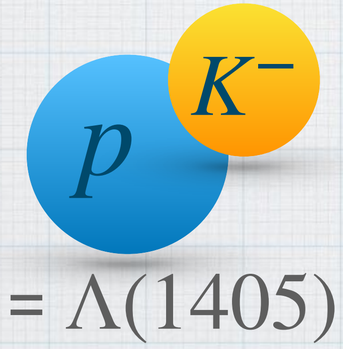
Hobby : Playing baseball

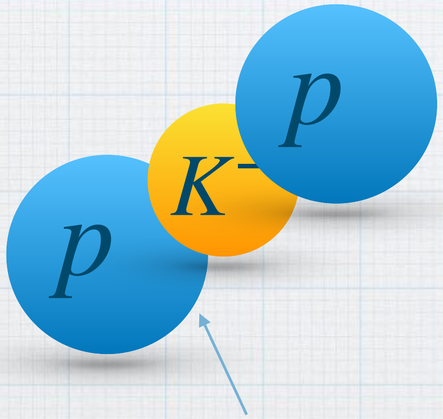
I mainly work in J-PARC.

What are “Kaonic Nuclei”?

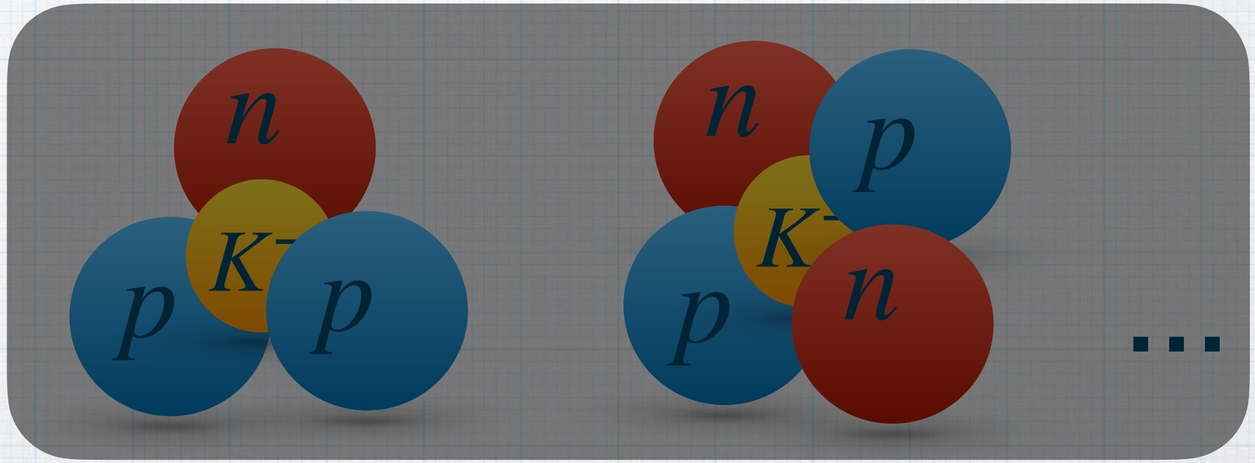
* Kaonic nuclei = anti-kaon($\bar{K}$) — nucleus(N) bound states
  * Predicted from attractive $\bar{K}N$ interaction in $I = 0$ channel and the existence of $\Lambda(1405)$



= $\Lambda(1405)$



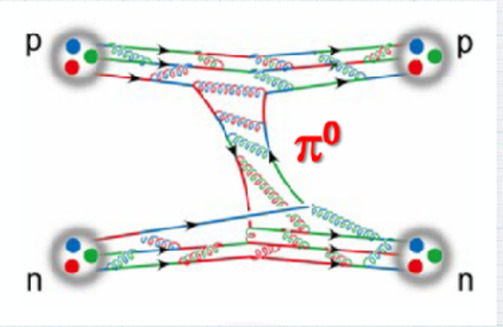
Confirmed in J-PARC E15 experiment



Not revealed yet…

How interesting?

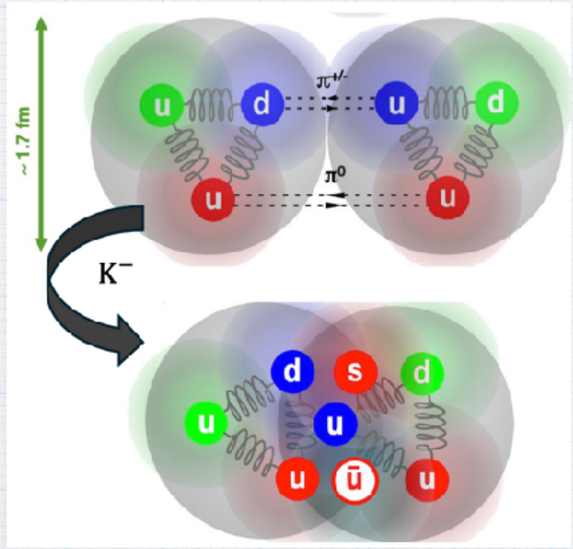
- **“Real” meson in nuclei**
  - Usualy, meson is “vertial particle” in nuclei (Yukawa theorem).
    Only in vacuum, real meson exists (cf. meson beam).



- **High-density state may emerges**
  - Predicted from its bigger binding energy and $\bar{K}N$ attractive force
    cf. $B.E.(K^- pp) = \sim 50$ MeV

    pp -> unbound

    $B.E.(d) = 2$ MeV

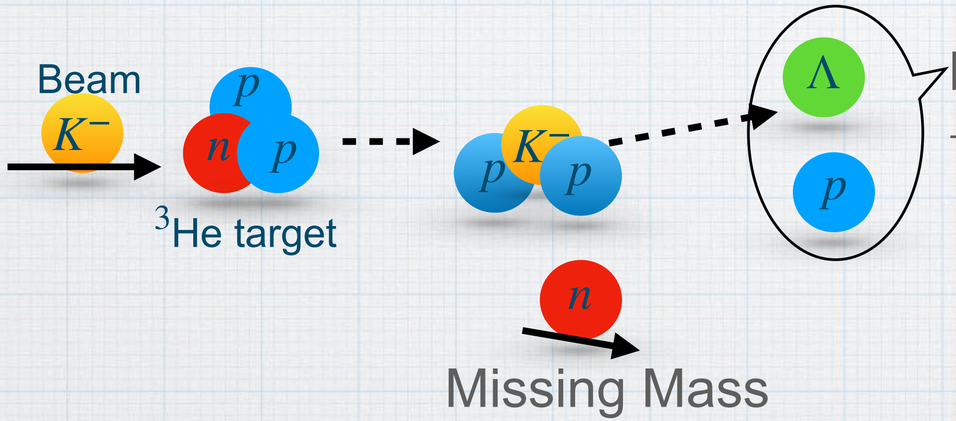


Molucle? Quark matter?

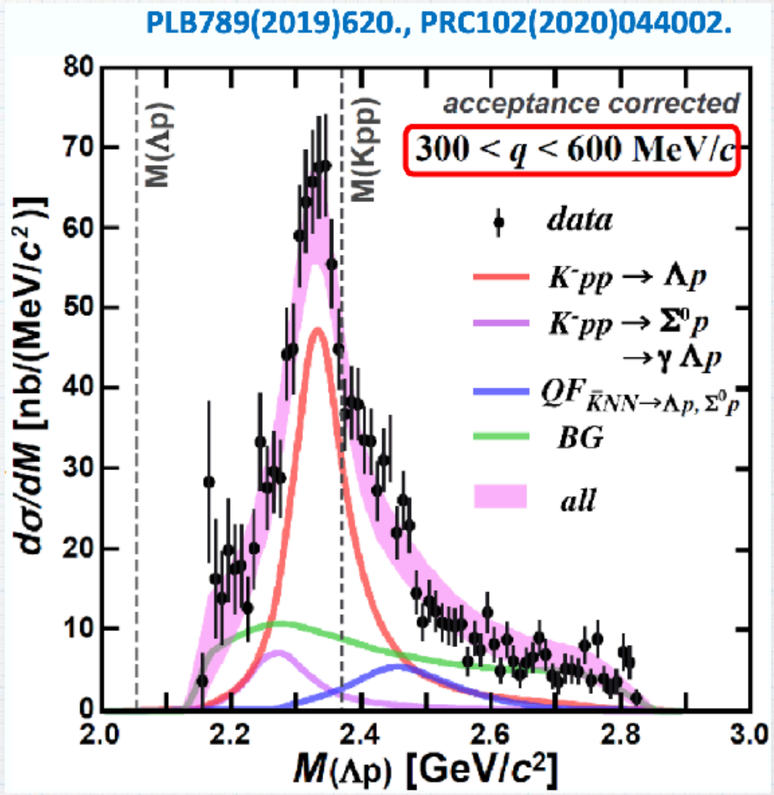
- **A hint to understanding the unknown nature of exotic hadrons**
  - If these are so dense that their components overlap each other, they could become quark matter, not molecule-like state, I think.

From Existence to Properties

* Despite of many "K^-pp" searches, NO conclusive result.
* **J-PARC E15 experiment (2013~2015)**:
  The simplest kaonic nucleus "K^-pp" was finally confirmed.
  [PLB789,620(2019). PRC102,044002(2020). PRC10,014002(2024). etc]



Detected
→ reconstruction of invariant mass



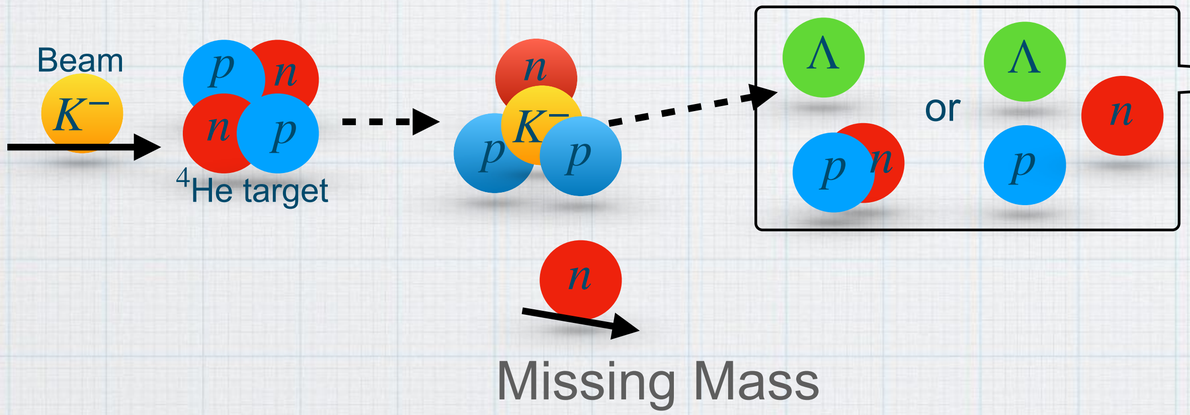
* **The research focus have been shifted from "Existence" to "Properties."**

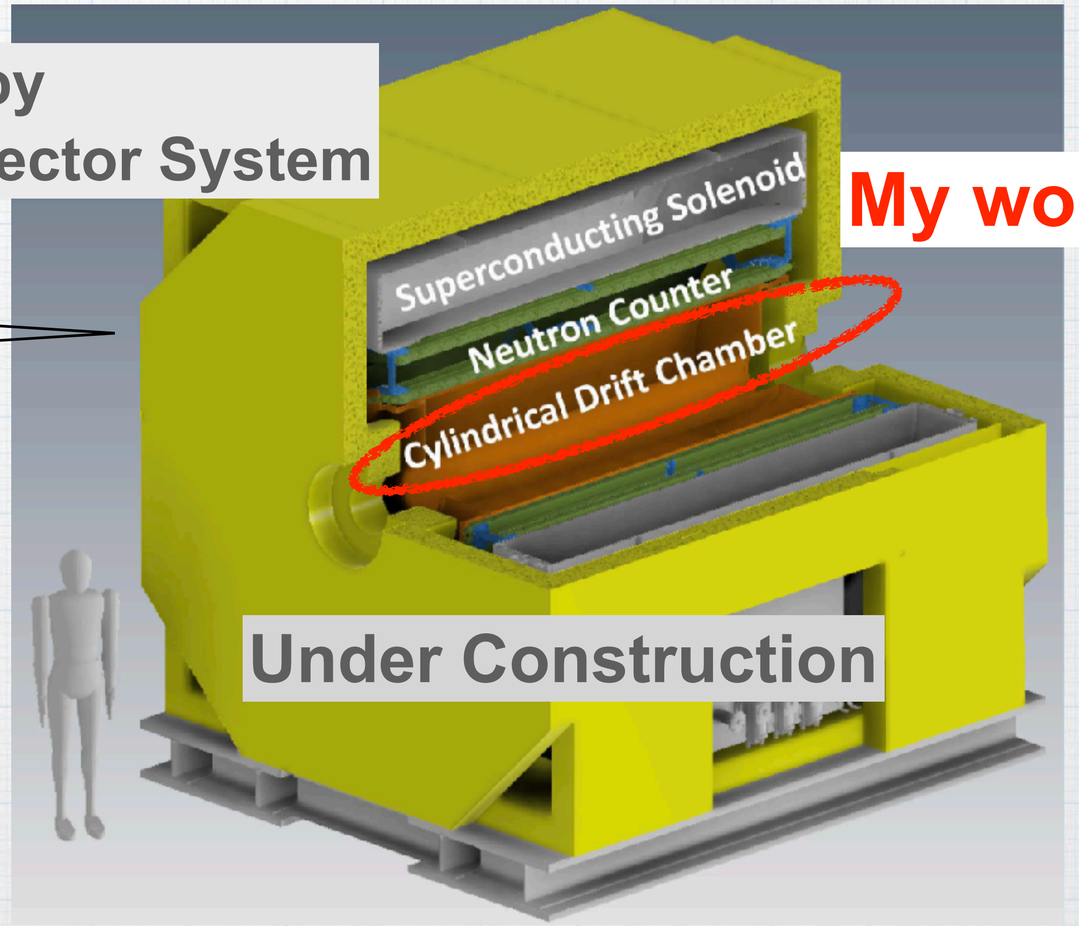
→ Systematic studies of light kaonic nuclei

"K^-ppn" search (J-PARC E80)

* **J-PARC E80: "K^-ppn" as a first step of the systematic research (scheduled in 2026)**

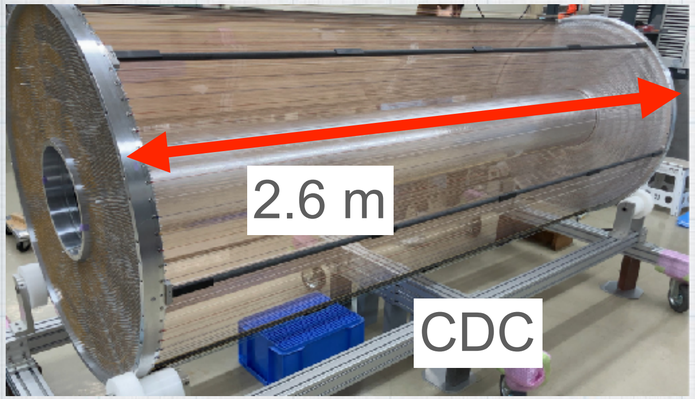
Detected by "new" Cylindrical Detector System



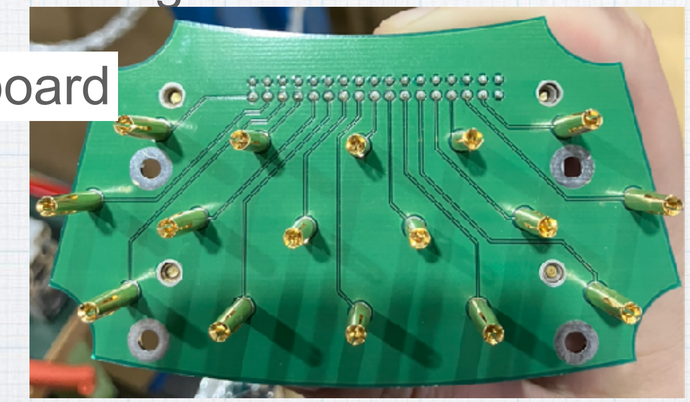


What I do mainly ①

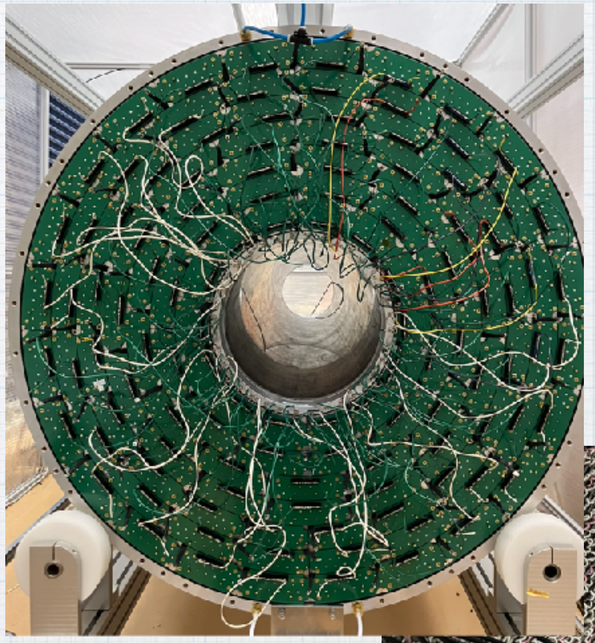
- **Cylindrical Drift Chamber (CDC):**
  calculation of particles' momenta, using curvatures of their tracks with a magnetic field
  - I assembled the read-out boards and handmade cables for HV distribution into the CDC, and started the comissioning.



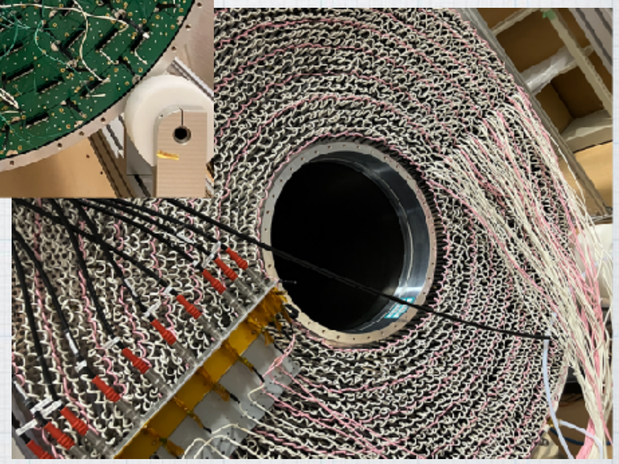
Read-out board



Handmade cables for HV distribution



It took ~6 monthes.



What I do mainly ②

- **Cylindrical Drift Chamber (CDC):**
  calcuration of particles' momenta, using curvatures of their tracks with a magnetic field
  - Wire drift chamber needs gas to operate properly.
  - **I studied the filling gases in the CDC.**
    Especially, I revealed the difference of the peformance between Ar-C_2H_6 and Ar-CO_2.
  - As a result, we could decide to use Ar-C_2H_6 for the CDC.

I will skip the detail here.
They were summarized in my master-thesis and a proceedings of the "J-PARC Symposium 2024".

Summary

- My research forcuses on kaonic nuclei, especially the experimental search for "$K^{-}ppn$".
- We are constructing the new Cylindrical Detector System (CDS).
- I'm responsible for Cylindrical Drift Chamber (CDC), one of the main detecors in the CDS.

Prospect

- I will begin test experiment with the new pre-amplifier board "ASAGI", using the test chamber at RIBF.
- The other detectors are also being prepared smoothly.
- We will perform the J-PARC E80 in 2026, and I will write my doctoral thesis based on it.