

**Meson Science Laboratory**  
**Chief Scientist: Masahiko Iwasaki (Dr. of Science)**



**(0) Research field**

CPR Subcommittee: Physics

**Keywords:** Nuclear Physics, Meson, Hadron

**(1) Long-term goal of laboratory and research background**

We are conducting two different research subjects. One is the hadron physics focusing at the interaction between mesons and nuclei in the “Pioneering Research Cluster”. The major activity is to study K-meson, second lightest meson having strange-quark, property in the nuclear matter at J-PARC. We are also making experimental spectroscopy of deeply bound pionic atoms at RI Beam Factory and experimental exploratory of  $\eta'$ -mesic nuclei at GSI, Germany. Another is the muon science, muon science researches covering from condensed matters physics to the fundamental science, mostly using RIKEN-RAL muon facility in “Nishina Center for Accelerator Based Science”.

**(2) Current research activities (FY2020) and plan (until Mar. 2025)**

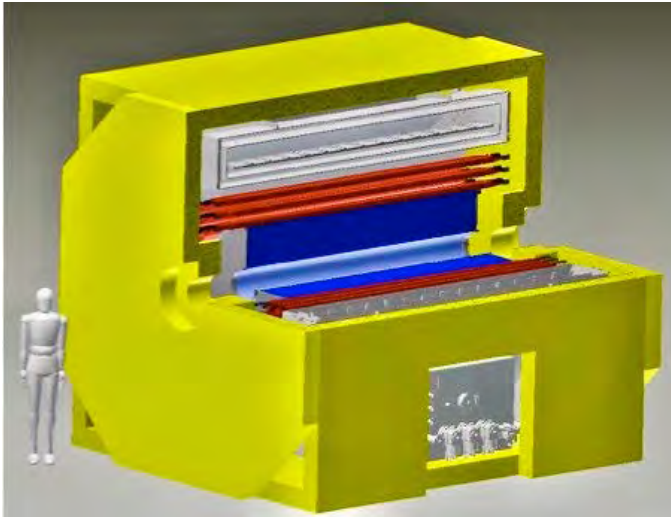


Figure 1: Overview of the large detector dedicated to the study of K meson nuclear states (to be completed in 2025).

We have studied the decay process of the “ $K\text{-}pp$ ” bound state, which we discovered at J-PARC, and found that the decay branching ratio of the “ $K\text{-}pp$ ” bound state with pions is very large. We have also obtained evidence of the “ $K\text{-}ppn$ ” bound state with one more nucleon that ensures the presence of the kaonic nuclear bound state.

This K meson bound state is an extremely unique nuclear form that has been completely unknown until now, and it is extremely important to make a great leap forward in this research. Therefore, we have started construction of the new large detector shown in Fig. 1, aiming to complete the construction by the end of FY2025. As soon as it is completed, we will start a systematic study of K meson bound states.

In the deeply bound pionic atom spectroscopy, data analysis to obtain the information on chiral symmetry breaking in nuclei has been completed and a paper has been submitted for publication. For  $\eta'$  mesonic nuclei, a search experiment using the WASA large detector was conducted at the Heavy Ion Research Institute of Germany (GSI). The data are now being analyzed.

In the muon science field, we have been developing ultra-slow muon beams as a fundamental technology for g-2 precision measurements, and we confirmed ionization of muonium emitted from silica aerogel by 1s-2s laser to establish ultra-slow muon generation technology for muon g-2 experiments, and proceeded with detailed design of an actual muon source system for muon g-2 measurements. In addition, the RIKEN RAL branch office collaborated with the Rutherford Appleton Laboratory (RAL) in the UK on a major refurbishment of the muon experimental facility installed at RAL.

### (3) Members

as of March, 2022

#### (Chief Scientist)

Masahiko Iwasaki

#### (Senior Research Scientist)

Haruhiko Outa, Kenta Itahashi  
Fuminori Sakuma, Yue Ma,  
Shigeki Fujiyama, Yugo Oshima

#### (Postdoctoral Researcher)

Takumi Yamaga, Hidemitsu Asano,  
Rie Murayama

#### (Junior Research Associate)

Toya Tanaka, Shota Matsumoto,  
Masaya Ichikawa, Ryohei Sekiya

#### (Student Trainee)

Takaya Akaishi,

#### (Assistant)

Mitsue Yamamoto

### (4) Representative research achievements

1. "Observation of a  $K^{\text{bar}}\text{NN}$  bound state in the  $3\text{He}(K^{\text{bar}},\Delta p)n$  reaction", T.Yamaga et al., *Physical Review C* **102**, 044002 (2020).
2. " Study of muonium emission from laser-ablated silica aerogel ", J. Beare, et al.: *Prog. Theor. Exp. Phys.* **2020**, 123C01 (2020).
3. "Spectroscopy of  $\eta'$ -mesic Nuclei with WASA at GSI/FAIR", Y.K. Tanaka et al., *Acta Phys. Polon. B* **51**, 39 (2020).

### Supplementary



### Laboratory Homepage

[https://www.riken.jp/en/research/labs/chief/mes\\_sci/index.html](https://www.riken.jp/en/research/labs/chief/mes_sci/index.html)

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