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**Proposal of Experiment at RCNP using WS course and Grand Raiden**

# Resonance States in Proton Rich Nuclei and the Reaction Rates in the rp-Process.


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**Running Time:** A total of 9 days running time is requested, 5 days for beam line matching, spectrometer setup, and development, 4 days for the initial measurements.

**Beam Line:** Dispersive WS beam line and Grand Raiden Spectrometer in 0° mode.

**Beam Type and Energy:** $^4$He of 185 MeV, min. 50 nA, desirable 200 nA for ($^4$He,$^8$He)

**Other requirements:** Single turn halo-free beam, fully disp. matched beam on GR target.

**New Equipment required:** GR $^4$He stop in D1, momentum defining slits in WS course, time-of-flight pickups in WS course, 1, 10 and 6 mm thin plastic detectors in GR focal plane for $\Delta$-E, E and veto signals, respectively.

**Budget:** New Equipment expenses: $^4$He stop in D1 of GR (0.2 MYen), momentum defining slits in WS course (0.2 MYen), time-of-flight in WS course (0.2 MYen), Plastic detector in GR focal plane (0.6 MYen), Travel Expenses: 0.5 MYen

# 1 Summary of the Proposal

• **Proposed experiment:** Measurements of ($^4$He,$^6$He), ($^4$He,$^8$He), and ($^3$He,$^6$He) reactions on several targets with astro-physics motivation are proposed using the recently commissioned WS course and Grand Raiden (GR). GR will be used in a new 0° mode with a new Faraday cup inside dipole D1.

In the first experiment we plan to measure the ($^4$He,$^6$He) reaction and to test the feasibility of the ($^4$He,$^8$He) reaction. Measurements using this reactions and also the ($^3$He,$^6$He) will be requested in follow-up proposals.

• **Targets:** The targets for the initial beam time request are $^{28}$Si,$^{24}$Mg, and $^{40}$Ca for the ($^4$He,$^6$He) reaction measurements. A $^{13}$C target with a relatively large ($^4$He,$^8$He) cross section is needed to test the feasibility of this reaction. Target thicknesses 1 - 2 mg/cm$^2$ will be used.

• **Apparatus and Beam Properties:** The WS course in dispersive mode and the Grand Raiden spectrometer with the standard VDC focal plane detector system will be used. A new thin 1 mm thick $\Delta$E plastic scintillator is needed to provide an energy loss signal for particle identification. This thin scintillator will have to be mounted approximately normal to the exiting $^8$He particles when the ($^4$He,$^8$He) reaction measurements are made. The low cross sections requires redundant identification measurements.

The ($^4$He,$^6$He) reaction with typical cross sections of 0.1 mb/sr will be measured with a dispersive beam and full matching techniques to obtain a resolution $\leq$ 100 keV) smaller than the beam spread of about 150 keV.

Feasibility and required setup conditions for the ($^4$He,$^8$He) reaction with a cross section of the order of 10 nb/sr will be addressed during the first proposed ($^4$He,$^6$He) experiment.