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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  $0^\circ$  mode.

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

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

**New Equipment required:** GR  $^4\text{He}$  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:  $^4\text{He}$  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 ( $^4\text{He},^6\text{He}$ ), ( $^4\text{He},^8\text{He}$ ), and ( $^3\text{He},^6\text{He}$ ) 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  $0^\circ$  mode with a new Faraday cup inside dipole D1.

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

• **Targets:** The targets for the initial beam time request are  $^{28}\text{Si}$ ,  $^{24}\text{Mg}$ , and  $^{40}\text{Ca}$  for the ( $^4\text{He},^6\text{He}$ ) reaction measurements. A  $^{13}\text{C}$  target with a relatively large ( $^4\text{He},^8\text{He}$ ) cross section is needed to test the feasibility of this reaction. Target thicknesses 1 - 2 mg/cm<sup>2</sup> 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  $^8\text{He}$  particles when the ( $^4\text{He},^8\text{He}$ ) reaction measurements are made. The low cross sections requires redundant identification measurements.

The ( $^4\text{He},^6\text{He}$ ) 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 ( $^4\text{He},^8\text{He}$ ) reaction with a cross section of the order of 10 nb/sr will be addressed during the first proposed ( $^4\text{He},^6\text{He}$ ) experiment.