RCNP EXPERIMENT E328

PROPOSAL FOR EXPERIMENT AT RCNP

13 July 2009

TITLE:
Stellar neutron sources and the s-process in massive stars.

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Running Time: A total of 6 days running time is requested of which 2 days are needed for cyclotron optimization (momentum spread) beam line matching, spectrometer setup, and 4 days for production and calibration measurements including the time needed for mode changes (0° mode, Faraday cups behind Q1 and in scattering chamber) and gas target changes (^{18}O and ^{22}Ne gas and solid target).

Beam Line: Dispersive WS beam line and Grand Raiden Spectrometer in three modes (0° mode, Faraday cups behind Q1 and in scattering chamber).

Beam Requirements: Particle type and energy: ^{4}He of 206 MeV

Beam intensity and energy spread: A maximum of 100 pnA is required, beam energy spread of the order of 100 keV or better.

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

Equipment required: Only existing and standard GR and focal plane equipment is needed

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SUMMARY OF THE PROPOSAL

• **Proposed experiment:** Measurements of (α,α') on ^{18}O and ^{22}Ne gas targets and a ^{26}Mg target foil with astrophysical motivation are proposed using the WS course and Grand Raiden (GR). GR will be used in three Faraday cup modes including the 0° mode with a Faraday cup downstream of the Focal plane detector.

This experiment is part of an astrophysics program at RCNP. It aims at resonance states above the α-threshold around 10 MeV excitation energy and is only possible with the high-resolution spectrometer since a resolution of 20 - 30 keV is required to resolve high-lying excited in the final nucleus. Two of the targets are gas targets and we will make use of the special, flat gas-target cell that allows dispersion matching as demonstrated previously. Targets will be of the order of 2 - 3 mg/cm^2 for best possible resolution.

• **Targets:** The targets of astrophysical interest are T = 1 nuclei in the sd-shell and we propose in this experiment measurements on ^{18}O, ^{22}Ne and ^{26}Mg targets. The target thicknesses of about 2 - 3 mg/cm^2 are a compromise of count rate and good resolution requirements.

• **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 stack of 3 mm, 10 mm, and 6 mm thick ΔE plastic scintillator will provide energy loss and timing signals for particle identification in the first two detectors for α-particles. Deuterons and protons will pass through the first two detectors and provide a veto signal in the third, 6 mm thick detector.

• **Beam time request:** The total beam time request of 6 days will be used as follows:

a) 2 days for beam preparation, detector and particle identification verifications, ion-optical setup and dispersion matching.

b) 3 days for measurements on all three targets. Count rates are about 200 events per hour for a ^{26}Mg target, an estimated cross section of 1 μb/sr, a solid angle of 2.4 msr solid angle, a detector efficiency of 0.8 and a beam current of 100 pnA.

c) 1 day is needed for measurements on calibration targets.