E379

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, 2 days for production runs (including the time needed for mode changes) and 2 days for normalization using a ^{16}O target and background measurements with an empty gas cell.

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: ^{6}Li of 80 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 dispersion-matched beam on GR target.

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

Target Budget: ^{22}Ne gas is available from a previous experiment.
Chemically pure oxygen gas with natural abundance (Yen 5000).

1 Summary of the Proposal

• **Proposed experiment**: Measurements of (^{6}Li, d) on ^{22}Ne with astrophysical motivation are proposed using the WS course and Grand Raiden(GR). The beam will be used directly from the AVF cyclotron. GR will be used in three Faraday cup modes including the 0° mode with a Faraday cup inside dipole D1. 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 a high-resolution spectrometer since a resolution of 40 keV is required to resolve high-lying excited levels in the final nucleus. ^{22}Ne and ^{16}O (for normalization) are gas targets and we will make use of the special, flat gas-target cells that allow dispersion matching as demonstrated previously. Target thickness will be 0.2 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 ^{22}Ne. The target thicknesses of about 0.2 mg/cm^2 are a compromise of count rate and good resolution requirements. ^{22}Ne gas target will be used as the energy calibration target as well since precise excitation energies are known up to 12 MeV. A ^{16}O target is needed for cross section normalization.

• **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 and 10 mm thick ΔE plastic scintillator will provide energy loss and timing signals for particle identification in the first two detectors for deutrons.

• **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) 2 days for measurements on ^{22}Ne target.
c) 2 additional days are required for the normalization of the cross section using a ^{16}O target and for background measurements with an empty cell at all measured angles.