RCNP EXPERIMENT E210

# PROPOSAL FOR EXPERIMENT AT RCNP

27/01/2003

**TITLE:**

**Study of the GT strength distributions via $^{60,62,64}$Ni($^3$He, $t$)**

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**EXPERIMENTAL GROUP:**


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**RUNNING TIME:**

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|---|---|
| Beam tuning time | 1.5 days |
| Set up time of the matching conditions | 0.5 days |
| Data runs | 3.0 days |
| Mesurement time for calibration targets | 0.5 days |

**BEAM LINE:** WS (WS beam line + Grand Raiden)

**BEAM REQUIREMENTS:**

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|---|---|
| Type of particle | $^3$He |
| Beam energy | 420 MeV |
| Beam intensity | $10 \sim 30$ nA on target |
| Energy resolution | $\Delta E \leq 100$ keV, small emittance |
| Injection mode | High Resolution Mode |
| WS transport mode | Dispersive/Achromatic Modes |

**BUDGET:**

Support to the two PhD students from Gent
(for their stay of about a month for data analysis).

**SCHEDULE:** We request the beam time late in the fall, 2003.

## SUMMARY OF THE PROPOSAL


We propose to study the Gamow-Teller (GT) excitations in $fp$-shell nuclei $^{60}$Cu, $^{62}$Cu, $^{64}$Cu with the ($^3$He, $t$) charge-exchange (CE) reactions on target nuclei $^{60}$Ni, $^{62}$Ni, $^{64}$Ni, respectively. The target nuclei have ground-state (g.s) isospins $T=2$, $T=3$, $T=4$ and final nuclei have isospin $T=1$, $T=2$, $T=3$.

For this study, a 140 MeV/nucleon $^3$He beam from the RCNP Ring Cyclotron will be used. The outgoing tritons are momentum analyzed by

the spectrometer Grand Raiden at 0°. In these experiments a high energy resolution of less than 40 keV is very important. This has been achieved only at RCNP for intermediate energy CE reactions. Also important is the good angle resolution of the scattering angle around 0° and the capability of reconstructing the angle. The ion-optical conditions *dispersion matching* and *angular dispersion matching* will be realized between the spectrometer and the newly constructed WS beam line to achieve a high resolution and good angle resolution. The over-focus mode of the spectrometer is essential in realizing good angle resolution in vertical direction and also in correcting kinematic aberrations.

The first important goal of this proposal is to obtain via the $^{60,62,64}$Ni($^3$He, $t$) reaction the accurate GT$^-$ strength distributions to discrete levels and the continuum up to about 20 MeV in $^{60,62,64}$Cu. The excellent energy resolution with the Grand Raiden Spectrometer system at RCNP should make possible the identification of individual levels up to high excitation energies. We think that our experimental results will permit a level to level comparison with the theoretical calculations of Caurier et al.

The second goal of the proposal is to identify the $T_0 - 1$, $T_0$ and $T_0$+1 isospin components by combining the information on $B$(GT) distributions from complementary $(p, n)$-type, $(n, p)$-type and inelastic reactions. Also the behavior of the coupling energy between the isospin $T_0$ of the ground state and the isospin of the vibration $\tau$ as given by Bohr and Mottelson will be checked.

In the ($^3$He, $t$) reaction at 140 MeV/nucleon, it has been established that there is a "specific" proportionality, i.e., a proportionality between the cross sections at 0° and the transition strengths $B$(GT) in one specific nucleus. Unfortunately there is not enough data to discuss "the universal" proportionality. In order to answer this question, the study of $^{62,64}$Ni($^3$He, $t$) reactions play important roles. The calibration standards of $B$(GT) values for these reactions are obtained from the $^{62}$Cu and $^{64}$Cu $\beta$-decays, respectively.

The spectrometer Grand Raiden and the standard VDC focal plane detector system will be used for the analysis and detection of outgoing tritons. We request $\approx 10 - 30$ nA of good quality single-turn extracted 140 MeV/nucleon $^3$He beam. In order to realize various matching conditions, various capabilities of the WS course will be fully utilized. More information on *matching conditions* including *dispersion matching*, *angular dispersion matching* and *focus matching* will also be accumulated through the experiences in the experiments. Studies are performed to further improve the resolutions.