RCNP EXPERIMENT E208

# PROPOSAL FOR EXPERIMENT AT RCNP

27 January 2003

**TITLE:**
**Agenda to E158: Study of Gamow-Teller transition strength by $^{37}$Cl($^{3}$He, $t$)$^{37}$Ar**

**SPOKESPERSON:**


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**RUNNING TIME:** Installation time without beam 1 days Beam tuning time 1.5 days
Set up time of the matching conditions 0.5 days
Data runs 2.5 days

**BEAM LINE:** Ring : WS course

**BEAM REQUIREMENTS:**
Type of particle $^{3}$He
Beam energy 420 MeV
Beam intensity $10 - 30$ nA
energy resolution $\Delta E \leq 100$ keV, small emittance

**BUDGET:** Production costs for the new Faraday cups 80,000 yen

**SCHEDULE:** We request the beam time in April, May, 2003

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**SPOKESPERSON:** Yoshihiro Shimbara, Yoshitaka Fujita

## SUMMARY OF THE PROPOSAL

We propose to measure the $^{37}$Cl($^3$He,$t$)$^{37}$Ar and $^{35}$Cl($^3$He,$t$)$^{35}$Ar reactions at $0-6^\circ$ as an extension of the E158 experiment. This experiment will give realistic Gamow-Teller (GT) strengths $B$(GT) for the $^{37}$Cl $\rightarrow$ $^{37}$Ar and $^{35}$Cl $\rightarrow$ $^{35}$Ar transitions. The results will give an important calibration standard for the study of solar neutrino using $^{37}$Cl detector.

Under the assumption of isospin symmetry, the $B$(GT) of $^{37}$Cl $\rightarrow$ $^{37}$Ar and $^{37}$Ca $\rightarrow$ $^{37}$K transitions should be the same. However, the $B$(GT) distributions empirically determined in the $^{37}$Cl$(p,n)^{37}$Ar and $^{37}$Ca $\beta$ decay measurements are not consistent. Although, in charge exchange reactions, the proportionality between $B$(GT) and cross section is used for the empirical extraction of $B$(GT) values, it has been discussed that the proportionality is broken for the $j_< j_<$ transitions. This is exactly the case of GT strengths in $^{37}$Cl $\rightarrow$ $^{37}$Ar and $^{35}$Cl $\rightarrow$ $^{35}$Ar transitions. A DWBA calculation for the $^{37}$Cl($^3$He, $t$)$^{37}$Ar reaction was performed. Two states with different configurations of $(\pi d_{3/2}, \nu d_{3/2}^{-1})$ and $(\pi d_{3/2}, \nu d_{5/2}^{-1})$ were assumed. The calculated angular distributions for these transitions were different. By using this difference of angular distributions, we can classify the GT states and evaluate more accurate the $B$(GT) values with different unit cross sections. In E158 experiment at RCNP we measured the $^{37}$Cl($^3$He,$t$)$^{37}$Ar and $^{35}$Cl($^3$He,$t$)$^{35}$Ar reactions at $0^\circ$ and $4^\circ$. Among the same $\Delta J^\pi = 1^+$ states some significant differences of the angular distributions were observed for the states below $E_x = 5$ MeV. Unfortunately, we have data only at $0^\circ$ and $4^\circ$. Our aim of this proposal is to extend the measurements to other scattering angles in order to roughly distinguish the configurations of GT states. This experiment will give more realistic $B$(GT) values of the $^{37}$Cl $\rightarrow$ $^{37}$Ar and $^{35}$Cl $\rightarrow$ $^{35}$Ar transitions. In addition, it makes the charge exchange reaction more reliable as a tool to search for the Gamow-Teller transition strengths.

For this study, a 140 MeV/nucleon $^3$He beam from the RCNP Ring Cyclotron will be used to excite the target nucleus. The outgoing tritons are momentum analyzed by the spectrometer Grand Raiden at $0-6^\circ$. In this experiments a high energy resolution of the order of 30 keV is very important. Therefore a chlorine gas target is not suited. In order to achieve a high resolution by using a magnetic spectrometer, a newly developed thin film made by calcium chloride ($CaCl_2$) and polyvinylalcohol (PVA) will be used as targets. In order to improve the energy spread of the beam, the dispersion matching

method will be used. The ion-optical conditions *dispersion matching* and *angular dispersion matching* will be realized between the spectrometer and the WS beam line to achieve a high resolution and good angle resolution, respectively. The over-focus mode of the spectrometer is essential in realizing good angle resolution in vertical direction and also in correcting kinematic aberrations.