PROPOSAL FOR EXPERIMENT AT RCNP

August 4, 2017

TITLE:
Determination of proton distribution radii of p-sd shell nuclei by Charge Changing Cross Section measurements. (Revised proposal)

SPOKESPERSON:

Full Name	TRAN Dinh Trong
Institution	Research Center for Nuclear Physics, Osaka University
Title or Position	Research Associate
Address	10-1 Mihogaoka, Ibaraki, 567-0047, Osaka, Japan
Phone number	+81-6-6879-8852
FAX number	+81-6-6879-8899
E-mail	tdtrong@rcnp.osaka-u.ac.jp

EXPERIMENTAL GROUP:

Full Name	Institution	Title or Position
H.J. Ong	RCNP, Osaka Univ.	Lecturer
I. Tanihata	RCNP, Osaka Univ./Beihang Univ.	Professor
N. Aoi	RCNP, Osaka Univ.	Professor
E. Ideguchi	RCNP, Osaka Univ.	Professor
H. Sakaguchi	RCNP, Osaka Univ.	Professor
T.H. Hoang	RCNP, Osaka Univ.	D1
M. Fukuda	Department of Physics, Osaka Univ.	Assoc. Professor
K. Matsuta	Department of Physics, Osaka Univ.	Assoc. Professor
M. Mihara	Department of Physics, Osaka Univ.	Assis. Professor
D. Nagae	Institute of Physics, Univ. of Tsukuba	Professor
A. Ozawa	Institute of Physics, Univ. of Tsukuba	Professor
D. Nishimura	Tokyo City Univ.	Assoc. Professor
S. Momota	Kochi Univ. of Technology	Professor
M. Takechi	Niigata Univ.	Assoc. Professor
S. Terashima	Beihang Univ.	Assoc. Professor
T. Hashimoto	Institute for Basic Science	Researcher
T. Kawabata	Department of Physics, Kyoto Univ.	Assoc. Professor
T. Furuno	Department of Physics, Kyoto Univ.	D3
J. Tanaka	TU Darmstadt	Postdoc
L.H. Khiem	Institute of Physics, VAST	Professor
M.H. Bui	Institute of Physics, VAST	Researcher
T.T. Nguyen	PNT Univ. of Medicine/VNU-HCMUS	D3
Y. Ayyad	LBNL	Researcher
W. Lin	IMP, China	Assis. Researcher

RUNNING TIME:

Installation time without beam	5 days
Detector, DAQ startup and beam tuning	1.5 days

	Data runs	10.5 days
	Total beam	12 days
BEAM LINE:		Ring : EN course
BEAM REQUIREMENTS:	Type of particle	^{40}Ar
	Beam energy	65A MeV or highest
	Beam intensity	$\geq$ 10 pnA
BUDGET:	Construction cost of mini MUSIC	400,000 yen

SAFETY CONTROLLED ITEMS:

- PR10 gas
- Beryllium

Dear RCNP Director and B-PAC members;

The present proposal is a revision of the proposal of E372 experiment, which was approved on March 4, 2011. The scientific motivations and the experimental methods have already been described in detail in the last proposal. Thus far, we have spent TEN days, out of the approved TWENTY TWO days beam time, for detector development as well as to measure the charge-changing cross sections for $^{10-12}Be$, $^{10-15}B$ and $^{12-18}C$ isotopes on a carbon target.

We have successfully published an article on the carbon-isotope measurements, are currently preparing two manuscripts for submission, and are finalizing the data analysis for the boron isotopes, which will be eventually submitted for publication. In this revised proposal, we would like to provide some updates on what we have achieved so far, discuss the current scientific merit and technical improvements to be implemented in the coming experiments, as well as the relevance of this experiment to RCNP.

Finally, we would like to announce a change in the spokesperson. The whole collaboration has agreed that the remaining part of the experiment should be headed by Dr. Tran Dinh Trong, who has played significant role in the first part of the experiment.

We hope that you will support our request to complete this experimental project.

Yours sincerely,

The RCNP-E372 collaboration

TITLE:
Determination of proton distribution radii of p-sd shell nuclei by Charge Changing Cross Section measurements. (Revised proposal)

SPOKESPERSON: TRAN Dinh Trong

SUMMARY OF THE PROPOSAL

We propose to measure the charge-changing cross sections (σ_{CC}) of N, O and F isotopes on a carbon target using radioactive beams of energy $\sim$50A MeV. The CCCS, which is the total cross sections of all processes that reduce the proton number of a projectile nucleus, is closely related to the proton distribution in a nucleus. The interaction cross sections (σ_I), which is the total cross sections of all processes that change the mass number of a projectile nucleus, have been measured extensively and used to extract the mass radii of stable as well as unstable nuclei. Recently, we have developed a global parameter set for the Glauber model calculation of the σ_{CC} to extract the proton distribution radii of neutron rich nuclei in a wide range of incident energy. Applying our Glauber model to the measured σ_{CC}'s for neutron-rich carbon isotopes, we have shown that the extracted proton distribution radii for $^{12-14}$C are consistent with those from the electron scattering. We have also obtained evidence for a sub-shell closure at Z=6 in the neutron-rich carbon isotopes.

In this proposal, we plan to study the systematic change of the proton distribution radii as well as the neutron-skin thicknesses of neutron-rich N, O and F isotopes. Such experimental data are important to understand the evolution of the shell structure in the p-sd shell nuclei where the clustering effect is also expected to play a substantial role. Besides, these data will also provide important test for the nuclear structure model, especially the *ab-initio* type theoretical models that employ the realistic or chiral effective nucleon-nucleon and three-nucleon forces.

We plan to use the EN course to produce beams of the radioactive nuclei. The σ_{CC}'s will be measured using the transmission method. The incident beam will be measured by a mini MUlti-Sampling Ionization Chamber (MUSIC) and a plastic scintillator, while the unreacted particle (with the same Z as the beam) exiting the reaction target will be measured by a MUSIC and a NaI(Tl) detector. Measurements will be performed with and without the carbon target to eliminate the effect of reactions in the detector material. Several technical improvements to experimental setup will be implanted to achieve 1% uncertainty in the σ_{CC}'s. The proton distribution radii of N, O, F isotopes will be extracted from the measured σ_{CC} using our Glauber model calculation.