Exit Report for JUSTIPEN Calem R. Hoffman May 29th – June 29th 2007

I have recently returned from Japan after participating in the Japan U.S. Institute for Physics with Exotic Nuclei. My stay lasted one month and was primarily based at RIKEN with a five day stay at Kyoto University and the Yukawa Institute for Theoretical Physics. There were two main focuses during my stay as part of the JUSTIPEN program. The first being participation in three International Conferences (DREB2007, INPC, NS07) as well as a mini-symposium at RIKEN. Attending and presenting provided me with a wonderful opportunity to meet and discuss nuclear structure. The relationships that were forged through these arena's with be very fruitful to my current and future work.

The other major focus of my trip was to discuss my recent results on the neutron-rich oxygen isotopes with theorists performing calculations in this region. In particular, I worked with Professor Otsuka and one of his graduate students Koshiro Tsukiyama.

In the summer of 2005 we performed an experiment at the National Superconducting Cyclotron Laboratory at Michigan State University. The primary goal of this experiment was to measure, for the first time, the ground state energy of 25O. The reaction consisted of a 26F beam impinging on a Be target whereby the removal of one proton resulted in the population of 25O. Due to the unbound nature of 25O it immediately (10^-21sec) decayed into 24O and a neutron. The neutron was detected by the Modular Neutron Array (MoNA), and the 24O fragment was bent by a large-gap dipole magnet and measured in the focal plane. Full four vector reconstruction provided the observation of a resonance around 820 keV for the 24O-n coincident events. As a bonus 23O-n coincidences were also recorded providing some preliminary results as to the excited states of 24O.

These results were compared with calculations that are being worked on by Professor Otsuka's student Tsukiyama-san. Tsukiyama's calculations involve first taking a closed shell of 22O, then using the lowest configuration, neutron separation energies are matched for 23O and 24O by adjusting a T=1 monopole term. The next vital part is the inclusion of the 0d3/2 orbit for the neutron into the continuum. This is accomplished by taking an unbound 0d3/2 that is closed inside a box at a particular length (1000 fm) by an infinite potential wall. The wave function is composed of the unbound 0d3/2 and the Hamiltonian is diagonalized with a residual interaction. Using a Gaussian type interaction with variable parameters the TBME can be matched to the original interaction, SDPFM in this case. The only difference for the calculation is the continuum coupling inside the wave function. The ground state of 25O can then be calculated by considering that the neutron emission probability is proportional to the spin-isospin operator acting on 25F. Using the 3/2+ continuum basis for 25O with the Harmonic oscillator basis of 25F the emission probability is determined with a most probable energy of ~740 keV. This result is in excellent agreement with my measured result of 820 keV! Furthermore the first 2+ and 1+ states for 24O were also calculated by Tsukiyama and his resulting values of ~840 keV and 1.2 MeV are again very close to my very preliminary results of 670 keV and 1.35 MeV.

From discussions with Tsukiyama and Otsuka, it is clear that continuum states must be handled differently when reaching these drip line nuclei. As proof, calculations done using the USD05 interaction produce results that are off by nearly 500 keV for the 25O ground state.

Finally, I would just like to give my warm regards for everyone involved in JUSTIPEN for an enlightening and exciting time during my stay in Japan and RIKEN. Thank you for this opportunity.