E436
PROPOSAL FOR EXPERIMENT AT RCNP

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TITLE: Probing High-Spin States in $^{61}$Fe Using the $^{48}$Ca($^{16}$C,3n) Reaction

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and CAGRA collaboration

RUNNING TIME:  
Installation time without beam  
5 days

Beam Tuning  
1 days

Data runs  
7 days

BEAM LINE:  
EN

BEAM REQUIREMENTS:  
Type of particle:  
$^{18}$O

Reaction to be used:  
$^{9}$Be($^{18}$O,$^{17}$N)$^{10}$B

Beam energy:  
9.3 MeV/A

Beam intensity:  
up to 2$\mu$A
We propose to identify high-spin states in $^{61}$Fe utilizing the radioactive-ion beam, $^{16}$C, which is under development at RCNP. This nucleus have been studied up to moderate spins utilizing deep-inelastic collisions in conjunction with Gammasphere [1]. Interest in Cr-Ni nuclei around $N = 40$ has resulted from the evidence of collectivity at or near the ground state in the $N = 40$ isobars $^{64}$Cr, $^{66}$Fe and $^{68}$Ni. A recent paper by Carpenter et al., [3] has attempted to reproduce the yrast structures of $^{60,62,64,66,68}$Fe and $^{60,62,64}$Cr using a simple two-band mixing calculation where shapes of both spherical and deformed states are assumed to co-exist and interact resulting in the observed behavior of the level structure below $I=10\hbar$. This analysis relies heavily on the availability of high-spin data measured for $^{58,60}$Fe using fusion-evaporation reactions. In order to confirm the conclusion of ref. [3] that the observed collectivity at $N = 40$ results from deformation as opposed to vibration, we propose to begin a program to measure high-spin states in neutron-rich Fe nuclei using fusion evaporation reactions with radioactive beams. As a first case, we propose to populate high-spin states in $^{61}$Fe using the $^{48}$Ca($^{16}$C,3n) reaction with the goal of extending in spin the states built on top of the known $9/2^+$ isomer and identifying the unfavored signature partner band associated with the underlying $g_{9/2}$ configuration. These observation will provide the necessary information to ascertain whether or not the $9/2^+$ state is prolate or oblate deformed. Determining the deformation driving effects of the $g_{9/2}$ neutron orbital as one approaches $N = 40$ in the Fe and Cr isotopes is critical if one is to understand fully the nature of the collectivity observed near $N = 40$ and below $Z = 28$. Excited states in $^{61}$Fe will be identified by measuring the $\gamma$ rays de-exciting populated levels with the CAGRA spectrometer.