Symmetry Energy Constraints

• LRP objectives: *the nature of neutron stars and dense nuclear matter & the nature of the nuclear force*

• Consistent constraints with credible uncertainties obtained from nuclear structure and nuclear reactions: NuSYM13 & ICNT2013 & J. Phys. G (in press)

• Extend strategies developed at low energy to explore symmetry energy in high density.
• Affects symmetry energy constraints

• Influences the thermal properties of neutron-rich matter

• First results indicate that the effective mass splitting is small.

• Approved experiment with upgrade HiRA to extend $E_{CM}$ range.
Isoscaling and Neutron Spectra

- Neutron spectra are critical to explore effective nucleon mass and density dependence of symmetry energy
- Neutrons are difficult to measure and efficiency corrections not better than ~ 15%

- Excellent agreement between n spectra extracted from isoscaling of particle energy spectra and measured n spectra