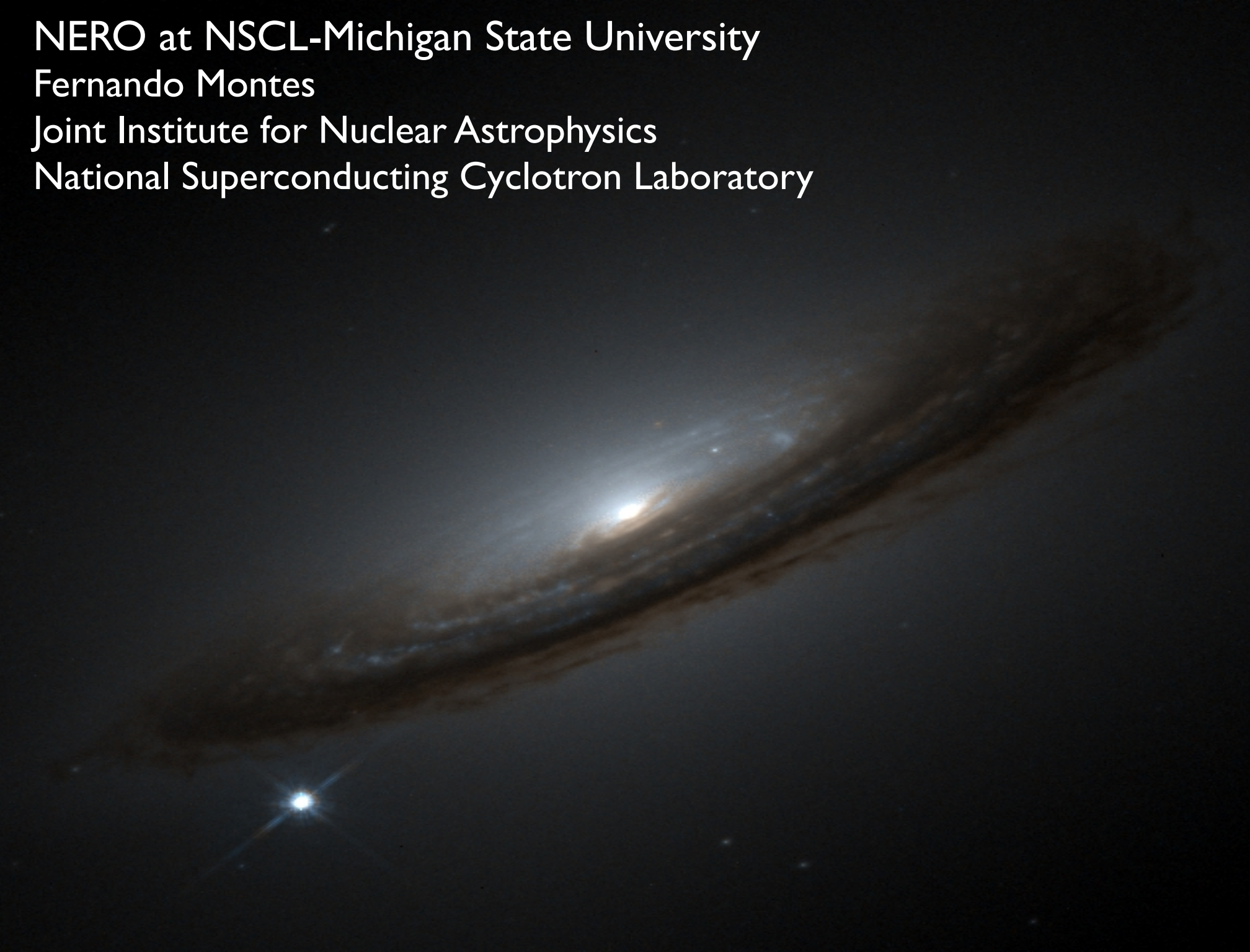
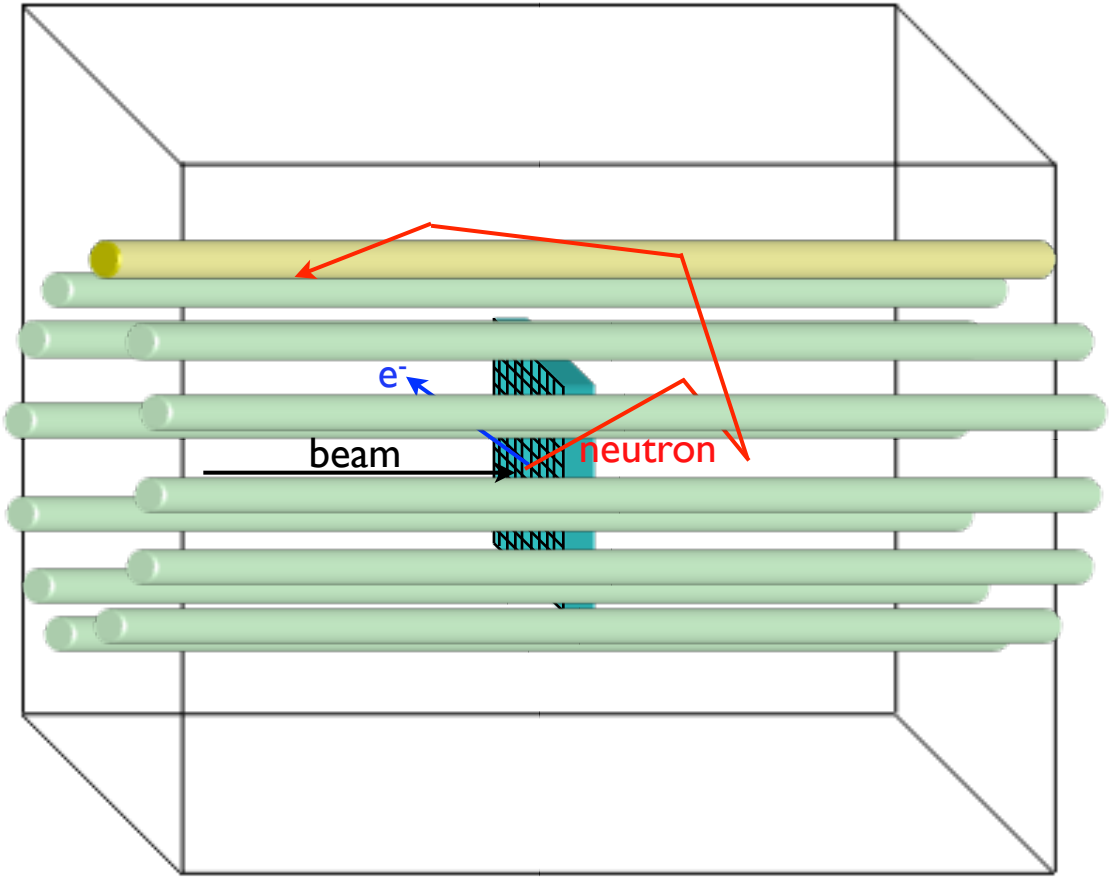


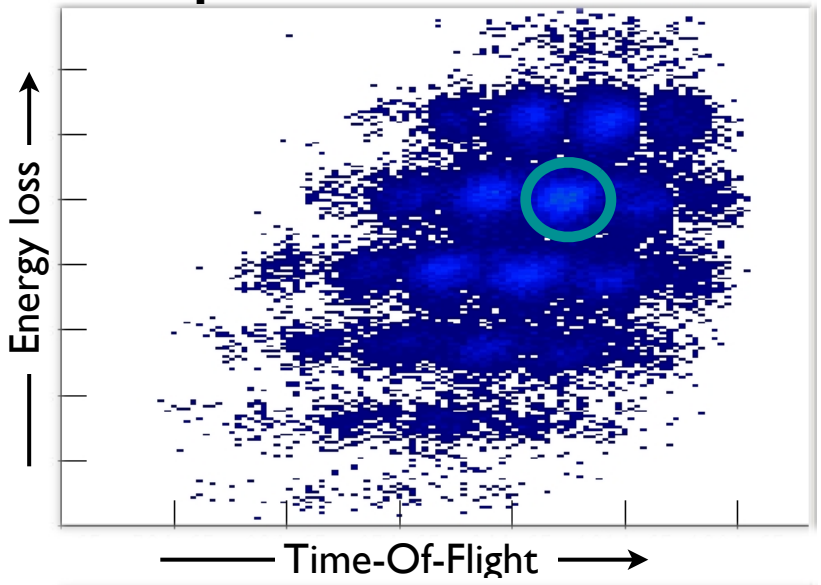
NERO at NSCL-Michigan State University

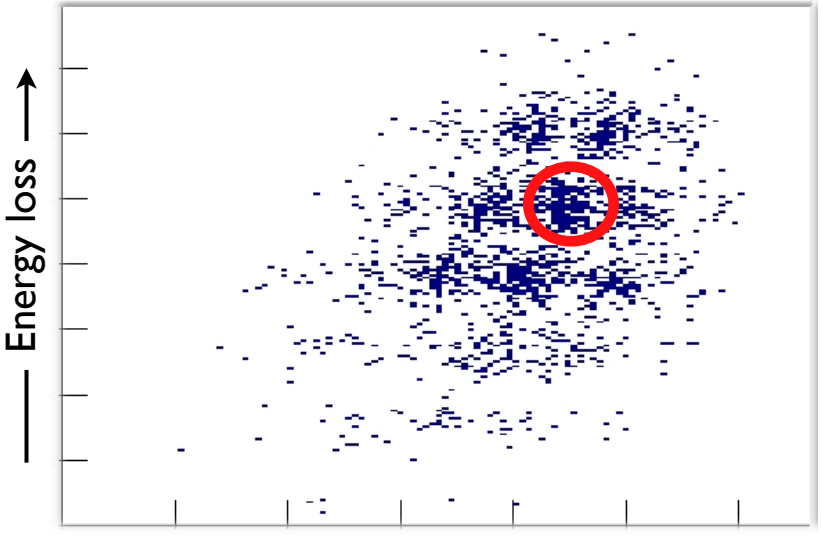
Fernando Montes
Joint Institute for Nuclear Astrophysics
National Superconducting Cyclotron Laboratory

Neutron detector NERO



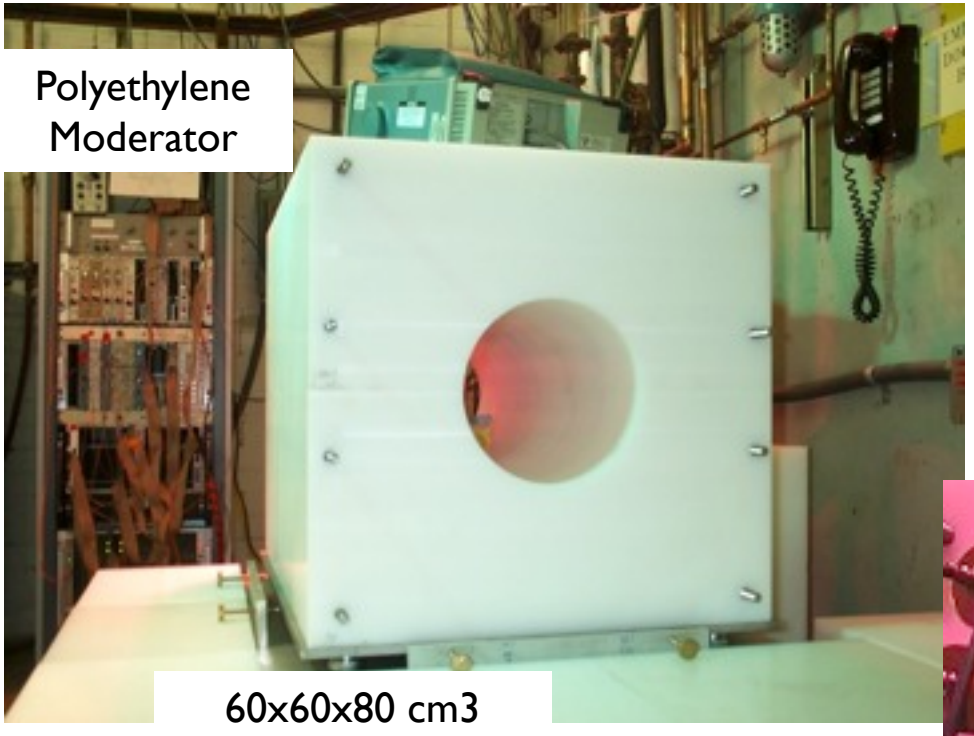
Implants with correlated e^-





Implants with correlated e^- and neutrons

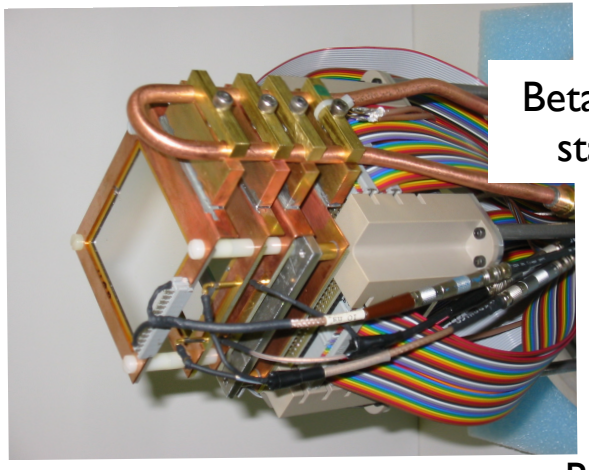
Neutron detector NERO



Polyethylene Moderator

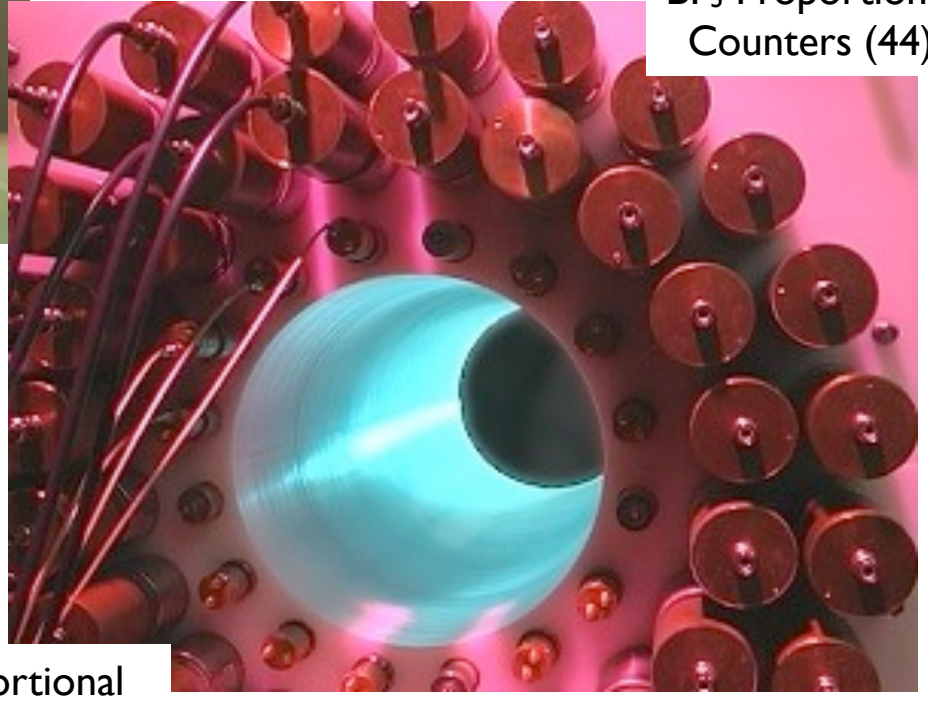
60x60x80 cm3
22.8 cm diameter
Efficiency ~35%

Pereira et al., NIMA 618, 275 (2010)



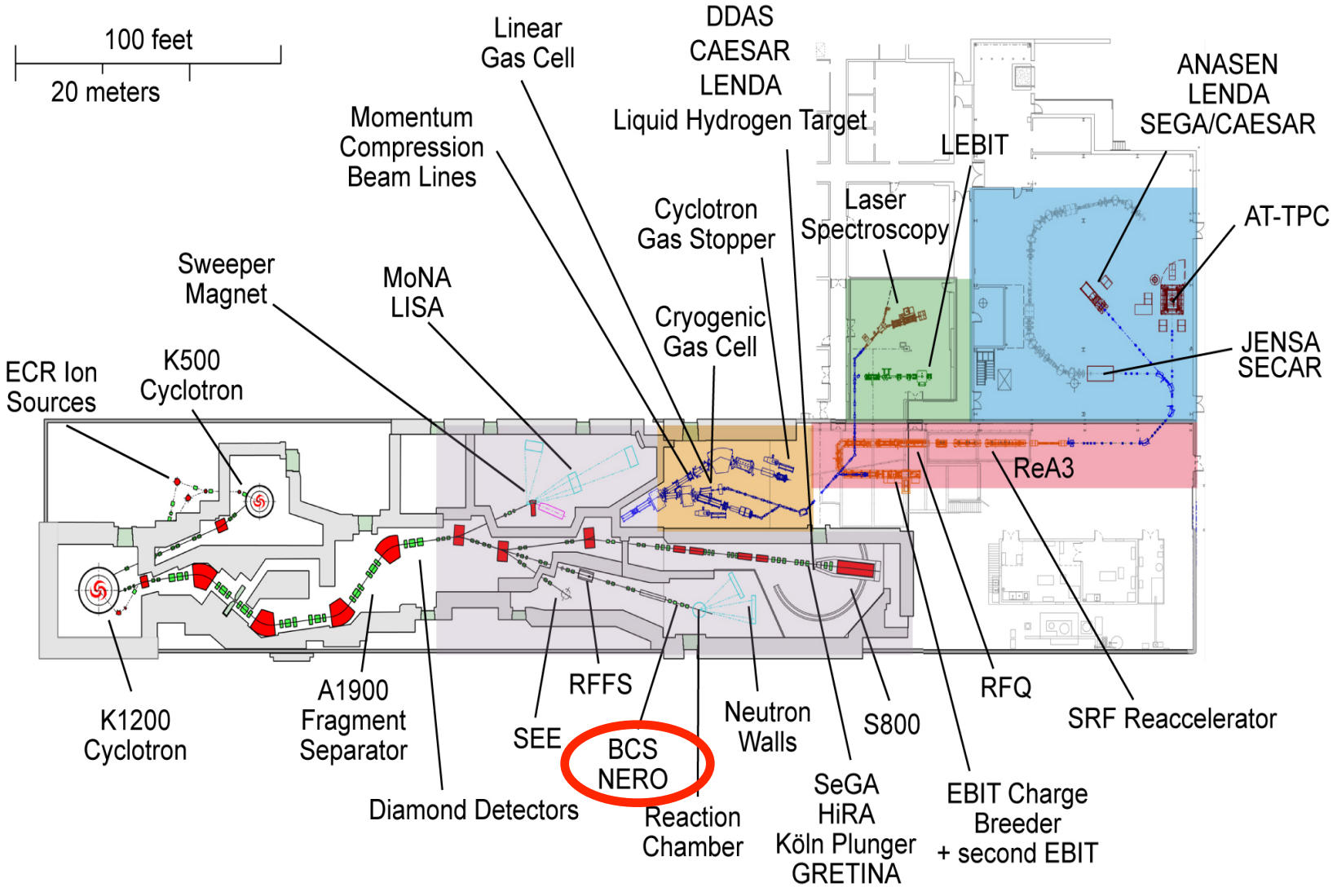
Beta-decay station

BF_3 Proportional Counters (44)

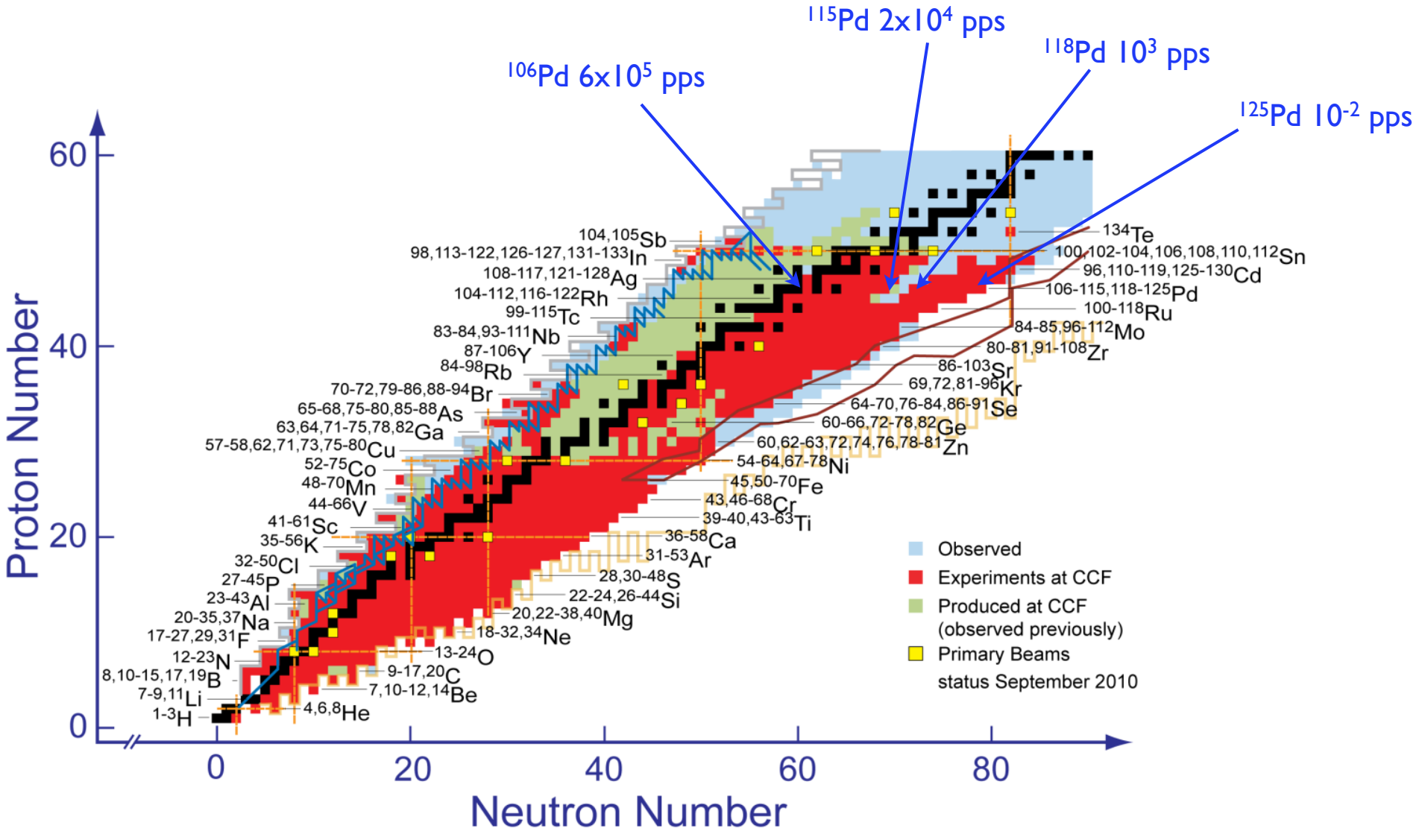


He3 Proportional counters (16)

NSCL experimental halls and instrumentation

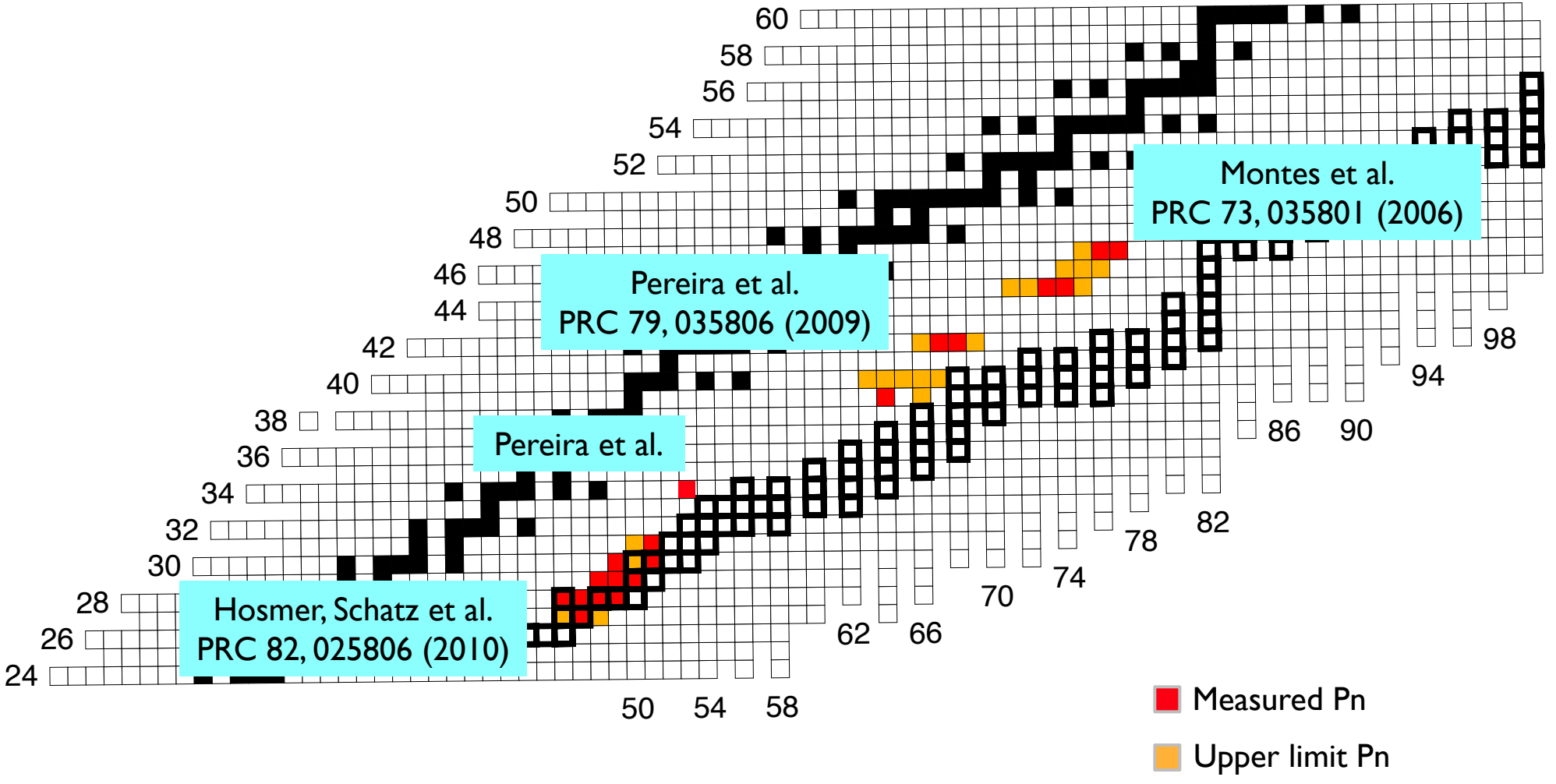


Beams produced at NSCL



More than 1000 RIBs have been made, and more than 830 RIBs have been used in experiments

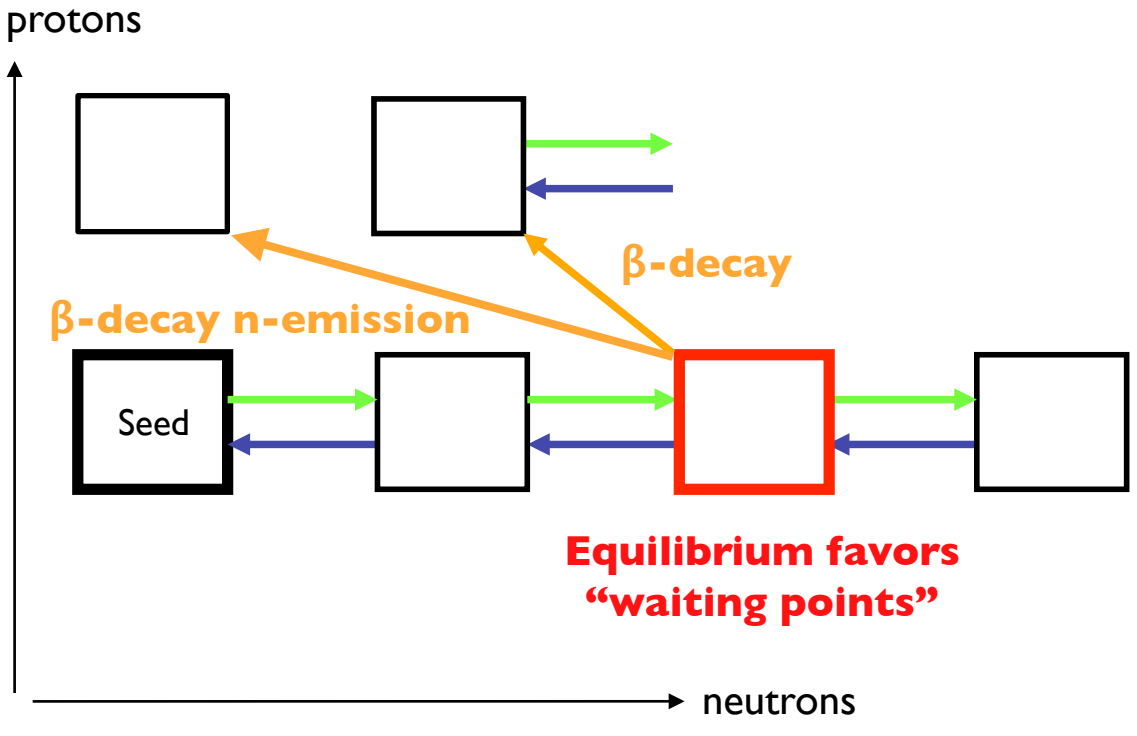
β-delayed neutron emission probabilities measured with NERO



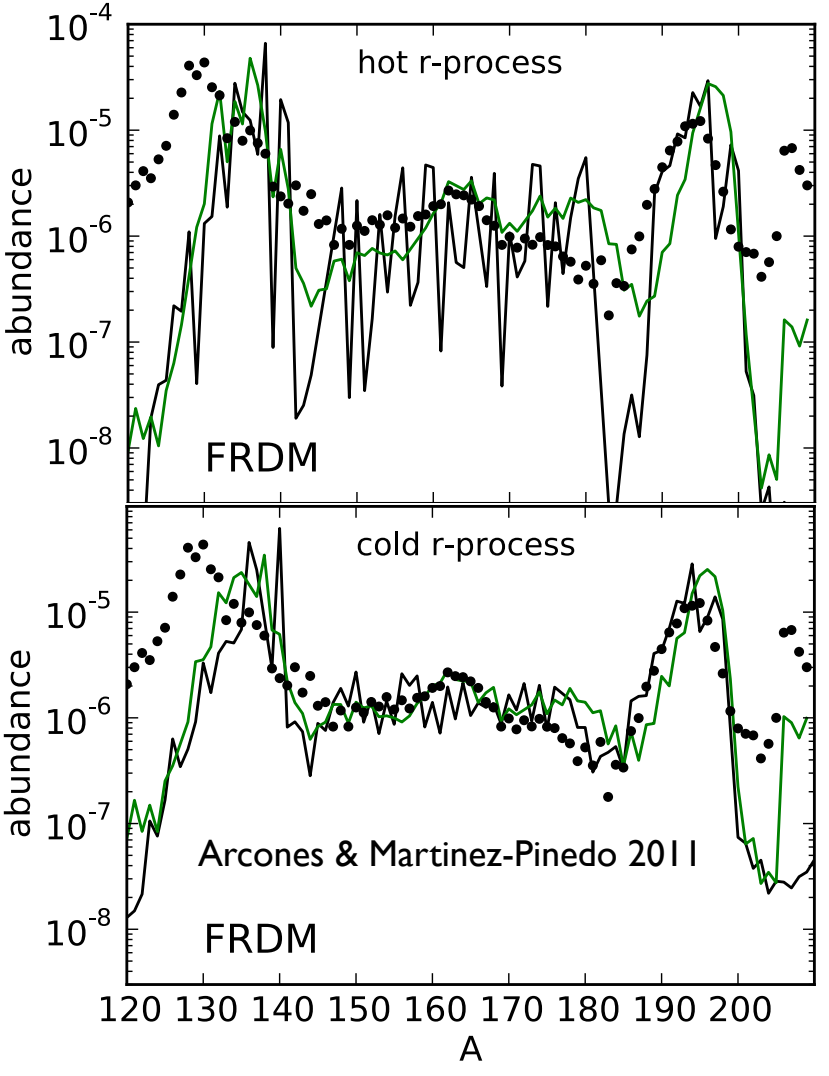
Important nuclear physics r-process

Sensitivity to nuclear physics

Delayed neutron emission probabilities of isotopes involved in the **r-process** define the decay path towards stability during freeze-out and provide a source of late time neutrons

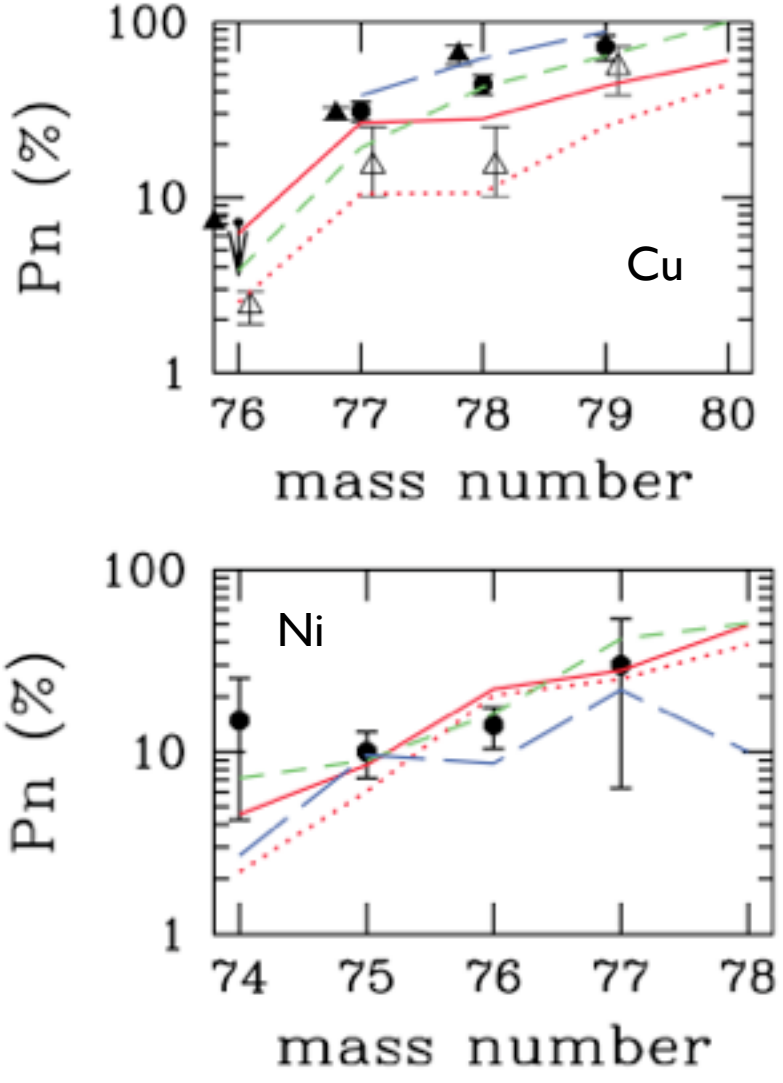


Sensitivity to astrophysics

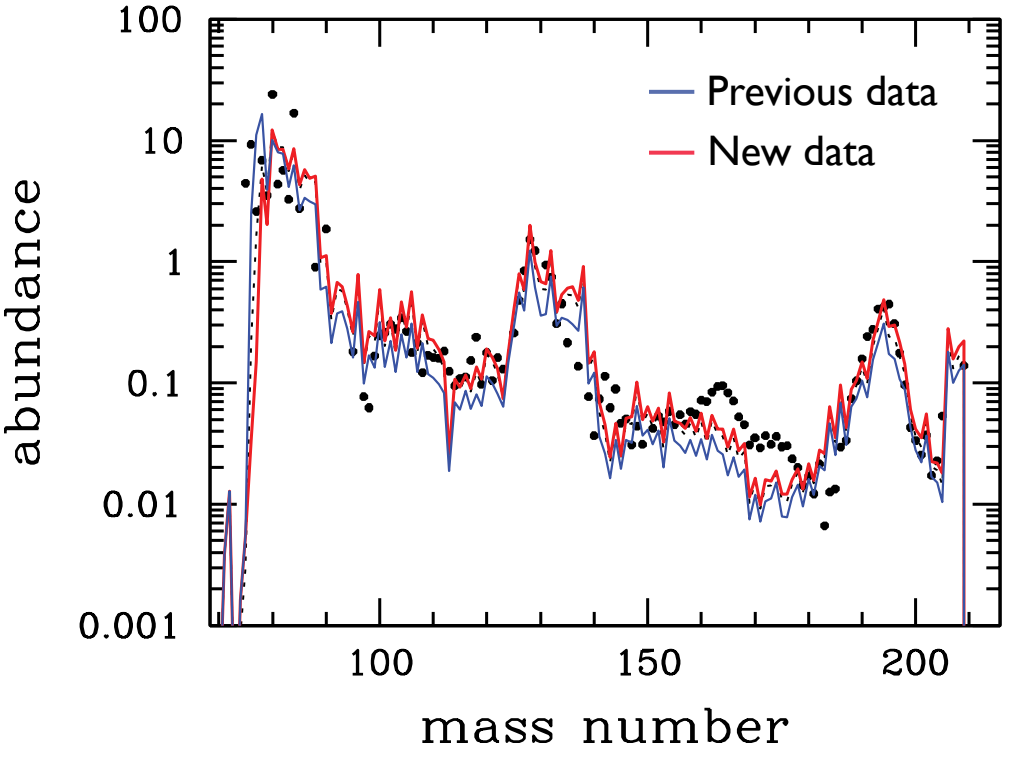


R-process implications

β-delayed neutron branching ratios

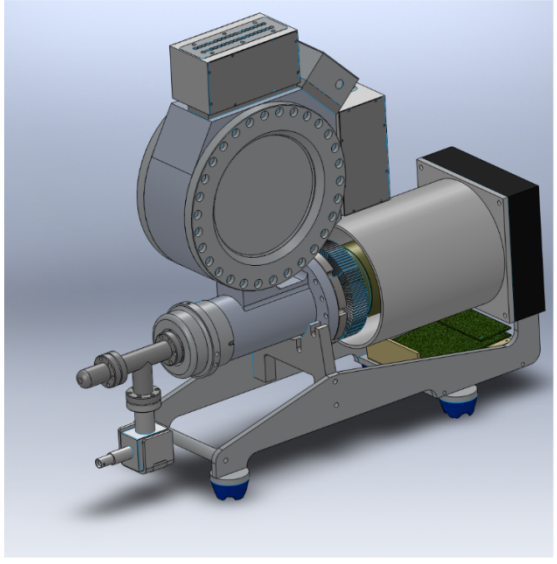


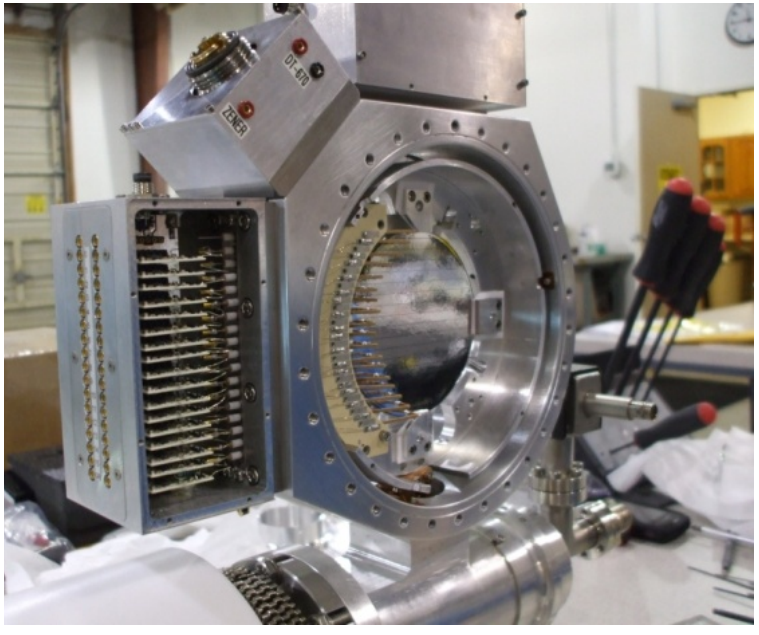
Hosmer et al. 2010



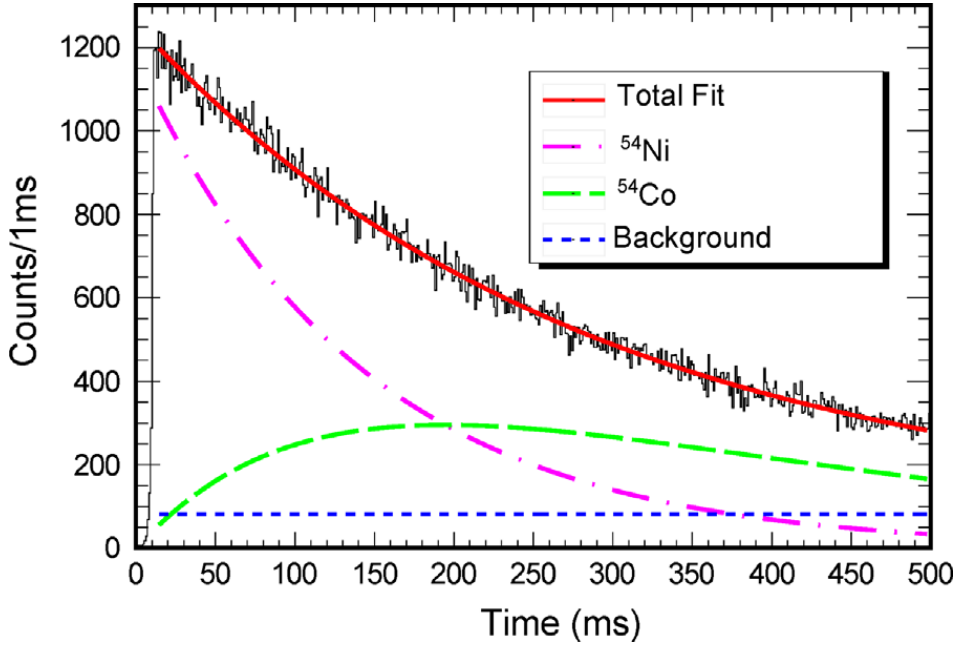
New beta-decay system

- Prototype GeDSSD
- Electrically segmented
- Dual gain
- High beta-detection efficiency compared to Si due to higher Z of Ge and availability of greater thickness
- **Expect final detection efficiency ~85%**





N. Larson et al., Nucl. Instrum. Methods Phys. Res. 727, 59 (2013)



Summary

- Beta-delayed neutron experiments have been done at NSCL (38 Pn measurements).
- Beam intensities limit the current reach of what can be measured.
- Current understanding of the r-process limited by incomplete nuclear physics. So far only the nuclear physics in the A~80 region is in a solid basis. Now the astrophysical conditions responsible for the abundances in this region can be unambiguously determined.

- New measurements of beta-decays and beta-decay neutron emission probabilities are crucial to understand the creation of about 50% of the abundances heavier than Fe (r-process).
- Facilities such as BigRIPS are ideally suited to measure the relevant nuclear physics