HRIBF Users Workshop
“Upgrade for the FRIB Era”
Nov 13-14th 2009

Applications Working Group
Session Summary

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Applications Working Group

Topics: Isotope Facility Proposal
Surrogate Reactions
Triton Beams and Targets
Accelerator Mass Spectroscopy
Miscellaneous Projects

Topics covered areas that will benefit from the proposed IBA C70 driver upgrade and activities that generally enhance the HRIBF research portfolio.

The proposed isotope production R&D program was the main focus of the discussions.

Attendance: 25-30 participants

Topic: Isotope Facility Proposal

Presentations:

- Mike Saltmarsh (Consultant): The proposal for an Isotope R&D facility complementary to the HRIBF upgrade
- Lee Riedinger (UT), Tom Ruth (TRIUMF): Overview of NSACI perspectives
- Lee Riedinger (UT): Overview of the structure and funding of the existing isotopes program
- Tom Ruth (TRIUMF): Report summary from the Medicine and Biology Working Group of the "Accelerators for America's Future" workshop , Oct 2009

Discussion: lively, friendly, and constructive; focus on learning how the isotopes and basic science programs can not only co-exist, but complement and enhance each other at HRIBF with the proposed IBA C70 driver upgrade.

Topic: Isotope Facility Proposal

Major consensus item:

The isotope facility/ HRIBF upgrade offers significant potential synergies between the HRIBF science program and the isotopes program.

Benefits and opportunities:

- Production of longer-lived radioisotopes for subsequent "batch-mode" acceleration at HRIBF (continuation of 7Be, extension to 10Be, 26Al, 44Ti, 56Ni, 59Fe ??)
- High power density target technology needed for both ISOL and isotope production targets.
- Co-location of the two programs provides a bridge between the nuclear-physics and radiochemistry expertise needed by both.
- Co-location of facilities and the extensive ORNL isotope infrastructure provide unique opportunities for enhancing workforce development by offering connections for faculty and students in one area to interact and/or practice in the other.

Topic: Isotope Facility Proposal

Suggestions on how to improve the isotope proposal:

- Explore with IBA how to extend the proton minimum energy down to 20 MeV to cover more of the energy range of interest to the industry
- Identify a “niche” isotope production capability, similar to 13N as a tracer.
- Be more explicit about how to accommodate the potentially rigid schedule demands of any medical isotope production.
- Are there possibilities for HRIBF mass separation technologies/ capabilities to enhance radioisotope purity?
- Are there connections to other fields to be made? (NNSA, environmental tracer needs etc.)
- Be more explicit about the shielding required between target stations to allow adequate access to the target areas for the Production R&D program.
- For workforce development: could one “piggyback” at existing Nuclear Physics Summer Schools by developing isotope production contributions?

Topic: Surrogate reactions

Main points:

- Indirect approach for obtaining compound-nuclear reaction cross sections
- Method successful for (n,f), now being developed for (n,γ) and, at ORNL, for inverse-kinematics use. Expected to be important for RIB facilities, as inverse-kinematics cross section measurements are typically of surrogate type
- Method combines theory and experiment, is driven by applications
- Meeting the cross section needs for astrophysics, nuclear-energy, and stockpile-stewardship applications requires inverse-kinematics use of the method. Upgraded HRIBF can address some of these needs.
- Some reactions were suggested (130Sn region, fission fragments), more information on cross-section requirements need to be solicited from practitioners
- Tritium beams could be useful: (t,p) moves to more n-rich isotopes
- HRIBF upgrade can provide data to guide and test reaction-theory development

Suggestion for the proposal:

- Identify 1-2 specific reactions for each application that can be measured with the upgraded facility. This requires more discussion between experimental group, theorists, and practitioners of each application.

Topic: Surrogate reactions

General statement about cross sections for applications:

- Cross section needs for various applications can be addressed by
  - direct measurements, where targets can be produced
  - Surrogate measurements, when the compound nucleus can be reached
  - Hauser-Feshbach calculations, if reliable input (level densities, γ-ray strength functions, optical-model potentials) is available

- An ISOL facility, like the one achieved through the proposed upgrade can provide valuable information for all three approaches, by providing:
  - Unstable, but sufficiently long-lived isotopes for direct measurements
  - Radioactive beams for Surrogate measurements
  - Structure and reaction data on unstable nuclei to improve reaction-theory models and their inputs, and to validate the calculations

Topic: Triton beams and targets

Presenters: Anna Hayes (LANL), Alfredo Galindo-Uribarri (ORNL)

Main points:

- Tritium beams are needed for: (i) direct cross section measurements for t-induced reactions; (ii) indirect cross section measurements for compound reactions with the surrogate (t,p) mechanism; (iii) t+t experiments
- Hayes reported on radiochemical diagnostic tools for the National Ignition Facility (NIF) at LLNL:
  - Neutron spectrum from t+t reaction gives information on areal density and ion temperature of fuel in NIF laser-driven fusion experiments
  - Cross sections for t-induced reactions on shell material of NIF capsules needed to extract information on hydrodynamic instabilities and electron temperatures
  - Discrepancy needs to be resolved: results from an old t(t,n)nα experiment, which seem to fit well with theory analysis do not agree with observations of recent t+t fusion experiments at Omega (Rochester) - Solution: perform a t+t experiment with tritium beam and tritiated target
- Galindo-Uribarri reported on the general interest in the reactions and structure community in tritium beams, as well as tritium targets. He laid out a plan for implementing a tritium-beam capability at ORNL.

Topic: Accelerator Mass Spectroscopy

Main points:

- Renewed interest in Accelerator Mass Spectrometry (AMS) is emerging in connection with Radioactive Ion Beams (RIBs).
- Isobar separation is one of the main challenges for both AMS and RIB Science. The cyclotron upgrade will extend the range of radioactive species available for experiments. Developing new techniques that improve isobar separation will benefit both fields.
- HRIBF has equipment for beam transport and analysis that is ideal for AMS. Unique capabilities for performing the highest sensitivity measurements of AMS are: (i) the highest operating voltage in the world, and (ii) folded geometry with 180 degree magnet in the terminal.
- The HRIBF tandem accelerator is the most sensitive in the world for the measurement of 36Cl, as illustrated by recent AMS measurements in seawater samples. This ultra-high sensitivity opens opportunities for applications in a variety of areas: oceanographic tracers, waste disposal, nuclear safeguards, rock erosion, neutron flux monitors, homeland security, and measurement of nuclear cross sections.

Miscellaneous topics

Ongoing/potential areas of study at ORNL:

- Joint wear studies using 7Be; program will benefit from isotope program, as 7Be can be produced on site
- Explore opportunities for collaborating with the UTK Nuclear Engineering department
- Emission channeling technique: movement of charged particles through a single crystal subsequent to radioactive decays provide information on structure of materials
- Detection of 3He at ultra-low levels for fundamental physics at SNS (presented by Paul Mueller, ORNL)