ROAD MAPPING SESSION 4, PART 1: NUCLEAR DATA FOR ISOTOPE PRODUCTION

DAVID A. ROTSCH
Principal Chemist
Deputy Program Manager, Radioisotope Research and Production Program
Chemical and Fuel Cycle Technology Division
Argonne National Laboratory

JERRY NOLEN,
JEONGSEOG SONG,
ROBIN de KRUIJFF,
TOM BROSSARD,
MATT GOTT,
SERGEY CHEMERISOV,
RAVI GAMPA,
BRAHIM MUSTAPHA

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ARGONNE’S RADIOISOTOPE RESEARCH AND PRODUCTION PROGRAM

R2P2 Mission

- Make critical isotopes more readily available to the community
- Develop **novel production** and **purification technologies**
ARGONNE INFRASTRUCTURE AND CAPABILITIES

- Low Energy Accelerator Facility
  - 30-50 MeV electron linac, ~10-25 kW beam power
- Argonne Tandem Linac Accelerator System (ATLAS)
  - Superconducting linac
  - CW heavy ion beams, any expect deuterons, up to ~10 MeV/u
  - Currents up to ~10 particle µA – limited by shielding for light ions
- Nuclear physics instrumentation, target development
- Reaction yield simulations
- Radiological handling – remote handling in hot cells
- Robotics
- Chemical separation and purifications
- Engineering support
WE USE THE MONTE CARLO CODE PHITS EXTENSIVELY, ESPECIALLY FOR PHOTONUCLEAR SIMULATIONS – LARGE SCALE COMPUTING IS ESSENTIAL

- The **photonuclear** and **light ion data bases are far from adequate** – there is a need for much more data to systematically validate the models.
- Obtaining accurate isotope specific data via activation is difficult and time consuming requiring many iterations between simulations and measurements.

Quick Facts
- 1024 public nodes
- 128GB DDR4 (Intel Broadwell) / 96GB DDR4,5GB MCDRAM (Intel Knights Landing) of memory on each node
- 36 cores (Intel Broadwell) / 64 cores (Intel Knights Landing) per compute node
- Omni-Path Fabric Interconnect
PHOTONUCLEAR CROSS SECTION R&D
Fundamental Science Required to Establish Cross Sections

Duke Free Electron laser and Gammas via laser Backscattering
KEY EXAMPLES

Need to develop witness reaction(s) and perform more measurements to improve theory.
LIGHT-ION ISOTOPE R&D AT ATLAS

Ion-linac Accesses Unique Production Pathways

- Direct bombardment of light-ions on target material induces nuclear reactions
  - Delivers any ion beam from protons to uranium

Target station for Auger emitter research at ATLAS
“HEAVY” LIGHT-ION REACTIONS FOR AUGER-EMITTER PRODUCTION

LDRD – Novel Production of Theranostic Precious Metal Radionuclides at ATLAS

- Radionuclides to produce advanced chemotherapeutic drugs for improved treatments.

- Reaction Pathways of Interest:
  - $^{187}\text{Re}(^6\text{Li}, 5n)^{188}\text{Pt}$
  - $^{184}\text{W}(^6\text{Li}, 4n)^{186}\text{Ir}$

- No data exists in EXFOR for reactions of interest.

- Theoretical simulations predict > 1 barn max cross sections for these compound nucleus reactions

- Running experiments to measure the excitation function by using a target stack for comparison with the simulations

- Iron witness foils are being used as a cross check of our absolute cross section measurements
  - *Phys Rev C*, 1979, 19(3), 724-739

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