LBNL/UCB Status Report

Period (May, 2017 - April, 2019)

For the 23rd NSDD Meeting, Vienna, Austria, April 8-12, 2019

Program Summary:

Nuclear Data activities under the Nuclear Data Group of LBNL+UCB (Also known as Isotopes Project at LBNL) cover nuclear structure data evaluation, experiments and evaluation of neutron capture gamma ray data for Evaluated Gamma ray Activation File (EGAF), evaluation of (n,n′γ) data, Reference Database for Photon Strength Functions, and nuclear reaction studies for applied applications using neutrons from local facilities, like deuteron breakup reaction at 88-Inch Cyclotron at LBNL and DD neutron generator at the University of California at Berkeley (UCB) and other facilities like, Nuclear research reactors at Budapest, Hungary and FRM, Germany, and Cyclotron facility at the University of Oslo through an International Collaboration. The group is also involved for organization/coordination of workshops/meetings related to applied nuclear data activities and with IAEA CRP projects.

Evaluation/Compilation:

In this reporting period – mass chains A=59, A=99, A=170, A=171, and A=193 were published in the Nuclear Data Sheets (NDS). Mass chains A=23, A=59 and A=186 were submitted (one published in this period and other two are in the publication pipeline). Mass chain A=24 revision is ongoing, which was revised by R. Firestone in 2006. Senior ENSDF evaluators (contract with UCB) have submitted A=99 (also with BNL), A=82, and A=229 for publication in NDS. Three mass chains were reviewed. Compilation of 56 datasets from 35 papers was done for XUNDL database. Neutron capture studies of ^{139}La target related to EGAF have been published in the Phys. Rev. C. and ^{187}Re(n,γ)^{188}Re analysis ongoing in collaboration with student (Trevor Warren) from the Air Force Institute of Technology.

Two horizontal evaluations are ongoing. The first one is the compilation of (n,n'γ) data from Baghdad Atlas. Several datasets have been compiled and evaluated for the EXFOR database and currently in the pipeline. Earlier plan to expand this compilation into a full horizontal evaluation of (n,n'γ) by incorporating adopted levels and gammas information from ENSDF together with more recent measurements at international experimental facilities is in progress. The second activity is a horizontal evaluation effort of beta-delayed proton emitters being led by Jon Batchelder and it is in the process of publication in Atomic and Nuclear Data Tables.

Publication/Experiment:

In total thirty-one journal papers/conference proceedings/meeting reports related to experimental activities have been published, authored/co-authored by nuclear data group

members, in this reporting period. **Error! Hyperlink reference not valid.** The LBNL/UC group has performed several measurements related to medical isotope production campaign in collaboration with LANL, BNL groups, and other international collaborators. Data analyses are in progress.

Other Activities:

Following the recommendation of the participants at the 22nd NSDD meeting, a web site has been developed on *"Nuclear Structure Experimental Issues"*, formerly known as the "High-Priority Nuclear Structure Request List": http://nucleardata.berkeley.edu/hpnsrl/ by A. Hurst to disseminate inconsistencies related to nuclear structure data for possible experimental initiatives and solutions.

The LBNL/UC nuclear data group played a key role in several meetings. This included:

- The Workshop on Applied nuclear Data Activities (WANDA), held January 22-24, 2019 in Washington DC, NY which was organization by Lee Bernstein.
- Bernstein was also the co-organizer of the 6th International Compound Nuclear Reactions Workshop which was held 24-28 September 2018 LBNL and the Nuclear Data Road mapping Enhancement Workshop (NDREW) held in Washington DC, January 19-22, 2018.
- LBNL also hosted the 22nd NSDD technical meeting in May 22–26, 2017, Berkeley, California.
- R. B. Firestone attended the IAEA Coordinated Research Project on Photonuclear Data and Photon Strength Functions meetings in Vienna, October 16-20, 2017 and December 17-21, 2018.
- Several group members presented papers at the Workshops on Nuclear Level Density and Gamma Strength in Oslo, 8-12 May, 2017 and in Svalbard, 22-25 May, 2018.
- A. M. Hurst attended the IAEA CRP on Nuclear Data Portal Web Tools in Vienna, July 30 – August 1, 2018.

Two graduate students received their doctoral degrees in August 2018 working with the nuclear data group. This included Leo Kirsch (Gamma Strength from Quasi-Continuum Lifetimes using ^{56}Fe(p,p')) and Andrew Voyles (Nuclear Excitation Functions for Production of Novel Medical Radionuclides). Six more graduate students are working with the nuclear data group for their Ph.D including Amanda Lewis, Eric Matthews, Jonathan Morrell, Morgan Fox, Austin Lo and Christopher Brand.

Future Plan:

Future plan of Nuclear Data Group at LBNL will continue activities for the ENSDF, XUNDL, Photon Strength Functions, EGAF databases and NSR compilation (new consideration). The group will also lead the effort to compile and evaluate inelastic neutron scattering cross sections – with the goal of developing a new reaction benchmark based on the

updated Atlas of Gamma-ray from the Scattering of Reactor Fast Neutrons (http://nucleardata.berkeley.edu). In addition, specific interest will be devoted to targeted cross section and decay data measurements in support of medical isotope productions including ^{64,67}Cu, ^{193m}Pt, ^{51,52}Mn, ^{134}Ce, ^{72}Se, ^{68}Ge and ^{225}Ac. These efforts will involve activation measurements using charged particle beams (mainly proton and deuteron) and neutrons from the thick target deuteron breakup source at the 88-Inch Cyclotron and the High Flux DD Neutron Generator on the UC Berkley campus.

During the next three years the LBNL/UC Nuclear Data Group will also participate in two experimental activities supported through the new Nuclear Data Interagency Working Group process started in the United States. This includes a collaborative effort to develop a new set of evaluated fission product yields and an effort to improve the ^{238}U(n,n') cross section evaluation. Both efforts will utilize the intense neutron beams from the 88-Inch cyclotron and will be performed in collaboration with nuclear data group at BNL, LANL and LLNL.

Personnel:

In this reporting period, group members at LBNL and UCB-NE include Lee A. Bernstein (Group Leader), M. S. Basunia, Aaron M. Hurst, Jon Batchelder, Richard B. Firestone, Eddie Browne, Jagdish Tuli along with postdoc Andrew Voyles, six graduate students mentioned above, visiting students from the University of Oslo - Daniel Murphy, Hannah Lovise Okstad Ekeberg and Nora Petersen, visiting scientists Milan Krticka from Charles University in Prague and Md. Shuza Uddin from Bangladesh Atomic Energy Commission.