

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE, LLC
POST OFFICE BOX 2008, OAK RIDGE, TENNESSEE 37831-6285

ORNL
FOREIGN TRIP REPORT
TA 414169

DATE: November 10, 2017

SUBJECT: Report of Foreign Travel to Geel, Belgium – Klaus H. Guber, Reactor and Nuclear Systems Division

TO: Angela Chambers, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-511/GTN, 1000 Independence Ave., SW, Washington, DC 20585-1290

FROM: Klaus H. Guber

**MEETING:
TITLE** N/A

**MEETING:
LOCATION** JRC-Geel, Geel, Belgium

**MEETING:
DATES** 9/27/2017 – 10/20/2017

**ATTENDEES:
ON BEHALF
OF NCSP** Klaus H. Guber

**MEETING:
BENEFIT TO
NCSP** Dr. Guber is a nuclear data specialist who has experience in nuclear data measurements, and he traveled to Geel, Belgium to perform neutron cross-section measurements using the Geel Electron Linear Accelerator (GELINA) at JRC-Geel. The measurements have been performed in accordance with the Nuclear Criticality Safety Program (NCSP) Five Year Plan, and the measurements provide needed nuclear data for the NCSP.

PURPOSE: The primary purpose of the travel is to perform nuclear cross-section measurements at the Joint Research Center of the European Union (JRC-Geel) in Geel, Belgium. The primary objective during this trip was to initiate neutron capture cross-section measurements on for La samples at JRC-Geel. Furthermore, additional work includes data reduction and sorting tasks for previous measurement campaigns for a thick Ce sample neutron capture cross-section at JRC-Geel. All of these work tasks have been performed for the NCSP, and the nuclear data measurement work is performed in collaboration with JRC-Geel of the European Community.

**SITES:
VISITED** The Joint Research Institute of the European Community, Geel, Belgium

ABSTRACT: The traveler visited JRC-Geel in Geel, Belgium. At JRC-Geel, the objective of the visit is to initiate additional neutron capture cross-section measurements for La using samples of various thickness at the GELINA facility. During the visit, Guber performed data reduction tasks for Ce capture data obtained through measurements with the thick sample.

**Access to the information in this report is limited to those indicated
on the distribution list and to U.S. Government Agencies and their Contractors.**

REPORT OF FOREIGN TRAVEL

**Klaus Guber
Geel, Belgium**

September 27 – October 20, 2017

PURPOSE OF TRAVEL

The main purpose of the travel is to perform nuclear cross-section measurements at JRC-Geel in Geel, Belgium. The primary objective of this trip was to initiate transmission and neutron capture cross-section measurements on lanthanum samples of various thickness at JRC-Geel. Also, data sorting and reduction for the newly obtained data for a thick Ce sample was started (see previous report). These work tasks have been performed for the NCSP, and the nuclear data measurement work is performed in collaboration with JRC-Geel of the European Community.

Report

Klaus Guber traveled to JRC-Geel to perform nuclear data measurement and analysis work for the NCSP. At JRC-Geel, the GELINA (Geel Electron Linear Accelerator) neutron facility can be used to perform neutron-induced cross-section measurements in the neutron energy range from thermal up to ~20 MeV that includes the resonance region for many isotopes/nuclides of interest to the NCSP. GELINA is similar in capability to the Oak Ridge Electron Linear Accelerator (ORELA) in the U.S.; however, ORELA is no longer available for performing neutron cross-section measurements. GELINA is a neutron source driven by a pulsed electron beam, which produces neutrons via Bremsstrahlung from a uranium target. Due to a special compression system, the accelerated electron pulse of GELINA can be compressed to one nsec pulse width at full power. In combination with a long flight path, the GELINA facility provides excellent time-of-flight (TOF) resolution, which determines the neutron energy. Therefore, individual resonances of the cross section can be resolved at much higher neutron energies, and this neutron energy-resolution capability is essential for determining the detailed neutron cross-section structure for nuclides of importance to criticality safety applications.

In the course of this trip, new La neutron capture cross-section measurements were initiated. La being on the list of appendix B was moved forward, since it is quasi monoisotopic (99.91% natural abundance of La-139) a natural metallic sample could be purchased. Due to the new lease policy of DOE for enriched isotopes, which allows no radioactivity added to the sample it was reasoned that the La experiments could be performed first until the leasing issue of isotopically enriched samples was resolved. However, the La samples were not delivered in time as promised for this trip. Therefore, transmission experiments could not be executed, so it was decided to start with background measurements for the neutron capture set up first. These data are needed for the background correction of the neutron capture for La and the reference sample.

Beside the background experiments, the main focus on this trip was to start the data sorting tasks at JRC-Geel for the previous neutron capture experiment measurements of the thick natural Ce samples. For this task, the GELINA specific software packages AGL and AGS were used. In the first step, all list mode data were converted into TOF spectra. This data conversion was completed for the sample, reference sample, sample holder, scattering sample, open beam and different background filter configurations. With AGS, the data can be converted to cross-section data or transmission data. The GELINA data-reduction software enables the experimentalist to process all experimental uncertainties in a consistent way to produce a

covariance matrix describing all experimental effects, and the experimental covariance data are essential for supporting the cross-section covariance evaluation effort.

Based on preliminary analysis of the Ce data, the measured cross-section data are useful to support subsequent resonance evaluation work at ORNL as planned in the NCSP Five Year Plan. In the previously obtained cerium data not only resonance to higher neutron energies could be observed but also resonances of the minor isotopes (abundances less than 0.2%) could be seen. GELINA's high neutron flux in combination with a short pulse width and long flight path will enable ORNL to extend the resolved resonance region for Ce beyond the existing resonance evaluation limit. In the high-energy neutron region, the dominating factor determining neutron energy resolution is the neutron pulse width.

Attended a seminar of Dr. Roberto Capote from the IAEA about "Unrecognized Systematic Uncertainties".

Overall, Guber's foreign travel to JRC-Geel was essential to enable ORNL to complete the planned NCSP measurement and evaluation tasks as defined in the NCSP Five Year Plan.

Persons Contacted at JRC-Geel

Peter Schillebeeckx, Host
Willy Mondelaers, Section Head NP Unit
Peter Siegler
Stefan Kopecky
Jan Heyse
Arjan Plompen
Roberto Capote, IAEA

Itinerary and Schedule

09/27/17 – 09/28/17	Travel from Knoxville to Geel, Belgium
09/28/17	JRC-Geel -GELINA, Geel, Belgium. Preparing data from previous runs for the flux measurements for the thick Ce sample. Sorting of flux list mode for data into TOF spectra.
09/29/17	JRC-Geel -GELINA, Geel, Belgium. Sorting of flux list mode data into TOF spectra. Discussion about NCSP-JRC agreement with Wim Mondelaers (division director), Arjan Plompen, Peter Schillebeeckx.
09/30/17 – 10/01/17	Weekend
10/02/17	JRC-Geel -GELINA, Geel, Belgium. Calibration and preparing of experimental set up. Sorting of flux list mode for data into TOF spectra.
10/03/17	JRC-Geel -GELINA, Geel, Belgium. Discussion with Stefan Kopecky about the experimental data situation of the O(n,alpha) reaction for the CIELO project and new ENDF/B-VIII evaluation. Sorting of flux list mode for data into TOF spectra.
10/04/17	JRC-Geel -GELINA, Geel, Belgium. Sorting of flux list mode for data into TOF spectra. Discussion with Stefan Kopecky about the problems of data sorting for various flux runs.
10/05/17	JRC-Geel -GELINA, Geel, Belgium. Discussion with Peter Schillebeeckx about the contributions to the CIELO collaboration. Investigation of the problematic flux runs individually. Finalizing flux measurements.

10/06/17 JRC-Geel -GELINA, Geel, Belgium. Preparing data from previous runs for the thick Ce sample measurements. Sorting of Ce list mode for data into TOF spectra. Discussion with Peter Schillebeeckx about the new publication of U238 evaluation performed by JRC-Geel.

10/07/17 – 10/08/17 Weekend

10/09/17 JRC-Geel -GELINA, Geel, Belgium. Calibration of experimental set up. Start of experiments for La neutron capture. Sorting of Ce list mode for data into TOF spectra.

10/10/17 JRC-Geel -GELINA, Geel, Belgium. Continue La runs. Sorting of Ce list mode for data into TOF spectra.

10/11/17 JRC-Geel -GELINA, Geel, Belgium. Discussion with Stefan Kopecky and Peter Schillebeeckx about the experimental data situation of the O(n,alpha) reaction for the CIELO project and new ENDF/B-VIII evaluation. Continue La runs. Sorting of Ce list mode for data into TOF spectra.

10/12/17 JRC-Geel -GELINA, Geel, Belgium. Continue La runs. Sorting of Ce list mode for data into TOF spectra.

10/13/17 JRC-Geel -GELINA, Geel, Belgium. Continue La runs. Sorting of Ce list mode for data into TOF spectra.

10/14/17 – 10/15/17 Weekend

10/16/17 JRC-Geel -GELINA, Geel, Belgium. Calibration of experimental set up. Continue La runs. Sorting of Ce list mode for data into TOF spectra.

10/17/17 JRC-Geel -GELINA, Geel, Belgium. Continue La runs. Sorting of Ce list mode for data into TOF spectra.

10/18/17 JRC-Geel -GELINA, Geel, Belgium. Continue La runs. Sorting of Ce list mode for data into TOF spectra.

10/19/17 JRC-Geel -GELINA, Geel, Belgium. Continue La runs. Sorting of Ce list mode for data into TOF spectra. Finalizing sorted data and save data to external disk for transfer to ORNL.

10/20/17 Travel from Geel, Belgium to Knoxville, USA

DISTRIBUTION

1. Doug G. Bowen (bowendg@ornl.gov)
2. Angela Chambers (angela.chambers@nnsa.doe.gov)
3. Jerry N. McKamy (Jerry.McKamy@nnsa.doe.gov)
4. Lori Scott (Lorisc0tt@aol.com)
5. Jamie Sweers (jsweers@lanl.gov)