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**ORNL  
FOREIGN TRIP REPORT  
TA 397024**

**DATE:** November 12, 2016

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

**TO:** Jerry N. McKamy, 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** International Conference on Nuclear Data for Science and Technology, Bruges, Belgium (ND2016)  
JRC-Geel, Geel, Belgium

**MEETING:  
DATES** 9/19/2016 – 10/20/2016

**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.  
In addition, Dr. Guber gave a presentation of the NCSP neutron cross section measurement activities at the International Conference on Nuclear Data for Science and Technology in Bruges, Belgium.

**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 continue neutron cross-section measurements on natural zirconium (Zr) at JRC-Geel. Furthermore, additional work includes data reduction tasks for previous measurement campaigns for vanadium transmission and 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. In addition a presentation of the NCSP neutron cross section work was given at the International Conference on Nuclear Data for Science and Technology in Bruges, Belgium.

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

**ABSTRACT:** The traveler visited JRC-Geel in Geel, Belgium. At JRC-Geel, the objective of the visit is to continue neutron capture cross-section measurements for the thick vanadium sample using the GELINA facility. Furthermore, new measurements for natural Zr were initiated at JRC-Geel. During the visit, Guber finalized data reduction tasks for vanadium neutron capture data obtained through measurements with the “thick” sample and produced cross sections. At the International Conference on Nuclear Data for Science and Technology in Bruges, Belgium, the traveler gave a presentation of the NCSP work.

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## **REPORT OF FOREIGN TRAVEL**

**Klaus Guber  
Bruges and Geel, Belgium  
September 9 – October 20, 2016**

### **PURPOSE OF TRAVEL**

The primary 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 continue neutron capture cross-section measurements on zirconium at JRC-Geel. Also, data reduction for the newly obtained data for vanadium was initiated. Furthermore, additional work includes data reduction tasks for previous measurement campaigns in 2014 and 2015 for V transmission and 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. A presentation of the neutron cross-section work for the NCSP was given at the ND2016.

### **Report**

During the first part of this trip, Klaus Guber traveled to Bruges in Belgium to attend the International Conference on Nuclear Data for Science and Technology. This triennial conference is a nuclear data expert meeting. In the session “Thermal and resonance neutrons” of the track “Nuclear reaction measurements”, Dr. Guber gave a presentation about the neutron induced cross section measurement work for the NCSP with the title: Neutron nuclear data measurements for criticality safety.

In the second part of this trip, 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, the vanadium cross-section measurements data for the thick sample were sorted. The neutron capture experiments for the thick V sample including all background and calibration measurements were completed in summer. Furthermore the experiments for natural Zr were initiated. The data from the natural Zr sample will be used to check the analysis of the individual Zr isotopes. Neutron capture and transmission measurements for natural Zr using different sample thickness were started or continued, respectively.

In addition, data reduction tasks were finalized at JRC-Geel for the previous neutron capture measurement of the thick V sample. 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, sample holder, 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 vanadium data, the measured cross-section data are useful to support subsequent resonance evaluation work at ORNL as planned in the NCSP Five Year Plan. 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 vanadium beyond the existing resonance evaluation limit of 212 keV. However, because the first inelastic channel opens at 320 keV, neutron capture data can only be used up to this energy. In the high-energy neutron region, the dominating factor determining neutron energy resolution is the neutron pulse width.

Overall, Guber's foreign travel to JRC-Geel was very successful and 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

### **Itinerary**

09/09/16 – 09/10/16	Travel from Knoxville to Bruges, Belgium
09/10/16 – 09/16/16	ND2016 in Bruges, Belgium,
09/16/16 – 09/30/16	JRC-Geel -GELINA, Geel, Belgium
10/01/16 – 10/09/16	Personal time (vacation)
10/09/16 – 10/20/16	JRC-Geel -GELINA, Geel, Belgium
10/20/16	Travel from Geel, Belgium to Knoxville, USA

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