

Neutron Activation Experiments and Elemental Analysis Experiments by Gamma-ray Spectrometry Using Electron Accelerator Driven Neutron Source at Hokkaido University

1. Summary

Quantum beams such as neutron beams are used in materials science, life science, nuclear physics, particle physics, industrial applications, cancer therapy, and pharmaceutical applications. Among these, elemental analysis experiments using neutron activation and gamma-ray spectrometry are used for nondestructive elemental analysis of valuable samples such as sandstone brought back from asteroids by space probes and ancient cultural heritages.

In this practical training, you will learn neutron activation and gamma-ray spectrometry using HUNS (Hokkaido University Neutron Source), an electron linear accelerator-driven pulsed neutron experimental facility of the Graduate School of Engineering, Hokkaido University, which conducts a wide range of academic, industry-academic, and international joint research on demand, including materials research, food research, cultural heritage research, and cosmic ray resistant semiconductor research using neutron beams. The course provides experience in elemental analysis experiments using neutron activation and gamma-ray spectrometry. The program is very basic in content and is designed to be comfortable for beginners. On the other hand, the program is designed to provide a valuable experience for those who are not beginners so that they can experience radiation practice, spectrum analysis, and discussions based on the students' free ideas, surrounded by a different environment and people than usual.

2. Date and Time

Monday, August 28, 2023 9:30 a.m. - Friday, September 1, 2023 3:00 p.m.

3. Location

Graduate School of Engineering, Hokkaido University

Laboratory of Instantaneous Intense Pulsed Radiation Generator (LINAC), Hokkaido University

Kita 13 Nishi 8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan

<https://www.eng.hokudai.ac.jp/labo/QBMA/LINAC/index-e.html>

4. Practice Schedule

See Attachment 1 for contents.

Meeting time and date: Monday, August 28, 9:30 a.m.

Meeting place: Graduate School of Engineering, Hokkaido University

Meeting room on the 1st floor of the Laboratory of Instantaneous Intense Pulsed Radiation Generator

(See Attachment 2: Campus Map)

Emergency Contact
Hirotaka Sato

5. Lodging

Basically, please secure your own accommodations.

- Since August 28th is early in the morning, you can stay the night before: 27th.
- On September 1, if you cannot arrive home by the end of the day, you can stay overnight for the day.
- Please contact us as soon as possible with the name of the hotel where you will be staying. We will not be able to process your travel expenses and payment will be delayed.

6. Travel expenses

The prescribed transportation, lodging (9,800 yen/day), and daily allowance (2,200 yen/day) will be transferred to the designated account later. Please contact us for the designated account.

- **When coming to Hokkaido, be sure to come by air.** Do not use trains or ferries. Also, finalize your reservation as soon as possible and contact the office. **Please submit the boarding certificate or ticket stub and PDF of the receipt to the office later.**

7. Various procedures

- Submission of Application for Registration as an Outpatient Radiation Worker

If you are a Radiation Worker at your university, please visit the following web site

<https://www.eng.hokudai.ac.jp/labo/QBMA/LINAC/application.html>

If you are a radiation worker at your university, please download and fill out the application form for registration as an outpatient radiation worker by referring to "3. Please bring the original completed application form to the venue on the day of the seminar. **Please submit a copy in PDF format by Tuesday, July 25 at the latest for verification.** ((Send to: h.sato@eng.hokudai.ac.jp and anecoffice@eng.hokudai.ac.jp). It would be greatly appreciated if you could return it as soon as possible.

Please bring your institution's personal dosimeter (glass badge, etc.) on the day. In doing so, please make sure that your personal dosimeter does not pass through the airplane baggage X-ray inspection. **You are not a radiation worker at your university**, Alternatively, those who are unable to attend (or cannot make it to) the facility training session on the morning of the first day will be asked to enter the management area for a short time as a temporary visitor.

8. Precautions

- If you have a body temperature of 37.5 degrees Celsius or higher, have lost your sense of taste, **or are otherwise feeling unwell, please contact us immediately.** If you have reservations for transportation, lodging, etc., please cancel them. If a cancellation fee will be charged, please submit a request for the cancellation fee with the receipt to the secretariat later.

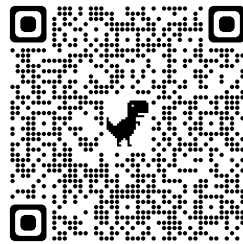
- Please take precautions against infection by sterilizing your skin frequently.

- Please wear long pants and socks as you will be entering a controlled area.

- Please bring your own lunch. The university has a cafeteria and a convenience store (Seicomart, Seven-eleven).

9. questionnaire carried out in advance

Please cooperate with us by filling out the preliminary questionnaire. Please scan the QR code below with your smartphone and respond by **Friday, August 25.**



We will also ask for your cooperation after the training is over, as we will conduct a questionnaire afterwards to see the effects of this tour.

... and upwards

Practical training at HUNS

- Education and Training of Radiation Facilities
- Introduction and tour of the Electron Linear Accelerator and Neutron Experimental Facility at Hokkaido University
- Introduction to Quantum Beam/Neutron Science
- Introduction to Accelerators, Neutron Beam Sources and Neutron Beam Engineering
- Introduction to Neutron Activation Analysis
- Neutron activation experiments using the HUNS, Hokkaido University Electron Linear Accelerator Driven Neutron Source
- Measurement of Gamma-ray Energy Spectra Using an NaI Scintillator Type Gamma-ray Spectrometer
- Energy calibration experiment of spectrometer
- Energy resolution evaluation experiment of the spectrometer
- Gamma-ray background
- Measurement of gamma-ray spectra from neutron-activated samples
- Identification and quantification of elements and nuclides
- Estimation of neutron flux at the sample irradiation position
- Proposal and execution of experiments based on students' free ideas
- Small group presentations (including theme setting, additional experiments, investigations, preparation for presentation, and discussion by instructor and TA)

	Mon.	Tue.	Wed.	Thu.	Fri.
8:45-10:15	放射線施設の教育訓練	中性子放射化分析実験 (10pps,15分)	放射化試料のスペクトル測定	追加実験(時間・距離・遮蔽とか?)	プレゼンテーション
10:30-12:00	施設の説明、施設見学	NaIシンチ式γ線スペクトロメーター試験	元素(核種)同定	追加実験のデータ解析	プレゼンテーション
13:00-14:30	量子ビーム/中性子科学概論	エネルギー校正実験	中性子束推定(元素の定量)	調査、プレゼンテーション準備	プレゼンテーション、まとめ、解散
14:45-16:15	加速器・中性子源・中性子工学概論	エネルギー分解能評価、バックグラウンド	プレゼンテーションのテーマ設定	調査、プレゼンテーション準備	黒:講義等 青:実習 赤:管理区域内での実習
16:30-18:00	中性子放射化分析概論	ディスカッション(バッファ)	ディスカッション(バッファ)	調査、プレゼンテーション準備	



Hokkaido University Campus Map



Engineering School Direction Map (note the direction)