Nuclear nonproliferation and security research and education at Tokyo Tech

Tokyo Institute of Technology
Lab. Zero-Carbon Energy

Hiroshi Sagara
1956 Research Laboratory for Nuclear Reactors (RLNR) Established
1957 Dept. of Nuclear Engineering (Graduate Program) Established
  Nuclear / Radioactive Materials, Radiation Generators, ...
  Advanced Education and R&D on Nuclear Energy, Radiation, ...
2011 “The Global Nuclear Safety and Security Dojo Program” Supported by MEXT
  3S Education to Develop Global Leaders
2016 Graduate Major in Nuclear Engineering by Education Reform
Laboratory for Advanced Nuclear Energy (LANE)
2017 “The Advanced Nuclear 3S Education and Training (ANSET) Program” Supported by NRA Japan for 5 years
2021 Laboratory for Zero-carbon Energy (ZC)
Research activities

**Laboratory for Zero-carbon Energy**

Established in 2021, reorganized from LANE (Lab Adv. Nucl. Energy)

To contribute to the realization of a carbon-neutral (CN) society by constructing a carbon and material circulation system based on zero carbon energy (ZCE)

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**Fig. 1** Prospects for zero carbonization of primary energy

**Fig. 2** Energy society aimed at the ZC

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**Director**

- Social Cooperation Advisory Board
- Future Energy Division
- Nuclear Energy Division
- Fukushima Reconstruction and Regeneration Research Unit, TEPCO Collaborative Research Cluster
Accident Tolerant Fuels (ATFs) have been developed, $\text{U}_3\text{Si}_2$ Fuel is one of the candidates. Due to its high metallic density and heat conductivity, performance improvement is expected in both neutron economy and safety. Its chemical stability also contribute to reduce the Material Attractiveness by the Pu separation difficulty.
Modular Reactor and its nuclear safeguards/security approach

- Modular reactors are the key technology in future
- Offshore Floating Nuclear Plant (OFNP) is proposed
- Its nuclear safeguards/security approach is needed to be researched for its installation in non-weapon states

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4. 浮体式原子力発電所，産業競争力懇談会（COCN）2021年度プロジェクト中間報告
Passive Gamma/Neutron Emission Tomography (PGET) Device

Source: Winning Entries to IAEA Tomography Reconstruction and Analysis Challenge to Aid Safeguards Activities

Research activities

Fuel rods

Dummy rods

Channel box

Lead collimator

Fuel rod

Pure water

Stainless canister

Figure: Principle of tomographic acquisition and geometric considerations.

3Ss Education ANSET Program

Systematic Education

- Nuclear Engineering (Existing)
- Nuclear Safety Engineering

Practical Education

- World Politics and Non-proliferation in the Nuclear Age
- Risk Assessment and Management
- Crisis Management
- Nuclear Security School
- Radiation Disaster Response Exercise

3S Lectures

- Nuclear Non-proliferation and Security
- World Politics and Non-proliferation in the Nuclear Age
- Risk Assessment and Management
- Nuclear Disaster Response Exercise
- Radiation Disaster Response Exercise

3S Exercises

- Nuclear Non-proliferation and Security Exercise
- Environmental Dynamics of Radioactive Material
- Nuclear Disaster Response Exercise
- Radiation Disaster Response Exercise

3S Internships

- Domestic Internship
- Overseas Internship

Selection

Expertise, Insight & Leadership, Practical Skills
Nuclear Non-proliferation and Security Exercise

- Uranium Enrichment Verification

- Numerical Simulations of Shock Wave Impact on Structural Materials

- Facility visit to JAEA PP Field and Nuclear Fuel Cycle Engineering Laboratories @Tokai

http://www.ne.titech.ac.jp/kiseijinzai/
Environmental Dynamics of Radioactive Material

- Small-Scale and Large-Scale Atmospheric Dispersion of Radioactive Material

Face to face and Remote Hybrid Exercise

http://www.ne.titech.ac.jp/kiseijinzai/
radiation disaster response exercise, collaboration with tees, us.

- radiological source identification and recovery, emergency response

@ texas a&m engineering experiment station in 2019

@ tokyo tech in 2021
Results for 5 years in ANSET

Number of registrations in each course, as of August 2021.

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<th>Japan Fis. Year</th>
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<td>8</td>
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<td>9~</td>
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<td>28</td>
<td>11</td>
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- More than **500 Tokyo Tech students** have taken the courses
- **25** Students Awarded Certificate
- More than **60 working professionals** from outside have joined
- Internship agreement with **JAEA, NMCC, and IAEA!**
- Due to **COVID-19, negative impacts** in 2020, especially on internship
- But, **Online lecture makes positive impact** to working professionals

Acknowledgement: This program is supported by Nuclear Regulation Authority, Japan
Impact by COVID-19 in university

• Difficulty to access abroad or other facilities
  • No internship, business trip were performed in 2020
  • Physical experiments or exercises were limited
  • Good to establish the alternative experimental contents virtually or locally

• Information sharing and R&D
  • Remote working has good compatibility with numerical simulations with software
  • Problem; Interictal properties, licenses
  • Difficulty to make “small talks” by online,

• Verification activity at LOF
Research topics for post-COVID-19

• **Sharing PDI with regional regulators**
  • IAEA HQ and Regional office
  • IAEA and State/region regulators

• **Unattended monitoring technologies**
  • Needed to efficient IAEA Safeguards activities
  • Needed to expansion of SMRs
    (Monitoring technology for NM movement and design information, ex., Muon tomography, Neutron/Gamma tracers, etc.)

• **Information sharing, R&D and Education**
  • Open source wares based on web based such as OpenMC by MIT, IAEA software
  • Virtual nuclear reactor and fuel cycle facility