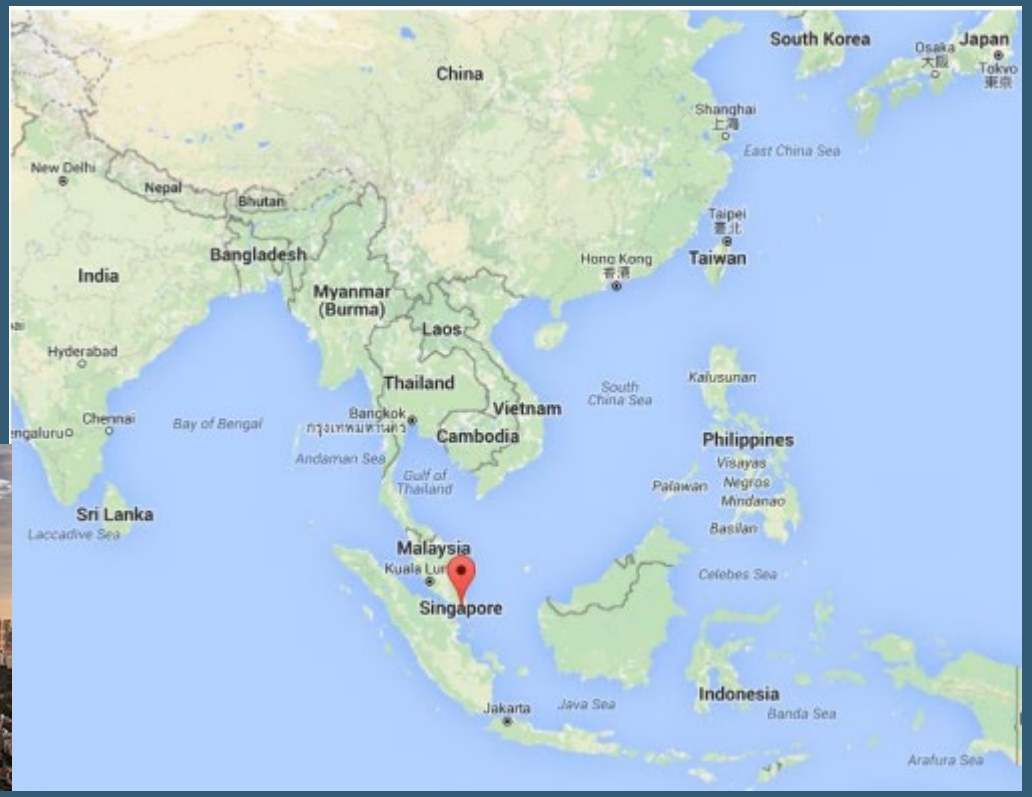
Singapore Presentation

ASEAN NPSR 5TH ANNUAL MEETING

Singapore

- Population: 5.637 million
- Population density: 7,688 per km2
- Land area: 728.3 km2
- No natural resources
- High demand for energy



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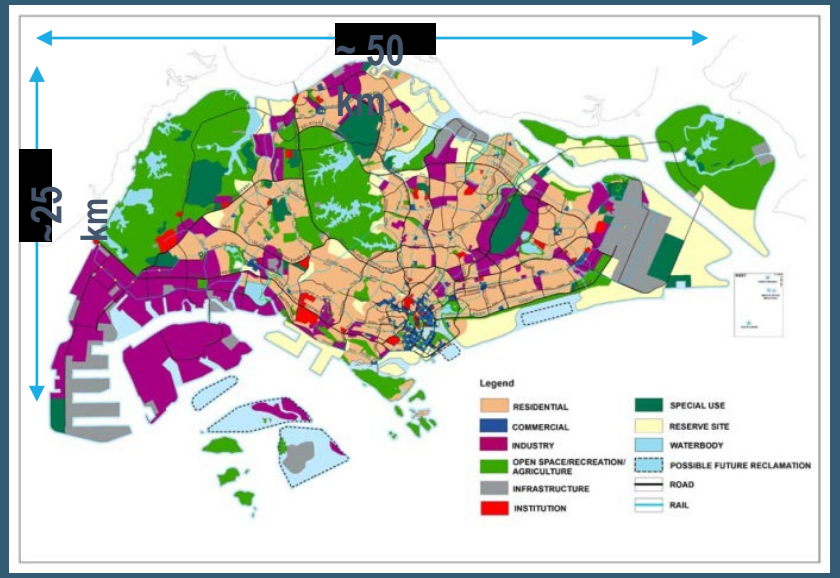
Pre-Feasibility Study on Nuclear Energy

After a two-year pre-feasibility study, Singapore has announced in parliament in October 2012 that it will **NOT** pursue nuclear power with current Nuclear Power Plant (NPP) technology.

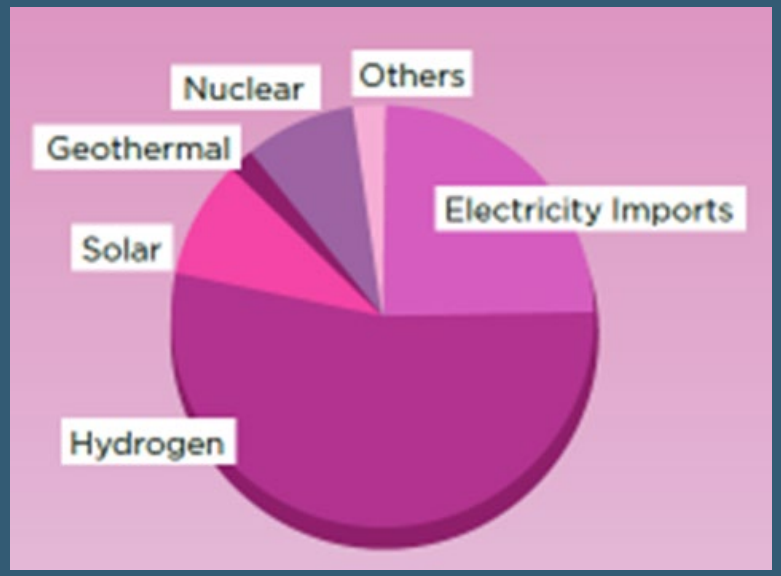
"… the risks to Singapore, given that we are small and dense, still outweigh the benefits at this point. As we are planning for the very long term and not for our immediate energy needs, **we prefer to wait for technology and safety to improve further before reconsidering our options."**

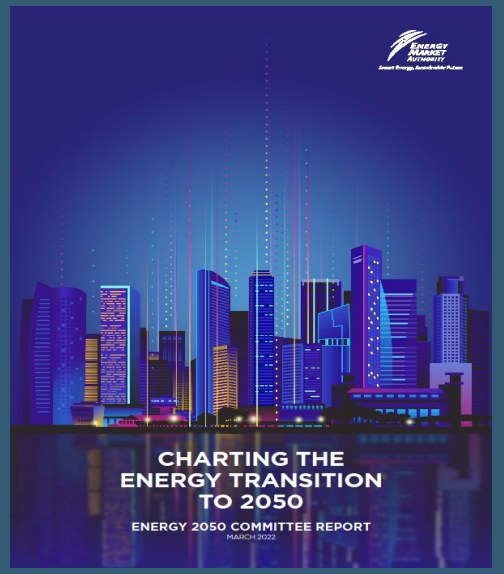


Singapore Energy 2050 Report

"With increasing number of countries adopting nuclear energy to decarbonise their economies, Singapore was now ready to assess the viability of nuclear energy for domestic deployment. It had closely monitored the progress of emerging nuclear technologies and had built deep capabilities over the years to assess the safety performances of these technologies.

In one of the three scenarios described [Emergent TechnologyTrailblazer] in Report, nuclear contributes about 10% of the energy mix for Singapore in 2050 (and is expected to grow beyond that) .





NSREP & SNRSI

- **Singapore Nuclear Research and Safety Initiative** (SNRSI) was set up in 2014
  - Execute **research and educational programmes** in **nuclear safety**.
  - Manage Scholarships to attract interested graduates to pursue postgraduate programmes in nuclear engineering and related fields (radiochemistry, radiobiology, etc.) in renowned overseas universities
  - Presently located at Interim facilities in CREATE Tower, National University of Singapore (NUS)

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Development of SNRSI

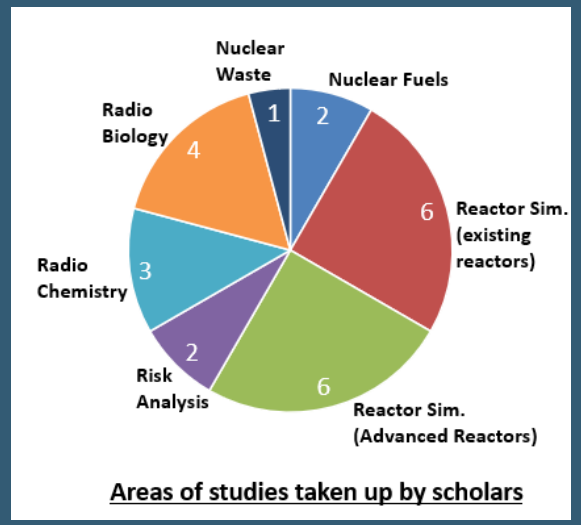
Future SNRSI Building is under construction along Prince George's Park in NUS. Gross floor area of 13,000 m^2 and targeted for completion in April 2023 at cost of ~S$70M

Will house the wet labs and simulation labs, offices as well as some related national facilities such as the Secondary Standard Dosimetry Lab and National Radiochemistry Lab.

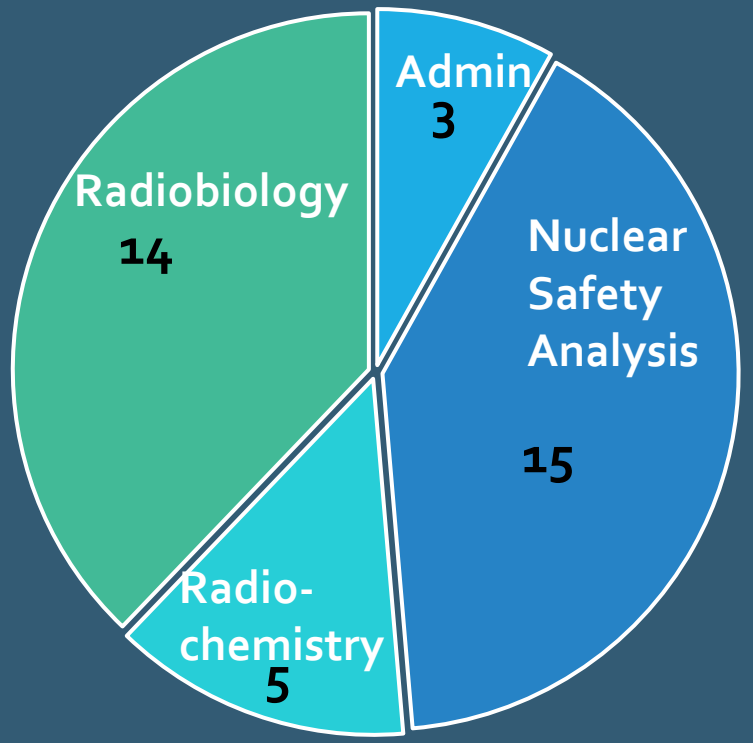
Manpower Development

Target: About **30** researchers in **each** of the three research focus areas (Nuclear Safety Analysis, Radiochemistry and Radiobiology) supported by a small team of technical and admin support by 2025 - 30. Growth by direct hires and SNRSI Scholarships.

- There has been a total of 24 SNRSI scholars awarded from AY2015 to AY2021. 11 of these scholars have since completed their studies and started their research at SNRSI.



Areas of studies taken up by scholars



Current composition of SNRSI

Research Focus of SNRSI

Nuclear Safety Analysis

Conduct simulation studies of the processes in NPP to understand the risk and consequences of possible emergencies, and the spread of radioactive contaminants in various incident scenarioS

Radiochemistry

Develop capabilities for reliable detection and accurate measurement of radioactivity; support National Environment Agency (NEA) and other government agencies in establishing baseline levels of radioactivity in our local environment and imported materials before the region goes nuclear

Radiobiology

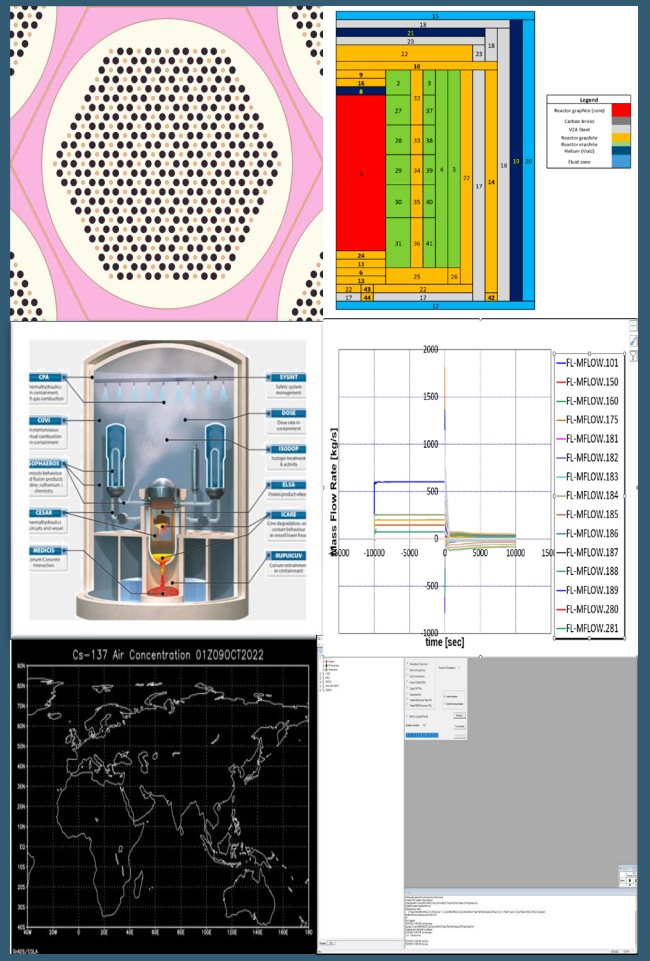
Study the effects of low-dose radiation on human health, to enable us to determine the appropriate levels of protection and courses of action in response to radiological threats. Develop expertise in dosimetry and bio-dosimetry

Nuclear Safety Analysis

Using modelling & simulation platforms to understand the operation and safety considerations of **current** as well as **advanced and safer reactor** designs

Method/Tool

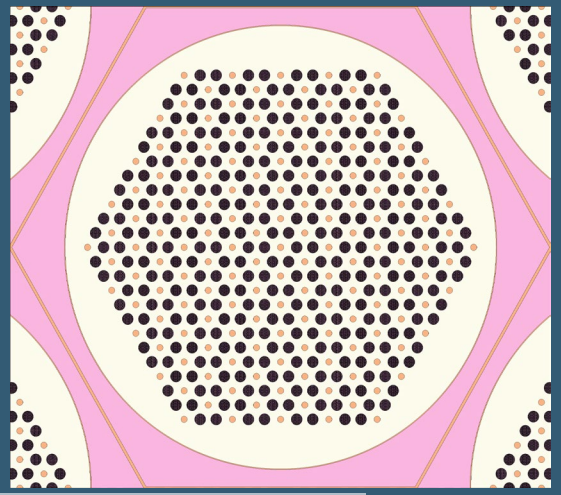
- Neutron Transport – SERPENT, VSOP
- Severe Accident Analysis – ASTEC, MELCOR
- Atmospheric dispersion – HYSPLIT, MACCS

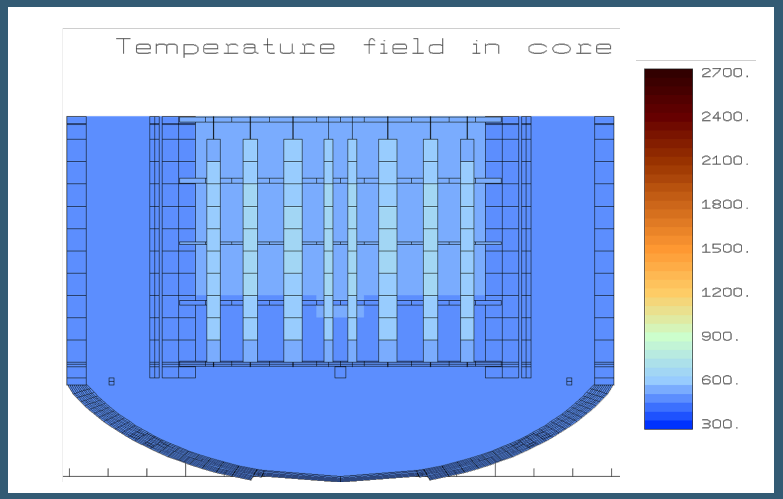


Nuclear Safety Analysis

Projects:

- Neutron Transport - Core design of Fluoride Salt-Cooled High Temperature Commercial Scale Reactor (FHCR)
- Severe Accident Analysis- Modelling of Small Modular Reactor (Nuscale) with ASTEC and MELCOR
- Atmospheric dispersion- Risk Map analysis of long range dispersion





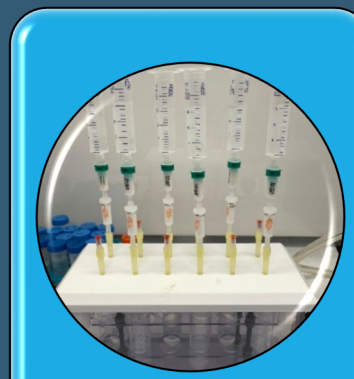
Radiochemistry

Alpha spectrometry

LA-ICP-MS/MS

HPGe Gamma spectroscopy

Liquid Scintillation Counter



Radio-analytical method development

New approaches for measurements of radionuclides in environmental samples

Remediation studies

Rapid Accurate Diverse (RAD)

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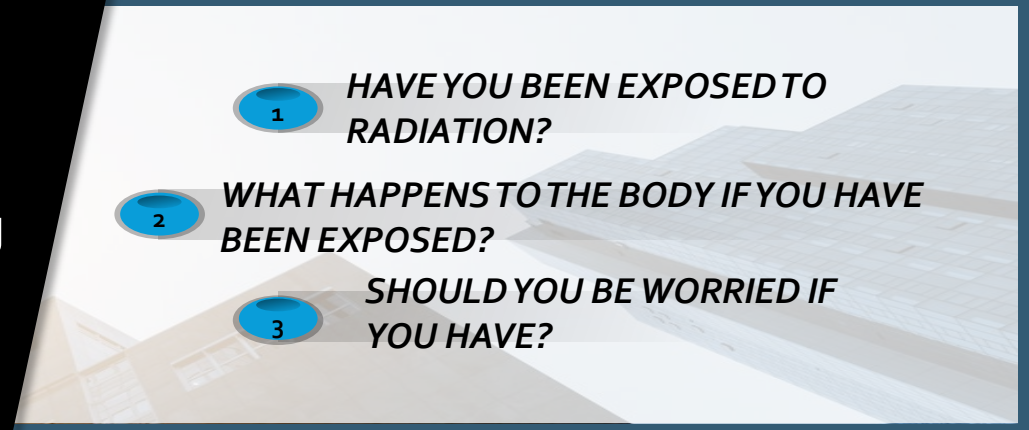
Radiobiology

What is radiobiology?

The study of the action of ionizing radiation on living organisms, and its potential applications



Our Aim

To address issues on immediate and long term health effects

- At areas of high background levels e.g. after cleanup efforts
- After medical or occupational exposure

Our Goals

- Contribute to global discourse on risk models of low dose exposure
- Identify tools for development of medical intervention
- Understand exposure limits in the context of Singapore's ethnicity and geography

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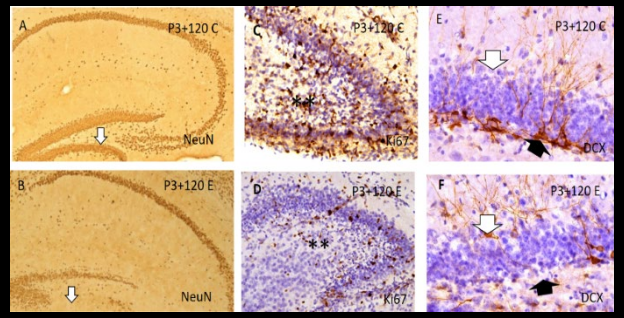
Radiobiology

IMPACT ON BRAIN DEVELOPMENT IN POSTNATAL

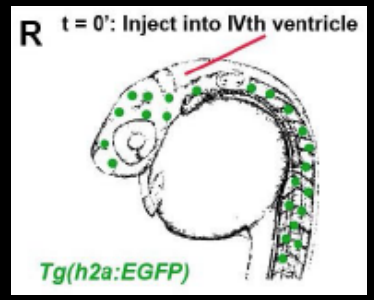


Observed structural changes in hippocampus
(memory and learning centre)

Ongoing research

- Study exposed rodents living in Chernobyl and Fukushima

REAL-TIME SENSING OF DAMAGE IN ZEBRFISH MODEL

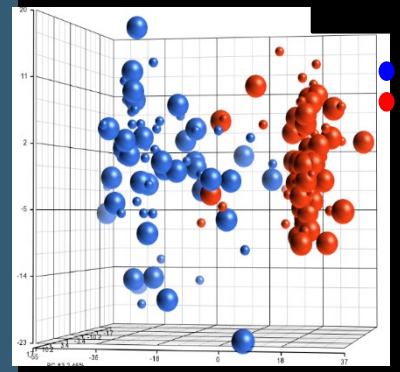


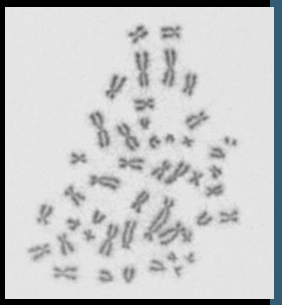
The zebrafish embryo is transparent and therefore amenable to real-time observations in live animals

Ongoing research

- Develop a fluorescent zebrafish model to study cellular changes and development after exposure, and provide data for simulation models

MOLECULAR AND CYTOGENETIC CHANGES IN BLOOD





Changes in gene expression or chromosome structure enable detection of radiation exposure

Ongoing research

- Enhanced methods of dosimetry for radiation exposure
- Bystander and adaptive effects of chronic low dose exposure

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International Engagement

Engage the international nuclear scientific community through research partnerships and will explore additional research collaboration with suitable countries were appropriate.

Cooperate and participate in regional and international nuclear fora, e.g.,

- Asia-Europe Meeting (ASEM) Seminar on Nuclear Safety
- ASEAN Network for Nuclear Power Safety Research
- International Atomic Energy Agency (IAEA)
- Asia MELCOR User Group meeting

Collaboration with overseas partners

- Institute for Radiological Protection and Nuclear Safety
- US Nuclear Regulatory Commission
- Ukraine National Research Center for Radiation Medicine

Summary

- Singapore is interested and keeping a lookout for current and advanced Nuclear Technology
- SNRSI contributes to this purpose by sustaining a community of nuclear experts through scholarships, training, undergraduate education programmes and research.
- SNRSI provides research capabilities in safety analysis, radiobiology and radiochemistry.
- We seek to develop relationships and collaborations with regional and international counterparts.

Thank you