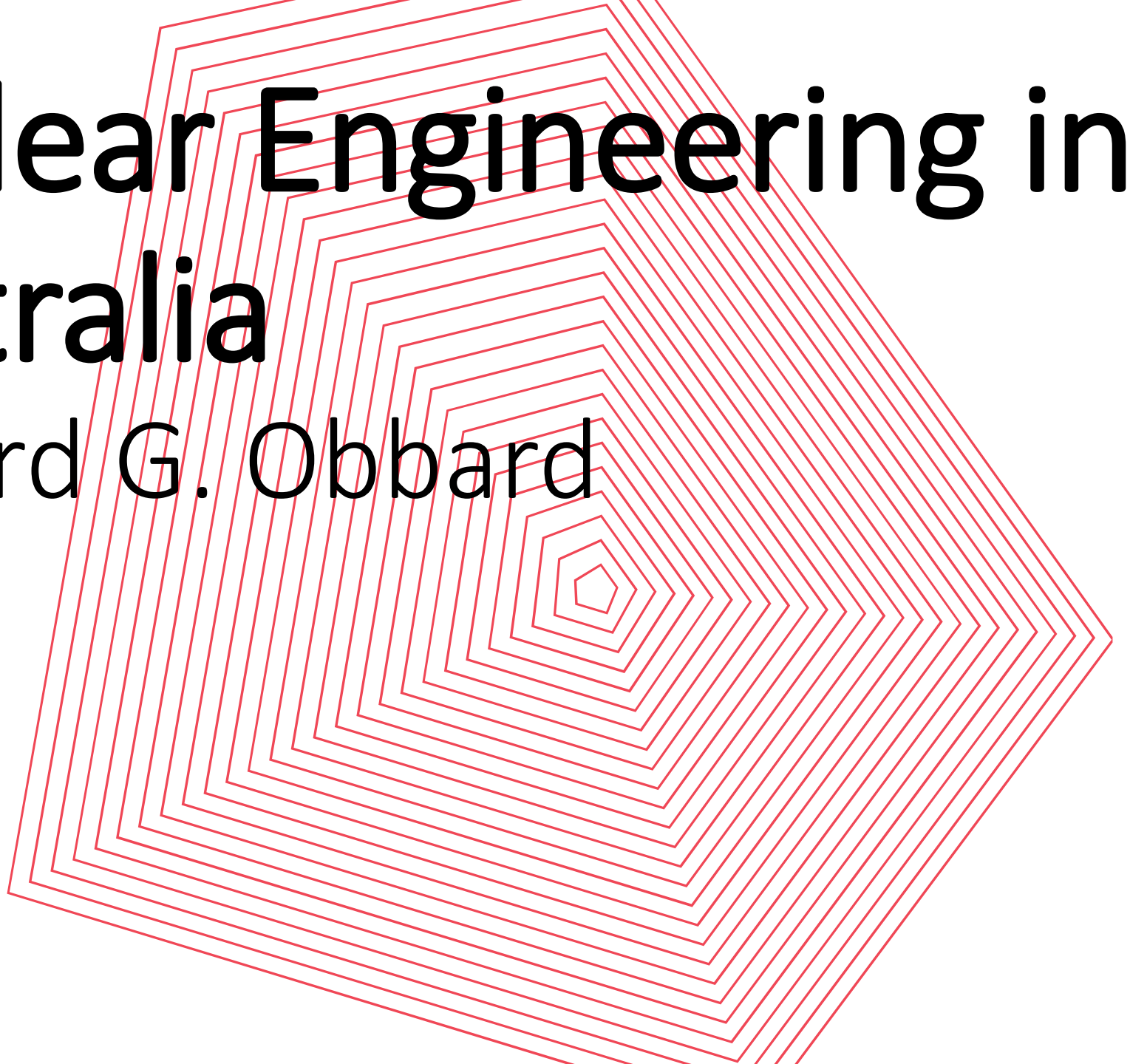
Nuclear Engineering in Australia

Edward G. Obbard



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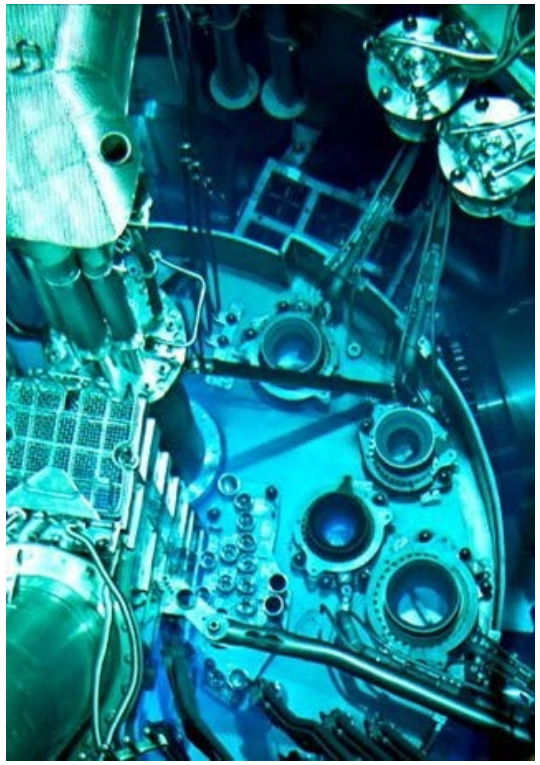
My story before UNSW

Edward Obbard

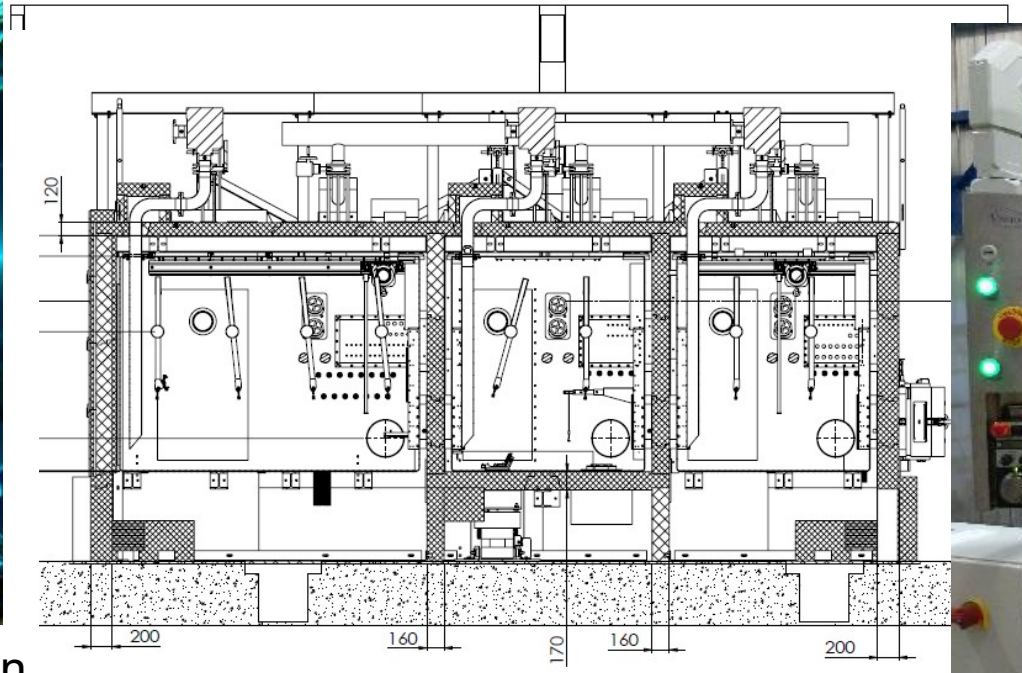
MEng PhD DiplPM PMP

About Edward:

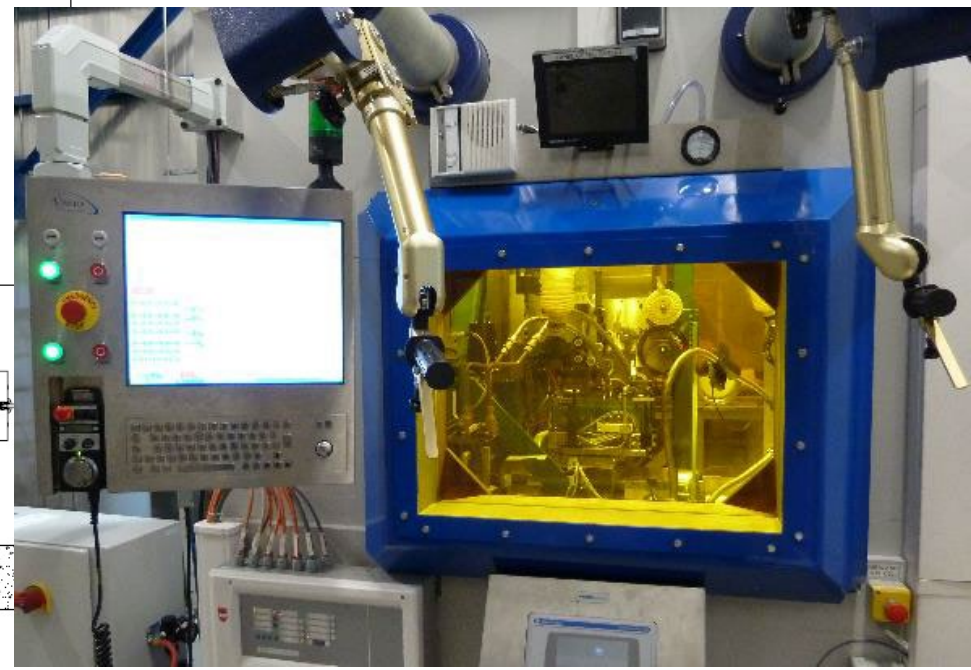
- PhD Chinese Academy of Science, IMR, Shenyang (2006-2010) – SXRD and ‘Gum Metal’
- User specification, concept design and program mgmt. for ANSTO PIE (2010-2015)
- Safety case for OPAL material irradiation facilities, and ‘target and canning specifications’
- UNSW Senior Lecturer 2015-



OPAL Reactor Bulk Irradiation Facilities

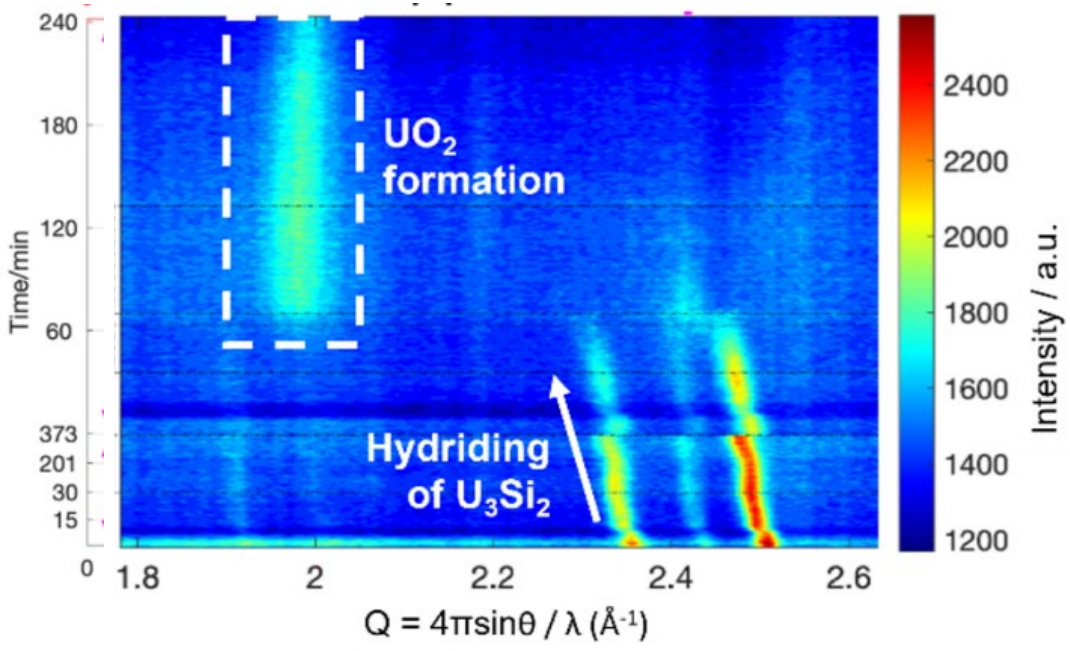


ANSTO PIE Hot Cells Engineering Design



PIE Hot Cells Build & Commissioning

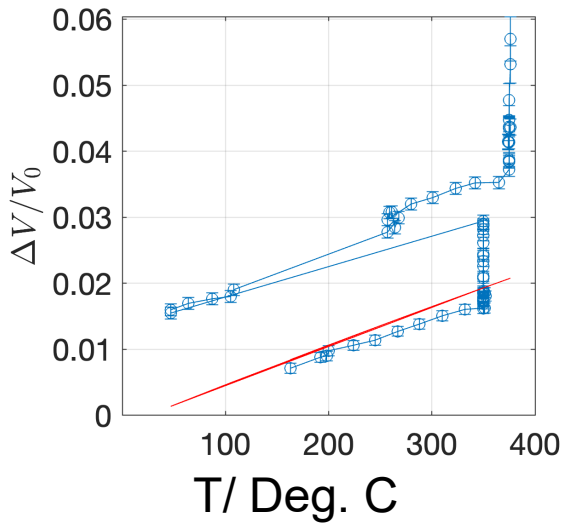
Neutron diffraction: In-situ U_3Si_2 Hydriding

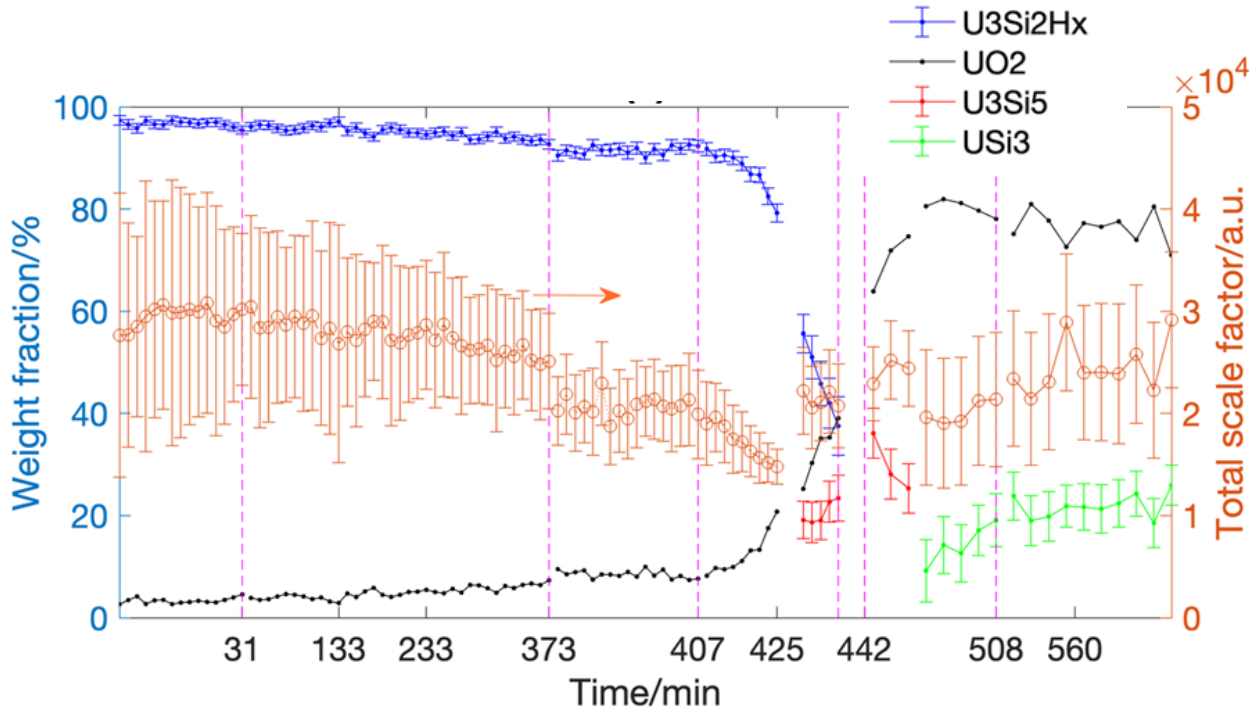


350 °C: $U_3Si_2 + \frac{x}{2}H_2O \rightarrow U_3Si_2H_x + \frac{x}{4}O_2$ (or non-crystalline oxide)

375 °C: $U_3Si_2H_x + \frac{18}{5}H_2O \rightarrow \frac{9}{5}UO_2 + \frac{2}{5}U_3Si_5 + \left(\frac{18}{5} + \frac{x}{2}\right)H_2$

400 °C: $U_3Si_5 + \frac{8}{3}H_2O \rightarrow \frac{4}{3}UO_{2\ 3} + \frac{5}{3}USi_3 + \frac{8}{3}H_2$





J. Liu et al., Corrosion Science. (2022)

ANSTO Program access :

In situ studies of advanced nuclear fuels

2023 - 2026

Wombat

High Intensity Powder Diffractometer

- Lattice parameter evolution
- Real-time phase information
- Mechanistic details
- Decoupled oxidation kinetics
- Fuel performance in representative core conditions

Dingo

Neutron tomography

- Non-destructive
- Crack formations
- Diffusion of coolant via defects

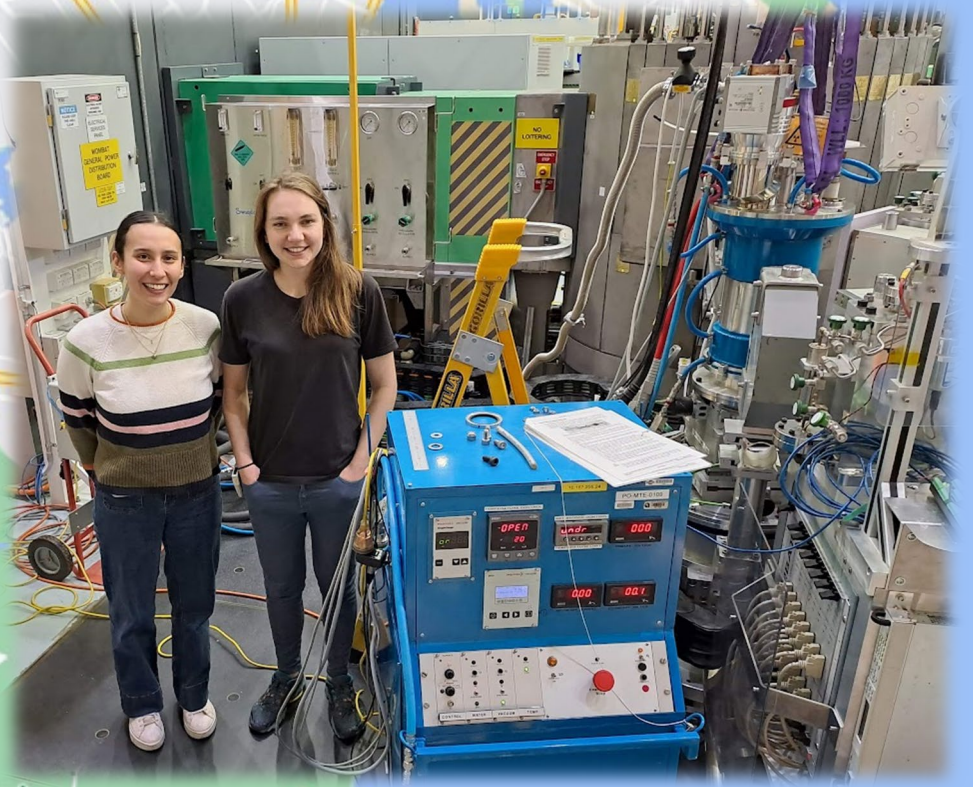
Kowari

Strain scanning

- Residual stresses
- Thermal stresses
- Texture analysis

Proposal round	Wombat (days)	Kowari	Dingo	Work package
2023-1	5	3	2	Isolate fuels and claddings
2023-2	5	3	2	
2024-1	5	3	2	
2024-2	5	3	2	Fuel-cladding capsules
2025-1	5	3	2	Fuel-cladding capsules
2025-2	5	3	2	Fuel-clad-coolant interactions

In-kind value of A$ 360,624



Sydney
Surry Hills
Bankstown
Mascot
UNSW Sydney
ANSTO - Australia's Nuclear Science and...
Royal National Park
M4
A22
M1
A34
M5
M8
A6
A1

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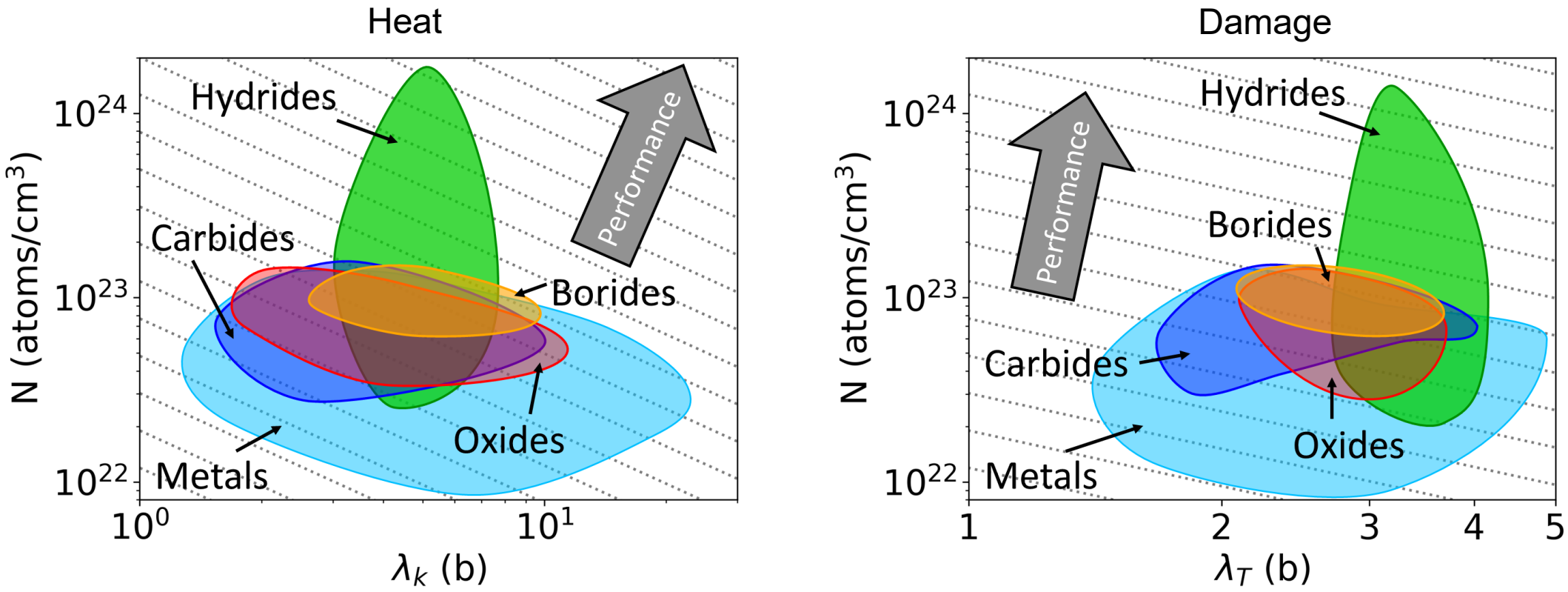
UNSW nuclear research group

Material Selection Charts for Shielding a HTS in a Fusion Flux

Shielding Yttrium-Barium-Copper-Oxide (YBCO) HTS from a Fusion Flux.
Compositions/densities taken from online catalogues



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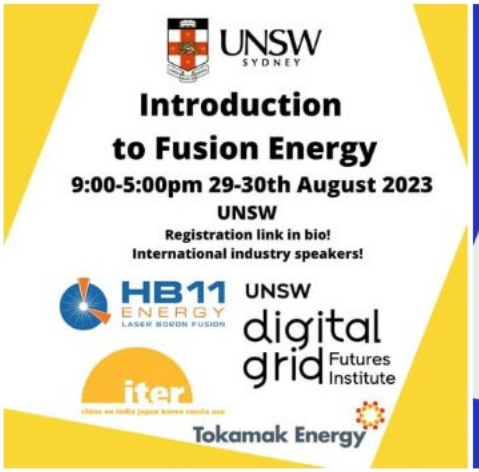
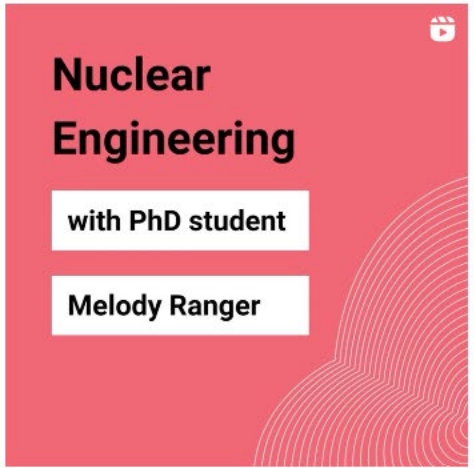
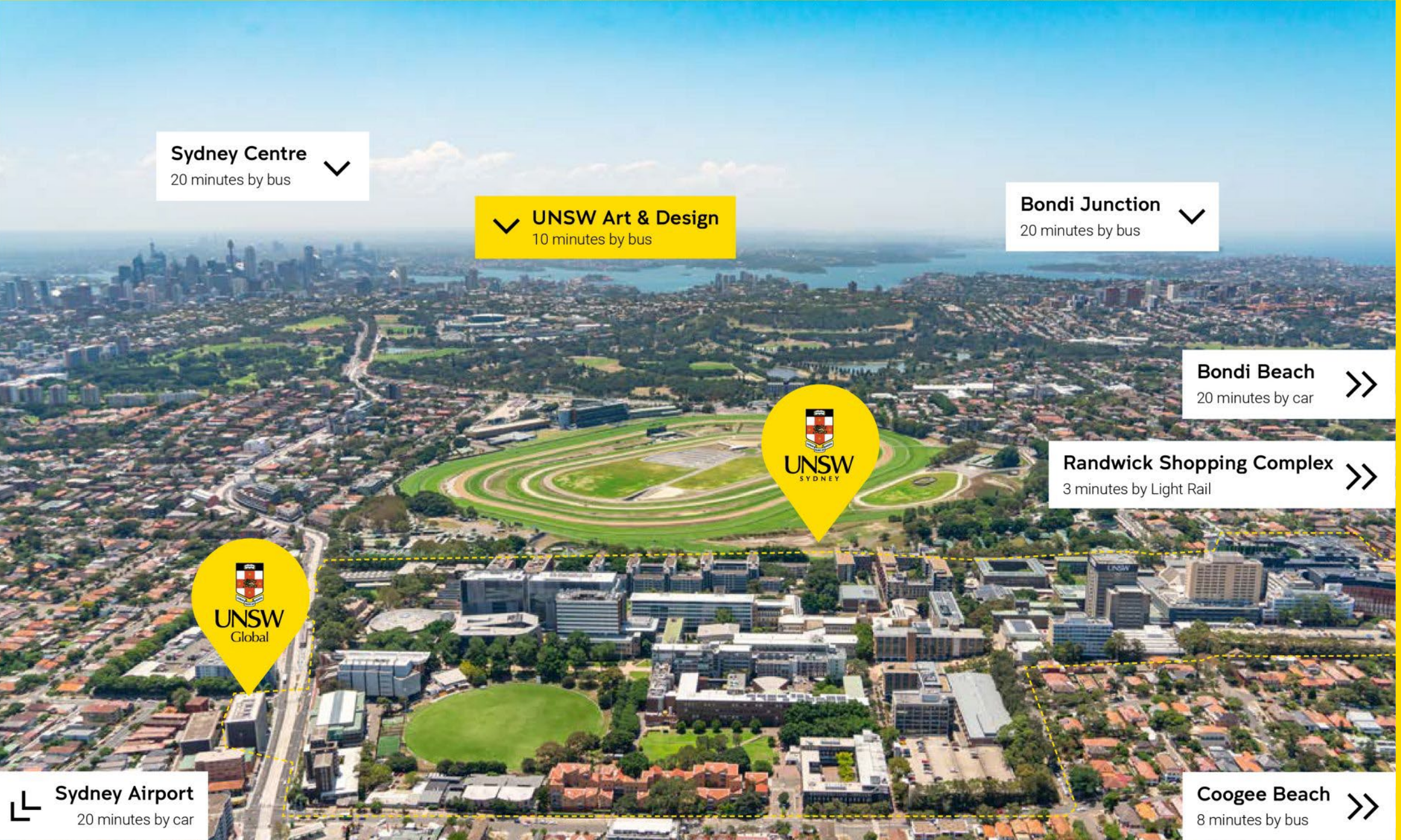
Community Organization
UNSW Student Nuclear Society (NuSoc) aiming to educate and promote nuclear science and technology. Interested in sponsoring email or send a message 😀
www.eventbrite.com.au/e/introduction-to-fusion-energy-technology-and-innovation-tickets-658207

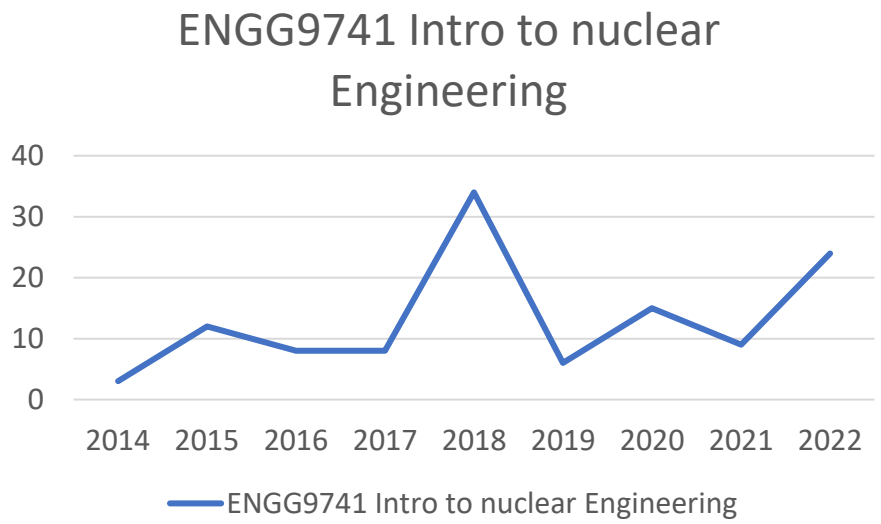




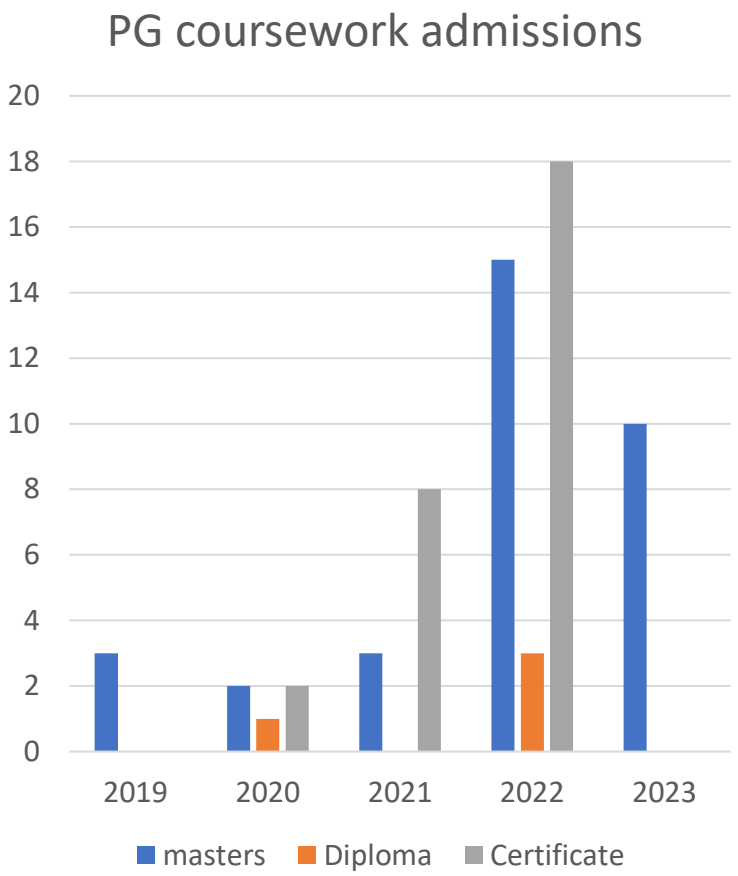

Sydney Centre
20 minutes by bus
UNSW Art & Design
10 minutes by bus
Bondi Junction
20 minutes by bus
Bondi Beach
20 minutes by car
Randwick Shopping Complex
3 minutes by Light Rail
UNSW SYDNEY
UNSW Global
Sydney Airport
20 minutes by car
Coogee Beach
8 minutes by bus

PG Nuclear Engineering coursework programs

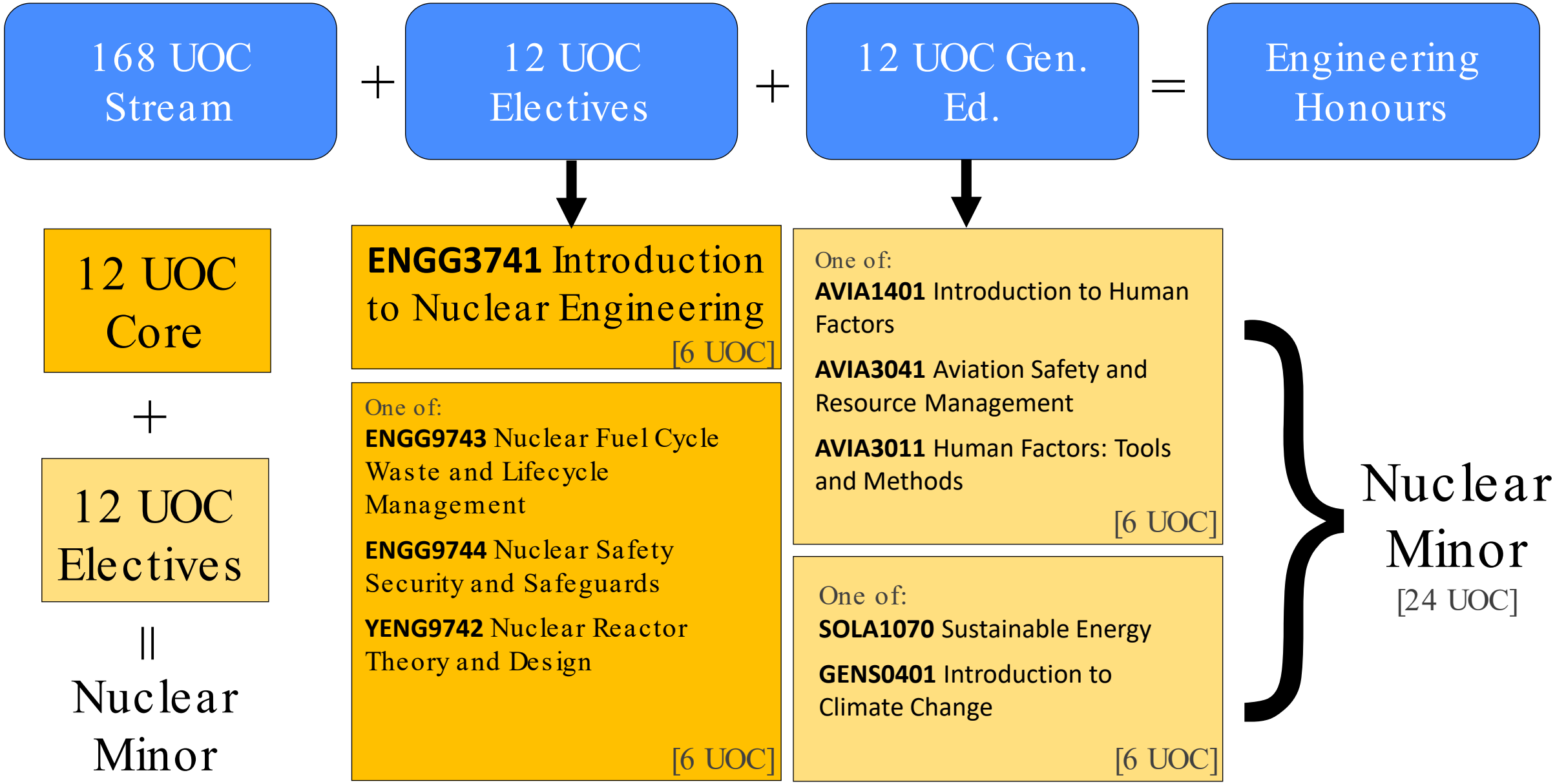
ENGG9741 YENG9741	ENGG9742 YENG9742	ENGG9743	ENGG9744	MMAN9451-3
Introduction to nuclear engineering	**Reactor Physics for Engineers**	**Fuel Cycle, Waste and Life Cycle Management**	**Nuclear Safety, Security and Safeguards**	**Masters Project A-C**



PG Program	UOC
Masters ENGGPS8338	96 (MEngSci)
Graduate Diploma ENGGQS5341	48 (GradDip)
Graduate Certificate ENGGRS7320	24 (GradCert)

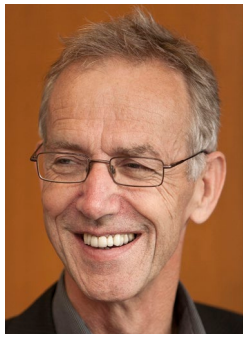


The courses in the table add up to 36 UOC. Remaining credits are accumulated through a combination of elective courses and recognition of prior learning.



Compatible with nine Engineering majors (approx. 3000 UG/yr)

Legacy Nuclear Waste at Little Forest Sydney: Radionuclide Migration and Remediation



David Waite
CIVIL

with Dr Tim Payne

ANSTO
Science. Ingenuity. Sustainability.

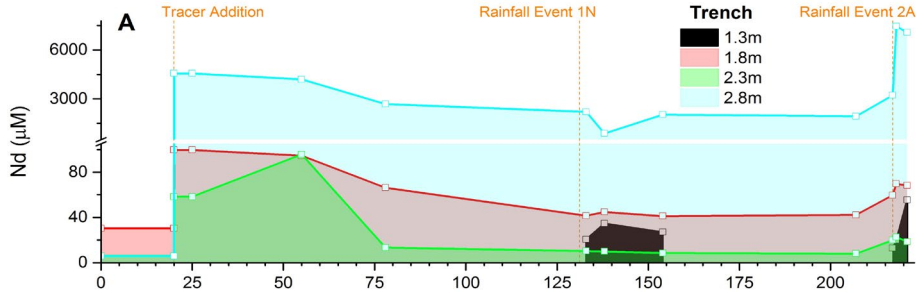
Little Forest Legacy Site, Sydney

Disposal of fissile isotopes, fission products and long-lived actinides at Little Forest, 1960s

Ariel photograph of the trenches at Little Forest, ~ today

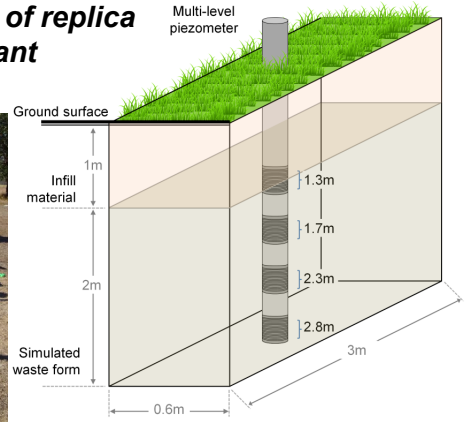
Robust Fundamental and Applied Scientific Outcomes

Response of radioactive contaminant analogues to rainfall events



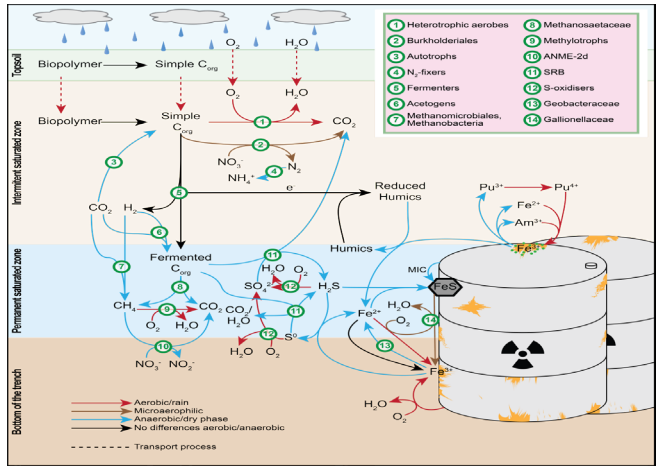
Replica Trench Installation and Sampling at Little Forest

Excavation and infilling of replica trench, using contaminant analogues



Monitoring contaminant behaviour

Investigating microbiological pathways



Structural Nuclear Materials

- Generation-IV reactor materials
  - Fatigue cracking in nick alloy 617 for very-high temperature reactors
  - Molten salt corrosion of Ni alloys
- Development of nuclear high-entropy alloys
- Micro-mechanical testing of irradiated samples
- In-reactor irradiation of pressure-vessel steels
- Concrete cracking in NPP containment buildings

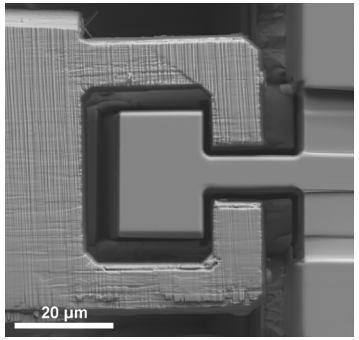

Jay Kruzic MECH

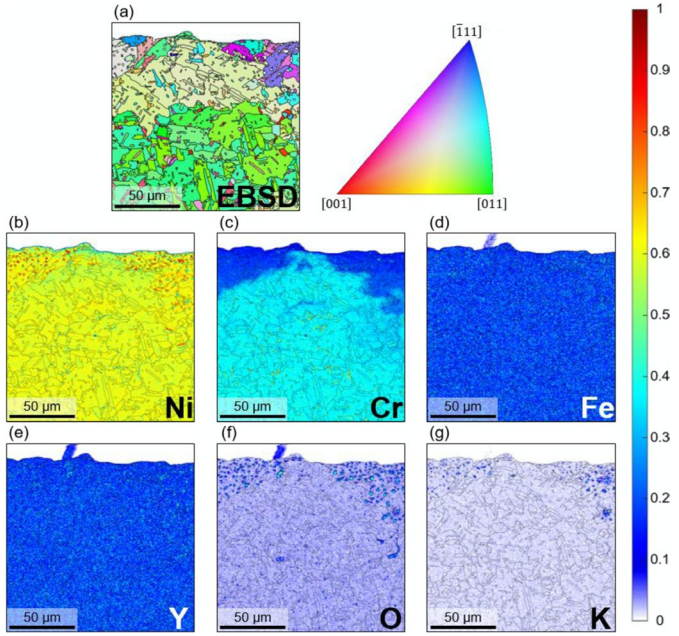

Bernd Gludovatz MECH

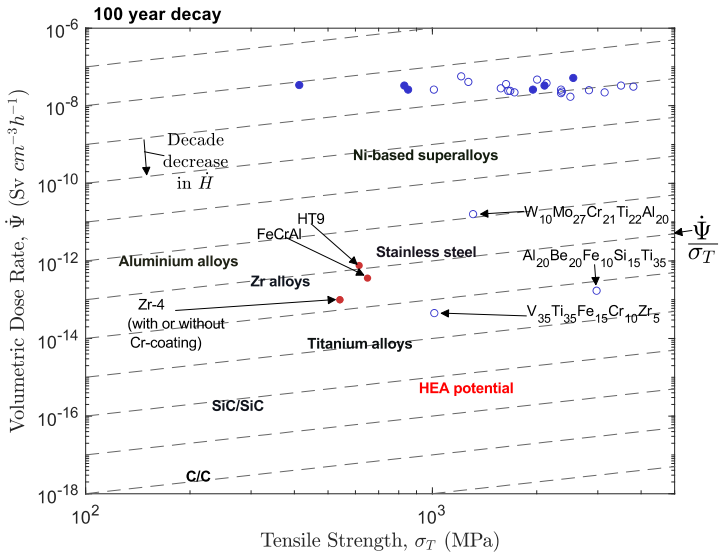

Ondrej Muransky MECH/ANSTO

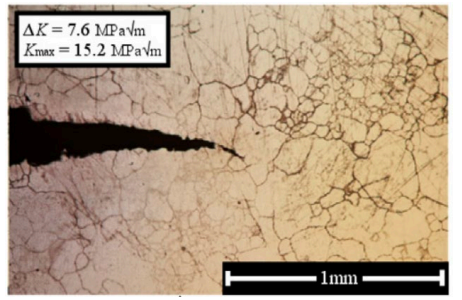

Kevin Laws Materials

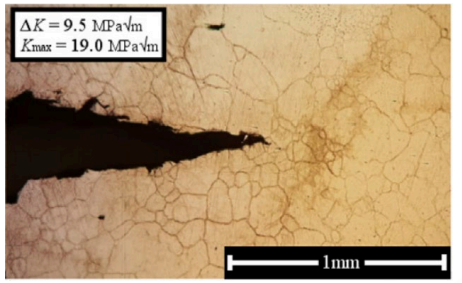

Ehab Hamed CIVIL

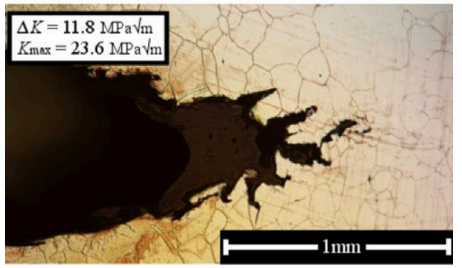


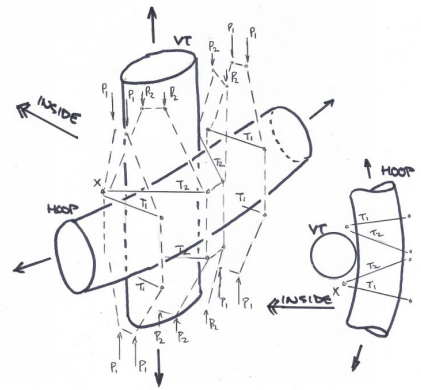


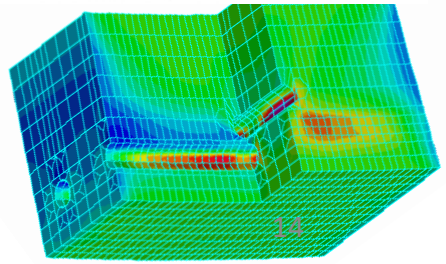












ANSTO

UNSW – at a glance

- 64,000 students from 132 countries
- Graduating **25% of engineering & technology PhDs** in the Group-of-8
- 334,000+ alumni from all parts of the globe
- 7 Faculties, 47 Schools across 4 campuses in Sydney and Canberra
- R&D focused university – 53 Centres and Institutes
- Annual turnover - $2.5 billion AUD / over $1.6 billion USD
- Annual research revenue: approx. $600 million in externally commissioned R&D
- $40 million in R&D funding from US Department of Defence in last 5 years
- Notable rankings: One of the world's top 50 universities
  - 45th – QS World Rankings
  - 50th – Aggregate Ranking of Top Universities (ARTU) Rankings
  - 70th globally in 2022 – Times Higher Education Ranking
  - UNSW Engineering is ranked 1st in Australia – QS and THE Rankings

UNSW Faculties

Arts, Design and Architecture
Business
Engineering
Law & Justice
Medicine & Health
Science & Environment
UNSW Canberra at ADFA

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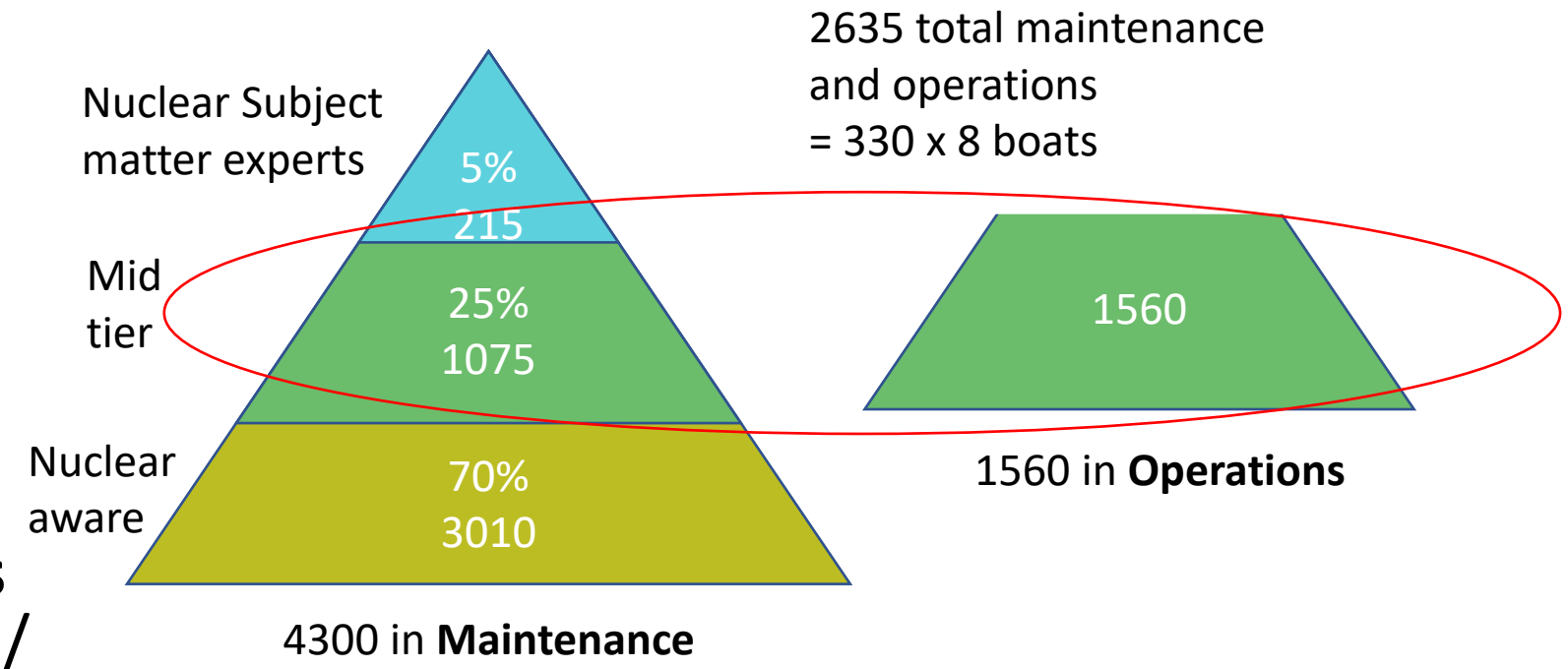
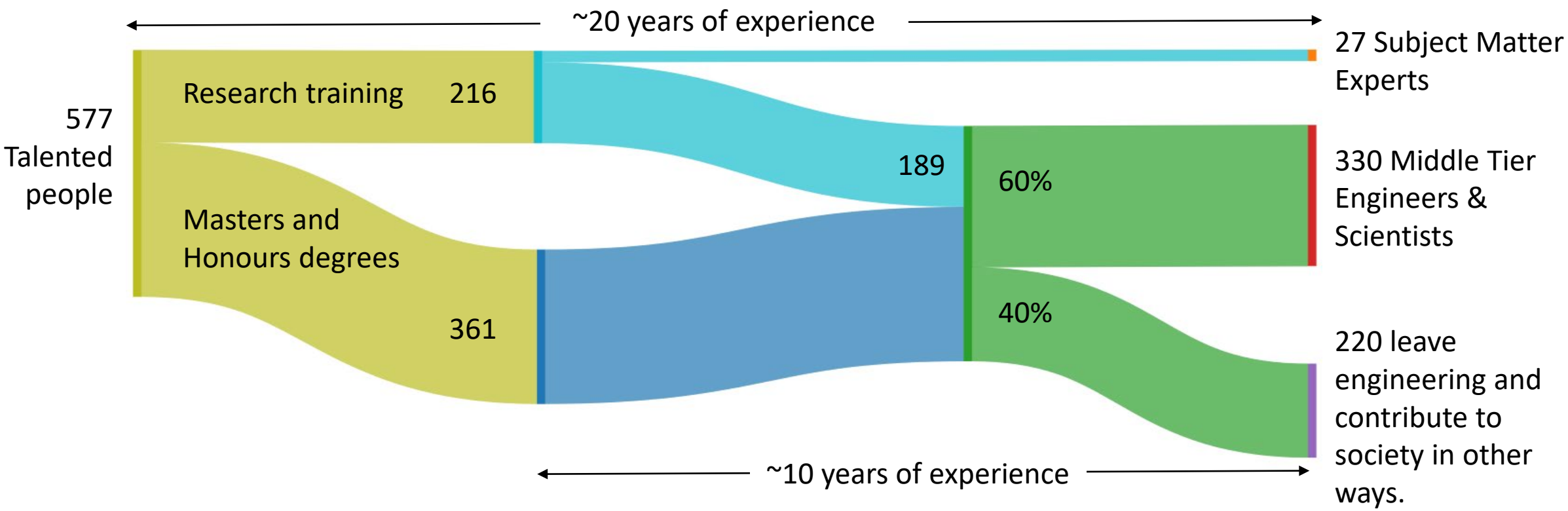
Human resource estimates: 8x boats = 5860 employed in maintenance and operations

- Tier 3, Chief scientist, principal engineer, renowned experts in specific field, **20+ yrs** experience, likely PhD.
- Tier 2, Senior scientist, engineer, technical managers, experienced reactor operators, **10+ yrs** experience, PhD /Masters/ Hons.



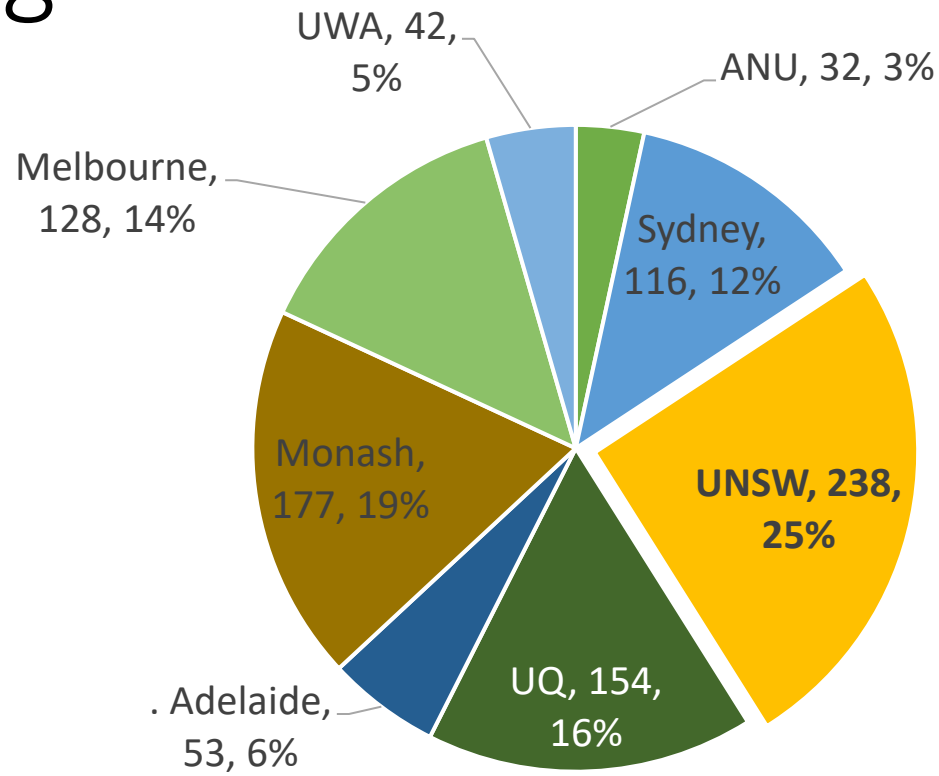
Two-year training drumbeat Tier 2/3



How to train 27 top tier subject matter experts and 330 middle tier engineers and scientists to operate and maintain Australia's first of eight nuclear submarines. Each successive boat needs the same number of people again.

Scaling up PhD training

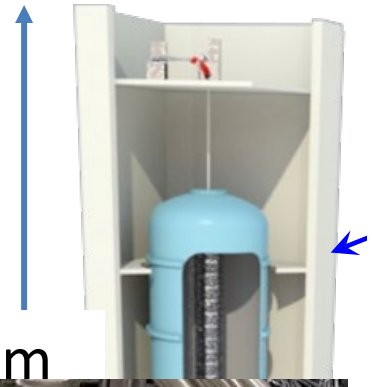
- UNSW graduates 25% of PhDs in the Go8 in Engineering & Technology.
- We should organically produce 27 PhD/yr in nuclear disciplines, anyway (=25% x 108)
- Can aim much higher than this
- Gov. just announced competition for $128.5 m = 4000 additional commencing university places in AUKUS subjects over next four years…

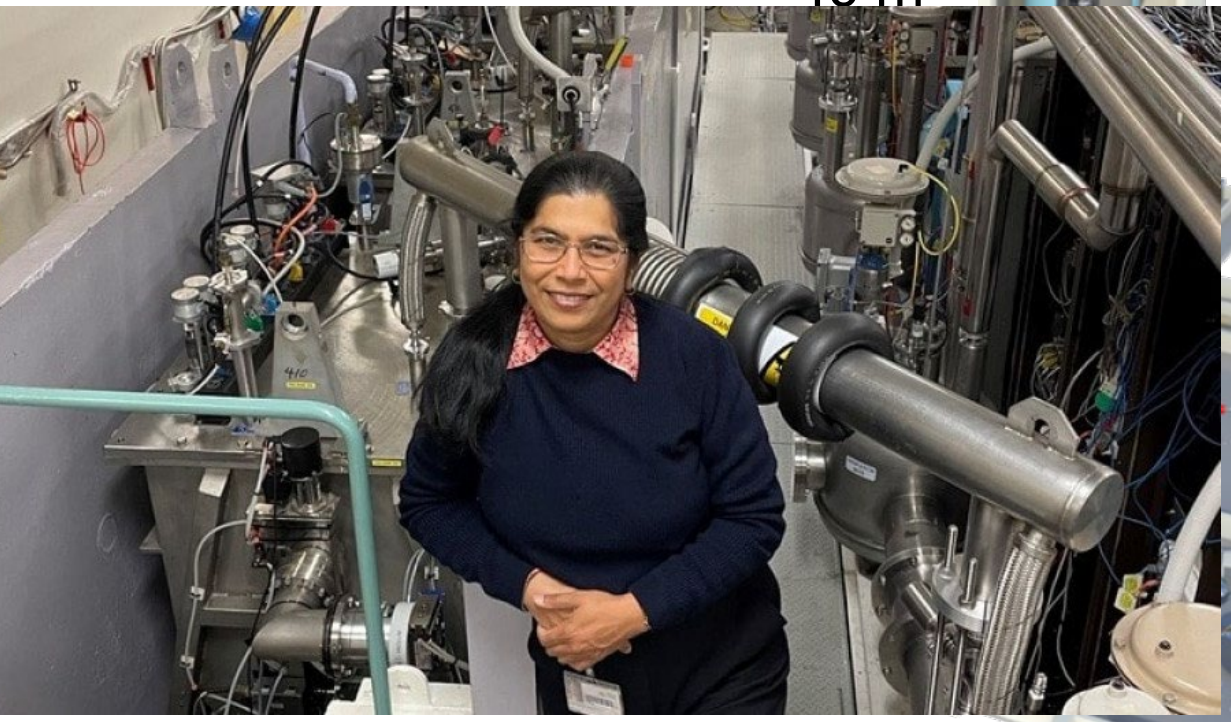


2020 Research degree graduations in Engineering & Technology, in Group of 8 universities (940 total)

Australian National University

Heavy Ion Accelerator Facility





Rendered by T. Tunningley, ANU

2023 nuclear grants in Australia – for fusion and rad. safety

- Dasgupta, et al (ANU, Adelaide Uni.) RadInnovate ARC training centre **A$4.99 m**
- Patrick Burr ARC Fellowship (UNSW): ‘Life prediction and optimisation of advanced first-wall fusion materials’ **A$1,053 k**
- Burr et al. ARC Linkage (UNSW, Tokamak Energy) Advanced shield materials for compact fusion energy **A$1,024 k**
- Francois Ladouceur et al. ARC Linkage (UNSW, HB11) Laser induced non-thermal fusion **A$559 k** + industry contributions

NCRIS National Research Infrastructure for Australia
An Australian Government Initiative

HIA HEAVY ION ACCELERATORS
https://accelerators.org.au/

Theory of change: AUKUS Optimal Pathway in Australia

Inputs

- Australian investment in industrial base in Australia, UK, and US
- State of the art facilities and capability upgrades
- UK and US decades of experience
- Existing Australian nuclear technical base
- The work of existing nuclear regulators
- Industrial capability and capacity of Australia, the UK and the US
- New sources of talent

Outputs (Activities)

Organisations

- Embed the highest security and safety culture within Australian organizations, and identify specific opportunities for Australian industry to participate in the SSN supply chain

People

- Build new education pathways to expand Science Technology Engineering and Maths (STEM) opportunities
- Establish training, skilling and educational programs, integrating, where appropriate, workforce and training exchange with US and UK partner organizations, and rotational presence of UK and US submarines

Research

- Research that strengthens Australia's technical base in nuclear safety, security, safeguards, and verification measures, lifecycle and waste management
- Engage with IAEA and international organizations.
- Consultation and engagement with stakeholders, including community and Indigenous groups considering social license and economic implication

Outcomes

- Expanded Vendor base and domestic industrial base, with unprecedented opportunities to build and maintain complex technology
- System of regulation calibrated to the unique needs of Australia's SSN
- A strong technical base and comprehensive safety management system, expanded base of skilled submarine and shipbuilding workers, and increase in uniformed Australia Navy Workforce.
- Workforce and know-how to manage radioactive waste from nuclear-powered submarines; a suite of safeguards and verification measures, reinforcing Australia's stewardship credentials; bespoke facilities, significant support infrastructure and a highly-experienced workforce

Impact

Build

- Boost Australia's technical capabilities, building its first SSN-AUKUS in Barrow-in-Furness, UK, and Adelaide, South Australia, by the end of this decade

Sovereign Ready

- Highest standards of nuclear safety and security for submarine crew, the greater workforce, local communities and the environment, so Australia is Sovereign ready to safely own, operate, maintain and regulate a sovereign conventionally-armed, nuclear-powered submarine capability in early 2030s

Lifecycle

- Australia will manage all radioactive waste generated by its own Virginia class and SSN-AUKUS submarines, defuel, dismantle and recycle its spent fuel and radioactive reactor compartment components

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Nuclear Engineering in Australia

e.obbard@unsw.edu.au