NNUF UKAEA-MRF Facility Experiments:

Investigation of proton-irradiation induced damage in POCO graphite

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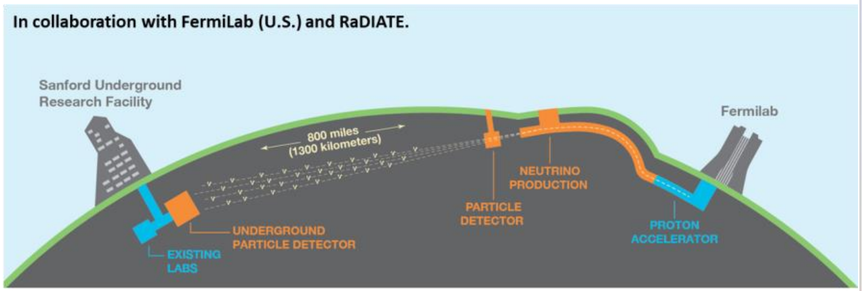
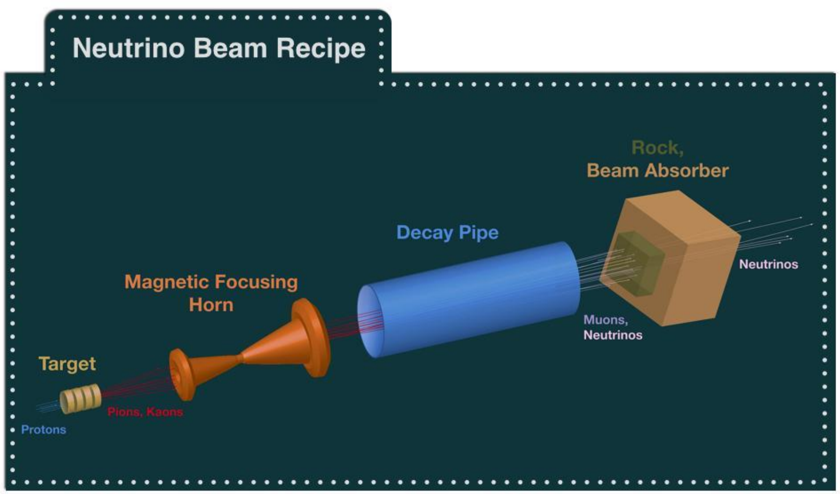
Background

- Student on this project: Eric Jiang
  (2nd year; Funded by the US Fermi National Accelerator Laboratory)

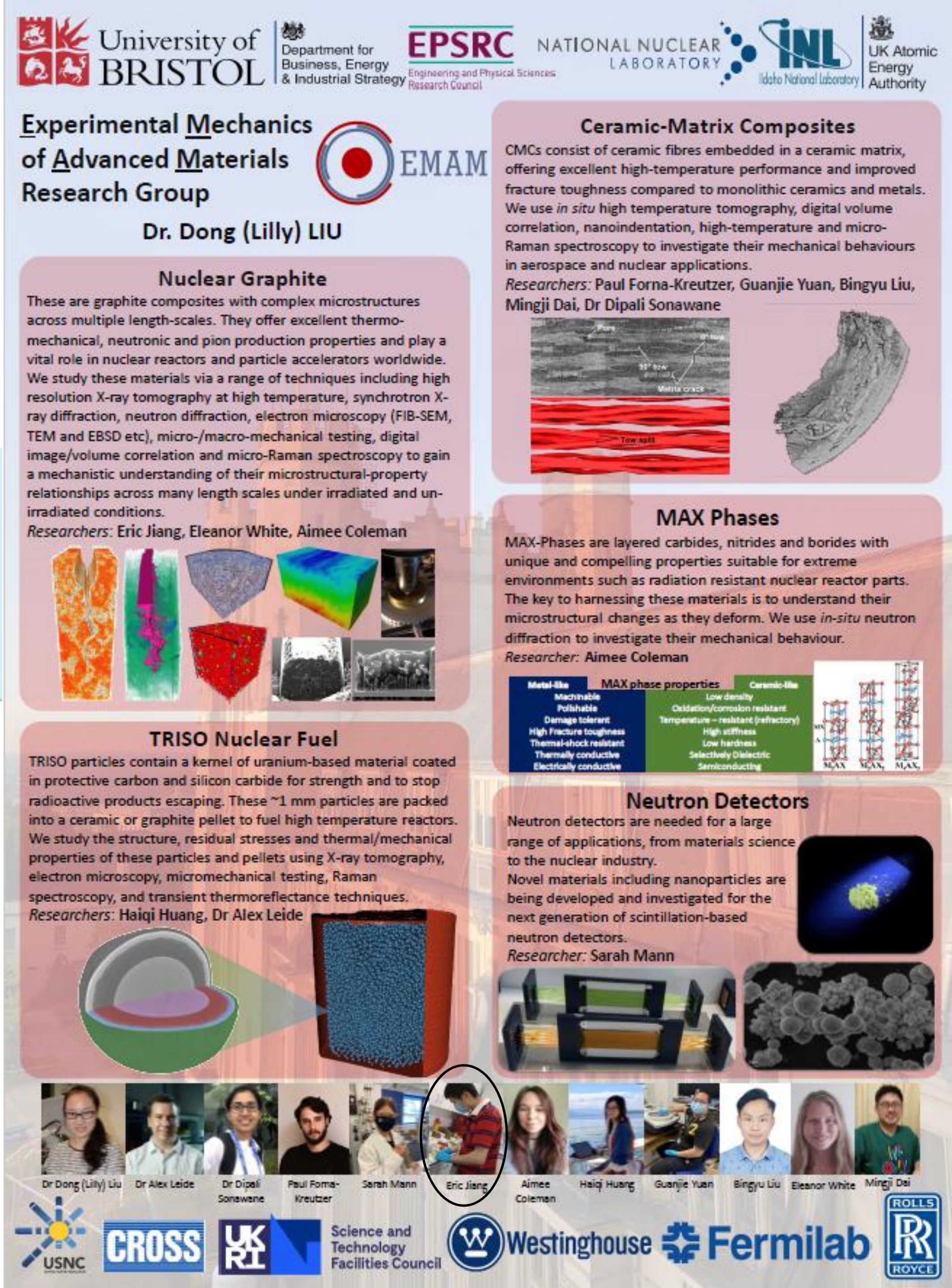
- Why POCO graphite?



The schematic of Deep Underground Neutrino Experiment (DUNE)

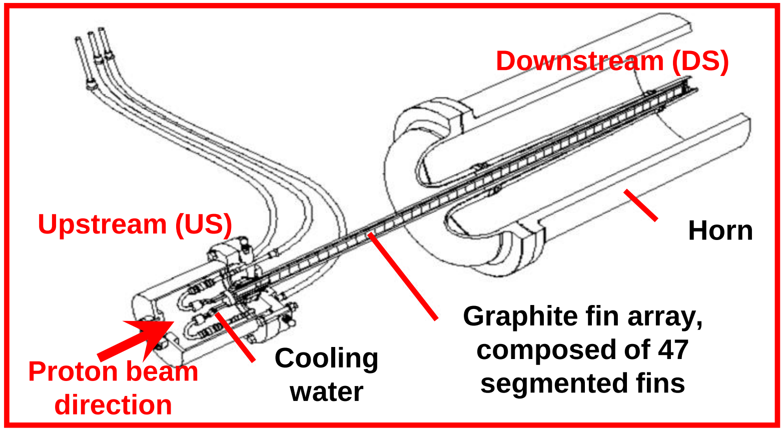


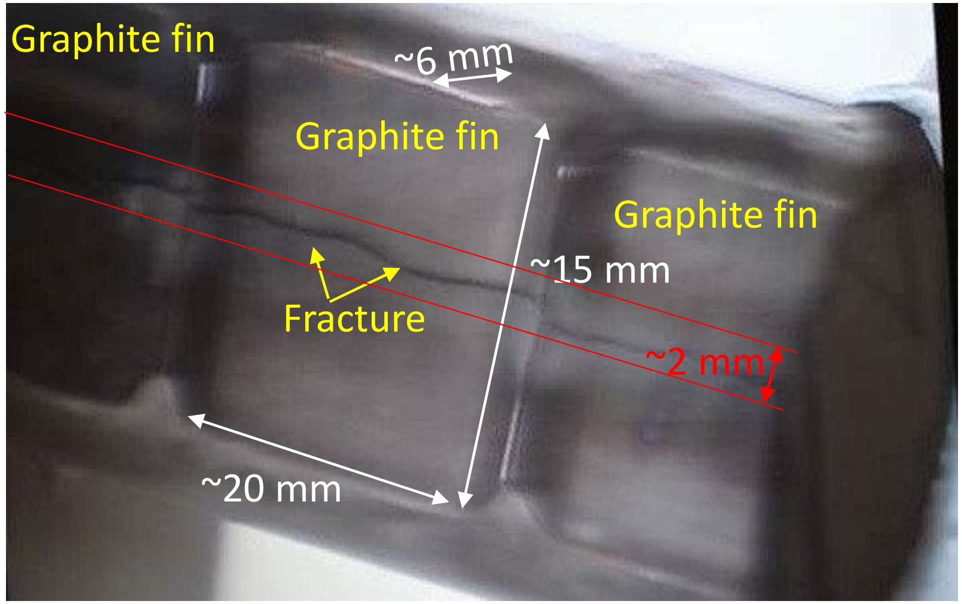
- $1.5bn Long Baseline Neutrino Facility (LBNF)
- UK are expected to contribute ~$500 m to Dune and LBNF



Background

Aim: Study the degradation in terms of microstructure, physical and thermo-mechanical properties of POCO graphite





47 graphite fins

UKAEA (Culham) MRF:

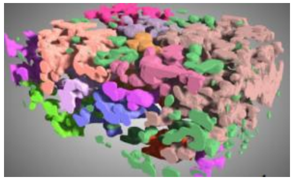
- Receiving and storage of hot samples:
  - Proton irradiated - hot materials beyond university limits
  - Shipped from the USA PNNL to Materials Research Facility, UKAEA (Culham)
- Experiments (two rounds about 14 days in total):
  - Micro-Raman spectroscopy
  - FIB-tomography
  - TEM foils liftouts for post analysis in Bristol
- Key outcome:
  - Overall irradiation damage on the graphite crystallites at various distances away from the beam centre
  - Porosity evolution
  - Successful TEM samples
- Follow-up experiments:
  - TEM analysis
  - Synchrotron beamline diffraction experiments at RAL
  - Comparison with other types of fine grain graphite

Materials Research Facility

Micro-Raman spectroscopy at MRF

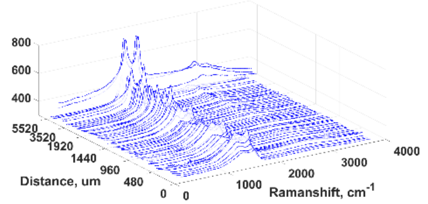
FEI Helios Nanolab 600i Dualbeam at MRF

Image segmentation



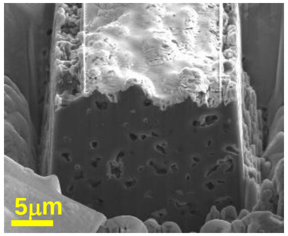
Porosity segmentation generated by deep learning method (30x17x23µm)

Micro-Raman spectroscopy

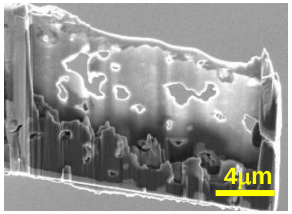


Raman line-scans and mapping

FIB-tomography and TEM foil liftout



FIB tomography of irradiated POCO graphite



TEM foil of irradiated POCO graphite