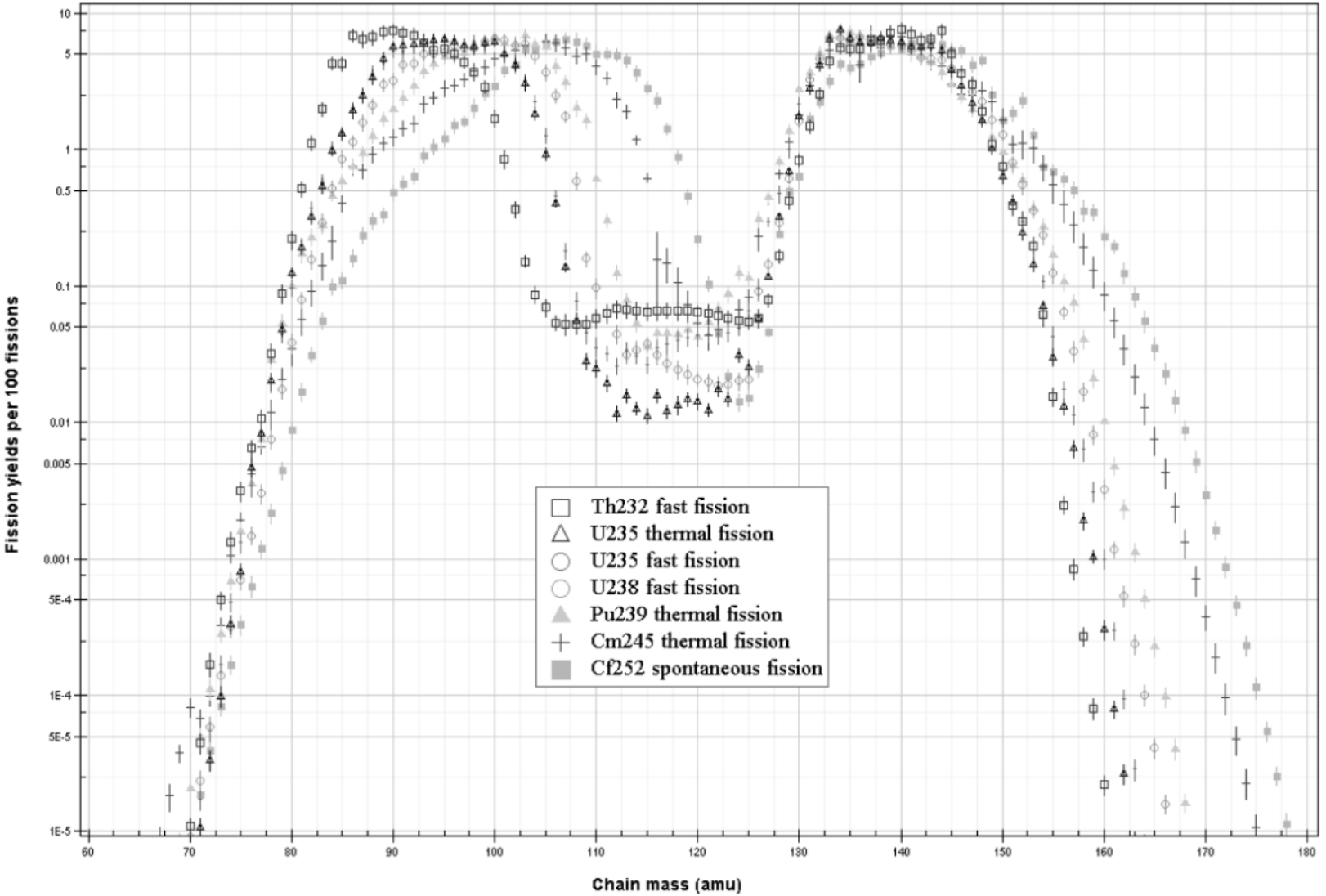
A ‘Quick’ Summary of Academic Research Landscape and Practice in ‘Nuclear Data’

Paddy Regan
Centre for Nuclear and Radiation Physics
Department of Physics,
University of Surrey,
Guildford, GU2 7XH
p.regan@surrey.ac.uk

Other EPSRC funded ‘nuclear academics’ EPSRC in this consortium

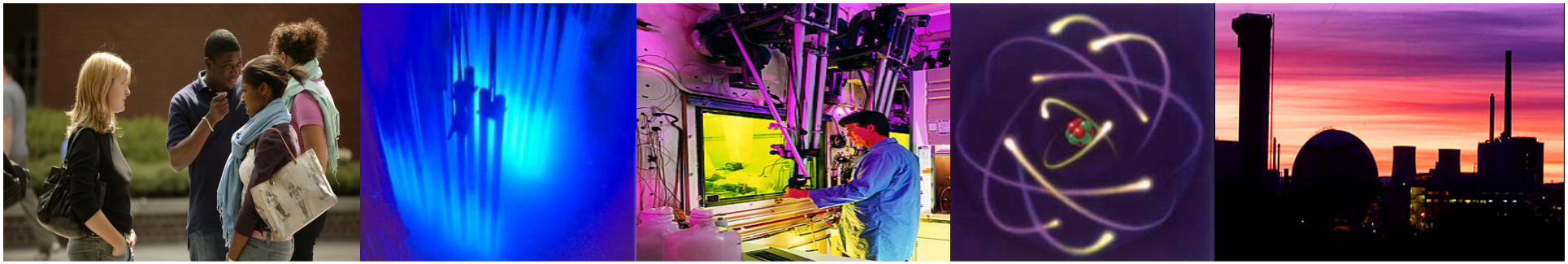
Gavin Smith, J. Billowes (U. Manchester)
Zsolt Podolyak, Bill Gelletly (U. Surrey)
David Jenkins (U. York)

Why do we still need (nuclear) data?



Fission yield of neutron induced fission of common nuclear fuels,

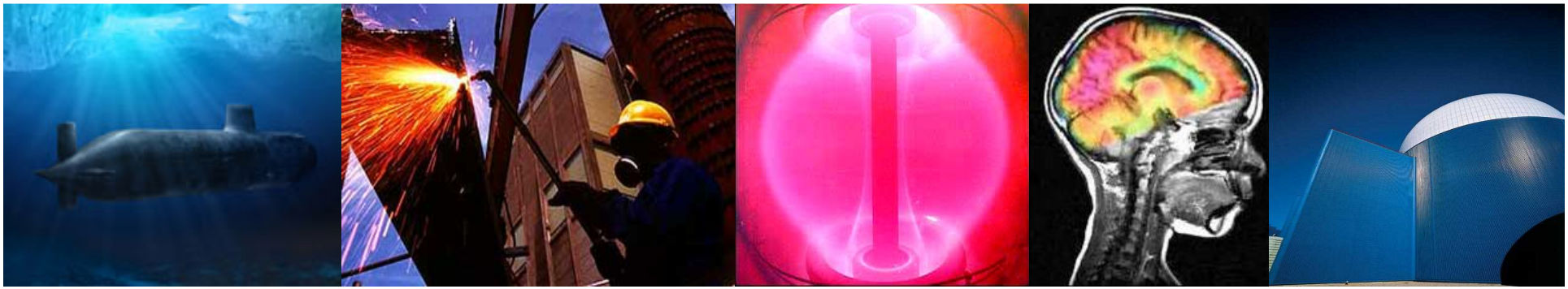
M. A. Kellett, O. Bersillon, and R. W. Mills, "The JEFF -3.1/-3.1.1 radioactive decay data and fission yields sub-libraies," Tech. Rep. JEFF Report 20, Nuclear Energy Agency, 2009.



Nuclear data:
fission yields, decay heat and neutron reaction cross sections:

A Proposal for a Nuclear Data Consortium

Universities of Manchester, Surrey & York



Consortium grant (Manchester, Surrey & York) Nuclear Structure Physics Groups

Nuclear data: fission yields, decay heat and neutron reaction cross sections:
A Proposal for a Nuclear Data Consortium
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Basic science aims of grant:

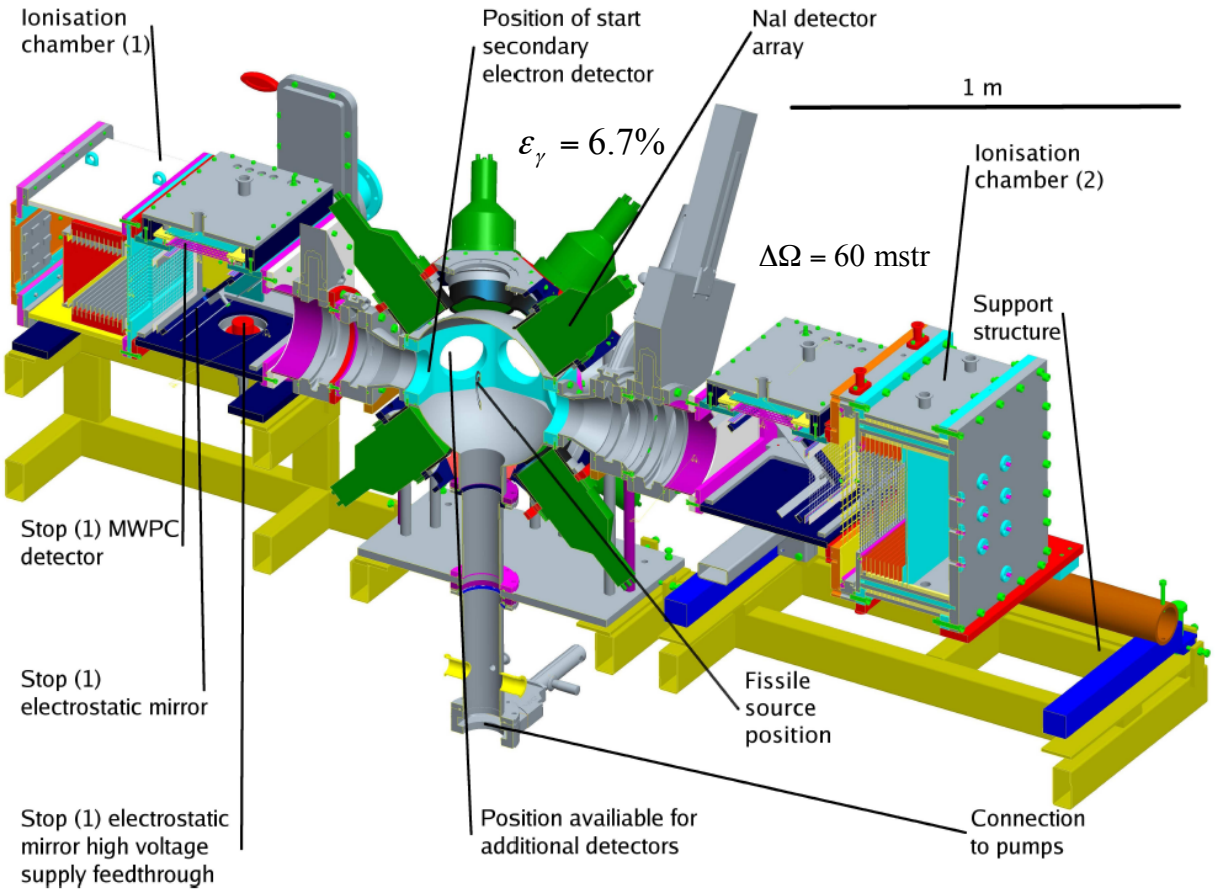
- Measure thermal neutron-induced fission fragment distributions, cross-sections and yields (Manchester-led theme).

- Performed detailed measurements of decay heat from fission fragments (Surrey-led theme)

- Measurement of neutron capture cross-sections on ^{238}U and ^{241,3}Am in the 'resonance' energy region with varying energy as part of the nTOF collaboration at CERN (York led theme).

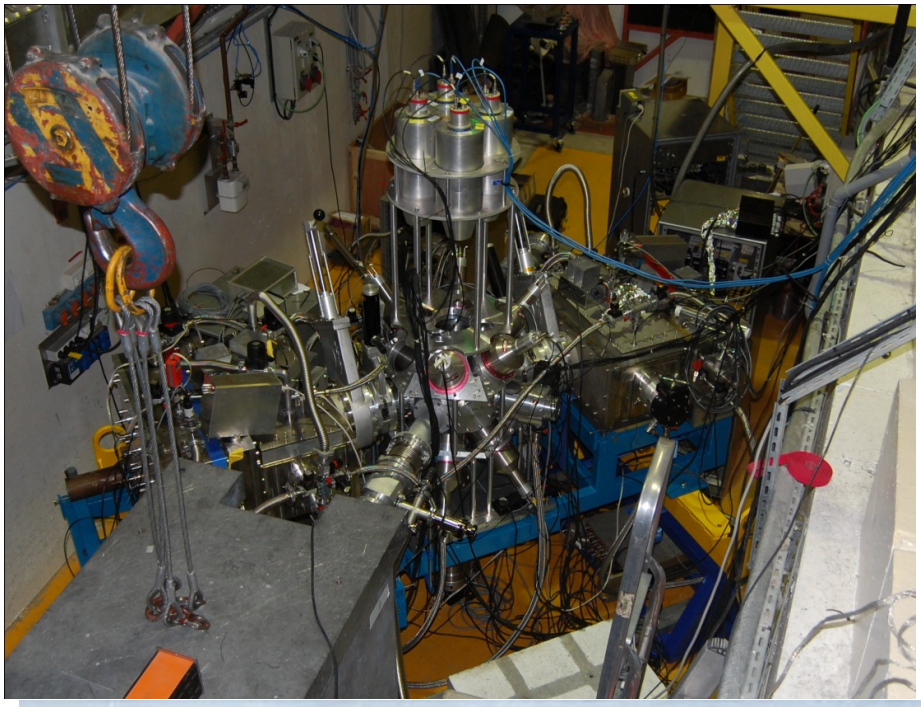
The **S**pectrome**T**er for **E**xotic **F**ission **F**ragments (**STEFF**)

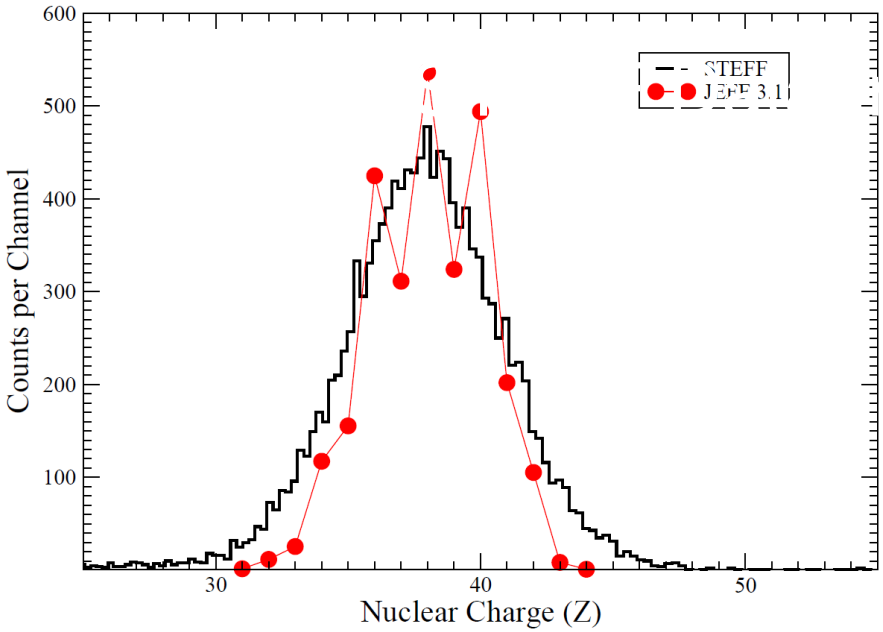
A.G.Smith et al. & STEFF collaboration



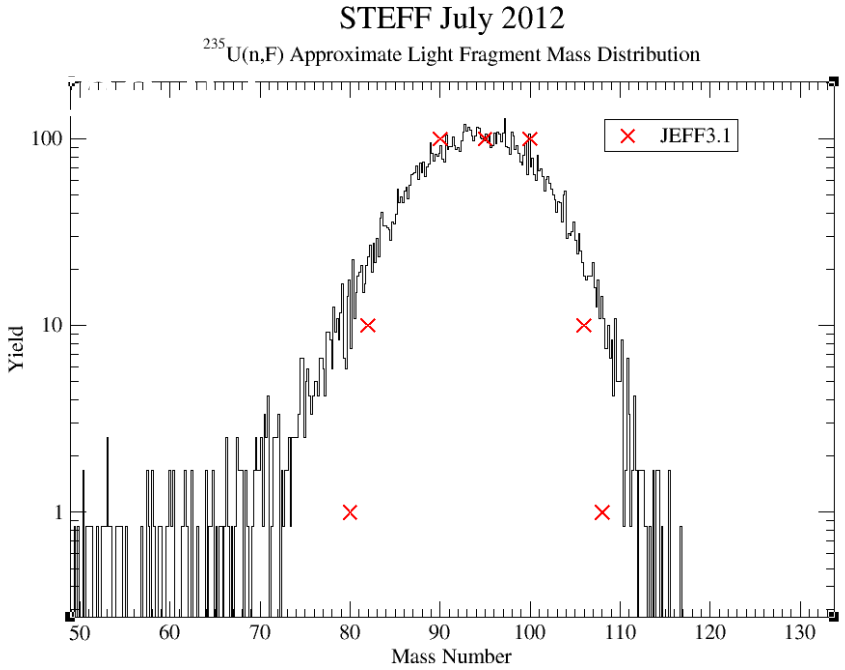
- **2E-2v device**
- **designed/built at UoM**
- **EPSRC Funded**
- **measures A,Z distributions**
- **NaI and Ne213 scintillators**
- **γ and neutron detection**
- **Neutron-induced fission**
- **ILL (thermal neutrons)**
- **LPSC (Fast 14 MeV)**
- **NFS(Fast spectrum)**

- PF1B neutron beamline
- Fission rate ~ 10^4 s^{-1}
- Flux (current experiment) = 5 x 10^7 cm^{-2} s^{-1}
- ^{235}U target : 1 cm2 100 mg cm^{-2}
- Setup December 2011 + 5 day run
- 25 Days June 2012
- **NEA High-priority request for Gamma Data for heating calculations**.

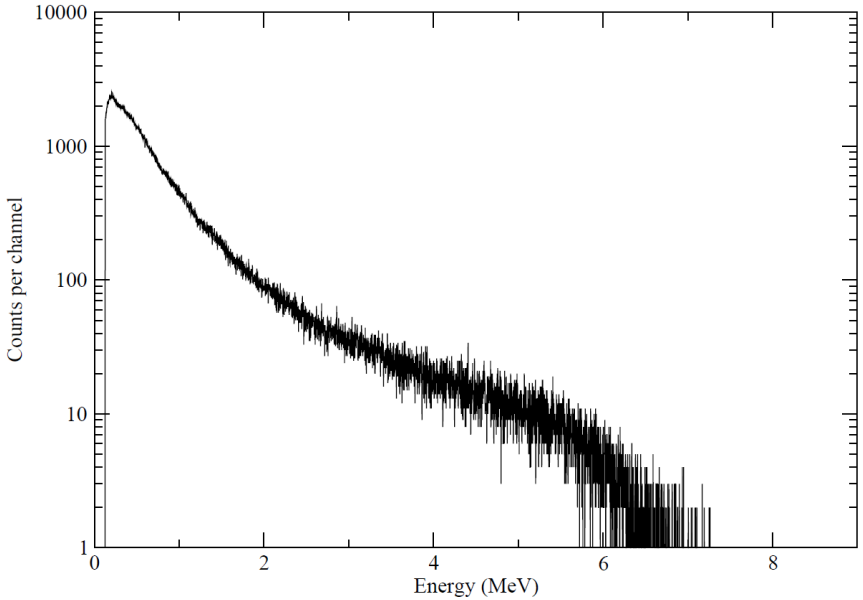




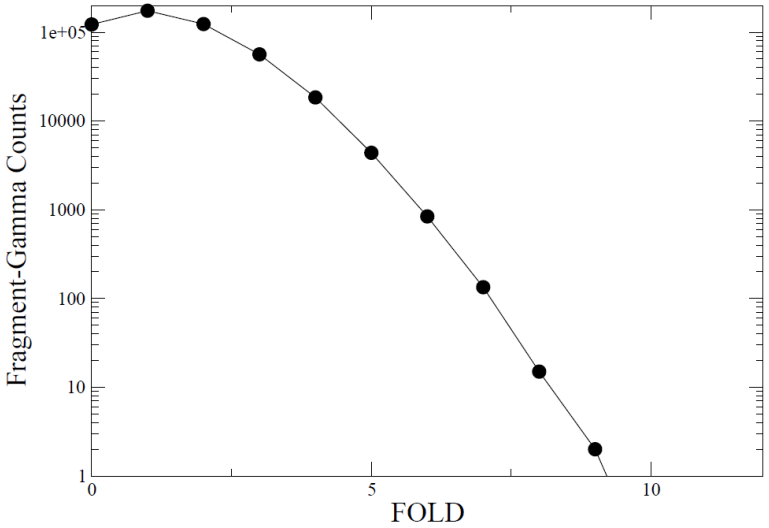
Nuclear Charge from energy-loss in gas



Mass number from E and TOF



Gamma Energy from NaI



Number of gamma rays per fission event

Decay Heat Measurements Using a Total Absorption Spectrometer (TAS)

Decay Heat

- Commercial reactors produce >1000 different species of radionuclide (from fission fragments, their daughter decays and activation products/minor actinides) etc.
- The energy released from the radioactive decay of these radionuclides, mostly in the form of beta-particles (i.e., electrons) and
- In normal operation approx 8% of the energy generated in a thermal fission reactor comes from decay heat.
- Need to know these accurately for reactor operation and also what happens (heat wise) when a reactor is switched off or there is a LOCA (e.g., Fukushima)

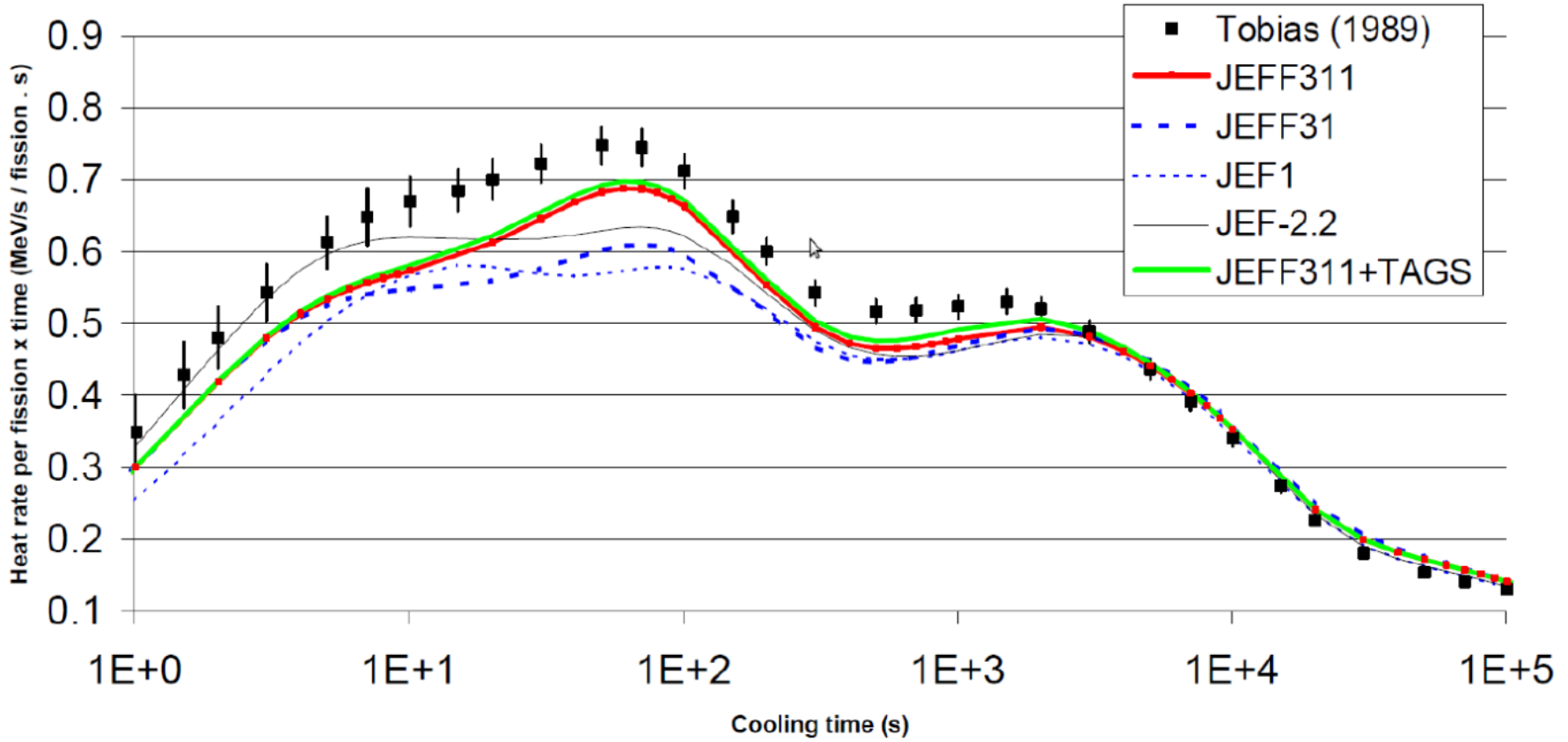
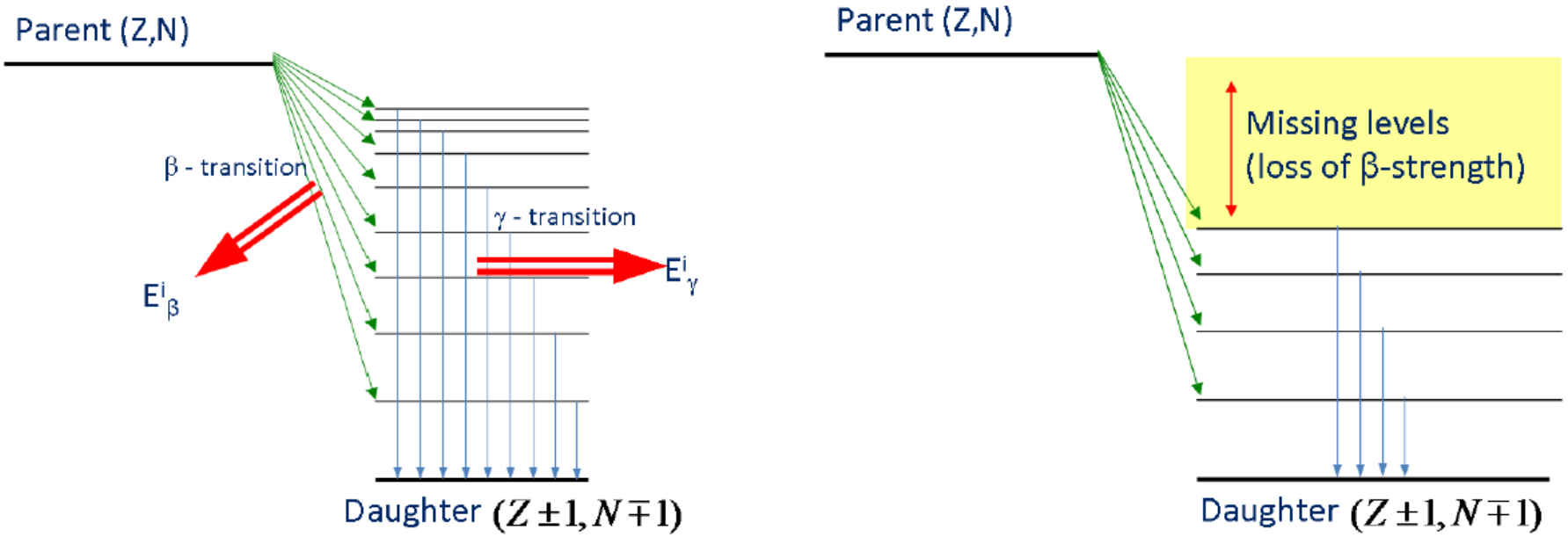


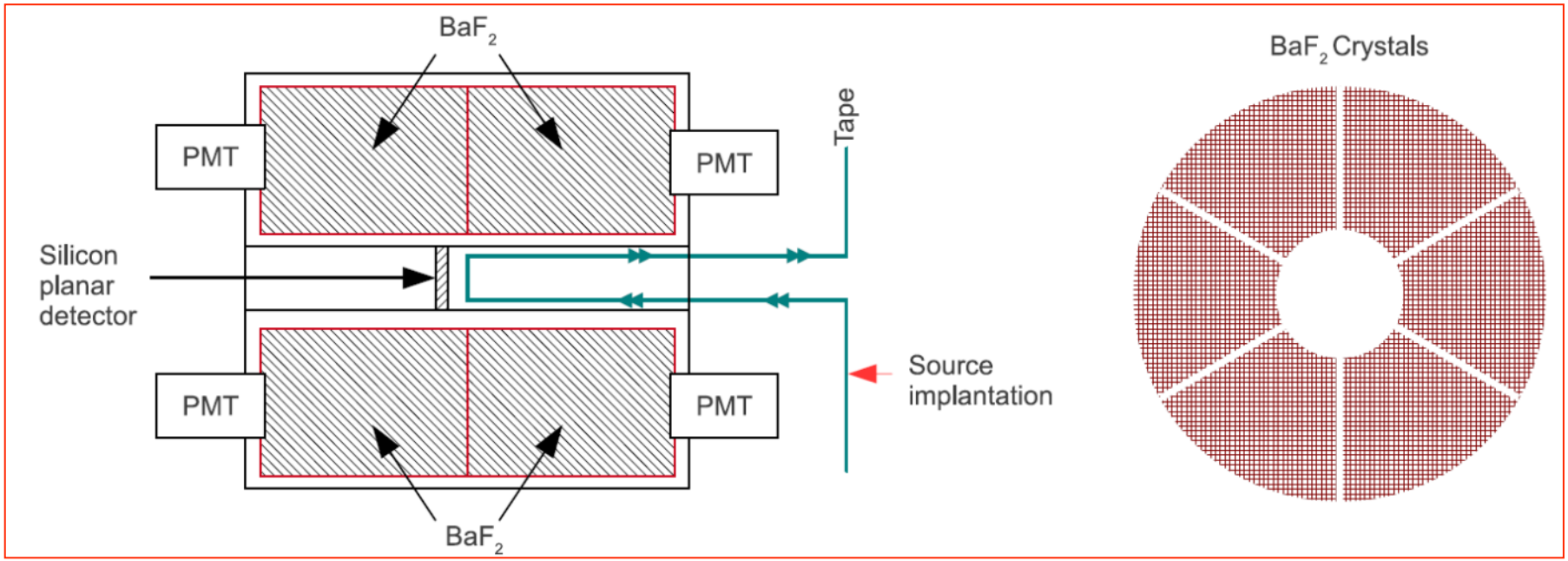
Figure 2.1: Decay heat produced by photons from ^{235}U thermal fission, comparing Tobias calorimetry data to JEFF database data and the improvements made by new TAS measurements. Data taken from [2, 1].



(a) Real feeding levels

(b) Detected feeding levels

Figure 2.2: Schematic representation of the *pandemonium effect* in beta decay.



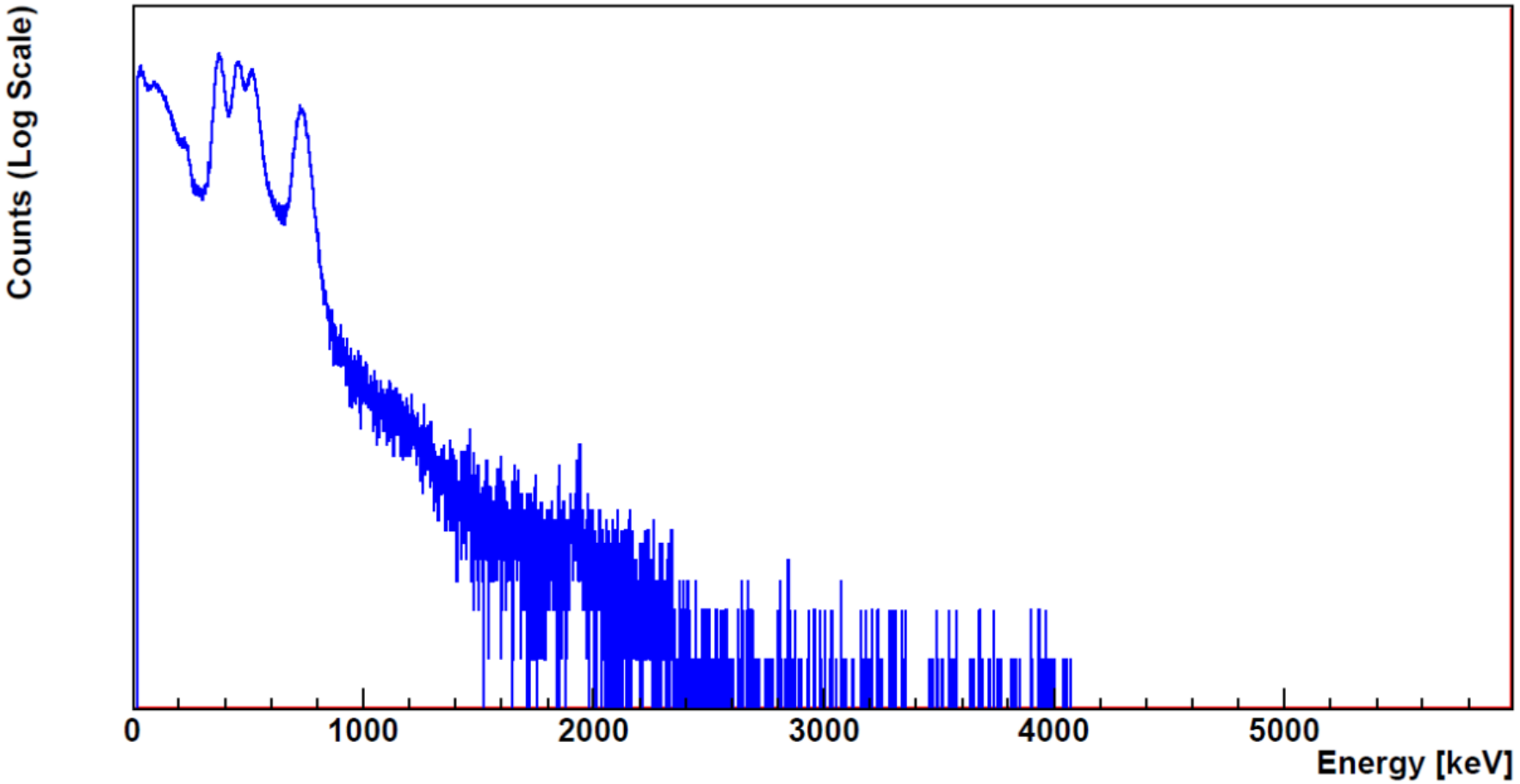


Figure 6.1: Example of the ^{94}Sr *Software Sum* spectra (only rough calibration applied).

nTOF

Manchester and York joined nToF collaboration at CERN in 2010
Supported by EPSRC grant under “Keeping the nuclear option open” programme

Group comprises academics: Jon Billowes (M), David Jenkins (Y)
research fellow: Tim Ware (M)
PhD students: Toby Wright (M), Mark Vermeulen (Y)

nToF (neutron time-of-flight) use 25 GeV protons from CERN PS accelerator to produce neutrons (NB: UK already supporting running of this as member state)

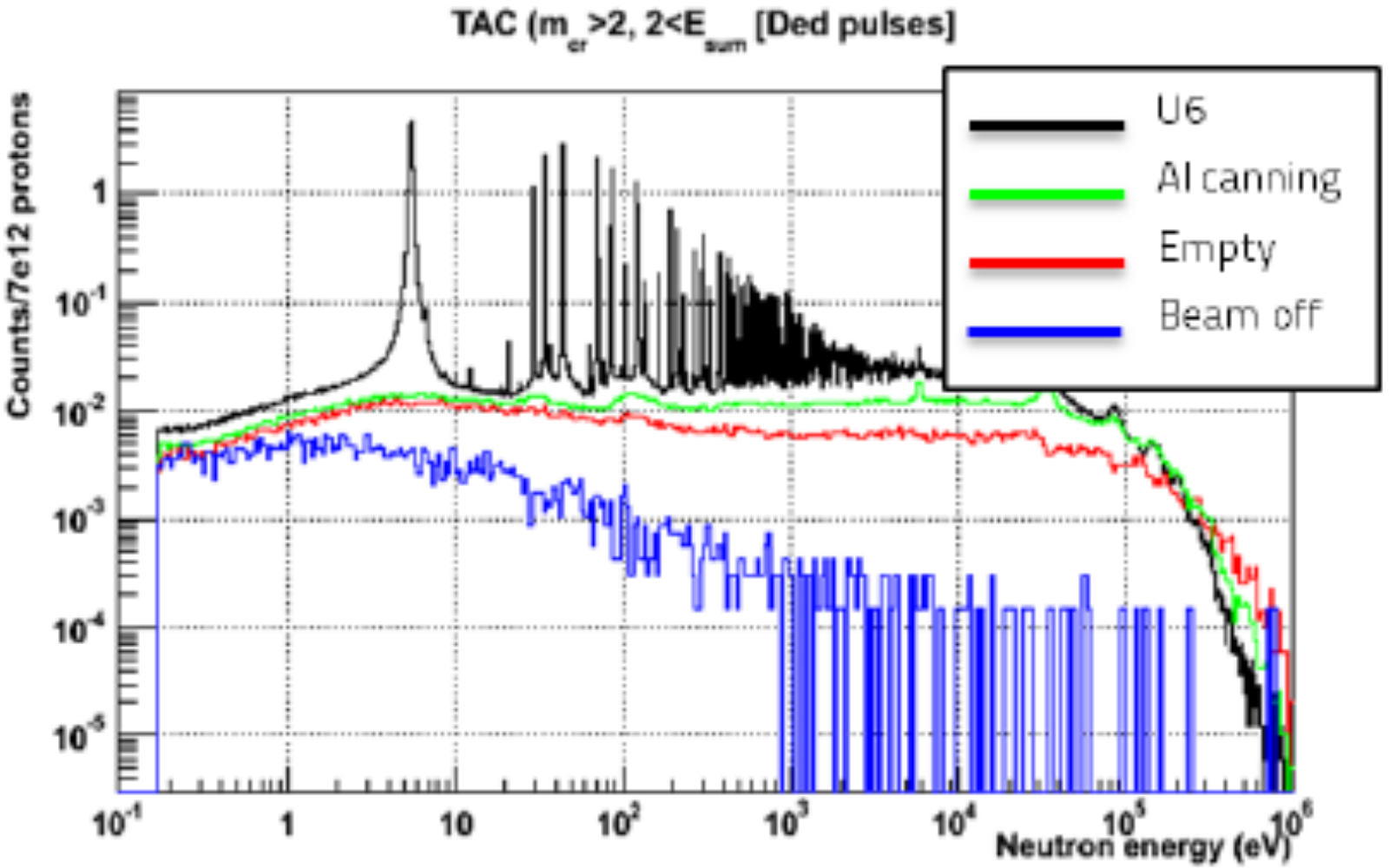
Neutrons fly ~ 100 m and hit secondary target to measure (n,g); (n,fission) etc. cross-sections to high precision i.e. < few %

Cross-section can be measured from high energies to thermal in one measurement

Programme has two strands: reactions of interest to nuclear astrophysics and reactions interesting to present and future reactor cycles including accelerator-driven and thorium reactors

PhD students from Manchester and York have data on ^{236}U(n,g) and ^{238}U(n,g) respectively which will lead to publications

As members of the collaboration, we can propose new experiments of interest to UK



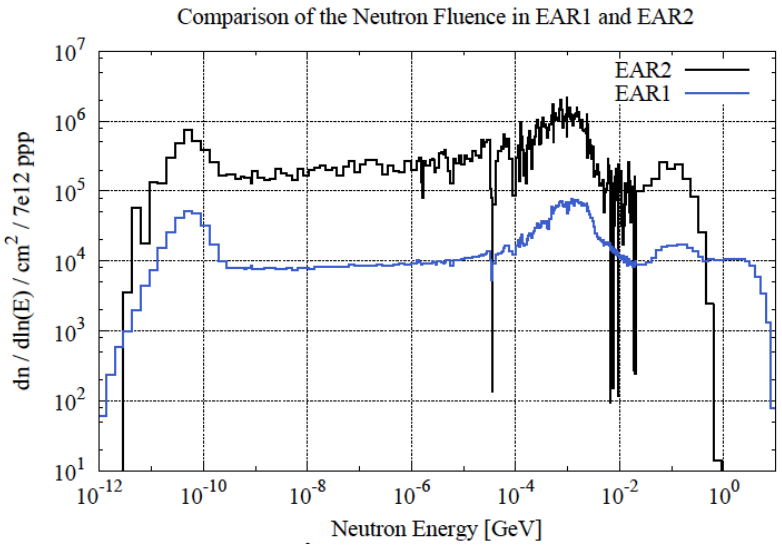
Thesis data of Mark Vermeulen (York) on $^{236}U(n,g)$ relevant to the Thorium cycle

Proposal accepted at CERN to build shorter (20-m) neutron beam-line known as EAR-2

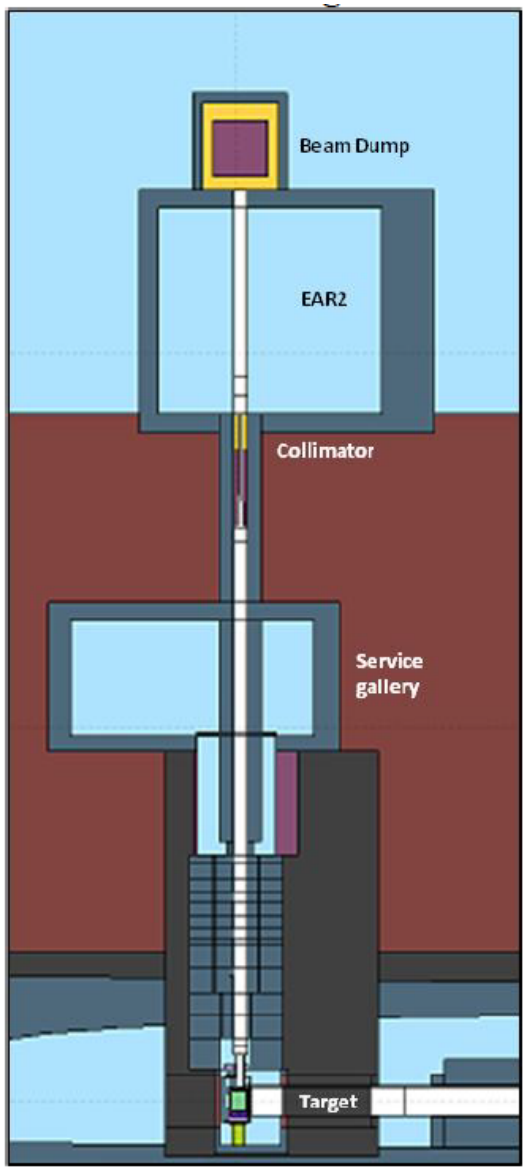
Should come on-line ~ 2015

Much higher neutron fluence allows measurements to be extended to minor actinides which are highly active and hard to handle as large target materials

Scope for UK to bid to provide new detectors needed for EAR-2



Neutron fluence increases by factor of 10



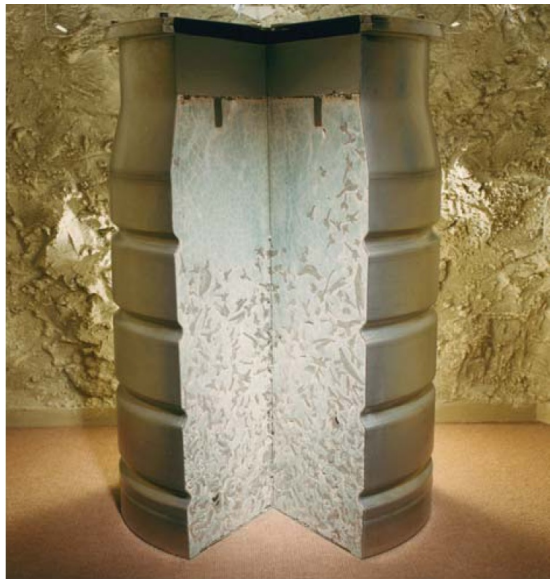
Some other aspects of interest within the wider UK nuclear physics research community (mostly STFC funded work at present).

Other nuclear ‘physics’ research groups in the UK at

- Liverpool (nuclear spectroscopy, imaging, MSc in Radiometrics)
- Birmingham (nuclear spectrometry, MSc in Nuclear reactor Physics)
- York, Surrey, Edinburgh, Brighton, UWS, Glasgow,…

NNL Muon Tomography Project - Overview

The overall aim of the research programme is to assess the feasibility of deploying cosmic muons for use within the civil nuclear industry on behalf of **Sellafield Ltd.**



The focus is on whether or not cosmic muons can be used to interrogate the interiors of containers/ structures which can't be probed by more traditional methods (e.g. X-rays).

The scenario being investigated is one where the spatial distribution of elements within a 500 litre waste drum are imaged using only cosmic muons.

The ongoing multi-phased research programme has been under way at the University of Glasgow's Nuclear Physics Department since November 2009 in partnership with the NNL.

NNL Muon Tomography Project

The multi-phased (multi-year) experimental research programme which has the objective of designing, fabricating and commissioning a fully operational, small-scale prototype detector system in order to validate the results of Monte Carlo modelling is proceeding very well.

The technology can potentially applied to several other application areas which are not accessible (either physically or economically) by traditional techniques.

Some potential applications areas are:

- Waste Skip interrogation
- Silo/Building interrogation