CCFE Contributions to Geant4/V

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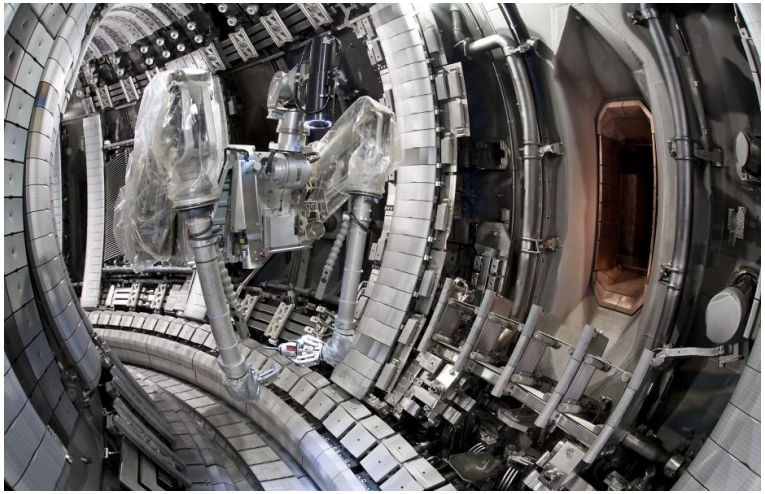
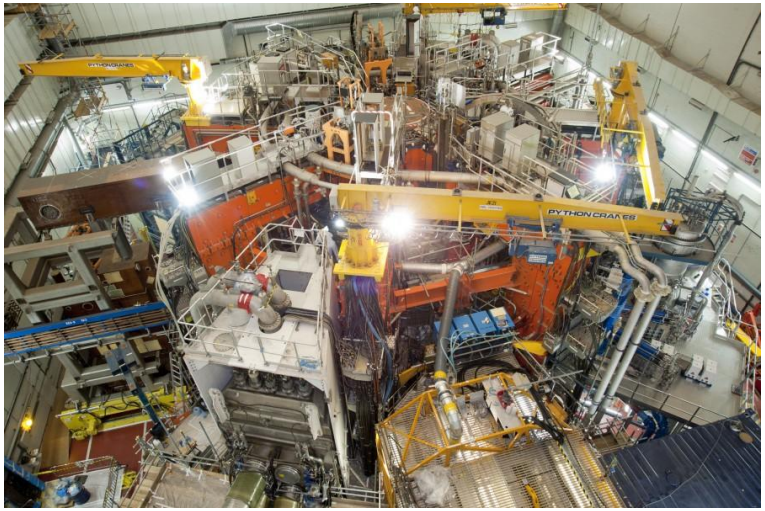
Geant4 Working Groups

- We would like to join two working groups
  - Geometry - Our interest in regular and CAD geometry I think will be beneficial to a wider audience
  - Hadronic - Neutron Physics (data driven < 20 MeV) - will perform significant amounts of validation

Who are we? (i)

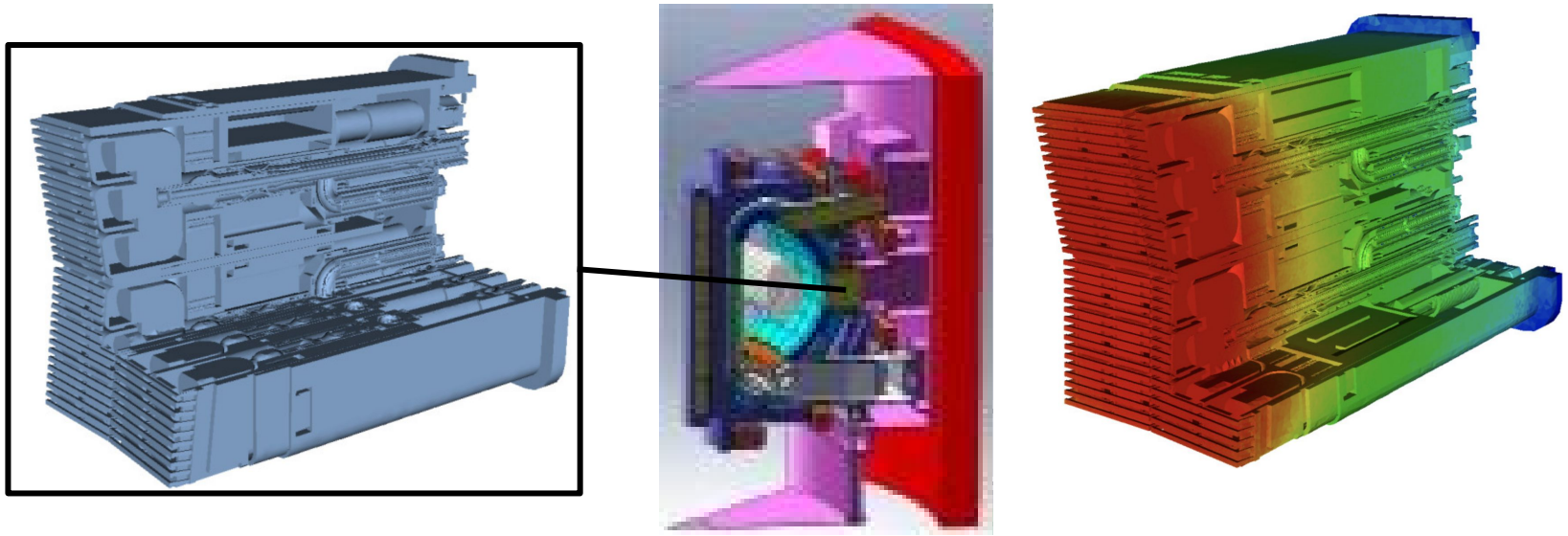
- CCFE is the fusion research arm of the United Kingdom Atomic Energy Authority (UKAEA)
- One of the major research deliverables of our neutronics analysts is to perform neutron (+photon transport) in support of the design of ITER, Detector design in support of experiments - MAST and JET





Who are we? (ii)

- Most radiation transport code users are MCNP5/MCNP6 users
- Take CAD model - convert to MCNP - run transport



- Responses (like DPA, Nuclear Heating) are of primary concern - coupling to other upstream analyses - transmutation etc

Testing/Benchmarking < 20 MeV

- **Validation:** the < 20 MeV community uses a suite of 2000+ benchmarks from ICSBEP, SINBAD and others
  - A suite of these for Geant4 is required to convince members of that community
- **New nuclear data forms**: the nuclear data community is actively developing new techniques
  - Working Party on International Nuclear Data Evaluation Co-operation (WPEC) subgroups 38 and 43 for new formats (XML, HDF5…)
- **New processing codes**: NJOY21
  - NJOY-12/16 (F77) -> NJOY21 (C++)
  - Fully open-source
  - Collaborate to develop Geant-specific forms/formats and/or utilise another format
  - Leverage considerable amount of effort from others

Neutron physics < 20 MeV

- Nuclear data (ENDF) is an area of strength of CCFE
  - Processing from ENDF-6 format to NDL through open-source, documented package
  - Utilise nuclear data processing codes, which are **fully open source NJOY/PREPRO**
  - We have expertise in nuclear data processing, but less with NDL - availability of translation (processed ENDF -> NDL) scripts would be useful
  - Ability to add various derived quantities from NJOY and unresolved resonance treatment (PTs)
  - Addition of cutting-edge nuclear data libraries (TENDL-2017, ENDF/B-8, JEFF-3.3…)
  - Covariances, Total/Bayesian-Monte Carlo and more
  - Uncertainty Propagation (Univ. Liverpool)

CAD Geometry Support (i)

- DAGMC Geometry Support
  - DagSolid (as part of DAGMC) has existed since 2013 and has been used in a few projects
    - NASA - RAD Detector
    - SNS - Proof of concept
    - ITER Physics Comparions
- Baseline implementation has been shown to be inefficient
  - Follows a very Geant4 like implementation
  - DagSolid is-a G4TesselatedSolid
  - The hierarchical geometry performance suffers when tree is wide with high valence volumes

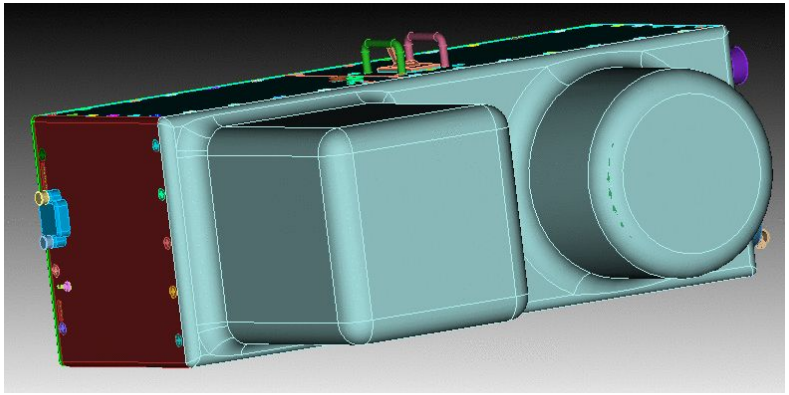


Fig: RAD Detctor Fly Through

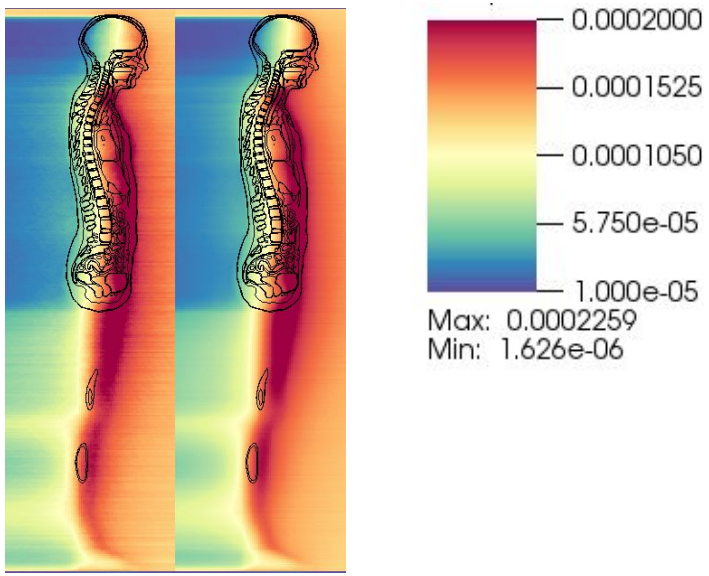


Fig: Triangle mesh human phantom

CAD Geometry Support (ii)

- Work on the concept of a DAGMC Navigator
  - Honour the calls as needed by G4Navigator
- Ensure thread safety - test DAGMC thread manager concept wrt to G4MT
- Investigate vectorisation of DAGMC Queries
  - Already some work underway with vectorisation of OBB Tree
- In collaboration with Univ. Bristol
  - Investigate Geant4/V on ARM platforms (T2 ARM Cluster Isambard)
  - ARM SVE would be of interest

GeantV

- We have good access to HPC
  - GPU
  - Cloud
- We are heavily involved in
  - EOSC Pilot - HPCaaS
  - EOSC Hub - Lead Partner
  - SAGE2 - Data Storage for Exascale applications
- We are looking to scale and develop new workflows for future systems

CCFE Contributions to Geant4/V Summary

- **Nuclear data < 20 MeV**
  - Verify Geant4 neutron transport using simple broomstick and spheres against other MC codes
  - Validate Geant4 against Sinbad and ICSBEP
  - Produce **open** tool to process ENDF files into the G4NDL format with documentation
    - Offer all libraries and facilitate uncertainty quantification
- **Geometry**
  - Investigate DagNavigator concept
  - Investigate DagSolid MT compatability
  - Investigate DagMC Opti/X Compatibility
- **GeantV**
  - Contribute to HPC Development/Deployment

Questions

Thankyou