EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

Software for the calculation of residual activity and dose in components exposed to radiations

Spanish engineering SME specialized in radiation calculation, located near Madrid offers the use of a software that allows to calculate the 3D activation of an equipment or structure close to a neutron source and the residual dose when the neutron source is off. SEA have been working with CIEMAT on the calculation of activation and dose maps around the beam dump to optimize the design of IFMIF define the proper local shielding device. This knowledge acquired during these developments could be applied in medical or nuclear dismantling applications for prevention and reduction of radiations exposures

Description of the technology

The technology consists in a software which automates the process of calculation of neutron activation of a structure or component and the residual dose around this structure or component. It decomposes the 3D geometry in a set of layers of approximately 50x50 voxels and allows using the energy-detailed neutron flux in these voxels to determine the activity of nuclides of interest at each layer. It also provides the source distribution of photons produced in the decay of such nuclides and calculate the dose around the structure produced by the different nuclides. The process of automation and residual dose calculation may take 1 hour for a 15 layers case of such 50x50 voxels array. It is being used in metallic components inside fission reactor vessel and inside reload cavity during dismantling operations. The wide experience with the use of MCNP and ACAB (Activation Abacus Code) codes allows the creation and easy use of this program instead of the long processing times of automated routines using MCNP+FISPACT (inventory code capable of performing modelling of activation, transmutations and depletion induced by neutron, proton, alpha, deuteron or gamma particles incident on matter)

Innovation and advantages of the offer

- Highly specialized in the analysis of radiation transport problem by the use of three-dimensional Monte Carlo tools, mainly MCNP (Monte Carlo N-Particle) family of codes.
- Simplifies the strict process of “neutron flux-activation calculation-residual dose” calculation by using highly visible geometry arrays and keeping control of the whole calculation process without the risks of “black box” use of other solutions
- The system works in reasonable time frame for arrays smaller than 100x100 voxels each layer (Beyond that the activation process and the interactive mode is not practical). takes too long

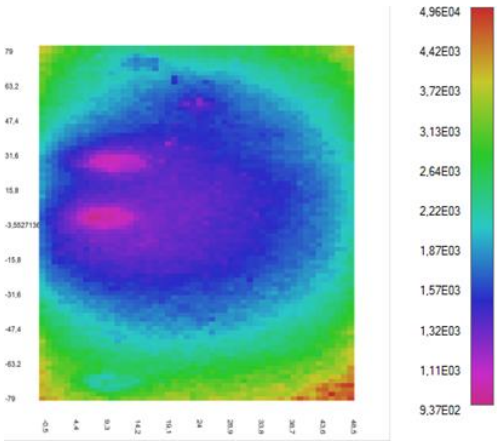

Fig. 1: Residual Activity in components

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Non-fusion Applications

This solution could find promising applications in nuclear fission (analysis of the activation and residual dose produced by metallic components inside reactor vessel), dismantling operations (inside reload cavity) or in healthcare (prevention and reduction of radiations exposures during medical treatment).

The overall capabilities of this solution in fusion research and beyond include:

- Design of shielding elements and materials, design of buildings layout for the installation of sources, Analysis of neutron damage, neutron activation, neutron heating and gas production
- Analysis of residual dose at shutdown due to the neutron activation of the shielding materials and of the components near the neutron source, Determination of residual dose maps
- Isotopic evolution of fission reactor fuel along depletion Shielding of spent fuel assemblies. Criticality safety with credit to burnup.

EUROfusion Heritage

There is a strong need in fusion research to calculate the activation of the structures for the design of TBM shielding modules in order to meet the requirements of residual dose to operators 12 days after reactor shutdown. SEA have been working with CIEMAT on the calculation of activation and dose maps around the beam dump to optimize the design of IFMIF define the proper local shielding device :

- Preliminary design of IFMIF beam dump: Conceptual design of the IFMIF facility defining the thickness of the building walls around and the ceiling over accelerator beam dump. Calculation of dose at operation and after shutdown. Definition of a shielding device to reduce the activation
- Design of local shielding of IFMIF-EVEDA beam dump : Analysis of the limiting dose points in an existing facility building in order to optimize the shielding elements.

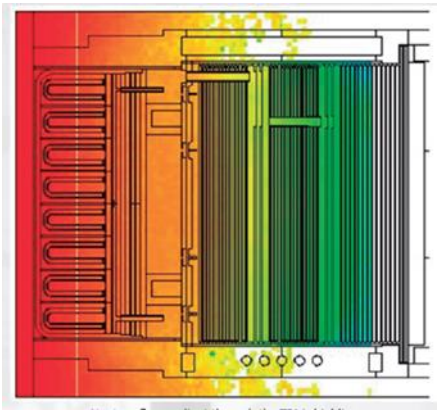

Fig. 2: Neutron flux gradient through the TBM shielding

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This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission