FDS Consortium

FDS, the consortium for nuclear technology innovation in China, focuses on R&D of advanced nuclear systems and applications of nuclear technology. Its history can be traced back to the 1980s. In addition to fundamental research on neutron science and technology, FDS conducts applied research in the fields of Nuclear Informatics and Software Applications, Neutron Detection and Applications, Advanced Nuclear Energy and Safety, and Radiation Medicine and Applications. Through years of unwavering explorations, FDS has successfully established an innovative developing model which integrates the resources of scientific research organizations, universities, high-tech enterprises, and financial institutions. FDS has set up the International Academy of Neutron Science (IANS) as an example research organization with branches in Qingdao, Chongqing, and Hefei. Up to now, FDS Consortium has registered more than 20 subsidiary independent legal entities and established five R&D bases located in Chongqing, Qingdao, Nanjing, Hefei and Anqing.

FDS Consortium has over 800 employees with 80% of its R&D members holding doctoral degrees. Its growth and development strategies are steered by academicians of Chinese Academy of Sciences and academies of other countries. Many chief scientists and directors of many international and national mega research and industrialization programs serve as leading talents key advisors of FDS.

FDS Consortium has undertaken more than 200 domestic and international projects. These include the International Thermo-nuclear Experimental Reactor (ITER) related projects at home and abroad, collaborations with International Atomic Energy Agency (IAEA) and International Energy Agency (IEA), as well as participation in prominent national programs such as the National Basic Research Program of China, the National High-tech R&D Program of China, the National Key R&D Program of China, the Mega Program of Natural Science Foundation of China, the Strategic Priority Research Program of Chinese Academy of Sciences, and the Major Industrialization projects.

FDS Consortium has won more than 20 prestigious national and international science and technology awards, including the National Natural Science Award, the National Science and Technological Progress Award, the European Prize for Innovation in Fusion Research, and the American Nuclear Society Fusion Energy Division Outstanding Achievements Award. These accolades serve as testament to FDS's remarkable contributions and groundbreaking advancements in the field of nuclear technology.

FDS Consortium has developed a suite of cutting-edge products including Advanced Nuclear Software, Neutron Detection Equipment, China Lead-Based Reactors (CLEAR), and Accurate Radiotherapy Systems (KylinRay).

The mission of FDS Consortium is “Better Technology, Better Life”. FDS actively seeks collaborators sharing common ideals and beliefs around the world, forging ahead together in the pursuit of better life for humankind.

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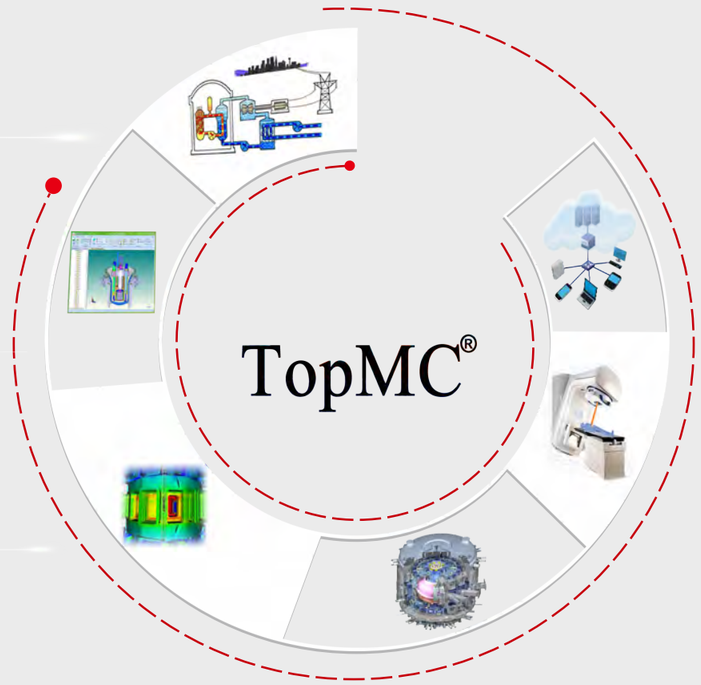
2024-08

FDS 凤麟核

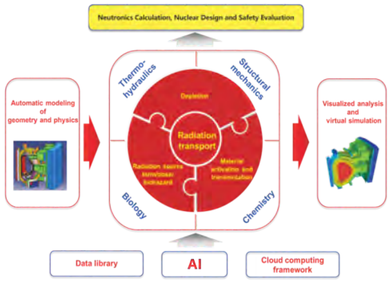


TopMC: Multi-Functional Program for Neutronics Calculation, Nuclear Design and Safety Evaluation

FDS

Introduction

Multi-Functional Program for Neutronics Calculation, Nuclear Design and Safety Evaluation (TopMC, updated and extended version of SuperMC) is a large-scale nuclear design software, which has been developing by FDS Consortium for more than 30 years. Taking radiation transport calculation as the core, TopMC supports the whole process neutronics calculation containing depletion, radiation source term/dose/biohazard, material activation and transmutation. It is featured with high efficiency and high fidelity multi-physics calculation, accurate modeling, visualized analysis, virtual simulation and intelligent nuclear design and safety evaluation, etc. TopMC can be used for the design and safety evaluation of nuclear energy systems, as well as nuclear technology application fields including radiation medicine, nuclear detection and so on.



TopMC architecture

TopMC has been widely used in more than 1000 well-known nuclear-related institutions in energy, healthcare, industry, in more than 90 countries.It has been selected as the reference code by ITER, and passed the Generic Design Assessment (GDA) of United Kingdom. It is available from OECD/NEA and RIST/NCC. Related methodologies and technologies have won the National Natural Science Award, the European Prize for Innovation in Fusion Research, etc.

Functions

Radiation Transport Calculation

- Multi-particles: neutron, photon, electron, etc.

Isotope Depletion Calculation

- Inner-coupling methods: beginning-of-step constant flux approximation (BOS) , predictor-corrector (PC), improved semi-predictor-corrector (ISPC), etc.

Material Activation Calculation

- Computational modes: point activation calculation, transport-activation inner-coupling calculation
- Activation properties: activity, decay heat, biological hazard, dose rate, clearance index and the corresponding contribution of each nuclide in the activation properties, etc.

Shutdown Dose Rate Calculation

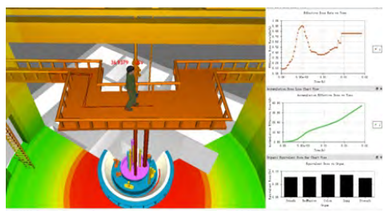
- Rigorous-Two-Step (R2S) method, Improved Direct-One-Step (IDIS) method

Multi-physics Coupling Calculation

Accident Evolvement Simulation

Organic Dose Evaluation based on Virtual Roaming

Intelligent Nuclear Design and Analysis


Advanced interactive virtual-reality simulation

Advanced Features

Full-function & High-efficiency Neutronics Calculation

- Inner-coupled whole process neutronics calculation
- Strong anisotropic neutron transport calculation

CAD/Image-based Accurate Modeling for Complex Irregular Geometry

- Parameterized high-fidelity (pin-by-pin level) whole reactor modeling
- Whole model interactive modeling (geometry, material, source, tally, etc.)
- Extended supporting of modeling for multiple codes, including MCNP, Geant4, FLUKA, TRIPOLI, PHITS, TORT, etc.

Data Analysis based on Multi-dimensional / Multi-style Visualization

- Various styles visualization: volume rendering, visualized analysis of results coupled with geometries, etc.
- Extended supporting of visualization for multiple codes, including MCNP, TORT, etc.

One-key Nuclear Design and Safety Evaluation based on Artificial Intelligence

- Intelligent modeling: interactive generation of complex nuclear system computing models
- Intelligent computing: intelligent prediction of key parameters of nuclear system based on deep learning
- Intelligent analysis: nuclear analysis based on multimodal interaction

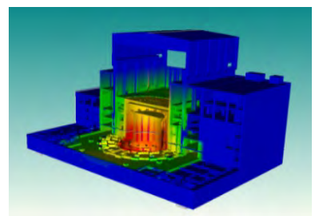
Applications

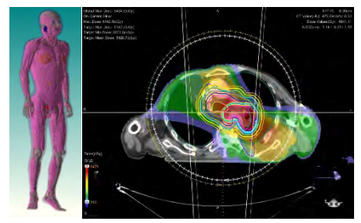
Nuclear Energy

- International Thermonuclear Experimental Reactor (ITER): applied in ITER design for over 10 years; supported to establish ITER reference neutronics basic models
- China Lead-based Reactor (CLEAR): selected as the reference software for nuclear design and safety evaluation of CLEAR; supported the compact design of CLEAR
- HPR1000: applied in the radiation shielding assessments of HPR1000 and passed the Generic Design Assessment (GDA)

Nuclear Technology

- Nuclear detector: support the quantitative analysis of the impact of detector structure, the optimization of detection efficiency, etc.
- Particle accelerator: support the system design, the optimization of beam quality, radiation protection, etc.
- Neutron radiography: support the optimized design and plan formulation
- Radiation therapy: support the accurate dose evaluation of photon/electron/neutron radiation in human body
- Nuclear logging: support the design of the detector, shielding, interpretation system, etc.
- Irradiation processing: support the dose simulation to optimize/evaluate the irradiation plans


ITER neutronics analysis


Dose evaluation in human body