

R&D Activities Within the Framework of the FZK/IRS Collaboration on the SAD Project

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SAD Activities at IRS

Current work focused on radioprotection calculations in collaboration with NIKIET (Russia)

Goal: Supply a first complete evaluation, under normal operating conditions, of the radiation dose from sources within the reactor hall for a 660 MeV proton beam energy, aiming to identify the principal areas of concern

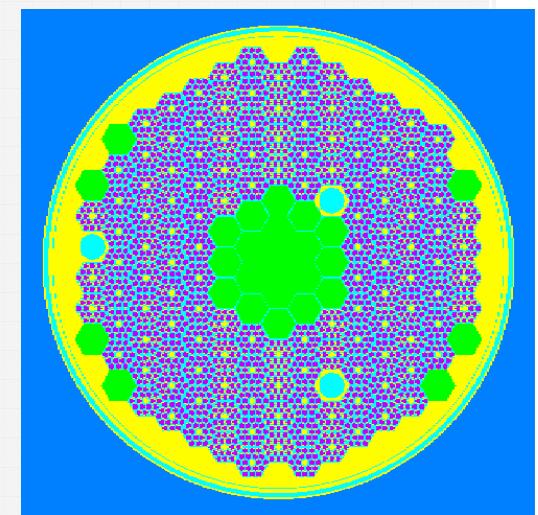
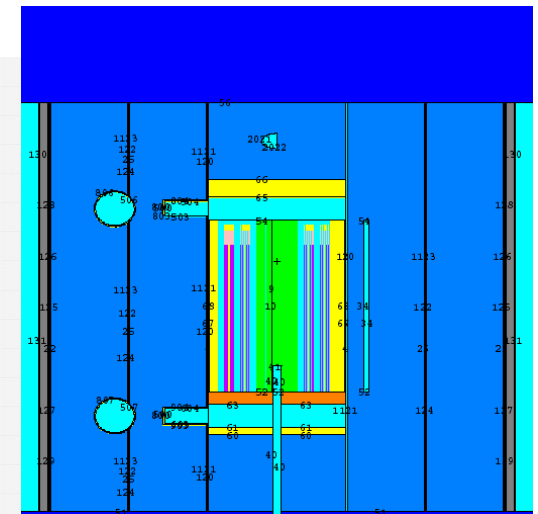
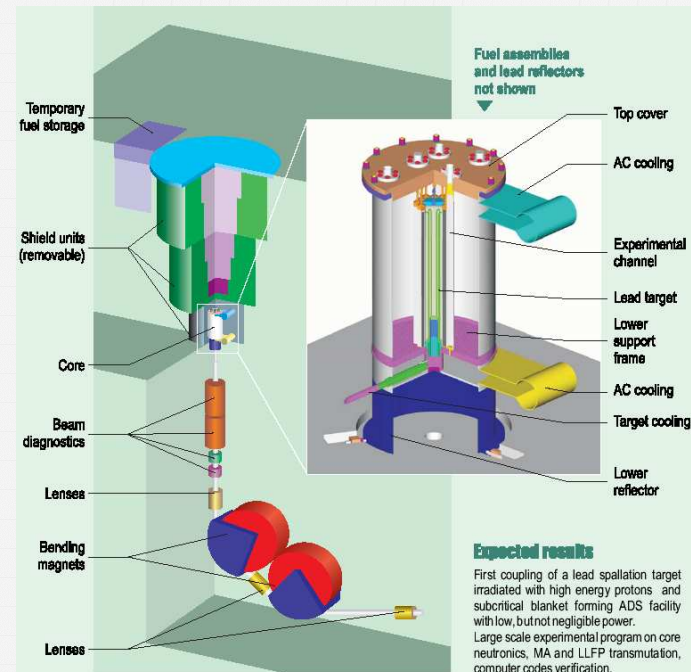
The SAD source term may be conveniently divided into three principal components:

- ➔ 1) Proton beam losses through normal operation from the beam in the vacuum tube line (BTL) and magnets
- ➔ 2) Proton beam impinging into the spallation target:
 - 2a) Radiation not involving a fission neutron in the SAD fuel among its progenitors (spallation source)
 - 2b) Radiation deriving from core fission neutrons
- 3) Proton beam losses through accidental events

SAD Activities at IRS (cont'd)

- MCNPX 3D Model of the SAD facility (originally developed at NIKIET)
- Design parameters: 660 MeV protons, 1.5 μ A beam current

Main SAD Core Parameters	
k_{eff}	0.95
Fission power	27.6 kW
Fuel loading (UO ₂ -PuO ₂)	~ 397 kg
Fuel assemblies	141
Lead assemblies in core	7
Density of fuel	10,2 g/cm ³
U enrichment	0,7 %
Coolant flow rate	~ 0.6 kg/s
Coolant velocity	10 m/s
Temperature (inlet/outlet)	50/96 °C
Pressure (inlet)	0,12-0,135 MPa



SAD Activities at IRS (cont'd)

- Particular efforts are at the moment being put in the calculation of the dose from the core
 - Goal: To calculate the neutron and gamma spectra from 660 MeV to 0.003 eV in the concrete shield at the top of the reactor
- Nuclear data:
 - LA150 libraries (when available)
 - ENDF/B-VI data ($E < 20$ MeV) + Cascade-Exciton Model ($E > 20$ MeV)
- Deep penetration problem (1 m of concrete): very unsatisfactory statistics associated to a reasonable computational time with Monte Carlo analog simulations
- Variance reduction techniques are required to speed up the convergence of the tallies within a few percent of error:
 - Population Control Methods:
 - Weight Windows (space-energy splitting and Russian Roulette technique)

SAD Activities at IRS (cont'd)

Preliminary results of dose rates are currently being analyzed

Future near-term activities at IRS on the SAD project will include:

- Refinement of the computational model in order to obtain a satisfactory statistics allowing a subsequent necessary parameterization of the shield (material and thickness optimization). Safety coefficients will be needed
- Assessment of the uncertainties on the calculated spectra due to nuclear data and models above 20 MeV. Calculations with different combinations of nuclear models and data for neutron, and for protons at all energies (LA150, CEM2k, Bertini INC, RAL, ABLA, etc.)
- Activation calculations