Evaluation of Biological Dose for ARIES-CS and Comparison with Approximate Contact Dose Approach

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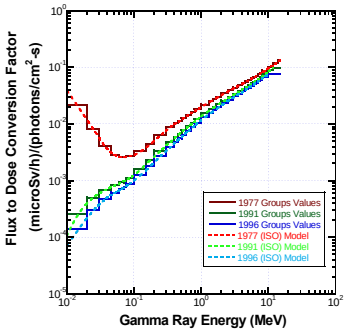
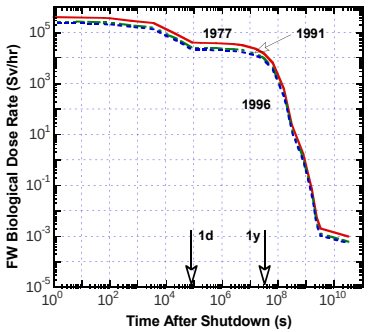
Rigorous Two Step Adjoint Method (R2SA) of Calculating Dose Rate

FORWARD N FLUX (DANTSYS/PARTISN) → GAMMA SOURCES, DOSE RATE at all cooling times (ALARA)

ADJOINT P FLUX (DANTSYS/PARTISN) → GAMMA SOURCES, DOSE RATE at all cooling times (ALARA)

PHOTON FLUX-to-DOSE CONVERSION FACTORS → ADJOINT P FLUX (DANTSYS/PARTISN)





ADVANTAGES:

1.Forward neutron flux only needs to be generated once

2.Radiation from all components contributes to dose

3.Actual geometry is used – no simplification

4.Doses at all cooling times are calculated simultaneously

DISADVANTAGES:

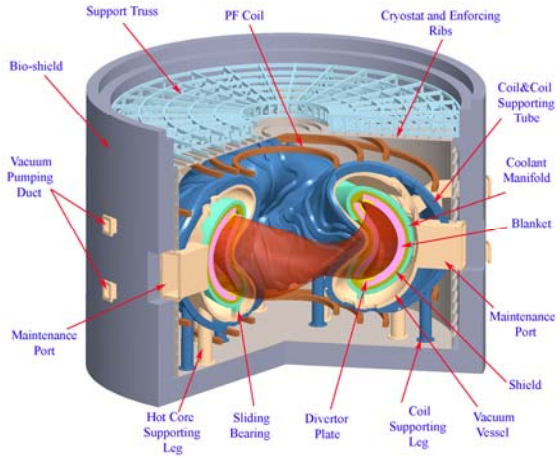
1.Adjoint photon flux has to be recalculated for each detector region

2.Calculations take longer than simple contact dose method

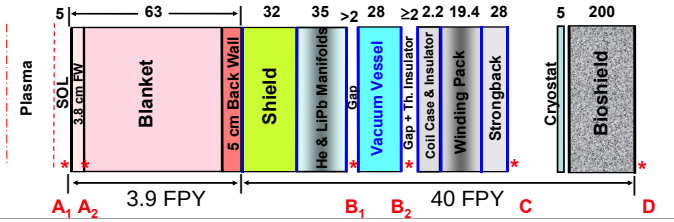
FISPACT Contact Dose Methodology

- Simple but approximate
- No contributions to dose from surrounding components
- Assumes semi-infinite slab for all components regardless of geometry
- Assumes a fixed build-up factor of 2 for all materials
- Gammas below **0.1** MeV are not considered due to discontinuities in the attenuation and absorption coefficients

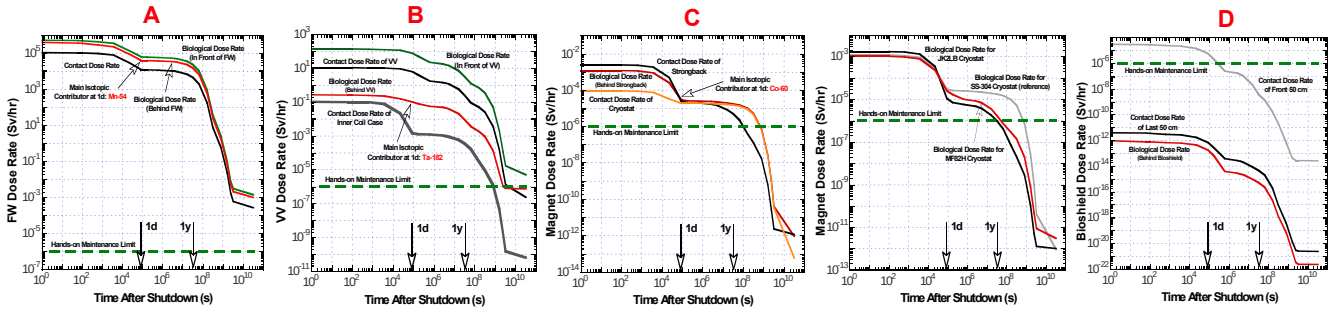
ARIES-CS and Radial Build

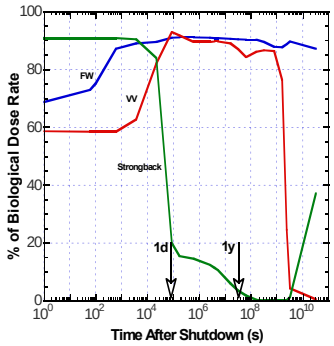


- Latest design of ARIES series - developed in 2006 to enhance attractiveness of stellarators as a commercial power plant
- Power core divided into two distinct sets of components:
  1. Replaceable (3.9 FPY life) – FW, blanket, back wall
  2. Permanent (40 FPY life) – shield, manifolds, VV, magnet, cryostat, bioshield
- Main structural material is F82H - low activation ferritic steel
- Radial build is typical for any fusion power plant with DCLL blanket, except the toroidal field magnets are continuous in ARIES-CS
- No penetrations or assembly gaps modeled to simplify biological dose calculations – neuton streaming was not considered



Biological and Contact Dose Comparisons





Conclusions

- The simple contact dose method tends to underestimate the dose from highly activated components, such as the FW
- Averaging of the activity (gamma sources), especially for thick components, incurs the largest errors in the contact dose method
- If biological dose rate is largely from surrounding components, large errors in contact dose results occur
- We recommend using the R2SA method for all future calculation of biological dose at points of interest