Aalto University
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Neutronics, burnup and nuclear fuel (NEPAL15)

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Project objectives, effect on safety

NEPAL15 = direct one-year extension of NEPAL (SAFIR2014)

►**Methodology development of computer codes** ◄

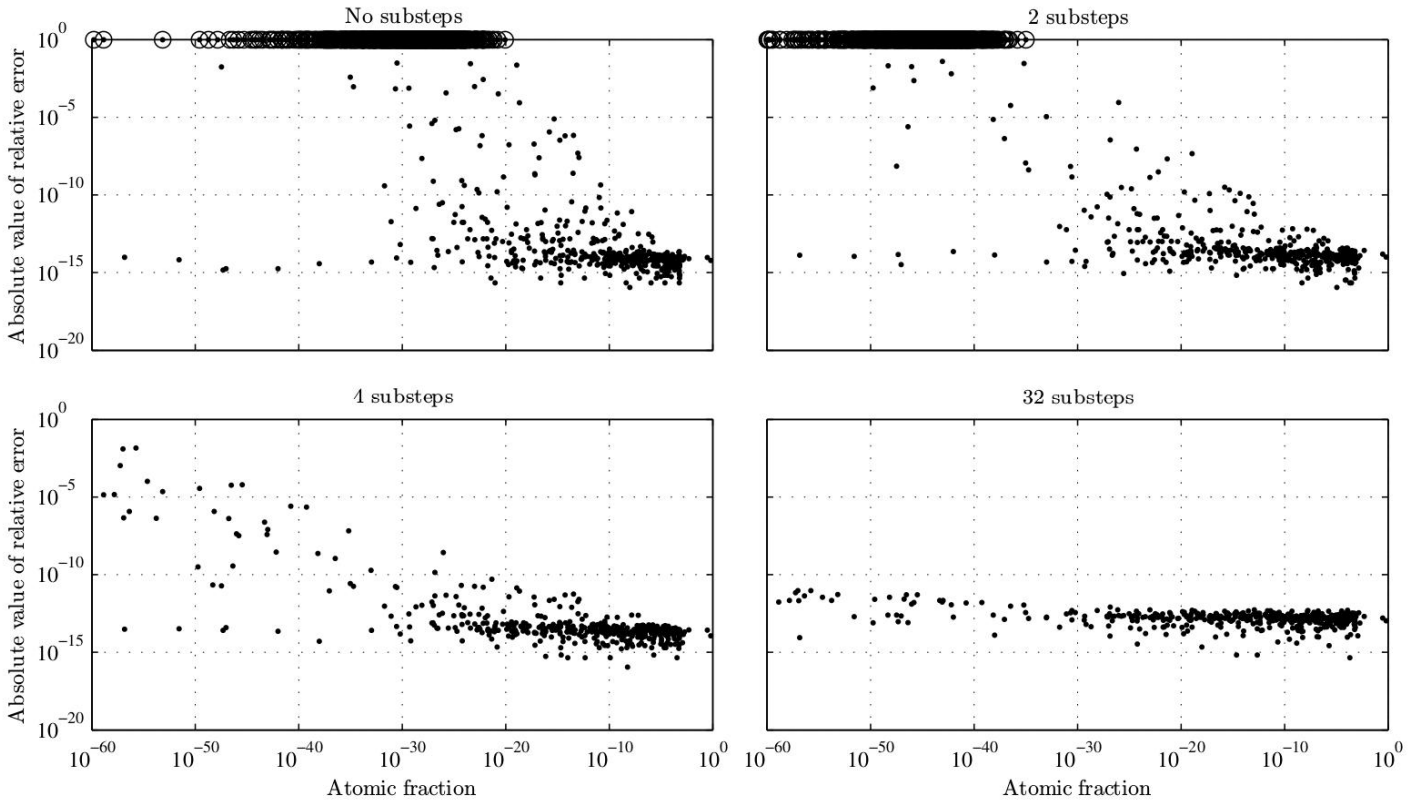
1. Accurate burnup calculations
2. Mesoscopic modeling of nuclear fuel
3. Coupling of fuel temperature profile to neutronics
4. Processing of cross section libraries for Serpent

Deliverables: new calculation methods → scientific publications + improved codes

Deliverables: new expertise and the **new experts** themselves (1 DSc, 1 MSc and 2 BSc)

Example 1: Accurate burnup calculations

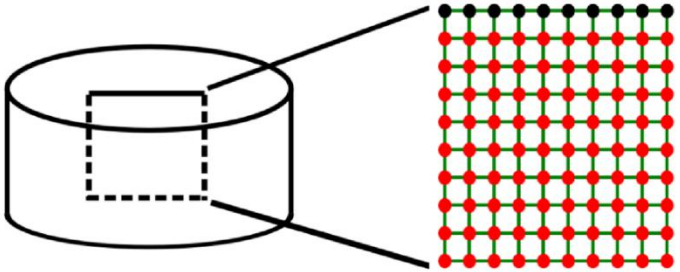
Monte Carlo burnup calculations combine sequential steady state neutronics and depletion calculations with a coupling scheme. CRAM is a fast and accurate method for depletion calculation that was further developed in NEPAL15. Internal substeps illustrated below.



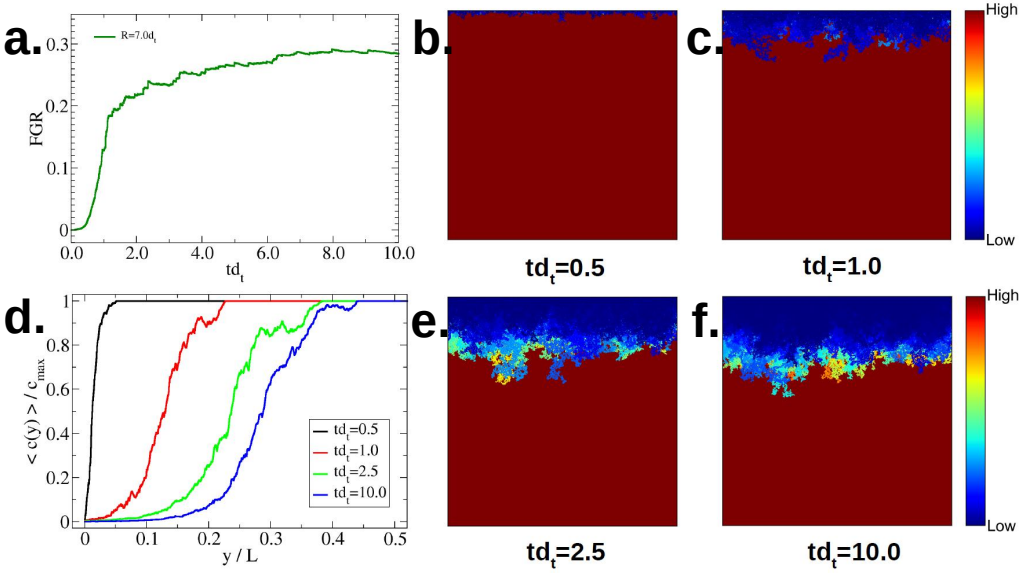
Note:
Atomic fraction 10^{-30} <
one atom per cubic meter

CRAM = Chebyshev Rational Approximation Method

Example 2: Mesoscopic fuel model



Percolation theory
Gas nodes
Interconnecting bonds
Microcracks, porosity
Pore pathways



Fission gas release simulated with creep damage and repair models.
Fractional gas release as a function of scaled time is shown in **a**.
Snapshots of gas concentration **b-c-e-f**: gas is released through the top boundary.
The corresponding y-directional concentration profiles are plotted in **d**.
Here the damage repair rate is sufficiently high to limit gas release to the top part of the system.