The SEG Experiments: preliminary core assessment

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RRR/SEG Fast-Thermal Coupled Facility

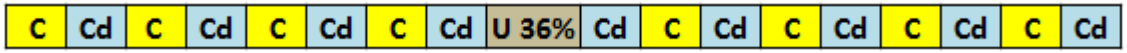
- Rossendorfer Ringzonen-Reaktor (RRR)
  - Zero power Argonaut type reactor
  - Annular thermal driver fuel zone:
    - 60 %U_3O_8 / 40% Al (20% U-235)
  - Graphite or natural U converter

- Schnelles Einsatz-Gitter (SEG)
  - Fast insertion lattice
  - Al or Fe matrix filled with varying pellets (unit cells)
    - Different pellet arrangements lead to both hard and soft neutron spectrums and different adjoint function shapes
      - Obtain separate capture and scattering information
  - 7 primary configurations
  - Initial focus on SEG 4 – 7: Measurements/data on structural materials and fission products

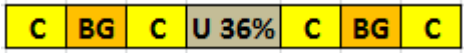
SEG Pellet Unit Cells

- SEG 4/5: energy-independent adjoint spectrum
  - Slowing down effect disappears: i.e. the reactivity change is due only to capture

SEG 4 ⟶



SEG 5 ⟶



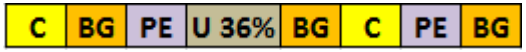
BG=borated graphite

- SEG 6 EK-10/EK-45: monotonously rising adjoint function
  - Hard neutron spectrum with and a dominant, negative scattering effect: suitable for inelastic scattering data

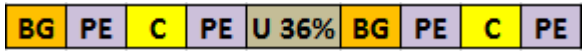
SEG 6 ⟶ no unit cell (radial arrangement of nat U and 36% U)

- SEG 7A/7B: similar to SEG 6 but have soft neutron spectrums
  - Capture and scattering effects are negative

SEG 7A ⟶



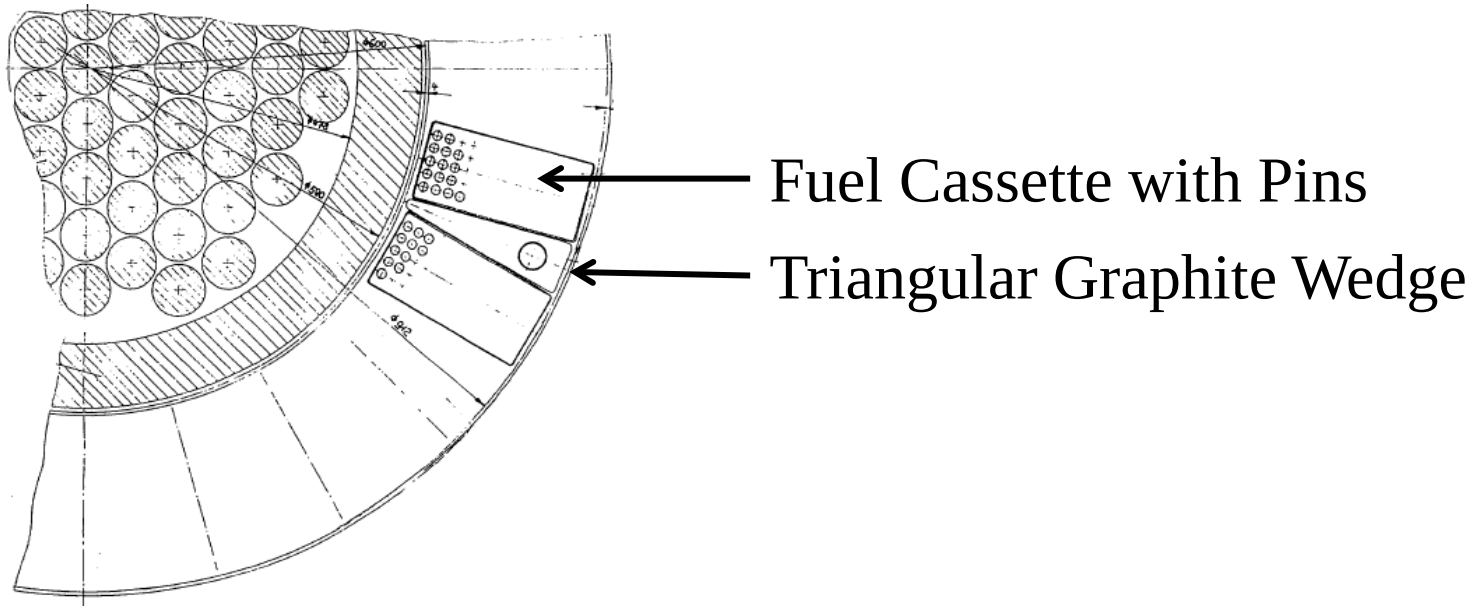
SEG 7B ⟶



PE=polyethylene

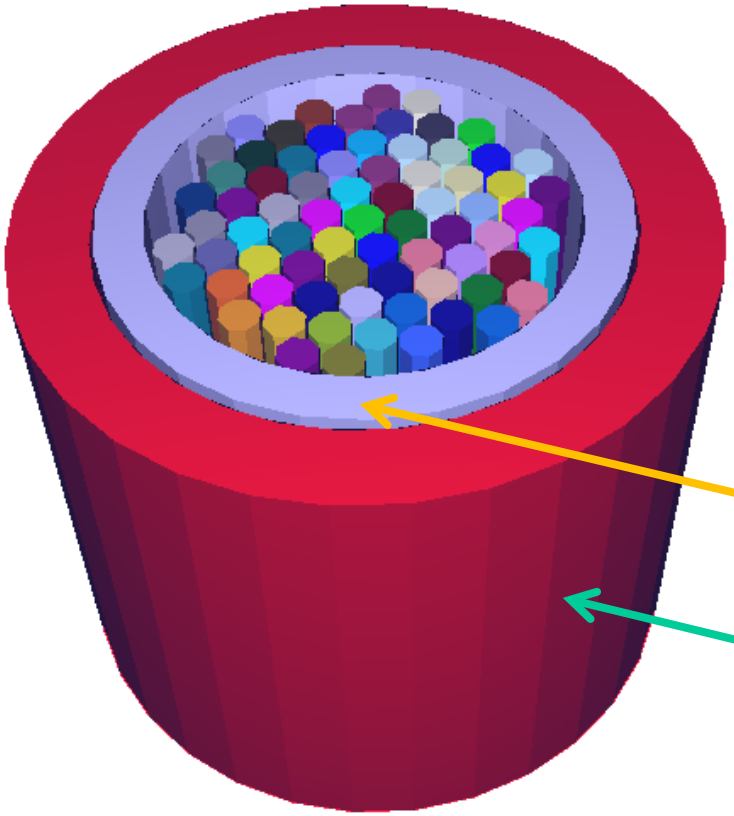
RRR Driver Zone

- Annular driver zone consists of 24 rectangular cassettes with a max of 12 fuel sections of 6 pins in each cassette
  - 24 triangular graphite wedges fill in between; water moderated
- This zone is treated homogenously since the exact number of fuel sections varies (and is unknown); vary the radius to achieve criticality



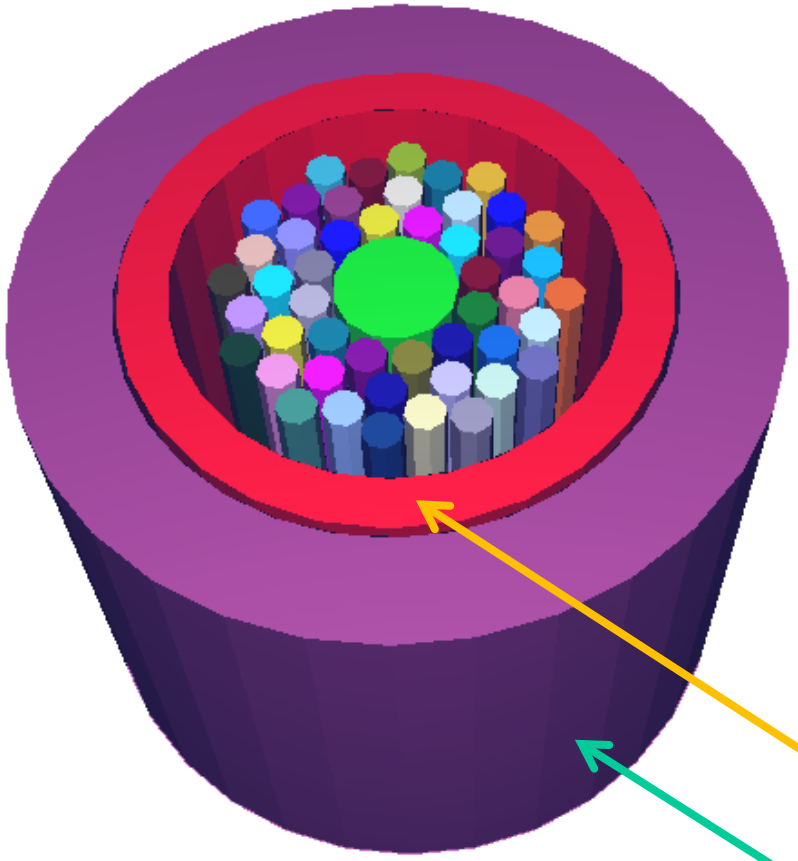
Picture taken from "The Rossendorf RRR/SEG – Facility", K. Dietze.

RRR/SEG Fast-Thermal Coupled Facility



- SEG 4, 5, & 7 lattice
  - 72 holes in a six-angular arrangement
  - Central channel filled with graphite and sample material
  - Pellets grouped in unit cells fill holes
  - Graphite converter surrounded by annular driver fuel

RRR/SEG Fast-Thermal Coupled Facility



- SEG 6 lattice
  - Radial arrangement of 4 rings each having 12 channels
  - Inner ring: 36% enriched U
  - Outer 3 rings: natural U
  - Inner absorption zone: B_4C
  - Experimental channel is either 5.0 or 1.2 cm in diameter
  - Natural U converter surrounded by annular driver fuel

RRR/SEG Critical Configurations

With the SEG lattice inserted, criticality is achieved by varying the radius of the annular homogenized driver fuel (r_d).

- Results obtained using MCNP6.1 with the ENDF/B –VII.I cross section library

SEG 4: $k_{eff} = 1.00029 \quad , \quad \sigma = 0.00003 \quad , \quad r_d = 10.00 \text{ cm}$

SEG 5: $k_{eff} = 1.00026 \quad , \quad \sigma = 0.00003 \quad , \quad r_d = 9.10\ cm$

SEG 6 EK-10: $k_{eff} = 1.00015 \quad , \quad \sigma = 0.00003 \quad , \quad r_d = 11.20\ cm$

SEG 6 EK-45: $k_{eff} = 1.00020 \quad , \quad \sigma = 0.00003 \quad , \quad r_d = 11.20\ cm$

SEG 7A: $k_{eff} = 0.99956 \quad , \quad \sigma = 0.00003 \quad , \quad r_d = 10.55\ cm$

SEG 7B: $k_{eff} = 1.00050 \quad , \quad \sigma = 0.00003 \quad , \quad r_d = \ 8.75\ cm$

On-going and Future Work

- Verify the adjoint energy shape with MCNP6.1
- Review of experimental results and uncertainties
  - Central Reactivity Worths (CRWs)
  - Cross-sections
- Analysis of selected experiments
- Sensitivity/uncertainty analysis