Karlsruhe Institute of Technology

Severe accidents and ESFR design issues

A. Rineiski

Third Joint GIF – IAEA Workshop

SAFETY DESIGN CRITERIA FOR SODIUM-COOLED FAST REACTORS

26 – 27 February 2013, IAEA HQ, Vienna

KARLSRUHE INSTITUTE OF TECHNOLOGY (KIT), INSTITUT für KERN UND ENERGETIK (IKET)

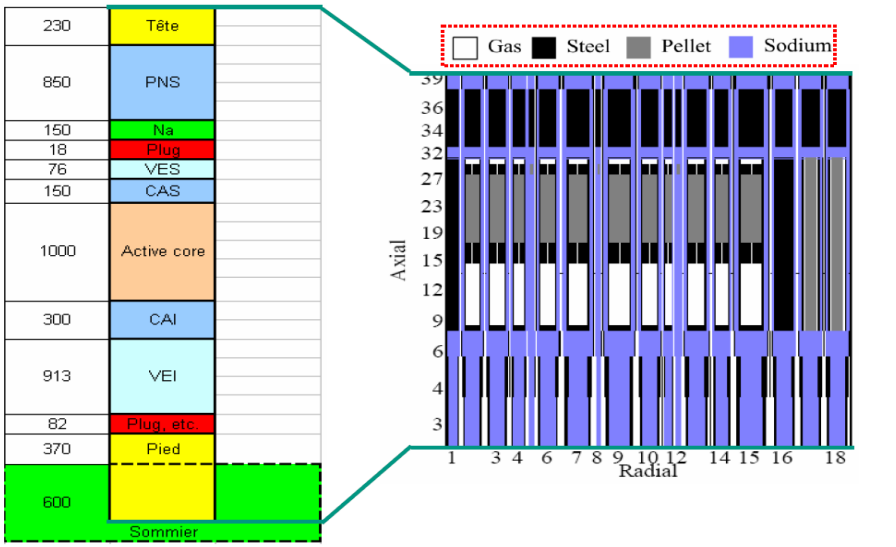
Background

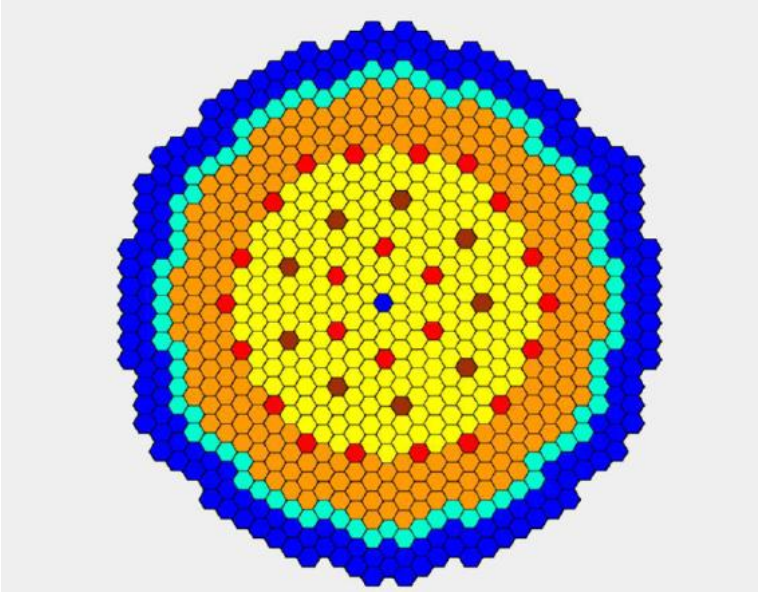
❑ Current SFR studies in Germany

- In support of European SFR studies, mainly on safety and safety-related (design optimization) issues
- ADS and SFR as main options for spent fuel management in studies on the possibility of P&T
- ESFR-type designs studied recently
- ASTRID-type designs to be studied in the future
- Particular area: modeling of severe accidents with SAS4A/SAS-SFR and SIMMER codes

CP-ESFR studies: EU project lead by CEA

- 3600 MWth large SFR: several design options with MOX fuel, thick pins (pellet 9.43 mm)
  - Higher void cores: reference with steel axial blankets and optimized versions with Minor Actinides (core void of e.g. about +5$)
  - Lower void cores with a Na plenum: optimized versions without MAs (e.g. +1$ void in the core and Plenum)





❑ Issues

- ULOF analyses show power excursions after Na boiling onset in reference and optimized cores
- Further multiple re-criticalities may occur, they may contribute stronger (as compared to the first excursion) to the released mechanical energy
- Potential fuel release paths considered: CRGT, empty pins (e.g. 19 pins per SA), empty subassemblies (introduction of empty pins or SAs leads to addition of SAs at the core periphery to preserve the number of fuel pins)
- Substantial reduction of the computed energy release in case of multiple open paths
- Homogenization of fuel and clad after their melting introduces a negative reactivity effect, more than 1$ in absolute value (for the full core)
- This homogenization effect is of a rather large value due to thick pins and is comparable with the void effect in optimizes cores

❑ Considerations

- A MOX SFR core is not in its most reactive configurations
- A re-criticality event leading to a power excursion is possible and should be considered in safety assessments
- Mitigation of further multiple re-criticalities due to design measures (facilitating controlled material relocation) may limit substantially the mechanical energy release
- This mitigation via design modifications is possible without a strong economic penalty
- In an optimized core with a low Na void effect, reactivity feedbacks neglected for earlier designs (e.g. homogenization after melting) are more important