SMR-Core Analysis at pin-level using PARCS-SP3

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Presentation Outline

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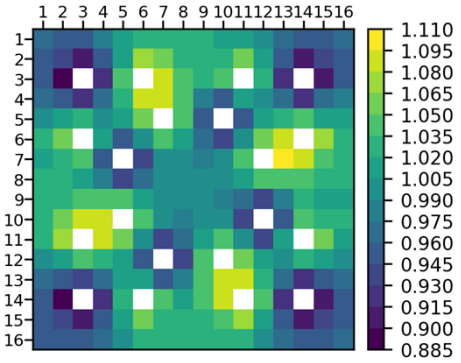
SMR-Core Analysis at pin-level using PARCS-SP3

Motivation:	**Pin-wise TH Feedback** **Pin-wise Simulation with “ASSY_TYPE”** **Pin-wise XS Optimization**
Development:	**Function Extension of PARCS V331**
Verification:	**Steady State pin-by-pin Simulation for KIT-SMR**
Sumarry and Outlook:	**Transient Simulation** **Implementation to PARCS-ICoCo** **Coupling with TH code**

Motivation: Pin-wise Simulation, XS Optimization, TH Feedback

*The discussion in this slide only concern **Cartesian** geometry*



Pin-wise results are important

In KIT, we would like to do:

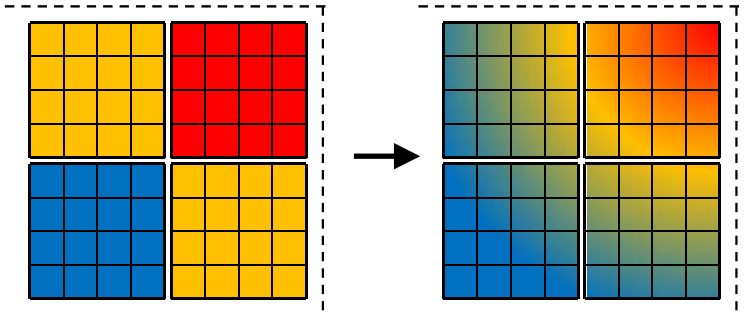
- Pin-by-pin simulation in core-scale with “ASSY_TYPE”.
- Enable pin-wise XS optimization and TH feedback.

PARCS V331 can not do this

Function extension is required

PARCS V331 has two methods for pin-wise results:

- Nodal + Pin power reconstruction



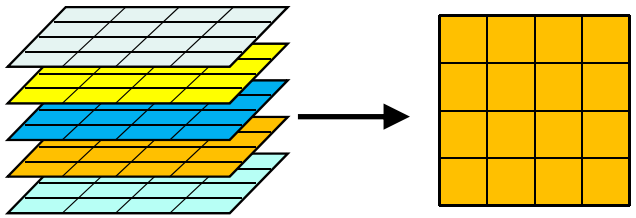
Advantage:

- Fast running.

Limitation:

- No Pin-wise TH coupling.
- No Pin-wise XS optimization.

- FMFD (Fine Mesh Finite Difference)



Advantage:

- SP3 Pin-wise simulation.

Limitation:

- Use “PLANAR_REG”, no “ASSY_TYPE”.

Development: Function Extension of PARCS V 331

*The discussion in this slide only concern **Cartesian** geometry*

For pin-by-pin SP3 simulation with “ASSY_TYPE” activated:

- the most straightforward way is to compose the input files as cases using traditional nodal solvers.
- PARCS V331 has problems dealing with “big data”.

Workflow of PARCS V331:

- Input processing
- Calculation
- Output processing

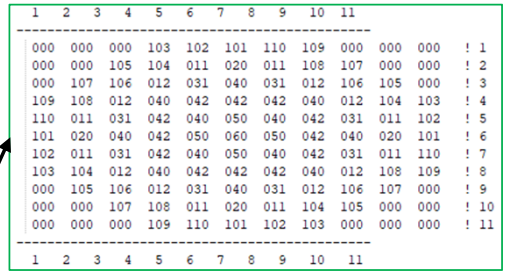
For example → Memory problems

Input blocks:

- CNTL
- PARAM
- GEOM
- FDBK
- TH
- DEPL

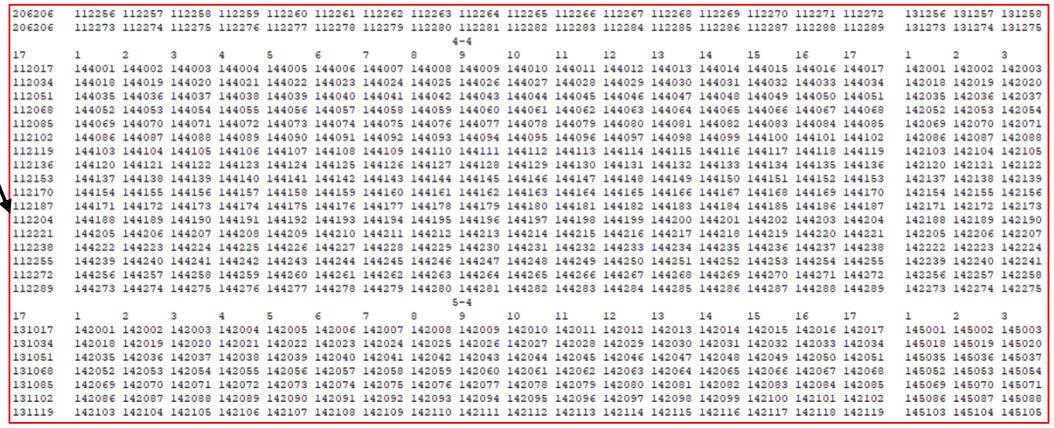
In GEOM, the problem in

- “RAD_CONF”
- “BANK_CONF”



Small Matrix OK

Large Matrix KO

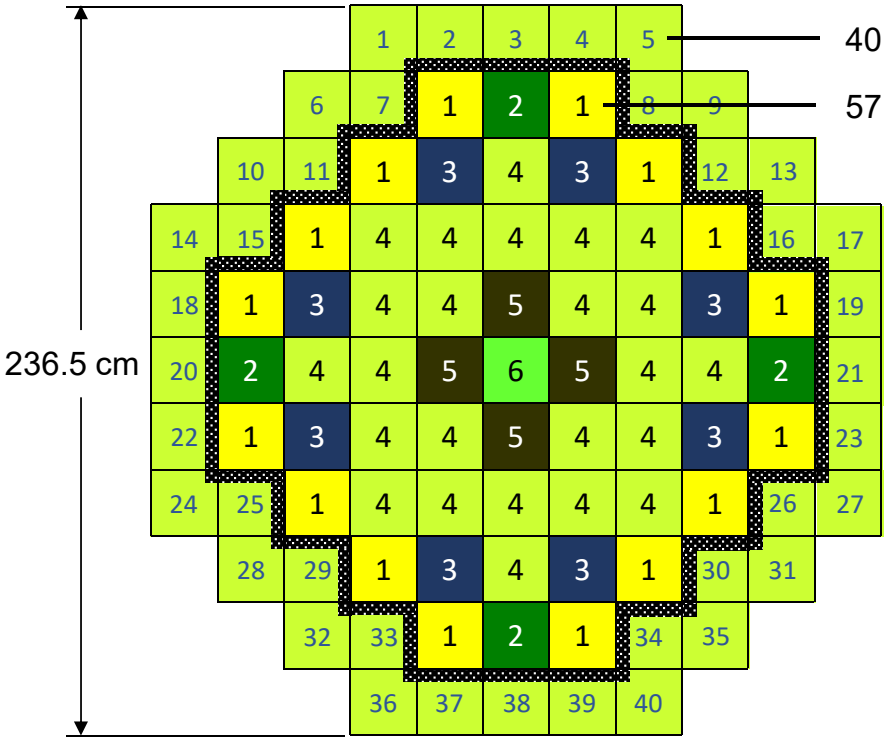


Function extension:

- 20 files related to input and output processing were modified.
- PARCS V331 now works well with “big data”.

Verification: Steady State pin-by-pin Simulation for KIT-SMR

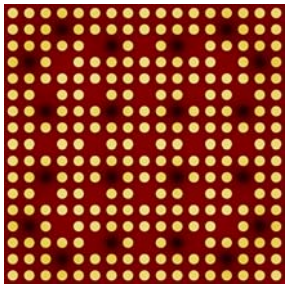
Case Specification – KIT-SMR – assembly configuration:



Radial configuration

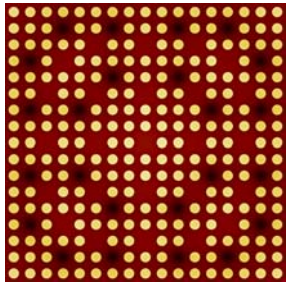
40 radial reflectors

57 fuel assemblies, 6 types, 2 poison types

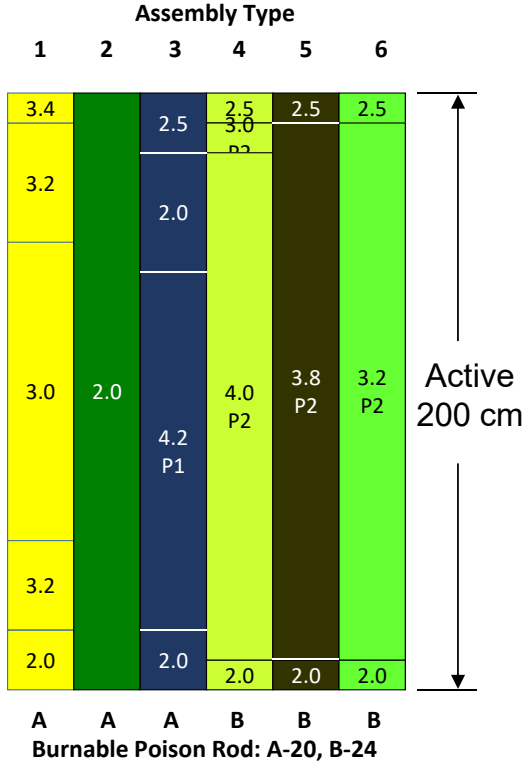


P1 – Type A 20 poison rods

21.5 cm



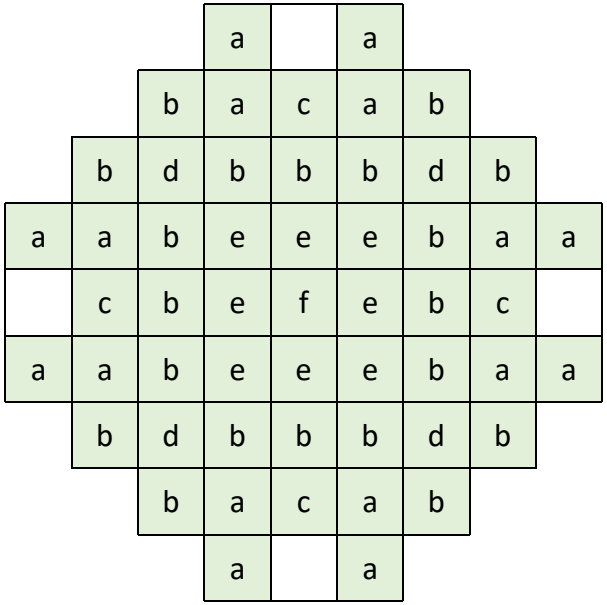
P2 – Type B 24 poison rods



Axial configuration

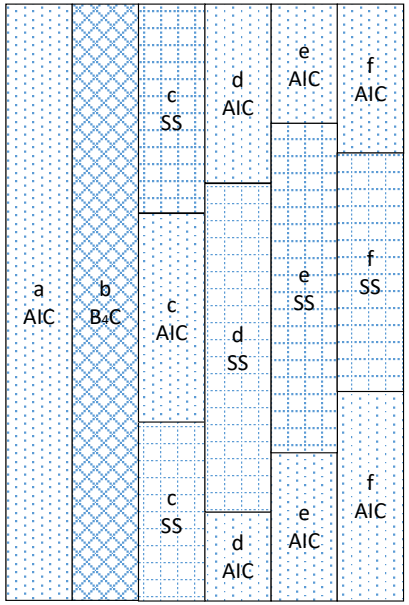
Verification: Steady State pin-by-pin Simulation for KIT-SMR

Case Specification – KIT-SMR – control rod configuration:



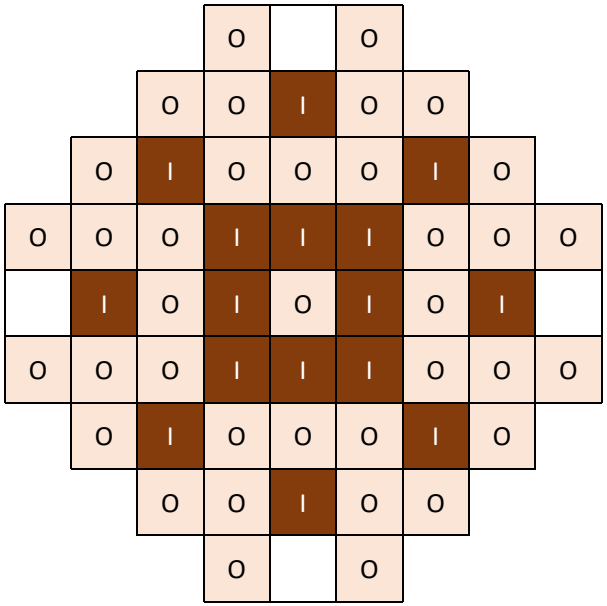
Radial configuration

- 6 types



Axial configuration

- AIC – AgInCd
- SS – Stainless Steel
- B4C

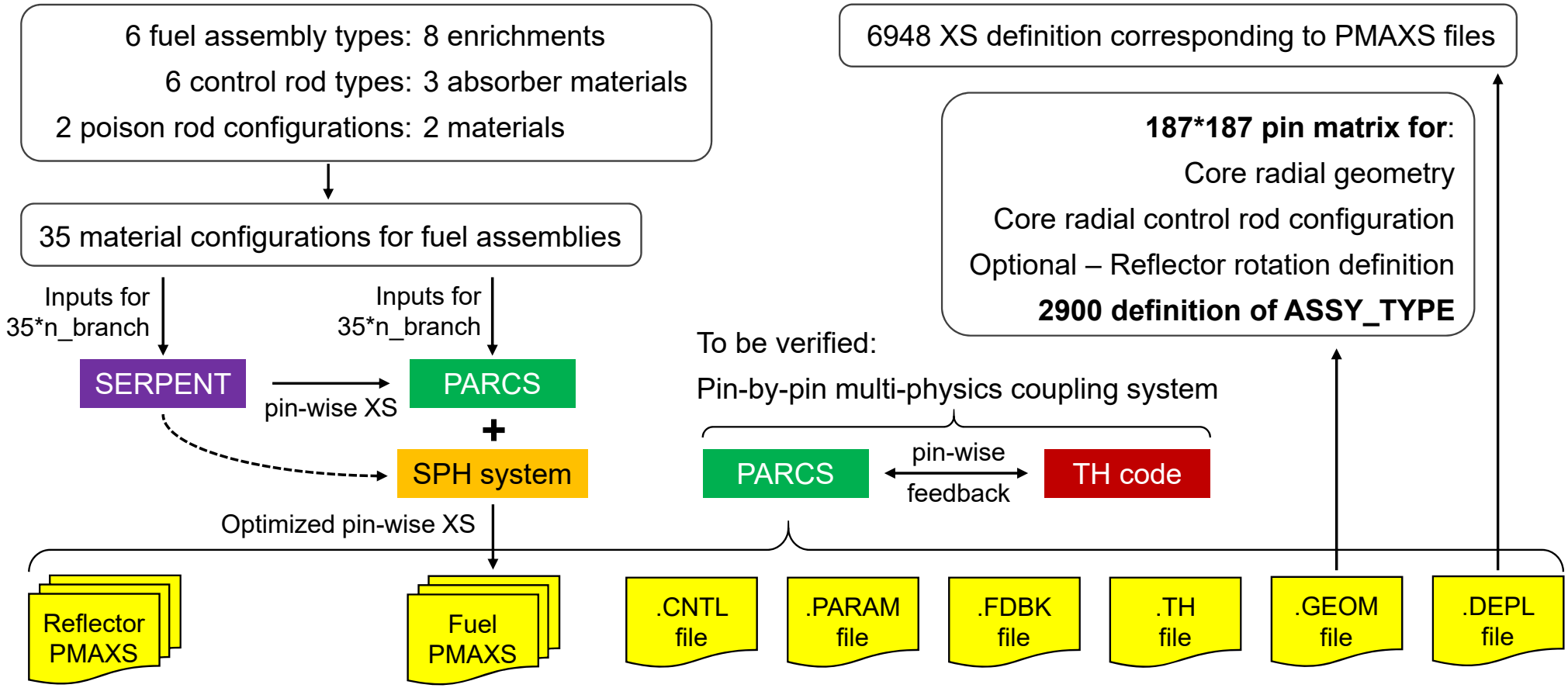


Critical configuration

- I – fully inserted
- O – fully withdraw

Verification: Steady State pin-by-pin Simulation for KIT-SMR

Modeling – KIT-SMR – PARCS:



Verification: Steady State pin-by-pin Simulation for KIT-SMR

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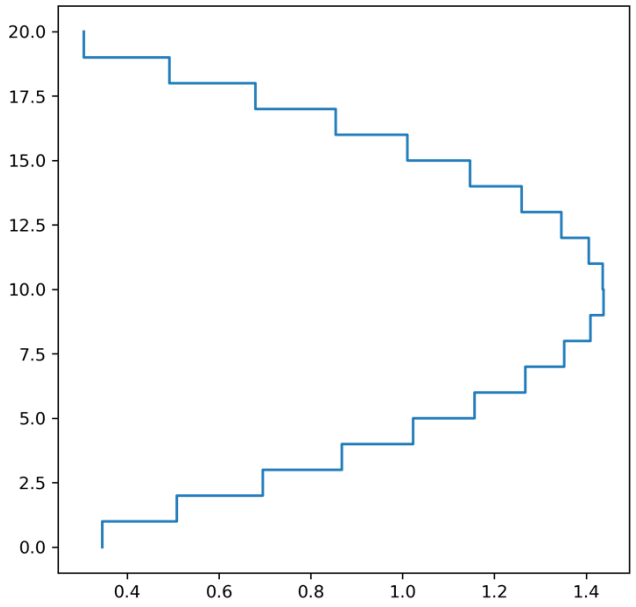
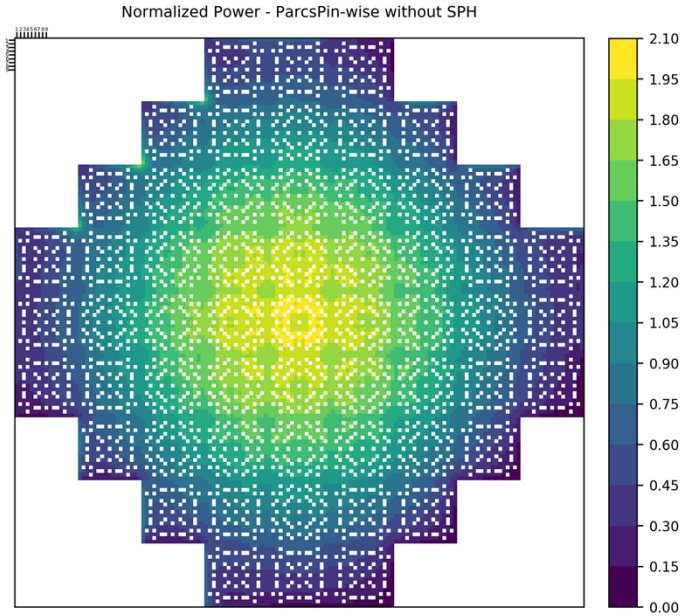
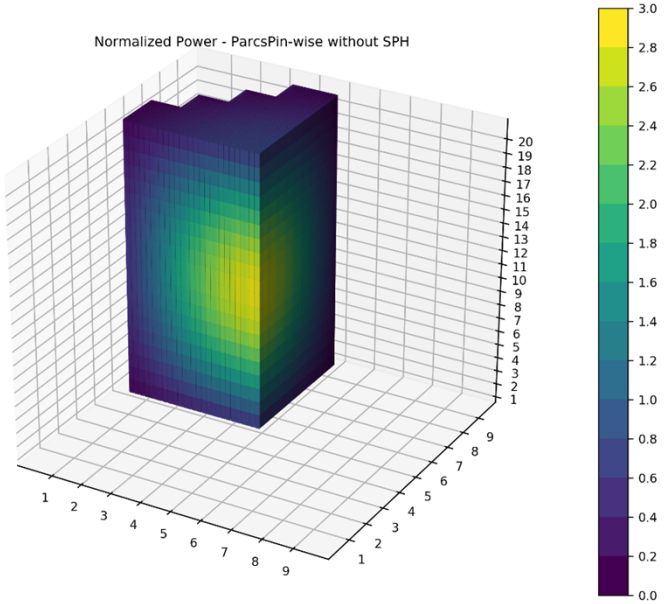
First Results – uniform fuel assembly (enrichment 2.0%, no CR):



Axial power distribution



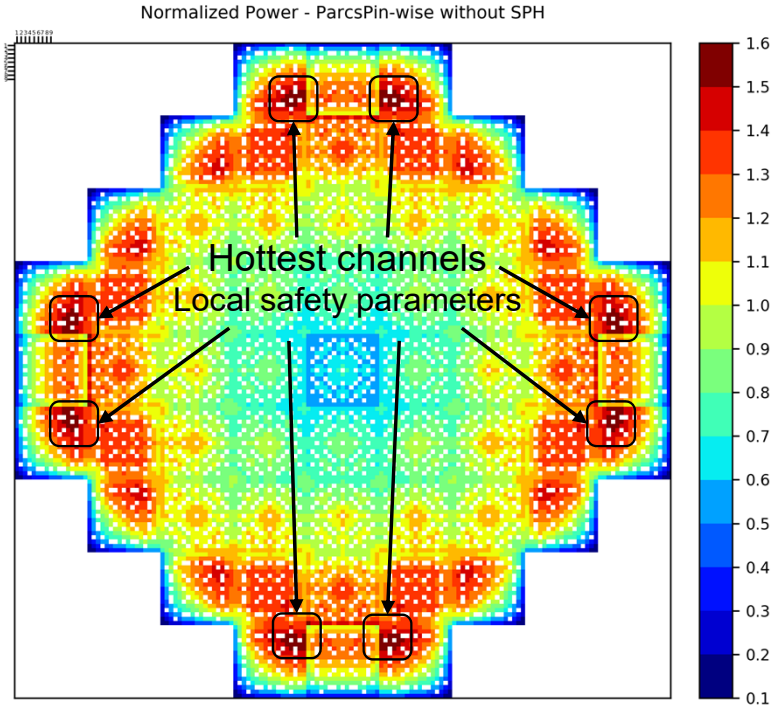
Radial power distribution



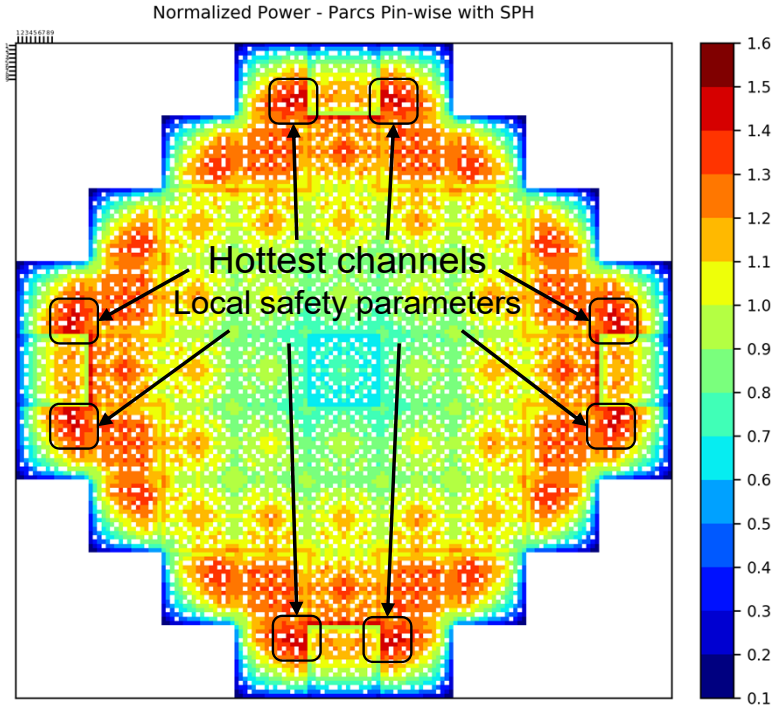
Spatial power distribution

Verification: Steady State pin-by-pin Simulation for KIT-SMR

First Results – KIT-SMR – All Rods Out (AIO) – radial relative power distribution:



Original pin-wise XS
from Serpent



SPH optimized
pin-wise XS

Verification: Steady State pin-by-pin Simulation for KIT-SMR

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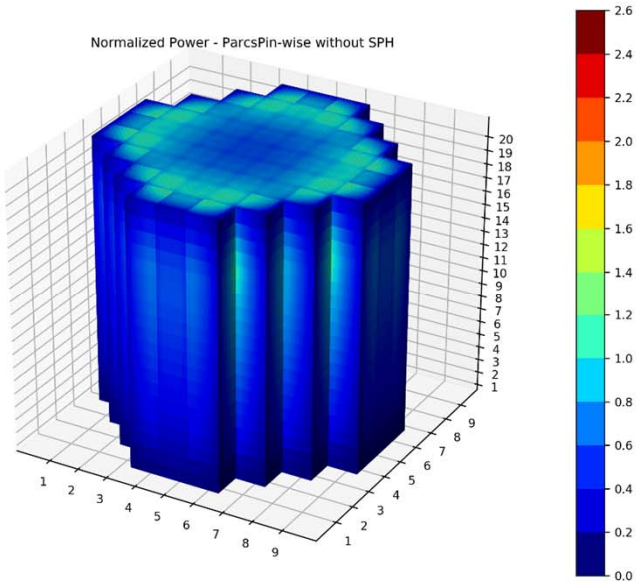
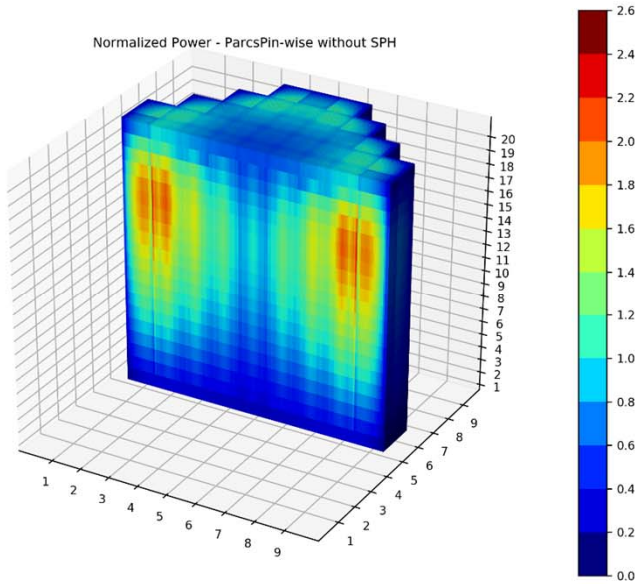
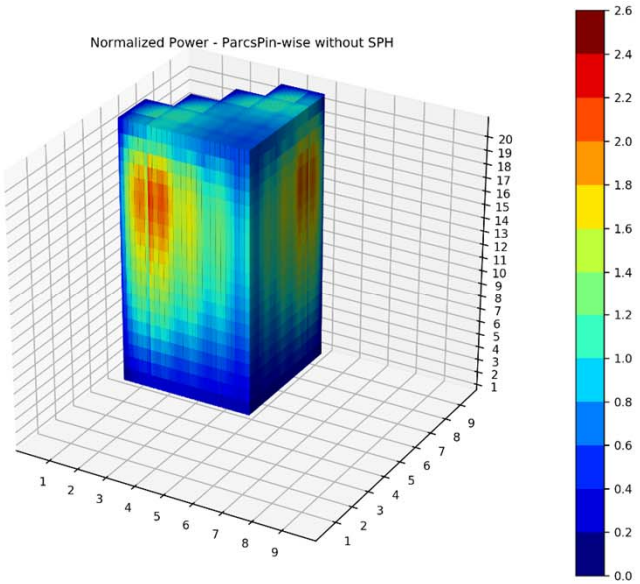
First Results – KIT-SMR – All Rods Out (AIO) – spatial relative power distribution:



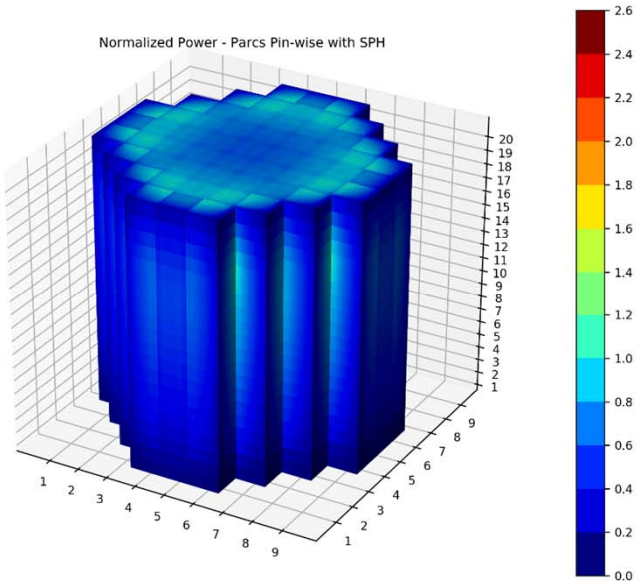


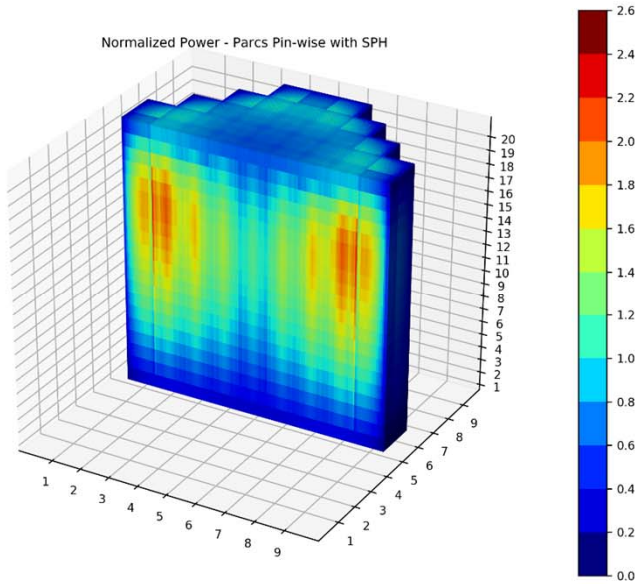


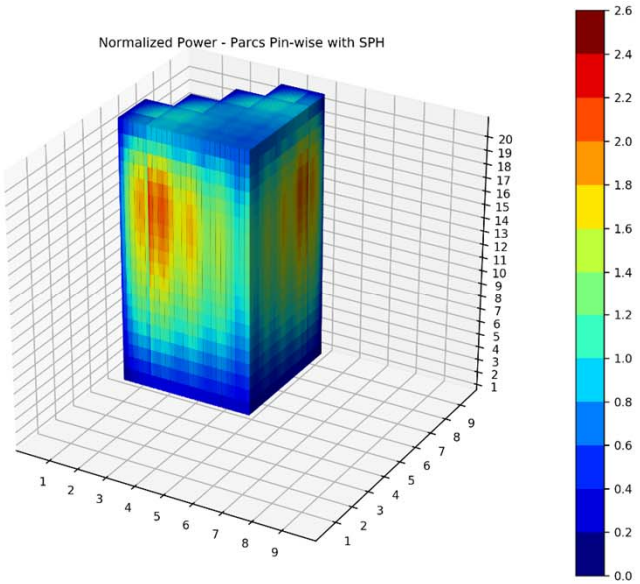
Original pin-wise XS from Serpent

Verification: Steady State pin-by-pin Simulation for KIT-SMR

First Results – KIT-SMR – All Rods Out (AIO) – spatial relative power distribution:

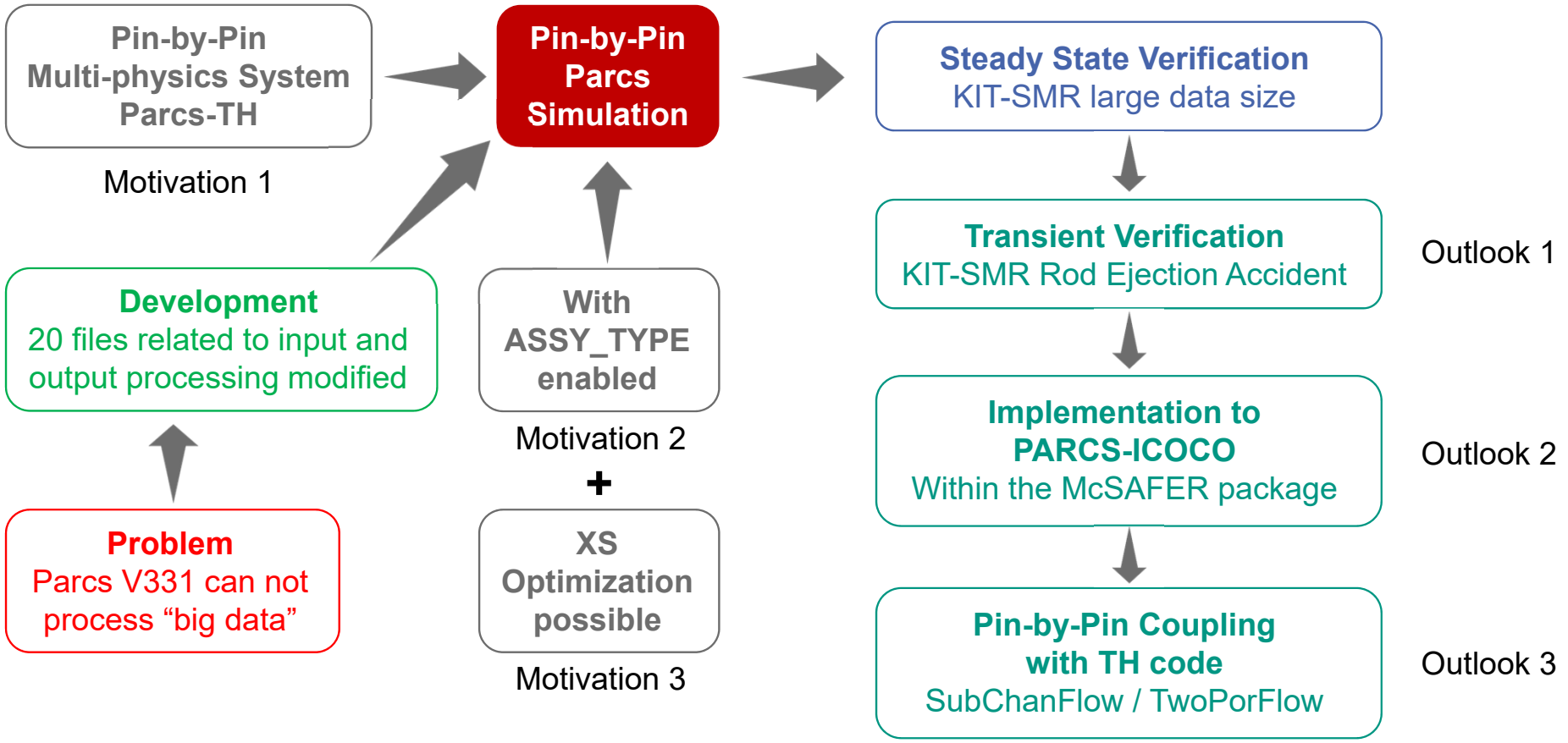






SPH optimized pin-wise XS

Summary and Outlook



Questions and Problems

1. **PARCS V331 crash due to illegal operation when do the 3rd nodal update:**
   - The reflector XS relates to the problem.
   - When the neutron leakage is not significant, PARCS runs well.
   - When the neutron leakage is significant, PARCS crash at the 3rd nodal updating.
2. **How to merge two PMAXS files into one single PMAXS file.**
   - One file contain the XS data without CR, the other contain the XS with XR.
   - Use GenPMAXS to combine the two PMAXS files?