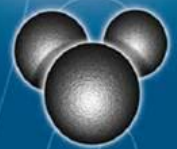
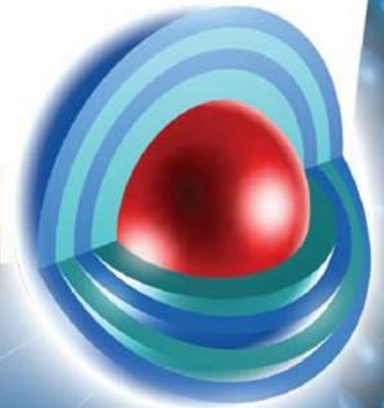
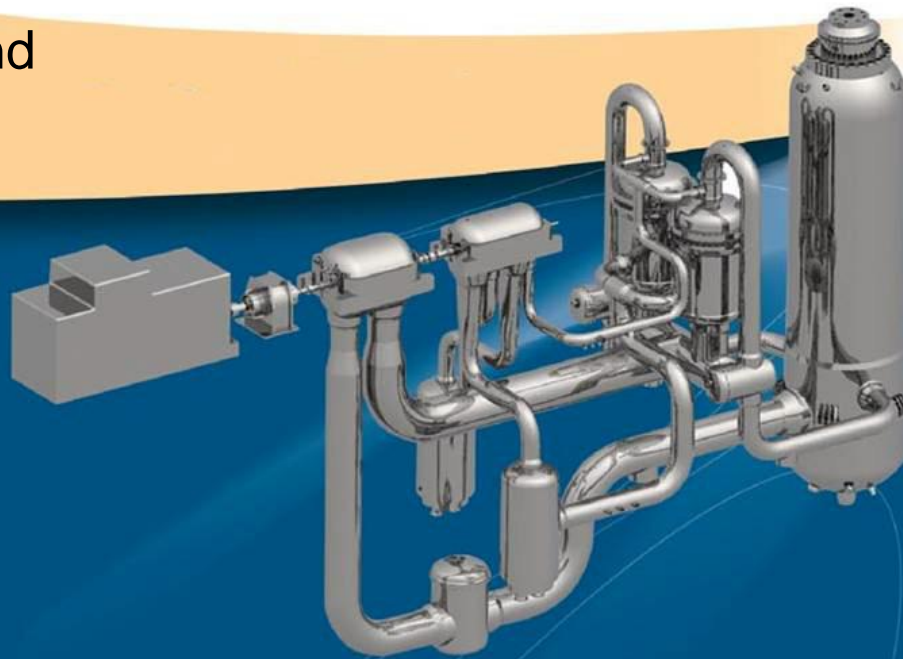




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## Closing Remarks and Action Plan



**PBMR COUPLED NEUTRONICS/THERMAL HYDRAULICS TRANSIENT  
BENCHMARK**

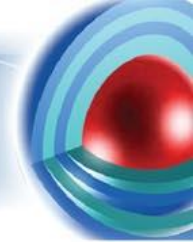
**THE PBMR-400 CORE DESIGN**

**Interlaken, Switzerland**

**14 September 2008**



# PBMR Related Benchmarks and Experimental Facilities



- Proteus Pebble Bed Critical Facility Experiments
  - IAEA-TECDOC-1249, “Critical experiments and reactor physics calculations for low –enriched HTGRs”, IAEA, (2001)
- ASTRA Critical Facility
  - N.N. Ponomarev-Stepnoi, N.E. Kukharkin, et. al., ‘Experiments on HTR criticality parameters at the ASTRA facility of the Kurchatov Institute,’ Nucl. Eng. Des., 222, 215, (2003)
  - F. Reitsma, D. Naidoo, ‘Evaluating the Control Rod Modelling Approach used in the South African PBMR; Comparison of VSOP Calculations with ASTRA Experiments,’ Nucl. Eng. Des., 222, 147, (2003)
- HTR-10 Reactor in Beijing
  - Y. Xu, ‘The HTR-10 project and its further development,’ Proceedings of HTR2002, Petten, The Netherlands, April 2002
  - International Handbook of Evaluated Reactor Physics Benchmark Experiments
- Reactors and Facilities Operated in Germany, such as the AVR
  - K Krüger, A Bergerfurth, S Burger, P Pohl, M Wimmers and J.C. Cleveland, “Preparation, Conduct, and Experimental Results of the AVR Loss-of-Coolant Accident Simulation Test,” Nucl. Sci. Eng. 107, 99, (1991)
  - H. Gerwin, W. Scherer and E. Teuchert, ‘The TINTE Modular Code System for Computational Simulation of Transient Processes in the Primary Circuit of a Pebble-Bed High-Temperature Gas-Cooled Reactor,’ Nucl. Sci. Eng, 103, 302-312 (1989).
- Code-to-Code Comparisons in IAEA CRP-5 (Evaluation of HTGR Performance)
  - IAEA-TECDOC-1382, “Evaluation of high temperature gas cooled reactor performance: Benchmark analysis related to initial testing of the HTR and HTR-10,” IAEA, (2003)
  - IAEA-TECDOC. Draft Title: “Evaluation of High Temperature Gas Cooled Reactor Performance Benchmark analysis related to the PBMR, GT-MHR, HTR-10 and the ASTRA Critical Facility” (In Preparation).
- VSOP and MCNP Comparisons for PBMR
  - S. Sen, F Alborno, F. Reitsma, “Comparison of VSOP and MCNP results of PBMR equilibrium core models”, To be published: Proceedings of HTR1006, Sandton, South Africa, October 1-5, 2006.



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# Future benchmarks



- Burnup benchmark proposal
- ASTRA analysis (IAEA / CRP5 definition available)
- Pebble Box (IAEA / CRP5 definition available)
- Gen-IV plans (limit duplication)
- AVR (In European program; DLOFC simulated test, Melt-wires)
- ?



- PBMRT5 meeting summary with all presentations to be published (also CD) Target October 2008
  - Official summary, All presentations, All submitted spreadsheets, All comparison spreadsheets
  - Action list with final deadlines and plans
- Discussions between current submissions to clarify differences
  - Axial offset – Tinte
  - Kernel models ?
    - Differences in Fission Power (Case 6)
    - Kernel model vs no kernel model
    - Differences between temperatures although powers are similar
  - Steady State submissions / updates / converged results (Action F Reitsma)
    - Old results removed (as applicable)
- All outstanding questionnaires to be submitted by 15 October 2008
  - Updated PARCS-Agree ? (PARCS-Direkt received 2007)
  - CITATION – PBMR for SS Exercise 1
  - DORT-Thermix (could not locate)
  - Many Others? Please send again: (email sent by James Han in July)



- Finalised comparative spreadsheet and statistical analysis (send to PSU, finalised by end October 2008)
  - Updated spreadsheets placed on web
- Draft Benchmark report sent to participants (mid / end November)
  - Comments submitted by end December 2008
- Final report at OECD end January 2009
- Published report, March / April 2009
  - Presentations and other data on CD
- Special Journal issue to be published in 2009 (KI feedback)



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# Conclusions & Future work



- Benchmark definition is final and no changes will be made
- Successful workshops well attended with very stimulating discussions
- Wide variety of codes and methods are applied
- Decision to publish only one report (and not a separate specification)
  
- Next and final workshop now completed
  
- Major deadlines
  - Finalisation of results and all submissions (30 October)
    - Questionnaires
    - Code descriptions
  - Drafted report will be sent to all for comment (November 2008)
    - 2-3 weeks for comments
  - Report submitted to OECD / NEA (Dec 2008/ Jan 2009)
  - Published report (March / April 2009)
  
- A special Journal issue containing all the detailed submissions of the OECD PBMR 400MW Transient Benchmark Exercise will be pursued in 2009 (as a final detailed summary of all the related work)



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# Value added by the benchmark



- Countless fruitful discussions and opportunity to learn
- The OECD PBMR 400MW Code to code Benchmark added a lot of value
  - Will form part of PBMR's V&V work supporting the license application
  - Part of all other Code verification
  - At least five PhD related to this work completed or in progress
  - Increased confidence in the tools used to calculate pebble bed reactors
- Was the catalyst for new code developments
  - Handful of couplings made between neutronic and thermal fluid codes
  - New applications of existing codes
  - Cross section generation and representation lessons learned
- Value of reverse engineering done at PBMR emphasized

# THANK YOU

- All participants
- Support from all organizations, sending participants
- Organizing committee
  - Kostadin Ivanov – support to chairman and comparisons
  - James Han – Student at PSU - Comparisons
  - Enrico Sartori – organizing meeting and support
- OECD / NEA / NSC
- PBMR releasing information to be used in benchmark



Purdue University



Universität Stuttgart

OAK RIDGE NATIONAL  
LABORATORY