Very High Temperature Gas Cooled Reactor (VHTR)

Presented at the

Generation IV R&D Scope Meeting
Boston, MA
June 25, 2002

by

Masuro Ogawa, JAERI

Werner von Lensa, FZJ (Juelich)

Main VHTR Features

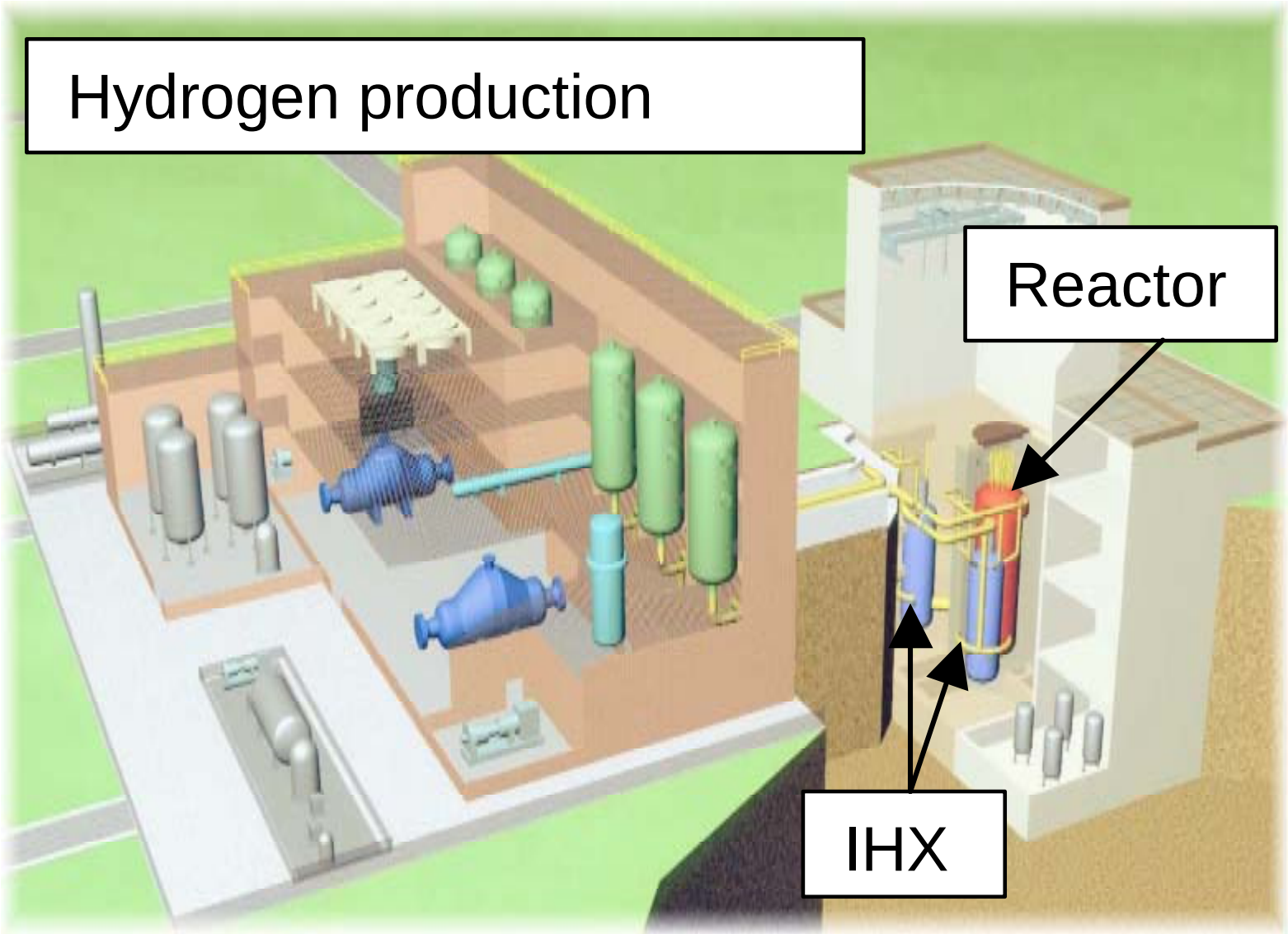
- Basic technologies for VHTR have been established in former HTR plants (DRAGON, Peach Bottom, AVR, THTR, FSV) and are being advanced in the near-term deployment projects on PMR (GT-MHR) and PBR (PBMR)
- Further R&D is needed to increase coolant temperature beyond 850-900 C and to develop the interface between the Nuclear Heat Supply System (NHSS) and the heat utilization systems.
- The HTTR and HTR-10 projects will demonstrate the feasibility of VHTR as well as co-generation / non-electric applications, and will provide first data from nuclear operation of VHTR in addition to the results from former Nuclear Process Heat (NPH) Projects (e.g. Prototype Nuclear Process Heat (PNP) in Germany) which are still of high relevance for the future VHTR development.

Main VHTR Features

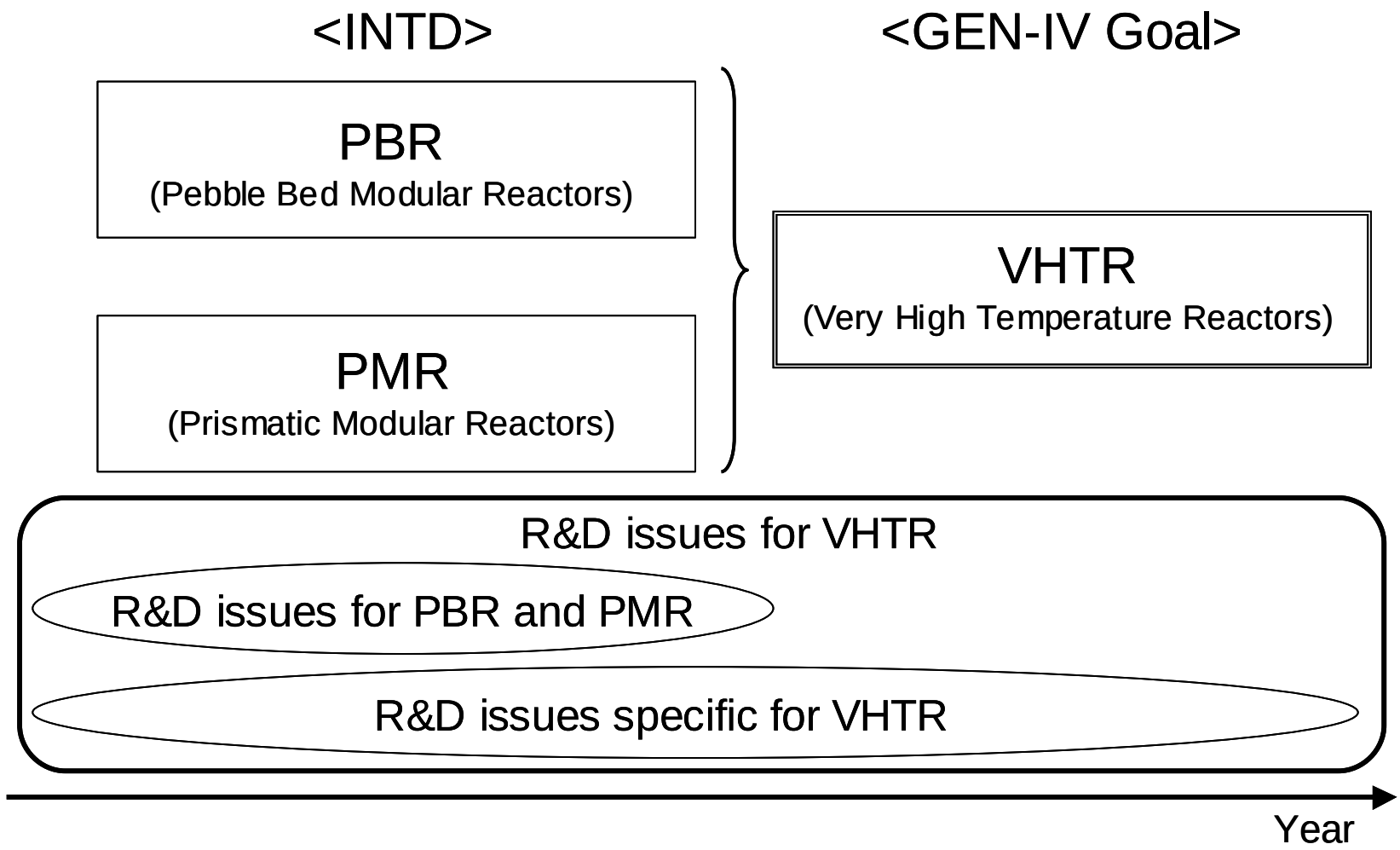
- *Extension of prismatic modular reactor (PMR) and of pebble bed modular reactors (PBR)*
- *Higher coolant core outlet temperatures to enhance process heat applications*
- *Direct Brayton cycle energy conversion*
  - *He coolant, >900ºC outlet temperature*
  - *Efficient electricity generation (>50%) and/or H_2 production (e.g. hot electrolysis)*
- *Thermochemical water splitting (e.g. Iodine Sulphur (IS) Process)*
- *Deployment in crude oil refining and petrochemistry by substituting process heat (steam reforming, process steam)*
- *Coal gasification, oil sand / shale retorting*
- *Production of aluminum oxide and metals (aluminum, iron)*

- *Estimated deployment time: 2025*

VHTR Plant Schematic



Range of VHTR R&D Issues



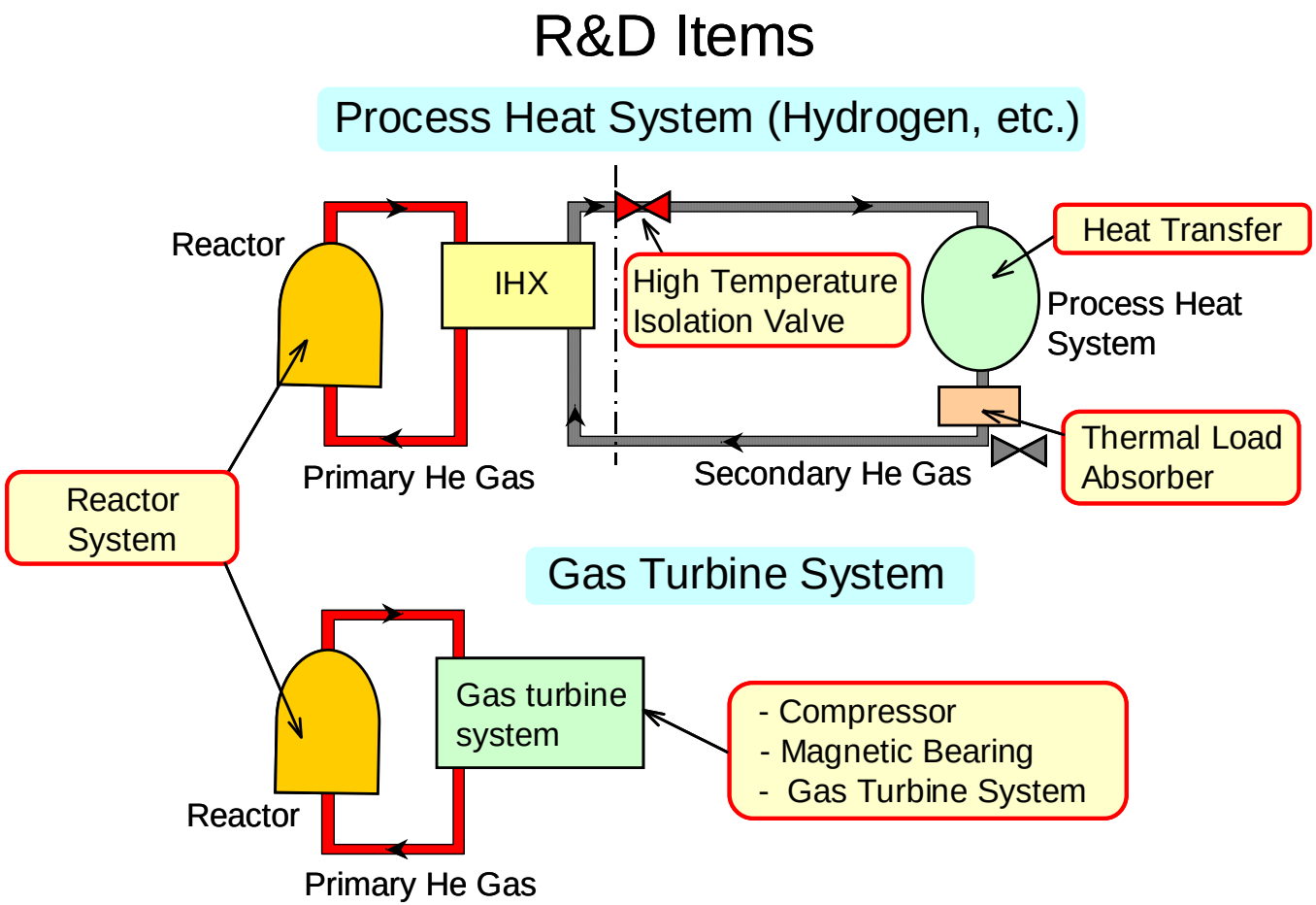
VHTR R&D Needs

- Fuel -- Need to extend to 200,000 MWD/MTU and 1300 C
- For core exit coolant temperatures above 900 C, fuel temperatures above 1300 may be needed. Examine higher temperature coatings (e.g. ZrC).
- Fabrication Process needs to be developed in US.
- Spent Fuel characteristics need to be demonstrated

- Ultra-high burn-up fuel for actinide transmutation (Deep-Burn Concept, no multiple recycling)
- Re-fabrication of Pu / Np driver fuel
- Symbiosis with accelerator-driven systems and GFR

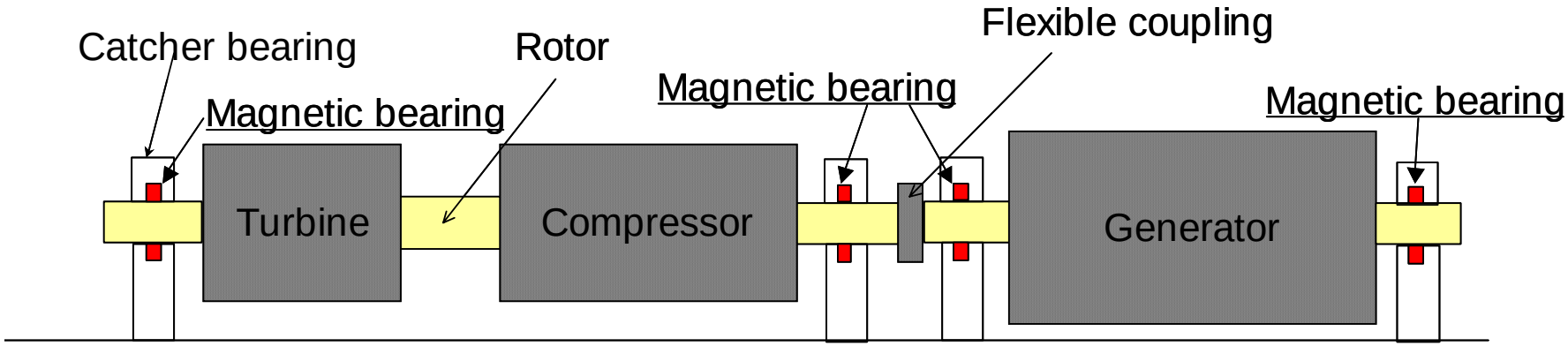
GFR R&D Needs, cont'd

- ***Materials, Components***



VHTR R&D Needs

Gas Turbine R&D



VHTR Safety Concept R&D Needs

- Air ingress behavior needs confirmation
- TRISO fuel performance needs demonstration
- Reactivity insertion events need to be assessed
- Transient models need qualification
- Thermal mixing at core outlet uncertain
- RCCS tube failure needs to be modeled
- Effect of direct cycle on existing system codes required
- FP transport in RCS needs definition
- Collocation issues of process applications and nuclear supply

VHTR Nuclear Process Heat Application-related R&D

- *Development of interface between nuclear heat supply system and heat utilisation (IHX, valves, hot gas ducts)*
- *Reduction of product contamination (tritium retention by coatings, doping, filters etc.)*
- *Process adaptation for nuclear use (e.g. higher pressure)*
- *Development of process-related components e.g.:*
  - *hot electrolysis,*
  - *heat exchangers for thermochemical water splitting,*
  - *steam reformers, steam crackers (e.g. for naphta), evaporators, superheaters*
  - *fluidized-bed reactors (e.g. for aluminum oxide)*
- *Process-related corrosion resistent material development*
- *New reactor pressure vessel types (e.g. prestressed cast-iron vessel) for ease of transport / decommissioning, exclusion of sudden burst, larger diameters & power size, efficient, integrated decay heat removal*