US Plans and Strategy for ITER Blanket Testing

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A critical element in the ITER mission since its inception has been testing integrated blanket modules in special ports. Among the principal objectives of the ITER Test Blanket Module (ITER-TBM) Program are: 1) develop the technology necessary to install breeding capabilities to supply ITER with the tritium necessary for operation in its extended phase of operation; and 2) provide experimental data vital to evaluating the feasibility, constraints, and potential of the D-T cycle for fusion systems (including limitations on options for improving plasma physics performance, e.g., conducting shells, passive coils, thick armors/first wall). Adequate tritium supply is a central issue for the operation of ITER and the development of fusion energy. TBMs will be inserted in ITER from Day 1 of its operation and will provide the first experimental data on the feasibility of the D-T cycle for fusion.

With the US rejoining ITER, the US community has decided to have strong participation in ITER-TBM. The US has been a leader in the science and engineering of technology testing on ITER and other fusion devices and has many unique capabilities to contribute to the ITER-TBM program. A US strategy for ITER-TBM has evolved that emphasizes international collaboration. A study was initiated to select the two blanket options for the US ITER-TBM in light of new R&D results from the US and world programs over the past decade. The study is led by the Plasma Chamber community in partnership with the Materials, PFC, Safety, and physics communities. The study focuses on assessment of the critical feasibility issues for candidate blanket concepts and it is strongly coupled to R&D of modeling and experiments. Examples of issues are MHD insulators, SiC insert viability and compatibility with LiPb, tritium permeation, MHD effects on heat transfer, solid breeder "temperature window" and thermomechanics, and chemistry control of molten salts.

The initial conclusion of the US community, based on the results of the technical assessment to date, is to select two blanket concepts for the US ITER-TBM with the following emphases:

1. Select a helium-cooled solid breeder concept with ferritic steel structure and neutron multiplier, but without a fully independent TBM. Rather, plan on unit cell and submodule test articles that focus on particular technical issues of interest to all parties. (All ITER Parties have this concept as one of their favored options.)
2. Focus on testing Dual-Coolant liquid breeder blanket concepts with ultimate potential for self-cooling. Develop and design TBM with flexibility to test two options:
    a. a helium-cooled ferritic structure with self-cooled LiPb breeder zone that uses SiC insert as MHD and thermal insulator (insulator requirements in dual-coolant concepts are less demanding than those for self-cooled concepts);
    b. a helium-cooled ferritic structure with low melting-point molten salt. The choice of the specific lithium-containing molten salt will be made based on near-term R&D experiments and modeling. Because of the low thermal and electrical conductivity of molten salts, no insulators are needed.