US Participation in the
ITER Test Blanket Module Program

For a few million dollar expenditure on test blanket modules, we will acquire vital data and develop critical technologies - an excellent return on the billions of dollars invested in ITER.

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What is the ITER Test Blanket Module Program?

- The ITER Basic Device has shielding, but no breeding blanket
- Breeding Blankets will be tested in ITER, starting on Day One, by inserting Test Blanket Modules (TBM) in specially designed ports
- Each TBM will have its own dedicated systems for tritium recovery and processing, heat extraction, etc. Each TBM will also need new diagnostics for the nuclear-electromagnetic environment
- Each ITER Party is allocated limited space for testing two TBM's
- ITER's construction plan includes specifications for TBM's because of impacts on space, vacuum vessel, remote maintenance, ancillary equipment, safety, availability, etc.

Testing tritium breeding blankets has always been and remains a principal objective of ITER.

Objectives of the Test Program

1) First integrated experimental demonstration of the principles of tritium self-sufficiency

2) Breeding technology for producing the tritium necessary for extended operation of ITER

3) Critical experimental data on the feasibility, constraints, and potential of the DT cycle for fusion systems
(including conducting shells, passive coils, coatings/thick armors/FW for improving plasma physics performance)

Tritium supply and self-sufficiency are as critical to fusion energy as demonstrating a burning plasma.

They are "Go-No Go" Issues for Fusion:

- There is no practical external source of tritium for fusion energy development beyond a few months of DT plasma operation in an ITER-like device.
- There is NOT a single experiment yet in the fusion environment to show that the DT fusion fuel cycle is viable.

ITER has now set the schedule for development and this development must start immediately.

Tritium Consumption and Production

Fusion Consumption

- Huge, Unprecedented → **55.8 kg per 1000MW fusion power per year**

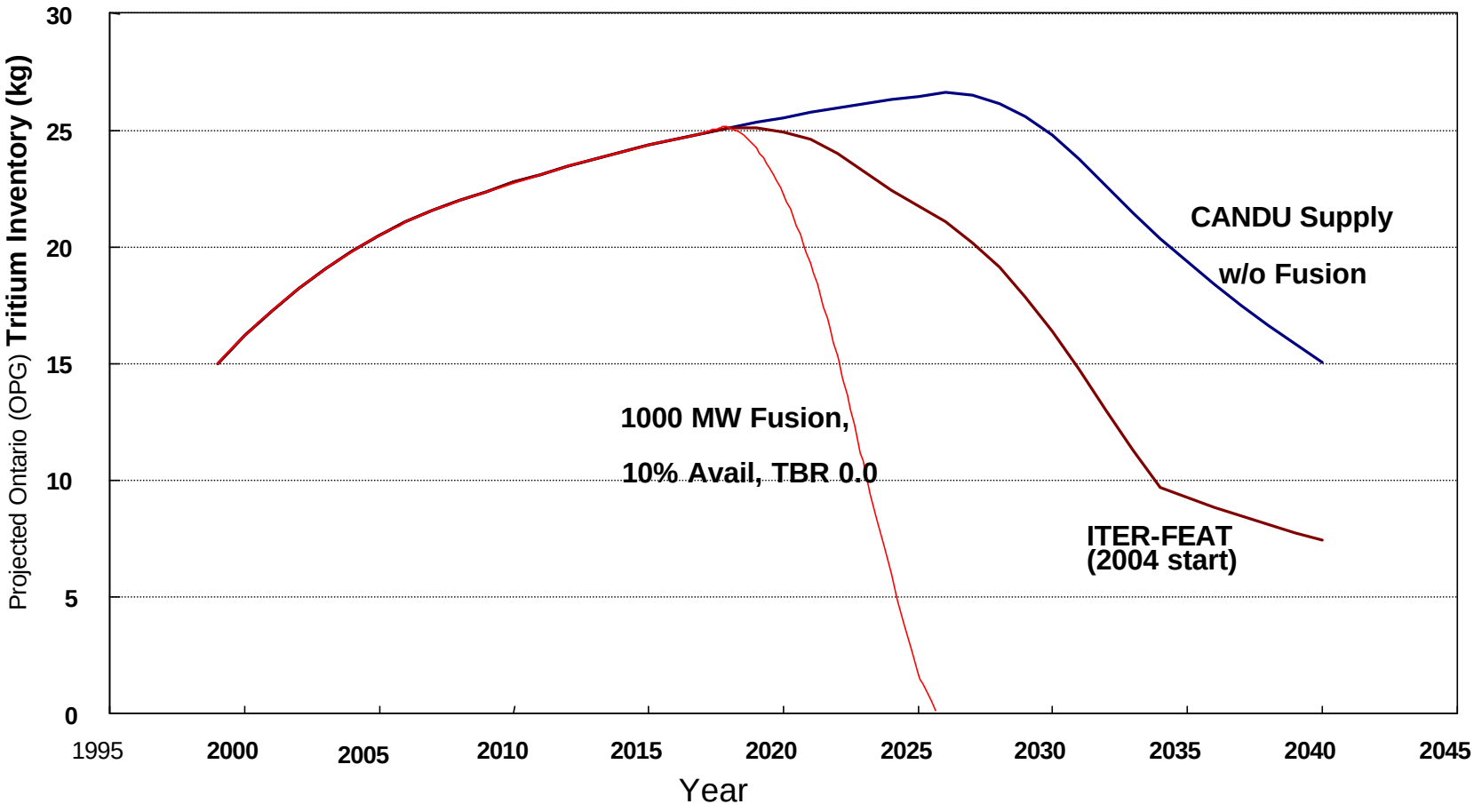
Production & Cost

- CANDU Reactors: 27 kg over 40 years, $30M/kg (current)
- Fission Reactors: few kg per year, $200M/kg!! (projected cost after Canadian tritium is gone) It takes tens of fission reactors to supply one fusion reactor.

Conclusions

- ITER's extended phase requires tritium breeding.
- Large power DT facilities must breed their own tritium.

World Tritium Supply Would be Exhausted by 2025 if ITER Were to Run at 1000MW and 10% Availability (OR at 500 MW and 20% availability)

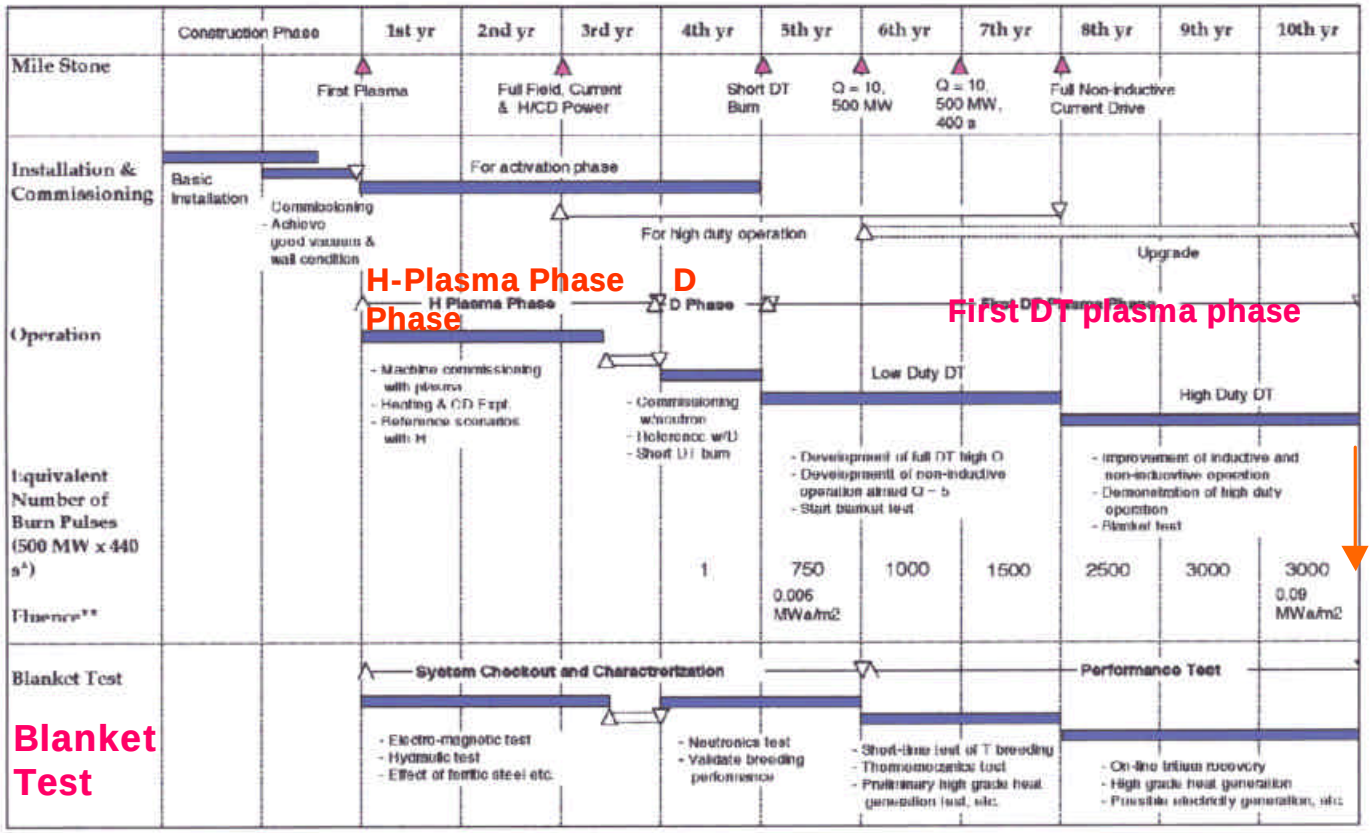


Why should the US have an ITER TBM?

- Test critical technologies for any further US development of fusion (CTF, DEMO, DT alternates, power plants)
- Evaluate the viability of DT cycle (plasma-blanket interactions, material combinations, configurations, high temperature heat extraction, etc.)
- Access R&D information from much larger blanket programs (EU and Japan) and other international partners
- To build US knowledge, experience, and competence in fusion nuclear and tritium technologies needed to develop practical and safe DT fusion devices
  (Building competence takes decades)

ITER Operational Plan Calls for Testing Breeding Blankets from Day 1 of Operation

(Initial tests without neutrons: effects of ferritic steel, LM MHD and hydraulic tests, etc.)



* The burn time of 440 s includes 400 s flat top plus 40 s of full power neutron flux to allow for contributions during ramp-up and ramp-down

** Average fluence at first wall (neutron wall load is 0.56 MW/m^2 on average and 0.77 MW/m^2 at outboard equator)

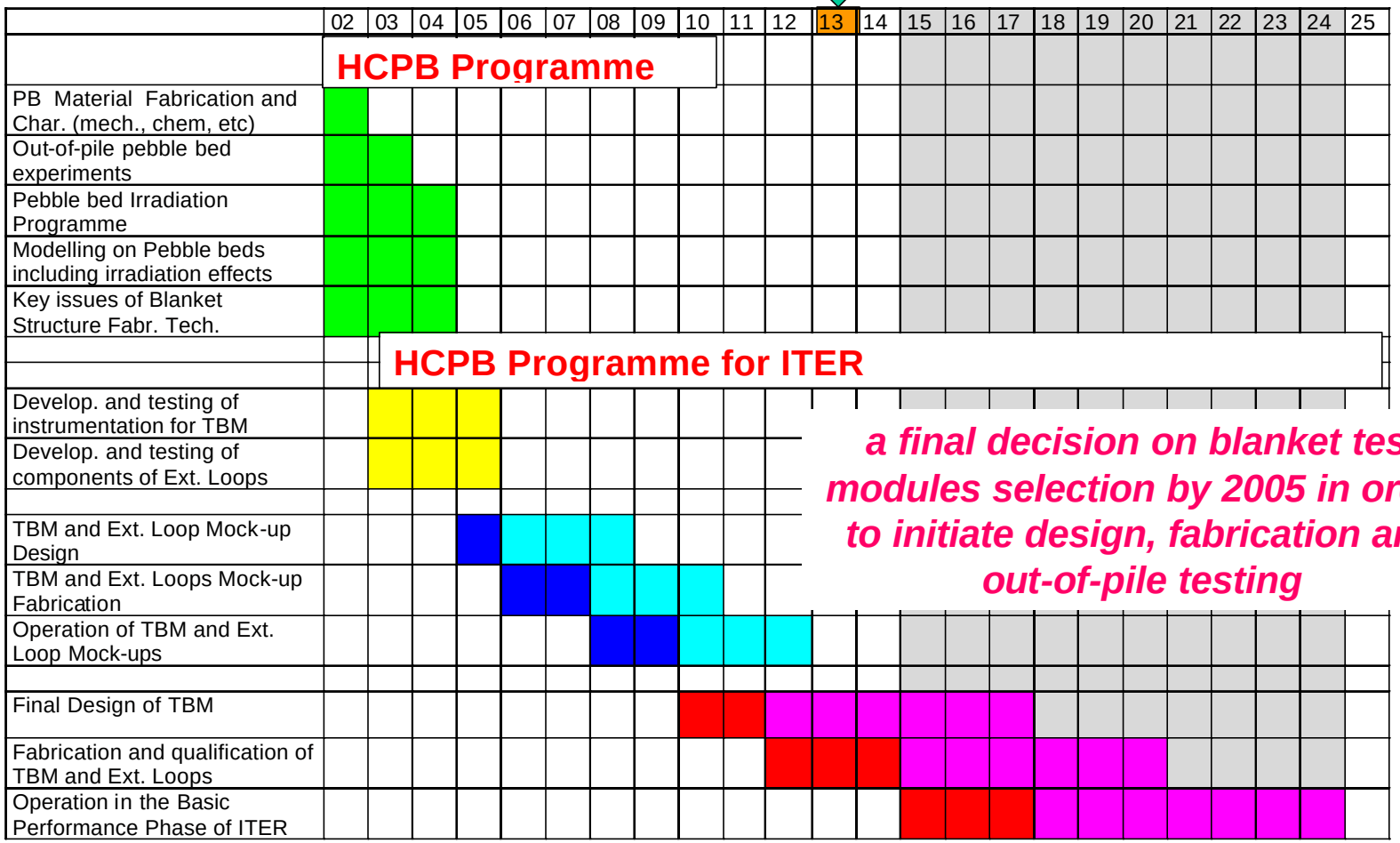
Figure 2.2-1 Initial Operation Plan

TBM Roll Back from ITER 1st Plasma

Shows R&D must be accelerated now for TBM Selection in 2005

EU schedule for Helium-Cooled Pebble Bed TBM (1 of 4 TBMs Planned)

ITER First Plasma



a final decision on blanket test modules selection by 2005 in order to initiate design, fabrication and out-of-pile testing

(Reference: S. Malang, L.V. Boccaccini, ANNEX 2, "EFDA Technology Workprogramme 2002 Field: Tritium Breeding and Materials 2002 activities- Task Area: Breeding Blanket (HCPB), Sep. 2000)

What must the US do NOW in the TBM Program?

- Evaluate and select TWO blanket concepts for testing in ITER by 2005. Form a team of experts (Chamber Tech., Tritium, Safety, Materials, PFC, and Plasma Physics Programs).
- Perform concurrent R&D on a few critical issues needed for prudent decisions (e.g. MHD insulators, tritium permeation barriers, material interactions and thermomechanics).
- Interact with international partners and refocus some existing international collaborations to emphasize ITER TBM.
- Join the ITER TBWG (Test Blanket Working Group) and ensure ITER plans do not exclude US-favored TBM concepts.