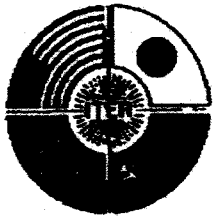
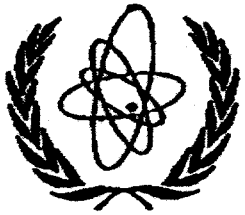


International Thermonuclear Experimental Reactor



ITER: TEST PROGRAMME

Presented by **M. ABDOU**

THIRTEENTH INTERNATIONAL CONFERENCE ON PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH

Washington, DC, United States of America, 1 - 6 October 1990

ROLE OF ITER IN TECHNOLOGY DEMONSTRATION

Two elements of ITER

1) Basic Machine

   Conservative design of the machine components (including basic blanket) maximizes reliability, flexibility and safety of ITER

2) Test Programme

   Space for test modules allows for testing of advanced concepts and partial (powerful) demonstration of the ultimate potential of fusion

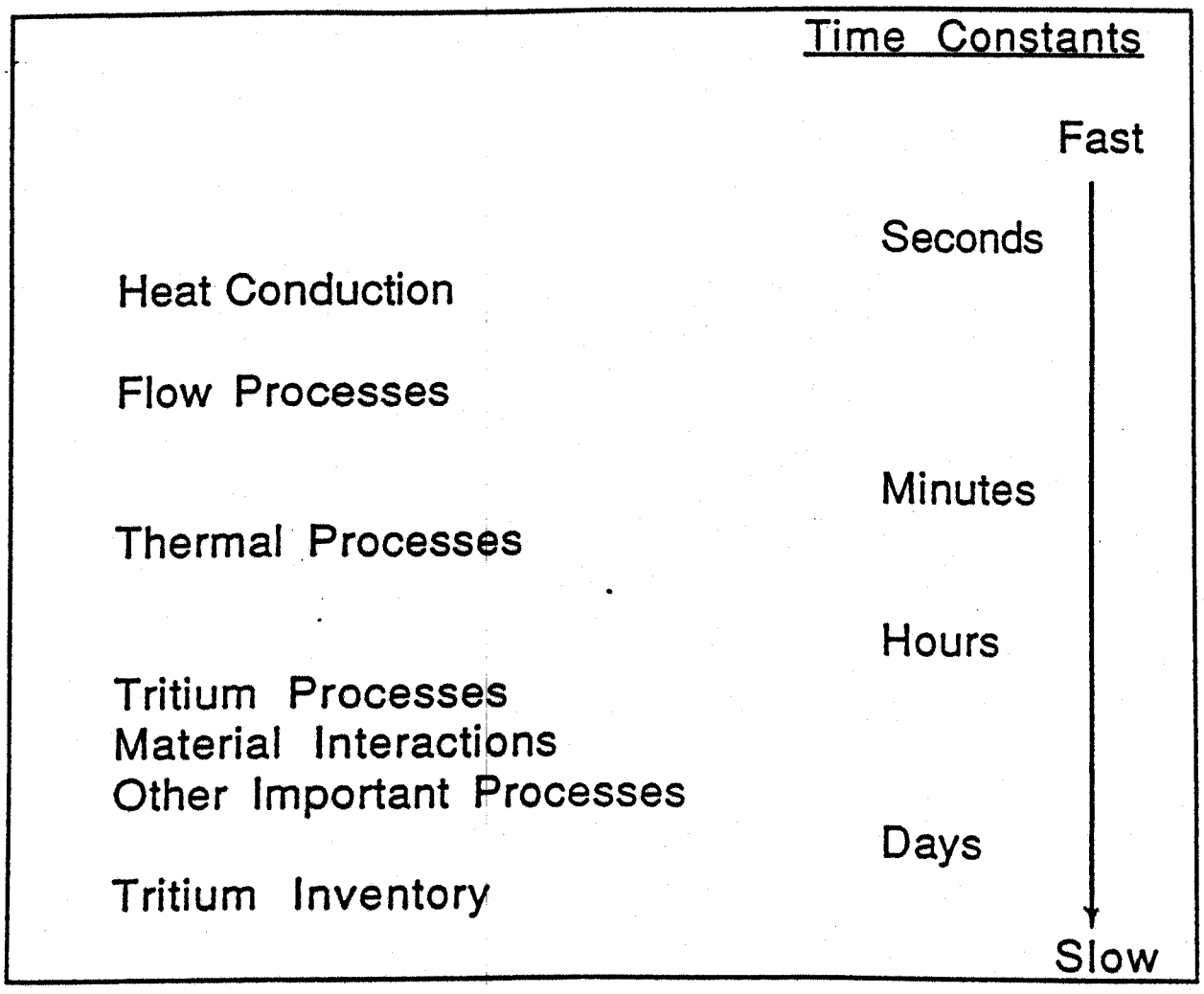
EXAMPLES OF "ACCOMPLISHMENTS" THROUGH TESTING IN ITER

- Perfomance Attractiveness
  - Demonstrate ability to operate with parameters adequate for electricity generation
  - Demonstrate operation of the entire fuel cycle
  - Demonstrate temperature limits of materials
  - Obtain data crucial to tritium self-sufficiency
- Safety Demonstration
  - Inherent safety
  - Response to transients and off-normal operating modes
  - Operating experience with tritium, radioactive materials, hazardous chemicals (e.g., liquid metals, Be)
- Environmental Demonstration
  - Direct measurement of induced radioactivity, after heat
  - Demonstration of low activation options (e.g., Li/V, Li_20/SiC, etc.)
- Others

NUCLEAR TESTING REQUIREMENTS

	Recommendations		ITER
	Minimum	Highly Desirable	Reference Parameter
Neutron Wall Load (MW/m^2)	≥ 1	2	1.3
Plasma Burn Time	≥ 1000 s	1-3 hours to steady state	2500 S
Dwell Time	a	< 20 s	200 - 400 s
Continuous Test Duration (100% availability)	> 1 week	2 weeks	
Average Availability	10 - 15%	25 - 30%	18%
Total Neutron Fluence ($MW \cdot y/m^2$)	1.5	4 - 6	1.5

TIME CONSTANTS FOR KEY NUCLEAR PROCESSES RANGE FROM VERY FAST TO VERY SLOW

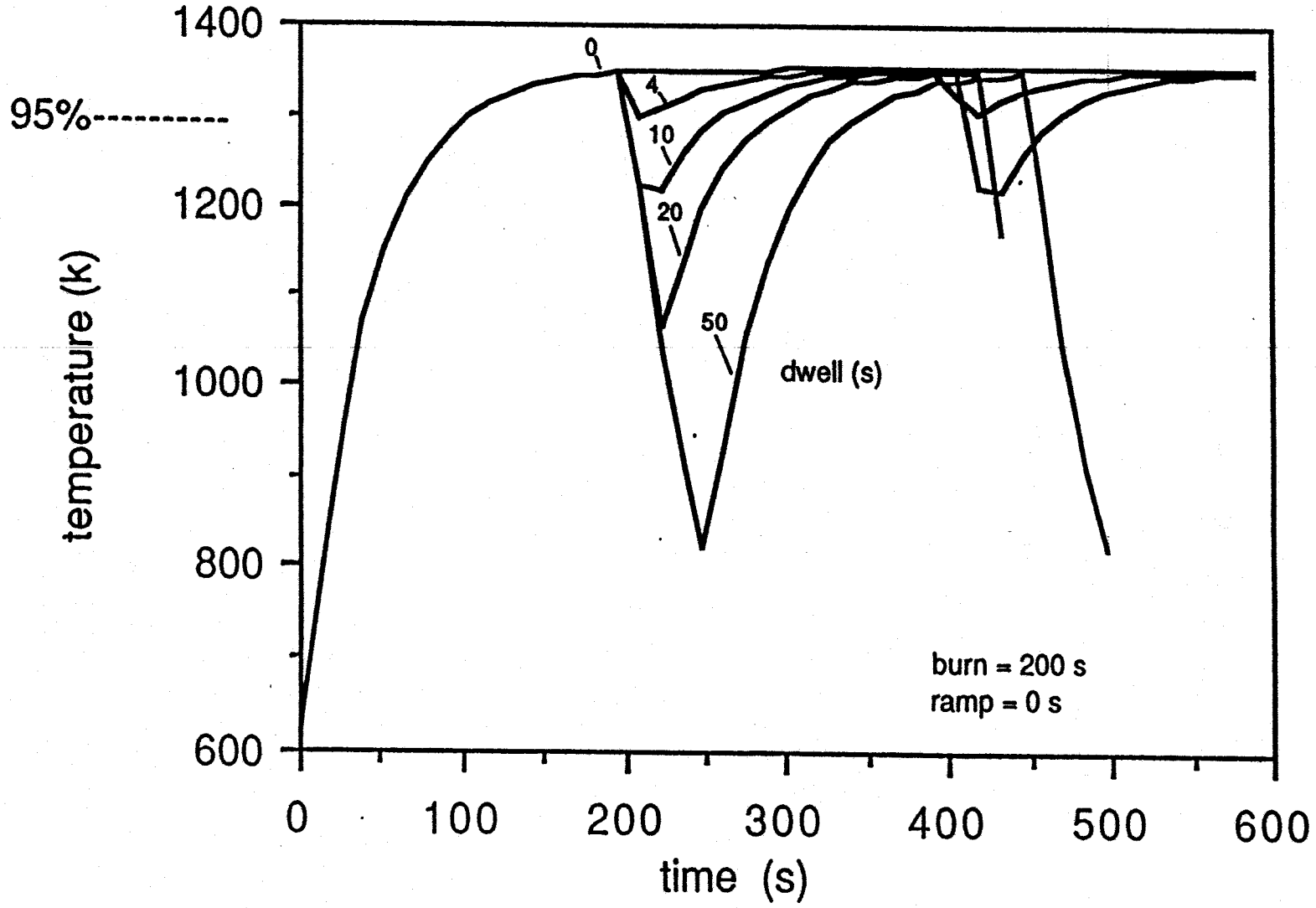


Most Critical Nuclear Issues for Testing in the Fusion Environment Have *Two* Characteristics:

1) Processes with long time constants
2) Crucial dependence on other processes with short time constants

(It takes a long time to establish equilibrium; a short time to ruin it)

VARIATION OF TEMPERATURE WITH TIME FOR DIFFERENT DWELL TIMES (LIALO2 BREEDER)



FLUENCE EFFECTS

- **0-0.1 MW-yr/m^2** (at test module)

  Some changes in thermophysical properties of non-metals occur below 0.1 MW-yr/m^2 (e.g., thermal conductivity)

- **0.1-1 MW-yr/m^2** (at test module)

  Several important effects become activated in the range of 0.1-1 MW-yr/m^2
  - Radiation creep relaxation
  - Solid breeder sintering and cracking
  - Possible onset of breeder/multiplier swelling
  - He embrittlement

  Correlation of materials data with fission reactors and 14 MeV sources can be done with 1 MW-yr/m^2

- **1-3 MW-yr/m^2** (at test module)

  Numerous individual effects and component (element) interactions occur here, particularly for metals, e.g.:
  - Changes in DBTT
  - Changes in fracture toughness
  - He embrittlement
  - Breeder burnup effects
  - Breeder swelling
  - Breeder/clad interactions

Credible concept verification requires attainment of fluence within a factor of 2-3 of DEMO

ITER TEST PROGRAM DESCRIPTION

Physics Phase: 6 years

Machine checkout
Physics testing
Some technology testing

Technology Phase: 8 years

Technology testing
- Test modules
- Information from basic device

Space Available for Testing

Physics phase: 3 ports
Technology phase: 5 ports

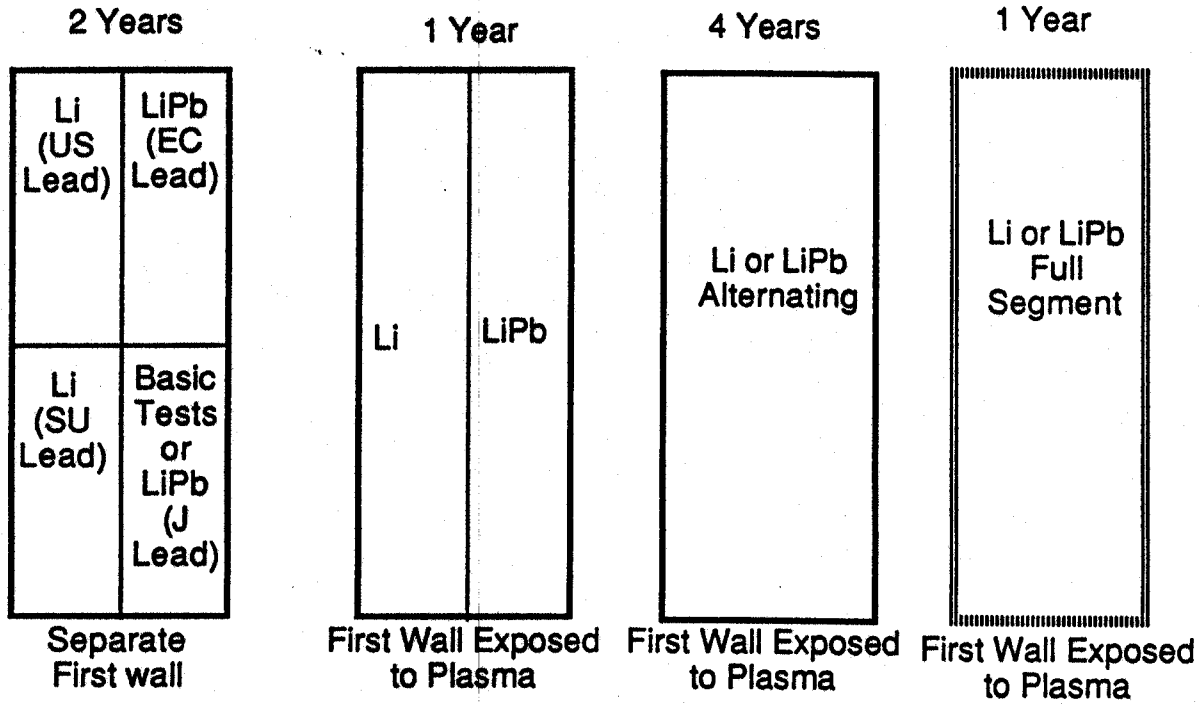
Each port is 1m x 3m at first wall

INTERNATIONAL ASPECTS OF ITER TEST PROGRAM

- There is neither sufficient space nor time to serve the needs of four independent national programs
- International collaboration is necessary
- A scheme has been developed for sharing space and time on ITER among the four parties
- Such collaboration involves issues that extend beyond collaboration on construction of ITER
  - It involves the world Base Programme
  - This is an additional benefit from ITER as it encourages collaboration on Base Programme

Fig 2.5-1 Test Sequence for Liquid Metal Blankets

Liquid Metal Cooled Tests



Water Cooled Tests

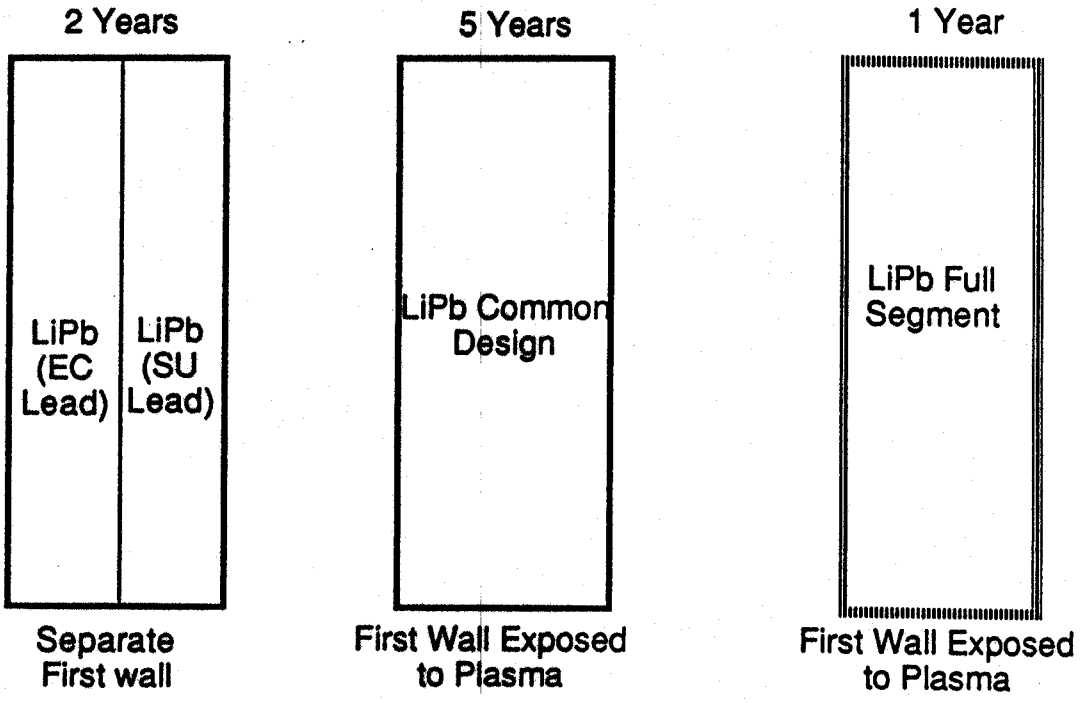
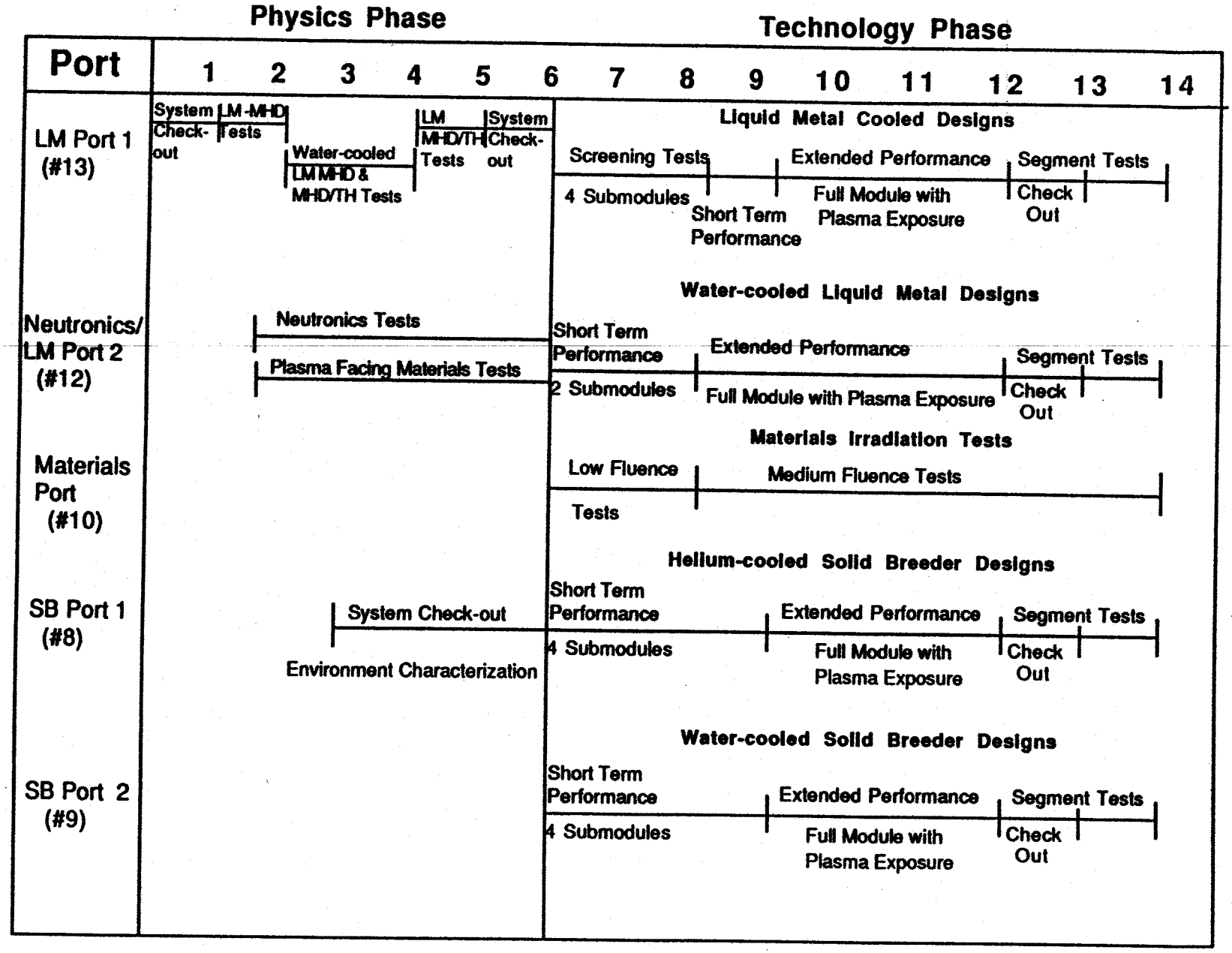


Fig. 2.3.-1 Blanket Test Schedule



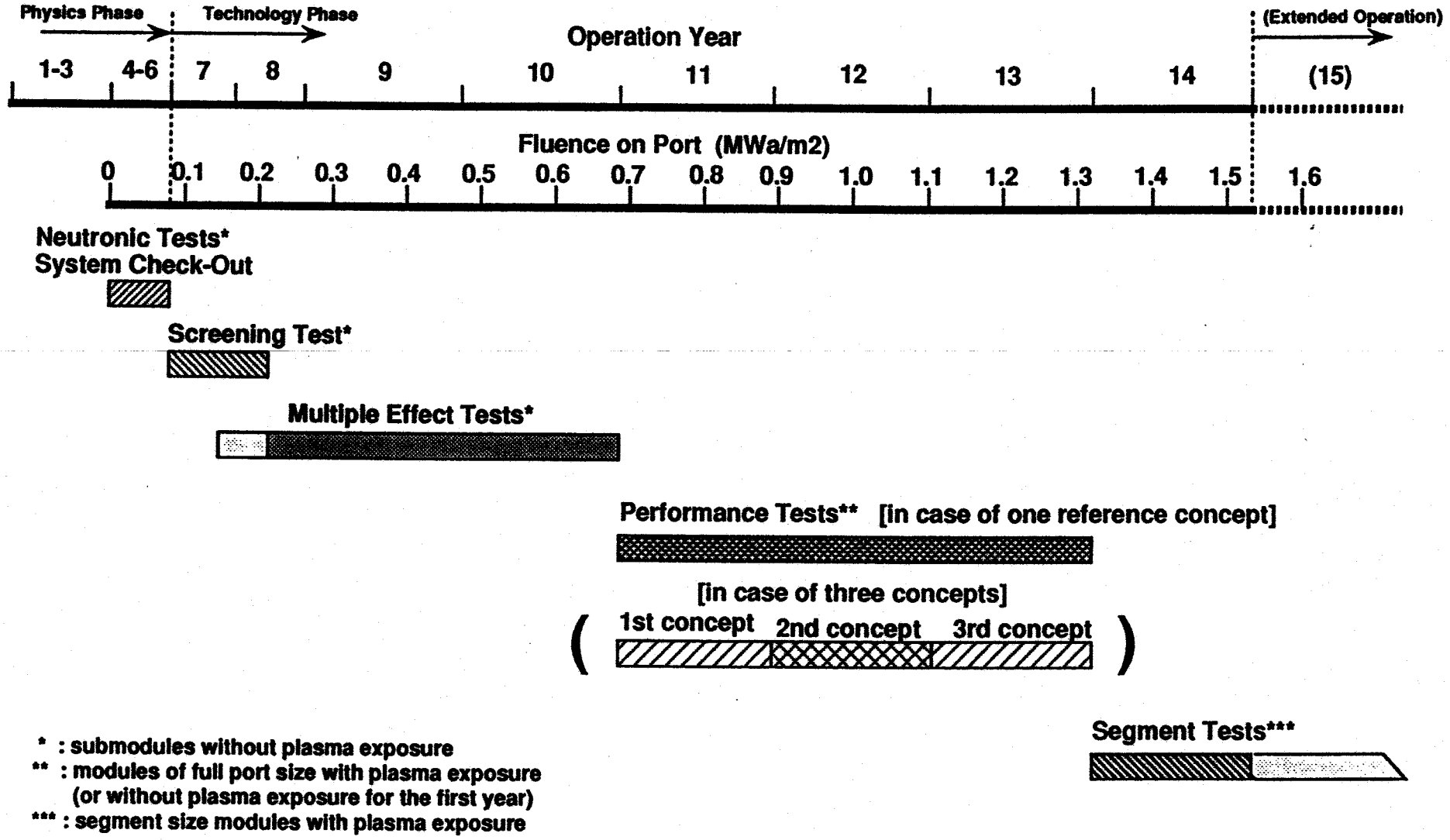


Fig. II.6.37 Testing Schedule for Helium- and Water-Cooled Solid Breeder Blankets

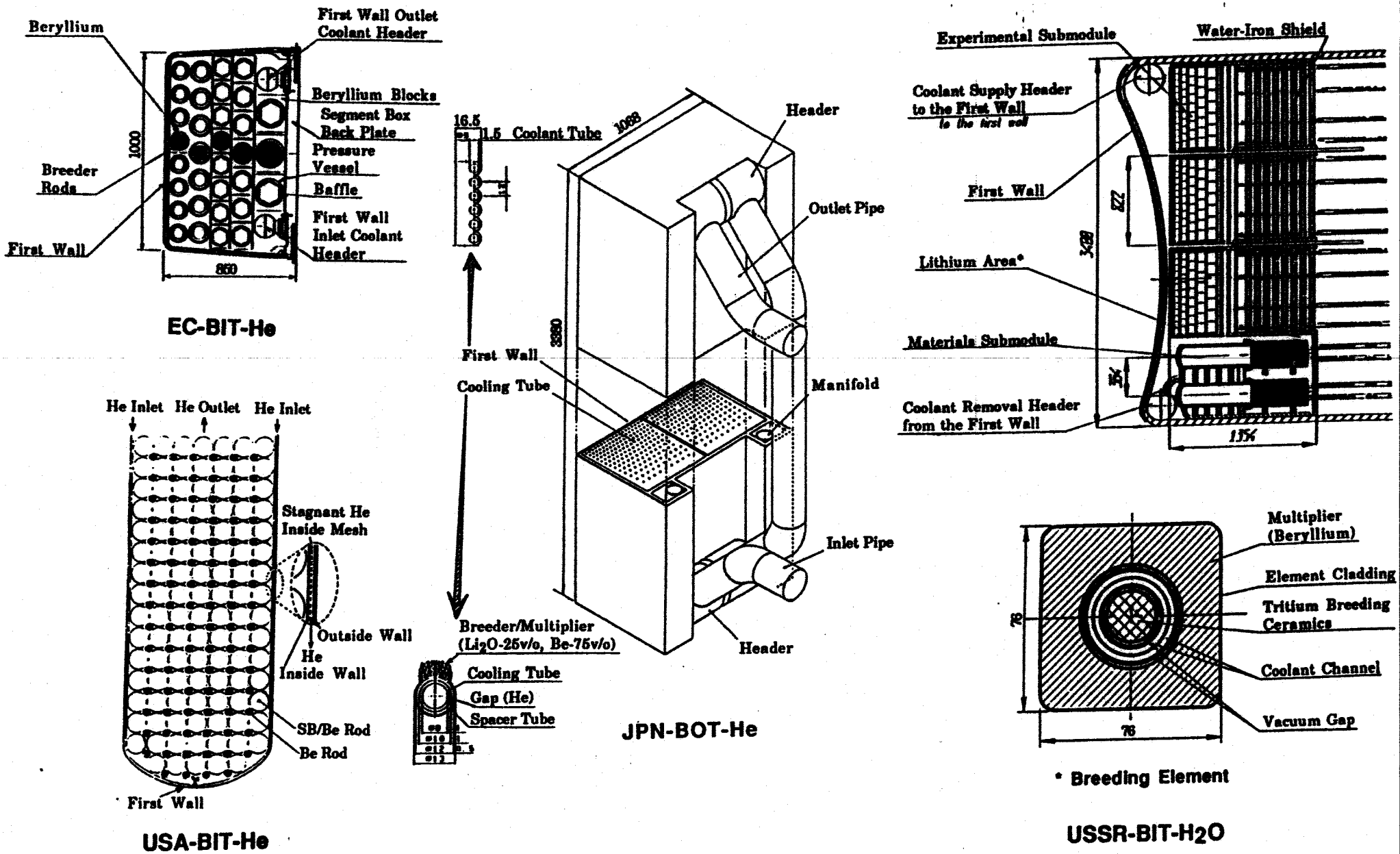


Fig. II.6.39 Examples of Test Module Design

(Ancillary Equipment)

Space allocation during the Technology Phase