ITER Test Program

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Presented at the US Home Team Meeting
Maidson, August 15, 1995

Introductory Remarks

- The first meeting of the Test Blanket Working Group (TBWG) was held at Garching JWS on July 19-21, 1995 to discuss:
  - DEMO-Relevant Blanket Concept Test Program in ITER (and review of national DEMO Blanket R&D programs)
  - Basic Breeding Blanket for ITER
- The US DEMO blanket R&D is now focused on two blankets:
  1) Helium-Cooled Solid Breeder
     He/Be/Li_2TiO_3/SiC (FS)

     Alternative Breeder: Li_2O, Li_2ZrO_3
  2) Self-Cooled Li/V with insulator coating
- Industrial participants are functioning:
  - M. Dagher (RD) attended an ITER plant layout meeting held at San Diego JWS on July 5, 1995
  - JCT (San Diego JWS) expressed interest in cooperation with US industry in developing the design of the test port area
  - L. Waganer (MDA) visited San Diego JWS

Highlights of The First Test Blanket Working Group (TBWG) Meeting

- The Meeting Was Well Attended:
  - the Director,
  - four members of TBWG representing the JCT,
  - three members of TBWG from each of the four home teams and
  - experts from the home teams and JCT
  - The meeting was chaired by Dr. E. Proust(EU) and co-chaired by Dr. R. Parker(JCT)
- Presentations were given by each home team for:
  - National DEMO Blanket R&D: Status and Prospects
  - National Strategy for Blanket Testing in ITER and Requirements on ITER Design/Operation
- Four presentations were given by JCT concerning ITER Design and Constraints on Test Blanket Program
  - Overview of Design by R. Parker (Garching)
  - Plant Layout by C. Ahlfeld (San Diego)
  - Remote Handling and Tritium Processing by R. Haange (Naka)
  - Safety by G. Saji (San Diego)

Director Dr. Aymar's Comments on TBWG

- Objectives of TBWG

  1) to promote coordination of the parties' test programs which would lead to one test program;
  2) at a minimum, to promote coordination between parties' DEMO development plans; and
  3) to make results available to JCT regarding ITER breeding blanket.

- The first priority work for the group is to provide JCT with:

  1) requirements (including both those placed on the ITER device by the needs of the test blanket program and those imposed on the test program by the ITER machine) and

  2) test module conceptual design [initial data for interface issue analysis such as safety].

- Test module may be recessed by several centimeters to eliminate direct plasma impingement and runaway electron interaction.

Allocation of Test Port During ITER BPP Was Defined After Reviewing National Interest on DEMO Blanket Concepts:

- 2 Ports for Helium-cooled Ceramic Concepts
- 1 Port for Water-cooled Concepts

  e.g. Water/ceramic and LiPb
- 1 Port for Liquid Metal Concepts

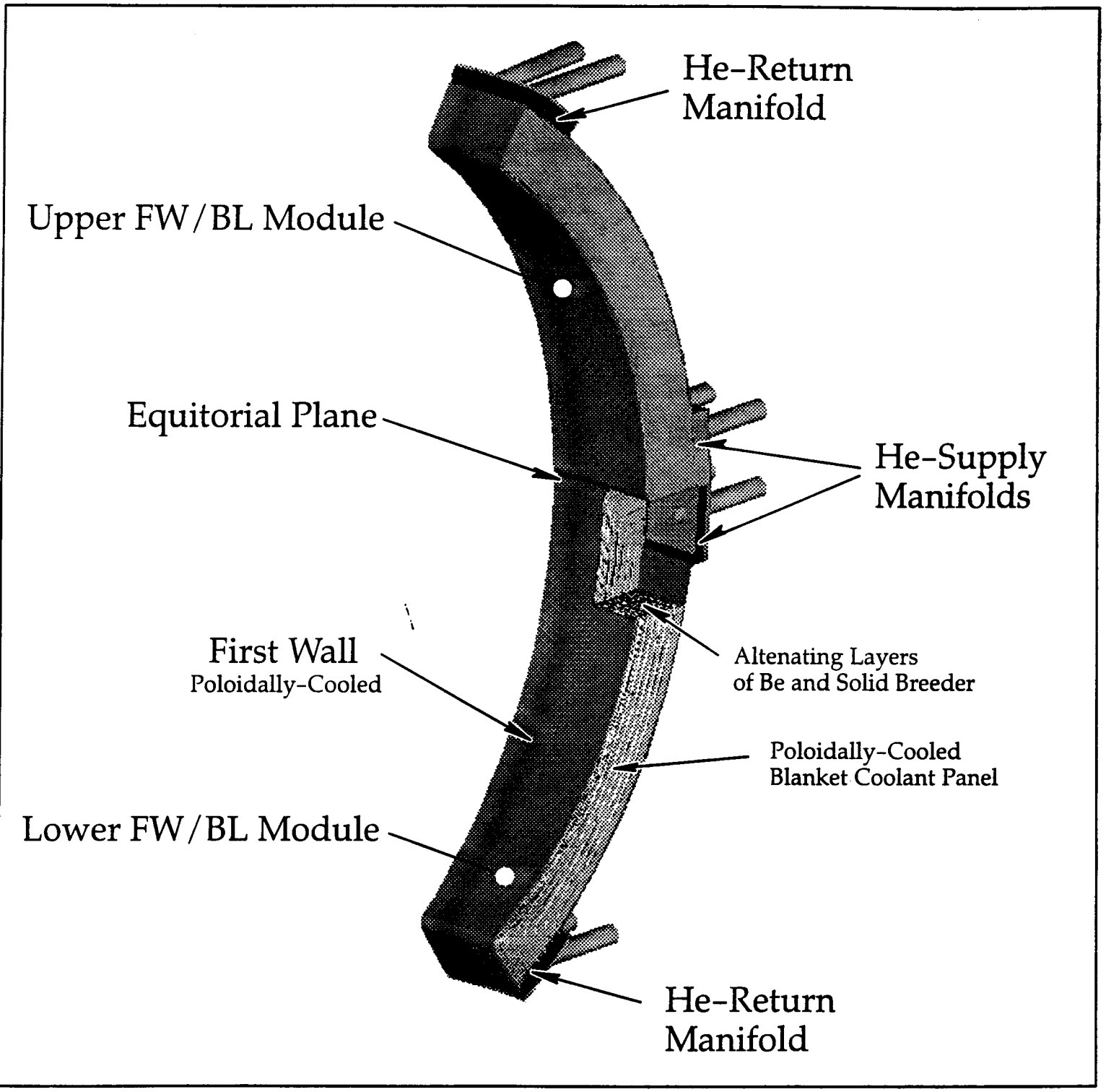
  e.g. Li/V, He,LiPb/LiPb
- 1 Port for EPP Breeding Blanket [can become neutronics/material test port during EPP]

Summary of National Interest on DEMO Blanket Concepts

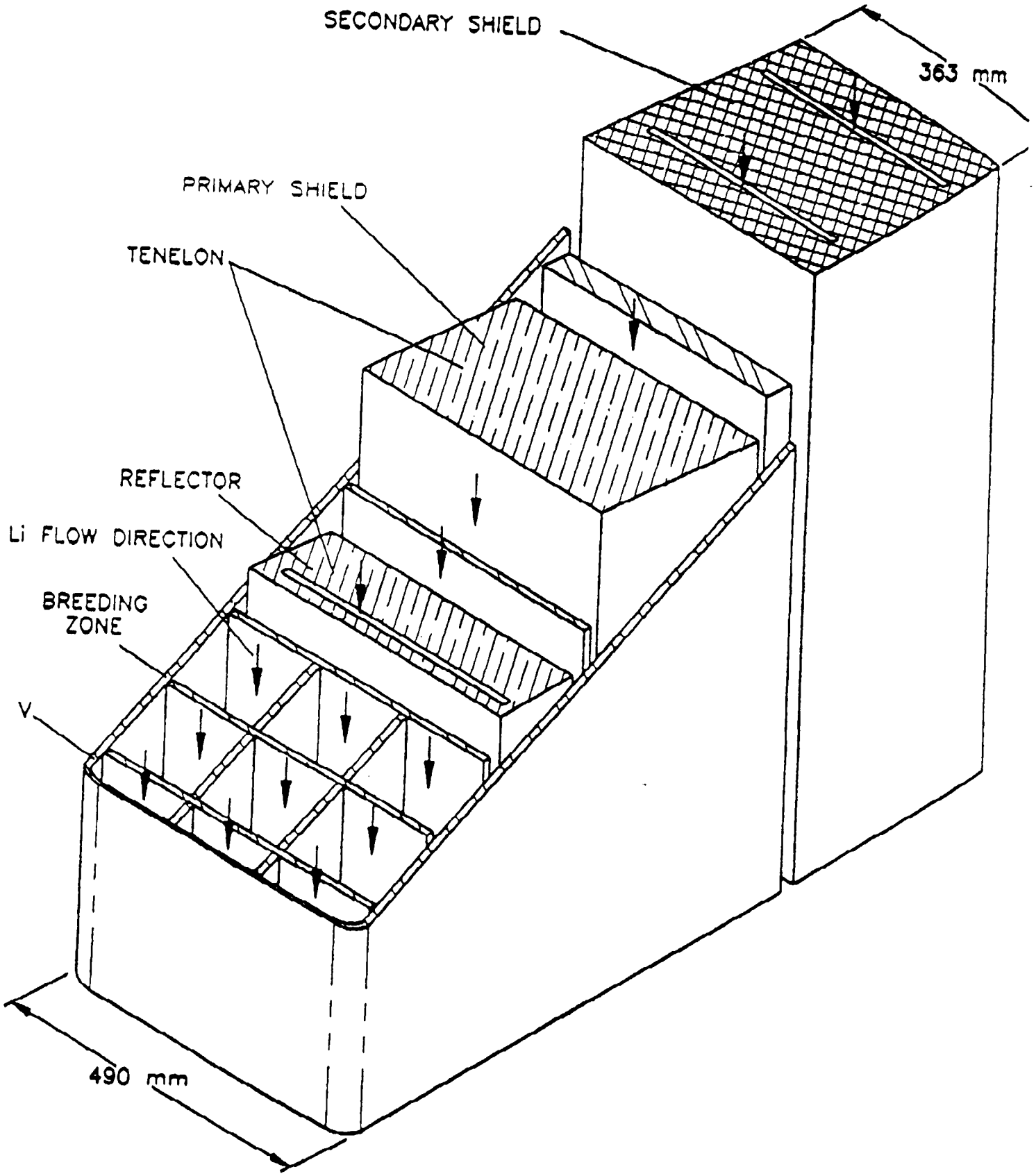
	He-Ceramic	Water-Ceramic	Li/V	H_2O/He-LiPb
EU	1			1
JA	1(F82H,TiAl, SiC)	1(F82H)		
RF	1		1	
US	1(SiC, FS)		1	

U.S. DEMO He-Cooled Solid Breeder Reference Blanket

One Complete First-Wall/Blanket Segment

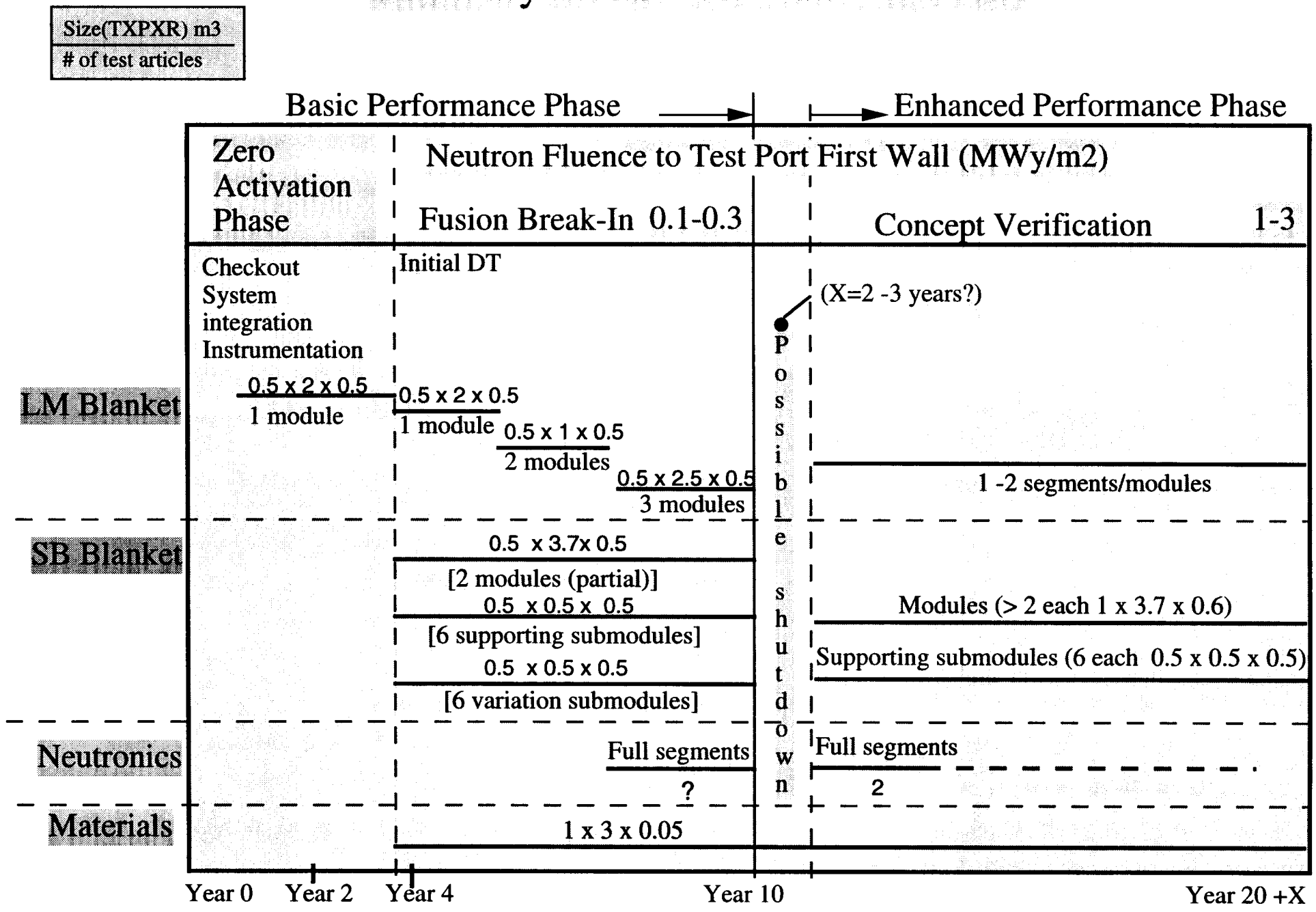


UCLA



CUTAWAY VIEW OF DEMO INBOARD BLANKET/SHIELD SEGMENT

Summary of US Test Matrix in ITER



European DEMO-Blanket Development Programme

Background to Blanket Programme

- An R & D programme for the development of four tritium breeding blanket concepts for a DEMO-type fusion reactor was launched in the EU in 1989.

- The objective of the first 7 year development phase was to identify the 2 most promising concepts for further development in a second phase, starting in 1996, which will include the design and construction of DEMO-relevant blanket modules to be tested in ITER. (concept selection in 1995)

- To establish a set of common boundary conditions for the different concepts, a specification for a DEMO blanket was elaborated in 1990 by a Ad-Hoc group on the basis of the NET parameters. The use of martensitic steel as the structural material was one of the specified parameters (MANET: MArtensitic steel for NET).

- The work on the blanket programme is performed mainly by the three Associations:

  - CEA
  - ENEA
  - FZK

Support on some of the tasks has been provided by other Associations e.g. ECN and SCK.

- Coordination in the programme is provided by the Blanket Coordination Group (BCG), which includes representatives from the EC and NET as well as the three main Associations.

The 4 Blanket concepts which form the subject of the review are:

- Breeder-in-Tube Concept (BIT)

Characterised by a poloidal canister design with annular shaped solid ceramic pellets of $LiAlO_2$ or Li_2ZrO_3 contained in steel cladding cooled by Helium. A separate Helium circuit purges Tritium from the annular ceramic pellets.

- Breeder-out-of-Tube Concept (BOT)

Characterised by toroidal canisters containing a multi-layered sandwich of Li_4SiO_4 and Beryllium pebbles between Helium-cooled ~~Beryllium~~ plates. There are separate Helium cooling and Tritium purge circuits.

MANET

- Dual-Coolant Pb-Li Liquid Metal Concept

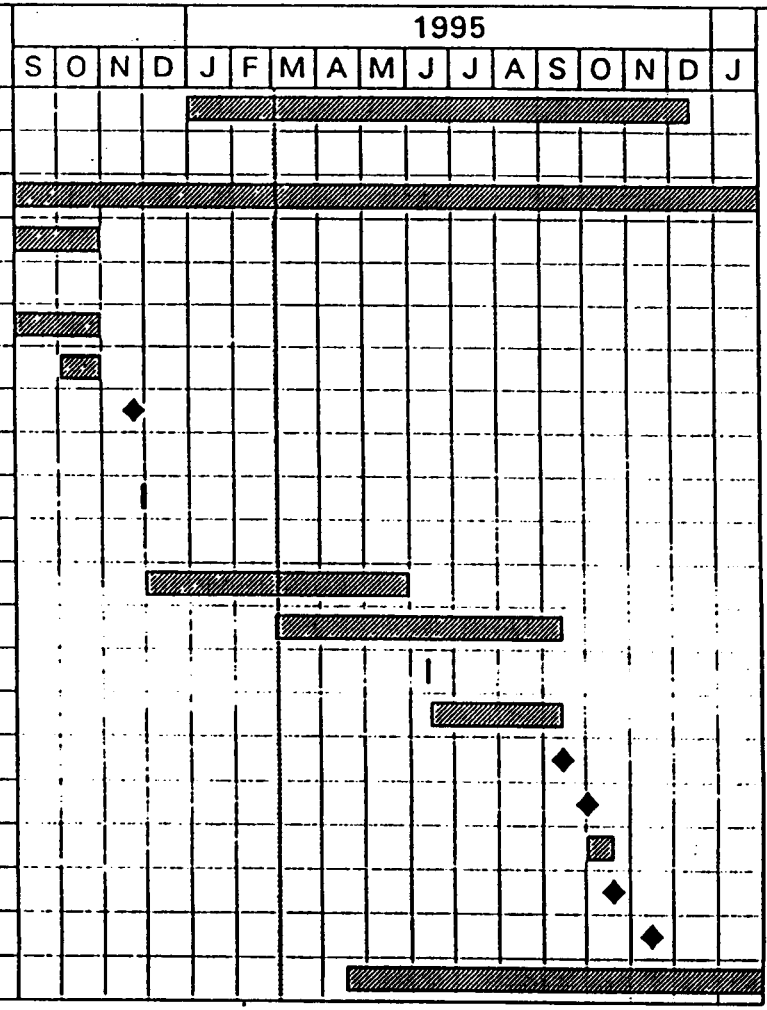
Characterised by a liquid metal eutectic (Pb-17Li) acting as both coolant and breeder and being circulated poloidally through thick-walled rectangular channels. Whilst the breeding zone is self-cooled, the first wall is Helium-cooled.

- Water-cooled Pb-Li Liquid Metal Concept

Characterised by a liquid metal eutectic (Pb-17Li) which is contained in a steel box. Cooling of the slow-moving Pb-17Li is provided by an independent water circuit utilising double-walled small-bore pipes.

European Blanket Concept Selection Exercise

ID	Name
1	Blanket Concept Selection Exercise (BCSE)
2	
3	Ongoing Blanket R & D Programme in Assoc. Labs
4	Summary Paper on Selection Criteria
5	
6	Reference Blanket Concept Status Reports
7	Proposal for Review by Industry
8	Presentation of BCG Proposals to FTSC-P
9	
10	1st Workshop for Working Group Recommendations
11	
12	Blanket Concept + Supporting R & D Status Reports
13	Involvement of EFET in Joint Assessment
14	2nd Workshop for Working Group Recommendations
15	Formulation of BCG/Industry Recommendations on Concepts
16	Completion of Recommendations from BCG & Industry
17	Presentation of Recommendations to FTSC-P
18	FTSC-P Discussion of Blanket Concept Recommendation
19	FTSC-P Recommendation to CCFP on Blanket Concepts
20	Endorsement of Recommendations by CCFP
21	Liaison with ITER-TBWG & International Programmes



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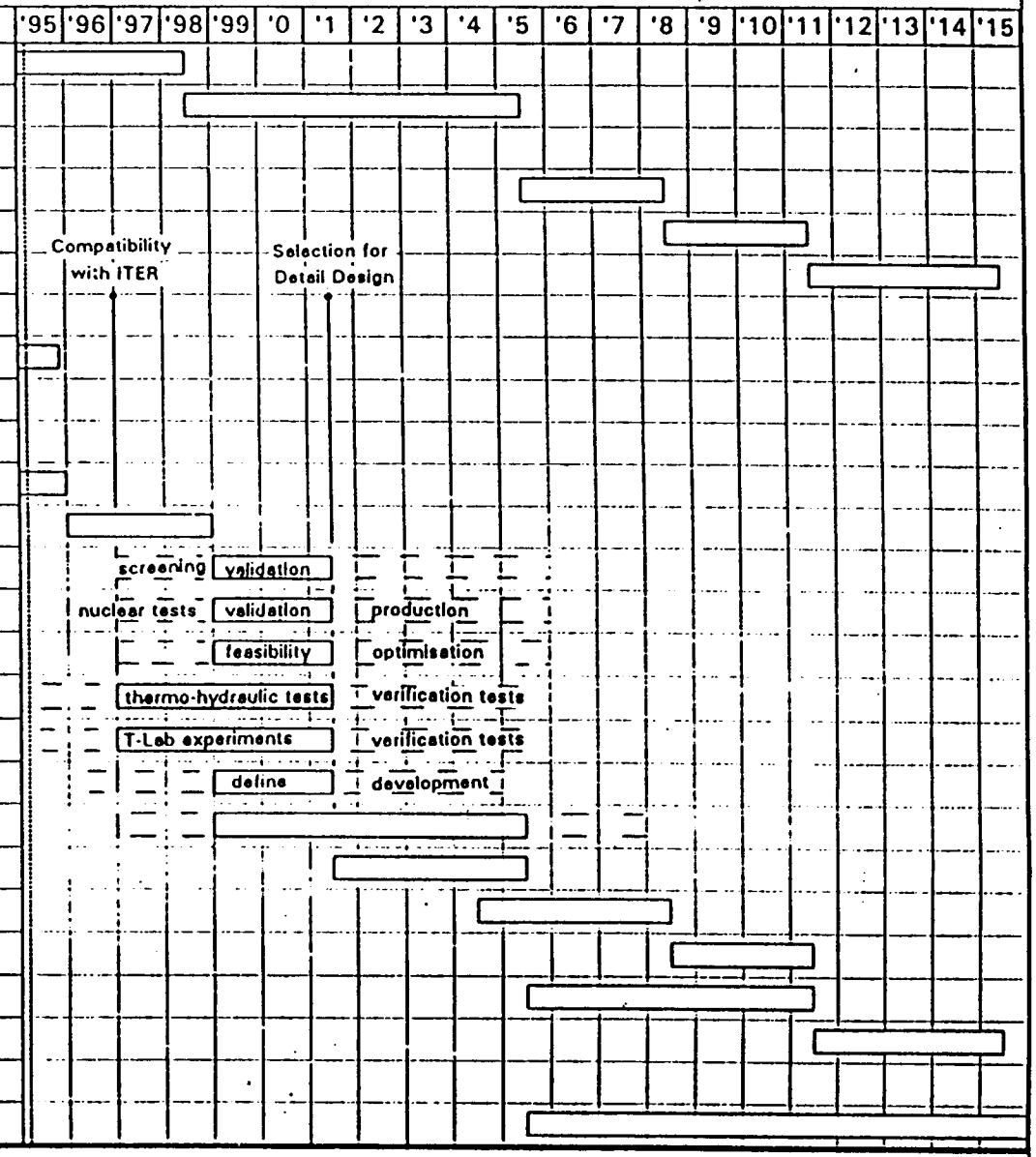
European Blanket Development Programme

ID	Name
1	ITER-EDA
2	Construction
3	Basic Performance Phase (BPP)
4	H,D Plasma Ops
5	<0.04 MWa/m2
6	<0.2 MWa/m2
7	
8	BLANKET CONCEPT SELECTION EXERCISE
9	
10	BLANKET MODULES FOR ITER TESTING
11	Determination of ITER Test Parameters
12	CDA
13	Structural Materials
14	Breeder Materials
15	Permeation Barriers
16	Coolant Parameters (p, t, $\dot{m}$)
17	Tritium Extraction System
18	Instrumentation
19	Prototype Fabrication and Testing
20	Detail Design of Test Modules & Ancillary Systems
21	Fabrication of Ancillary Systems and Dummy Test Module
22	Functional Testing of Ancillary Systems with Dummy Module
23	Test Module Fabrication & Material Procurement
24	Start of Module Testing in Neutron Flux
25	
26	NEUTRON SOURCE OPERATION (IFMIF)



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European Fusion Long-Term Programme

Provisional Budget for 1995-98 Period

Task Area	Budget Allocation
Blanket Development	50 MECU
Materials Development	29 MECU
Safety Studies	8 MECU
Neutron Source (IFMIF)	5 MECU
TOTAL	92 MECU

+ NUCLEAR DATABASE 2.25 MECU

Activities for DEMO Blanket in Japan

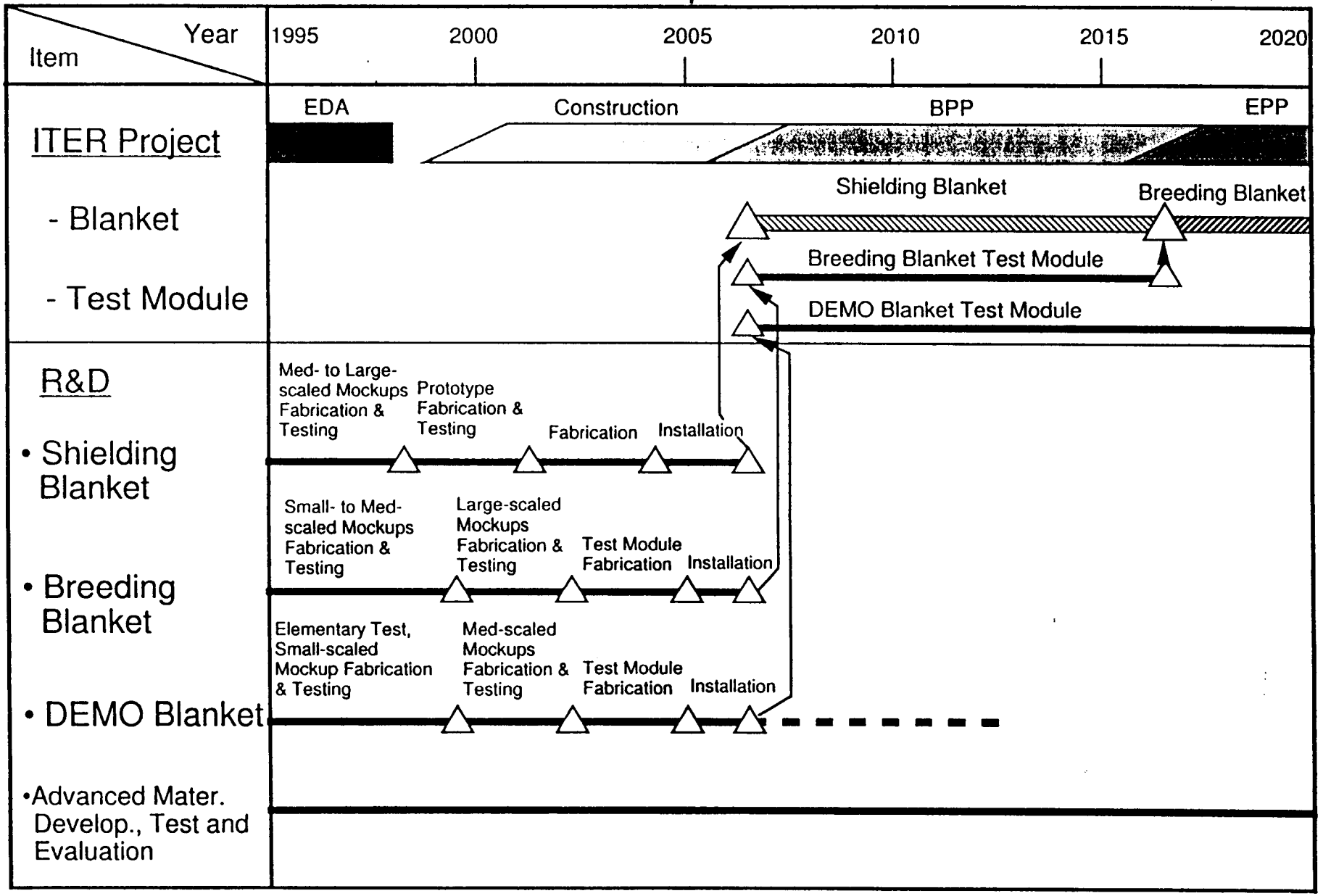
- Collaboration among
  - JAERI
  - Universities
  - NRIM

- JAERI develop Solid Breeder Blanket
  - Ferritics/Water-cooled
  - Advanced Mater./He-cooled

- Universities cover a wide range of Fundamental Researches
  - Solid breeder
  - Liquid breeder
  - Advanced materials

- NRIM devoted to Advanced Materials Development

Blanket Development Schedule



AGREED

- The TBWG agrees to provide documentation concerning the Test Blanket Program. (TBP) Such documentation should include requirements (with justification where appropriate), including those placed on the ITER device by the needs of the TBP as well as those placed on the test blanket program by the ITER device, design descriptions of all proposed test articles, a plan for implementation of the test program, interface documents and additions to the ITER Work Plan as required by the TBP.

- The documentation should follow the format already established by the Project, namely input to the General Requirements Document, A Design Description Document with sections pertaining to each proposed test article, Interface Documents, and the ITER Work Plan.

- For the initial implementation, JCT will provide to the head of each Party delegation the format to be followed in supplying the required information. Principal JCT contact will be Y. Gohar.

- Time table for initial work:

Format, examples, preliminary requirements sent to each delegation Head:	1 August 1995
Response of party delegations including requirements and justification (GDRD, Section 1, DDD) and proposals for test program	1 October 1995
TBWG 2 (Naka JWS)	16-18 October 1995
Initial draft of DDD Section 2 (design descriptions)	15 December 1995
TBWG 3 (San Diego JWS)	17-19 January 1996
Agreed GDRD	End January 1996
DDD Approval	Spring 1996