CTC Top Level Goals and Milestones to Support HAPL Case for Going to Phase II

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The HAPL development path to laser fusion energy consists of 3 phases as illustrated in Figure 1, starting off at low cost with an emphasis on research and development, and ending with a power plant-size testing facility. To advance from one phase to the next requires that specific milestones and goals be met. Overall chamber program milestones in support of this development path have been proposed as shown in Figure 2. The objective is to develop a schedule and key milestones for the different chamber tasks to help make these overall chamber program milestones happen. This document focuses on the first overall chamber milestone which would help make a credible case for going to Phase II.

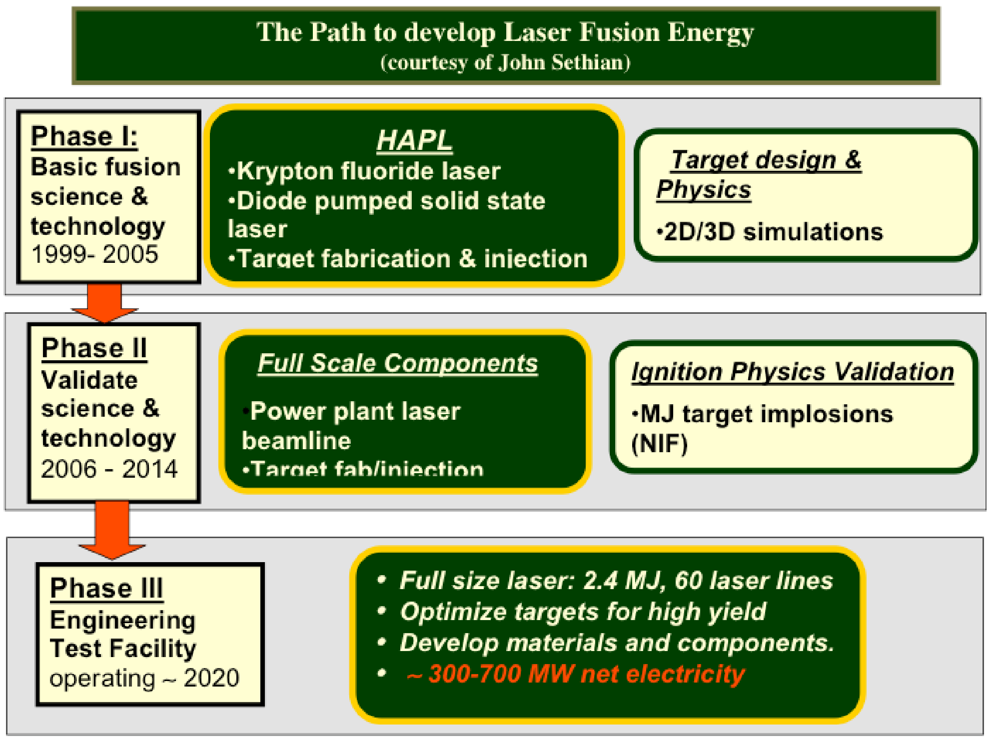

Figure 1 The HAPL path to develop Laser Fusion Energy

The chamber tasks cover critical issues associated with armor/first wall, blanket and system. Armor/FW operation in IFE is particularly challenging due to the combination of threats (X-rays and ions) and to the highly transient mode of operation. Thus, the R&D has a particular focus on addressing the critical issues in this area, namely:

(1) Viable Material Structures
(2) Helium and Hydrogen Isotope Diffusion.
(3) Ablation (ions & X-rays including surface roughening)

(4) Thermomechanical Fatigue and Fracture Toughness
(5) Thermophysical Properties (including irradiation effects)

These issues as well as detailed of the tasks and milestones are covered in the overall CTC document. Here, top-level goals in addressing these issues (as well as those for the blanket and systems tasks) and the tasks/deliverables required to achieve these goals in support of the first overall chamber milestone (within ~1-1.5 years) are described. A few tasks/deliverables scheduled over a period >1.5 years are also included for reasons of uncertainty in their completion date or for completeness. They are shown in italic.

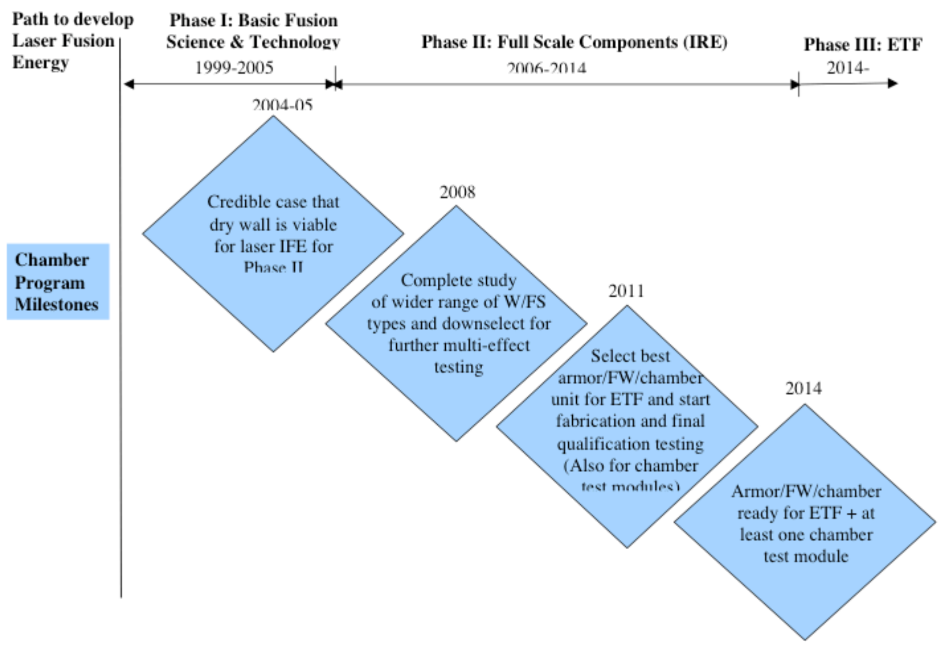

Figure 2 Proposed overall chamber milestones in support of the path to develop Laser Fusion Energy

I. Armor/First Wall

(1) Viable Material Structures

Top Goal: Develop a W/LAF structure with good bond integrity and thermal stability

Deliverables

(1.i)	Complete initial screening through bend testing and thermo-mechanical testing.	~ 6 months
(1.ii)	Down select to ~3 material combinations that look the best.	~ 1year
(1.iii)	Assess and select most promising engineered structure(s) (including pre-testing in RHEPP, XAPPER, DRAGONFIRE Lab, He-testing).	~1 year
(1.iv)	*Complete bonding and similar pre-screening and testing for engineered structure.*	*~2-3 years*

(2) Helium and/or Hydrogen Isotope Diffusion.

Top Goal: Demonstrate zero armor exfoliation

Deliverables

Complete:

(2.i)	Model development (refinement) for He behavior in tungsten	~6 months
(2.ii)	Monoenergetic He testing	~1 year
(2.iii)	Spectrum testing (with foils)	~1 year
(2.iv)	Synergetic effect (He+H)	~1 year
(2.v)	*Implantation/anneal to prototypic FS/W structure*	*~ 2 years*
(2.vi)	*Similar testing as (2.ii) to (2.v) for engineered W*	*~ 2-3 years*

(3) Ablation (Ions & X-rays including surface roughening)

Top Goal: Demonstrate that armor should have acceptable lifetime of about 3 years

(End of life armor characteristics (thickness))

Deliverables

Complete:

(3.i) Engineering modeling (including validation) in support of short-term experimental results — ~6 months

(3.ii) Development of long term predictive capability (understanding mechanisms such as roughening — *~ 2 years*

(3.iii) Demonstration testing (RHEPP, DRAGONFIRE, XAPPER)

- Cook and look experiments (scoping) — ~6 months
- Model validation experiments — ~ 1 year
- *Full range of testing to enable prototypical evaluation (in conjunction with modeling)* — *~ 2 years*
- *Same range of tests for engineered materials* — *~2-3 years*

(4) Thermomechanical Fatigue and Fracture Toughness

Top Goal: Demonstrate that for a nominal stress level fatigue-induced cracks will not propagate in the underlying structure and delamination will not occur

Deliverables

Complete:

(4.i) Modeling of temporal stress state of W/FS interface

- Fully dense material — ~ 6 months
- Engineered material — ~ 6 months

(4.ii) Thermomechanical fatigue testing of bond and fatigue crack growth

- Fully dense material — ~ 1.5 years
- *Engineered material (depending on availability)* — *~ 2 years*

(4.iii) IR thermal-fatigue of selected coupons (Prototypical conditions) 10^6 *pulses* — *>2 years*

(5) Baseline and irradiation effects on thermophysical properties

Top Goal: Compile baseline property data base (including irradiation effects)

Deliverables

Complete:

(5.i) Compilation of relevant MFE material properties — ~6 months

(5.ii) Identification of data need — ~6 months

(5.iii) Development of plan to measure missing properties if possible ~1 year (including irradiation effects)

(5.iv) Compilation of Materials Handbook ~1 year

II. Blanket

Top Goal: Develop at least one credible blanket concept compatible with the choice of armor (W) and structural material (FS).

Deliverables

Complete:

(B1.i) Scoping study and down selection of blanket concepts (choose 1-2 concepts for detailed study) ~1-1.5 years

(B1.ii) Detailed design study of selected blanket concept(s) ~2-3 years

III. System Studies

Top Goal Develop an integrated systems code that can be used to investigate a variety of laser-IFE design options and configurations

Deliverables

Complete:

(S1.i) Integrated chamber/blanket/power cycle model for 2-3 blanket options, including cost estimates ~6 months

(S1.ii) Development and inclusion of performance and costing models for KrF and DPSSL drivers ~2 years

(S1.iii) Inclusion of cost scaling models for remaining power plant systems ~3 years