The HAPL Program:
Integrated program to develop the science and technologies
for Fusion Energy with Laser Direct Drive

19th HAPL meeting
Oct 22-23, 2008
Madison, WI
54 participants, 10 students

**Universities**
1. UCSD
2. Wisconsin
3. Georgia Tech
4. UCLA
5. U Rochester, LLE
6. UC Berkeley
7. UNC
8. Penn State Electro-optics

**Government Labs**
1. NRL
2. LLNL
3. SNL
4. LANL
5. ORNL
6. PPPL
7. SRNL

**Industry**
1. General Atomics
2. L3/PSD
3. Schafer Corp
4. SAIC
5. Commonwealth Tech
6. Coherent
7. Onyx
8. DEI

9. Voss Scientific
10. Northup
11. Ultramet, Inc
13. PLEX Corporation
14. APP
15. Research Scientific Inst
16. Optiswitch Technology
17. ESLI
HAPL “Business Model” for IFE development

1) Develop science & technology as an integrated system

2) Pick approaches that:
   a) Lead to an attractive power plant
      technically, economically, environmentally
   b) Requires less investment to develop
   c) Value simplicity and durability

3) Encourage competition

4) Managed by one institution, partnership among many.
   a) Synergies with other fusion approaches
   b) Engage non fusion community (e.g. materials)
   b) Encourages alternative views, avoids “groupthink”

5) Staged program with well defined “go / no-go” points
   a) S&T advances pace program, not mandates
An "integrated systems" approach is essential. Much harder, but much more likely to yield something that works!

Example: target physics

21.83 nsec

22.40 nsec

GAIN = 160

simulations A.J. Schmitt

f# & uniformity (Laser damage)

Emission Damage

First wall (survival)

Blanket- (tritium breeding)

tritium supply

Target fabrication

Target injection survival

DT strength (acceleration)

Laser

Chamber environment

Final optics

target emissions

2004/03/01; 12:21

3 bal
The keys to economically attractive fusion power:
Simplicity, Durability, Performance
Encourage competition. It leads to innovation and a better product. And leads to it faster.
HAPL generated credible solutions for most key components needed for IFE (1 of 2)

**Final Optics:**
High Laser Damage Threshold
Grazing Incidence Metal Mirror

10 M shots at 3.5 J/cm² (not a limit!)

**Penultimate Optics:**
Neutron Resistant Dielectric Mirror

**Laser Damage Threshold**
($\text{Al}_2\text{O}_3/\text{SiO}_2$)

<table>
<thead>
<tr>
<th>No dpa</th>
<th>0.001 dpa</th>
<th>0.01dpa</th>
<th>0.1 dpa</th>
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</thead>
<tbody>
<tr>
<td>86-87%</td>
<td>84-86%</td>
<td>78-83%</td>
<td>83-84%</td>
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**Target Fabrication:**
Mass Produced Foam Shells

**Target Fabrication:**
Smooth DT ice layers over foam

Estimate Target Cost 16 ¢ each
HAPL generated credible solutions for most key components needed for IFE (2 of 2)

**Target Engagement:**
Glint system: accuracy 35 microns

**First wall experiments & modeling**
Study threats on Chamber Wall

<table>
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<th>Developing two chamber concepts</th>
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<td>Engineered Wall</td>
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<tr>
<td>Magnetic Intervention</td>
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Conceptual designs for ancillary components:

- Chamber/structure
- Blanket
- Tritium Breeding/processing
- Vacuum system
- Power conversion
HAPL team had over 210 publications /presentations

|---------------------------|--------|--------|------------------------------------------------------------------------------------------|---------------------------------------------------------------|-------------------------------------------|
The HAPL Program produced > 31 students