Suggested Path to Develop Inertial Fusion Energy

NRL Laser Fusion Program

“A phased (IFE) program with competition and unambiguous selection criteria is needed”

Outline

- Our recommendations for such a “phased program.”
- Particular path forward with direct-drive and KrF.

Phased program with gates for both the overall program and the individual approaches

Phase I

Basic IFE S&T
- High rep rate driver technology
- IFE target design
- IFE target physics
- Target fabrication
- Reaction Chamber
- Fusion materials

Phase II

Develop full size components.
- Full scale driver module
- DEMO low cost mass target fabrication
- DEMO target engagement
- IFE ignition experiments
- Design Fusion Test Facility

Phase III

(Inertial) **Fusion Test Facility (FTF)**
- Demonstrate integrated physics / technologies for a power plant.
- Tritium breeding, fusion power handling.
- Develop/ validate fusion materials and structures.

Increased level of effort with demonstrated progress & credibility for attractive power plant

Technical, scientific and economic basis for follow-on prototype IFE power plants.

Sample Gates Phase I to Phase II

✓Driver technology projected to meet requirements (efficiency, durability, cost)

✓Test module successful – long duration operation

✓Overall concept attractive for energy

HAPL program was an unfinished Phase I effort for the S&T of inertial fusion with laser Direct Drive

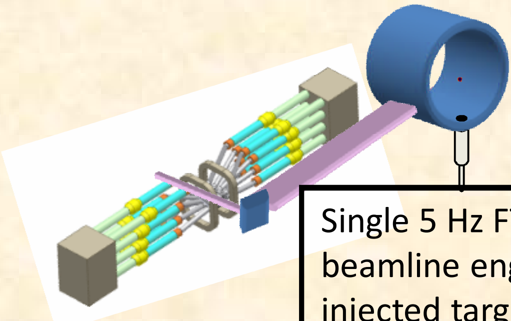
- Electra KrF and Mercury DPSSL high repetition rate lasers.
- Efforts in all critical IFE technologies needed for this approach. In many cases solutions identified and tested on small scale
- We believe this particular Phase I effort could be completed in about 3 years. (if adequately supported).

Some particulars of a Phased program with KrF

Laser Fusion

Complete Phase I:

- Install solid-state pulse power on Electra system
- Demonstrate long continuous runs (e..g >500J, >100 hours
- Complete auxiliary IFE S&T efforts begun by HAPL
- Design full scale beamline.
- Refine target design and physics

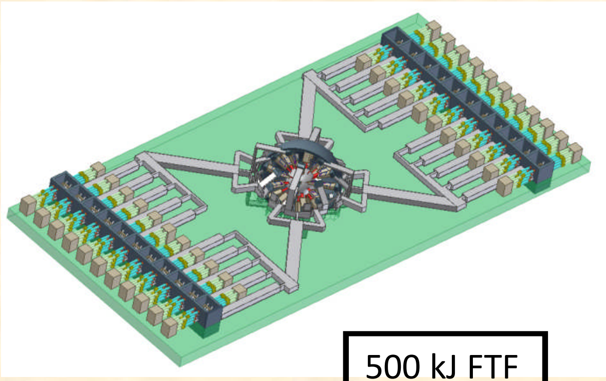


Phase II : Develop full size components (~5 years)

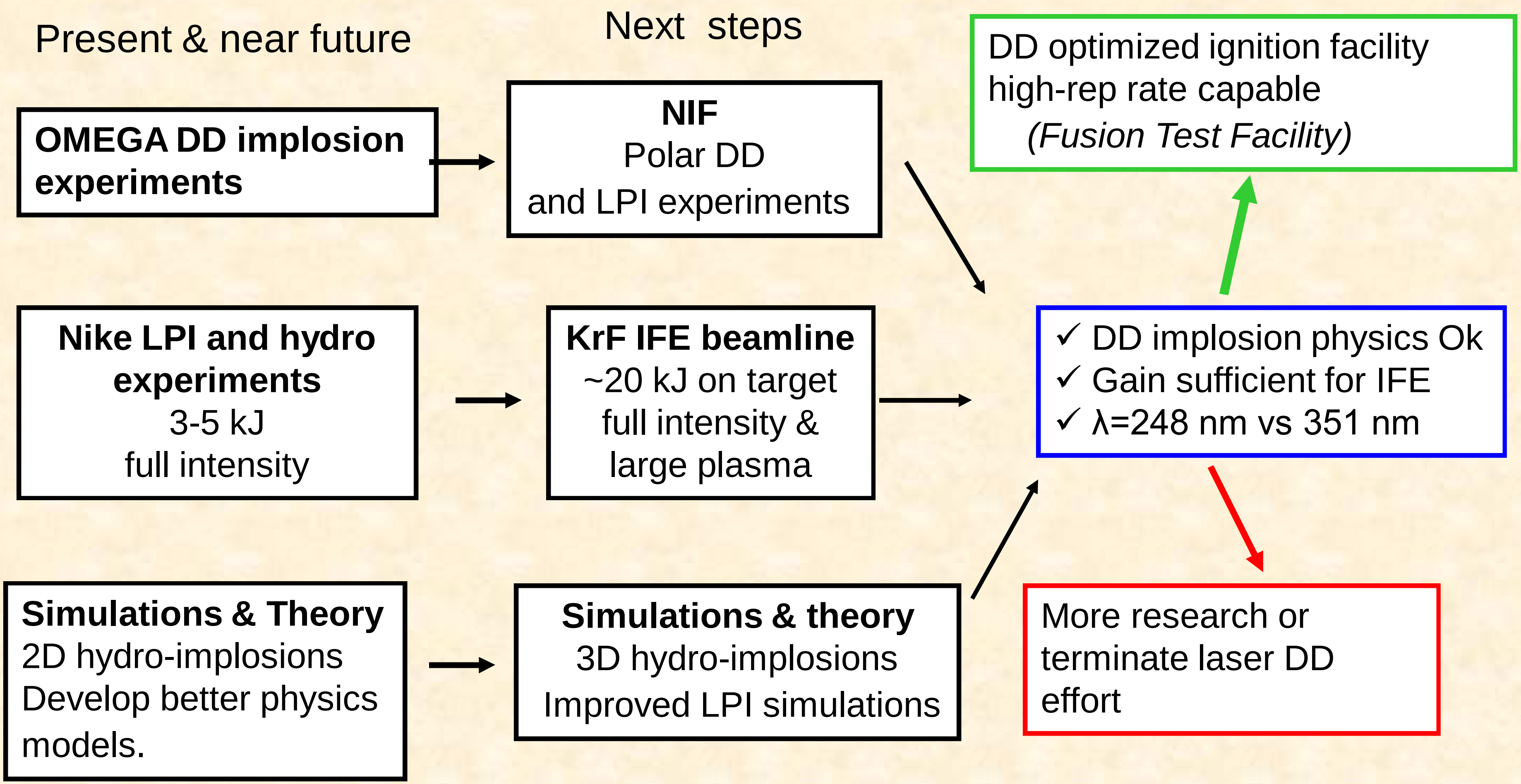
- Develop full scale KrF laser beamline (e.g. 18 kJ, 5 Hz KrF beamline)
- Engage injected targets with beamline.
- Increased efforts in all critical IFE technologies
- Develop high confidence in pellet designs & physics

Phase III Fusion Test Facility (FTF)

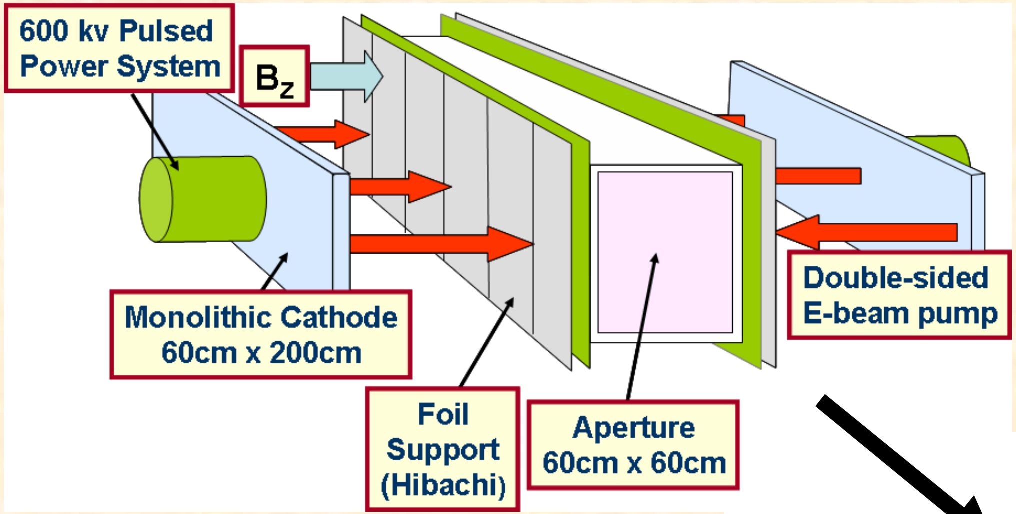
- 500 kJ 5 Hz KrF system utilizing shock ignition.
- Develop/ validate fusion materials and structures
- Significant participation by private industry



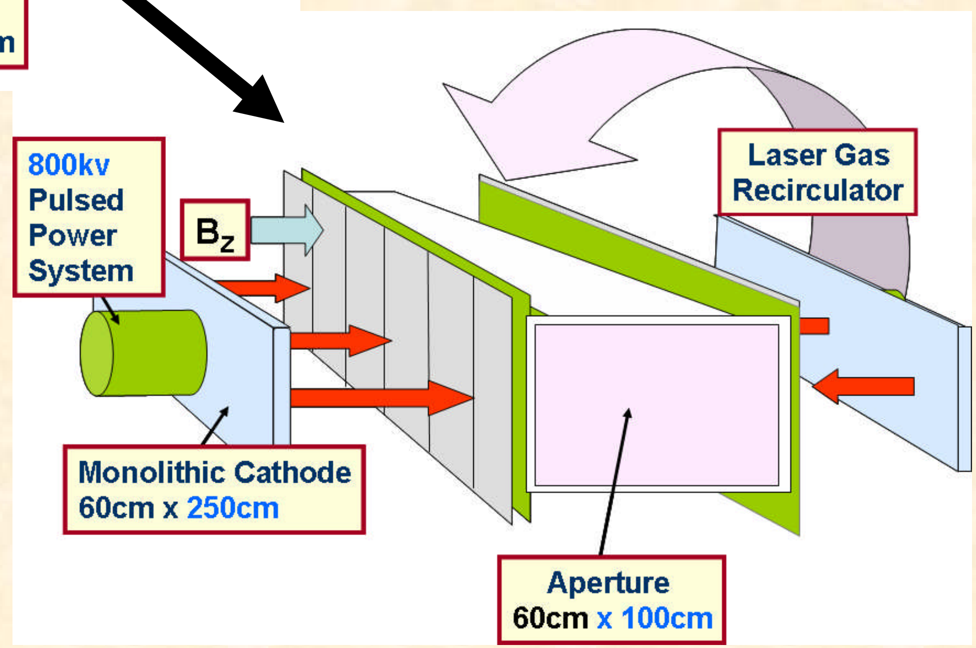
Path Forward towards IFE
Direct Drive (DD) Target Physics



As discussed before, our FTF final amp design is modest scale-up of Nike's 60-cm amp. using Electra's 5 Hz pulse power.



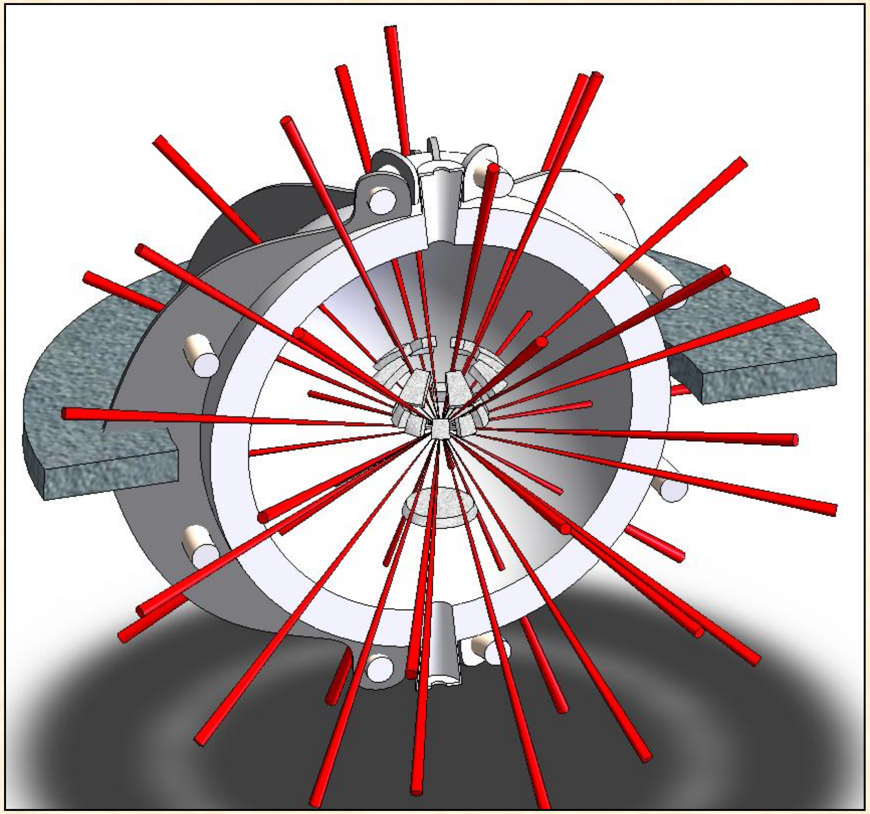
"5 kJ" Nike Amplifier
Codes predict 8 to 9 kJ with planned hibachi & cathode upgrades.



"18 kJ" FTF Amplifier

- Similar current pulse
- Diode voltage → 800 kV
- Aperture width → 100 cm
- 5 Hz solid-state pulse power

The combination of shock ignition and KrF is predicted to allow high performance at modest energy



KrF based FTF parameters

0.5 MJ energy @ 5 Hz

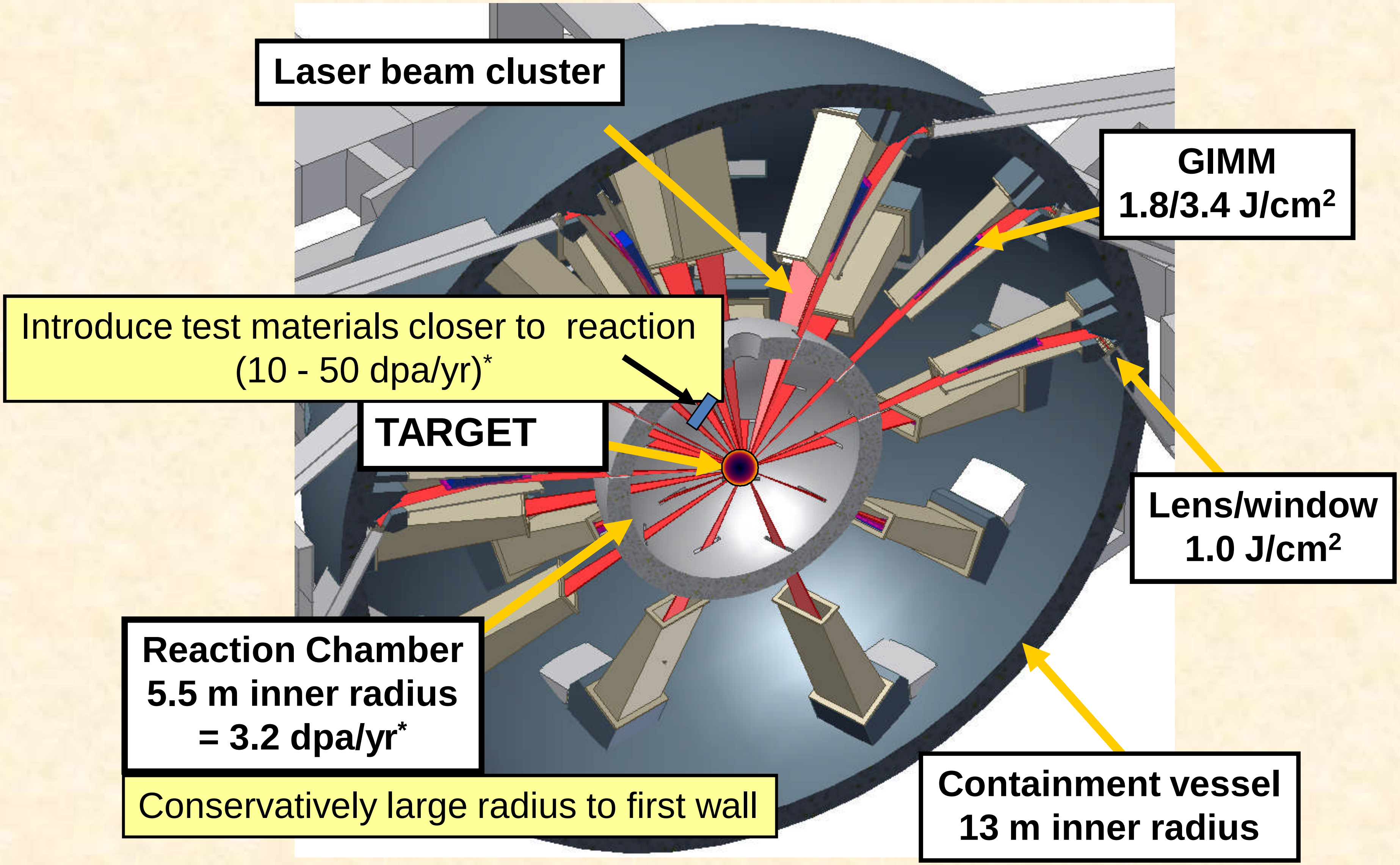
(e.g. thirty 18-kJ beamlines)

~100× target gain

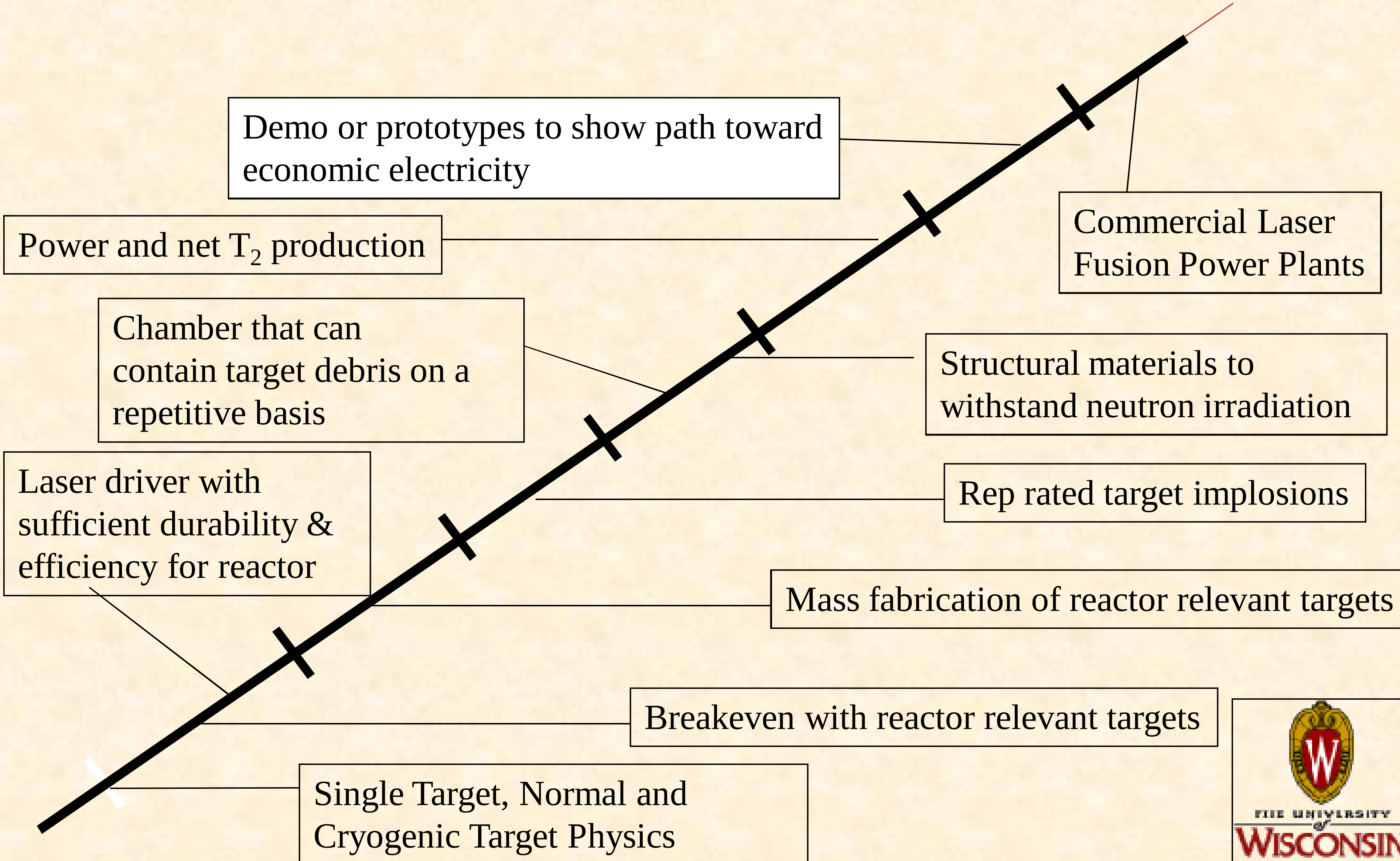
→ ~ 250 MW fusion thermal power

The FTF Chamber (conceptual)

*dpa assumes 70% availability, 250 MW Fusion Power, 70% in neutrons



What Needs to be Done on the Path to a Commercial Laser Fusion Reactor?



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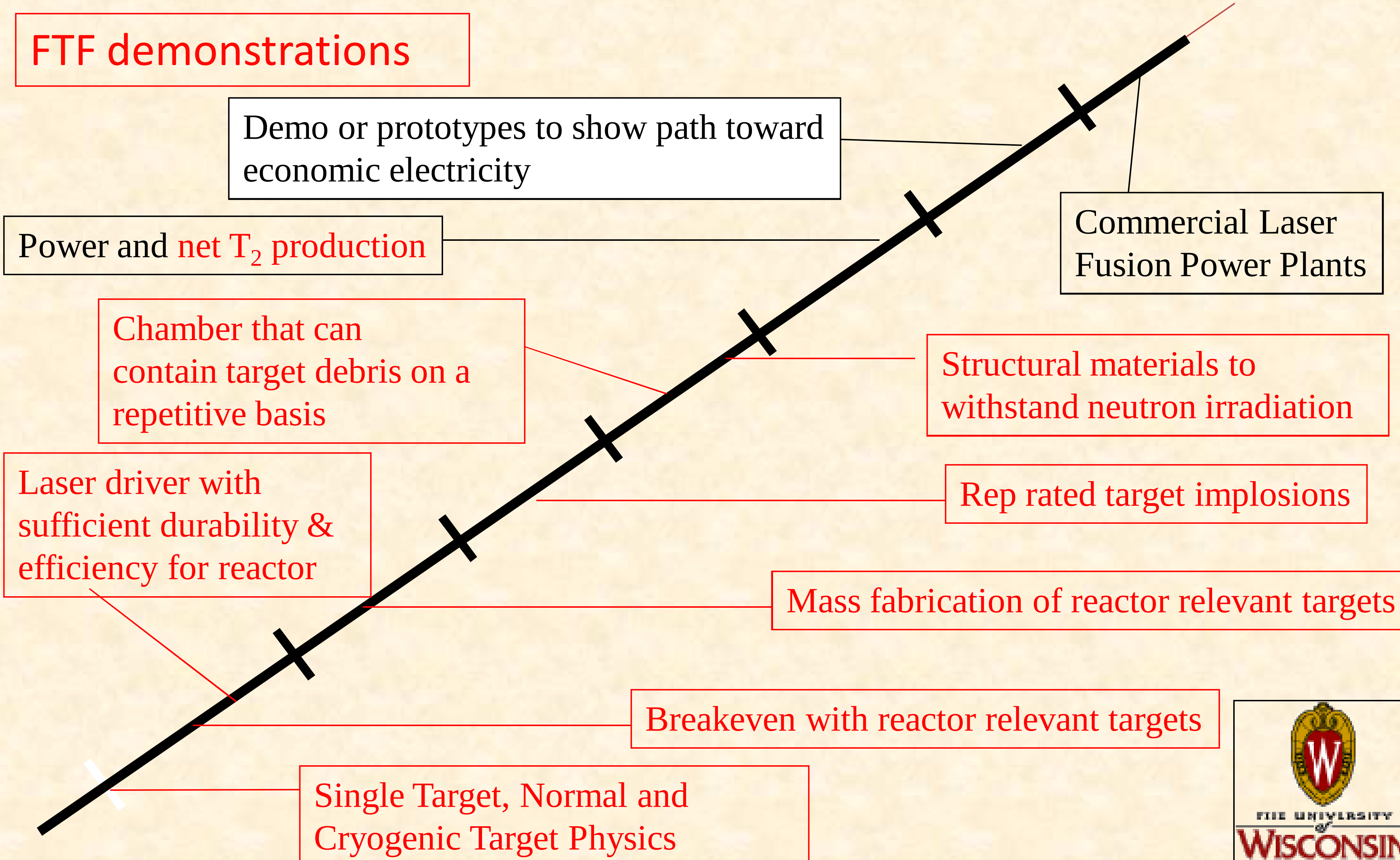

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