

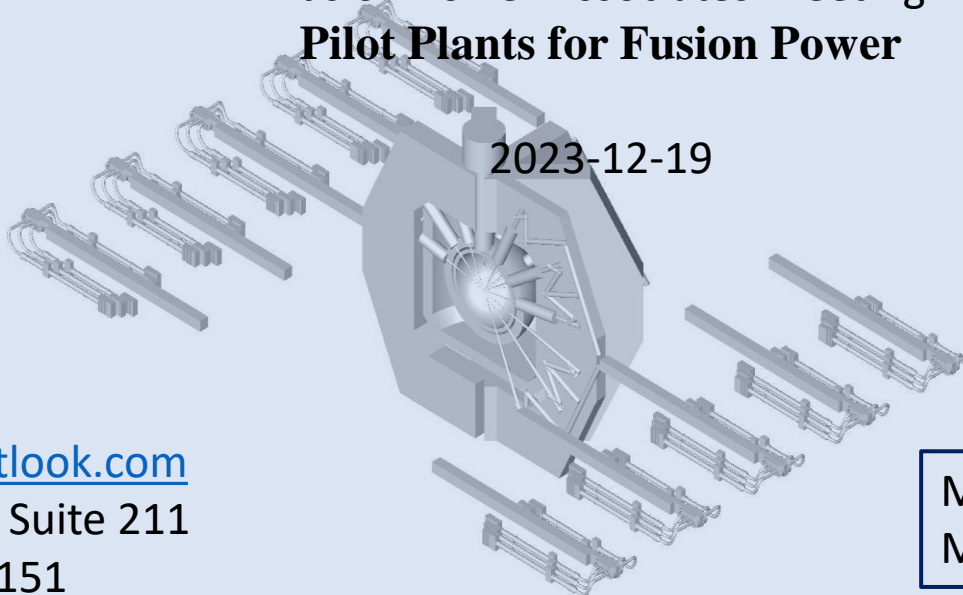
# LaserFusionX Inc.

Path to an ArF laser fusion pilot power plant that also serves as a Fusion Test Facility (FTF)

Stephen Obenschain

Fusion Power Associates Meeting  
**Pilot Plants for Fusion Power**

2023-12-19

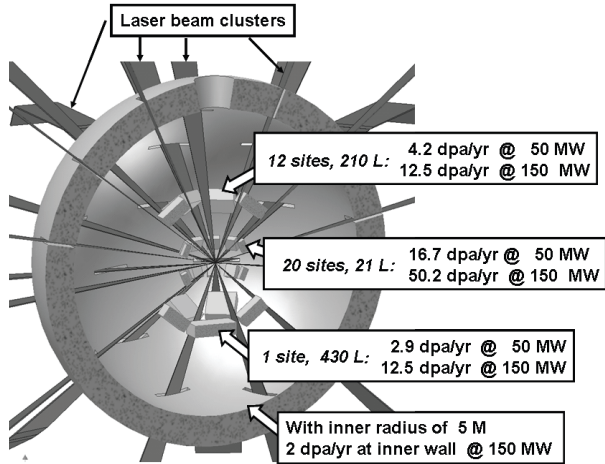
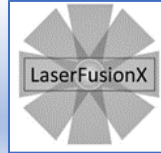


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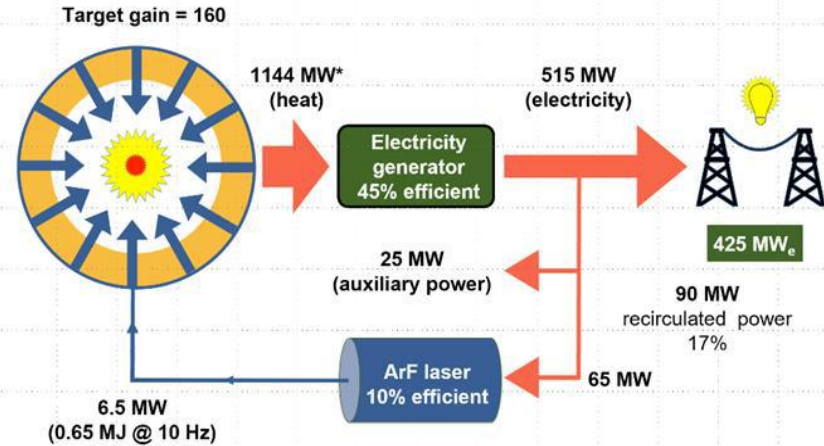
Malcolm McGeoch, PLEX LLC  
Matthew Levy, AE Blue Capital

# A Fusion Test Facility (FTF) vs a pilot power plant



## FTF proposed during HAPL program

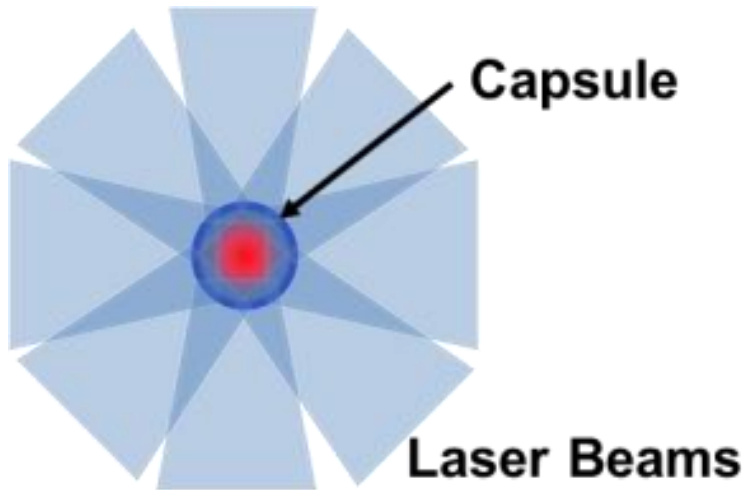
- Laser direct drive (with KrF)
- Main mission to test fusion components, materials and procedures.
- Breed tritium and DEMO power generation
- Make as small and low cost as feasible to carry out the missions.



## Pilot power plant

- Laser direct drive with ArF
- Similar technical missions to FTF – test components, materials and procedures.
- Approach size and performance of a commercial power plant – e.g. 400 MWe with most electrical power to the grid.

**Direct Laser Drive** – laser light directly illuminates the capsule

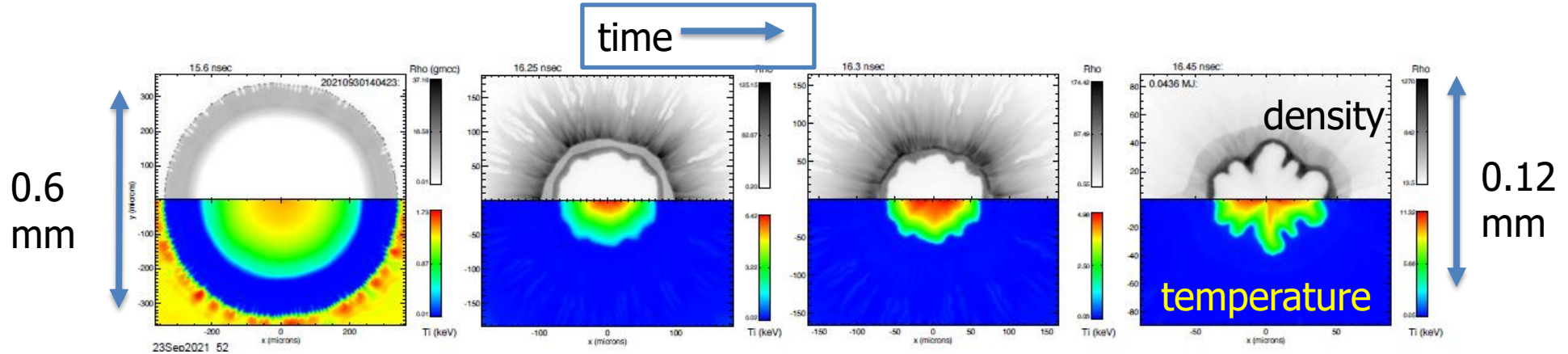


- The combination of direct drive and the ArF laser's deep UV light increases the efficiency 6x over NIF's approach
- Gains >100 can be obtained with much less laser energy than generated by NIF.\*
- The ArF laser has sufficient efficiency and repetition rate for a fusion power plant.

\* Per simulations conducted at the U.S. Naval Research Laboratory (NRL)

NRL 2D simulations indicate an ArF laser can achieve target gains ( $>100$ ) needed for laser fusion power plant with much less laser energy than achieved by NIF

Sample NRL 2D simulation of a **410 kJ ArF** driven shock ignited implosion



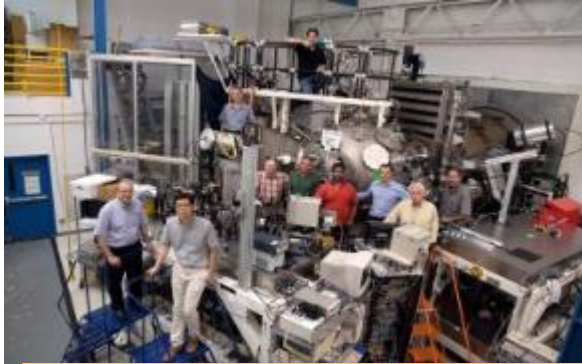
- 160x gain including effects of target imperfections
- 148x gain adding effects of laser imprint @ 5 THz bandwidth

A. Schmitt DPP 2021

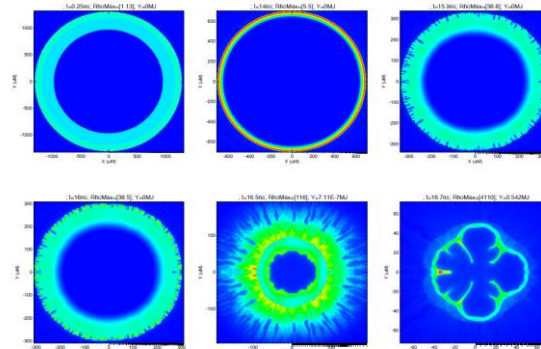


NRL PPD

The LaserfusionX approach is based on advances in the ArF laser technology and high gain target designs conducted at the U.S. Naval Research Laboratory (NRL)



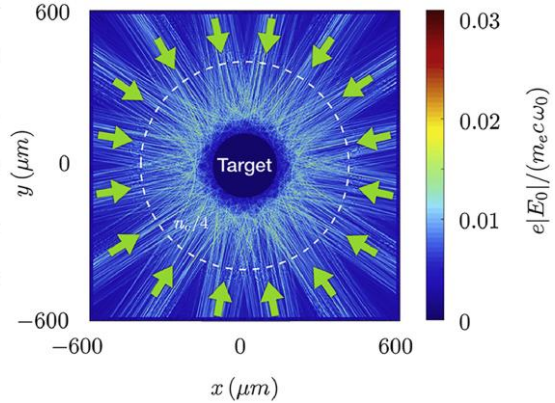
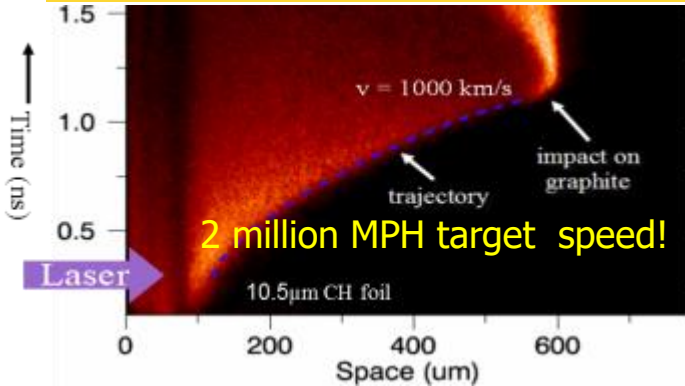
Laser target interaction experiments  
Nike KrF laser facility



Simulation of a pellet implosion  
and of a laser-plasma instability



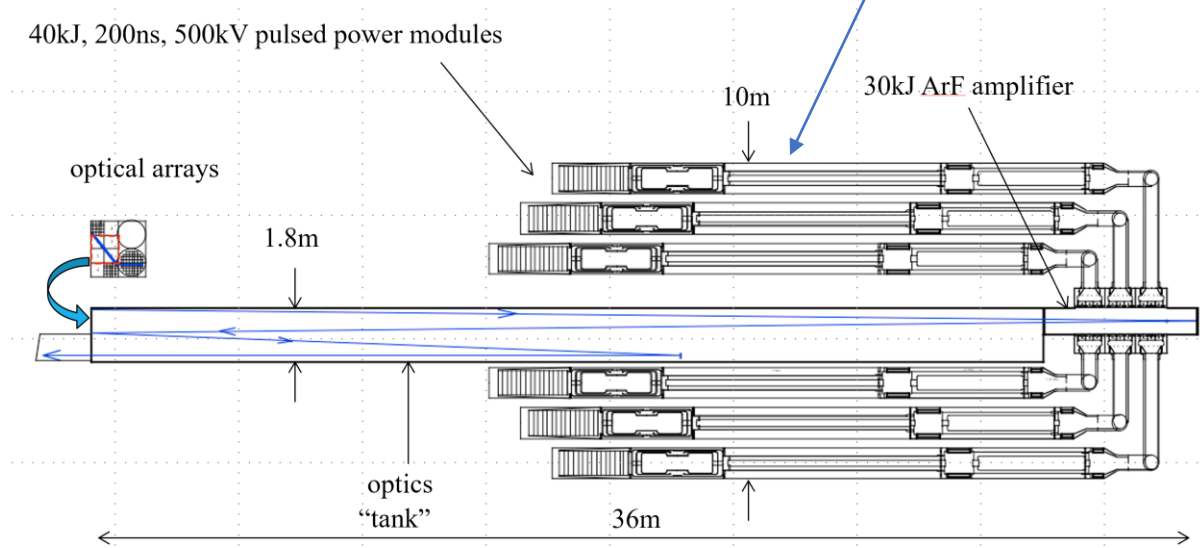
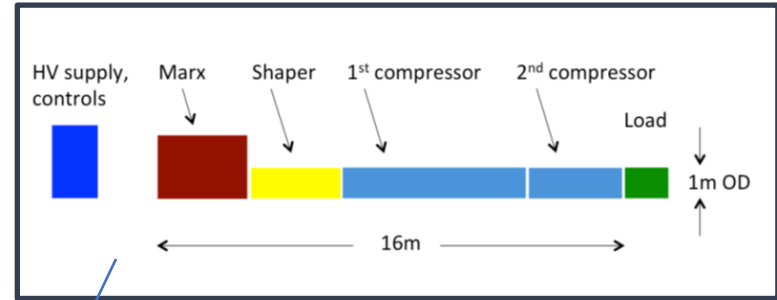
Electra Argon Fluoride laser



# We have developed a design for the high energy high-rep-rate ArF amplifier needed for a laser fusion power plant



All solid-state switched (silicon & magnetic) pulse-power module

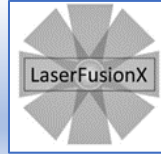


ArF laser gas cell  
90 cm x 90 cm aperture

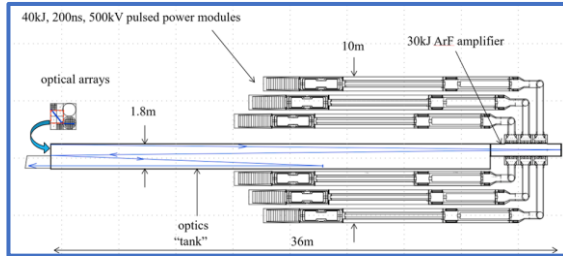
M. McGeoch. Plex LTD

30-kJ 10-pulse-per-second 90-cm aperture ArF amplifier

# Three phase path to a pilot ArF laser-fusion power plant

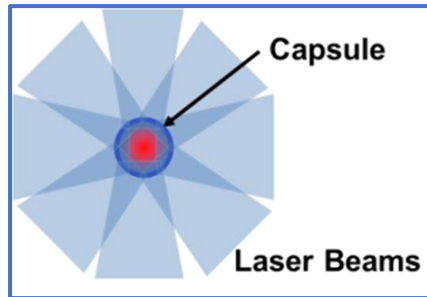


## Phase I (6 years)



**Develop and operate 30 kJ ArF laser beamline.**

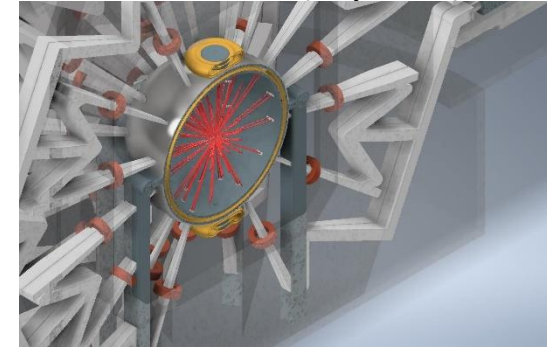
## Phase II (5 years)



**High-gain implosion facility operating @ 100 shots/day**

- DEMO high gain implosions
- Develop components for pilot power plant
- Design pilot power plant.

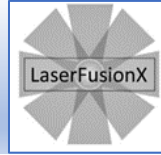
## Phase III (5 years)



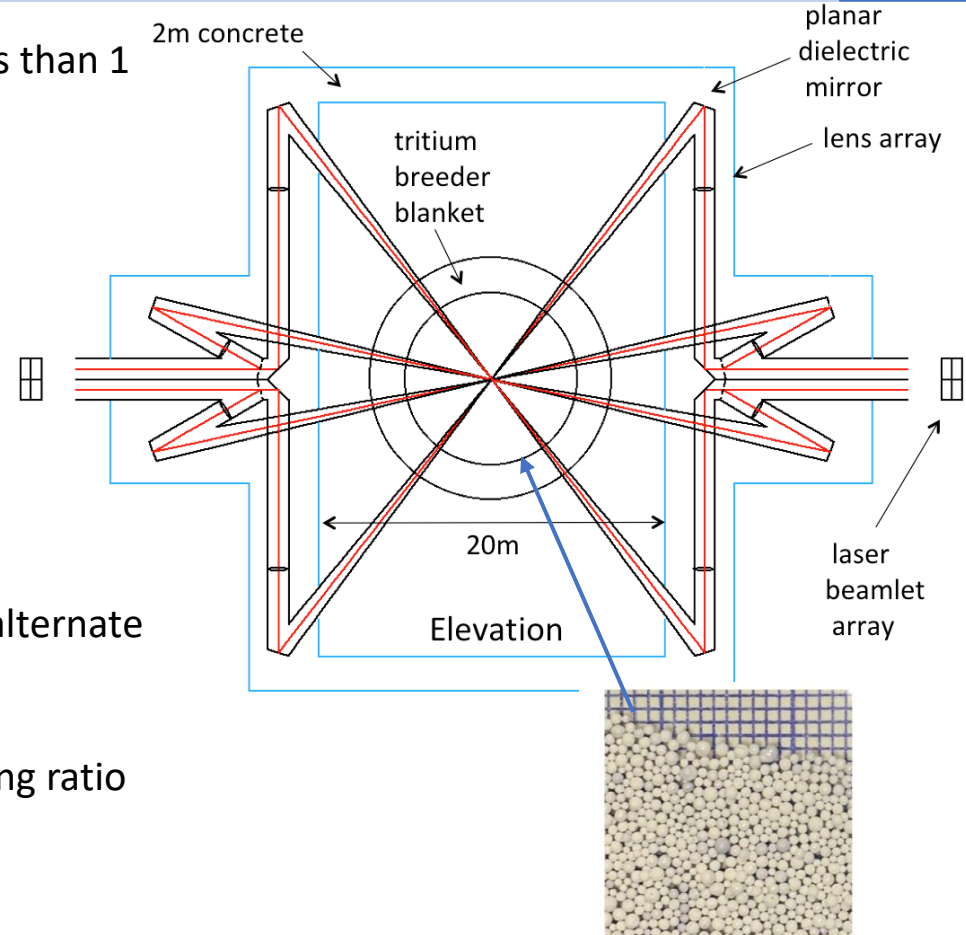
**ArF laser fusion pilot power plant**

- E.g. 650 KJ ArF @ 10 Hz
- Test components and procedures
- Generate electrical power 425 MW

# LaserFusionX Generic D-T Reactor Concept



1. ArF direct drive with high target gain ( $>100$ ) with less than 1 MJ laser energy.
2. Dry-walled chamber under vacuum
3. Ceramic breeder blanket
4. Helium-cooled at 5Bar, 10MW flow power
5. Magnetic intervention, alpha particles diverted
6. Dielectric final mirrors at 20m, present status 1FPY, alternate is grazing incidence mirror
7. Expansion of fleet can be rapid if high tritium breeding ratio achieved



Appearance of pebbles of  $\text{Li}_4\text{SiO}_4\text{-Li}_2\text{TiO}_3$  biphasic ceramics.



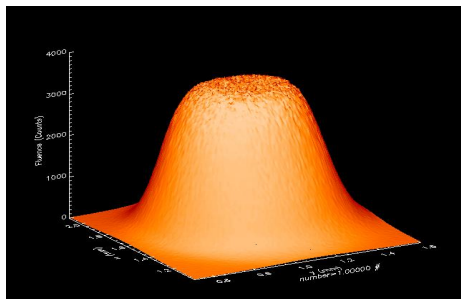
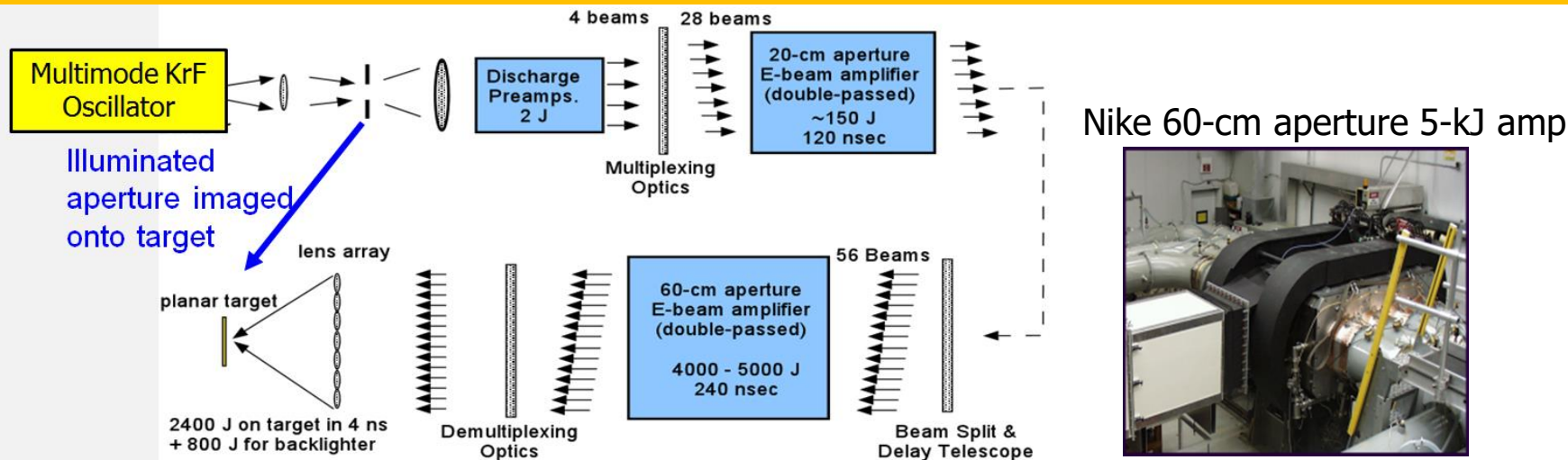
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Extra slides

# The NRL Nike krypton fluoride (KrF) laser demonstrated that large electron beam pumped excimer laser systems could be built & operated

Nike: Aperture in the front end is imaged through the amplifier system to target



Time averaged laser spatial profile in target chamber

Nike zoomed focus:

