



**Argonne**  
NATIONAL  
LABORATORY

*... for a brighter future*

# ***Beam Activities of the DOD Project Office***

***focus today on the Navy's Free  
Electron Laser Program***

Argonne Accelerator Institute Meeting  
June 16, 2009



U.S. Department  
of Energy

UChicago ►  
Argonne<sub>LLC</sub>

A U.S. Department of Energy laboratory  
managed by UChicago Argonne, LLC

## *Several Beam Activities and Interests Ongoing*

- Terahertz sources and applications
- **Navy Free Electron Laser (Focus area today)**
- Free Electron Laser Applications
- Electromagnetic Interference Technology Review Committees
- Novel Fiber Optic Materials with Army Research Lab
- Optical Diagnostics for next-generation light sources
- Neutron detection schemes
- NATO Sensors and Electronics Panel, international field tests of directed energy source applications
- Controls
- Radiation Oncology

# Background, Naval Directed Energy History

The U.S Navy has been investigating utility of lasers since the 1960's and the use of Directed Energy (DE) and Electric Weapons to defend Navy Surface and Air Platforms from an assortment of threats. The Navy continues to focus efforts in four areas specific to the naval-warfare domain:

- Laser source development
- Stand-off effectiveness
- Maritime propagation
- Systems engineering



# Funding Sources for FELs include the following DOD organizations

## ■ Office of Naval Research (*Predominant*)

- Discovery and Invention Programs, *Basic Science and Engineering Investigations*
- Applied Programs, *Applied Investigations*
- Innovative Naval Prototypes, *Game-changing and High risk/high-payoff*



## ■ High-Energy Laser Joint Technology Office

- Basic and Applied funding in the areas of 1) Beam Control, 2) Gas Lasers, 3) Free Electron Lasers, 4) Solid State Lasers, 5) Advanced Lasers, and 6) High Energy Laser System Modeling & Simulation
- The High Energy Laser-Joint Technology Office (HEL-JTO) intends to release a Broad Agency Announcement (BAA) on or about June 23, 2009.



## ■ NAVSEA, PMS-405

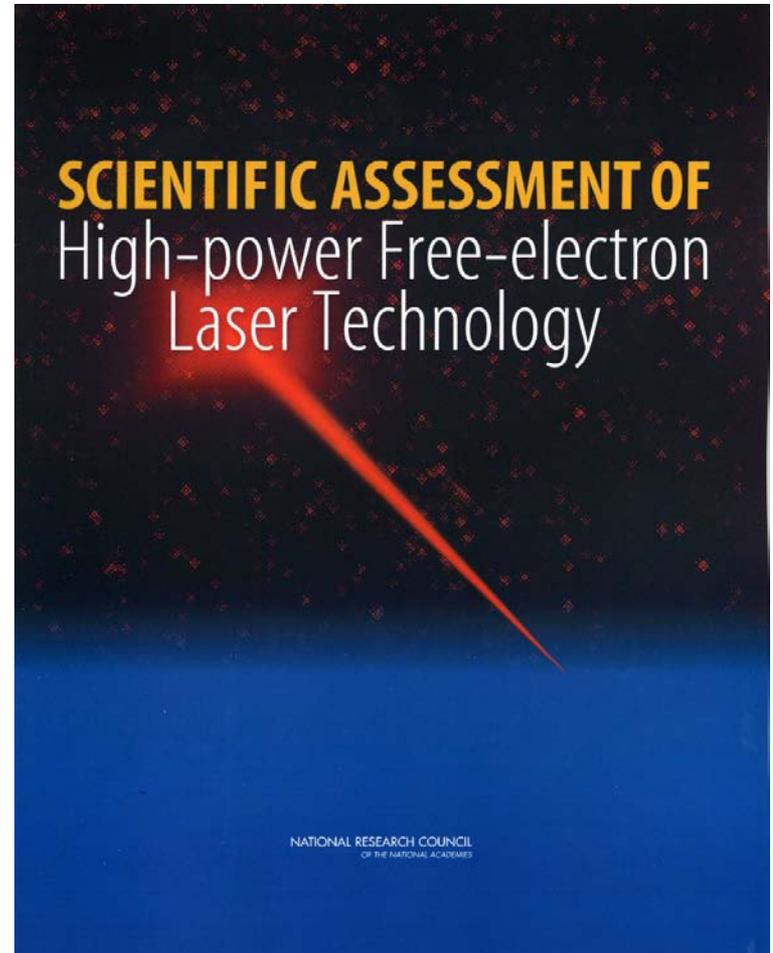
- The Directed Energy and Electric Weapons organization



# **ONR, Steps to realization of a fieldable Naval FEL**

## **Scientific Review of Technology**

- ONR sponsored a National Academy's committee to assess the feasibility of a high power 100-kW and higher average power, infrared FEL
- Report is published
- Since there were no technical "show stoppers" assessed by the committee, the high-risk, high-payoff Innovative Naval Prototype (INP) for the 100-kW FEL was launched.



## ***ONR, Steps to realization of a fieldable Naval FEL Innovative Naval Prototype***

- ONR sponsored a call for proposals for a multi-phase competition for the 100-kW INP for industrial leads to team with academia and national labs.
- Five industrial teams competed in the competition: Boeing, General Atomics, Raytheon, Northrop Grumman and Lockheed Martin
- The winners were announced in December of the first phase: Boeing and Raytheon. This is a a 14M USD, 1-year phase split equally amongst the two competitors.
- Next phase is the actual INP, ~150M USD developing 100kW FEL INP planned for FY 2015 demonstration.

## ***ONR, Steps to realization of a fieldable Naval FEL Innovative Naval Prototype – Argonne Involvement***

- Argonne has entered into a Work for Others agreement with the Boeing Company for the INP.
- This first phase of activity requires mostly accelerator, project, and FEL know-how/expertise for the formulation of the proposal to build and test a 100-kW device.

# ONR, Steps to realization of a fieldable Naval FEL

## Discovery and Invention Activities

### ■ Components

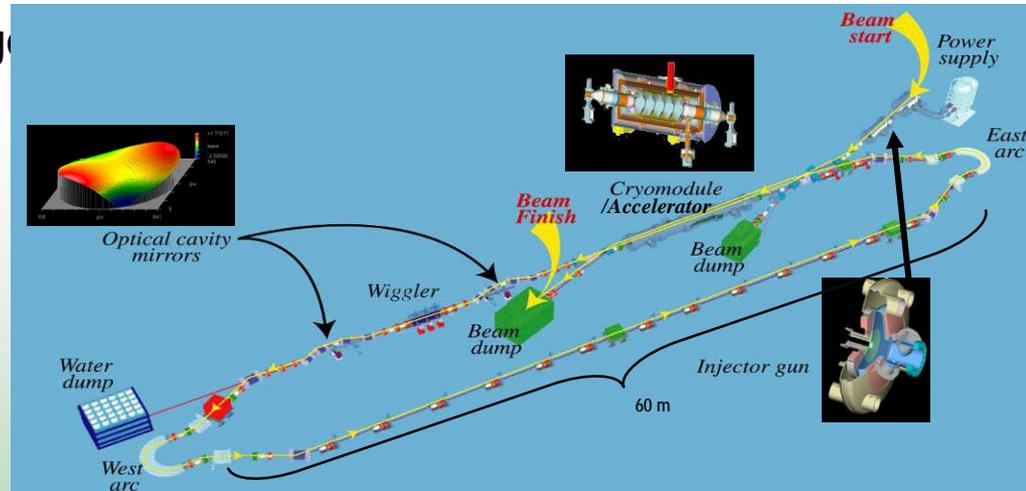
- Photo injectors with  $\sim 1$  A average current,  $\sim 1$  nC/bunch injector
- Efficient wiggler & compact, survivable optical resonator
- Optical Components
- Cryomodule

### ■ Anchored Models & Simulations

### ■ Optimum FEL concept for scale-up

### ■ Lethality

### Critical Technologies being developed for INP



**14.3 kW's have been reached. Provides confidence for Scale-Up for Navy Program**

#### **10 kW FEL System Test Bed**

- Demonstrates FEL scalability
- Anchors engineering and physics codes
- Useful to evaluate concepts
- Adds confidence to next step

**Focus of ONR FEL D&I Program and OSD HEL JTO Investment**  
**Mature Technology and Reduce Risk for 100kW Demonstration**  
**Prepare Technology for Future MW System**

# ***ONR, Steps to realization of a fieldable Naval FEL***

## ***Discovery and Invention Activities – Argonne Involvement***

- Cathodes
- Electrical RF Breakdown
- Novel electron sources
- Beam transport challenges
- Novel undulator devices
- Novel gain properties
- Novel accelerator concepts
- Seed laser systems
- Controls

## *Future Directions*

- Argonne continues to be a leader in beam technologies and is recognized by several DOD and industrial sponsors.
- We continue to work in a matrixed environment across the laboratory and supported through the AAI entity to help grow the laboratory and beam expertise/experiences for Argonne.
- The DOD and industrial sponsors are very grateful to partner with the DOE labs to leverage national resources.
- We are hopeful Argonne will be successful in the partnership with Boeing in securing the next phase of the 100-kW FEL INP. This would permit additional experience of Argonne in new areas with beams as well as strengthen present areas of expertise.