The High Average Power Laser Program

National Nuclear Security Administration
Office of Defense Programs

Coordinated, focussed, multi-lab effort to develop a rep-rate laser facility for Inertial Fusion Energy and DP needs

- **Based on direct drive with lasers**
- **Builds upon recent DP advances in lasers and target design**

Program Goals

National Nuclear Security Administration
Office of Defense Programs

Intermediate Term (five years)

R & D to develop required science & technology
(*Mission Oriented Science*)

Long term (ten years)

Build the Integrated Research Experiment

1. Cryogenic, layered target can be injected into a fusion chamber environment. And survive.

2. A high energy laser beam line (e.g. 50-100 kJ) can be steered to hit the target.

3. System operates with the efficiency, durability, uniformity and & precision required for Inertial Fusion Energy.

The Program Elements

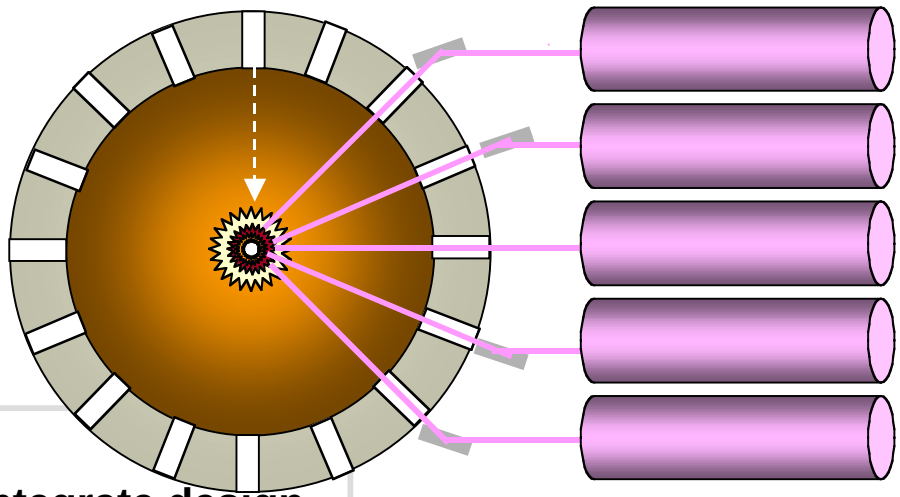
National Nuclear Security Administration
Office of Defense Programs

1. **Direct Drive Target Designs**
   NRL- target design
   LLNL: Yield spectrum
   WISCONSIN: spectrum

Target factory

2. **Target Fabrication**
   GA: Fab, charac, mass production
   LANL: Adv mat, target fab, DT inv
   SCHAFER: Foams, cryo layering

3. **Target Injection**
   GA: Injector, Injection & Tracking
   LANL: Materials prop, thermal resp.



4. **Lasers**
   NRL: KrF
   LLNL: DPSSL

5. **Final Optics**
   LLNL: X-rays, ions, neutrons
   UCSD: Laser, debris mitigation
   LANL: Neutrons

6. **Chambers**
   WISCONSIN: Dry wall, integrate design
   LLNL: Other walls, neutron damage
   UCSD: Chamber clearing, materials
   SNL et al: Materials resp x-rays / ions
   ORNL/UCLA: materials

Objectives of the February 6-7 Laser IFE Workshop at NRL

National Nuclear Security Administration
Office of Defense Programs

Present Program Plan for FY 2001…..

A. Deliverables and statement of work

B. Technical discussion of the program plan

1. **Ensure we are all working in an integrated coordinated manner**

2. **Update on latest advances**

Agenda for Laser IFE Program Workshop
Tuesday Morning, February 6, 2001

National Nuclear Security Administration
Office of Defense Programs

8:00 - 8:30	Coffee & Bagels		
INTRODUCTION			
8:30 - 9:00	Objectives of this workshop	J. Sethian	(NRL)
LASERS			
9:00 - 9:30	Mercury Diode Pumped Solid State Laser Program	C. Bibeau	(LLNL)
9:30 - 10:00	Electra KrF Laser Program	J. Sethian	(NRL)
10:00-10:15	**BREAK**		
TARGETS			
10:15-10:30	High Gain Target Designs for IFE (DP)	A. Schmitt	(NRL)
10:30-11:15	Target Fabrication - GA		
	Overview of proposed GA tasks	D. Goodin	(GA)
	High volume filling	N. Alexander	(GA)
	Target Manufacturing cost issues & QC	J. Sauerwein	(GA)
11:15-12:00	Target Fabrication-LANL		
	Mass production	A. Nobile	(LANL)
	Tritium inventory issues	A. Schwendt	(LANL)
	Methods for fabricating foam capsules	W. Steckle	(LANL)

Agenda for Laser IFE Program Workshop
Tuesday Afternoon, February 6, 2001

National Nuclear Security Administration
Office of Defense Programs

12:00-13:00	**LUNCH**	
13:00-13:30	Advanced foam shell production	D. Schroen-Carey (Schafer)
13:30-14:00	Cryogenic layering	D. Bittner (Schafer)

TARGET INJECTION

14:00-14:30	Overview of proposed GA tasks	D. Goodin (GA)
	Design of Injection & tracking system	R. Petzold (GA)
14:30-15:00	Cryogenic DT Thermal response experiments	J. Hoffer (LANL)

FINAL OPTICS

15:00-15:30	Radiation Hard Final Optics	S. Payne (LLNL)
15:30-16:00	Laser Damage and Effects of Debris	M. Tillack (UCSD)
16:00-16:30	Neutron exposure of components	S. Wilms (LANL)
16:30-16:45	Laser-Induced damage to IFE Final Optics (OFES)	N. Ghoniem (UCLA)

TOUR

17:00-18:00	Ribbon cutting for ELECTRA Laser	Dr. T. Coffey (NRL) Capt. D. Rau (NRL) Dr. B.B. Rath (NRL)

Agenda for Laser IFE Program Workshop
Wednesday Morning, February 7, 2001

National Nuclear Security Administration
Office of Defense Programs

8:00-8:30	Coffee & Pastries	
CHAMBERS		
8:30-9:15	Chambers	G. Kulcinski (Wisconsin) R. Peterson (Wisconsin) D. Haynes (Wisconsin)
9:15-9:45	Chamber clearing	F.Najmabadi (UCSD)
9:45 - 10:00	**BREAK**	
10:00-10:30	Chamber Studies	W. Meier (LLNL)
10:30-11:00	Chamber materials response program	C. Olson (Sandia)
11:00- 11:15	C-C Composites (OFES)	L. Snead (ORNL)
FINALE		
11:15-12:00	Action Items / plans	All
12:00	**ADJOURN**	**All**

ELECTRA

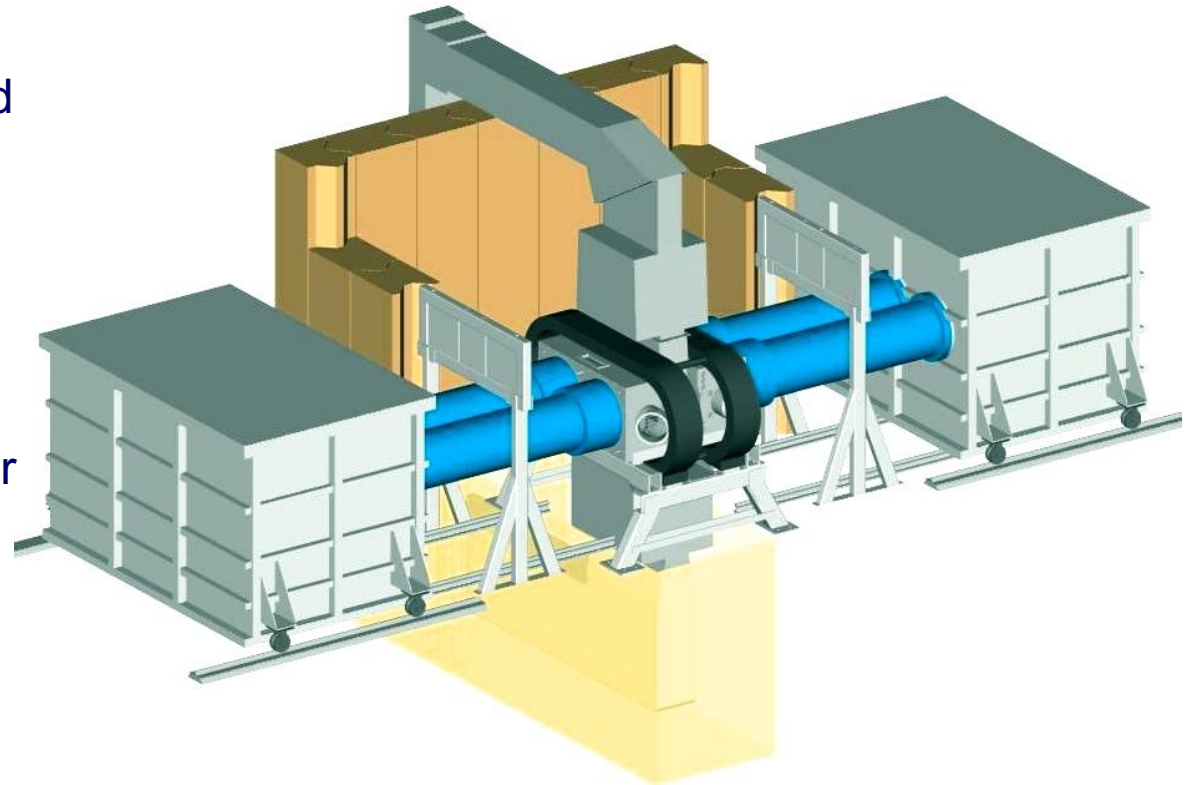
National Nuclear Security Administration
Office of Defense Programs

Overall Objective……

- Develop technologies for low cost, durable and efficient rep-rate KrF laser.
- Technologies will be integrated into a 700 J, 5 Hz laser called ELECTRA.
- Technologies scalable to large (50-150 kJ)systems

FY 01 Deliverables……..

1. Develop cathode, hibachi and gas recirculator
2. Advanced pulsed power component dev.
3. KrF Physics research to maximize efficiency
4. Optics development (amplifier window)
5. Design Advanced Front End (input laser)



The Electra KrF Laser Program Plan (NRL)

ELECTRA LASER ***(700 J, 30 cm, 5 Hz KrF Laser)***

First Generation Pulsed Power	Develop Laser components: Emitter, Hibachi, Gas Recirculator	Input Laser	Integrated Test

ADVANCED PULSED POWER

Systems Designs	Component R & D, Component test and evaluation	Design / Build Advanced System	Integrate into Electra

ADV FRONT END ***(pulse shape/zooming)***

Design	Build and Test	Integrate into Electra

KrF PHYSICS (***optimize efficiency & develop design tools***)

Electron beam propagation & KrF Kinetics/ASE Codes	Code integration

Experimental Validation

OPTICS DEVELOPMENT

Amp Window Coating Development	Steering/focussing Optics

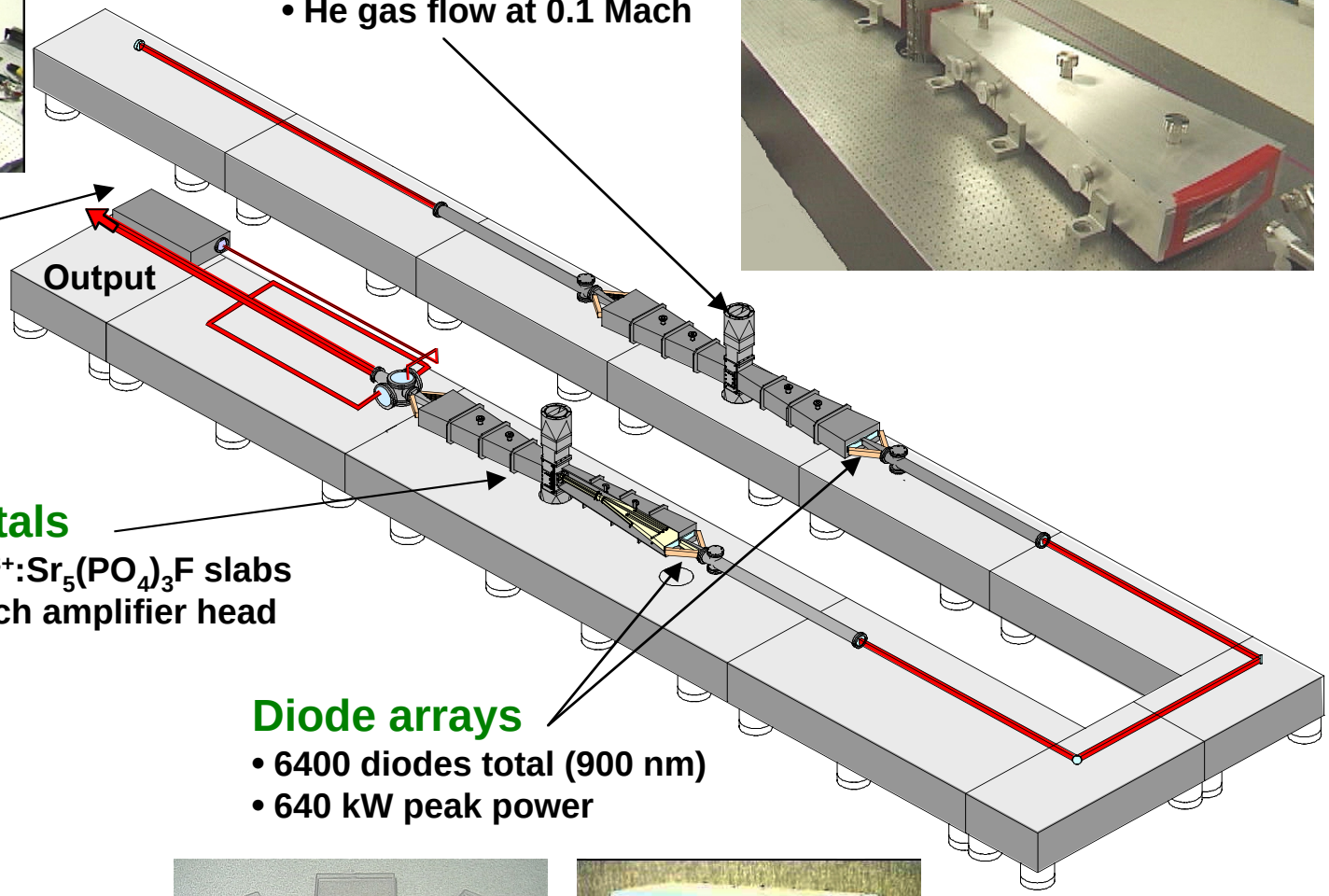
KrF SYSTEMS ***(architecture for 2 MJ system)***

Optimum Amplifier Size	Architecture Optimization

FY 1999 | FY 2000 | FY 2001 | FY 2002 | FY 2003 | FY 2004 | FY2005

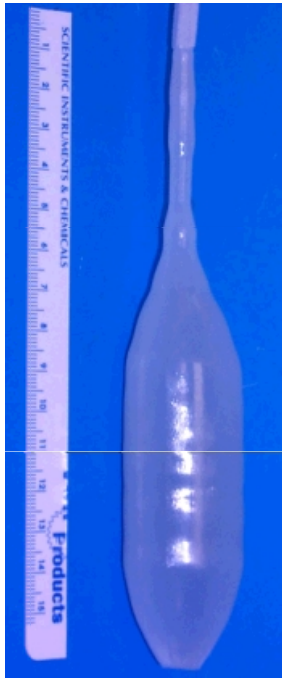
Gas-cooled amplifier heads

- He gas flow at 0.1 Mach



Front-end

- 300 mJ, M^2=1.8

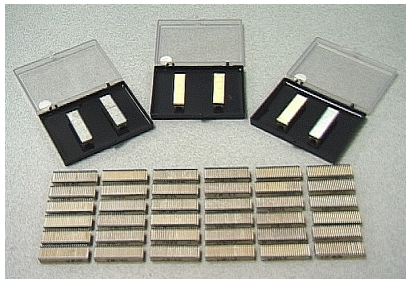


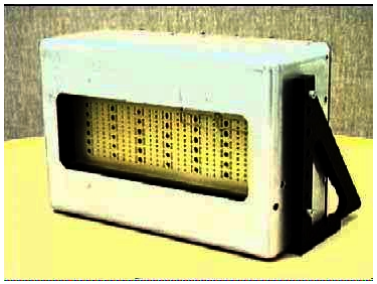
Crystals

- 7 $Yb^{3+}:Sr_5(PO_4)_3F$ slabs in each amplifier head

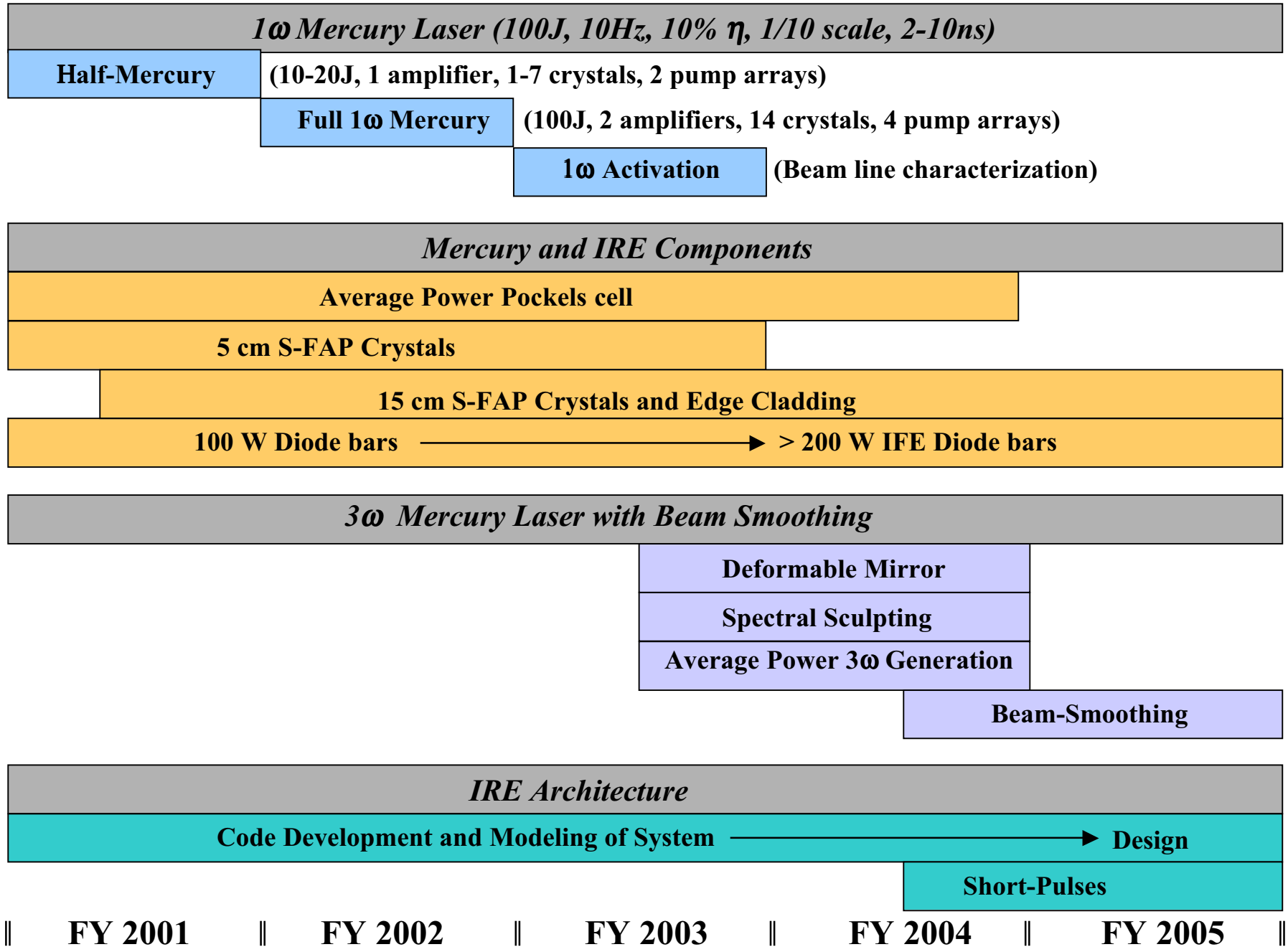
Diode arrays

- 6400 diodes total (900 nm)
- 640 kW peak power

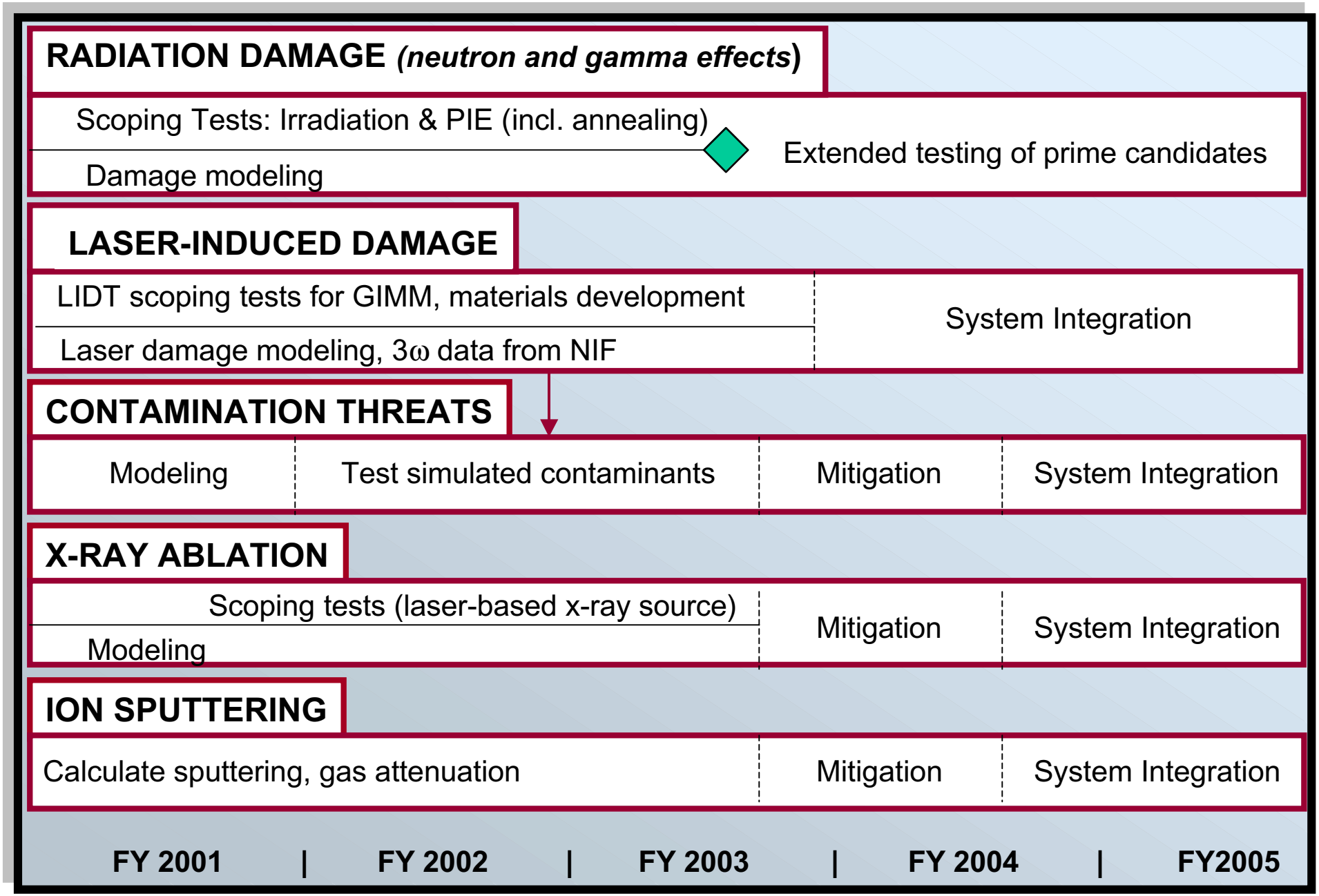
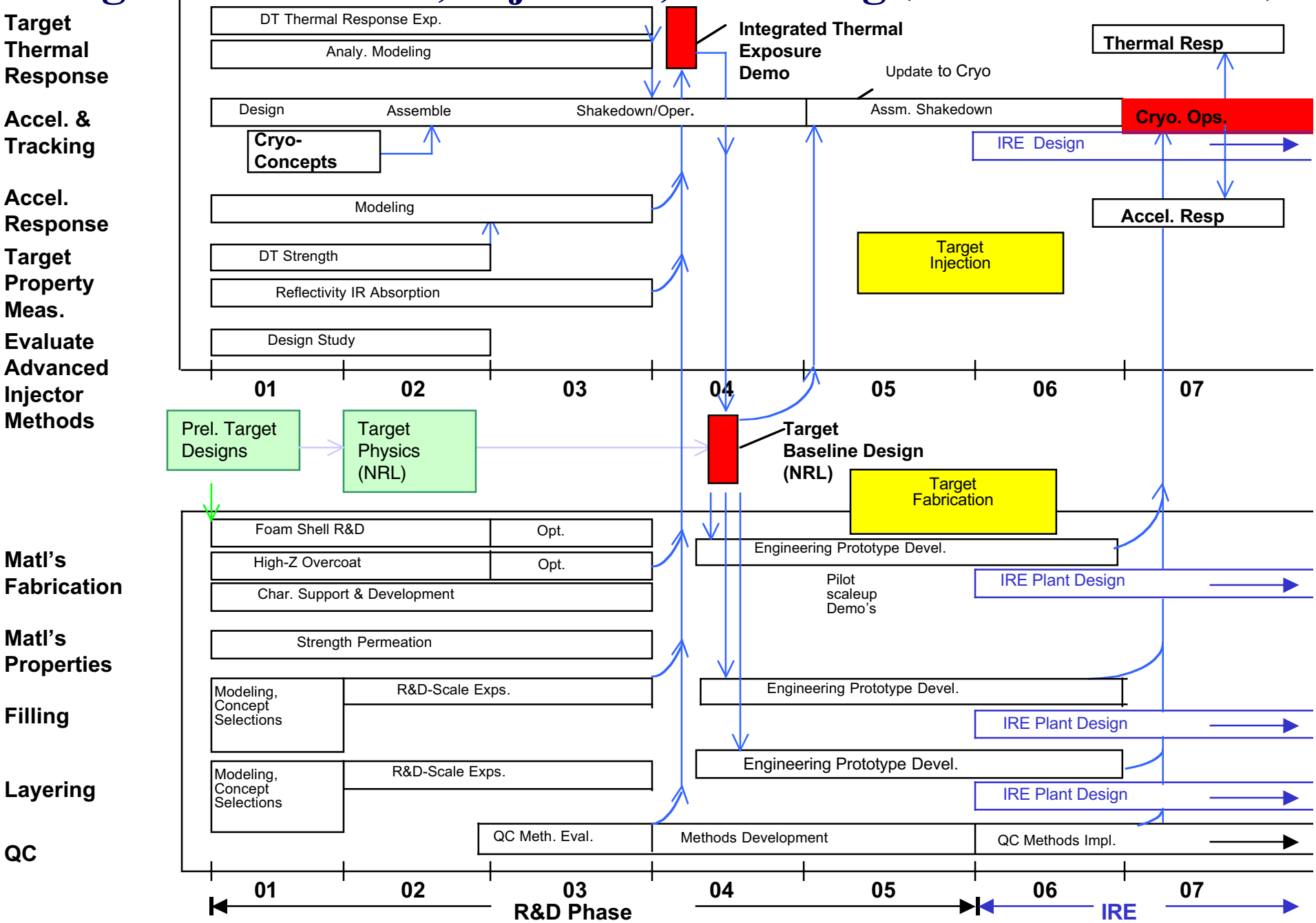




The 5 Year Plan for Mercury Laser Development



Final Optics Program Plan (UCSD +LLNL)



Target Fabrication, Injection, Tracking (GA + LANL + Schafer)