

LIFE

Pathway from the National Ignition Facility to an operational LIFE power plant

Presentation to
AAAS 2013 Annual Meeting
February 14-18, 2013, Boston

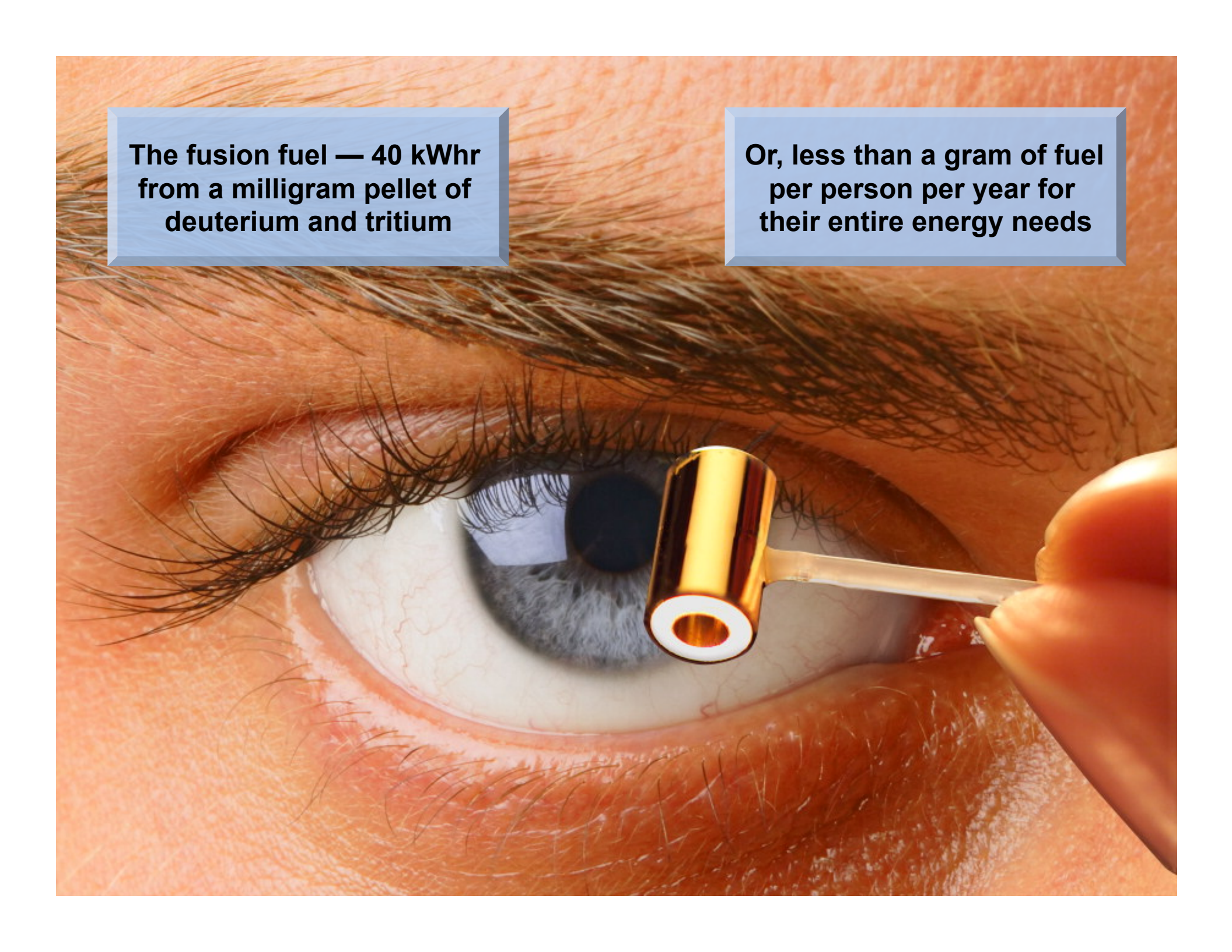
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Lawrence Livermore National Laboratory • Laser Inertial Fusion Energy

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

**NIF can demonstrate
full-scale performance
for a power plant based
on Laser Inertial Fusion
Energy (LIFE)**

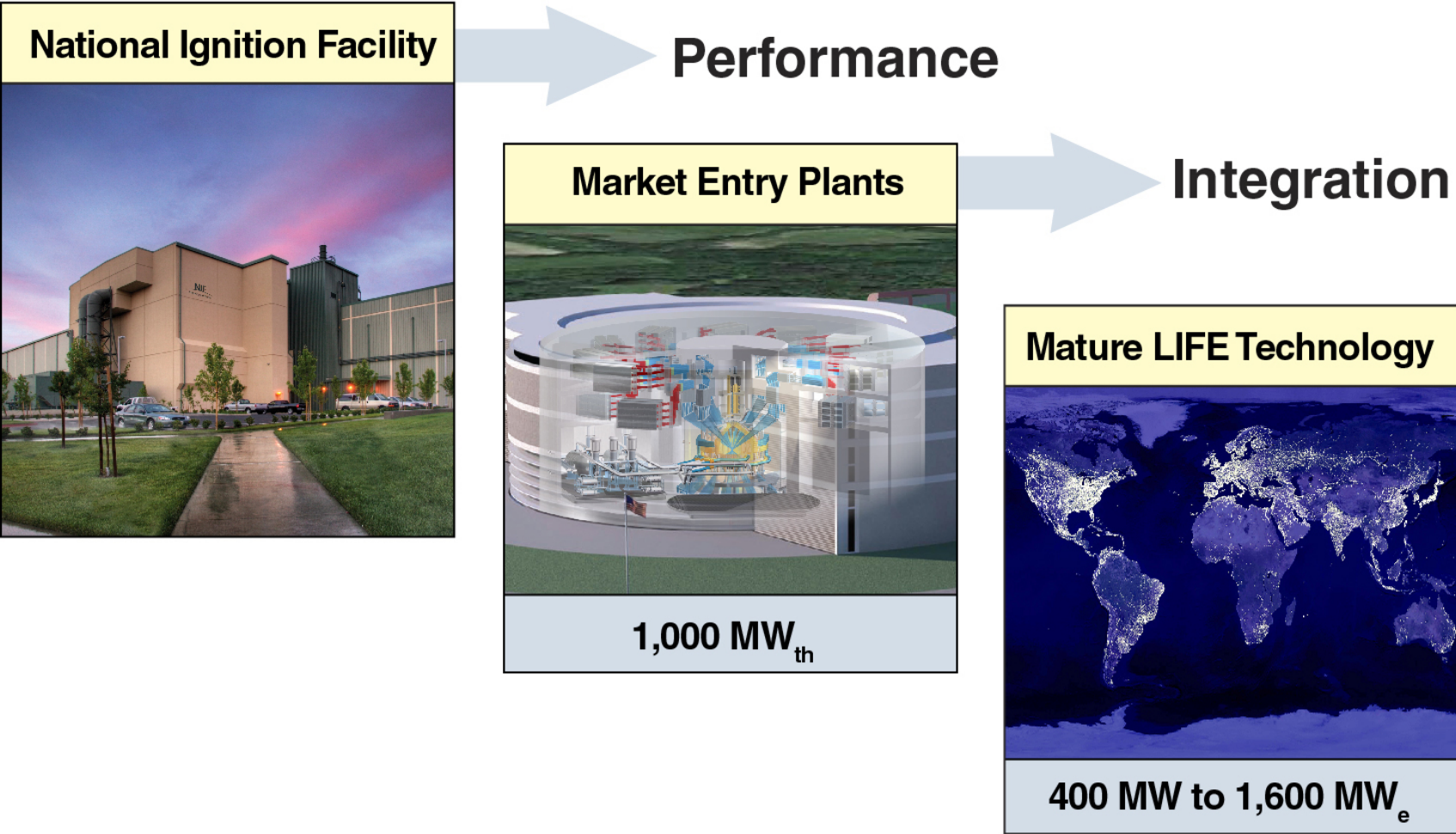




**The fusion fuel — 40 kWhr
from a milligram pellet of
deuterium and tritium**

**Or, less than a gram of fuel
per person per year for
their entire energy needs**

The next step, after NIF, is construction of a full-scale power plant





LIFE: An integrated approach to plant design

- **Based directly on NIF performance**
- **Modular, factory built design for high plant availability**
- **Use of available materials and technologies**
- **Attractive safety bases enabling simplified licensing**

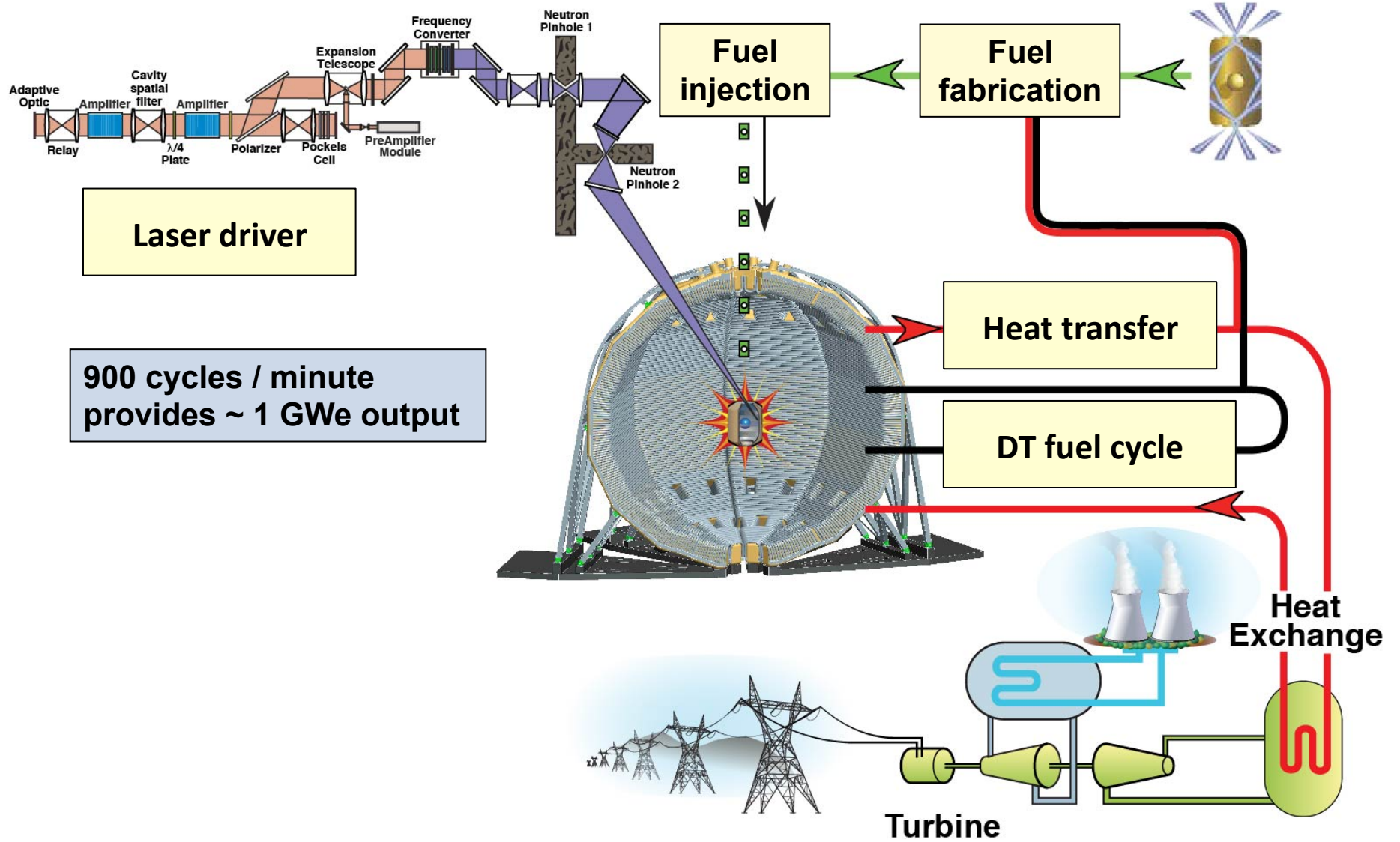
Industrial partnerships

Utility requirements	Industry investments	Quantitative impact on industry, jobs
<p>CEO / COO / CNOs from:</p> <ul style="list-style-type: none"> • Exelon • Dominion • Entergy • Mid America • Pinnacle West • PG&E • Southern Company • Wisconsin Energy • SSEB 	<p>Power Plant Vendors</p> <p>Laser diode vendors</p> <p>Laser and optics vendors</p> <p>A&E construction firms</p> <p>Gas processing</p> <p>Remote Handling</p> <p>Control Systems</p> <p>Petrochemical industry</p>	<p>Recent independent analyses show that the impact for purely domestic market could lead to:</p> <ul style="list-style-type: none"> • 17 to 47 B\$ / year GDP • 155 to 425,000 jobs • 4 to 12 B\$ pa tax revenue <p>Comparable to the aircraft manufacturing or machine tools industries</p>

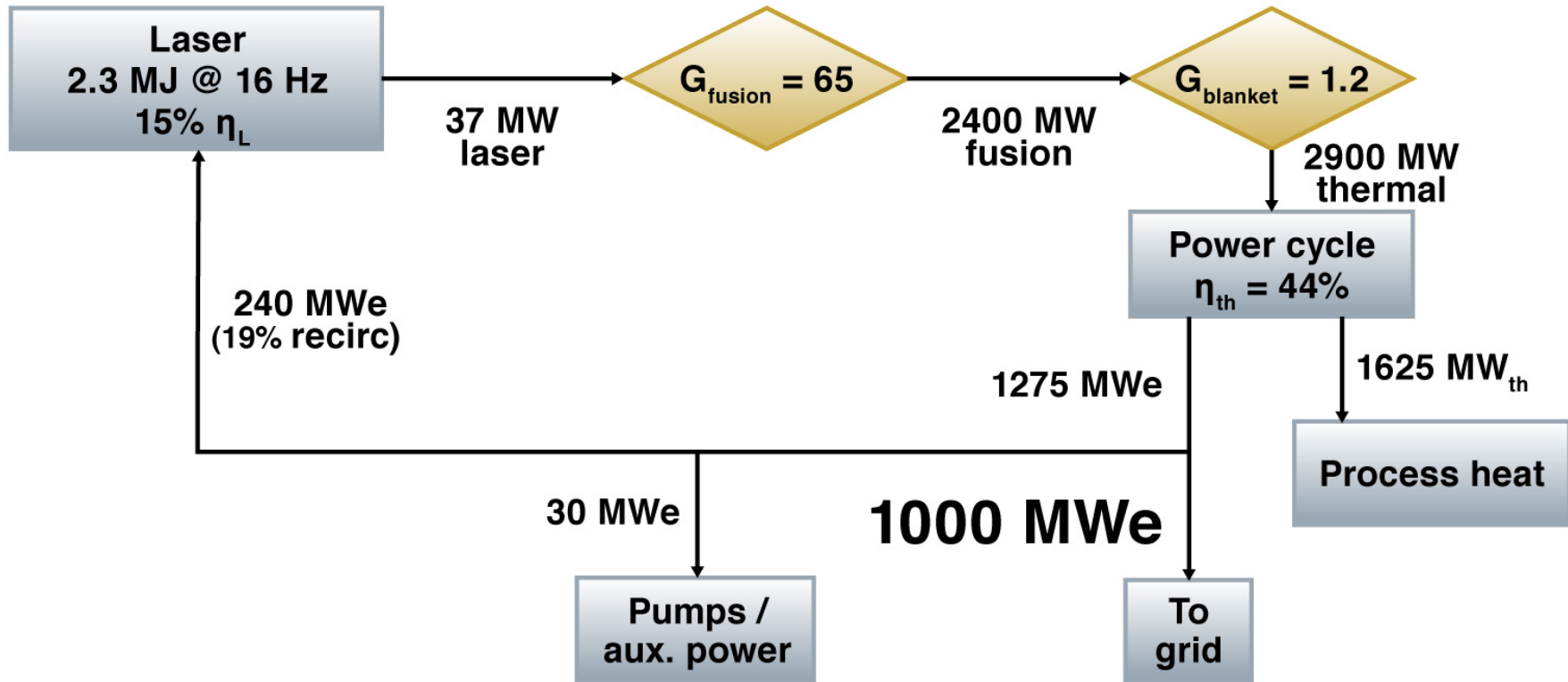
Delivery will need to be via a Public-Private-Partnership that provides for near-term market impact and commercial plant delivery



Principle of LIFE plant operation

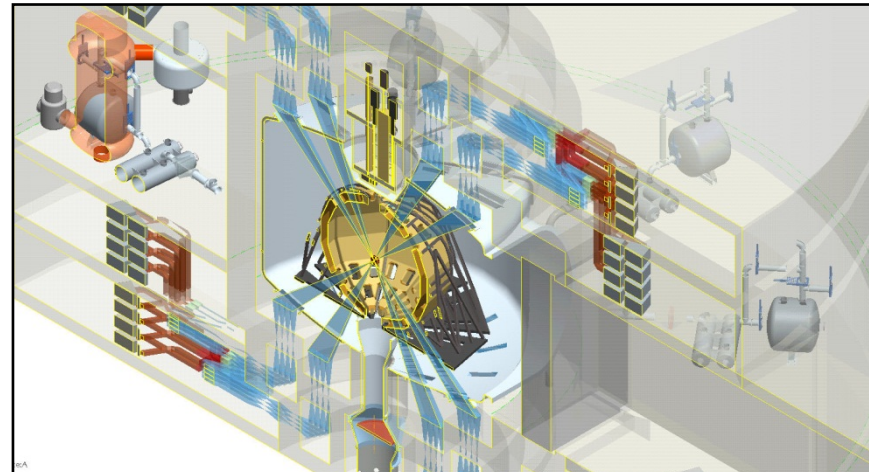
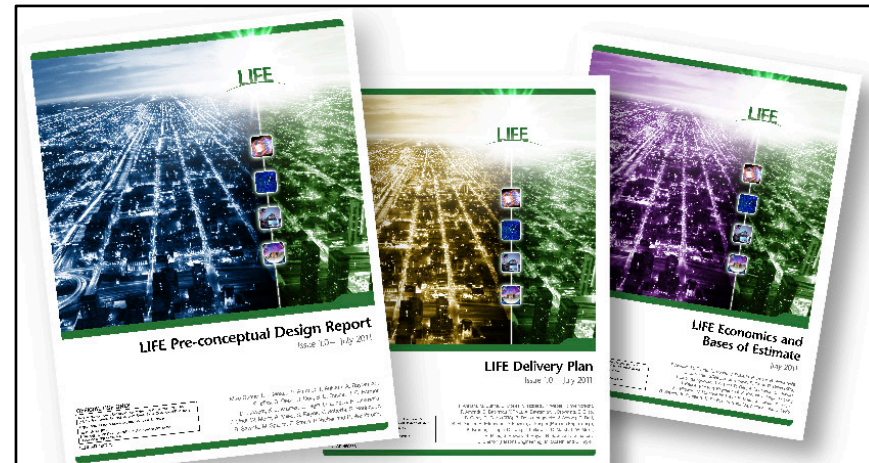


LIFE Power Balance (example)



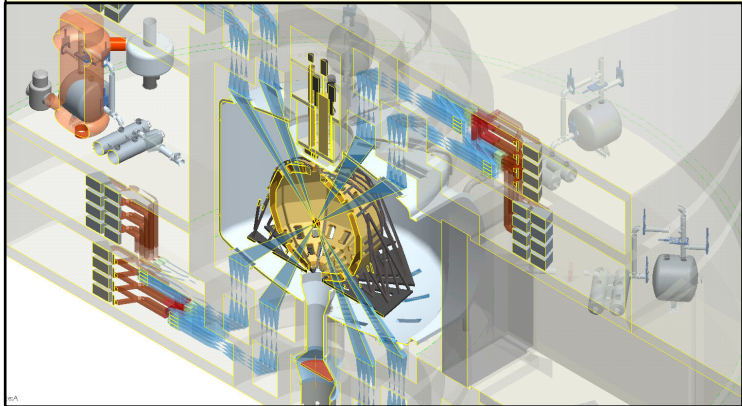
LIFE power plant – design and delivery

- LIFE power plant site design established, working with Parsons Engineering on plant layout, cost, schedule, operations and maintenance, and with over 30 vendors on sub-system performance, readiness and cost.
- Initial safety assessment completed, representing a key element of the LIFE value proposition.
- Industry executive board from major US electrical utilities to guide the project from an end-user (power production) perspective

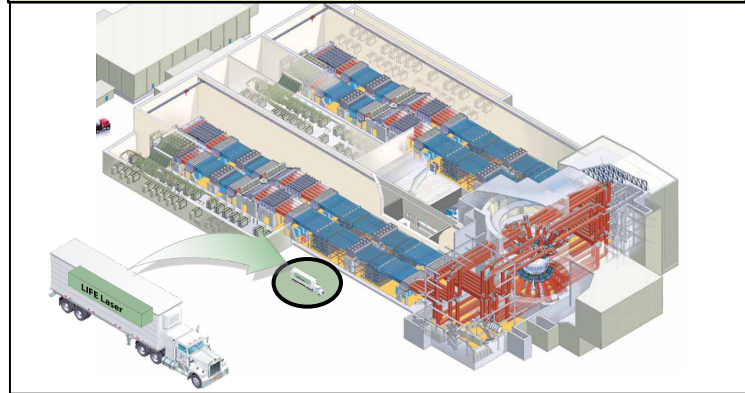


The LIFE design addresses the long-standing science and technology challenges for IFE

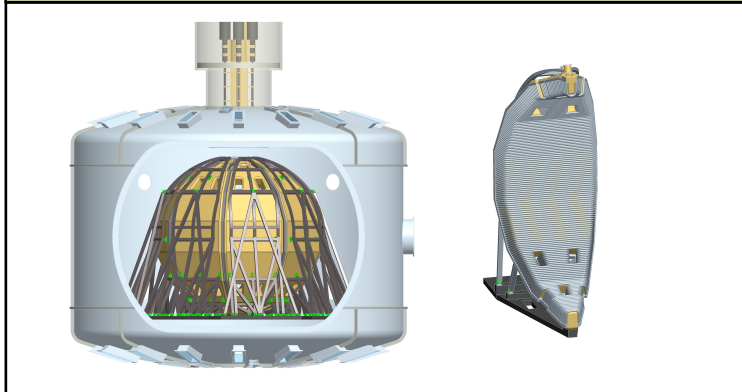
Modular, accessible architecture for high plant availability



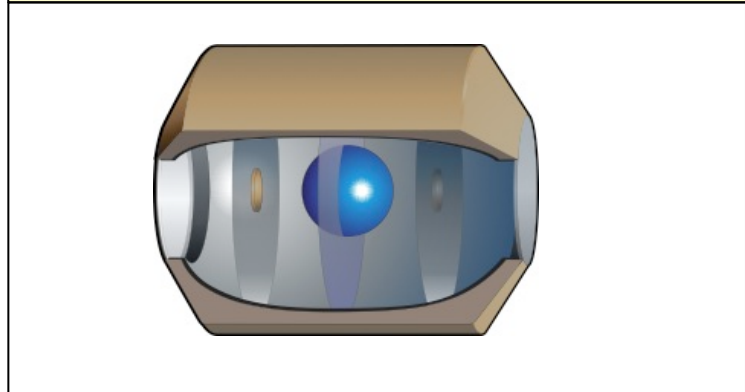
Compact, affordable, efficient diode-pumped laser system



Replaceable, unsealed chamber using conventional materials

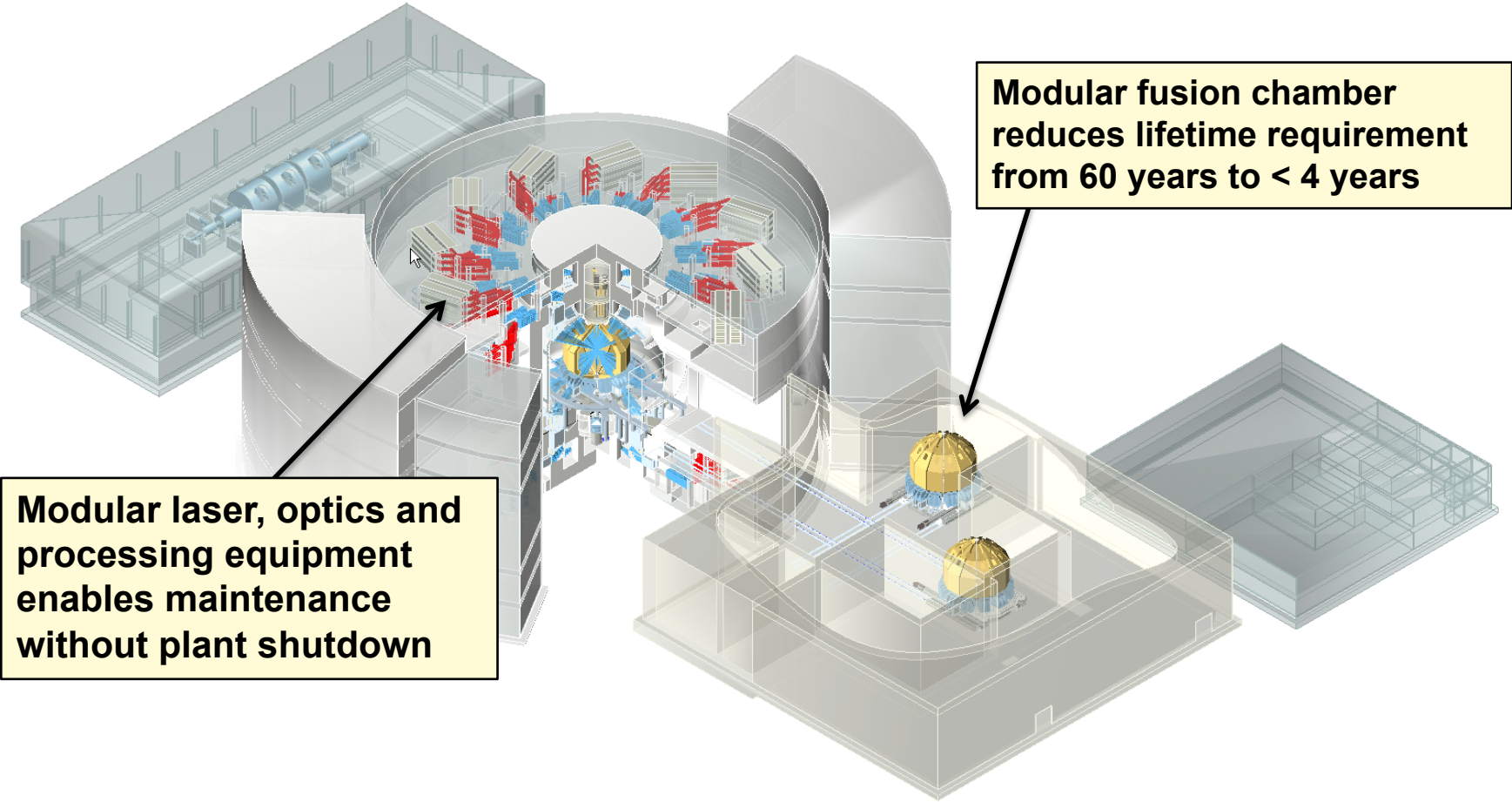


NIF-based fusion performance, with low tritium inventory in the plant





NIF performance, and LIFE's modular architecture is what enables commercialization in a relevant timeframe



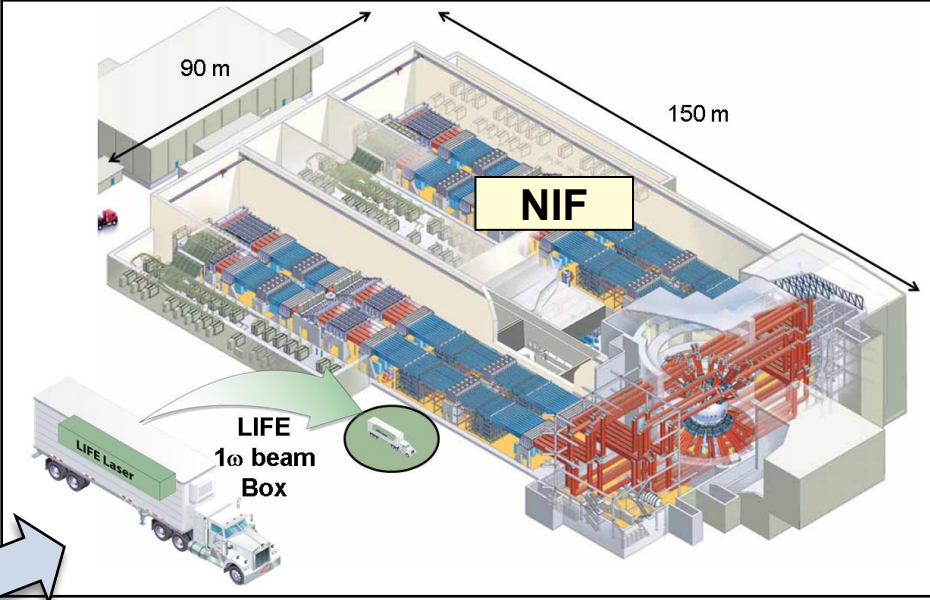
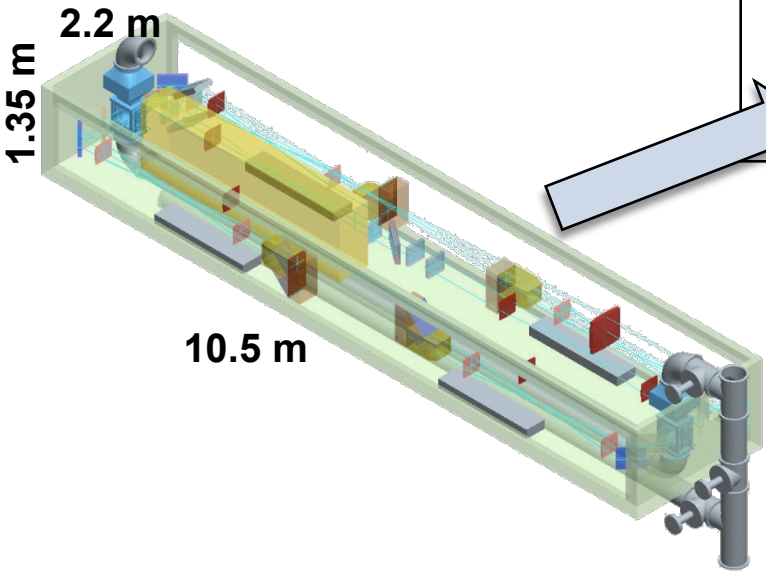
Modular fusion chamber reduces lifetime requirement from 60 years to < 4 years

Modular laser, optics and processing equipment enables maintenance without plant shutdown

Fusion chamber can use conventional steel rather than wait for new radiation-resistant alloys to be developed

A LIFE beamline folds into a transportable box, enabling an efficient & cost-effective supply chain

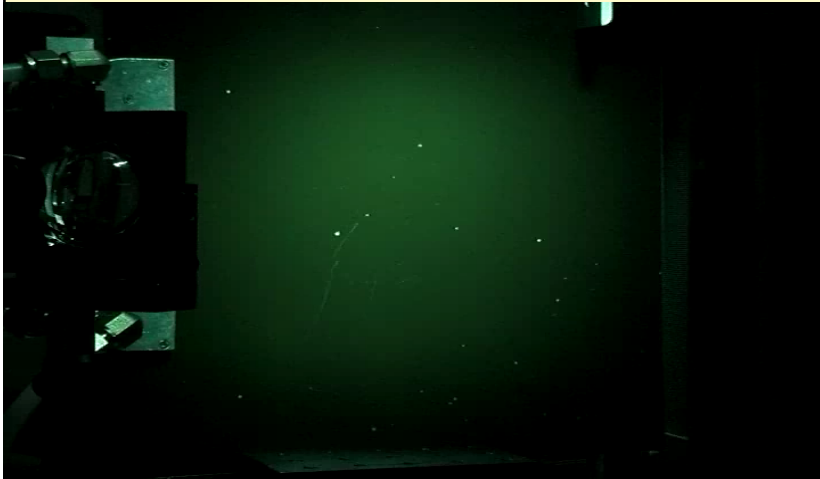
Ability to “hot swap” beamlines during plant operations.



- Offsite beamline factory
- Truck-shippable 1 ω beamline
- Low-overhead installation
 - Kinematic placement
 - Few interfaces

The underpinning laser architecture has been developed for a range of other activities

65 kW high average power laser



24/7 operational laser (AVLIS)

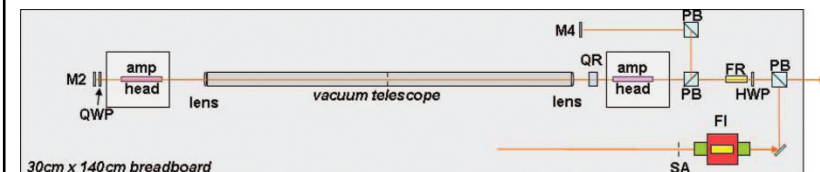
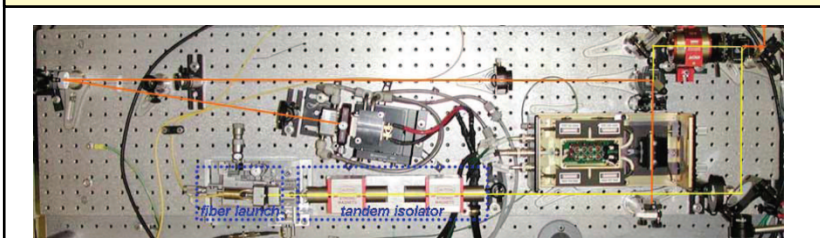


10 Hz laser fusion technology



A.J. Bayramian et. al, *Fusion Sci. Tech.* 52, 383 (2007)

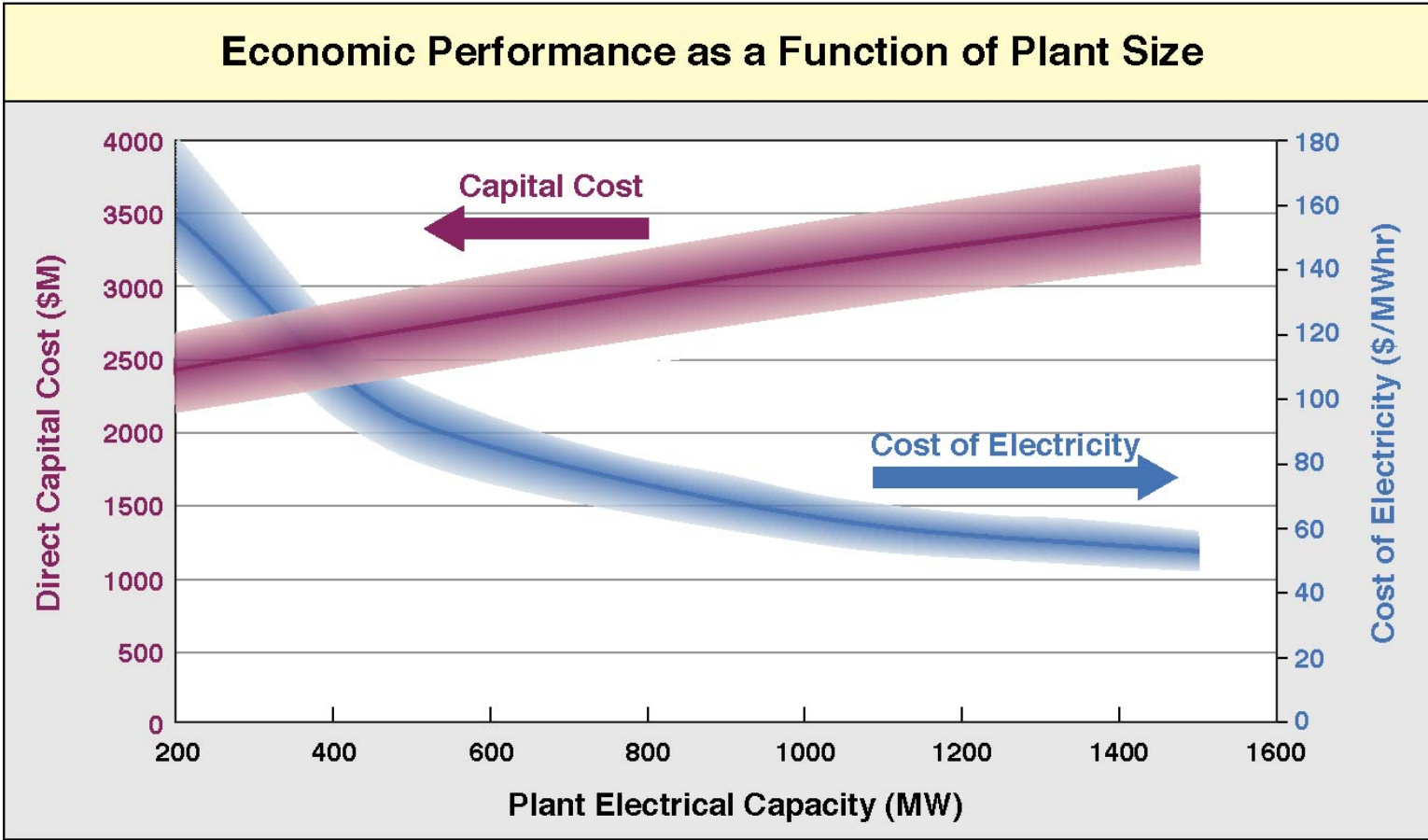
300 Hz laser architecture



30cm x 140cm breadboard
J. Honig, et. al, *Appl. Opt.* 46, 3269 (2007)

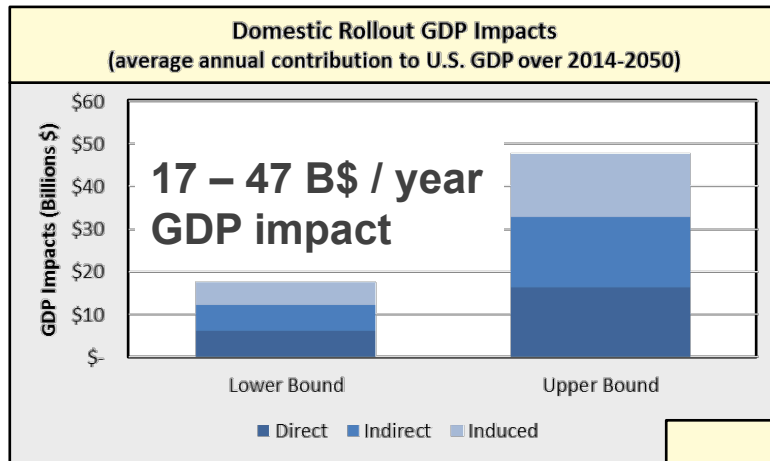


LIFE is economically viable over a range of plant sizes





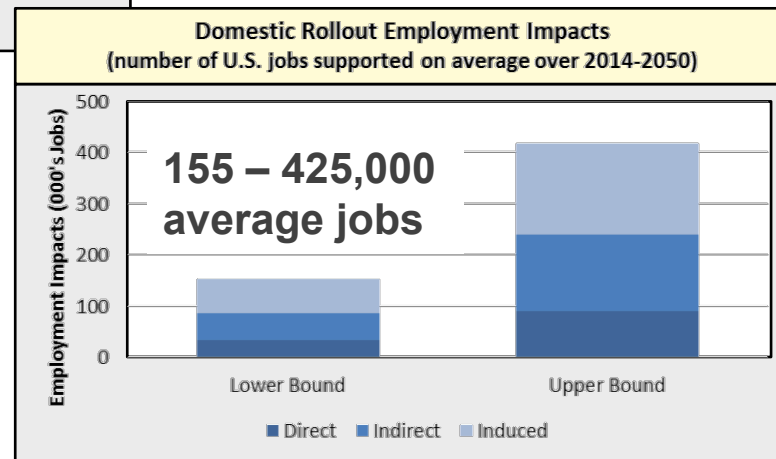
Oxford Economics have calculated the potential impact of domestic rollout on GDP and new jobs



- 4 to 12 B\$ annual federal and state tax revenue
- Substantial jobs impact in the high-tech sector

Similar industrial scale to:

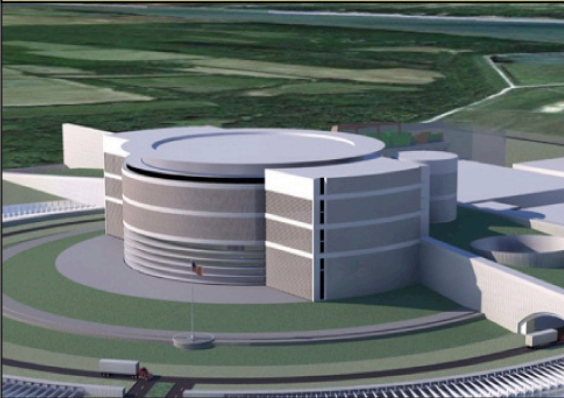
- Aircraft manufacturing (230,000)
- Machine shops (246,000)
- Semiconductor manufacturing (182,000)



Low / High scenarios are for 10 or 5 year doubling times

We have been consulting with a range of environmental groups on the sustainability of LIFE

Compact land use



Minimal water use



Abundant, distributed fuel



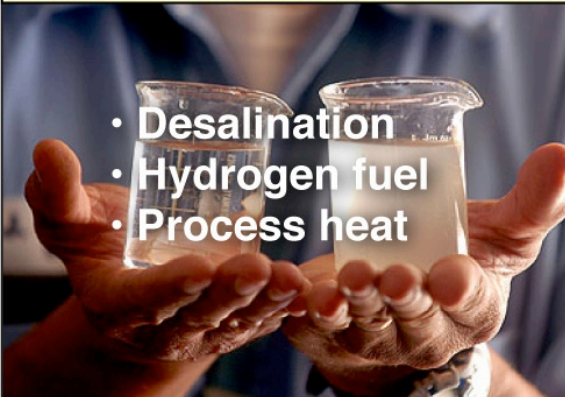
CO₂ free



No toxic emissions



Efficient use of power



Achieving ignition on NIF can be a defining moment for the world's energy future



LIFE

