Omega Facility Overview
Progress on 2009 OLUG Recommendations

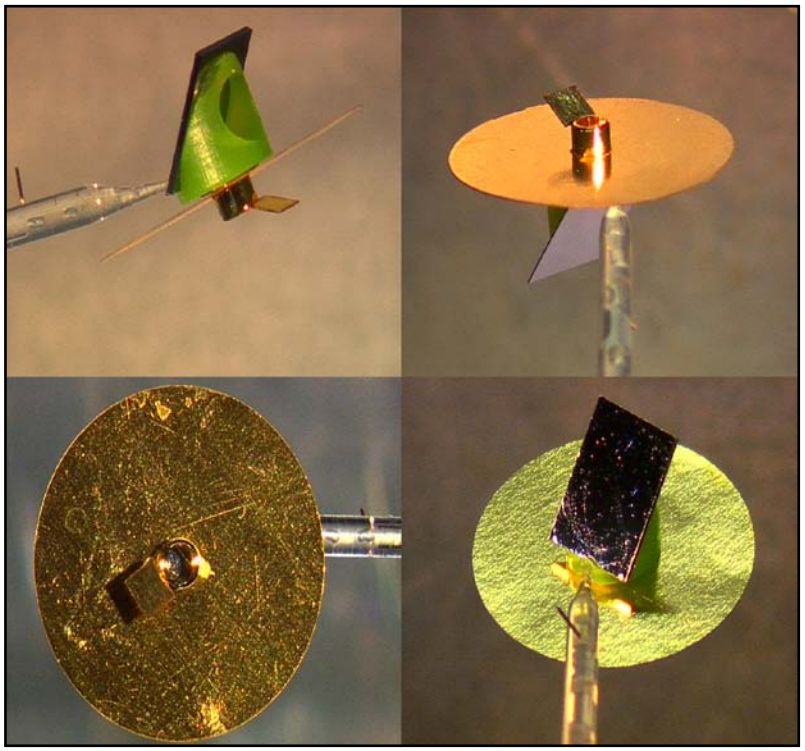
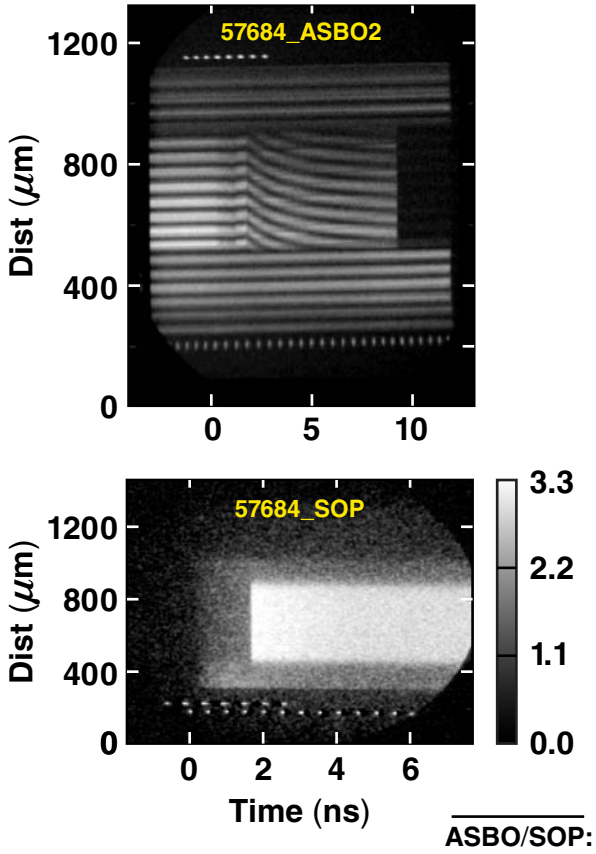


Photo credit: Richard Seugling



ASBO/SOP: H. S. Park

S. F. B. Morse
Omega Facility Division Director
University of Rochester
Laboratory for Laser Energetics

Omega Laser Facility
Users' Group Workshop
Rochester, NY
28–30 April 2010

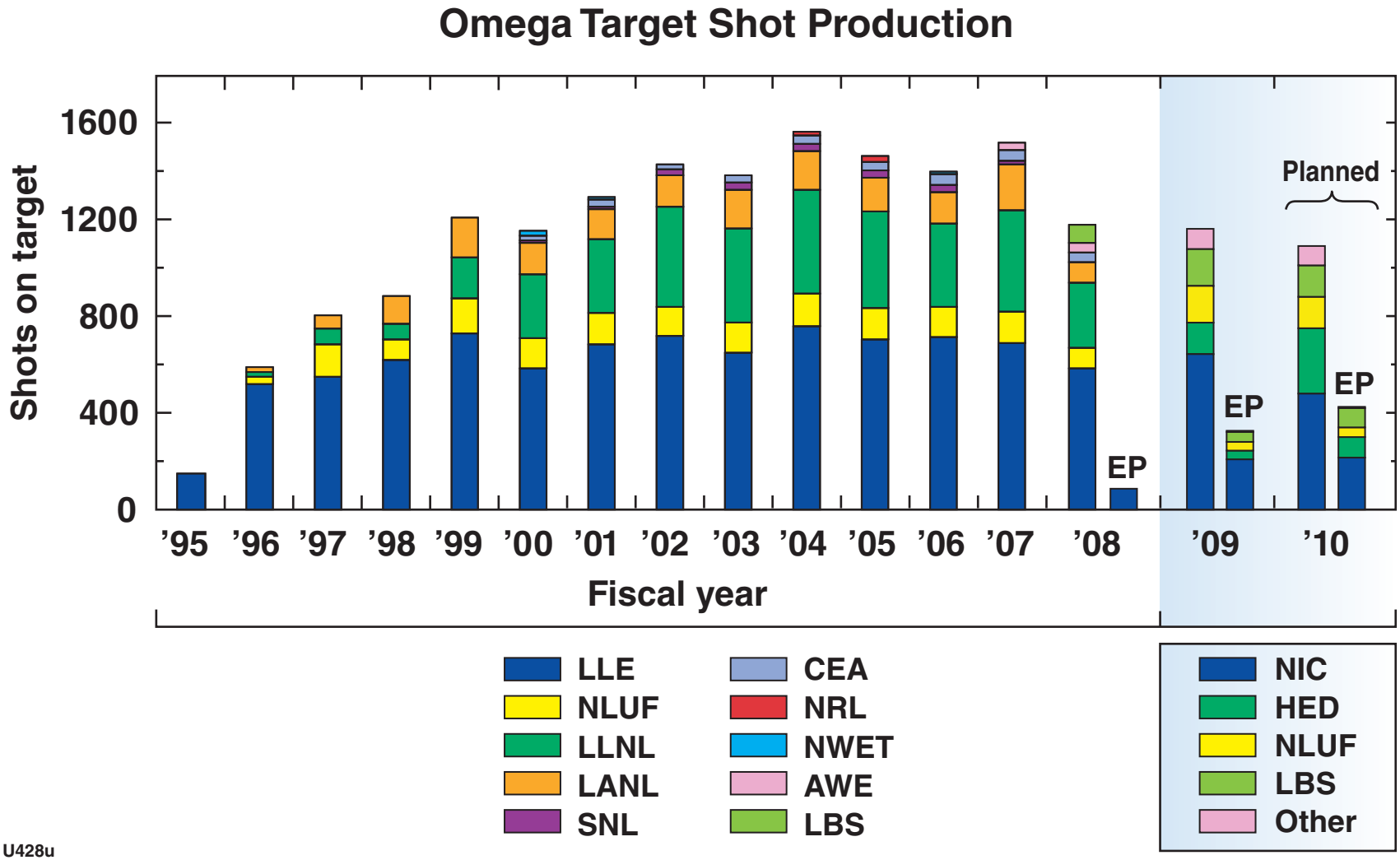
Summary

Omega is a reliable platform for conducting experiments and benefits from a strong user community

UR LLE

- The Omega Facility is comprised of two coupled systems:
  - 60-beam OMEGA, completed in 1995
  - OMEGA Extended Performance (OMEGA EP), completed in 2008
  - more than >17,500 target shots have been performed on the Omega Laser Facility to date
- The Omega Facility is making progress on 2009 OLUG recommendations
- OMEGA EP extends the utility of OMEGA and was built leveraging significant elements from OMEGA and the NIF
- Features of OMEGA and OMEGA EP continually evolve to meet user requirements

Omega has conducted >17,500 experimental target shots



U428u

The Omega FY11 schedule is in development and will be completed in June 2010

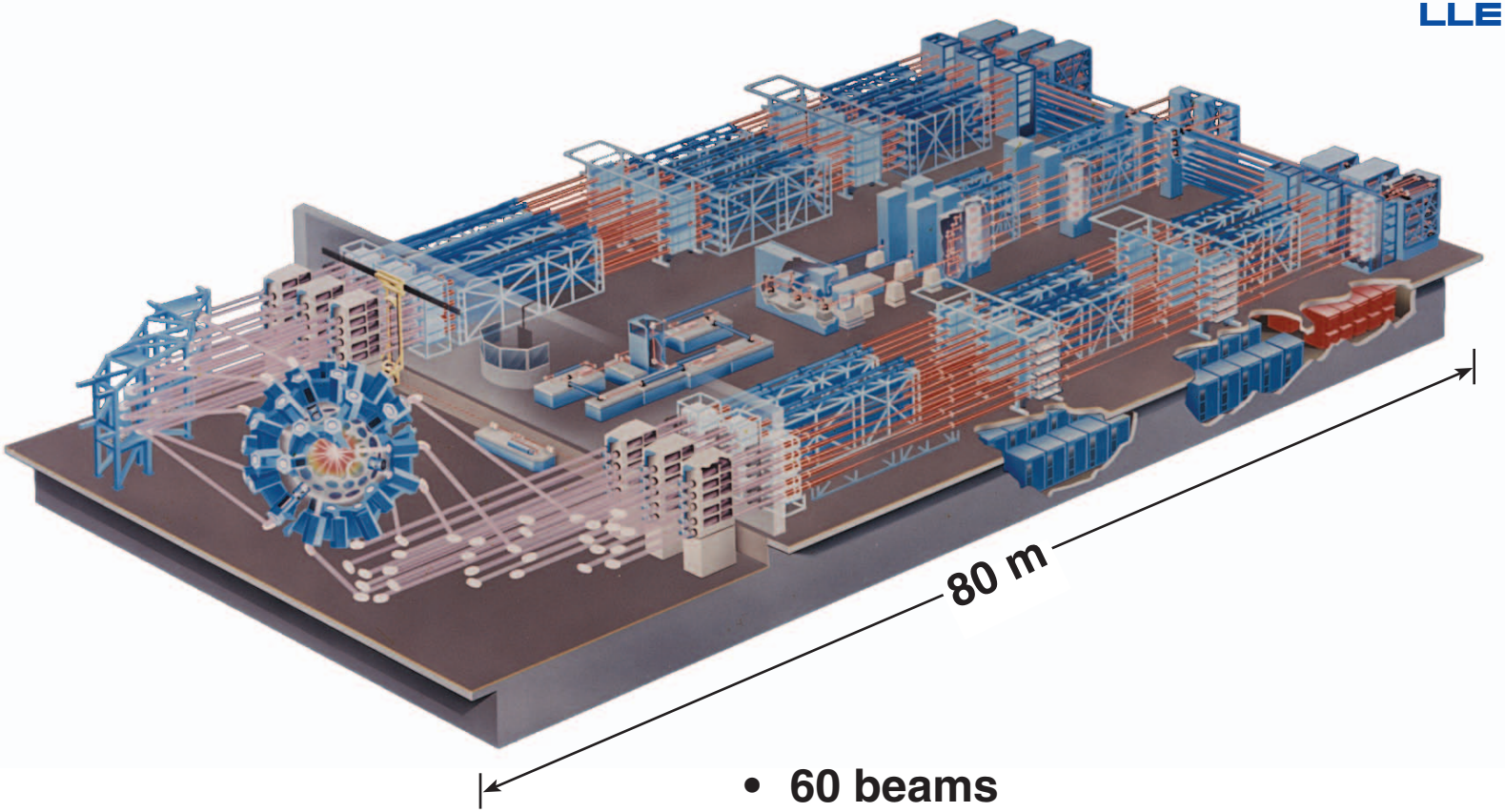
Category	Subdivision	FY11 Notional Allocation		
		%*	OMEGA days	OMEGA EP days
National Ignition Campaign		40	48	32
HED	LLNL and LANL	25	31	19
Basic Science	NLUF Laboratory	15 15	18 18	12 12
Contingency		5	6	4
Total		100	121	79

NOTE

- 1 day (12 h) of system time nominally produces 10 shots on OMEGA (7 on Cryo days) and 5 shots on OMEGA EP.

*Allocation recommended by FSAC in June 2009 and approved by LLE Director and NNSA.

The OMEGA laser is designed to achieve high irradiation uniformity with flexible pulse-shaping capability



- 60 beams
- >30-kJ UV on target
- 1% to 2% irradiation nonuniformity
- Flexible pulse shaping
- Short shot cycle (1 h)

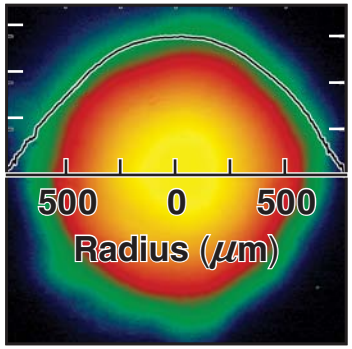
Fully instrumented with ~200 diagnostics

Successfully operated for 15 years

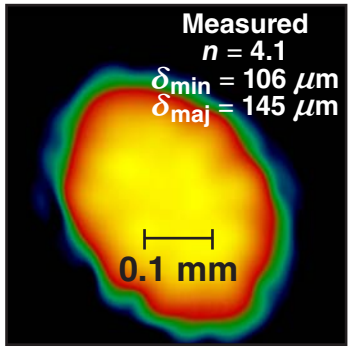
G8885b

A variety of irradiation conditions are available on OMEGA using phase plates, 2-D SSD beam smoothing, and polarization rotators

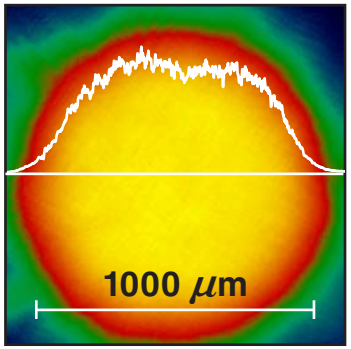
Direct-Drive Super-Gaussian



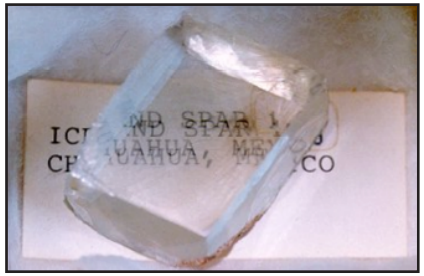
Indirect-Drive Elliptical



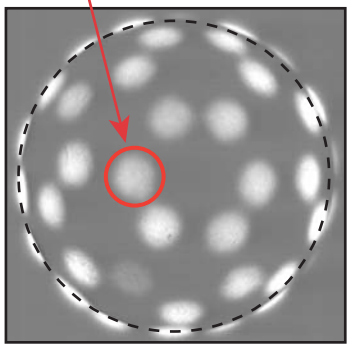
Backlighting/Specialty Super-Gaussian High Order (and others)



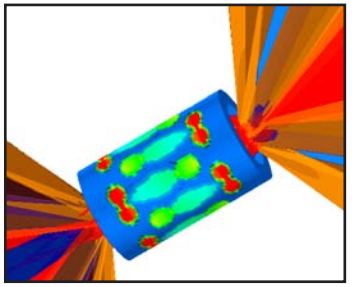
Polarization Rotators



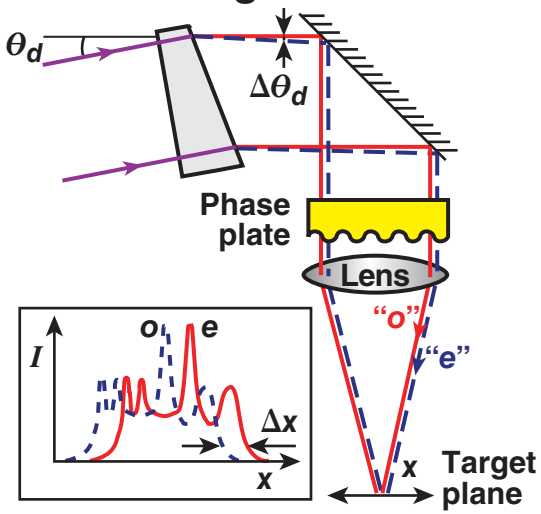
Direct-Drive Target Size



40 Beams PS26, ~14 kJ



Wedge of KDP

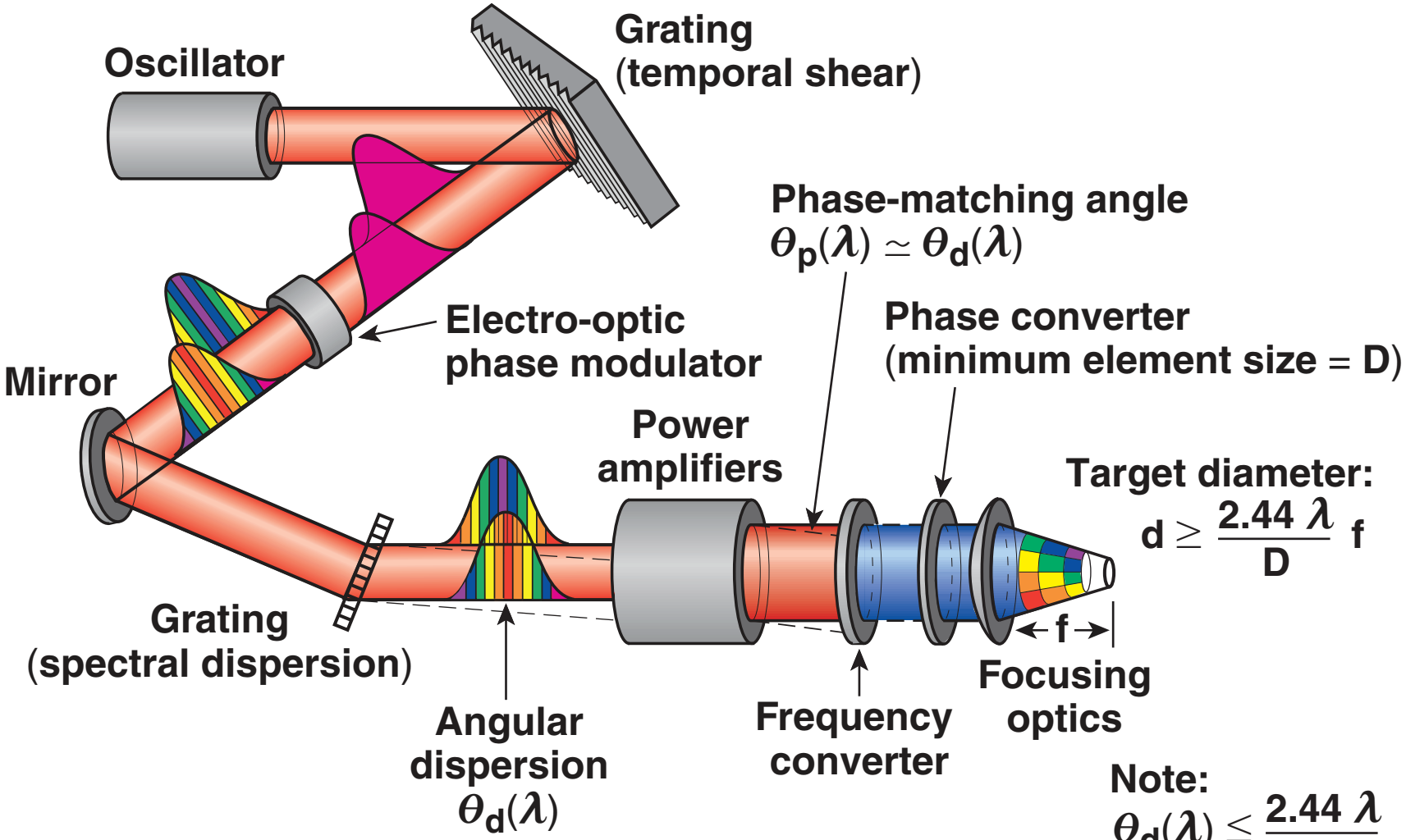


167 different phase plates are routinely used on OMEGA.

G8886b

SSD (smoothing by spectral dispersion) provides uniform target illumination for frequency-converted laser systems

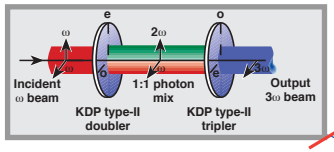
UR LLE



Irradiation conditions on OMEGA are driven by direct-drive uniformity and have evolved

UR LLE

1980: High-efficiency frequency tripling

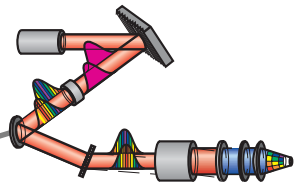


1980

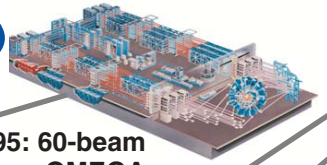
1981: 24-beam OMEGA

1985: OMEGA UV conversion

1989: Smoothing by spectral dispersion (SSD)

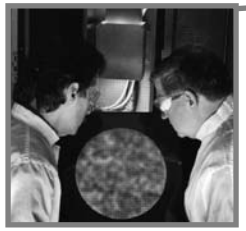


1990



1995: 60-beam OMEGA

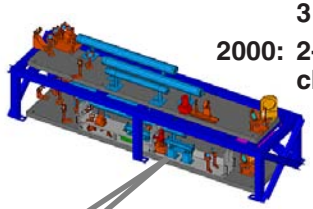
1996: Continuous phase DPP's



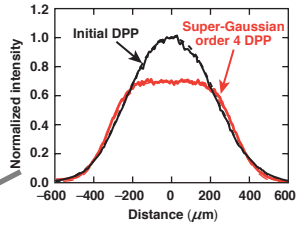
1996: Initial 2-D SSD

1999: 2-D SSD module installed in OMEGA, 3 color cycle

2000: 2-D SSD changed to THz

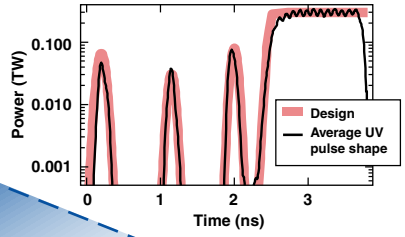


2003: SG4 DPP's

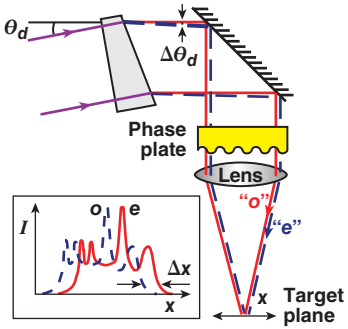


2000

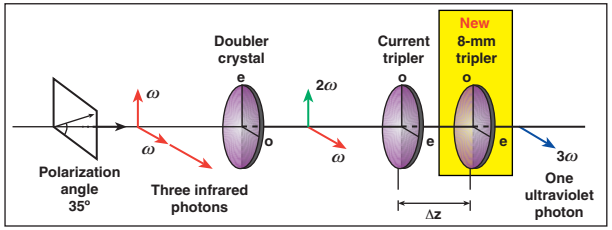
2008: Triple-picket adiabat shaping



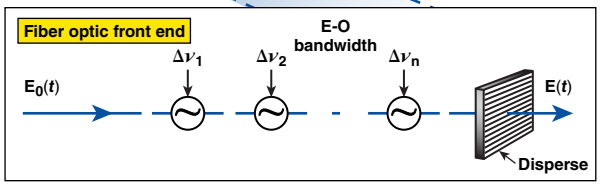
2001: Polarization smoothing



2000: Broadband frequency tripling



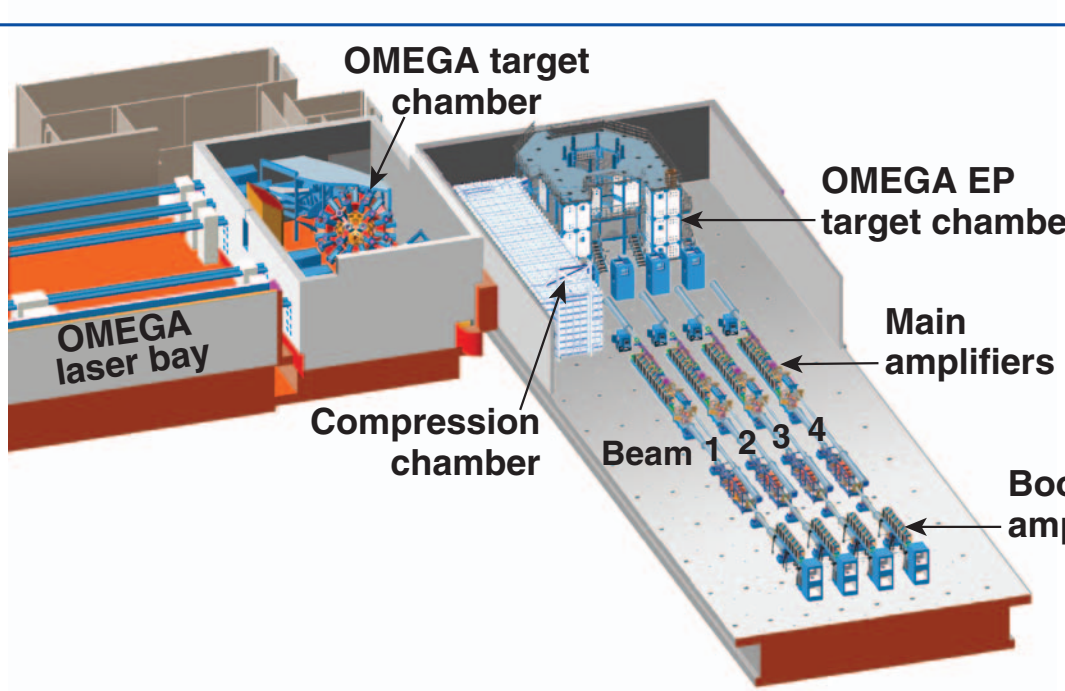
2010



Future: Multi-FM beam smoothing

S599b

OMEGA EP beamlines can be operated as short-pulse high-energy petawatt at 1.0 μm or long-pulse at 0.35 μm

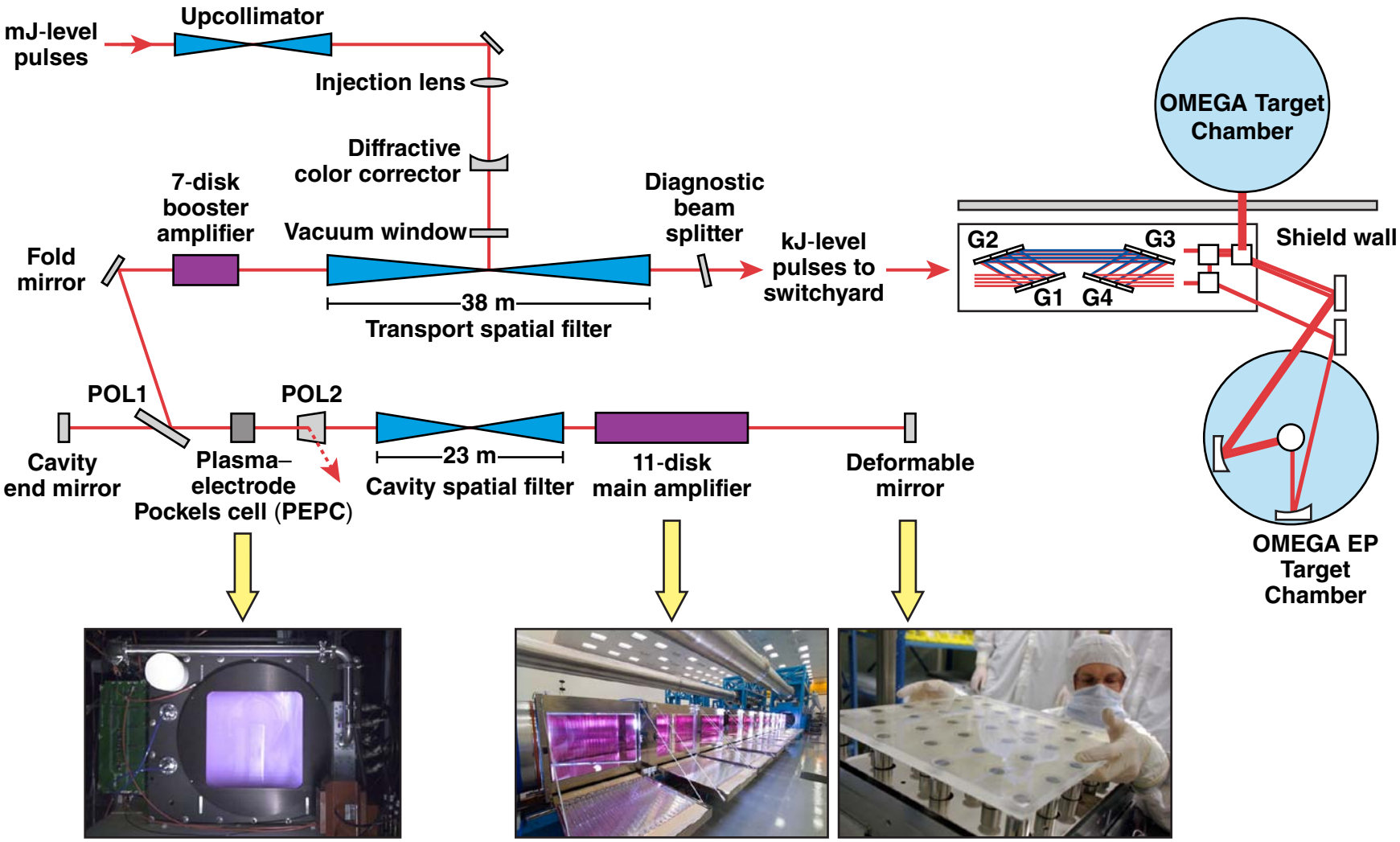


Performance capabilities	Short-pulse Beam 2	Short-pulse Beam 1	Long pulse (any beam)	
Wavelength	Infrared (1.0 μm)	Infrared (1.0 μm)	UV (0.35 μm)	
Pulse width	1 to 100 ps	1 to 100 ps	1 ns	10 ns
Energy on target (kJ)	2.6 kJ, 10–100 ps grating limited <10 ps	2.6 kJ, 80–100 ps beam combiner limited <80 ps	2.5	6.5
Intensity (W/cm^2)	3×10^{20}	~2×10^{18}	3×10^{16}	8×10^{15}
Focusing (diam)	>80% in 20 μm	>80% in 40 μm	>80% in 100 μm	

Short-pulse beams can be directed either to OMEGA or to the OMEGA EP target chamber.

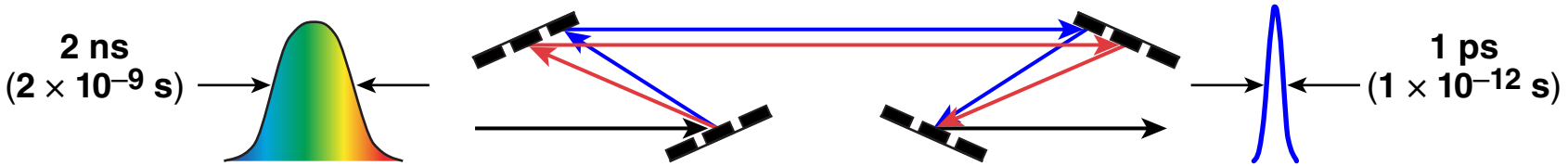
G8893b

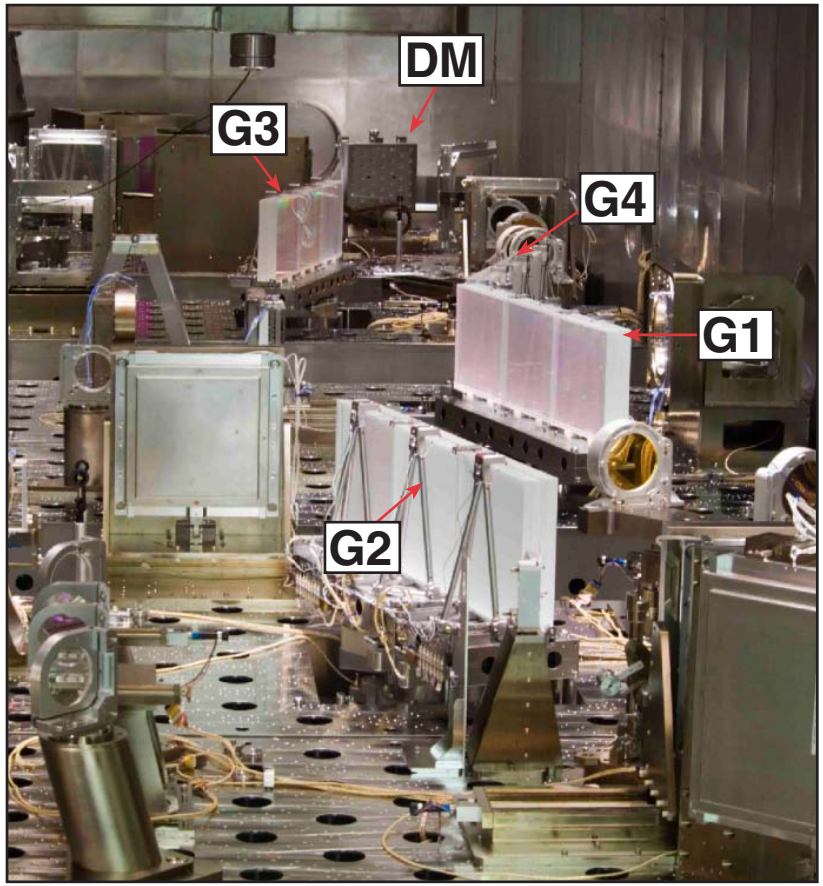
OMEGA EP IR beamlines use a folded architecture based on the NIF



G7793d

The grating compression chamber contains two four-grating pulse compressors

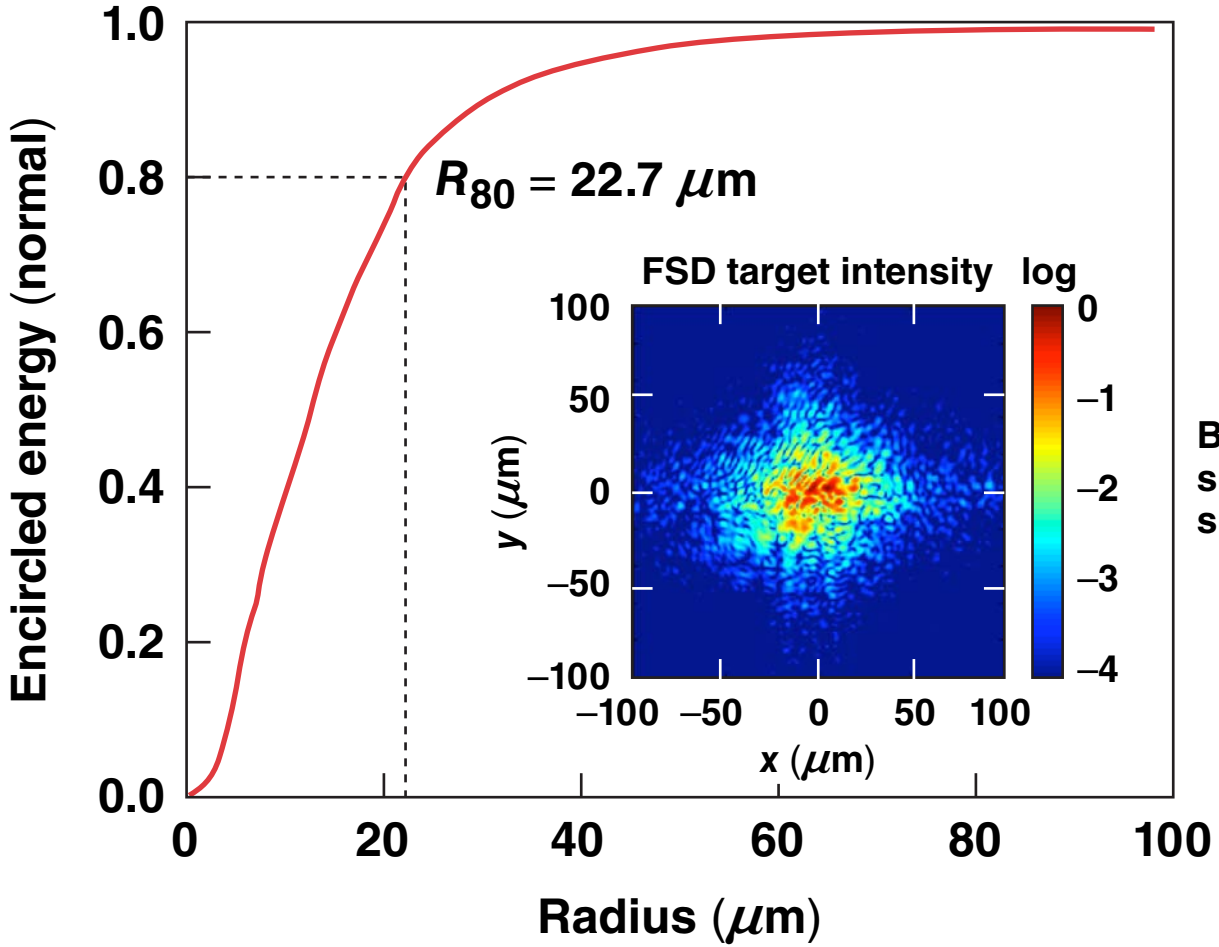




G8234d

- Pulse compressors are stacked vertically in the GCC
- The wavefront of each compressor is corrected with a vacuum-compatible deformable mirror (DM)
- Input-beam size is 37 cm × 37 cm with a grating size of 141 cm × 43 cm

The OMEGA EP focal spot has improved encircled energy (R_{80}) from $R_{80} \approx 34\ \mu$m at commissioning to $R_{80} < 25\ \mu$m

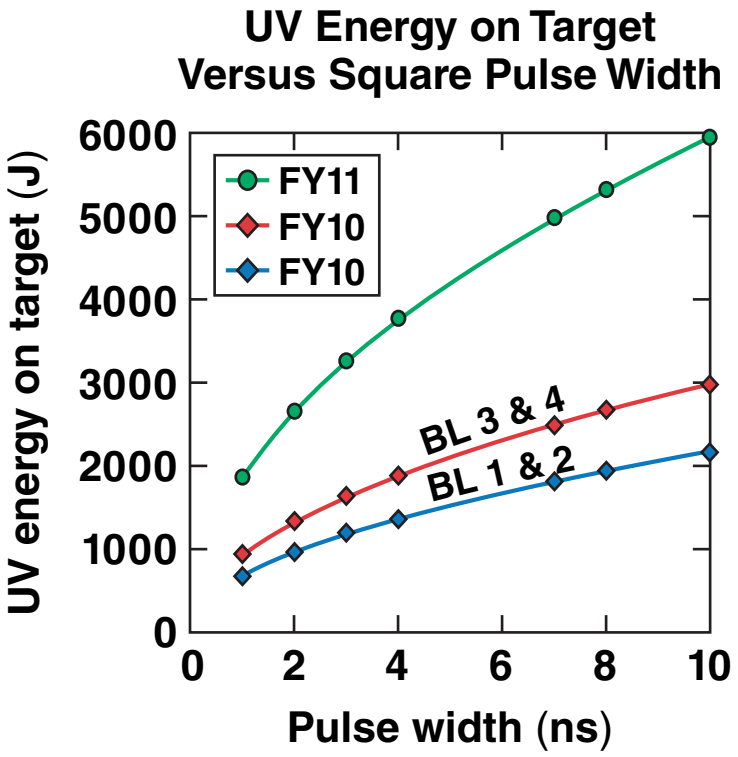


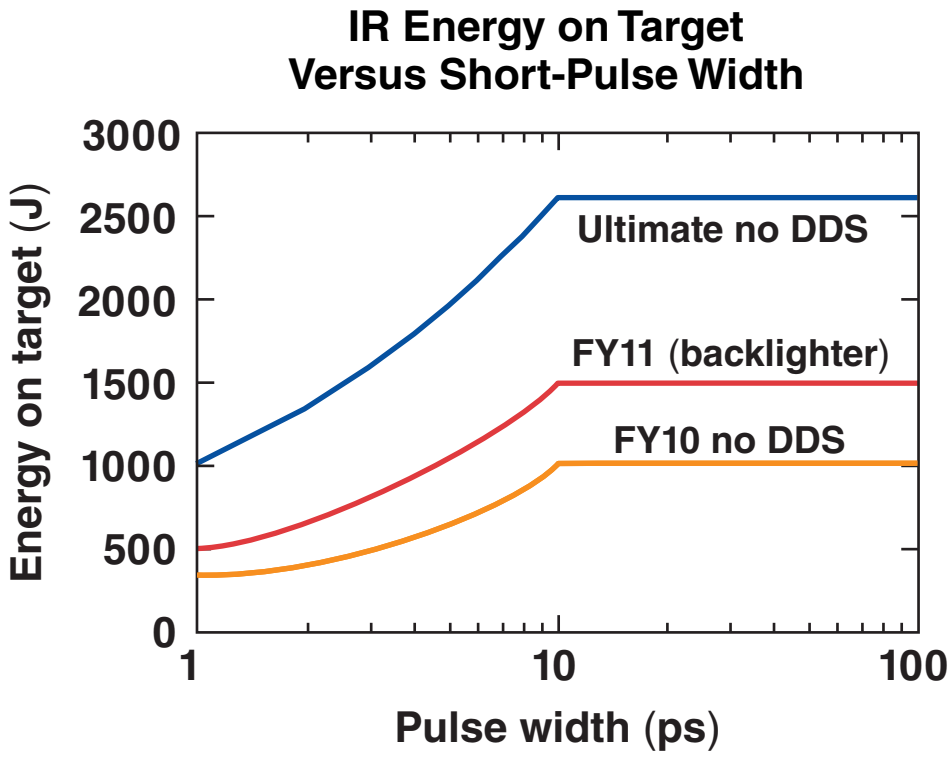
BL1 to OMEGA EP sidelighter indicated, shot 4800

G8730f

The effort to safely move OMEGA EP energy on target to the maximum operating envelope is making progress

UR LLE





Replacement optics in production are expected to expand envelope to full UV and improved IR on target performance.

G8958

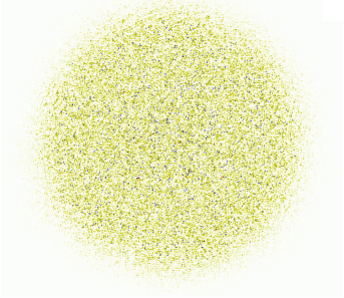
Progress update on OLUG recommendations for the OMEGA (60 beam) system

UR LLE

- **Delay and conflict information**
  - LLE has analyzed most common sources of delay
    - see G. Pien presentation
  - any questions, please call/e-mail the Facility
- **More options for driving the legs**
  - not undertaken in FY10, but potential paths forward have been identified, see K. Thorp talk
- **More static x-ray PHC's**
  - *two cameras added to OMEGA*
- **More SG8 or similar phase plates**
  - *priority on OMEGA EP in FY10, facility soliciting recommendations for possible FY11 acquisitions*
- **Spherical crystal imaging**
  - *see G. Fiksel talk*

Progress update on OLUG recommendations for the OMEGA EP system

- **Beam smoothing (phase plates and SSD)**

750-μm DPP (quantity 2) currently available	1100-μm DPP (quantity 3) available FY11	2000-μm DPP (quantity 2) available FY11
		

  - 2-D SSD for multiple beamlines of OMEGA EP is not planned
  - Multi-FM smoothing is being explored in FY10 as an element aligned with LLE long-term goals
  - Multi-FM may be a viable beam-smoothing technique for OMEGA EP
  - It may eventually be possible to retrofit OMEGA with Multi-FM

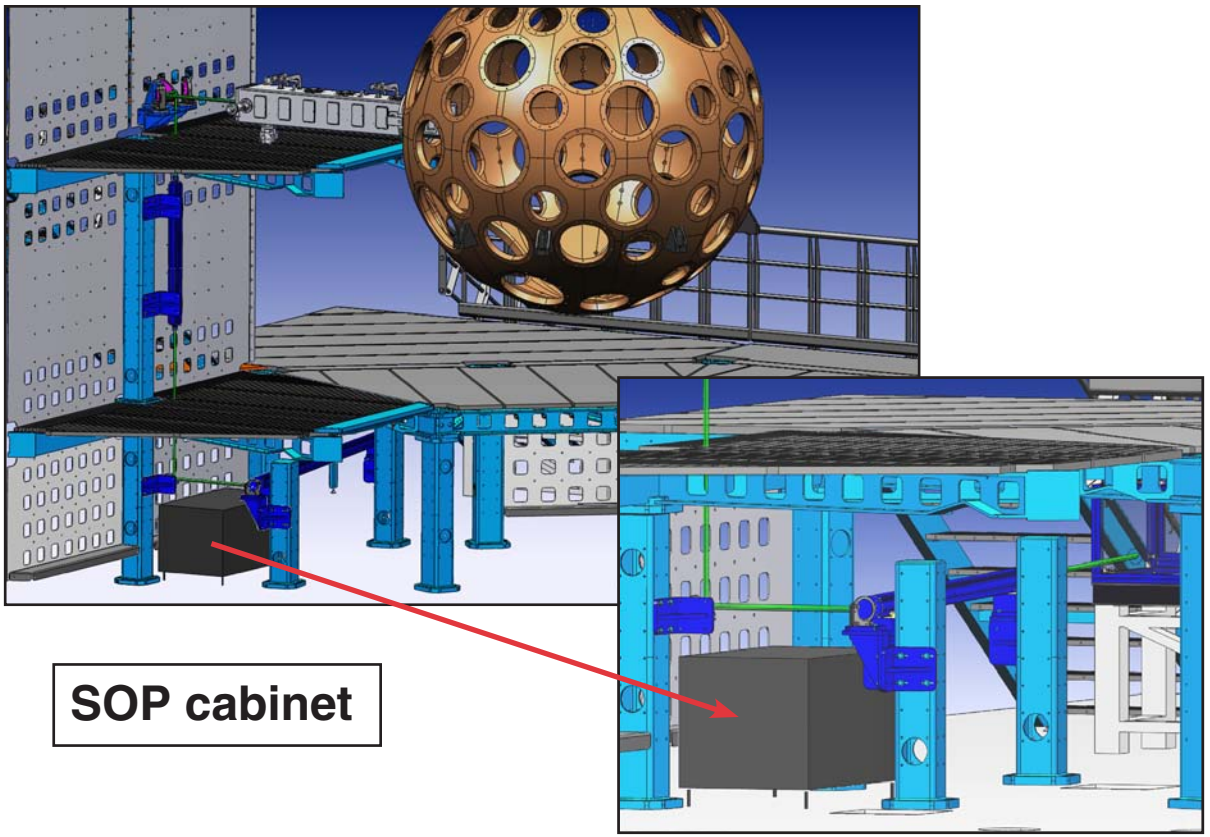
Progress update on OLUG recommendations for the OMEGA EP system (continued)

- **Pulse shaping**
  - *operation of pulse shapes outside the currently available 1.0- to 10.0-ns duration is not planned for FY10; will be considered in FY11*
  - *the LLE regenerative oscillators and four-pass amplifiers will not support longer pulses*
  - *users are reminded that OMEGA EP pulses can be "stacked" in time to create up to a 40-ns drive*

- **Intensity contrast ratio enhancement**
  - *see C. Dorrer presentation*
- **Implementation of low-energy probe beams**
  - *see W. Theobald presentation*

Progress update on OLUG recommendations for the OMEGA EP system (continued)

- **Addition of streaked optical pyrometry (SOP) with the active shock breakout (ASBO diagnostic)**
  - ***in progress; should be available by mid-FY11 (needs streak camera)***



Progress update on OLUG recommendations for the OMEGA EP system (continued)

UR LLE

- **Spherical crystal imaging**
  - *see G. Fiksel presentation*
- **Record of electromagnetic pulse (EMP) and radiological noise**
  - *EMP signatures are currently collected on each short-pulse shot on OMEGA and OMEGA EP*
  - *diagnostic EMI-related failures are logged by the shot crew when encountered*
- **Penalty and conflict information**
  - *OMEGA EP penalty and conflict information is not as significant an issue as it is on OMEGA*
  - *with the ~2-hr shot rate, every diagnostic reconfiguration that has been scheduled has fit within the shot cycle*
  - *the primary delay and conflict concerns are in shifting from one campaign configuration to another*
  - *the Facility Advisory and Scheduling Committee carefully evaluates campaign compatibility and any questions can be forwarded to the primary user contact (J. Soures)*

Progress update on OLUG recommendations for Section IV: General User Issues

UR LLE

- **Earlier assessment of conflicts or problems in the setup; e.g., more access to scheduling committee outputs; evaluation of operational delays introduced by the initial plan and feedback into plan development**
  - **the Facility is available for advance review and planning at the request of any user**
  - **J. Soures is the user point-of contact and will aid in identifying LLE resources to address any concerns**
  - **user proposals submitted in advance of the two month deadline are now reviewed and evaluated**
  - **potential conflicts with other experiments during the same week may preclude approval of the campaign proposal**
- **Arrange calibration and testing as a dedicated instrument maintenance block of time**
  - ***see G. Pien presentation***

Progress update on OLUG recommendations for Section IV: General User Issues (continued)

UR LLE

- **Feedback to the facility is constrained by post-shot EEAF and two week Critique form; OLUG recommends allowing the critique to be submitted several months after campaign date to allow the PI to form a more accurate and realistic feedback**
  - ***feedback solicitations are integral to achieving high effectiveness***
  - ***the EEAF is used to obtain the PI evaluation of the performance of all diagnostics designated as primary and laser issues in real time***
  - ***allowing longer time for Critique sheet submissions may be appropriate for some investigators; however, the two week solicitation for the current Critique has worked well for many users***
- **Better and more complete information about diagnostics**
  - ***see G. Pien presentation***

Progress update on OLUG recommendations for Section IV: General User Issues (continued)

UR LLE

- **Improve the link between scientists and Facility Engineers and Technicians**
  - *LLE recognizes the value of an interface such as the dedicated resource available to the National Labs.*
  - *the Experimental Operations group has similar assets capable of performing a liaison role*
  - *the Facility is working to get to a point where the lead OMEGA and OMEGA EP Engineers and Techs can be assigned*
- **Continue using Beryllium**
  - *LLE expects to continue supporting the use of Be*
- **Additional office space for users for visits and shot preparation**
  - *while space is limited, additional office space assignments can be made on an ad-hoc basis. Please contact J. Soures with specific requests*
- **Website request for collection and dissemination of common interest information and interest group collaboration**
  - *see G. Pien presentation*

Progress update on OLUG recommendations for Section IV: General User Issues (continued)

- **Diagnostics**
  - *see G. Pien presentation*
- **OMEGA EP Information**
  - *see K. Thorp presentation*
- **Miscellaneous**
  - *phase-plate availability is currently only through the Shot Request Form on the "Beams help" page*
  - *LLE is continuing to evaluate the reorganization and indexing of answers to common questions on the laser*
  - *call or e-mail with any questions*

Summary/Conclusions

Omega is a reliable platform for conducting experiments and benefits from a strong user community

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