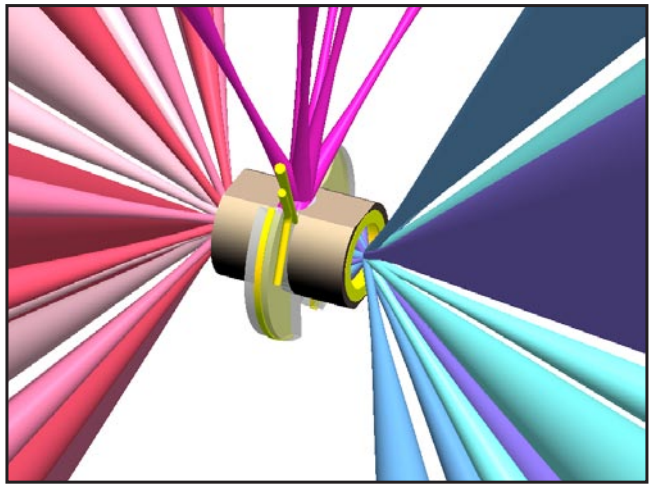
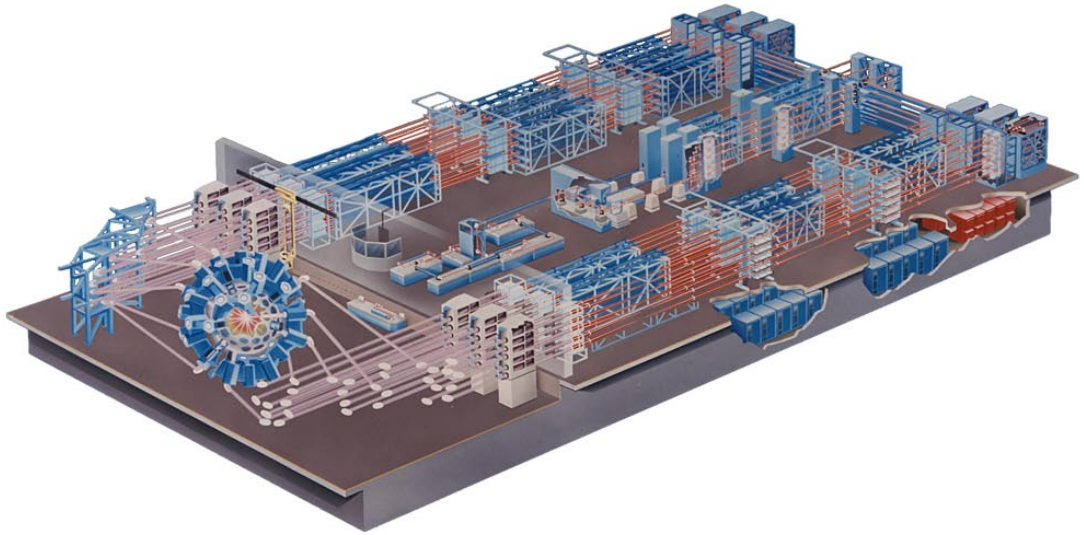
Conducting Effective Experiments on OMEGA





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Omega Laser Facility
Users' Group Workshop
Rochester, NY
29 April – 1 May 2009

Summary

OMEGA supports unique experimental configurations for a large variety of users

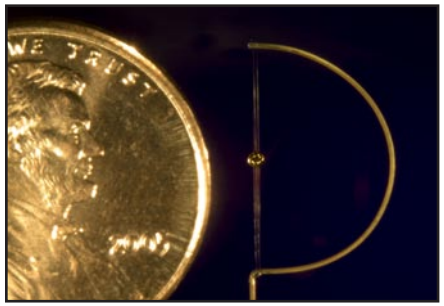
UR LLE

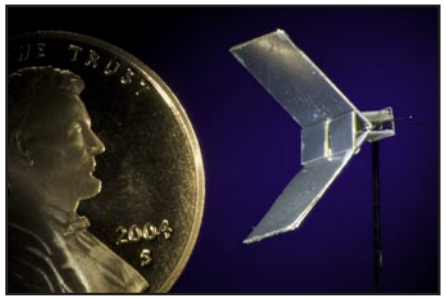
- Omega Facility capabilities continue to evolve to meet user demands
- Conducting experiments on OMEGA is a partnership between the scientist and OMEGA operations
- Careful planning with the Principal Investigator (PI) begins well in advance of shot day and is essential for safe, effective operations
- OMEGA EP extends and enhances OMEGA performance

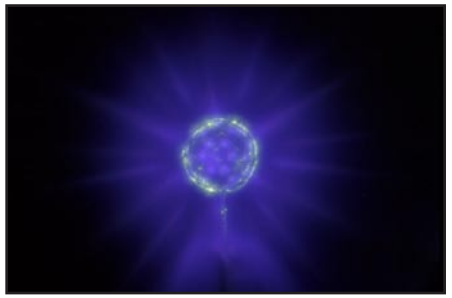
The OMEGA Operations Team works directly with the scientist to ensure experiment success and effective OMEGA system utilization.

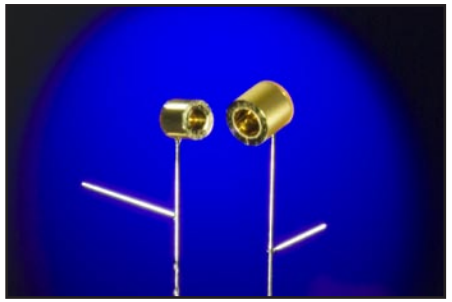
OMEGA reliably supports a large number of complex experiments for a variety of users each year

- Shot rate remains high while the complexity and number of experiments per day/per week has increased
- OMEGA conducts up to 11 unique experiments and averages 6 unique experiments per week
- A typical week may include spherical cryogenic targets, interleaved planar cryogenic and ambient targets, and indirect-drive hohlraums





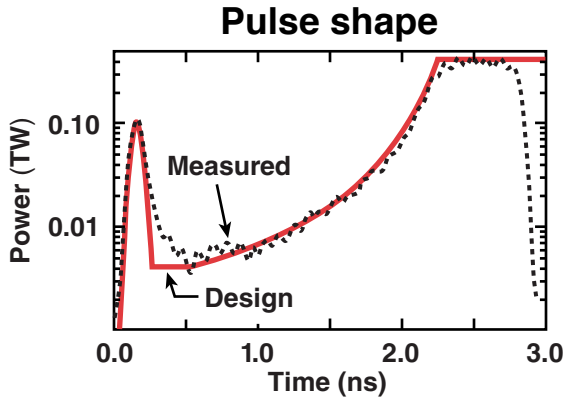


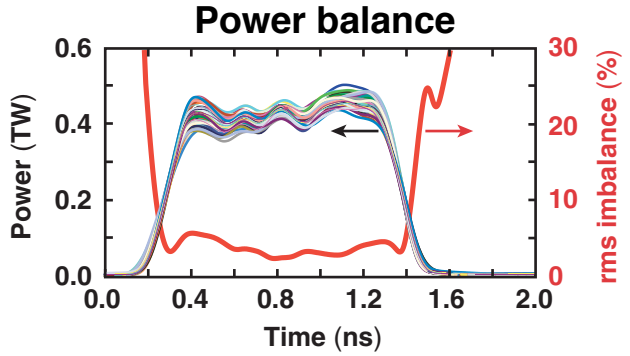


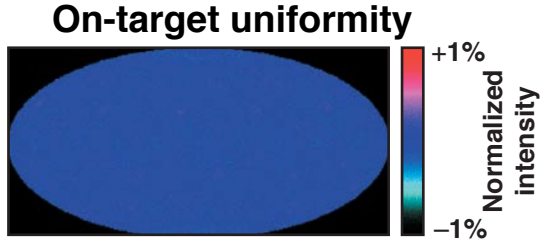
OMEGA's track record demonstrates flexibility for a large variety of experimental configurations.

OMEGA is a high-performance, high-uniformity world class laser facility and is better than ever

- 30-kJ energy on target continues to have strong demand from user community
- OMEGA provides flexible pulse shaping, drive/backlighting capabilities
- UV energy balance on target is typically less than 3% rms, and power balance can exceed 5% rms
- On-target irradiation uniformity exceeds 1% with SG4 DPP's and 10-μm-rms pointing
- Beam-pointing accuracy of 16-μm rms is routine and 10-μm-rms precision is available upon demand







OMEGA has met or exceeded all performance goals specifications.

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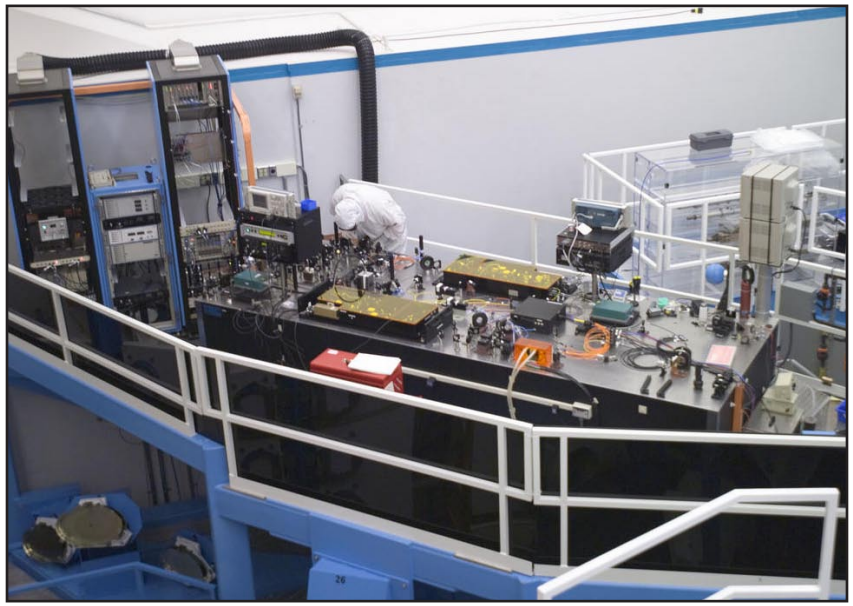
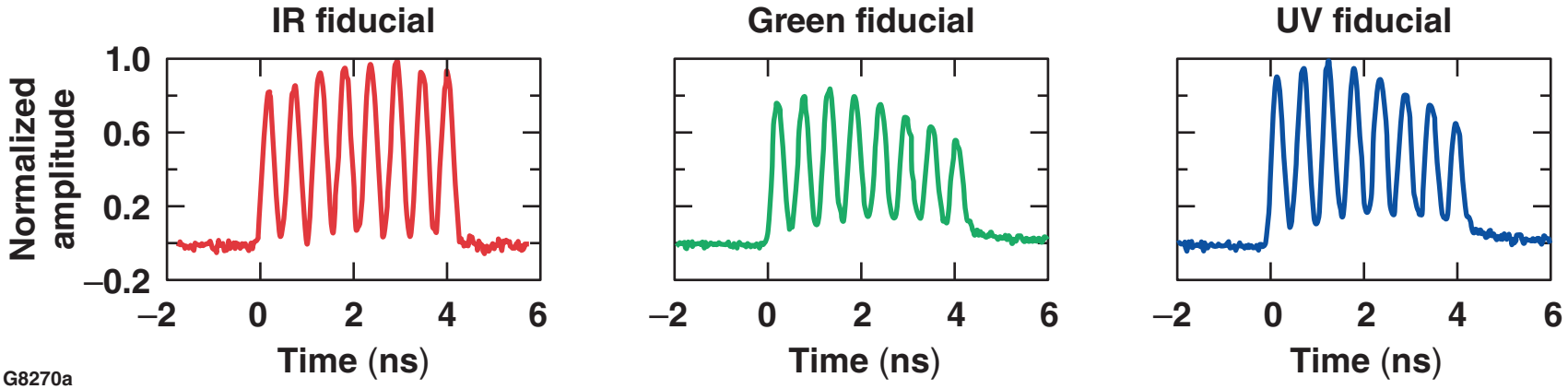
OMEGA's new Target Viewing System significantly improves target viewing capability

UR LLE

- Five cameras provide
  - 5-μm/pixel resolution
  - up to 50-mm field of view
  - up to 2000 frames/s
  - real-time image processing
- Improved image quality permits more accurate positioning of cryogenic targets
- Supports on-shot position and vibration measurements
- Cameras can be remotely focused
- "Smart cameras" simplify target detection for all shot types being used
- The illuminator uses high-reliability light-emitting diodes (LED's)

The OMEGA target bay fiducial is used throughout OMEGA including OMEGA EP areas





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Principal investigator indoctrination (qualification) is required to ensure safety and effectiveness

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Principal investigators (PI's) must complete the following prior to leading experiments on OMEGA:

- **Briefing on laser and experimental system capabilities**
- **Facility tour**
- **Review of responsibilities including Shot Request Form preparation and target metrology and positioning requirements**
- **Observation of operations, preferably with an experimental PI**
- **Briefing on diagnostic qualification procedures**

The Proposal Template is reviewed and approved two months prior to the planned shot date

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- Initiates the preparation phase at least two months prior to the date of the experiment.
- The proposal is reviewed by the Scheduling Committee to ensure that the experiment's requirements are consistent with the capabilities of the Omega Laser Facility.
- The Committee reviews safety of specified experiments: targets, materials, special pointing or laser conditions.
- The Committee reviews progress of the preparation for and execution of approved experiments.

Experiment requirements, system safety, campaign compatibility, and intra-shot delays are carefully evaluated.

Shot Request Forms (SRF's) are required for shot specification

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- SRF's capture a detailed record of the laser and diagnostic configurations for each shot
- The SRF's are "differenced" to identify changes to the configuration during the shot day and aid development of the shot plan
- Effectiveness is optimized by capturing expert information centrally, controlling it carefully, and incorporating the process into planning tools
- On shot day the SRF functions to synchronize the shot crew to a common objective and ensures that the configurations are implemented correctly

Proposals must be submitted two months prior to the experiment

Detailed experimental configurations allow optimized facility planning and improved compatibility verification between adjacent experiments

Target Request Forms improve target tracking and specification

Experimental Configuration Name	4.2.1.3 Example RID #	4.2.1.4 Targets			4.2.1.5 VISRAD Filename (RID-PI Name.vrw) (Submit files with proposal)	4.2.1.6 # of Target Shots
		TRF #	Complex Yes No	Quantity		
			☐ ☐			
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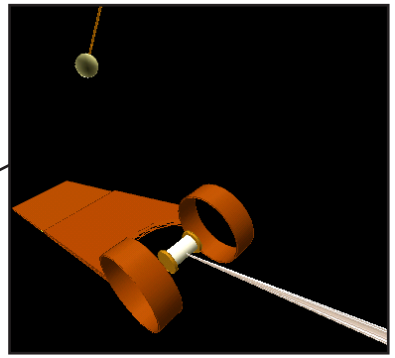
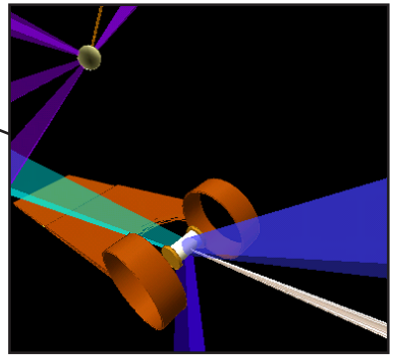
4.2.1.7 Identify all diagnostics required that are not qualit...						





OMEGA proposal analysis for week of 16 February 2009

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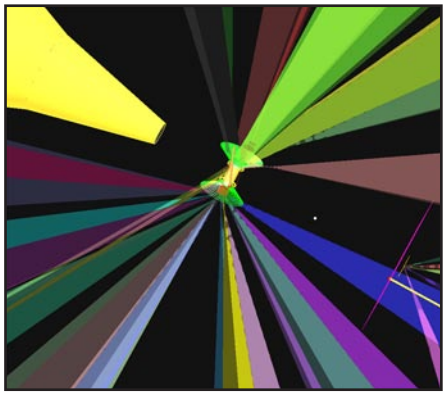
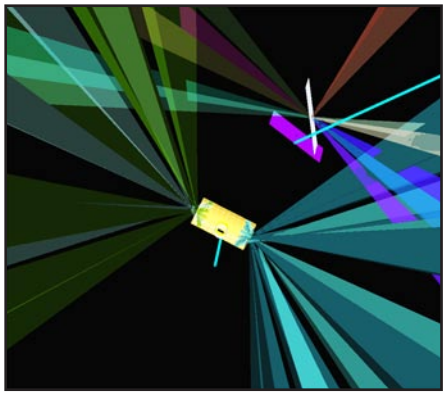
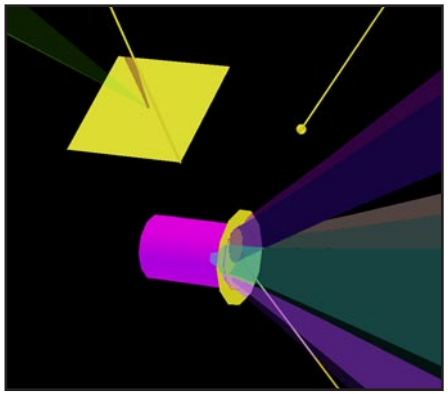
Date	Campaign	PI	Targets	Configuration	Overnight Reconfiguration	Mid-Day Reconfig.	Comments
2/17/09	AGEX EOS	Lanier	Hohlraums + foils (PABL)	9 beams ~8 mm off-axis w/SG8 DPP's 24 beams ~8 mm off-axis w/no DPP's	Point 33 beams to 18 locations	—	Dual drivers. Max energy on BL driver: SG0301 105 J, SG1014 425 J. Composite pulser shape reduction required
2/18/09	NIF 5	Keiter	Hohlraums and foils (PABL)	30 beams ptd along P6/P7 w/no DPP's 12 beams to 6.15/39/141 w/no DPP's	5 DPP operations point 42 beams to 5 locations	—	—
2/19/09	Proton radiography	Li/ Petrasso	Small spheres + foils + halfraums	10 beams to TCC w/SG8s 18 beams 9 mm/P6 no DPP's 2 beams 9 mm/H3 no DPP's	10 DPP operations point 30 beams to 3 locations	—	Dual Drivers Drive Advanced 125 ns



Lanier – AGEX EOS



Keiter – NIF 5



Li/Petrasso – proton radiography

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A thorough review of the shot plan begins at the first PI brief two weeks before shot day

UR LLE

- The first PI brief is held to review the planned experiment in detail, identify issues, and optimize the shot plan
- The PI presents experimental objectives and gives detailed specifications for laser and experimental conditions
- Sample SRF's for each unique configuration are reviewed in detail and inconsistencies are identified
- Models of beams and targets are carefully reviewed

The shot plan is finalized at the one-week PI brief

- Final SRF's for all planned shots are due Monday, one week before the planned shot week
- The one-week brief is the final opportunity to interface with the PI directly to resolve outstanding issues prior to shot day
- System experts ensure that the PI's made changes to the SRF's based on recommendations provided at the two-week brief
- All details must be finalized at the end of the meeting and the SRF's are locked at midnight on Thursday
- All subsequent changes MUST go through the Laser Facility Manager or Experimental Operations group leader

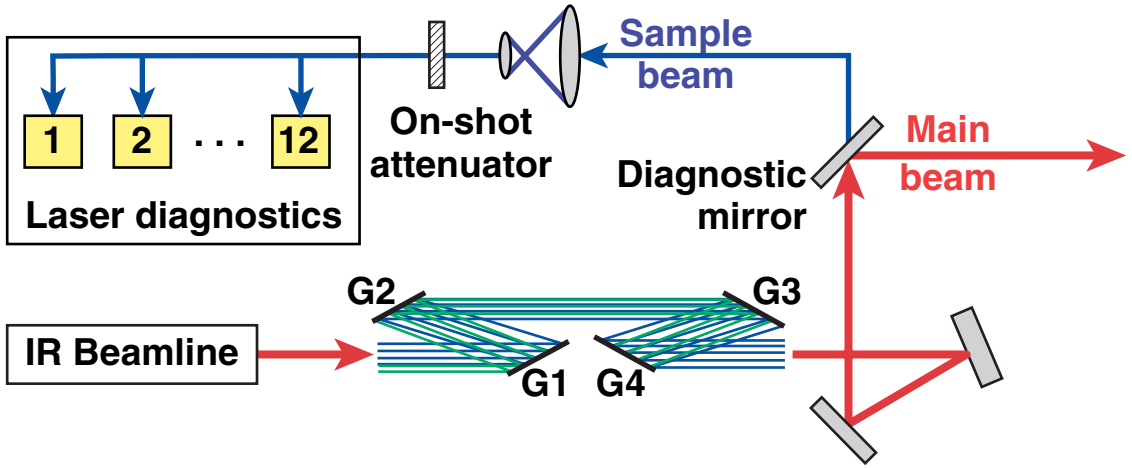
Significant changes to the shot plan after the one-week PI brief requires explicit approval.

Direct involvement of the PI is required to ensure the success of the experiment

- Involvement prior to each shot may include
  - verification and approval of the pulse shape being generated
  - verification of the target prior to insertion
  - verification of the target positioning
  - confirmation of system configuration via the Shot Director

- Involvement after each shot may include
  - checking the measured pulse shape
  - assessment of pointing
  - checking total energy on target and balance
  - diagnostic film/CCD for filtering, pointing, and timing
  - checking diagnostic trigger monitor if required

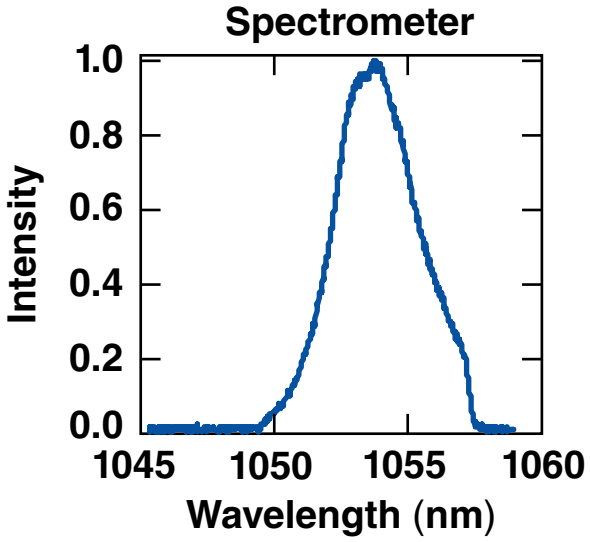
The short-pulse diagnostics package (SPDP) is used for pre-shot and on-shot pulse characterization

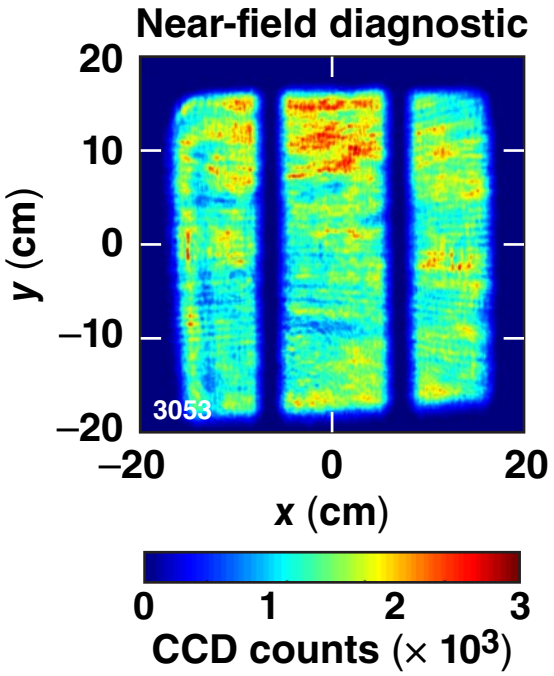


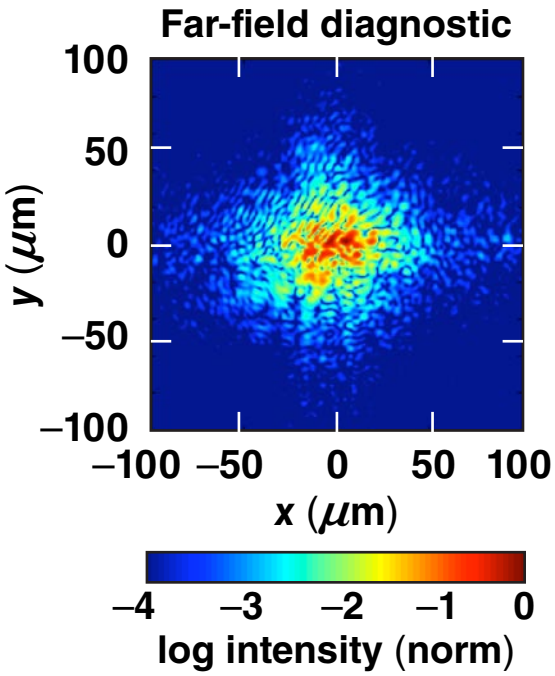
- Temporal diagnostics
- Spectrometer
- Near-field
- Far-field
- Wavefront

(Near-field, Far-field, Wavefront: On-target focal spot)

- Energy
- Contrast







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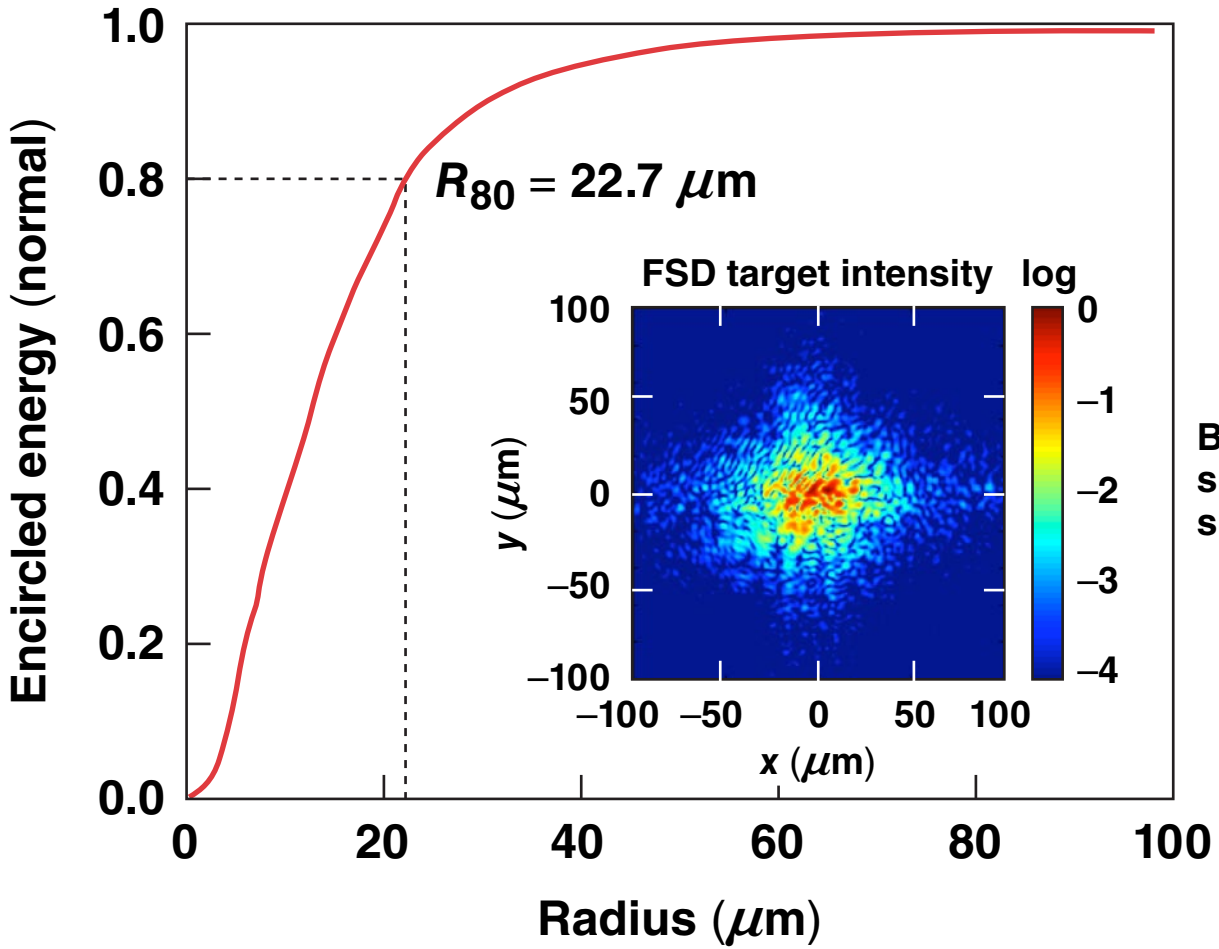
The OMEGA EP focal spot typically has $R_{80} < 25\ \mu$m and is improving



BL1 to OMEGA EP sidelighter indicated, shot 4800

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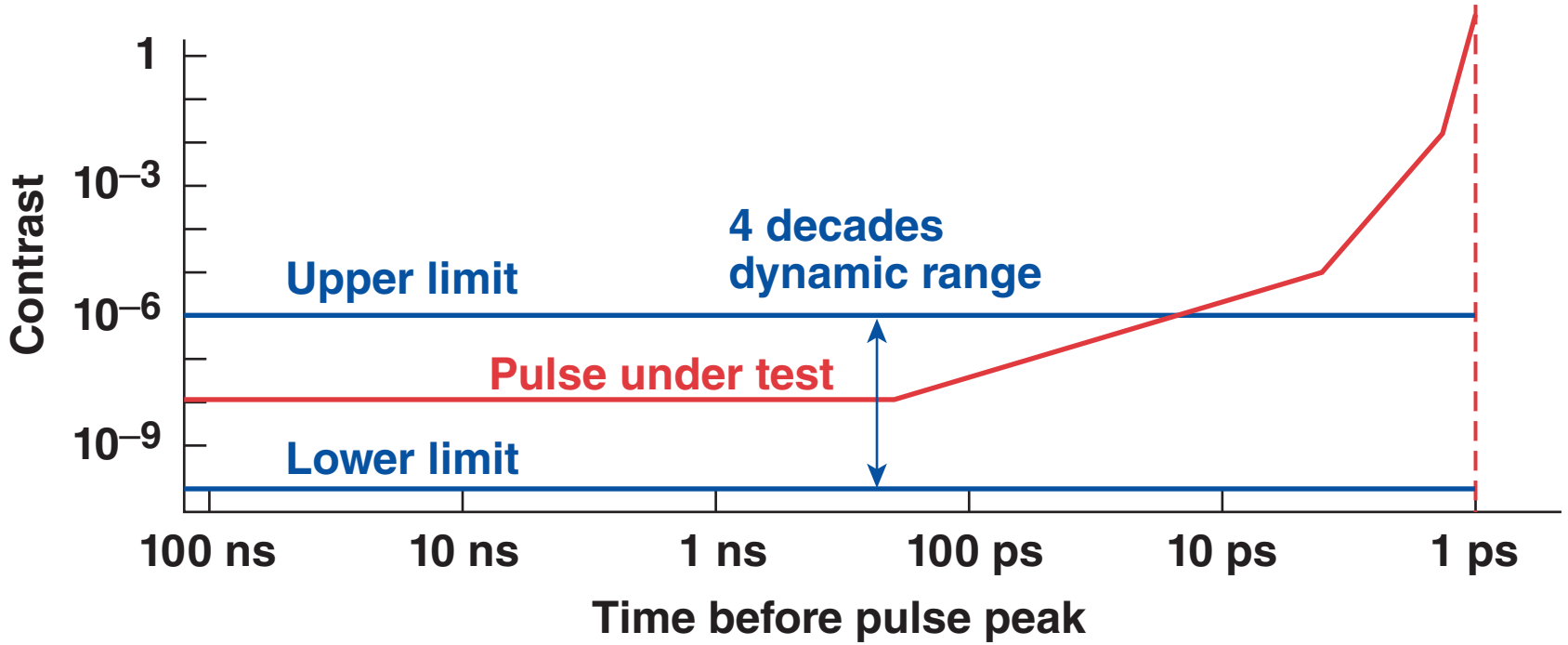
A high-contrast diagnostic is being installed

Time range before pulse	Temporal resolution	Highest contrast sensitivity	Dynamic range
100 to 0.5 ns	0.5 ns	10^{-10}	10^{4}
500 to 0 ps	10 ps	10^{-10}	10^{4}



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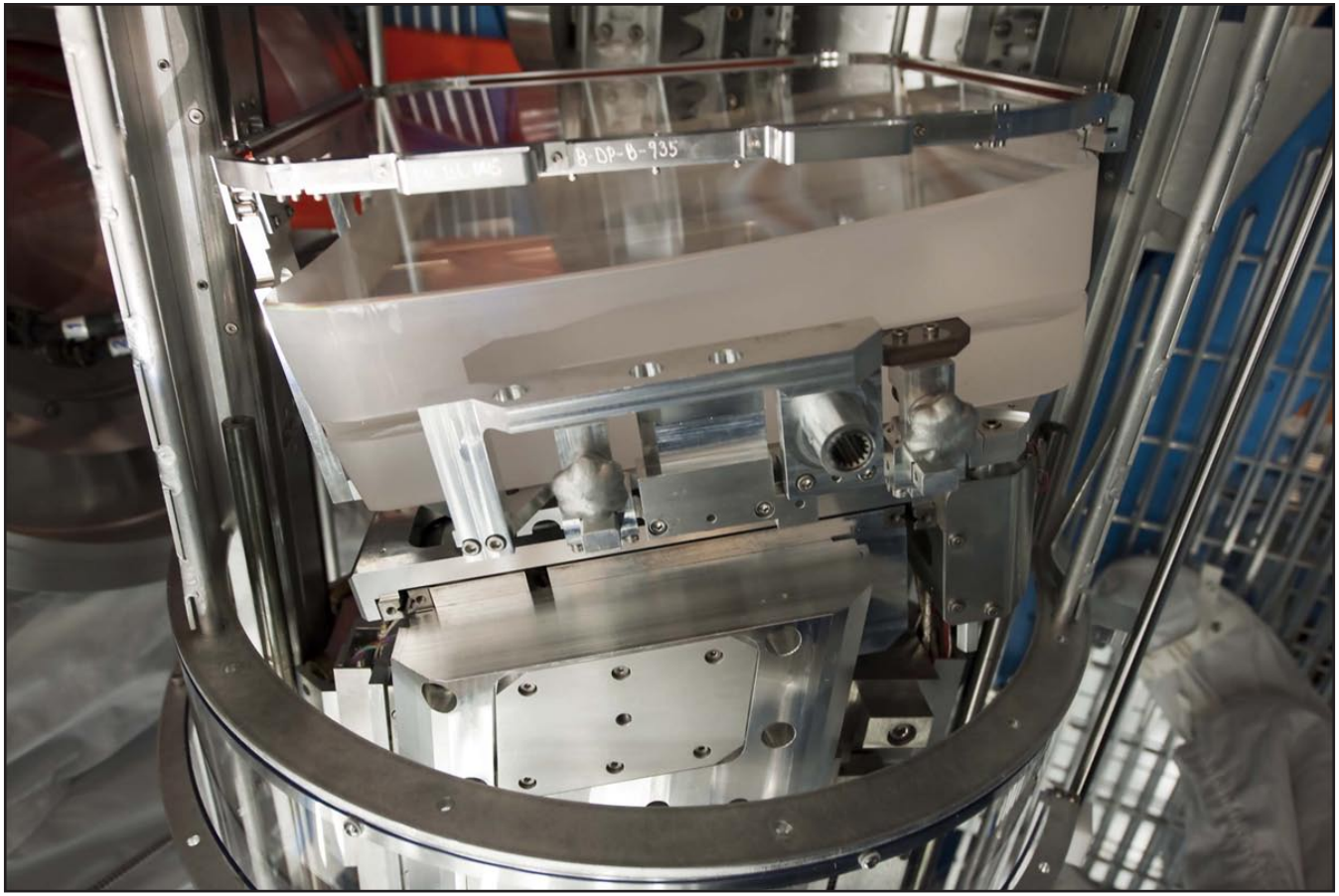
For experiments that are capable of generating significant target debris a disposable debris shield is required to protect the parabola



The FY10 short-pulse operating envelope is constrained by a disposable debris shield (DDS) B-integral below 12 ps

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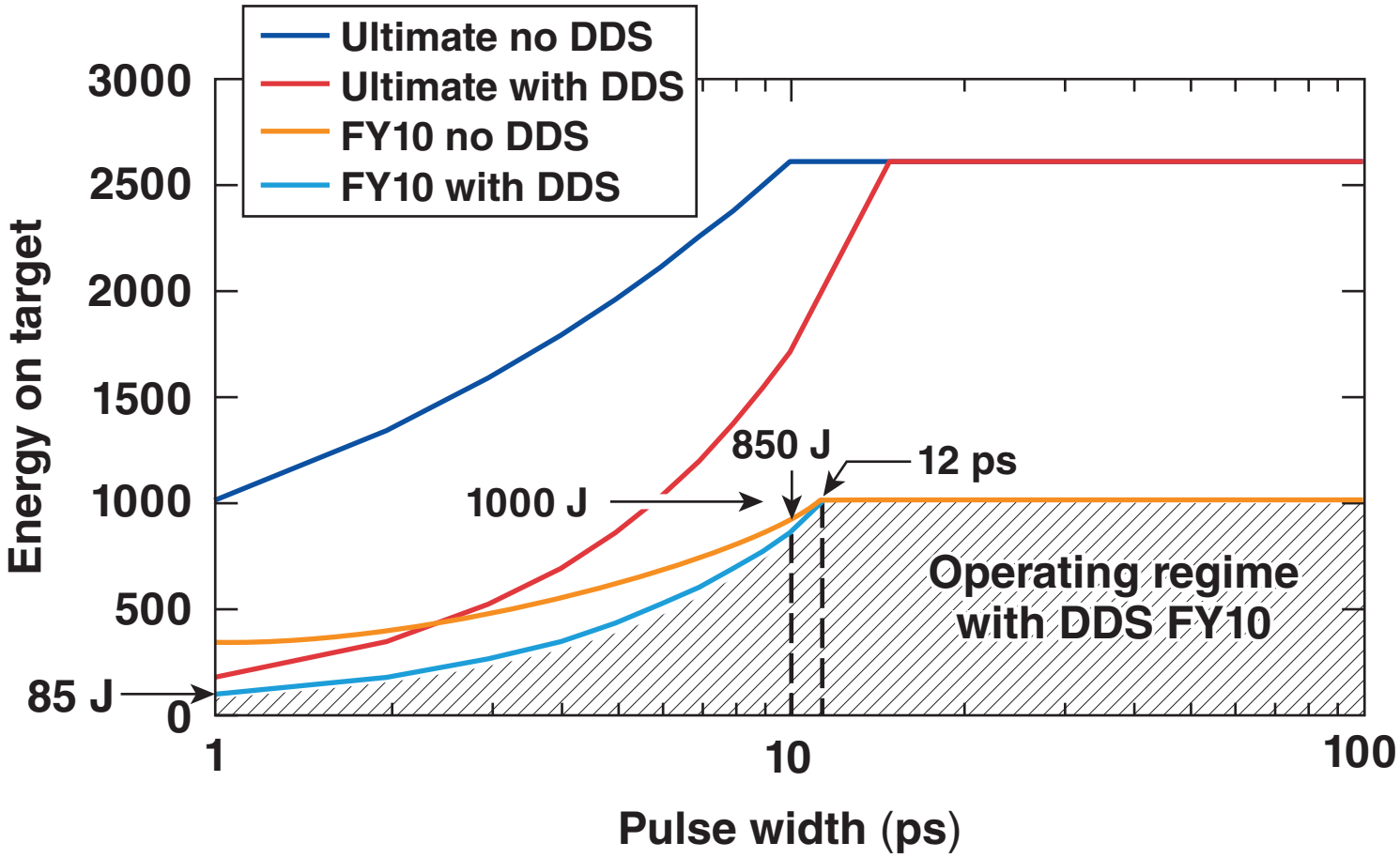

Focal-spot measurement and quality are compromised by the debris shield.

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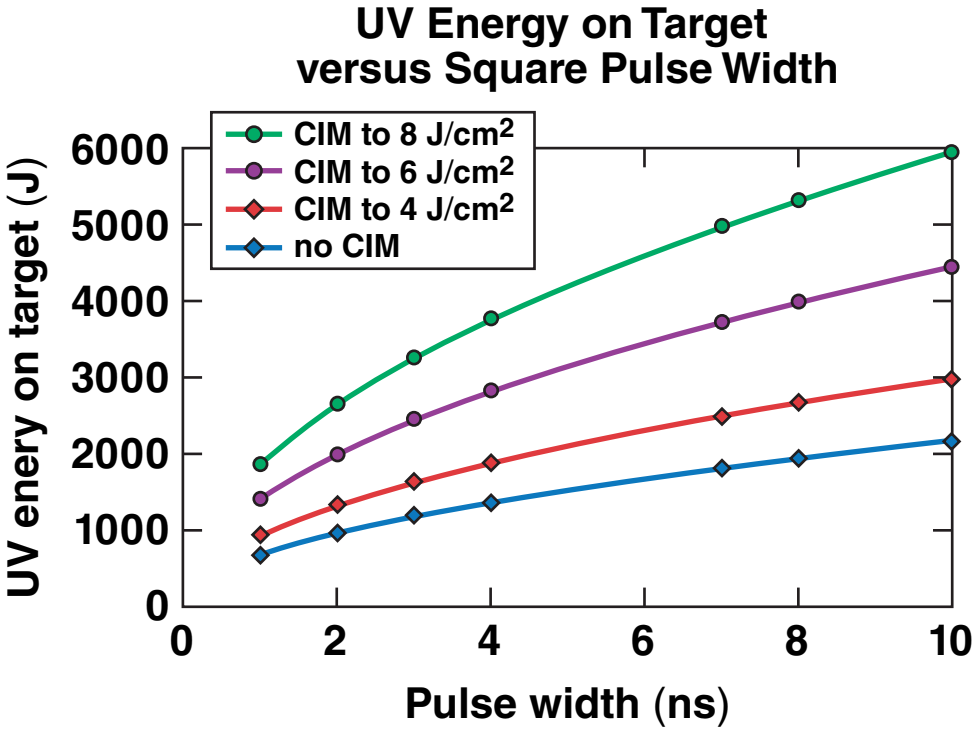
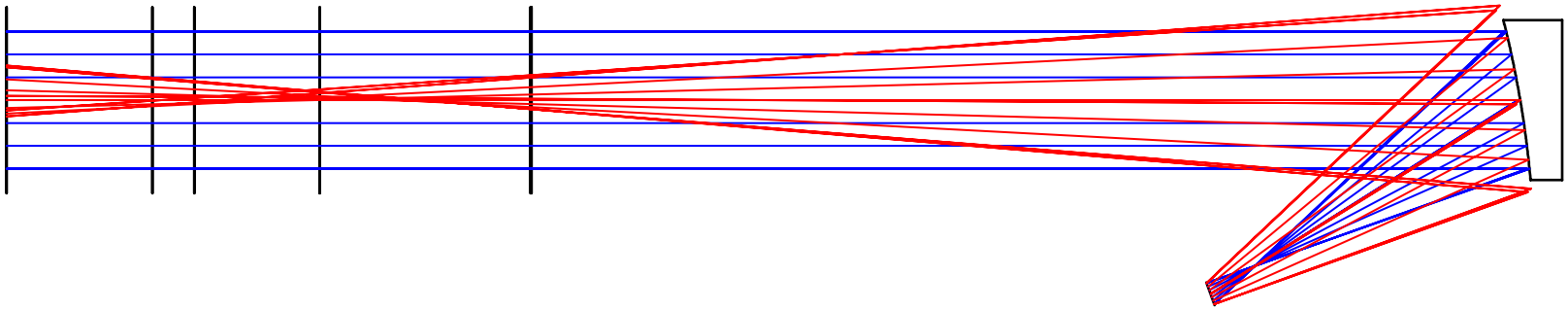
UV-optic laser-damage thresholds will limit initial OMEGA EP fluence



- LLNL is managing the procurement of replacement optics for OMEGA EP
- Bulk fused-silica inclusions and surface-finish quality limits UV laser-damage threshold (LDT) of initial optics
- LLNL procedures, quality control, and processing are required to achieve high LDT's

Diagnostic retroreflections from OMEGA EP short-pulse beams must be managed to prevent the transport optics from being damaged



- Diagnostic qualification now includes retroreflection analysis and mitigation strategies when necessary
- Flat nose cones positioned within 100 mm of the short-pulse focal spot must be tilted ~10° to prevent the retroreflection from damaging system optics
- Flat nose cones positioned between 100 mm and 300 mm from the short-pulse focal spot may need to be tilted
- Flat nose cones positioned more than 300 mm from the short-pulse focal spot will not likely require tilt

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