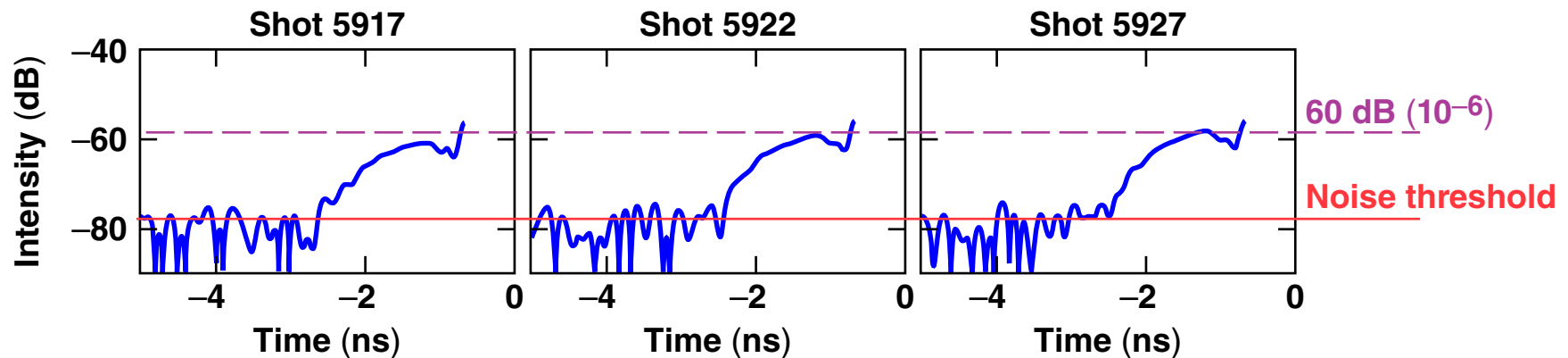


# Performance of the OMEGA EP Laser System



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## Summary

# OMEGA EP is routinely delivering the world's highest short-pulse energy



- New optics for the UV beamlines will be arriving throughout FY10
  - the first two phase plates will be available Q1FY10
- The OMEGA EP high-energy petawatt laser beams routinely deliver ~1 kJ to target in a 10-ps pulse
- An energy ramp was carried out in August/September 2009
  - up to 2.1 kJ on target in a 12-ps pulse<sup>1</sup>—damage was observed
  - a new operating limit of 1.5 kJ in a 10-ps pulse was determined
- A single-shot contrast diagnostic with 80 ~ 100 dB dynamic range is being installed
- Initial experiments show promising results<sup>1,2</sup>

**OMEGA EP's first year as a user facility has been successful—350 shots with 30 PI's.**

# Collaborators

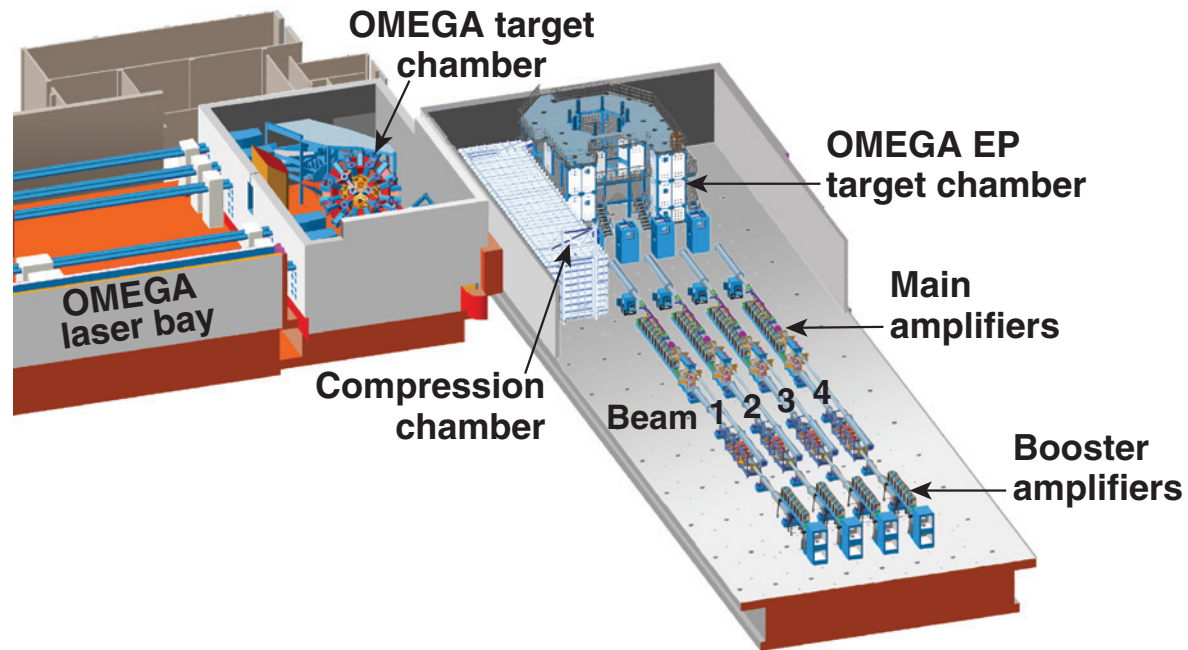
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**R. Betti, T. R. Boehly, J. Bromage, C. Dorrer, V. Yu. Glebov,  
J. H. Kelly, B. E. Kruschwitz, S. J. Loucks, R. L. McCrory,  
S. F. B. Morse, J. F. Myatt, P. M. Nilson, J. Qiao, T. C. Sangster,  
A. A. Solodov, C. Stoeckl, W. Theobald, and J. D. Zuegel**

**Laboratory for Laser Energetics  
University of Rochester**

# OMEGA EP beamlines can be operated as short-pulse high-energy petawatt at $1.0 \mu\text{m}$ or long-pulse at $0.35 \mu\text{m}$

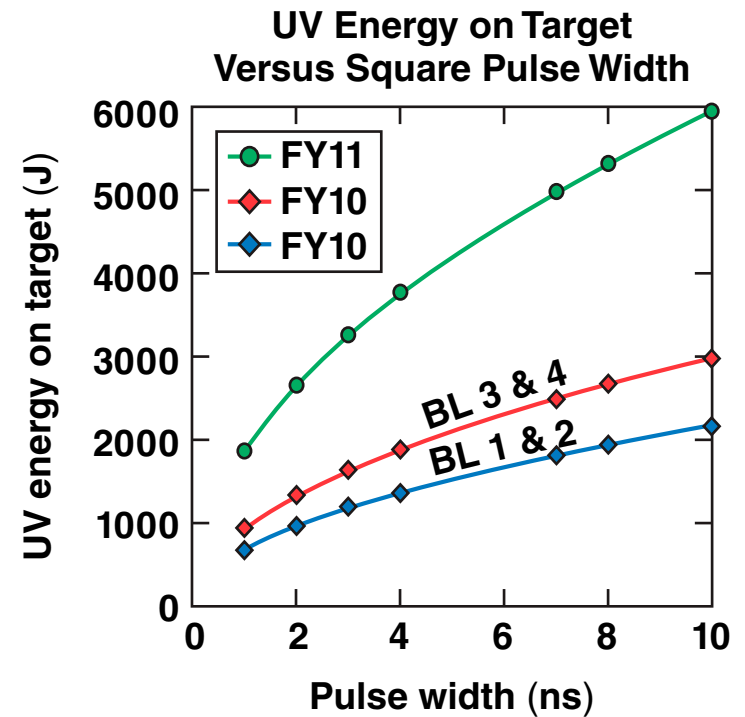
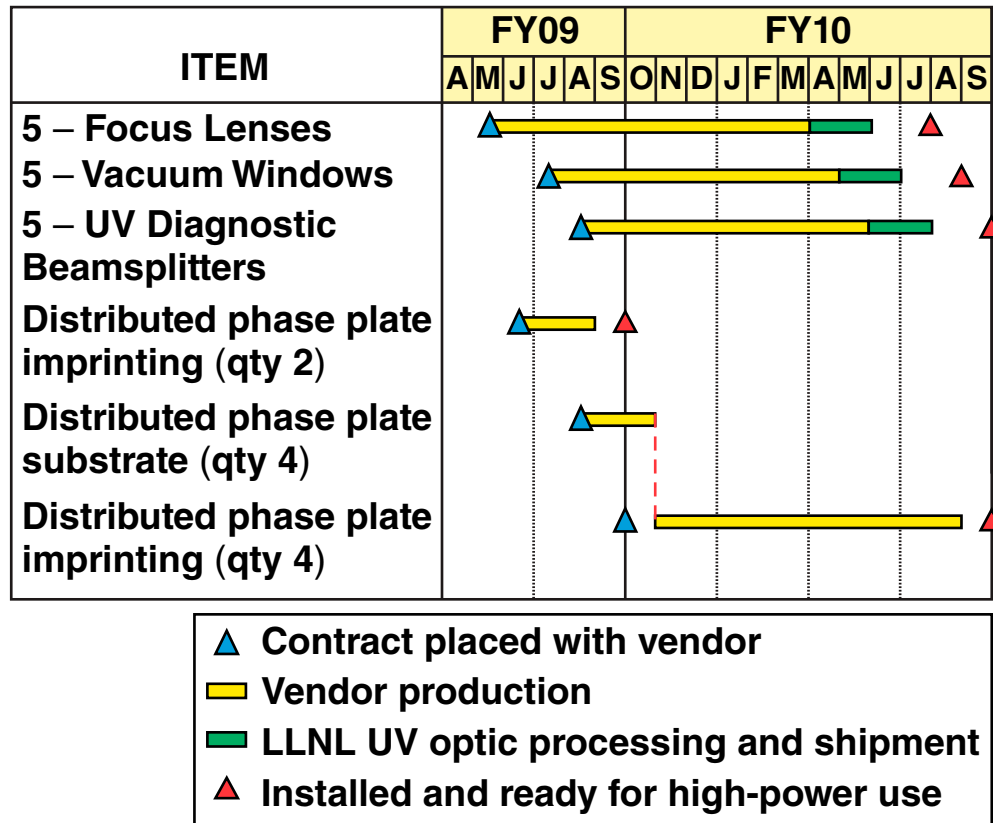


Performance capabilities	Short-pulse Beam 1	Short-pulse Beam 2	Long pulse (any beam)	
Wavelength	Infrared ( $1.0 \mu\text{m}$ )	Infrared ( $1.0 \mu\text{m}$ )	UV ( $0.35 \mu\text{m}$ )	
Pulse width	1 to 100 ps	1 to 100 ps	1 ns	10 ns
Energy on target (kJ)	2.6 kJ, 10–100 ps grating limited <10 ps	2.6 kJ,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

# LLE is obtaining a set of higher damage-threshold UV optics

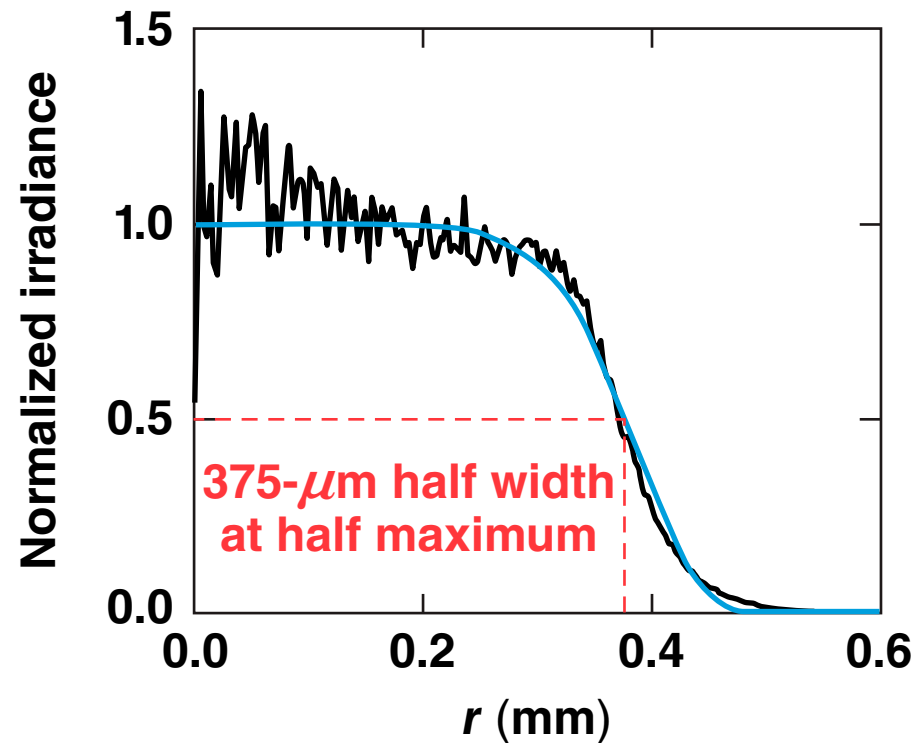


## UV Optics Acquisition



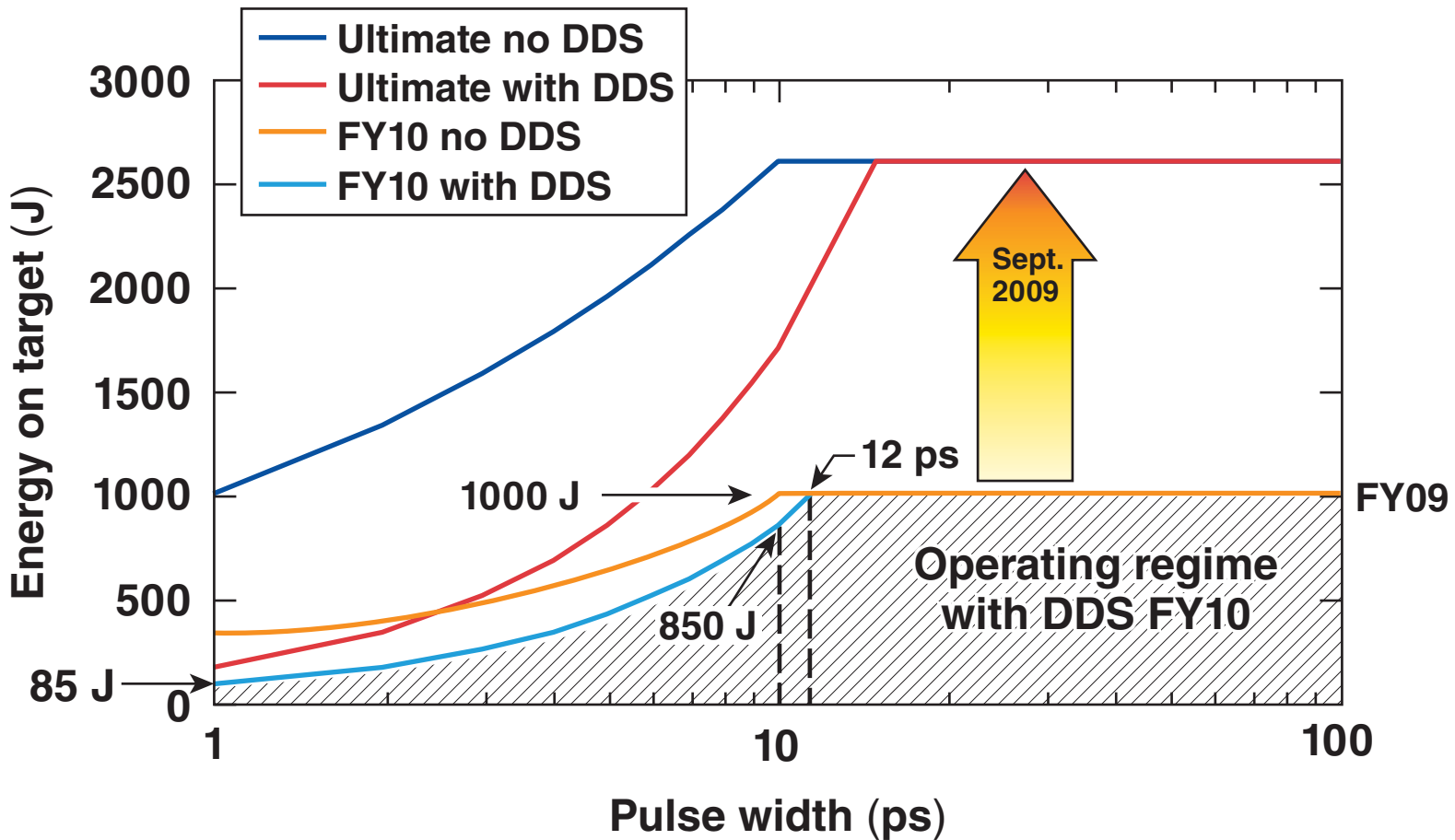
- LLNL is managing the procurement of replacement optics for OMEGA EP

# The first two OMEGA EP distributed phase plates are available for use in FY10



The next three phase plates will have 550- $\mu$ m HWHM.

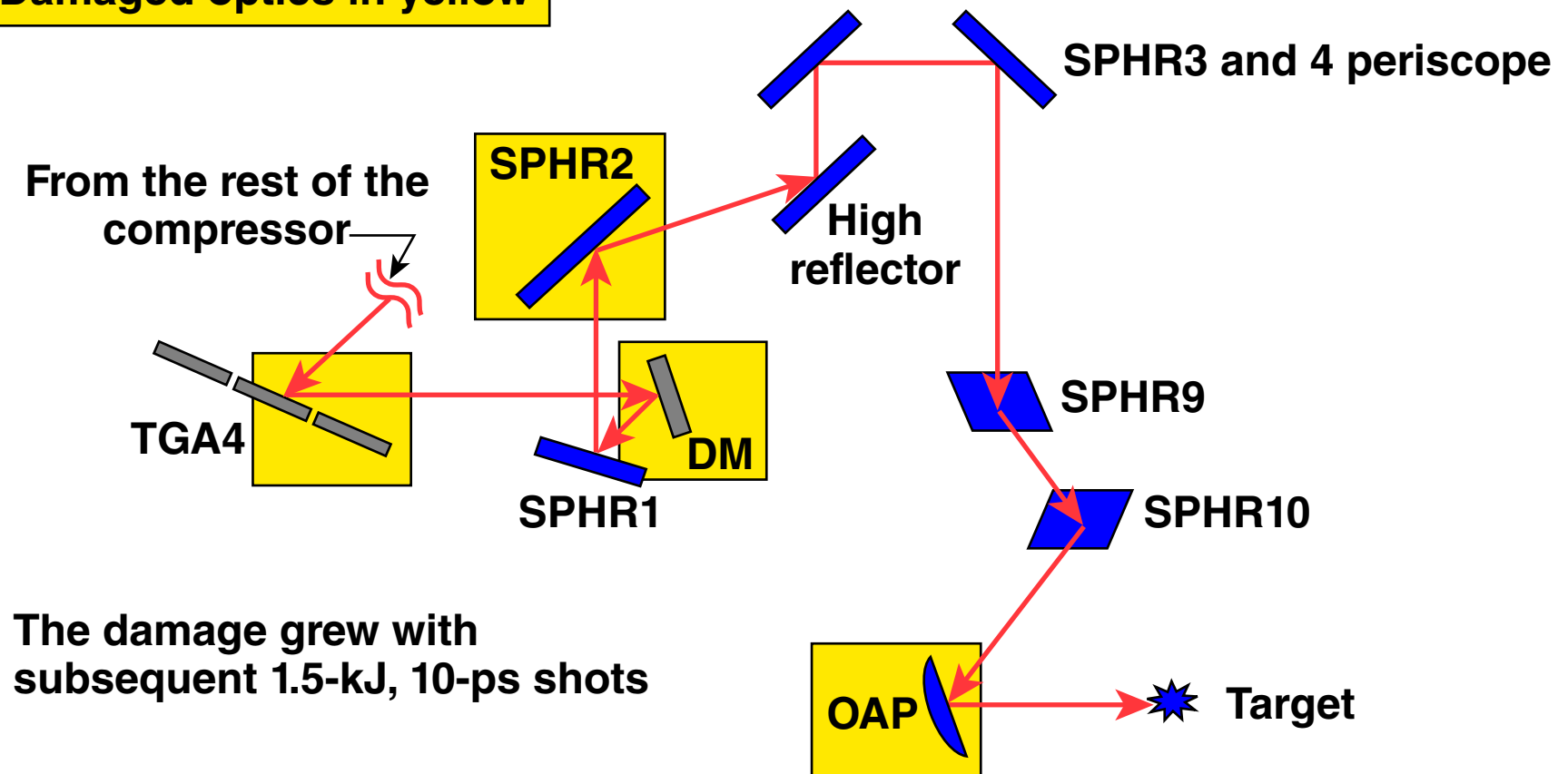
# The FY10 short-pulse (IR) operating envelope is constrained by optics damage and the *B*-integral of the disposable debris shield (DDS)



**A test energy ramp in September 2009 assessed an expanded operational envelope—2.1 kJ on target.**

# The backlighter ramp to 2.1 kJ showed significant optics damage

Damaged optics in yellow



The damage grew with subsequent 1.5-kJ, 10-ps shots

Approximately 1% of the surface area was damaged.



# **OMEGA EP short-pulse capability will be ramped to 1.5 kJ on-target in 10 ps by February 2010**

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- **The four damaged optics have been replaced**
- **Damage-free operation at 1 kJ 10 ps will be available immediately**
- **The system will be ramped to 1.5 kJ, 10 ps during Q1FY10 and the first part of Q2 campaigns with extensive pre- and post-campaign inspections**

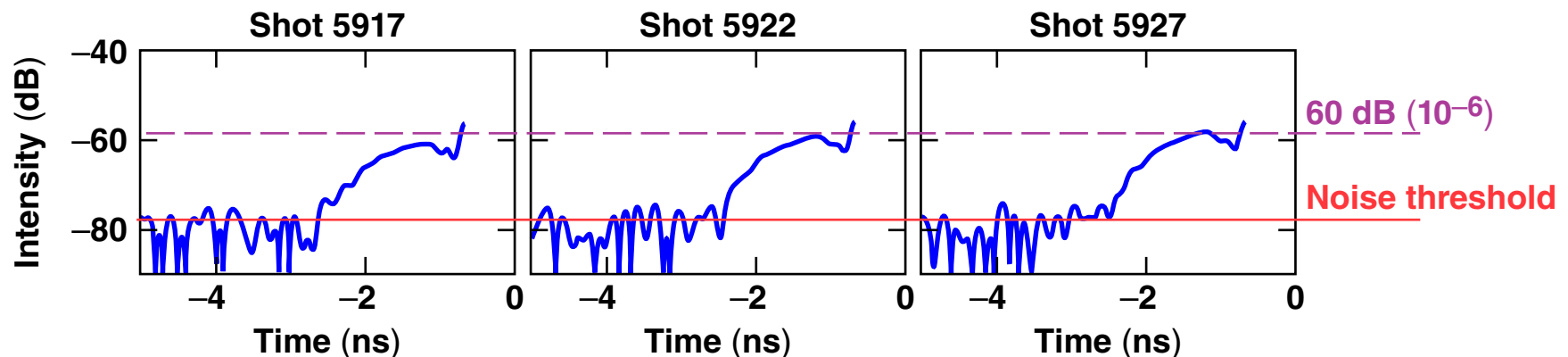
**Work to understand the damage will continue with the goal of providing 2.6 kJ in the future.**

# The OMEGA EP on-shot contrast diagnostics will be deployed in Q1FY10



- The on-shot OMEGA EP contrast will be measured with two diagnostics
  - fast diode and scope
    - up to ~0.5 ns before the pulse, 80-dB dynamic range
    - currently installed in a temporary location
  - single-shot cross-correlator\*
    - 0.5 ns before the peak-to-peak, 80 ~ 100-dB dynamic range

Contrast to 0.5 ns before the peak with 1.5-kJ,  
10-ps pulse duration relative to 10-ps pulse



The pedestal contains approximately  $10^{-4}$  of the main pulse energy (~150 mJ).

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