Status of the OMEGA EP Laser System

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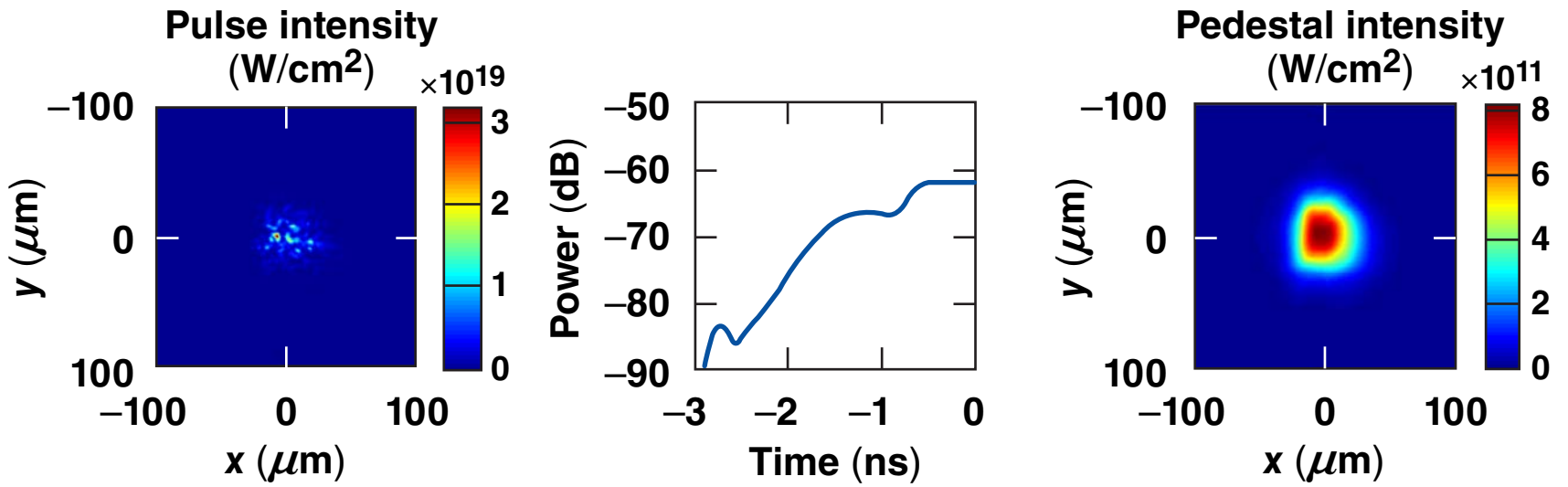
The OMEGA EP intensity contrast of the order of 10^8



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Chicago, IL
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Summary

The performance of OMEGA EP continues to improve

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- LLE is working to bring OMEGA EP to its design energy specifications
  - new UV optics are being procured
  - the gratings in one of the short-pulse beamlines are being replaced
  - a new programmable spatial light modulator is being installed in the front end to improve the fill factor and reduce near-field modulations
- The on-shot focal-spot information is being provided routinely to Users
- New on-shot contrast diagnostics are installed and new techniques to improve the temporal contrast are being developed

OMEGA EP is well on its way to being a well-characterized and effective User Facility.

Collaborators

S.-W. Bahk, J. Bromage, C. Dorrer, J. H. Kelly,
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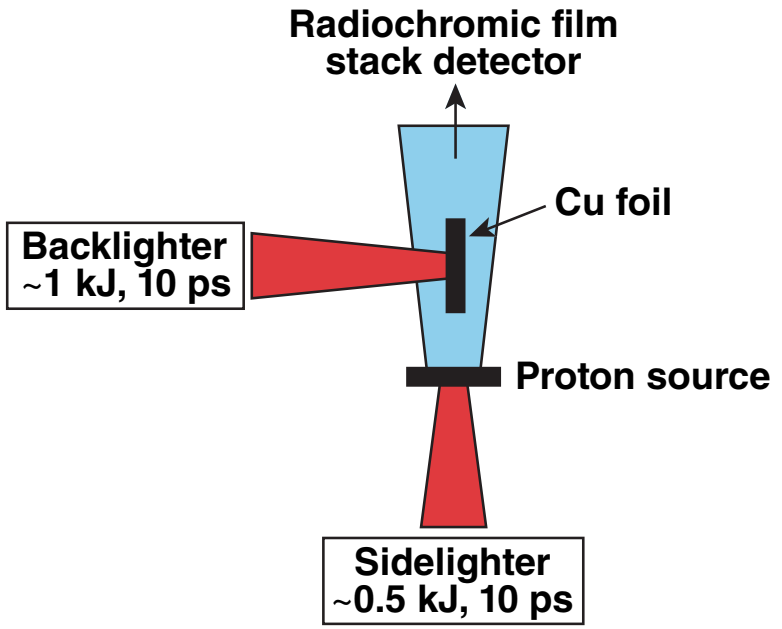
J. Qiao, C. Stoeckl, and L. J. Waxer

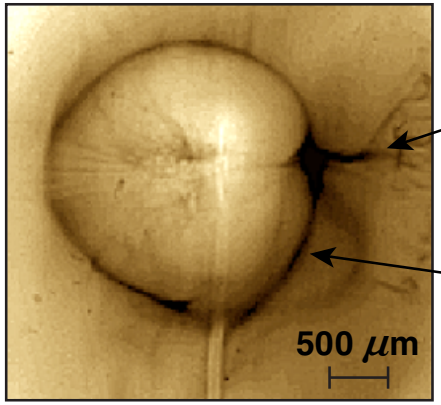
Laboratory for Laser Energetics
University of Rochester

OMEGA EP has performed >1000 target shots for a variety of experiments since its completion in April 2008

- Target shots to date (through October 2010)
  - 750 short pulse only (188 to Ω TC)
  - 200 long pulse only
  - 78 combined short and long pulse
- Scientific advances enabled
  - integrated fast ignition
  - positron production
  - proton radiography

Proton radiography measurements of target charging





P. M. Nilson *et al.*, "Scaling Hot-Electron Generation to High-Power, Kilojoule-Class Laser–Solid Interactions," Phys. Rev. Lett. accepted, and TI3.00003 (2010).

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OMEGA EP is aggressively working to meet its design specifications

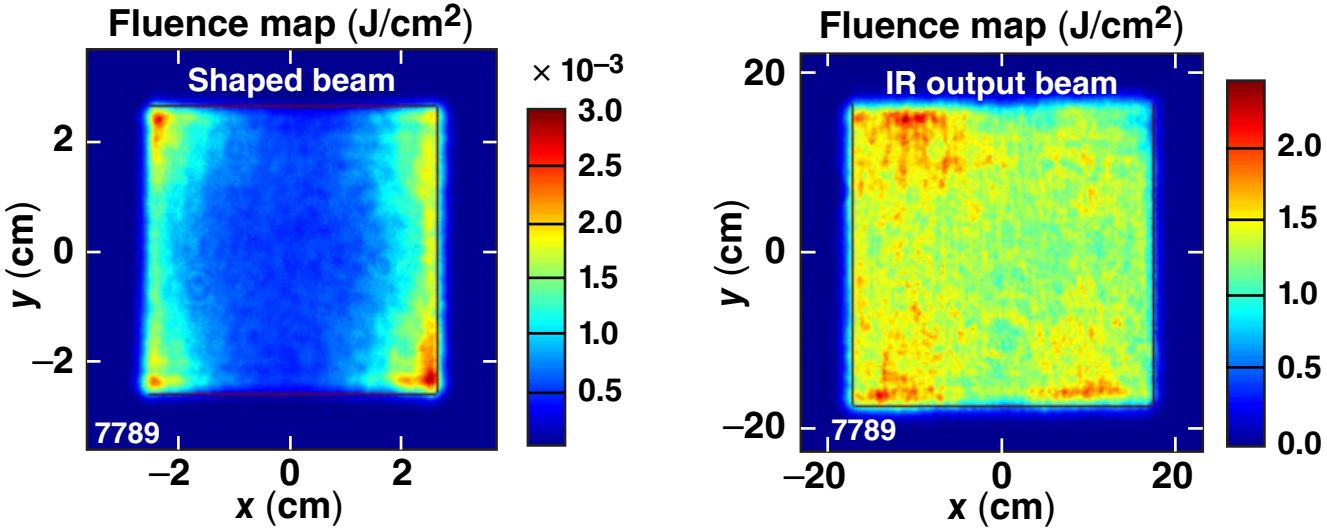
	Design	Current
Peak IR Power at 0.6 ps	1 PW (600 J)	0.5 PW (300 J)
IR Energy for ≥ 10 ps	2.6 kJ	1.0 kJ
UV Energy for τ = 3 ns	3.2 kJ_{UV}	1.6 kJ_{UV}

Challenges

- Increase short-pulse damage threshold of gratings and transport optics (include replacing compression gratings, Fall 2010)
- Optimize beam fill factor and minimize beam modulation
- Minimize on-target focus-spot size
- Minimize prepulse
- OMEGA EP's UV operating envelope may be limited by optical damage thresholds, cost, and procurement times

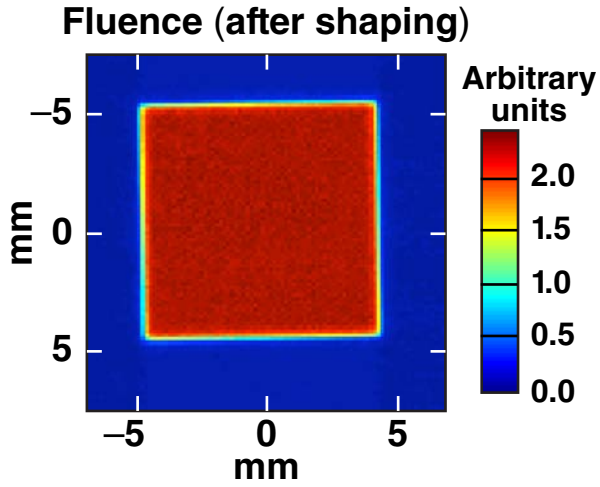
OMEGA EP is evolving its capability to compensate gain nonuniformity and optimize beam quality

Current approach: Static beam shaping with an apodizer



Improved approach: A programmable spatial-light modulator will refine the statically shaped beam (March 2011)

Hamamatsu LCOS-SLM
Area: 12 × 16 mm^2
Resolution: 600 × 792 (20-μm pixel)
Dynamic range: 2 waves



Beam-shaping results from prototype testing

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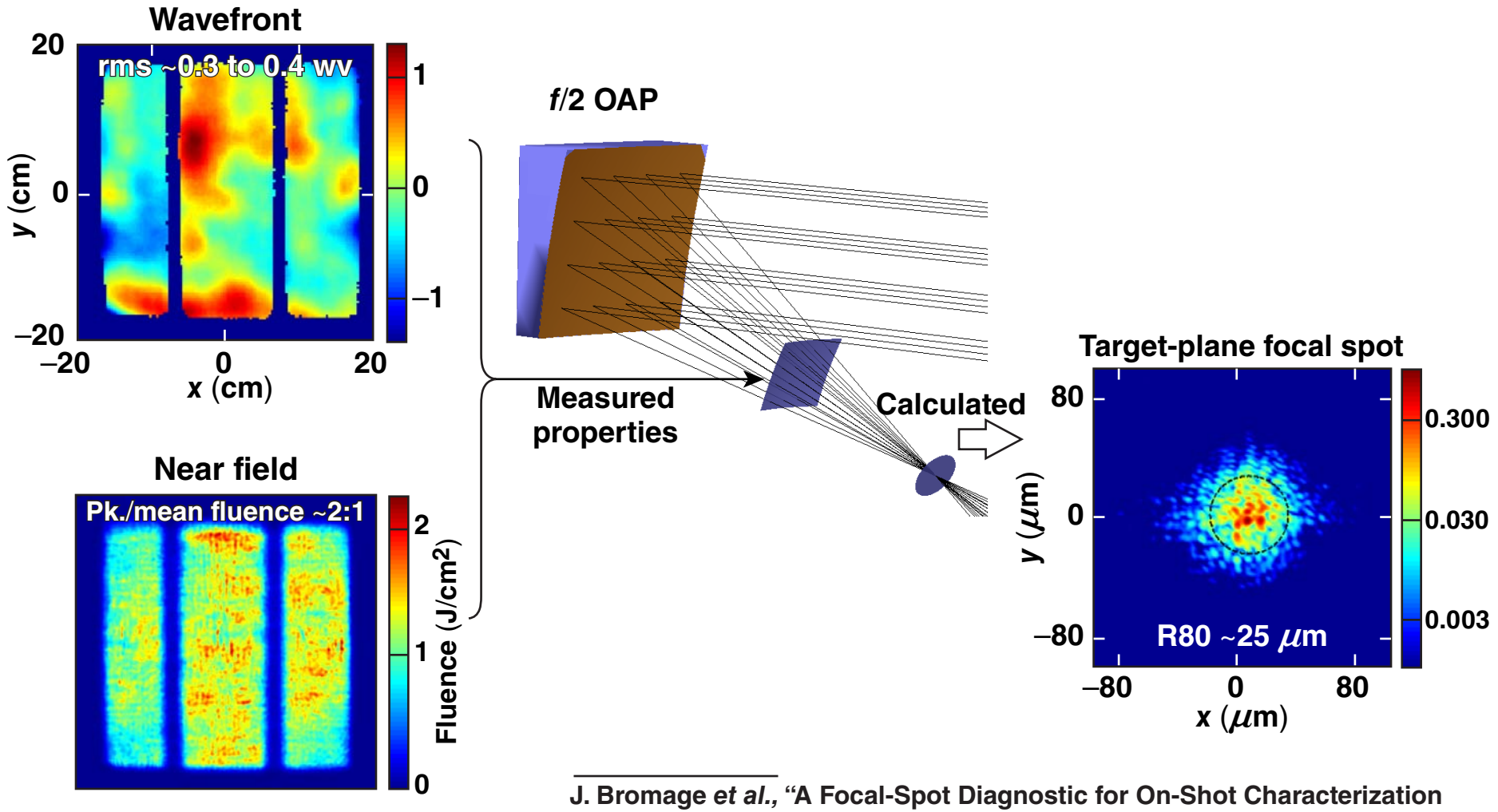
Diagnostics and analytical tools are used to provide a focal-spot measurement to the Principal Investigators



J. Bromage *et al.,* "A Focal-Spot Diagnostic for On-Shot Characterization of OMEGA EP," ICUIL 2008, Shanghai-Tongli, China, 27 October 2008.
B. Krushvitz, ICUIL 2010

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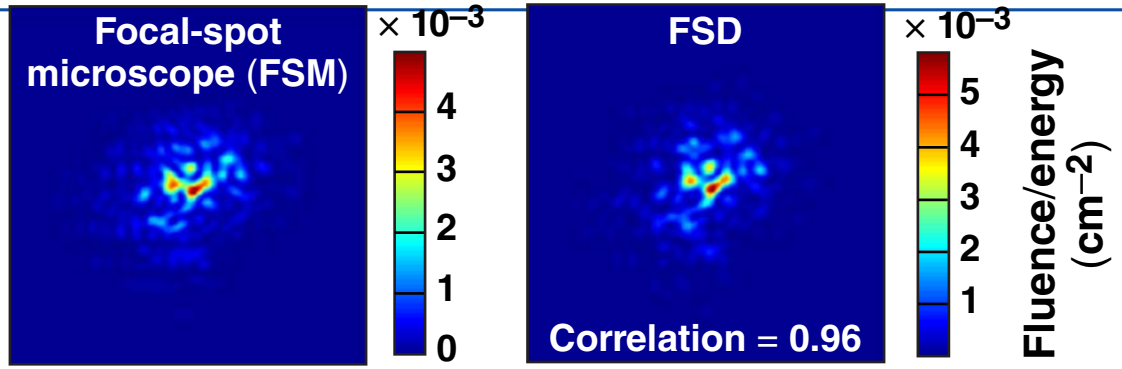
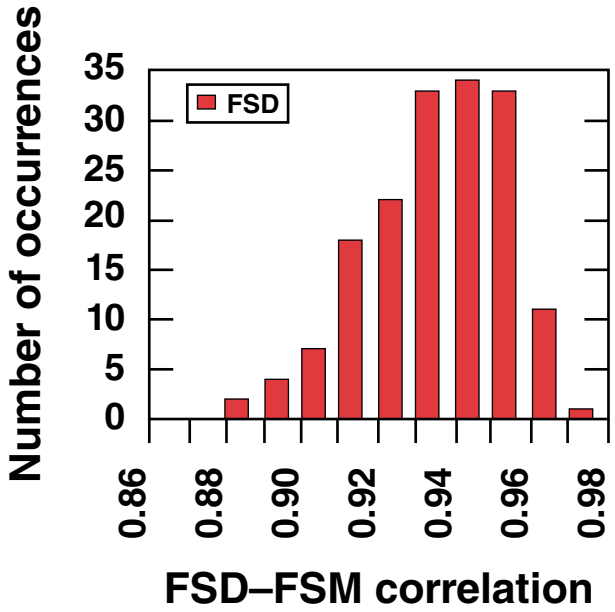
The focal-spot measurement accuracy was confirmed with direct target-plane microscope images in low-energy qualification testing



Statistics for all low-energy FSM shots



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Significant work is being devoted to measuring and improving the OMEGA EP temporal contrast

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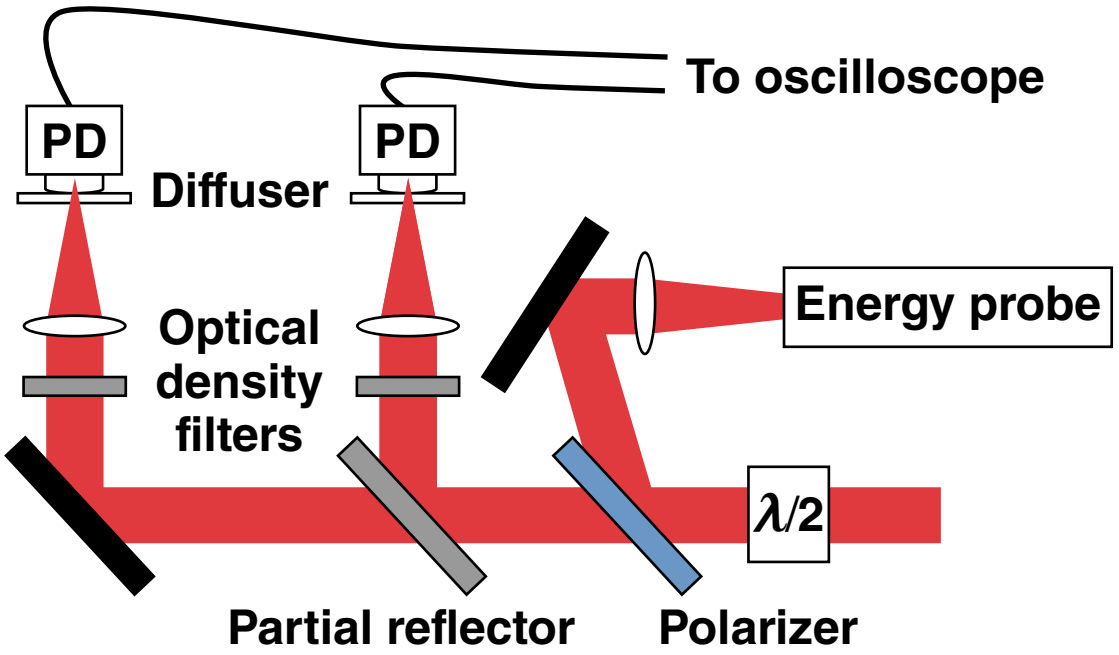
- On-shot diagnostics to measure the contrast to the 100-dB level have been developed and are being implemented
  - the contrast up to 500 ps before the pulse is measured by photodiodes
  - a single-shot cross-correlator is being installed to measure the contrast in the final 500 ps
- Laser technologies to improve the contrast are being developed
  - an ultrafast optical parametric amplifier will increase the nanosecond contrast by a factor of ~300
  - the contrast in the final 200 ps will be improved through the use of a narrowband filter in the pump laser

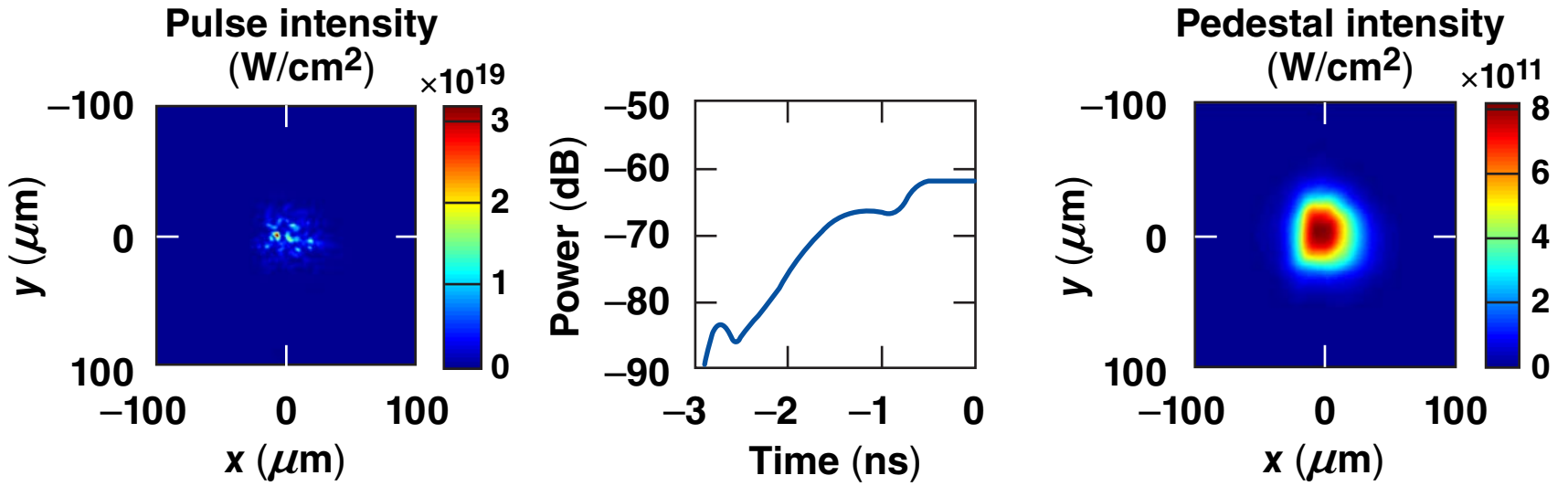
The current on-target intensity contrast is on the order of 80 dB (10^8).

The on-shot OMEGA EP nanosecond contrast is measured with calibrated fast photodetection



- Consistent contrast measurements obtained using precalibration and knowledge of on-shot filtration and reference energy
- Two simultaneous measurements per beamline
- Diagnostic performance:
  - temporal resolution: ~200 ps
  - dynamic range: 90 dB
  - temporal range: >1 μs

The on-shot focal-spot and power-contrast measurements lead to the on-shot intensity contrast



Shot 8061 Contrast data (dB)	Energy Contrast	Power Contrast	Intensity Contrast
	48	67	80

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