

1st Asia-Pacific Conference on Plasma Physics, 18-23, 09.2017, Chengdu, China

10²² W/cm², 0.1 Hz, High-Contrast J-KAREN-P Laser Facility at QST

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The J-KAREN-P laser facility [1] can provide PW peak power at 0.1 Hz. It is based on the generation of short pulses of 30 fs and energy of 30 J after compression. The contrast of the generated pulses is better than 10¹² and the final focused intensity is higher than 10²² W/cm². Such performance in high field science will give rise to the birth of new applications and breakthroughs, which include relativistic particle acceleration, bright x-ray source generation, and nuclear activation.

The key points of the J-KAREN-P laser system architecture are: 1) the high contrast front-end source based on a combination of some saturable absorbers and low gain OPCPA configuration, 2) the main amplification composed of four moderate gain Ti:sapphire amplifiers, employing simple off-axis beam expanders with low aberration, 3) the adaptive control of the residual spectral phase based on a high dynamic range Dazzler and the active wavefront correction based on a deformable mirror, 4) the main compressor stage based on four high quality large sized gold gratings.

Figure 1 shows the measured dependence of output broadband energy from the final amplifier, which uses a 120 mm diameter Ti:sapphire crystal, on the total pump energy at a 0.1 Hz repetition rate. The maximum output energy of 63 J is achieved with an incident energy of 92 J.

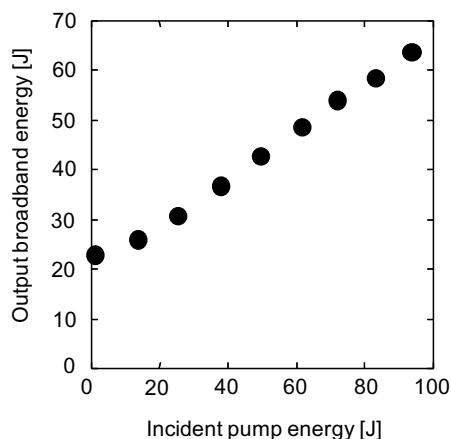


Fig. 1. Output energy from final amplifier.

The amplified pulses are up-collimated to ~280 mm diameter and finally compressed in the compressor consisting of four 1480 grooves/mm gold coated gratings of 565 x 360 mm². The measured spectrum has a bandwidth of ~50 nm (FWHM). The obtained recompressed pulse duration is less than 30 fs. The peak power is expected to be over PW at 0.1 Hz on target, because the beam-line throughput from the laser room to

the target chamber including the compressor is ~60 %. The contrast at less than 200 ps before the main pulse is 3 x 10⁻¹² (detection limited) as shown in Fig. 2. With an f/1.3 off-axis parabolic mirror, according to measurements of the focal spot and energy contained within it, a peak intensity of 10²² W/cm² on target is achieved at the 0.3 PW power level.

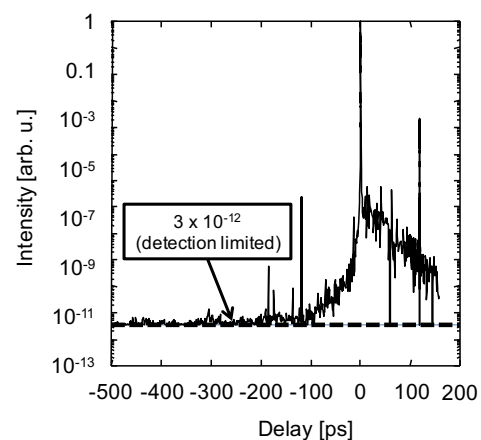


Fig. 2. Temporal contrast.

The J-KAREN-P laser system at QST is one of the leading facilities in the provision and application of ultra-high intensity lasers for the broad community. The J-KAREN laser has been used in a variety of pioneering and cutting-edge research, which have resulted in high impact discoveries for high field science [1-5].

References

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