# HIGH-POWER LASERS

1 femtosecond = 1/1,000,000,000,000,000 seconds.

If light travels 300,000 km in one second, in one femtosecond it travels just 0.3 micrometers, which is roughly the size of a virus.

1 petawatt = 1,000,000,000,000,000 watts.

1 petawatt is approximately equivalent to 80 times the average power consumption of the whole world.

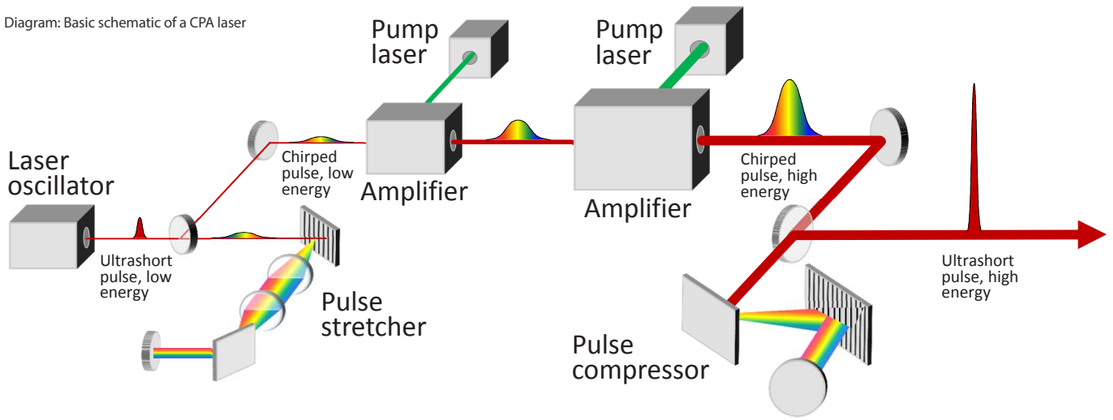
## Technology

The EuPRAXIA laser will produce ultrashort pulses of infrared light with durations of a few tens of femtoseconds and energies up to 100 joules, yielding a peak power of several petawatts (1 PW = $10^{15}$ W).

CPA laser amplifiers use gain media which are capable of supporting amplification over a large bandwidth. The most versatile gain media available today is titanium doped sapphire (Ti:Sa).

High-power laser pulses are produced using the Chirped Pulse Amplification (CPA) technique. In a CPA laser the pulses are stretched, amplified, and then compressed down to the original duration. In this way, the energy of the pulses can be safely amplified while maintaining their power below the damage threshold of the different optical components.

Diagram: Basic schematic of a CPA laser




EuPRAXIA

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## Challenges & Innovation potential of EuPRAXIA

### High repetition rate PW lasers and pump laser technology

A low repetition rate yields an average electron flux that is too low for some practical applications.

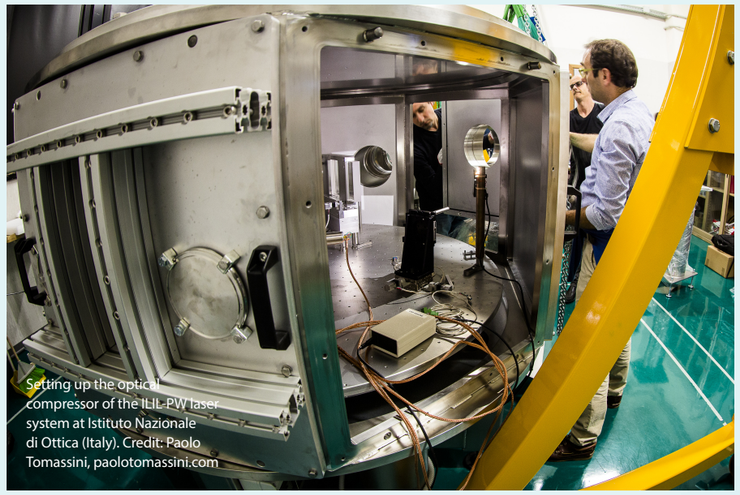
The main impediments for high-repetition rate and high-power lasers are the efficiency of the pump lasers and the thermal load on the laser crystals.

### Stabilized PW laser technology

The mechanical miniaturization of the systems leads to a much reduced tolerance in stability. EuPRAXIA investigates the limits and designing solutions that will improve the stability of the lasers.

### The $100^3$ Challenge

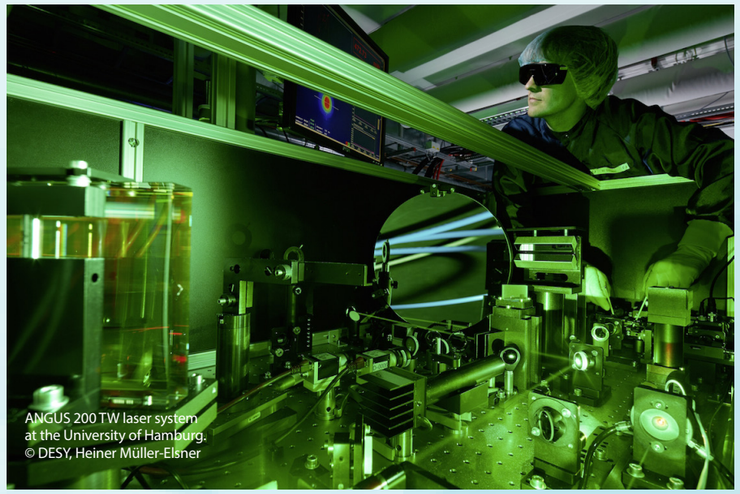
EuPRAXIA has set the "$100^3$ challenge": the design and construction of a laser capable of delivering pulses of **100** femtoseconds duration, with an energy of **100** joules, at a repetition rate of **100** hertz.



Setting up the optical compressor of the ILIL-PW laser system at Istituto Nazionale di Ottica (Italy). Credit: Paolo Tomassini, paolotomassini.com

### Ultrafast synchronization, electronics and correction loops

The timing and the accuracy required for a plasma accelerator are in the femtosecond domain. Ultra-precise timing reference systems and correction feedback loops must react before operational limits are violated.



ANGUS 200 TW laser system at the University of Hamburg. © DESY, Heiner Müller-Elsner

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