13.11.2019

Generation and Applications of Ultrahigh-Intensity Laser Pulses

Problem Set 3

Laser Intensity

1. How to not destroy your mirrors

The ATLAS-3000 laser delivers pulses of 60 J energy at 1 Hz repetition rate. The beamline mirrors have a damage threshold of about 150 mW/cm^2.

- Which minimum diameter is needed for a beam with gaussian intensity profile to stay below 50 % of this threshold? Which mirror size is required?
- How does this situation change for a top hat beam, i.e. a beam with uniform intensity within a circular disk?

2. Focus size of a Gaussian beam

- Explain how the f number of a focusing optic is related to the Rayleigh length z_R and beam waist w_0 in focus for a gaussian beam.
- Calculate z_R and w_0 for a laser with 800 nm central wavelength and an $f/30$ focusing optic.

3. Field Strength of Ultrahigh-Intensity Pulses at Focus

Assume a laser that generates light pulses of 20 fs duration at full width at half maximum (FWHM) and 60 J pulse energy. The laser pulses have a central wavelength of $\lambda = 800\,\text{nm}$.

- Assume that the laser will be focused using an $f/30$ optic. What is the peak intensity for (a) a gaussian beam profile and (b) a top hat beam profile?
- What are the peak electric fields at these intensities?
- Which energies can an electron gain over one half-cycle of the laser? Which energies would an electron gain if accelerated by these fields over the Rayleigh length of $f/30$?
- What does this imply for the behavior of matter at ultra-high intensities?

Please remember to register for the lecture by sending an E-Mail to: `a.doepp[at]lmu.de`