Towards High Harmonic Generation in Laser-Produced Tin Plasma

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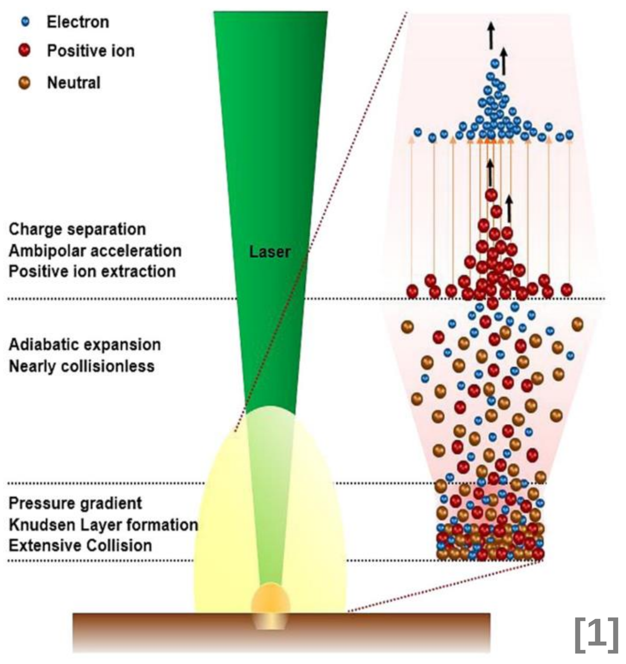
Abstract

Next-generation nanolithography devices use extreme ultraviolet (EUV) radiation, produced by a laser-produced plasma (LPP) in tin. The EUV emission characteristics of this LPP depend strongly on the plasma properties. Therefore we aim to investigate the spatial and temporal distribution of the different charge states in the tin plasma plume. For this purpose, we are developing a pump-probe experiment in which high harmonics (HH) are generated in a LPP and afterwards analysed in a spectrometer. A picosecond laser pulse will be used as a pump pulse to generate plasma. Additionally, a femtosecond pulse from a home-built optical parametric chirped pulse amplification (OPCPA) system operating at 1550 nm wavelength with tuneable pulse duration and energy will be used to generate the HH.

Motivation: HHG as a Probe of Tin LPPs



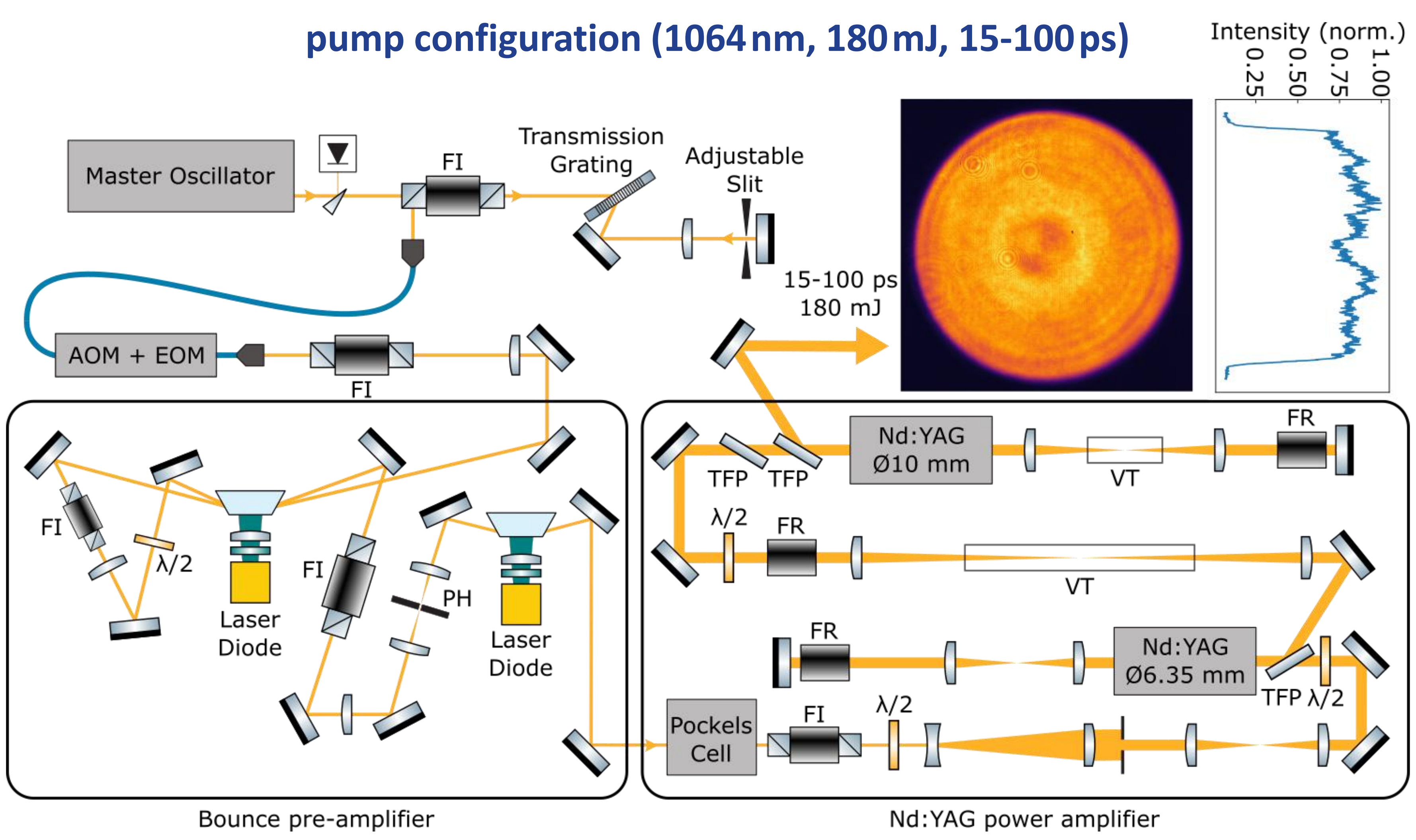
[1]

Our focus is to probe the spatial and temporal charge state distributions within laser produced tin plasmas. The HHG phase-matching is strongly dependent on different charge states and electron densities.

Experimental parameters:
- **Pump pulse: 1064 nm, 100 ps, E < 100 mJ, for LPP**
- **Probe pulse: 1550 nm, 200 fs, E = 10 mJ, for HHG**

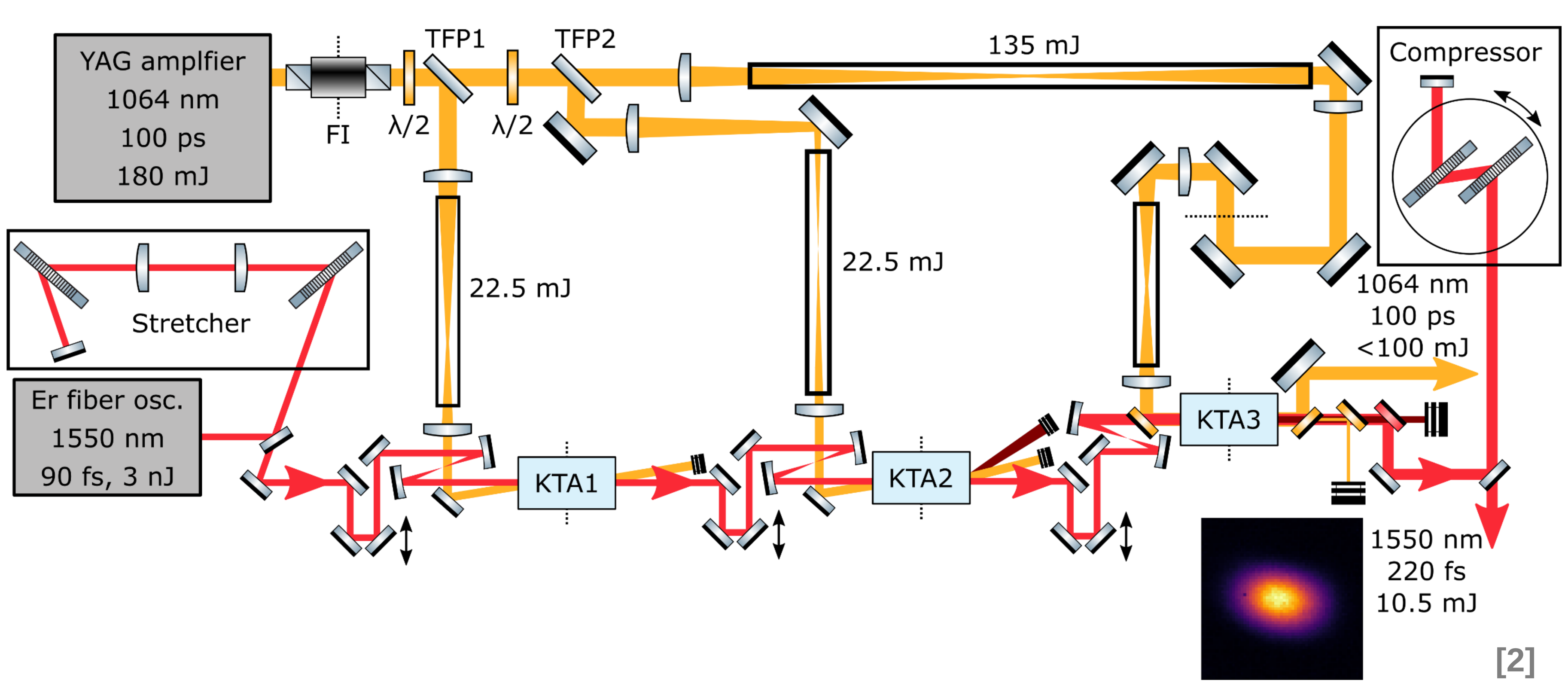
OPCPA and Pump Laser System

pump configuration (1064 nm, 180 mJ, 15-100 ps)



[2]

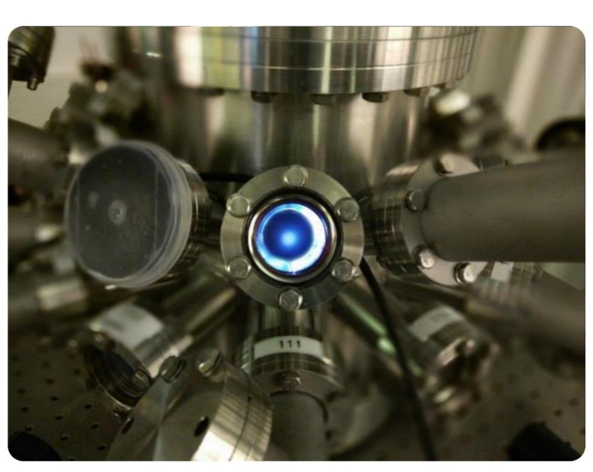
OPCPA configuration (1550 nm, 10.5 mJ, 220 fs)



[2]

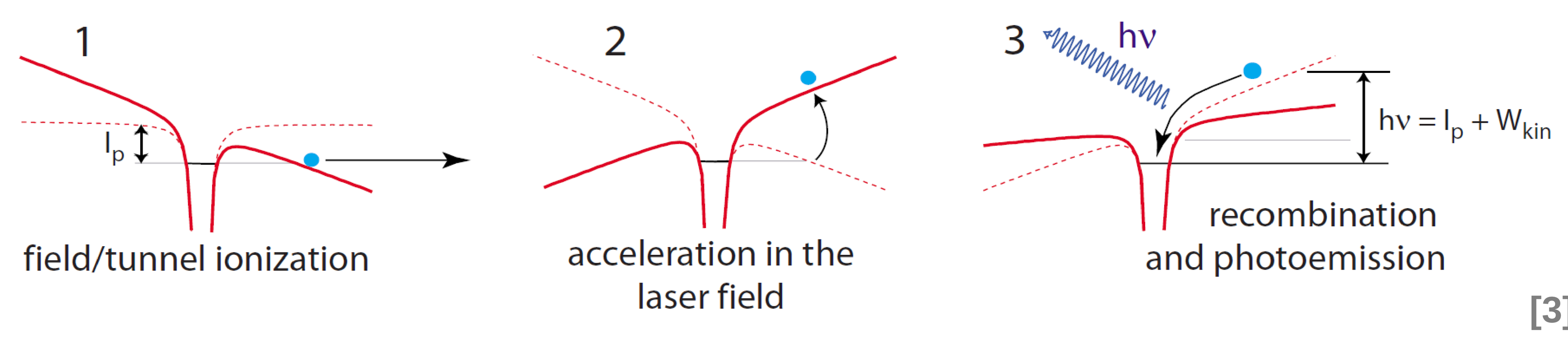
Current and Future Work

- **Re-aligning laser system after move to a new building**
- **Planning and building of the experimental setup**
- **Start experiments with different**
  - **Laser energies**
  - **Pulse delays**
  - **Laser wavelengths**
  - **Focus positions**



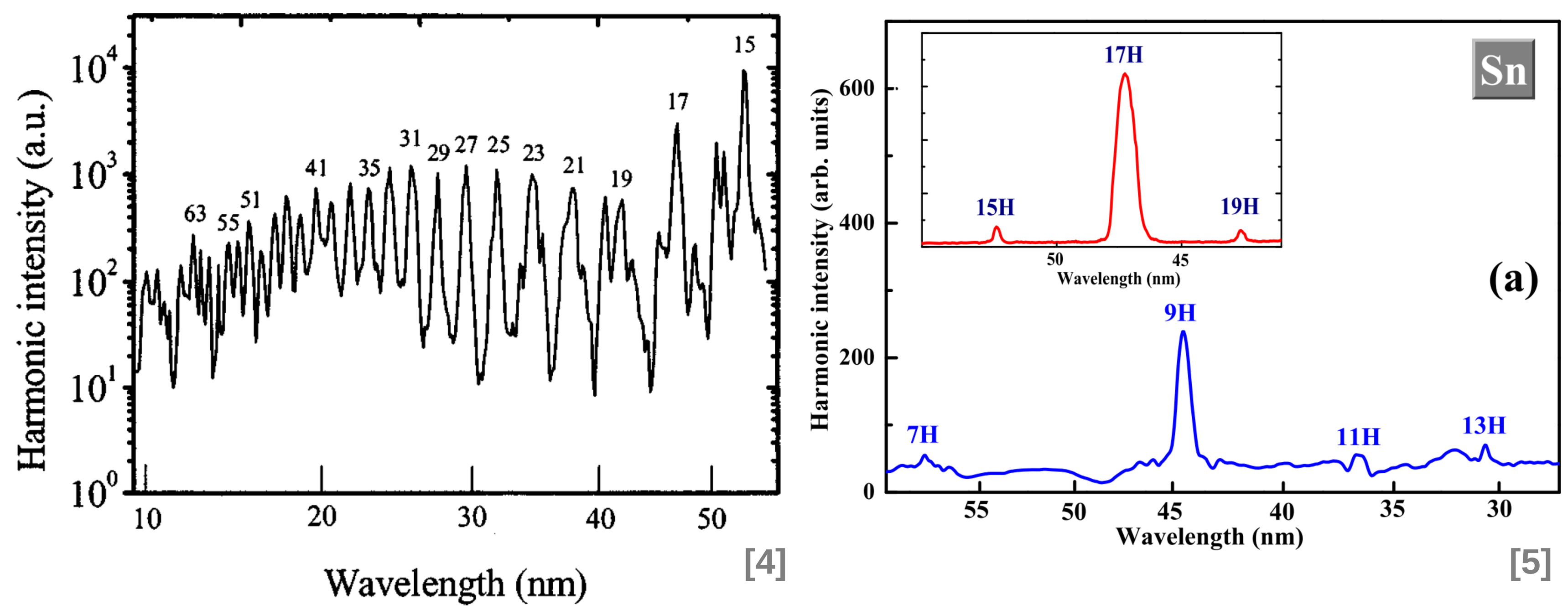
High Harmonic Generation

General three-step model



[3]

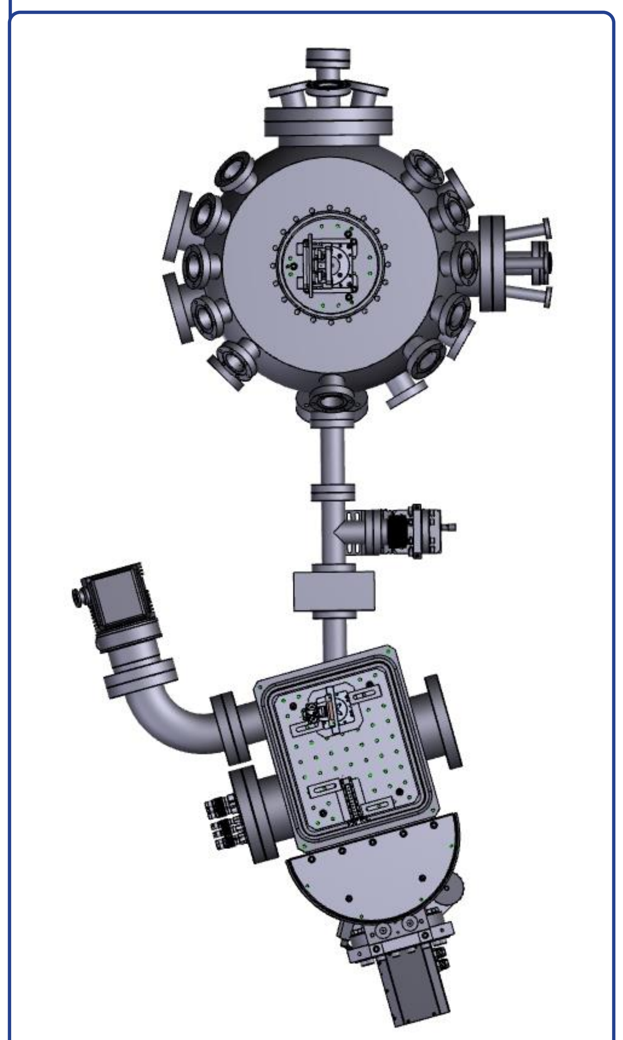
HHG in laser produced plasmas

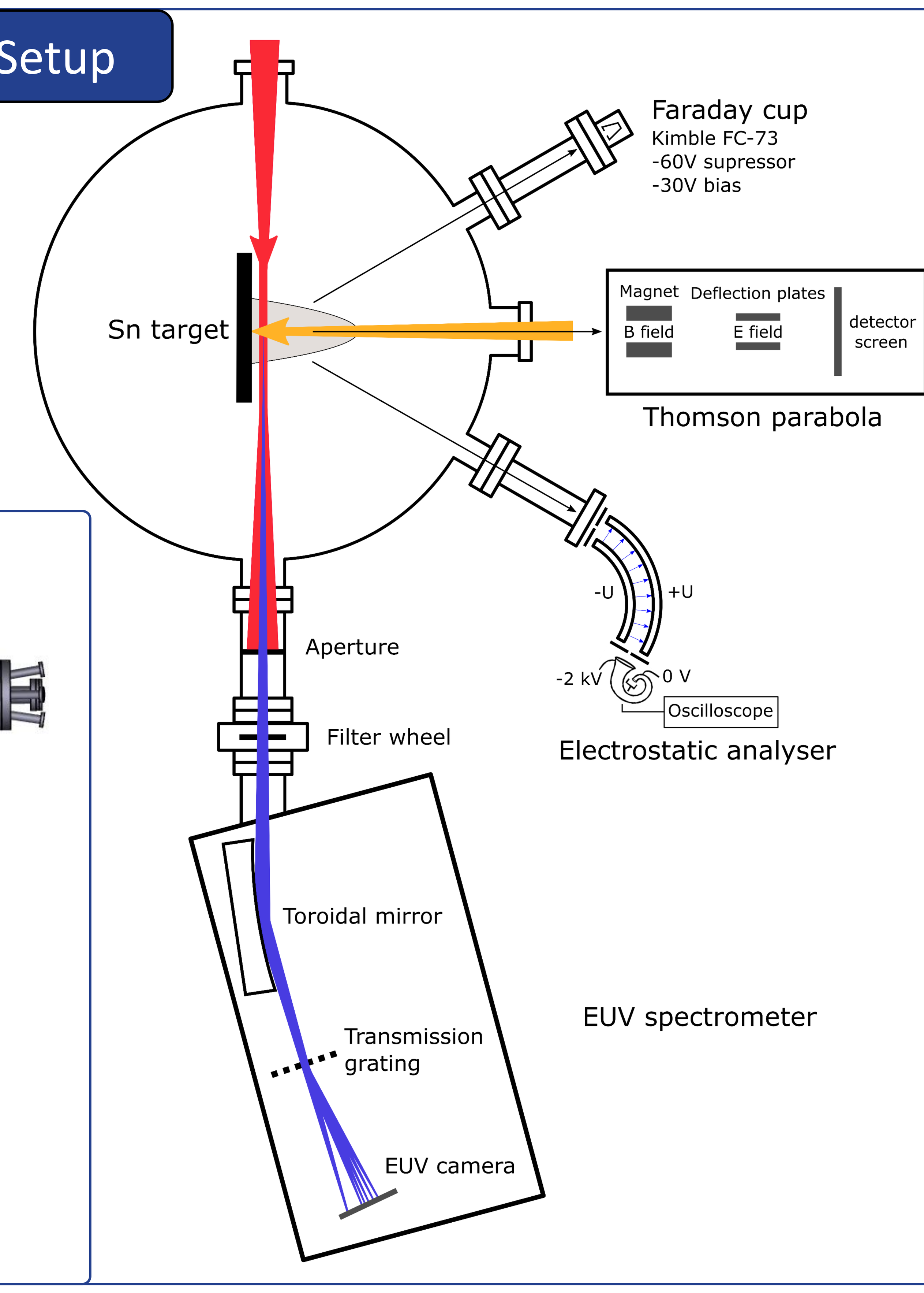


[4] [5]

To study the laser-plasma interaction dynamics we will probe the spatial and temporal charge state distributions within laser produced tin plasmas by analyzing HH spectra generated at different positions and pump-probe delays. Successful HHG in LPP has been shown in many different materials, e.g. boron and tin [4,5]. Additionally, the intensity of single harmonics can be increased by resonance enhancement [5].

Experimental Setup





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