

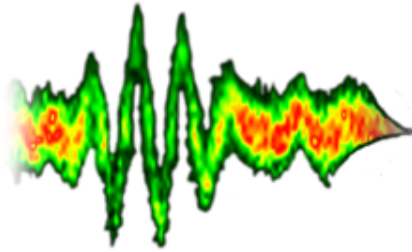
Temporal Characterization of High Harmonics Generated in High-Intensity Laser-Solid Interactions

R. Hörlein

Max-Planck-Institut für Quantenoptik, Garching, Germany

and

Department für Physik, Ludwig-Maximilians-Universität München, Germany



Outline

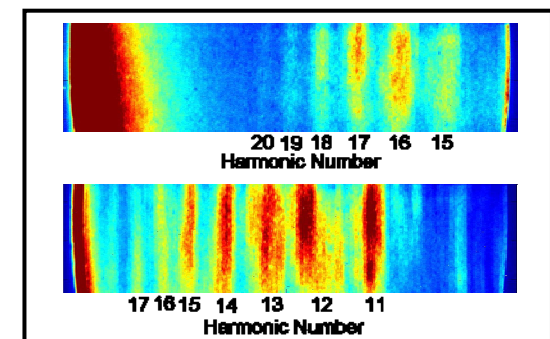
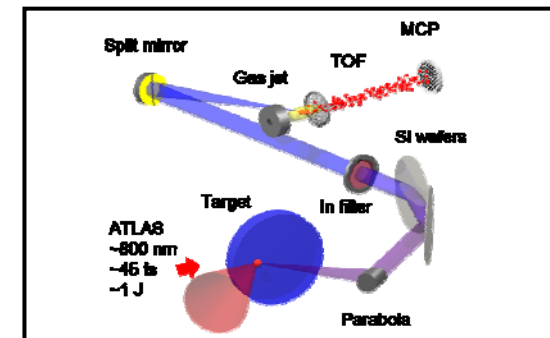
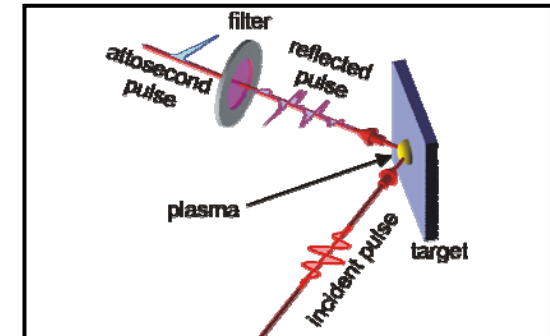
1. Introduction

- 1.1 Relativistic Oscillating Mirror
- 1.2 Coherent Wake Emission

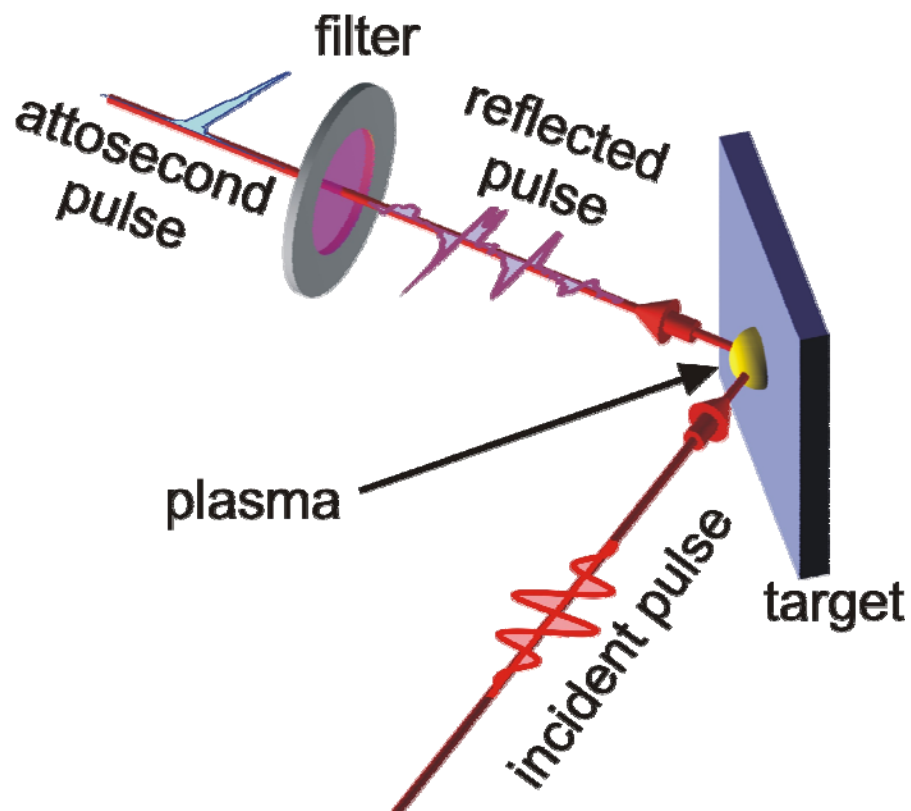
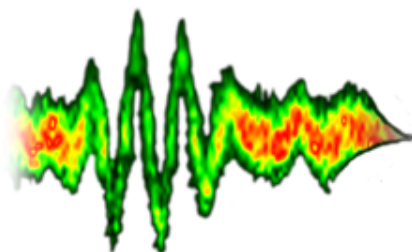
2. Temporal Characterization

- 2.1 Two-Photon Ionization Experiments
- 2.2 XUV - Autocorrelation

3. Conclusions and Outlook



1. Introduction



ATLAS Upgrade

Power:
8 TW / 25 TW

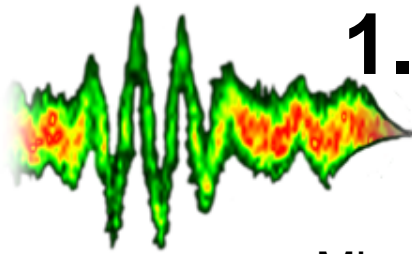
Energy:
350 mJ / 1.2 J

Pulse duration / rep. rate:
40 fs / 10 Hz

ASE contrast:
 1×10^{-8} @ -4 ps
 $> 10^{-10}$ @ -200 ps

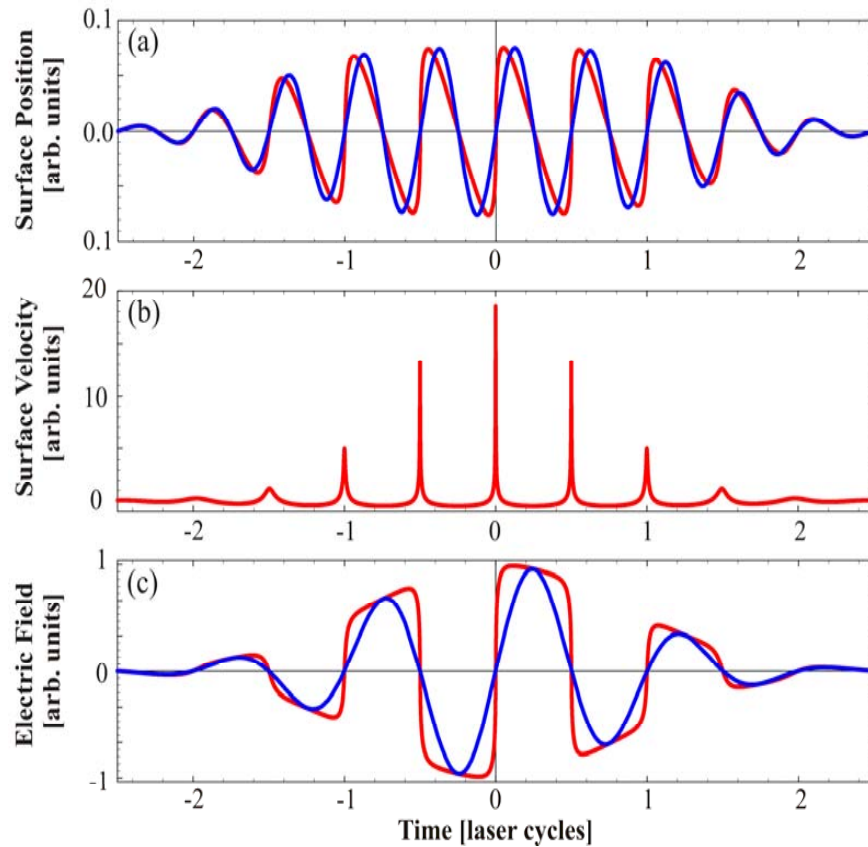
Focusability:
0.83 Strehl

Bandwidth:
25 nm

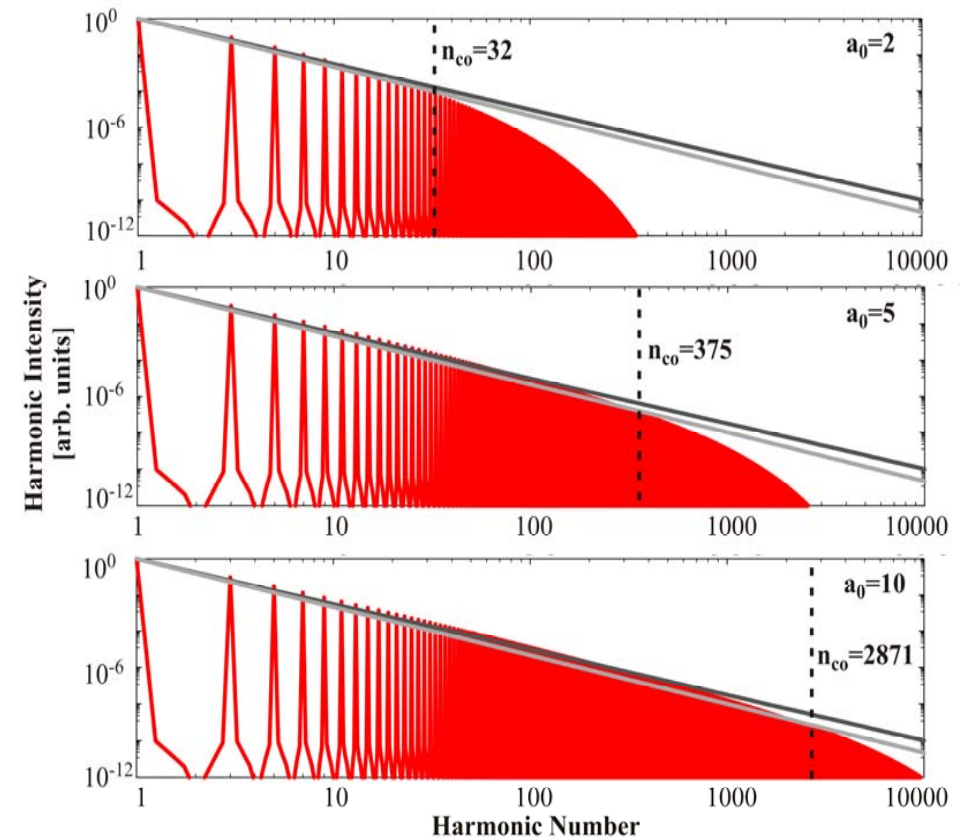


1.1 Relativistic Oscillating Mirror

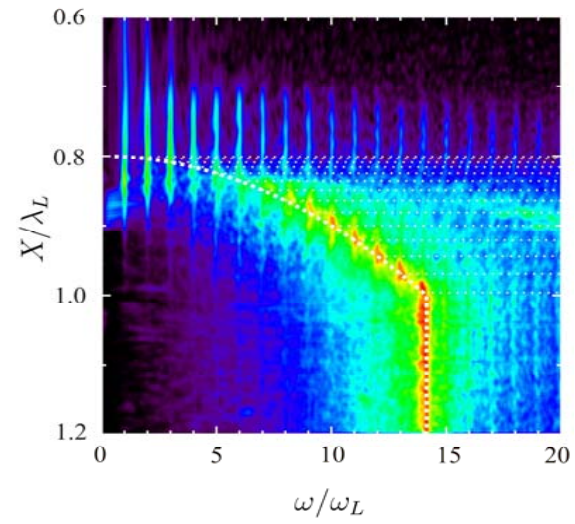
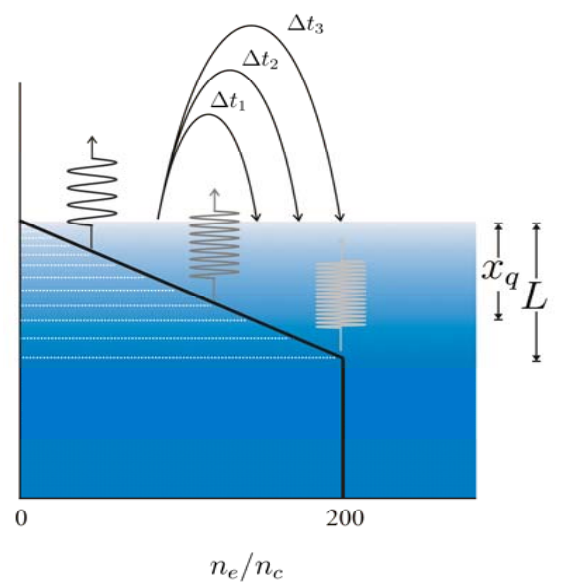
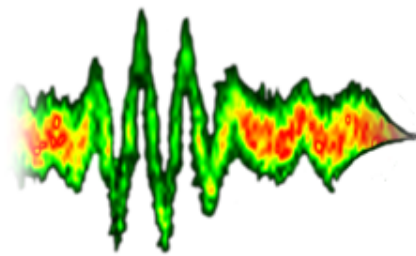
Mirror Motion:



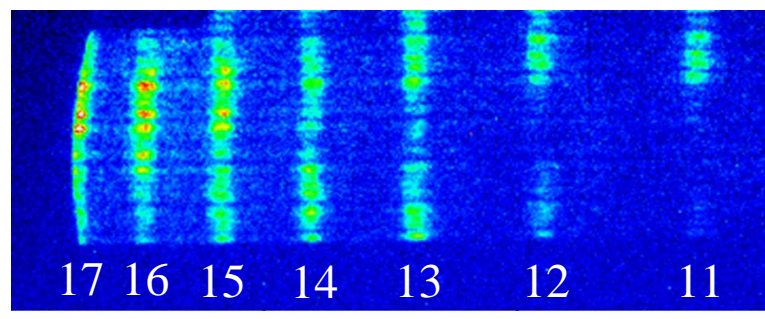
Harmonic Spectra:



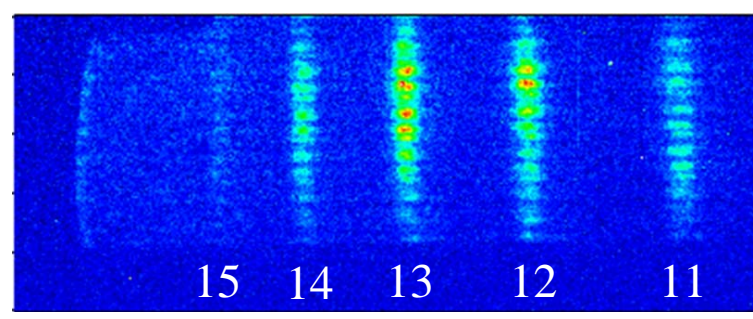
1.2 Coherent Wake Emission

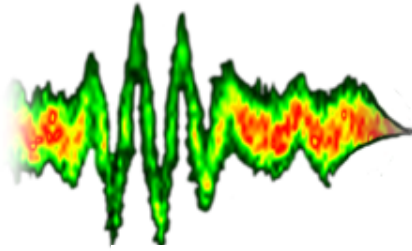


Glass Target (Density ⌚ 2.6 g/cm³):



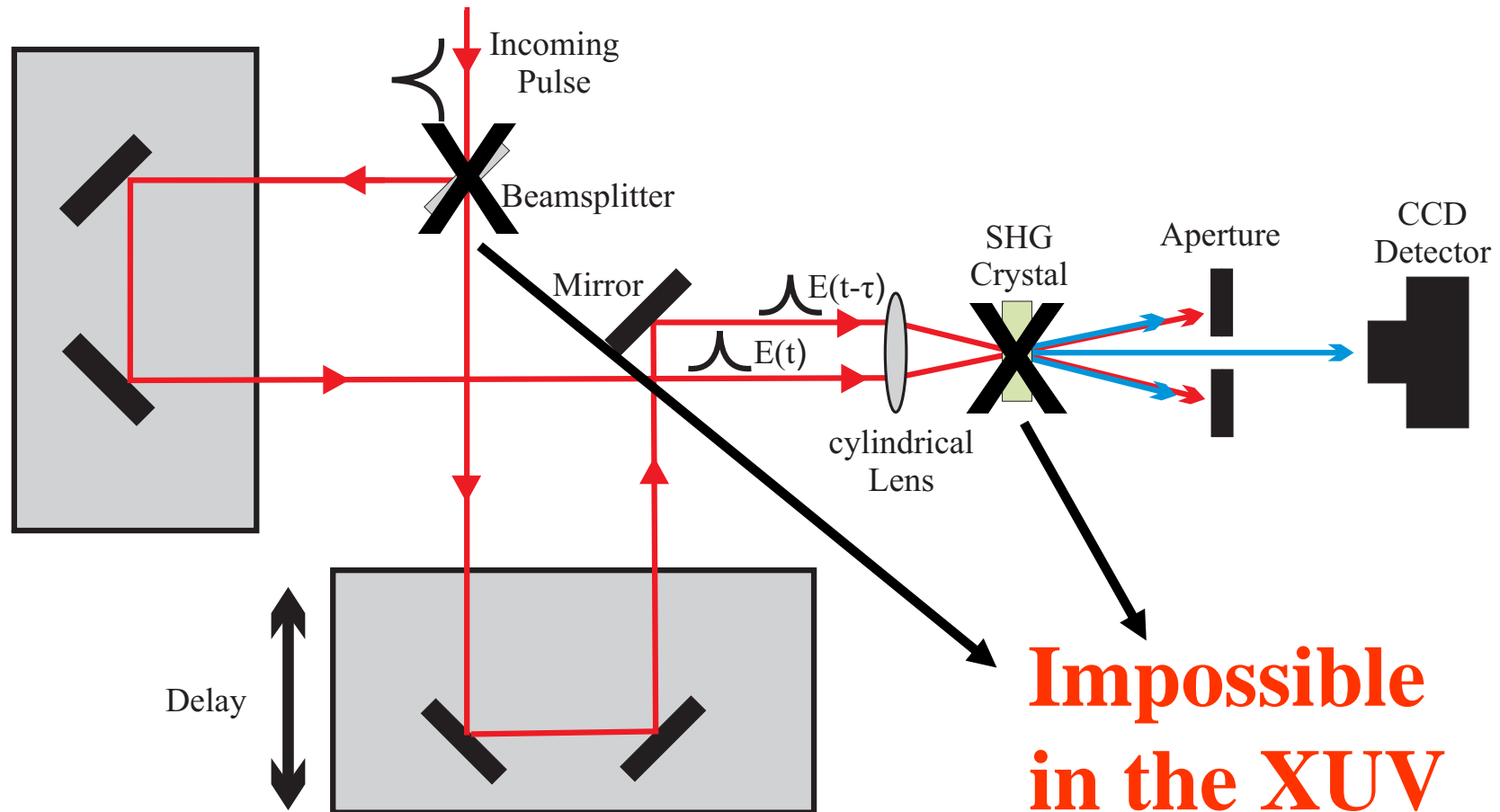
Plexiglass Target (Density ⌚ 1.3 g/cm³):





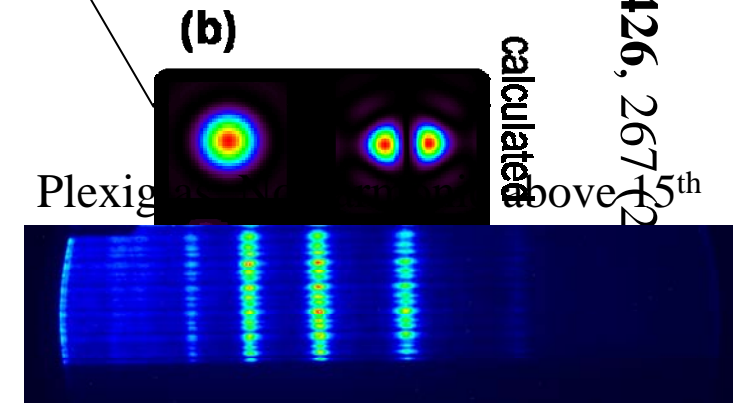
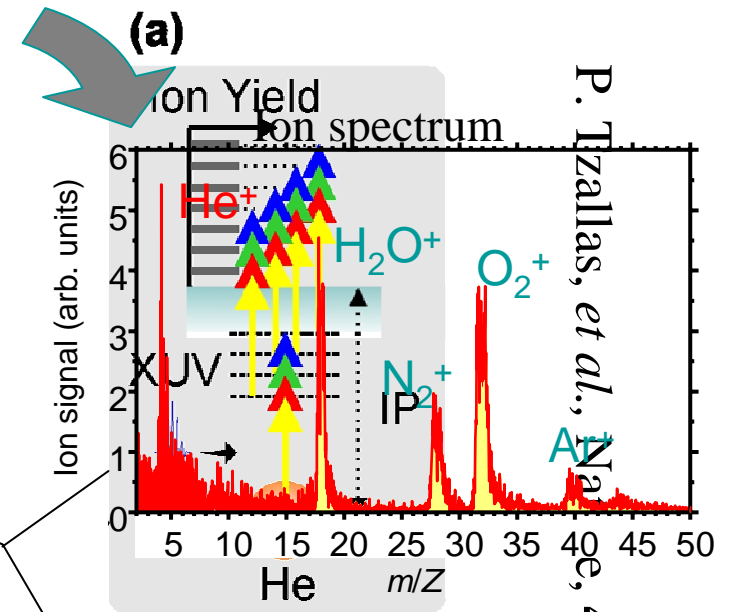
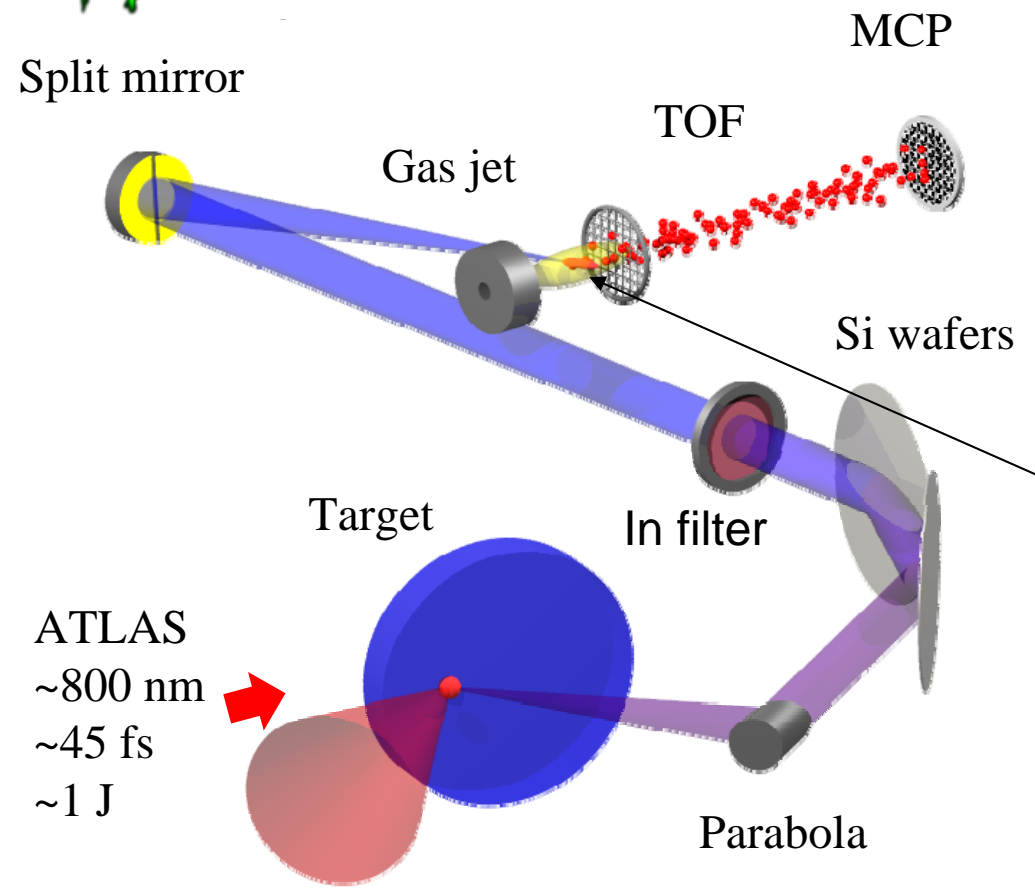
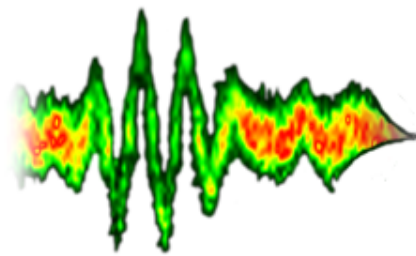
2. Temporal Characterization

Simplest Method second-order AC:

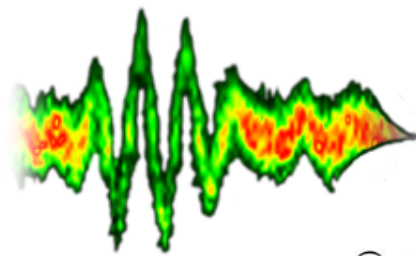


**Impossible
in the XUV**

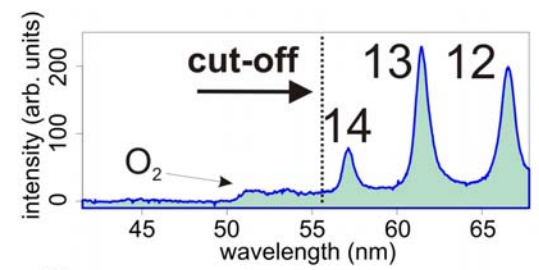
2. Temporal Characterization



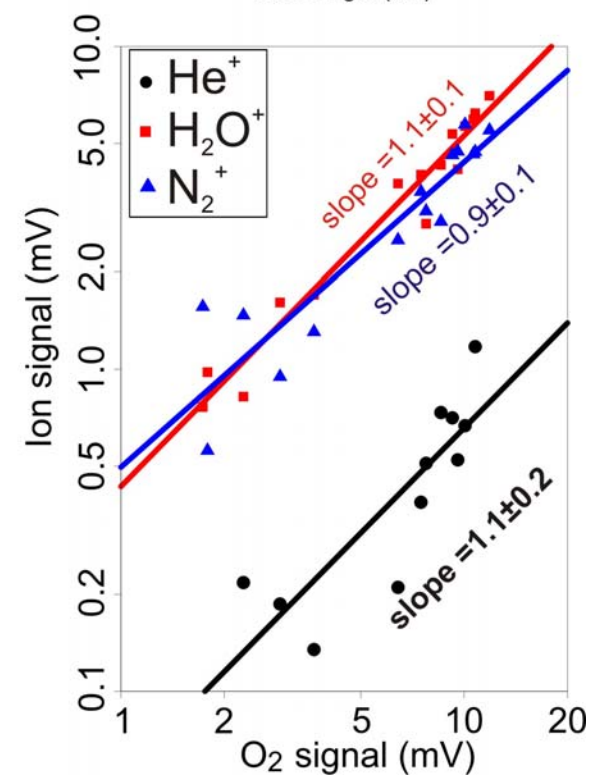
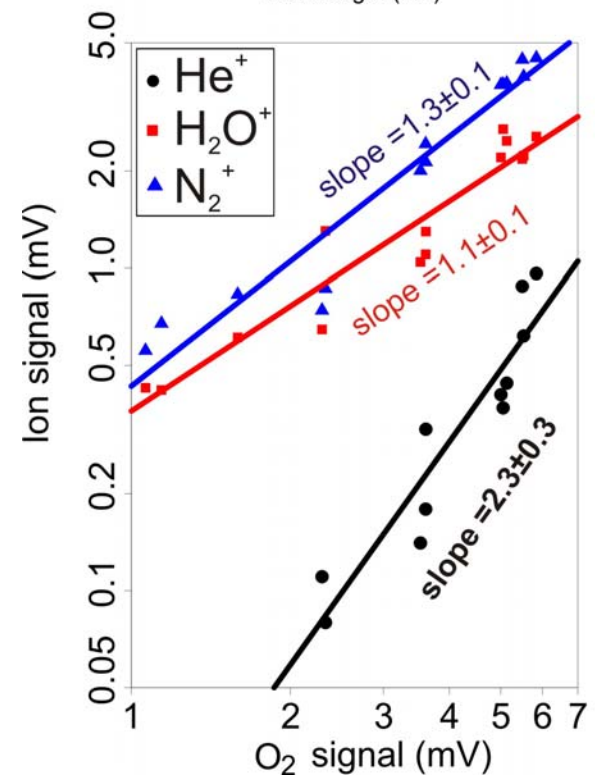
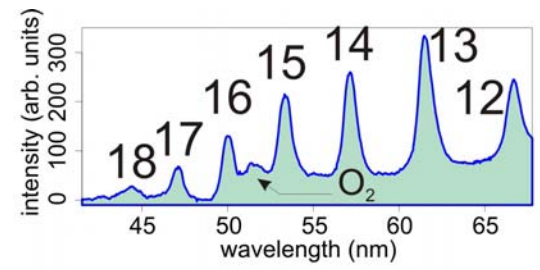
2.1 Two-Photon Ionization



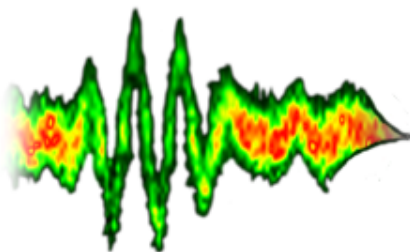
Low density target



High density target

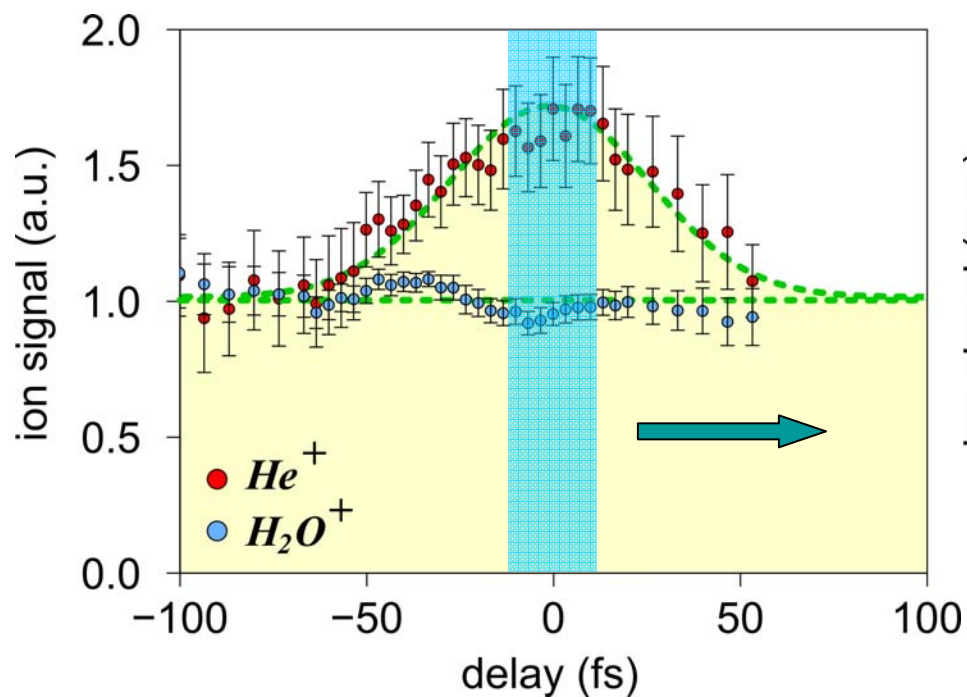


2.2 XUV - Autocorrelation

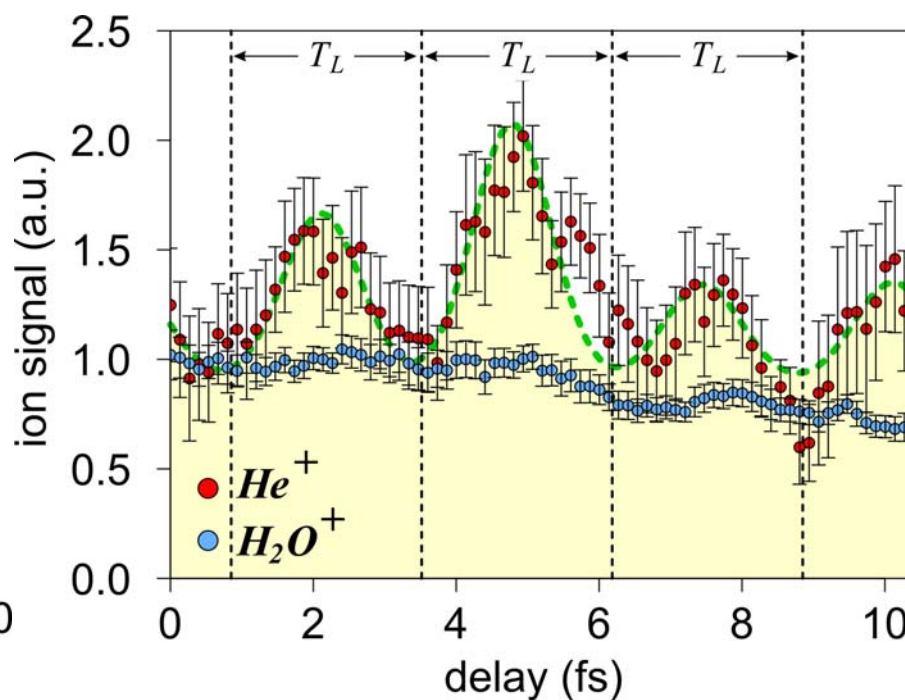


Coarse scan

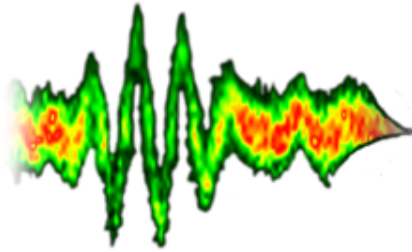
Fine scan



XUV emission duration ~ 45 fs

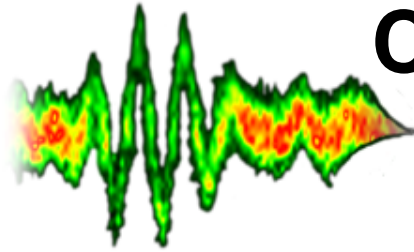


XUV pulse train with ~ 0.9 fs duration



3. Conclusion

- **Generation of high harmonics from a plasma-vacuum interface promises the generation of ultra-intense attosecond-pulses**
- **Recent experiments have demonstrated that surface harmonics are indeed phase-locked and emitted as a train of as-pulses**
- **The method offers the realistic prospect for a unique attosecond pulse source enabling XUV-pump XUV-probe studies of fast dynamic processes.**
- **First demonstration of surface-harmonic generation using a few-cycle laser opens the route toward the generation of single as-pulses**
- **Generation of single attosecond (zeptosecond?) pulses is within the capabilities of existing or just emerging laser technology.**




Contributors and Collaborators

MPQ / LMU

HHG-Experiments:

- **R. Hörlein**
- **Y. Nomura**
- G. D. Tsakiris
- F. Krausz

PIC-Simulations:

- **S. Rykovanov**
- M. Geissler 
- J. Meyer-ter-Vehn
- G. D. Tsakiris

ATLAS/LWS10:

- J. Osterhoff
- Zs. Major
- S. Karsch
- R. Hörlein
- L. Veisz

Collaborations

IESL, FORTH, Heraklion, GR:

- **P. Tzallas**
- D. Charalambidis



Queens University Belfast, UK:

- **B. Dromey**
- M. Zepf

