WORKPACKAGE

WP2: Non-linear XUV spectroscopy

Coordinators: Marc Vrakking (MBI); Xiaowei Chen (AMPL)

Period: 4-48 Month

WP2 will focus on the investigation of molecular and cluster dynamics through the use of intense **ultrashort XUV pulses generated by FELs or HHG**. While intense XUV pulses have now been used in FEL experiments for a few years, thanks to recent results in the generation of intense IR driving pulses, it now seems extremely realistic that reproducible intense isolated attosecond pulses generated by field-controlled (i.e. CEP stable) driving pulses will be available for use in **XUV pump-XUV probe experiments within the next few years**. This achievement will represent a major breakthrough in attosecond science and it will require close joint collaborations between the industrial and academic partners of the network. In this context, nonlinear attosecond experiments and attosecond XUV-IR studies will strongly benefit from the **investigations of molecules and clusters exposed to high XUV intensities that can be carried out in the femtosecond domain at FELs**. While established attosecond XUV-IR pump-probe techniques can be extended to large systems, new, challenging, **attosecond XUV-XUV experiments will have to be necessarily restricted to small, easy-to-prepare systems**.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 641789

DETAILS AND SUB WORKPACKAGES

WP 2.1 Femtosecond non-linear XUV spectroscopy

(ESR FREIB-2, ESR AU-2)

Experiments using intense XUV pulses generated by FELs (FERMI and FLASH)

WP 2.2 High-energy driving pulses for attosecond non-linear XUV spectroscopy

(ESR FORTH,ESR AMPL-2, ESR MBI-1)

Experiments using intense XUV pulses generated by table-top laser sources (FORTH, MBI, LUND)

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EARLY STAGE RESEARCHERS' PROJECTS IN WP

1) **ESR FREIB-2 Nonlinear XUV excitation of dimers and clusters (to be filled)**
   Supervisors: G. Sansone/F. Stienkemeier

2) **ESR AU-2 Ultrafast dynamics of doped helium droplets (James Pickering)**
   Supervisor: H. Stapelfeldt

3) **ESR FORTH XUV pump-XUV probe of electron correlation in H2/D2 (Javier Chamarro /Ioannis Makos)** Supervisor: D. Charalambidis

4) **ESR AMPL-2 High-energy CEP-stable pulses for nonlinear XUV spectroscopy (Michele Natile)**
   Supervisor: P. M. Paul -> X. Chen

5) **ESR MBI-1 Attosecond XUV pump-XUV probe spectroscopy (Nils Monserud)**
   Supervisor: M. Vrakking

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DELIVERABLES WP2

WP	Deliv.	Title	Lead Benefic.	Est. Del. date (annex I)	1st delivery date
WP2	D2.1	Influence of the environment on ultrafast electronic/nuclear dynamics	FREIB	31 Dec 2018	
WP2	D2.2	TW-level peak power laser system with CEP-stabilization	AMPL	31 Dec 2017	
WP2	D2.3	Attosecond XUV-pump-XUV-probe on molecules	FORTH	31 Dec 2016	23 Dec 2016
WP2	D2.4	Demonstration of coherent control schemes using XUV FELs	FREIB	31 Aug 2018	

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MILESTONES WP2

Number	Name	Lead Beneficiary	Delivery Date (Annex I)	Achieved	Del. Date (actual)
7	Award of beamtime at FELs-1	FREIB	01 Jul 2017	X	06.09.2016
8	Ultrafast pump-probe on helium droplets	AU	01 Jan 2017		
9	Energy stability of the intense isolated attosecond pulse by CEP-stable pulses	FORTH	01 Nov 2016		
10	Mechanical stability of new-designed optical mounts	AMPL	01 Jan 2017	X	21.12.2016
11	Photon flux in the XUV region	MBI	01 Jan 2016	X	21.11.2016

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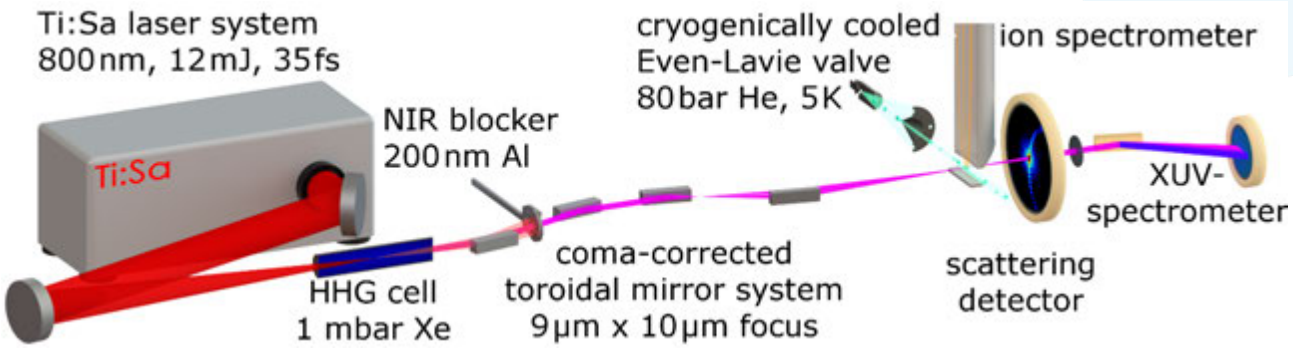
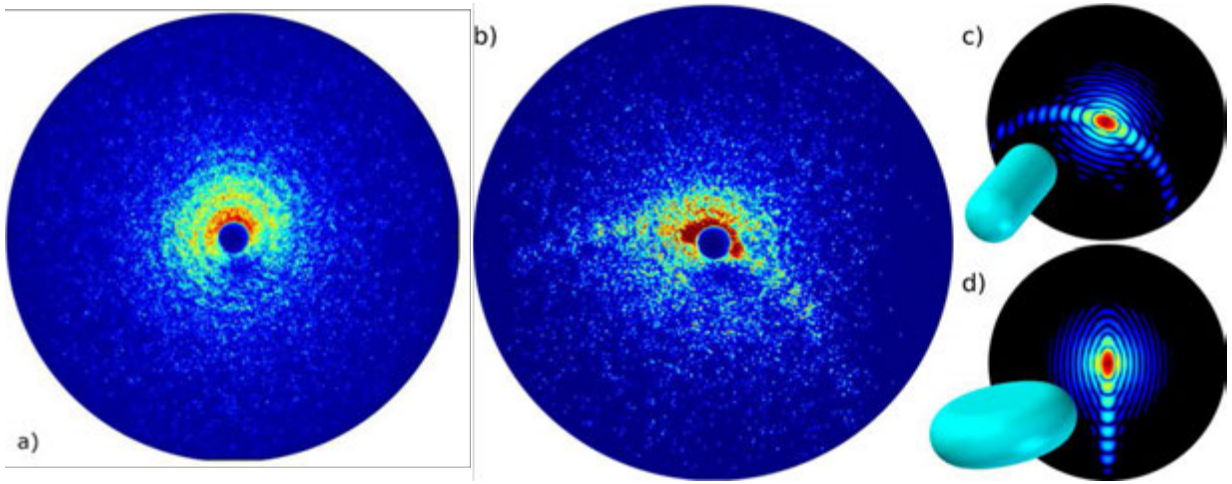
Highlights of WP2: *Coherent Diffractive Imaging on helium nanodroplets*

Collaboration between **MBI, POLIMI**

Intense XUV attosecond source at MBI



Single-shot diffractive imaging of helium nanodroplets



Daniela Rupp, Nils Monserud *et al.*, "Coherent diffractive imaging of single helium nanodroplets with a high harmonic generation source", *Submitted to Nature Communication*

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Highlights of WP2: *Coherent control in the extreme ultraviolet spectral region*

Collaboration between **ELETTRA, POLIMI, FREIB, MPIK**

Seeded Free Electron Laser FERMI Elettra Trieste

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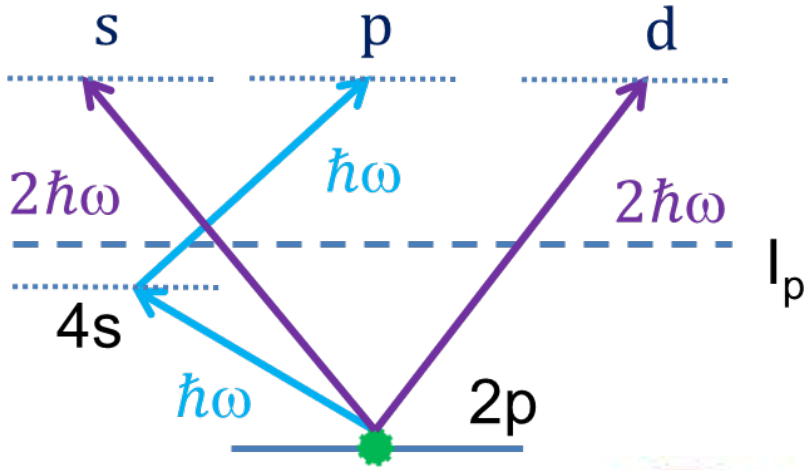
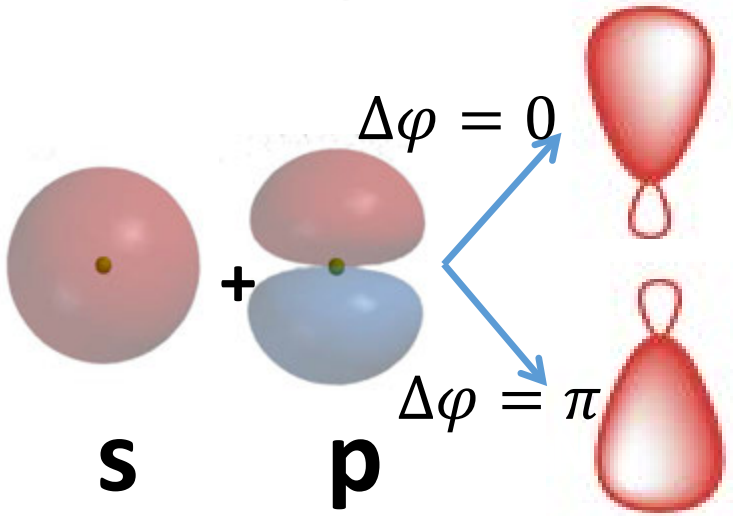
Highlights of WP2: *Coherent control in the extreme ultraviolet spectral region*

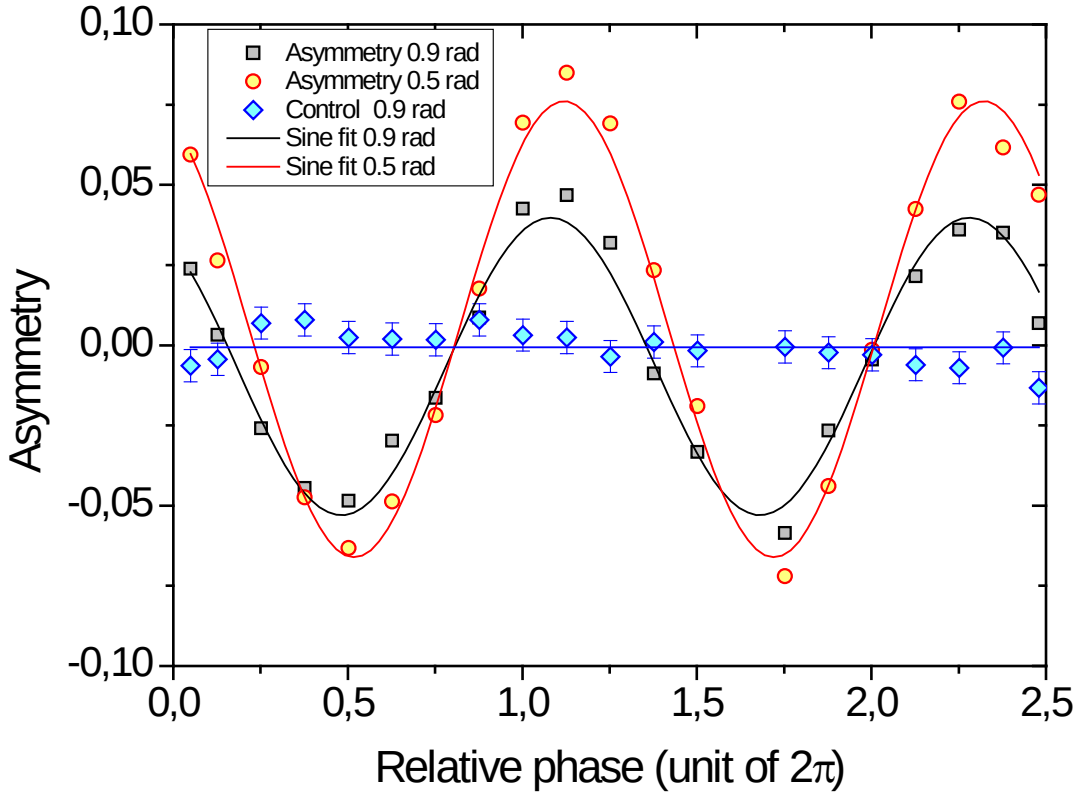
Collaboration between **ELETTRA, POLIMI, FREIB, MPIK**





Target atom: Neon

$\hbar\omega = 19.6$ eV



K. Prince *et al.* Nature Photonics **10**, 176–179 (2016)

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Thank you for the attention

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