PAUL SCHERRER INSTITUT

PSI

Maloja

4th SwissFEL Performance Workshop – Jan 26th 2022

Maloja Team

Scientists

Kirsten Schnorr

Andre Al Haddad

Gregor Knopp

Christoph Bostedt

Thanks to everyone for making this possible!

MALOJA

Postdoc

Zhibin Sun

Postdoc

Ana Sofia Morillo Candas

PhD student

Jonas Knurr

PhD student

Ningchen Yang

Technician

Simon Tiefenbacher

Laser

Xinhua Xie

Science IT

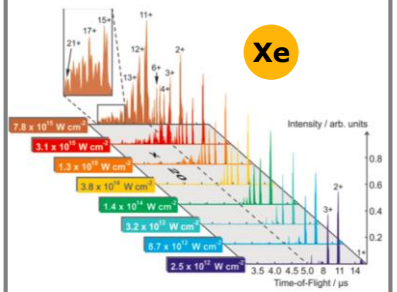
Sven Augustin

FNSNF
FONDS NATIONAL SUISSE
SCHWEIZERISCHER NATIONALFONDS
FONDO NAZIONALE SVIZZERO
SWISS NATIONAL SCIENCE FOUNDATION

PAUL SCHERRER INSTITUT

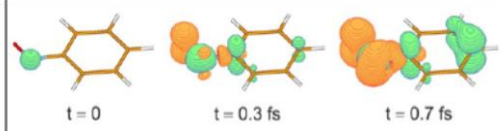
Science Opportunities

High-intensity X-ray interaction



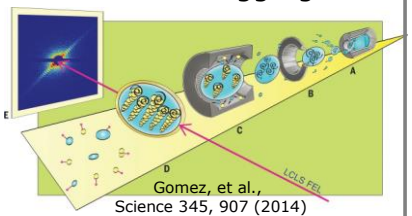
Sorokin et al., PRL 99, 213002 (2007)

Charge migration



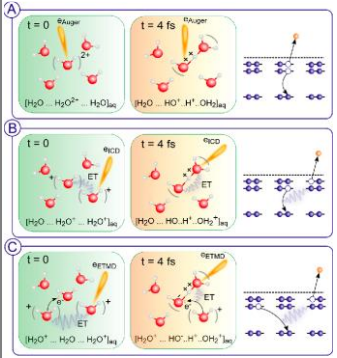
Kuleff et al., PRL 117, 093002 (2016)

Dynamics and structure of short-lived aggregates



Gomez, et al., Science 345, 907 (2014)

Charge and energy transfer



Slavíček et al., JACS 2014 136 (52)

Athos CHIC

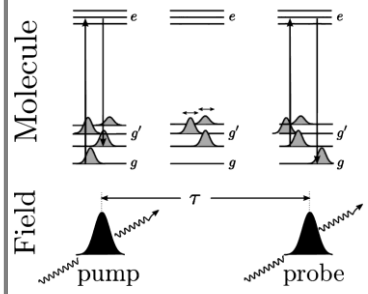
250 – 1800 eV

- Intense few to sub-fs pulses
- Multiple X-ray colors
- Tunable bandwidth and polarization

+

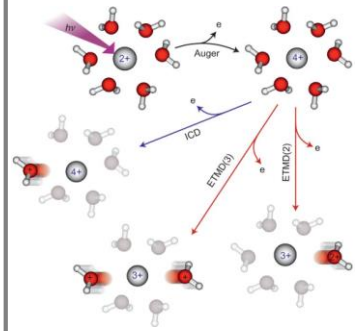
MALOJA

Non-linear photon-matter interaction



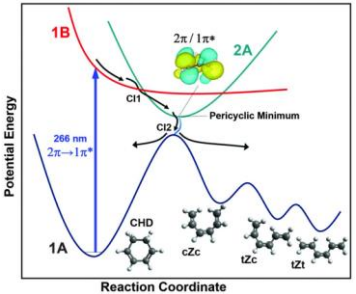
Biggs et al., PNAS 110, 15597 (2013)

X-ray induced chemistry



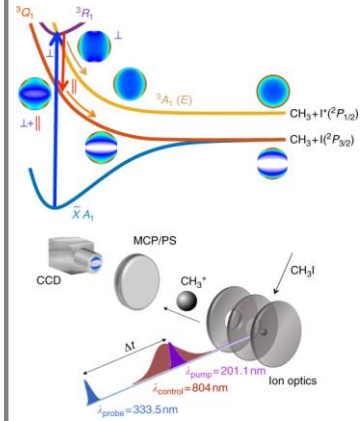
Stumpf et al., Nat. Chem. 8, 237 (2016)

Femtochemistry/ Molecular movie



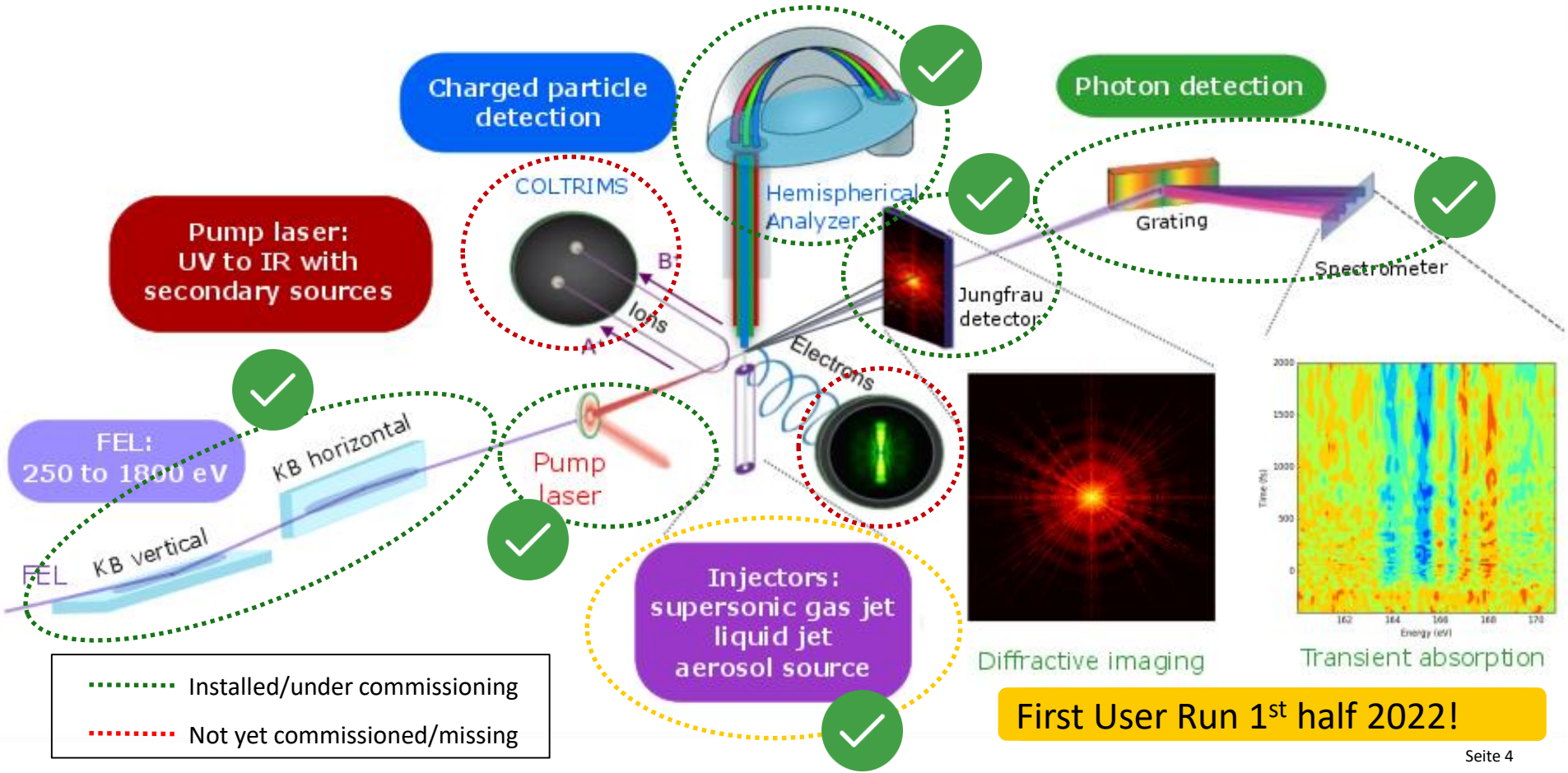
Attar et al. Science 356, 54-59 (2017)

Quantum control



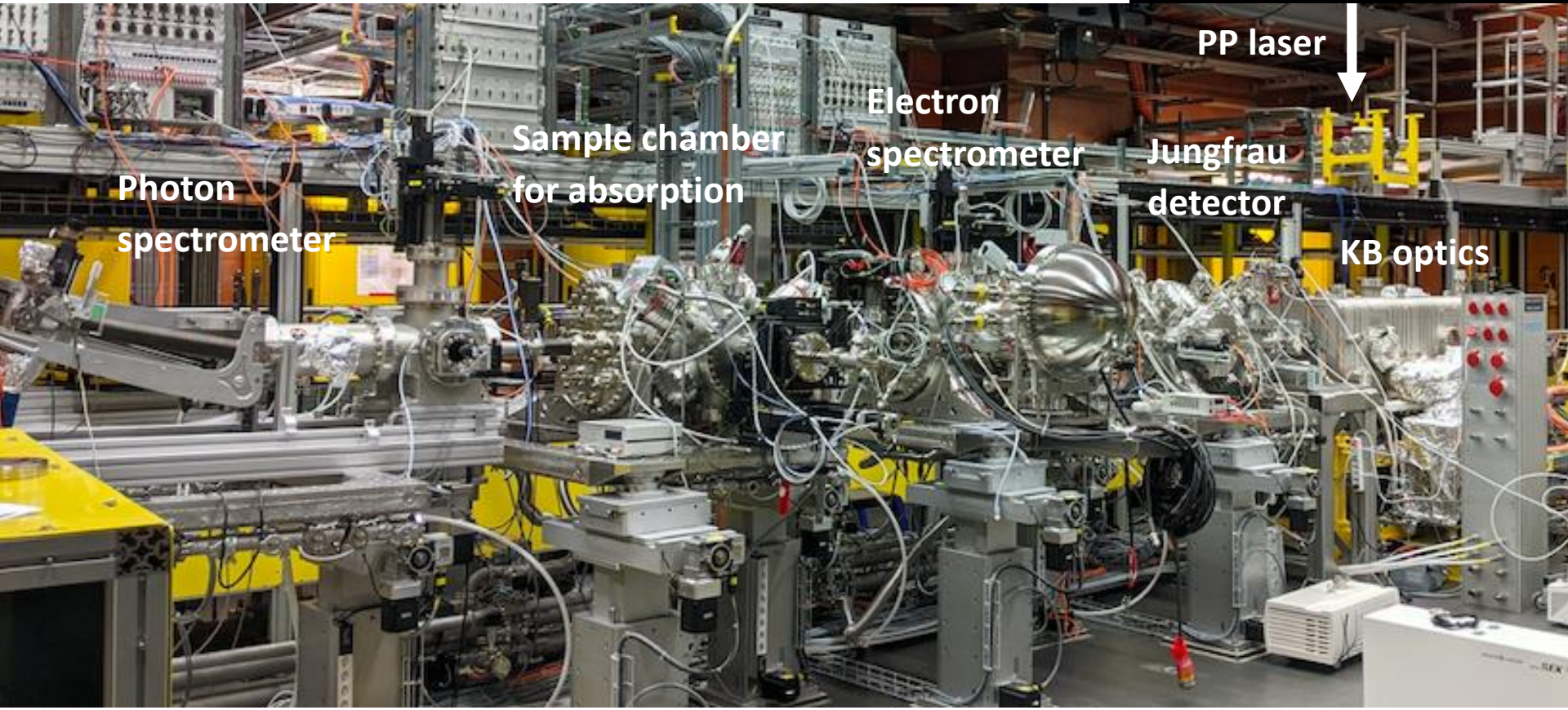
Corrales et al., Nat.Comm.8, 1345 (2017)

Maloja Instrument Nears Completion



Endstation status

20mJ, 800nm, 35 or 100fs



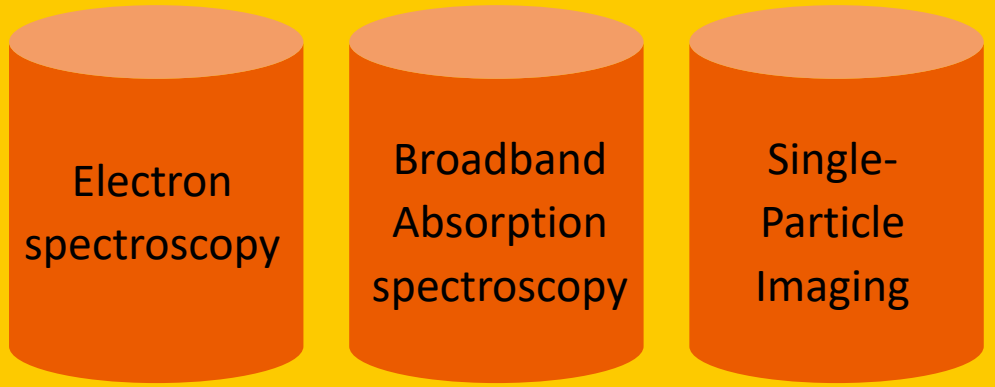
From Demonstration Experiments to User Operation

User operation - Start Q1/2022

Pilot experiments - Q2/2021

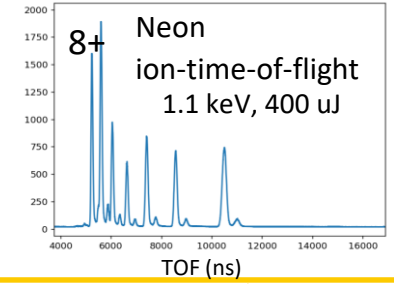
- Time resolved with optical laser
- Two-color X-ray pump probe

Demonstration experiments – Q1/2021

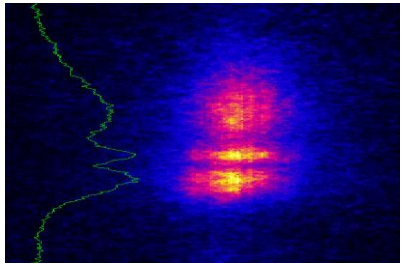


Commissioning and Demonstration – 1st half 2021

Sequential multi-photon ionization



Broadband absorption spectroscopy

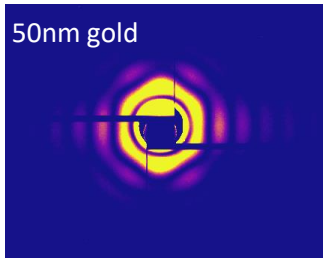


2 X-ray colors

Jungfrau detector

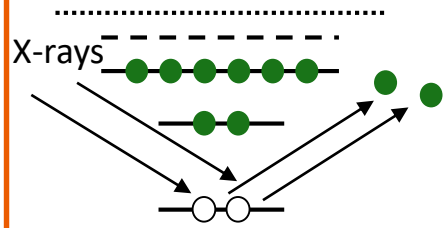
Optical laser

Aerosol injector commiss. and SPI on nanoparticles

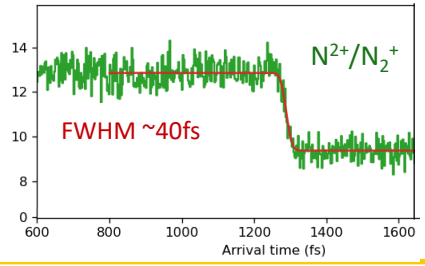


Jan | Feb | Mar | Apr | May | Jun

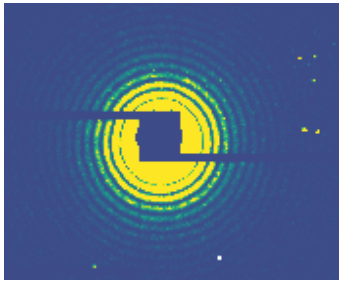
Double core hole spectroscopy neon



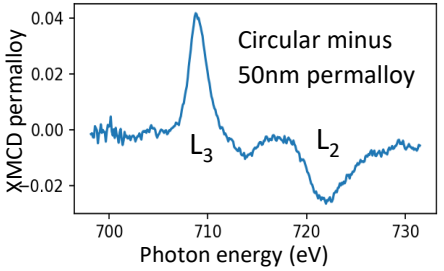
Laser time-resolved experiment with TT



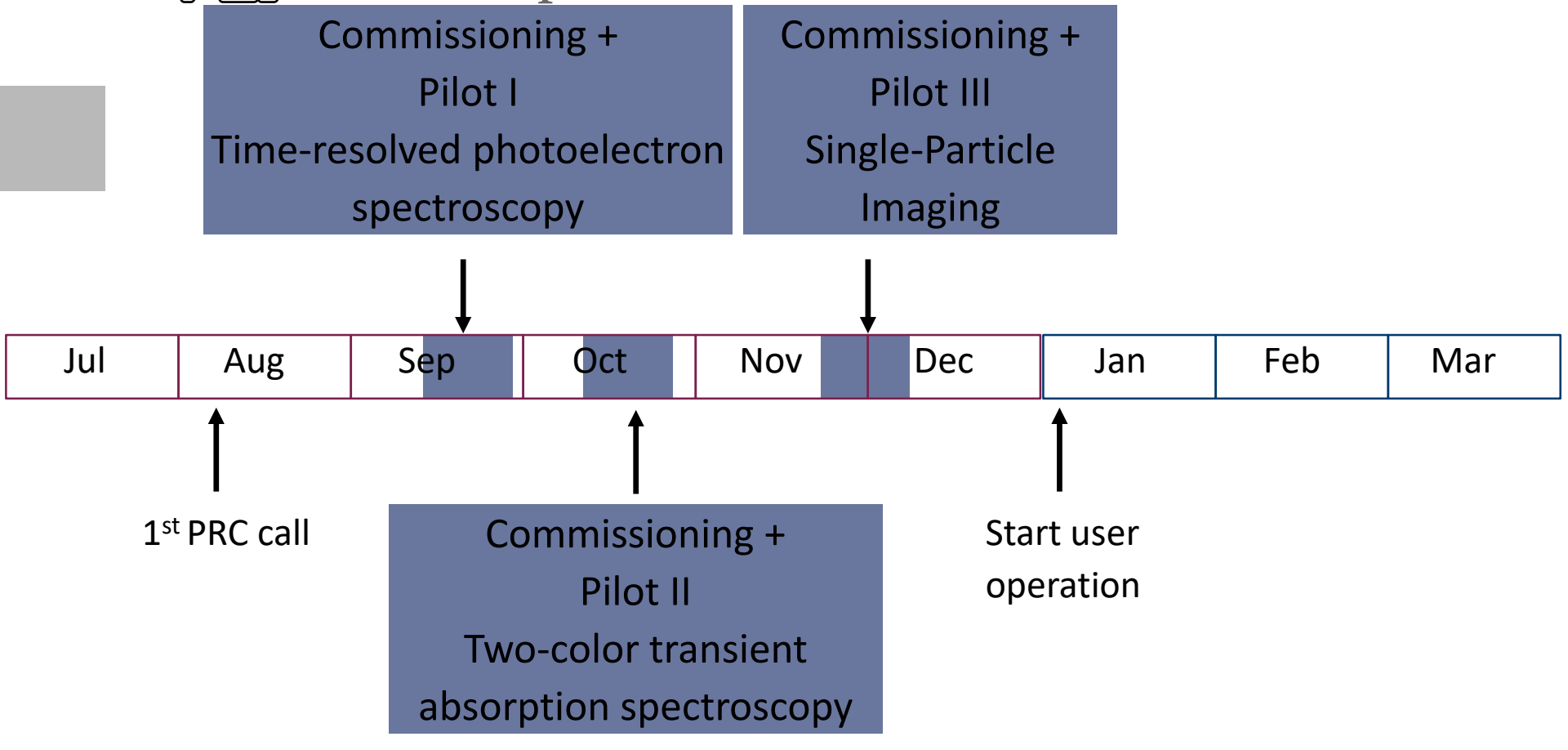
SPI on xenon clusters



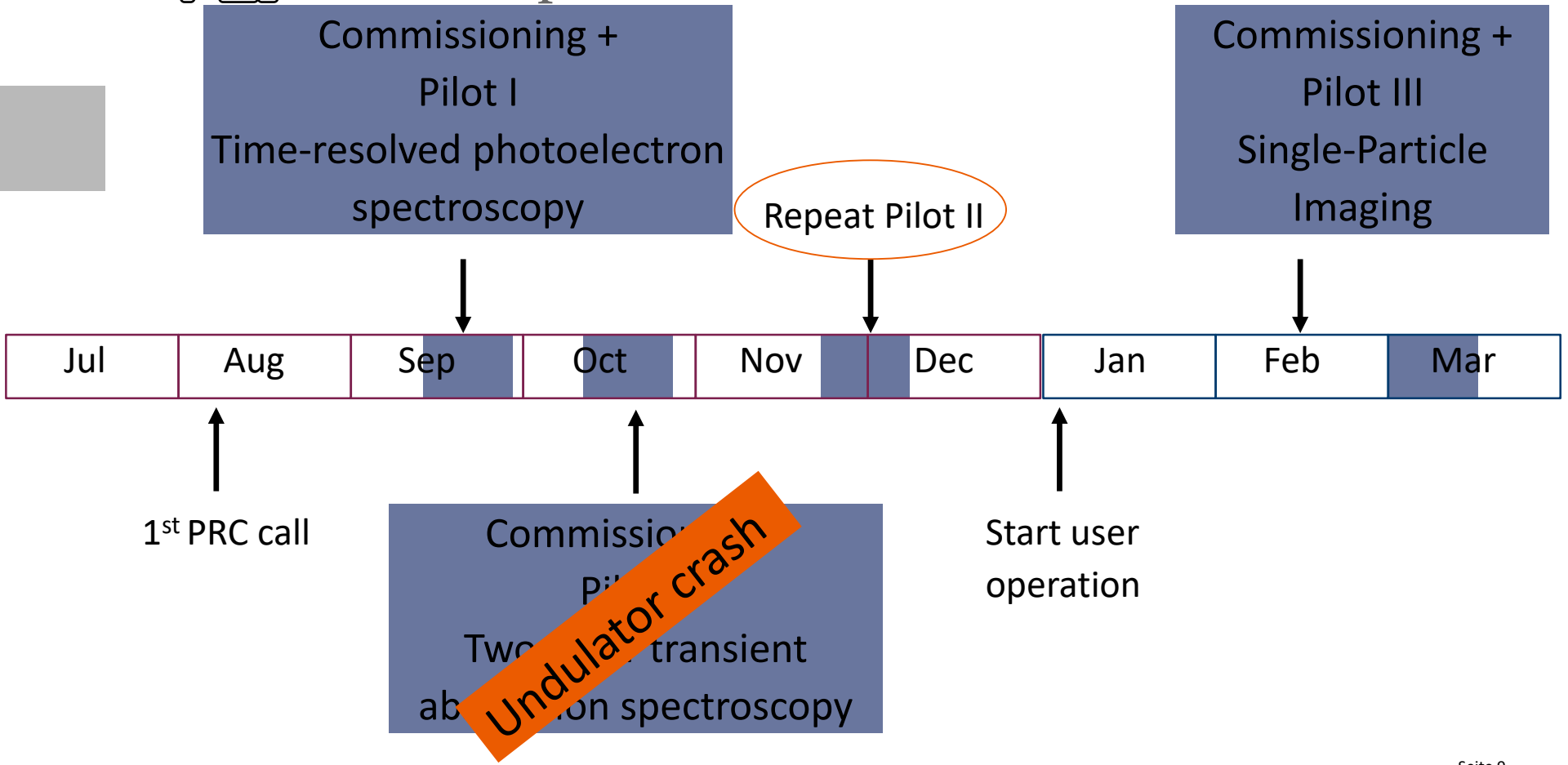
Circular dichroism in permalloy



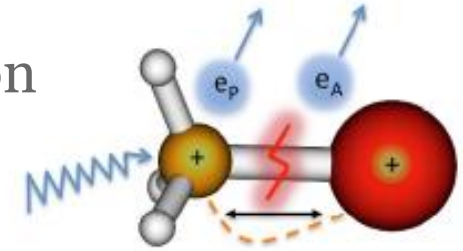
Pilot Experiments – 2nd half 2021

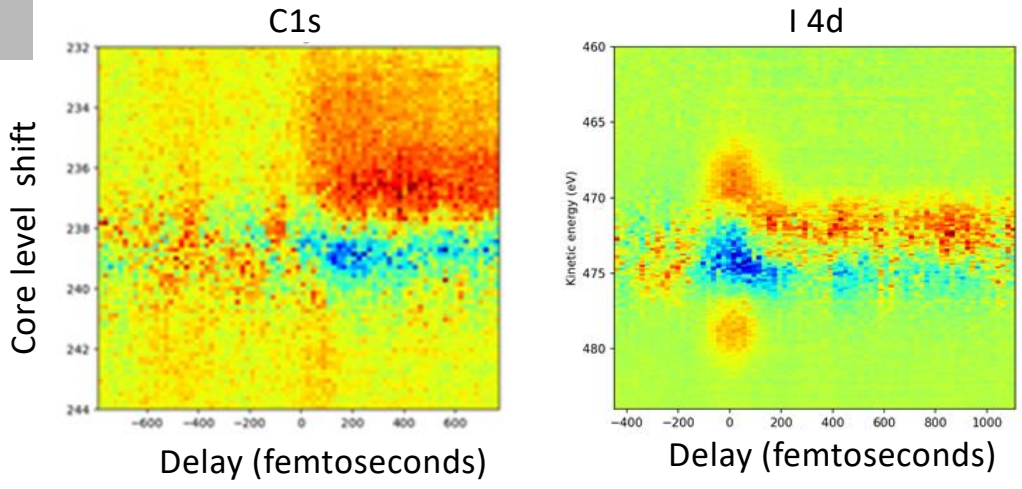


Pilot Experiments – 2nd half 2021



Pilot I – Time resolved photoelectron spectroscopy





- Excite Methyliodide CH_3I with optical pulse
- Probe the C1s or I4d photoline
- Dynamics are reflected by chemical shift of the core electrons
- Track dynamics in real time (10s-100s of fs)

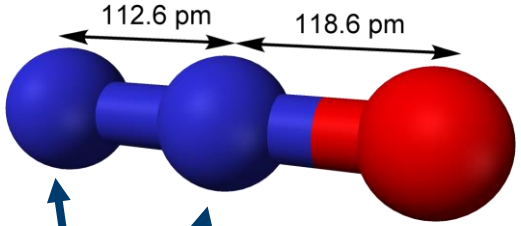
September 2021

First Maloja pilot successful, showcasing laser and photoelectron capabilities of instrument

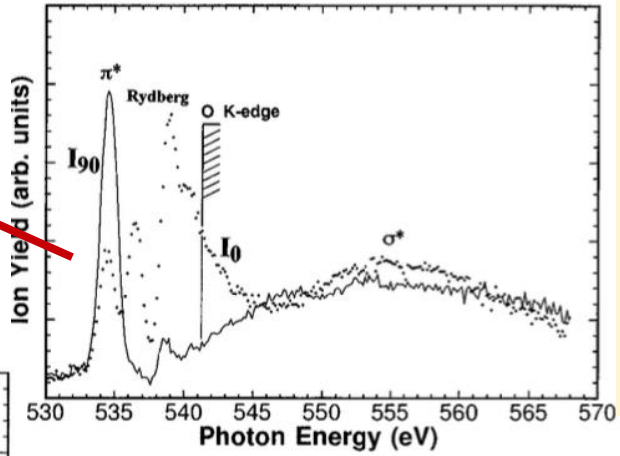
Large collaboration with Swiss (ETHZ, EPFL, PSI) and international (D, E, F, US) users, experimentalists and theoreticians

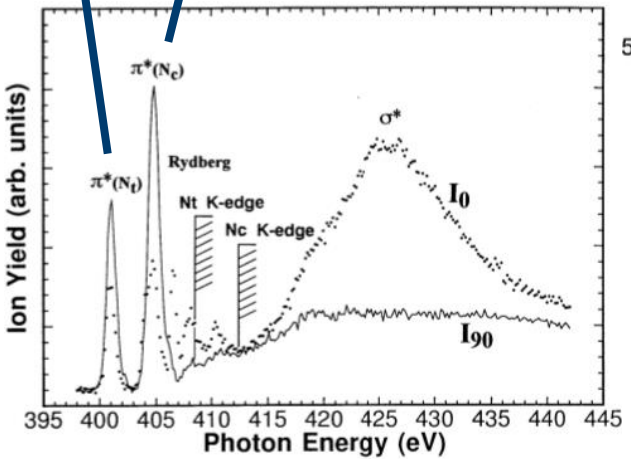
Pilot II – Transient absorption spectroscopy with two X-ray colors

Site-specific resonant pumping at terminal or central N atom with first X-ray color at nitrogen edge



Resonantly probe at oxygen K-edge



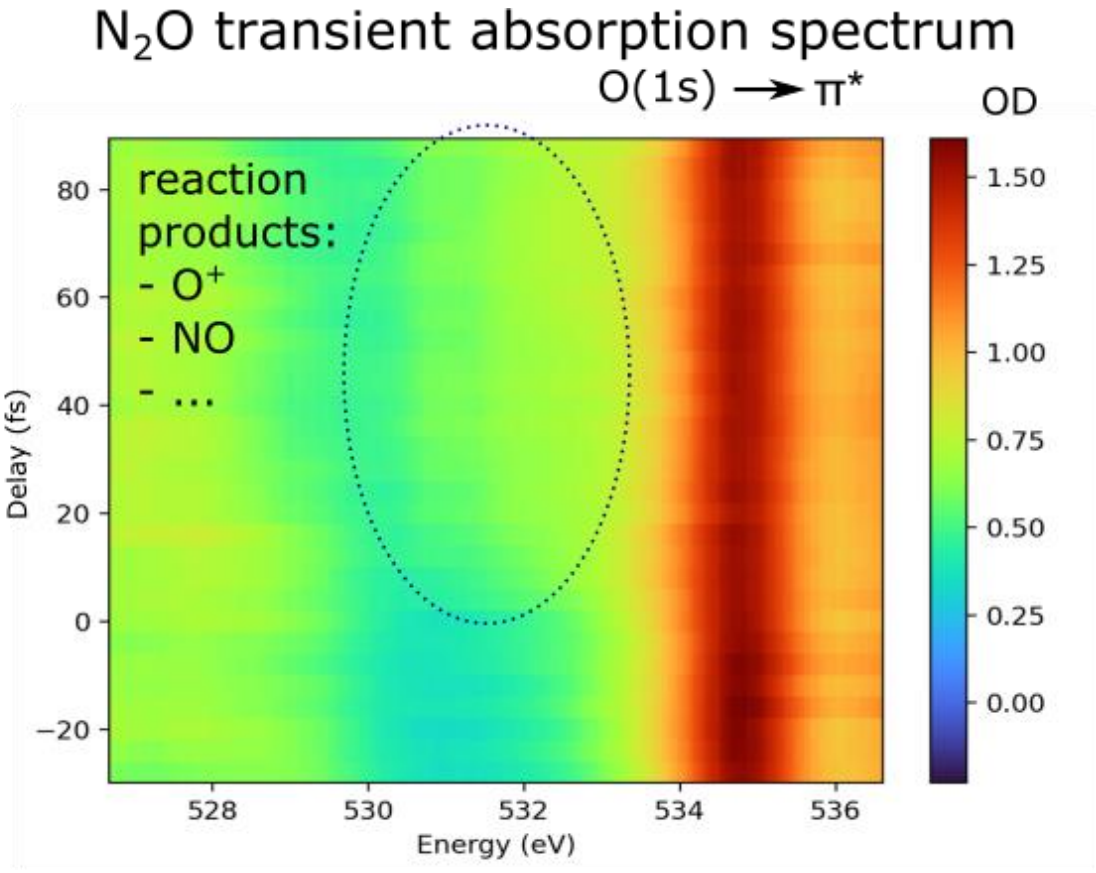


Adachi et al, J. Chem. Phys., 102, 19, 1995

Goal:
Probe core-hole induced dynamics in N_2O by X-ray pump-probe spectroscopy

Pilot II - Transient absorption spectroscopy with two X-ray colors

- Fixed pump energy, tuned on resonance
- Scan probe energy in 1eV steps
- Record spectrum after sample
- Record spectrum before sample using electron spectrometer
- Data for CO_2 and N_2O



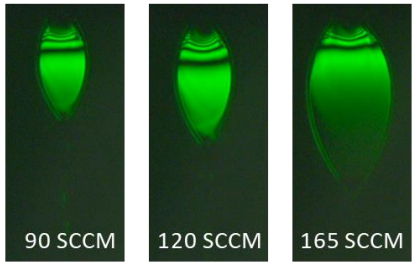
Outlook and conclusions

- Commissioning + Pilot III in March – Single-Particle Imaging
- Start 1st User Run:
  - 1st User Experiment in March - Single-Particle Imaging
  - …

- Open commissioning tasks:
  - COLTRIMS spectrometer and injector
  - Liquid jet

COLTRIMS spectrometer

Varying thickness with gas pressure



Liquid jet

Successful 2021 due to close collaboration with machine side!