MAC: Experimental station for AMO science and Coherent Diffractive Imaging

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Brief description of the available set up:
The MAC end station is a *M*ultipurpose end station for *A*MO (Atomic, Molecular and Optical) and *C*DI (Coherent Diffractive Imaging) science [1,2]. The design of the MAC vacuum chamber is similar to that of the LAMP chamber in the AMO station at LCLS and the CAMP chamber now located at FLASH, DESY with a DN400CF central tube (stainless steel 316LN ESR) with a large number of ports for mounting equipment.

Sample delivery and target stages
For the present run we focus on experiments using a cryo-cooled cluster source.

- Cryo-cooled Even-Lavie valve, maximum repetition rate of 500 Hz
- Typical opening time of 15- 20 μs, backing pressure up to 100 bar, and working temperature range of 6 to 380 K.
- Two skimmers (Beam Dynamics) for differential pumping
- The source setup is pumped by two TMPs: 2200 and 1600 l /sec, respectively.

For CDI experiment

- 5 axis fixed target station
- PI MTE in vacuum XUV CCD
- In-vacuum microscope for sample observation
- HHG focusing with 5:1 ellipsoidal mirror (70 μm x40 μm spot)

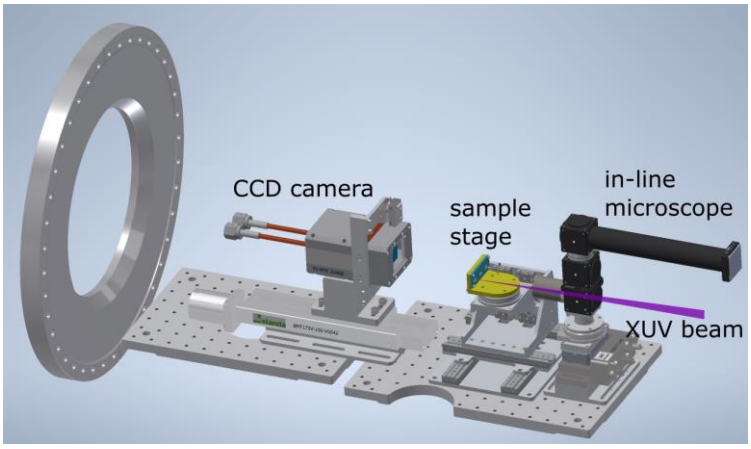

Fig. 1 Sketch of setup for CDI experiment showing in-vacuum microscope, sample holder and PI MTE camera

Spectrometers and detection systems
At present the following spectrometers and detection systems are operational:

- Electron and ion Time of Flight spectrometers (in house development)
- Velocity Map Imaging (VMI 75 mm MCP with a phosphor screen imaged by a camera with 166 fps 1936 x 1216 pix Sony CMOS 1/1.2" sensor 72 dB (~ 12 bit resolution)) with ns gated imaging detector (Velocitas/Photec)

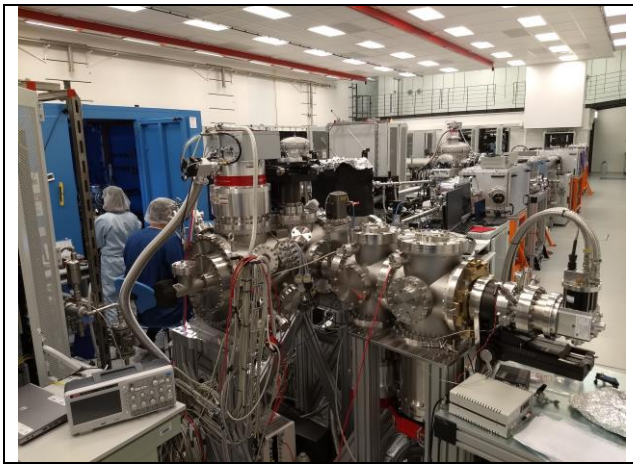

Fig 2. The MAC end station with cryo-cooled cluster source during testing in the E1 experimental hall.

Pump-probe experiments

We invite experienced users also interested in establishing pump-probe capabilities with a monochromatized HHG and a NIR laser beam. For an updated status of the pump-probe setup please contact the MAC instrument team for the latest updates (maria.krikunova@eli-beams.eu).

Table 1: Expected parameters of the pump beam in MAC chamber assuming at least 1 mJ available pulse energy.

Parameter	Value
Energy per pulse	1 mJ
Pulse duration	~ 100 fs
Lens focal length	250 mm
Focal spot diameter (measured)	35 μm
Focused intensity	1 x 10^{15} W cm^{-2}

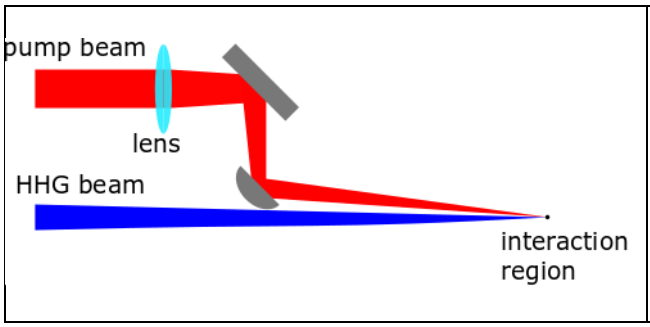

Fig. 3: Schematic of pump beam focusing in MAC chamber. HHG beam is focused by an ellipsoidal mirror (5:1 ratio, expected spot size 70 μm x 40 μm). Pump beam enters the vacuum chamber from top and is focused with a lens. A D-shaped mirror is used to overlap the two beams at a small angle.

Monochromator and HHG focusing

Further information is available on the HHG information page **(link to HHG document)**

Refs.

[1] Plasma channel formation in NIR laser-irradiated carrier gas from an aerosol nanoparticle injector Sci Rep 9, 8851, https://doi.org/10.1038/s41598-019-45120-3 (2019). E. Klimešová, et al.
[2] MAC technical paper, in arXive soon