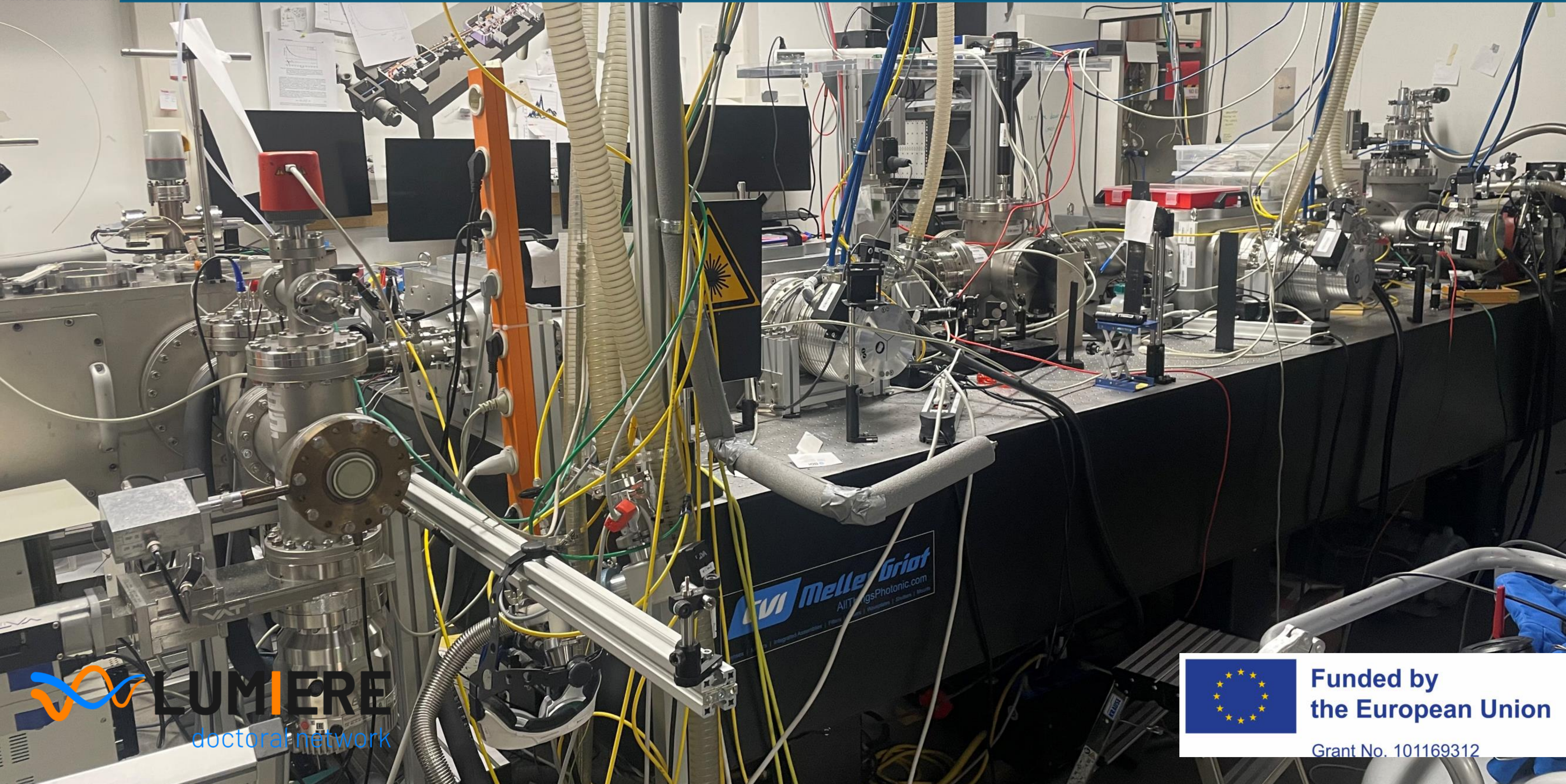
Time-Resolved PhotoEmission Spectroscopy

Max-Born-Institut



LUMIERE
doctoral network

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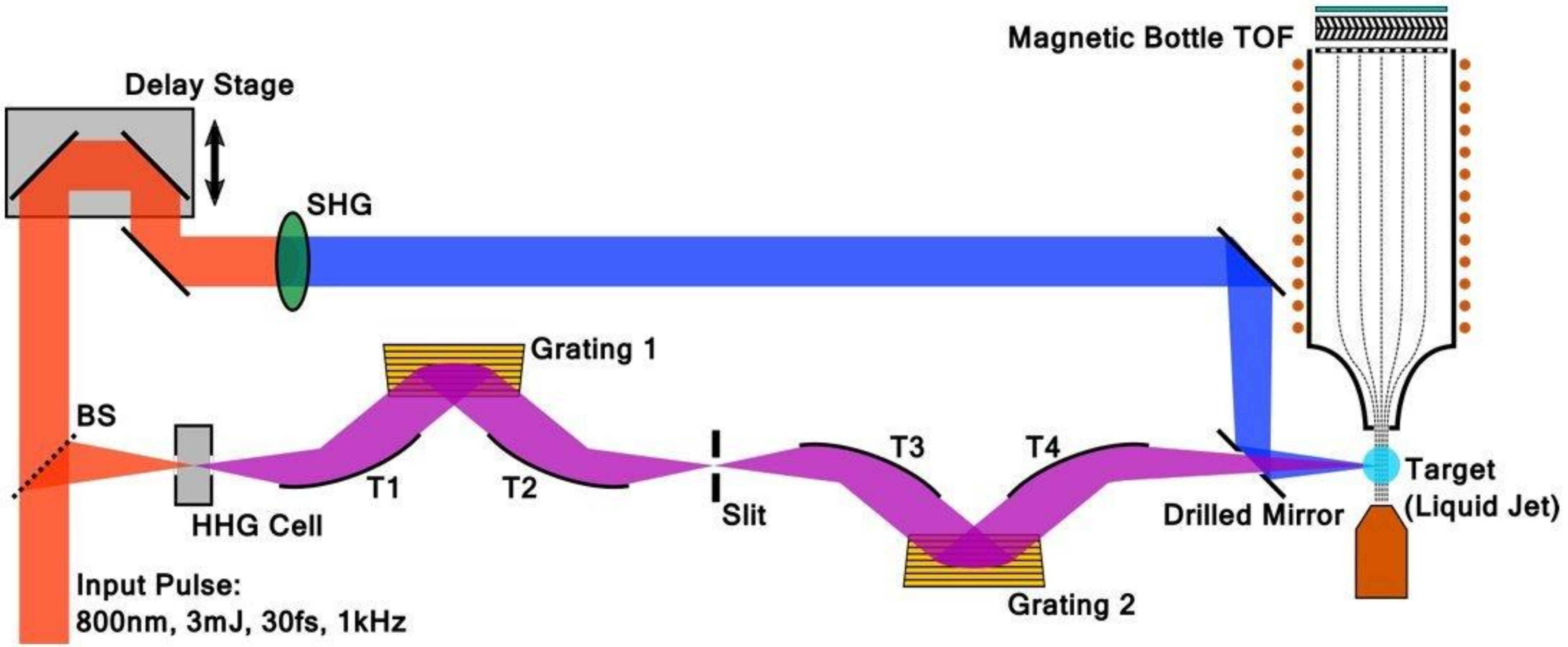
MONO beamline @ MBI

- Time resolution: **35 fs** (cross-correlation between XUV and IR).
- Spectral resolution: **100meV**.
- Transmission: **3%-16%** for 3 eV - 50 eV (calibrated AXUV photodiode).
- Up to 10^7 photons per pulse at **1kHz** repetition rate.



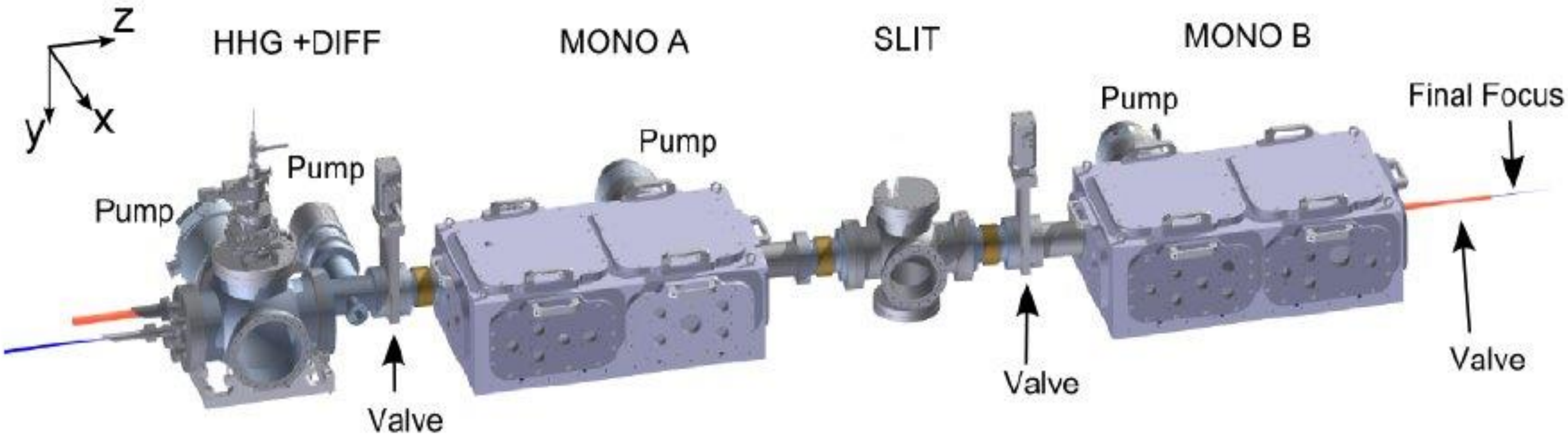
MONO beamline @ MBI

HHG chamber held at 10^{-5} mbar, **differential pumping** needed because of the Ar flow.

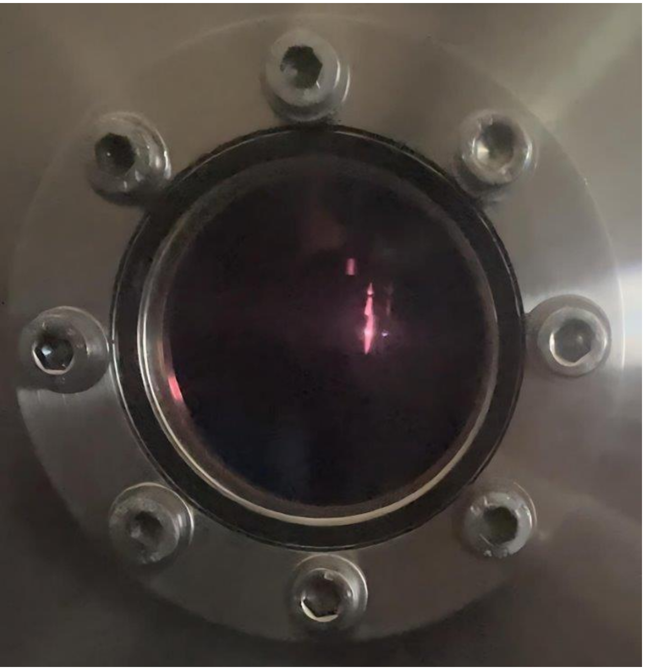
MONO A, held at 10-7 mbar. It contains the first grating. Where **monochromation** happens.

SLIT placed between the gratings. It determines **bandwidth** of the selected harmonic.

MONO B, held at 10-7 mbar. It contains second grating. **Pulse recompression** in time domain.



HHG chamber



Strong-field radiation induces non-linear effects producing **attosecond pulse trains (APT)** containing harmonics.

The generation is driven by **800 nm** driver laser light with pulse energy of **1-3 mJ** and duration from **30 fs to 10 fs**, when phase modulated through hollow-core fiber and recompressed with chirped mirrors.

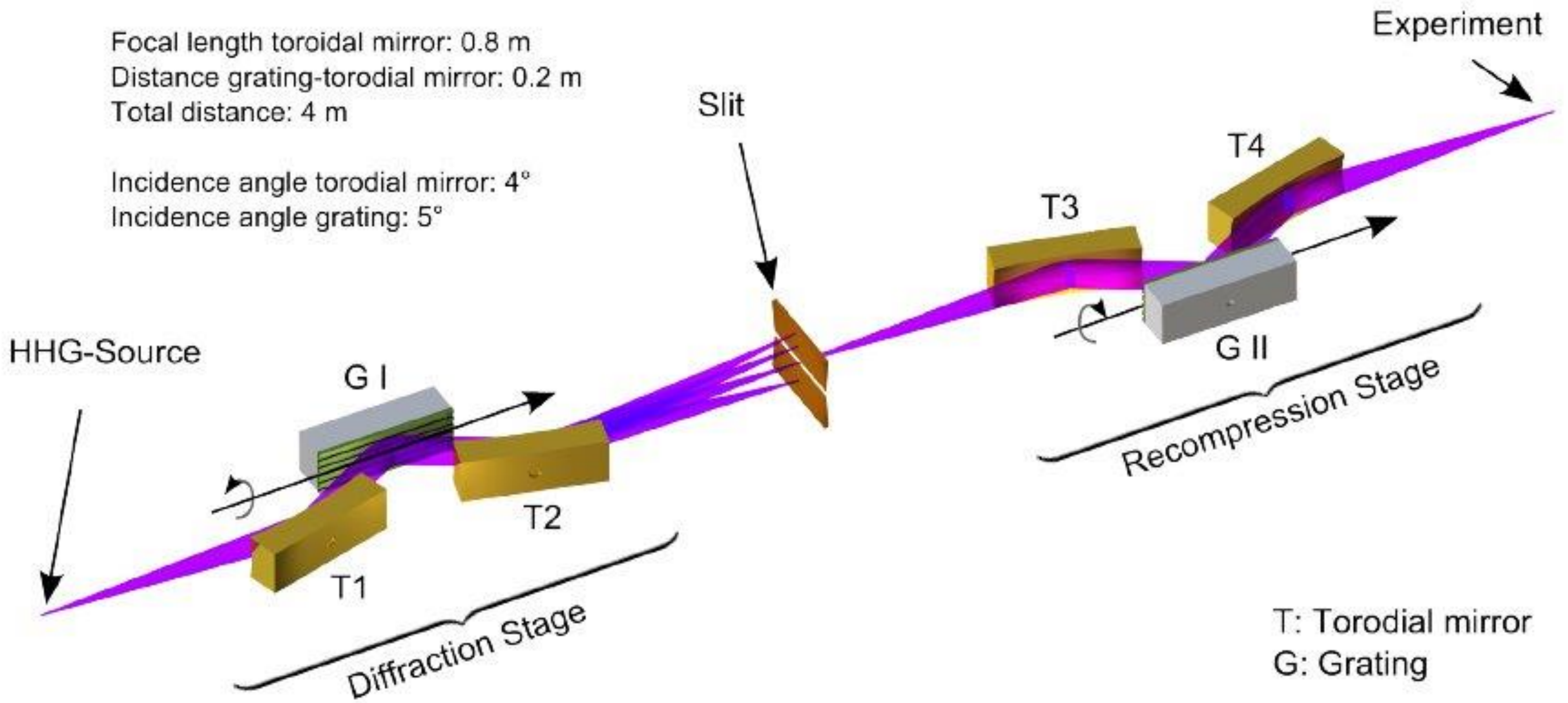
Ar is delievered in a drilled metallic cell. Apertures are covered on both sides with Al foil. The beam ablates this layer and produces a point-like light source.

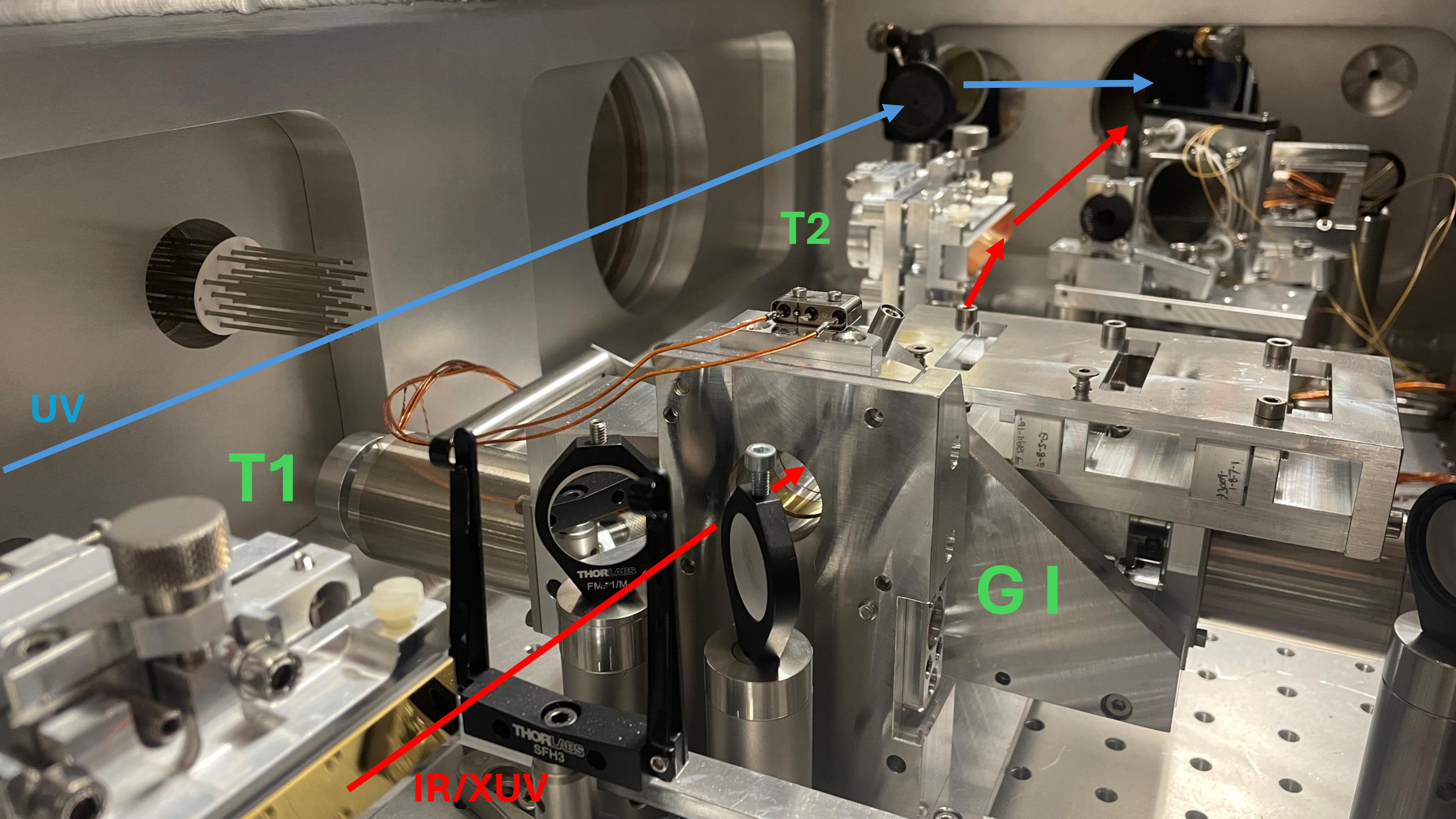
Other noble gases can be used to increase **cutoff energy**.

Time Delay Compensated Monochromator (TDCM)

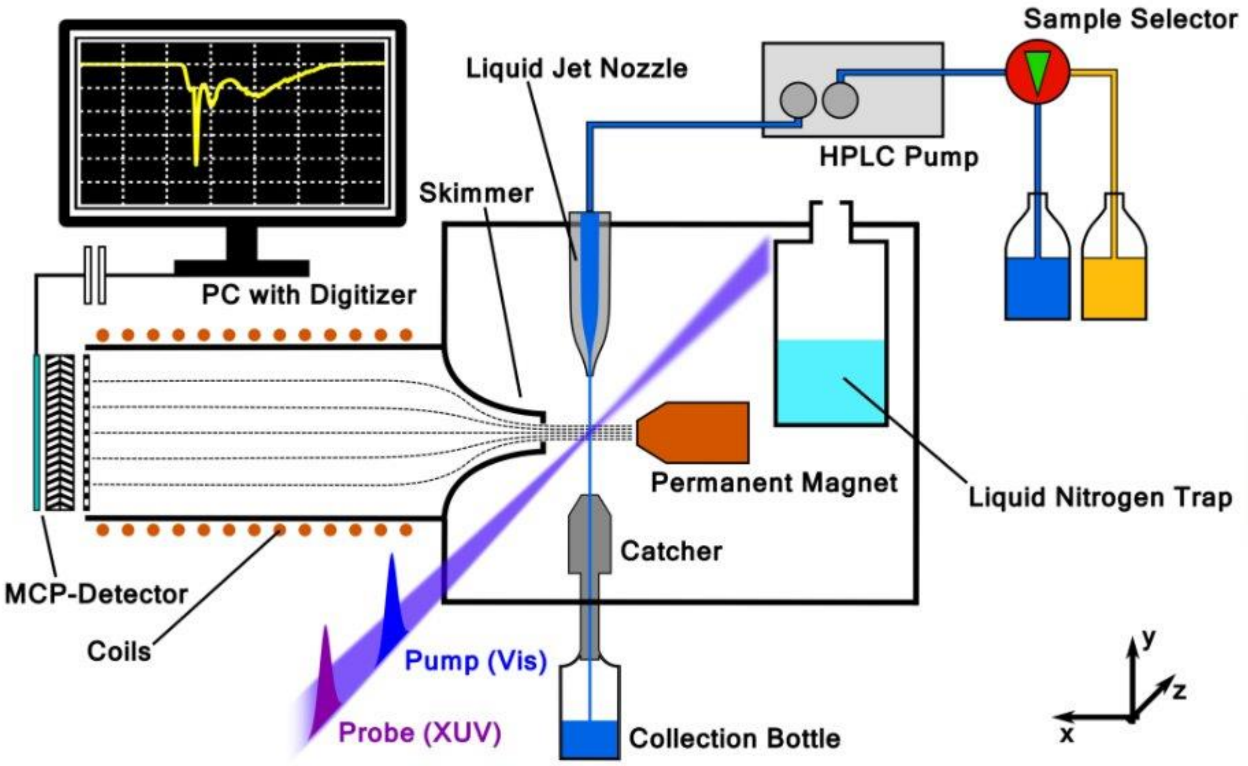
Gold coated **toroidal mirrors** are used to collimate and focus the beam. They provide low astigmatism at shallow angles. Alignment needs to be extremely fine to avoid aberrations.

G I and G II consist of sets of **three gratings** (150 gr/mm, 300 gr/mm and 600 gr/mm) capable of selecting the full spectrum of the generated harmonics.




UV
T2
T1
G I
IR/XUV
THORLABS
FMP1/M
THORLABS
SFH3

Interaction Chamber

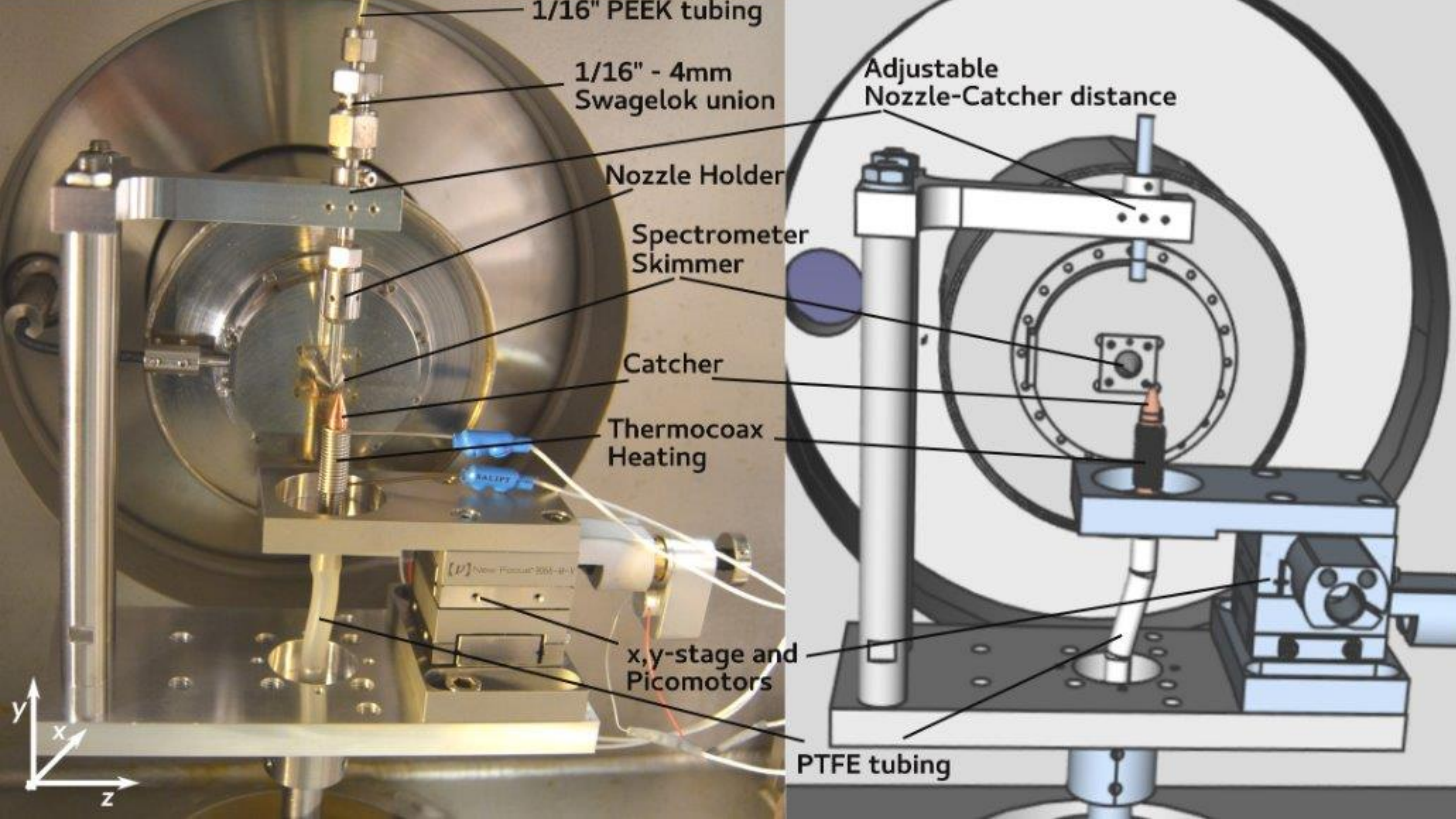


A fused silica nozzle produces **15-30 µm** liquid jet propagating at 30 m/s.

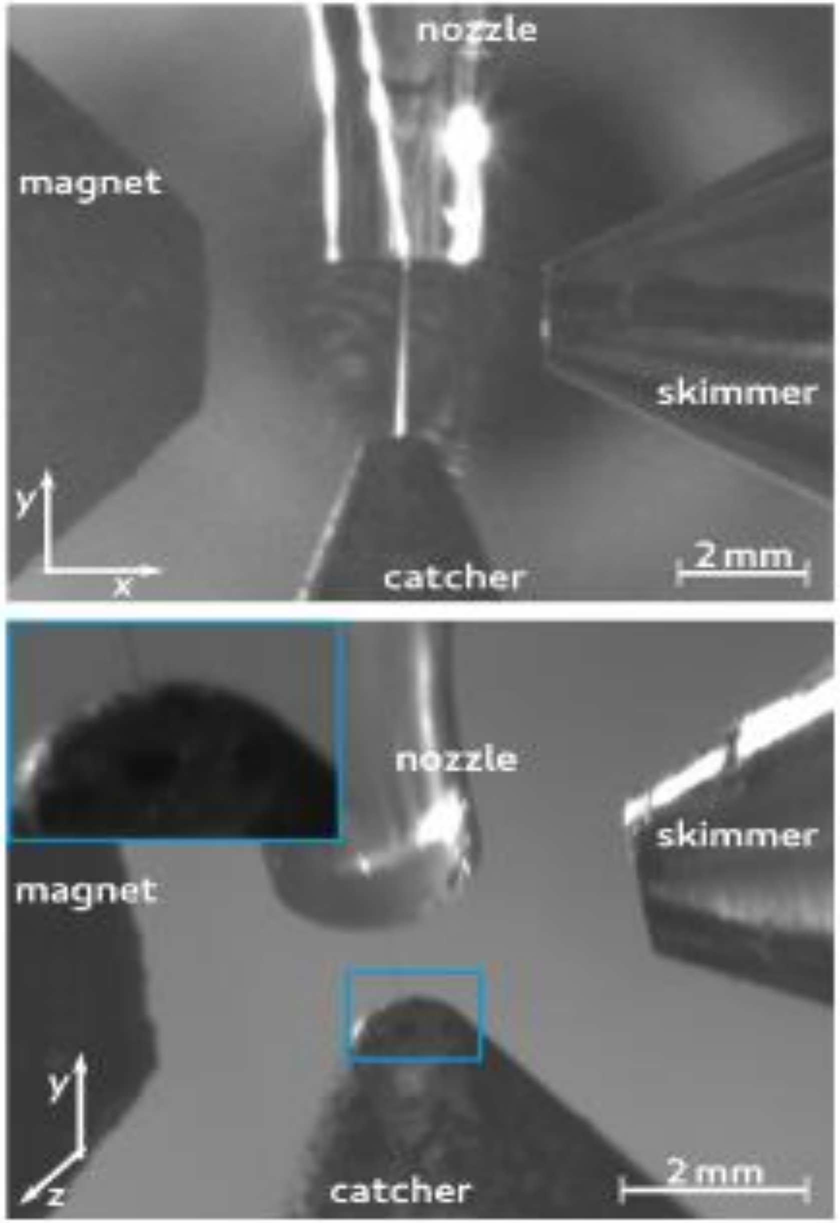
The liquid stream is collected in a heated steel/brass catcher to allow **sample recirculation**.

The chamber is pumped through a turbomolecular pump. Additional pumping is provided by a **LN2 trap**.

Pump and probe beams come at a few degree angle and produce photoelectrons. These particles are collected and analysed by a "**magnetic bottle**" time-of-flight detector.


1/16" PEEK tubing
1/16" - 4mm
Swagelok union
Adjustable
Nozzle-Catcher distance
Nozzle Holder
Spectrometer
Skimmer
Catcher
Thermocoax
Heating
x,y-stage and
Picomotors
PTFE tubing
y
x
z

Liquid Jet setup



The nozzle tip is kept at 3-5 mm from the catcher to avoid the onset of **Rayleigh breakup** in vacuum, causing freezing of the stream.

The catcher is **heated** to prevent the growth of ice crystals that can potentially obstruct its aperture or accumulate static charge that will distort the signal.

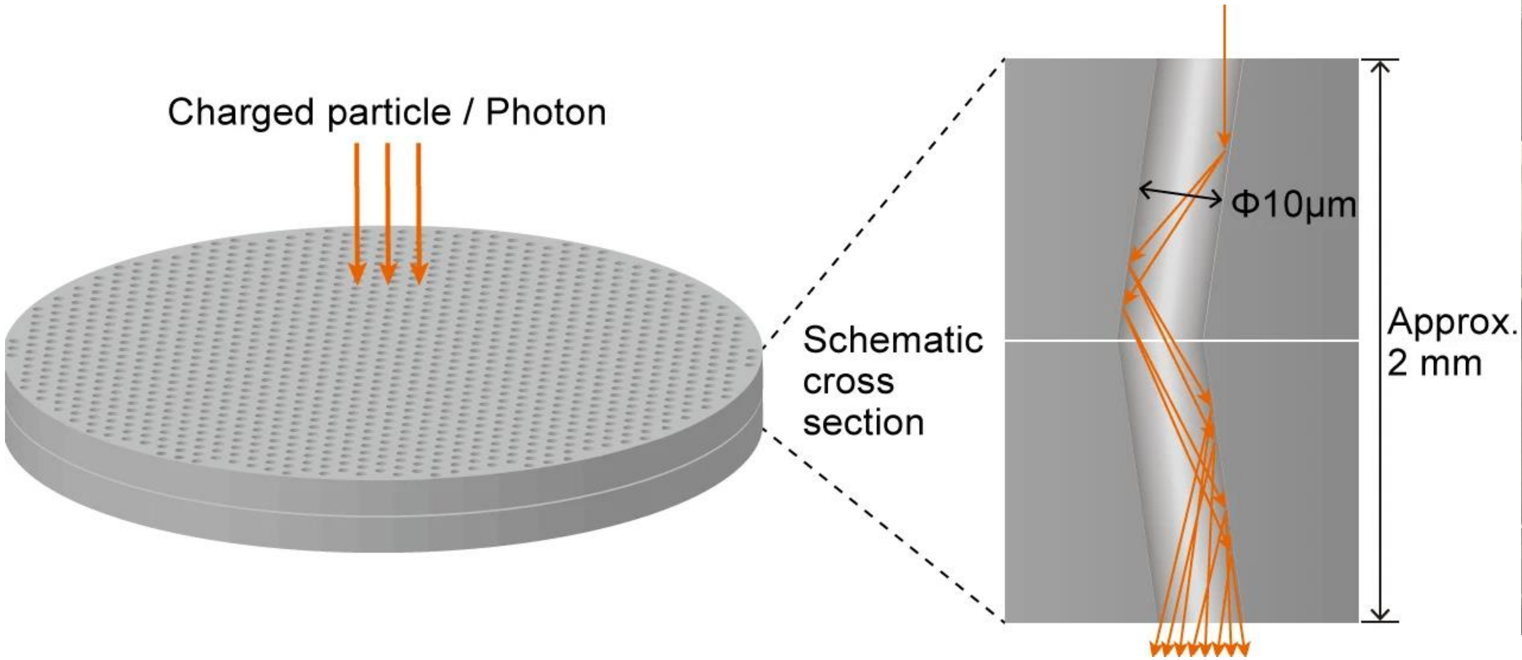
Two Nd **permanent magnets** coupled with a steel tip produce a roughly 0.5 T magnetic field that funnels all the electrons inside the skimmer and through the flight tube.

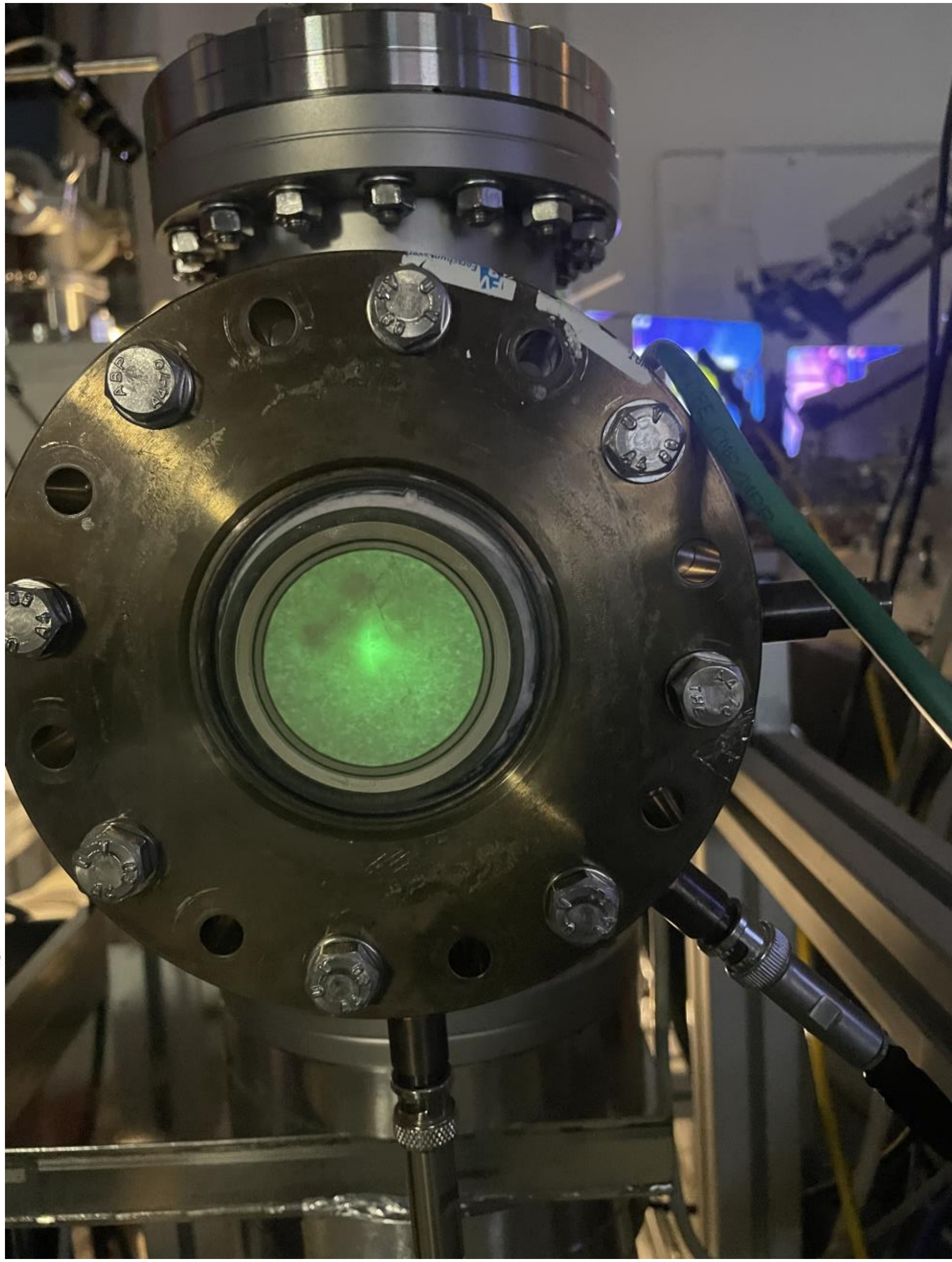
Detection process

Photoelectrons fly inside a **μ-metal** tube, shielded from external magnetic fields.

Finally, they are detected on a **Microchannel plate (MCP)** detector, amplifying the current similarly to an avalanche photodiode.

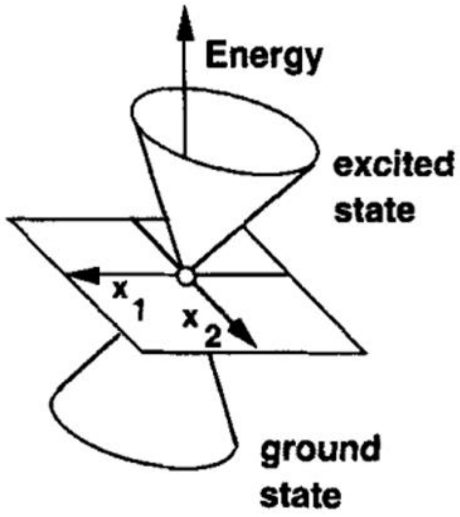
The spatial distribution of the electrons on the detector can be seen on a **phosphor screen**.

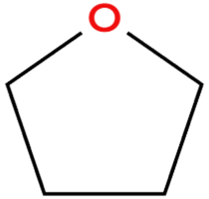


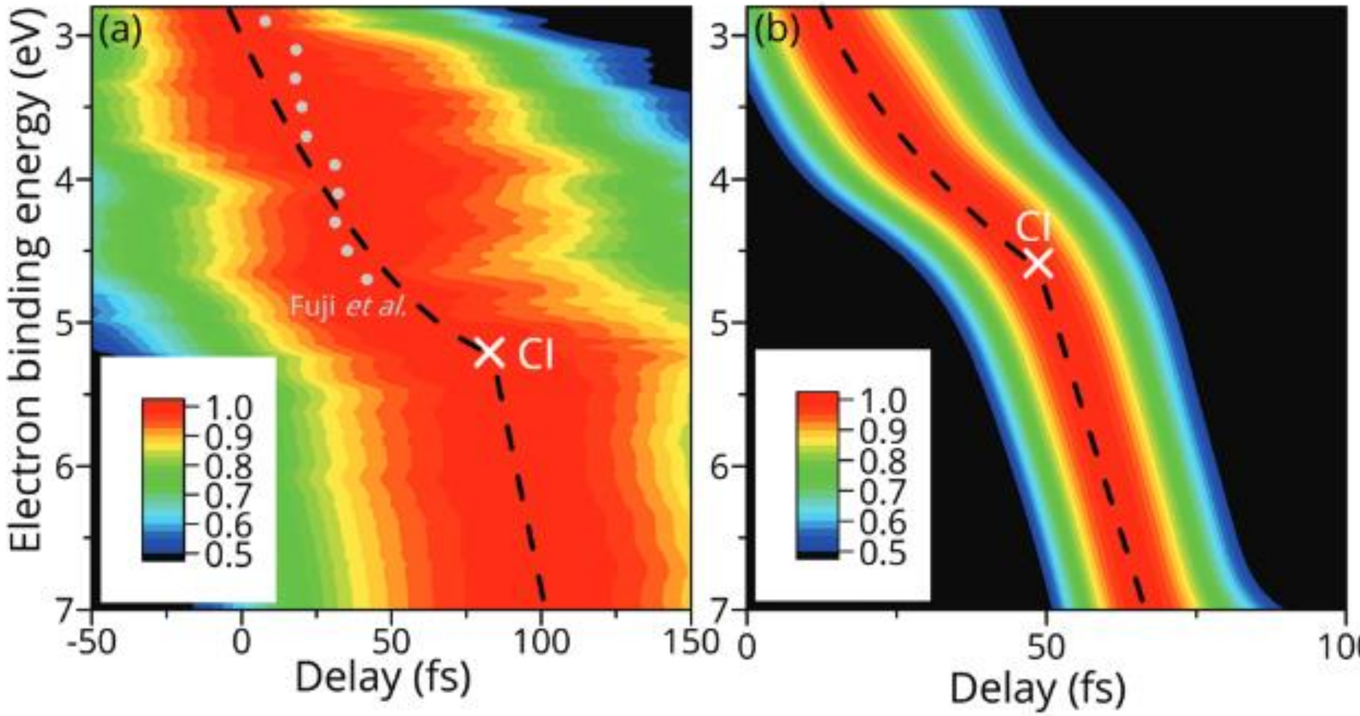


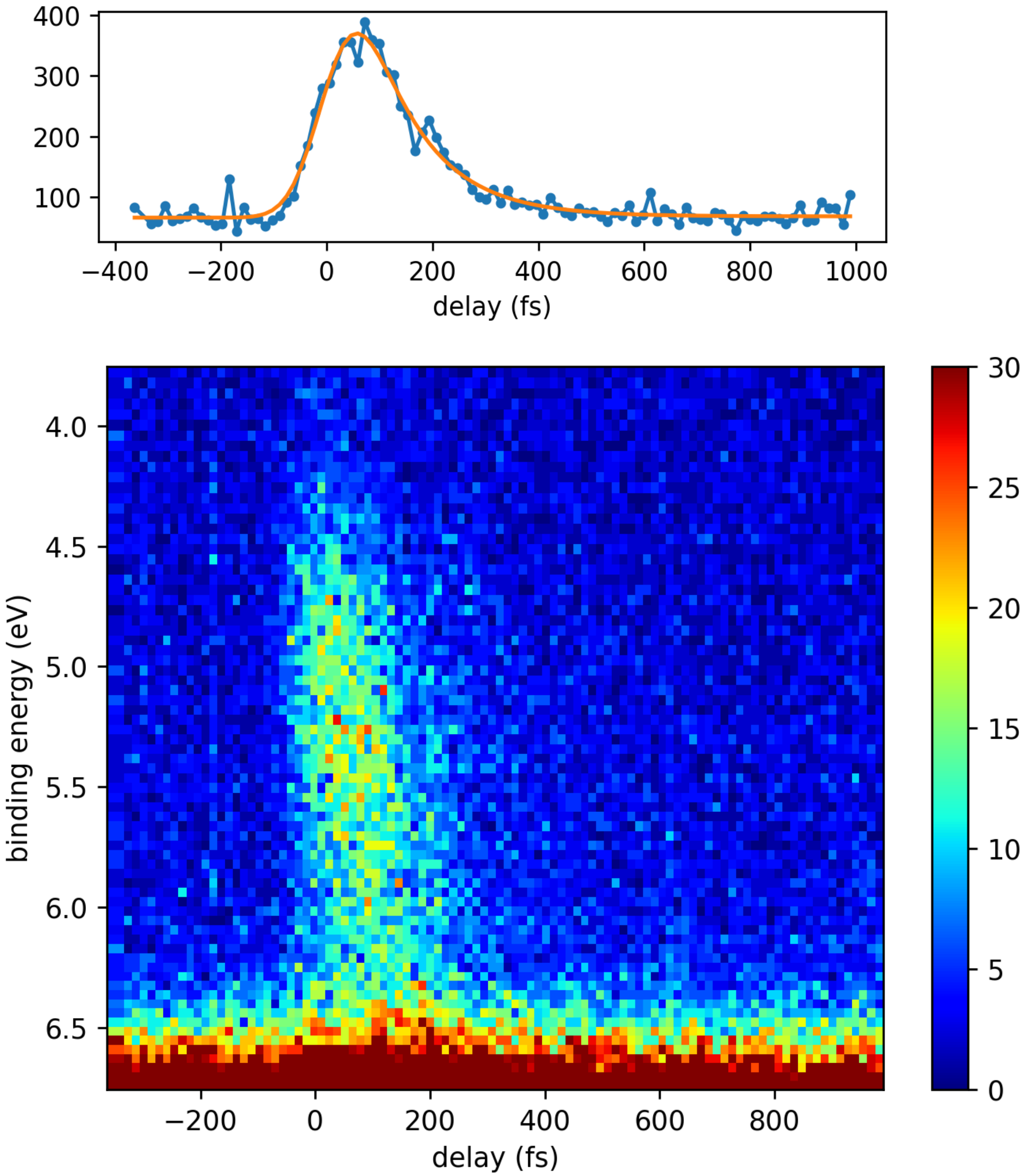

And now...
TO THE LAB!

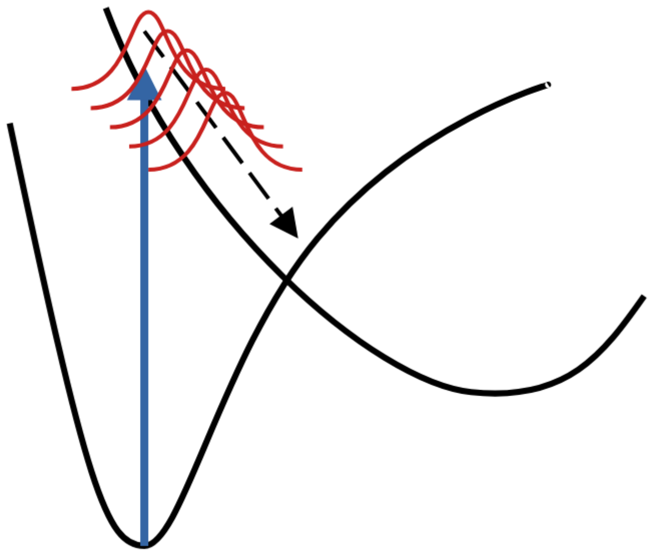
Conical Intersections in LJ-TRPES











The wavepacket appears to behave **ballistically**, decaying with femtosecond timescale to the ground state.

Such movement characterise photoswitches and are allowed by **CIs**.