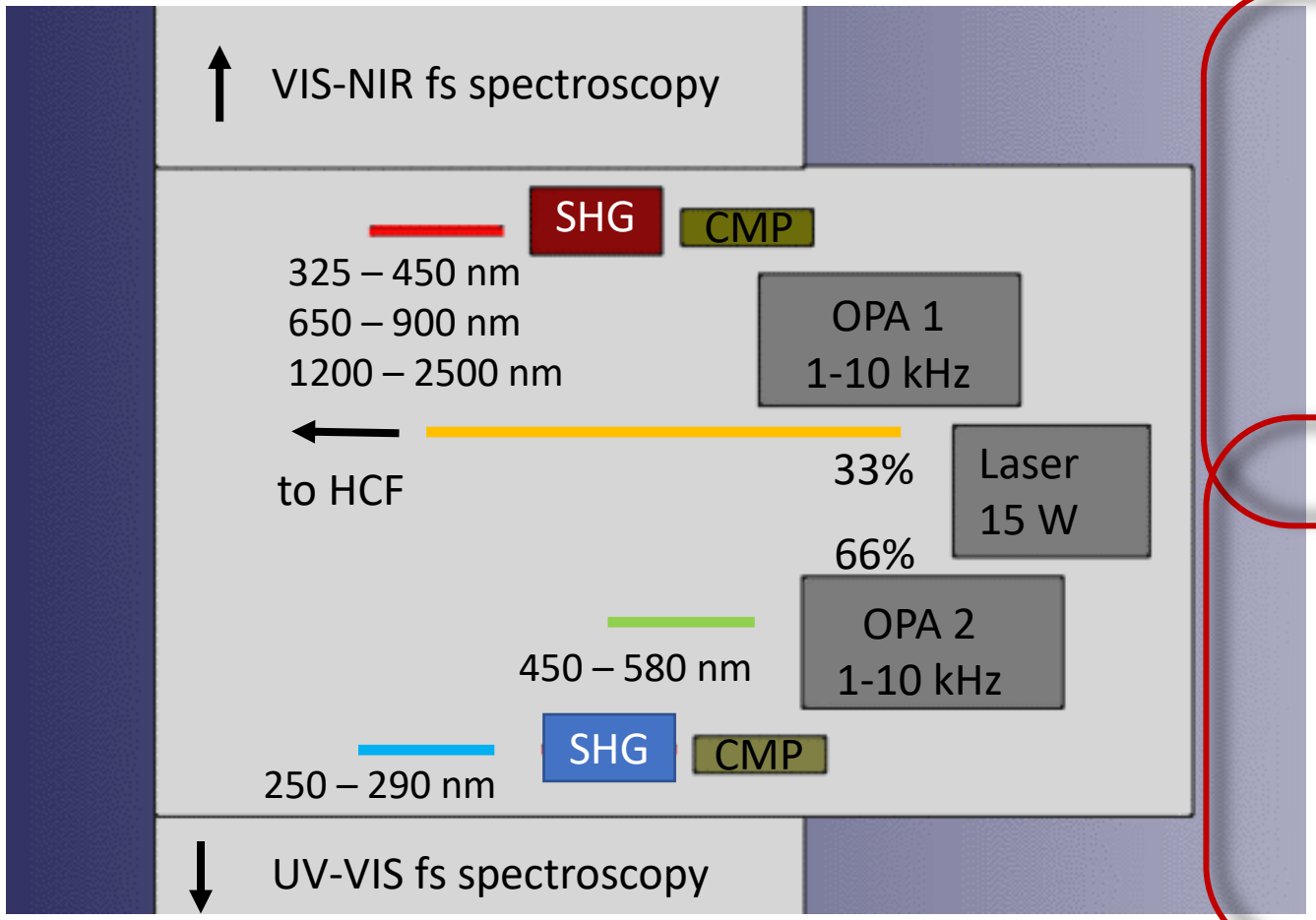
Femto-chemistry laboratory



Specifications

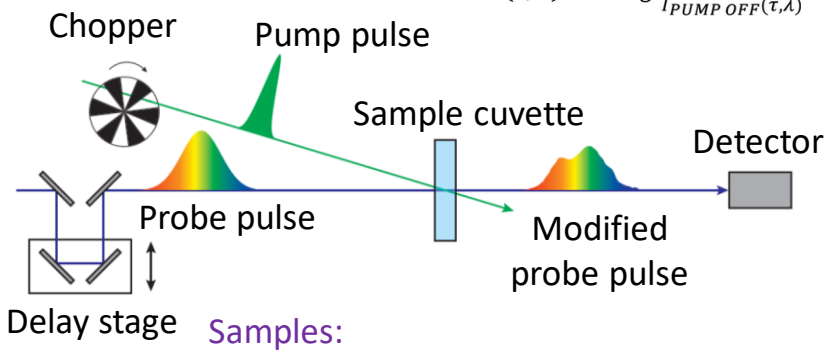
CMP - OPA	650 – 2000 nm 55 – 100 fs 15 – 30 µJ
CMP - SHG	325 – 475 nm 60 – 110 fs < 4 µJ

1033 nm; 15 W; 170 fs

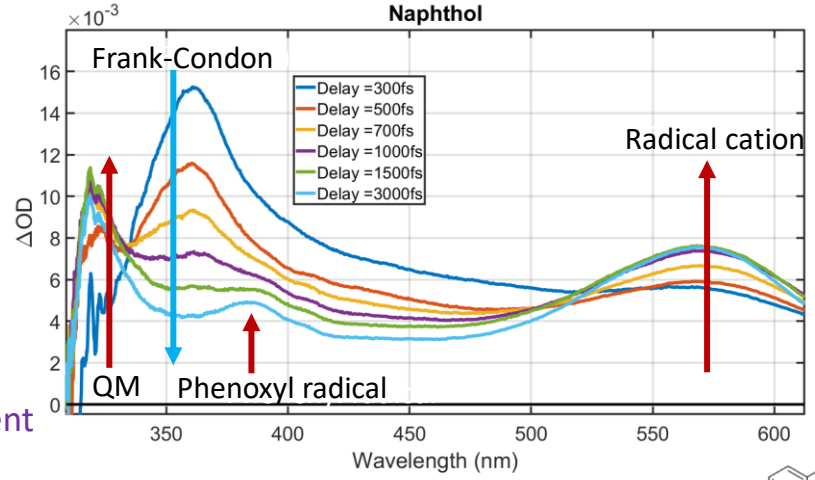
CMP - OPA	450 – 580 nm 40-60 fs 10-20 µJ + 250-290 nm <50 fs ~ 1µJ

Femtosecond nonlinear spectroscopies

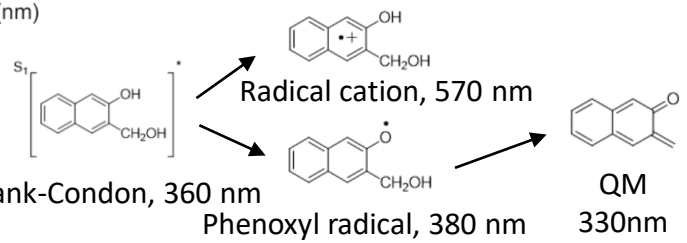
$$\Delta OD(\tau,\lambda) = -log\frac{I_{PUMP\ ON}(\tau,\lambda)}{I_{PUMP\ OFF}(\tau,\lambda)}$$

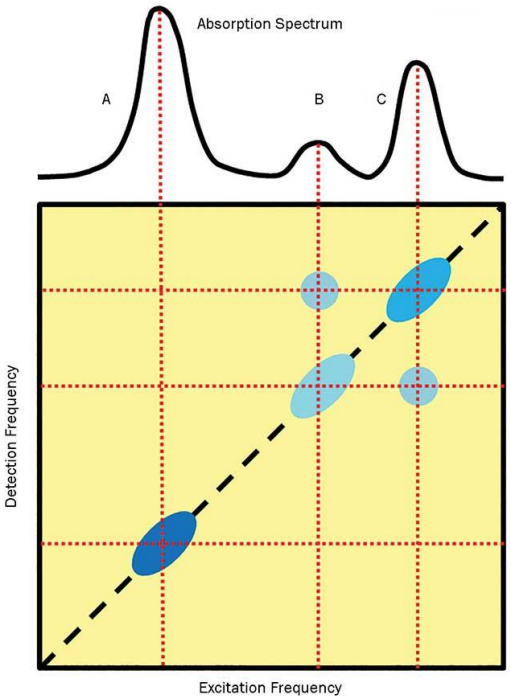


Time resolution:
<100fs



Samples:
Molecules, thin films, bulk crystals – transparent or non-transparent



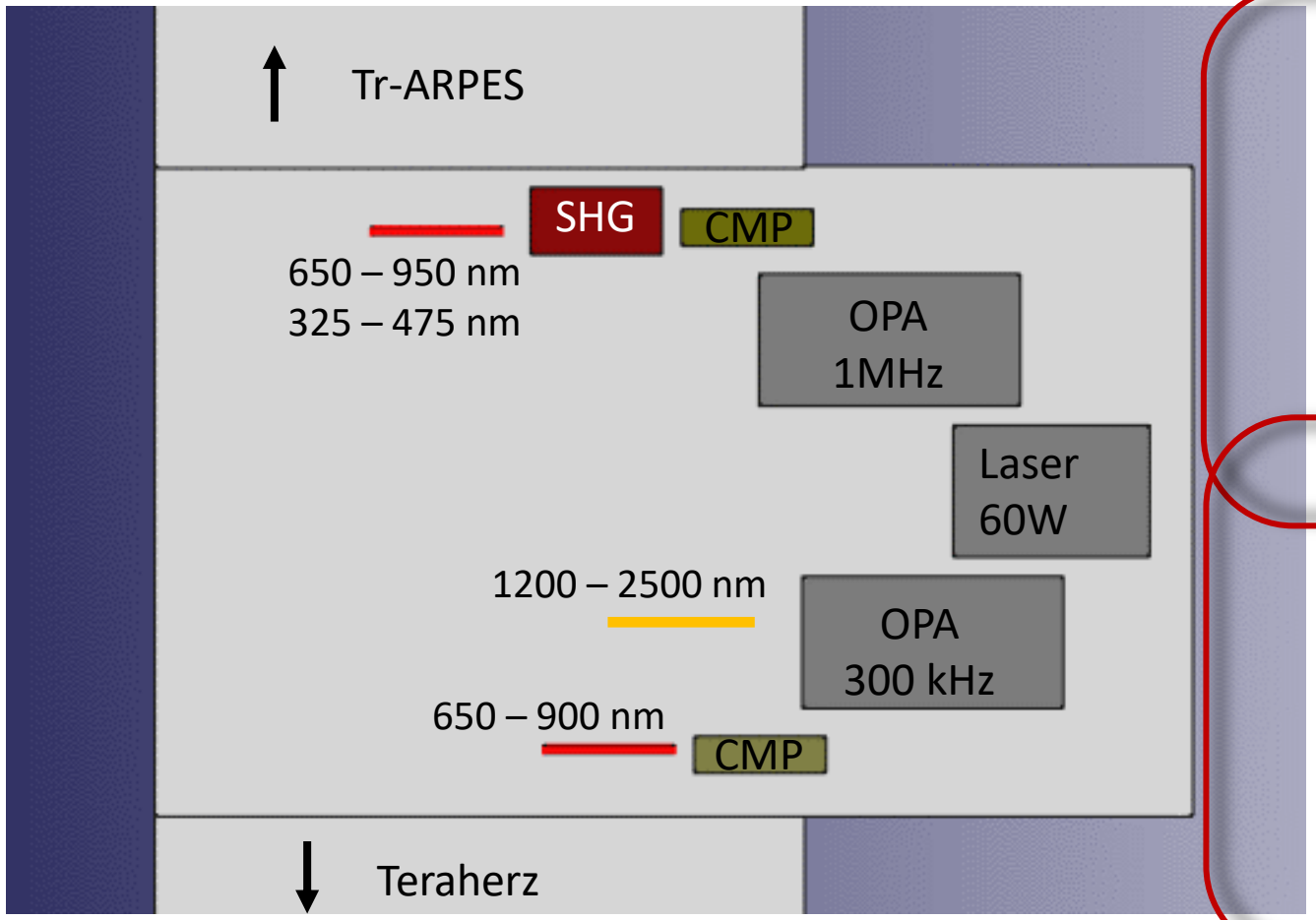


Strengths of 2D spectroscopy:
- uncoupling of time and excitation frequency resolution
- lack of background signals = excellent S/N ratio
- a single run of 2D spectroscopy provides information with a wide range of excitation frequencies

Apllications:
- Energy transfer in complex molecular systems – photosynthesis
- Characterization of transport processes in semiconductor nanocrystals ('quantum dots') in solid-state devices and metal-organic hybrid systems
- Exploring exciton dynamics in DNA-chromophore assemblies
- Bright-Triplet Excitons and Phonon Coupling in Colloidal Nanocrystals

Application of TA:
- Photo-processes on single wall carbon nanotubes
- Plasmon damping in colloidal metallic nanoparticles
- Surface plasmon resonance of metal nanoparticles
- Acoustic vibrations in gold nanoparticles
- Photochemistry of cadmium selenide quantum dots
- Non-linear absorption of PbS nanoparticles
- Ultrafast Polaron and Triplet Exciton Formation in Polythiophene Films
- carrier dynamics in heterostructures of graphene and hexagonal boron nitride (hBN)
- excitonic dynamics due to mid-gap defect states and carrier-phonon renormalization in TMDs

Femto-solids laboratory



Specifications

CMP - OPA
650 – 950 nm
20 – 30 fs
530 – 5800 mW

CMP - SHG
325 – 475 nm
20 – 30 fs
2 – 200 mW

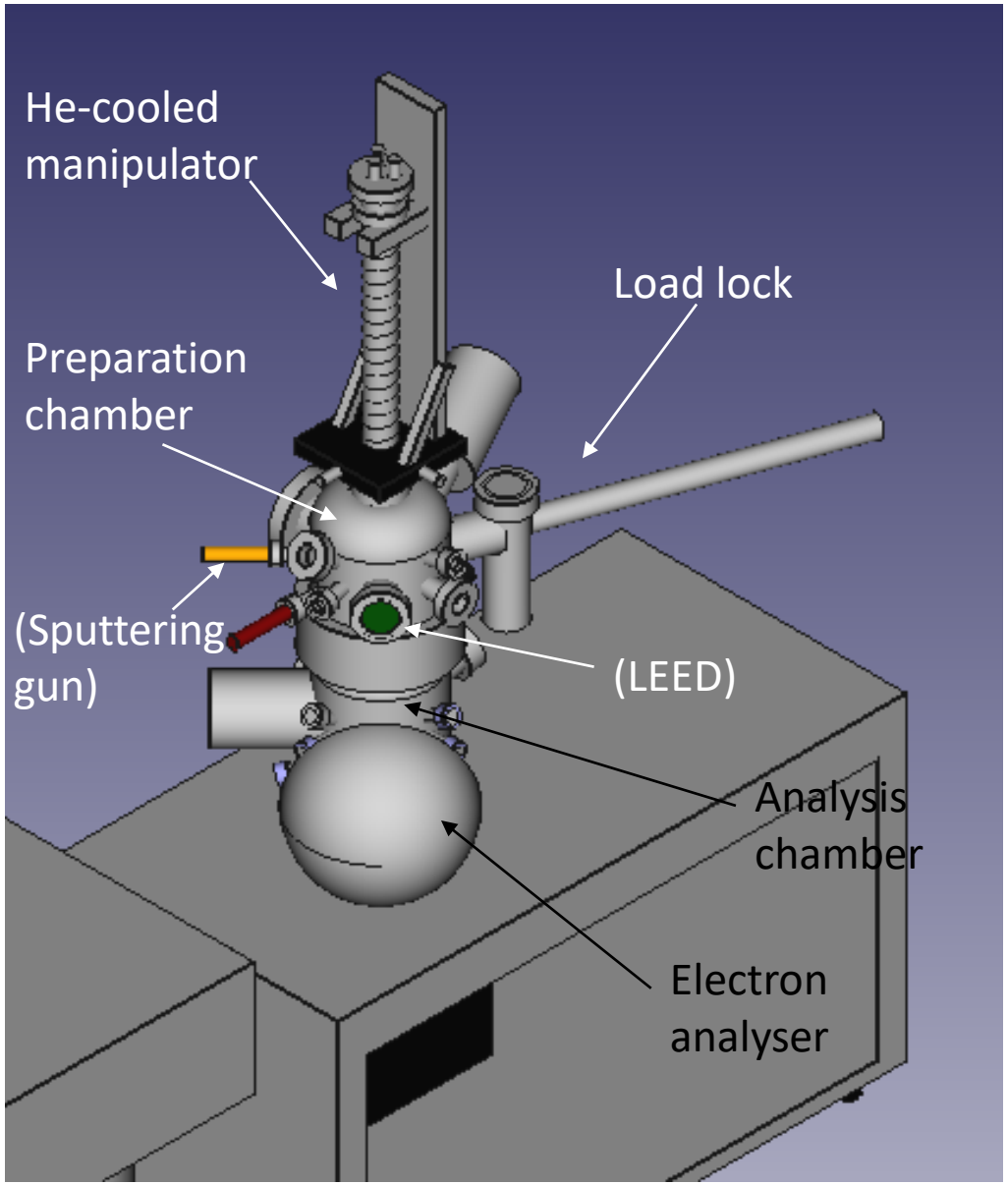
1 MHz

1033 nm; 60 W; 210 fs

CMP - OPA
650 – 950 nm
30-50 fs
3.5-4 W
+
1200-2500 nm
~100 fs
~ 1.5 W

300 kHz

Time resolved - ARPES



UHV setup

Sample manipulator:

- 5 axes: x, y, z, θ = ±180° polar rotation, ϕ = ±90° azimuthal rotation
- Open cycle LHe cryostat
- cooling down to 20 K on sample surface.
- e-beam heating up to 800 °C

Electron Analyser:

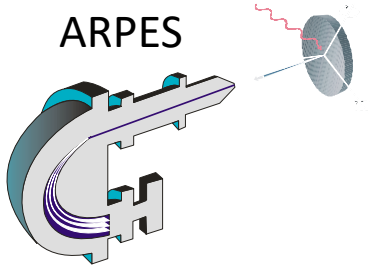
- The maximum lens acceptance angle full cone: ± 30°
- Energy resolution: <1.5 meV
- k-resolution: 0.003 $Å^{-1}$ for 0.1 mm emission spot
- Angular resolution: <0.1° for 0.1 mm emission spot @ HeI
- Detector type: 2D-CMOS
- Optimized for low-energy electrons

UHV:
Turbo + ion pump: p in the range ~ 10^{-10} mbar

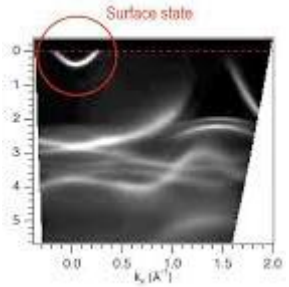
Future:
LEED, heating stage, sputtering gun

Time resolved - ARPES

ARPES



Band structure

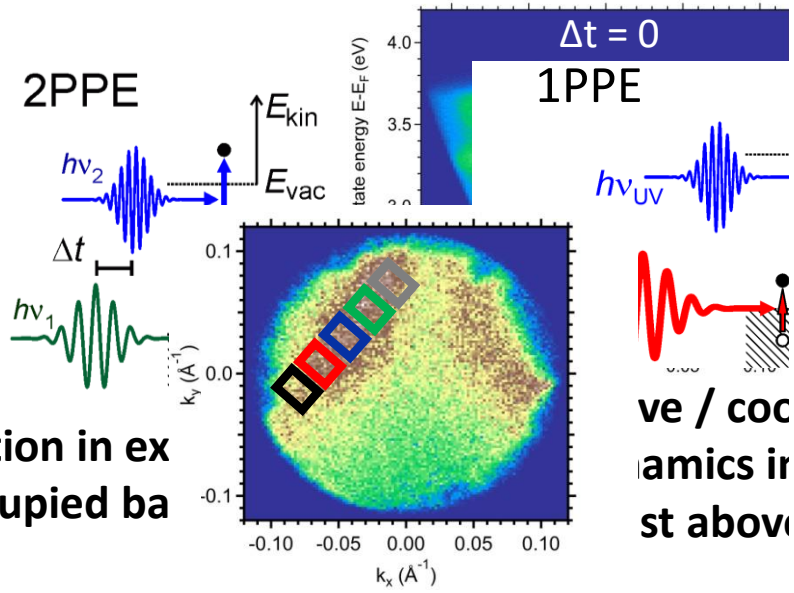


k-resolved
photoemission spectrum
of occupied bands

- conductive samples
- single-crystals for k-resolution

+ Pump-probe

+ ultrafast timescale



relaxation in ex
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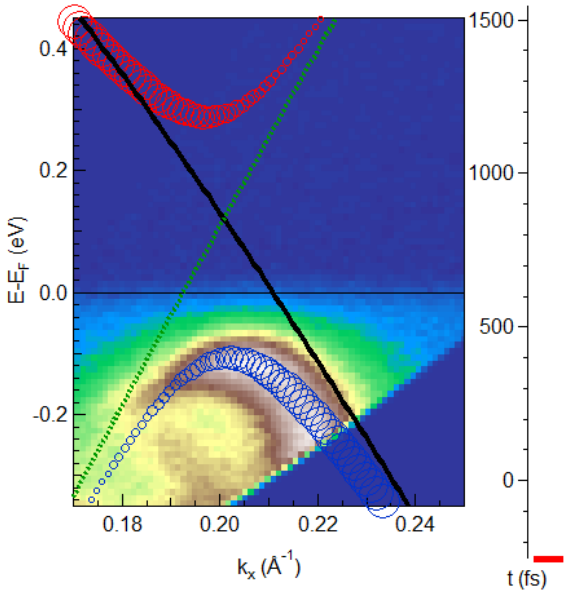
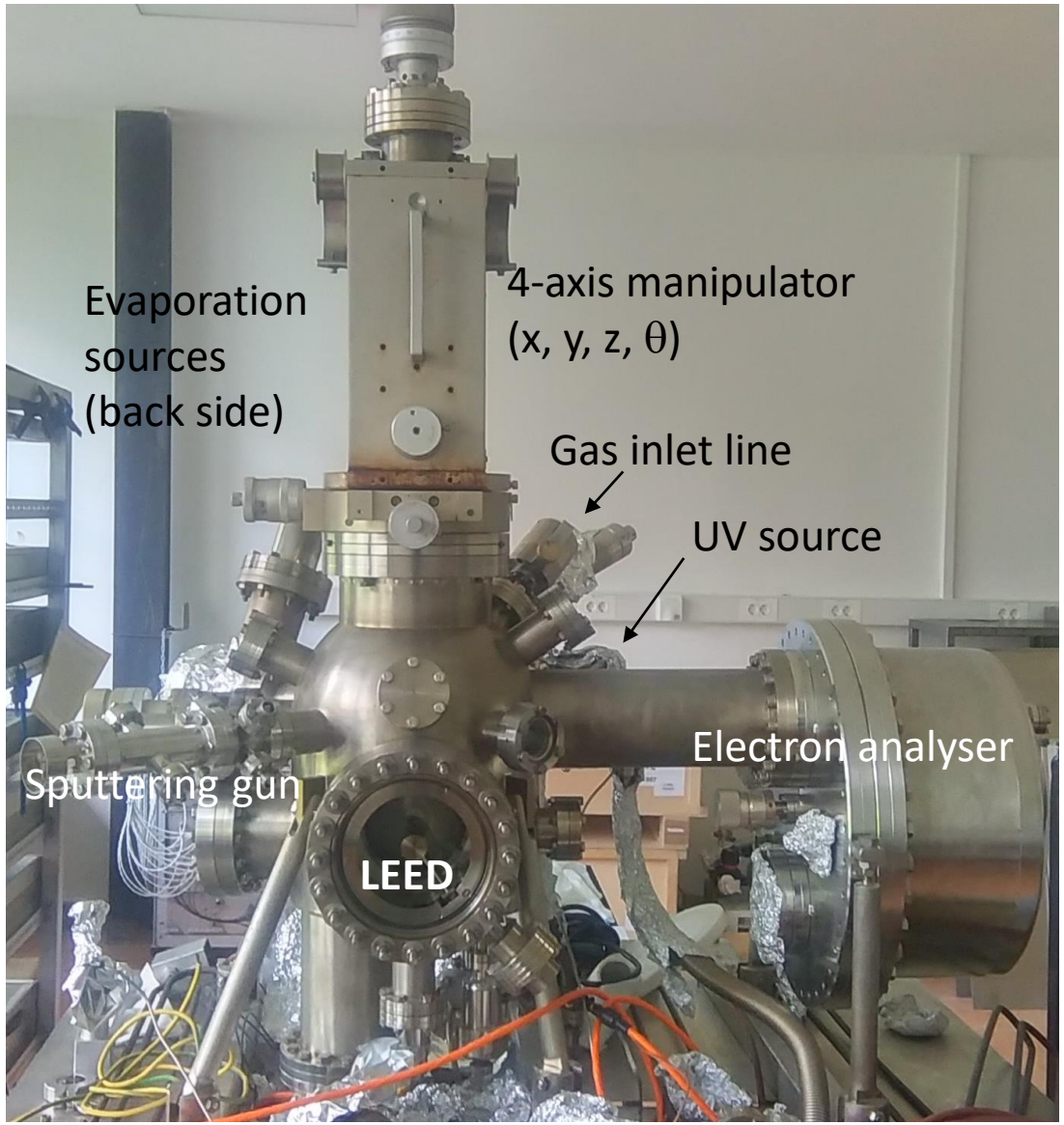


- unoccupied bands
- k-dependent dynamics
- light induced phase change
(directly in the band structure)

UHV ARPES (II wing)



- conductive samples
- single-crystals for k-resolution

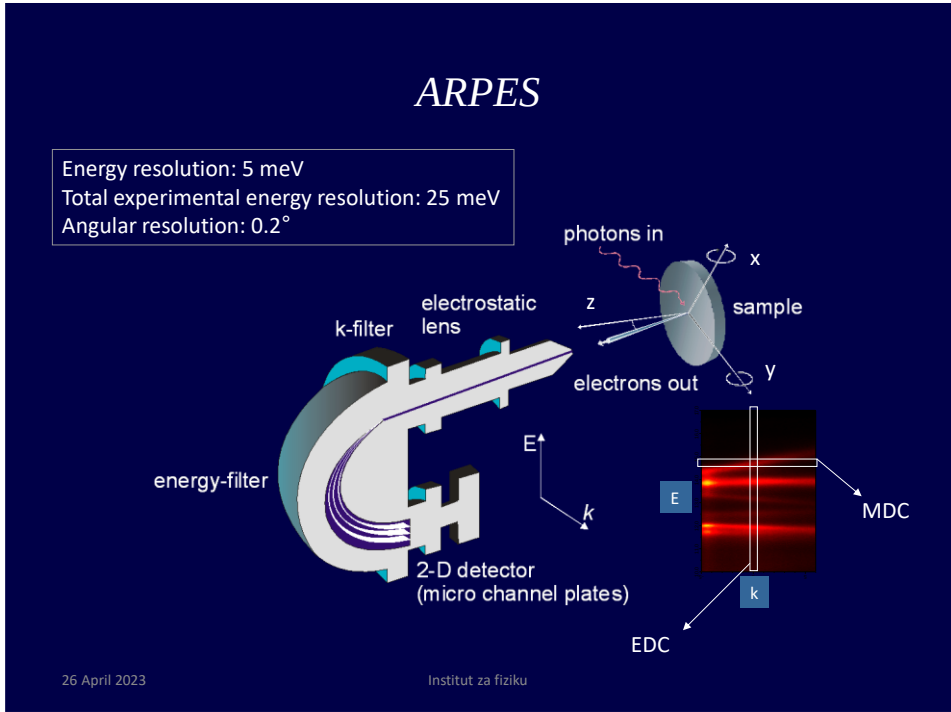
Manipulator:
- 4 axes: x, y, z, θ polar rotation
- e-beam heating up to 1700 K

Closed-cycle helium refrigerator:
- $T \geq 50K$ at the sample surface

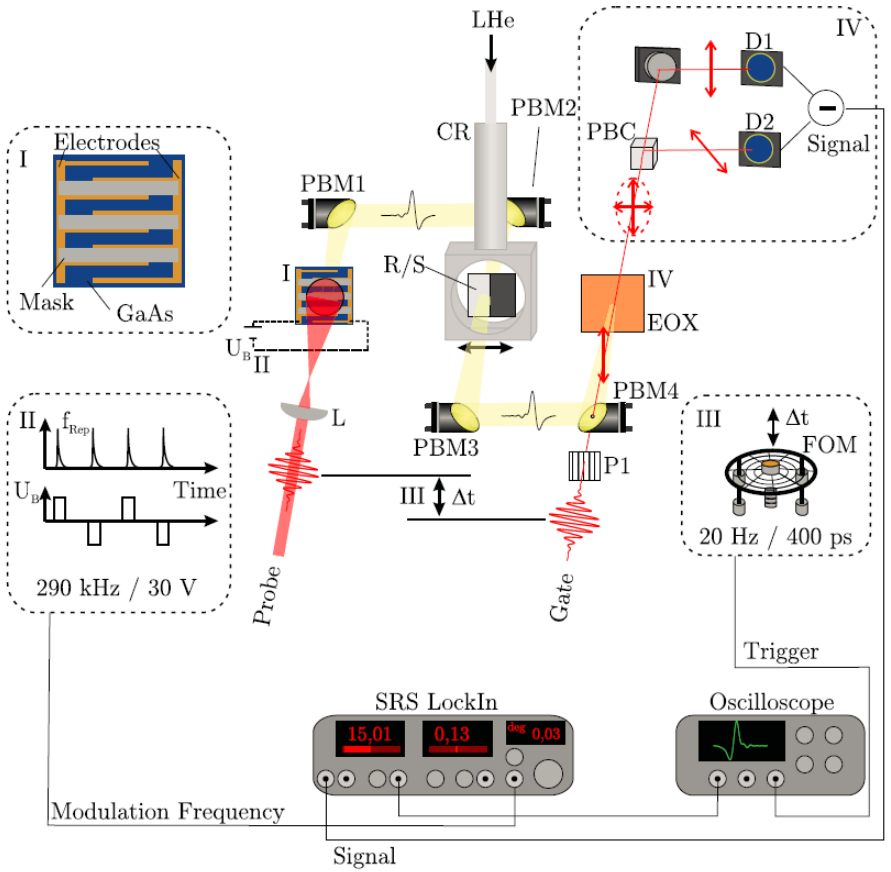
UV source:
- HeI: 21.2 eV

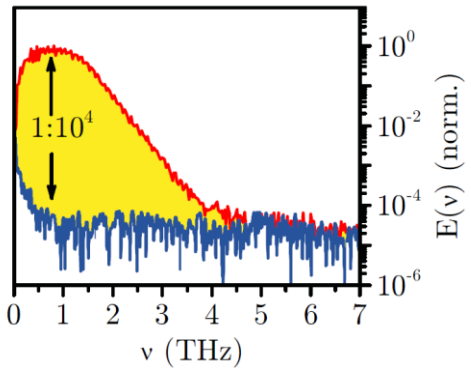
Sputtering gun:
- Ar^+ up to 5 keV

UHV ~ 10^{-10} mbar

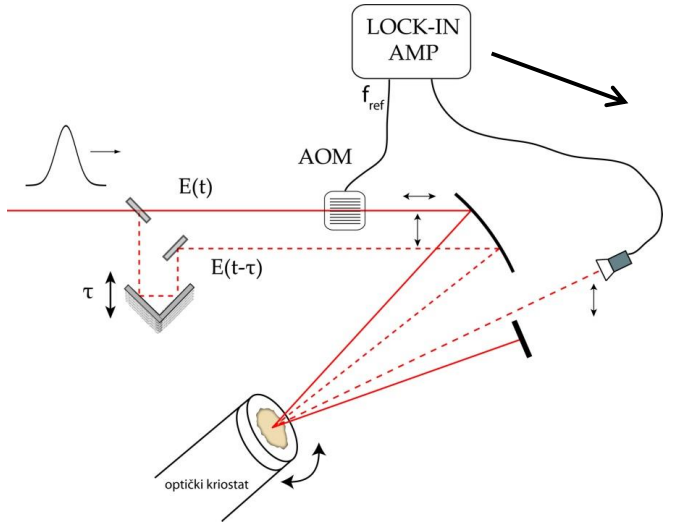


THz and P-P Spectroscopy



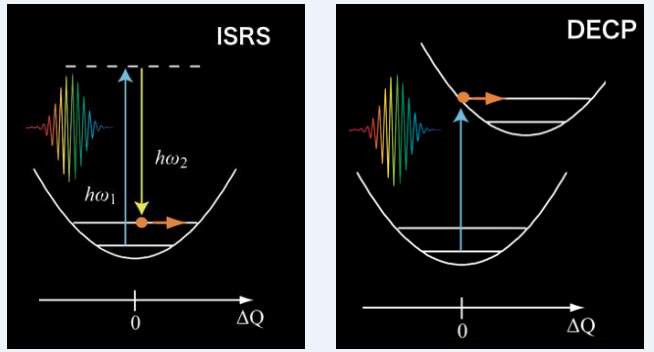


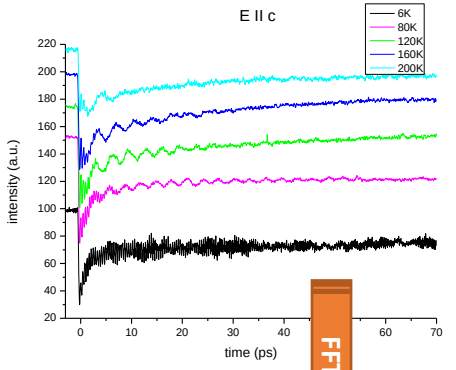
3 mm to 0.1 mm



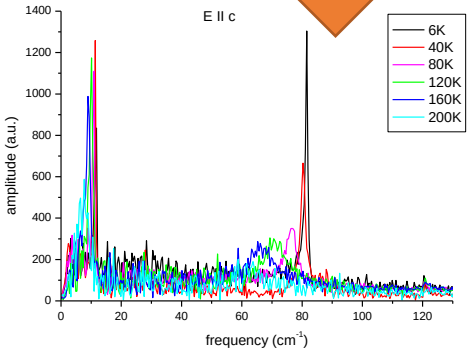
ΔR/R ~ 10^{-6}

Coherent phonons:

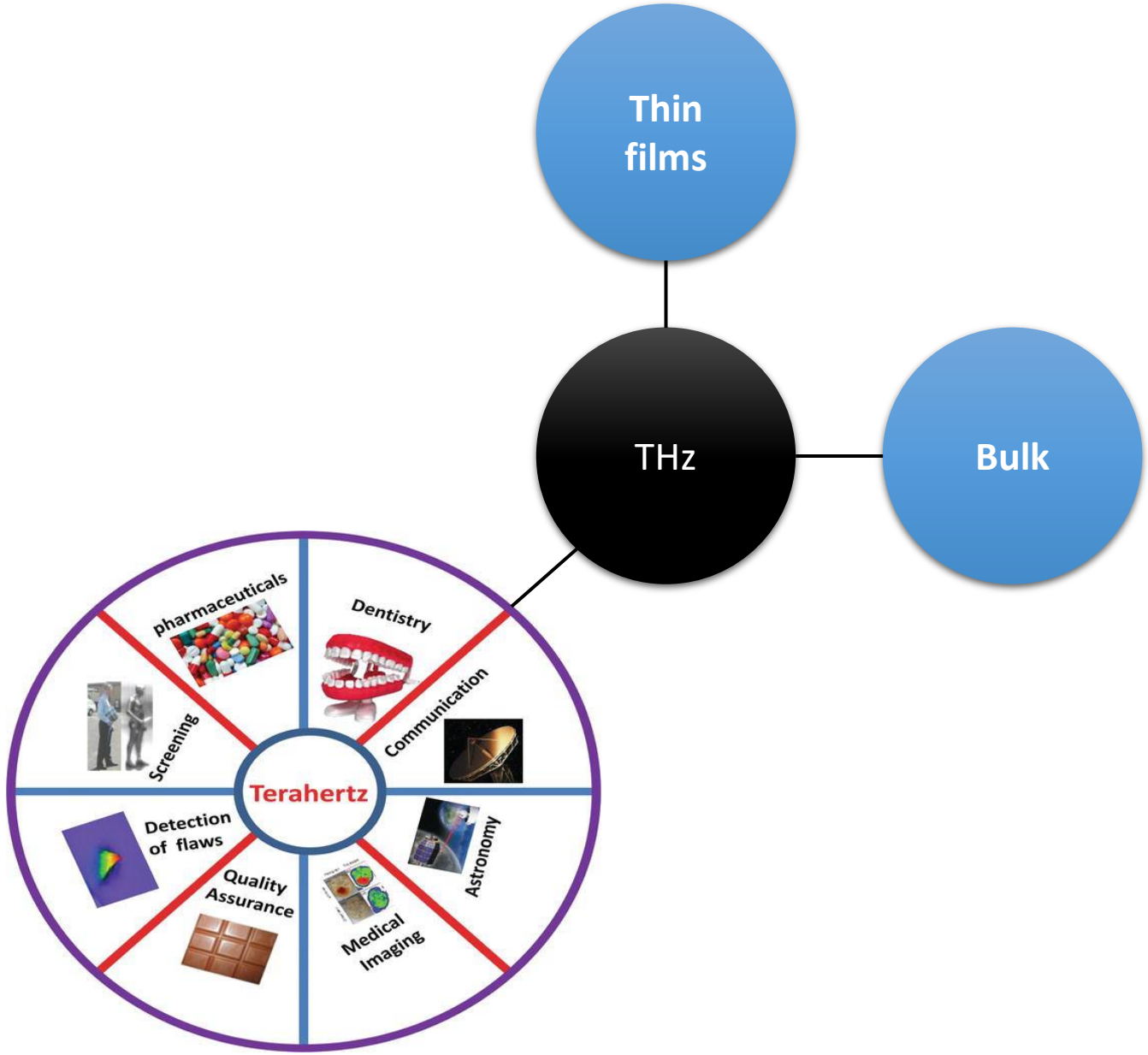




FFT



THz Spectroscopy



- 1st in Croatia
- IR active modes
- Complex conductivity
- Imaging through THz transparent materials (plastics, paper…)