**Division of Chemical Physics, Department of Chemistry**

**Lab. Name:**

Ultra

**Contact persons**:

Arkady Yartsev (arkady.yartsev@chemphys.lu.se),

**Condition for using:** hire the tool technician to run the experiment / collaborative project

**Equipment:**

Femtosecond laser (Pharos, Light conversion), 1030 nm, 1-600 000 Hz, 200 fs (http://www.lightcon.com/products/product.php?ID=28)

NOPA second harmonic (Orpheus, light conversion), 325-475 nm, 650-950 nm, 1-10 kHz, 40 fs (http://www.lightcon.com/products/product.php?ID=33)

NOPA third harmonic (Orpheus, light conversion), 490-900 nm, 1-10 kHz, 40 fs (<http://www.lightcon.com/products/product.php?ID=33>)

**Equipment capabilities:**

The laser is used for time resolved pump-probe transmission/reflection spectroscopy in the near-UV to near IR spectral region, which allows identification of photo-generated species (photo-reaction intermediates, photoexcited carriers etc.) and monitoring their dynamics (type of reaction such as mono- or bi-molecular, lifetimes etc.). Dynamics can be measured from 0 to 550 ps (±0.3 fs); from 0 to 11 ns (±100 fs) and from 0 to 10 ms (±1 ns; 1064, 532 and 355 nm excitation). Noise level down to 3×10-5 per elementary measurement (two probe pulses: with and without excitation) can be achieved for high optical quality samples.

Characterization of fast processes by means of pump-probe may benefit from combination with time-resolved photo-luminescence and time-resolved THz spectroscopy, also available at the Division.

This setup can also permit the study of sub-THz to few THz phonons. This allows the possibility to perform multiple characterization of a materials: elastic constants of thin films and nanostructures (stiffness tensor, Young modulus, Poisson ratio…), thickness measurement of thin films, dimensions of nanostructures, sound velocity, refractive index, piezoelectric tensor, quality of bonding between two materials. With further development, the technique could be used to measure thermal conductivity and thermal boundary resistance.

Adaptive pulse shaping controlled by multi-dimensional evolutionary optimization algorithm or selective variation of specific pulse characteristics for coherent control experiments is also available.

Incident excitation density can be varied from 1011 to 1017 photons/cm2×pulse depending on S/N and damage threshold in the system under study.

Low temperature experiments down to 10 °K are possible.

**Lab. Name:**

Time Resolved Photo Luminescence

**Contact persons**:

Arkady Yartsev (arkady.yartsev@chemphys.lu.se)

**Condition of use:**

Hire the tool technician to run the experiment/collaborative project.

**Light source:**

A Ti:Sapphire laser (Tsunami, Spectra-Physics)

<http://www.spectra-physics.com/products/ultrafast-lasers/tsunami>,

used as an excitation source for Streak-camera and the time-correlated single-photon counting (TCSPC) time-resolved photoluminescence (TRPL) measurements.

Wavelength range of 750-850 nm; can be converted to 375-425 nm by second and to 250-280 nm by third harmonic generation (Tripler TP-2000B, Photop Technologies); pulse duration ~100 fs. Repetition rate 81 MHz; can be reduced to 8, 4, 1.6, 0.8, 0.4, 0.16 and 0.08 MHz by a Bragg cell pulse picker (NEOS technologies).

**Equipment capabilities:**

*Streak camera*

<https://www.hamamatsu.com/resources/pdf/sys/SHSS0006E_STREAK.pdf>

is an ultrahigh-speed detector which captures the dynamics of light emission. Our streak camera system can be used to measure TRPL up to 2 ns with the temporal revolution of down to 2 ps. Sensitive in the range from 280 nm to 920 nm. Provides spatial resolution: better than 1 µm by confocal microscope (coming soon) and at ~30 µm via imaging optics and photocathode spatial resolution.

Incident excitation density up to 1015 photons/cm2×pulse depending on S/N and the damage threshold of the system under study.

*TCSPC* (PicoQuant)

<https://www.picoquant.com/images/uploads/page/files/7253/technote_tcspc.pdf>

is a set-up with a very high sensitivity: upper limit of counting rate is 10-4 counts per laser pulse. For TCSPC pulsed diode lasers (438 nm, 635 nm and 705 nm) with 100 k−2.5 MHz repetition rate can be also used for excitation in addition to Tsunami. The response time of TCSPC is ~100 ps with diodes and ~50 ps with Tsunami. The upper limit of the time range is limited by S/N and your patience: longer time ranges require longer accumulation time.

Both systems can be used to measure TRPL in transmissive or reflective geometries (liquid and solid samples).

Experiments at low temperature down to 10 °K and in selected gas (liquid) environments are possible.

**Set-up:**

Time-resolved THz spectroscopy (TRTS)

**Lab. Name:**

Millennia

**Contact persons**:

Arkady Yartsev (arkady.yartsev@chemphys.lu.se), Xiaojun Su (Xiaojun.Su@chemphys.lu.se)

**Condition of use:**

Hire the tool technician to run the experiment/collaborative project.

**Light source:**

An amplified fs laser (Spitfire Pro, Spectra-Physics)

<http://pdf.directindustry.com/pdf/micro-controle-spectra-physics/spitfire-pro-xp-ultrafast-amplifier/7436-136846.html>

Wavelength ~800 nm, pulse duration ≥35 fs, repetition rate 1 kHz, can be tuned from 300 to 2600 nm by Topas-C <http://www.lightcon.com/products/product.php?ID=233>;.

**Equipment capabilities:**

TRTS (optical pump-THz probe set-up) used to time-resolve photo-conductivity kinetics with temporal resolution down to 100 fs and spectra in 0.1-1.5 THz spectral range.

Incident excitation density from 1011 to 1016 photons/cm2×pulse depending on S/N and the damage threshold of the system under study.

Experiments at low temperature down to 10 °K.

Lab. Name:
**Phase Modulated Multidimensional Spectroscopy**

Contact persons:
Khadga Karki (khadga.karki@chemphys.lu.se)
Tonu Pullerits (tonu.pullerits@chemphys.lu.se)

Condition for using it: hire the tool technician to run the experiment/ collaborative project

Equipment:
Femtosecond oscillator (SynergyTM Femtolasers), 800 nm (130 nm bandwidth), 10 fs, 80 MHz.
Inverted microscope (Nikon Ti-S) with reflective objective.
Low noise  current amplifier (SR580, Stanford research systems)
xyz piezo scanner (Madcity labs)
Microscope cryostage (77 K) with electrical feedthroughs (Linkam)
Avalanche photodiodes

Equipment capabilities:
Measurement of fast dynamics in semiconductors with high temporal (~10 fs), spatial (~1 um) and frequency resolution (meV to ueV) by detecting photocurrent as well as fluorescence. The system is useful to investigate coherent phenomena, carrier dynamics such as thermal relaxation, trapping and drift as well as diffusion. The measurements also provide information about how these dynamics contribute to the photocurrent or fluorescence from the sample.

The equipment can also be used to investigate nonlinear light-matter interaction, such as two photon absorption.

**Set-up:**

Time-resolved pump-probe spectroscopy (TRPPS)

**Lab. Name:**

Millennia

**Contact persons**:

Pavel Chabera (pavel.chabera@chemphys.lu.se)

**Condition of use:**

Hire the tool technician to run the experiment/collaborative project.

**Light source:**

An amplified fs laser (Spitfire Pro, Spectra-Physics)

<http://pdf.directindustry.com/pdf/micro-controle-spectra-physics/spitfire-pro-xp-ultrafast-amplifier/7436-136846.html>

Wavelength ~800 nm, pulse duration ≥35 fs, repetition rate 1 kHz, can be tuned from 300 to 1200 nm by Topas-C <http://www.lightcon.com/products/product.php?ID=233>;.

**Equipment capabilities:**

The laser setup is used for time resolved pump-probe (transmission) spectroscopy in the near-UV to near IR spectral region, which allows identification of photo-generated species (photo-reaction intermediates, photoexcited carriers etc.) and monitoring their dynamics (type of reaction such as mono- or bi-molecular, lifetimes etc.). Dynamics can be measured up to 10 ns with ~80 fs time resolution and probed either by narrow-band (OPA) or broad band (WLC) probe. It is also possible to probe dynamics up to ~300 s, provided that the sample can be excited or probed at 532 nm – time resolution of the experiment is ~2.4 ns in that case.

Setup is equipped with automated sample mover preventing a photodamage while measuring solid samples like dye-sensitized nanoporous films.

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| 1. **Name of infrastructure**

*The full, descriptive name of the infrastructure* | **Laboratory of Steady-state Spectroscopy** |
| 1. **Acronym**

*If applicable.* | **Spectroscopy lab** |
| 1. **Web address**

*The infrastructure’s web page* | **http://www.chemphys.lu.se/research** |
| 1. **Organisational placement**

*LU-internal unit(s) the facility belongs to.* | **Chemical Physics** |
| 1. **Management of the infrastructure**

*Short description of the management of the infrastructure, e.g. a board.* | **Lab responsible –Yuchen Liu**  |
| 1. **Contact person**

*Include name, email, role.* | **Yuchen Liu <yuchen.liu@chemphys.lu.se>; lab responsible** |
| 1. **Overview description**

*Short summary. Around 5-10 sentences.* | **Spectroscopy lab occupies one half of a room and contains apparatus for recording steady-state absorption and emission spectra. Absorption spectrometer Lamda 1050 (Perkin Elmer) can measure absorption spectra in high resolution from UV to IR (~200-1600 nm), operating in dual beam mode (sample and reference) and can be equipped with integrating sphere. Emission spectrometer Fluorolog-3 from Horiba, coupled with TRIAX spectrometer can measure both excitation and emission spectra in wide range of wavelengths due to several available detectors (PD, CCD and InGaAs PD for IR detection).** |
| 1. **LU Faculties involved**
 | **N,**  |
| 1. **Connections to international or national infrastructures**

*If the infrastructure is part of an external infrastructure/structure, please provide a short description of these relations.* | **N/A** |
| 1. **Sub-facilities/infrastructures**

*If the infrastructure has one or more sub-facilities/infrastructures, please describe this structure.* | **N/A** |
| 1. **Equipment and resources**

*Short text description of equipment/types of equipment available. This could include instrument names where relevant.* | **Absorption spectrometer Lamda 1050 (Perkin Elmer) can measure absorption spectra in high resolution from UV to IR (~200-1600 nm) from very diluted samples up to very high OD (saturates around OD 8). Operation in dual beam mode (sample and reference) assures that correct background can be subtracted at the same time as the sample is measured. Both liquid and solid samples (films) can be measured. The integrating sphere is particularly useful for high-scattering samples. Emission spectrometer Fluorolog-3 from Horiba, coupled with TRIAX spectrometer can measure both excitation and emission spectra in wide range of wavelengths due to several available detectors. PD offering high sensitivity over broad range of wavelengths, CCD for detecting large spectra region at a time and InGaAs PD for detection of IR photons. Both CCD and InGaAs need to be cooled by liquid nitrogen for noise suppression.**  |
| 1. **Digital and physical collections**

*Short description/summary listing of digital and/or physical collections provided by the infrastructure.* | **Connection to nitrogen and vacuum lines. Internet.**  |
| 1. **Services provided by the facility**

*Short description/summary listing of services provided by the infrastructure, if applicable.* | **N/A** |
| 1. **Information on access**

*Short description of access policies for internal and external users and how to get physical or virtual access if applicable.* | **Laboratory of Steady-state Spectroscopy is accessible for general use. This is to be arranged with lab responsible, considering current booking of the instrument/s.**  |
| 1. **Funding**

*A short description of how the infrastructure is funded (national, international, LU, Region Skåne?) with approximate amounts and time frames if possible.* | **Grant from Faculty of Science. 2012 Optical steady-state characterization laboratory 930 000 SEK.** |
| 1. **Other info**

*Any other information you wish to provide on the infrastructure.* |  |
| 1. **Email to the person who filled in this form**
 | **pavel.chabera@chemphys.lu.se** |
| 1. **Comments to the working group**

*Any additional comments you may have to the working group.* |  |

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| 1. **Name of infrastructure**

*The full, descriptive name of the infrastructure* | **Single Molecule spectroscopy laboratory** |
| 1. **Acronym**

*If applicable.* | **SMS Lab** |
| 1. **Web address**

*The infrastructure’s web page* | **http://www.chemphys.lu.se/research/groups/scheblykin-group/** |
| 1. **Organisational placement**

*LU-internal unit(s) the facility belongs to.* | **Chemical Physics** |
| 1. **Management of the infrastructure**

*Short description of the management of the infrastructure, e.g. a board.* | **Lab responsible – Prof. Ivan Scheblykin** |
| 1. **Contact person**

*Include name, email, role.* | **Ivan Scheblykin, lab responsible and the head of the SMS group,** **Ivan.Scheblykin@chemphys.lu.se****, 24848** |
| 1. **Overview description**

*Short summary. Around 5-10 sentences.* | **SMS Lab occupies a one room and contains laser spectroscopy and optical microscopy equipment. The main purpose of the lab it to archive optical spectroscopy with spatial resolution using optical microscopy.** |
| 1. **LU Faculties involved**
 | **~~EHL, HT, J, K, LTH, M, MAXIV,~~ N, ~~S, USV~~**  |
| 1. **Connections to international or national infrastructures**

*If the infrastructure is part of an external infrastructure/structure, please provide a short description of these relations.* | **???** |
| 1. **Sub-facilities/infrastructures**

*If the infrastructure has one or more sub-facilities/infrastructures, please describe this structure.* | **???** |
| 1. **Equipment and resources**

*Short text description of equipment/types of equipment available. This could include instrument names where relevant.* | **Several lasers (pulsed and CW): Ar-ion laser, laser diode lasers (CW and 100 ps pulses, PicoQuant), pulsed continuum laser (“white” light, NKT photonics). Three epi-fluorescence microscopes where fluorescence can be excited by one of the laser sources and detected either by EM CCD cameras or by an avalanche photodiode. In the latter case fluorescence kinetics can be measured by time-correlated single photon counting. The sensitivity of the setup allows working with individual fluorescent molecules or luminescent nano-particles.****Especially design light polarization equipment allows for so-called 2-dimensional polarization imaging. This method is original and allows for detailed characterization of anisotropic molecules, films, biological samples.****One of the microscopes is coupled to a femtosecond laser and a streak camera (physically located in the Fluorescence Lab, next door) where luminescence decays with 1 ps time-resolution can be measured. All experiments can be carried out at low temperature down to 5K using a micro cryostat.** |

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| 1. **Name of infrastructure**

*The full, descriptive name of the infrastructure* | **Two-dimensional electronic spectroscopy infrastructure** |
| 1. **Acronym**

*If applicable.* | **2D Lab** |
| 1. **Web address**

*The infrastructure’s web page* | **http://www.chemphys.lu.se/research/groups/zigmantas-group/** |
| 1. **Organisational placement**

*LU-internal unit(s) the facility belongs to.* | **Division of Chemical Physics** |
| 1. **Management of the infrastructure**

*Short description of the management of the infrastructure, e.g. a board.* | **Infrastructure manager Donatas Zigmantas** |
| 1. **Contact person**

*Include name, email, role.* | **Donatas Zigmantas, the head of the 2D group at the Div. of Chemical Physics,** **donatas.zigmantas@chemphys.lu.se****, tel.: 24739** |
| 1. **Overview description**

*Short summary. Around 5-10 sentences.* | **2D lab occupies one laboratory and contains multiple laser instruments, as well as ultrafast spectroscopy equipment. The main purpose of the infrastructure is to support two-dimensional electronic spectroscopy experiments on the variety of chemical and biological systems. Measurement are carried out both at ambient and cryogenic temperatures.** |
| 1. **LU Faculties involved**
 | **N** |
| 1. **Connections to international or national infrastructures**

*If the infrastructure is part of an external infrastructure/structure, please provide a short description of these relations.* | **LLC, provides an access to the users via the Laserlab Europe network****NanoLund, the lab PI is a full member of NanoLund.** |
| 1. **Sub-facilities/infrastructures**

*If the infrastructure has one or more sub-facilities/infrastructures, please describe this structure.* | **The whole infrastructure is one unit** |
| 1. **Equipment and resources**

*Short text description of equipment/types of equipment available. This could include instrument names where relevant.* | **Amplified ultrashort pulse laser system (Pharos, Light Conversion).****Two parametric amplifiers (one from Light Conversion and one home-built), pumped by the Pharos laser for generating sub 15 fs pulses with a wide range of spectral tunability.****Spectrograph with the CCD camera detector (Princeton Instruments) for interferometric measurements.****Home-build two-dimensional spectroscopy spectrometer with three delay stages for changing delays between the pulses.****Cryogenic equipment for carrying out experiments at cryogenic temperatures, including cryostats (Oxford Instruments), dewars and cryogen transfer line (Oxford Instruments).** |

**List of equipment at the Lund High-Power Laser Facility with relevance to the Lund Nano Characterization Lab (LNCL)**

The Lund High-Power Laser Facility is operated by the Division of Atomic Physics. The facility includes several state-of-the-art ultrashort pulse lasers, including the Lund Terawatt laser (Scandinavia’s most intense laser). The core scientific activity at the facility focusses on high-intensity laser-matter interaction, including particle acceleration (electrons and protons) as well as the generation of attosecond light pulses in the extreme-ultraviolet (XUV) spectral range and their application in time resolved pump-probe measurements. The latter activity is pursued by the researchers of the Lund Attosecond Science Center (LASC), which is part of the High-Power Laser Facility.

In the following table the different laser sources and the attosecond sources driven by them are listed with their respective parameters and their main scientific applications:

|  |  |  |  |
| --- | --- | --- | --- |
|  | High XUV pulse energy beam line | High flexibility beam line | High repetition rate beam line |
| Driving laser (wavelength, pulse energy, pulse duration, repetition rate) | 800 nm, 100 mJ, 45 fs, 10 Hz | 780-820 nm, 5 mJ, 20 fs, 1 kHzOPA (1100-1800 nm, <1 mJ) | 850 nm, 10 µJ, <7 fs, 200 kHz |
| Attosecond source: | APTs 17-120 eV | APTs and SAPs 17-120 eV | APTs (2-4 pulses), 17-45 eV |
| Main scientific applications | Pump-probe measurement schemes with intense XUV attosecond pulses mostly dedicated towards charge migration in molecules | Pump-probe measurement schemes for attosecond time-resolved atomic physics | Three-dimensional photo-electron momentum mapping and coincidence spectroscopy.Time-resolved photo-electron emission microscopy (PEEM) on nanostructured systems (in collaboration with A. Mikkelsen) |

APT – Attosecond pulse train; SAP – Single attosecond pulse; OPA – Optical parametric amplifier

**Solid State Physics**

**Electrical measurements**

**Oxford Triton200 Dilution Fridge (new)**

Low-temperature (ca 100-200 mK) closed-cycle dilution fridge for transport studies under magnetic fields (vector magnet 1,1,9 T).

Contact person: Adam Burke

Open for collaborative projects.

**Oxford Dilution fridge (old)**

Low-temperature (100-200 mK) dilution fridge for transport studies under a magnetic field.

Contact person: Simon Abay Gebrehiwot

Open for collaborative projects.

**Janis fridge**

Low- (variable) temperature (min ca 1.5 K) pumped He4 system for transport studies under a magnetic field.

Contact person: Adam Burke

User training required

**Janis Probe Station**

Variable temperature probe-station (down to 6K) for electrical and electro-optical measurements. Closed-cycle system. 5 probes for electrical measurements, and 1 probe equipped with an optical fibre. High-temperature stage available (up to 650 K).

Contact person: Claes Thelander

User training required

**FTIR** (Fourier-transform infra-red)

Photoconductivity studies at low temperatures

Contact person ???

User training required

**Bio**

- Fluorescence microscopy, confocal fluorescence microscopy

Responsible: Jonas Tegenfeldt, email: jonas.tegenfeldt@ftf.lth.se

Open to collaborative projects

- PDMS lab and 3D printing for microfluidics

Responsible: Jonas Tegenfeldt, email: jonas.tegenfeldt@ftf.lth.se

Open to collaborative projects

-Optical tweezers

Responsible: Heiner Linke, email: heiner.linke@ftf.lth.se

Open to collaborative projects

From September 2016:

- 3D STED microscope 775 nm with Rescue, polarisation detection and FLIM

Responsible: Jonas Tegenfeldt, email: jonas.tegenfeldt@ftf.lth.se

Open to collaborative projects

- 3D STED microscope 775 nm with Rescue, with an additional 405 nm laser and detection channel.

Responsible: Christelle Prinz, email: christelle.prinz@ftf.lth.se

Open to collaborative projects