Transient Absorption Spectroscopy Set-up

HELIOS is a broadband pump-probe femtosecond **Transient Absorption Spectrometer** designed to work with an amplified femtosecond laser. A complete turnkey system, HELIOS comprises an enclosed optical bench containing all necessary optical and opto-mechanical components and a 19" rack enclosing all required electronics and a PC. A rack mounted PC contains the necessary data acquisition hardware and software. The optical bench is connected to the rack by a shielded umbilical cord. This architecture allows keeping all regularly accessed parts of the system within reach, while protecting and consolidating all auxiliary components in a steel rack. Additionally, such a two-unit design facilitates quick and easy installation and relocation. The preconfigured routing optics kits offered with HELIOS allow for easy accommodation of various excitation sources, such as harmonics generators and OPAs. Top quality hardware components from Hamamatsu, JY Horiba, ThorLabs, Newport, CVI and other industry leaders ensure high reliability and longevity of HELIOS and all our other spectrometers. HELIOS comes with advanced data analysis software, SURFACE XPLORER, capable of various types of data processing including Global Analysis. With its broad spectral coverage and longtime window, HELIOS will produce superb spectral and kinetic data needed for your investigations of photoexcitation events with ultrafast time resolution.

At any time HELIOS's time window can be extended to sub-milliseconds and beyond by integrating it with EOS, our broadband pump-probe sub-nanosecond transient absorption spectrometer.

Feature and capabilities:

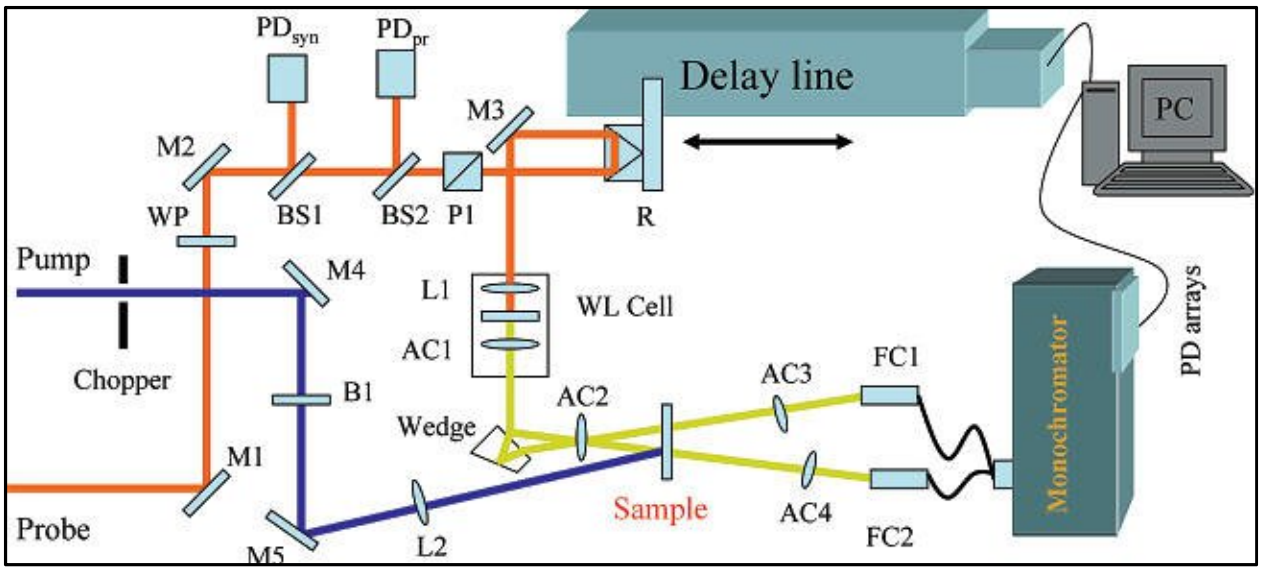
- 2-unit design with the optical bench isolated from the electronics and detectors.
- Advanced user-friendly LabVIEW based software for instrument control and data acquisition.
- Broad probe spectral range: 350-2400 nm.
- 8 ns time window. We achieve it using a low profile direct-drive ultra-high speed optical delay line. We use custom designed mounts for the delay line optics to increase the beam alignment reproducibility and the overall reliability. This delay line features high resolution as well as very high speed. Scanning at high speeds is very important because it allows for pseudo-random stepping without a significant increase in the experiment time. This type of stepping is very useful for minimizing the effects of laser instability and sample degradation. The delay line is integrated inside the HELIOS optical bench. This keeps the delay line optics protected from accidental bumping and misalignment. To ensure perfect alignment of the delay line we use a beam profiler for computer assisted control.
- Time window extendable to milliseconds with the EOS add-on.
- Support for large pump beam diameters. The proprietary design of our fully enclosed optical chopper accommodates pump beams of up to 9 mm in diameter without sacrificing the contrast of pump-on and pump-off measurements and the transient absorption signal amplitude. This is important because when you don't have much power out of an OPA (especially in the UV) you cannot afford putting an iris in front of a chopper. In such cases being able to utilize the whole pump beam cross section is critical for getting good data.
- Fiber coupled high-speed spectrometers
- Optional computer controlled filter wheel for varying pump energy, etc.
- Magnetically stirred sample holder. Easily interchangeable with optional XY rastering sample holder or flow cell.
- All electronics, including spectrometers, are enclosed in a separate electronics rack connected to the main Helios unit by a protected umbilical cable.
- An optional anisotropy extension allows for transient absorption anisotropy measurements.
- Probe Reference. HELIOS has an option for a second probe (reference) channel. In this variant the probe beam is split into two before passing through the sample. While one arm travels through the sample, the other is sent directly to the reference spectrometer that monitors the fluctuations in the probe beam intensity. The main advantage of this technique is that it allows the user to achieve the specified signal-to-noise ratio with a lower number of averaged laser pulses. This method is primarily used for the experiments with low repetition rate and/or easily photodegradable samples where the number of laser shots is strongly limited. The advantage of the standard single probe channel detection method remains in the simpler optical alignment, which is especially useful for multi-user facilities. With the current versatility of Helios a user can decide whether to run a single probe channel

experiment or to utilize the dual channel detection. The switching between the two data modes is very quick and simple.

System specifications:

- Low profile direct-drive ultra-high speed optical delay line integrated in the spectrometer housing.
  - Time window: 8 ns
  - Resolution: 14 fs
  - Minimum step size: 2.8 fs
  - Max. speed: >10 ns/s
  - Acceleration: > 260 ns/s^2
- Temporal Resolution. The instrument response function is a cross-correlation of the pump and probe pulses. The typical HELIOS IRF is 1.4 times longer than the laser's fundamental pulse duration. See the optical delay line description for more details.
- Probe spectral range
  - 350-750 nm
  - 450-800 nm
  - 800-1600 nm
  - 1600-2400 nm
- Spectral Resolution
  - Intrinsic spectral resolution
    - VIS – 2 nm
    - NIR – 5 nm
    - SWIR – 5 nm
  - Spectral resolution with a 200 µm slit (recommended)
    - VIS – 4 nm
    - NIR – 13 nm
    - SWIR – 13 nm
  - Detectors
    - VIS. Custom designed fiber-coupled alignment-free spectrometer with a 1024 pixel CMOS sensor (spectral response: 200-1000 nm). Typical spectral range spans 600 nm (i.e. 350-950 nm). Spectral acquisition rate – up to 2400 spectra/s. Mounted in a 19″ rack outside of the optical bench.
    - NIR. Custom designed fiber-coupled alignment-free spectrometer with a 256 pixel InGaAs sensor (spectral response: 800-1600 nm). Typical spectral range spans 800 nm (i.e. 800-1600 nm). Spectral acquisition rate – up to 7900 spectra/s. Mounted in a 19″ rack outside of the optical bench.

- SWIR. Custom designed fiber-coupled alignment-free spectrometer with a 256 pixel InGaAs sensor (spectral response: 1000-2600 nm). Typical spectral range spans 800 nm (i.e. 1600-2400 nm). Spectral acquisition rate – up to 7900 spectra/s. Mounted in a 19″ rack outside of the optical bench.



- **Dimensions**
  - Optical bench: W24” x L36” x H10” (W610 x L915 x H250 mm)
  - Electronics rack: W21” x L24” x H27” (W534 x L610 x H686 mm)

Software:

HELIOS features versatile and user-friendly LabVIEW based software for instrument control and data acquisition. The software allows for experiment automation, such as preset optical delay step sizes, averaging time for each transient spectrum, time window. Alternatively user can adjust the above parameters during the data collection process. Random delay line stepping is available for the above regimes.

- Supports computer controlled translating sample holder
- Supports CaF2 motorized stage (for generating probe continuum in the UV)
- Support pump beam shutter for increased automation.
- Supports motorized filter wheel for automated pump intensity control.
- Saves every individual kinetic scan, so if experiment is aborted (due to laser fluctuations, power outages, etc.), all previous scans are not lost.

- Threshold adjusted automatic continuum spike rejection- advanced setting which collects data points again if the continuum is not stable.
- Automatic anisotropy calculation when appropriate optics are used and a reference channel is included.
- Two levels of user access – basic (default, most commonly used settings), advanced (allows to change DAQ parameters, such as continuum stability thresholds, digitizer dynamic range, etc.)
- Support for multiple choppers to facilitate customized experiments, such as “pump-pump-probe”, “pump-dump-probe” or experiments where the probe beam is also modulated.
- API (Application Programming Interface) for HELIOS is provided for further experiment customization and integration with external applications. For example, studying temperature dependence on the kinetics with a computer controlled cryostat, etc. can be easily automated through the API. Another example is integration of a computer controlled ND filter wheel or an OPA to perform multiple kinetic scans at different excitation energies or wavelengths.
- Data format. The Helios software produces a 3-Dimensional Wavelength-Time-Absorbance data matrix in a form of an .ufs file, which can be easily exported into ASCII with Surface Xplorer.