

## PSI Central Facilities

### CW lasers

#### Tunable ultra-narrow linewidth Ti:sapphire laser systems

We have three *Matisse TX* single frequency Ti:sapphire ring lasers (Newport Spectra-Physics/Sirah) pumped by 15W *Millennia PRO* DPSS lasers (Newport Spectra-Physics). Each system has its own *WaveTrain* external cavity resonant doubling unit (Newport Spectra-Physics) and a high specification wavelength meter (HighFinesse: WSU-10) continuously calibrated by a stabilised He-Ne laser.

#### Tunable ultra-narrow linewidth dye laser system

We have a *Matisse DX* single frequency dye ring laser (Newport Spectra-Physics/Sirah) pumped by a 15W *Millennia PRO* DPSS laser (Newport Spectra-Physics). This system also has its own *WaveTrain* external cavity resonant doubling unit (Newport Spectra-Physics) and a high specification wavelength meter (HighFinesse: WSU-10).

#### Tunable narrow linewidth dye laser system

We have a *Matisse DS* single frequency dye ring laser (Newport Spectra-Physics/Sirah) pumped by a 25W *BeamLok 2080-25S* argon laser (Newport Spectra-Physics) which can be operated with multiline (or single-line) optics in the visible or UV. This system also has its own *WaveTrain* external cavity resonant doubling unit (Newport Spectra-Physics) for generation of UV radiation between 205 and 350nm

#### UV Argon ion laser

We have a 25W argon ion pump laser (Coherent: *Sabre DBW 25/5*) with multiline and single-line optics for the visible, long-, mid-, and short-UV

### Ultrafast lasers

#### Tunable ~100fs/80MHz Ti:sapphire oscillator

Our *Mai Tai HP* (Newport Spectra-Physics) can be tuned automatically between 690 and 1020nm

#### Broadband Ti:sapphire oscillator

We have a large bandwidth *Mantis* Ti:sapphire oscillator with integrated Optically Pumped Semiconductor pump Laser (Coherent) that can be used with a Compact chirped-mirror Pulse Compressor (Coherent: *CPC*) to obtain <20fs pulses at 800nm.

#### Tunable high repetition rate system

We have a *Mira 900-Optima Dual* femto/picosecond tunable Ti:sapphire oscillator (Coherent) with a 2<sup>nd</sup> and 3<sup>rd</sup> harmonic generation unit (Inrad: *5-050*) and pulse picker (APE *PulseSelect Dual*).

Additionally, the *Mira* oscillator can be used to synchronously pump a ring-Optical Parametric Oscillator equipped with bulk KTP and PP crystals (Coherent/APE: *Mira-OPO advanced ring*), or (in femtosecond mode) to seed a *RegA 9000* Ti:sapphire regenerative amplifier (Coherent). The *Mira* and *RegA* are both pumped by an 18W DPSS laser (Coherent: *Verdi V-18*). A 2<sup>nd</sup>/3<sup>rd</sup> harmonic generation unit (Photop: *Timeplate THG*) and two Optical Parametric Amplifiers (Coherent: *OPA 9400* and *OPA 9800*) are used to extend the tuning range of the amplified ~100kHz *RegA* output. Mid-IR can also be generated by Difference Frequency Generation of the *OPA 9800* output (Coherent: *DFG 9800*).

#### Tunable 1kHz ultrashort pulse system

A large bandwidth Ti:sapphire oscillator with integrated pump laser and Carrier-Envelope Phase stabilisation unit (Coherent/Menlo Systems: *Micra-CEP*) is used to seed a two-stage Ti:sapphire regenerative and single pass power amplifier pumped by an integrated solid-state Nd:YLF laser (Coherent: *Legend Elite-USP Duo*). The *Micra* output is routed through a dual spatial light modulator for phase and amplitude control (Coherent/Biophotonics Solutions: *Silhouette-II*) and the pulses can be compressed with a *CPC* compact chirped mirror unit (Coherent) for stand alone use if desired. The <40fs/>6mJ amplified output is split to simultaneously pump three white light-seeded Optical Parametric Amplifiers (Coherent/Light Conversion: *OPerA Solo*). Two are configured for operation down into the deep-UV and UV, and the third is configured for IR operation. Higher energy pulses can also be obtained at the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> harmonics of the amplifier in place of the output from one of the OPAs. Planned upgrades of this system include CEP stabilisation of the amplifier and addition of a noble gas-filled hollow fibre and chirped-mirror compressor system for high harmonic generation.

#### Tunable 1kHz femtosecond system

A tunable one-box *Mai Tai BB* Ti:sapphire oscillator (Newport Spectra-Physics) is used to seed a ~130fs Ti:sapphire regenerative amplifier (Coherent: *Spitfire-HPR* upgraded with *Legend Elite HE-F* optics) pumped by an *Evolution-30* solid-state Nd:YLF laser (Positive Light). This amplifier is used to pump two UV-visible non-collinear Optical Parametric Amplifiers (Light Conversion: *TOPAS-White*) and an IR-configured white light-seeded Optical Parametric Amplifier (Coherent: *OPerA Solo*).

#### Tunable 1kHz picosecond system

The *Mai Tai BB* Ti:sapphire oscillator (Newport Spectra-Physics) used to seed the ~130fs Ti:sapphire regenerative amplifier is also used – in conjunction with a stretcher grating mask – to seed a ~1ps two-stage Ti:sapphire regenerative and single pass power amplifier pumped by an integrated solid-state Nd:YLF laser (Coherent: *Legend Elite-P Duo*). One portion of the amplified output is frequency doubled in a linewidth-narrowing SHG unit (Light Conversion: *SHBC*) and this output is then used to pump two *Topas 400* Optical Parametric Amplifiers (Light Conversion). One of these is configured for operation down into the deep-UV and the other has just SHG. The remaining output from the amplifier is converted into tunable IR radiation with a *Topas 800* Optical Parametric Amplifier (Light Conversion) with a separate sum-frequency mixing unit (Light Conversion: *MIR*) for enhanced mid-IR output.

## Nanosecond lasers

### Tunable UV-Visible system

This *Surelite III-10* flashlamp-pumped Nd:YAG pump laser with 2<sup>nd</sup> and 3<sup>rd</sup> harmonic generators (Continuum) is used to pump a *NarrowScan D-R 2400* dye laser (Radiant Dyes) configured for narrow linewidth UV-visible operation and a *versaScan/240/MB* mid-band Type-II BBO Optical Parametric Oscillator (GWU) with second harmonic and sum-frequency mixing options (GWU: *uvScan/240*).

### Narrow linewidth tunable IR laser systems

The second harmonic output from an injection-seeded, flashlamp-pumped, Nd:YAG pump laser (Continuum/NP Photonics: *Powerlite 8000* with *Scorpion* seeder) is used to pump a *PrecisionScan 1800 SL* dye laser (Sirah) which is then used to seed an Optical Parametric Amplifier unit (Sirah: *OPANIR*) by difference-frequency mixing and amplification in LiNbO<sub>3</sub> stages pumped by the Nd:YAG fundamental beam. A AgGaSe<sub>2</sub> difference frequency mixing stage is used to extend the tuning range in the mid-IR region (Sirah *MIR*)

This system uses an injection-seeded, flashlamp-pumped, Nd:YAG pump laser (Continuum/NP Photonics: *Powerlite 8000* with *Scorpion* seeder) to pump a KTP/KTA Optical Parametric Oscillator/Amplifier (LaserVision: *OPO/A Custom*) to generate tunable IR radiation. A AgGaSe<sub>2</sub> difference frequency mixing stage is also available with this system to extend the tuning range.

## Spectrometers

### UV-Vis-NIR spectrophotometer

The  $\lambda$ -1050 (PerkinElmer) is a research grade spectrophotometer that uses three separate detectors (a PMT, a wideband InGaAs photodiode and a PbS photodiode) to cover the range 175 to 3300nm. The snap-in detection module can also be replaced with either an automated Universal Reflectance Attachment (URA), or a 150mm Integrating Sphere module with a centre mount and external port which uses a built-in PMT and cooled InGaAs photodiode for detection.

The URA enables absolute reflectance spectra to be measured in the range 200–3100 nm (using a Si photodiode and a temperature-stabilised PbS detector) at angles between 8 and 65° in 0.5° intervals. It is used with an automated polariser unit with plug-in Glan-Taylor (210–1100 nm) and Glan-Thompson polarisers (300–2600 nm).

### UV-Vis-NIR spectrofluorometer

Our modular *Fluorolog 3-22-iHR* (Horiba) spectrofluorometer is configured with double excitation and emission monochromators and, for detection, a cooled R928P photomultiplier tube operated in photon-counting mode is used. A second emission channel is configured for detection of near-IR emission using an imaging spectrograph (*iHR-320*) with a liquid-nitrogen cooled InGaAs array (Horiba: *Symphony IGA-512*). Accessories include automated polarisers, an integrating sphere, a thermostatted cuvette holder, a solid sample holder and a cryostat holder.

### Triple Raman/Photoluminescence spectrometer

A *T64000* triple 0.64m spectrometer system (Horiba), which can be used in additive or double subtractive modes, will shortly be installed. This system has micro- and macro-sampling capabilities provided by a UV–NIR Free Space confocal Microscope with motorised mapping stage and a separate macro chamber. A standard TE-cooled open electrode CCD covering the range 300–1000nm will initially be used for detection.