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Sirah
Lasertechnik

Matisse C Ring Laser

Matisse C

Resonator design for hands-free operation

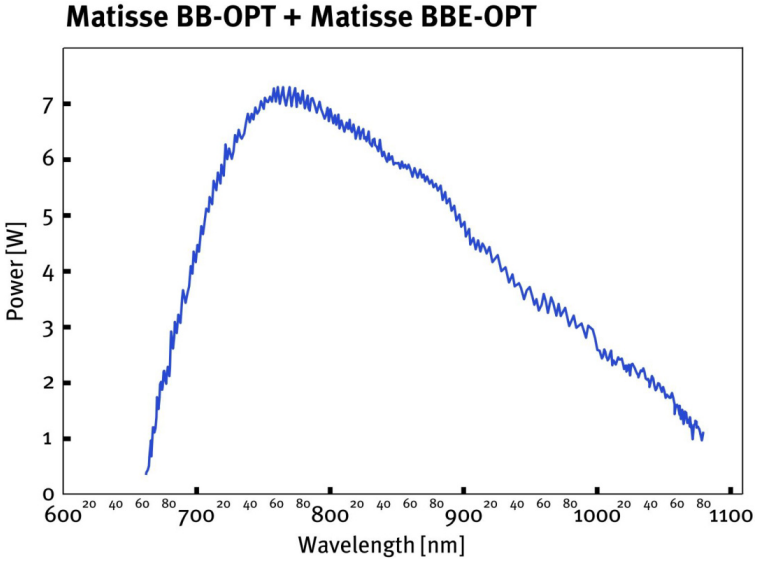
The Matisse C is a tunable, single longitudinal mode Ti:Sa-ring laser.

The system is designed to meet the requirements of research in the fields of quantum technologies for atomic clocks, quantum computers, quantum sensors, etc.. The laser is also well suited for high resolution spectroscopy, for example for Raman spectroscopy. The Matisse C series combines a small footprint with ease of operation and includes these basic features:

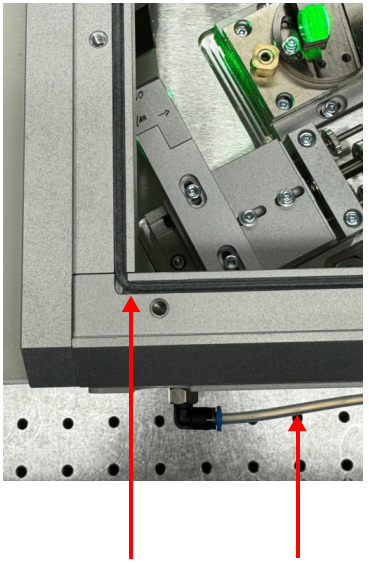
1) Automated optimization of the Matisse C with electronic laser self alignment (ELSA).
2) Sealed, fully automated design with purge ports for trouble free operation across atmospheric absorptions and long term stability.
3) Automated extended scans over nanometers (requires wavemeter).
4) Field serviceable: optics change, maintenance, upgrades, etc..
5) High output power of > 8 W at maximum.
6) Ultra stable flexure mounts for long term stability.

A broad variety of optional accessories makes the Matisse C the most versatile laser system on the market:

a) Broadest hands-free tuning ranges of over 375 nm with broadband options:
   Matisse BB-OPT 700 nm - 1000 nm
   Matisse BBE-OPT 670 nm - 1045 nm
b) Intracavity electro optical modulator (EOM). The ultimate fast actuator inside the resonator with bandwidth in the MHz-range is much faster than any piezo. With the EOM, a stabilization to ULE-reference cavities with very high finesse becomes possible.
c) Linewidth reduction by PDH stabilization down to 20 kHz in 100 µs with optional reference cavities.
d) Fiber ports for wavemeter and for an external reference cavity on the connector panel of the Matisse C.
e) Extension modules are available for even broader wavelength ranges. WaveTrain and MixTrain units give access to a gapless wavelength range of 210 nm - 4200 nm.



Matisse C with both broadband options: 664 nm - 1080 nm typical tuning curve, pumped with 23 W



Matisse C housing sealed with O-ring, purge tube input

Automated Usage

Matisse C can be pumped with pump powers between 5 - 25 W at 532 nm. Higher powers typically result in broader wavelength ranges. For a tuning coverage of 700 nm to 1000 nm at least 10 W pump power is necessary for example. With the broadband options users can benefit from an impressive wavelength range from 670 nm to 1045 nm. The Matisse C is designed for full control of the tunable Ti:Sa-laser by the operation software. This hands-free operation allows the user to fully focus their time on their research.

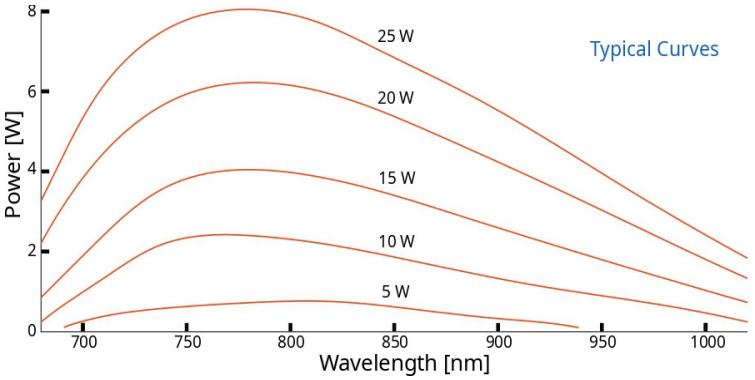
Electronic Laser Self Alignment: ELSA

Two pump beam steering mirrors are guiding the 532 nm beam into the Matisse C housing. The first steering mirror is equipped with two piezo-driven micrometer screws (red colour in picture). After a warm up period of the pump laser the pump beam is adjusted automatically by these two screws for maximum output power of the Matisse C. Either "refresh" the output power with one click in the software or let the software do it continuously.

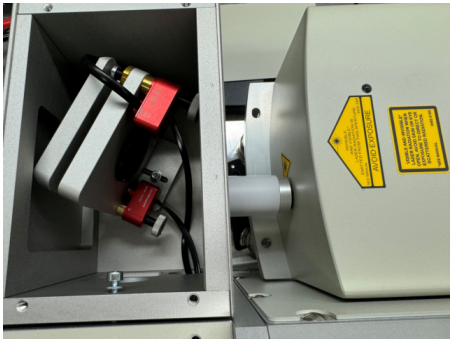
Automated extended Scans

An automated scan software is integrated in the software at no additional costs. It controls the frequency selective elements inside the Matisse. A wavemeter is required for this option. Then the app allows to automatically go to a selected wavelength ("Go-To-Wavelength" command). Also, extended scans over nanometers are possible. Here, single-mode mode-hop-free scans of up to 50 GHz length (app. 0.1 nm) are stitched together. Depending on scan conditions gapfree scans within < 5 minutes per nm are obtained.
Another scan mode can do overview scans using only the birefringent filter with a higher speed of a few nanometers per second.

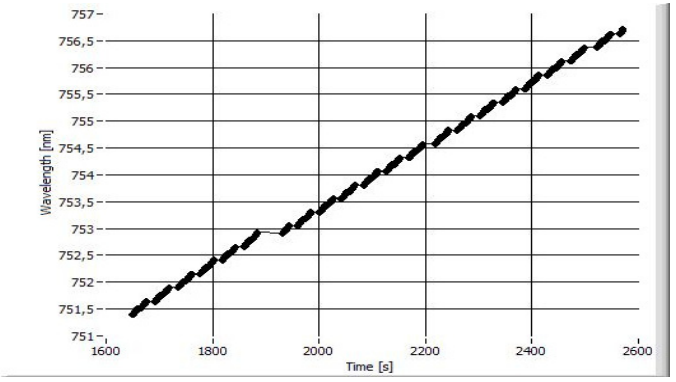
Tuning Ranges for different Pump Powers



ELSA Matisse



Pump Laser Millennia eV



Matisse C

Designed for low noise and high long term stability

Thorough Design of Mechanics

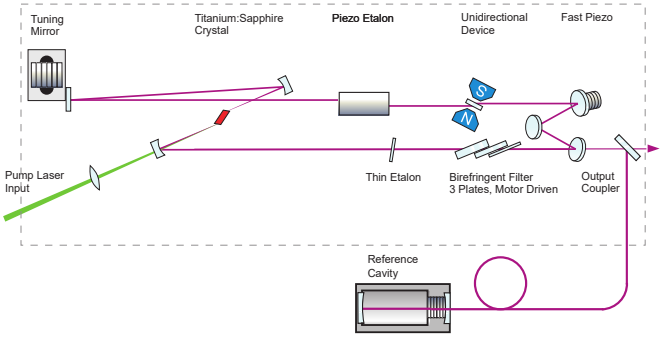
The resonator baseplate of Matisse C is a monolithic metal block of up to 40 mm thickness. Special damping material is incorporated inside this block to avoid resonances. The resonator is mounted in an outer housing with three acoustical isolating feet. The outer housing has been optimized for highest acoustical shielding and still allowing adequate accessibility. This advanced construction reduces the sensitivity against disturbance from the surrounding and still allows to manually adjust and service the laser. There is no need to send the laser system back to the factory, when maintenance or service is required.
The Matisse C family offers three versions with three different linewidths.

Matisse CR

The Matisse "R-Series" with its mechanically quiet design provides excellent passive stability and low noise, single-frequency operation. The linewidth specification is 1 MHz in 100 ms (100 kHz in 100 µs).

Matisse CS

The "S-Series" actively-linewidth-stabilized laser uses a temperature controlled reference cell to provide feedback to a piezo-driven mirror inside the Matisse resonator, to reduce the optical linewidth of the Matisse output. The reference cell is operated in the side-of-fringe locking scheme. The fiber coupled cell is mounted underneath the pump laser to save table space. The linewidth of the Matisse CS is 50 kHz in 100 ms (35 kHz in 100 µs).



Provides excellent stability

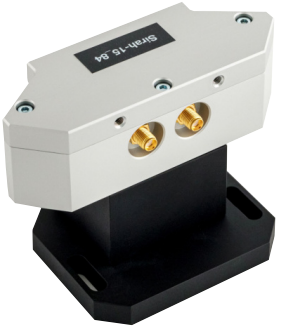
Matisse CS reference cell with built in temperature stabilization underneath 532 nm pump laser.

Matisse CX

The "X-Series" features a linewidth as low as 30 kHz in 100 ms. (20 kHz in 100 µs). The ultra-narrow linewidth is the result of a high bandwidth stabilization in combination with a high-finesse reference cavity (F = 400). The latter is operated with a Pound-Drever-Hall locking setup. This scheme ensures a high stability of the lock and a feedback signal that is not influenced by laser intensity fluctuations. An intra-cavity electro-optical modulator (EOM) is used to compensate fast changes of the ring cavity's optical path length. Due to the inertia-free nature of the electro-optical actuator the bandwidth of this element is eXtremely high (CX), up to 100 MHz. Typically the high voltage amplifier of the EOM limits the bandwith to a few MHz.

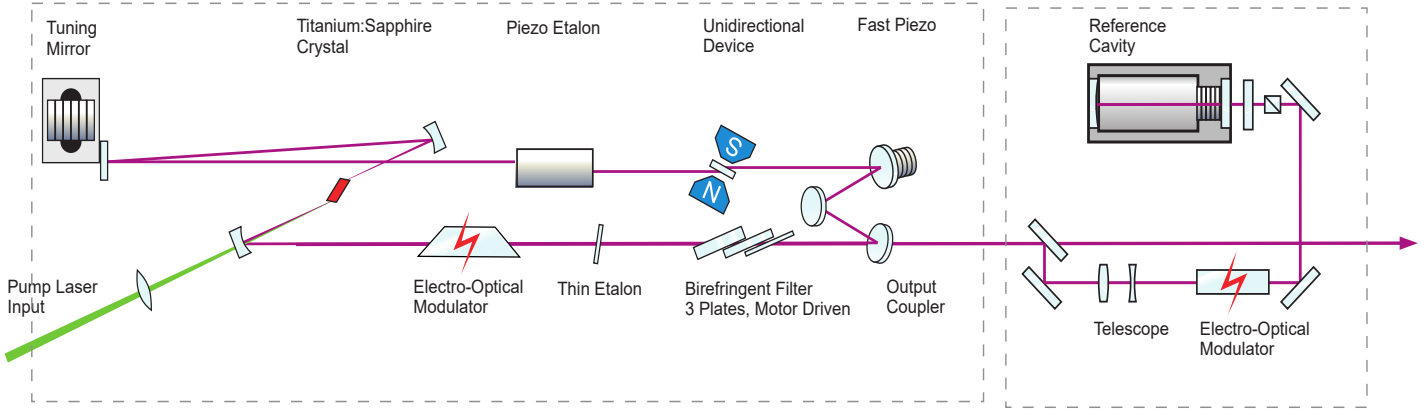
Stabilizing to a high finesse ULE-cavity

Ultra-low-expansion cavities (ULE) are available with very high finesse of 300,000 and higher over a small wavelength range. A Pound-Drever-Hall locking scheme with a high bandwidth can be adapted even to such reference cells. A linewidth down to the Hz-level with very low drift is the benefit of using such ULE-Cavities with high finesse. Our Matisse lasers can be stabilized to such cavities. For this purpose the linewidth reducing actuators slow piezo, fast piezo and EOM have external inputs. These allow the adaptation of special external PID-devices and amplifiers enabling a long term stable lock. Sirah can offer all components needed for such a PDH-lock. For users that already have an ULE-cavity with all components for PDH-error signal generation, we can support the integration to ensure a good locking setup.



Electro-Optical-Modulator (EOM)

Optical Layout Matisse CX



Matisse C

Wavelength extensions 210 nm - 4200 nm

WaveTrain 3D

The WaveTrain 3D is a powerful tool for efficient and stable second harmonic generation (SHG) of single-frequency continuous wave lasers like the Matisse.
Wavelength ranges are:

1. doubling of Matisse 335 nm - 515 nm
2. doubling of MixTrain19: 257.5 nm - 330 nm
3. fourth harmonic Matisse: 210nm - 257.5 nm

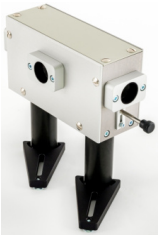
MixTrain 5/10/15/19

The MixTrain is using quasi-phase matching in periodically poled crystals for sum or difference frequency mixing of two CW-lasers. Typically, one of the lasers is our Matisse while the other is a powerful fixed wavelength fiber laser.
Wavelength ranges are:

1. fiber laser 1950 nm (MixTrain 19:
   SFG: 515 nm - 670 nm DFG: 1100 nm - 1750 nm
2. fiber laser 1550 nm (MixTrain 15):
   SFG: 488 nm - 615 nm DFG: 1650 nm - 2800 nm
3. fiber laser 532 nm and 1064 nm (MixTrain 5 / 10):
   DFG 532: 1180 nm - 2350 nm
   DFG 1064: 1980 nm - 4200 nm

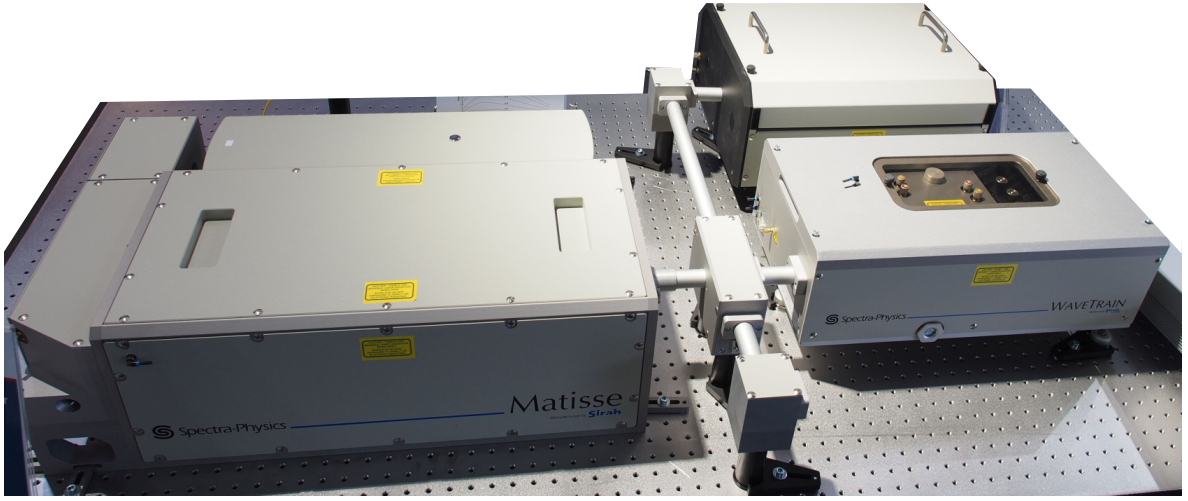
Extensions for optical table layout: MirrorShift, MirrorSteering, Matisse VAR-ATT

The MirrorShift unit is a top adjustable flexure mount on a very precise sliding stage with magnetically fixed end stops. An incoming beam can be guided 90° to the right or to the left or go straight through the unit. All is enclosed in a laser safe housing with metal tubing protecting components against dust.
The MirrorSteering is a 90° mirror mount for easy beam encapsulating with tubes.
With Matisse VAR-ATT you can split off an adjustable amount of the green pump laser in 90° direction between pump laser and Matisse. These three units are designed for long term stability and for high reproducablity. It allows to build up larger laser systems including the wavelength extension units, providing a convenient change between the options.



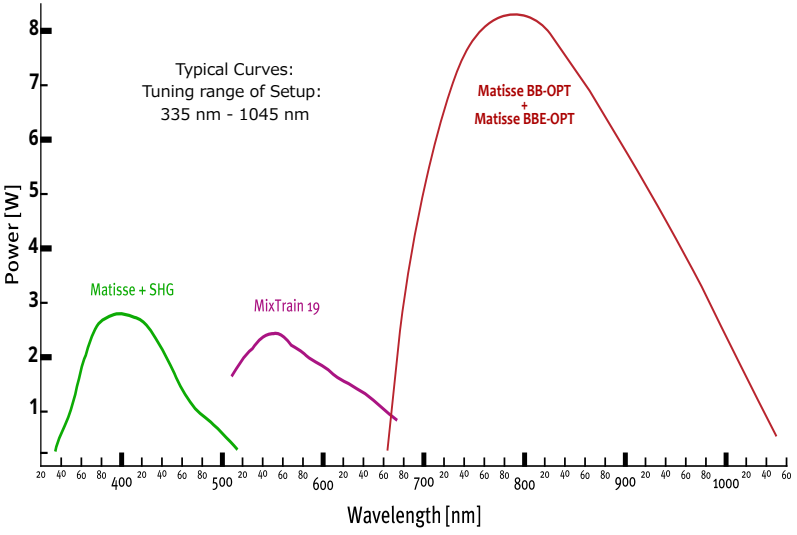
MirrorShift unit

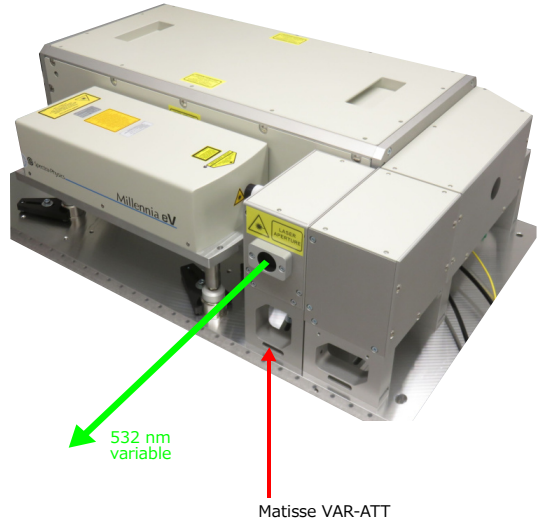
MirrorSteering



Laser Setup: Millennia 25W, Matisse C, WaveTrain 3D and MixTrain with 2x MirrorSteering and 1x MirrorShift

Operation with GUI

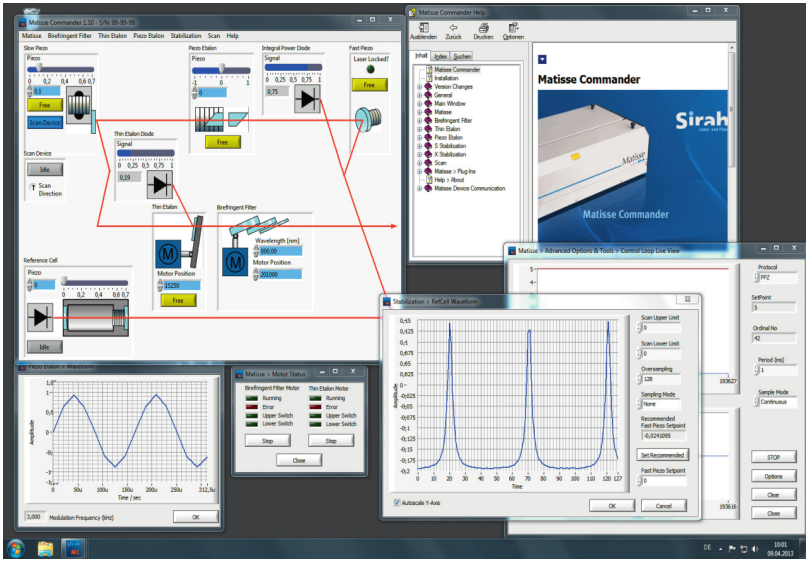




Matisse Commander

The Matisse Commander control program makes daily operation of the laser quick and easy.
This software features:

a) fast acquisition and display of signals
b) no additional scope is required for operation of the laser
c) user access to all control loops
d) built in monitor for laser linewidth
e) possiblity to interface with external hardware, such as a wavemeter or a frequency comb



Programming Support

Our USB interface uses a standardized protocol (TMC) that is fully supported by National Instruments' LabView architecture. It is easily integrated into existing laboratory automation solutions. Control over Python, C++, etc. is possible. No proprietary external software is required. The Matisse can be controlled using Windows and Linux platforms. Free software updates are available.

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