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Sirah
Lasertechnik

Matisse 2 Ring Laser

Matisse 2

A versatile approach to Ring Laser Design

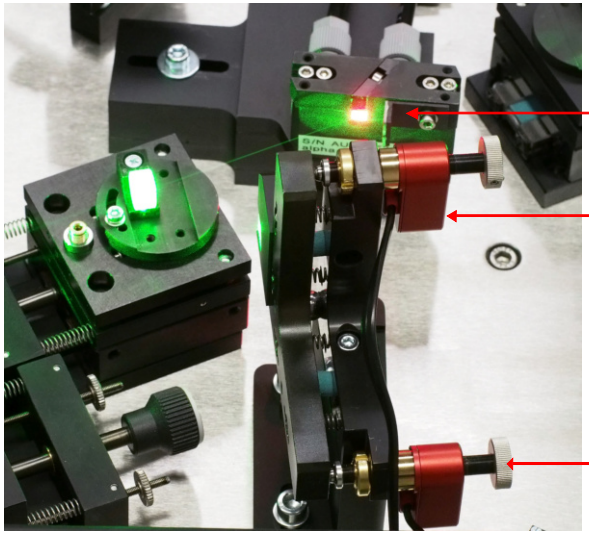
The Matisse 2 is a tunable, single longitudinal mode ring laser.

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 Raman spectroscopy.
The modular design of the Matisse 2 series allows to use it with dyes as well as with TiSa as active laser media. Additionally, the system is optimized for ease of operation and includes these basic features:

1) Automated optimization of the Matisse 2 with electronic laser self alignment (ELSA).
2) Sealed, highly 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 TiSa
   > 7 W at maximum Dye

A broad variety of optional accessories make the Matisse 2 the most versatile and advanced system on the market:

a) Broadest tuning ranges of over 450 nm with broadband options:
   Matisse 2 BB-OPT (mechanics)
   Matisse 2 BB-TiSa 700 nm - 1000 nm
   Matisse 2 BB-Dye 550 nm - 760 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 collimators: making internal reflexes accessible for wavemeter readout and/or an external reference cavity.
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 2 laser with Titanium:Sapphire

Matisse 2 dye jet

Optimized for full flexibility

Full flexibility

The Matisse 2 laser is designed for full flexibility. It is based on a modular design and any model can be converted or upgraded to any other model. In fact, most of these upgrades can conveniently be performed in the field. For example conversion from dye solution to Ti:Sa-crystal can be done by the user in the lab.
Using the Titanum:Sapphire crystal gives access to the wavelength range from 670 nm - 1045 nm.
Higher pump powers typically result in broader wavelength ranges.
Using various dyes, the tuning range can be extended to shorter wavelengths, down to 550 nm. The upper limit is 760 nm, offering an overlap to the Ti:Sa-range.

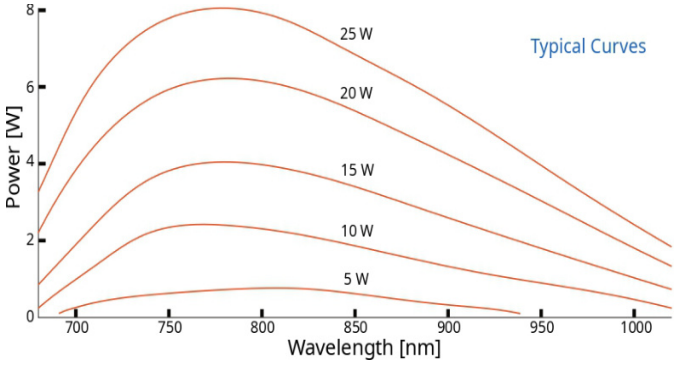
Electronic Laser Self Alignment: ELSA

Two pump beam steering mirrors are guiding the 532 nm beam inside the Matisse 2 housing. The first steering mirror is equipped with two piezo-driven micrometer screws (see page 2). 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 2. Either "refresh" the output power with one click in the software or let the software do it continuously.

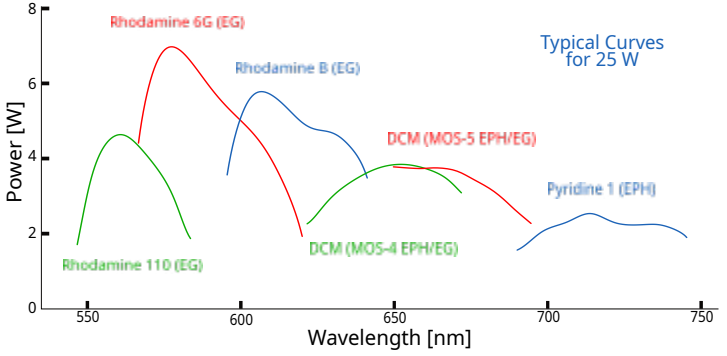
Broadband option: no exchange of optics

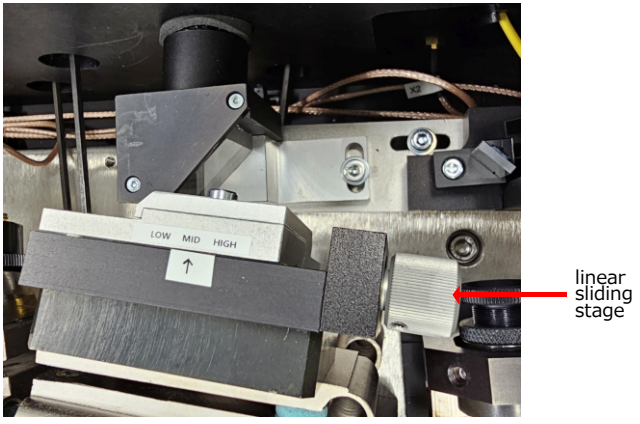
The output coupler of the Matisse 2 can be equipped with the broadband option Matisse 2-BB-OPT. This is a precise linear sliding stage which can be shifted manually. For the Titanium:Sapphire version three different output coupler coatings are used on one single substrate (LOW, MID, HIGH) to cover the whole 700 nm - 1000 nm range, with no cavity alignment.
In the dye version, the 550 nm -760 nm range is covered by two coatings. In both cases all other cavity mirrors are broadband coated for the respective wavelength range.

Tuning ranges Titanium:Sapphire



Tuning ranges Dye





Matisse 2

Designed for low noise and high long term stability

Thorough Design of Mechanics

The resonator baseplate of Matisse 2 is a reinforced stainless-steel plate of 60 mm thickness. Special damping material is used inside the laser housing to suppress resonances. The resonator is mounted in an outer housing with four acoustically isolating feet. The housing has been optimized for highest acoustical shielding, while allowing adequate accessibility. This advanced construction reduces the sensitivity against disturbances 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. In the Matisse 2 family three models are offered each with Ti:Sa or dye as the active medium. The models differ in frequency stabilization scheme and the achievable linewidth.

Matisse 2 TR / DR

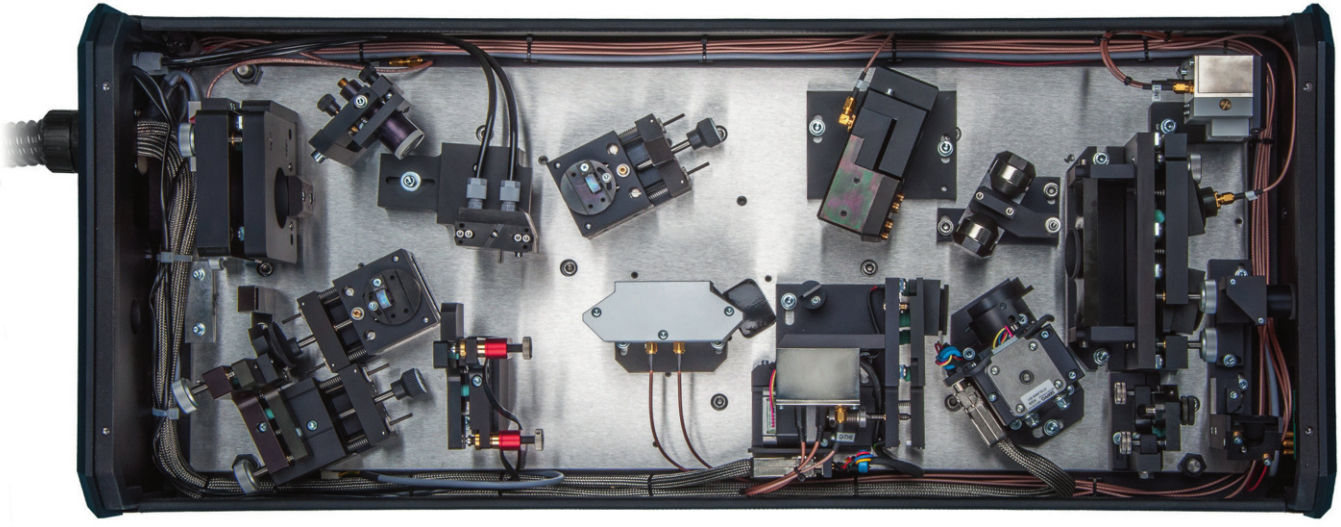
The Matisse "R-Series" with its mechanically quiet design provides excellent passive stability and low noise, single-frequency operation. The linewidth specification is 1 MHz in 100 ms (100 kHz in 100 µs) for the Ti:Sa (TR) and 20 MHz in 100 ms (2 MHz in 100 µs) for the dye version (DR).

Matisse 2 TS /DS

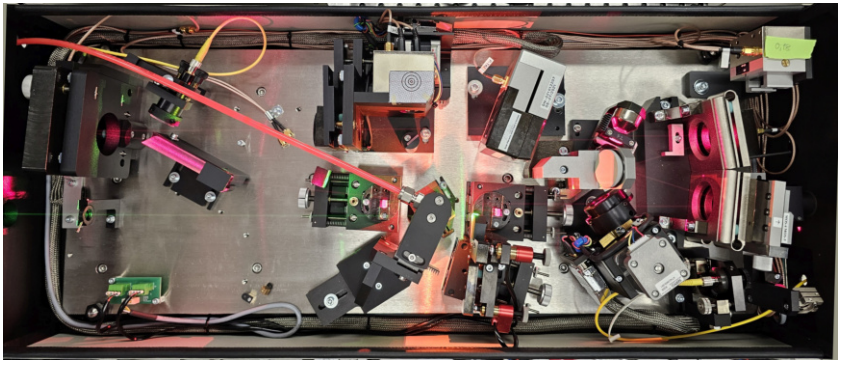
The "S-Series" actively-linewidth-stabilized laser uses a temperature controlled reference cell to provide feedback to a piezo-driven mirror inside the Matisse 2 resonator, to reduce the optical linewidth of the Matisse output. The reference cell is operated in the side-of-fringe locking scheme. The fiber coupled cell is a stand alone unit, which can be placed close to the laser. The linewidth of the Matisse 2 TS is 50 kHz in 100 ms (35 kHz in 100 µs) and 200 kHz in 100 ms (140 kHz in 100µs) for the Matisse 2 DS.

Matisse 2 TX / DX

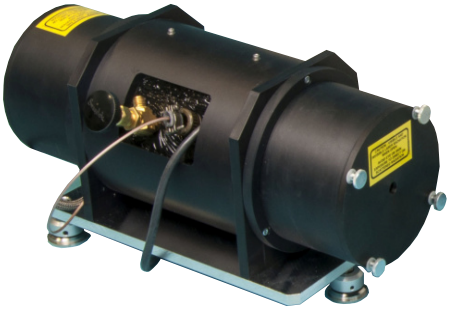
The TX-series features a linewidth as low as 30 kHz in 100 ms. (20 kHz in 100 µs). For the DX-series it is 100 kHz in 100 ms (70 kHz in 100 µs). The ultra-narrow linewidth is the result of a high bandwidth stabilization in combination with a high-finesse reference cavity (F = 400). The latter is operated 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 (TX /DX), up to 100 MHz. Typically the high voltage amplifier of the EOM limits the bandwith to a few MHz.



Matisse 2 TX laser with Titanium:Sapphire



Matisse 2 DS dye laser

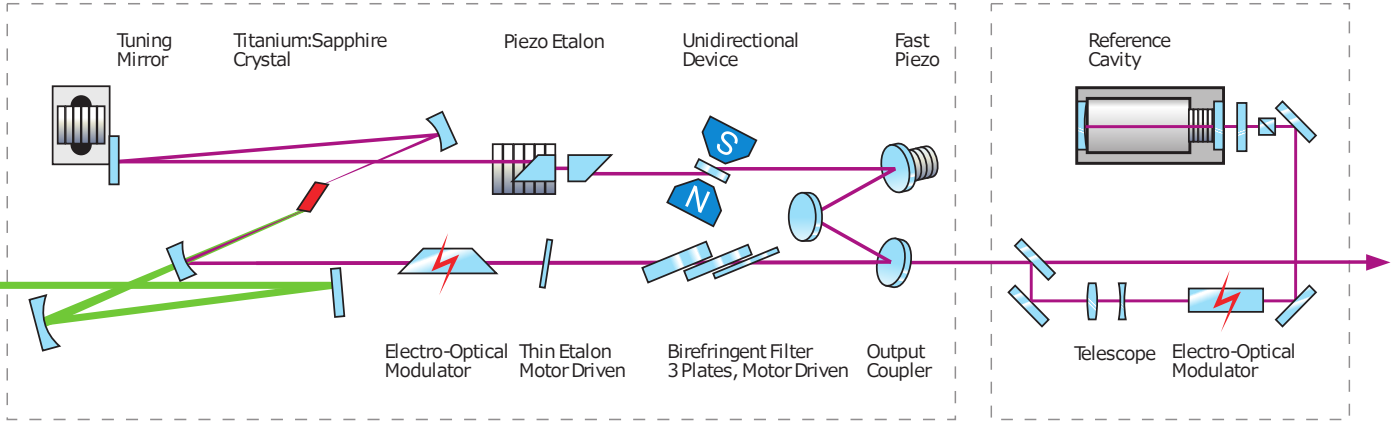


Matisse 2 S-reference cell

Electro-Optical-Modulator (EOM)

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 to such reference cells. A linewidth down to the Hz-level with very low drift is the benefit of using 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. They 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.



Matisse 2 TX optical layout

X-reference cell

Matisse 2

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:

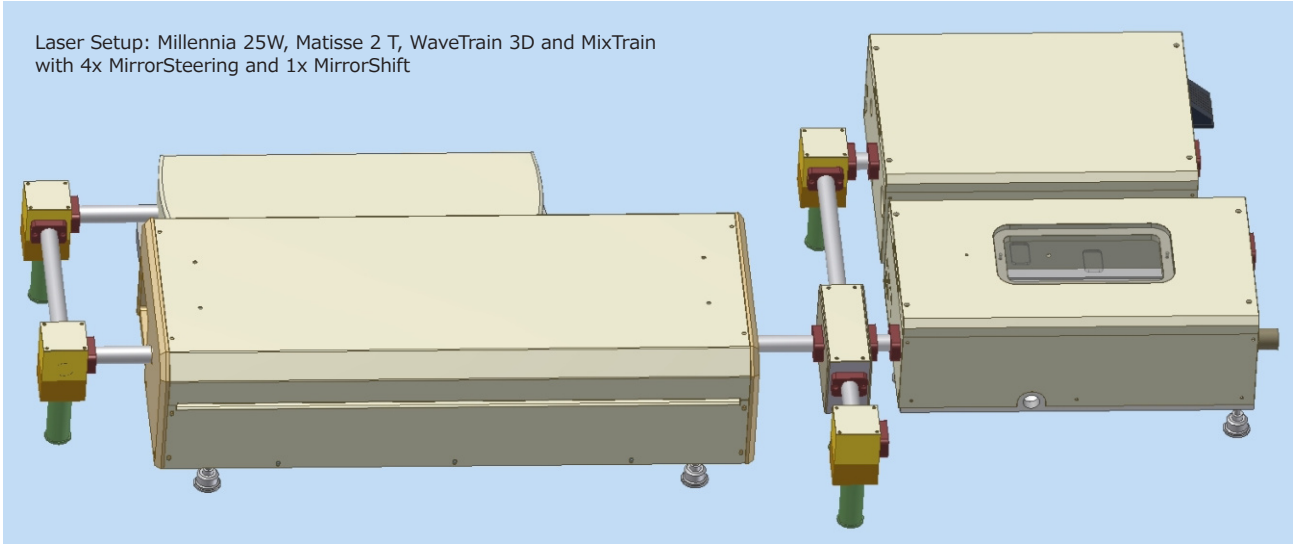
1. fiber laser 1950 nm (MixTrain 19):
   SFG: 515 nm - 670 nm DFG: 1100 nm - 1750 nm
2. fiber laser 1550 nm (MixTrain 15):
   SFG: 488 nm - 615 nm DFG: 1650 nm - 2800 nm
3. fiber laser 532 nm and 1064 nm (MixTrain 5 / 10):
   DFG 532: 1180 nm - 2350 nm
   DFG 1064: 1980 nm - 4200 nm

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.

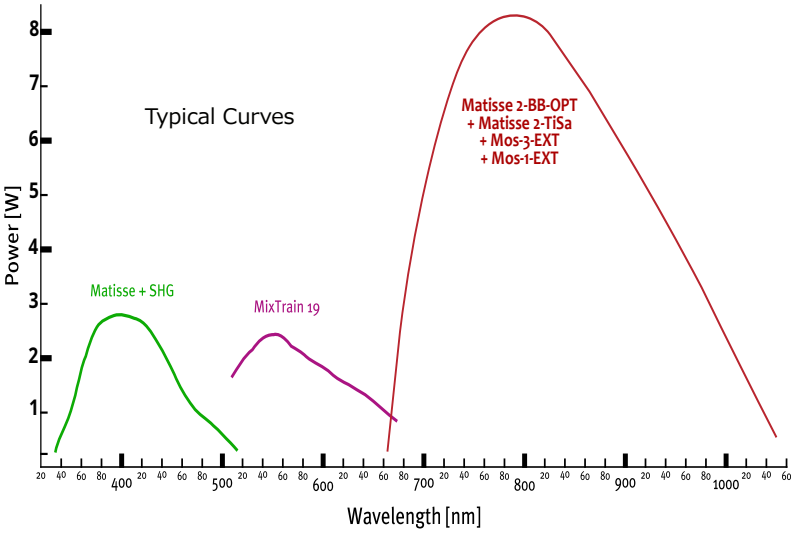
MirrorShift unit

MirrorSteering



Laser Setup: Millennia 25W, Matisse 2 T, WaveTrain 3D and MixTrain with 4x MirrorSteering and 1x MirrorShift

Operation with GUI

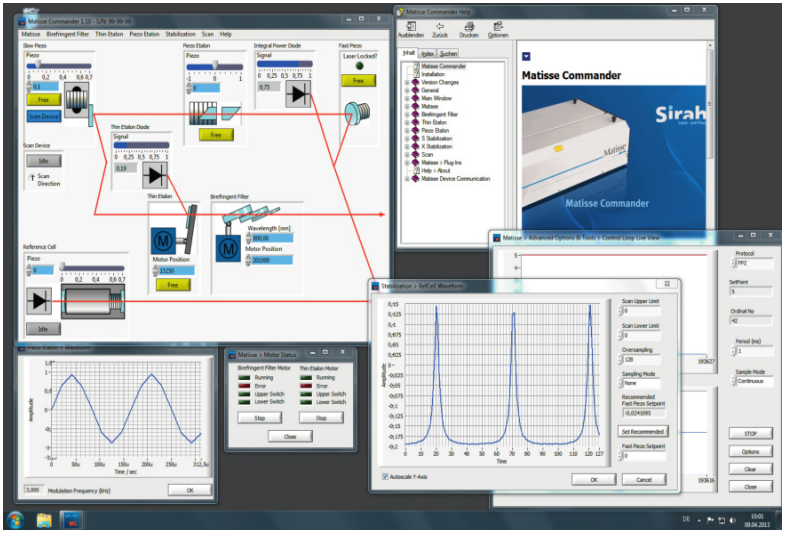


Matisse VAR-ATT

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) possibility 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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