

# Matisse<sup>®</sup> 2

Ultra-Narrow Linewidth  
Tunable Ring Laser

mks | Spectra-Physics<sup>®</sup>

The Spectra-Physics Matisse 2 series is a family of state-of-the-art single frequency ultra-stable, narrow linewidth tunable ring lasers that are ideal for Quantum and AMO (atomic, molecular and optical physics) applications. The Matisse 2 system has the industry's highest output power, the narrowest external linewidth, the broadest tuning range, and the most flexible architecture.

Coupled with the Millennia<sup>®</sup> eV™ 25 pump laser, the Matisse 2 produces over 7.2 W of output power. With flexibility to be configured for either Ti:Sapphire or dye as the laser gain medium, Matisse 2 provides an unprecedented tuning of >470 nm and linewidths down to 30 kHz, with fully integrated PDH lock to X reference cell.

## Matisse 2 TR and DR

The Matisse 2 R-Series ring laser with its mechanically quiet design provides excellent passive stability

and ultra-low noise, single-frequency operation. Electronically controlled wavelength-selecting elements—a birefringent filter, a thick etalon, and a thin etalon—keep the laser centered on a single longitudinal mode. This enables long, mode-hop-free wavelength scans while maintaining constant, low-noise output power levels.

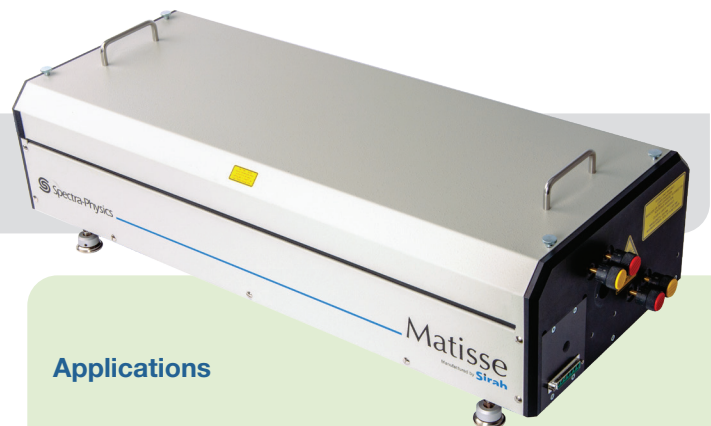
The Matisse 2 TR Ti:Sapphire ring laser provides a spectral linewidth of <4 MHz and can be readily upgraded to the higher resolution Matisse 2 TS. In fact, because of its modularity, any Matisse 2 laser can be field upgraded to either a Ti:Sapphire or dye gain medium, or to a configuration with higher resolution – from an R-Series to an S-Series or an X-Series.

## Matisse 2 Advantage

- Highest output power available >7.2 W
- Narrowest linewidth <30 kHz rms
- Field-upgradeable to dye or Ti:Sapphire gain medium
- Widest mode-hop-free Diezo tuning of 50 GHz
- Dust-sealed housing and massive steel baseplate
- Fast Digital Signal Processing (DSP) with open-source software
- Sapphire dye jet nozzle
- Automated picomotor alignment

## Applications

- High-resolution spectroscopy
- Atom cooling and magneto-optic trapping (MOT)
- Atomic clocks
- Bose-Einstein condensates
- Frequency combs
- Quantum computing
- Microcavity resonators
- Quantum applications



### **Matisse 2 TS and DS**

The Matisse 2 S-Series actively-stabilized ring laser incorporates an external reference cavity with feedback to a cavity-length-stabilizing fast piezo-driven mirror. To guarantee a truly independent frequency feedback signal, the reference cavity is thoroughly isolated against thermal and mechanical perturbations and is fiber coupled outside the laser housing.

The Matisse 2 TS actively-stabilized Ti:Sapphire ring laser has an internal spectral linewidth of <50 kHz, while the Matisse 2 DS dye ring laser provides a spectral linewidth of <200 kHz.

### **Matisse 2 TX and DX**

The Matisse 2 X-Series ring laser provides spectral linewidths to <30 kHz for the Ti:Sapphire active gain medium, and <100 kHz for the dye laser. This ultra-narrow linewidth is the result of very fast cavity length stabilization with a response bandwidth in the MHz range. This is achieved by use of an intra-cavity electro-optic modulator (EOM).

Also key to achieving this ultra-narrow linewidth is the feedback error signal from the external reference cavity using the Pound-Drever-Hall stabilization scheme and a high finesse external reference cavity. Pound-Drever-Hall provides an unambiguous measure of wavelength position uninfluenced by laser intensity fluctuations.

### **Matisse 2 TX-light**

The Matisse 2 TX-light fills the linewidth gap between the Matisse 2 TS and the Matisse 2 TX. It utilizes the Pound-Drever-Hall locking technique and the high-resolution reference cavity of the TX to provide the feedback signal to the fast Piezo-driven mirror of the TS. The negligible sensitivity of the Pound-Drever-Hall method to intensity fluctuations, as well as the extremely stable locking it provides, lead to laser linewidths of less than 50 kHz.

**Open cavity Matisse 2 TX showing intra-cavity EOM for fast cavity length stabilization**



**Matisse 2 TX with separate, optional reference cavity with Pound-Drever-Hall feedback scheme**



## Matisse 2 Specifications<sup>1,9</sup>

	Matisse 2 TR	Matisse 2 TS	Matisse 2 TX-light	Matisse 2 TX	Matisse 2 DR	Matisse 2 DS	Matisse 2 DX
<b>General Characteristics</b>							
Laser Gain Medium	Ti:Sapphire	Ti:Sapphire	Ti:Sapphire	Ti:Sapphire	Dye	Dye	Dye
Linewidth <sup>5</sup>	<4 MHz rms	<50 kHz rms <sup>6</sup>	<50 kHz rms <sup>6</sup>	<30 kHz rms <sup>6</sup>	<20 MHz rms <sup>6</sup>	<200 kHz rms <sup>6</sup>	<100 kHz rms <sup>6</sup>
Spatial Mode	TEM <sub>00</sub>				TEM <sub>00</sub>		
Beam Diameter <sup>2</sup>	1.4 mm (typical)				1.4 mm (typical)		
Beam Divergence <sup>7</sup>	<1 mrad				<1 mrad		
Amplitude Noise	<0.1% rms (above pump noise, added in quadrature)				<0.5% rms		
Scan Range	>50 GHz (at 780 nm)				>60 GHz (at 575 nm)		
<b>Tuning Range<sup>3,8</sup></b>							
MOS-1 Optics Set	680–790 nm	680–790 nm	680–790 nm	690–770 nm			
MOS-2 Optics Set	750–870 nm	750–870 nm	750–870 nm	750–870 nm			
MOS-2-BB Optics Set	730–930 nm	730–930 nm	730–930 nm	730–930 nm			
MOS-3 Optics Set	880–1038 nm	880–1038 nm	880–1038 nm	880–1010 nm			
MOS-4 Optics Set					550–660 nm	550–660 nm	550–660 nm
MOS-5 Optics Set					650–760 nm	650–760 nm	650–760 nm
<b>Output Power<sup>4</sup></b>							
Millennia eV 25 W pump		7.2 W		6.2 W		6.0 W	4.5 W
Millennia eV 20 W pump		5.5 W		4.7 W		4.5 W	3.4 W
Millennia eV 15 W pump		3.8 W		3.3 W		3.0 W	2.2 W
Millennia eV 10 W pump		2.0 W		1.6 W		1.8 W	1.4 W
Millennia eV 5 W pump		0.8 W		N/A		0.8 W	N/A
<b>Millennia Pump Laser and Lab Requirements</b>							
Pump Laser Polarization	Horizontal						
Pump Laser Power	5–25 W						
Ambient Conditions	±0.5°C in the 20–25°C range, non-condensing humidity conditions						
Cooling	Water required to remove 20 W of heat from crystal; series connection from Millennia chiller recommended; 16–21°C ±0.1°C suggested Dye versions: Water required to remove 100 W from dye circulator						
Laboratory	Vibrational isolated optical table, dust-free air (flow box)						
Electrical	100–250 VAC, max 2.5 A						
Computer Control	Windows operating system; USB port						

1. Due to our continuous product improvement, all specifications are subject to change without notice.

2. At Matisse 2 output port.

3. Specification applies to Millennia eV 15 W, 20 W and 25 W pump lasers. Please inquire for other pump powers.

4. At 780 nm for Ti:Sapphire and at the peak of R6G dye for dye version.

5. Linewidth measurements made over a period of >100 msec.

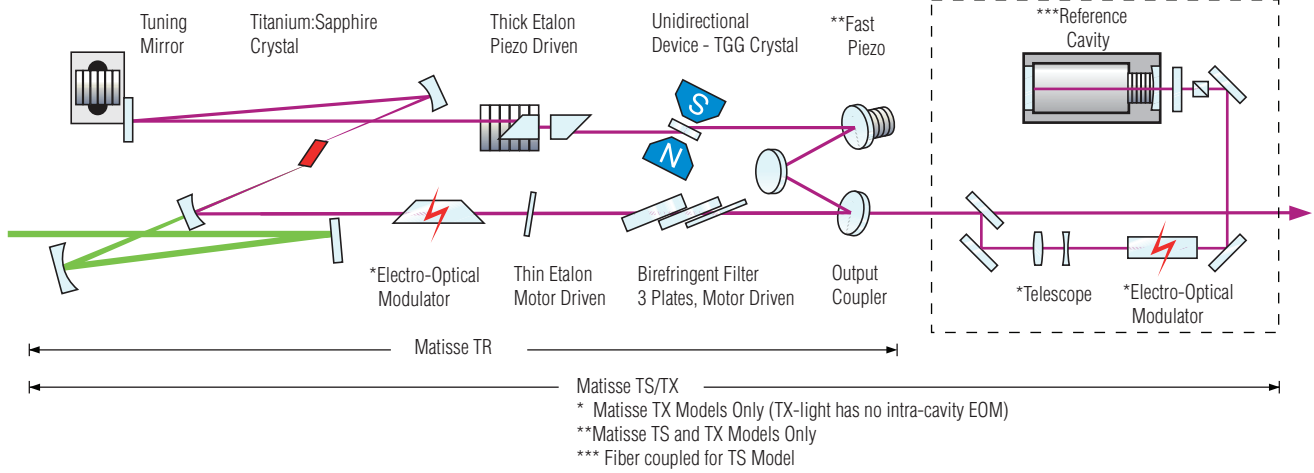
6. Linewidths relative to built-in reference cavity.

7. Measurement of half angle.

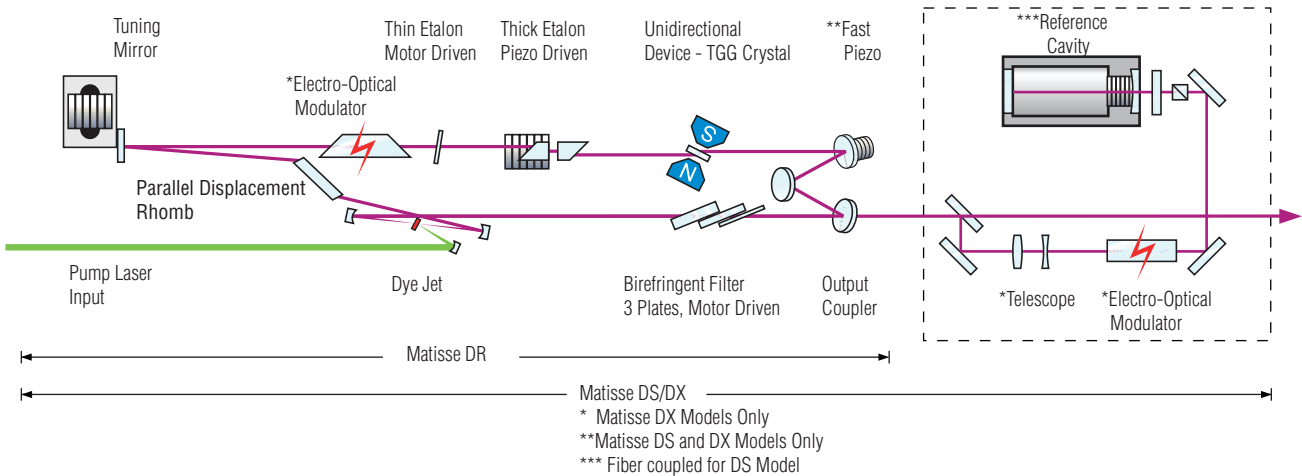
8. Extended tuning ranges available upon request. Contact Spectra-Physics.

9. The Matisse 2 is a Class IV – High Power Laser, whose beam is, by definition, a safety and fire hazard. Take precautions to prevent exposure to the direct and reflected beams. Diffuse as well as specular reflections can cause severe skin or eye damage.

## Matisse 2 Ti:Sapphire Optical Layouts



## Matisse 2 Dye Optical Layouts



## Matisse 2 Dimensional Drawing

