

# Matisse<sup>®</sup> C

## Compact Ultra-Narrow Linewidth Ti:Sapphire Tunable Ring Laser



The Spectra-Physics Matisse C is a fully automated and compact single frequency tunable ring laser that is ideal for Quantum and AMO (atomic, molecular and optical physics) applications. The Matisse C system has the industry's highest output power, the narrowest external linewidth, and the broadest mode-hop-free tuning range. The compact, sealed, and fully automated design with broadband mirrors and specially developed optical mounts provide long term stability and worry free operation.

### Fully Automated

The Matisse C is fully automated for truly hands free operation. The laser is controlled with an intuitive GUI for quick and easy wavelength selection, piezo scanning, and frequency locking. It is housed in a compact closed box with no external adjustment knobs. An automated alignment optimization routine utilizes picomotors to seamlessly optimize the system for peak performance. Broadband coated mirrors enable hands-free tuning across 668–1068 nm, eliminating the need to manually change optics sets.

### Highest Power and Broad Tuning

Broadband optics provides unprecedented 668–1068 nm automated continuous tuning. Coupled with the Millennia<sup>®</sup> eV<sup>™</sup> 25 pump laser, the Matisse C produces >7.2 W of output power. The Matisse C provides more than 400 nm of tuning with automated optics set switching and linewidths down to 20 kHz, with fully integrated PDH lock to X reference cell.

## Matisse C Advantage

- Highest output power available >7.2 W
- Narrowest linewidth <20 kHz rms
- Compact, sealed, fully automated design
- Hands free operation
- Broad tuning range (>400 nm) with one optics set
- Widest mode-hop-free piezo tuning >50 GHz
- Scan Stitching for mode-hop-free tuning up to 400 nm
- Extended scans over nanometers (requires wavemeter)

### Applications

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



# Matisse C

## Frequency Stabilization

### Matisse CR

A unique phase lock loop technique provides <100 kHz linewidth with passive frequency stabilization. The Matisse CR can be readily upgraded to the higher resolution Matisse CS.

### Matisse CS

The Matisse CS actively-stabilized Ti:Sapphire ring laser utilizes a reference cavity and offers a spectral linewidth of <35 kHz.

### Matisse CX

The Matisse CX provides spectral linewidths below 20 kHz. This ultra-narrow linewidth is achieved by use of an intra-cavity electro-optic modulator (EOM) and the Pound-Drever-Hall stabilization scheme with a high finesse external reference cavity.

## Narrowest Linewidth

Noise contributions to linewidth occur on different timescales: seconds correspond to thermal drifts, tens to hundreds of milliseconds correspond to acoustic noise and vibrations, and microseconds correspond to electrical noise. Linewidth measurements for the Matisse C are provided for 100 milliseconds and 100 microsecond intervals. The 100 millisecond measurement fully accounts for electrical and vibrational noise contributions and showcases the exceptional engineering of the Matisse laser platform.

## Mode-Hop-Free Tuning

Superior mechanical stability, specially designed optical mounts, unique tuning methods, and the preferred Out of Plane cavity design of the Matisse C all contribute to the exceptional mode-hop-free scanning range of >50 GHz. In order to take this to the next level, we have developed Scan Stitching for wide mode-hop-free tuning over the full wavelength range (up to 400 nm.) The fully automated Scan Stitching function is easily activated through the Matisse C GUI.

## Dynamic Scan Range

The Matisse is featured with a Dynamic Scan Range function for easy adjustment of the wavelength tuning resolution. This is achieved via a built in switchable piezo amplifier with easy software control. Tuning resolutions down to 50 kHz can be selected when fine wavelength adjustments are needed.

## Variable Low Frequency Locking

CW single frequency ring lasers utilize a Phase Lock Loop (PLL) in order to stabilize the laser cavity to a single longitudinal mode. The Matisse C incorporates a unique PLL technique that delivers low dither frequencies (down to 500 Hz) to minimize laser noise and offers the user easy adjustment of the frequency (500 Hz – 3 kHz) via software.

# Matisse C Specifications<sup>1</sup>

	Matisse CR	Matisse CS	Matisse CX
<b>General Characteristics</b>			
Linewidth (100 msec)	<1 MHz rms	<50 kHz rms <sup>2</sup>	<30 kHz rms <sup>2</sup>
Linewidth (100 $\mu$ sec) <sup>3</sup>	<100 kHz rms	<35 kHz rms	<20 kHz rms
Spatial Mode	TEM <sub>00</sub>		
Beam Diameter <sup>4</sup>	0.8–1.0 mm (typical)		
Beam Divergence	<1.2 mrad (half angle)		
Amplitude Noise	<0.1% rms (above pump noise, added in quadrature)		
Scan Range	>50 GHz (at 780 nm)		

## Optics Tuning Range<sup>5, 6, 7</sup>

Matisse BBE-OPT <sup>8</sup>	668 - 1068 nm		
Matisse BB-OPT	700 - 1000 nm		
MOS-1 Optics Set	680 - 780 nm		
MOS-2-BB Optics Set	730 - 930 nm		
MOS-3 Optics Set	860 - 1020 nm		
MOS-1-EXT	668 - 700 nm		
MOS-3-EXT	1000 - 1068 nm		

Output Power (780 nm) Matisse CR and CS	Millennia eV 25 W	Millennia eV 20 W	Millennia eV 15 W	Millennia eV 10 W	Millennia eV 5 W
MOS-1, MOS-2-BB Optics	7.2 W	5.5 W	3.8 W	2.0 W	0.8 W
Matisse BB-OPT Broadband Optics	6.5 W	4.7 W	3.5 W	1.8 W	0.7 W

Output Power (780 nm) Matisse CX	Millennia eV 25 W	Millennia eV 20 W	Millennia eV 15 W	Millennia eV 10 W
MOS-1, MOS-2-BB Optics	6.2 W	4.7 W	3.3 W	1.7 W
Matisse BB-OPT Broadband Optics	5.3 W	4.0 W	3.0 W	1.5 W

## Millennia Pump Laser and Lab Requirements

Pump Laser Polarization	Horizontal
Pump Laser Power	5–25 W
Ambient Conditions	$\pm 0.5^\circ\text{C}$ in the 20–30 $^\circ\text{C}$ range, non-condensing humidity conditions
Cooling	Water required to remove 20 W of heat from crystal; series connection from Millennia chiller recommended; 16–21 $^\circ\text{C}$ $\pm 0.1^\circ\text{C}$ suggested
Laboratory	Vibrational isolated optical table, dust-free air (flow box)
Electrical	100–250 VAC, max 2.5 A
Computer Control	XP/Vista/Windows7/Windows8/Windows10/USB Port

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

2. Linewidth relative to built-in reference cavity.

3. Extrapolated.

4. At Matisse C output port.

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

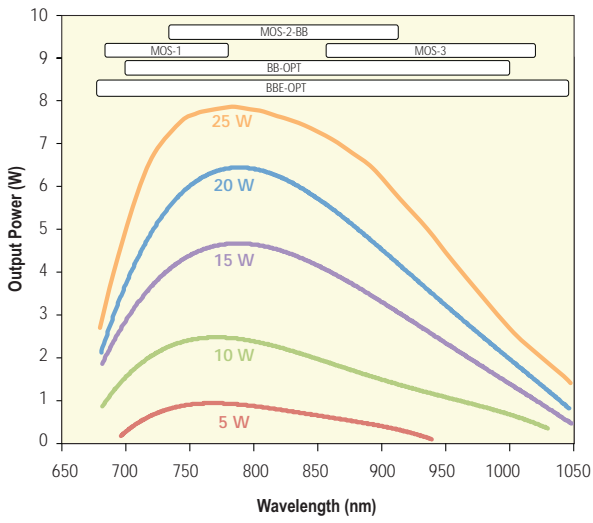
6. Special optics available for custom tuning ranges.

7. Matisse CX version has a reduced tuning range.

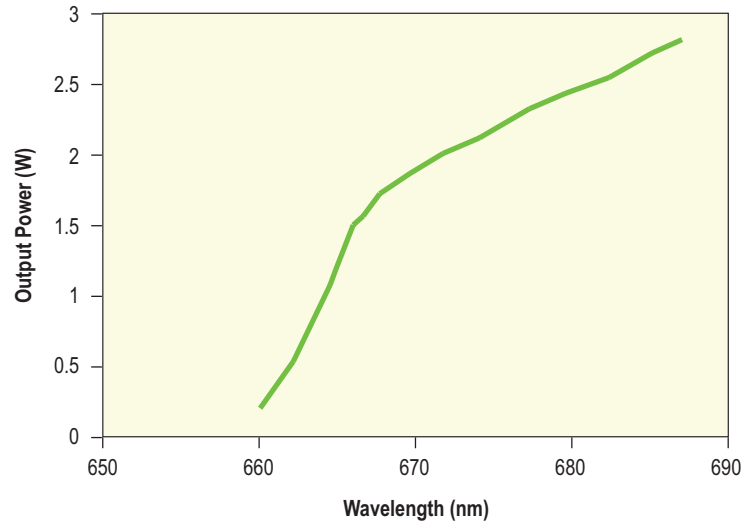
8. Matisse BBE-OPT must be ordered with Matisse BB-OPT.

# Matisse C

Typical Matisse CR, CS Tuning Curve<sup>1,2</sup>

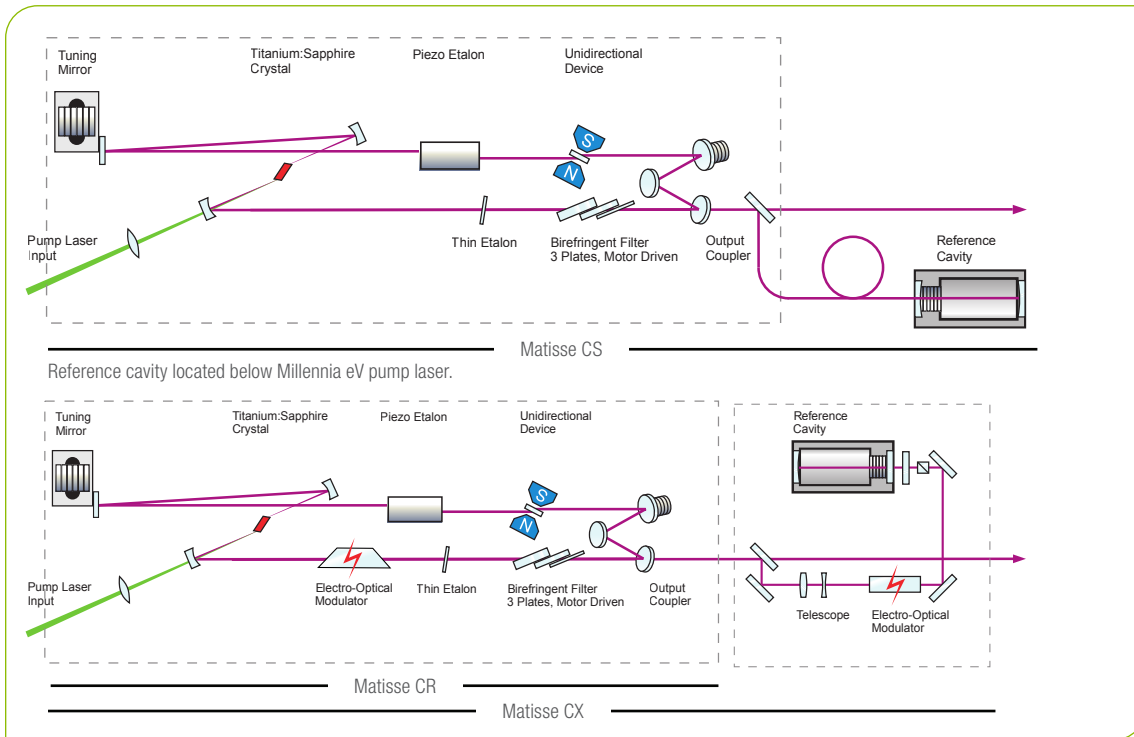


Typical Matisse CR, CS Tuning Curve with MOS-1 and MOS-1-EXT Mirrors<sup>1,3</sup>

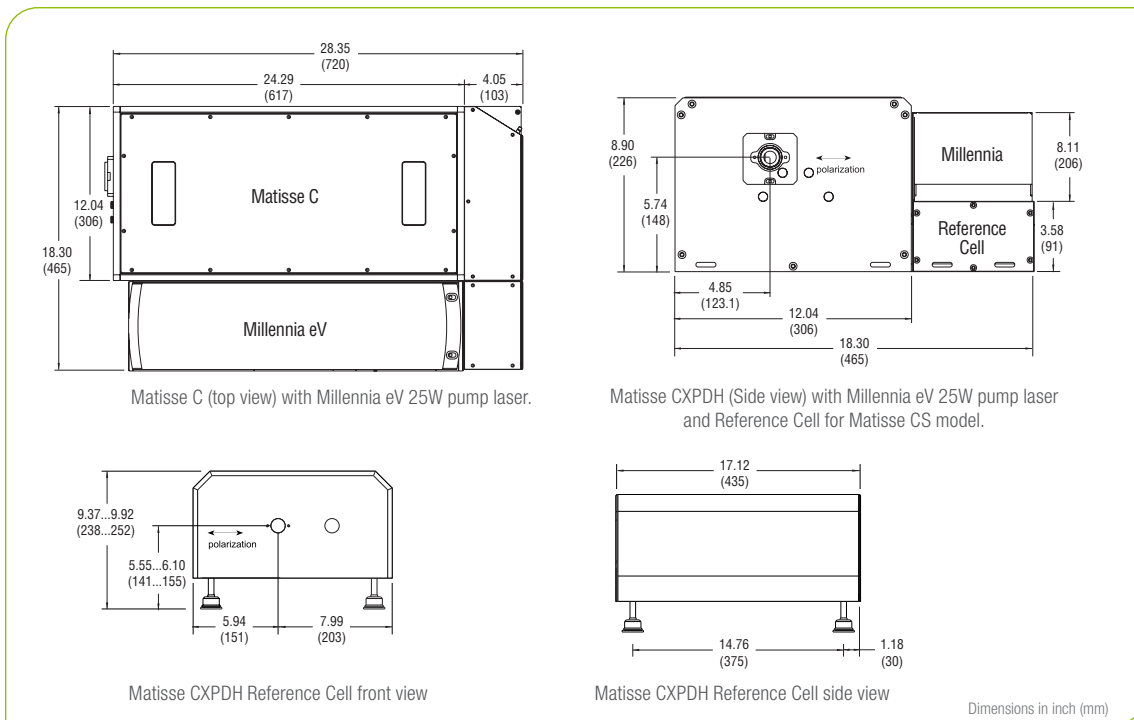


1. Typically measured performance; not a guaranteed or warranted specification.
2. Pumped with Millennia eV laser with output power level as labeled on each curve.
3. Pumped with Millennia eV 15 W laser.

# Matisse C



## Matisse C Optical Layouts



## Matisse C Dimensions



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