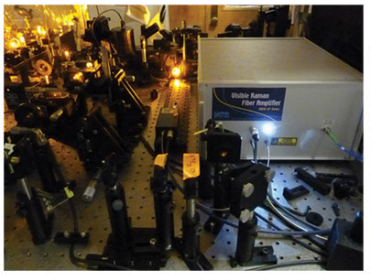
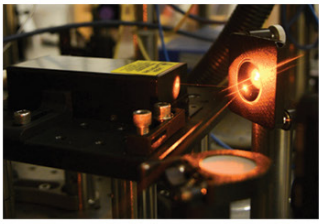
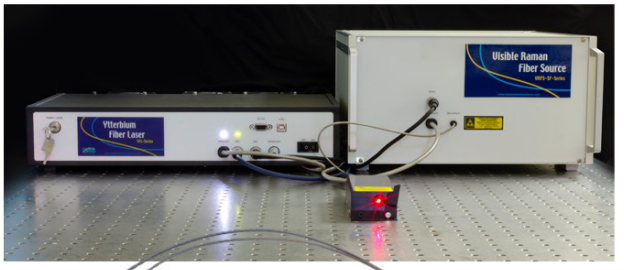
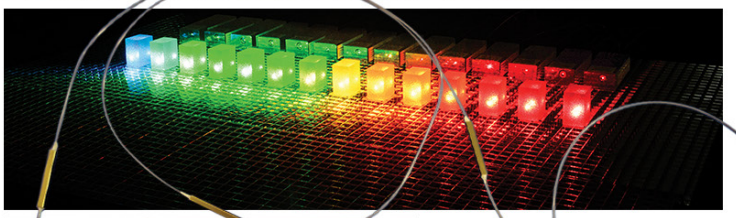
Visible Single Frequency Fiber Lasers

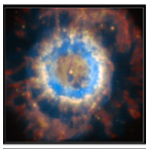
FOR ASTRONOMY, ATOM COOLING, QUANTUM COMPUTING AND SPECTROSCOPY

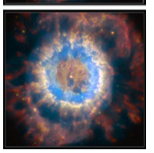












MPB Communications Inc. (MPBC) launched the first visible fiber laser at Photonics West in 2006. These lasers were soon successfully implemented in a variety of Biomedical applications, from Flow Cytometry to STED, STORM, GSD and Light Sheet microscopy. MPBC's portfolio of Visible Fiber Lasers quickly grew to include dozens of wavelengths across the visible and NIR range. MPBC's outstanding product quality and willingness to provide customized solutions make us the "go-to" company for leading researchers and industrial laser users worldwide.

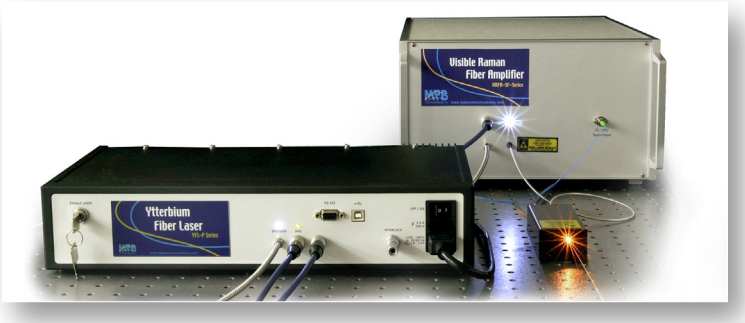
Building from that substantial success base, MPBC created CW Single Frequency Fiber Lasers with fine wavelength tuning, narrow line widths, low noise and diffraction limited beams to address the most demanding applications in Astronomy (Laser Guide Stars), Atom Cooling/Trapping, Quantum Computing, Interferometry, Holography, Sensing and Spectroscopy.

MPBC's specialized Single Frequency PM Raman-based technology in combination with second harmonic generation (SHG), and PM fiber laser pumps, allows customers to choose any custom central wavelength between 510 to 790 nm, and output powers up to 4 Watts*. MPBC SF visible lasers utilize single pass second harmonic generation. This doubling system design is simple and robust, resulting in excellent beam quality and ensuring long term stability, long lifetime, with low cost of ownership.

MPBC's SF Systems were typically configured to accept the customer's infrared seed laser source, however more recently, MPBC also offers systems with integral seed sources. Dual wavelength output systems (fundamental and SHG), and visible single mode fiber coupled outputs are also available.

Single Frequency Fiber Lasers

brilliant power and performance



MPBC's Single Frequency Fiber Laser Product Line has grown rapidly out of its highly reliable Raman Fiber Laser technology deployed for 20+ years in Telecom fiber optic systems worldwide. MPBC's exceptional performance has set the bar for demanding applications at the world's most prestigious academic, national and industrial labs.

The all-fiber architecture eliminates the need for system/cavity alignment and provides for unprecedented wavelength and output power stability; ensuring diffraction-limited linearly polarized output. These lasers exhibit mode-hop free performance. They operate with very narrow linewidths, resulting in long coherence length and low RIN.

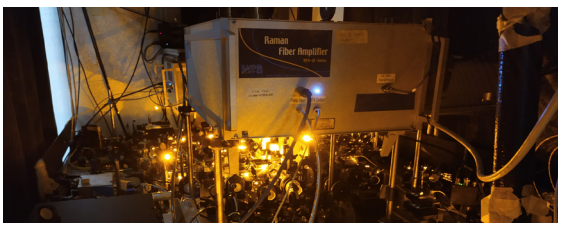
Built-in intelligence allows control and monitoring through a user-friendly GUI via an RS-232 or USB port. Features include automatic power monitoring and control.

With no maintenance, easy operation and a long life, the reliability of this fiber laser technology is unparalleled.

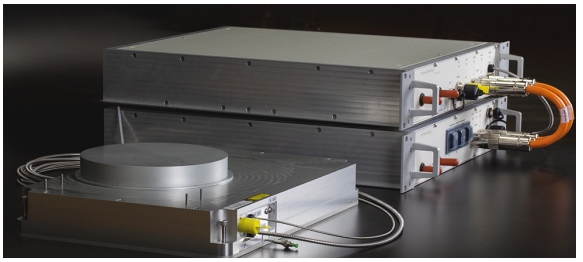
Some Collaborations

Development of a suite of single frequency lasers for Atom Cooling, Prof. Martin Zwierlein, MIT

On-going development of fiber lasers for microscopy applications for Dr. Gael Moneron & Dr. David DiGregorio, Institut Pasteur Paris



MPBC, in collaboration with LEOS, has provided Visible SF Fiber Laser Systems incorporating LEOS Seed Laser & Resonant Cavity Doubler to provide 5+ W using 2nd harmonic generation (~532 nm - 671 nm) and up to 1 Watt in the Ultraviolet using 4th harmonic generation (~320 nm)



Development of a 100 W Raman Fiber Amplifier for Na layer return flux studies to be carried out by ESO and for high-power Laser Guide Stars for next-generation Extremely Large Telescopes and for space debris tracking telescopes

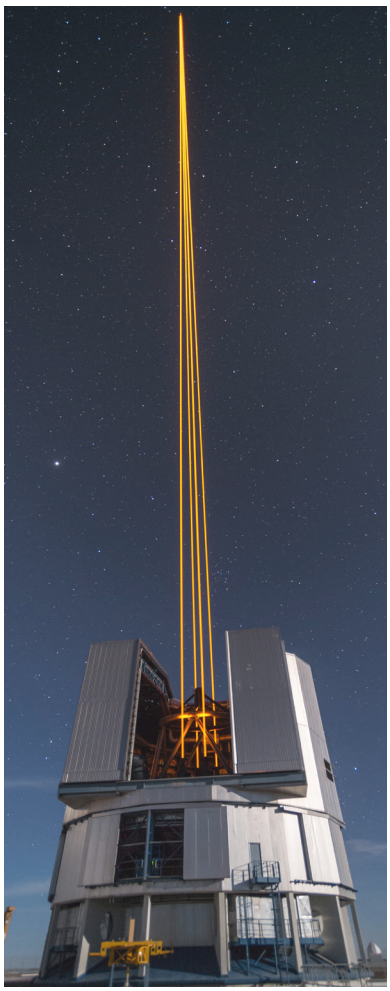
Lasers In The Field

In this "next generation" Laser Guide Star, installed at the European Southern Observatory (ESO) in Paranal, Chile, ***narrow-band 1178-nm emission from a 25-mW diode laser*** *is amplified to the* ***40-W*** *level and then frequency doubled in a resonant cavity doubler to provide* ***22 W*** *at the desired sodium resonance wavelength of* ***589 nm.*** *The novel technology developed to achieve such high power amplification of an extremely narrow-band seed is the* ***polarization-maintaining (PM) Raman fiber amplifier (RFA)*** *developed by MPBC, based on an ESO licensed patent. The 4 Laser Guide Star Facility (4LGSF), using four such lasers, is the most powerful laser guide star system in the world.*

As part of the Guide Star Alliance, MPBC, along with partners ESO and Toptica, have received the prestigious ***Berthold Leibinger Innovationspreis Award,*** *as well as the* ***Paul F. Forman Team Engineering Excellence Award.***

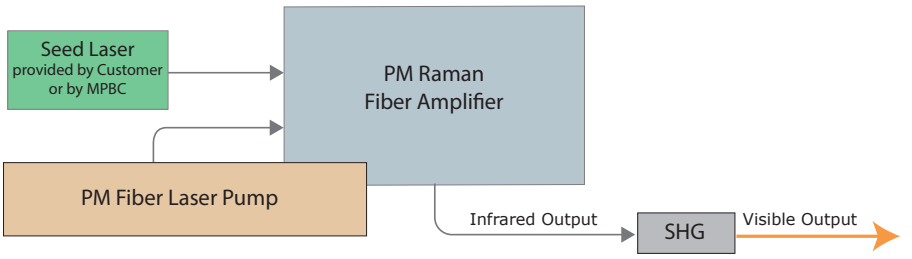
ESO in Paranal was the first to install this Laser Guide Star system. Further systems have since been installed on ***Keck, Gemini North,*** *and* ***Subaru*** *telescopes in Mauna Kea, Hawai'i, and on* ***Gemini South*** *in Cerro Pachón, Chile.*

using MPBC's PM Raman Fiber Amplifier pumped by MPBC's 100 W Fiber Laser



F. Kamphues/ESO

Typical Configuration

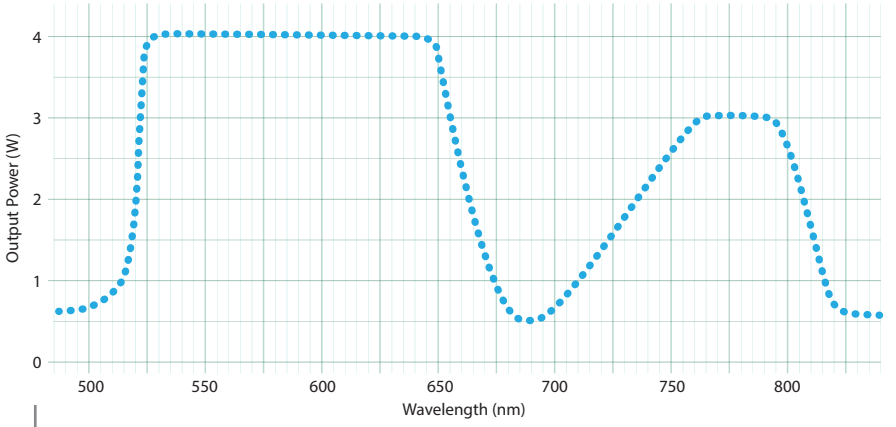


A typical MPBC Single Frequency Visible Laser system is composed of 4 modules, all connected by fiber optic cables: a SF Seed Laser, a Laser Pump for the amplifier, a PM Raman Fiber Amplifier, and an SHG.

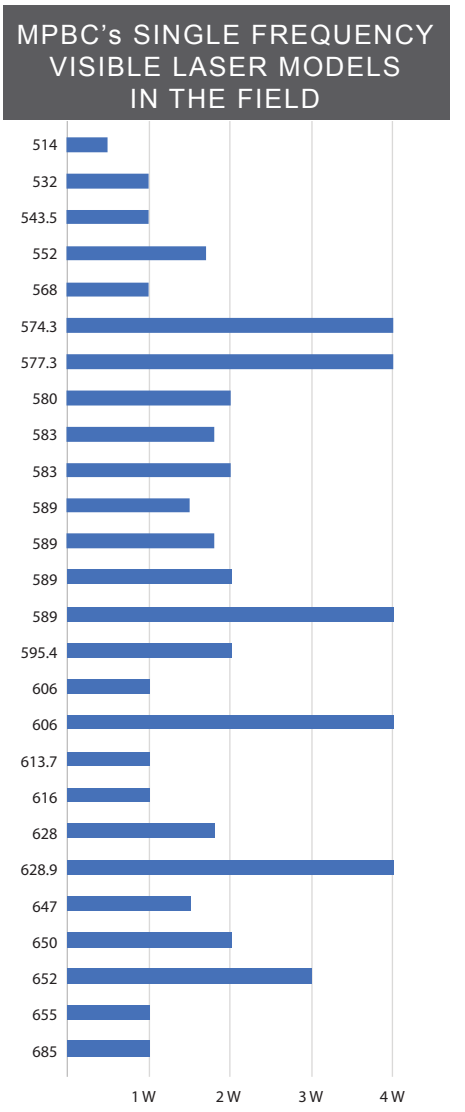
The Laser Pump and SF Seed Laser are both separately input to the PM Raman Fiber Amplifier to create a high-power, polarized SF Infrared Output beam. A fixed armored fiber cable then transmits that beam to the Single Pass SHG, where it is frequency doubled - resulting in the Visible Output beam.

MPBC is a licensee of ESO Fiber Raman Amplifier Technology, ESO patent EP 2081264A1, US patent 8,733,752B2

Output Power vs. Wavelength



Available Visible Single Frequency Output Power (W) vs. Wavelength (nm)



Typical Performance of Single Frequency Systems

	Comments	Minimum	Nominal	Maximum	
Input Signal Power		15	20	40	mW
Input Wavelength Range	with respect to preselected nominal wavelength within 1030 - 1340 nm	-1		1	nm
Output Wavelength	depending on model	510		810	nm
Output Power			4*		W
Adjustable Power Range		10		100	%
Output Linewidth	provided seed signal has narrower linewidth			5	MHz
Relative Intensity Noise	RMS, 5 Hz - 100 kHz			1	%
Polarization	vertical in respect to the base		Linear		
Polarization Extinction Ratio		98			%
Transverse Mode			TEMoo		
Beam Quality (M^2)			1.1	1.2	
Diameter of Collimated Output Beam		0.8	1	1.2	mm
Beam Pointing Stability	Constant Temperature		5	10	uRad

** depends on wavelength*

Visible & NIR Fiber Lasers

Features

- Narrow Linewidth
- Beam Characteristics: TEM_{00}, M^2<1.1
- Active Power Stabilization to ensure longterm power stability of < 2%
- Excellent wavelength stability (± 0.02 nm)
- Graphical User Interface for easy command and control
- Compact laser head
- Tunable output power (from 20% to 100% of nominal) to adapt to application-specific requirements
- High reliability
- Maintenance-free

Applications

- Flow Cytometry
- Fluorescence Microscopy
- Structured Illumination Microscopy
- Super Resolution Microscopy
- Light Sheet Microscopy
- Atom Cooling
- Dual Photon Microscopy
- 3rd Generation DNA Sequencing
- Micromachining
- Optical Tweezers
- Holography
- Entertainment
- Military and Scientific Research
- Environmental Sensing

About MPBC

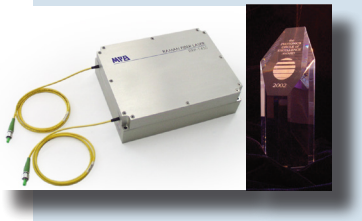
MPBC is a leading supplier of innovative, high performance fiber laser and fiber amplifier systems and subsystems to the international high tech industry.

The company is privately held and self-financed. It has maintained its technological leadership through an on-going commitment to R&D, investing approximately 20% of annual revenues back into research and development. MPB Communications Inc. is a Certified Women's Business Enterprise, and part of the WEConnect International's Global eNetwork.

Laser Heritage

*MPBC's **Flight Sensor Demonstrator**, currently aboard ESA's PROBA-2 marks the **first time a fiber laser incorporated into an all-fiber-optic sensing system on a satellite is in space.** The system has been operating successfully since the satellite was deployed in 2009.*

*Three innovative FBG sensors are included in the **PROBA-2** systems. The custom FBG gratings were manufactured using MPBC's proprietary FBG writing facility.*



*MPBC's **patented Super Raman technology**, based on third-order pumping techniques, is recognized throughout the telecommunications industry as a key enabling technology which appreciably augments the distance and channel counts of unrepeatered systems. The award-winning Super Raman Fiber Laser was first introduced in 2002.*

*In 1992, MPBC introduced the **first commercially available Er^{3+} fiber laser.** This was followed in 1994 by the introduction of the **award-winning tunable single-frequency Er^{3+} fiber laser;** the lowest-phase-noise source of any kind available commercially at the time.*

*From 1977 and for over 20 years, MPBC offered a **GN-Series CO_2 Laser System.** Their long lifetime (most over 10 years), exceptional stability and excellent mode quality were unmatched in the industry.*

MPB Communications Inc.
147 Hymus Boulevard
Montreal, Quebec
Canada H9R 1E9

www.mpbcommunications.com
email: info@mpbc.ca
telephone 1-514-694-8751
fax: 1-514-694-6869

Printed in Canada r2 11/19