Photon etc
A spectrum of solutions

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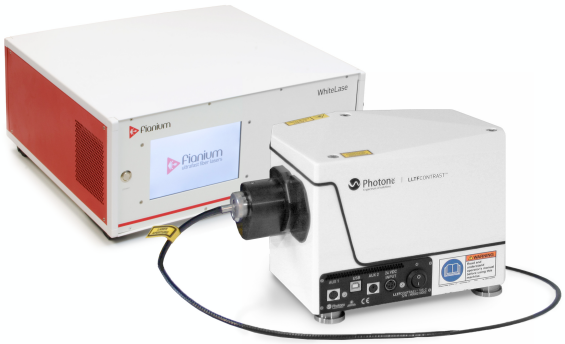
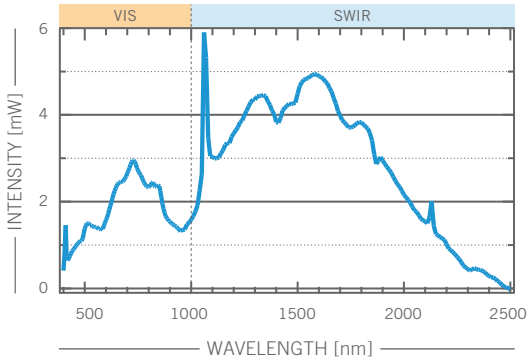
CANADA

TUNABLE LASER SOURCE



The tunable laser source (TLS) provides continuous output from 400 nm to 1000 nm (VIS) and 1000 nm to 2300 nm (SWIR) with bandwidths (FWHM) of 2.5 nm and 5 nm respectively. Custom and extended spectral ranges (up to 2500 nm) and bandwidths (sub-nm) are also available. Photon etc. tunable Laser Source (TLS) is compatible with any VIS-NIR broadband source, but is optimized for Fianium's, NKT's and Leukos' supercontinuum sources. This high-end product provides the highest out-of-band refection (< -60 db) available on the market. It is an ideal tool for instruments calibration, spectroscopy and hyperspectral imaging.



Output from Photon etc's tunable laser source when coupled with a 4 W supercontinuum source.

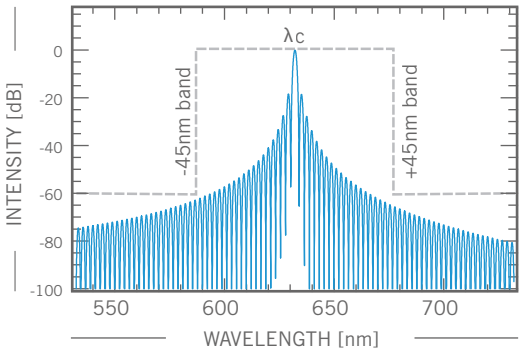


Illustration of the out-of-band rejection of a volume holographic grating at λ_c= 632 nm. Bands of ±45 nm are presented and an out-of-band rejection of -60 dB is obtained.

TECHNICAL SPECIFICATIONS

	CONTRAST **VIS**	CONTRAST **SWIR**	***NEW*** CONTRAST **X**
Spectral Range	400-1000 nm	1000-2300 nm (2500 nm optimal*)	where **X** represents a custom spectral range
Bandwidth (FWHM)	1.0 - 2.5 nm	2.0 - 5.0 nm	***High resolution*** 0.15 nm - 0.9 nm
Out of Band Rejection**	< -60 dB @ ± 40 nm	< -60 dB @ ± 80 nm (measured up to 1.7 µm)	Depends on the bandwidth
Maximum input average power	HP8 (up to 8W), HP20 (up to 20W)	HP8 (up to 8W), HP20 (up to 20W)	HP4 (up to 4W)
Peak Efficiency	typically around 65%		
Optical Density (OD)	> OD6 (measured at 1064 nm)		*TBD*
Spectral Power Density	Coupled with **4W** supercontinuum source < 1 - 3 mW Coupled with **8W** supercontinuum source < 2 - 5 mW	Coupled with **4W** supercontinuum source < 2 - 5 mW Coupled with **8W** supercontinuum source < 5 - 9 mW	Depends on the bandwidth
Damage Threshold	< 5 GW/cm² peak power @ 1064 nm, 8 ns		
Beam Diameter	2 to 5 mm (depending on λ)		
Input Beam Divergence Requirement	< 0.45 mrad		
Wavelength Resolution (Relative)	FWHM / 8		
Pointing Stability	< 1 mm lateral displacement @ 1 m from filter		
Scanning speed (multiple step)	35 ms stabilization time for 0.1 nm step, 45 ms stabilization time for 0.2 nm step, 55 ms stabilization time for 1 nm step, 60 ms stabilization time for 2 nm step, 65 ms stabilization time for 5 nm step, 70 ms stabilization time for 10 nm step		
Operating System (OS)	Windows Vista (32 & 64 bits), Windows 7 (32 & 64 bits), Windows 8 (32 & 64 bits)		
Software	PHySpec™ included (SDK available)		
Computer Connection	USB 2.0 (compatible 1.1)		
Dimensions (L x W x H)	9" x 6.3" x 6.7" / 23 cm x 16 cm x 17 cm (filter)		
Operating Temperature	5 to 40°C		
Storage Temperature	0 to 50°C		
Power Supply	100 - 240 V , 50 - 60 Hz		

OPTIONS & ACCESSORIES

Enhance SWIR	N/A	* up to 2500 nm	
Fibered Output	An X-Y-Z translation adjustment allows coupling optimization. The FC APC output is available with the following fibers : 9/125 µm (single mode), 50/125 µm (multimode), 105/125 µm (multimode)		
Harmonic Filter	Blocks the harmonics coming from the region 400-500 nm	Blocks the harmonics coming from the region 500-1000 nm and/or 1000-1250 nm	Filter chosen according to spectral range
Background Suppressor	Removes unwanted reflections of light coming from the inside of the LLTF		
Alignment Kit (for free space)	In free-space (input/output) configuration, the alignment kit allows the user to rapidly find the correct alignment		

NOTE: Photon etc reserves the right to change the design and specification of the product at any time, without notice.
**To reach this specification in free space configuration, it is required to couple the filter with Photon etc's background suppressor accessory.

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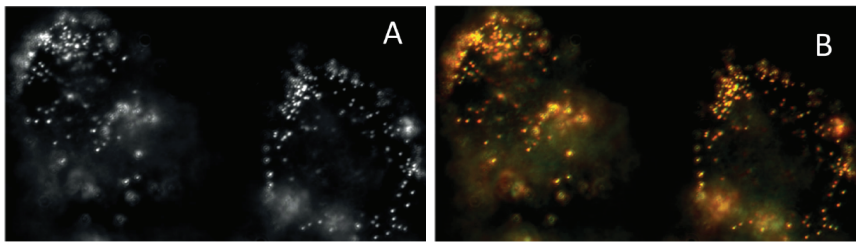
APPLICATIONS

DETECTING BREAST CANCER CELLS USING GOLD NANOPARTICLES[1]

[1] Sergiy Patskovsky, Eric Bergeron, David Rioux, and Michel Meunier, Hyperspectral darkfield microscopy of PEGylated gold nanoparticles targeting CD44-expressing cancer cells, Biophotonics, **2013**.

Gold plasmonic nanoparticles (AuNPs) are used extensively as biomarkers, and are a viable candidate for a variety of other biological applications. However, it has been proven that their small size and the complex environment in which they navigate make their observation and characterization quite a challenge. In order to address this issue Patskovsky et al.[1] used a hyperspectral dark field microscope in backscattering configuration, replacing the usual white light illumination with a tunable laser source. With this set-up, the group of researchers was able to sweep the illumination over the range 400nm to 1000nm. The wide range of wavelengths and high output power of the source were essential parameters for this study. They could indeed follow the spatial position and distribution along the z axis of the AuNPs targeting CD44 (see figure 1), a cell surface receptor actively expressed in cancer stem cells. The hyperspectral imaging set-up described here can also be helpful in a wide range of biological applications requiring a combination of spatial and spectral information.



F1: Reconstructed image obtained by hyperspectral scanning in backscattering optical configuration. Scan was performed with 100x oil immersion objective, 300ms time constant, 4 nm step wavelength from 450 nm to 640 nm. The illumination was obtained with Photon etc. TLS. Total intensity (A) and calculated color distribution (B). : Modified from [1].

TESTING THE GEMINI PLANET IMAGER'S CORONAGRAPH

The Gemini Planet Imager (GPI) is an astronomical instrument made to detect giant planets in nearby star system. The GPI uses a coronagraph in order to eliminate 99% of the coherent starlight. Before sending the GPI at Gemini South (located in Chilean Andes), it was crucial to test the coronagraph by reproducing the experimental conditions in which it would serve. The light source required to measure its performances had to be nearly achromatic, tunable across the GPI's wavelength domain (near-IR 0.95-2.4µm), in addition to being powerful and collimated. Most of the light sources match one or two of these requirements but only Photon etc's unequalled and efficient tunable laser source combines all three above. The wide spectral range of the TLS and its high output power were exploited for sensitivity measurements of the imager. Figure 2 illustrates the sensitivity measurements of GPI's coronagraph across the astronomical H band (1.50-1.80 µm). At the wavelengths it is most efficient (i.e. 1.60 and 1.65 µm), GPI's coronagraph allows the detection of a source less than a million times fainter that the diffraction core of the unmasked star at a separation of only 0.35". This would be sufficient to detect a planet only slightly more massive than Jupiter around a 100 million year old Sun-like star.

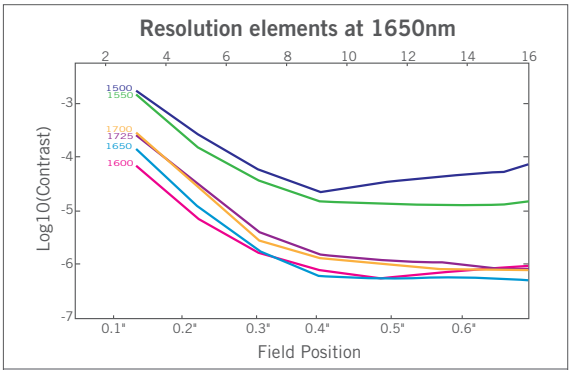
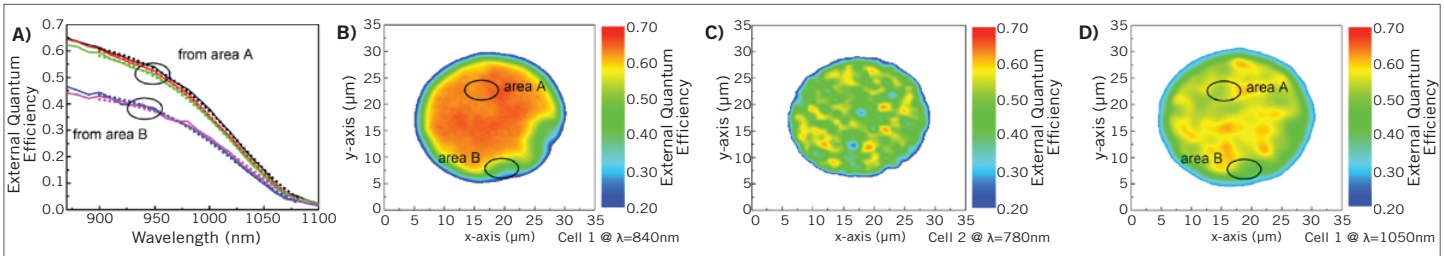


FIGURE 2 : Contrast at six wavelengths ranging from 1.5 to 1.78 µm; contrast on the short wavelength side of the bandpass is markedly poorer.

SOLAR CELL EXTERNAL QUANTUM EFFICIENCY MAPPING[2]

[2] L. Lombez, D. Ory, M. Paire, A. Delamarre, G. El. Hajje, J. F. Guillemoles, Micrometric investigation of external quantum efficiency in microcrystalline CuInGa(S,Se)2 solar cells, Thin Solid Films, **2014**.

In the race for higher solar cell efficiency, a better understanding of their fundamental electronic properties is paramount. With that in mind, Lombez et al.[3] investigated the spatial variations in the spectral response of $CuInGa(S,Se)_2$ solar cells. In this study, Photon etc's TLS served as the illumination source for measurements of light beam induced current (LBIC) at different excitation wavelengths. The LBIC experiment allowed an estimation of the external quantum efficiency (EQE) at different positions of the sample (see figure 3). The LBIC measurements at enough positions on the sample allowed a map reconstruction of EQE. To carry out successfully this experiment, the illumination source needed both a wide spectral range and a high output power, delivered in a diffraction limited point source to achieve the best spatial resolution. Combining all of the above requirements, Photon etc's TLS was chosen to excite the sample, mounted on a piezoelectric stage, to map the EQE for a large range of wavelengths.



F3: measurement of the external quantum efficiency of 25µm diameter microcell. (a) spectral response EQE(E) from different areas on cell 1; Lines are the experimental data, dots represent the corresponding fits; (b) EQE map of cell 1 at 870 nm (c) EQE map cell 2 at 780 nm and (d) EQE map of cell 1 at 1050 nm. From [2].