OVERVIEW

- Established in 1985 The Photonic Science Group has over 30 years' experience in designing, manufacturing and delivering high technology cameras and camera systems.

- Manufacturing base Robertsbridge UK, Sales & Marketing Grenoble France. PSL supply complete imaging systems covering the range from visible, SWIR, to x-ray and neutron detection for end users and OEMS Worldwide.

- Highly qualified team of 30 with track record and extensive knowledge of camera design and integration.

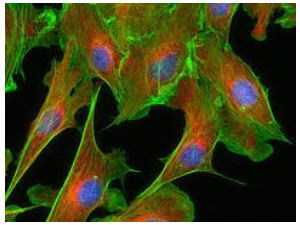
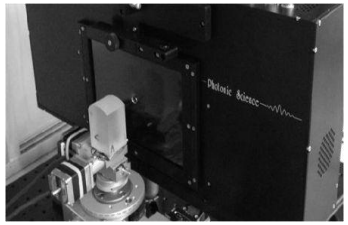
- Balanced activity between scientific, industrial and military market segments with Turnover 4.5 to 6M Euros on average

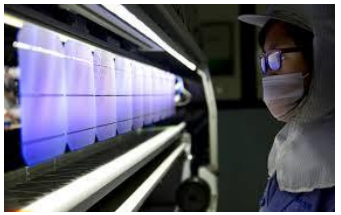
TRACK RECORD

- 95 % export, 15 % to china, expertise in export licence preparation
- Camera systems installed in over 100 prestigious international institutes
- Since 2014 >100 InGaAs cameras and systems installed Worldwide
- Successful completion of 5 government funded European Projects
- Start up PSL SAS in Grenoble area
- Comprehensive technology portfolio with ICCD / SWIR / sCMOS / EMCCD cameras
- Capability for customized solutions and volume production
- Design of turnkey sub-assemblies / system
- OEM cameras design / customised solutions licensed for volume production

APPLICATION AREAS

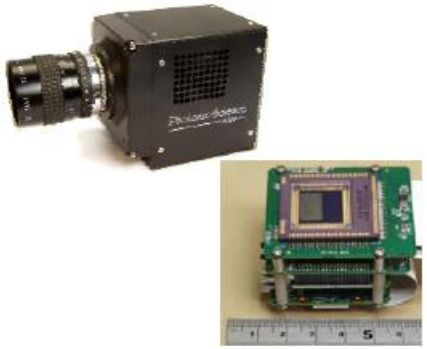
MEDICAL / PHARMA	BIOTECH	PHYSICAL SCIENCE	MILITARY / AEROSPACE	INDUSTRIAL

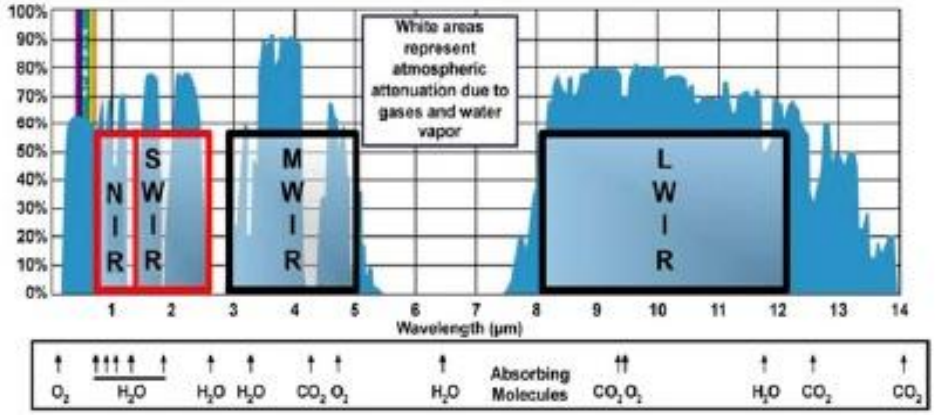


Near Infra Red Gated Intensified CCD

Cooled sCMOS



Cooled SWIR



SWIR Imaging

In the last few years a whole new waveband of the electromagnetic spectrum has been opened up for exploitation: the Short Wave Infra Red (SWIR). The band runs from the edge of the near IR region at 900 nm up to 1700 nm.

Some Applications

- Spectroscopy and microscopy
- Hyperspectral imaging
- Crop surveys
- Laser gated imaging
- Low light level imaging
- High speed imaging
- Homeland security and image fusion
- Solar panel testing
- Bio-medical

Cooled InGaAs SWIR Camera Design

Based on Metal Organic Vapor Phase Epitaxy InGaAs sensors

Pin diode structure: InP/InGaAs/InP

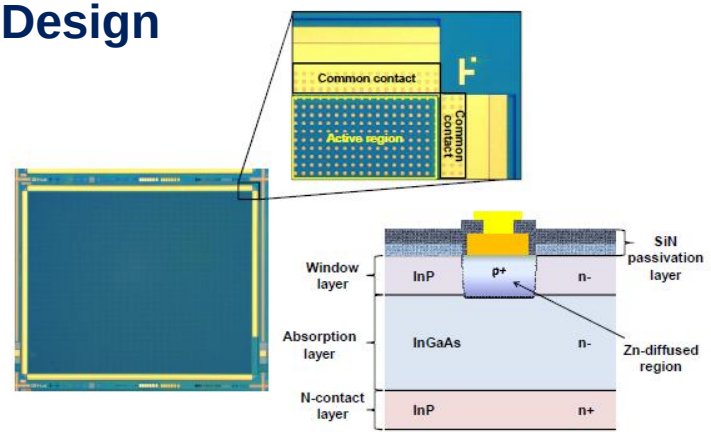
100% filled factor / no cross talk (common biais)

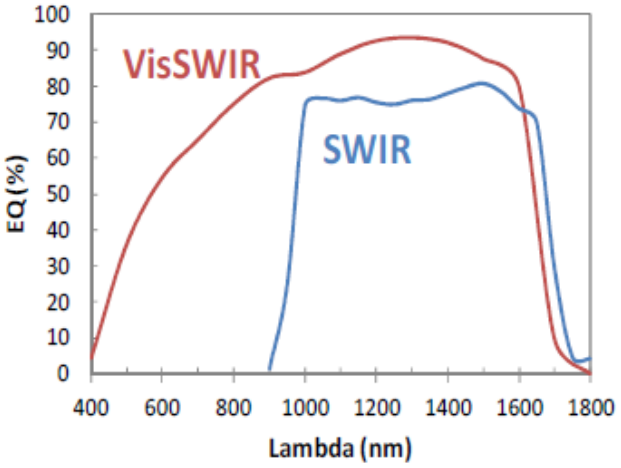
Indium bump bonding to Read Out Integrated Circuit

Good quantum efficiency compared to Si beyond 1μ

Potential visible extension in the visible with thin InP substrate

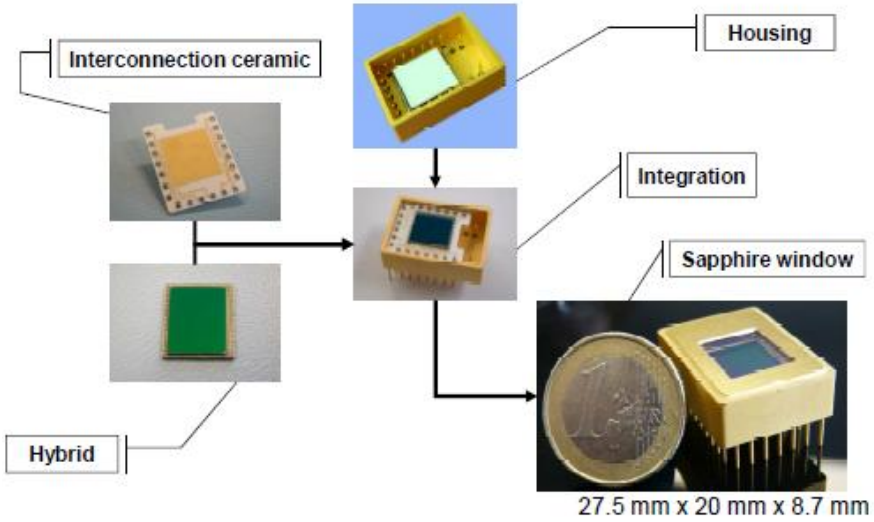
Integration into metrology / measurement tools for quantitative imaging

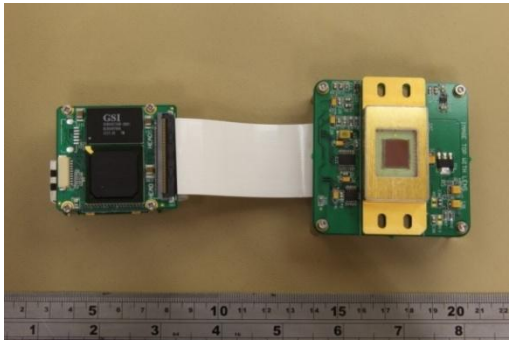




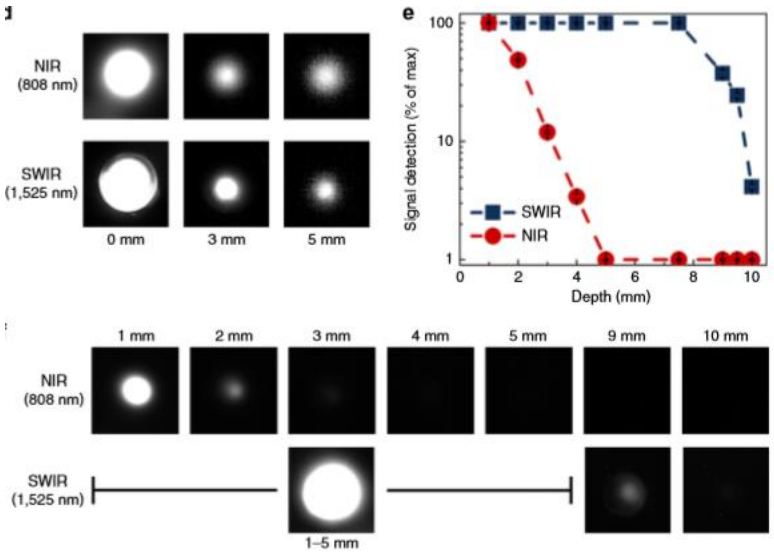
New 15 micron pitch cooled InGaAs OEM camera

Array format	640x512
Pixel Size	15 µm
Windowing mode	down to 1 row x 24 columns
Full Well / ROIC Noise	40ke- (35e-)
	100ke- / 150ke- (75e-)
	1.5Me- (600e-)
Integrating mode	Snapshot
Reading mode	ITR, IWR, NDR
Master Clock	9MHz
Output rate	18MPixel/s
Number of output channels	2, 4 or 8 (programmable)
Frame rate	60 Hz – 2 outputs
	120 Hz – 4 outputs
	300 Hz – 8 outputs
Power Consumption	< 160mW – 2 outputs





Advantages of SWIR over visible: endogenic contrast based on reflectance / transmittance

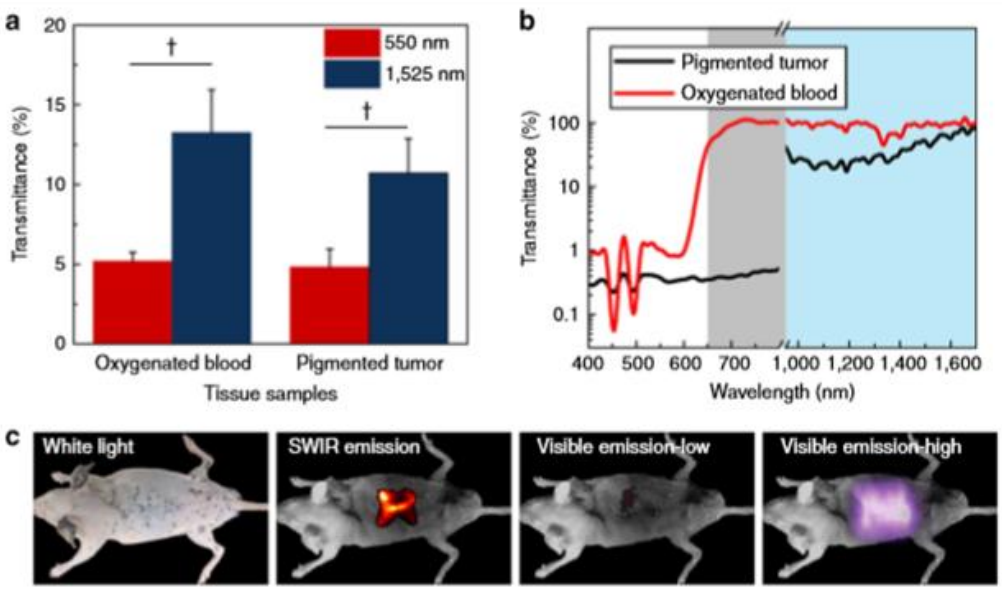


Comparing scattering from 808nm NIR to 1525nm SWIR light demonstrate improved resolution quality of SWIR signals. The intensities of both the SWIR and NIR light were measured to be identical prior to the application of the tissue phantoms: ie 30μW were applied.

Less disturbance with biological material compared to visible light decreasing the risk of disturbing or damaging the biological systems observed

Second 'tissue-transparent window' using short-wavelength infrared light (SWIR, 1,000–2,300nm) with comparably low absorbance as NIR but up to a 1,000-fold greater reduction in scatter losses, leading to unprecedented improvements in detection depth and resolution despite larger airy disk diameter

Advantages of SWIR over visible: fluorescence based systems



SWIR light (1525nm) emitted from Er-doped REs is significantly more effective at transmitting through blood and pigmented tumour tissue (a) than visible light at 550nm

Low autofluorescence in the SWIR part of spectrum allowing better discrimination of signal over background when used with fluorescent dyes:

- MOFs (Metal Organic Frameworks hosting Lanthanide based cations)

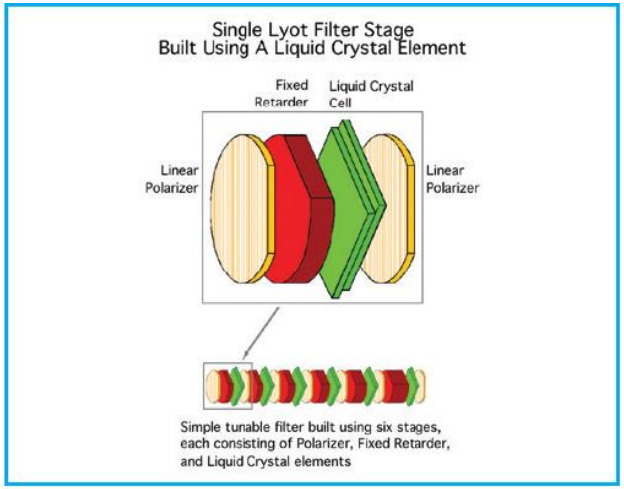
- SWNT (Single Wall Nano Tubes) rare earth–doped quantum dots.

Deep cooled SWIR camera with integrated laser illumination

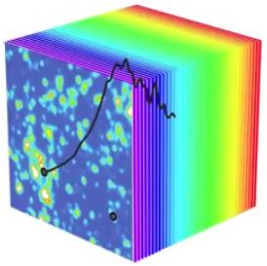
NIR light excitation well below the laser exposure limit for skin (defined as 0.73Wcm-2 for 980nm)

InGaAs Detector Array for on-line inspection	• 512 x 512 and 1024 x 1024 resolution • 320 and 160 microns pixel size on wafer • Shutter less acquisition • QE > 80% at 950nm, >70% at 1150nm • High dynamic range with 16-bit digitisation • Gigabit Ethernet interface • Secondary air cooling
High Power Laser Illumination System	• Single wavelength illumination at 808nm • Homogenized Illumination area of 180mm x 180mm • Adjustable illumination intensity 0 – 3 Suns (75W) • TTL synchronization with camera acquisition • Illumination Non-uniformity < 6% • Peltier Thermal Controller for cooling laser pump

Multispectral acquisition using SWIR & sCMOS cameras in macro and microscopy: nematic filters

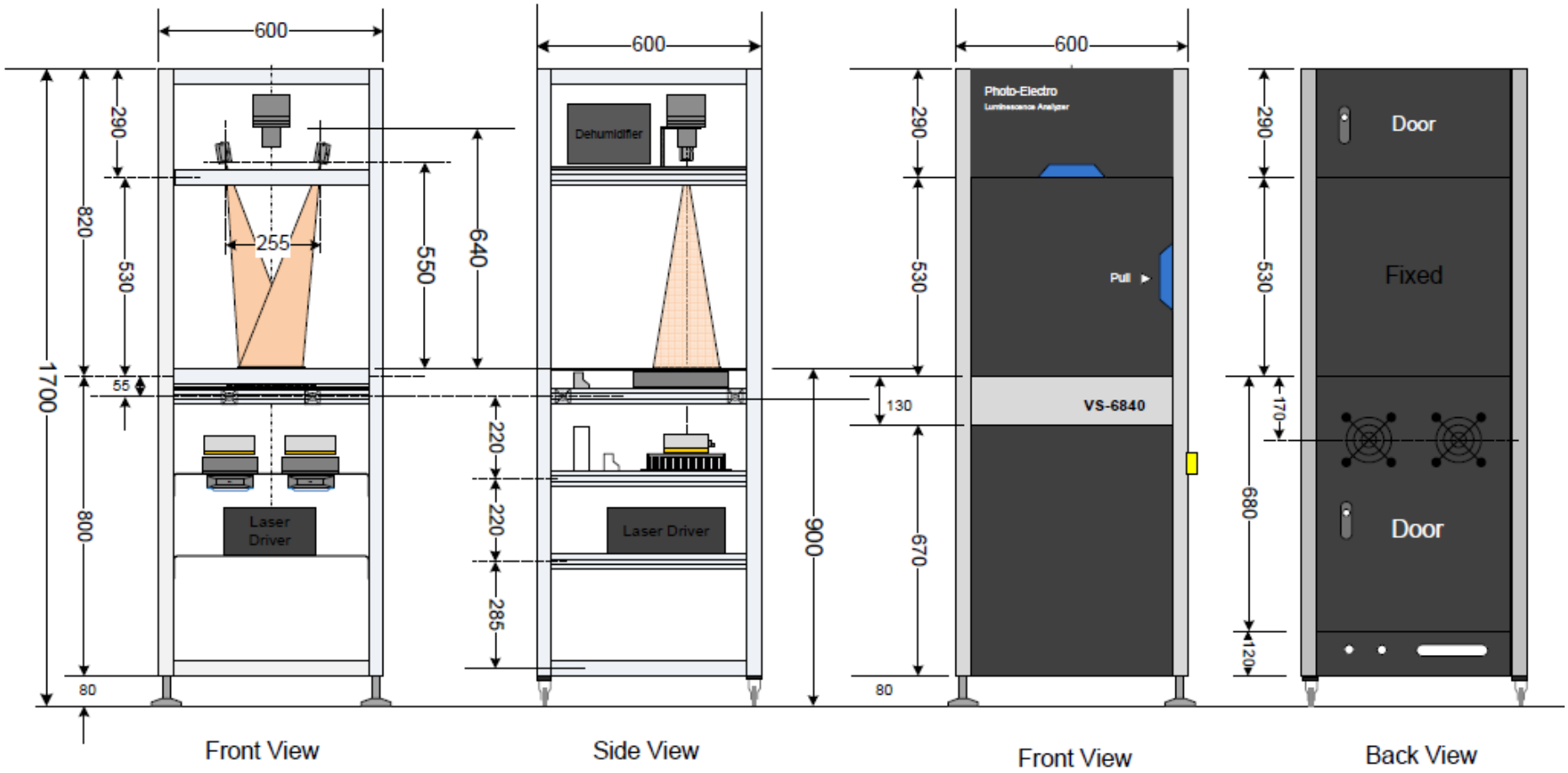


An illustrative six-stage Lyot filter design is shown here with the addition of LC cells which can be precisely controlled. Typical VariSpec filters utilize 12 or more stages enclosed within a rugged aluminum housing.

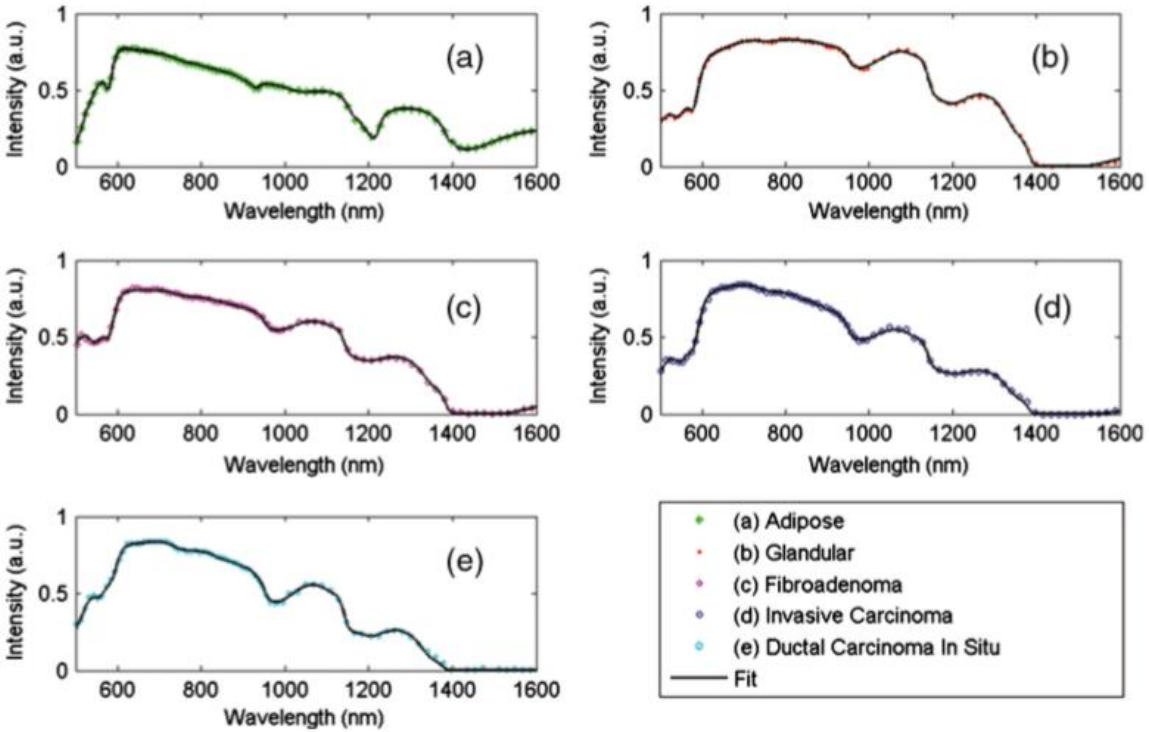


Hyperspectral stack

Spectral range	400 - 720 nm (VIS) 480 - 720 nm (VISR)	650 - 1100 nm	850 - 1800 nm
Bandwidth	7, 10, or 20 nm (VIS) 0.25 nm (VISR)	7 or 10 nm (SNIR) 0.75 nm (NIRR)	6 or 20 nm
Aperture	20 or 35 mm	20 mm	20 mm
Angle-of-acceptance	7.5° half-angle (VIS) 3.5° half-angle (VISR)	7.5° half-angle (SNIR) 3.5° half-angle (NIRR)	3.5° half-angle
Response time (room temp)	50 ms (VIS) 150 ms (VISR)	150 ms	150 ms
Wavelength accuracy	Bandwidth/8 ±0.5 nm	Bandwidth/8 ±0.5 nm	Bandwidth/8 ±0.5 nm
Maximum optical throughput	500 mW/cm^2	500 mW/cm^2	500 mW/cm^2
Operating temp	10 to 40 °C	10 to 40 °C	10 to 40 °C
Storage temp	-15 to 55 °C	-15 to 55 °C	-15 to 55 °C
Computer interface	USB 1.1	USB 1.1	USB 1.1
Power supply	USB bus-powered	USB bus-powered	USB bus-powered
Software	Free SDK, demo program	Free SDK, demo program	Free SDK, demo program


600
290
820
530
1700
55
800
80
255
550
640
Laser Driver
Front View
600
Dehumidifier
220
220
285
Laser Driver
Side View
600
290
530
130
670
80
900
Photo-Electro
Luminescence Analyzer
Pull
VS-6840
Front View
290
530
170
680
120
Door
Fixed
Door
Back View

SWIR Diffuse reflectance spectra / spectroscopy



SWIR measurements of biological tissues are capable of detecting changes in absorption from such as water, collagen, suggesting that SWIR spectroscopy and imaging techniques provide potential for enabling a more information-rich means of tissue diagnostics and characterization.

(a)–(c) noncancerous and (d) and (e) cancerous human breast tissues over the range from 500 to 1600 nm, measured ex vivo with a fiber-probe-based setup.
Differences between tissue types can be clearly seen and quantitatively related to changes in water and lipid volume fractions, which can then be employed for tissue classification.

Conclusion

- Comprehensive technology portfolio
- Enhanced sensing performance with FPGA / embedded algorithms
- Demonstrator units using state of the art components: SWIR cameras and integrated systems
- Highly qualified team with track record / retained knowledge
- Capability for customized solutions and potential volume production from UK & France

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