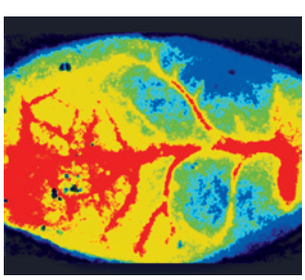
Microcirculation Imaging Techniques

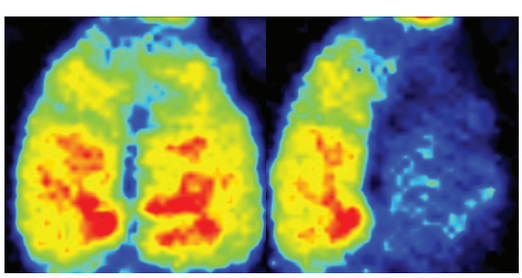
PeriScan PIM 3 System and PeriCam PSI System

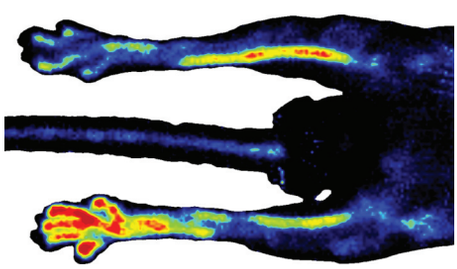
In many different physiological and pathophysiological conditions it is of interest to study the microcirculation. One of the functions of the microcirculation is to sustain the nutritive flow to and from the tissue. As a consequence, a wound will not heal or angiogenesis is impaired, if the microcirculation is not functional.

Blood perfusion imaging techniques are a non-invasive approach to studying the microcirculation. Since no physical contact with the tissue is required, and no dyes or tracer elements are used, the influence on the perfusion can be kept to a minimum. Currently, the most widely used techniques for these types of studies are laser Doppler and laser speckle/LASCA (Laser Speckle Contrast Analysis).[1-6] Perimed offers two different imaging systems based on these techniques, the PeriScan PIM 3 System and the PeriCam PSI System. Both systems are operated using PimSoft software.

Two popular applications







Cerebral Blood Flow

In many animal models designed to study the cerebral blood flow, imaging systems such as the PeriScan PIM 3 System and the PeriCam PSI System have proven to be useful tools. Using non-invasive analysis, they can provide microcirculatory data that can aid in understanding stroke, cortical spreading depression/depolarization, angiogenesis and more. It is even possible to scan straight through intact rat skull with the PeriScan PIM 3 System, avoiding the need to open/thin the skull. The PeriScan PIM 3 System yields quantitative blood perfusion data, whilst the speed of the PeriCam PSI System is useful for studying any dynamic variations.

Angiogenesis

During angiogenesis and arteriogenesis, new blood vessels are formed in response to different stimuli. Understanding these processes could potentially result in better treatment options for patients suffering from clinical conditions characterized by insufficient blood supply (e.g. peripheral arterial disease). For this purpose, many researchers use the ischemic hind-limb model, an animal model in which ischemia is induced by femoral artery ligation.[7] The PeriScan PIM 3 System provides an excellent method for following the microcirculatory blood perfusion in this model.

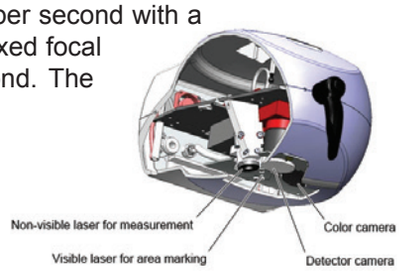
PeriCam PSI System

Real-time microcirculation imaging

Laser Speckle technique

Tissue illumination by laser light produces an interference pattern, or speckle pattern, on the tissue surface. When the illuminated object is static, the speckle pattern is stationary. However, when moving particles, such as blood cells, are present, the speckle pattern will fluctuate over time. By analyzing these intensity fluctuations, information about the blood perfusion in the tissue is obtained.

The PeriCam PSI System uses the LASCA technique to assess the microcirculation in the tissue/organ of interest. This allows you to combine speed - instant real-time imaging - with high resolution images. The CCD camera used for detection captures blood perfusion images at speeds of up to ~100 images per second with a maximum image size of 1388 x 1038 pixels. To control measuring precision, a fixed focal length is used as well as automatic background compensation once per second. The PeriCam PSI System is available in normal and high resolution models.



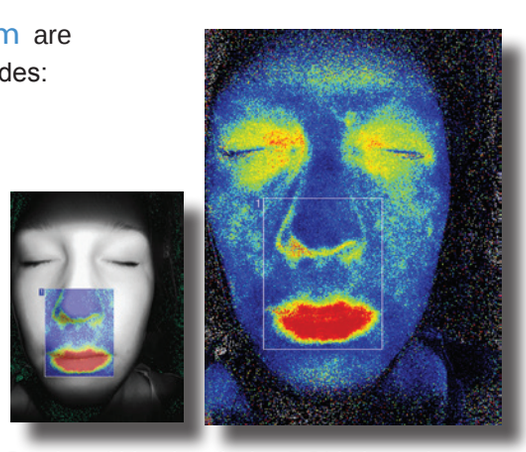
PeriCam PSI System - scanner head

PIMSoft software

Blood perfusion imaging software

The PeriCam PSI System and PeriScan PIM 3 System are operated using the sophisticated PIMSoft software, which includes:

- ✓ Real-time graphs of ROI (Region Of Interest) blood perfusion
- ✓ Advanced ROI editing
- ✓ Video playback at 1/4 - 64x original speed
- ✓ Saved settings and templates for repeated use
- ✓ TOIs (Time periods Of Interest) that allow evaluation of mean blood perfusion during specific time periods



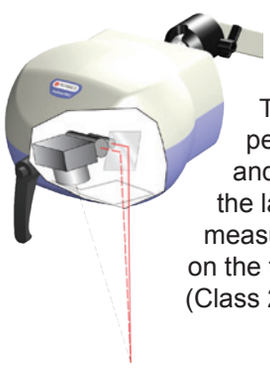
Overlay of blood perfusion ROI in intensity image

PeriScan PIM 3 System

Laser Doppler blood perfusion imager

Laser Doppler technique

When a laser beam enters tissue it will become scattered. If this scattered light hits moving blood cells, the light will change frequency due to the Doppler effect. The proportion of shifted to non-shifted light is related to the number of moving objects within the path of light. These properties are analyzed and used to calculate the blood perfusion.



Principle of PeriScan PIM 3 System

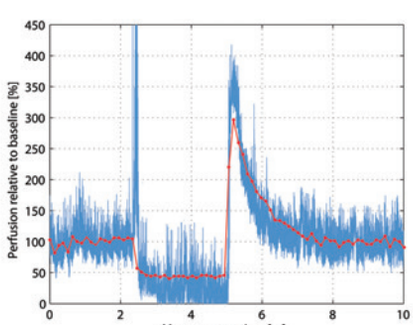
The PeriScan PIM 3 System is based on the established laser Doppler technique. Blood perfusion is measured in Perfusion Units (PU) and there is a documented linearity between PU and the true blood perfusion in the tissue being imaged. Using a patented stepwise movement of the laser beam across the tissue, background noise is kept to a minimum, improving the quality of measurements in minimally perfused areas. The penetration depth is around 0.5 – 1 mm, depending on the tissue. Highly perfused tissues will lead to more superficial measurements. A low power laser (Class 2) ensures that no additional safety precautions are necessary.

Comparison of techniques

Laser Doppler versus Laser Speckle

	PeriScan PIM 3 System	PerCam PSI System
Technique	laser Doppler Proven quantitative	laser speckle / LASCA
Units	Perfusion Units	Perfusion Units
Resolution *(max. measurement points)*	255 x 255	1386 x 1036
Speed	Depends on number of measurement points e.g. 5.7 x 6.1 cm (20 x 20 points) = 15 s	Up to 100 images/second
Max. Image size	50 x 50 cm	15 x 15 cm
Software	PIMSoft	PIMSoft

Occlusion and post-occlusive reactive hyperemia (PORH) in an arm. Simultaneous detection using both the PeriScan PIM 3 System (red) and the PeriCam PSI System (blue).



PeriCam PSI System Specifications

Measurement Principle:	LASCA (LAser Speckle Contrast Analysis)
Image Size:	Normal Resolution model: ~5.9 x 5.9 cm – 15 x 15 cm High Resolution model: ~20 x 27 mm
Image Acquisition Rate:	50 Hz: 94, 44, 21, 16, 10, 5, 2, 1, 0.5, 0.2 images per second 60 Hz: 112.8, 52.8, 25.2, 19.2, 12, 6, 2.4, 1.2, 0.6, 0.2 images per second
Precision:	+/- 4% (Motility Standard), +/- 3 PU (Zero Perfusion)
Accuracy:	+/- 4% (Motility Standard), +/- 3 PU (Zero Perfusion)
Image Resolution:	Maximum 1386 x 1036 measurement points Normal Resolution model: 100 µm/pixel (at 10 cm) High Resolution model: 20 µm/pixel
Scale:	0-3000 PU
Camera Resolution:	Measurement Camera: 1388 x 1038 pixels Documentation Camera: Color, 752 x 580 pixels, up to 1 image per second
Working Distance:	Automatic working distance calculation
Background Compensation:	Automatic background compensation once per second
Lighting Conditions:	Normal, ambient room lighting
Laser Specifications:	Measurement laser: 785 nm, 70 mW, Class 1 per IEC 60825-1:2007 - Safe to use without eye protection Area indicator laser: 650 nm, NR: 7 mW HR: 3 mW, Class 1 per IEC 60825-1:2007 - Safe to use without eye protection
Software:	PIMSoft, Windows based, Export options: pdf, avi, xml, binary Available in several languages
Dimensions and Weight:	Scanner head: 22 x 15 x 20 cm, ~2.4 kg

PeriScan PIM 3 System Specifications

Measurement Principle:	Laser Doppler			
Image Size:	50 x 50 cm			
Scan Times/Sizes:	Area	Time	Image format	
(approx. 25 cm from object, low resolution)	2.7 x 2.9 cm	4 s	(10 x 10 points)	
	5.7 x 6.1 cm	15 s	(20 x 20 points)	
	15 x 16 cm	1:30 min	(50 x 50 points)	
	26 x 29 cm	4:29 min	(85 x 85 points)	
Image Resolution:	Maximum 256 x 256 measurement points			
Step Resolution:	Low	Medium	High	Very high
(approx. 25 cm from object)	3 mm	2 mm	1 mm	0.5 mm
Documentation Camera:	CMOS, 1280X1024, digital zoom			
Laser Specifications:	Class 2 per IEC60825-1:2001 658 nm, 1mW, Beam diameter: 1 mm			
Dimensions and Weight:	Scanner head: 22 x 15 x 20 cm, 2.0 kg			

Due to Perimed's commitment to continuous improvement of our products, all specifications are subject to change without notice.

References

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