

Components and Testing

Optical Coherence Tomography



Optical Coherence Tomography (OCT) is an interferometric optical imaging technique, which can be 100 times better than conventional ultrasound, has profound implications for the diagnosis of internal problems in biological tissues as well as inorganic samples. OCT has become increasingly popular for medical applications such as non-invasive ophthalmological imaging, endoscopic gastrointestinal tract imaging and diagnostics for coronary intervention.

Fiber-based OCT systems require precise polarization management, accurate delay control, fast wavelength tuning and complete optical system integration capabilities.

Your Advantage

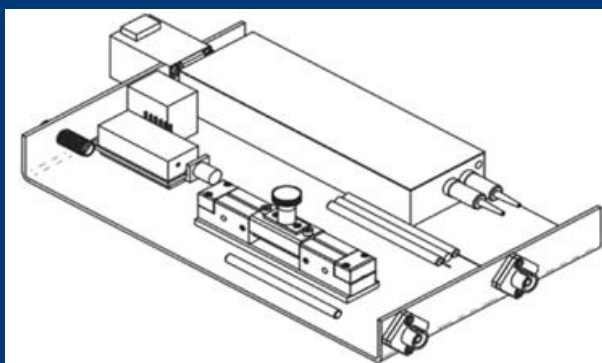
Instead of addressing the test, measurement and control challenges of OCT systems with different products from different companies, our customers have access to a complete suite of products with comprehensive testing capabilities of passive components and interferometer.

Luna Innovations offers a wide range of solutions for OCT systems designers and component suppliers that include:

- Customized products or subsystems for particular applications
 - Dynamic polarization control for real-time tracking of polarization changes/drift
 - More sophisticated polarization control and analysis devices for Polarization-Sensitive OCT (PS-OCT) Systems
 - High spatial resolution reflectometers, which can help scan the OCT interferometer for high loss and reflection events, stray reflections, and confirming stringent length measurement requirements
 - **Products for building OCT systems – OEM components and custom subassemblies**
- Luna has the capability and expertise to integrate various elements of an OCT system into subassemblies optimized to the requirements of different applications.

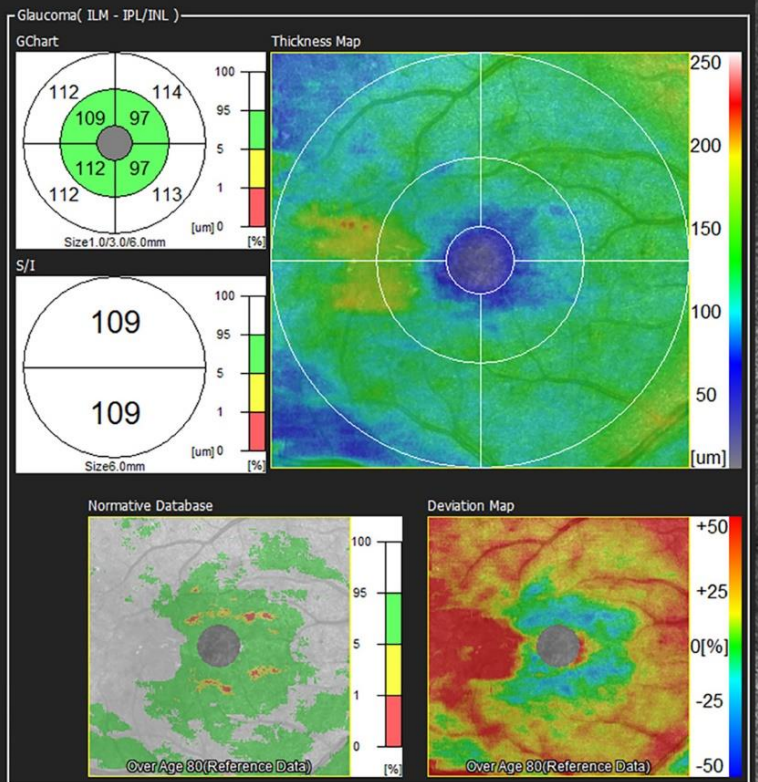
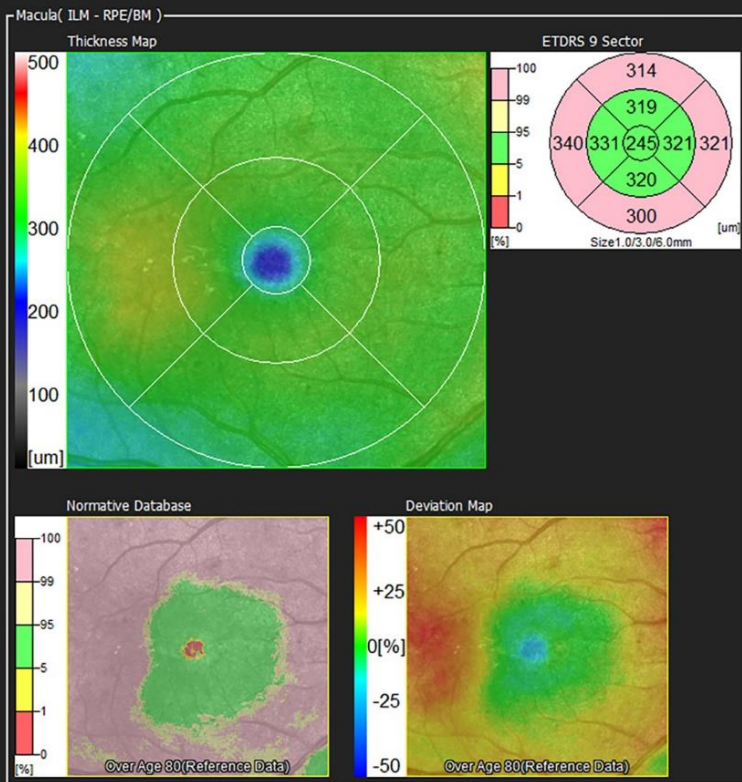
Examples of such subassemblies include:

- Interferometer assembly: integrated optical components with path and loss matching
- Interferometer + delay lines
- Interferometer + delay lines + polarization controllers + balanced detector



Typical solutions:

- Polarization Control:** For demanding applications, sophisticated polarization trackers can be used to obtain the maximum detection sensitivity by actively and automatically stabilize the polarization and mitigate polarization fading.
- Optical Delay Control:** Optical path matching is mandatory to produce perfect interference patterns. Luna offers multiple manual and motorized delay lines with high speed, high accuracy, high repeatability and reliability performance. For more fine tuning of phase, Luna has fiber optic-based phase shifters to do active phase locking.
- Detectors:** Luna supplies high-speed balanced photonics detectors (BPD) with low noise and small package size. For polarization-sensitive OCT, a more sophisticated polarization-sensitive balanced detector is offered.
- Optical components:** Faraday mirrors, fiber couplers and circulators, fiber Fabry-Perot Interferometer/tunable filter etc.



We offer a variety of standard products for OCT systems, as well as the capability to build customized products or subsystems for particular applications:

Motorized variable delay lines
(MDL-002/003)

Functions:

- Automatically adjust the optical path lengths of the interferometer arms.
- Provide a “zoom” function to look for details around a certain depth.



Manual variable delay lines
(VDL-001/002)

Function:

- Manually adjust the optical path lengths of the interferometer arms.



Manual polarization controller
(PLC-003 & PLC-006)

Function:

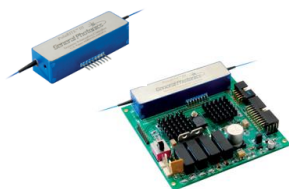
- Manually adjust the polarization states of the interferometer arms.



Dynamic polarization controller
(PCD-M02 & MPC-3x/4x)

Function:

- Dynamically tune the polarization states of the interferometer arms.



Polarization scrambler
(PCD-005/003 & PSM-002/003)

Function:

- Randomize the polarization state to eliminate polarization effects.



Polarization switch
(PSW-003)

Functions:

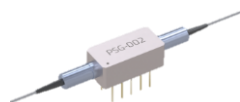
- Switch polarization state by 90 degrees to decrease the polarization sensitivity of the OCT system.
- Enables polarization sensitive OCT (PS-OCT)



Polarization State Generator
(PSG-002)

Functions:

- Mueller-matrix-based polarization imaging
- Enables polarization sensitive OCT (PS-OCT)



Balanced photodetector
(BPD-003)

Function:

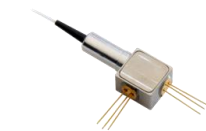
- Low noise balanced detector for accurate detection of small signals.



Polarization Diversity Detector
(PDD-001)

Function:

- Simultaneously detect the powers of the two orthogonal polarization states.
- Useful for PS-OCT.



Fiber Fabry-Perot Interferometer/Tunable Filter
(FFP-TF & FFP-TF2 & FFPI)

Function:

- Enables short cavity Fabry-Perot (SCFP) ring lasers
- Offers fast and wide tuning range



Faraday mirror
(FRM-001)

Functions:

- Reflect light back to the coupler
- Passively compensate for polarization



Fiber couplers/ circulator
(PMC & CIR)

Function:

- Divide and combine optical beams for the interferometer.
- Isolate back-reflected light and direct it to the detector.



Polarization Diverse Optical Receiver Module
(PDORM-001)

Function:

- Perform balanced detection on the two orthogonal polarization components of an input optical signal
- Perform polarization independent balanced detection.



Coming Soon

OCT Subsystems
(INT-00x)

Function:

- Integrate multiple functions/components in one subassembly
- Custom made upon request



Testing and Quality

During the development, production and/or quality control stages, high performance measurement devices are needed. **LUNA OBRs – the advanced test suite for OCT applications**

Luna's unique test systems, based on optical frequency-domain reflectometry (OFDR), deliver accuracy and speed for testing modern optical components and subsystems.

“See Inside” Components with 10 μm Resolution

Luna's ultra-high-resolution reflectometers offer backscatter-level sensitivity for unprecedented distributed loss analysis of passive components. In addition, it provides very accurate length/delay measurement which is essential for building fiber interferometers.

Complete Component Characterization with Single Instrument

Luna's Optical Vector Analyzer (OVA) measures a passive component's linear transfer function (Jones Matrix) with a single scan, yielding insertion loss (IL), group delay (GD), chromatic dispersion (CD), polarization mode dispersion (PMD), polarization dependent loss (PDL), and other critical parameters.



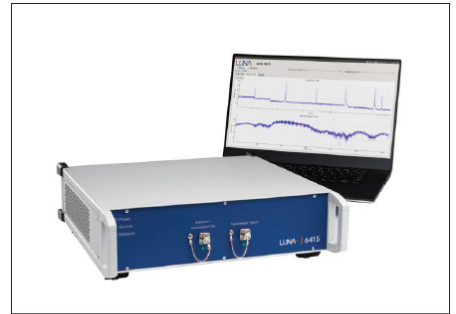
**Optical Vector Analyzer
OVA 5000**

- **Complete characterization** of fiber optic components
- **Full polarization analysis** without need for polarization controller or aligned PM fiber
- **Instantaneous measurement** of IL, RL, PDL, PMD, TE/TM states, waveguide scatter, and more in a single fast scan



**Optical Backscatter Reflectometer
OBR 4600**

- **Unprecedented visibility** into the details of silicon photonics, PICs and fiber optic components
- **10 μm resolution; -140 dB sensitivity**
- **Waveguide scattering** and loss easily measured and analyzed
- **Skew measurements** with sub-picosecond resolution

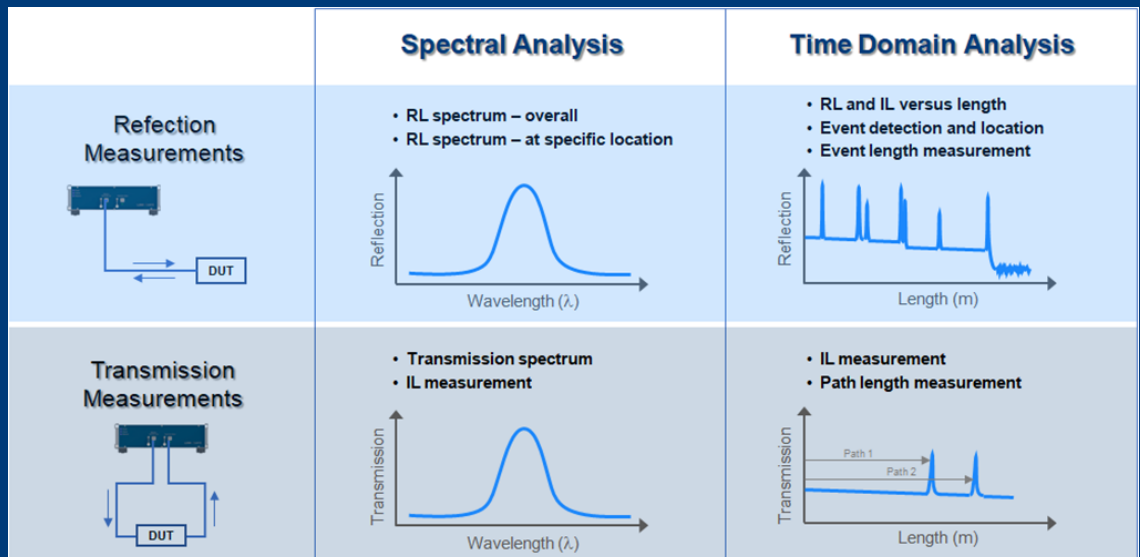


**Lightwave Component Analyzer
Luna 6415**

- **High speed analyzer** for production test and quality control
- **Reflectometer and transmission analyzer** combined in single instrument
- **Measure distributed loss** versus length with very high resolution
- **Spectral analysis** of transmission and reflection paths

Example:

Locating High Reflection Peaks with Luna 6415



Polarization Control Instruments for Manufacturing Test

In many applications, the polarization of light is an important parameter, in particular in some OCT devices. With the equipment shown below, you have full control on the polarization at the input and can measure the influence of the component on it at the output.

Lithium Niobate based: NRT 2500

- Reliable: solid state design
- High speed with sub-microseconds switching speed
- Endless rotation with no resets

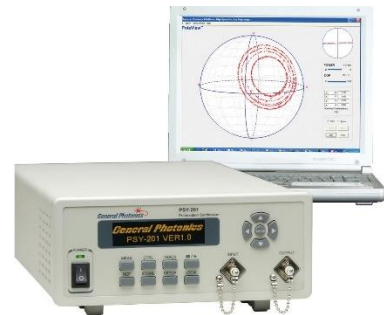
Multiple functions in one box: Control, Scramble, Track, Depolarize



All fiber-based: PSY-201

- All fiber-based design
- Low IL, PDL
- Deterministic polarization generation capabilities

Multiple functions in one box: Control, Scramble, Track, Analyze



Polarimeter POD-201

The POD-201 is an in-line fiber-coupled polarimeter that simultaneously measures the four Stokes parameters to yield the instantaneous state of polarization (SOP) and degree of polarization (DOP) of input light.



Links to the products:

Luna OBR
Luna Polarization Control Platform