Webinar Q&A

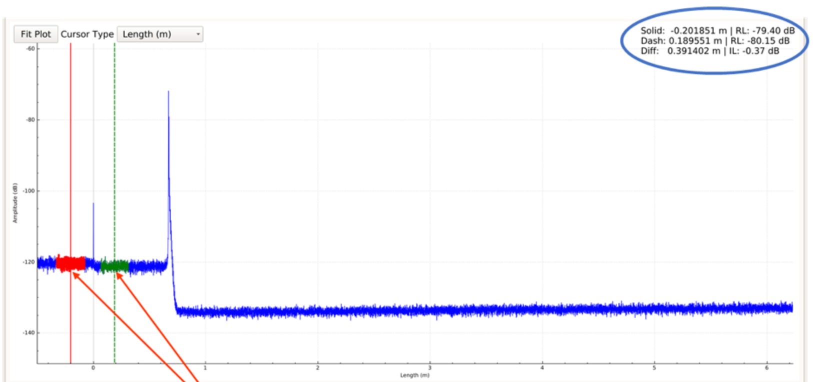
How to Test and Characterize Conventional and Specialty Optical Fibers

October 14, 2020

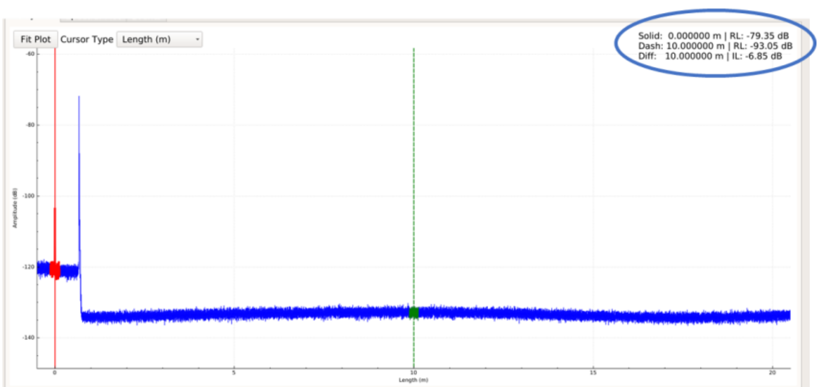
How do you take Insertion Loss and Return Loss measurements with OBR 4600 (and 6225)?

Insertion Loss (IL) measurements are made by integrating over the Rayleigh scatter in separate parts of the network under test.

Each peak has an associated return loss (RL) that is calculated by integrating the reflectivity under the red and green highlighted areas. These areas can be made either very small to isolate only a single event or large enough to cover the entire fiber assembly. The RL can then be associated with either a single event or the entire link.

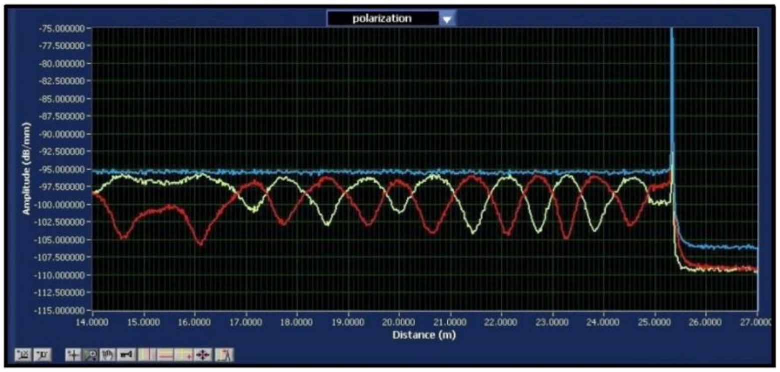


Compare the Rayleigh scatter on either side of the loss event by integrating under the colored sections of data. From this calculate one-way Insertion Loss (Differential Loss).



What polarization measurements can the OBR 4600 do?

The OBR 4600 uses a polarization diverse receiver that detects the power returned in two orthogonal polarization states. The power in these two states can be summed to form the total power returned from a particular location in the fiber. This summation is the blue curve displayed in the linear and logarithmic reflection amplitude plots. (See Figure below.) In some cases, particularly where birefringence is present, it is useful to look at the power returned in each of the polarization states. The polarization graph shows these two power levels in red and yellow, as well as the sum of the powers in blue.



In this case, the period of the white and red traces is equivalent to one half the beat length of the birefringence induced by coiling the fiber (half, because in reflection the light traverses the birefringence twice).

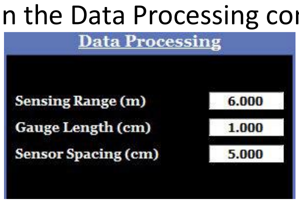
Is it possible to detect or measure temperature changes along the fiber with the OBR or other system?

Yes, the OBR 4600 is available with a Distributed Sensing option, which provides measurements of the following time-domain parameters:

- Spectral Shift
- Spectral Shift Quality Factor
- Temperature Change
- Strain
- Temporal Shift

With the Distributed Sensing option, the instrument can compare a reference and measurement state scan of a fiber's Rayleigh scatter signature and compute the spectral shift. The spectral shift can be converted to either a temperature or strain change with user specified calibration coefficients.

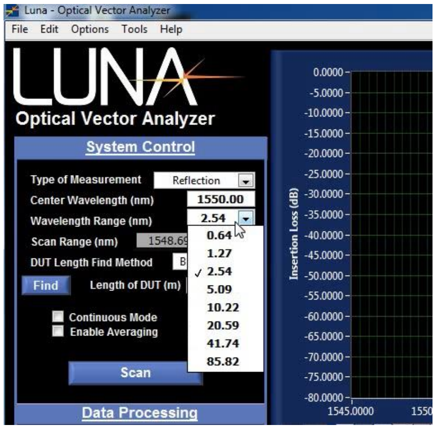
The user can also define the maximum detectable spectral shift range via the choice of wavelength range of the reference and measurement scans, and the spatial resolution of the measurement can be defined in the Data Processing controls, as shown below.



Luna also offers a dedicated fiber optic sensing system, the ODiSI, that uses the same operating principle as the OBR but provides very accurate and repeatable measurement of distributed temperature or strain.

From the demo, it appears that the OVA 5000 has a wavelength range of 50 nm? Does that limit the applications of the OVA 5000?

The OVA 5000 instrument actually has a wavelength range of up to 85.82 nm. In the live demo we scanned between 1525 – 1610 nm. However, the DUT's operating wavelength was specified to be 1528 nm – 1565 nm, so the live demo zoomed into this range.



The OVA 5000 is also available with a 1270 -1340 nm range. The C, L and O bands are the most popular operating wavelengths for the telecommunications test markets that we primarily serve.

For IL measurements, which system is recommended between the OBR 6225 and OBR 4600 to measure IL? The length of interest is 30 m to 100 m.

Of course, the OBR 6225 provides a portable form factor that is convenient for field and mobile applications. The OBR 6225 provides 80 um spatial resolution for 20 m lengths, 100 um for 50 m lengths, and 0.2 mm for 100 m lengths.

The OBR 4600 delivers the highest spatial resolution - 10 um for 30 m lengths and 30 um for 70 m lengths. The OBR 4600 also supports a 2000 m measurement range with 1 mm resolution. The OBR 4600 will also deliver a higher IL dynamic range.

What is the difference between the LCA 500 and OVA 5000?

The OVA 5000 is the most sophisticated instrument we offer. It can work in the transmission and reflection mode. It directly measures the linear transfer function (Jones Matrix) of the device under test, from which all standard linear parameter measurements can be accurately extracted (IL, PDL, PMD, SOPMD, GD, CD, RL, etc.)

The LCA 500 is similar to the OVA 5000 in its design and user interface, but provides only RL, PDL and IL as a function of wavelength for a lower cost.

Can the 2nd or 3rd order nonlinear coefficients in a chirped FBG be measured?

When speaking about nonliniear coefficients, we assume you mean the higher order optical phase response term.

The OVA 5000 measures the test device's amplitude and phase response as a function of optical frequency. From the phase response, we make a number of built in calculations: Linear Phase Deviation, Quadratic Phase Deviation, Group Delay, Chromatic Dispersion, and Phase Ripple. If there is a phase related measurement that isn't supported in the software, the user can export the phase or Group Delay data to a text file and perform additional measurements through some other analysis tool (ie. Matlab).

The OVA also has a "pulse compression" tool (that was demonstrated in the webinar) that allows the user to compensate for large linear dispersion in the device; this has the benefit of narrowing down the time impulse response of the device, so that a tight time domain filter can be placed on the impulse response, improving the signal to noise ratio of the measurement. When the pulse compression tool is used, the measured phase/GD/CD the user sees is whatever is left over after the specified linear term is removed.

What the best resolution provided by OTDRs? Is it micron level?

Centimeter to meters spatial resolution is typical for OTDRs. While 1-10 m is typical of a standard OTDR unit, high performance units can use photon counting and averaging techniques to reduce the sampling resolution to 1 cm or so. However, keep in mind that measurement time and sensitivity usually suffers as a consequence.

What capabilities does Luna have with regards to PER measurement?

The POD-201 and PSGA instruments use the polarization technique to calculate PER. The ERM-202 uses rotating polarizer technique to measure PER, and the PXA-1000 uses the distributed polarization information to integrate a certain PM section and provide the PER of that section only.

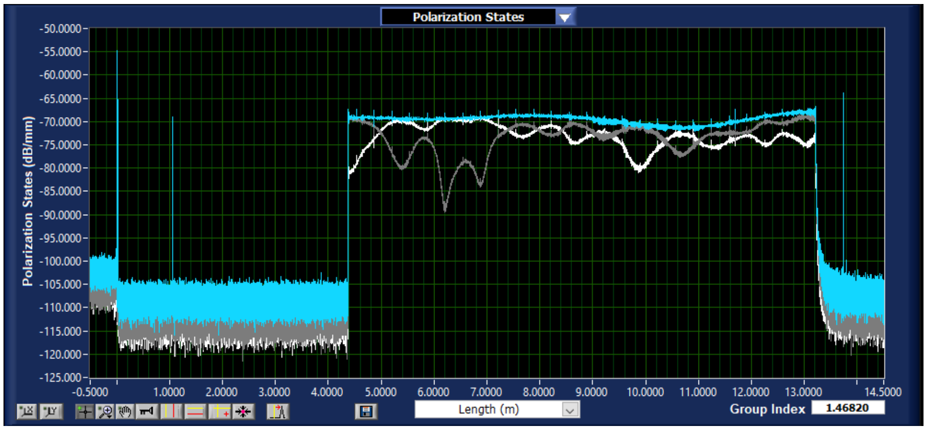
How do you integrate the instruments into an automated test system?

All of the Luna instruments support remote control functionality, although the specifics depend on the unit. So for example if you want to use a polarimeter or reflectormeter to test a series of components over a wide temperature range, you could control an optical switch, temperature chamber and the instrument from a controlling computer. In this scenario you might write code to set the chamber temperature, select a port on the switch, then instruct the Luna instrument to initiate a measurement and save the result, then repeat.

Can you describe how you measure beat length of a chirped fiber?

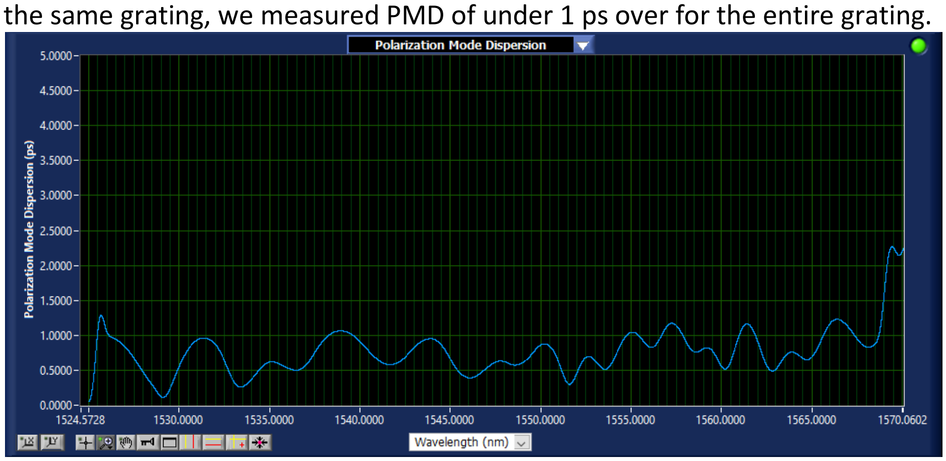
Beat length in a fiber is inversely proportional to the differential group delay; it is the length the light must propagate to generate a full wavelength of optical path length difference (or a two pi phase difference) between light propagating in the fast and slow modes in the fiber.

In the demonstration, we showed the response of a chirped FBG for both the OBR 4600 and OVA 5000. For the OBR, we could look at the S and P orthogonal detector response over the length of the grating and measure the beat length as described in the response to Question 5. Here is a plot of the data:



The period of the oscillations of the white and grey traces varies over the length of the grating, from roughly 1.5 to 1 m; so the Beat Length is varies roughly 3 to 2 m. This is likely a consequence of the fiber the FBG is in being coiled up in the module it is housed in.

The OVA 5000 primarily makes measurements in the spectral domain, and measures PMD, not beat length. For the same grating, we measured PMD of under 1 ps over for the entire grating.



Do you have any examples of large core area, photonic crystal (holey fiber) measurements on OVA or OBR?

We have consulted with customers on such measurements, but we don't have data that we can share publicly. We can make a few general comments though. Please feel free to contact us to discuss this in more detail.

Often times when connecting to PCF fiber, or between fibers with a large index of refraction difference, we see a strong Fresnel reflection, and we can also see a strong reflection from the end face of the test fiber. Because the OBR 4600 has a RL dynamic range limit of 80 dB, we generally want to keep the interface and termination reflections below roughly -40 dB in order to see the test fiber Rayleigh scatter. Of course, hollow core fibers don't strictly have Rayleigh scatter from light propagating in the core, although we may see other types of backscatter, for example from surface roughness of the core and air hole boundaries.

If we can see the fiber backscatter level, we can use the backscatter signature to look for distributed loss, or spectrally dependent loss. Although the 4600 doesn't make a full polarization state measurement you often can observe polarization state evolution corresponding to local birefringence. Also, the instrument can make a Group Delay measurement from a Fresnel reflection even, for example from a connector or interface at the far side of the test fiber, in order to get dispersion measurements from short lengths of test fiber.