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Coherent Optical Comb Characterization

The ultra-low noise and GHz repetition rate of the MENHIR-1550 Optical Frequency Comb (OFC) series are important features for many applications such as high-speed telecommunication or photonics analog to digital convertor. However, standard grating-based Optical Spectrum Analyzers with spectral resolution down to 10 pm, cannot resolve individual comb lines.

The APEX Technologies High-Resolution Optical Spectrum Analyzer (OSA) and Optical Complex Spectrum Analyzer (OCSA) are perfect tools to verify and evaluate some important specifications of OFC sources. This equipment is based on an interferometric method and is able to measure spectrums with the highest resolution in the market (5 MHz/40 fm), and high wavelength accuracy (± 1 pm) for any wavelength from 700 nm to 1700 nm. The added benefit of this analyzer is measuring the optical phase as a function of frequency. The phase and intensity information can then be used to calculate the chirp, α-parameter or pulse shape, as a function of time.

We describe here the characterization of the MENHIR-1550 laser with 400 MHz comb line spacing using the OCSA-AP6 from APEX Technologies.

Menhir Photonics' product strengths

Excellent passive comb-line stability

Compact all-in-one design

400 MHz to 10 GHz spacing

APEX Technologies product strengths

Highest spectral resolution in the market

No baud-rate limitation

No modulation-format limitation

Apparatus involved

Figure 1 — (Left) MENHIR-1550 Optical Frequency Comb with 400 MHz comb-line spacing. (Right) APEX Technologies High resolution Optical Complex Spectrum Analyzer for the C+L band (model OCSA-AP6-6). The APEX Technologies OCSA-AP6 measures the Intensity, phase and pulse width of the MENHIR-1550 comb laser.

High-resolution optical spectral measurement

Thanks to the state-of-the-art technology used in APEX devices, the equipment can measure not only the OFC envelope, but also each comb line. The OCSA can resolve the perfect sech^2 spectrum-shape of the OFC and confirms that frequency spacing between the comb lines corresponds to 400 MHz.

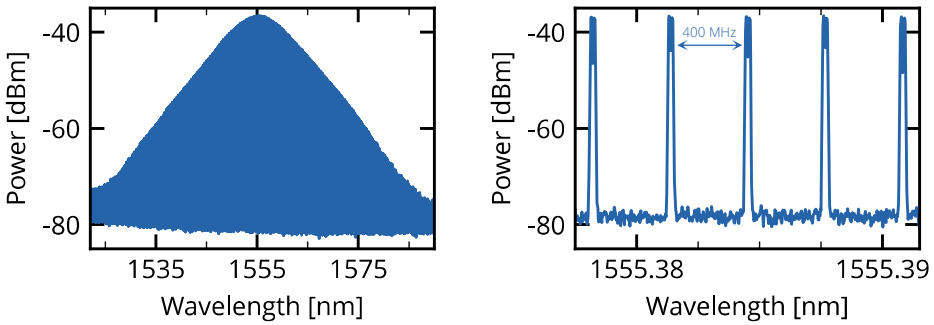

Figure 2 — (Left) Sech^2 envelope spectrum measurement of the MENHIR-1550 OFC. (Right) The OCSA-AP6-6 can resolve comb-lines up to a resolution of 40 fm (250 fm used in this graph). The heterodyne principle used for spectrum characterization induce a particular M-shape, which is not physically present in the MENHIR-1550 comb spectrum. The heterodyne signal is detected with balanced photodiode to suppress the DC noise.

Relative spectral phase and pulse width and measurement

The principle of OCSA is to measure the complex amplitude of each mode, through power and phase values in spectral domain. In addition to the spectral phase characterization, this enables the calculation of the pulse width in the time domain by Fast Fourier Transform (FFT).

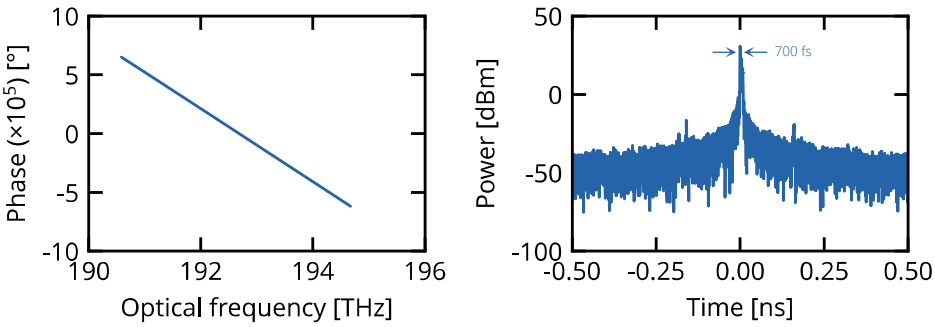

Figure 3 — (Left) The relative phase of the MENHIR-1550 comb is clearly linear. This display mode was selected to emphasize the phase linearity. Another display mode can show the phase on a scale [-180°, +180°]. (Right) Calculated time domain profile. The pulse width is 700 fs, which corresponds to the expected value by the manufacturer (200 fs pulses stretched to 700 fs by the propagation in the fiber).

Related product

MENHIR-1550 at 400 MHz		APEX OCSA-AP6	
Repetition rate	400 MHz	Resolution	5 MHz
Average power	> 50 mW	Dynamic range	>75 dB
Central wavelength	1555 +/- 10 nm	Band cover	<T, T, O, E, S, C, L & U bands
Spectral bandwidth at -3 dB	> 10 nm	Wavelength Rep.	< 0.5 pm

Contact & Info

For further information, please contact Menhir Photonics at contact@menhir-photonics.com or APEX Technologies at sales@apex-t.com. Find more videos and tutorial on these experiments in our Youtube pages (Menhir Photonics AG or APEX Technologies).