OptiSystem

Optical Communication System
and Amplifier Design Suite

13

New Features

Created to address the needs of research scientists, photonic engineers, professors and students; OptiSystem satisfies the demand of users who are searching for a powerful yet easy to use photonics system design tool.

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Key Features for OptiSystem 13

OptiSystem 13 includes many important enhancements including several additions to the tool kit for building higher order modulation and Nyquist-based transmission system designs, new components and models for analyzing the impairments/limitations associated with high speed transmitter and receiver design, improved tools for multimode system characterization, and multi-threading for parameter sweeps. Key new features include:

- The introduction of a new ***Universal DSP*** component with a complete suite of DSP algorithms (including a new nonlinear compensation model) for analyzing a multitude of modulation formats (including BPSK, QPSK, 8PSK, 16PSK, 16QAM and 64QAM).
- Updates to our existing ***Decision*** component (to support BPSK, QPSK, 8PSK, 16PSK, 16QAM and 64QAM) and the introduction of a new ***PAM Decision*** component for the analysis of m-PAM systems.
- Updates to the *Optical Sources Library* including important improvements to our ***DFB*** and ***FP Lasers*** (including the introduction of our new **Transmission Line Laser Model**!), a new ***Empirical Laser Measured*** component (which will allow designers to more closely match their OptiSystem simulations with manufacturer and lab measurement data of semiconductor lasers), and a new dedicated optical source component for setting up accurate OSNR sweeps (***Set OSNR*** component).
- The introduction of ***Analog to Digital*** and ***Digital to Analog*** converters to allow for the more realistic simulation of laser/modulator drivers and the characterization of impairments such as quantization errors.
- The introduction of a ***90 Deg Optical Hybrid*** component for the design and analysis of coherent homodyne receiver systems
- Updates to our ***PIN*** and ***TIA*** components, as to more effectively match these component models to the current state of the art high modulation photodetectors (>25 Gb/s).
- Updates to our *Optical* and *Electrical Filter Libraries* to better align our models with the latest developments in Nyquist-based transmission system design and analysis.
- The introduction of *Multi-threading support for parameter sweeps* to greatly accelerate calculation times when performing multiple iteration analysis of OptiSystem projects on multi-core CPU platforms.
- The introduction of a new ***Lightwave Analyzer*** visualizer that can be used for measuring the responsivity and frequency response of a multitude of devices under test (DUT) including PINs, TIAs, lasers, optical modulators, etc.!

New library components and enhancements

<u>Transmitters/Optical</u>: DFB Laser, Fabry-Perot Laser, Empirical Laser Measured, Set OSNR

The new ***DFB Laser*** model (derived from the former ***Laser Rate Equations*** component – now called the ***Ideal Single Mode Laser***) includes a more advanced set of tools to characterize the dynamics of a distributed feedback (DFB) cavity design and includes the following new features:

- An updated spatially averaged multimode model which uses couple mode theory to more accurately calculate the longitudinal modes present in the DFB cavity
- The introduction of Optiwave's new Transmission Line Laser Model (TLLM), which discretizes the laser rate equations in both time and longitude, thus allowing for the analysis of non-linear and fast transient events (including spatial hole burning and two-photon absorption)
- Support for external optical signal injection into the laser cavity
- A new parameters tab for DFB grating properties (grating index difference, grating order, grating period, etc.)

The new ***Empirical Laser Measured*** component will allow designers to more closely match their OptiSystem simulations with manufacturer and lab measurement data of semiconductor lasers. Its features include:

- The calculation of LI curves based on temperature and input current by using measured LI curves (polynomial fitting) or manufacturer supplied operational data (threshold current, slope efficiency, slope efficiency variation with temperature, etc.)
- The ability to model laser dynamics through a flexible transfer function feature which employs an analytical frequency domain model that can be based on direct parameter input (resonance frequency, damping factor, circuit parasitics), D and K factor values, or imported S21 transmission data

The ***Fabry Perot Laser*** component has been updated and now includes an improved spatially averaged multimode model using Optiwave's new Transmission Line Laser Model (TLLM) model for the analysis of non-linear and fast transient events.

The new ***Set OSNR*** component, now a dedicated standalone compound component, can be used to accurately set the OSNR level of an optical signal thus allowing for a rapid means to perform BER analysis versus OSNR in transmission system analysis.

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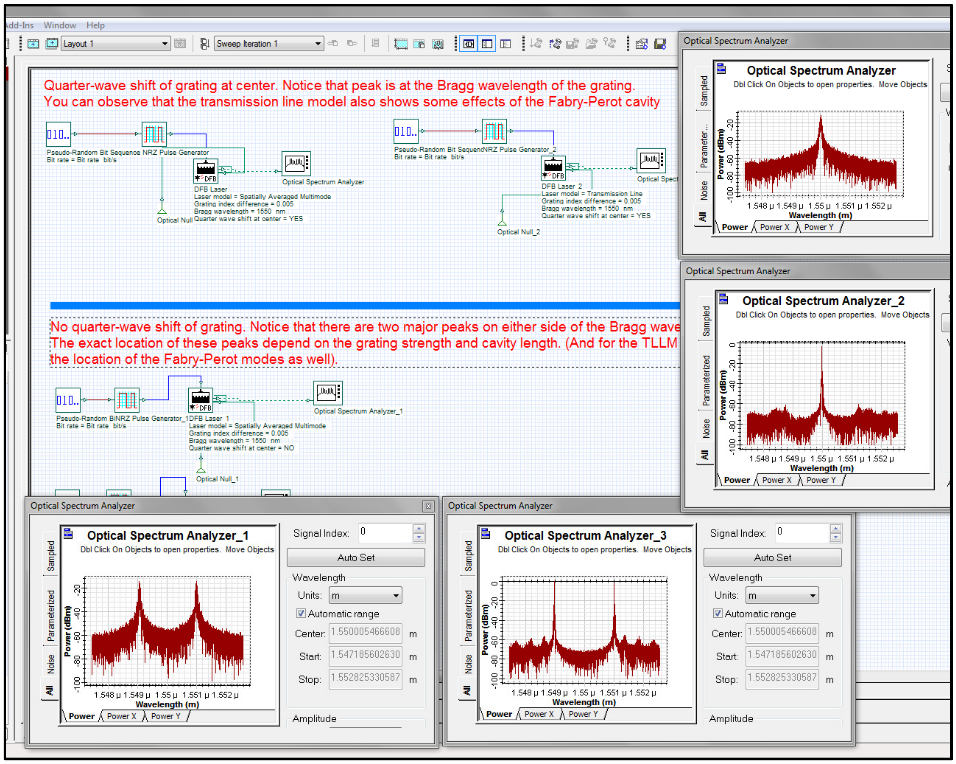

Fig 1: ***DFB laser model*** *– Sample results for DFB laser model (including the effect of quarter wave shifting and analysis using TLLM*

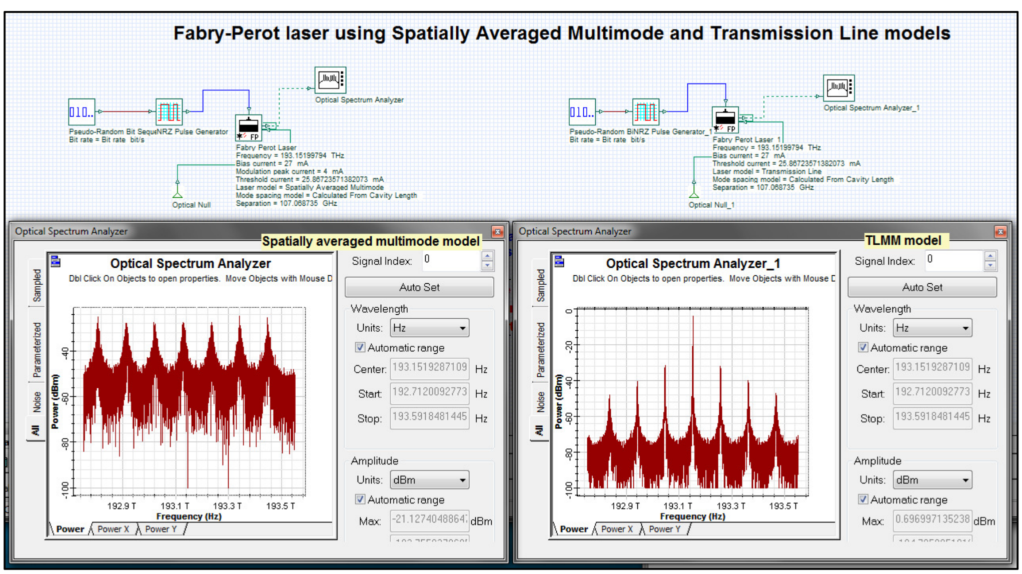

Fig 2: ***Fabry Perot laser model*** *– Sample results for the Fabry Perot laser model (for the TLMM, due to the bandwidth of the gain, the slightly larger gain at the central frequency will amplify its power much more than the others as the wave travels back and forth through the cavity)*

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<u>High performance transmitter and receiver sub-system design and analysis</u>: Universal DSP, PAM Decision, DAC, ADC, 90 deg optical hybrid, DSP for QAM update, DSP for PSK update, PIN update, TIA update

Several new component and model updates have been introduced to assist designers with the design and analysis of high performance transmitter and receiver sub-system design in optical links. These include:

- Updates to the ***DSP for 16QAM*** and ***DSP for PSK*** components, including support for BPSK/QPSK/8PSK/16PSK and 16QAM/64QAM designs. Also, support for nonlinear compensation has been added (based on the digital back propagation method).
- The introduction of our new ***Universal DSP*** component which will allow our users to configure and analyze all available higher order modulation DSP schemes within one component.
- Improvements to our existing ***Decision*** component (now supporting BPSK, QPSK, 8PSK, 16PSK, 16QAM and 64QAM) and the introduction of an ***PAM Decision*** component for the analysis of m-PAM systems (including normalization, Error Vector Magnitude (EVM) and Symbol Error Rate (SER) calculations, and automated decision and optimization to account for constellation rotation and timing misalignment)
- The introduction of ***Analog to Digital*** and ***Digital to Analog*** converters to allow for the more realistic simulation of laser/modulator drivers and the characterization of impairments such as quantization errors (of growing importance to high speed modulation systems).
- The introduction of a ***90 Deg Optical Hybrid*** component for the design and analysis of coherent homodyne receiver systems
- Updates to our ***PIN photodiode*** component including a new integrated RC-based or user-defined frequency transfer function model and new results for noise impairment analysis including calculations for average shot noise and thermal noise currents, noise equivalent power (NEP), carrier transit time estimation and 3-dB modulation bandwidth.
- Updates to our transimpedance amplifier (***TIA***) model including a first order frequency-dependent shunt feedback transimpedance gain model, user-defined signal bandwidth settings, and calculations for determining the input referred noise current.

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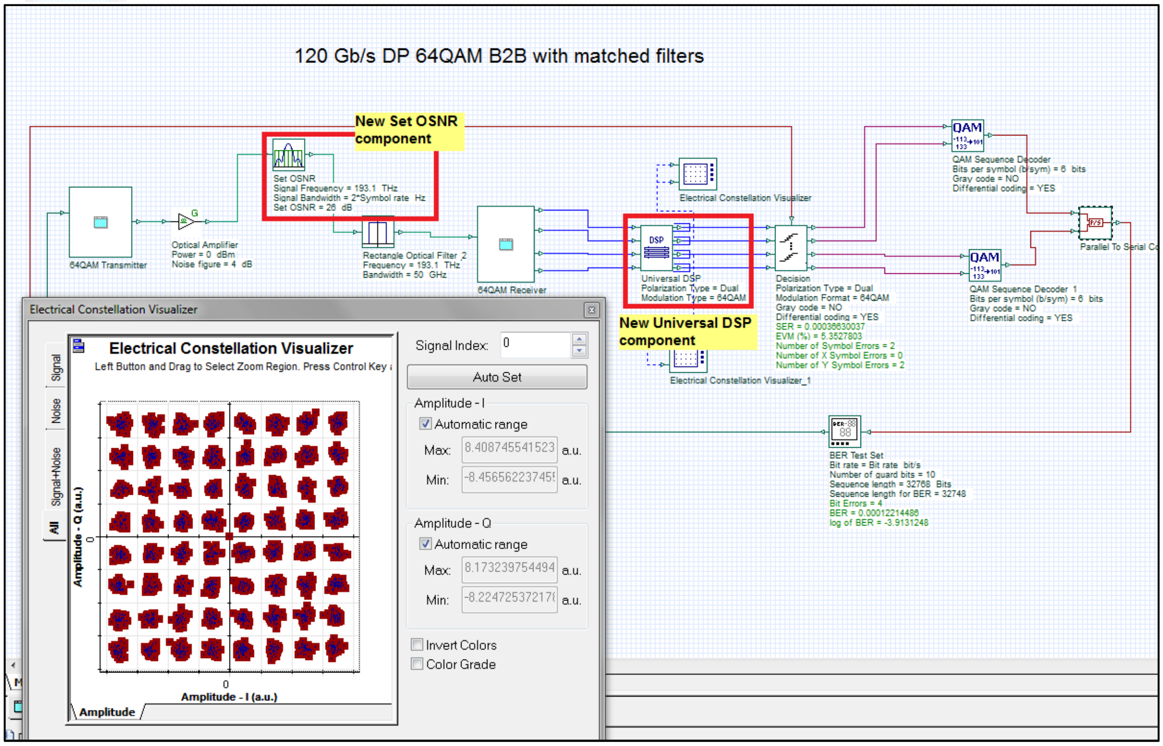

Fig 3: 120 Gb/s 64-QAM design analysis using new Universal DSP and updated Decision components.

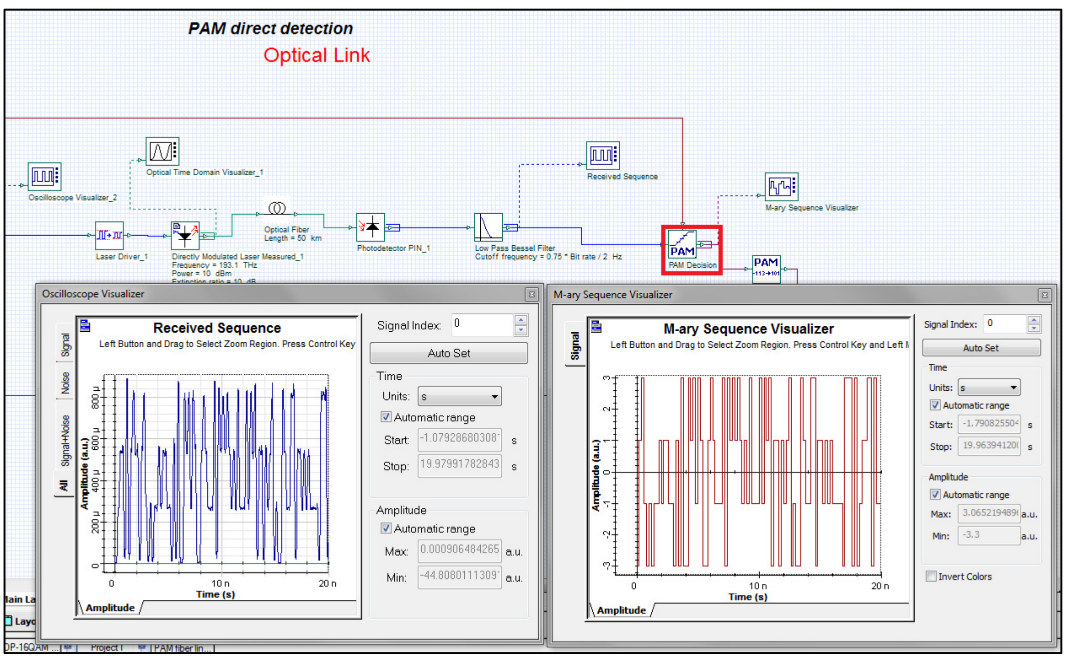

***Fig 4: New PAM Decision component** – The new PAM Decision component allows for the analysis of any m-PAM system and includes features such as normalization, Error Vector Magnitude (EVM) and Symbol Error Rate (SER) calculations, and automated decision and optimization to account for constellation rotation and timing misalignment.*

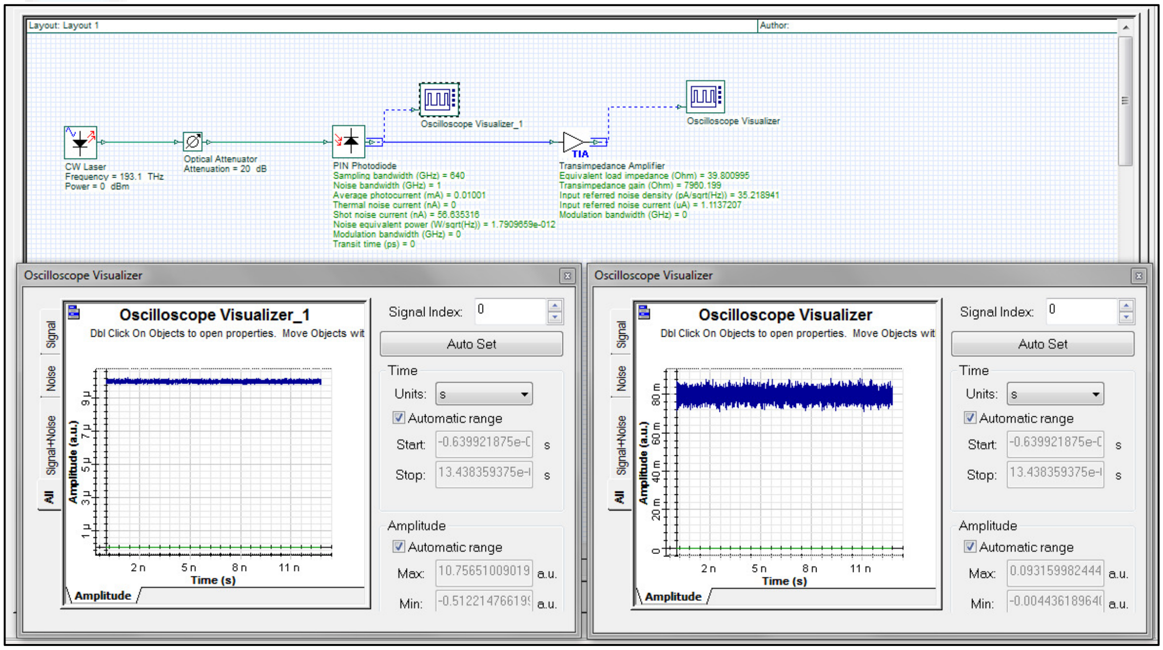

Fig 5: Updates to the PIN and TIA components *– Several improvements have been added to our PIN and TIA components, as to more effectively match these component models to the current state of the art high modulation photodetectors (>25 Gb/s). These updates include new integrated transfer function models (RC for PIN, first order shunt feedback trans-impedance gain model for the TIA), more detailed noise models, and new results for PIN and TIA noise sources including NEP and input referred noise current.*

<u>Nyquist transmission</u>: Updates to the Electrical and Optical filter library models

Several updates have been implemented to enhance analysis capabilities for Nyquist-based transmission systems. These updates include:

- The addition of new electrical filters including ***Low Pass Inverse Gaussian***, ***Low Pass Inverse Sinc***, ***Band-Pass Inverse Gaussian*** and ***Band-Pass Inverse Sinc*** filter components
- The addition of new optical filters including ***Inverse Gaussian***, ***Inverse Sinc*** and ***Raised Cosine/Root Raised Cosine*** filter components.
- Improvements to the ***Low Pass***/***Band-Pass Raised Cosine Electrical*** and ***Raised Cosine Pulse Generators***, including a Root Raised Cosine transfer function for matched filtering.

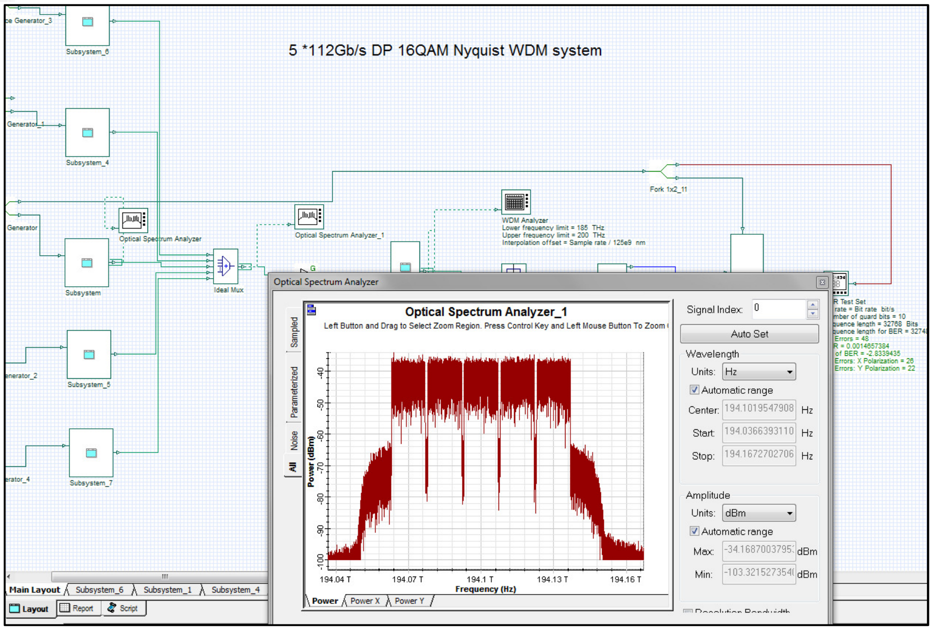

Fig 6: 5 x 112 Gb/s WDM Nyquist transmission system *– This example demonstrates the use of the Raised Cosine Pulse Generator for the creation of Nyquist-based channels in a WDM configuration (5 x 112 Gb/s DP-16QAM channels).*

<u>Multimode fiber analysis</u>: Updates to the Measured Index Multimode fiber, Encircled Flux Analyzer and Spatial Visualizer

The ***Measured-Index Multimode fiber*** has been updated to include the modeling of intra-mode coupling effects and the ability to calculate the dopant concentration profile for a refractive index profile with defined material properties.

Also, the ***Encircled Flux Analyzer*** and ***Spatial Visualizer*** can now be used to see the effects of the coherent summation of modes!

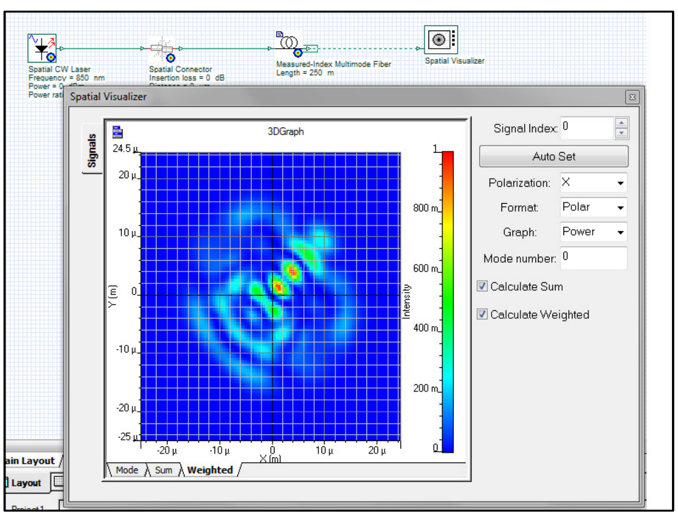

Fig 7: Multimode fiber and visualizer updates *– Example visualization of the coherent summation of modes at the output of the Measured Index Multimode fiber.*

Visualizers: Lightwave Analyzer

Optiwave is pleased to announce the introduction of our new ***Lightwave Analyzer (LWA)*** component. Based (in concept) on the Agilent Lightwave Component Analyzer, the LWA can be used to measure the responsivity and frequency response of a multitude of devices under test (DUT). Multiple configurations can be tested; including optical-optical, optical-electrical, electrical-optical, and electrical-electrical device layouts thus allowing for the rapid characterization of PIN, electrical/optical amplifiers, modulators, laser modules, filters, etc.!

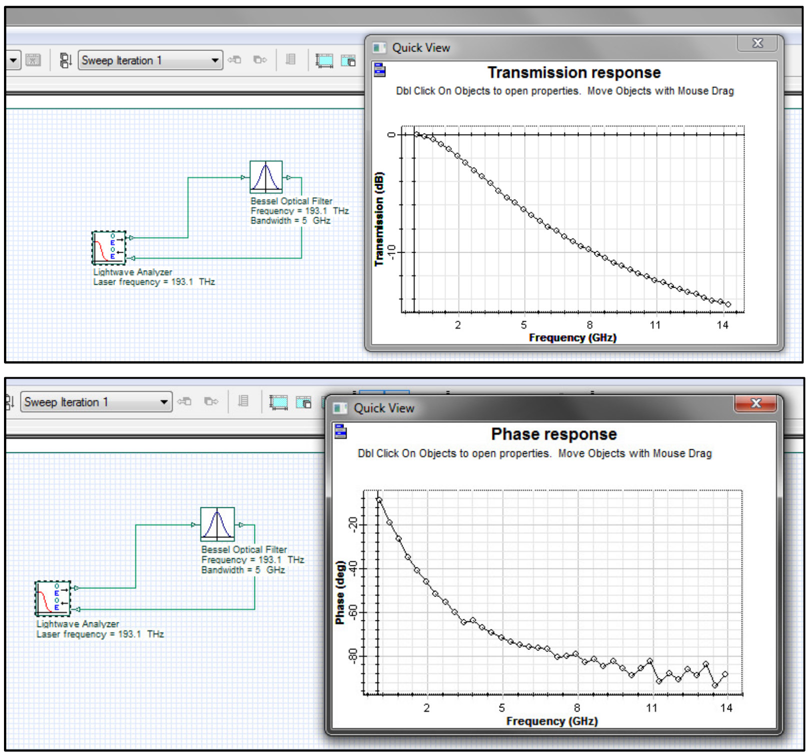

Fig 8: Lightwave Analyzer Test Set *– Allows designers to connect any devices to quickly assess/validate their transmission and responsivity characteristics*

OptiSystem performance and functionality

Multithreading for parameter sweeps

Multithreading is now available with parameter sweeping. When selected (see Fig 9), if multiple sweep iterations are setup for a design, the OptiSystem calculation scheduler will issue dedicated threads for each instance (parameter sweep) of an OptiSystem project. This will provide a significant improvement to the completion time of simulations (especially for designs which may have in excess of 100-200 sweep iterations).

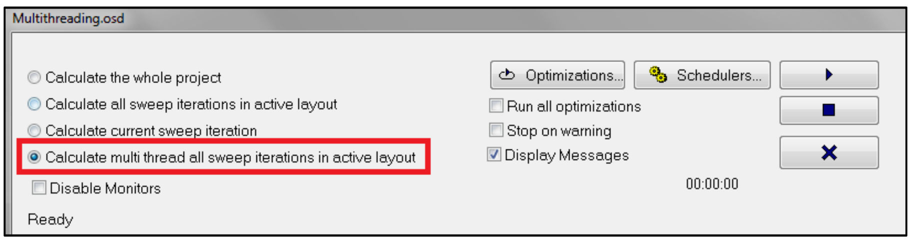

Fig 9: Multithreading for sweep iterations

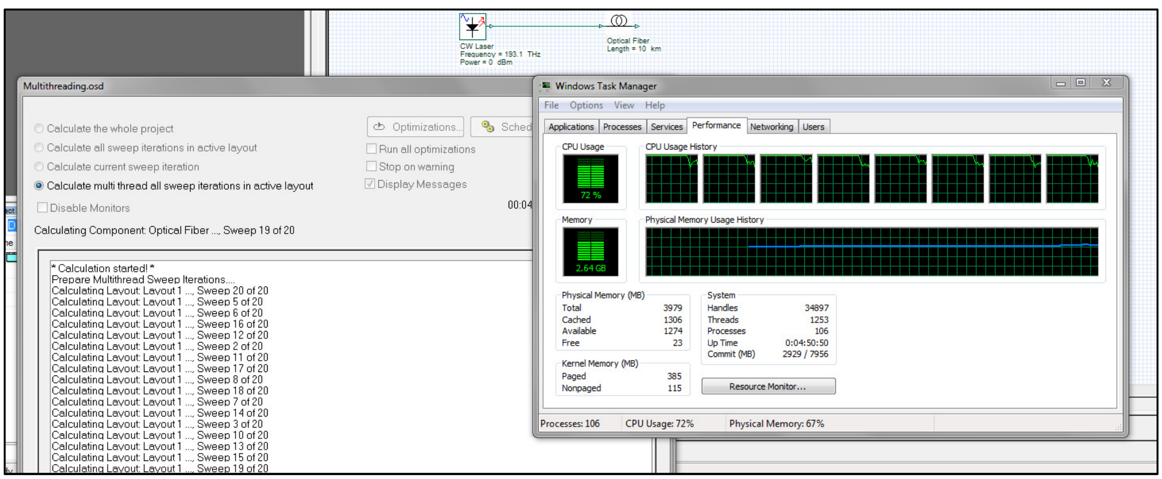

***Fig 10: Multithreading for sweep iterations** – Example of calculation scheduler report when multithreading for sweep iterations is selected.*

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