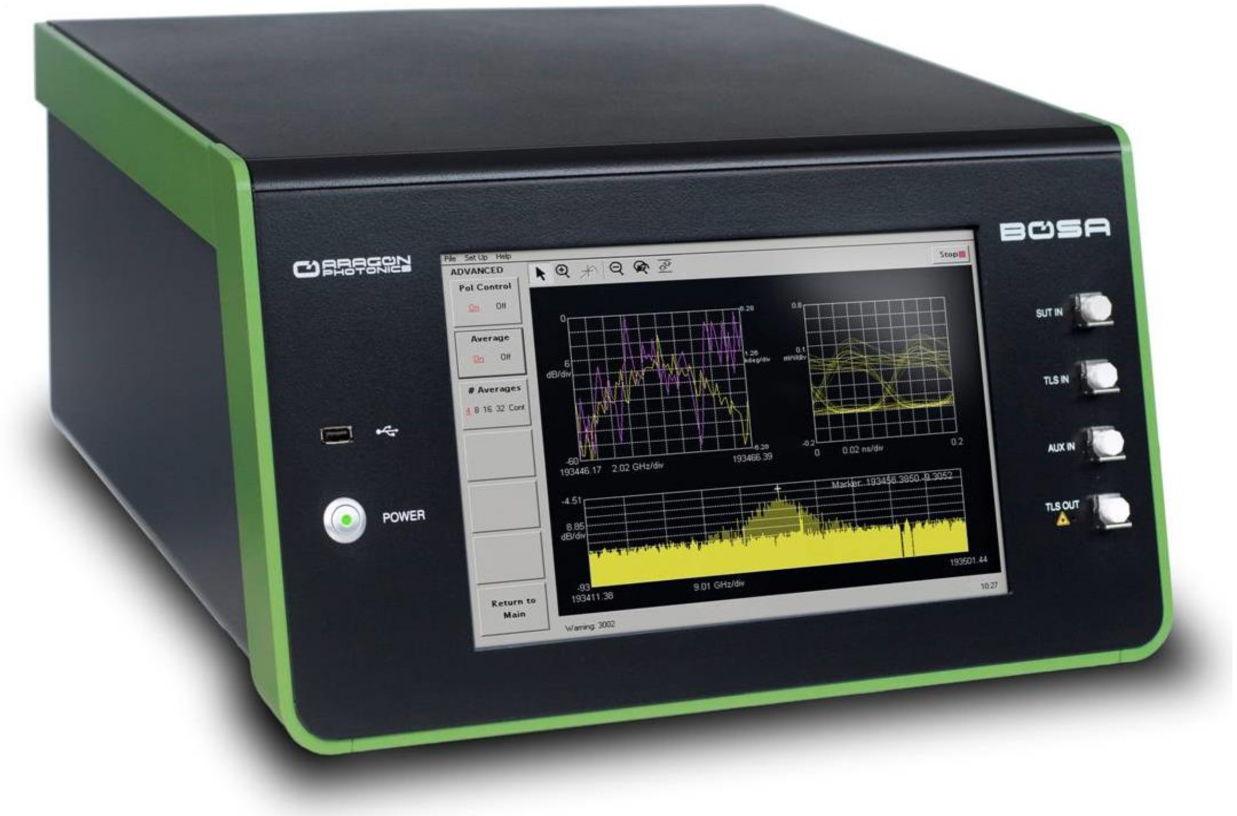
ARAGON PHOTONICS

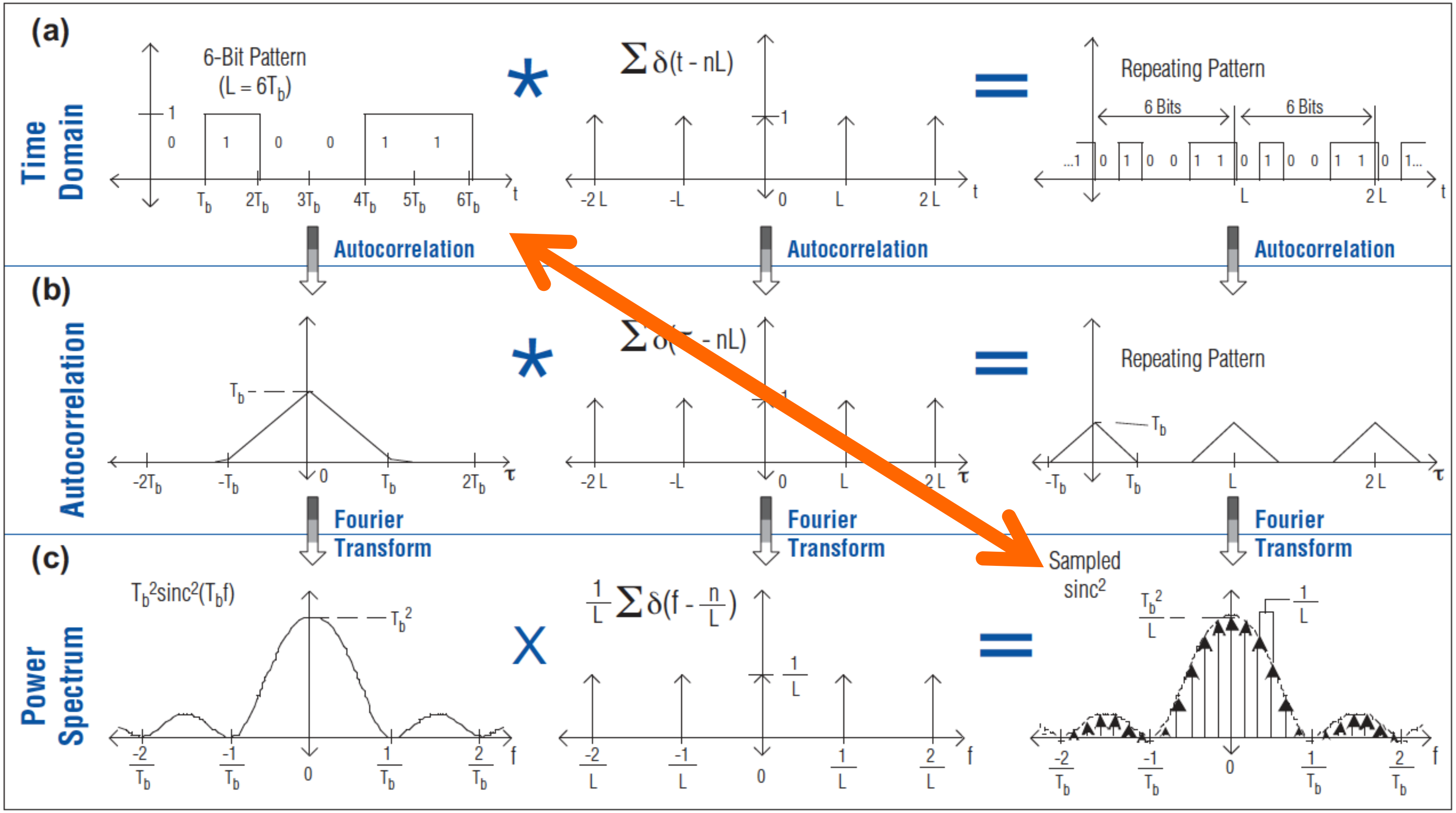


BOSA PHASE MEASUREMENT

Patterned signals & FFT

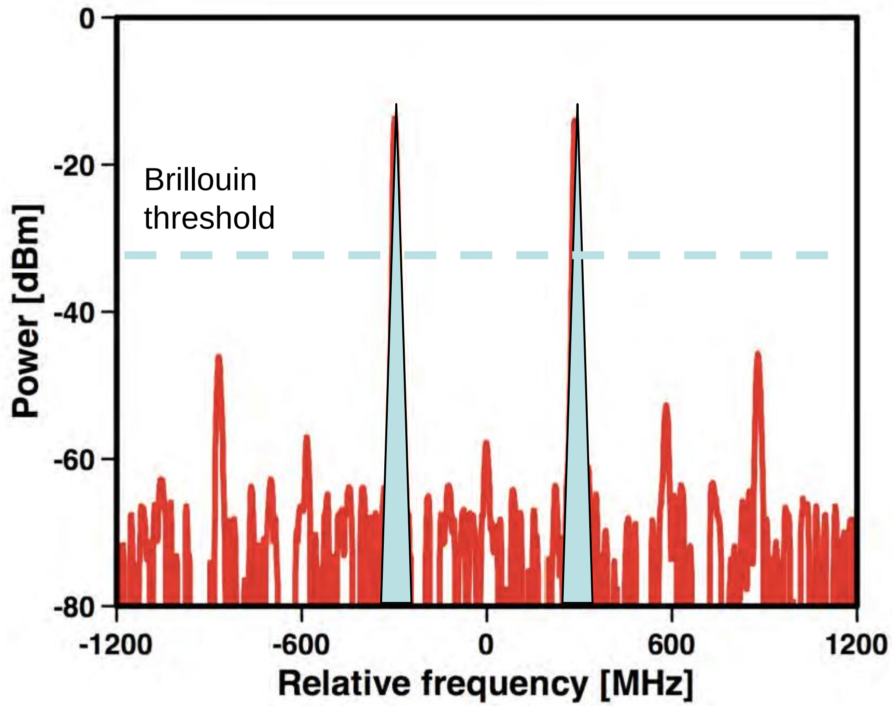
- A repetitive pattern produces a spectrum composed by spectral lines with a constant amplitude and phase = **complex spectrum**
- If we are able to measure the complex spectrum of a signal we have the equivalent to the FFT of the signal
- We can use inverse FFT to transform this signal to the time domain
  - We will recover amplitude and phase of the signal!

Patterned signals & FFT



Technology

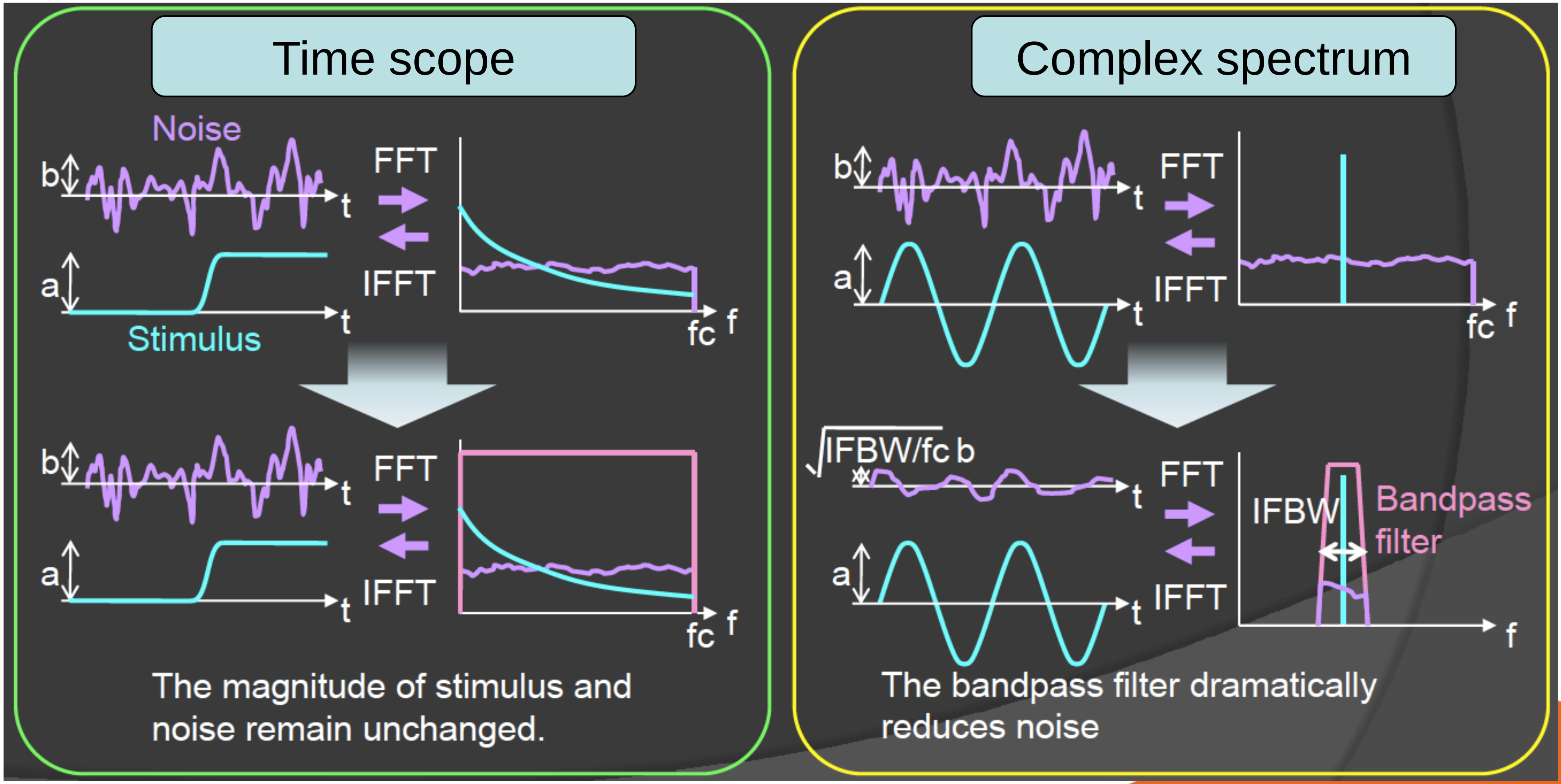
- In BOSA, SBS is pumped using a tunable laser source (TLS), creating a narrow-bandwidth filter that can be swept.
- To measure phase, the TLS light is split in two spectral lines by using carrier suppressed modulation.
  - Thanks to the Brillouin Threshold, only the first order sidebands produce SBS.
  - This creates a double filter that can select two spectral components at the same time
  - The detected signal will be a sine wave with a phase equal to the phase difference between spectral components



Complex analyzer vs Scope

Noise performance

- The measurement is always done with the same low bandwidth, so noise does not increase with signal bit rate!



BOSA Option 440

Specifications

	New BOSA 400 + 440
Bandwidth	80MHz to full span
Pattern frequency	**70MHz – 2GHz**
Phase accuracy	**±1 deg.**
Electrical reference input power	-15 to 0dBm
Sensitivity for phase measurement	-70dBm
Measurement time	**1sec for 10nm**

Target applications

- BOSA Phase is better to measure
  - **High bandwidth signals**, as there is no low pass filter due to the photodetector stage and the oscilloscope itself.
  - **Arbitrary waveforms**, thanks to the better S/N ratio and much better bit depth of the acquisition.
  - **Pattern-dependent jitter** (because random jitter is suppressed by the measurement)
  - Phase effects (chirp, SPM, XPM, dispersion)
- BOSA Phase cannot measure
  - Live traffic or high order PRBS as the do not produce a constant complex spectrum.
  - Random time-domain effects: jitter (but will be mixed with pattern-dependent jitter) and noise (which can be measured through OSNR).

BOSA Option 440
Software GUI

CHART B:
Complex spectrum
(amplitude and phase)

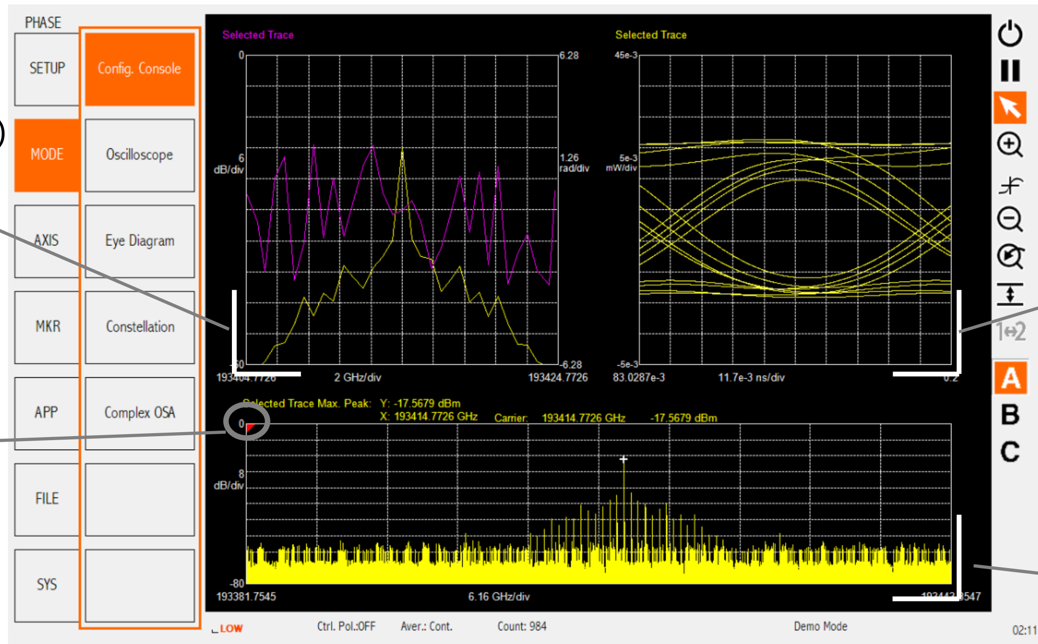
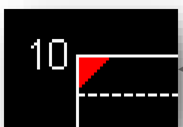


CHART C:
Analysis chart (TRC, TRP, I and Q eye diagram, constellation, amplitude and phase eye diagram)

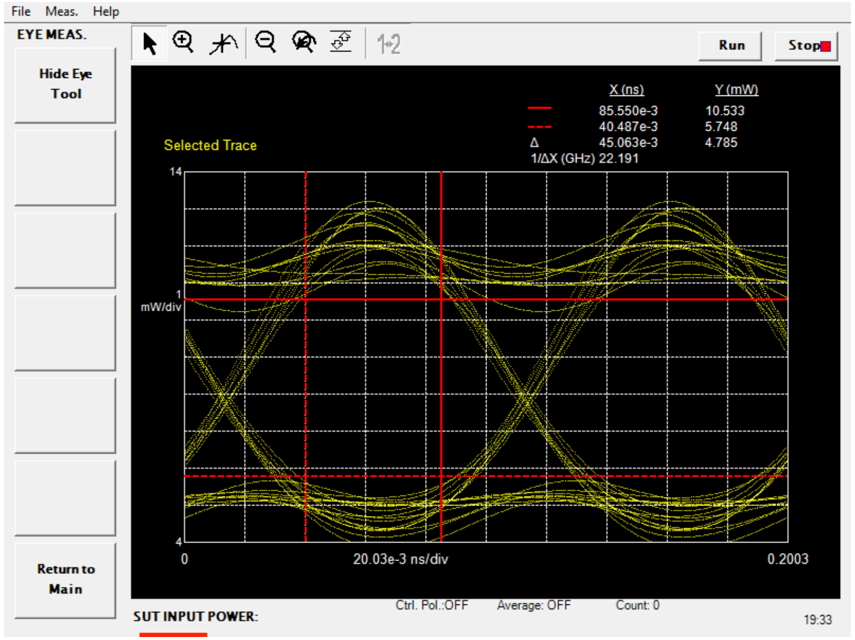


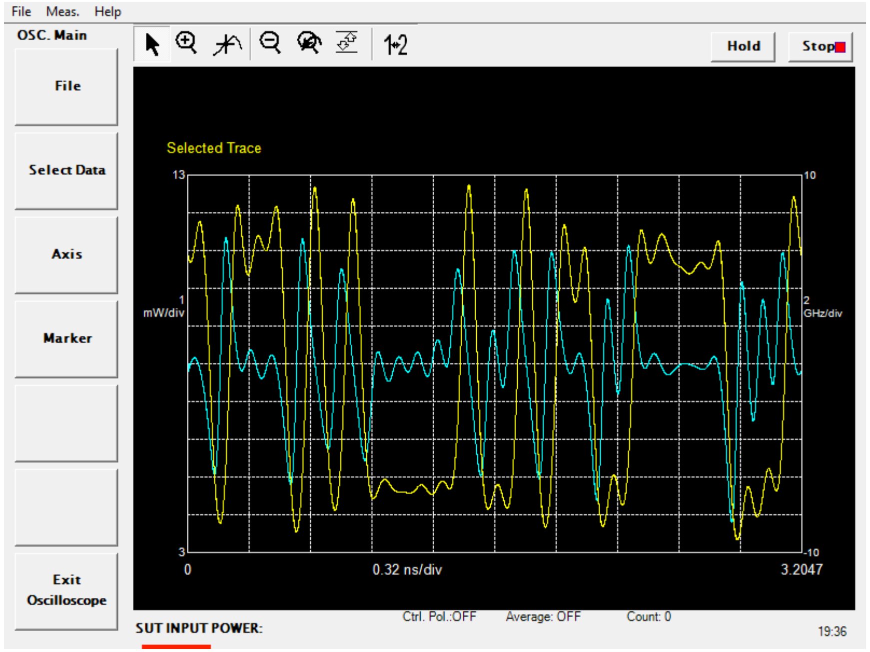
The red triangle indicates the active chart

CHART A:
High resolution optical amplitude spectrum

Example: ILM – 10 Gbps 2^5 bits NRZ pattern modulation – 312MHz pat. freq. Repetition

BOSA Option 440
Software GUI

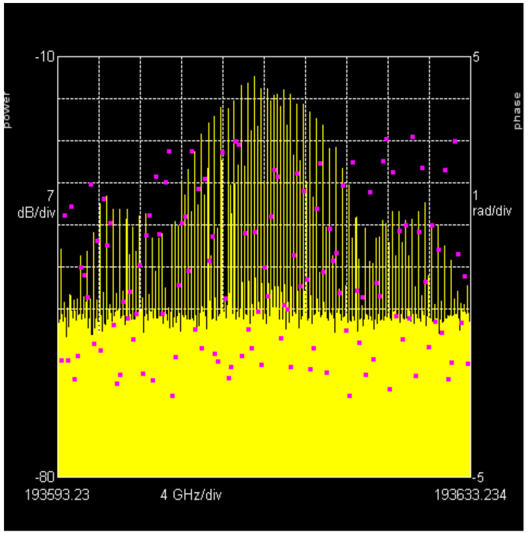


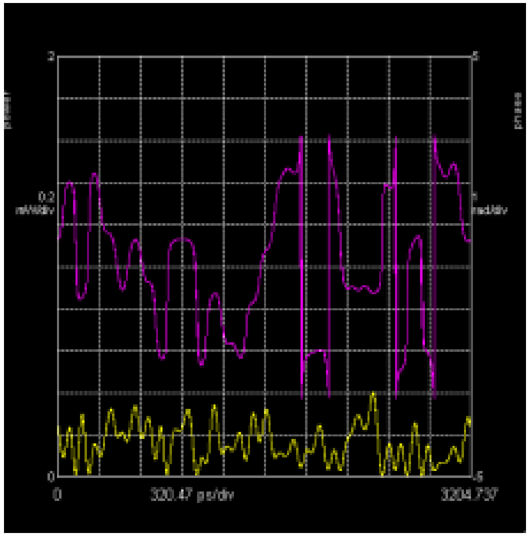


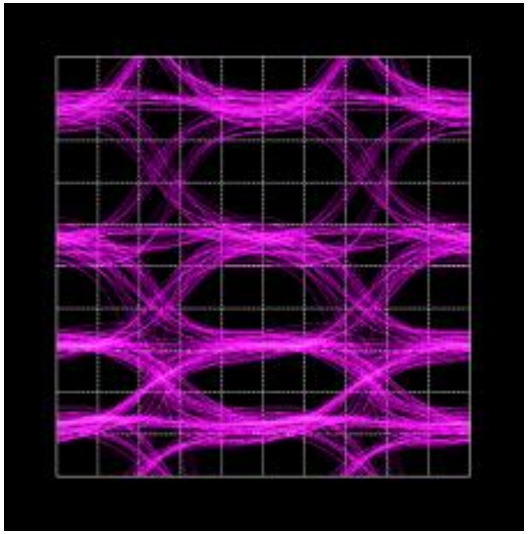
- Oscilloscope mode: amplitude, phase, time resolved chirp…
- Eye diagram mode: amplitude, phase, I or Q eye diagrams
- Constellation mode
- Complex OSA mode

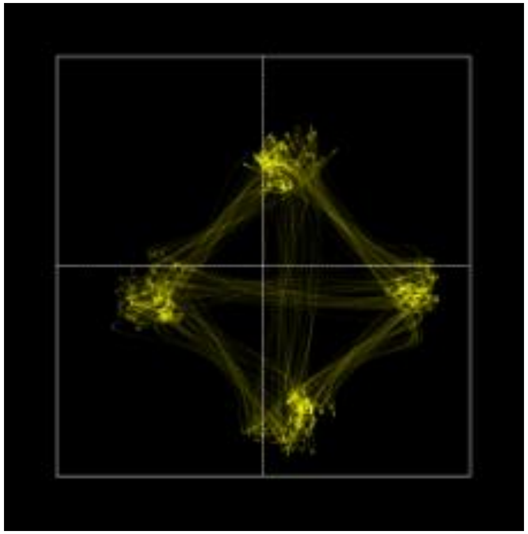
Measurement examples

20 Gb/s DQPSK







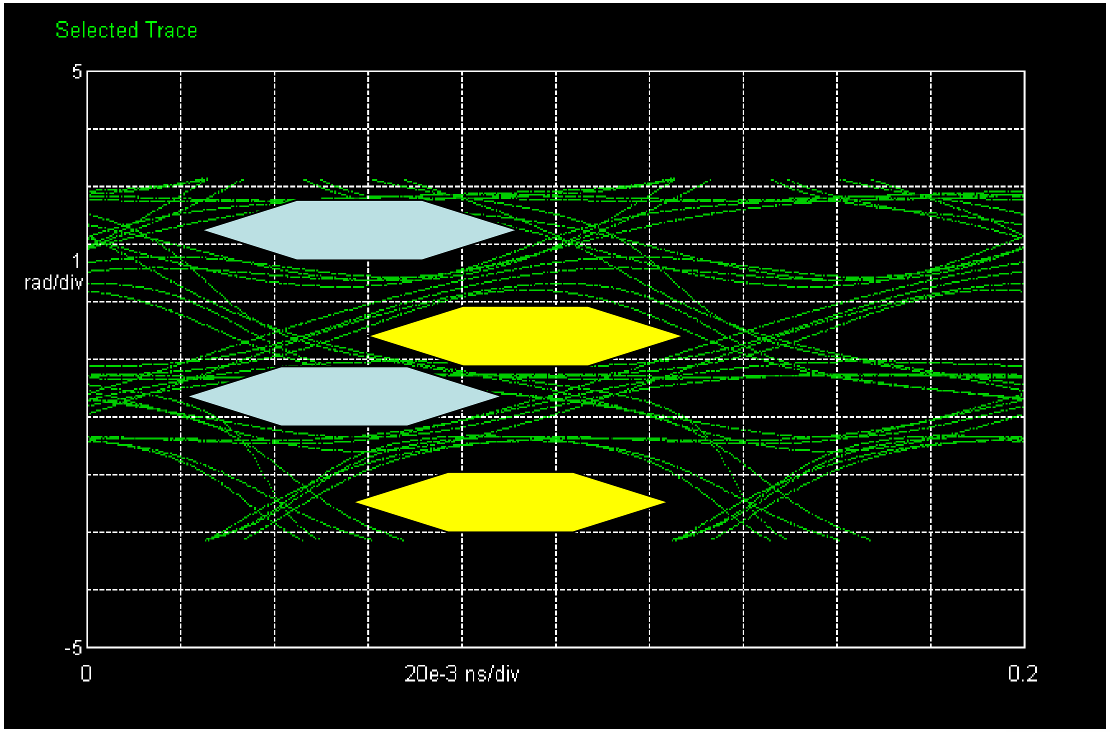


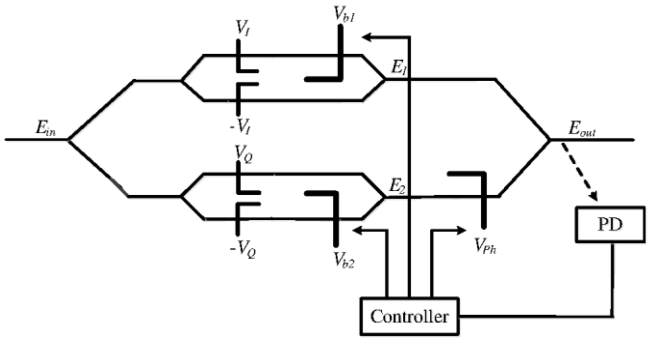
- The measurement of BOSA Opt. 440 gives you the complete or “analogic” complex field: amplitude and phase.
  - No need to demodulate.
  - Multilevel amplitude and phase diagram, great por QPSK and QAM.

Measurement examples

20 Gb/s DQPSK

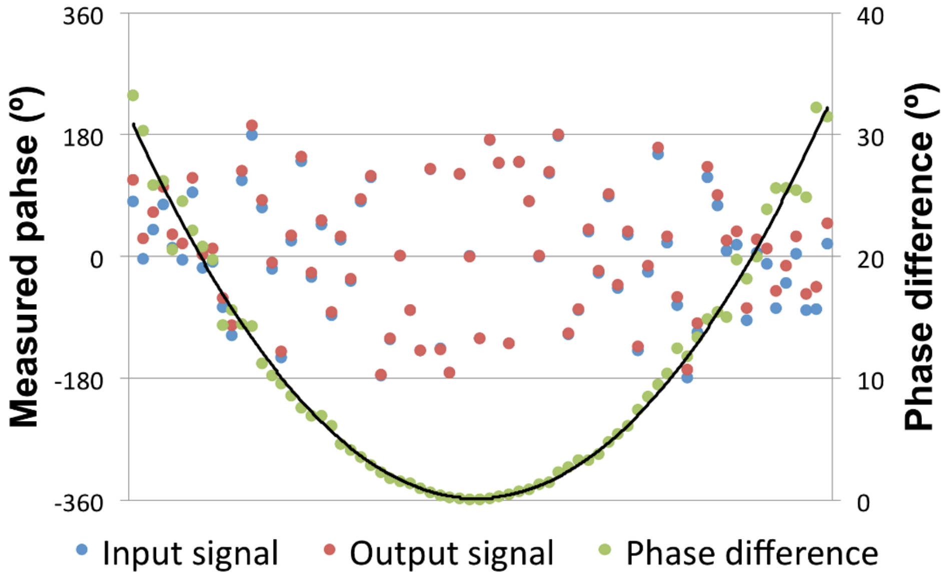
- Delay unbalance from the two branches of the QPSK modulator can be seen directly in the phase eye diagram
  - Perfect adjustment is easier than ever!





Complex transfer function

- Compare input and output complex spectra to get the **complex transfer function** of a device

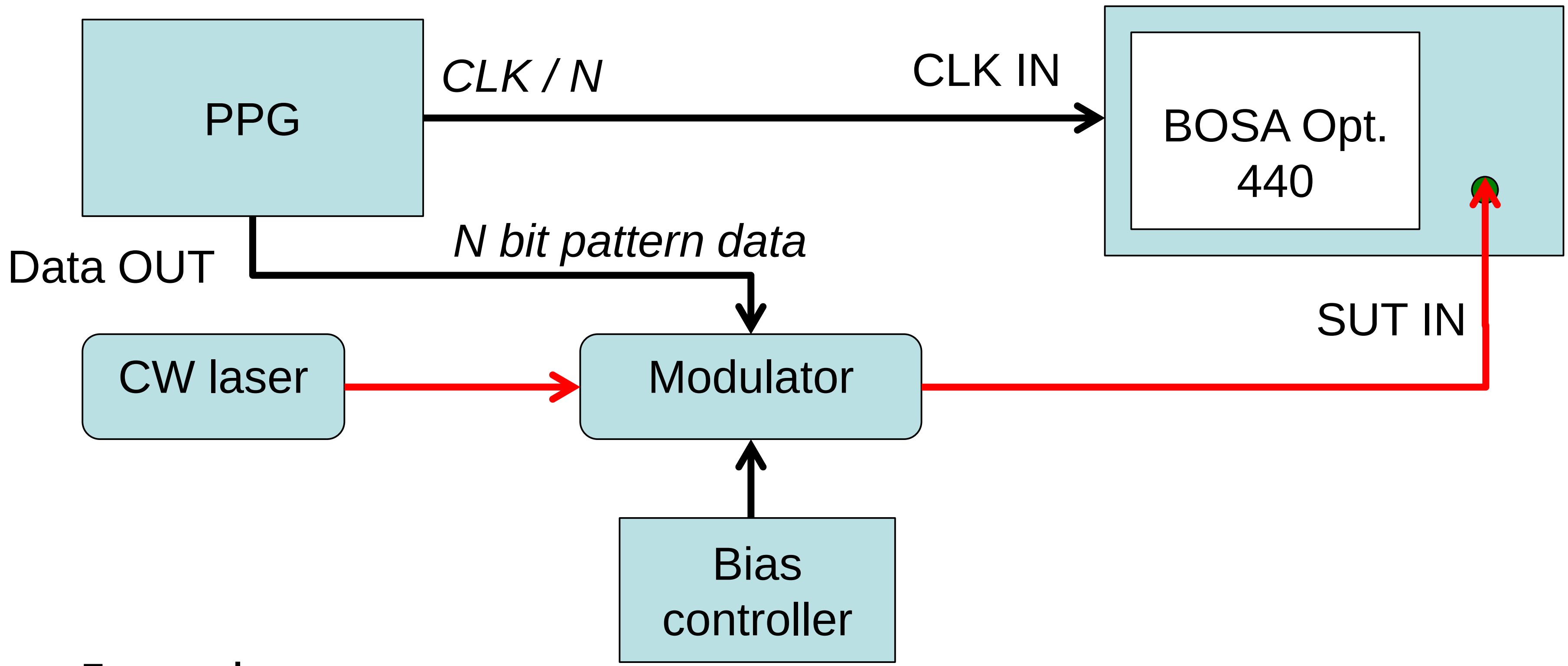


- Example: fiber CD appears as a phase parabola centered on the optical carrier

How to

MEASURE WITH BOSA OPT.440

External modulator



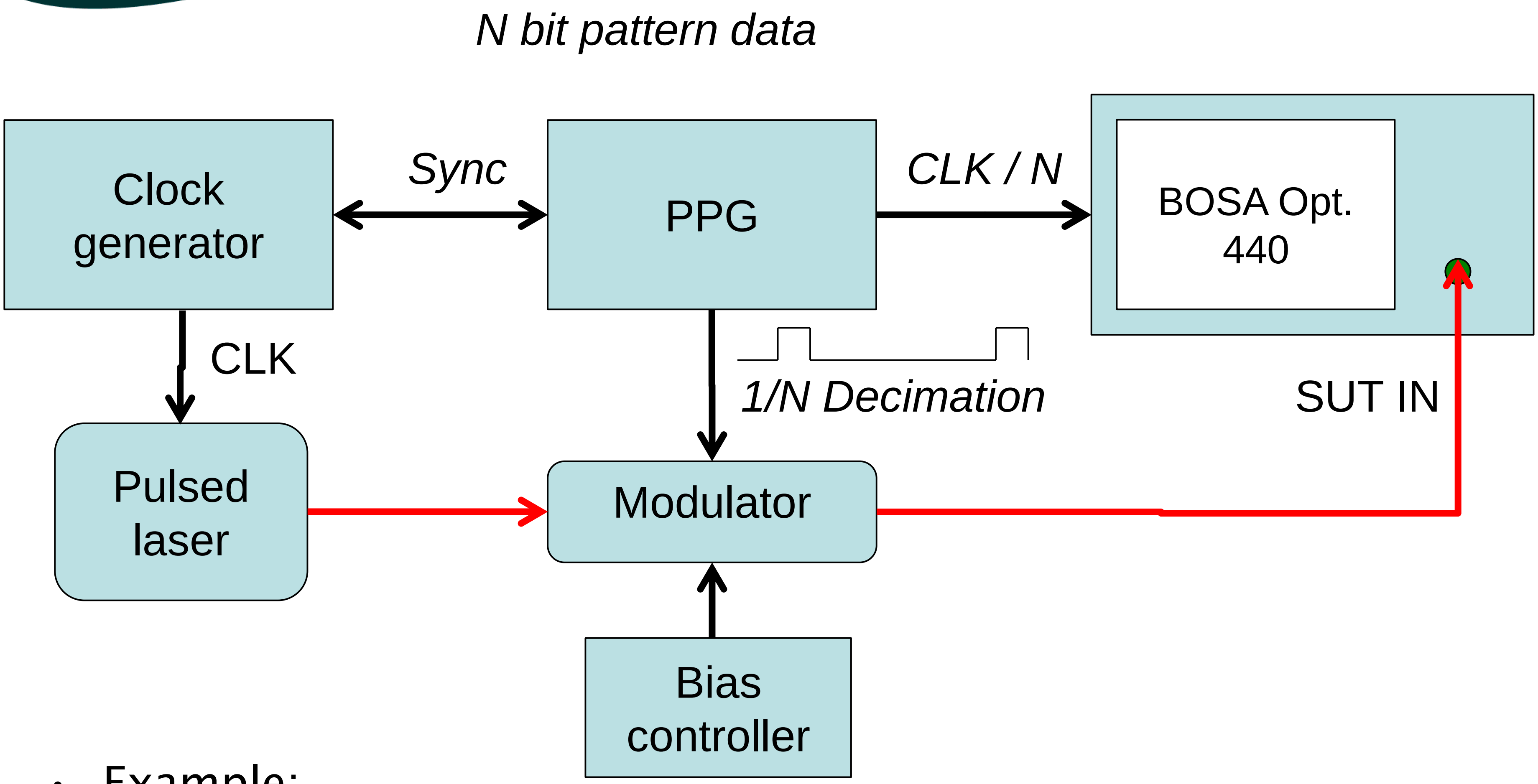
- Example:
  - Data rate = 25.6 Gbps
  - Pattern length =32 bits
  - Pattern clock = 25.6G/32 = 800 MHz

Measurement example

Pattern / rate / analysis frequency

Transmission rate R	2.5 Gb/s (±0.4)	10Gb/s (±1.6)	25 Gb/s (±4.0)	40 Gb/s (±6.4)	100 Gb/s (±15)
Nominal Pattern Length (for 1250 MHz)	2 bits	8 bits	20 bits	32 bits	80 bits
Nominal Pattern Length (for 800 MHz)	3 bits	12 bits	32 bits	50 bits	128 bits
Nominal Pattern Length (for 312 MHz)	8 bits	32 bits	80 bits	128 bits	320 bits
Nominal Pattern Length (for 156 MHz)	16 bits	64 bits	160 bits	256 bits	640 bits

Pulsed source



- Example:
  - Clock = 10 GHz
  - Decimation factor = 8
  - Analysis frequency = 10G/8 = 1.25GHz

Measurement example

Decimated pulsed source

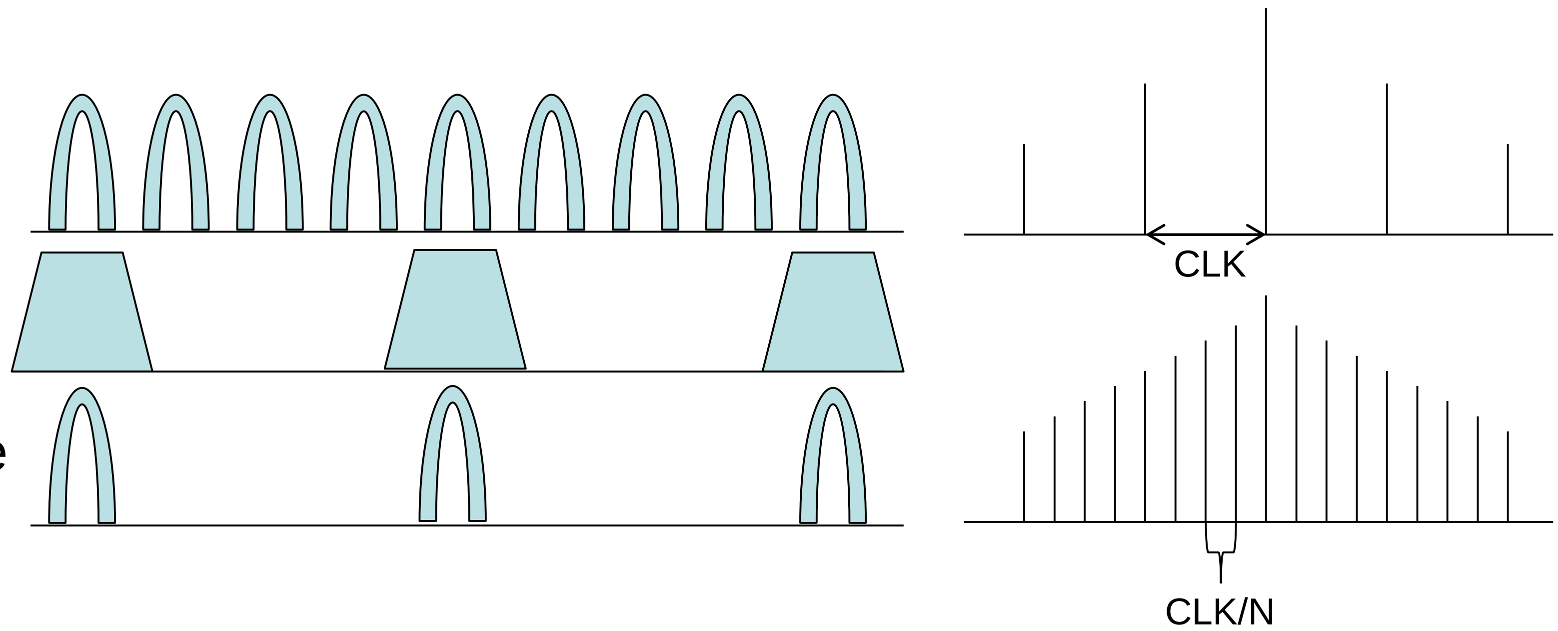
TIME DOMAIN

SPECTRUM

Original

Decimation

Measurable signal



- Example:
  - Clock = 5 GHz
  - Decimation factor = 4
  - Analysis frequency = 5G/4 = 1.25GHz

BOSA option 440 – Phase measurement

THANK YOU FOR YOUR TIME!