Demonstration of Coherent Detection of Ultra-Dense WDM (6.25 GHz spacing) 2-PSK 2.5 Gbit/s signals

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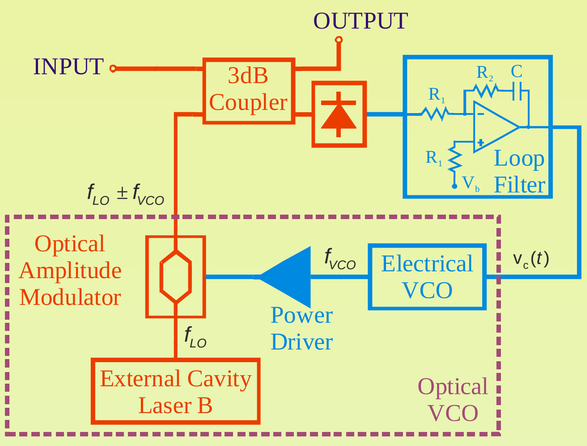
➢ **Coherent detection: potential field of application:**

- Ultra-dense WDM
- Multilevel optical phase modulation (*N*-PSK)
- Dispersion compensation in the electrical domain
- Fastly reconfigurable optical networks
- Optical sensor, microwave photonics, etc.

➢ **Targets of this work:**

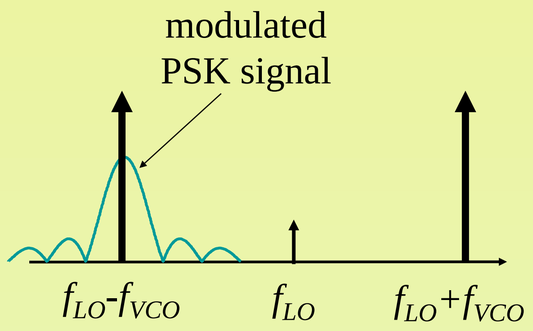
- **We introduce the use of our Sub-Carrier Optical PLL as a 2-PSK 2.5 Gbit/s coherent receiver for Ultra Dense WDM systems**
  - The use of narrow optical filtering is not necessary
- **We study the effects of the channel spacing on the performance of a 3-channel system**
  - We show that a channel spacing of 6.25 GHz is feasible

Sub Carrier Optical PLL (SC-OPLL)

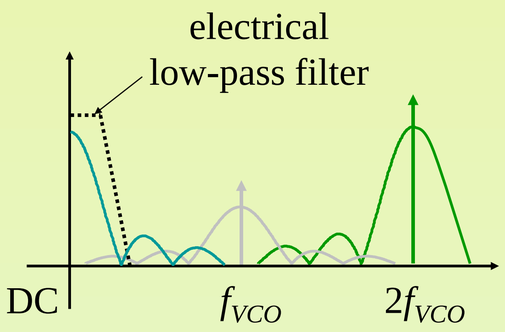


Two main Sub Carriers at frequency $f_{LO} \pm f_{VCO}$ are generated. We are able to tune *both* by simply changing the voltage applied to the *electrical* VCO, thus implementing an Optical VCO. f_{LO} is set in order to obtain f_{LO}-f_{VCO} equal to the received signal frequency f_{TX}.

Photodiode Input

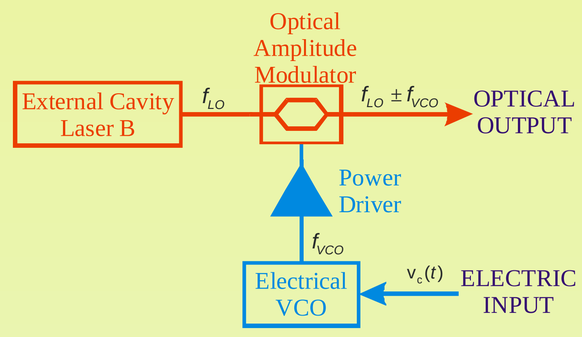


Photodiode Output



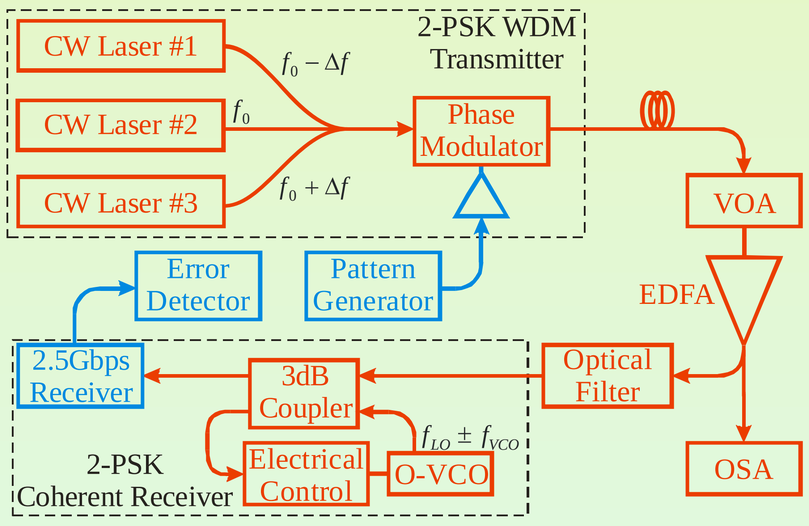
At photodiode output, the signal carried by the transmitter is translated to base-band. In principle, due to beating with the other SCs, copies of this signal appears also around frequencies f_{VCO} and $2 \cdot f_{VCO}$, but they are filtered out by the electrical receiver filter.

Optical VCO



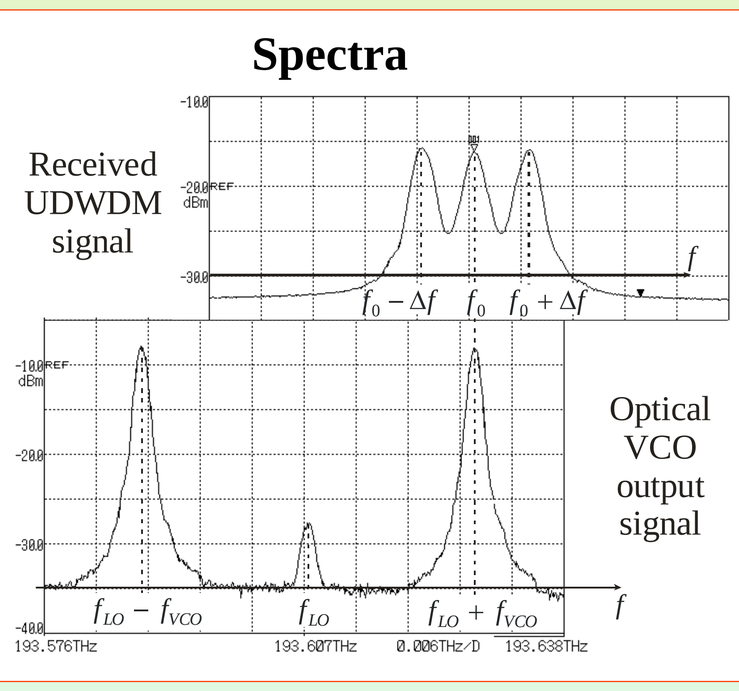
The amplitude modulator is a high bandwidth Corning-OTI $LiNbO_3$ Mach-Zehnder (MZ) and is biased at a null of its transfer function, a sinusoidal carrier-suppressed modulation is obtained.
The electrical VCO is a low jitter silicon-bipolar based 20 GHz VCO from Agilent Technologies.

2.5 Gbit/s UD-WDM System schematic

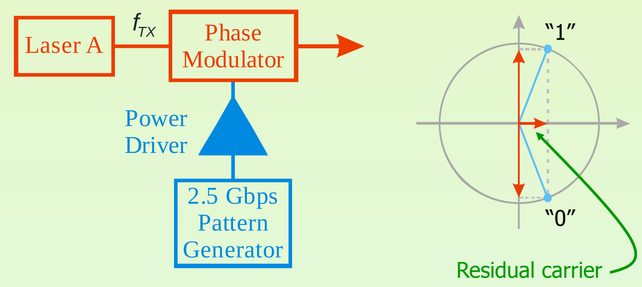


- The coherent receiver is based on the SC-OPLL
- The optical filter reduces the ASE noise but let the 3 channels pass through undistorted
- The SC-OPLL locks the central channel frequency f_0
- UDWDM channel demodulation is directly obtained through the receiver electrical filters

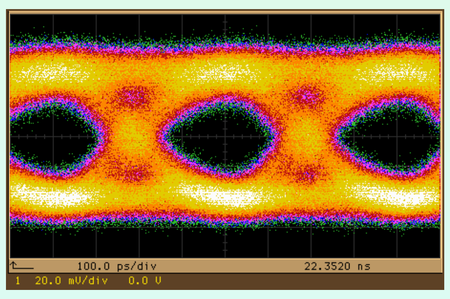
Spectra



Single channel 2-PSK Transmitter



The transmitter is based on a Corning-OTI $LiNbO_3$ 10Gbit/s phase modulator, driven by a 2.5 Gbit/s NRZ signal. The modulation voltage has been set to a slightly lower value than the modulator V_π voltage. The SC-OPLL locks the residual carrier.



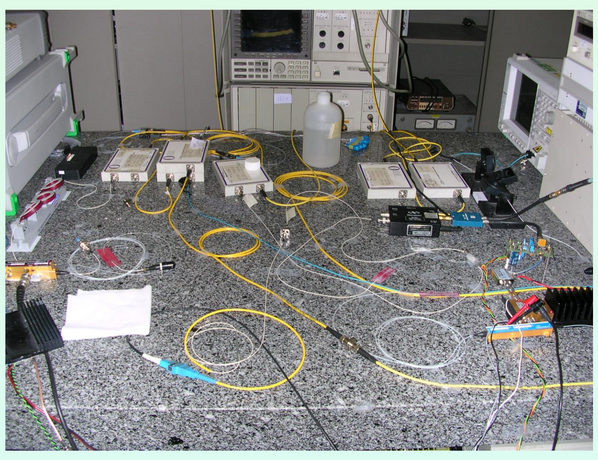
Eyediagram

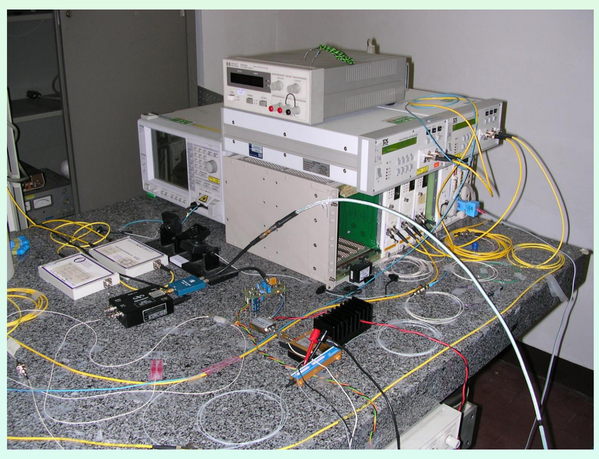
2.5Gbps PSK System

6.25 GHz Channel spacing

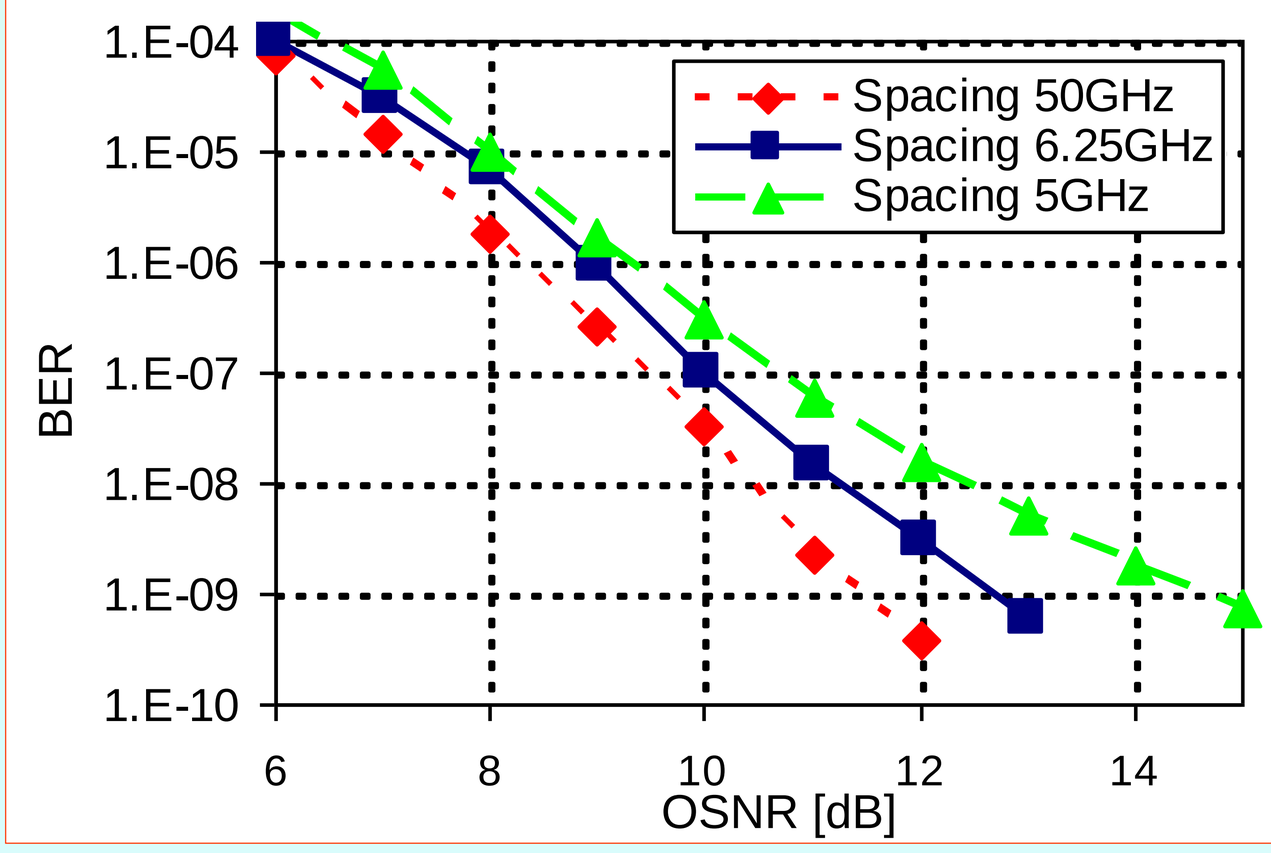
OSNR=13 dB (@ Res BW = 0.1 nm)

Measured BER = $6 \cdot 10^{-10}$





Experimental Results



Conclusions

➢ All the SC-OPLL components are commercially available today

➢ We demonstrated the demodulation of 2.5 Gbit/s 2-PSK signals with 6.25 GHz channel spacing and 1 dB penalty

➢ Optical homodyning mitigates the requirements on optical filtering

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