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Paper We.1.B.1

OPTCOM

Optimization of uncooled RSOA parameters in WDM reflective PONs based on self-coherent or direct detection OLT receivers

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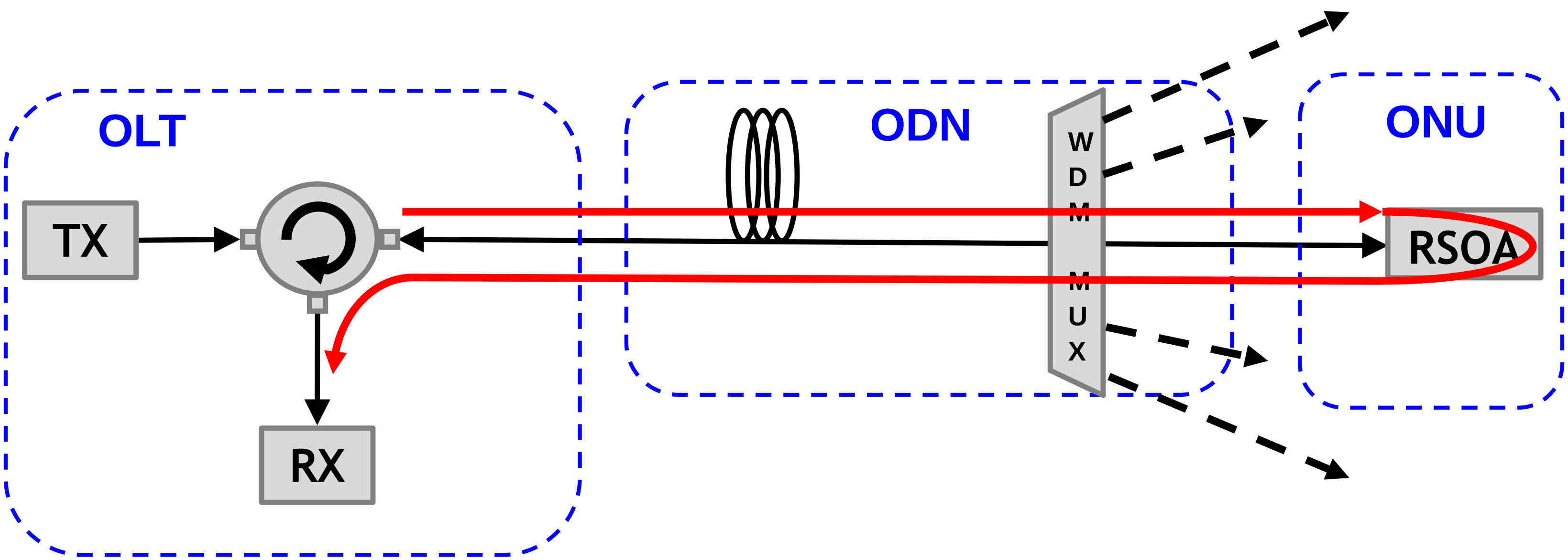
Reflective WDM PON

- Reflective WDM PON architectures allow **colorless** and **laser-less ONU** (the **upstream** transmission wavelength is generated at the OLT side)
- A reflective device (**RSOA**) is used to **reflect**, **amplify** and **modulate** signal at the ONU

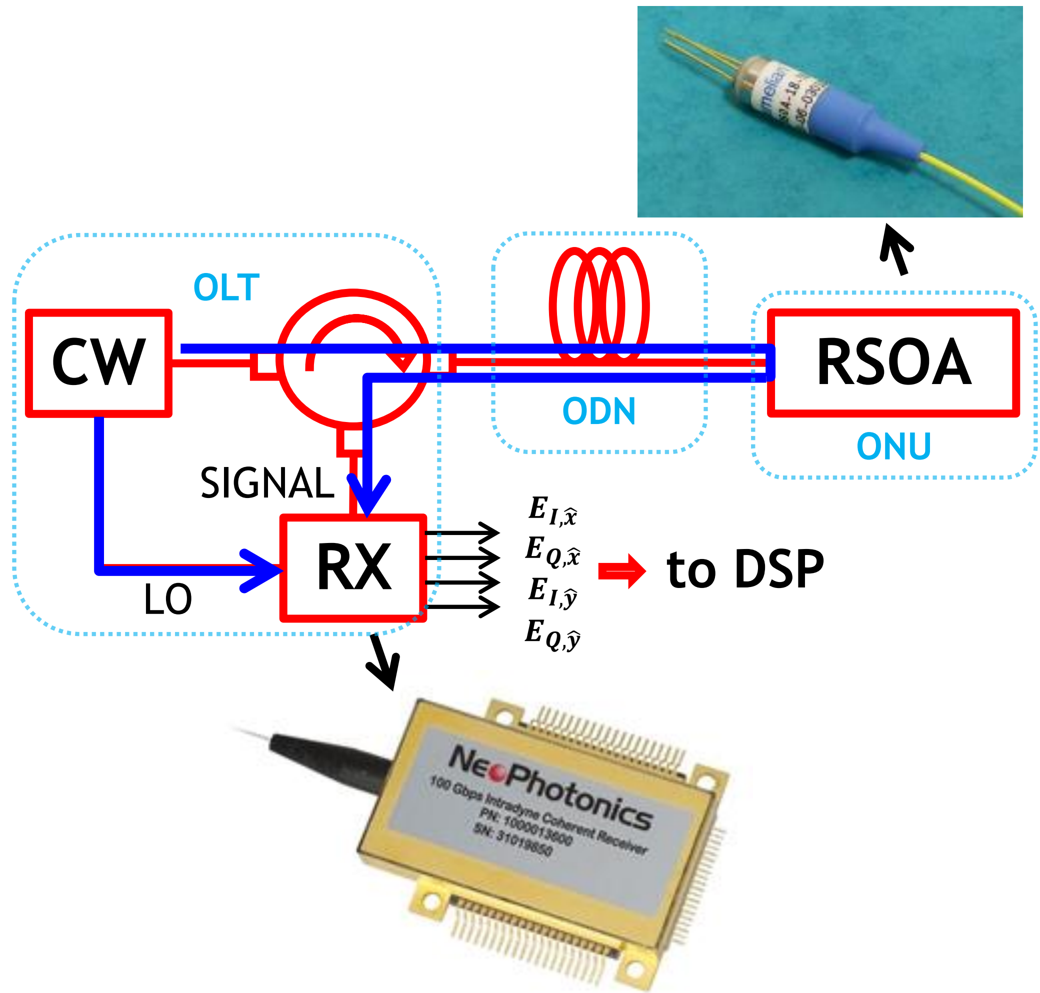


Direct detection

- Currently, PON commercial solutions are based on **direct detection** receivers
- NG-PON2 goals are
  - increase of the reach to 40-60 km (or more)
  - increase of the splitting ratio up to 256 users (or more)
  - increase of the effective bit-rate per user (in both directions) to a value closer to 1 Gbit/s per user
- Pure IM-DD on a single wavelength per direction seems out of question

Coherent detection

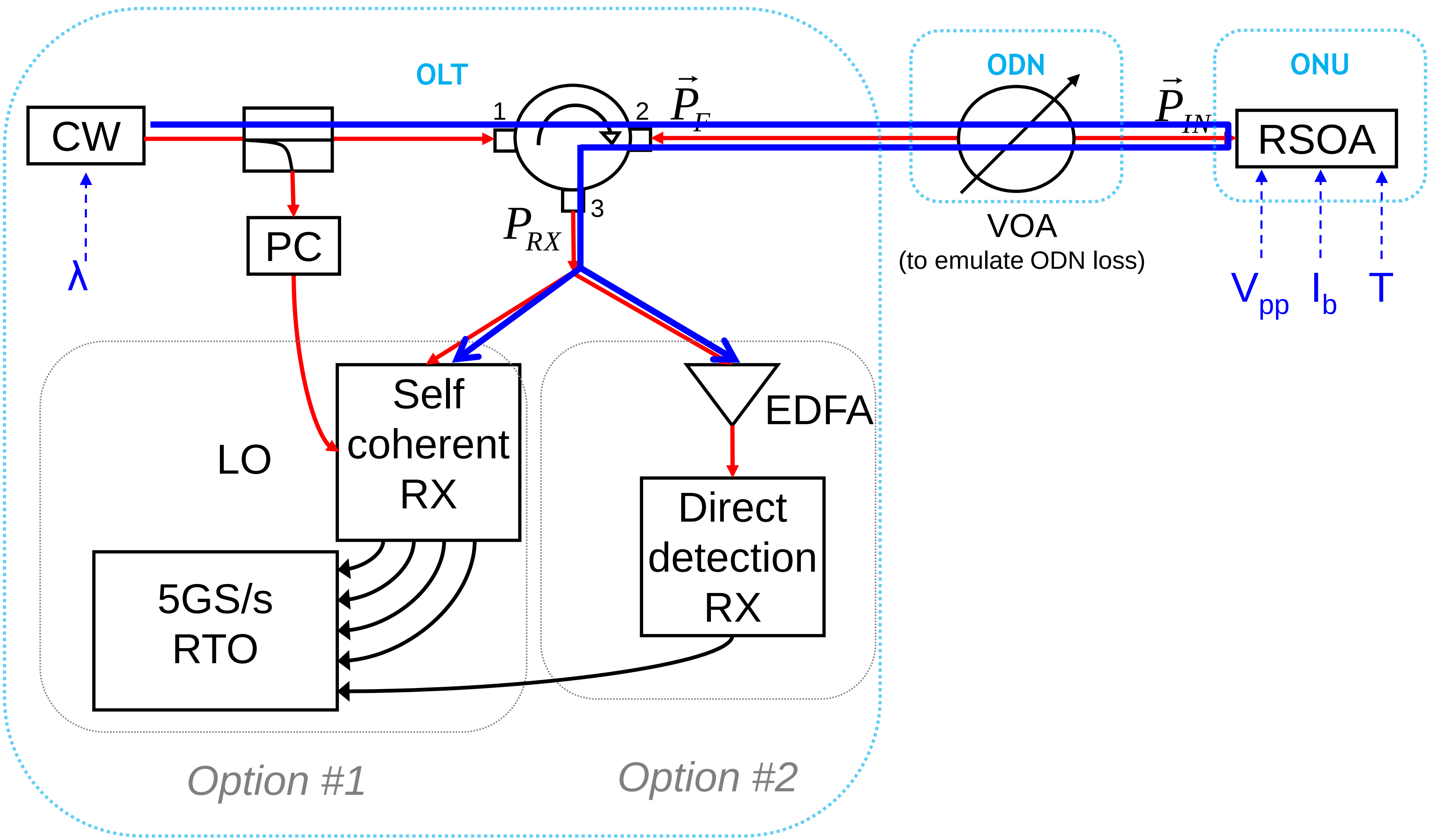
- The use of the coherent detection at the OLT side implies:
- **PROS:**
  - Very **cheap ONU** (uncooled RSOA, no DSP)
  - Very good performances in terms of
    - Back-to-back sensitivity
    - 80km system performances (see **Paper We.1.B.3**)
    - 100km system performances (see **Post-deadline paper Th3D.6 - Session IV**)
- **CONS:**
  - Higher costs and complexity at the OLT (for the receiver and the DSP)



Target: optimizing for coherent RX

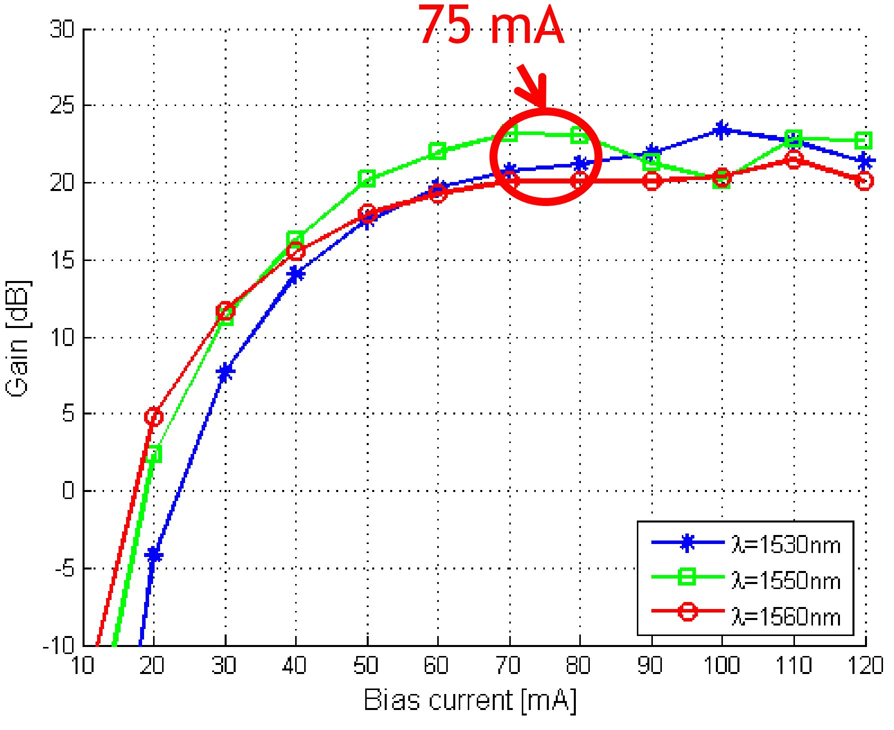
- We measured the optical back-to-back performance when changing:
  - Biasing current
  - Modulation amplitude (@ 1.25 Gbps)
  - Device temperature (from 10 to 50°C)
  - Operating wavelength (from 1530 to 1560 nm)
  - Receiver type
    - Coherent receiver
    - Direct-detection receiver (with EDFA preamplifier)
- The main target was to find the **optimal driving** parameters, and to check if they change with operating temperature and wavelength

Experimental Setup - Back-to-back

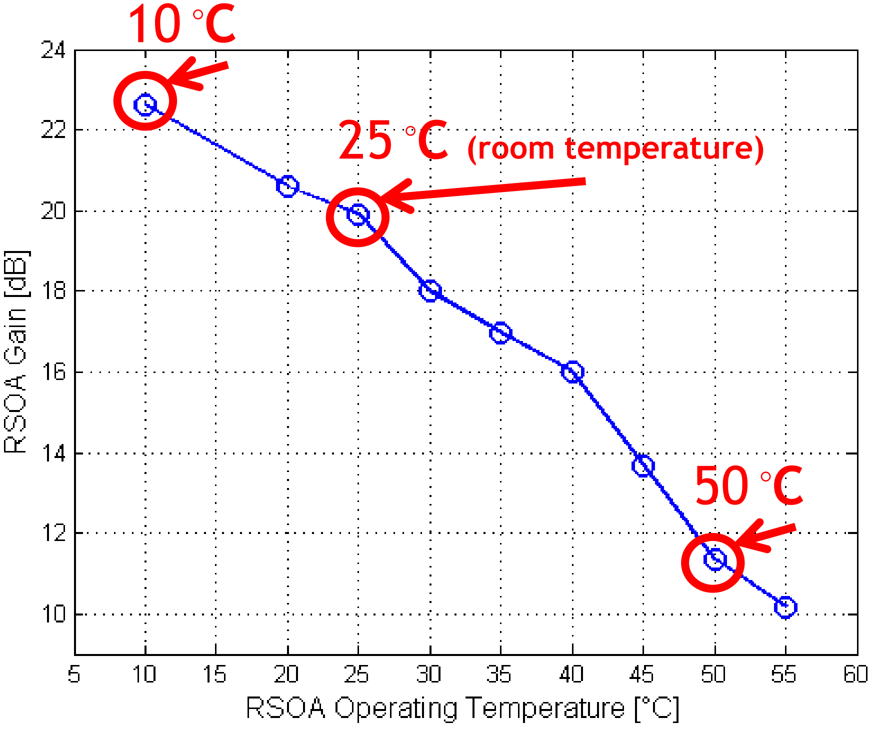


RSOA static characterization

Kamelian
RSOA-18-TO-C-FA



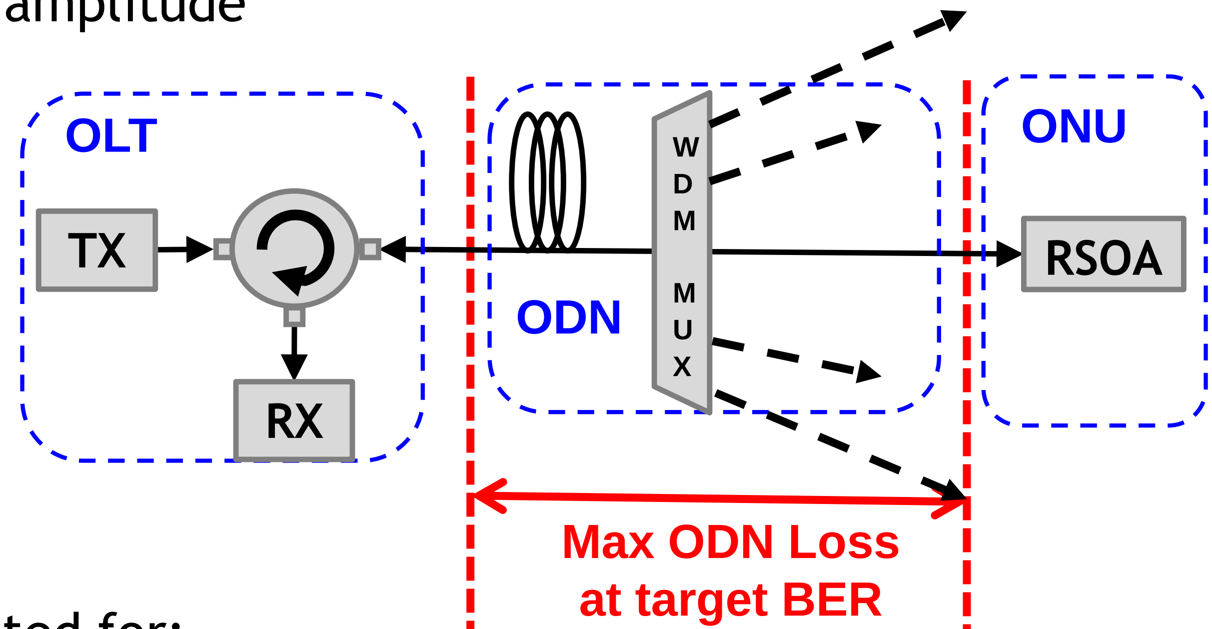
RSOA gain vs. bias current, for different wavelengths, P_{IN}=-25dBm



RSOA gain vs. operating temperature, P_{IN}=-35dBm, I_b=75mA, λ=1550 nm

Modulation optimization

- The following slides show the maximum reachable ODN loss (ODN_{LOSS} @BER=10^{-3}) in a contour plot with inputs:
  - Biasing current
  - Modulation amplitude

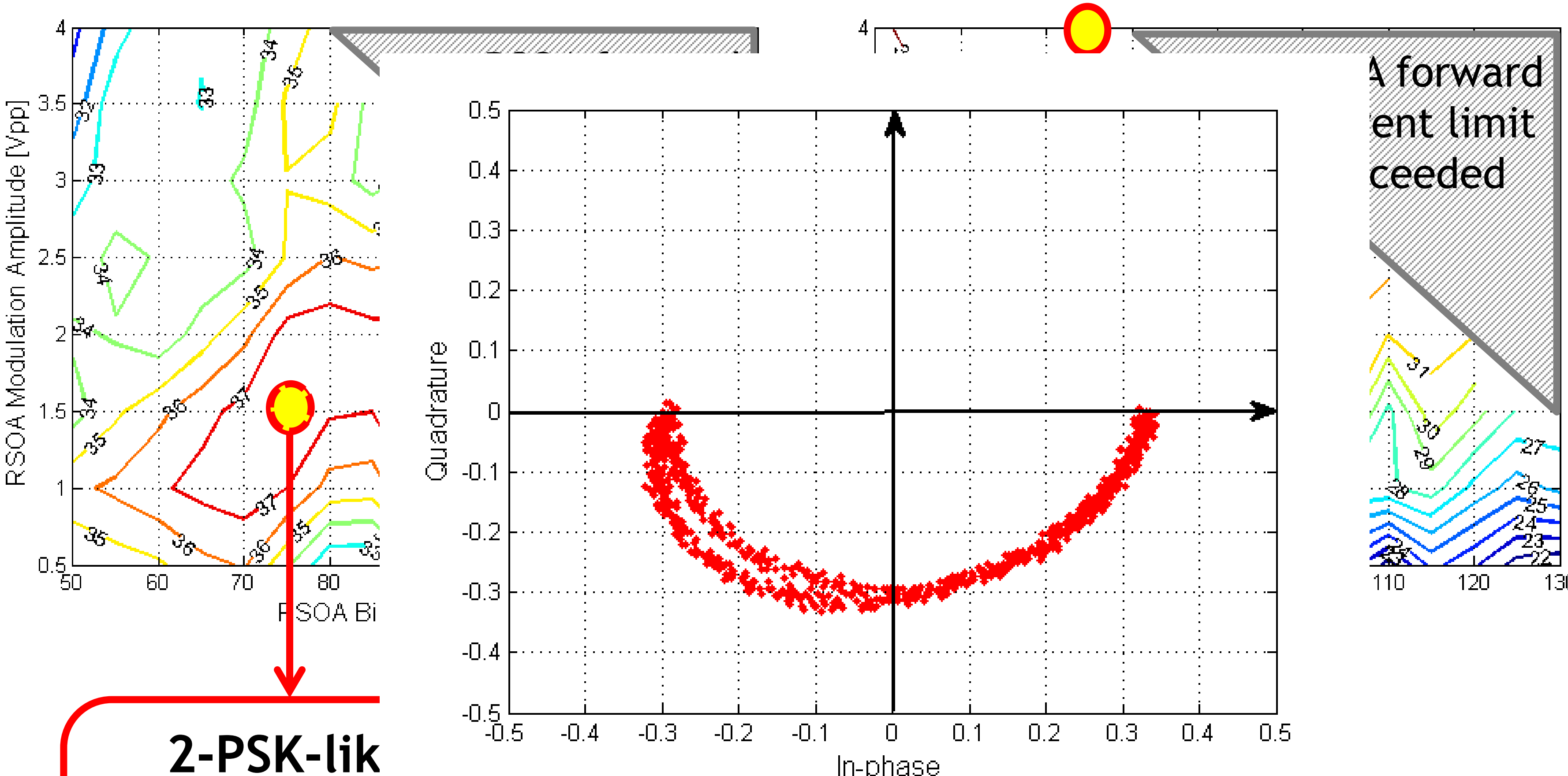


- They are repeated for:
  - Two different receivers (coherent and DD)
  - Three different temperatures
  - Three different wavelengths

Temperature=25°C, λ=1550 nm

Coherent detection

Direct detection



2-PSK-lik
ODN_{LOSS}=38 dB
Ib=75 mA
Vpp=1.5 V

ODN_{LOSS}=36 dB
Ib=75 mA
Vpp=4 V

Temperature=10°C, λ=1550 nm

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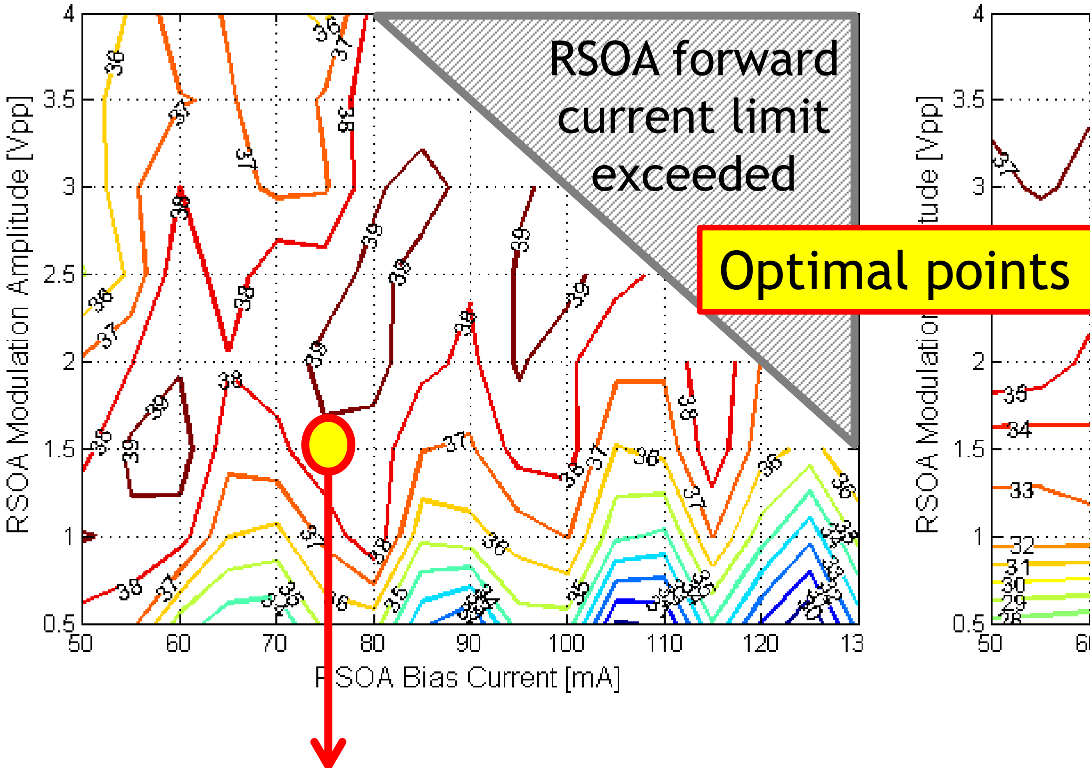
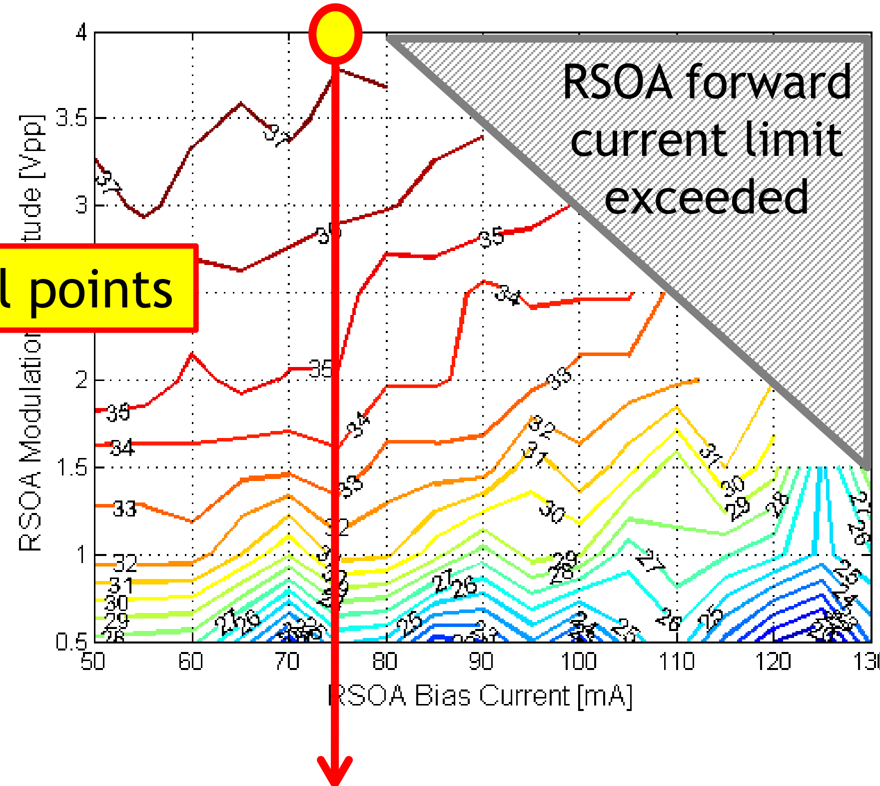
Coherent detection



2-PSK-like
ODN_{LOSS}=39 dB
Ib=75 mA
Vpp=1.5 V

Direct detection



OOK
ODN_{LOSS}=37 dB
Ib=75 mA
Vpp=4 V

Temperature=50°C, λ=1550 nm

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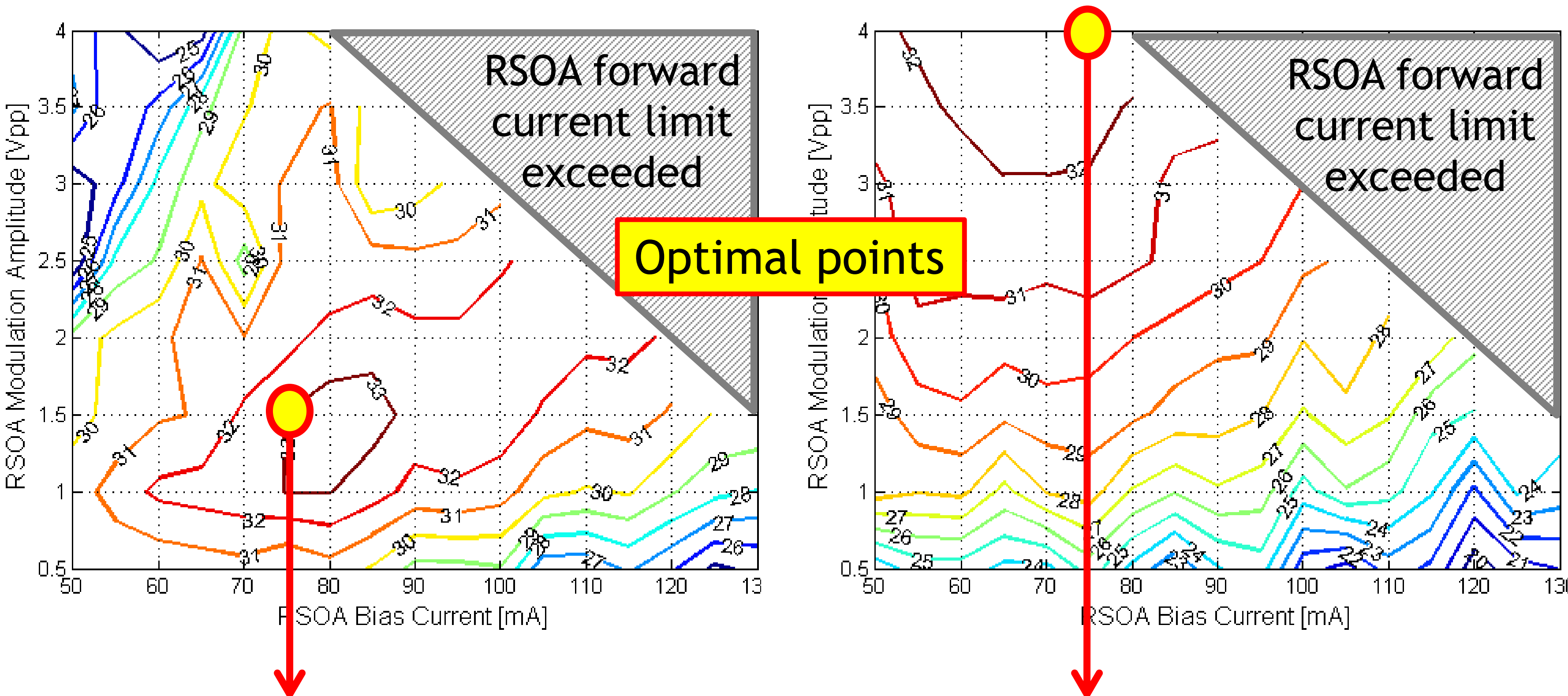
Coherent detection　　　　　　　　　　　　Direct detection

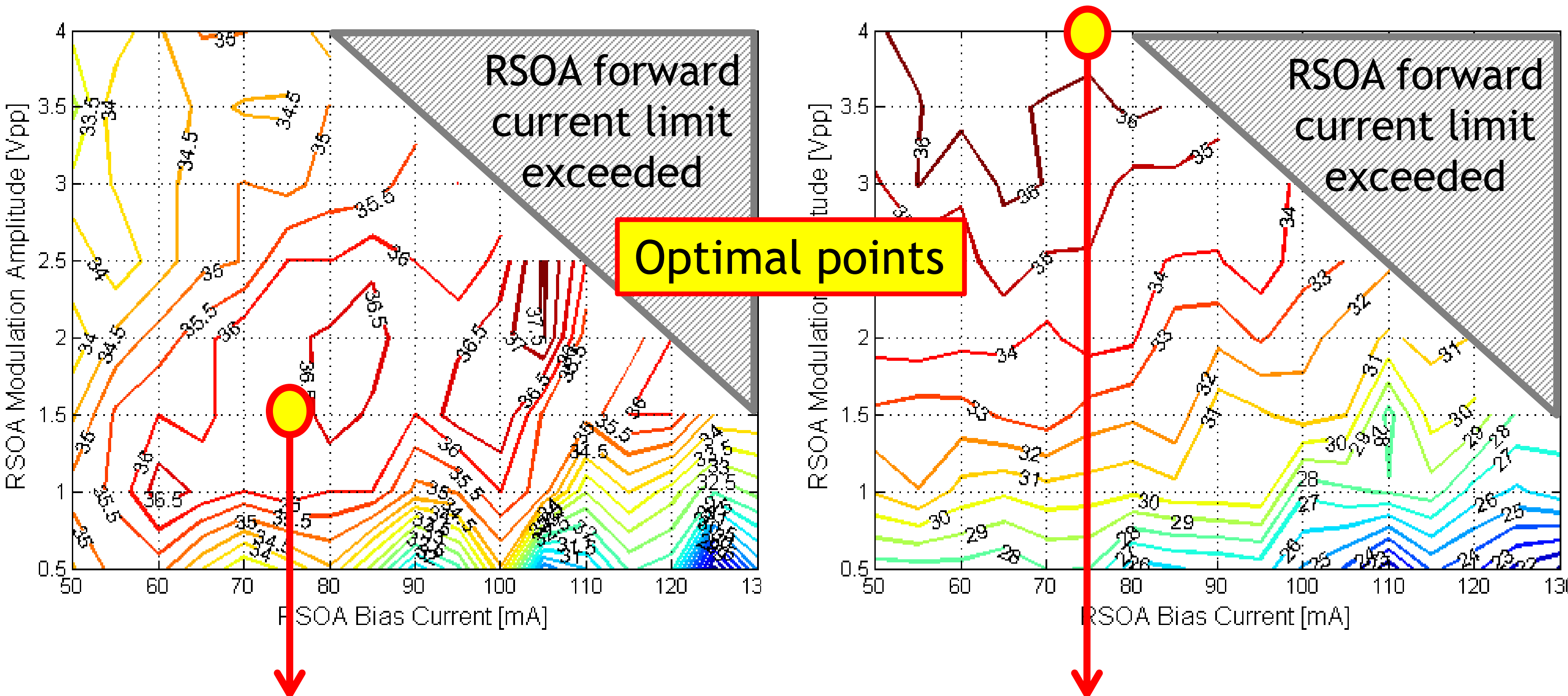


2-PSK-like
ODN_{LOSS}=33 dB
Ib=75 mA
Vpp=1.5 V

OOK
ODN_{LOSS}=32 dB
Ib=75 mA
Vpp=4 V

Temperature=25°C, λ=1530 nm

Coherent detection | Direct detection

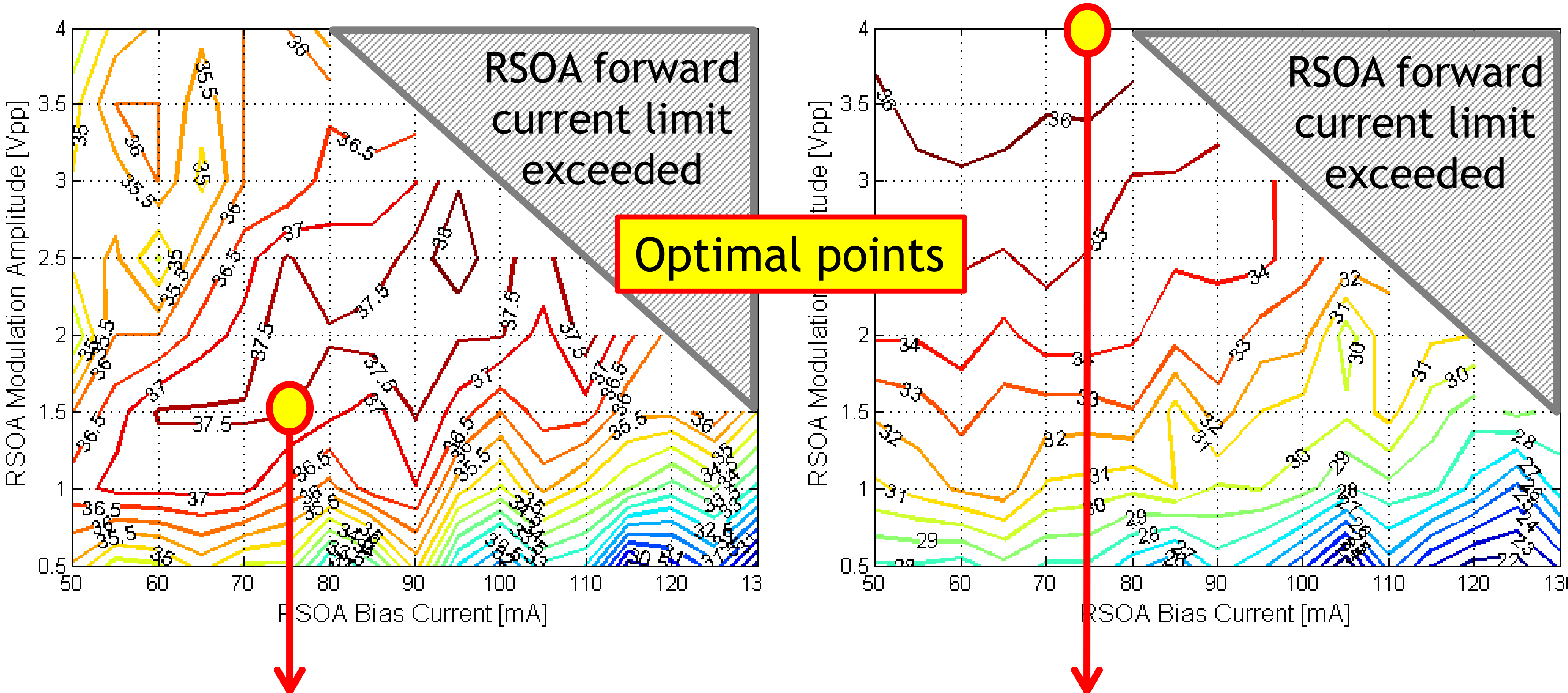


2-PSK-like
ODN_{LOSS}=37 dB
Ib=75 mA
Vpp=1.5 V

OOK
ODN_{LOSS}=36 dB
Ib=75 mA
Vpp=4 V

Temperature=25°C, λ=1540 nm

Coherent detection | Direct detection

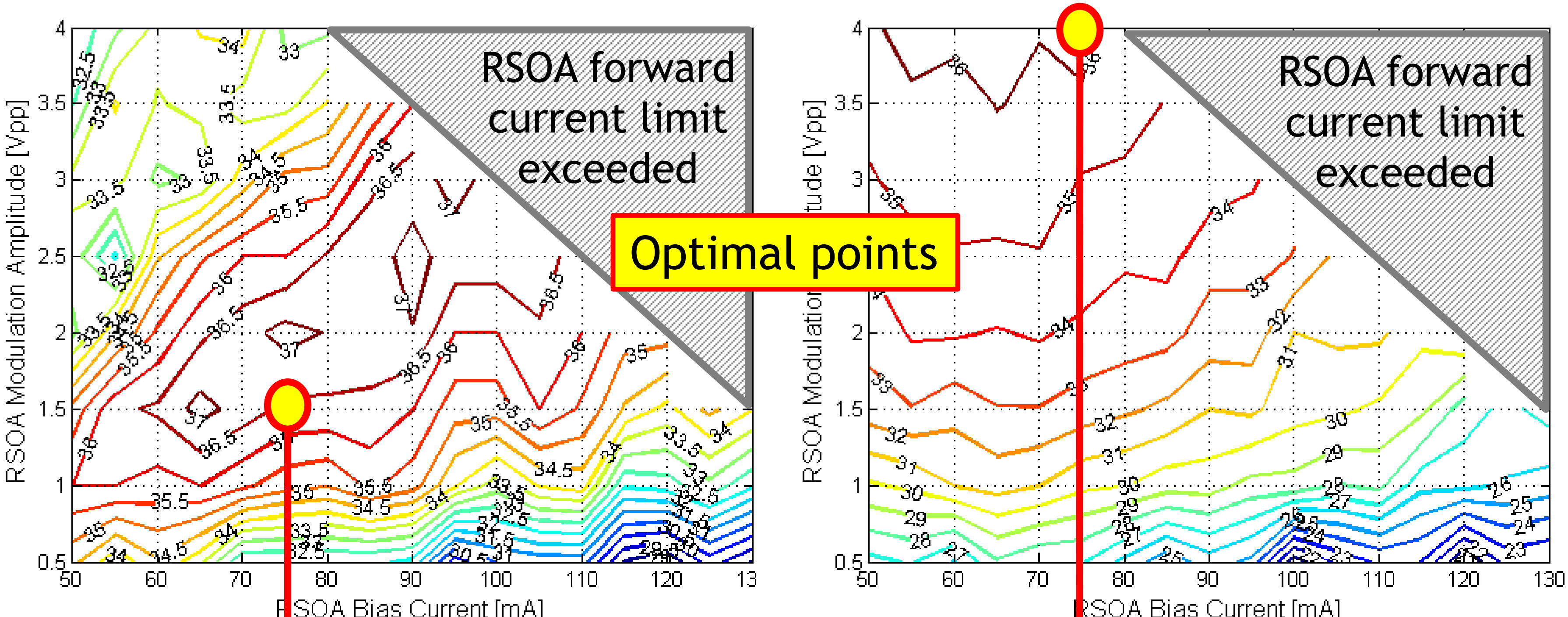


2-PSK-like
ODN_{LOSS}=37.5 dB
Ib=75 mA
Vpp=1.5 V

OOK
ODN_{LOSS}=36 dB
Ib=75 mA
Vpp=4 V

Temperature=25°C, λ=1560 nm

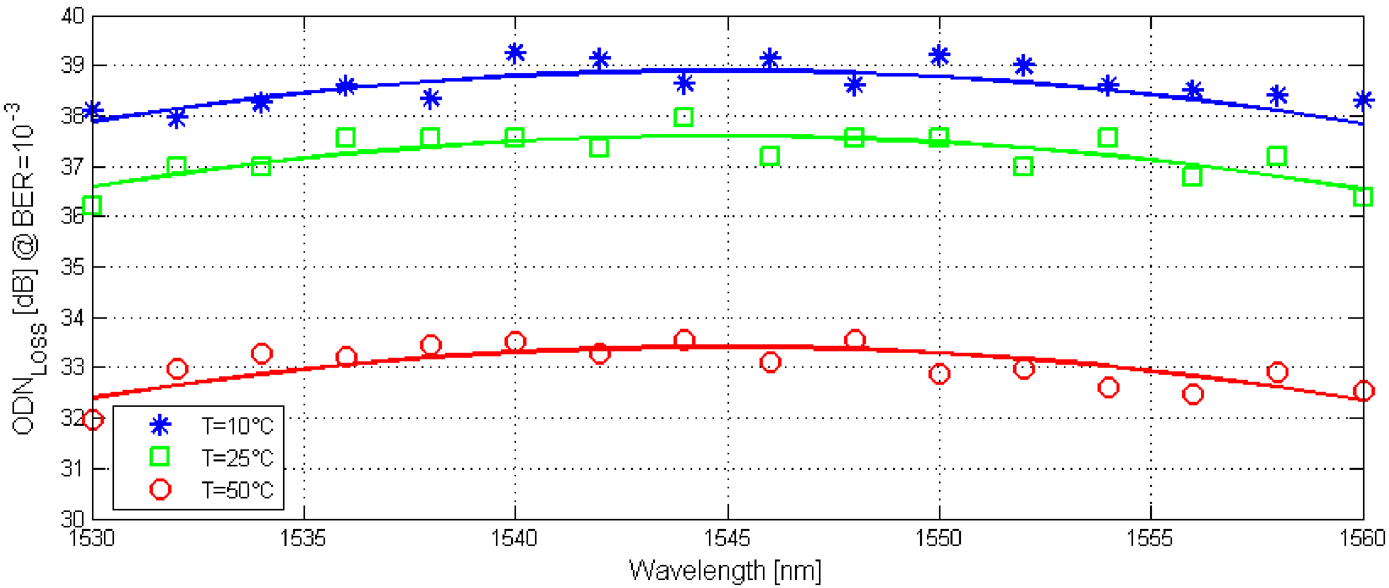
Coherent detection — Direct detection



2-PSK-like
ODN_{LOSS}=37 dB
Ib=75 mA
Vpp=1.5 V

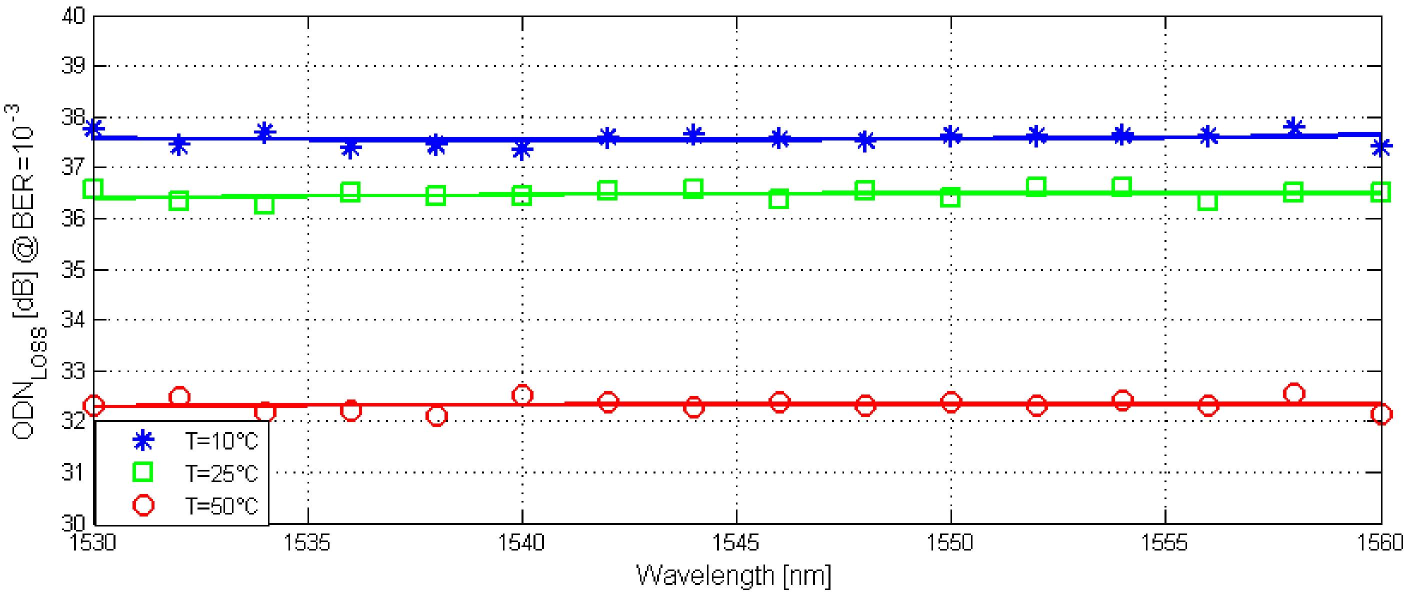
OOK
ODN_{LOSS}=36 dB
Ib=75 mA
Vpp=4 V

Best ODN Loss vs λ and T



ODN_{LOSS} @BER=10^{-3} for P_{FIBER}=0dBm, $RSOA_{Ib}$=75mA, $RSOA_{MOD}$=1.5V_{PP},

Coherent detection



ODN_{LOSS} @BER=10^{-3} for P_{FIBER}=0dBm, $RSOA_{Ib}$=75mA, $RSOA_{MOD}$=4V_{PP},

Direct detection

Conclusions

- The use of coherent receivers at the OLT completely changes the optimal operating condition of the RSOA
  - direct detection receiver → high OOK extinction ratio (**4 Vpp**) and low chirp
  - coherent receiver → high chirp and minimum extinction ratio (**1.5 Vpp**), to obtain a quasi-PSK signal
- The power consumption at the ONU side is sensibly reduced using a coherent detection at the OLT side
- The optimal points on each contour plot are almost the same at different temperatures/wavelengths
  - This seems a good results, since it may suggest a “set and forget” approach the RSOA driving parameters
- Please, do not miss the rest of our results in the 3rd presentation and in our **POST-DEADLINE** paper **Th3D.6 - Session IV!**

Thank you for your attention!

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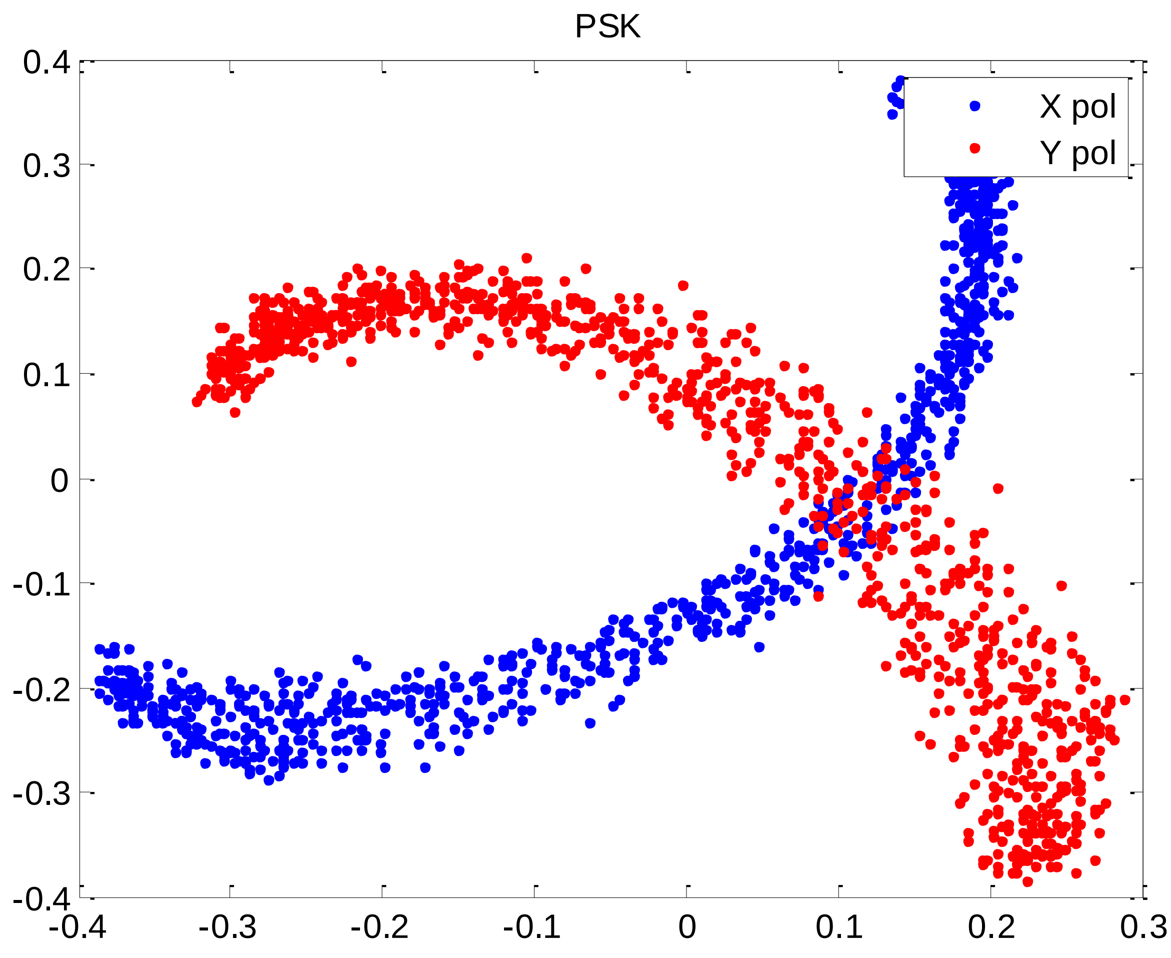
Coherent detection constellation



Direct detection constellation