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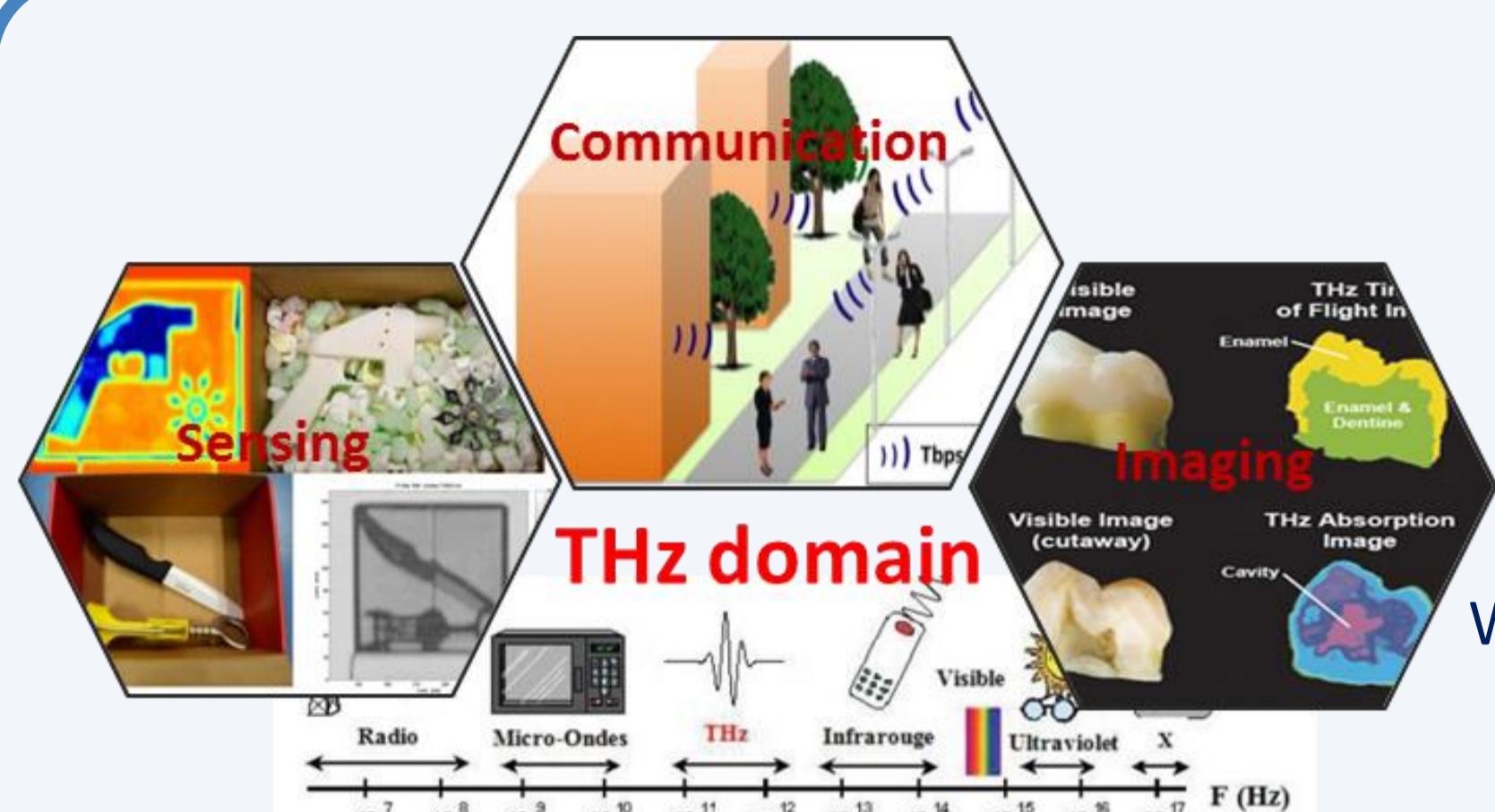
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Structural & Spectroscopic Study of InAs/InP Quantum Dots for Dual-Frequency Laser Engineering

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Why VECSEL ?

- Low intensity and phase noise
- Dual-wavelength regime possible

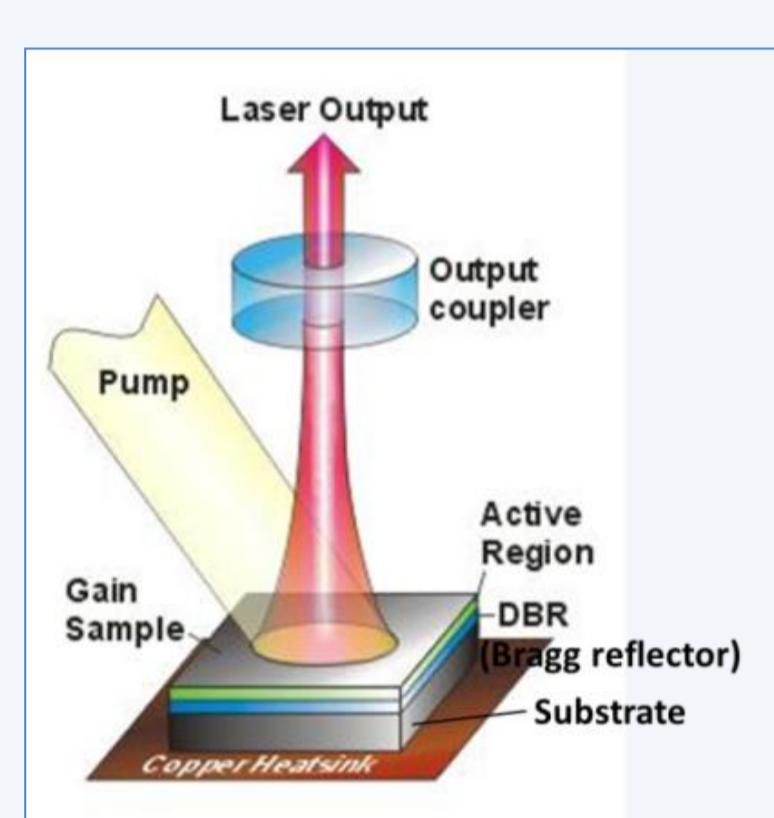
Why QDs ?

- Weak coupling (inhomogeneous medium)
- Possible electrical injection

Problem

Few efficient compact tunable room temperature THz sources available

Wavelength beating from a Coherent dual wavelength Quantum Dots (QDs) based Vertical External Cavity Surface Emitting Laser (VECSEL)



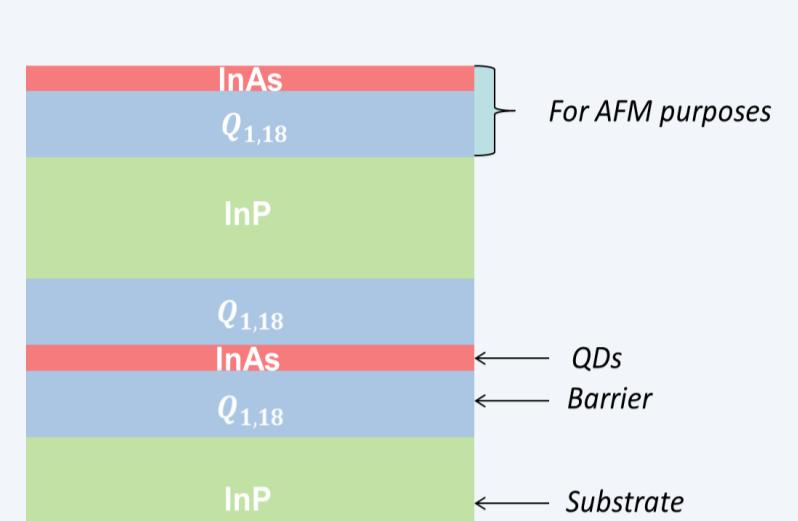
Introduction

Requirements for the QDs

InAs/InP QDs

Molecular Beam Epitaxy Growth parameters:

- AsH₃ Flow
- Quantity of deposited InAs



Telecom wavelength

Weak Coupling

Density

Homogeneous linewidth

Photoluminescence

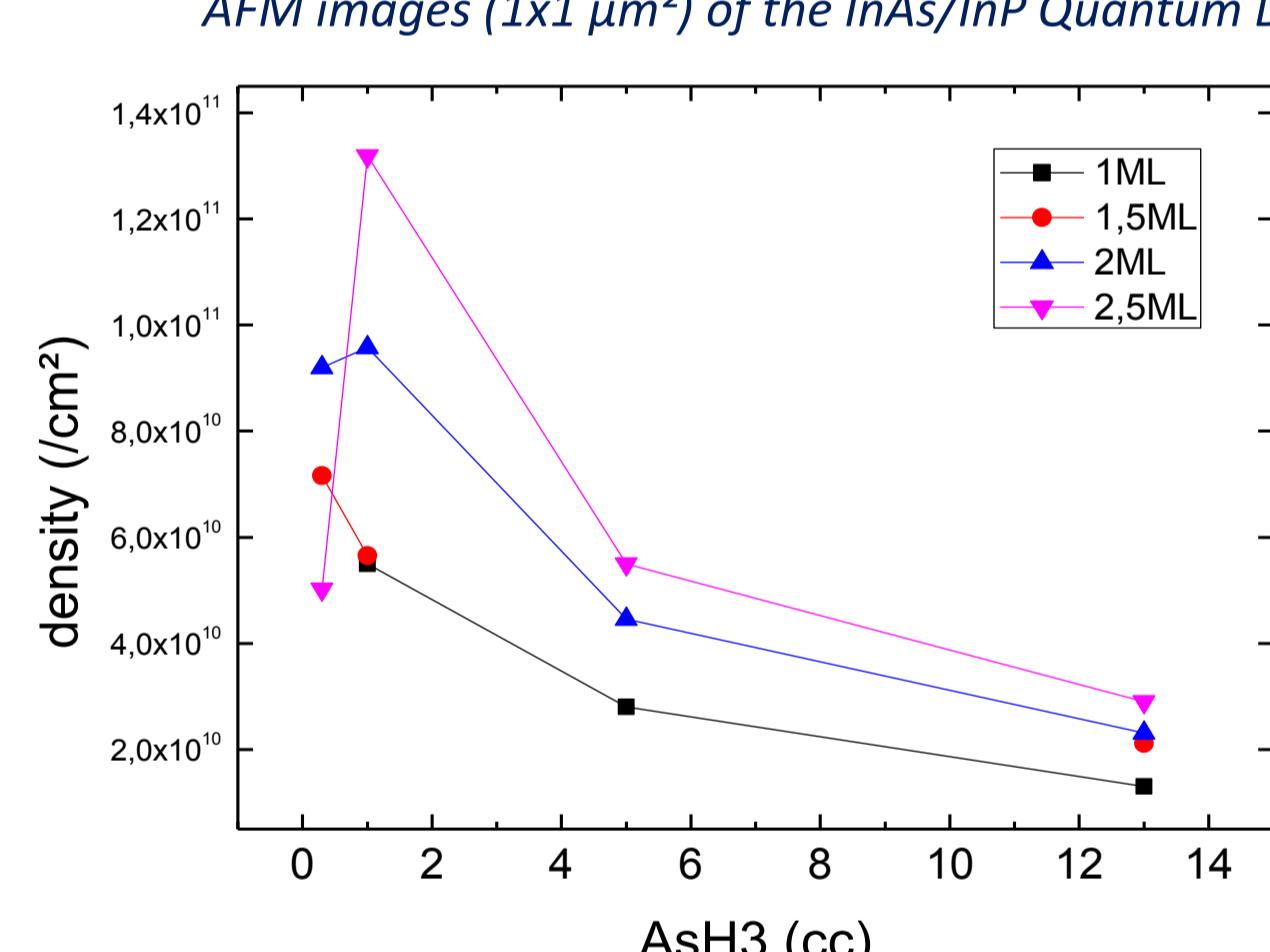
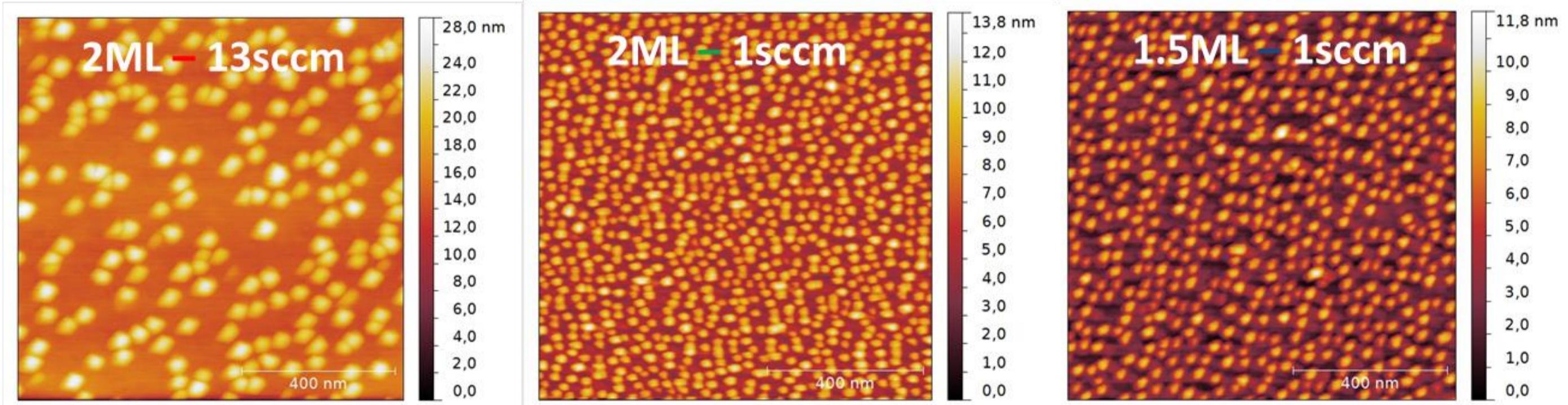
Atomic Force Microscopy

Spectral Hole Burning

Absorbance (a.u.)

Wavelength (nm)

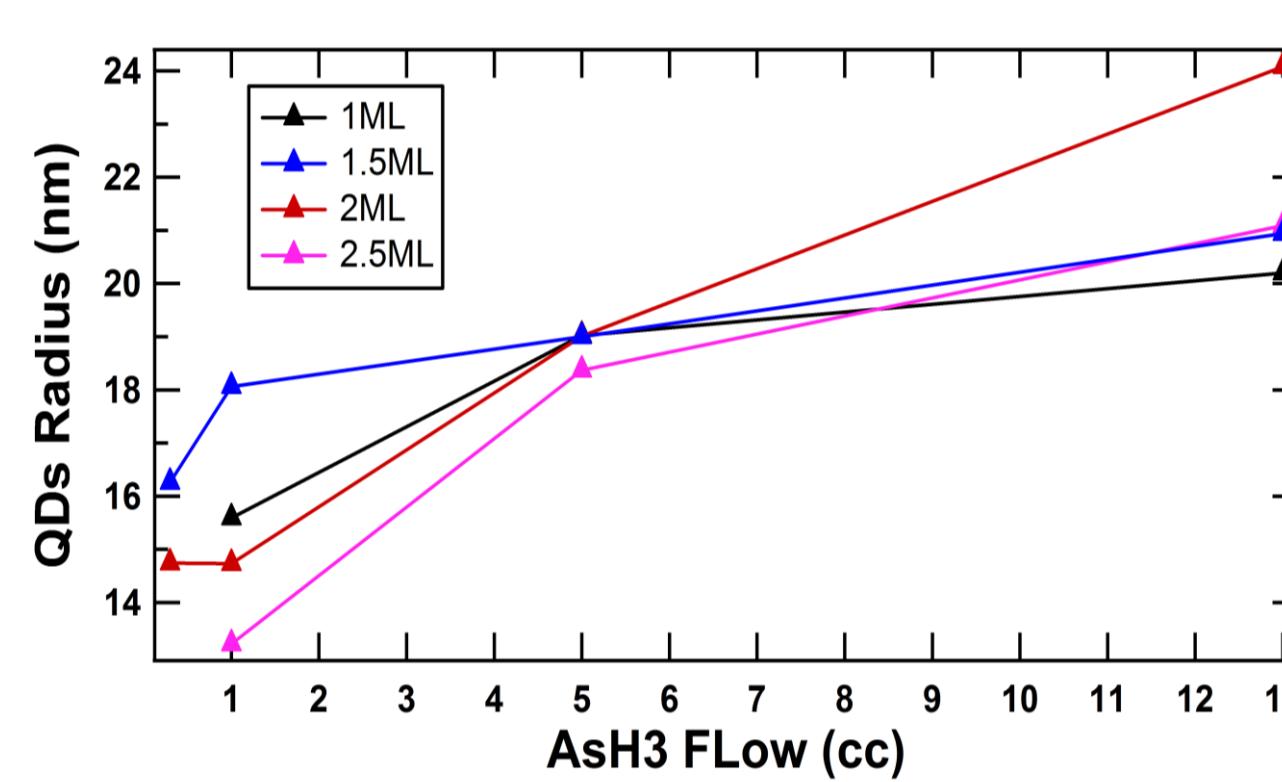
Tuning of the QDs density - AFM



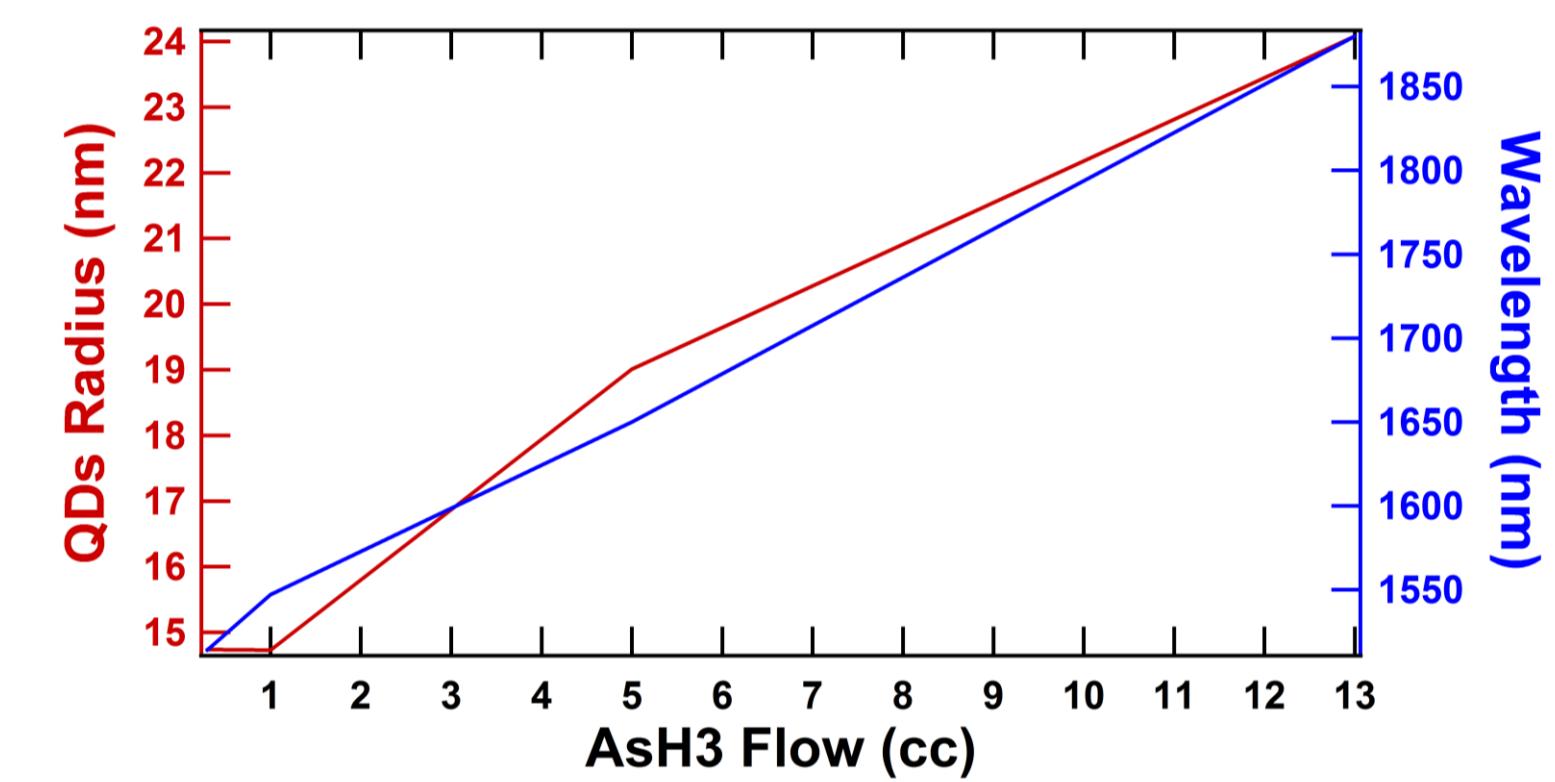
QDs density as a function of AsH₃ Flow

When the AsH₃ Flow increases, the QDs get bigger and the density greatly decreases ($\times 10$)

QDs size and emission wavelength



The radius of the QDs is bigger for higher flow

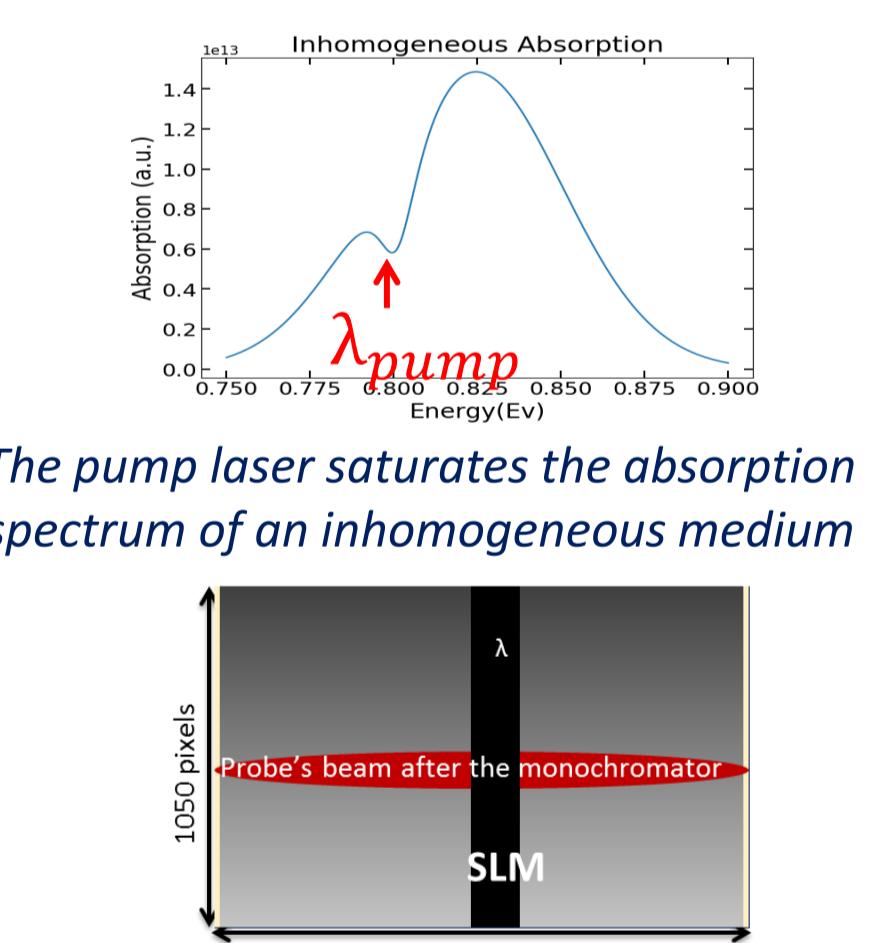
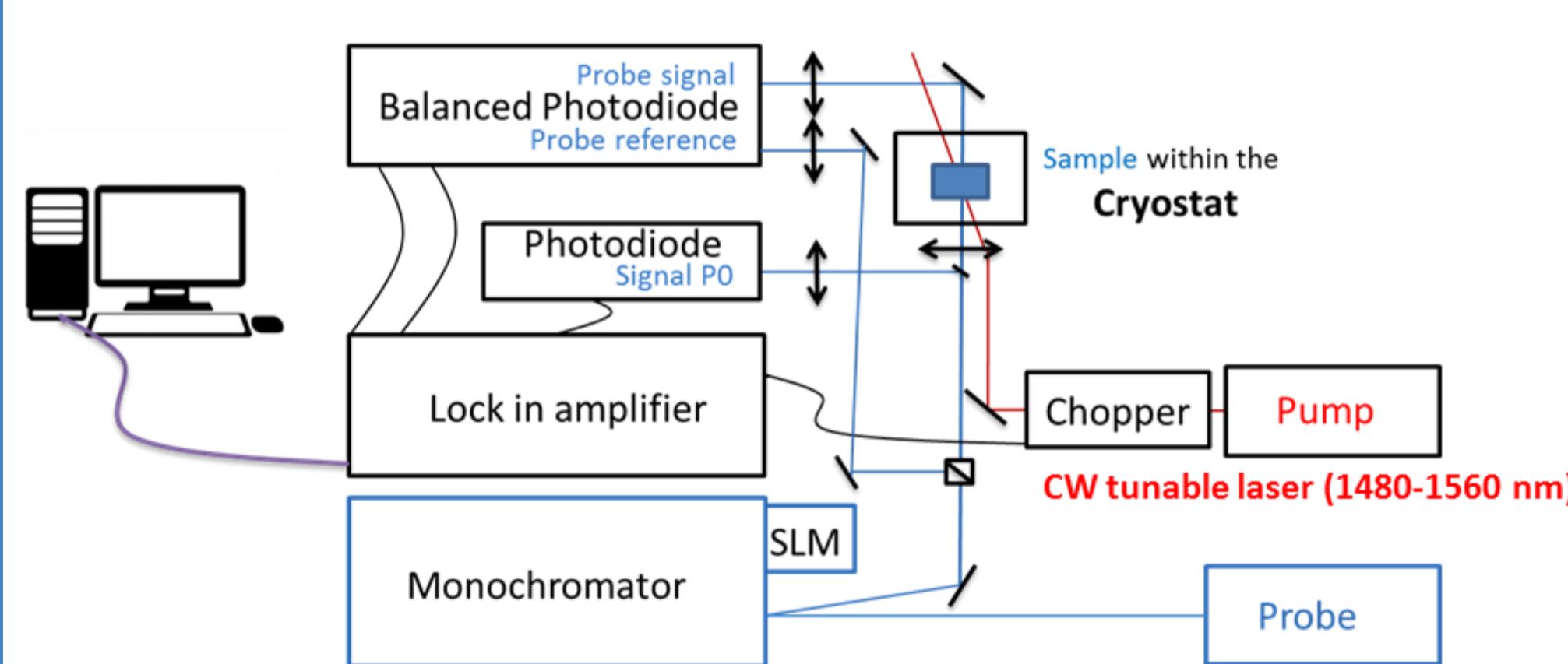


For 2ML: QDs radius and wavelength as a function of As Flow
Bigger QDs → Higher emission wavelength

QDs = self-assembled nanostructure → impossible to control the size and consequently the wavelength

Spectral Hole Burning

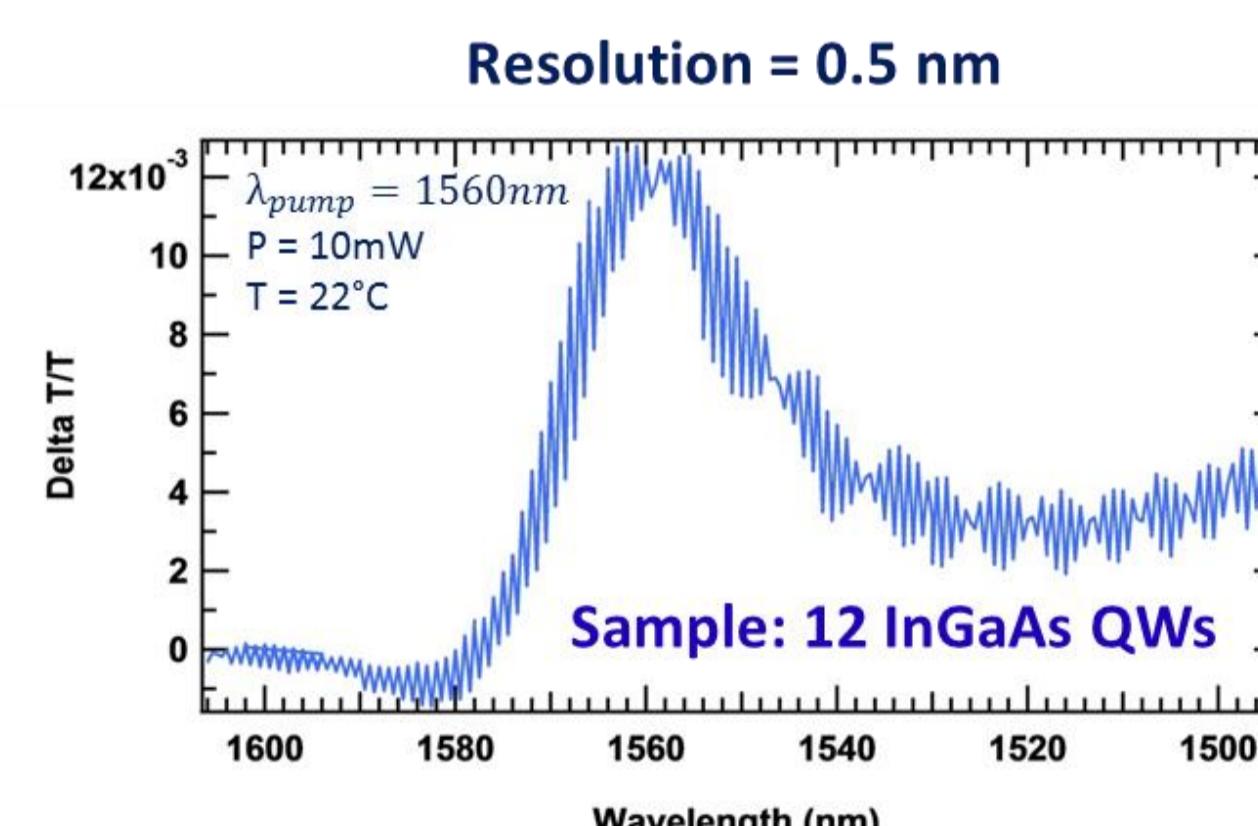
Experimental Setup



The homogeneous linewidth

$$\gamma = \Gamma_{hb}/2$$

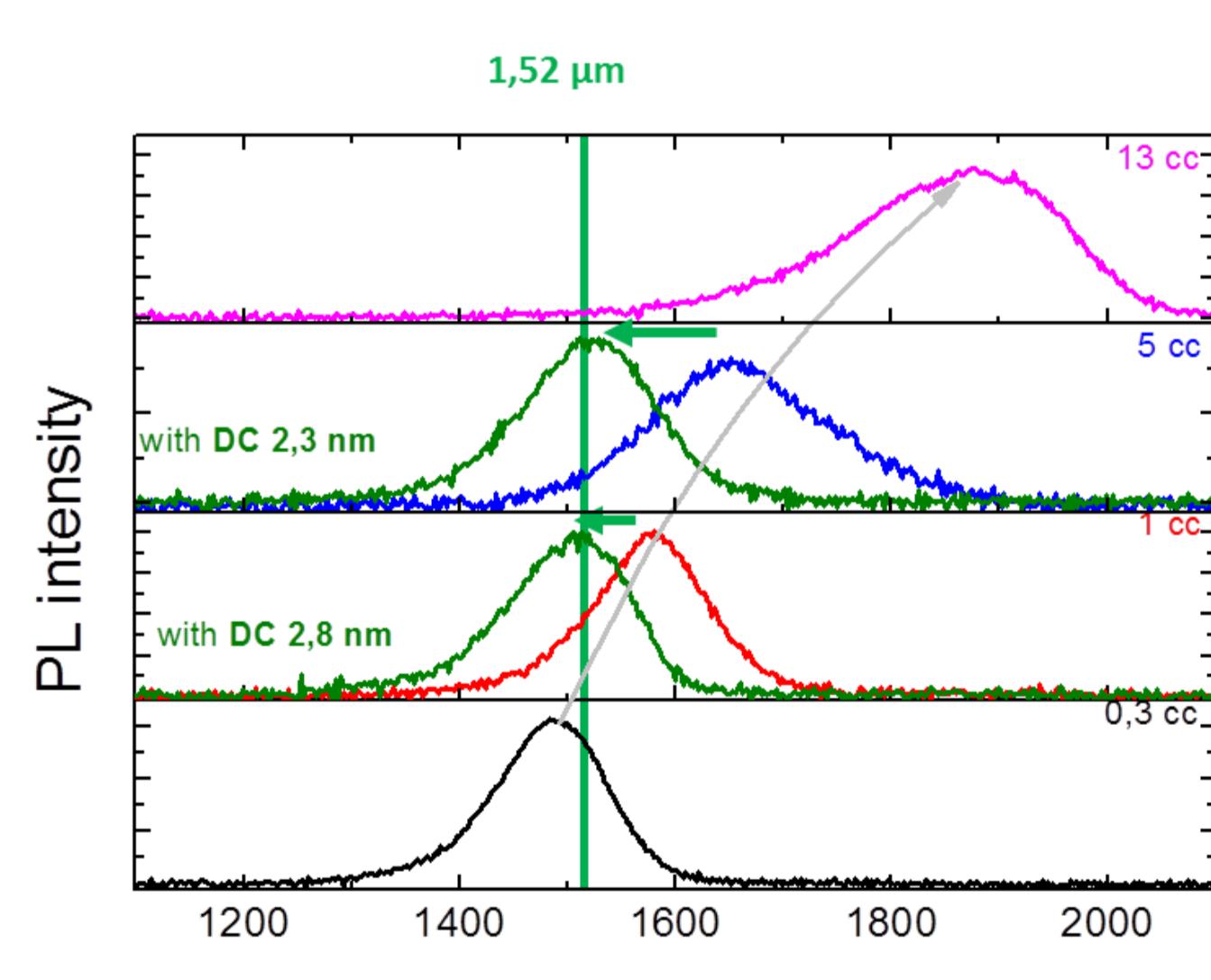
Preliminary Results (on QWs)



Experimental SHB spectrum and Reference

Same shape, good resolution (visible interferences due to the sample), higher spectral range
Typical characteristics of QWs: thermal carriers exponential decline, exciton photo-bleaching

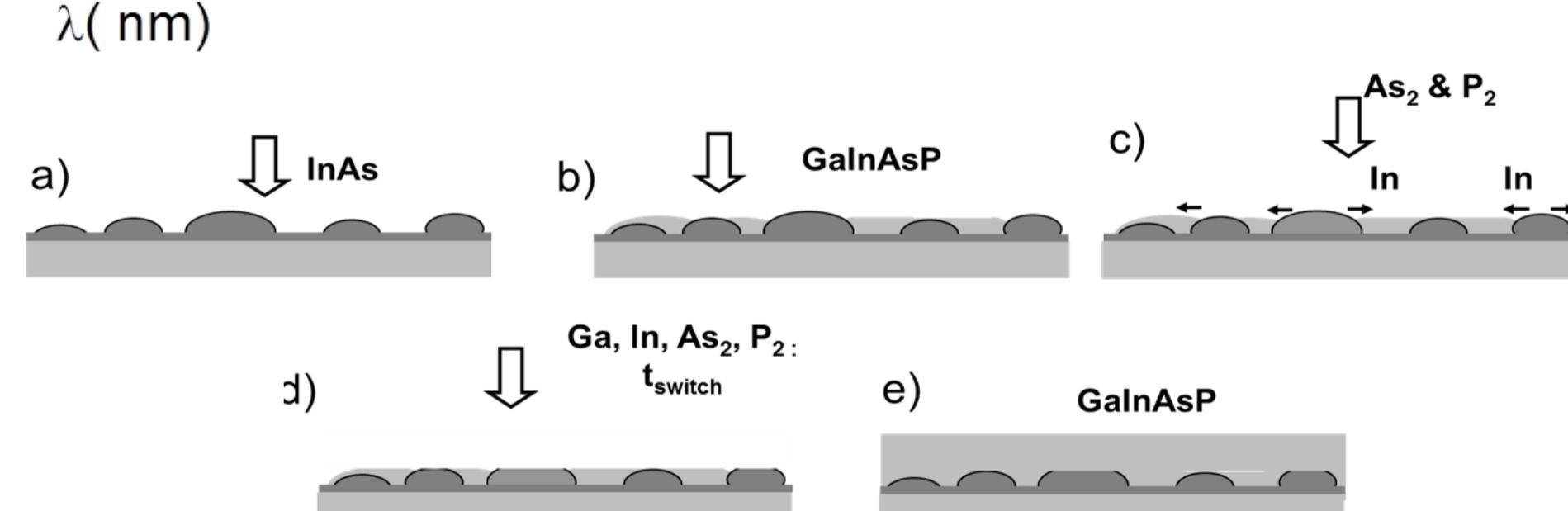
Control of the wavelength – Double Cap



Emission Wavelength for different AsH₃ flow

QDs Wavelength: Tendency with growth parameters but impossibility to control it by only the growth

Double cap process



Schematic of the Double cap process

Conclusion

- QDs density (and coupling) mainly controlled by the As flow: changed from 10^{11} down to 10^{10} cm^{-2} , with a strong effect on the wavelength emission: from 1500 nm to 1945 nm
- Independent control of the density and wavelength (double cap)
- SHB experimental setup ready with good resolution (<0.5nm) and high spectral range (500 nm)
- Results on QWs correspond well with the bibliography

- Achievement of SHB in order to get the homogeneous linewidth broadening as a function of QDs density, temperature, input power
- Optimisation of QDs density to get the weaker coupling
- VECSEL characterisation

Perspectives