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

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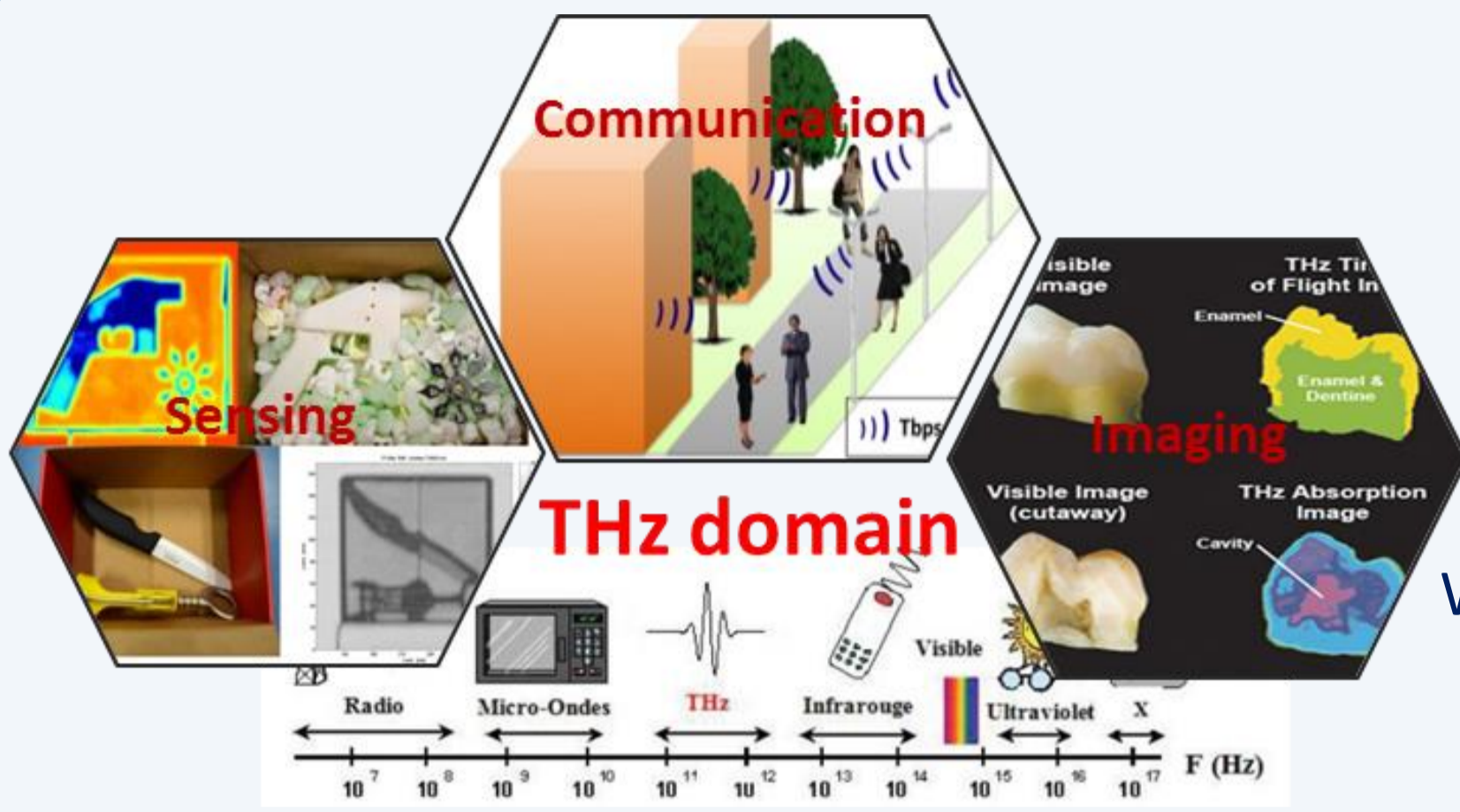
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Structural & Spectroscopic Study of InAs/InP Quantum Dots for Dual-Frequency Laser Engineering

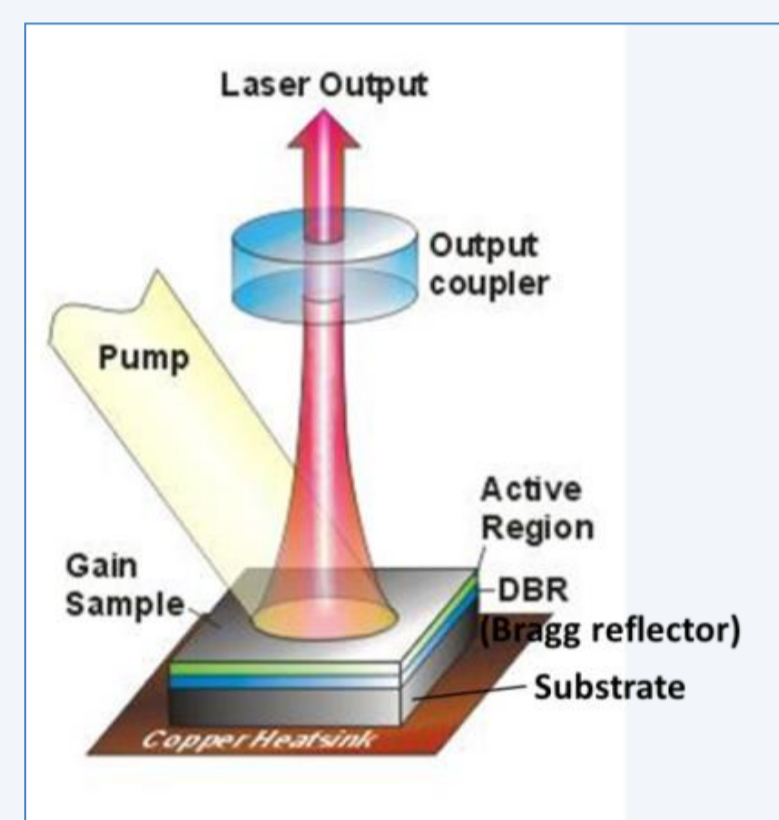
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Introduction



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)



Why VECSEL ?

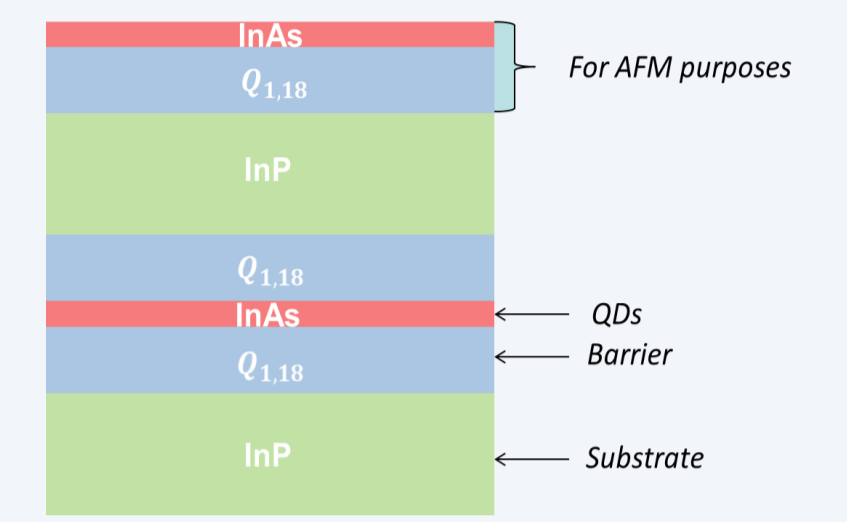
- Low intensity and phase noise
- Dual-wavelength regime possible

Why QDs ?

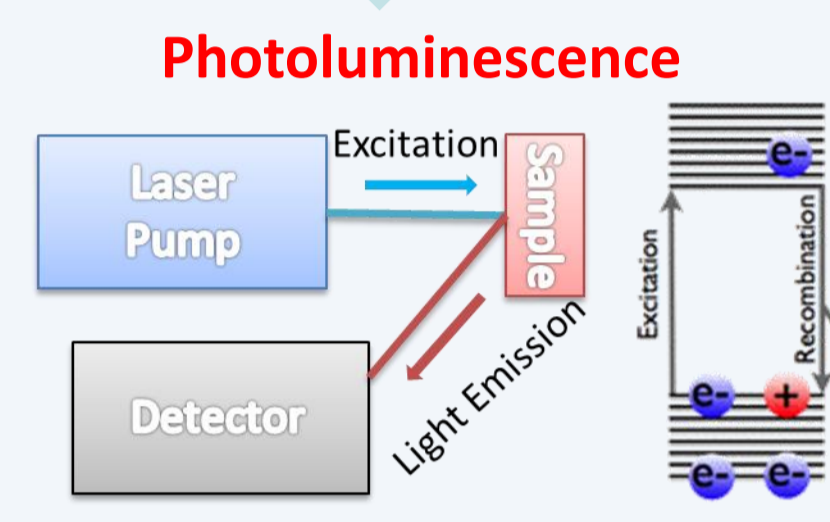
- Weak coupling (inhomogeneous medium)
- Possible electrical injection

Requirements for the QDs

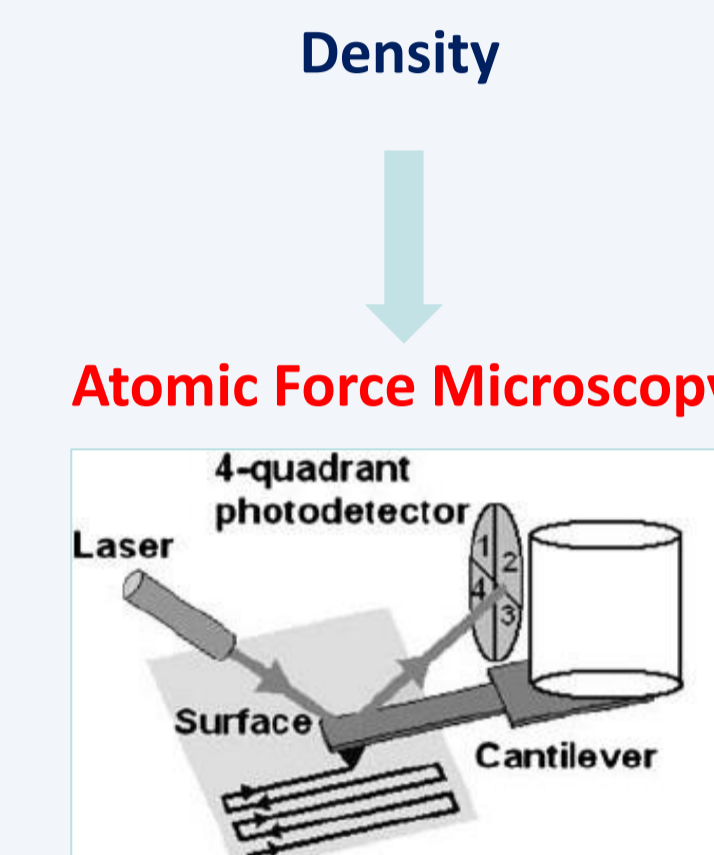
InAs/InP QDs
Molecular Beam Epitaxy Growth parameters:
• AsH₃ Flow
• Quantity of deposited InAs



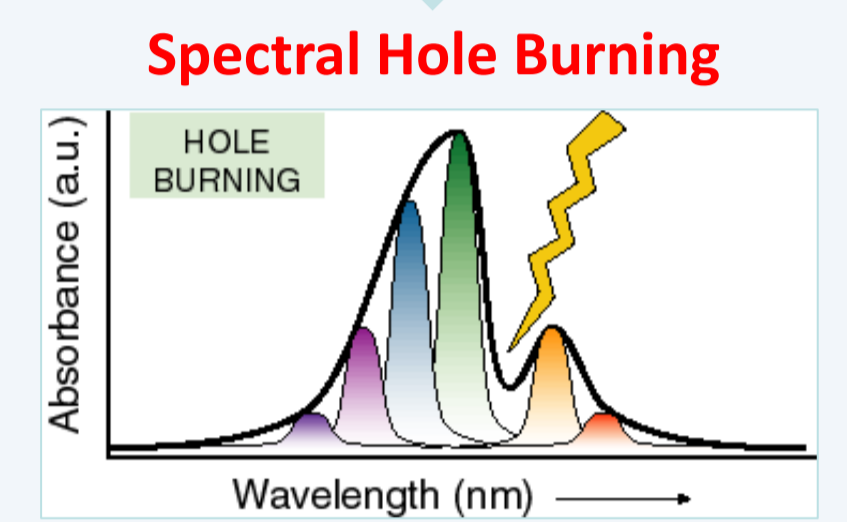
Telecom wavelength



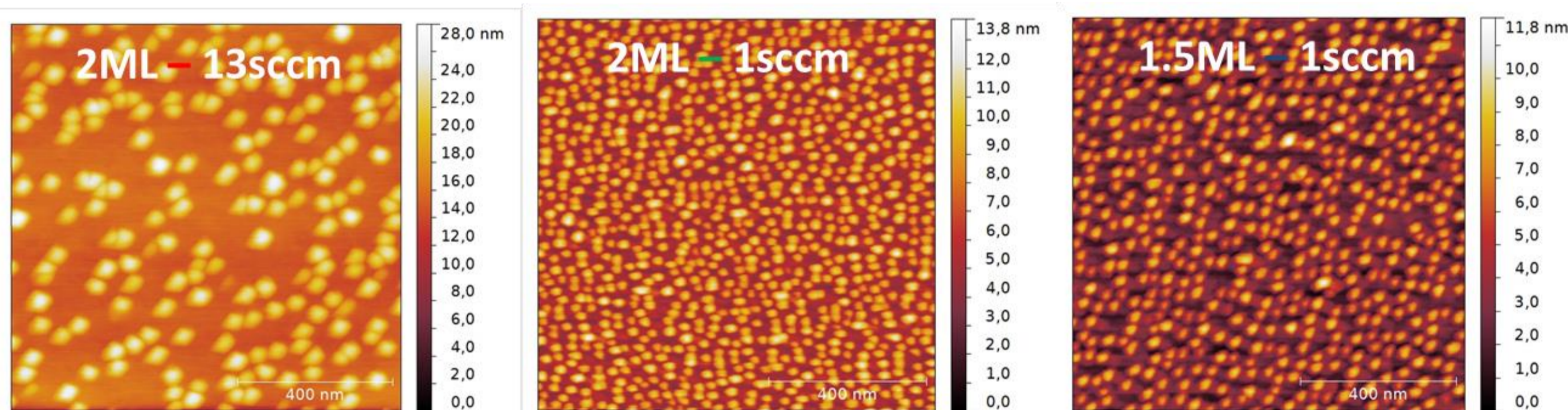
Weak Coupling



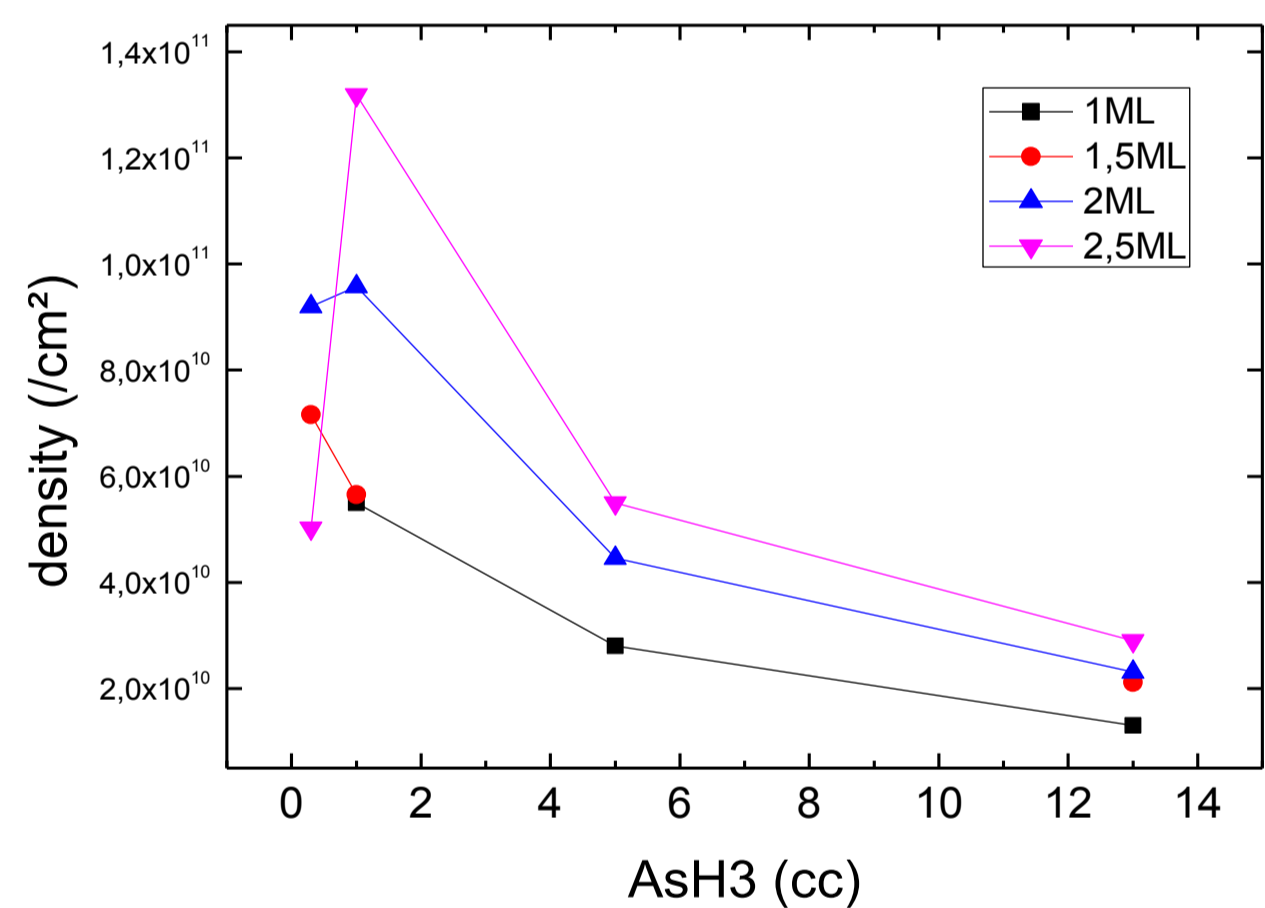
Homogeneous linewidth



Tuning of the QDs density - AFM

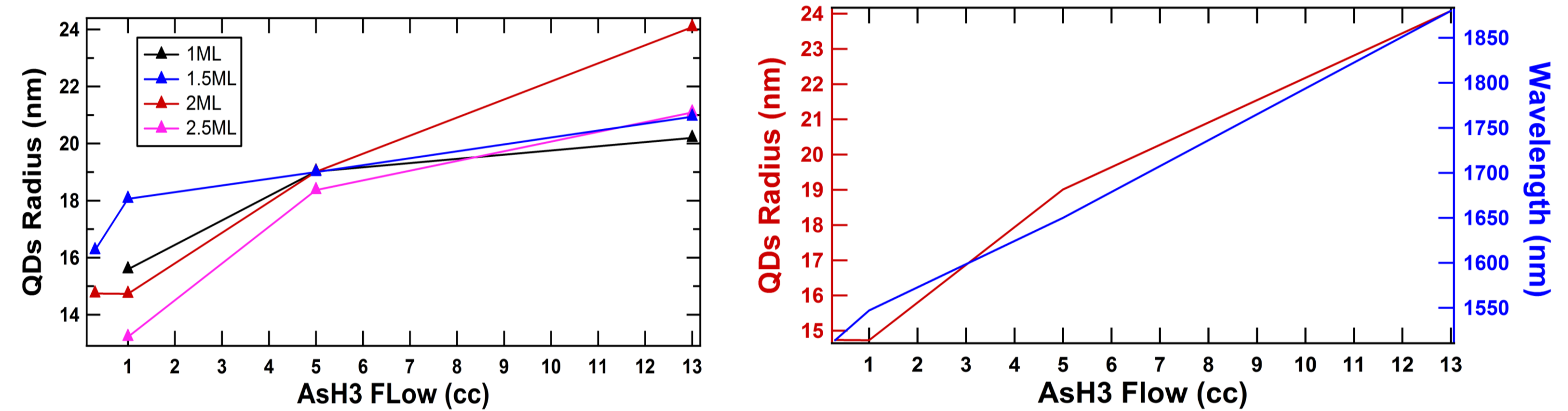


AFM images (1x1 μm²) of the InAs/InP Quantum Dots which have different growth parameters



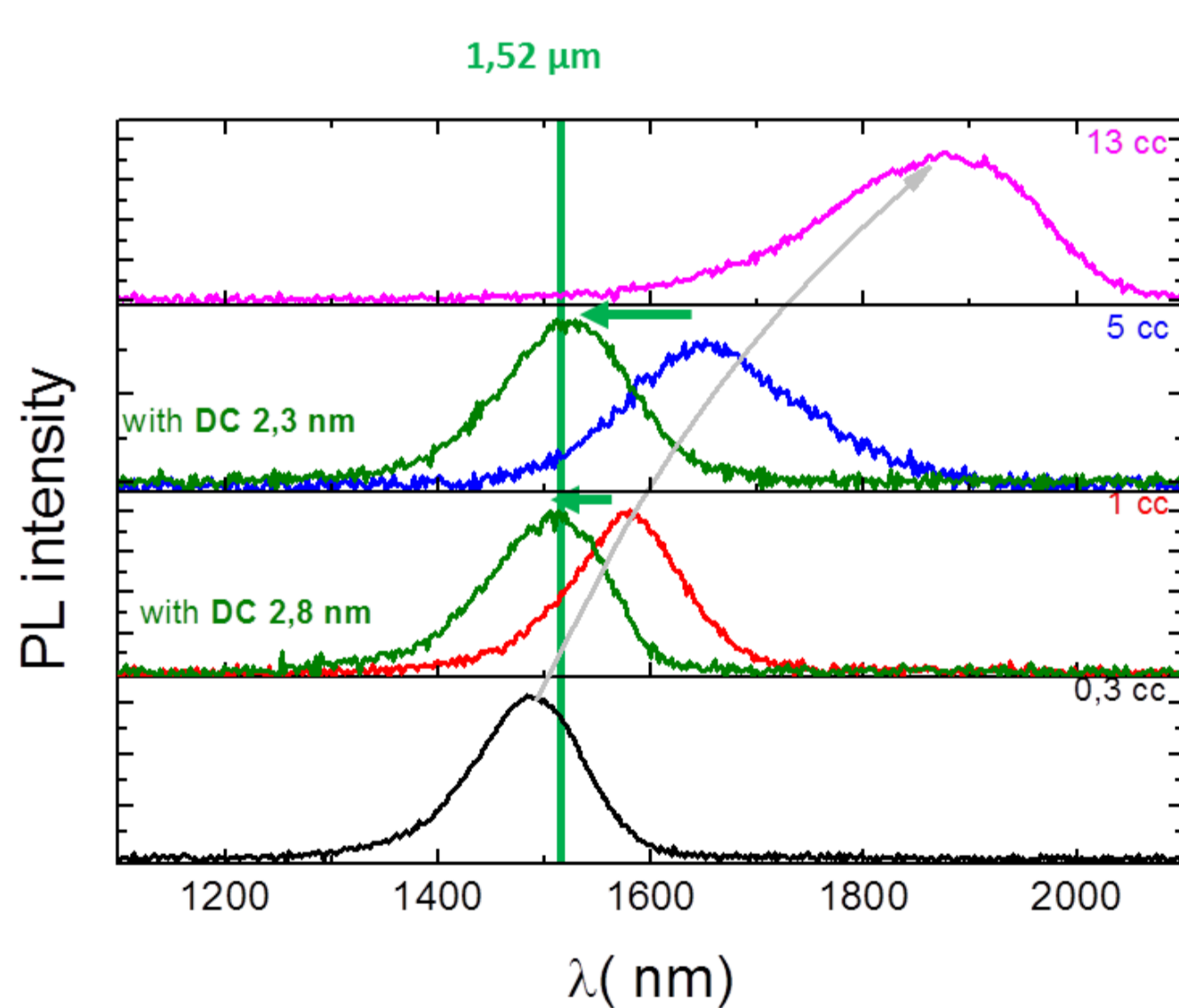
QDs density as a function of AsH₃ Flow
When the AsH₃ Flow increases, the QDs get bigger and the density greatly decreases (x10)

QDs size and emission wavelength



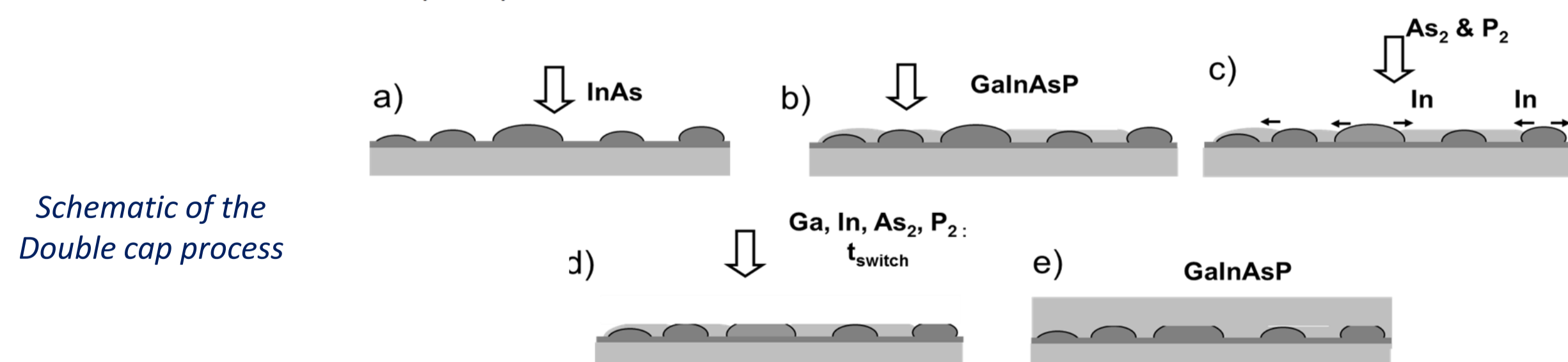
The radius of the QDs is bigger for higher flow
For 2ML: QDs radius and wavelength as a function of As Flow
Bigger QDs → Higher emission wavelength
QDs = self-assembled nanostructure → impossible to control the size and consequently the wavelength

Control of the wavelength – Double Cap



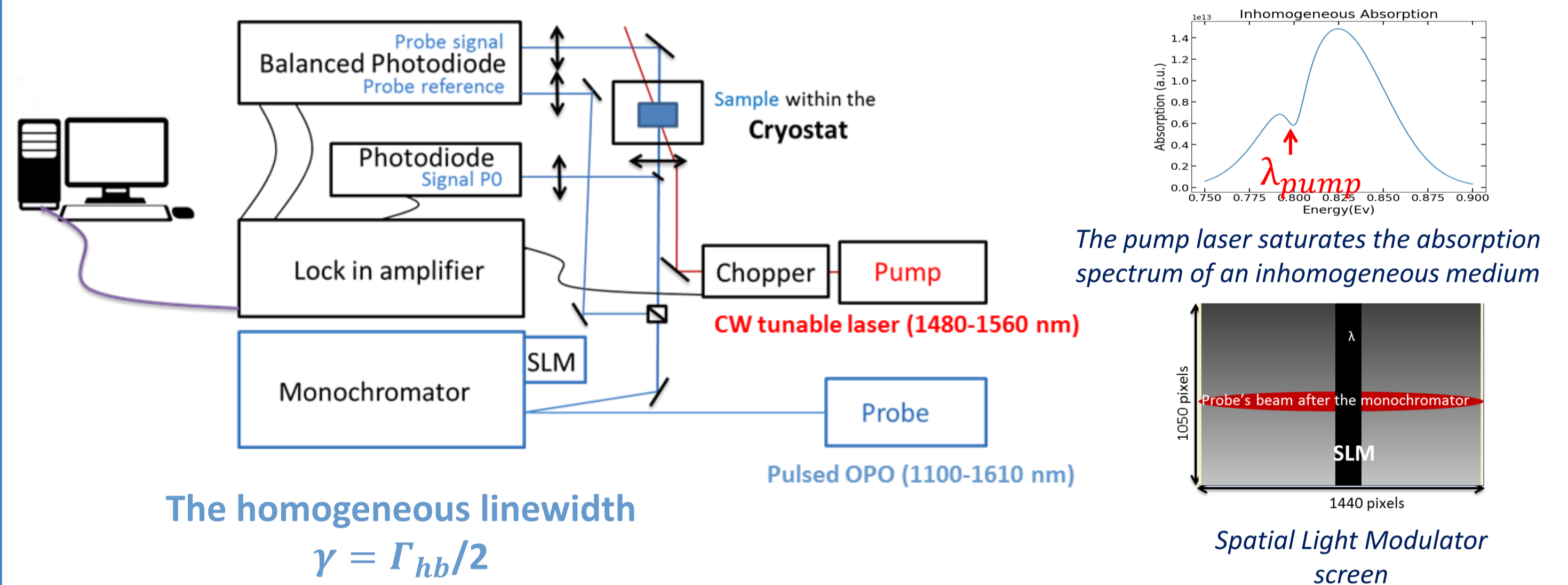
Emission Wavelength for different AsH₃ flow
QDs Wavelength: Tendency with growth parameters but impossibility to control it by only the growth

Double cap process



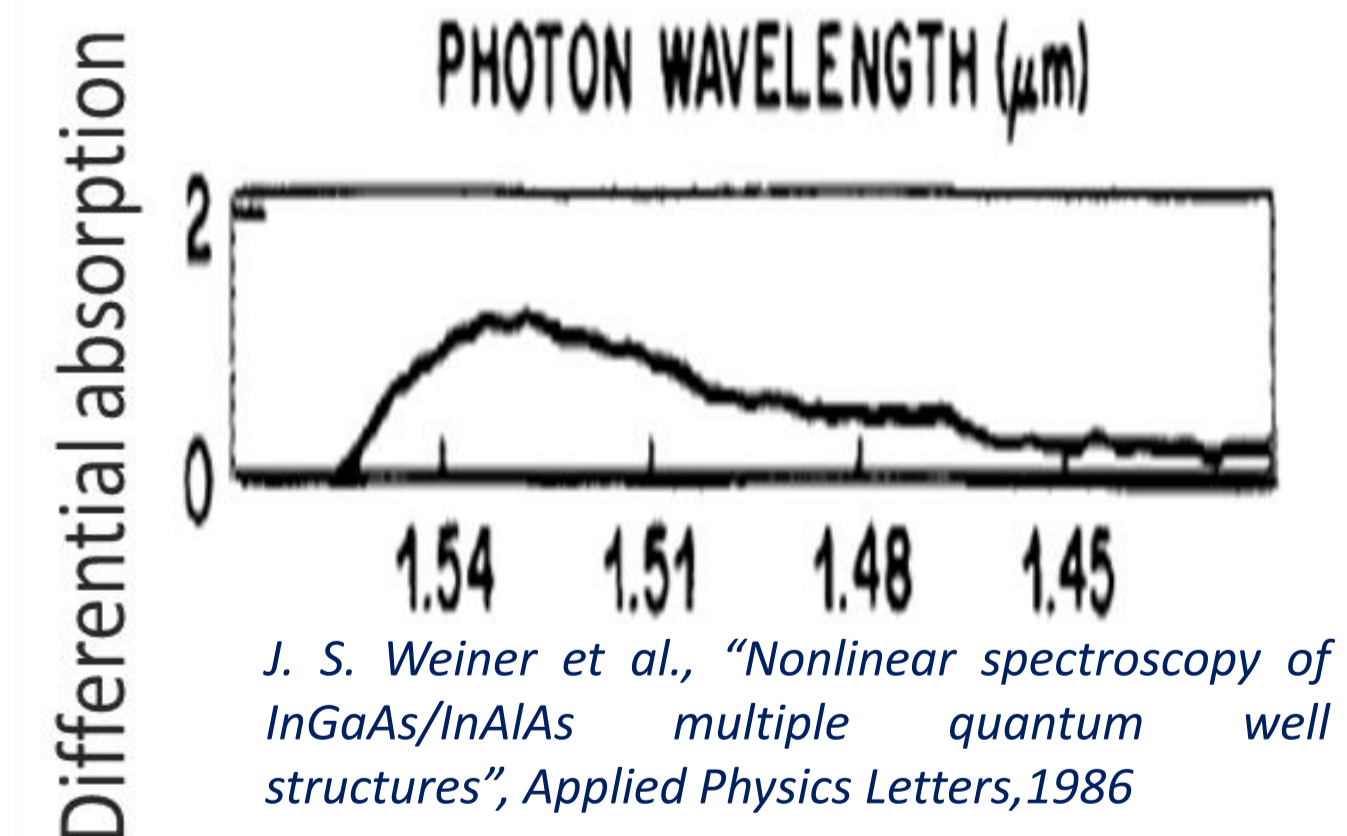
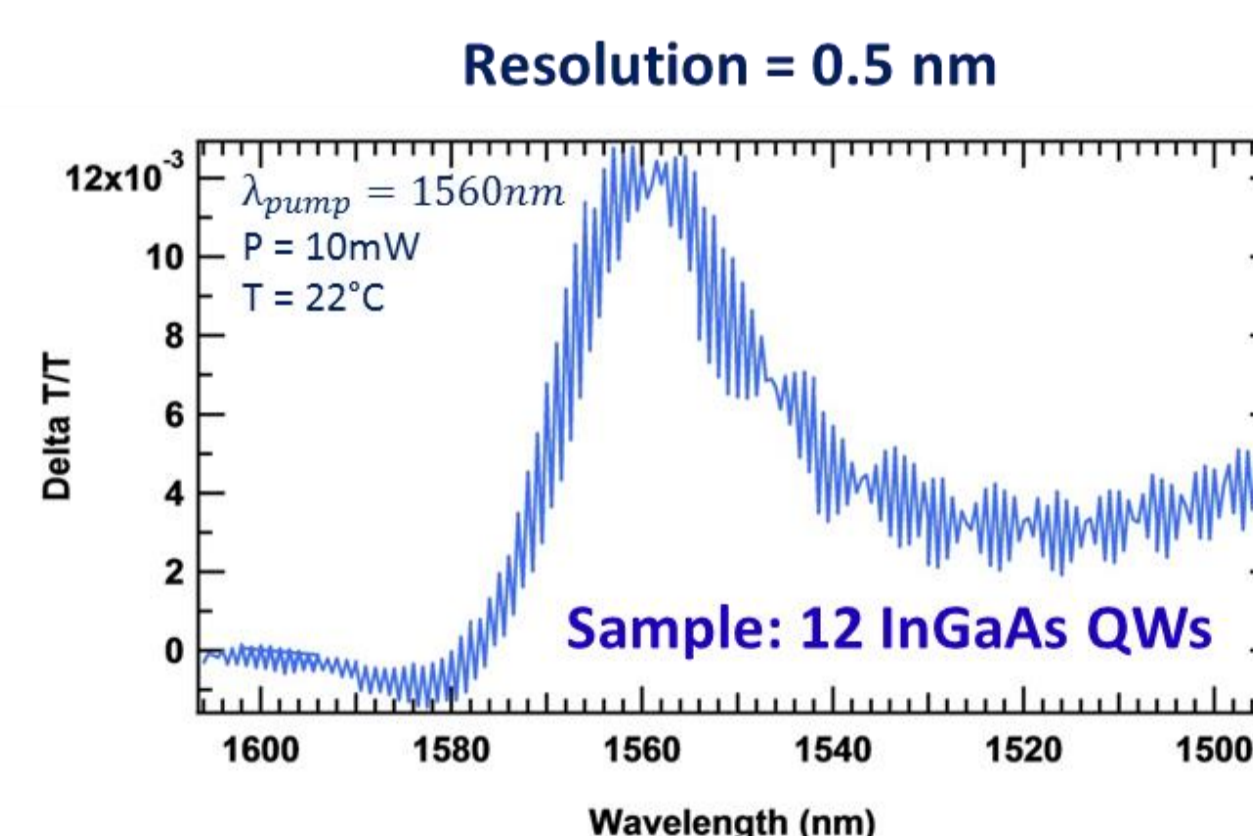
Spectral Hole Burning

Experimental Setup



The homogeneous linewidth
 $\gamma = \Gamma_{hb}/2$

Preliminary Results (on QWs)



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

Conclusion

- QDs density (and coupling) mainly controlled by the As flow: changed from 10¹¹ down to 10¹⁰ 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

Perspectives

- 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