Going to 2.1 µm for Space Quantum Key Distribution

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Quantum Key Distribution (QKD)

Cryptography

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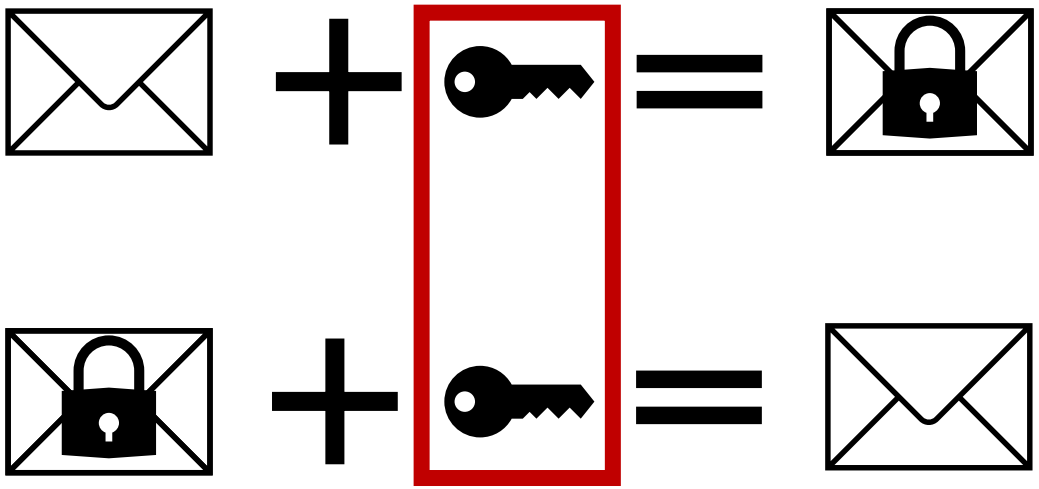
Cryptography



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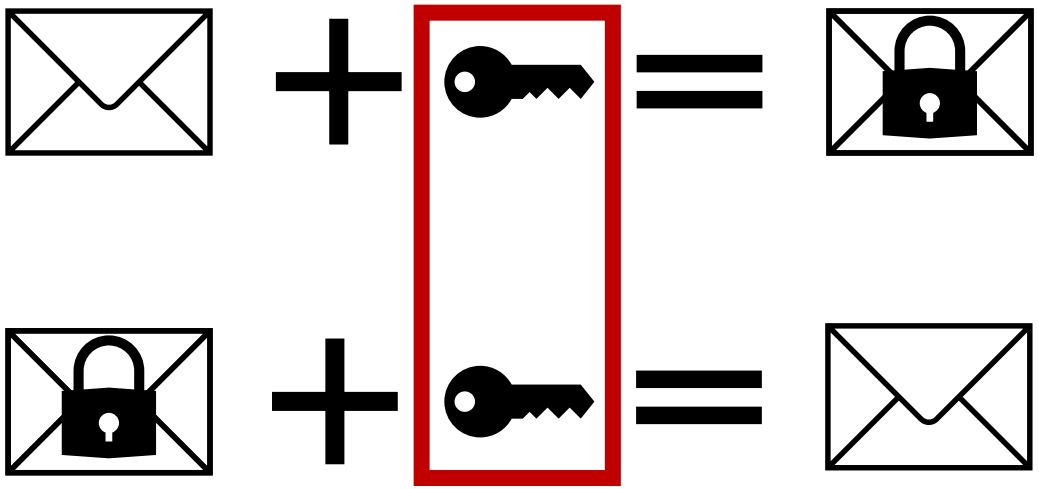
Cryptography



Threat

Quantum computer

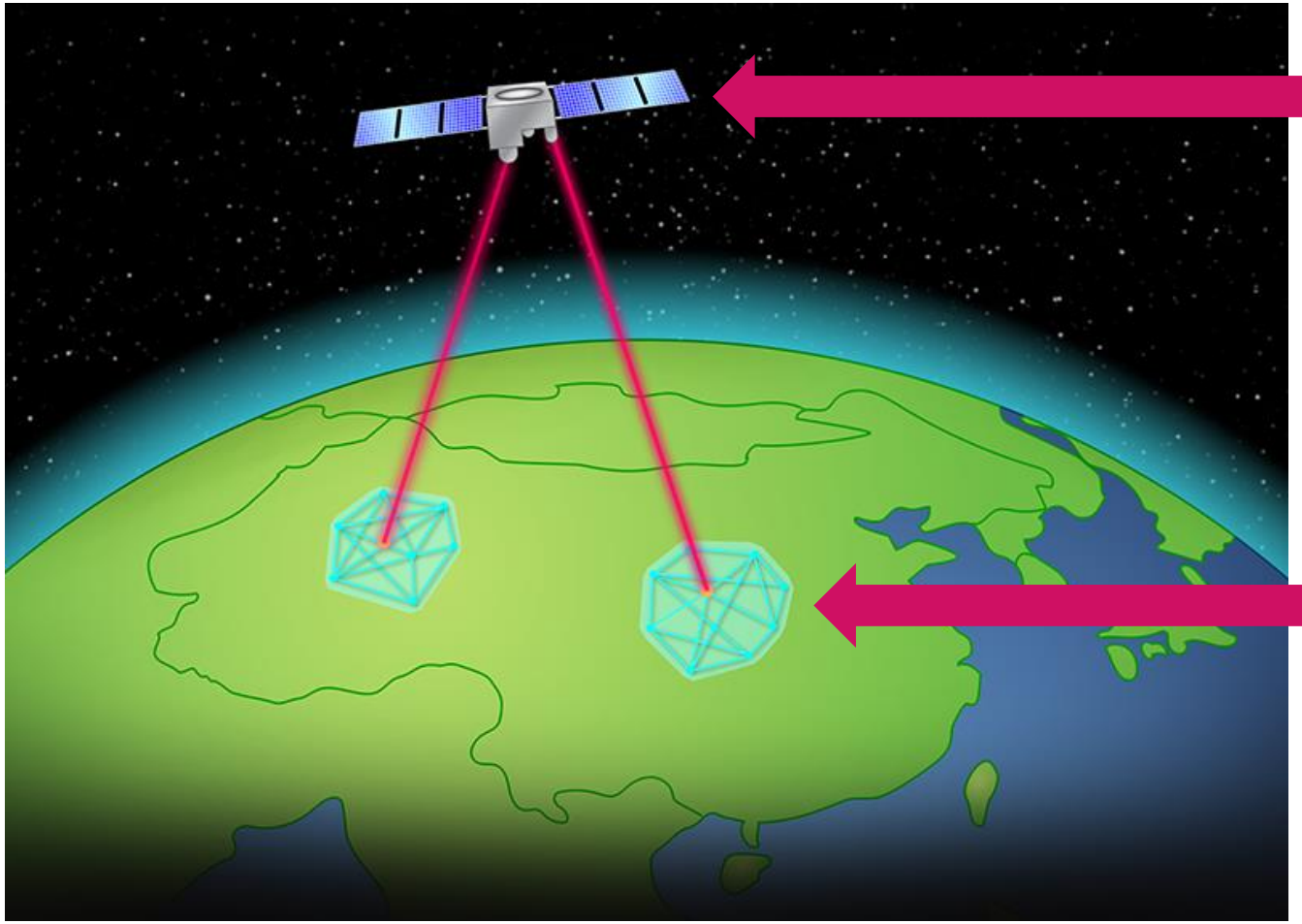
[IBM]

Network

Why going to space?

Two use cases :

1) Implement large scale links
2) Retrieve data gathered by satellites



Large scale free space link

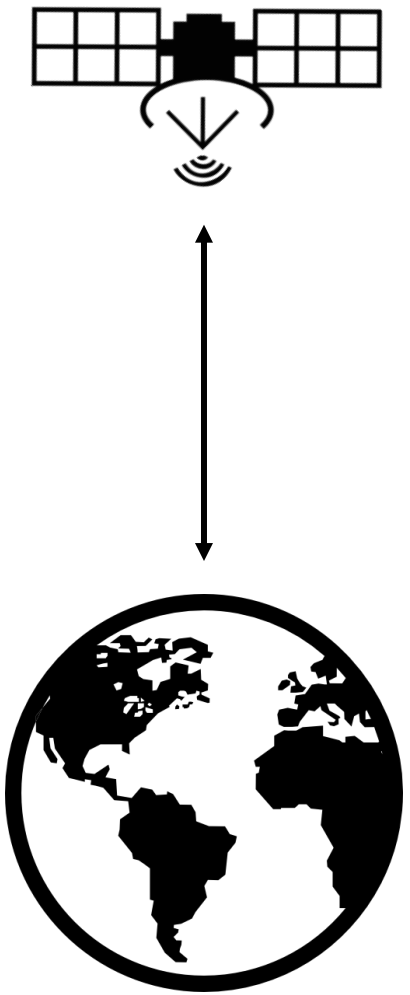
Small scale fiber link

[APS/Carin Cain]

Theoretical Model

1) Link distance :
   - Altitude of the satellite
   - Zenith angle
2) Atmosphere :
   - Absorption
   - Rayleigh & Mie scattering
3) Beam effects :
   - Gaussian divergence
   - Atmospheric turbulence
4) Noise :
   - Solar noise
   - Doppler effect
5) Telescopes :
   - Limited aperture

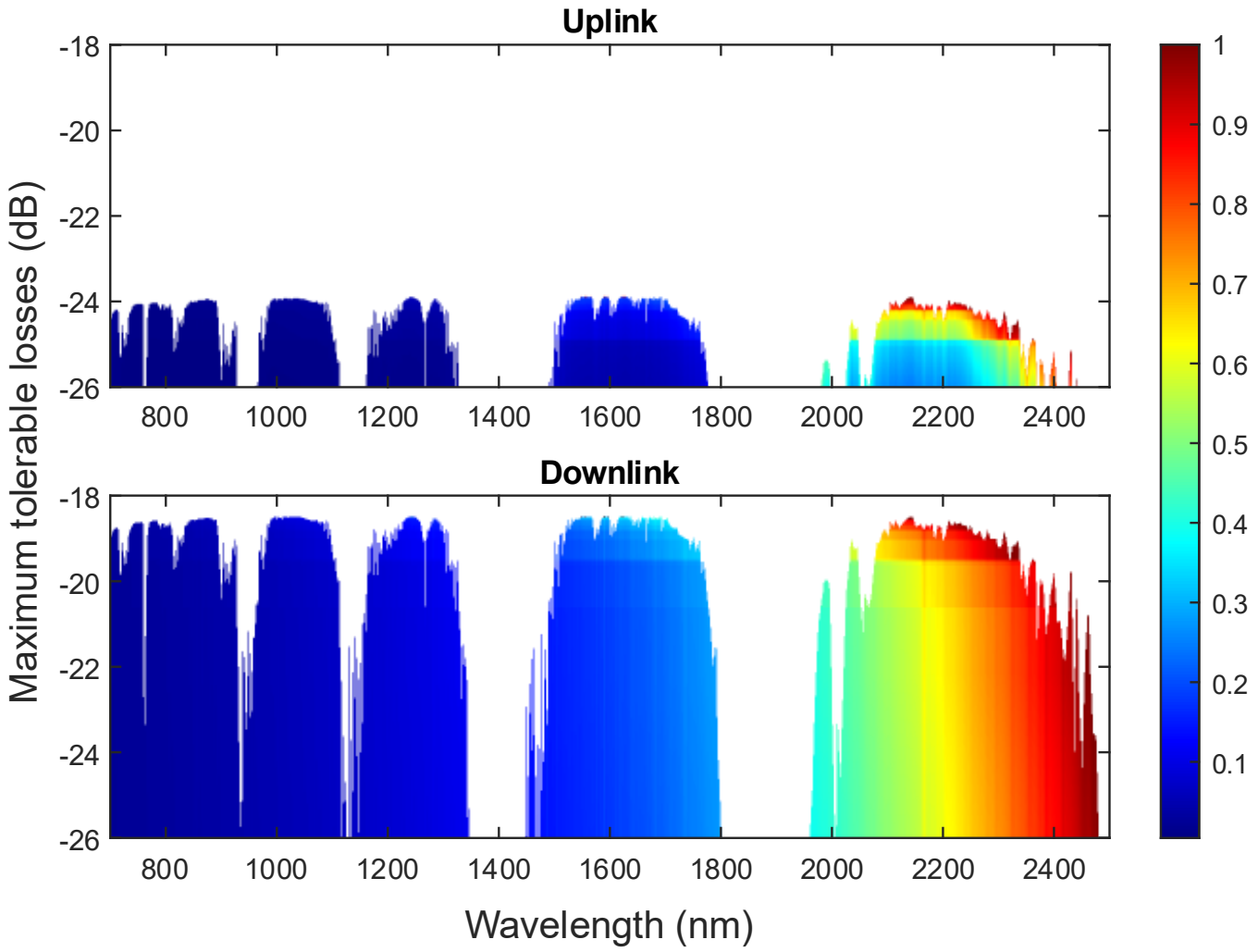
Wavelength dependency



Theoretical Model

Classical physics ✓

Quantum physics ✗



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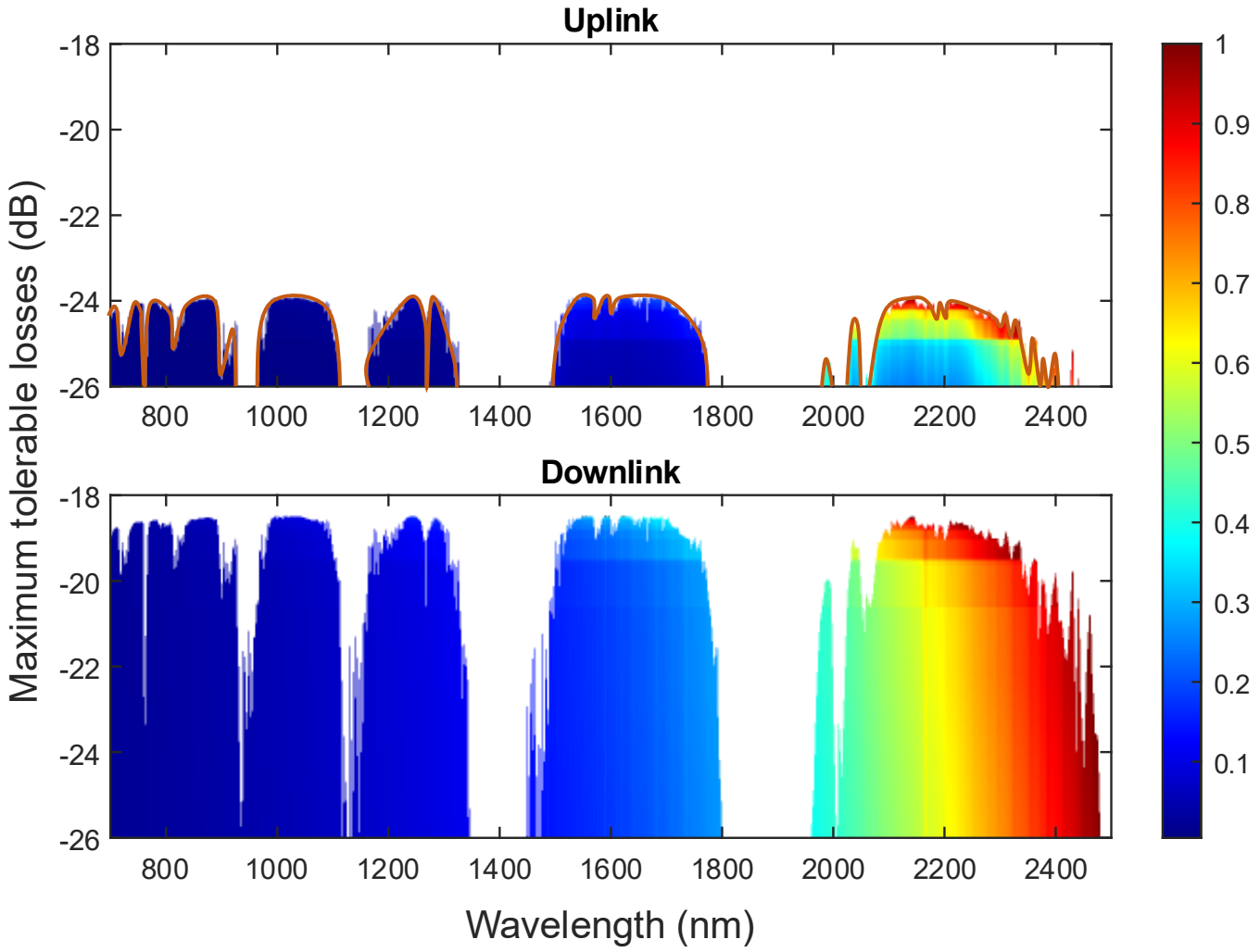

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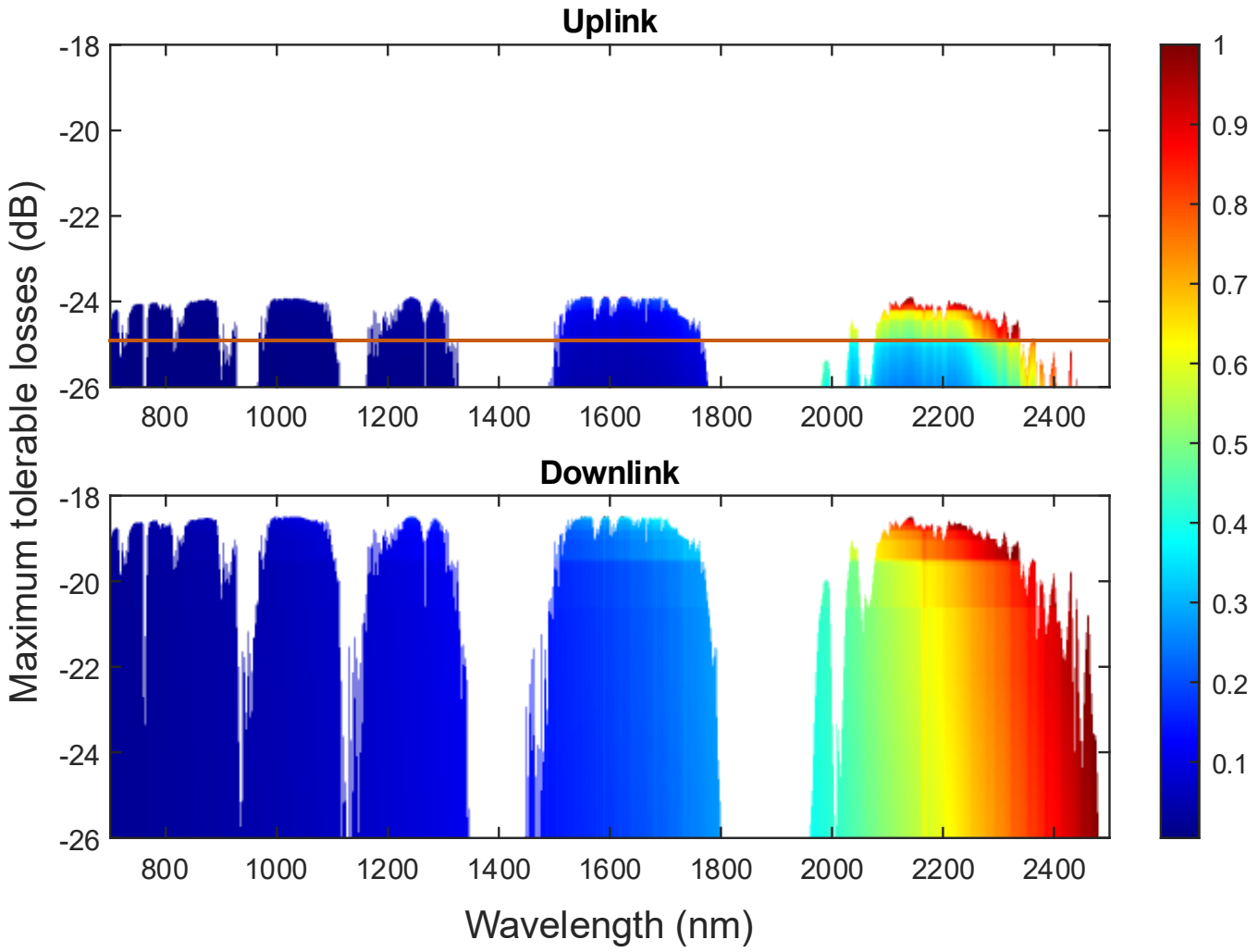

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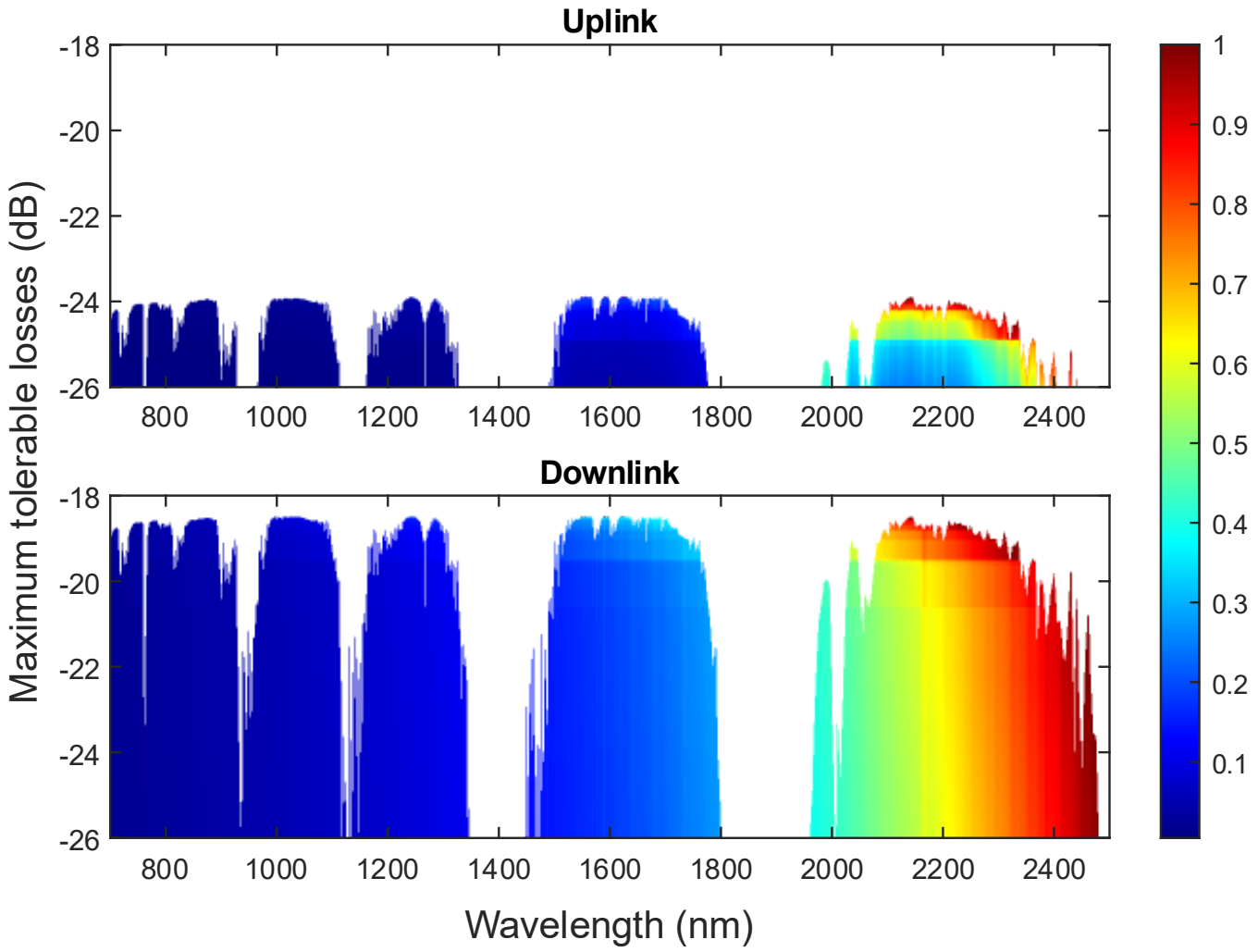
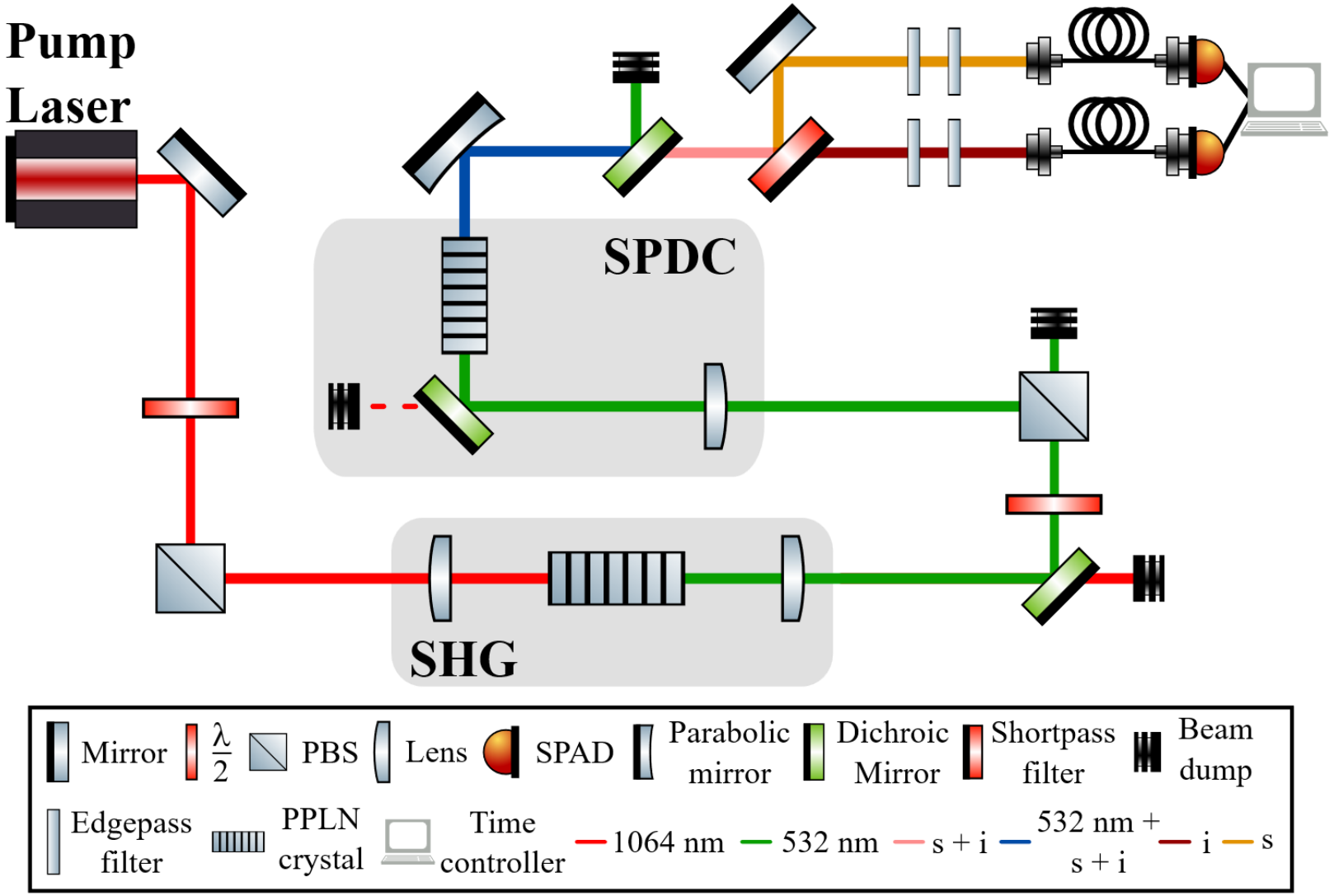
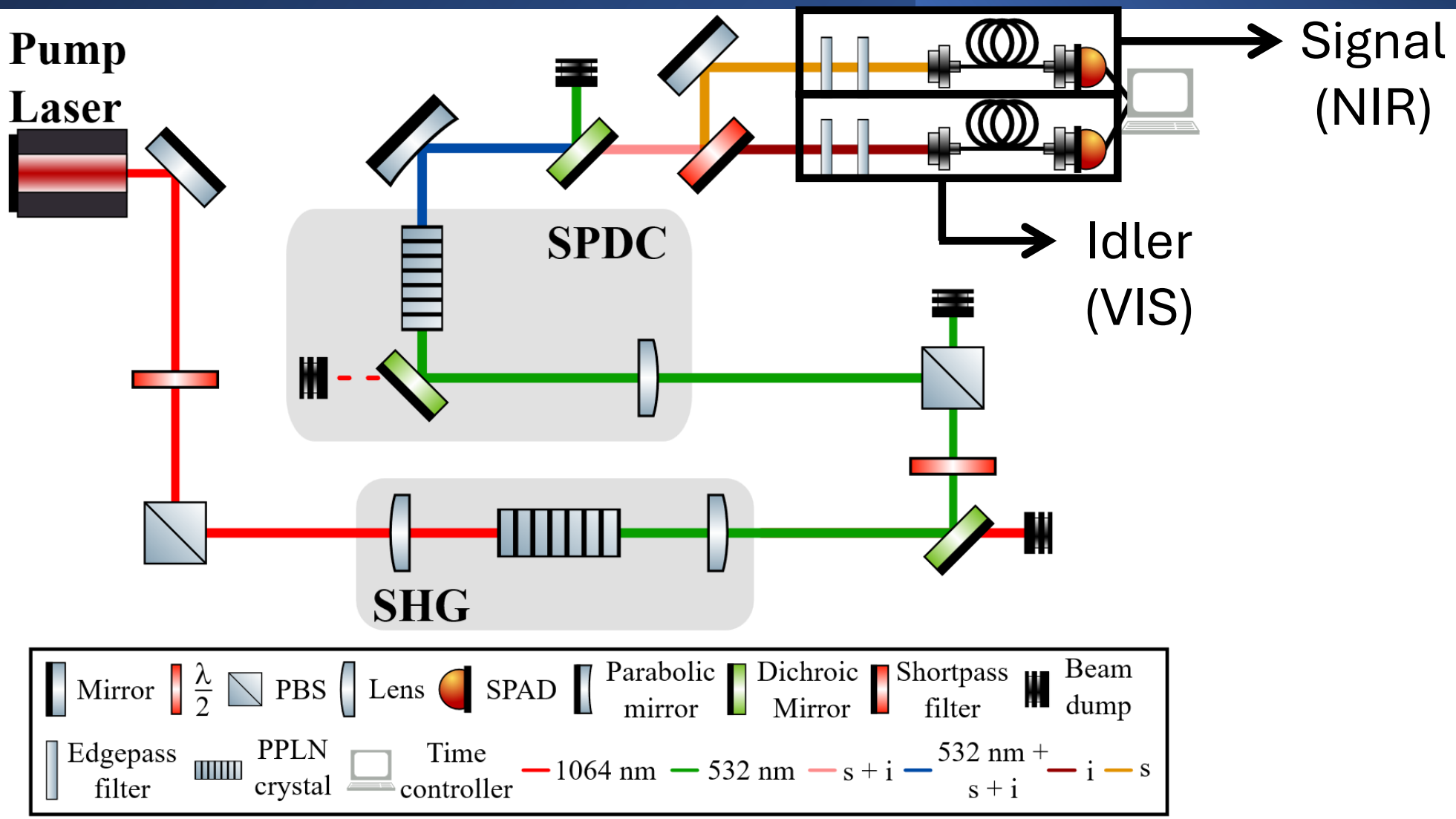


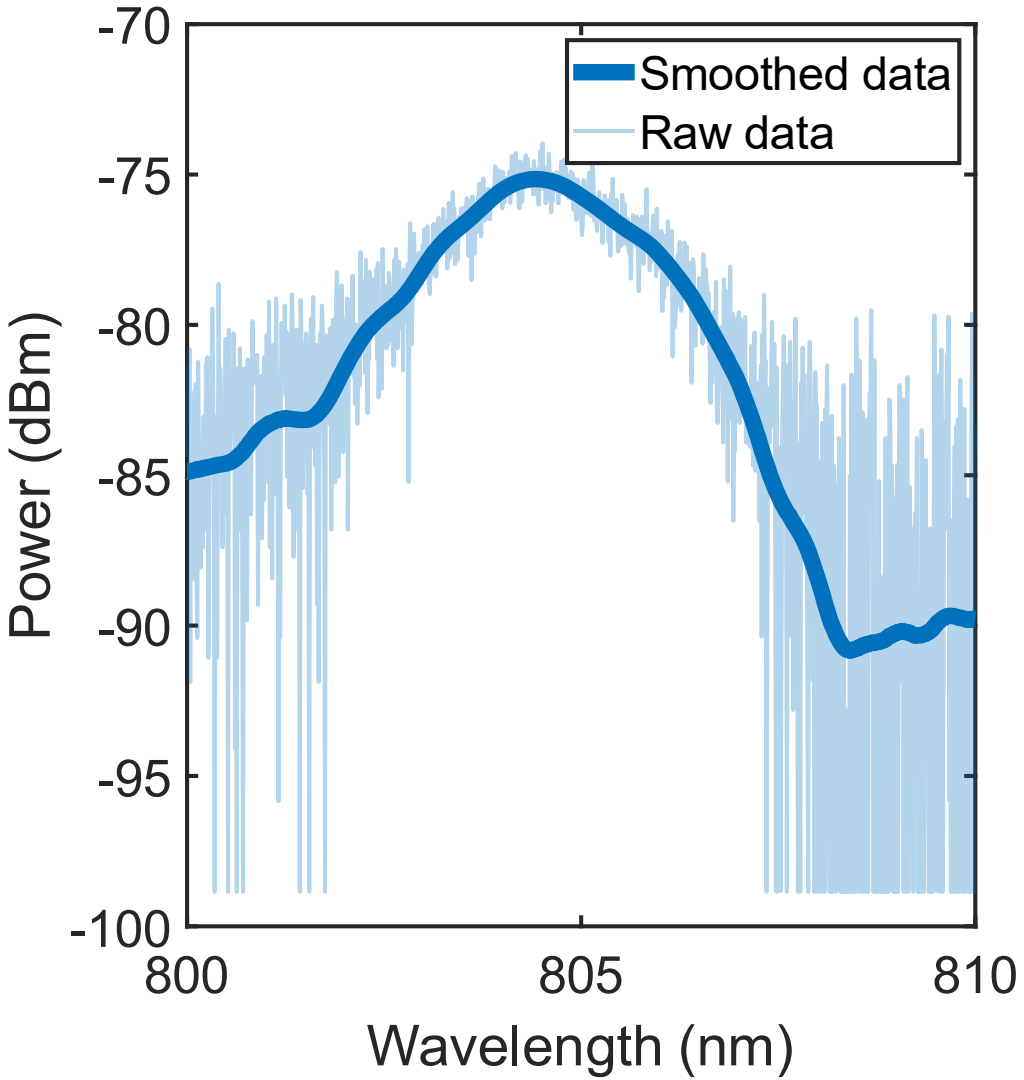
Optical set-up

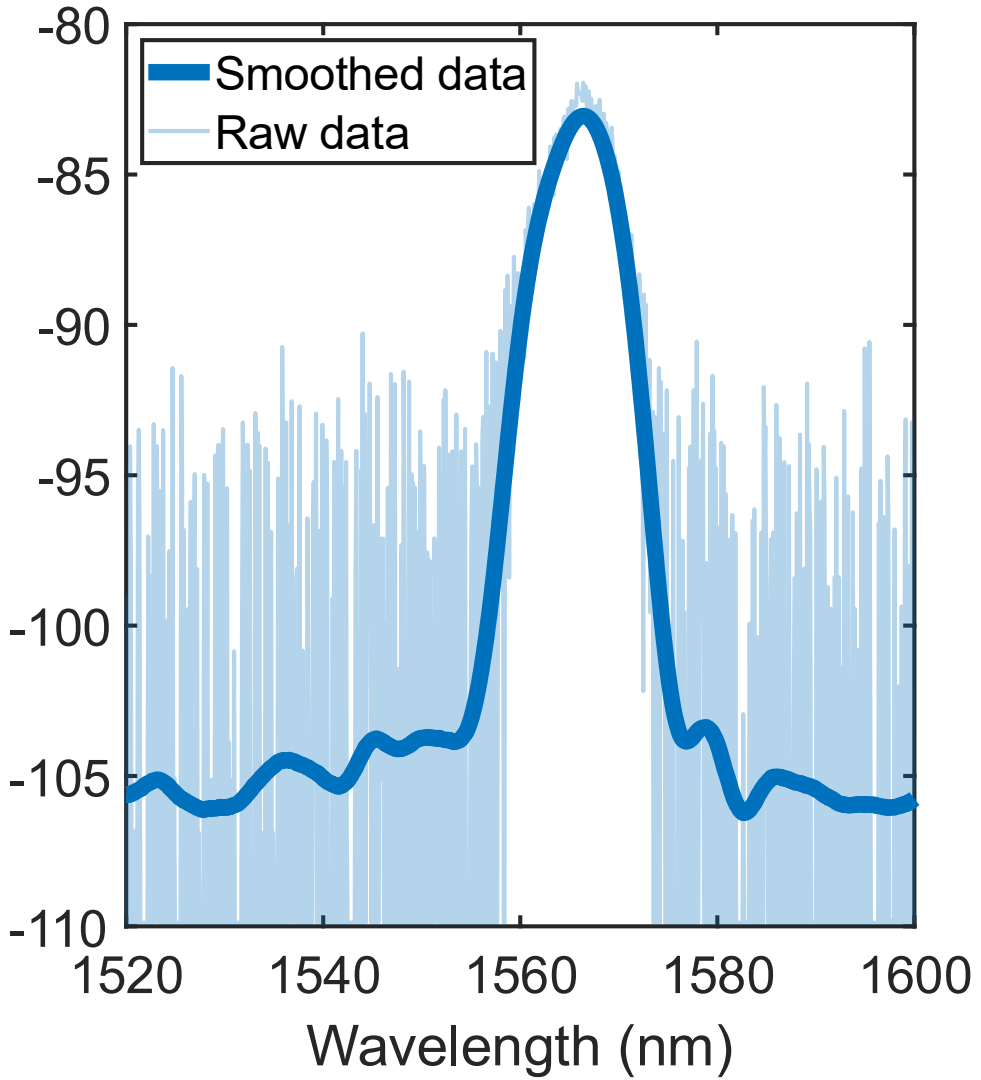


Optical set-up



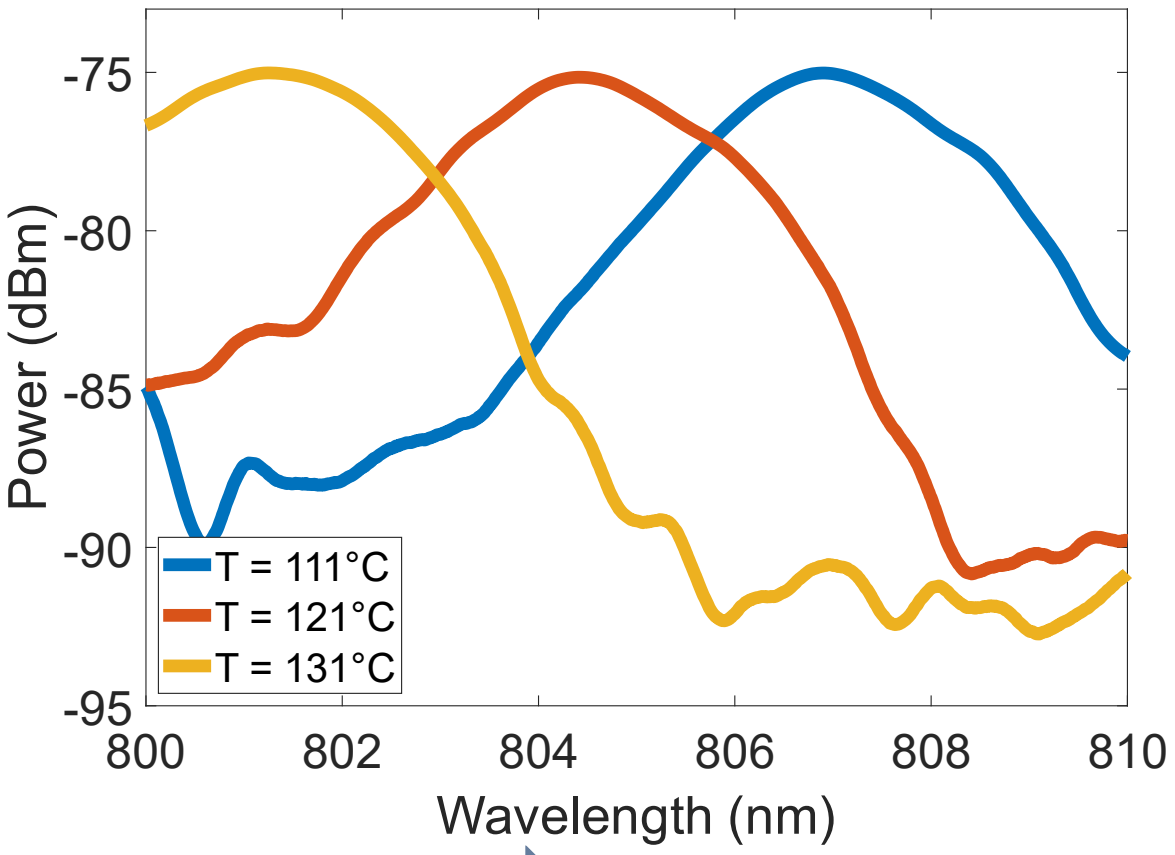
Photon pairs generation



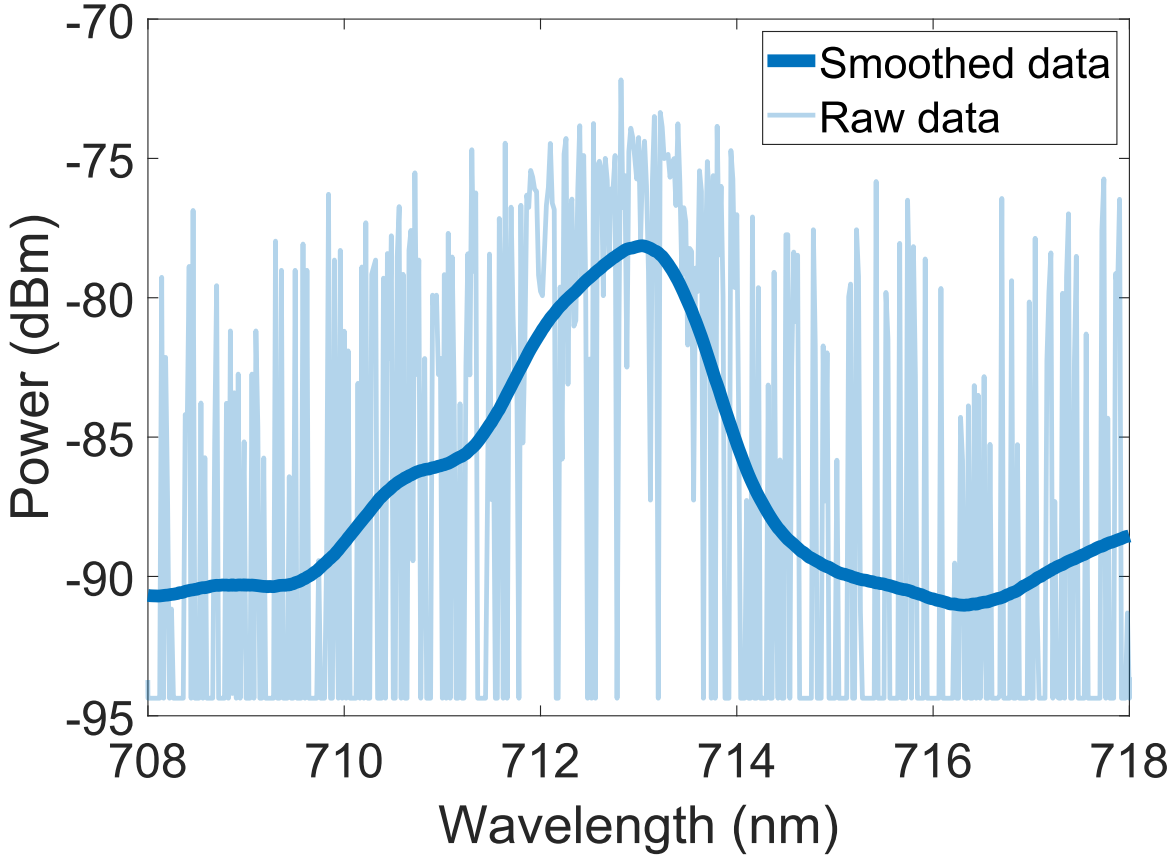


Wavelength tunability

Temperature variation

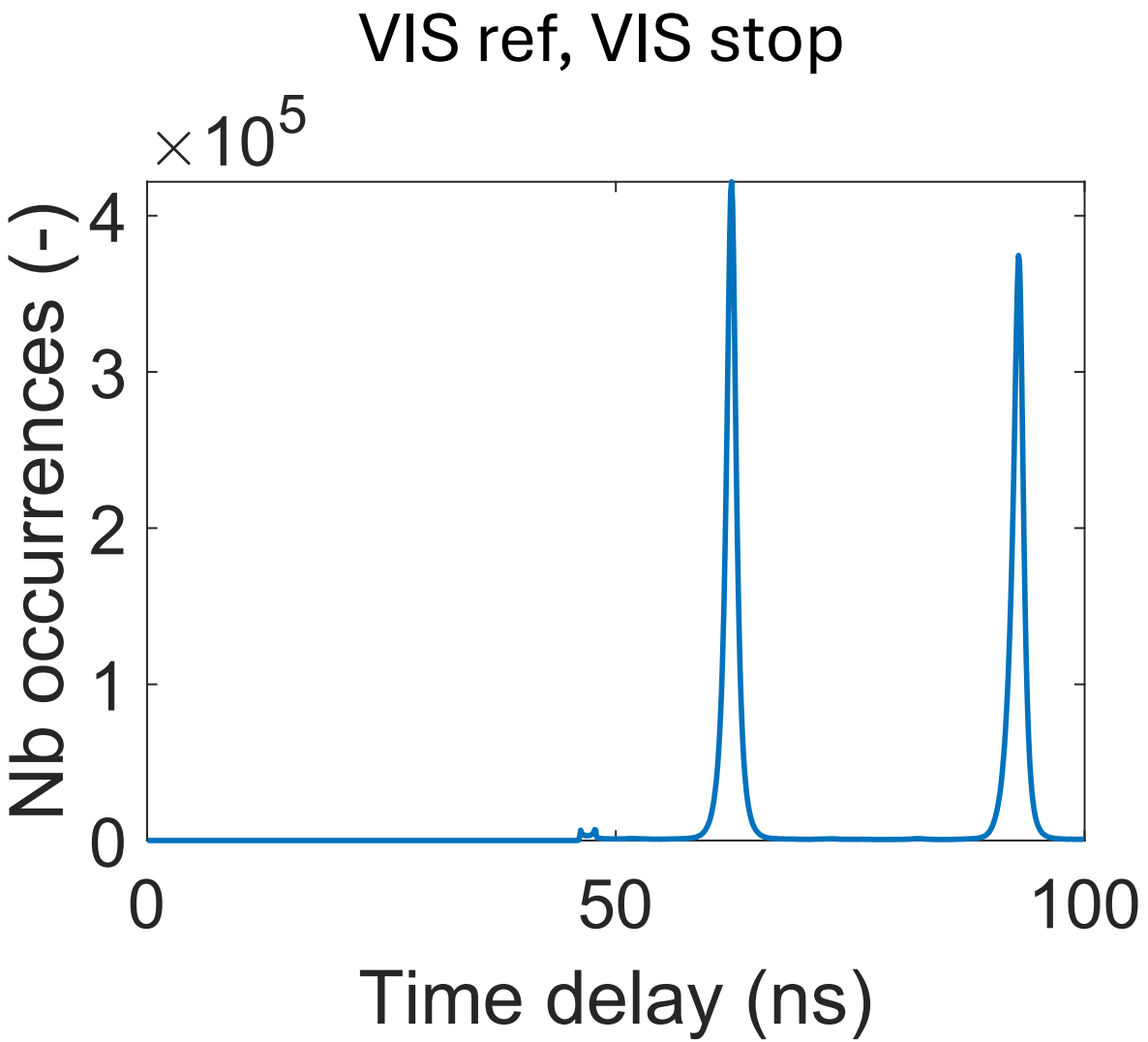


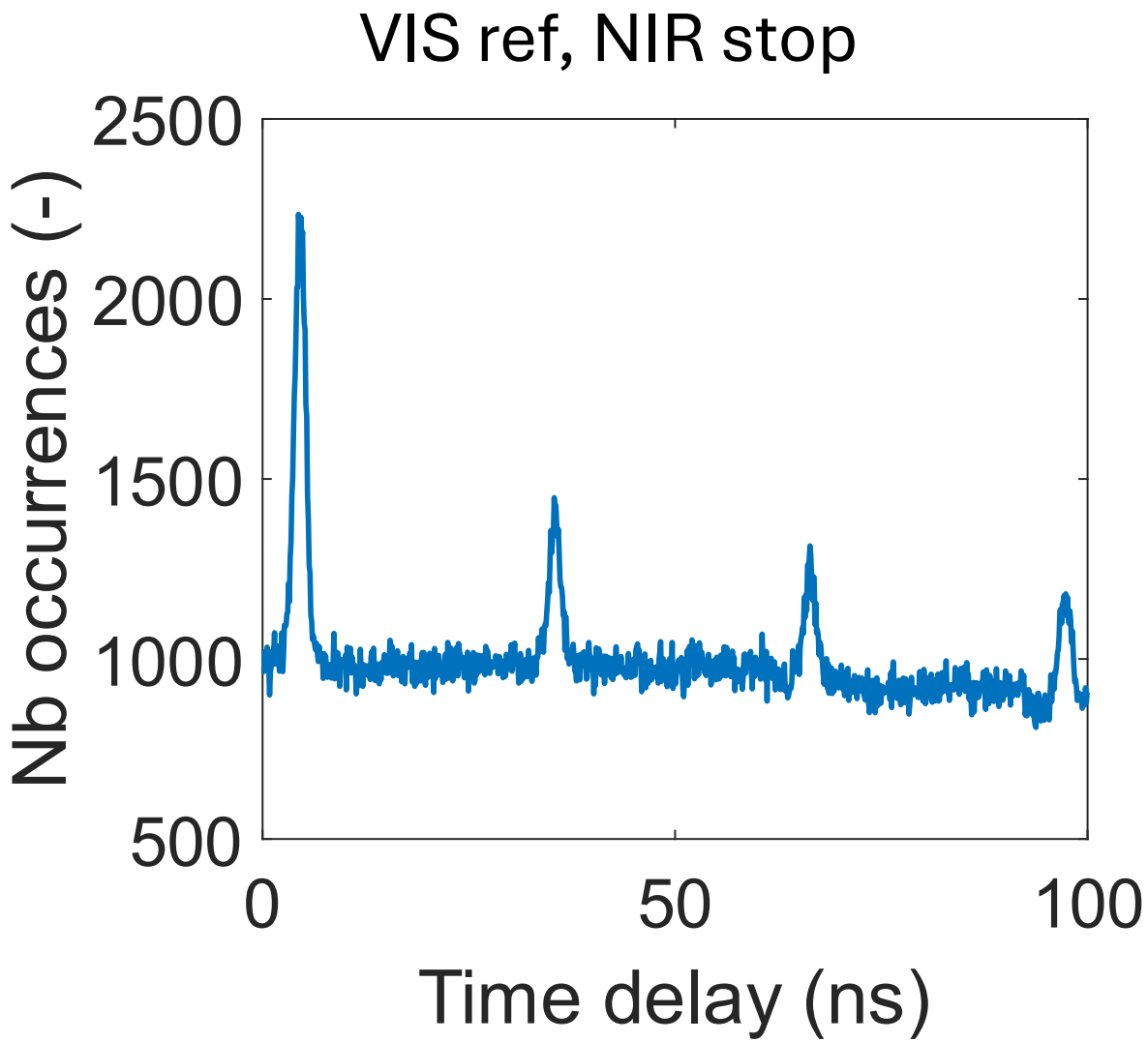
Launching in another grating



Signal photons from 1064 nm to 2360 nm

First correlation measurements





Perspectives

Link model

Quantum effects

Detectors errors

Photon source

Heralding efficiency

Pairs of single photons

Characterisation at other wavelengths

Focus on 2.1 µm

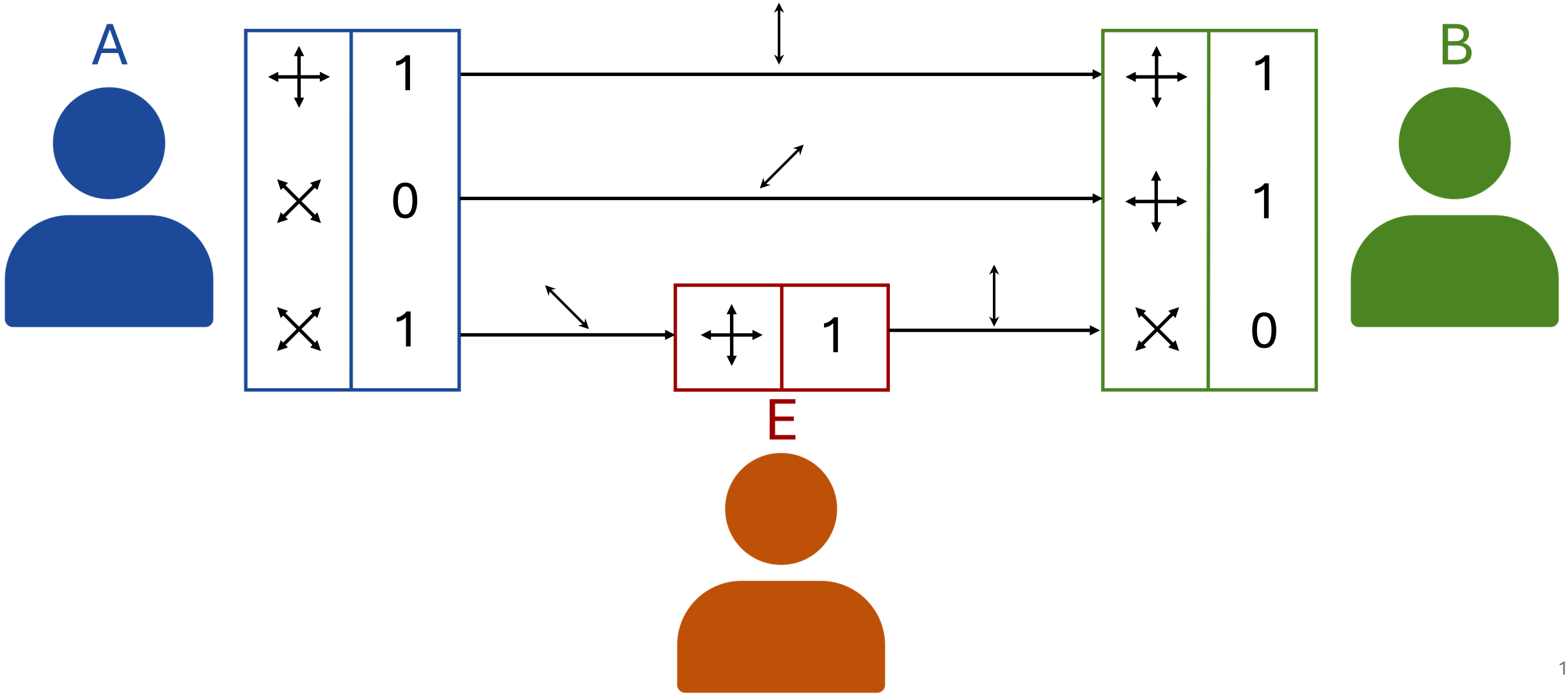
Special thanks

Part of this research is part of the Space4ReLaunch project, which is supported by the SPW Economie Emploi Recherche of the Walloon Region, under grant agreement no. 2210181.
More information is available at: *https://www.space4relaunch.be*.

Wallonie

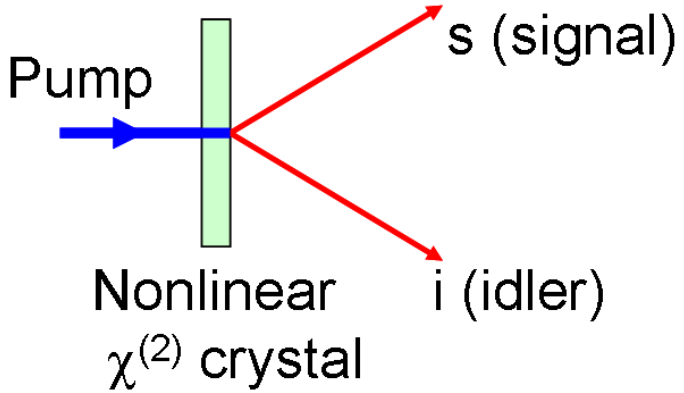
Thank you for your attention!

The BB84 protocol

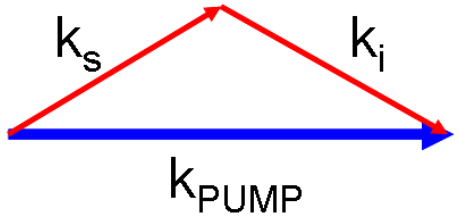


Spontaneous Parametric Down-Conversion

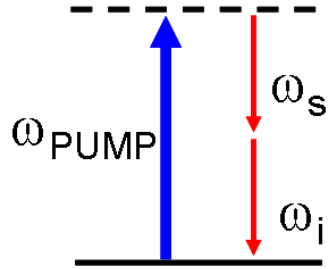
Spontaneous
Parametric
Downconversion



Momentum Conservation



Energy conservation



$$\varphi_{PUMP} = \varphi_s + \varphi_i$$