Mutual optical injection in coupled DBR laser pairs

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Collaboration

University of Essex

Design and testing of THz emitters based on photomixing

CIP technologies

Fabrication of THz devices and DBR laser pairs for photomixing

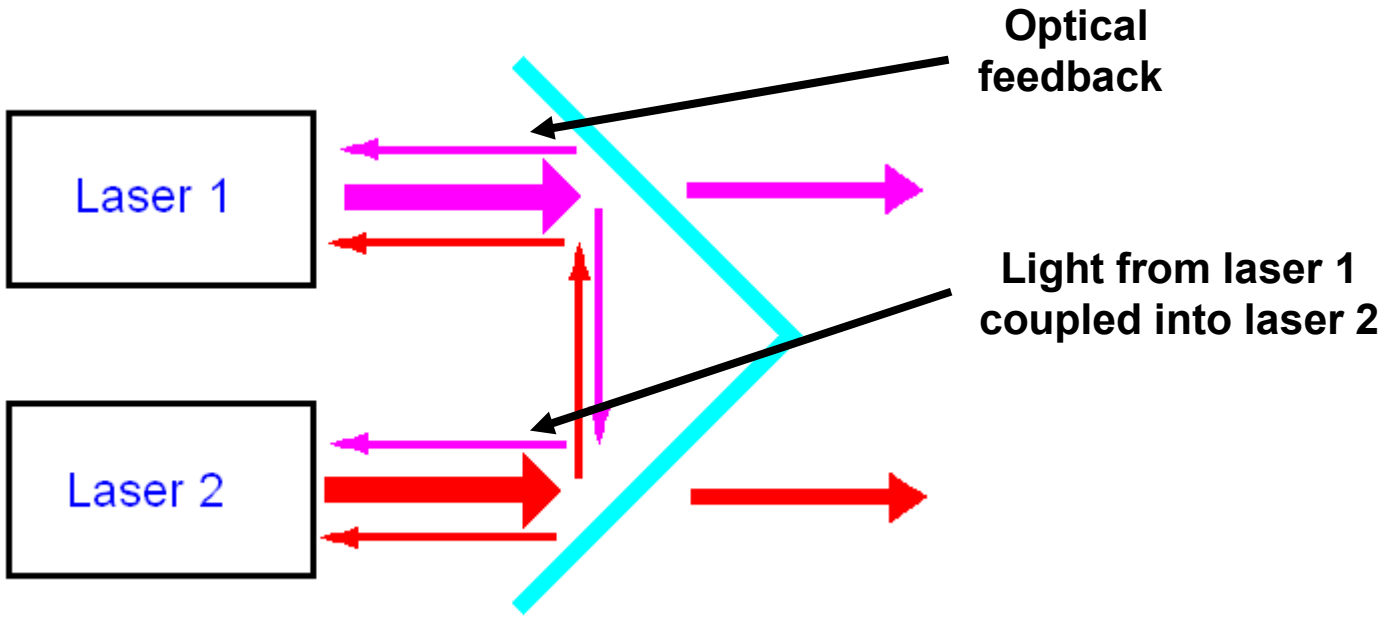
Part of the PORTRAIT project
(Portable Terahertz Systems Based on Advanced InP Technology)

Outline

- Mutual optical injection
- Description of device
- Experimental setup
- Nonlinear phenomena
- Conclusions

Mutual optical injection

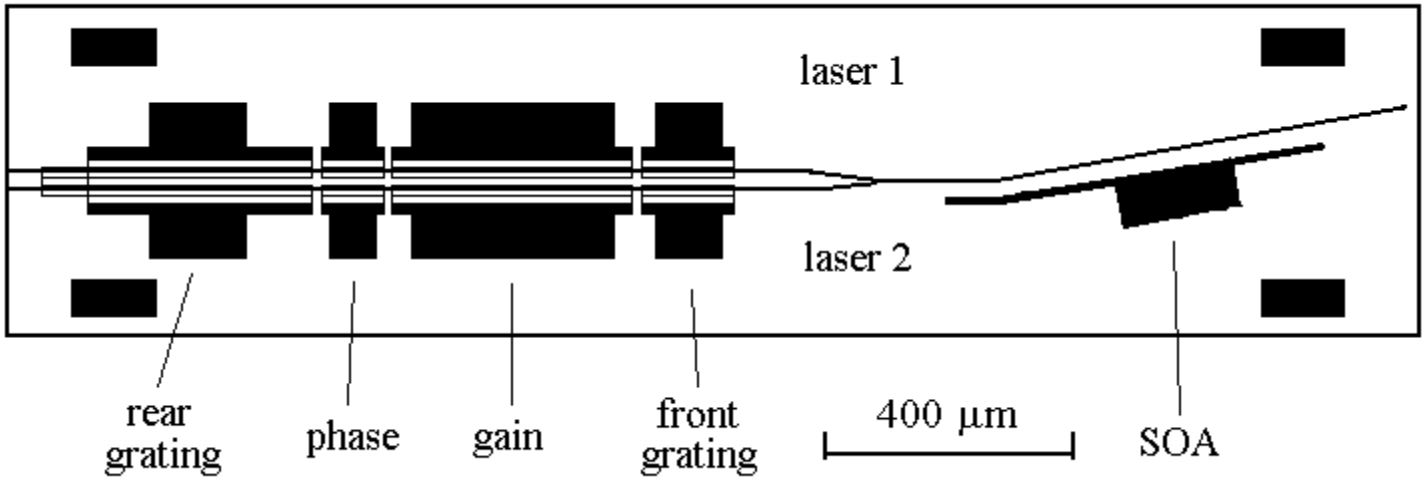
Schematic mutual optical injection (including optical feedback)



Potential applications:

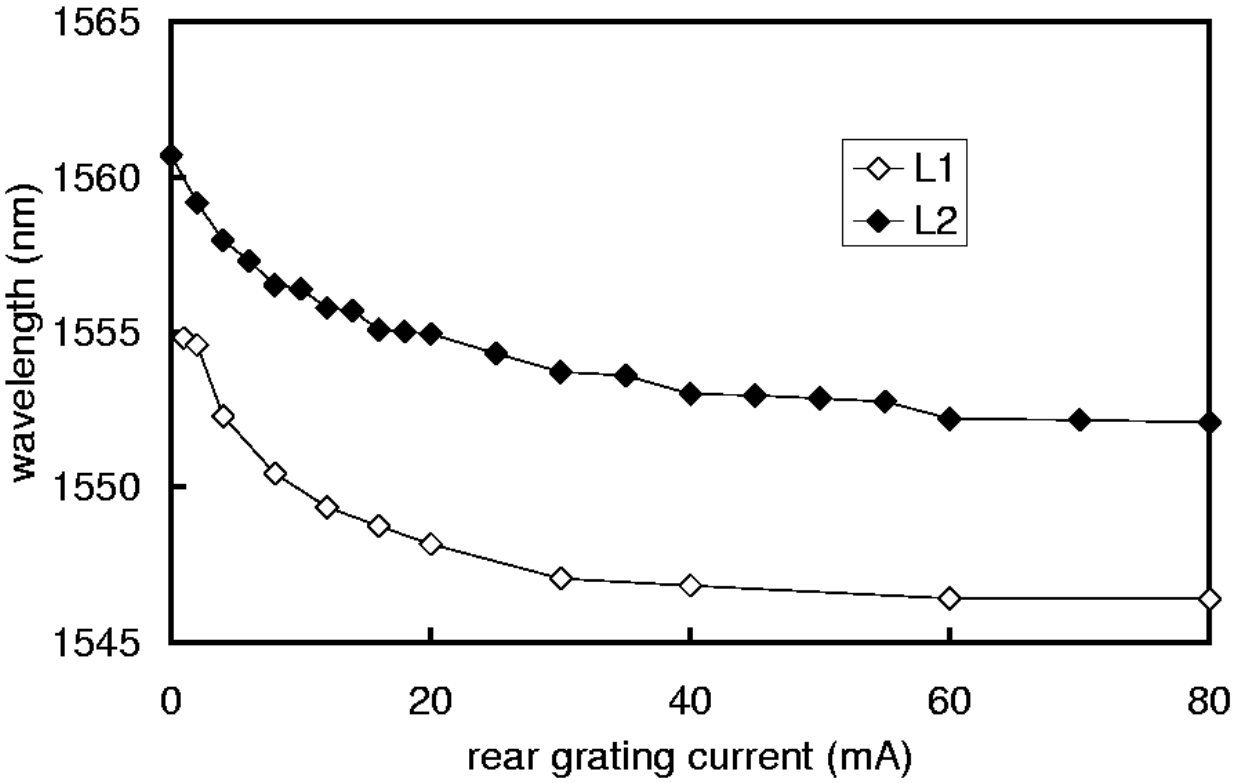
- Noise reduction
- Frequency stabilisation in phase-locking regime
- Cryptographic applications based on chaotic communications

Schematic of device



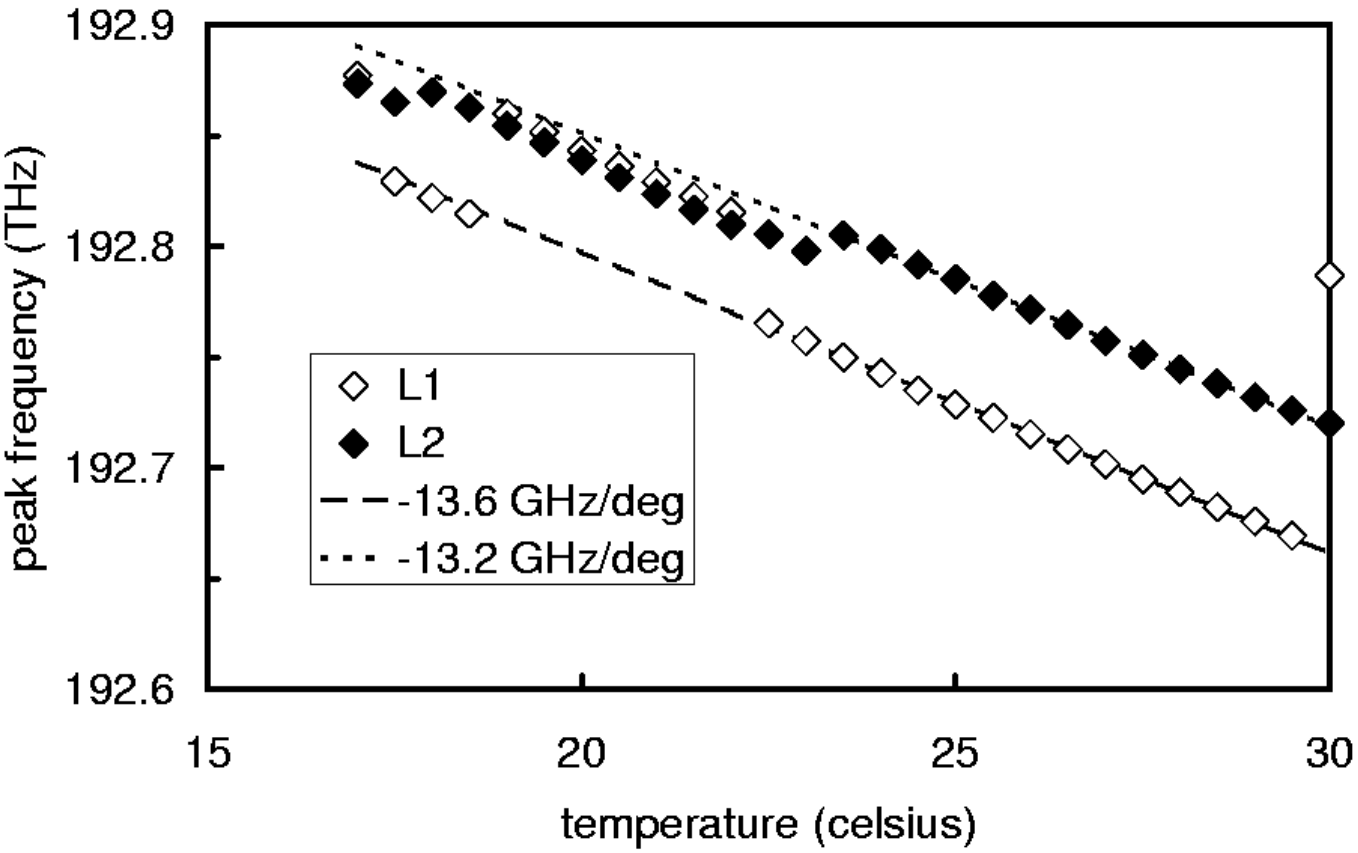
Schematic of the twin DBR device showing contacts and waveguide (to scale)

Electrical tuning curves



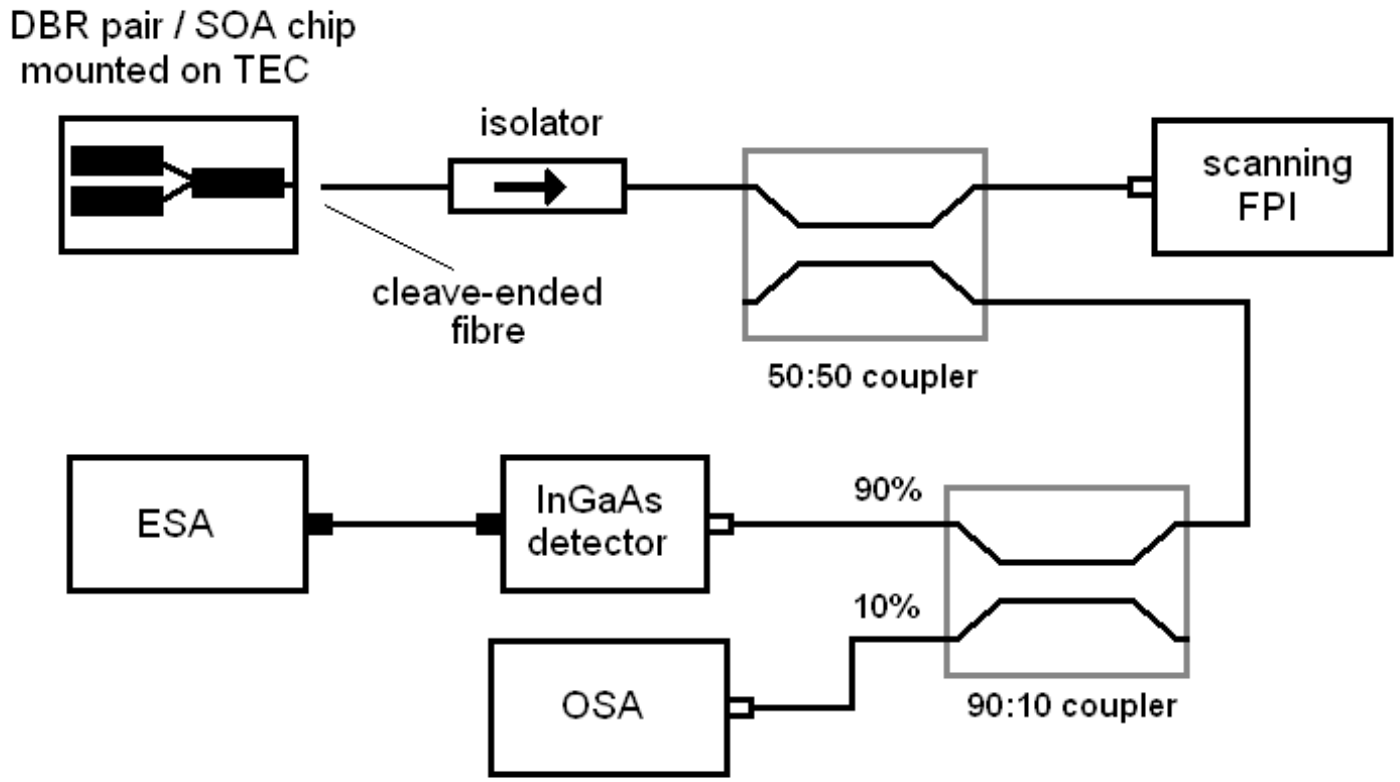
Electrical tuning curves for the lasers.

Temperature tuning



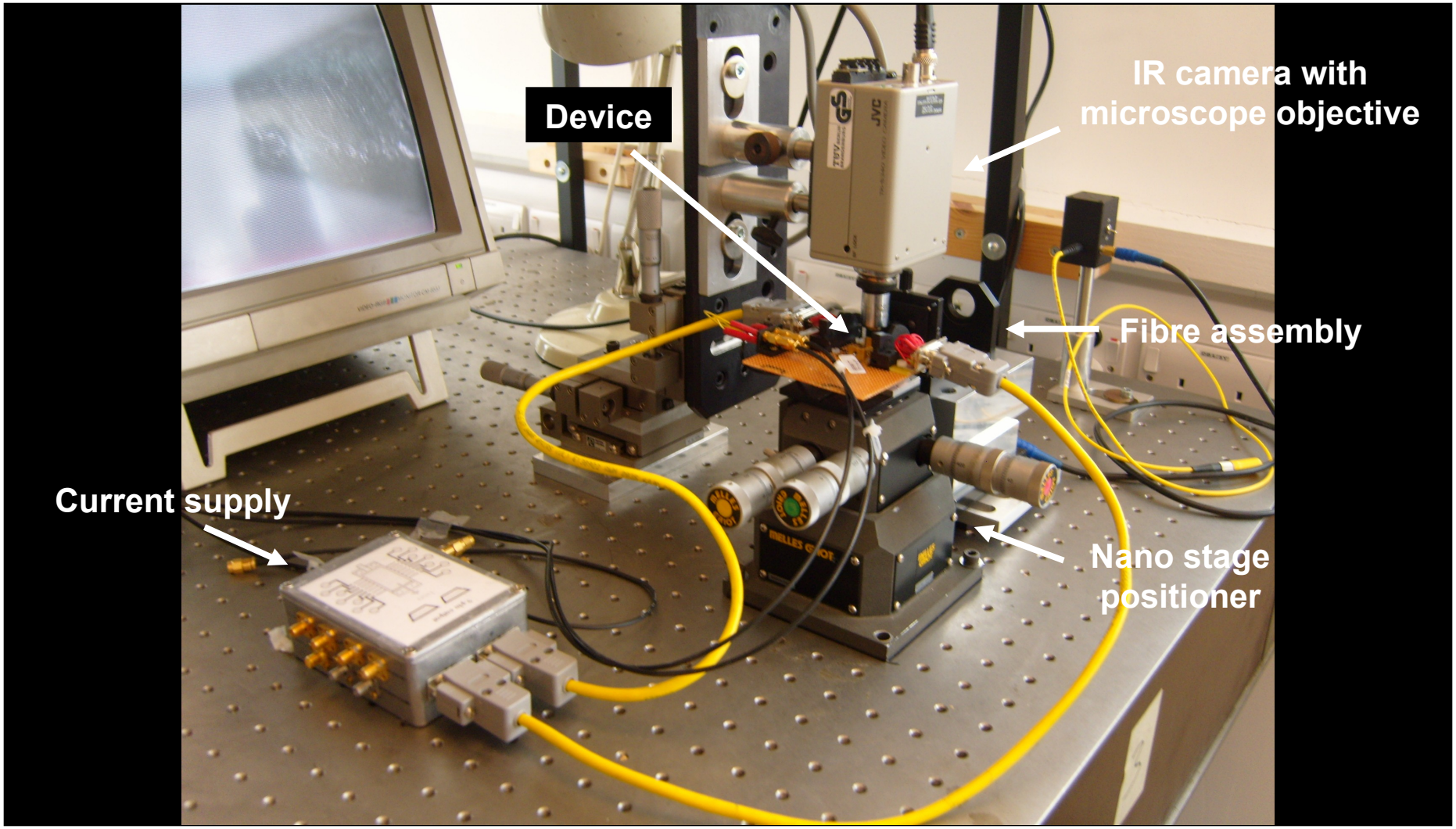
Temperature tuning of the DBR lasers.

Experimental setup

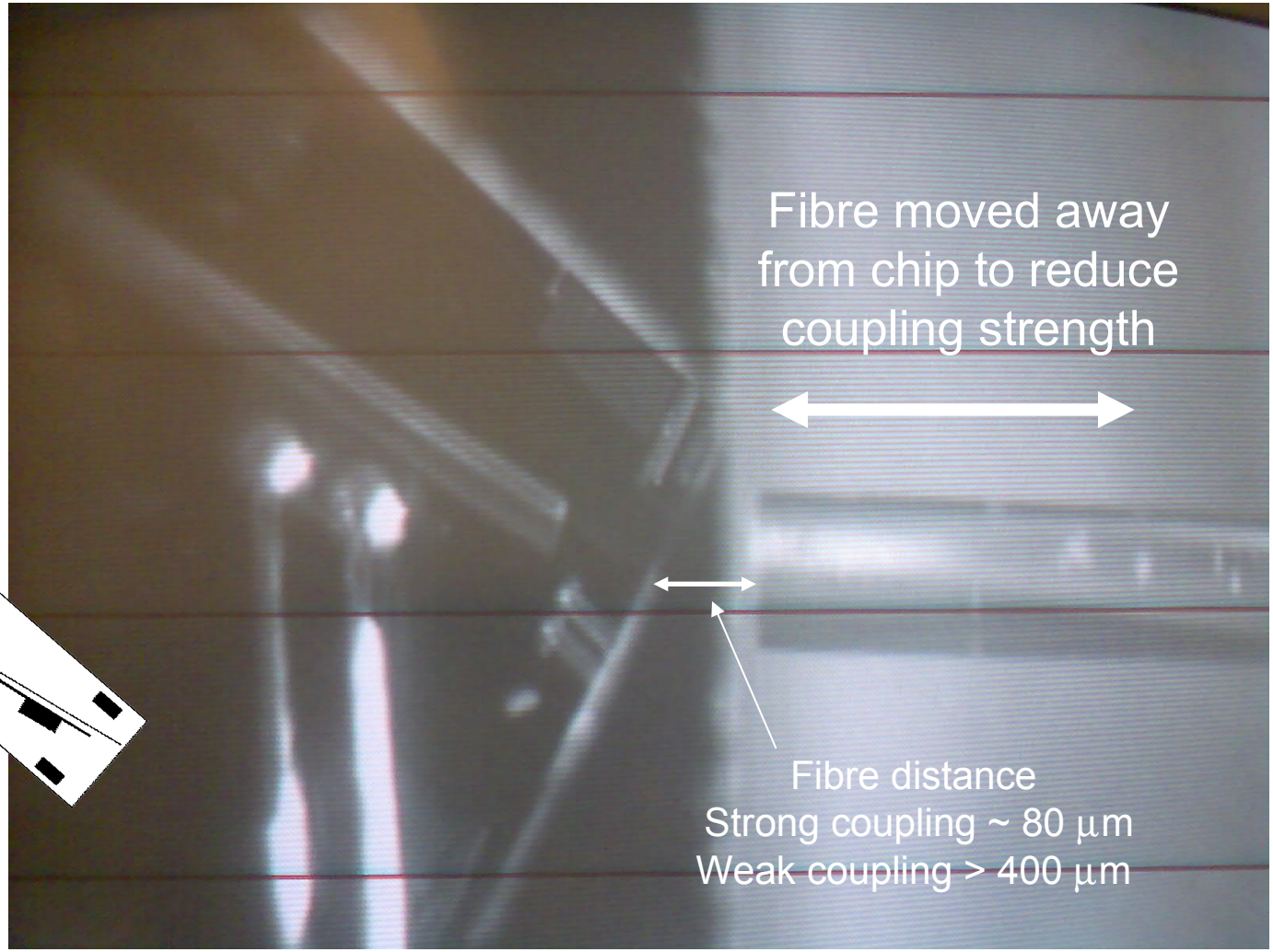


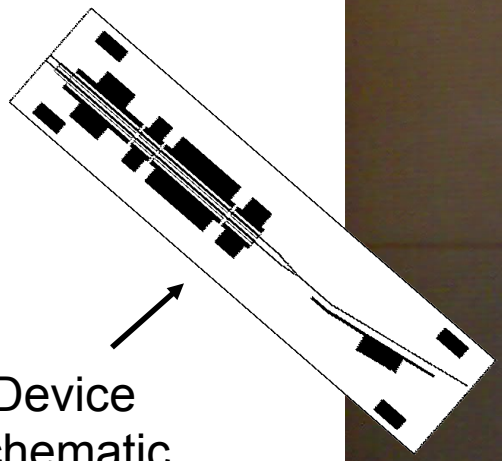
Schematic of the experimental setup for the mutual injection measurements.

Laser mounting



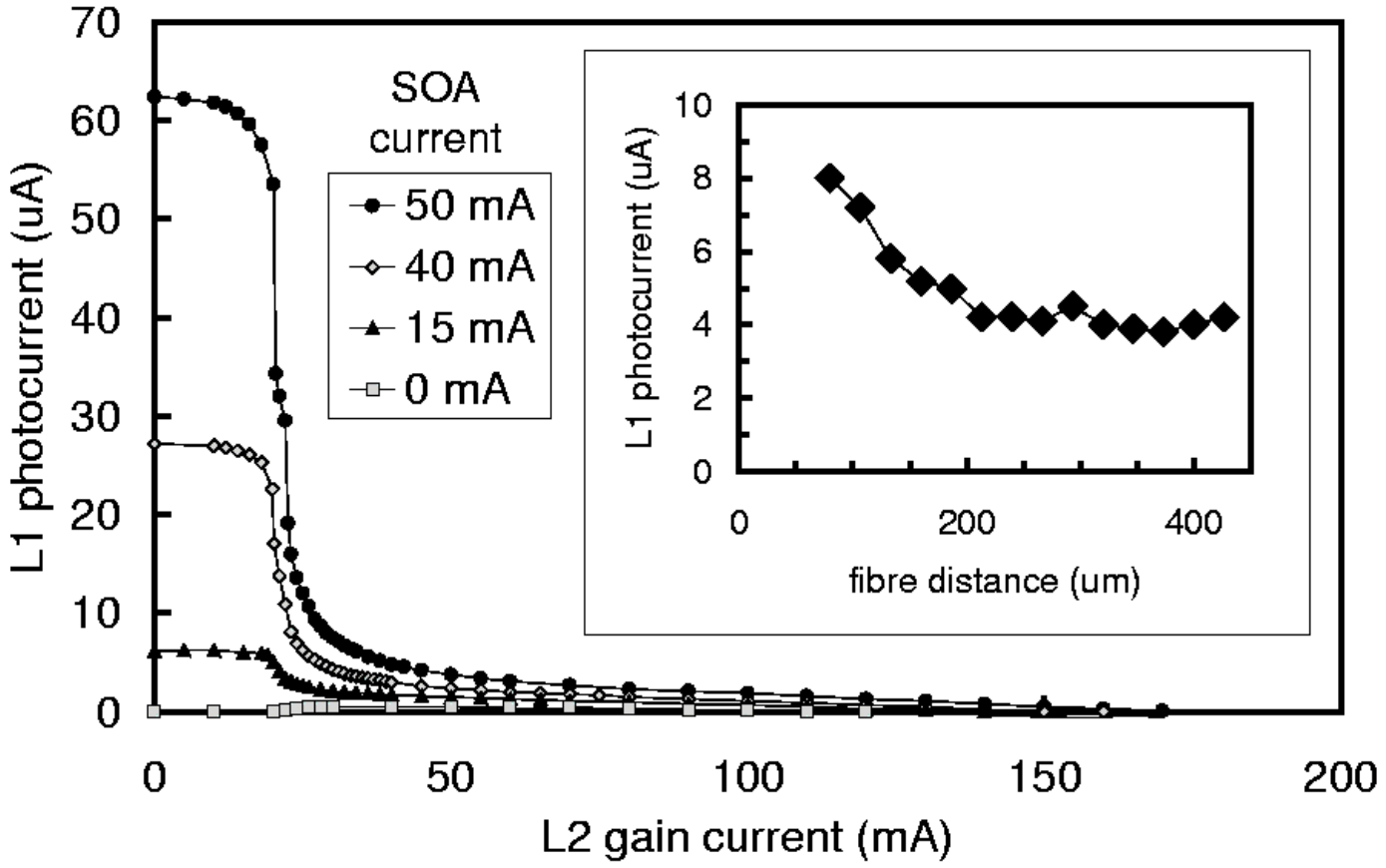
Fibre coupling





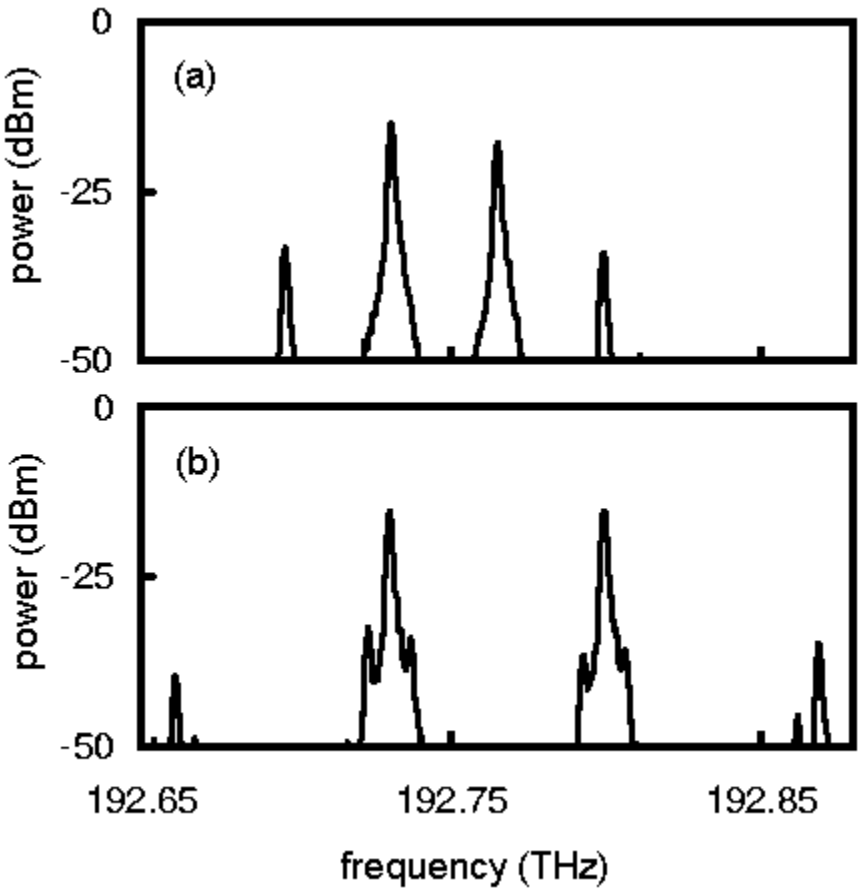
Device schematic

Photocurrent in coupled laser



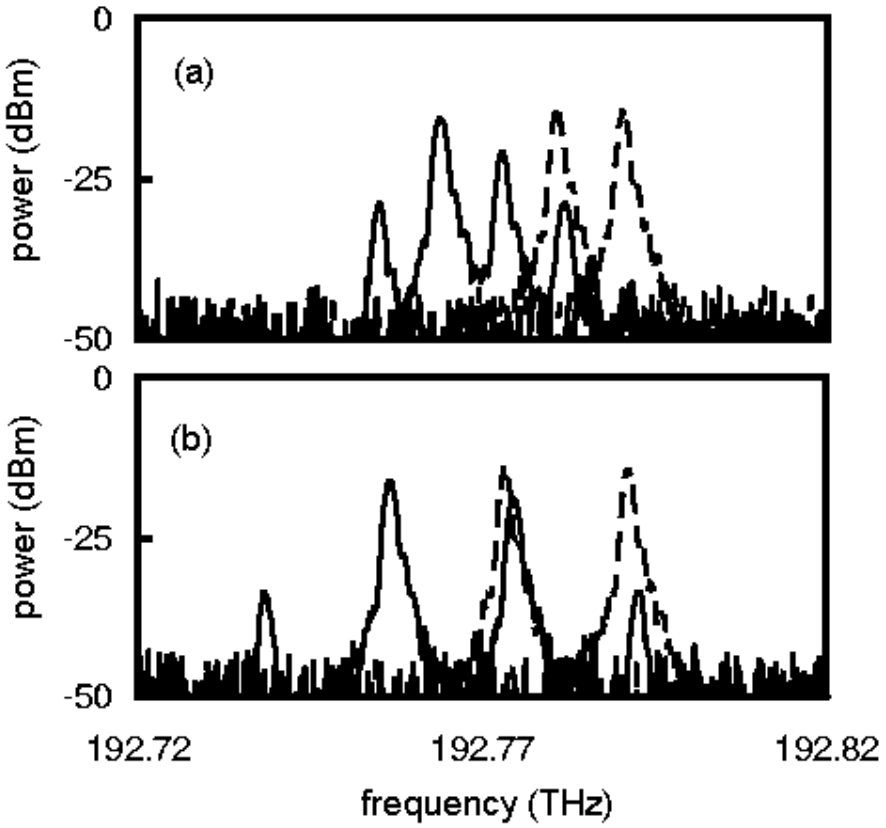
Photocurrent in the L1 laser gain section as a function of L2 gain current and fibre distance with a gain and SOA currents of 60 mA and 30 mA respectively (insert).

Four wave mixing in the strong coupling regime



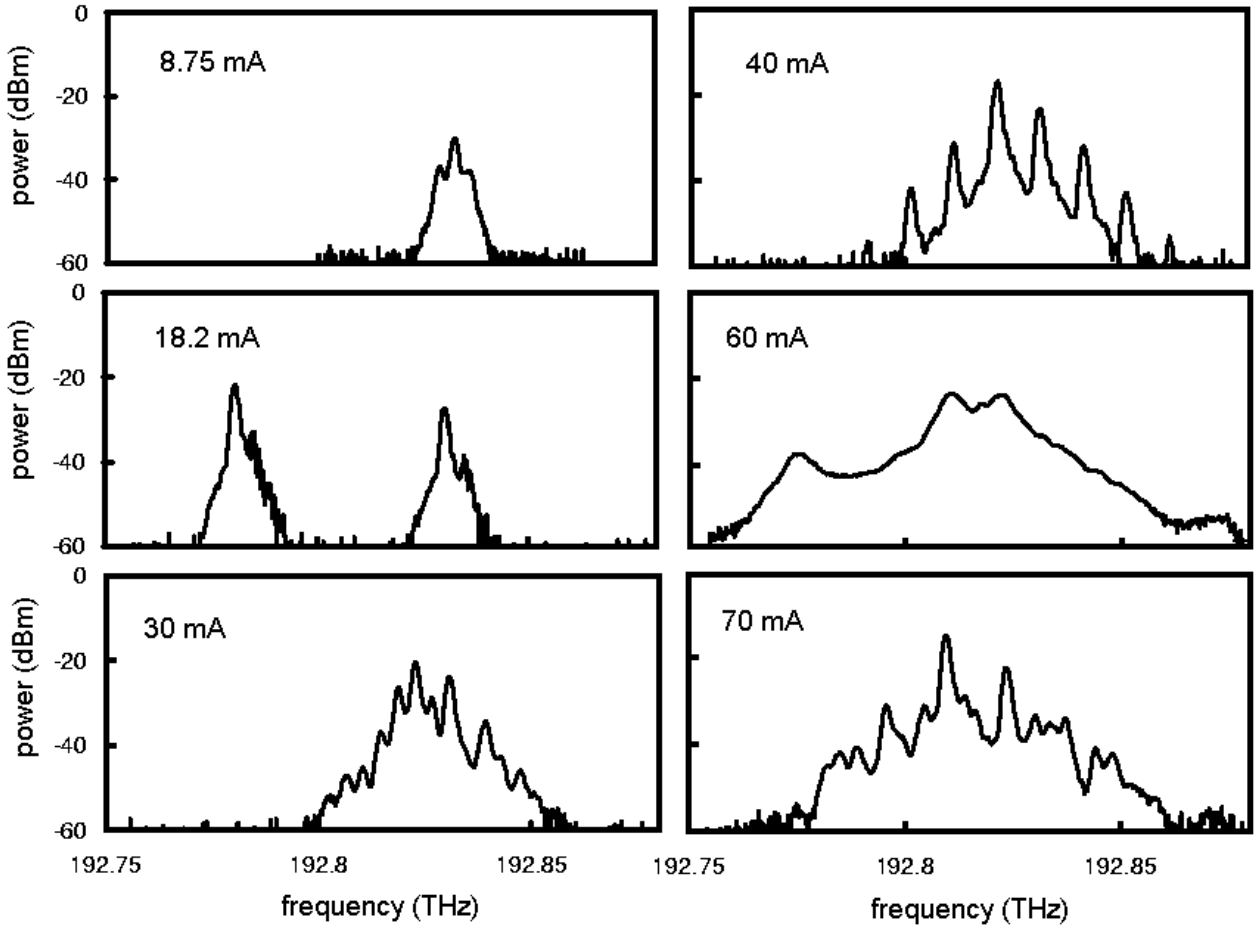
OSA spectra with 80 mA (a) and 90 mA (b) SOA current in the strong coupling regime.

Four wave mixing in the weak coupling regime



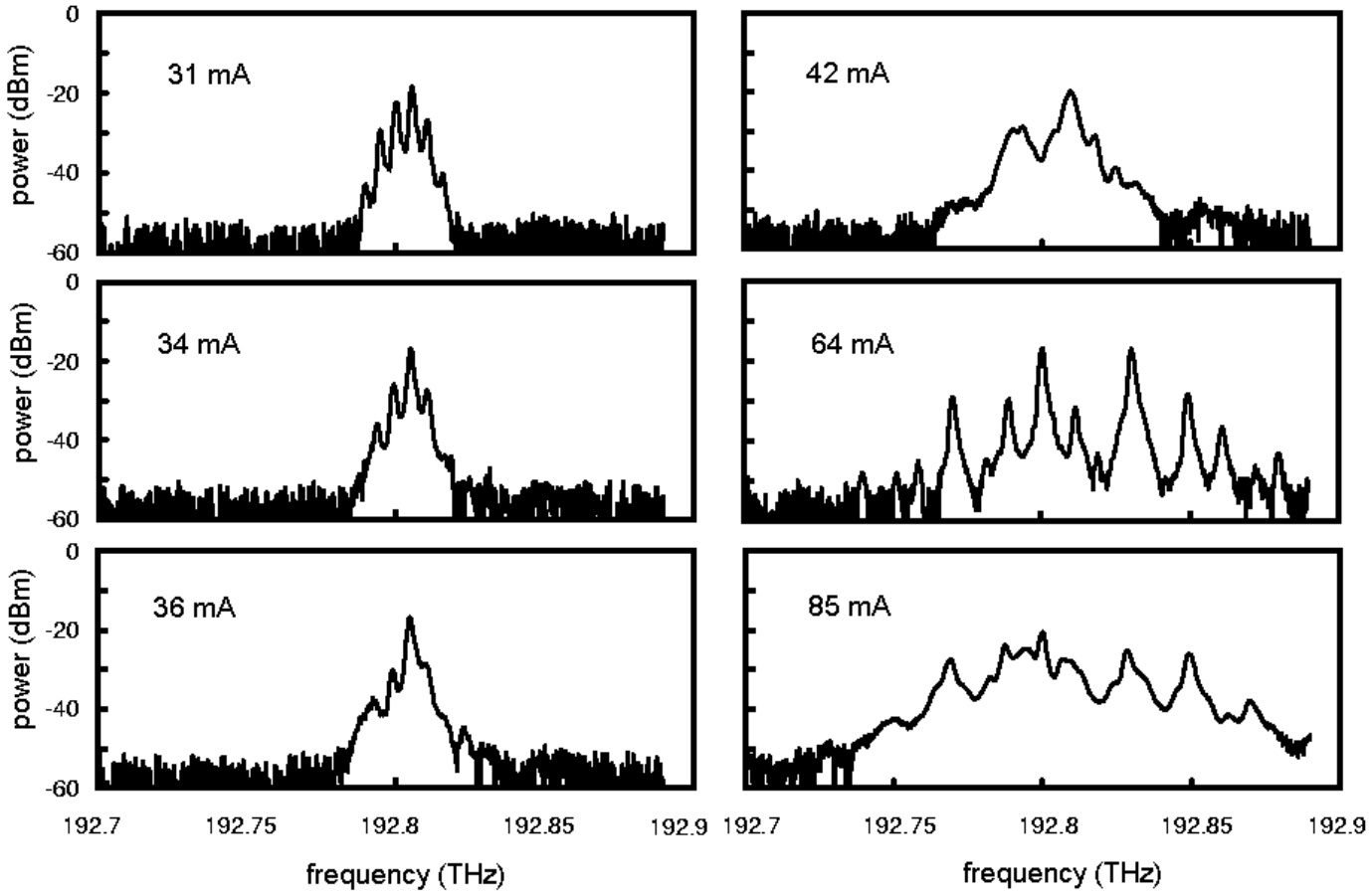
OSA spectra with an initial detuning of 9 GHz (a) and 18 GHz (b) with 43 mA SOA current in the weak coupling regime (distance to fibre 600 μm).

Nonlinearities due to coupling (1)



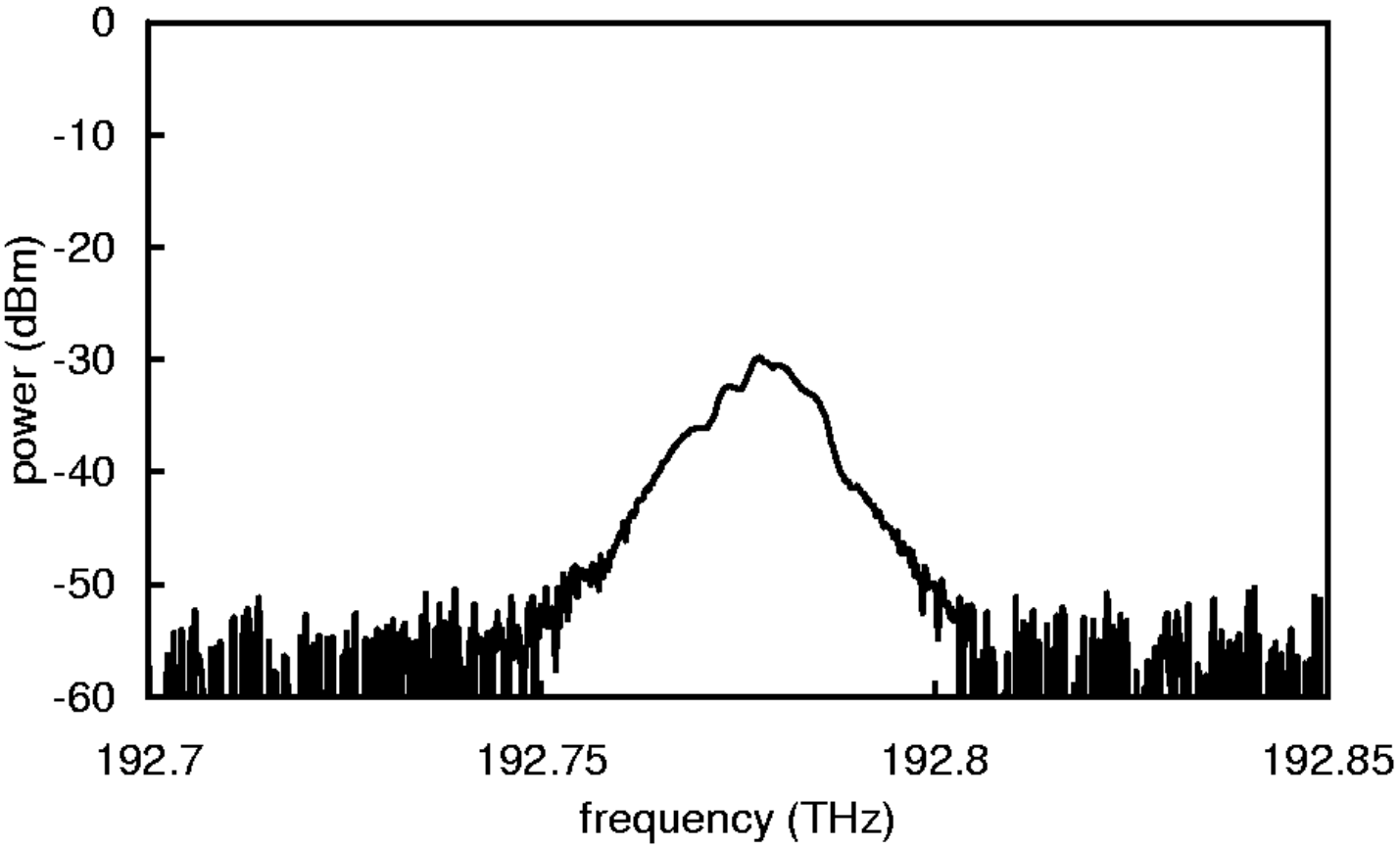
OSA spectra in the strong coupling regime with an initial detuning of 0 GHz for 8.75 mA to 70 mA SOA current.

Nonlinearities due to coupling (2)



OSA spectra in the strong coupling regime with an initial detuning of 7 GHz for 31 to 85 mA SOA current.

Weak coupling phenomena



OSA spectra with an initial detuning of 11 GHz with 78 mA SOA current in the weak coupling regime (distance to fibre 430 μm).

Conclusions

- Variety of nonlinear phenomena observed including:
  - Four wave mixing
  - Nonlinear injection phenomena
- Proper theoretical treatment needed incorporating:
  - Thermal coupling between lasers
  - Amplified mutual optical coupling and optical feedback
  - Nonlinear phenomena in SOA
- Consequences for integrated optical systems

Acknowledgements

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Thank you for your attention.