Ground state lasing in a high quality single quantum wire

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-Outline –

- Sample structure
- Fabrication of high quality single quantum wire laser

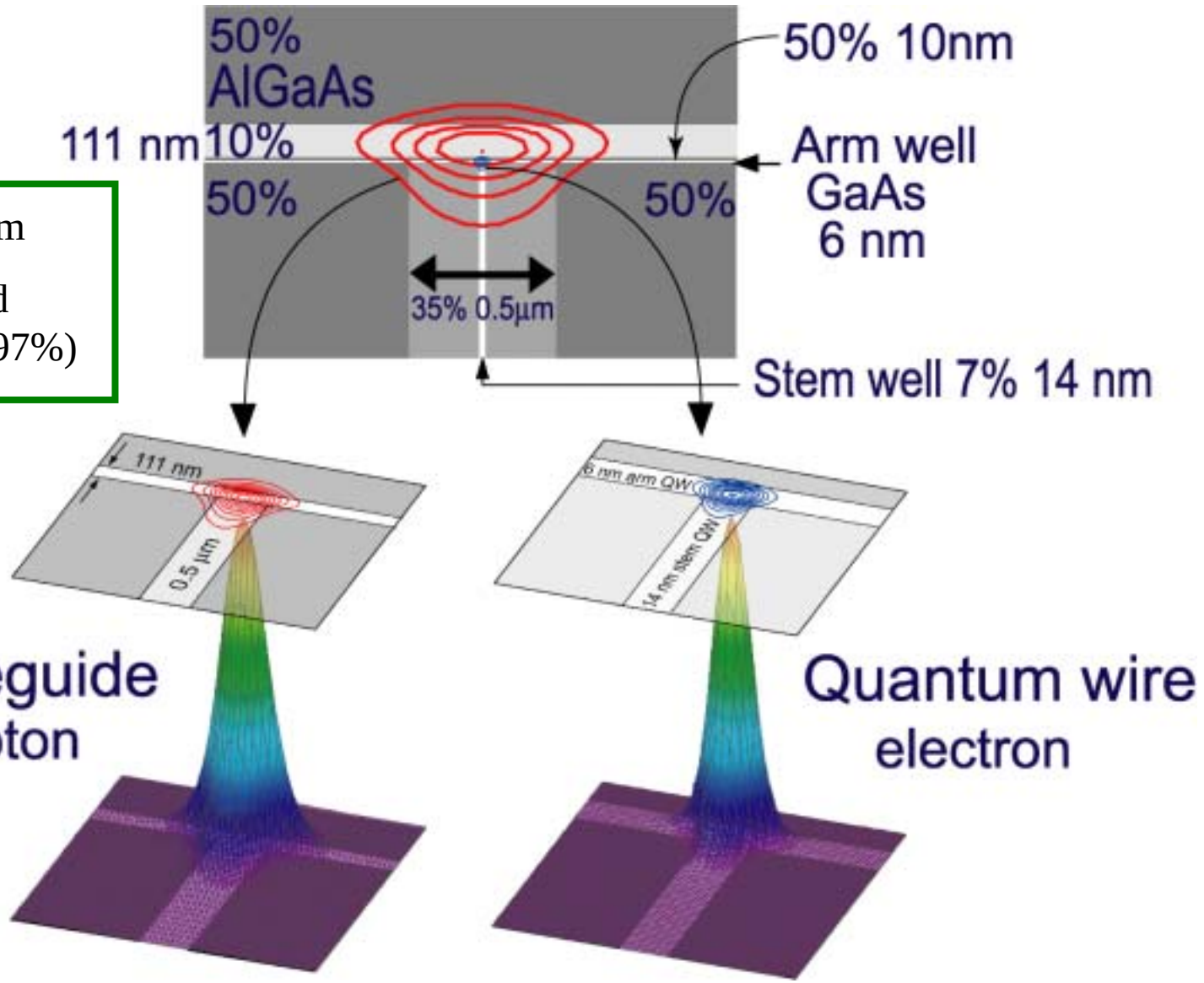
  Cleaved edge overgrowth method

  Growth interruption annealing technique
- Micro-PL imaging and scanning measurements
- Optically pumped lasing measurement
- Conclusion

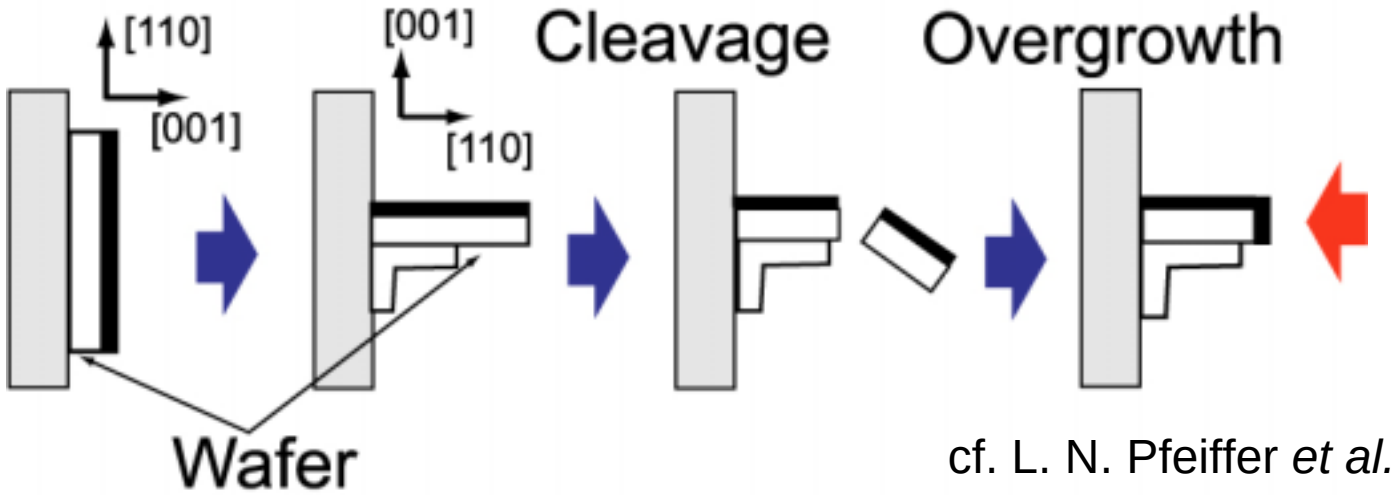
Single quantum wire laser

Cavity length : 500µm

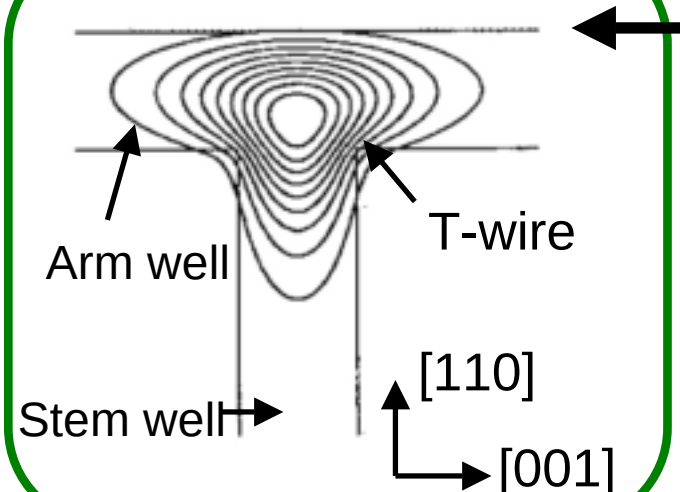
Cavity mirrors : Gold coating (reflectivity 97%)



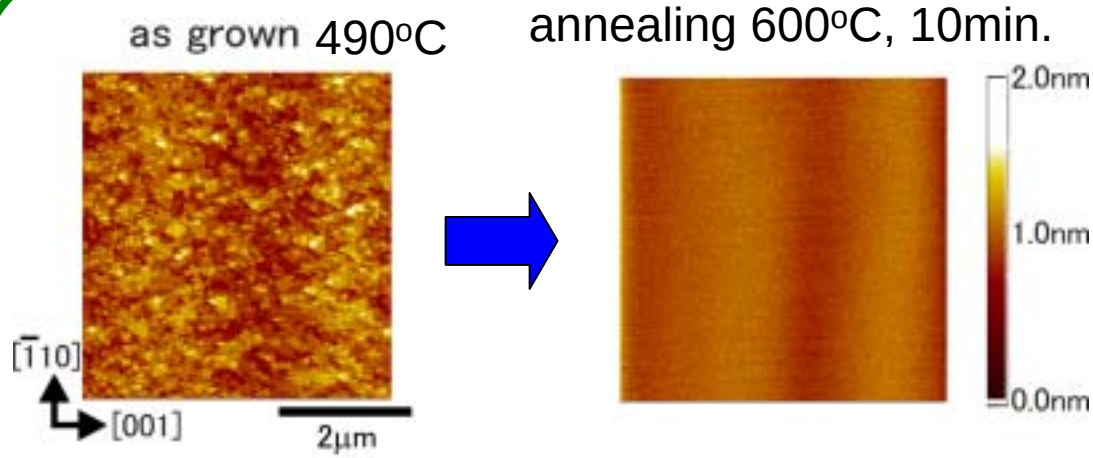
Cleaved edge overgrowth method



cf. L. N. Pfeiffer *et al.*, 1990



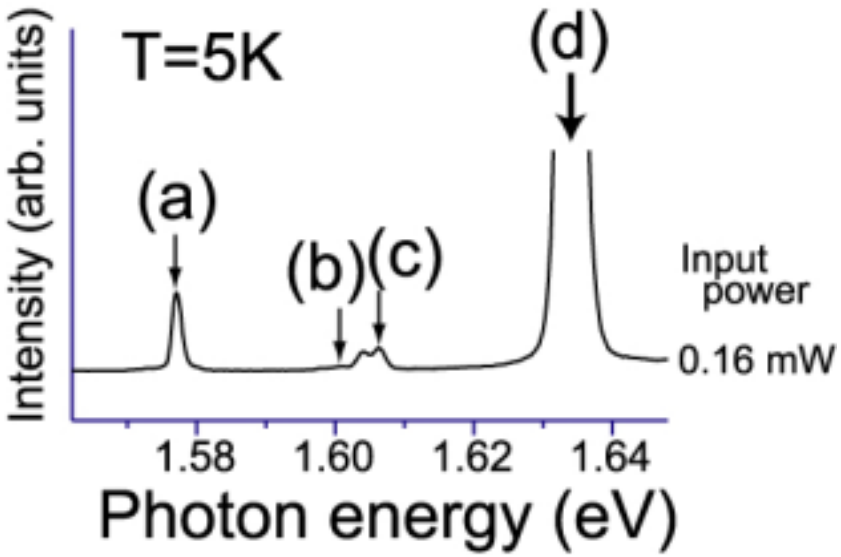
cf. W.Wegscheider *et al.*,
Phys. Rev. Lett. **71**, 4071 (1993)

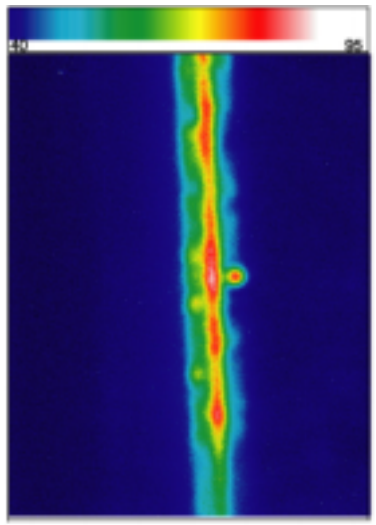


AFM images of (110) surface

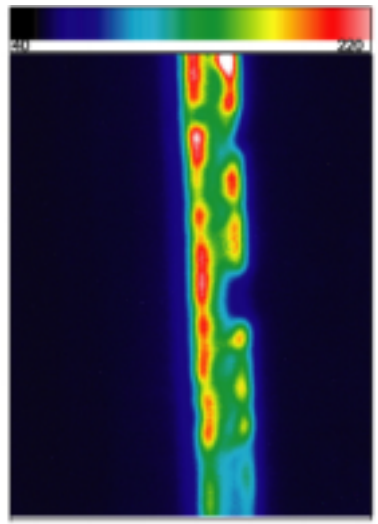
M. Yoshita, *et al.*,
Jpn. J. Appl. Phys. **40**, L252 (2001)

PL images

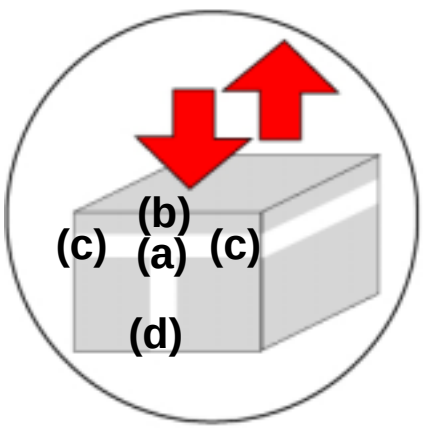


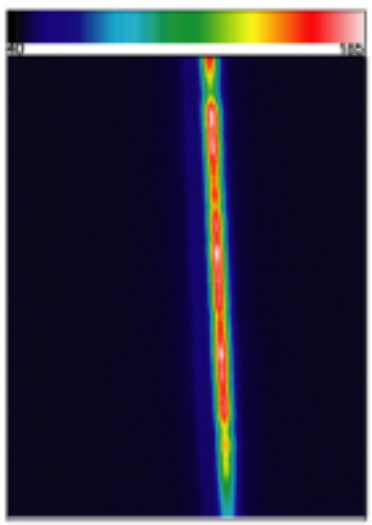


(b) Core arm well

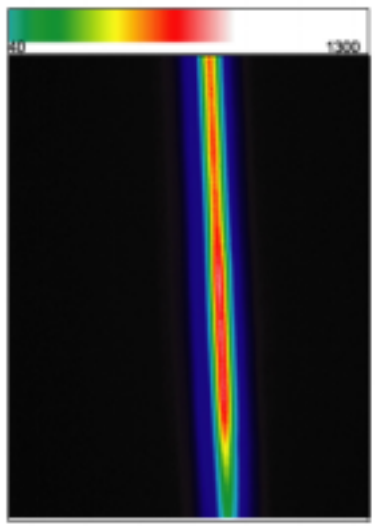


(c) Clad arm well

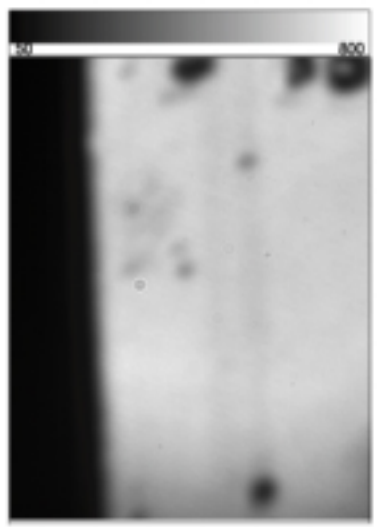




(a) quantum wire



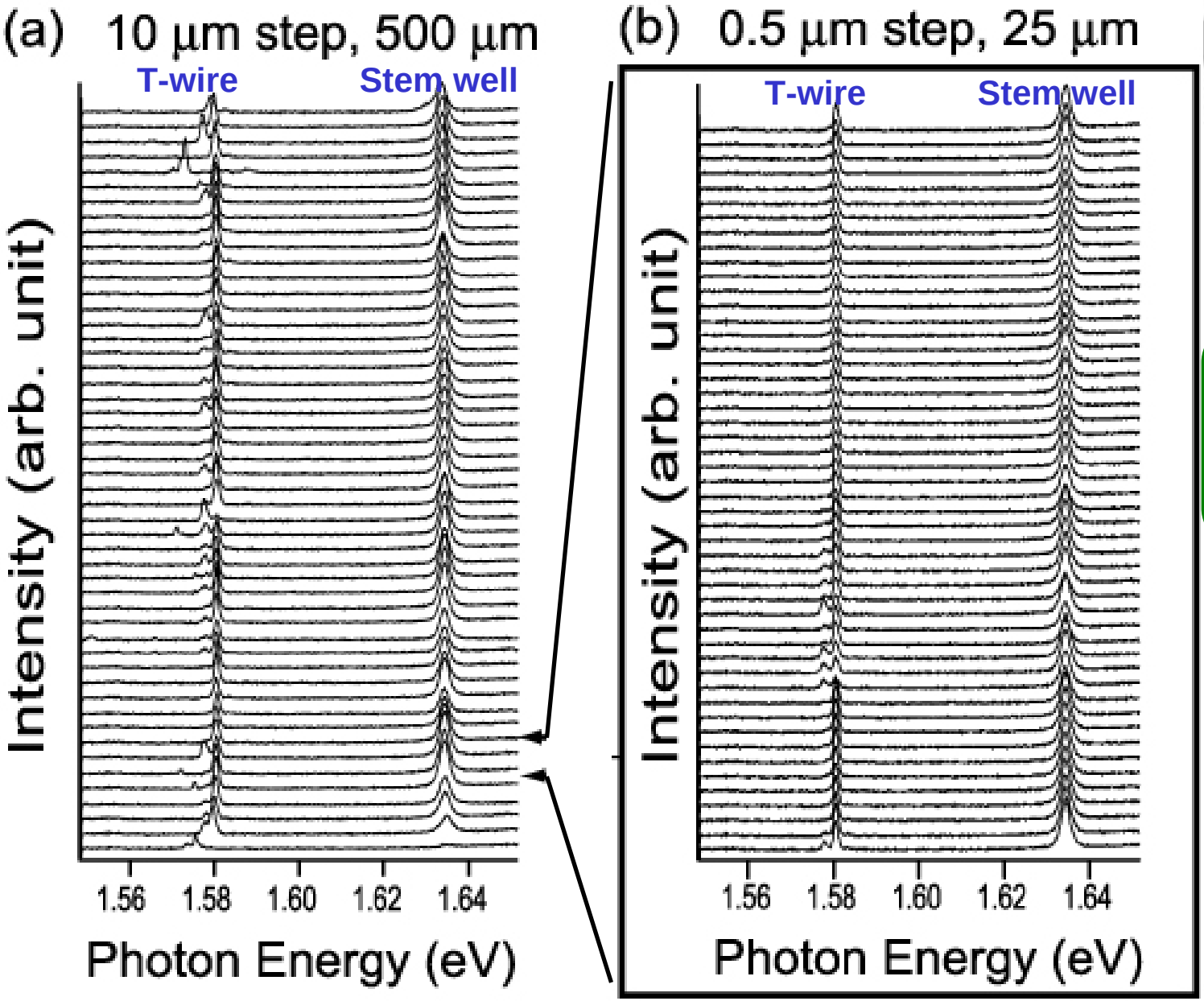
(d) Stem well

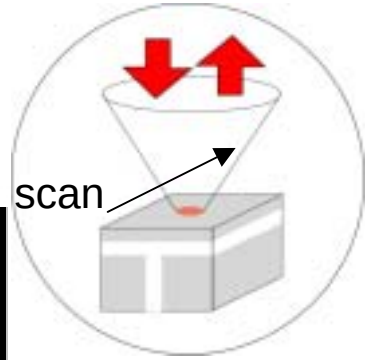


Reflection image

30 μm

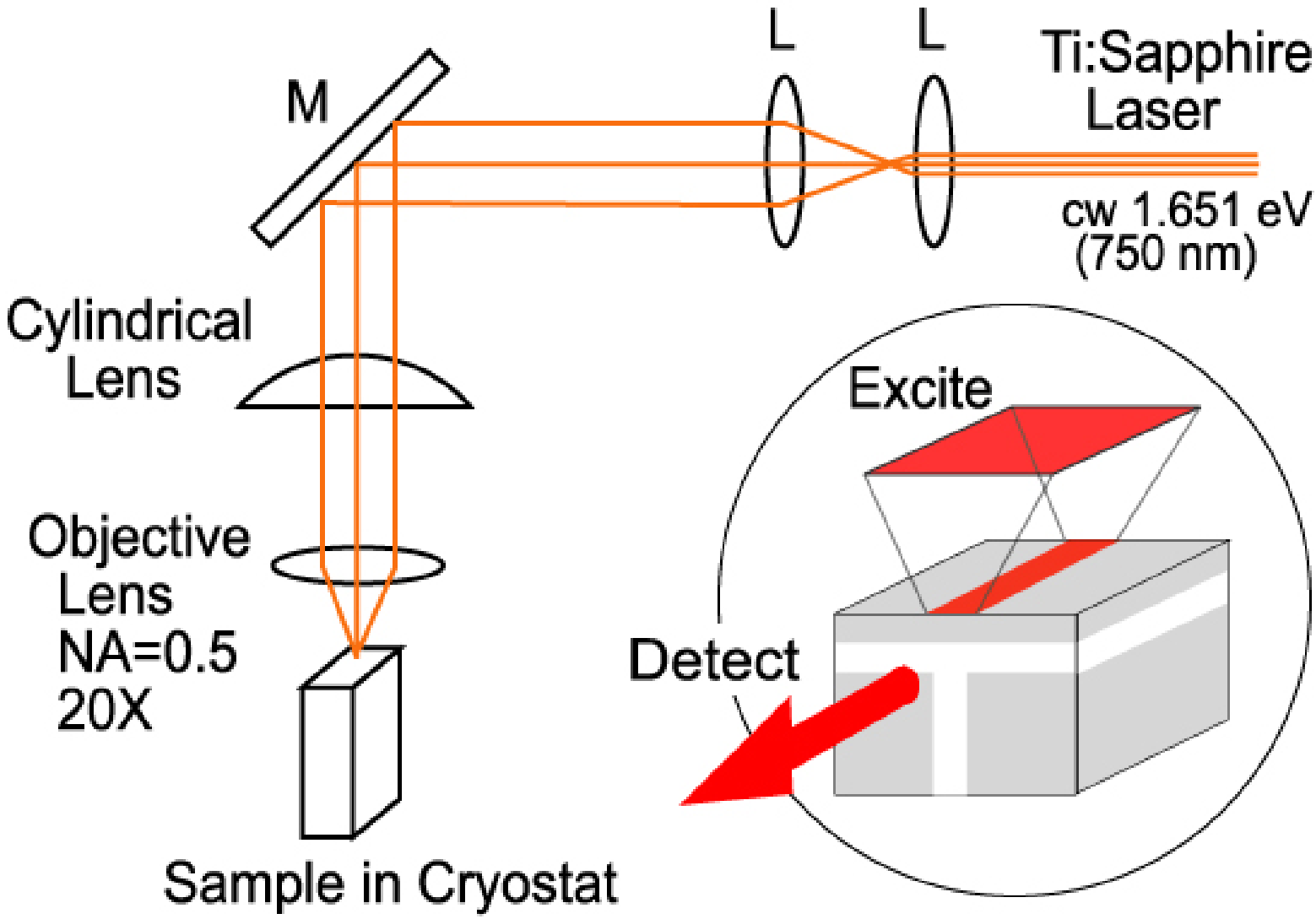
PL spectra with point excitation



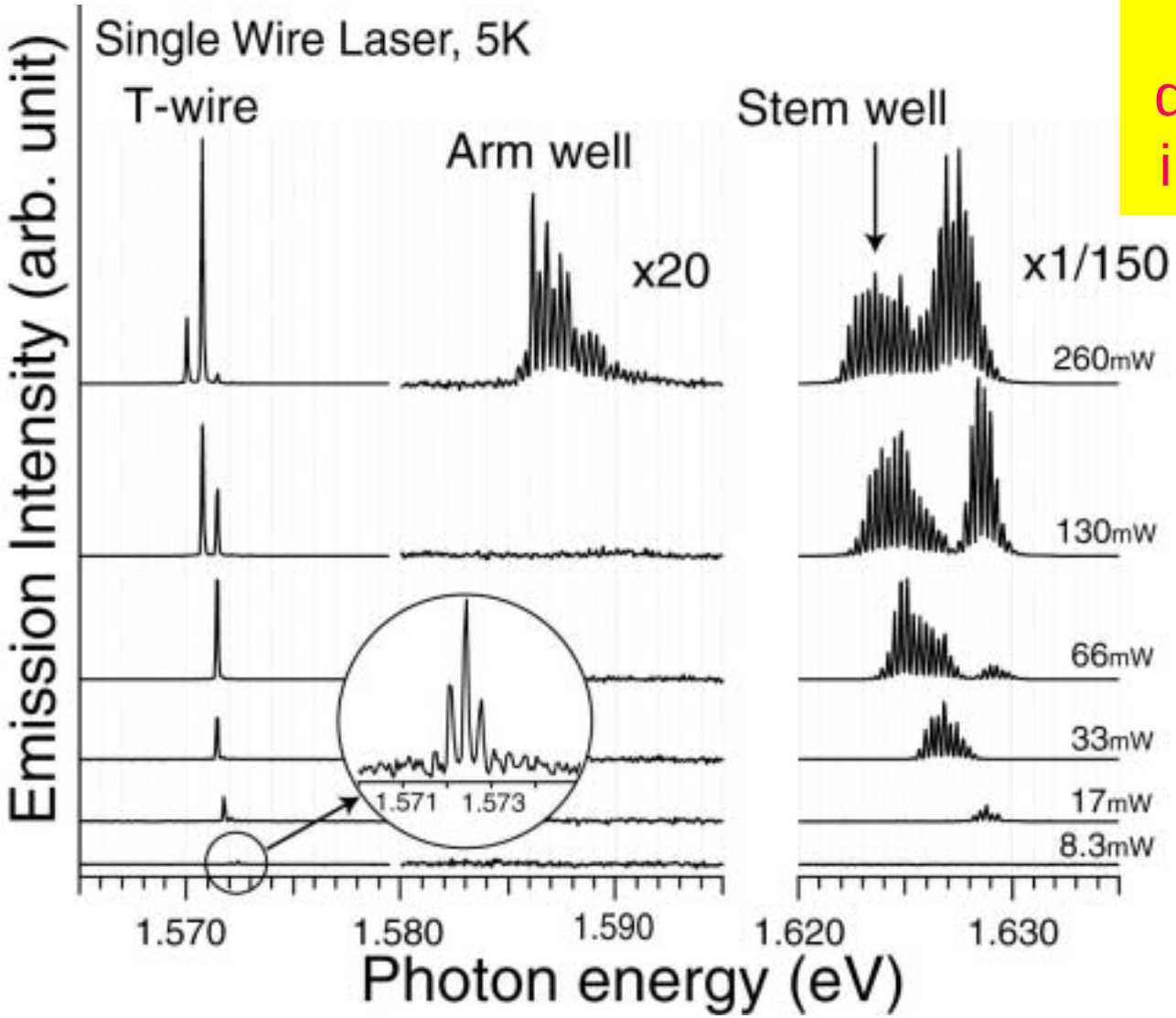


No monolayer fluctuation over 20 μm

Lasing measurement setup



Laser spectra of single quantum wire laser



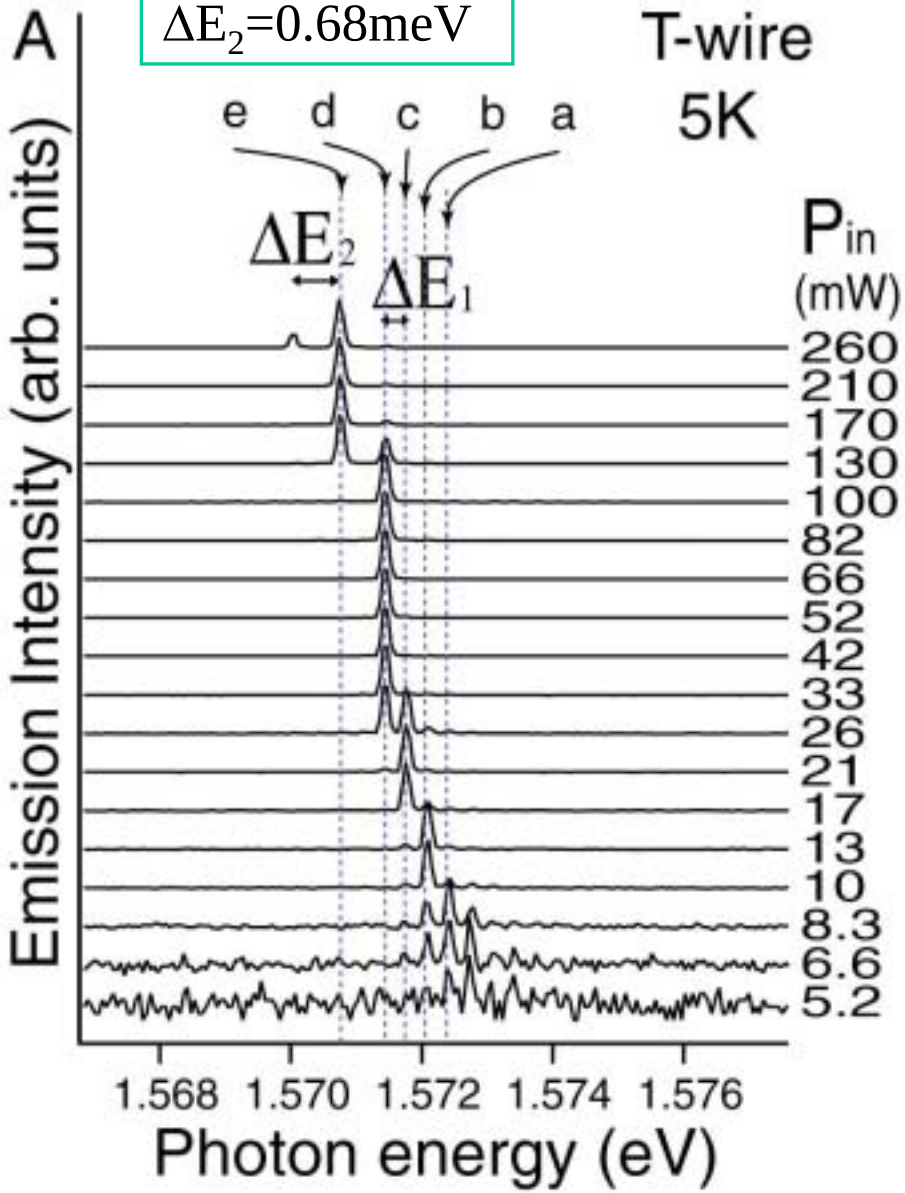
First single quantum wire laser in the ground state

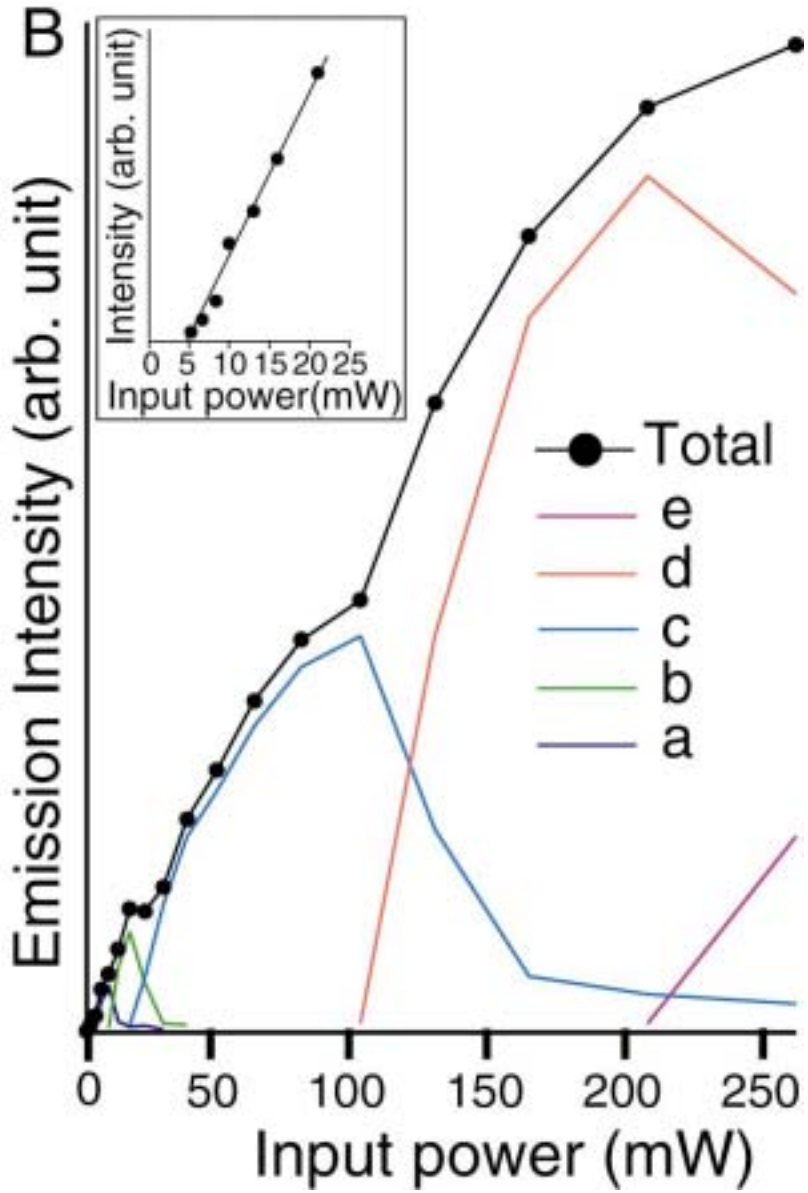
- Low threshold
- Single mode lasing
- Small shift

Input power

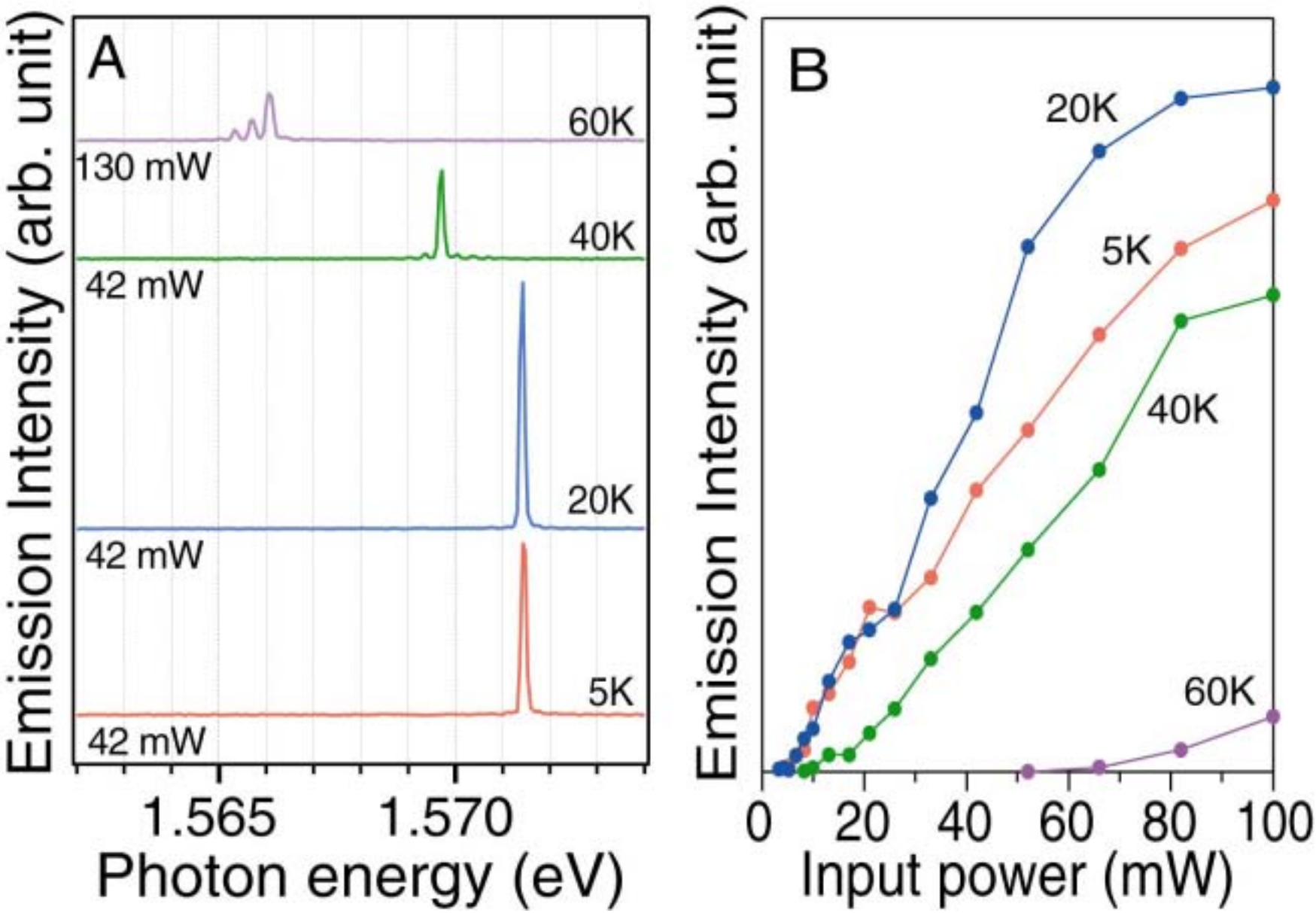
Excitation power dependence

ΔE_1=0.34meV
ΔE_2=0.68meV





Temperature dependence



Conclusion

- High quality single quantum wire laser was fabricated :
  14 nm x 6 nm, only one subband,
  no monolayer fluctuation over 20 μm

- The first observation of
  lasing in the ground state of a single quantum wire
- Low threshold, 5 mW, at 5 K.
- Single mode lasing
- Small shift of 2 meV for input powers of 5 – 260 mW
- Operating temperatures: 5 - 60 K.