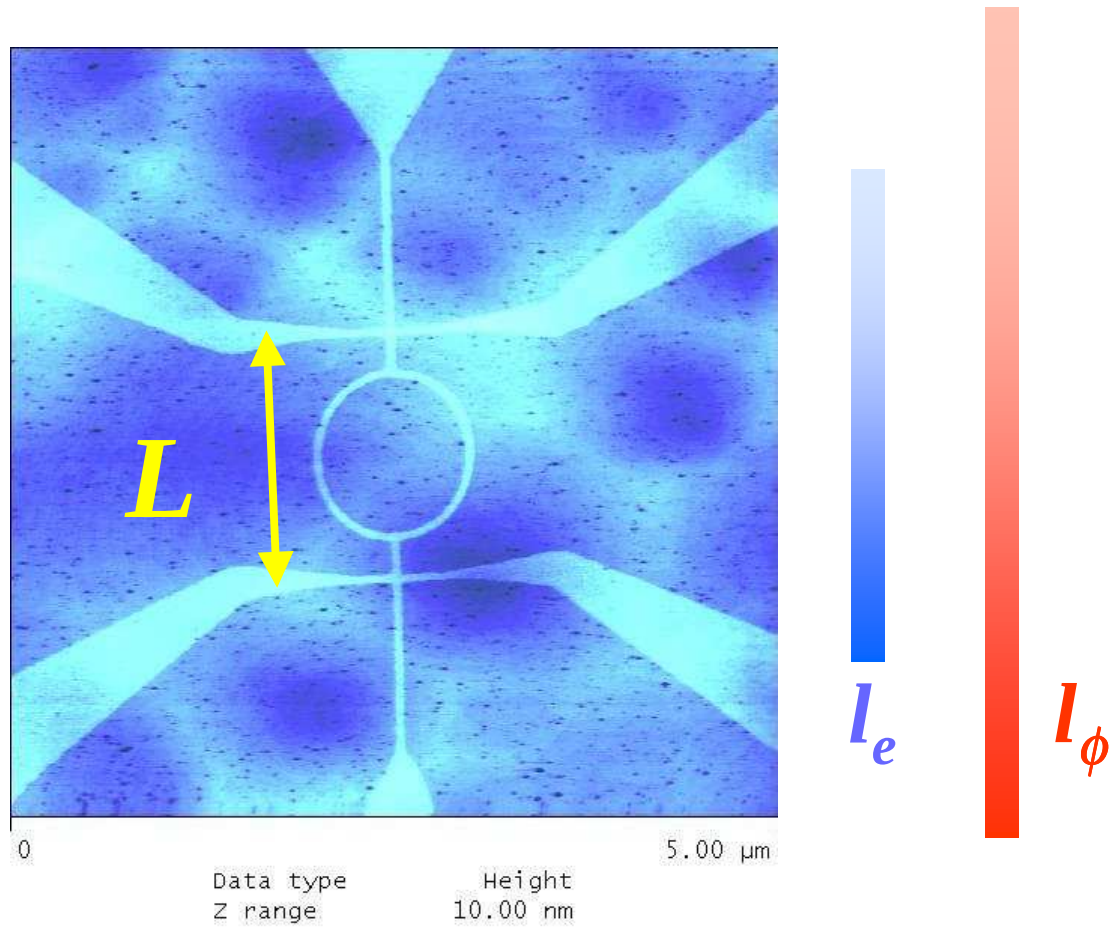
Nanometer Scale InAs/AlSb Quantum Structures

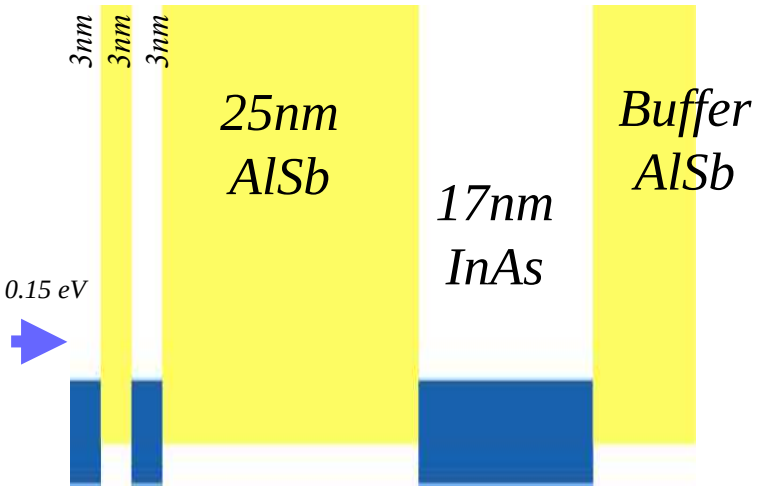
Code 6876

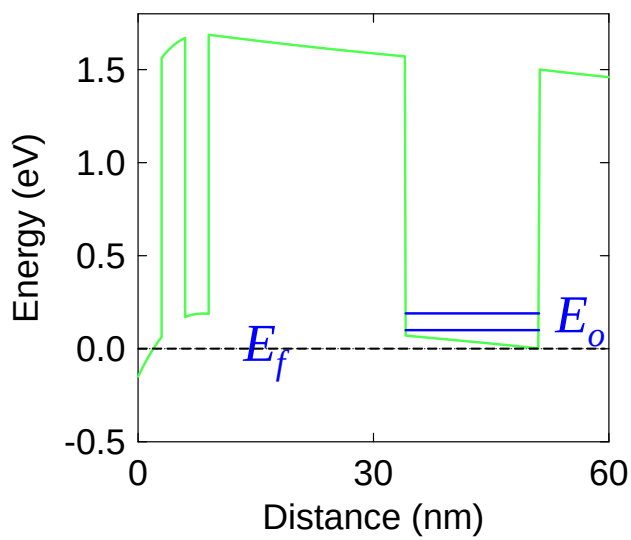
Objective: Complex quantum circuit within phase coherence length

➔ Nanometer scale wires/dots with high material quality



Using E_f pinning and modulation doping to control n_{2D}





*A **3nm shallow** wet-etch can provide both excellent control and no damage to the surface*

***Scheme** to define quantum wire:*

1. *As-grown is insulating*
2. *A shallow wet-etch to create a conducting channel underneath*

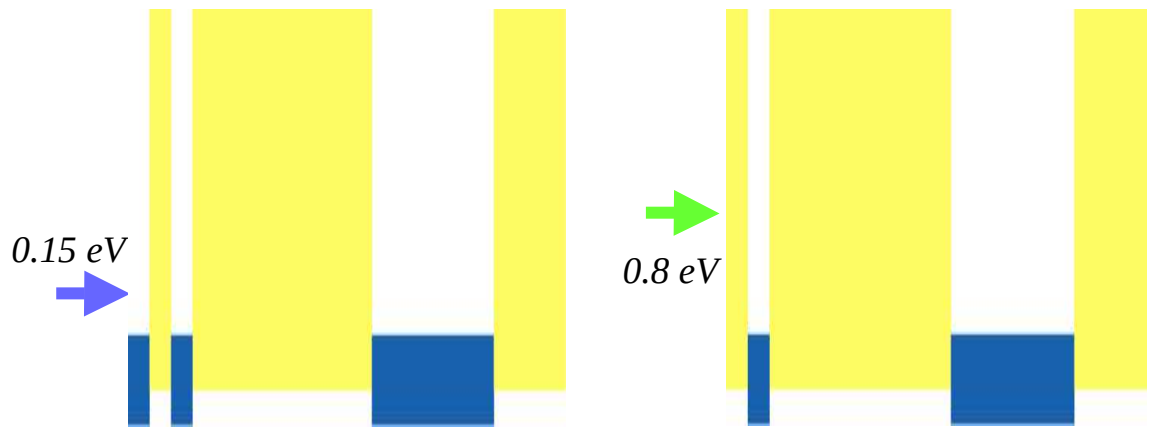
***Design** sample structure*

1. *E_f pinning voltage differences*
2. *Modulation doping*
3. *$E_o - E_f > 100$ meV (insulating!)*

Create 2DEG by a shallow (3nm) wet-etch

1 *As-grown sample*

2 *1st InAs cap wet-etched*

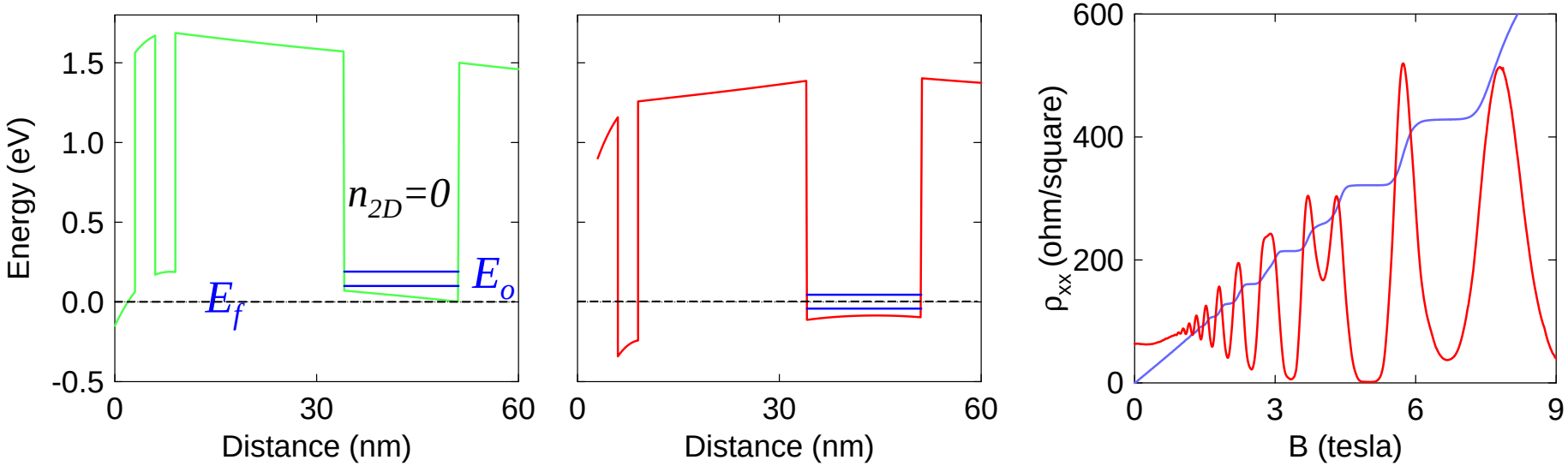


$E_f = 41\ meV$

$n_{2D} = 4.92\times 10^{11}\ cm^{-2}$

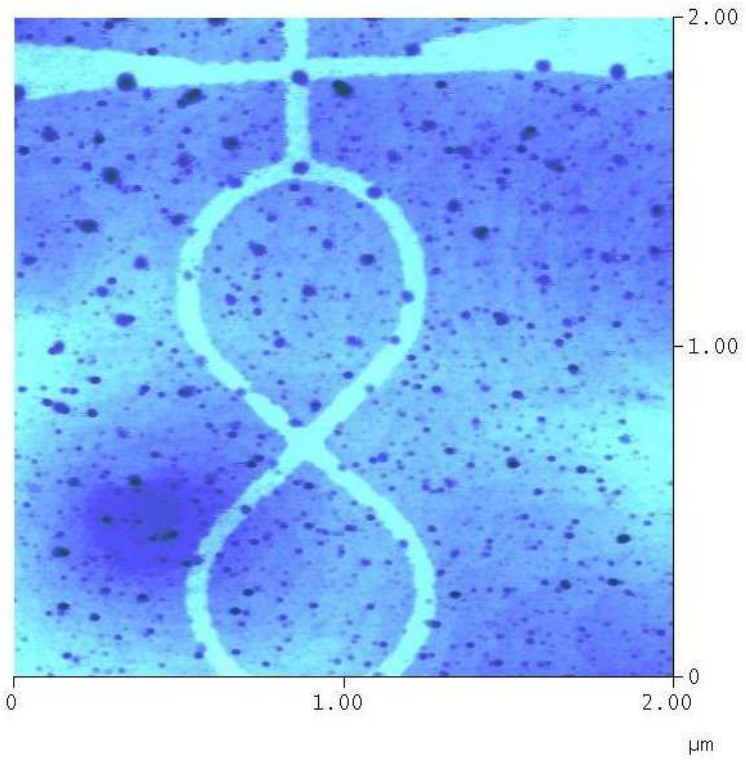
$\mu = 200{,}000\ cm^2/Vs$

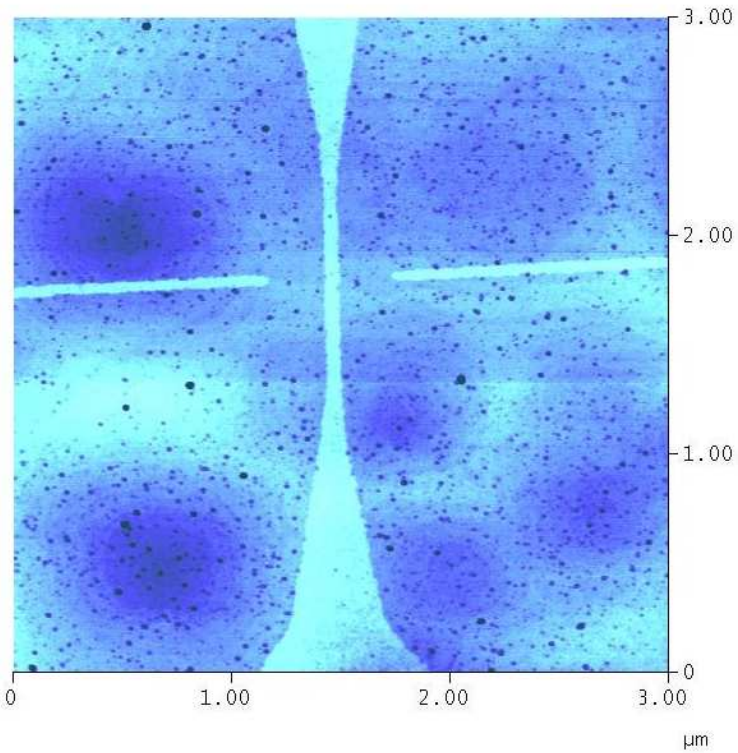
$l_e = 2.3\ \mu m$



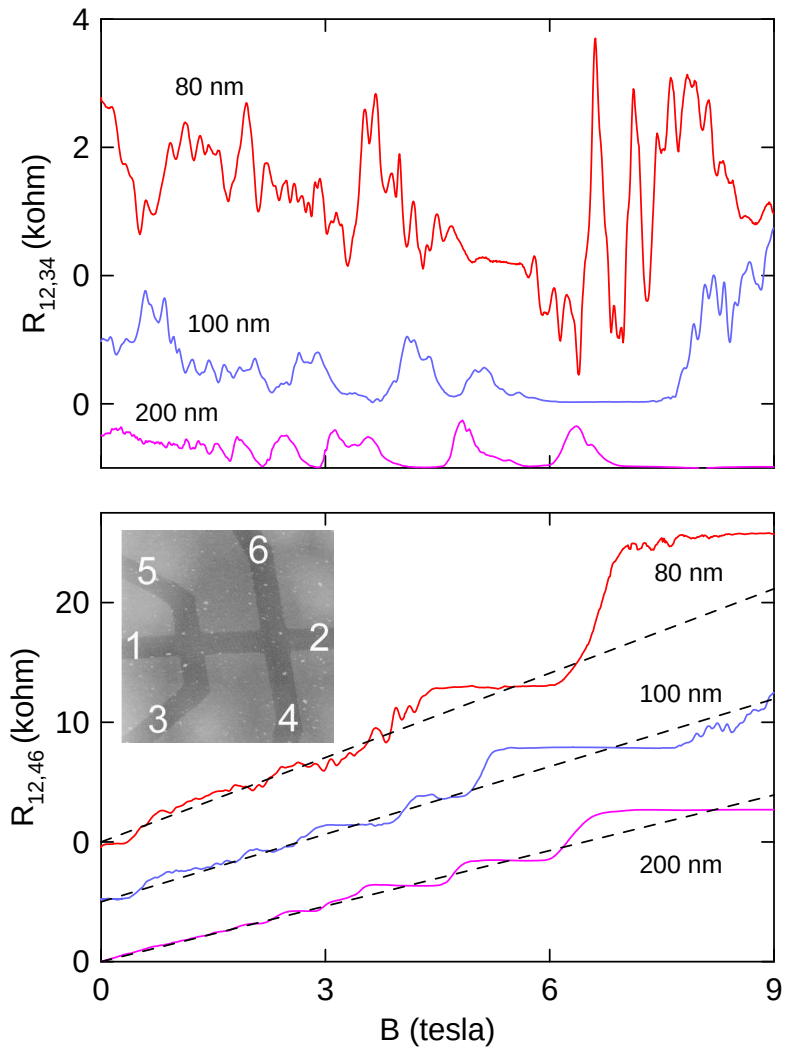
AFM Characterizations

- 50 nm wire width with nm sidewall roughness
- Planer nanofabrication, simple and flexible
- Additional transport control by side/top gates





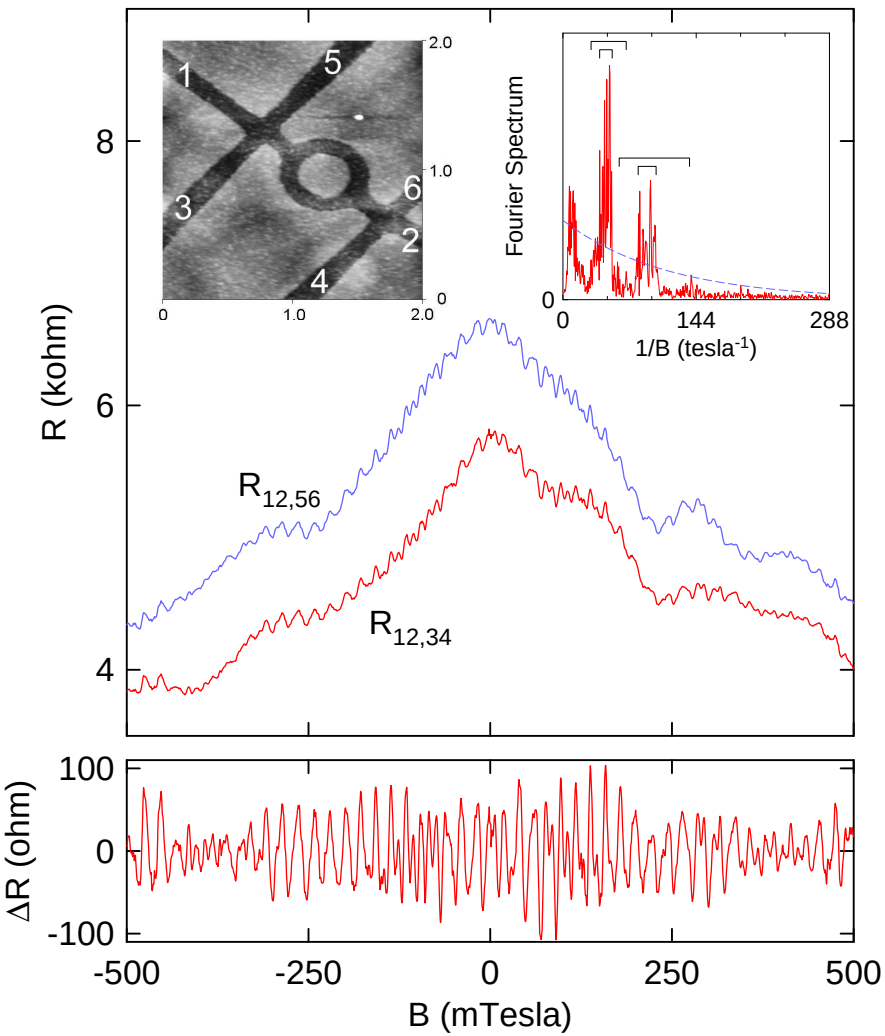
Magnetotransport Characterizations



The InAs nanostructures possess three important properties:

- Specular boundary scattering
  ⇒ Long elastic mean path
- Hard-wall lateral confinement potential
  ⇒ Large 1D sublevel spacing
- Conducting channel width is approximate the lithographic width
  ⇒ Width is controllable down to nm.
  ⇒ Nano devices can be placed in close proximity for quantum manipulations.

Aharonov-Bohm Interferences



The InAs ballistic rings exhibit characteristics different from those reported in GaAs rings:

- The amplitudes of four harmonic peaks do not follow the simple exponential decay as expected by the diffusive picture.
- The full width of the *h/e* peak in InAs ballistic rings is much narrower than that estimated from the channel width
- The position of the *h/e* peak does not shift toward lower frequencies as the magnetic field is increased.