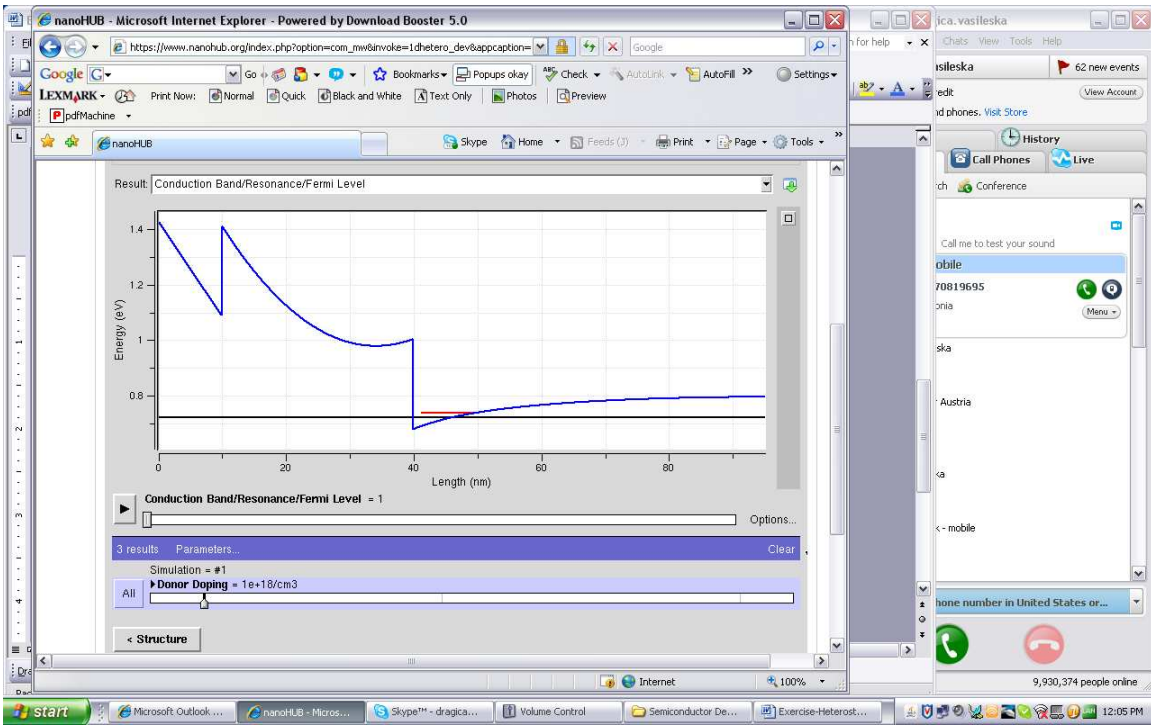


# 1D Heterostructures – Simulation Exercise: Parallel Conduction Channel

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This exercise uses the 1D Heterostructure lab and the purpose of it is to demonstrate that adding more dopants in the buffer layer becomes ineffective after certain critical doping density beyond which the additional dopants practically fill in the parallel conduction channel sitting in the AlGaAs layer in which carriers have significantly lower mobility due to alloy scattering. To demonstrate this point, consider the following structure. Cap layer is GaAs with thickness of 10 nm and doping of  $10^{14} \text{ cm}^{-3}$ . The buffer layer is AlGaAs layer that is 30 nm thick and the doping of this layer is varied between 1, 5 and  $10 \times 10^{18} \text{ cm}^{-3}$ . The underlying GaAs substrate is 55 nm thick and the substrate doping is  $10^{14} \text{ cm}^{-3}$ . Plot the conduction band profile, electron density and the variation of the sheet electron density with gate bias for the three doping densities specified for the buffer layer. Comment on the results obtained. Design similar experiment that uses delta-doped layers to prove the same point. This is needed to justify that the design of the heterostructure layers in HEMTs has to be very carefully done and that 1D Heterojunction Lab can significantly help in this design process.



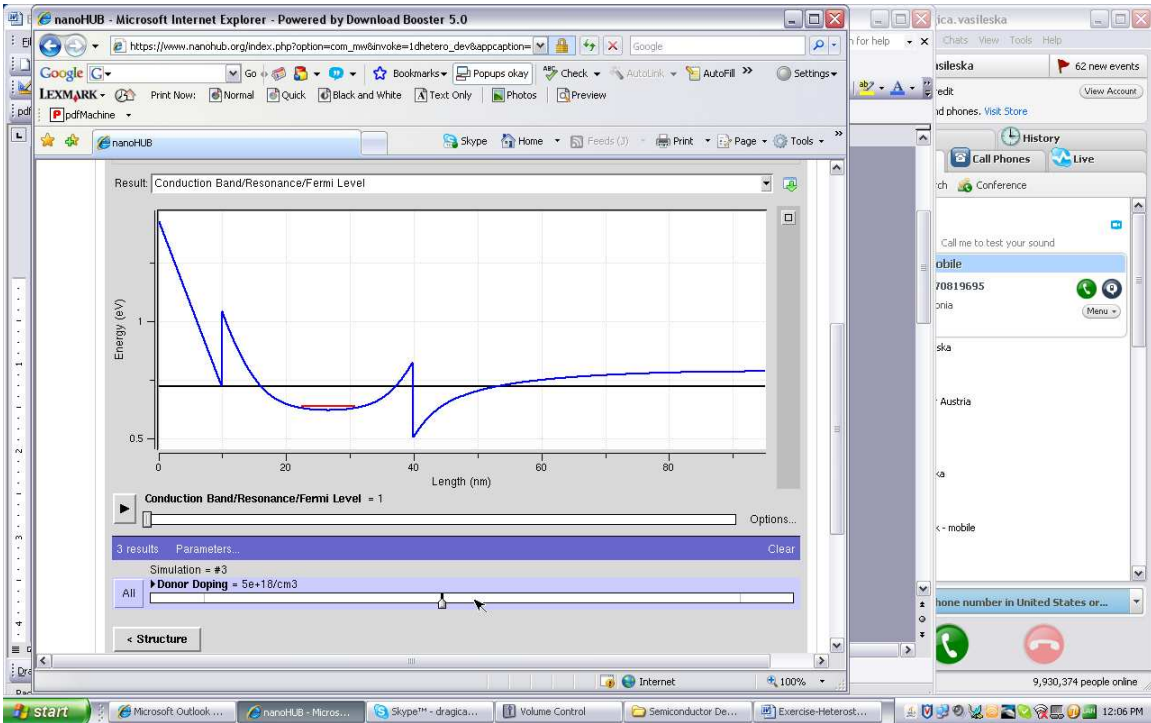
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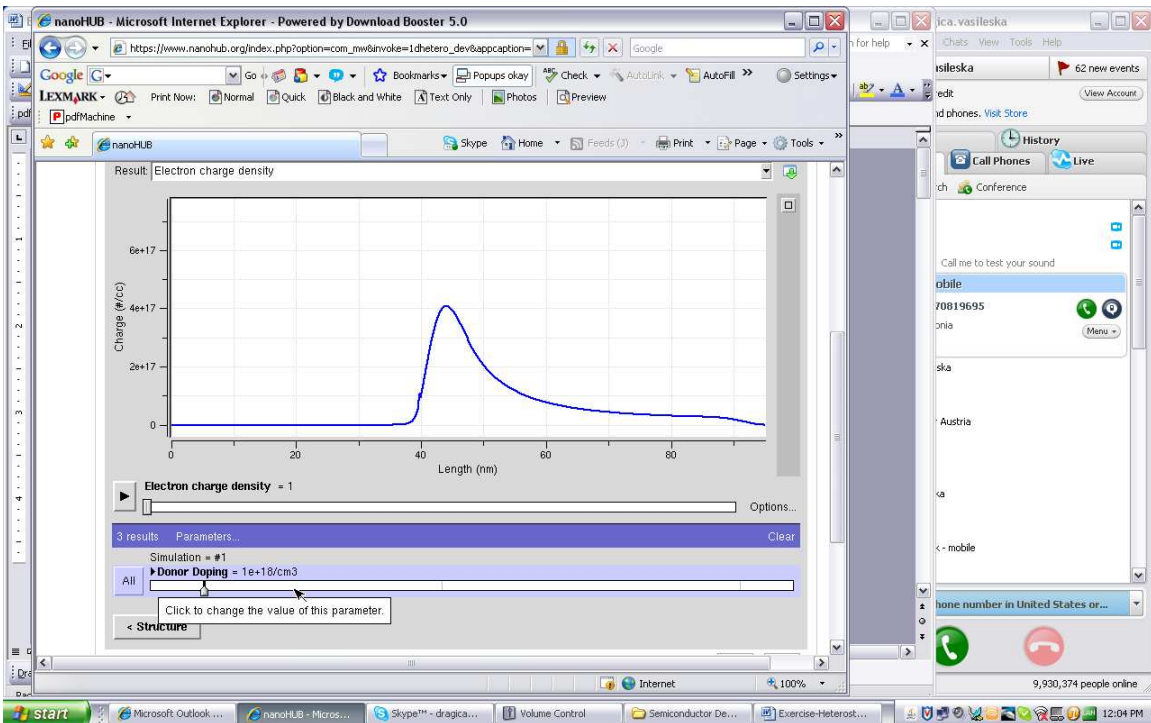
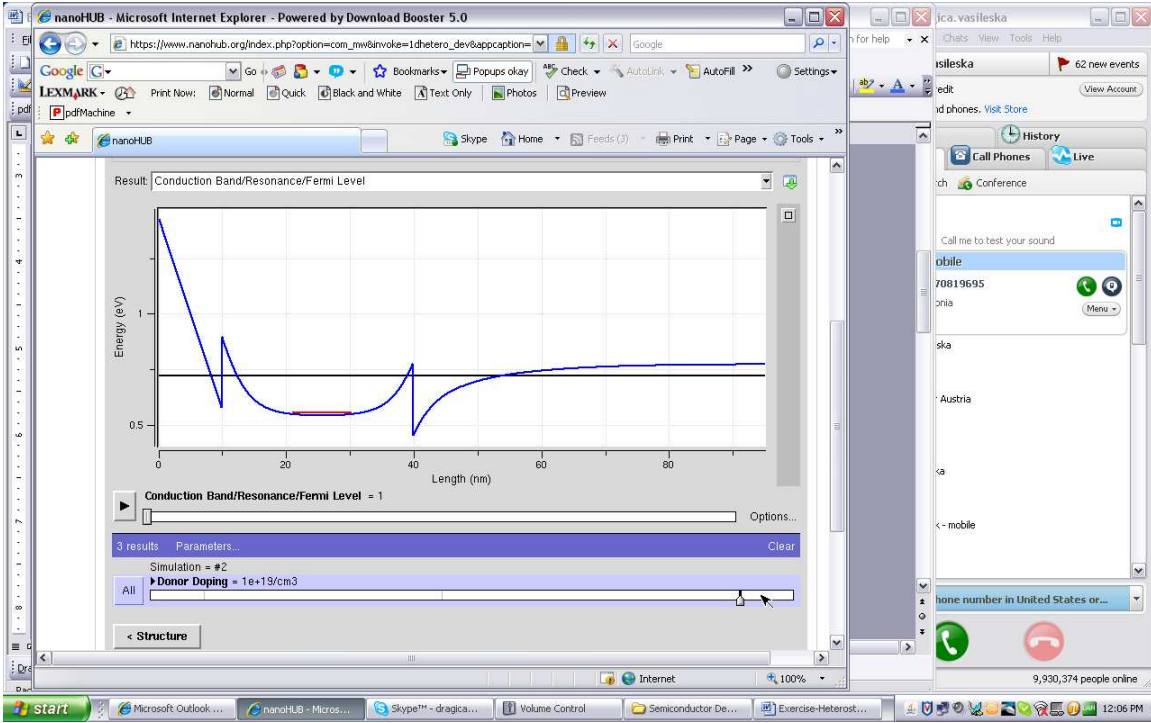
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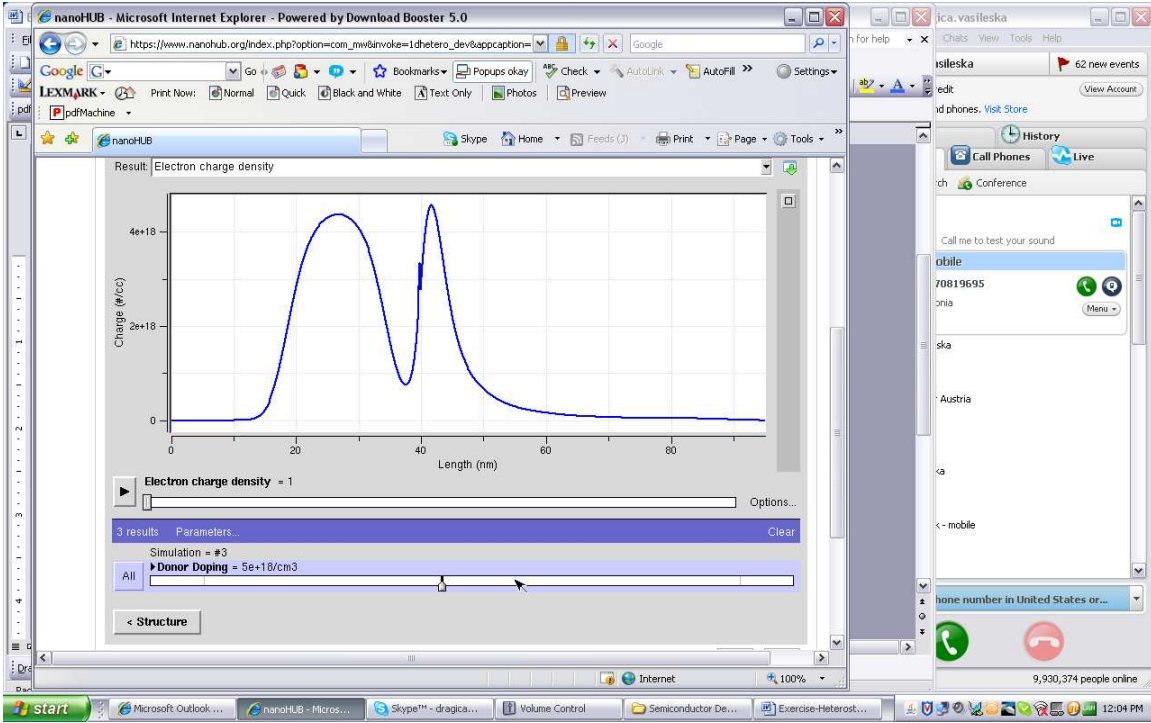
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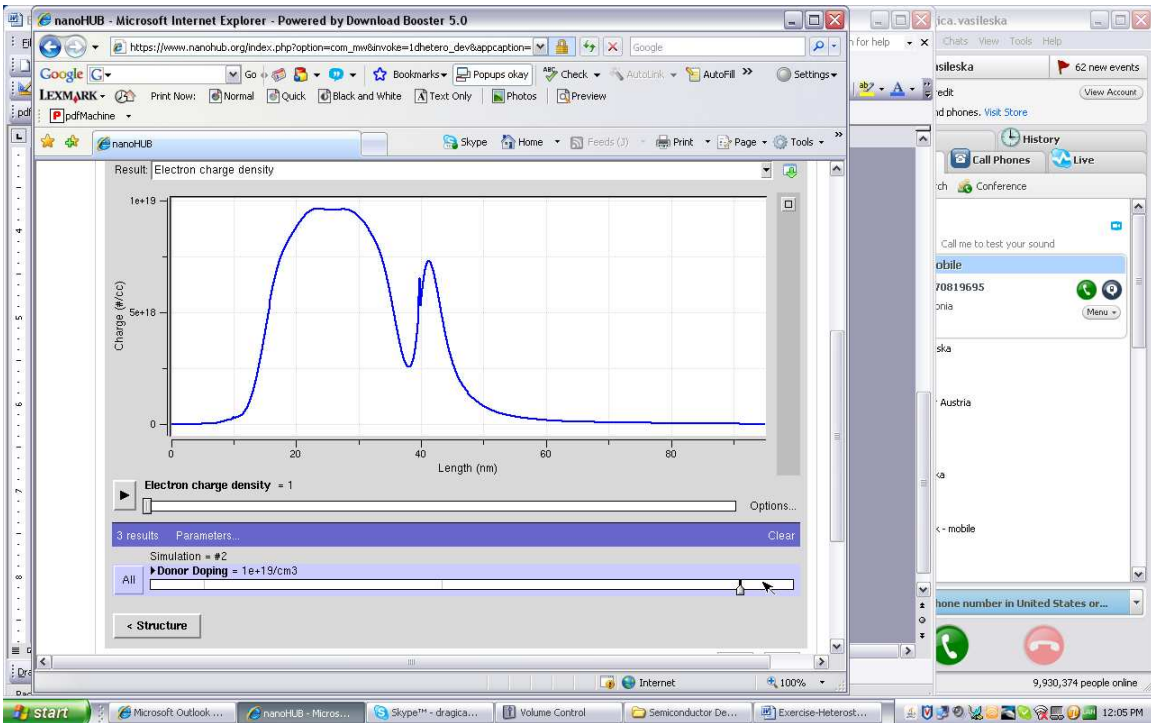
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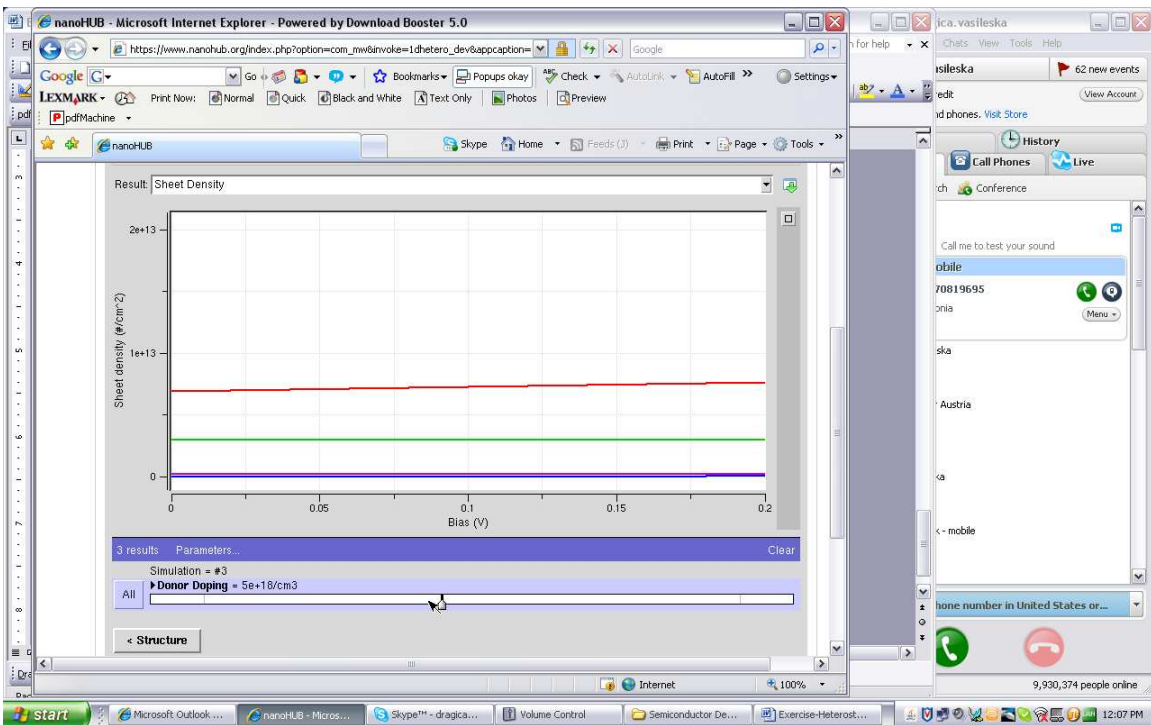
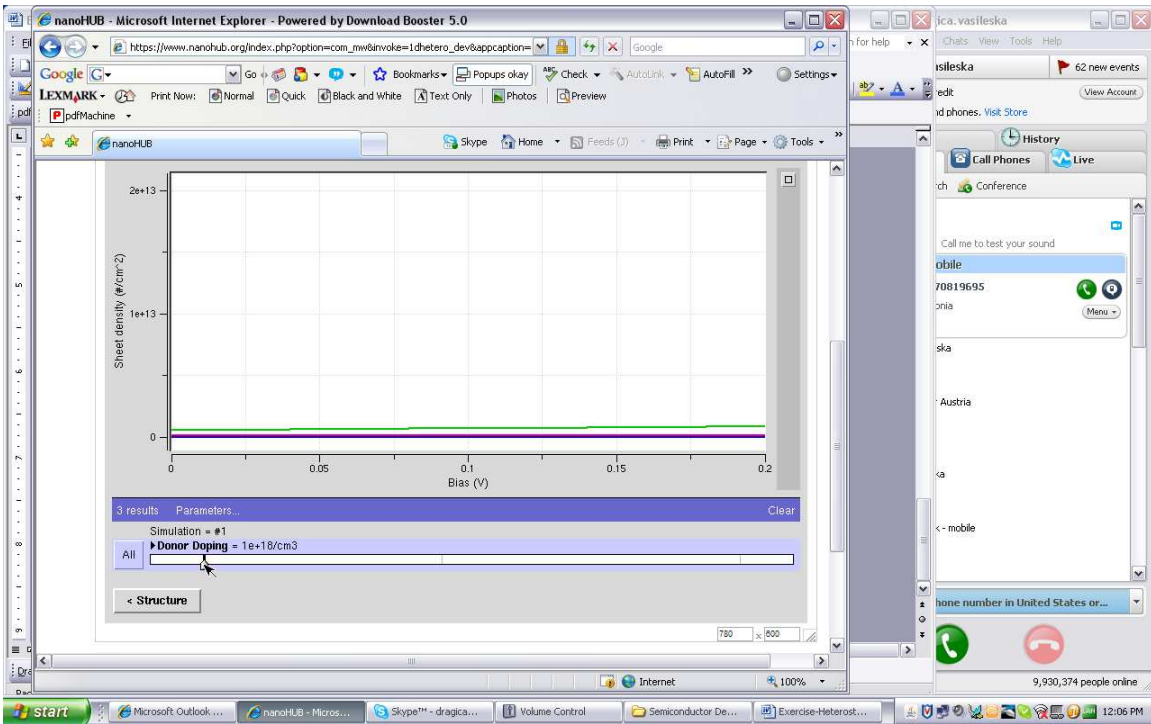
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Result: Sheet Density

Sheet density (#/cm<sup>2</sup>)

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Simulation = #2

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