Before starting, please take your time and read the whole project first. The last part might help you to make your simulations better.

Start with a <100> silicon wafer doped with **Boron** at **1e15 cm^{-3}**. The temperature for pre-deposition is **900 °C**.

a. First, do a pre-deposition. Choose a temperature (**900°C**) and run it for **5 minutes**. Set the surface concentration (*Ns*) to the solid solubility limit of the dopant (**Phosphorus**) at that temperature—find this value from a reliable source. Plot the final doping concentration vs. depth.

b. Now do the drive-in step at **900 °C**. Plot the doping profile after **10, 30, 90, and 300 minutes** on one graph.

c. Run a sweep of the drive-in time at **900 °C**. Make plots showing how the Junction Depth (*Xj*), Sheet Resistance (*Rs*), and Surface Concentration (*Ns*) change over time.

For **Xj= 2.5 micron**, Find Ns and Rs.

If You decide to reduce Rs to Rs/m, with the same Xj, how can you achieve it?

If You decide to increase Xj to n Xj, with the same Rs, how can you achieve it?

Try for **m**=2, 3, 4 ,10 and **n**=2, 3, 4, 10

d. Look at your results from various **n** and **m** values. Using your plot, as a device engineer, suggest two possible, two hard and two impossible targets. Your targets should be reasonable (tell why you chose that target).

	Target Xj	Target Rs	Related Ns	
1				Possible
2				Possible
3				Hard/expensive
4				Hard/expensive
5				Impossible
6				impossible
example	n=8	m=7	?	?
example	n=2	m=9	?	?

e. For the targets in part (d) that are hard or impossible, figure out how to fix it. Change the pre-dep time or temperature (time is better) to make it work. Remember, you can't run a furnace for days in real life!

Hint: Can you repeat Pre-dep and another drive in?

Which approach is better? Increasing total dose in a single pre-dep, or using multiple pre-deps with shorter durations, after each drive in?

f. Now start with a wafer doped at **1e18 cm^{-3}** Boron. And repeat above steps. Discuss the challenges, and possible solutions. Try to hit the same targets from part (d). You can do another pre-dep and drive-in (multi-step diffusion) and change other parameters if you need to.

g. Instead of pre-dep, use ion implantation. Max energy is 200 keV. Use a reasonable dose to achieve targets. Simulate the implant and then a drive-in/anneal. Discuss how to get the right balance between Xj and Rs. You can try using a nitride barrier to keep dopants from diffusing out of wafer. Also mention secondry effects you find from Silvaco results.

h. (bonus)

- Verification of Results
Verify your simulation results against at least 3 reliable sources (examples, published papers reporting processing details for BJT, Solar cell, MOS wells).
Do you obtain the exact same values in Silvaco simulations? If not, investigate and report on how TCAD tools like Silvaco execute and solve simulations. Discuss the reasons why results may deviate from analytical solutions or real-world experiments

Do Sensitivity analysis for dependence of Xj and Rs, on processing parameters (Temp, and times of pre-dep, and drive in). Feel free to change them for achieving Xj assigned to you.

- Importance of Meshing
How critical is meshing? Outline effective strategies and tips for meshing your device structure.

- Solver Models and Methods
Experiment with different Silvaco solver models and numerical methods for your simulations. Discuss how these choices affect the results.

- Customized Solver Scenarios
Explain at least three situations where standard simulation settings are inadequate, requiring a properly customized solver model and method to achieve accurate results.

For this section, the *ATLAS* and *ATHENA* module manuals will serve as excellent references.

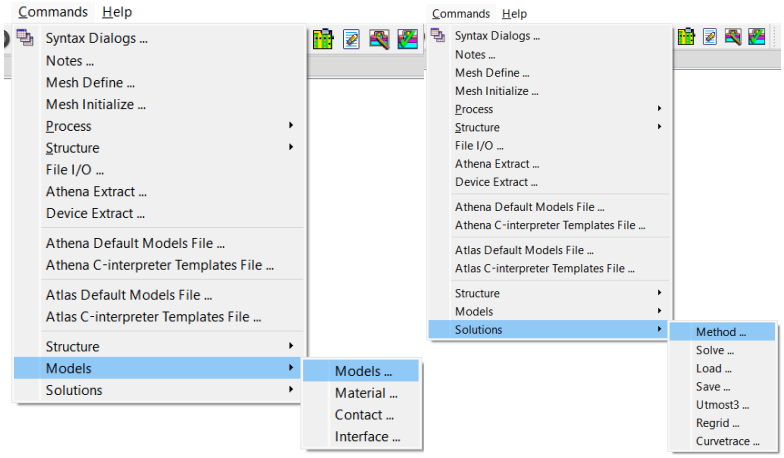

Figure 1- solver wizard location