SILVACO

SiC technology optimisation using advanced modelling tools.

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Problem statement: everything is coupled

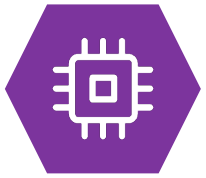
- Many events are random but coupled.
- Prediction requires solving the governing equations.
- Large number of equations must be solved simultaneously.

Silvaco at a Glance

800+
Customers
Worldwide

200+
University Customers
Worldwide

270+
Employees



#1
TCAD and Modeling
for **Flat Panel, Power**

Solutions for
Display, EV Power, SoC, IoT, Fab Process Optimization

Deep Industry &
Academic
Collaborations

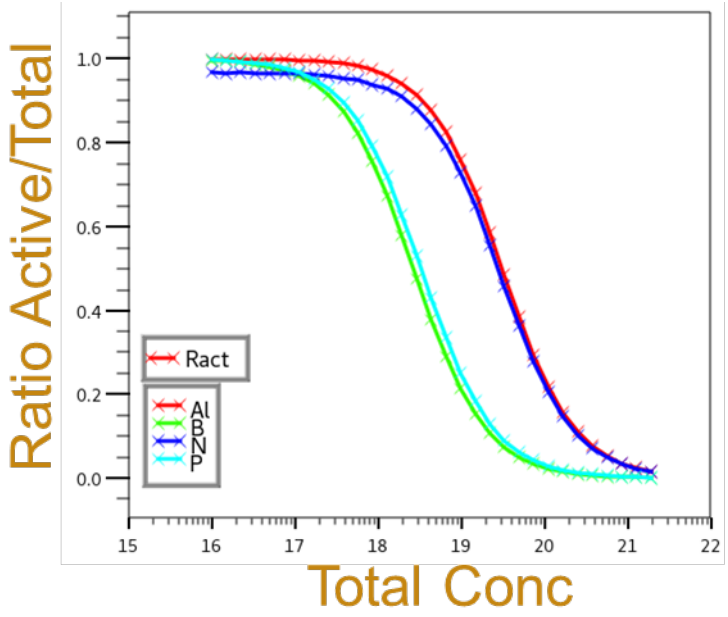
Challenges facing technology designers

Pain and gain

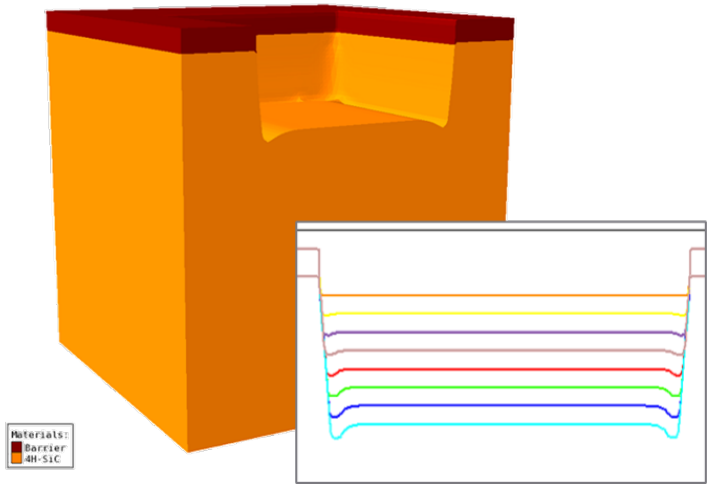
- **SiC offers advantages but…**
  - New electrical and fabrication behaviors to understand and improve
  - Understand role of crystallographic defects on charge transport
- **Complex 3D Device Geometries**
  - Need to maximise performance/power density
  - Novel layouts to increase device density
- **High Demand for Power Devices**
  - Immense market opportunity with associated risks
  - Higher volume applications (e.g., Electric Vehicles) require scaling of semiconductor technologies with high yield
- **Design tools**
  - New (enhanced) tools are needed- Higher precision, new transport models, etc...
  - New SPICE models are needed

Fabrication: **Victory Process**

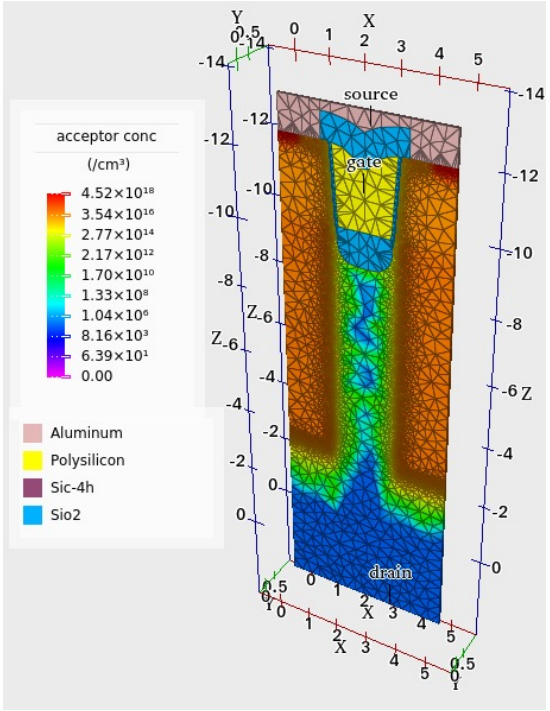
Virtual fabrication to optimize the next generation power devices



Activation Ratio vs Concentration for 4H-SiC at 1700C



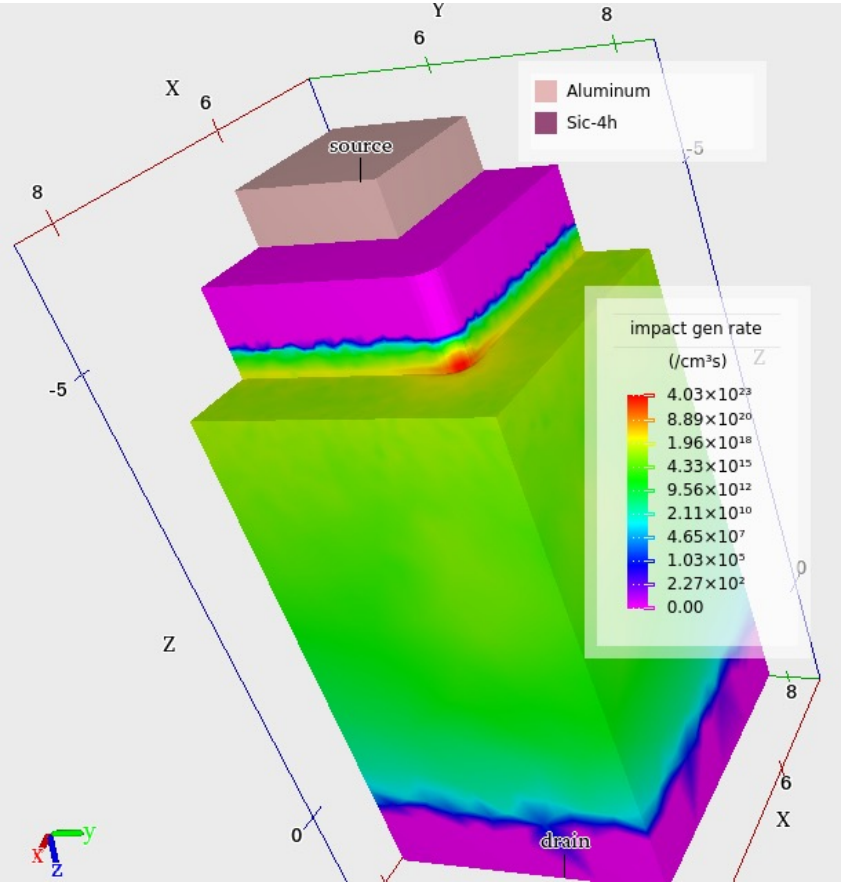
Emulation of SiC Microtrench formation with time evolution

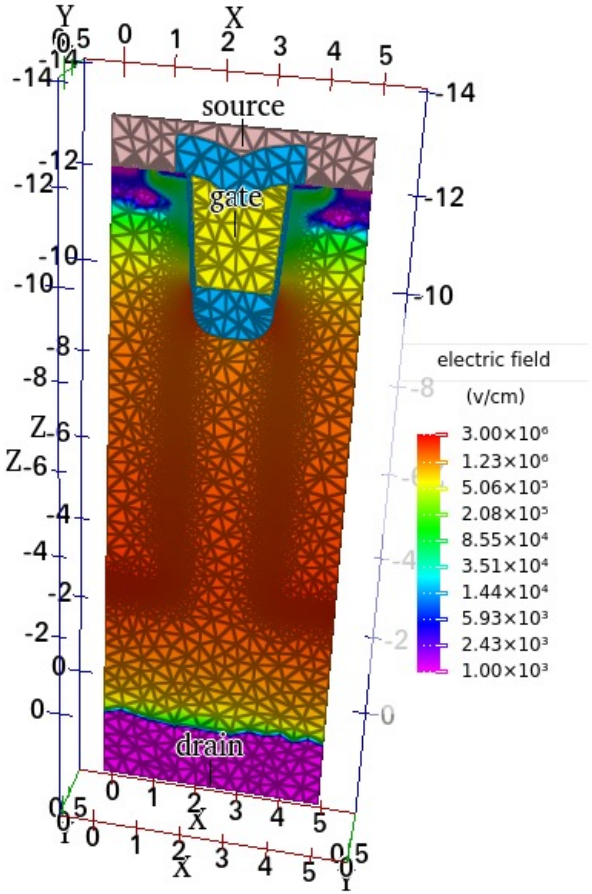


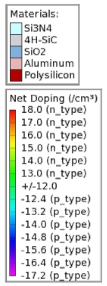
Trench gate MOS SiC device

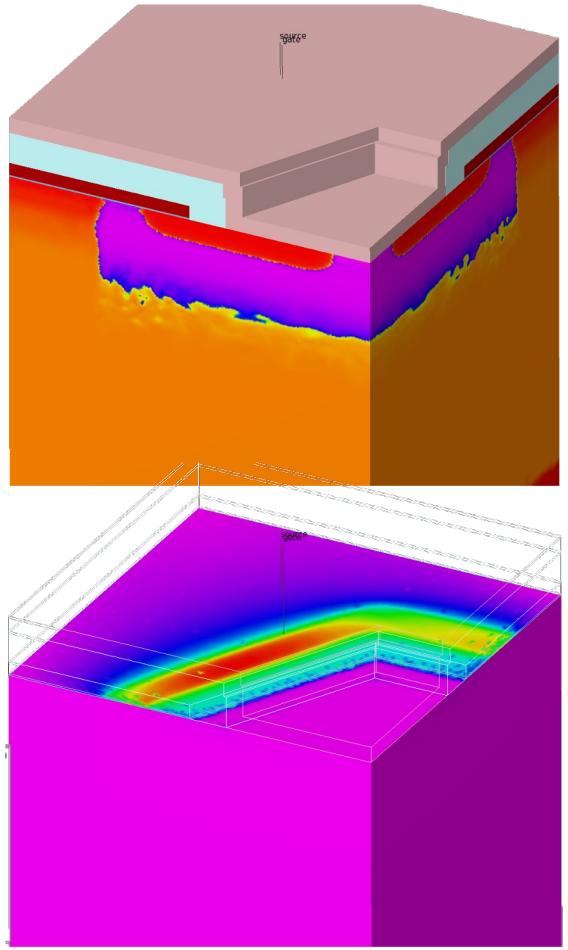
Technology performance: **Victory Device**

Victory Device for power device simulation needs





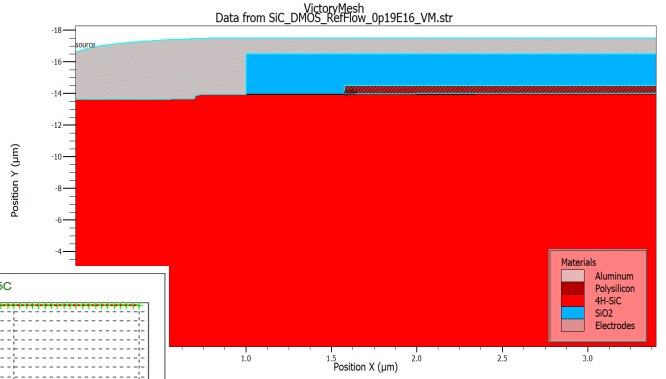


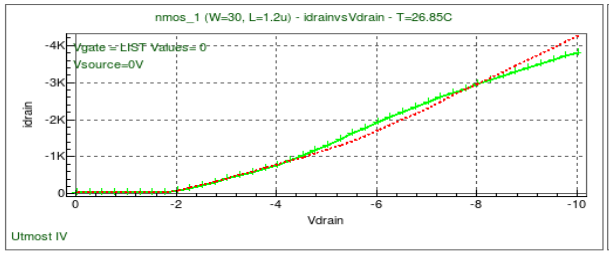


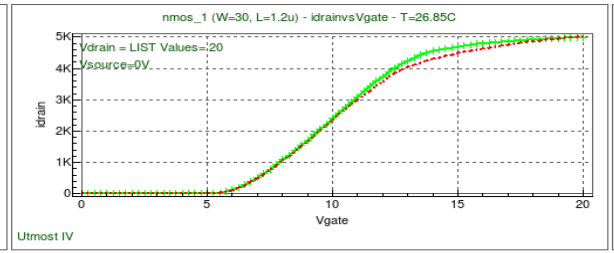
Anisotropic Mobility of SiC HexFET

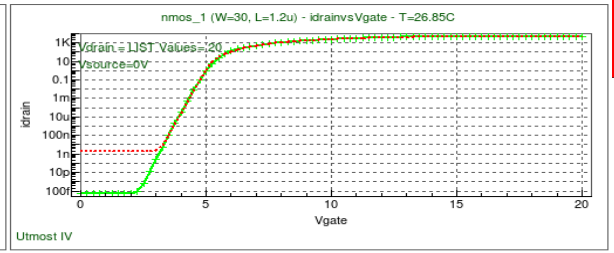
System performance: **UTMOST4 + SmartSpice**

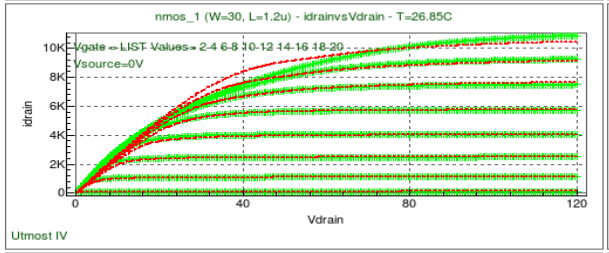
- No SiC based devices standard SPICE models yet.
- Use SPICE BSIM4-based Macromodel can produce reasonable fit to extract parameters for circuit and system design.

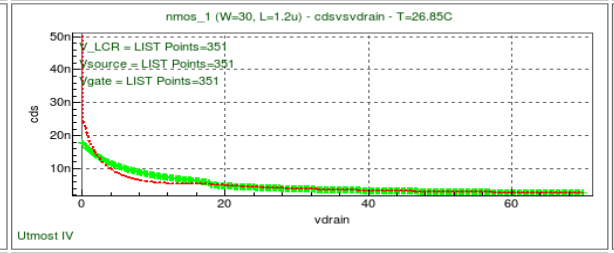


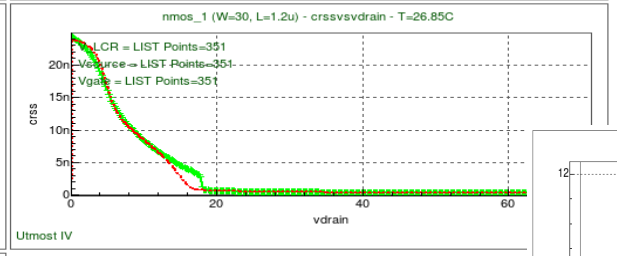


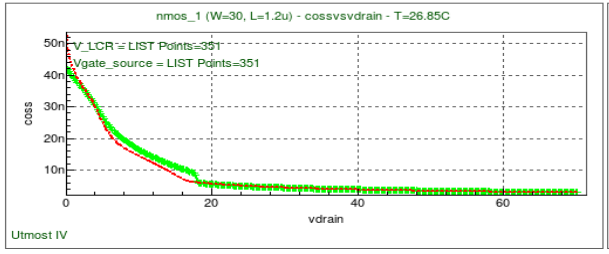


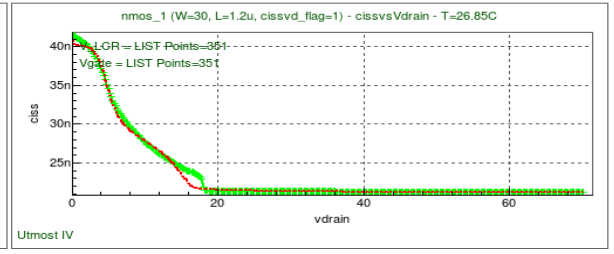


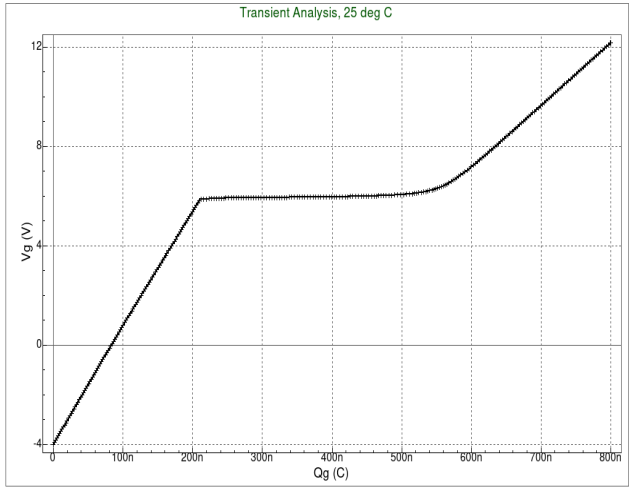












Optimisation flow

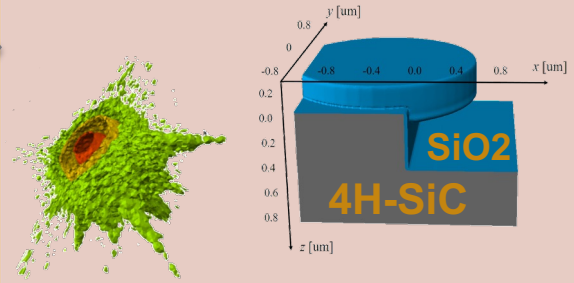
Linking Fab to product design

FAB oriented design flow ➡ complex DOE matrix + ML driven data analysis

Design (GDSII) Process Info

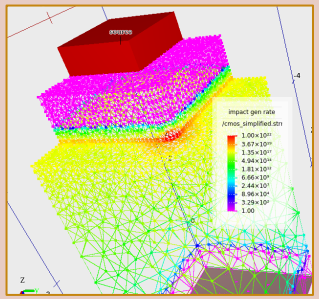
Process Simulation Solid Modeling

Victory Process



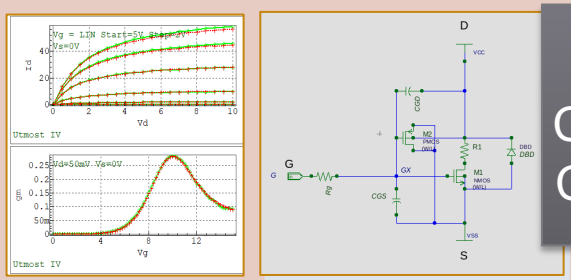
Device Simulation

Victory Device



Modeling Circuit Simulation

Utmost IV



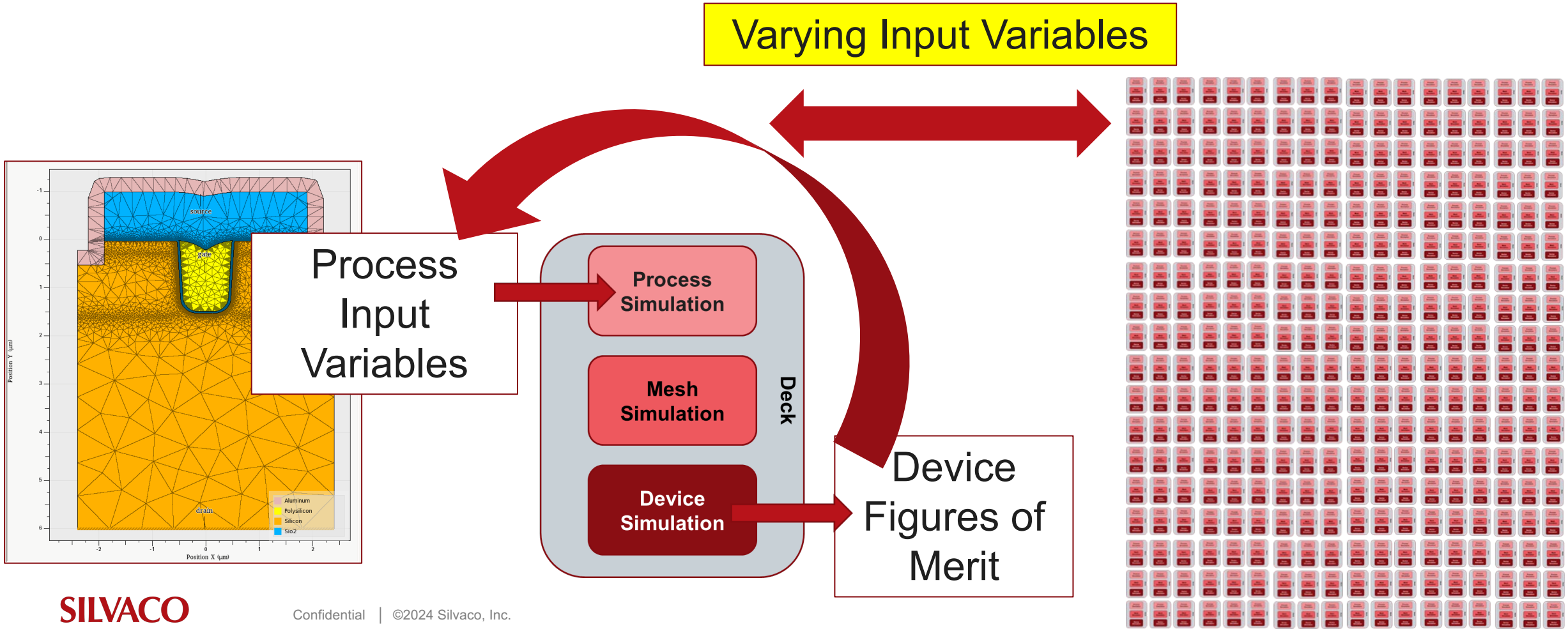
Model / Circuits to Customer

Design Technology Co-Optimization

Design space – Left to right DOE

One candidate into many

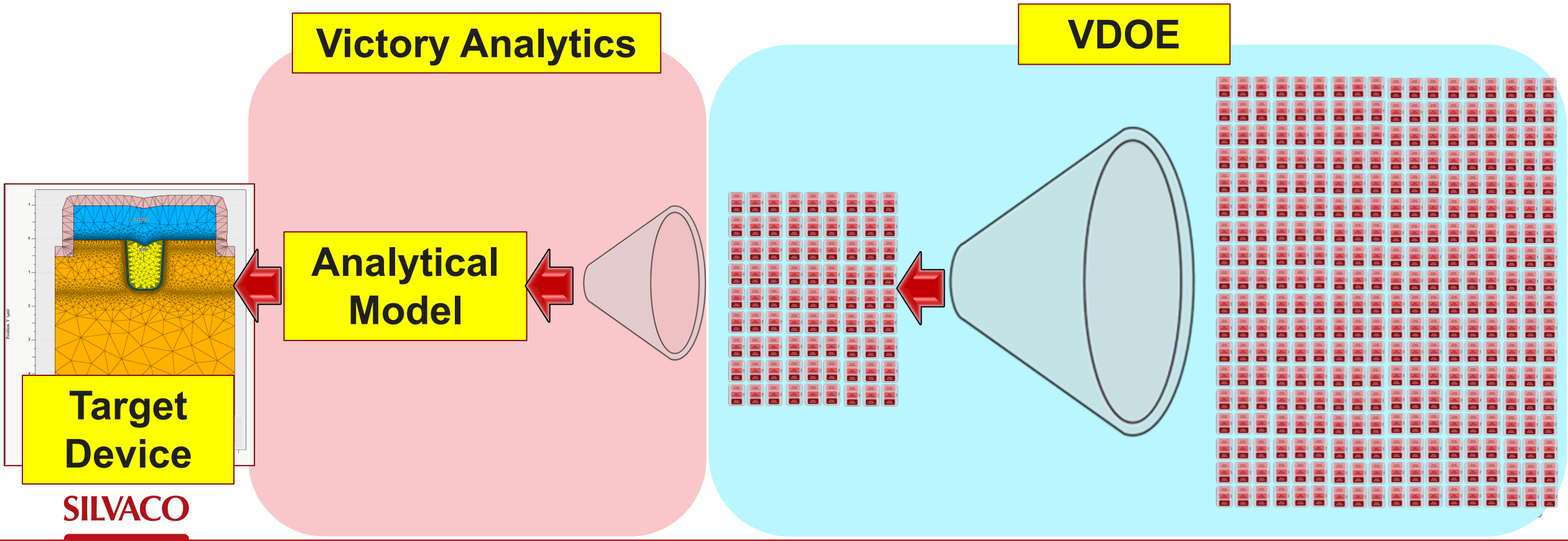
- TCAD Simulation Flow for **Device Optimization is not one-shot procedure!**



Finding “the one” – Right to left

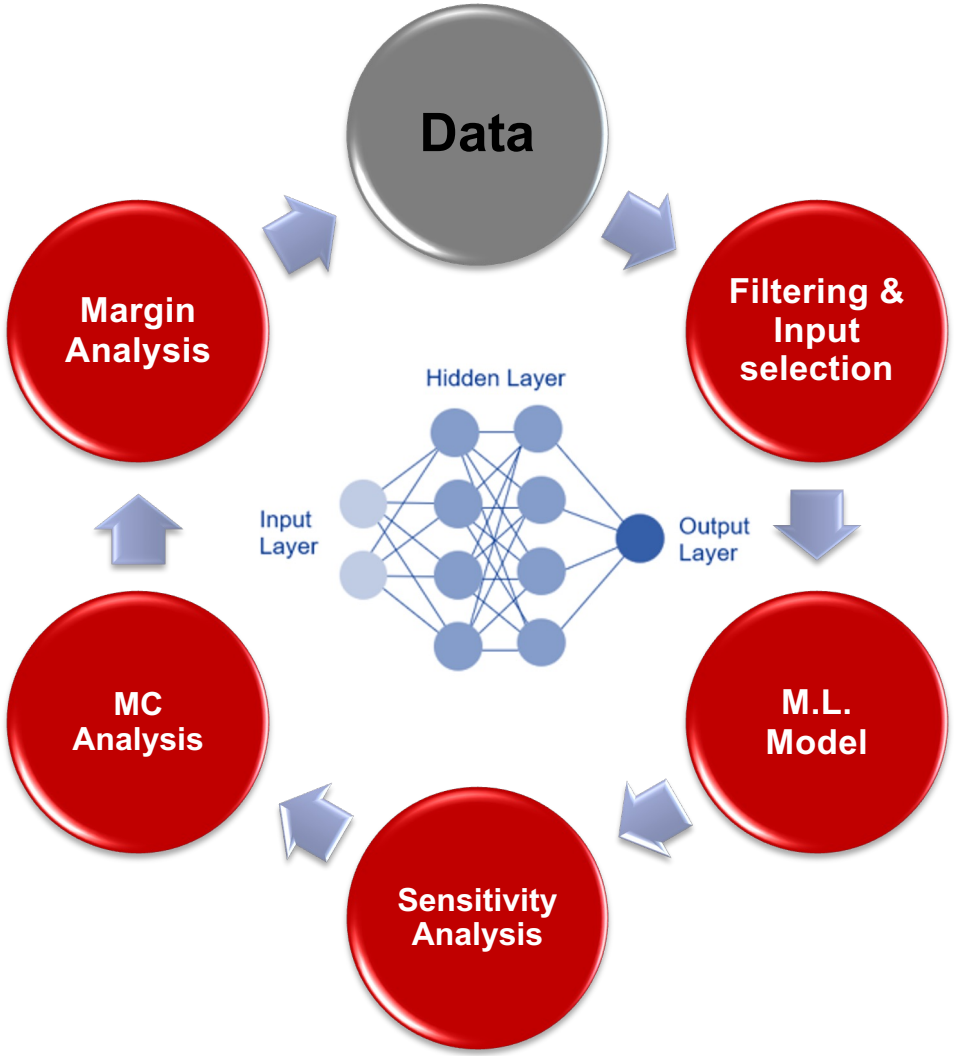
Smarter R&D Flow

- **Data from VDOE needs to be analyzed** to find the relationship between multiple **Process Input Variables** (factors) **and Device FOMs** (key responses).



Victory Analytics – What's under the bonnet

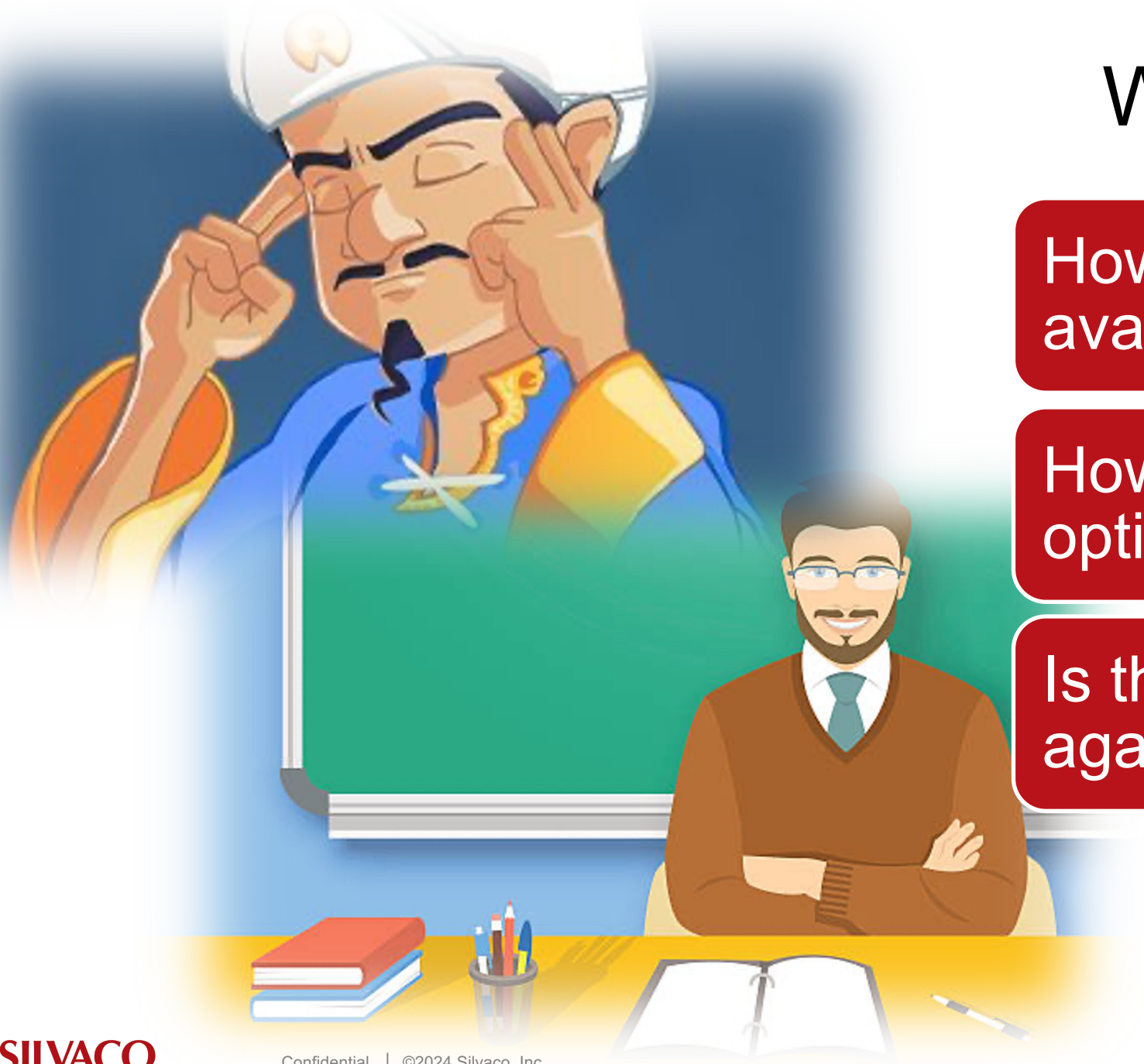
- **Filtering and Input selections**
  - Automatically filter outliers and find the dominant inputs
- **Machine Learning Model**
  - Modeling the correlation between input to output based on neural network
- **Statistical/Sensitivity Analysis**
  - Sensitivity, Interaction, ANOVA, Trend, Overfitting etc.
- **Monte Carlo Cp/Cpk analysis**
  - Failure rate w.r.t. input parameters
- **Margin analysis**
  - Identify the control window of input parameters



Final thoughts

- **Most things in life are coupled**
  - How do we dis-entangle our design.
- **SiC technology requires new design tools.**
  - New processing requirement, new charge transport models, new SPICE models, etc.…
- **Linking the design elements into a seamless flow**
  - All modules are driven by one script
- **Parametric model (the secret sauce) requires advanced algorithms**
  - ML is used to generate the final parametric model
- **Expectations are inexorable. Development continues.**
  - Market expectations are fast changing. Design tools have to keep up.

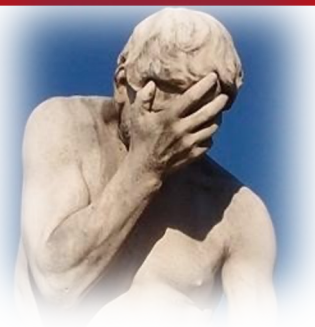
Wisdom



How to "discover" available options.

How to "discover" optimal solution.

Is there insurance against wrong choices?



Silvaco produces advanced Power Technology design tools

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