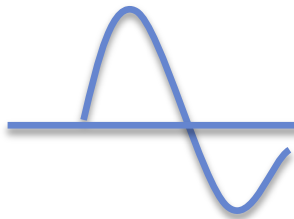


Lighting up the Semiconductor World...

Advanced TCAD Simulation for Power Semiconductor Devices

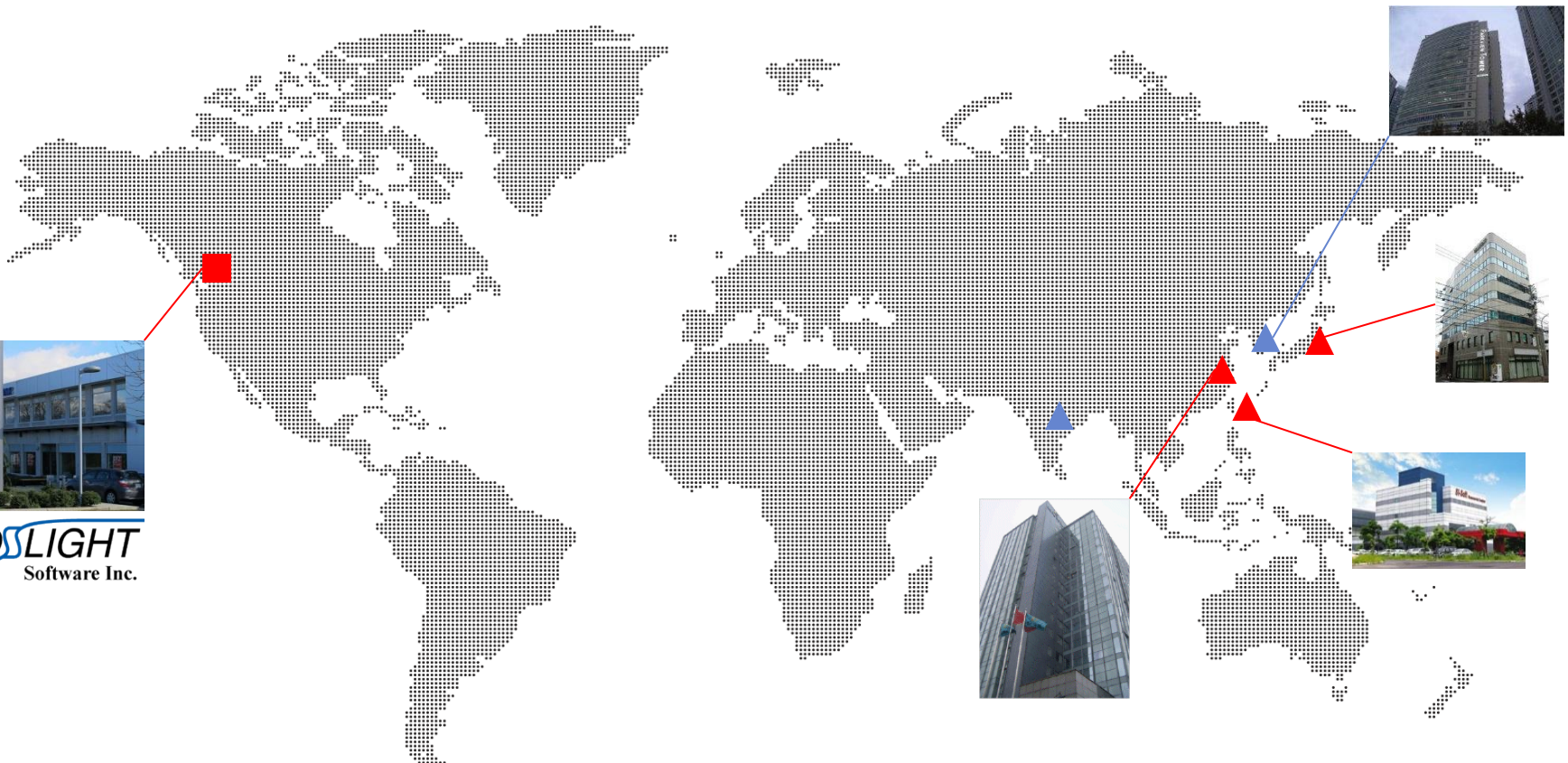


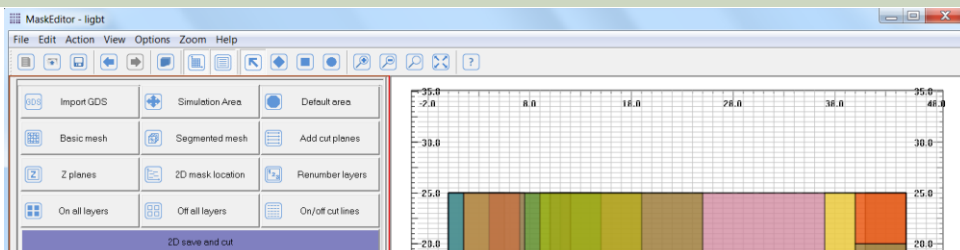
A Canadian company with **20** years of history

The world's **first** commercial TCAD for laser diode

The world's **No.1** provider of optics and photonics TCAD

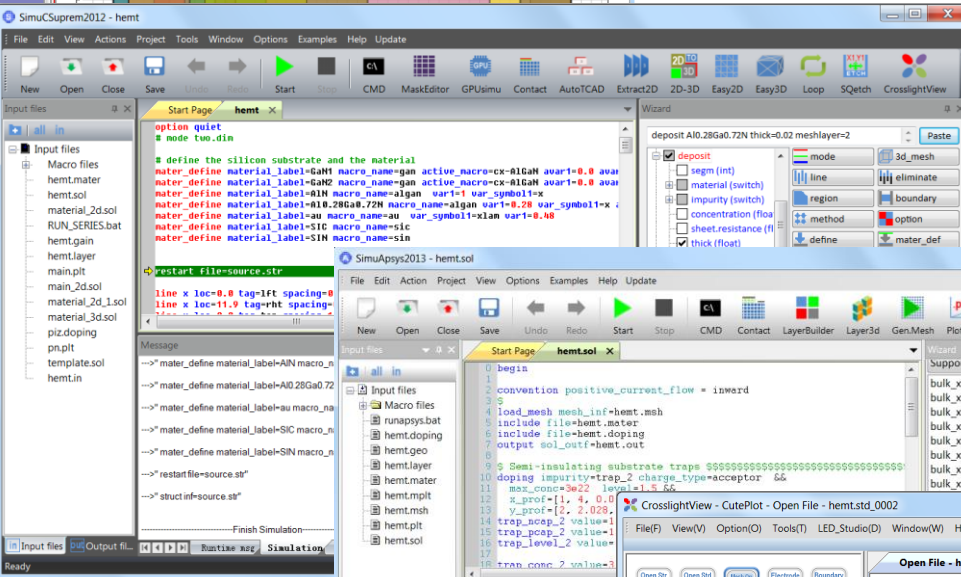
The world's **most advanced** stacked planes 3D TCAD



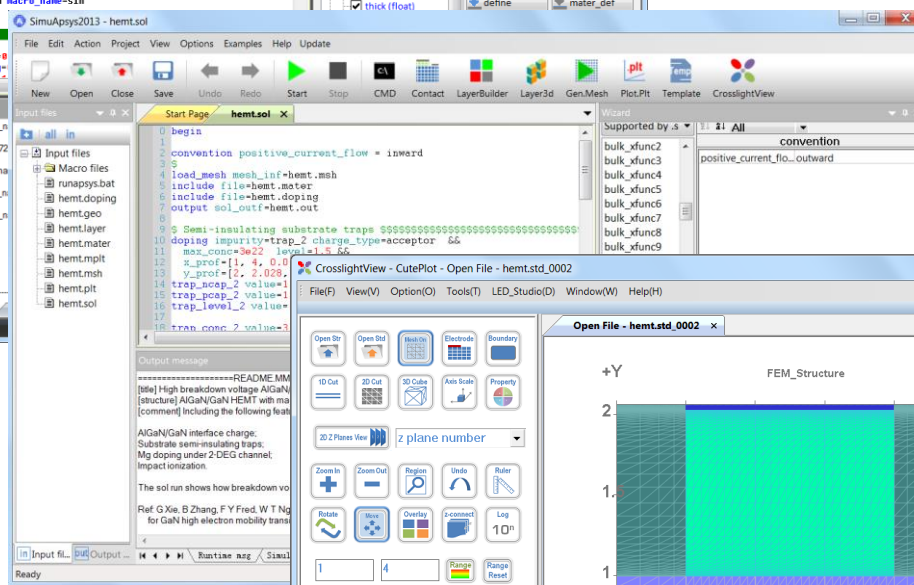


MaskEditor: 3D/2D GDSII import and prepares necessary files for process simulation

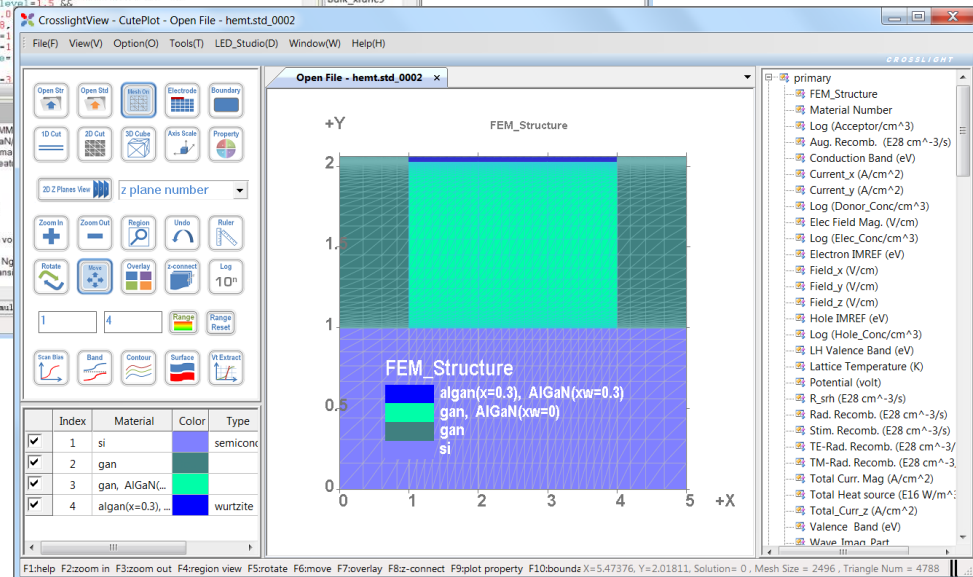
No.	Label	Color	Purpose
1	Active	general	general
2	LOCOS	etch	etch
3	Gate	etch	etch
4	Contact	etch	etch
5	metal1	yellow	general
6	npolys	general	general
7	PBL	general	general
8	iso	general	general
9	Pbody	general	general



CSuprem: 2D/3D Process Simulator



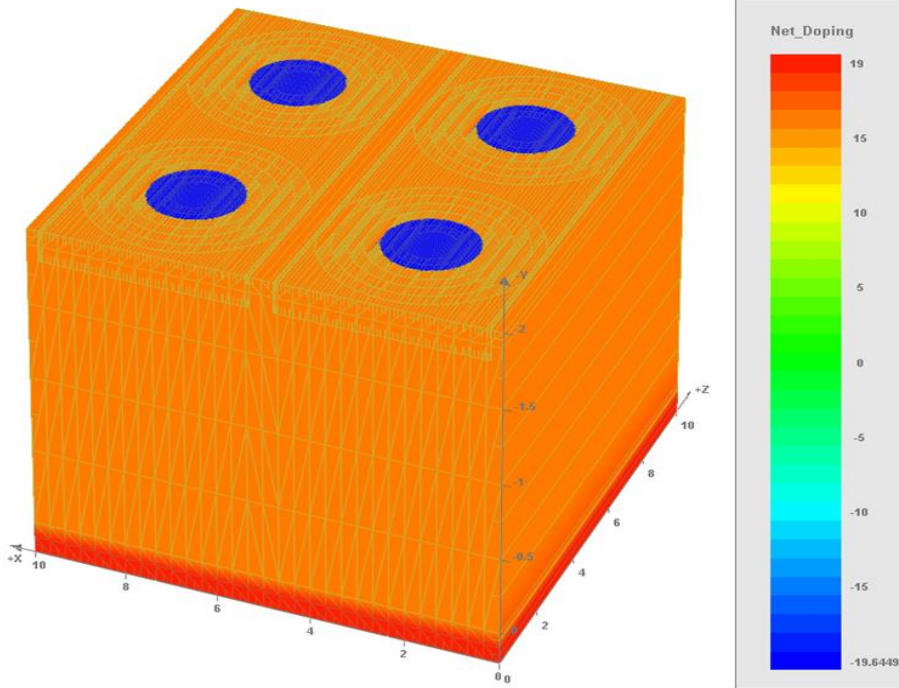
APSYS: Advanced 2D/3D Device Simulator



CrosslightView: GUI For 2D/3D plots and structures

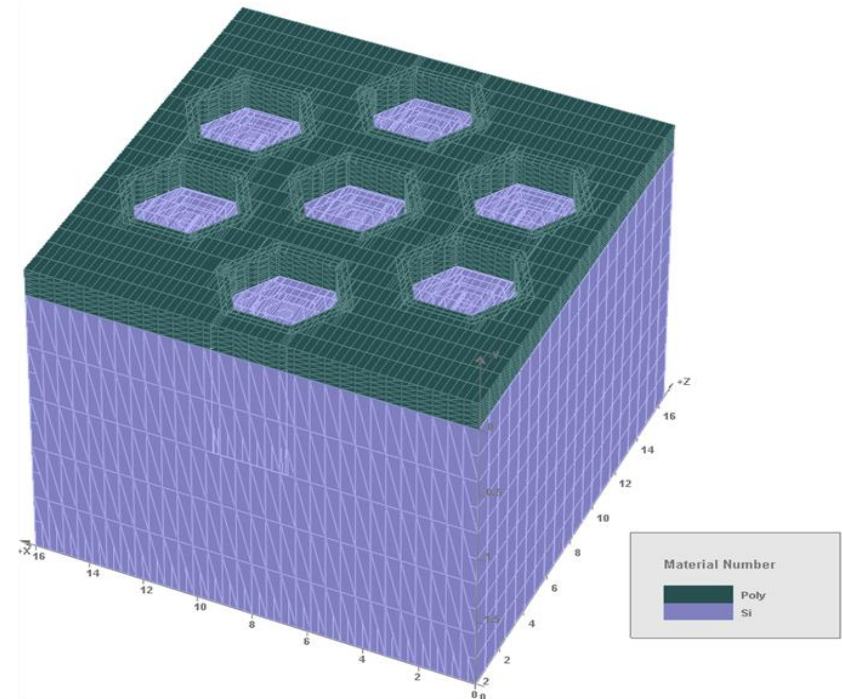
Capabilities: ✓ 3D Process simulations

Power Diodes



(a) Power Diodes with Anode on top (circles) and Cathode at the bottom

Power Hexagonal Vertical DMOS

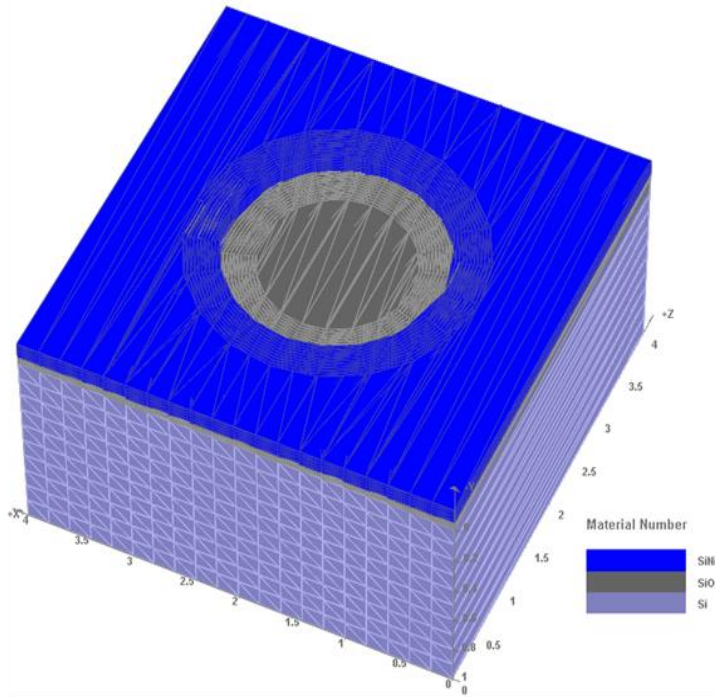


(b) hexagonal shaped gates of a vertical DMOS

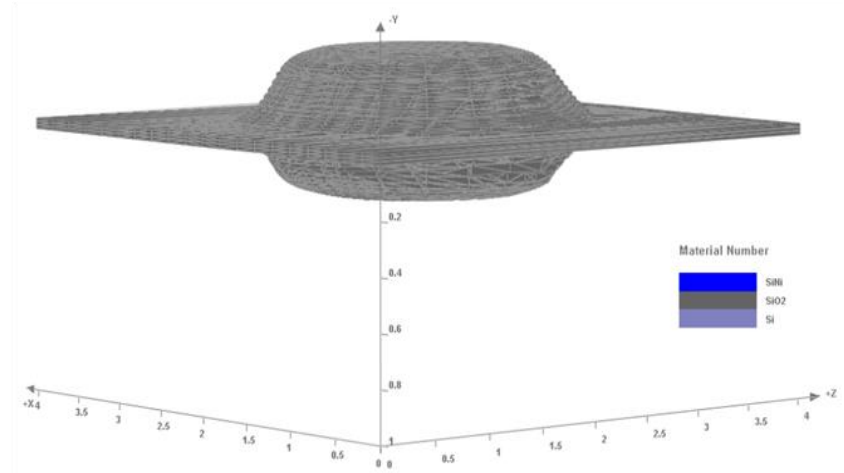


Capabilities: ✓ 3D Process simulations

3D LOCOS Diffusion "UFO"



(a) oxide and nitride mask before oxidation



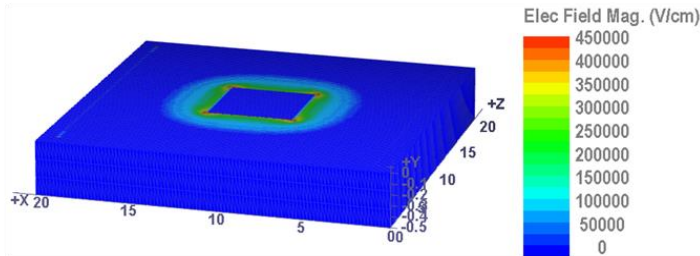
(b) After oxidation with silicon and nitride removed



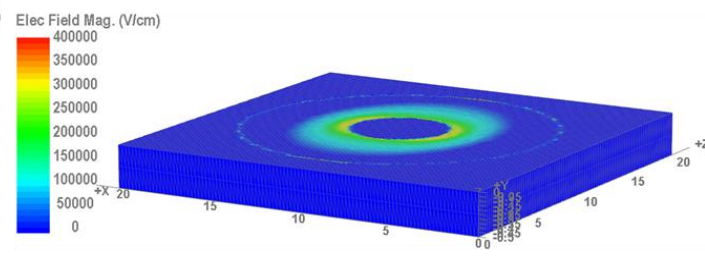
Capabilities: ✓ 3D Device simulations

Square vs. Circle

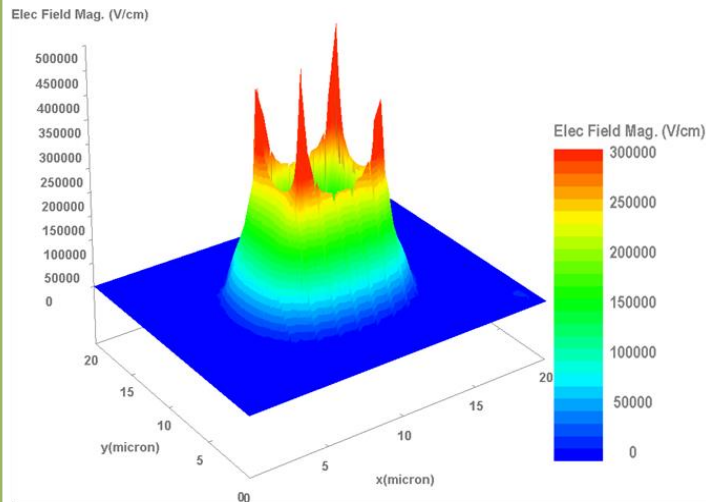
3D Electric Field Comparison: Circular and Square shapes



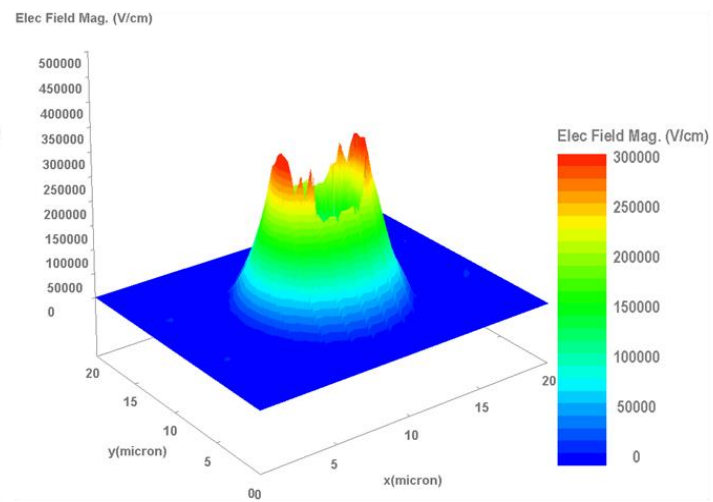
(a) Electric field plot of the square shaped structure



(b) Electric field plot of the circular shaped structure



(c) Surface plot of electric field of square shaped structure (XZ plane at Y=0)

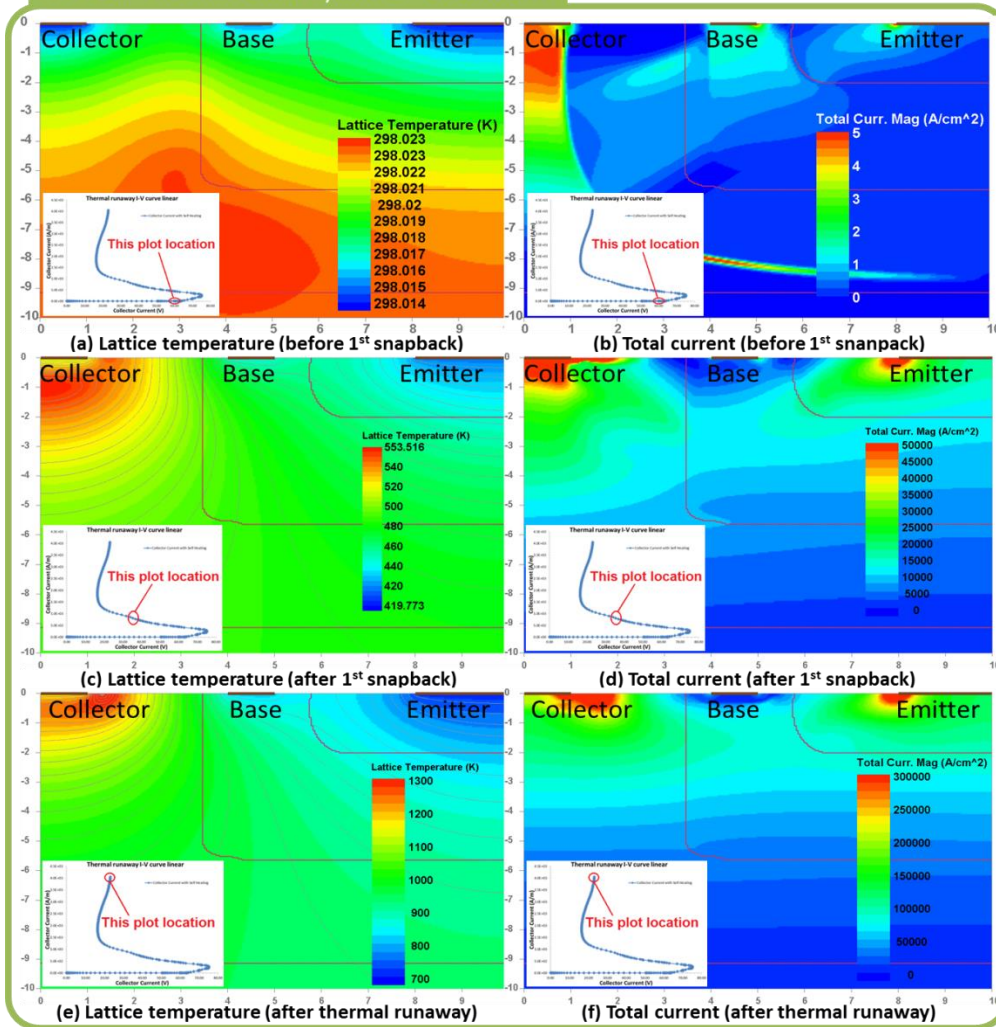


(d) Surface plot of electric field of circular shaped structure (XZ plane at Y=0)



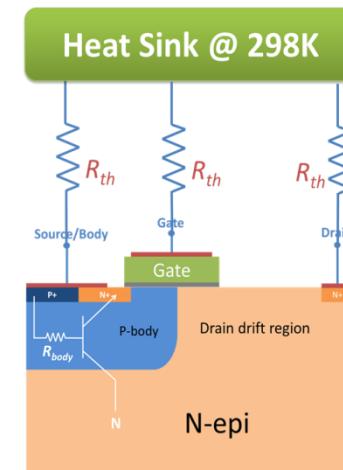
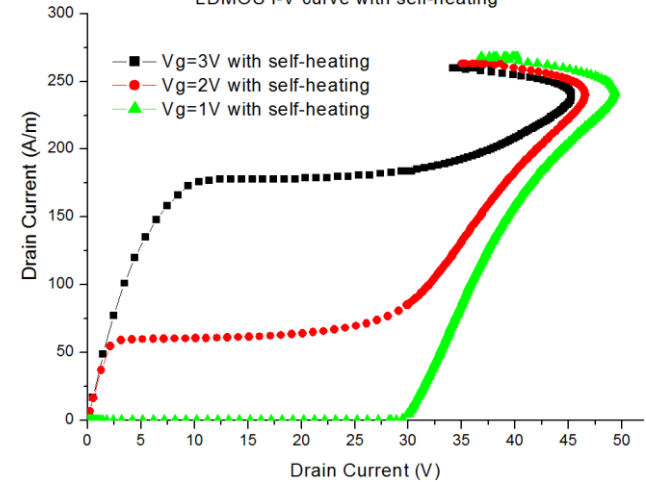
Capabilities: ✓ Thermal Simulations

NPN BJT Thermal runaway and 2nd breakdown

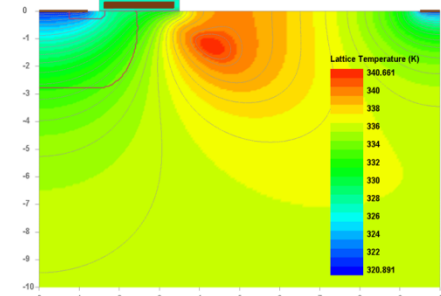


BJT Thermal Runaway

LDMOS I-V curve with self-heating



(a) Schematic of heat sink connection with $R_{th}=80$ (W/m)/K

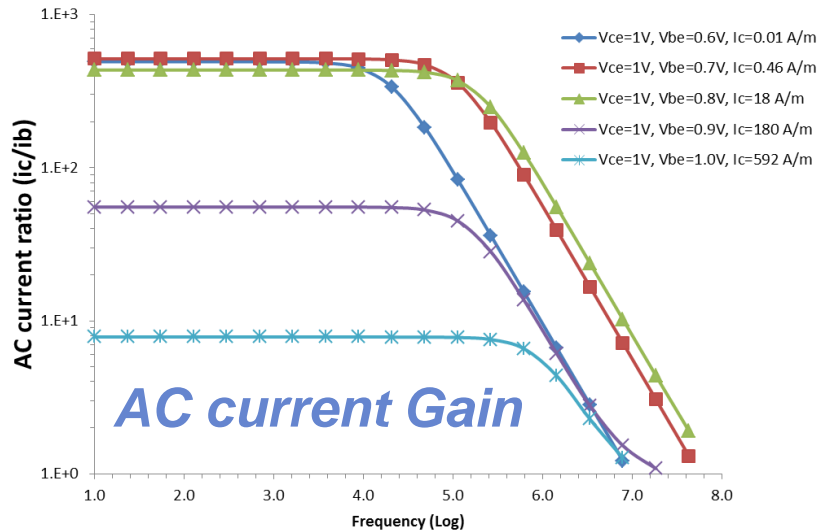
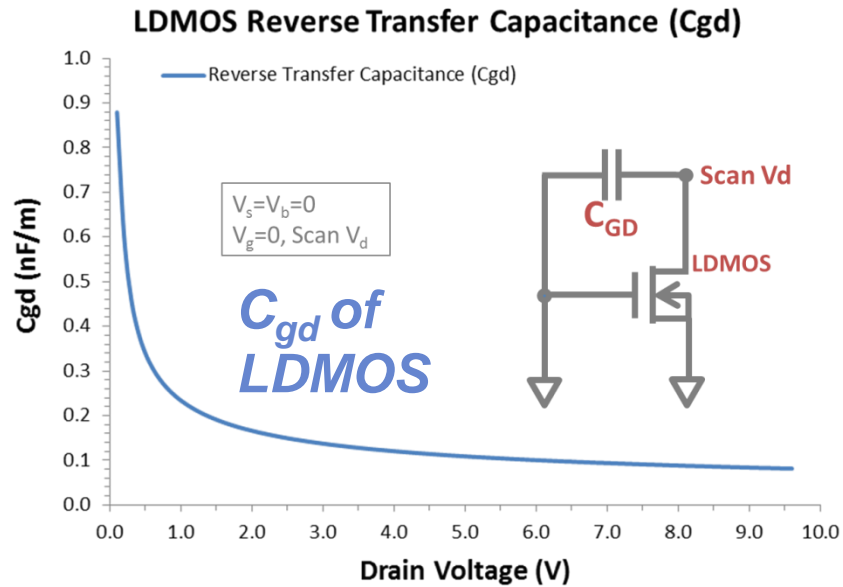


(b) Lattice temperature plot of LDMOS self heating at $V_g=3V$, $V_d=30V$

LDMOS Snapback

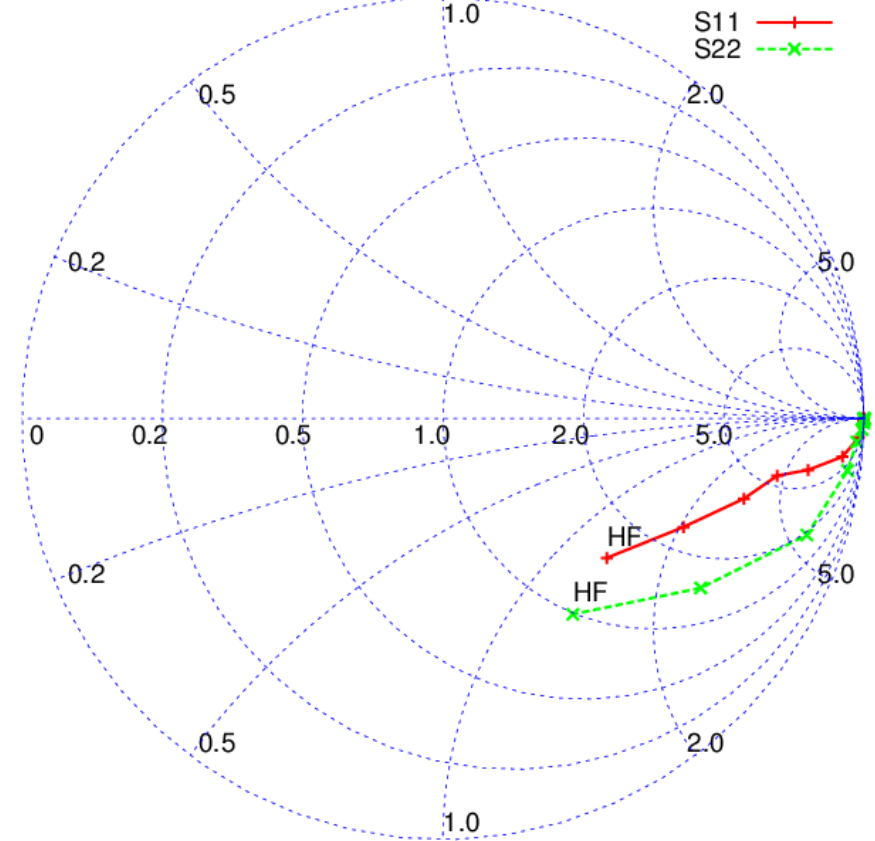


Capabilities: ✓ AC simulations



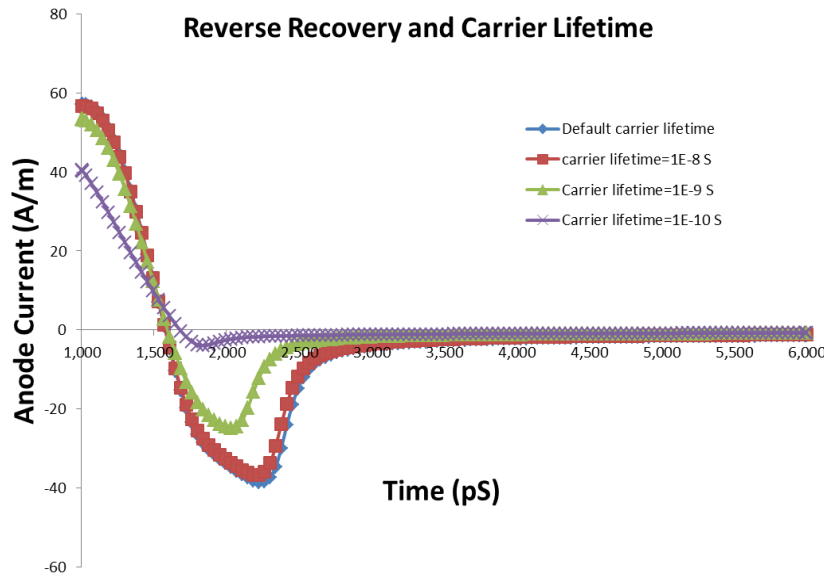
Smith Chart

HF=Higher Frequency

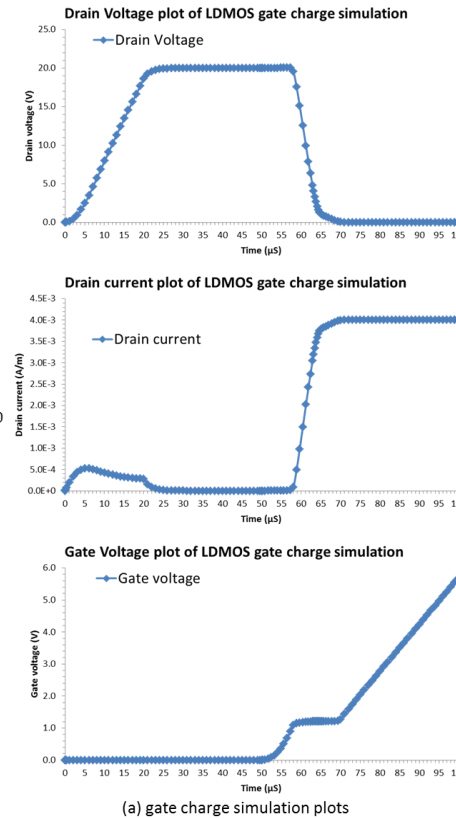


Capabilities: ✓ Transient Simulations

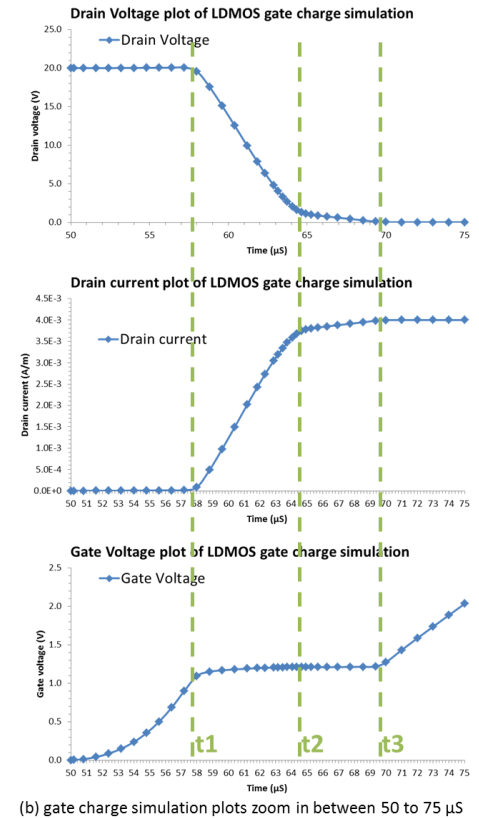
Reverse Recovery and Carrier Lifetime



Diode Reverse Recovery With Various Carrier Lifetime



(a) gate charge simulation plots

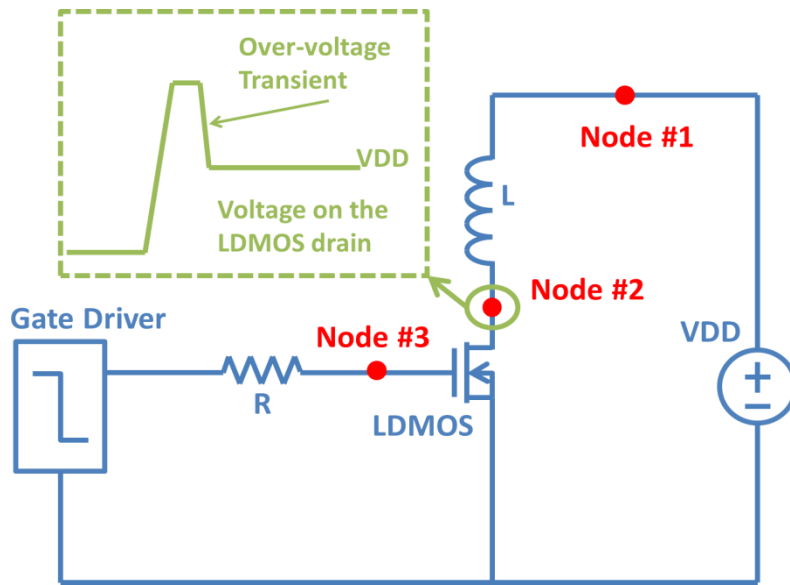


(b) gate charge simulation plots zoom in between 50 to 75 μs

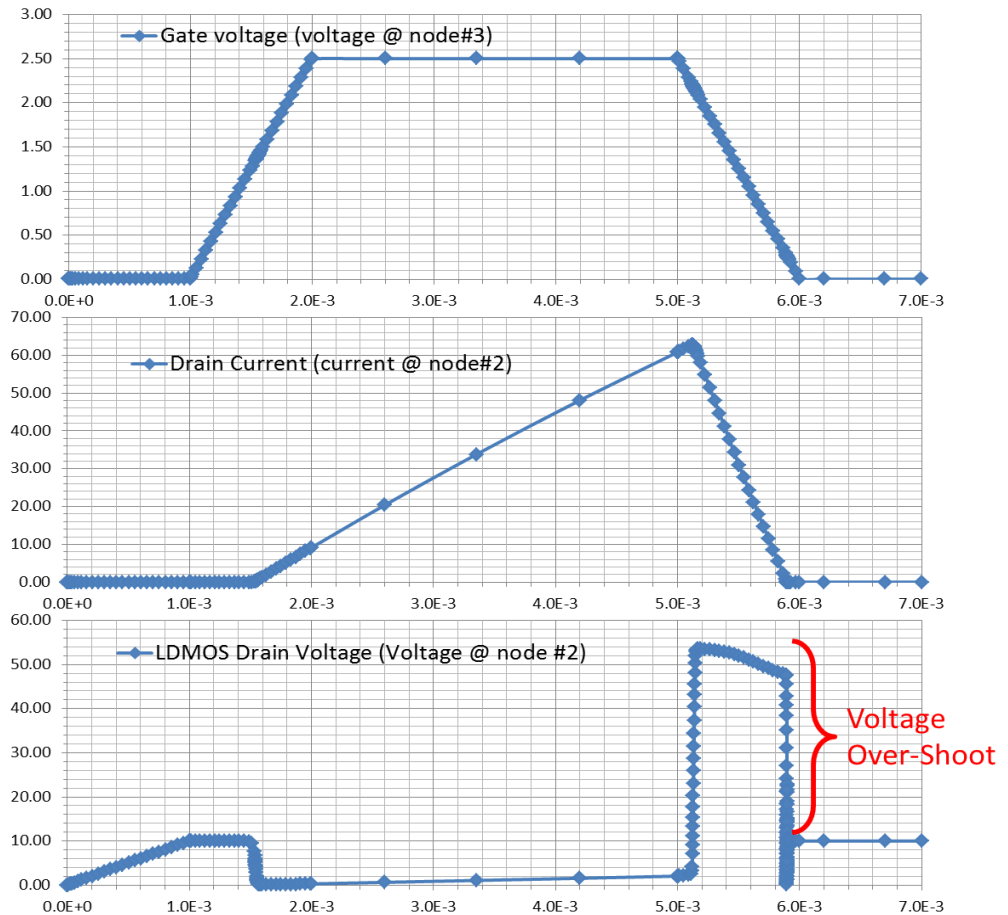
LDMOS Gate Drive



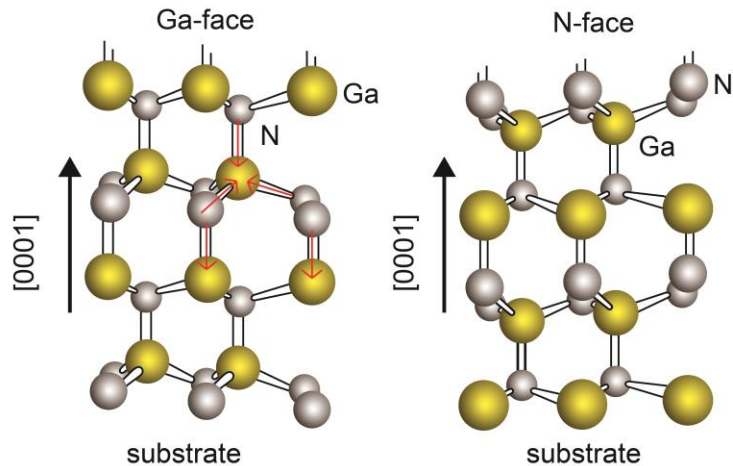
Capabilities: ✓ Mixed mode simulation



Unclamped Inductive Switching (UIS)



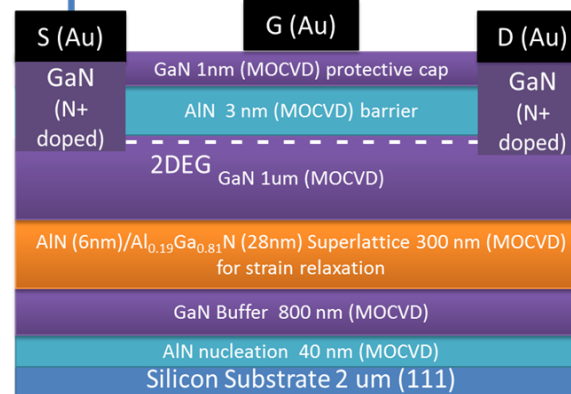
Capabilities: ✓ GaN



Parallel resistor between gate and source, representing defects in the barrier and surface that form a resistive path

Series resistor to the gate, representing metal contact quality

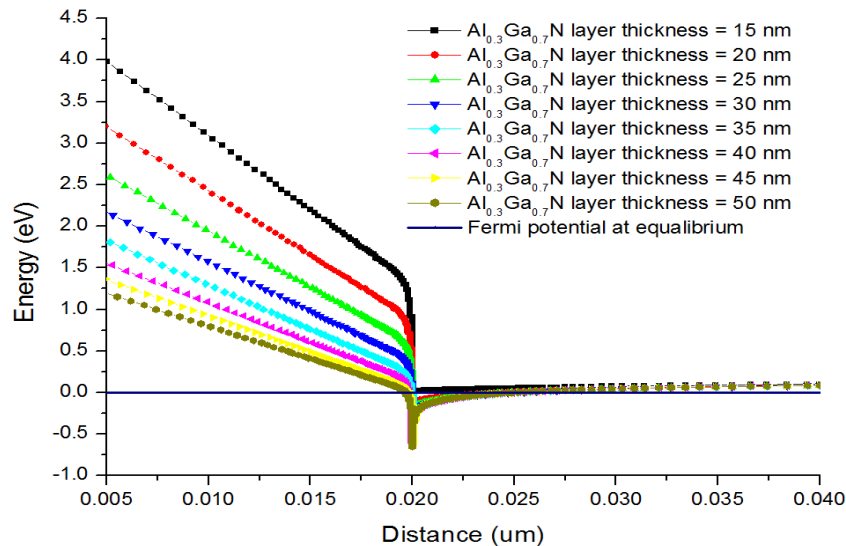
Parallel capacitor between gate and source, representing traps



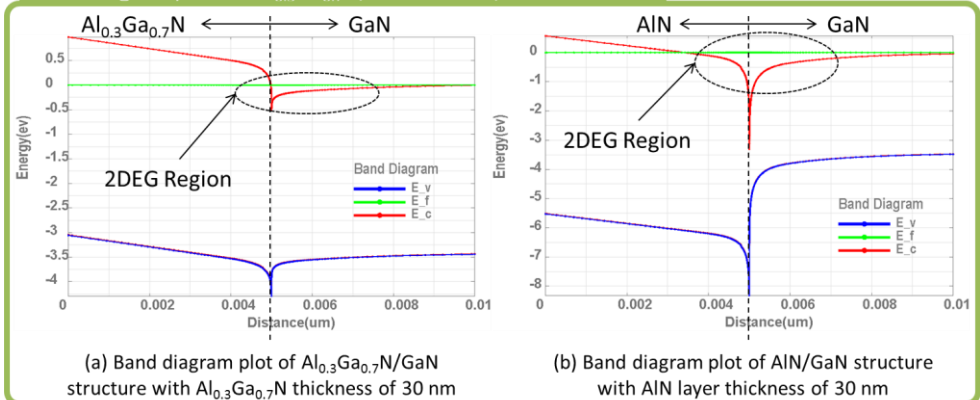
Parameters	Values
Series Resistor	0.05 $\Omega \cdot m$
Parallel Resistor	25 $\Omega \cdot m$
Parallel Capacitor	0.14 nF/m

Mixed mode gate leakage simulation

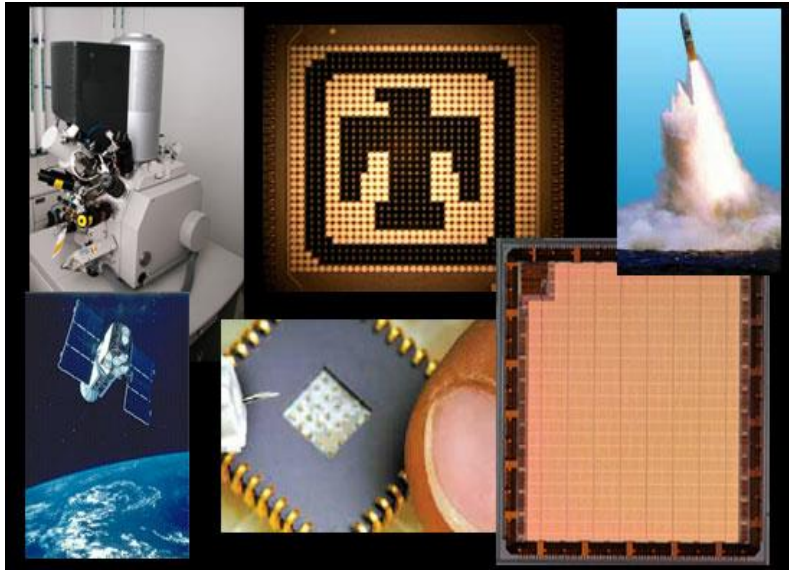
Conduction band diagrams of $Al_{0.3}Ga_{0.7}N$ with various layer thickness



Band diagram plots of $Al_{0.3}Ga_{0.7}N/GaN$ and AlN/GaN structures

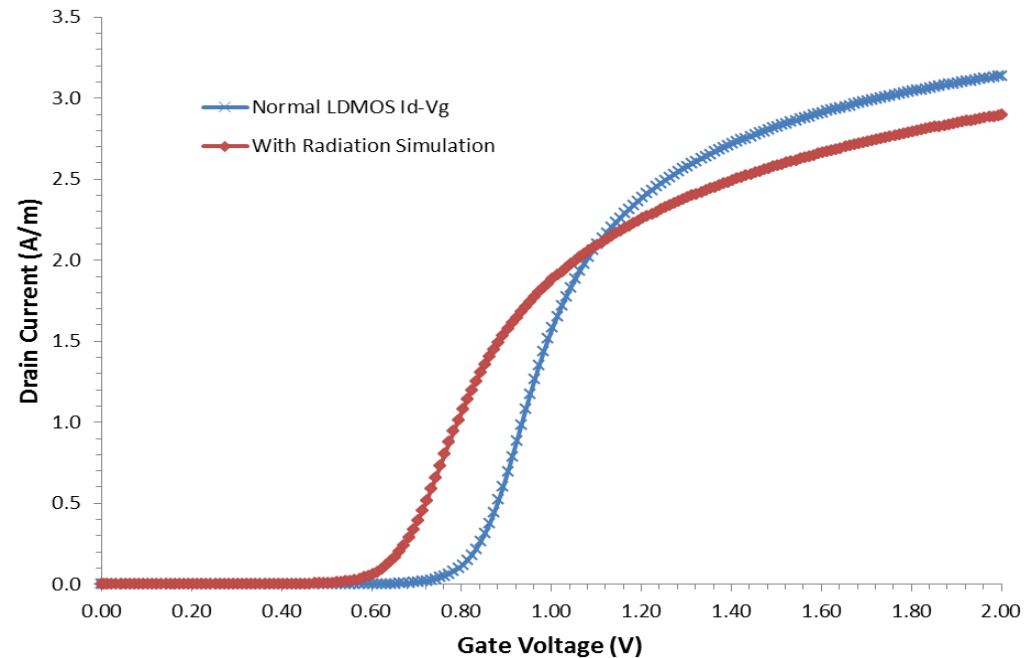


Capabilities: ✓ Radiation Hardening



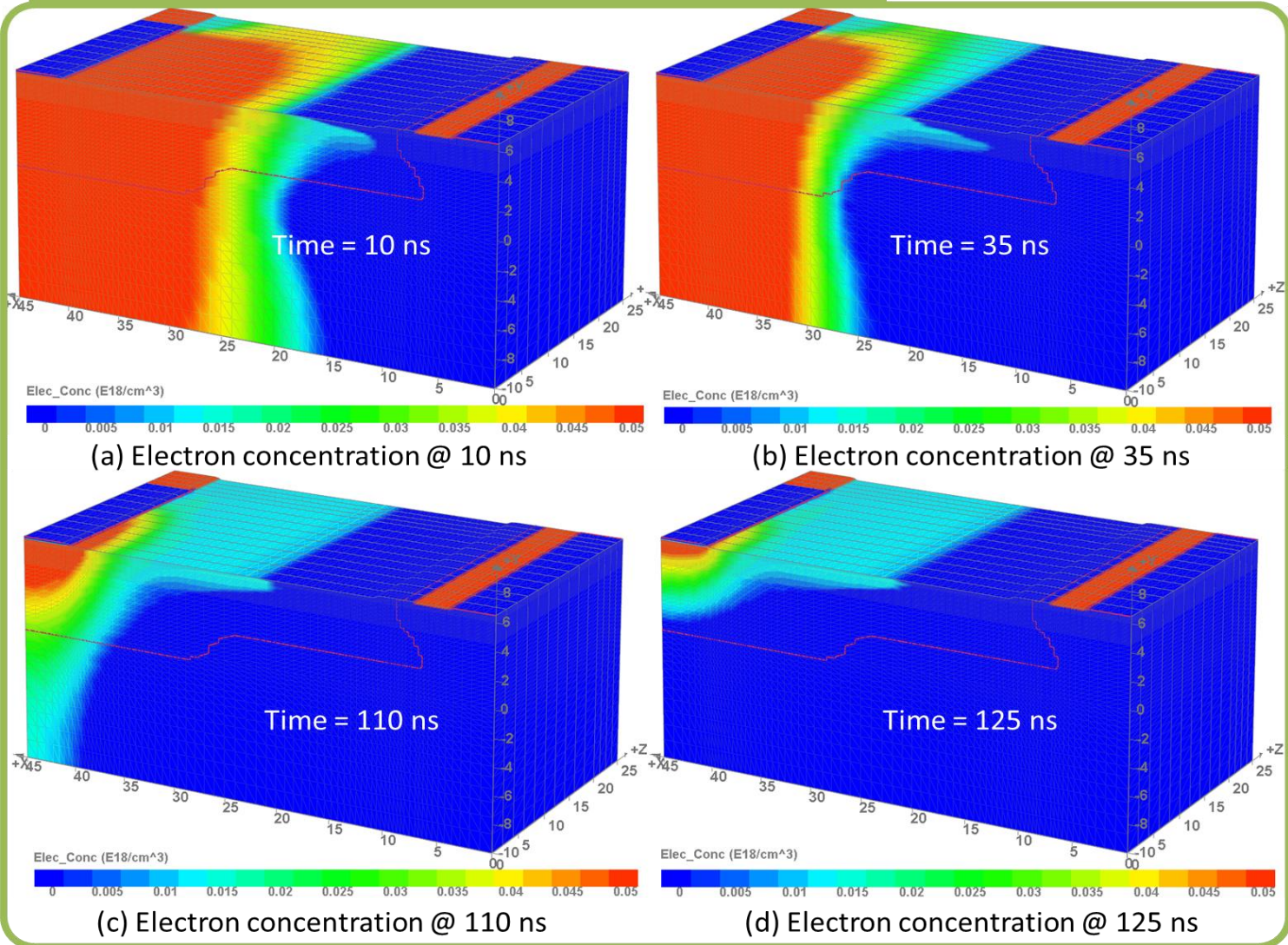
(Taken from Sandia National Lab website)

Radiation Hardening with Fixed charge simulation

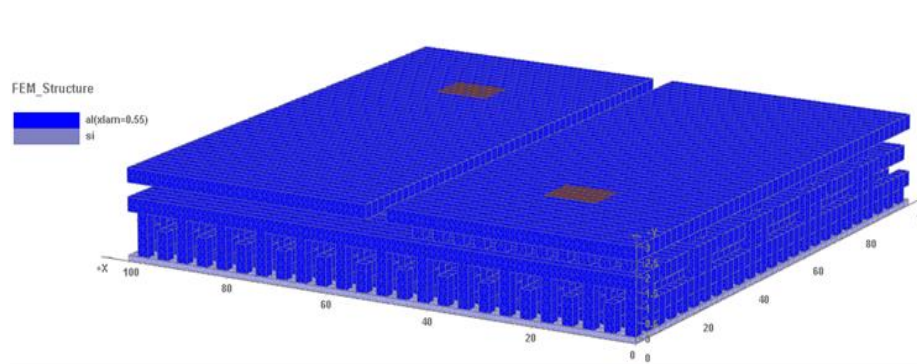


More examples: ✓ Electron-Hole Plasma for LIGBT

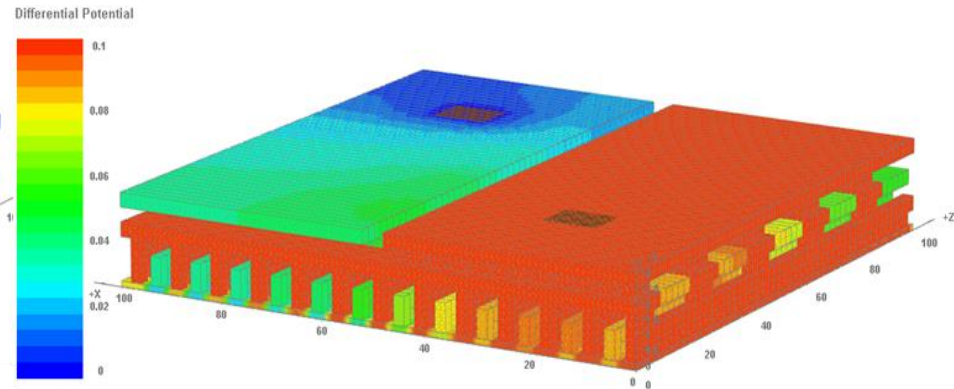
LIGBT electron concentrations at various turn-off transient time



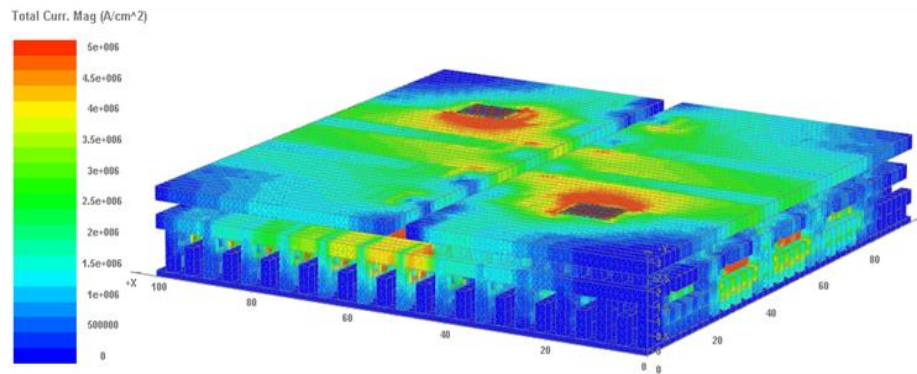
More examples: ✓ Large Interconnect



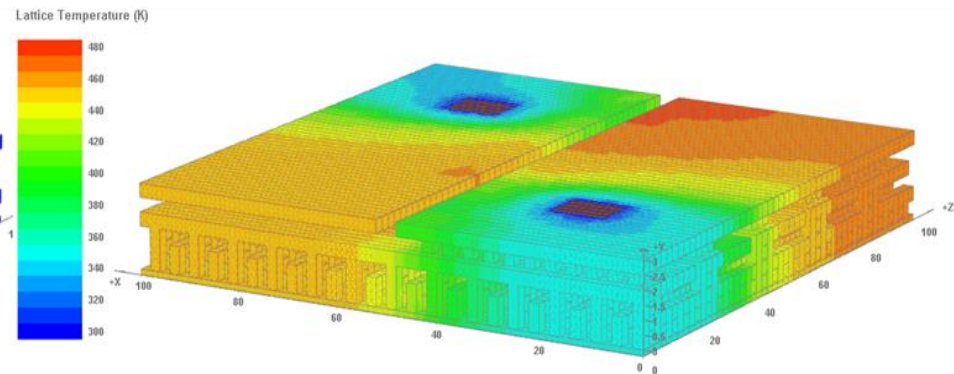
(a) Contacts placement



(b) Differential potential plot



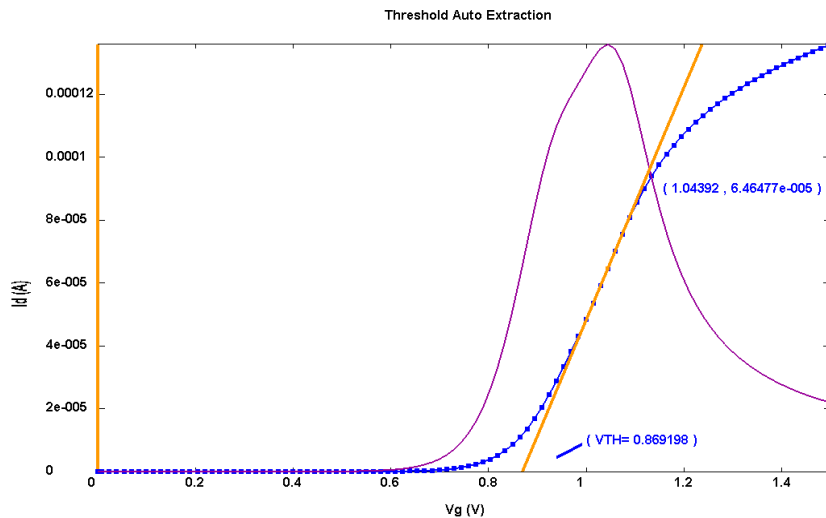
(c) Total current magnitude plot



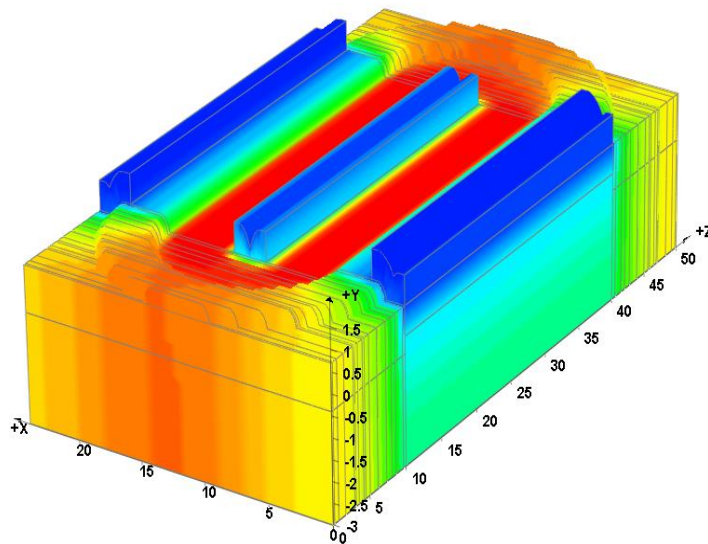
(d) Lattice temperature plot



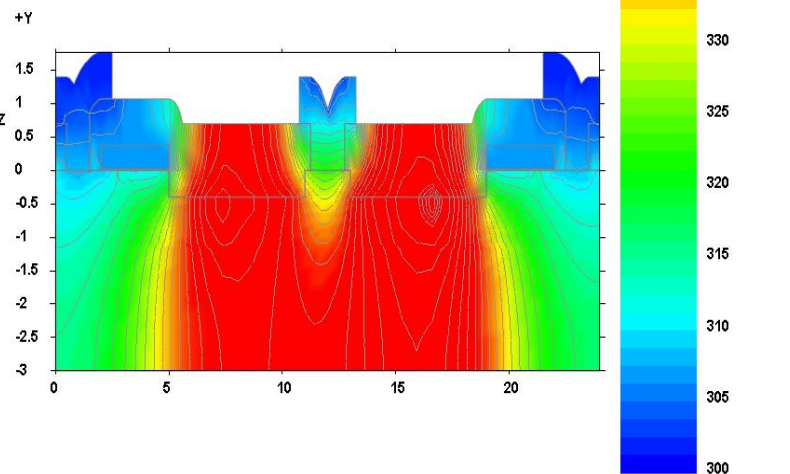
More examples: ✓ Racetrack LDMOS



Threshold Auto Extraction

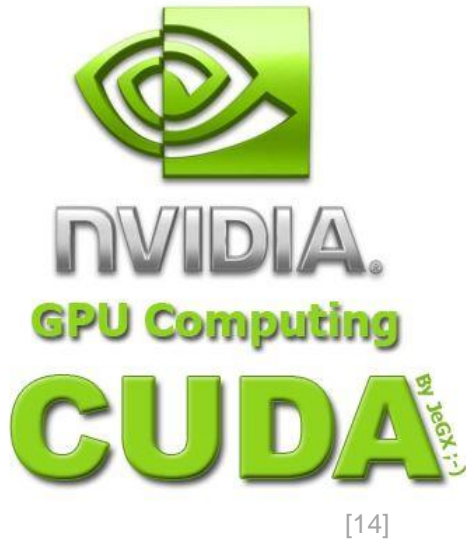
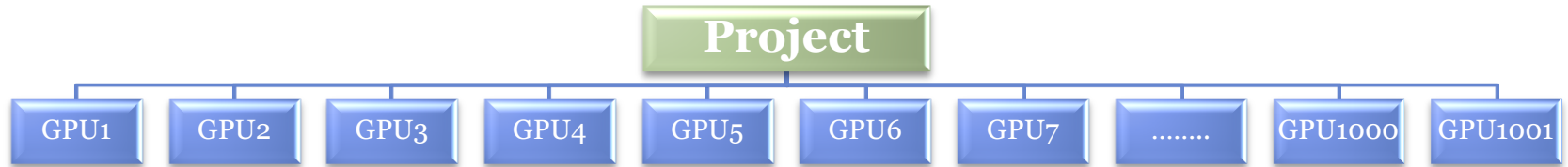


Self Heating Effect

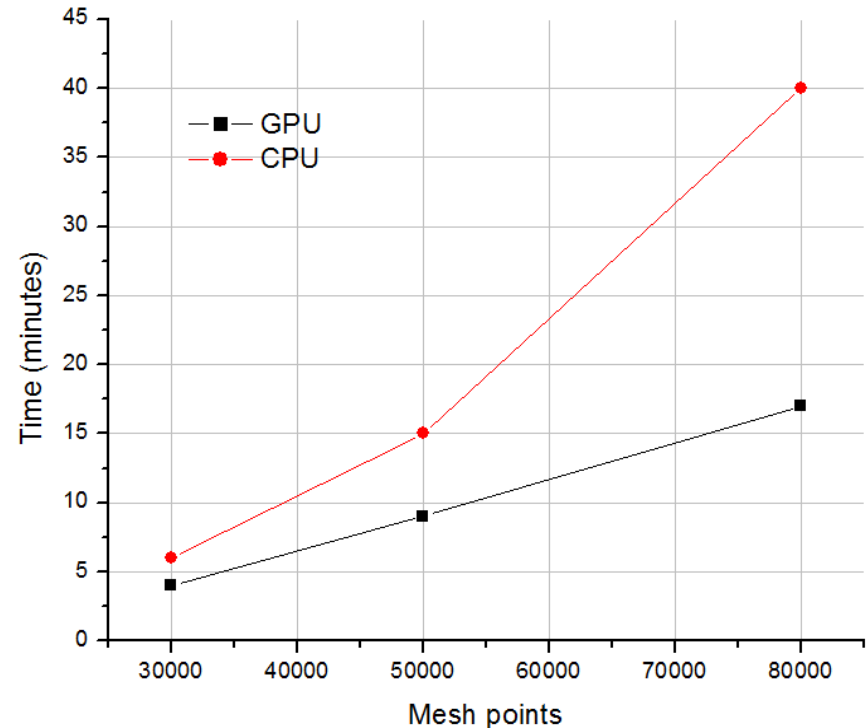


About GPU Simulation

GPU (Graphic Processing Unit) simulation enables large-scale parallel computation on GPU cores to greatly reduce simulation time.



3D Process Simulation Time Comparison



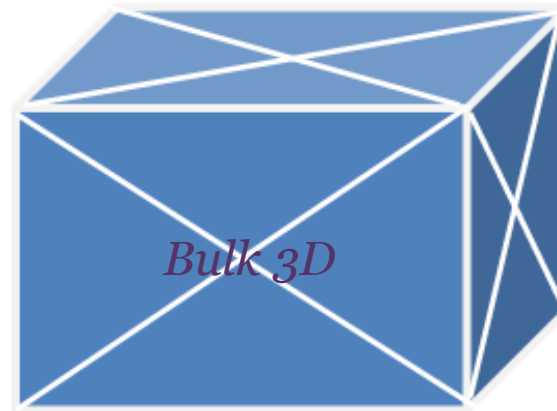
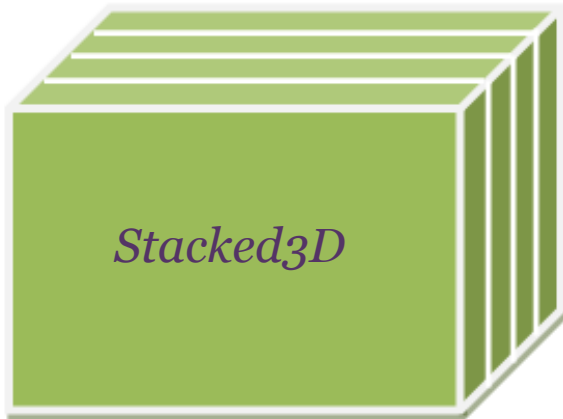
Intel core i7 920@ 2.67GHz with 12G memory and 64bit Windows 7 OS. GPU: NVidia Tesla C1060



About 3D stacking planes

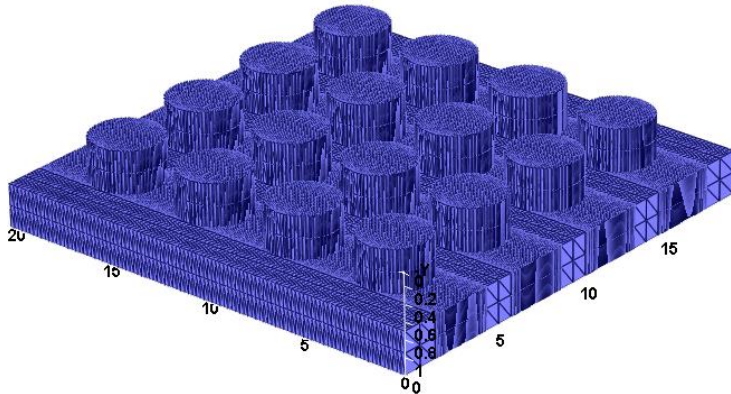
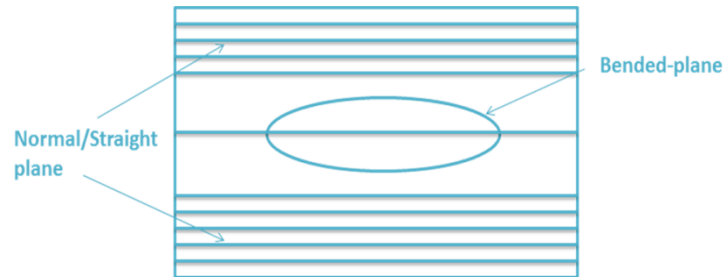
Stacked3D Advantages

- ✓ *High Efficiency*
- ✓ *Easy to build and control*
- ✓ *Easy to optimize the mesh*
- ✓ *Increased 3D success rate*
- ✓ *Directly extract 2D planes*
- ✓ *Better convergence*

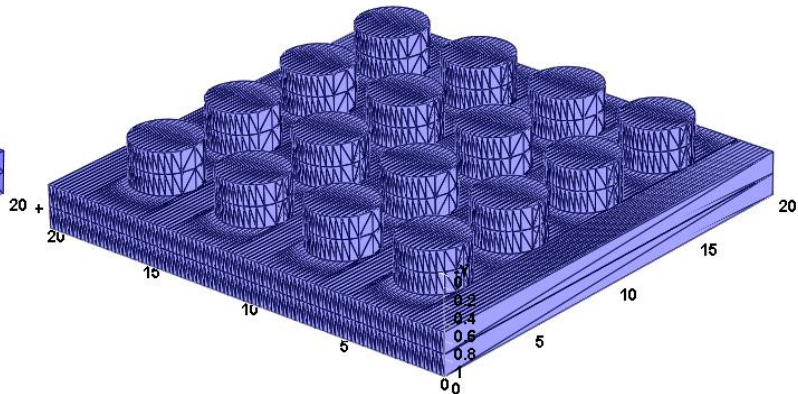


About Bent Planes

Unique bent planes technology allows not only straight planes but also bent planes to exist during 3D stacking process which greatly reduces the total mesh count in many applications



- Total Mesh Count: 52682
- Straight planes: 134
- Process Simulation time: 50 minutes



- Total Mesh Count: 4958
- Planes: 2 straight+ 16 bent planes
- Process Simulation time: 2 minutes

