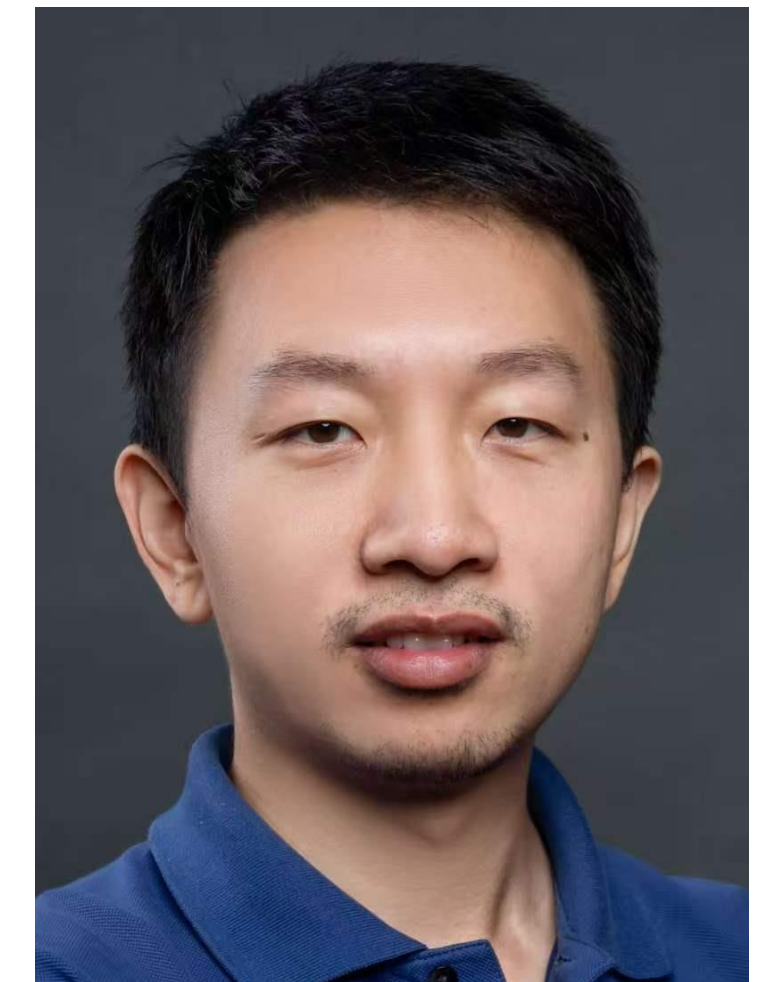


Influence and Analysis of Different Device Modeling and Optimization on Tvj Calculation of SiC MOSFET under Extreme Operating Conditions

Hao Zhang¹, Xing Liu², Qing Sun², Ghazaryan Areg²,
Xiaobo Jing¹, Andreas Huerner², Maria Cotorogea²

¹ Infineon Technologies China Co., Ltd. Shanghai, China

² Infineon Technologies AG, Germany

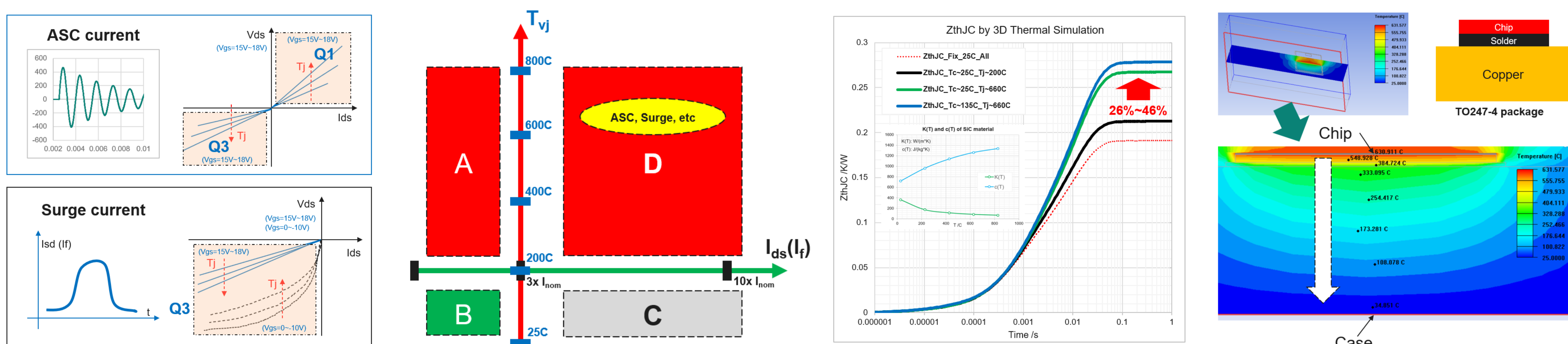


Hao Zhang

The Background and Overview

The Requirement of Tvj calculation under Extreme Operation Conditions(ASC, Surge, etc) and the Limitations of Typical SiC MOSFET Modelling

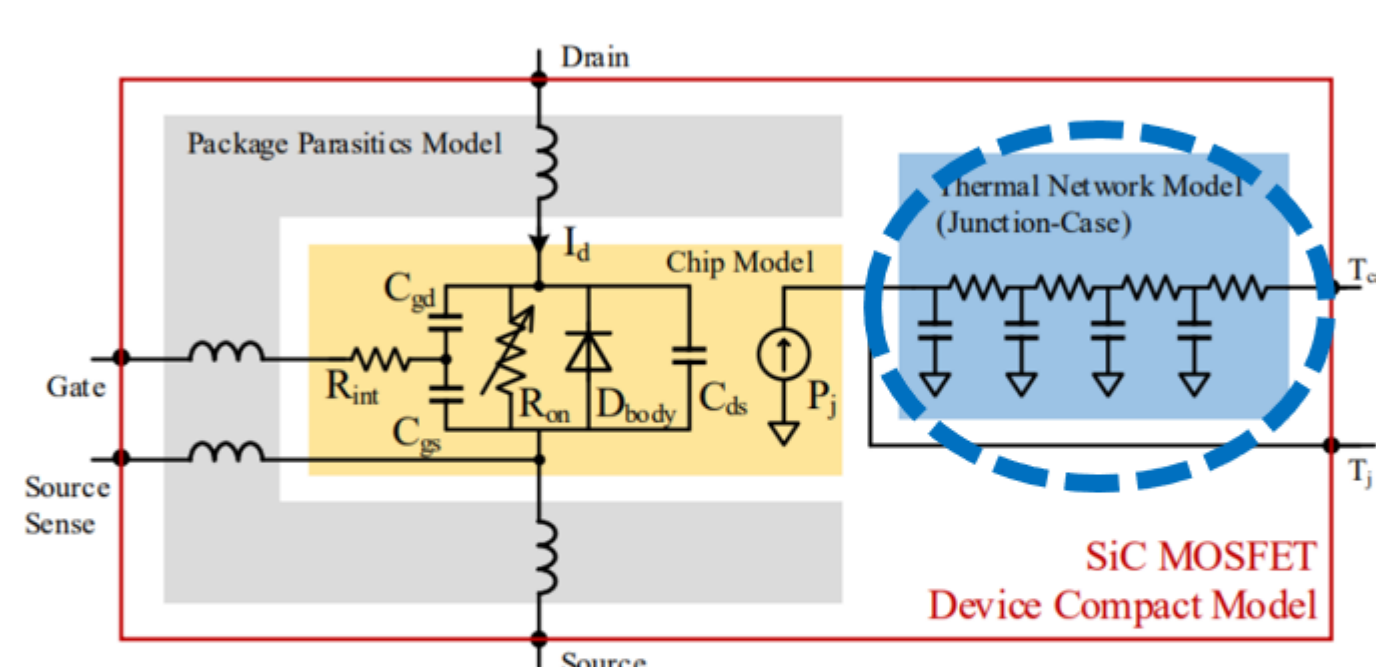
→ The Modelling of SiC MOSFET Device Must be Optimized on the Electric and Thermal Parts !



Modelling and Optimization of SiC Devices under Extreme Operating Conditions in SPICE

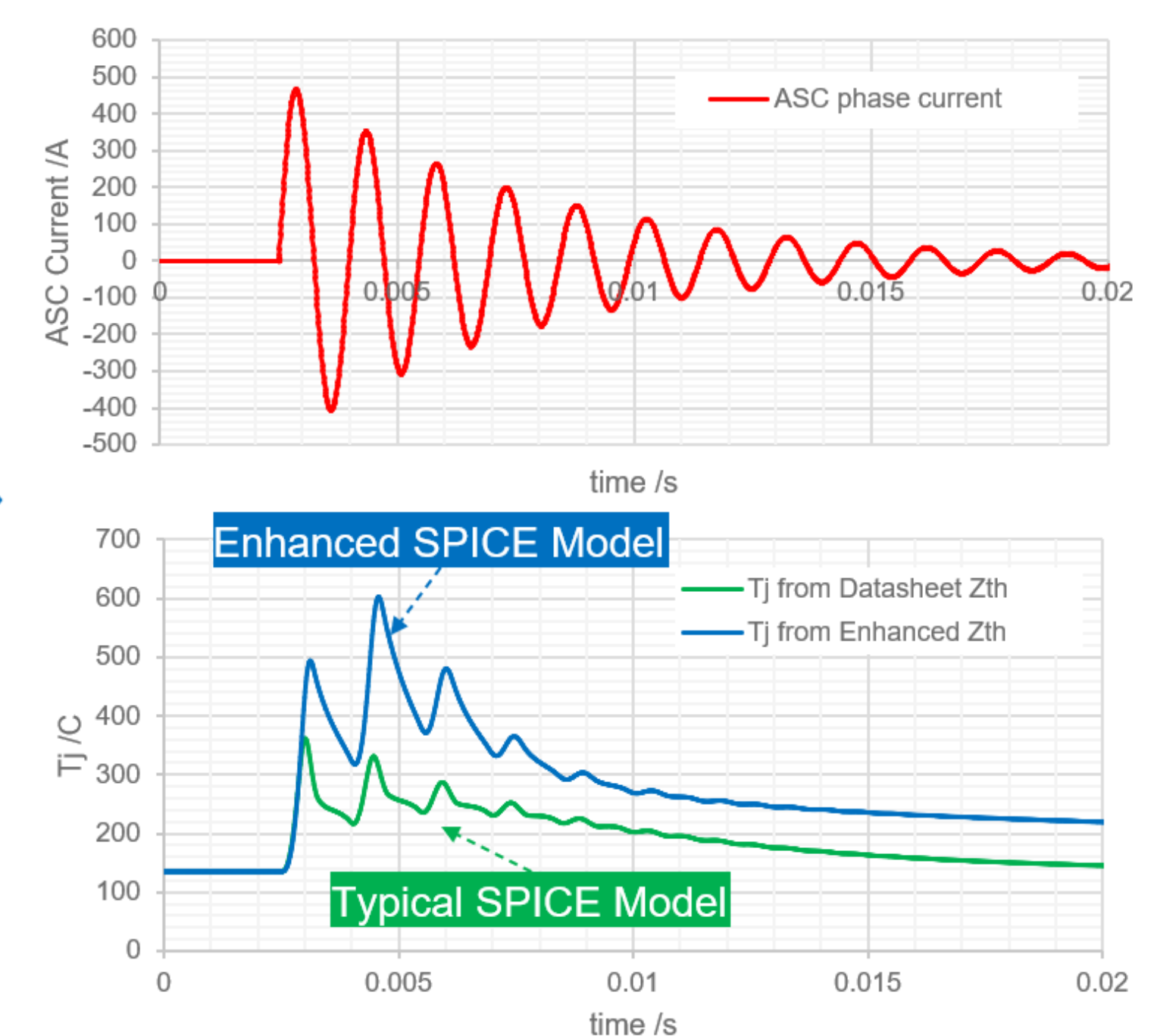
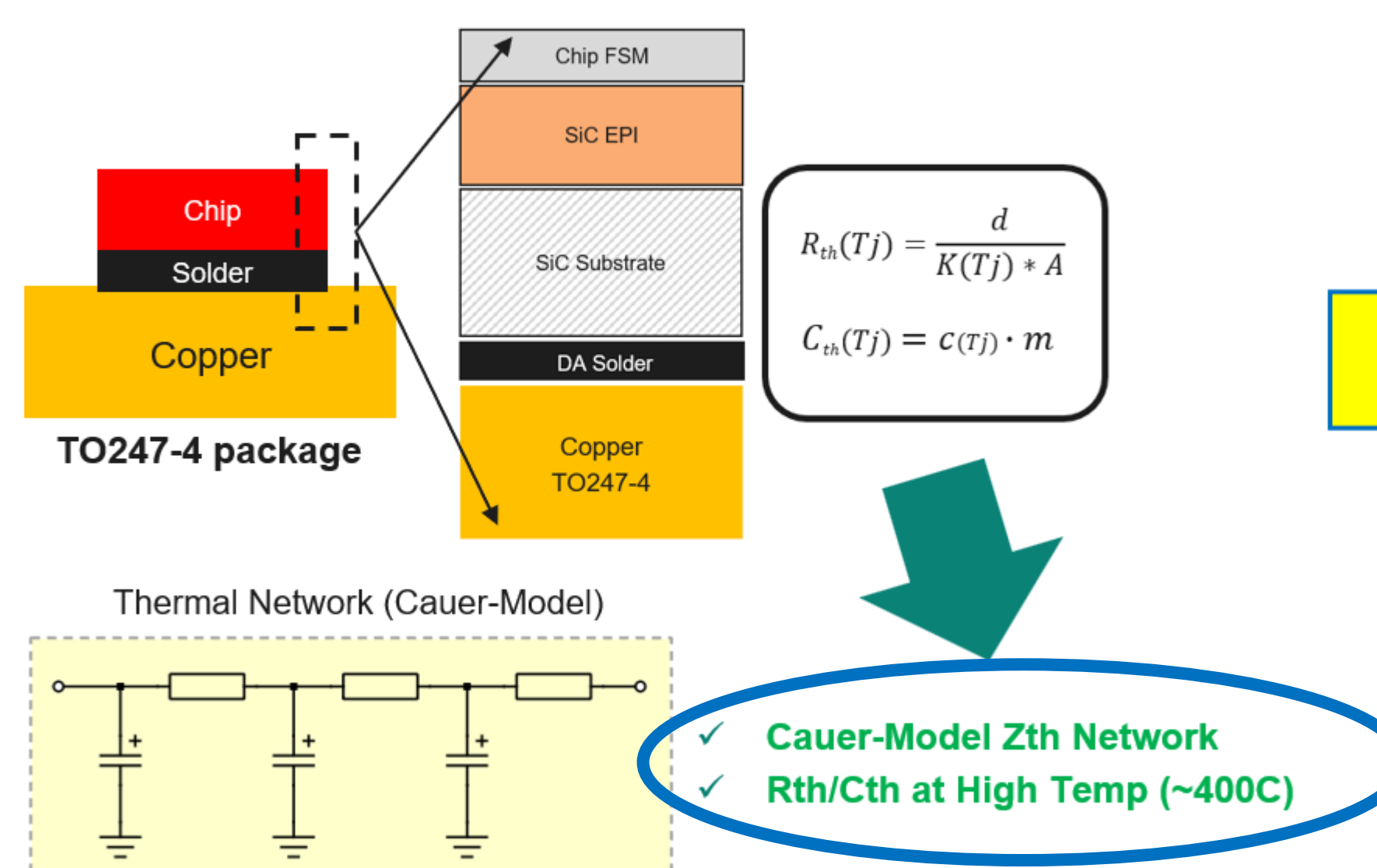
Modelling and Optimization of the Enhanced SPICE model of SiC MOSFET under ASC conditions → Great Improvement !

- Typical SPICE Model
- IFX SiC Compact Model (example)



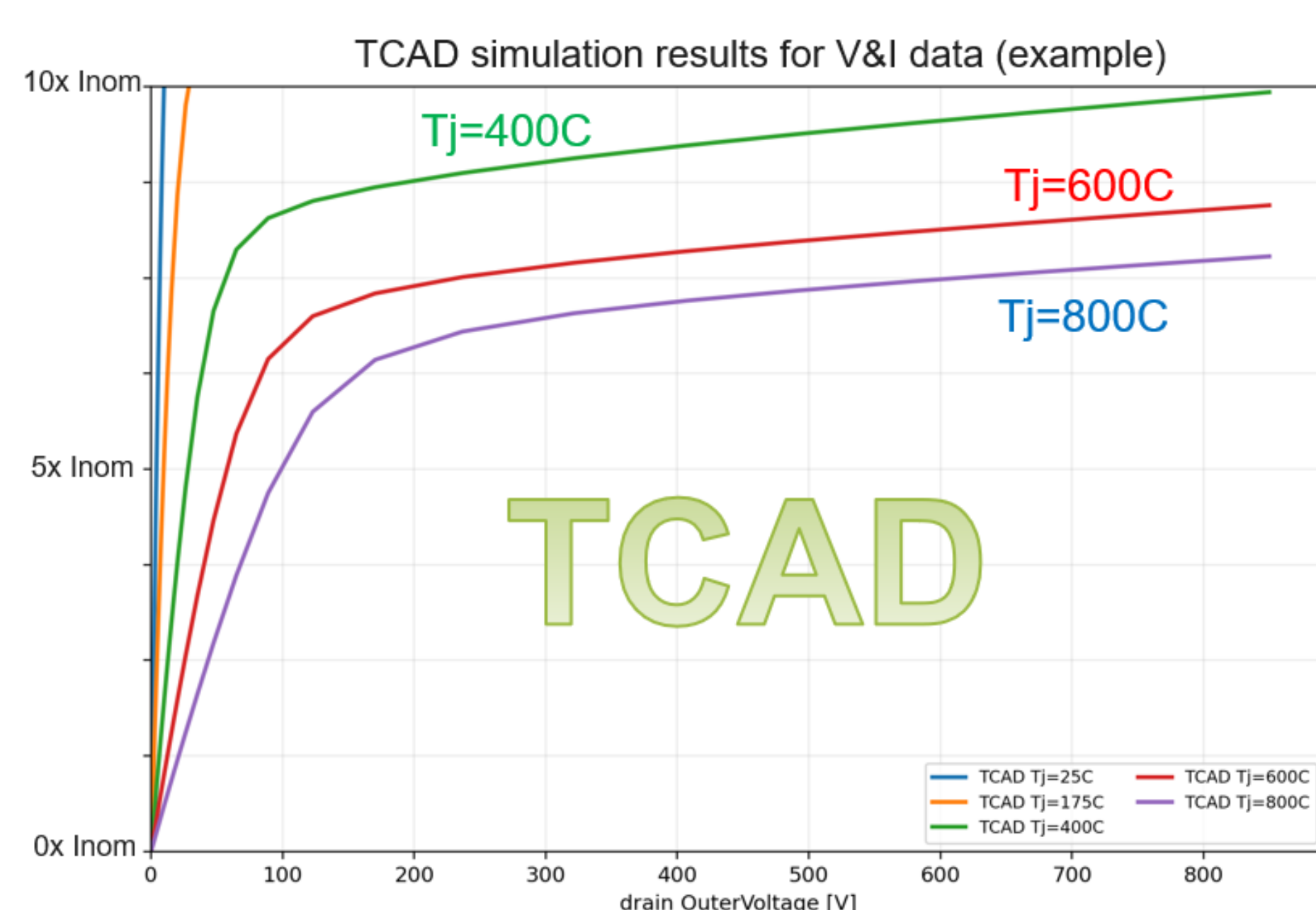
- Model parameters are calibrated by datasheet SPEC
- Model cannot cover extreme operating conditions (such as ASC, surge, SC, etc)

- Enhanced SPICE Model
- Zth Model Optimizing for ASC and Surge



Modelling and Optimization of SiC Devices under Extreme Operating Conditions in PLECS

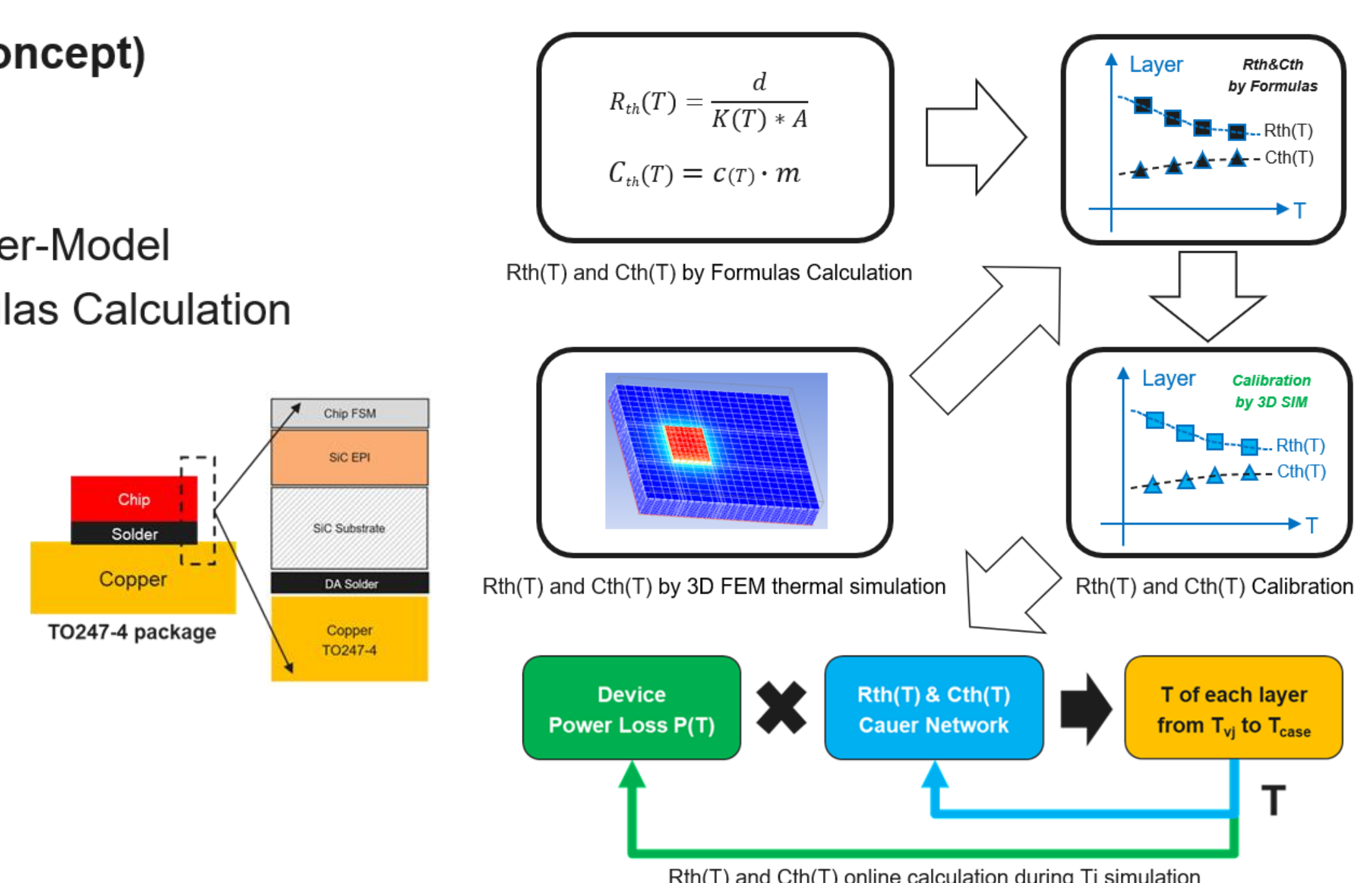
1) Modelling and Optimization for Electric Parts



2) Modelling and Optimization for Thermal Parts

- Optimized PLECS Model (Concept)

- Step 1:
 - Physical Structure based Cauer-Model
 - Rth(T) and Cth(T) from Formulas Calculation
- Step 2:
 - 3D FEM thermal simulation
 - Rth(T) and Cth(T) calibration
- Step 3:
 - PLECS circuit implementation
 - Zth online updating function

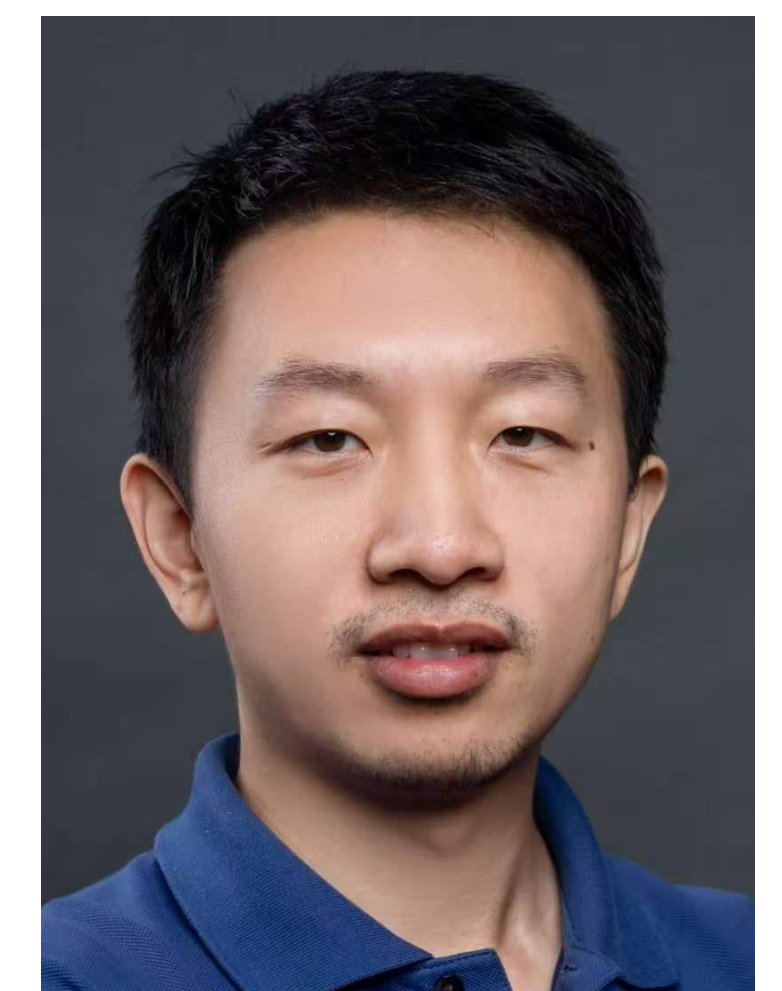


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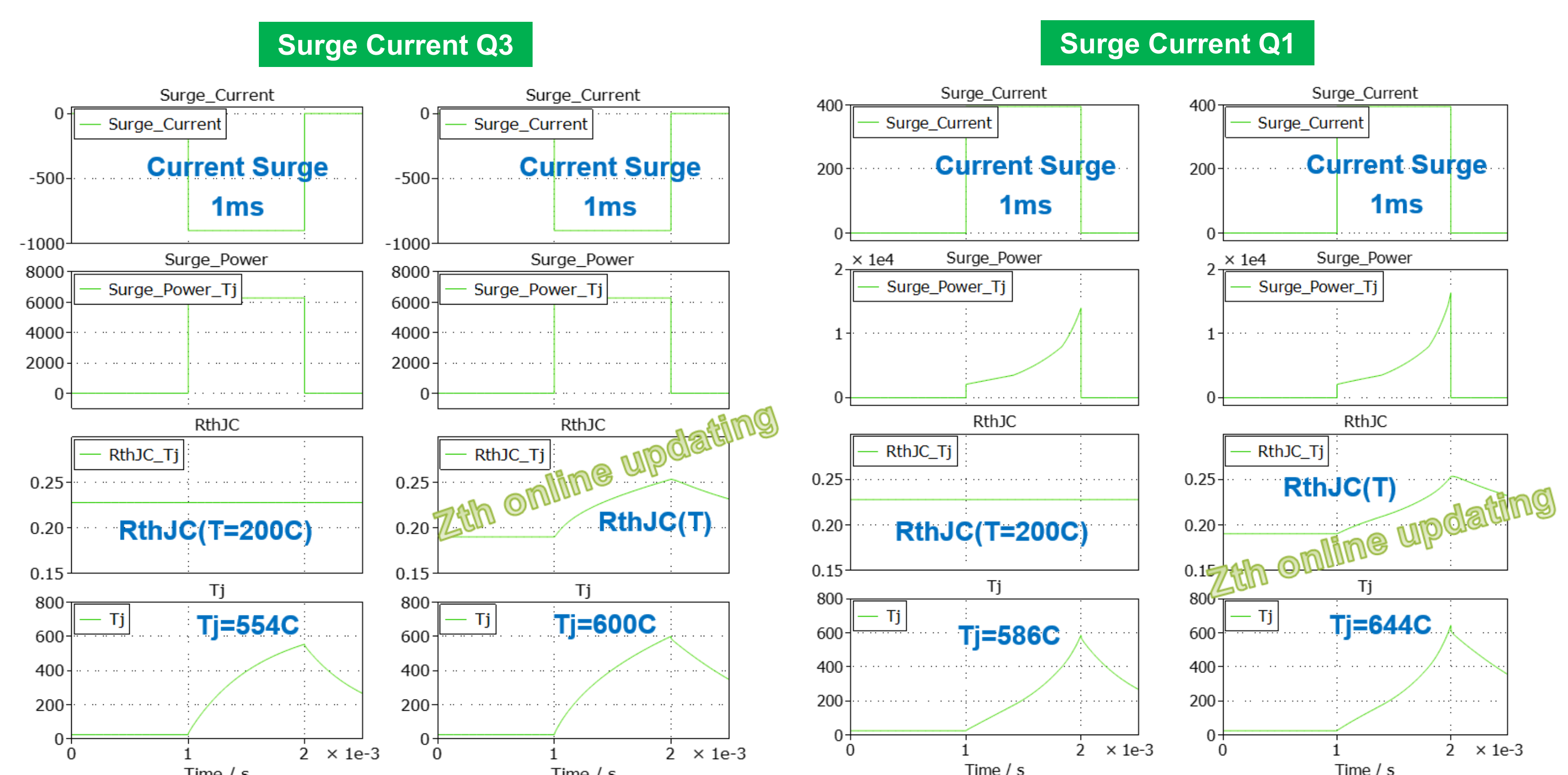
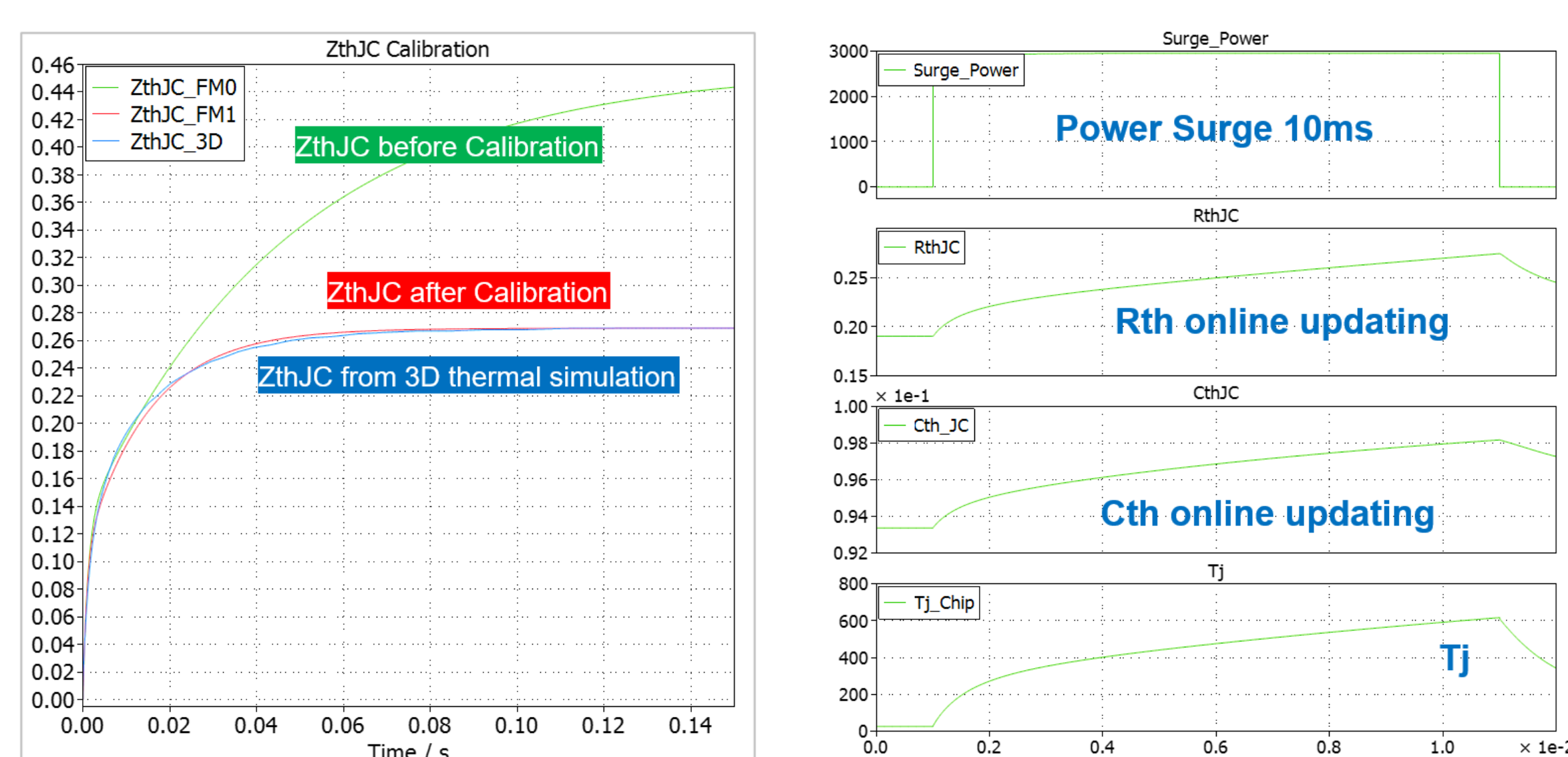
² Infineon Technologies AG, Germany



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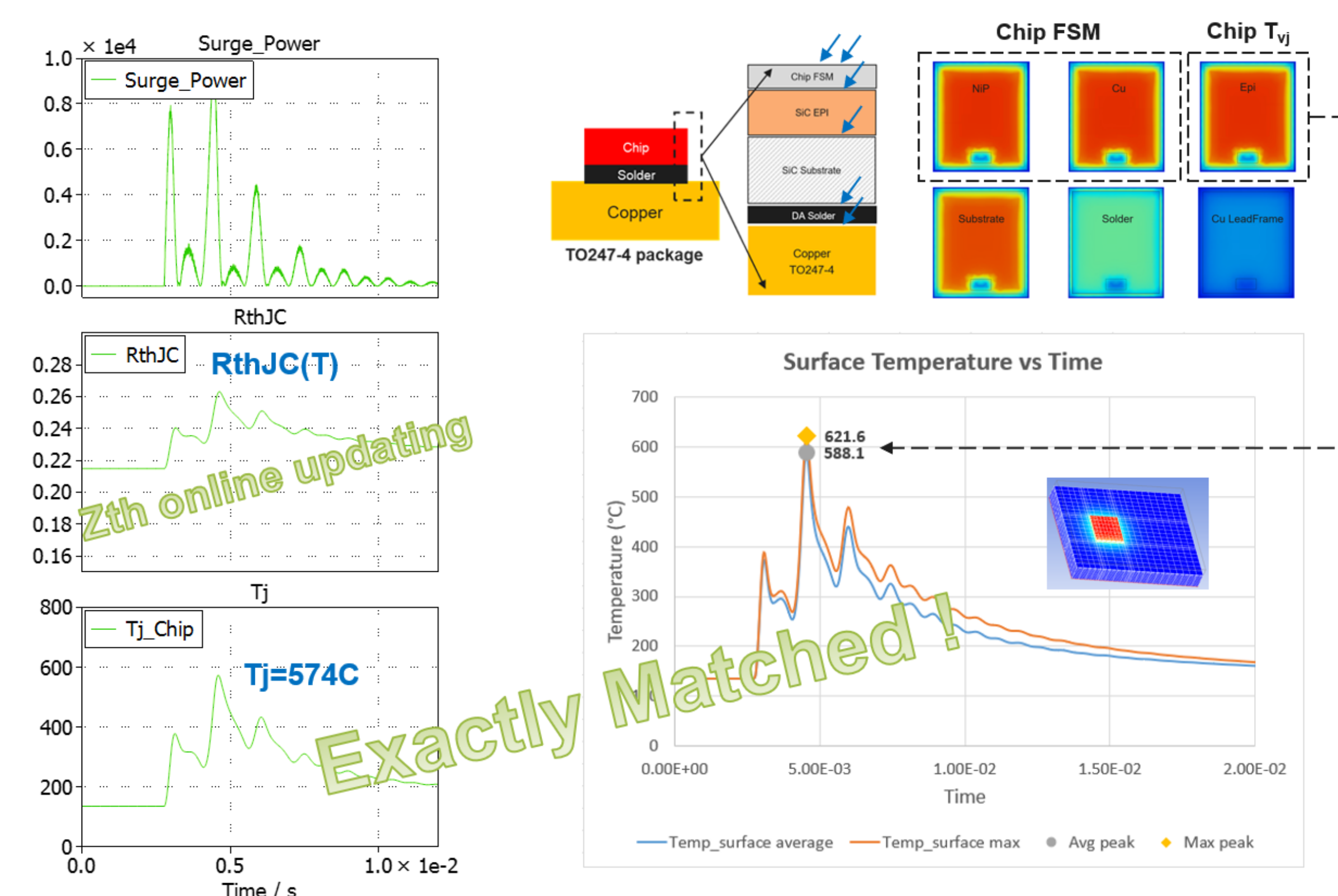
Modelling and Optimization of SiC Devices under Extreme Operating Conditions in PLECS

3) The Implementation and simulation verification in PLECS

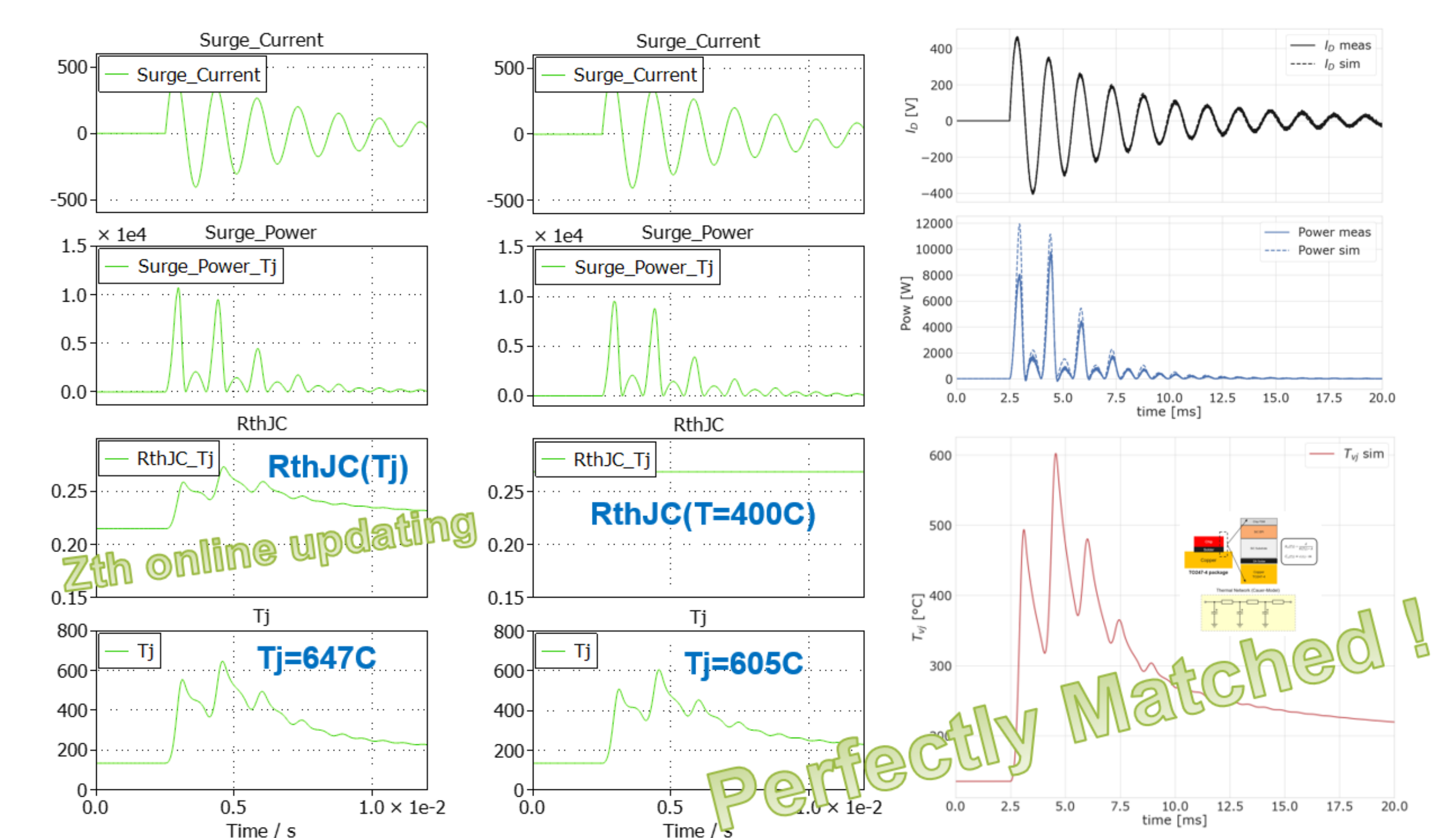


Comparison and Analysis in ASC Simulation by Optimized PLECS, Enhanced SPICE, 3D Thermal FEM Simulation

1) The Optimized PLECS and the 3D Thermal Simulation Results

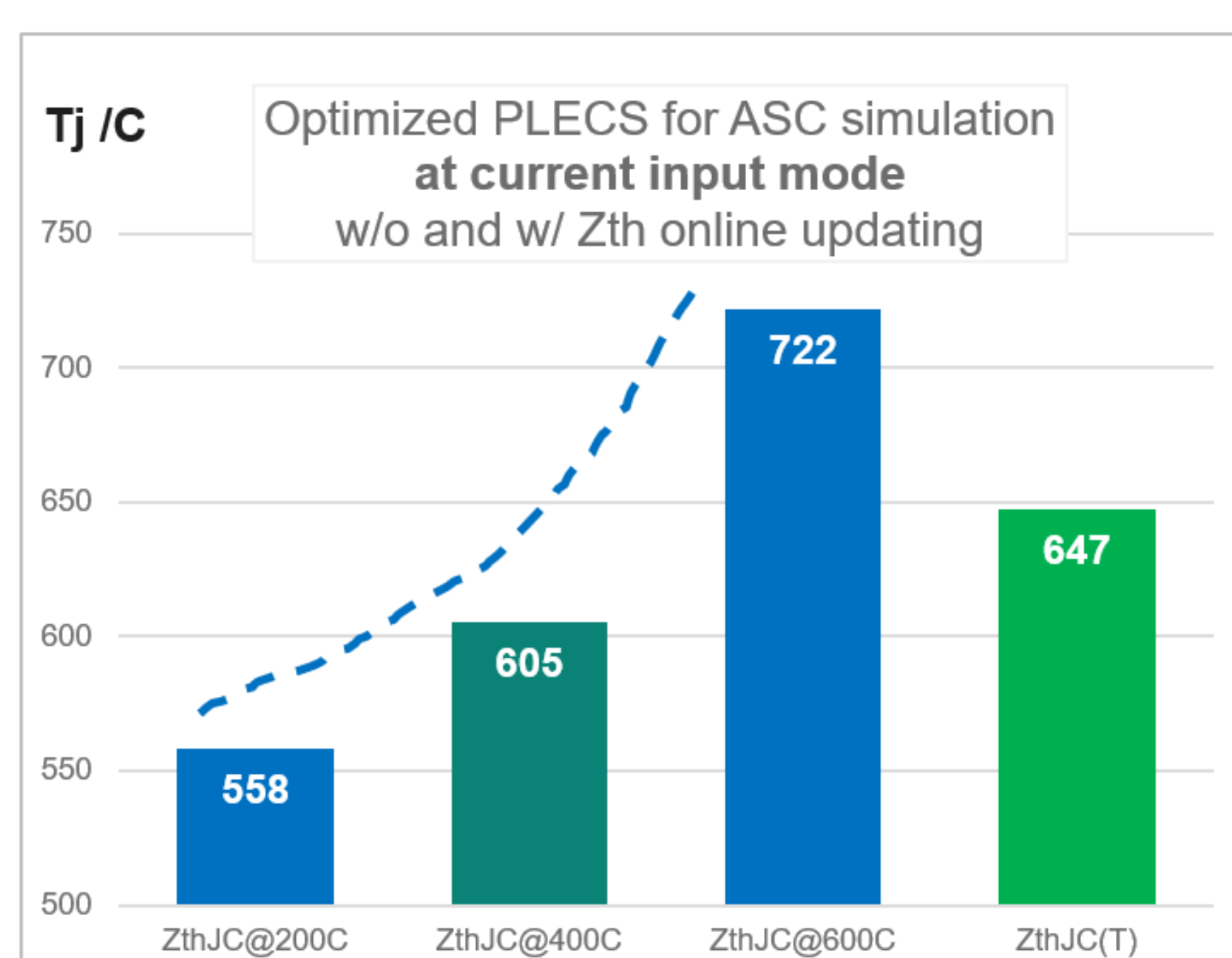


2) The Optimized PLECS and the Enhanced SPICE Simulation Results



Comparison and Analysis Simulation

3) The Optimized PLECS with different setup



Conclusion

Conclusion

- ❑ The typical SiC MOSFET models do not work for the Tvj simulation under ASC, Surge conditions.
- ❑ The enhanced SPICE modelling and the remarkable improvement for ASC simulation !
- ❑ The optimized PLECS modelling and the impressive improvement for Surge simulation !
- ❑ The optimized PLECS compared with 3D FEM thermal and enhanced SPICE in ASC simulations
- ✓ Exactly matched with the 3D FEM thermal simulation results
- ✓ Perfectly matched with the enhanced SPICE simulations, and even better there.
- ✓ Especially, the Zth calibration and Zth online updating idea in optimized PLECS, it could achieve furthermore accurately characterize the impact of high temperature fluctuations on Zth and the chip Tvj simulation.