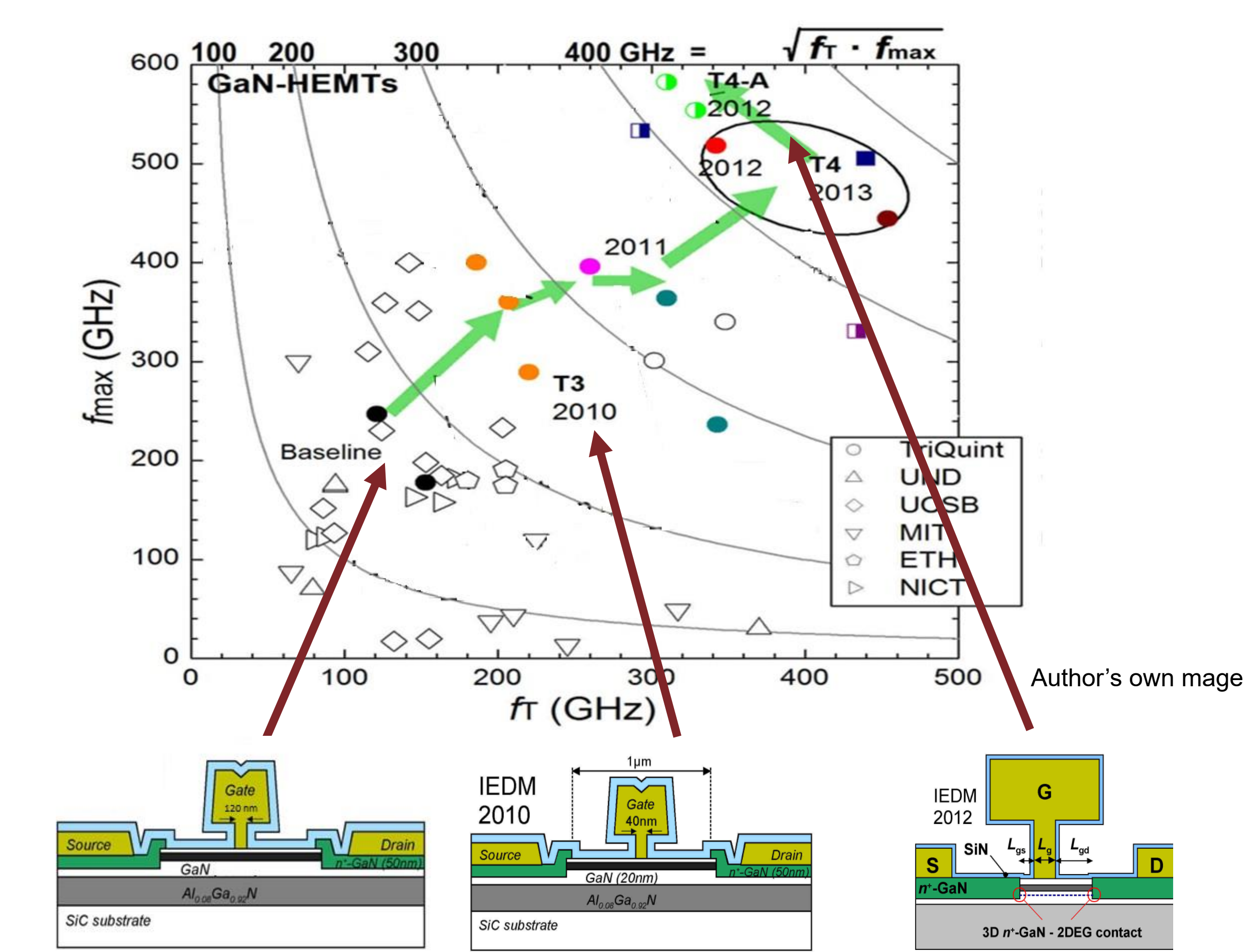


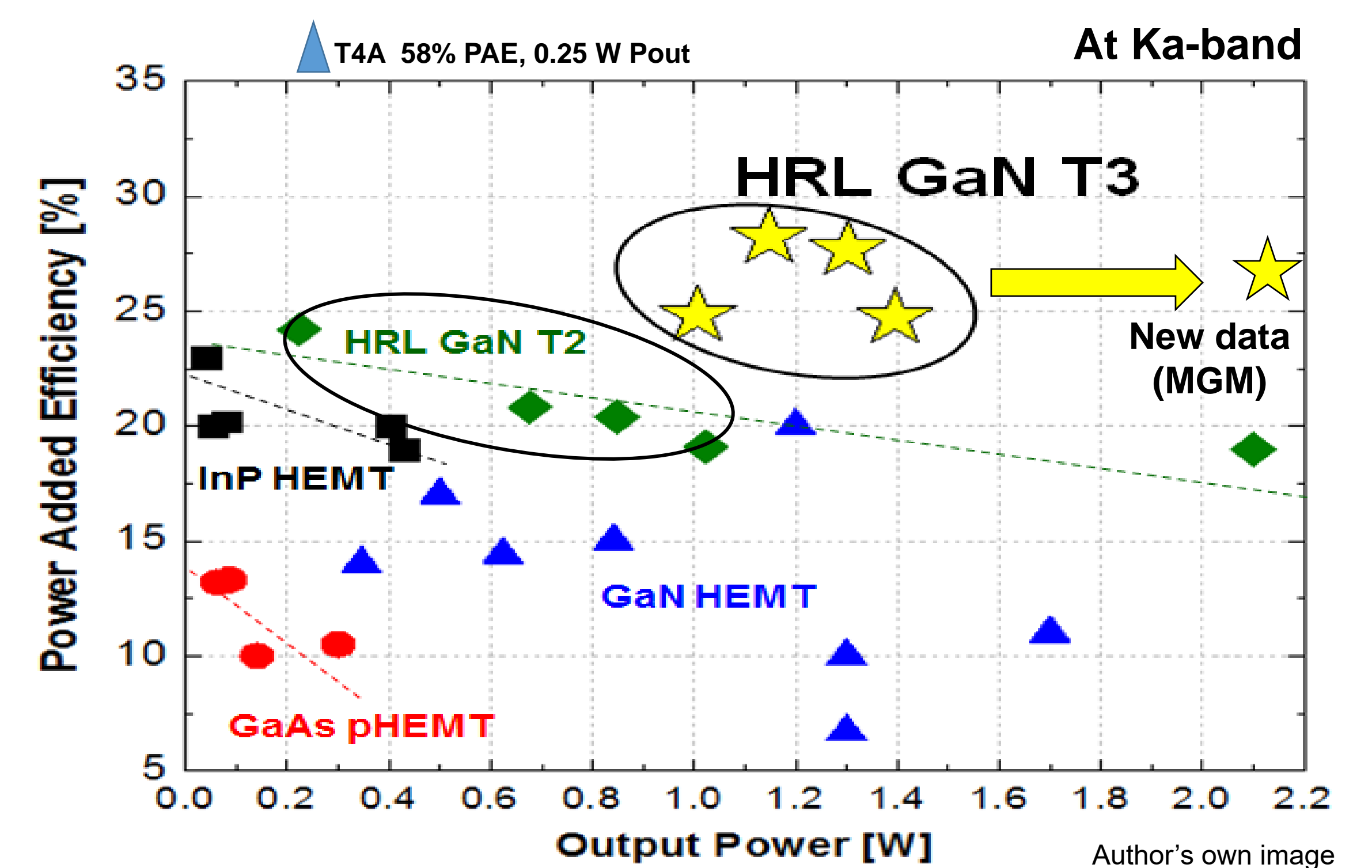
mm-wave GaN Maturation Program (MGM)

Background

The DARPA MTO NEXT Program established the world's fastest GaN technology at HRL



Process	HRL T2	HRL T3	HRL T4a
Key Feature	Baseline	Vertical & Lateral Scaling	Asymmetric Self-Aligned Gate, 3D n+ Contact
Gate Length	150 nm	40 nm	20 nm
f_t/f_{MAX}	90/220 GHz	200/400 GHz	320/550 GHz
Breakdown	>40 V	>40 V	17 V

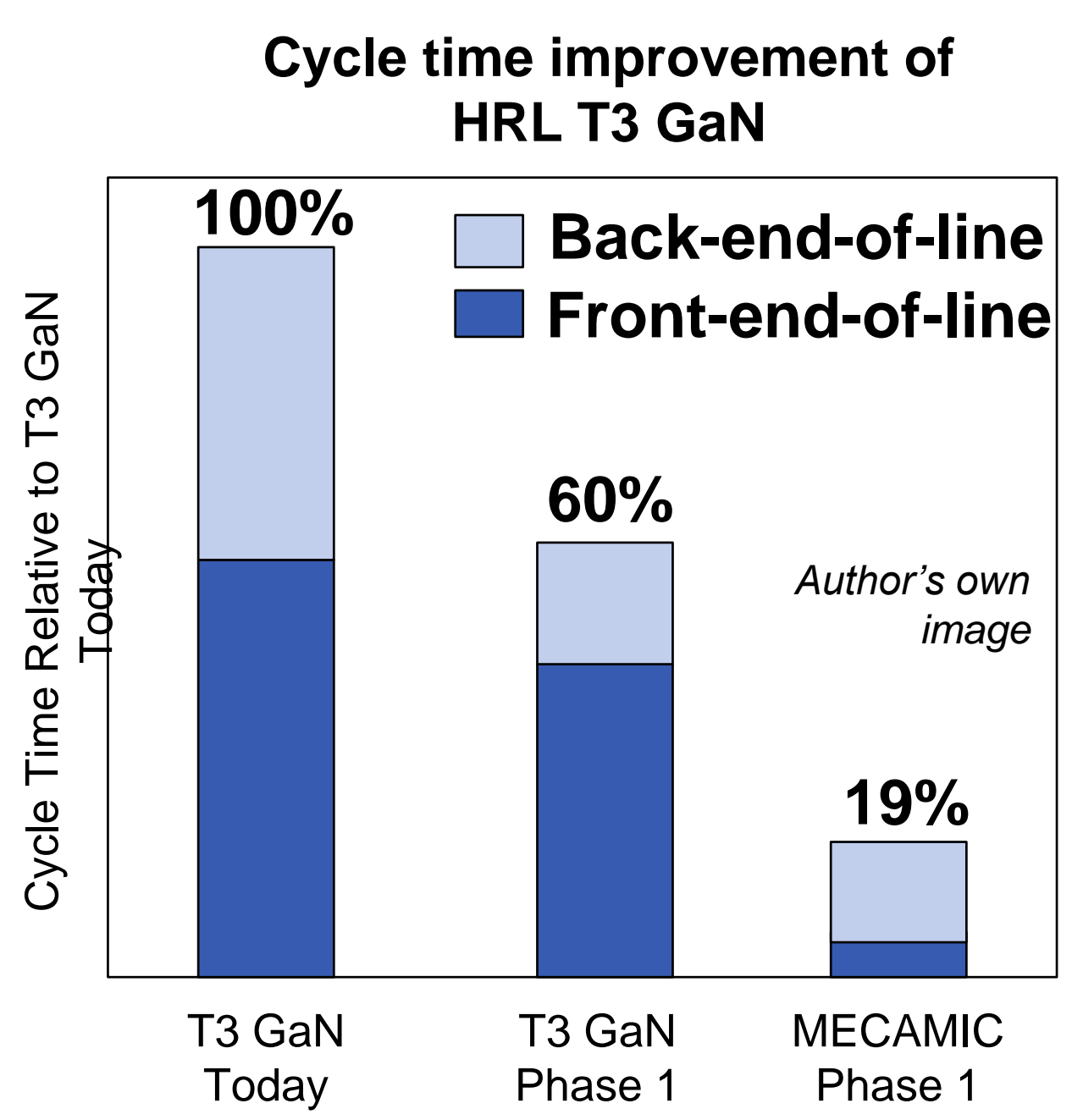


HRL's GaN T3 and T4A device technologies enable unprecedented millimeter-wave phased-array radar power and efficiency

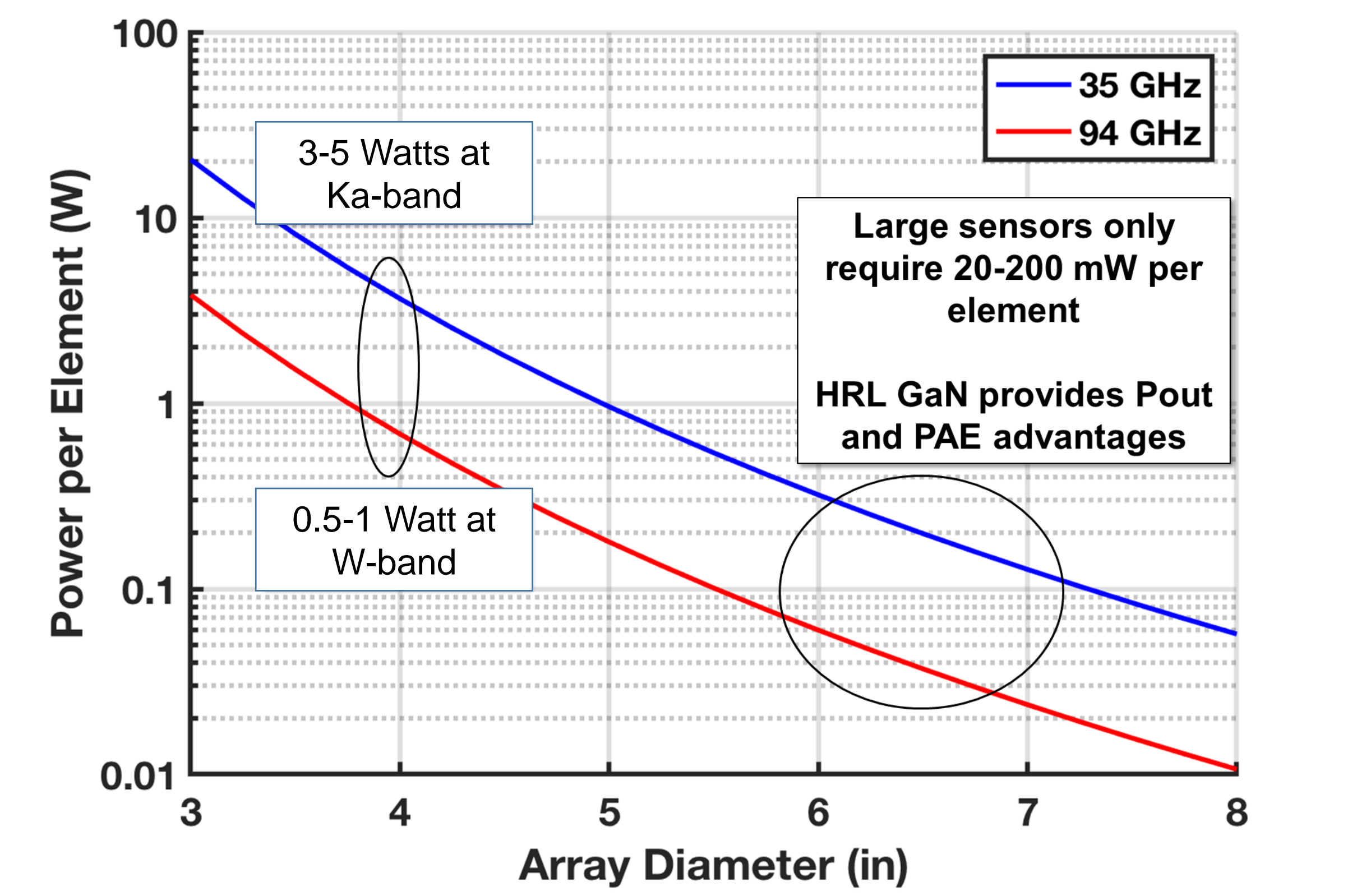
Approach

MGM Program: 1) Process maturation to enhance production readiness 2) provide external access to HRL technology, and 3) develop novel manufacturing techniques with unprecedented low cycle time & cost

- Decrease T3 cycle time by 40% through re-engineering process flow to alleviate bottlenecks and redundancies & equipment acquisition
- Physics-of-failure & targeted experimentation to increase T3 fabrication yield by 50%
- Develop novel manufacturing approach (Metal-Embedded Copper Chip Assembly Microwave ICs = MECAMIC) for unprecedented short cycle time
- Advance Manufacturing Readiness Level (MRL) to 6
- Perform Multi-Project-Wafer (MPW) foundry runs for external designers



Application Pull & Circuit Demonstrations



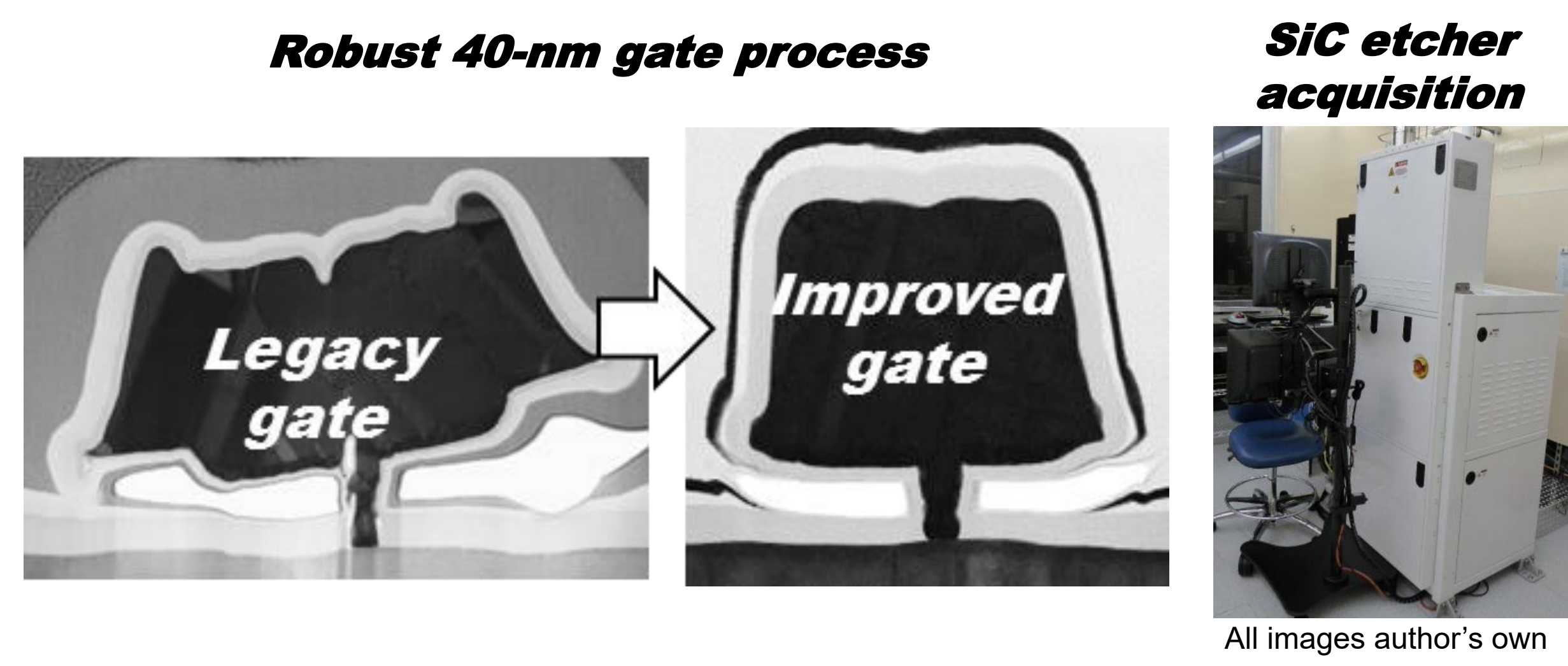
- T3 Ka-band MMIC: >4 Watts, >40% efficiency
- T4A W-band MMIC: >0.5 Watts, >35% efficiency

Goal – Achieve high power & high efficiency at mm-wave to enabling high-power arrays & with reduced cooling

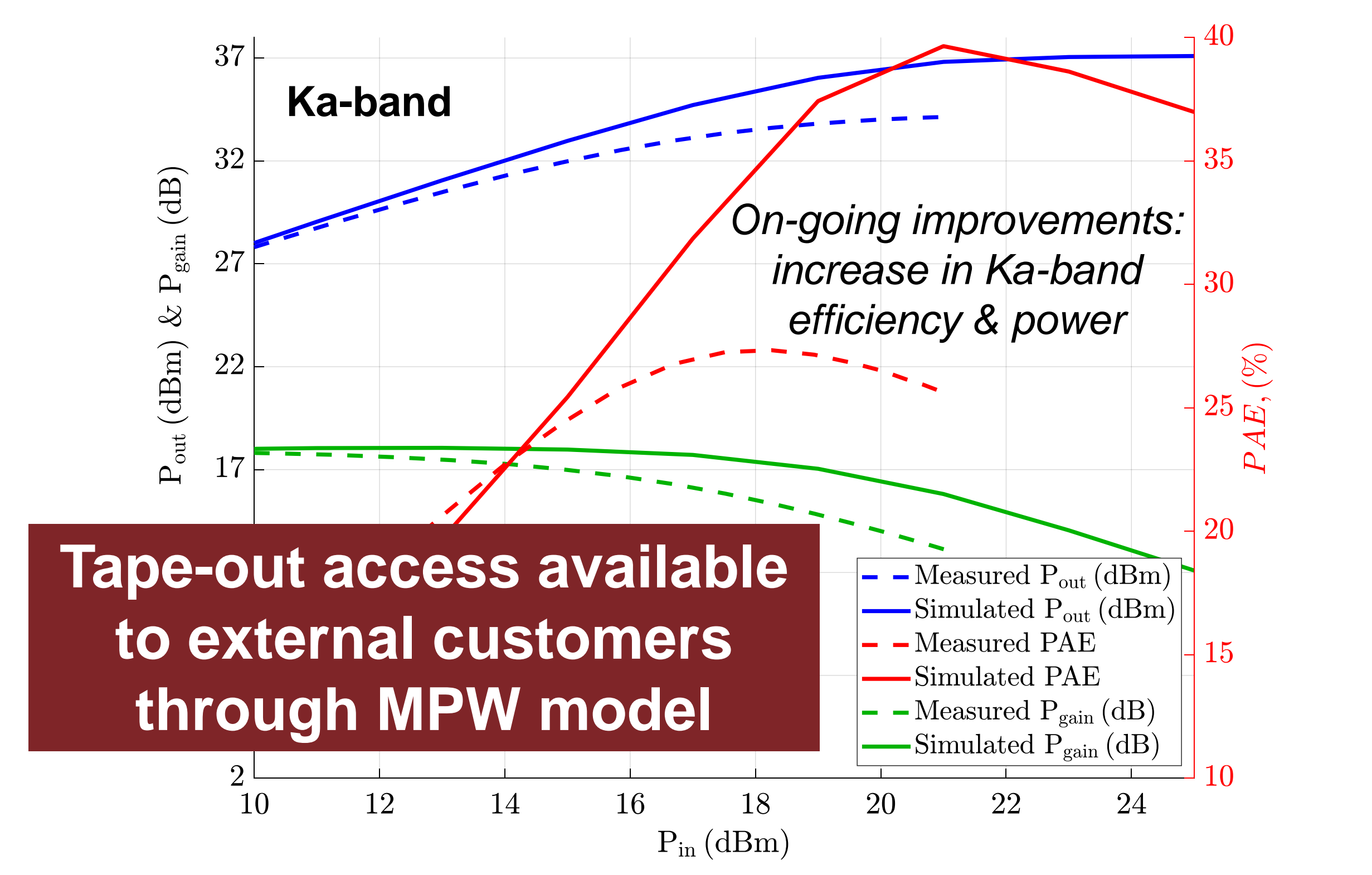
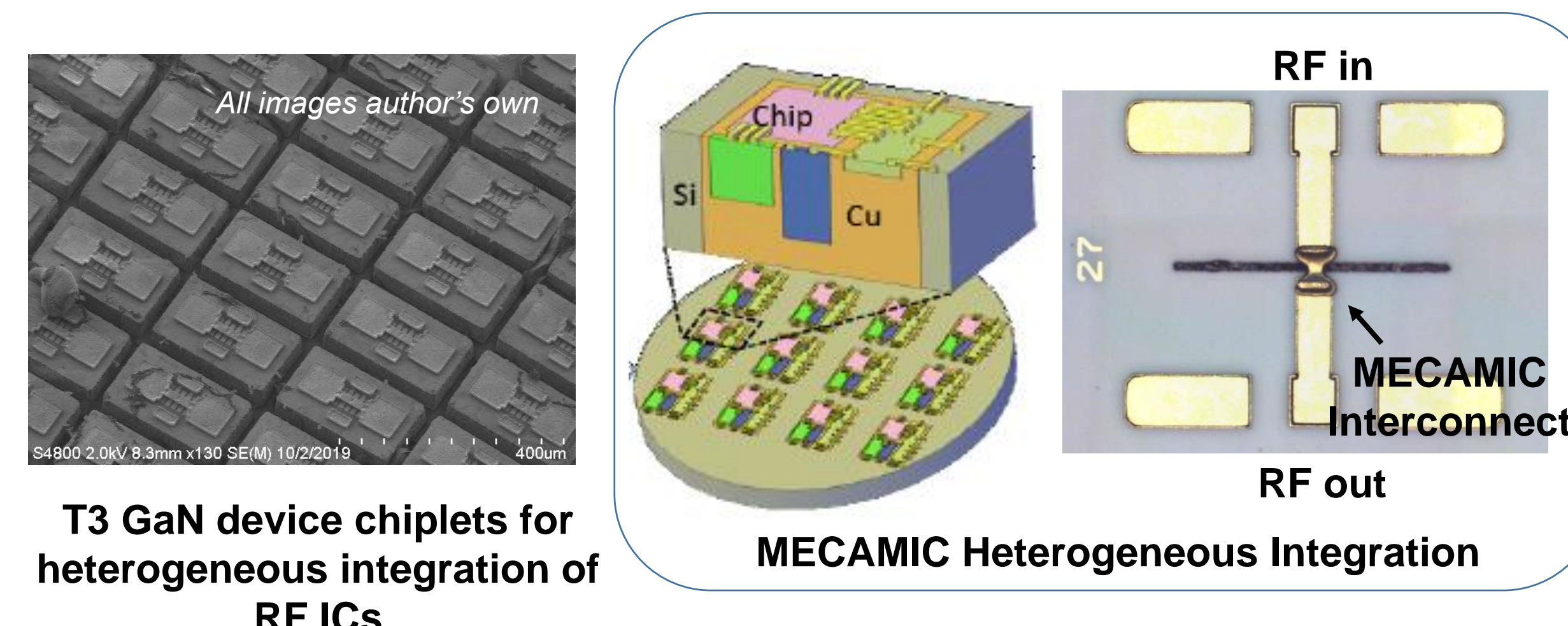
Heterogeneous 3D

Results and Impact

Optimization of critical processing steps with decreased cycle time



Process Design Kit (PDK) improvements, high-power Ka-band & W-band amplifiers, MPW Foundry runs available to external customers, Metal-Embedded Chip Assembly for Microwave Integrated Circuits (MECAMIC) for potential unprecedented short cycle time



Tape-out access available to external customers through MPW model