GaN-baserade komponenter för SSPA:s

Oliver Silva Barrera
Chalmers University of Technology

NRFPIII Seminar
November 15th, 2018

Outline

- Description
- Solid State TWT replacement
- Multicarrier characterization
- Future Work
- Questions

Description

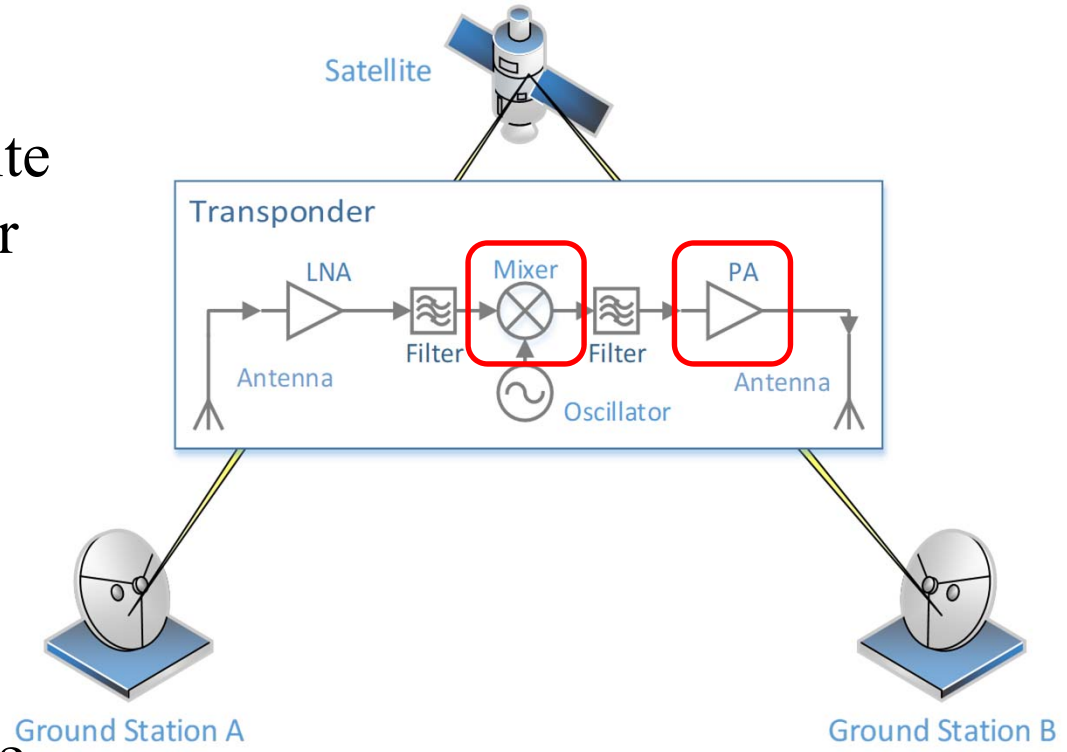
- Complementary research subjects to the “Microwave components” projects
- Research topics
  1. Solid state TWT replacement
     - GaN HEMT is candidate to replace traveling wave tube amplifiers due to its high power density
     - It is necessary to investigate possible **power combining** and **linearization topologies**
     - High power requires special care of MMIC temperature distribution and dissipation
  2. Characterization of GaN HEMT based SSPA with focus on memory effects.
     - Memory effects caused by the electron traps in the semiconductor

Motivations

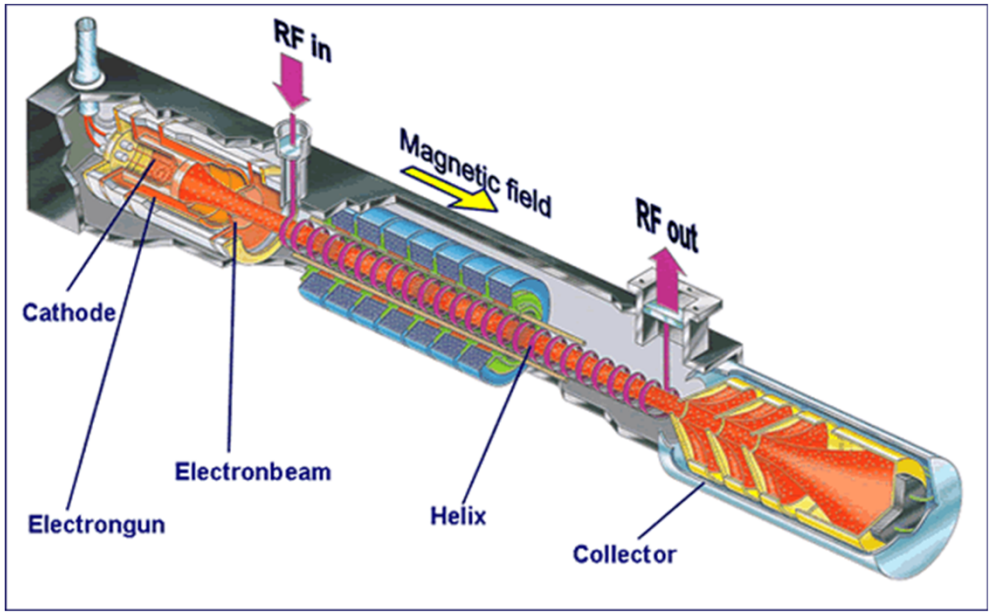
Multiple transponders per satellite
Multiple carriers per transponder

Multiple carriers will combine constructively demanding linearity performance for power amplifier

How to design for high linearity?



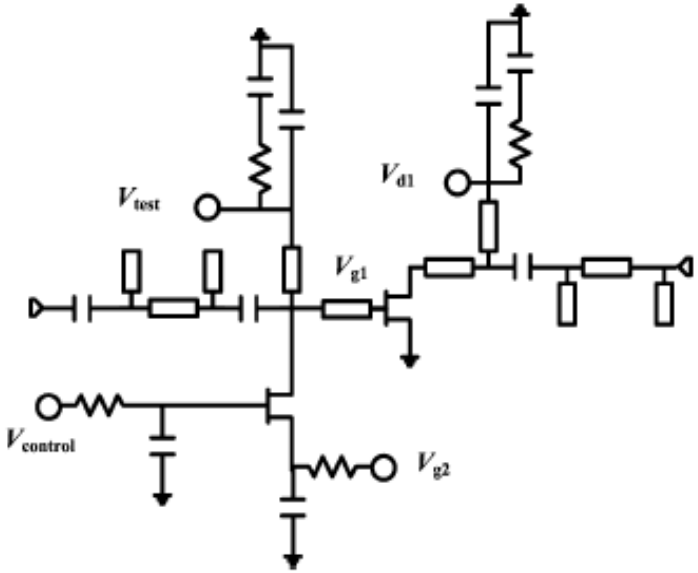
1. Solid state TWT replacement



- SSPA are candidates to replace TWT amplifiers:
  - Smaller size and lower weight
  - Lower supply voltage
  - Redundancy
  - Antenna integration
  - Lower output power
  - Lower Efficiency
  - Cooling

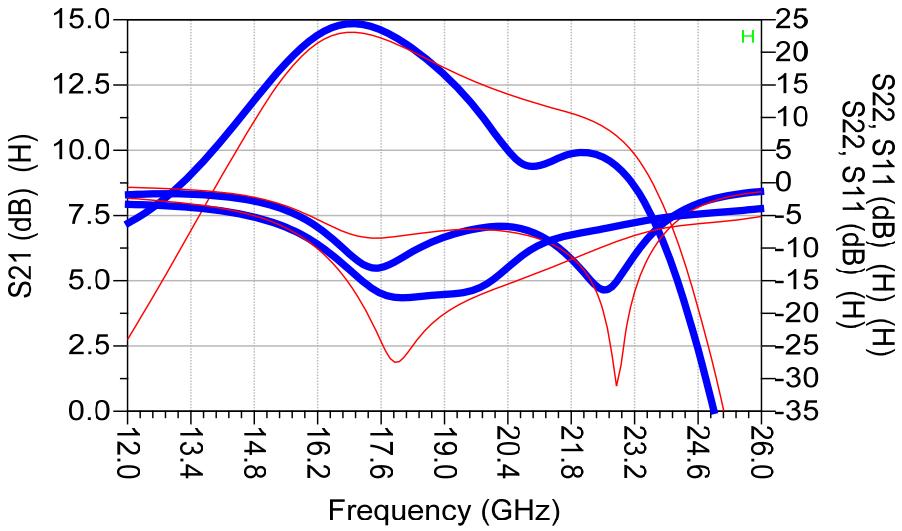
1. Solid state TWT replacement

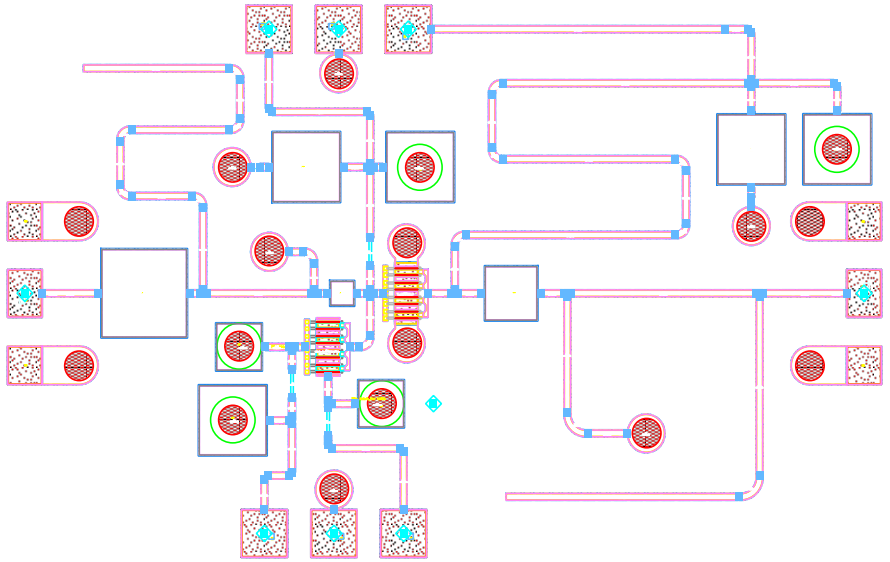
- Desired Specifications:
  - K Band: 17.8 GHz to 20.2 GHz
  - Output Power 45 dBm (31.6w)
  - PAE: 30%
  - IMD: -25 dBc
  - Junction temperature: 200 ºC

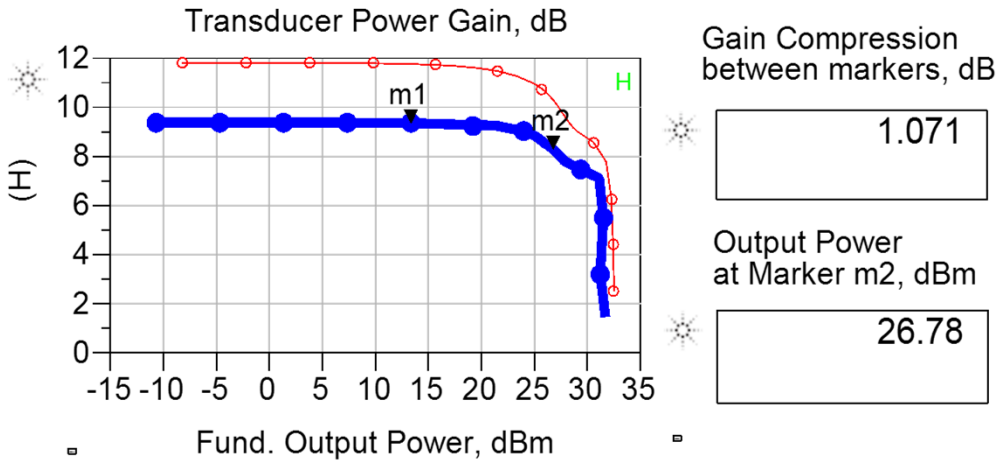


- A prototype of a **linearization method** at the desired frequency has been designed and fabricated.
  - GaN TQGaN15 from TriQuint/Qorvo
    - GaN on SiC
    - Cut off frequency 120 GHz
    - High break down voltage

1. Solid state TWT replacement





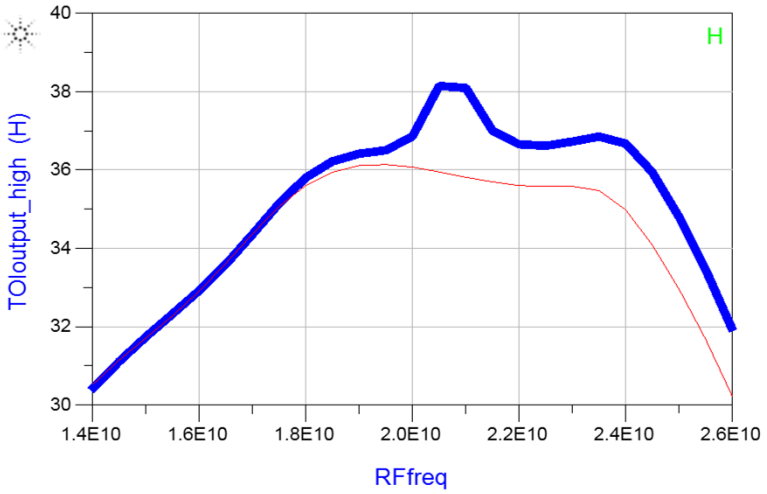


Gain Compression between markers, dB

1.071

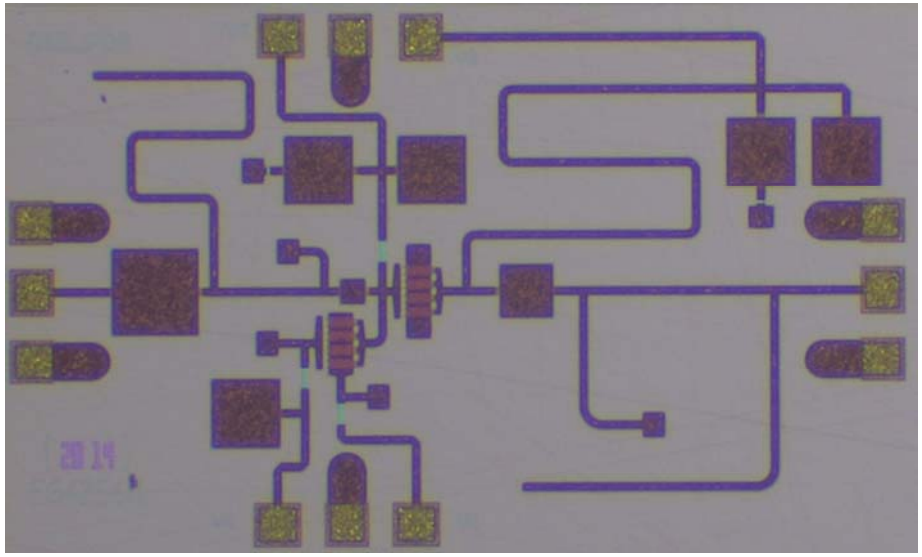
Output Power at Marker m2, dBm

26.78



1. Solid state TWT replacement

- Small Signal gain > 12 dB
- 1 W output power
- OIP3: 36dBm
  - Expected 2-3 dB improvement with linearization technique

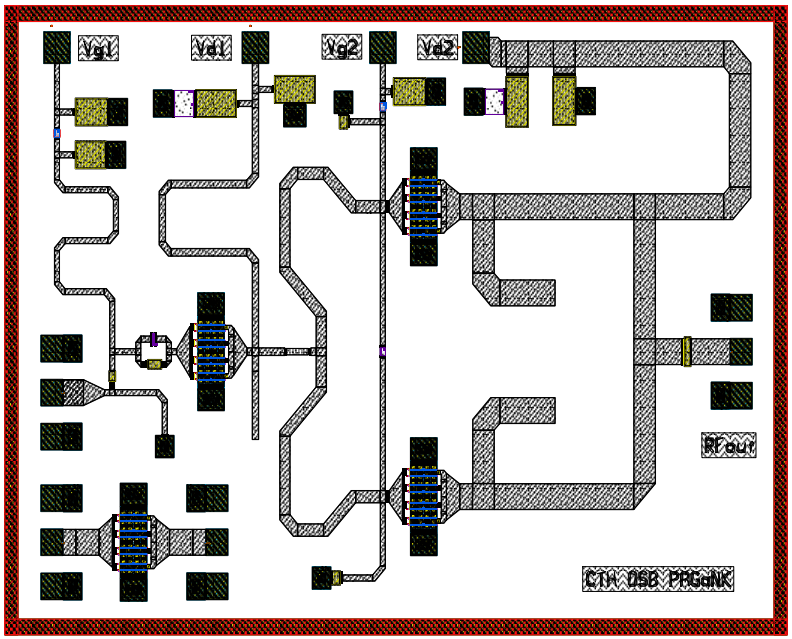


After a problem with the fabrication process the chip had to be fabricated again.

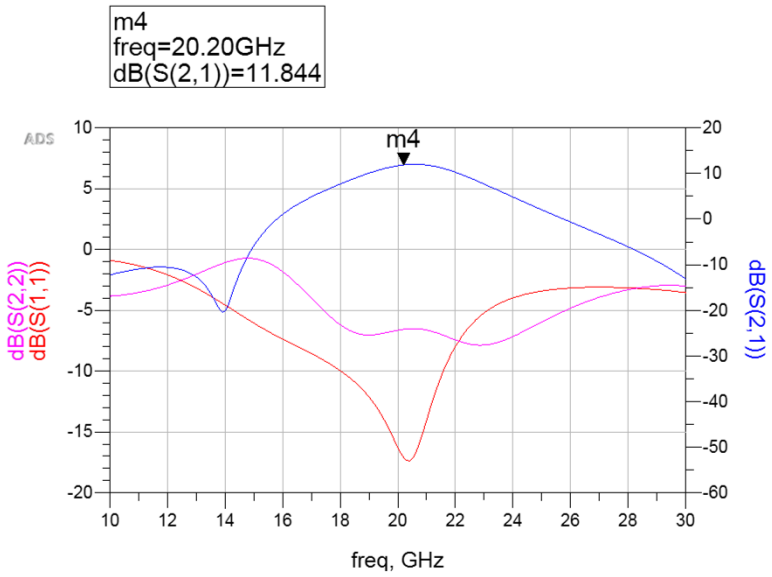
Delivered and currently being characterized.

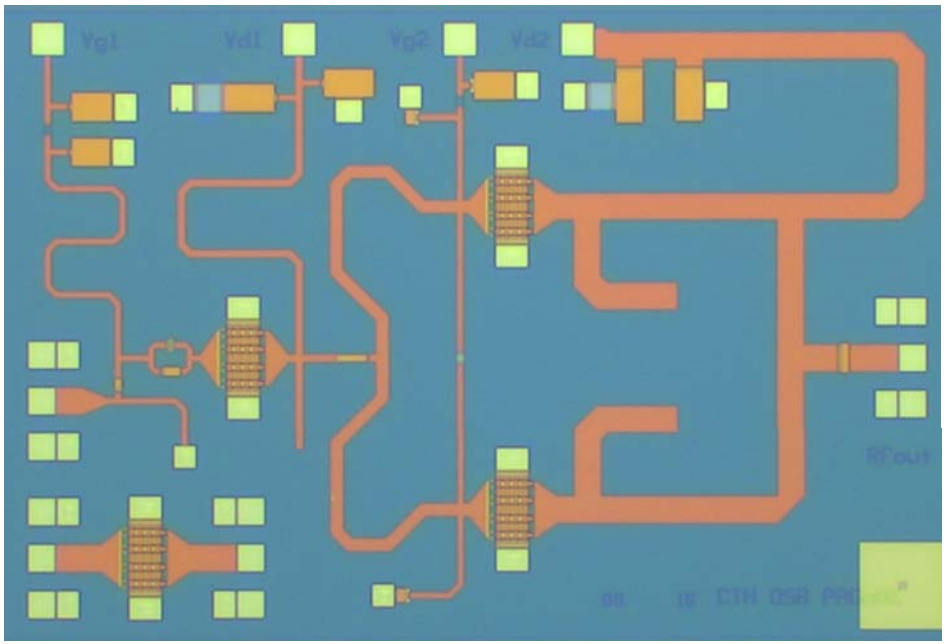
K-Band High Linear Amplifier

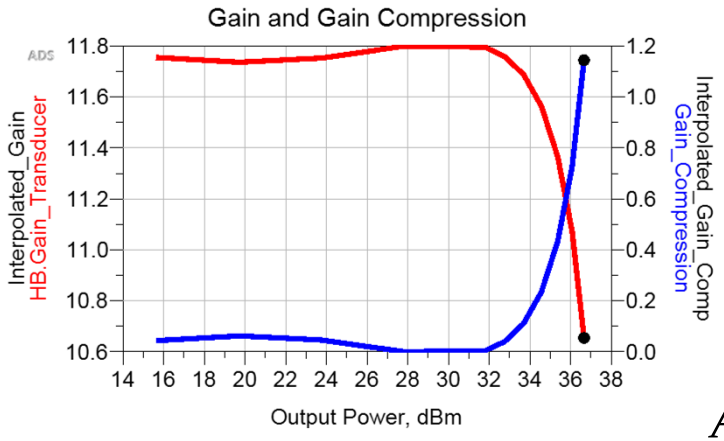
- Apply the findings of the previous GaN research (Mikrovågs komponenter) to design a Ka Band amplifier
- OMMIC GaN D01GH process
  - Cut off frequency 160GHz
  - Power Density 3.3 W/mm
- Design challenges:
  - Higher frequency of operation
  - Combining methods
  - Thermal distribution and dissipation



K-Band High Linear Amplifier







- 20 GHz central frequency
- Small signal gain 11 dB
- ~5 Watts output power
- OIP3 >50 dBm

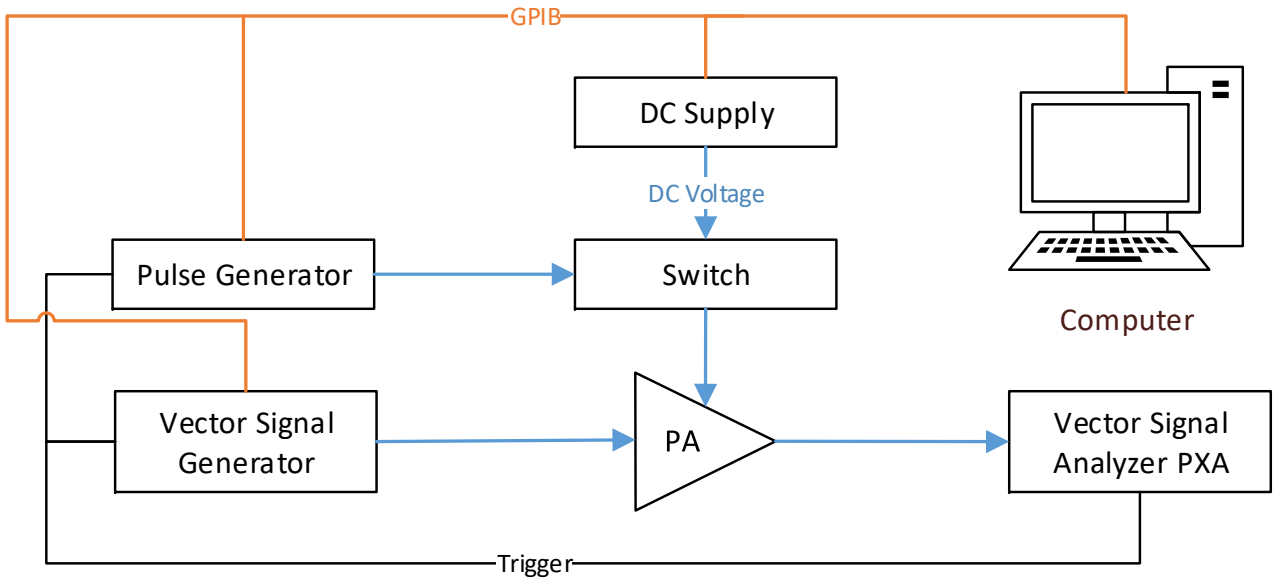
After a fabrication delayed chips have been delivered and are being characterized.

2. Multicarrier characterization

- Linear amplifiers characterization is commonly made by continuous wave and two-tone
- Generate input signal similar to the real signals used in multicarrier satellite links
- Apply the generated signal to GaAs and GaN SSPAs
- Evaluate the amplified modulated signal and its correspondent baseband.

2. Multicarrier characterization

- A modulated signal test bench was built using a Vector signal generator and a PXA together with a pulsed setup.



- Input signal generated can be modulated in different schemes as BPSK, 16QAM, 64QAM etc.
- EVM (error vector magnitude) is calculated from the received signal in the PXA

Future work

- Test the modulated signal with the desired circuits.
- Built a multicarrier test bench
- Predistorted amplifer characterization
- Conceptual desing for TWT replacement
- Temperature measurements and thermal modeling for GaN technology

THANK YOU!

RUAG RYMDSTYRELSEN Swedish National Space Board MC2