New Technologies for Space Projects: Gallium Nitride (GaN) Power Switching Transistors & Assembly- and Test House (ATH)

The 28th Microelectronics Workshop

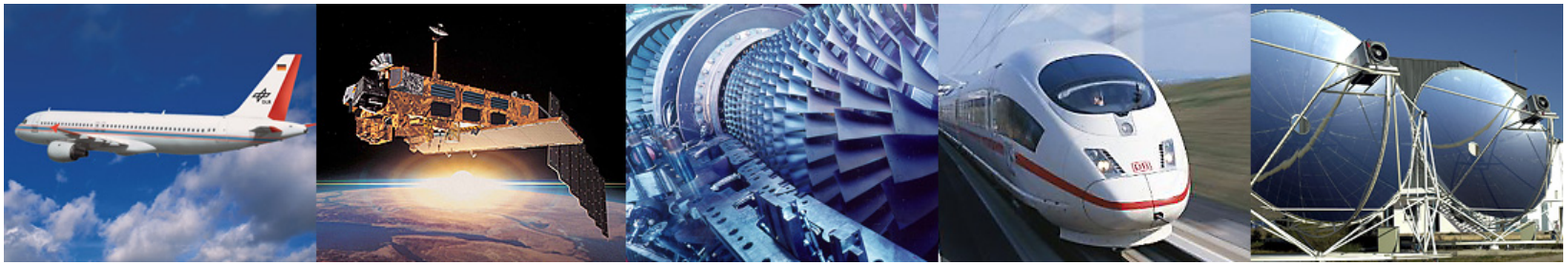
G. Joormann, DLR (German Aerospace Center)

Agenda

- Introduction
  - DLR
  - EEE-parts Section
- GaN Power Switching Transistors
  - Initial situation
  - Status of running activity
  - Outlook
- Assembly- and Test House
  - Initial situation
  - Status
  - Outlook

Introduction DLR
German Aerospace Center

- Research Institution
- Space Agency
- Project Management Agency

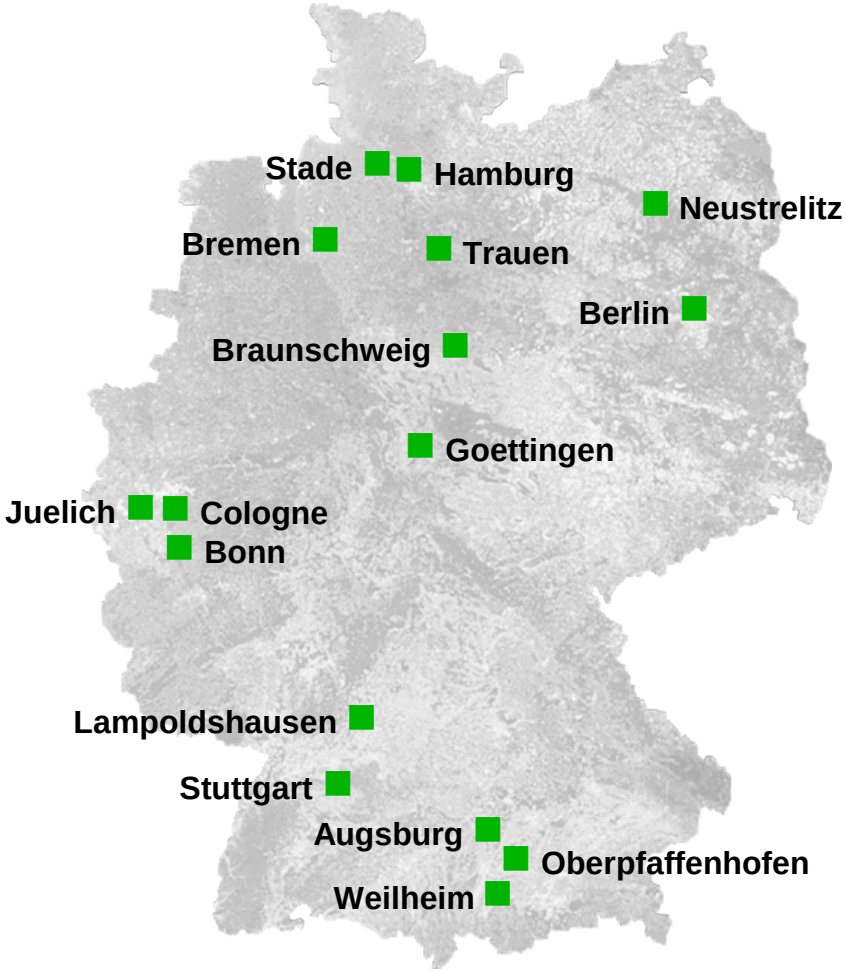


Research Areas:
Aeronautics, Space Research and Technology, Transport, Energy,
Defence and Security, Space Administration, Project Management Agency

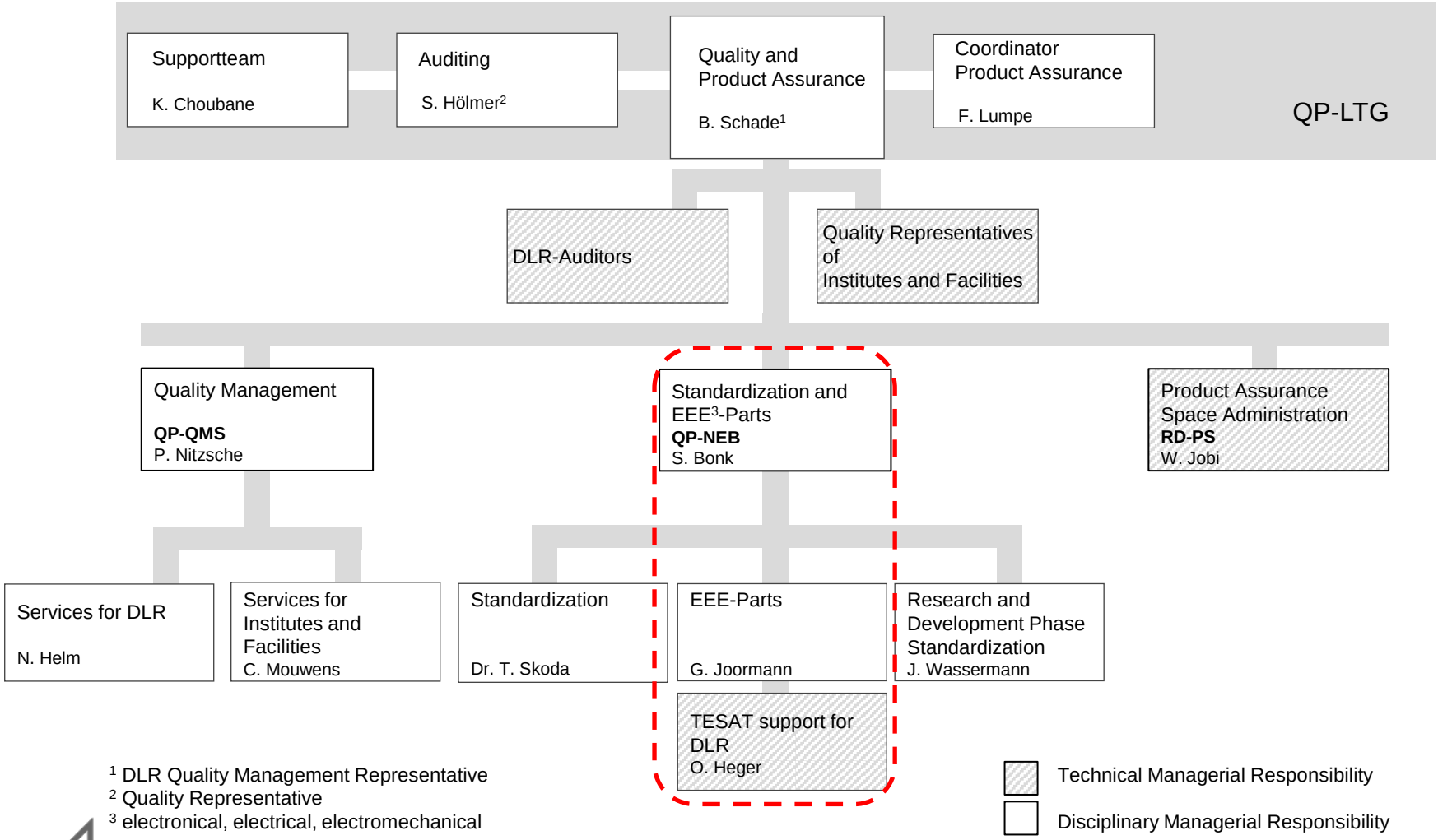
Introduction DLR
Locations and employees

Approx. 8000 employees across 52 institutes and facilities at
- 16 sites.

Offices in Brussels, Paris, Tokyo and Washington.



Introduction DLR
Organizational Chart Quality and Product Assurance



[1] DLR Quality Management Representative
[2] Quality Representative
[3] electronical, electrical, electromechanical

Technical Managerial Responsibility

Disciplinary Managerial Responsibility

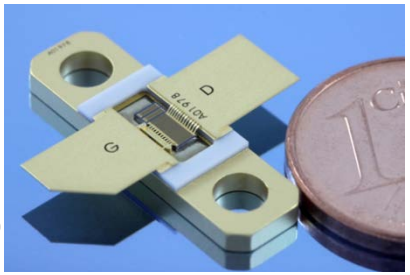
Introduction DLR
Tasks and Responsibilities of DLR EEE-parts Team

Alignment of National Technology Development and Qualification Program for EEE-Parts for Space Applications

- Investigation of new technologies for usage in space
- Initiation and support of EEE –part qualifications of existing and new technologies (approx. 10 projects simultaneously)
- Coordination of national EEE –part activities (DLR Parts Conference, external team site)
- Identification and prioritization of EEE –parts demand with respect to the
  - Availability of "strategic parts" in the context of national participation in ESA's European Components Initiative (ECI)
  - European harmonization of EEE –part activities
  - Strengthening Germany's technological competitiveness
- Member of the European Space Components Coordination (ESCC):
  - Representatives of the National Space Agency and the national interests of the space industry in the ESCC bodies
  - National Executive for ESCC qualifications and audits

GaN Power Switching Transistors
Initial Situation

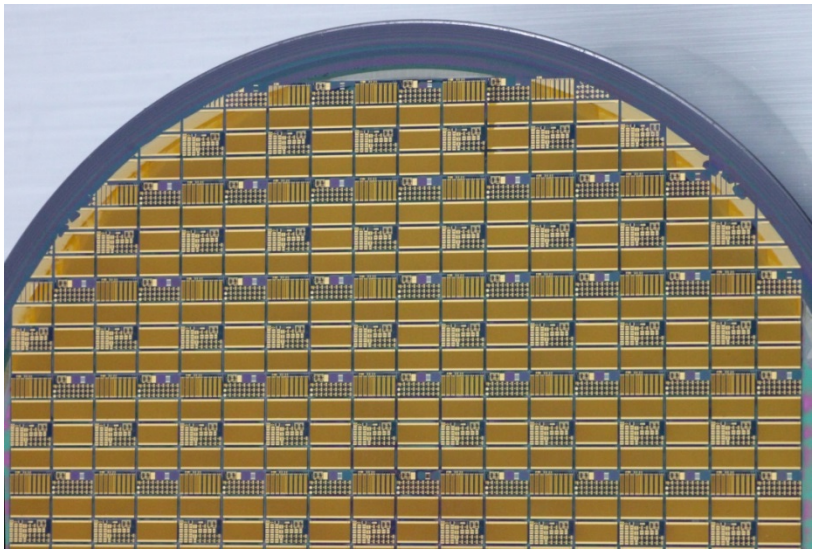
- Initial Situation:
  - RF Power Amplifiers are Key Components for Satellite Communication
  - Power Switching Transistors are required for their power supply
  - Actually no space qualified GaN Power Switching Transistors are available
  - GaN shows advantages compared to Silicon
    - Efficiency
    - On-resistance
    - Breakdown voltage
- DLR project with Ferdinand-Braun-Institute (FBH) 2007-2012 :
  - Goal: Development of radhard 100V GaN Switching Transistor
  - Results: Development of 1000V Serial Transistor and 250V and 250V Switching Transistors, threshold voltage >1V and Flip Chip assembly with low thermal resistance.
  - Problems: High dynamic on-resistance and leakage current
  - Conclusion: Follow-up project

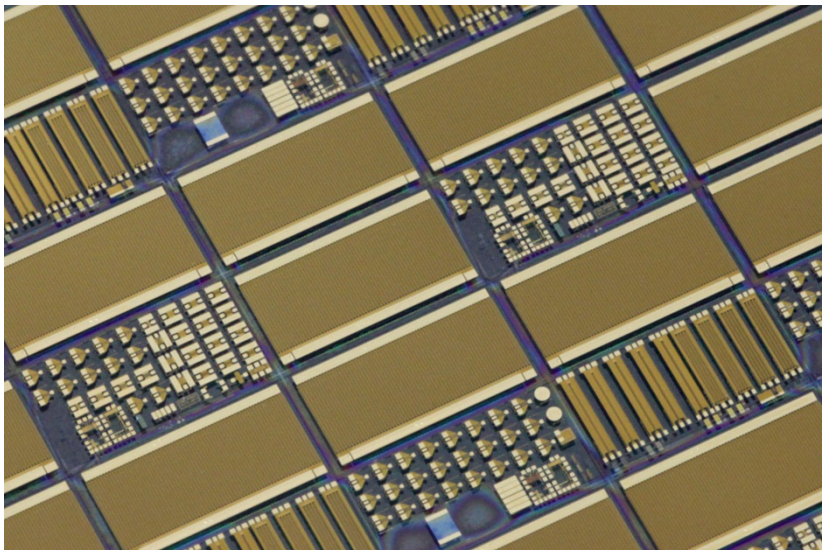


100 mΩ GaN Normally-off Transistor Chip
in a ribbon bonded Microwave Package

GaN Power Switching Transistors
Status of running activity

- Facts:
  - Activity running 03/3015 – summer 2016,
  - Project is based on experiences and results of previous project
  - Risk assessment preparing decision for subsequent space evaluation
  - Prime: Ferdinand Braun Institut, FBH (Berlin)
  - Subcontractors: Fraunhofer IAF (Freiburg) and Infineon (Munich)



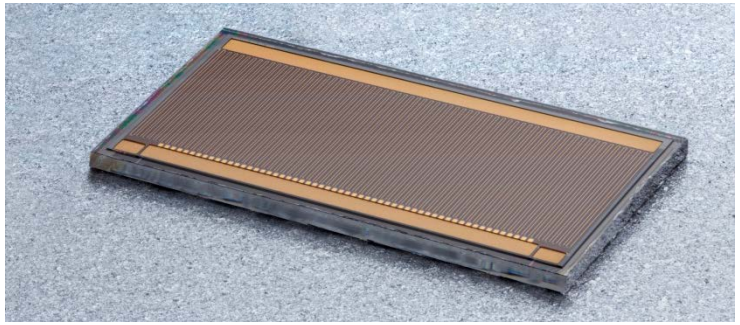


Processed GaN normally-off switching transistors 65 mOhm, GaN on Si Technology

GaN Power Switching Transistors
Status of running activity

- Status:
  - Work packages allocated
  - Radiation tests conditions defined
  - Development and manufacturing of samples done and test fixtures
  - First functional tests running at IAF and FBH
  - Start of radiation tests soon

- Outlook:
  - To analyze in detail the impact of radiation tests on several different GaN epitaxy structures dependent on Si/SiC substrates
  - Space evaluation & qualification according to ESCC



65 mOhm GaN normally-off Chip

Hybrid integrated semi-bridge

100 A GaN normally-off chip for flip-chip assembly

Assembly- and Test House
Initial Situation

- More semiconductor manufacturers focus on commercial mass market ☹
- Those who target the space market are mostly located in the US ☹
  - ITAR regulation ☹
- Many non-US semiconductor manufacturers are able to deliver space suitable chips ☺ but…
- Only few manufacturers are capable to assemble into space suitable packages and to run the tests necessary for space applications ☹

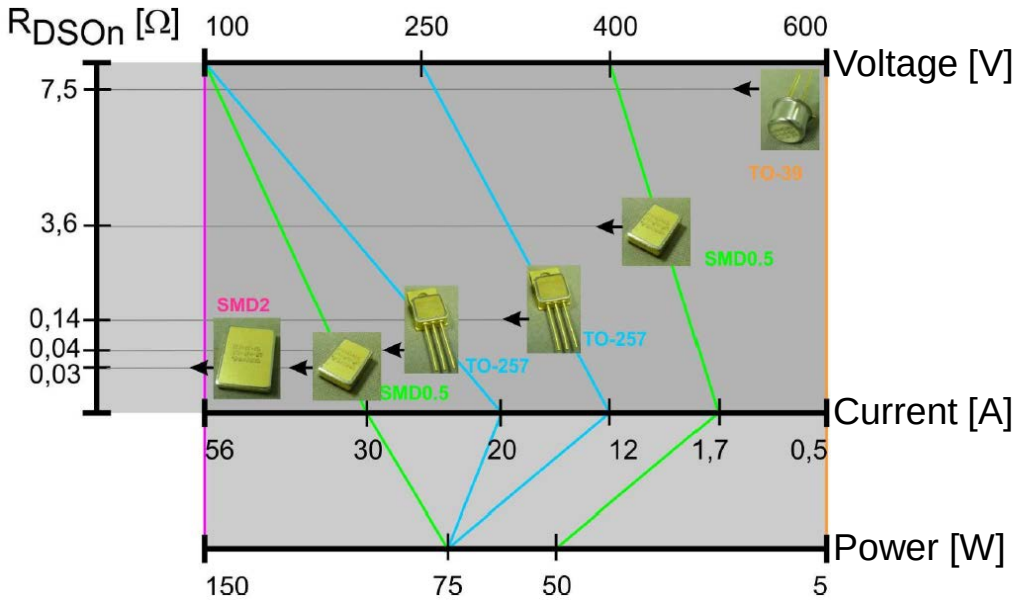
- Conclusion: Growing demand for one centralized institution responsible for:
  - Procurement of chips and packages
  - Assembly of chips into space suitable packages
  - Implementation of space qualification tests
  - Sale

- → Reaction: DLR funded project for establishing an ATH in Germany/Europe

Assembly- and Test House Status

- DLR project Assembly- and Test House (ATH) successfully completed in 2014
- First Sensor Lewicki GmbH certified as ATH for the domain Power MOSFETs

- Domain overview



Bescheinigung Nr. 02 a

Hiermit wird bestätigt, dass die Firma

First Sensor Lewicki GmbH

im Rahmen des Vertrages mit dem Förderkennzeichen 50 PS 0606 die Fähigkeiten als Assembly- und Test-House für die Domäne Power MOSFETs gemäß der unten angegebenen DLR Spezifikationen erfolgreich nachgewiesen hat.

DLR-RF-PS-STD-006, Iss. 1, Generic Spec.
DLR-RF-PS-STD-013, Iss. 2, Detail Spec. (SMD05)
DLR-RF-PS-STD-014, Iss. 2, Detail Spec. (TO-39)
DLR-RF-PS-STD-016, Iss. 2, Detail Spec. (TO-257/SMD05/SMD2)
DLR-RF-PS-STD-019, Iss. 2, Detail Spec. (TO-257)

Diese Bescheinigung ist gültig bis Dezember 2016.

Köln, 23.07.2015

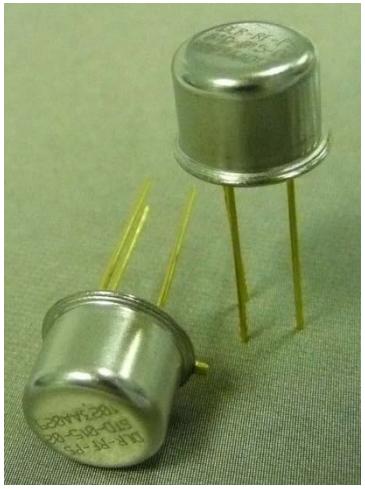
i.V. Britta Schade
Qualitätsmanagement-Beauftragte des DLR e.V.

i.A. Guido Joormann
Gruppenleiter EEE Bauteile Qualitäts- und Produktsicherung

DLR Deutsches Zentrum für Luft- und Raumfahrt

- Packages inside domain: SMD-2, SMD-0.5, TO-257 & TO-39

Assembly- and Test House Outlook



L6002 in TO-39 acc. to
DLR-RF-PS-STD-014-01

L1056 in TO-257 acc. to
DLR-RF-PS-STD-016-01

L1056 in SMD-2 and SMD-0.5 acc. to
DLR-RF-PS-STD-016-03 and DLR-RF-PS-STD-016-02

. . . ?

- Outlook:
  - Domain extension(s) shall enlarge the range of ATH-qualified parts
  - Survey to determine the need for domain extension ongoing

Thank you for your attention!

- Photos and graphs published with the kind permission of

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and

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