1500 SiC

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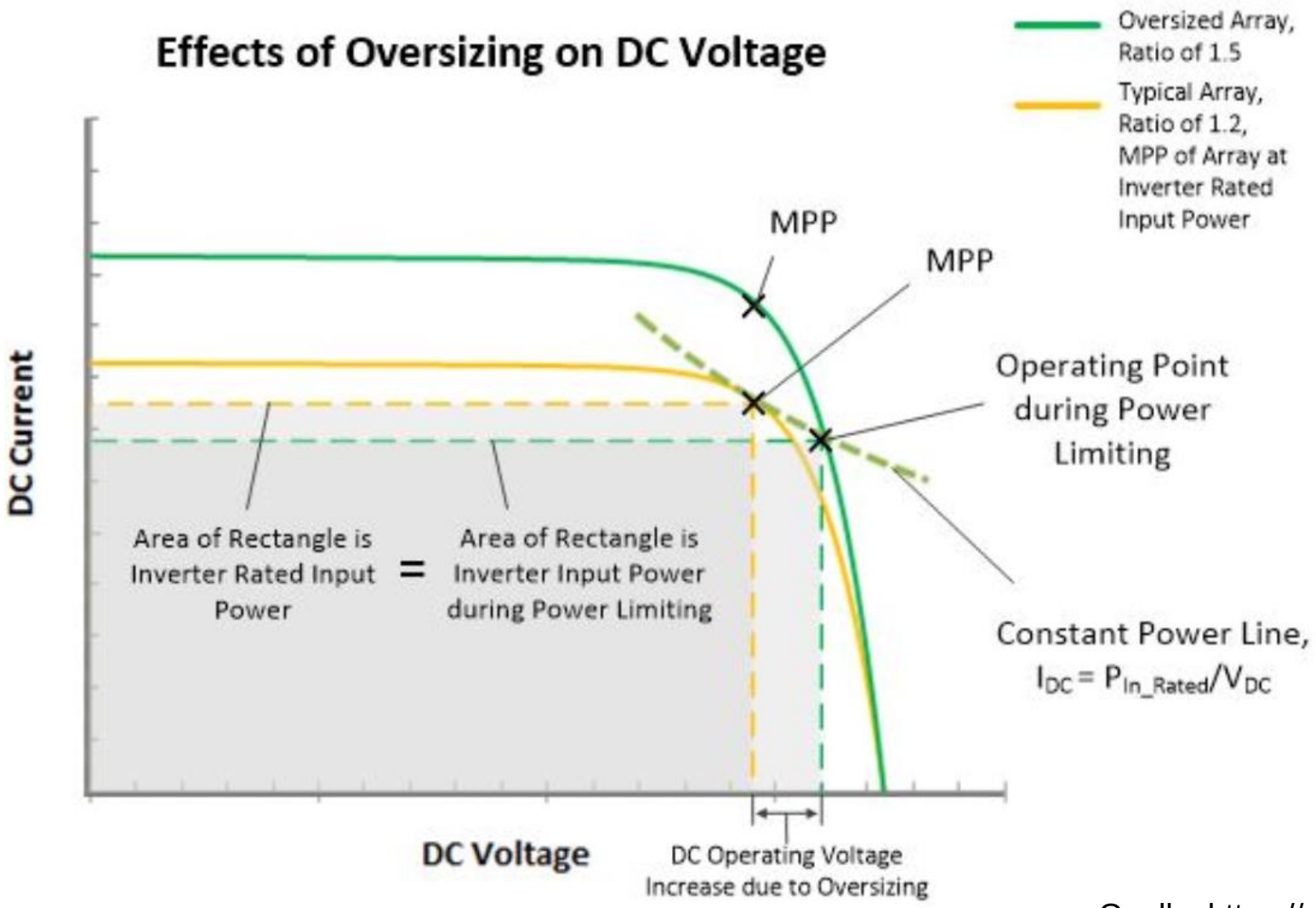
Inhalt

Forschungsthemen bei PV-Großanlagen

- Steigerung der Anlagenausnutzung
- Höhere Energieeffizienz
- Verbesserte Höhenstrahlungsfestigkeit

Steigerung der Anlagenausnutzung



Quelle: https://www.civicsolar.com/article/solectria-array-oversizing

Cosmic Radiation

Universe

Earth

Semiconductor

Primary cosmic particles (protons)

↓

Shower of particles not absorbed by magnetic field of earth

↓

Secondary cosmic particles (neutrons)

↓

Defects in semiconductors

↓ ↓

Higher altitudes = higher likelihood e.g. alps

Lower altitudes = lower likelihood e.g. sea level

- **Cosmic radiation can cause spontaneous failures in high voltage semicondutors**
- **Influential factors**
  - Applied reverse voltage
  - Device temperature
  - Period of time under which the device is reverse biased
  - Total chip area used (including all paralleled devices)
  - Altitude (due to increase of neutron flux)
- **All HV semiconductors can be affected independent of supplier**
- **Infineon measures cosmic radiation-induced FIT[1)] rates as part of the development process of high voltage device technologies**

[1)] FIT: Failure in time rate of a device is the number of failures that can be expected in one billion device-hours of operation

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1. Forschungsthemen bei PV-Großanlagen
2. **Partner**
3. Ergebnisse
4. Fazit

1500 SiC Partner

- Advanced Power Semiconductor Laboratory — ETH Zürich, Schweiz
- GamesaElectric — GamesaElectric, Spanien
- Infineon — Infineon Technologies Austria AG, Österreich

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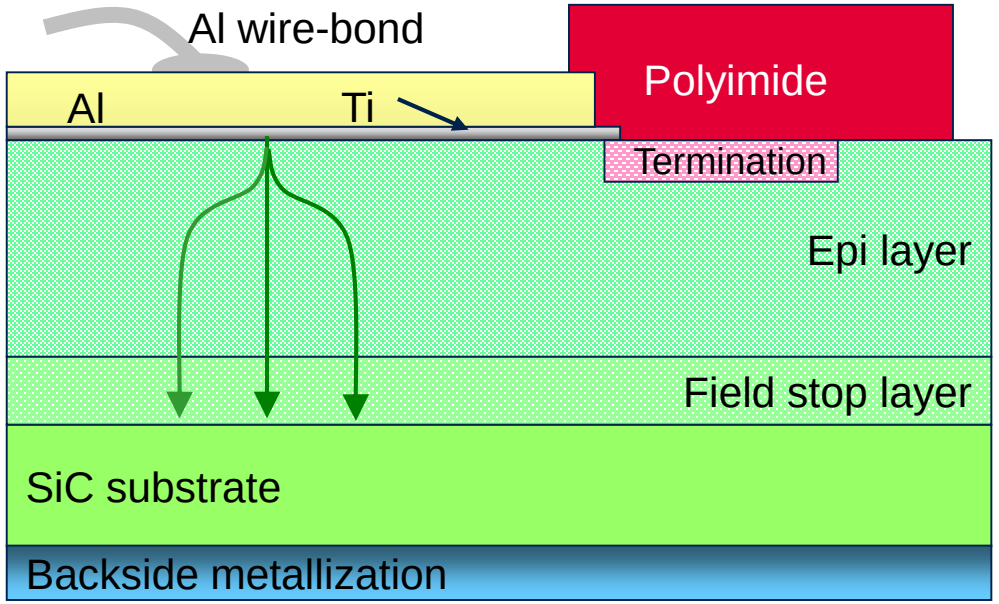
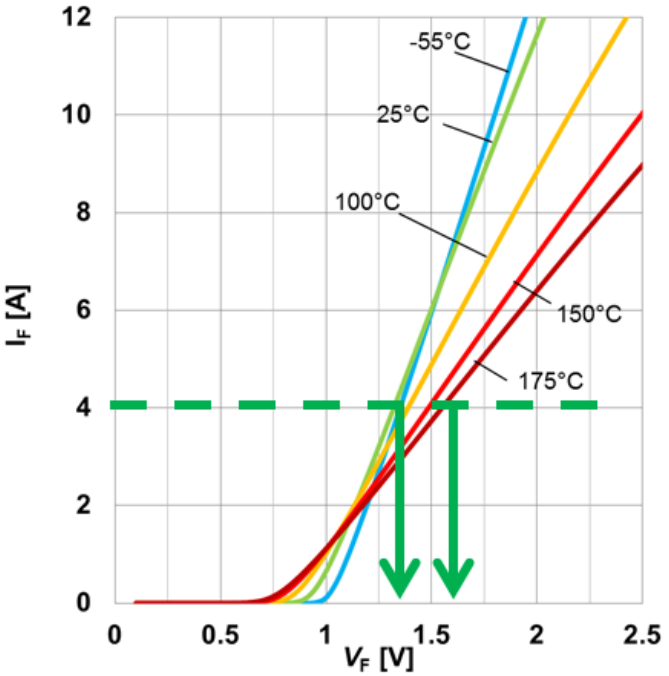
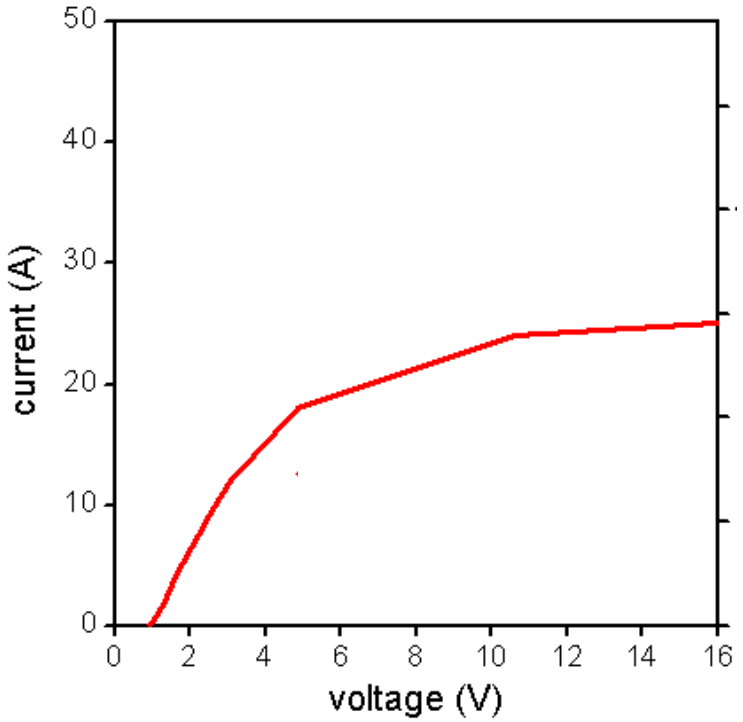
I-V characteristics of SiC Schottky diodes



4A diode – nominal mode

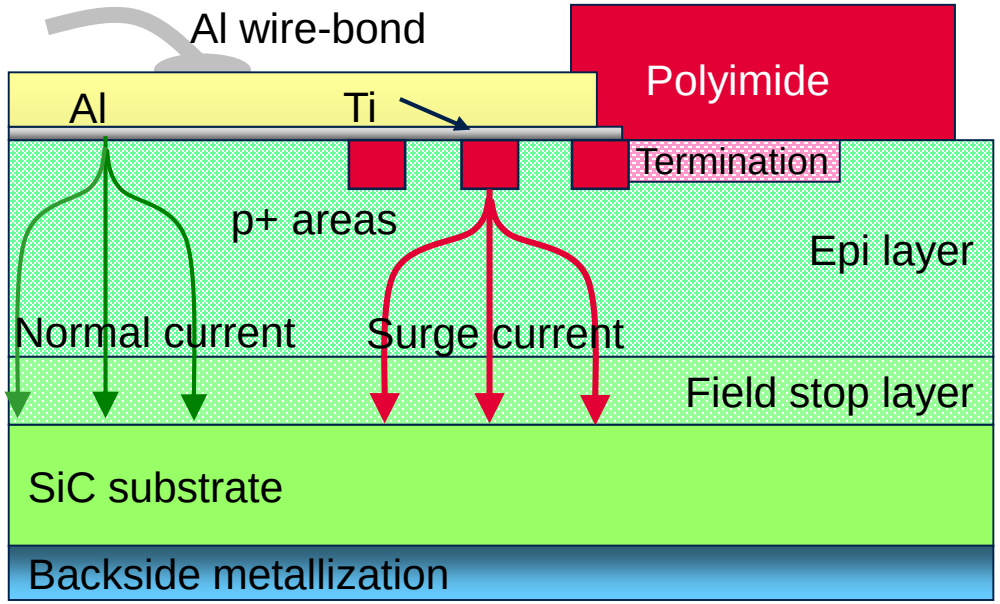


4A diode – surge mode

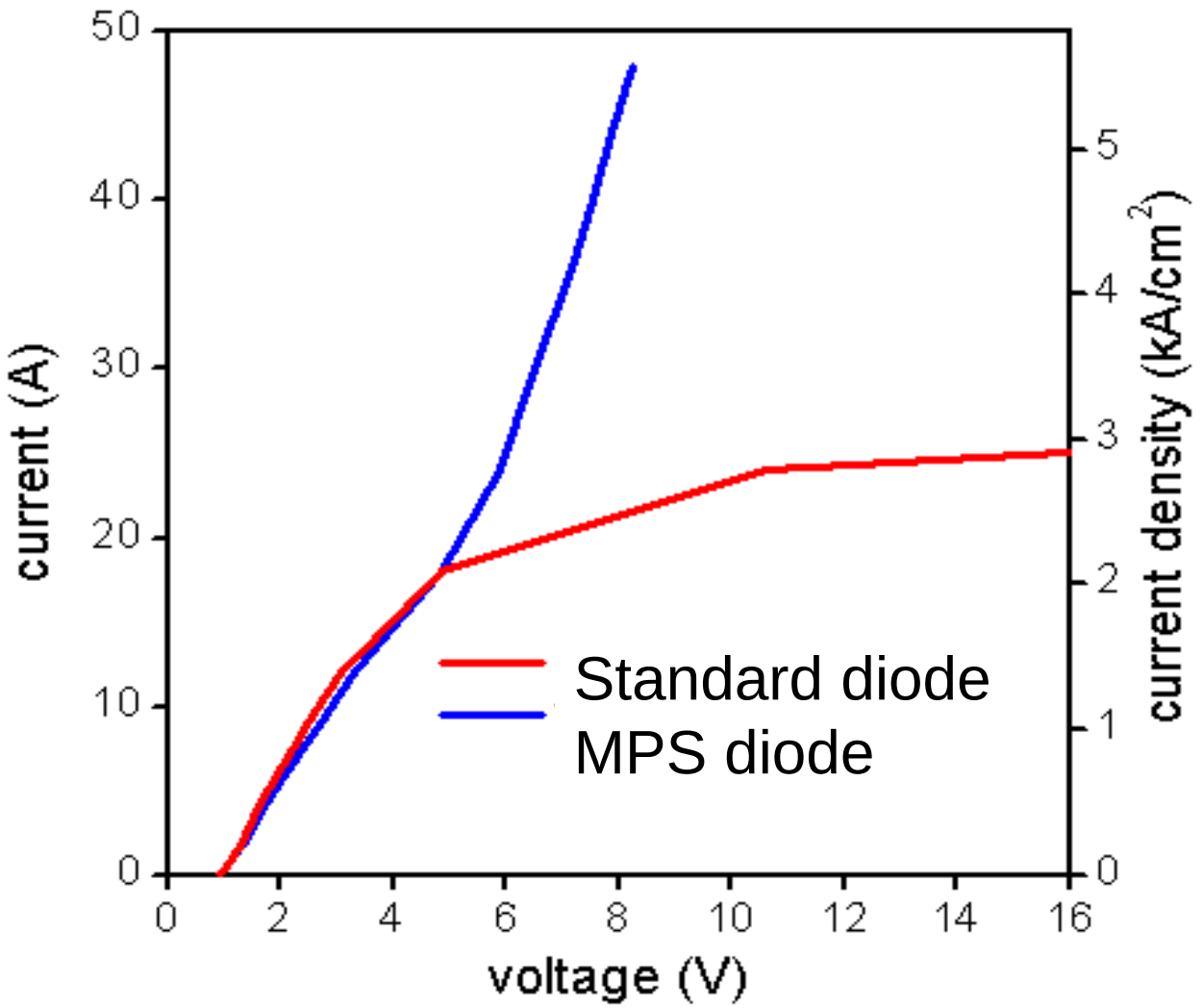


Positive temperature coefficient for high current
→ thermal runaway

Improvement step 1 : introduction of M

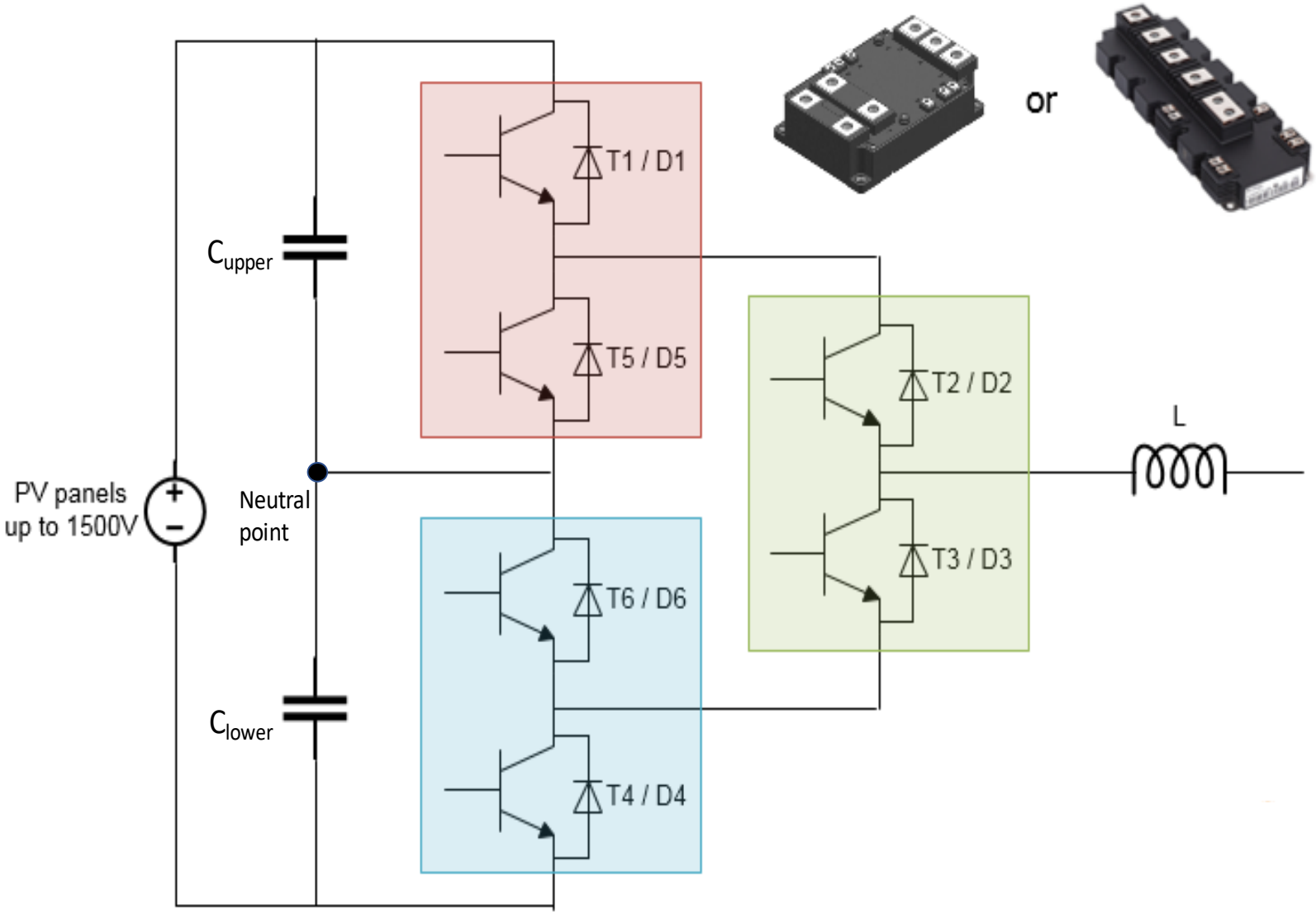


pn junction part temperature stable even for 10x rated current



* MPS – merged pin-Schottky diode – add **ACTIVE** pn junction islands to the structure (in contrast to JBS where pn-islands are passive)

Steigerung der Effizienz



or

Steigerung der Effizienz:

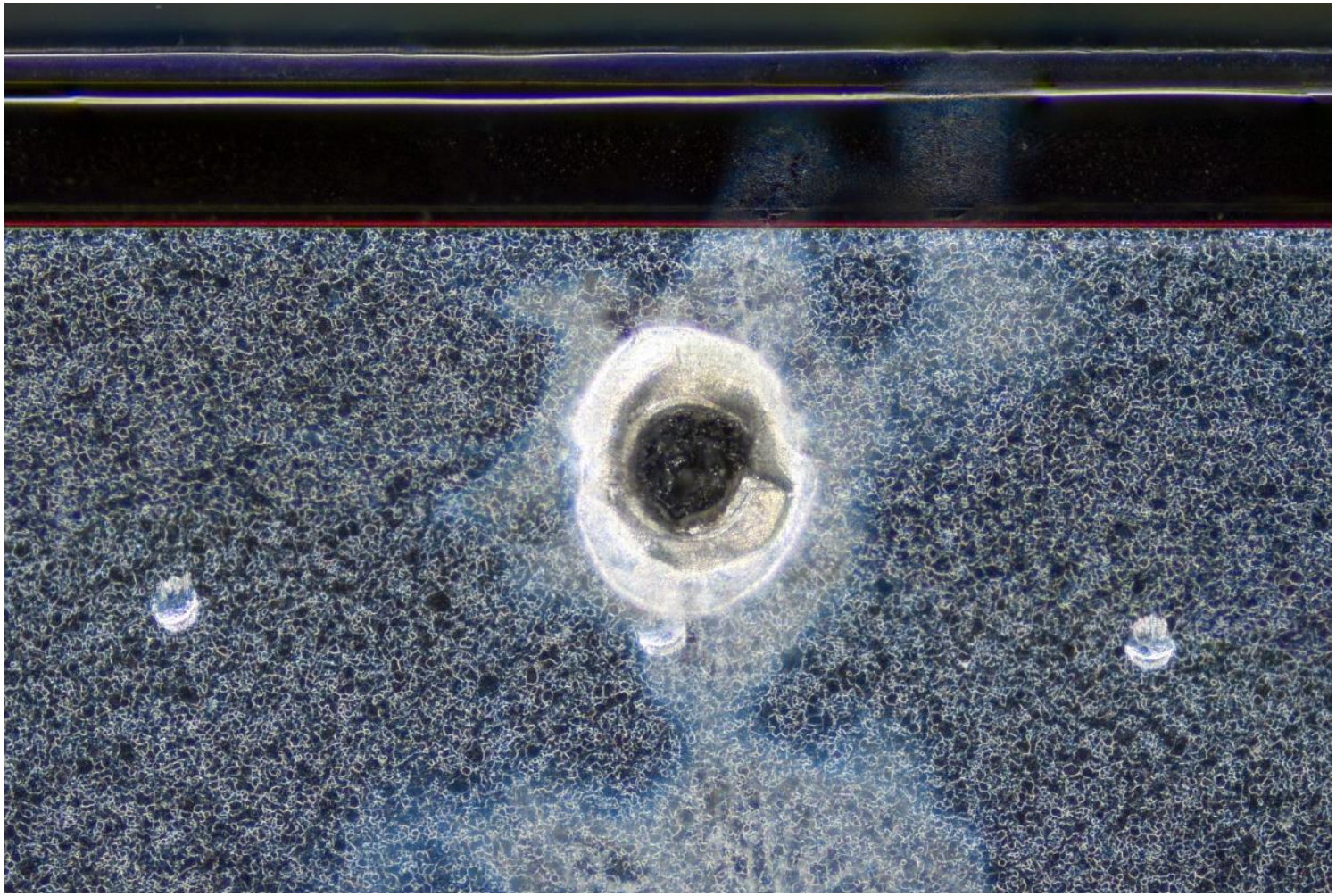
- Topologie und
- Bauteilauswahl

Ergebnis:

Peak-Efficiency = 98,8%

Radiation tests
Devices after test

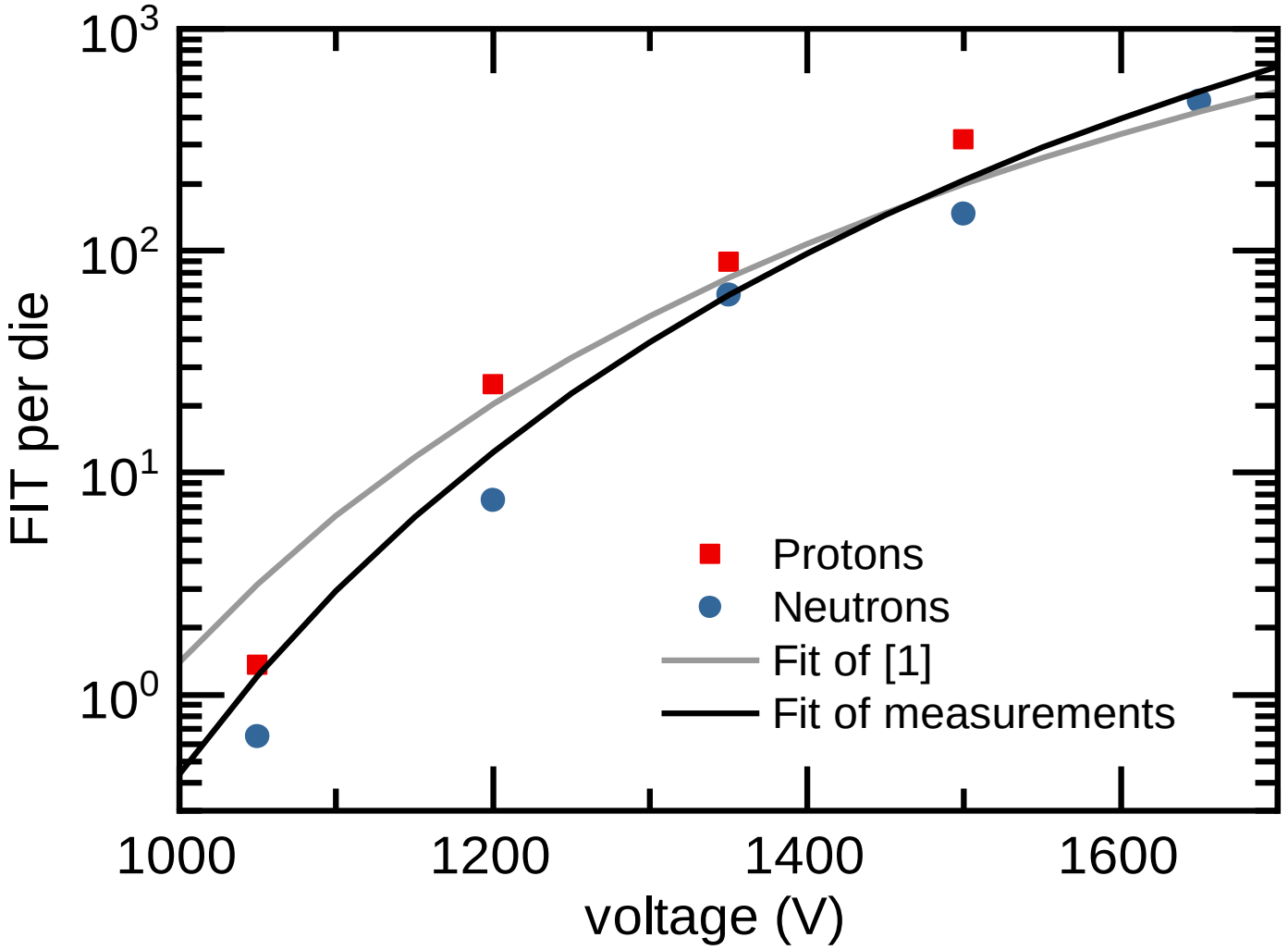
- Small hole in surface of device
- Short of anode and cathode



Radiation tests
FIT fit

- Fit using the established equation
- $FIT/cm^2 = C_3 * \exp\left(\frac{C_2}{C_1 - V_{DS}/V_{DS,br}}\right)$
- $C_1 = 0.2$, $C_2 = 5$, $C_3 = 4*10^6$
- $V_{DS,br} = 1800$ V, $A_{active} = 14\,mm^2$

- [1]: Lichtenwalner et al. “Reliability of SiC Power Devices against Cosmic Ray Neutron Single-Event Burnout.” Materials Science Forum, vol. 924, June 2018, pp. 559–562



Demonstration

Gamesa’s new PV Station (up to 7.5MW) including MV transformer and switchgear.

Inhalt

DREI GUTE GRÜNDE FÜR DAS PROJEKT

- Die Erhöhung des Wirkungsgrades um 1 % in der PV Energiewandlungskette entspricht ca. Einer Einsparung von 2.5 Megatonnen CO_2 (bei ca. 500 GWpeak weltweit installierter PV-Leistung 2018).

- Betriebsspannungen von 1500 V für größere Anlagen reduzieren die Systemkosten und sparen wertvolle Ressourcen (z. B. Kupfer).

- Höhere Robustheit des Gesamtsystems steigert die Zuverlässigkeit und reduziert den Wartungsaufwand.

Acknowlegdement

The Project “**1500-SIC**” was supported under the umbrella of **SOLAR-ERA.NET** by
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