MAPPING OF SEE-SENSITIVE REGIONS AND LOCATING OF ADDITIONAL FAILURE MODES RELEVANT FOR RHA IN DIGITAL ISOLATORS

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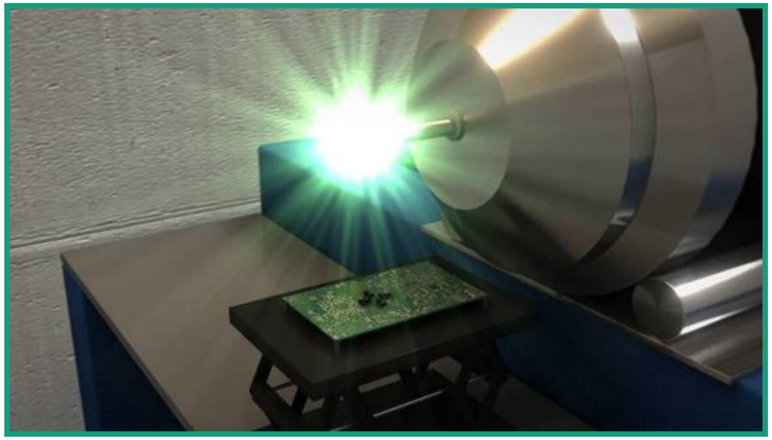

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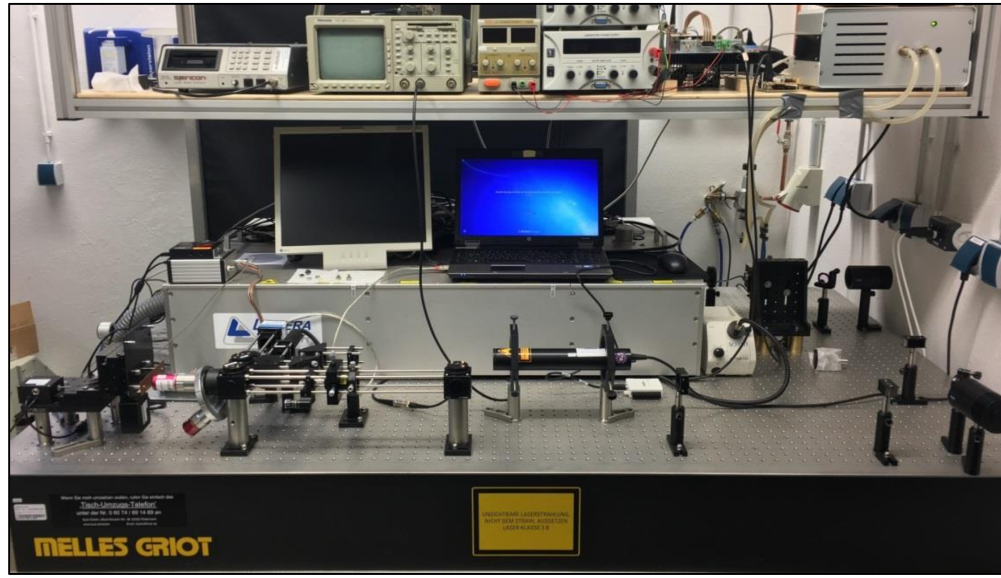
Mapping of SEE-sensitive regions
Abstract

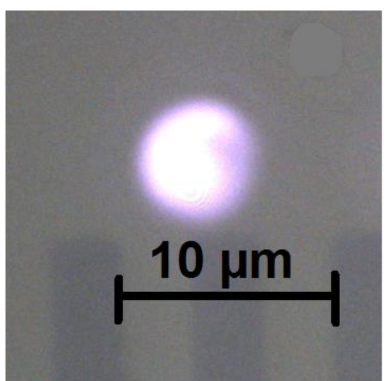
- A **pulsed laser mapping** of Digital Isolators was done
- They were **previously characterized with heavy ions** at RADEF
- During the test there was not only an identification of the **regions which are sensitive to single-event effects** (SEE) but it also revealed **additional failure modes** (i.e. high-frequency ringing and latchup) not seen during heavy ion testing
- So this device was considered **latchup free up to an LET of 60 MeV cm^2/mg**. But those effects could also be induced by highly penetrating particles and hence must be taken into account for radiation hardness assurance (RHA)
- In addition it was possible to **measure the sensitive area** for the different types of SEE at **different laser energies**

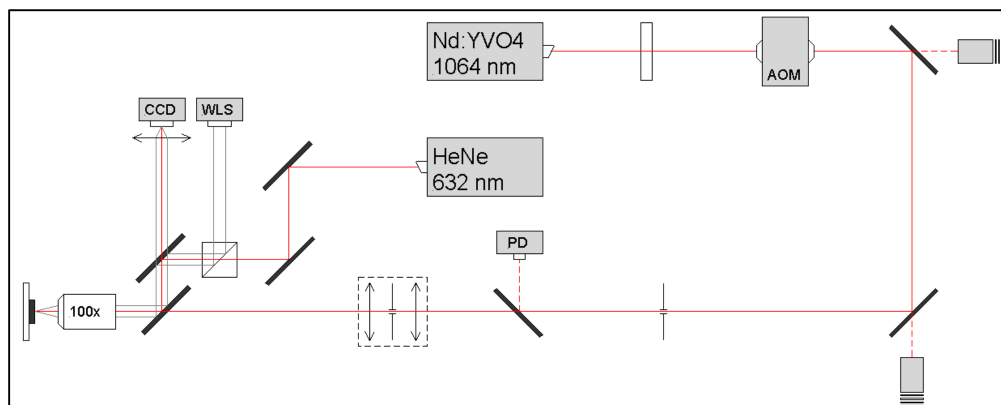
Laser testing @ INT
Laser Facility

- A **9 ps 1064 nm** Staccato Nd:YVO4 laser from LUMERA
- An **acousto-optical modulator** (AOM) for transmitting of single pulses
- A Mitutoyo **100x microscope objective** for beam focussing
- A piezo-moveable **xyz-table** (0.1 µm steps) for scanning
- A **laser power meter** 13 DSJ 001 from CVI Melles Griot



- The **laser spot** has a full width (90 %) of about **5 µm**
- The **laser energy** can be varied between **0.1 and 100 nJ**





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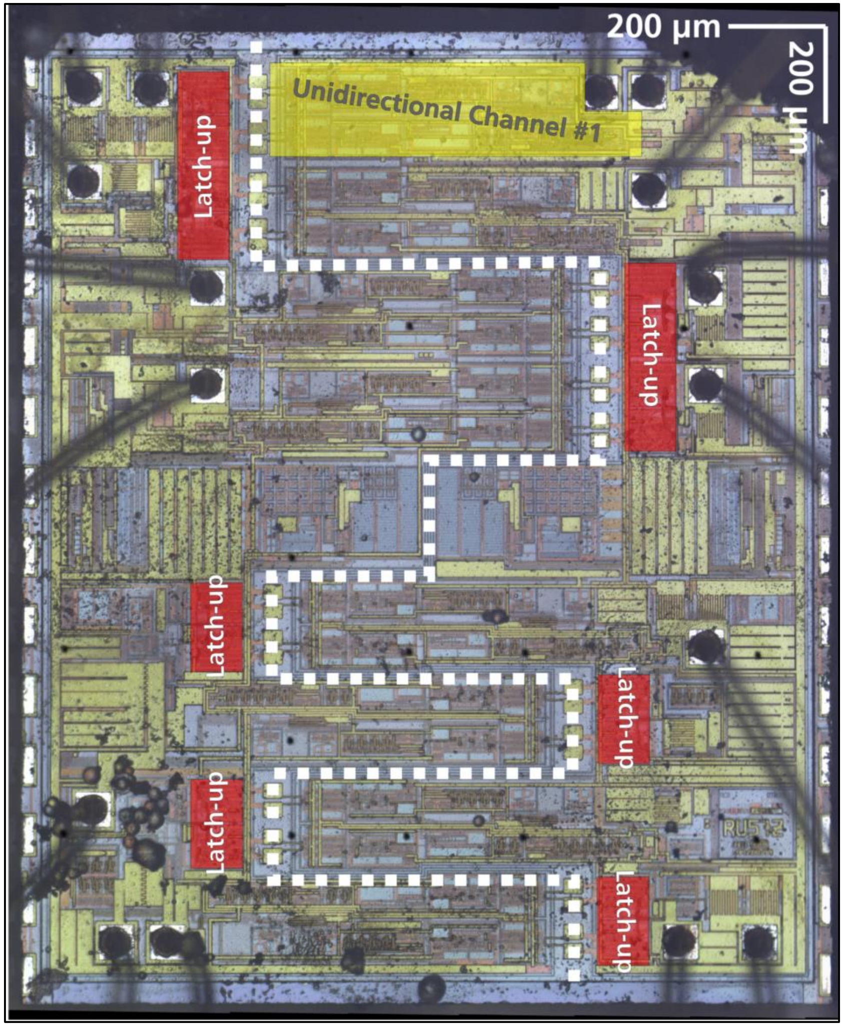
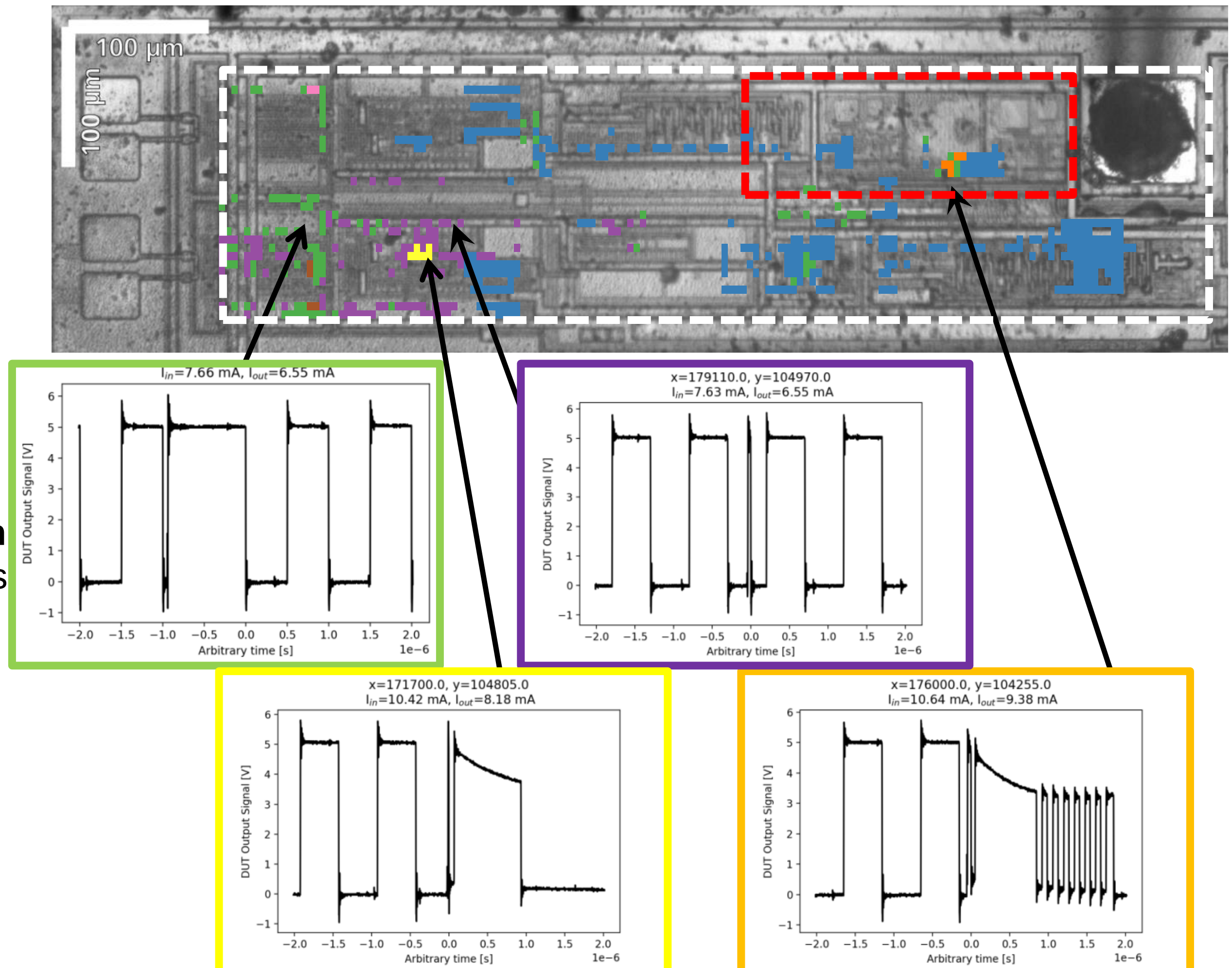
Laser testing @ INT
Device under Test: MAX 1480-ASE+

- The commercial-of-the-shelf Digital Isolator MAX14850, by Maxim Integrated, is a **six-channel Digital Isolator** with four unidirectional and two bidirectional channels
- The in- and output side of the DUTs have separate power lines
- The data transfer from input to output is realized through capacitive coupling



Laser testing @ INT
Raster scans with a picosecond laser beam

- **Raster scans** of the output of unidirectional channel #1 (white border), at **5 µm step** width, and of **a subsection** (indicated in red) at **2 µm** resolution
- The input side of each transmission channel and some areas of the output side are **latchup sensitive** when hit by the laser beam
- **SEL were not observed with heavy ions.** No further effects were observed on the input side



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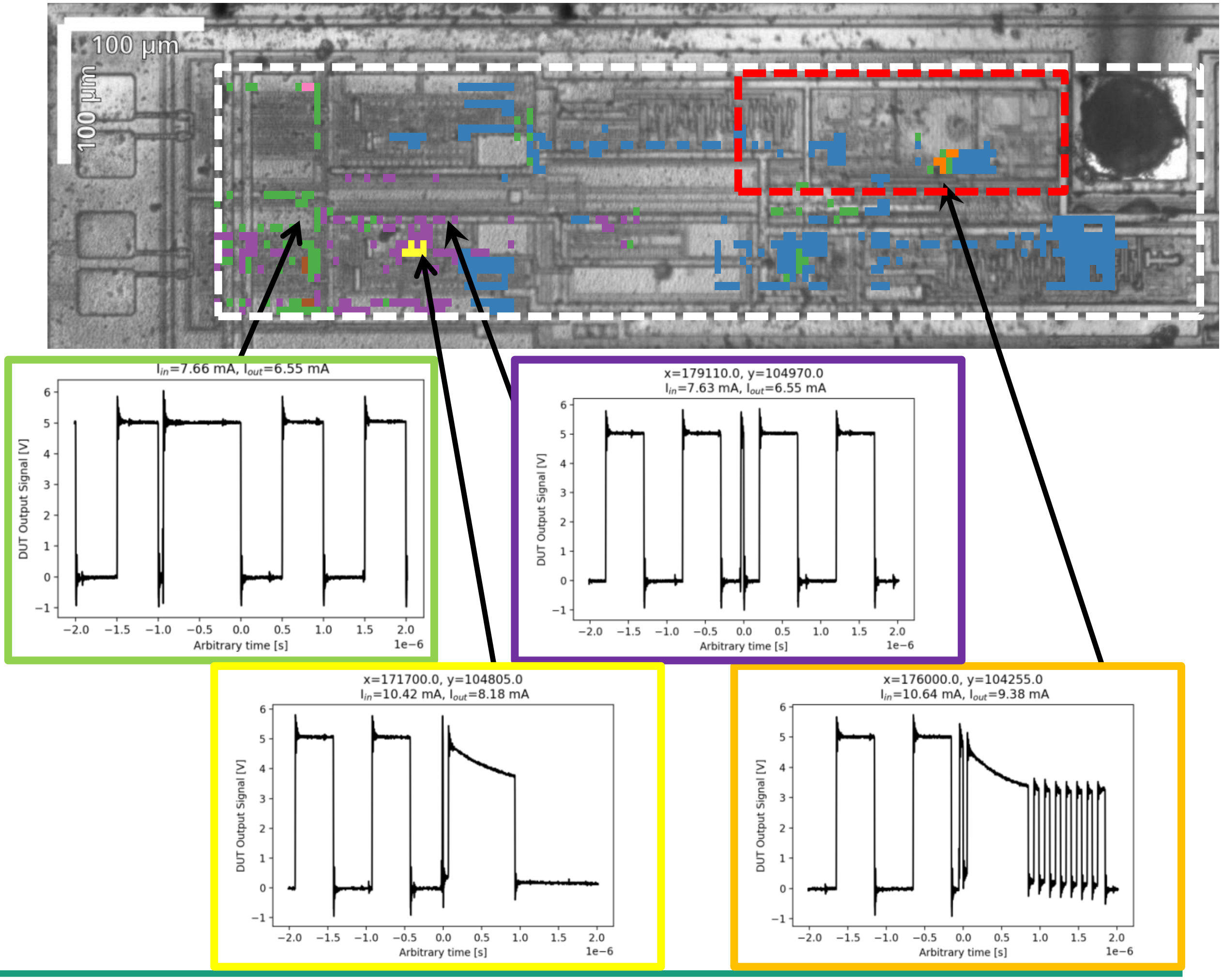
Laser testing @ INT

Raster scans with a picosecond laser beam

- Further effects, not seen in heavy ion tests, were the **collapse of the signal output** in the wake of a transient. A similar effect further introduces a **high frequency ringing** on the output.
- **Transients** and **„bitflip"-like** events (change of logical state) are spread over the DUT. These were the only SEE observed with heavy ions
- More details on heavy ion tests: „Radiation Evaluation of Digital Isolators for Space Applications" (see RADECS 2017)



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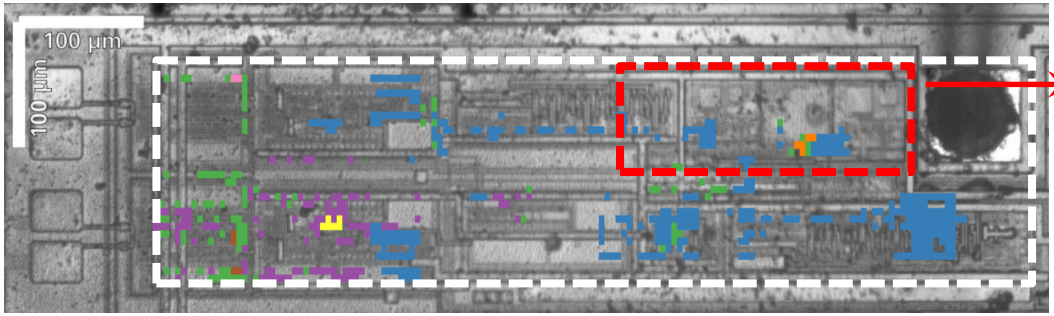
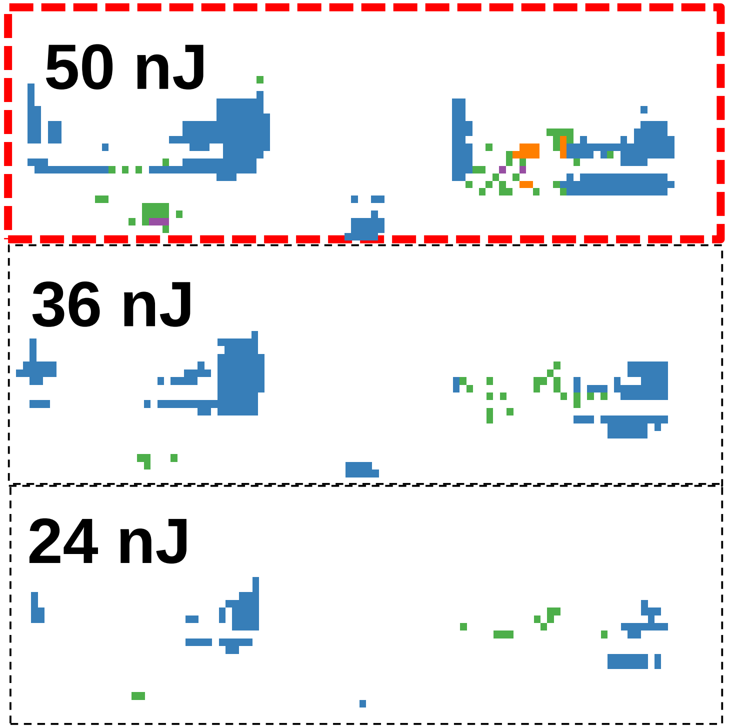
Laser testing @ INT

Raster scans with a picosecond laser beam



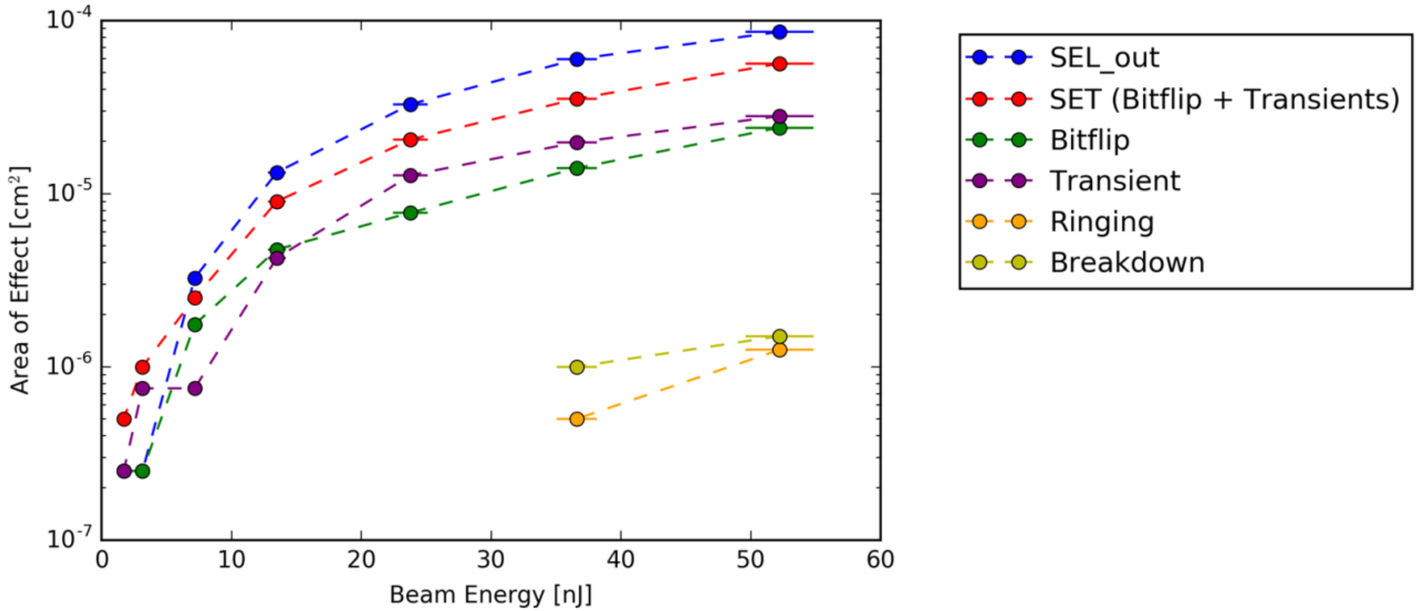
2 µm x 2 µm step width



- **Subsection** scan with **2 µm** resolution
- The **collapse of the signal output** in the wake of a transient and the **ringing** on the output are only seen at **high laser beam energies** (50 nJ) and are highly localized

Laser testing @ INT
Analysis

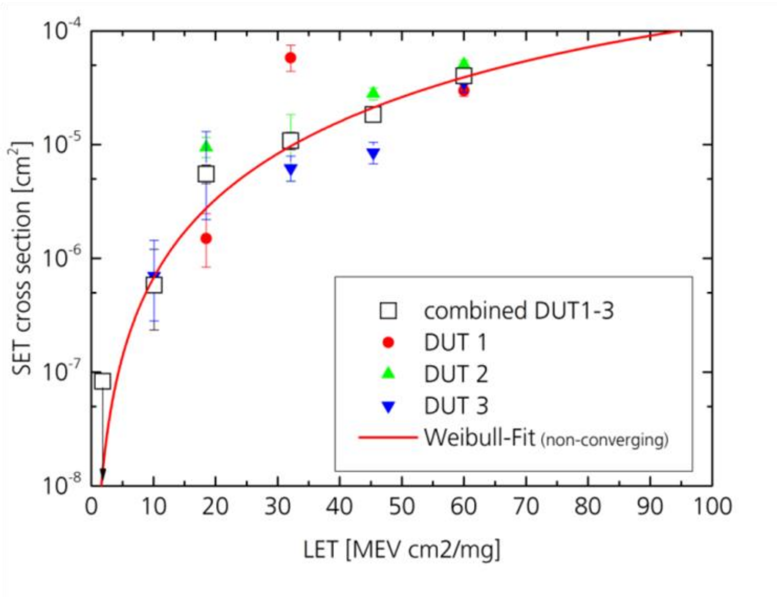
- The **cross section** is calculated by assuming a contribution of 5 µm x 5 µm (= step width²) to the total area of each effect



Laser testing @ INT
Analysis

- **Similarities** to the heavy ion test data:
  - **No saturation level** found at high LET and laser beam energies
  - **Low threshold** for both LET and laser beam energy
  - Occurrence of **SEL** probably due to **higher penetration depth** of 1064 nm laser beam (photon energy near Si-band gap) compared to high LET ions at RADEF

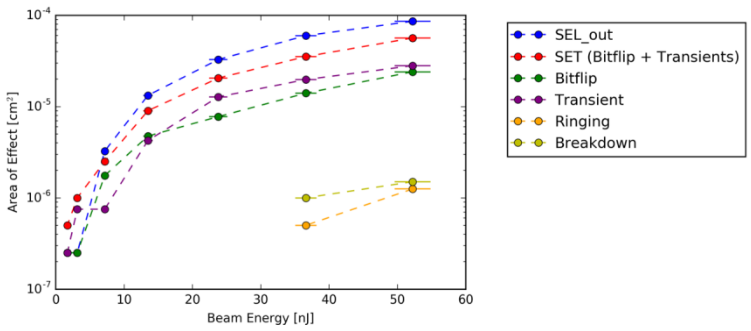
SET cross sections from Heavy ion test data



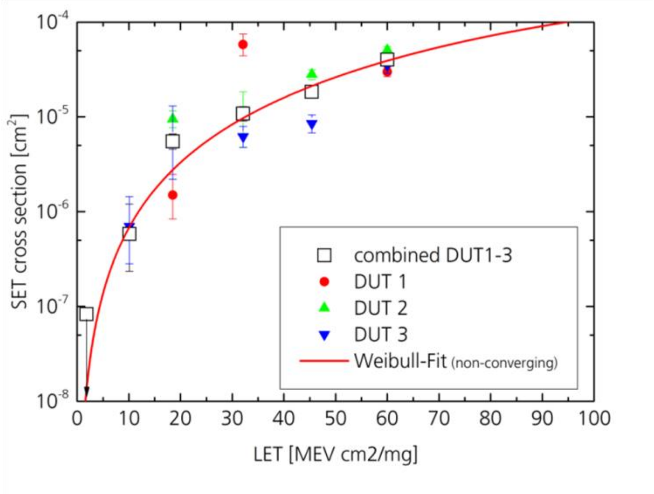
Laser testing @ INT
Outlook and Acknowledgements

- Try to relate **LET** and **laser energy** for this device by **SET cross section comparisons**

- Heavy ion testing and device procurement was carried out in the TRP framework (contract no. 4000112480/14/NL/SW) of the European Space Agency



SET cross sections from Heavy ion test data (see **DW-32**)



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Contact

- **Thank you!**

- Contact:
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