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This research aims to design pulse-detecting antennas, quantify, classify, and localize ESD pulses in clean and complex environments (e.g., placement machinery), and enable robust CDM-type ESD testing at the chiplet level during manufacturing steps. It further seeks to detect CDM events during production at frequencies and magnitudes arising from chiplet stacking, serving as early indicators of failed charge-voltage suppression, and to characterize chiplet ESD behavior for System Efficient ESD Design. The research also includes the development of ESD/EMC training materials for online and onsite delivery with laboratory components.

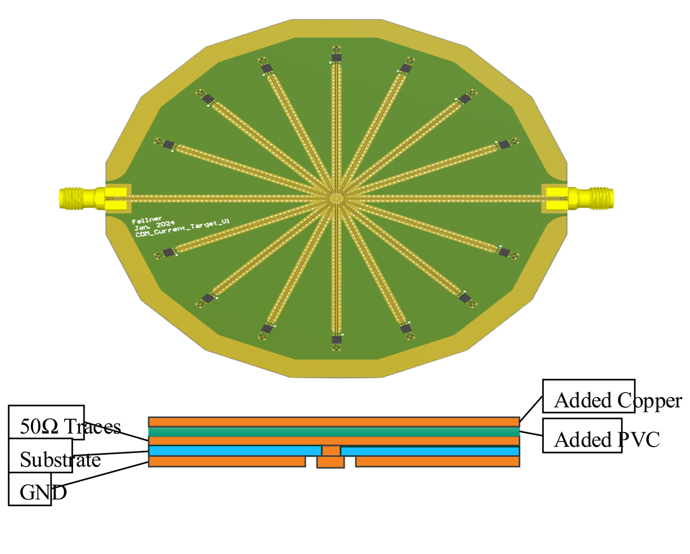
Transmission Line Based Current Target

Charged Device Model (CDM) events exhibit very fast rise-times (< 20 ps) and short pulse widths (< 50ps), making failure thresholds rise-time dependent and imposing strict requirements on current measurement such as high-voltage rating, pulse-current capability, low resistance, and high bandwidth/low inductance. Conventional targets have limited bandwidths.

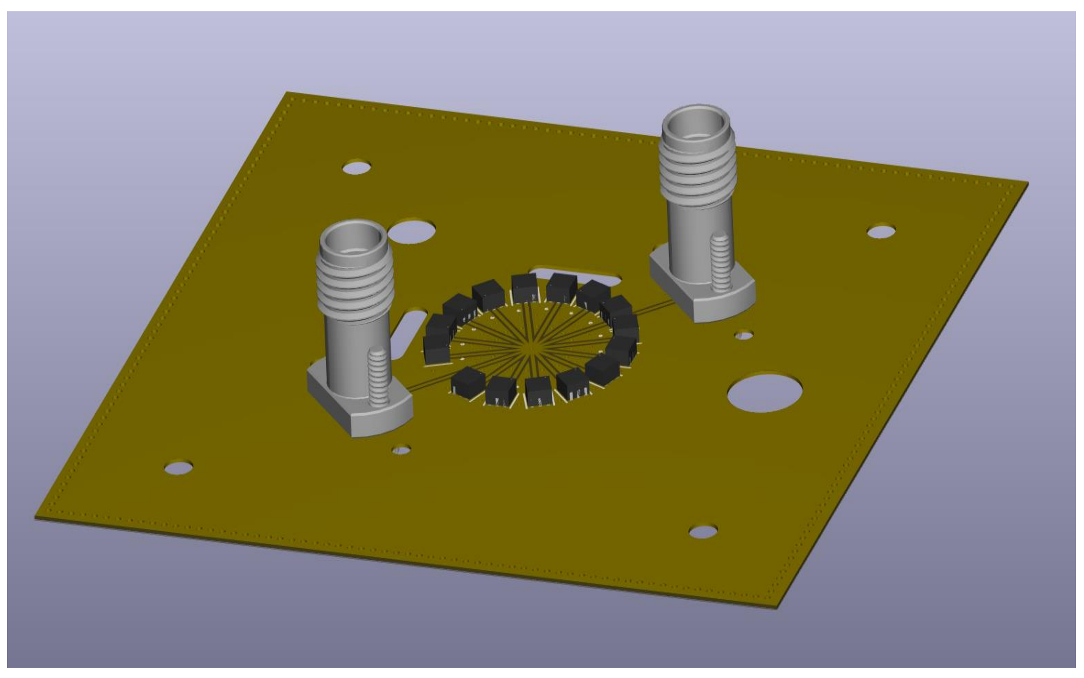
To overcome these limitations, a transmission-line current target using 16 parallel ground-referenced coplanar waveguide (GCPWG) lines was designed with terminations via 14 SMT attenuators (DC–43.5 GHz) plus two SMA connectors for target validation with VNA. CST simulations were used to optimize the design and alow direct impedance extraction seen at target middle discharge pad.

A controlled and automated CDM discharge setup was used to measure discharges with pulse widths of 35 ps to 400 ps, low ringing, and no target-induced reflections. The rise-times decrease with sample area, reaching 16.3 ps for a small sphere, with significant spectral energy above 10 GHz and beyond 15 GHz for a 5×5 mm sample. De-embedding shows increasing target impedance with minor signal impact at increasing frequencies. The concept is validated with rise-times down to ~15 ps.

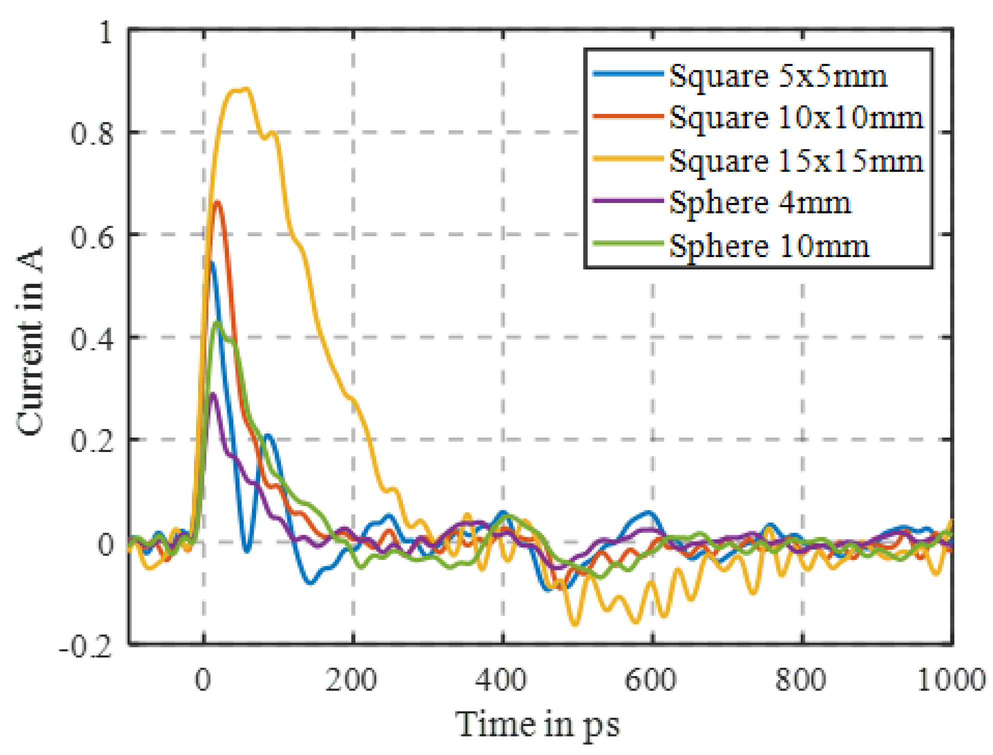
New, version of the current target with improved geometry and high frequency impedance behavior is currently being assesed, with measurements and shows even better high frequency response.



25+ GHz current target for the measurement of chiplet CDM discharges (original version)



25+ GHz current target for the measurement of chiplet CDM discharges (new, currently being evaluated version)



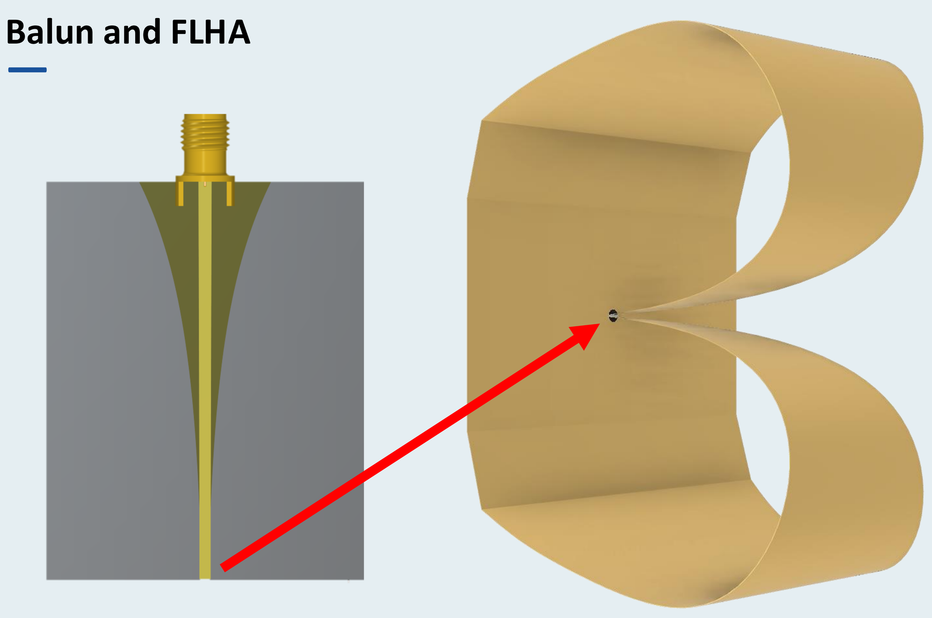
Time domain CDM measurements from the 25 GHz target

Folded Long-Hexagon Antenna

Conventional EMI setups require multiple antennas across bands. To enable single-antenna coverage, a folded long-hexagon antenna (FLHA) with an improved feed derived from a folded rhombic topology was designed for 400 MHz - 65 GHz operation.

The FLHA is constructed using a brass long-hexagon with inward-bent wings. A tapered-trace PCB balun converts the 50 Ω unbalanced 2.92 mm connector to a balanced 70 Ω output at the wing tips, improving impedance matching, preserving symmetry, and enhancing launch robustness. The balun sits in a 3D-printed holder that provides mechanical strength, allows proper cable torquing, and facilitates mounting of the antenna.

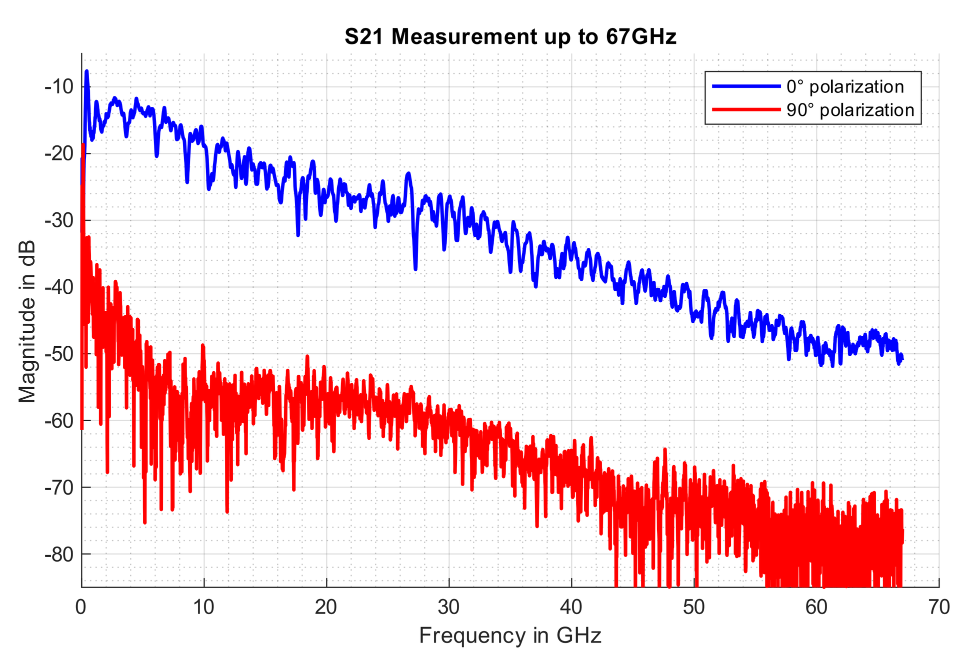
Balun and FLHA



FLHA antenna with balun

CST simulations show good correlation with measurements in the balun region. At the upper band, the antenna becomes electrically large, making full-wave simulation resource-intensive and challenging.

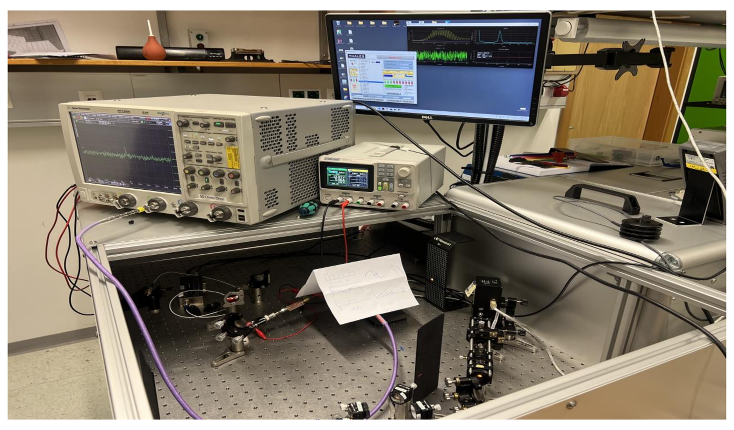
TDR measurements confirm, that the balun improves matching, yet residual reflections persist at the wing-tip transition, indicating a need for further transition optimization. Transmission measurements using two identical FLHAs at 70 cm distance show good S21 with an approximately linear roll-off at increasing frequency. When paired with the developed current target, the FLHA demonstrates a good response to CDM discharges, supporting its suitability for broadband ESD sensing.



S21 of two FLHA antennas using in plane and out of plane setups

Fast switches and CDM measurements

The goal is to create pulses with voltages of up to 500 V and rise times of 10 ps, for Charged Device Model (CDM) pulse generation using Transmission Line Pulse (TLP) methodologies. The primary objective is to assess pulse shape fidelity and repeatability, particularly in regards to rise time performance under CDM-relevant stress conditions. Several high-speed switching technologies are investigated, including HG reed switches, RF relays operated under dry conditions and with Galinstan-modified contacts. Furthermore, we are testing laser-triggered GaN-based switches and optically induced switches in air, as well as an RF power amplifier driven by an arbitrary waveform generator (investigated by EMFT). Lately nanoplasma switches have also drawn our atention and are being investigated currently. The competing solutions will be optimized, after which a decision will be made on the most suitable solution for CCTLP testing of the ESD robustness of chiplets. Picosecond-range rise-time waveforms were achieved with 67 GHz RF relays in dry conditions, which are suitable for advanced CDM emulation; however, pulse stability remains a challenge.



Optically induced switch test setup

Joint Technology Development

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Additional information

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