



FAILURE ANALYSIS INVESTIGATION. SAMPLE PREPARATION

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ACCEDE | ESCCON

2025

Seville - Spain
25 to 27th March

ALTER



ESA UNCLASSIFIED - For ESA Official Use Only



→ THE EUROPEAN SPACE AGENCY

ESA MATERIALS AND ELECTRICAL COMPONENTS LABORATORY

ASSESS WHETHER EEEE COMPONENTS ARE FIT TO FLY TO SPACE

OUR CUSTOMERS:

- ESA projects
- External companies
- FA (Failure Analysis)
- DPA (Destructive Physical Analysis)
- CA (Constructional Analysis)

OUR POLICY:

- Non-routine work
- Confidentiality
- Time critical activities
- Impartial approach
- Always according to project requirements



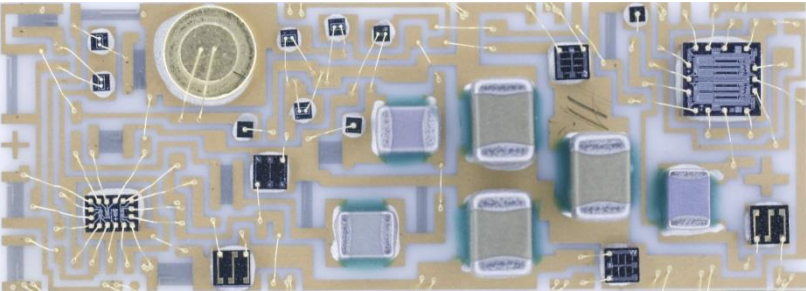
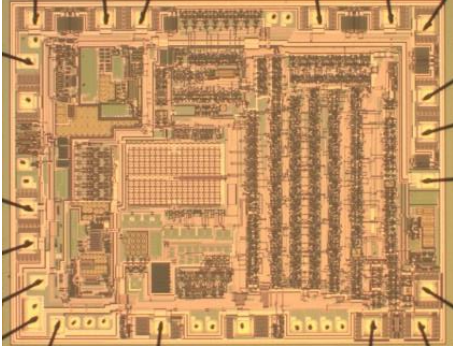
ESTEC -TEC LABORATORIES FAILURE ANALYSIS INVESTIGATION



OPTICAL MICROSCOPY

Non destructive technique used in EVI, IVI

Stereo / High magnification microscopes - Bright field, dark field, UV



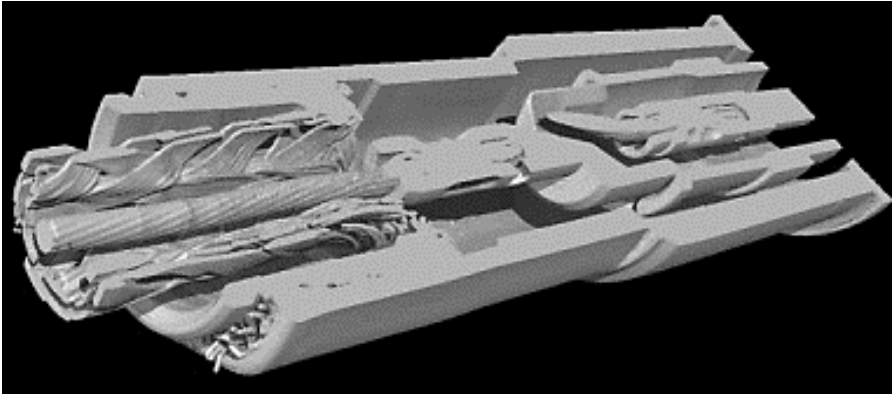
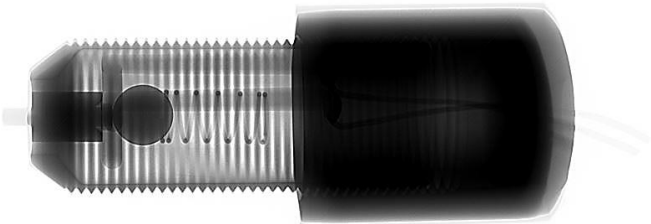
RADIOGRAPHIC INSPECTION

2D-Xray

3D-Xray: Computed Tomography (CT) scan

160KV / 300KV

4000x4000 pixel detector

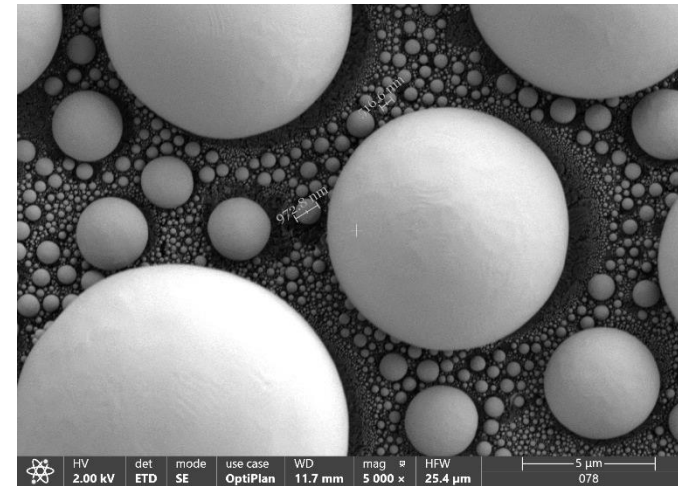
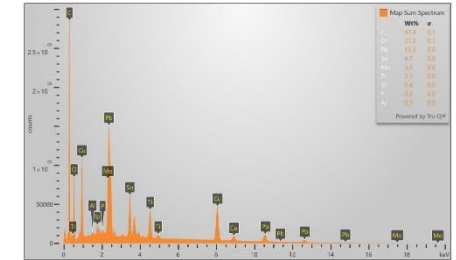
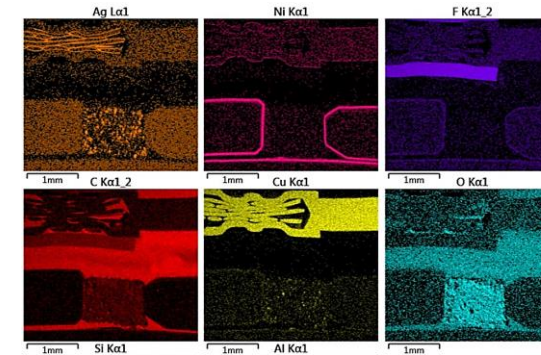


SCANNING ELECTRON MICROSCOPE (SEM). ENERGY DISPERSIVE X-RAY SPECTROSCOPY (EDX OR EDS)

Non destructive technique used in IVI

Secondary Electron Detector for high definition images, topography

Backscattered Electrons: materials discrimination

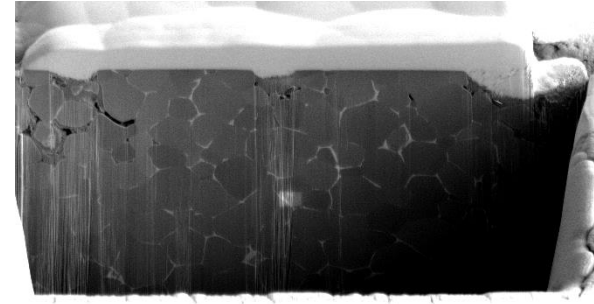


FOCUSED ION BEAM (FIB)

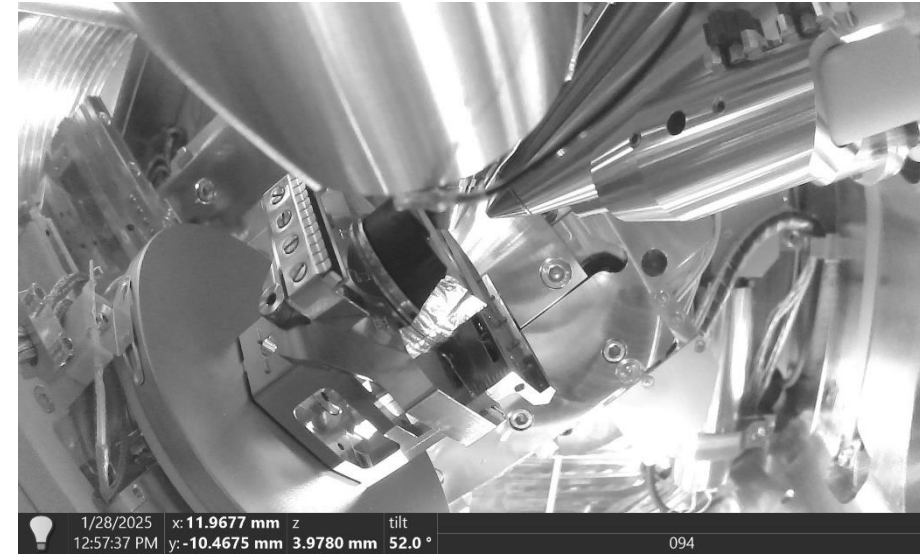
Dual beam Ga FIB, SEM and FIB on one same instrument

Fine sections, Lamella preparation

Dual beam Xe PFIB, designed for faster material removal



1/28/2025 HV curr det mode SEM Mode z img □ HPW 20 µm
2:11:38 PM 2.00 kV 0.80 nA ETD SE Field-Free 4.1178 mm 5 000 × 82.9 µm 094

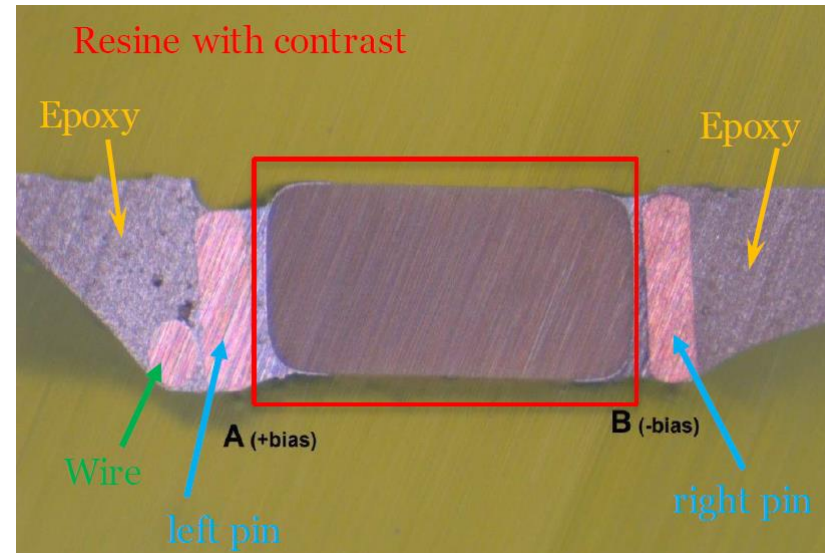
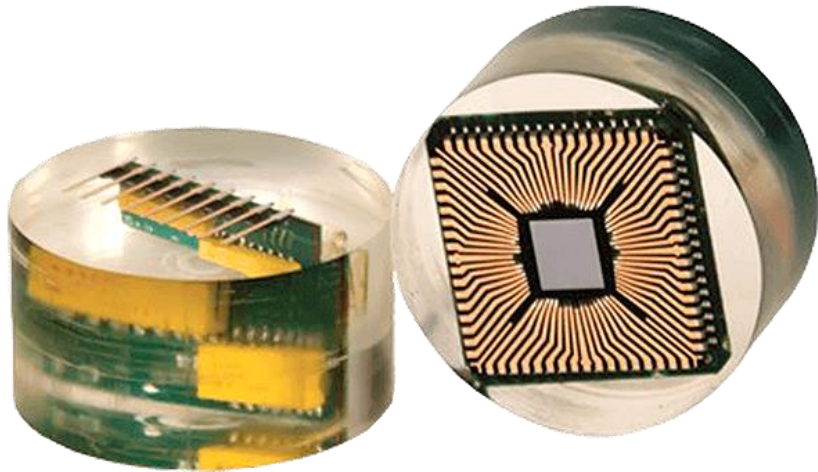


1/28/2025 x: 11.9677 mm z tilt
12:57:37 PM y: -10.4675 mm 3.9780 mm 52.0 ° 094

MICROSECTION

Sample preparation to mechanically expose a plane of interest for further analysis.

Grinding, polishing, and staining the specimen until the plane of interest is ready for inspection by optical or electron microscopy



MECHANICAL AND ENVIRONMENTAL TESTING

Mechanical, Vibration, Temperature cycling, Humidity test, Shock test

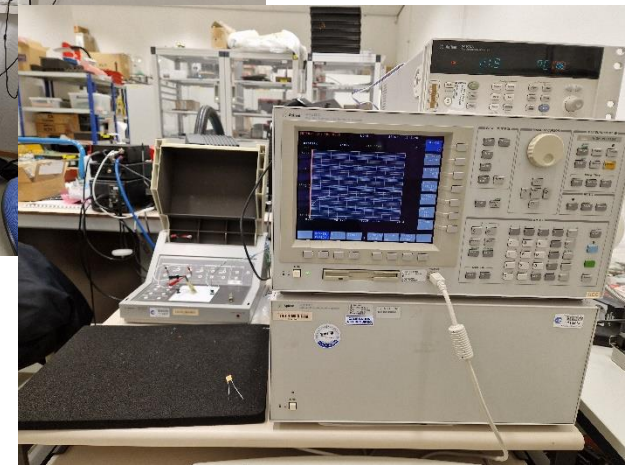
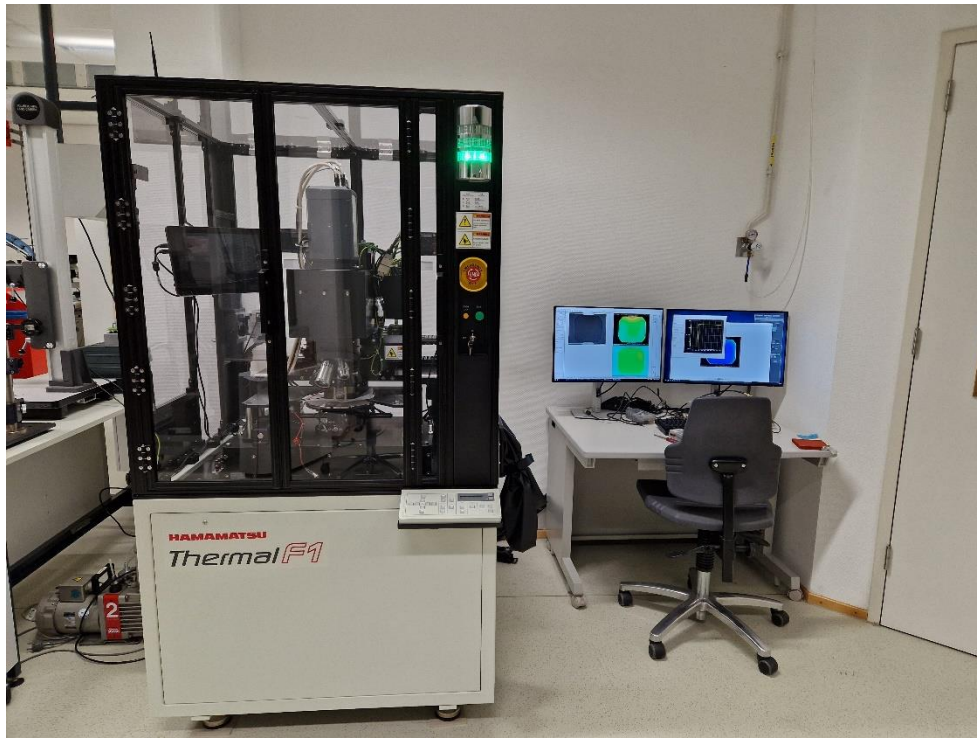


ELECTRICAL TESTING

Lock in thermography: Detects leakage current defects on the device based on heat distribution

OBIRCH: Finds anomalies at the exact location based on current variation

Characterisation and bespoke test set ups for electrical performance



ESTEC -TEC LABORATORIES SAMPLE PREPARATION AND RADIATION TESTS

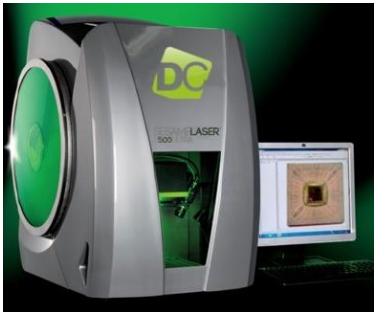


TOOLS AND TECHNIQUES FOR SAMPLE PREPARATION



Acid Wet Etching

- Partially selective etching
- Material dependant
- Coarse opening
- Works fine with Gold Bonding Wires
- Resin Mold (plastic) components only



LASER Ablation

- Allows removal of plastic material very fast
- Destructive on the die
- Plastic / Metal / Ceramic

Plasma Etching

- (Microwave Induced Oxygen Plasma)
- Slow process
- Not destructive
- Highly selective etching between plastic and metal/semiconductor
- Safe for most structures
- Plastic Only



Mechanical Milling, Grinding and Polishing

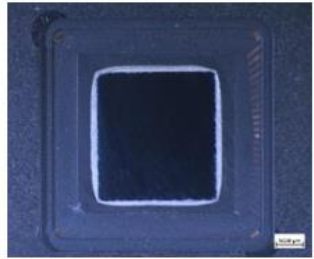
- Very high precision (μm range)
- Precise dimensions needed
- Plastic / Metal / Ceramic
- Can perform Silicon backside thinning of the die



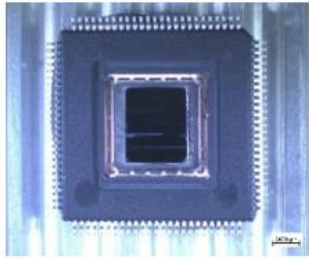
Reactive ion etching (RIE)

- (Type of plasma etch technology used in specialty semiconductors)
- Removal of material from surfaces via plasma processes.
- Wide range of materials can be etched by RIE technology (SiO_2 , Si_3N_4 , Si, A Si, poly-Si)
- Metals (Al, Cr, Ti), III-V materials (GaAs, InP, GaN)

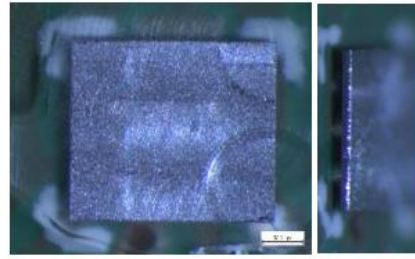
EXAMPLES OF SAMPLE PREPARATION



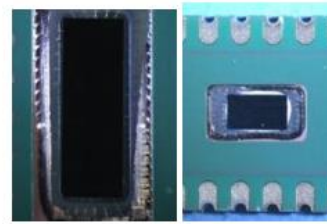
PIC24FJ256GA110



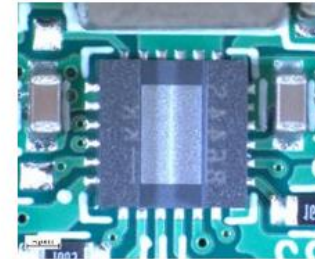
STM32F427VIT6TR



MAX20313



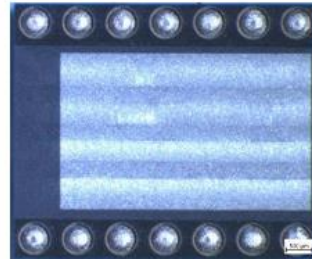
PWM, Vclamp and PoL



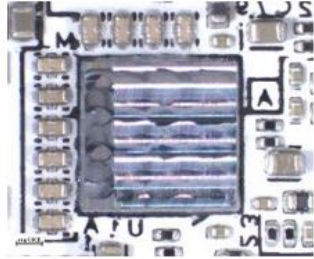
LT8644



ADC3683



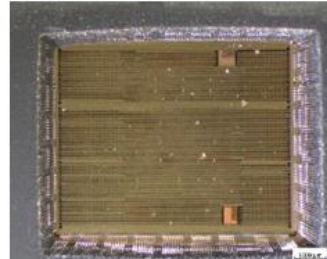
IDQ20MC



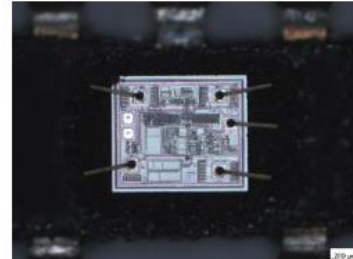
Coral Edge TPU



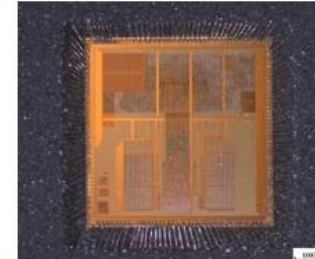
PICO 5AV100



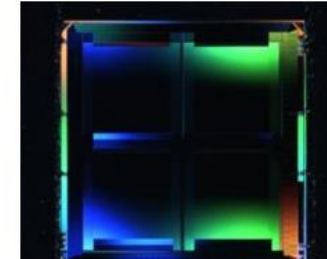
HIMA-HICore2



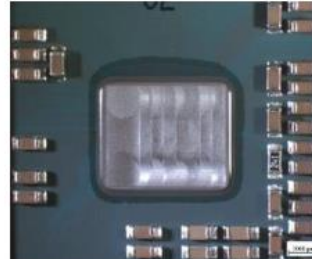
MAX823



LPC2294HBD144



MR25H40MDF



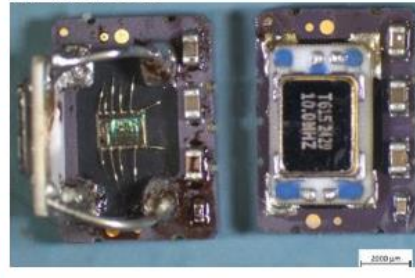
D65-XX-LGA635-1224



IS46TR1625



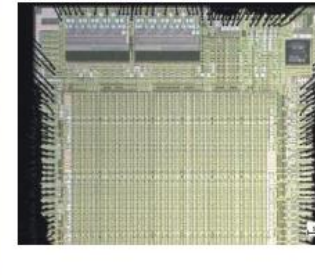
NT1068-23



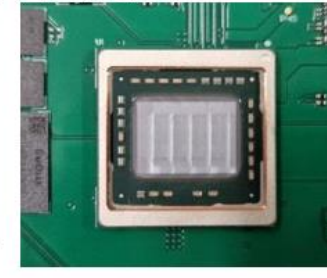
TCXO T615-010-0M



Myriad-X and LPDDR4



FPGA



TE0950 AMD Versal VE2302



AMD Versal SoC TE0950

Overall yield rate in 2024 of around 90%

Contact us if you have interesting and challenging components for preparation: Co60.Facility.ESTEC@esa.int

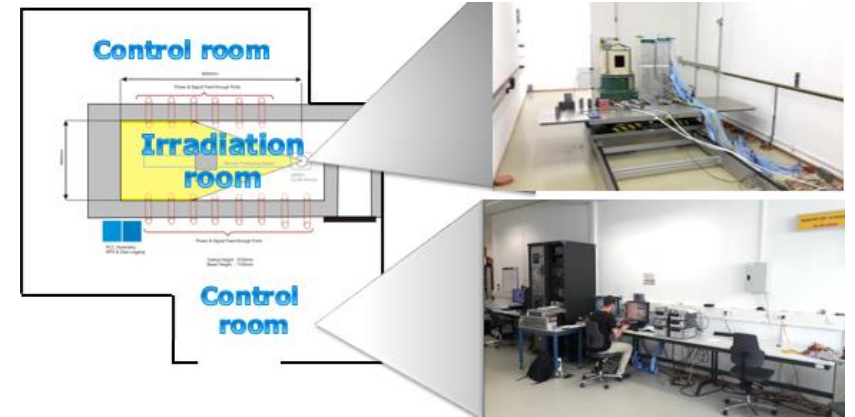
ESTEC-TEC. RADIATION TESTS OVERVIEW

Co60 Facility

80 TBq Co60 source for Total Ionising Dose tests

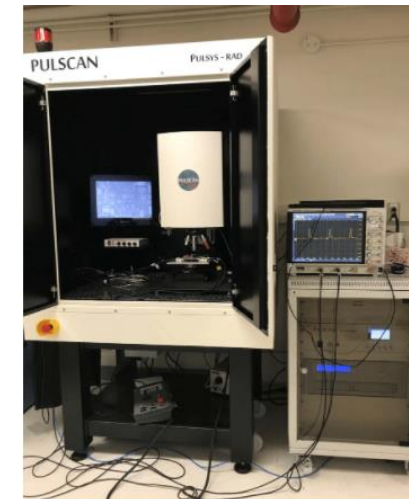
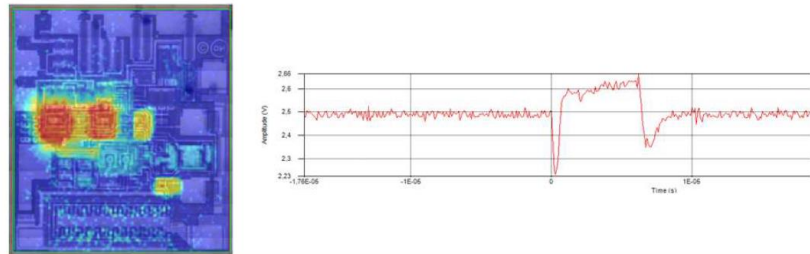
Dose rate window compliant with the ESCC22900 standard
(from 0.01 rad/s [Si] to 3rad[Si]/s)

ISO17025 accredited dosimetry



Single and Two Photon Absorption Laser (SPA/TPA)

Single and Two Photon Absorption Laser System for SEE qualitative investigations



INFO AND CONTACTS

Materials & Electrical Components Laboratory

<https://technology.esa.int/lab/materials-electrical-components-laboratory>

Third Parties Activities (external requests of services at ESTEC TEC-Laboratories)

<https://tpa.esa.int/>

Contacts for Radiation tests and Components analysis :

Sample preparation and components analysis:

EEElabs@esa.int

TID tests: Co60.Facility.ESTEC@esa.int

ESA Website for Radiation Test data

<https://esarad.esa.int/>

Which EEE components would you like to see in the ESA Radiation Test Database?

[Pilot survey \(link\)](#) Please submit your inputs here:

<https://forms.office.com/e/hV6sytgsTu>

The requests shall remain confidential with ESA and test data from selected components will be shared on esarad.esa.int

ESA Radiation Test Database

This database contains radiation test reports of tests (SEE TID DO) performed on EEE components by ESA or by European partners under ESA contracts and/or other relevant works pertaining radiation effects.

This part of the esarad database is public and open to the industry, with the aim of sharing data within the radiation effects on EEE components community. For this reason, no login credentials are needed to access the reports in <https://esarad.esa.int/>.

Due to its public nature, this open section of ESA RAD Database does not contain any confidential report. Any user can be a contributor to the database: to contribute to the database please send them to this e-mail address. Their publication will be subjected to ESA-TEC-QEC approval.

Note: when sending a report, the user should specify in their email whether the document is FOR PUBLIC USE or ESA INTERNAL ONLY. If the former is chosen, the report will be available internally on the ESA Intranet but not on the public website. Oppositely, the latter option will make the report publicly available.

For any further info or enquiry please email esarad@esa.int

ESAT part type	ESAT Manufacturer user	Report File	Radiation Test Type	Radiation Test Method	SPPL Facility	SPPL Group	Function	Hardware ID	Report Source	Report Date
WSP010GAA	Windand	Download	TID (Over-irradiation)	Non specified	0	28 INDIAPY-07405	CMOS	Micro-Amp	Micro-Amp	20/10/2022
TC8M050007A0	Teledyne	Download	TID (Over-irradiation)	Non specified	0	28 INDIAPY-07405	128 Pin memory	Micro-Amp	Micro-Amp	20/10/2022
RT006	Infineon	Download	ESD (Single Event Effects)	Non specified	0	28 INDIAPY-07405	128 Pin memory	Micro-Amp	Micro-Amp	20/10/2022
IM441801000	Exxon	Download	ESD (Single Event Effects)	Non specified	0	28 INDIAPY-07405	128 Pin memory	Micro-Amp	Micro-Amp	20/10/2022
IM4400	Teledyne	Download	TID (Over-irradiation)	Non specified	0	28 INDIAPY-07405	128 Pin memory	Micro-Amp	Micro-Amp	20/10/2022
LM4400	Teledyne	Download	TID (Over-irradiation)	Non specified	0	28 INDIAPY-07405	128 Pin memory	Micro-Amp	Micro-Amp	20/10/2022
LM4401	Teledyne	Download	TID (Over-irradiation)	Non specified	0	28 INDIAPY-07405	128 Pin memory	Micro-Amp	Micro-Amp	20/10/2022

Produced by

THANK YOU!

