Reliability issues of photonic components for space applications

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OBJECTIVE

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To become a single solution provider for all parts selection, design, procurement, testing and validation activities

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HIREX ENGINEERING

optocap

- Requirements Definition
- Parts selection

- Procurement
- Design
- Packaging

- Test bench development
- Reliability Testing
- Failure Analysis

ESA QUALIFIED PARTS LIST

Last edition: January 2017

https://escies.org/download/webDocumentFile?id=64928

Section 18 **Component Type: Optoelectronics**

Sub-Section	Page No.	Cert.	Type Designation	Manufacturer
			Currently there are no qualified sources of Optoelectronics	

Parts Selection rules for Space applications
Case Study: SOLAR ORBITER

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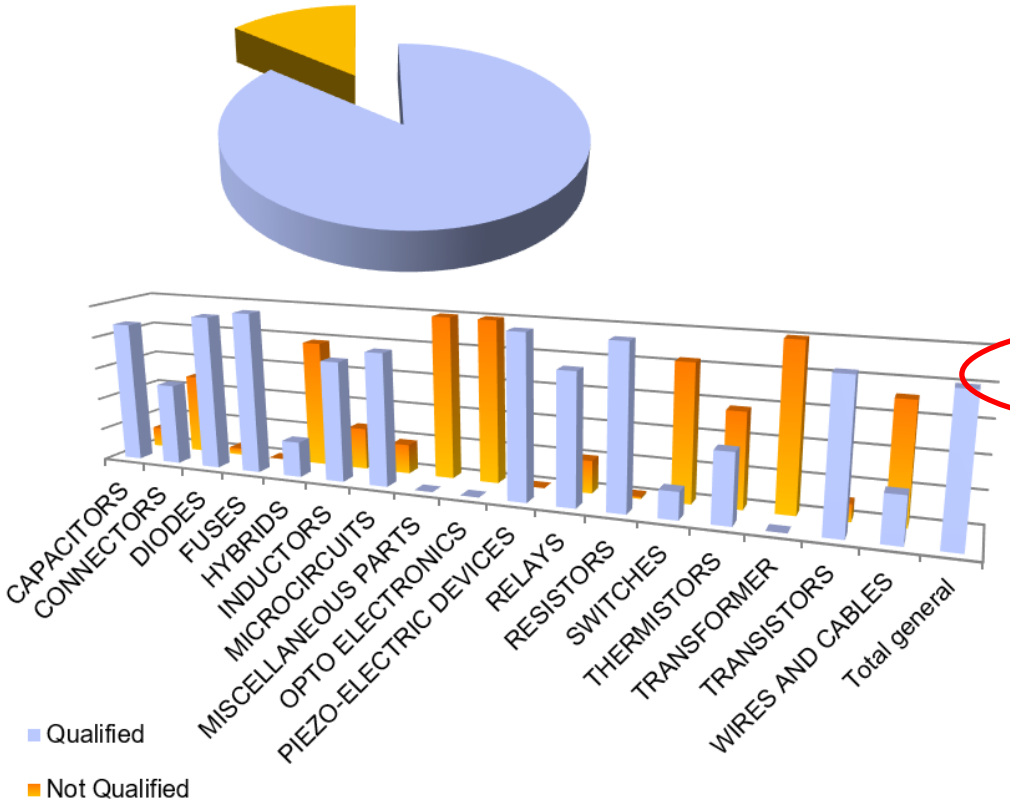
- **3769 line items procured for FM**

Qualified	Not Qualified
86.26%	13.74%



STATISTIC

	ESCC	MIL	NOT QUALIFIED
CAPACITORS	391	197	83
CONNECTORS	123	2	123
DIODES	76	131	9
FUSES	1		
HYBRIDS		16	57
INDUCTORS	50	2	18
MICROCIRCUITS	39	358	88
MISCELLANEOUS PARTS			2
OPTO ELECTRONICS			29
PIEZO-ELECTRIC DEVICES	3		
RELAYS	4		1
RESISTORS	859	796	21
SWITCHES		1	5
THERMISTORS	12	2	19
TRANSFORMER			14
TRANSISTORS	107	70	21
WIRES AND CABLES	11		28
Total	1676	1575	518

Parts Selection for Space Applications
Step by step approach for optoelectronics parts

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01	Specification performance requirements
02	Definition of environmental constrains
03	Survey of available commercial candidates
04	Parts Engineering
05	Parts Procurement
06	New Packaging (As needed)
07	Pre-evaluation test
08	Screening
09	Evaluation
10	LOT readiness

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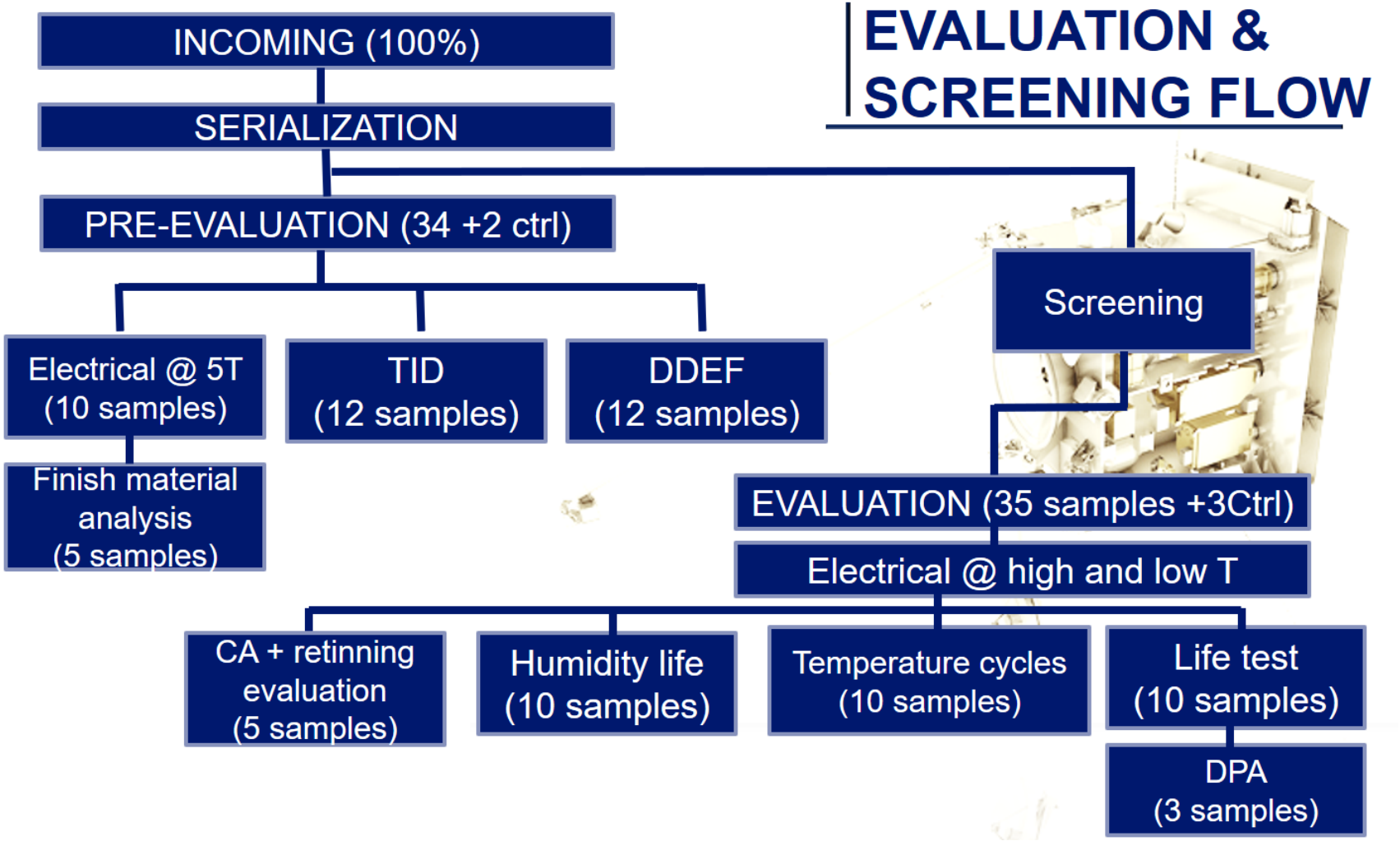
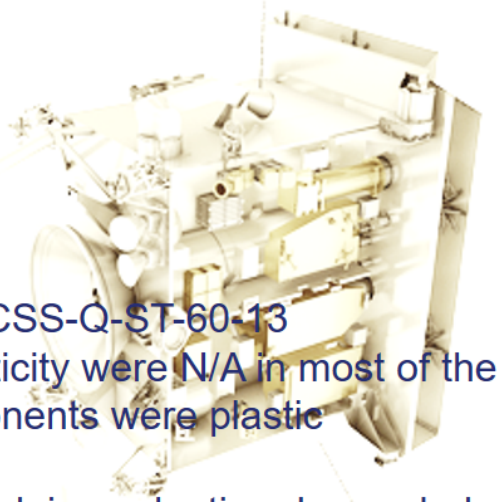
EVALUATION & SCREENING FLOW



SCREENING (100%)

- Retinning
- X-Ray
- Temperature cycling
- Electrical @ RT
- Burn-in
- Electrical @ RT, HT and LT
- PDA calculation
- External Visual Inspection

EVALUATION and SCREENING FLOW



- Flow based on ECSS-Q-ST-60-13
- PIND and Hermeticity were N/A in most of the cases (the components were plastic encapsulated)
- Vibration and shock in evaluation demanded at assembly level (due to exotic packages and assembly techniques)
- Outgassing was also part of evaluation when the plastic compound figure was unknown
- Whenever no Single wafer lot was assured then TID and Life test sampling was increased by 40%

Additional Challenges

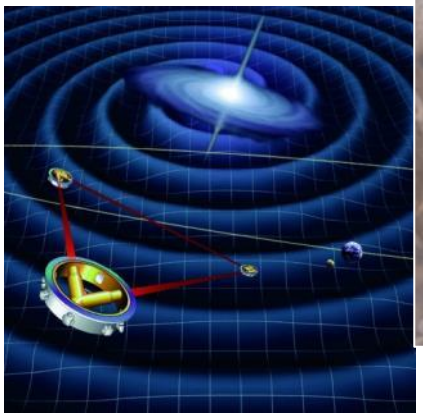
Constellations

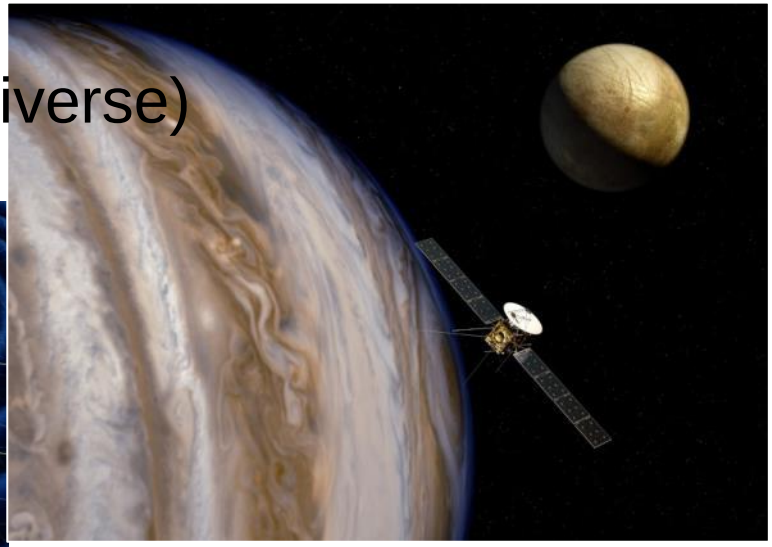
Extreme environments:

JUICE (JUpiter ICy moons Explorer)

EUCLID (Geometry of the dark Universe)

LISA (Gravitation waves)





Additional Challenges

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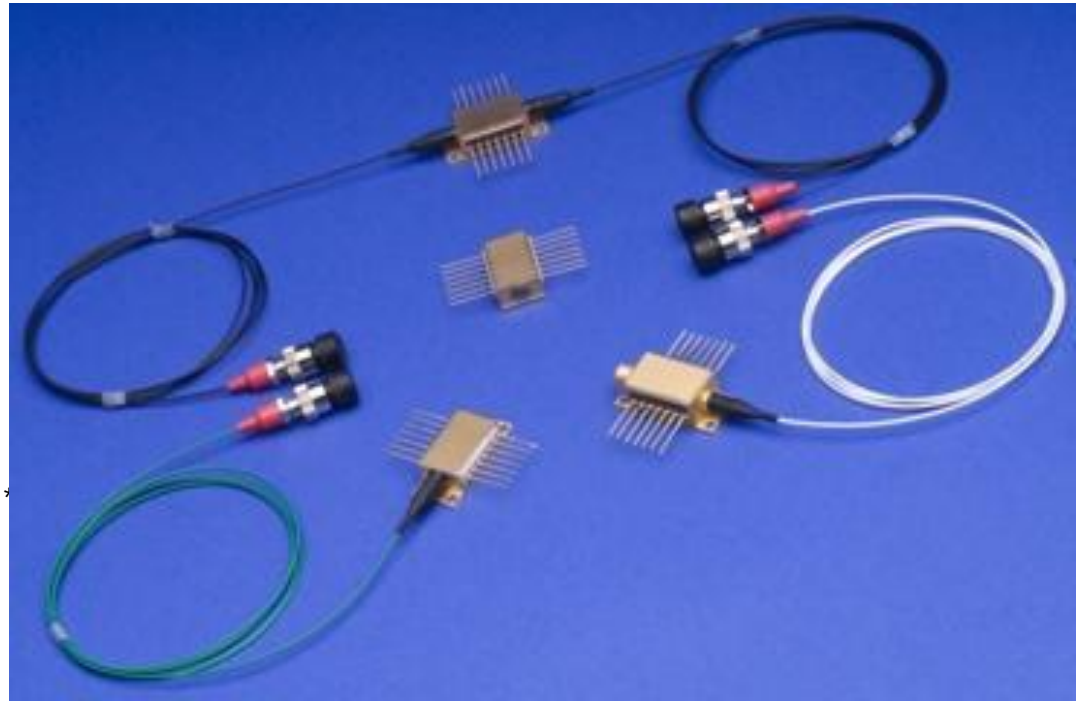
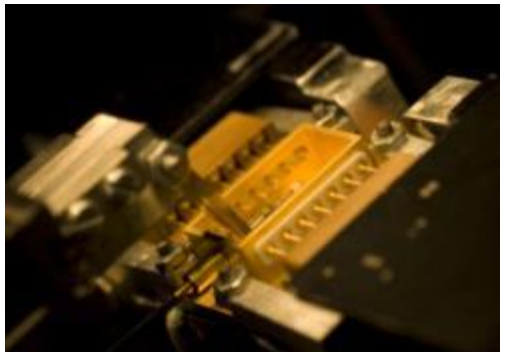
Custom package for space application

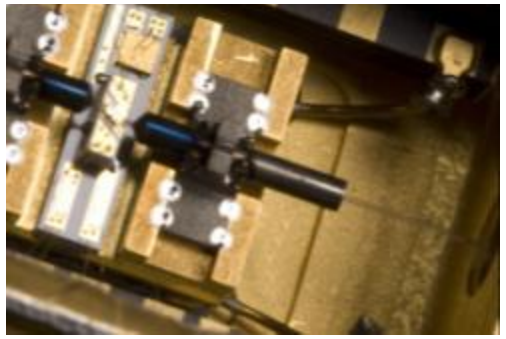
optocap
A company of ALTER TECHNOLOGY GROUP



Fibre Align of High reliability fibre ⇒



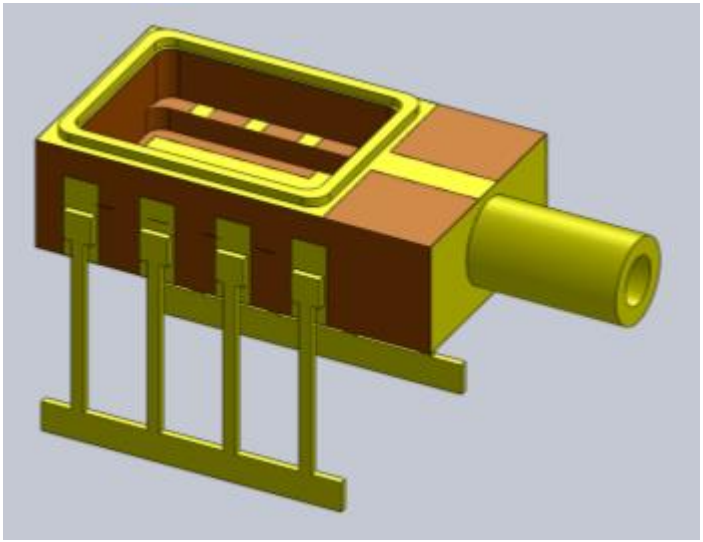
Dual fibres laser welded in position ⇒



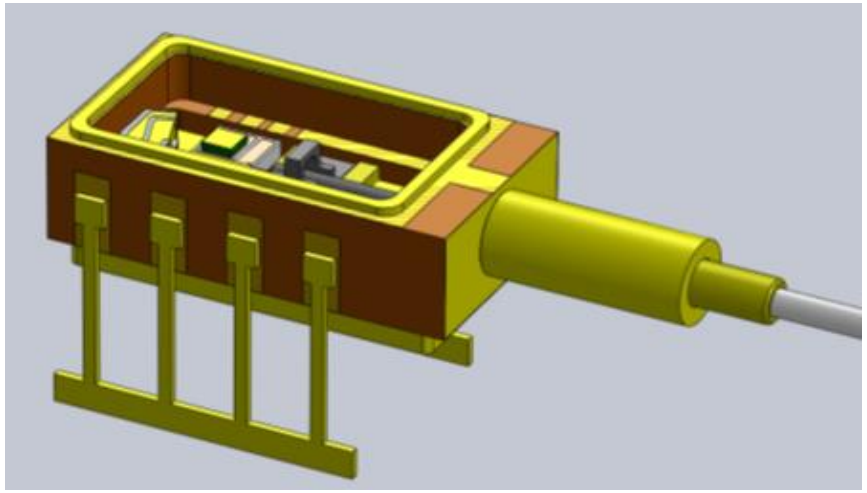
Above: Butterfly Package Options
Single & Dual Fibres, Window & RF connections

Additional Challenges

Space Qualifiable* MiniDIL Module



Standard Ceramic miniDIL Package: Off the shelf option



Modified Ceramic miniDIL Package: Same footprint in x, y dimensions.
Integrating key features of Optocap's 14 pin butterfly package, such as laser welded fibre alignment. No TEC included.

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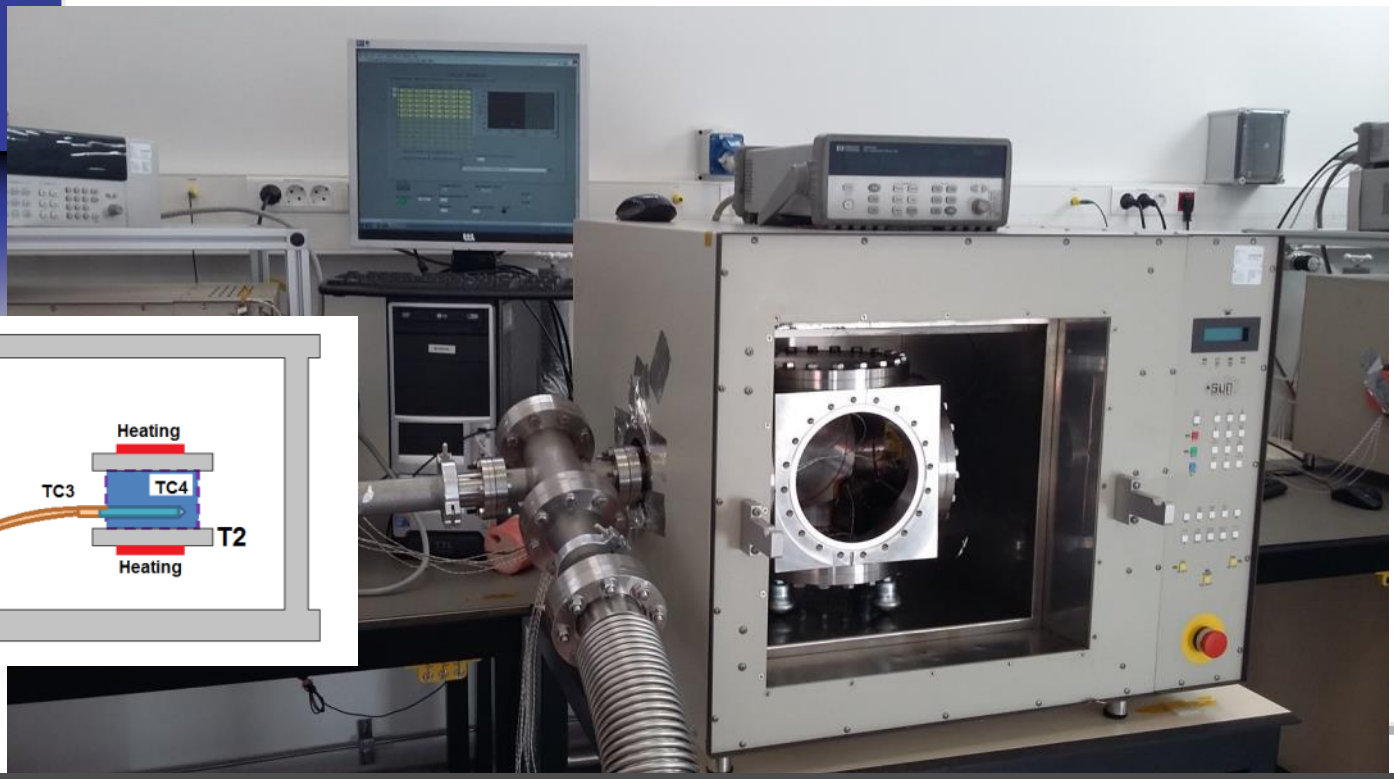
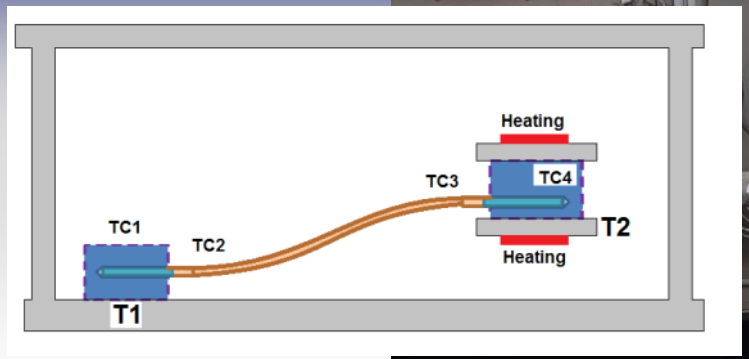
Image Sensor Thermal Strap Characterization

Thermal Vacuum setups

Thermal Vacuum and characterization at liquid nitrogen temp range

- **Image sensor dissipation straps**
- **Vacuum tests from -180ºC to more than 200ºC.**





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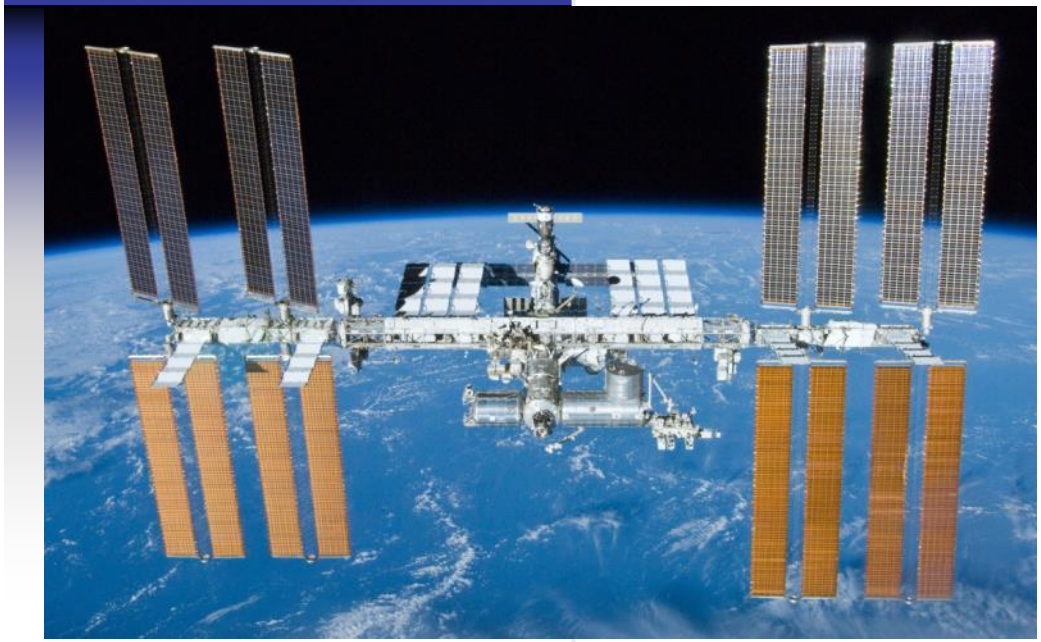
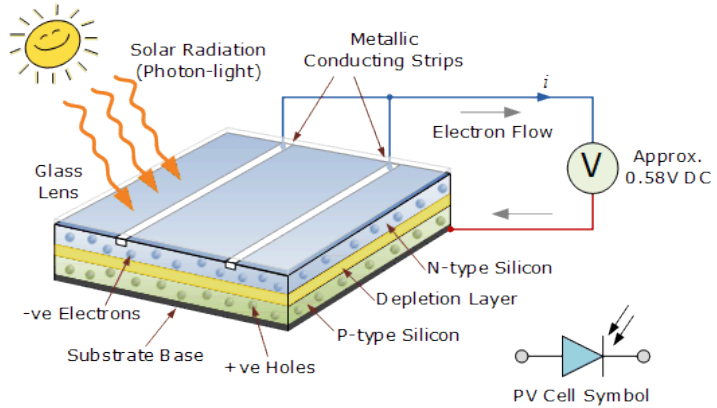
Thermal Vacuum test on Solar Cells

Thermal Vacuum Solar Cells

Thermal Vacuum and characterization at liquid nitrogen temp range

- **Small Vacuum Chambers for faster thermal vacuum chambers**
- **Cu sealing for wider temp range**





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Combined Radiation Gamma and Low Energy Proton Test

- Low Energy Proton Effects

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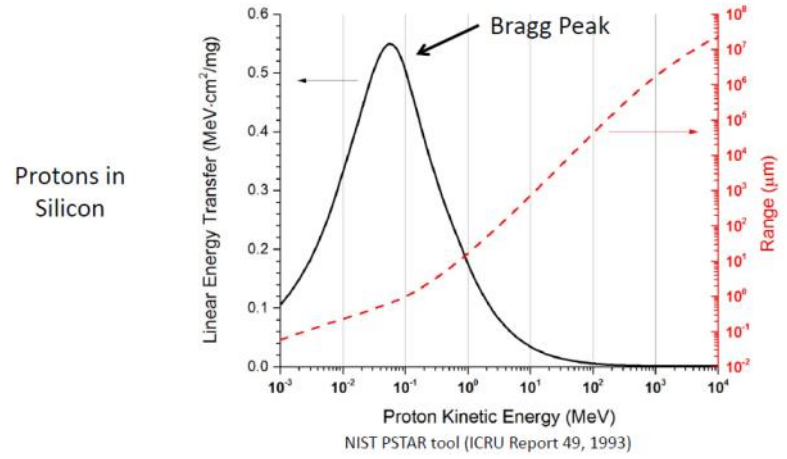
Evaluation of Low-Energy Proton Sensitivity



- Only protons near the Bragg Peak can cause SEUs
  - Protons (and other ions) near end-of-range behave erratically

v5

To be presented by J. Pellish at the 2012 Microelectronics Reliability & Qualification Workshop (MRQW), 11-12/Dec/2012 in Los Angeles, CA and published on https://nepp.nasa.gov/

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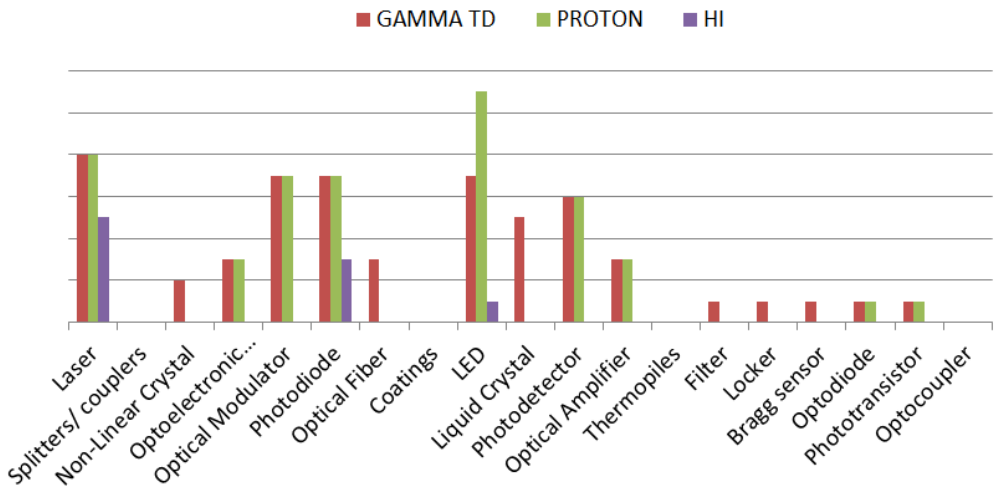
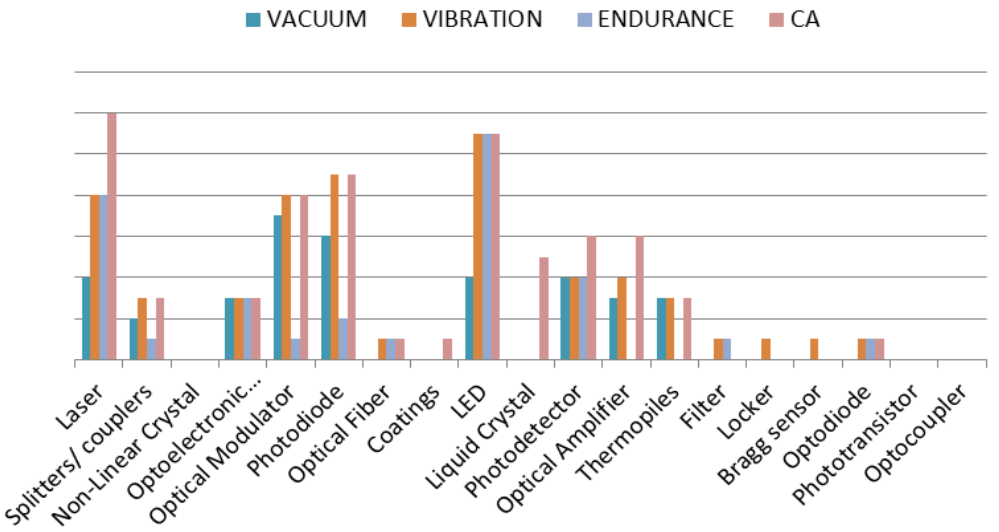
Jonathan Pellish
One of the CONCLUSIONS:
CMOS nodes at and below 90nm have been identified as sensitive to low-energy proton direct ionization

https://nepp.nasa.gov/workshops/etw2014/talks/Thur/1430a%20-%202014-561-Pellish-Final-Pres-Web-ETW-CMOS-TN16640.pdf

ATN EXPERIENCE IN OPTOELECTRONICS

ALTER TECHNOLOGY has gathered a large experience and knowhow in optical and reliability testing on photonics parts covering the full range of different technologies.





Range of optoelectronics and photonics parts:

- Laser & Leds 250 to 5000 nm.
- Receivers modules (180 to 11000 nm).
- Optical Amplifiers & Optical modulators
- Switches and splitters.
- Optocouplers & Photodiodes
- Multimode and monomode Fibers
- Liquid Crystal Devices
- Image Sensors
- Optical Transceivers

Gracias por su atención

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