Space of The Shelf…

DEFENCE AND SPACE

Renaud MANGERET – TOPEE1 EEE and radiation engineering
9th of March, 2021

AIRBUS

Outline

Introduction

Missions & customers – Airbus Space Systems

“COTS”

Radiation effects on electronics

Radiation testing

Conclusion

Introduction

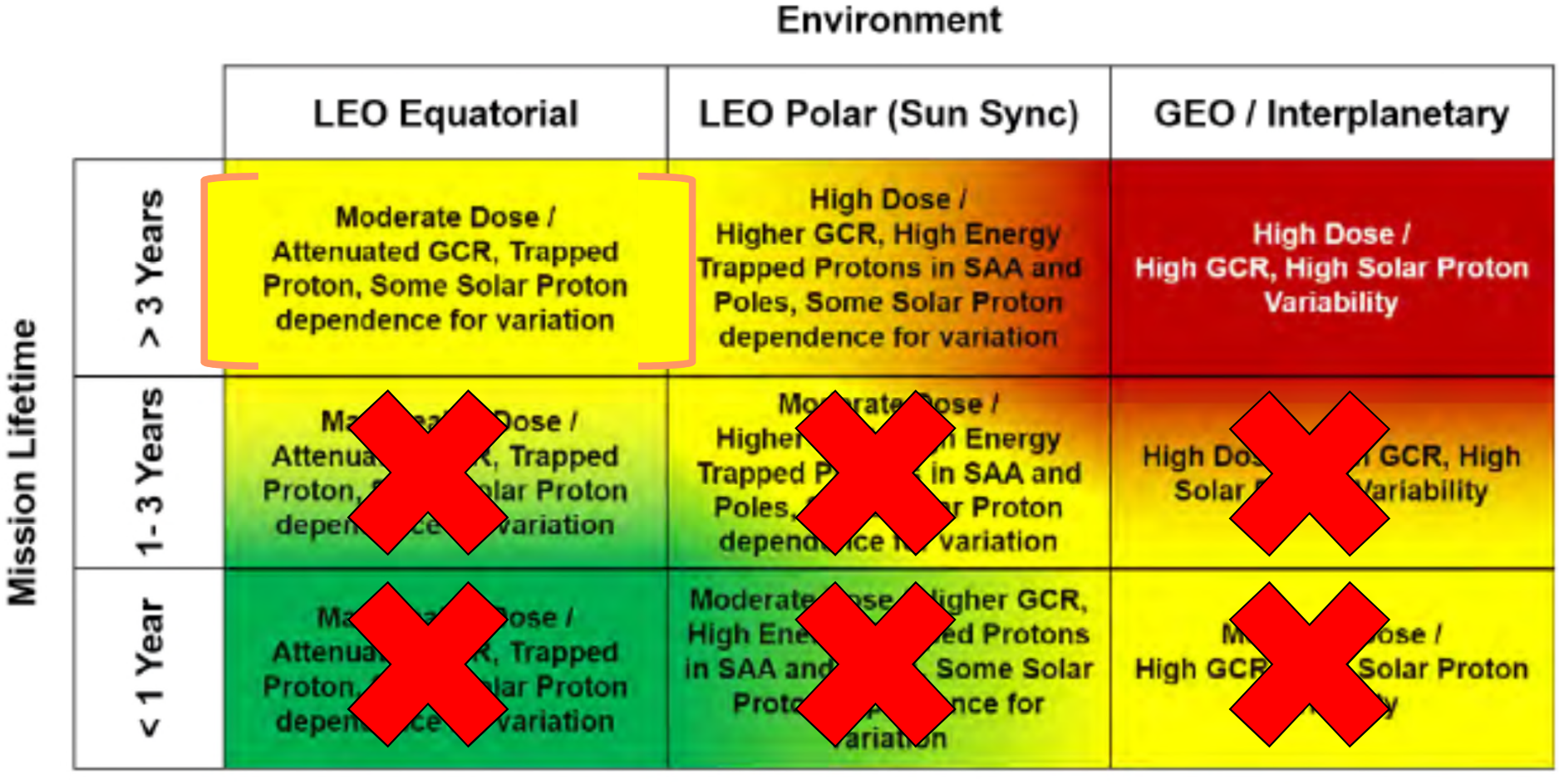
"There is no space system in which radiation effects can be neglected"

This remains valid for « new space », whatever it means
This remains valid for "COTS", whatever it means

How to maintain/improve industrial competitiveness, without jeopardizing the reliability / availability of a "new space" product?

⇒ Impact on the Radiation Hardness Assurance process in general and radiation testing in particular ?

Missions



After M. Campola / J. Pellish - RADECS short course, 2019

AIRBUS

Some customers

OneWeb Satellites

Orbital ATK

SES

RFP SES-01/09

Schedule D
Product Assurance Plan

SES

ESA UNCLASSIFIED – For Official Use

esa estec

European Space Research and Technology Centre
Keplerlaan 1
2201 AZ Noordwijk
The Netherlands
T +31 (0)71 565 6565
F +31 (0)71 565 6040
www.esa.int

DOCUMENT

JUICE Environmental Specification

INM-CO/10-xxxx/TS

nmarsat

telenor

TELENOR SATELLITE BROADCASTING AS

eutelsat
communications via satellite

ThalesAlenia Space
A Thales / Finmeccanica Company

cnes

Direction du Centre de Toulouse
Sous-direction Assurance Qualité
Service Qualité Projets systèmes orbitaux

IASI NG

PIASI-AQ-1100-0069-CNES

НПО ПМ

RSCC

NEC

Payload Module General, Design and Interface Requirements. Attachment C

AIRBUS

Component Off The Shelf

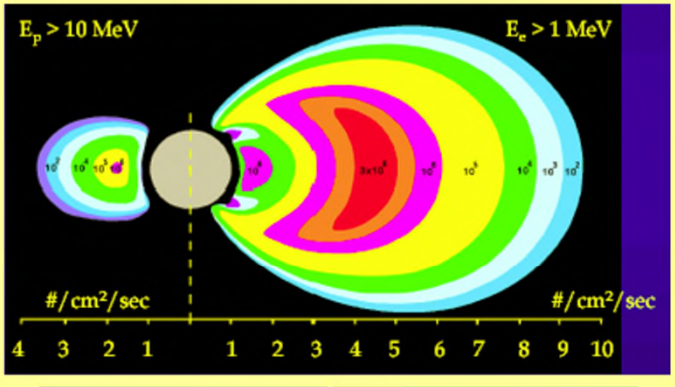
COTS – a definition (as per SAE standard AS6294™/1)

Commercial-off-the-shelf (COTS) part is a part designed primarily for commercial applications for which the item manufacturer solely establishes and controls the specifications for performance, configuration and reliability, including design, materials, processes, testing and physical/failure analysis without communicating additional or custom requirements imposed by users.

In general, difficult to get traceability information

Radiation effects on electronics w.r.t. space radiation environment

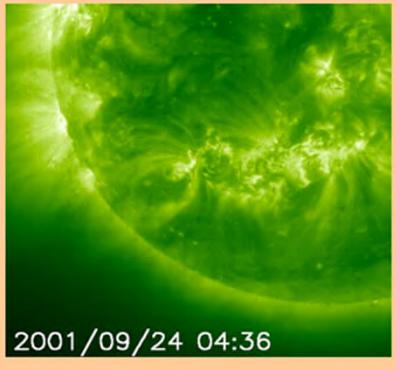
Radiation belts



Protons | **Electrons**

keV- 500 MeV | eV ~ 10 MeV

Solar Particle Event



Protons | **Ions**

keV- 500 MeV | few 1-10 MeV/n

Cosmic rays

Ions

max ~ 300 MeV/n

Total Ionising Dose (TID)

Displacement Damage (DD)

Single Event Effects (SEE)

After R. Ecoffet – RADECS 2013 short course

AIRBUS

Radiation testing - welcome to “new space”

Complexity/advanced technologies of COTS devices (compared to Hirel)
⇒ exhaustive radiation testing is not anymore a possibility
⇒ Analysis of test results is also pretty complex, and failure mechanisms are sometimes quite difficult to understand/characterize (e.g. SEFI)

SEE testing: the burden starts with device preparation

System-level testing should not be seen as a low-cost tool capable of achieving the same goals as the component-level characterization. Rather, system-level testing should be seen as a way to provide RHA for those systems that would otherwise not go through any level of radiation tolerance verification.

Radiation testing – test at board / system level

- **A “good bad” idea?**
  - TID/DD: Does not allow Worst Case Analysis (WCA) elaboration (parts’ parameter drift not known)
    - Including temperature consideration (radiation test performed at ambient T°)
  - If the function is not operating, time of investigations in series with new tests.
  - COTS board: traceability
  - Testing shall cover the various radiation effects with the proper radiation source
    - Single proton test for TID, DD and SEE: ELDRS and destructive SEE issues
  - Some drifts not result in immediate malfunction/failure but may impair adjacent part reliability
  - If RLAT is required (RDM below 2), requires a requalification at board level.
  - Statistics? How many boards/modules to test?
  - Allow to test in real application conditions, which are known late

Conclusion

At Airbus, COTS usage is a fact, for years, and these COTS are following standard RHA requirements

“New space” tolerates more risks: “more”?

Ownership cost: certainly less if everything runs well. If not…

Radiation testing @ system level: not a generic solution ; could be usable for specific cases/environment/products

Optimization/generalization of COTS usage is definitely a challenge however one cannot expect **magic** solution like : take it, do nothing and fly it, it will work.

Thank you