




Reliability needs in Aerospace industry

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NEXUS meeting - STRESA, 25th April 2006

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Outline

- ☞ *Introduction : Space environment overview*
- ☞ *Space constraints*
- ☞ *MEMS Reliability status*
- ☞ *Where to go ...*
- ☞ *Conclusion*

2

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Space Environment overview

☞ Temperature

- *Highly depending of equipment :*
 - ♦ *from -40 °C up to +80 °C for equipment inside satellite*
 - ♦ *from -100 °C up to +100 °C for specific equipment*
- *For EEE components : must be usable in the military range : -55 °C up to +125 °C*

☞ Vacuum

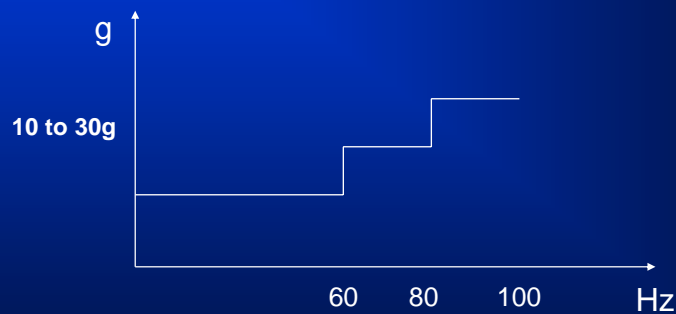
- *from 10^{-7} up to 10^{-10} Torr depending of the orbital position*
- *Out gazing concern !*

3

Space environment overview

☞ Vibrations (1/2)

- *During the launch (some minutes)*
- *Depending of the launcher (shape)*

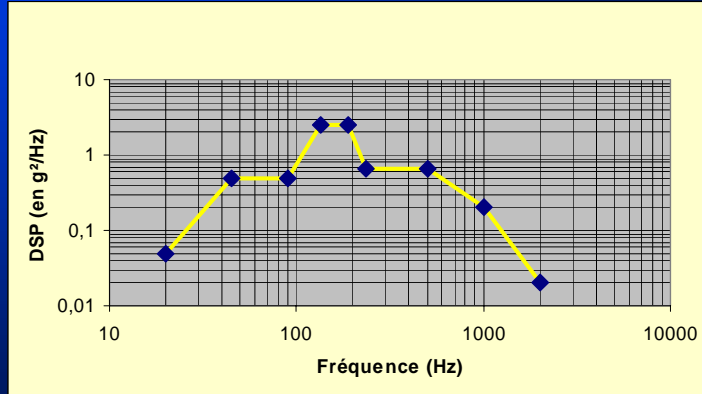


Vibration level example (sine)

4

Space environment overview

Vibrations (2/2)



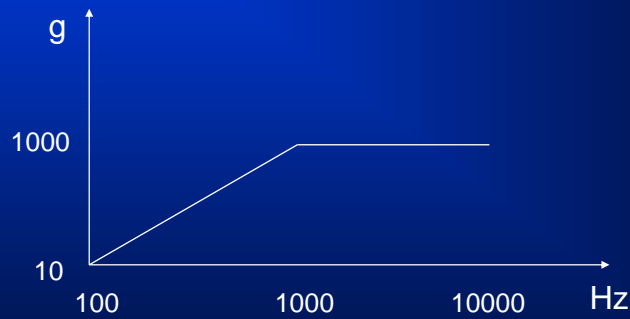
Random vibration example

5

Space environment overview

Chocks

- Due to pyro events (after the launch in the preparation phase)



Chock level example

6

Space environment overview

☞ Radiations

- For materials used in MEMS
 - ◆ Total dose ionization : from 0 up to some 100 Krad
- For electronic components
 - ◆ Total dose
 - ◆ latch up
 - ◆ Single Event upset

7

Space constraints (non exhaustive)

☞ Storage

- Some years at ground

☞ Effective life

- from 1 up to 15 years in orbit

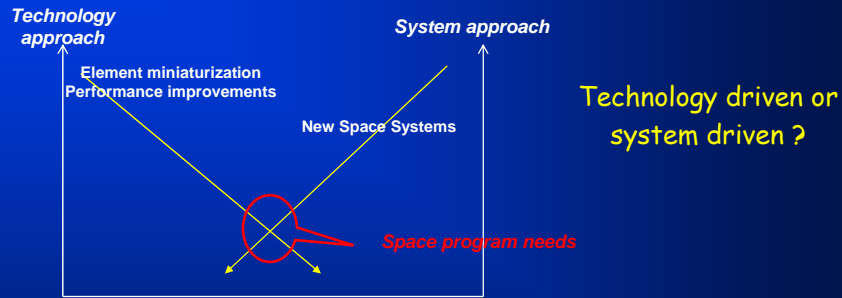
☞ New technologies introduction

- Non technical constraints
 - ◆ Space segment cost is less than 20% of the total system cost...
 - ◆ Assurance concern (proven technology versus new technology dilemma)

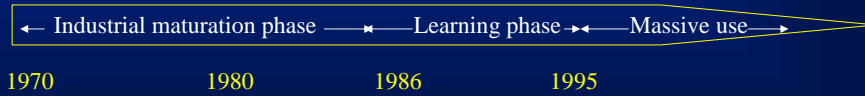
8

New technology introduction

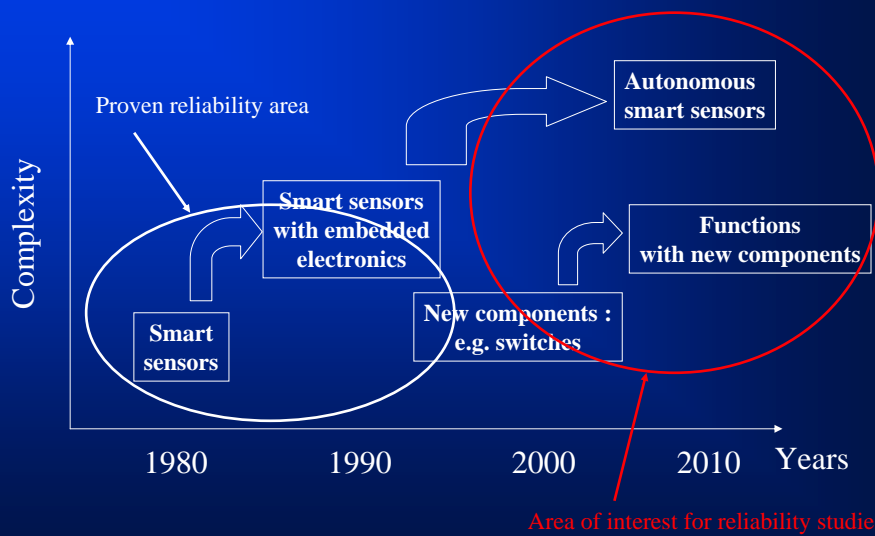
Enhancement of space systems



Introduction of new technologies: example of ASIC



MEMS reliability status



MEMS reliability status

- ☞ Reliability proven area : sensors, smart sensors, ...
 - High volume production (ADXL accelerometers)
 - More than 20 years experience (sensors)
 - Stabilized function, simple process (homogenous)

↪ Standard qualification plan

- ☞ Others areas
 - New concepts
 - Convergence between different physical domains
 - Low volume production
 - Unstabilized processes (process changes occur very often)



- process evaluation
- product evaluation
- additional screening and qualification

11

Where to go ?

- ☞ Design
 - Mandatory to propose new ideas to space community
 - But do not mismatch concept and final product !
- ☞ Reliability and test
 - The goal is to achieve the level of confidence obtained in EEE components
 - Mandatory to perform phases described in previous slide
- ☞ Blocking points
 - Technologies, except for standard products, are not mature
 - Reliability figures generally presented has a limited interest due to technology weaknesses...
 - Volume production for space community...

12

Conclusion

- ☞ 3 steps to use mid/high TRL in space systems:
 - process evaluation
 - product evaluation
 - product qualification
- ☞ Domain to explore and role of space players
 - Design : space will be follower
 - Reliability and test : space could be associated
 - Technology development : limited support from space users (included agencies)... space community could be a catalyzer.
- ☞ 2 main parameters:
 - volume production (high/low)
 - level of process control at foundry site