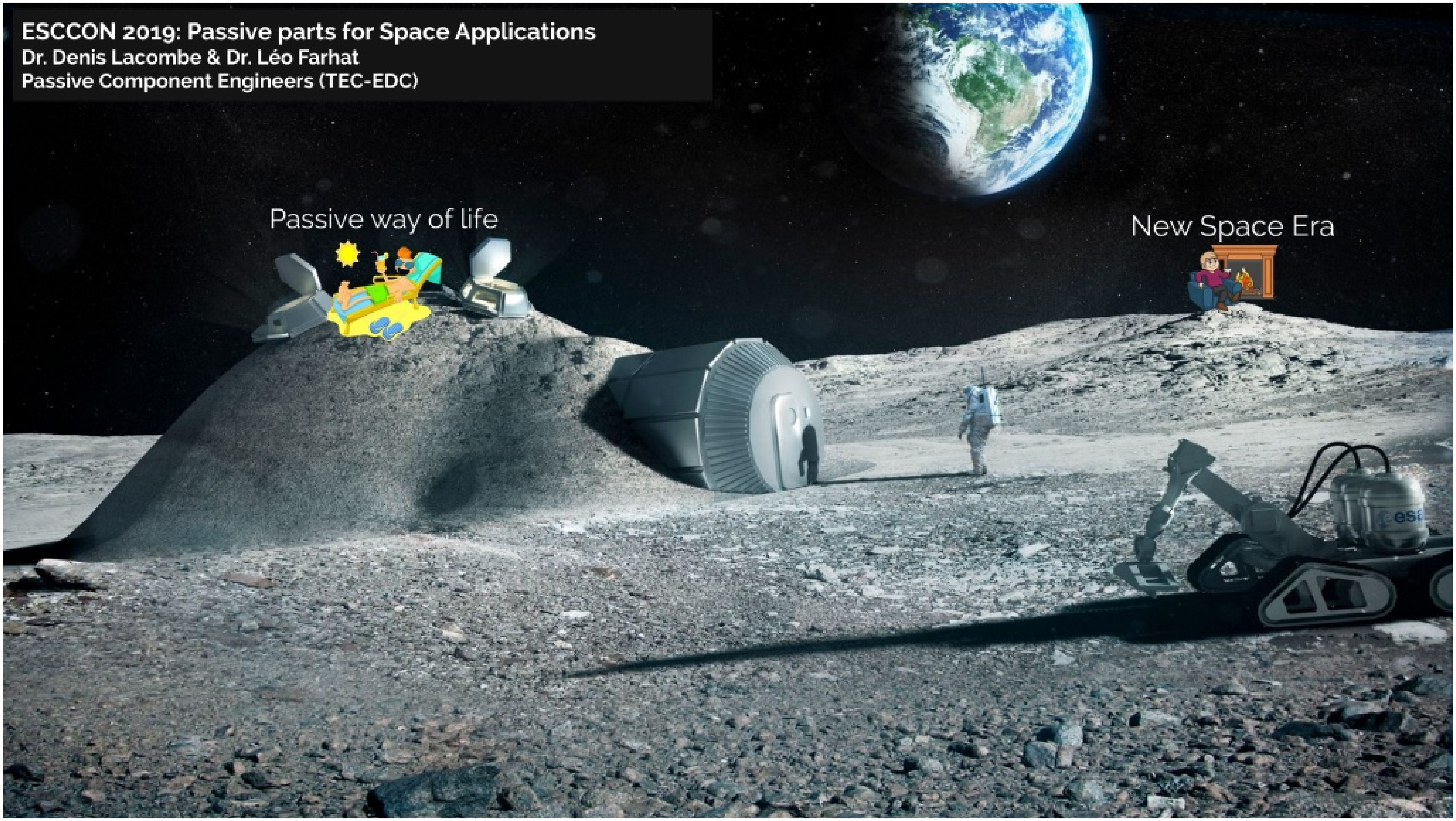
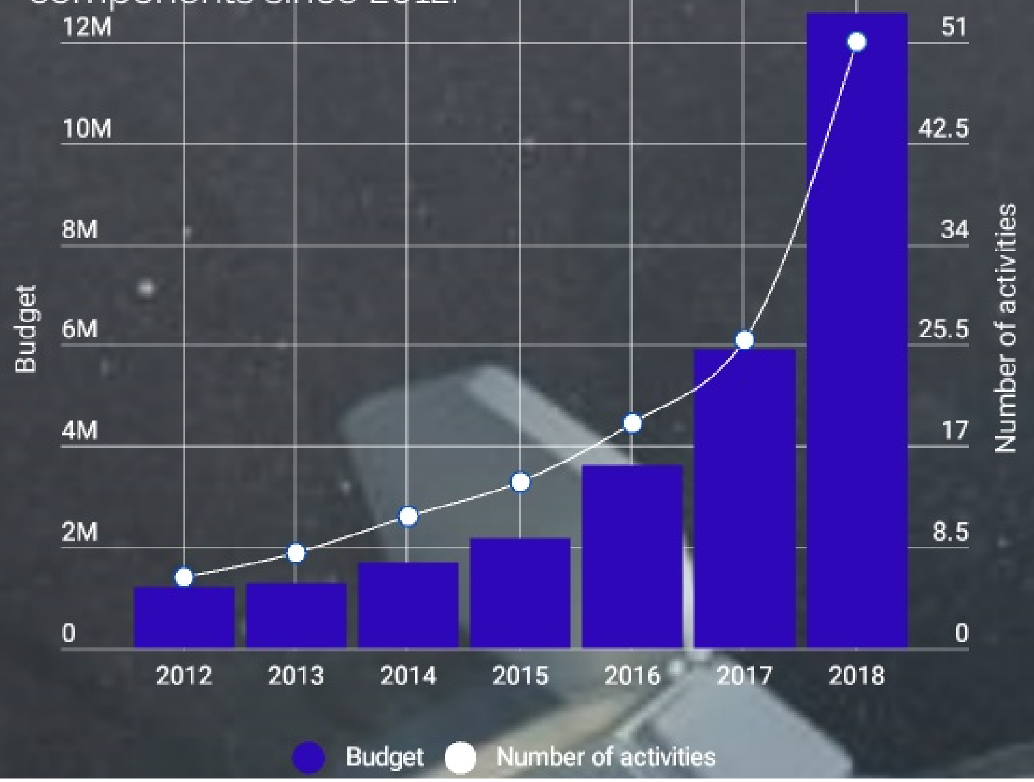

ESCCON 2019: Passive parts for Space Applications
Dr. Denis Lacombe & Dr. Léo Farhat
Passive Component Engineers (TEC-EDC)
Passive way of life
New Space Era
esa


Activities
ESCC:
past 10 years
Achievement
Passive way of life!
Good Performances & Quality Time

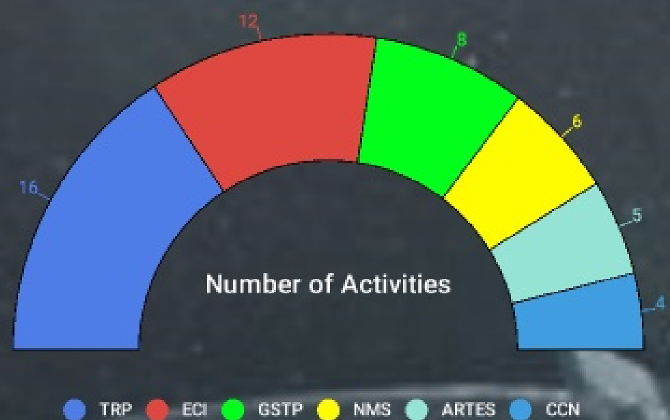
ACTIVITIES

ESA has funded 51 activities (including CCNs) involving Passive components since 2012.



Total Budget : 12.55 M€.
~270K€ per activity
~7 new activities per year

+ activities to be stared in 2019



ESCC for Passive Components

Thanks to national space agencies, manufacturers and ESA funding:

From 2009 to 2019:

- More than 100 ESCC certificates. (almost x2 compared to 2009)

- Tens of new qualified technologies and components:

Base metal electrode ceramic capacitor, flex ceramic capacitor termination, multi-anode tantalum capacitor, SAW filter, fuses, shunt, platinum sensor, circulator and isolator, RF cable assembly, fast locking connector, RF connector SMA 2.9, SMP and high power TNC

- New ESCC generic standards: oscillator, cable assembly, RF passive specifications, etc.


Good Performances & Quality Time
Rectangular Connectors
RF Connectors
Fuses
Supercapacitors
Tantalum Capacitors
Ceramic Capacitors

Ceramic Capacitors: Performances

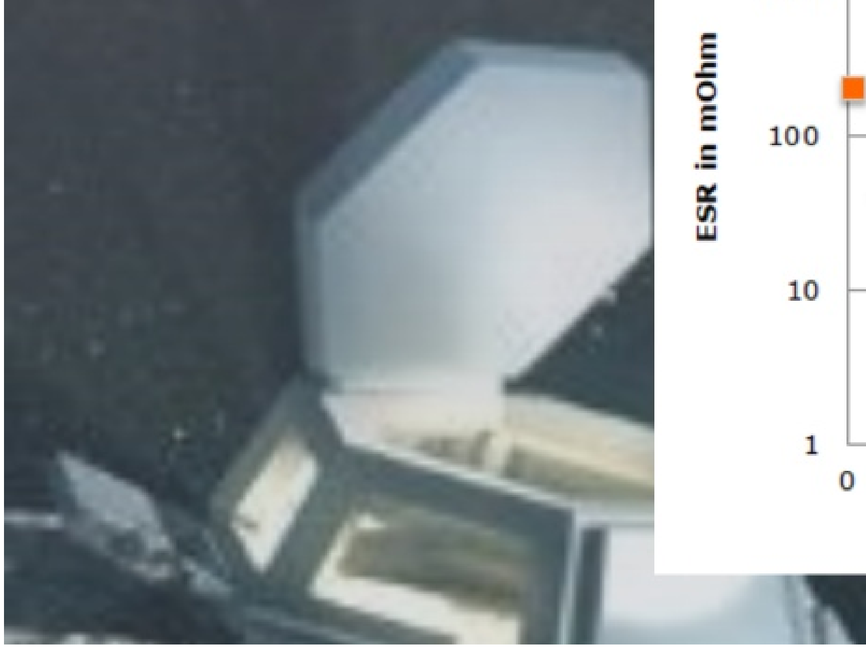
2009	25V	50V	100V
0805	68nF	68nF	47nF
2220	1.5µF	1.5µF	1µF

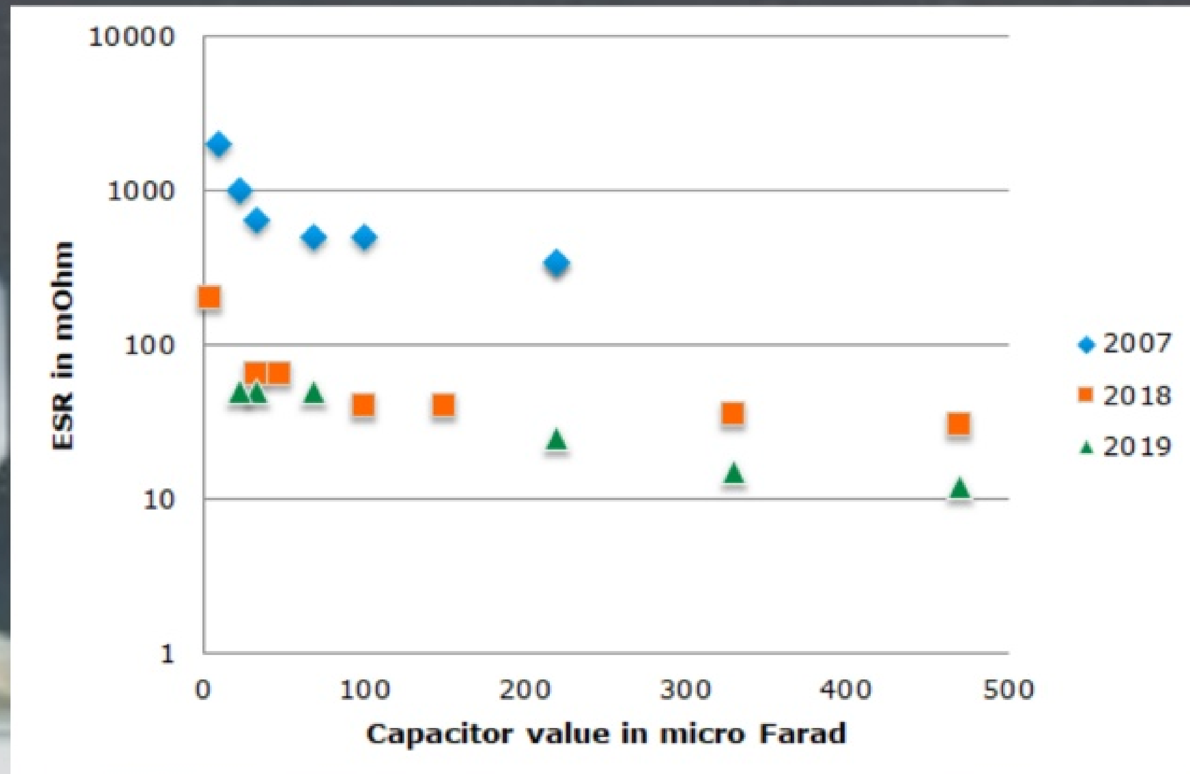
Ceramic Capacitors: Performances

2009	25V	50V	100V
0805	68nF	68nF	47nF
2220	1.5µF	1.5µF	1µF

2019	25V	50V	100V	200V
0402	33nF	27nF	10nF	
0805	68nF 1µF	68nF 470nF	47nF 100nF	15nF
2220	1.5µF 22µF	1.5µF 10µF	1µF 4.7µF	330nF

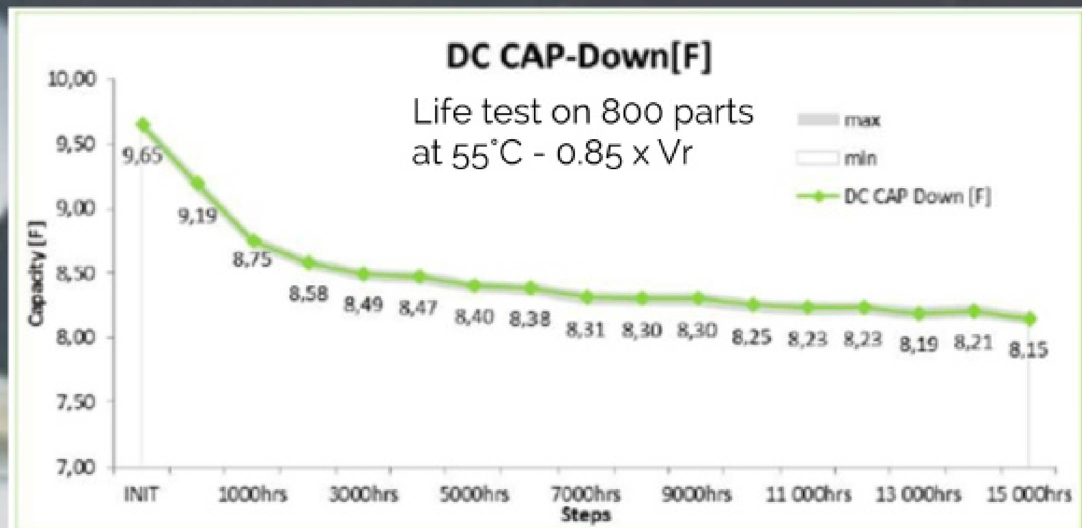
Tantalum Capacitors: Performances





Supercapacitors: Quality

- Several on-going activities in order to develop new technologies: CDC, VACNT, etc.



- Today, we are building reliability figures.

- Objective:
European supply chain for supercapacitors and bank of supercapacitors

Fuses: Quality Time

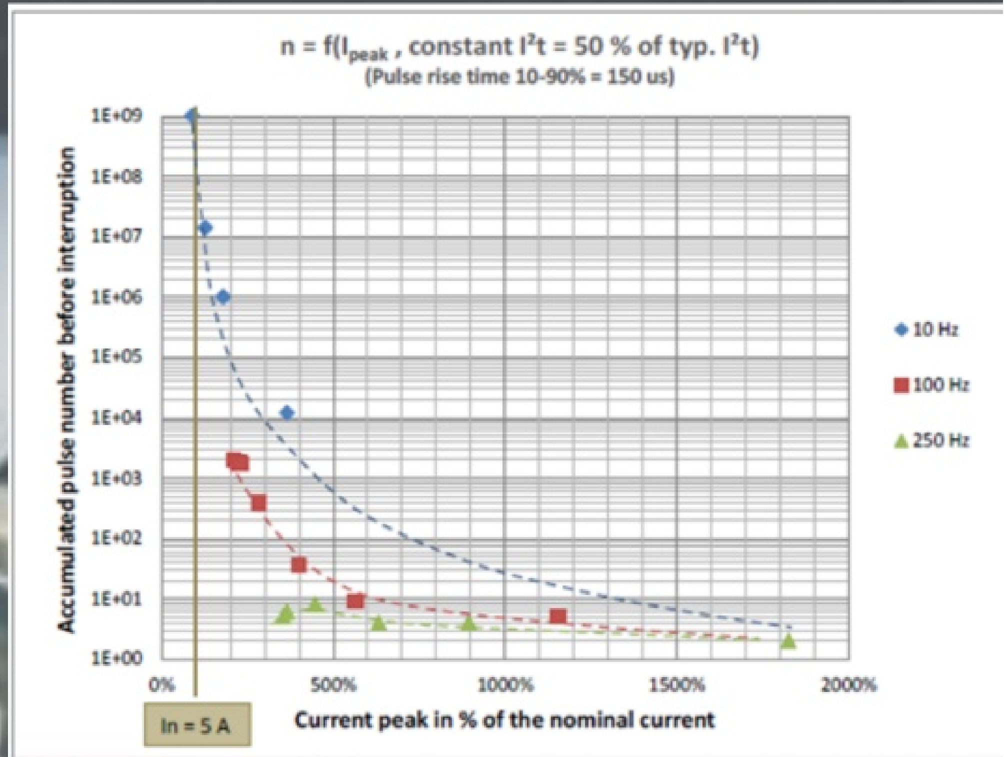
- Qualified technologies :

MGA-S and HCSF fuses, Schurter

-
- Under what conditions the fuse should operate?

Proper use of fuse is complex.

A fuse is most of the time a resistor but should go to open circuit when overcurrent.



RF connectors: Time to market

Qualified high power TNC VHP connectors, Radiall

10 years from development to ESCC qualification!

No equivalent in the world in terms of power for TNC

Need driven by roadmap on RF power

Currently, in integration in many RF components with Very High Power (VHP) levels

Rectangular Connectors: Time to Market

- MMC originally developed in the frame of an ESA funded TRP activity:

« Miniaturisation of Power/Coaxial Connectors »

- Successful ESCC evaluation but 2 years of delay. Why 2 year of delay?

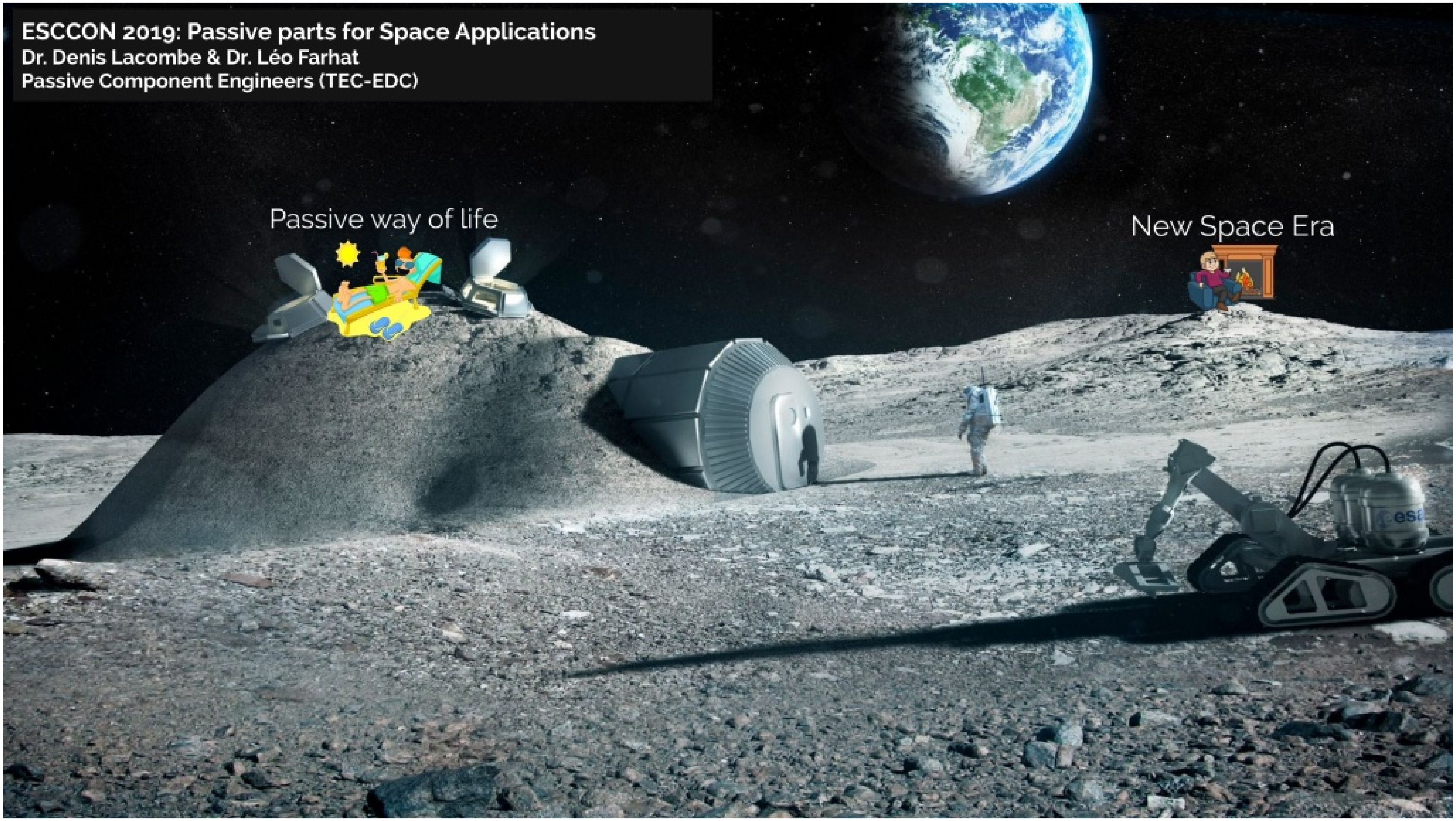
- TRL9, since 2 weeks!!!

Bye-bye good quality time?

In Europe, we have one of the largest portfolio of passive components manufactured, qualified and tested for space applications.

This was ONLY possible because we built it and we have prepared for it.

But it came with TIME and COST.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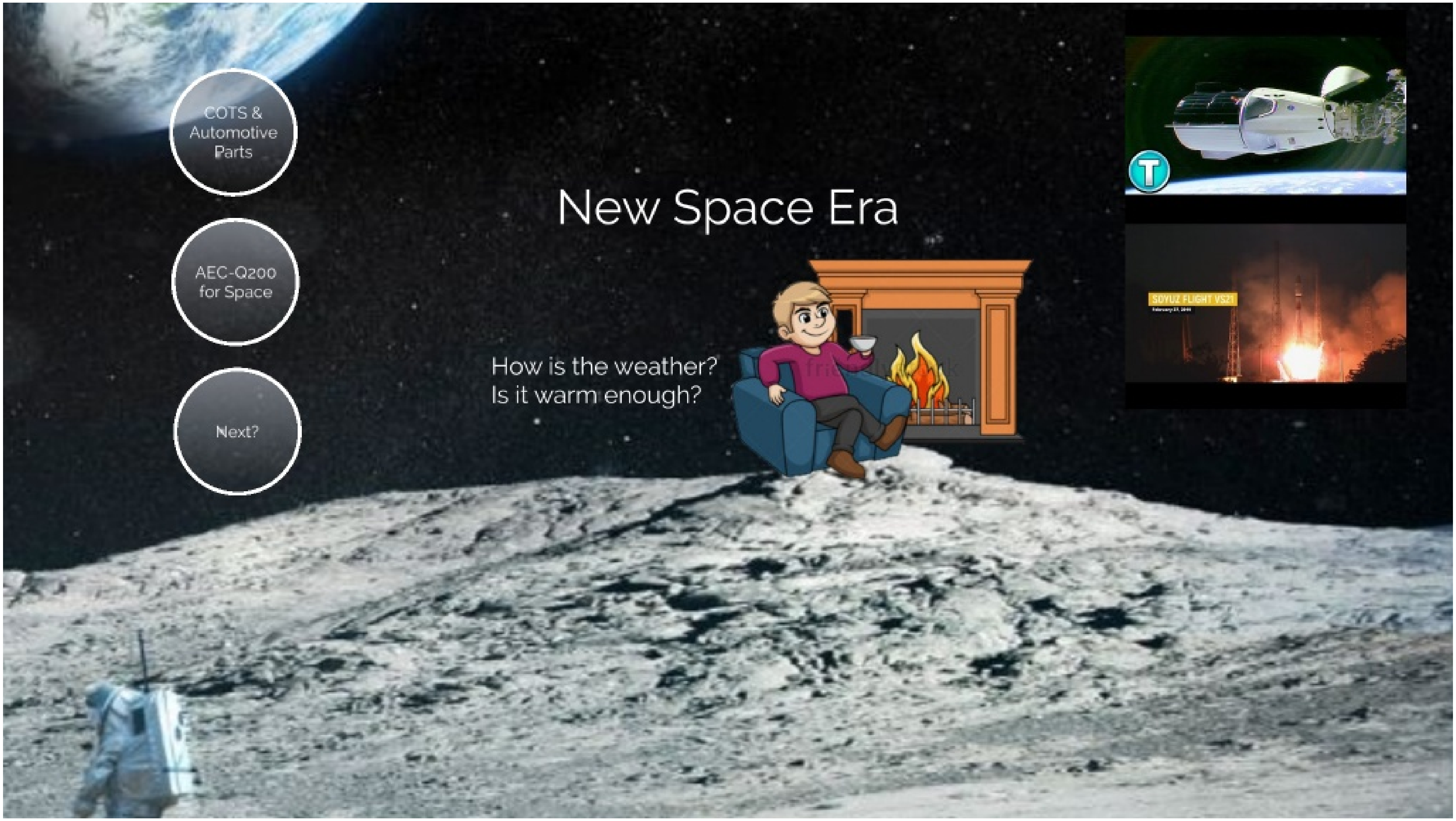
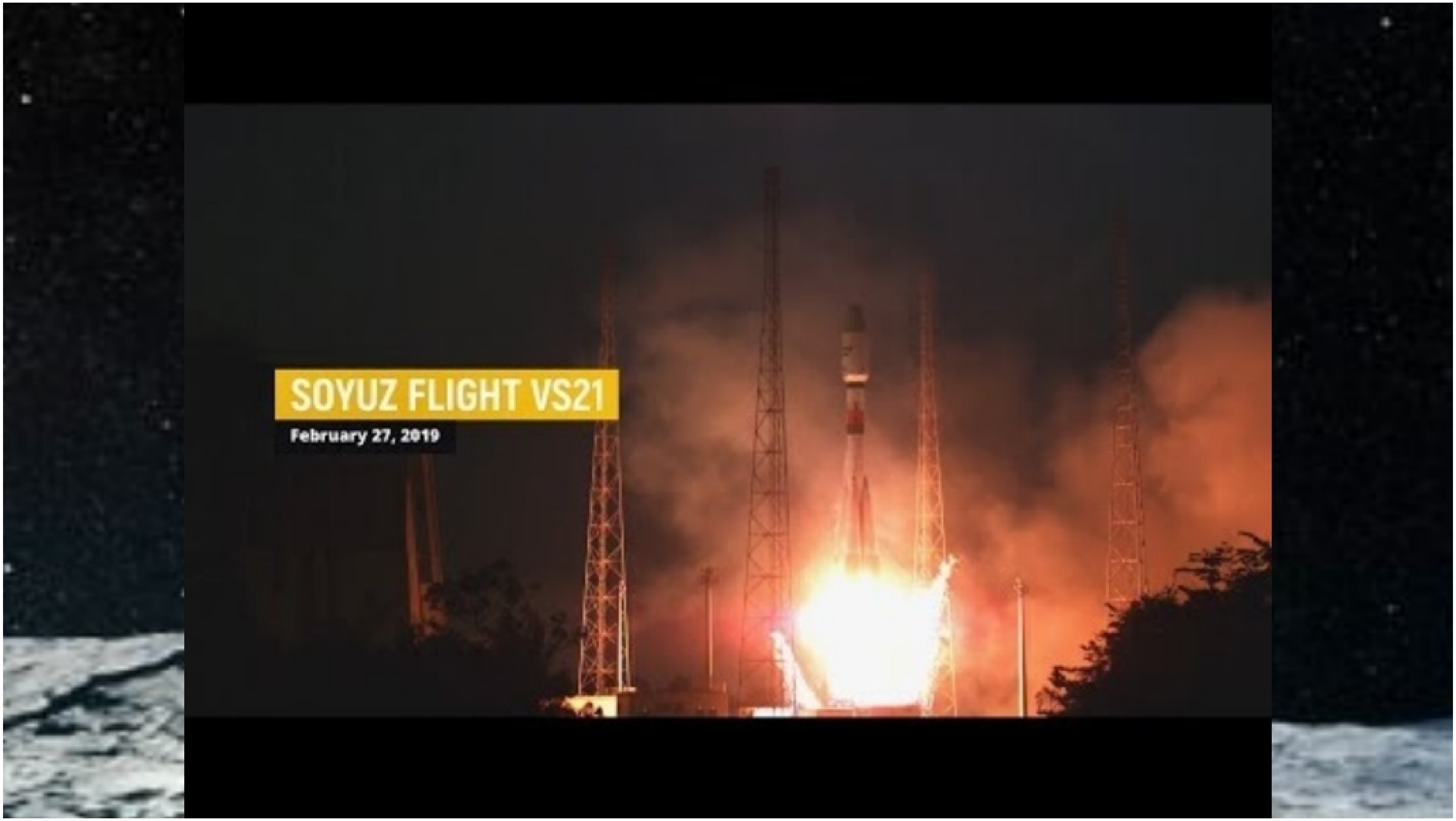

COTS &
Automotive
Parts
AEC-Q200
for Space
Next?
New Space Era
How is the weather?
Is it warm enough?
SOYUZ FLIGHT VS21


SOYUZ FLIGHT VS21
February 27, 2019

Automotive Parts

Parts manufactured and tested for a vehicle.

As for car brands, it is based on trust.

Based on zero defect manufacturing -> no screening.

AEC-Q200 for Space

- Based on defined family range and similar to ESCC PID.

- Based on one initial qualification with numerous tested parts.

Maintenance in case of process change:

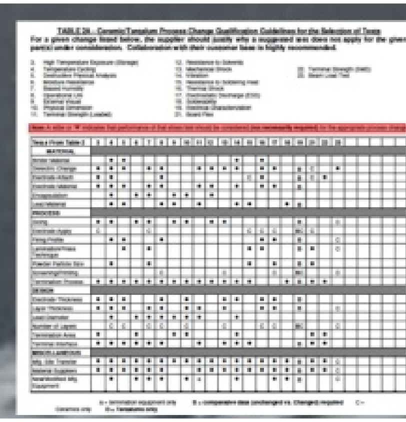
Note: A letter or "." indicates that performance of that stress test should be considered (not necessarily required) for the appropriate process change.

We speak about :

TRUSTED manufacturers= Fabricants de confiance

TABLE 1 - QUALIFICATION SAMPLE SIZE REQUIREMENTS

Stress	NO.	Note	Sample Size Per Lot	Number of lots	Accept on Number failed
Pre-and Post-Stress Electrical Test	1	G	All qualification parts submitted for testing		0
High Temperature Exposure	3	DG	77 Note B	1	0
Temperature Cycling	4	DG	77 Note B	1	0
Destructive Physical Analysis	5	DG	10 Note B	1	0
Moisture Resistance	6	DG	77 Note B	1	0
Humidity Bias	7	DG	77 Note B	1	0
High Temperature Operating Life	8	DG	77 Note B	1	0
External Visual	9	NG	All qualification parts submitted		0
Physical Dimensions	10	NG	30	1	0
Terminal Strength	11	DGL	30	1	0
Resistance to Solvent	12	DG	5	1	0
Mechanical Shock	13	DG	30	1	0
Vibration	14	DG	Note B		
Resistance to Solder Heat	15	DG	30	1	0
Thermal Shock	16	DG	30	1	0
ESD	17	D	15	1	0



AEC-Q200 for Space

- Relevance of tests for space?

TABLE 2 - TABLE OF METHODS REFERENCED TANTALUM & CERAMIC CAPACITORS

Stress	No.	Reference	Additional Requirements
Vibration	14	MIL-STD-202 Method 204	5g's for 20 min., 12 cycles each of 3 orientations Note: Use 8"X5" PCB .031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10-2000 Hz.
Resistance to Soldering Heat	15	MIL-STD-202 Method 210	No pre-heat of samples. Note: Test condition D for SMD. Test condition B for Leaded. Pre-heat condition of 150°C, 60-120sec is allowed for ceramic components.
ESD	17	AEC-Q200-002 or ISO/DIS 10605	
Solderability	18	J-STD-002	For both Leaded & SMD. Electrical Test not required. Magnification 50 X. Conditions: Leaded: Method A @ 235°C, category 3. SMD: a) Method B, 4 hrs @155°C dry heat @235°C b) Method B @ 215°C category 3. c) Method D category 3 @ 260°C.
Electrical Characterization	19	User Spec.	Parametrically test per lot and sample size requirements, summary to show Min, Max, Mean and Standard deviation at room as well as Min and Max operating temperatures. Parameters C, DF, IR at min / room / max temperatures to be measured at a minimum. SEE PARAMETER TABLE FOR SUGGESTIONS.
Board Flex	21	AEC-Q200-005	Required for MLCCs only. 60 sec minimum holding time.
Terminal Strength (SMD)	22	AEC-Q200-006	
Beam Load Test	23	AEC-Q200-003	Ceramics Only

TABLE 2 - TABLE OF METHODS REFERENCED TANTALUM & CERAMIC CAPACITORS

Stress	No.	Reference	Additional Requirements
Pre- and Post-Stress Electrical Test	1	User Spec.	Test is performed at 25±5°C except as specified in the applicable stress reference and the additional requirements in Table 2.
High Temperature Exposure (Storage)	3	MIL-STD-202 Method 108	Unpowered 1000 hours. Measurement at 24±4 hours after test conclusion. The maximum rated temperature should be employed for the dielectric used in the device.
Temperature Cycling	4	JESD22 Method JA-104	1000 Cycles (-55°C to +125°C) Measurement at 24±4 hours after test conclusion. 30min maximum dwell time at each temperature extreme. 1 min. maximum transition time.
Destructive Physical Analysis	5	EIA-469	Only applies to SMD Ceramics. Electrical Test not required.
Biased Humidity	7	MIL-STD-202 Method 103	1000 hours 85°C/85% RH. Note: Ceramics only - Specified conditions: Rated Voltage and 1.3 to 1.5 volts. Add 100Kohm resistor. Tantalums - Rated Voltage Only. Measurement at 24±4 hours after test conclusion. For ceramics that have silver content (e.g., PdAg electrodes), the low voltage portion of this test must also be performed.
Operational Life	8	MIL-STD-202 Method 108	Condition D Steady State T_A=125°C. 2/3 rated for Tantalum caps Full rated for Ceramic caps Measurement at 24±4 hours after test conclusion. The maximum rated temperature and voltage rating for the dielectric employed in the device shall be used.
External Visual	9	MIL-STD-883 Method 2009	Inspect device construction, marking and workmanship. Electrical Test not required
Physical Dimension	10	JESD22 Method JB-100	Verify physical dimensions to the applicable device specification. Note: User(s) and Suppliers spec. Electrical Test not required.
Terminal Strength (Leaded)	11	MIL-STD-202 Method 211	Test leaded device lead integrity only. Conditions: Ceramics: A (454 g), C (227 g), E (1.45 kg-mm). Tantalums: A (2.27 kg), C (227 g), E (1.45 kg-mm).
Resistance to Solvents	12	MIL-STD-202 Method 215	Note: It is applicable to marked and/or coated components. Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents.
Mechanical Shock	13	MIL-STD-202 Method 213	Figure 1 of Method 213 SMD: Condition F LEADED: Condition C

AEC-Q200 for Space

AEC-Q200 life test for ceramic capacitors

	Temperature K	Derated voltage x Vr	Test temperature K	Test voltage x Vr	Test duration (hours)	Year equivalent (years)
ESCC life	358	0,6	398	2	2000	304
AEC-Q200 life	358	0,6	398	1	1000	19
ESCC screening	358	0,6	398	2	125	19

- All ESCC part are passing the AEC-Q200 life test: several millions of parts!

- It is not demonstrated that all AEC-Q200 tested parts would pass the ESCC life test

- This is enough for automotive applications:

500 000km at 50km/hours is equivalent to 10 000 hours of use (less than 2 years).
19 years life test for les than 2 years of use: Margin is almost x 10.

- **Is that enough for Space applications?**

AEC-Q200 for Space

- Do we fly without screening?
- Range of ESCC qualified parts are based on automotive line.
- ESCC screening is rejecting in the order of 1 parts for 3000 – 5000 parts.
- For AEC-Q200, in order to find a defect, tests in initial qualification should be performed on 5000 parts in life test:

in reality, tests are perfomed "only " on (order of) 1000 parts.

- Is that OK for space applications?

AEC-Q200 for Space

- Is that OK for space applications?

The answer is : We don't know!

- why that?

Reject = out of spec but may be not a critical defect.

We are not monitoring the burn-in, no information about early and end life failures: we don't know if failures occur at the beginning or at the end.

Some application may be tolerant for failures: decoupling, redundancy.

What should be done?

At component Level

• Establish a common approach and understanding of "trusted manufacturers""
Inclusion of passive components in ECSS-Q-ST-60-13 (currently, includes only active parts)

Therefore, we need DATA&statistics analysis on Screening tests.
Do we have these information?

• Studies on burn-in failures : different technologies and manufacturers
Number of rejects
Type of rejects
When and how failures appear?

What should be done?

At Project Level

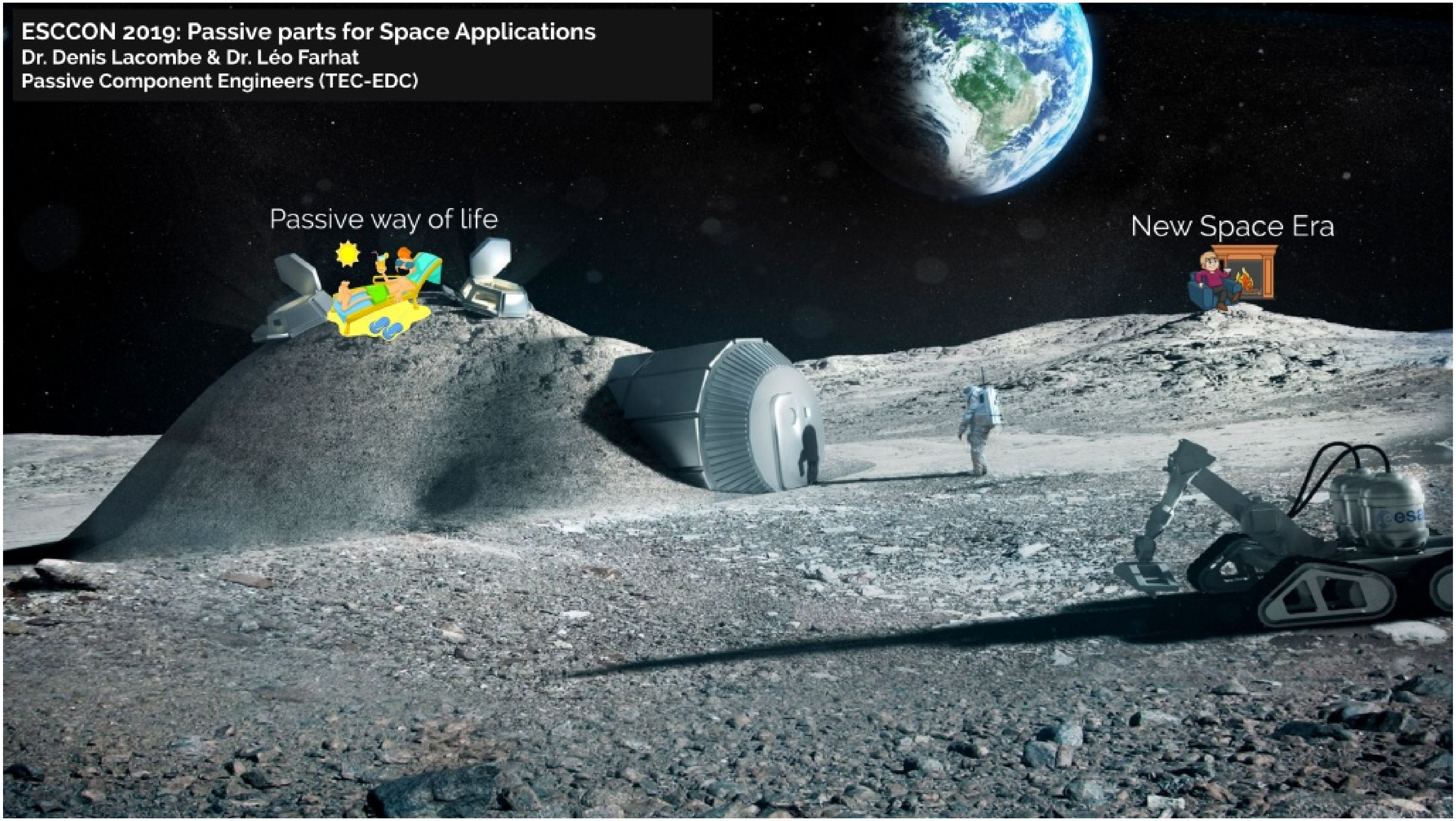
- Applications like SpaceX (manned missions) may still need a high reliability level as one failure can be catastrophic

- Applications like Oneweb may be different: is it critical if 1 or 10 satellites fail(s) in a constellation of ~900?

- Therefore, at project level, one should choose the adequate component level and possibly up to the board, equipment or satellite level. (with a link to components ECSS-Q-60 classes' definition)

Is the New space era a threat for the passive way of ;life?

Hopefully not, of course if we are well prepared.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