

# **Extreme Conditions Characterization of Passive Components**

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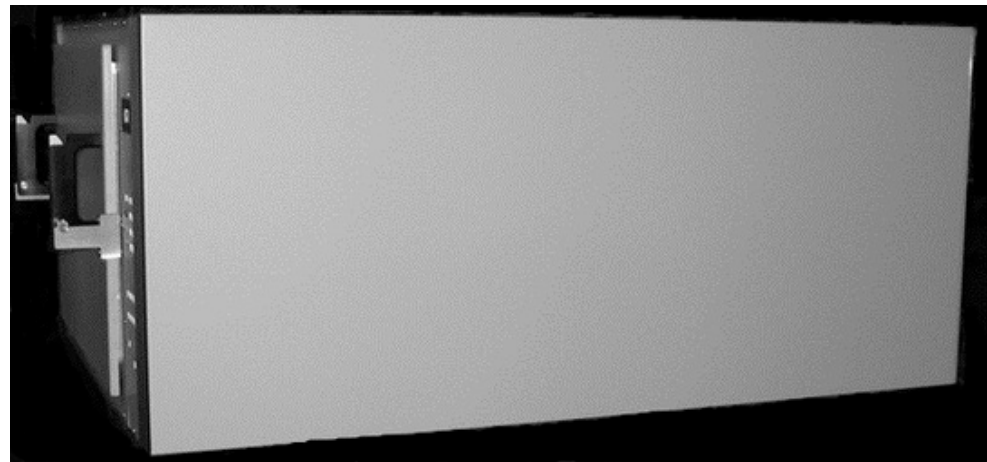
- Motivations
- Extreme Temperature Electrical Characterization
  - Capacitors
  - Resistors
  - Thermistors
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- Thermal Vacuum Characterization
  - Pressure test of Heaters
  - Life test of Strain Gages
- Mechanical Tests under Temperature
  - Characterization of Strain Gages

Passive parts for space usage, motivations to develop specific test setups

- Components to be tested in very harsh environments they will find in space:
  - Characterization at extreme temperatures
  - Characterization under vacuum conditions
  - Mechanical stresses under extreme temperatures
  - Radiation
- Customization and flexibility in order to fulfill any special customer requirements
- High number of parts to be tested and need to avoid any damage in the component terminals during screening

# SPCD Extreme Conditions Characterization of Passive Components

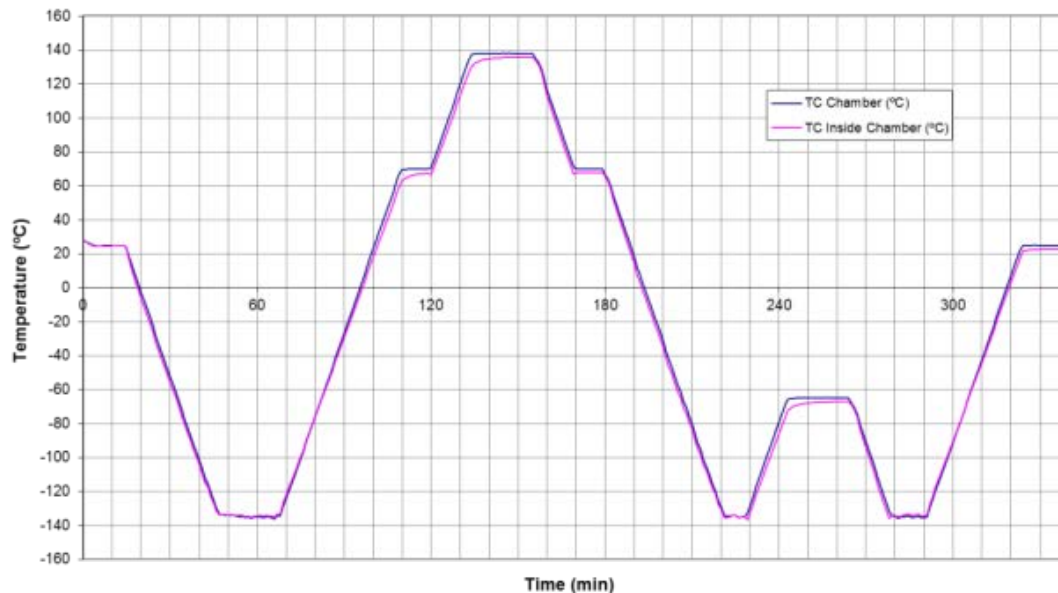
- Extreme Temperature Electrical Characterization
  - Based on Sun Systems climatic chambers.
  - Expectorant liquid N2. Low coolant consumption.
  - Wide temperature range: -185°C to 315°C.
  - Very precise temperature rate. Up to 48°C/min.
  - Very versatile, different chamber doors and feedthroughs allow several different setups based on the same climatic chamber.



# SPCD Extreme Conditions Characterization of Passive Components

## Complex temperature profiles

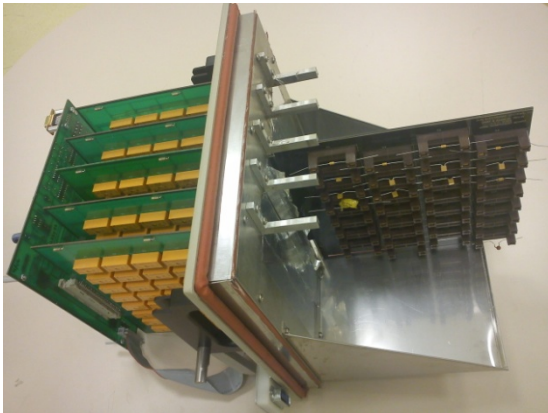
LN2 Chamber Thermal Cycling



- Custom Thermal Profiles
  - Custom software developed to carry out complex temperature profiles
  - Matching the final application environment
  - Wide range -185°C to 315°C
- Complex PID optimization
  - Ensuring precise temperature limits are not exceeded even with complex thermal profiles.

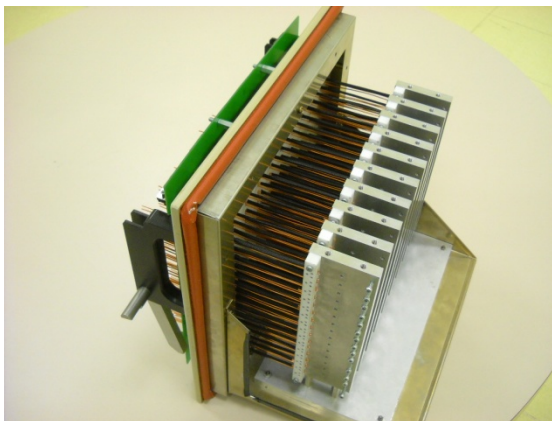
# SPCD Extreme Conditions Characterization of Passive Components

## Custom conmutation matrix door:



- Temperature range: -184°C to 200°C
- Up to 160 components
- 4-wire measurements
- Up to 4 amps maximum current
- Fully automated measurement using custom made control software

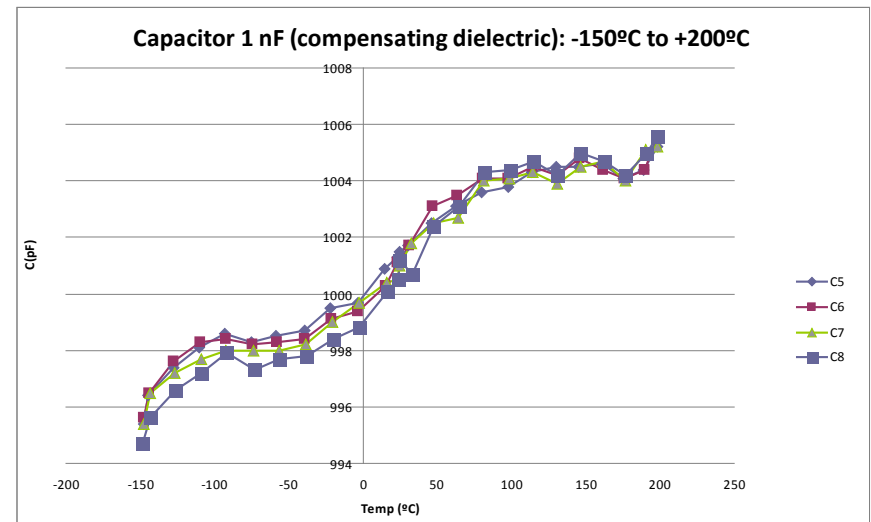
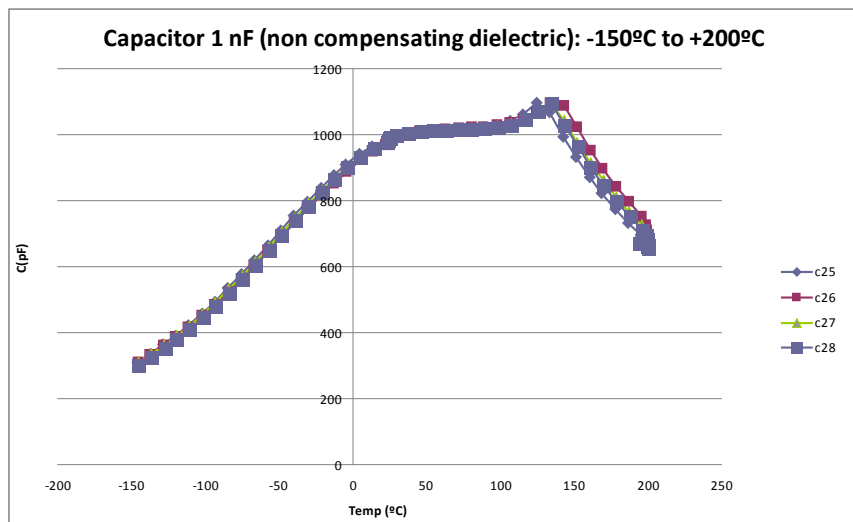
## Custom high temperature characterization setup:



- Temperature range: -184°C to 300°C
- Up to 150 components
- Allows higher current measurements
- Temperature monitoring for each single part
- Semiautomatic measurement software assisted

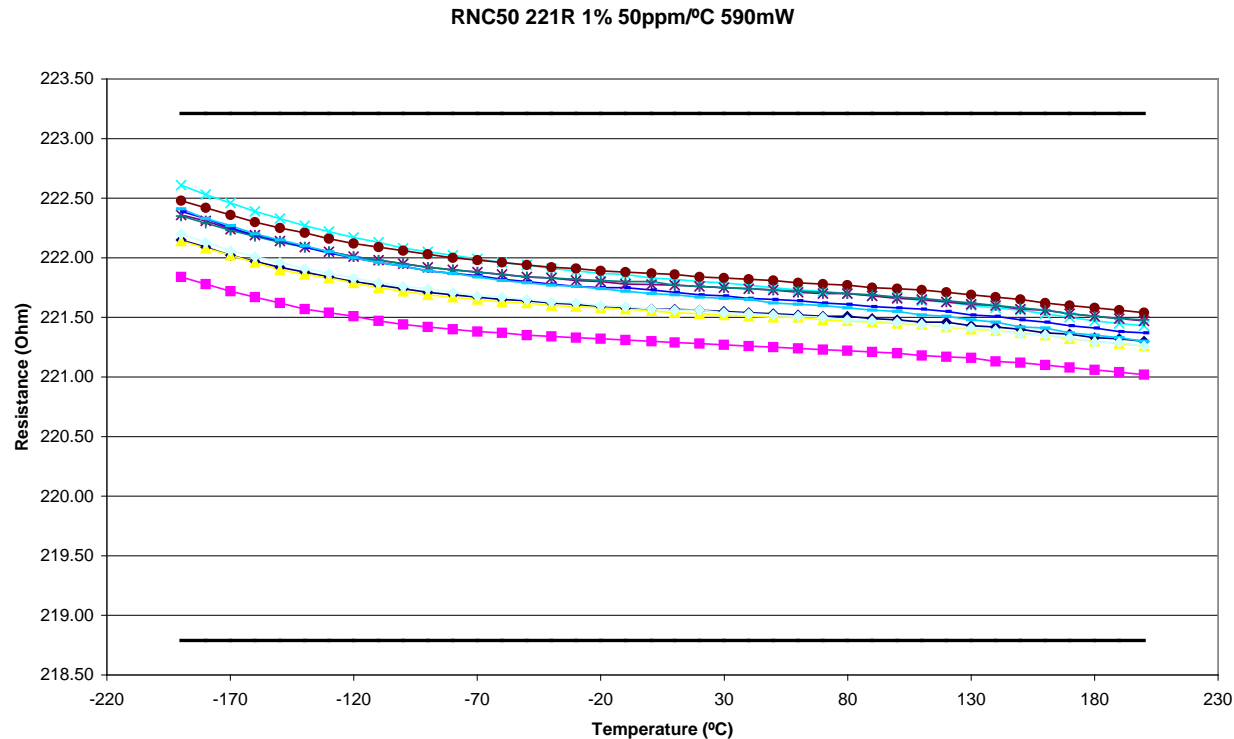
# SPCD Extreme Conditions Characterization of Passive Components

- Capacitor measurements:
  - Wide temperature range capacitance measurements
  - High number of capacitors tested at the same time
  - Quick commutation allows capacitance measurements at high number of intermediate temperatures (i.e. each 10°C)
  - Previous automated calibration of each path ensures accurate measurements



# SPCD Extreme Conditions Characterization of Passive Components

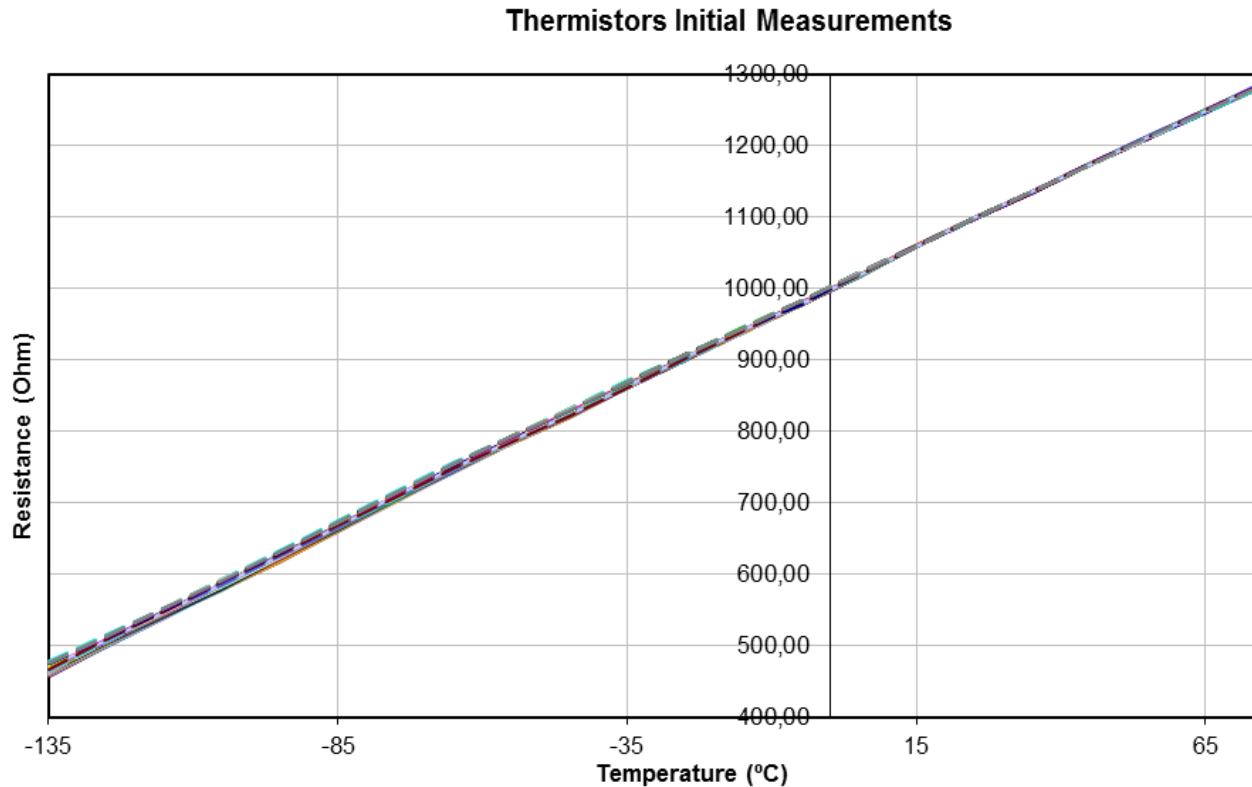
- Resistors characterization



- Characterization from qualified to COTS parts out of their rated temperature range
- High number of intermediate measurements during the sweep
- Fast ramp rates (up to 48°C/min) with electrical monitoring to detect structural related degradation



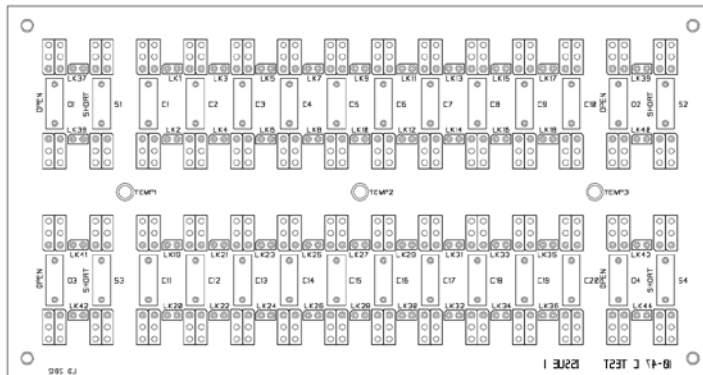
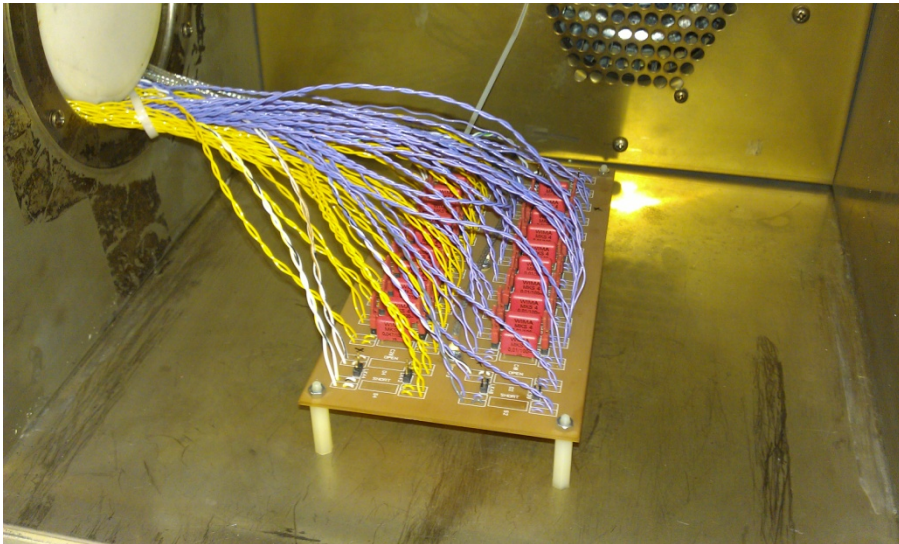
- Thermistors characterization



- High number of samples tested at the same time
- High number of intermediate measurements during the sweep

# SPCD Extreme Conditions Characterization of Passive Components

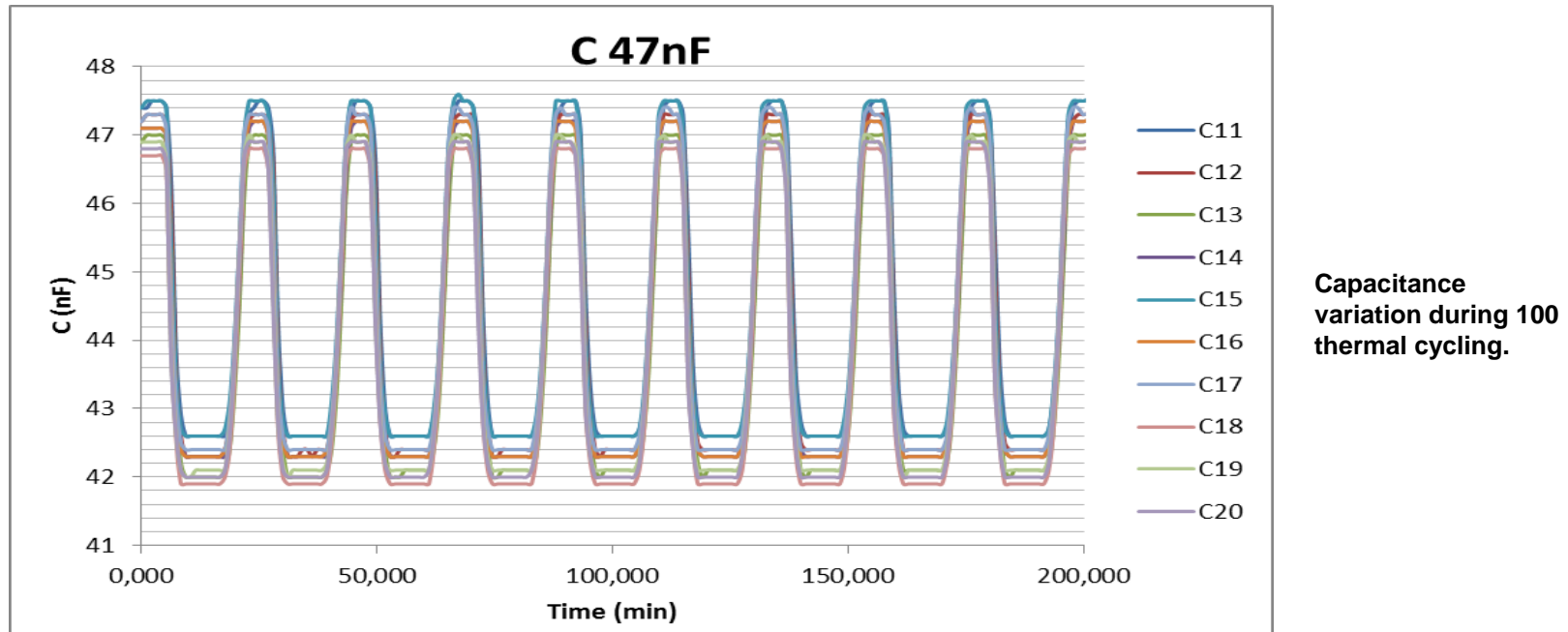
## Custom Testing Board example



- Custom test board
  - Designed to evaluate the suitability of the components and related soldering method to withstand the nominal temperature range of the mission
  - Test of a high number of parts in the final flight conditions
- Combined thermal cycling & continuous electrical characterization of:
  - Samples in parallel
  - Capacitors in series
  - Each part measured independently

# SPCD Extreme Conditions Characterization of Passive Components

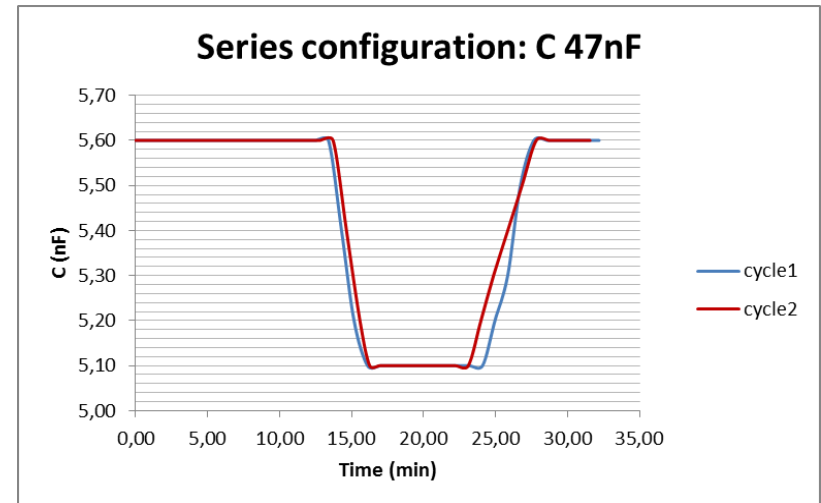
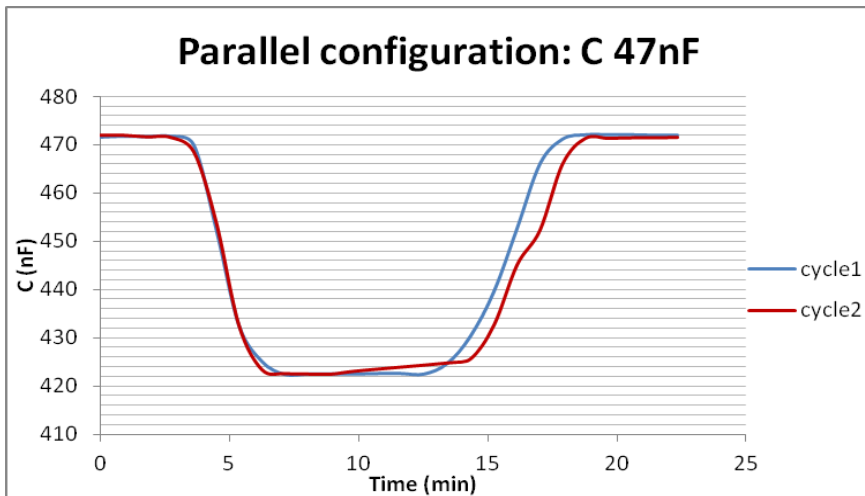
## Custom Testing Board example



- Sample of 10 thermal cycles from 25°C to -150°C (40°C/min rate)
- Fast sweep allowing nearly real time monitoring of each part

# SPCD Extreme Conditions Characterization of Passive Components

- Parallel and series configuration
  - Comparison of the behaviour before and after 100 thermal cycles
  - Very slight variations can be detected



# SPCD Extreme Conditions Characterization of Passive Components

## Temperature + Vacuum Characterization Custom setup



- Designed to fit in the our climatic chambers
- Temperature range: -184°C to 300°C
- Vacuum: Down to  $10^{-7}$  mbar
- Several electrical feedthroughs
  - Up to 5 thermocouples: Temperature monitoring the DUT
  - Optical feedthroughs:
    - Free space
    - Optical fiber feed-through
  - Electrical feedthroughs: DUT in operating conditions

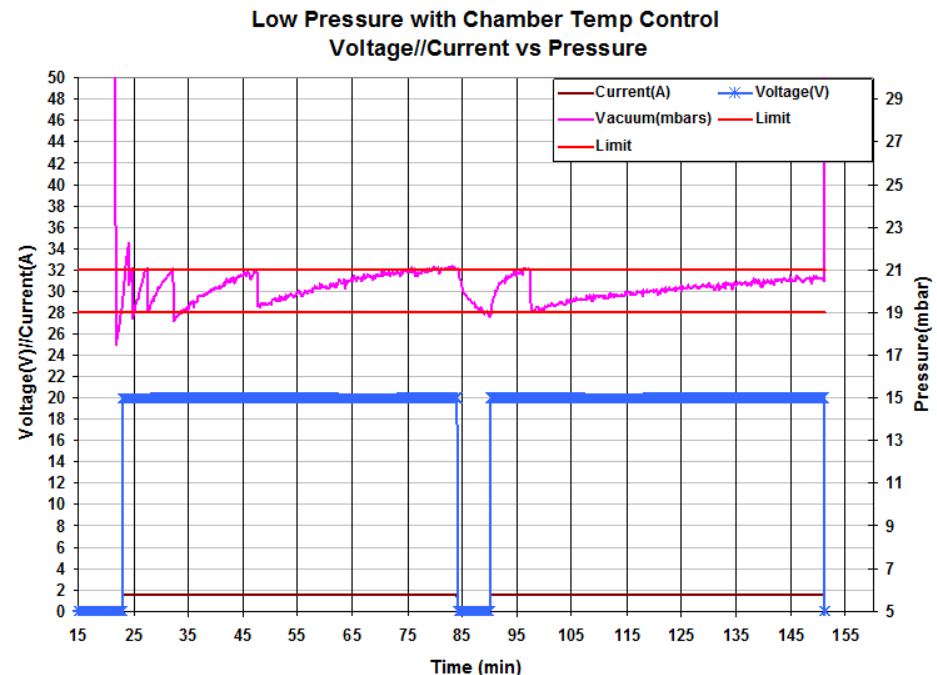
# SPCD Extreme Conditions Characterization of Passive Components

## Example of Low Pressure Life Test of Heaters



- Evaluation of heaters behavior while operating in low pressure environments
- Continuous monitoring of the electrical parameters

- Two subsets of 5 heaters tested sequentially
- Pressure control:  $20 \pm 1$  mbar
- Vacuum chamber walls temperature control:  $16^\circ\text{C}$





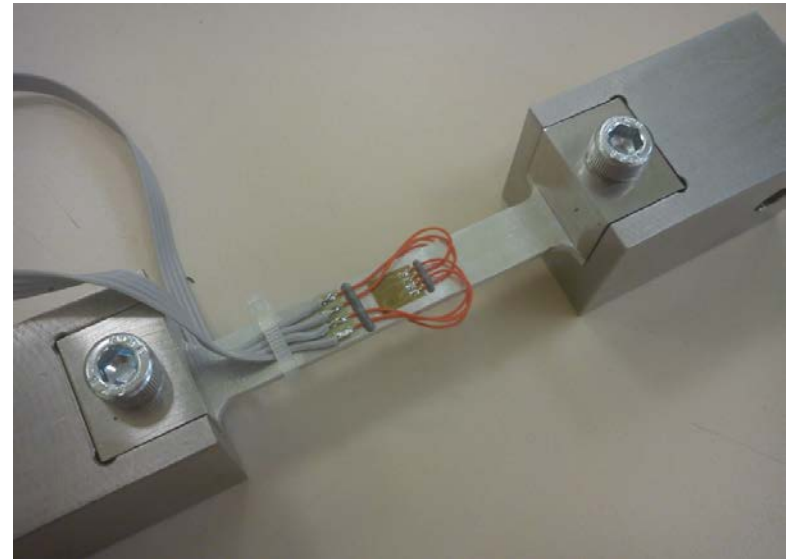
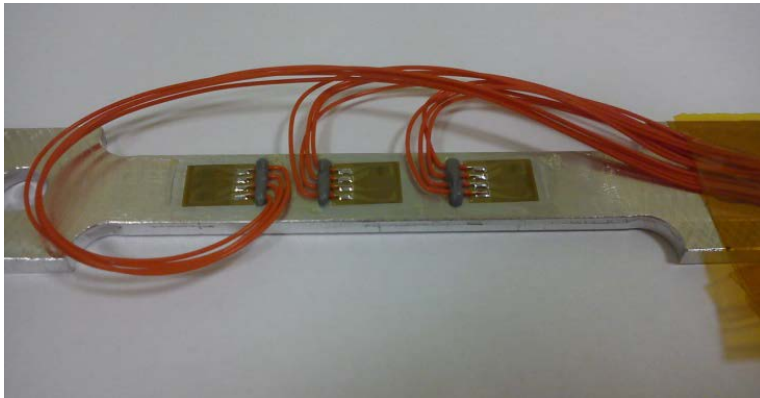
## Temperature + Mechanical Stress



- Mechanical stress:
  - Wide tension/compression range (up to 5KN)
- Temperature:
  - From -185°C to 300°C
  - Thermocouple direct contact with the sample for temperature monitoring
- Custom control/measurement software:
  - Temperature control and monitoring.
  - Mechanical stress control and monitoring
  - Allows continuous monitoring of all the electrical parameters.

# SPCD Extreme Conditions Characterization of Passive Components

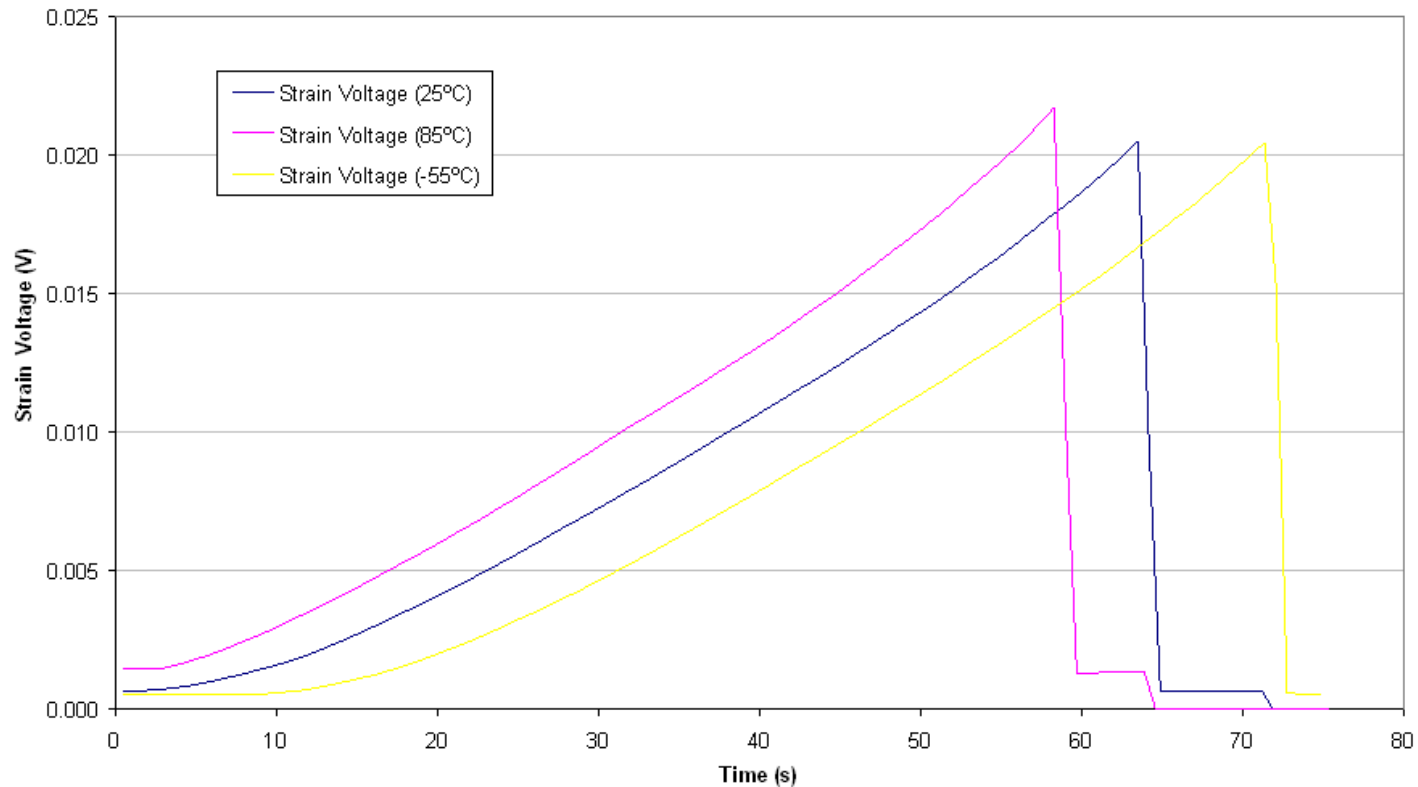
- Mechanical test of Strain Gages
  - Design of a suitable support for the strain gages
  - Strain gages glued as in the final application for representative test (thanks to RUAG)
  - Design of fixtures compatibles with the mechanical test equipment





# SPCD Extreme Conditions Characterization of Passive Components

- Strain Gages characterization (resistors bridge)

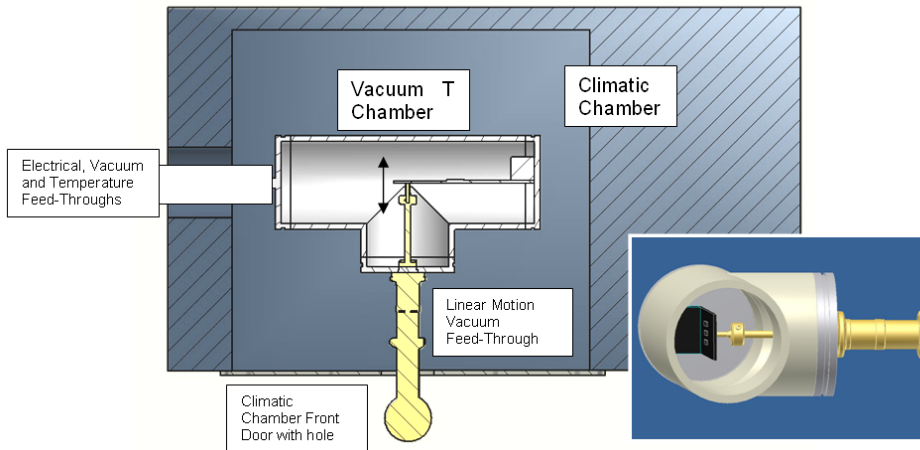


- Sweep from 0 to 130MPa
- Performed at 25°C, 85°C & -55°C

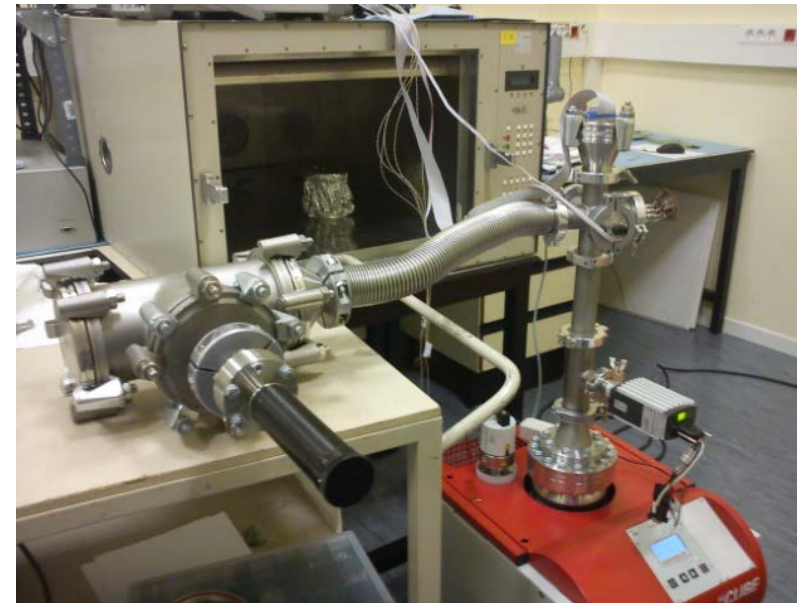
# SPCD Extreme Conditions Characterization of Passive Components

## Temp + Vacuum + Mechanical Stress + Electrical Characterization Setup

Vacuum + Thermal + Mechanical test of strain sensors

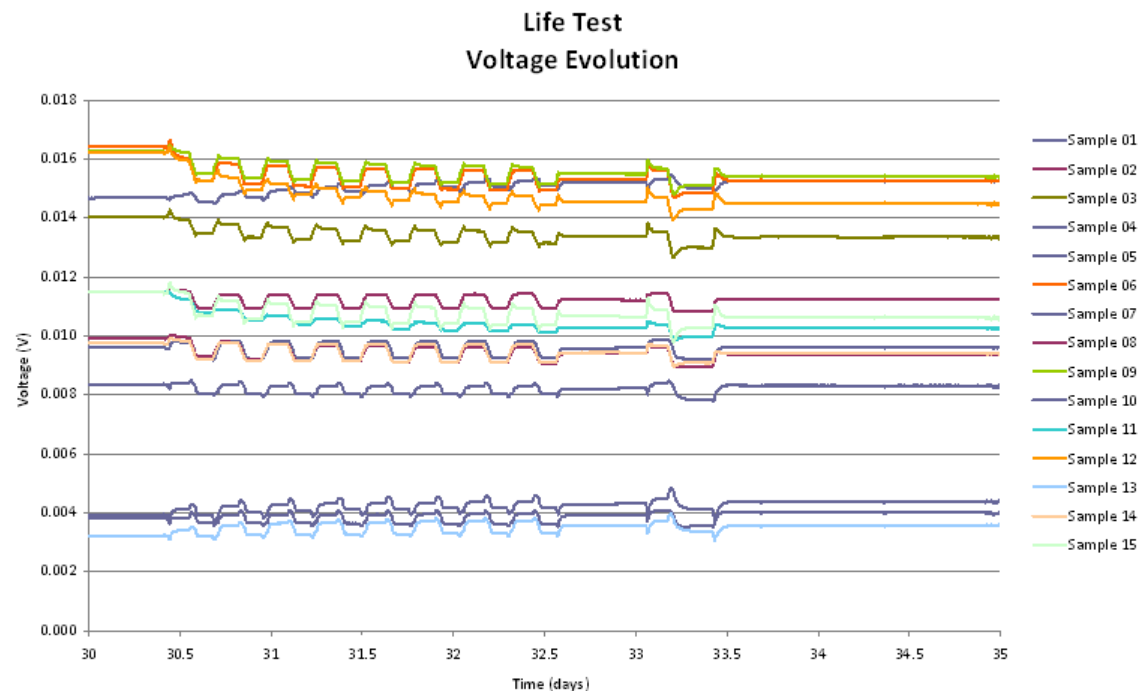


- +85°C to -55°C operating thermal cycles
- Linear motion feed-through allows to apply mechanical stress to the samples
- Vacuum conditions: < 10-5mbar



# SPCD Extreme Conditions Characterization of Passive Components

## Strain gages life test



- +85°C to -55°C operating thermal cycles
- Sensors in loaded conditions (mechanical stress applied)
- Vacuum conditions: < 10<sup>-5</sup>mbar
- Continuous monitoring the sensors output

- Conclusions
  - Only examples of our custom setups
  - Let us know any special need, it may be possible with the right setup

# SPCD Extreme Conditions Characterization of Passive Components



**THANK YOU FOR YOUR ATTENTION**



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