WE LOOK AFTER THE EARTH BEAT

Circular robotic connectors for the ExoMars Program

D. Delaude – TASI

H. Demailly - SOURIAU

24/09/2013

Ref.:

OPEN

ThalesAlenia Space

A Thales / Finmeccanica Company

83230912-DOC-TAS-EN-002

Overview

- Short description of the ExoMars 2016 Mission
- Souriau 8977 Circular Robotic Connectors
- Qualification and Acceptance approach
- Where we are: available test results
- Still to do: future outlook
- Conclusion

ExoMars 2016 Mission

ExoMars Program

- ESA program with ROSCOSMOS support
- Robotic exploration of Mars searching for sign of life
- The program is developed by Thales Alenia Space as Prime Contractor.

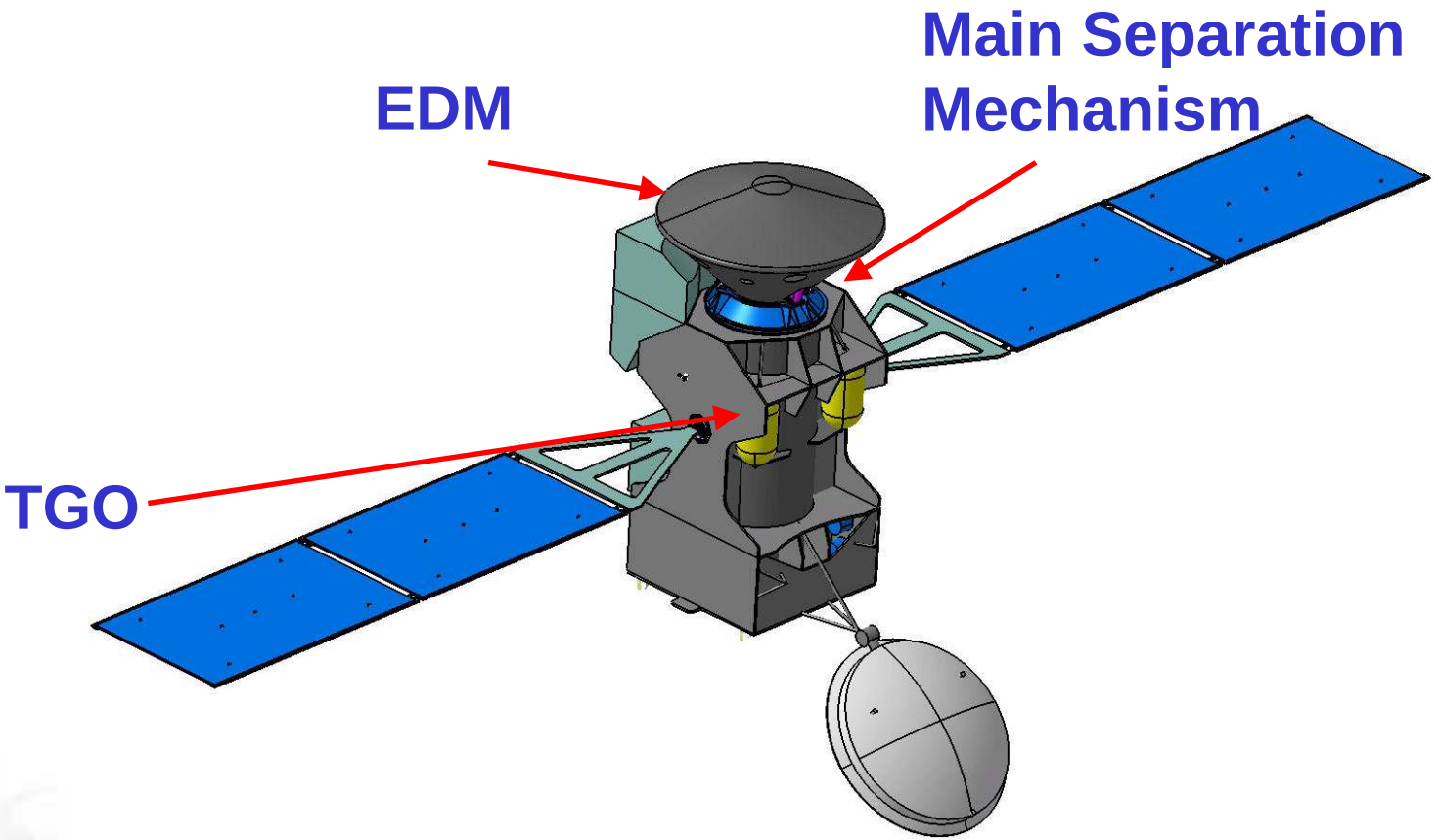
- 2016 mission: An Orbiter dedicated to the analysis of the Martian atmosphere (TGO) and a Descent Module (EDM) to demonstrate the European safe landing capability

ExoMars 2016 Mission

MISSION PROFILE

- Launch in January 2016 from Baikonour (Proton) as part of SCC
- Interplanetary cruise (on TGO)
- Separation from TGO in October 2016
- 72 h Coast phase
- Entry Descent & Landing (318÷369 s)
  - Parachute deployment (Mach 1.95)
  - Front Shield jettison ➔ RDA operational
  - Back Cover separation (1400 m, 80 m/s) ➔ RCS activation 1 s later
  - Final braking with RCS (up to ≈2 m)
  - Landing on Meridiani Planum during Global Dust Storm season
- Surface Phase (2 to 8 sols)

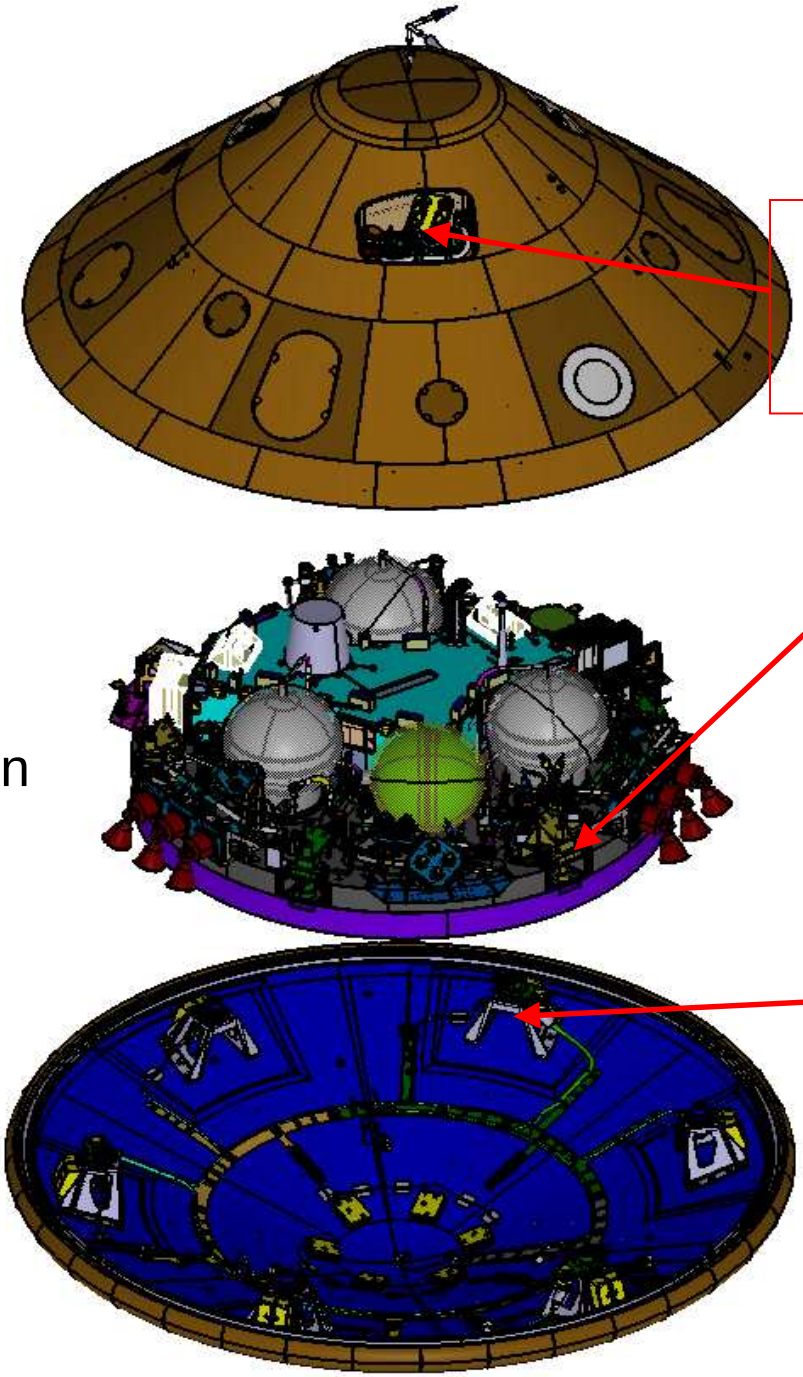
ExoMars 2016 Mission



ExoMars 2016 Mission

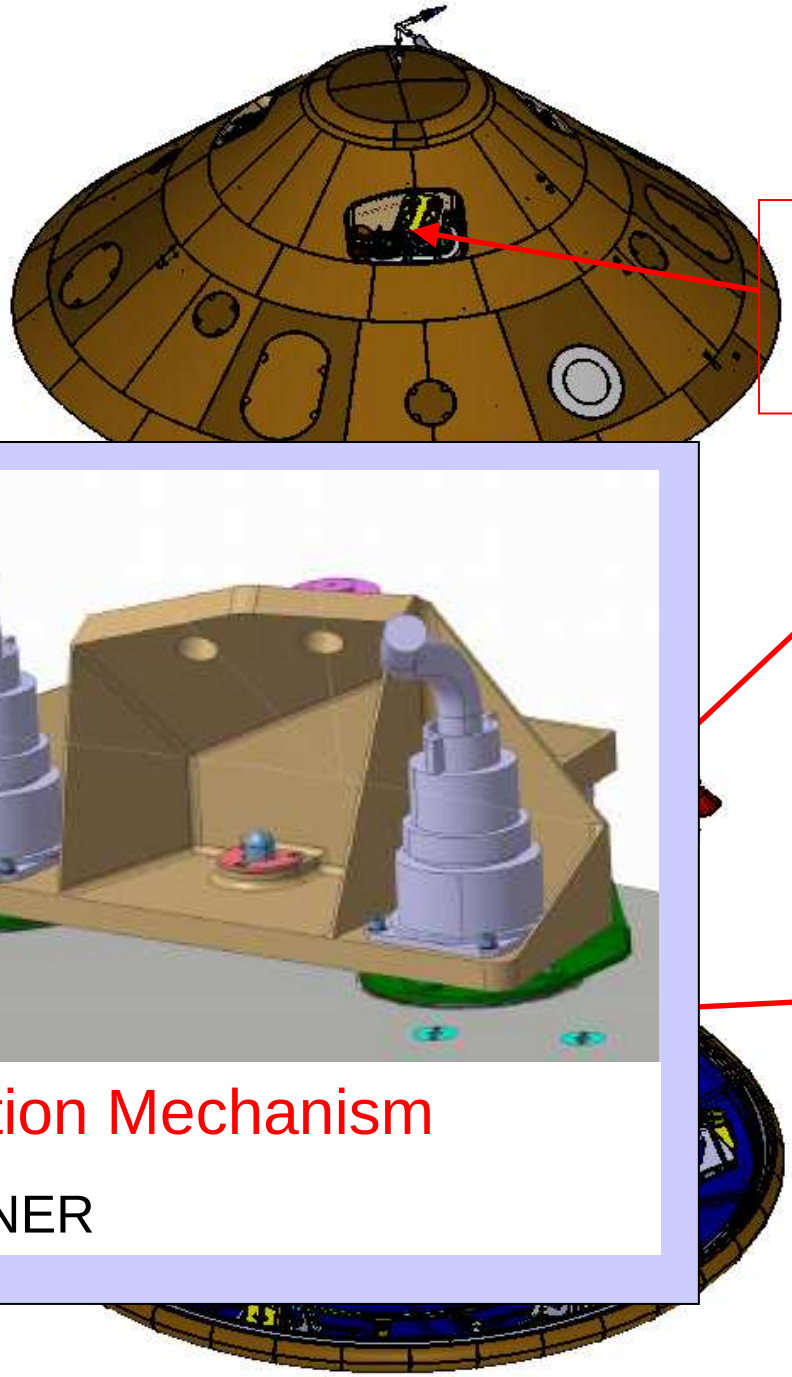
EDM

- 3 Separation Mechanisms
- 12 connectors pairs
- Separation = fine balancing between mechanism spring repulsive forces and friction
- Un-homogeneous performances induce undesired momentum



OPEN

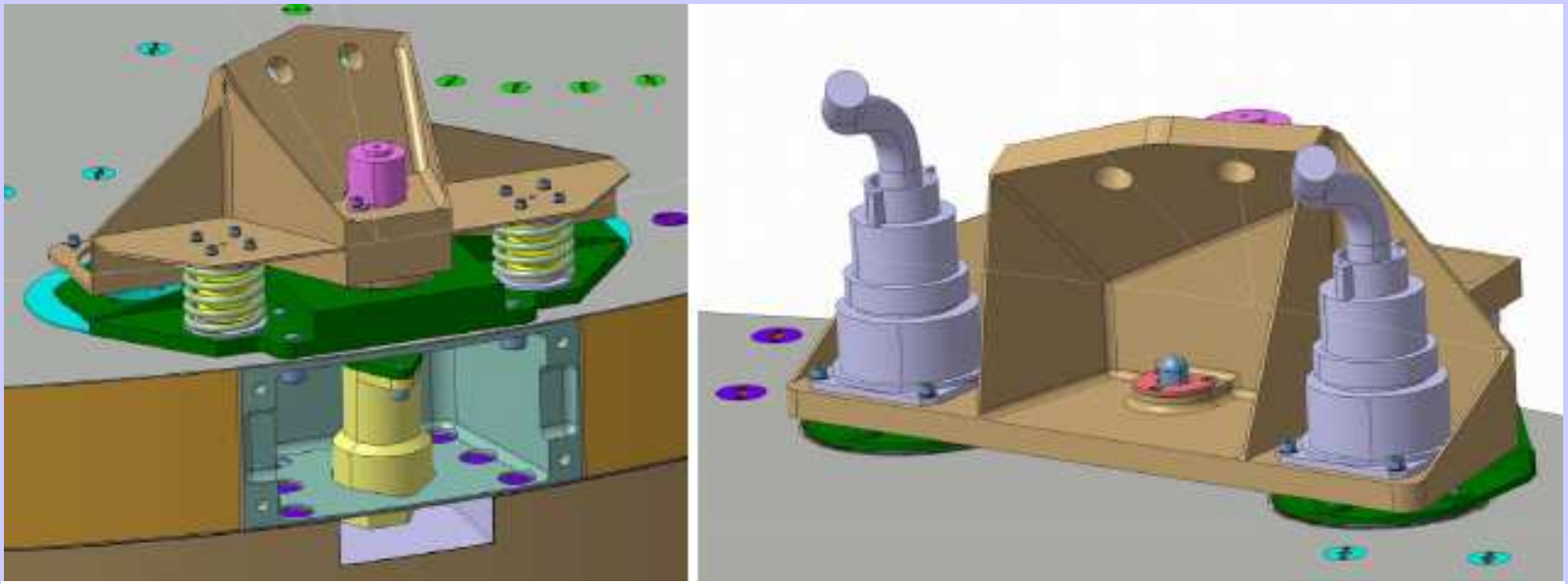
EDM



Main Separation Mechanism

Surface Platform Separation Mechanism

Front Shield Separation Mechanism



Surface Platform Separation Mechanism

Courtesy of SENER

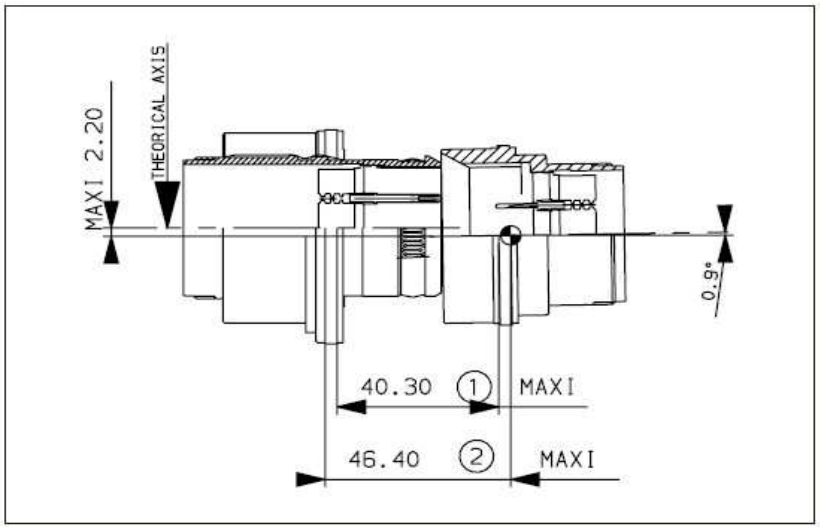
Souriau 8977 Connectors

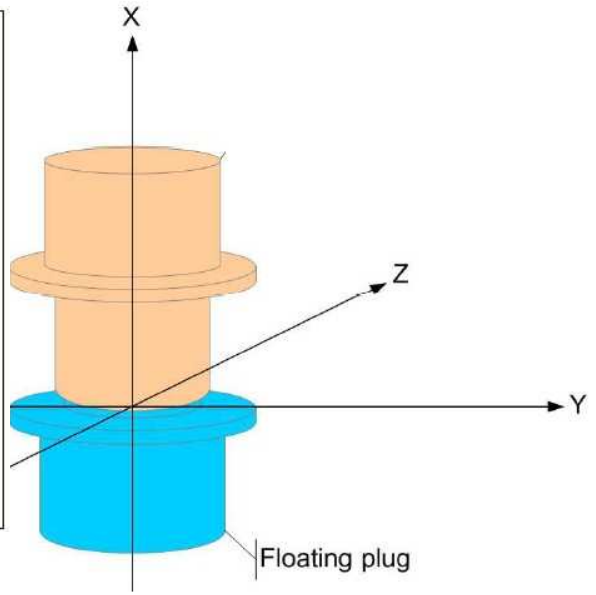
- Quick Disconnect high reliability circular connectors for robotic operations on Extra Vehicular Activity

→ **Low Insertion Force** contacts
→ Thermal gradient compatibility
→ Integrated misalignement catching system
→ High durability - **6000** operations
→ High EMI shielding efficiency
→ Arrangements from MIL-DTL-38999.

Souriau 8977 Connectors

- 8977 Mechanical Performance





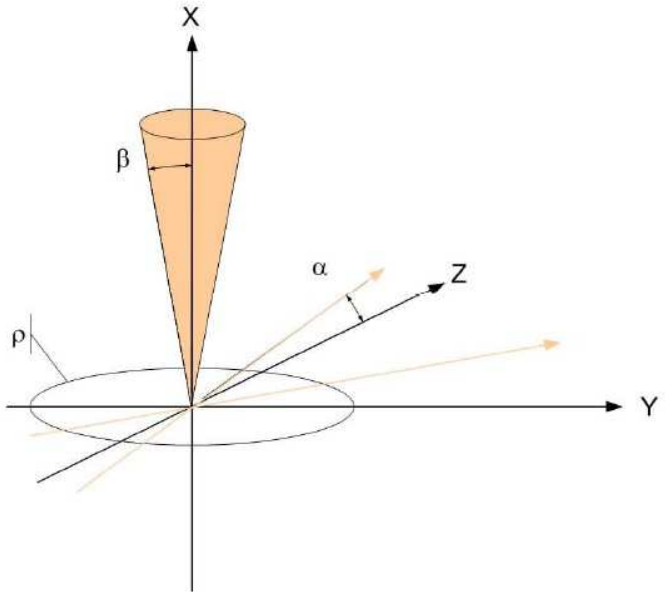


Figure 1: Connectors axis definition

The connector is able to mate, unmate and operate under the following combined misalignment conditions:

Direction	Designation	Values
ρ	Plan movement YZ = circle of radius ρ	≤ 1.95mm
β	Angle between the panels = cone of angle 2β	≤ 0.9deg
α	Movement around the X axis	≤ 0.9deg

Mass
- < 180 g for ORU plug
- < 95 g for receptacle

ORU receptacle overstroke
- ΔX ≥ 1.5 mm

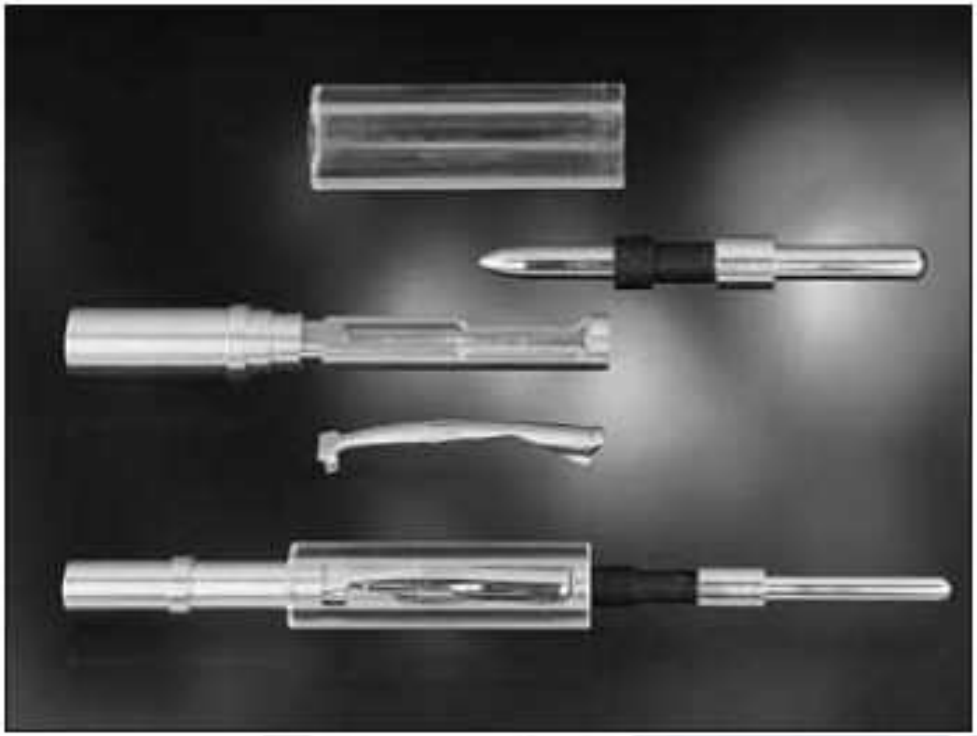
SOURIAU Esterline Connection Technologies

OPEN

ThalesAlenia Space

Souriau 8977 Connectors

- Fitted with **Low Insertion Force (LIF) contacts**
  - → low mating/demating forces
  - → high number of mating/demating cycles
  - → Sizes from #4 to #22, signal, power, coax, triax
  - → Compatible with MIL-DTL-38999 connectors



Souriau 8977 Connectors

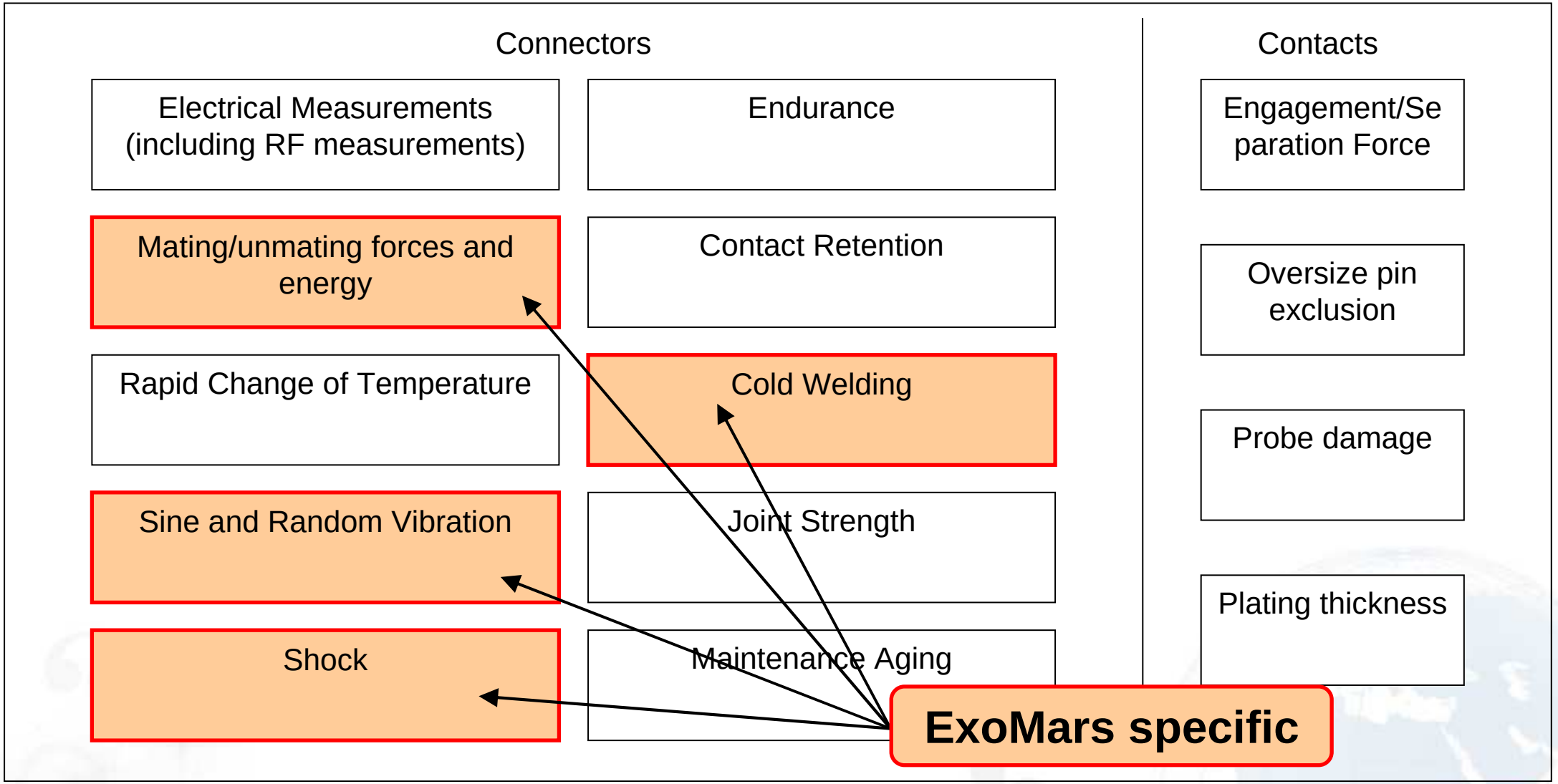
- Heritage
  - → Aboard the **ISS** on the Japan Experimental Module
  - → Separable harness for **Cassini-Huygens** mission
  - → Intermodule separation on **BepiColombo** mission
  - → Umbilical separation connectors for **ExoMars 2016** mission

Qualification and Acceptance approach

- ExoMars mission requires additional performance data and qualification tests from the 8977 Souriau connectors, such as :
  - **values and dispersion of the un-mating force and energy** at the ExoMars worst case conditions expected at separation (temperature and misalignment)
  - **effect of the cold welding** at T_{min}=-80℃ in vacuum condition on the un-mating force
  - capability to maintain **electrical continuity during sine and random vibration** at the mission levels with maximum contact disturbance time of 1µs
  - capability to maintain **electrical continuity during shock** up to a peak acceleration of 3000g SRS with maximum contact disturbance time of 1µs
- Qualification tests also covering the **ESCC3401** and **ESCC3402**

Qualification and Acceptance approach

List of Qualification Tests



Qualification and Acceptance approach

- Tests are on wired connectors, equipped with different contact types (L.I.F., Coaxial and Thermocouple contacts) and with backshells in order to reproduce as far as possible the flight configuration

- Tests are carried out at *Laboratoire Central d'Essais* (LCE) at SOURIAU. This laboratory is used to qualify SOURIAU space ranges, with the support of CNES and ESA.

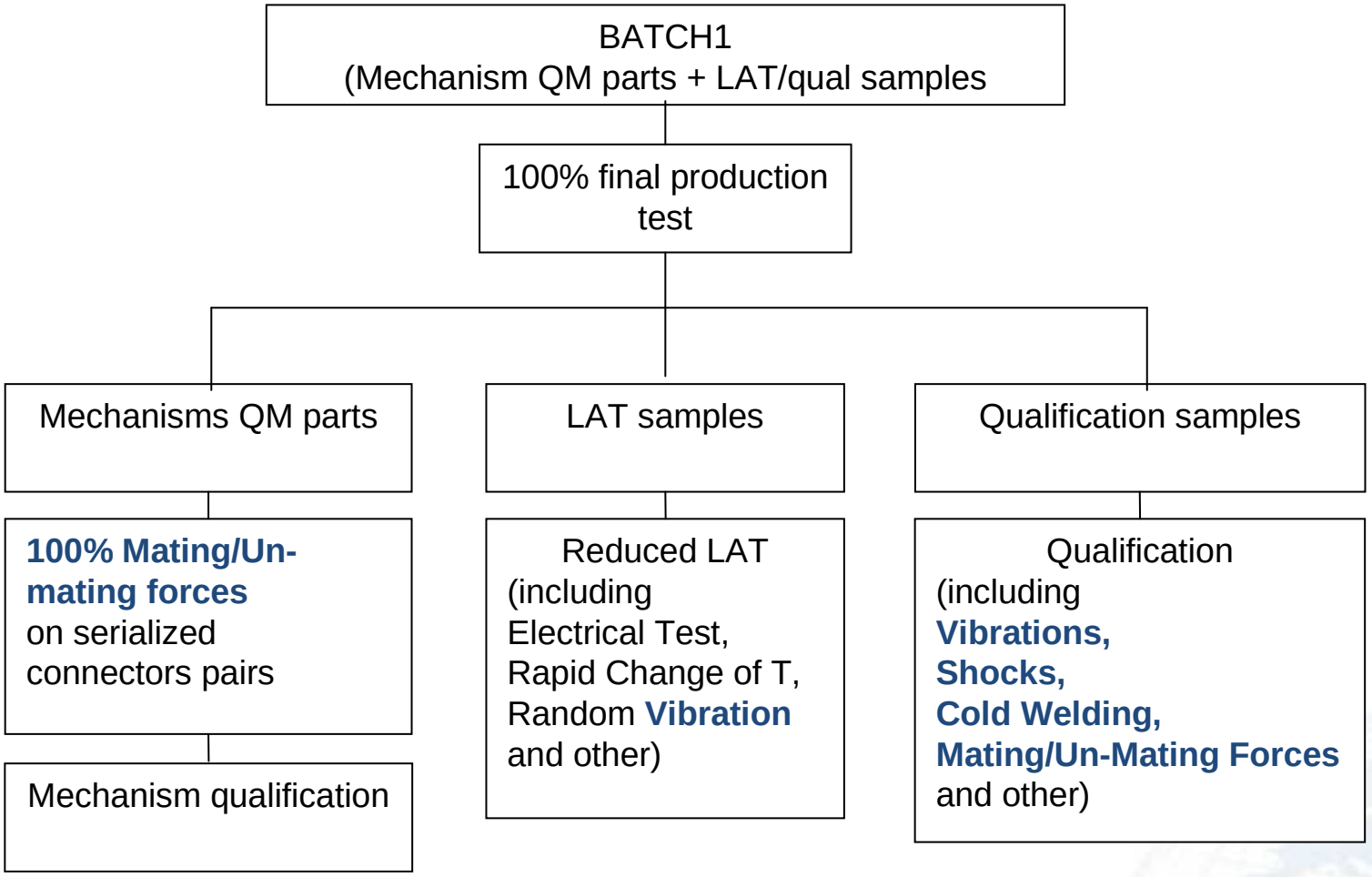
Qualification and Acceptance approach

- 12 pairs of connectors will be mounted on Flight Model

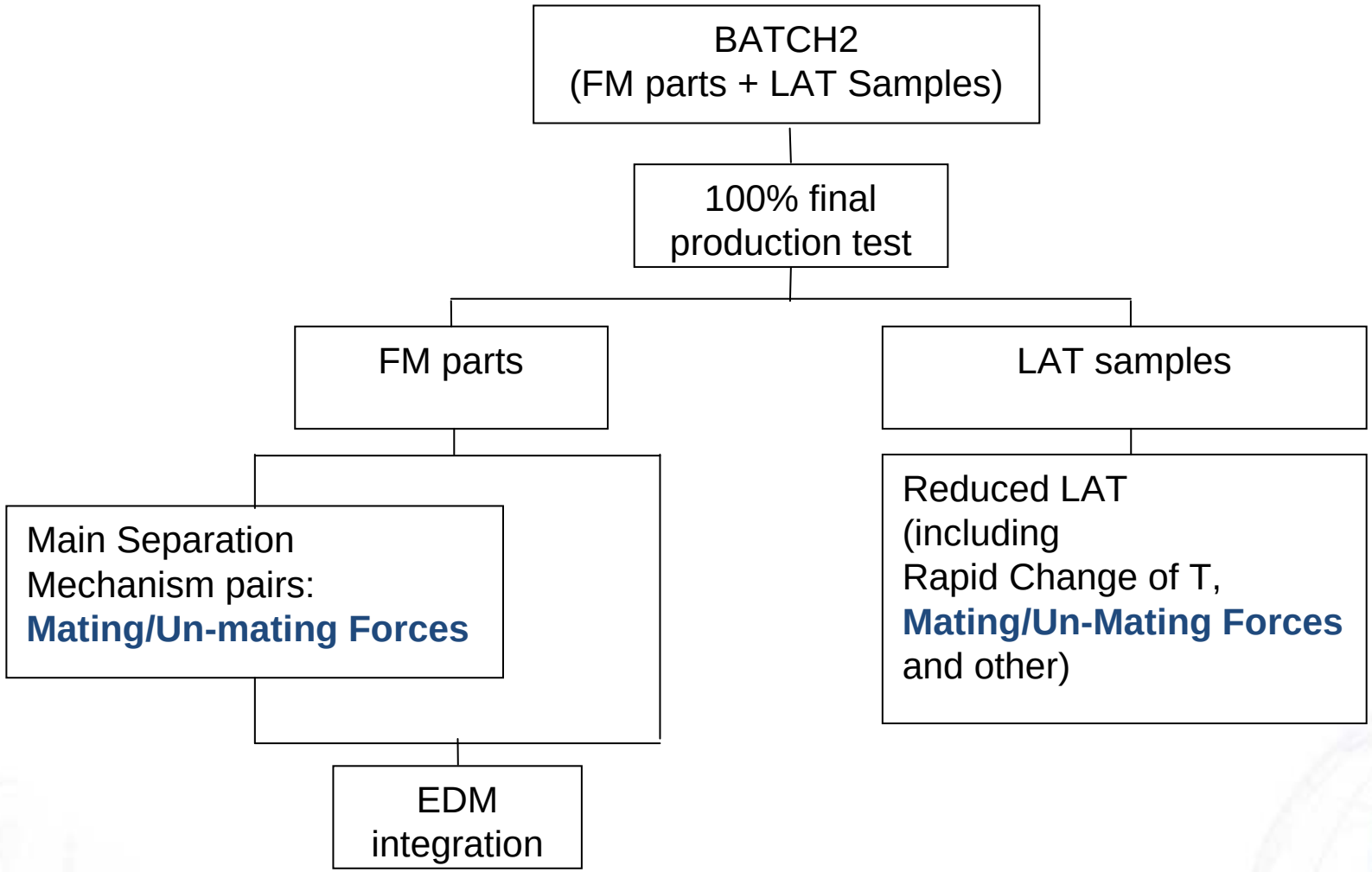
- In addition several connectors will be used for
  - Qualification of the separation mechanisms (QM assemblies)
  - Test harness
  - Qualification of the connectors

- This amount of connectors cannot be produced in a single lot, therefore the production has been splitted in 2 batches:
  - Batch 1 for QM assemblies and qualification purpose
  - Batch 2 for FM with specific LAT

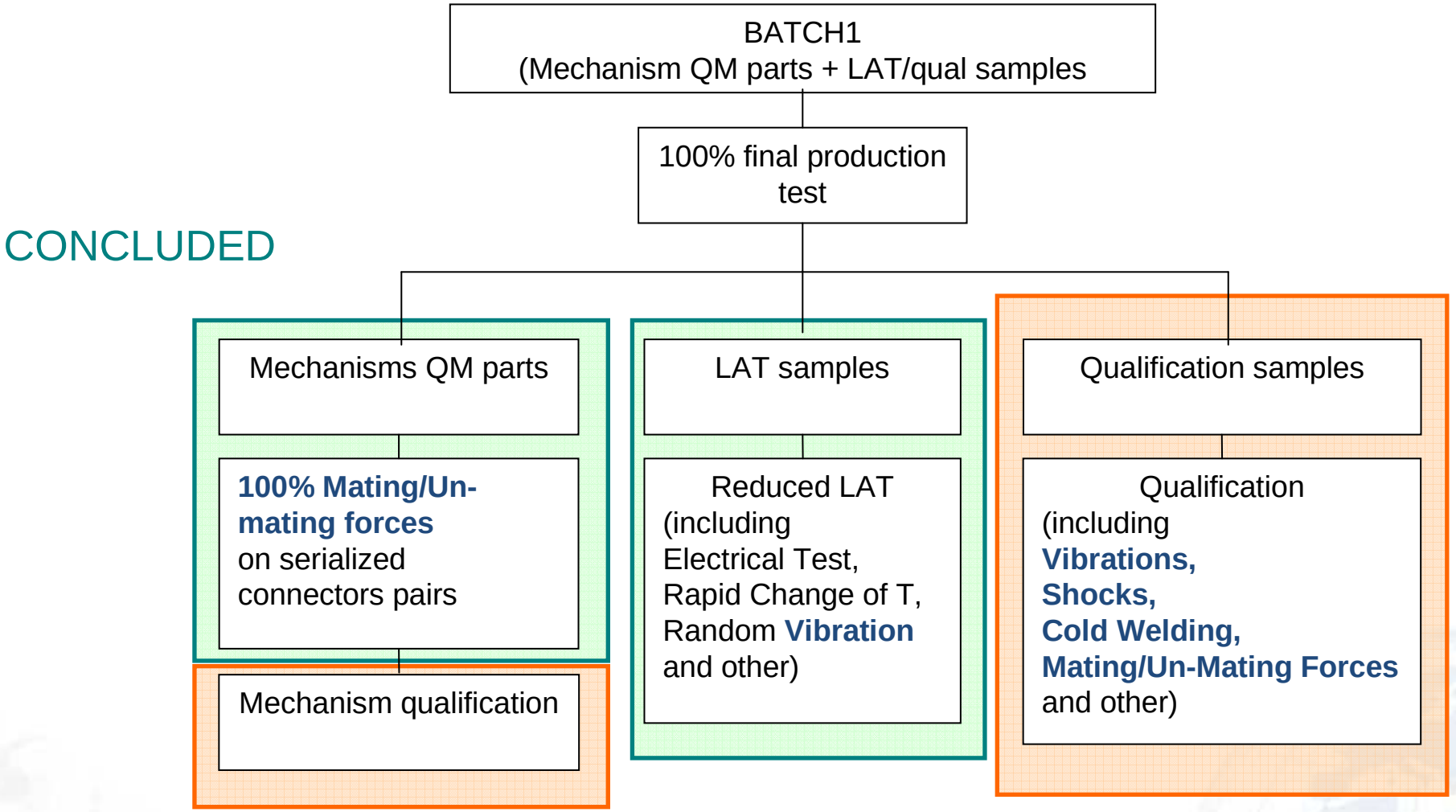
Qualification and Acceptance approach



Qualification and Acceptance approach



Where we are: available test results



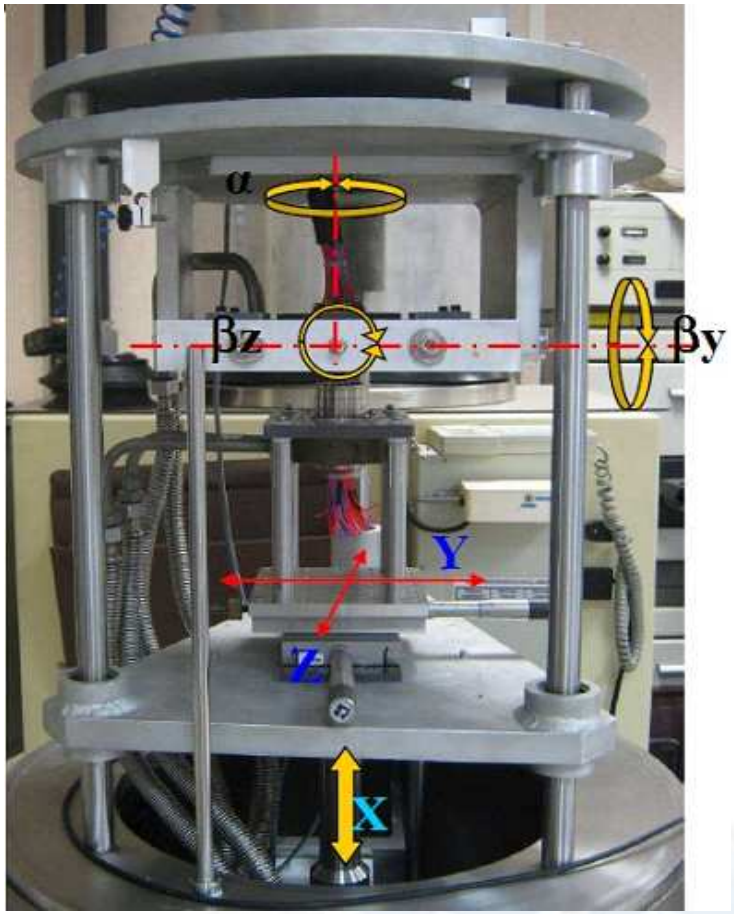
Where we are: available test results

Mating/Un-mating Forces

- Connectors pairs tested in vacuum at the worst-case temperatures expected at separation:

  Tmin=-60℃, TMAX=+70℃

- Tested at different misalignment conditions (up to the maximum angular and in-plane misalignment).

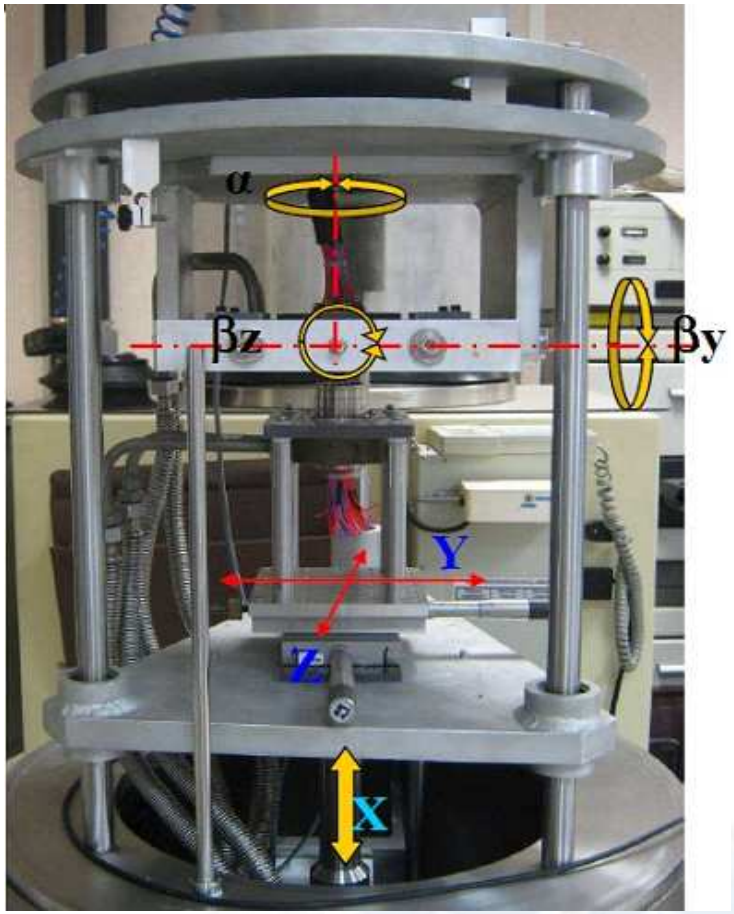


Mating/un-mating forces test bench

Where we are: available test results

Mating/Un-mating Forces

- **Repeatable** behaviour of each connector pair
- **No effect** of the **wiring** on the un-mating forces and energy (as expected)
- Separation force dependence on **contact** arrangements:
  - connectors fully equipped with LIF contacts < Sep. F (as expected)
  - use of thermocouples and coaxial contacts not jeopardizing the separation
- Un-mating force @ **-60°C ~ 145%** un-mating force @ **+70°C**
- **No** significant **change** of un-mating force in **aligned and misalignment** (same pair)
- Connectors fully equipped with LIF contacts: forces **dispersion ~ ±25%**

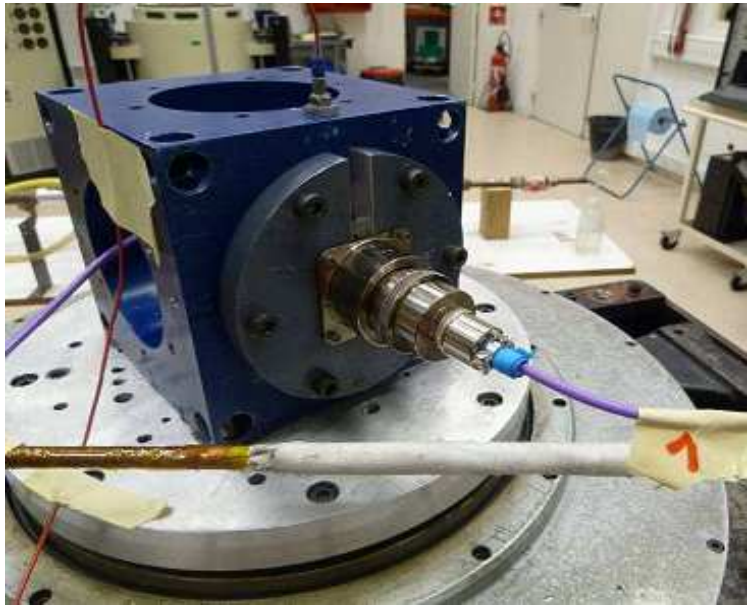


Mating/un-mating forces test bench

Where we are: available test results

Vibration

- Experience of the shocks and vibrations induced by the separation and by the entry phase in the Martian atmosphere
- Electrically monitored connectors to detect any signal interruption >1µs
- Connectors have successfully passed the vibration test of the LAT maintaining the electrical continuity and without any mechanical damage



Vibration test bench

Still to do: future outlook

- Completion of the qualification flow including
  - Vibration Test
  - Shock Test
  - Cold Welding Test
- Batch 2 LAT
- Testing of the de-mating forces on the Main Separation Mechanism Connectors before integration on the FM

Conclusion

- An extended characterization of the 8977 connectors in the ExoMars condition is in progress
- Measurements so far obtained during LAT are used to enhance the qualification test setup
- The results of the demating forces test on the QM assemblies have been used to tune the **qualification test of** the three **EDM Separation Mechanisms** and to refine their design.
- The LAT vibration test are successful : promising also on the results of the forthcoming shock test.
- The qualification campaign will be concluded in the next months. Focus is on the **Shock and Cold Welding** test results.
- The un-mating force and energy of the connectors that will be mounted on the Flight Model of the Main Separation Assembly will be **measured before integration** on the EDM and will be **used as input for the final calibration of the mechanisms.**
- Initial results are encouraging on the suitability of the 8977 connectors for the ExoMars 2016 mission and confirm the maturity of the **European space technology.**

Acknowledgment

Thanks to D. Lacombe and ESA ExoMars PA team
for the support in the definition of the qualification approach