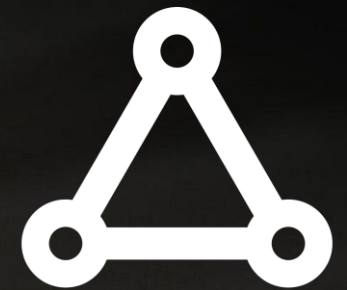
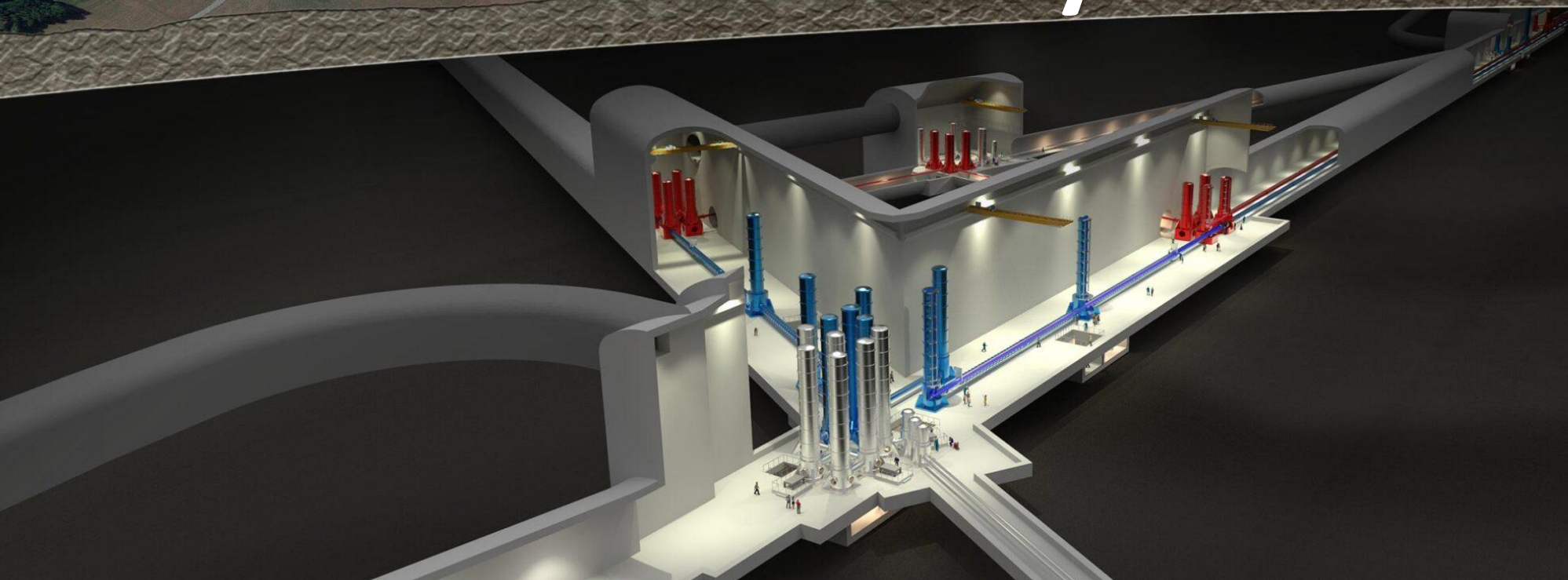


The Einstein Telescope

Break-out session:
Robotic Assembly & Mechatronics



Einstein
Telescope

Who-is-Who



Problem Statement



Problem Statement

⚠ Building the first towers has taken months

- x 300 towers → ~50 years

⚠ Much is done manually

- Risk of accidental pollution
- Risk of construction errors in some of the 300 towers

➔ Need for automation

E.g. cobots, heavy construction robots

➔ Bring in “Design for manufacturing”



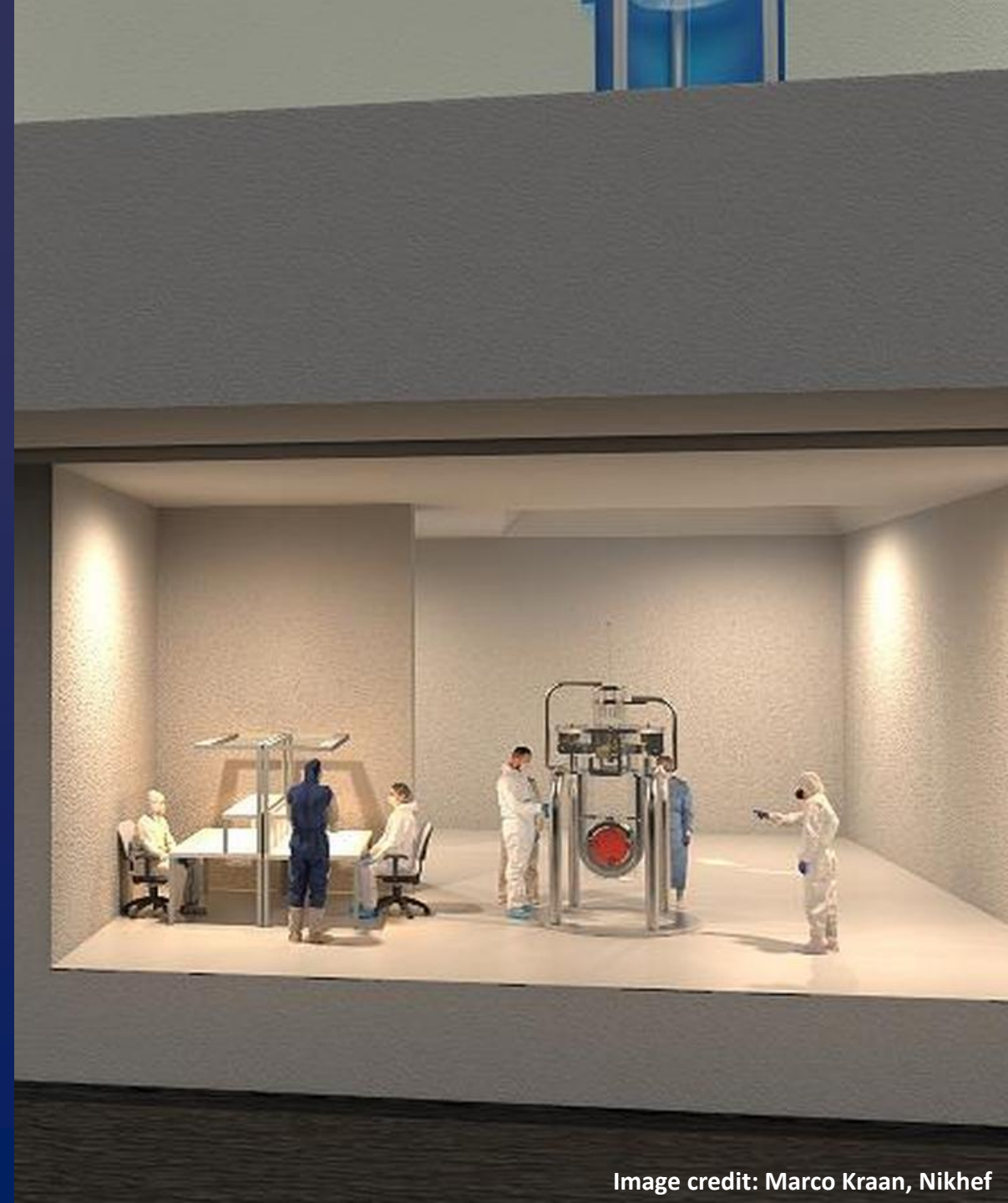
Problem Statement

△ Work done in cleanroom environments in the caverns

- Only trained personnel (safety aspects)
- Complex and long travel to underground structures
- Preparation areas for working in the cleanrooms (dust blowers, changing rooms ...)
- Each part requires its own specialised team

➔ Preparation of components and assemblies on the surface

➔ Defective components are unmounted and shipped to the surface



Problem Statement

△ “Millions of components” expected

- Parts can arrive on site randomly
- Storage and preparations must be done in cleanroom environments
- Some parts have >1year delivery leads
- Integration with WMS and ERP systems
- Some parts are exceptionally big
- Storage of individual components up to larger assemblies

➔ Need for specialised warehouses

➔ (Very) large storage space needed, with cleanroom requirements

➔ Advanced software for track & trace and logistics

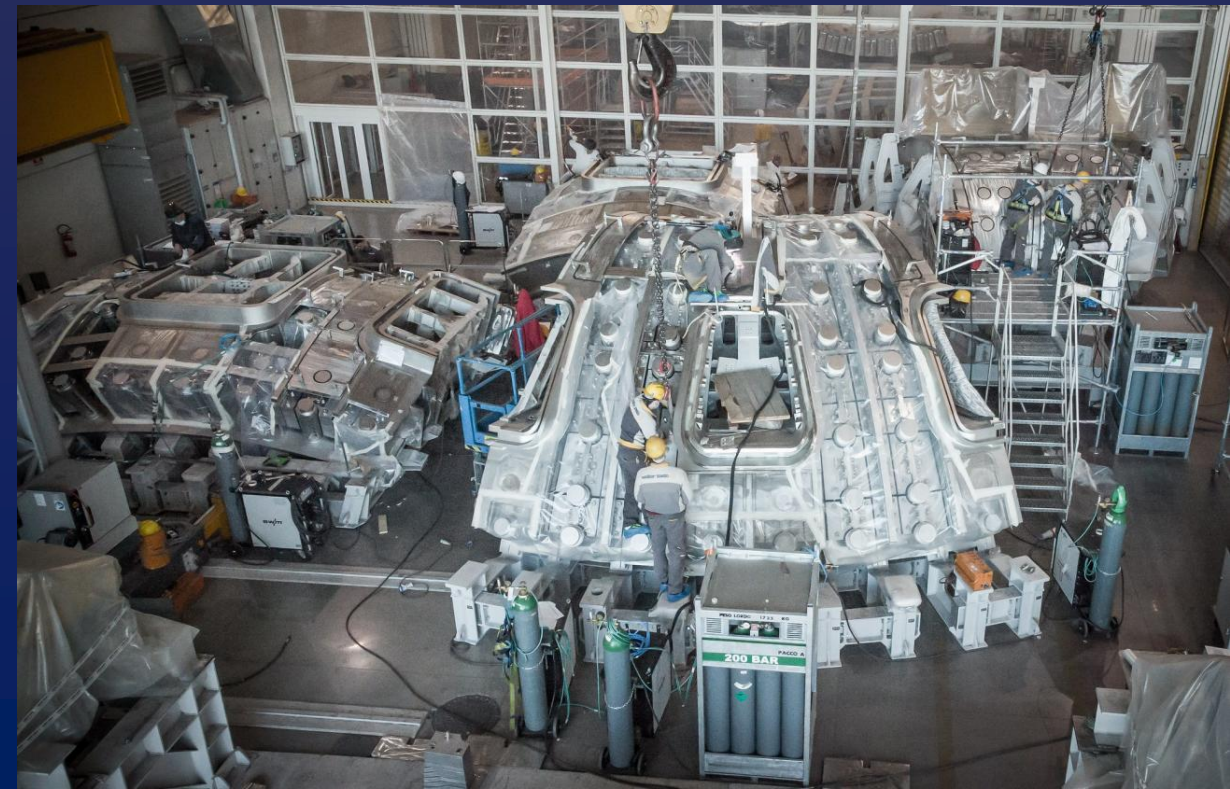


Image credit: ITER

Problem Statement

- △ Ultra High Vacuum components
 - need for cycles of bakeout + ultrasonic cleaning
 - Cleaning must be possible locally
 - Need for periodic re-cleaning
 - UHV cleaning of large components
- △ Infrastructure needed for local UHV cleaning



Image credit: ETpatfinder

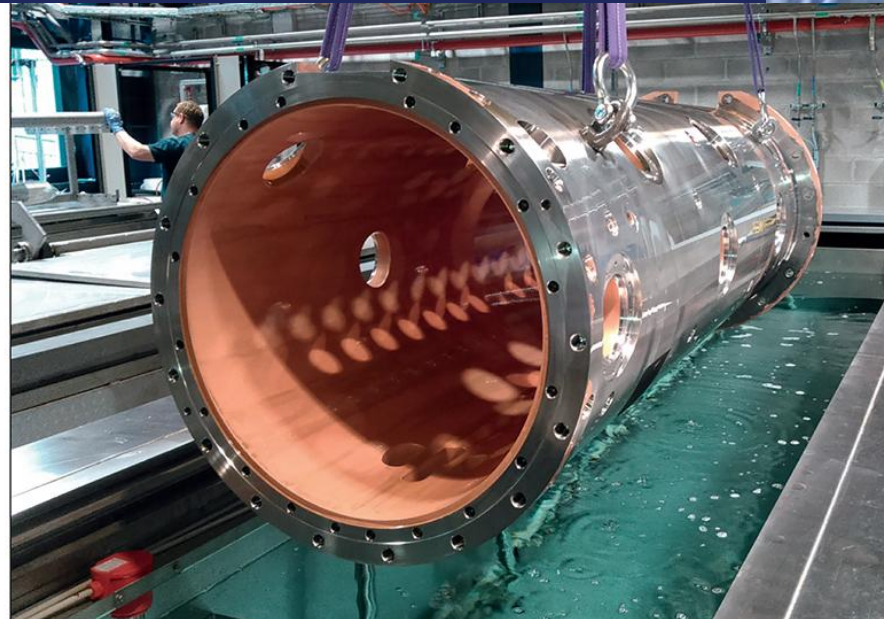


Image credit: CERN



Problem Statement

⚠ Need for inspection and test

- Observation that many components come in defective
- Observation that pre-assemblies can be faulty
- Even assembly line components can include bad parts

➔ “Every single part will require individual testing”

➔ Factory Acceptance Test / Site Acceptance Test

➔ Need for specialised personnel and advanced measurement setups

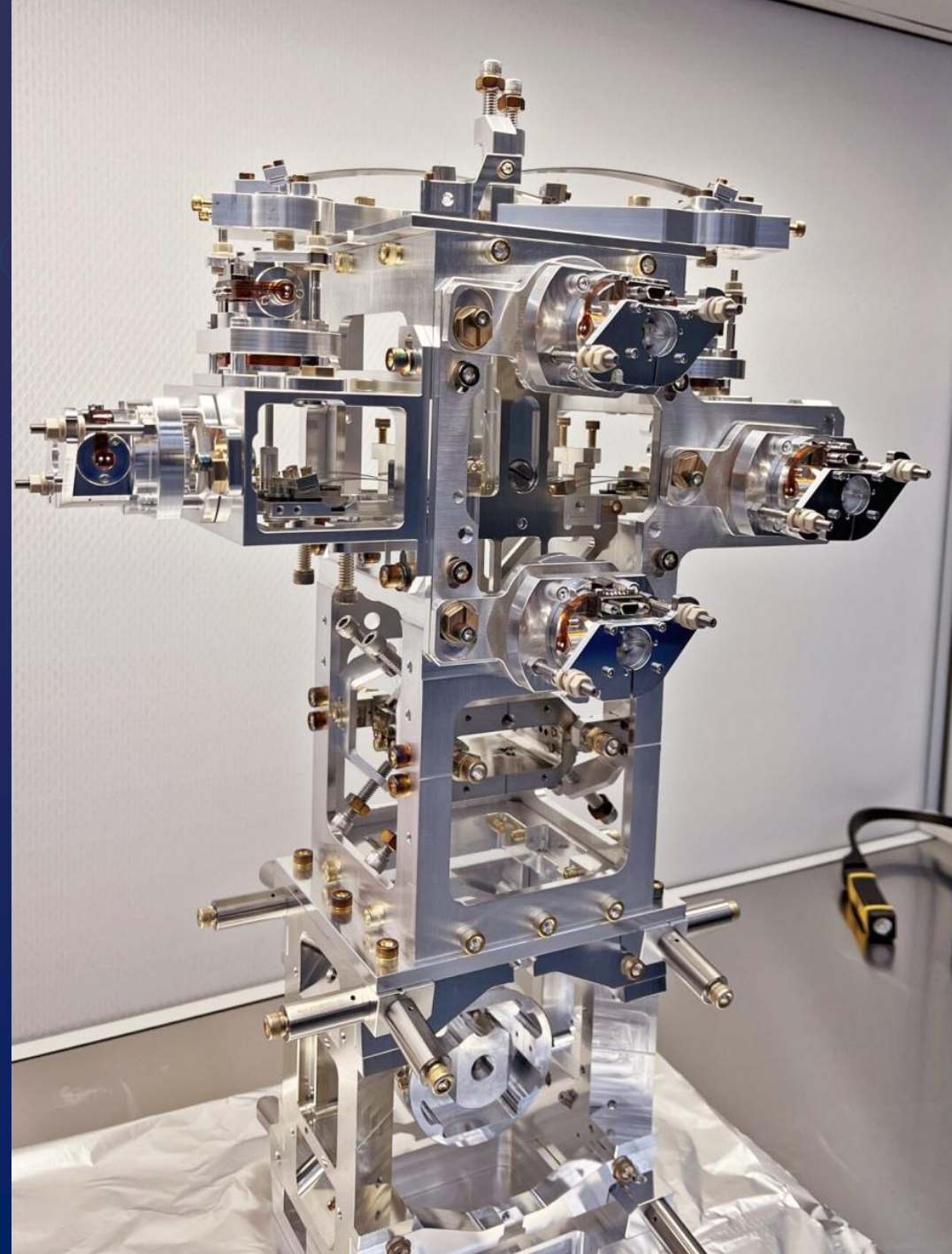


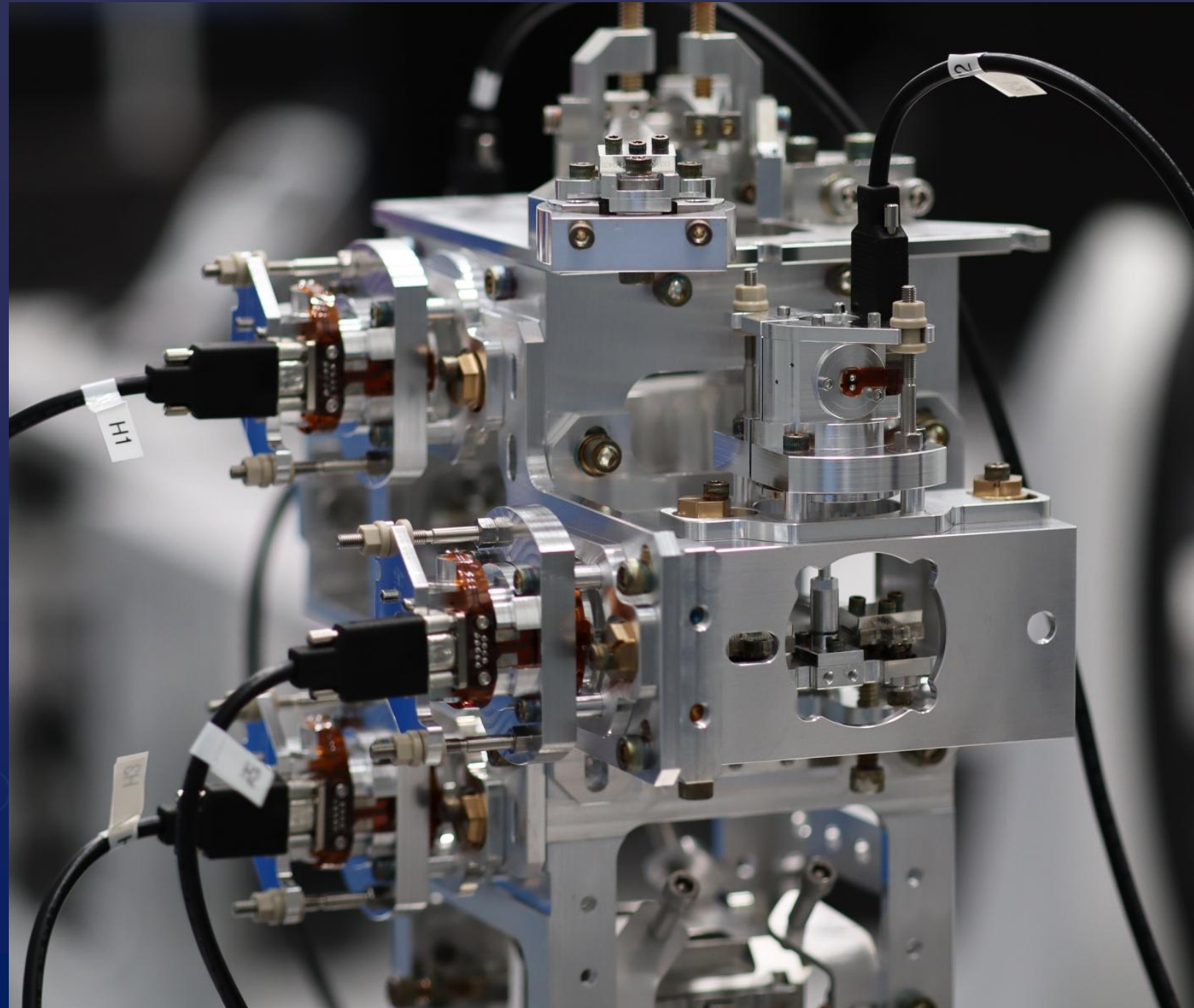
Use Cases



Use Case: Bench-top suspension

- △ Problem statement: highly specialised equipment to be installed in confined spaces
 - Pre-assembly and test must be done on the surface
 - Need for specialised personnel for qualification and calibration
- △ Example: HRTS (HAM Relay Triple Suspension)
 - 6 DoF damping system for mirrors and equipment
 - Need for UHV cleaning and packaging (3 layers)
 - Need for dedicated low-vibration transport





Use Case: GAS Dampers

△ Geometric Anti Spring dampers

- Positive + negative temperature coefficients allow use at low temperatures without deformation
- Passive high frequency damping (GAS springs)
- Active low frequency damping (voice coils)

