JUICE RIME Antenna in-flight anomaly

J. Gumpinger, R. Le Letty, D. Monteiro, A. Atzei, D. Escolar

24/06/2024

Content

RIME antenna deployment

Nominal steps

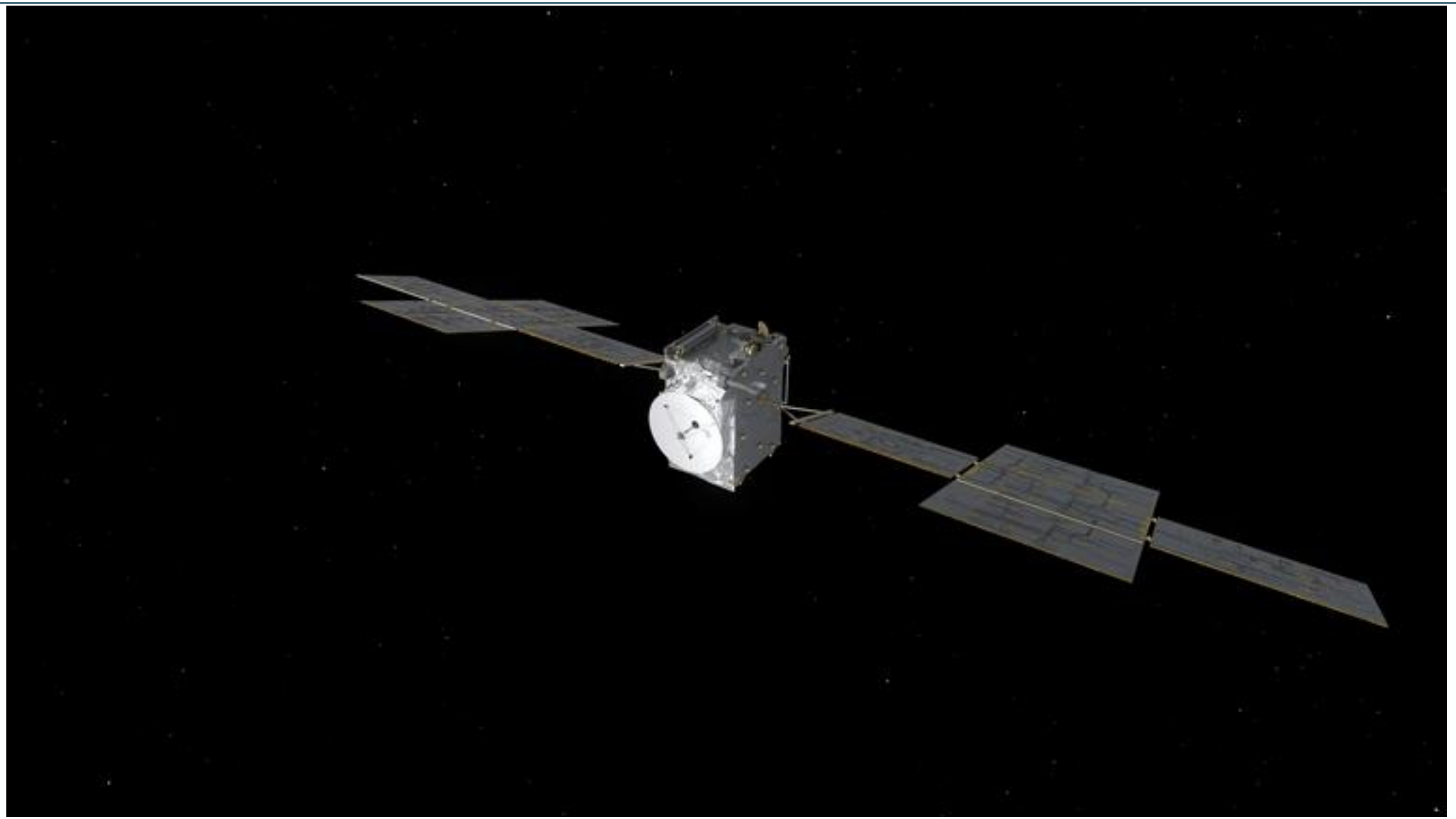
Overview of the RIME antenna and HDRM

Root Cause Analysis

Recovery options and associated risks

Lessons learnt

RIME antenna deployment

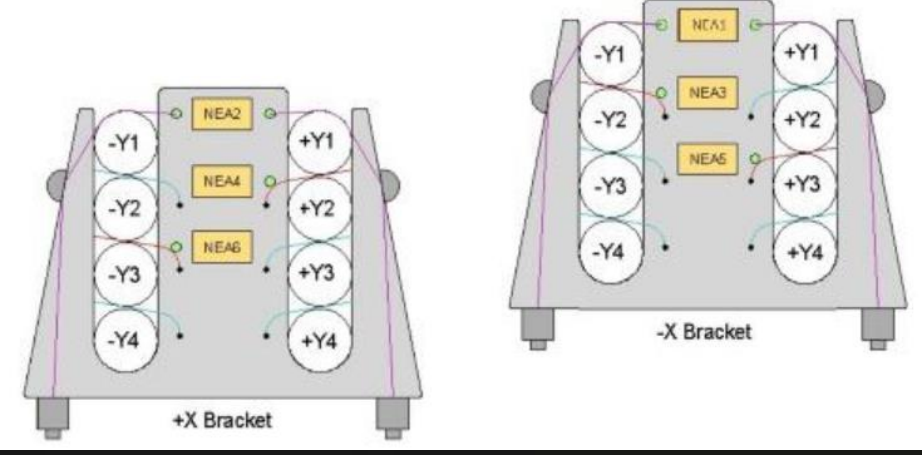


Nominal steps

NEA1 and 2 → deployment of first segments on +Y and -Y booms

T= -80C

Before actuation:

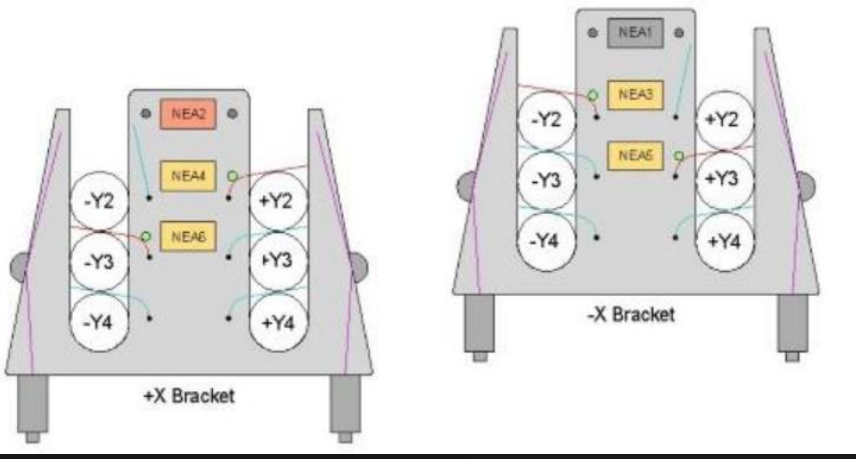


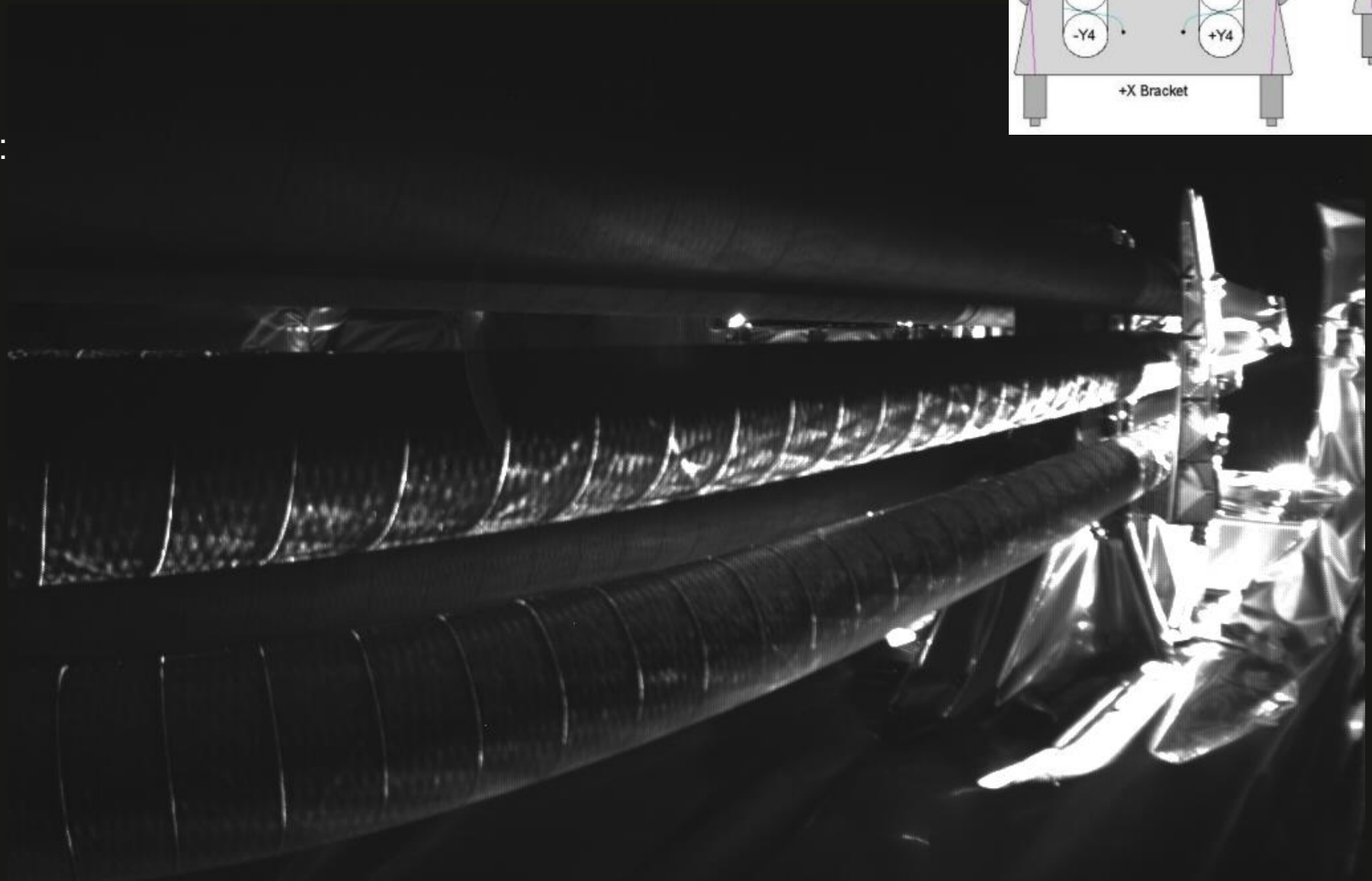
Nominal steps

NEA1 and 2 → deployment of first segments on +Y and -Y booms

T= -80C

After actuation:

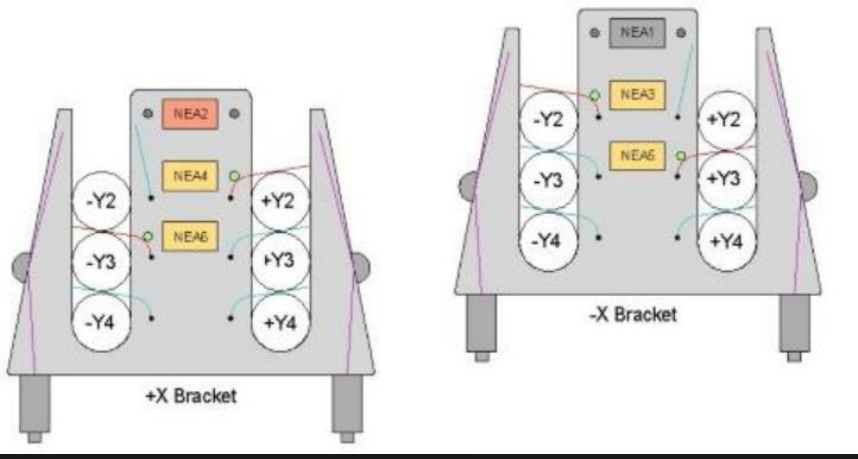




Nominal steps

NEA4 → no deployment of +Y boom's second segment

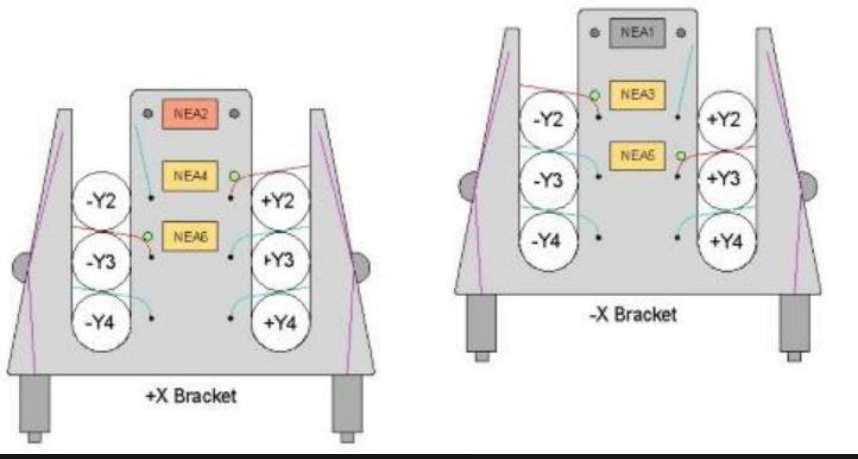
T= -80C



First attempt to recover

NEA5 → no deployment of +Y boom's second segment

T= -80C



Overview of the RIME antenna

Planned sequence:

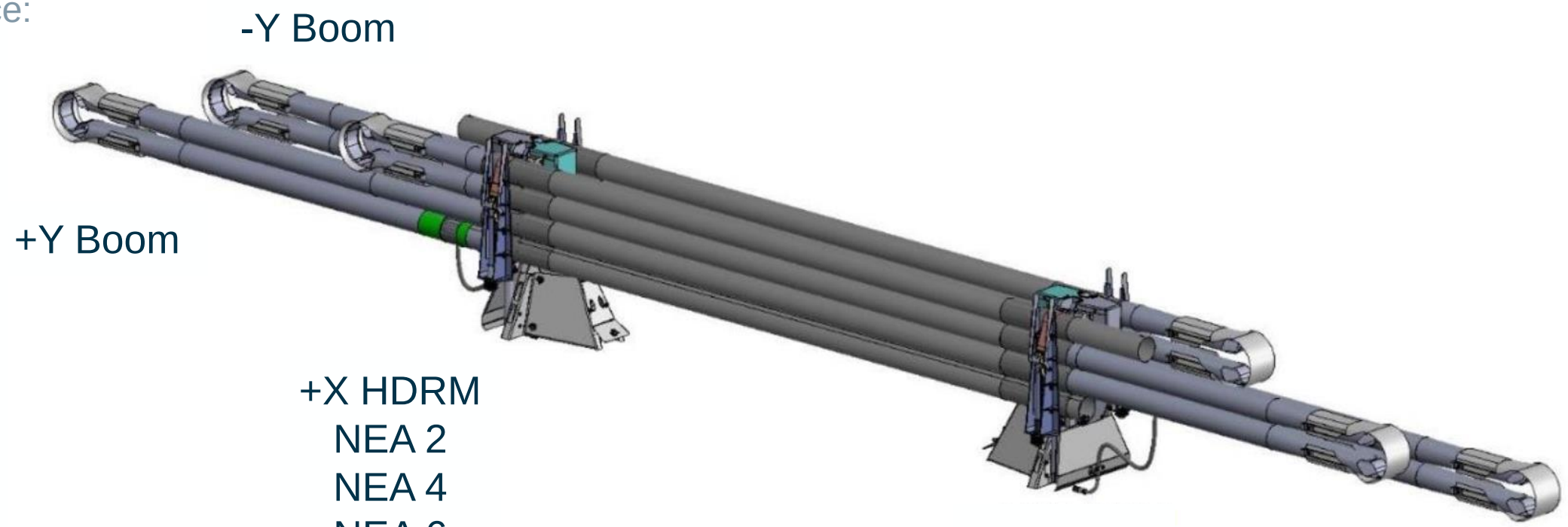
NEA1 and 2

NEA4

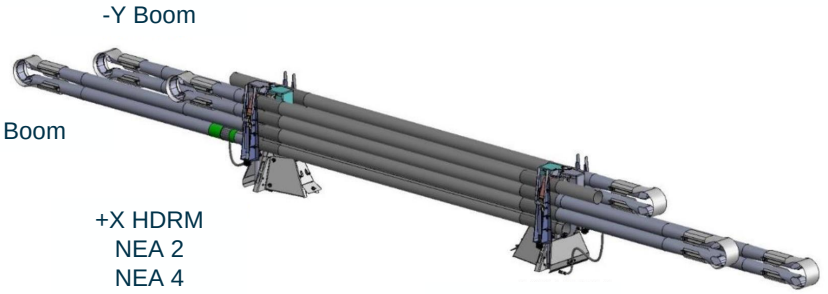
NEA5

NEA3

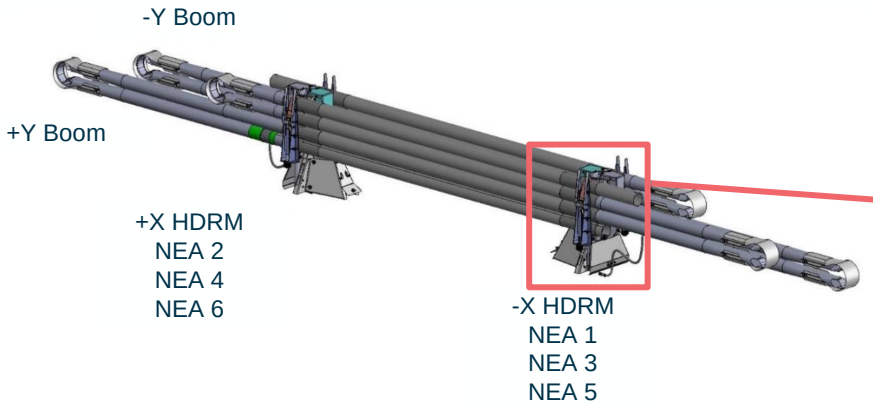
NEA6

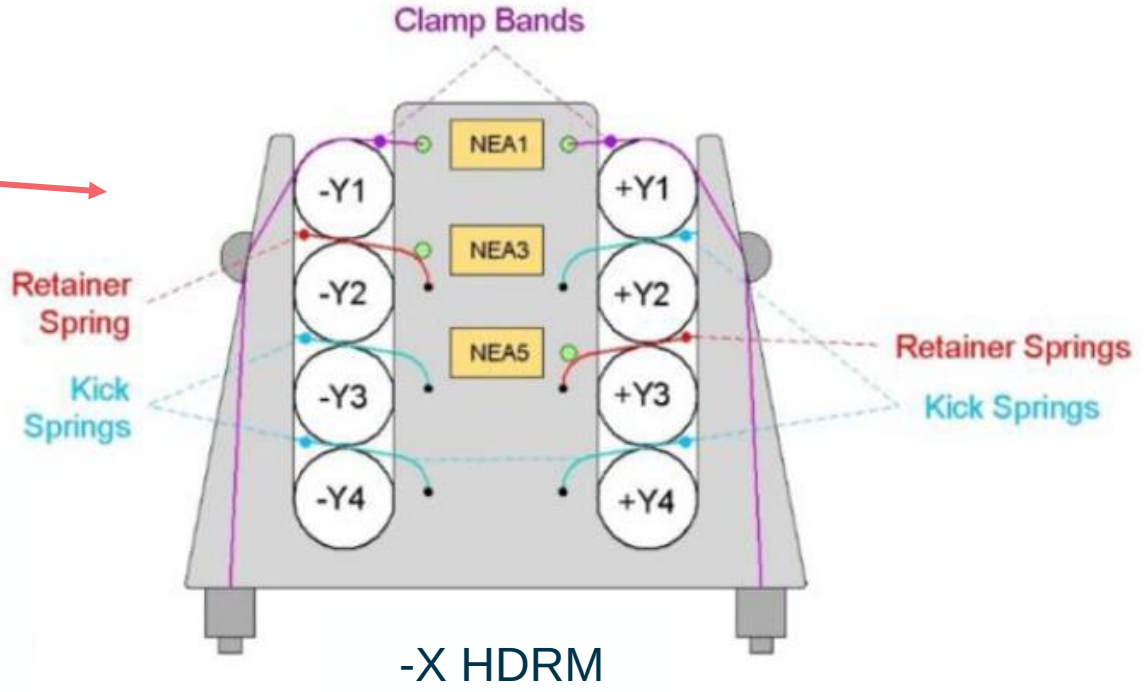


Overview of the RIME antenna

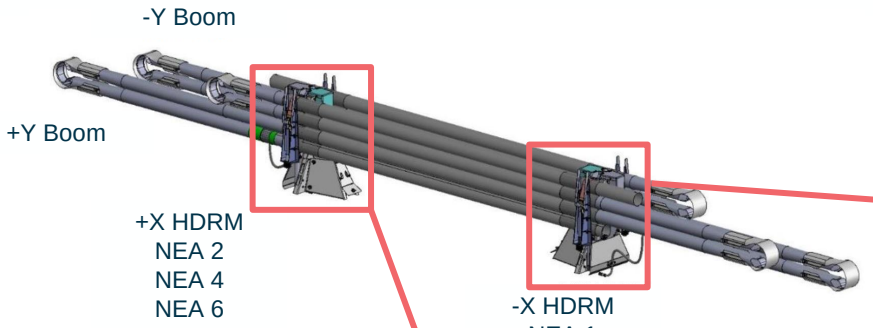


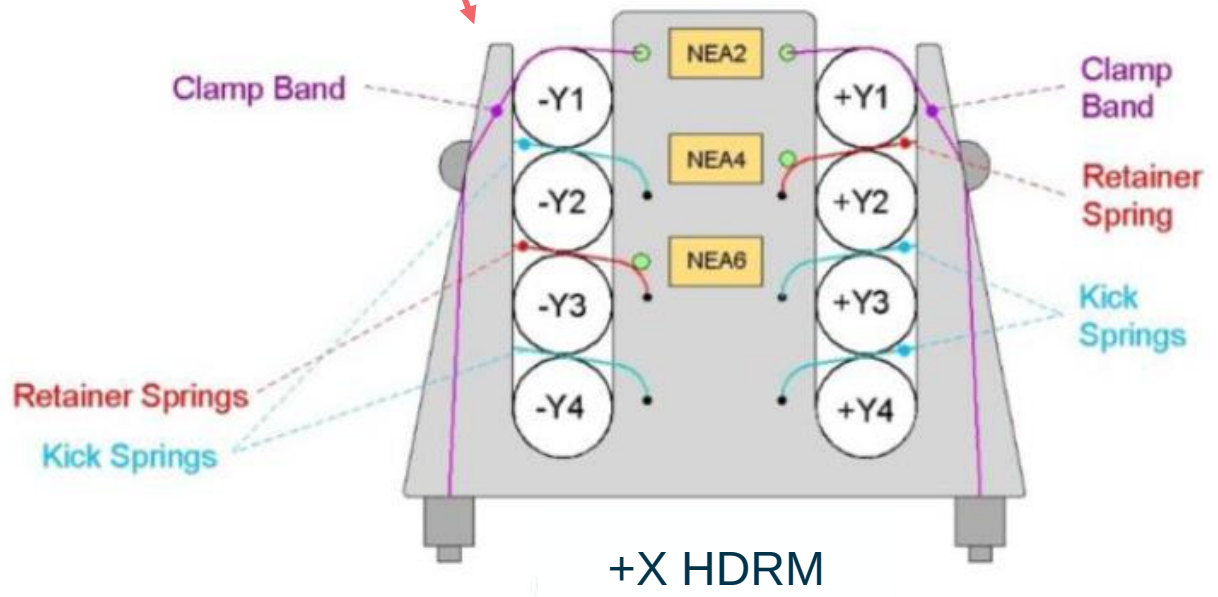
Overview of the RIME antenna

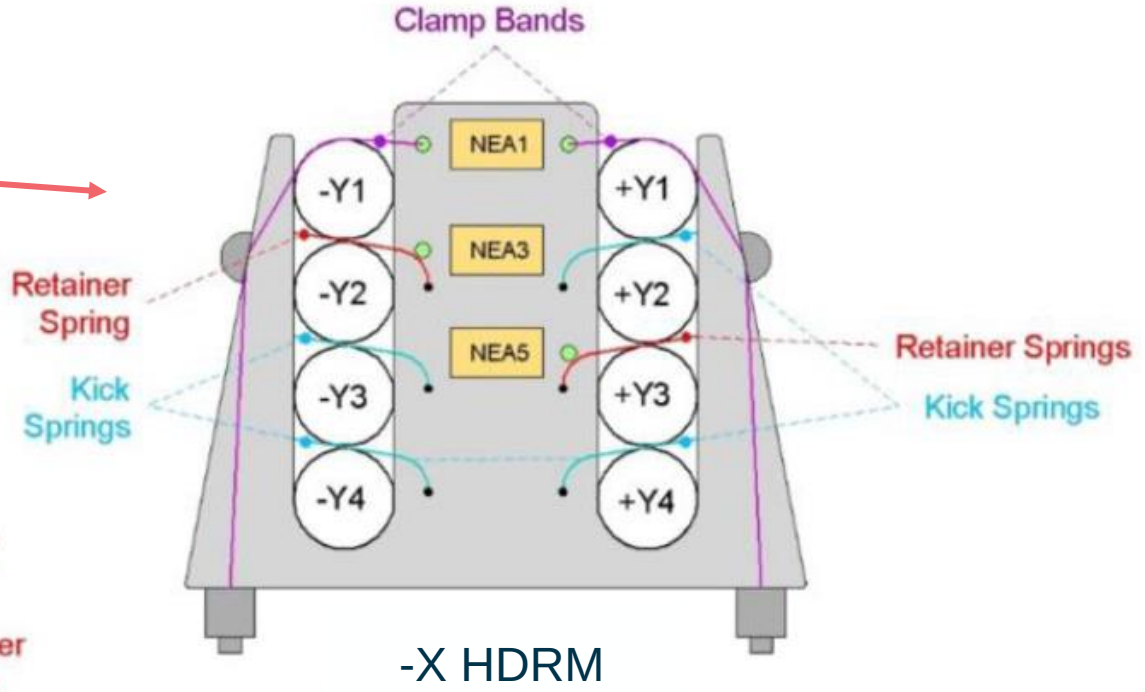




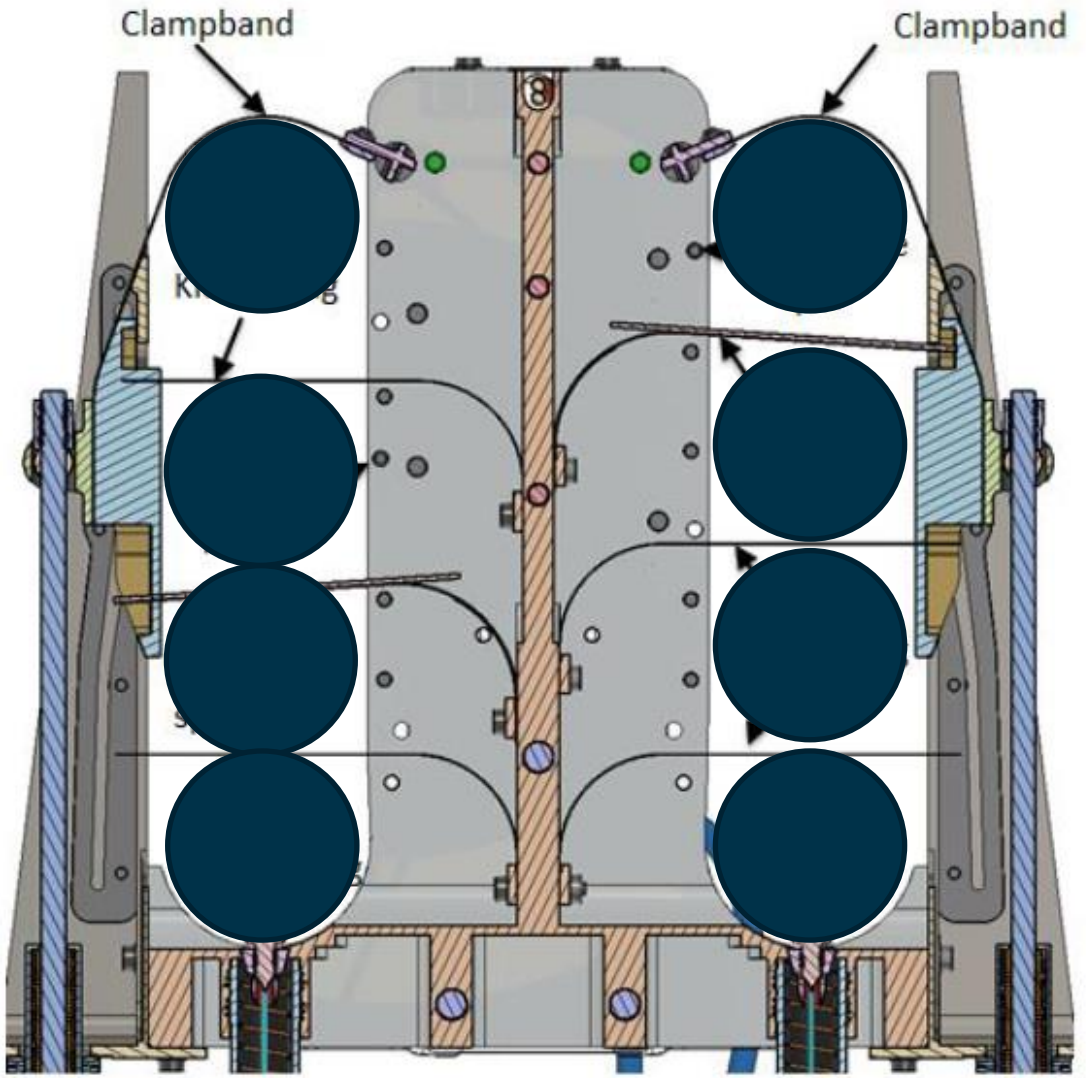
Overview of the RIME antenna



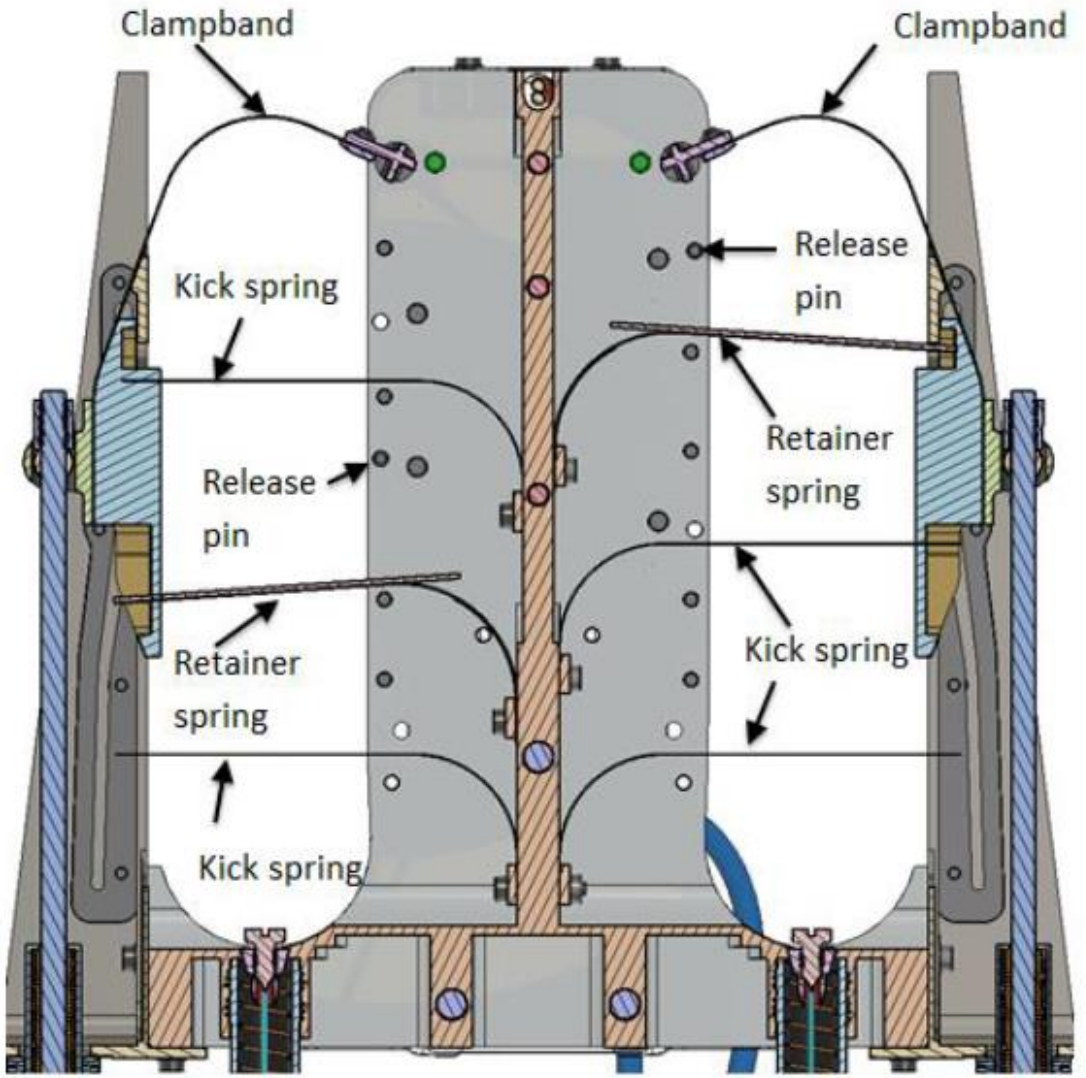




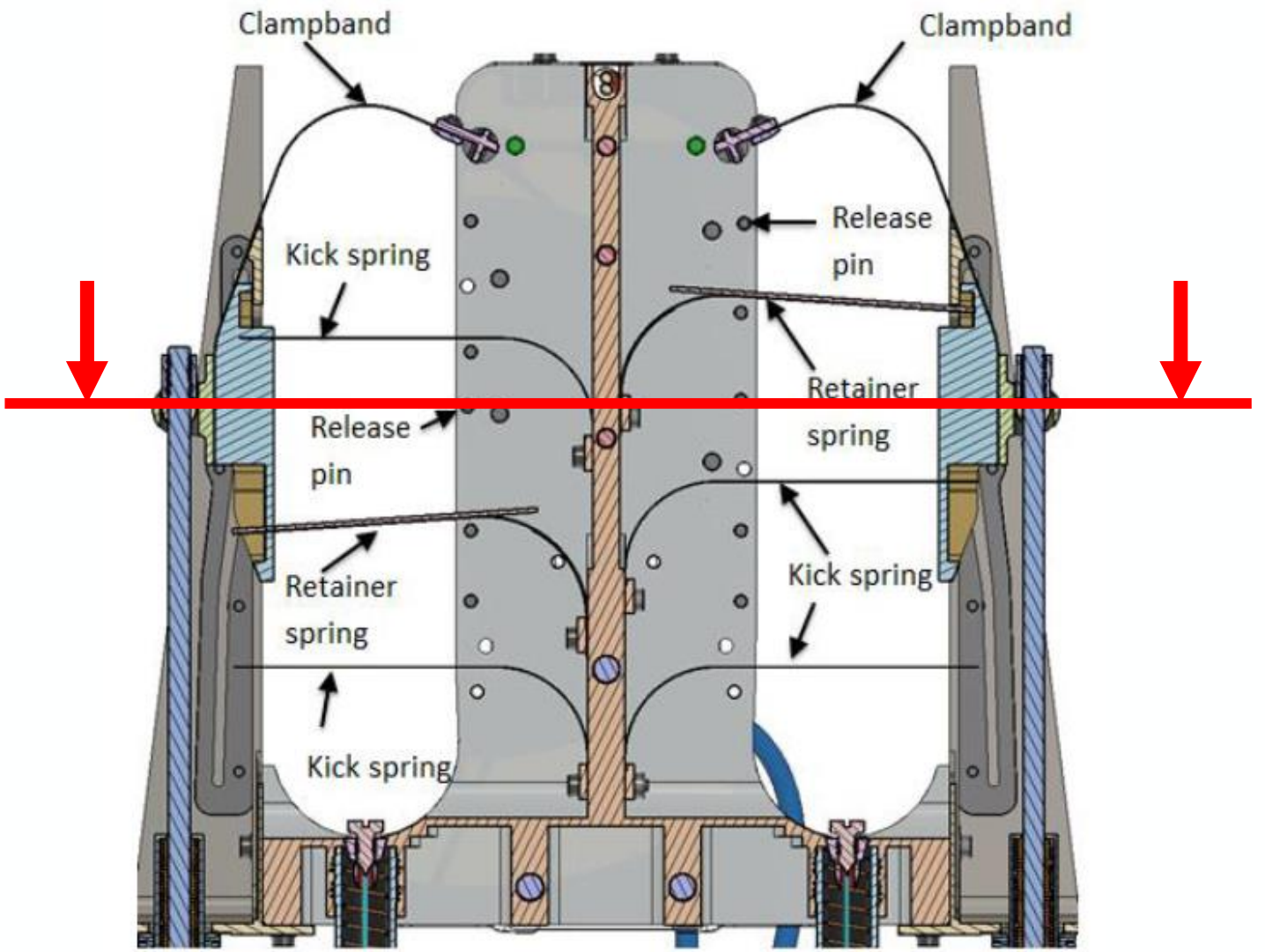
Brief description of the HDRM



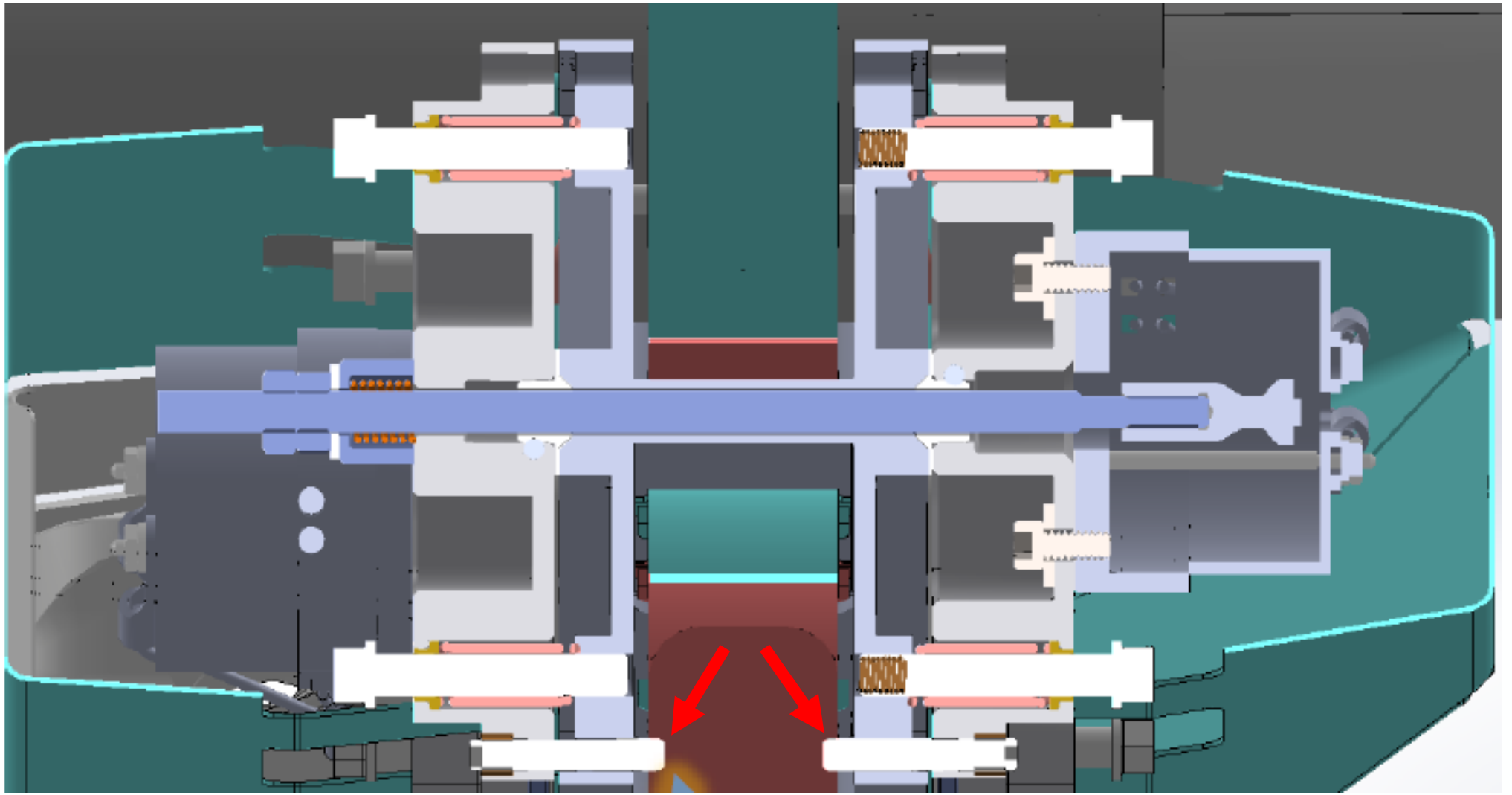
Brief description of the HDRM



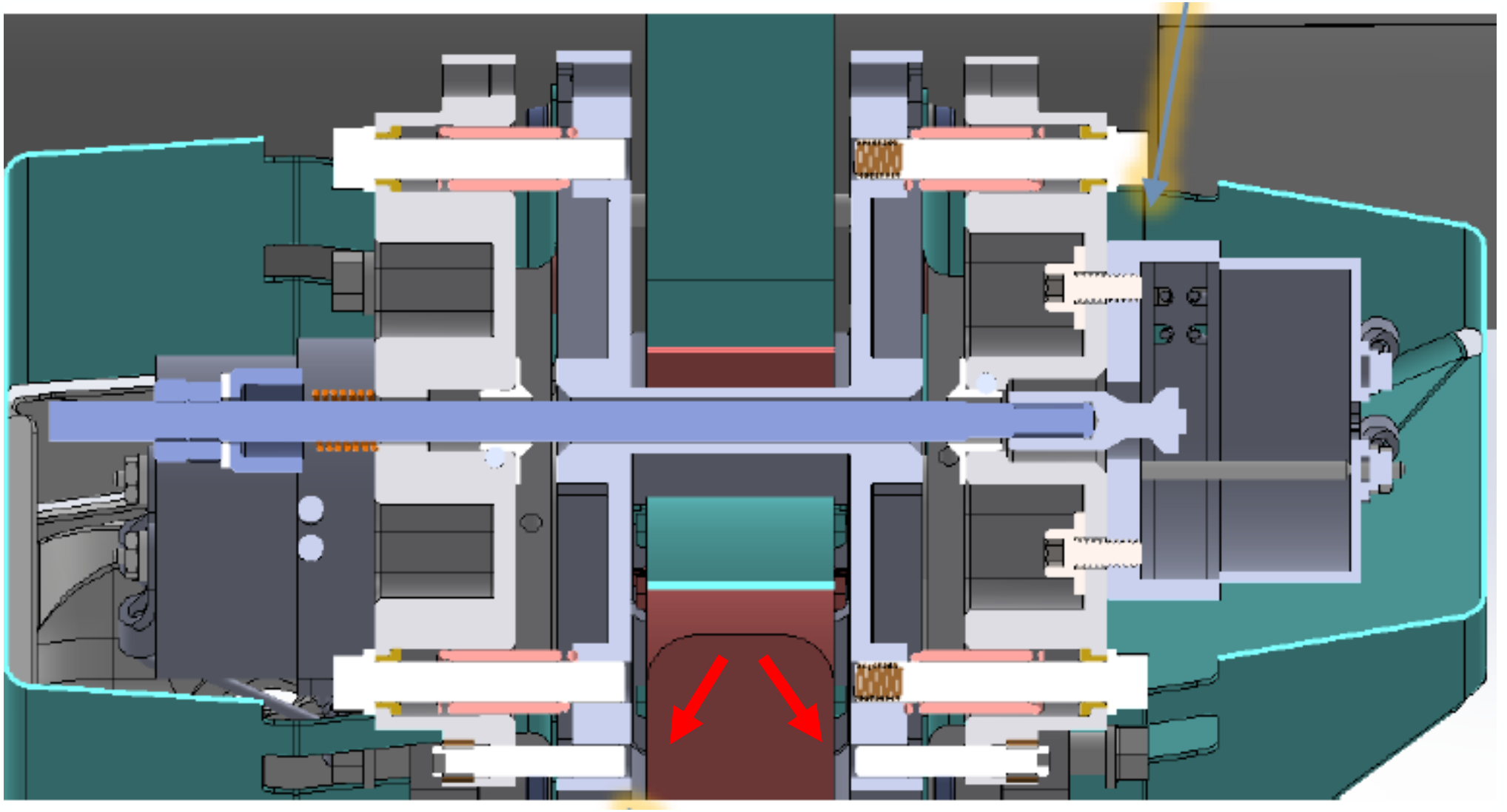
Brief description of the HDRM



Brief description of the HDRM



Brief description of the HDRM



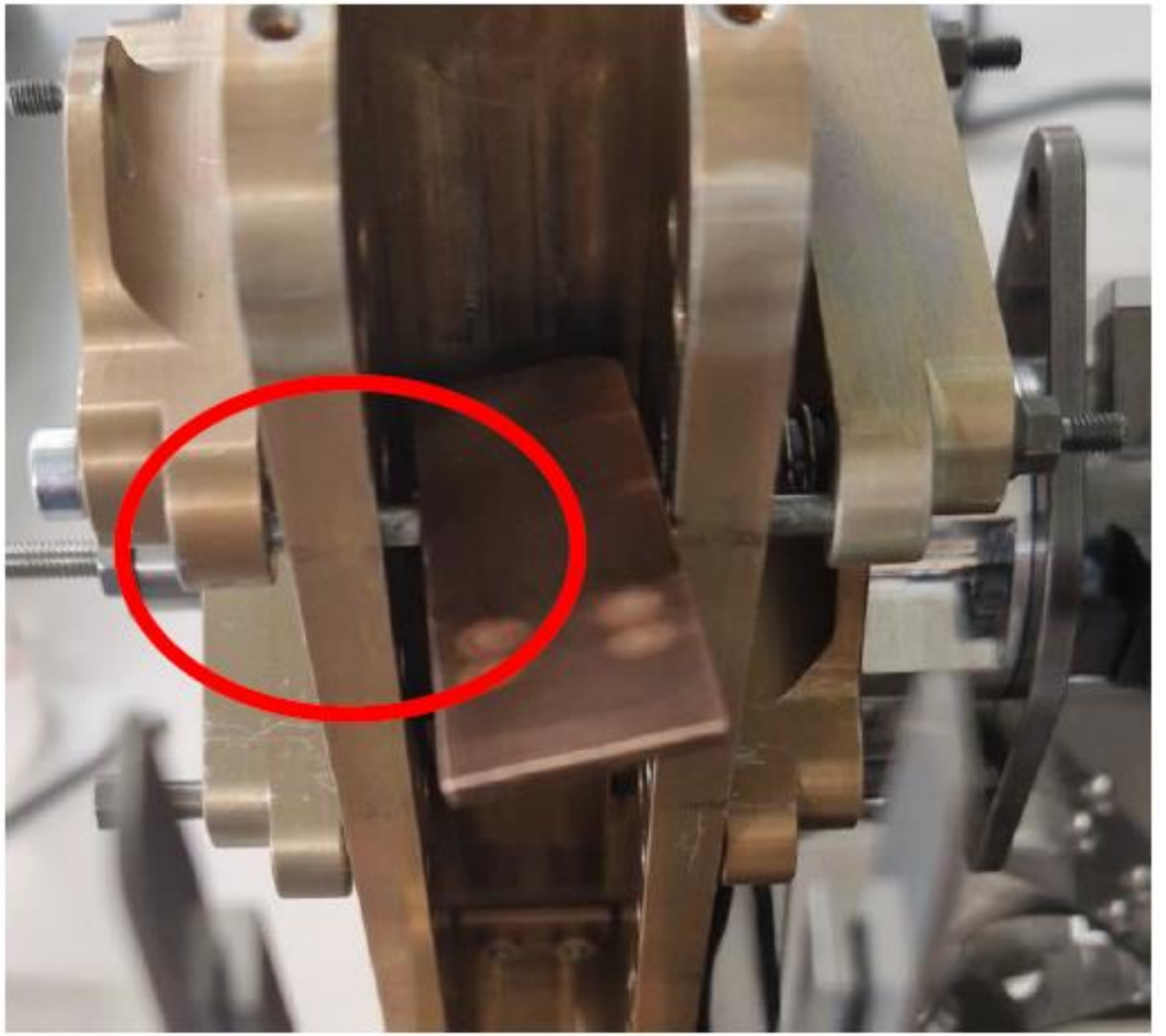
Root Cause Analysis

- Most likely root cause in the initial RCA table was the boom being stuck in the HDRM (RC 4) → related on-ground NCR
- However, RC 3 could be re-produced on ground, this RC became more likely

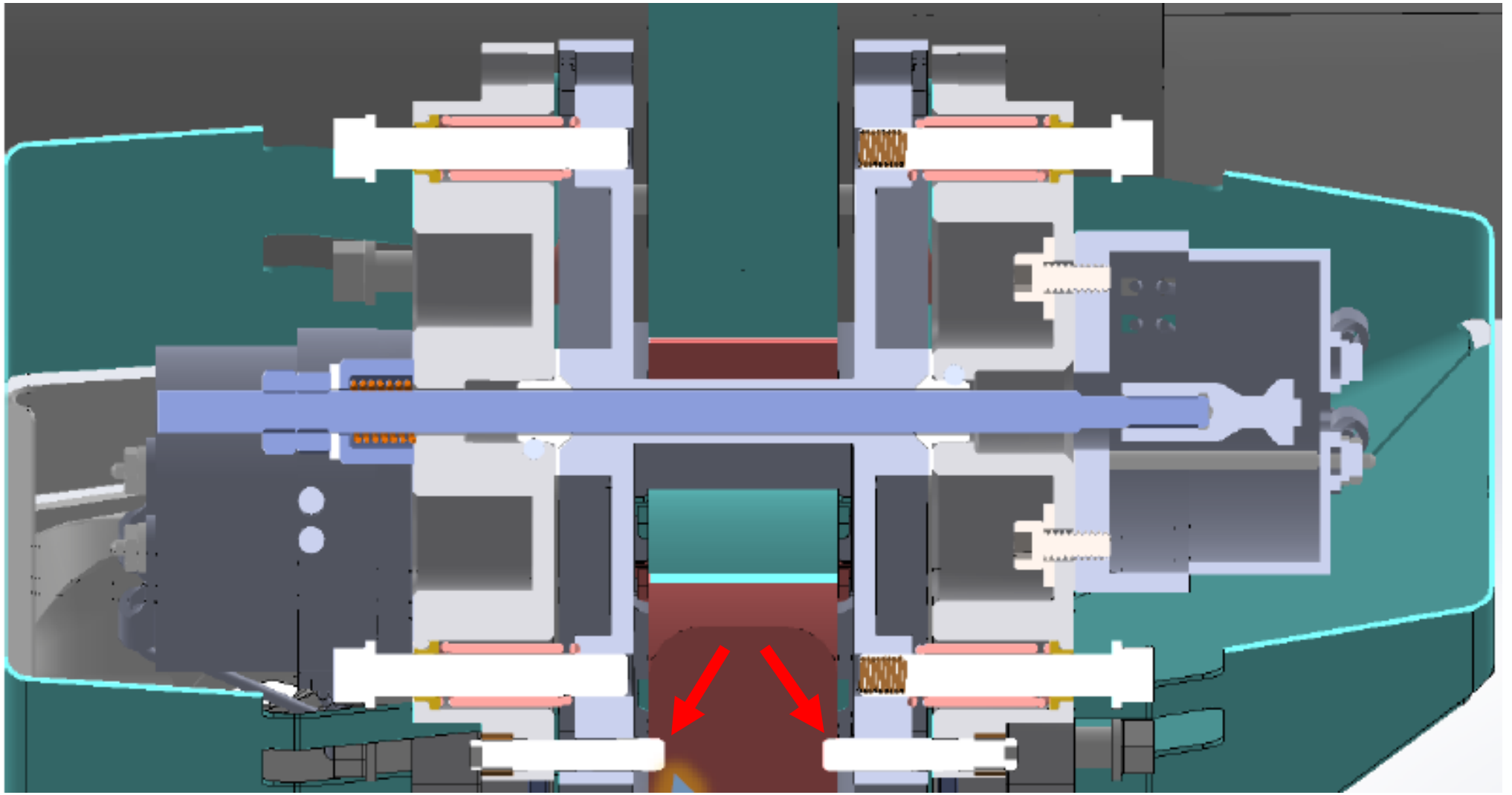
Id	Root Cause	Evidence	Refutation	Likelihood
3	NEA4 associated release spring failed to open	None (PX HDRM bracket not visible on JMC)	No on-ground NCR	Low
4	PY intermediate boom stuck in the PX HDRM bracket	None (PY HDRM bracket not visible on JMC	On ground NCR on this risk (all possible mitigations were taken i.e., hinge rollangle, …)	Possible
5	2nd PY hinge creep	None	Unlikely the hinge has lost all its energy after 3 days facing the sun	Low
6	2nd PY hinge damaged during launch	Arianespace reported a higher mechanical environment at the post-launch review	JMC-2 view shows a PY intermediate hinge in apparent good condition	Low
7	Icing impeded release		Good outgassing behaviour, no sign of icing on JMC views, slightly open hinge on JMC-2	Low

Root Cause Analysis

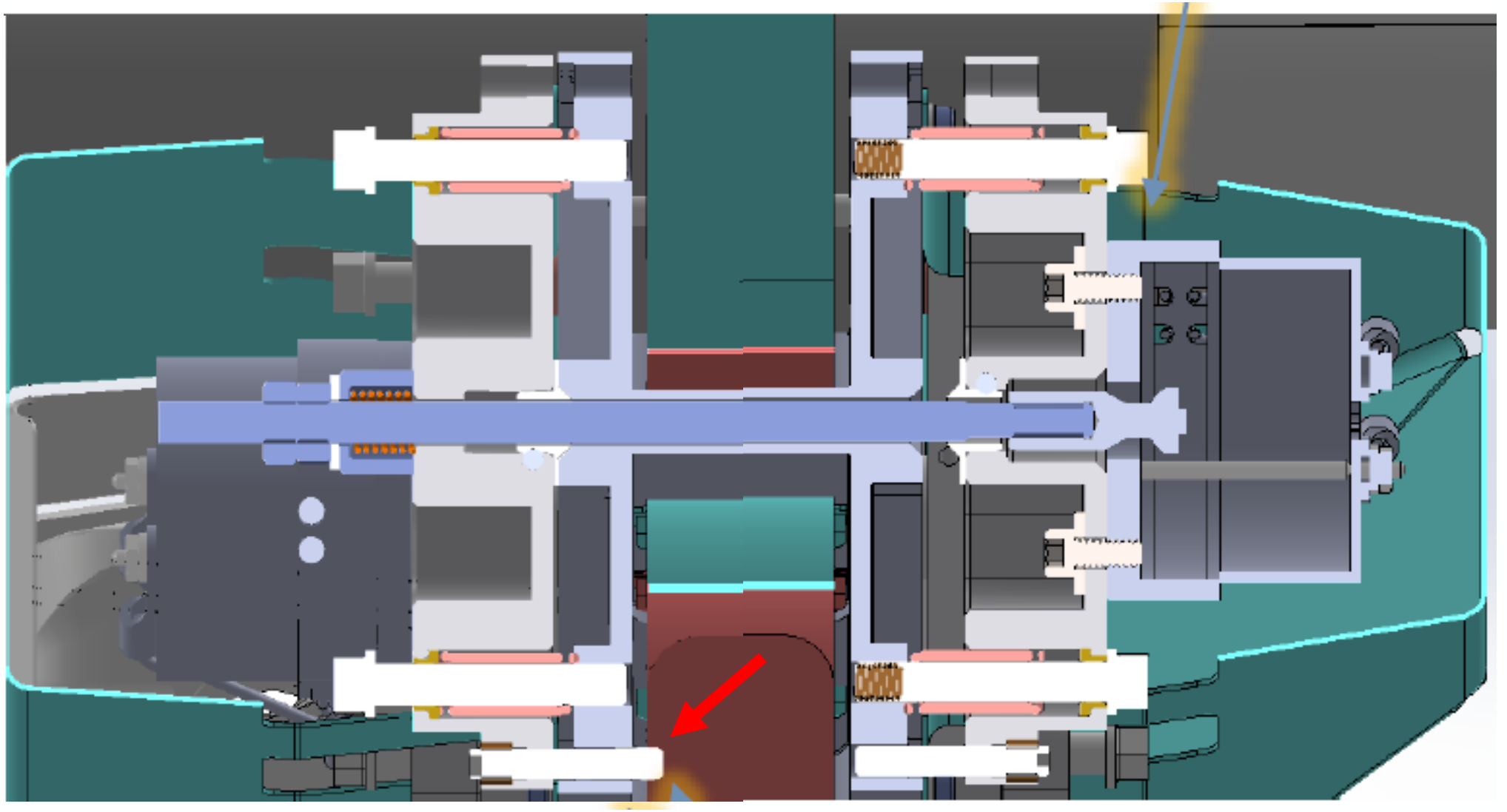
- Re-produced RC3: release spring failed to open
- Is believed to be due to a not fully retracted retainer pin
- Photo shows a simulation of this error on the EQM done at the supplier



Root Cause Analysis



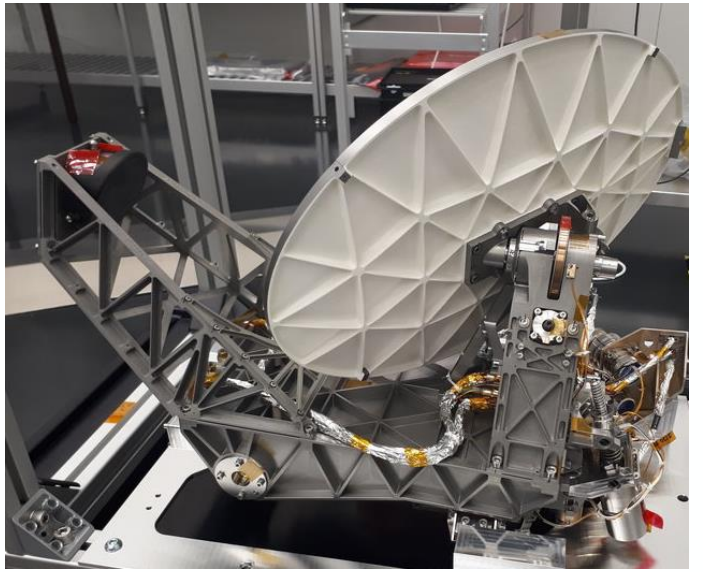
Root Cause Analysis



Recovery options and associated risks

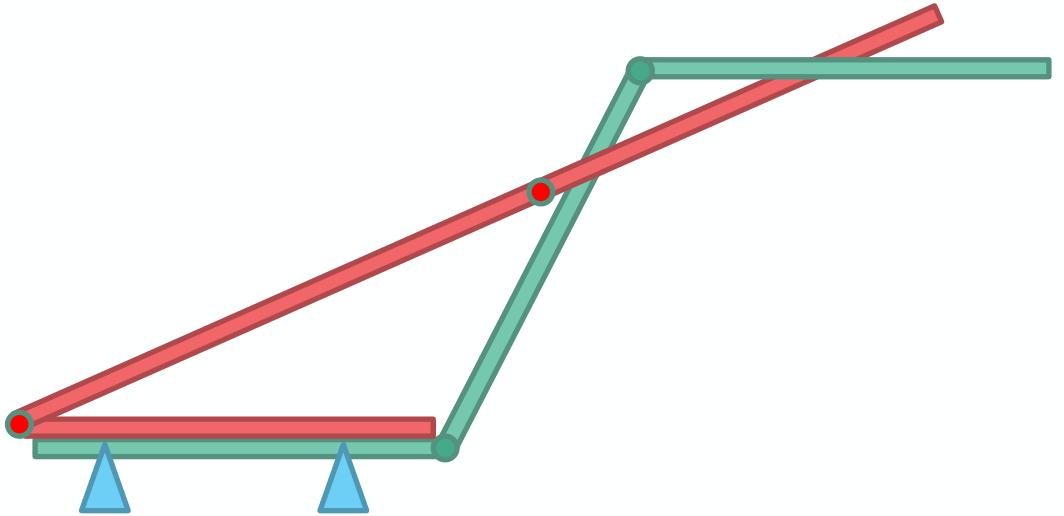
The basic ideas:

- **Increase temperature** to overcome a possible CTE mismatch
- Initiate other NEAs on the HDRMs to create **localised shocks**
- Deploy the MagBoom to create shock
- **Excite the antenna boom** at its eigenfrequency (localised excitations with relatively low input forces)



However:

- Partly deployed RIME antenna (the first booms) and deployed SWI instrument are **sensitive to shock** loads from other deployments like the MAGBoom
- When deploying both the +Y and -Y booms at the same time, there is a risk of **entanglement**
- Slews may **expose sensitive instruments** to sun



Attempts to recover

Slew of S/C to increase temperature to about -44C and Release of MagBoom → no deployment

Attempts to recover

Main Engine Firing → no deployment

Successful deployment

Slew of S/C to increase temperature to about ambient temperature and NEA6 → deployment of +Y boom’s second and third segment

Successful deployment

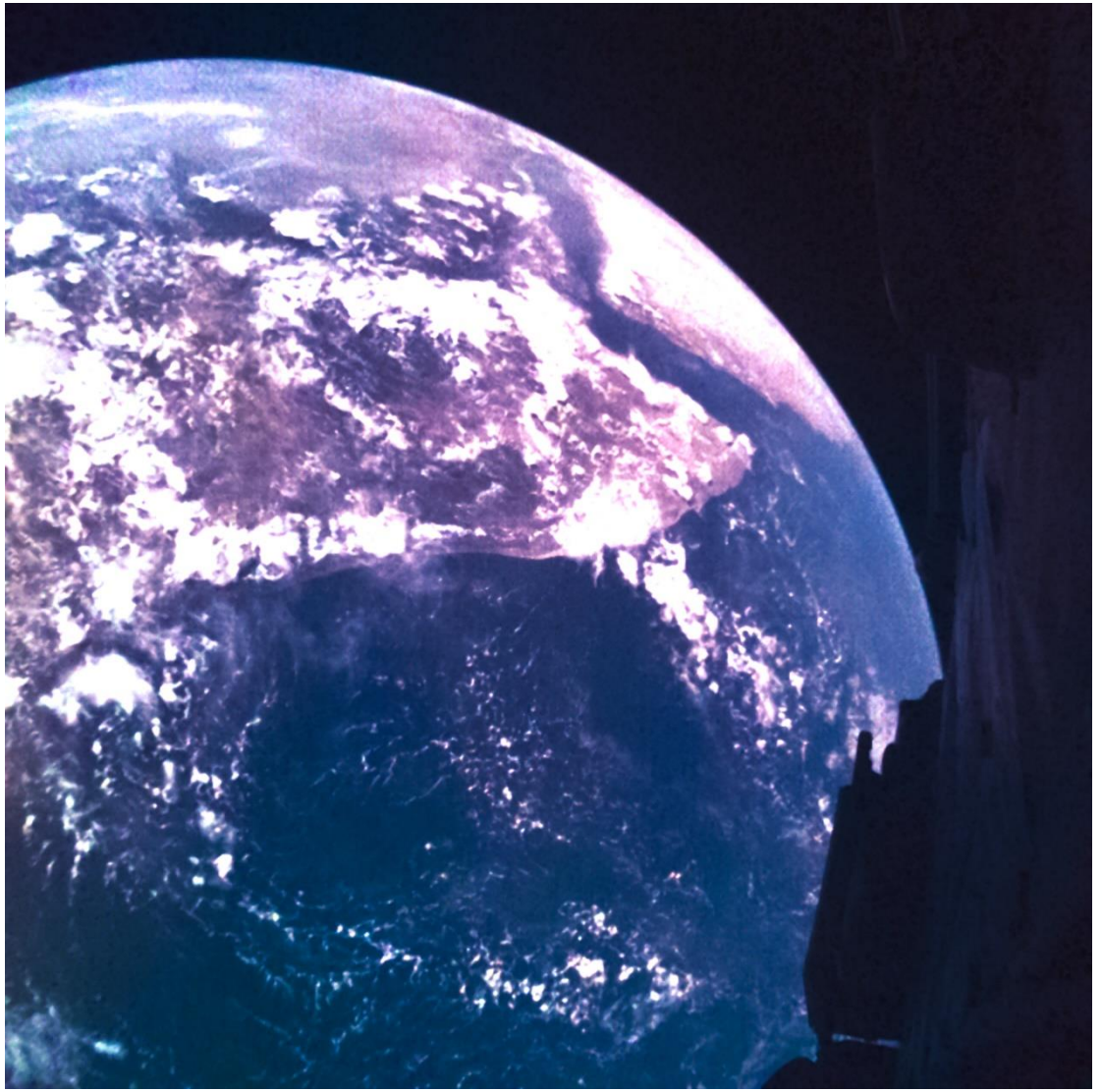
NEA6 → deployment of +Y boom’s second and third segment

Successful deployment

NEA3 → deployment of -Y boom’s second and third segment

Key lessons learnt

- HDRM design is **over-constrained** (hyperstatic) and should be avoided
- **Cold release of PFM brackets** may have helped to identify the issue
- **In-flight deployments** “far away from room temperature” should be avoided
- Plan for **multiple observables**: without monitoring camera, RCA would have been much more difficult




Thank you for your attention!
ANESPACE / Optique Vidéo du CSG - JM GUILLON