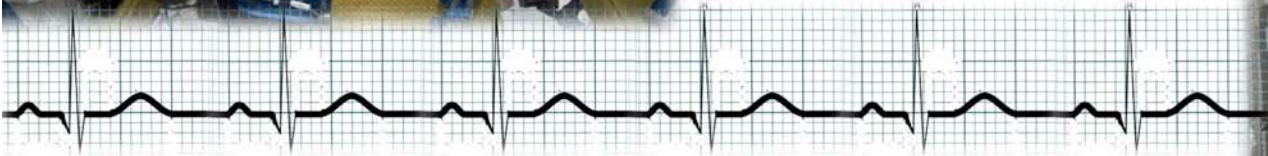


ISS Exercise Equipment Highlights

HRP NSBRI Evening Topic
February 11, 2013

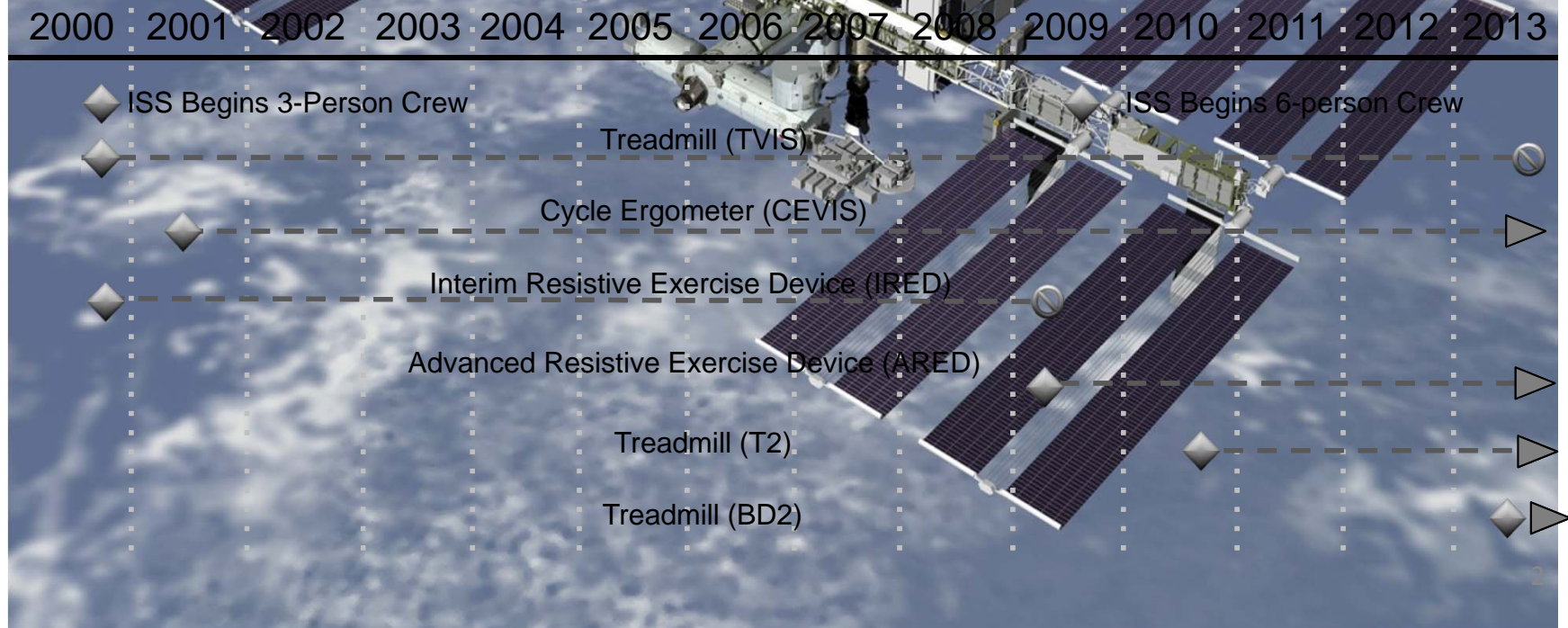


Presented by:
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Timelines

AGENDA:

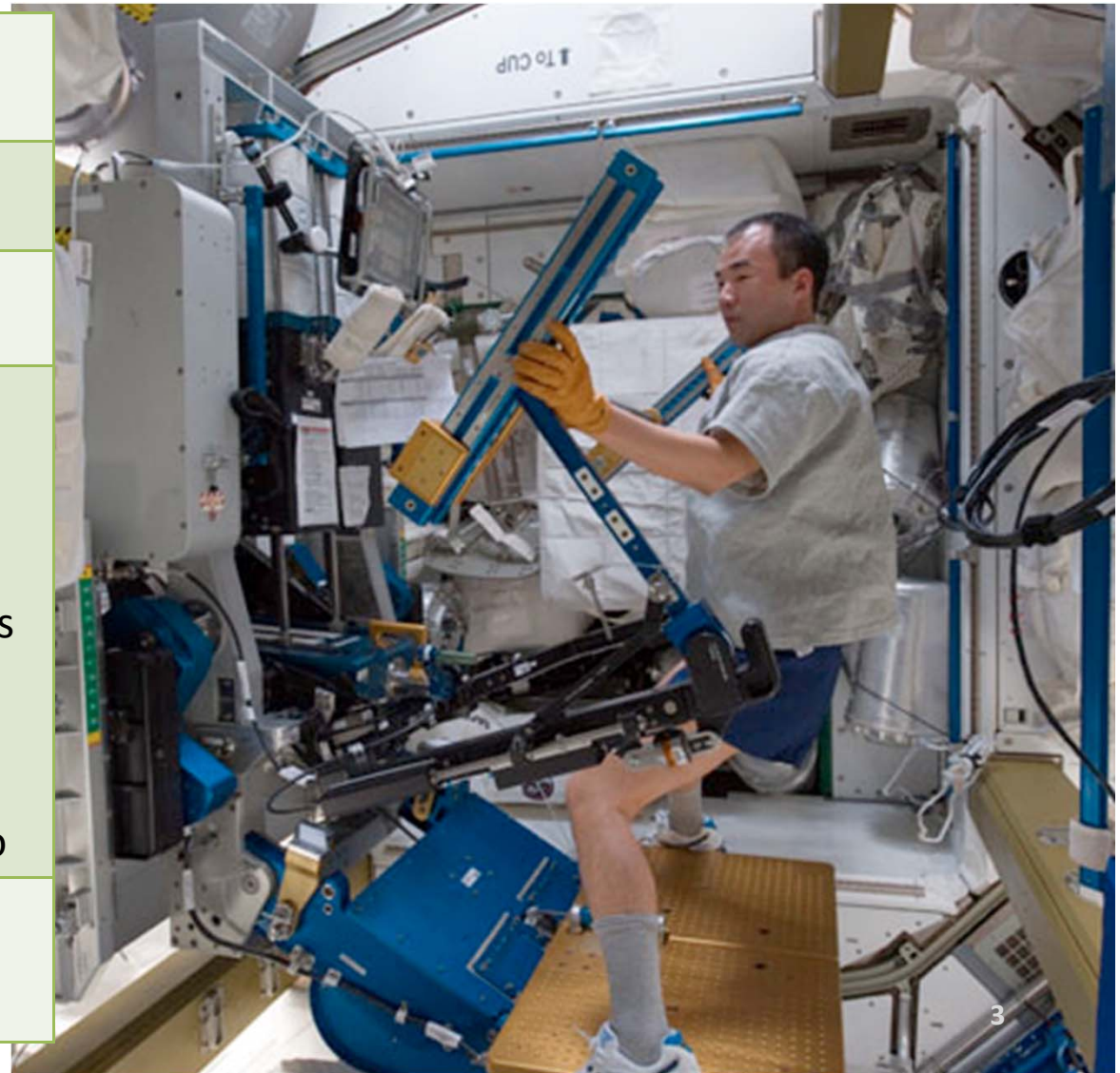
- ISS Exercise Equipment Overview
 - Summary of the currently used exercise equipment
- Exercise Hardware Engineering Successes
 - Two example on-orbit anomalies and how the teams recovered the hardware with minimal impact to its availability to exercise



Exercise Hardware Overview

Advanced Resistive Exercise Device - ARED

Years On-Orbit	4.1 years (1.5 hrs/crew/day)
Total Cycles	932,853 (through July 2012)
Maximum Load Capability	600 lbs.
Data Captured (manually captured in Excel since 6/1/11)	<ol style="list-style-type: none">1. Cycles2. Exercise Time3. Exercise Performed4. Weight/Exercise5. Sets/Exercise6. Crew ID7. Example video
Yearly Maintenance Time Required	Approx. 14 hours





Exercise Countermeasures System

Exercise Hardware Overview

Treadmill – T2

Years On-Orbit	2.3 years (inst. Oct 2010) (1 hr/3 crew/day)
Total Hours Used	Approx. 1,000 hours
Maximum Speed	12 mph
Data Captured	1. Session Time/Total Time used 2. Accelerometer Data 3. Load Cell Data 4. Motor Speed 5. Electronics Sensor Data (e.g. current, voltage, temperatures, water flow rates) 6. Heart Rate 7. Example video
Yearly Maintenance Time Required	Approx. 11 hours



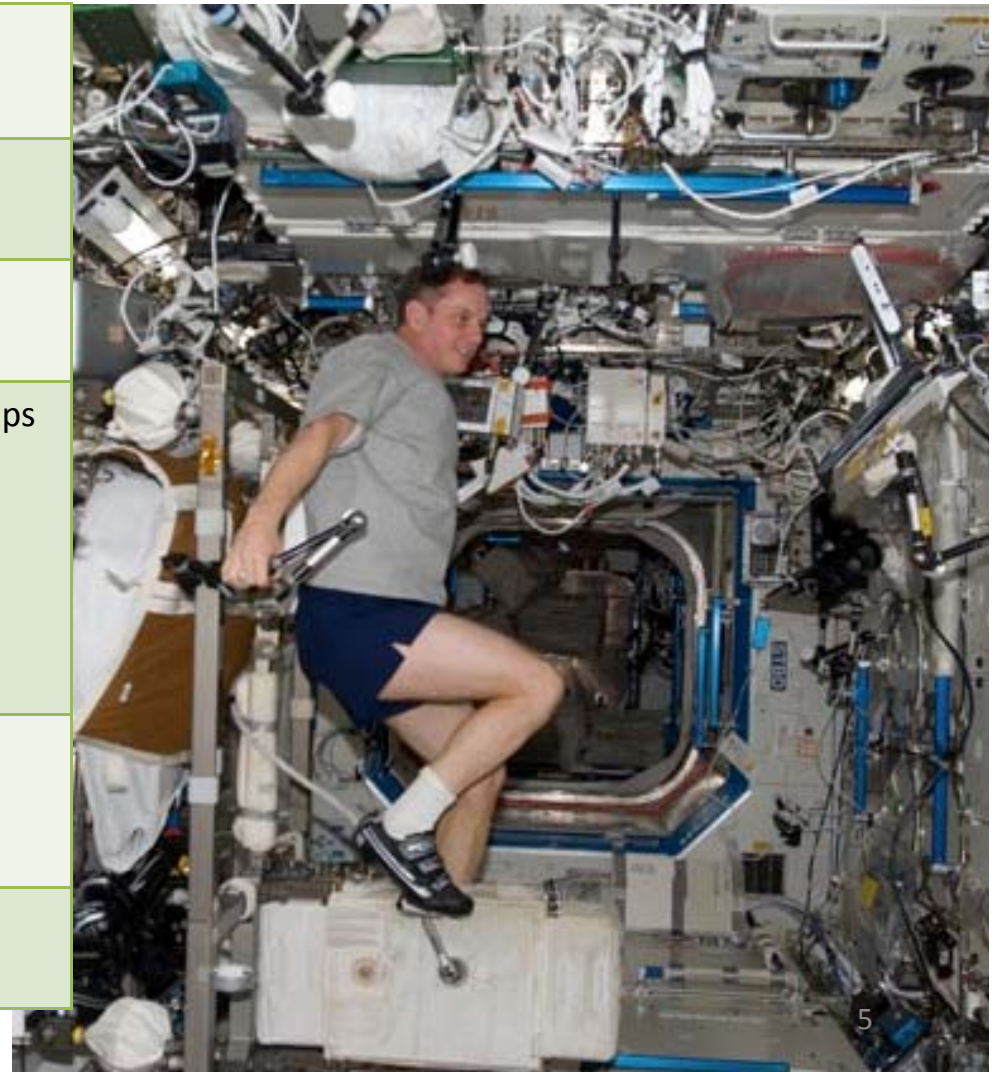
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Exercise Hardware Overview

Cycle Ergometer with Vibration Isolation & Stabilization (CEVIS)

Years On-Orbit	12 years (inst. Mar 2001) (~ 30 min/day)
Total Hours used	2,037 hours (through Feb 2013)
Maximum Load Capability	350W
Data Captured	<ol style="list-style-type: none"> 1. Exercise Duration & Time Stamps 2. Speed (Planned & Actual) 3. Workload (Planned & Actual) 4. Heart Rate 5. Crew ID 6. Protocol Name 7. Example video
Yearly Maintenance Time Required	Maximum of 2.5 hours
External Interface	Operable through RS-232 Port

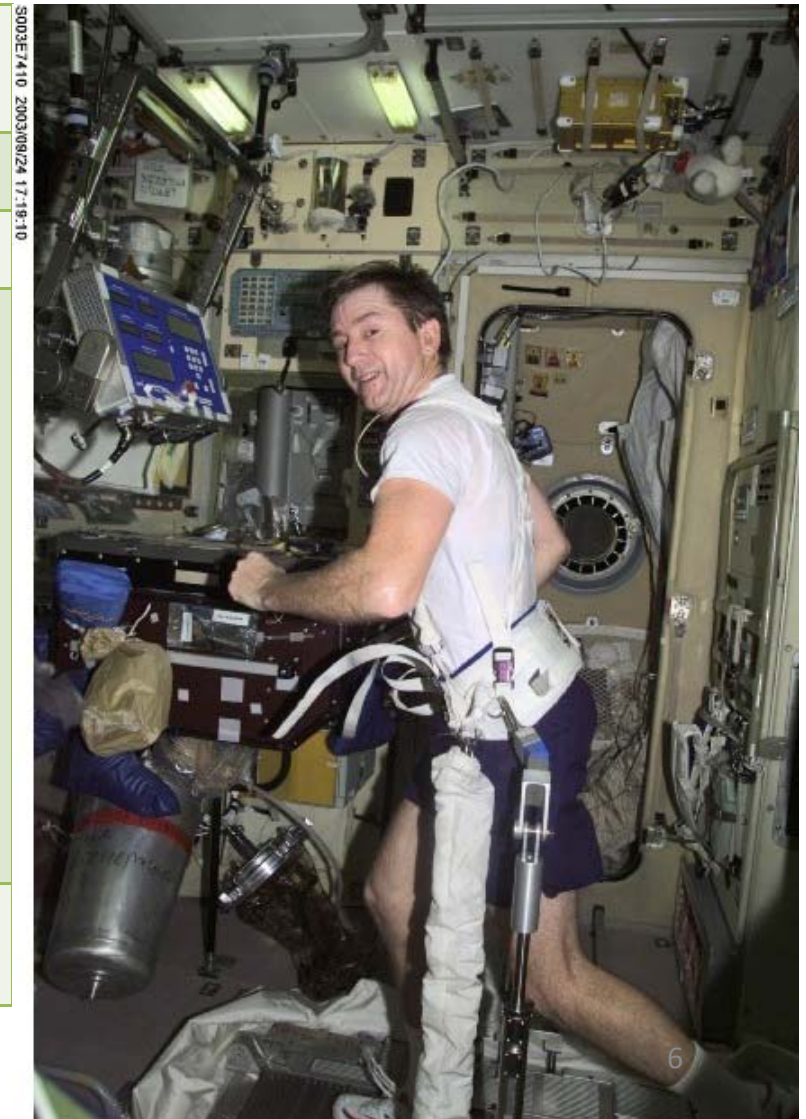




Exercise Hardware Overview

Treadmill with Vibration Isolation & Stabilization (TVIS)







Years On-Orbit	12 years (1 hr/crew/day)
Total Hours Used	Approx. 4,100 hours
Maximum Speed	10 mph
Data Captured	<ol style="list-style-type: none"> 1. Exercise Duration & Time 2. Session Distance 3. Belt Speed 4. Subject Loading 5. Gyroscope Speed 6. Temperatures 7. Voltages/Currents 8. Heart Rate 9. Crew ID 10. Example videos
Yearly Maintenance Time Required	Approx. 30-35 hours



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Example Hardware Challenges

Today's status:

Hardware	Health Status	Comments
ARED		Instrumentation Box failure & Inaccurate Load data
CEVIS		
T2		1 of 4 accelerometers failed
TVIS		Gyroscope or Gyroscope Power Cable failure
BP/ECG		
HRM2		New Receiver Boards installed. T2 HRM Receiver Board experiencing interference issues.

Legend



Operating as expected/no known issues



Off-nominal, not violating limits, no significant operational impacts

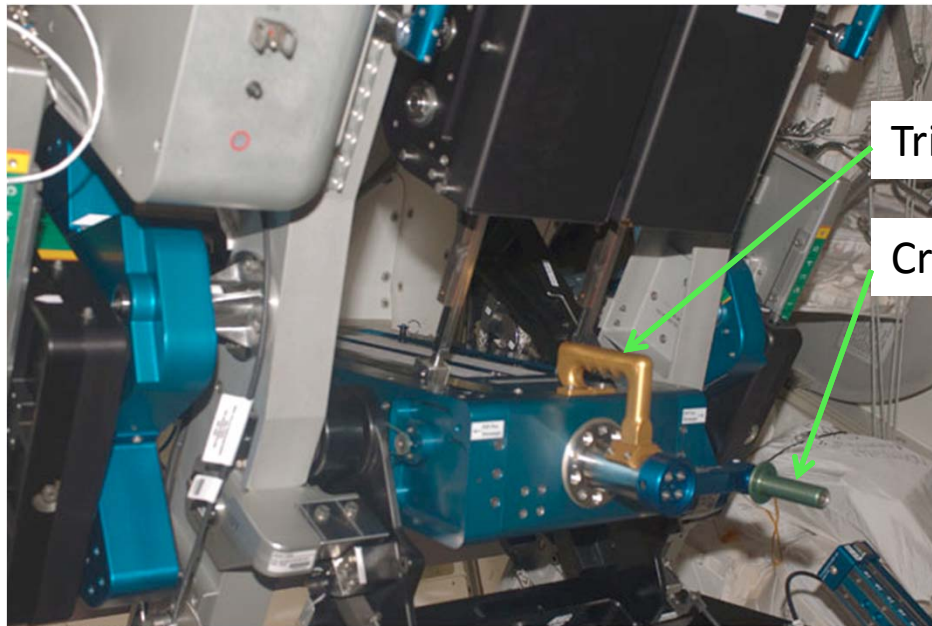


Off-nominal, not violating limits but impacting operations

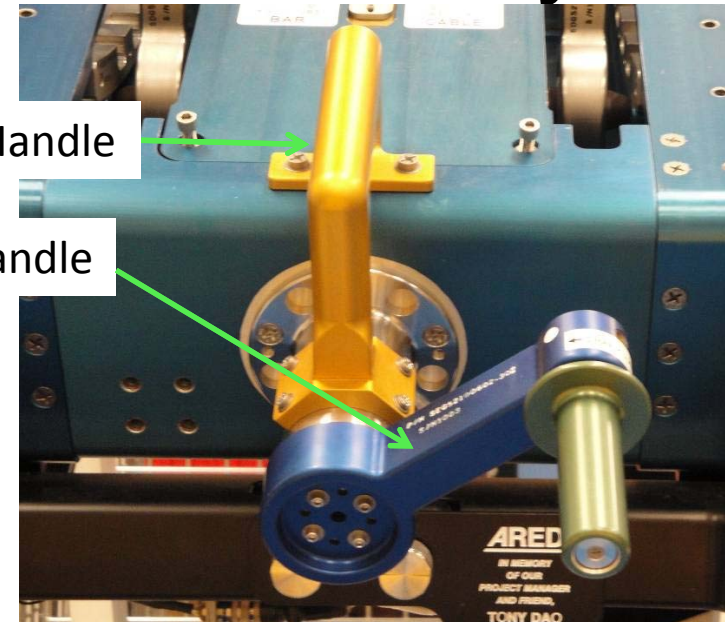


Off-nominal, violating limits

ARED Crank Handle Anomaly

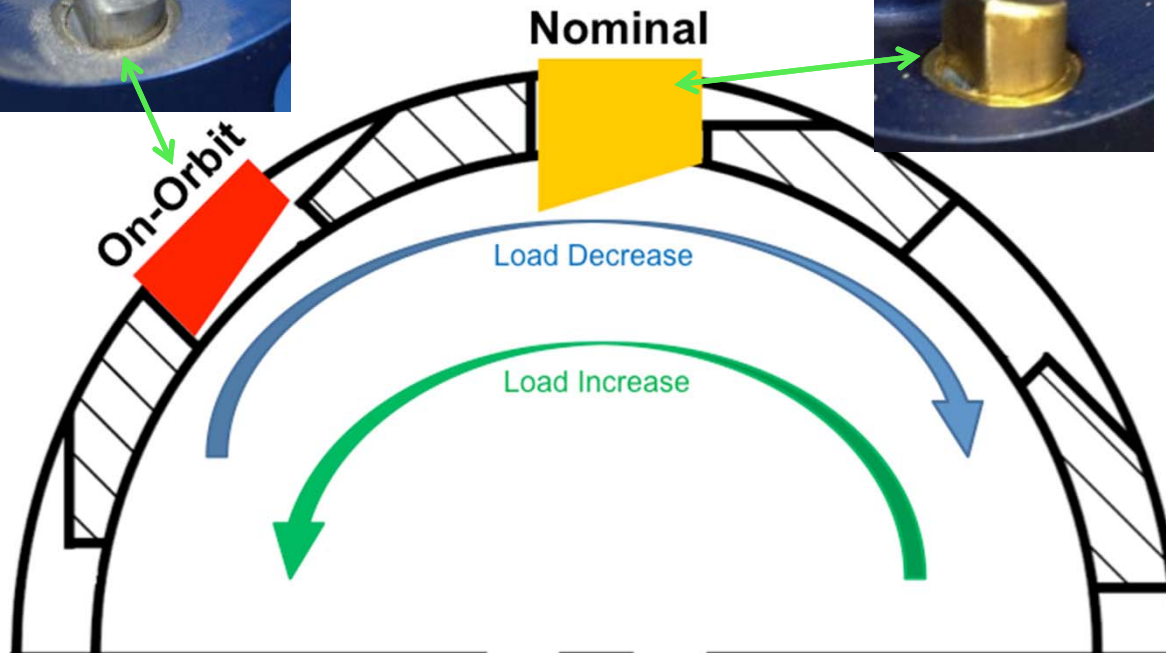


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- Jan 2012 Crew experienced the load jump when they would adjust it and during exercise.
- Investigation identified 2 issues preventing further ARED use:
 1. A keyed connection pin between the load adjustment unit (LAU) and the crank handle had walked out resulting in the decoupling of the LAU from the handle.
 2. Unexpected use of the handle and release mechanism had worn down the locking pin and the ratcheting mechanism
- Short Term repairs (see next page)
 1. A Snap-On Deep Socket was used as spacer to push the key back into position and secure it
 2. A Fastener was used to act as the locking pin for the ratcheting mechanism
- Replacement components were flown within a few weeks and installed about 3 months later.

ARED Crank Handle Anomaly

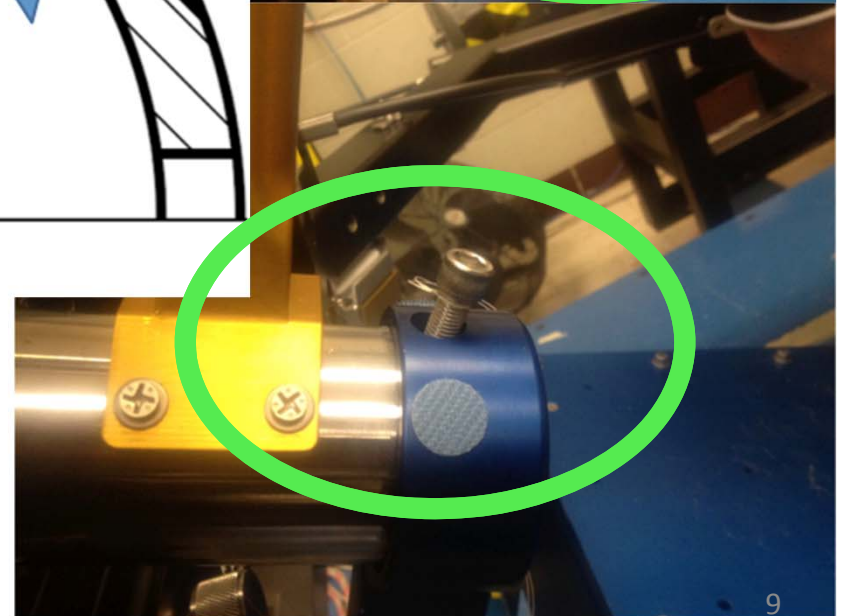
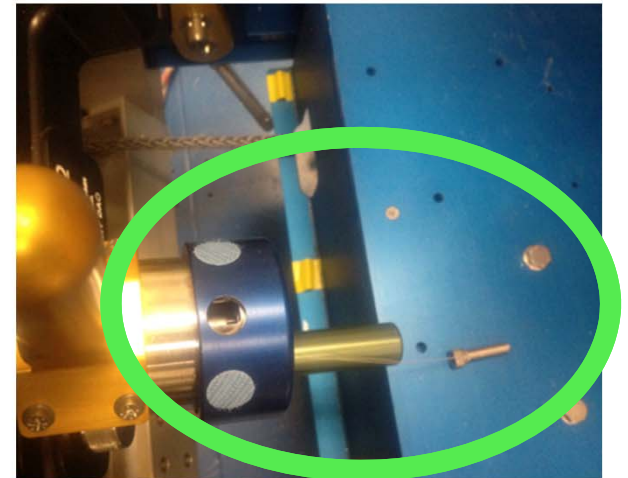


Not to scale

Locking Design
Repair limited load
adjustments to 7-
10 lb. increments
until replaced.

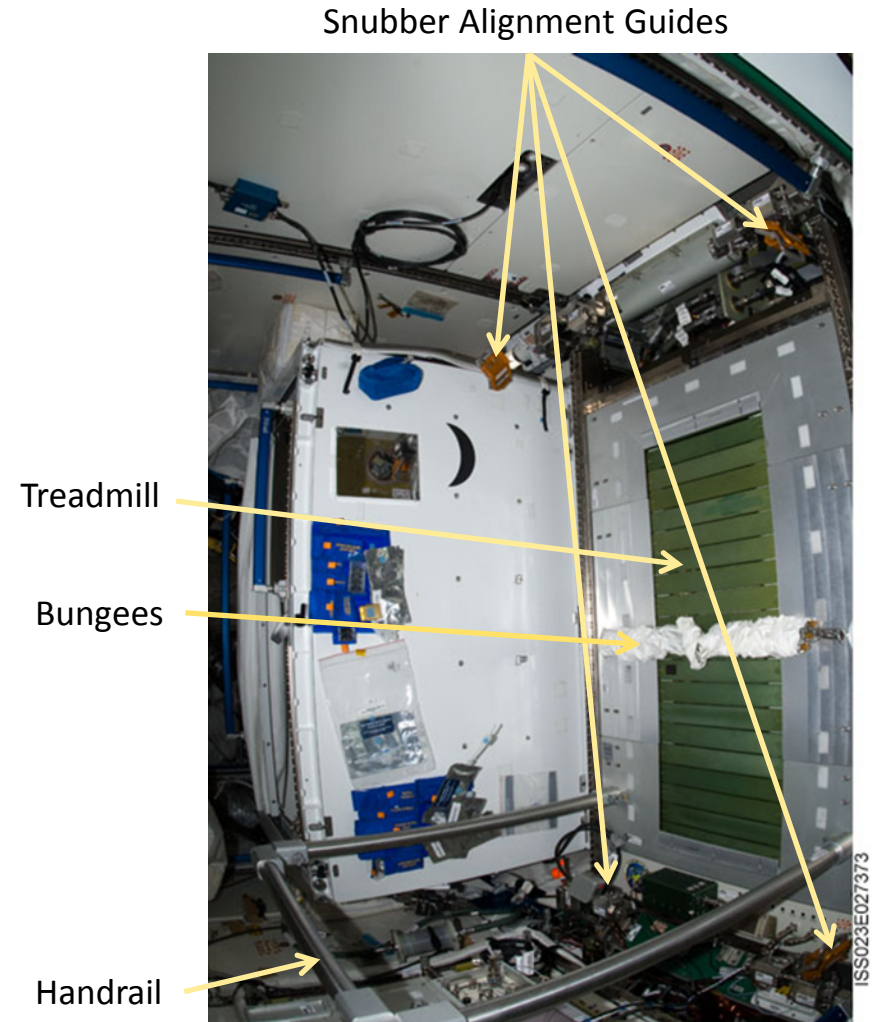


Keyed connection pin



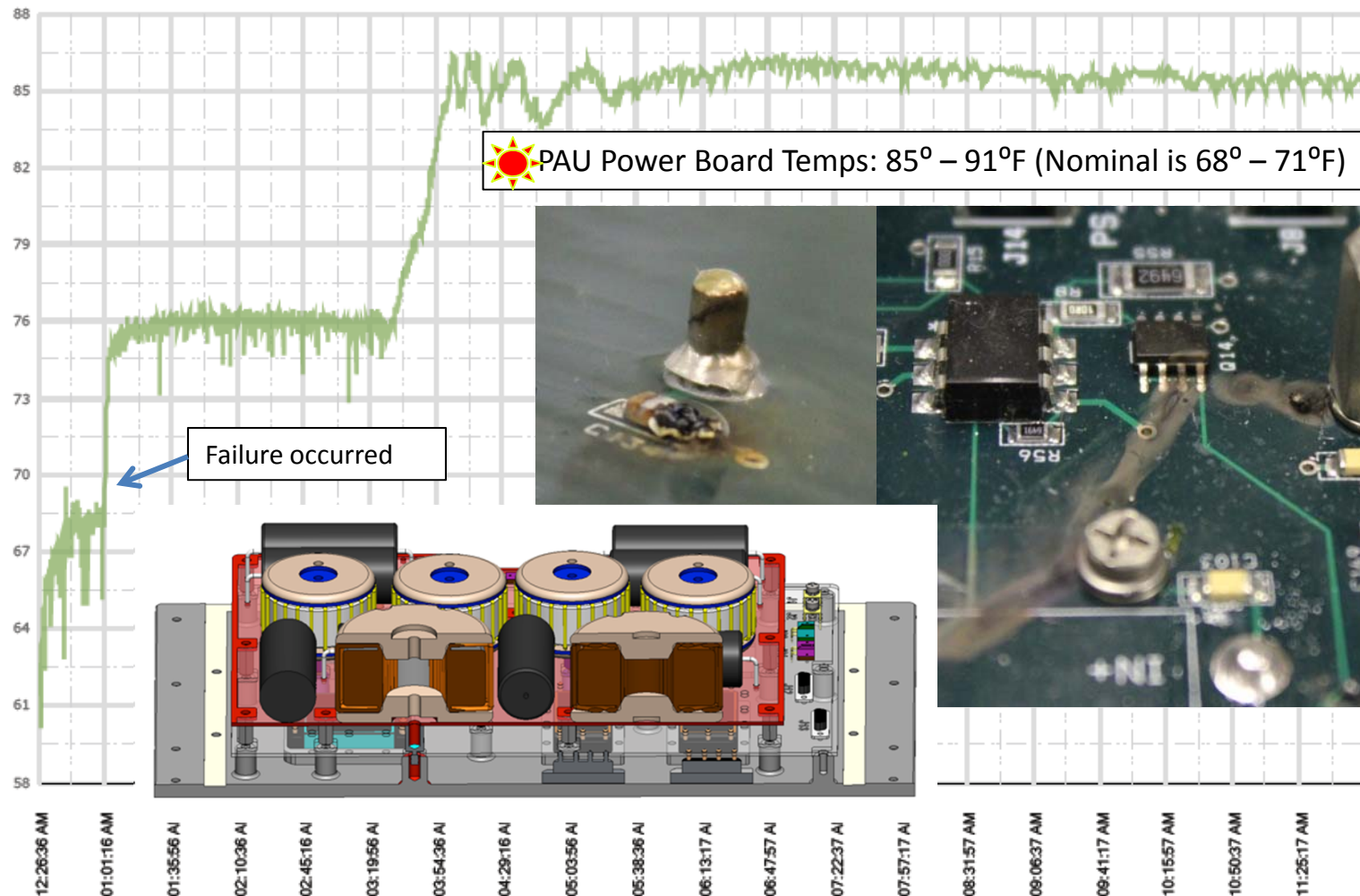
T2 Power Avionics Unit (PAU) Anomaly

- Data signatures in April 2010 pointed to a failure of the Power Avionics Unit (PAU) secondary 120 Volt circuit.
- Short term recovery turned off the power to the damaged circuits which limited the maximum speed on T2.
- PAU was replaced several months later and full capability was restored.



T2 Power Avionics Unit (PAU) Anomaly

PAU Power Board Temp beginning on 4/10/2010 00:00:00 for 12 hours





Conclusion

On-orbit exercise equipment has many additional factors from 1-G commercial equipment that have to be taken into consideration from initial design, through testing and during on-orbit operations so as to result in a reliable, low maintenance, high performance exercise device.

- Any questions?

Thank you for your time!