SIDLOC: Satellite Identification and Localisation

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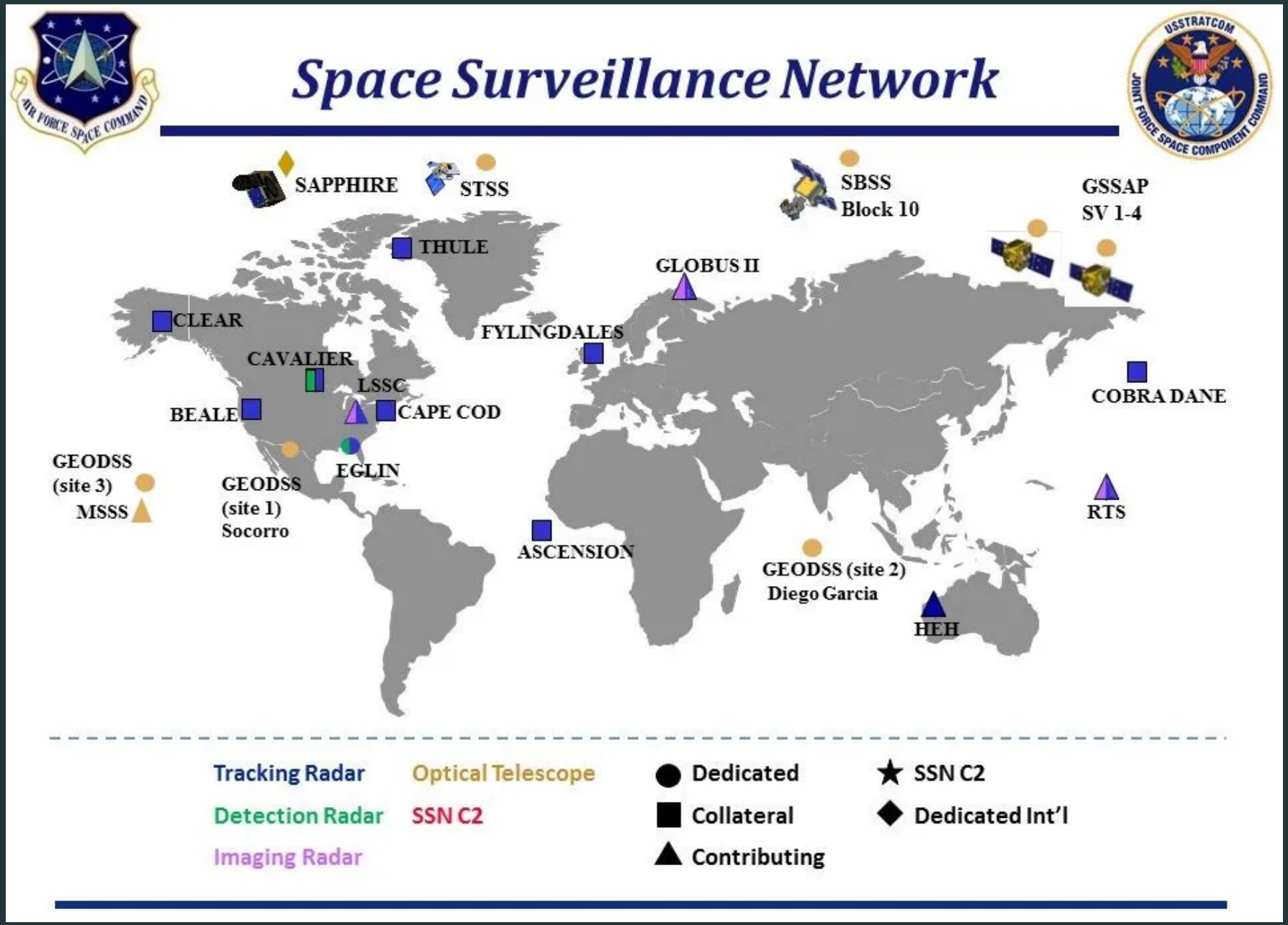
Libre Space Foundation

Space Situational Awareness

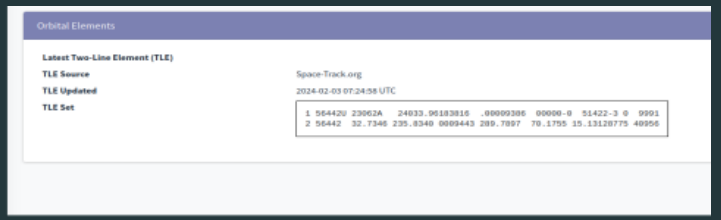
- Limited sources of orbital data
- Public, but not libre!
- No public tracking data for objects < 10 cm
- Orbit estimation updates may take too long

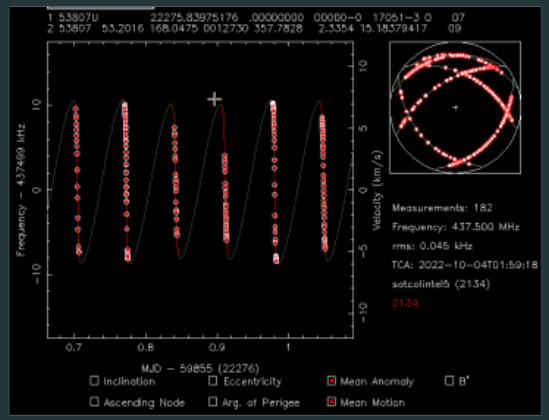
Space Situational Awareness



Space Situational Awareness

About SIDLOC





SatNOGS

SIDLOC

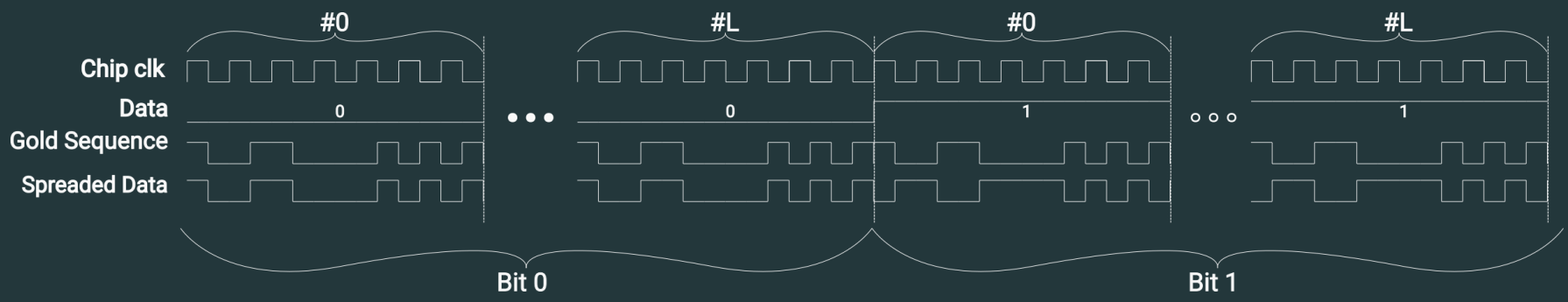
Key characteristics

- Low power
- Low cost, zero maintenance
- Minimal integration effort, small size, no special requirements
- Autonomous operation
- Take advantage of existing ground station networks, like SatNOGS

RF characteristics

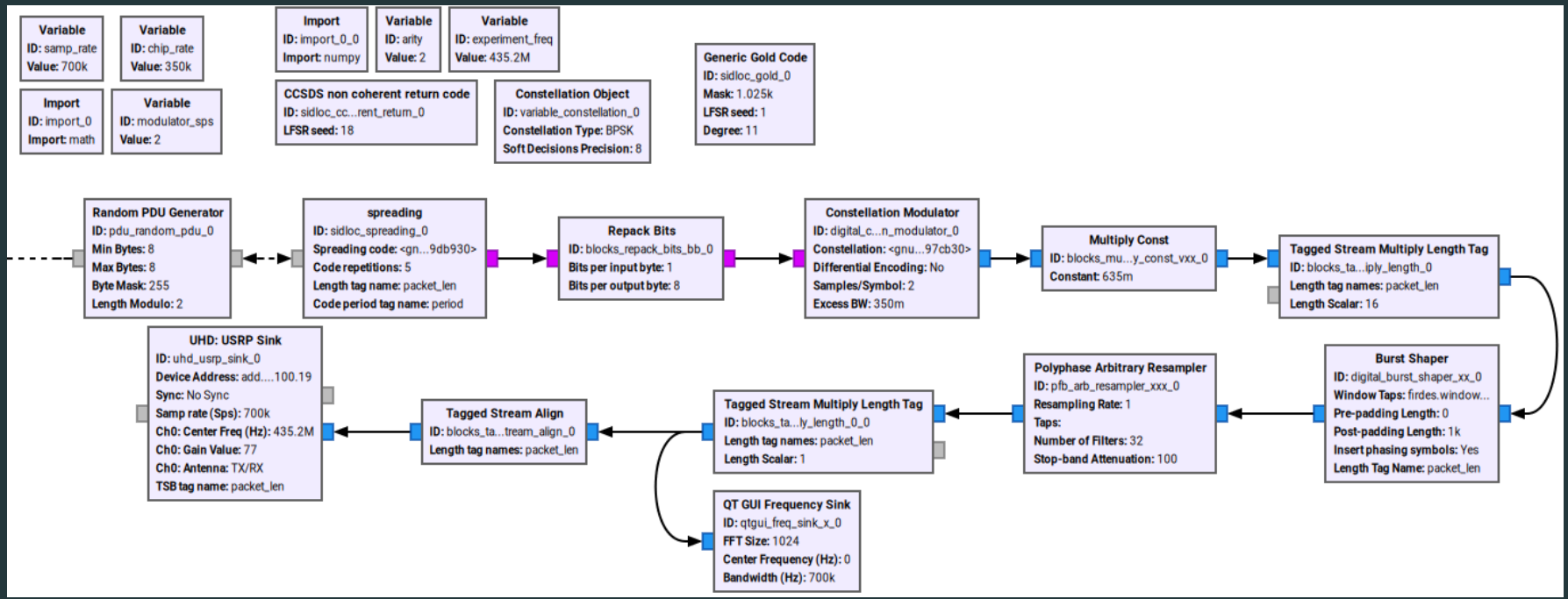
- 401 - 402 MHz
- 900 kHz occupied bandwidth
- BPSK modulated DSSS
- 2047-bit long Gold sequence
- 10 repetitions for each bit
- 50 bps effective data rate
- TX Power: 25 dBm

TX procedure



$$R = \frac{\text{Chip Rate}}{\text{len(Gold Sequence)} \times L} = \frac{1e6}{2047 \times 10} \approx 48 \text{ bps}$$

GNU Radio TX flowgraph



RX procedure

- Sensitivity vs Computational cost
- Auto-correlation
- Cross-correlation with coherent integration
- Cross-correlation with non-coherent integration

Beacon types

Data Type	Minimal	Full	Integrated
SIDLOC Info	Required	Required	Required
Unique Satellite ID	Required	Required	Required
Datetime	No	Required	Optional
Location	No	Required	Optional
Satellite Status	No	No	Optional
Satellite Reserved Info	No	No	Optional

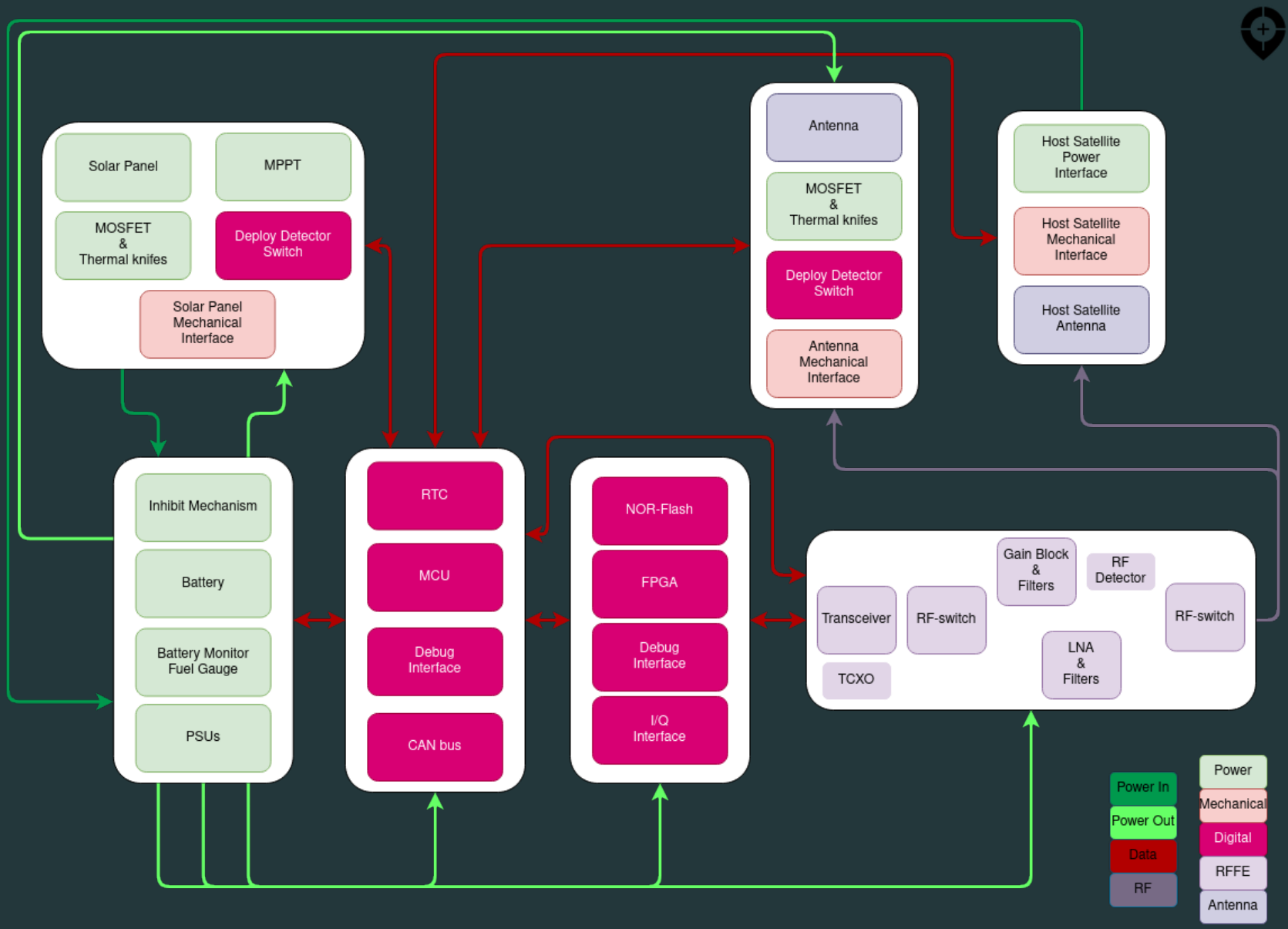
Beacon fields

#	Name	Size (bits)	Size (bytes)	Description
0	Sync Word	24	3	0xFFF
1	SIDLOC type	4	0.5	SIDLOC type and version (16 possible ones)
2	Satellite ID	72	9	Universally unique satellite ID
3	TJD	16	2	Truncated Julian Day (TJD)
4	s of day	16	2	Second of the day
5	Coordinate system	2	0.25	00 geocentric 01 HEEQ
6	x	28	3.5	range [+-134217728] in m
7	y	28	3.5	range [+-134217728] in m
8	z	28	3.5	range [+-134217728] in m
9	x dot	24	3	range [+- 10485.75] in m/s
10	y dot	24	3	range [+- 10485.75] in m/s
11	z dot	24	3	range [+- 10485.75] in m/s
12	x dot dot	18	2.25	range [+- 655.35] in m/s^2
13	y dot dot	18	2.25	range [+- 655.35] in m/s^2
14	z dot dot	18	2.25	range [+- 655.35] in m/s^2
15	Satellite status	8	1	
16	Satellite use	8	1	
17	CRC	32	4	

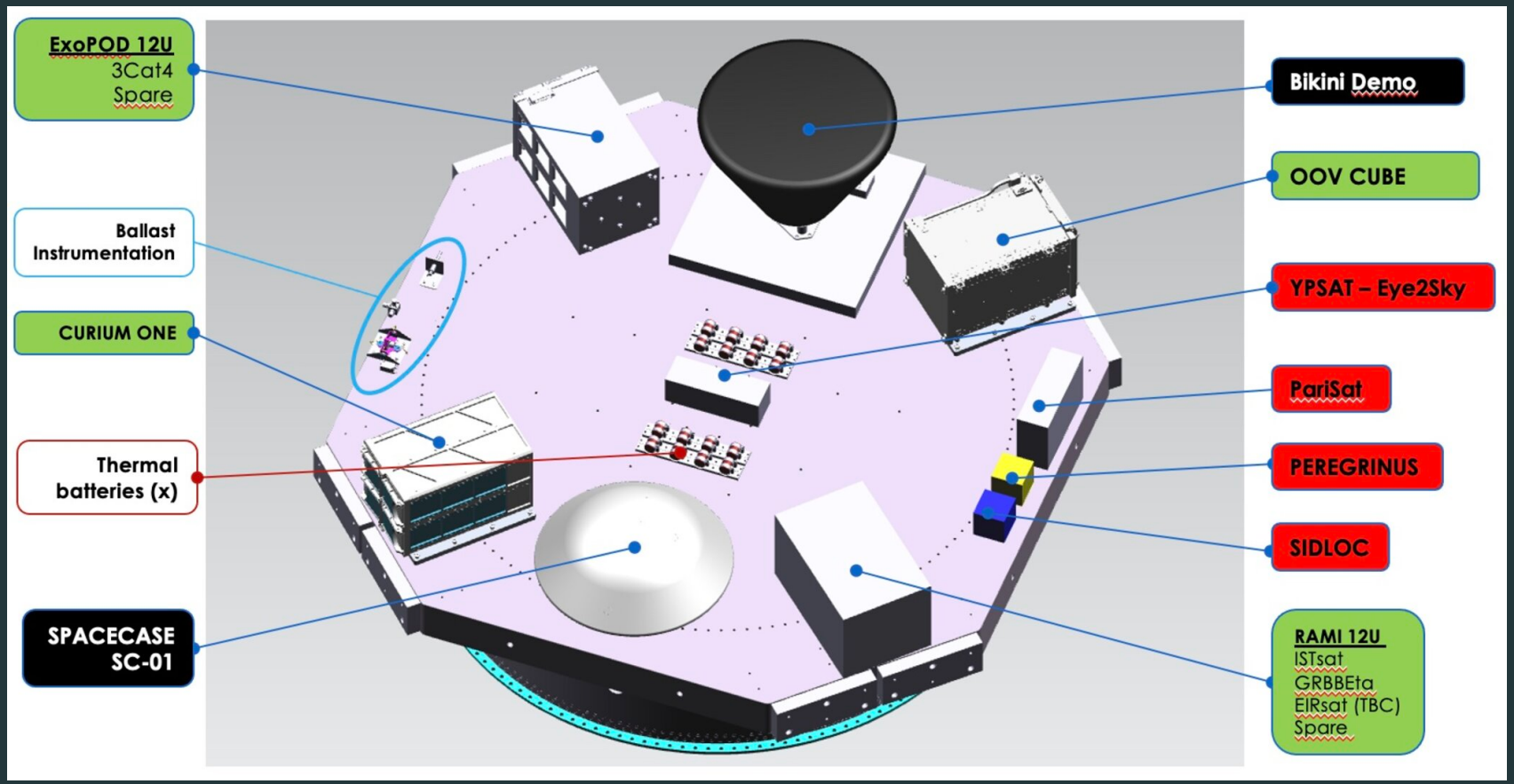
SIDLOC reference hardware

- **STM32L4 MCU:** Main control, SIDLOC frame encapsulation
- **AT86RF215:** Frequency up-convert and IQ interface
- **ECP5 FPGA:** SIDLOC DSP routines and IQ transmission

SIDLOC reference hardware



SIDLOC on Ariane 6



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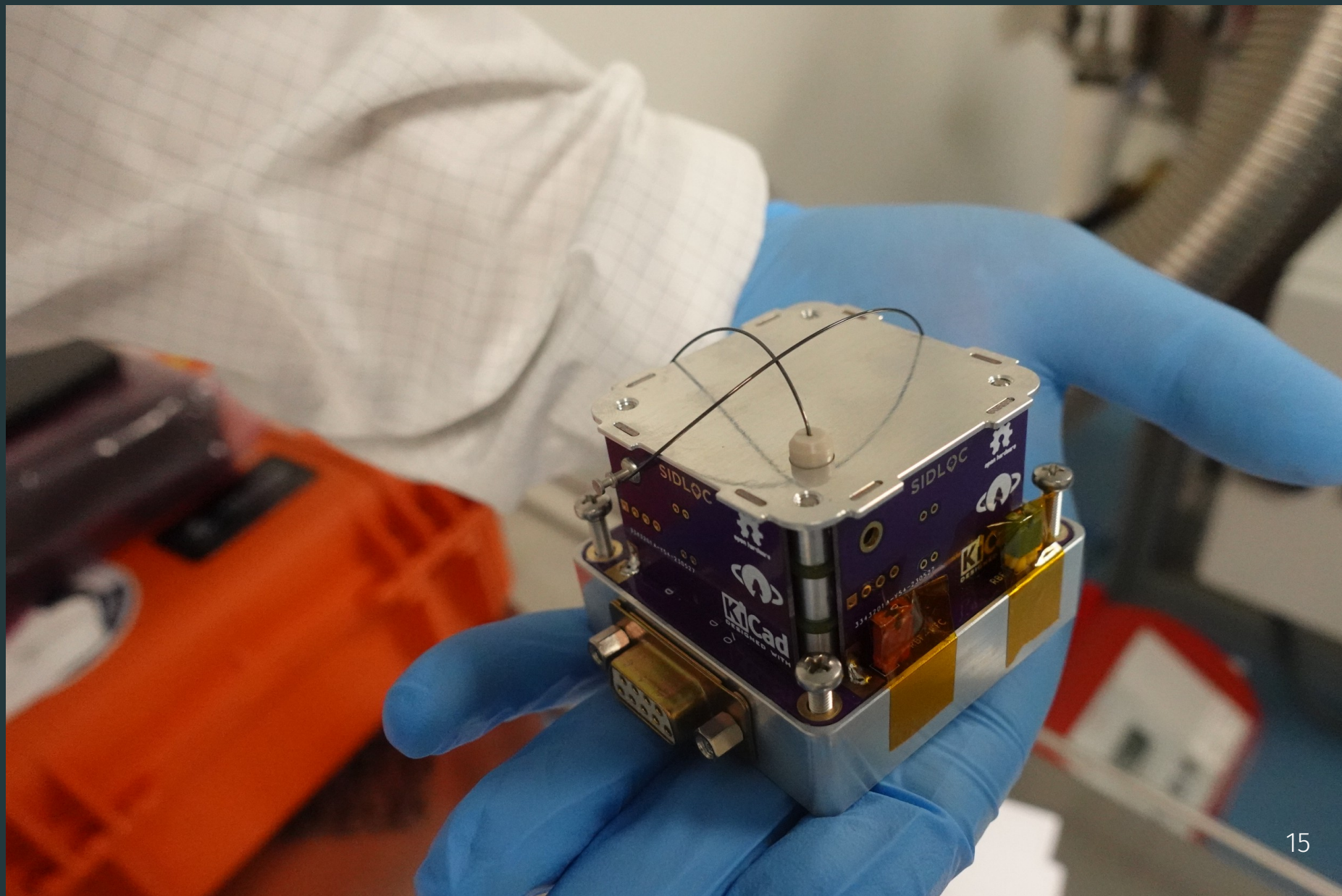

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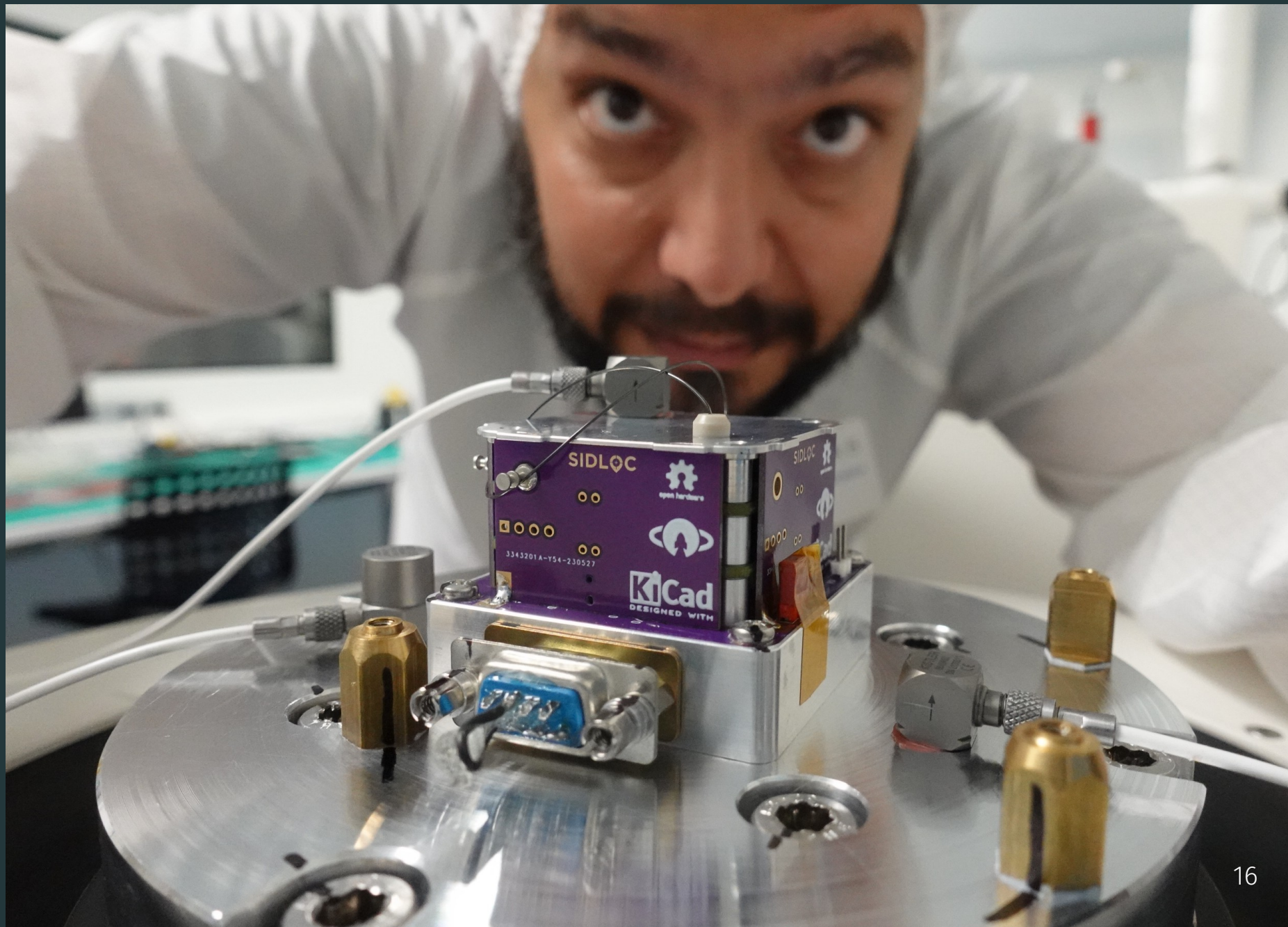

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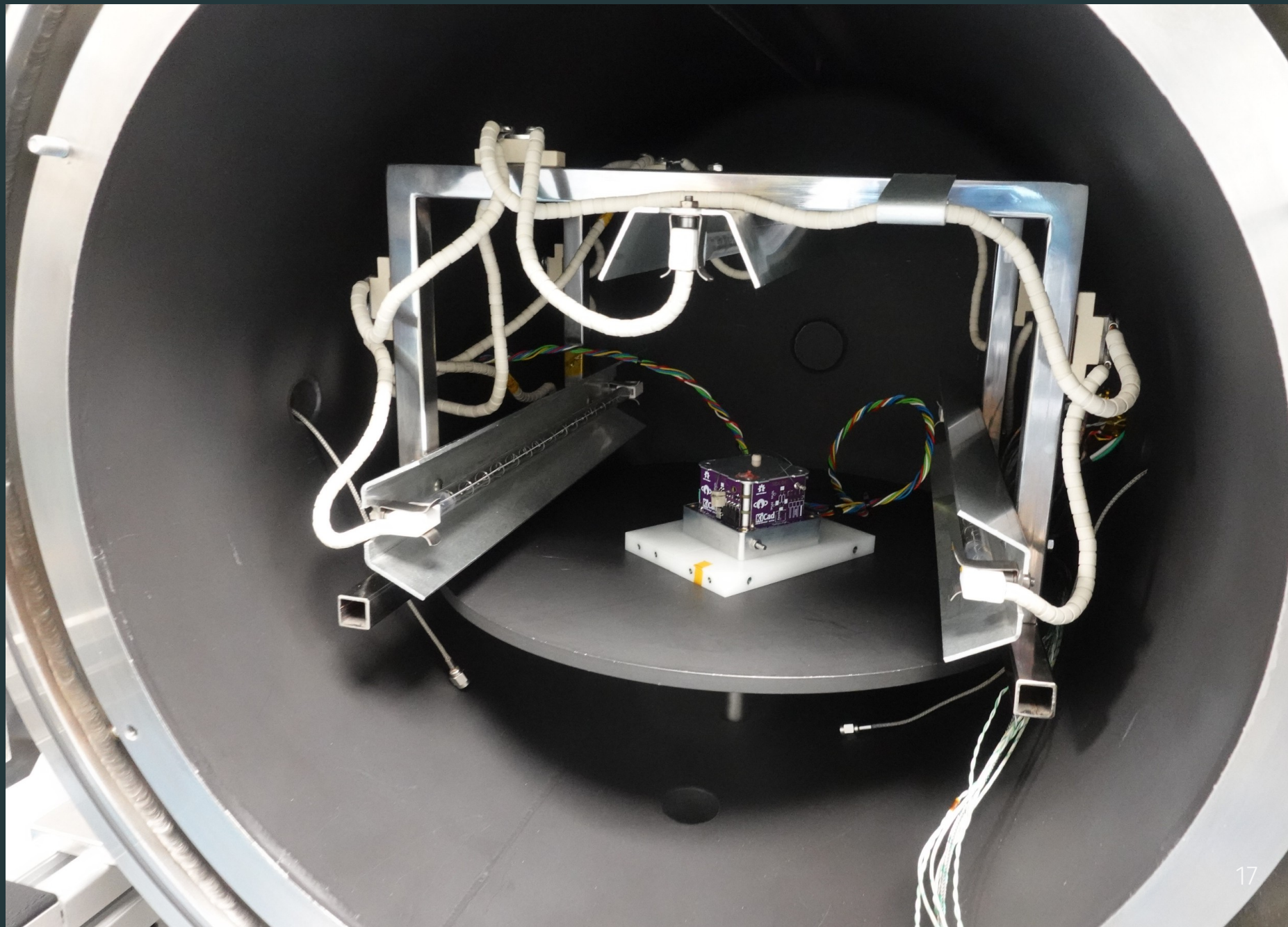
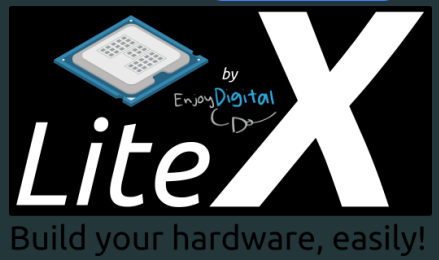
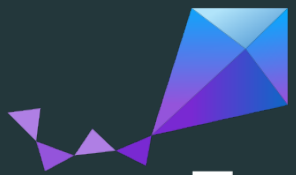


Fully open-source open-hardware ecosystem!





Zephyr®

+

yosys + trellis + nextpnr

https://sidloc.org

gitlab.com/librespacefoundation/sidloc

#sidloc:matrix.org

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