Reliability + Anomaly Detection
at CERN

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LLRF Workshop 2023

Sources of reliability issues

| Hardware	Firmware	Software	Environment	Human
Bad design	Bad design	Bad design	Bad design ;)	Operational mistakes
Component degradation	Unhandled edge cases	Unhandled edge cases	Wildly varying conditions	Lack of understanding of the system
External interference		System load	Power cuts	Experts ;)
		Lack of deterministic behaviour		

… and solutions?

| Hardware	Firmware	Software	Environment	Human
Design reviews	Design reviews	Design reviews	Design reviews	Automatic parameter validation
Monitoring & Maintenance	Better specification & Testing	Better specification & Testing	Monitoring & Corrections	Trainings…
…		Monitoring & HW upgrade	UPS	More strict access rules
		Well defined timing dependencies & RT software		

Monitoring tools

- TIMBER

- LASER

- Inspector panels

- Beam Performance Tracking
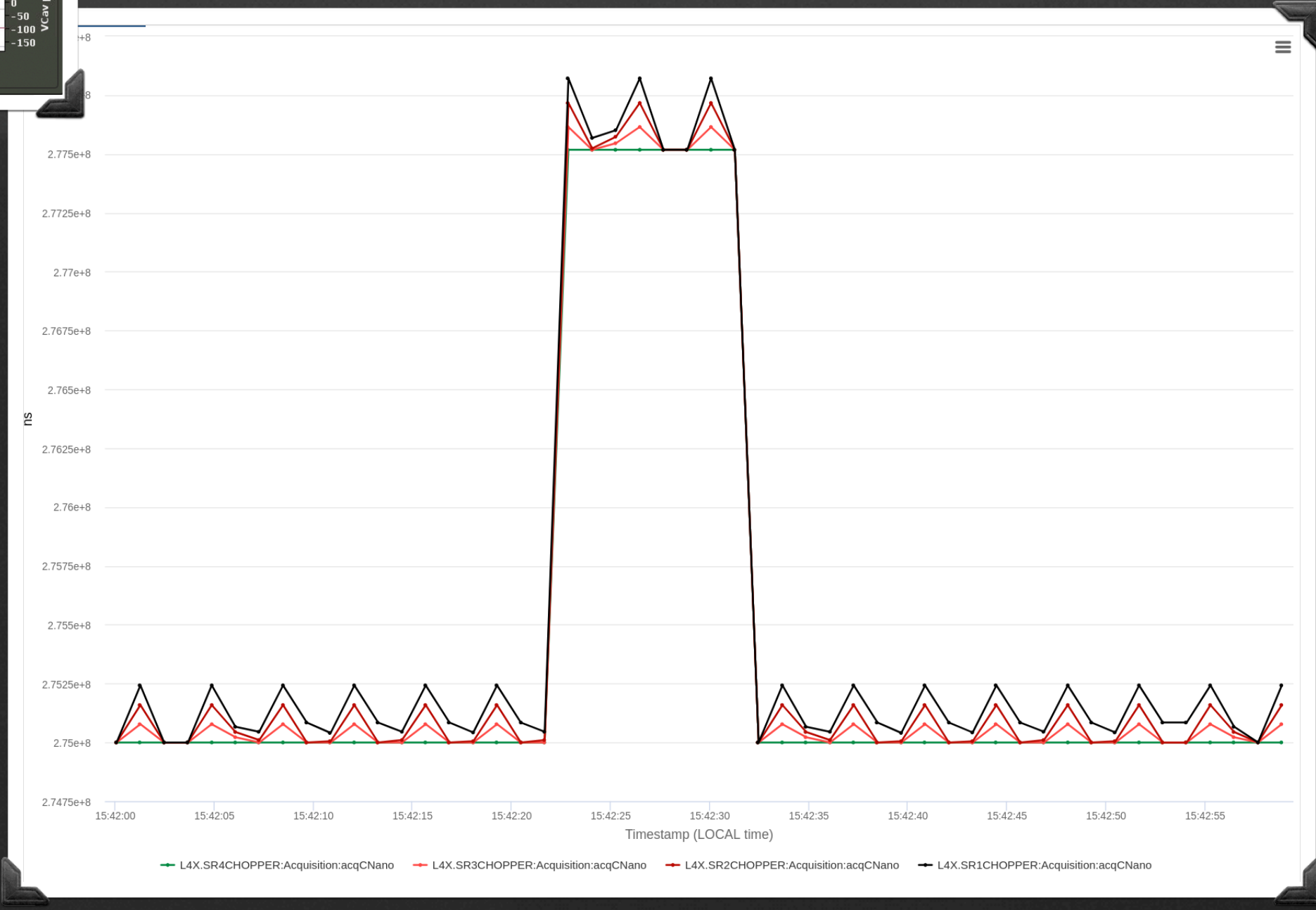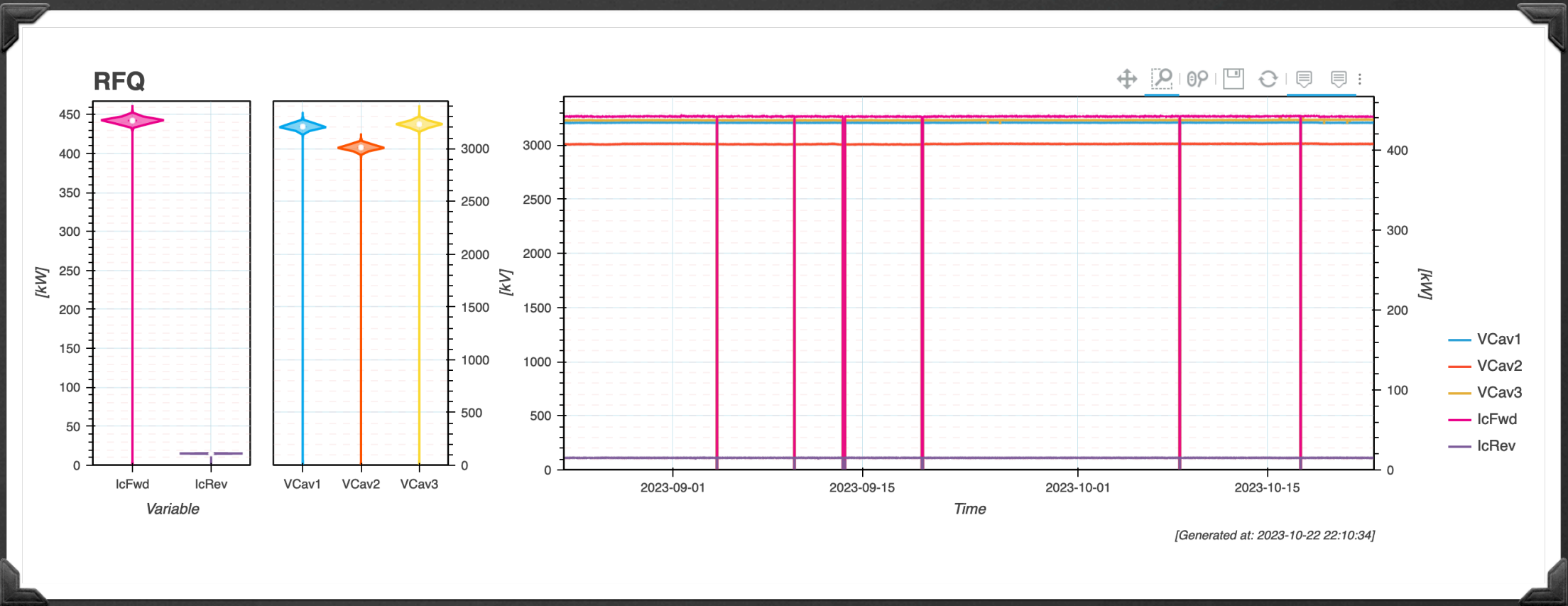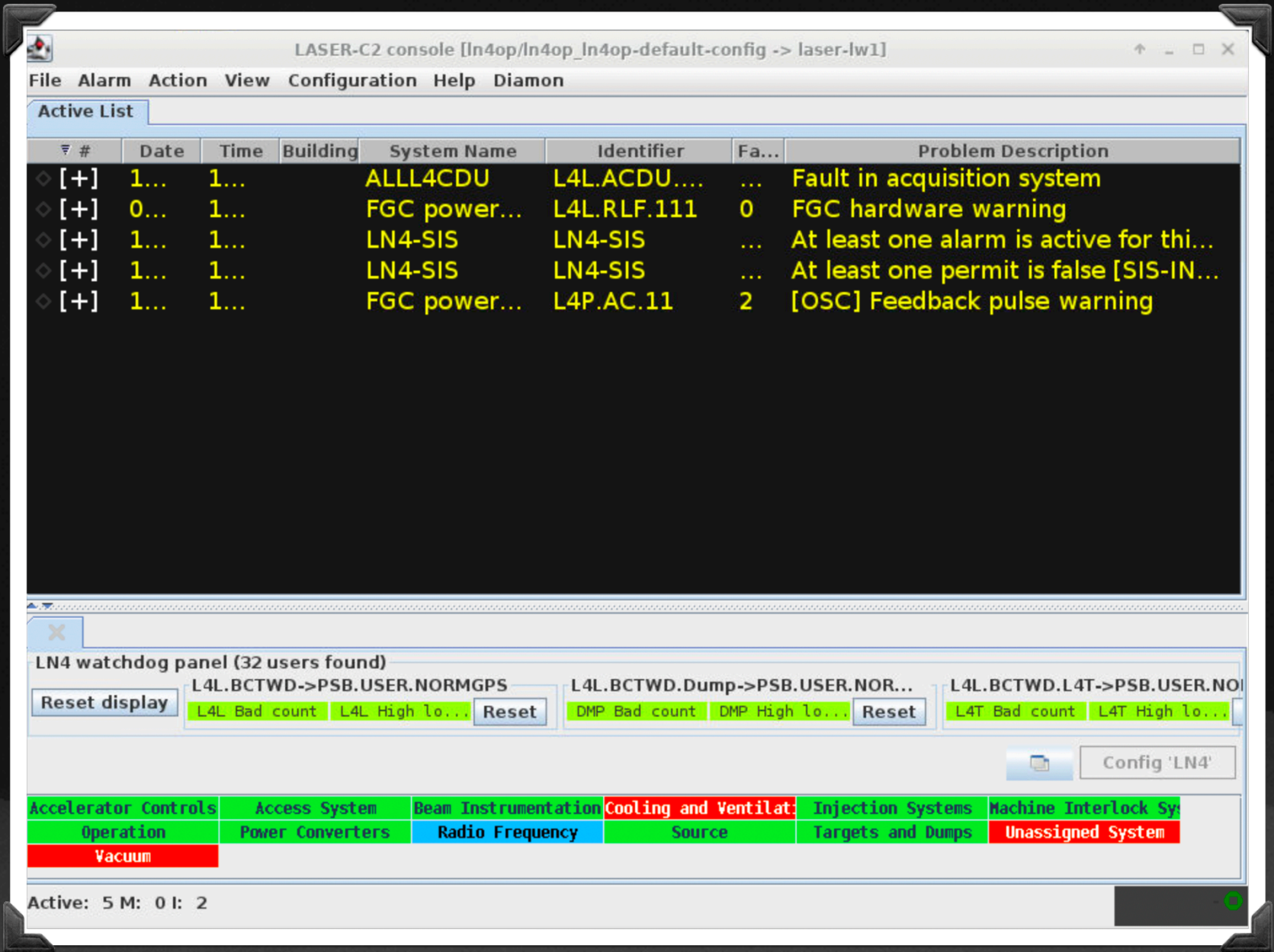
Anomaly detection tools

- LASER

- TIMBER

- Commissioning & setting-up scripts

- Automatic observation systems:

    - algorithm based,

    - machine learning?
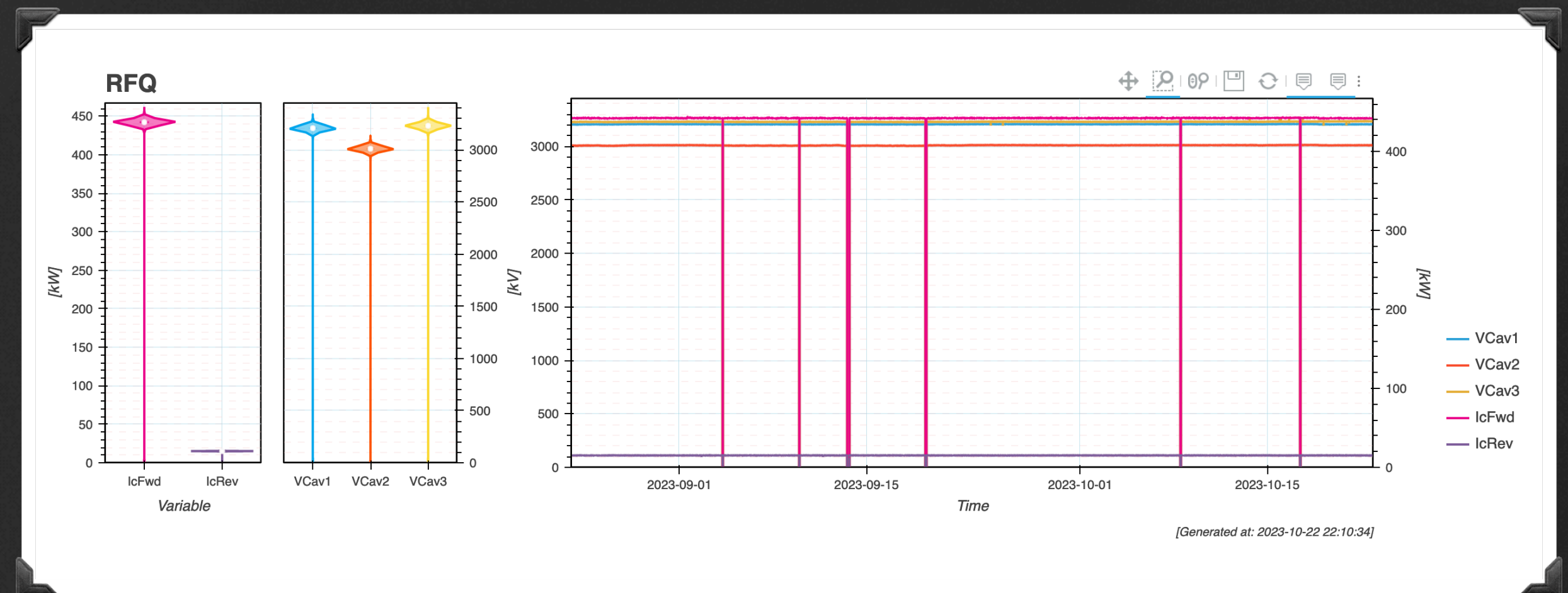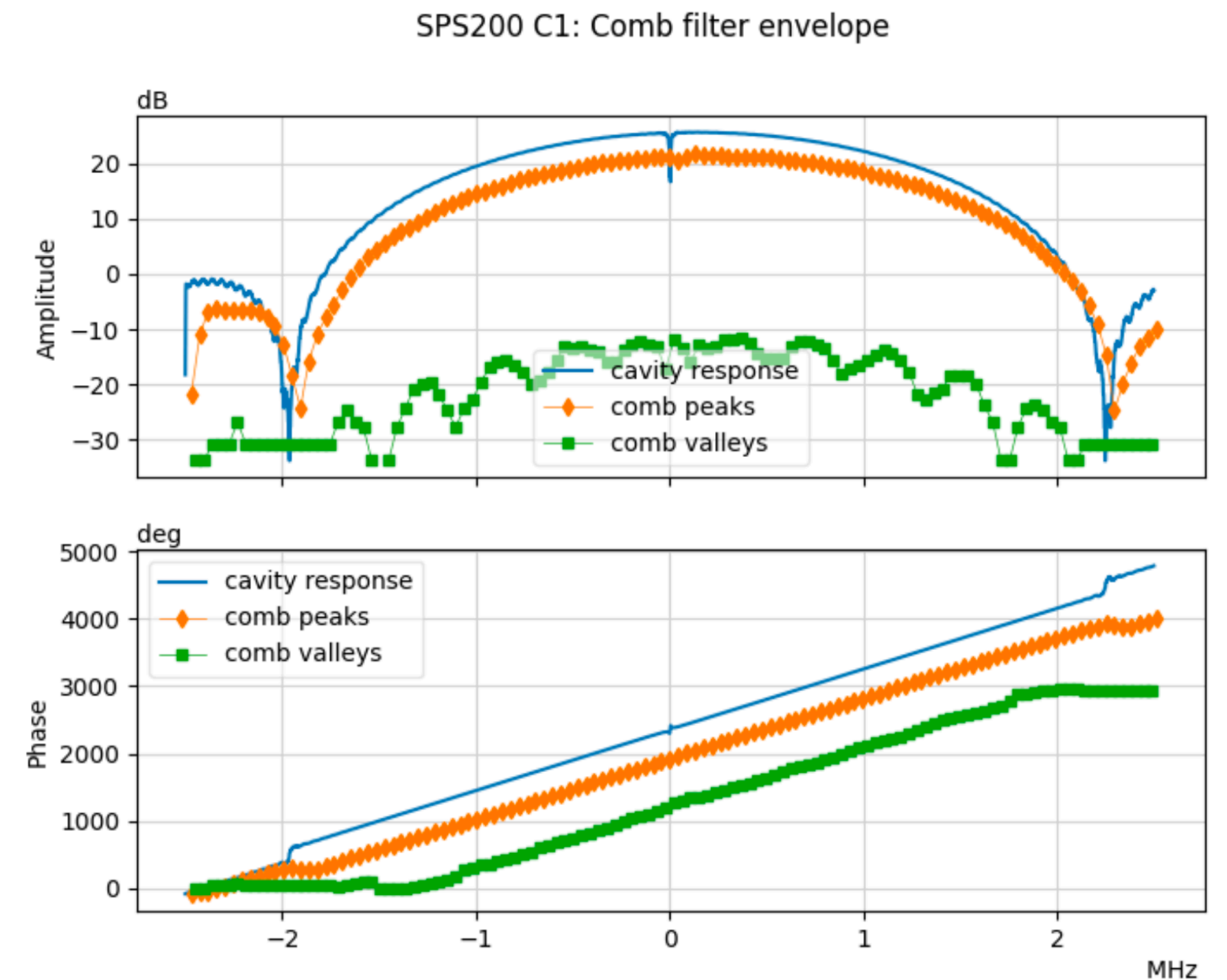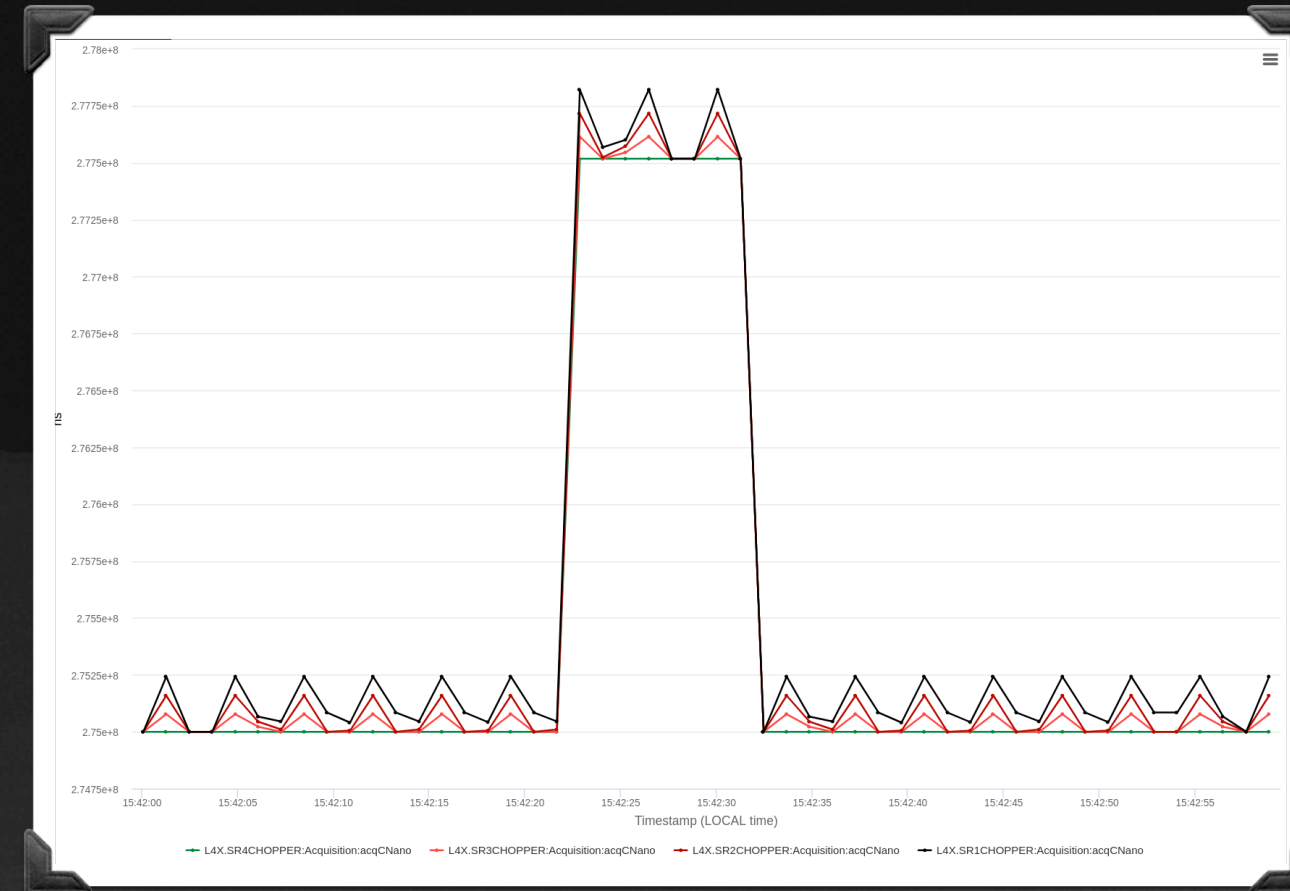
Human supervision

- Weekly on-call duty debriefing-briefing meetings:

  - Issue system to monitor ongoing issues,

- Close cooperation with Operators,

- Experts monitoring machine health.

Automation tools

- Sequencers (C++/FESA, Python),

- Breakdown Protection & Recovery Systems (LN4),

- Phase monitoring systems,

- Automatic firmware updater,

- Self-automated LLRF setting up for SPS200,

- SPS200 integrated VNA + scripts.

Thank you