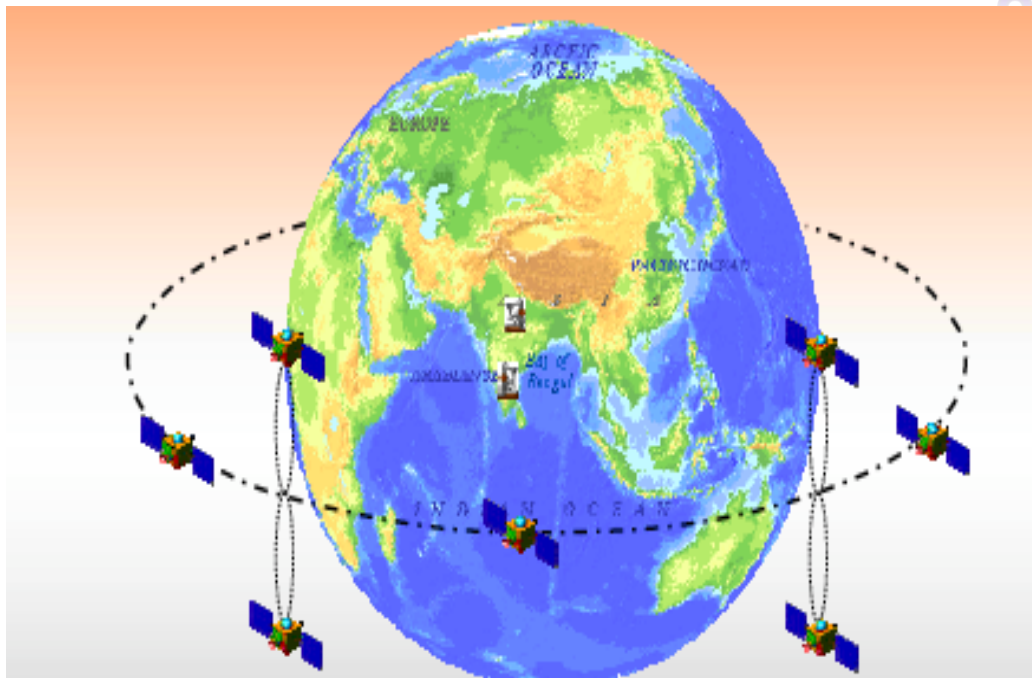


RUBIDIUM CLOCK MONITORING UNIT WITH ENHANCED INTEGRITY



Alak Banik

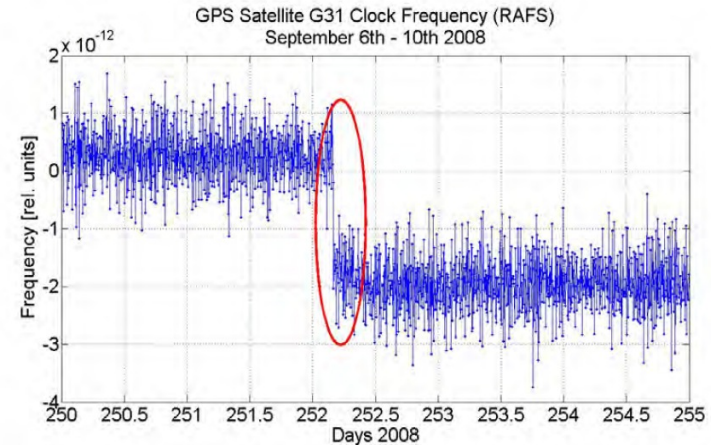
Space Applications Centre, ISRO, India

Frequency Jump in Rubidium Atomic Clock

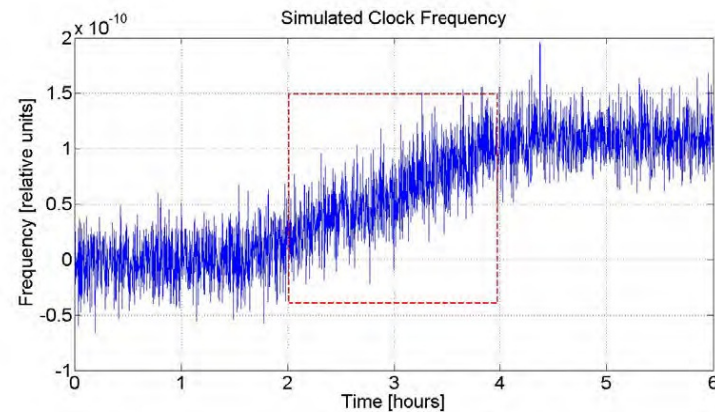
- Frequency jumps are commonly noted in **Rubidium atomic clocks onboard navigation satellites**. These jump behaviors must be detected quickly and accurately to minimize the impact on user positioning.

Frequency Jump in Rubidium Atomic Clock

❖ Sudden Frequency Jump

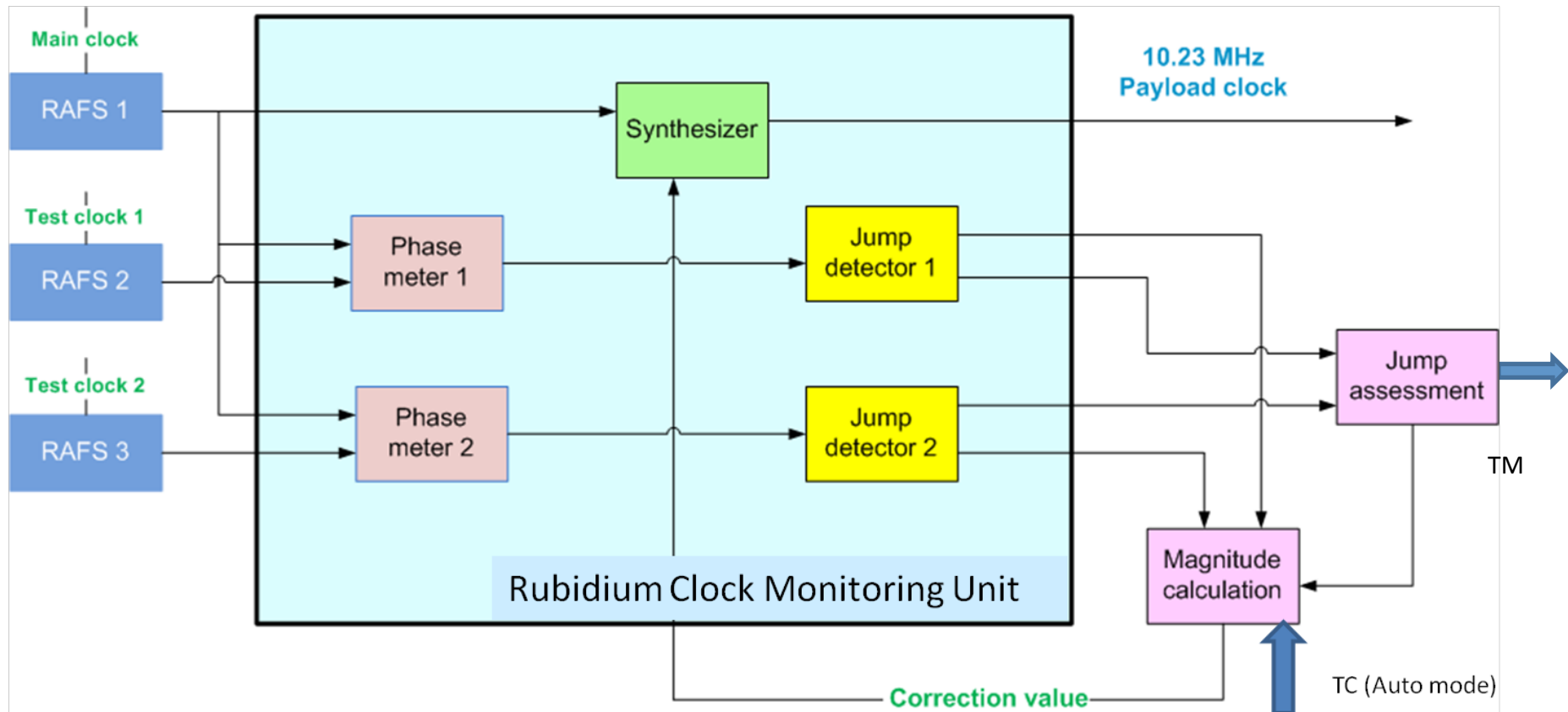


❖ Slow Frequency Jump



❖ Reference: The thesis title "Timing Experiments with Global Navigation Satellite System Clocks" by Alice Cernigliaro, POLITECNICO DI TORINO, march 2012, page 129-132

Rubidium Clock Monitoring Unit with enhanced integrity



- To monitor jumps, clock monitoring unit uses three RAFS clocks
- Two jump detectors are used to confirm the frequency jump in payload clocks
- Magnitude of jump is calculated and correction is sent to synthesizer

Algorithms for Frequency Jumps in Rubidium Atomic Clock

There are following algorithms for sudden frequency jump detection.

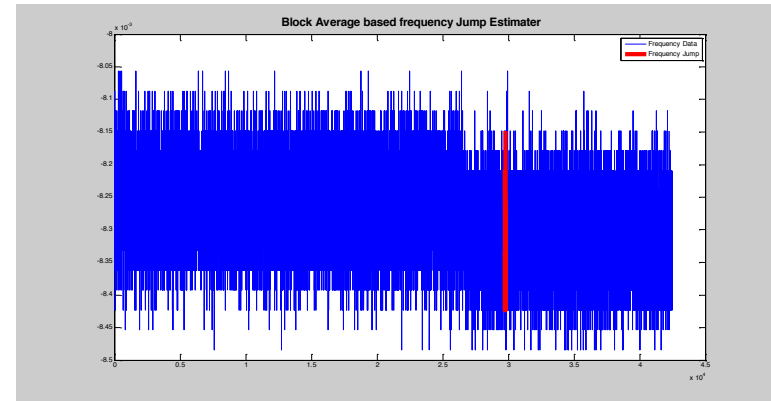
- I. **Block Average Jump Detection Algorithm.**
- II. **Sequential Average Jump Detection Algorithm .**
- III. **Kalman Filter based Jump Detection Algorithm.**

Rubidium Clock Monitoring Unit with enhanced integrity

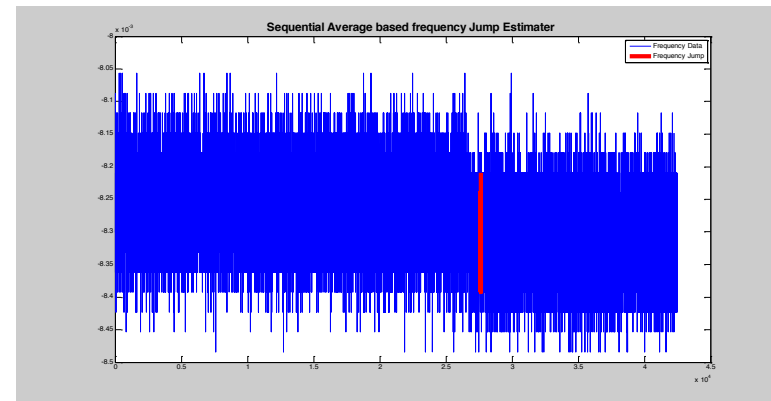


Jump Detection using various Algorithms

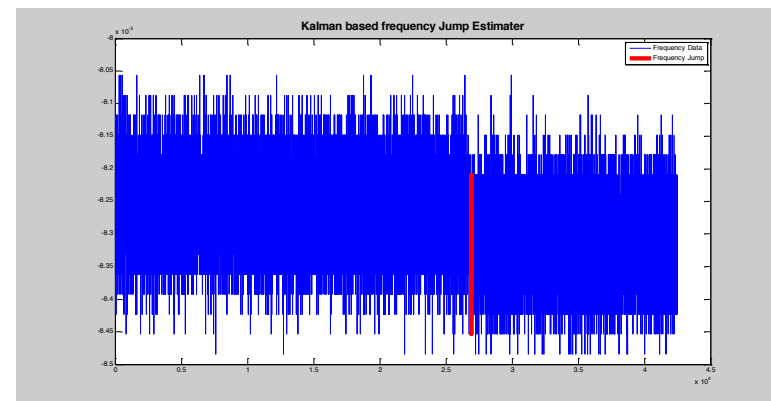
Block Average



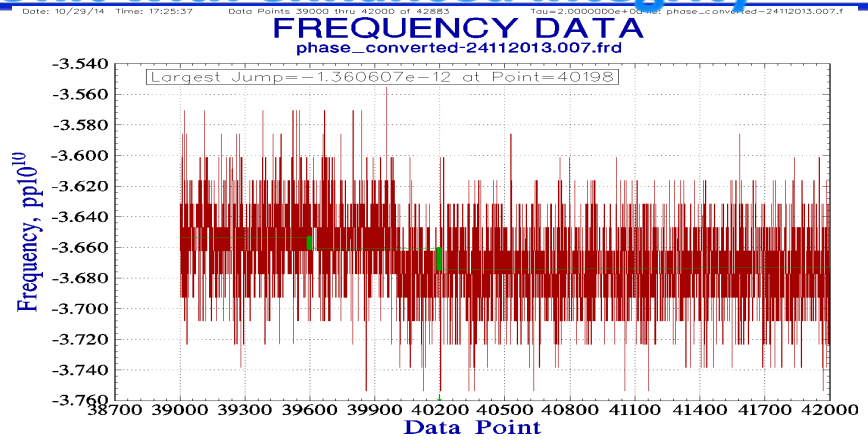
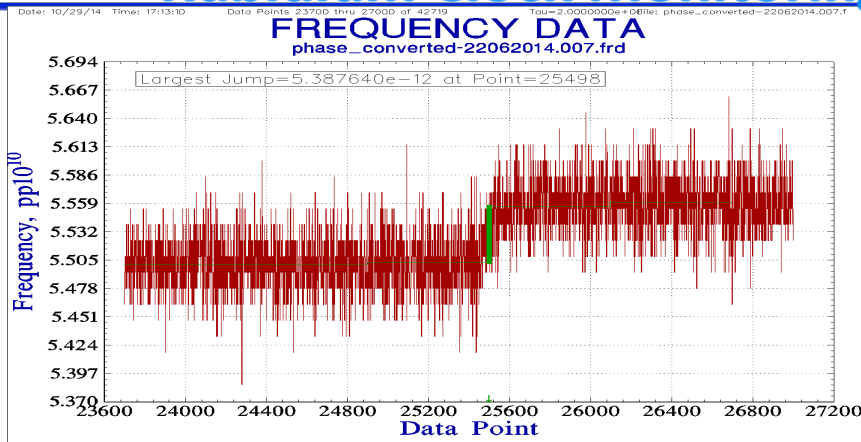
Sequential



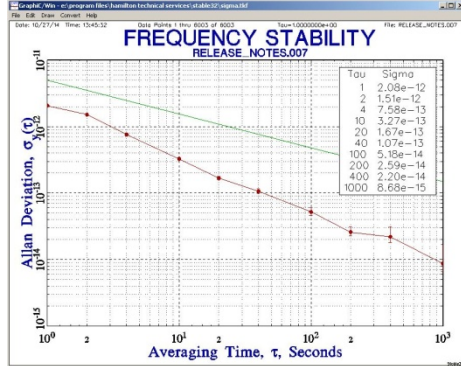
Kalman Filter



Rubidium Clock Monitoring Unit with enhanced integrity



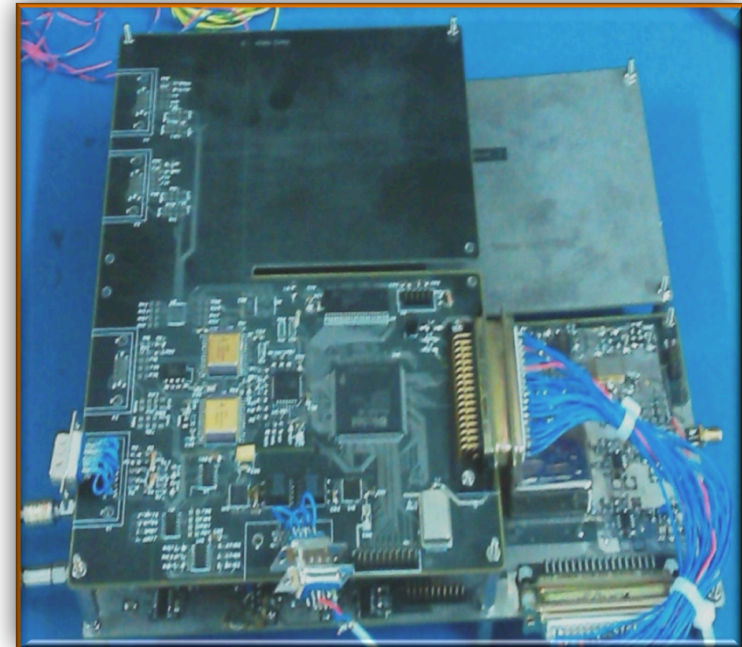
Window length= 600; Jump threshold= 4e-13



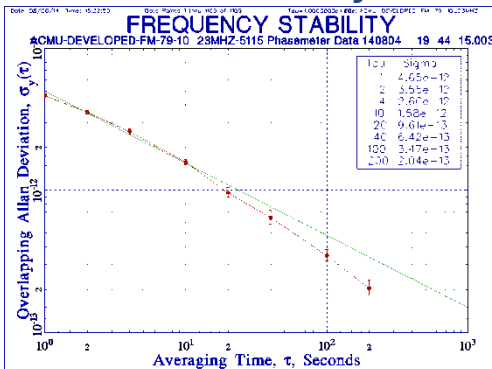
10.23 MHz Phase noise



DVM RCMU



Phase meter noise floor



10.23 MHz Allan deviation

THANK YOU ALL