Summary on the LBDS triggering issues

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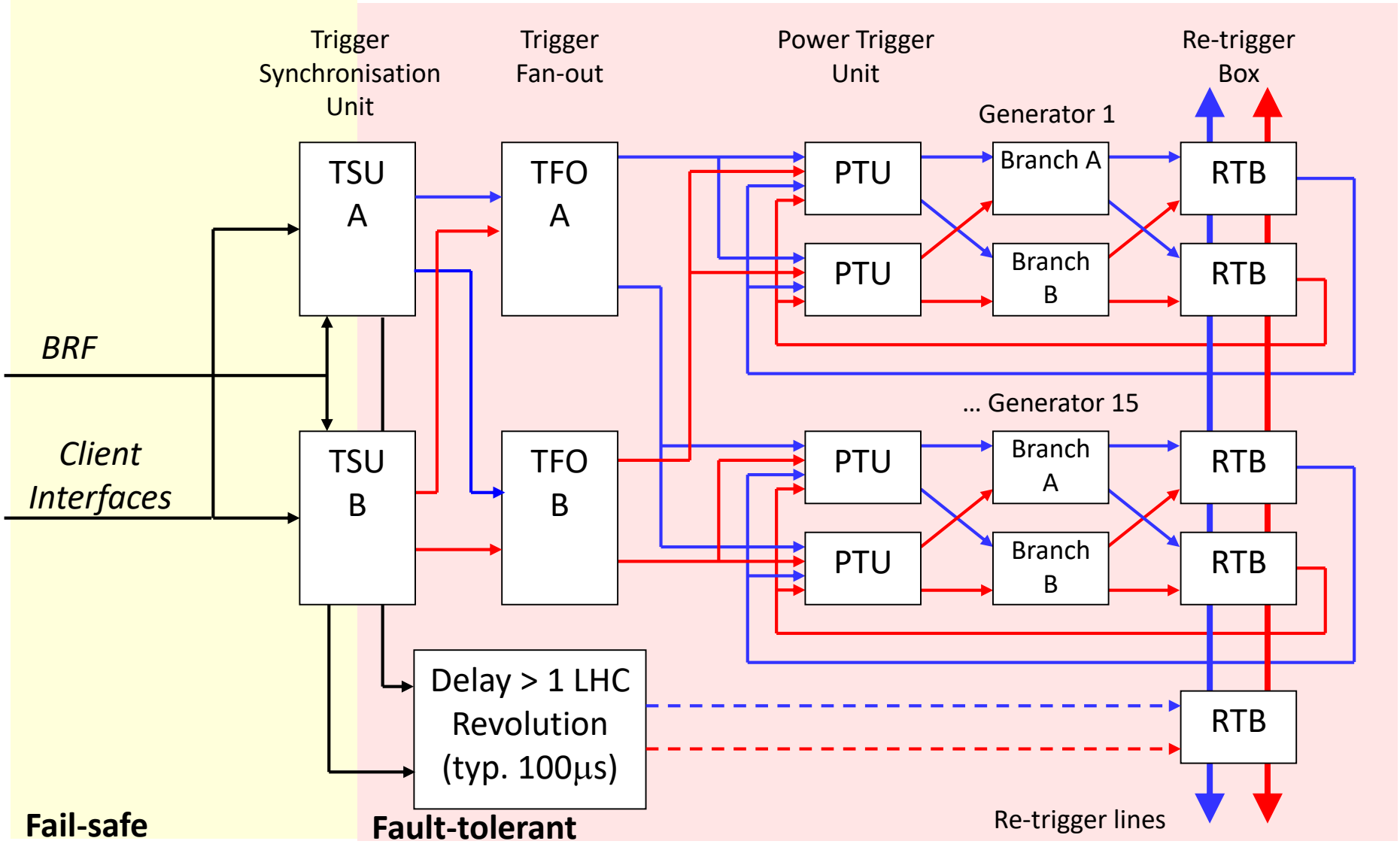
MPP – 11/12/2009

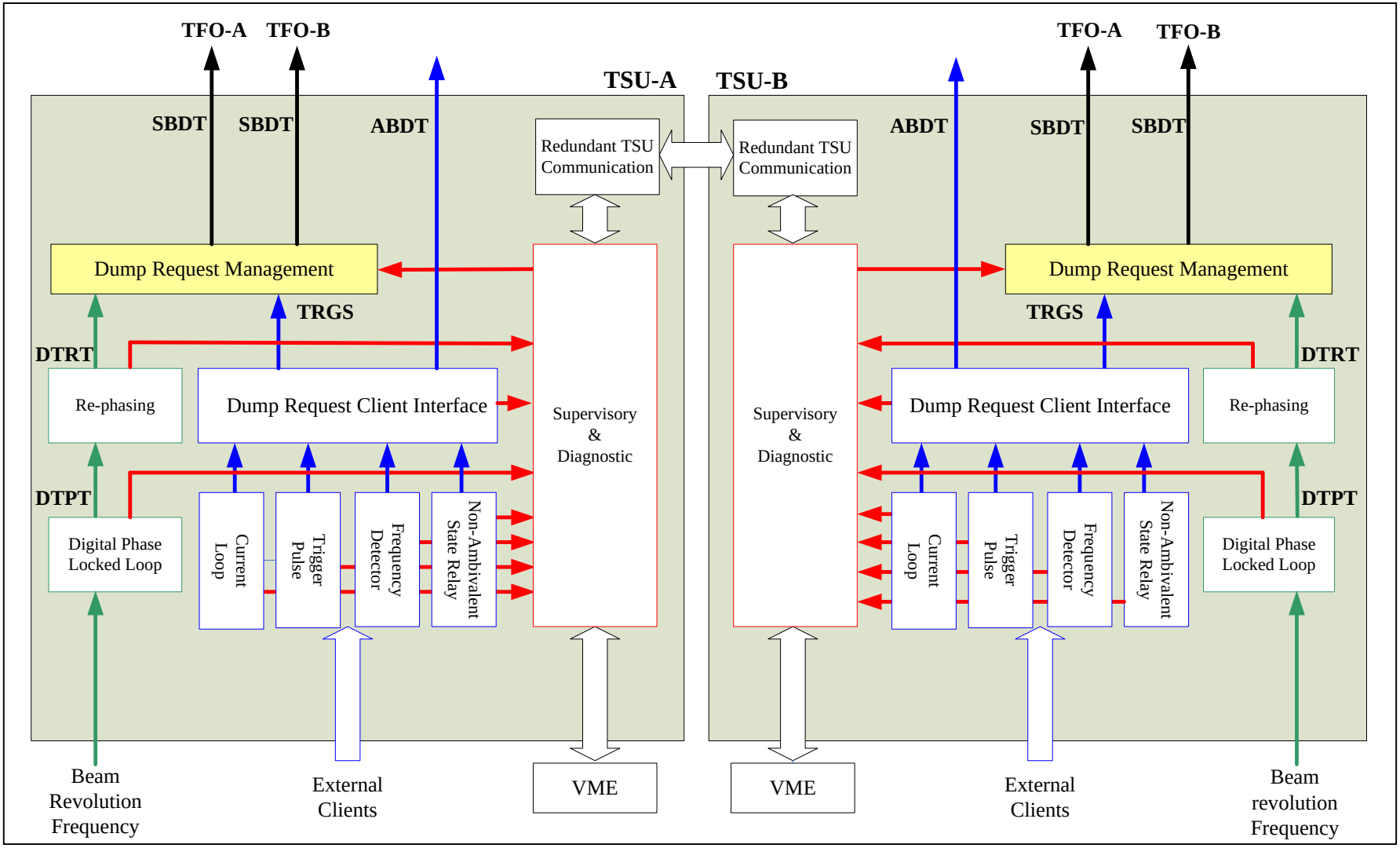
Outline

- Trigger Synchronisation and Distribution System
- Trigger Synchronisation Unit
- Failures Scenario and Possible Actions
- Synchronisation
- Revolution Frequency Instabilities
- Asynchronous Dump
- Asynchronous “Synchronised” Dump
- Summary

Trigger Synchronisation and Distribution System



Trigger Synchronisation Unit



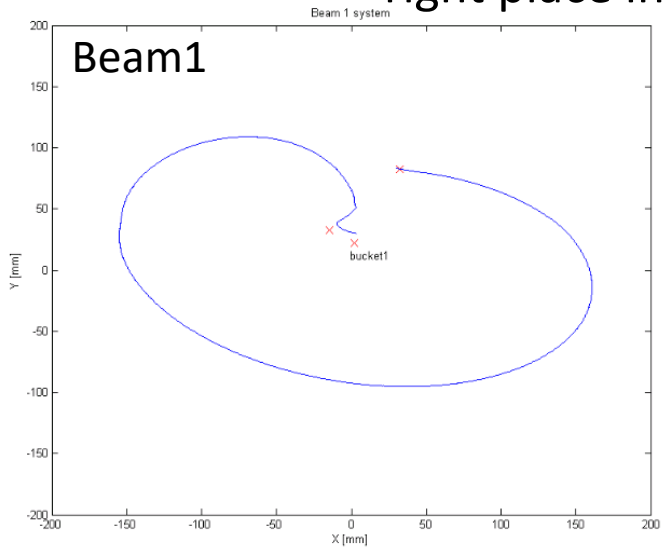
Synchronisation
Failure Scenarios and Possible Actions

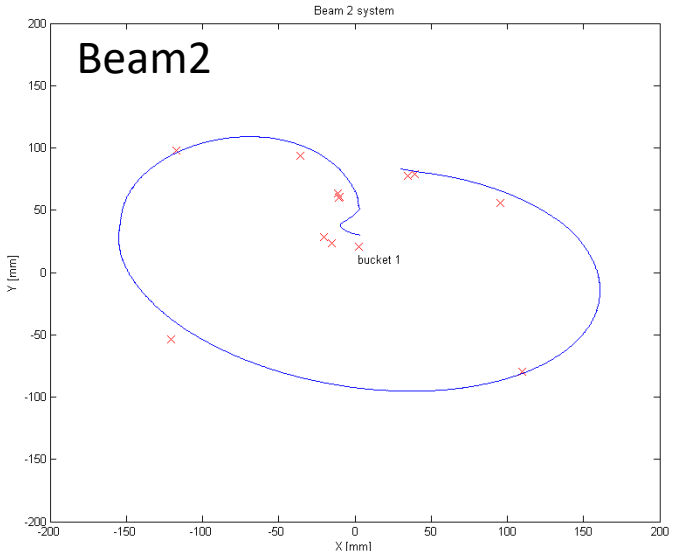
TSU-A	TSU-B	State	TSU-A Action	TSU-B Action
OK	OK	All OK	No action	No action
Faulty	OK	Synchronisation TSU-A Faulty	Inhibit SBDT Generate ABDT	Generate SBDT & ABDT
OK	Faulty	Synchronisation TSU-B Faulty	Generate SBDT & ABDT	Inhibit SBDT Generate ABDT
Faulty	Faulty	No Revolution Frequency	Generate SBDT (NCO_{n-2} value) & ABDT	Generate SBDT (NCO_{n-2} value) & ABDT

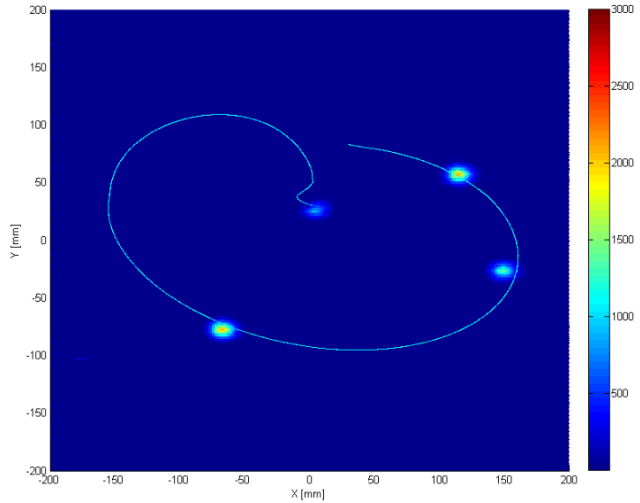
SBDT : Synchronous Beam Dump Trigger
ABDT : Asynchronous Beam Dump Trigger
NCO : Numerically Controlled Oscillator

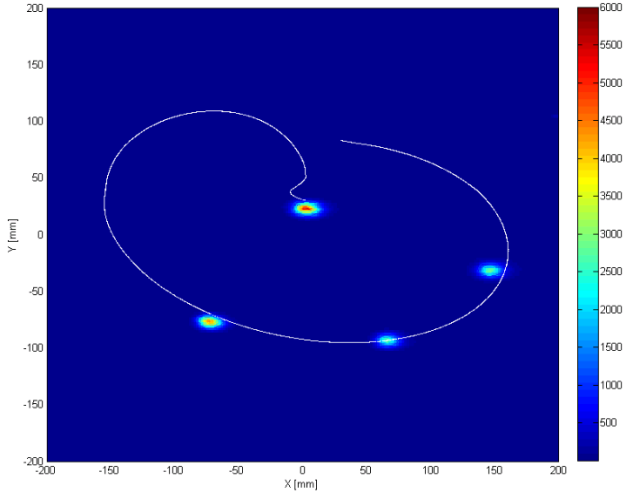
Synchronisation

Adjusted, checked, stable and reproducible for B1 and B2 – bucket 1 now at the right place in the extraction sweep









F_{rev} Instabilities

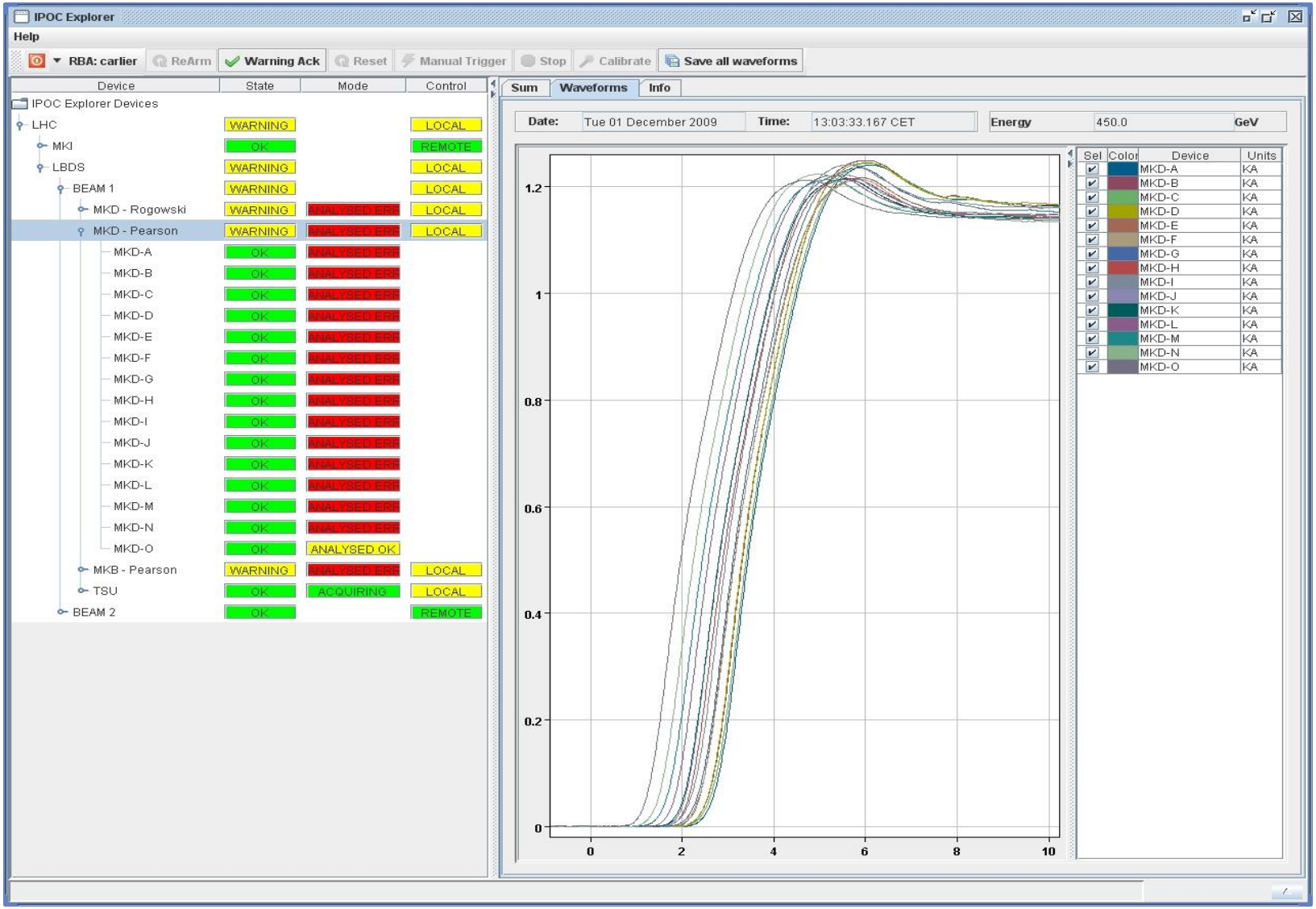
- Common mode failure
  - Same hardware signal used by both redundant TSUs
- Typical failure modes tested (dry runs and with beam)
  - Lost of F_{rev} → Dump OK
  - Modulation of F_{rev} → No dump (Maximum 400MHz $\Delta f/f$ is within ADPLL ±30ns locking margin)
  - Re-phasing when LBDS armed → Dump OK
  - RF Beam1 to LBDS Beam1 / RF Beam2 to LBDS Beam2

Asynchronous dump

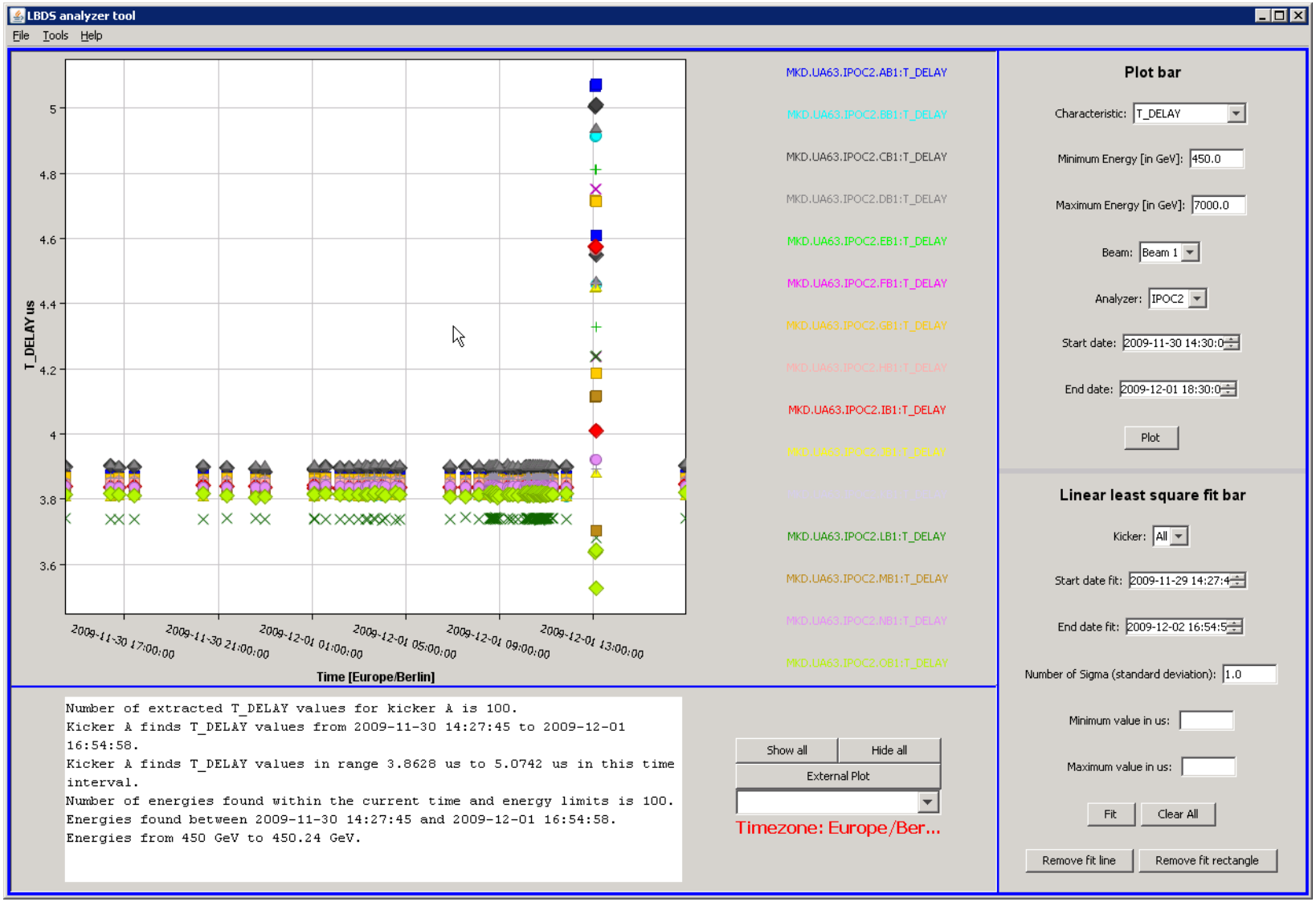
- 2 events identified
- Only possible during execution of an arming sequence, if
  - All the clients are OK,
  - BIS frequencies properly generated, and
  - BRF is not present or unstable.
- IPOC & XPOC give ERRORS.
  - Expert action required for errors acknowledgement… Should not be necessary as the LBDS was not armed

F_{rev} presence and ADPLL locking now checked in sequencer before starting an arm sequence.

Asynchronous dump
IPOC



Asynchronous dump Signature

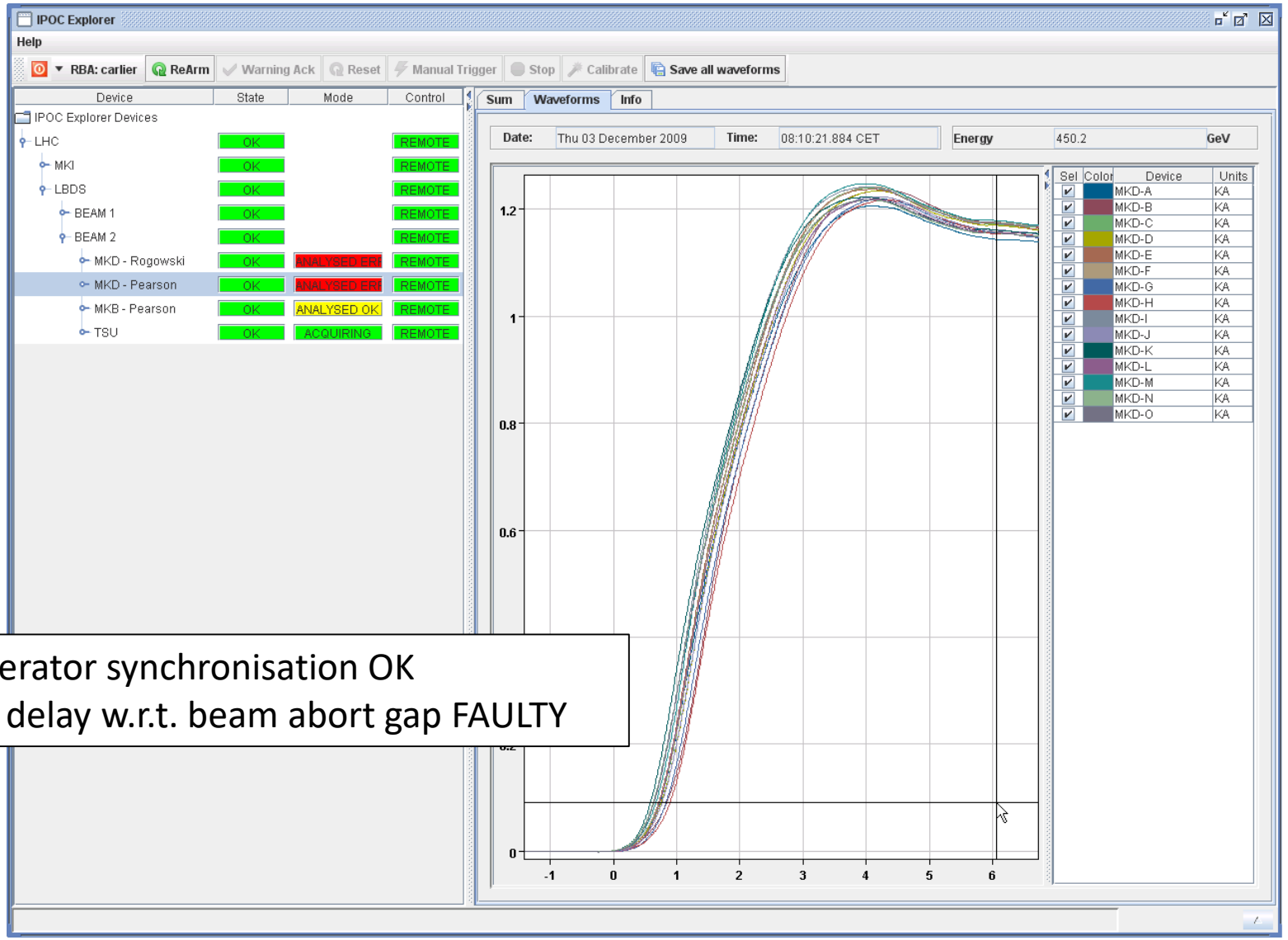


Asynchronous “Synchronised” Dump

- Dump request received during the 1.5µs F_{rev} pulse duration
  - Dump request inhibited for the current turn
  - Dump request executed at the next rising edge of the F_{rev} signal (turn+1)
- Original inhibition mechanism lets a “glitch” going out
  - Synchronous trigger of the 15 kicker generators
  - Asynchronous trigger w.r.t. the circulating beam
- IPOC triggered ~600ns later by the signal coming from the Re-trigger lines
- Synchronisation fault detected by the IPOC and XPOC system
  - Expert action required for errors acknowledgement

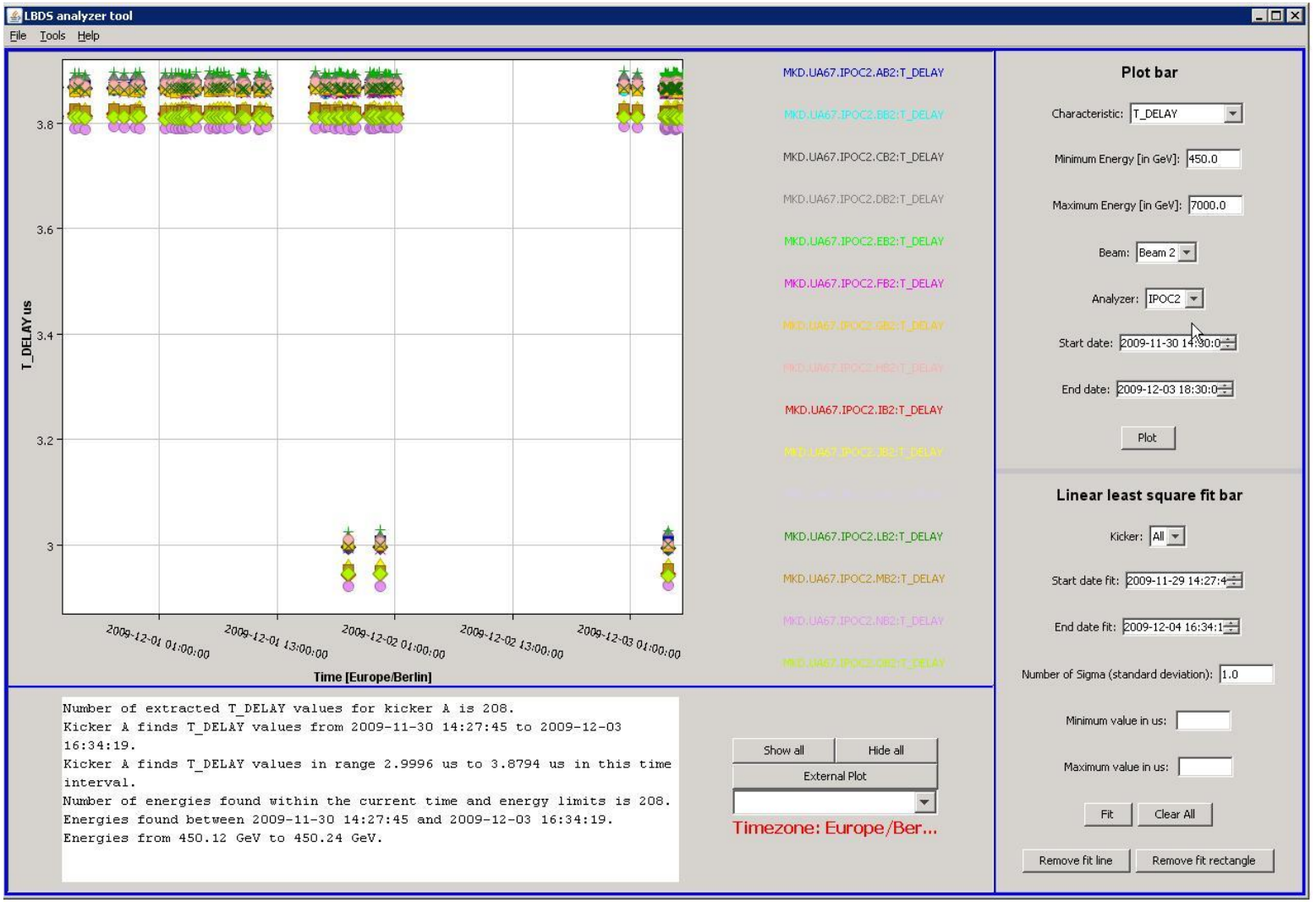
TSU firmware upgraded and successfully tested

Asynchronous “Synchronised” Dump IPOC

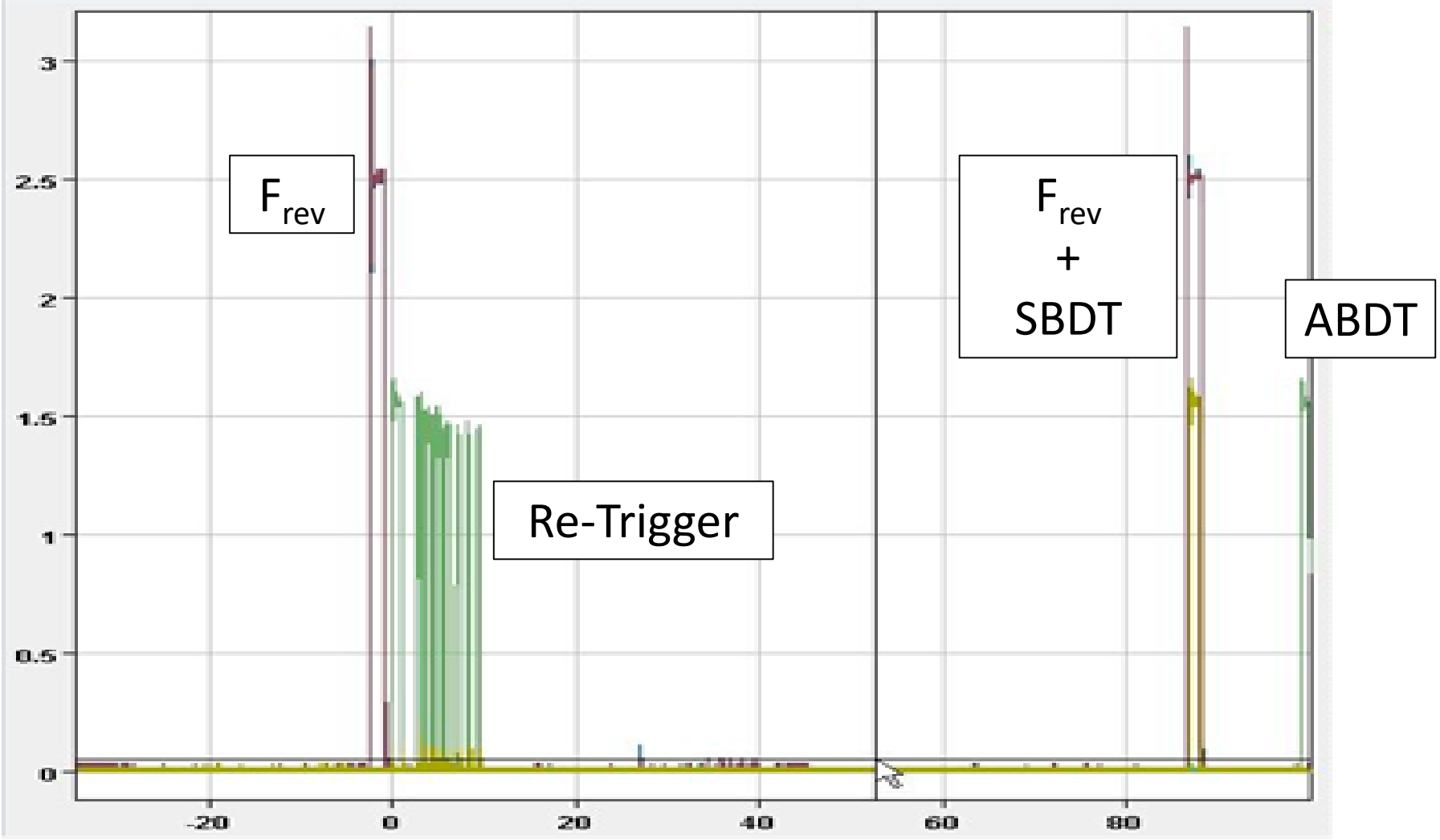


- Generator synchronisation OK
- Kick delay w.r.t. beam abort gap FAULTY

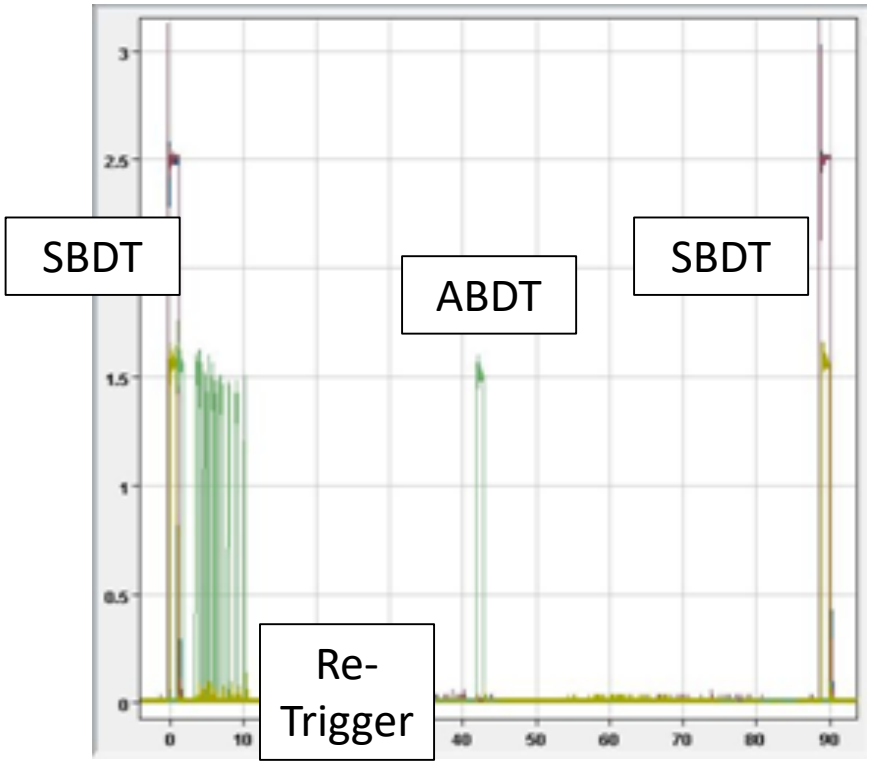
Asynchronous “Synchronised” Dump Signature



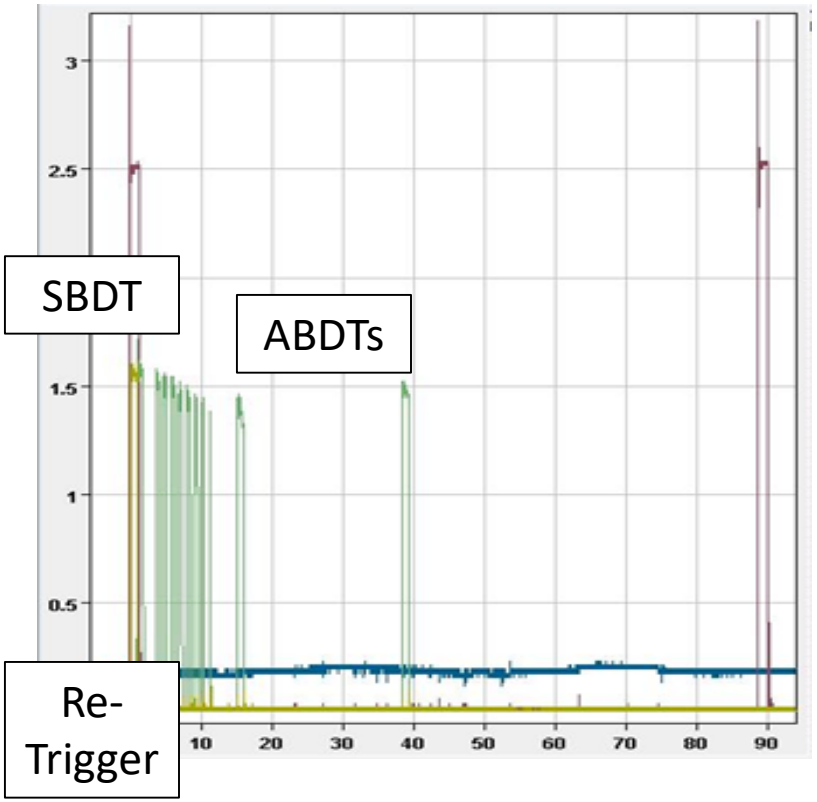
Asynchronous “Synchronised” Dump
Faulty Triggering Sequence



Synchronisation
Nominal Triggering Sequence



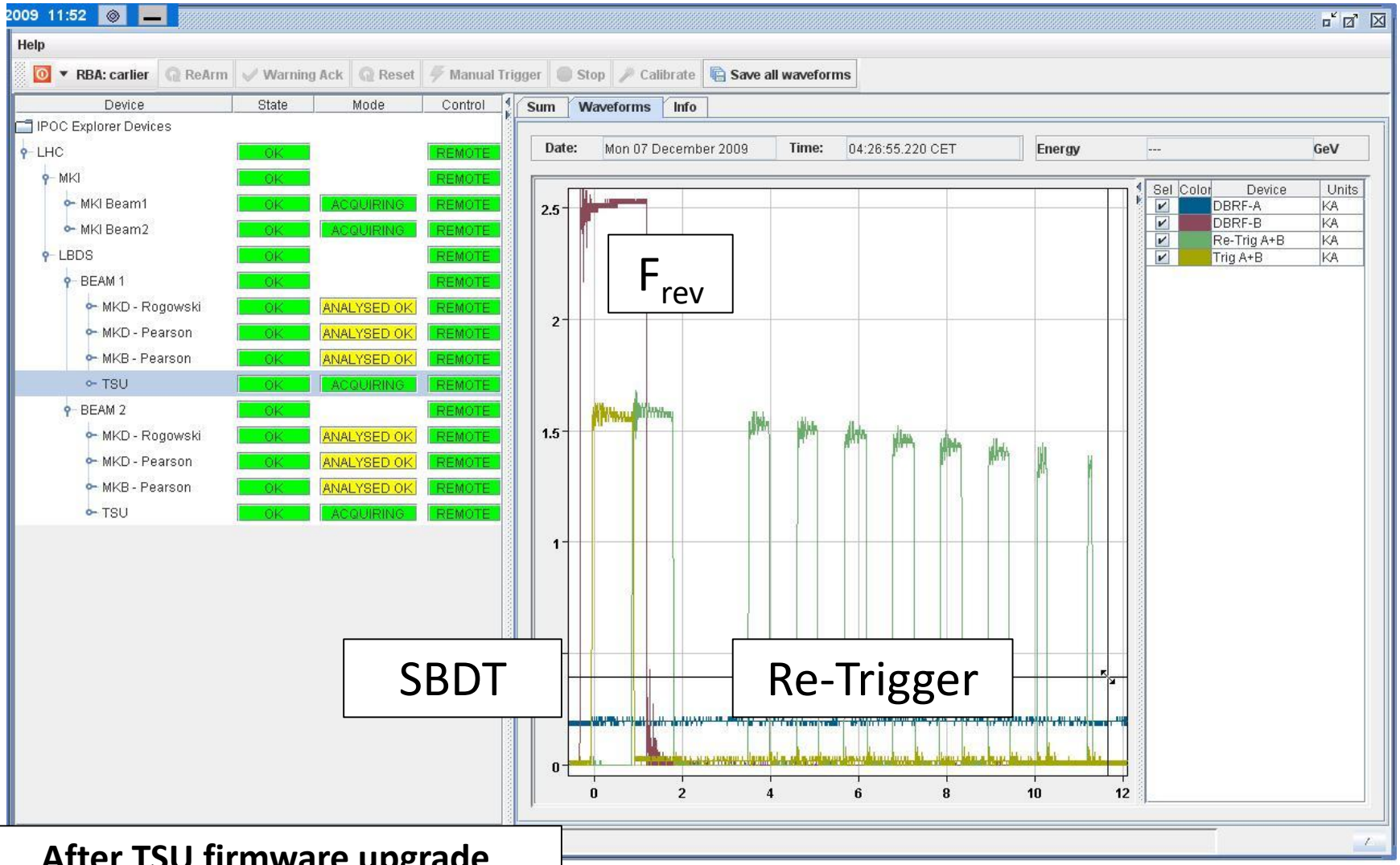
Dump request from IP5
One TSU triggered by the BIS. The second TSU triggered by the BETS and the BIS one turn later



Dump request from IP2
Both TSUs triggered by the BIS on the same turn

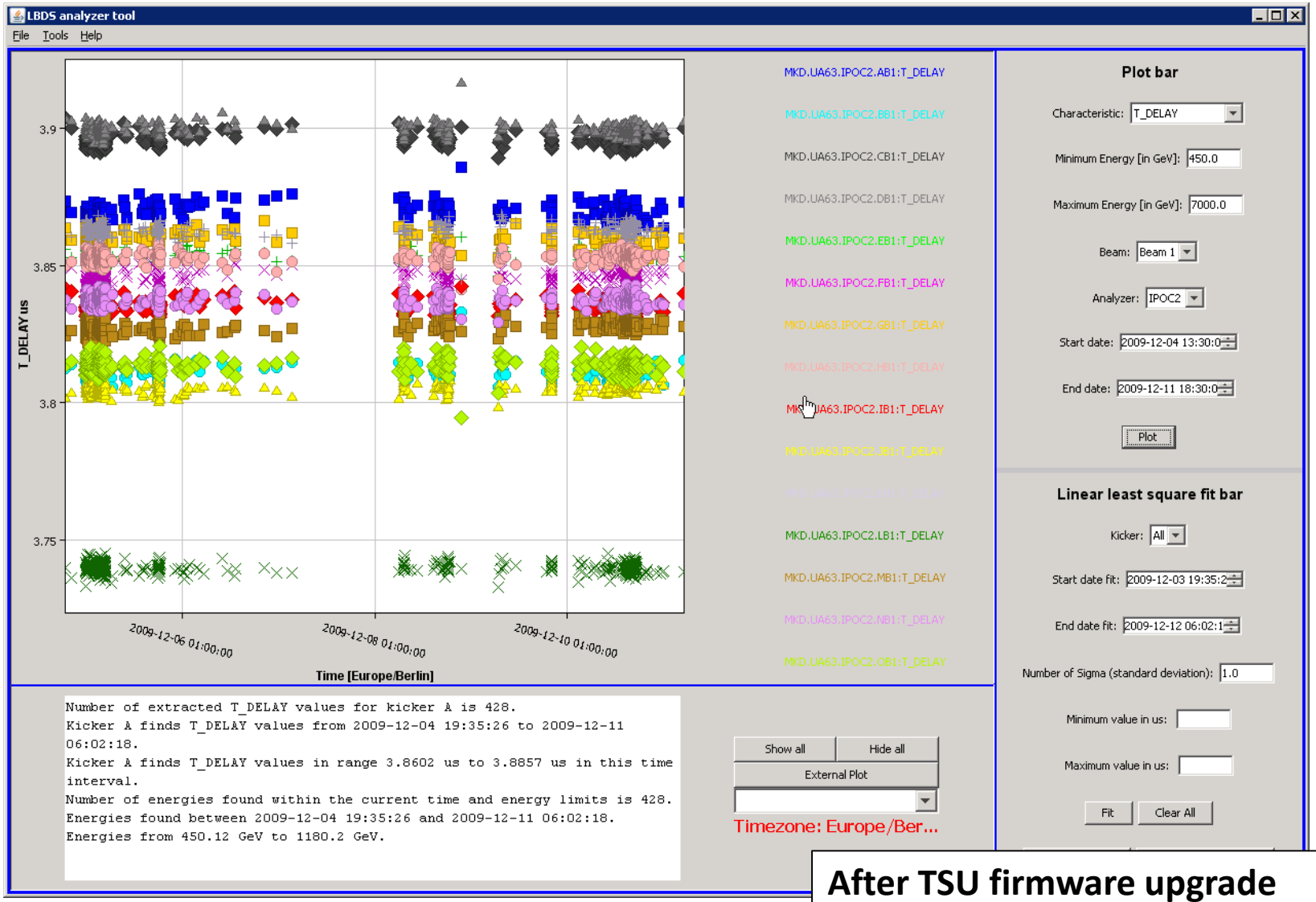
After TSU firmware upgrade

Synchronisation
Nominal Triggering Sequence (cont.)



After TSU firmware upgrade

Synchronisation
Stability



After TSU firmware upgrade

On-going

- Development of a redundant firmware started
  - 2 different VHDL codes with the same functional requirements
- TSU-V3 in preparation
  - Implementation of high resolution IPOC at the TSU firmware level (ns range)
  - High precision measurement of the F_{rev} (correct connection between LBDS and 400MHz RF systems)
- External review of the TSU (hardware and firmware) in progress

Summary

- Asynchronous dump recorded only during execution of arming sequence.
  - No event identified when the system was armed
- F_{rev} instabilities, tested when the system is armed, have always resulted in synchronised dumps.
- Issue with Asynchronous “Synchronised” dumps has been successfully solved by upgrading the TSU firmware.
- IPOC and XPOX have detected and recorded all the faulty events