

EXTERNAL POST-OPERATIONAL CHECKS FOR THE LHC BEAM DUMPING SYSTEM

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ABSTRACT

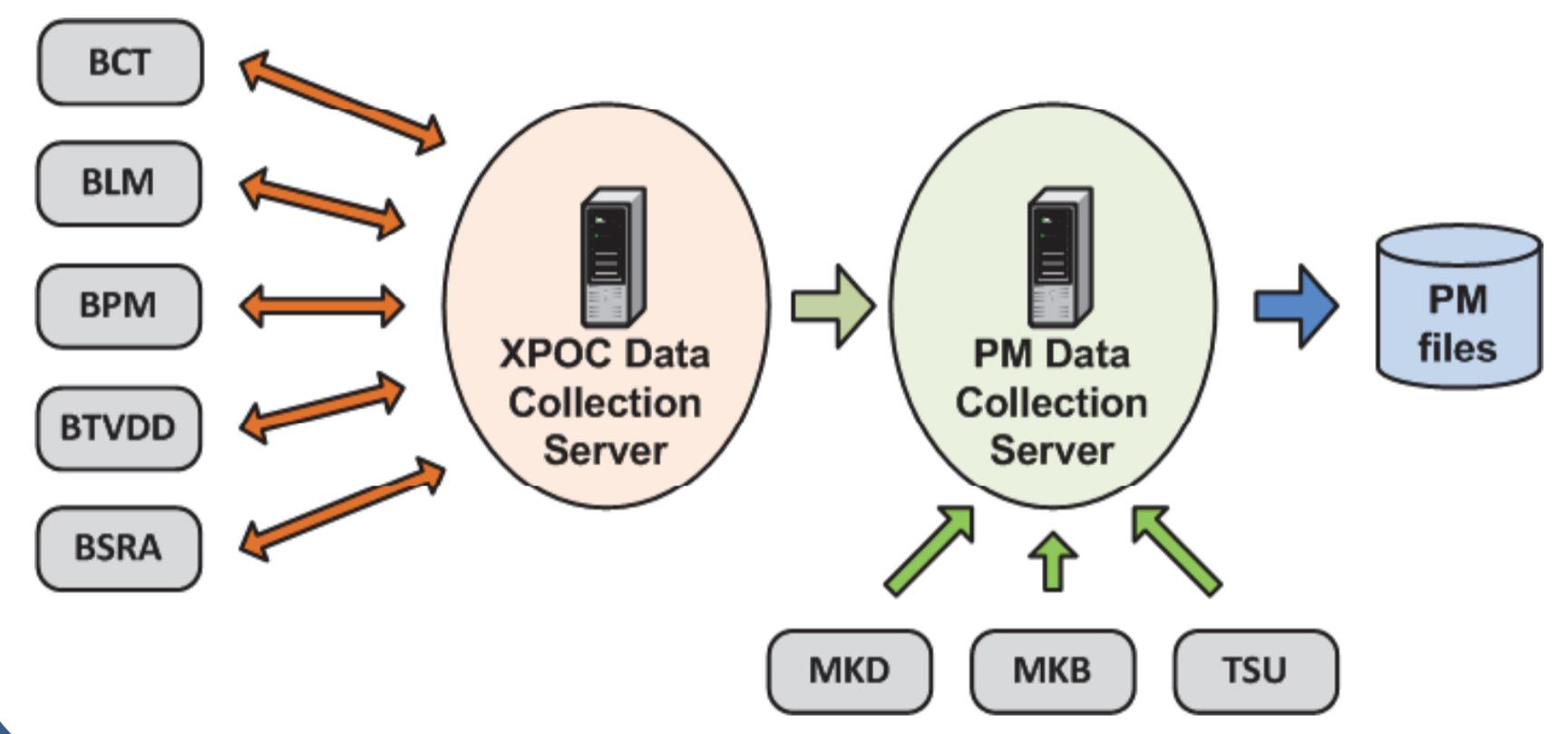
The LHC Beam Dumping System (LBDS) is a critical part of the LHC machine protection system. After every LHC beam dump action the various signals and transient data recordings of the beam dumping control systems and beam instrumentation measurements are automatically analysed by the eXternal Post-Operational Checks (XPOC) system to verify the correct execution of the dump action and the integrity of the related equipment. This software system complements the LHC machine protection hardware, and has to ascertain that the beam dumping system is ‘as good as new’ before the start of the next operational cycle. This is the only way by which the LBDS stringent reliability requirements can be met.

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The XPOC data collection server starts to collect, after each dump of Beam1 or Beam2, Post-Mortem (PM) data buffers from:

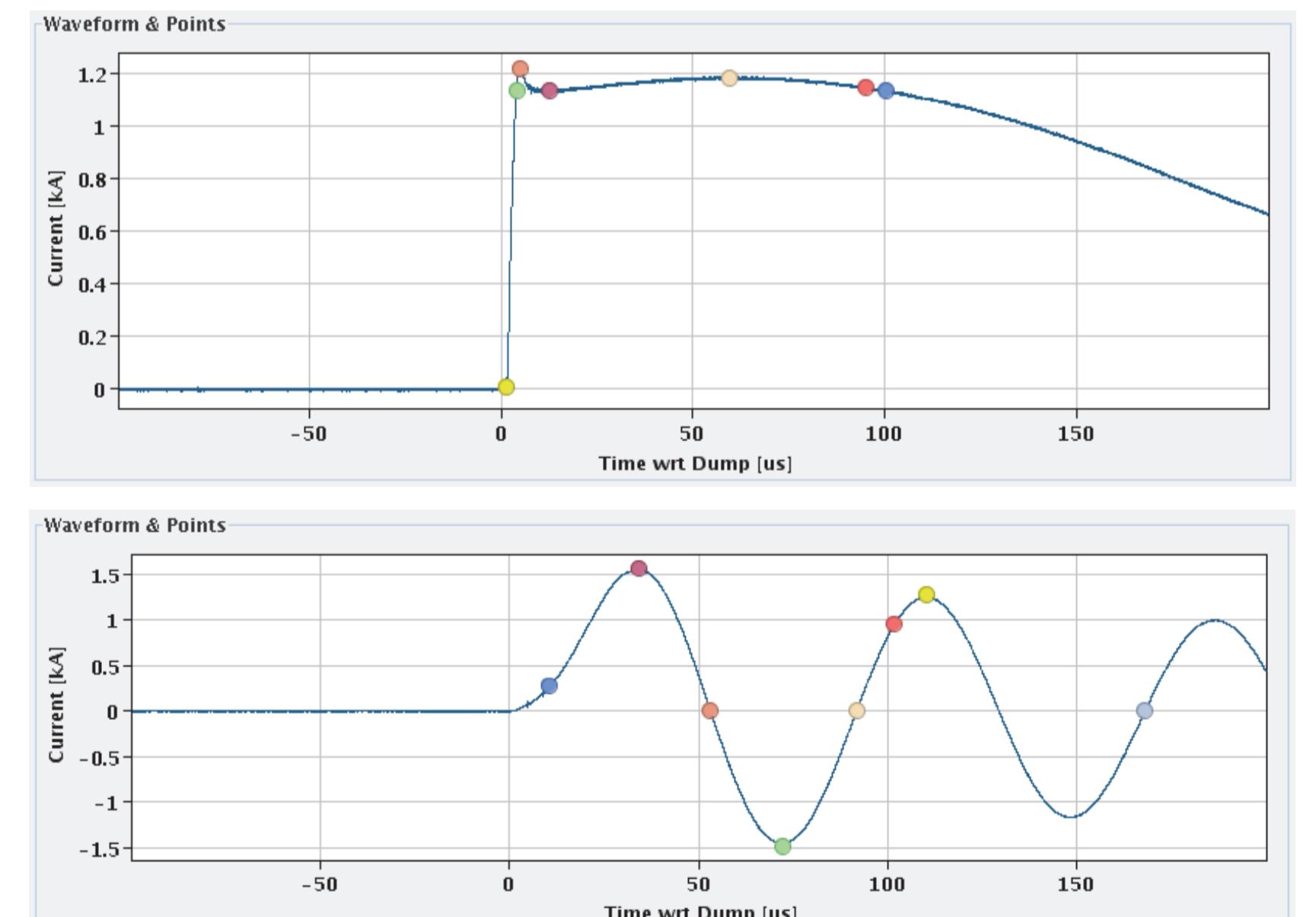
- LBDS kicker control system devices
- Beam instrumentation devices

and sends them to PM Data Collection storage. A new XPOC PM event is built, with all collected data attached.



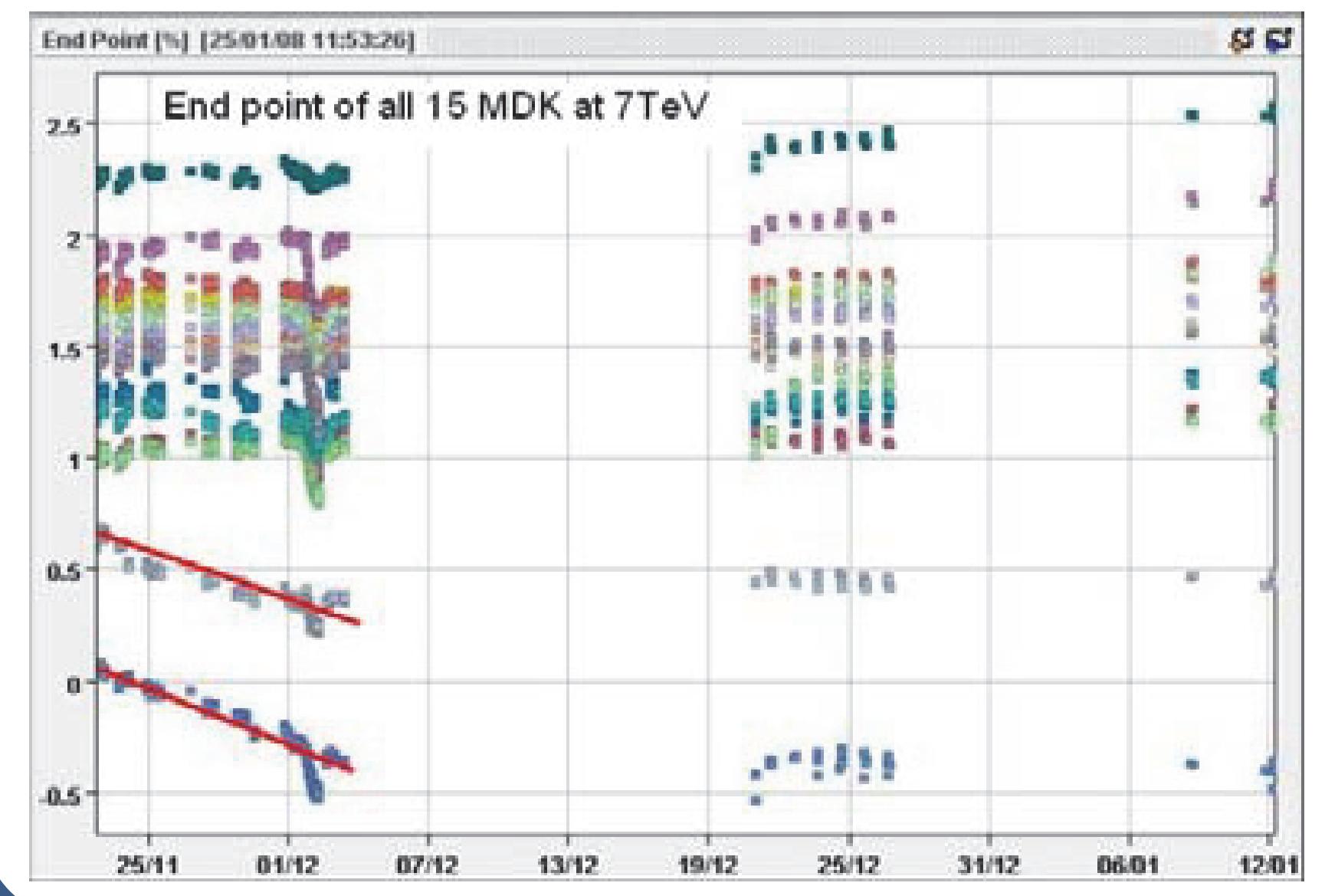
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The MKD & MKB modules analyse the MKD & MKB current waveforms and check that their characteristics like delay, rise time, frequency and strength are within computed limits.



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The LHC Logging Database receives and stores all XPOC analysis results. This allow us to perform long term trends of XPOC analysis results, and detect for instance any degradation in LBDS kicker characteristics.

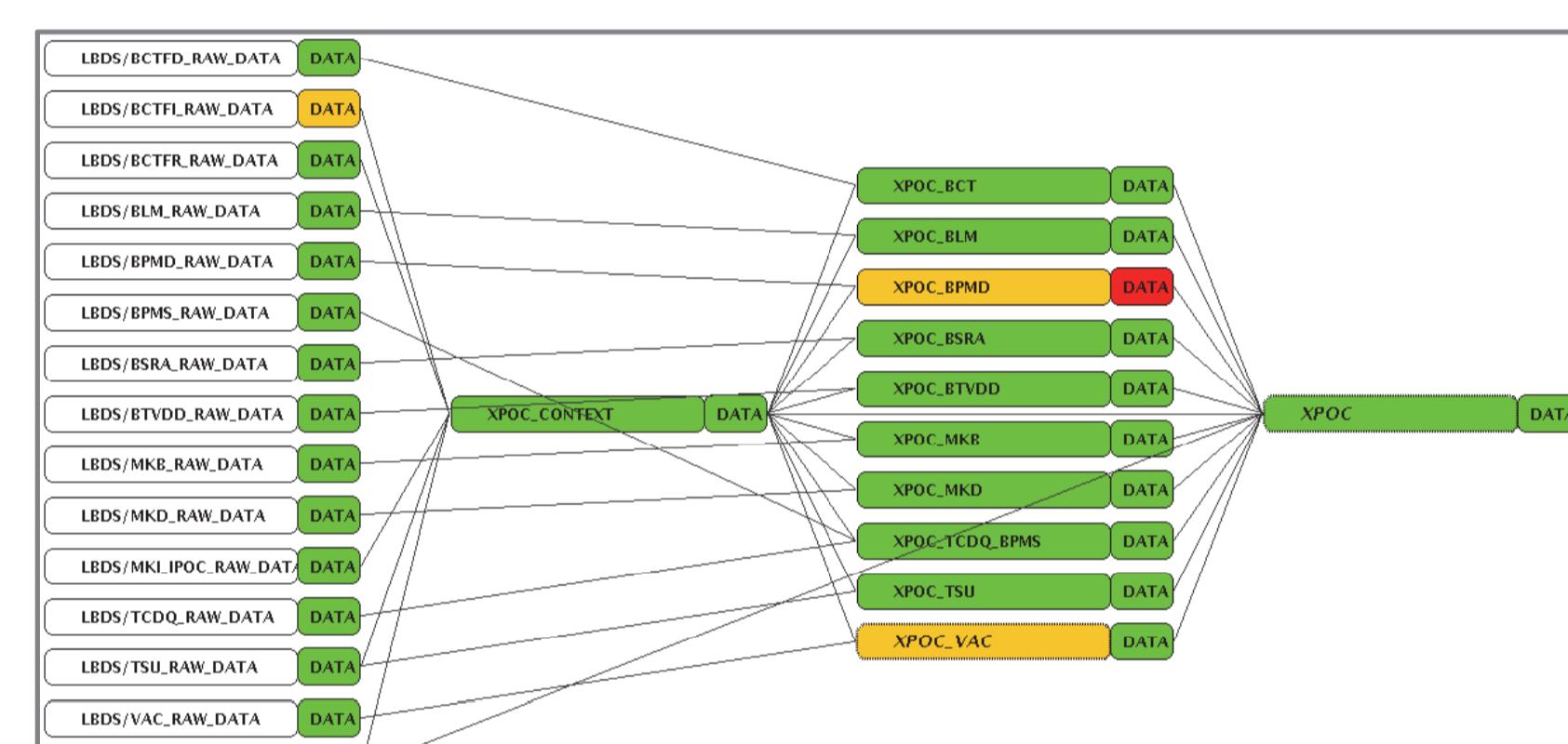


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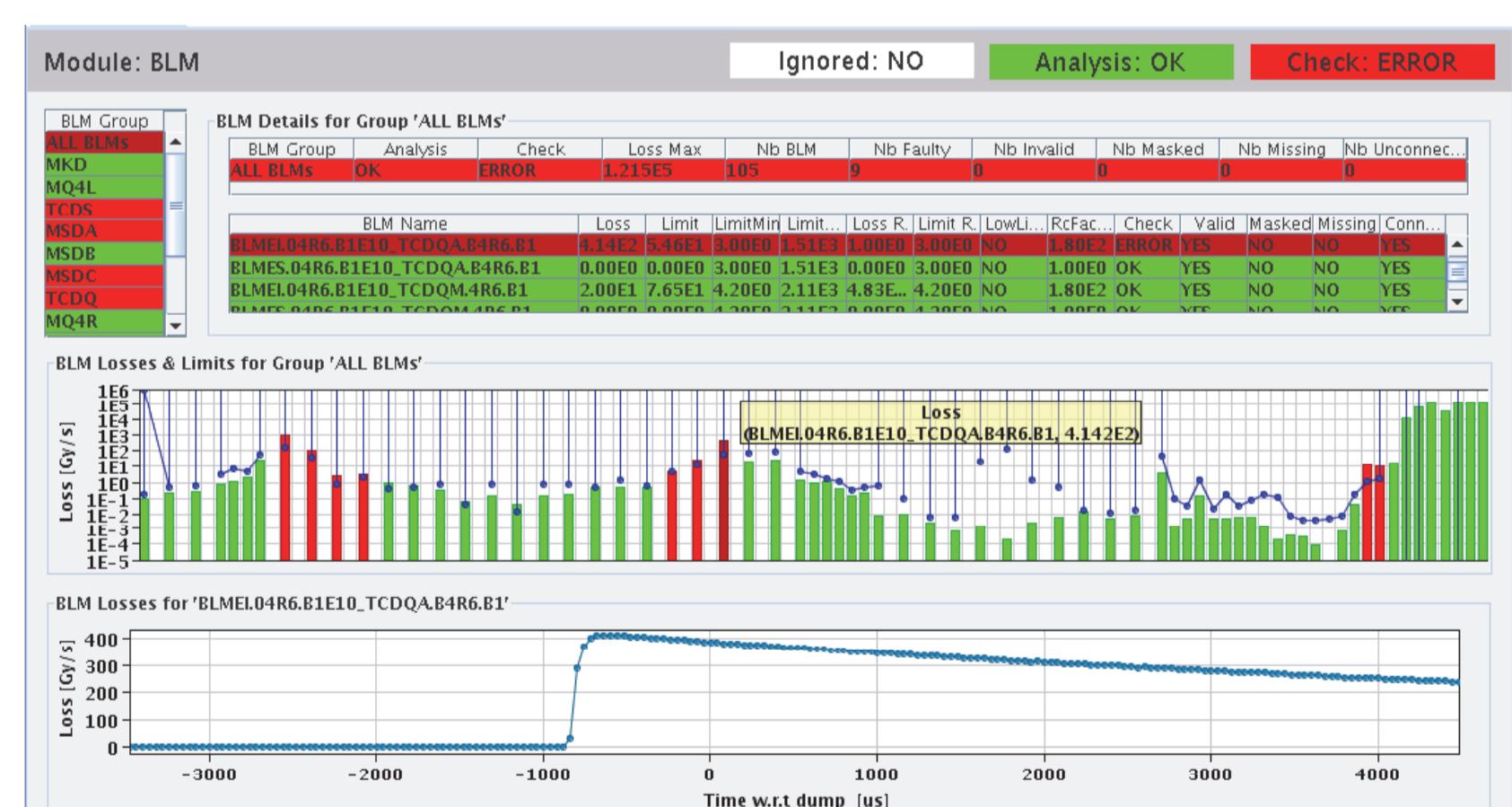
The XPOC analyser server starts a new analysis session for each PM event, and launches the execution of all expert analysis modules in parallel, following their configured dependencies:

- First the CONTEXT module,
- Then all analysis modules,
- Finally the XPOC overall analysis module.



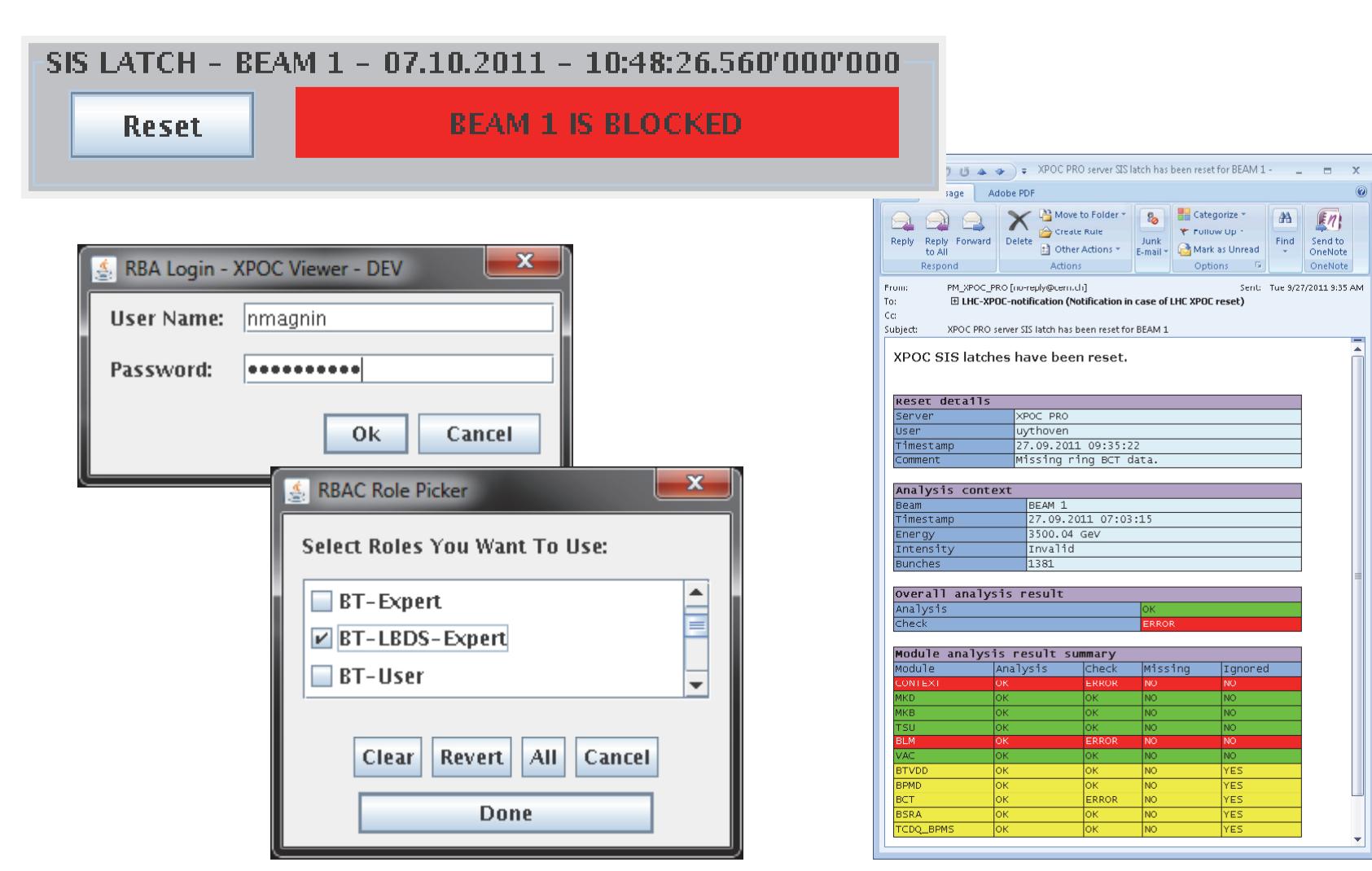
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The BLM module analyses the losses measured by each of the Beam Loss Monitors (BLM) placed at LBDS and in the extraction channel, computes its loss limits using beam energy and beam intensity, and checks that its maximum loss is within the computed limits.



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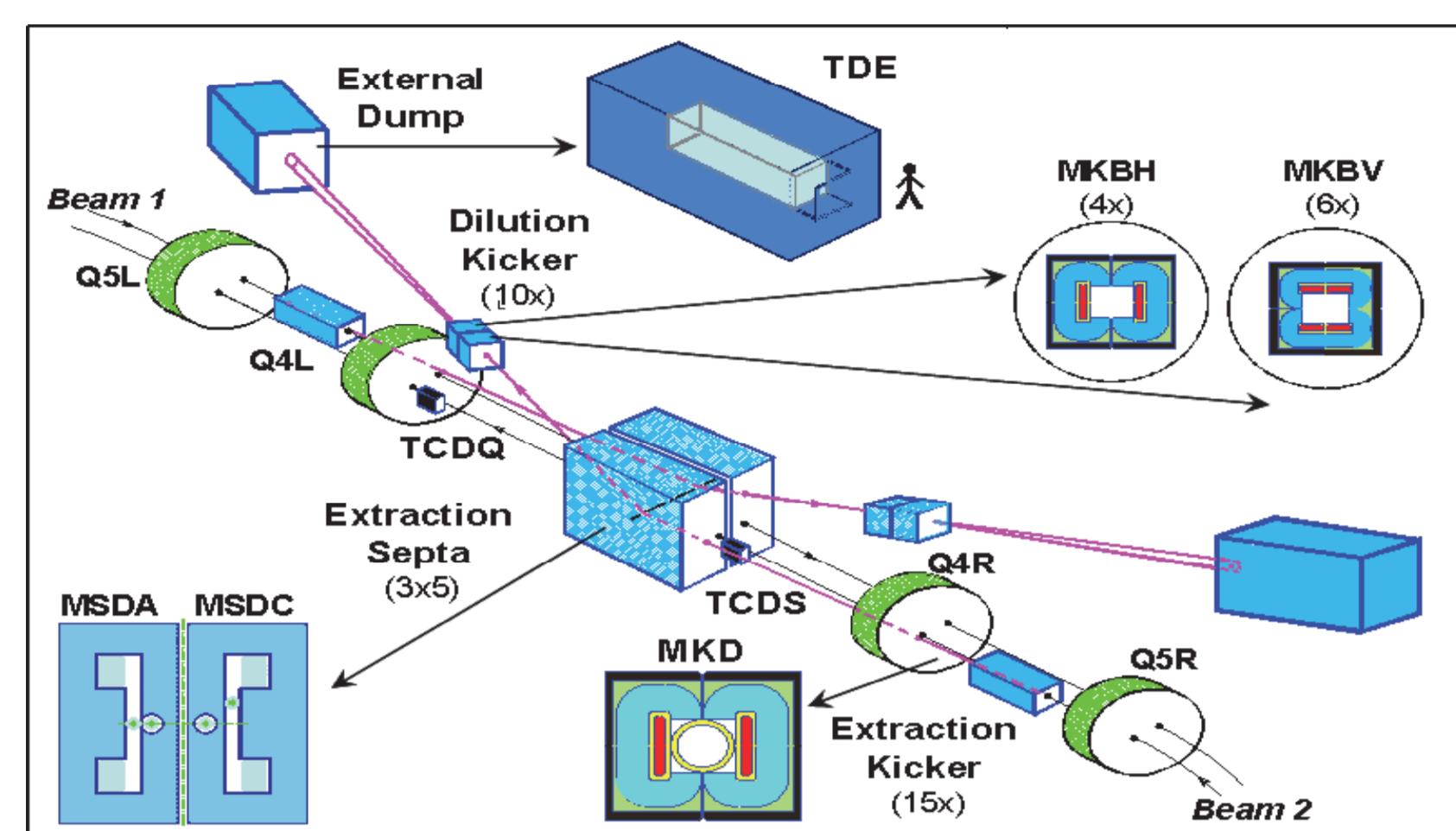
The SIS Latch blocks the injection if any error is detected during the analysis. A reset of the SIS-Latch by an expert is mandatory. The reset is protected using the Role-Based Access Control (RBAC) mechanism. An email with dump error summary is sent to all experts.



1

The LBDS kicker system mainly consists of:

- 15 horizontal extraction kickers (MKD);
- 15 vertically deflecting septum (MSD);
- 10 dilution kickers (MKB);
- The absorber block (TDE)

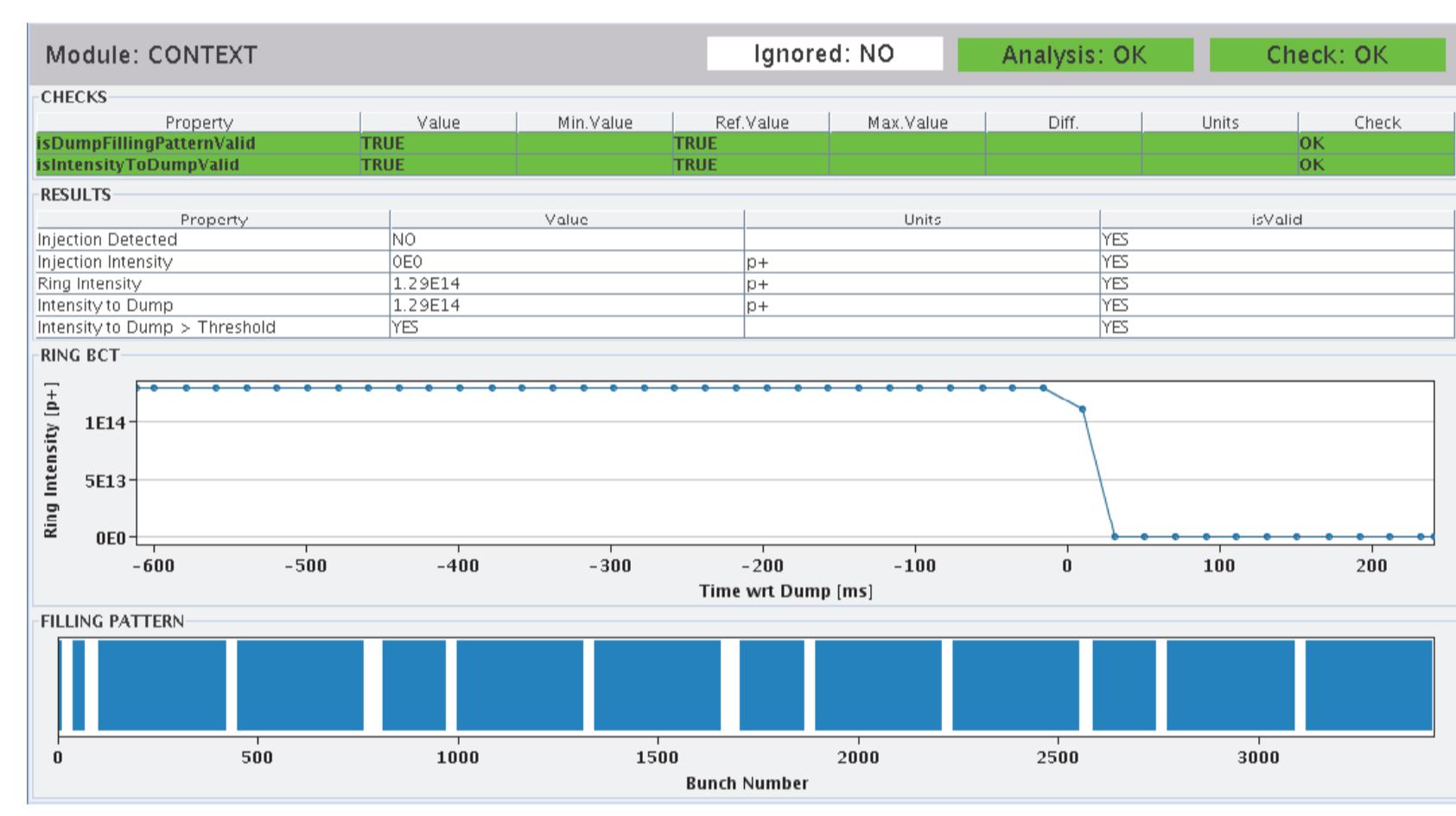


4

The CONTEXT module computes:

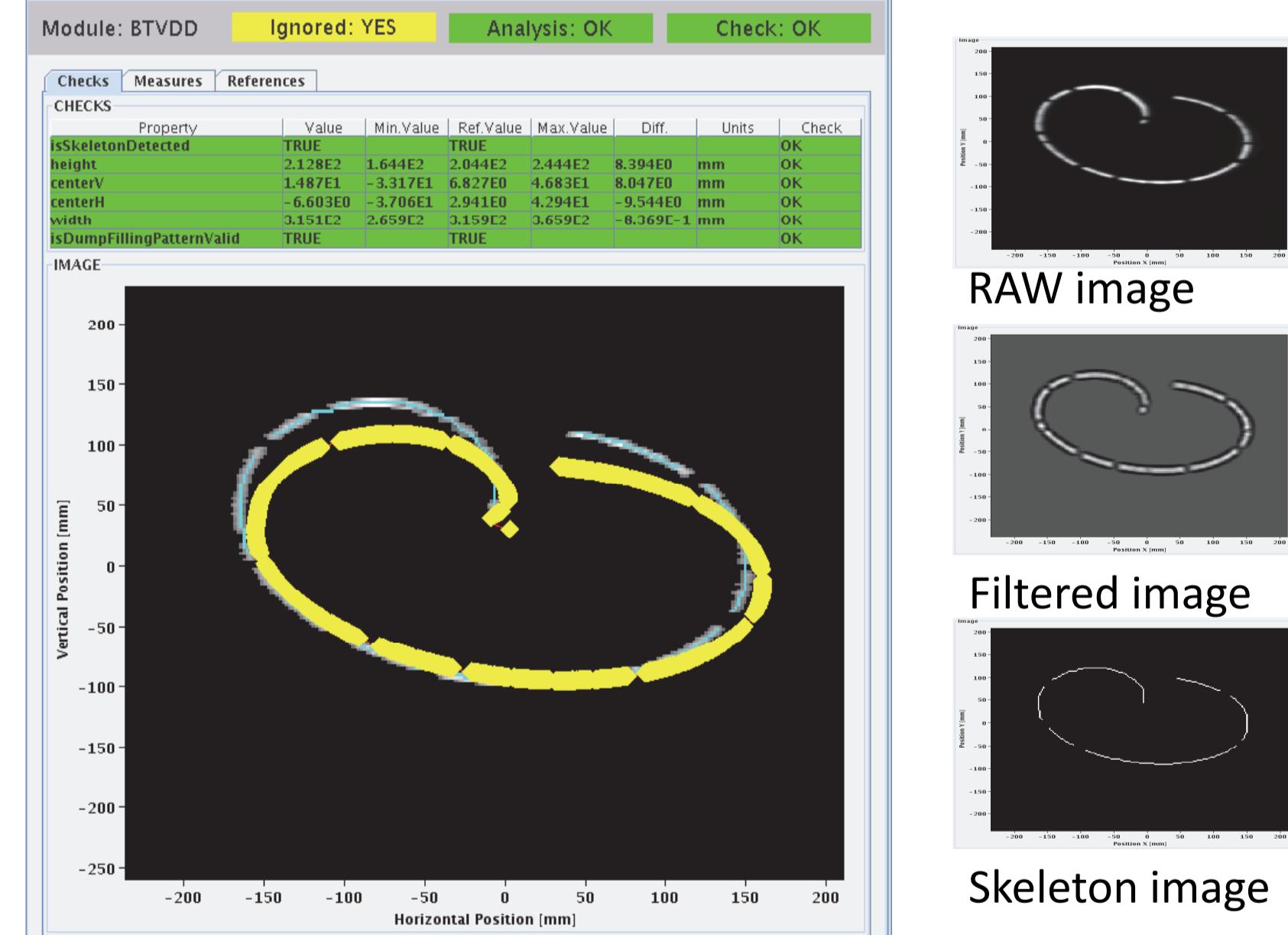
- The “dumped intensity”,
- The “dumped filling pattern”.

You can see below the “dumped filling pattern”, and above, the beam intensity which drops at beam dump time.



7

The BTVDD module analyses the image of the beam sweep on a screen placed in front of TDE. The beam skeleton position (blue) is checked against reference position (yellow).



CONCLUSION

The XPOC system has proven its efficiency in detecting unexpected behaviour during execution of beam dump actions. It allowed the anticipation of LBDS hardware problems before any system failure occurred, using the trends of logged XPOC analysis results. The LBDS stringent reliability specifications can only be met by the XPOC system guaranteeing that the latest dump was correctly executed, including all redundant parts. For this reason the reset of the XPOC SIS latch, which can only be done by experts having the required RBAC roles, is taken very seriously in daily operation of the LHC.