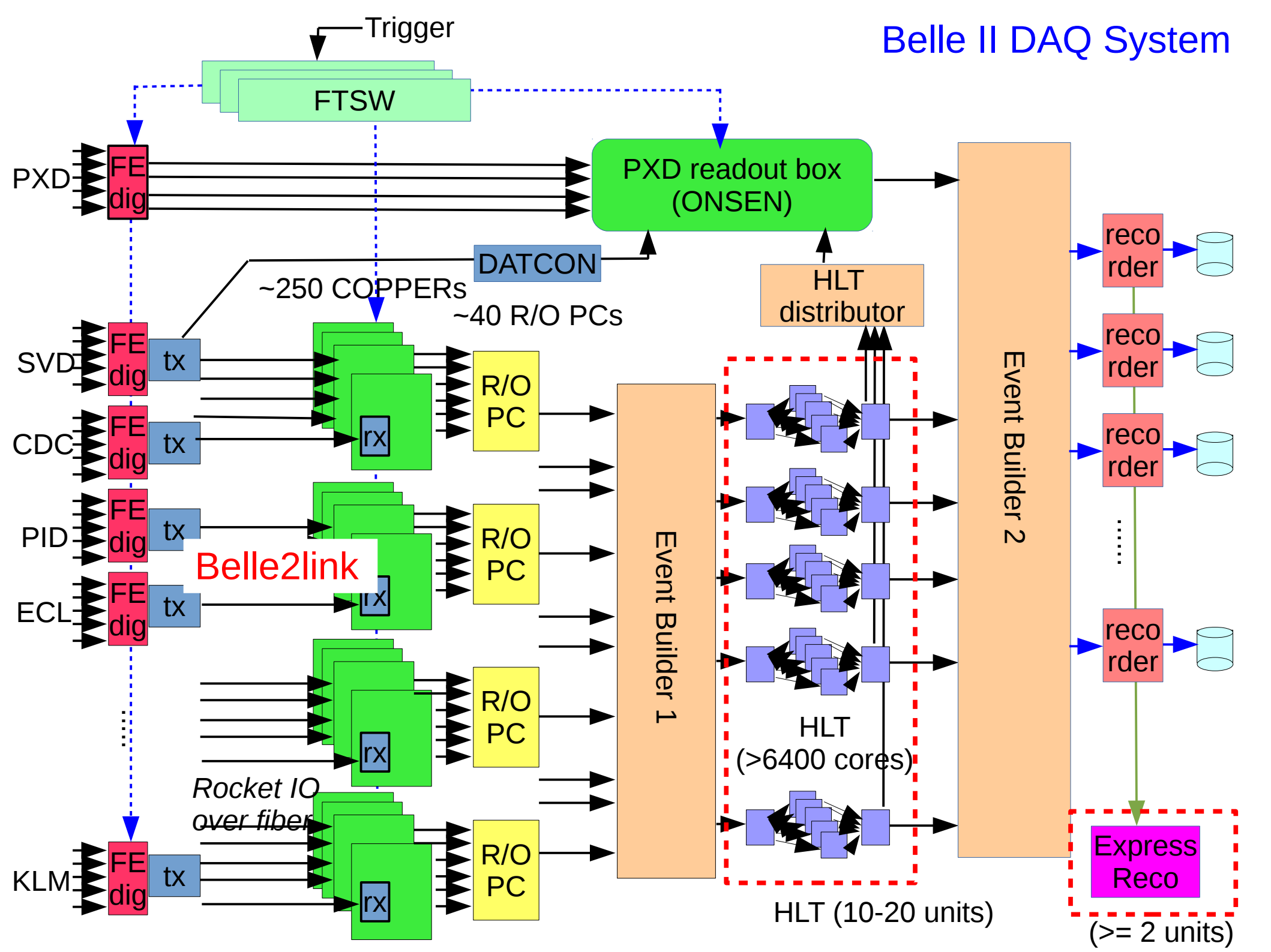
RoI feedback and HLT in DESY-TB

R.Itoh, KEK


Belle II DAQ System
Trigger
FTSW
PXD
FE dig
PXD readout box (ONSEN)
DATCON
~250 COPPERs
~40 R/O PCs
HLT distributor
SVD
CDC
PID
ECL
KLM
tx
rx
Belle2link
Rocket IO over fiber
R/O PC
Event Builder 1
Event Builder 2
HLT (>6400 cores)
HLT (10-20 units)
reco rder
Express Reco
(>= 2 units)

Test of HLT operation in 3rd DESY test beam (Feb-Mar)

Goals:

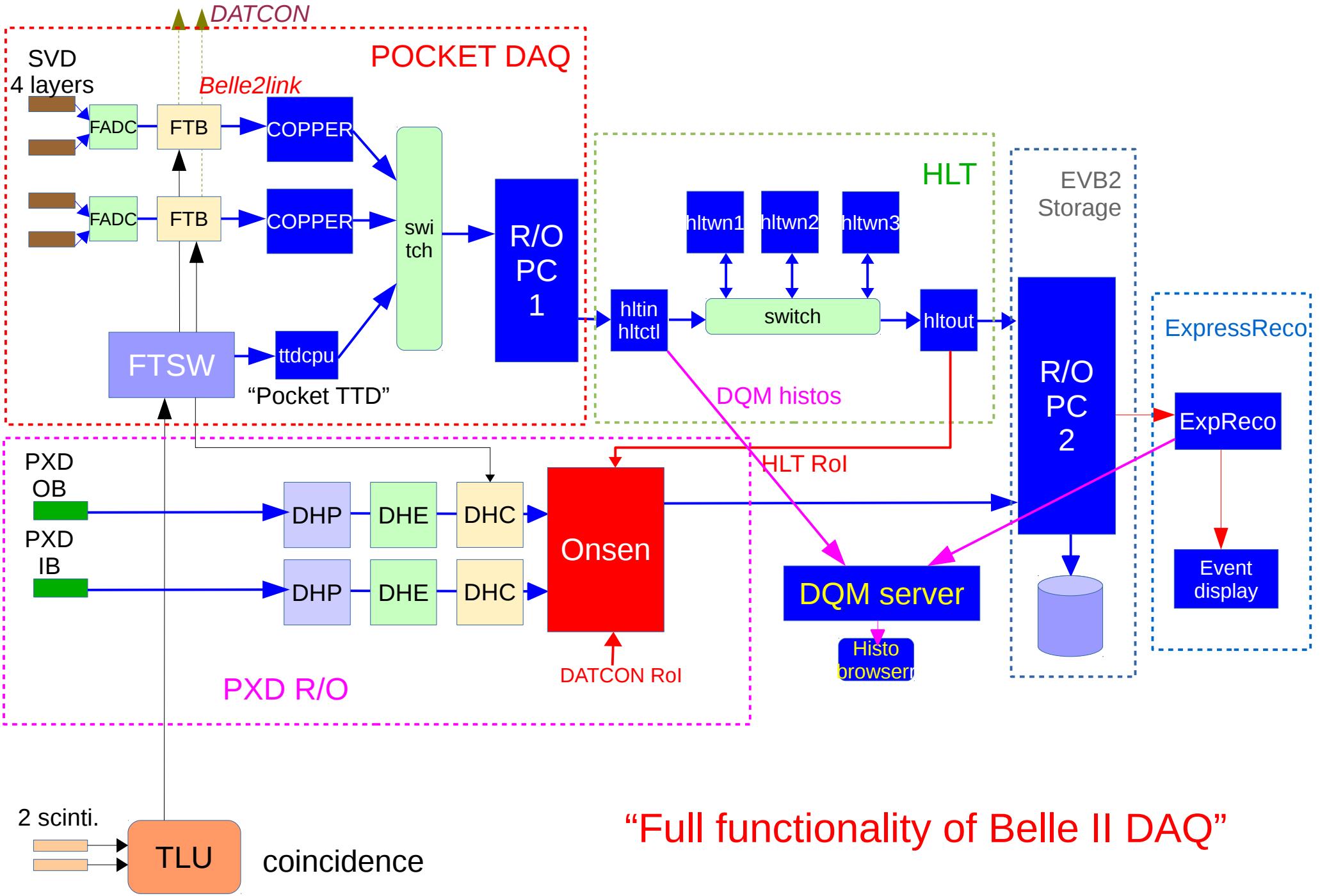
1. Stable operation of tracking code (VXDTF and VXDTF2).
   * In the 2nd beam test, we had a lot of HLT crashes because of the segmentation fault in the tracking code.
   * Self-recovery mechanism was implemented and tested.

2. Real time RoI (Region of Interest on PXD surface) generation and feedback to PXD readout subsystem
   * In addition to RoI obtained from tracks, “dummy RoI”s are added for the monitoring purpose.

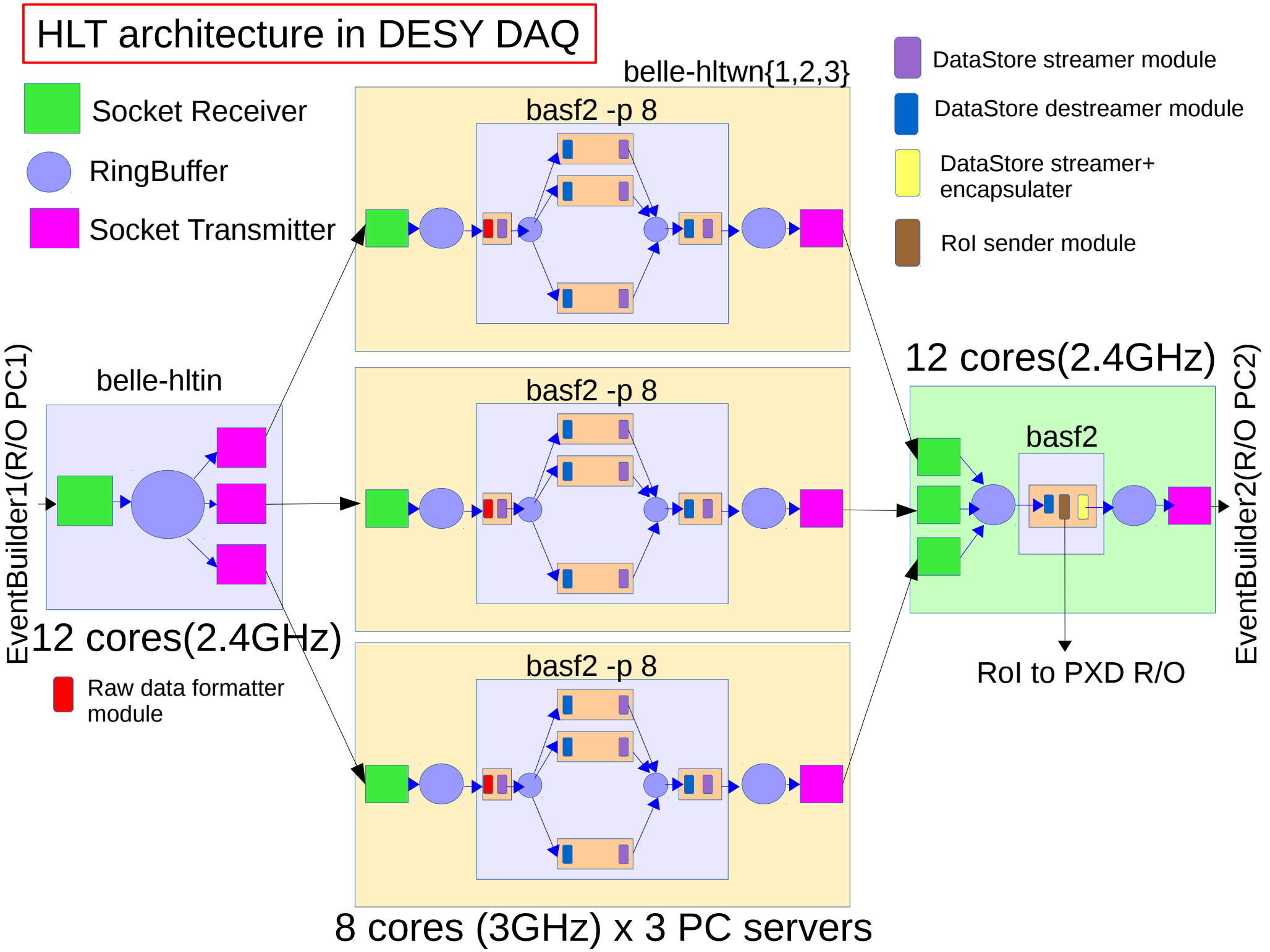
3. Real time DQM histogram accumulation and live histogram transfer to the monitor node.
   * DQM codes for SVD hit-map, tracking quality check, etc. are implemented.

4. Test of Software Trigger scheme
   * Just a test of putting selection tag in output objects.
   * No selection at all.

DAQ for DESY beam test

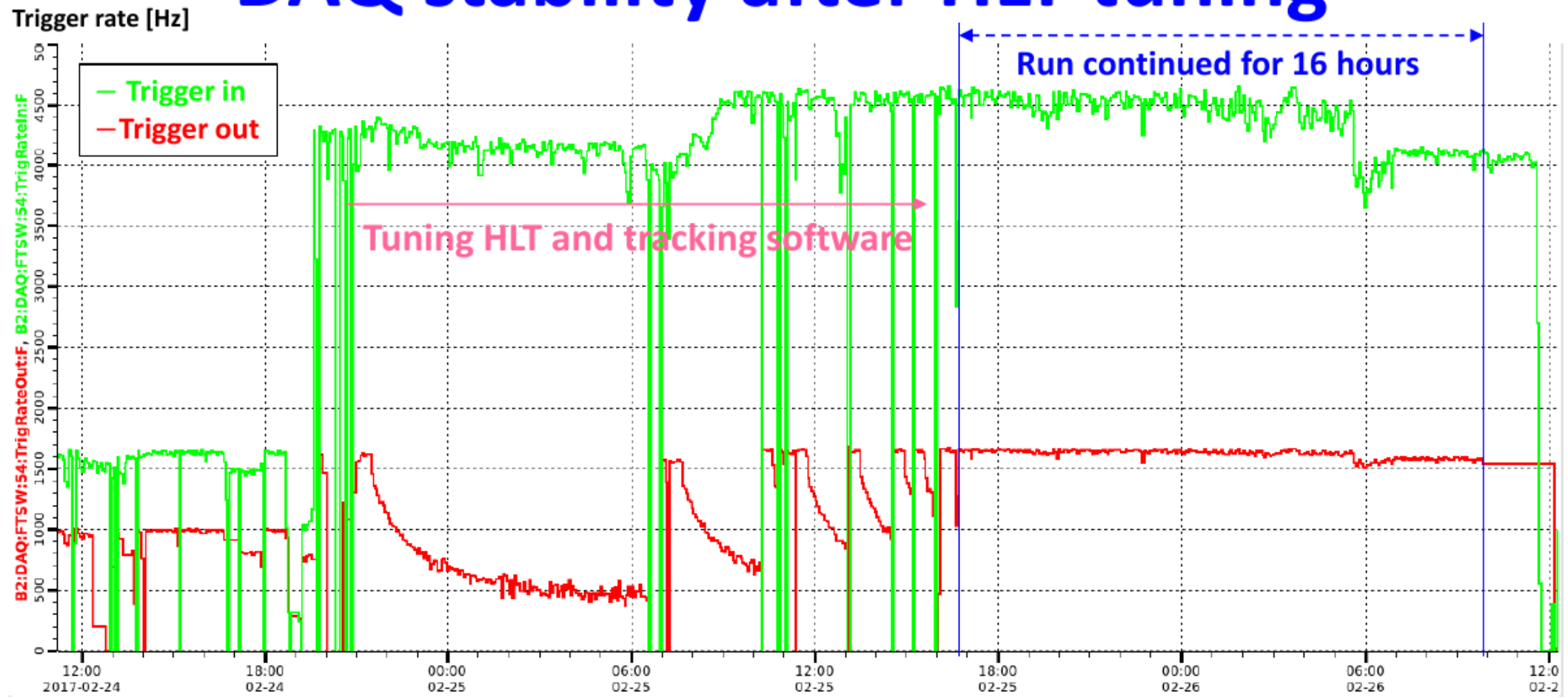


"Full functionality of Belle II DAQ"


HLT architecture in DESY DAQ
Socket Receiver
RingBuffer
Socket Transmitter
DataStore streamer module
DataStore destreamer module
DataStore streamer+ encapsulater
RoI sender module
belle-hltwn{1,2,3}
basf2 -p 8
basf2 -p 8
basf2 -p 8
belle-hltin
12 cores(2.4GHz)
Raw data formatter module
12 cores(2.4GHz)
basf2
RoI to PXD R/O
EventBuilder1(R/O PC1)
EventBuilder2(R/O PC2)
8 cores (3GHz) x 3 PC servers

T.Konno

DAQ stability after HLT tuning



- HLT software caused back pressure to suppress trigger rate to 500Hz
  - Error handler was slow due to writing to disk => omitted in this test
  - Waiting time in the ring buffer was tuned for cosmic ray test => Fixed
  - Finally trigger rate was sable around **1.6kHz** with tracking by **VXDFT1**
- The longest run continued **16 hours** without any issues in data

Why did the HLT performance degrade as a function of time?

Observations:

- The performance degradation first observed when operated with VXDTF + SVDDQM.

- At the time, the SVDDQM was considered to be the cause because of a large CPU consumption, and moved to ExpReco. The observed performance degradation was gone by the fix.

- Still the degradation was observed and “tuning” was done.
  * Various delay parameters in RingBuffer queuing were adjusted.
  -> The degradation was gone and the stable operation up to 16 hours was confirmed. No HLT crash occurred.

- The problem occurred again when switching tracking software to VXDTF2.

- The same DESY software environment was ported to KEK test bench (real HLT : HLT unit 3) to reproduce the degradation.

- The same HLT configuration (8 cores x 3 servers with input/output) was built.

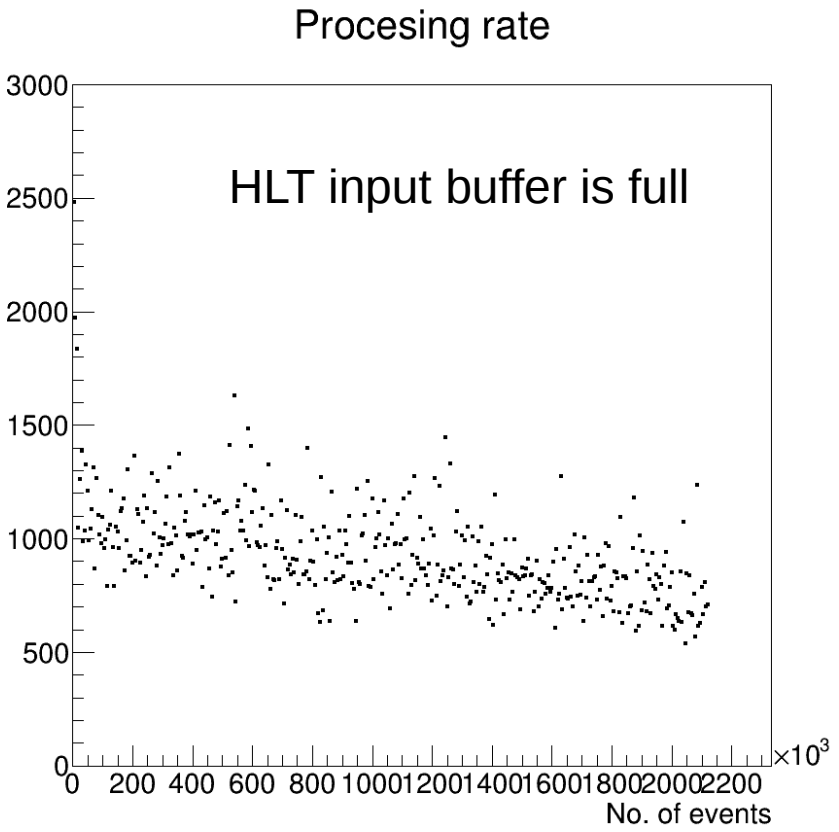
- The recorded data were fed into the same HLT processing chain at a Poisson distributed rate (3kHz input).

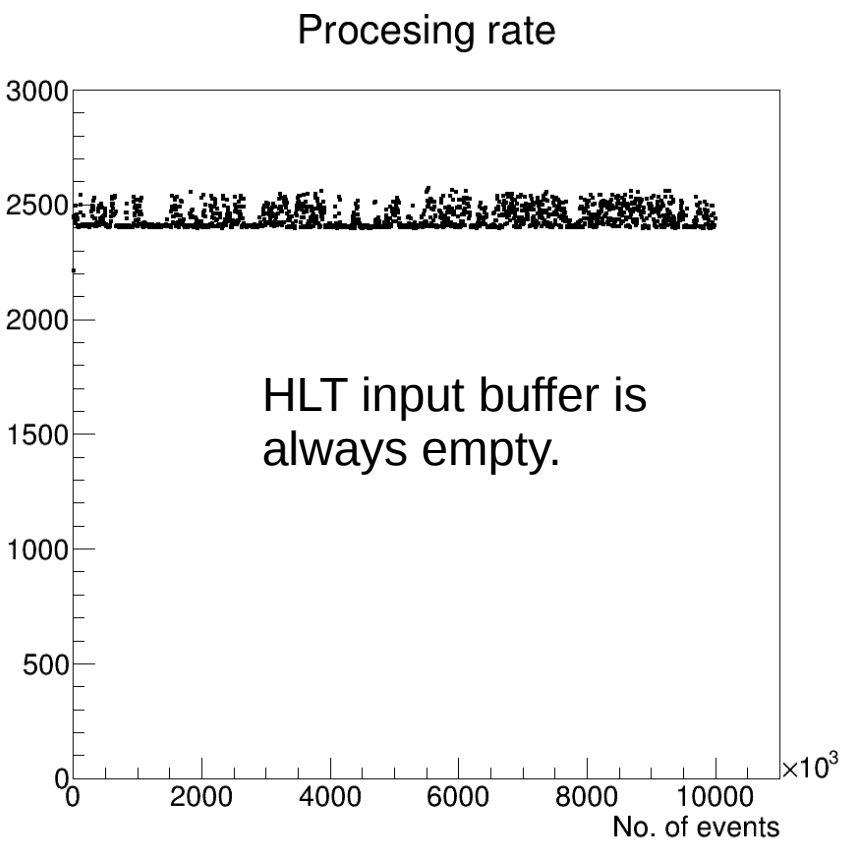
- The degradation was reproduced on the test bench.

- After detailed investigations, the cause was pinned down.
  1) The duration of DQM histogram transfer over the network was too frequent. The socket buffer became full gradually and the event processing was blocked until the buffer becomes available.
  2) The other DQM histograms(TTrees, Tuples) were dumped to a file at the same interval. It fully occupied the NFS bandwidth and slowed down the network speed.

- By reducing the frequency, the degradation was gone.

Input : EventMetaData + RawSVDs + RawFTSWs
Input rate : Poisson 3kHz
HLT processing : VXDTF2 + TrackDQM + RoI extraction





Histogram dump rate : once / 1000 events

once / 10000 events

* Histogram dump was performed for every 1000/8 for each core...

RoI Generation in HLT at DESY

- Tracking of beam was done by VXDTF(2) on each of 24 cores in HLT.

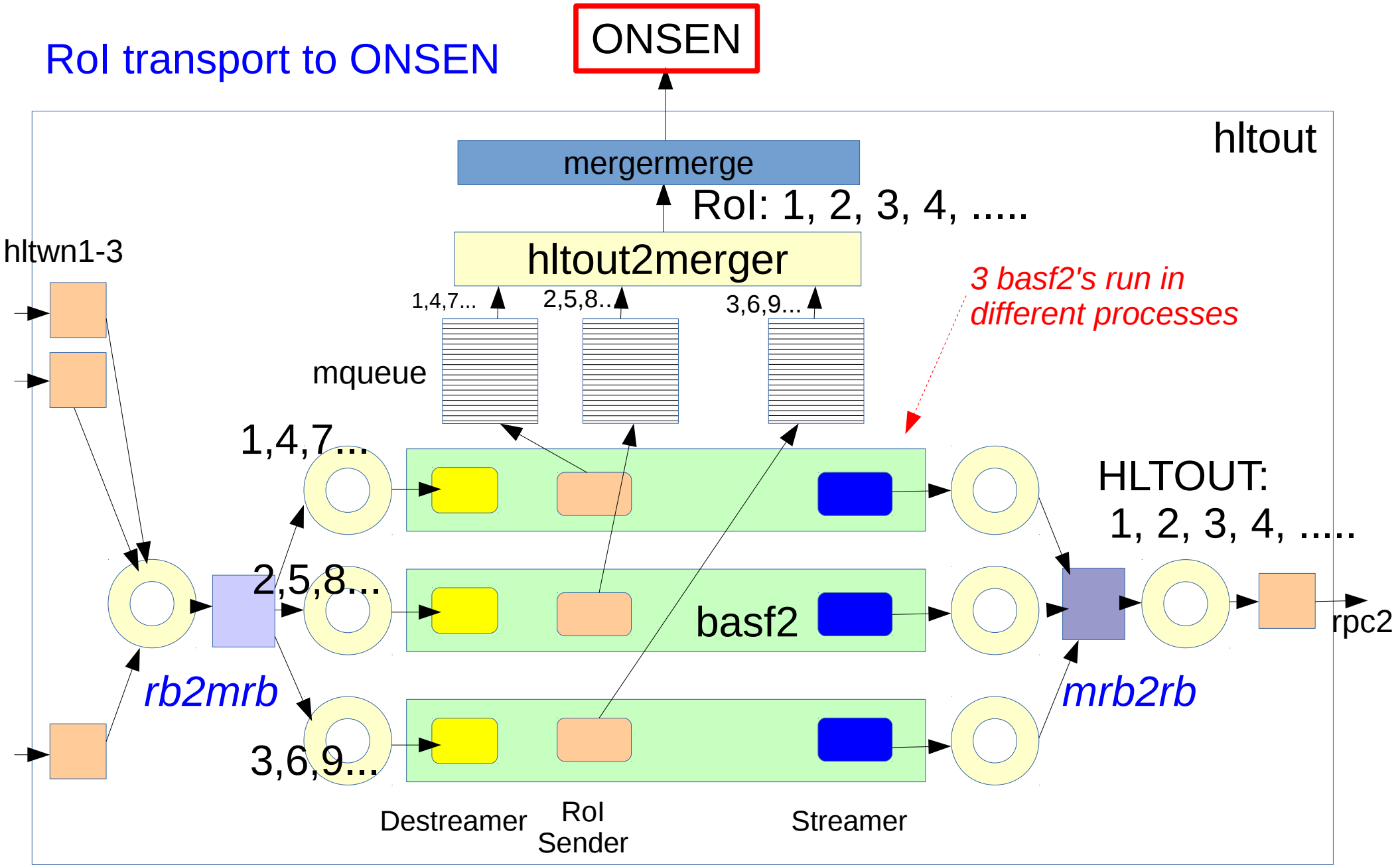
- From the reconstructed track information, RoIs are extracted by “PXDDataReduction” module on 24 cores.

- In addition, “dummy RoIs” are added for debugging purpose.
  * Generated by multiple “ROIGenerator” module
  * “full frame” RoIs for the debugging purpose for every 1000 events.
  * The RoIs are packed by “ROIPayloadAssembler” module

- On the HLT output node, ROIs are extracted by “ROISender” module and put them in message queues.

- The ROIs are then sent to ONSEN through network socket.

RoI transport to ONSEN

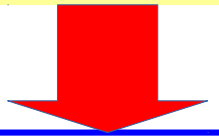


* rb2mrb, mrb2rb, and hltout2merger distribute/pick up records in turn to/from ringbuffers/mqueues in the same order.

Management of HLT script

- In the previous beam test at DESY, the management of the HLT script was chaotic and it caused a problem in taken data.
  * Wrong dummy RoIs were sent to PXD readout box and the taken data were sometimes useless.

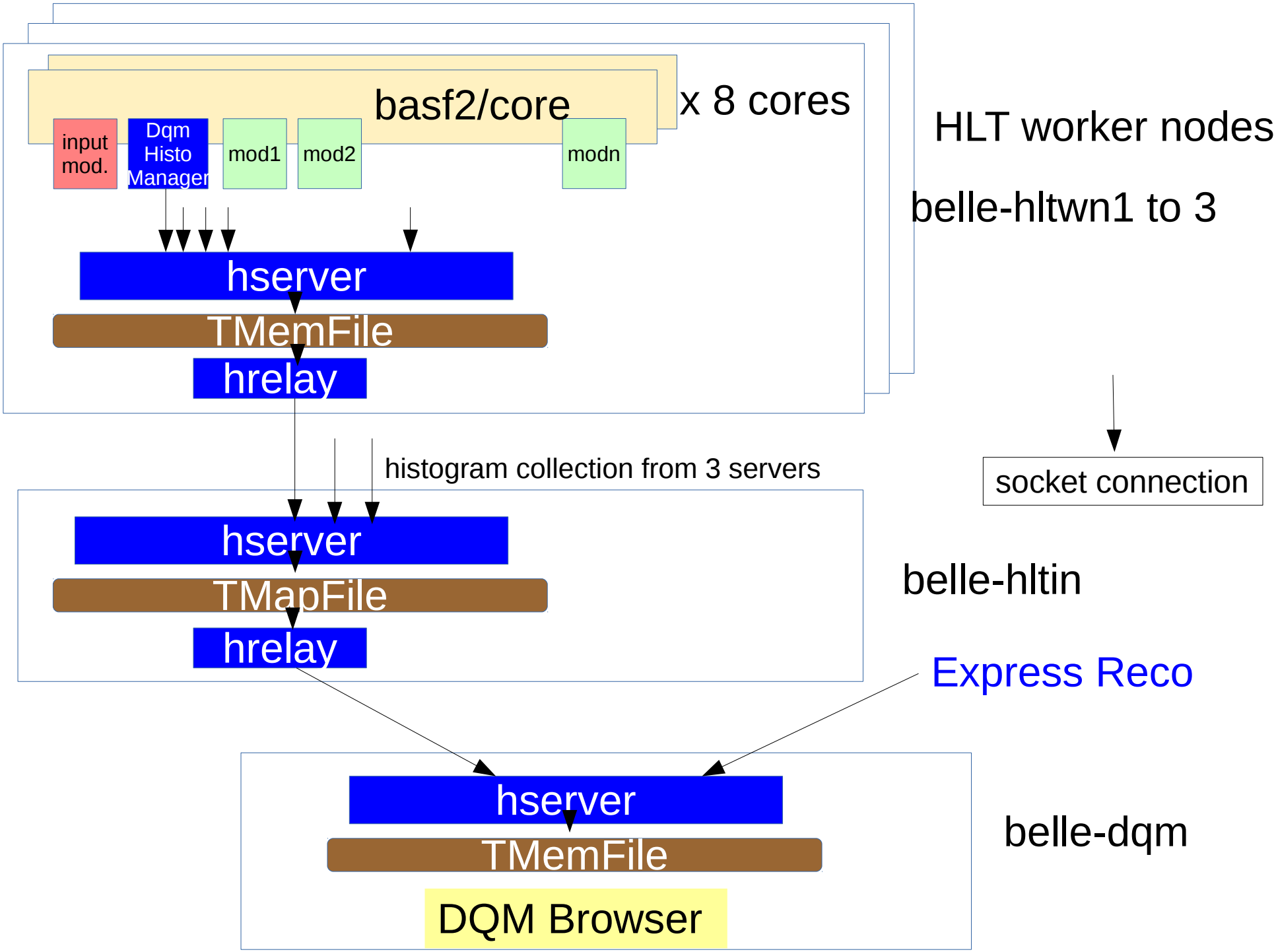
- Lesson : the HLT script should be modified and checked by experts (not DAQ operators) before implemented in HLT.



- We introduced “git” based management of HLT scripts.
  * Ask experts to check and update the script in git.
  * The latest script is “pulled” to HLT and used.
  * The modification history is tracked by git.
  * The script is managed as a part of Belle2 software library

- The scheme worked well in the test beam.
  * RoI generation : Klemens, Giulia....
  * Tracking : Thomas Lueck, Eugenio, Tobias....
  * I/O and DQM management : me

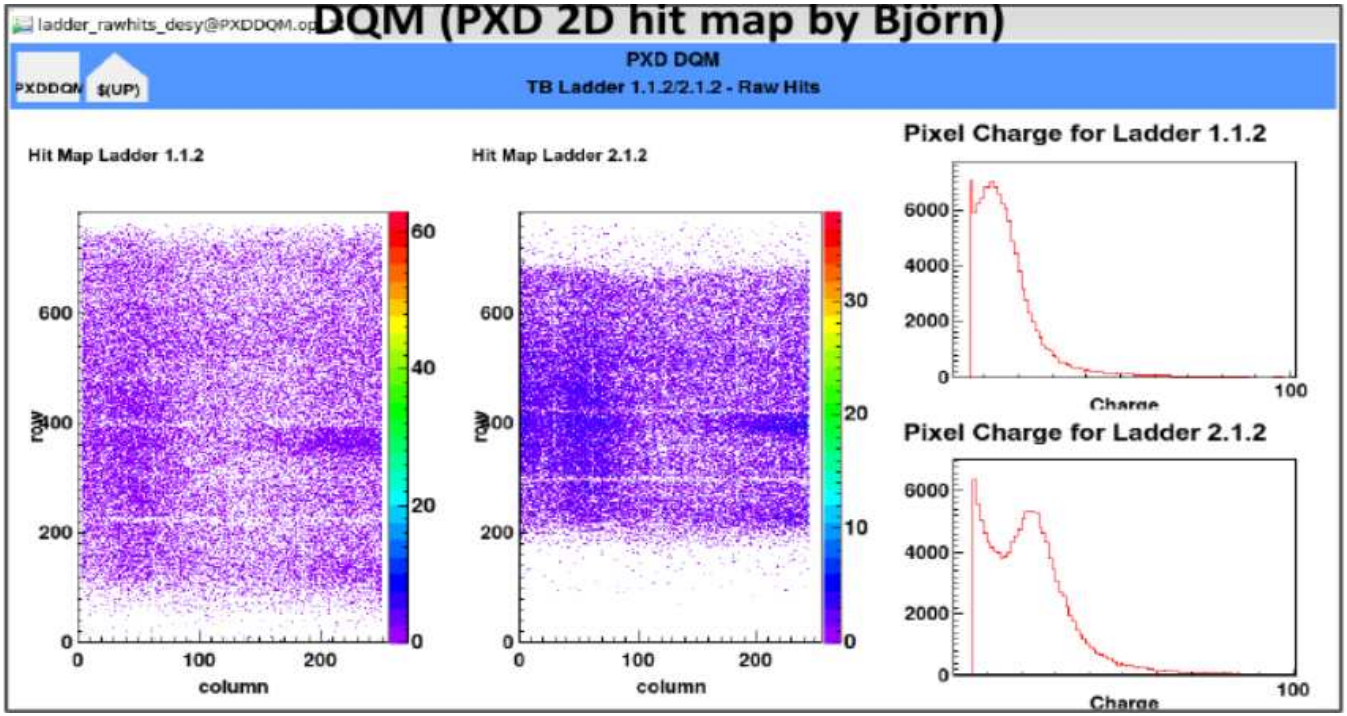
Multi-layered Live Histogram Collection for DQM in DESY-TB DAQ

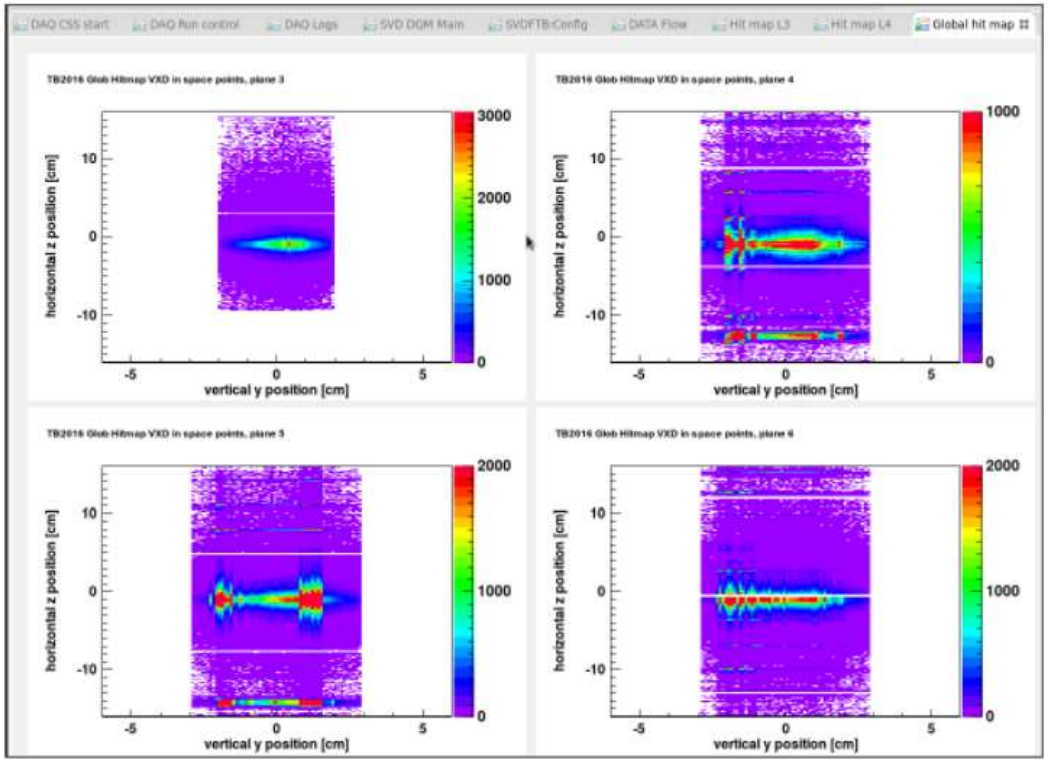


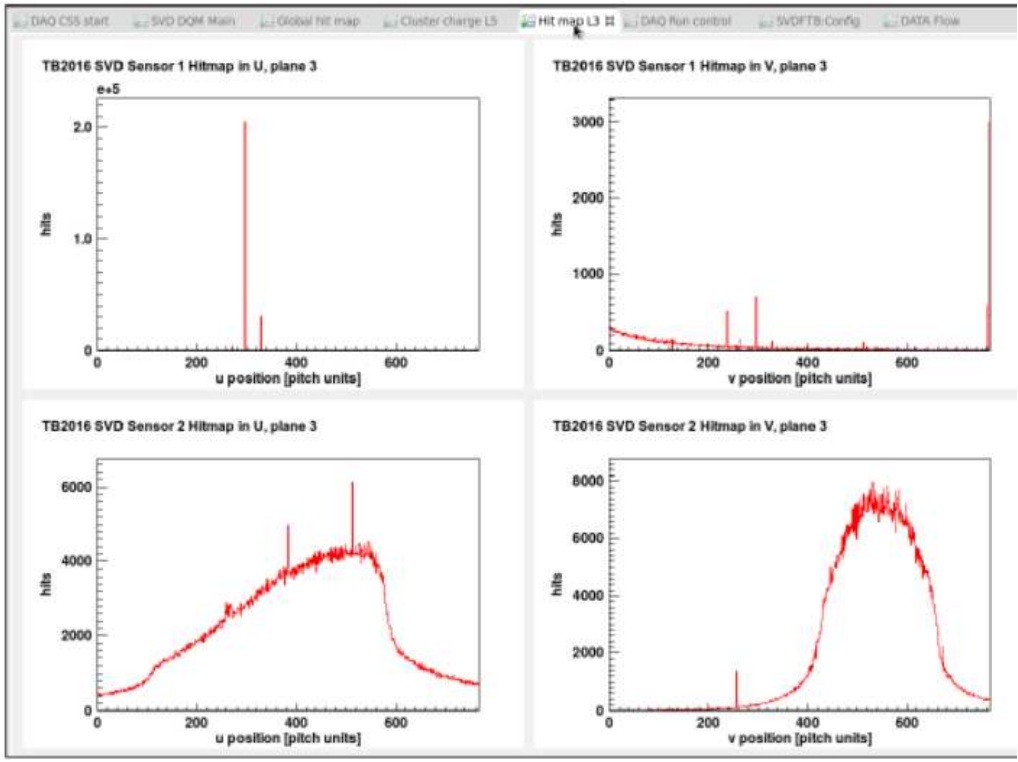
PXD histograms accumulated in ExpressReco

Real time DQM browsing in DESY TB

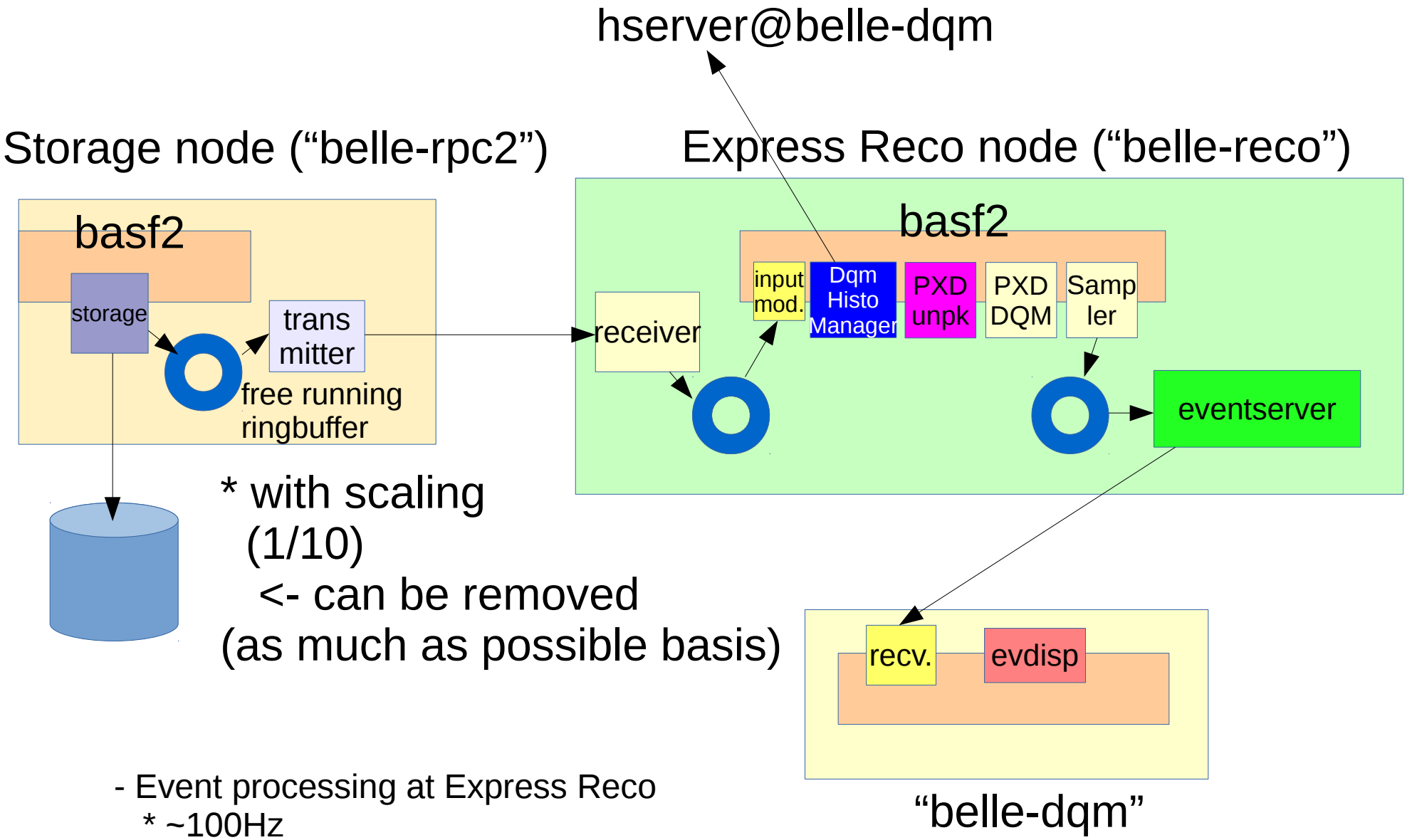
SVD histograms accumulated in HLT



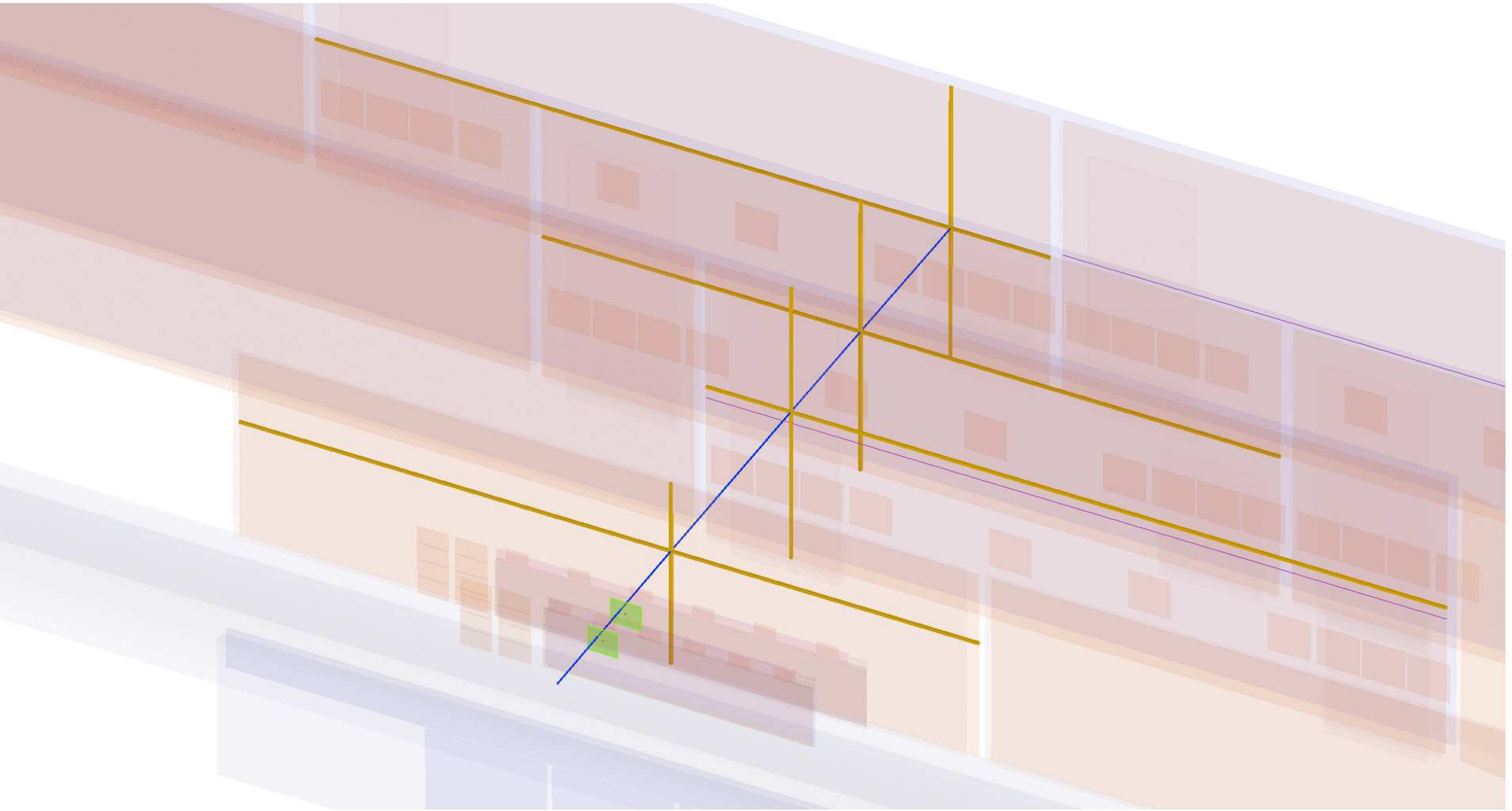




Express Reco and Event Display



- Event processing at Express Reco
  * ~100Hz
  * Simple PXD monitoring only
    -> more complex monitoring with PXD+SVD tracking was possible, but no time remained to make it work.



- １秒間に２０００回のデータを実時間処理して粒子の飛跡を求め、内側のセンサーのどこを通ったかを求める。
- 飛跡が通ったまわりだけのデータを後段に送る。

Summary

- HLT and ExpReco framework were confirmed to work in the DESY test beam runs.

- A real time RoI feedback to ONSEN was proven to work.

- The optimization of operation parameters have to be done carefully in coming phase 2 operation.

- The management of HLT software and scripts with “git” was tested in DESY-TB and confirmed to be effective. The implementation in the on-going cosmic ray run is in progress.