

# Real-time monitoring of operational data in the Belle II experiment

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on behalf of the Belle II collaboration

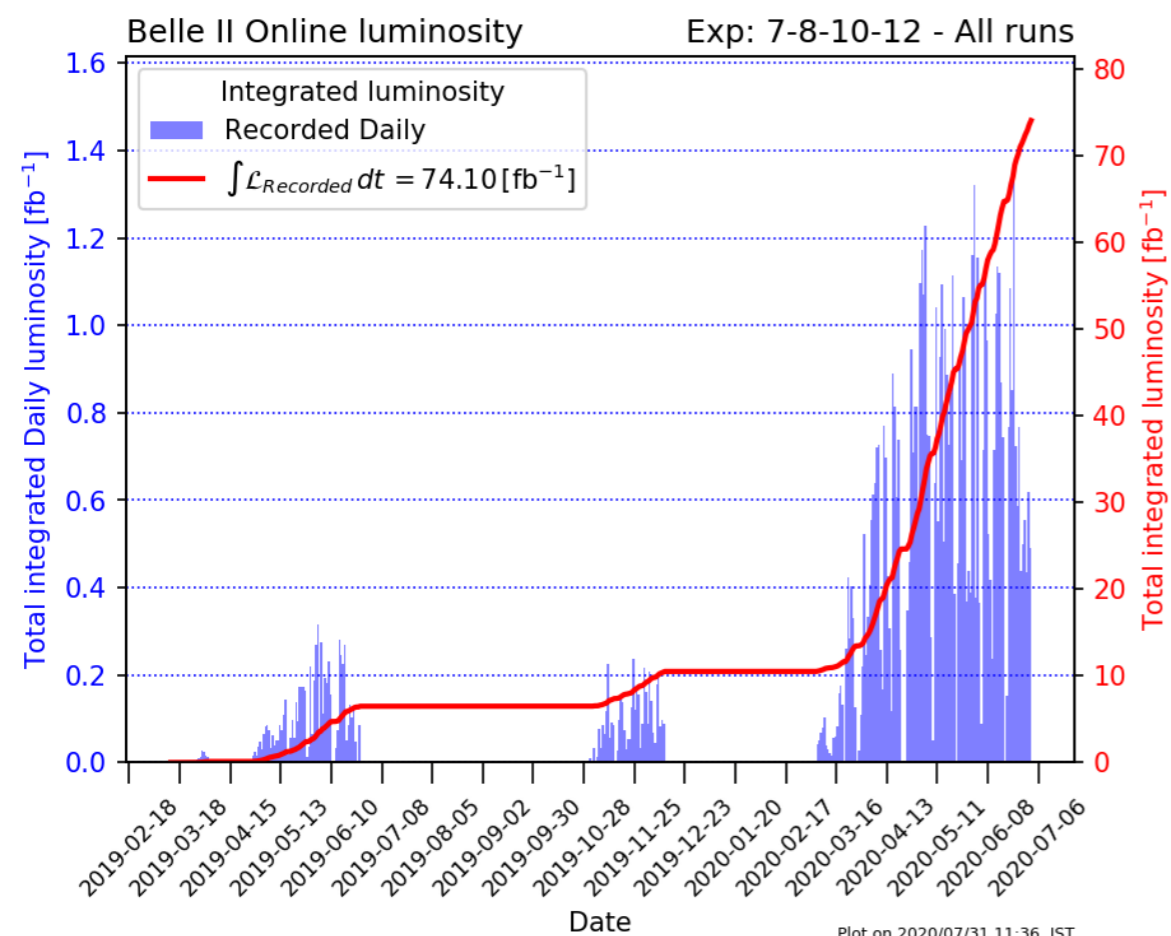
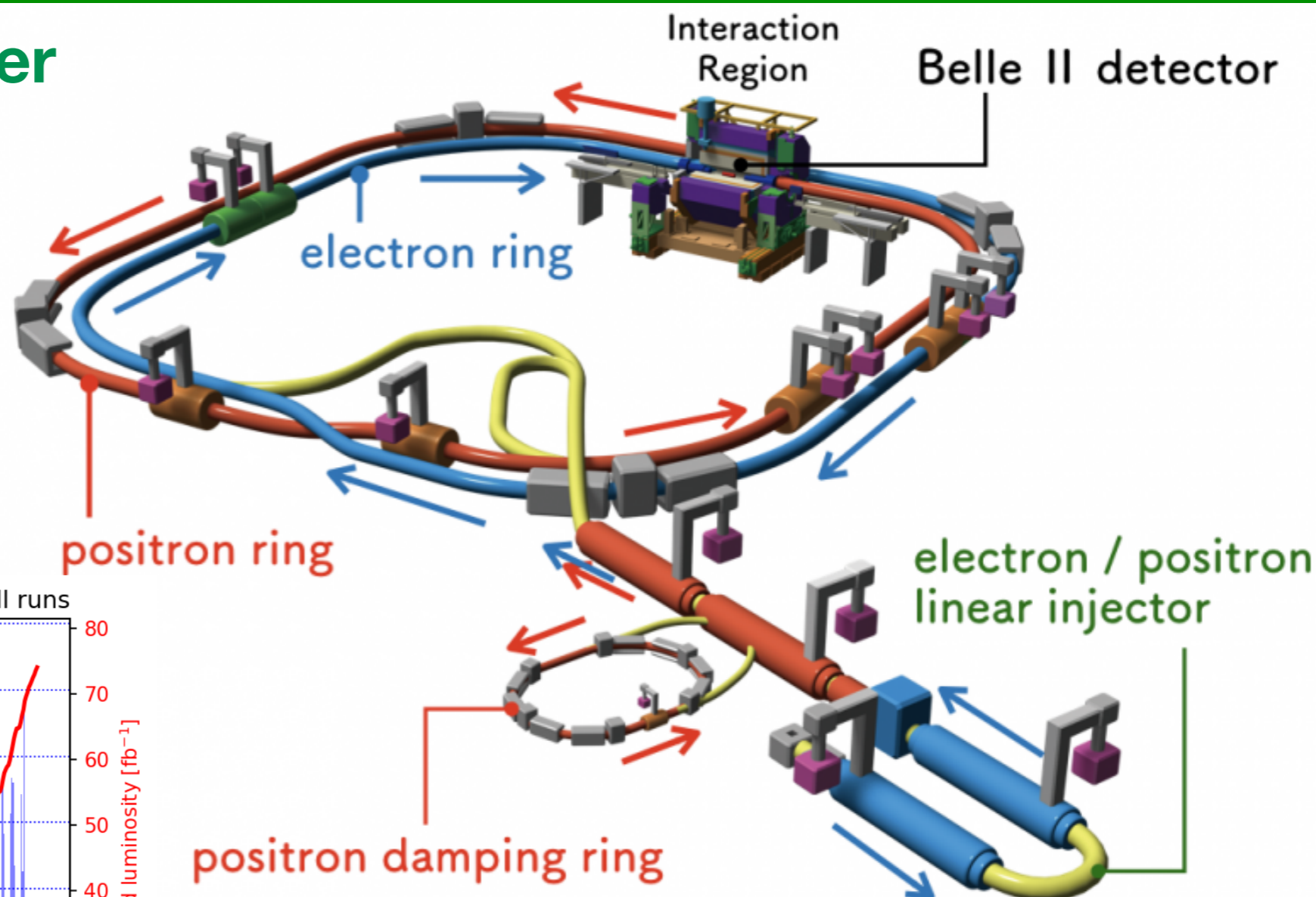
**22nd IEEE Real Time Conference**

**Poster session-B**



# SuperKEKB

4 GeV e<sup>+</sup> 7 GeV e<sup>-</sup> collider



**World record achieved in June 2020**  
 $L = 2.4 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$

**Goal: 50  $\text{ab}^{-1}$  (= Belle x 50)**

# Belle II detector

Search for new physics beyond SM via high precision measurement with high statistics samples of B/D/tau decays

Inner

Tracking

Pixel Detector (PXD)

Silicon Vertex Detector (SVD)

Vertex detector

Central Drift Chamber (CDC)

$e^-$  (7 GeV)

TOP counter (TOP)

PID

Aerogel RICH counter (ARICH)

$e^+$  (4 GeV)

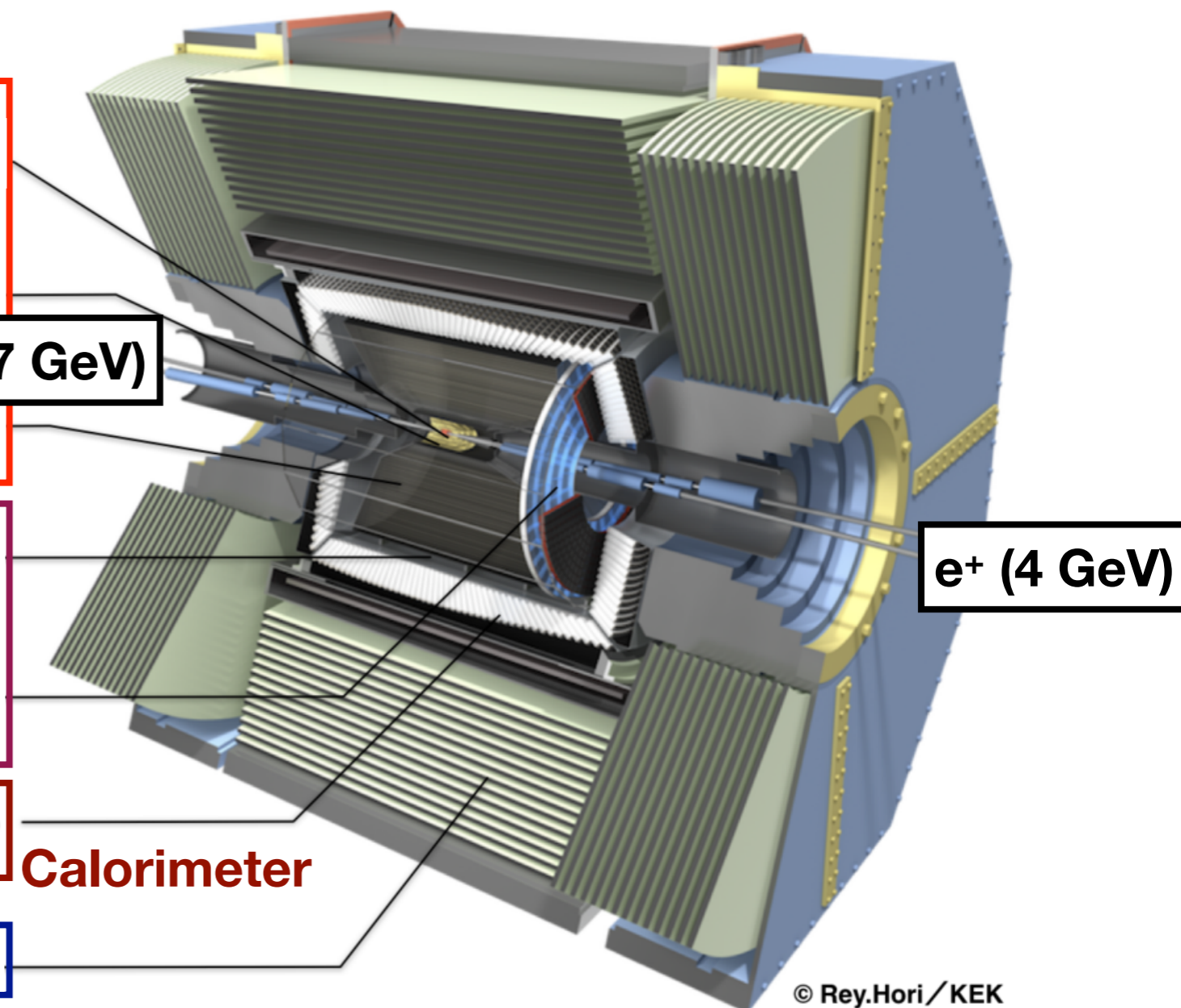
Electromagnetic Calorimeter (ECL)

Calorimeter

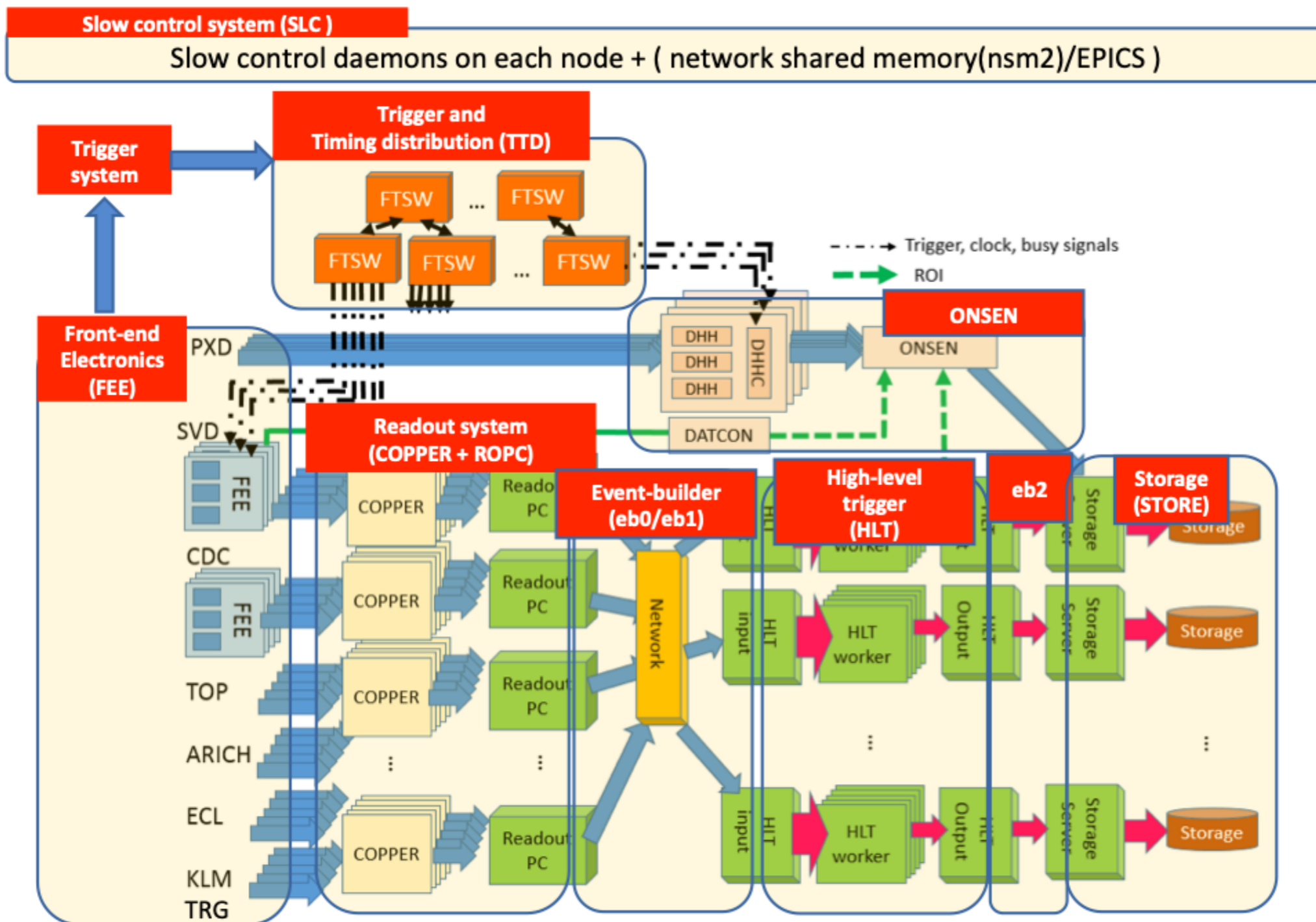
$K_L^0$ /Muon Detector (KLM)

Muon spectrometer

Outer



# Belle II DAQ system



**Many components**  
**Need to monitor each component carefully**



# Monitoring system

## System overview

Input data

Log messages

Trigger and DAQ condition

SuperKEKB status

PC usages

...

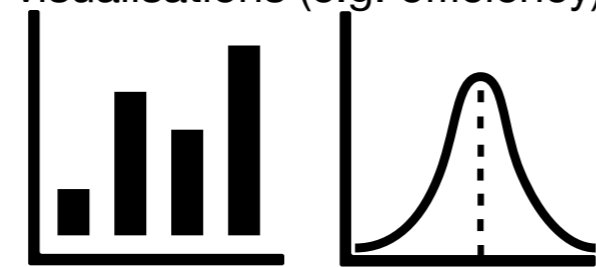
Database

Integrated database 'Elasticsearch'

Applications

Web-interface 'Kibana'

visualisations (e.g. efficiency)



Alerting framework



Alerts for 'ABCD'

check 'XYZW'

Offline analyses

publication-quality plots  
via ROOT



Users



Collaborators

for example



Control room  
shifters



Sub-system  
experts

# 1. Visualisations on Kibana

## Example: DAQ efficiency

### Efficiency definitions

#### 1. Luminosity-based

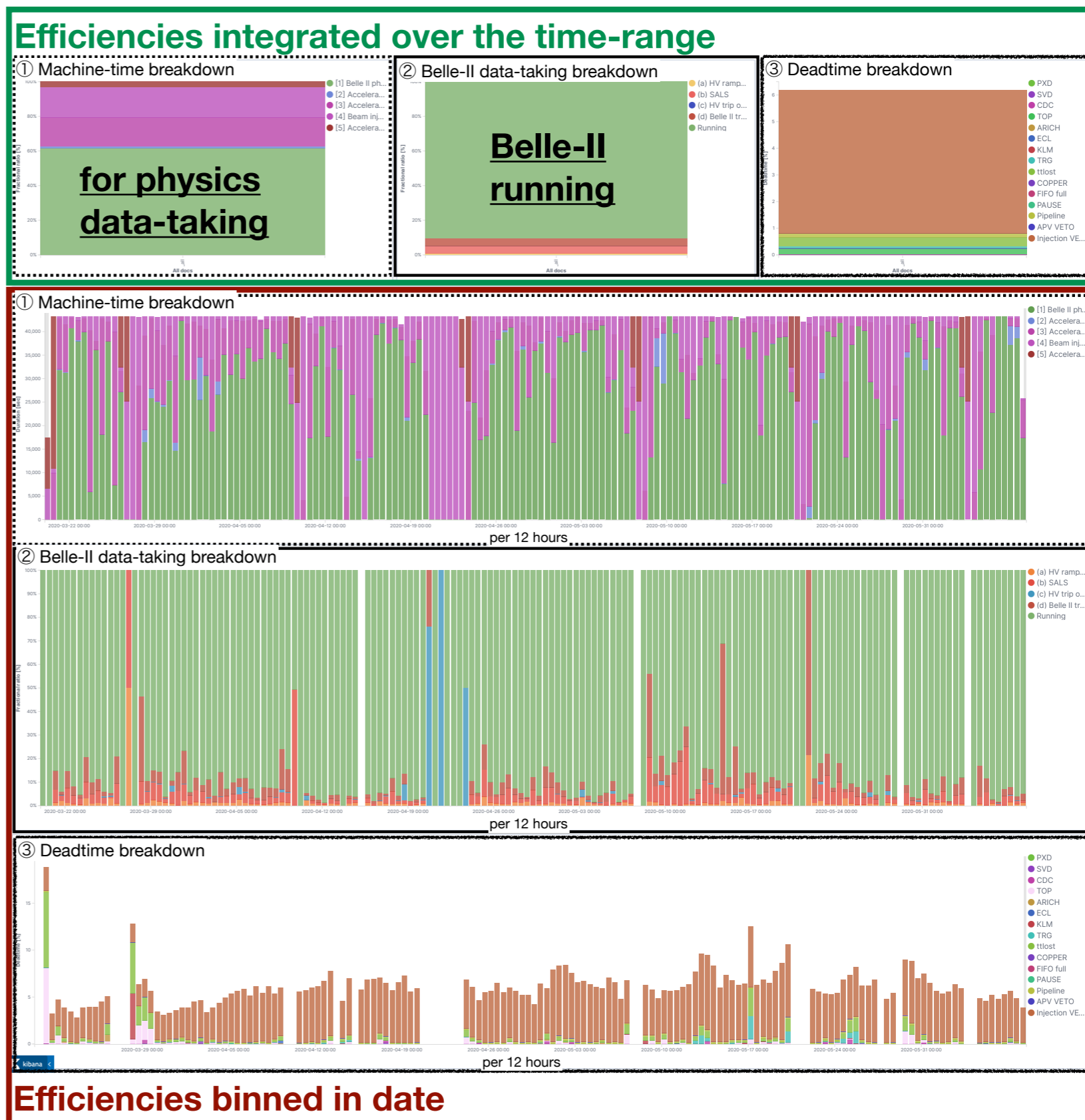
#### 2. Kibana

### Goals

- to categorise the in-efficiency sources
- to choose time-range freely

and...

Many monitoring plots  
(Event size, Network-traffic, errors etc.)



# 2: Alerting system



## Elastalert

- is a third-party tool allows us to implement **alerting function**
- **Alert destinations:** RocketChat, e-mail, SNS message, etc...

**Example: Automatic advice for the control room shifters via the RocketChat (chat tool)**

elastalert @rocket.cat Bot 11:03 PM

[data corrupted on ARICH cpr4017 at 2020-05-27 23:02 JST](#)

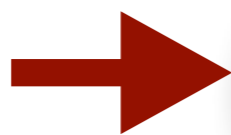
```
cpr4017 : ERROR_EVENT : CORRUPTED DATA: Different event number over HSLBs : slot A 0x02c2f7a0 : B
0x02c21697 :C 0x02c21697 : D 0x02c21697 : eve 0x2c2f7a0 exp 0 run 3328 sub 188
```

CR shifters: SALS may not be able to cure the problem. You can try SALS once, but if this is not fixed by the 1st try, contact the ARICH expert immediately.  
ARICH experts: (1) FEEs connected to cpr4017 and/or (2) the faulty HSLB may need to be reprogrammed. Please be prepared for it.

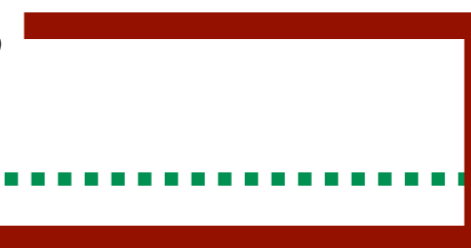
# 3: Offline analyses



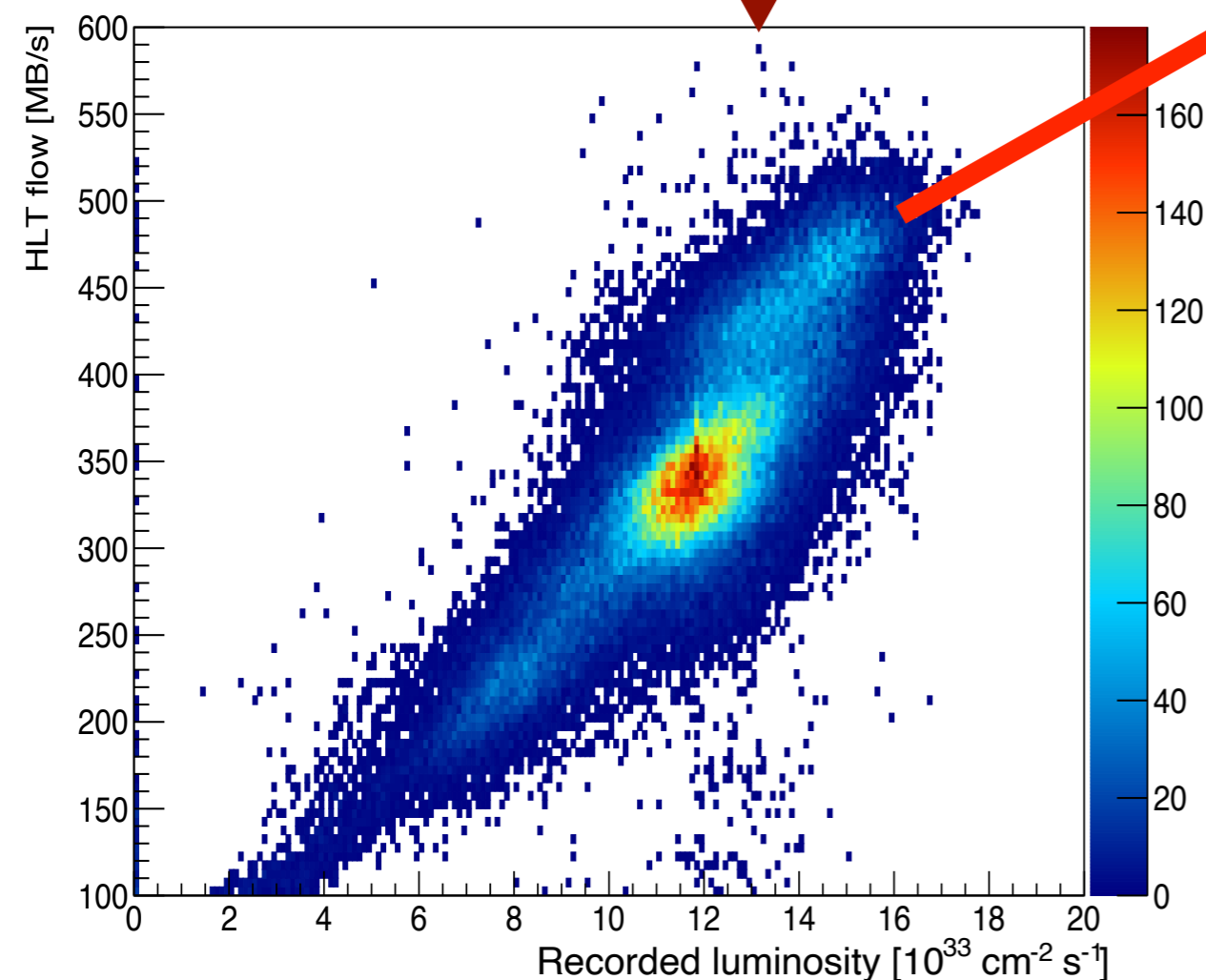
**Elasticsearch  
(database)**



**ROOT files**



Extrapolate to (for example)  
the designed luminosity

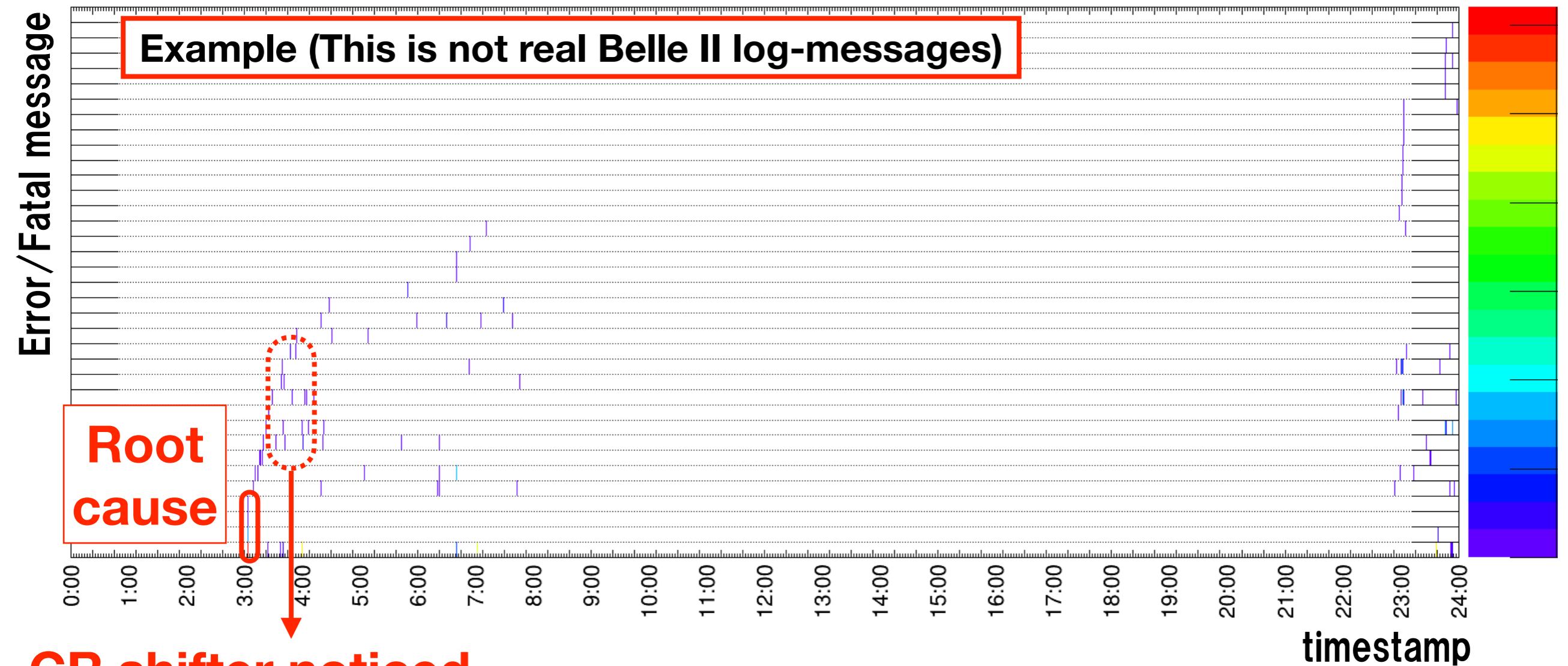


- Basic plot to evaluate the current HLT performance
- Various metrics are stored in Elasticsearch
- ➔ We try to evaluate the beam-background-induced contribution



# Plan: Root cause analysis

## Visualisation of error “propagation”



**CR shifter noticed**

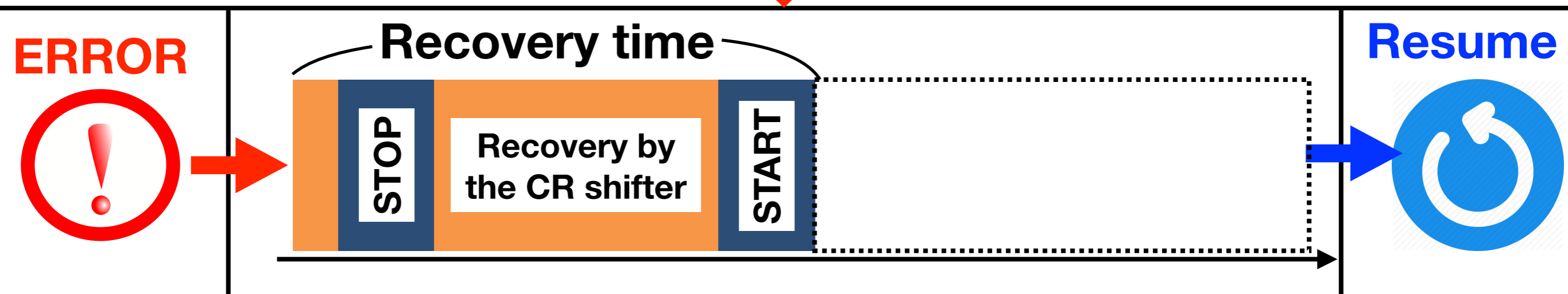
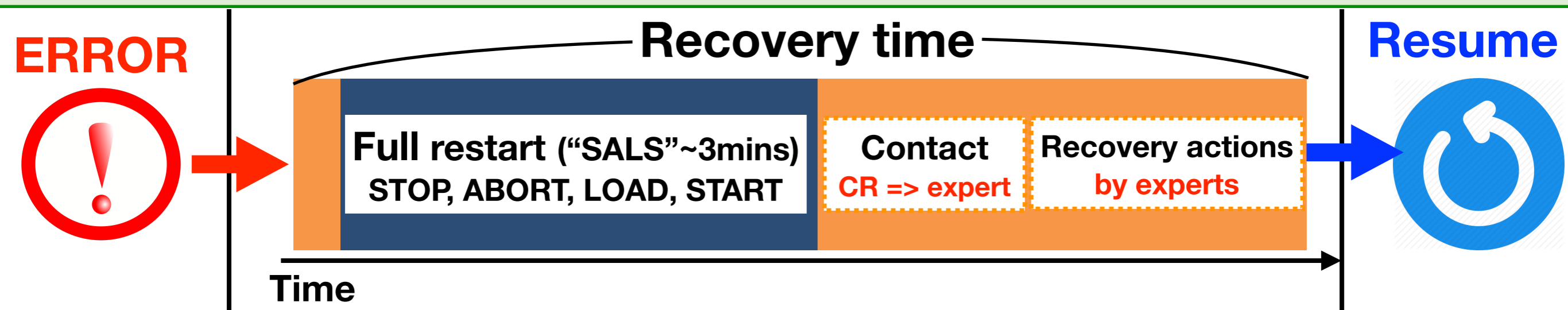
Many log messages

➔ **Visualisations**

➔ Quick diagnosis

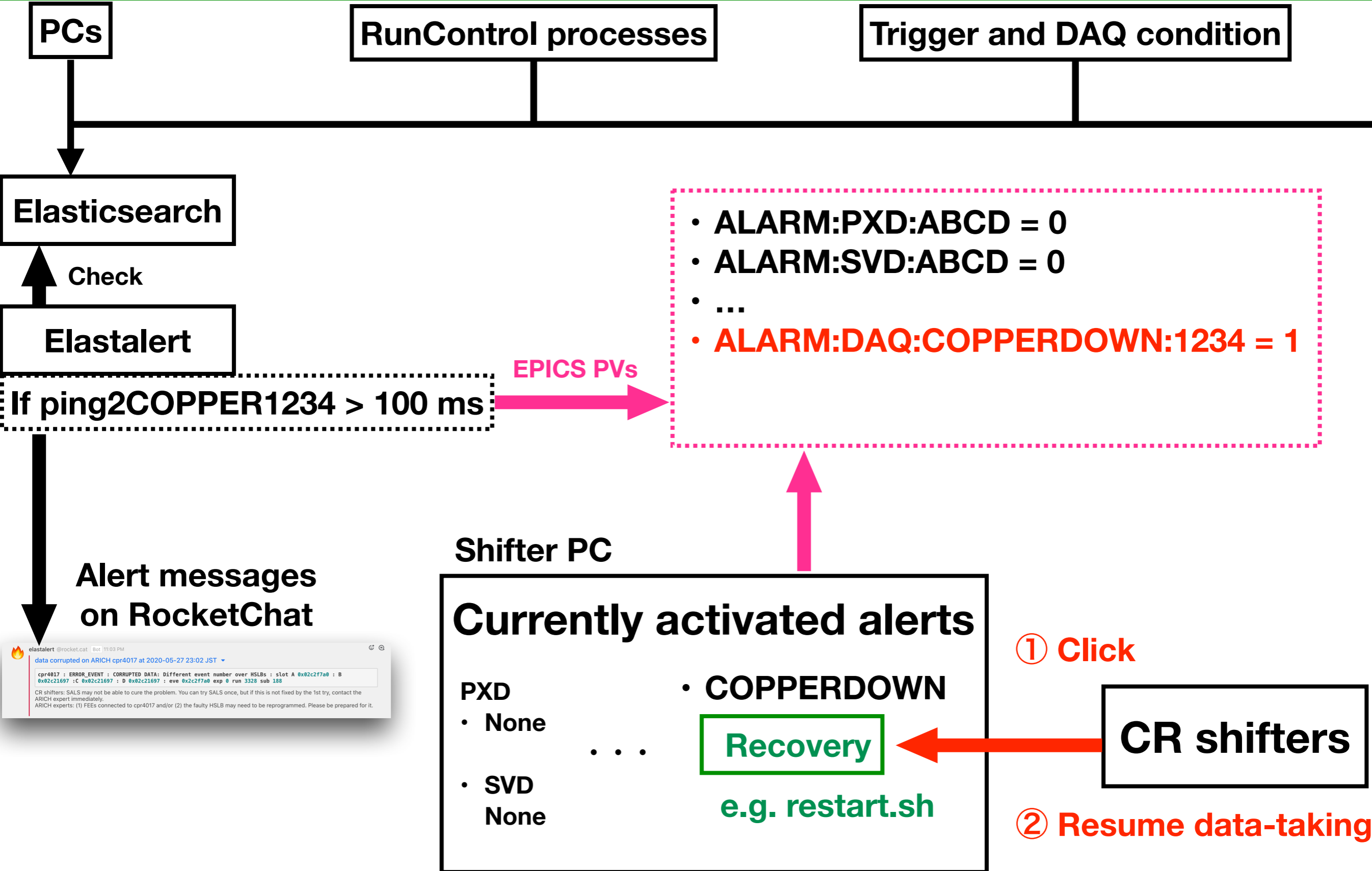
**Powerful tool to find  
the root cause of problems**

# Plan: connected with recovery actions



- The alert system automatically detect many problems
- The next step is to connect the error-diagnosis with the appropriate recovery actions
- ➔ **If it is implemented in a GUI, CR shifter can take the recovery action and then we can reduce our recovery time**

# Schematic view



# Summary

## Current status

- We have started using the Elastic Stack for real-time monitoring of the Belle II DAQ system
- Working smoothly, making good contributions to reduce downtime
- Three major applications:
  1. Online visualisations on Kibana (e.g. data-taking efficiency)
  2. Alerting system
  3. Offline analyses

## Future plan

- Root cause analysis
  - It is worth to try machine learning on Elastic stack
- To connect the detection results with quick recovery actions
  - Implementation is on-going