

# Real-time analysis with the LHCb trigger in Run-II

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The LHCb software trigger underwent a paradigm shift before the start of Run-II. From being a system to select events for later offline reconstruction, it can now perform the event analysis in real-time, and subsequently decide which part of the event information is stored for later analysis.

The new strategy is only possible due to a major upgrade during the LHC long shutdown I (2012-2015). The CPU farm was increased by almost a factor of two and the software trigger was split into two stages. The first stage performs a partial event reconstruction and inclusive selections to reduce the 1 MHz input rate from the hardware trigger to an output rate of 150 kHz. The output is buffered on hard disks distributed across the trigger farm. This allows for an asynchronous execution of the second stage where the CPU farm can be exploited also in between fills, and, as an integral part of the new strategy, the real-time alignment and calibration of sub-detectors before further processing. The second stage performs a full event reconstruction which is identical to the configuration used offline. LHCb is the first high energy collider experiment to do this. Hence, event selections are based on the best quality information and physics analyses can be performed directly in and on the output of the trigger. This concept, called the “LHCb Turbo stream”, where reduced event information is saved, increases the possible output rate while keeping the storage footprint small.

In 2017, around half of the 400 trigger selections send their output to the Turbo stream and, for the first time, the Turbo stream no longer keeps the raw sub-detector data banks that would be needed for a repeated offline event reconstruction.

This allows up to a factor of 10 decrease in the size of the events, and thus an equivalent factor higher rate of signals that can be exploited in physics analyses. Additionally, the event format has been made more flexible, which has allowed more used of the turbo stream in more physics analyses. We review the status of this real time analysis and discuss our plans for its evolution during Run-II towards the upgraded LHCb experiment that will begin operation in Run-III.

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## Primary Keyword (Mandatory)

Trigger

## Tertiary Keyword (Optional)

**Primary author:** STAHL, Sascha (CERN)

**Co-authors:** FITZPATRICK, Conor (Ecole Polytechnique Federale de Lausanne (CH)); RAVEN, Gerhard (Nikhef National institute for subatomic physics (NL)); VESTERINEN, Mika Anton (Ruprecht-Karls-Universitaet Heidelberg (DE))

**Presenter:** RAVEN, Gerhard (Nikhef National institute for subatomic physics (NL))

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