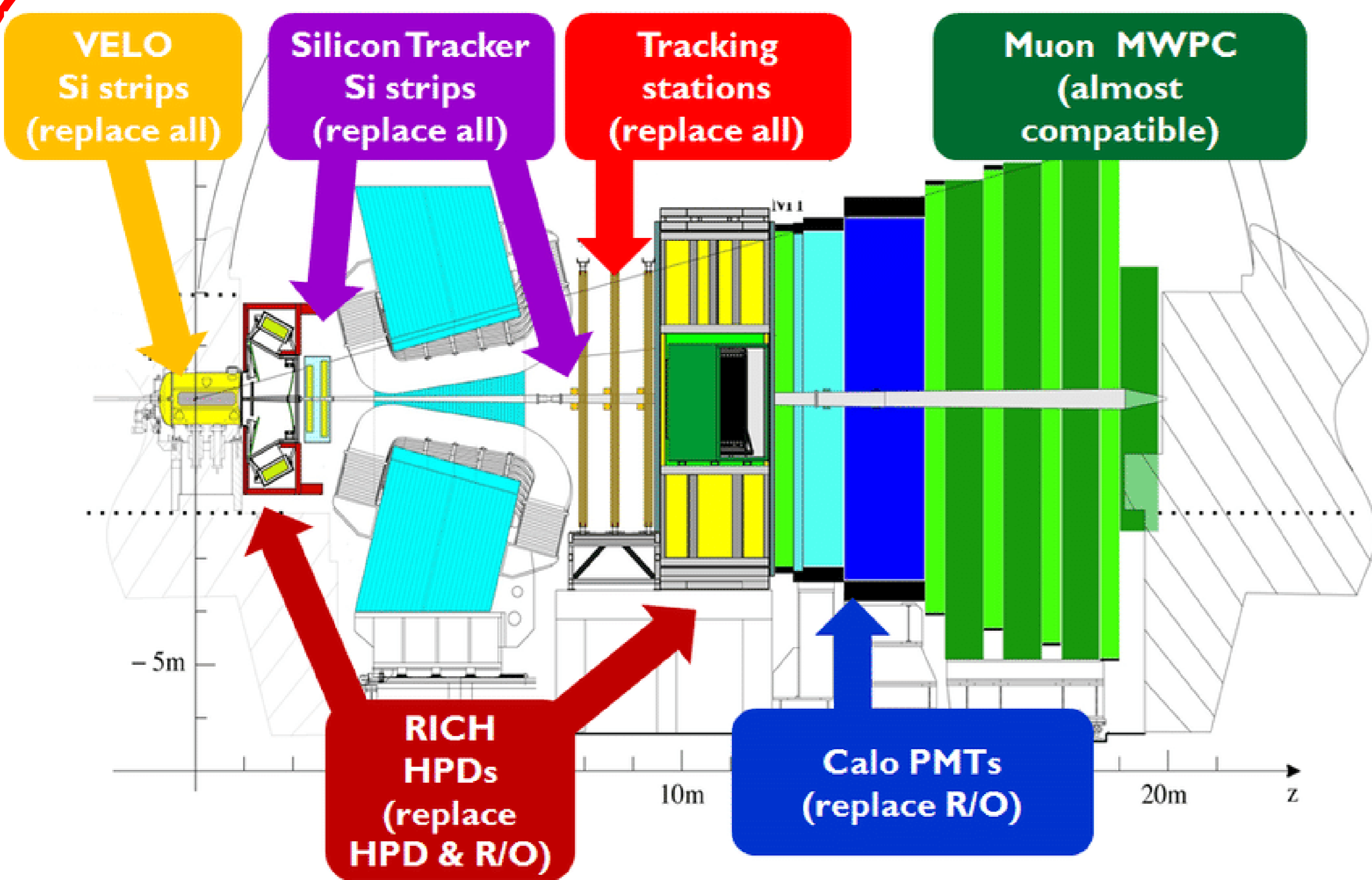


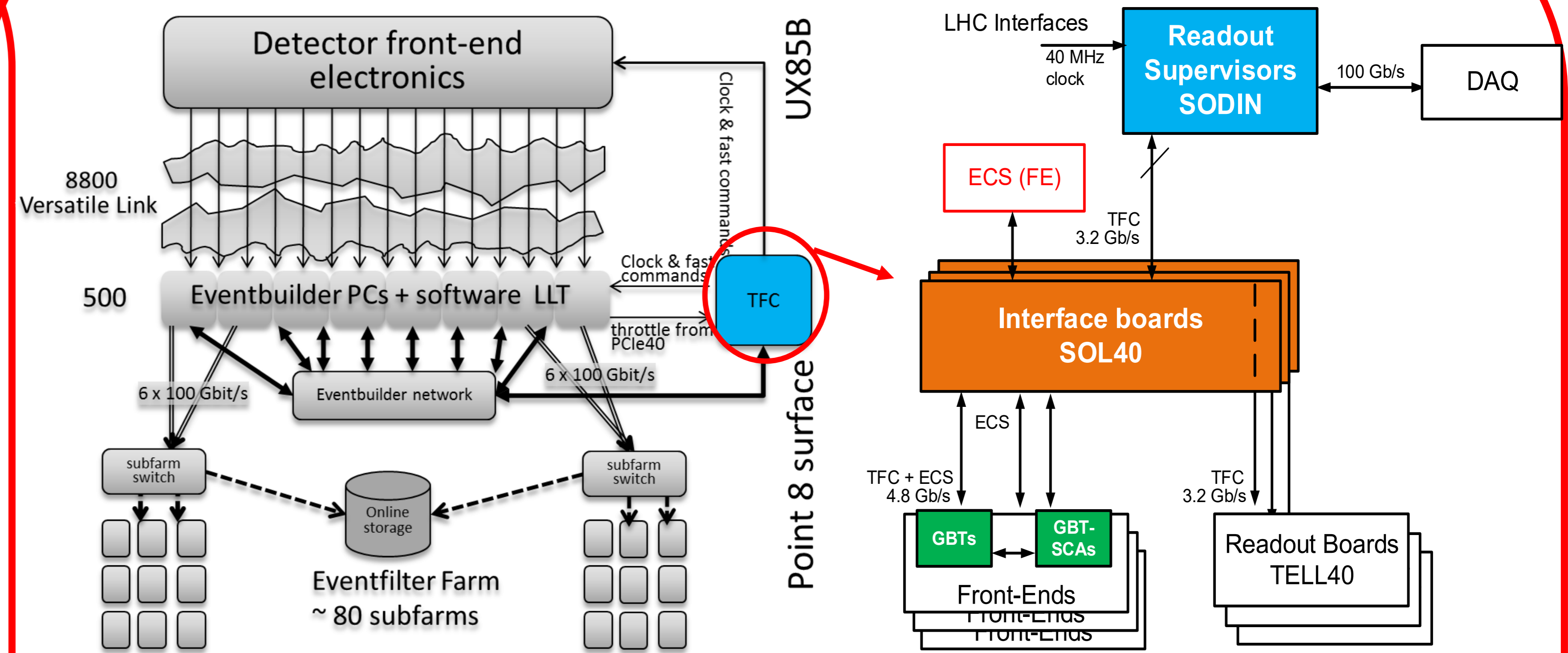
The upgraded LHCb detector



Complex upgrade of the LHCb detector in 2019-2020

- replace all Front-End and Back-End electronics
- replace >90% of the detector channels
- trigger-less data taking at full LHC frequency
- run at x10 more instantaneous luminosity for the next 10 years
- ~40 Tbps data acquisition system

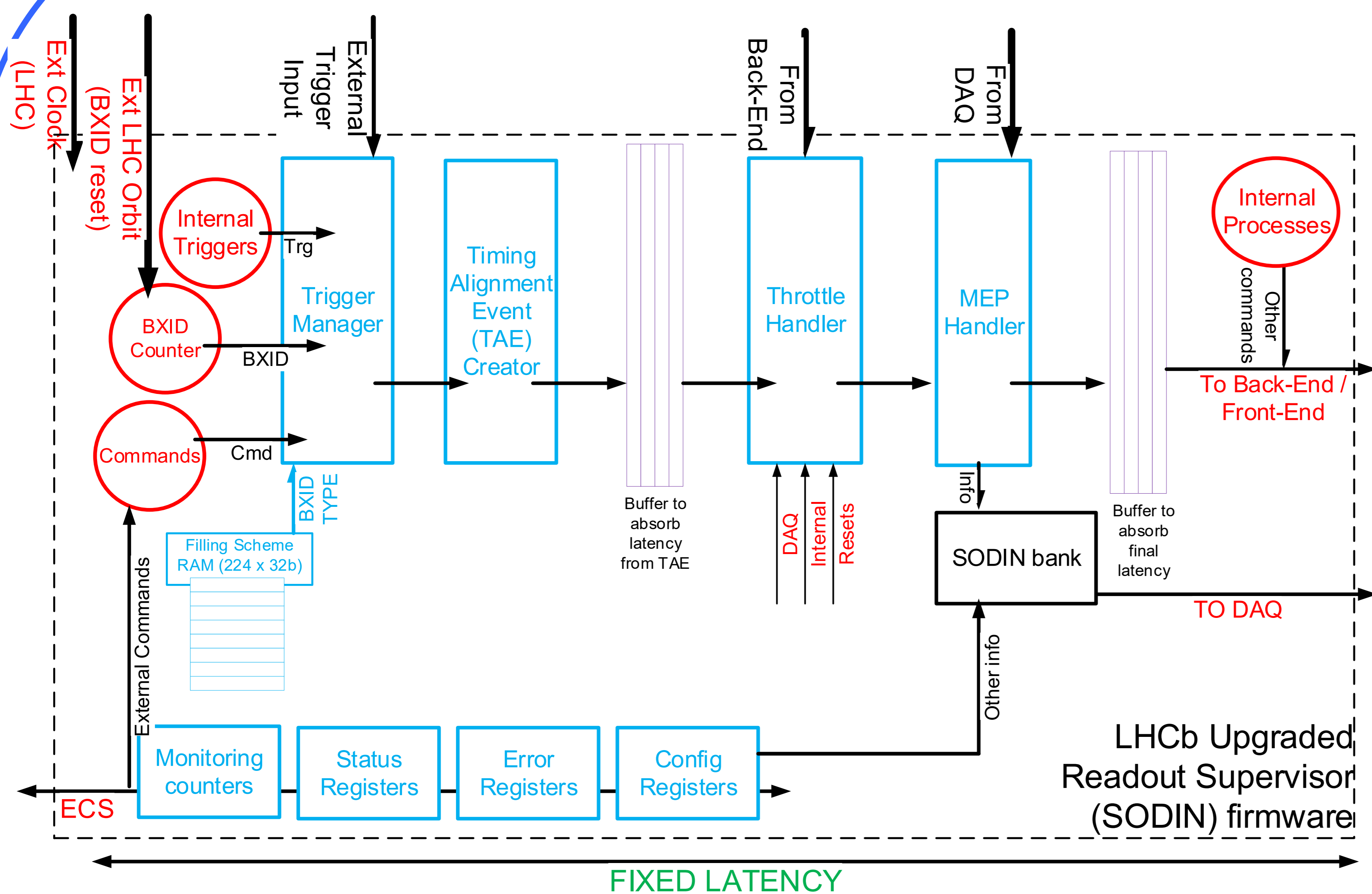
The upgraded LHCb readout system



The upgraded LHCb readout system^[1] will be centrally controlled by a single Readout Supervisor, with these functionalities:

- reception and distribution of global timing
- generation and distribution of synchronous and asynchronous commands
- generation of events veto, triggers and calibration events
- interface to central control system for run management, activity configurations and special data taking recipes
- timestamping and description of events

The upgraded Readout Supervisor firmware

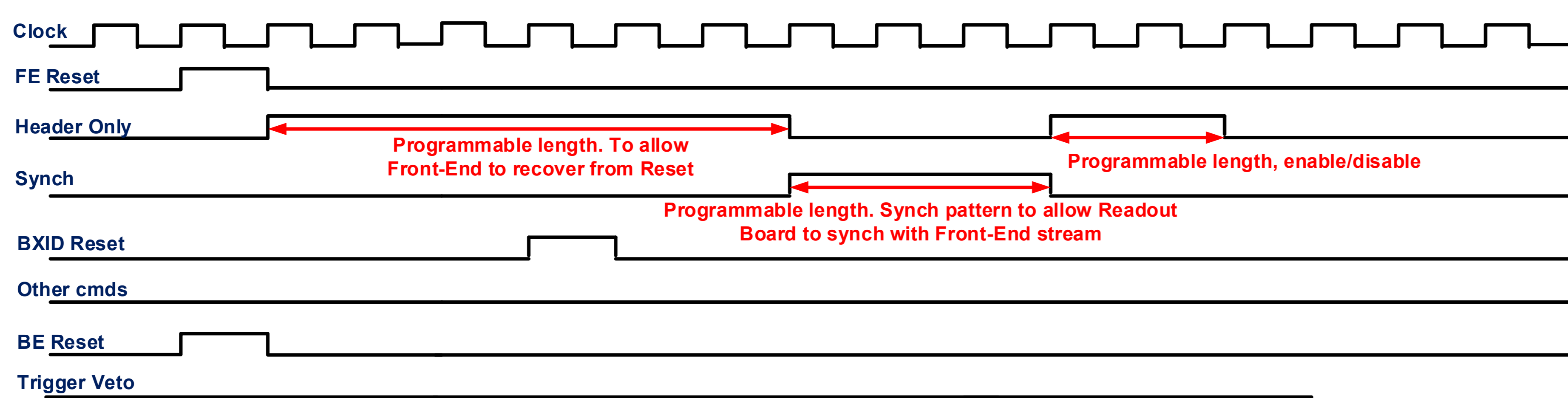


Centralized supervision in a single VHDL firmware:

- coverage of all Front-End and Back-End specifications
- generic code to allow for the higher level of flexibility avoiding ad-hoc processes
- high level of programmability
- real-time monitoring and control
 - ⇒ asynchronous commands from ECS
- distribution of commands and triggers at a fixed latency with respect to the passage of the beam
 - ⇒ extensive usage of buffers and pipelines to ensure fixed latency in the distribution
- generation of an event description (data bank) for each "non-rejected" event
 - ⇒ LHC filling scheme loaded in FPGA
 - ⇒ absolute event ID counting and matching
 - ⇒ absolute timestamping and event type
- Common LHCb hardware backbone^[2]
- Common LHCb software framework^[3]

Centralized control of data taking modes

⇒ example of a start of run synchronization mechanism



1. TFC generates a centralized Synch command for the full readout system
2. (All) Front-End electronics generates a programmable pattern
3. (All) Readout Board synchronize on the pattern and associated BXID
4. TFC releases trigger veto, data taking starts

Centralized readout control allows for synchronicity across the system

Real-time readout control

- ⇒ asynchronous commands from ECS
- ⇒ changing configurations based on data taking conditions (pause trigger/ pause data acquisition)
- Event type definition based on origin of event
 - ⇒ calibration event associated to a calibration command: isolate specific event
 - ⇒ veto trigger(s) according to predefined rules