combinations in the event. Events selected by the HLT1 trigger are buffered to disk storage in the online system. This is done for two purposes: events can be processed further during inter-fill periods, and the detector can be calibrated and aligned run-by-run before the HLT2 stage. Once the detector is aligned and calibrated, events are passed to HLT2, where a full event reconstruction is performed. This allows for a wide range of inclusive and exclusive final states to trigger the event and obviates the need for further offline processing.

This paper describes the design and performance of the Run 2 LHCb trigger system, including the real-time reconstruction which runs in the HLT. The software framework enabling real-time analysis (“TURBO”) has been described in detail elsewhere. The initial proof-of-concept deployed in 2015 [2] allowed offline-quality signal candidates selected in the trigger to be written to permanent storage. It also allowed physics analysts to use the offline analysis tools when working with these candidates, which was crucial in enabling LHCb to rapidly produce a number of publications proving that real-time analysis was possible without losing precision or introducing additional systematics. Subsequent developments [3] generalized this approach to allow not only the signal candidate but also information about other, related, particles in the event to be saved. These developments also transformed the proof-of-concept implementation into a scalable solution which will now form the basis of LHCb’s upgrade computing model [4].