

PERFORMANCE OF THE ATLAS TAU TRIGGER IN RUN 2

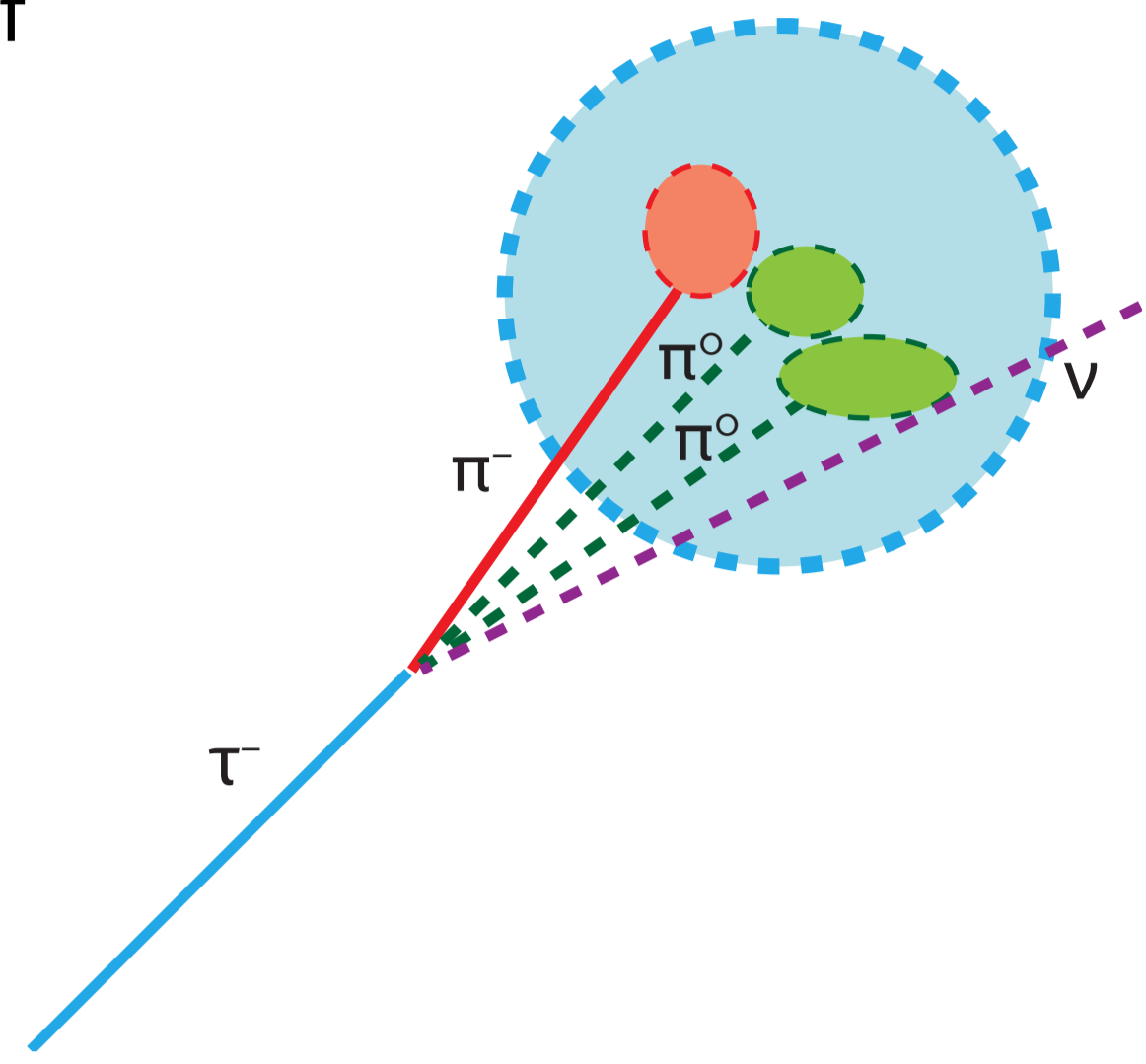
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ON BEHALF OF THE ATLAS COLLABORATION



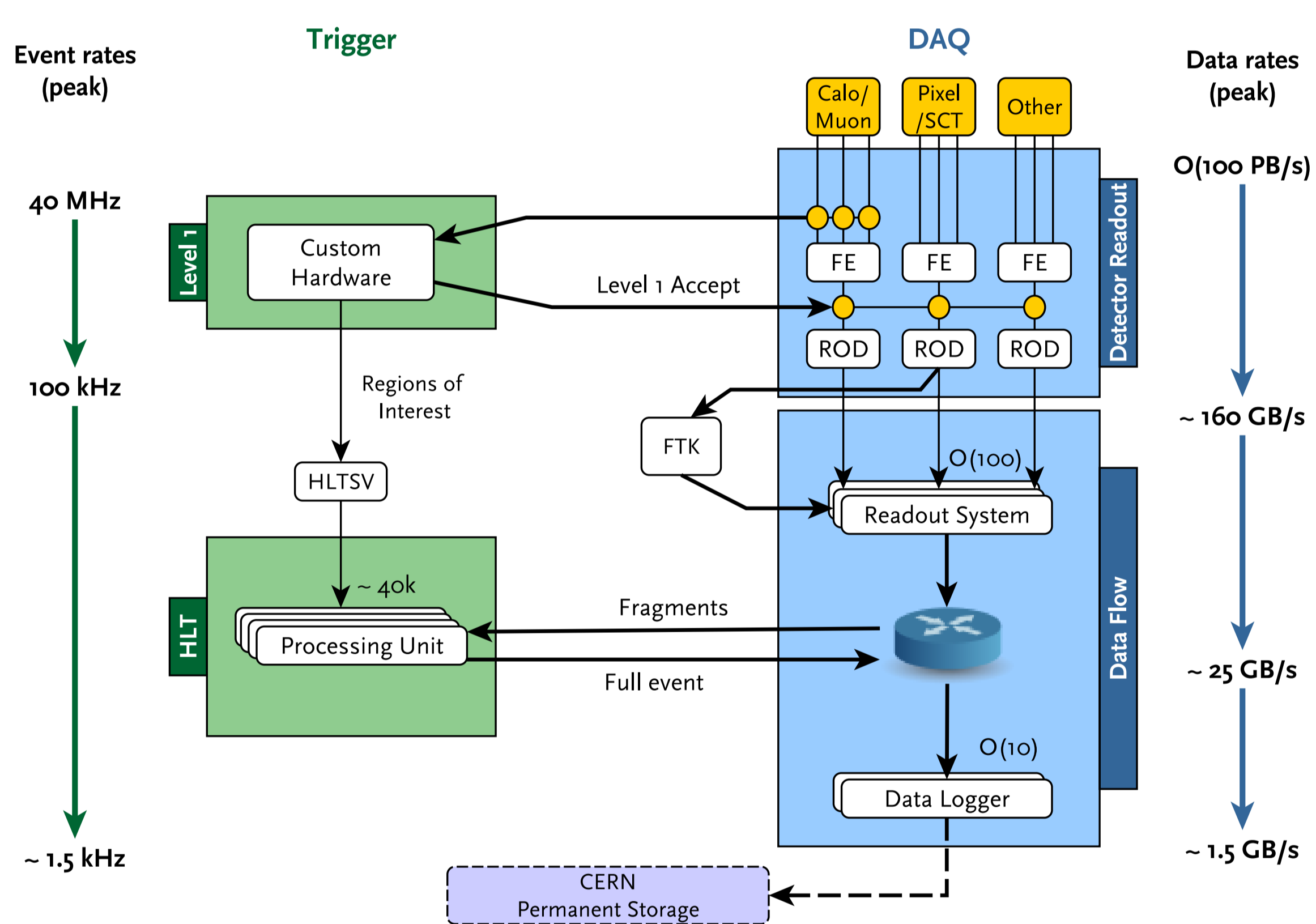
TAU LEPTONS

- * **Longest lived lepton:** proper decay length of 87 μm ; generally decays in a few cm
- * **Identified by its decay particles:** either leptons or hadrons (pions), and neutrinos
- * **Quark- and gluon-initiated jets form the major background:** discriminate using variables based on displaced vertex, track multiplicity, collimated shower shape
- * As heaviest lepton, taus are **important in SM Higgs physics and BSM searches**



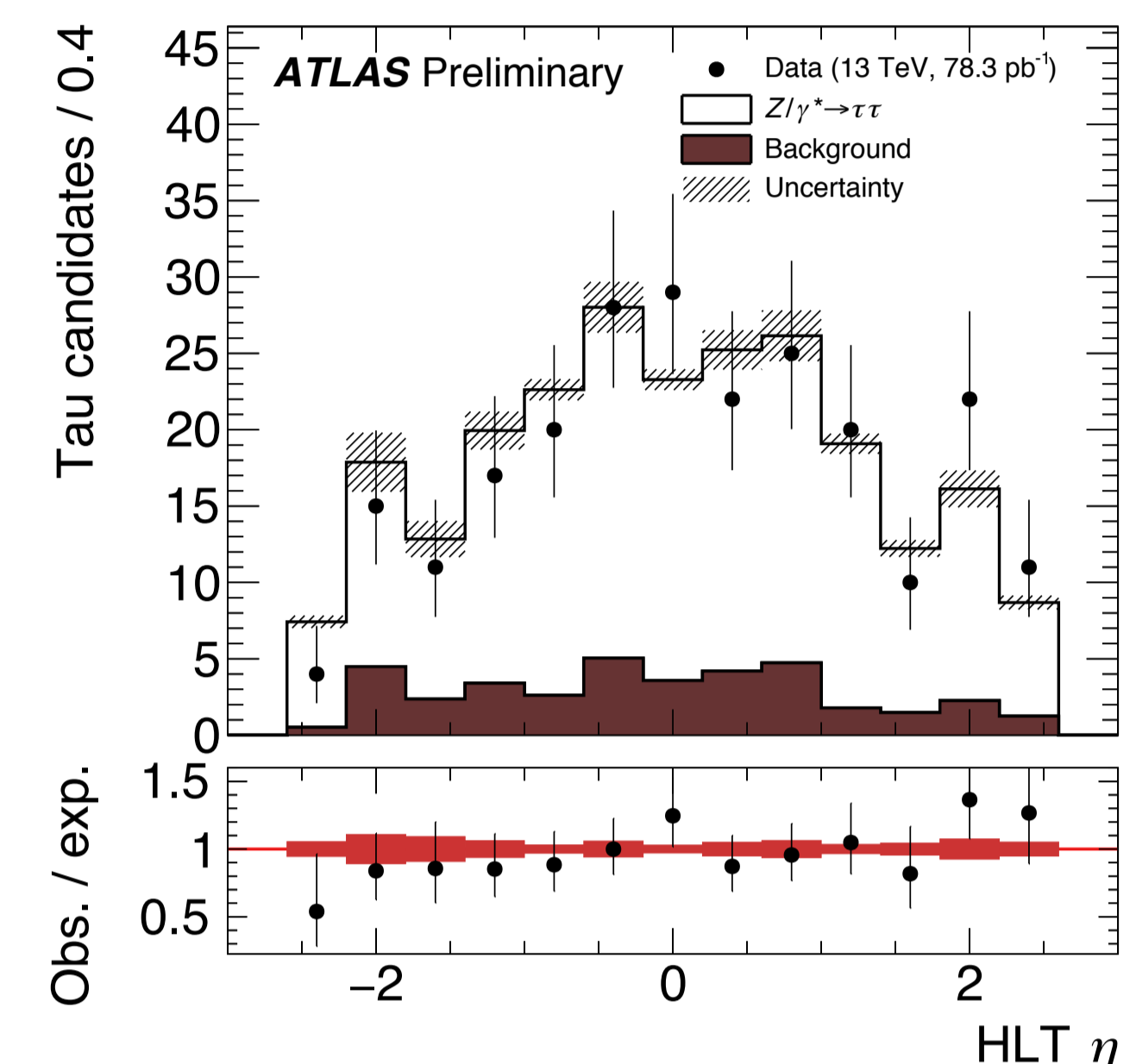
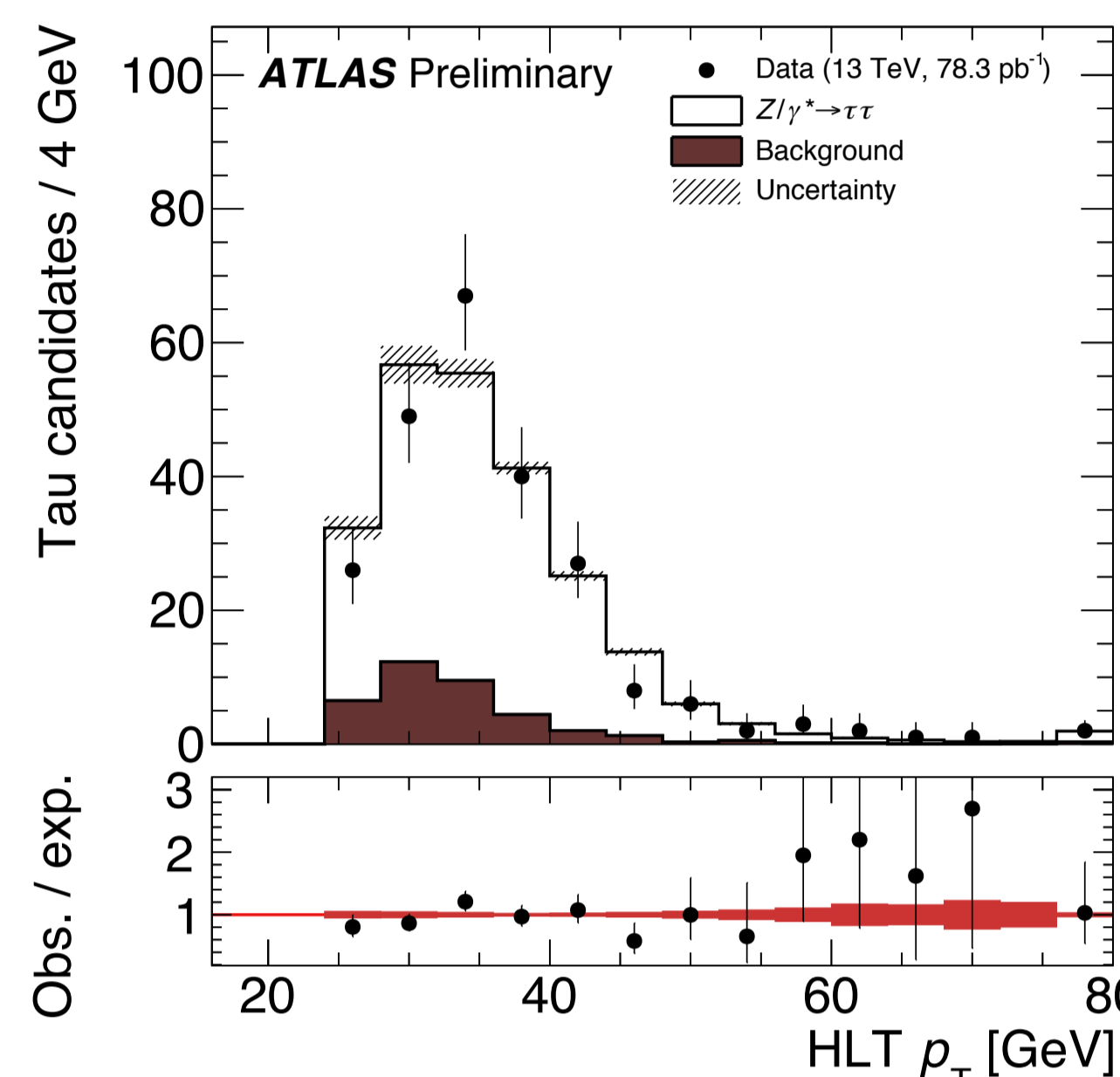
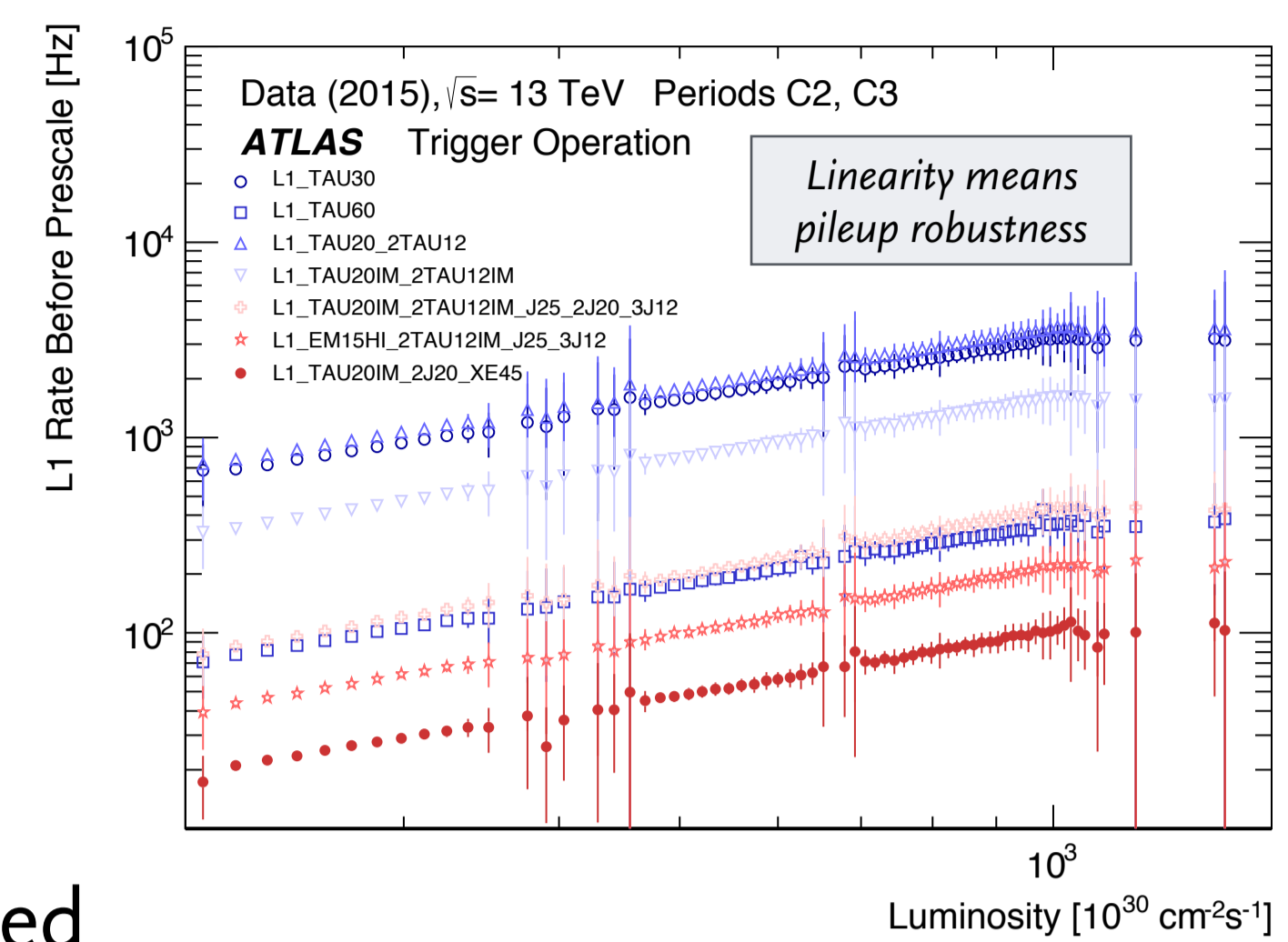
THE ATLAS TRIGGER SYSTEM

- * **Two-level system reduces rate from collision rate: 40 MHz to avg 1 kHz**
- * **First level (L1) hardware-based:** identifies regions of interest (Rois) from the muon system and calorimeters; output rate max 100 kHz
- * **Software-based high-level trigger (HLT) refines L1 information**
- * HLT accesses data from all subsystems; includes tracking information
- * Uses **algorithms very similar to offline counterparts**
- * **Substantial changes w.r.t. Run 1** to deal with increased LHC collision energy and luminosity: bandwidth increases; hardware improvements; merged two stages into one HLT; optimised algorithms
- * Further rate reductions will require changes in triggering strategy

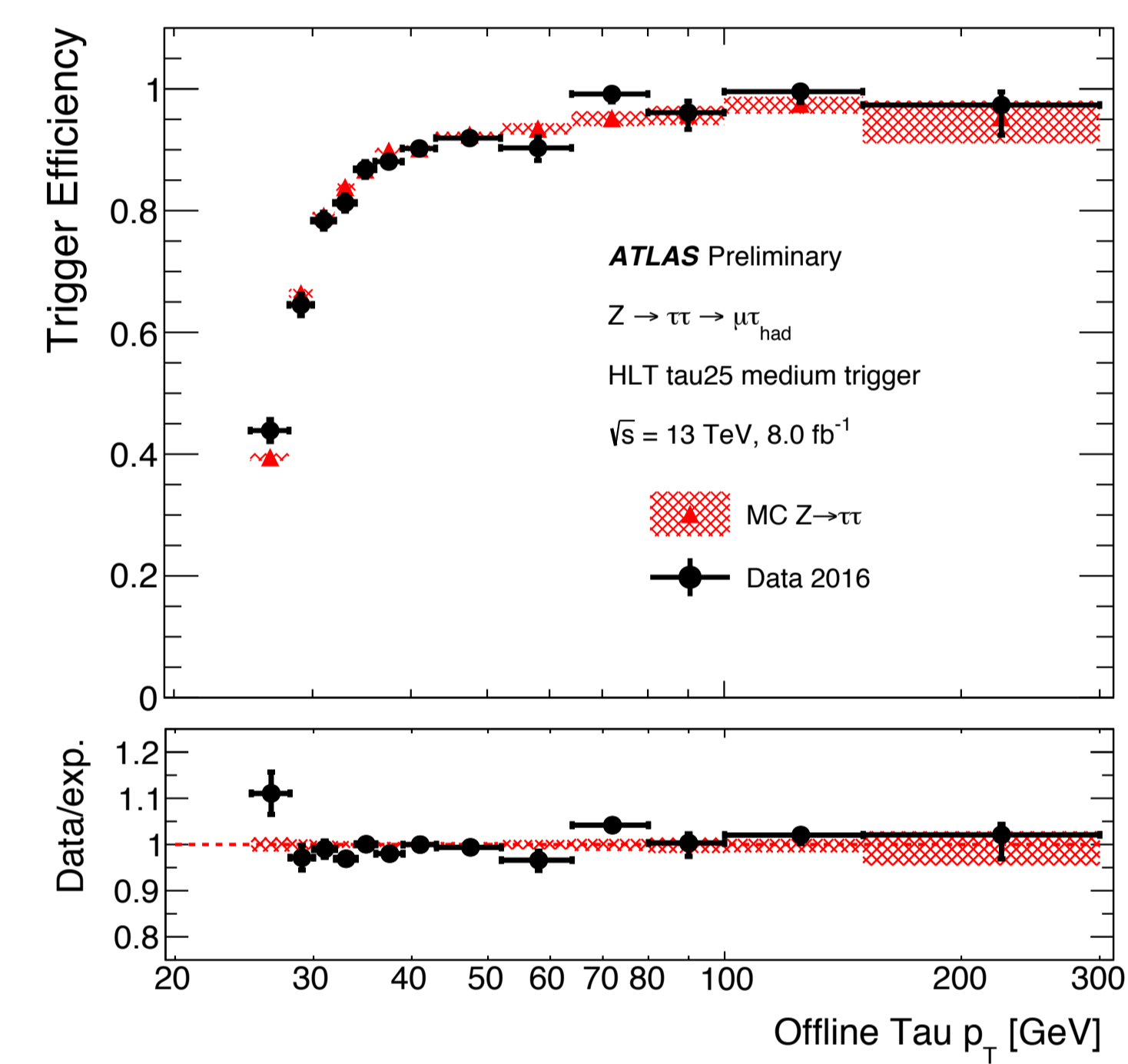
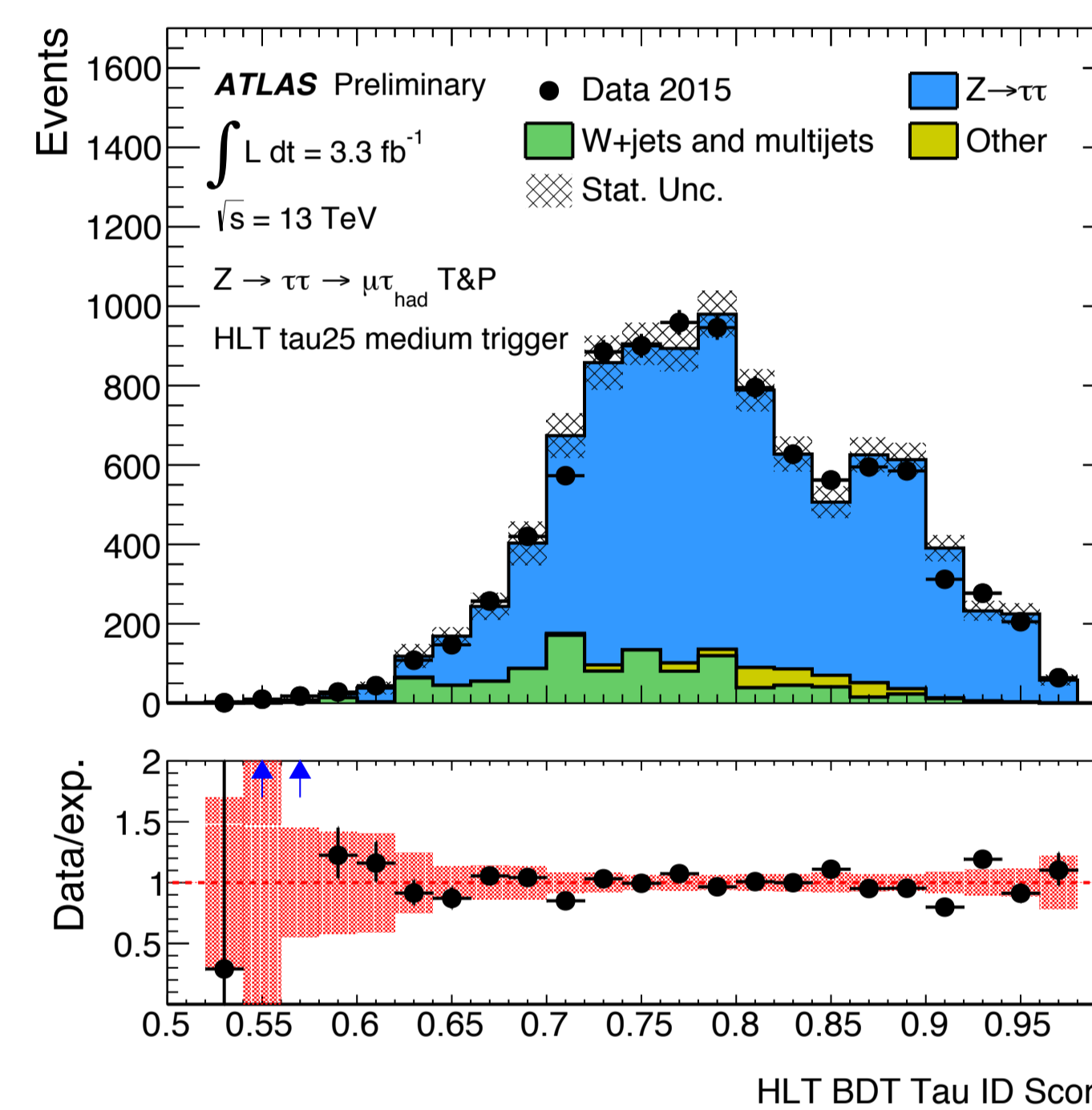
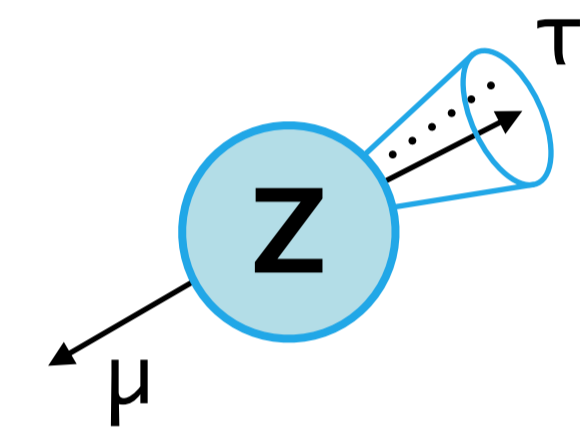


PERFORMANCE IN RUN 2

- * **L1 trigger rate** measured as function of instantaneous luminosity (6–12 July 2015)
- * 'TAU', 'EM', 'J' and 'XE' refer to taus, electrons, jets and missing energy; 'IM' and 'HI' indicate isolation and hadronic veto req.
- * **Offline $Z \rightarrow \tau\tau$ events** (medium BDT) show trigger observables well-modelled

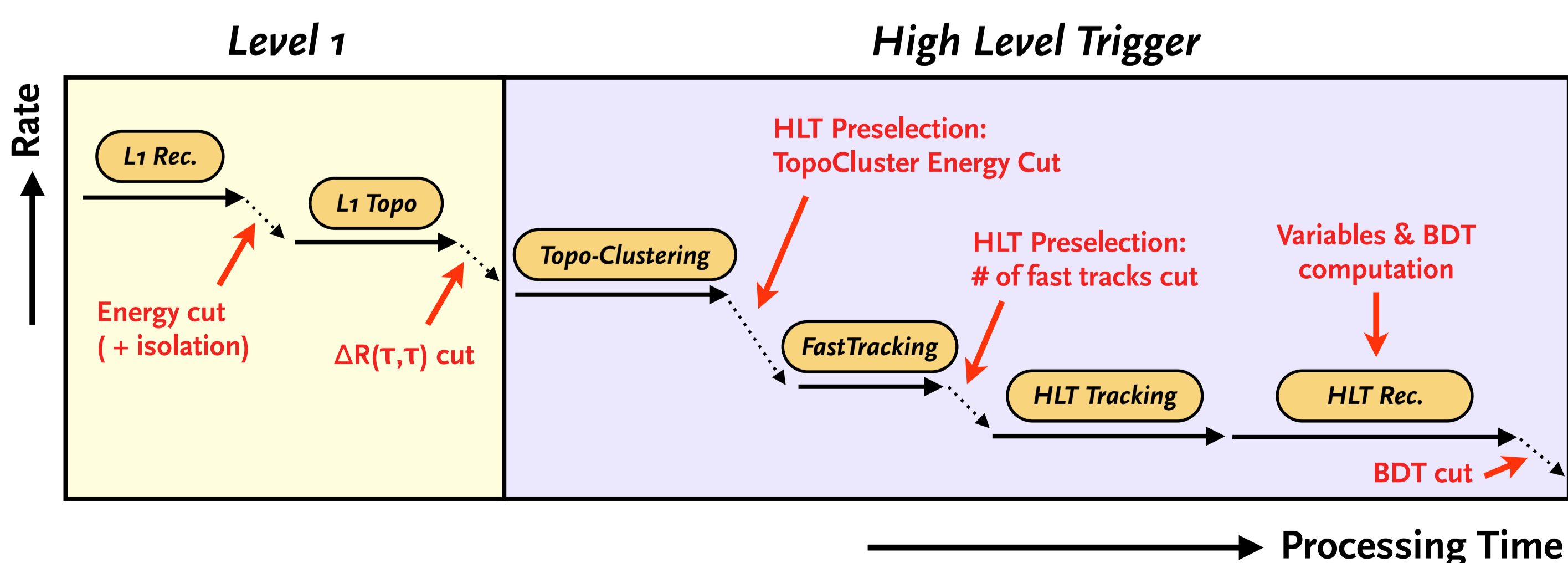
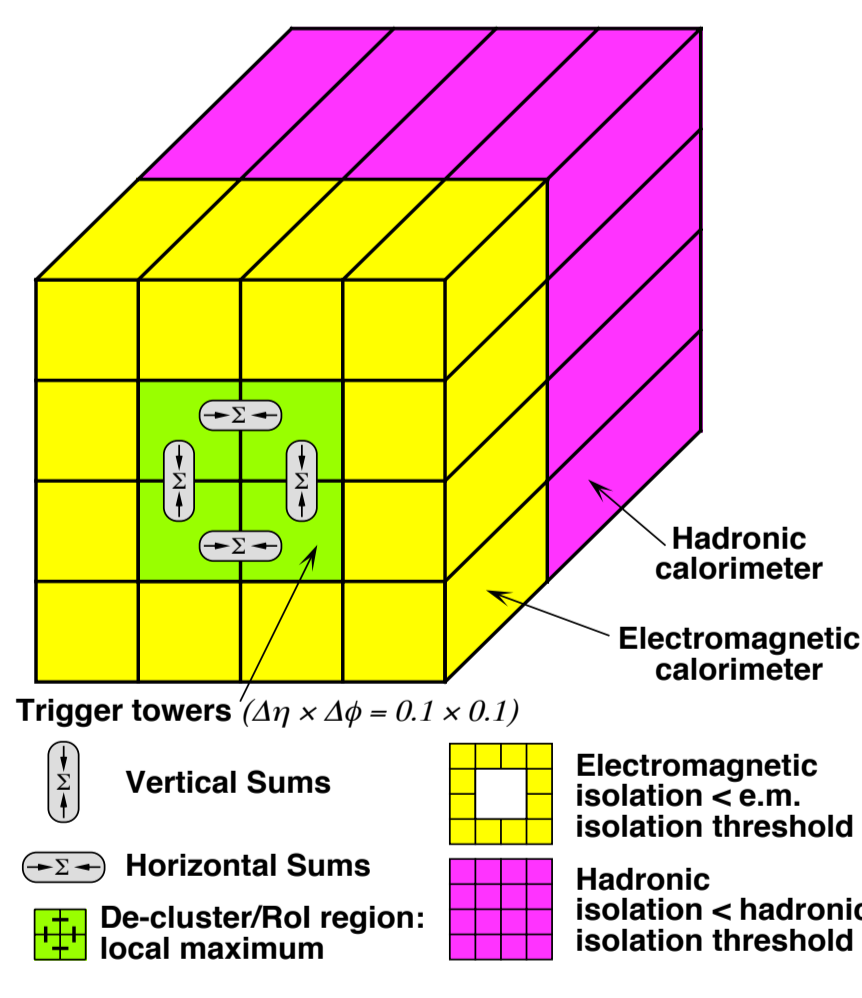


- * **Efficiencies measured using tag-and-probe method** on $Z \rightarrow \tau\tau \rightarrow \mu + \tau_{\text{had}}$ events: *tagged* muon passed muon trigger; efficiency measured on *probe* tau



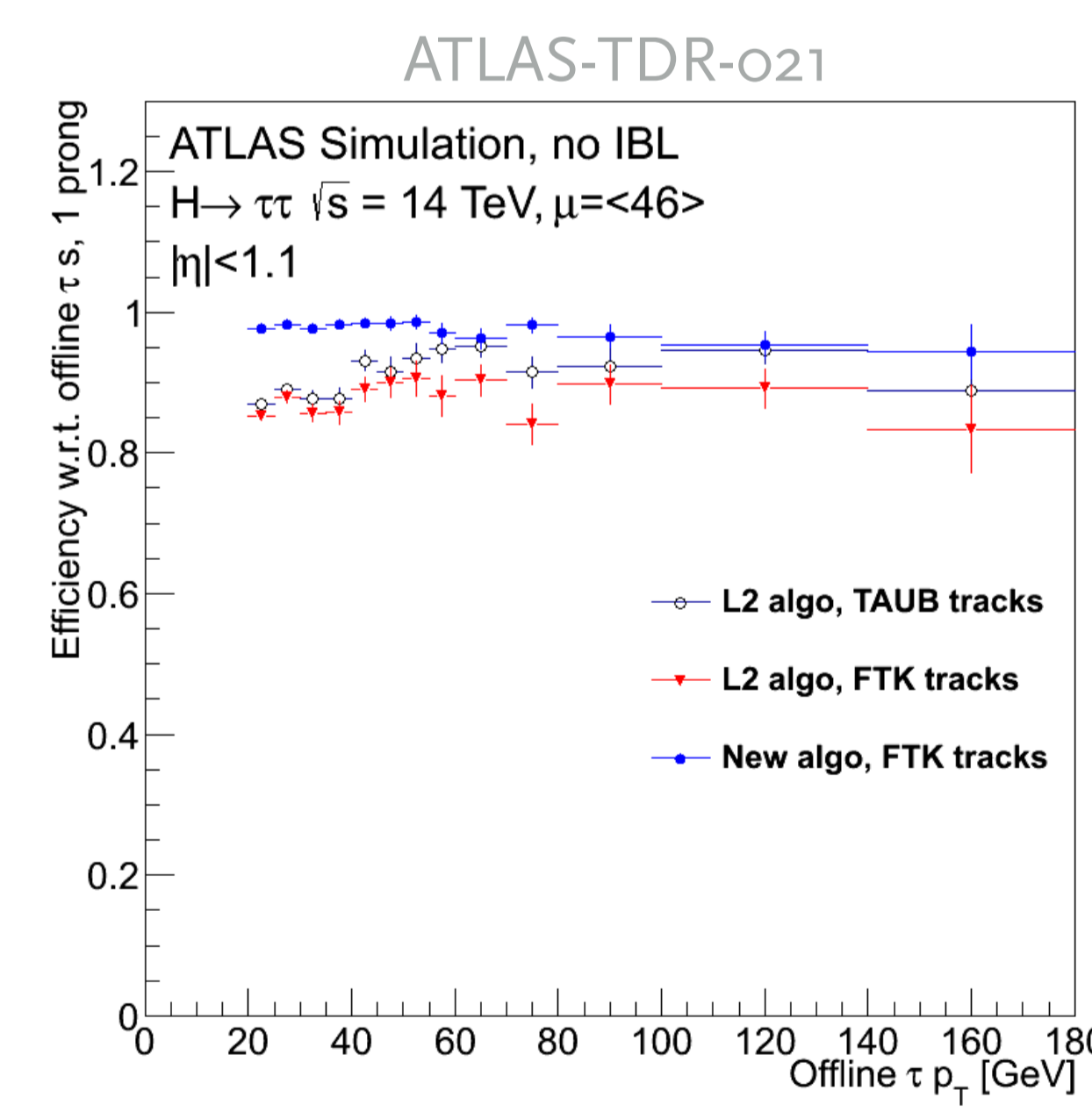
TAU TRIGGER STRATEGY

- * **ATLAS tau trigger aims to identify hadronic decays**
- * **L1: narrow cascade in both calorimeters**
- * Energy-dependent isolation cuts to control rate
- * Topological L1 triggers may be used in future
- * **HLT combines energy clusters with tracking**
- * Topological clustering of cells in RoIs
- * **Fast-tracking algorithm** optimised to perform selections based on no. of core and isolation tracks
- * **Improvement w.r.t. Run 1: full HLT tracking and 13-variable BDT harmonised with offline selection** used in final selection

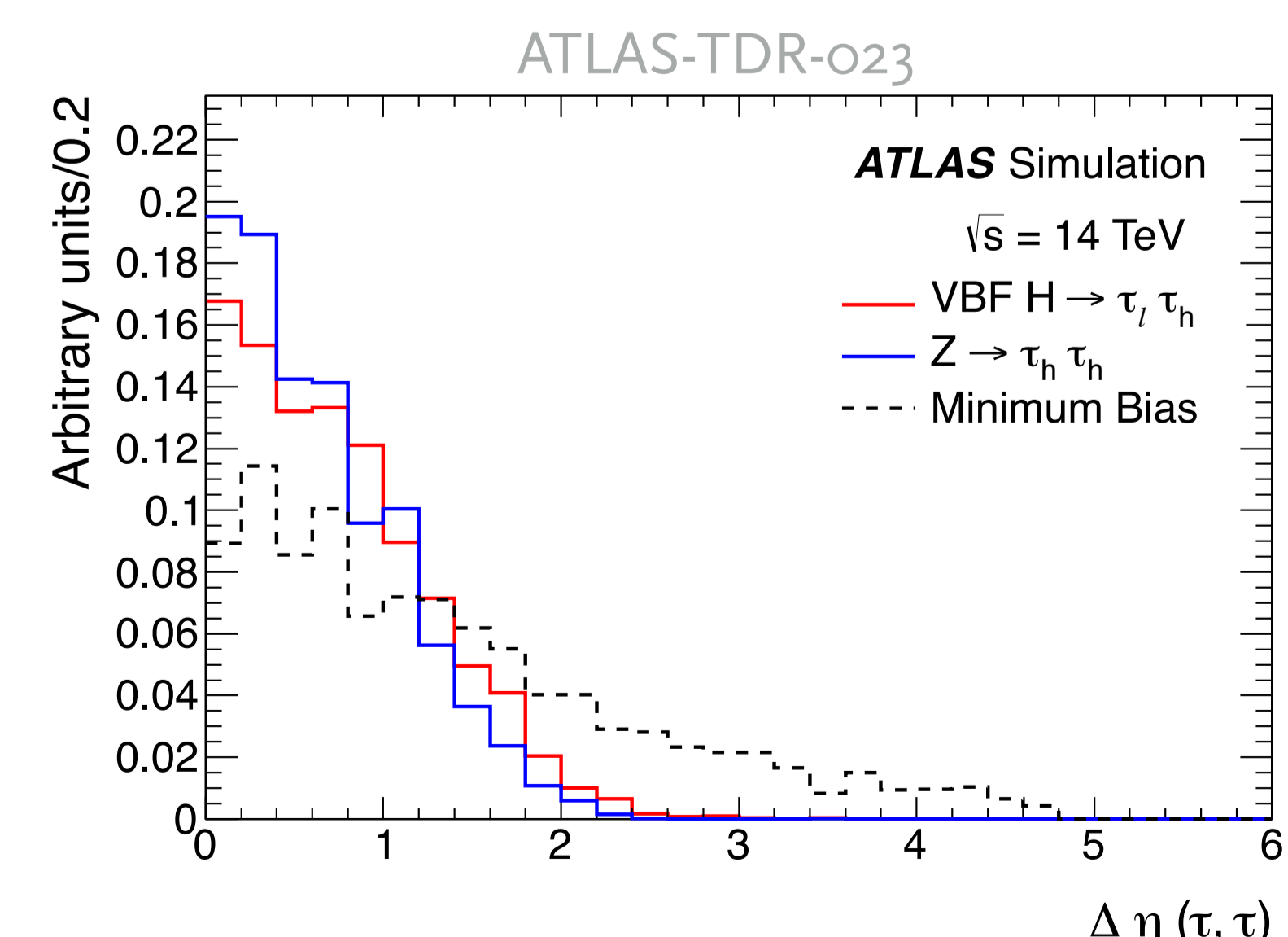


PROSPECTS

- * The **ATLAS Fast Tracker (FTK)** will provide full-scan tracks after L1 selection with trained *pattern banks*
- * Allows for redesign of HLT tau algorithm: tracking can be used before calorimeter information
- * **HLT energy resolution impact on efficiency can be reduced**
- * Very useful for e.g. SM $H \rightarrow \tau\tau$
- * **First triggers operational in 2017**



- * **Topological triggers at L1** allow for selection by angular criteria
- * Crucial at higher instantaneous luminosity and pile-up
- * Exploit kinematic differences between multi-jet and Higgs signal events



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