Status of the Run 3 trigger white paper

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On behalf of the LHC LLP WG

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Eighth workshop of the LHC LLP Community

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Because there is nothing better than pictures of the Backstreet Boys and NSYNC in the '90s/early 2000s.

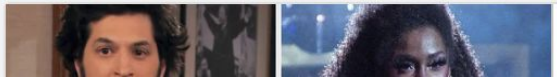
Matt Stopera • 27 minutes ago

Trending

38 Useful Or Downright Cute Triggers To Get For Your Next LHC Run

You won't believe #12!

CERN 19 minutes ago



26 Minor Characters Who Were Way More

New LLP triggers for run 3

We've been talking about LLP trigger opportunities at almost every LLP workshop for the past few years. With the start of Run 3 coming up, now is the time to 'put up or shut up'.

At the last LLP workshop, there was a fruitful discussion on new triggers and we* decided to summarize these discussions in a white paper, focusing on **concrete** and hopefully **realistic** trigger ideas that in our opinion should be a priority for Run 3.

**we = LLP WG conveners, David, Yuri + ATLAS/CMS/LHCb experts who joined the effort…. More on the authorlist later…..*

Current Status: We have a complete draft, including ~15 concrete trigger suggestions for ATLAS/CMS, and ~15 for LHCb. :)

ATLAS/CMS and LHCb

We discuss ATLAS/CMS together, since the two big detectors have general similarities (though we discuss individually where appropriate).

LHCb is discussed separately, since
1) it is of a very different design,
2) has very fine-grained capabilities in Run 3 (*no hardware trigger layer*),
3) our understanding of LHCb BSM reach has expanded considerably in last few years.

We want to highlight the complementarity between LHCb and ATLAS/CMS.
LHCb's unique capabilities should more than make up for its lower lumi dataset for many BSM scenarios, especially LLPs with modest masses below ~ 50 - 100 GeV, including ones produced in Higgs decays.

Opportunities for new long-lived particle triggers in Run 3 of the Large Hadron Collider

PRELIMINARY DRAFT

ABSTRACT: Long-lived particles (LLPs) are highly motivated signals of Beyond Standard M (BSM) physics with great discovery potential and unique experimental challenges. The LLP search programme has made great advances during Run 2 of the Large Hadron Collider (LHC), but many important regions of signal space remain unexplored. To fully exploit the opportunities that the increased luminosity of Run 3 provides, it is imperative that LLP triggers be preserved and expanded. In this document we present a list of concrete and highly motivated suggestions for new LLP triggers at ATLAS, CMS and LHCb that can be implemented for Run 3. These triggers would greatly extend the reach of the LHC experiments for BSM signals that would otherwise escape detection, and their development should be a high priority. [Draft document, 16 Nov 2020]

Strictly focused on what is possible for Run 3 only!

ATLAS/CMS trigger ideas are organized by detector/trigger subsystem.

LHCb trigger ideas are organized by LLP decay mode/mass (due to more detailed and complete online reconstruction available).

Physics motivation example
LLPs in low-H_T events, e.g. from exotic Higgs decay
LLPs in low-H_T events, also emerging jets, dark showers, disappearing tracks, etc.
displaced jet + X searches, e.g. low mass LLPs or dark showers recoiling against SM objects
Hadronically decaying LLPs with low-HT where displaced track reconstruction is particularly difficult
Slow LLPs (heavy or produced near threshold)
LLP decaying in calorimeter, analogous to existing ATLAS capability
Dramatic reduction of HLT thresholds for various LLP scenarios
GMSB
Soft displaced leptons; GMSB staus, freeze-in DM, LLPs from higgs decays
Soft displaced multi-lepton, e.g. dark photons, dark shower
Fractionally charged particles
Displaced muons with impact parameter $>$ 10s of cm
Hadronic LLPs decaying in muon system, analogous to existing ATLAS triggers

Table 1. Summary of new ATLAS/CMS trigger suggestions for Run 3. The new component of each trigger is marked with a star *.

Detector	New LLP Trigger	Physics motivation example	Section
		Hadronically decaying LLPs $<$ 15 GeV	3.1
		General LLPs that decay hadronically	
		Hadronically decaying LLPs with masses $\sim \mathcal{O}$(GeV)	3.2
		ditto	
		LLPs that decay through Higgs portal, in particular for $\lesssim$ 50 GeV masses that are most challenging for main detectors	3.3
		Heavy neutral leptons	
		Dark photon, dark showers	3.4
		Axion-like particles, dark showers	
		Increase trigger efficiency for hadronic modes by relying on impact parameter (speed up with VELO-only Kalman filter)	3.5
		Use of electromagnetic calorimeter clusters for selecting neutral LLPs	
		Addition of downstream tracks to trigger LLPs decaying outside the VELO region	
		Implementation of computationally expensive algorithms	
		Fractionally charged and massive stable charged particles	3.6
		SUEPs	

Table 2. Summary of new LHCb trigger suggestions for Run 3.

Right now: 0th order Feedback?

Did we leave out any important/obvious LLP trigger ideas that could realistically be implemented for Run 3?

→ leave a comment in these slides, or email David/Yuri/LLP WG Conveners!

(We plan to eventually release the document draft for more detailed feedback within the LLP community/WG, but we need to coordinate this with experimental collaborations, see next slide.)

Gathering official feedback & Strategy for publication

The original aim is to make this public on arXiv/CDS before the end of 2020. Since this is an LHCC LLP Working Group document and should carry the weight of officially endorsed recommendations, we want buy-in from the experimental collaborations.

In the next few days we plan to start disseminating the white paper draft within ATLAS/CMS/LHCb collaborations, and collect feedback and necessary acknowledgements, especially from LLP/trigger experts. We will add people who give feedback to the author list.

Once the collaborations have a chance to vet the document, we will release a draft for a period of public feedback.

After that, we will finalize and eventually upload to arXiv/CDS, either late 2020 or early 2021.