



Swedish Flavoured BSM Searches in ATLAS

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On behalf of the ATLAS groups in Lund, Uppsala, KTH, and Stockholm

Partikeldagarna 2019, Linköping

There must be physics beyond the Standard Model

Empirical evidence:

Neutrino oscillations

Dark universe

Matter-antimatter asymmetry

Theoretical reasoning:

Naturalness

Topics of this talk

- Dijet resonance searches
- Long-lived particles
- Leptoquarks

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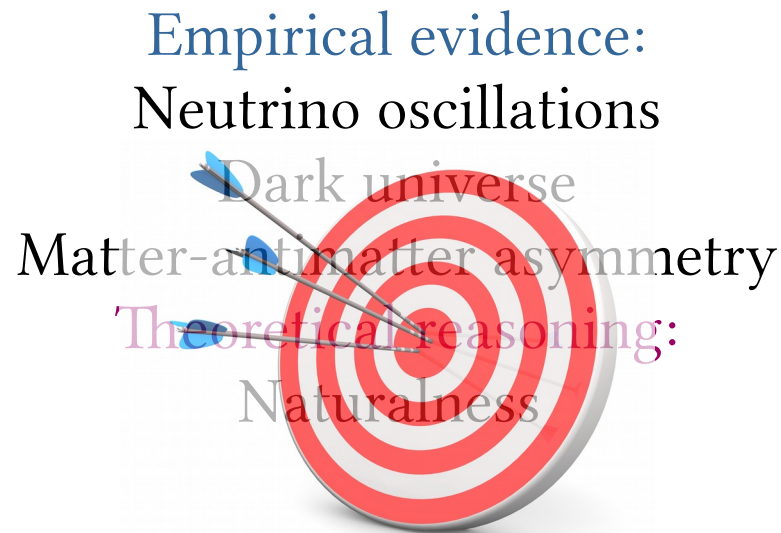
- Dijet resonance searches
- Long-lived particles
- Leptoquarks

Empirical evidence:
Neutrino oscillations



Topics of this talk

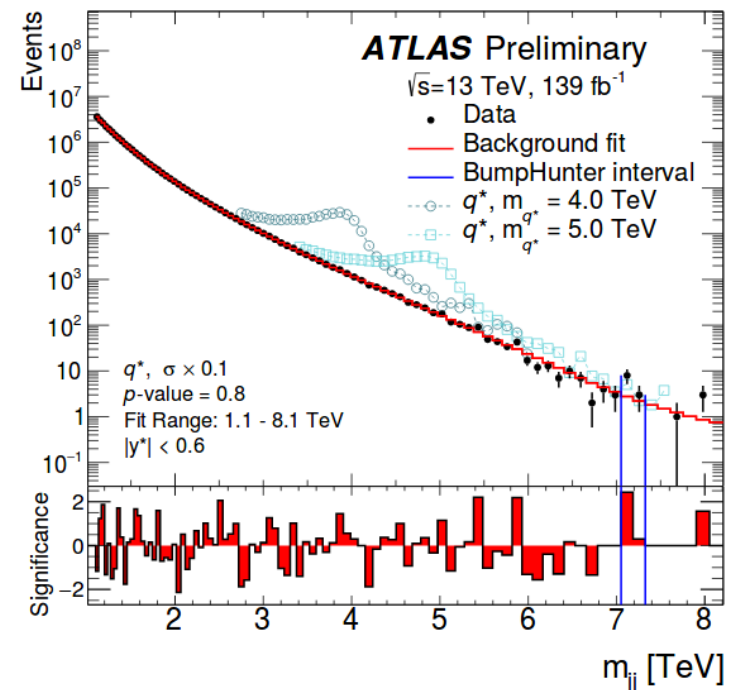
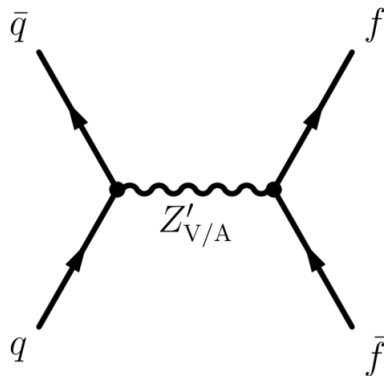
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- Emphasis on results published since last Particle Days
- Other talks dedicated to Higgs- and top-related BSM searches

Dijet Resonance Searches

- Any mediator produced from quarks can also decay back into quarks
 - Could give bumps in the dijet invariant mass spectrum
 - Or features in the angular distributions (Dijet Angular Analysis [CERN-EP-2017-042](#))
- Simplified DM models of s -channel mediator often used for optimising and interpreting
- The “standard” search is just sensitive to high resonance masses due to high energy thresholds for jets in the trigger



ATLAS-CONF-2019-007

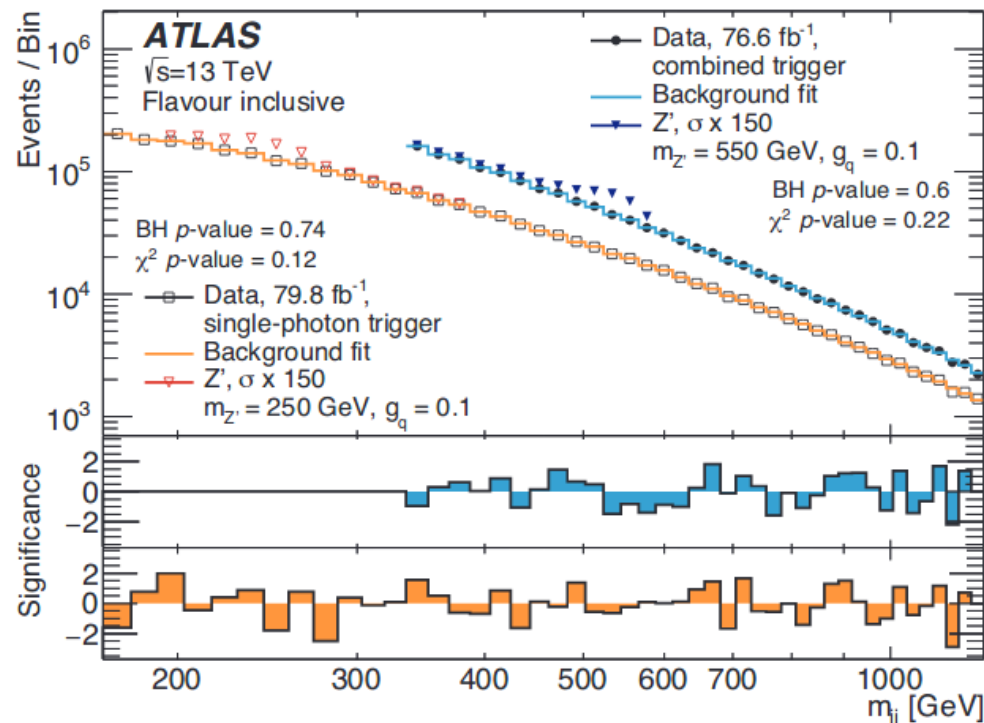
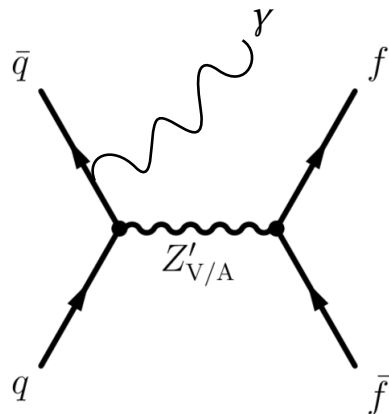
Dijet + Initial State Radiation



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- By targeting events with ISR (jet/photon) we gain sensitivity to lower-mass resonances that we don't trigger on using only their decay products
- Extends the ATLAS constraints to the lower mass range 225-1100 GeV
- Alternative approach: Use only information available at the trigger level
([CERN-EP-2018-033](#))

Eric Corrigan, Caterina Doglioni,



CERN-EP-2018-347



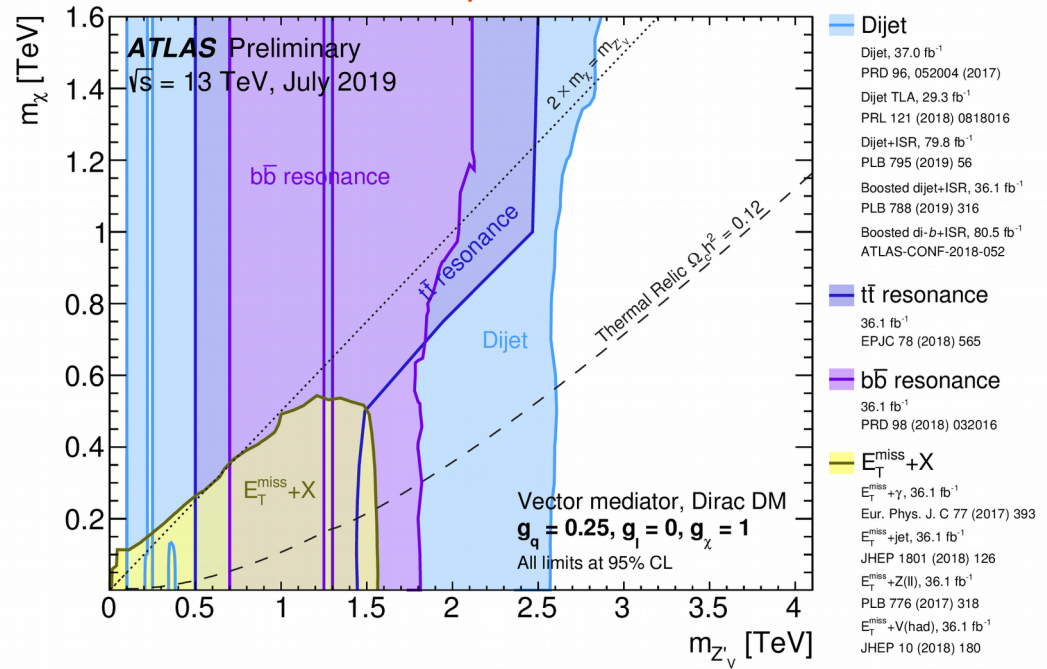
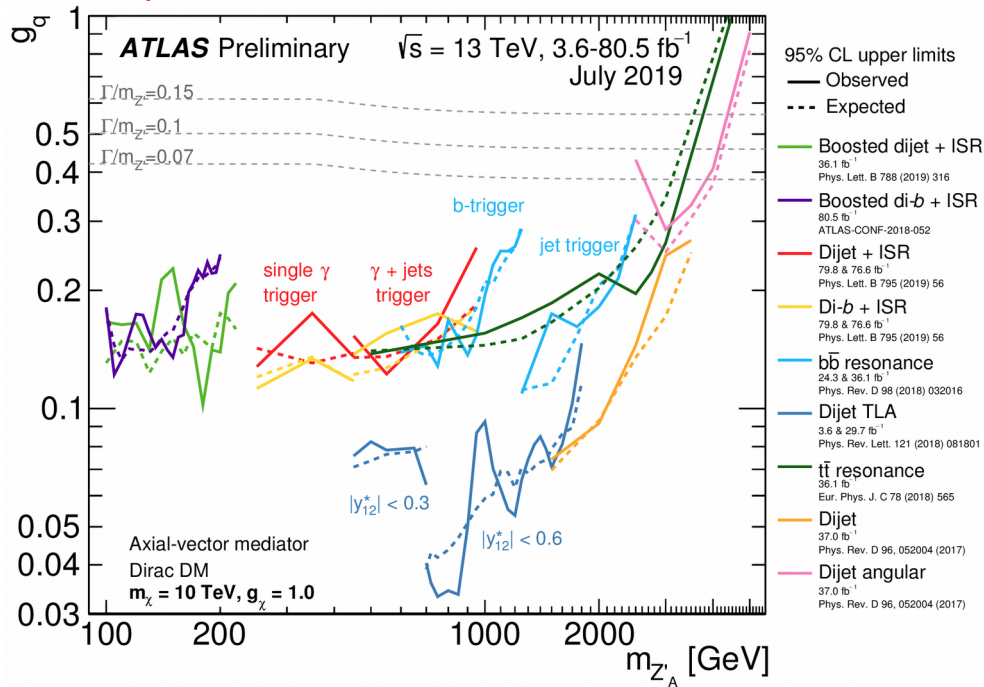
Summary of constraints on typical simplified DM model



- The wide and complementary program of DM searches requires dedicated efforts to summarise and compare the results

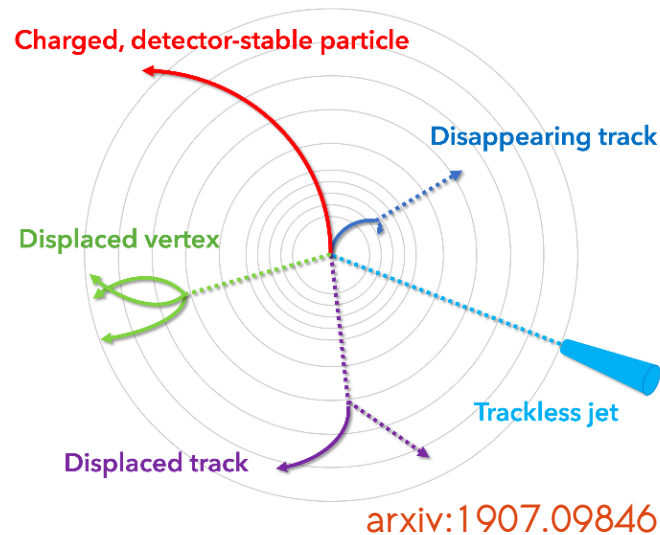
Eric Corrigan, Trine Poulsen, Eva Hansen, Christian Ohm, Caterina Doglioni, Torsten Åkesson, Will Kalderon

<https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/EXOTICS/>



Long-lived Particles

- ATLAS (and CMS) designed mainly for promptly decaying BSM particles
- Long-lived particles (LLPs) can result in various, **tricky** detector signatures:



Review paper of
collider searches
for LLPs:

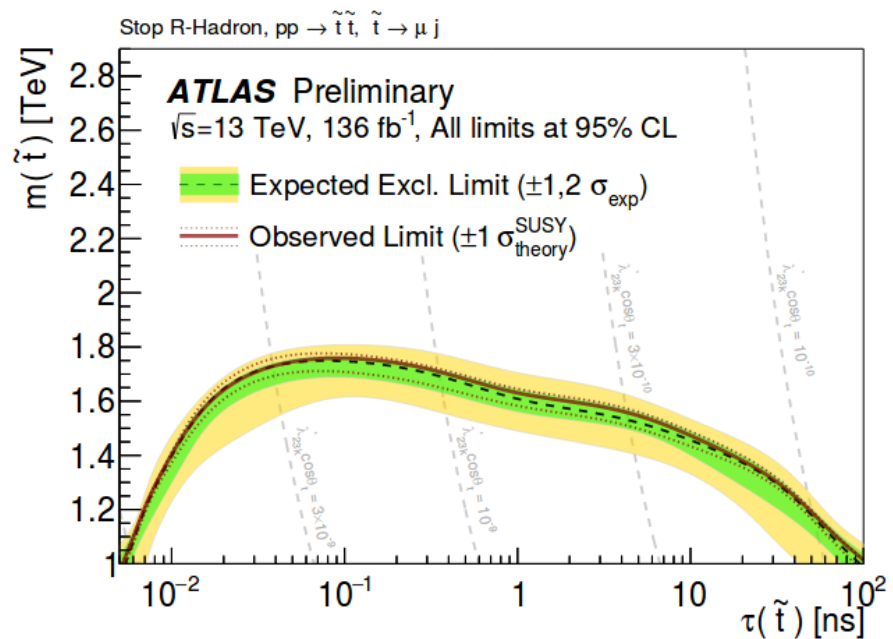
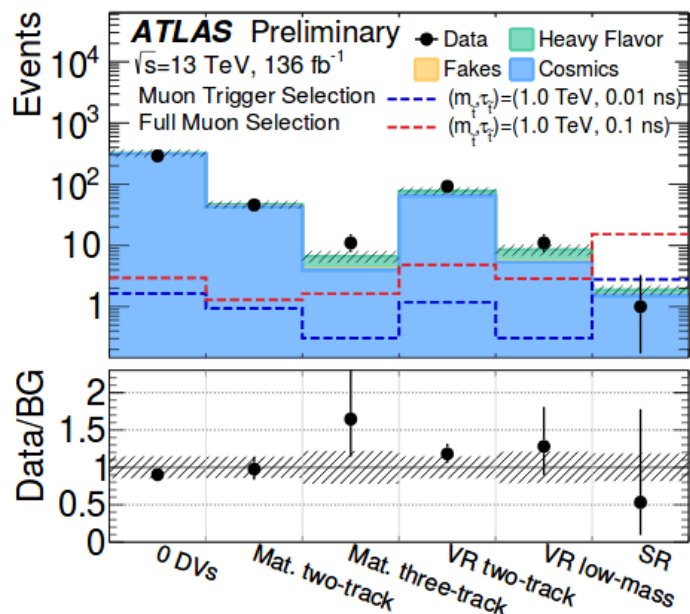
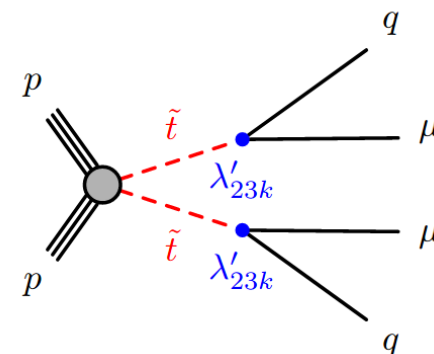
[arxiv:1810.12602](https://arxiv.org/abs/1810.12602)

- Dedicated search strategies needed to identify LLPs with decay lengths of $\gtrsim 1$ mm
 - And to estimate the instrumental (non-physics) backgrounds
- Developments on triggers and reconstruction is ongoing to target LLPs more efficiently in Run3 and beyond

Displaced Vertex + Muon

- Analysis is optimised for pair-produced top squark decaying via R-parity violating coupling to a quark and a muon
- Requires dedicated track and secondary vertex reconstruction
- Analyses of full Run2 data in the making: DV+jet and DV+MET

Christian Ohm, Filip Backman, Rebecca Carney, Giulia Ripelino, David Milstead



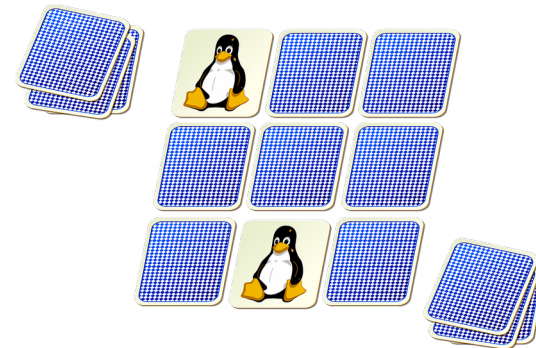
ATLAS-CONF-2019-006

Hardware Track Trigger (HTT)



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- With HL-LHC tracking will be very computationally expensive
- Hardware-based tracking system is being developed for the trigger
- Two hit-filtering algorithms for identifying displaced tracks are studied
 - **Hough transform:**
 - Calculates all combinations of parameters consistent with each data point and casts votes in a histogram-like object
 - **Pattern matching:**
 - MC generated bank of patterns (set of hits)
 - Look for hits that match a pattern



- Both can be implemented on hardware to improve triggering on LLPs
- Described in this (non-ATLAS) paper: [arxiv:1907.09846](https://arxiv.org/abs/1907.09846)

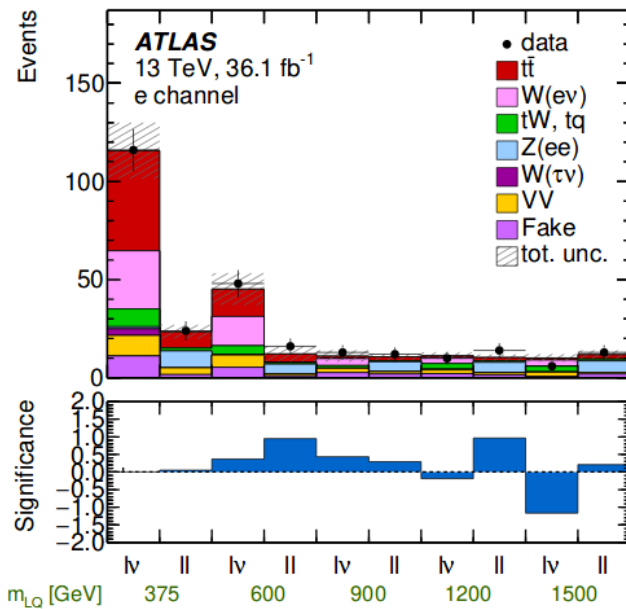
M. Mårtensson, M. Isacson, H. Hahne, R. Gonzalez Suarez and R. Brenner

Leptoquarks

- Leptoquarks appear in many BSM models and can provide explanation for lepton-quark similarities and observed b -flavour anomalies ([arxiv:1412.1791](https://arxiv.org/abs/1412.1791))
- Expected to decay directly into lepton-quark pair

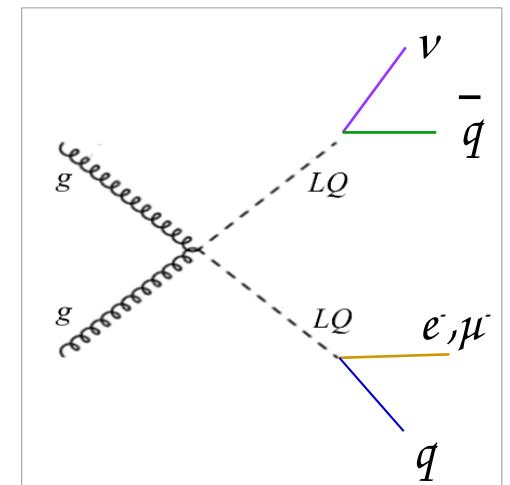
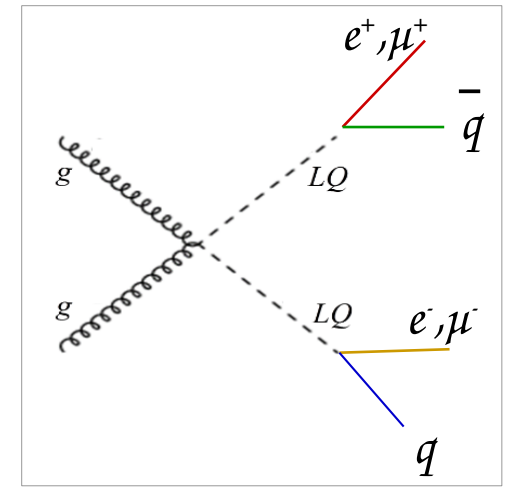
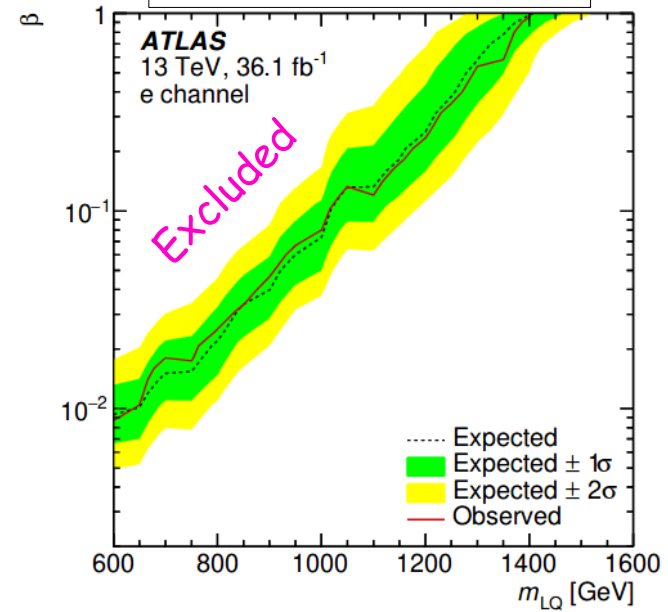
David Milstead, Ruth Pöttgen,

CERN-EP-2018-262



$$\text{BR}(\text{LQ} \rightarrow lq) = \beta$$

$$\text{BR}(\text{LQ} \rightarrow \nu q) = 1 - \beta$$



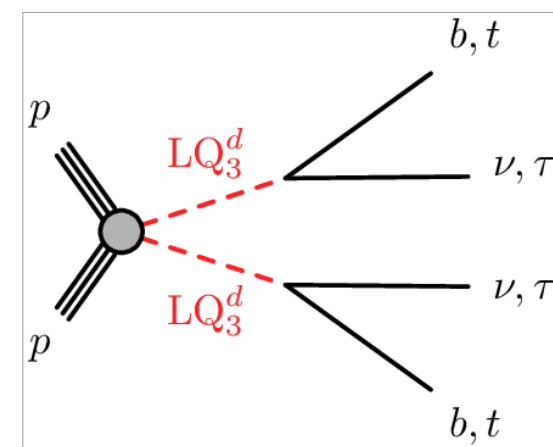
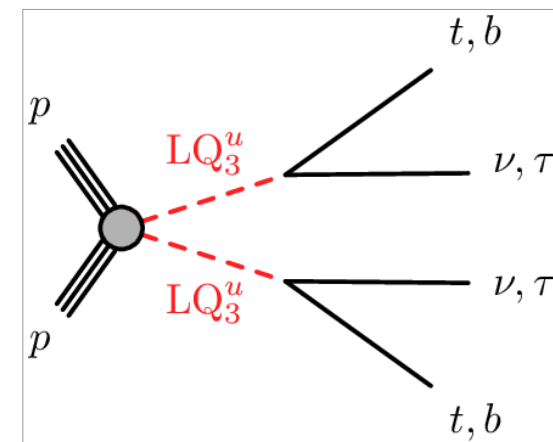
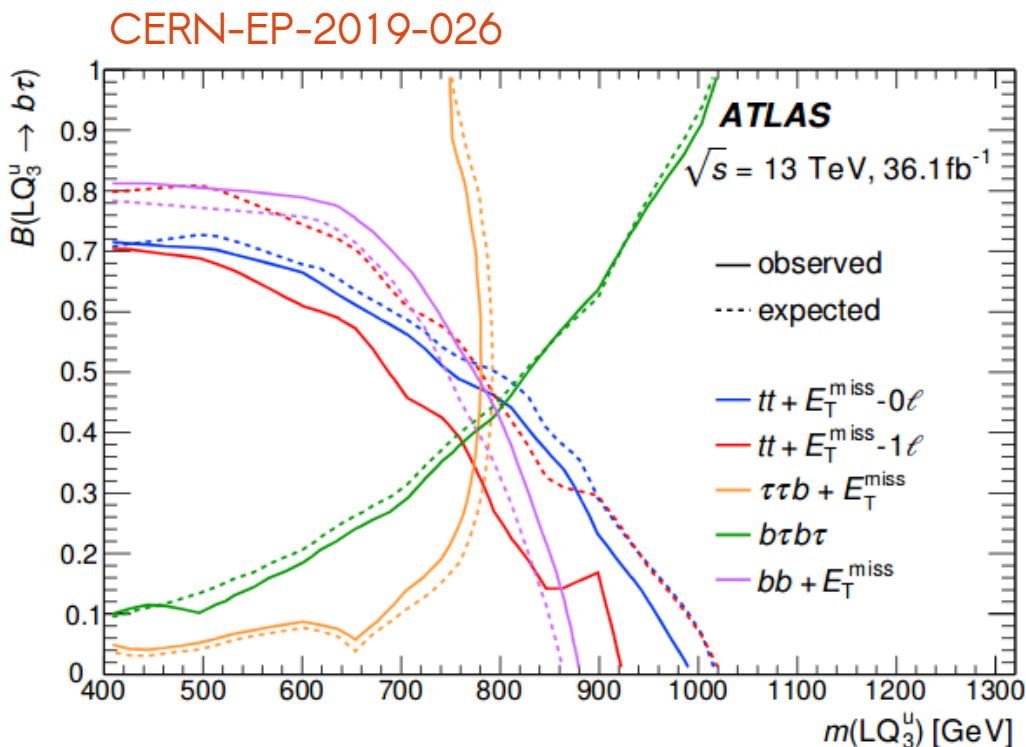


LQ Reinterpretations



- LQs can have similar experimental signatures to SUSY or di-Higgs models
 - Four reinterpretations of existing ATLAS searches performed
 - Focuses on 3rd generation LQs

Mikael Mårtensson, Pedro Sales de Bruin, Ruth Pöttgen, Arnaud Ferrari



Outlook

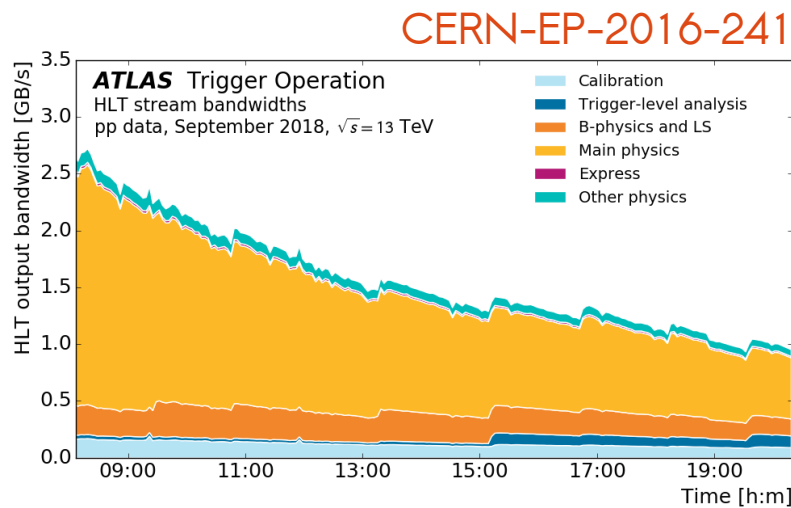
- Lots of Swedish activity in ATLAS BSM searches!
- Ongoing analyses of the full Run2 dataset:
 - Jet resonances, including angular dijet analysis and TLA
 - Expanding scope to "dark sector" searches as well
 - LLPs with displaced vertices: DV+MET and DV+jets
- Higgs- and top-related physics already covered by Mike Nelson and Venugopal Ellajosyula

Backup

Dijet Trigger Level Analysis

- Uses only the information available at the trigger level
- High rates but small event size (< 5% of standard event)
 - Little effect of the total bandwidth
- Requires extra work on validating jet calibration

Eva Hansen, Will Kalderon, Caterina Doglioni,



CERN-EP-2018-033

