A year in A-**TLA**-S update

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(See 3rd slide for A-TLA-S pun, *borrowed from the name of our Mattermost workspace*)

About me

- Completed BSc (Astrophysics) and MPhil (ATLAS, HEP) at the University of Adelaide
- Started PhD at the University of Manchester in Oct 2022 funded by REALDARK (*I am an affiliated student, not funded by SMARTHEP*)
- Current research interests include dark matter mediator searches, non-standard data-taking strategies in HEP, hadronic jet physics

  … and exploring Swiss/French mountains / climbing / cycling (trying [sometimes unsuccessfully] not to crash) in my down time

Pictures at top of slides courtesy of Google Images

Looking for Z' dark matter mediators with ATLAS

(1) Motivation: we can *"see"* 5% of the Universe, the remaining 25-26% is *dark matter (DM)* which interacts very weakly (primarily gravitationally – cf. astronomical observations)

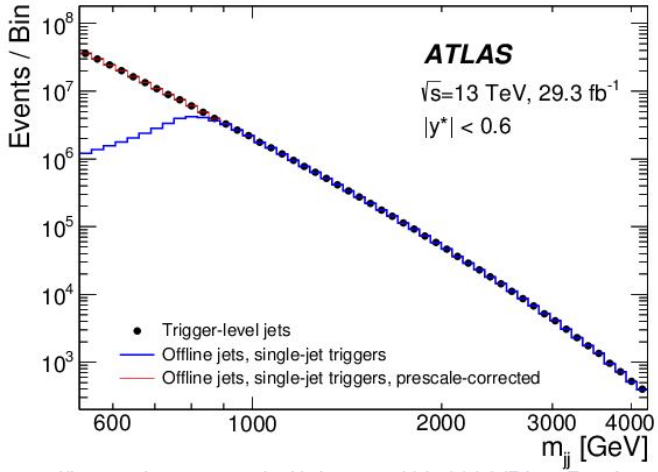
(2) Goal: find a new particle (mediator) that interacts with dark matter acting as a *portal* between a "*dark sector*" and the Standard Model → **if discovered, we can study (<u>some of</u>) its properties at the LHC**

(3) Problem: reaching uncovered parameter space ***for dijet resonance searches***? i.e low interaction strengths (couplings) and low masses → **normal data-taking strategies reject low-mass events to cope with LHC 40 MHz data rate or require a huge dataset (low couplings)**

Enter **T**rigger-**L**evel **A**nalysis (TLA)...

- Save **<u>only</u>** information reconstructed in the ATLAS High-Level (Software) Trigger (HLT)
- Small event size == we can afford ***<u>much</u>*** higher rate triggers (selections/filtering) for data collection i.e. within "data bandwidth" constraints

[early] Run 2 dijet TLA:



From https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.121.081801

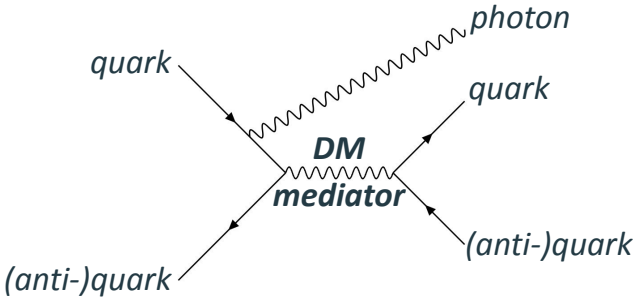
Expanding on Z' DM mediator searches in Run 3

Another way to reach lower masses resonances: **trigger on an *initial state photon***, allowing lower jet pT thresholds

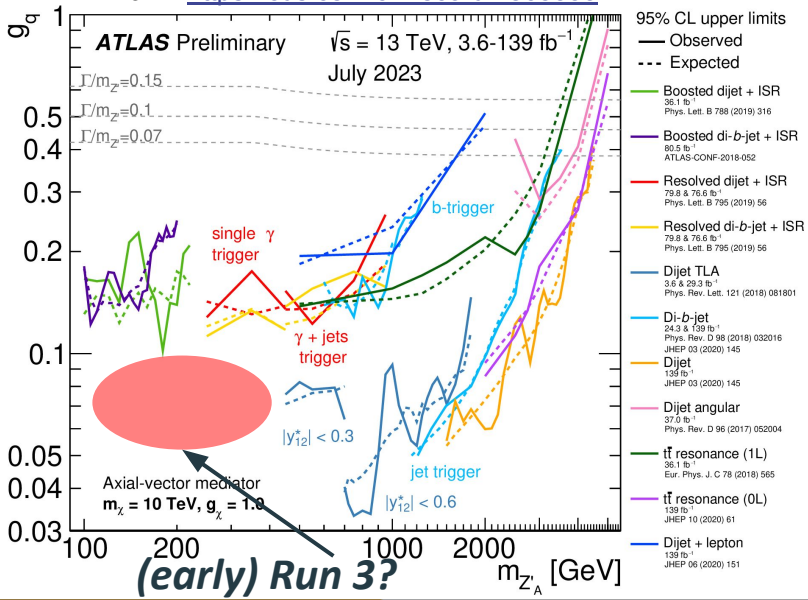
Combined initial-state radiation (ISR) signature with TLA to target low Z'-SM couplings and search for ***electroweak scale resonances***

The big challenge (*for any TLA*): physics object (jet, photon, etc.) performance must be exceptional & objects should be well calibrated to avoid introducing *fake bumps* in the di-jet m(jj) [invariant mass] distribution (i.e. a fake signal)

For Run 3, we need to be able to use jets with pT as low as 25 GeV in our search…



From : https://cds.cern.ch/record/2865335



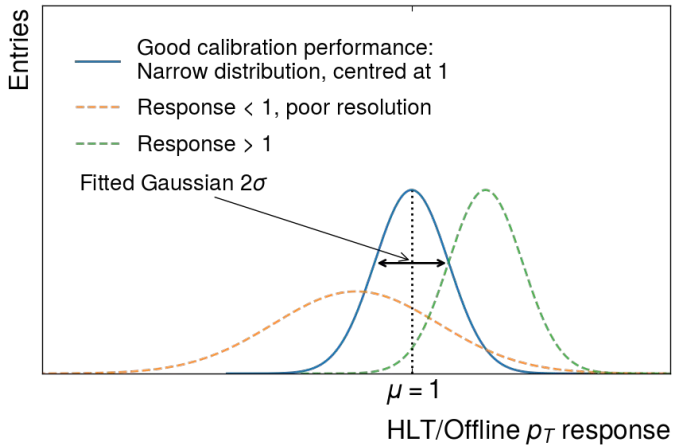
(early) Run 3?

Studying jet calibration performance

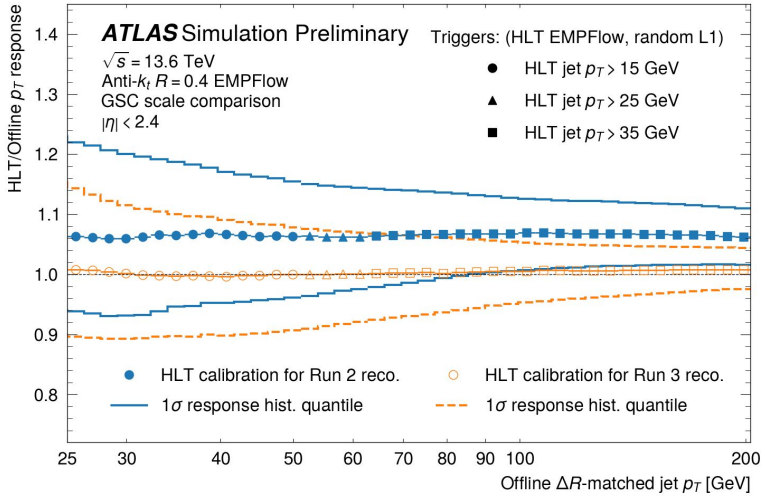
How well does the calibrated 4-momentum of HLT jets compare to jets reconstructed from raw detector data offline (“offline jets”)?

Look at the **HLT/Offline jet pT response**…

1. Geometrically match HLT and “offline” jets
2. Calculate pT ratios of HLT to offline & extract mean of Gaussian fit
3. Plot…



Fully-calibrated jets in simulation (see CHEP2023)



HLT jet calibration updated to the newest correction used for offline jets in 2023 to fix offset seen in HLT/Offline jet pT response

Further improvements expected with dedicated calibration derived for HLT jets

Plots also available at https://twiki.cern.ch/twiki/bin/view/AtlasPublic/JetTriggerPublicResults

Summary & next steps

- Lots of work done so far to understand the calibration state of 2022 and 2023 HLT jets – further improvements possible with (1) new calibrations derived specifically for HLT jets, (2) new techniques (e.g. ML) for jet calibration
- Work is ramping up on the *Dijet+ISR Trigger-Level Analysis*
  - My focus will be on:
    - Data-driven corrections for the jet energy scale
    - Understanding analysis selection & trigger performance in terms of analysis sensitivity i.e. *how low in m(jj) can we search for new resonances?*
  - Also helping with coordination of the analysis as one of the “analysis contacts”