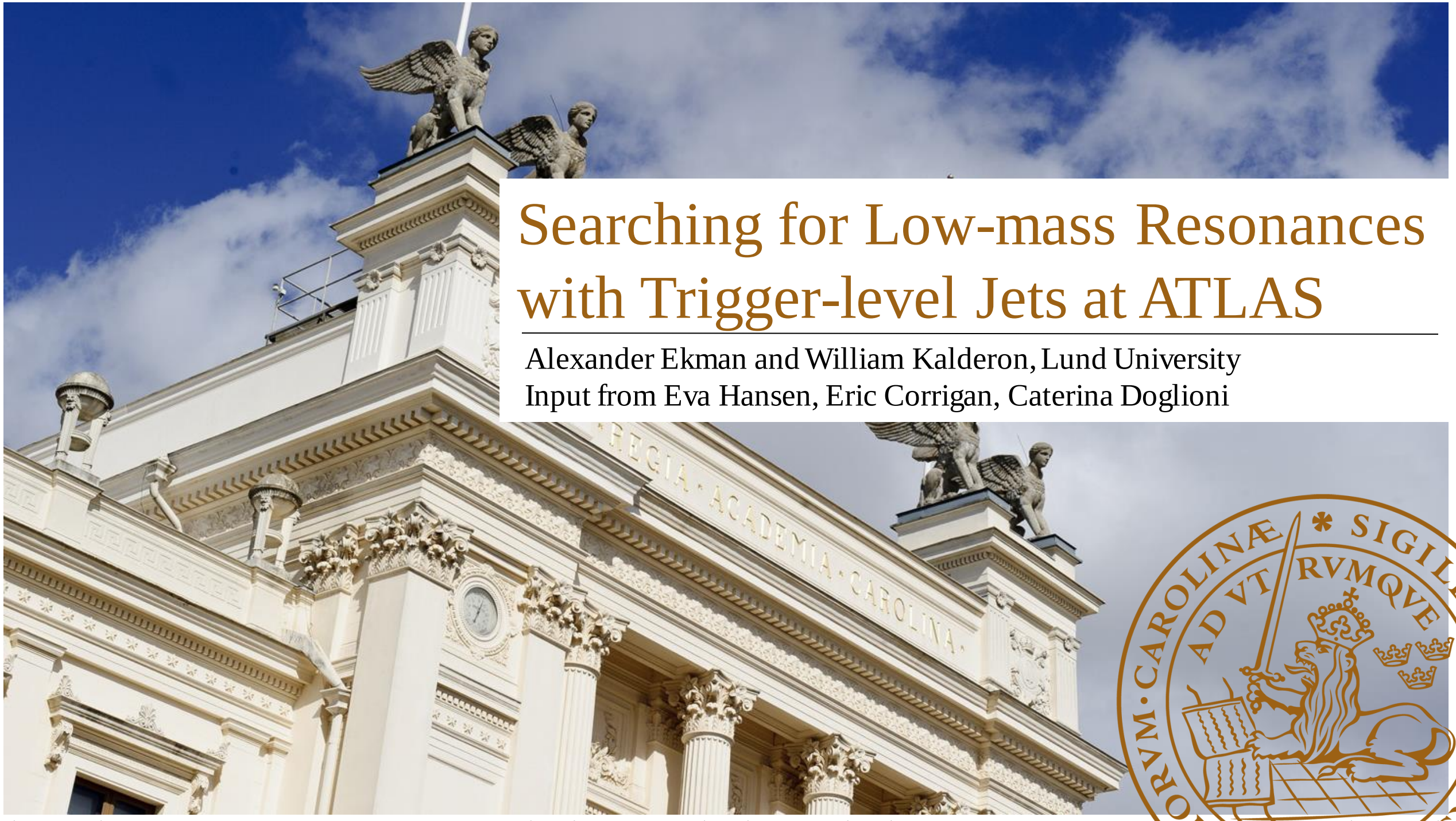


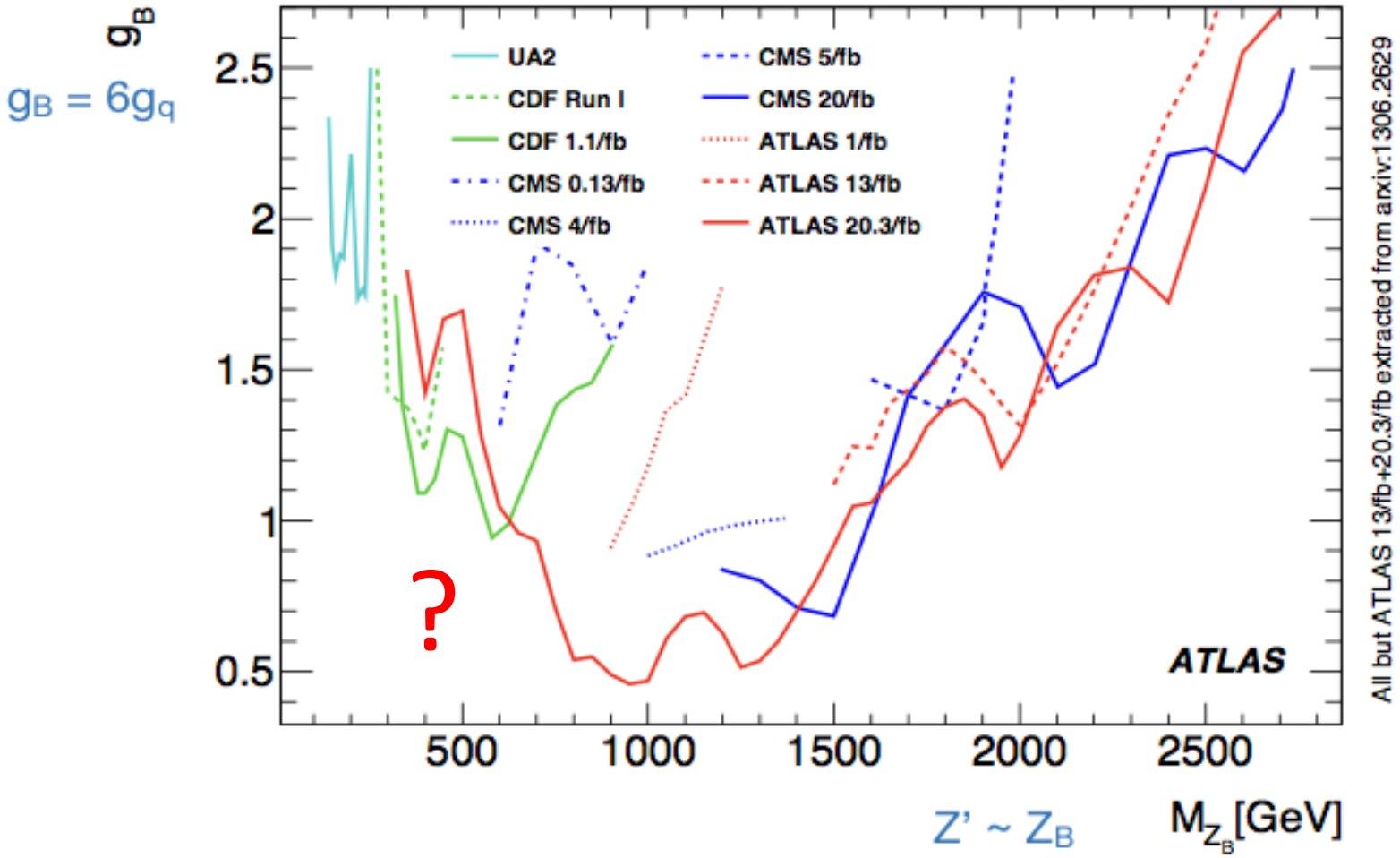

# Searching for Low-mass Resonances with Trigger-level Jets at ATLAS

Alexander Ekman and William Kalderon, Lund University
Input from Eva Hansen, Eric Corrigan, Caterina Doglioni

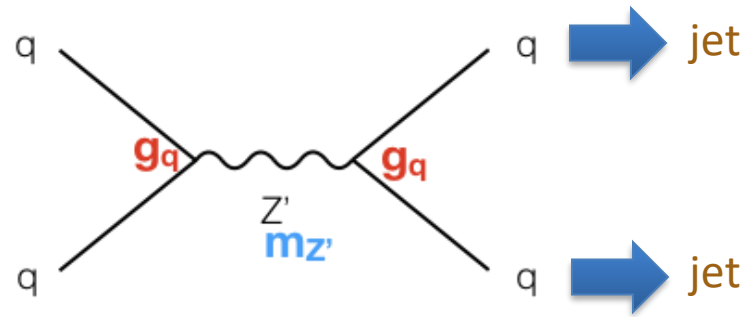
# Outline

1. What is Trigger-object Level Analysis (TLA)
2. Results from 2016
3. Jet Calibration and future plans for TLA

# Constraints on New Resonances, End of LHC Run-1




At the end of LHC Run-1, parameter space for resonances decaying to jets below 1 TeV was still unexplored by ATLAS




[1] Phys. Rev. D. 91, 052007 (2015)

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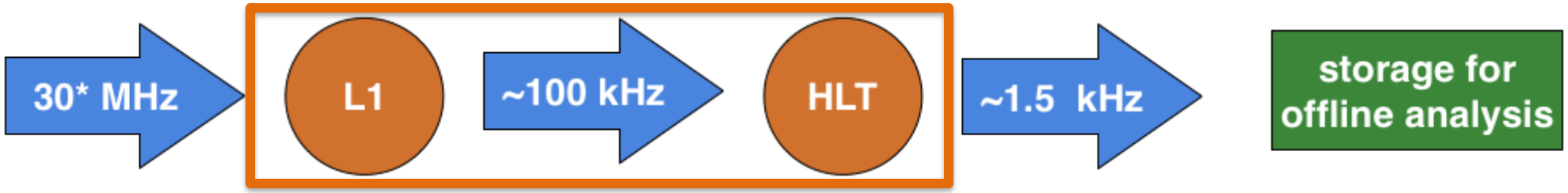
# ATLAS Trigger and Low-mass Resonances




Reason for this unexplored region:

- Signal and background events have very similar characteristics
- Background (QCD) very high rate and cannot be recorded in its entirety
  - » Most events discarded by the ATLAS ***trigger system***
- Signal is discarded as well!

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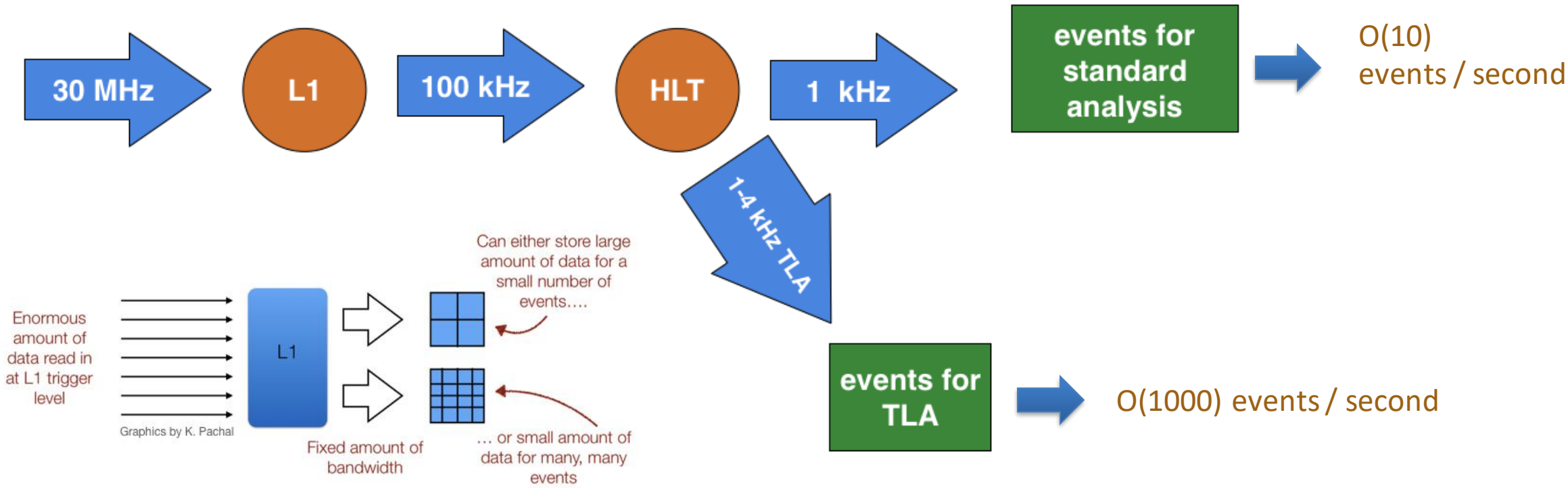
# Solution: Trigger-object Level Analysis (TLA)




- Instead of discarding the events, keep only the objects used for making the decision (0.5% of full size) and use for them analysis
- LHCb: Turbo Stream, CMS: Data Scouting

[2] Comput. Phys. Commun. **208** (2016) 35, [3] Phys. Lett. B **769** (2017) 520

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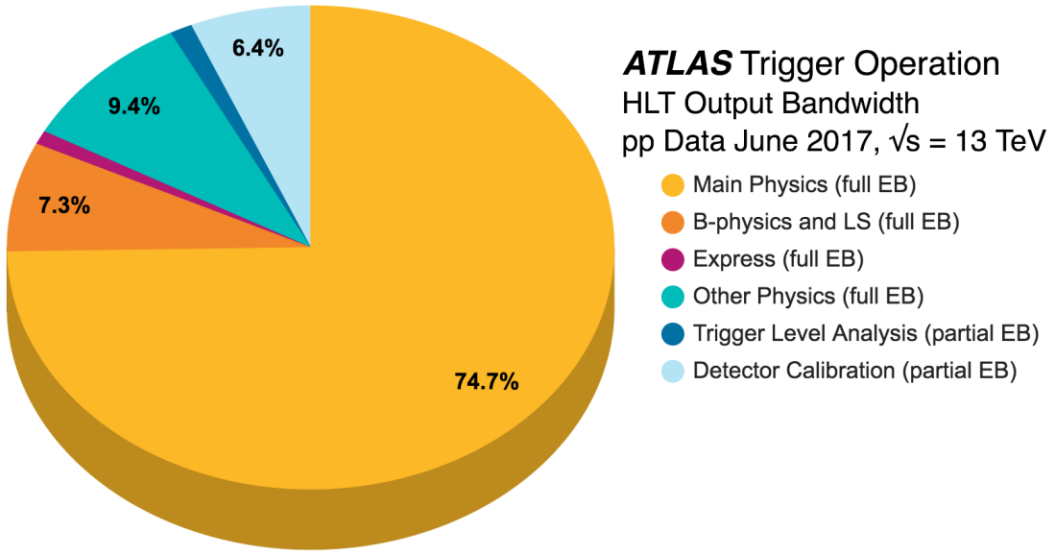
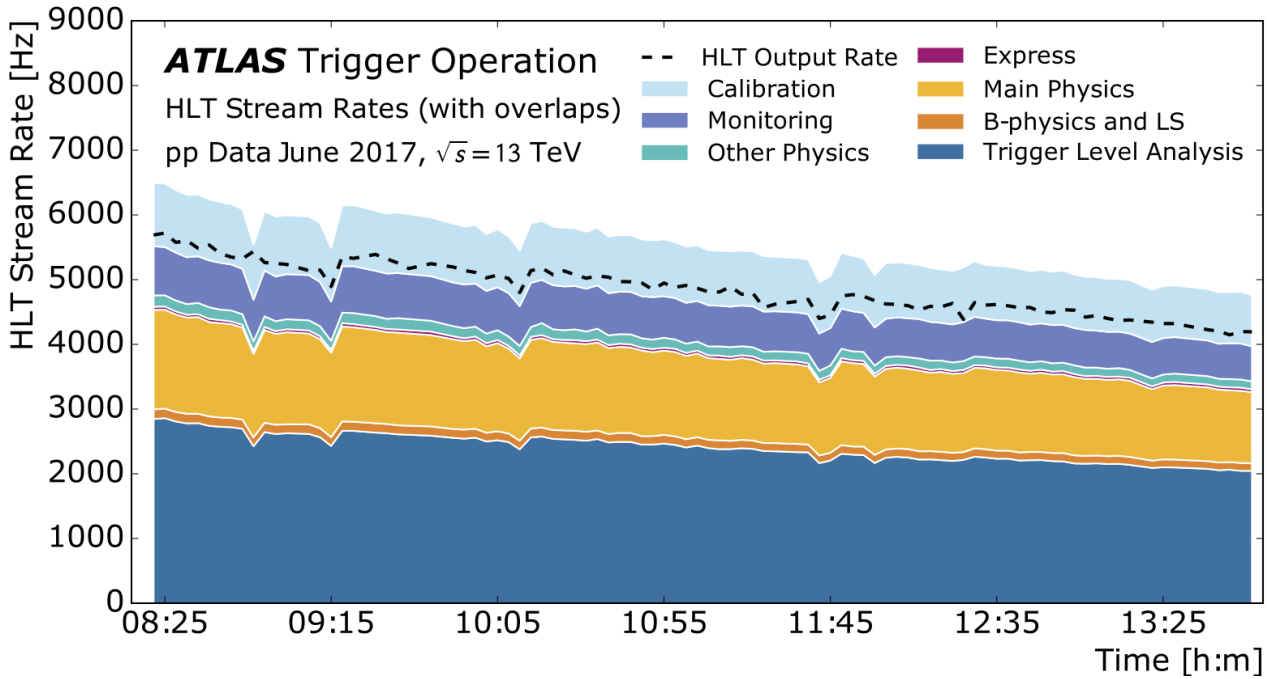
# Trigger-object Level Analysis (TLA): Rates

Event size reduced to <1% of fully recorded event

Rates of TLA data recorded are larger than rates for all other ATLAS analyses combined




[4] https://twiki.cern.ch/twiki/bin/view/AtlasPublic/TriggerOperationPublicResults#2017_pp_at_13_TeV

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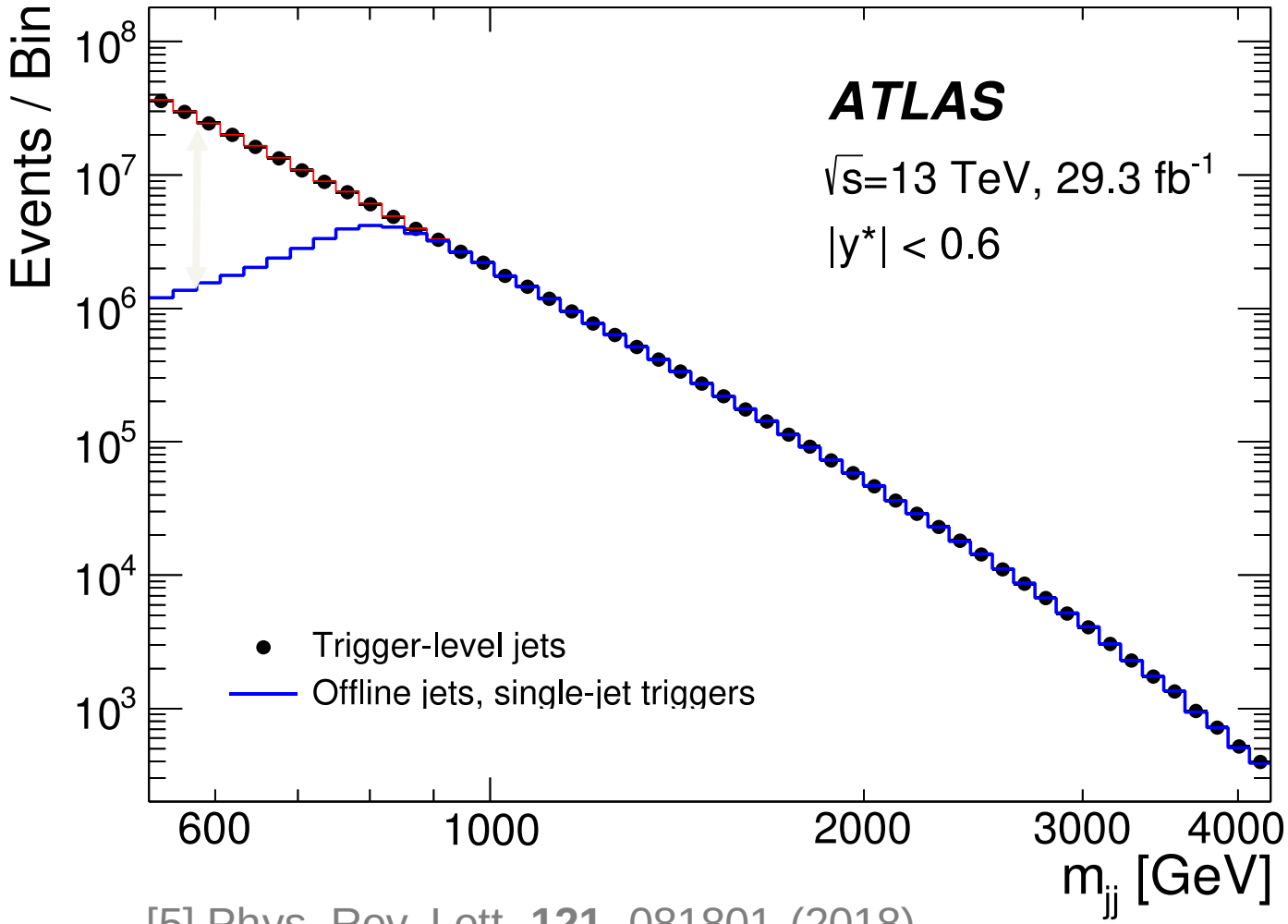
# TLA: Results

**Increase in number of events**
recorded with TLA
compared to **traditional techniques**




[5] Phys. Rev. Lett. **121**, 081801 (2018)

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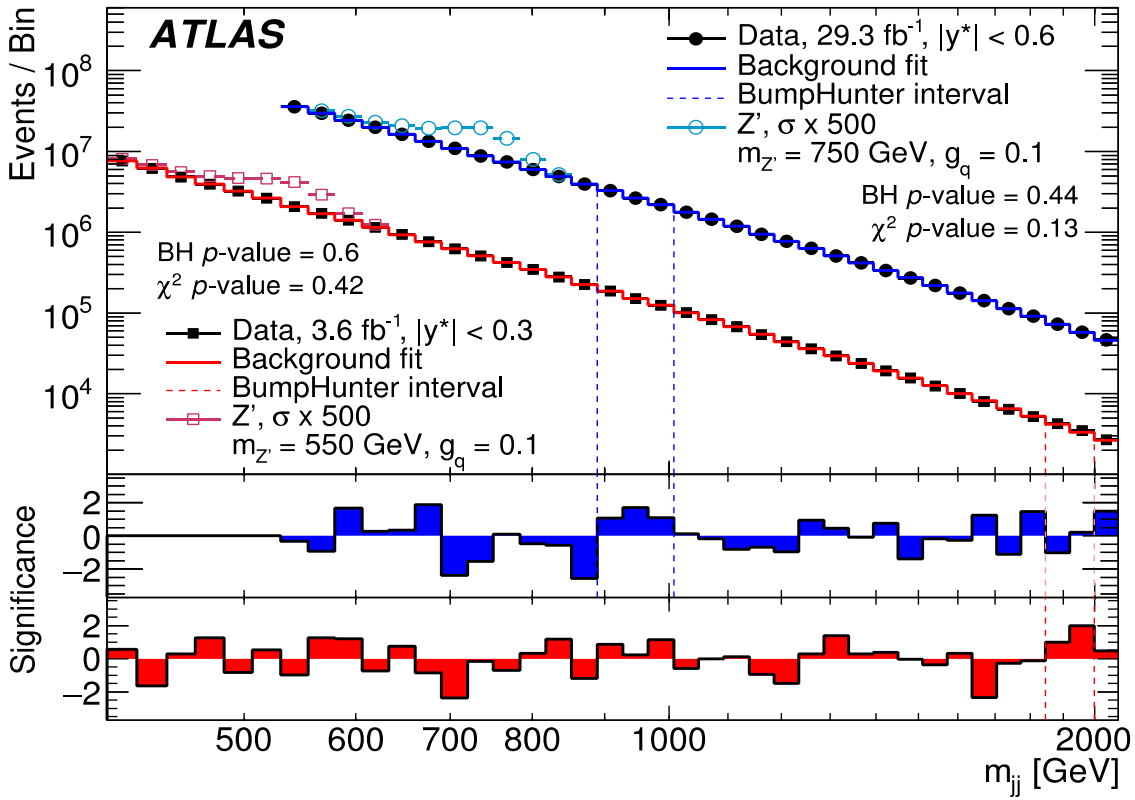
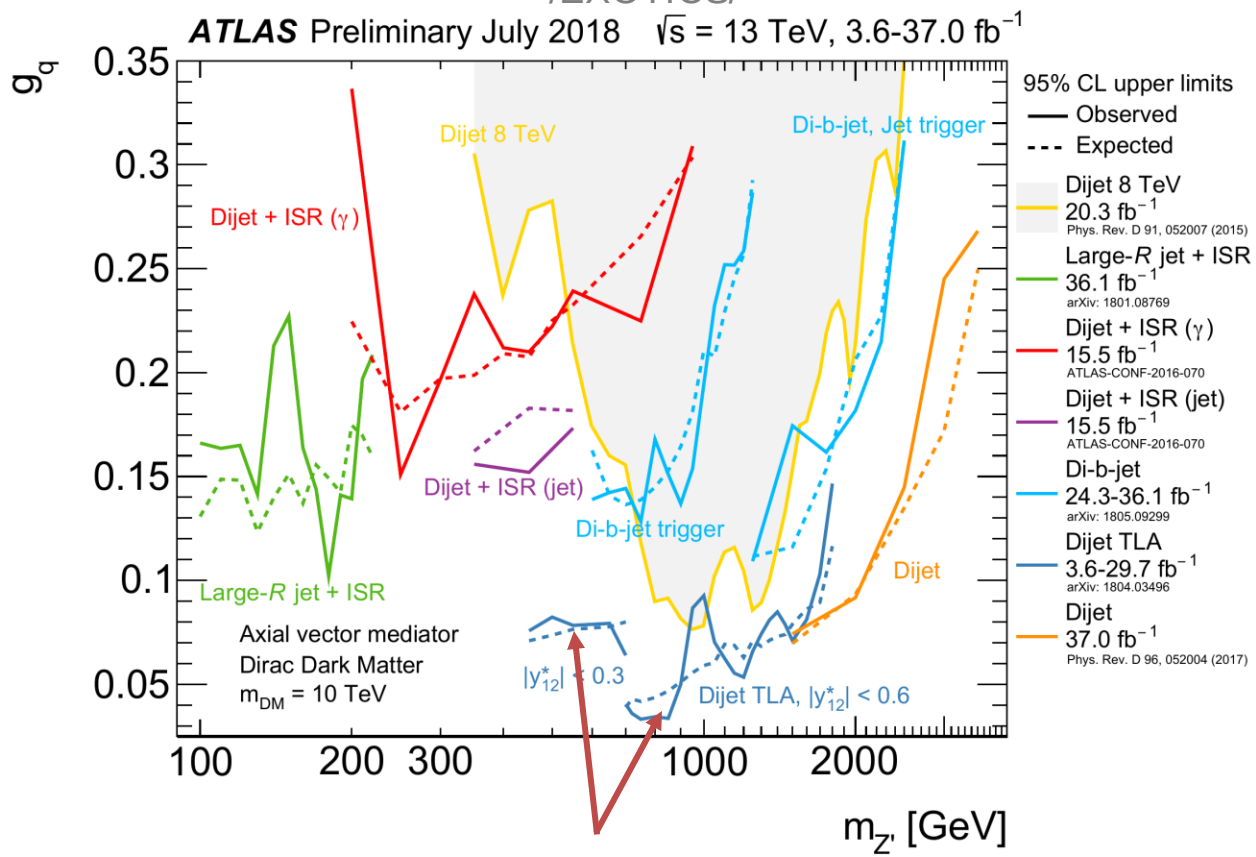
# TLA: Results

[5] Phys. Rev. Lett. **121**, 081801 (2018)




[6] https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/EXOTICS/




No signs of excesses in 2016 dataset

→

Set constraints on models of dark matter mediators

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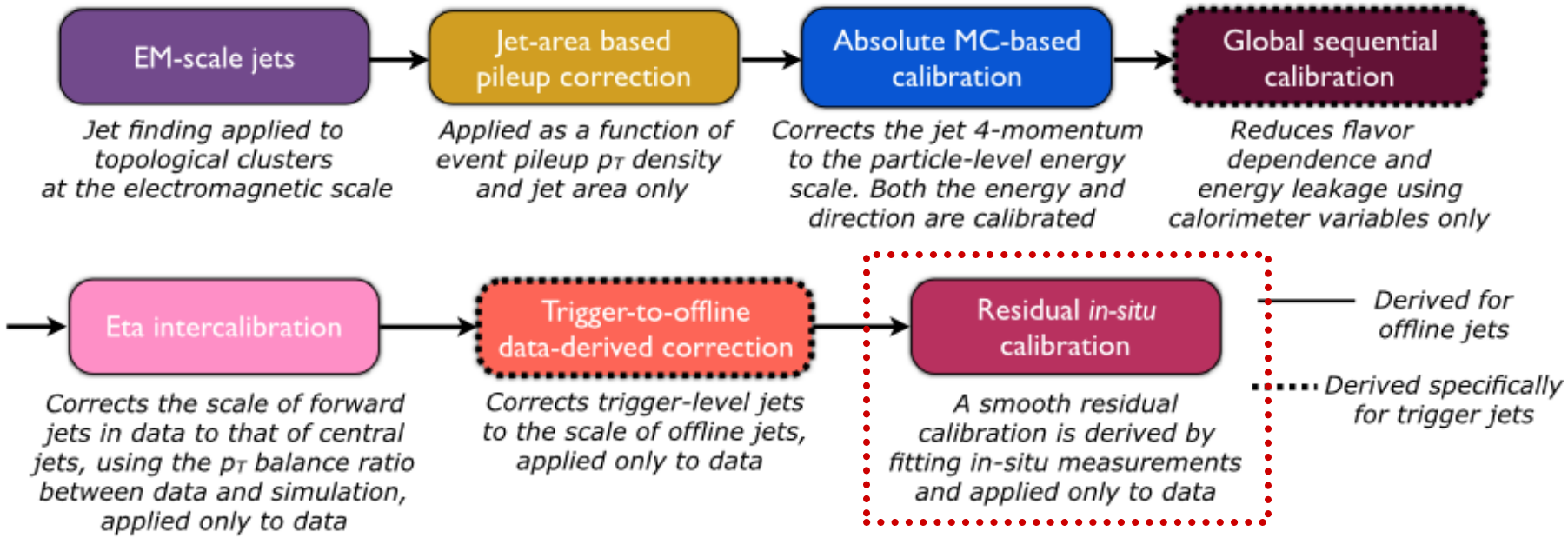
# Jet Calibration: Crucial for this Analysis

- The calibration is a chain of steps, each applying a different correction/calibration
- Example: final in-situ calibration derives calibration factors by balancing jets and better calibrated objects (e.g. photons, Z bosons)
  - Note: this step has less statistical precision than the TLA dataset




[5] Phys. Rev. Lett. **121**, 081801 (2018)

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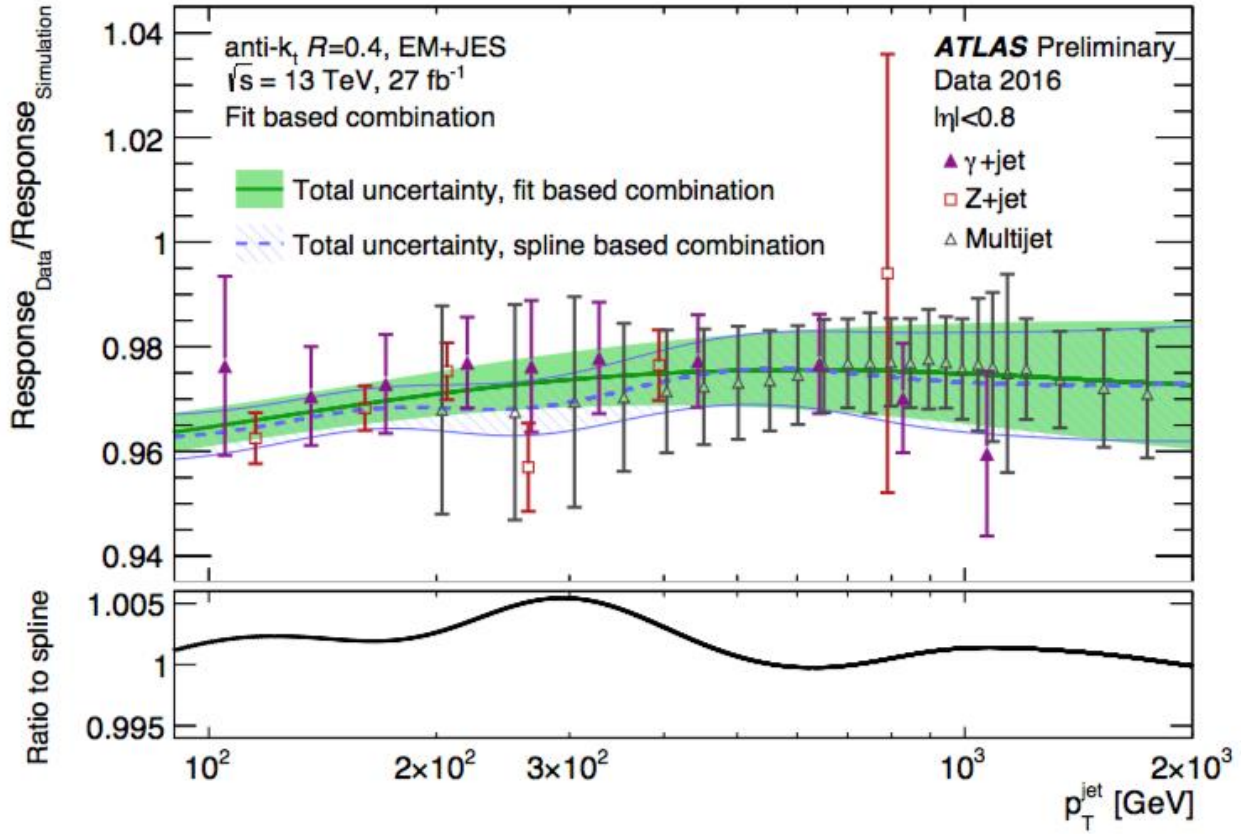
# Challenges of Analysis With Very High Statistics

- Background estimation relies on the fact that QCD is **smoothly falling** so we can use a fit
- Case of in-situ step:
  - Any features from calibration due to limited statistical precision can create “bumps” that are signal-like
  - Necessary to use calibration techniques that keeps the calibration **smooth**




[5] Phys. Rev. Lett. **121**, 081801 (2018)

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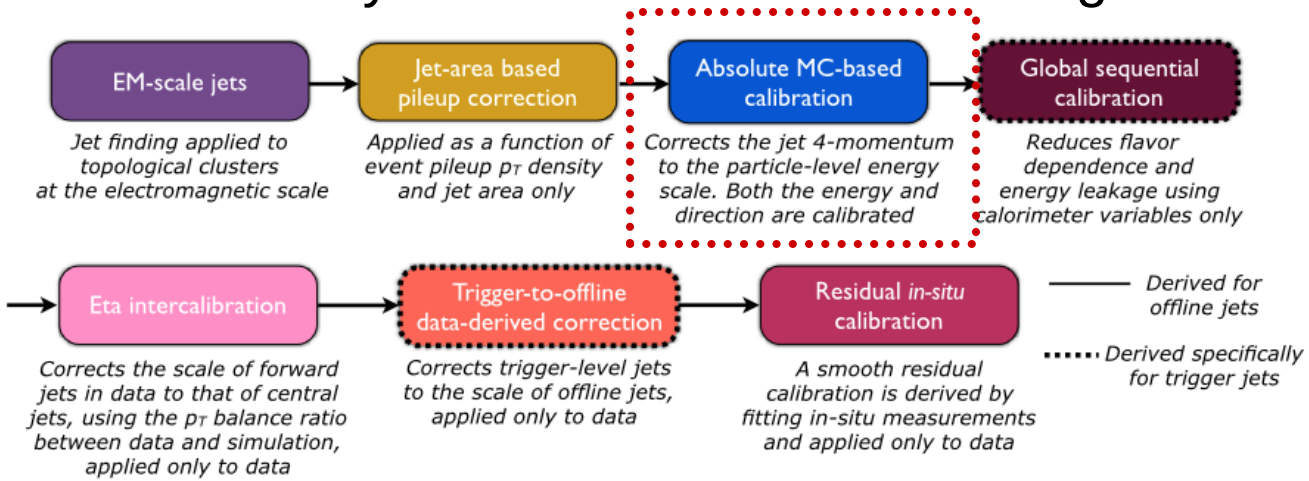
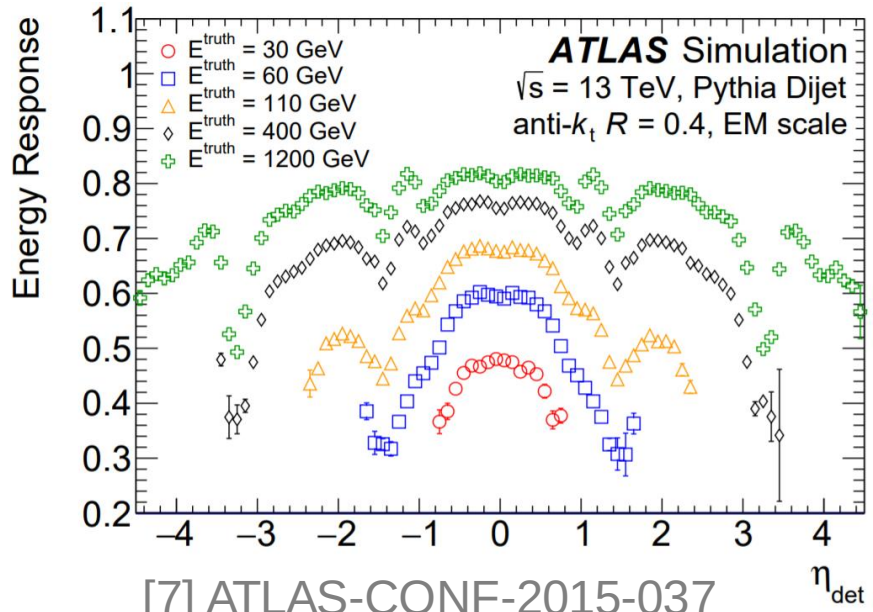
# My Work for the 2018 Analysis: Jet Calibration

- Master's thesis with the ATLAS group
- I am working on the "Absolute MC-based Calibration" step
  - This step determines the calibration factors needed to bring reconstructed jets to the particle level energy scale
  - My work will be about showing that it is **smooth in pT**




[5] Phys. Rev. Lett. **121**, 081801 (2018)




[7] ATLAS-CONF-2015-037

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# Summary and outlook

- Trigger-object Level Analysis technique is very effective to search for low-mass resonances that would otherwise not be reachable
- Results with 2016 LHC dataset show no excesses -> strongest constraints on certain kinds of dark matter mediators
- Preparing for analysis with 3x more data (full Run-2)

# References


- [1] ATLAS Collaboration, Search for new phenomena in the dijet mass distribution using pp collision data at √s= 8 TeV with the ATLAS detector, Phys. Rev. D **91**, 052007
- [2] LHCb Collaboration, *Tesla : an application for real-time data analysis in High Energy Physics*, Comput. Phys. Commun. **208** (2016) 35, arXiv: 1604.05596 [physics.ins-det].
- [3] CMS Collaboration, *Search for dijet resonances in proton–proton collisions at √s* = 13 *TeV and constraints on dark matter and other models*, Phys. Lett. B **769** (2017) 520, arXiv: 1611.03568 [hep-ex].
- [4] https://twiki.cern.ch/twiki/bin/view/AtlasPublic/TriggerOperationPublicResults#2017_pp_at_13_TeV
- [5] ATLAS Collaboration, *Search for low-mass dijet resonances using trigger-level jets with the ATLAS detector in pp collisions at √s = 13 TeV*, Phys. Rev. Lett. **121**, 081801 (2018), arXiv:1804.03496 [hep-ex].
- [6] https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/EXOTICS/
- [7] ATLAS Collaboration, Monte Carlo Calibration and Combination of In-situ Measurements of Jet Energy Scale, Jet Energy Resolution and Jet Mass in ATLAS, ATLAS-CONF-2015-037, 2015


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