ATLAS Fast Physics Monitoring: *TADA*

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Abstract

The ATLAS Experiment at the LHC is recording data from proton-proton collisions with 13 TeV center-of-mass energy since spring 2015.
The collaboration is using a fast physics monitoring framework (TADA) to automatically perform a broad range of fast searches for early signs of new physics and to monitor the data quality across the year with the full analysis level calibrations applied to the rapidly growing data.

TADA is designed to provide fast feedback directly after the collected data has been fully calibrated and processed at the Tier-0 [1], the CERN Data Center. The system can monitor a large range of physics channels, offline data quality and physics performance quantities nearly final analysis level object calibrations.

TADA output is available on a website accessible by the whole collaboration that gets updated twice a day with the data from newly processed runs. Hints of potentially interesting physics signals or performance issues identified in this way are reported to be followed up by physics or combined performance groups.

The poster reports as well about the technical aspects of TADA: the software structure to obtain the input TAG files, the framework workflow and structure, the webpage and its implementation.

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References

[1] D. Adams et al., "The ATLAS Computing Model", ATL-SOFT-2004-007, CERN

[2] A. Valassi et al., 2011 LCG Persistency Framework (CORAL, COOL, POOL): Status and Outlook,*J. Phys. Conf. Ser.* 331 042043

[3] Albrand S, Doherty T, Fulachier J and Lambert F 2008 "The ATLAS METADATA INTERFACE" *J. Phys.: Conf. Ser.* 119 072003

Introduction

- TADA is the ATLAS Fast Physics Monitoring System
- It runs at the Tier-0, as part of the prompt data processing after the calibration loop
- Its task is to look for early signs of new physics in the data
- It allows to monitor the quality of the data after full detector and analysis level calibrations have been applied

Data format

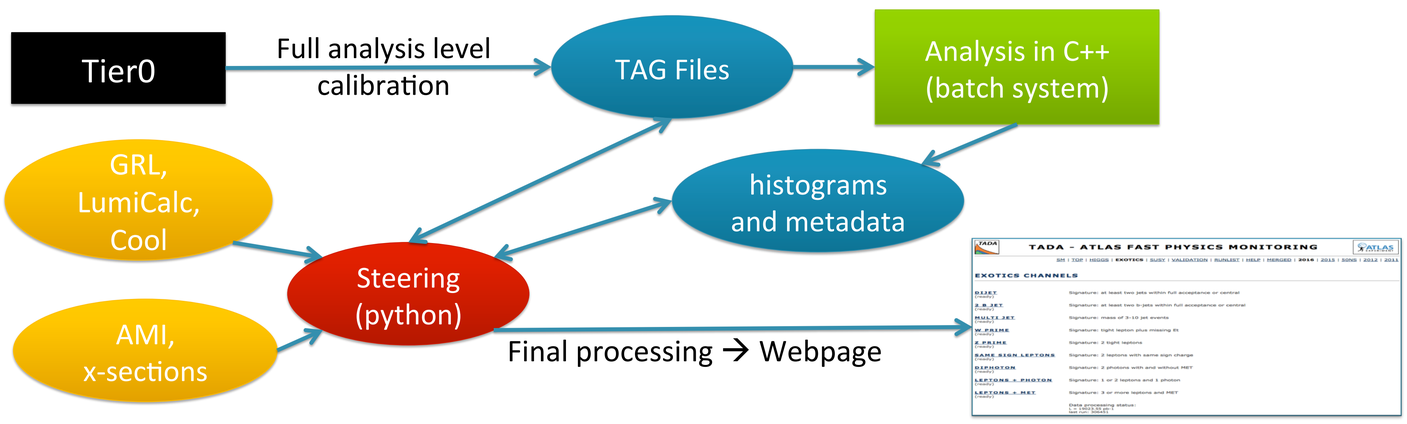
- Ntuples (so called TAG files) are produced centrally at Tier-0 as part of prompt production chain
- Very condensed event information:
  - Leading (4) e, (4) μ, (2) τ, (2) γ, (6) jets, missing transverse energy (MET) info, trigger counters, global event info, etc.
- For each object we store:
  - Kinematics
  - Bit-encoded info on particle identification, quality, isolation, etc.

Fast search for new physics

- TADA can monitor channels from a broad spectrum of physics channels, including standard model, top, Higgs, exotics and SUSY searches
- Distributions for different channels, like invariant mass of ee and di-jet events are displayed on the webpage (Figure 5+6)
- TADA is as well used to spot interesting events, e.g. 8.8 TeV di-jet events in 2015 as shown in Figure 7

TADA Workflow

- The TAG based monitoring is using a hybrid software approach
  - Ntuple processing is done in C++
  - Python is used for job steering, metadata handling, bookkeeping, and web page generation



- The diagram 1 shows a schematic of the data flow for TADA:
  - TADA runs after the calibration loop (at Tier-0) and after the first pass processing.
  - The system uses the full analysis level calibrations :
    - ✓ Excellent data quality in a 'quasi' online framework!
  - TADA uses:
    - ✓ X-sections and the data luminosity is used to normalize the Monte Carlo
    - ✓ Data is compared to Monte Carlo after pileup reweighting
    - ✓ Good Run List (GRL), ATLAS Luminosity Calculation tool (LumiCalc), Cool[2] for trigger pre-scales
    - ✓ Atlas Metadata Interface [3](AMI) to get metadata on runs and files
  - TADA batch system processes TAG files from new runs to produce histograms and metadata files
  - TADA final pass processing creates plots, cut flows, event dumps and updates webpages with all results.

Analysis level data quality monitoring

- TADA monitors a lot of physics/trigger/detector performance aspects in different channels involving jets, photons, W, Z, tops, missing energy, …
- Jet energy calibration:
  - γ-jet back-to-back events are a standard handle on access jet energy calibration
  - A selection of γ-jet events is implemented in TADA to monitor the p_T balance defined as $p_T^{jet}/(p_T^{\gamma}\cos(\Delta\phi))$
  - The mean of the p_T balance distibution vs p_T^{γ} and data taking run are shown in Figures 1+2
- Monitoring of the stability of the physics performance across the data taking period:
  - Mean of Z→μμ mass vs run number is sensitive to mis-alignment effects (Figure 3)
  - Yield of leptonic top pair events normalized to luminosity vs run is shown in Figure 4, for the channel e+μ+(b)jets+missing energy

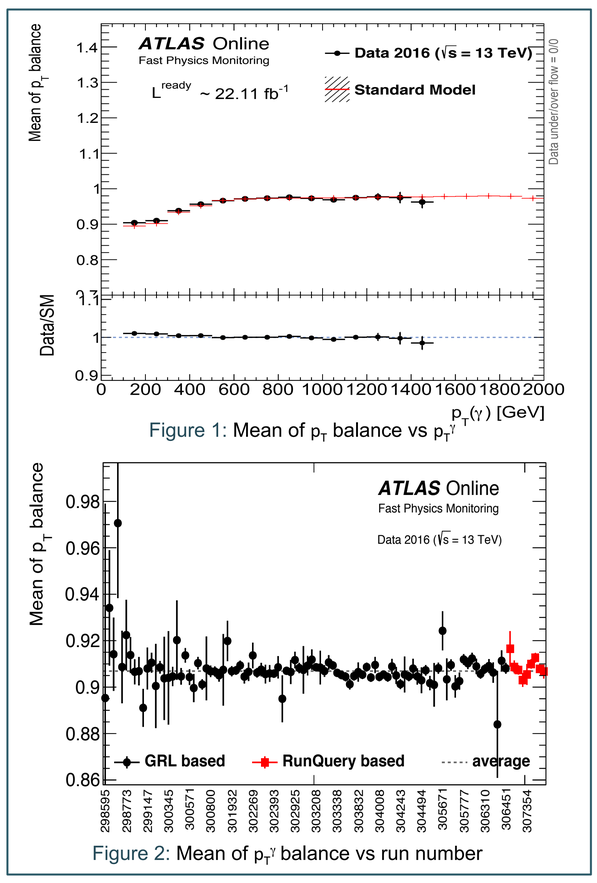


Figure 1: Mean of p_T balance vs p_T^{γ}

Figure 2: Mean of p_T^{γ} balance vs run number

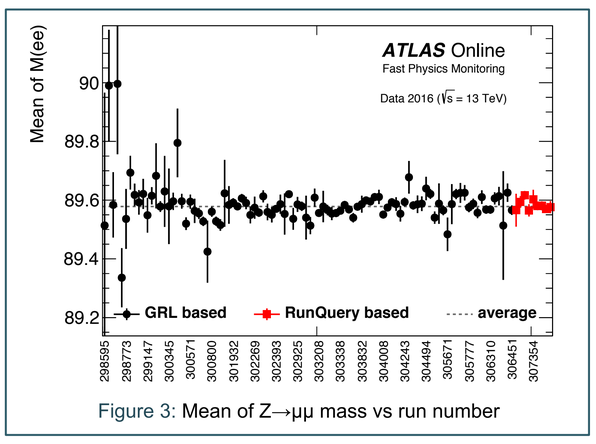


Figure 3: Mean of Z→μμ mass vs run number

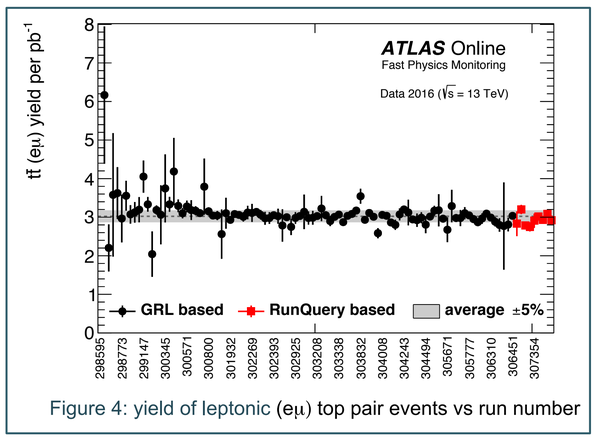


Figure 4: yield of leptonic (eμ) top pair events vs run number

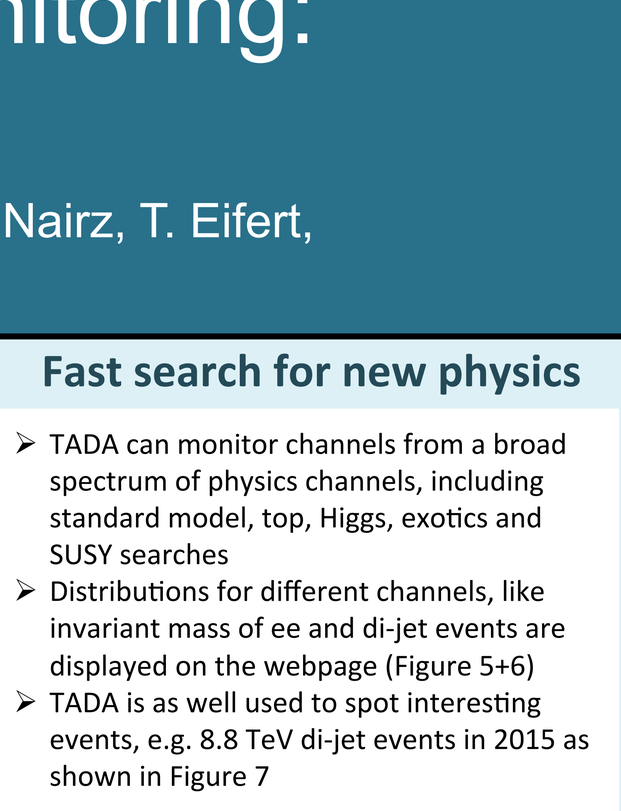


Figure 5: ee invariant mass

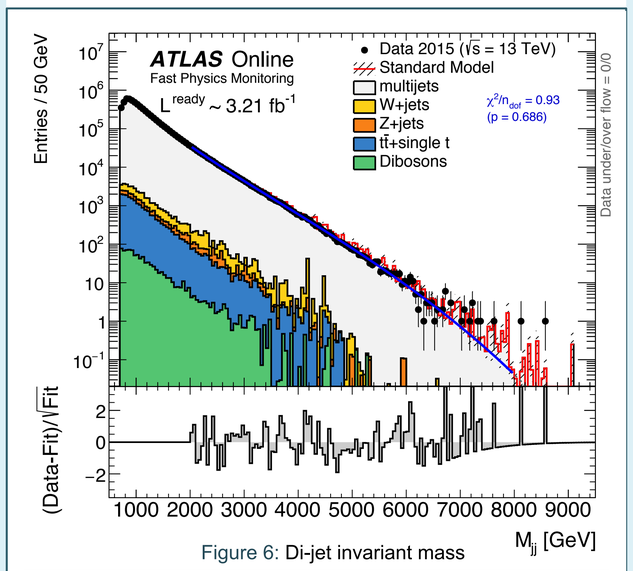


Figure 6: Di-jet invariant mass

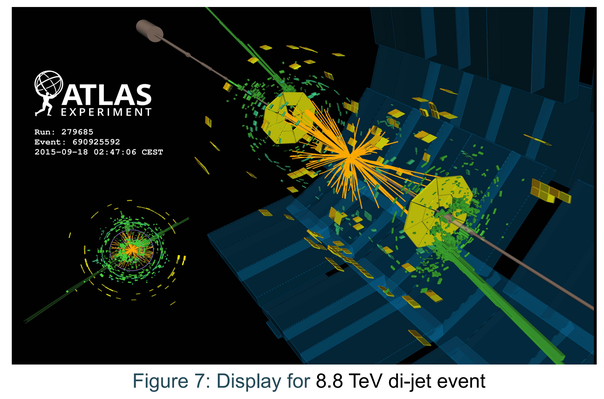


Figure 7: Display for 8.8 TeV di-jet event

Webpage

- Webpage provides results for 2015 and 2016 data, as well as their combination
- Several categories of physics channel and validation pages:
  - 322 different selections are applied to fill order of 2k histograms
  - Updated twice a day
- Each channel provides:
  - Main selections, plots grouped by mode, event dumps and 3D views for of interesting events (Figure 8), cut flows

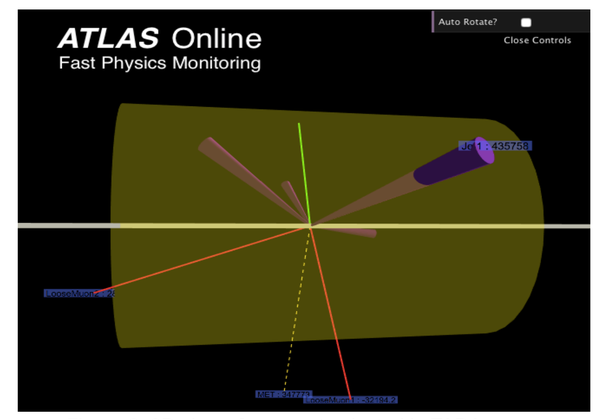


Figure 8: 3D view of an event selected in TADA