Measuring ATLAS Photon Trigger Efficiency

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Outline

ATLAS Trigger System

Why and how?

Motivation

Inclusive Photon Cross Section

Trigger Efficiency

Key Concepts & Main Challenges

Methodology

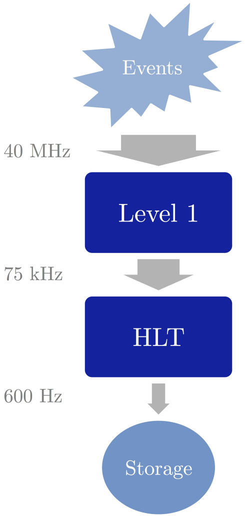
Unbiased Samples & Bootstrapping

Results

Why triggers?

- $\sim 10^9$ collisions per second in the ATLAS detector
- DAQ system cannot keep up with the raw data rate
  - Need a way to reduce the amount of data!
- Most events are well-understood – not of interest for our current studies
- Need to decide *in real time* which events could be interesting and which can be discarded

ATLAS Trigger System



- 3 levels progressively reduce the data rate
- Can think of *2 distinct parts*:

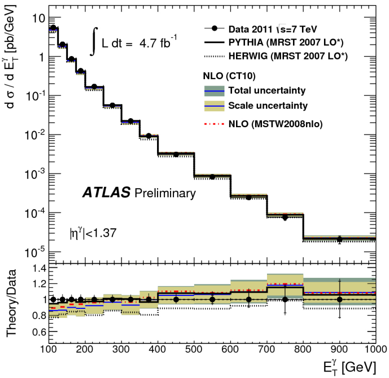
  LVL1 hardware-based

  HLT LVL2 + EF: software

- Trigger menu contains *chains* which correspond to profiles of interest
- An event is recorded if it satisfies a trigger chain in the menu
  - E.g., *g20_loose* selects γ (hence g) with $E_T > 20$ GeV meeting *loose* criteria

Inclusive Photon Cross Section

- Probability of one or more γ being produced in a collision
- 2012 data provides test of SM in new energy regime
  - Can constrain PDFs
- Need to quantify the performance of the photon triggers used
- Identify photons offline, find efficiency for these photons



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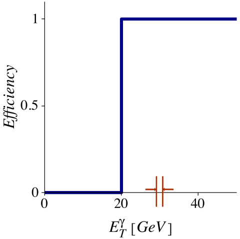
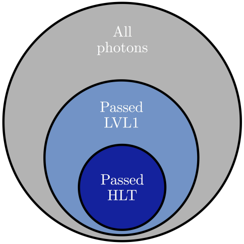
Trigger Efficiency



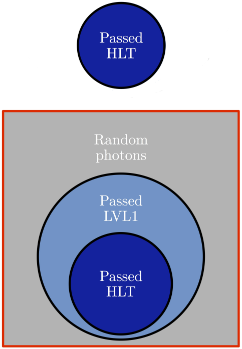


- Trigger efficiency is the probability of a γ passing the chain
- Consider a fixed value of E_T

$$\epsilon = P(\gamma \text{ passes trigger}) = \frac{\#\text{ of } \gamma \text{ that pass}}{\text{total } \#\text{ of } \gamma}$$

- Repeat over a range of E_T and construct efficiency curve

Complications. . .



- $\epsilon = P(\gamma \text{ passes trigger}) = \frac{\#\text{ of } \gamma \text{ that pass}}{\text{total } \#\text{ of } \gamma}$
- Photons that don't pass the trigger are not normally recorded
    - We don't know the total # of γ!
- Certain events are recorded *regardless* of the trigger decision
- There aren't enough of these events to make an accurate measurement

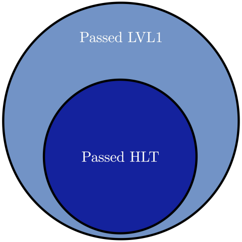
Bootstrap Method

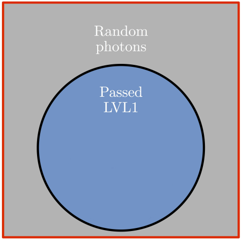
- Conditional probability $P(A|B) = \frac{P(A \;\&\; B)}{P(B)}$, or

$$P(A \;\&\; B) = P(A|B) \cdot P(B) \tag{1}$$

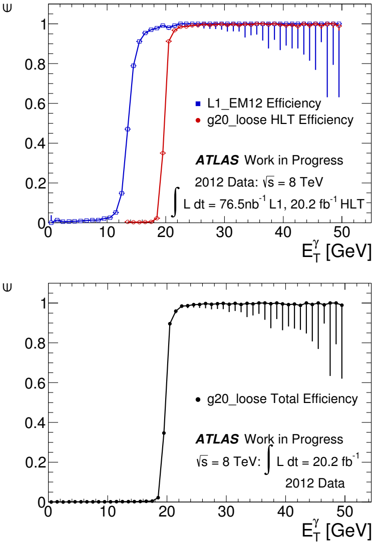
- Passing a trigger chain *means* passing LVL1 and HLT

$$\epsilon = P(\text{chain}) = P(\text{HLT} \;\&\; \text{LVL1}) \tag{2}$$
$$= P(\text{HLT} \mid \text{LVL1}) \cdot P(\text{LVL1}) \tag{3}$$





Results & Next Steps



- Multiplying LVL1 and HLT efficiencies yields the full *g20_loose* efficiency
- Consistent with 100% efficiency for $E_T > 22$ GeV
- Uncertainties still large in high E_T region, must see if this is a limiting factor in the overall analysis

Summary

- ATLAS requires a sophisticated trigger system to handle the enormous raw data rate
- To measure inclusive photon production cross section we need to know photon trigger efficiencies
- In order to get reduce uncertainties we employ the bootstrap method to decompose the efficiency
- The measured *g20_loose* efficiency is consistent with 100% for $E_T > 22$ GeV
- If necessary we may need to employ variable binning or conduct a complimentary radiative Z decay analysis to reduce high-E_T uncertainties