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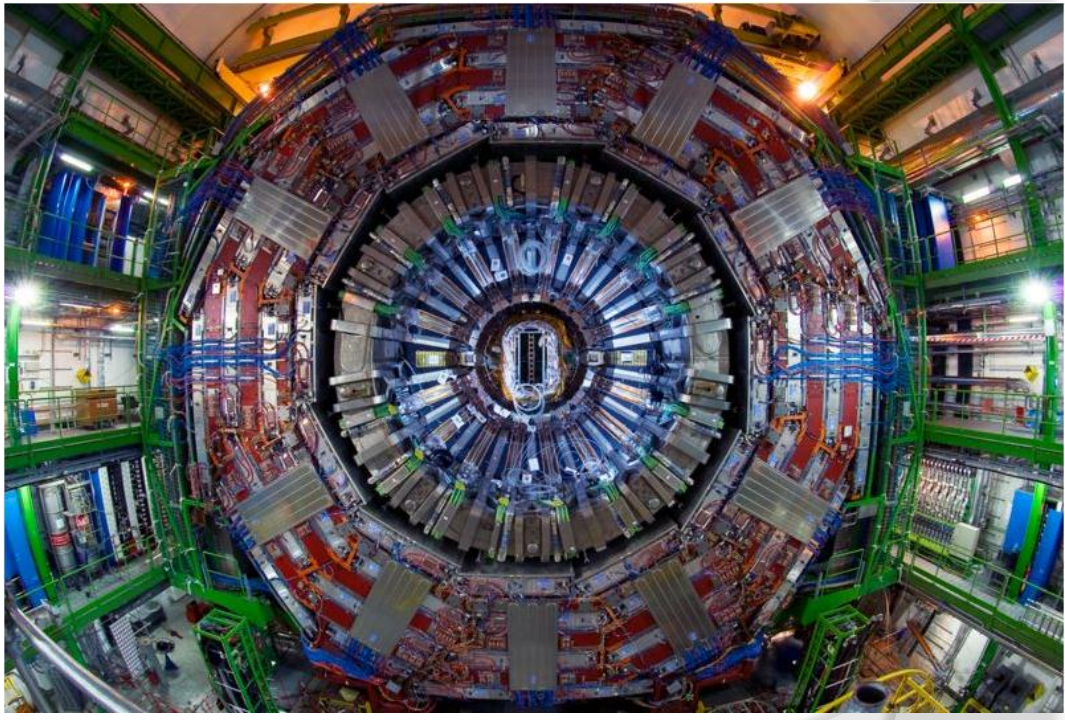
CMS HIGH LEVEL TRIGGER STUDIES FOR THE H > WW > LVJJ SEARCH

Overview

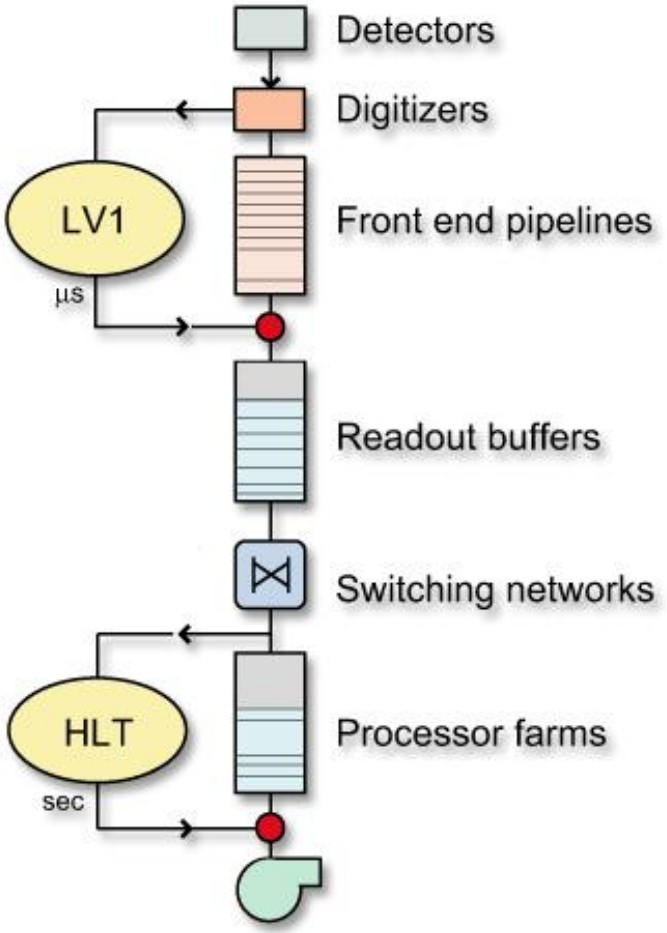
- Introduction
  - CMS and the high level trigger
  - H > WW > lvjj decay
  - Analysis trigger
- Trigger efficiency measurements
- Results

The CMS Experiment

- General Purpose Detector
- Search for Higgs Boson, Supersymmetry, Extra Dimensions, New Physics…



CMS and the High Level Trigger



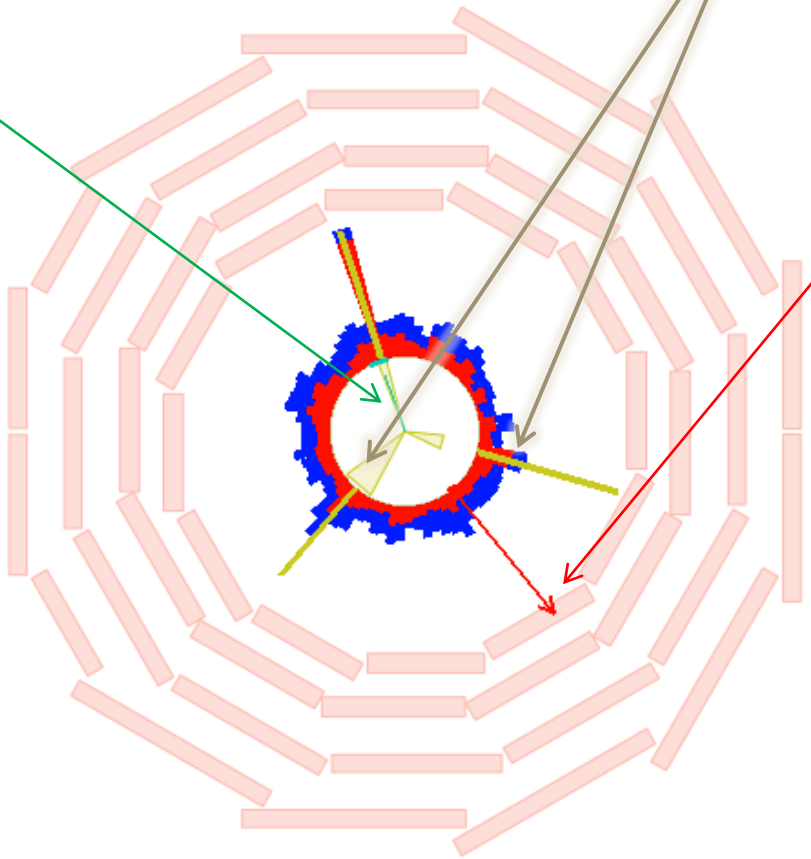
- Level-1 Trigger (L1T) – Hardware – 40 MHz to 100 kHz
- High Level Trigger (HLT) – loose software reconstruction – 100 kHz to ~100 Hz

The Analysis

- Study the H > WW > lvjj decay
  - Pros
    - High cross section x branching ratios
  - Cons
    - Poor mass resolution
    - Huge background – W + Jets
    - Requires complex trigger (1 electron, MHT, 2 jets)
- My work – analyze the effects of the trigger on the evjj final state

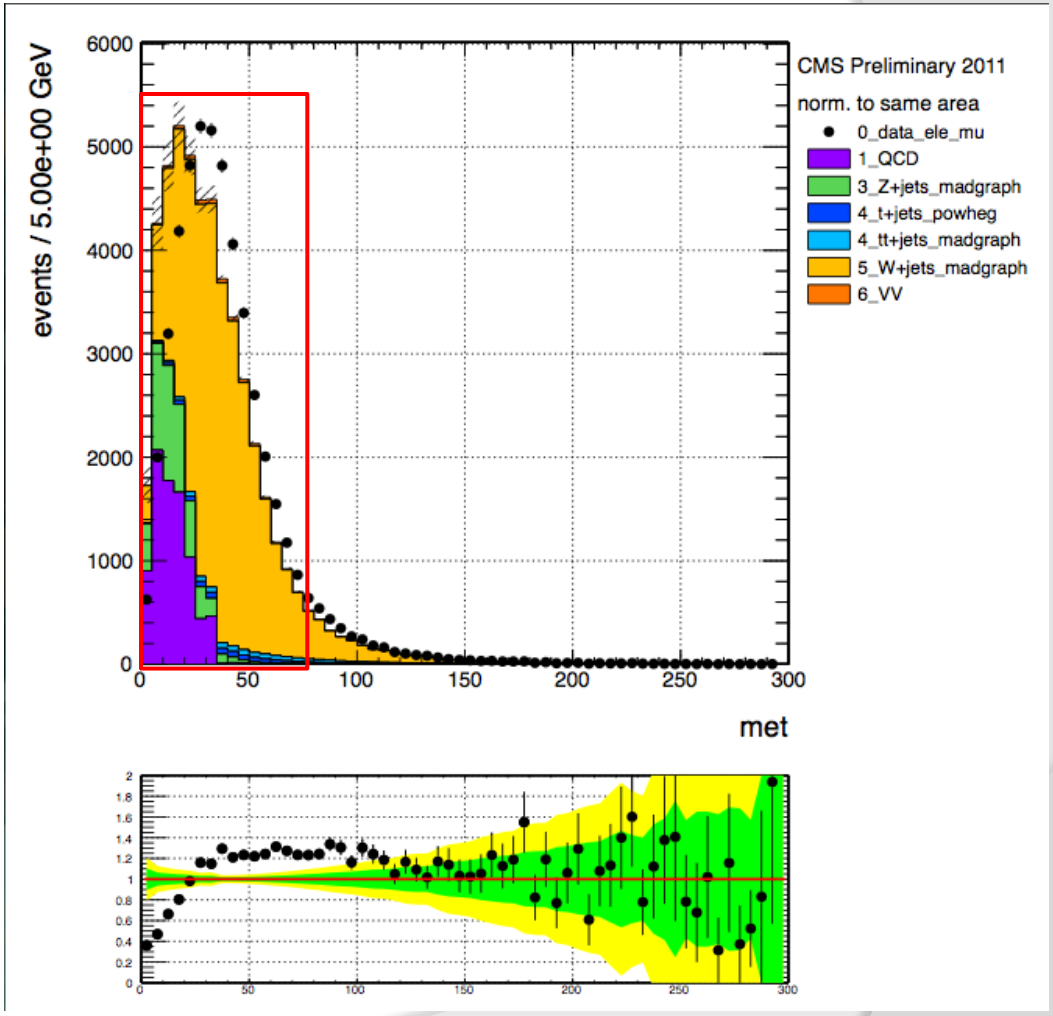
H > WW > evjj Analysis Trigger

HLT_Ele25_CaloIdVT_CaloIsoT_TrkIdT_TrkIsoT_CentralJet30_CentralJet25_PFMHT20_v4



The Problem

- Effects of the trigger not taken into account in simulations
- Must measure this trigger effect and correct the simulation



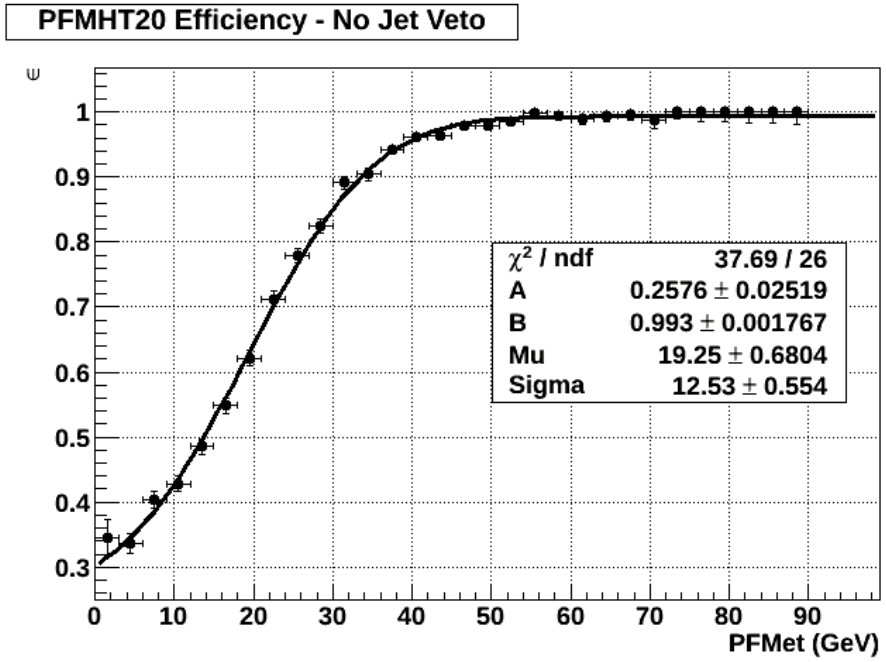
Trigger Effects on H > WW > evjj

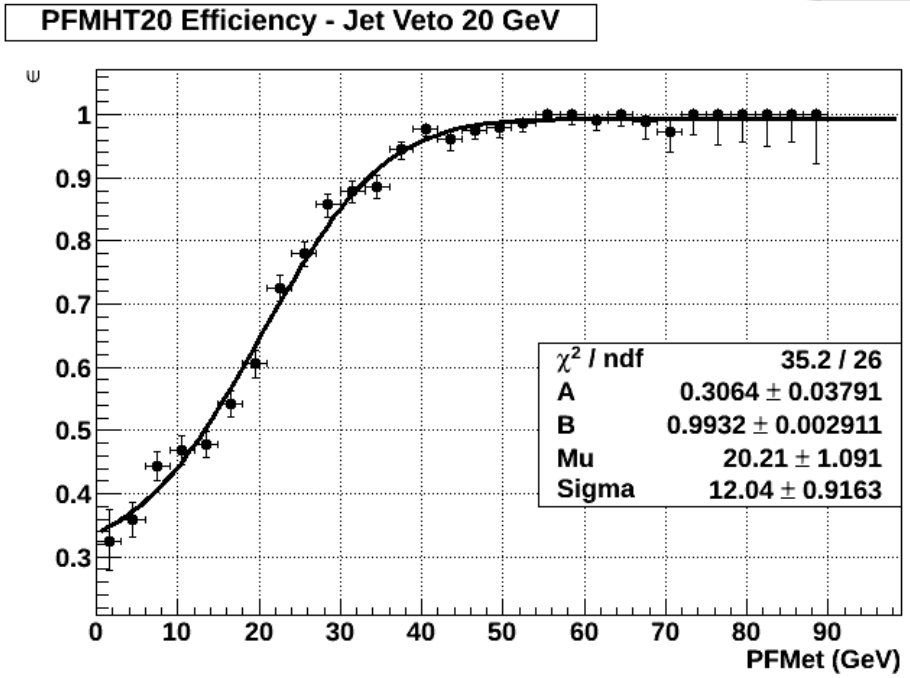
- Breaking down the total trigger efficiency into simpler components
- $\varepsilon(A,B|C) = \varepsilon(A|C,B)\ \varepsilon(B|C)$
  - A – MHT
  - B – 2 Jets
  - C – Offline selection & HLT electron
- HLT Electron efficiency studied with tag and probe

Efficiency Construction

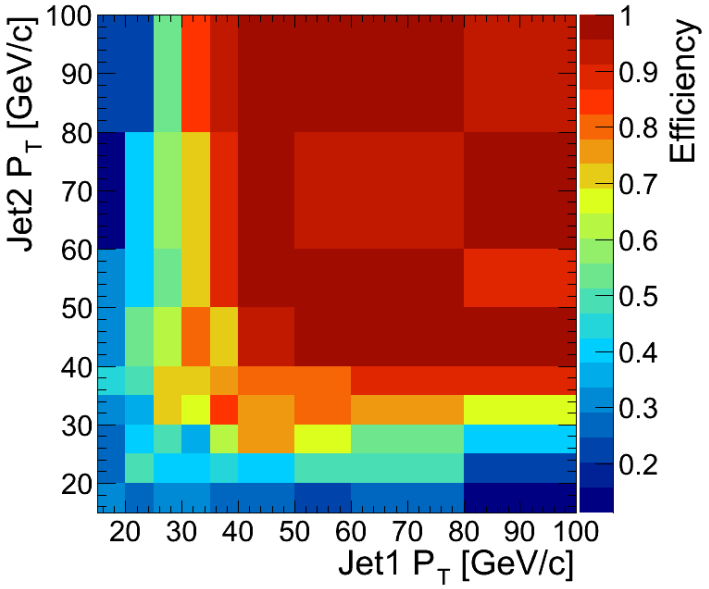
- Divide
  - Denominator – offline selection + reference trigger
  - Numerator – denominator + test trigger
- Turn-On curve produced as a function of main Jet/Met variables
  - PFMet
  - Jet1 and Jet2 p_T

PFMHT20

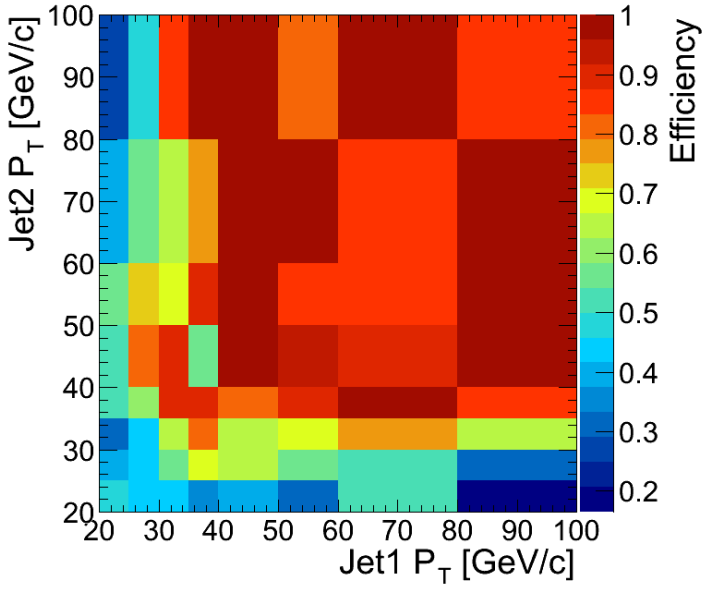

PFMHT20 Efficiency - No Jet Veto
ε
PFMet (GeV)
χ² / ndf 37.69 / 26
A 0.2576 ± 0.02519
B 0.993 ± 0.001767
Mu 19.25 ± 0.6804
Sigma 12.53 ± 0.554


PFMHT20 Efficiency - Jet Veto 20 GeV
ε
PFMet (GeV)
χ² / ndf 35.2 / 26
A 0.3064 ± 0.03791
B 0.9932 ± 0.002911
Mu 20.21 ± 1.091
Sigma 12.04 ± 0.9163

DiCentralJet30

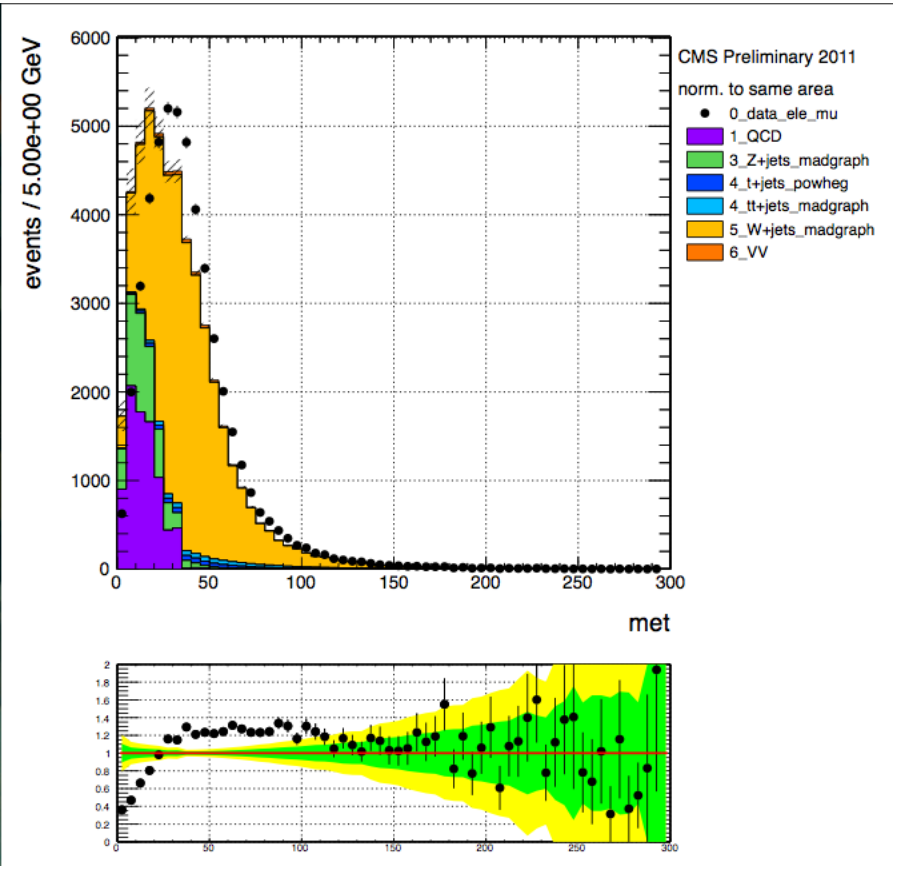


With Met Cut

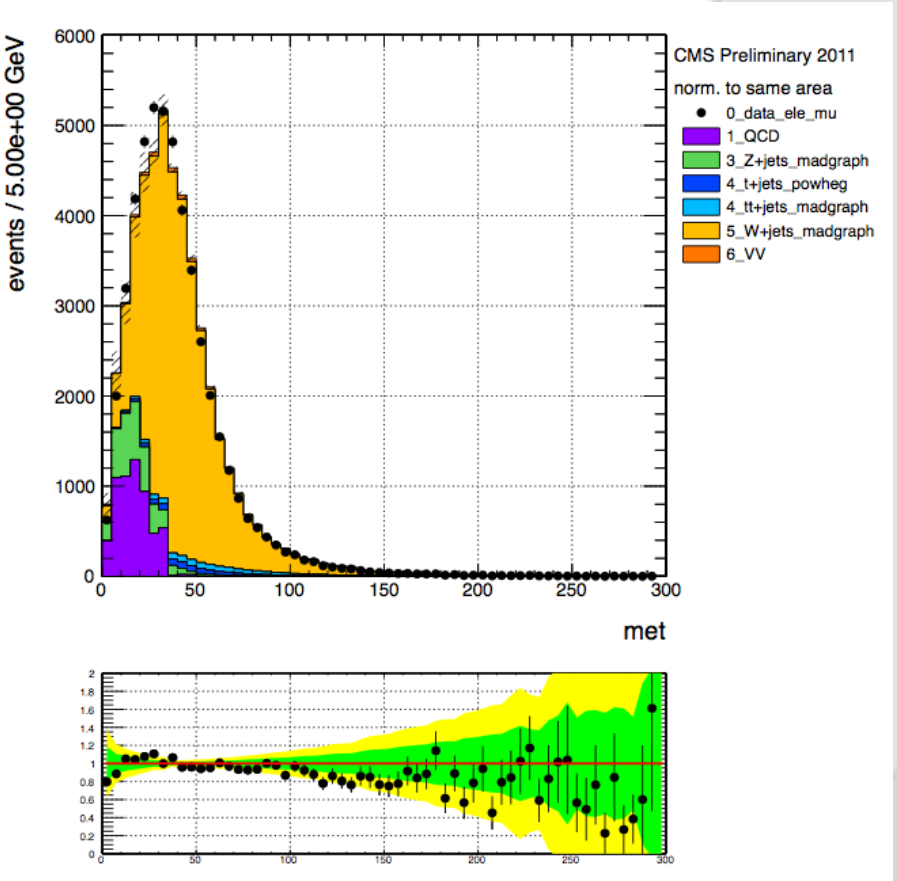


With Met Cut & Jet Veto

Trigger Effects on evjj Final State



Without Jet/Met Correction



With Jet/Met Turn-On Correction

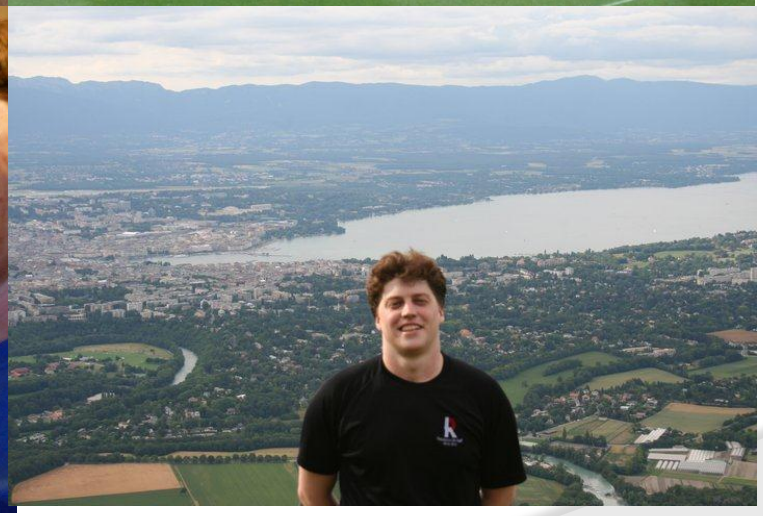
Conclusions and Future Plans

- First estimation of H > WW > evjj trigger effect on the analysis addressed
- Corrections fix the data/MC comparison for the PFMet
- Next Steps:
  - Propagate fit uncertainty through the analysis
  - Redo study with HLT/offline matching
  - Exploit new data to improve statistical uncertainties

Thanks To

- Dr. Govoni, Andrea Benaglia, and Leonardo Di Matteo
- Dr. Krisch, Dr. Neal, and Dr. Goldfarb
- NSF REU Program
- CERN Summer Student Program

Fun



Questions?

Backup

evjj Offline Selection

- 1! Good Electron (Ele Id/Iso WP70)
- PFMet > 40 GeV
- 2! Central PFJet with p_T > 30 GeV/c
- Jet Veto on Central 3rd Jet with p_T > 20 GeV/c

PFMHT20 Efficiency

- Test Trigger
  HLT_Ele25_CaloIdVT_CaloIsoT_TrkIdT_TrkIsoT_CentralJet30_CentralJet25_PFMHT20_v4
- Reference Trigger
  HLT_Ele25_CaloIdVT_CaloIsoT_TrkIdT_TrkIsoT_DiCentralJet30_v1
- From ElectronHad dataset PromptRecoV4
- Fit: $\varepsilon = \mathrm{A} + \frac{\mathrm{B}-\mathrm{A}}{2}\left[1 + Erf\left(\frac{x-\mu}{\sigma\sqrt{2}}\right)\right]$
  - A – Lower Plateau
  - B – Upper Plateau
  - μ - Turn-On
  - σ – Trigger Resolution Width

Jets Efficiency

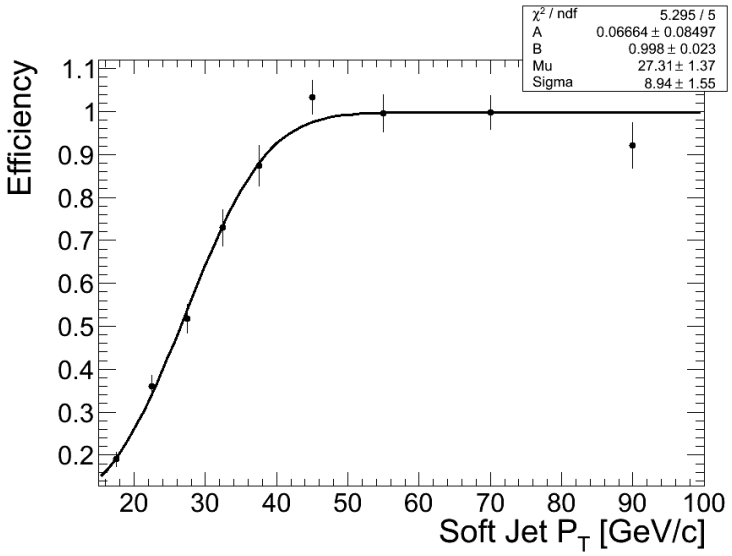
- Test Trigger

  HLT_Ele25_CaloIdVT_CaloIsoT_TrkIdT_TrkIsoT_DiCentralJet30_v1
- Reference Trigger

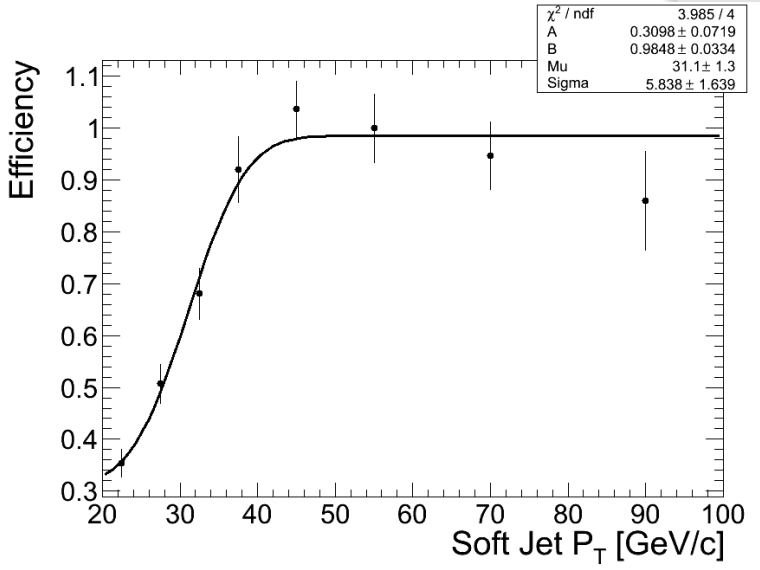
  HLT_Ele27_CaloIdVT_CaloIsoT_TrkIdT_TrkIsoT_v*
- From ElectronHad dataset PromptRecoV4
- Fit Procedure
  - Analyze pure DiJet events -> no HLT/offline matching
  - Efficiency as a function of Jet1 p_T and Jet2 p_T is the product of two equal functions
  - Performing a 2D fit using as a function

    $\varepsilon(\text{Jet1 } p_T)\varepsilon(\text{Jet2 } p_T)$

Fit Cross Check



With Met Cut



With Met Cut and Jet Veto

- We want to check validity of 2D fit by studying the turn-on in one dimension
- Put the hardest jet on the plateau (p_T > 50 GeV/c) and measure efficiency of the single jet
- Found compatibility between the two fits

2D/1D Fit Compatibility

With Met Cut

Parameter	1D Value	2D Value	Compatibility
A	0.067	0.23	-0.00076
B	0.998	0.954	0.952
Mu	27.31	26.68	1.24
Sigma	8.94	7.18	-0.0827

With Met Cut and Jet Veto

Parameter	1D Value	2D Value	Compatibility
A	0.310	0.00668	0.296
B	0.985	0.973	0.808
Mu	31.1	24.2	1.10
Sigma	5.84	9.13	-0.413