QCD VBFMET samples MadGraph Studies

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Introduction

Summary of PPD meeting

- Presentation was made on our proposal for QCD VBF-MET samples and feedback was requested.
- Main concern points were:
  - The huge amount of time required by obtaining events in the low pT hats (filter efficiency is 5×10^{-6} for working point A at lowest pT hat)
  - The amount of events going over DIGI (apparently this request would be $\sim 15\%$ of the a last campaign)
- The size of the sample itself did not sound like a big problem.
- It was suggested to look into looking into MadGraph with some reasonable generator cuts in order to reduce filtering needs and processing time.

Steps to preform

After the meeting in a chat within our group it was suggested

- Looking into usable MadGraph variables, avoid $\Delta\phi$ or even $\Delta\eta$ cuts.
- Study the relationship between generator partons and generator jets
- Study filter efficiency
- (I would also like to) Look into parton versus HLT objects
- (I would also like to) Look into a mini sample of this versus data.

Introduction

The event production runs on MadGraph are controlled by a set of "card" files which contain all the parameters that are relevant. For the *run_card.dat* here are the relevant parameters for our analysis.

Relevant run_card.dat parameters

- **nevents**: Number of unweighted events requested
- **ptj**: (default 20) minimum pt for the jets
- **etaj**: (default 5.0) max rap for the jets
- **drjj**: (default 0.4) min distance between jets
- **mmjj**: (default 0.0) min invariant mass of a jet pair
- **ptj1min**: (default 0.0) minimum pt for the leading jet in pt
- **ptj2min**: (default 0.0) minimum pt for the second jet in pt
- **deltaeta**: (default 0.0) minimum rapidity for two jets in the WBF case

MadGraph process cross sections

I have tried several working points to check what would be the necessary number of events to produce.

Madgraph working points

etaj	ptj1min	ptj2min	mmjj	Cross Section [pb]	Notes
5.0	0	0	0	$7.008 \times 10^8 \pm 6.648 \times 10^5$	MadGraph Default values
4.8	0	0	0	$6.879 \times 10^8 \pm 6.644 \times 10^5$	Reducing jet eta range
4.8	40	40	0	$5.266 \times 10^7 \pm 4.772 \times 10^4$	Require 2 jets with $p_\perp > 40$ GeV
4.8	40	40	800	$8.911 \times 10^5 \pm 653.2$	Working Point A
4.8	35	35	800	$1.21 \times 10^6 \pm 878.9$	WP A: dijet $p_\perp$ -5 GeV
4.8	30	30	800	$1.699 \times 10^6 \pm 1304$	WP A: dijet $p_\perp$ -10 GeV
4.8	40	40	700	$1.234 \times 10^6 \pm 940$	WP A: dijet $p_\perp$ -100 GeV
4.8	40	40	900	$6.611 \times 10^5 \pm 482.6$	WP A: dijet $p_\perp$ +100 GeV
4.8	40	40	1000	$5.009 \times 10^5 \pm 377$	WP A: dijet $p_\perp$ +200 GeV
4.8	50	50	1000	$2.948 \times 10^5 \pm 222.8$	Working Point B

- Cross section obtained from generating 100k events with MG5_aMC_v2.3.0 (from 2015-07-01)
- Process `p p > j j` where `j = g u c d s u~ c~ d~ s~`
- Working Point A and be are basically the same as the previously proposed filters working points but without $\Delta\phi$ or $\Delta\eta$

The with pythia the total cross section of the pT hats to generate was: 1.87×10^8 two orders of magnitude higher.

CMSSW and Pythia8 hadronization

I have decided to proceed with Working Point A and with the help of Chayanit was able to interface CMSSW with the produced MadGraph events.

CMSSW details

- CMSSW_7_1_18 version
- Hadronization done by Hadronizer_TuneCUETP8M1_13TeV_MLM_5f_max4j_LHE_pythia8_cff
- Generator jets are AK4 GenJetsNoNu

Matching results

Events in	Events Pass	Event Eff [%]	xsec before [pb]	xsec match [pb]
100000	17077	17.1 ± 0.1	$8.911 \times 10^5 \pm 6.532 \times 10^2$	$1.522 \times 10^5 \pm 1.066 \times 10^3$

Questions

- Which file to use: events.lhe.gz or unweighted_events.lhe.gz (results with the unweighted events).
- Is this matching efficiency ok?
- What cross section to use? Pre or post matching?

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Matching Partons with Generator jets

Parton selection

- For partons selecting status:
  - 23 - outgoing
  - 24 - outgoing, nonperturbatively kicked out in diffraction

Pairing Partons and Generator Jets

- Selecting all generator jets within $\Delta R < 0.4$ (this may need to be a big bigger)
- From those selecting the generator jet with the lowest $p_{\perp}$ to the parton as a match.
  - This avoids picking up the wrong jet from just picking lowest ΔR

Pairing Results for 10k events

- Pythia8 matched events events: 1712
- Found genJet for 2 parton: 1489 (87.0%)
- Found genJet for 1 parton: 212 (12.4%)
- Found genJet for 2 parton: 11 (0.6%)
- Matched genJet was not the lowest ΔR: 120

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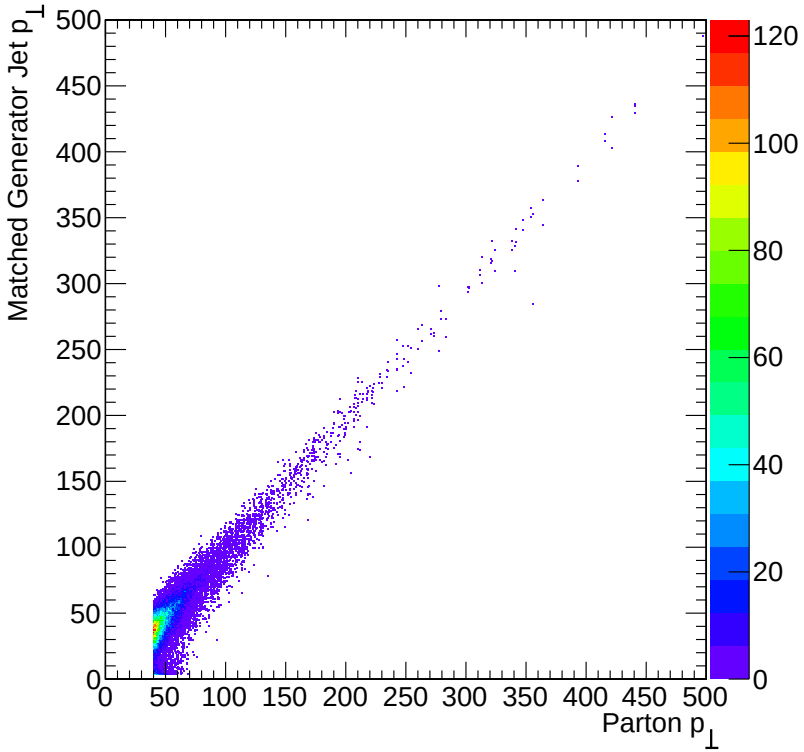
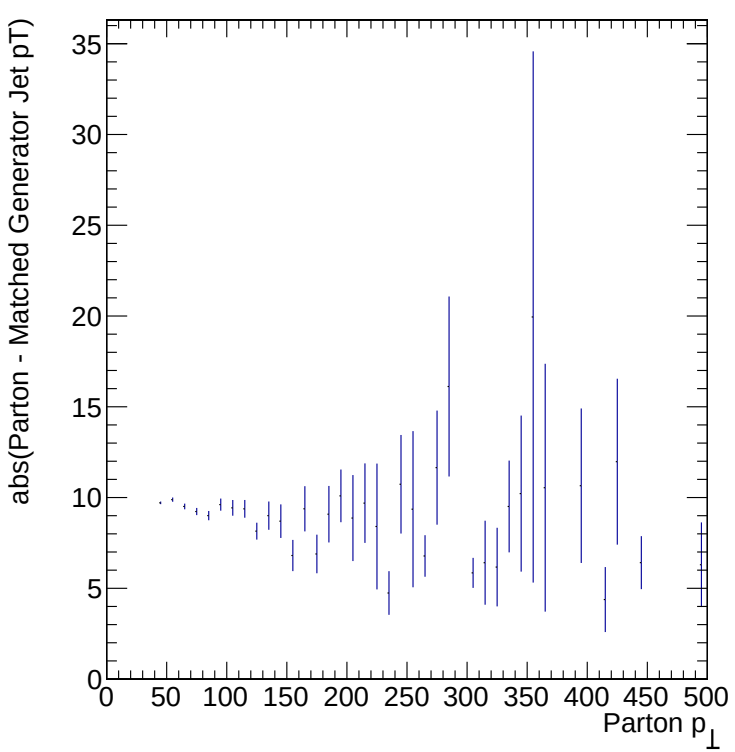
Parton vs Matched GenJet $p_\perp$





Parton vs Matched GenJet η