QCD VBFMET Gridpack Validation

João Pela

Imperial College London

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MadGraph Gridpack characteristics

- A grid pack was generated following the instructions found in the TWiki below:
  - TWiki: QuickGuideMadGraph5aMCatNLO
- Patches to include custom cuts were produced and included in the gridpack generation code

Sample characteristics

- Process: $pp \rightarrow jj, jjj, jjjj$
- At least one dijet with:
  - Jets $p_{\perp} > 30\ GeV$
  - Dijet $m_{jj} > 800\ GeV$

What changed from previous studies:

- Different MAdGraph version: MG5_aMC_v2_3_0 $\rightarrow$ MG5_aMC_v2.3.2.2
- Additional CMS patches and options
  - Physics Model: sm $\rightarrow$ sm-ckm_no_b_mass
  - PDF choice: nn23lo1 $\rightarrow$ lhapdf(263000)

At grid pack production the reported process cross section was: $1.03 \times 10^7 \pm 1.657 \times 10^4\ [pb]$

Preparatory studies reported: $1.11 \times 10^7 \pm 1.799 \times 10^4$ **which is compatible considering the changes.**

Hadronization

Software

- Using CMSSW_7_1_18 (like in previous studies)
- Showering: Pythia8
- Hadronizer: Configuration/Generator/python/Hadronizer_TuneCUETP8M1_13TeV_MLM_5f_max4j_LHE_pythia8_cff.py

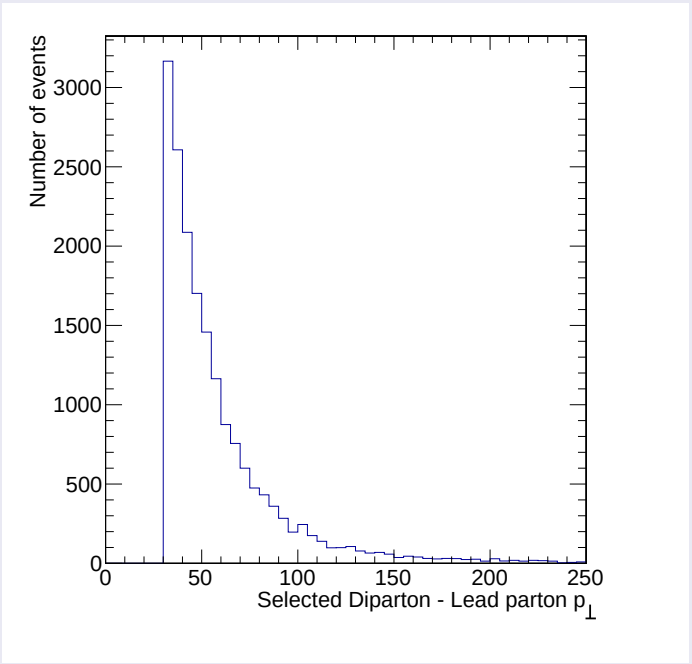
Results

	Events			Cross Section [pb]	
Process	Tried	Passed	accepted [%]	Before	After
$pp \to jj$	30295	7252	23.9 ± 0.2	$1.673e+06 \pm 8.616e+03$	$4.005e+05 \pm 4.591e+03$
$pp \to jjj$	64985	4776	7.3 ± 0.1	$3.547e+06 \pm 1.826e+04$	$2.607e+05 \pm 3.871e+03$
$pp \to jjjj$	89720	5843	6.5 ± 0.1	$4.939e+06 \pm 2.543e+04$	$3.216e+05 \pm 4.393e+03$
Total	185000	17871	9.7 ± 0.1	$1.016e+07 \pm 3.247e+04$	$9.828e+05 \pm 7.440e+03$

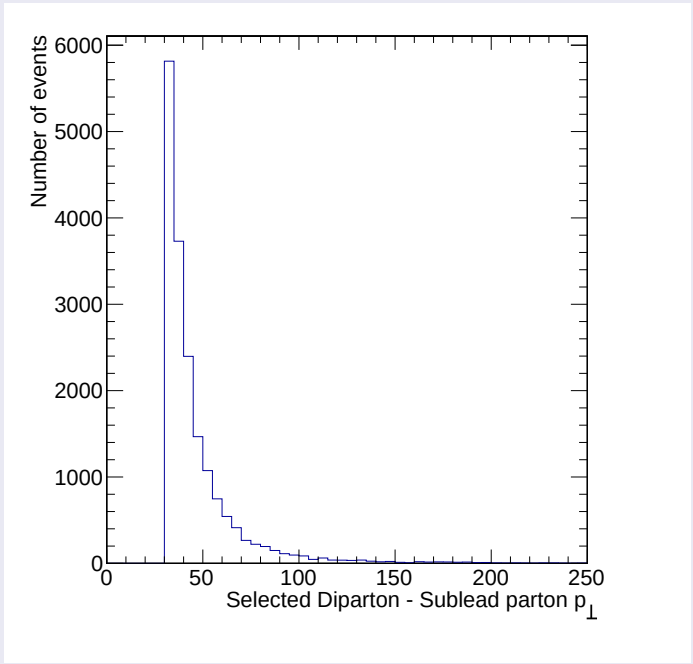
The 3 and 4 jets configurations fail more events since there is no restriction on min(jet $p_\perp$) which fails sometime the imposed hadronizer cut.

Selected Di-parton I

Lead Parton $p_\perp$



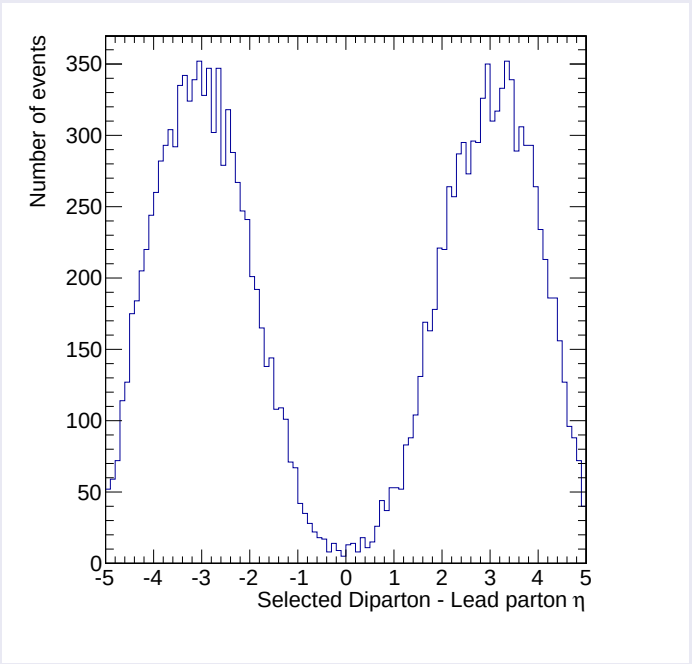
Sublead Parton $p_\perp$



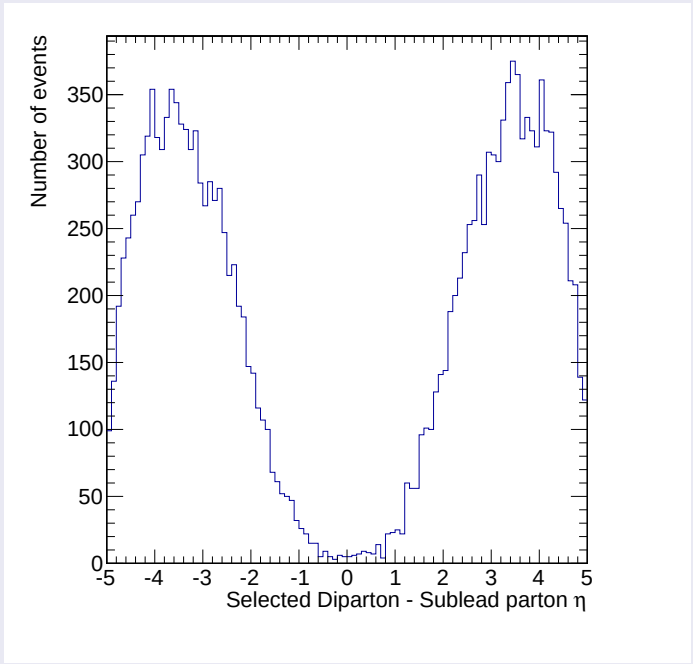
Custom MadGraph cuts on dijet parton $p_\perp$ are implemented correctly.

Selected Di-parton II

Lead Parton $p\eta$



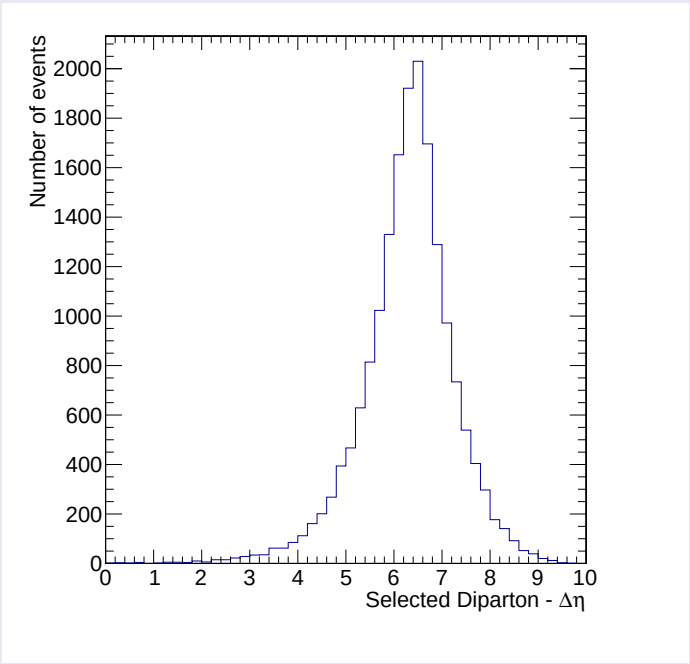
Sublead Parton η



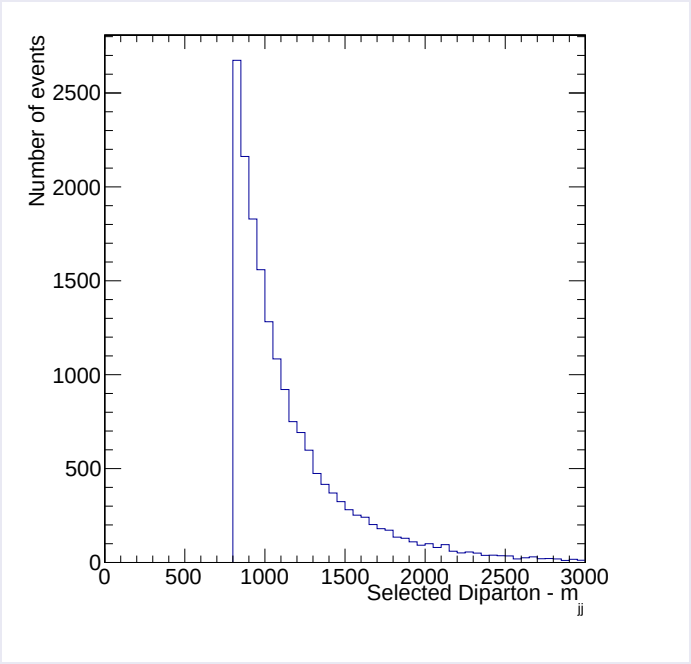
Jet η distribution looks ok. MadGraph cut is at 5.0.

Selected Di-parton III

Di-parton $\Delta\eta$



Di-parton m_{jj}



Custom MadGraph cuts on dijet parton m_{jj} are implemented correctly. $\Delta\eta$ peaks over 6 showing that this variable indeed could not be used to reduce QCD.

Parton-Generator Jet Matching procedure

Pairing Partons and Generator Jets

- Selecting all generator jets within $\Delta R < 0.4$
- 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

Results

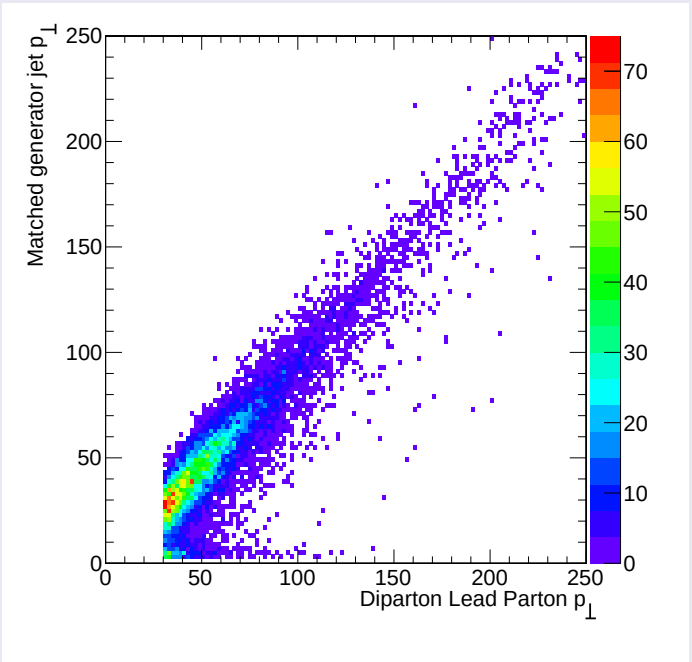
	Process			
n_{match}	jj	jjj	jjjj	Total
0	03.54%	0.29%	00.05%	01.53%
1	25.21%	4.23%	01.35%	11.80%
2	71.25%	27.55%	08.66%	39.11%
3		67.92%	36.16%	29.98%
4			53.77%	17.58%

- Selected diparton has a match : 73.96%
- Generator jet matched not lowest ΔR : 3.57%

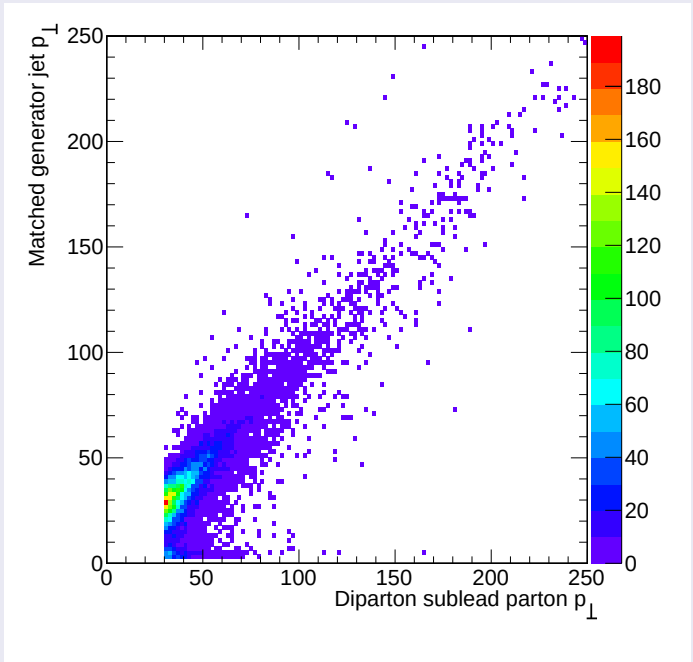
With the current matching procedure we can find matches for the selected di-parton most of the times.

Selected Di-partons vs Matched Generator Jet I

Lead Parton-Generator Jet $p_\perp$



Sublead Parton-Generator Jet $p_\perp$

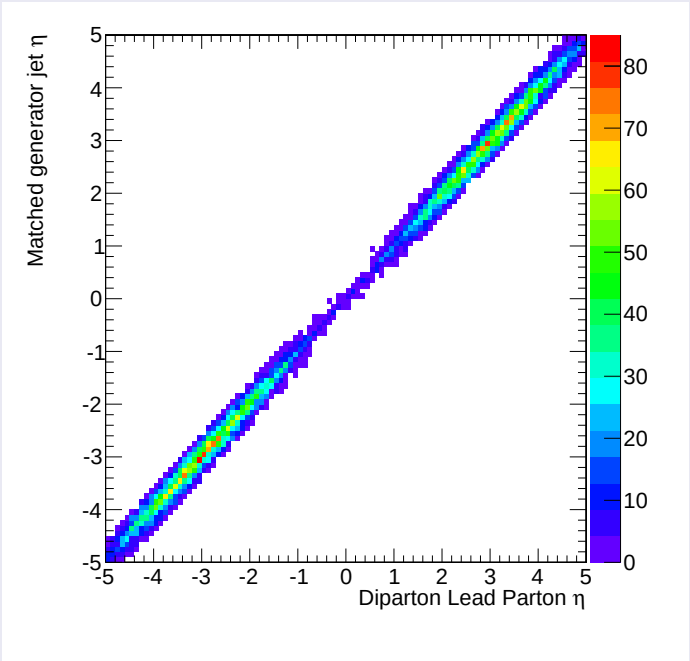


- Lead jets: In the bin Parton $30 < p_\perp \leq 32$ GeV only $2.04\% \pm 0.54\%$ generator jets are $p_\perp \geq 40$ *GeV*
- Sublead jets: In the bin Parton $30 < p_\perp \leq 32$ GeV only $3.34\% \pm 0.49\%$ generator jets are $p_\perp \geq 40$ *GeV*

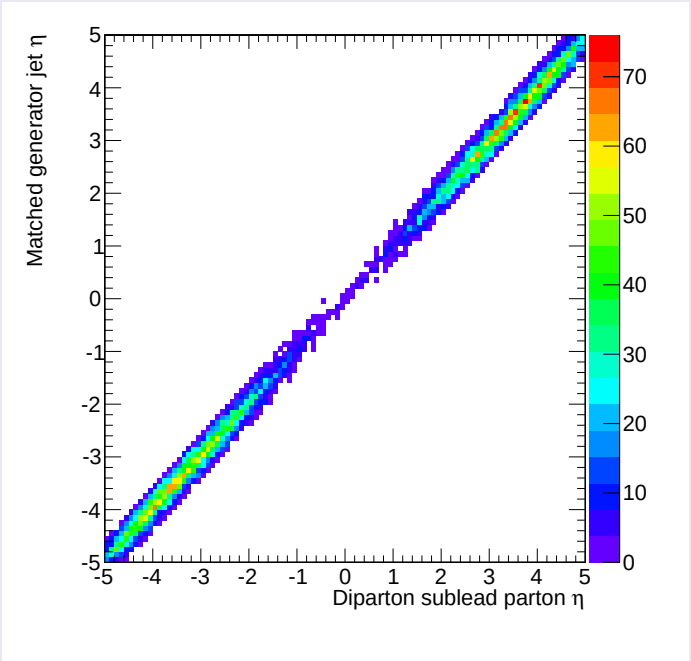
Parton to generator jet $p_\perp$ migration are under 3.5% at the bin $30 < p_\perp \leq 32$ and should be even lower at $p_\perp < 30$. This is acceptable.

Selected Di-partons vs Matched Generator Jet II

Lead Parton-Generator Jet η



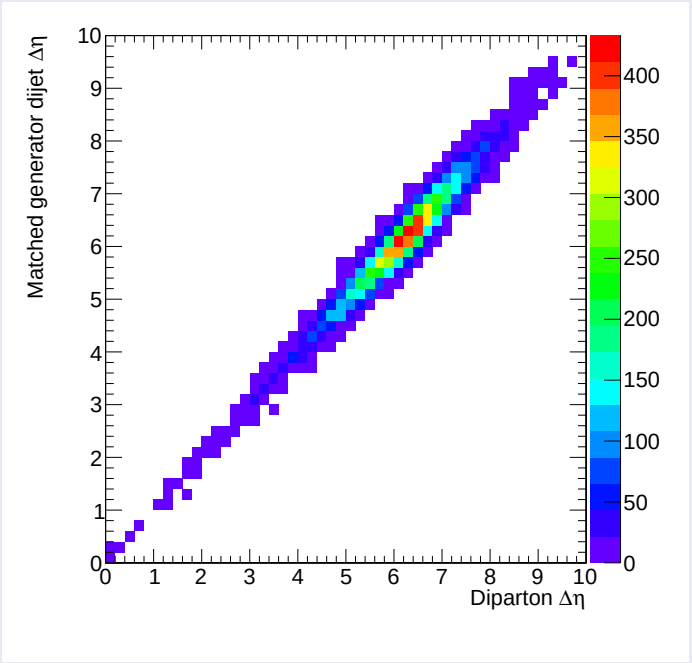
Sublead Parton-Generator Jet η



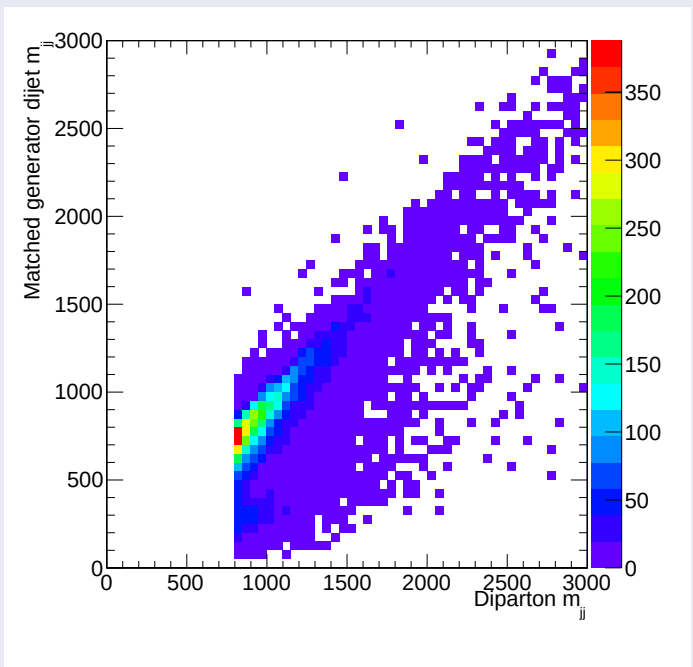
Parton to generator jet η migration are in general under 0.5.

Selected Di-partons vs Matched Generator Jet III

Di-parton-Generator Dijet $\Delta\eta$



Di-parton-Generator Dijet m_{jj}



- m_{jj}: In the bin Di-parton $800 < m_{jj} \leq 850$ GeV only $1.09\% \pm 0.23\%$ generator dijets are $m_{jj} \geq 900$ *GeV*

Migration in dijet m_{jj} are very small even at 900 *GeV*.

Conclusions

Summary

- A MadGraph gridpack was produce following the CMS Generator Group recommended instructions
- A test run was made producing 185k events where it was demonstrated that the custom proposed cuts were correctly implemented.
- Pythia8 hadronization was performed over the parton level events with an efficiency of 9.7 ± 0.1 and leading to a final sample cross section of $9.828e+05 \pm 7.440e+03$.
- A study over the key variable migration was performed showing that they are acceptable for the proposed generator level filter.
- We are ready to pass this gridpack to the generator group and request our new QCD sample production.