QGCs e+e- --> nunu qqqq

Short description:

Physics Motivation: A precision measurement of the quartic interaction between vector bosons is an important step in testing the validity of the Standard Model at high energies. On of the key interests is due to the necessity of the SM-Higgs for the unitarization of this process. Higgs-related as well as more general BSM effects are expected to be observable in this channel at high center-of-mass energies.

Search Channel: e+e- +WW/ZZ +qqqq, ECM=1TeV

Detector Benchmark: Separation of hadronic W and Z decays in a {di-boson + high E_miss} environment (incl. JES, JER). Expected limits on anomalous Quartic Gauge Couplings in (dim.-8) EFT framework.

Main observables:

Final observables: Dimension-8 EFT coefficients related to VVV'V' vertex

Intermediate observables: QGCs, JER, JES, W/Z separation by mass Di-Boson four momenta, missing four momentum, jet content, angular distributions.

IDR plots & note:

IDR note:

ILDBench_QGC_note.pdf

LateX on stash (requires stash account and access rights):

https://stash.desy.de/projects/JBPUBS/repos/ildbench_qgc_note/browse/LaTeX/ILDBench_QGC_note.pdf

Current proposals for IDR plots:

I. Full Q^2_ VV range:

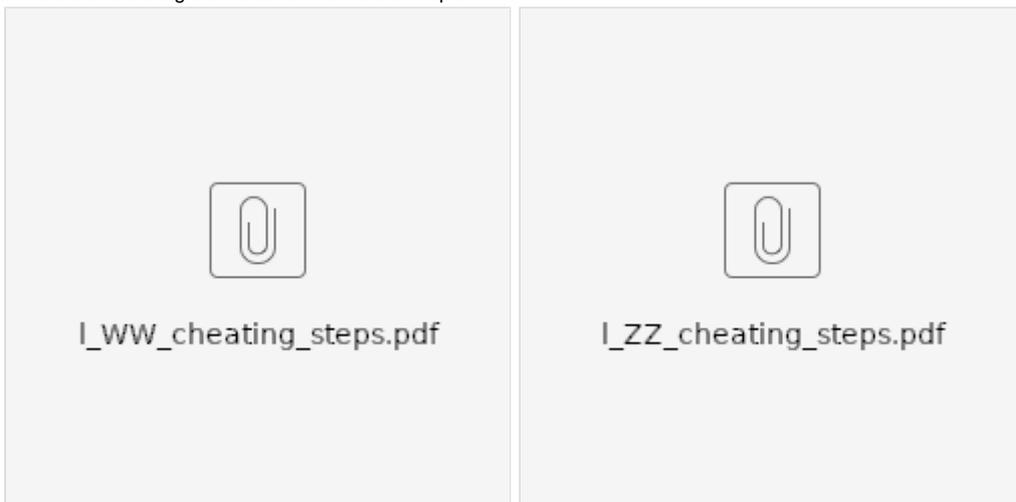- Reconstructed distributions:

ls_comp_rec_monly.pdf

m_m_rec.pdf

ls_comp_rec_monly.C , m_m_rec.C

- Fully cheated distributions:
  (Reconstructed particles belonging to initial boson, only events w/o semi-leptonic decays)

ls_comp_icn_noSLD_monly.pdf

m_m_icn_noSLD.pdf

ls_comp_icn_noSLD_monly.C , m_m_icn_noSLD.C

- Influence of cheating individual reconstruction steps:

l_WW_cheating_steps.pdf

l_ZZ_cheating_steps.pdf

l_WW_cheating_steps.C , l_ZZ_cheating_steps.C

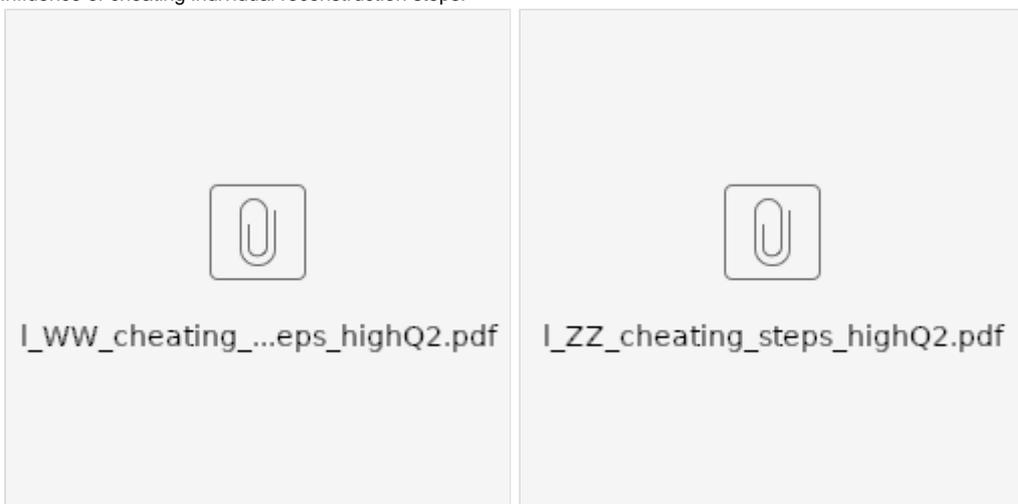*II. High-Q^2_ VV range (>500GeV):*

- Reconstructed distributions:

ls_comp_rec_monly_highQ2.C , m_m_rec_highQ2.C

- Fully cheated distributions:
  (Reconstructed particles belonging to initial boson, only events w/o semi-leptonic decays)

ls_comp_icn_noSLD_monly_highQ2.C , m_m_icn_noSLD_highQ2.C

- Influence of cheating individual reconstruction steps:

l_WW_cheating_steps_highQ2.C , l_ZZ_cheating_steps_highQ2.C

Proposal for IDR figure of merit:

Simple figure of merit proposal:

    Use 1D projection distributions
    Scan with a 1D cut (all left of m_cut is reco-WW, all right of m_cut reco-ZZ)
    Find point where confusion percentage is same for WW and ZZ (e.g. 70% of WW correctly ID'd and 70% of ZZ correctly ID'd)
    Figure of merit: Percentage of WW (ZZ) correctly identified as WW (ZZ)

Confusion figure of merit for different cheating steps:

cheating level	Correctly identified boson pairs [%]		
	full Q^2, IDR-L	high-Q^2, IDR-L	high-Q^2, IDR-S
Full reconstruction	71.1	73.0	72.9
... + cheated beam-background removal	79.6	84.6	84.0
... + cheated jet clustering	86.3	86.2	85.6
... + cheated jet pairing to bosons	88.4	86.6	86.1
... & only for events w/o semi-leptonic decays	94.4	92.6	92.5
Generator level	100		

This figure of merit can be (roughly) used to compare to the assumption of a recent aQGC generator level study [arXiv:1607.03030]. Assumption of the generator level study:

Confusion of WZ (ZW) of 88%
Correct reconstruction of a hadronic WW (ZZ): **77.4%**

People:

Jakob Beyer (DESY, Uni Hamburg, TU Dresden), reviewed by Taikan Suehara (Kyushu University)

References:

GitHub repository:

https://github.com/ILDAnaSoft/ILDbench_QGC

Talks:

Jakob Beyer :

- ILD pre-meeting 02/2018, KEK
- ILD Analysis/Software Meeting, 10.10.2018
- ILD Analysis/Software Meeting, 06.02.2019
- ILD Benchmarking Days II, 25.02.2019
- ILD meeting 2019, 27.02.2019
- ILD Analysis/Software Meeting, 03.04.2019