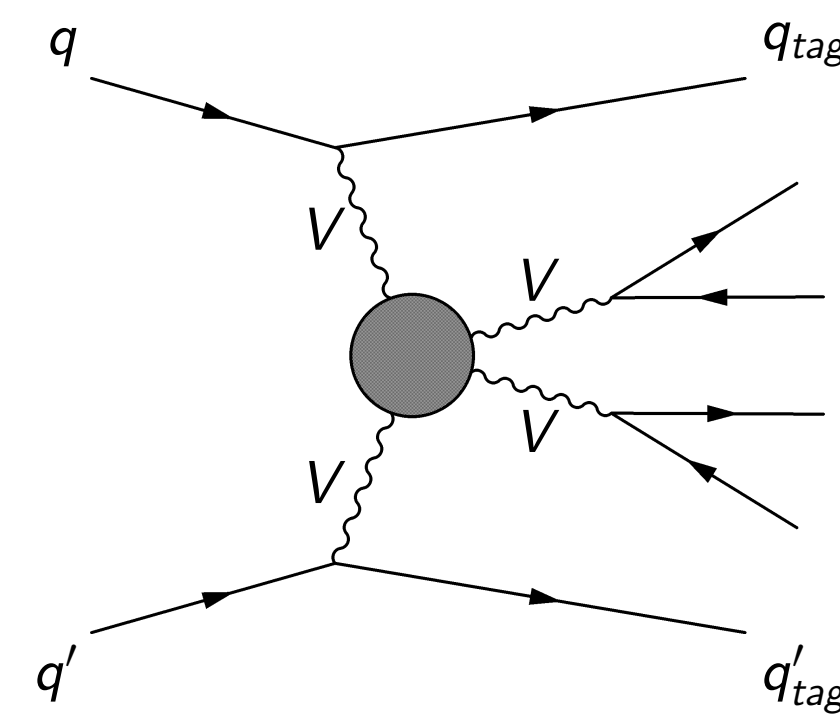


Vector Boson Scattering at the LHC

- Main physics goal of the LHC: Investigation of the mechanism which breaks electroweak symmetry
- Without a SM Higgs, longitudinal VBS would violate unitarity at $\sqrt{s_{VV}} \approx 1.2$ TeV
- We aim to test the properties of the new-found 126 GeV boson and the existence of further resonances in this channel
 - Probing the electroweak symmetry breaking mechanism
 - Providing limit setting on anomalous quartic gauge couplings



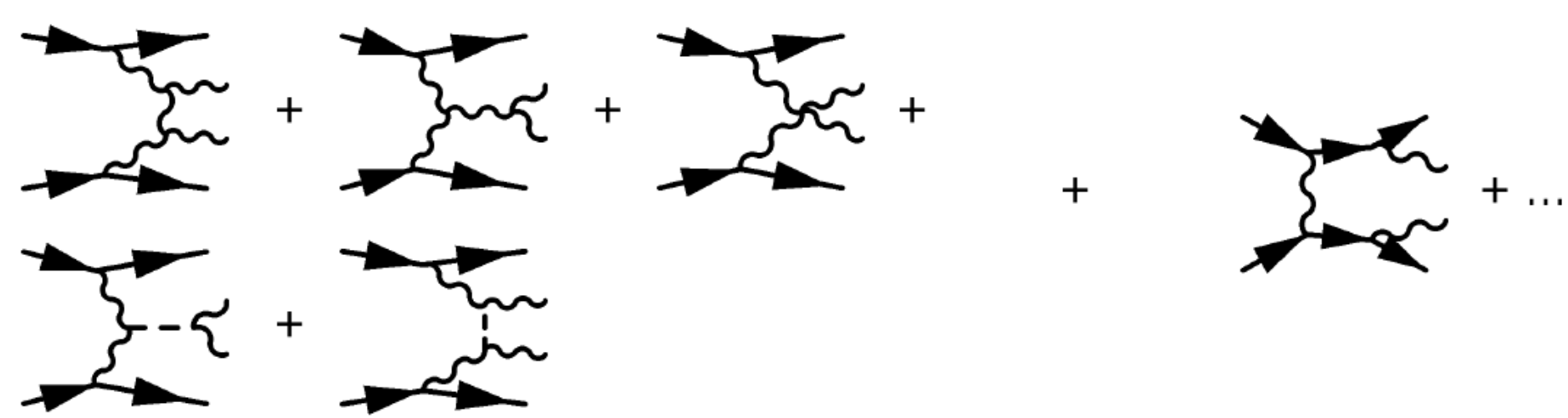
Scattering process produces two vector bosons always accompanied by 2 tagging jets

Event topology of VBS events:

- two energetic forward jets with high invariant mass
- decay products of vector bosons are rather central

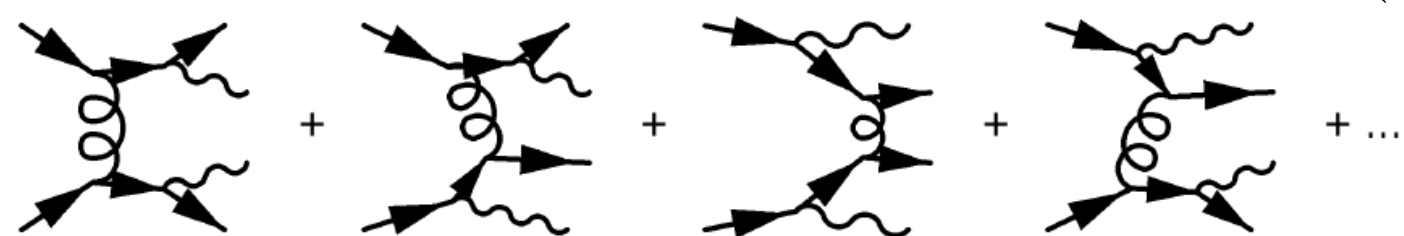
Monte Carlo Generation for VBS

Purely electroweak process (EW): $\alpha_s = 0 \rightarrow \mathcal{O}(\alpha_w^6)$
EW w/ VBS topology + EW w/o VBS topology



... contains scattering diagrams with triple/quartic gauge vertices, Higgs exchange, and additional electroweak diagrams without VBS topology.

VVjj-QCD process: $\alpha_s \neq 0 \rightarrow \mathcal{O}(\alpha_w^4)\mathcal{O}(\alpha_s^2)$



... contains diagrams with the same final state (VVjj) but including strong vertices
It is possible to separate VVjj-QCD from VVjj-EW via topological cuts.

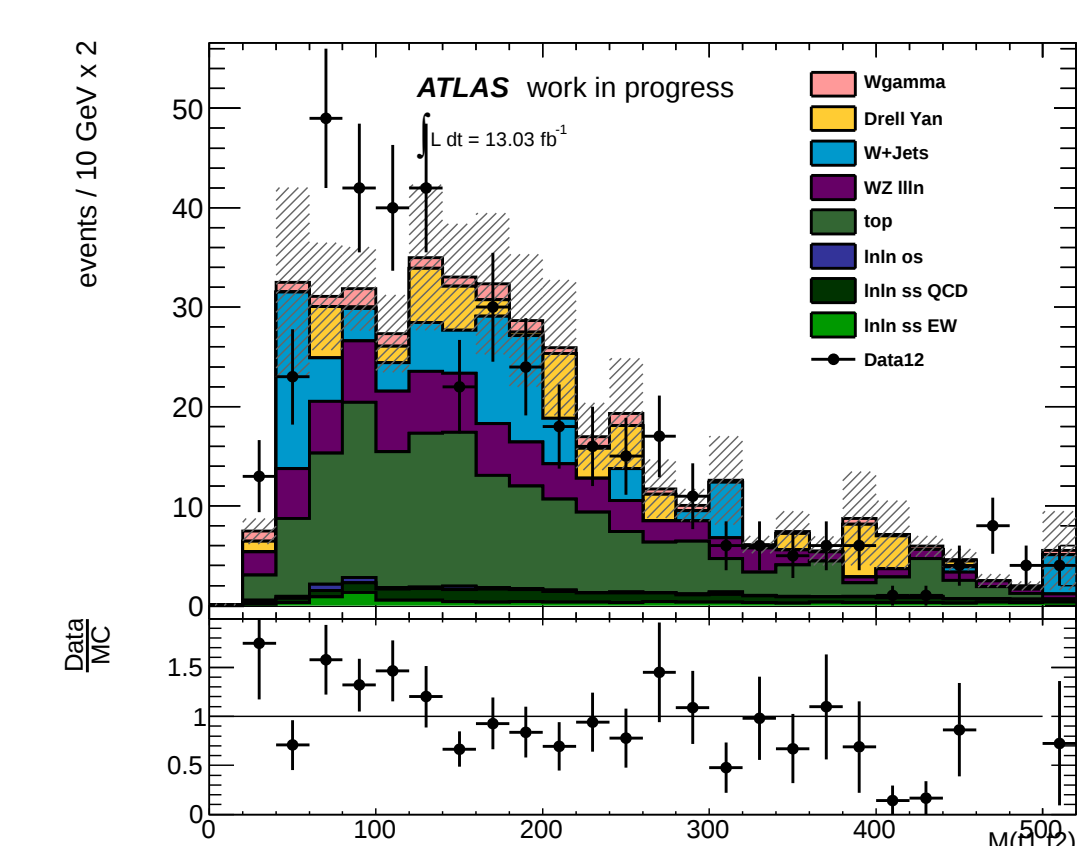
$W^\pm W^\pm jj$ in ATLAS

Measurement of like-sign WW pair production in association with two jets as first step for $W^\pm W^\pm$ -VBS measurement

- Advantage of this channel: due to lack of gluon-gluon initial state diagrams in $W^\pm W^\pm jj$ -QCD diagrams, this is the only leptonic VVjj channel in which EW and QCD are of the same order $\Rightarrow W^\pm W^\pm jj$ -QCD small background

Other backgrounds:

- Opposite-sign lepton pairs (e.g. Z+jets) with mis-identified charge
- WZ diboson production
- W + misidentified jets
- top, double-parton scattering, and others



Invariant mass of tagging jets in $l^\pm l^\pm jj$ +MET final state [blinded above $m_{jj} < 500$ GeV]

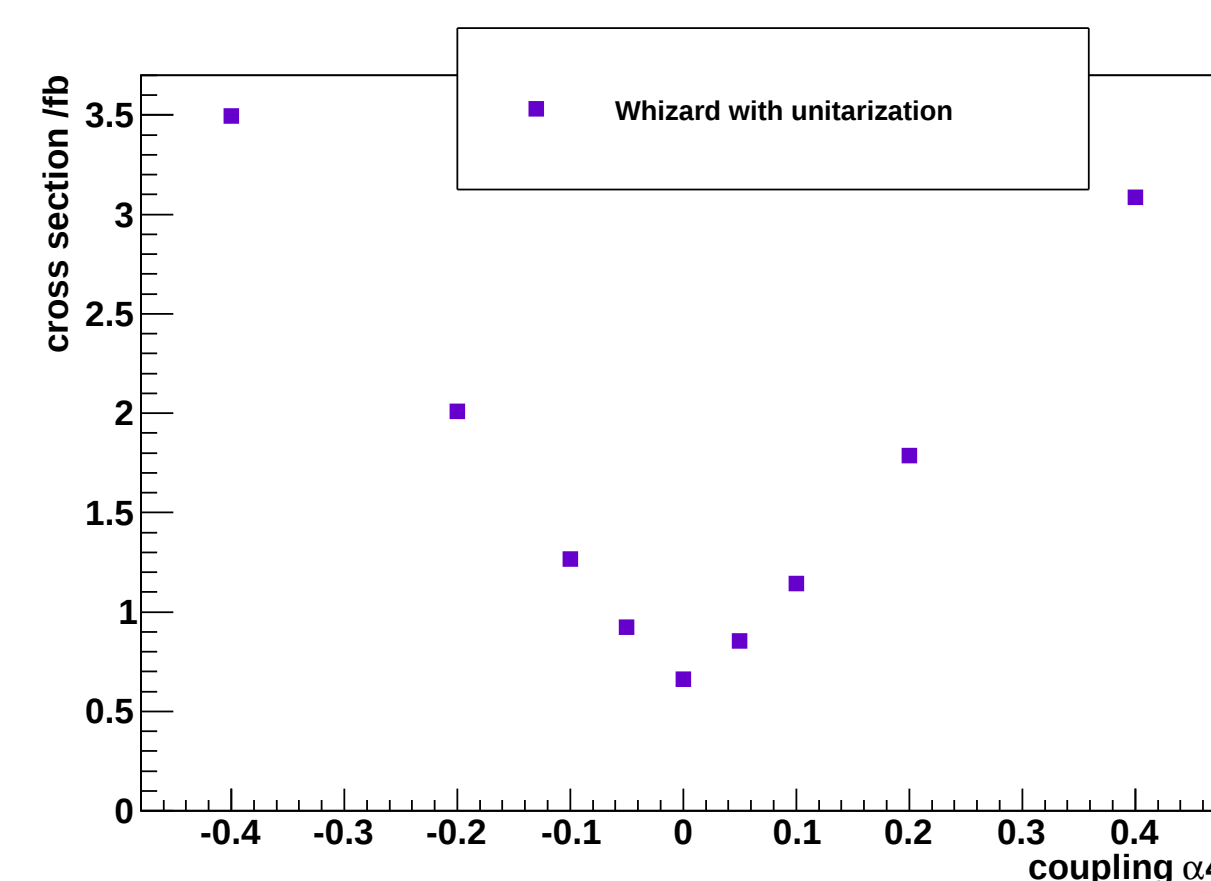
A glimpse on anomalous quartic gauge couplings

Measurement of VBS allows to set limits on anomalous quartic gauge couplings (aQGC).

WHIZARD model for aQGC [cf. arXiv:0806.4145]

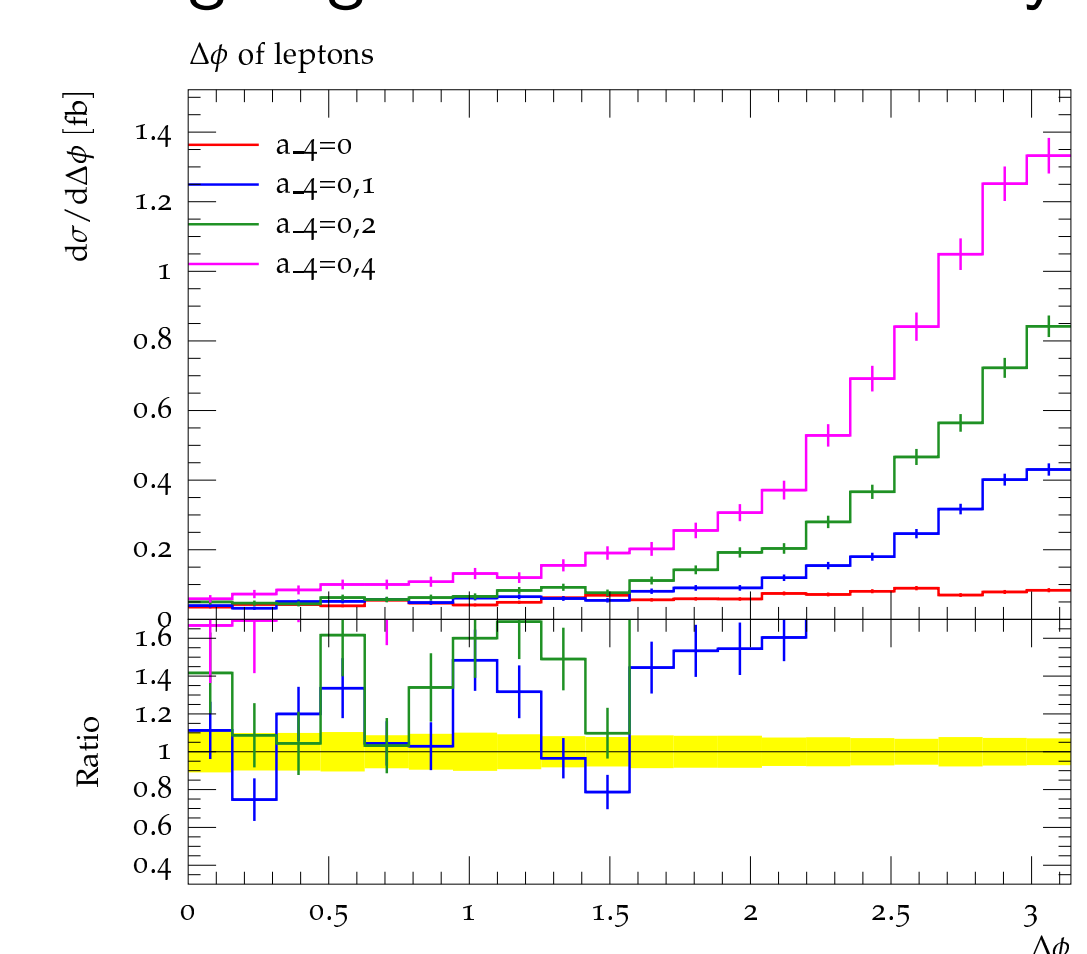
- Extension of the effective SM-Lagrangian (containing light SM-Higgs) with terms containing additional operators:
 $\mathcal{L} = \mathcal{L}_{SM} + \sum_i \frac{c_i}{\Lambda^2} \mathcal{O}_i + \dots$
- Parametrization of anomalous quartic gauge boson couplings α_4, α_5
- Unitarization of the amplitude using the k-matrix unitarization method
Parton level study for the process $pp \rightarrow jj e^+ \nu_e e^+ \nu_e$ containing SM-Higgs of mass $m_H = 126$ GeV and varying aQGC parameters

Cross sections in dependence of α_4 coupling parameter



Kinematics

Observable showing large differences with varying α_4 : $\Delta\phi(l\bar{l})$



Selected Talks

- Blockkurs Graduiertenkolleg, DESY Zeuthen, October 2011** Vector Boson Scattering at the LHC [talk]
- Whizard-Workshop, DESY Hamburg, November 2011** Simulation of Vector Boson Scattering with Whizard [invited talk]
- Helmholtz Alliance meeting, Bonn, December 2011** Studying weak boson scattering at the LHC (VBS plans in Central Jet Veto group) [talk]
- Implications of LHC results for TeV-scale physics, CERN, March 2012** Vector boson scattering with Whizard and Sherpa (MC studies) [invited talk]
- MCnet+LPCC Summer School on MC Event Generators, CERN, July 2012** Event generation for Vector Boson Scattering [Poster]
- ATLAS VBS/VBF Jamboree, BNL, November 2012** Monte Carlo for VBS: Standard Model and anomalous quartic gauge couplings [talk]

Publications

- Implications of LHC results for TeV-scale physics: signals of electroweak symmetry breaking. S. Heinemeyer, M. Kado, et. al. (Open Symposium of the European Strategy Preparatory Group, Krakow, Polen) 09/2012
- Studies of Vector Boson Scattering with an Upgraded ATLAS Detector at a High-Luminosity LHC. ATL-PHYS-PUB-2012-004, ATLAS Collaboration, 11/2012; to appear in: Briefing book for the European Strategy for Particle Physics

Profit from the GK

- Collaboration with other members (exchange about methods and tools, theoretical input)
- Blockkurs lectures as means to get more education and training
- Funding of travels to workshops, conferences, to give talks

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