

Working group I report

VBSCan Kick-off Meeting
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Marco Zaro
*LPTHE - Université Pierre et Marie Curie
Paris - France*



Mathieu Pellen
*TP2 - Universität Würzburg
Würzburg - Germany*



Working Group Deliverables

1. A standard for the definition of Vector Boson Scattering signal and background processes to be used in calculations and experimental analyses will be set.
2. Signal and background processes will be described a significantly better precision than available nowadays, with next-to-leading precision in the strong and electro-weak perturbation theory of the Standard Model.
3. Means will be developed for the isolation of the scattering of longitudinal vector boson modes and establish a protocol to be followed for theoretical predictions and the interpretation of experimental results, which will allow the measurement of the longitudinal component at the High Luminosity Large Hadron Collider
4. A reference parameterisation for beyond-the-Standard-Model physics effects in Vector Boson Scattering will be determined, with next-to-leading precision in the strong and electro-weak perturbation theory of the Standard Model.
5. Define the necessary features in theoretical calculations to achieve the Large Hadron Collider Run 2 data accuracy targets, and coordinate the implementation and validation of these theoretical features.



Working Group Objectives

I. A standard for the definition of Vector Boson Scattering signal and background processes to be used in calculations and experimental analyses will be set.

- Review of the state-of-the-art analysis techniques. (Month 1-15)
- Definition of the vector boson scattering signal for the phenomenological studies and data analyses within the first two years of the action. (Month 1-24)
- Study of an optimal strategy to isolate VBS from background processes in an experimentally sound manner (pile-up, non-perturbative effects, S/B issues, ...). The strategy should be suitable to be implemented in theoretical predictions, either at parton or at hadron level. (Month 1-24)

What has been done so far?

- Ongoing discussions with WG2 aimed at establishing a suitable definition for VBS
<https://twiki.cern.ch/twiki/bin/viewauth/VBSCan/VbsCanVBSCuts>

What are the plans for the future?

- Finalise set of cuts, keep them simple enough to be implemented by theorists in MonteCarlo's



Working Group Objectives

2. Signal and background processes will be described a significantly better precision than available nowadays, with next-to-leading precision in the strong and electro-weak perturbation theory of the Standard Model.

- Comparative study of the different tools/computer codes related to signal and background processes (both at fixed order and matched with parton showers), assessing the respective strengths and weaknesses. (Month 1-18)
- Set of predictions for the relevant processes including NLO QCD and EW corrections, and recommendations to include the effect of EW corrections (on central values and theoretical uncertainties) in event generators (NLO QCD+PS) used by experimental analyses. (Month 1-48)

What has been done so far?

- Comparative study of different tools/MonteCarlos just started → [Marco's talk](#)
- Progress in computation of higher-order corrections to VBS production (W^+W^+) → [Mathieu's talk](#)

What are the plans for the future?

- Continue and finalise the comparison, going beyond fixed-order NLO QCD
- Tackling processes other than W^+W^+ ?



Working Group Objectives

3. Means will be developed for the isolation of the scattering of longitudinal vector boson modes and establish a protocol to be followed for theoretical predictions and the interpretation of experimental results, which will allow the measurement of the longitudinal component at the High Luminosity Large Hadron Collider

- State-of-the-art review and comparative study of available tools/computer codes. (Month 1-15)
- Search of observables sensitive to the longitudinal polarisation state of the vector bosons, and development of experimental strategies to enhance such a sensitivity. (Month 6-24)
- Study of a suitable parameterisation to take into account BSM effects related to longitudinal polarisation, possibly using EFTs

What has been done so far?

- A new scheme for defining and measuring polarized cross sections for Vector Boson production has been proposed and applied to W^+W^-jj processes → [Ezio's talk](#)

What are the plans for the future?

- Complete implementation of the proposed scheme in a public event generator.
Extension of the method to the full set of VBS processes



Working Group Objectives

4. A reference parameterisation for beyond-the-Standard-Model physics effects in Vector Boson Scattering will be determined, with next-to-leading precision in the strong and electro-weak perturbation theory of the Standard Model.
- Theoretical motivations for EFT scan in terms of UV-complete theories. (Month 6-24)
 - Study of parameterisation for specific, widely used, models (MSSM, 2HDM, ...), including NLO QCD and EW effects (Month 6-24)
 - Validity of the EFT framework in VBS-like processes. (Month 6-24)
 - Determination of a standard reference for effective field theory parameterisation, to be used in all VBS studies and analyses within the first two years of the action. (Month 6-24)
 - Development of effective field theory parameterisations with NLO precision in QCD and EWK calculations. (Month 1-48)
 - Definition of analysis strategies to probe BSM effects (Month 6-24)
 - Estimate of the reach of the HL-LHC in terms of exclusion/discovery of BSM physics (Month 24-48)

What has been done so far?

- Just started! Kick-off meeting last week → [Ilaria's talk](#)

What are the plans for the future?

- Fix a parameterization for dimension 6 terms and define an analysis strategy
- Define optimal ways to report and use data for the EFT
- Analyse implications of VBS measurements in the EFT (e.g. possibility of distinguishing linear vs chiral EFT)



Working Group Objectives

5. Define the necessary features in theoretical calculations to achieve the Large Hadron Collider Run 2 data accuracy targets, and coordinate the implementation and validation of these theoretical features.
- Assessment of the experimental accuracy target and comparison with theoretical predictions (Month 24-48)
 - Understanding possible limitation of theoretical predictions (missing higher orders, uncertainties from parton distributions, ...) and wish-list of improvements in coordination with the RC2 deliverables (Month 24-48)

What has been done so far?

What are the plans for the future?

- Work on this objective has still to start

