# Muon Collider VBS WW analysis

Elham E Khoda*

*University of Washington

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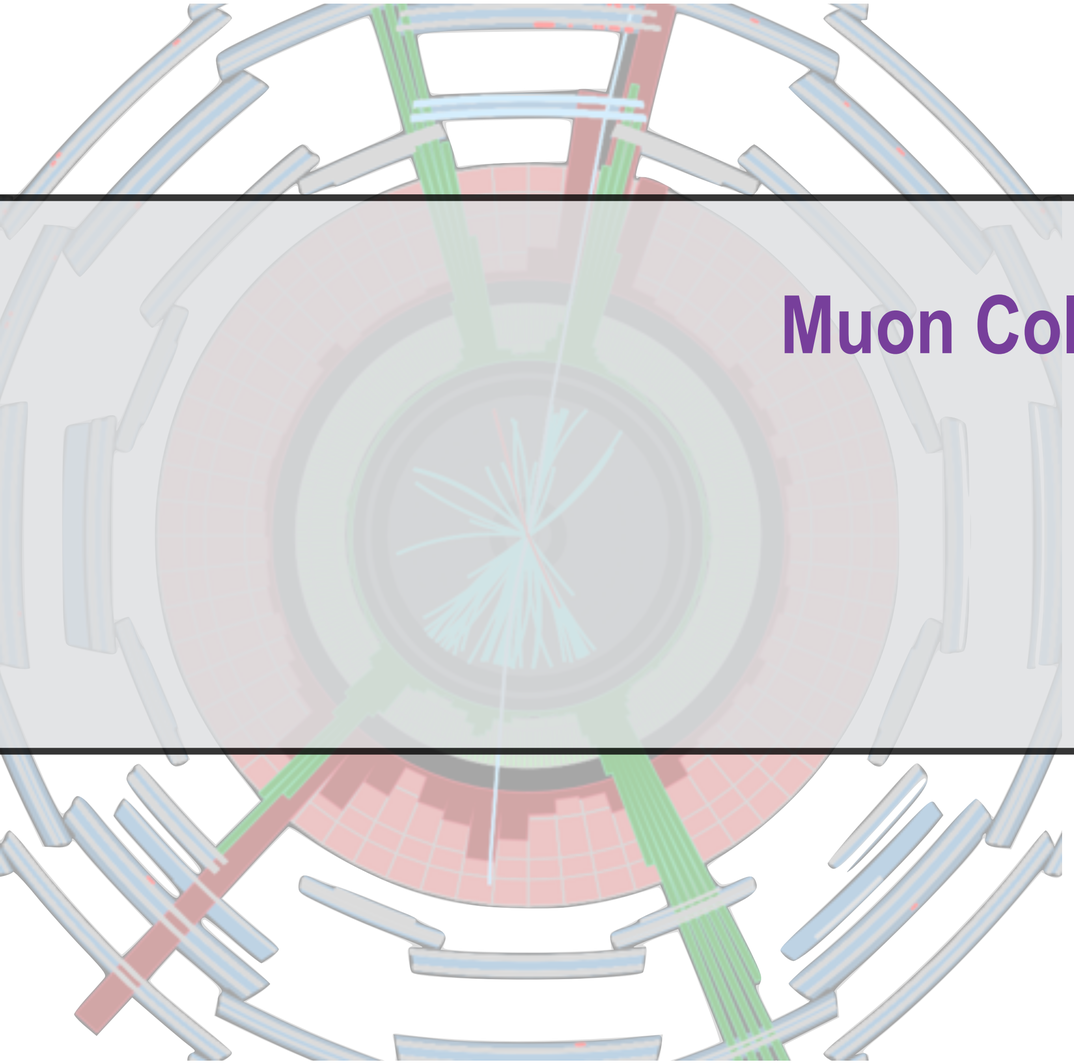
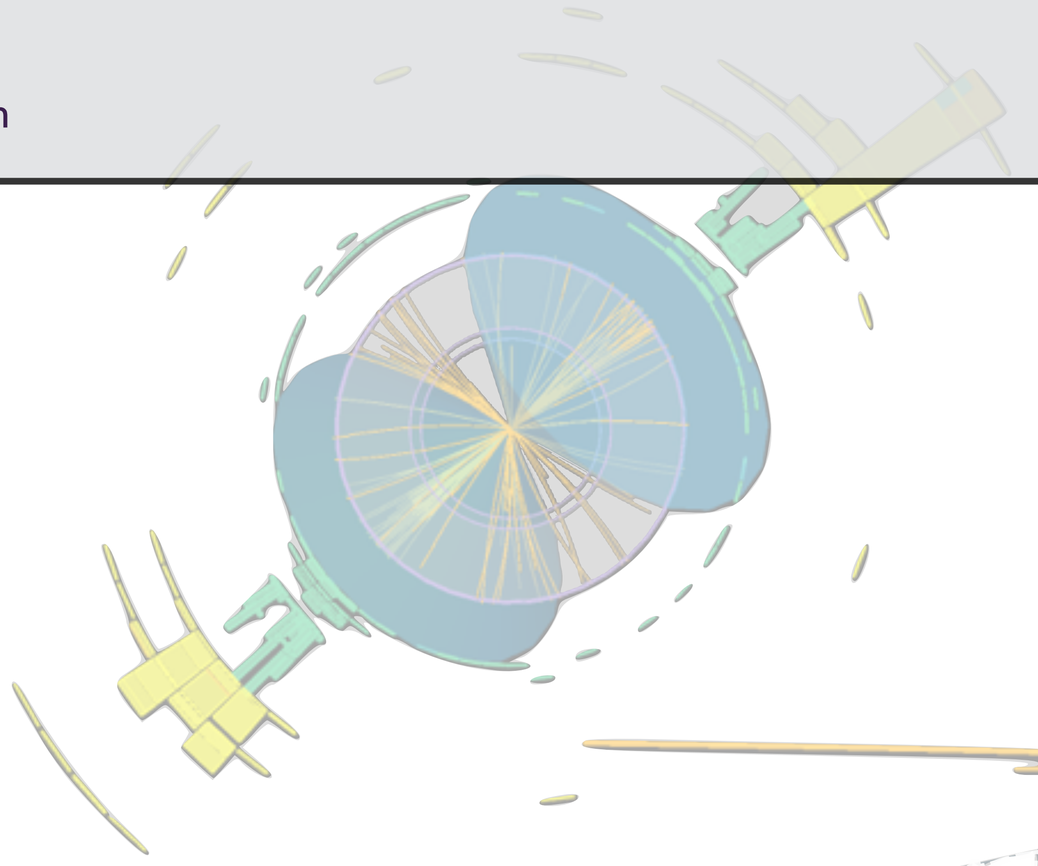




# Event selection studies: plan

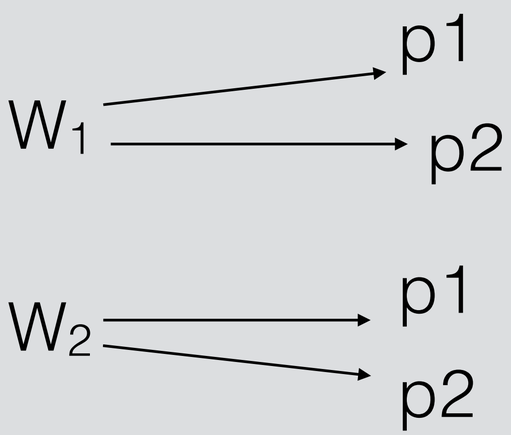
**Final state:** Fully hadonic WW + 2 neutrinos

- Do we need separate selections for **boosted**, **semi-boosted** and **resolved** ?

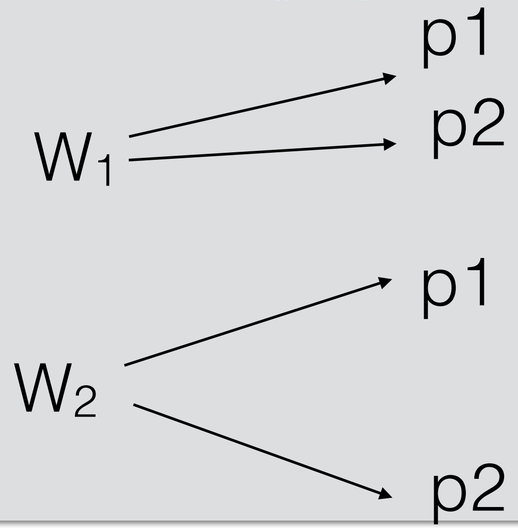
**Truth-level studies:**

- Initial explorations need to be done using truth-level partons
- Plot the dR (p1, p2) coming from each W as a function of W momentum/energy

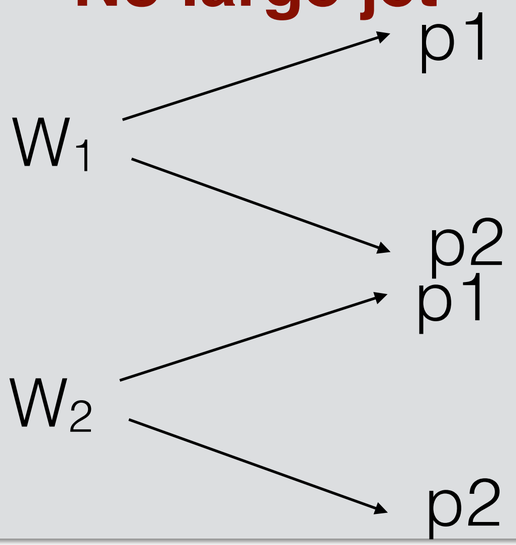
**Two large jets**




**One large jets**




**No large jet**



# Next step: Preliminary selection

Start with the basic selections applied in this paper (1 TeV ILC):
https://arxiv.org/pdf/1607.03030.pdf

Note: the paper has done only truth-level analysis

1. $M_{inv}(\bar{\nu}\nu) > 150$ GeV.
2. $|\cos\theta(W/Z)| < 0.8$ and $p_{\perp}(W/Z) > 150$ GeV.
3. $\theta(e) > 15$ mrad and $p_{\perp}(WW) > 45$ GeV, $p_{\perp}(ZZ) > 40$ GeV.
4. $575$ GeV $< M_{inv}(WW) < 800$ GeV, $600$ GeV $< M_{inv}(ZZ) < 800$ GeV.

**Moving towards reco:**

- First step is to find the appropriate jet clustering algorithm and Radius parameter
- Truth studies should give us some intuition

# Stat analysis setup

The EFT-fun tool and some basic config files are kept in the git repo
https://github.com/mumu-multiboson/eft-fun

The tool expects:

- SM signal, INT, QUAD separately
- The limits are generally expressed in the unit of TeV(-4) in publications
- When we set f = 1e-12 —> the unit is GeV(-4)

Table 3: The exclusion limits at 95% CL on each aQGC coefficient, parameterized using the distribution in $m_{W\gamma}$, and listed along with the unitarity bound. All coupling parameter limits are in $\text{TeV}^{-4}$, while the $U_{\text{bound}}$ values are in TeV.

| Parameters | Obs. limit | Exp. limit | $U_{\text{bound}}$ |
|---|---|---|---|
| $f_{M,0}/\Lambda^4$ | $[-8.1, 8.0]$ | $[-7.7, 7.6]$ | 1.0 |
| $f_{M,1}/\Lambda^4$ | $[-12, 12]$ | $[-11, 11]$ | 1.2 |
| $f_{M,2}/\Lambda^4$ | $[-2.8, 2.8]$ | $[-2.7, 2.7]$ | 1.3 |
| $f_{M,3}/\Lambda^4$ | $[-4.4, 4.4]$ | $[-4.0, 4.1]$ | 1.5 |
| $f_{M,4}/\Lambda^4$ | $[-5.0, 5.0]$ | $[-4.7, 4.7]$ | 1.5 |
| $f_{M,5}/\Lambda^4$ | $[-8.3, 8.3]$ | $[-7.9, 7.7]$ | 1.8 |
| $f_{M,6}/\Lambda^4$ | $[-16, 16]$ | $[-15, 15]$ | 1.0 |
| $f_{M,7}/\Lambda^4$ | $[-21, 20]$ | $[-19, 19]$ | 1.3 |
| $f_{T,0}/\Lambda^4$ | $[-0.6, 0.6]$ | $[-0.6, 0.6]$ | 1.4 |
| $f_{T,1}/\Lambda^4$ | $[-0.4, 0.4]$ | $[-0.3, 0.4]$ | 1.5 |
| $f_{T,2}/\Lambda^4$ | $[-1.0, 1.2]$ | $[-1.0, 1.2]$ | 1.5 |
| $f_{T,5}/\Lambda^4$ | $[-0.5, 0.5]$ | $[-0.4, 0.4]$ | 1.8 |
| $f_{T,6}/\Lambda^4$ | $[-0.4, 0.4]$ | $[-0.3, 0.4]$ | 1.7 |
| $f_{T,7}/\Lambda^4$ | $[-0.9, 0.9]$ | $[-0.8, 0.9]$ | 1.8 |

**Example CMS paper:**
https://arxiv.org/pdf/2008.10521.pdf

So, currently the plan is to generate all the **INT** and **QAUD** setting **f = 1e-12** and get the limits directly in the unit of **TeV (-4)**