

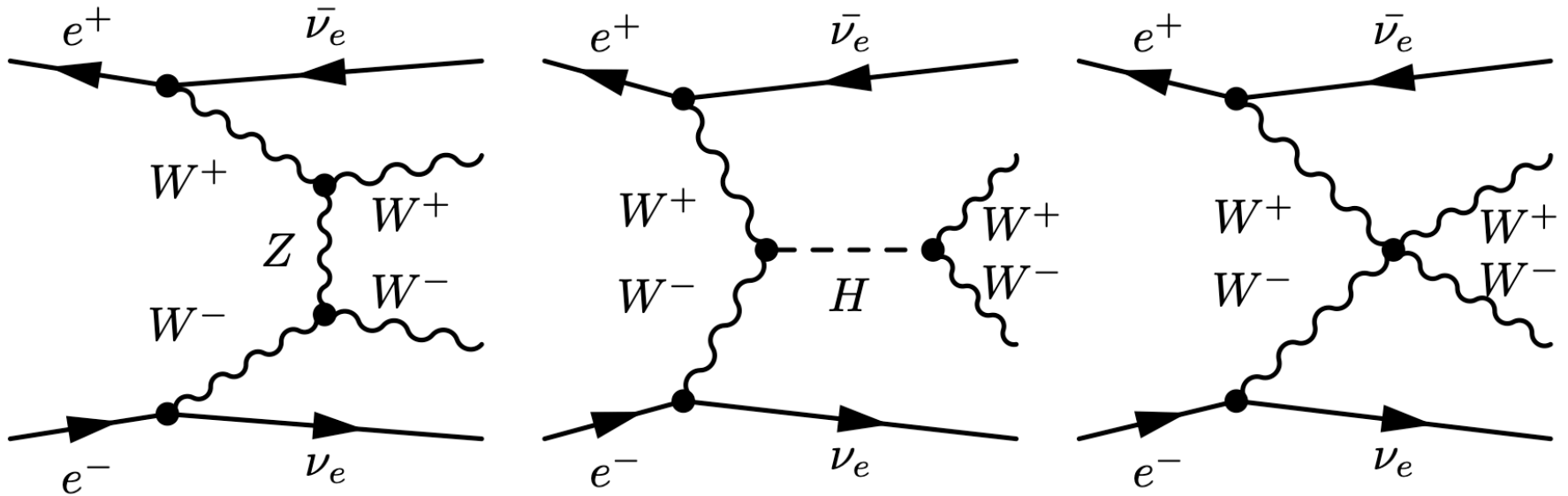
Delphes samples status

SM background samples

- Produced Delphes samples at $\sqrt{s} = 6$ TeV with WHIZARD
 - Initial state QED radiation. Lepton ISR structure functions included (soft-collinear, soft photon, and hard collinear radiation)
- Start with muon collider Delphes cards:
 - <https://github.com/delphes/delphes/tree/master/cards/MuonCollider>
 - Hybrid of FCC-hh and CLIC cards
 - Includes target detector performance without BIB background effects
 - Impact of BIB background can be assessed by varying the parameterized performances around the target performance without BIB
- Samples are currently located here (will copy to Snowmass space):
 - /eos/cms/store/user/arapyan/muon_collider/delphes_samples

VBS processes: $W^+W^- \nu \bar{\nu}$

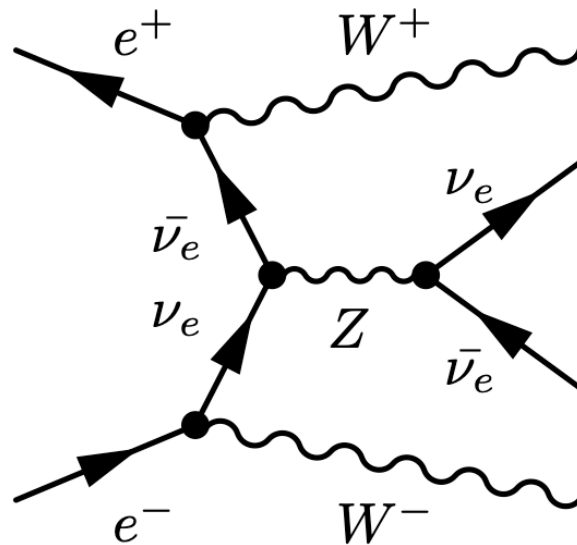
- Read $e^+ \rightarrow \mu^+$ in the Feynman diagrams that follow



- Cross section: 257.7 fb
- W s are decayed inclusively. Can produce fully leptonic and hadronic samples separately. Hadronic final state studied for e^+e^- in this ILC paper:
 - <https://arxiv.org/pdf/1607.03030.pdf>

$W^+W^- (Z \rightarrow \nu\nu)$

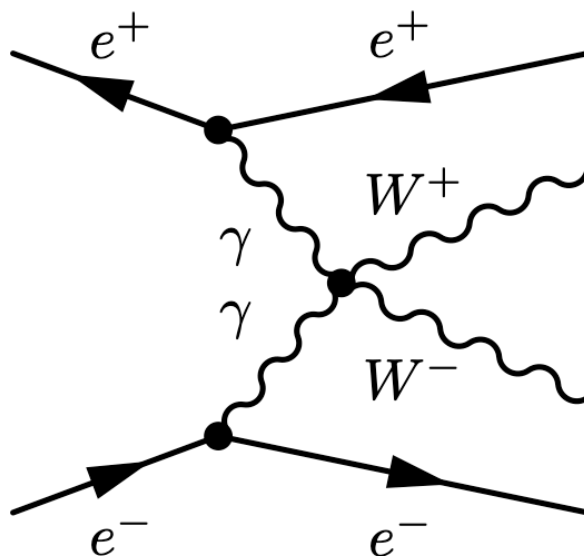
- Read $e^+e^- \rightarrow \mu^+\mu^-$ in the Feynman diagrams that follow



- Cross section: 3.6 fb
- W s are decayed inclusively. Can produced fully leptonic and hadronic samples separately. Hadronic final state studied for e^+e^- in this ILC paper:
 - <https://arxiv.org/pdf/1607.03030.pdf>

$W^+W^-\mu^+\mu^-$

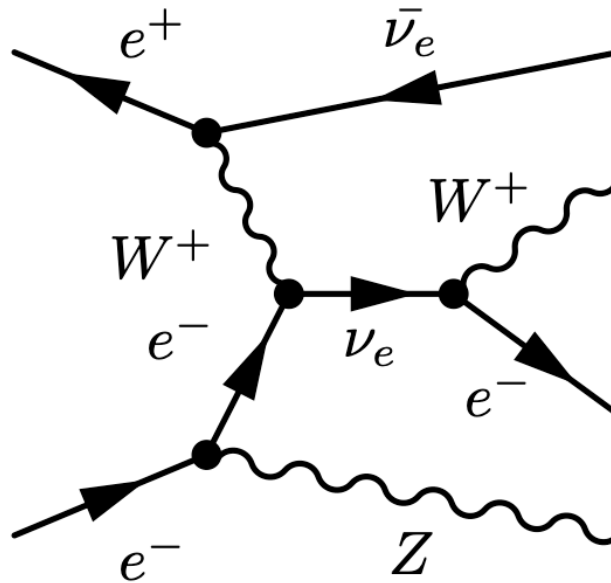
- Read $e^- \rightarrow \mu^-$ in the Feynman diagrams that follow



- Cross section: 2795.3 fb
- W s are decayed inclusively.
- Reducible photon-induced background: muons disappear in beam pipe. Can be reduced with forward muon veto and p_T requirements.

$W^+W^- \mu^+ \mu^-$

- Read $e^- \rightarrow \mu^-$ in the Feynman diagrams that follow



- Cross section: 2547.5 pb (to be understood, sent a question to the authors)
- W and Z are decayed inclusively
- Technical detail: don't allow intermediate Z and γ propagators as the generation becomes extremely slow with $\mu^+\mu^- \rightarrow Z/\gamma^* \rightarrow \dots$ diagrams

Samples

- `/eos/cms/store/user/arapyan/muon_collider/delphes_samples`
- `wpwm_6tev.root`, 1M events, 257.7 fb
- `wpwmz_6tev.root`, 1M events, 3.6 fb
- `ggwpwm_6tev.root`, 100K events, 2795.3 fb
- `wmuznu_6tev.root`, 1M events, 2547.5 pb (to be understood farther)

- Will cross check the cross sections with Madgraph as well. Madgraph doesn't have the beam ISR but should be small effect.

ADDITIONAL MATERIAL

Beam induced backgrounds

- Large amount of beam induced backgrounds from muon decays
 - Depends on beam energy and on the design of interaction region
 - High occupancy in the first layers of detector tracking system->need to asses the detector performance
 - Dedicated LOI #234 to study the performance of reconstructed objects in the presence of beam induced backgrounds

