

# NLO QCD and EW calculations with Recola and Sherpa

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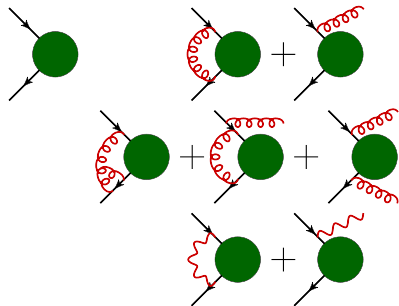


# Overview

- 1 NLO EW Calculations
- 2 QCD Results
- 3 EW Results
- 4 Conclusions

# Perturbative Accuracy in MCs

- Current Monte Carlo simulations are NLO QCD with a parton shower.
- Extending to NNLO QCD  $\rightarrow$  precision sensitive to EW corrections.  
 $(\mathcal{O}(\alpha_s^2) \sim \mathcal{O}(\alpha))$
- Large EW logarithms in Sudakov limit enhance correction



## NLO (EW) with SHERPA

S. Kallweit et al. arXiv:1511.08692, arXiv:1505.05704, arXiv:1412.5157

- $\sigma^{\text{NLO}} = \text{B} + \text{VI} + \text{RS}$   
 Sherpa: Born (B), real-subtracted (RS), integrated dipole (I)  
 OLP: virtual/loop (V)
- There is currently an implementation (not public) of full NLO EW computations with SHERPA+OpenLoops
- Currently papers on  $V$ +jets
- **Current work to also interface to Recola**
  - One-loop provider for NLO QCD and NLO EW
  - On-the-fly generation of NLO amplitudes
  - Can generate any SM process
  - **Validated: NLO QCD**
  - **Ongoing: NLO EW**

# SHERPA+Recola Collaboration



Mathieu  
Pellen -  
Recola



Benedikt  
Biedermann -  
Recola



Steffen  
Schumann -  
Sherpa

Stephan  
Bräuer -  
Sherpa

Jennifer  
Thompson -  
Sherpa

# NLO QCD Validation

## Several validation options

- Phase-space point comparison  
→ Precise numerical calculation
- Comparison of (Fixed Order) distributions  
→ Validation across phase-space regions

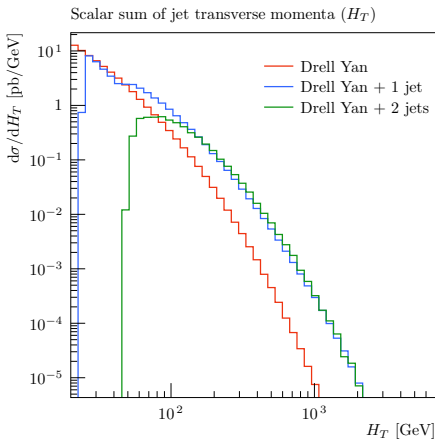
# NLO QCD Validation

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# NLO QCD DY Results

plots by Stephan Bräuer

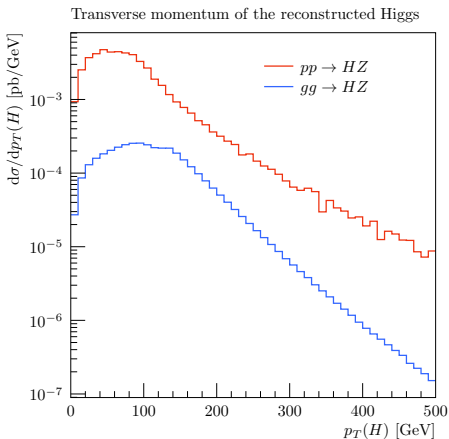


Only Sherpa+Recola shown. Sherpa+OpenLoops is identical



# NLO QCD vs Loop-induced $HZ$

plots by Stephan Bräuer



Only Sherpa+Recola shown. Sherpa+OpenLoops is identical

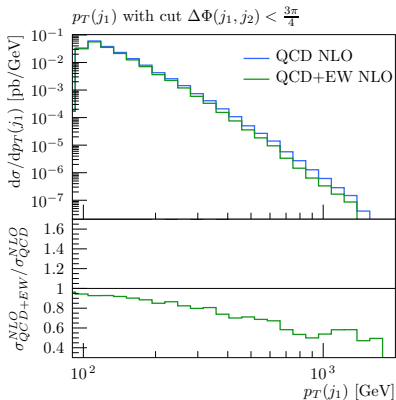
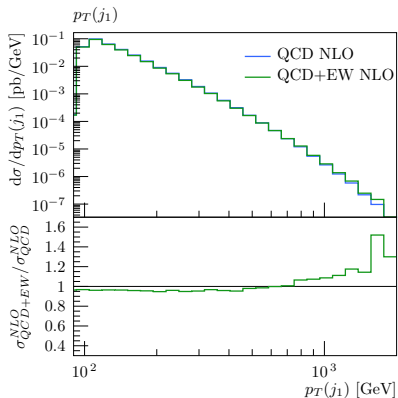
# NLO EW Validation

## More limited validation options

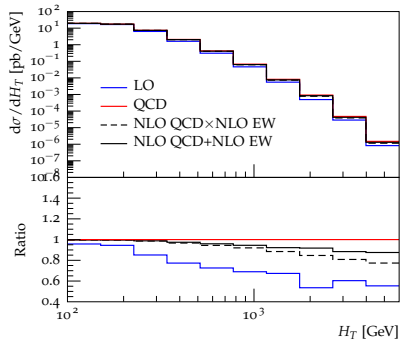
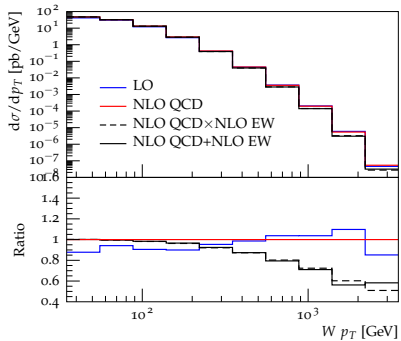
- No public options for phase-space point comparison
- Total cross sections
  - Precise comparison against published results
  - compare against in-house Monte Carlo
- Distributions
  - compares full phase-space
  - compare to published results
  - compare against in-house Monte Carlo

# Wj plots @ 13 TeV

c.f. S. Kallweit et al. arXiv:1412.5157v2 [hep-ph] plots by Stephan Bräuer

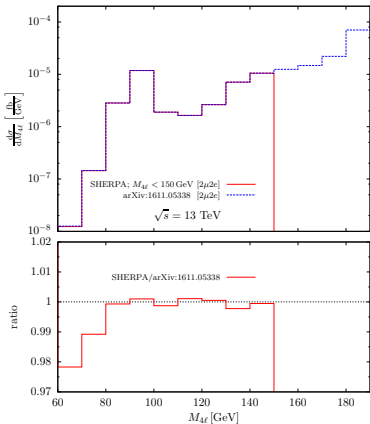
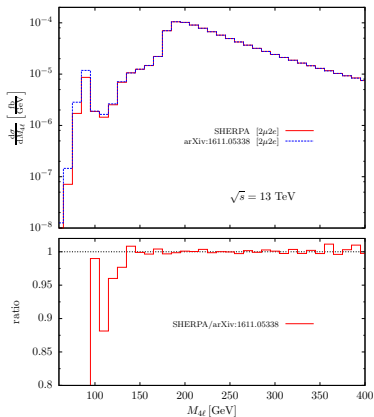


# Wjj plots @ 13 TeV



# Diboson @ 13 TeV: Comparison against independent code

B. Biedermann et al. arXiv:1611.05338, plot by Benedikt Biedermann



## Conclusions

- NLO EW ME corrections are an important extension to MC accuracy
- SHERPA already has an NLO EW interface to OpenLoops
- The SHERPA-Recola interface has been validated for NLO QCD
- Validation of NLO EW is ongoing
- Aim for full NLO QCD+NLO EW automation