

# MadFKS in MG5

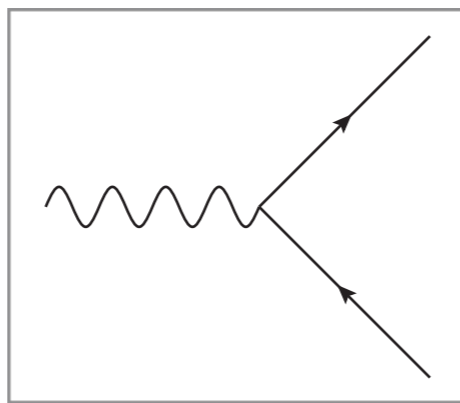
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# Automation of NLO computations

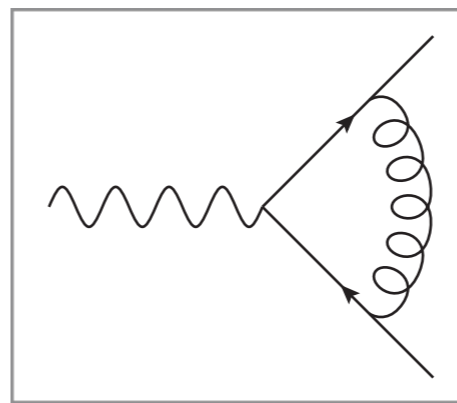
$$d\sigma_{NLO}^n = d\sigma_0^n + d\sigma_1^n + d\sigma_0^{n+1}$$

# Automation of NLO computations

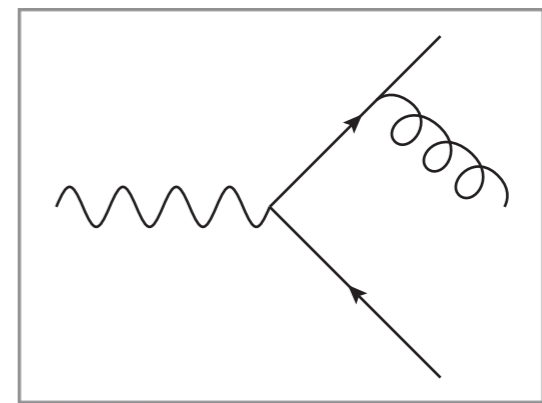
$$d\sigma_{NLO}^n = d\sigma_0^n + d\sigma_1^n + d\sigma_0^{n+1}$$



**Born**



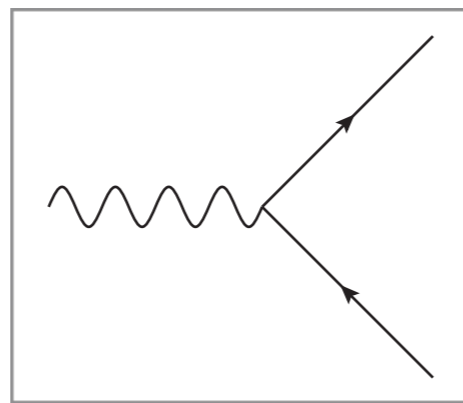
**Virtual**



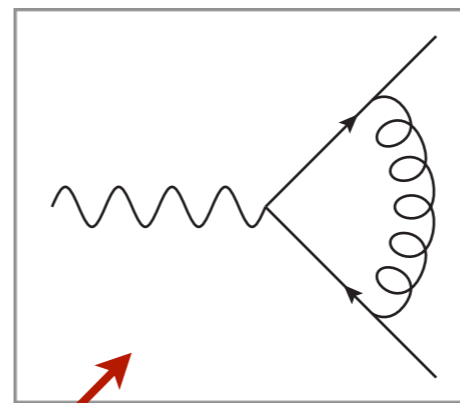
**Real**

# Automation of NLO computations

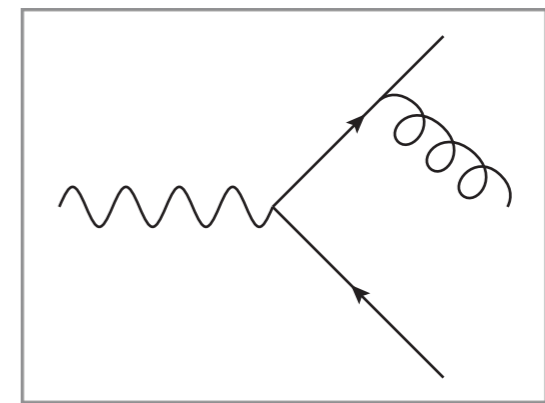
$$d\sigma_{NLO}^n = d\sigma_0^n + d\sigma_1^n + d\sigma_0^{n+1}$$



Born



Virtual



Real

See Valentin's talk

# Real emission: the ingredients

- Generate  $n+1$  body matrix element
  - Need to cure soft/collinear divergences
- Generate counterterms
  - Collinear counterterms (born)

$$\lim_{y_{ij} \rightarrow 0} |M|_{n+1}^2 \sim \frac{1}{p_i \cdot p_j} P_{j,j \oplus i}^0 |M|_n^2$$

- Soft counterterms (color-linked borns)

$$\lim_{\xi_i \rightarrow 0} |M|_{n+1}^2 \sim \sum_{jk} \frac{p_j \cdot p_k}{p_i \cdot p_j p_i \cdot p_k} |M|_{n,jk}^2$$

# Putting the ingredients together: the FKS subtraction

- Divergences arise in different PS regions
  - Need for an efficient cross-section integration
- Divide the PS in regions with at most one singular and one collinear singularity

$$|M|^2 = \sum_{ij} S_{ij} |M|^2 = \sum_{ij} |M|_{ij}^2$$

# Putting the ingredients together: the FKS subtraction

- Advantages:
  - Each contribution can be integrated independently with an *ad-hoc* PS parameterization
  - Number of contributions  $\sim N_{ext}^2$ 
    - Possibility to reduce exploiting symmetries

# MadFKS

- Use MadGraph to generate real-emission, born and color-linked born MEs
- Generate the PS parameterization
  - Born PS + splitting
- Integrate the cross-section
- Generate events



# Status (v4):

- MadFKS v4 is currently being used in aMC@NLO
  - Input: real emission process
  - Legs combinations (e.g.  $q \bar{q} \rightarrow g$ ) are hard-coded
  - Code generation can be slow
  - Many physics applications

# Status (v5):

- MadFKS v5:
  - Can start from real or born process
  - Leg splittings/recombinations are read from the model used
  - Code generation is fast (thanks to MG5)
    - ~40' for  $p p \rightarrow j j j (j)$ , starting from real
  - Further improvements possible
    - Process combination
    - ...

# MadFKS from real

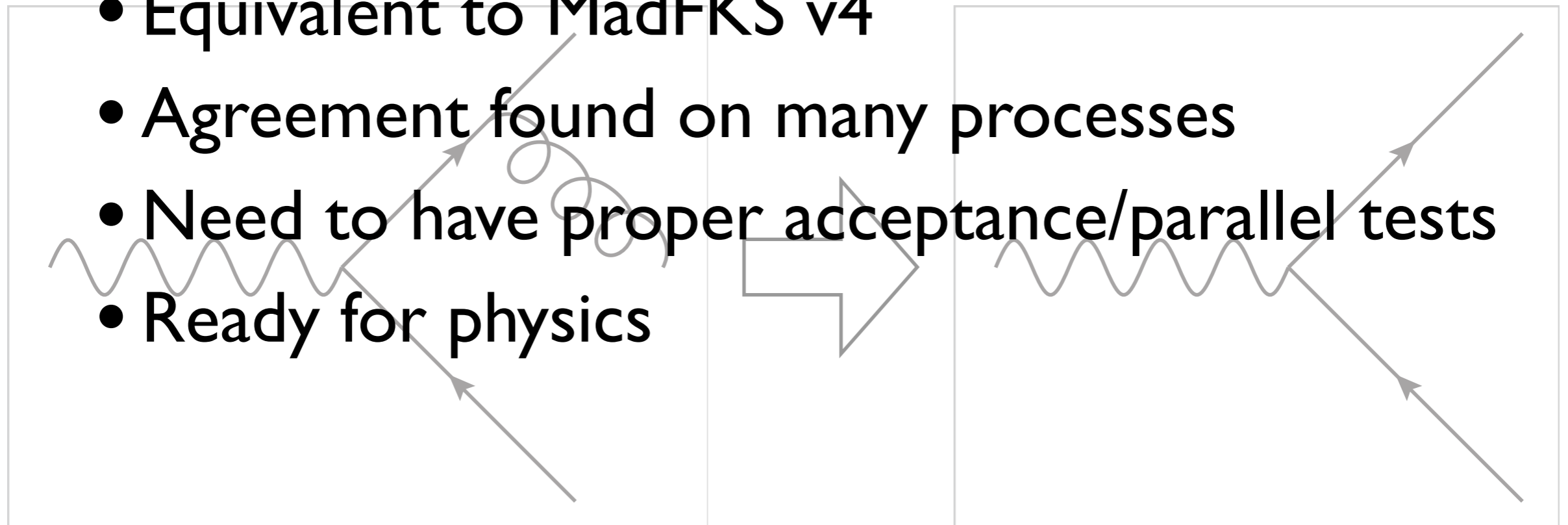
- MadFKS v5, from real:

- Equivalent to MadFKS v4

- Agreement found on many processes

- Need to have proper acceptance/parallel tests

- Ready for physics



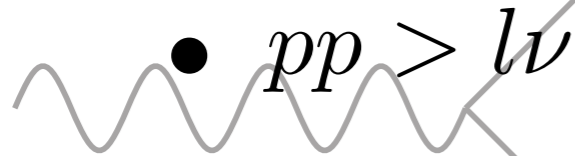
# MadFKS from born

- MadFKS v5, from born:

- Currently work in progress

- Tested for simple processes

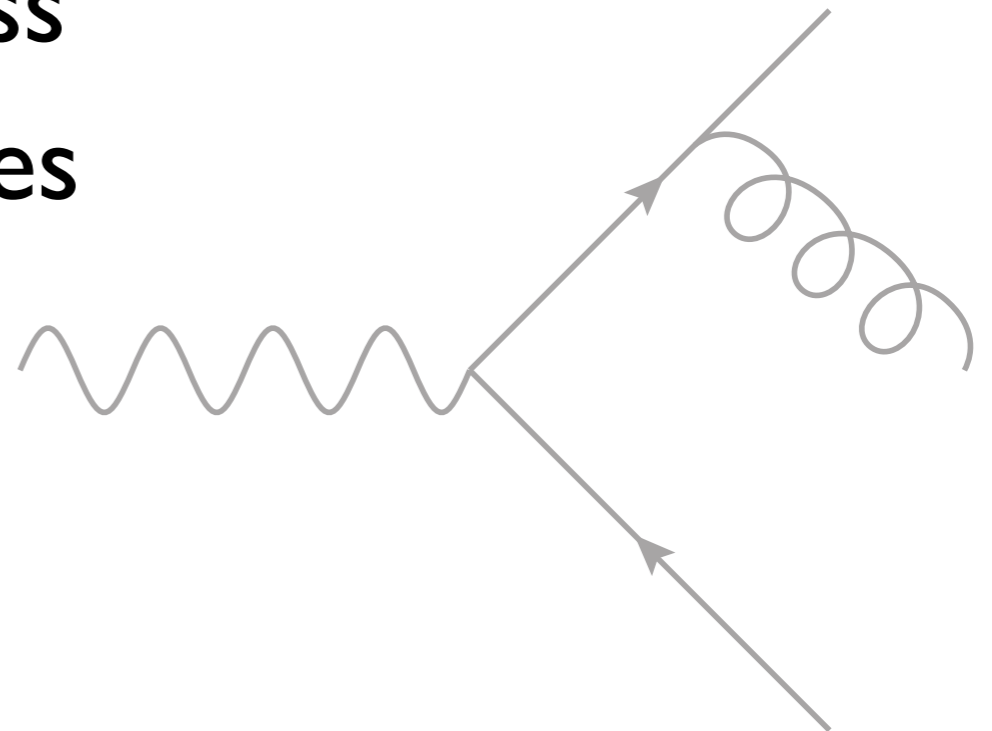
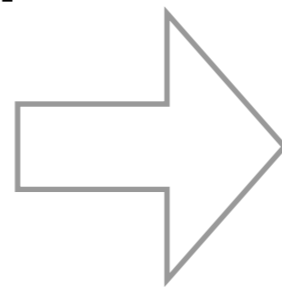
- $pp > l\nu$



A Feynman diagram showing a wavy line on the left and a straight line with an arrow pointing up and to the right on the right. A vertical line connects them, with a small circle at the top vertex.

- $pp > t\bar{t}$

- $e^+e^- > jj$



- Agreement found with MadFKS from real

# Conclusion

- MadFKSv5, starting from real emission, can be considered ready
  - The best test is to do real physics with real users
  - Works/studies on multi-jets in progress
- MadFKSv5, starting from the born, still needs some polishing/testing
- Need to merge asap with MadLoop 5