gg→ HH

NNLO σ in fb with CTEQ10

Scale	√s			
	7	8	13	14
$\mu = m_{HH}/2$	7.52	10.9	37.2	44.1
$\mu = m_{HH}$	**6.85**	**9.96**	**34.3**	**40.7**
$\mu = 2m_{HH}$	6.12	8.94	31.1	37.1
"+" [%]	**10%**	**9%**	**8%**	**8%**
"-" [%]	**11%**	**10%**	**9%**	**9%**

Scale uncertainty

Thanks to Mazzitelli and de Florian for numbers

Improvements in Theory

- What do we want?
  - Full NLO with masses

    Masses change distributions
  - When can we use $m_t \to \infty$
  - How to estimate m_t uncertainties?
  - aMC@NLO / Low energy expansion (Grigio) get opposite sign of m_t effects

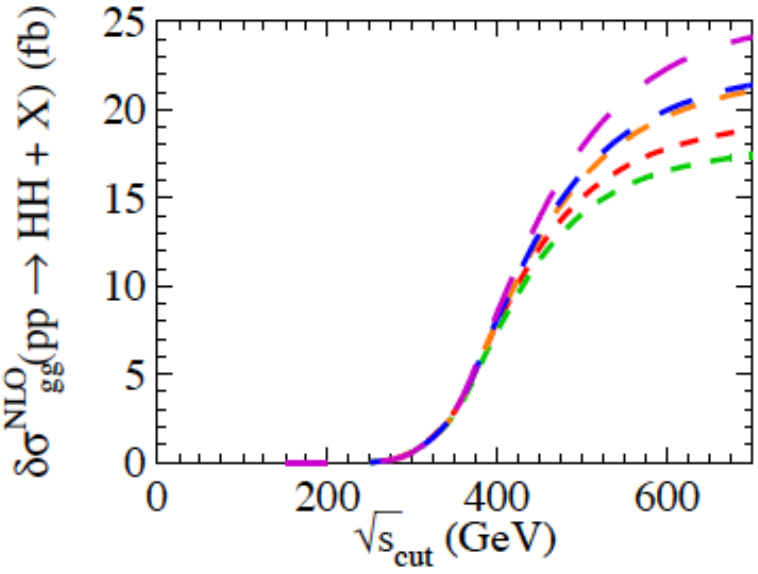
Advances/Improvements

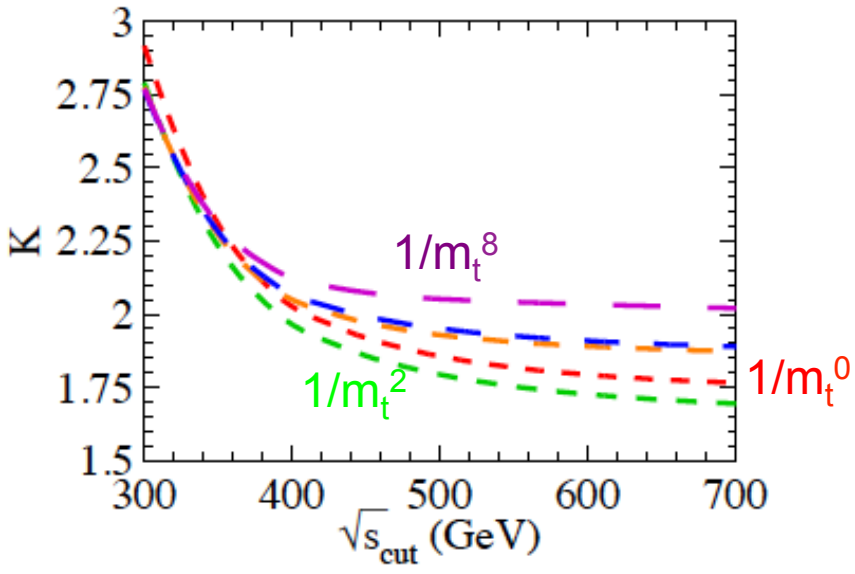
- HOW BIG ARE $1/m_t^2$ CORRECTIONS?
- Compute NLO with virtual corrections in $m_t \rightarrow \infty$ limit and real corrections with exact m_t dependence (improved HEFT)
- Compute $1/m_t^2$ corrections to NLO and normalize to exact LO
- Different results from 2 approaches

$1/m_t^2$ corrections at NLO: Grigo,Hoff, Melnikov, Steinhauser, arXiv:1305.7340
HEFT: Maltoni, Vryonidou, Zaro, arXiv: 1408.6542; Frederix et al, arXiv: 1401.7340

NLO with $1/m_t^2$ corrections

- Poor convergence of $1/m_t^2$ expansion
- Impose cut on partonic energy, $\sqrt{s}_{cut}$ (=m_{HH} at LO)





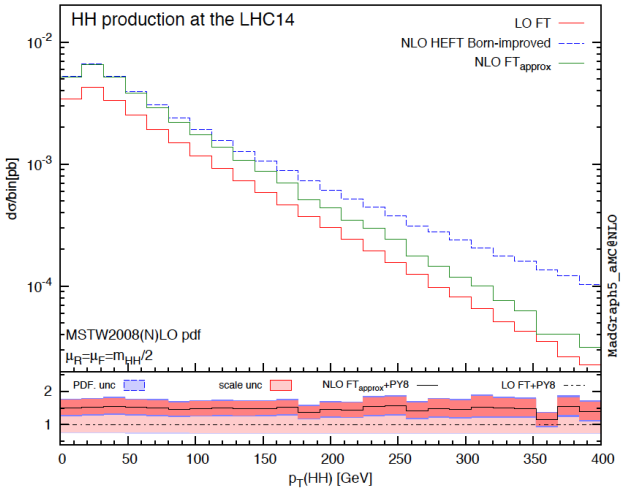
Mass corrections give O(10%) increase to NLO rate

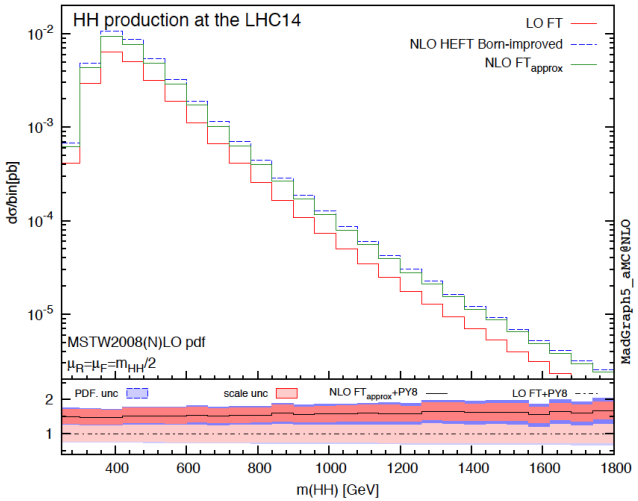
$1/m_t^2$ corrections at NLO: Grigo,Hoff, Melnikov, Steinhauser, arXiv:1305.7340

NLO FT_{approx}

- Include m_t in Born and in real contributions at NLO
- Only approximation is in 2-loop virtual contributions

11% decrease from result obtained rescaling mt➔∞ NLO K factor by exact





Uncertainty from m_t is +/- 10%?

Same order as EFT coefficients!

[Maltoni, Vryonidou, Zaro, arXiv: 1408.6542]

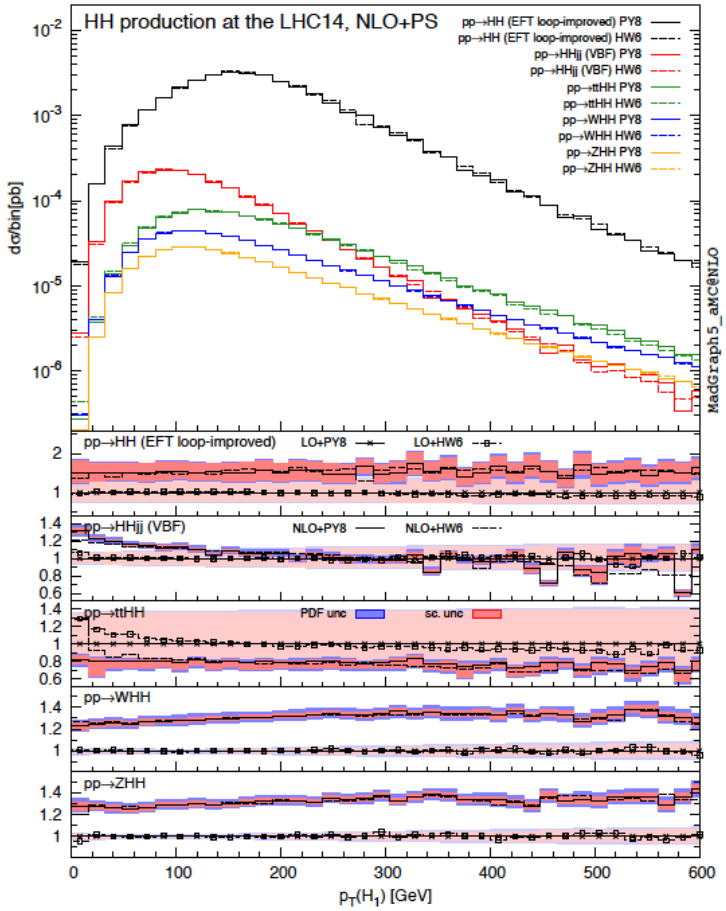
Improvements in Theory

What is status of MCs?

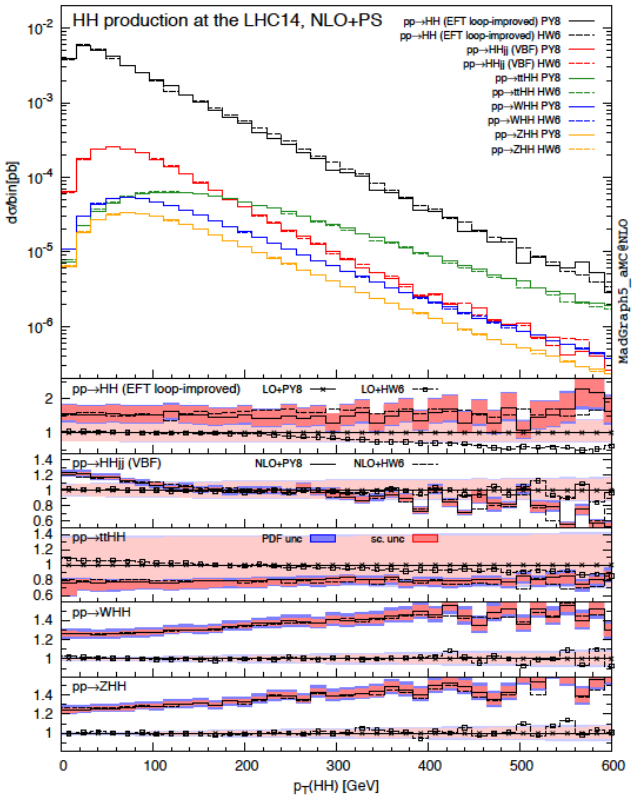
– What do we need?

- Are there re-summed calculations we need?
  – Jet vetos?

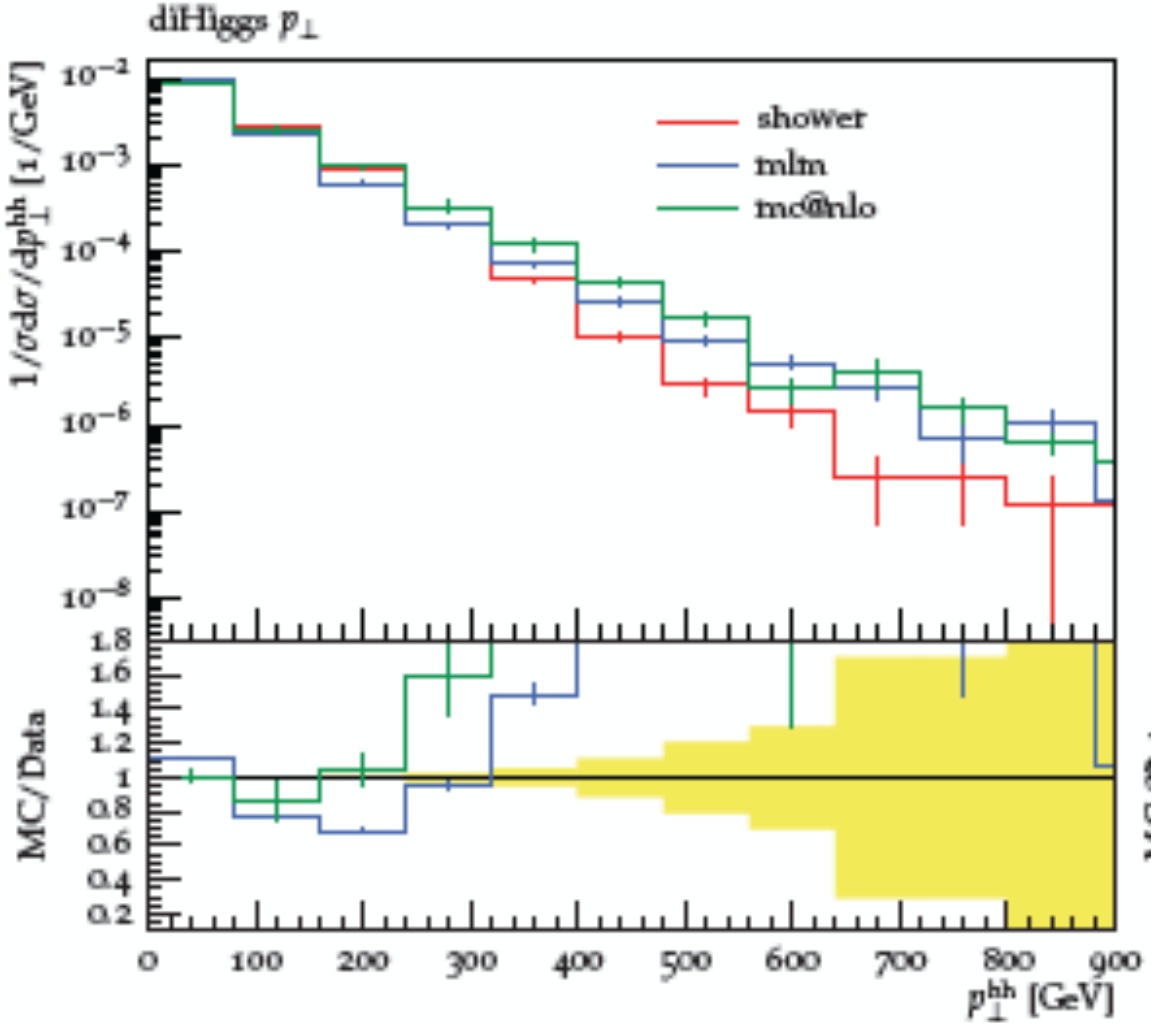
What is best strategy?



Constant K factor?



SM, HH
Frederix et al, 1401.7340



Operationally: What is best way to do simulations?