High precision physics for color singlet processes .

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HELMHOLTZ

DESY.

My background:

My background:

My background:

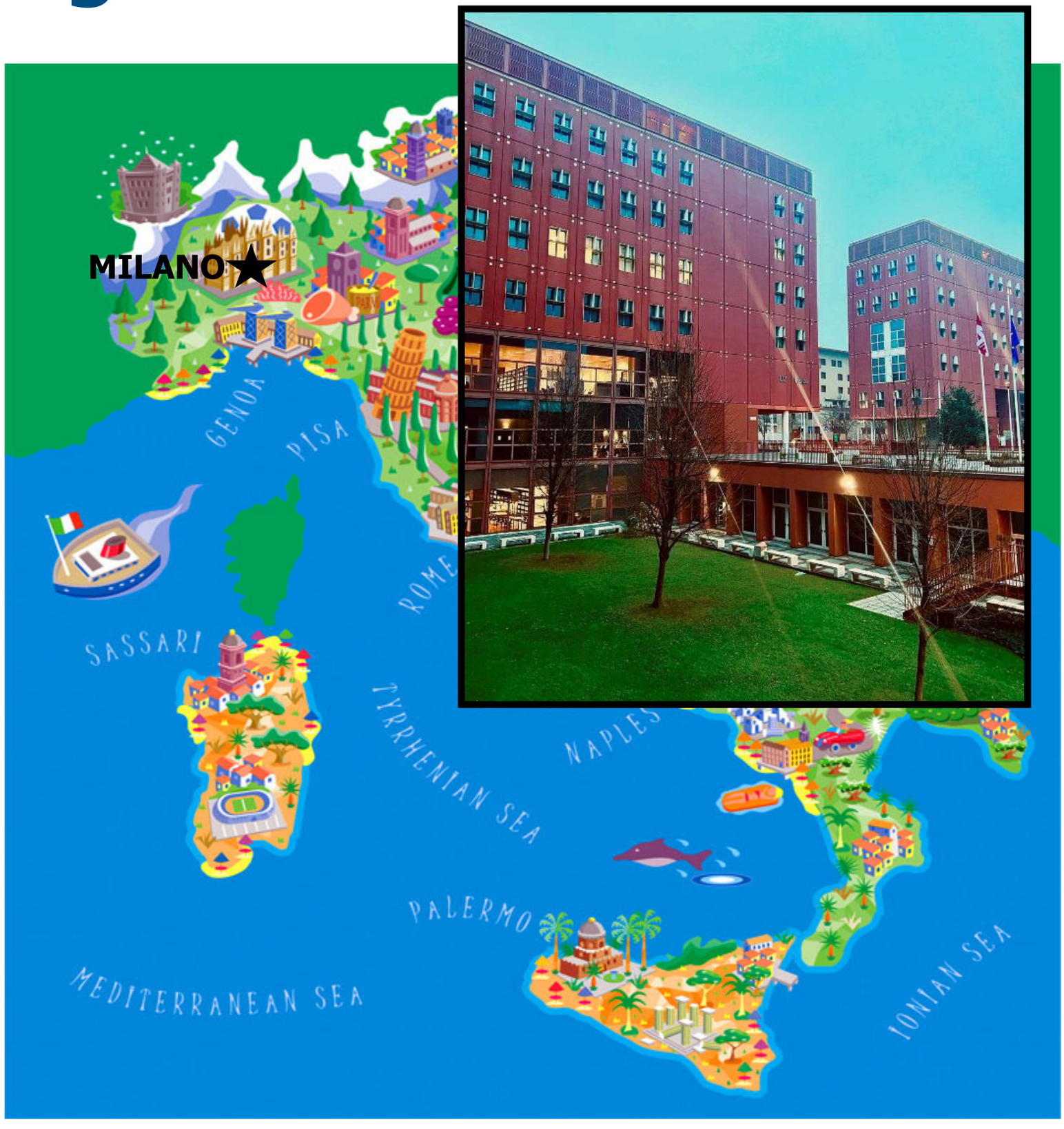
My background:

Bachelor and Master Degree

My background:

My background:

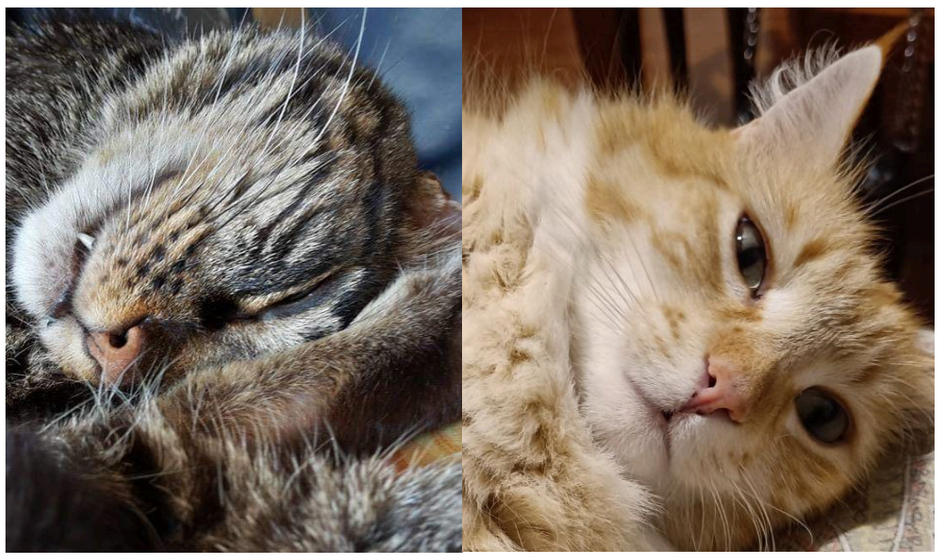
Almost Ph.D. 🤞



About me:

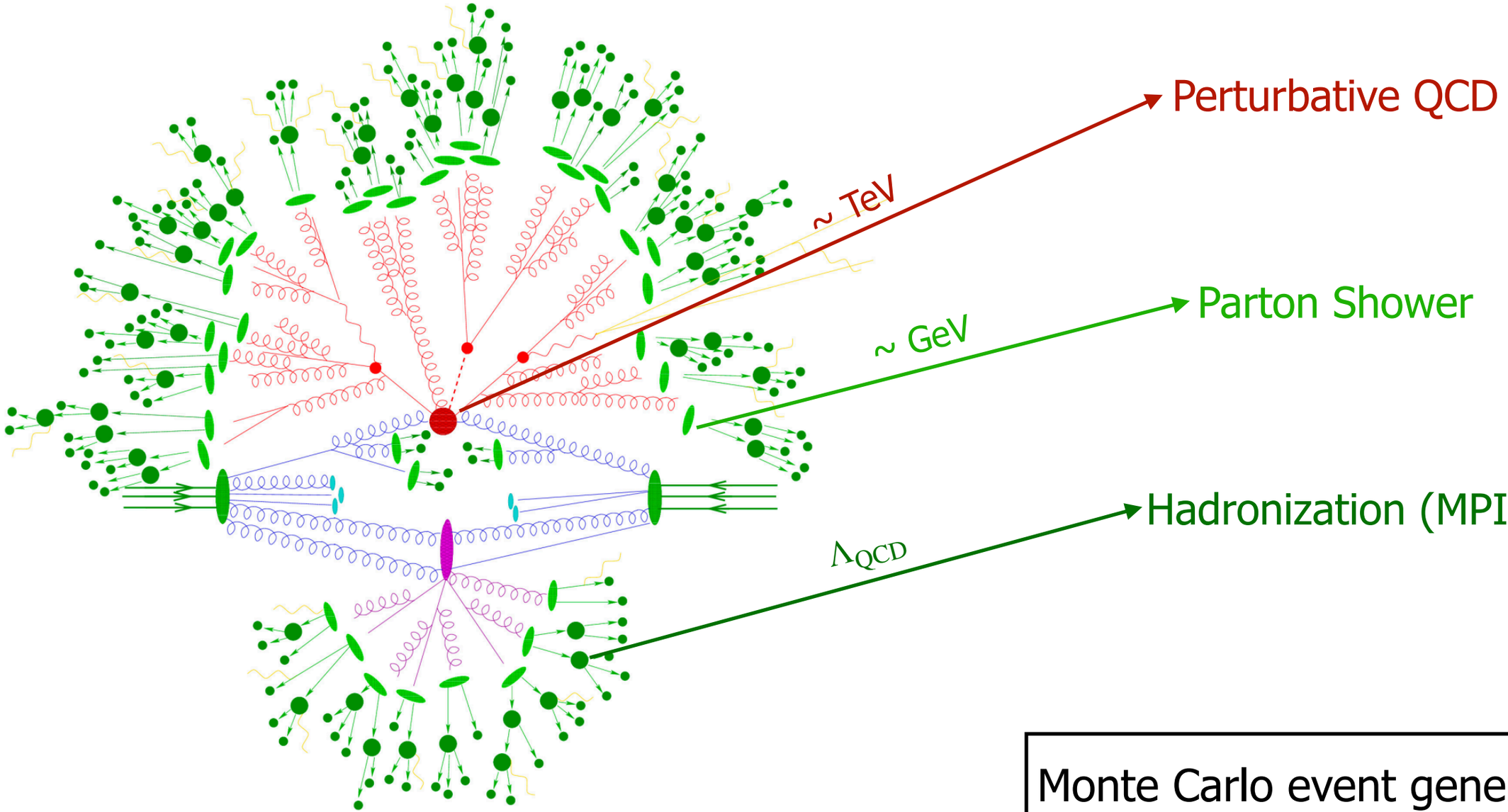
- FOOD and DRINKS:

- TRAVELLING
- READING: Italo Calvino ❤️
- SPORT: Athletics, Volleyball, Beach Volley, Rugby, Crossfit
- MUSIC: everything BUT Daniele Silvestri and Blink 182
- CATS:



My work:

High-energy precision physics



Monte Carlo event generator

My work:

Perturbative QCD:

$$\hat{\sigma} = \sum_k \alpha_S^k \hat{\sigma}_k$$

CAN depend on logarithms of energy scale ratios

$$\hat{\sigma}(Q^2, \ldots, \alpha_S) = \hat{\sigma}_0(Q^2, \ldots, \alpha_S)[\#1$$
$$+\#\alpha_S + \#\alpha_S \log(x)$$
$$+\#\alpha_S^2 + \#\alpha_S^2 \log(x) + \#\alpha_S^2 \log^2(x)$$
$$\ldots$$
$$+\#\alpha_S^n + \#\alpha_S^n \log(x) + \ldots + \#\alpha_S^n \log^n(x)]$$

If $\alpha_S \log(x) \sim 1$ resummation to all orders is needed!

Threshold resummation

Threshold Resummation:

On the approaches to threshold resummation of rapidity distributions for the Drell-Yan process

(10.1140/epjc/s10052-023-12089-3)

$$\frac{1}{\tau}\frac{\mathrm{d}\sigma}{\mathrm{d}Q^2\mathrm{d}Y}(\tau, Y, Q^2) = \sum_{i,j}\int_{x_1^0}^1 \frac{\mathrm{d}x_1}{x_1}\int_{x_2^0}^1 \frac{\mathrm{d}x_2}{x_2} f_i^{(1)}(x_1,\mu_F^2) f_j^{(2)}(x_2,\mu_F^2) C_{ij}\left(\frac{\tau}{x_1x_2}, y, \alpha_S(\mu_R^2), \frac{Q^2}{\mu_F^2}, \frac{Q^2}{\mu_R^2}\right)$$

$$\tau = \frac{Q^2}{s} \qquad z = \frac{Q^2}{\hat{s}}$$

$$C_{ij}(z,y) = \frac{1}{z}\frac{\mathrm{d}\hat{\sigma}_{ij}}{\mathrm{d}Q^2\mathrm{d}y}(z,y) \longrightarrow \text{Threshold logarithms as } \alpha_S^n\left(\frac{\ln^k(1-z)}{1-z}\right)_+ \quad 0 \le k \le 2n-1$$

Resummation: Mellin space or Soft Collinear Effective Theory (SCET) approach

- **B**echer **N**eubert **X**u
- **B**onvini **F**orte **R**idolfi
- **B**anerjee **D**as **D**hani **R**avindran
  Ajjath **M**ukherjee **R**avindran **S**ankar **T**iwari
- **L**usterman **M**ichel **T**ackmann

MC event generator:

double Higgs boson production in the GENEVA framework

(10.1007/JHEP06(2023)205)

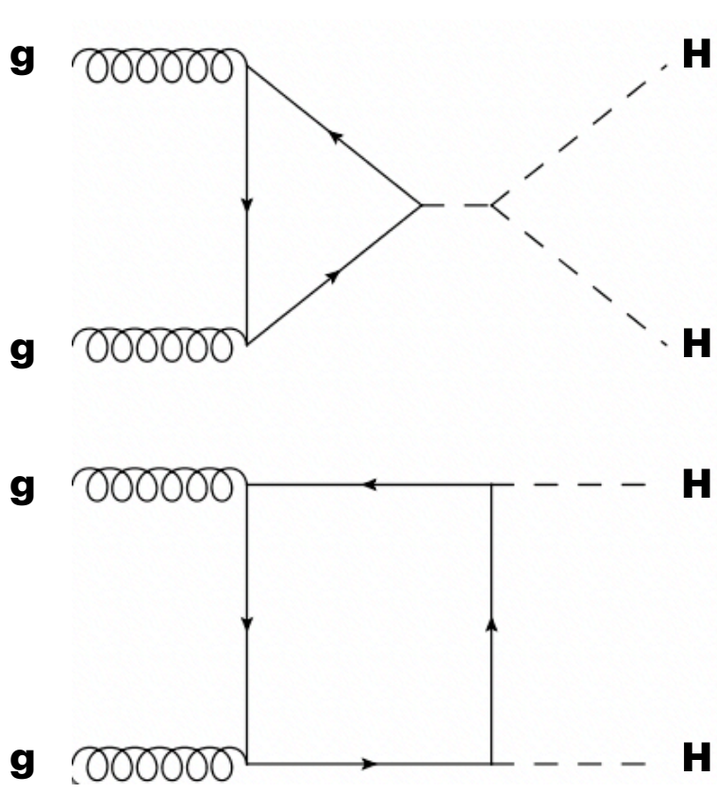
Fully differential fixed order calculations
up to NNLO in QCD through N-jettiness subtraction

Higher-logarithmic resummation
up to $\mathrm{N^3LL}$ through SCET or q_T-resummation for color singlet production

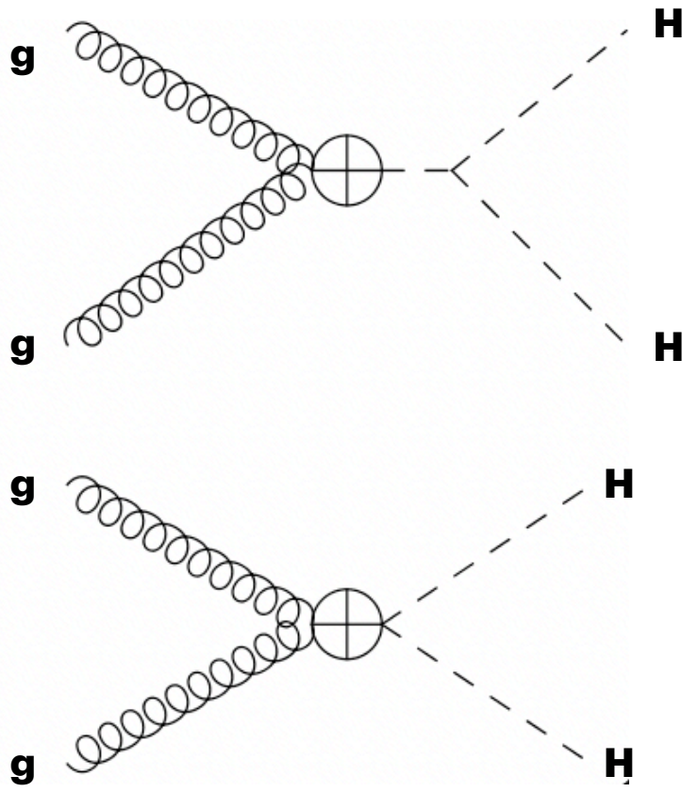
Parton showering, hadronization and MPI
Pythia8, Dire, Sherpa

Double Higgs boson production in the GENEVA framework

Massive



$m_t \to \infty$



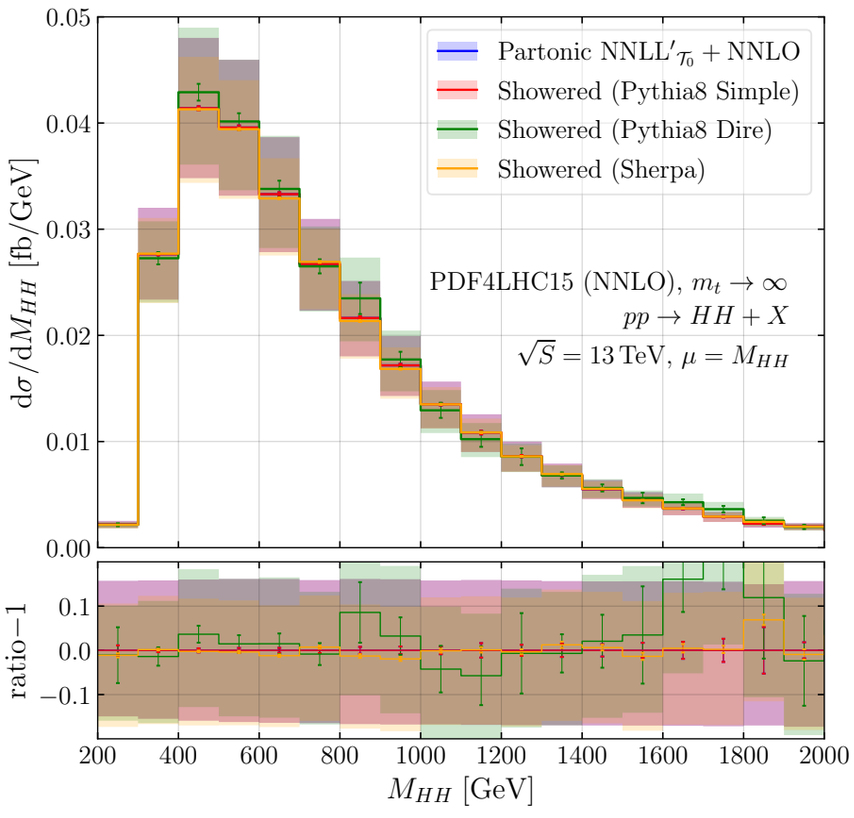
- $m_t \to \infty$ poor approximation for larger invariant masses;
- Top mass corrections needed for phenomenology.

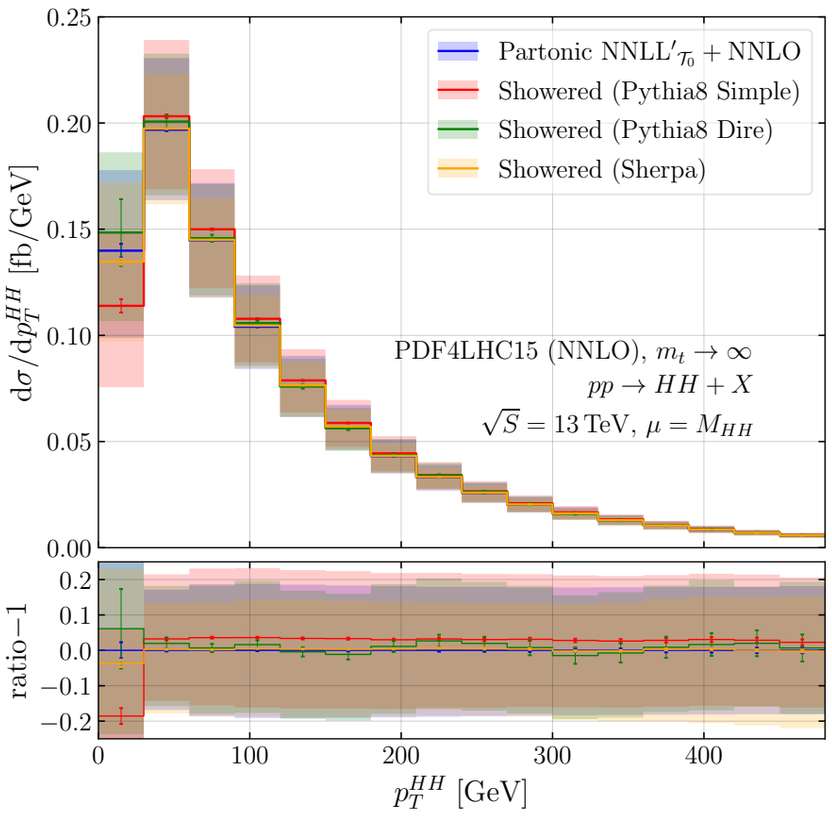
infinite top mass limit ($m_t \to \infty$) ✅, massive on going

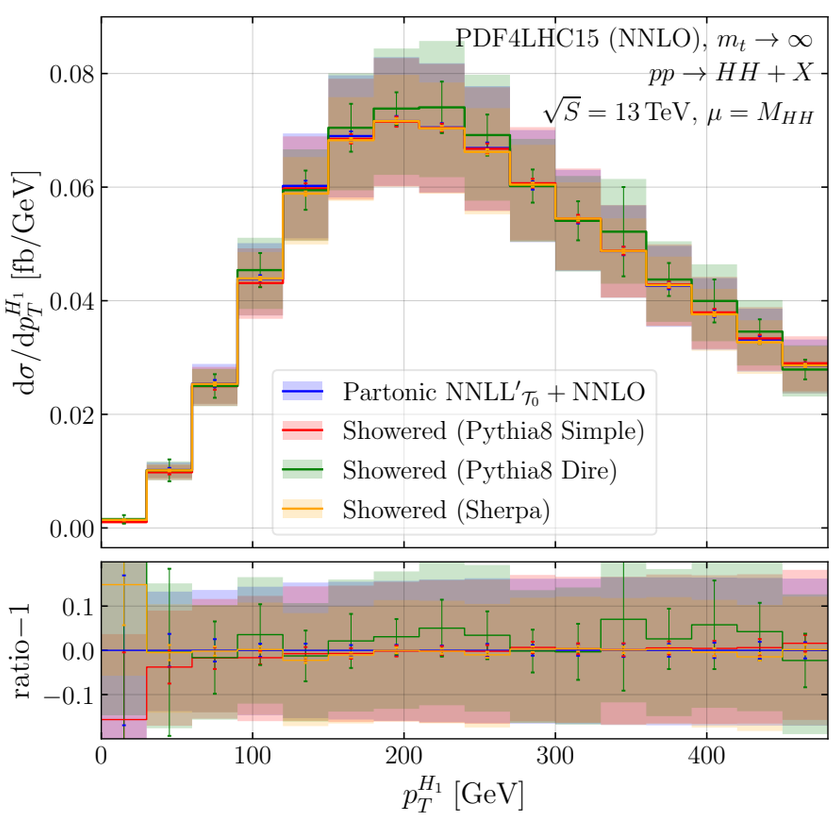
Double Higgs boson production in the GENEVA framework

Input parameters: $m_H = 125.09\,\text{GeV}$ $\mathcal{T}_0^{\text{cut}} = 1\,\text{GeV}$ $\mu_F = \mu_R = M_{HH}$

$\sqrt{S} = 13\,\text{TeV}$ $\mathcal{T}_1^{\text{cut}} = 1\,\text{GeV}$







THANK YOU !