update on semi-leptonic interference for the VBF final state

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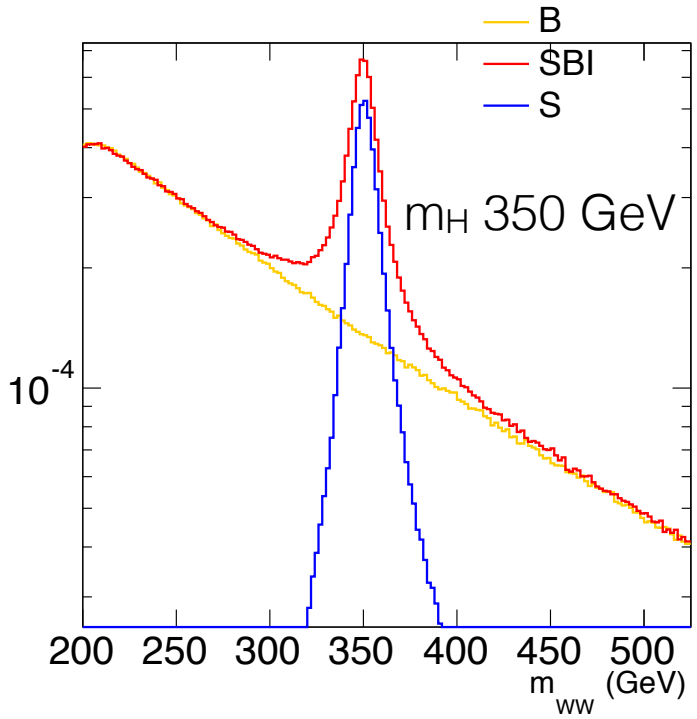
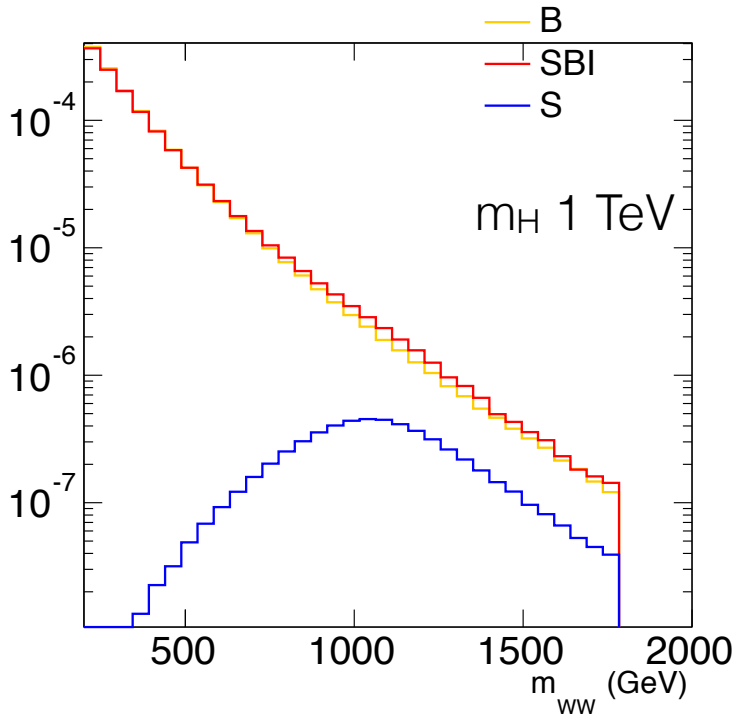
the starting point

- signal samples alone do not account for the **interference with the ewk production** (α_{EW}^6) of WW+2jets
- **phantom** performs the exact LO calculation of the 2→6 fermions process, with Higgs bosons with arbitrary masses
  - generated **samples with a Higgs-like resonance** at 350, 500, 650, 800, 1000 GeV
  - the generation with m_H = 126 GeV is used as **background-only estimate** (since all the Higgs effects have already taken into account at lower masses)
  - the difference between the two generations gives a **signal+interference distribution**
- **madgraph** generates at LO the signal alone, in a similar way to what powheg does at NLO

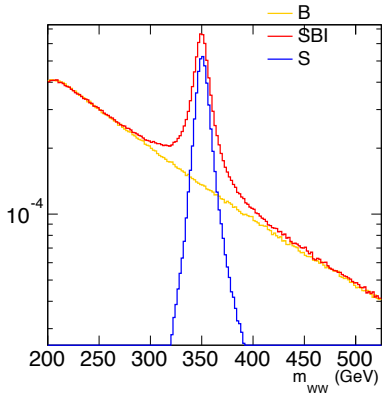
scales fixed to the Higgs pole mass for all the samples

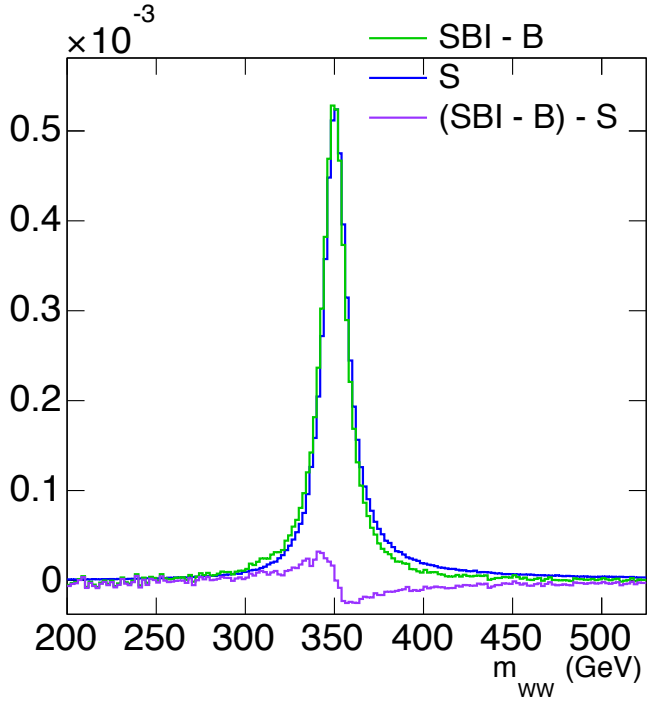




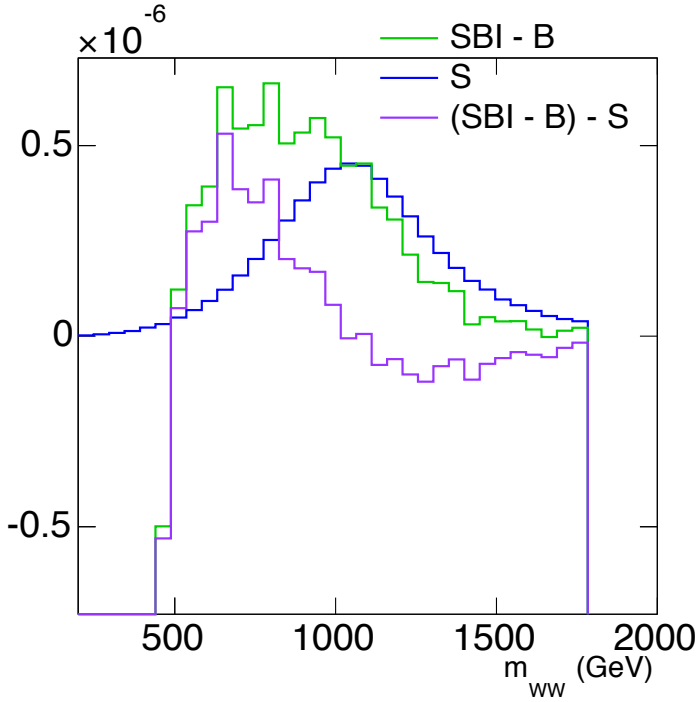
how to evaluate the interference

- SBI - B gives a signal + interference curve
- the signal-only curve comes from madgraph
- the comparison between the two gives a **correction factor to the signal-only distribution**, that introduces on the signal the effects of the interference, both in shape and normalisation
- effects become **important at large pole masses**,
  - the interference contribution alone (SI - S) is not necessarily symmetric
  - the peak gets shifted as well by the interference





m_H 350 GeV

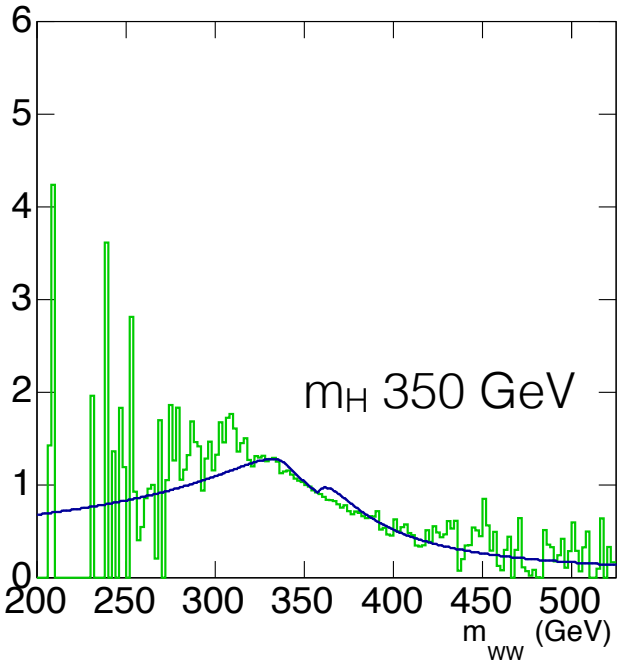


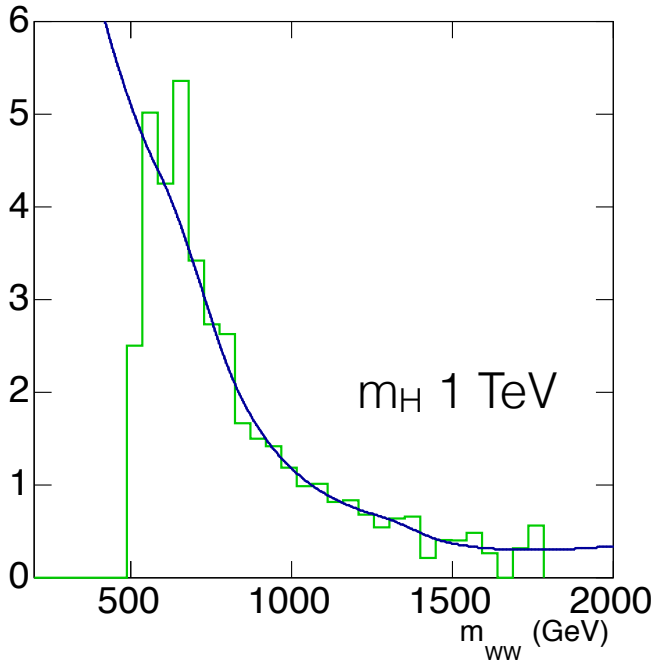
m_H 1 TeV

a correction factor

- for each available mass point, calculate the correction factor that needs to be applied

$$S_{\mathrm{pow}}^{corr}(m_{WW}) \;=\; S_{\mathrm{pow}}(m_{WW}) \times \frac{SBI_{\mathrm{ph}}(m_{WW}) - B_{\mathrm{ph}}(m_{WW})}{S_{\mathrm{mg}}(m_{WW})}$$



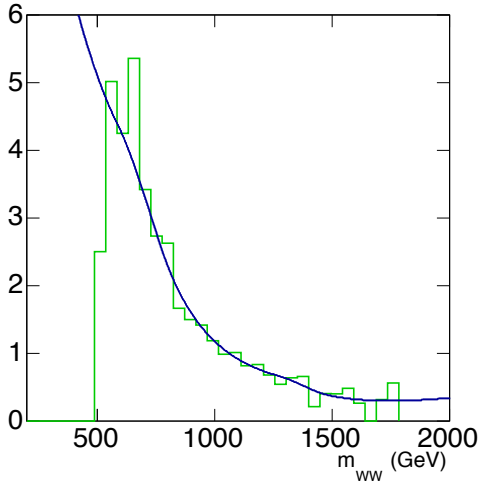


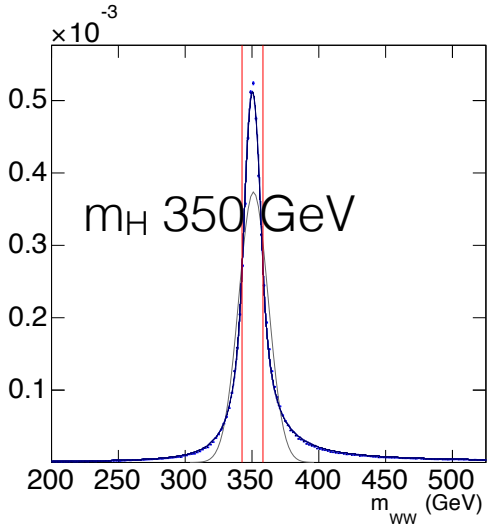
- blue lines are obtained from a fit…

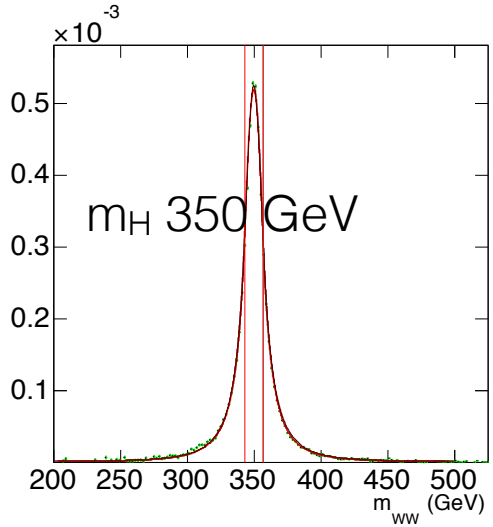
fit to the available masses

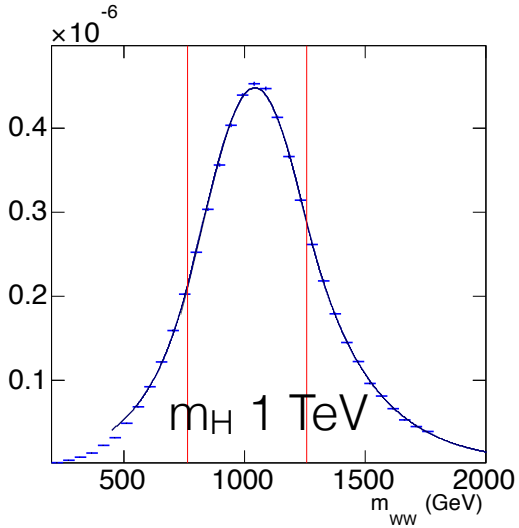
- the production of these corrections means generating at least 4M events per mass point in phantom, since most of them are background
- we have only few masses and look for a way to interpolate between the points
- for each mass **fit the signal and the signal+interference plots**

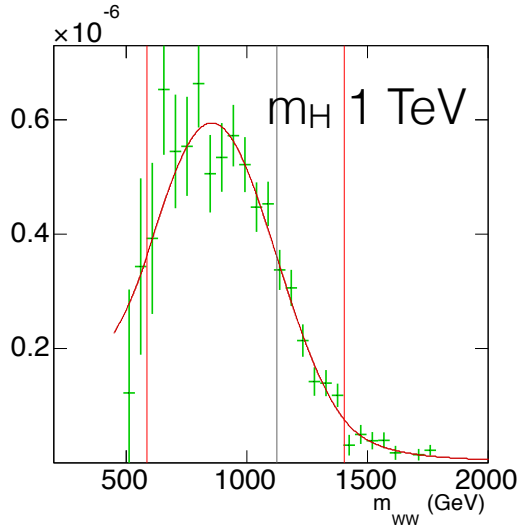
- on the left the madgraph signal, on the right the phantom signal +interference
- the **fitting function** has a gaussian core and two power-law tails (red vertical lines show the junctions)
- the **ratio of the fitting functions** gives the lines of the previous slide:









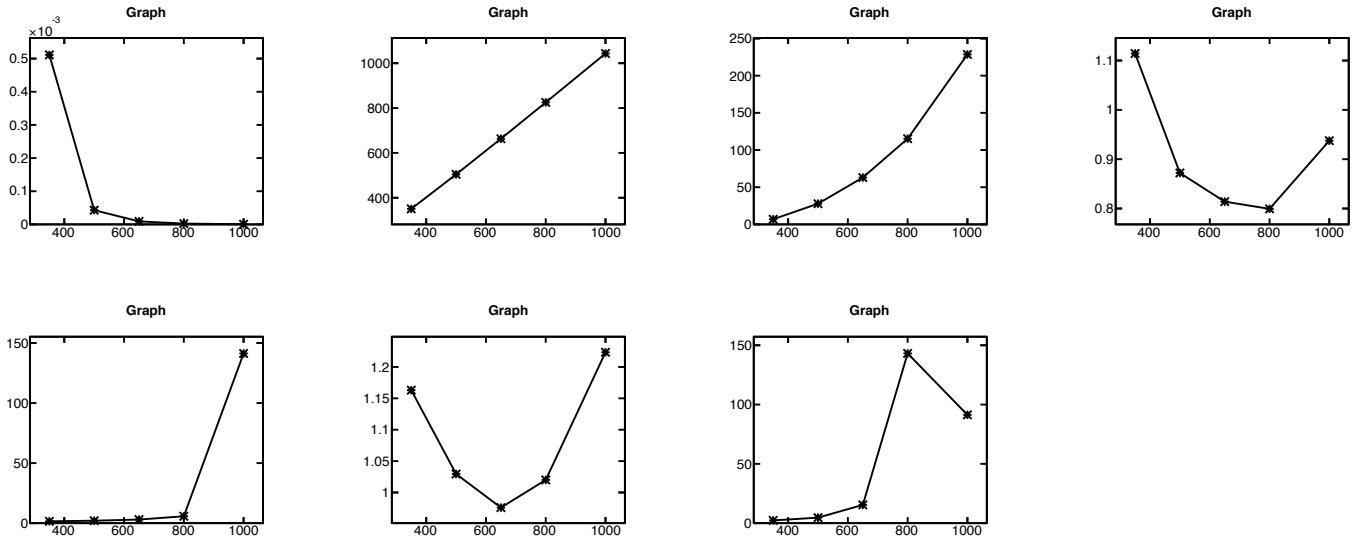


interpolation between masses

- **interpolate the parameters** of the fits as a function of the pole mass, for signal and background

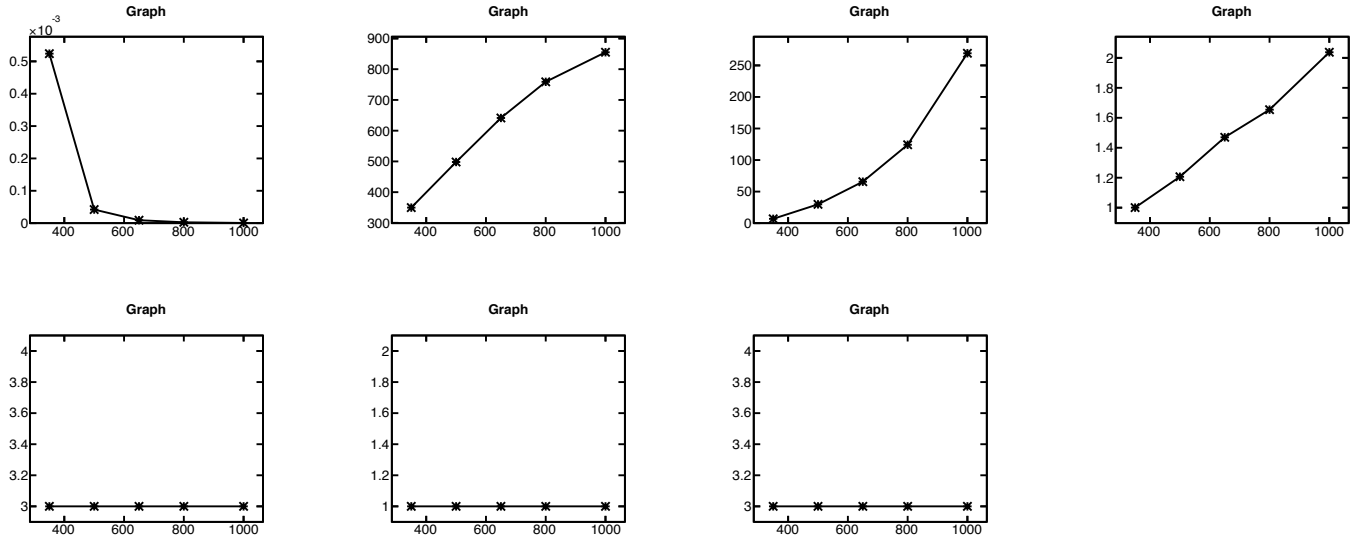
signal

linear extrapolation, but for the first parameter, where the linear extrapolation is done in log scale

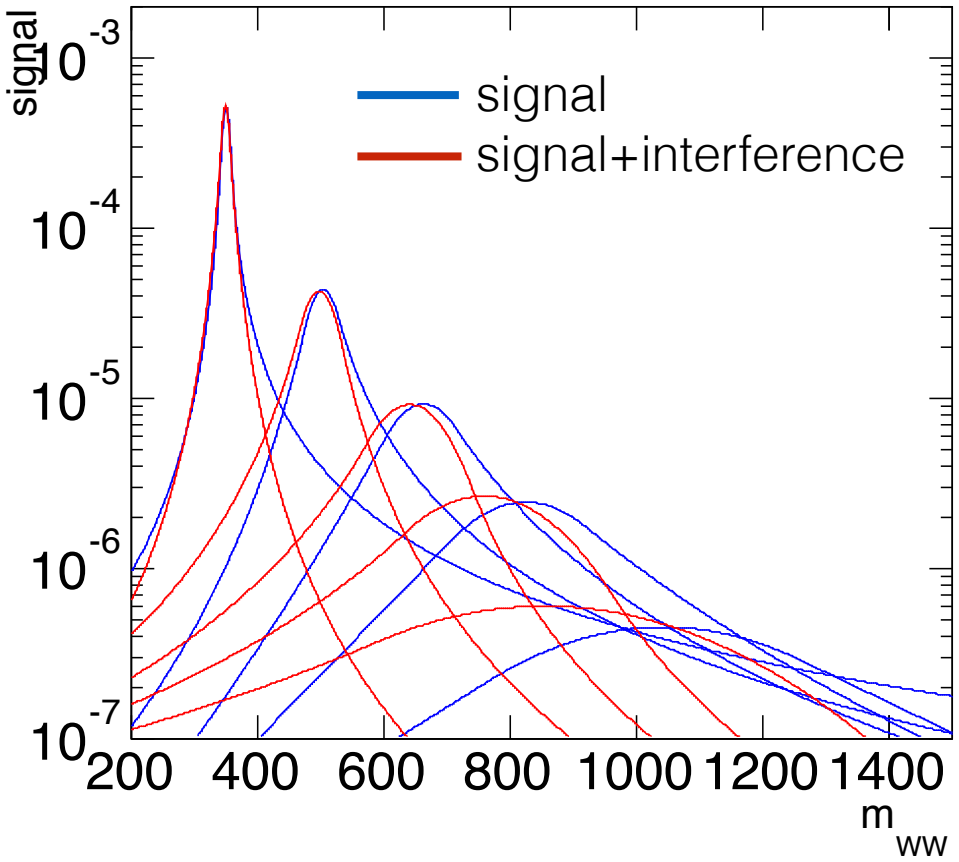


signal+interference

linear extrapolation, but for the first parameter, where the linear extrapolation is done in log scale



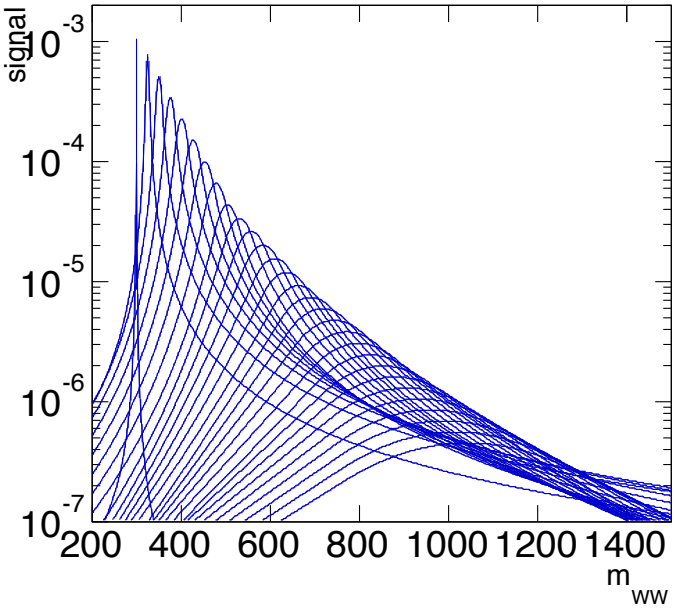
a first look at the obtained fits



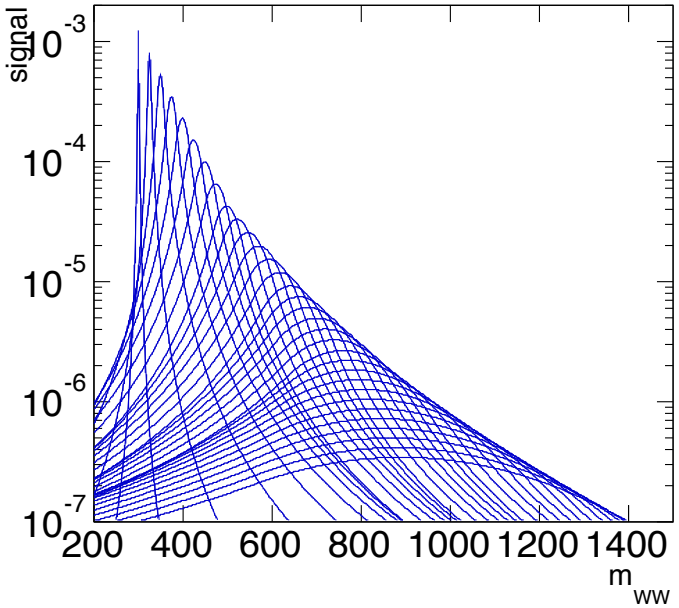
a glance at interpolated functions

- covers the mass range from 300 GeV to 1.1 TeV, at steps of 25 GeV

signal



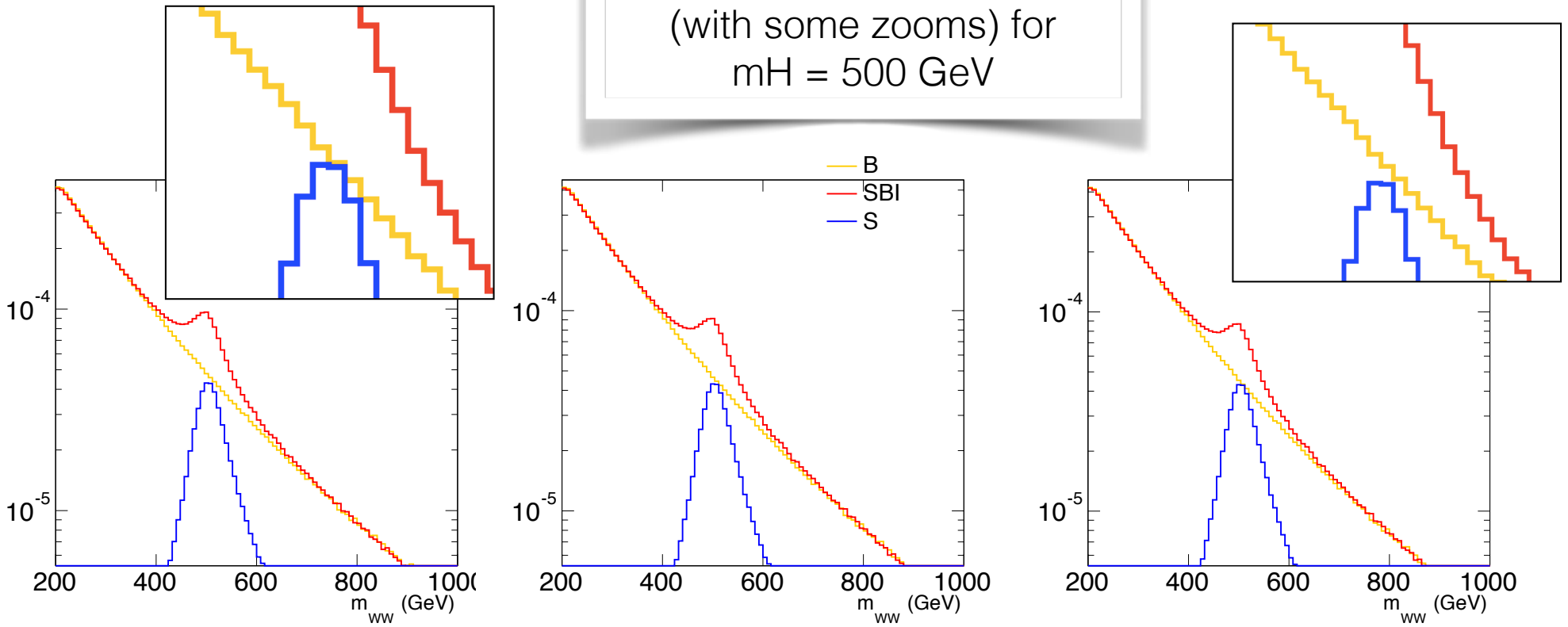
signal+interference



the uncertainty of the approximation

- to assess the **uncertainties related to this correction factors,** we **vary scales up and down**, to get an estimate of the uncertainty when going from LO to NLO
- the scales in phantom and madgraph are then changed coherently, to **0.5 times the pole mass or to 2 times the pole mass**
- the uncertainty band on the corrected distribution is calculated applying the correction with the rescaled samples

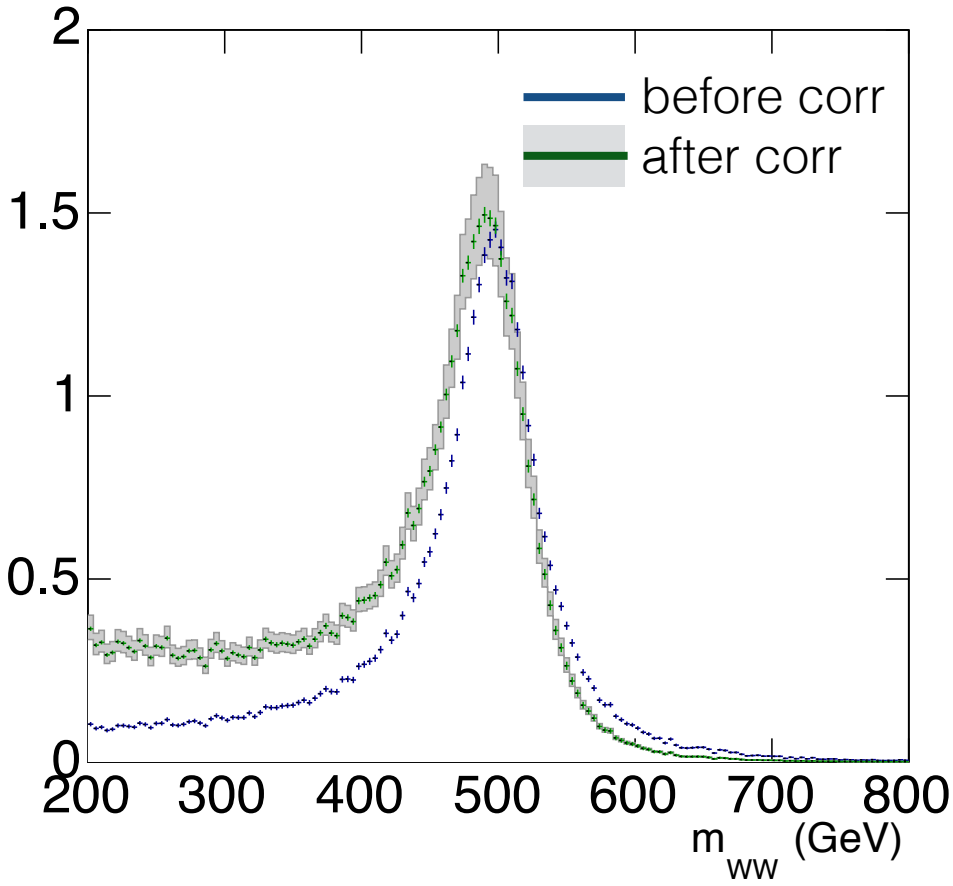
example of the scale effects (with some zooms) for mH = 500 GeV



0.5 m_H (250 GeV) scale : m_H (500 GeV) 2 m_H (1 TeV)

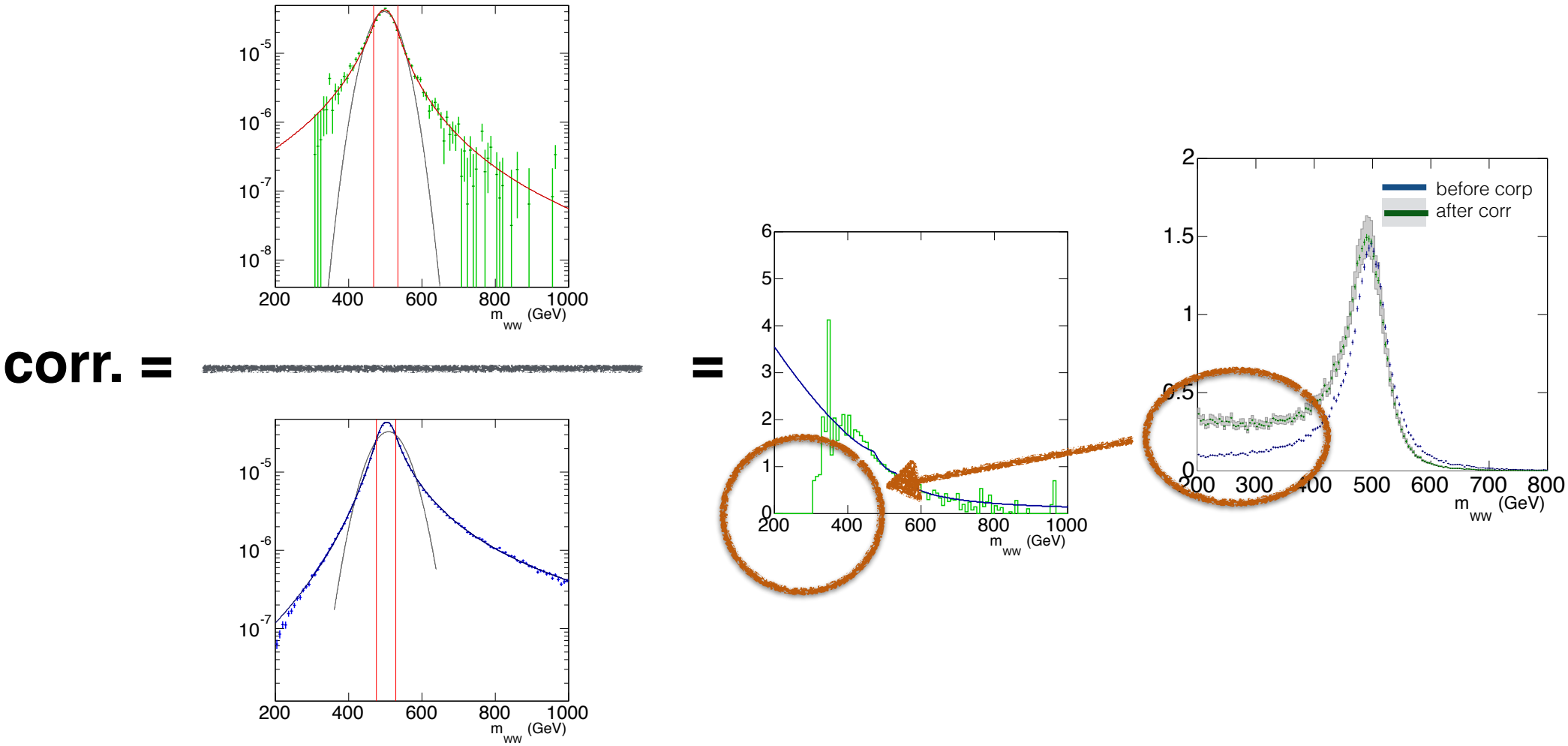
apply the scaling to a 500 GeV signal

- **powheg 500 GeV LHE file** as used in CMSSW
- same **selections on jets** as the ones used in the correction factors calculation
- **no selections on leptons or mets** (not available for technical reasons)
- corrections calculated with the pole mass of the sample (500 GeV)
- uncertainty band from the scale variation



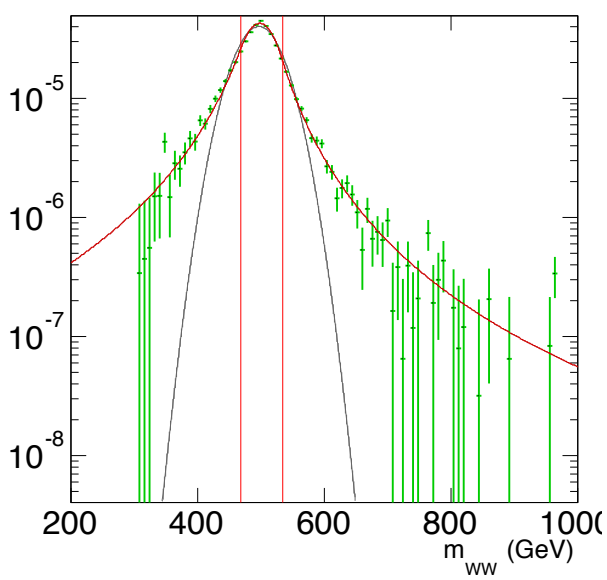
the low mass tail?!

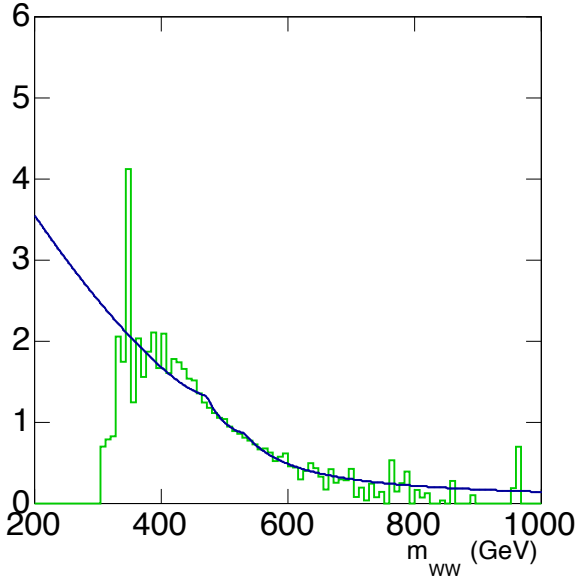
- the difference between phantom SBI and S, at low mass, is **not well fitted**, because of the constraint / expectation of the fitting function to be positive and go to zero for very low m_{WW} values

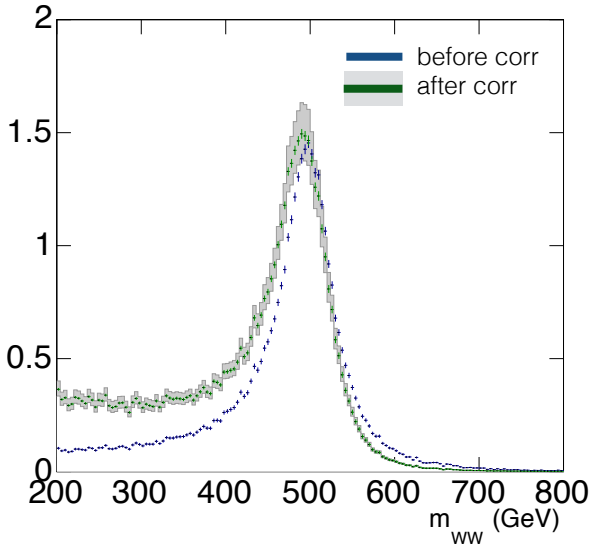


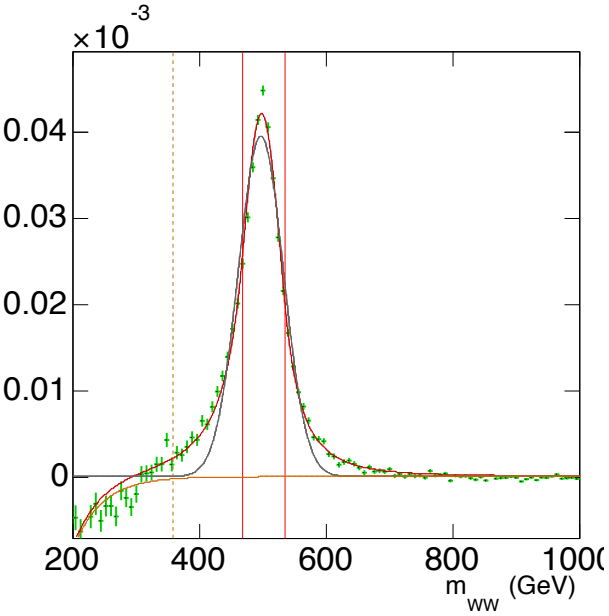
- try a **more faithful fit** of the curves…

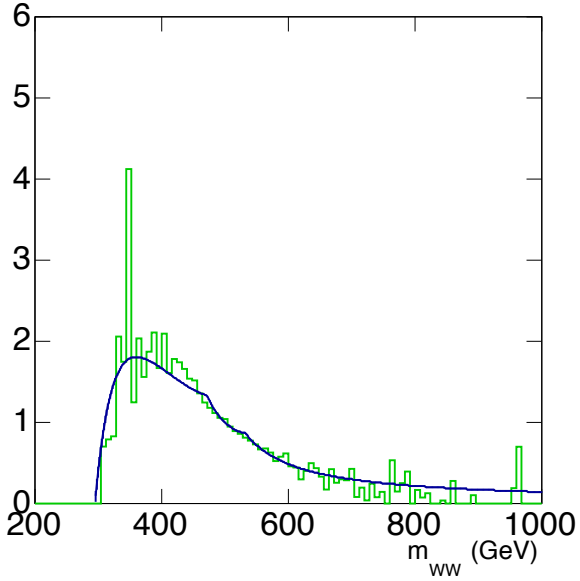
adding a turn-on at low m_{WW}

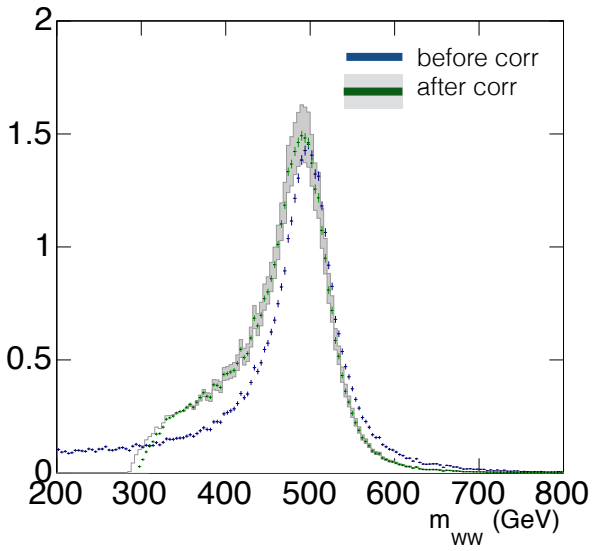






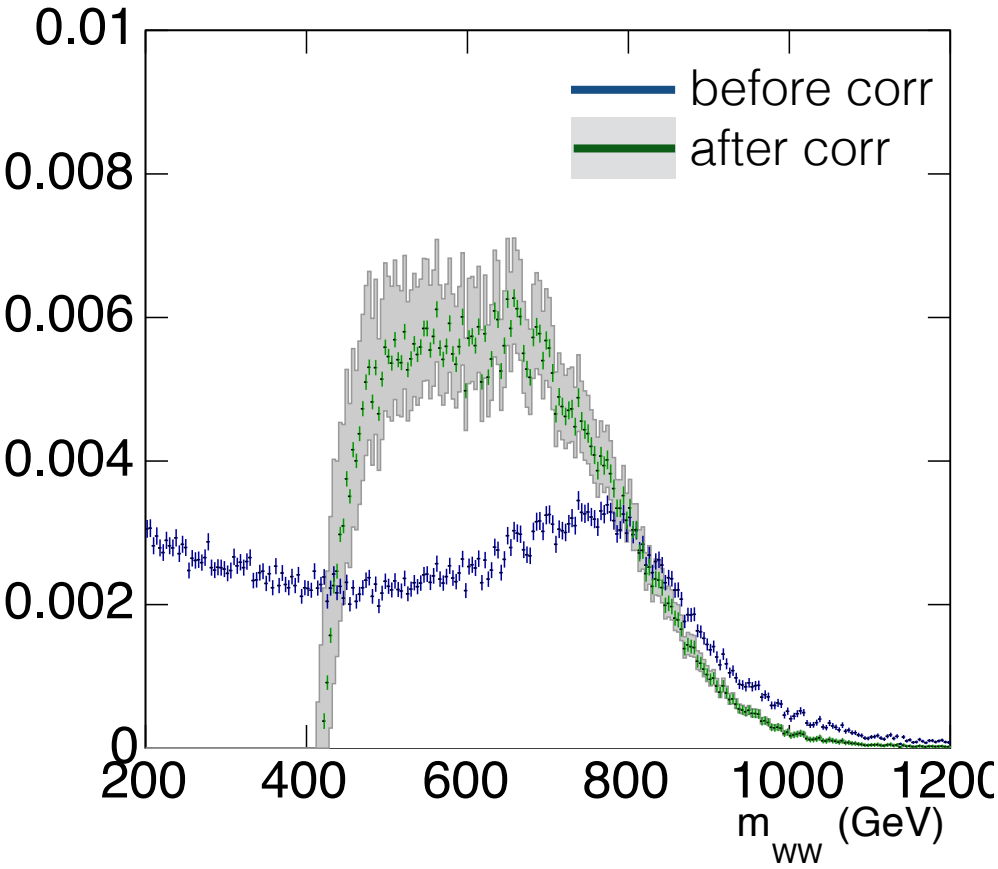


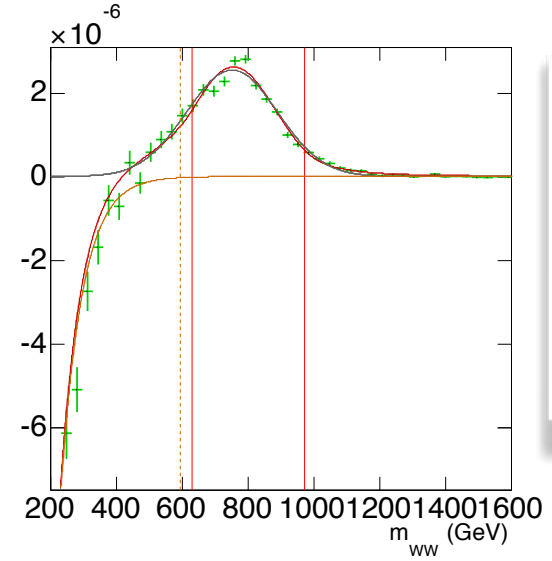




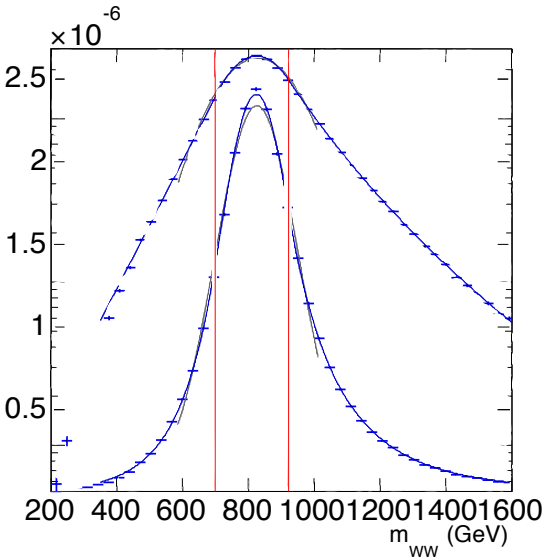
looking at a larger mass

- same procedure, applied to a 800 GeV powheg sample





numerator of the correction, with the fit used to get the correction function



denominator of the correction, with the fit used to get the correction function
The log version of the plot is superimposed, to appreciate the fit in the tails

summary

- interference corrections are being studied for large values of m_{WW}
  - on the basis of **LO fully EWK fixed scale generation**, with madgraph and phantom
  - the **background-only** is simulated by considering also the 126 GeV Higgs resonance
- **uncertainty** due to the extrapolation to the LO calculated varying the scales
  - is it ok?
- correction interpolated between the existing points

- concerning the **low mass tail**
  - probably **out of the fit region** for our first interests in the analysis
  - still it would be nice to know what is the right thing to do