VBF interference for high mass Higgs for H → WW → lνlν

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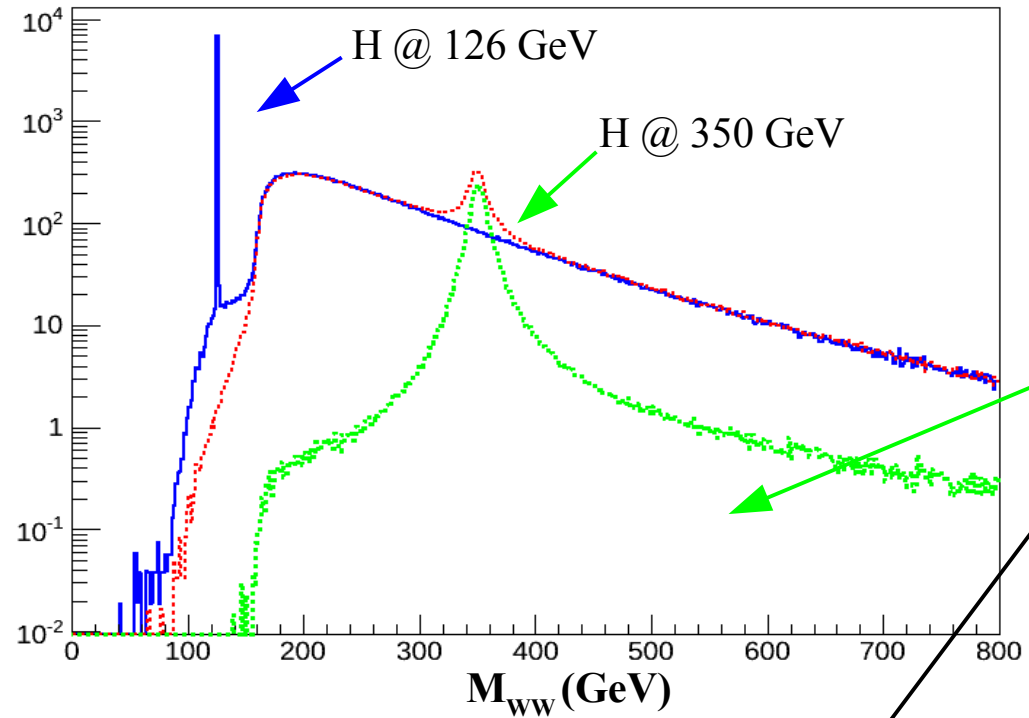
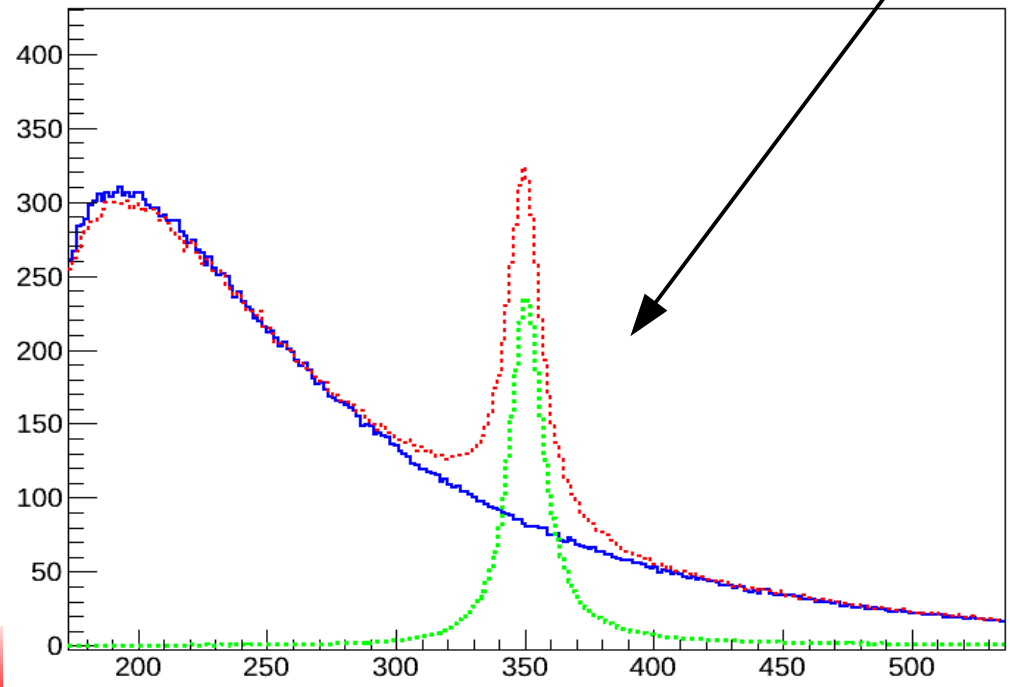
Recipe to calculate interference

- **Interference for VBF high mass**
  - **interference** between **qqH→WW→lνlν** and **WW→lνlν + 2jets** effect has not been corrected for so far
  - Glossary:
    - **S** = signal (qqH)
    - **B** = background
    - **I** = interference
  - How:
    - Simulation of **S+I+B**, B with Phantom, which can deal with interference
    - Simulation of S with Madgraph
    - Calculate re-weight function **w = (S+I) / S** as a function of the **di-W invariant mass**
    - S+I+B, B and S simulated at fixed scale, Higgs mass
  - Interference effect calculated with mild preselections at LHE level (generator cuts, see backup)
  - Interference effect calculated in ee+μμ and eμ final state separately (different diagrams may contribute)
  - Weight calculated at LO (MG and Phantom)
  - Systematic uncertainty on the method to be established
  - Re-weight has 2 effects:
    - Change in normalization → important in HWW>lνlν
    - Change in m_{WW} shape → less important but it can change m_{ll}/m_T distribution used in the analysis

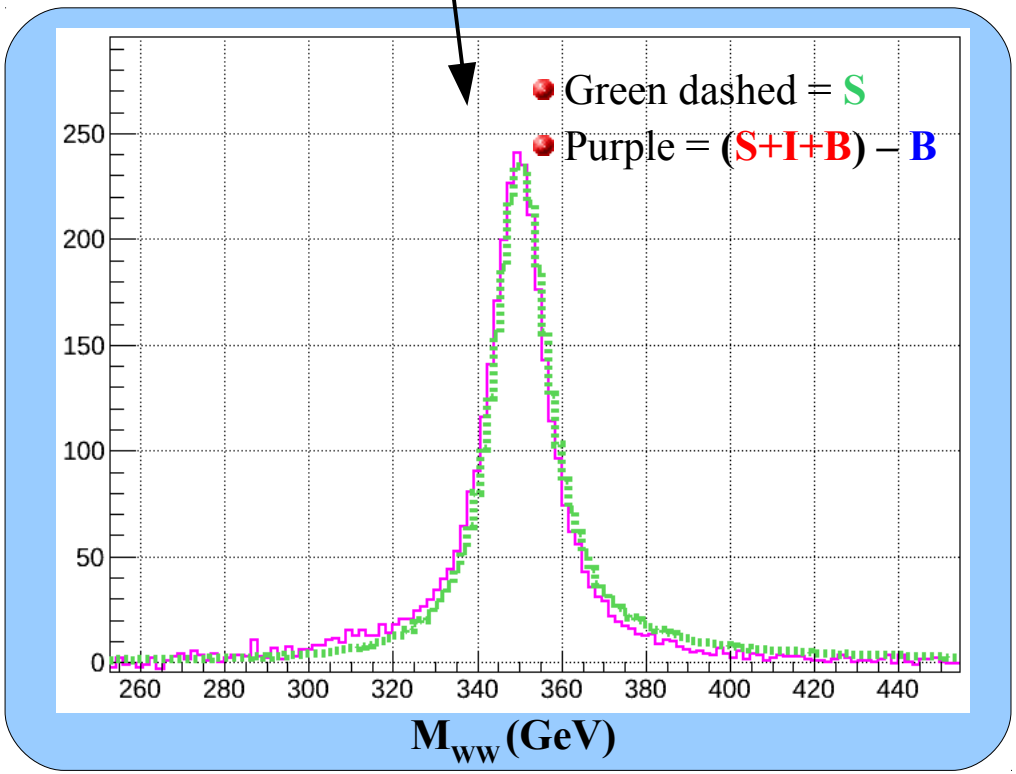
Example: M_H 350



- **S = H @ 350 GeV**
- **B = H @ 126 GeV**
- Legend:
  - **S+I+B** = dashed red line
  - **B** = blue line
  - **S** = dashed green line

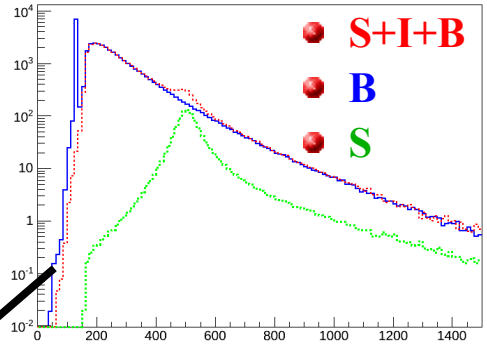


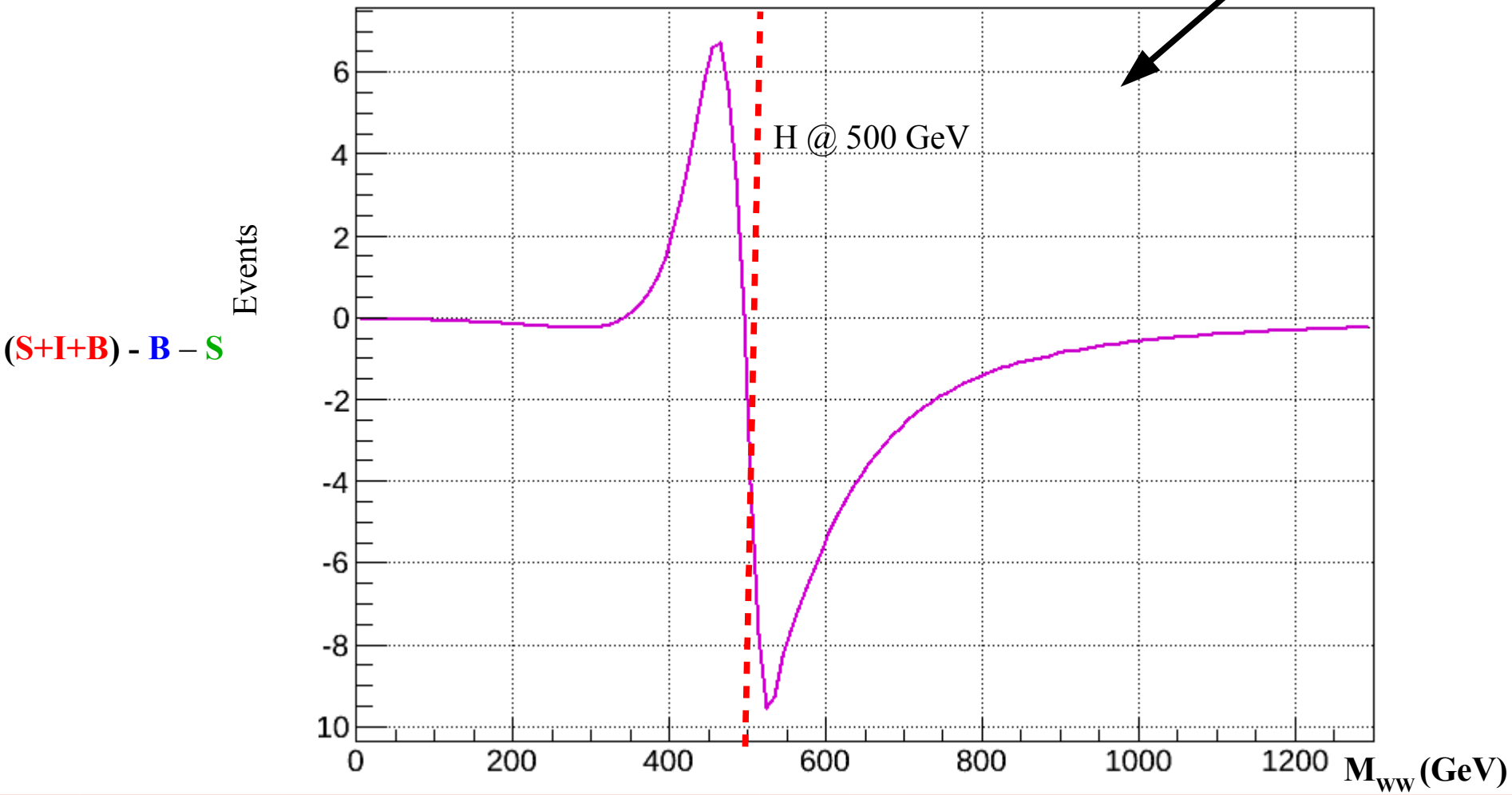
- Zoom around Higgs mass under investigation
- Weight = **((S+I+B) – B) / S**



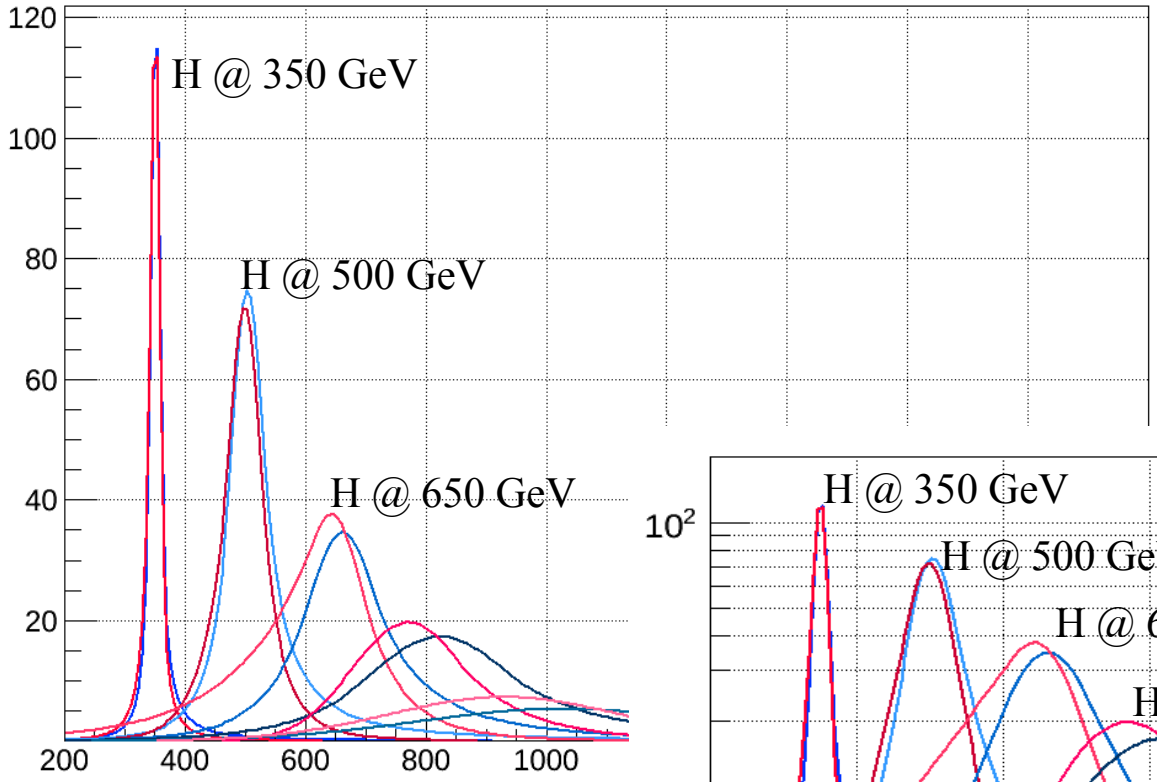
Interference pattern

- Interference pattern:
  - Different Higgs masses
  - **Interference = I = (S+I+B) - B – S**
- Tiny positive interference for $m_{WW} < m_H$
- Negative interference for $m_{WW} > m_H$

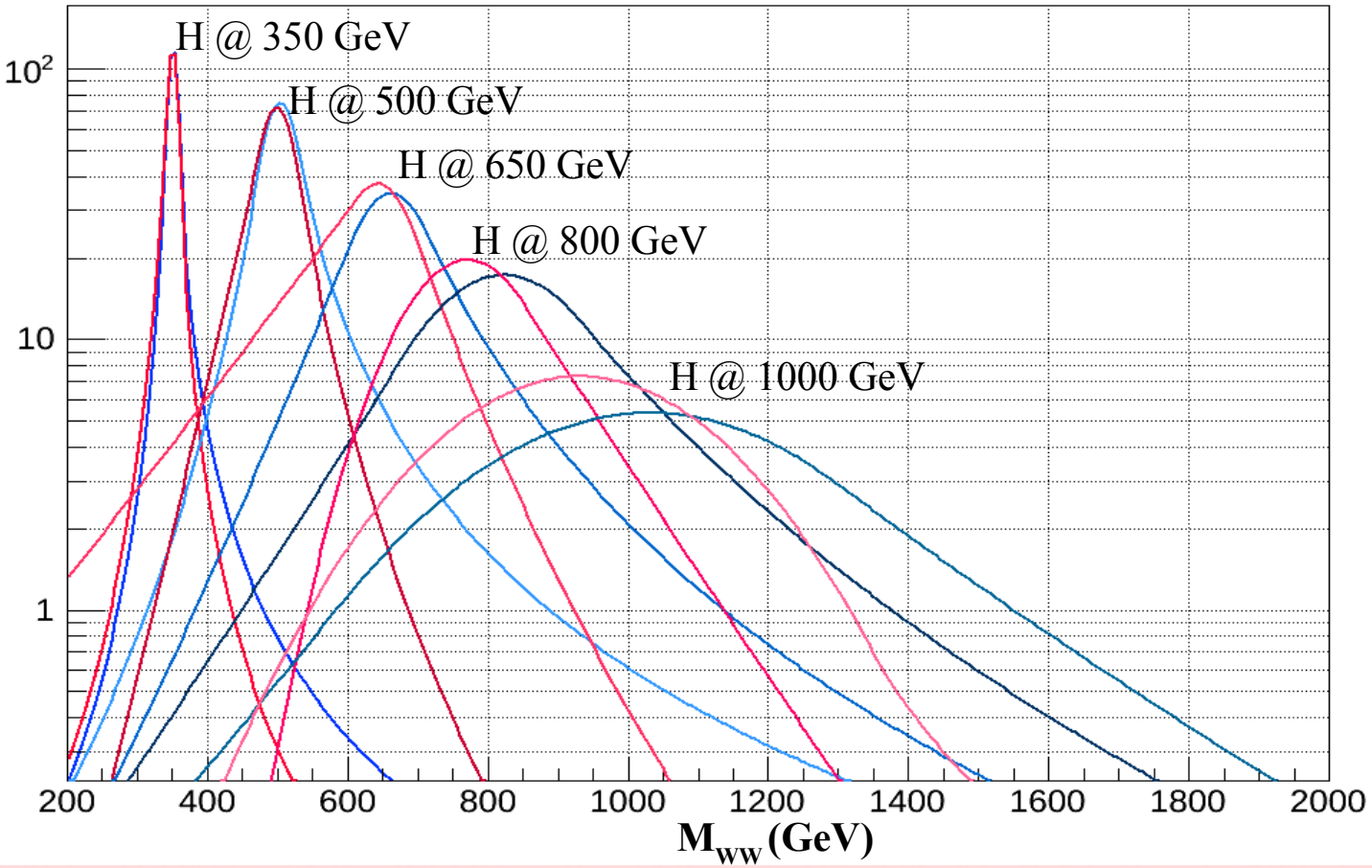




For all Higgs masses



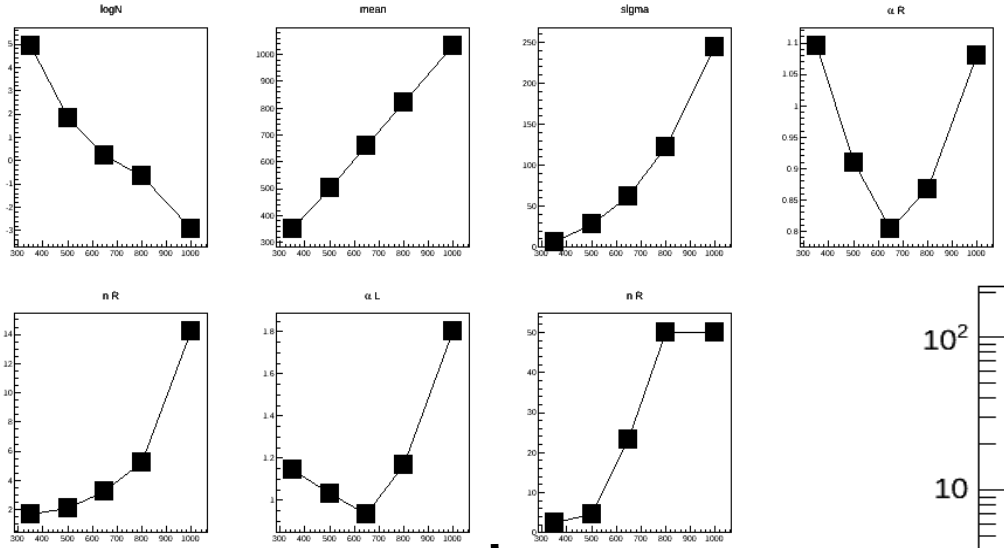
- Different Higgs masses
  - **Signal + interference = (S+I+B) – B**
  - **Signal = S**
- Effect negligible for $m_H < 400$ GeV

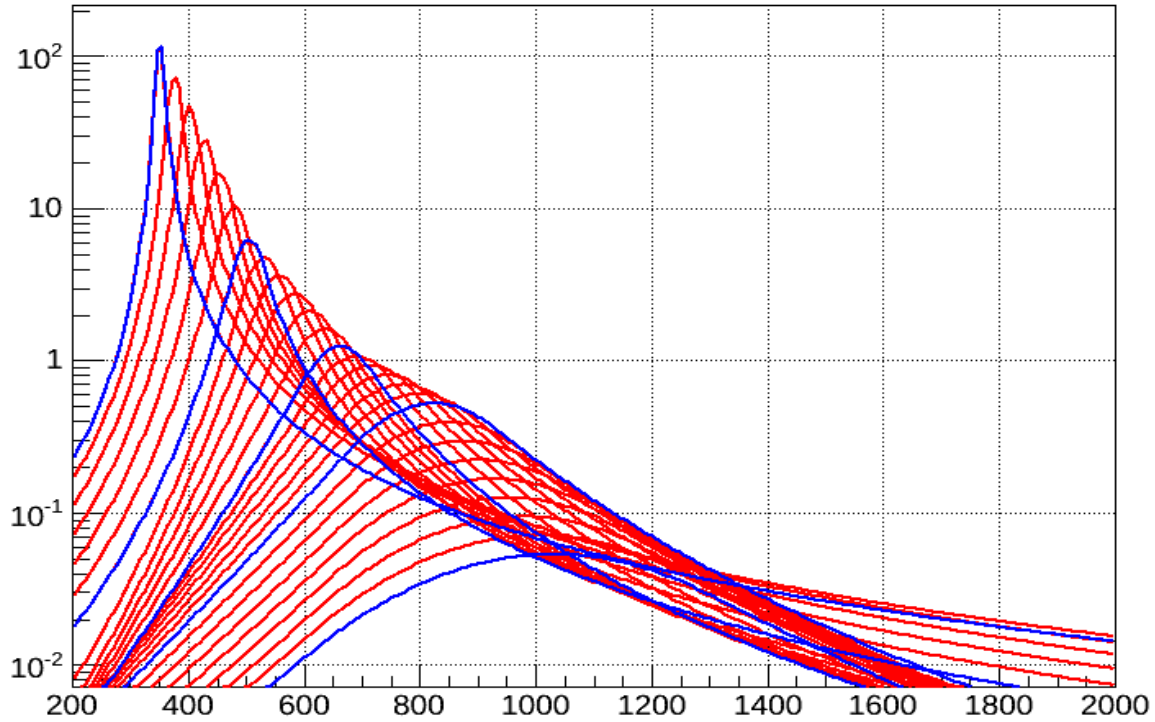


Interpolation technicalities

- A subset of Higgs mass hypotheses have been simulated:
  - Namely: 350, 500, 650, 800, 1000 GeV
- For each Higgs mass a fit with a double-crystalball is performed on the **S** and **(S+I+B) - B** distributions
- Parameters of the fit are interpolated between different masses
- The weight is calculated for any Higgs mass as **((S+I+B) - B) / S**

Parameters





- Blue lines are the nominal mass points
- Red lines are the interpolated distributions

Conclusions

- **Interference for VBF high mass**
  - **interference** between **qqH→WW→lνlν** and **WW→lνlν + 2jets** has been calculated
  - weight function **w = (S+I) / S** as a function of the **di-W invariant mass** measured with Phantom and Madgraph (LO)
    - Calculated for subset of Higgs masses and then interpolated

- Missing points/open discussion:
  - Error due to **LO → NLO** approximation
    - So far the approach is **w = (S+I) / S** @ LO to be applied to our signal that is NLO
  - **Systematic uncertainty** on the interference re-weight procedure to be established

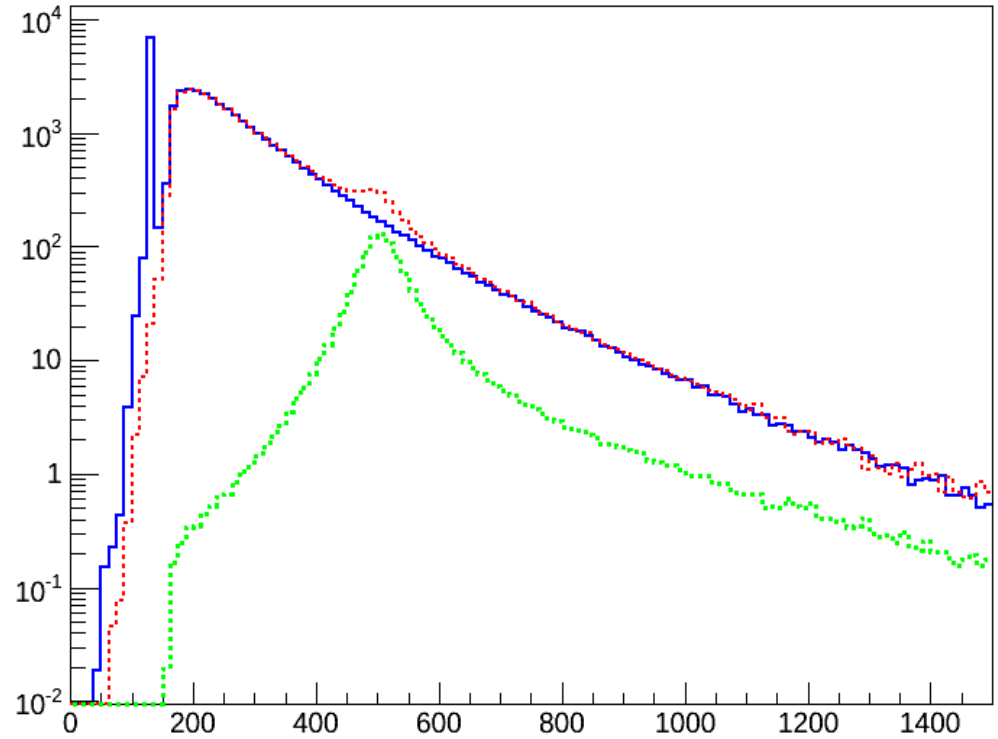
backup

Selections

- **Generator level selections**

leptons max eta	2.5
leptons min pT	8 GeV
leptons min E	5 GeV
di-lepton min invariant mass	8 GeV
jets min pT	10 GeV
jets max eta	6.5
min invariant mass of jets pair	30 GeV
minimum delta R between the fwd and bkw jets	0.4
minimum delta R between jets and leptons	0.4
minimum delta R between two leptons	0.4

H500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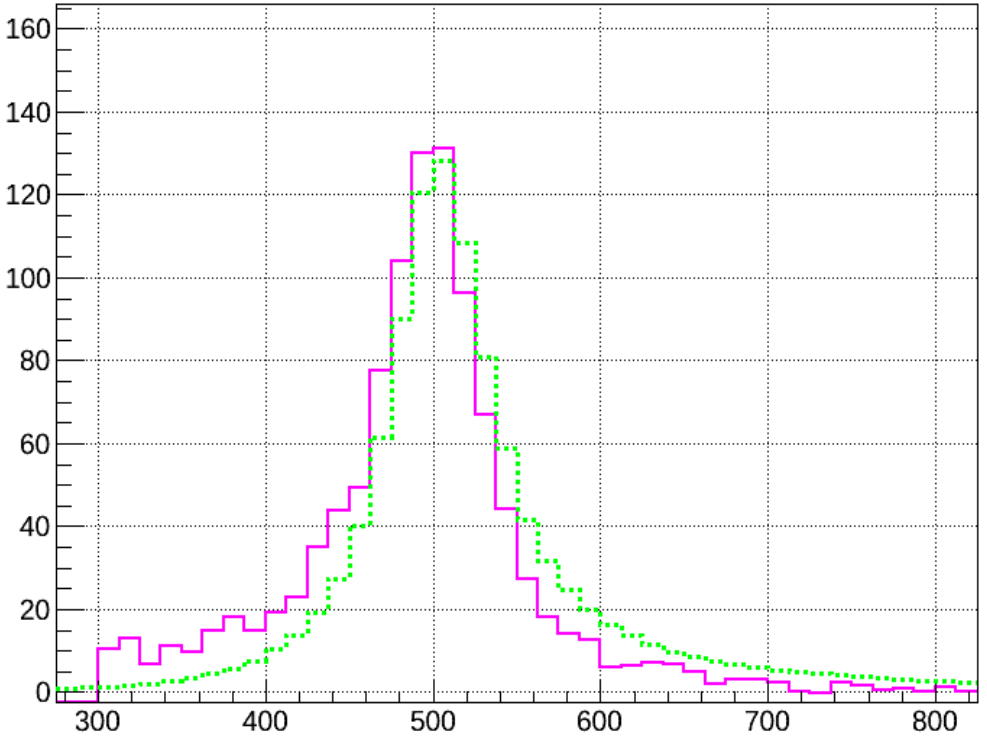
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