4ℓ signal optimization on $R \to SH \to 4\ell + E_{\mathrm{T}}^{\mathrm{miss}}$

Abdualazem Fadol

January 28, 2019

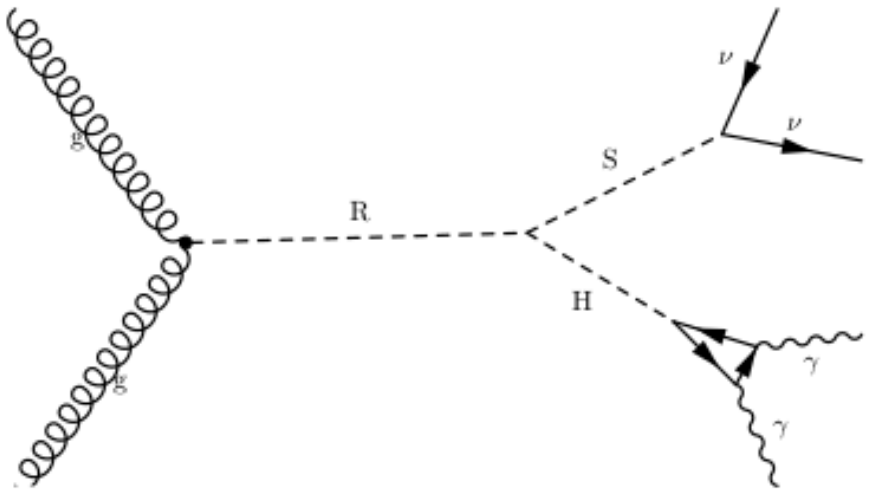
中國科學院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Contents

Introduction

- The model is a simple gluon fusion production;
- A heavy scalar R, which decays to SH;
- Then $H \to 4\ell$ and $S \to$ MET in the form of neutrinos;
- This is the same model as the $H \to \gamma\gamma/Zy$ case; and



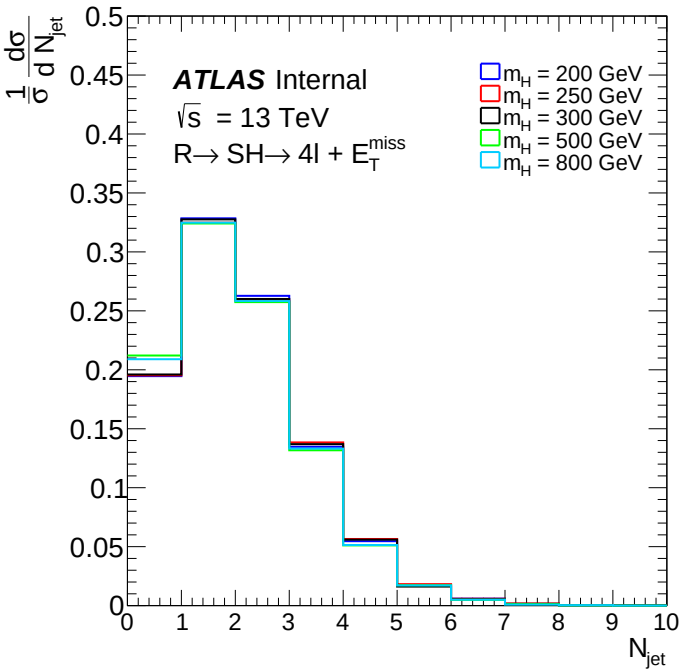
- Build optimization framework for this signal.

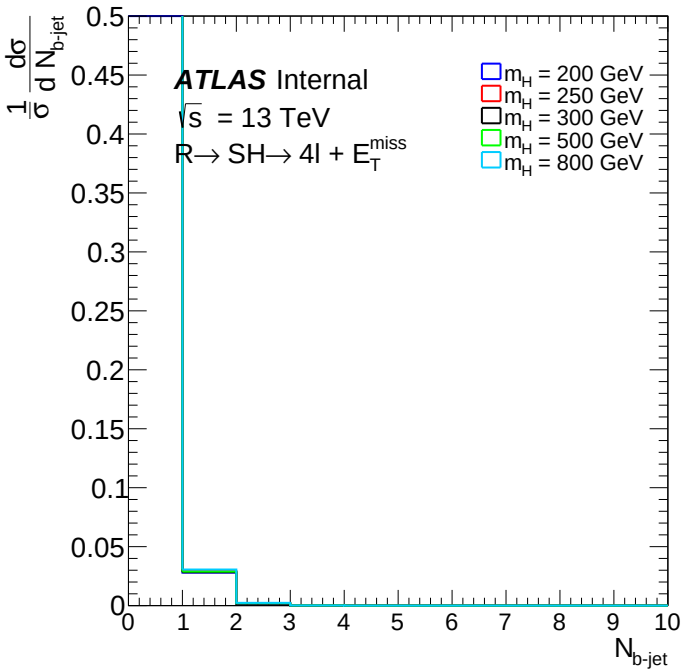
Event selection

- Electrons:
  - $|\eta| < 2.47$
  - $p_{\mathrm{T}} > 7$ GeV
- Muons:
  - $|\eta| < 2.7$
  - $p_{\mathrm{T}} > 5$ GeV
- Jets:
  - $|\eta| < 4.5$
  - $p_{\mathrm{T}} > 30$ GeV

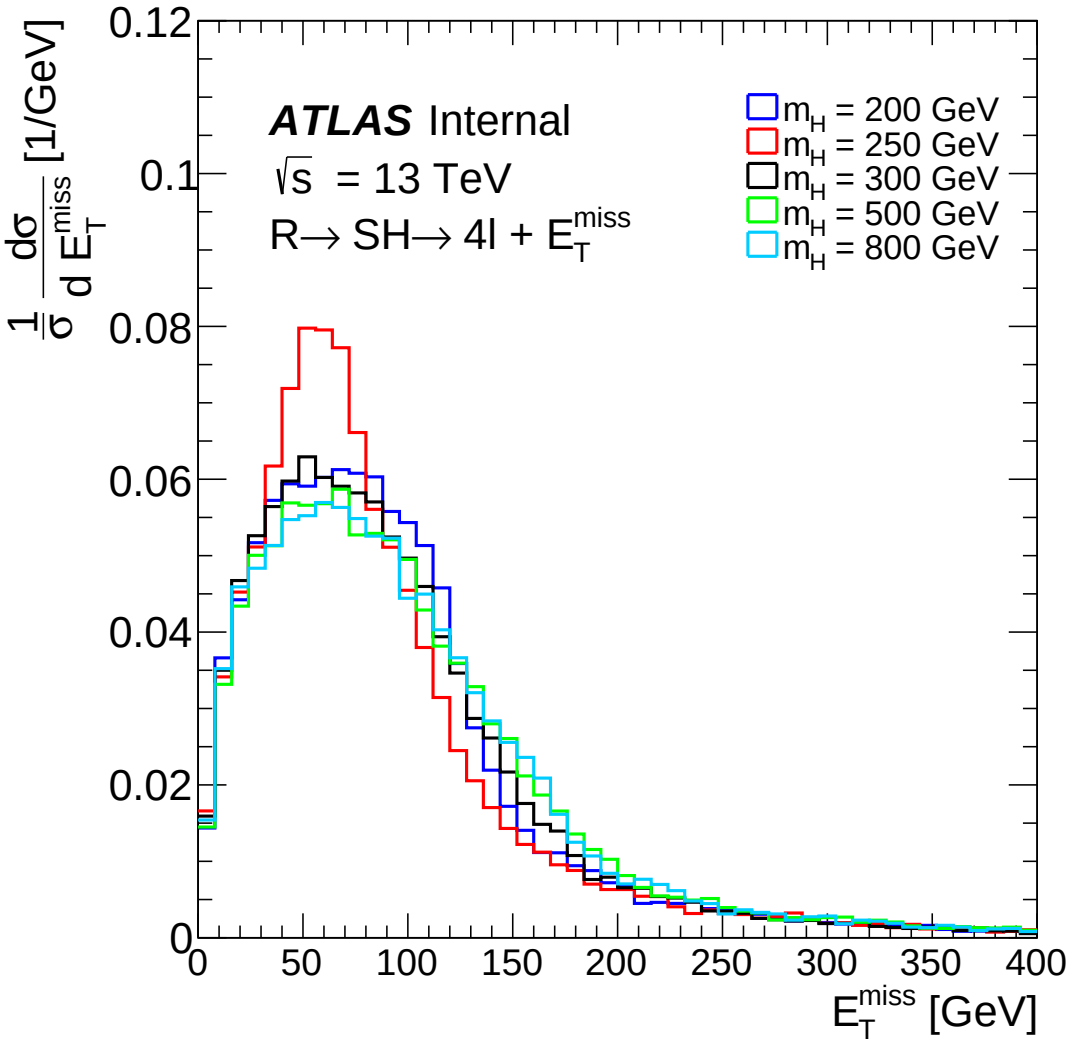
Kinematic distributions

Number of jets multiplicity and b-jet





Kinematic distributions
Missing transverse energy



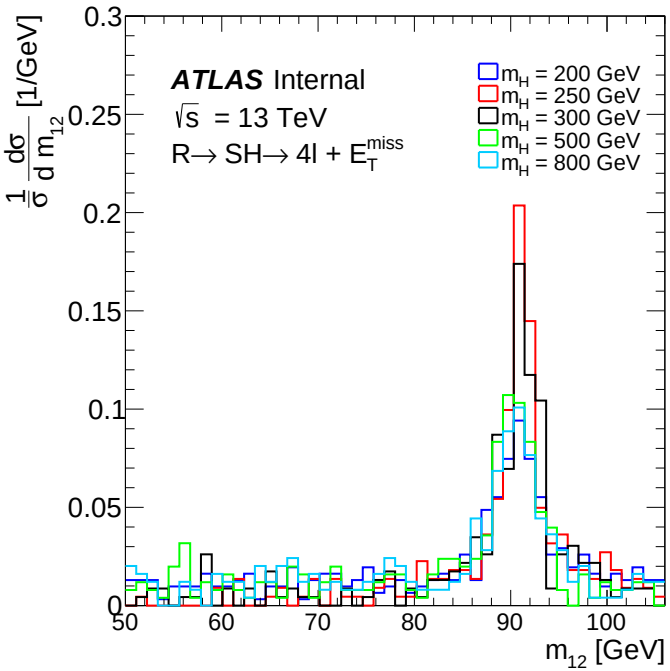
Cutflow table

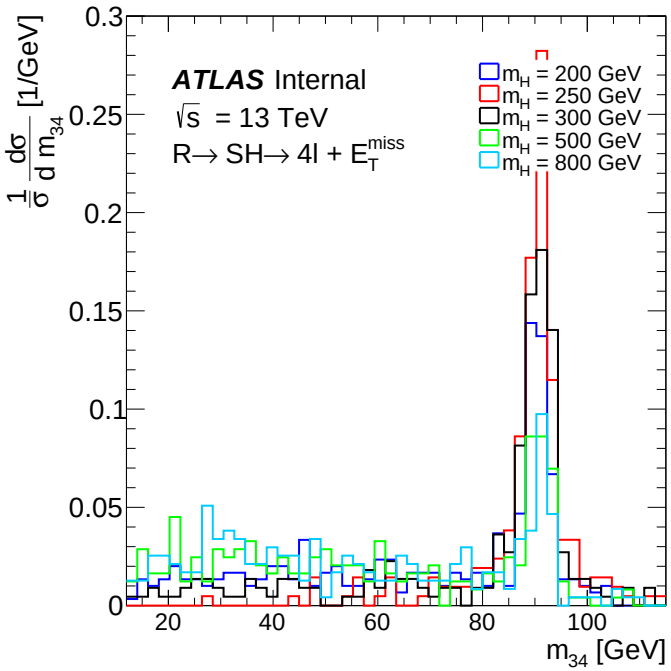
Cuts \ Samples	Resonance Mass m_H				
	200 GeV	**250 GeV**	**300 GeV**	**500 GeV**	**800 GeV**
All events	30000.00	30000.00	30000.00	30000.00	30000.00
$4e/4\mu/2e2\mu/2\mu2e$	2287.00	2305.00	2322.00	2136.00	2058.00
$p_{\mathrm{T}}^{1^{st}} > 20$ GeV	2287.00	2305.00	2322.00	2136.00	2058.00
$p_{\mathrm{T}}^{2^{nd}} > 15$ GeV	2287.00	2305.00	2321.00	2135.00	2056.00
$p_{\mathrm{T}}^{3^{rd}} > 10$ GeV	2287.00	2305.00	2321.00	2135.00	2056.00
$50 < m_{12} < 106$ GeV	1463.00	899.00	990.00	1181.00	1164.00
$12 < m_{34} < 115$ GeV	1463.00	899.00	990.00	1181.00	1164.00
$N_{b-jet} = 0$	1421.00	864.00	964.00	1154.00	1144.00
$N_{\mathrm{jet}} = 2$	308.00	221.00	230.00	252.00	248.00
$E_{\mathrm{T}}^{\mathrm{miss}} > 20$ GeV	298.00	212.00	225.00	248.00	242.00

Table: The accumulative cut for the resonance signal MC samples on $R \to SH \to 4\ell + E_{\mathrm{T}}^{\mathrm{miss}}$. S is considered to have a mass of 160 GeV, and it decays into a pair of neutrinos. The mass of R fixed to 430 GeV.

Kinematic distributions

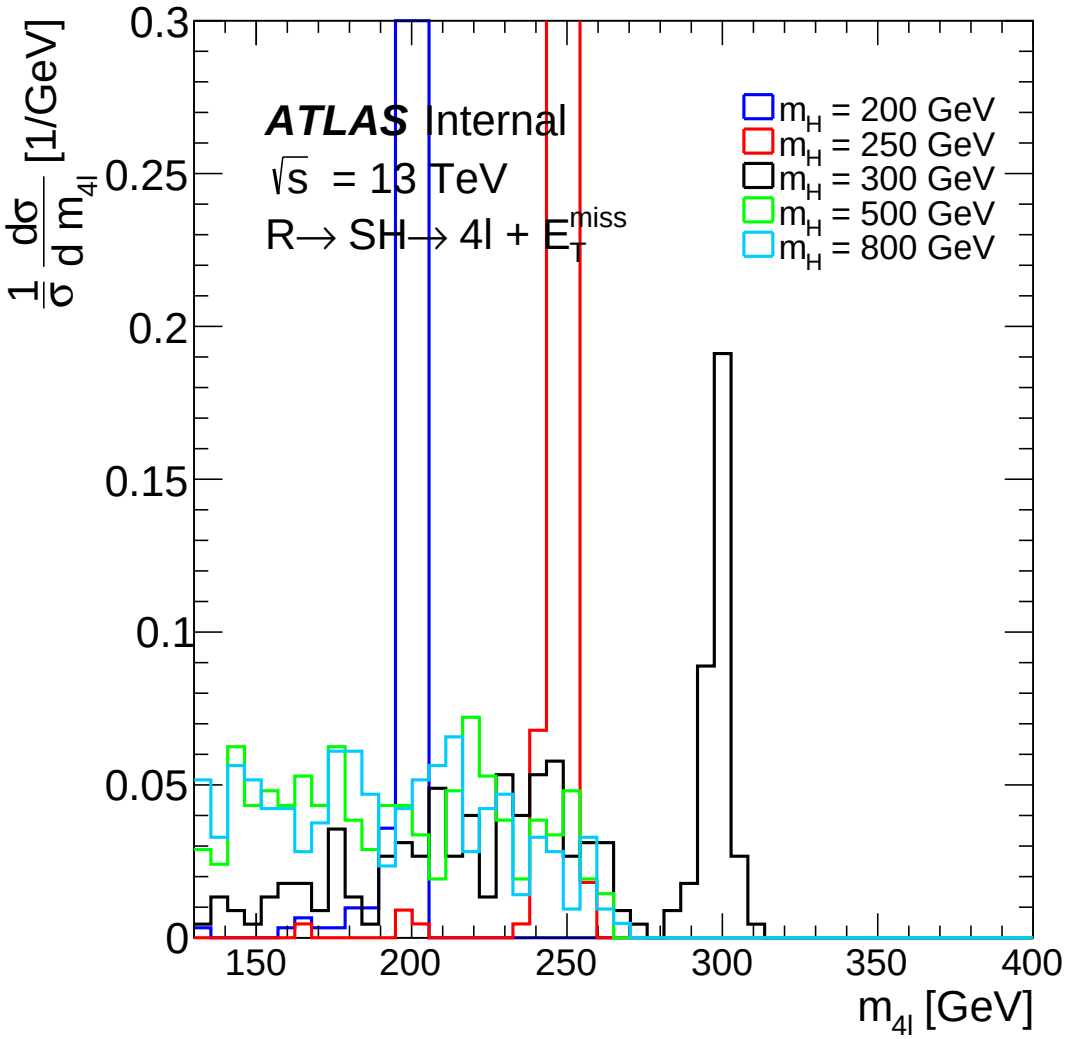
Dilepton invariant mass distribution





Kinematic distributions

Four leptons invariant mass distribution



Summary

- Low statistics problem. Generate events while we are waiting for the official samples;
- Now we have the problem of different variables between the signal samples and the background;
- We can rewrite the tree and include the variables of the official background samples; and
- Using $p_{\mathrm{T}}^{4\ell} > x$ and $E_{\mathrm{T}}^{\mathrm{miss}} > y$ for a significance scan.

Thank you!