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

Abdualazem Fadol

February 10, 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

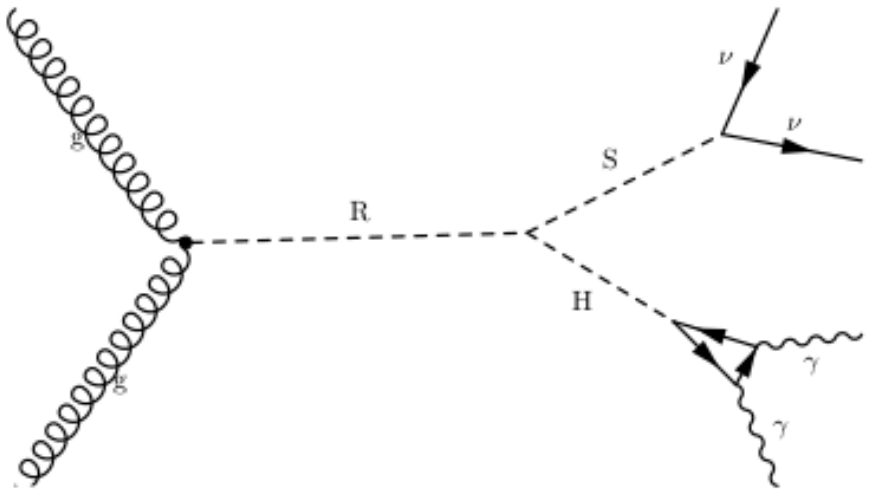
Event selection

Kinematic distributions

Cutflow table

Introduction

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



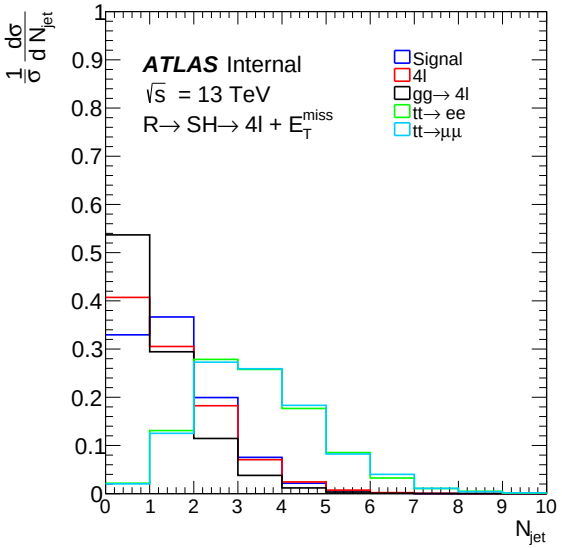
- Build optimization framework for this signal.

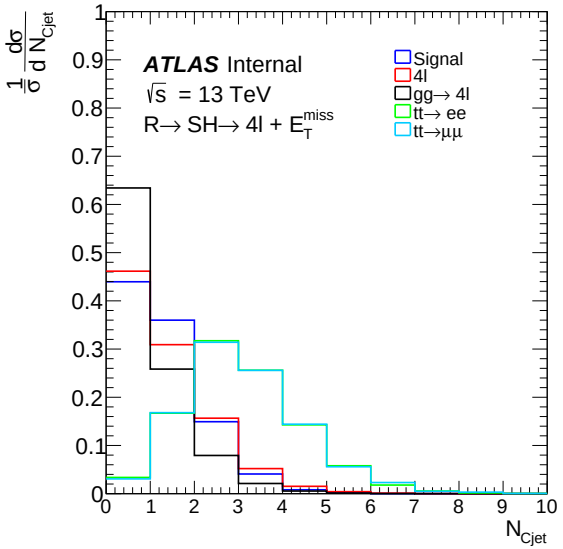
Event selection

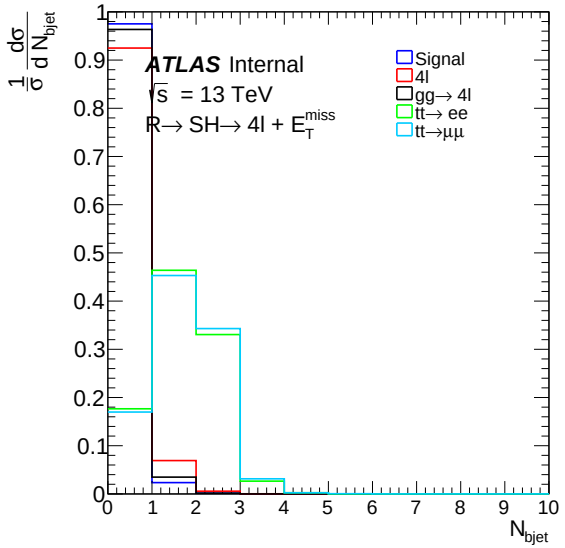
- Electrons:
  - $|\eta| < 2.47$
  - $p_{\mathrm{T}} > 7$ GeV
- Muons:
  - $|\eta| < 2.7$
  - $p_{\mathrm{T}} > 5$ GeV
- Jets:
  - $|\eta| < 4.5$
  - $p_{\mathrm{T}} > 30$ GeV
- Four lepton cuts

Kinematic distributions

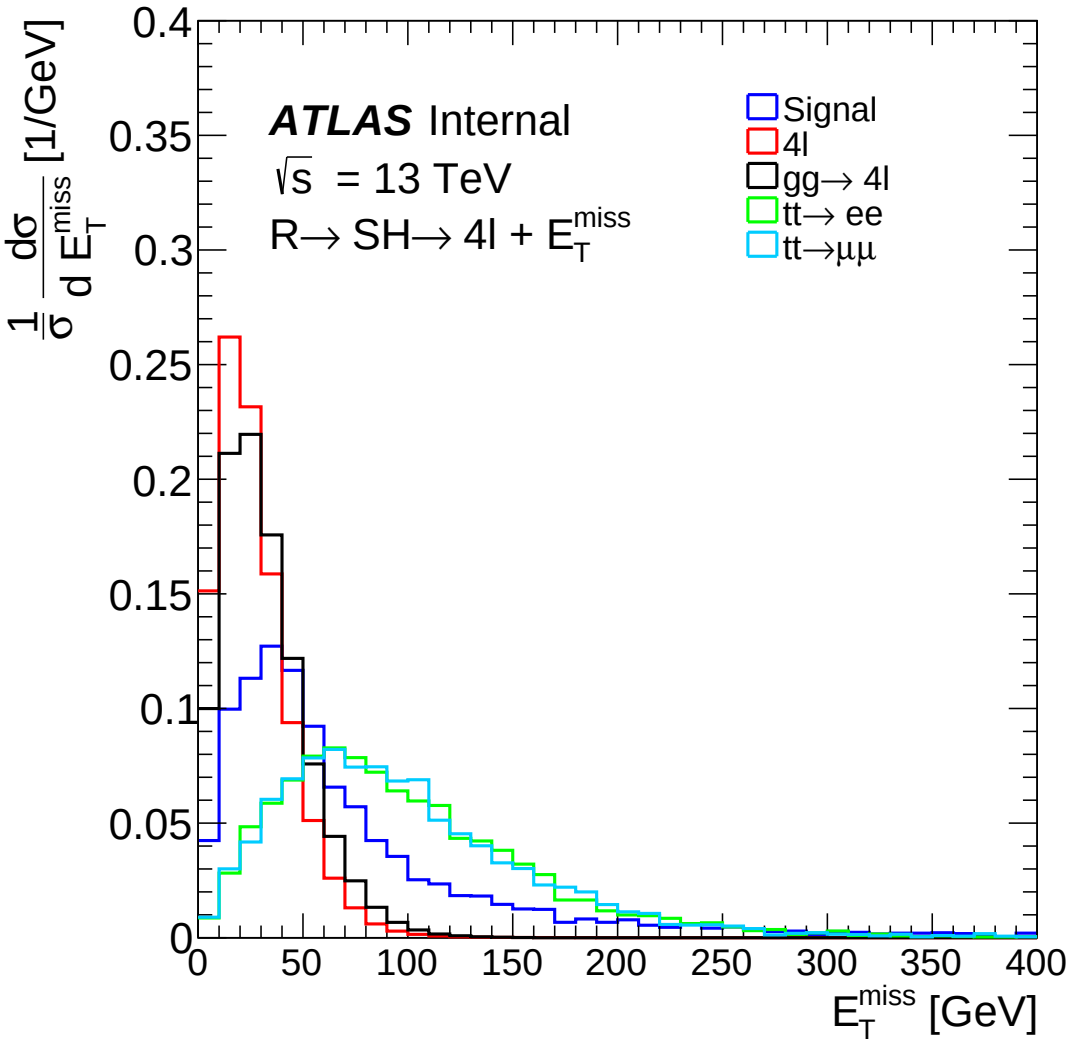
Number of jets multiplicity and b-jet





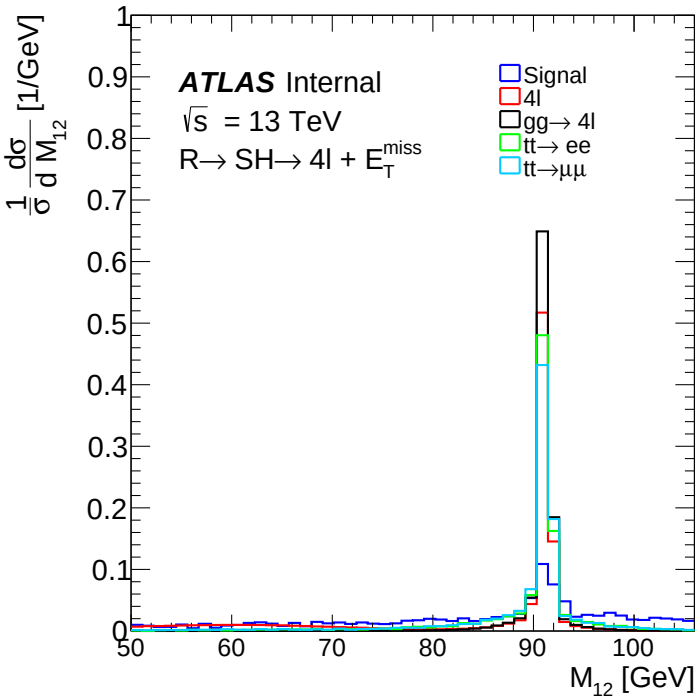


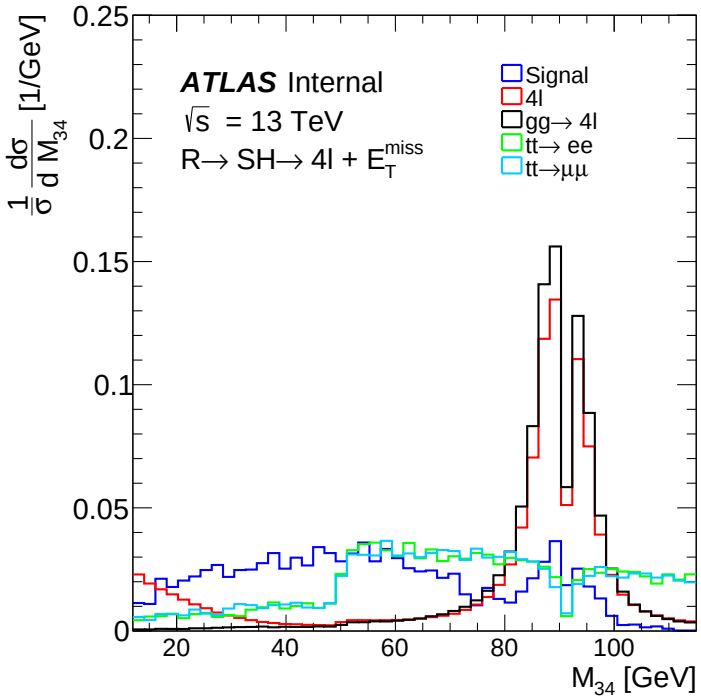
Kinematic distributions
Missing transverse energy



Kinematic distributions

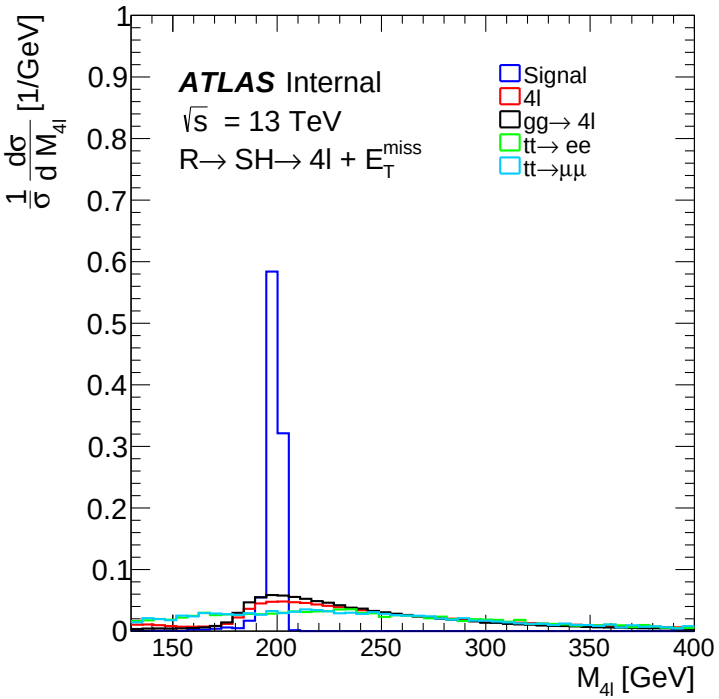
Dilepton invariant mass distribution

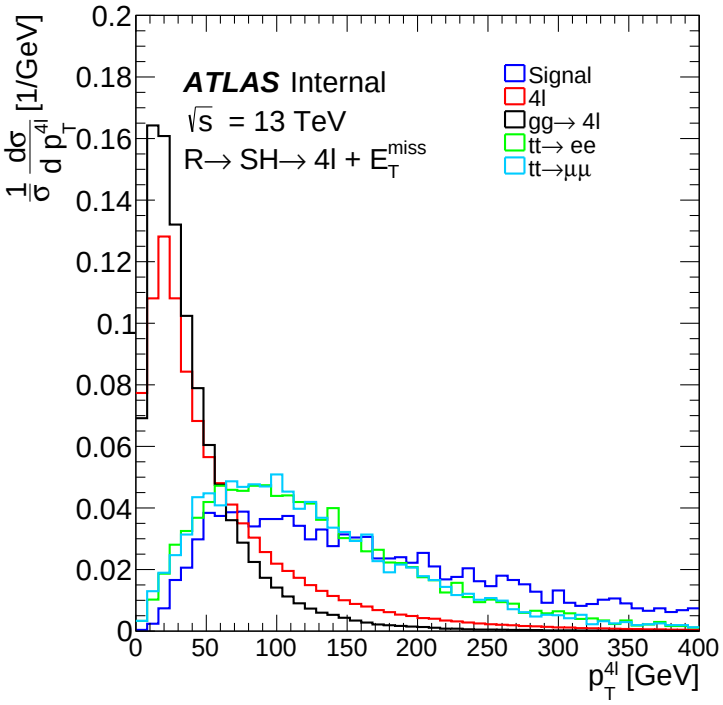




Kinematic distributions

Four leptons invariant mass distribution

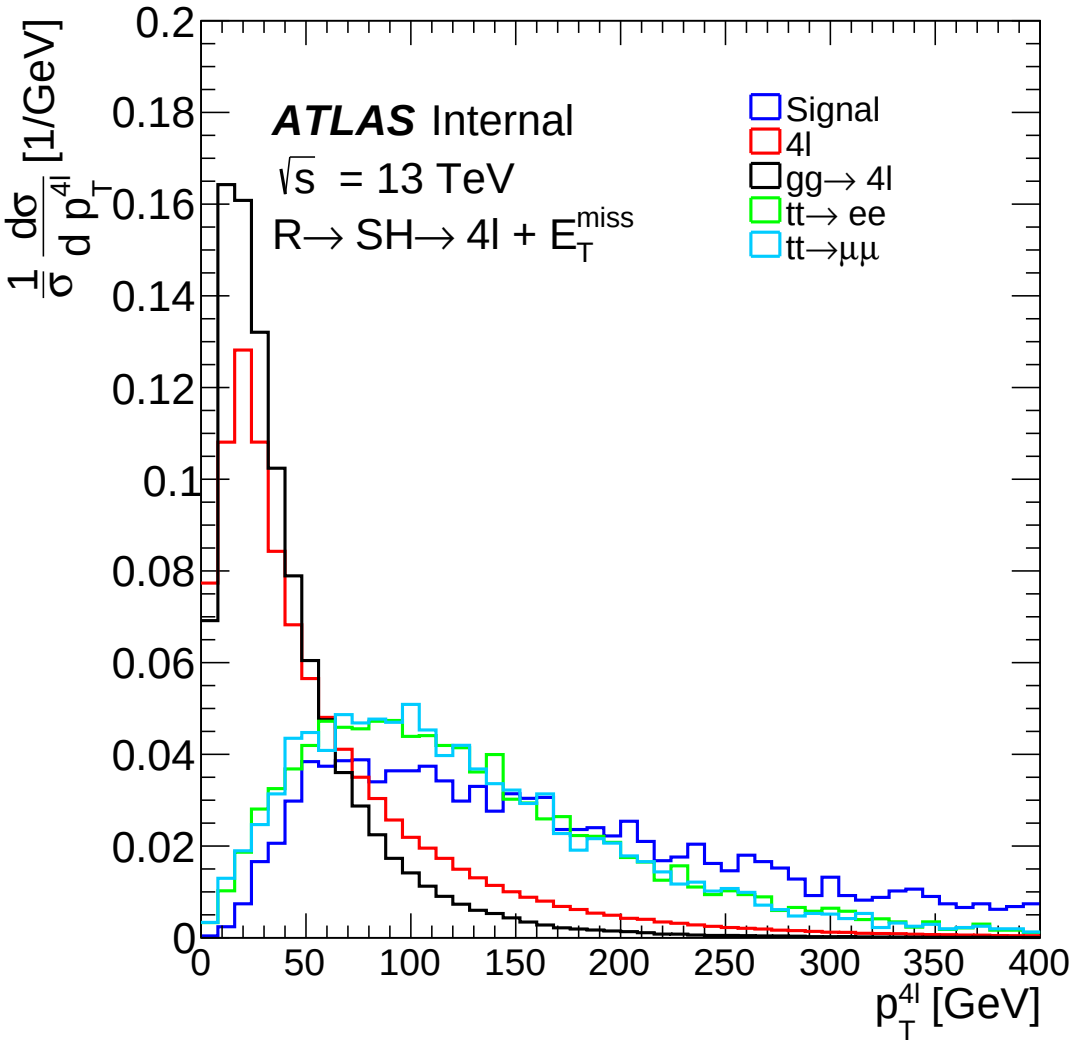




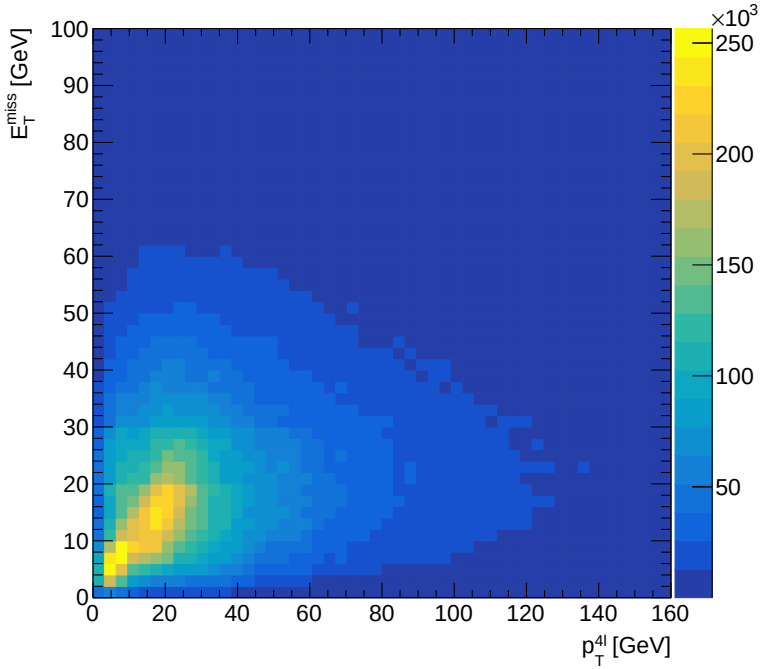
- Can we optimize the signal by getting on the $\mathrm{M}_{4\ell}$ and $\mathrm{p}_{\mathrm{T}}^{4\ell}$?

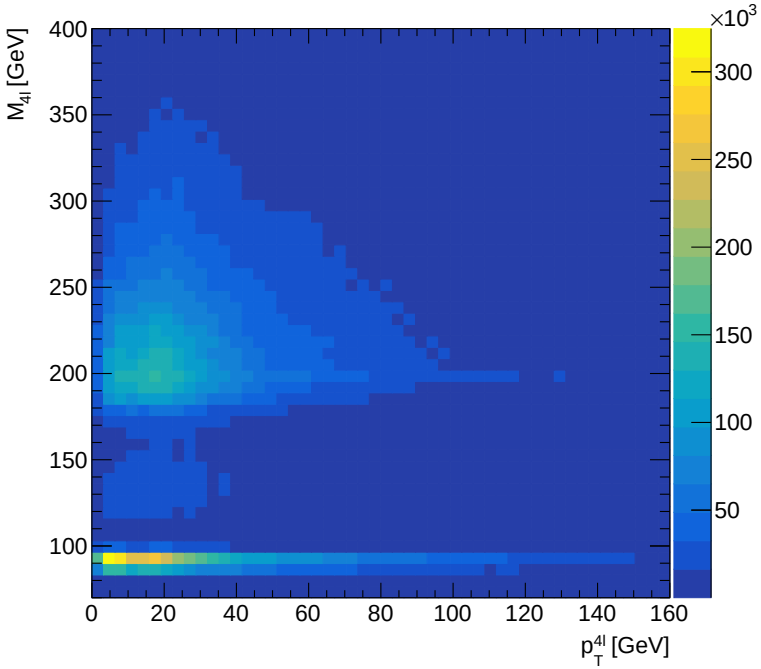
Kinematic distributions

Four leptons invariant mass distribution



Correlation between $p_T^{4\ell}$, E_T^{miss} and $M_{4\ell}$





- Trying to get the maximum significance by doing 2D scan of a grid of (a, b); and
- Install the significances on the z-axes of the 2D plot.

Cutflow table

	Signal	4ℓ	$gg \to 4\ell$	$tt \to ee$	$tt \to \mu\mu$	Significance
4ℓ	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	6.21
B-veto	97.51 %	92.49 %	96.35 %	17.66 %	16.99 %	6.31
$N_{Cjet} = 0$	43.83 %	46.15 %	63.42 %	3.37 %	3.06 %	3.88
$p_T^{4\ell} > 20$	43.51 %	24.39 %	34.61 %	3.25 %	2.94 %	5.26
$E_T^{miss} > 20$	33.08 %	15.00 %	25.10 %	3.17 %	2.90 %	4.96

	Signal	4ℓ	$gg \to 4\ell$	$tt \to ee$	$tt \to \mu\mu$	Significance
4ℓ	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	6.21
B-veto	97.51 %	92.49 %	96.35 %	17.66 %	16.99 %	6.31
$N_{Cjet} \geq 1$	53.68 %	46.34 %	32.93 %	14.29 %	13.92 %	5.09
$E_T^{miss} > 20$	50.24 %	29.07 %	23.85 %	13.84 %	13.55 %	5.92

Thank you!