Search for CP violation in $H \to b\bar{b}\gamma$ decays at ATLAS

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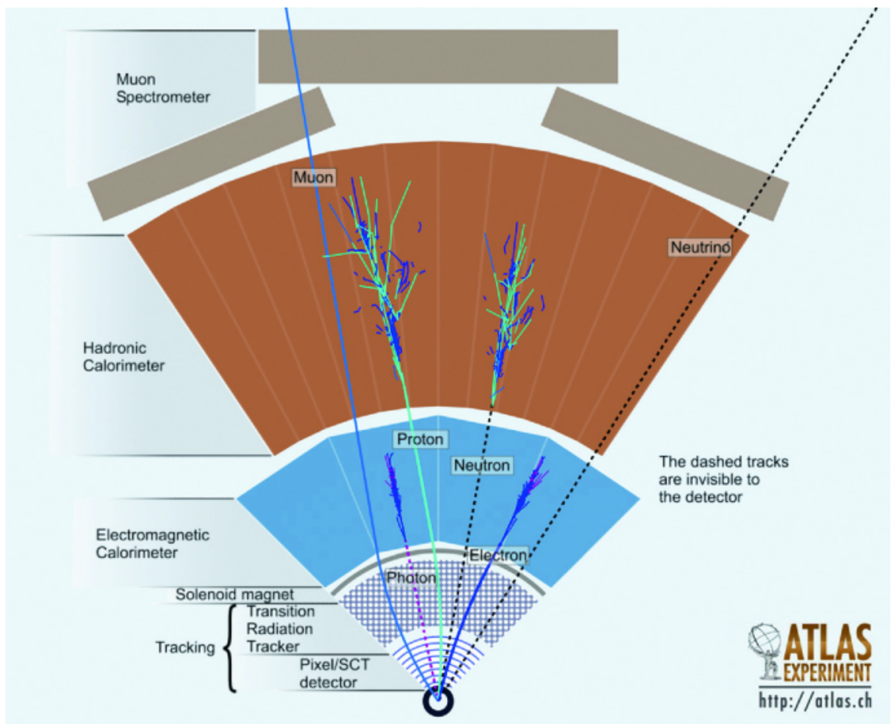
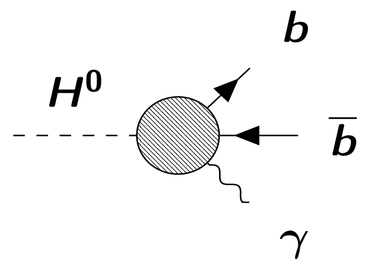
Atlas Detector



Motivation

- Not all of the Higgs boson properties have been yet precisely understood.
- One way of exploring the Higgs sector is to study how the Higgs boson interacts with quarks.
- My master thesis will be focused on the study of the $Hb\bar{b}\gamma$ interaction.

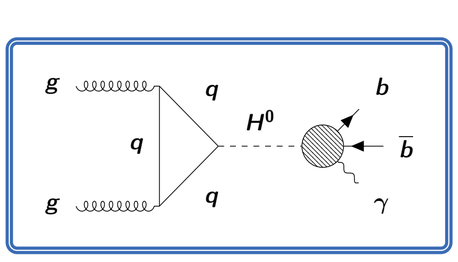
Figura 1: Higgs decay to 2 quarks b and 1 photon.



- The goal is to understand of the LHC sensibility to detect anomalous $H \to b\bar{b}\gamma$ interactions.

Choosing the Higgs boson production channel

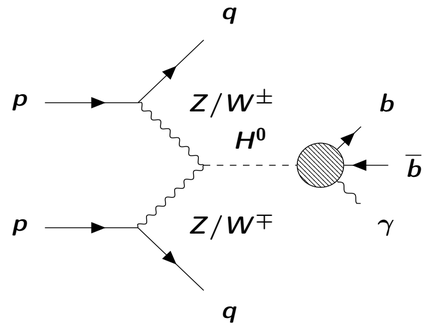
Figura 2: Feynman diagrams for different Higgs production channels and consequent decays, with the corresponding cross-sections.
From left to right: via gluon fusion, via vector boson, Z and Higgs associated production.
Cross-sections for $\sqrt{s} = 14\,TeV$ and $m_{Higgs} = 125\,GeV$



Production via gluon-gluon fusion (ggF)

$\sigma = 54.67\ pb$

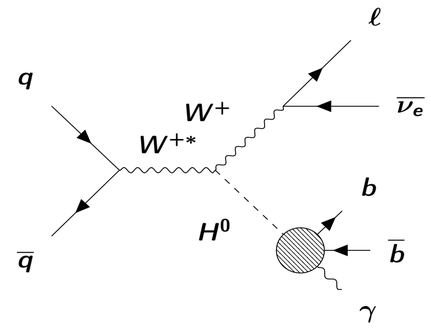
- largest cross-section
- large background from multijet events



Production via vector boson fusion (VBF)

$\sigma = 4.278\ pb$

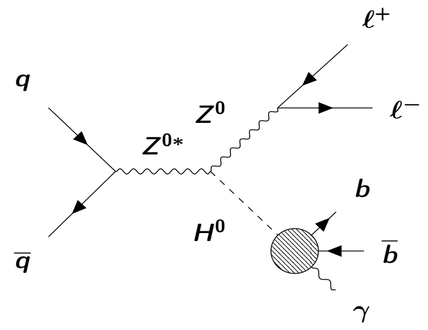
- 2^{nd} largest cross-section
- requires triggering on light jets



W and Higgs associated production (WH)

$\sigma = 1.514\ pb$

- leptons in the final state
- event selection using leptons and/or neutrinos
- smaller cross-sections



Z and Higgs associated production (ZH)

$\sigma = 0.986\ pb$

Results for the ggF production channel

Figura 3: Transverse momentum of the leading photon of each event, for SM and BSM simulated data sample.

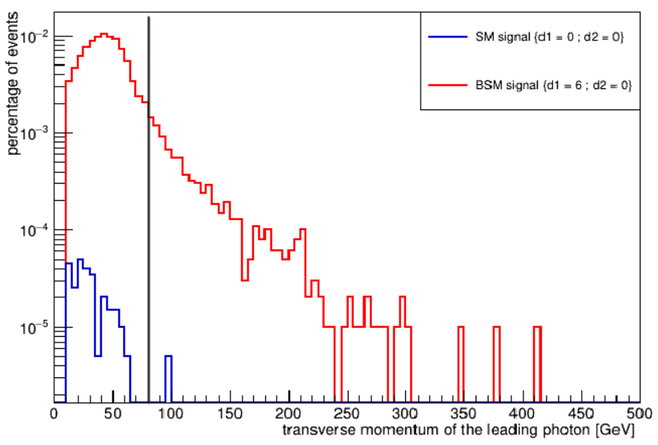
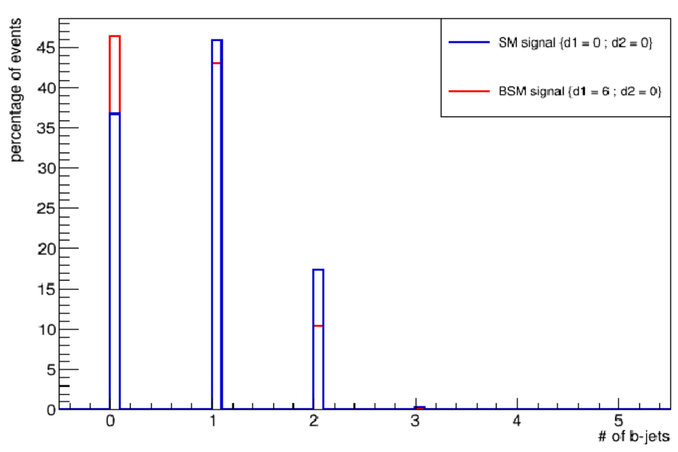


Figura 4: Number of b-jets per event in the SM and BSM simulated data sample



Taula 1: Efficiency table (in percentage) for the six different samples, cumulatively for the selection criteria applied.

	Standard Model	Beyond Standard Model	Background			
	pp ->h ->bb γ	**pp ->h ->bb γ**	**pp->bba**	**pp->bbj**	**pp->jja**	**pp->jjj**
lead photon $p_T > 80$	0,5E-05	0.864	11.7338	0.0048	12.5991	0.0086
$\#bjets > 2$	0	0.021	1.9017	5.70E-04	2.15E-02	1.91E-05
$\Delta R_{b\gamma} < 1.5$	0	0.021	0.3369	2.69E-05	3.05E-03	1.54E-06
$S < 0.02$	0	0.004	0.3335	2.62E-05	2.79E-03	1.47E-06
$135 > M_{b\bar{b}\gamma} > 100$	0	0	5.26E-04	1.54E-07	1.11E-06	8.67E-09

Next Steps & Analysis

- After applying the selection criteria no events survived the complete event selection.
- This indicates that the ggF channel is **not** a good candidate for this study.
- For my thesis I will use the WH and ZH production channels.
- The next steps and analysis will be as follows:

1. Determine the relevant backgrounds for these channels
2. Simulation of collisions for:
   - SM signal $(H \to b\bar{b}\gamma)$
   - BSM signals
   - backgroung processes
3. Optimise the selection criteria used in order to:
   - exclude the background events
   - keep the signal processes
4. Understand how it affects the **sensitivity** of the experiment to phenomena beyond the SM.

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