

# A Fast Track towards the Higgs Spin and Parity

## Paper Seminar

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## A Fast Track towards the ‘Higgs’ Spin and Parity

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## Content of the paper

- 1 introduction to the recently discovered boson
- 2 technical setup for different  $J^P$  assignments
- 3 definition of observables sensitiv to the  $J^P$  configuration
- 4 overview of related data analyses at the LHC and Tevatron
- 5 estimation of sensitivity to  $J^P$  state by simulating experimental event selections

# Introduction

## Facts on the new boson

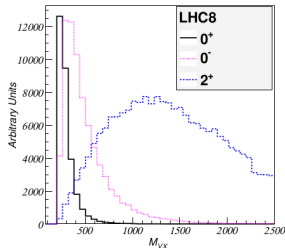
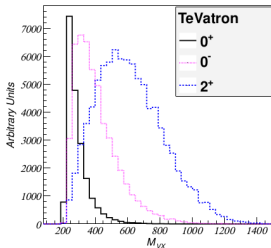
- mass around 126GeV
  - decay into a pair of on-shell photons
- ⇒ spin 1 is already excluded

## Implementation overview

- investigated  $J^P$  configurations:  $0^+, 0^-, 2^-$
- implemented pseudo-scalar couplings in MADGRAPH and FEYNRULES
- graviton-like couplings implemented in the HELAS library
- distributions for different scenarios generated with MADGRAPH and PYTHIA without any detector simulation
- fast detector simulations are done with DELPHES

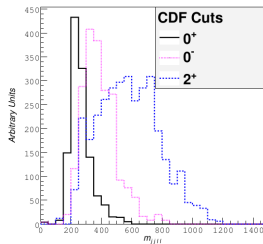
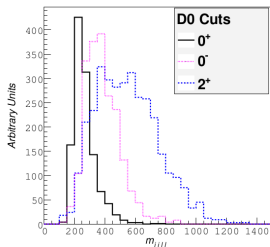
# Proposed observable

- suggestions: look at the production of the new boson  $X$  via radiation off a vector boson
- invariant boson - vector boson mass  $m_{VX}$  is sensitive to the spin and parity of the boson
- rise of the cross section at the production threshold different for different  $J^P$  configurations



# Simulating Tevatron analyses

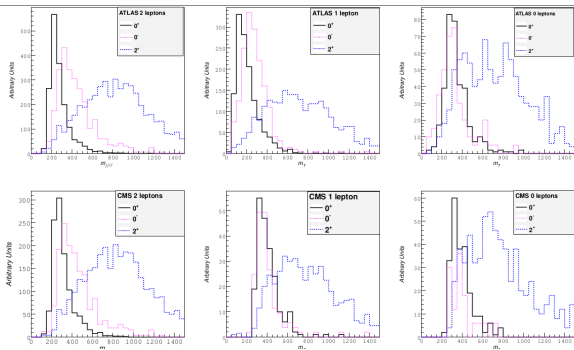
- investigate channel  $p\bar{p} \rightarrow Z \rightarrow Z(\rightarrow \ell^+\ell^-) + X(\rightarrow b\bar{b})$
- mimic analysis selection on generator level



- separation between different hypothesis remains after selection cuts

# Simulating LHC analyses

- investigate channel  $pp \rightarrow W/Z + X(\rightarrow b\bar{b})$
- use transverse masses in case of neutrinos in the final state



# Overview of results

- estimating separation significance using toy experiments
- neglect other experimental backgrounds and systematic uncertainties

Experiment	Category	Hypothesis A	Hypothesis B	Significance in $\sigma$
CDF	01	$0^+$	$2^+(0^-)$	3.7 (1.3)
	11	$0^+$	$2^+(0^-)$	2.5 (1.0)
	21	$0^+$	$2^+(0^-)$	1.4 (0.78)
	Combined	$0^+$	$2^+(0^-)$	4.8 (1.6)
D0	01	$0^+$	$2^+(0^-)$	3.5 (1.2)
	21	$0^+$	$2^+(0^-)$	1.8 (1.2)
	Combined	$0^+$	$2^+(0^-)$	4.0 (1.6)
ATLAS	21	$0^+$	$2^+(0^-)$	2.4 (1.1)
CMS	21	$0^+$	$2^+(0^-)$	2.3 (0.70)



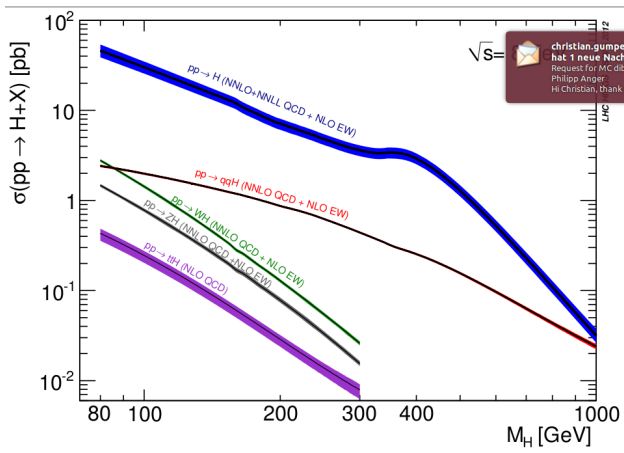
# Summary and Discussion

- investigate production of new boson via radiation off a vector boson
- ⇒ invariant mass  $m_{V\chi}$  is sensitiv to spin and parity of the new boson
- discrimination power larger for Tevatron experiments

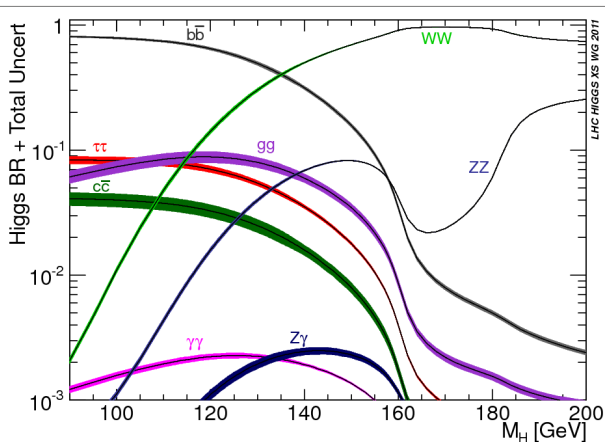
## Discussion

- questions, comments, thoughts ...

## Higgs boson production at the LHC



## Higgs boson branching ratios



## Higgs boson production times branching ratios

