Probing extended scalar sectors in multi-Higgs channels: Prospects at Future proton-proton Colliders

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EF02: LOI Review!

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The SNOWMASS21-EF2_EF0-198 team

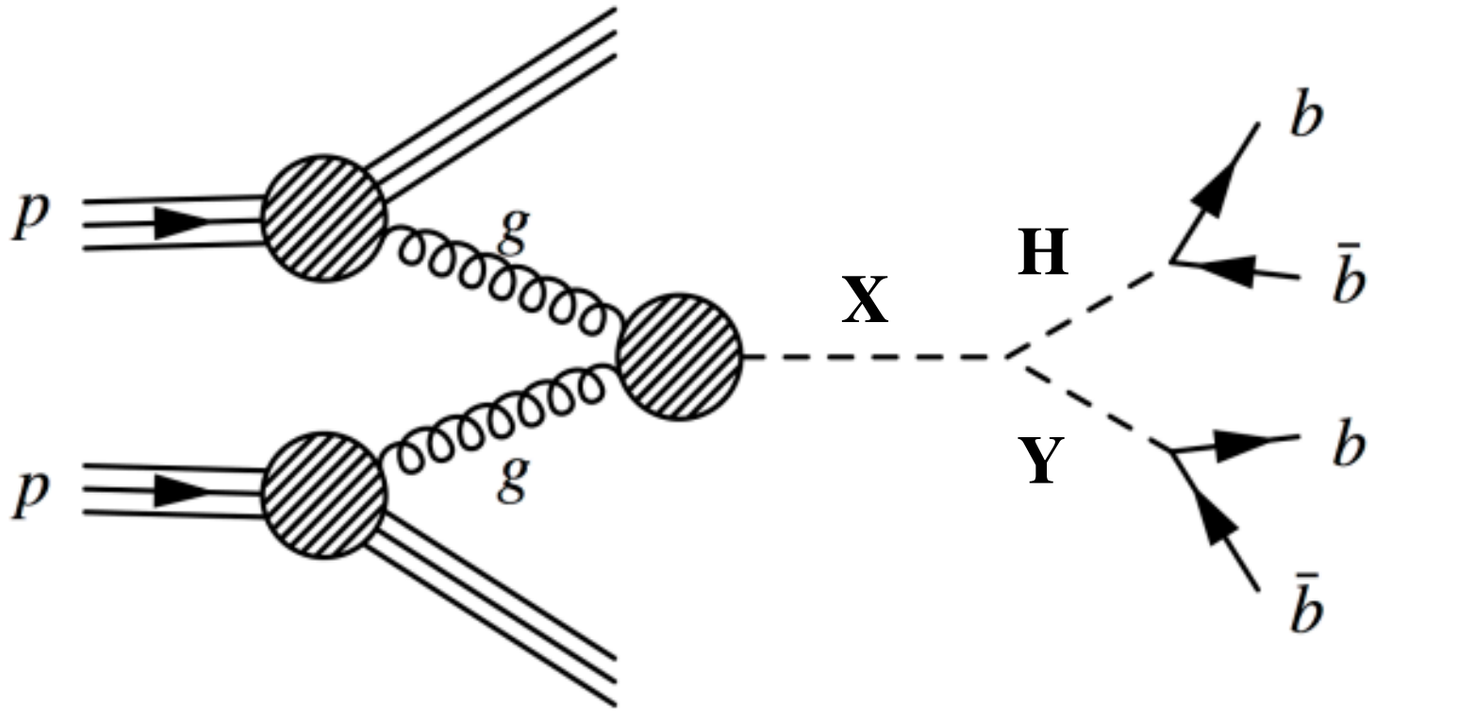
- Experimentalists
  - P. C. Bhat, L. Cadamuro, A. Canepa, C. Caputo, N. De Filippis, D. F. Guerrero Ibarra, J. Konigsberg, I. Margjeka, P. Merkel, F. Ravera, S. R. Rosenzweig, A. Taliercio, P. Vischia

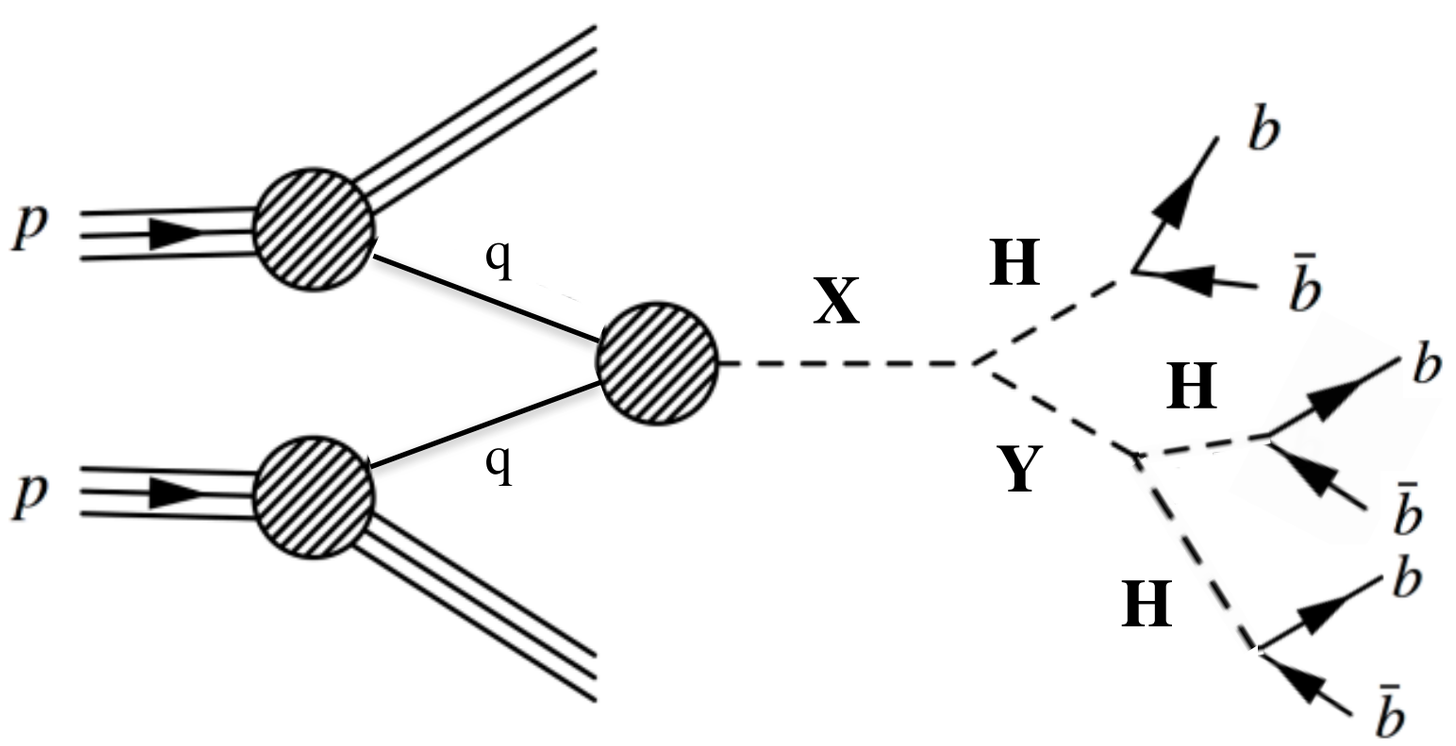
- Theorists
  - S. Baum, M. Carena, C. Gao, S. Gori, H. Haber, P. Huang, Z. Liu, I. Low, N. Shah, C. E. M. Wagner

- Same team works also on SNOWMASS21-EF1_EF2-196
  - Higgs Self Couplings: Measurements at Future proton-proton Collider

Channels investigated

- Studies on extended Higgs scalar sector
- 2 complementary processes:
  - X → HY → 4b
  - X → HY(HH) → 6b





- Resonances assumed narrow
- Only bb decays considered
- 2D search (m_X - m_Y plane)
- Main difference between the two channels is how Y candidate is defined

Fermilab

Plan of the activity

- Fermilab and UF experimentalists of the team are currently working on the CMS X → HY → 4b analysis: good knowledge of background composition, trigger efficiencies and analysis challenges

- Energy targets: HL-LHC (14 TeV), HE-LHC (27 TeV) and FCC-hh (100 TeV)

- A model-independent approach will be followed for developing the analysis

- Simulation of the detector with Delphes

- Plan to investigate ML techniques to maximize the sensitivity

Samples available

- Signals (to be requested for all energies)
  - 15-20 (m_X - m_Y) mass points for X → HY → 4b and for X → HY(HH) → 6b
  - technical setup for signal ready, need to converge on the mass range to explore for m_X and m_Y
- Montecarlo BKG (based on CMS X → HY → 4b studies)

Process	*14 TeV*	*27 TeV*	*100 TeV*
QCD b enriched	***NONE***	***NONE***	***NONE***
ttbar	***tev14pp_mg5nlo_ttbar tev14pp_mg5_ttbar_bjet***	***mgp8_pp_tt_5f_HT_****	***tev100pp_ttbar_pythia8 tev100pp_mg5_ttbar_bjet***
ttH	***tev14pp_mg5_higgs_ttbar***	***mgp8_pp_tth0123j_hbb_5f***	***tev100pp_higgs_ttbar_mg5***
single H	***tev14pp_pythia8_higgs_bbar***	***NONE***	***tev100pp_pythia8_higgs_bbar***
ZZ	***NONE***	***mgp8_pp_vv_5f_HT****	***tev100pp_wzdouble_pythia8***
ZH	***tev14pp_pythia8_higgswz***	***NONE***	***tev100pp_pythia8_higgswz***
ttZ	***tev14pp_mg4nlo_ttbarZ***	***mgp8_pp_ttz_5f***	***mgp8_pp_ttz_5f_zbb***

Conclusions

- Large group of experimental and theory physicists from several US and European institutes

- The study investigates channels of the extended Higgs scalar sector:
  - pp → X → HY → 4b
  - pp → X → HY(HH) → 6b

- Investigated experiments: HL-LHC, HE-LHC and FCC-hh

- Investigation of available samples ongoing
  - Signal models already available
  - QCD b-enriched sample missing