Invisible Higgs at LHC

Kirtimaan Mohan

Centre for High Energy Physics
Indian Institute of Science
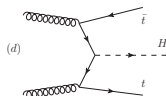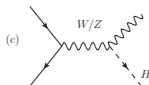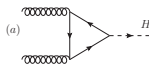Bangalore
India

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Invisible decays of the Higgs

Within SM the decay of the Higgs to invisible final states $\sim 1\%$ of total width.

Discovering a sizeable invisible BR is clear indication of BSM physics.

What can be done at LHC to put bounds on
$R_{inv} = BR(h \rightarrow invisible) \times \frac{\sigma^{BSM}}{\sigma^{SM}}$?

Monojet Searches

$\frac{2}{3}R_{inv}(ggF) + \frac{1}{3}R_{inv}(VBF)$

Highest production cross-section at LHC

Look for events with

p_t jet $(> 110 GeV)$

$\not{p}_T > 200$ GeV

$R_{inv} > 1.3$ exclusion at 95%CL $(4.7fb^{-1})$

$R_{inv} > 0.9$ for $15fb^{-1}$ luminosity [1]

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[1] arXiv 1205.3169

VBF topology

$0.15 \times R_{inv}(ggF) + 0.85 \times R_{inv}(VBF)$

Look for

dijets with large invariant mass and rapidity gap

$\not{p}_T > 100 GeV$

Most promising channel: for $20 fb^{-1}$ data Exclusion of $R_{inv} > 0.33$ at 95% CL for 8 TeV LHC can be probed [2]

However large systematic uncertainties

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[2]arXiv:1211.7015

$t\bar{t}H$

Small cross-section

Very complicated final state

Full hadronic: both tops decay hadronic, > 6 jets, 2b-jets

Semi leptonic:one top decays leptonically, > 4 jets 2b-jets 1 lepton

Large systematics and combinatoric background

$R_{inv} < 0.6$ at 95% CL for $30fb^{-1}$ LHC 14 TeV[3]

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[3]ATL-COM-PHYS-2003-016

$ZH \rightarrow \bar{l}l$

Cleanest channel
Statistically limited due to low cross-section. Look for

> dileptons that reconstruct Z

> large $\not{p}_T > 100\,GeV$

Exclusion of $R_{inv} > 0.55$ at 95% for $20fb^{-1}$ data at 8 TeV Possibility to use $Z \rightarrow b\bar{b}$ final states as well Exclusion of $R_{inv} > 1.0$ for $20fb^{-1}$ luminosity at 8 TeV , using both normal jet reconstruction and jet-substructure[4]
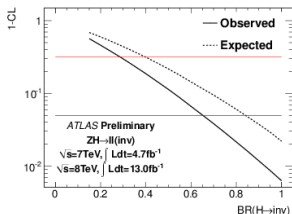WH, is not feasible : large irreducible backgrounds from inclusive W production.
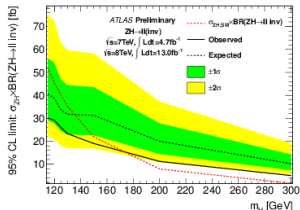
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[4]arXiv:1211.7015

ZH, *H*→invisible results

- Results are interpreted two ways:
  - ➔ Limit on **BR(*H*→invisible)** for SM m_H=125 GeV production

> 95% CL limit on **BR(*H*→invisible)** for m_H=125 GeV:
>
> **<65%** (measured); **<84%** (expected)

  - ➔ Limits on σ(*ZH*) * **BR(*ZH*→ℓℓ invisible)** for further Higgs-like states with 115 < m_H / GeV < 300

Undetected Higgs

Possibility of $H \to AA$

$A \to qq, gg, ...$ or partially invisible final states.

Difficult to detect at LHC: Large luminosity needed to place strong constraints.

However an in important BSM search.