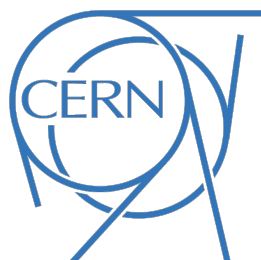# BSM Higgs searches at LHC

Mario Kadastik, Krisztian Peters

for the Heavy Higgs and BSM subgroup

25th May 2012, CERN

6th LHC Higgs Cross Section Workshop

Heavy Higgs and BSM subgroup

New subgroup responsible for B(MS)SM and heavy Higgs searches

- Modelling of the large Higgs width and the treatment of associated uncertainties

- Signal-background interference effects

- Prioritise BSM models:

    • Which are compatible with a possible signal observation

    • Could be tested next if a SM Higgs is excluded

- (High mass VV-scaterring processes)

Strongly correlated with property measurement plans/issues discussed in the light Higgs subgroup

|	*ATLAS*	*CMS*	*Theory*	
7.Heavy Higgs and BSM	Sara Diglio (Melbourne) Krisztian Peters (CERN)	Sara Bolognesi (Johns Hopkins) Mario Kadastik (NICPB Estonia)	Christophe Grojean (CERN)	Heather Logan (Carleton)

Introduction

Singly charged Higgs searches all in the context of MSSM, see dedicated subgroup

For more details on current BSM searches see Nikolaos' talk

→ In this talk some items for discussion

1. Higgs in 4th generation models

2. Fermiophobic Higgs

3. Doubly charged Higgs

4. Search for Light CP-Odd Higgs Bosons

5. …

Higgs in 4th generation models
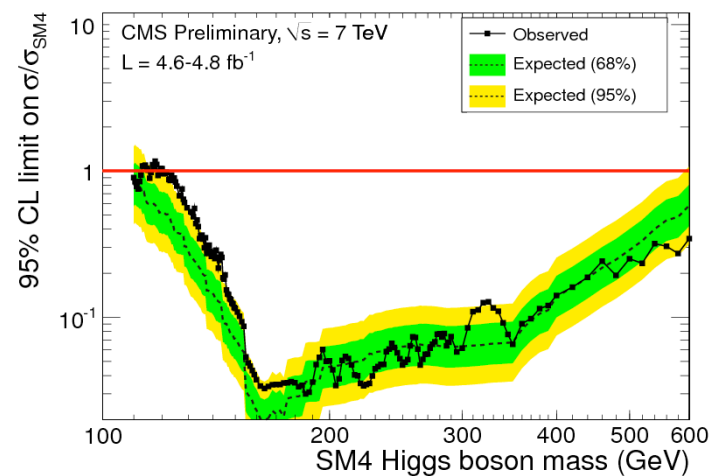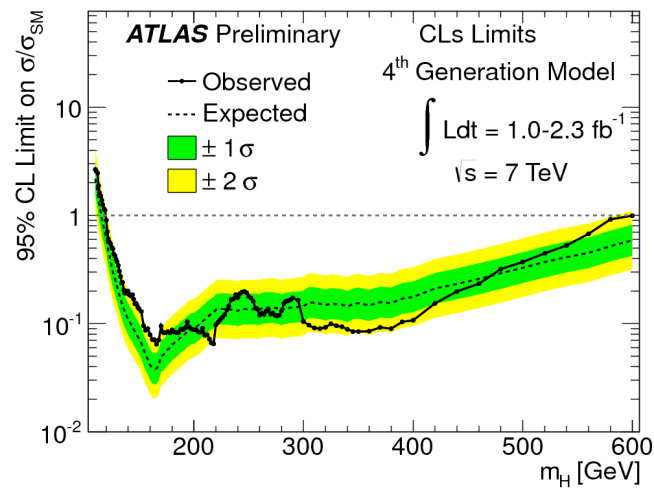
Need 8 TeV production cross sections for future updates

(7 TeV theory prediction was worked out in CERN Report 2, arriving very large NLO higher-order corrections, suppressing H → γγ in particular)

Exclusions beyond 600 GeV similar issues as SM heavy Higgs

Direct 4th generation quark searches give now very strong limits, approaching unitarity bound. Is it still interesting to approach this from the Higgs sector?

Expect current focus more on SM scenario

Fermiophobic Higgs

Several BSM models with strongly reduced coupling to all or some fermion generations

→ Experiments do not have the resources to test all these models individually

Fermiophobic benchmark point: H couplings to all fermions are set to zero while the couplings to bosons are kept at their SM values. Similar signal yield and kinematics to several models
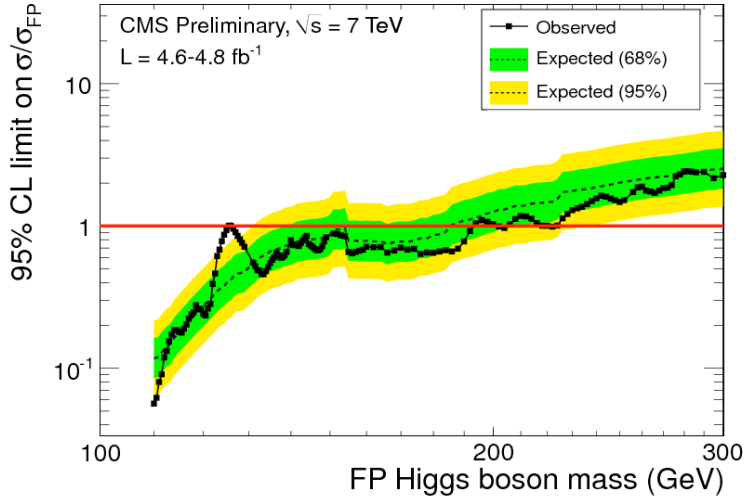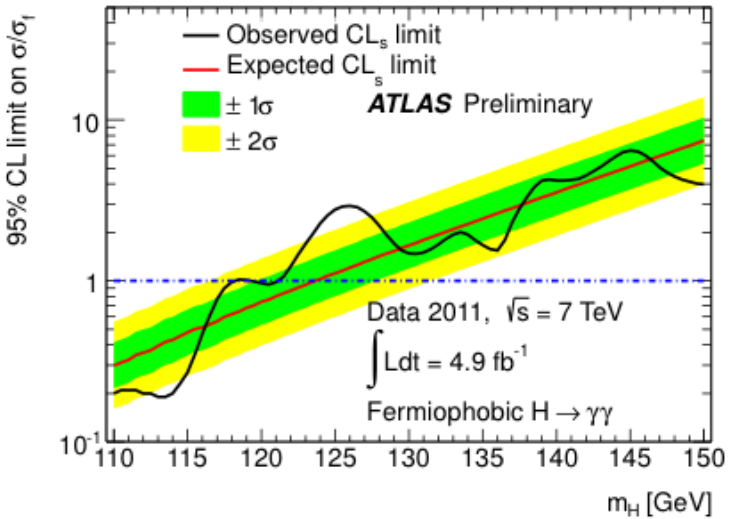

→ Use this benchmark for an approximate test of well defined models
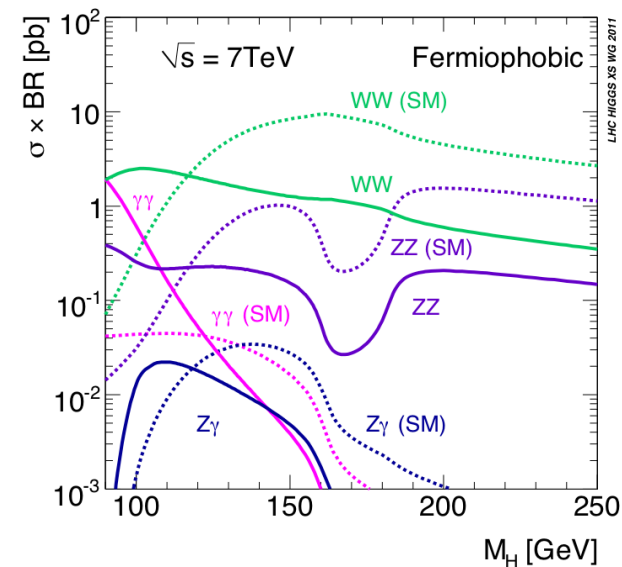
Higher order EW corrections not finite, theory uncertainties are in the same way not well defined as the central prediction. Loop induced fermion decays small and neglected

→ Is this a problem for the way the benchmark point is intended to be used?
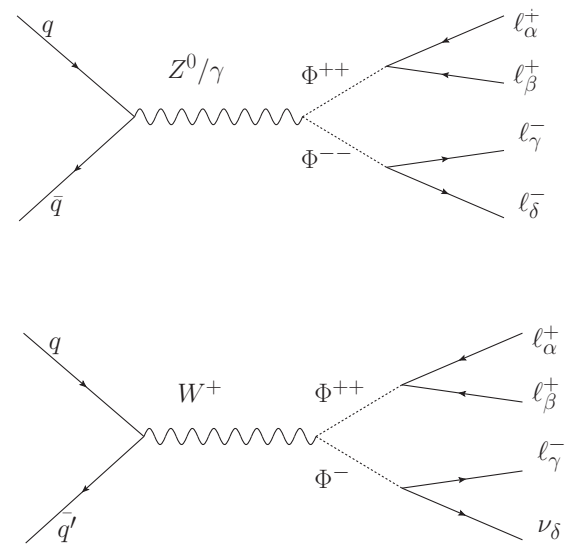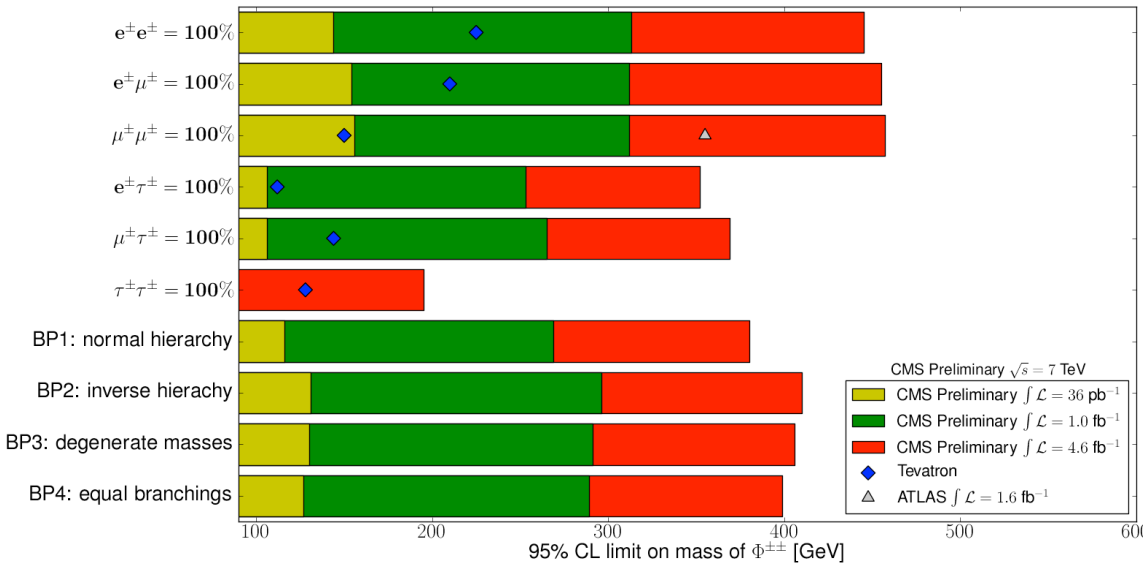
Fermiophobic Higgs

Large enhancement in the H → γγ signal yield at the lower mass range

Also investigated by LEP and Tevatron experiments

→ (Especially with an observed excess) FP benchmark should be superseded with globals fit of Higgs coupling strengths taking into account all possible search channels
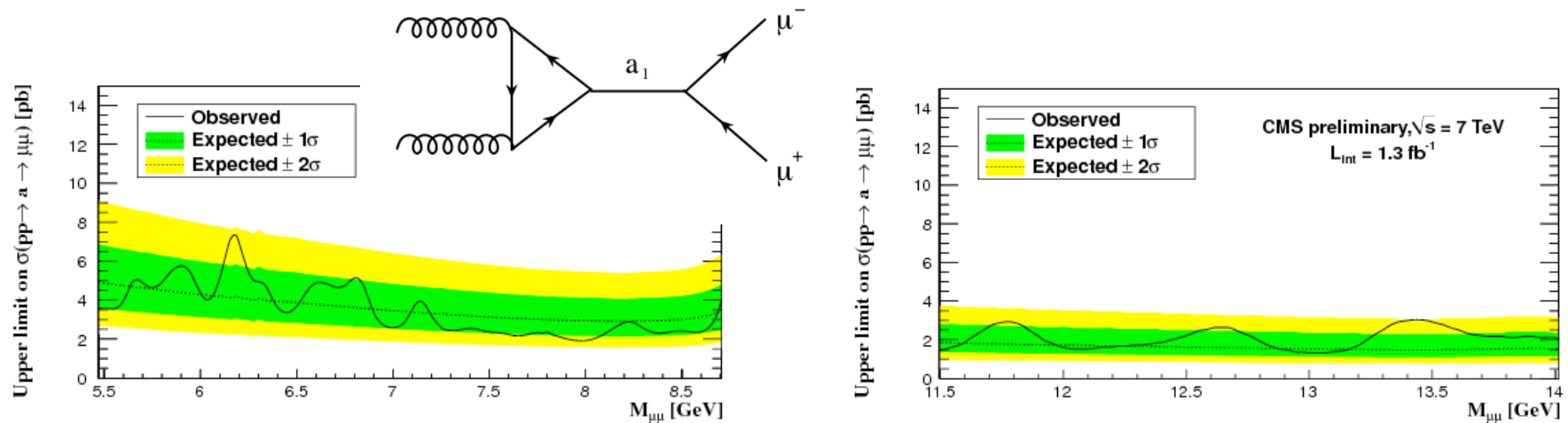
Doubly charged Higgs

Additional triplet (adding Φ^0, Φ^+, Φ^{++})

Predicted by a number of different models for new physics such as left-right symmetric models, Higgs triplet models, and the little Higgs model

Need synchronisation of benchmark points and cross sections

- associated production pp→W*→$\Phi^{++}\Phi^-$
- decay modes

Light CP-Odd Higgs

NMSSM: three CP-even (h_1, h_2 and h_3), two CP-odd (a_1, a_2) and two charged scalars (H^+, H^-). Search for a_1 decaying to $\mu^+\mu^-$

Di-muon masses around the Y resonances are excluded because uncertainties in the expected rate of Y production

Systematic uncertainties completely dominated by comparing Pythia vs MC@NLO for acceptance ~60% (half of the difference taken) *ATLAS example*

Plan to include $h \rightarrow aa \rightarrow \mu\mu\tau\tau$ and $h \rightarrow aa \rightarrow \gamma\gamma\gamma\gamma$

Other BSM Higgs scenarios

Invisibly decaying Higgs

- Assumption is that part of Higgs decay width is to a DM like particle that cannot be reconstructed
- Main sensitivity in associated production
- Very relevant for the Light Higgs subgroup discussions

Higgs decay to long-lived weakly interacting particles

- Hidden Valley scenario, (MSSM with R-parity violation, extensions of MSSM)
- Experimentally challenging (very large impact parameter or decay inside muon spectrometer)

Composite Higgs models

- Minimal composite Higgs models (MCHM)
- Strongly interacting light Higgs (SILH)

Etc., etc.