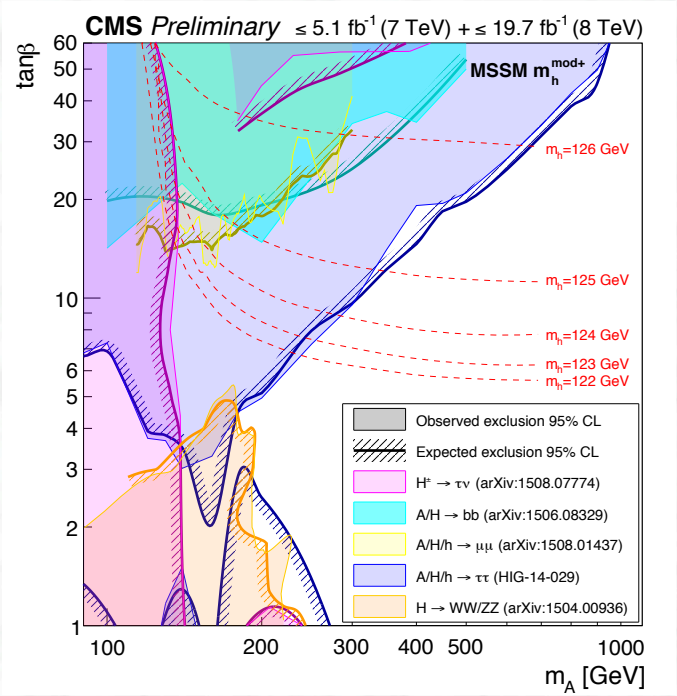
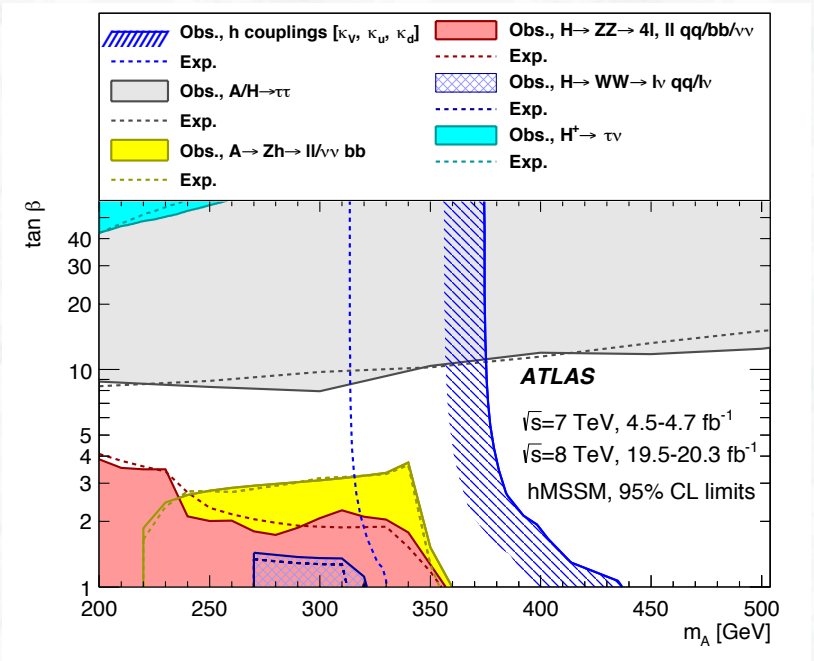
BSM Higgs Boson Searches in ATLAS and CMS

-a brief comparison and open issues-

based on talks by Luca Fiorini and Devin Taylor





Run 1 legacy

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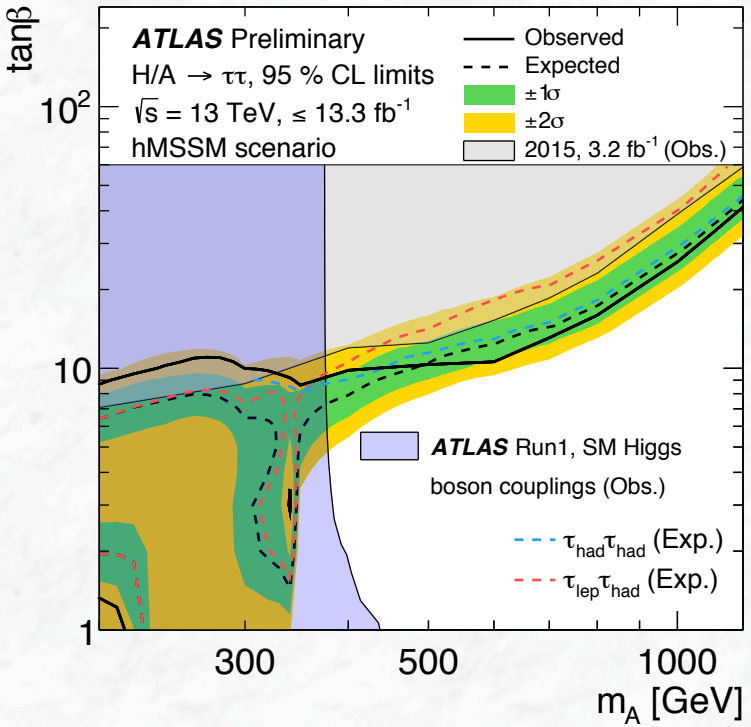
Fermionic decays of heavy neutral Higgs Bosons
$\phi \rightarrow \tau\tau$, $\phi \rightarrow tt$

- Similar analysis strategy in the two experiments
  - Use $\tau_e\tau_h$, $\tau_\mu\tau_h$, $\tau_e\tau_\mu$(only CMS), and $\tau_h\,\tau_h$ decay modes
  - b-tag and b-veto category (high E_T^{miss}, ATLAS)
- Large data set (13.3 fb^{-1}) at $\sqrt{s}$ = 13 TeV already analysed by ATLAS
- Increased sensitivity at high mass, compared to Run 1
- Some sensitivity at low tan β;
  Complemented by first $\phi \rightarrow tt$ studies



Future Issues:

- Improve analysis: tau-ID, fake backgrounds (l-had)
- Trigger issues? at Run-2 and beyond?
- Theory: tt interference

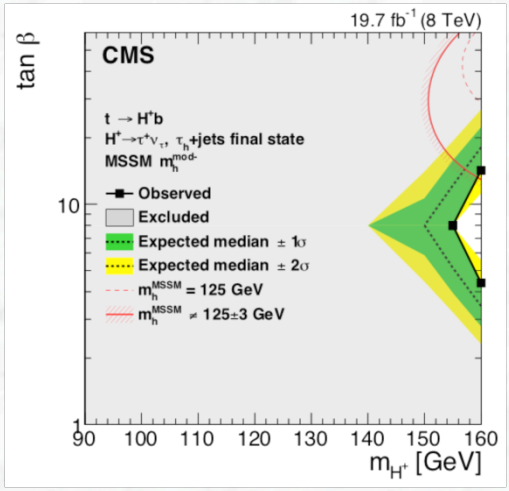
Search for Charged Higgs Bosons

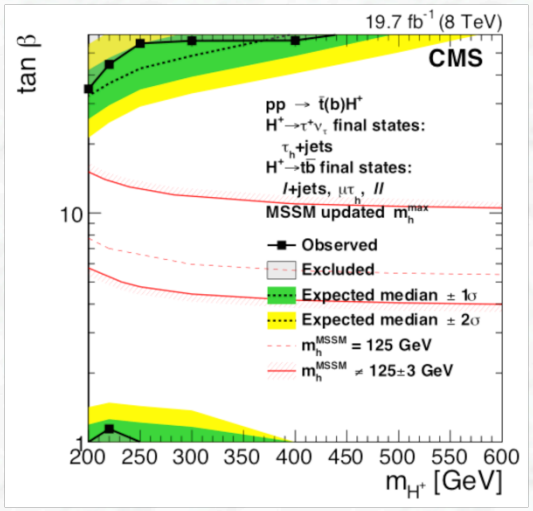
$H^{\pm} \rightarrow \tau\nu$ and $H^{\pm} \rightarrow tb$

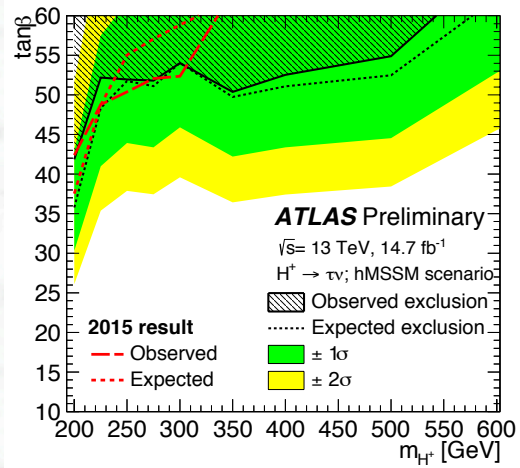
- The higher centre-of-mass energy gives access to large masses, $m_{H+} > m_t$ [Focus in Run 2]
  (MSSM region for m_{H+} below m_t essentially covered)

- First 13 TeV analyses appeared from ATLAS (14.7 fb^{-1}) and CMS (2.3 fb^{-1})

- First exclusions observed in large ($H^{\pm} \rightarrow \tau\nu$) and small ($H^{\pm} \rightarrow tb$) tan β region;
  limits set for $m_{H+} > 200$ (300) GeV







Future issues and challenges:

- Transition region? Is it completely covered?

- Trigger issues at high luminosity?

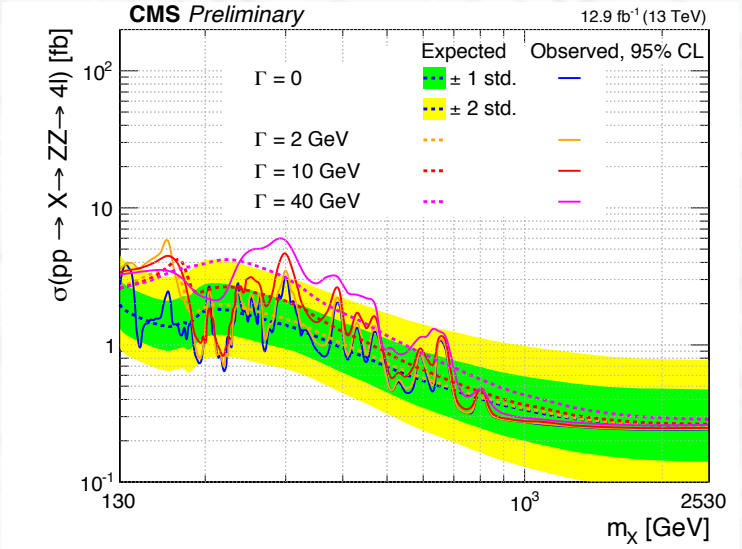
- Dominant systematic uncertainties:
  $H^+ \rightarrow \tau\nu$: tt-modelling, τ misidentification (fake rate), τ identification and energy scale
  $H^+ \rightarrow tb$: ttb, ttc modelling, b-tagging, ..

Di-boson decays: H → ZZ, H → WW

- The WW and ZZ channels have already been updated, improved limits on production cross sections w.r.t. Run 1

  Exploit “Boosted Jets”

- Results on other channels, e.g. A → Zh are expected to come soon

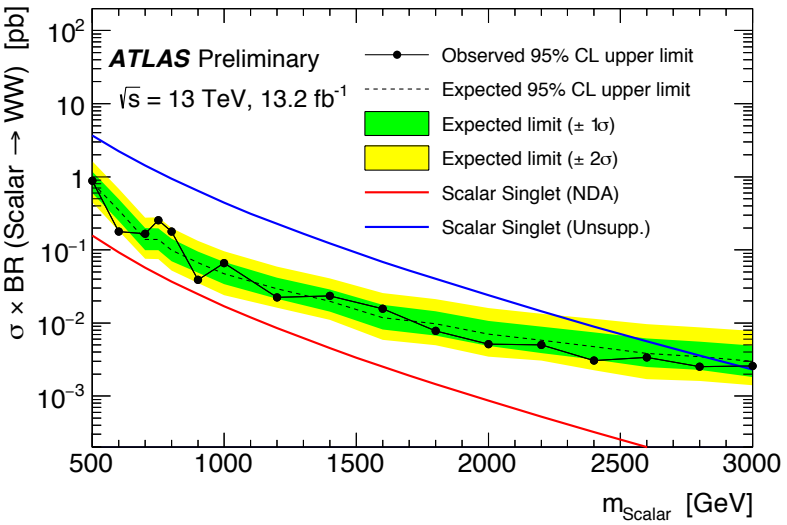


Future issues and challenges:

- Dominant systematic post-fit uncertainties:

  - Energy scale and resolution of large-R jets; (better understanding of boosted jets)

  - Shapes of W+jets and tt backgrounds



Di-Higgs production

The portal to Higgs boson self coupling

Non-resonant	ATLAS	CMS
hh → bb bb	Run 2 (2016): 13.3 fb^{-1} - Resolved analysis (4 b tags) σ_{hh} < 981 fb [29 SM]	Run 2 (2015): 2.3 fb^{-1} - 4 b tags - σ BR < 11.534 fb [342 SM]
hh → bb WW (lν jj)		Run 2 (2015): 2.3 fb^{-1} - W → lν lν decays - σ_{hh} < 13.480 fb [400 SM]
hh → bb $\tau\tau$	(entered combined ATLAS result based on … fb-1)	Run 2 (2016): 12.9 fb^{-1} - e τ_h , μ τ_h, τ_h τ_h - σ_{hh} < 6.740 fb [200 SM]
hh → bb $\gamma\gamma$	Run 2 (2015): 3.2 fb^{-1} σ_{hh} < 3.900 fb [116 SM]	Run 2 (2015): 2.7 fb^{-1} σ_{hh} < 2.961 fb [88 SM]
hh → WW $\gamma\gamma$	Run 2 (2016): 13.3 fb^{-1} σ_{hh} < 25.000 fb [742 SM]	

- Broad coverage of accessible decay chains by both collaborations
- 2016 data already analysed for many decay channels
- hh → bb bb channel turns out to have high sensitivity;
  Important for future studies, HL-LHC (potential for all channels should be evaluated using Run 2 experience → performance extrapolations)
  Major systematics: - b-tagging efficiency,
  - performance at high pile-up