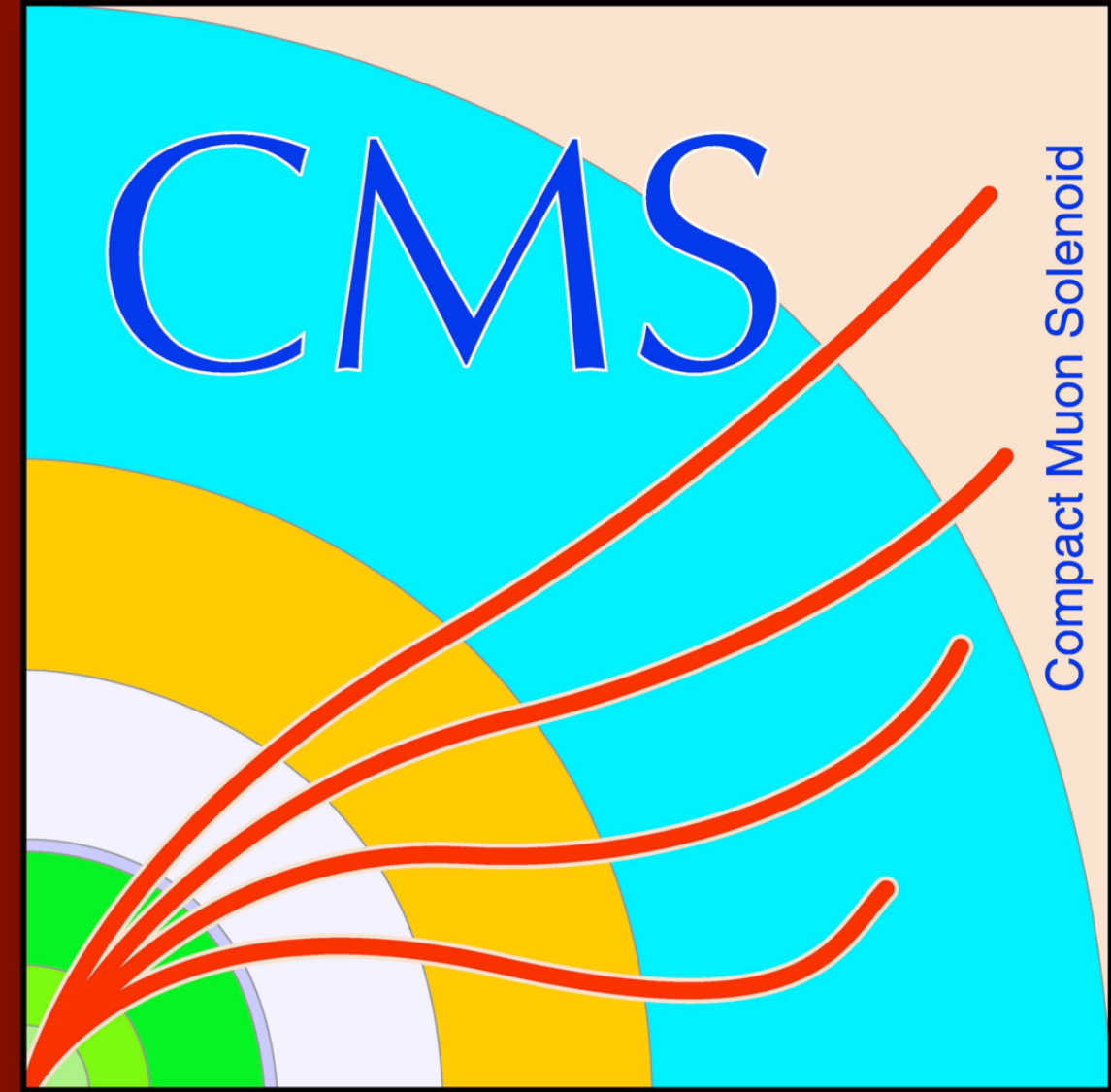
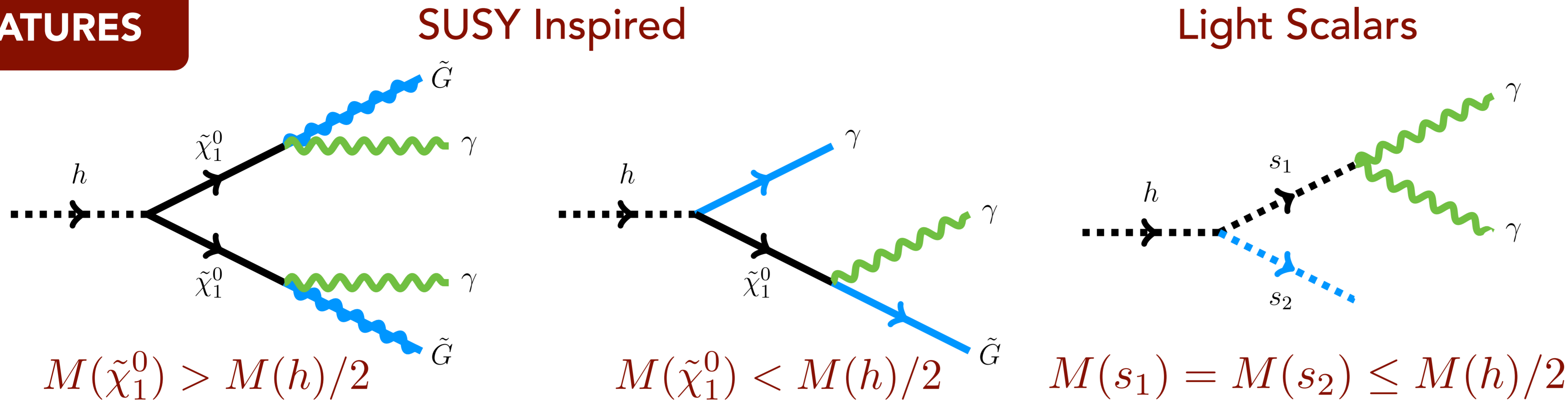


EXOTIC DECAYS OF THE HIGGS BOSON WITH PHOTONS AND MET: CMS RUN I RESULTS AND FUTURE PROJECTIONS



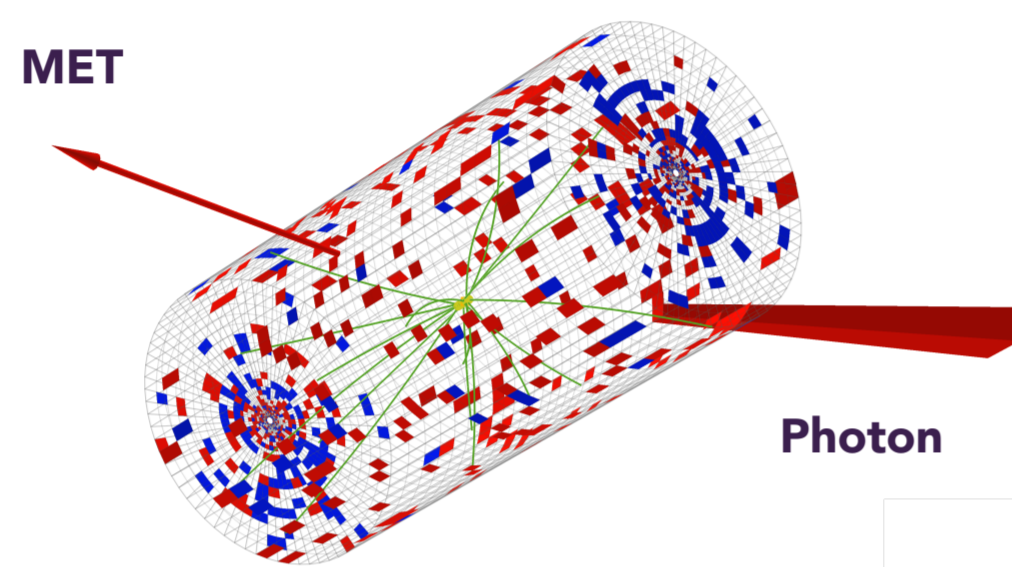
Rafael Teixeira de Lima (Northeastern University)
on behalf of the CMS Collaboration

SIGNATURES



RUN I: GLUON FUSION

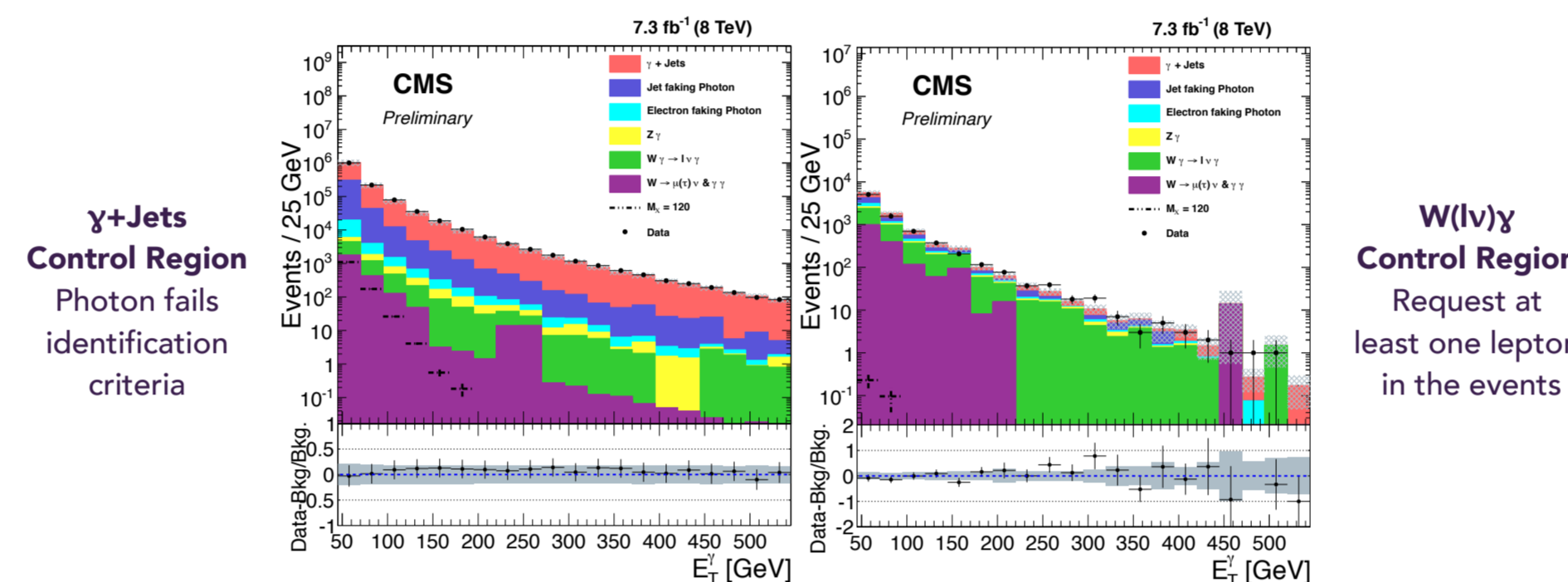
- Search for **SUSY inspired** $h \rightarrow \gamma + \text{MET}$ decay in the gluon fusion production mechanism
- Performed with **7.3/fb of parked CMS Run I data** ($\gamma + \text{MET}$ trigger) at 8 TeV
- Main backgrounds from **misidentified photons** (jets and electrons), **mismeasured MET**, $\gamma + \text{Jets}$ and $Z(\nu\nu)\gamma$
- Limits on **SUSY** exotic decay and on **model independent** signature



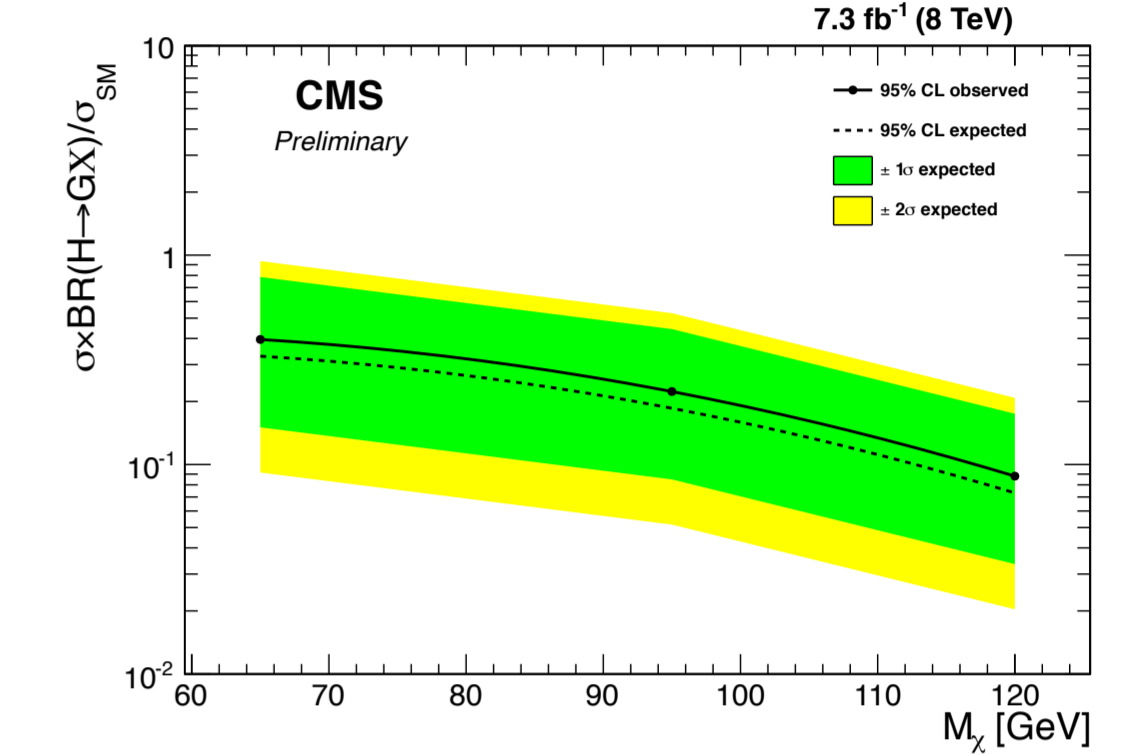
Background estimation with data

- Jets** \rightarrow **photons** contribution estimated by comparing templates of jets that pass γ requirements and overall jets
- Electrons** \rightarrow **photons** contribution estimated by measuring the fake rate from $Z \rightarrow ee$

Control Regions

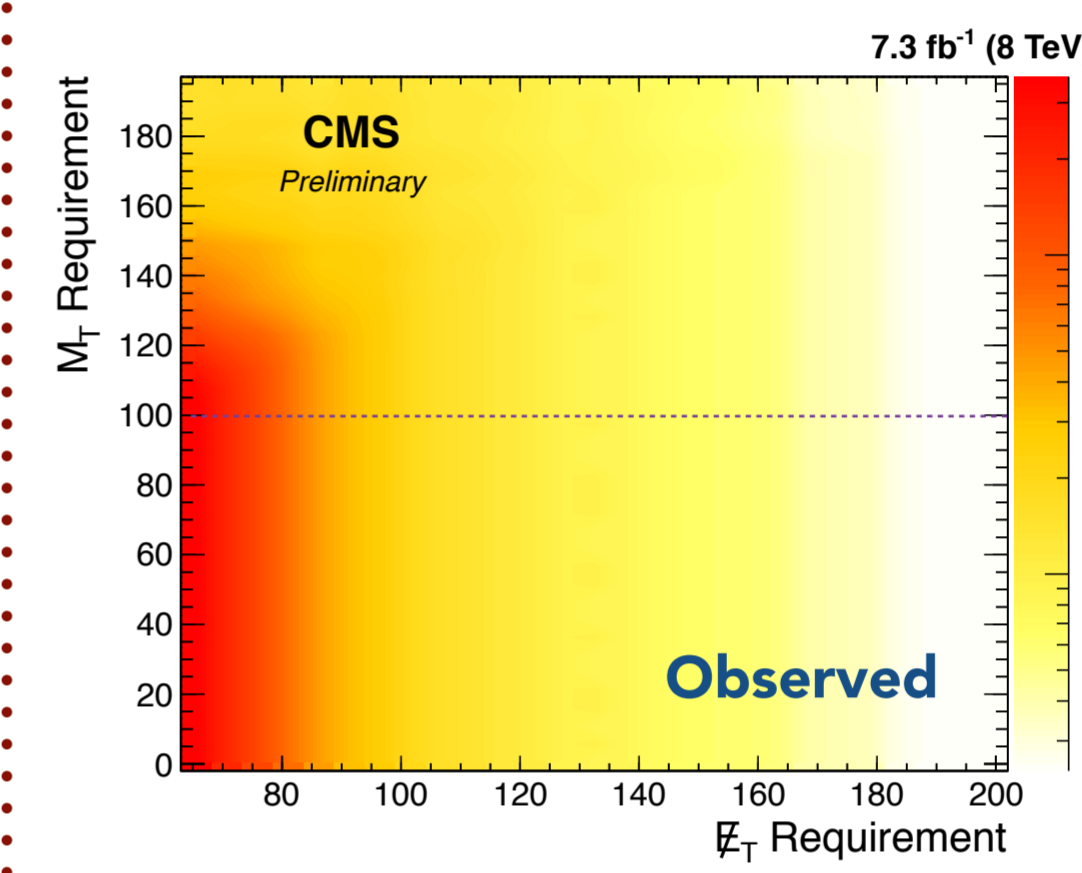


Model Specific Limit
Limits on branching ratio of $h \rightarrow \gamma + \text{MET}$ with selection optimized for SUSY model



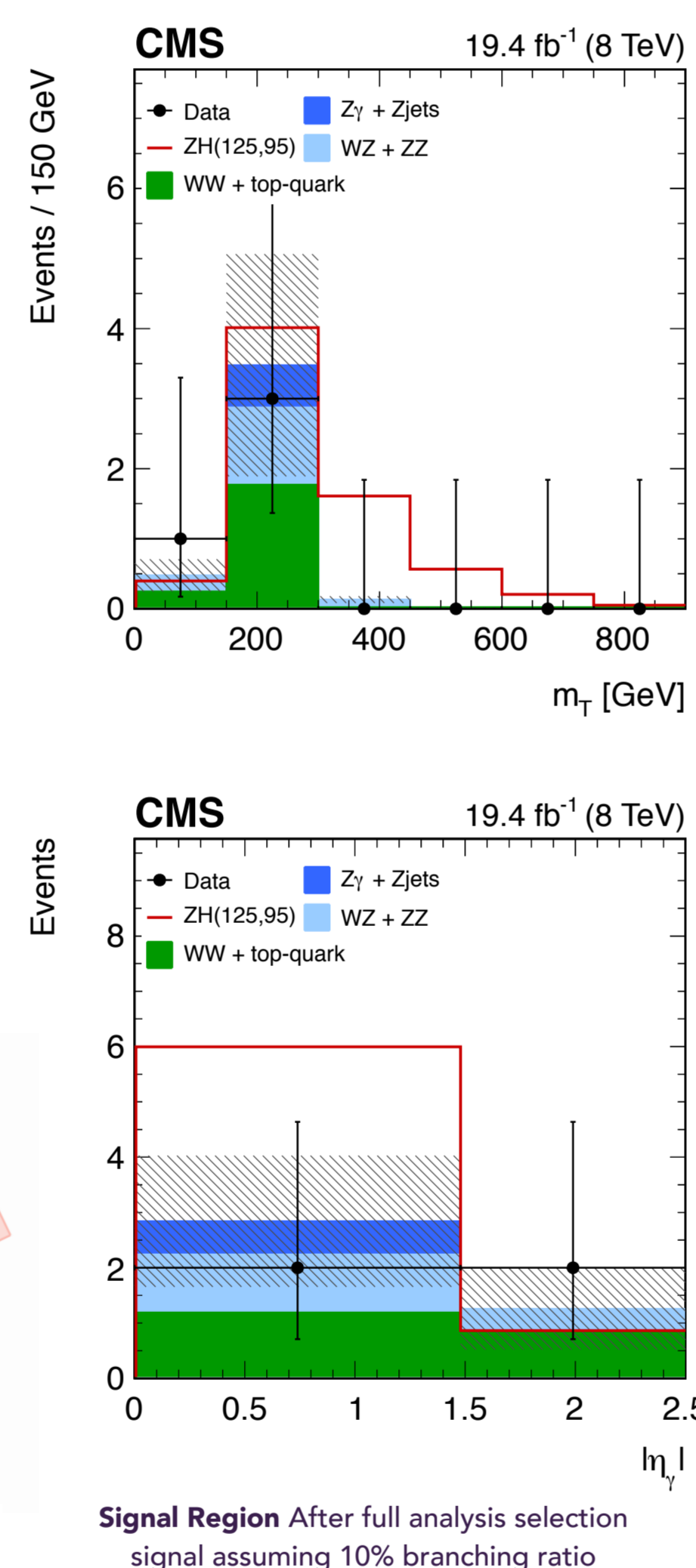
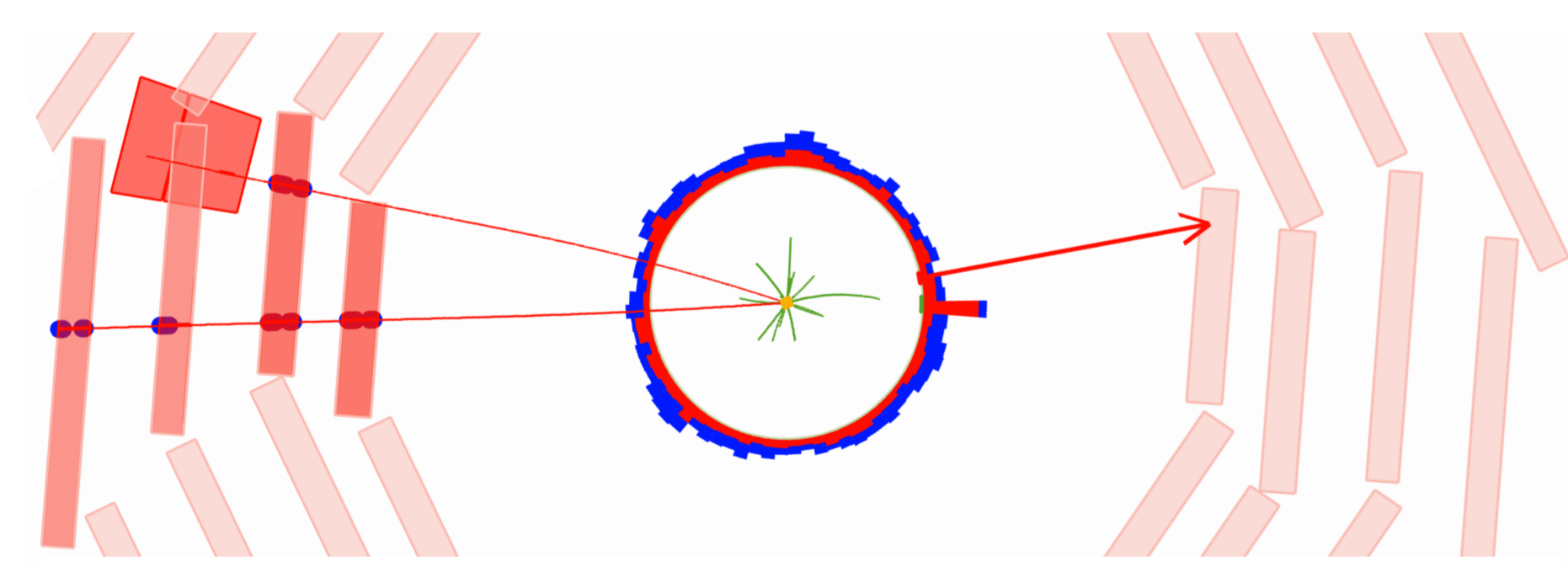
Model Independent Limit

Limits on branching ratio of $h \rightarrow \gamma + \text{MET}$ with looser selection as a function of the transverse mass and MET requirement



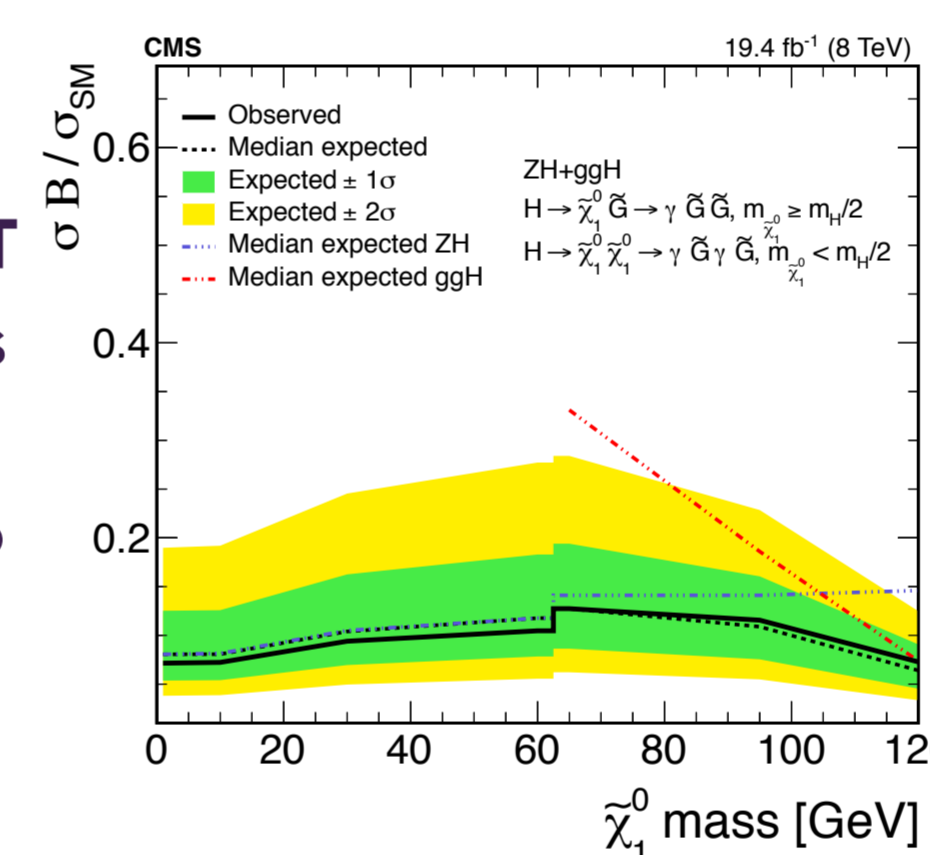
RUN I: Z(LL)H

- Search for **SUSY inspired** $h \rightarrow \gamma + \text{MET}$ and $h \rightarrow \gamma\gamma + \text{MET}$ decays in the ZH production mechanism with the Z leptonic decay
- Performed with **19.4/fb of CMS Run I data** at 8 TeV
- Main backgrounds from **Electroweak processes** and **top quark decays**
- Limits on **SUSY** exotic decay

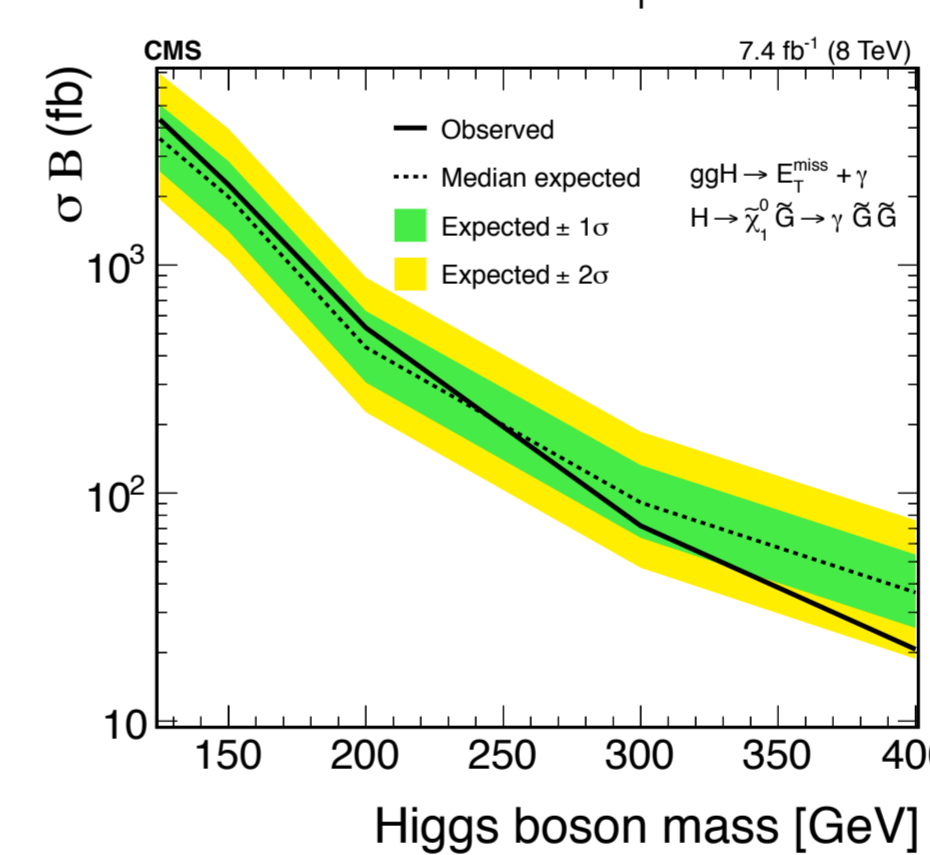


RUN I: COMBINATION

SUSY $h \rightarrow \gamma(\gamma) + \text{MET}$
Limits on the Higgs branching ratio for different neutralino masses

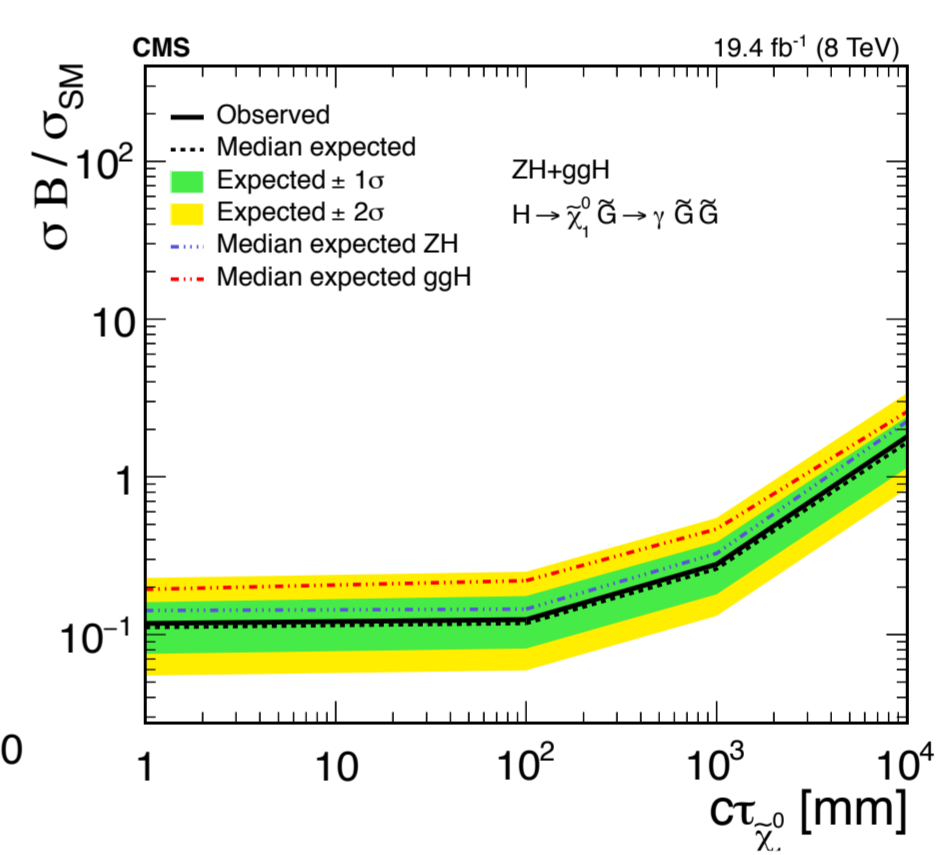


Other Higgs Bosons (gluon fusion)
Limits on cross section of $h \rightarrow \gamma(\gamma) + \text{MET}$ assuming different $M(h)$

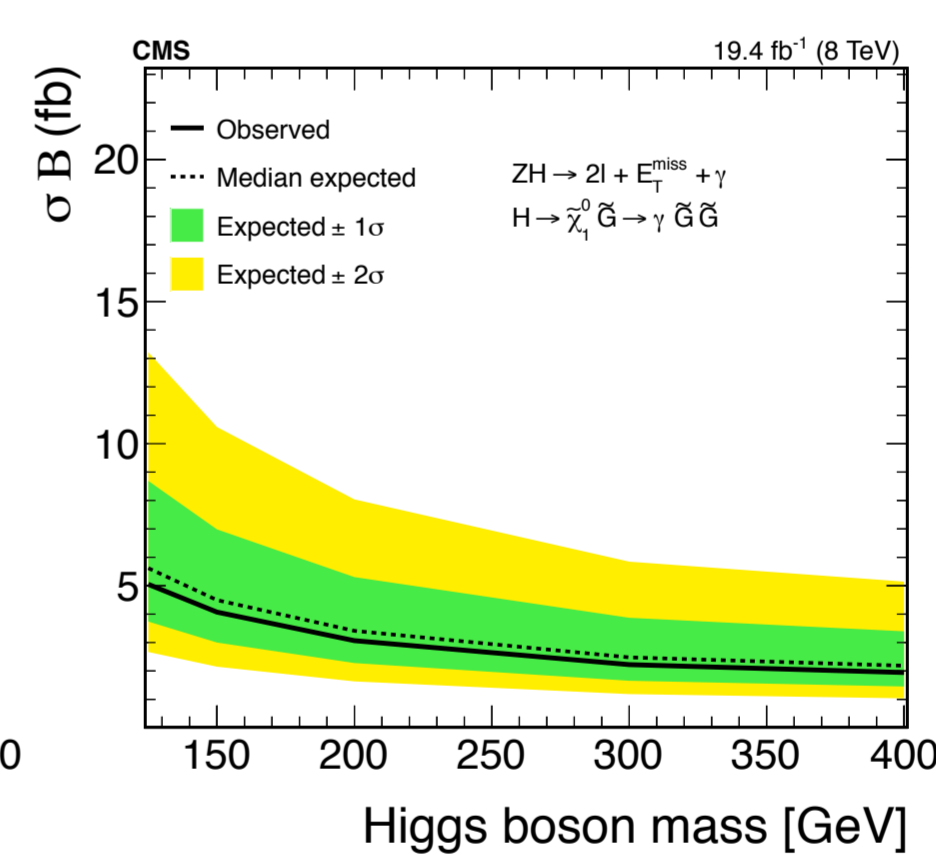


CMS Collaboration, Phys.Lett. B753 (2016) 363-388, arXiv:1507.00359

Long Lived Neutralino
Limits on branching ratio of $h \rightarrow \gamma(\gamma) + \text{MET}$ assuming different neutralino lifetimes



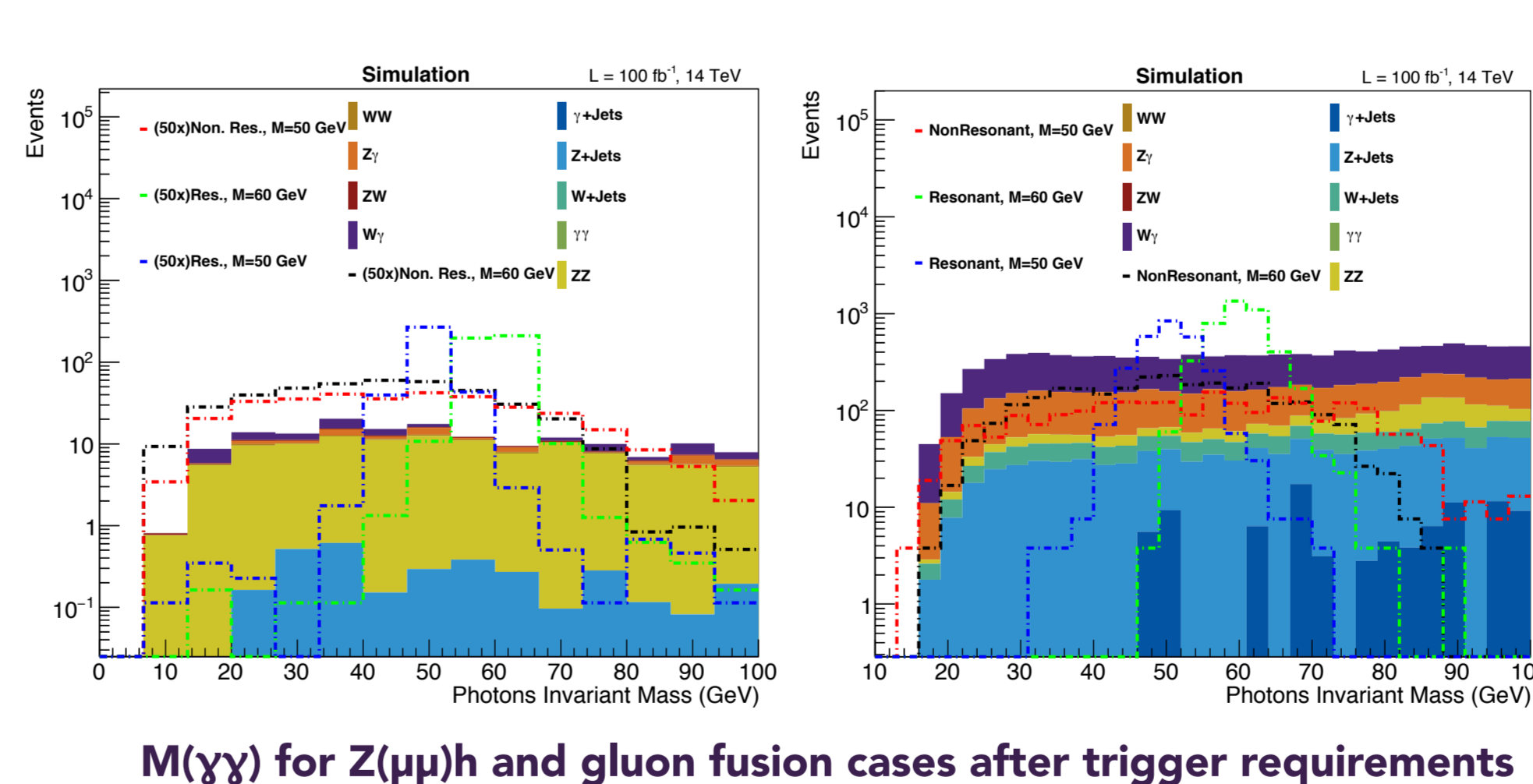
Other Higgs Bosons (ZH)
Limits on cross section of $h \rightarrow \gamma(\gamma) + \text{MET}$ assuming different $M(h)$



FUTURE PROJECTIONS

Study performed in the context of the Yellow Report 4 of the LHC Higgs Cross Section Working Group - RTdL, S. Bressler, S. Gori, A. Mohammadi, T. Orimoto, J. Shelton

- Projected sensitivities for the $h \rightarrow \gamma\gamma + \text{MET}$ final state in the SUSY (non-resonant) and Light Scalars (resonant) interpretations for the **14 TeV LHC with 100/fb integrated luminosity**
- Projected sensitivities estimated using LHE events for background processes generated for **Snowmass studies at 14 TeV**
- Signal events generated with MadGraph for **gluon fusion** and $Z(\mu\mu)h$ production mechanisms
- Detector simulation performed with **DELPHES** based on a CMS detector card
- Sensitivity estimated with $S = S/(\sqrt{B} + \sigma_{sys} \times B)$ where σ_{sys} is the effect of systematical uncertainties
- Selections optimized for maximal sensitivity
- Results given in terms of the $h \rightarrow \gamma\gamma + \text{MET}$ branching ratio for a 5σ sensitivity (discovery) or 2σ sensitivity (exclusion)



- Gluon fusion** analysis following **Run I trigger strategy** ($\gamma + \text{MET}$)
- Pure QCD** contribution neglected for **gluon fusion** (non-leading)
- $Z(\mu\mu)h$** analyses performed **requiring at least one photon** ($N(\gamma) \geq 1$, Run I strategy) and **at least two photons** ($N(\gamma) \geq 2$)

