Status of Search for a Resonance decaying to Wγ in CMS experiment

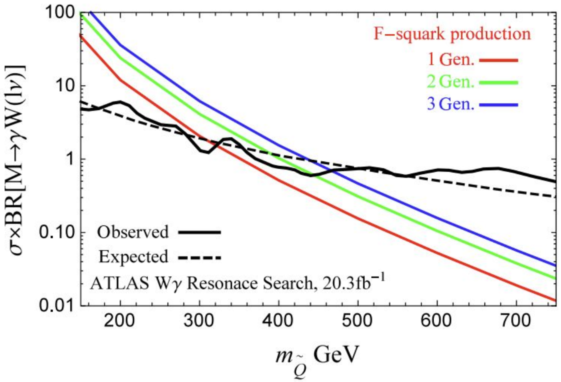
Kak Wong, 10/24/2018

Theory

- ➔ Final state described by various models
  - ◆ charged Higgs arXiv:1809.09127
  - ◆ F quark arXiv:1411.3310, Phys.Rev.D91.055007
  - ◆ Technicolor arXiv:1608.01675

- ➔ Model-independent search
- ➔ Set cross-section limit vs resonance mass
- ➔ **Lepton** channel expected to provide better background suppression for mass < 1TeV

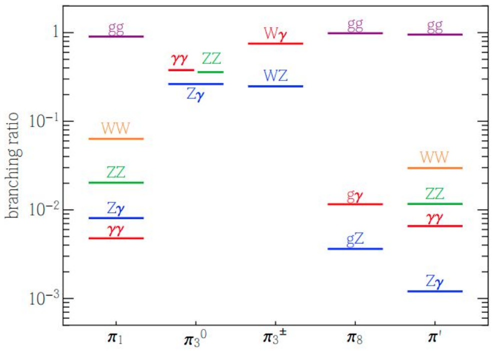
F mesons



Charged Higgs

$$
\begin{aligned}
pp &\to H_5^{\pm} H_5^{0} \to W^{\pm}\gamma + X \to \ell\, \nu_\ell\, \gamma + X, \\
pp &\to H_5^{\pm} H_5^{\mp\mp} \to W^{\pm}\gamma + X \to \ell\, \nu_\ell\, \gamma + X, \\
pp &\to H_5^{+} H_5^{-} \to W^{\pm}\gamma + X \to \ell\, \nu_\ell\, \gamma + X.
\end{aligned}
$$

Technicolor



Signal selection

- 2016,2017 dataset

Electron channel

- **MET>25**
- 1 electron and 1 photon only
- Medium photon in ECAL barrel
- Photon pT>50GeV, pass electron veto
- Tight electron with |η|<2.1
- Muon veto: veto event with muon with pT>10GeV
- **Inverse Z mass: |m(e,γ)-91.2GeV|>15GeV**

Muon channel

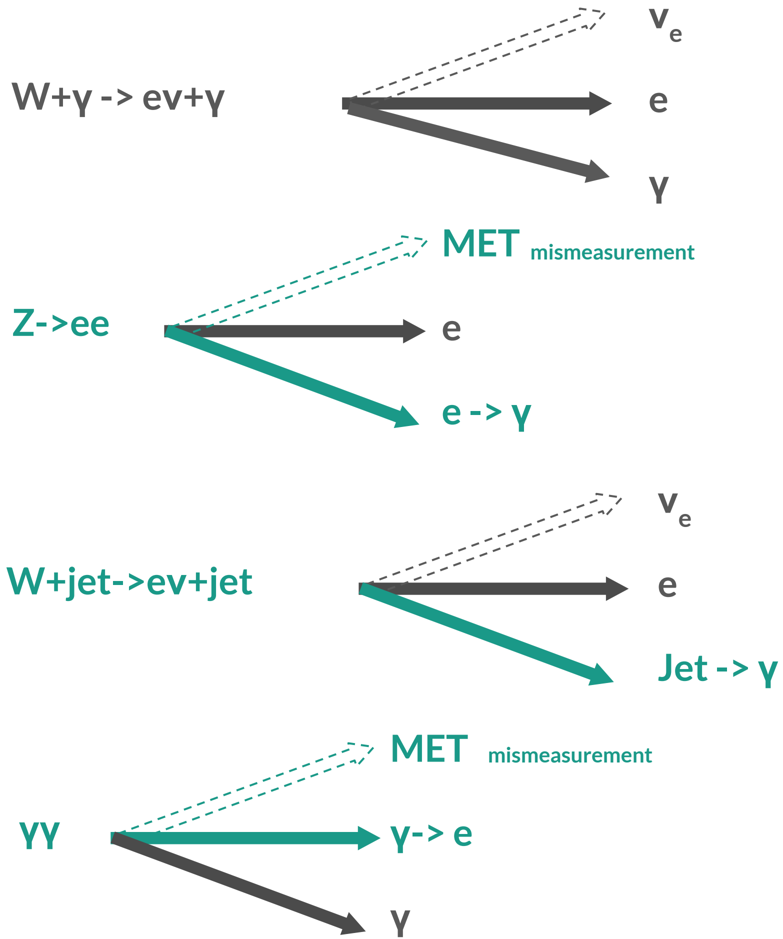
- MET>25
- 1 muon and 1 photon only
- Medium photon in ECAL barrel
- Photon pT>50GeV, pass Pixel Veto
- Tight muon with |η|<2.4
- Electron veto: veto event with electron with pT>10GeV

This talk focuses on e channel

Backgrounds

Electron channel

- ➔ Electron -> photon
  - ◆ Z+jets
- ➔ Jet-> photon
  - ◆ W+jets
- ➔ Photon -> electron
  - ◆ Diphoton
- ➔ SM Wγ: irreducible

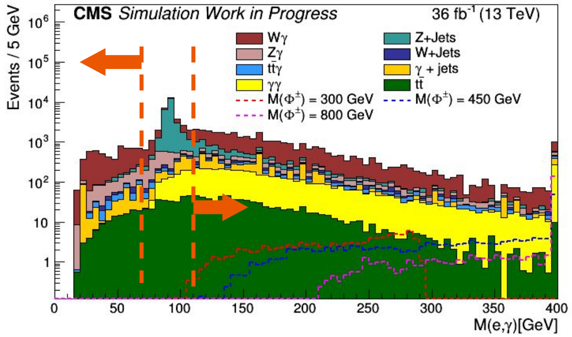


Backgrounds

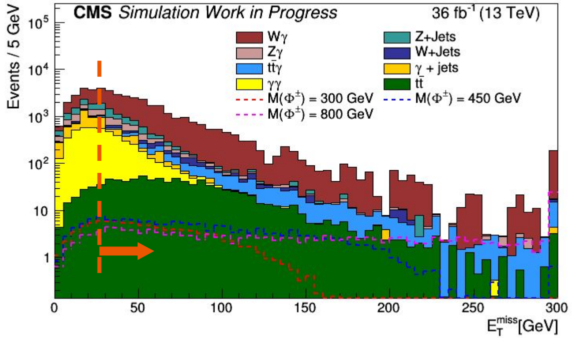
- ➔ Irreducible SM Wγ background dominates
- ➔ Sensitive to electron faking photon
  - ◆ Strict veto of electrons
  - ◆ Rejects photon with matching tracker seed in Pixel detector
  - ◆ Barrel photon only

Table 2: MC background passing signal selection in electron channel (statistical uncertainties only)

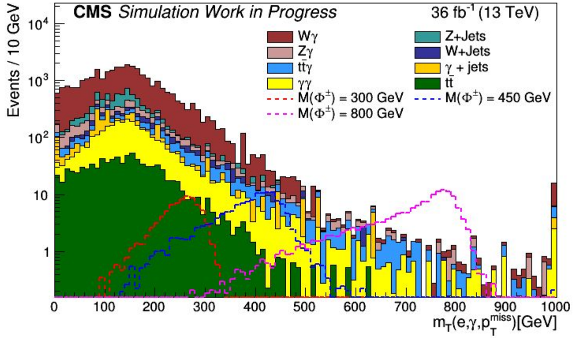
Sample	Event pass (Pixel)	Event pass (CSEV)
$W\gamma$	$(2.12 \pm 0.06) \times 10^4$	$(2.25 \pm 0.06) \times 10^4$
Z+Jets	$(2.17 \pm 0.10) \times 10^3$	$(5.68 \pm 0.16) \times 10^3$
$\gamma\gamma$	$(2.15 \pm 0.03) \times 10^3$	$(2.32 \pm 0.03) \times 10^3$
$Z\gamma$	$(1.64 \pm 0.04) \times 10^3$	$(1.78 \pm 0.04) \times 10^3$
γ+Jets	$(1.06 \pm 0.25) \times 10^3$	$(1.17 \pm 0.26) \times 10^3$
$tt\gamma$	990 ± 17	$(1.05 \pm 0.2) \times 10^3$
$t\bar{t}$	879 ± 25	$(2.06 \pm 0.03) \times 10^3$
W+Jets	662 ± 53	823 ± 59
Total	$(3.08 \pm 0.06) \times 10^4$	$(3.74 \pm 0.07) \times 10^4$



e-γ Invariant Mass (n-1)



Missing Transverse Momentum (n-1)

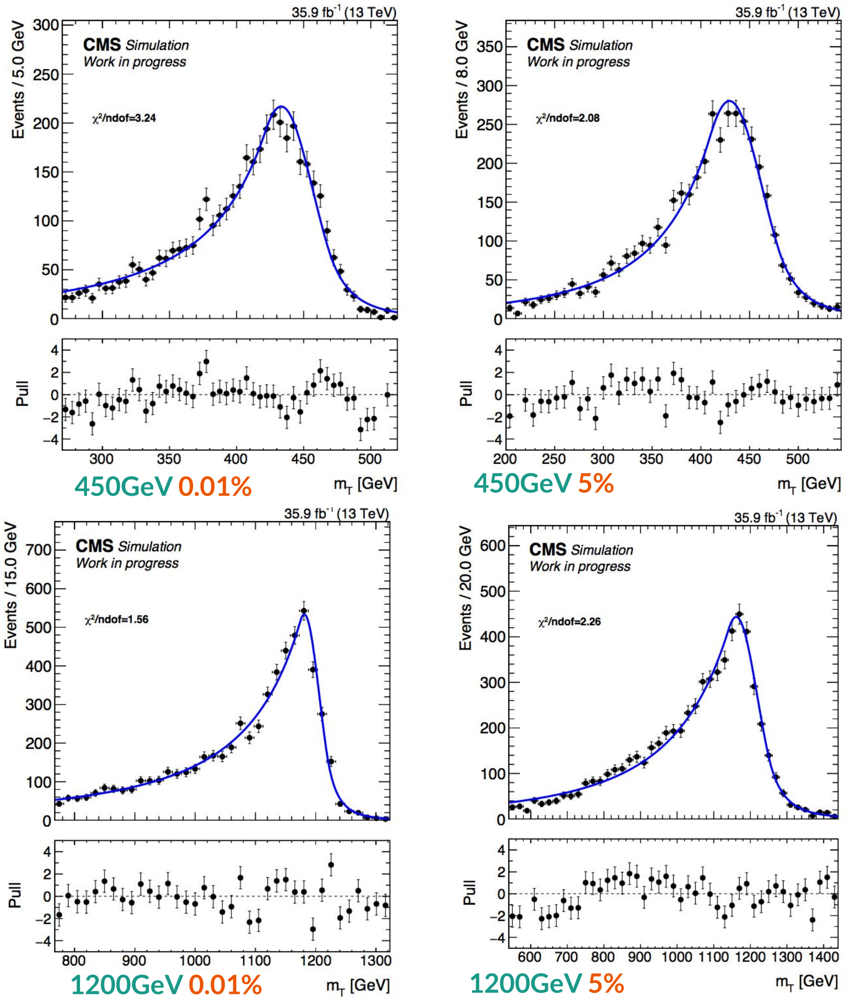


Resonance Mass (limit setting)

Signal Fitting

- Signal MC is fitted to double-sided Crystal Ball function
  - Gaussian with 2 power law tails
- Masses in range from 300 to 1400GeV
  - narrow 0.01% and wide 5% mass scenarios
- Standard Model Wγ distribution is fitted to Dijet function to 3rd order

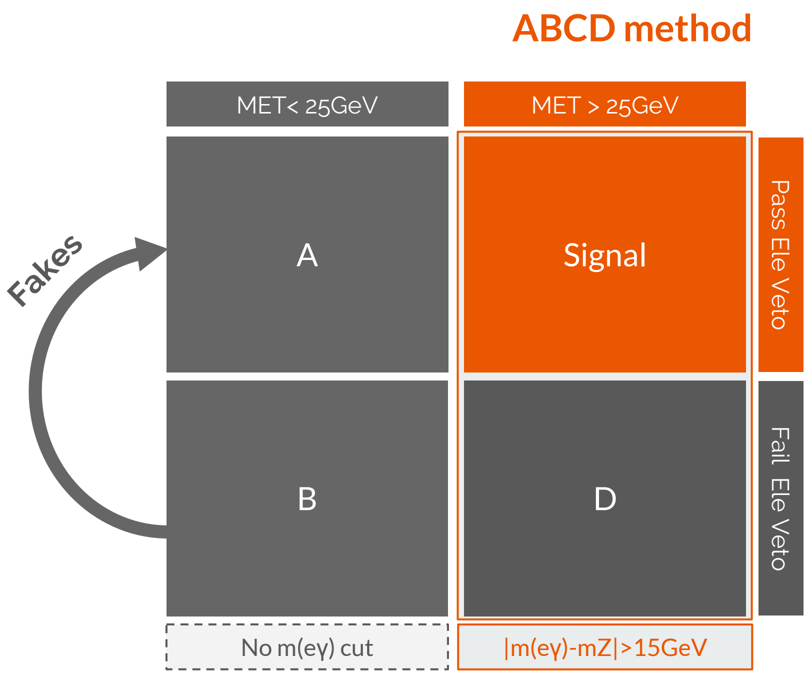
Mass -- Width



Electron fakes

- ➔ Data-driven method to estimate electron fake background
- ➔ Define control regions by inverting two selection cuts
  - ◆ electron veto; MET
- ➔ Fake rate can be measured by fitting Z resonance peaks in regions A, B
  - ◆ As function of photon η and p_T
- ➔ Apply measured fake rate to D to obtain a background estimate in signal region

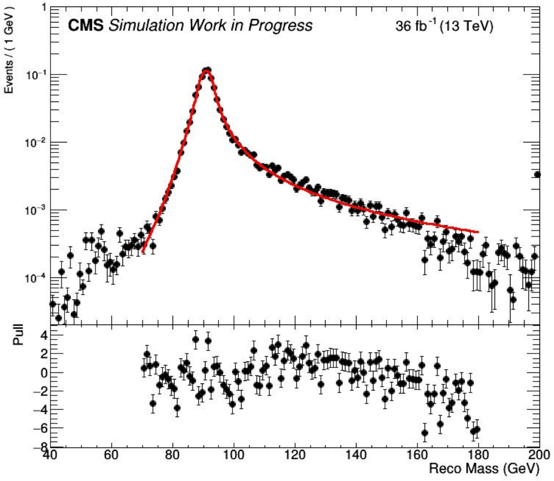
$$f_e^{\gamma} = \frac{N_{ee}^{e\gamma}}{2N_{ee}^{ee} + N_{ee}^{e\gamma}}$$



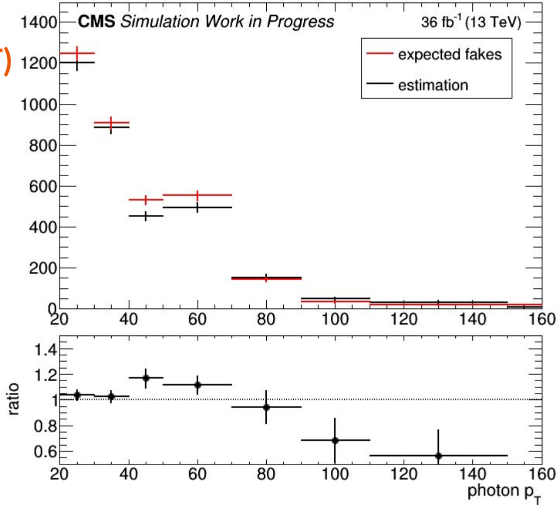
Closure

- Z mass resonance peak m(e,γ) in MC is also modeled with a double-sided Crystal Ball
- Largely mis-reconstructed events contribute to a long tail
- estimating and applying fake rate using only Z MC events leads to closure
    - 3.64k estimated vs 3.85k events with stat. unc. 0.06k

Fitting on Z+jets, Zγ background



Closure test with MC (in photon pT)



Summary

- ➔ Important signature to various BSM theories
- ➔ Lepton channel analysis
- ➔ Model electron faking photons in electron channel
- ➔ Data-driven method to measure leading reducible background

Questions?