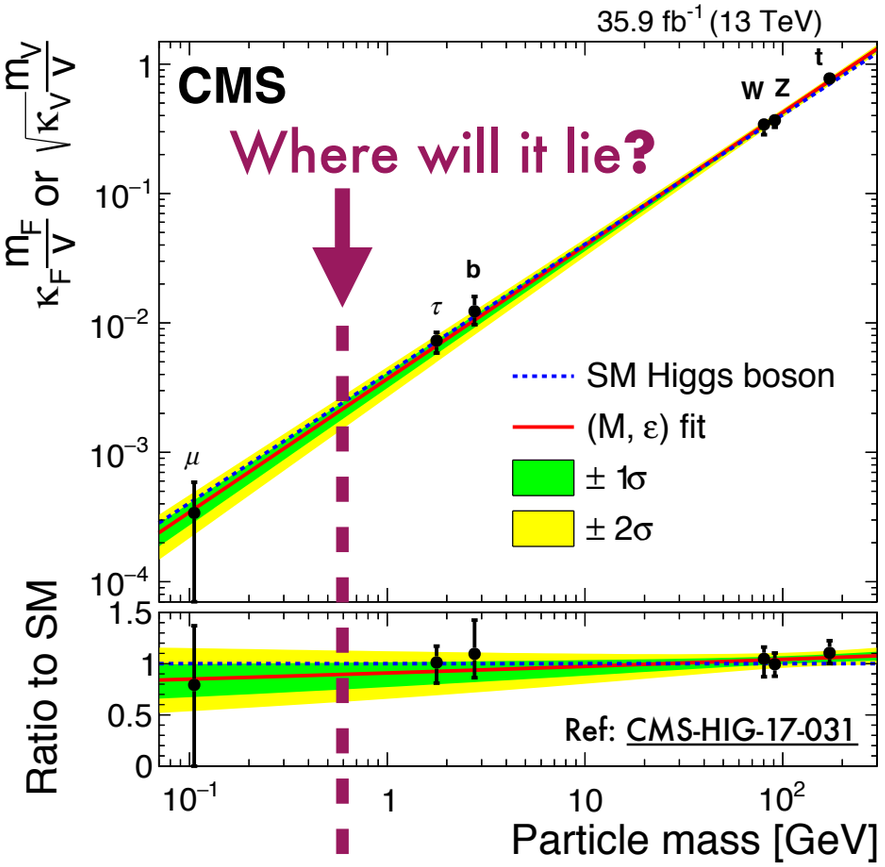
Overview

- Search for rare decays of Z and Higgs bosons to J/ψ and a photon in proton-proton collisions at $\sqrt{s}$=13 TeV; Eur.Phys.J. C79 (2019) no.2, 94
  - **I served as the contact person of this analysis**

- Search for the decay of a Higgs boson in the llγ channel in proton-proton collisions at $\sqrt{s}$=13 TeV; JHEP 1811 (2018) 152
  - **I was one of the main authors of this analysis, working on the trigger efficiency measurement & establishing the procedure for background model for the $H \to \gamma^* \gamma$ part**

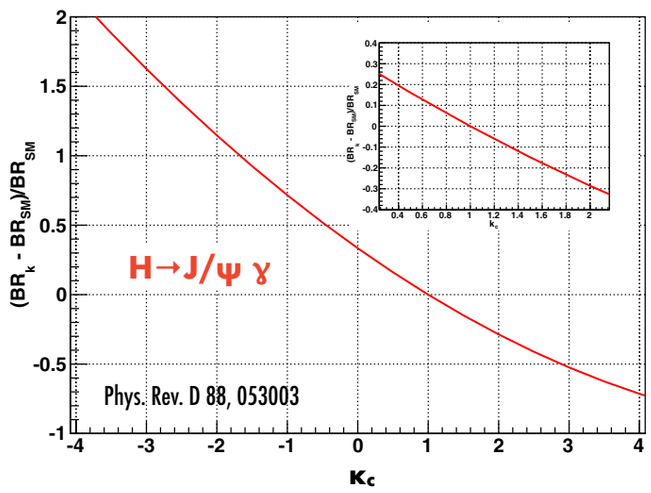
- First beam tests of prototype silicon modules for the CMS High Granularity Endcap Calorimeter; JINST 13 (2018) no.10, P10023
  - **I attended several beamtests for HGCAL**

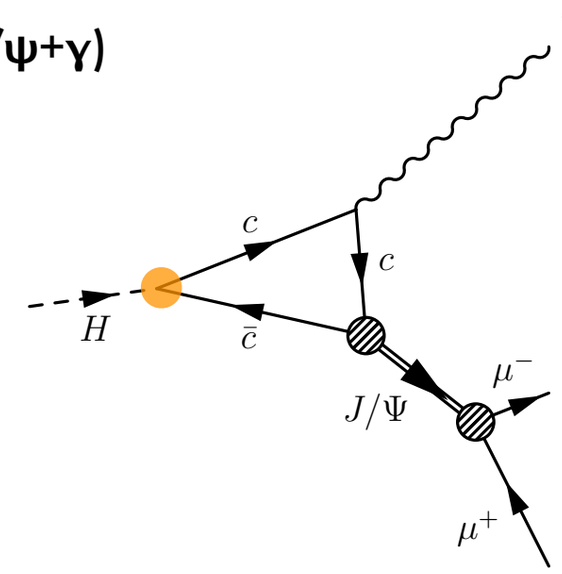
Z/H→J/ψ+γ search



$m_c(125GeV)\approx 0.6GeV$

The κ_c v.s the changes in BR(H→J/ψ+γ)





In some extensions to the SM, modified H-c coupling can arise

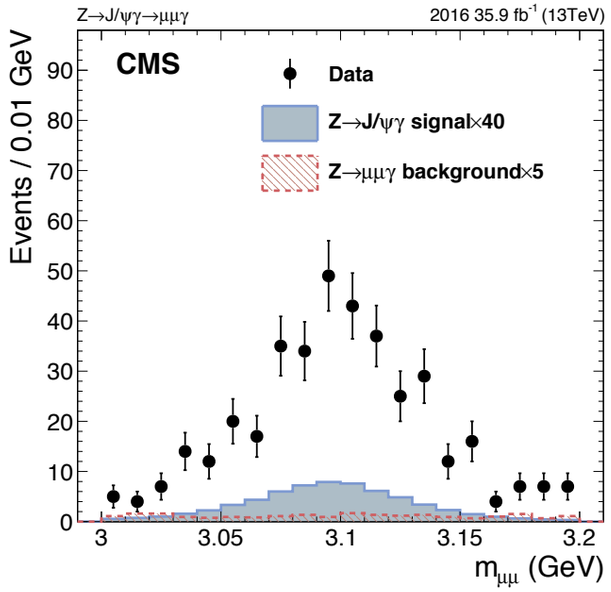
- Relevant in the BSM perspective

✦The search for Z→J/ψ+γ decay is jointly performed

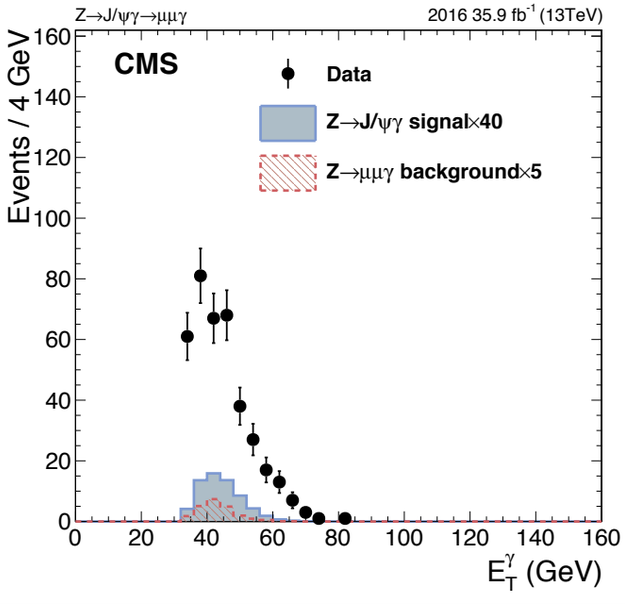
- (1) Similar event signatures (2) large XS for the Z boson, leading to a much better sensitivity than the Higgs decay (3) the first search of this decay in CMS that motivates searches for the Z/H to quarkonium states

Z/H→J/ψ+γ search

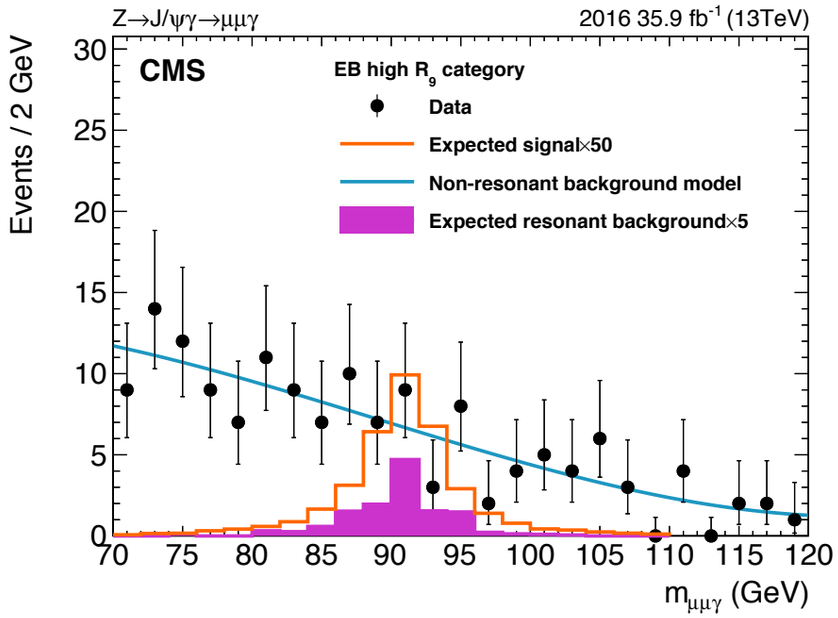
Two well-identified muons originated from PV to form J/ψ candidate

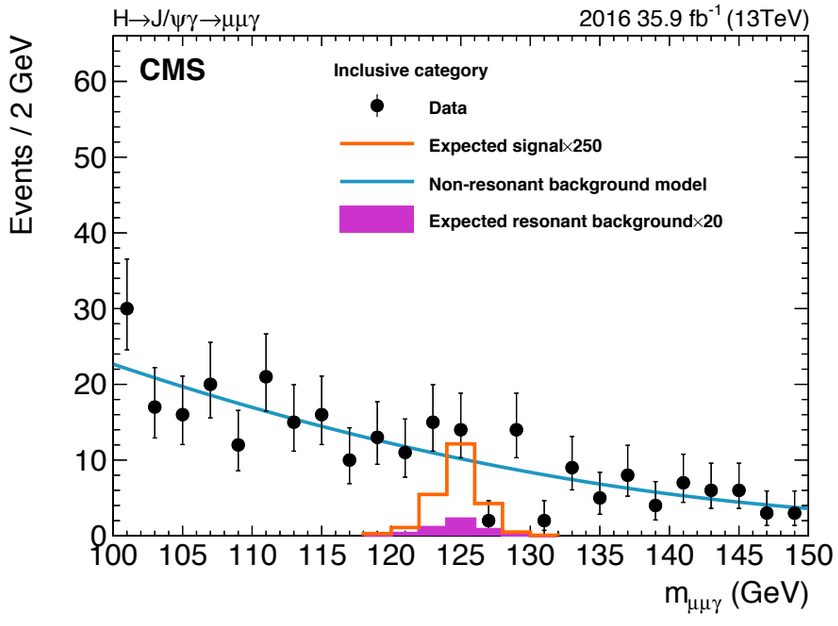


One energetic&isolated&well-separated from the J/ψ cand. photon



- **$m_{\mu\mu\gamma}$ is used as signal/background discriminating variable** in the hypothesis test.





Non-resonant bkg.
→ modeled with analytic function
→ data-driven

Resonant bkg.
→ independently modeled/ estimated from simulation

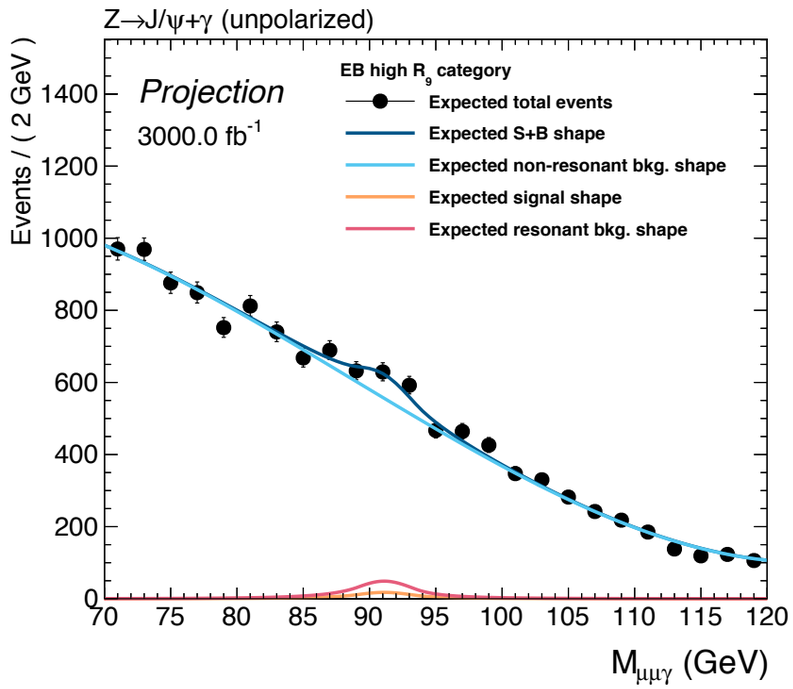
Signal
→ independently modeled/ estimated from simulation

Z/H→J/ψ+γ search

Channel	Obs. (exp.) upper limit BR	Obs. (exp.) upper limit $\frac{BR}{BR_{SM}}$	Run1 results ATLAS Phys. Rev. Lett. 114, 121801	Run1 results CMS Phys. Lett. B 753 (2016) 341
Z→J/ψγ	$1.4(1.6^{+0.7}_{-0.5})\times10^{-6}$	15 (17)	$2.6(2.0^{+1.0}_{-0.6})\times10^{-6}$	—
H→J/ψγ	$7.6(5.2^{+2.4}_{-1.6})\times10^{-4}$	260 (170)	$1.5(1.2^{+0.6}_{-0.3})\times10^{-3}$	$1.5(1.6^{+0.8}_{-0.8})\times10^{-3}$

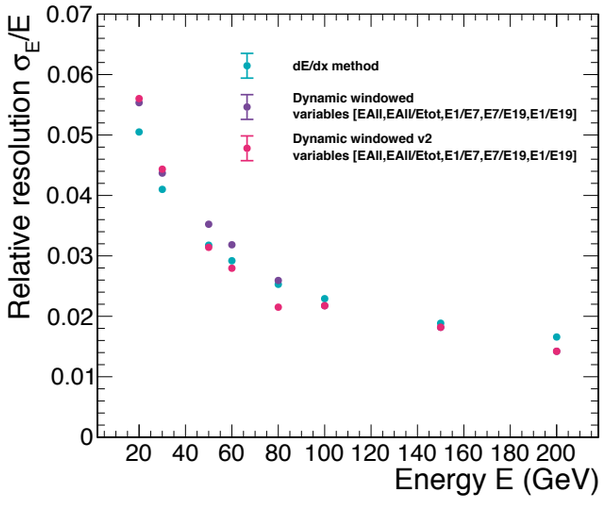
Combination with CMS Run1 result leads to an upper limit of **220 (160)**×SM

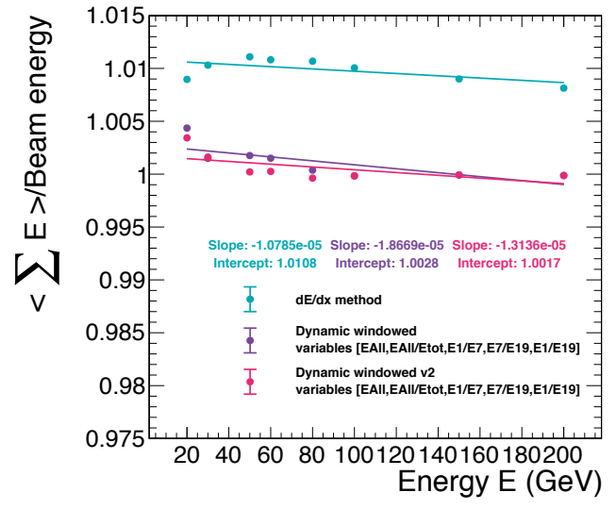
- **The results of this analysis (CMS-SMP-17-012) was published at Eur. Phys. J. C 79 (2019)94**
- It's still a long way to go for both channels → The Z boson decay seems more promising at HL-LHC → Further improvements to make the analysis more advanced are foreseeable!



HGCAL beamtest

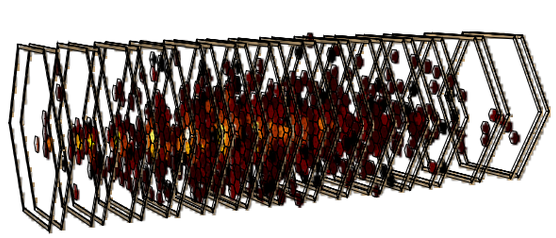
- One of the important upgrades of the CMS is the **HGCAL**. I was involved in several beamtests and worked on <u>the energy reconstruction</u> and <u>basic particle identification</u> using machine learning technique



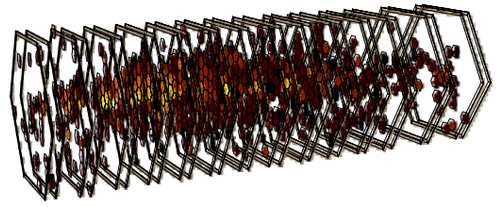


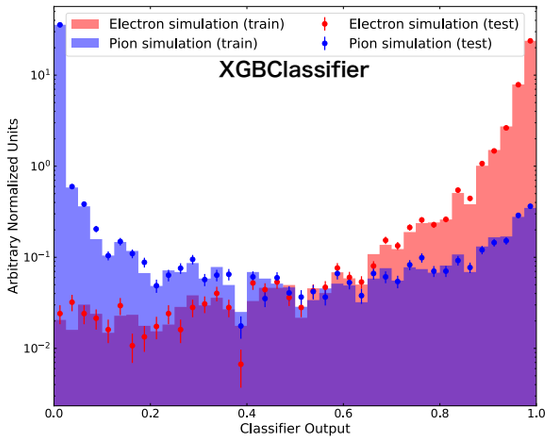
- "Regression": train a regressor with the information recorded in the silicon sensors to predict the energy of the electron

100GeV electron shower in the EM section of HGCAL



100GeV pion shower in the EM section of HGCAL





- "Classification": train a classifier to discriminate the electron (red in left plot) and pion (blue)

This study is still underway!