$ZZ\ell\ell\nu\nu$ BACKGROUND ESTIMATION WITH $ZZ \to 4\ell$ FOR HIGGS INVISIBLE SEARCHES

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DESY.

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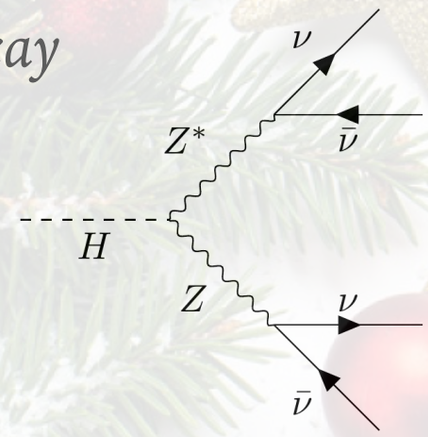
ATLAS EXPERIMENT

HIGGS TO INVISIBLE

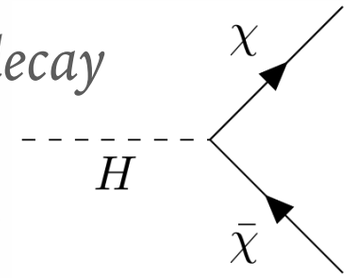
- SM Higgs to invisible decay (theoretical prediction $BR_{H\to inv} = 1.06 \times 10^{-3}$ for $m_H = 125$ GeV);
- So far, this measurement has been made by ATLAS with VBF (Vector Boson Fusion) and VH(associated production with a Z/W boson) production modes;
- The Higgs-portal model predicts a larger $BR_{H\to inv}$
- The Higgs could decay into two Dark Matter (DM) particles if:

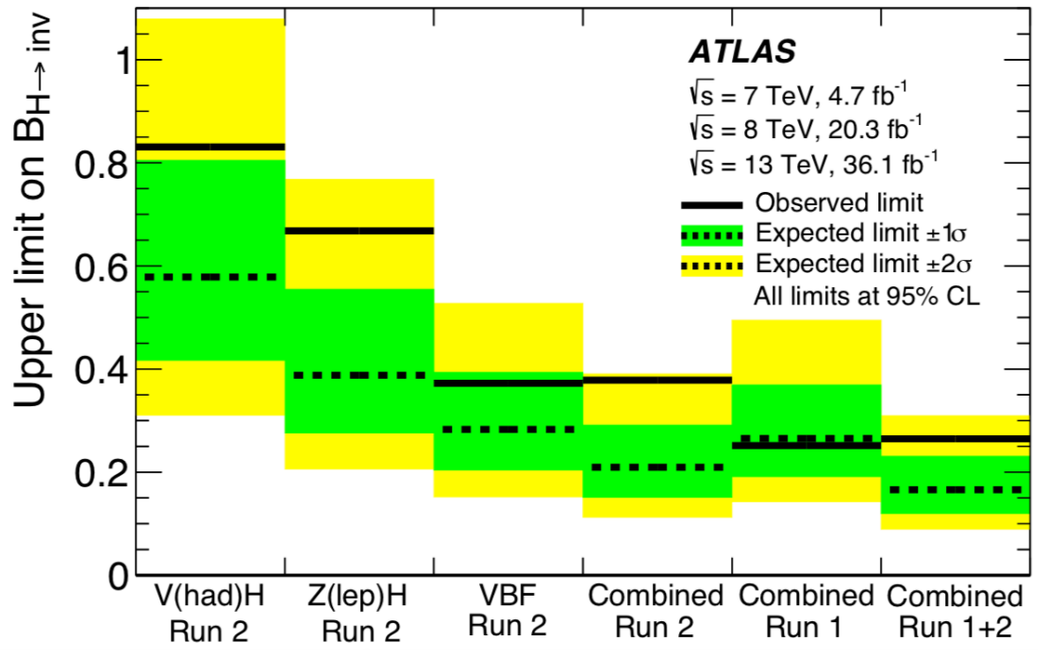
$$m_{DM} < \frac{m_H}{2}$$

SM decay

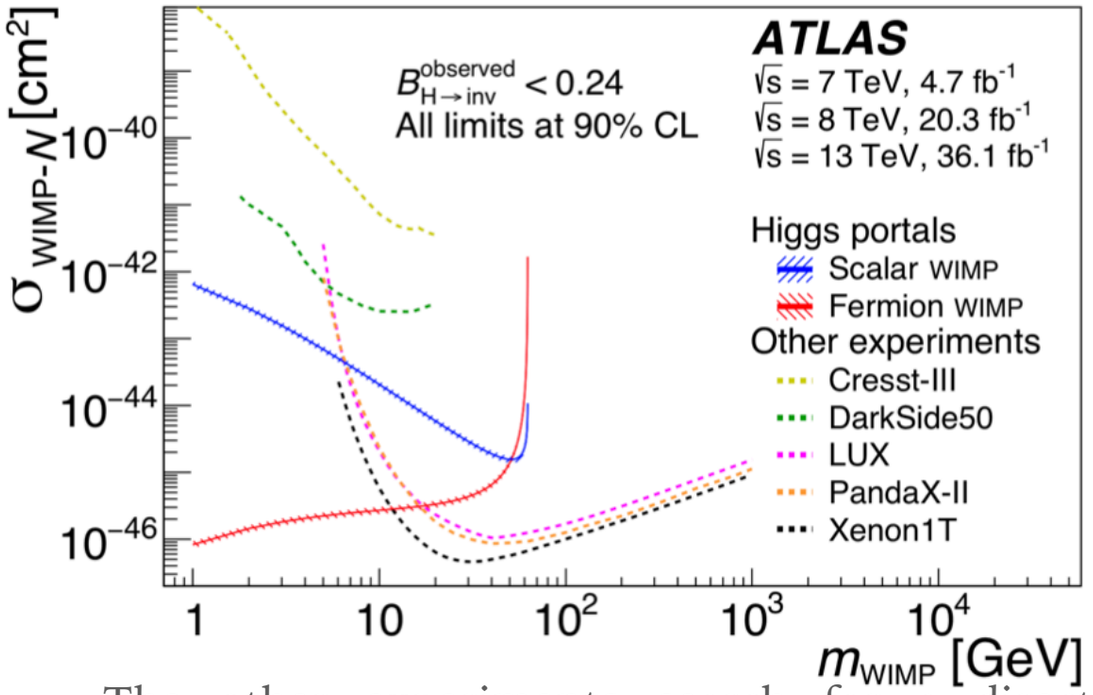


Higgs-portal to DM decay





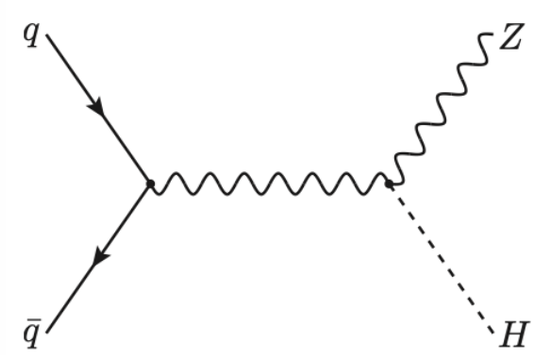
arXiv:1904.05105v1



The other experiments search for a direct interaction of WIMPs passing through the Earth.

ANALYSIS STRATEGY AND SM BACKGROUNDS

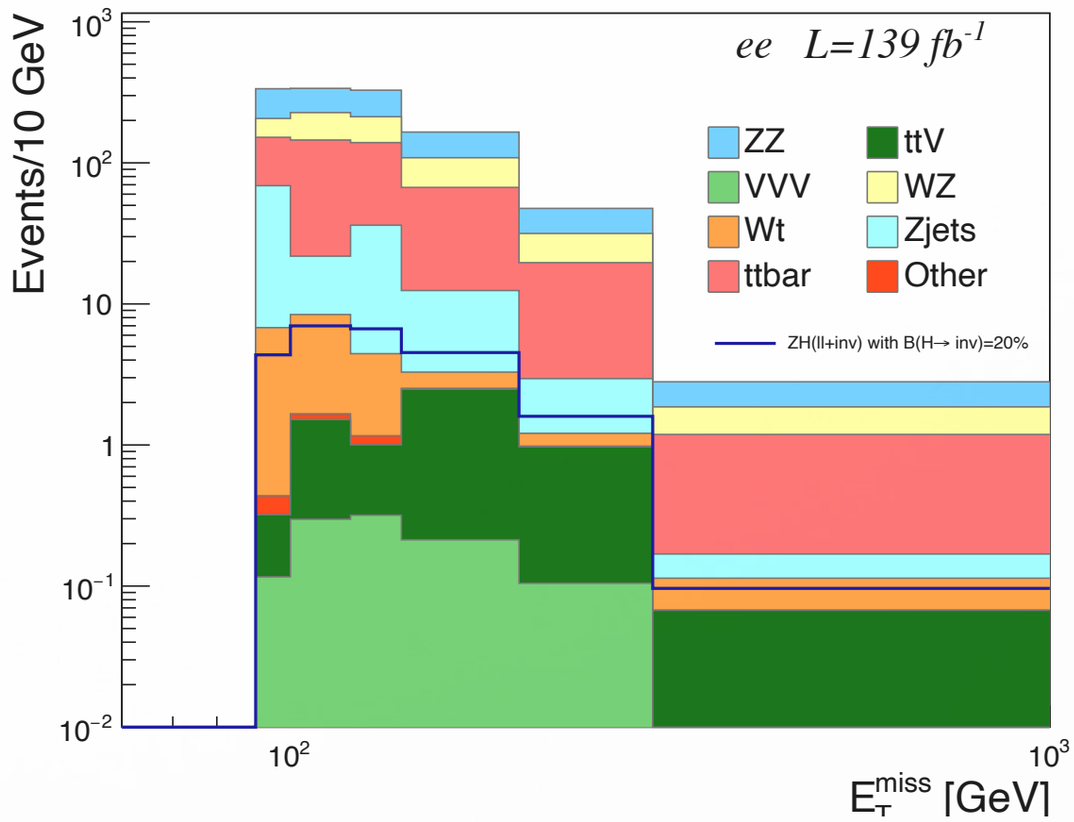
- We decided to concentrate on ZH production, with the Z decaying into two leptons;
- The signal is represented by two isolated leptons from a Z boson decay and large missing transverse momentum due to an invisible Higgs boson decay or a WIMP pair ($\ell\ell$+E_T^{miss}), with ℓ=e, μ



Selection:
- $E_T^{miss} > 90GeV$;
- $E_T^{miss} Sig > 9$;
- $\Delta R(\ell\ell) < 1.8$;
- $b-jets$ veto;

μμ plot very similar.

	ee	$\mu\mu$
Signal		
ZH with $BR(H \to inv.) = 20\%$	122	129
Backgrounds		
ZZ	915.8	952.7
WZ	313.2	334
Z+jets	133	133
non-resonant-$\ell\ell$	96.9	99.2
$t\bar{t}V/VVV$	3.6	3.6
Total background	1462.5	1522.5



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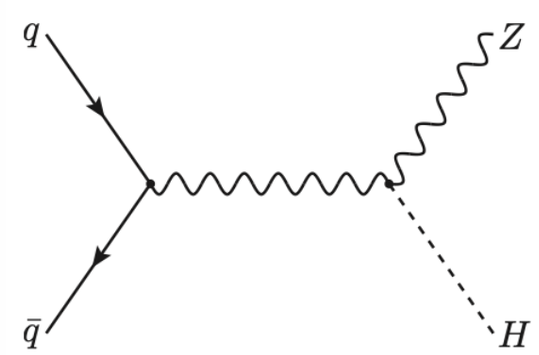

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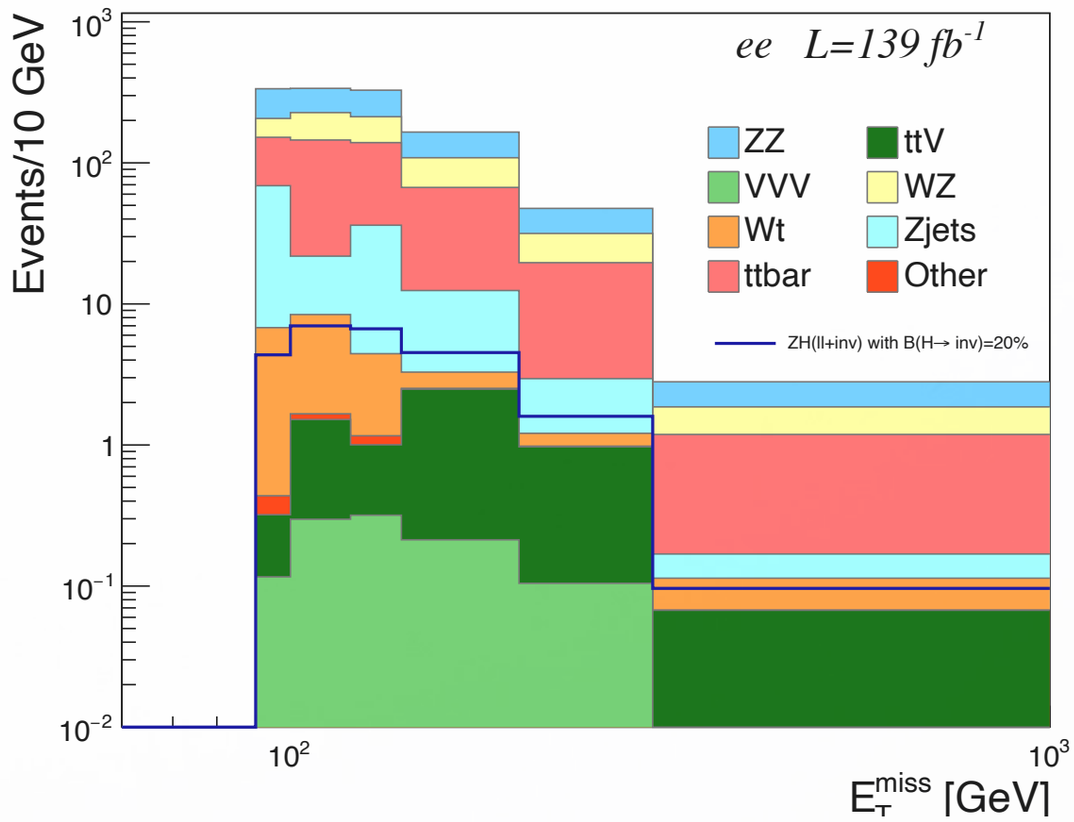
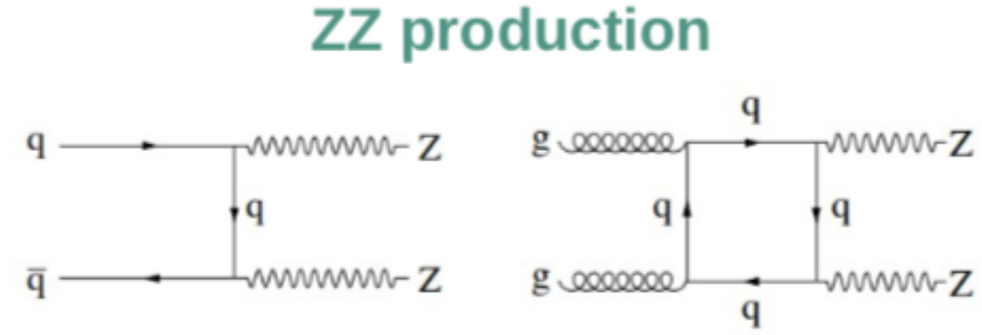
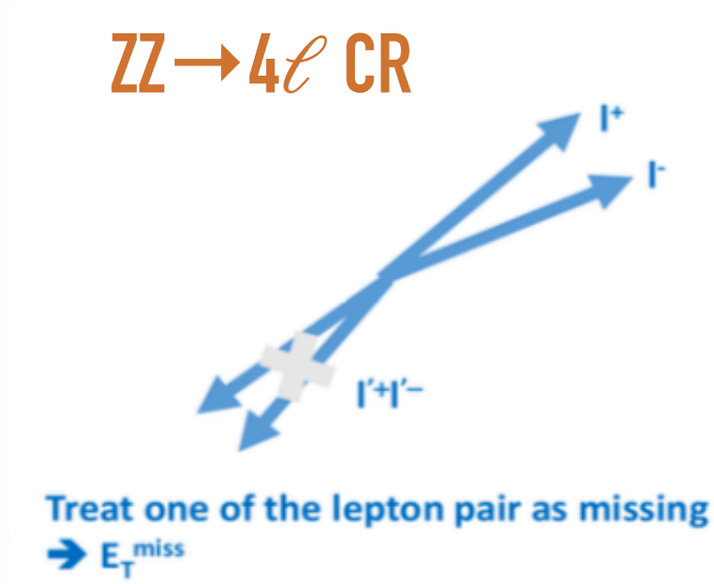


ZZ($\ell\ell$)+MET BACKGROUND

- The SM ZZ production is the dominant background in Z($\ell\ell$)+MET analysis;



- Currently this type of background is estimated from MC with ~10% uncertainty;
- The idea is to use semi data-driven methods in order to reduce the uncertainty.



ESTIMATE USING ZZ→4ℓ

- The ZZ→4ℓ Data/MC ratio can be used to rescale the Monte Carlo normalisation of this channel with the factor R:

$$R = \frac{N_{4\ell}^{Data} - N_{non\,ZZ}^{MC}}{N_{4\ell}^{MC}}$$

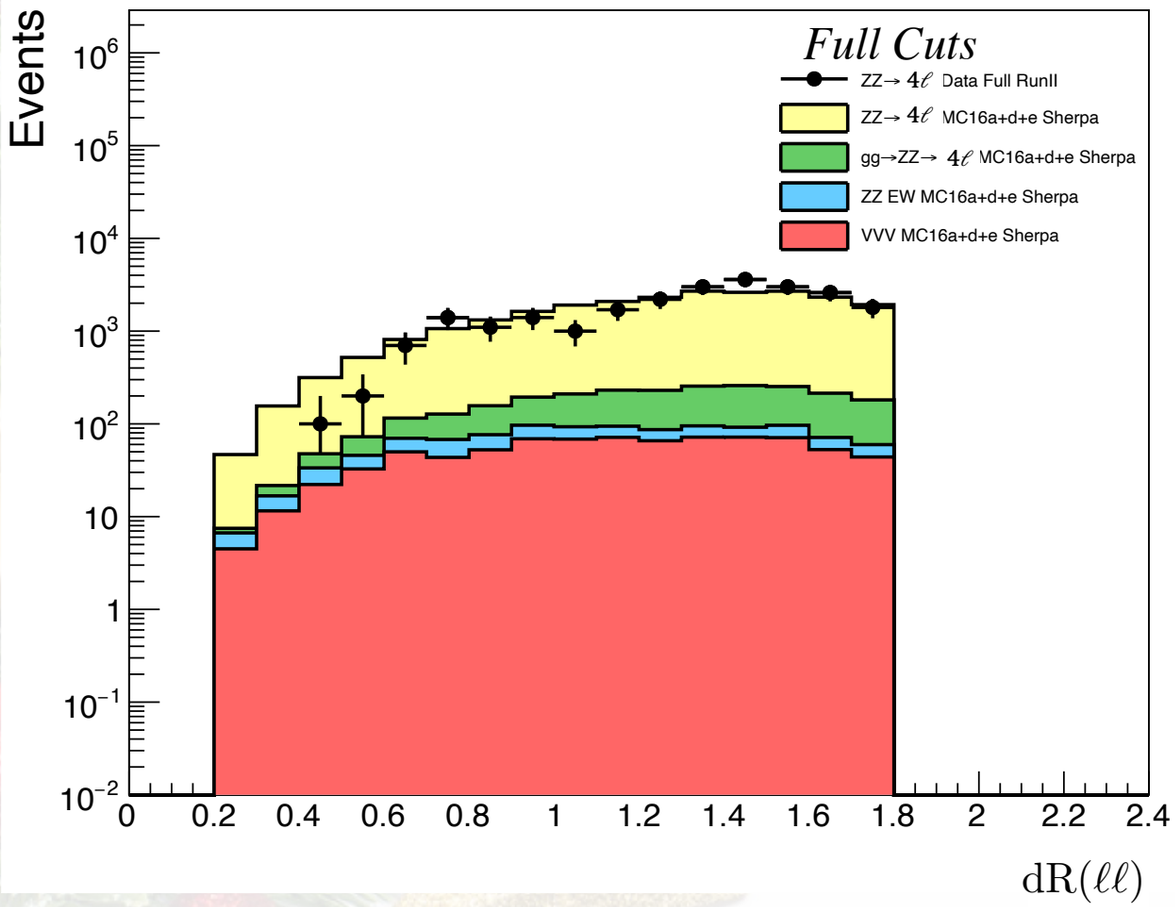
where $N_{non\,ZZ}^{MC}$ are the background events for the ZZ→4ℓ channel.

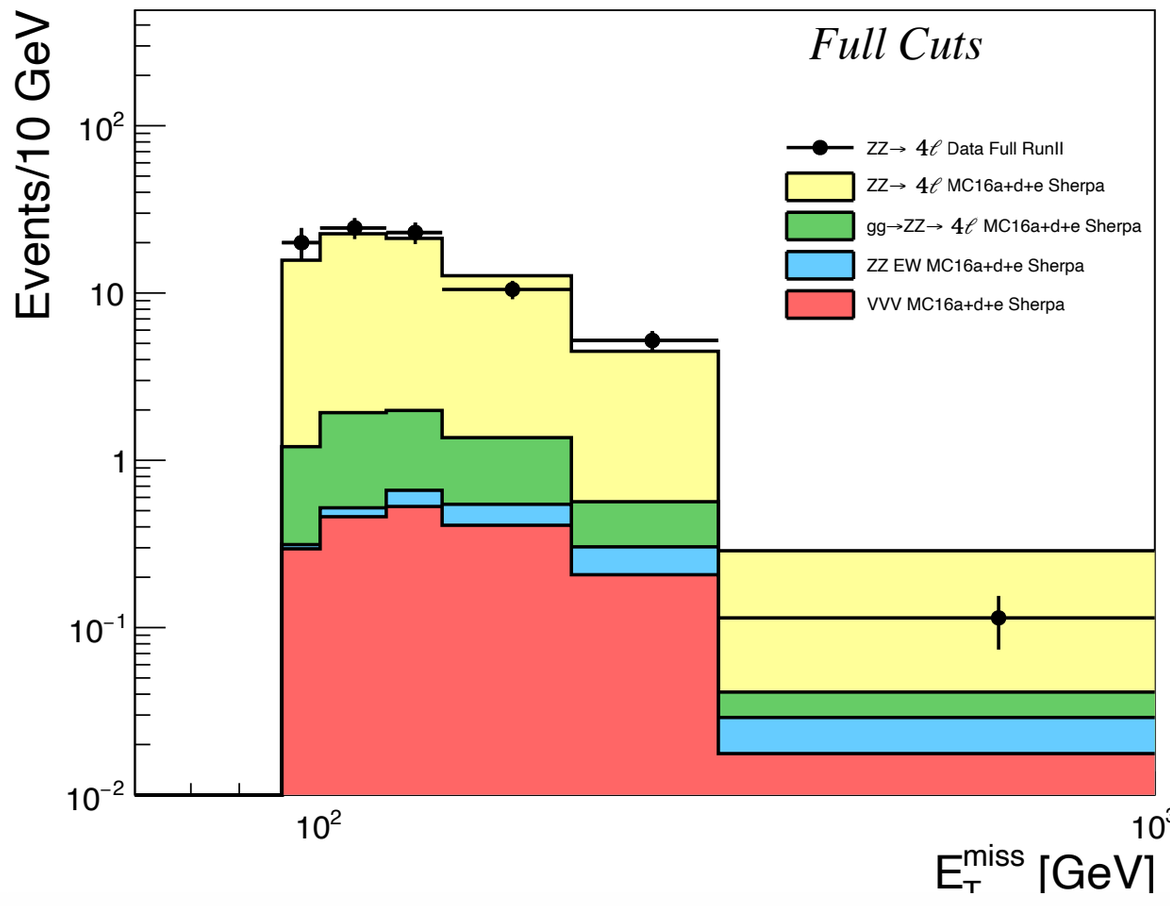
- Rescale the ZZ→$\ell\ell\nu\nu$ Monte Carlo samples:

$$N_{\ell\ell\nu\nu}^{\prime MC} = N_{\ell\ell\nu\nu}^{MC} \cdot R = N_{\ell\ell\nu\nu}^{MC} \cdot \frac{N_{4\ell}^{Data}}{N_{4\ell}^{MC}}$$

- This method takes only the normalisation from data, instead of the shape.

ZZ ESTIMATE USING 4ℓ REGION





All backgrounds evaluated for 4ℓ, finalising estimates for ZZ→$\ell\ell\nu\nu$.

$$R = \frac{N_{4\ell}^{Data} - N_{non\,ZZ}^{MC}}{N_{4\ell}^{MC}} = 0.89 \pm 0.06$$

No systematic uncertainties estimated yet (work in progress).

Data Full Run II	MC Total
219	244.46

CONCLUSION

This year:

- I have studied a method to estimate the $ZZ \to \ell\ell\nu\nu$ background using the $ZZ \to 4\ell$ channel;
- Moved to DESY in September, I will be there for two years;
- Started my Qualification Task to became ATLAS author on electron ID;
- Building probability density functions and re-tune the likelihood used for the electron ID;
- Improve the code for Run III.

Thank you for the attention

Merry Christmas!