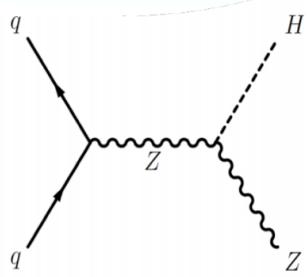
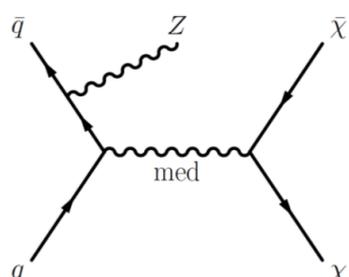


# Search for associated production of a Z boson with an invisibly decaying Higgs boson or dark matter candidates with the ATLAS detector using full Run-II Data at LHC

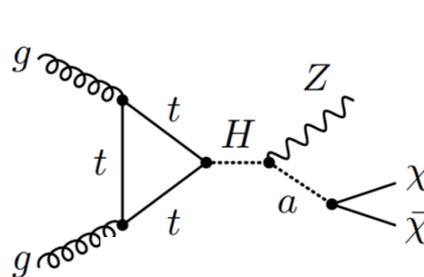
## 1. Mono-Z( $\ell\ell$ ) signal models



$ZH \rightarrow \ell\ell + \text{invisible}$   
where  $H \rightarrow ZZ \rightarrow 4\nu$   
with SM BR=0.1%

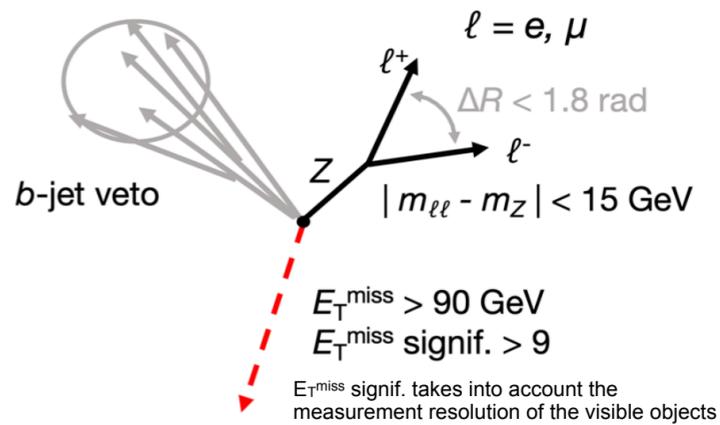


Simplified model with  
axial-vector or  
vector mediator



2HDM+a model where a  
is a pseudo-scalar  
mediator

## 2. Event selection



Common selection for all the models (SR, signal region).

Specific discriminating variables for the various models:

- Boost Decision Tree (BDT) for H to invisible. It uses several kinematic variables with the most important being the dilepton pair rapidity and their angular separation;

- $m_T$  for Dark Matter models, with:

$$m_T = \sqrt{\left[ \sqrt{m_Z^2 + (p_T^{\ell\ell})^2} + \sqrt{m_Z^2 + (E_T^{\text{miss}})^2} \right]^2 - \left[ \vec{p}_T^{\ell\ell} + \vec{E}_T^{\text{miss}} \right]^2}$$

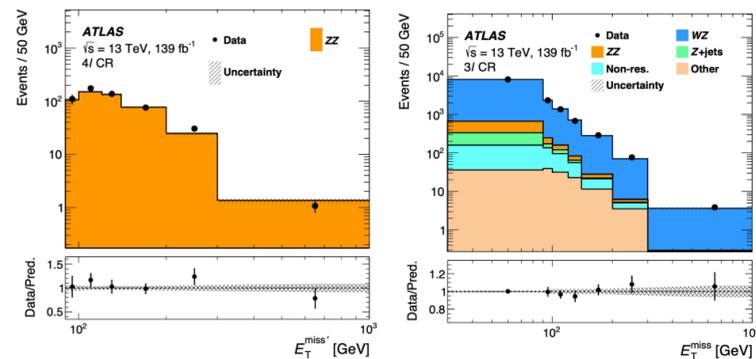
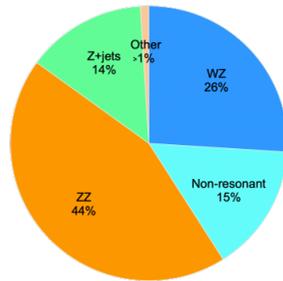
## 3. Background estimation

Main SM background:  $qq/gg \rightarrow ZZ$

Three Control Regions (CRs) used to constrain SM background Monte Carlo predictions in SR for all signal models:

- $4\ell$  CR  $\rightarrow ZZ$ : use random dilepton pair to mimic  $E_T^{\text{miss}}$ ;
- $3\ell$  CR  $\rightarrow WZ$ : region containing exactly three leptons;
- $e\mu$  CR  $\rightarrow$  non-resonant ( $tt, \bar{W}t, WW$ ) backgrounds: similar to SR, but different flavours for lepton pair.

NLO electroweak corrections are applied to the  $qq \rightarrow ZZ$  Monte Carlo processes.



## 4. Results

Data are compared with expectation by performing simultaneous maximum-likelihood fits in SR and CRs, using simulation as input and taking into account uncertainties. Good agreement between data and background predictions is found. Upper limits on the branching ratio of the Higgs boson to invisible particles and exclusion limits for simplified dark matter models and 2HDM+a models are set. Dark Matter constraints are also extracted.

### Higgs invisible decay

Observed (exp) limit at 95% CL:

$$BR_{H \rightarrow \text{inv}} = 0.19 \text{ (0.19)}$$

Early Run-II ATLAS H invisible combination observed (exp) limit at 95% CL:

$$BR_{H \rightarrow \text{inv}} = 0.38 \text{ (0.21)}$$

