

## 2 slides on the Inert Doublet Model

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*based on work with*

A. Ilnicka, M. Krawczyk, (D. Sokolowska)

(arXiv:1505.04734; arXiv:1508.01671; arXiv:1510.04159; arXiv:1705.00225)

A. Ilnicka, T. Stefaniak

(arXiv:1803.03594)

J. Kalinowski, W. Kotlarski, D. Sokolowska, A. F. Zarnecki

(arXiv:1809.07712)

D. Dercks (in progress)

Ruder Boskovic Institute

Prioritization of WG3 benchmarks

Workshop of the LHC Higgs Cross Section Working Group,

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# Did we miss BSM in investigated final states ?

**Did we miss BSM in already investigated final states ?**

- possible example: **Inert Doublet Model**
- 2HDM with  $Z_2$  symmetry, 4 additional scalars  $H, A, H^\pm$   
one of these: dark matter candidate (here: H)
- production modes:  $HA, HH^\pm, AH^\pm, H^+H^-$
- decays:  $A \rightarrow ZH, H^\pm \rightarrow W^\pm H$
- final state: **electroweak gauge boson(s) and MET**
- cross sections:  
**up to 1 pb at LHC13** (HA production for  $m_H \sim 60$  GeV)

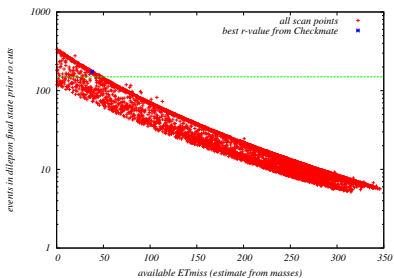
# Feasibility of 13 TeV $Z+\text{MET}$ search; estimate

[real work: w D. Dercks, in progress]

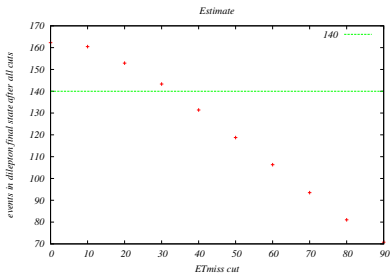
**signature:  $Z+\text{MET}$**

Search for an invisibly decaying Higgs boson or dark matter candidates produced in association with a boson in collisions at  $\sqrt{s}=13$  TeV with the ATLAS detector, arXiv:1708.09624

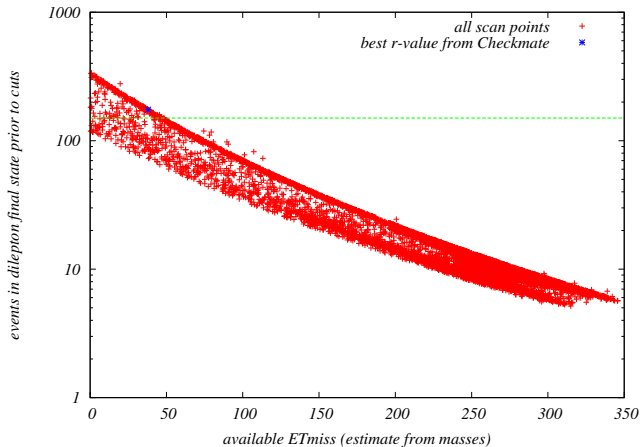
$\cancel{E}_\perp > 90$  GeV; in cutflow, reduces number of events by  $\sim$  factor 2



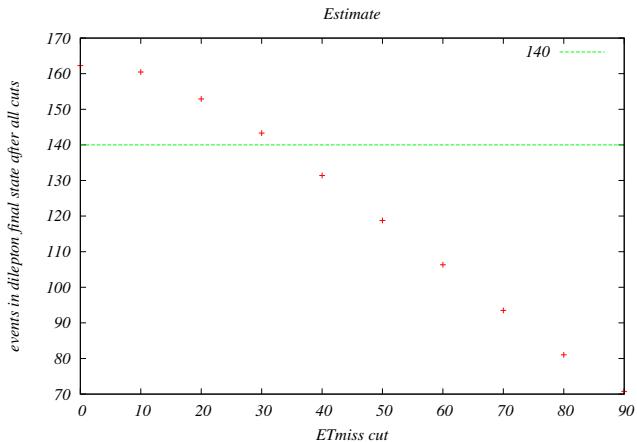
$\cancel{E}_\perp$  vs events prior to cuts, from scan



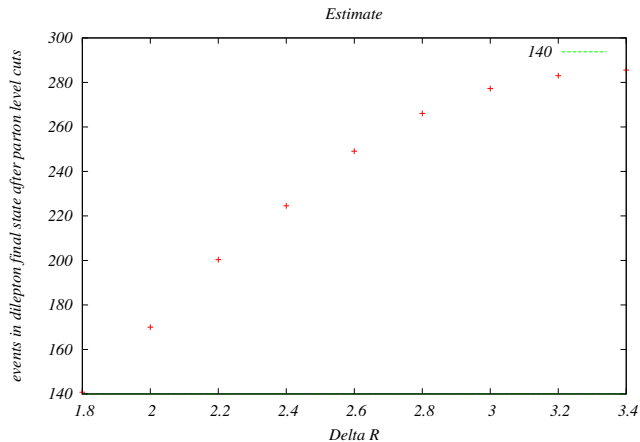
Events after cuts, in dependence of  $\cancel{E}_\perp^{\text{cut}}$ , specific point



- calculate  $\sigma_{HA} \times \text{BR}(Z \rightarrow \ell^+ \ell^-) \times \mathcal{L}_{\text{int}}$
- x-axis:  $m_A - m_H - m_Z$



- simulate  $pp \rightarrow HH\ell^+\ell^-$  with Madgraph5, parton level
- assume all other cuts have similar effect  
(implemented:  $p_{\perp}(\ell^{\pm}), m_{\ell\ell}$ )



- simulate  $pp \rightarrow HH\ell^+\ell^-$  with Madgraph5, parton level
- implemented:  $p_{\perp}(\ell^{\pm}), m_{\ell\ell}, \cancel{E}_{\perp} > 30 \text{ GeV}$

# ATLAS analysis in more detail

- processes investigated:

$$pp \rightarrow hZ, h \rightarrow \text{inv}$$

$pp \rightarrow$  invisible via s-channel with  $Z$  radiation from initial state

- cuts:
- $p_{\perp} \geq 30 \text{ GeV} (20 \text{ GeV})$  for leading (subleading)  $\ell$
- veto third lepton with  $p_{\perp} \geq 7 \text{ GeV}$
- $76 \text{ GeV} \leq m_{\ell\ell} \leq 106 \text{ GeV}$
- $\cancel{E}_{\perp} \geq 90 \text{ GeV}, \cancel{E}_{\perp}/H_{\perp} \geq 0.6$
- $\Delta\Phi(\vec{p}_{\perp}^{\ell\ell}, \vec{\cancel{E}}_{\perp}) \geq 2.7 \text{ rad}$
- $\Delta R_{\ell\ell} < 1.8$
- $|p_{\perp}^{\ell\ell} - p_{\perp}^{\text{miss,jets}}|/p_{\perp}^{\ell\ell} < 0.2$
- no b jets