

Searching for invisible Higgs boson decays at 380 GeV

*Krzysztof Mękała, Aleksander Filip Żarnecki
Faculty of Physics, University of Warsaw*

Previous study

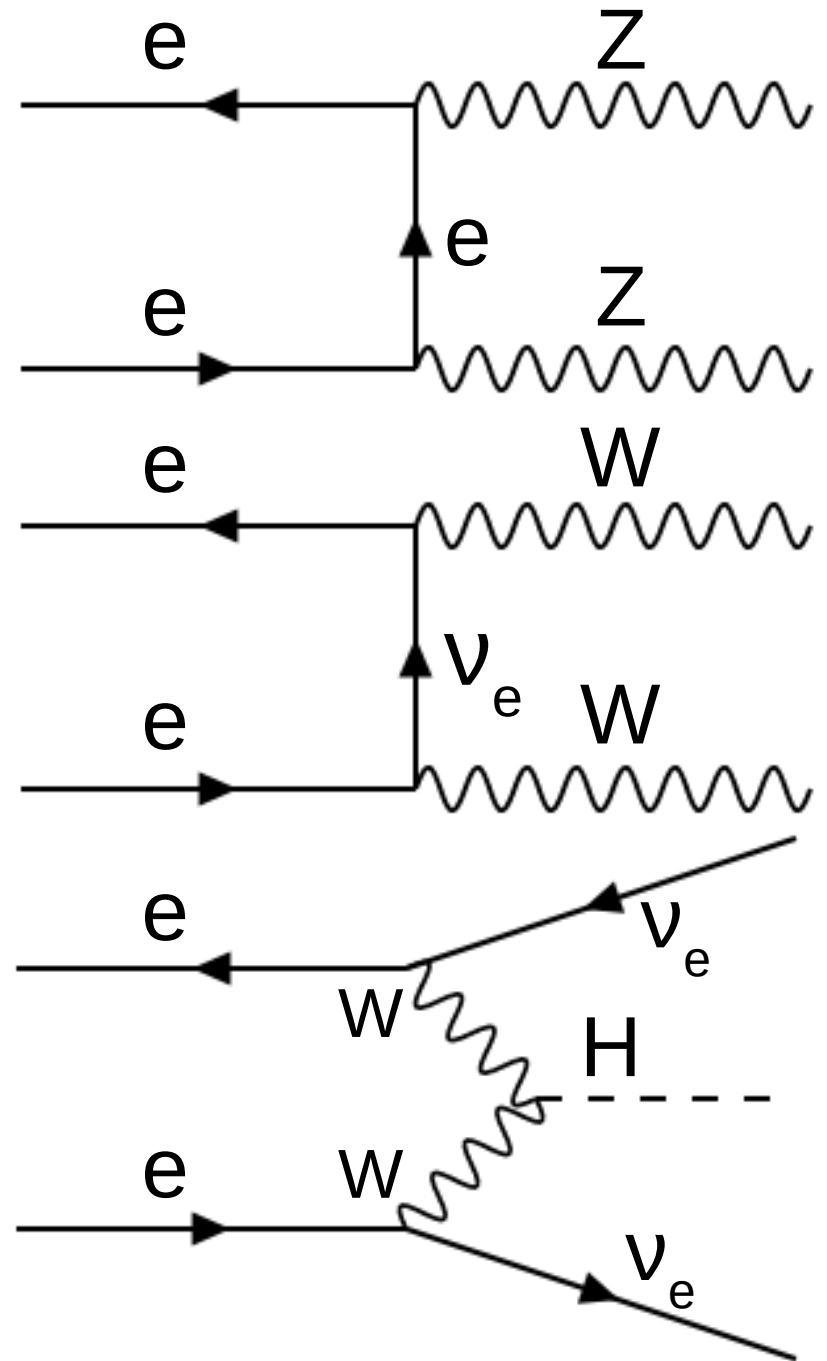
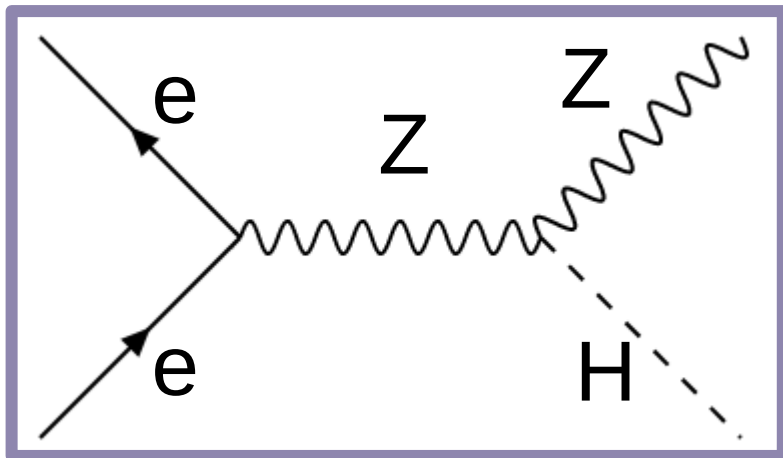
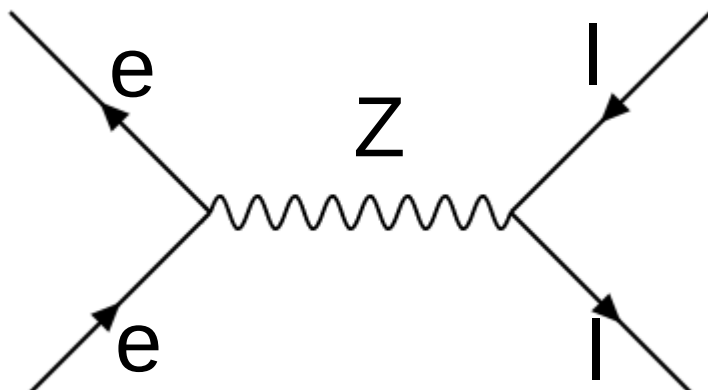
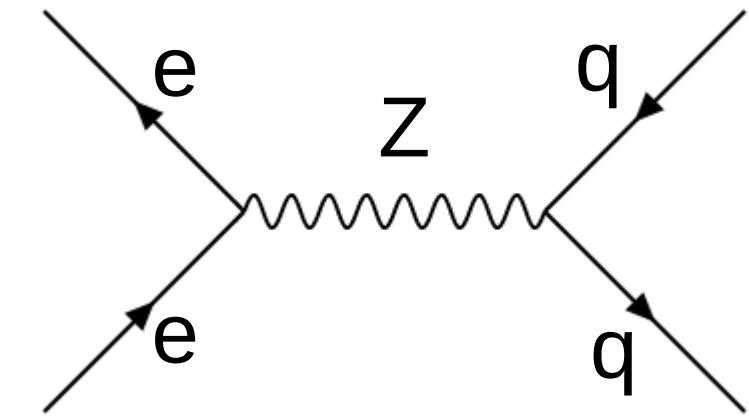
By M. A. Thomson, summarised in a publication:
*Model-independent measurement of the $e^+e^- \rightarrow HZ$
cross section at a future e^+e^- linear collider using
hadronic Z decays*
(*Eur. Phys. J. C* 76 (2016) 72, arXiv: 1509.02853)

Expected limit on invisible Higgs boson decays:

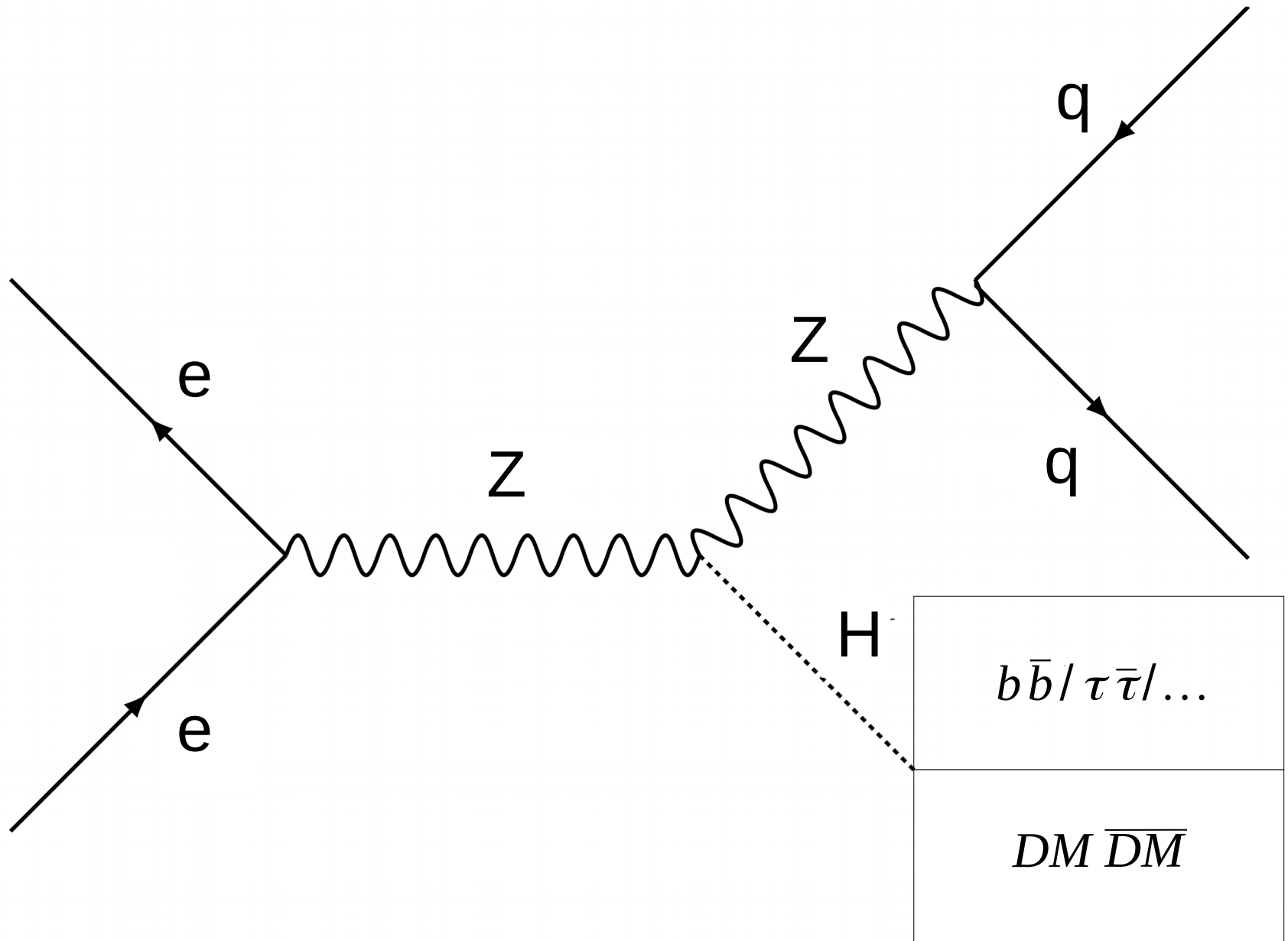
$$\mathbf{BR(H \rightarrow inv.)} < \mathbf{0.94\%} \quad \text{at } \mathbf{90\% CL}$$

for 500 fb^{-1} at 350 GeV

Processes considered



Our signal

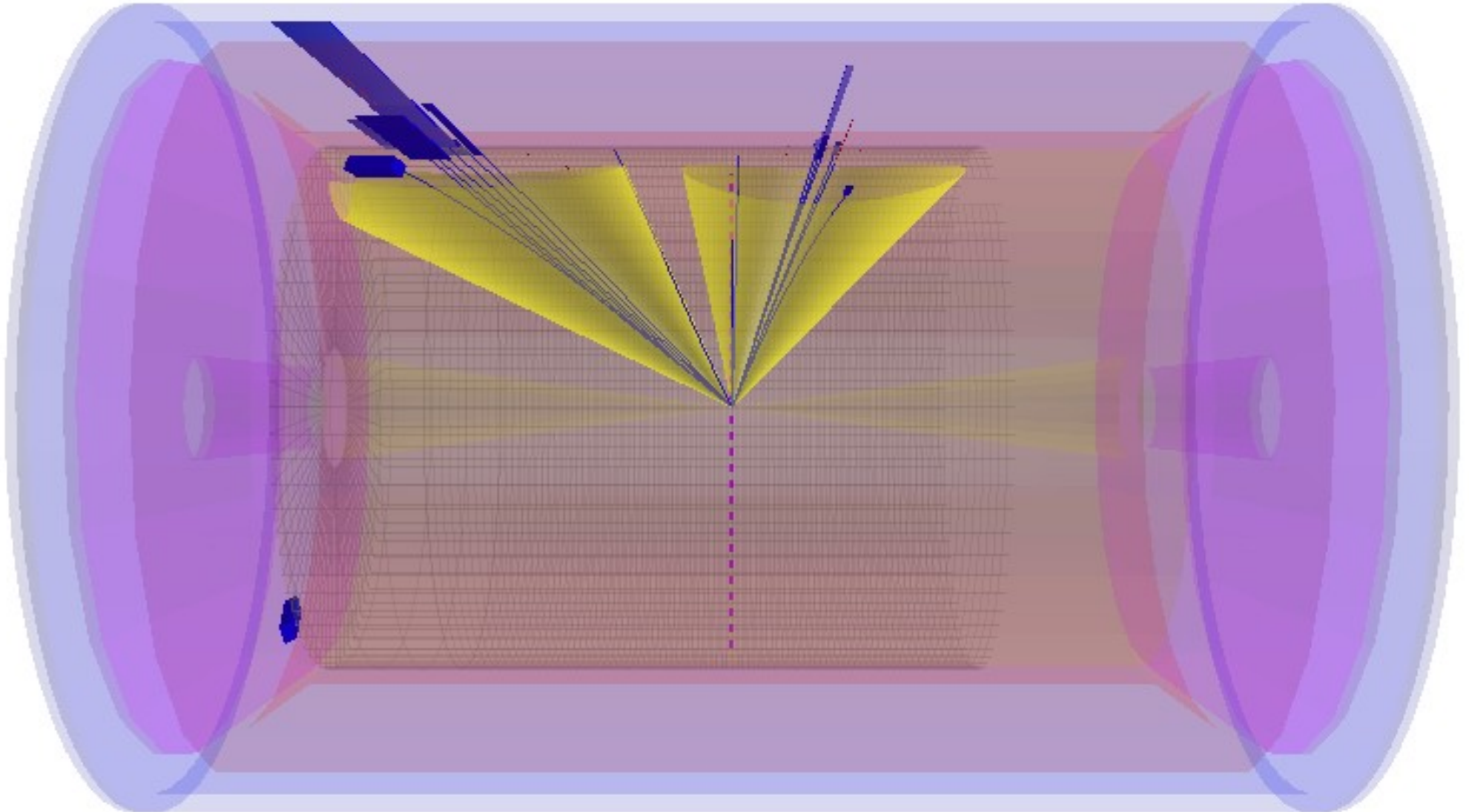


Technical information

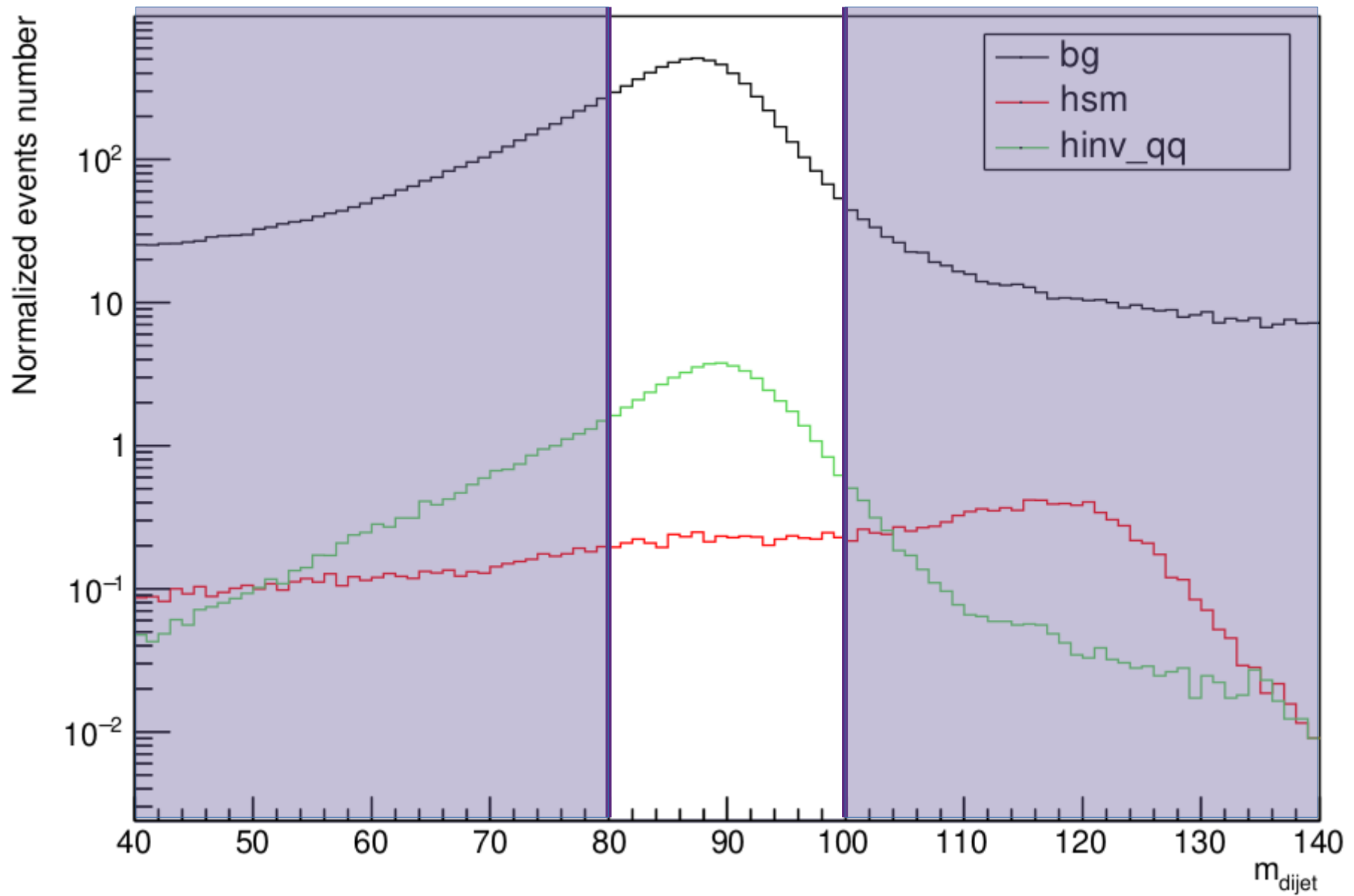
- CLIC energy spectra for **380 GeV**
- event samples generated with **WHIZARD 2.7.0**
- detector simulation and event reconstruction with **Delphes**, using (modified) CLICdet_Stage1 cards

Signature of $e^+e^- \rightarrow Z H \rightarrow jj + inv.$

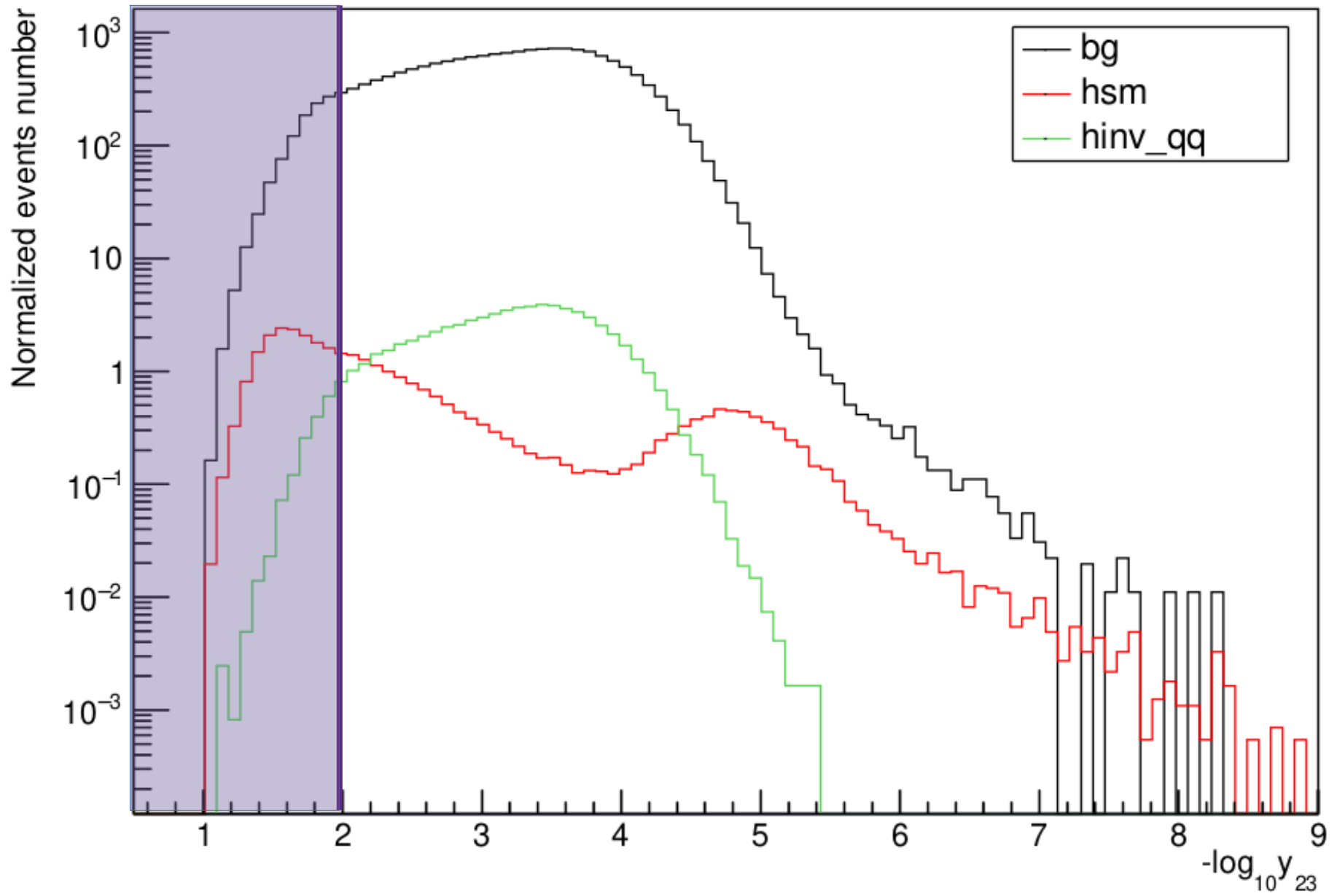
Two-jet events without electrons, muons, or isolated photons...



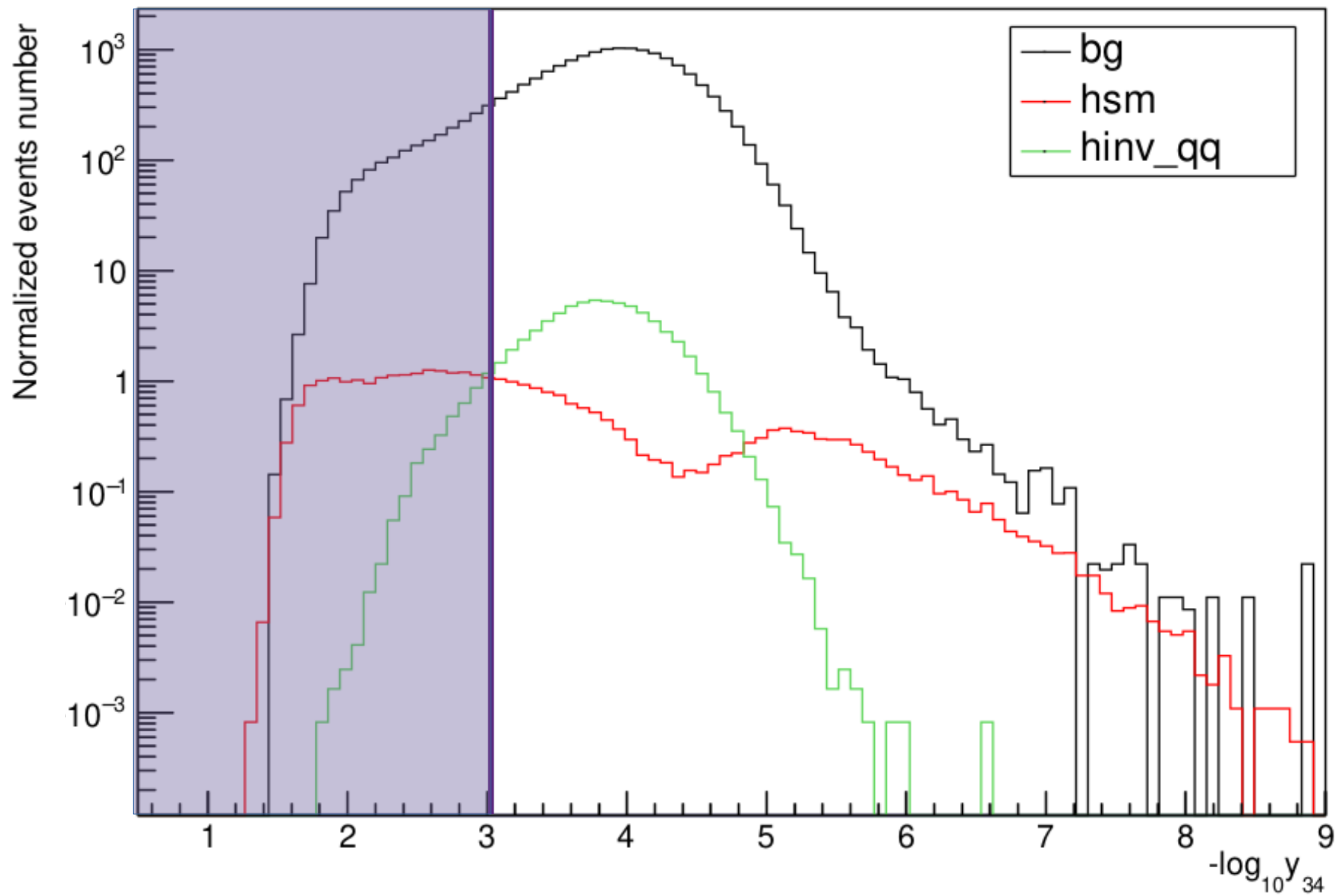
Preselection cuts: di-jet mass



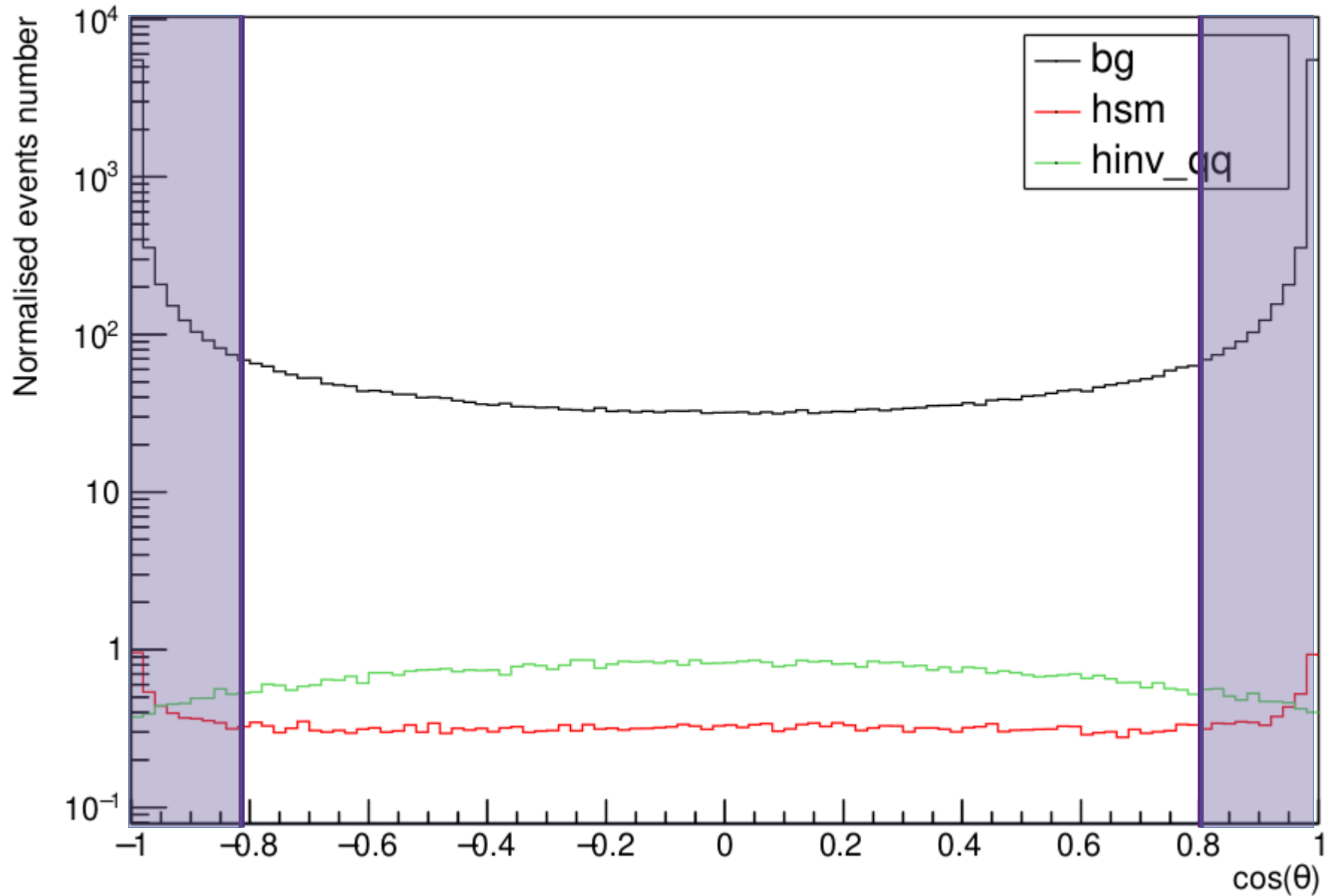
Preselection cuts: y_{23}



Preselection cuts: y_{34}



Preselection cuts: dijet emission angle



Preselection - efficiency

channel	σ [fb]	efficiency	events after preselection
qq	22191.2	0.09%	19234
qqlv	5560.0	0.68%	37588
qqqq	5076.1	<0.01%	51
qqll	1730.3	0.03%	593
qqvv	317.4	22.72%	72135
qqqqvv	1.4	<0.01%	0
$H_{sm} + qq$	82.3	0.06%	47
$H_{sm} + vv$	54.5	4.61%	2515
$H_{sm} + ll$	15.5	0.02%	3
$H_{inv} + qq$ *	82.2	46.95%	38557

* assuming BR ($H \rightarrow inv.$) = 100%

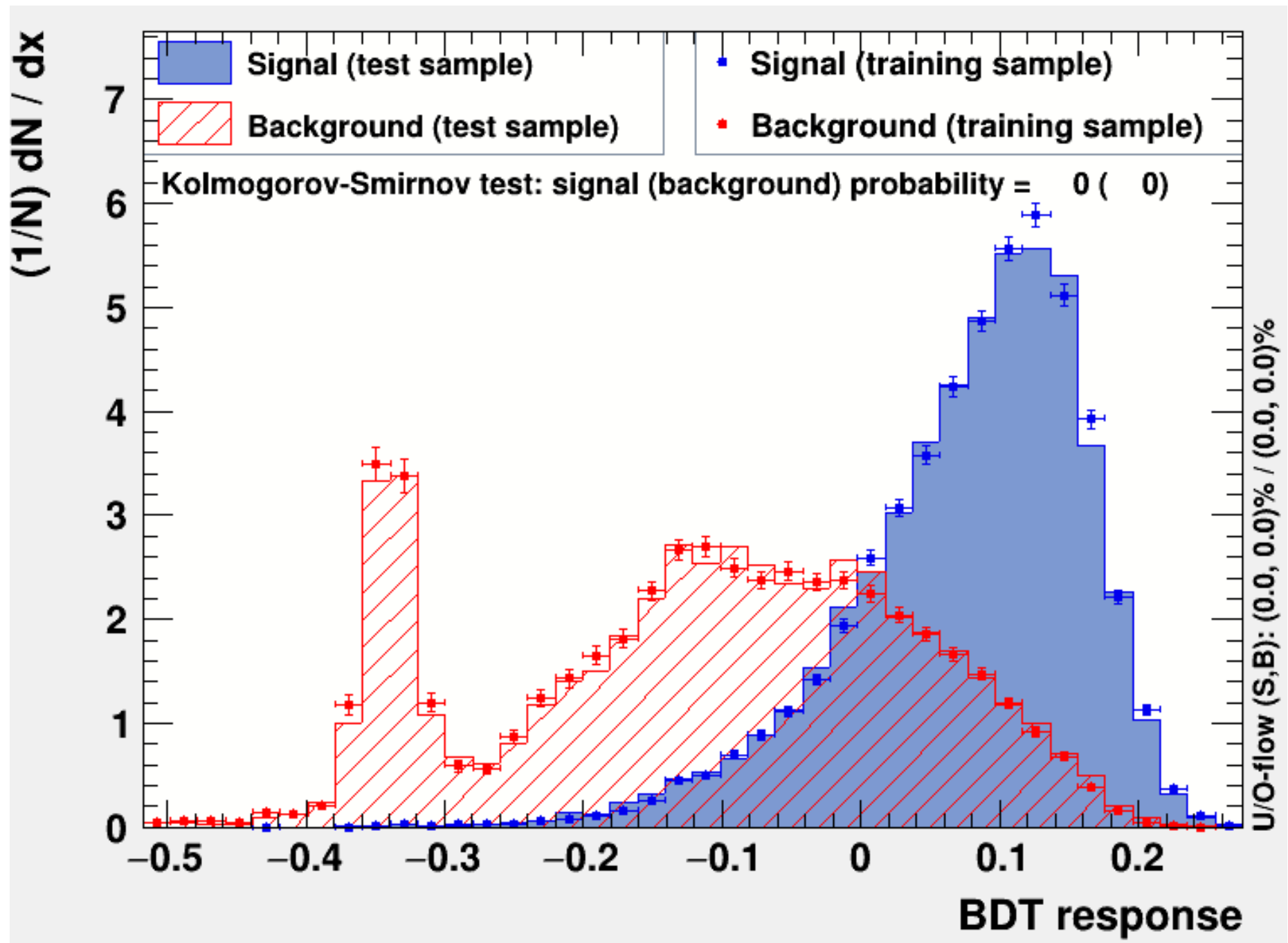
Preselection - summary

Event class	Efficiency
Background	0.37%
SM Higgs decays	1.68%
Invisible Higgs decay	46.95%

MVA - variables

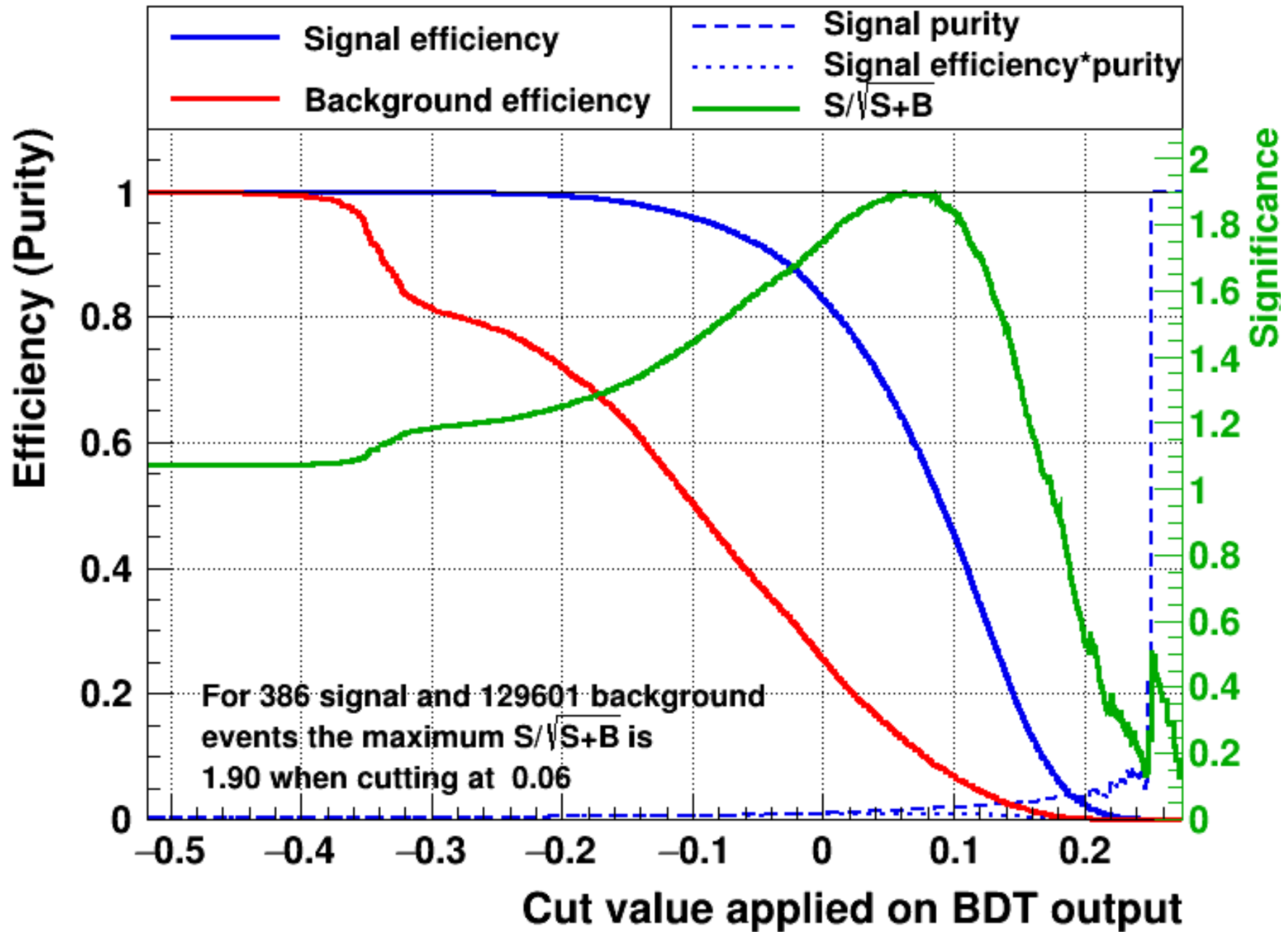
α	angle between two jets in the lab frame
m_{dijet}	mass of dijet
m_{missing}	missing mass
E_{dijet}	energy of dijet
$p_{\text{t-missing}}$	missing transverse momentum

BDT response

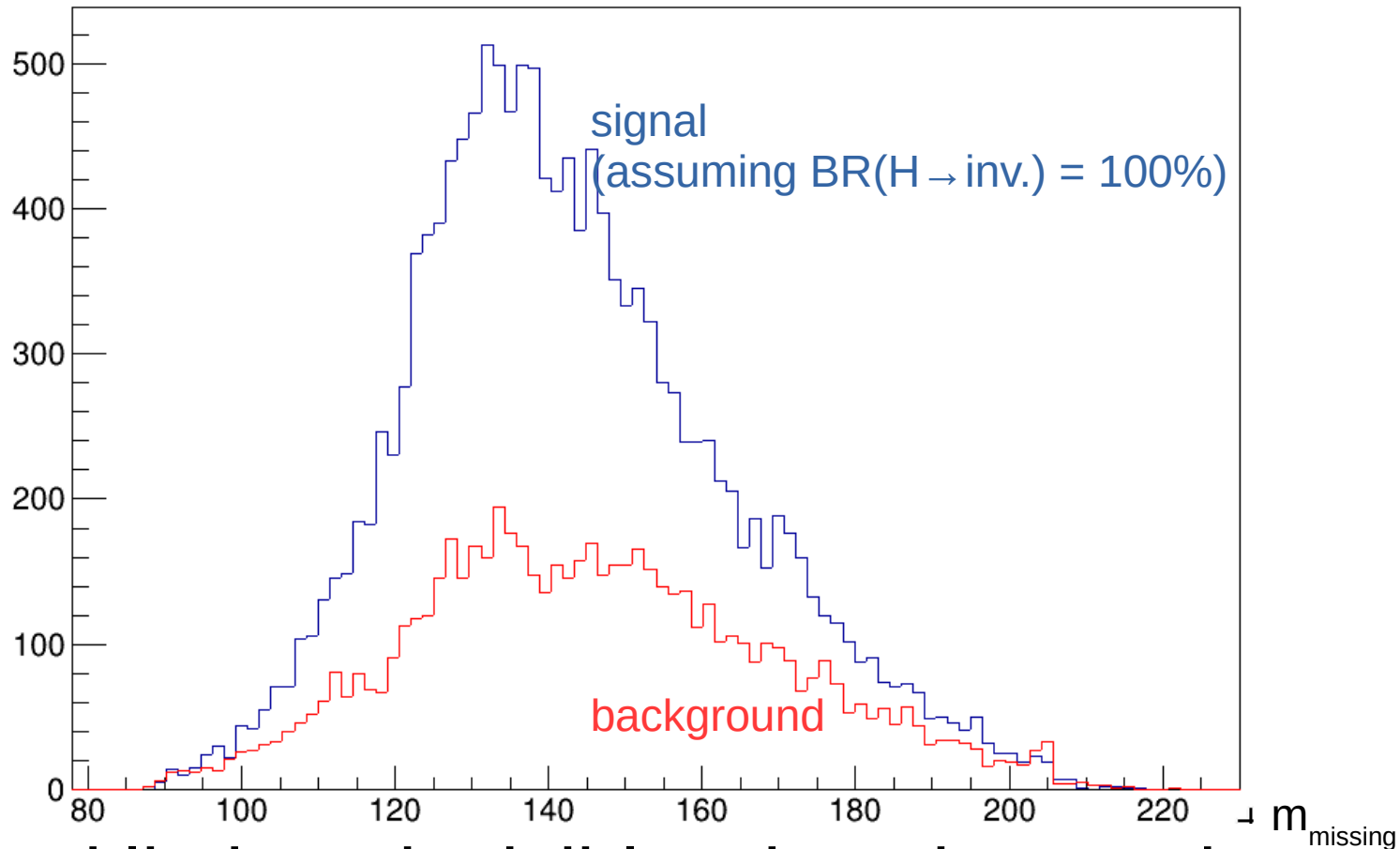


BDT - results

Assuming BR ($H \rightarrow \text{inv.}$) = 1%



Invisible decays of the 125 GeV higgs



Expected limit on invisible Higgs boson decays:

$$\mathbf{BR(H \rightarrow \text{inv.})} < \mathbf{0.86\%} \quad \text{at } \mathbf{95\% \text{ CL}}$$

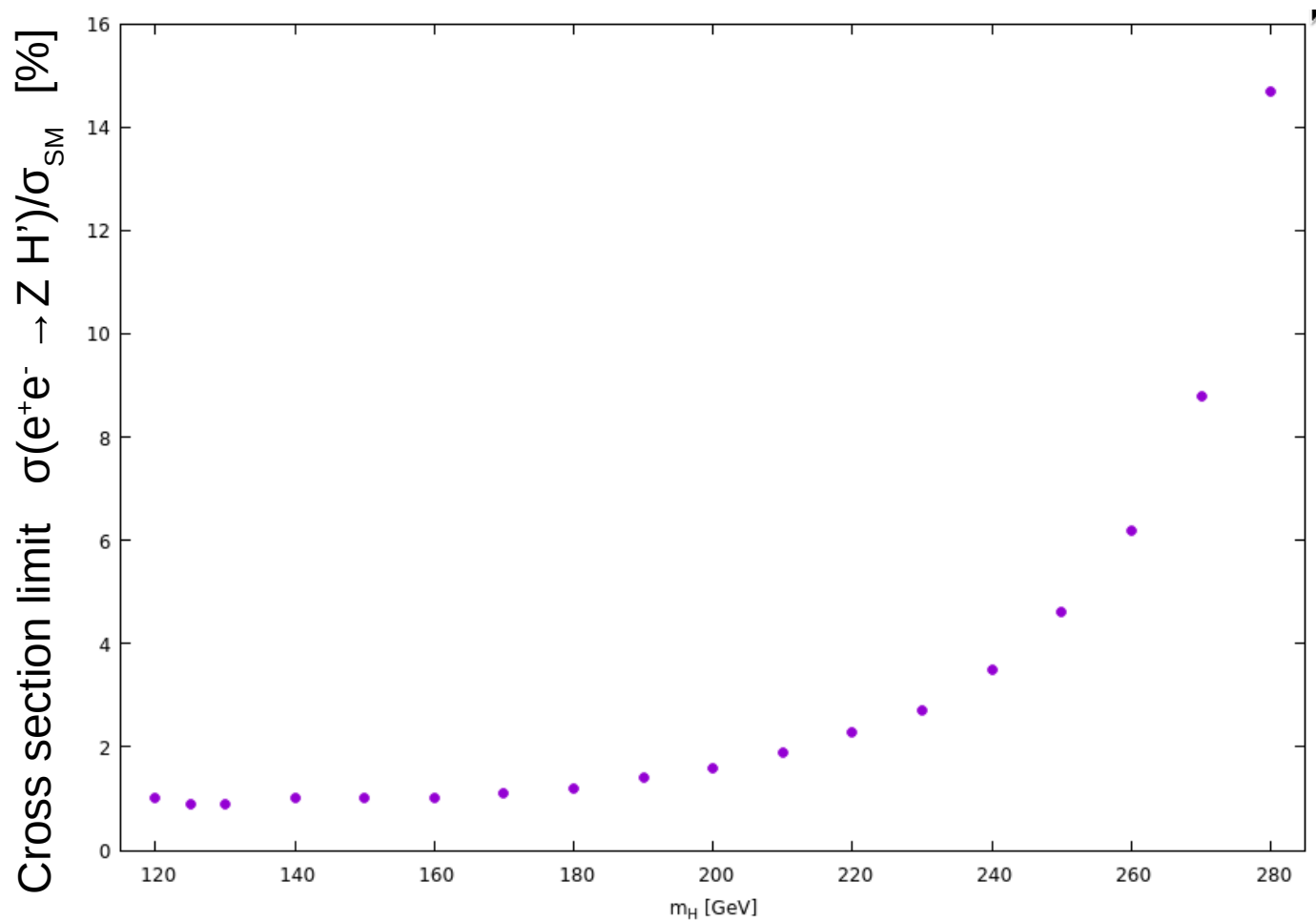
for 1000 fb^{-1} at 380 GeV

Invisible decays of H'

New „dark sector” scalars expected eg. in higgs-portal models.
Invisible decays dominate. Can be produced due to mixing with SM Higgs.

We extend our search to search for production of H' (assuming $\text{BR}(H' \rightarrow \text{inv.}) = 100\%$)

Using model with Vector-fermion dark matter [arXiv:1804.10289](https://arxiv.org/abs/1804.10289)



Conclusions

Search for invisible Higgs boson decays based on the WHIZARD event generation and fast simulation with Delphes.

CLIC running at 380 GeV can constrain the invisible decays of the SM Higgs boson to below 1%

Results consistent with the previous study based on full simulation

The study can be extended to search for new exotic scalars

Cross section limits can be translated to the limits on model parameters (still to be done)