Inert 2HDM scalar pair production @ FCC-ee

Follow-up from talk at FCC-Phys Perf meeting in Dec 2023,
https://indico.cern.ch/event/1357026/contributions/5715328/attachments/2774401/4847540/magnan_idmAtFCC_231218.pdf

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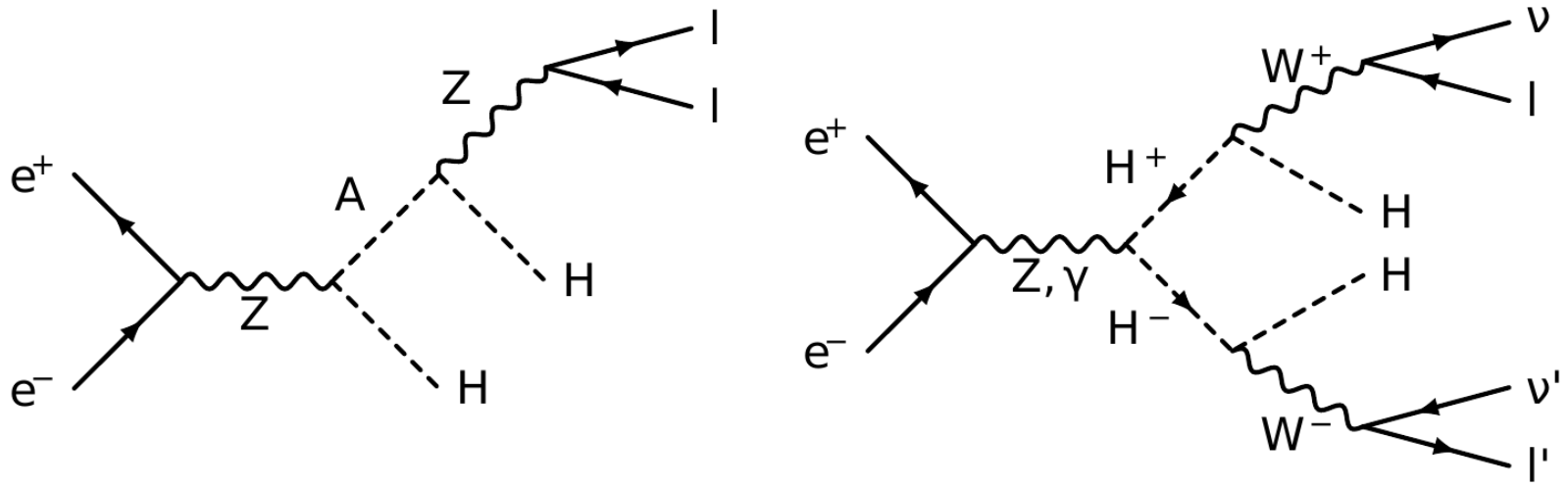
26/09/2024, FCC BSM searches meeting

Outline of the analysis

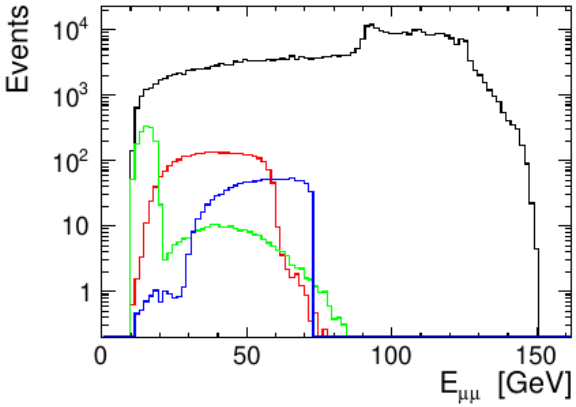


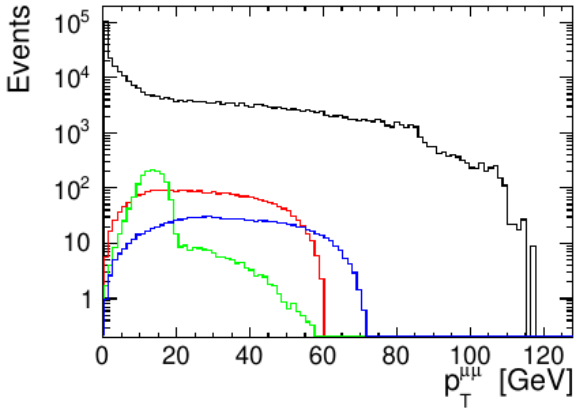
Final state: two same-flavour opposite-sign electrons or muons, and very little MET.

1. 2HDM+Z2 symmetry (JHEP 1812 (2018) 081): 5 scalars, h, H, A, H+, H-.
2. Define parameter space for the signal MC production (MG5_aMC@NLO) - reduced to 2 free parameters, m_H and m_A.
3. Use DELPHES objects.
4. Set of preselection cuts to reject main background (Winter2023 production), keeping signal for most of the parameter space under study.
5. Multivariate analysis with set of input features: parametric Neural Network.
6. Fit pNN output and extract 95% CL upper limit on signal XS using CMS Combine package.
7. Use $\mathcal{L} = 10.8$ (3) ab^{-1} of total integrated luminosity for $\sqrt{s} = 240$ (365) GeV.

Cross-check against CLIC Setup

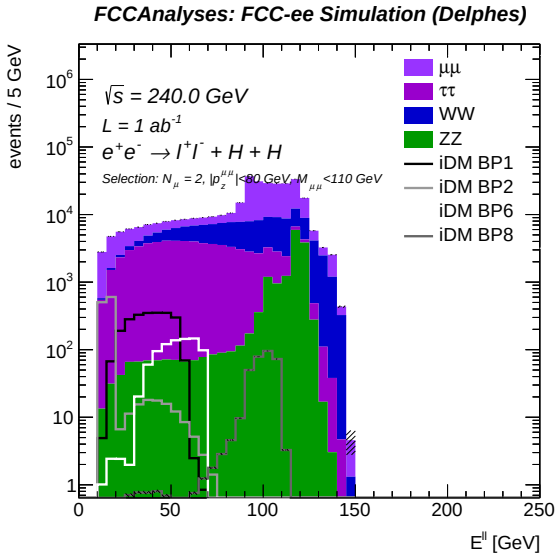
$\sqrt{s} = 250$ GeV

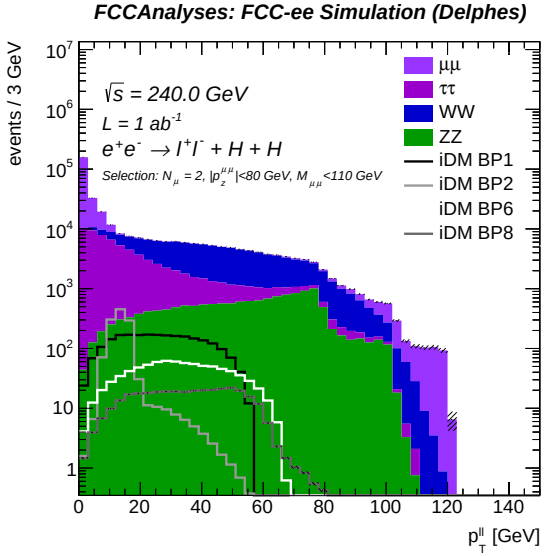




T. Robens et al, JHEP 07 (2019) 053 (@$\sqrt{s} = 380$ GeV)
Snowmass report: arXiv:2002.11716 (@$\sqrt{s} = 250$ GeV)

- All OK for signal and background generations !

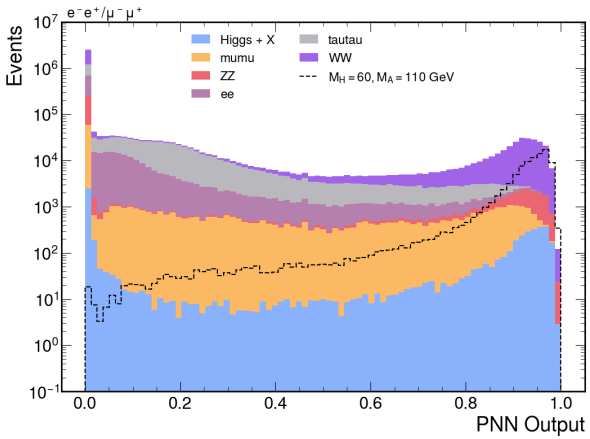




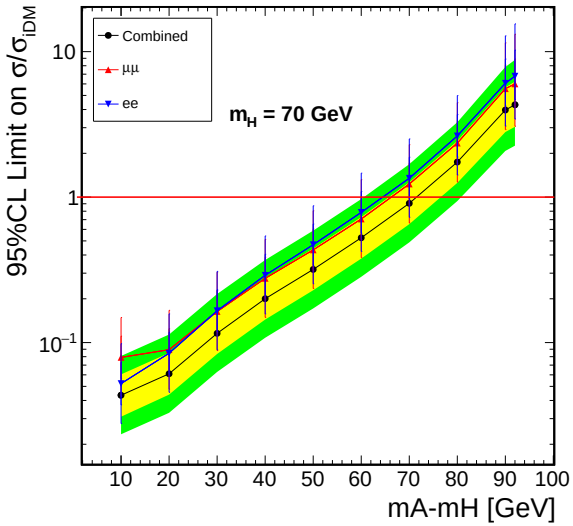
Limit results

- Maximum likelihood fit of pNN$>$ 0.9 distributions. Only one bin-by-bin uncertainty in the fit: MC stat.
- For each mH value, plot 95%CL upper limit as a function of mass splitting $m_A - m_H$, for ee and $\mu\mu$ channels separated and combination.
- Interpolate and extract limit in 2-D plot of $\Delta m = m_A - m_H$ vs m_H.
- To do: style to be improved and 365 GeV results to be added.

FCC-ee $\sqrt{s} = 240\,\text{GeV}$



FCC-ee $\sqrt{s} = 240\,\text{GeV}$



FCC-ee $\sqrt{s} = 240\,\text{GeV}$