H->bb/cc/gg at 350 GeV at CLIC

LCWS14 - 07 Oct 2014

Marco Szalay

Outline

- Introduction
- Higgs events selection
- Higgs branching fractions
- Template Fit
- Conclusions

Global Fit

- Higgs couplings can be calculated from σ x BR and total width Γ_H

- Γ_H can be determined with high precision from VBF and ZH for H→bb

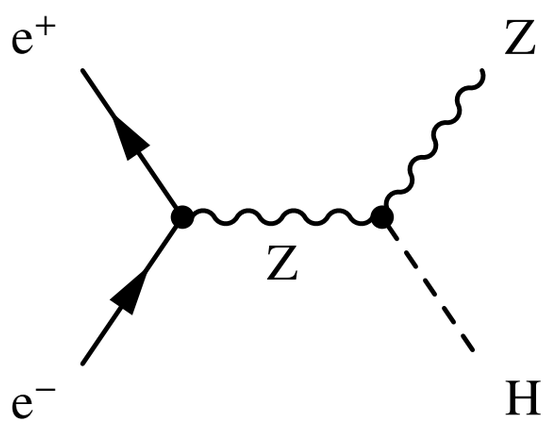
(i.e. $\frac{g_{HZZ}^2\, g_{Hbb}^2}{\Gamma}$ and $\frac{g_{HWW}^2\, g_{Hbb}^2}{\Gamma}$)

via a global fit → See Frank Simon talk for details

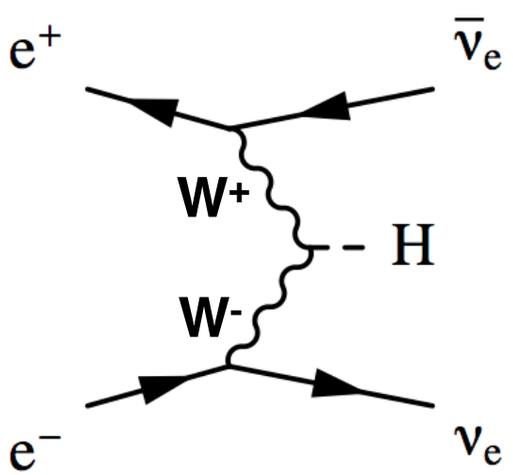
Higgs production in e^+e^- collisions

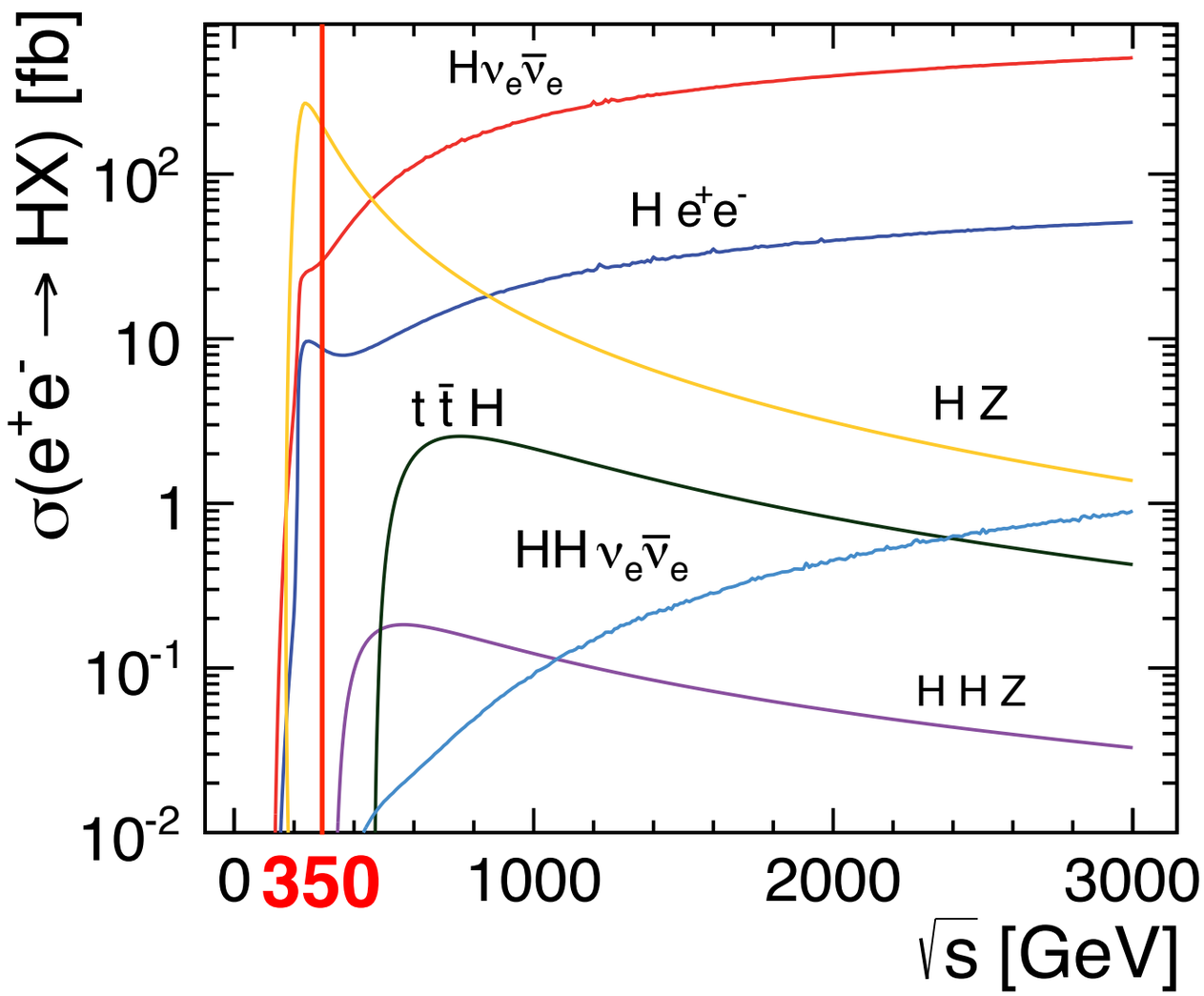
Main H production channels at 350 GeV:

- Higgs strahlung



- Vector Boson Fusion





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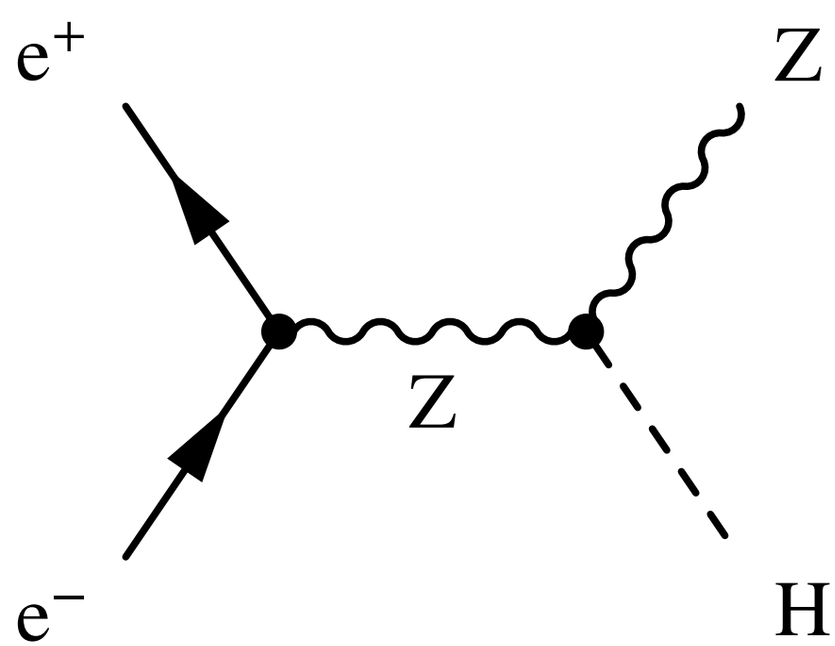
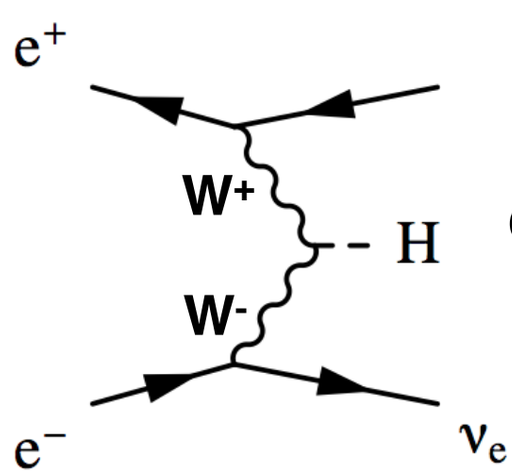
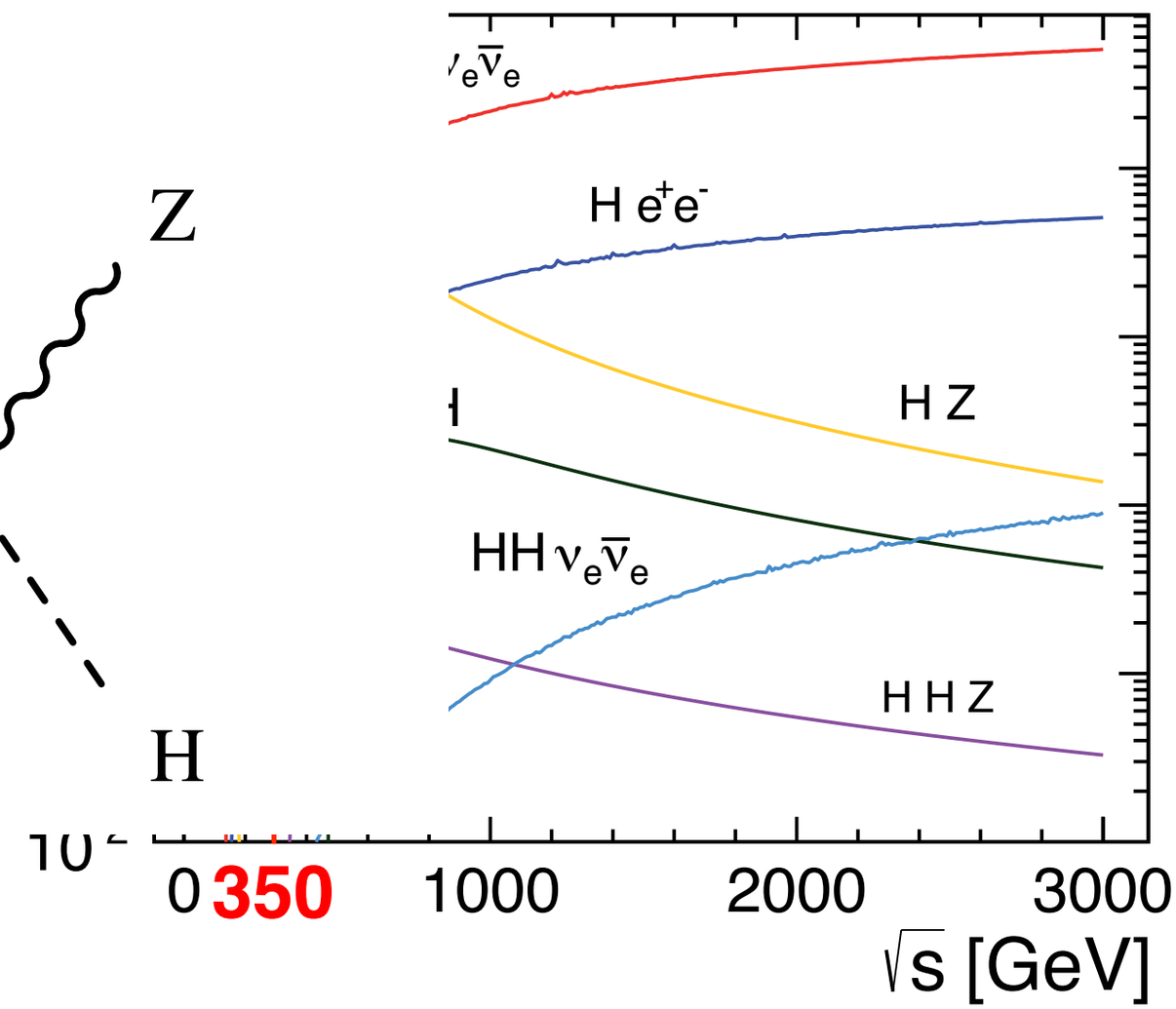


- Vector Boson F





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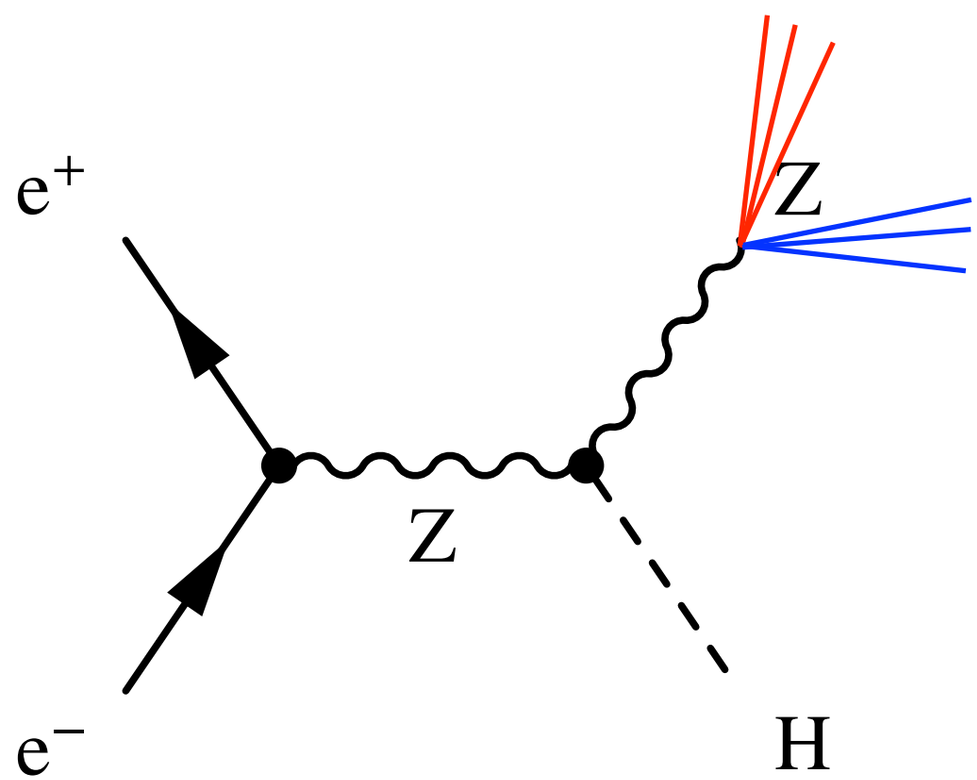

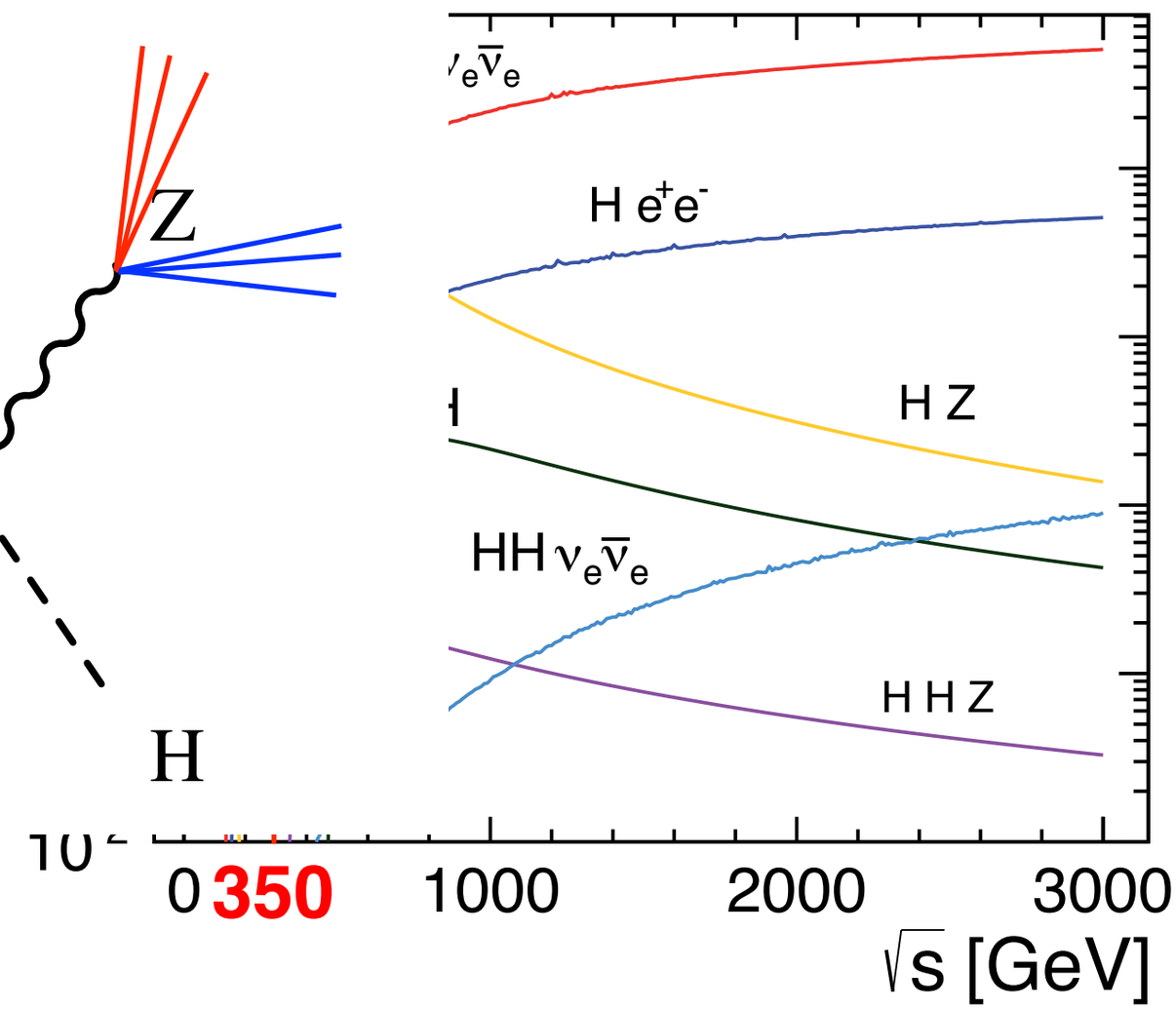

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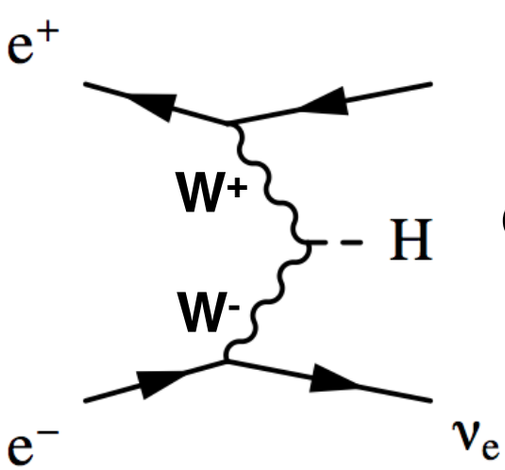

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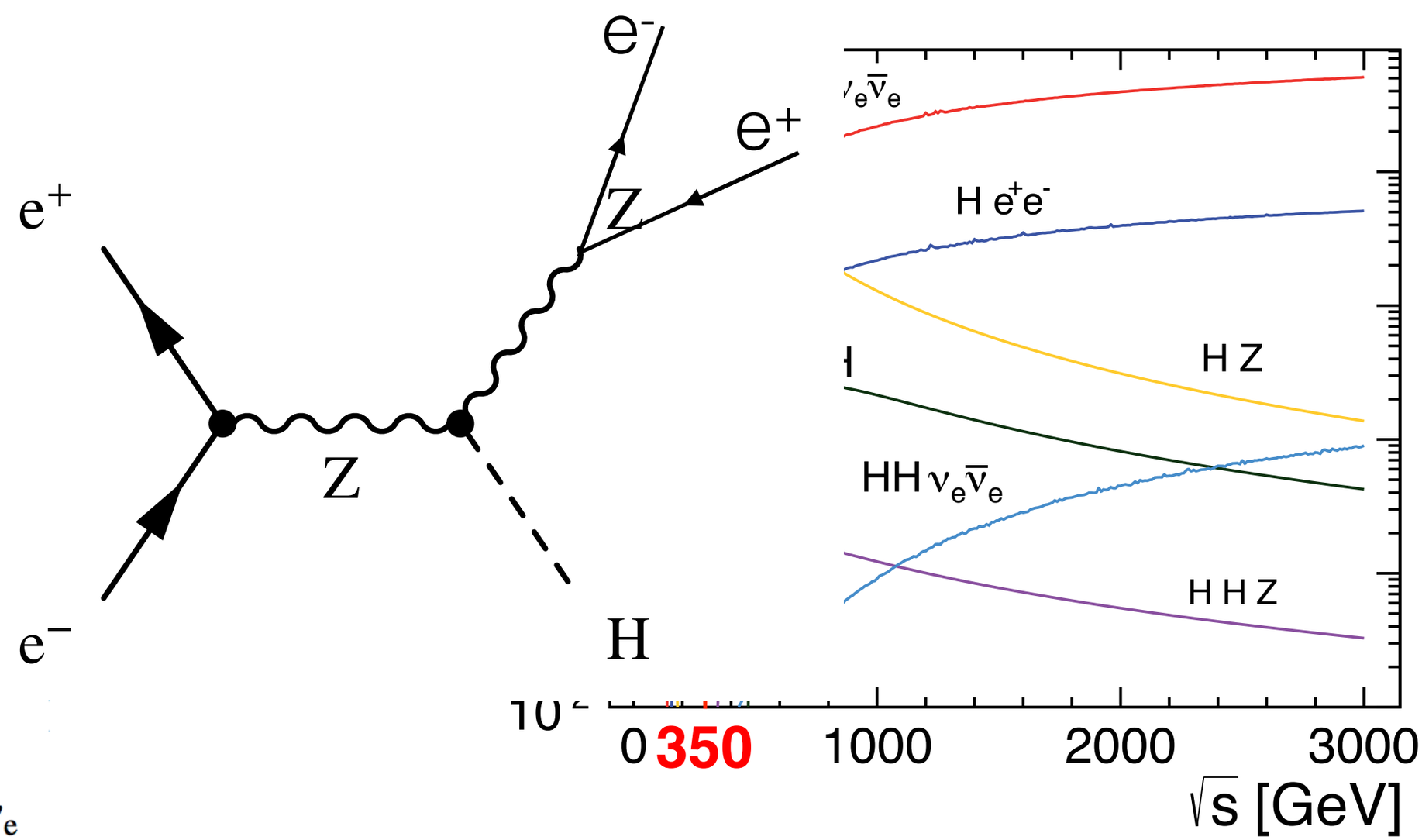

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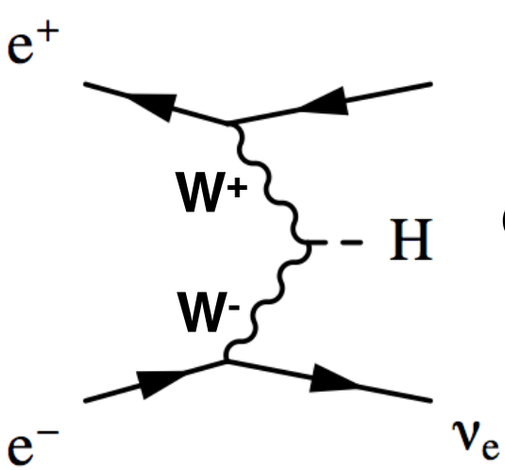

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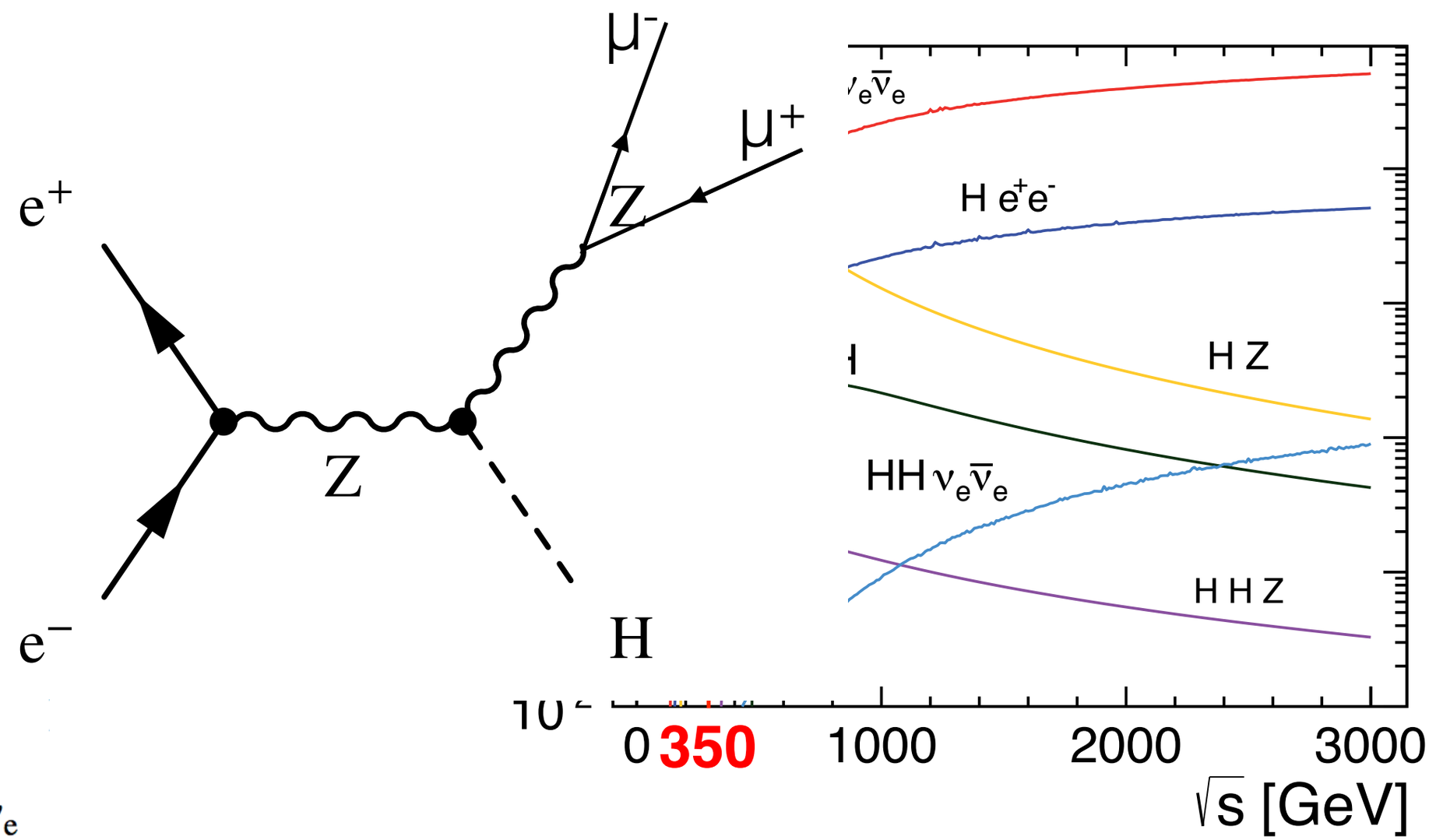

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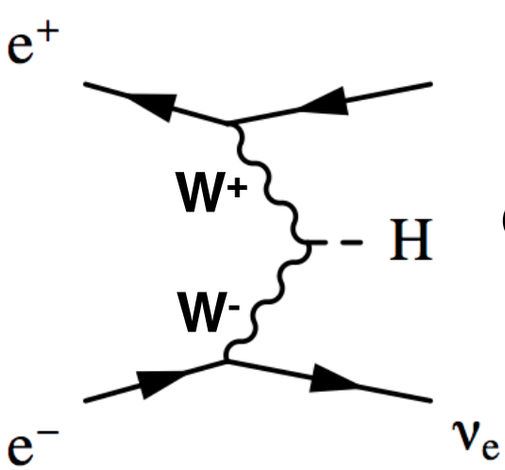

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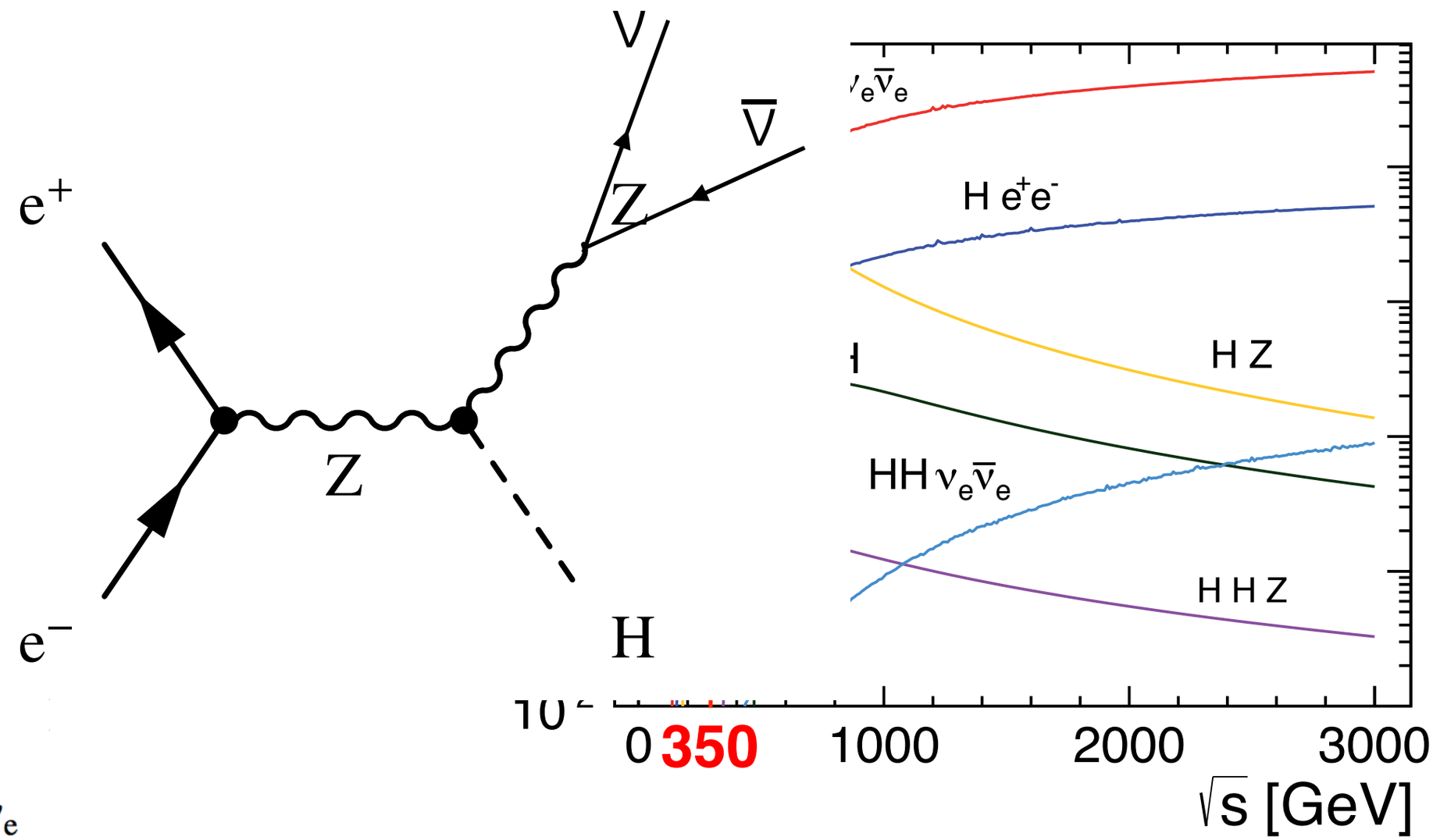

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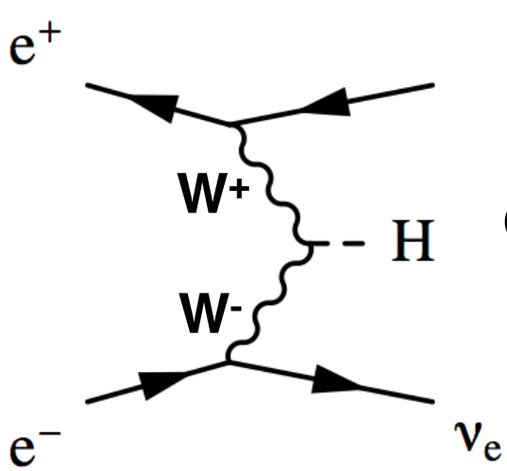
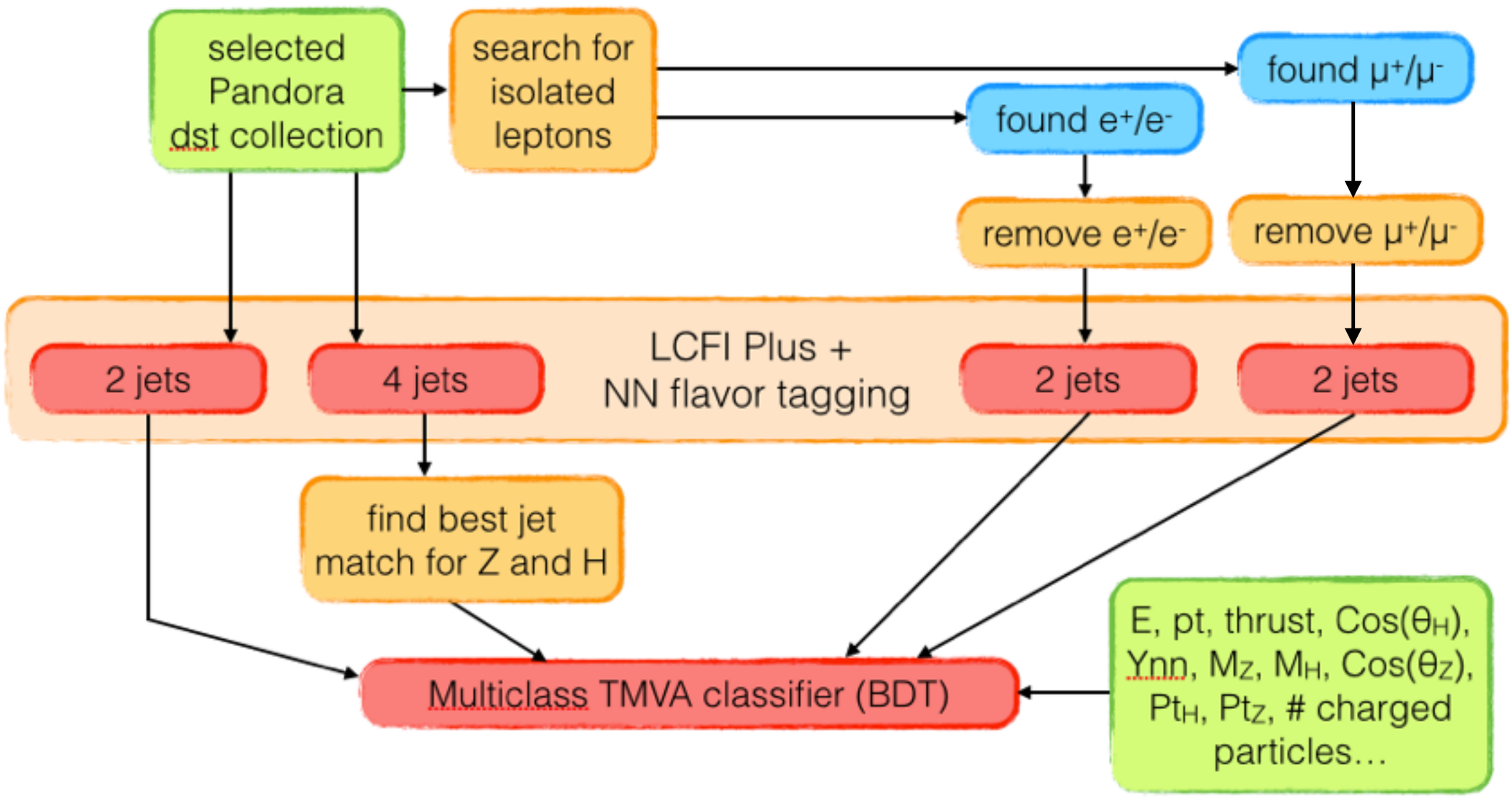


Event Selection

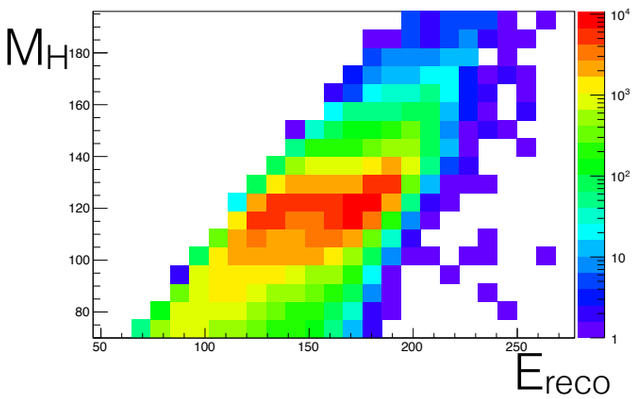
2-step analysis:
1) extract Higgs events from SM background
2) template fit to extract the decay fraction of the Higgs

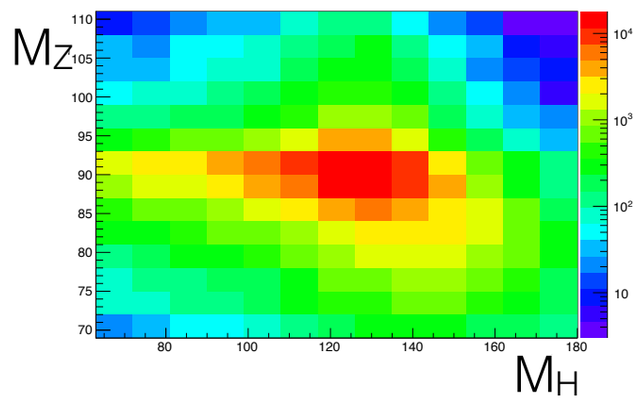


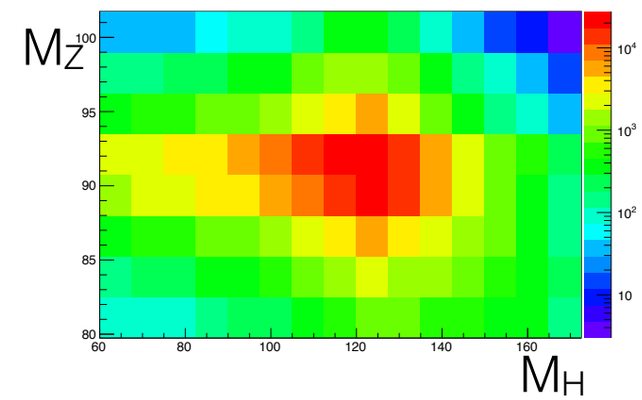
Preselection Cuts & Ranking

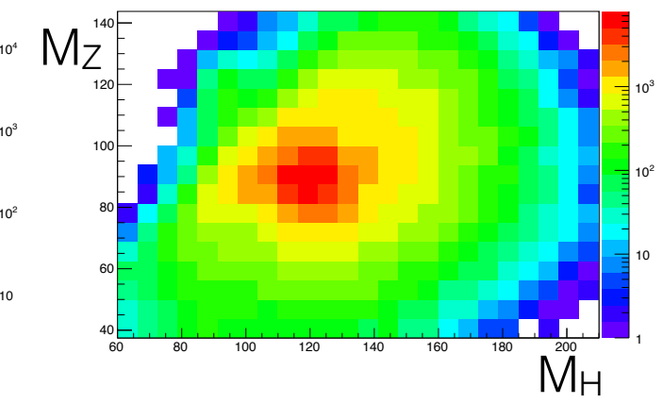
Preselection:

$H\nu\nu$	HZ: $Z \to e^+e^-$	HZ: $Z \to \mu^+\mu^-$	HZ: $Z \to$ jets
• $80 < M_H < 180$	• $80 < M_H < 170$	• $70 < M_H < 160$	• $70 < M_H < 200$
• $60 < E_{reco} < 260$	• $60 < M_Z < 120$	• $60 < M_Z < 120$	• $50 < M_Z < 130$







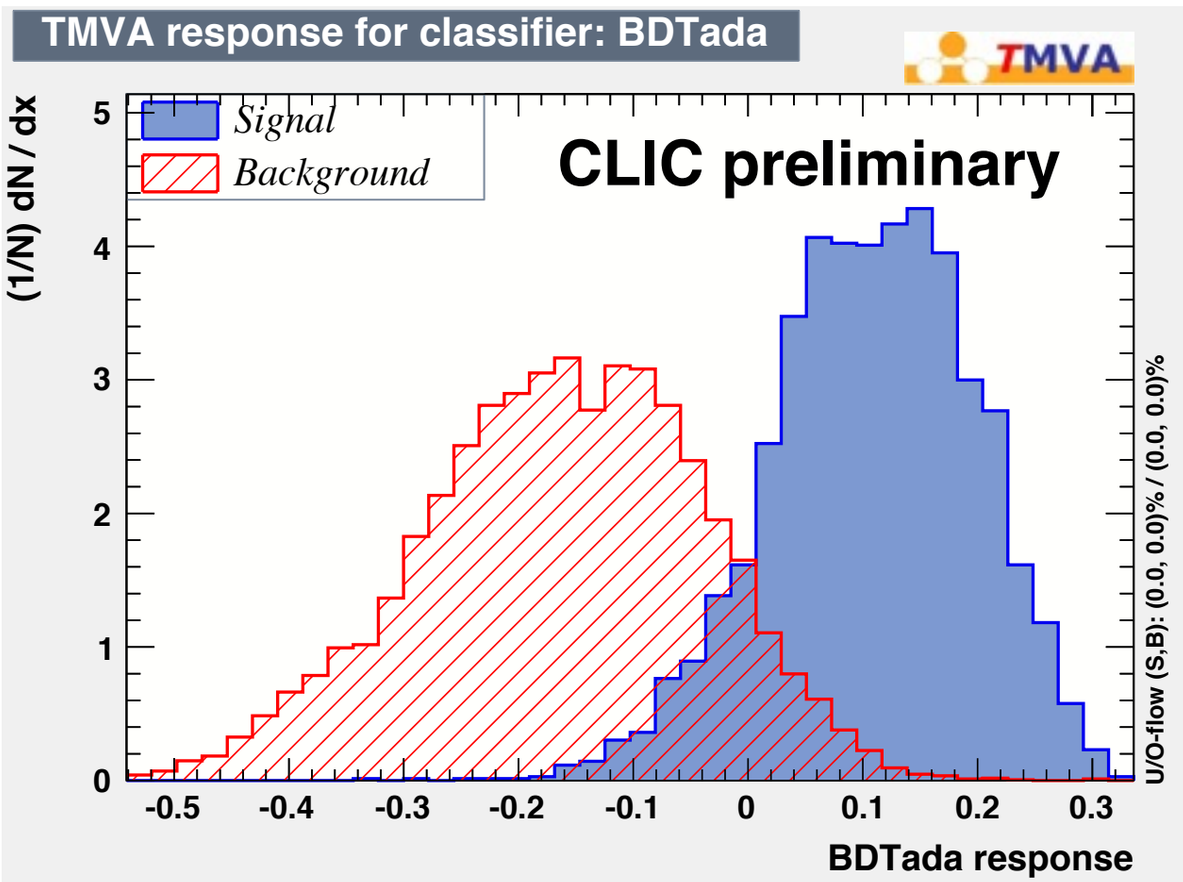


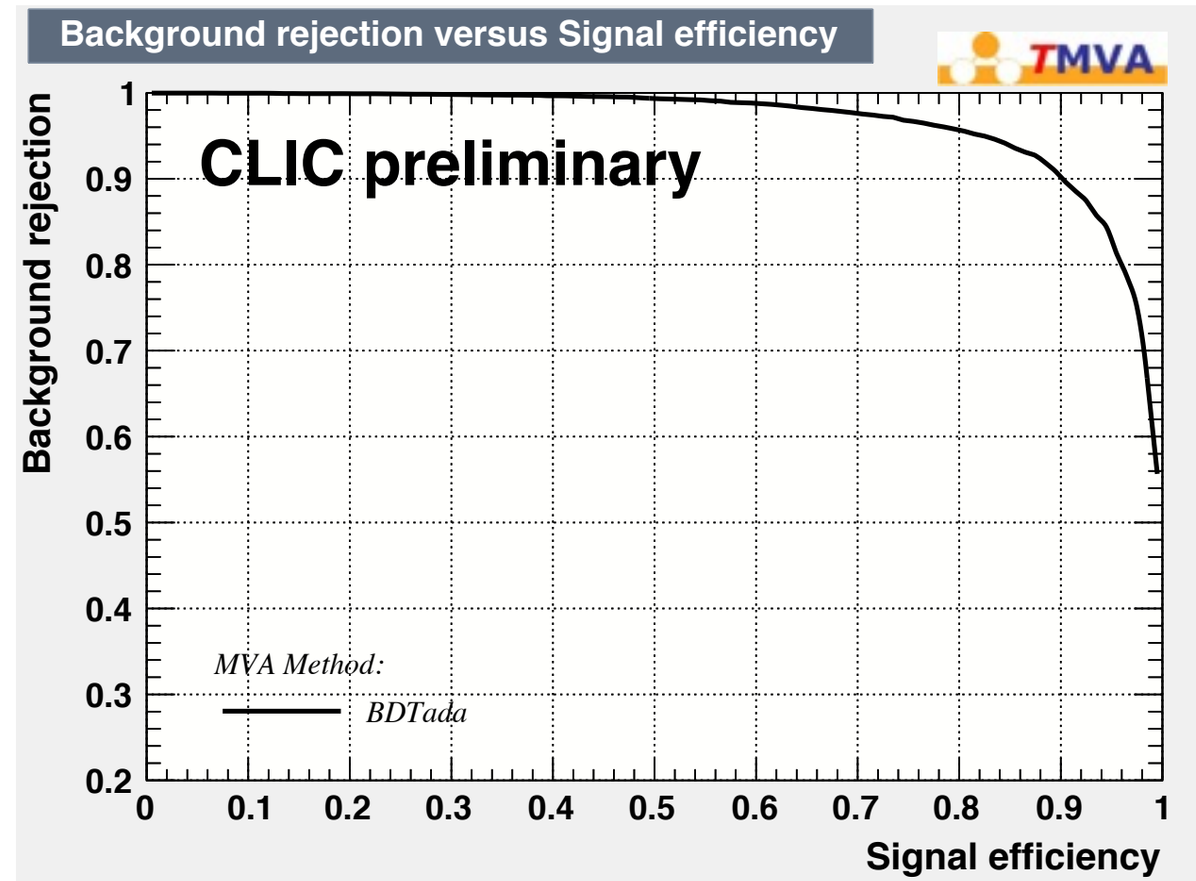
BDT ranking:

1) M_H,	1) N_P	1) N_P	1) N_P
2) thrust,	2) $\boldsymbol{\theta}_{ij}$	2) P_{max}	2) P_{max}
3) E_{reco},	3) M_H	3) thrust	3) thrust
4) $\boldsymbol{\theta}_H$,	4) ϕ_H	4) M_Z	4) Cos $\boldsymbol{\theta}_{thr}$
5) P_T,	5) thrust	5) M_H	5) $\boldsymbol{\theta}_{ij}$
6) ϕ_H	6) M_Z	6) Cos $\boldsymbol{\theta}_{thr}$	6) M_Z

Classifier performances

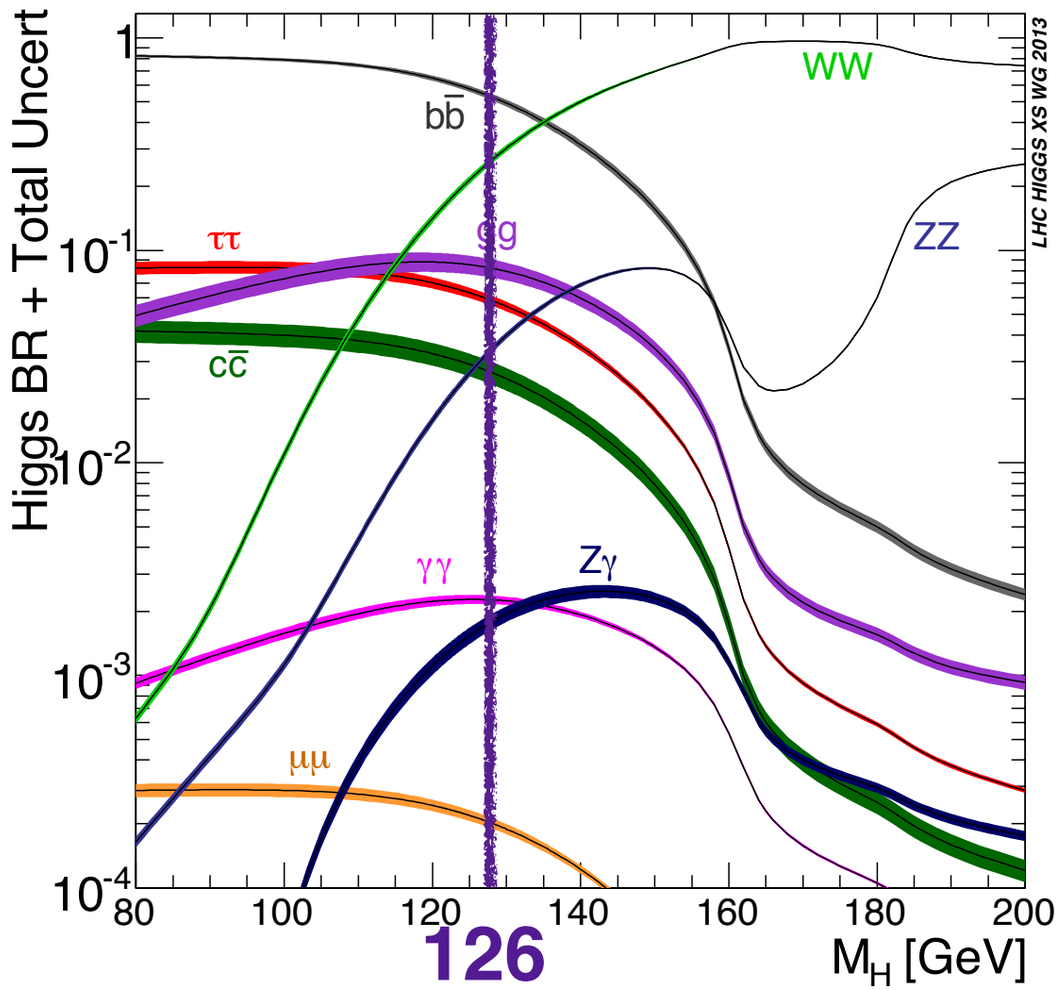
BDT classification for H$\nu\nu$





similar results for the other binary classifiers

Higgs Branchings

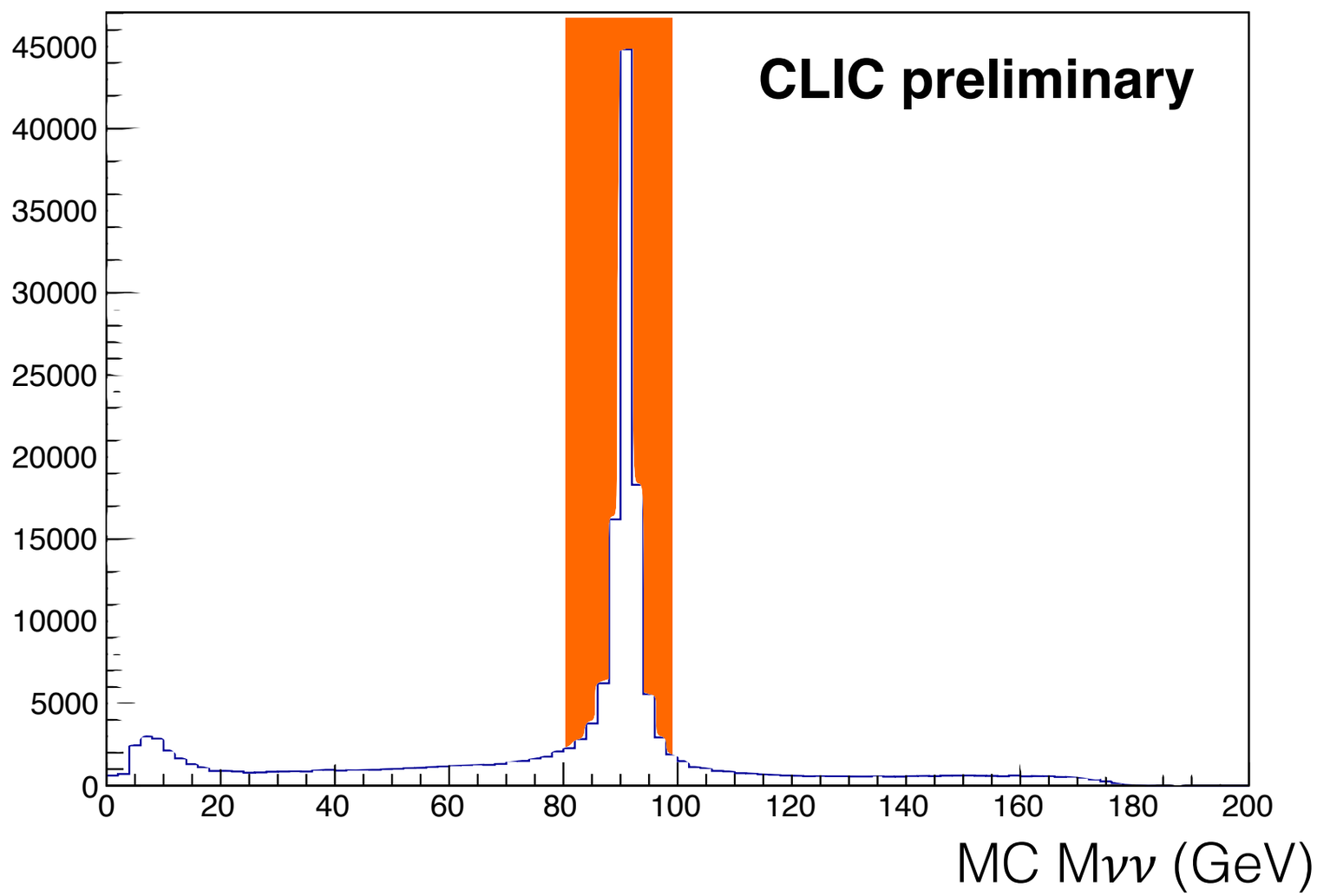


H →bb	56%
H →WW	23.3%
H →gg	8.5%
H →ττ	6.1%
H →ZZ	2.9%
H →cc	2.8%
H →γγ	0.23%
H → μμ	0.02%

Separate H → bb, H → cc and H → gg based on flavor tagging information

Separation of VBF and Z→$\nu\nu$ at generator level

From an H$\nu\nu$ inclusive sample



if 86 < M$\nu\nu$ < 96 → Z strahlung event (Z→$\nu\nu$)

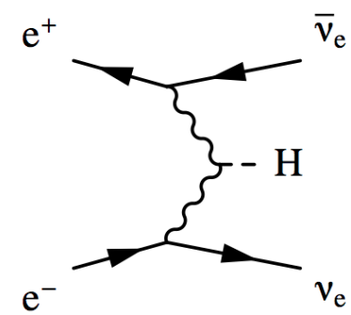
Template Fit - Combined

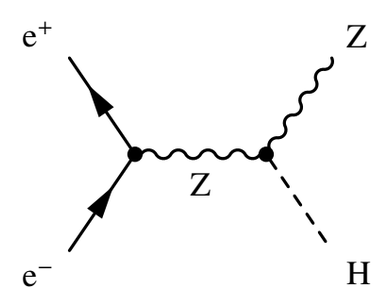
- 4D binned likelihood template fit
- 4 observables: b-likelihood, c-likelihood, bc-likelihood* and Higgs transverse momentum
- 6 templates:

  VBF, H -> bb

  ZH, H -> bb

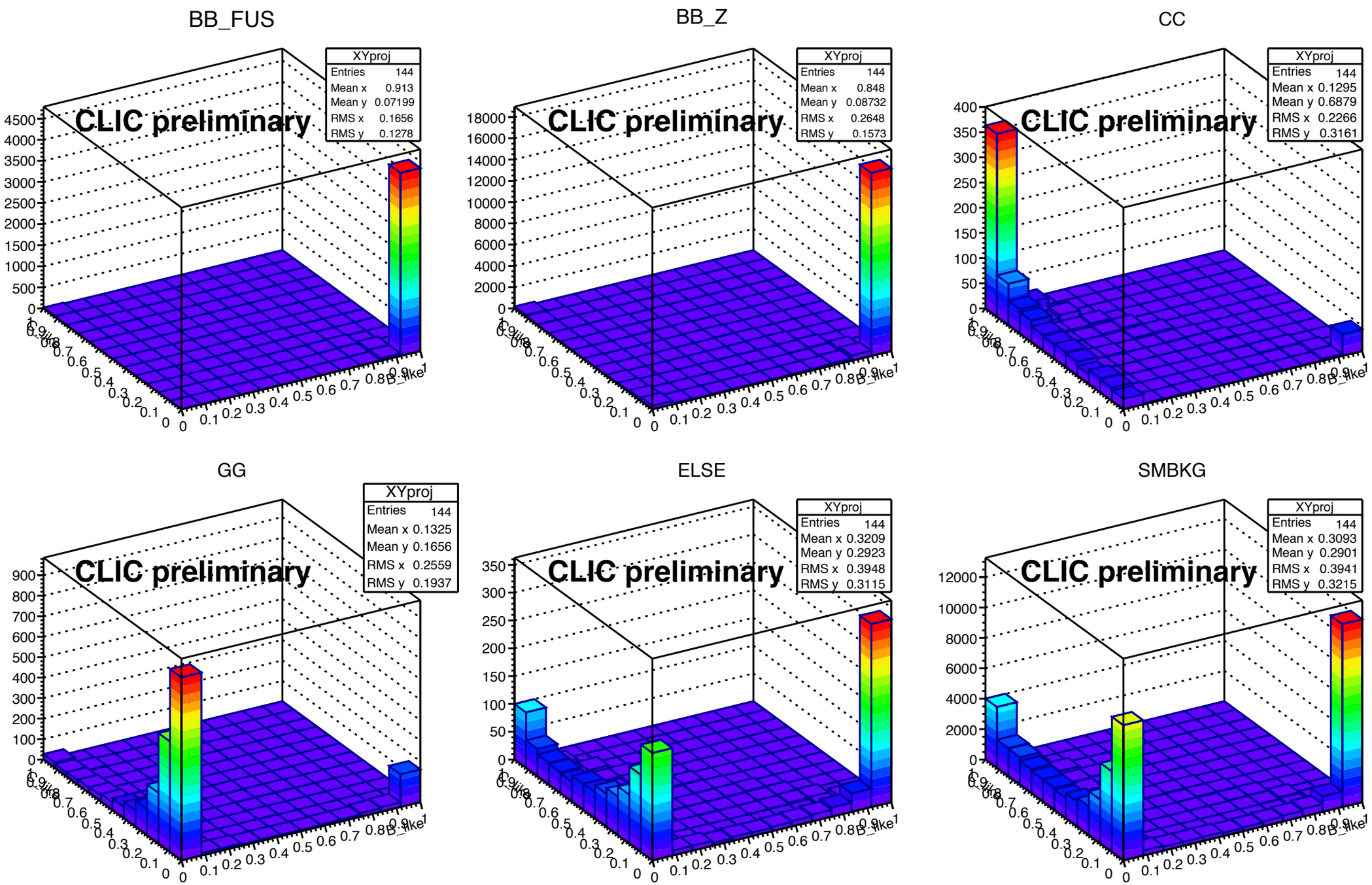
  H -> cc
  H -> gg
  H -> else (fix)
  SM background (fix)





*bc_like = c_like / (b_like + c_like)

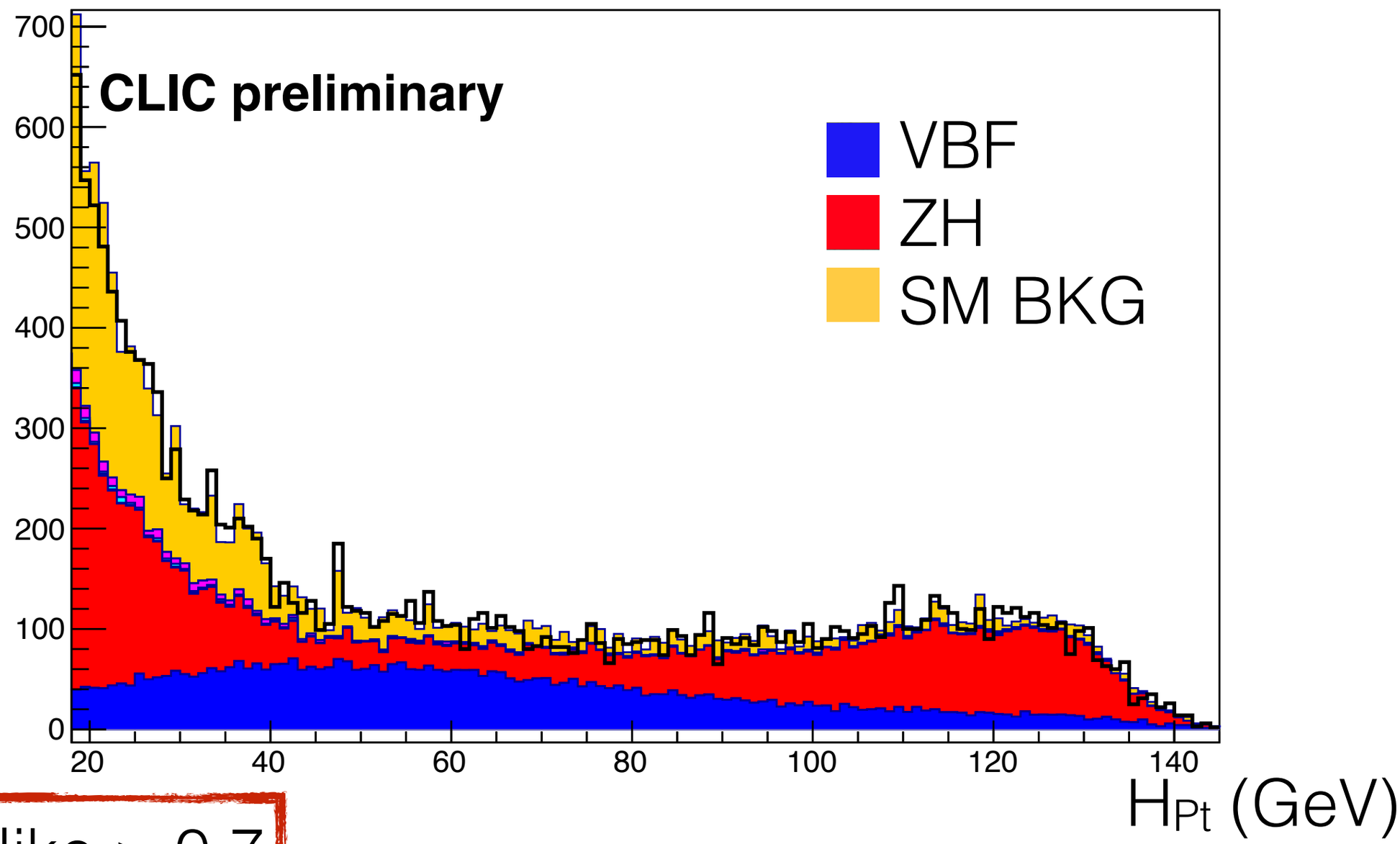
Templates



Projection on the B vs C plane, templates normalized to 500 fb^{-1}

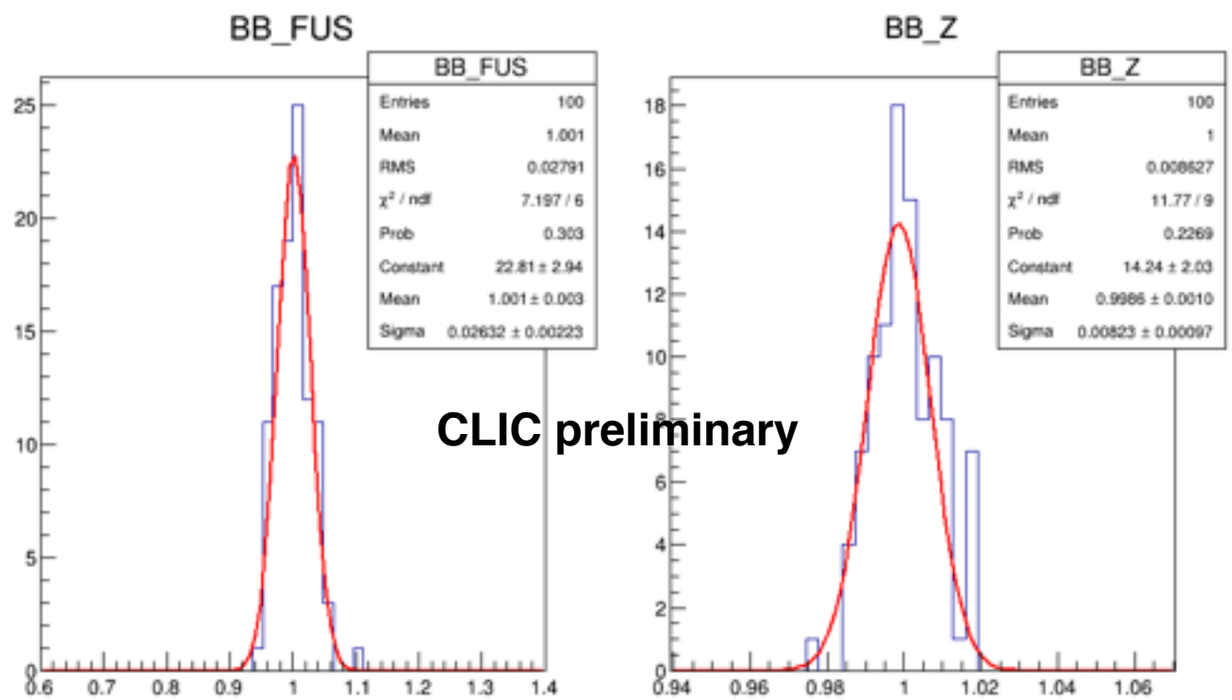
Higgs P_T

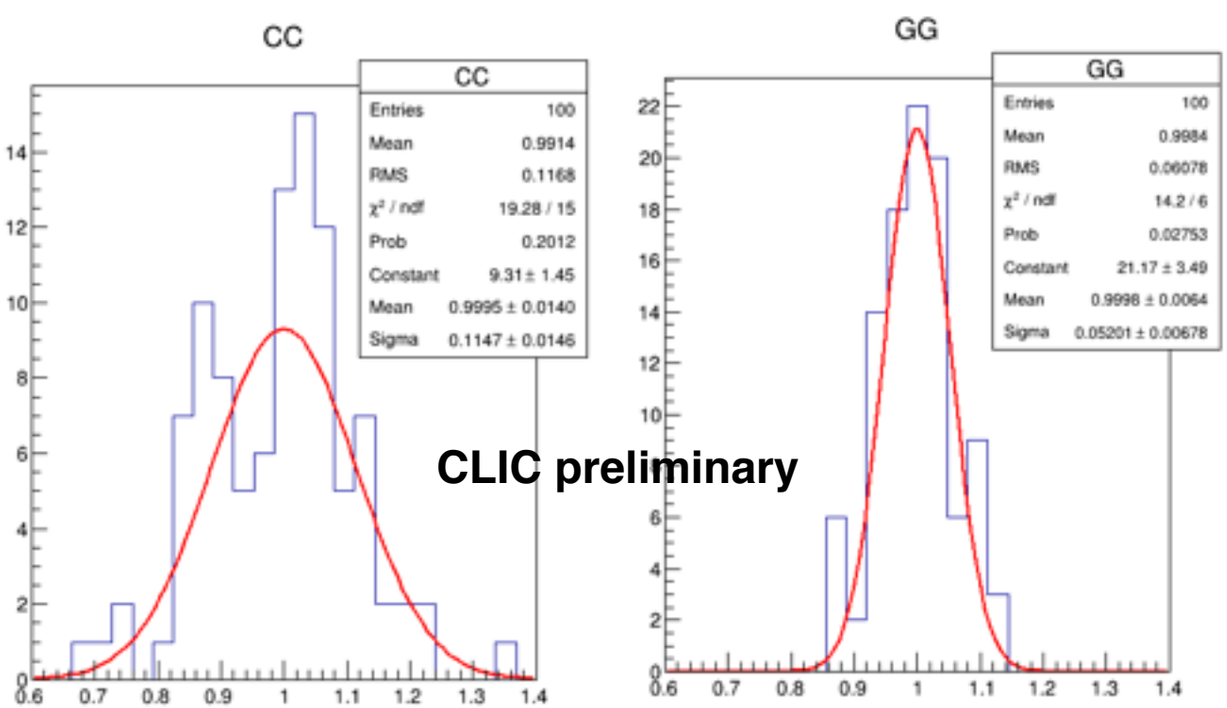
Using H_{Pt} in the fit, we can discriminate between VBF and ZH



b_like > 0.7

Fit Results





Uncertainties

Δbb (VBF)	2.63%
Δbb (ZH)	0.82%
Δcc	11.5%
Δgg	5.2%

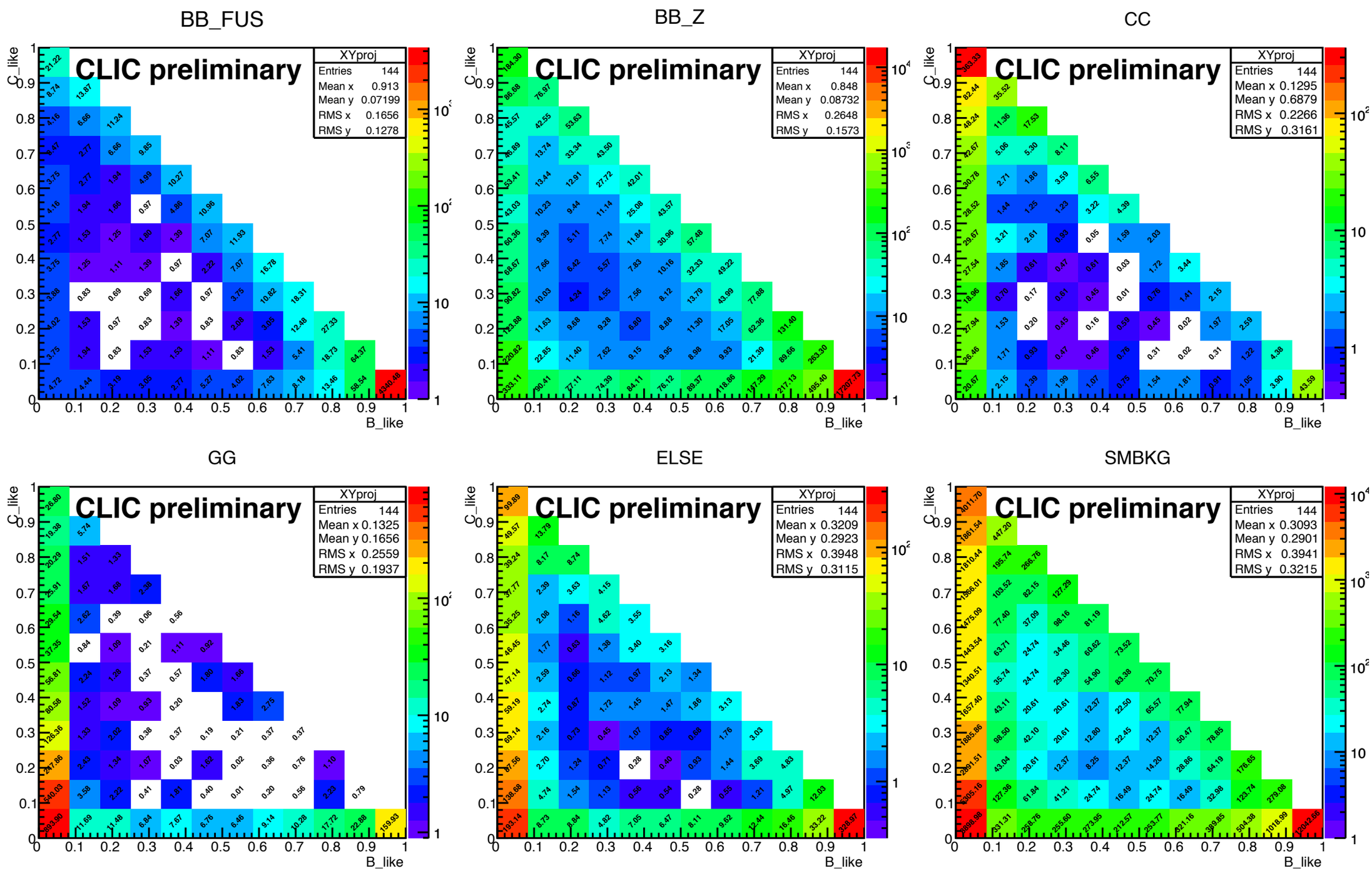
Correlations

	Δbb (VBF)	Δbb (ZH)	Δcc	Δgg
Δbb (VBF)	1	-0.451	-0.003	0.034
Δbb (ZH)		1	-0.066	-0.146
Δcc			1	-0.227
Δgg				1

Conclusions

- A measurement of the Γ_H needs high precision measurements on Higgs hadronic decays, in particular H→bb
- With this study, σ x BR for ZH: H→bb can be determined with sub-percent precision with 500fb^{-1} of data
- H→gg can be measured at a 5% level
- H→cc is more problematic due to the low branching fraction, need more work to explore potential improvement
- The correlation matrix can be used in the global fit to improve the measurement of Γ_H

BACKUP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Mean y 0.07199
RMS x 0.1656
RMS y 0.1278
BB_Z
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XYproj
Entries 144
Mean x 0.848
Mean y 0.08732
RMS x 0.2648
RMS y 0.1573
CC
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XYproj
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Mean x 0.1295
Mean y 0.6879
RMS x 0.2266
RMS y 0.3161
GG
CLIC preliminary
XYproj
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RMS y 0.1937
ELSE
CLIC preliminary
XYproj
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Mean y 0.2923
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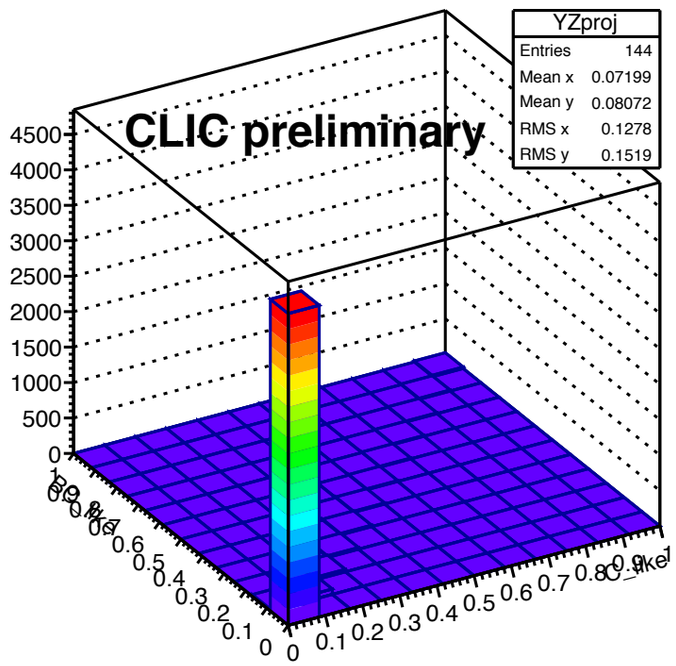
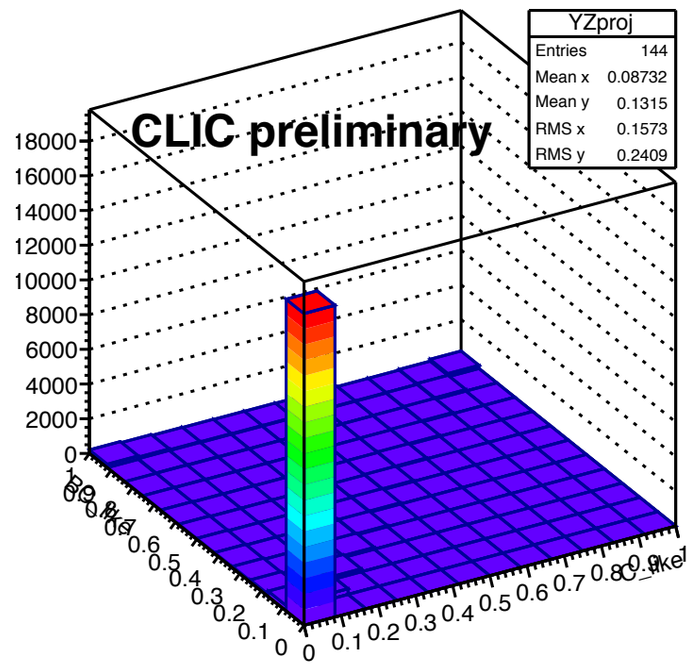
C_like
B_like

C vs BC

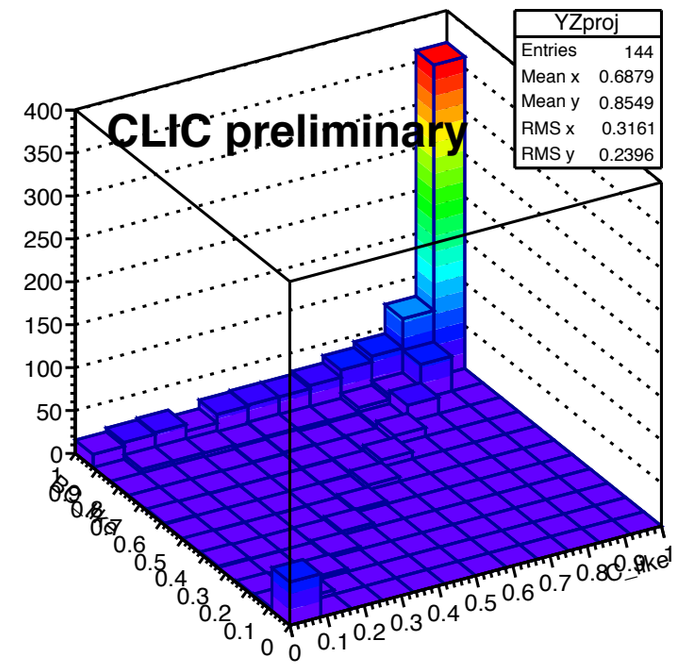
BB_FUS



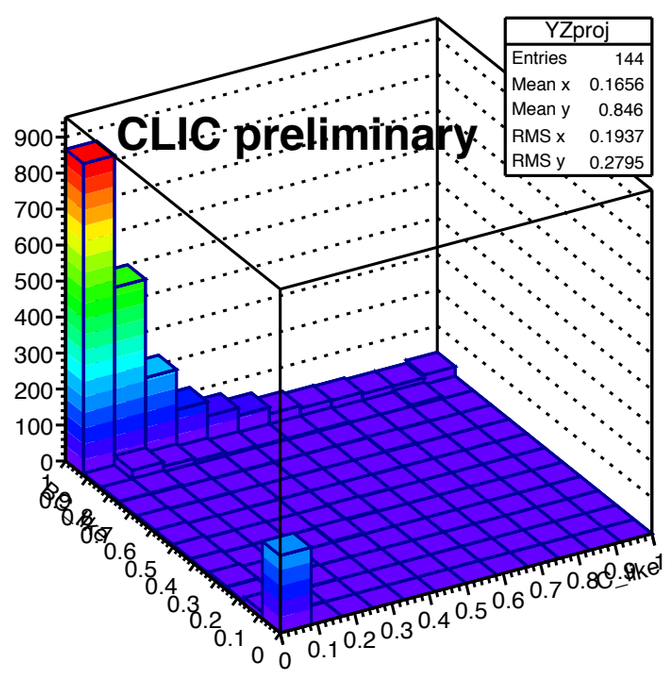
BB_Z



CC



GG



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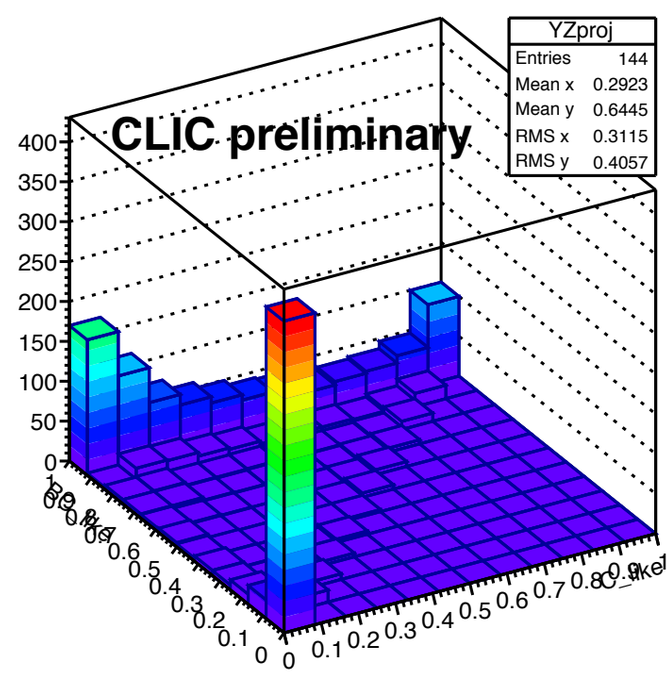
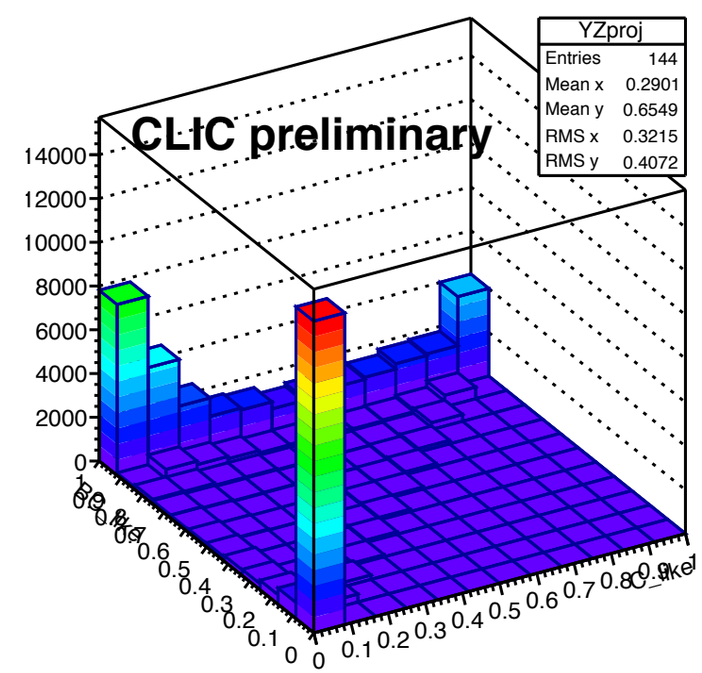
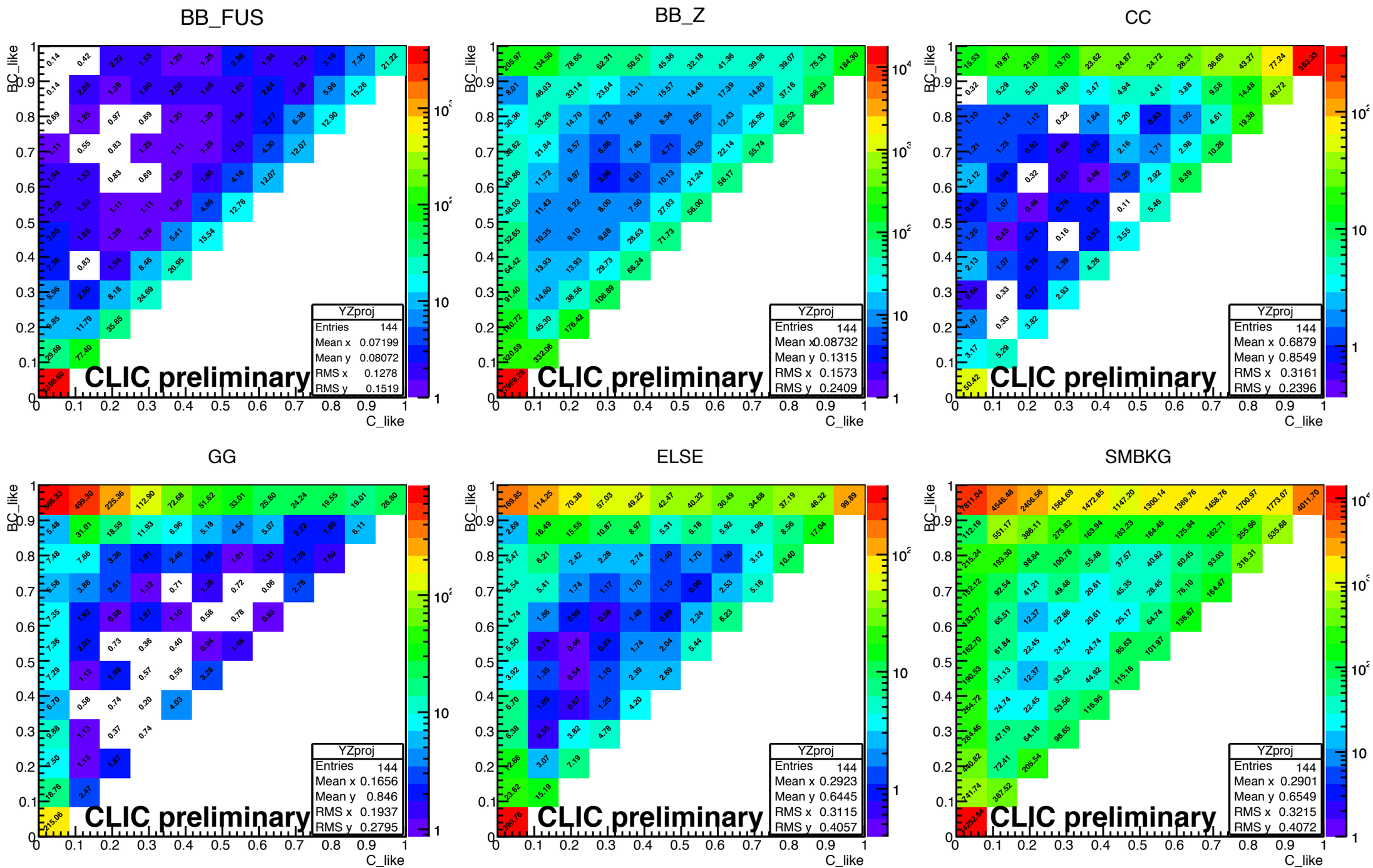


SMBKG



C vs BC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YZproj
Entries 144
Mean x 0.07199
Mean y 0.08072
RMS x 0.1278
RMS y 0.1519
CLIC preliminary
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Mean x 0.08732
Mean y 0.1315
RMS x 0.1573
RMS y 0.2409
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CC
YZproj
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RMS y 0.2396
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GG
YZproj
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RMS y 0.2795
CLIC preliminary
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Mean y 0.6445
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SMBKG
YZproj
Entries 144
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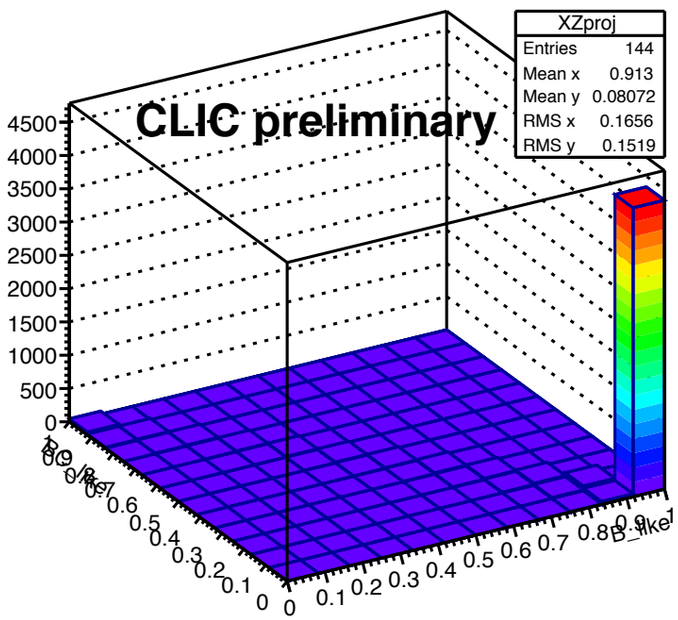
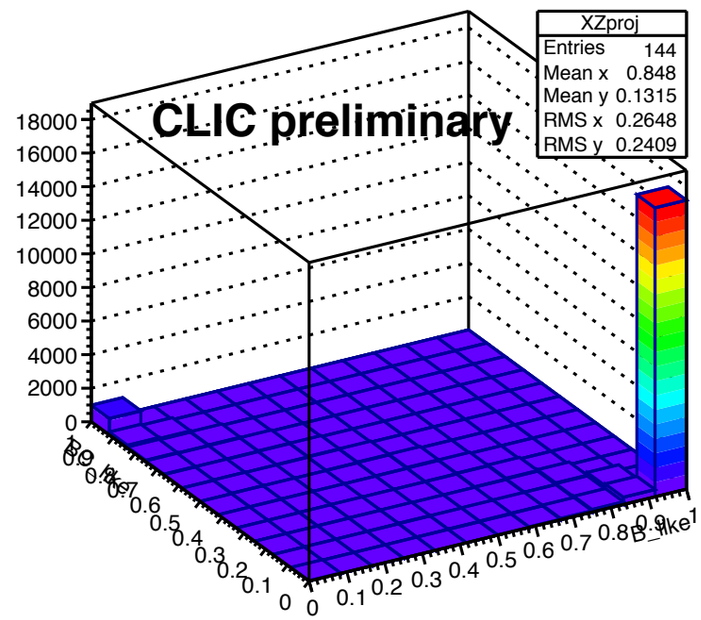
Mean y 0.6549
RMS x 0.3215
RMS y 0.4072
CLIC preliminary
BC_like
C_like

B vs BC

BB_FUS



BB_Z



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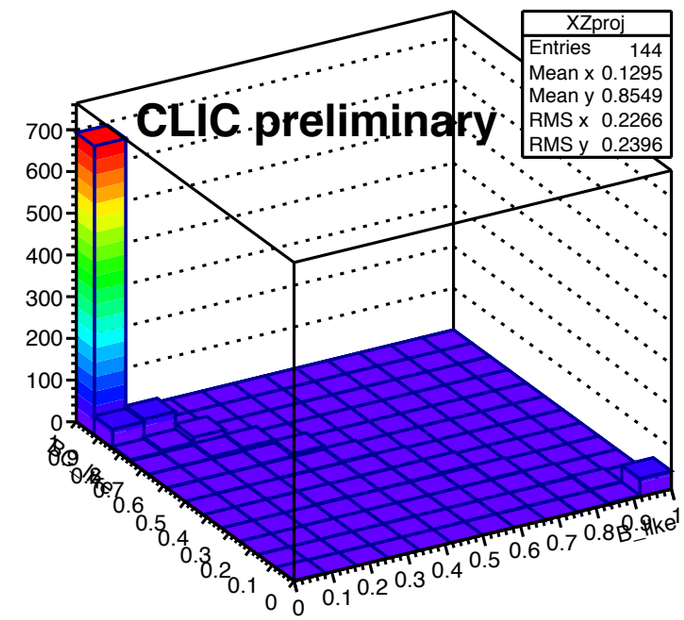
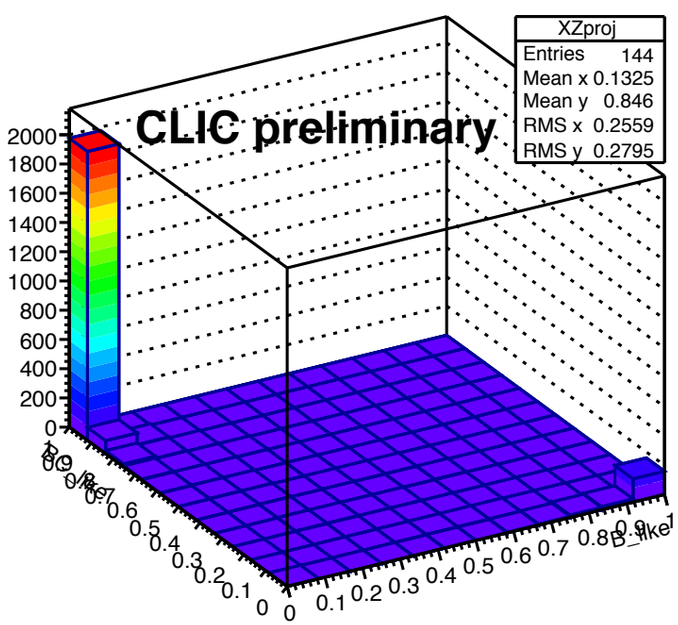
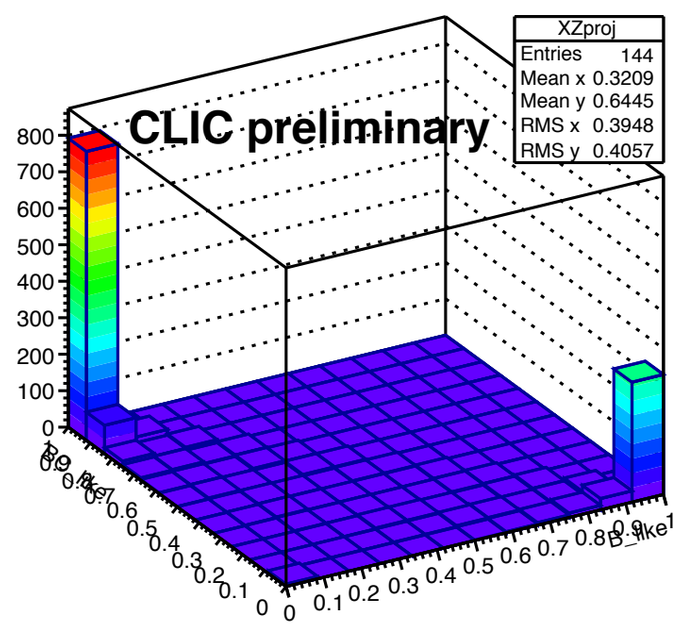


GG



ELSE



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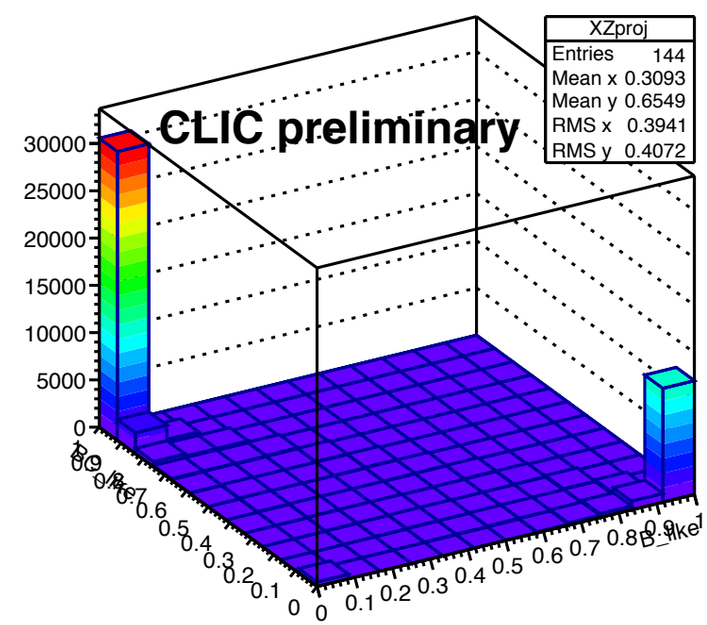
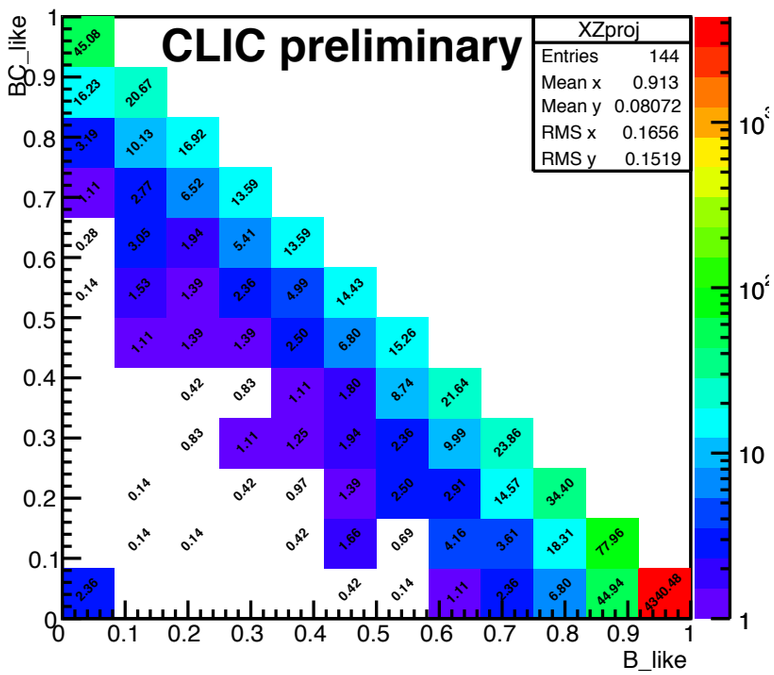


B vs BC

BB_FUS



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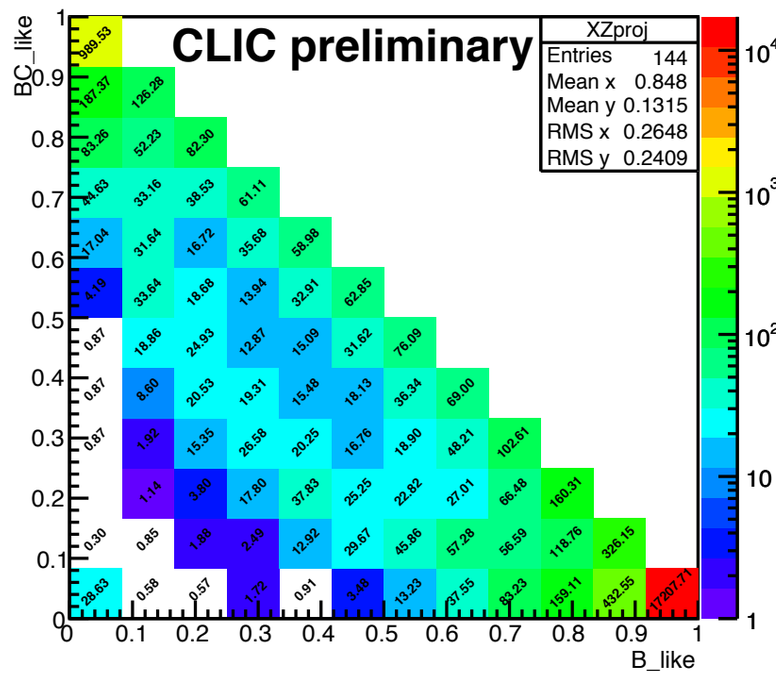

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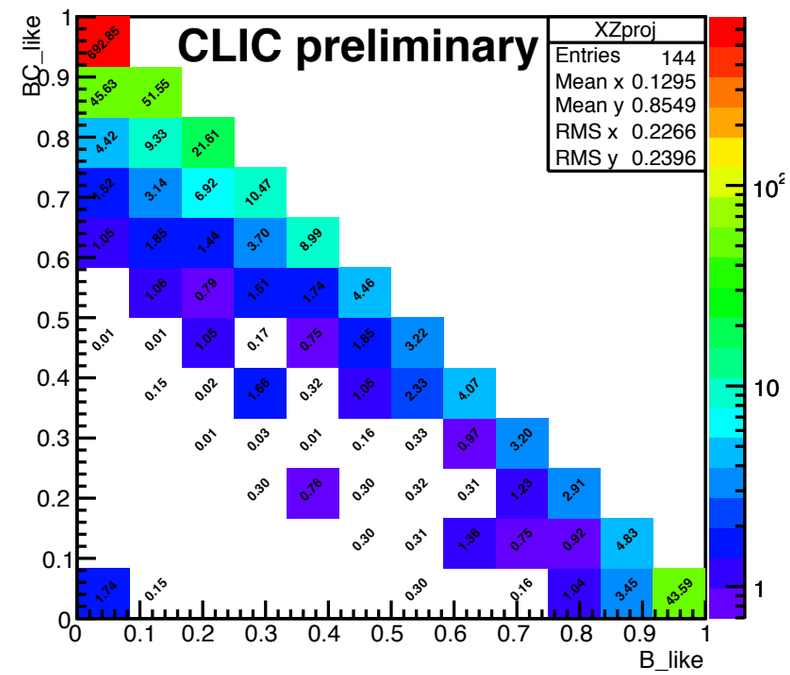
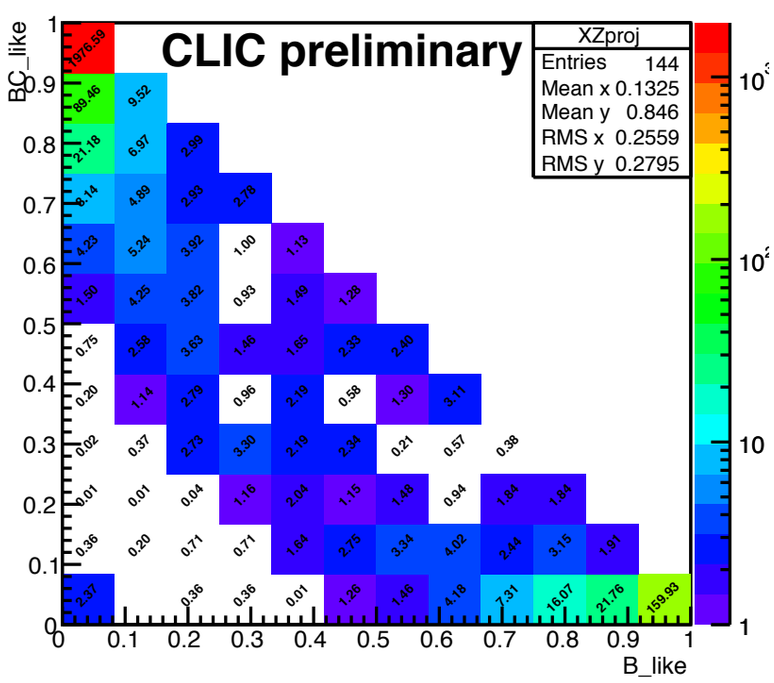


GG



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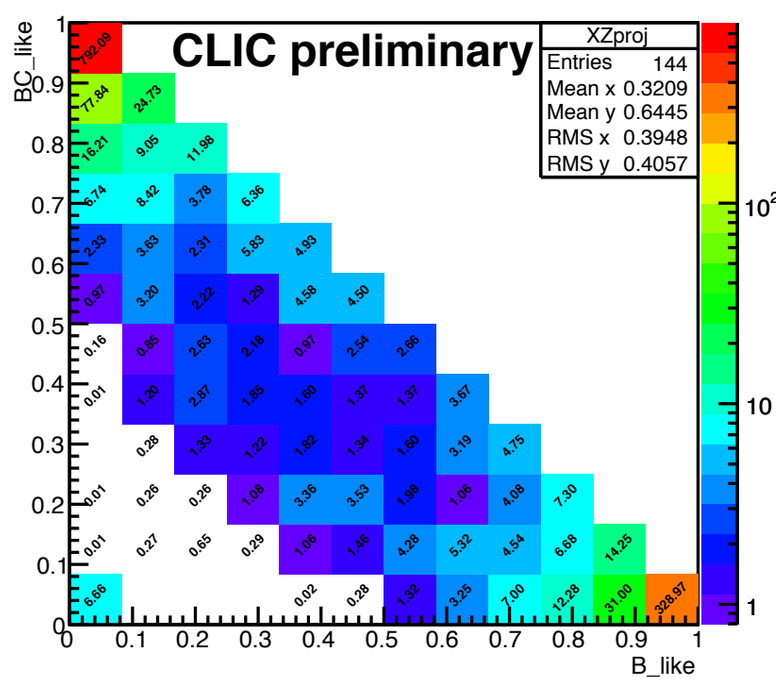

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