Branching Ratios for Higgs to Di-jet Sates and WW-fusion Fraction @ 250 GeV

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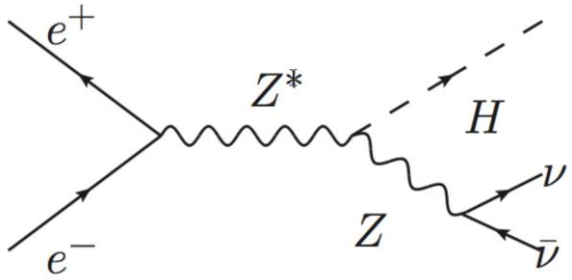
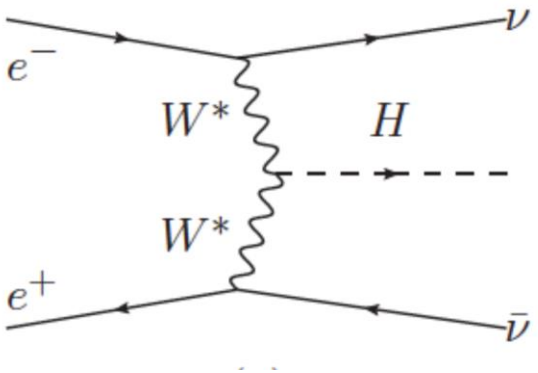
Analysis of e+e- --> ννH



- cross section
  - left-handed: 129 fb @ 250 GeV
  - right-handed: 65 fb
  - P(-80, 30): 77.5 fb
- Missing mass Z-mass (91 GeV)
- Visible mass Higgs-mass (125 GeV)
- Main Background: ZZ --> vvqq, WW --> qvqv, Z --> qq
- Accuracies of Higgs branching fraction
  - B(H -> bb), B(H -> gg), B(H -> cc)
  - fitting b/c-tag 2D-Historam
- Measurement of T-channel, S-channel and Interverence

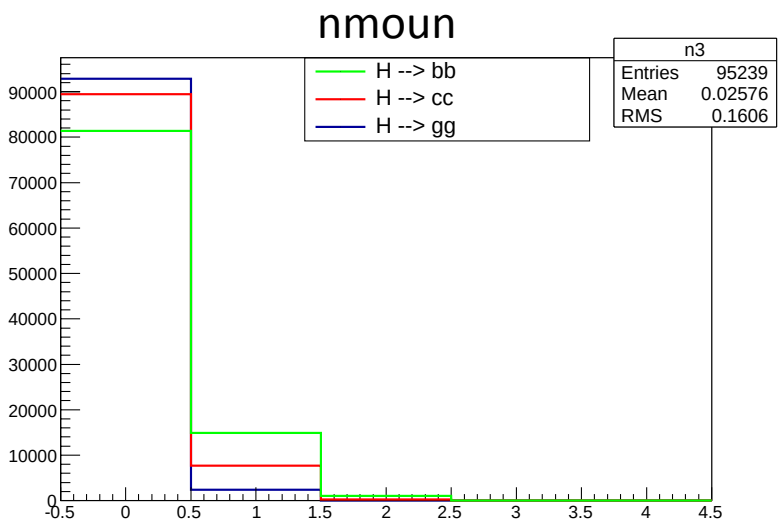


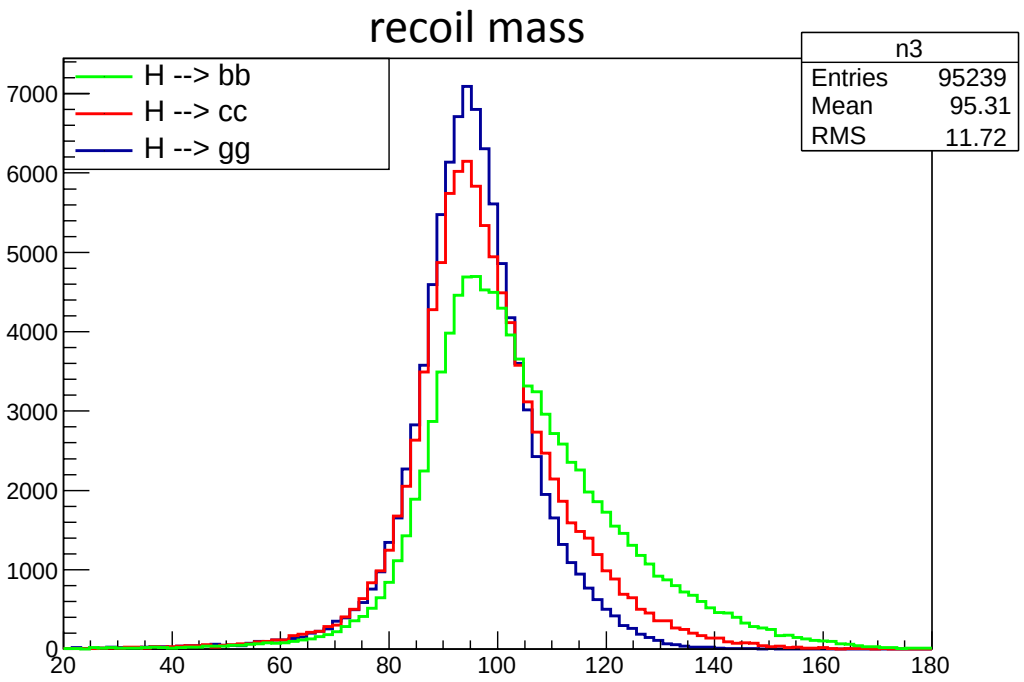
event selection

- finding cut range
- maximize significance program structure
  - while no change in siginificance
    - for cut in cut_list
      - looking for cut limit with highest siginificance
      - save cut limit

optimisation on each final state

- the final states are different in
  - detector resulution
  - number of events
  - nature of jets





optimisation on each final state

- the final states are different in
  - detector resulution
  - number of events
  - nature of jets
- maximize on $\frac{N(\nu\nu H \to \nu\nu xx)}{\sqrt{N(\nu\nu H \to \nu\nu xx) + N(not[\nu\nu H \to dijet])}}$

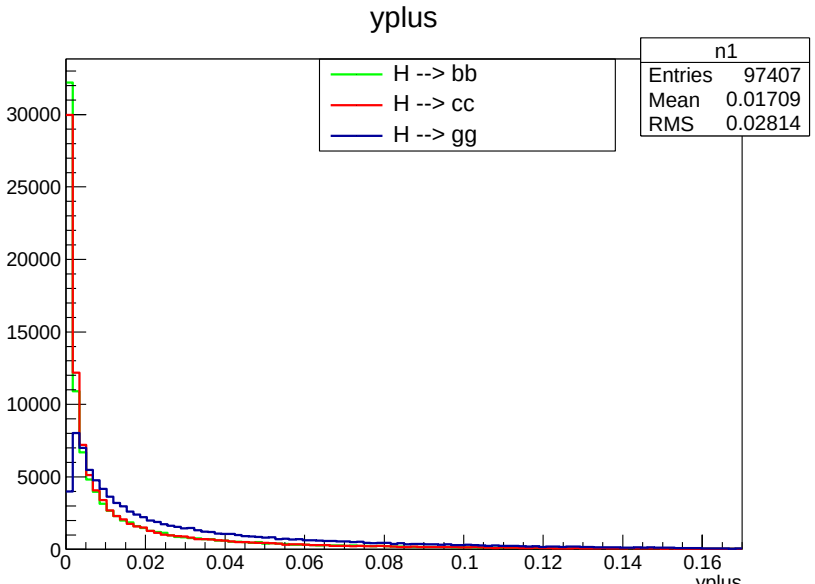
Significance after optimising

- with WW-fusion

optim on	bb	cc	gg	bb, cc, gg
Significance	50.6	38.3	32	50.7
Effi	0.347	0.137	0.111	0.367
Purity	0.551	0.803	0.689	0.523
Sig_bb	43.8	33.8	21.3	43.8
Sig_cc	1.95	1.81	0.655	1.97
Sig_gg	4.79	2.7	9.97	4.89

cut limits

- gloun-events
  - sharper cuts on z and higgs mass
  - no mouns
  - maximal PFO Momenten smaller
  - different event shape



optim on	bb	cc	gg	bb, cc, gg
npfos1>	20	14	30	20
npfos2>	11	9	23	11
maxPFOMomentum<	40.5	42.5	26.5	40.5
mass_z<	131.5	107.5	123.5	131.5
mass_z>	81.5	82	83	79.5
mass_higgs>	104.5	117	117.5	104.5
mass_higgs<	132	129	130	132
mom_t<	66.5	66.5	68	67.5
mom_t>	25.5	34	21	21.5
Abs(mom_z)<	55	49	57	55.5
majthrust<	0.5	0.48	0.56	0.5
pthrust>	0.8	0.83	0.64	0.77
minthrust<	0.35	0.3	0.47	0.35
minthrust>	0	0	0.09	0.03
nmuon<	4	3	1	4
y12>	0.29	0.285	0	0.29
y12<	0.955	0.885	0.96	0.91
yplus<	0.015	0.005	0.055	0.015
majthrust>	0.08	0.15	0	0.08

Fitting uncertainty

- with WW-fusion

optim on	bb	cc	gg	bb, cc, gg
BG in %	3.26	15.2	10.5	3.08
bb in %	1.78	2.62	3.45	1.8
cc in %	26.07	25.18	40.49	26.69
gg in %	12.99	37	9.08	14.41

- scaled to old cross section

optim on	bb	cc	gg	bb, cc, gg	
BG	3.34	16.29	9.63	3.18	Ono's study
bb	1.56	2.35	3.18	1.57	1.7
cc	21.3	20.42	39.85	26.25	11.2
gg	16.48	34.31	11.35	15.92	13.9

Fitting uncertainty

- with WW-fusion

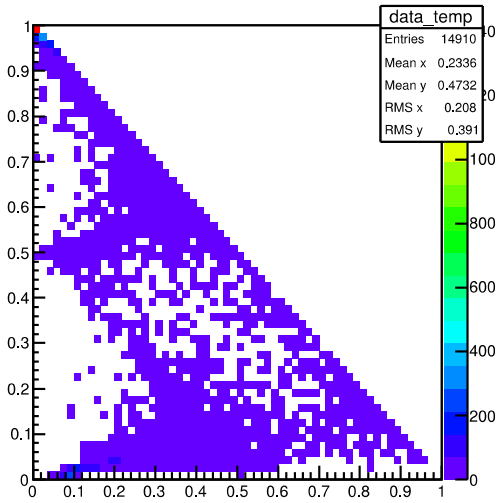
optim on	bb	cc	gg	bb, cc, gg
BG in %	3.26	15.2	10.5	3.08
bb in %	1.78	2.62	3.45	1.8
cc in %	26.07	25.18	40.49	26.69
gg in %	12.99	37	9.08	14.41

- TMVA with BDTG

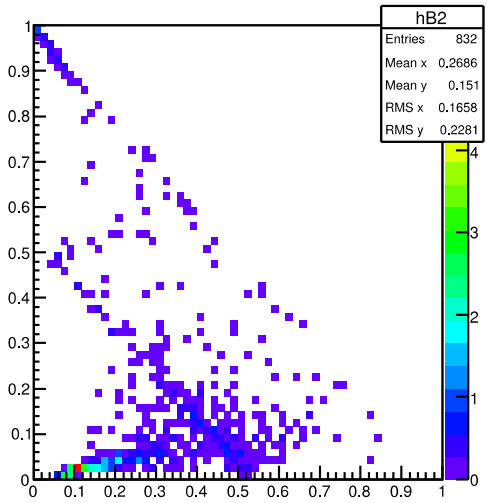
optim on	bb	cc	gg	bb, cc, gg
bb	1,75			1,73
cc		18.6		22.8
gg			6,3	(BDT) 9.7

Fitting templates

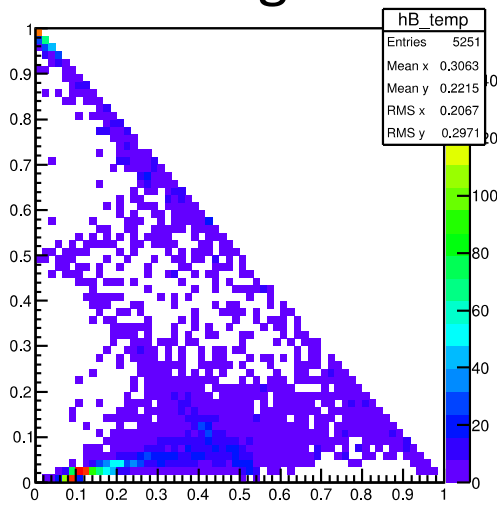
Data



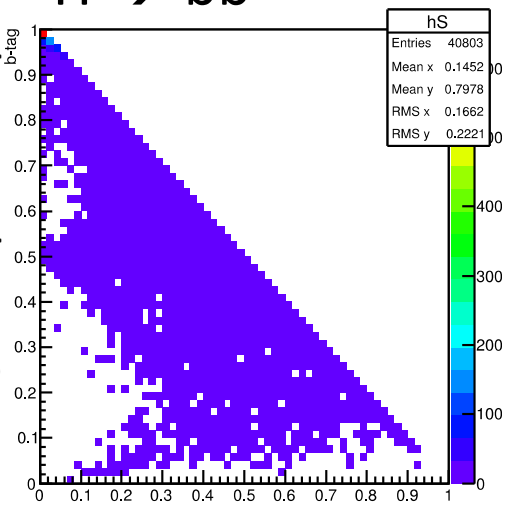
H → other



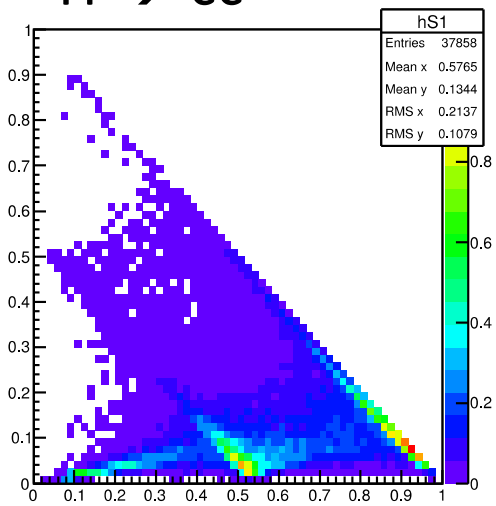
SM Background



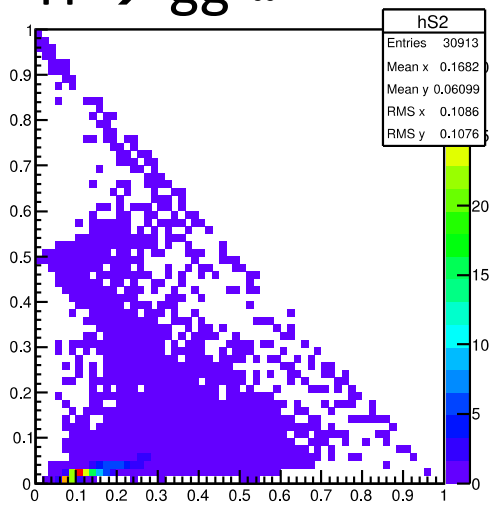
H → bb



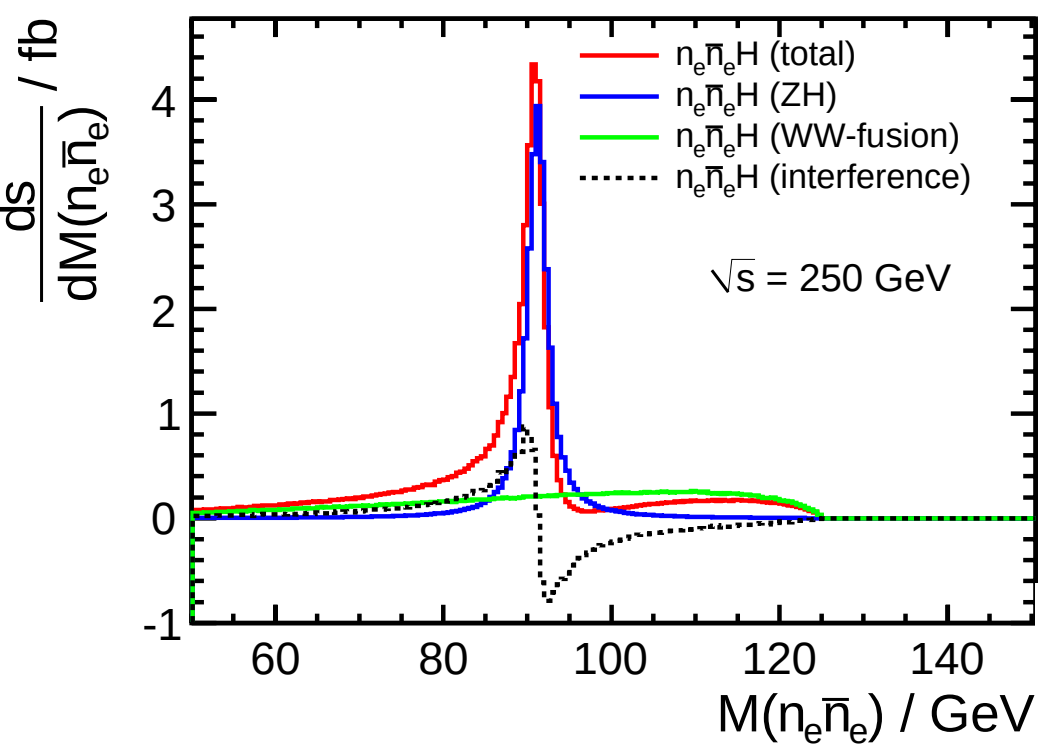
H → cc

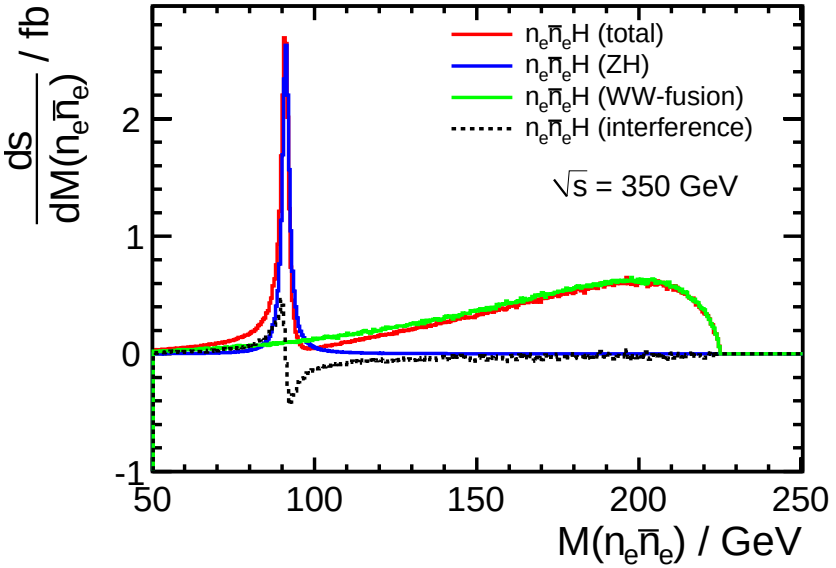


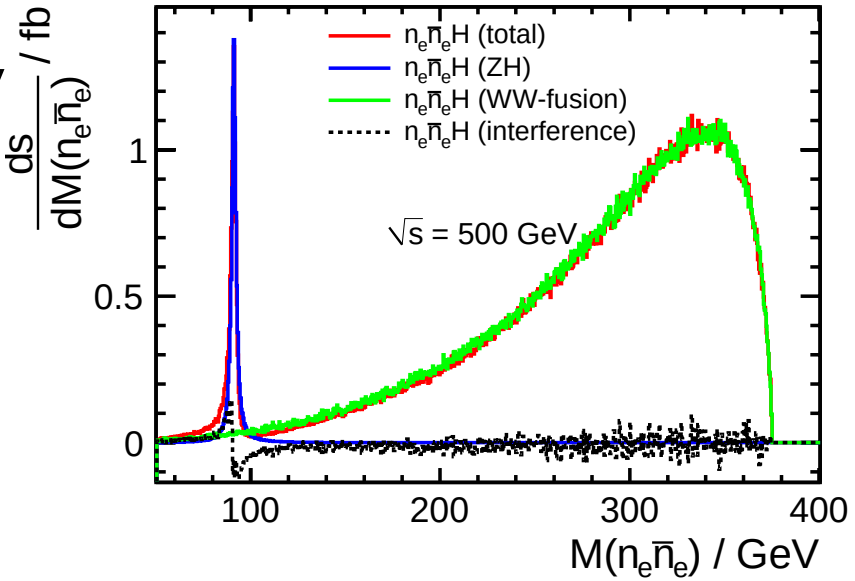
H → gg



Interverance depandent on CME





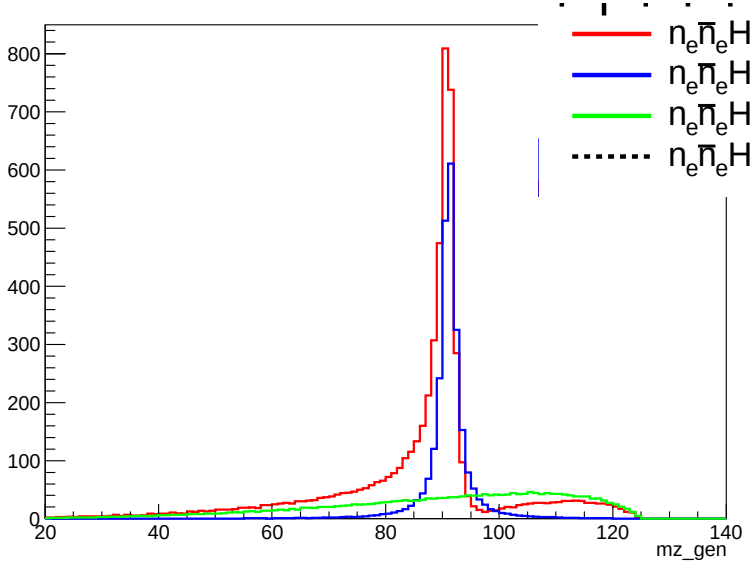


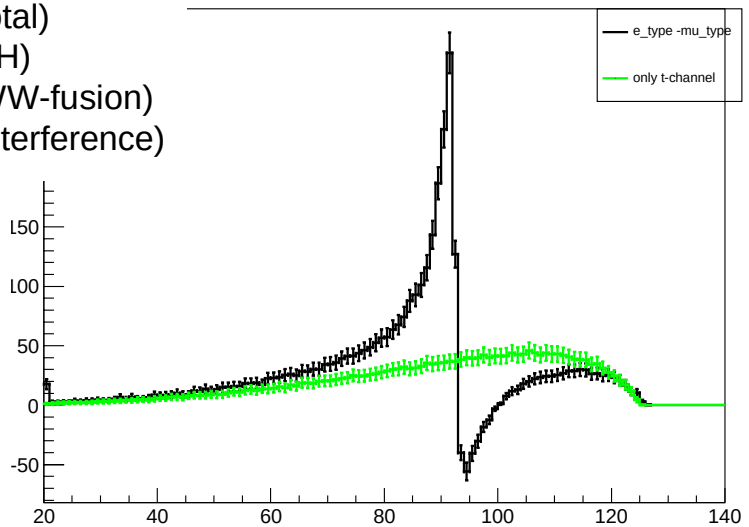
- @ 250 Interverence is important to study

plots by Junping

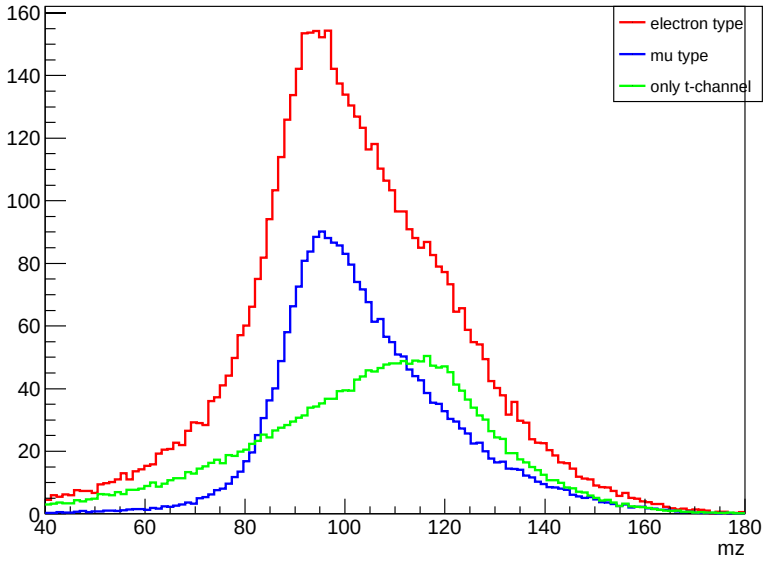
Interverance of ZH/WW in Z-mass

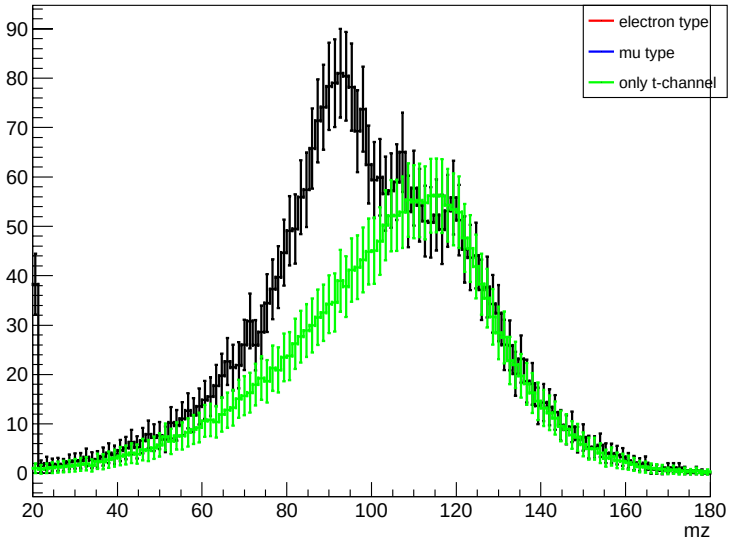
- gen. Z-mass



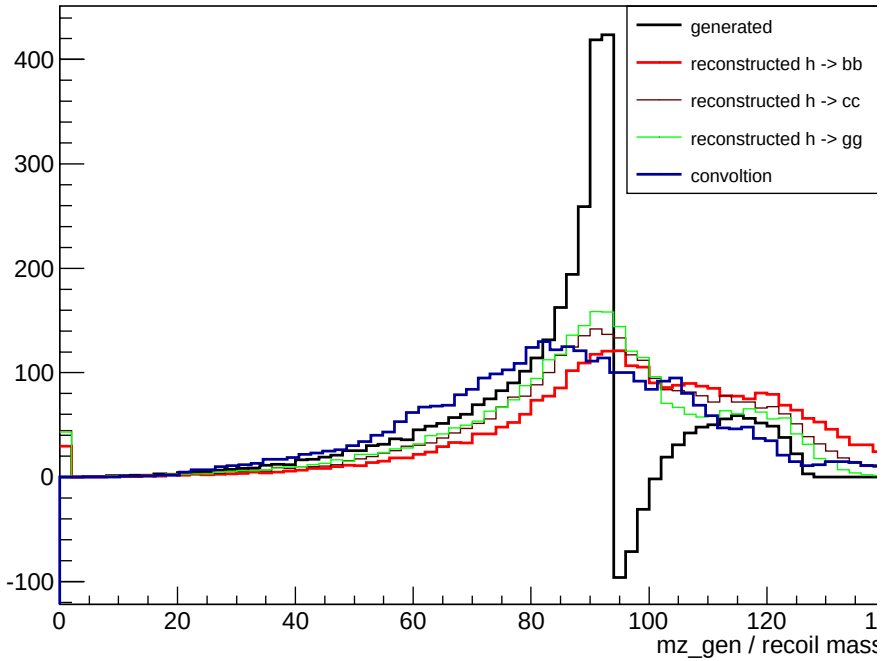


- Recon Z-mas

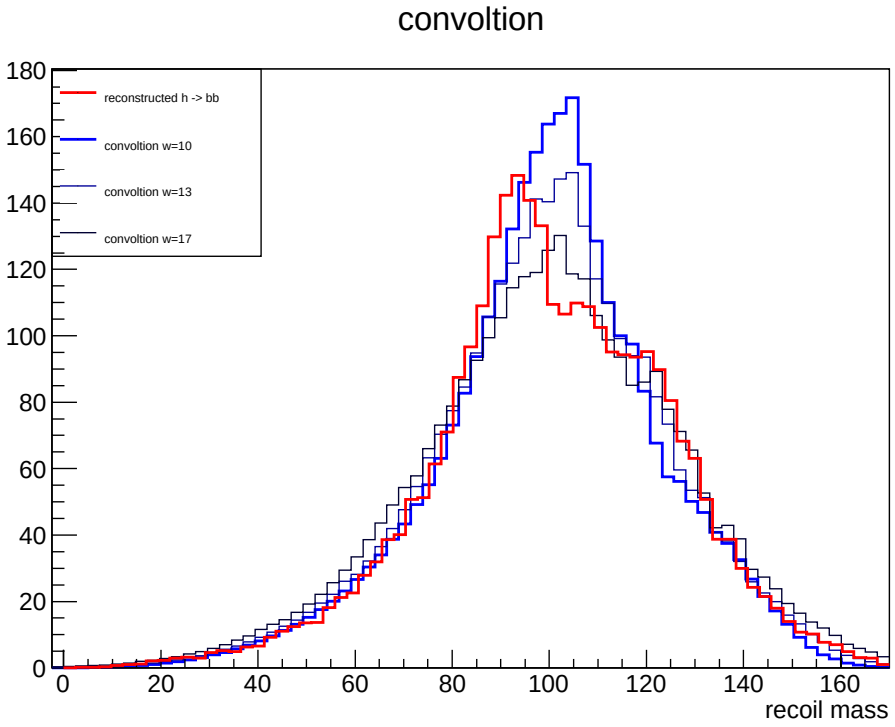




Detector resulution WW-fusion + interference

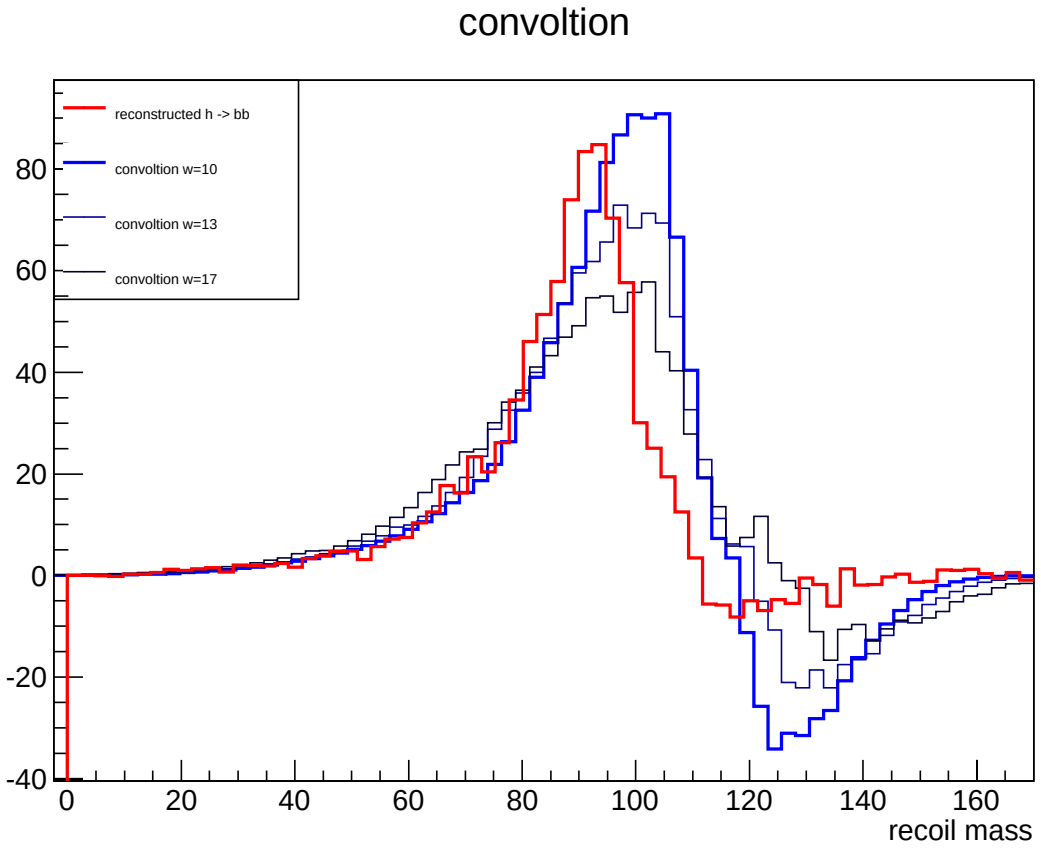


convolution is generated curve convoluted with gauss (width = 13 GeV)
- gg and cc have better resolution as bb curve because neutrinos in jet



convolution shifted by 15 GeV
- shape is not perfect but not bad ether

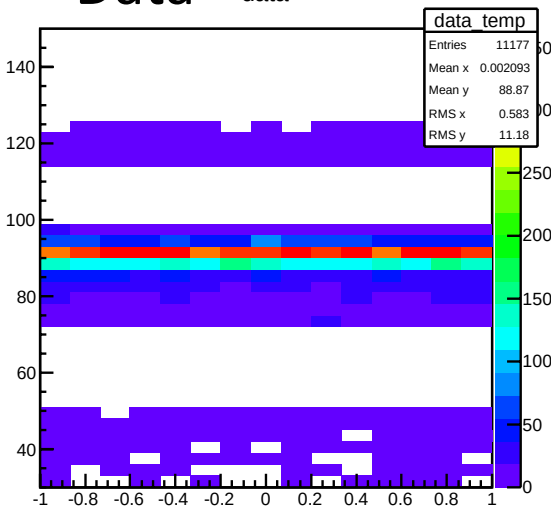
Detector resulution only interference



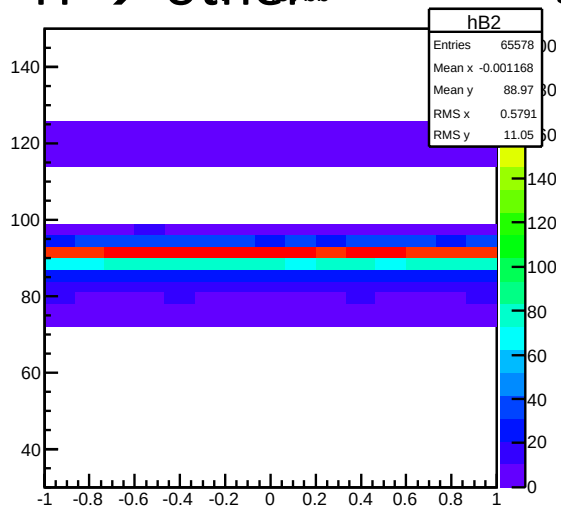
reconstructed interference looks to similar to Higgs-Strahlung

Fitting templates

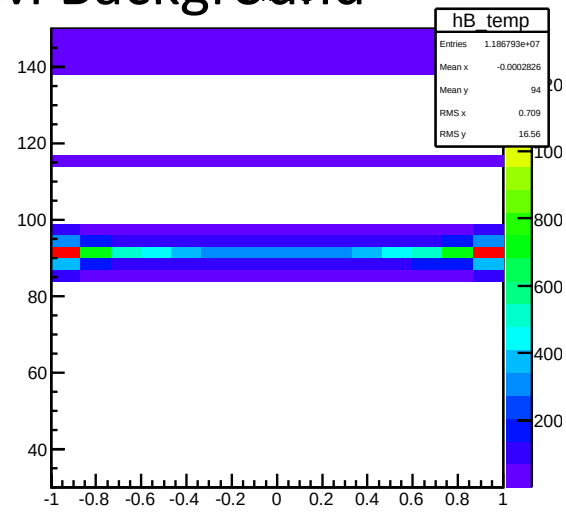
Data



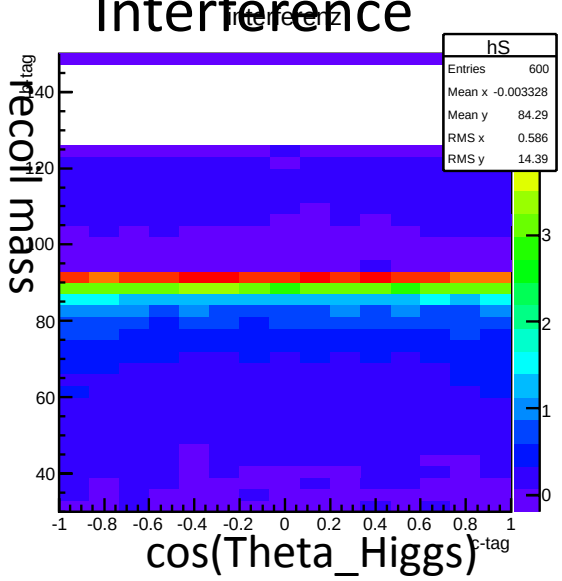
H → other



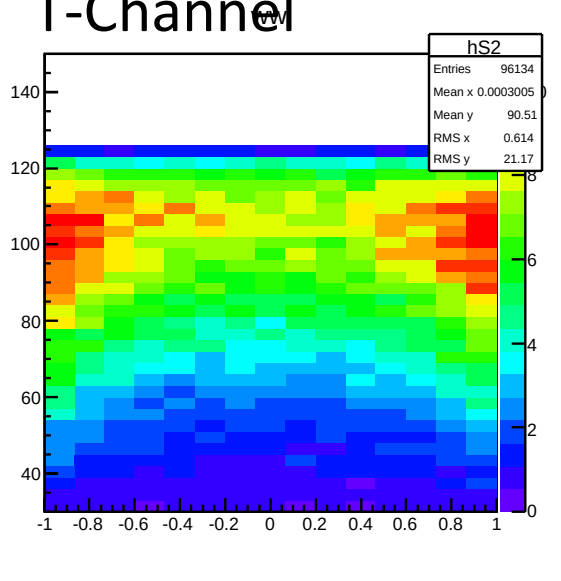
SM Background



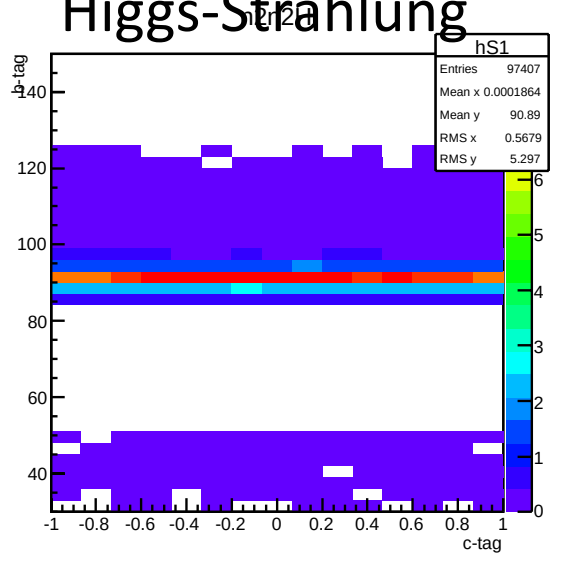
Interference



T-Channel



Higgs-Strahlung



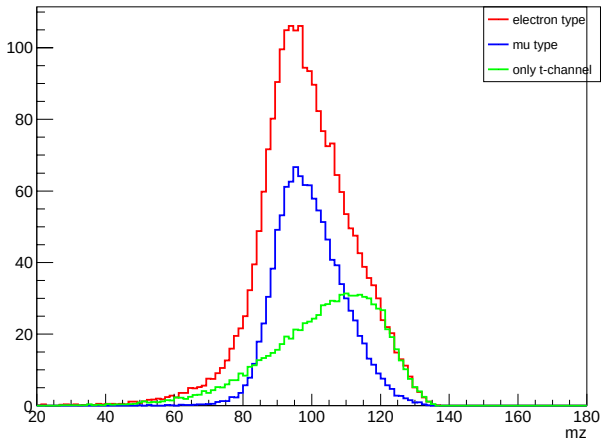
Plan

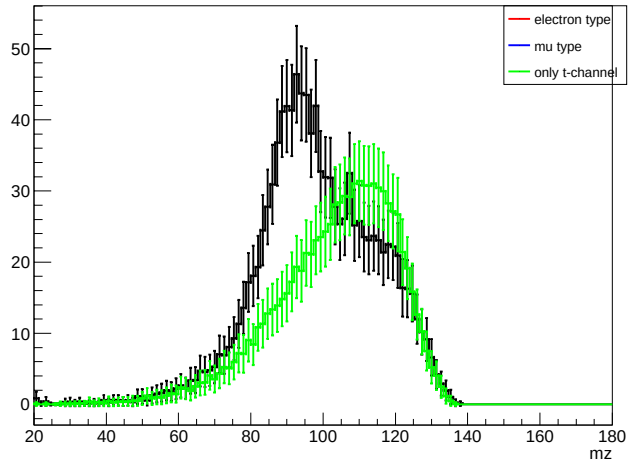
- Now writing bachelor thesis
- Look at overlay
  - Now overlay 0.2
    - What happens for overlay 0, 0.4
- other systematic errors
  - which and how?
- Deadline: 9th July
- Maybe figure something out for WW-Fusion

Backup

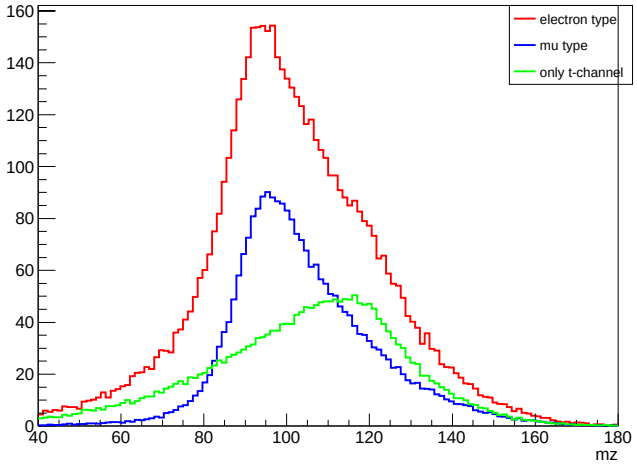
Interverance of ZH/WW in Z-mass

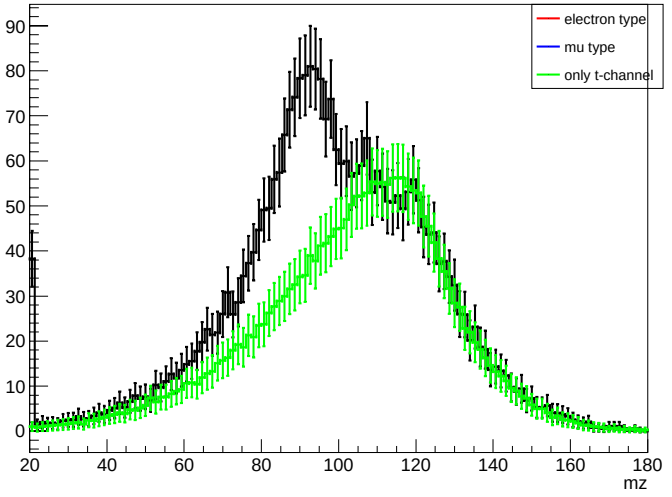
- Recon. Z-mass cut
  Sig ~ 43





- Recon. Z-mass





Fitting uncertainty

- with WW-fusion

optim on	bb	cc	gg	bb, cc, gg	bb with WW
BG	3.14	12.84	9.69	3.07	3.12
BG in %	3.14	12.84	9.69	3.07	3.12
bb in %	1.82	2.65	3.53	1.79	1.78
cc in %	26.43	25.14	210.32	19.35	30.44

- WW-fusion turned of

optim on	bb	cc	gg	bb, cc, gg	bb with WW
BG	3.26	15.12	10.38	3.27	3.13
bb	1.8	2.6	3.64	1.77	1.8
cc	20.03	30.81	143.4	19.95	21.81
gg	15.43	18.44	11.57	16.74	13.73

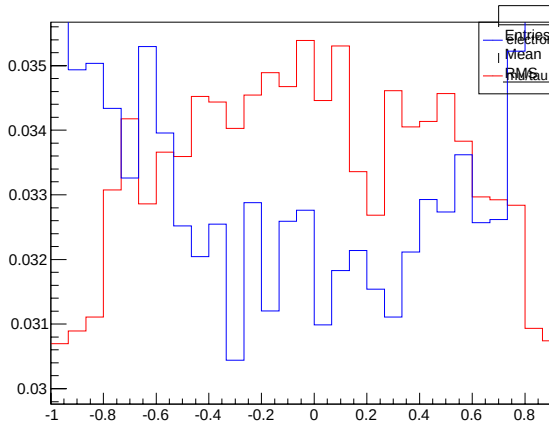
Fitting WW-fraction

electron neutrinos

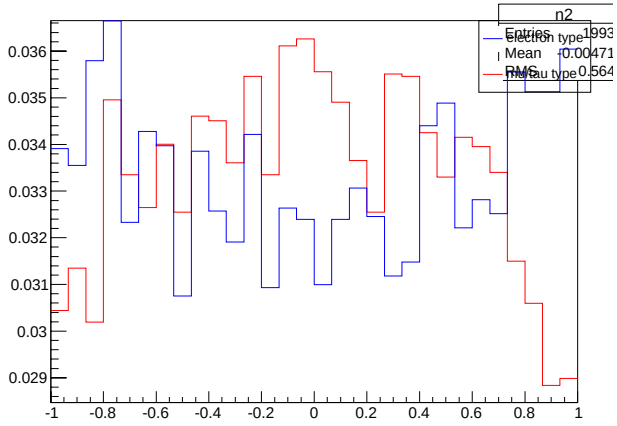
mu/tau neutrinos

- cosh

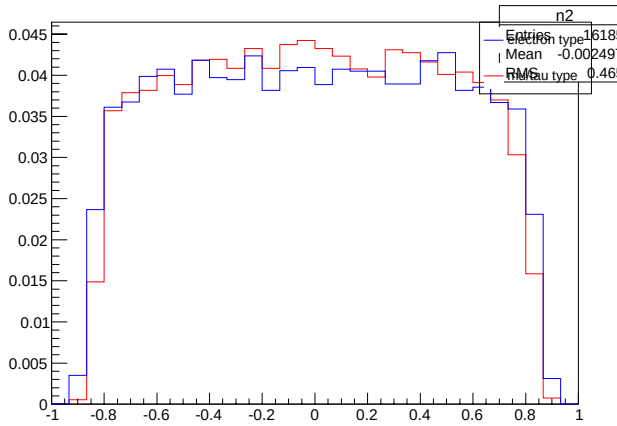
no cuts



no mpt cut

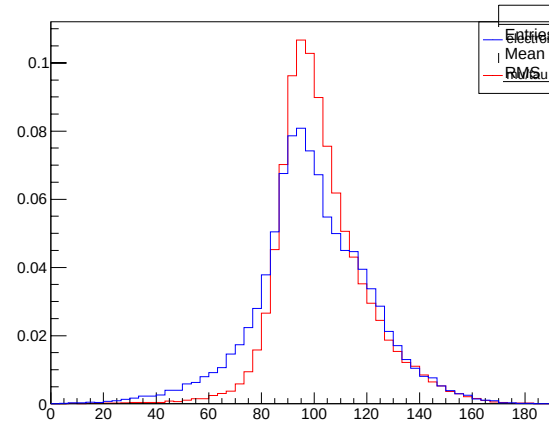


all cuts

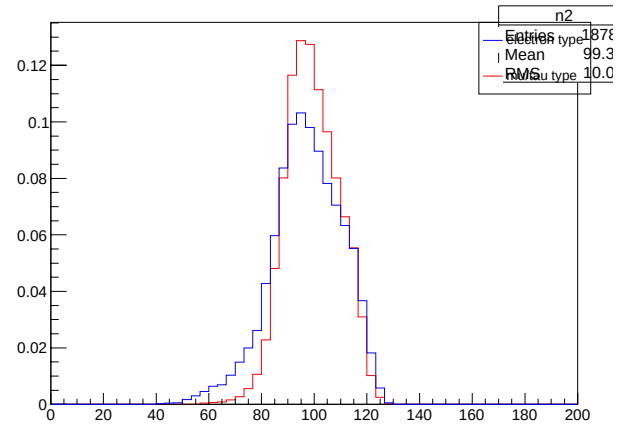


- Z-mass

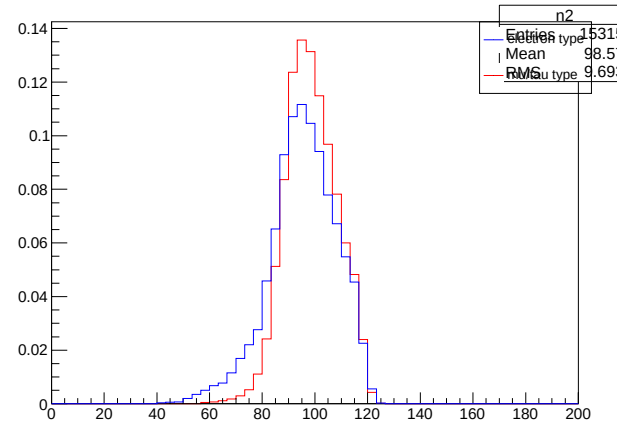
no cuts

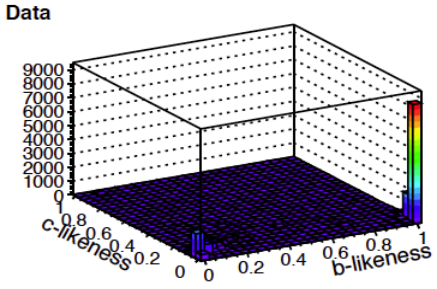


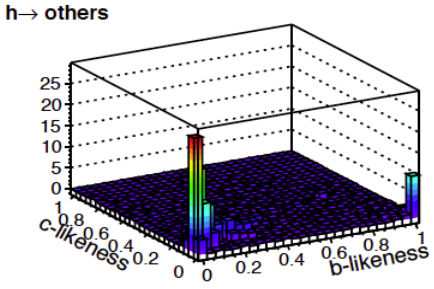
no mpt cut

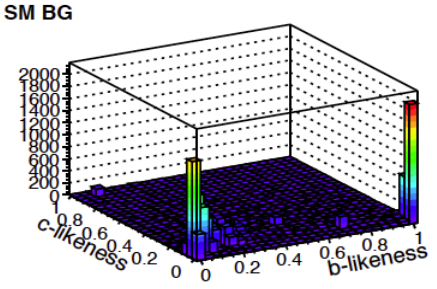


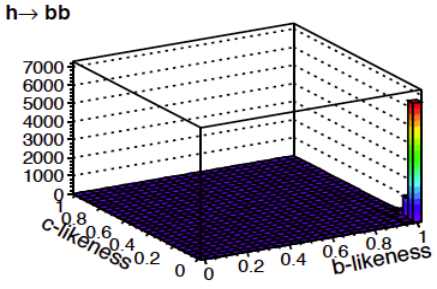
all cuts

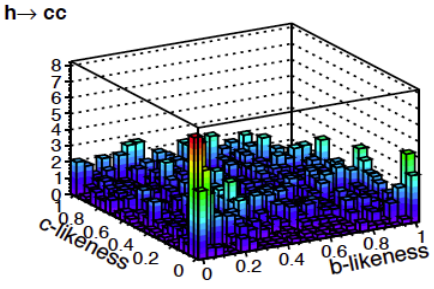


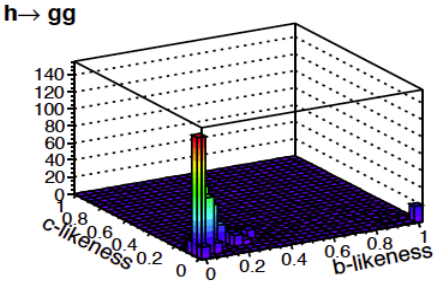

Data
c-likeness
b-likeness

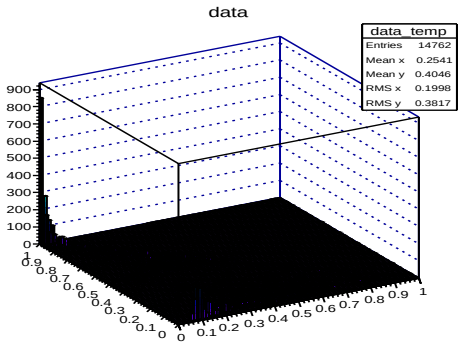

h→ others
c-likeness
b-likeness

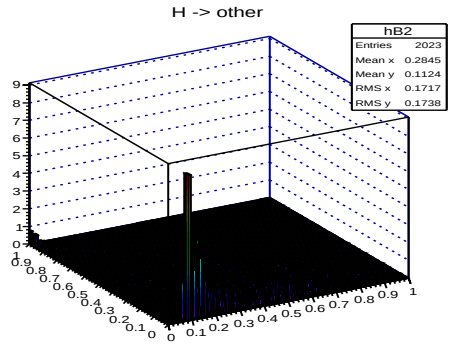

SM BG
c-likeness
b-likeness

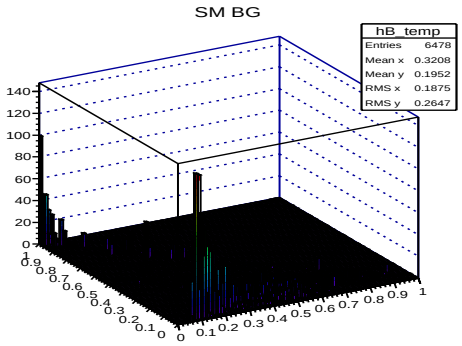

h→ bb
c-likeness
b-likeness

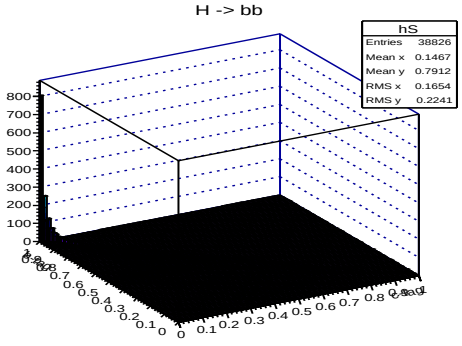

h→ cc
c-likeness
b-likeness

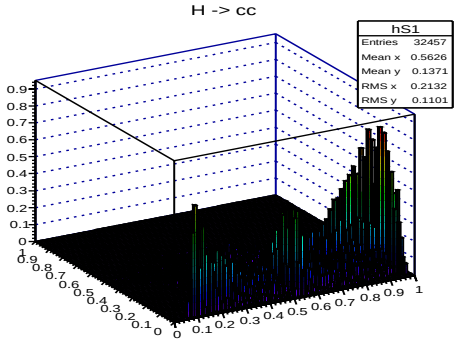

h→ gg
c-likeness
b-likeness

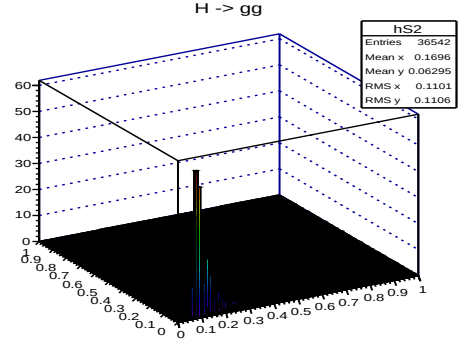

data
data_temp
Entries 14762
Mean x 0.2541
Mean y 0.4046
RMS x 0.1998
RMS y 0.3817


H -> other
hB2
Entries 2023
Mean x 0.2845
Mean y 0.1124
RMS x 0.1717
RMS y 0.1738


SM BG
hB_temp
Entries 6478
Mean x 0.3208
Mean y 0.1952
RMS x 0.1875
RMS y 0.2647


H -> bb
hS
Entries 38826
Mean x 0.1467
Mean y 0.7912
RMS x 0.1654
RMS y 0.2241


H -> cc
hS1
Entries 32457
Mean x 0.5626
Mean y 0.1371
RMS x 0.2132
RMS y 0.1101

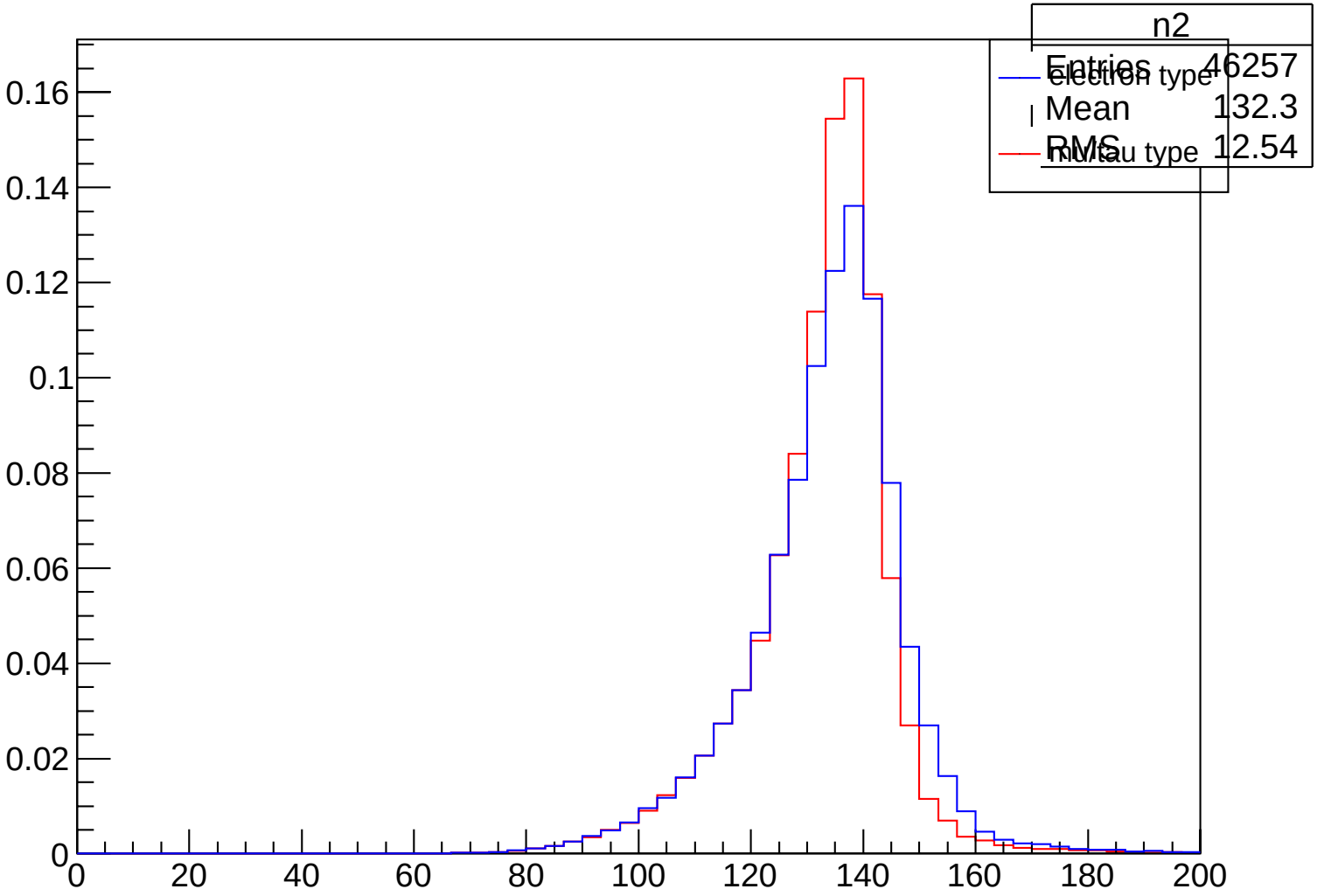

H -> gg
hS2
Entries 36542
Mean x 0.1696
Mean y 0.06295
RMS x 0.1101
RMS y 0.1106

Compare to Ono/Miyamoto's paper

CM energy (GeV)	250		
Cut names	condition	Sig.	Bkg.
Generated		19360	44827100
Missing mass (GeV)	$80 < M_{miss} < 140$	15466	6214050
Transverse P (GeV)	$20 < P_T < 70$	13727	549340
Longitudinal P (GeV)	$\|P_L\| < 60$	13342	392401
# of charged tracks	$N_{chd} > 10$	12936	374877
Maximum P (GeV)	$P_{max} < 30$	11743	205038
Y_{23} value	$Y_{23} < 0.02$	7775	74439
Y_{12} value	$0.2 < Y_{12} < 0.8$	7438	62584
Di-jet mass (GeV)	$100 < M_{jj} < 130$	6691	19061
Likelihood ratio	$LR > 0.165$	6293	10940
Significance (Efficiency)	$S/\sqrt{S+B}$	47.9 (32.5%)	

	vvH	BG
Expected	19383	5.11E+08
isoLepCuts	17644	3.62E+08
npfo	14677	1.92E+07
E_vis	13338	6.55E+06
Z-Mass	12013	1.54E+06
Higgs-mass	10977	321243
missMo_t	9807	54591
missMo_z	9451	38490
majthrust	8369	24327
pthrust	7598	20220
minthrust	7590	20171
maxPFOMom	7450	18586
y-Cuts	4994	4407
	51,5	(25,7 %)

evis


n2
Entries 46257
Mean 132.3
RMS 12.54
electron type
mu/tau type
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
20
40
60
80
100
120
140
160
180
200

optimizing cuts for each mode

	bb	cc	gg	bb, cc, gg	bb with WW	WW-Reconst
npfos1>	14	12	27	12	12	6
npfos2>	12	9	24	12	13	20
evis<	147	144.5	145	146.5	147	144
evis>	0	0	127	0	0	115
maxPFOMomentum<	37.5	42.5	39	38	36	59.5
mz<	131.5	107.5	113.5	131.5	131.5	0.99
mz>	82	84	83	82	79.5	0.96
mh>	104.5	117	117.5	104.5	106	117
mh<	132	129	130	132	132	129.5
mpt<	66	66.5	66	66	67.5	
mpt>	25.5	34	27	25.5	25.5	
TMath::Abs(mpz)<	53.5	49	55.5	53.5	53	
TMath::Abs(cosh)<	1	1	1	1	1	
majthrust<	0.49	0.48	0.56	0.49	0.5	0.49
pthrust>	0.8	0.83	0.63	0.8	0.8	0.76
pthrust<	0.99	0.98	0.98	0.995	0.99	0.955
minthrust<	0.3	0.3	0.47	0.3	0.35	0.33
minthrust>	0	0	0.07	0	0.03	0.03
nmuon<	4	3	1	4	4	2
y12>	0.29	0.295	0	0.29	0.29	0.28
y12<	0.925	0.885	0.86	0.925	0.935	0.91
yplus<	0.015	0.005	0.05	0.015	0.015	0.03
majthrust>	0.08	0.15	0	0.08	0.08	0.15

- h –> bb only (direct cut on b-tag)

	Claude Düring	my Analysis
Significans	51.6	68.2
Efficency	31.2 %	62.7 %
Purity	87.7 %	65.2 %

- H -> bb, cc, gg

	Ono/Miyamoto	my Analysis
Significans	47.9	51.8
Efficency	32.5	24,4 %
Purity	36.5	56,7 %

Fitting uncertainty

- with WW-fusion

optim on	bb	cc	gg	bb, cc, gg	bb with WW
BG in %	3.14	12.84	9.69	3.07	3.12
bb in %	1.82	2.65	3.53	1.79	1.78
cc in %	26.43	25.14	210.32	19.35	30.44
gg in %	17.91	37.08	11.77	19.67	18.7
Significance	50.2	37.9	34.9	50.2	50.4
Efficiency	0.347	0.134	0.116	0.348	0.339
Purity	0.543	0.802	0.784	0.54	0.561
Sig_b	45.3	35.1	27.9	45.2	45.4
Sig_c	2.92	3.68	1.58	2.92	2.87
Sig_g	6.42	5.25	14.8	6.38	6.83

Cut table (cuts taken at last)

0	vvh(Sig)	vvh(other)	znunu_sl	sw_sl	zz_sl	ww_sl	szee_sl	z_h	ww_h	zz_h	zzw_h	leptonic	higgs	aa_bg	Signifi	Purity	Eff
allcuts	4660	67.9	490	80.5	736	1810	0	443	0	0	0	0.206	39.4	364	50	0.536	0.348
npfo	4880	84.9	591	110	896	2340	0	530	0	0	0	688	44.1	458	47.3	0.459	0.365
E_vis	4660	67.9	490	80.5	736	1810	0	443	0	0	0	0.206	39.4	364	50	0.536	0.348
Z-Mass	4770	69.4	518	90	757	2090	0	476	0	0	0	0.206	40.5	397	49.7	0.518	0.357
Higgs-mass	4970	77.8	1300	125	1390	2770	0	897	0	0	0	3.68	57.9	996	44.3	0.395	0.372
missMo_t	5190	75	618	96.2	1010	2500	1.2	11000	2.02	1.89	1.69	42	46.2	105000	14.6	0.0412	0.388
missMo_z	4810	70.3	547	87.4	858	2180	0	573	0	0	0	0.206	40.3	388	49.2	0.503	0.36
cosTHiggs	4660	67.9	490	80.5	736	1810	0	443	0	0	0	0.206	39.4	364	50	0.536	0.348
nmoun	4660	67.9	490	80.5	736	1810	0	443	0	0	0	0.206	39.4	364	50	0.536	0.348
majthrust	4720	70	543	86.5	811	1890	0	476	0	0	0	0.206	44.7	385	49.7	0.523	0.353
pthrust	4690	75.8	503	82.1	753	1840	0	443	0	0	0	0.206	41.1	371	50	0.533	0.35
maxPFOMom	4810	71	542	96.7	832	2200	0	476	0	0	0	12.1	41.5	410	49.4	0.507	0.36
minthrust	4660	67.9	490	80.5	736	1810	0	443	0	0	0	0.206	39.4	364	50	0.536	0.348
y-Cuts	6070	357	912	336	1390	8840	0	601	0	0	0	4.39	99.9	880	43.5	0.311	0.454

Comparing fitting result

	$X = x_1 + x_2$			$X = x_1 * x_2 / (x_1 * x_2 + (1- x_1)(1- x_2)$		
	Reconst. N	abso. Error	rel. Error	Reconst. N	abso. Error	rel. Error
numBack	6290.00	103.00	2 %	6523.30	141.00	2 %
bb	4080.70	70.20	2 %	4089.20	74.30	2 %
cc	162.38	24.10	15 %	193.78	50.70	26 %
gg	582.03	58.20	10 %	410.78	77.10	19 %

TABLE IV: Summary of template fitting results r_s and accuracies of $(\sigma \cdot Br)$ and Br after correcting σ for an accuracy of 2.5% at $\sqrt{s} = 250$ GeV assuming $\mathcal{L} = 250$ fb^{-1} with $(e^-, e^+) = (-0.8, +0.3)$.

	$\nu\bar{\nu}H$	$q\bar{q}H$	e^+e^-H	$\mu^+\mu^-H$	comb.
$r_{b\bar{b}}$	1.00±0.02	1.00±0.01	1.00±0.04	1.00±0.03	1.00±0.01
$r_{c\bar{c}}$	1.02±0.11	1.01±0.10	1.02±0.27	1.01±0.23	1.02±0.07
r_{gg}	1.02±0.14	1.02±0.13	1.05±0.33	1.02±0.24	1.02±0.09
$\frac{\Delta(\sigma\cdot Br)}{\sigma\cdot Br}(H \to b\bar{b})$ (%)	1.7	1.5	3.8	3.3	1.0
$\frac{\Delta(\sigma\cdot Br)}{\sigma\cdot Br}(H \to c\bar{c})$ (%)	11.2	10.2	26.8	22.6	6.9
$\frac{\Delta(\sigma\cdot Br)}{\sigma\cdot Br}(H \to gg)$ (%)	13.9	13.1	31.3	33.0	8.5
$\frac{\Delta Br}{Br}(H \to b\bar{b})$ (%)	3.0	2.9	5.7	4.5	2.7
$\frac{\Delta Br}{Br}(H \to c\bar{c})$ (%)	11.4	10.5	31.3	22.8	7.3
$\frac{\Delta Br}{Br}(H \to gg)$ (%)	14.2	13.3	33.1	24.0	8.9

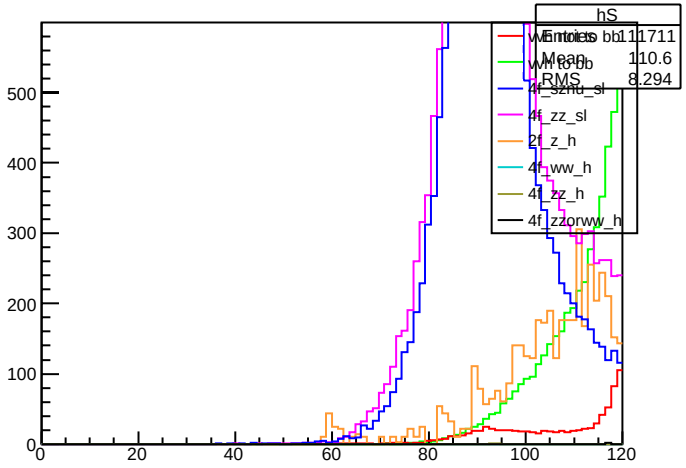
Compare to Claude Düring's study

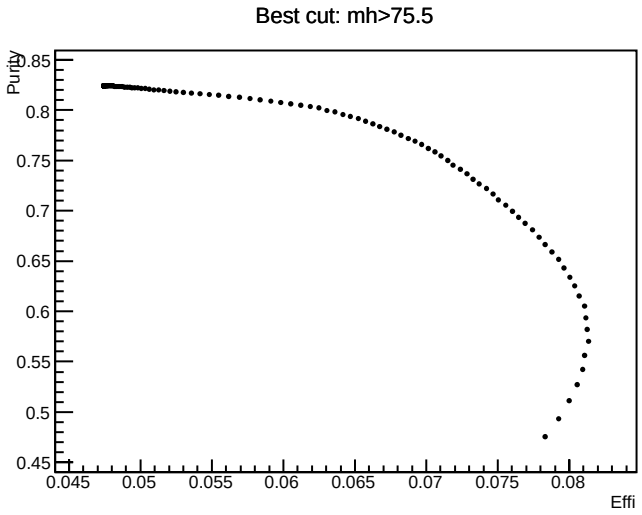
Process	expected	pre-selection	Cut1	Cut2	Cut3	Cut4	Cut5	Cut6	Cut7	Cut8
$\nu\bar{\nu}H(\text{fusion})$	3426	2663	2070	2023	1577	1053	965	547	519	507
$\nu\bar{\nu}H(ZH)$	1.4×10^4	10918	8356	8356	7448	4860	4594	2574	2546	2546
$\nu_l\bar{\nu}_l b\bar{b}$	3.05×10^4	23012	1040	1040	878	421	390	224	193	187
$\nu_l\bar{\nu}_l q\bar{q}$	1.19×10^5	88998	5548	5545	4714	2408	2271	15	9	9
$q\bar{q}l^+l^-$	2.99×10^5	153540	6196	5922	1760	588	508	65	38	36
$q\bar{q}l\nu$	1.73×10^6	1.15×10^6	181973	177193	134047	22654	20533	111	73	65
$q\bar{q}q\bar{q}$	3.91×10^6	1.15×10^6	782	728	3	1	0	0	0	0
$q\bar{q}$	26.02×10^6	17.27×10^6	852321	794892	1507	1199	683	289	152	152
BG	32.104×10^6	19.846×10^6	1.047×10^6	985320	142909	27271	24385	1404	465	449

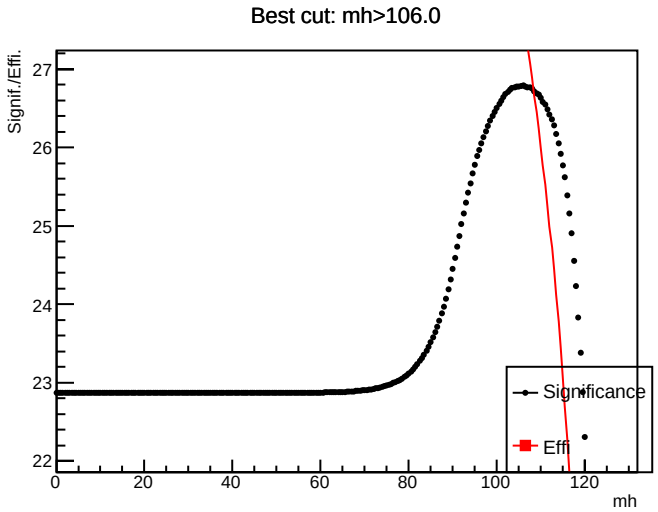
	Expected	isoLepCuts	npfo	E_vis	Z-Mass	Higgs-mass	missMo_t	missMo_z	cosTHiggs	B-Tag	all cuts
vvH(fusion)	3960	3610	3280	2890	2570	2410	1970	1830	1830	1240	1170
vvH(ZH)	1.54E+04	1.54E+04	1.54E+04	1.54E+04	1.54E+04	1.54E+04	9970	9890	9880	6530	6250
vvbb	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	2630	2160	2150	2020	1570
vvqq	1.26E+05	1.26E+05	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	9420	9420	104	54.8
qqll	2.18E+05	2.18E+05	2.18E+05	18700	7630	3900	1380	1140	1140	394	251
qqlv	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	4.22E+06	1190	677
qqqq	4.20E+06	4.20E+06	4.20E+06	486	331	217	5.6	5.6	5.6	0.717	0.132
qq	1.95E+07	1.95E+07	1.95E+07	1.95E+07	1.95E+07	1.95E+07	3550	2470	2450	1710	1510

- qqll before zz_sl + zee_sl (now only to l+l-)
- qqlv before only sw_sl (now + ww_sl)

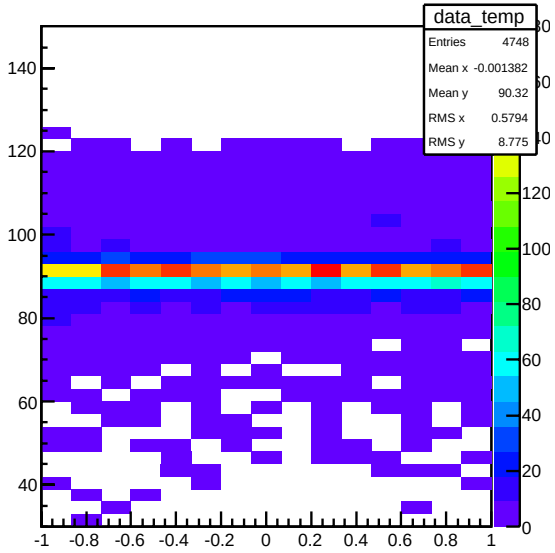
How I decided on cuts



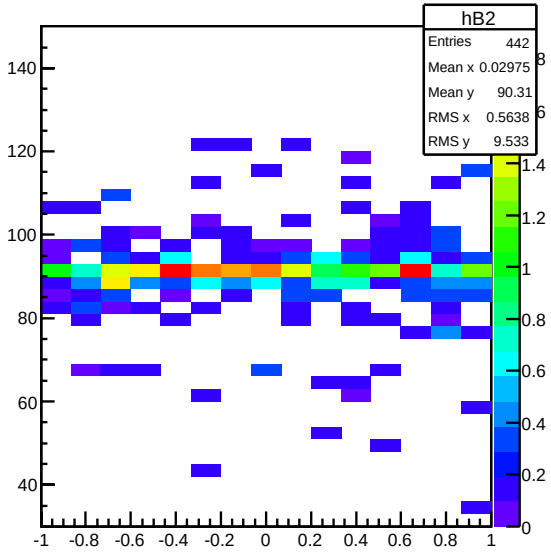




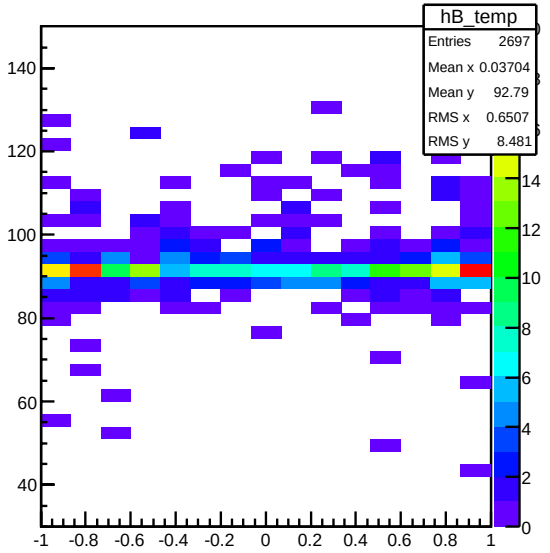
data



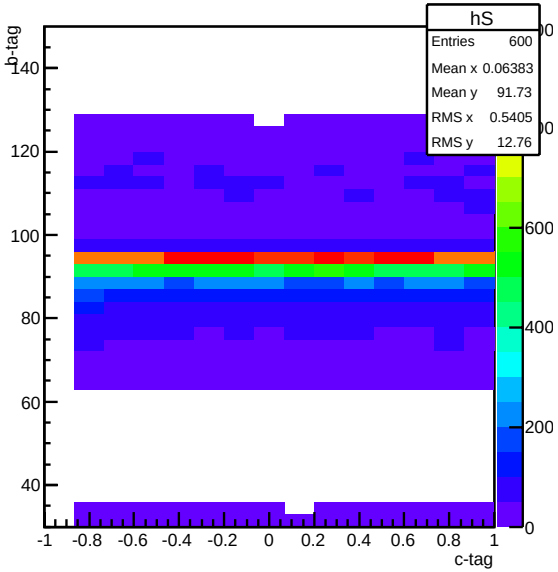
H -> not bb



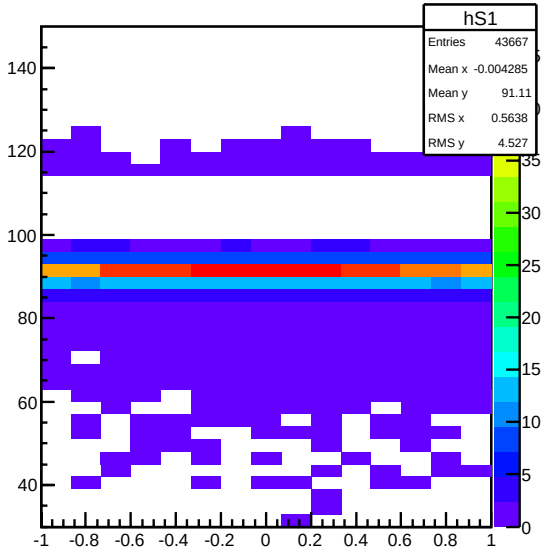
SM BG



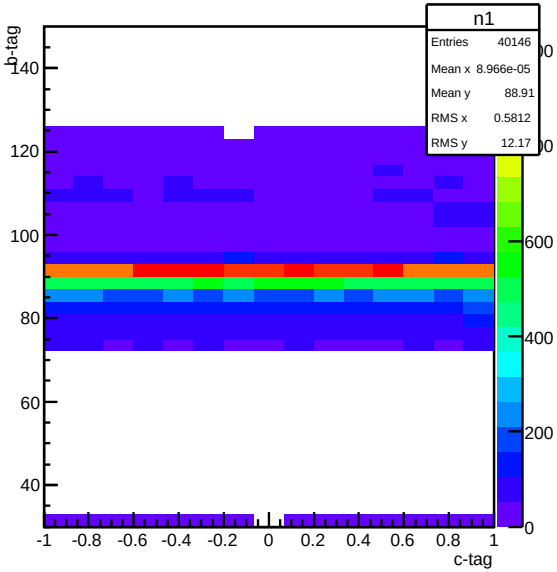
WW +interferenz



n2n2H



n1n1H



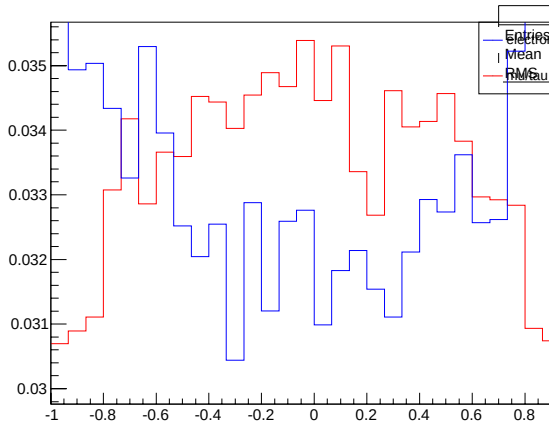
Fitting WW-fraction

electron neutrinos

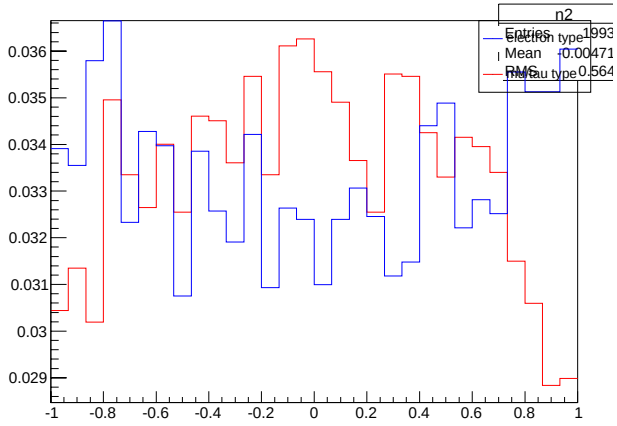
mu/tau neutrinos

- cosh

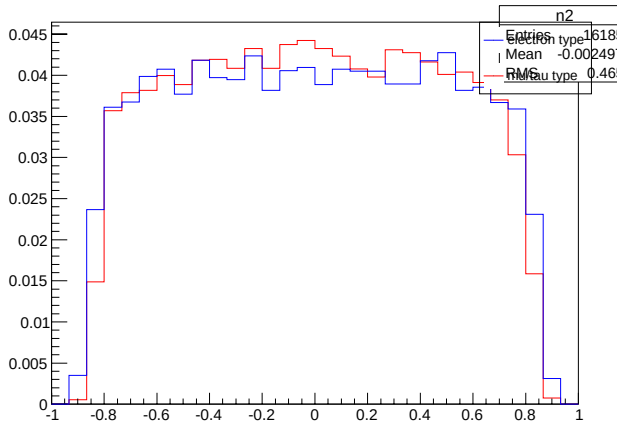
no cuts



no mpt cut

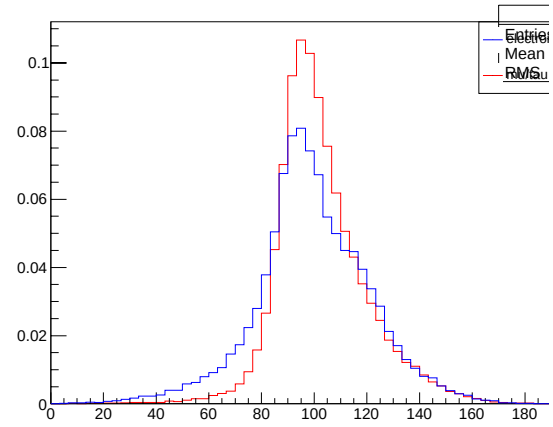


all cuts

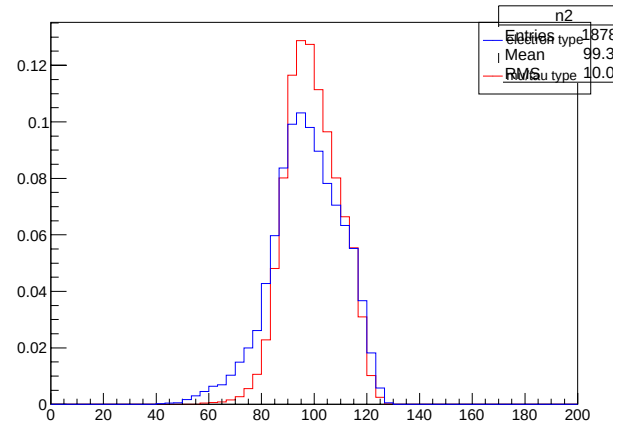


- Z-mass

no cuts



no mpt cut



all cuts