

Status report

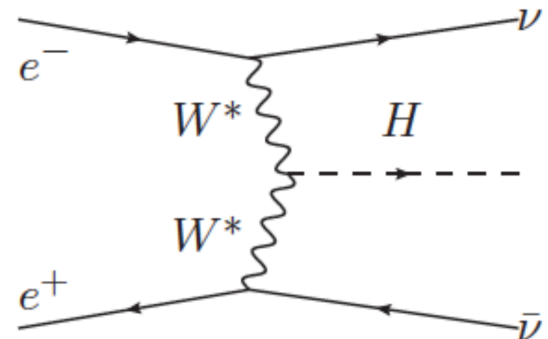
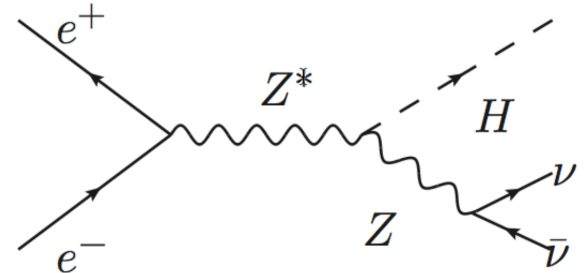
Asian Physics and Software Meeting

by Christian Drews

2014.06.06

Analysis of $e^+e^- \rightarrow \nu\nu H$

- cross section
 - left-handed: 129 fb @ 250 GeV
 - right-handed: 65 fb
- Missing mass $m_Z \sim 91 \text{ GeV}/c^2$
- Visible mass $m_H \sim 125 \text{ GeV}/c^2$
- Main Background: $ZZ \rightarrow \nu\nu qq$, $WW \rightarrow qq\nu\nu$
- Accuracies of Higgs branching fraction
 - $B(H \rightarrow bb)$, $B(H \rightarrow gg)$, $B(H \rightarrow cc)$
 - fitting b/c-tag 2D-Histogram
- Accuracy of WW-fusion-fraction



Fitting uncertainty

- with WW-fusion

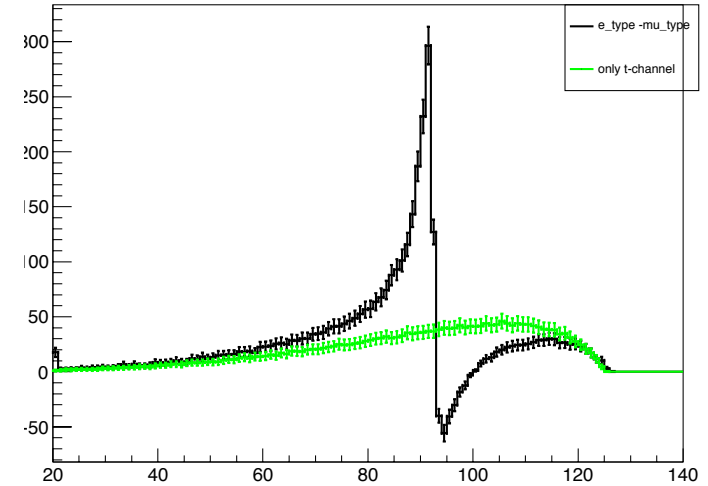
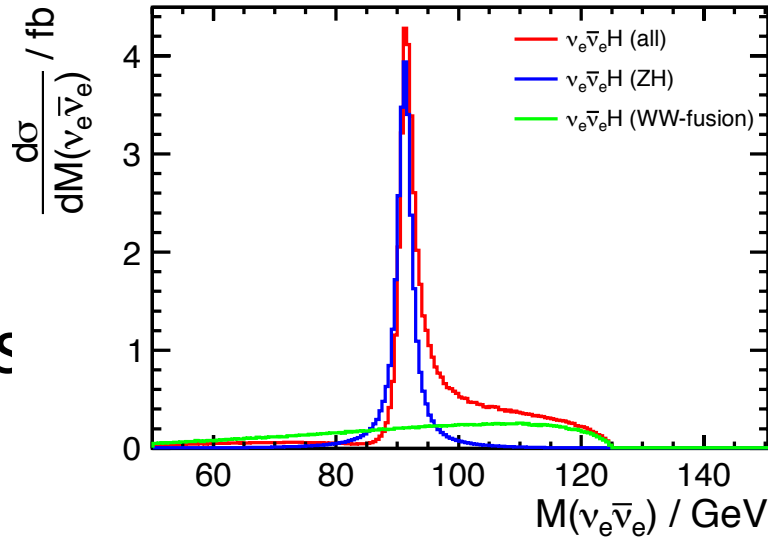
optim on	bb	cc	gg	bb, cc, gg
BG in %	3.26	15.2	10.5	3.08
bb in %	1.78	2.62	3.45	1.8
cc in %	26.07	25.18	40.49	26.69
gg in %	12.99	37	9.08	14.41

- scaled to old cross section

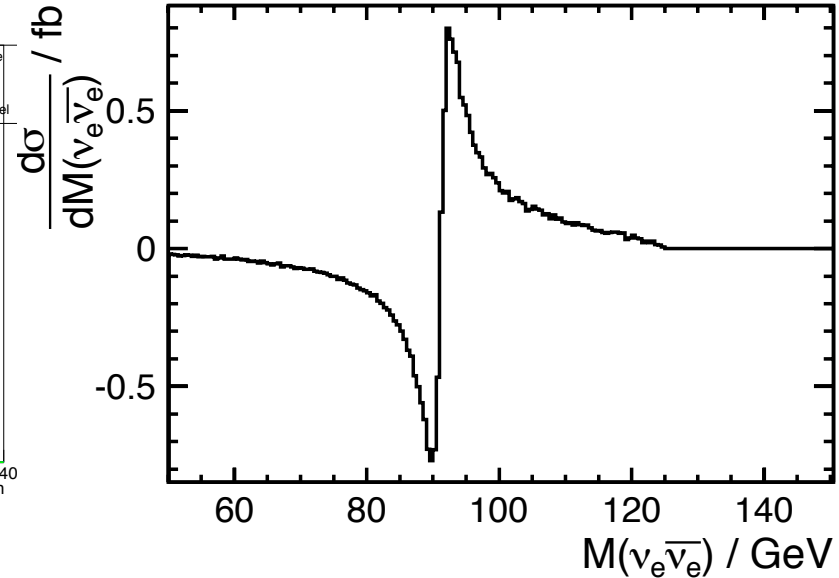
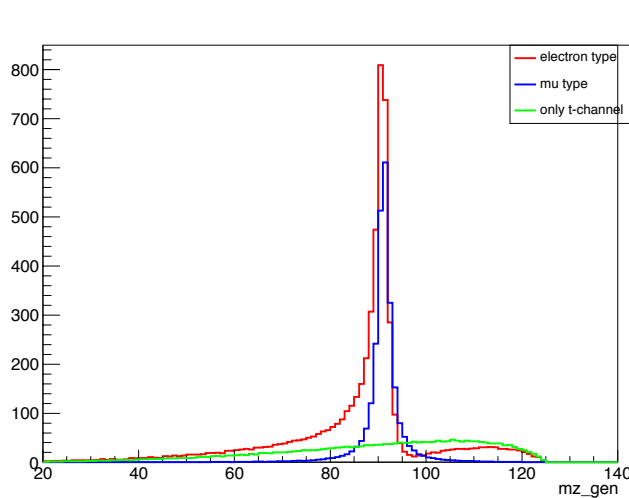
optim on	bb	cc	gg	bb, cc, gg	
BG	3.34	16.29	9.63	3.18	Ono's study
bb	1.56	2.35	3.18	1.57	1.7
cc	21.3	20.42	39.85	26.25	11.2
gg	16.48	34.31	11.35	15.92	13.9

Interference of ZH/WW in Z-mass

- from Data samples

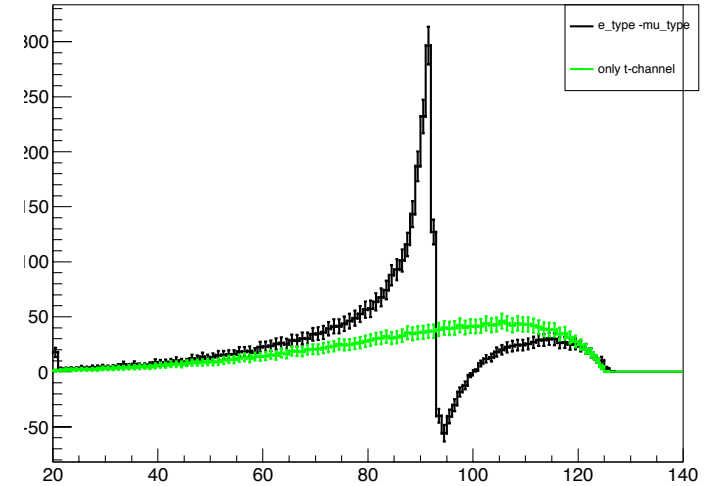
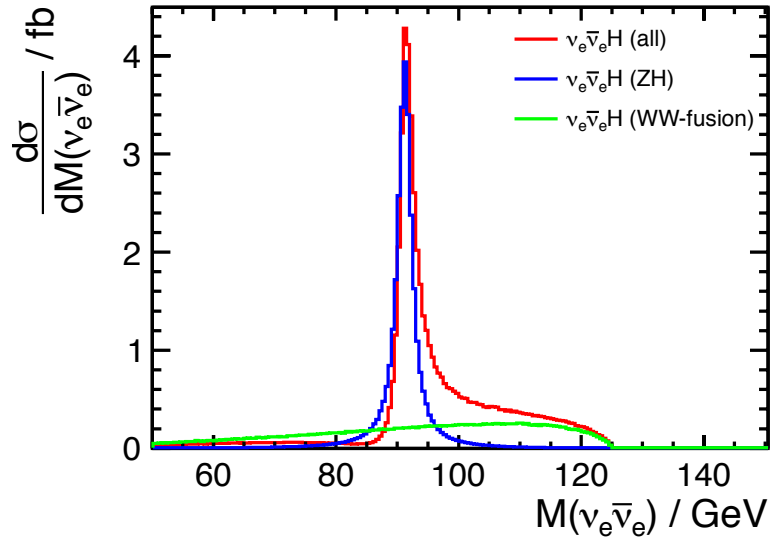


- Physsim by Junping

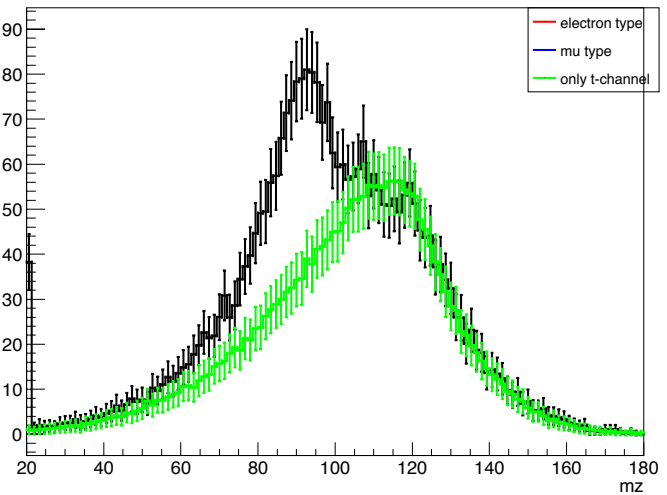
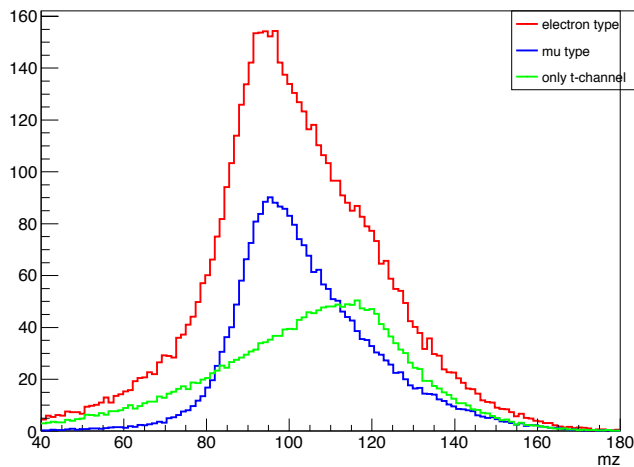


Interference of ZH/WW in Z-mass

- gen. Z-mass

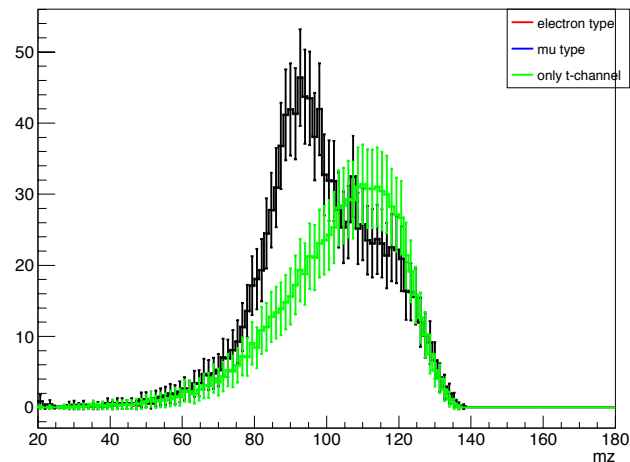
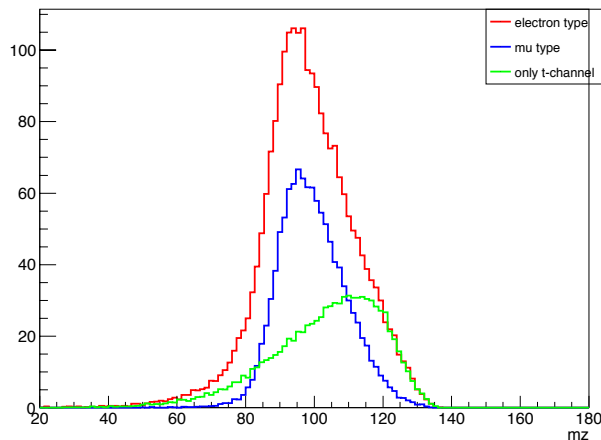


- Recon. Z-mass

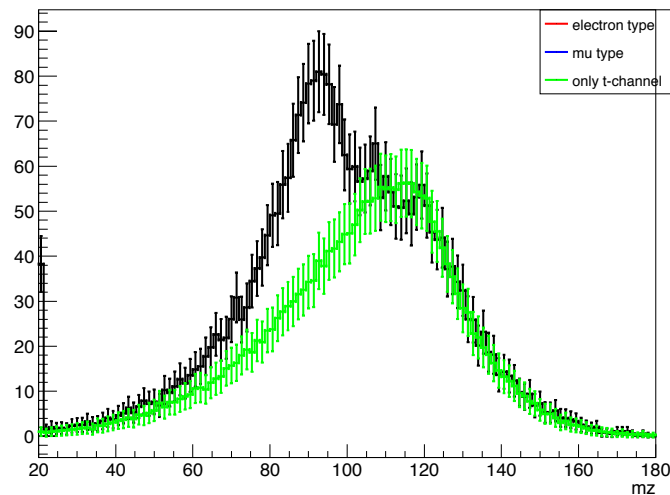
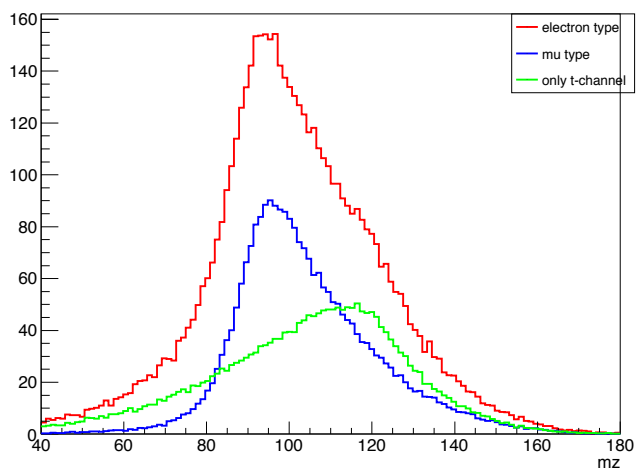


Interference of ZH/WW in Z-mass

- Recon.
Z-mass
cut
Sig ~ 43



- Recon.
Z-mass



Plan

- Look at WW-Fusion
- Look at overlay
 - Now overlay 0.2
 - What happens for overlay 0, 0.4
- other systematic errors
 - which and how?
- Stop research on 13.6. and start writing my thesis

Backup

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

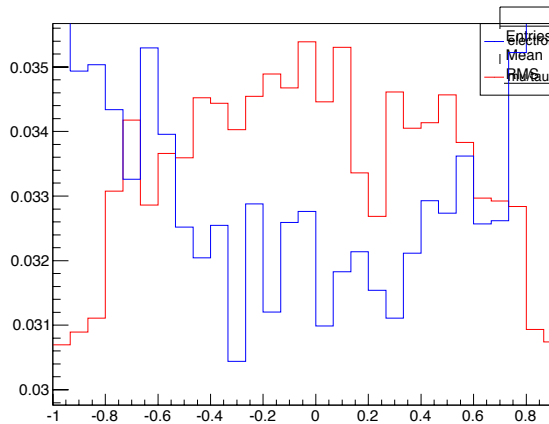
optim on	bb	cc	gg	bb, cc, gg	bb with WW
BG	3.26	15.12	10.38	3.27	3.13
bb	1.8	2.6	3.64	1.77	1.8
cc	20.03	30.81	143.4	19.95	21.81
gg	15.43	18.44	11.57	16.74	13.73

Fitting WW-fraction

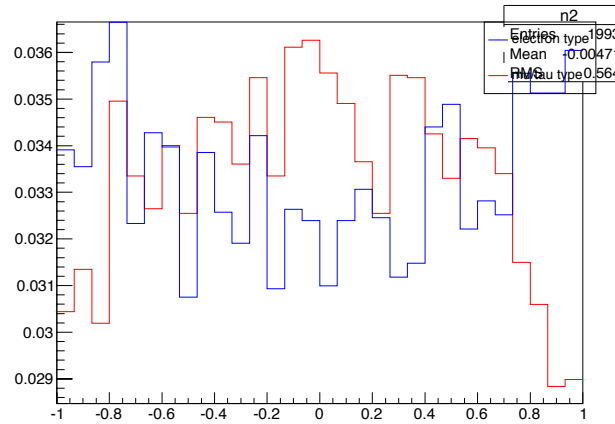
electron neutrinos
mu/tau neutrinos

- COSh

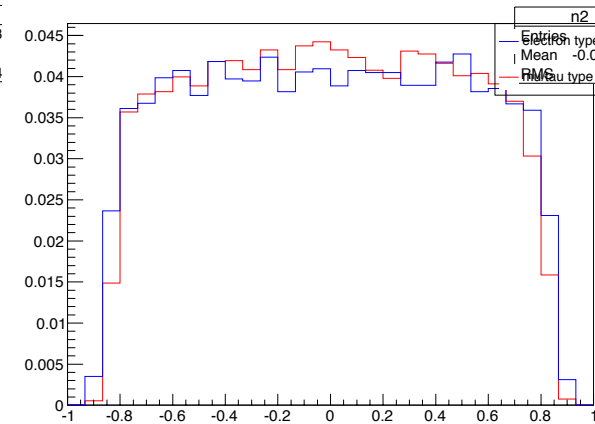
no cuts



no mpt cut

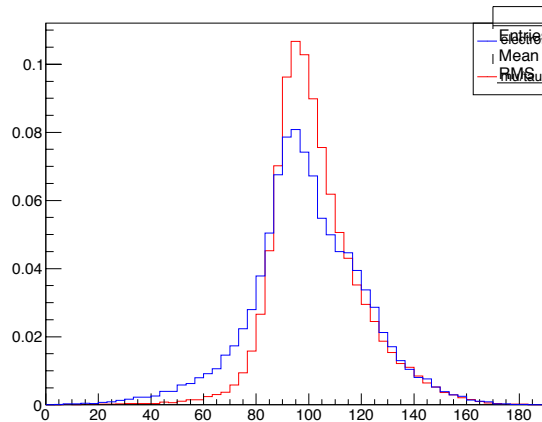


all cuts

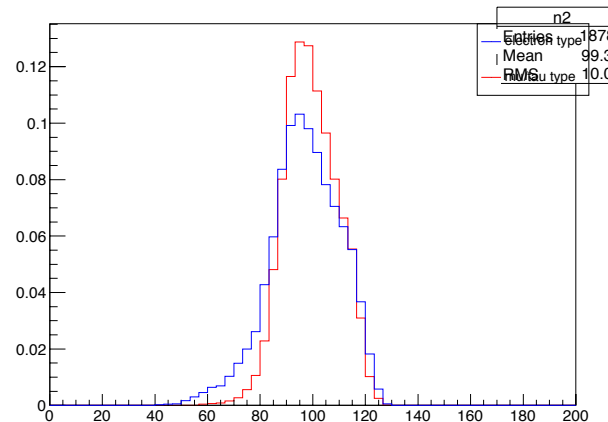


- Z-mass

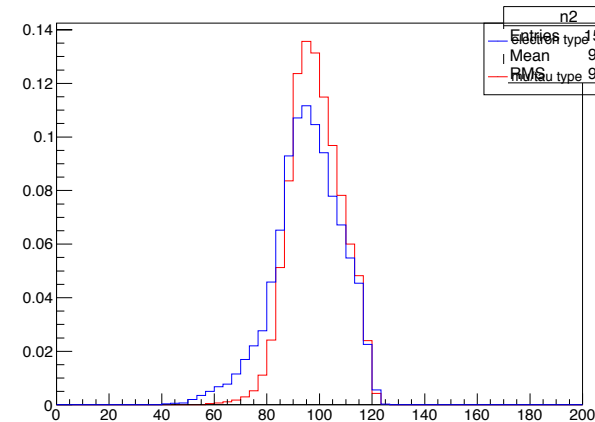
no cuts



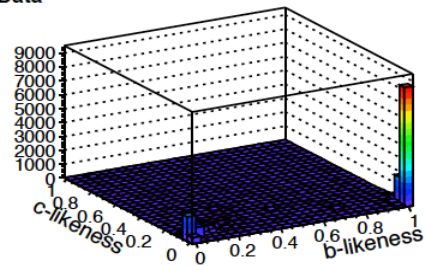
no mpt cut



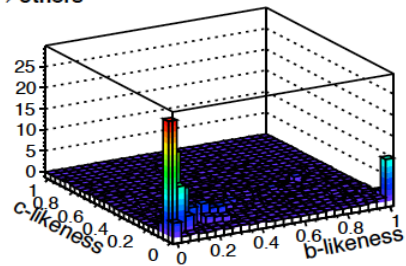
all cuts



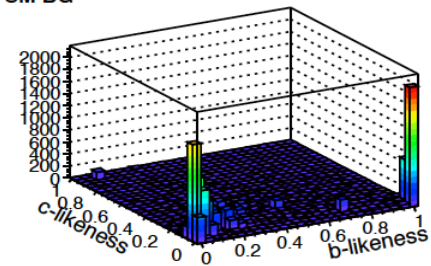
Data



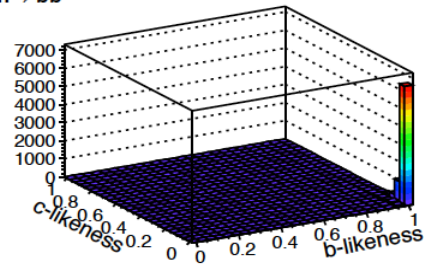
h → others



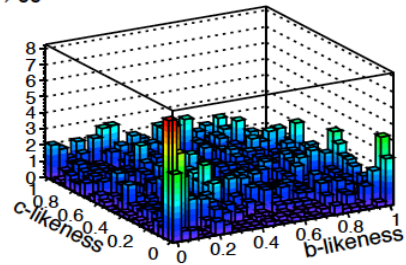
SM BG



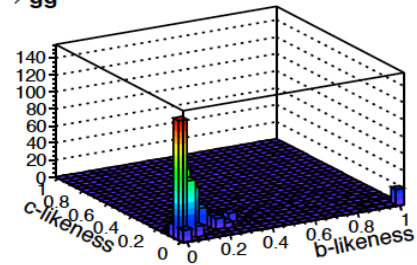
h → bb



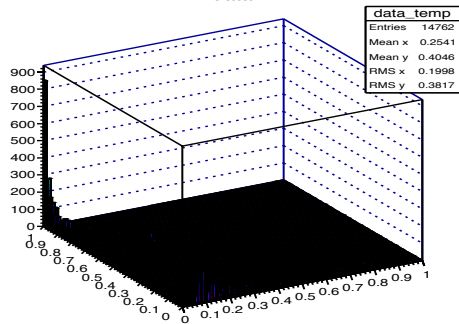
h → cc



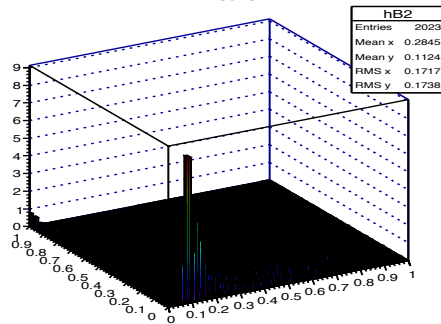
h → gg



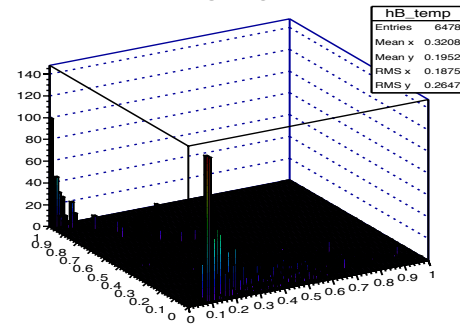
data



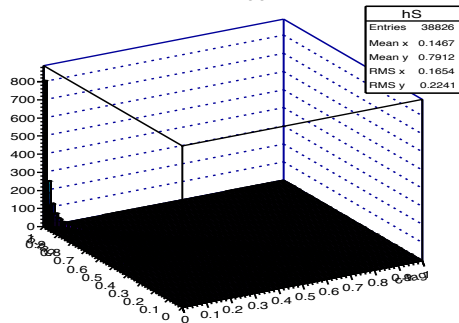
H → other



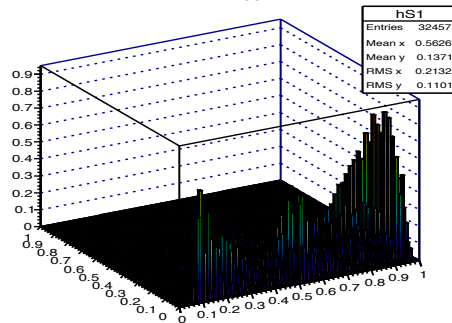
SM BG



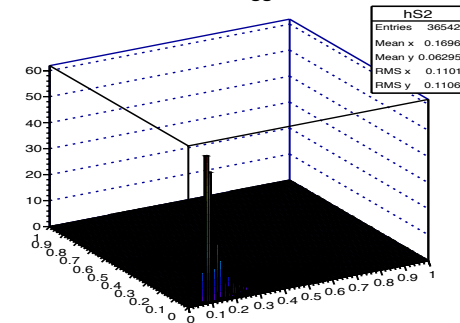
H → bb



H → cc



H → gg

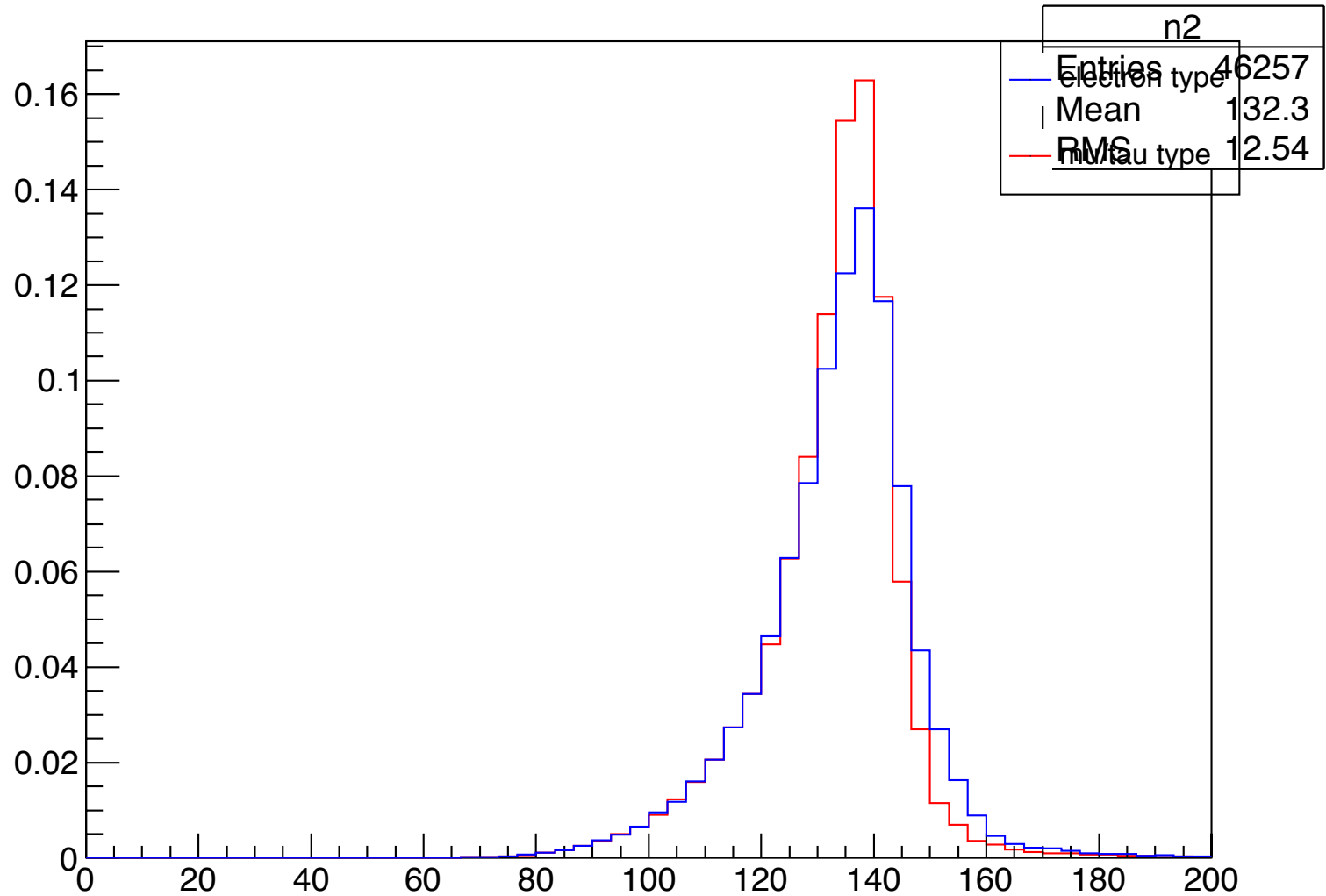


Compare to Ono/Miyamoto's paper

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	15102	2.21E+07
E_vis	13606	7.76E+06
Z-Mass	11954	1.80E+06
Higgs-mass	10911	371672
missMo_t	9256	49604
missMo_z	8915	36364
cosTHiggs	8915	36364
M_maxpfo	8915	36364
majthrust	7771	21741
pthrust	6649	15266
minthrust	6626	15140
maxPFOM		
om	6427	13065
y-Cuts	4726	3964
	51,8	(24,4 %)

evis



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
maxPFOMoment						
um<	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

- $h \rightarrow bb$ only (direct cut on b-tag)

	Claude Düring	my Analysis
Significance	51.6	68.2
Efficiency	31.2 %	62.7 %
Purity	87.7 %	65.2 %

- $H \rightarrow bb, cc, gg$

	Ono/Miyamoto	my Analysis
Significance	47.9	51.8
Efficiency	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)

	vvh(Si 0g)	vvh(ot her)	znunu _sl	sw_sl	zz_sl	ww_sl	szeesl	z_h	ww_h	zz_h	zzw w_h	lepton ic	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
missM o_t	5190	75	618	96.2	1010	2500	1.2	11000	2.02	1.89	1.69	42	46.2	10500 0	14.6	0.041 2	0.388
missM o_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
cosThi ggs	4660	67.9	490	80.5	736	1810	0	443	0	0	0	0.206	39.4	364	50	0.536	0.348
nmou n	4660	67.9	490	80.5	736	1810	0	443	0	0	0	0.206	39.4	364	50	0.536	0.348
majthr ust	4720	70	543	86.5	811	1890	0	476	0	0	0	0.206	44.7	385	49.7	0.523	0.353
pthrus t	4690	75.8	503	82.1	753	1840	0	443	0	0	0	0.206	41.1	371	50	0.533	0.35
maxPF OMom	4810	71	542	96.7	832	2200	0	476	0	0	0	12.1	41.5	410	49.4	0.507	0.36
minthr ust	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 $\mathcal{L} = 250 \text{ fb}^{-1}$ 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
$\frac{\Delta(\sigma \cdot Br)}{\sigma \cdot Br}(H \rightarrow b\bar{b})$ (%)	1.7	1.5	3.8	3.3	1.0
$\frac{\Delta(\sigma \cdot Br)}{\sigma \cdot Br}(H \rightarrow c\bar{c})$ (%)	11.2	10.2	26.8	22.6	6.9
$\frac{\Delta(\sigma \cdot Br)}{\sigma \cdot Br}(H \rightarrow gg)$ (%)	13.9	13.1	31.3	33.0	8.5
$\frac{\Delta Br}{Br}(H \rightarrow b\bar{b})$ (%)	3.0	2.9	5.7	4.5	2.7
$\frac{\Delta Br}{Br}(H \rightarrow c\bar{c})$ (%)	11.4	10.5	31.3	22.8	7.3
$\frac{\Delta Br}{Br}(H \rightarrow gg)$ (%)	14.2	13.3	33.1	24.0	8.9

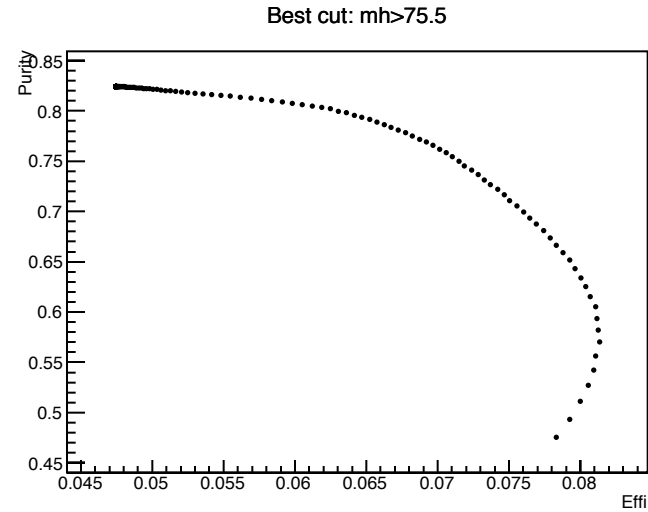
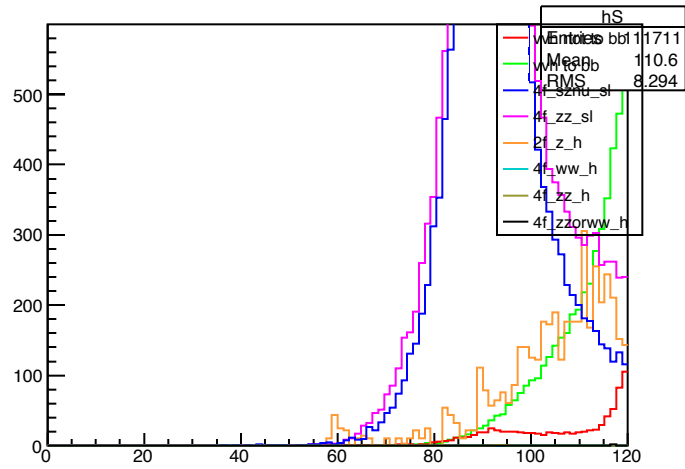
Compare to Claude Düring's study

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

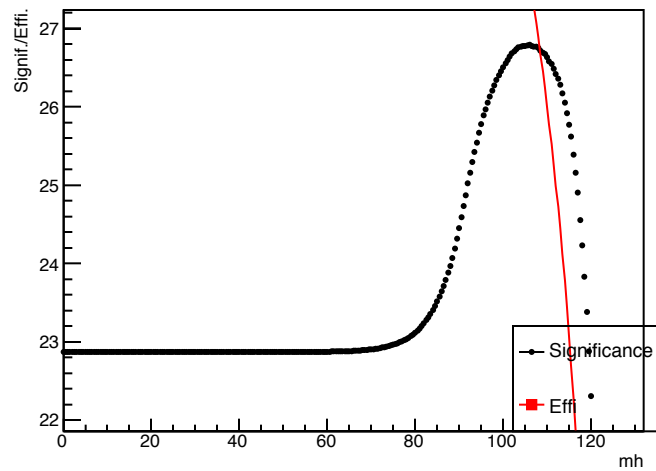
	Expected	isoLepCut s	npfo	E_vis	Z-Mass	Higgs- mass	missMo_ t _z	missMo_ z	cosTHiggs	B-Tag	all cuts
vvH(fusion)	3960	3610	3280	2890	2570	2410	1970	1830	1830	1240	1170
vvH(ZH)	1.54E+04	1.54E+04	1.54E+04	1.54E+04	1.54E+04	1.54E+04	9970	9890	9880	6530	6250
vvbb	3.31E+04	3.31E+04	3.31E+04	3.31E+04	3.31E+04	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)

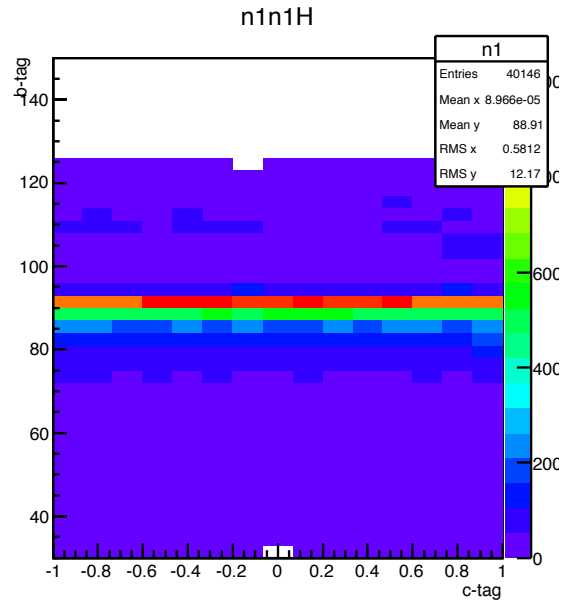
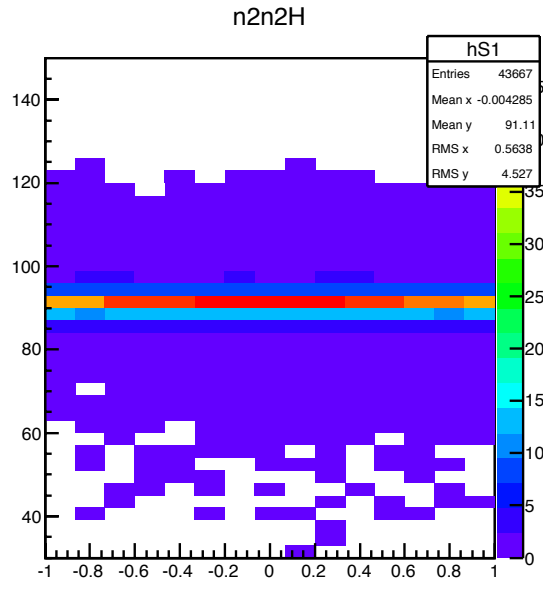
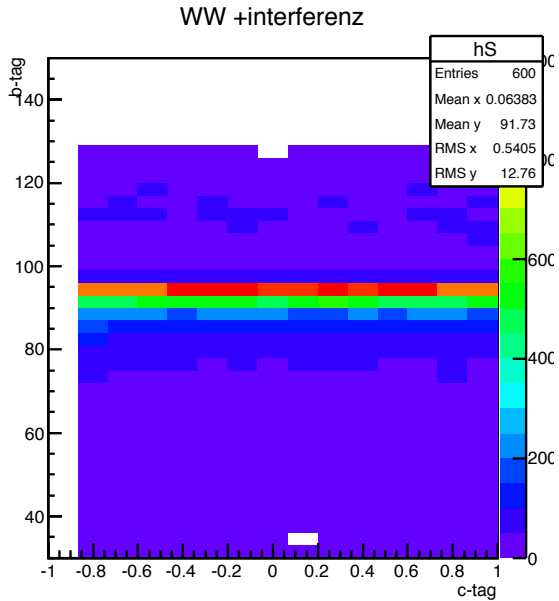
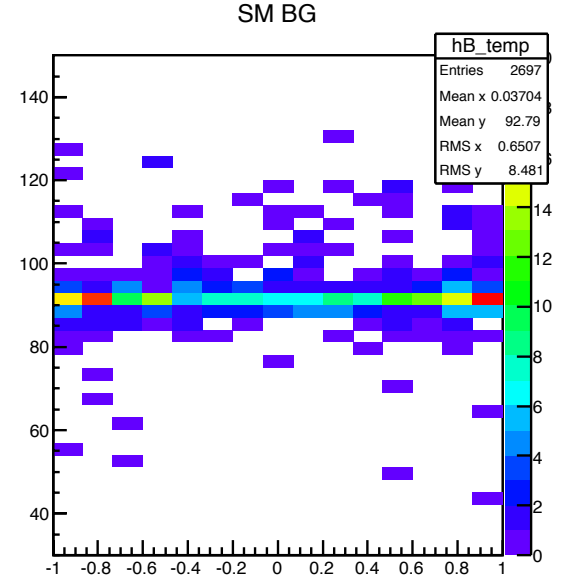
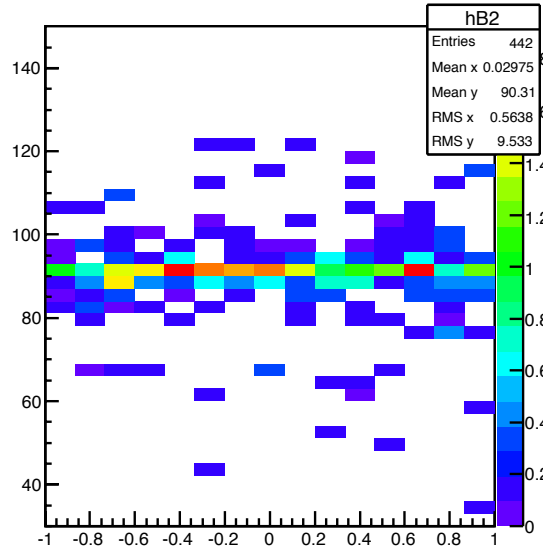
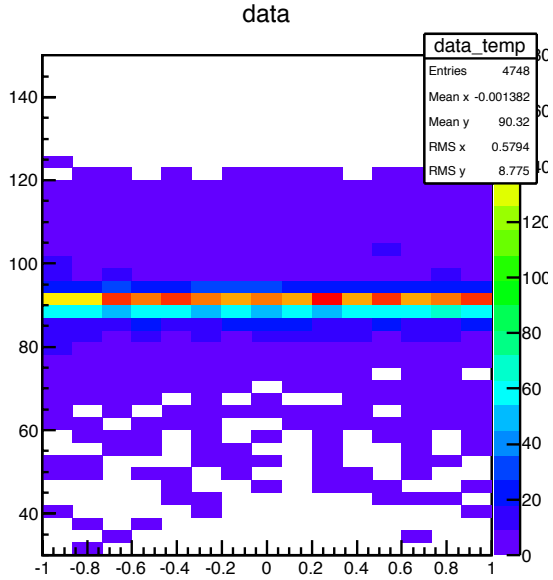
How I decided on cuts



Best cut: mh>106.0



H -> not bb



Fitting WW-fraction

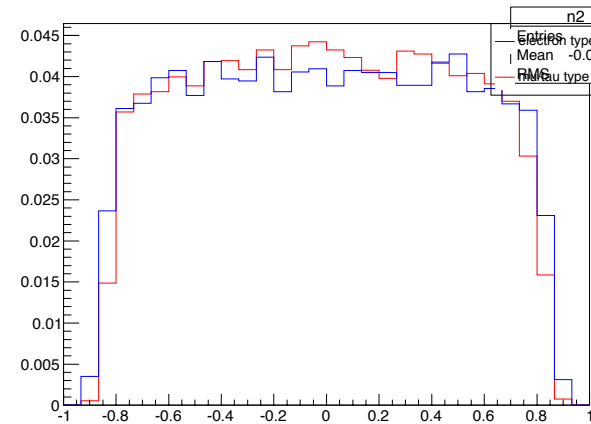
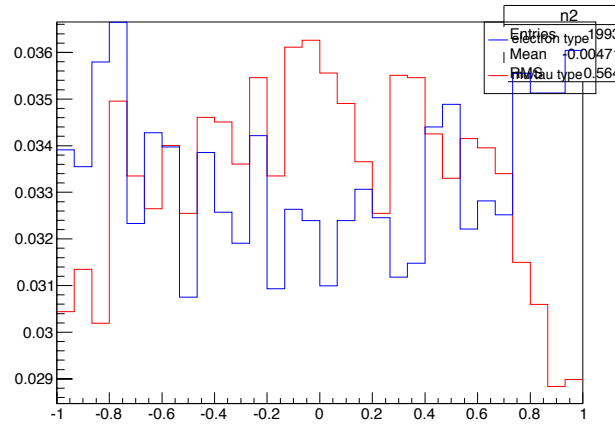
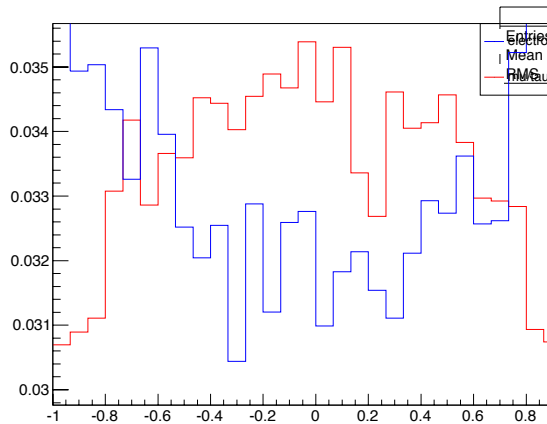
electron neutrinos
mu/tau neutrinos

- COSh

no cuts

no mpt cut

all cuts

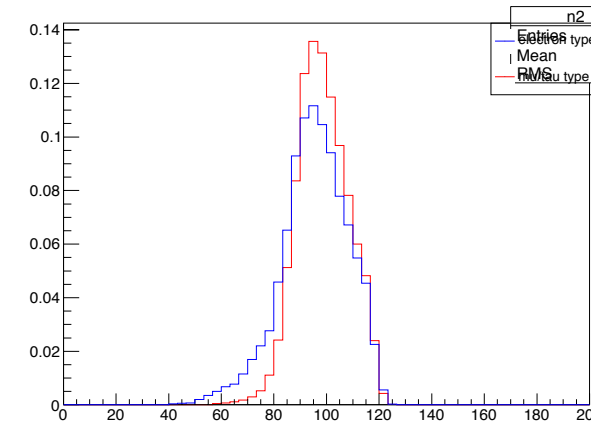
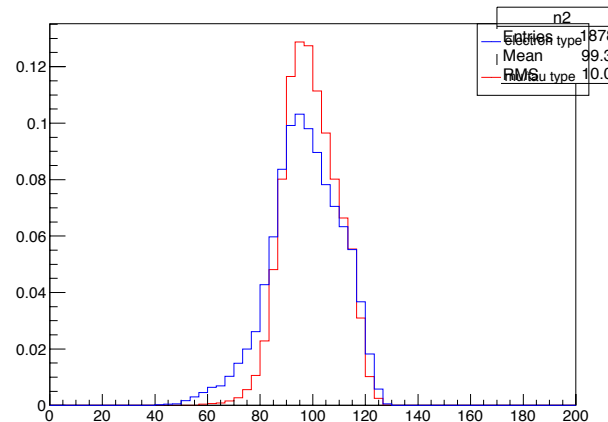
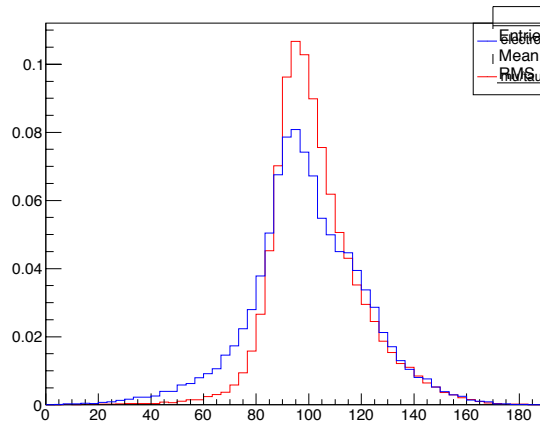


- Z-mass

no cuts

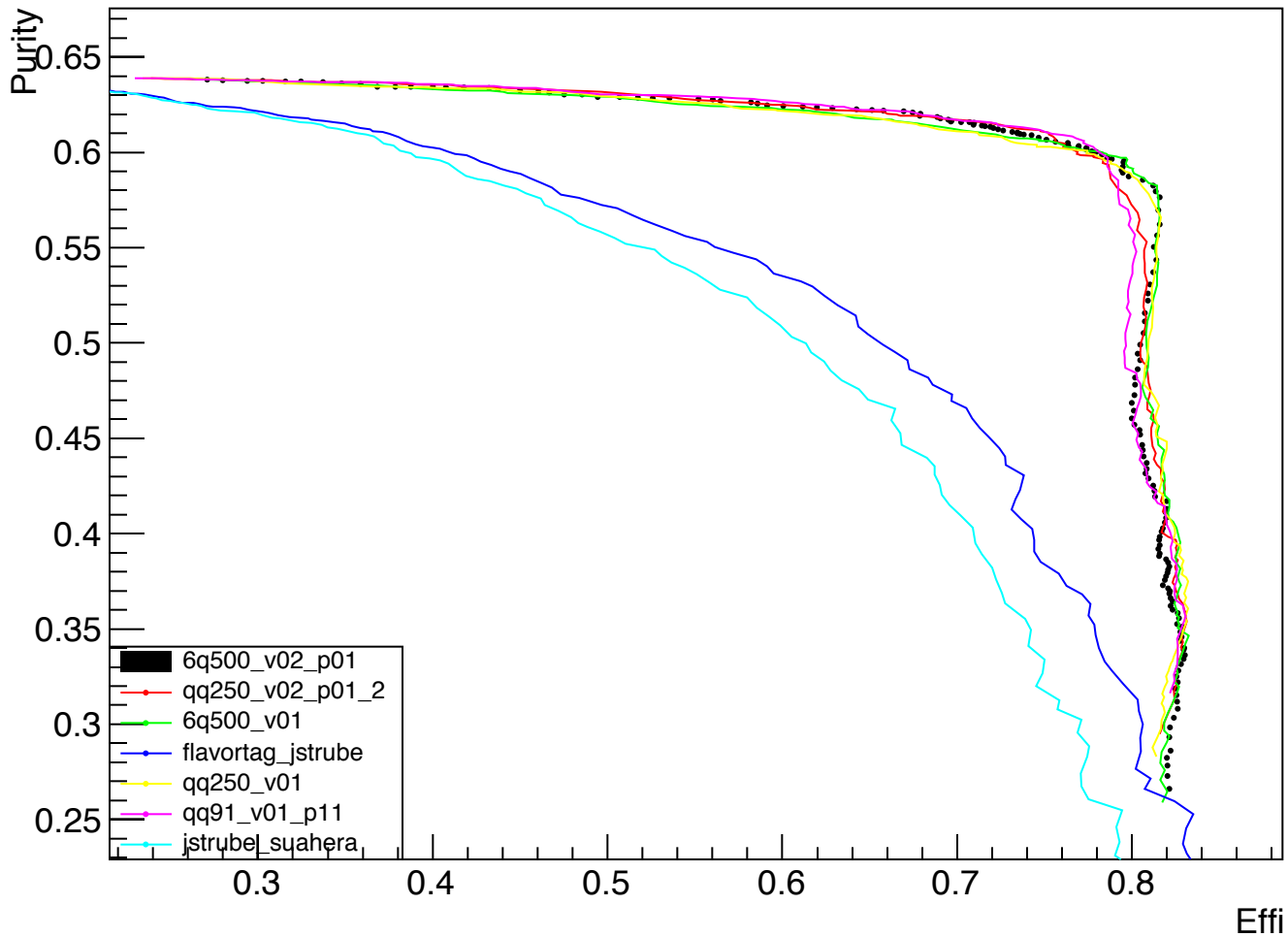
no mpt cut

all cuts

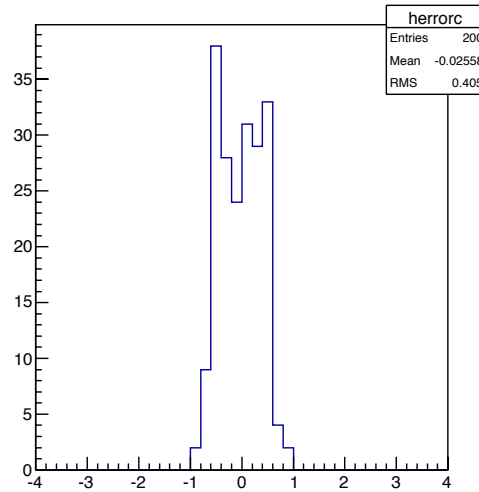
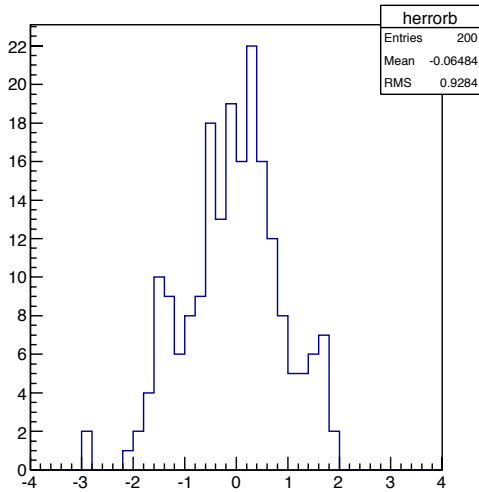


Flavor tagging weights

Best cut: 6q500_v01 bmax1+bmax2>0.97

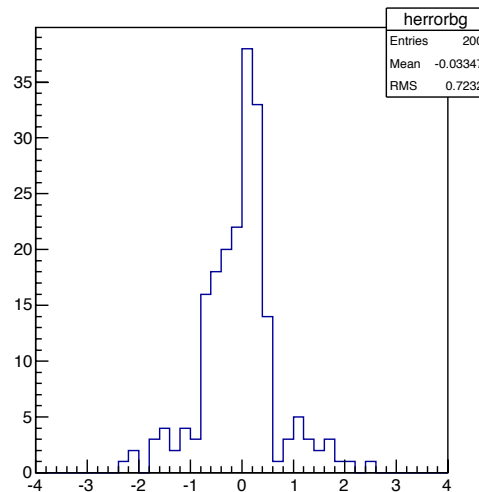
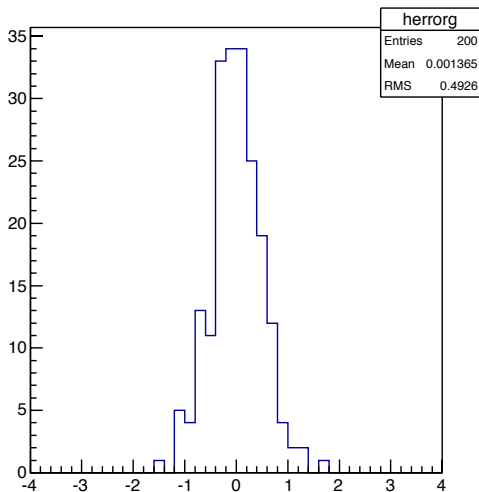


Error Check from fit



$$\frac{N_i - N_{exp}}{\sigma(N_i)}$$

- Background same as Tamplate



B-tagging weights on jets?

Graph

