

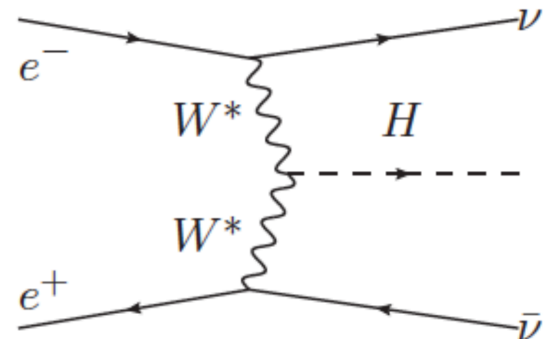
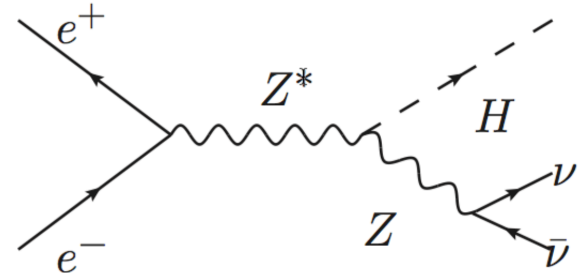
Status report
Asian Physics and Software Meeting

by Christian Drews

2014.05.30

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



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 %) |

- $h \rightarrow bb$ 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 % |

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 |

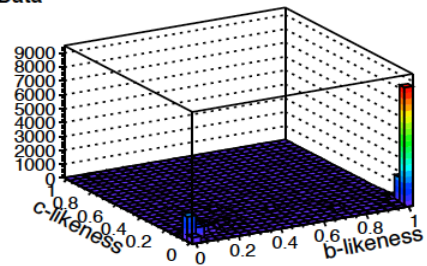
Comparing fitting result

| | $X = x_1 + x_2$ | | | $X = x_1 * x_2 / (x_1 * x_2 + (1 - x_1)(1 - x_2))$ | | |
|---------|-----------------|-------------|------------|--|-------------|------------|
| | 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 % |

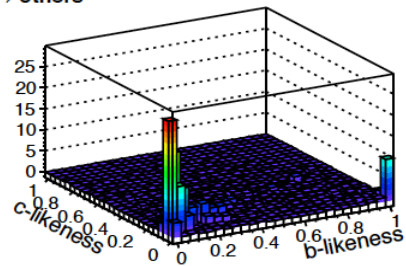
TABLE IV: Summary of template fitting results r_s and accuracies of $(\sigma \cdot Br)$ and Br after correcting σ for an accuracy of 2.5% at $\sqrt{s} = 250$ GeV assuming $\mathcal{L} = 250 \text{ fb}^{-1}$ with $(e^-, e^+) = (-0.8, +0.3)$.

| | $\nu\bar{\nu}H$ | $q\bar{q}H$ | 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 |

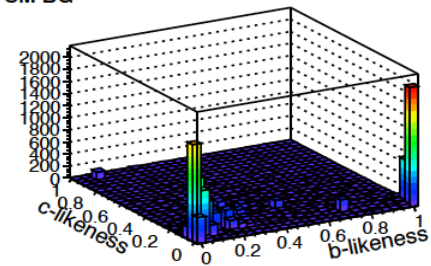
Data



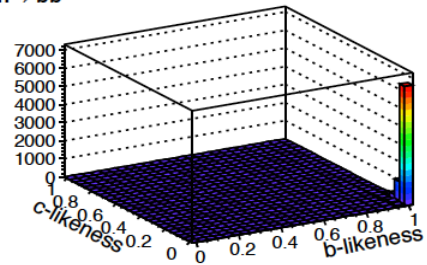
h → others



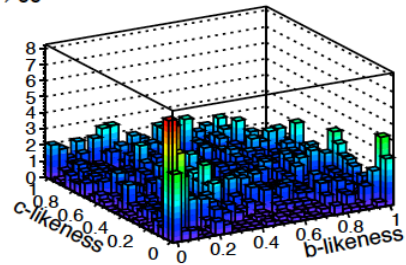
SM BG



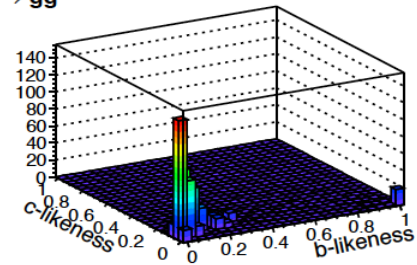
h → bb



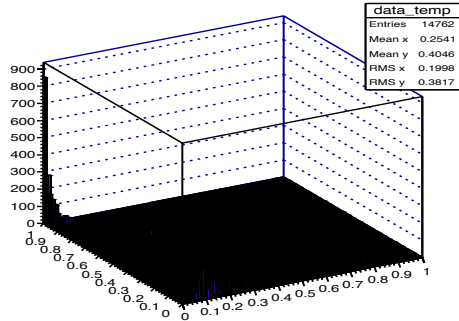
h → cc



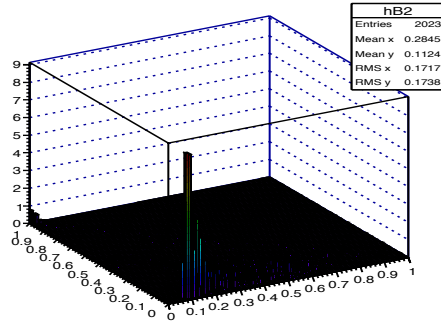
h → gg



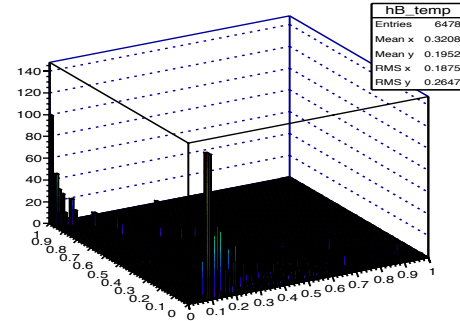
data



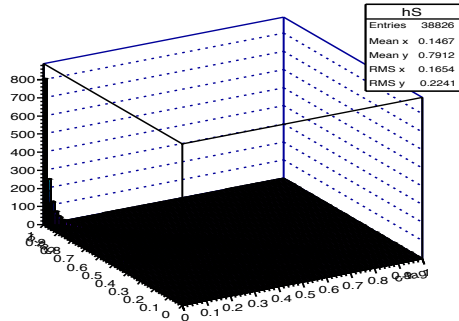
H → other



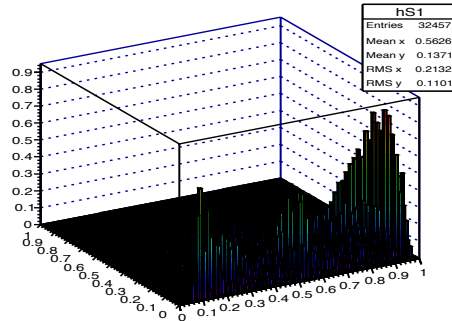
SM BG



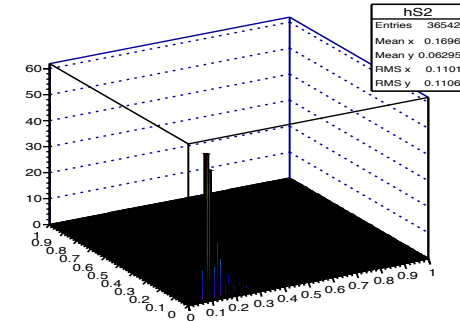
H → bb



H → cc



H → gg



- 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 |
| bb | 1.82 | 2.65 | 3.53 | 1.79 | 1.78 |
| cc | 26.43 | 25.14 | 210.32 | 19.35 | 30.44 |
| gg | 17.91 | 37.08 | 11.77 | 19.67 | 18.7 |

- 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 |

optimizing cuts for each mode

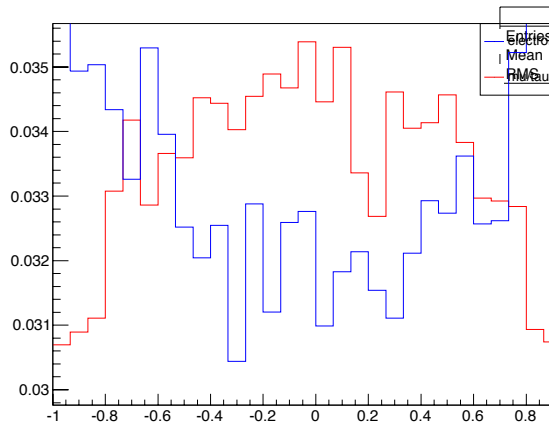
| | bb | cc | gg | bb, cc, gg | bb with WW | WW-Reconst |
|------------------|-------|-------|-------|------------|------------|------------|
| npfos1> | 14 | 12 | 27 | 12 | 12 | 6 |
| npfos2> | 12 | 9 | 24 | 12 | 13 | 20 |
| evis< | 147 | 144.5 | 145 | 146.5 | 147 | 144 |
| evis> | 0 | 0 | 127 | 0 | 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 |

Fitting WW-fraction

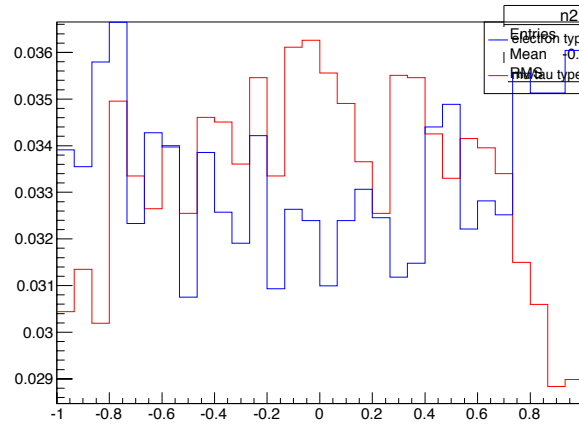
electron neutrinos
mu/tau neutrinos

- COSh

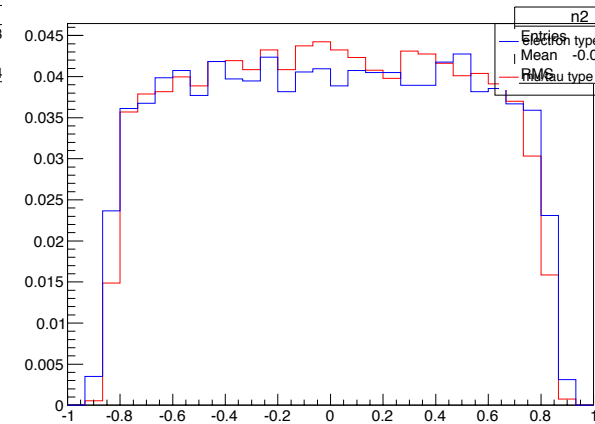
no cuts



no mpt cut

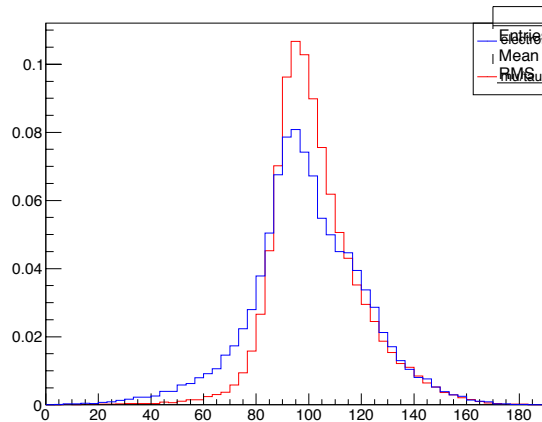


all cuts

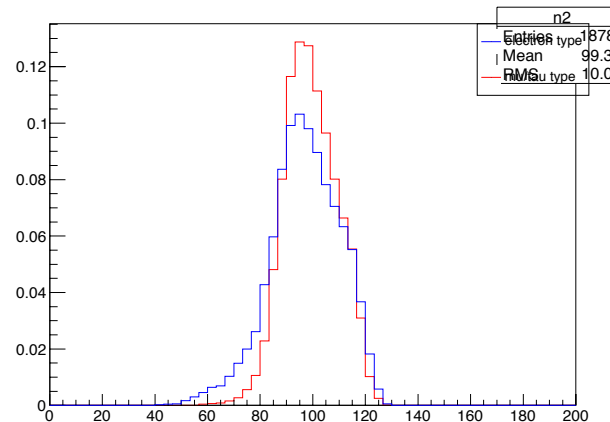


- Z-mass

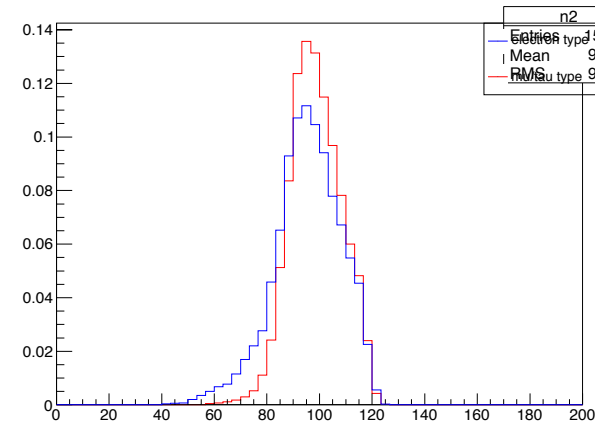
no cuts



no mpt cut



all cuts



Problems

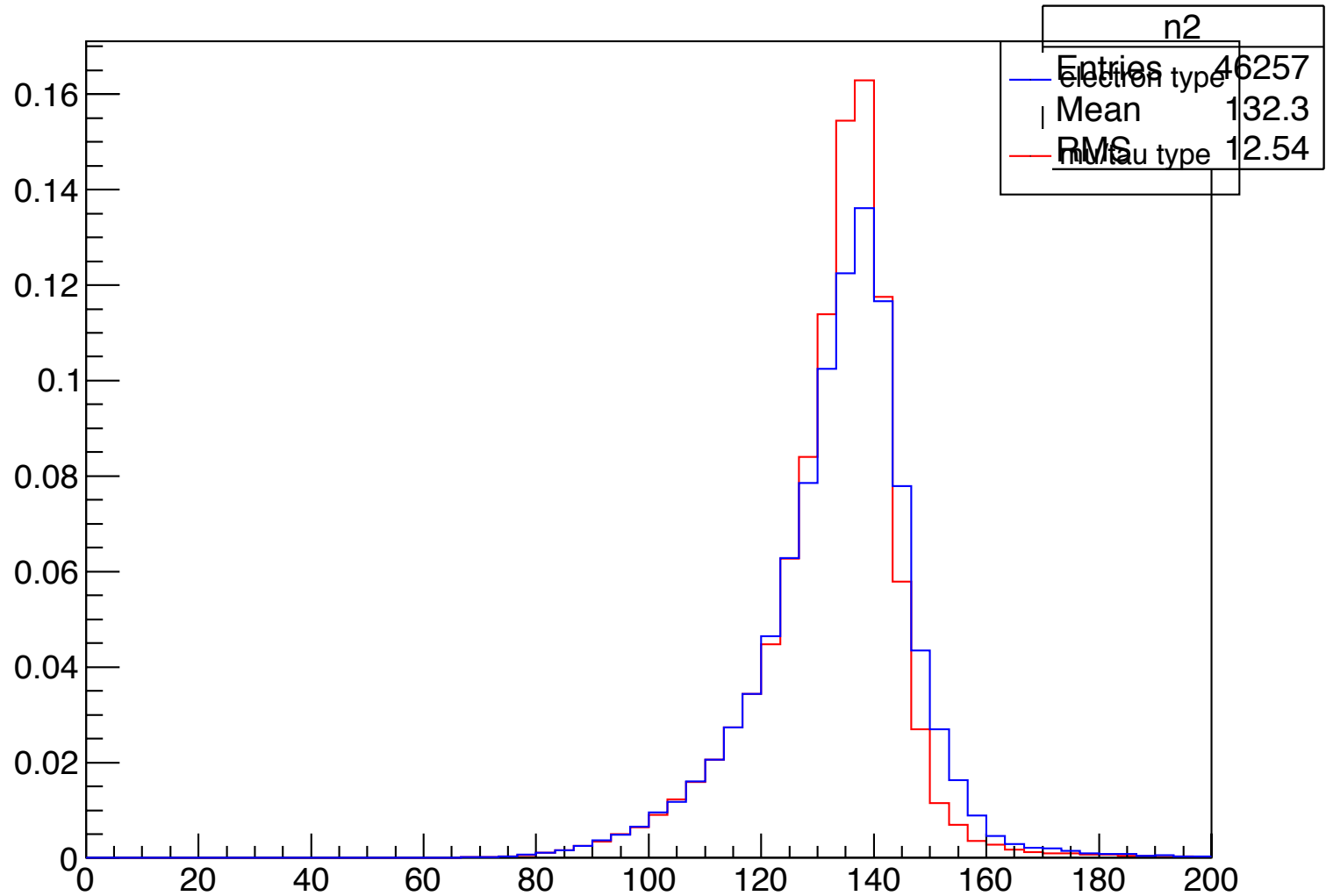
- Large uncertainties by fitting WW-fusion fraction
 - 18 % to 35 %

Plan

- Look at WW-Fusion
- Look at overlay
 - Now overlay 0.2
 - What happens for overlay 0, 0.4
- Look at cuts again to maximise Signiffigans
 - Likelihood cut ??? $\frac{m_i - \langle m \rangle}{\sigma(m)} + \frac{E_i - \langle E \rangle}{\sigma(E)} + .. < C$
- other systemetic errors
 - which and how?
- Stop research in tow weeks (13.6.) and start writing my thesis

Backup

evis



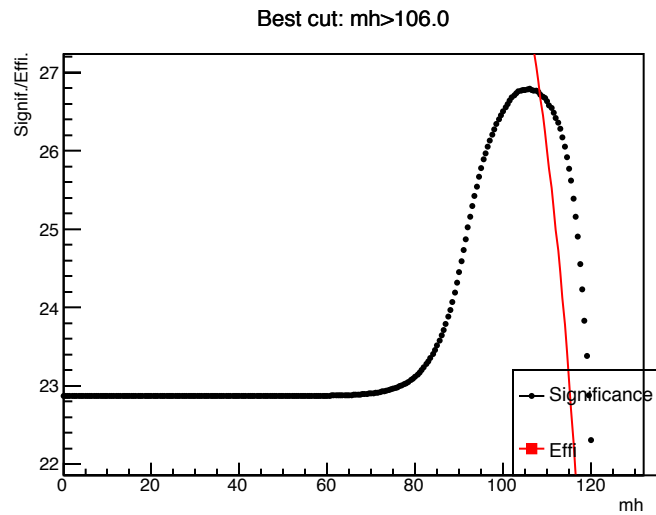
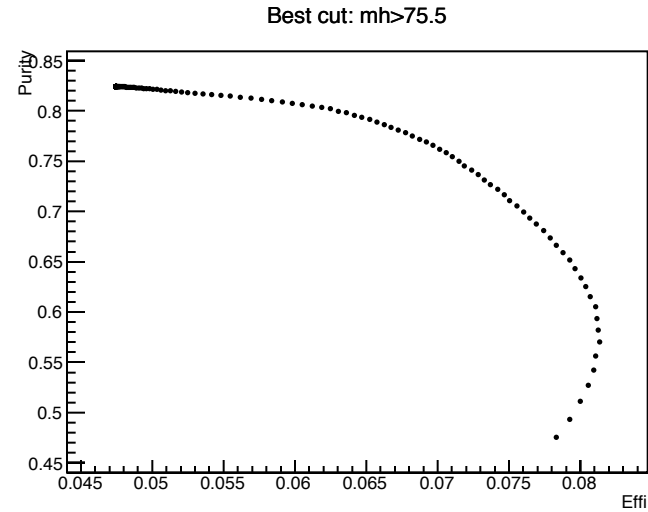
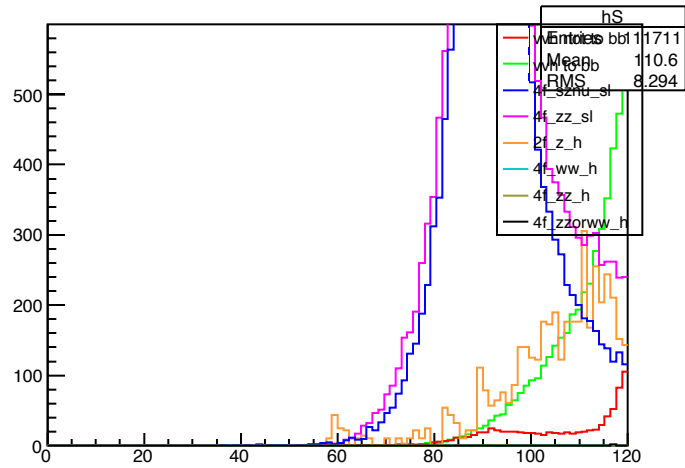
Compare to Claude Düring's study

| 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 |

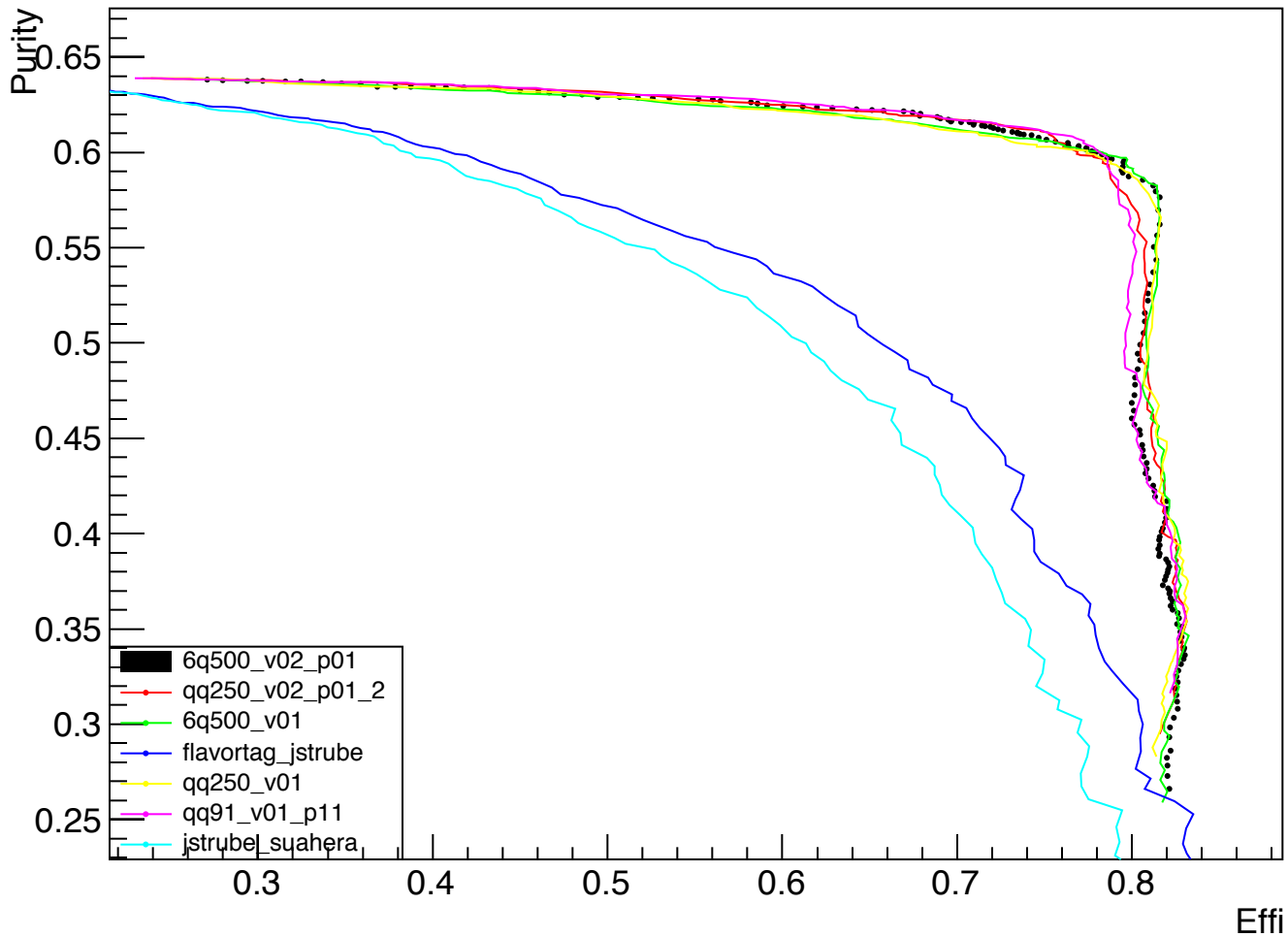
- qqll before zz_sl + zee_sl (now only to l+l-)
- qqlv before only sw_sl (now + ww_sl)

How I decided on cuts

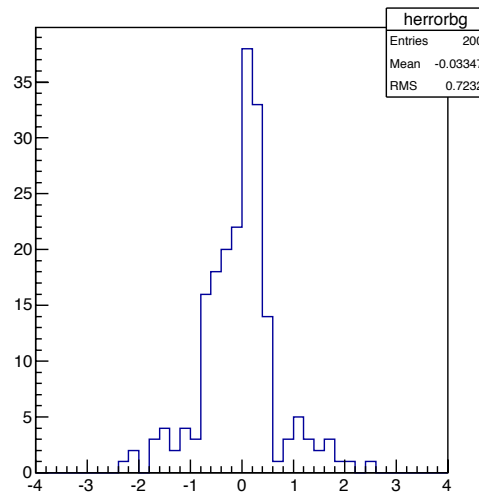
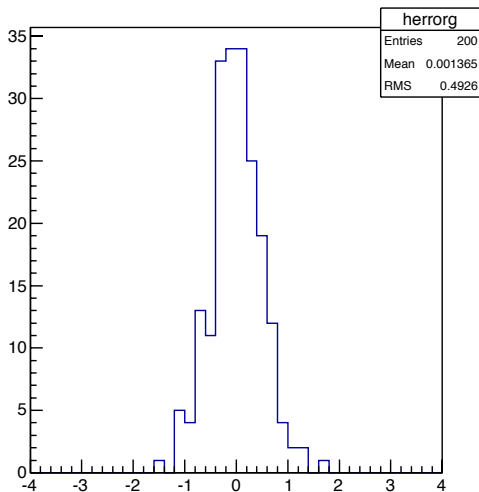
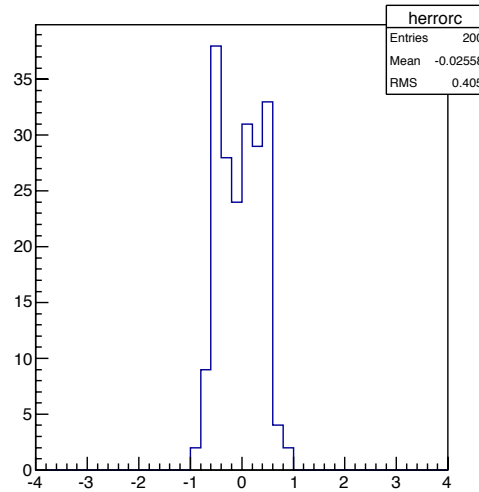
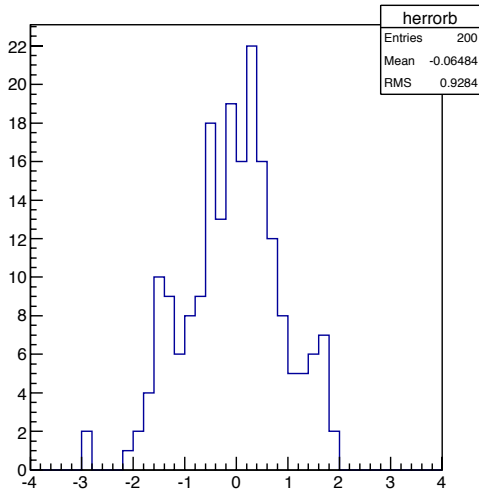


Flavor tagging weights

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

