Update on measurement accuracies of higgs branching fractions in vvh at 350 GeV

Work in Progress

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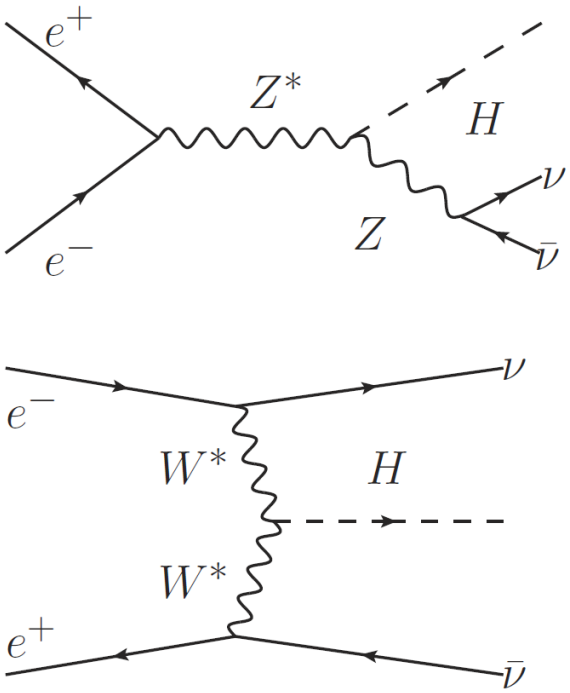
DESY

Analysis Goals

- Measure the higgs BR errors for bb,cc,gg at 350 GEV
- previously performed by Hiroaki Ono and Akiya Miyamoto on LOI data samples (arXiv:1207.0300) (M_{higgs}=120 GeV)
- Update study with DBD data samples
- Measure Δ(σ*BR)
- Need σ to get BR (higgs strahlung and WW fusion)
- Idea: add missing mass in the fit to get cross section ratio of both processes



DESY

Reconstruction Strategy

- vvh → 2 Jets + Missing Mass
- FastJetProcessor to remove γγ-overlay
  - kt algorithm
  - R value 1.3
  - 2 exclusive jets
- Use LCFIPlus for flavor tagging
- Evaluate flavor likeness X_i of the event (i=b,c,bc)

$$X_i = \frac{x_{i1} x_{i2}}{x_{i1} x_{i2} + (1 - x_{i1})(1 - x_{i2})}$$

  with x_i the flavor tag of the single jets

- Event selection with cut analysis and BDT
- Template fit to the flavor likeness of the higgs di-jets

Cut Flow

- Try same cuts as in the study by Hiroaki
  - LOI: No γγ-overlay
  - DBD: after γγ-overlay removal with Fast Jet

		LOI		DBD	
Cut	condition	BG	Signal	BG	Signal
Expected		20855900	26307	18937602	23218
Missing Mass	$240 > M_{miss} > 50$	5627040	23202	9747987	20570
Transverse P	$140 > P_{t,vis} > 10$	2271090	22648	3645606	20071
Longitudinal P	$130 > \|Pzvis_{}\| > 0$	2051010	22459	2472822	19885
# of charged tracks	$N_{chd} > 10$	1936220	21270	2433580	19064
Maximum P	$60 > P_{max} > 0$	1167050	20556	1665838	18181
Durham plus	$Y_{23} < 0.02$	465461	14992		
Durham minus	$0.8 > Y_{12} > 0.2$	413762	14500		
Di-jet mass	$135 > M_{jj} > 105$	71918	12344	99625	11601
Likelihood ratio	LR > -0.47	11092	9543	83009	11238

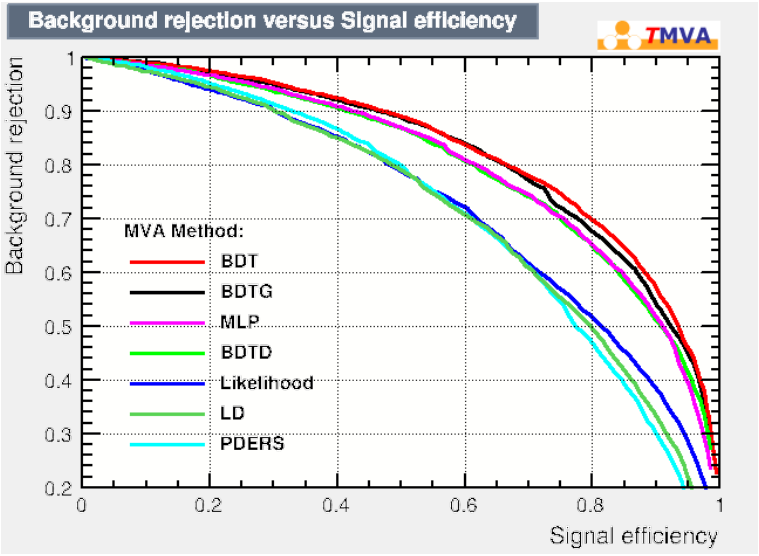
- Use TMVA Likelihood ratio with cut parameters as input
- 10 % difference of the expected events (higgs mass, beam energy spectrum?)
- Cuts are not as effective on DBD samples
- Dropped Durham parameters (significant change)
- Update necessary

New Cut Optimization

- Cuts optimized for significance

$$S = \frac{N_{sig}}{\sqrt{N_{sig} N_{bkg}}}$$

- BDT variables:
  - All cut parameters, missing energy, thrust, thrust axis, jet masses, jet momenta, jet angles

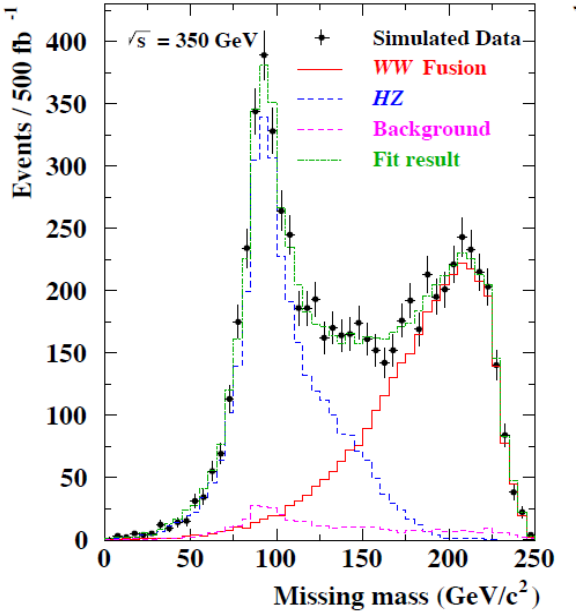


Cut	condition	BKG	Signal	Significance
Expected		18937602	23218	5.33
Transverse P	$260 > P_{t,vis} > 85$	183614	13482	30.37
Visible Mass	$135 > m_{vis} > 100$	17155	9368	57.52
# of charged tracks (>1GeV)	$N_{chd} > 23$	7818	8226	64.94
Angle between tracks	$0.30 > \cos a > -0.95$	5698	7803	67.15
Longitudinal P	$100 > \lvert P_{z,vis} \rvert > -0.01$	4929	7618	68.01
Durham minus	$0.6 > Y_{12} > 0.05$	4692	7541	68.18
BDT	BDT > -0.02	2473	7163	72.97

DESY

Missing Mass

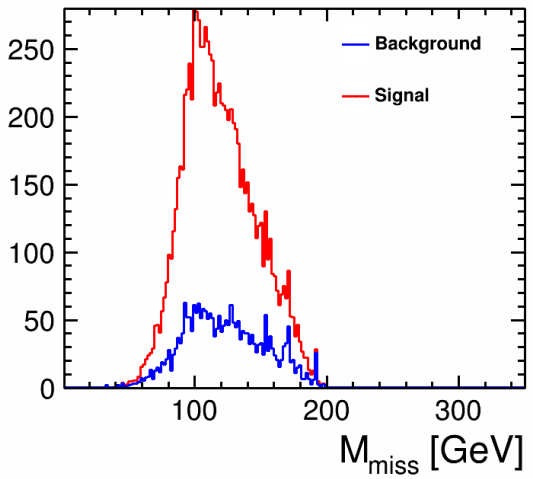
- Distinguish the two production processes by missing mass
  - Higgs strahlung: peak around z pole
  - WW fusion: cut off at 350 GeV-M_H~225 GeV (~240 GeV with beam energy spread)

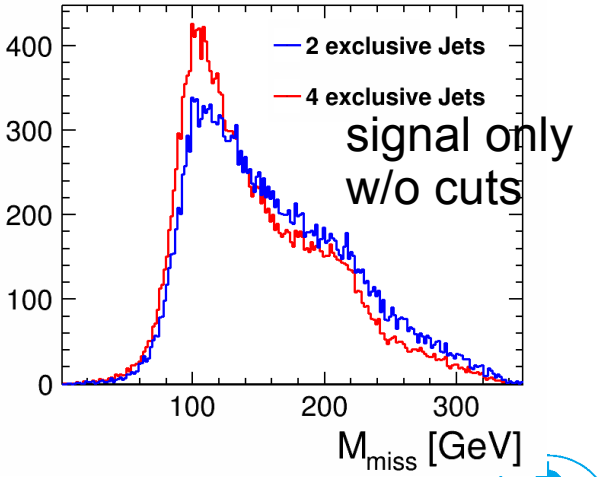


N. Meyer: Higgs-Boson at Tesla: Studies on Production in WW-fusion and Total Decay Width, University of Hamburg,2000

Missing Mass

- Current state: difficult to distinguish the two processes
  - Beam background?
- Too few WW fusion events?
  Cut away too many!
- Recheck cross sections
- Revisit cut flow
- M_{miss}>240 GeV must originate from overlay
- Optimize γγ-overlay removal





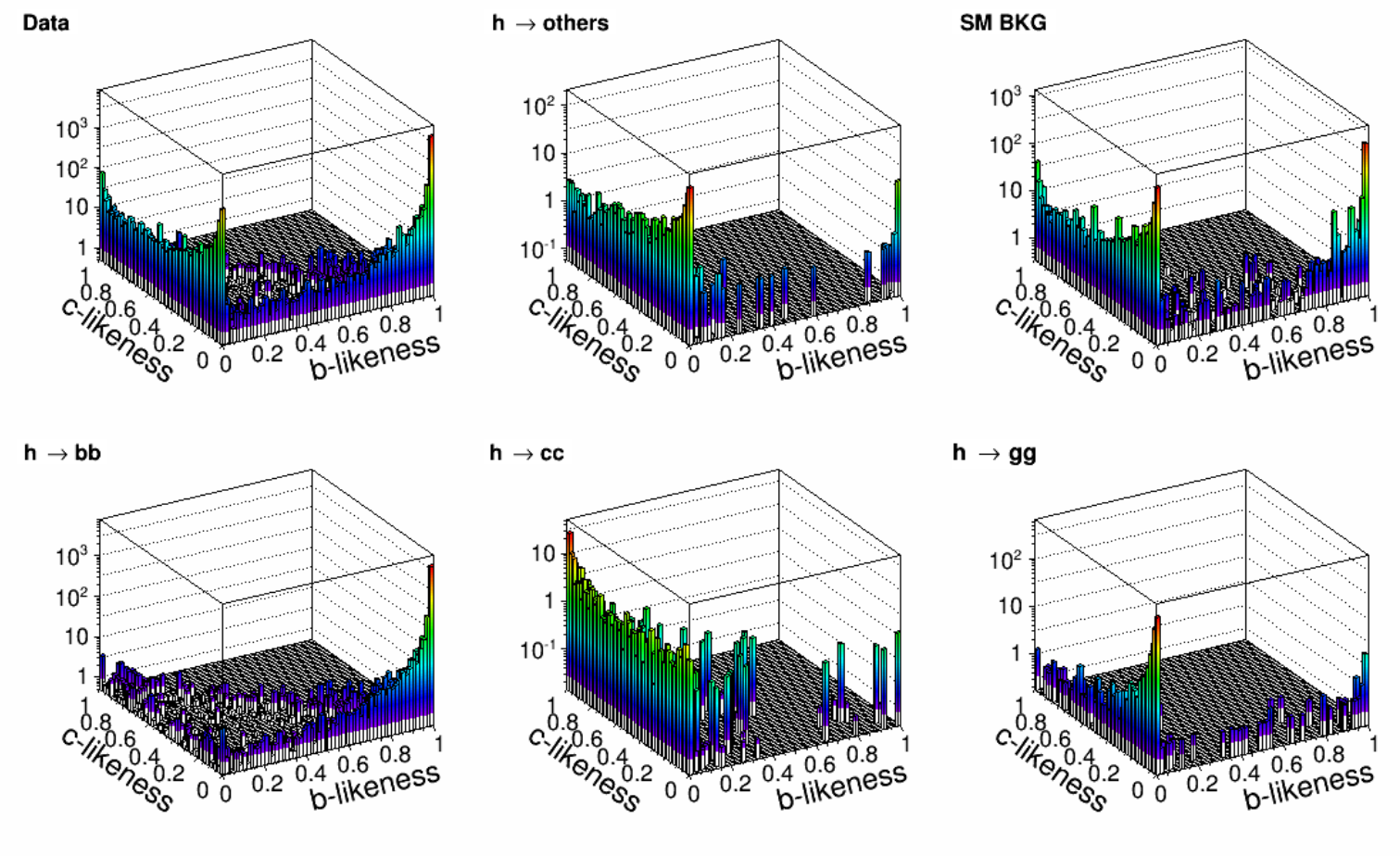
Preparation of the Template Fit

- Determine the flavor tag from LCFIPlus
- bc likeness is c likeness whose neural net training is done by using only $Z \rightarrow bb$ events as background (as implemented in LCFIVertex)
- Current release version of LCFIPlus does not provide this information (but trunk version does)
- Meanwhile, use bc tag: $x_{bc} = \frac{x_c}{x_c + x_b}$
- Create flavor histograms for $H \rightarrow bb, cc, gg$
- Fit sample histograms to the data (fit parameters r_s)

$$\frac{\Delta(\sigma \cdot Br)}{\sigma \cdot Br}(H \rightarrow s) = \frac{\Delta r_s}{r_s}(s = bb, cc, gg)$$

DESY

Preparation of the Template Fit



Summary

- Higgs branching ratios in vvh at 350 GeV are reinvestigated on DBD samples
- Broad missing mass distribution complicate process reconstruction
  - Recheck γγ-overlay removal
- Reoptimize cut flow and BDT training for equal sensitivity to ZH and vvH
- Template fit including missing mass on its way

Backup

Process	Z_had	WW_had	WW_semilep	ZZ_had	ZZ_semilep	singleW_semilep	singleZee_semi	singleZnn_semi	Higgs_BG	BG	Signal	Signf
CrossSection	68897	1298	1625	832	900	956	695	220	326	75750	93	
Generated	1739176	765437	1362602	347388	342909	1357102	215161	170342	307135	6607252	146236	
Expected	17224301	324446	406318	207980	225098	239006	173830	55107	81516	18937602	23218	5.33
Cut0	18079	978	66398	1730	39436	30798	602	18957	6636	183614	13482	30.37
Cut1	578	91	5983	236	2725	4661	52	1060	1769	17155	9368	57.52
Cut2	449	50	2243	158	1550	1399	12	665	1291	7818	8226	64.94
Cut3	307	37	1617	127	1094	886	10	510	1111	5698	7803	67.15
Cut4	245	33	1419	118	924	716	8	429	1036	4929	7618	68.01
Cut5	245	32	1302	109	878	680	8	409	1029	4692	7541	68.18
Cut6	245	32	1210	109	863	573	8	407	1016	4463	7486	68.48
Cut7	245	32	1210	107	863	573	8	407	1016	4461	7485	68.48
Cut8	127	18	495	72	525	201	2	240	794	2474	7163	72.97