Analysis Meeting vol.34

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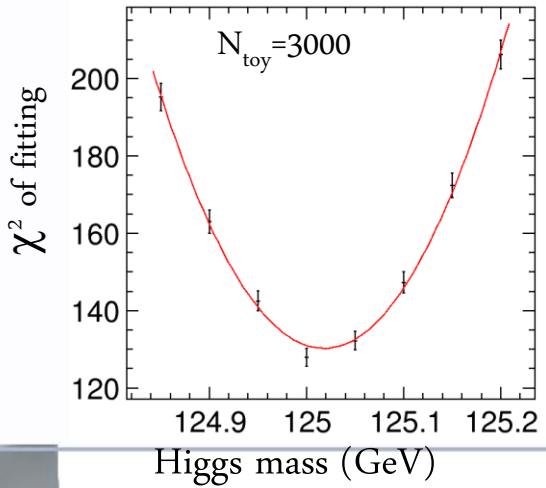
Mass Template Method

- In framework of recoil mass analysis, to avoid systematic bias of mass parameter, mass template method is tried.
- Fit dataset by PDFs from template samples with different Higgs mass.
- Template samples with M_{Higgs} = 124.85, 124.90, 124.95, 125.00, 125.05, 125.10, 125.15, and 125.20 are used (8points).
- Signal PDF is used as histograms reconstructed from template samples.
- BG PDF is used as 3rd order polynomial from DBD sample fitting.
- Toy-MC is made for data points, and mean of χ^2 values is plotted and fitted by parabola.
- Mass value at minimum χ^2 point is estimated Higgs mass.

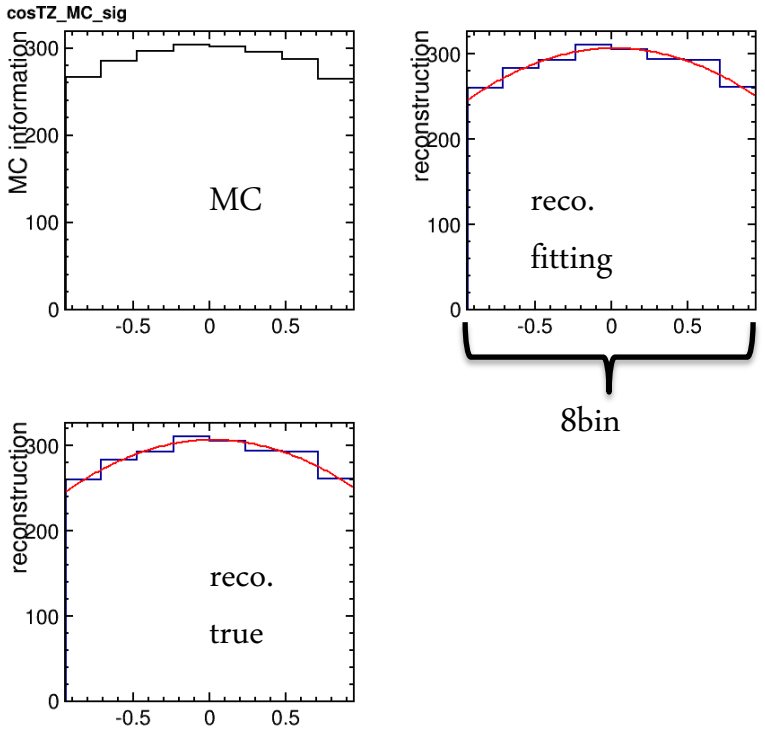


Minimum position :

x = 125.018 ± 0.021 (GeV)

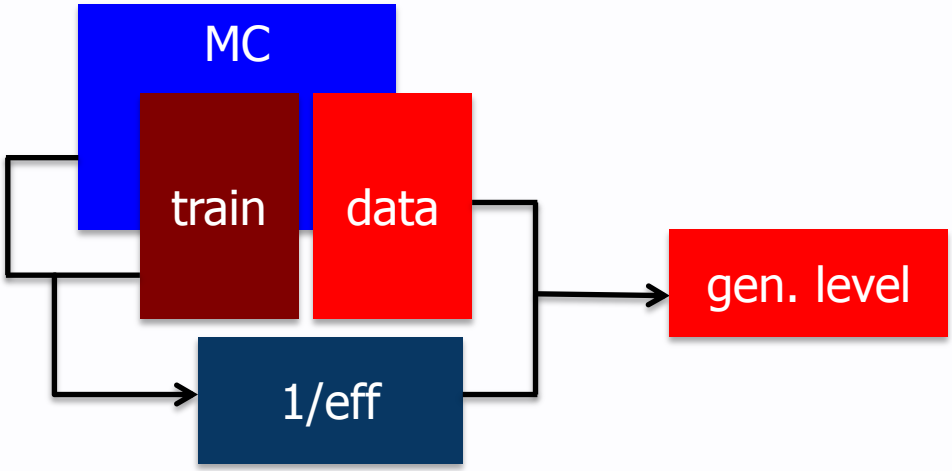
Procedure of CP-mixture Study

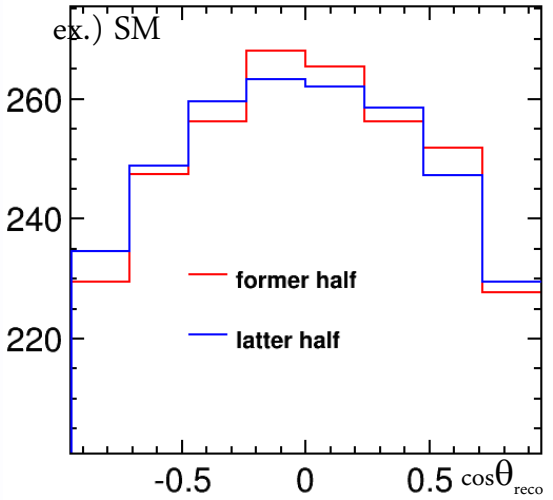
- Look Z production angle of μμh.
  - Optimal nbin is now being investigated (4bin and 8bin are tried).
- Estimate N_{sig} by recoil mass fitting for each region of $\cos\theta_{Z\ boson}$.
- Fit the obtained distribution by parabola, and check the asymmetry.



From Friday Meeting

Choosing Training Sample

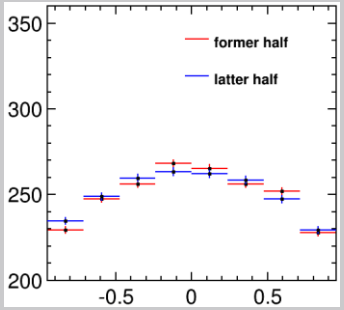
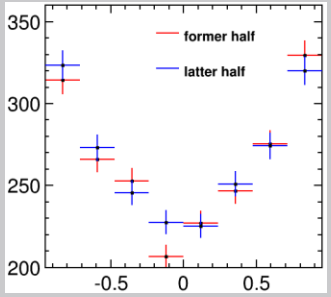
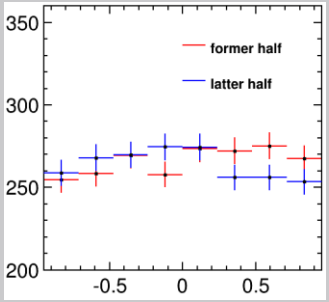
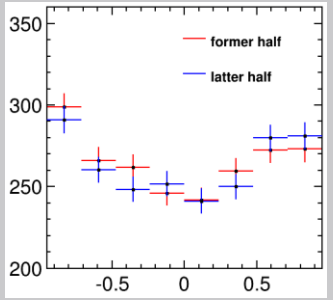
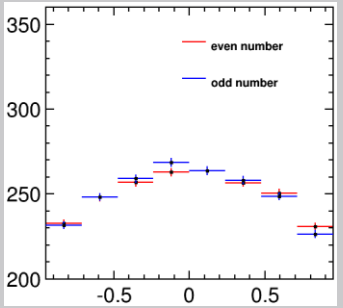
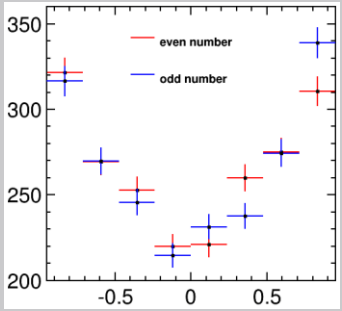
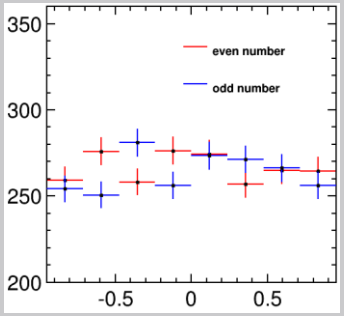
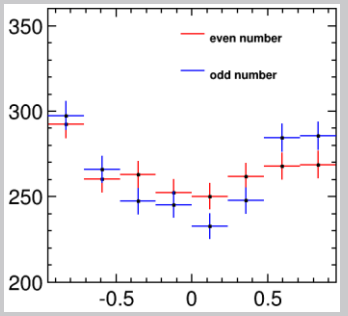




- Final distribution depends on how to choose training sample not negligibly (?).
- If former half events are used as training, efficiency distribution has smaller value in barrel part, so that final distribution scaled to generator level has smaller peak, and this causes worse result.
- A : former half events as training, latter half as data
  B : latter half events as training, former half as data

MC	266.9	285.0	296.9	304.0	301.5	295.7	287.4	264.2
A	272.9	286.6	300.8	298.5	297.7	298.3	282.1	266.2
B	261.0	283.3	293.1	309.5	305.4	293.0	292.7	262.3

Comparison Different Statistics

	DBD	a0b0bT3	a0b3bT0	a0b3bT3
former & latter				
KS	0.289337	0.879499	0.055522	0.780304
even & odd				
KS	0.696009	0.3992	0.573215	0.157217

- DBD has 100,000, others have 10,000 statistics.
- Though DBD has slight fluctuation also, it can be said that 100,000 statistics are needed when we look sensitivity to asymmetry of cosθ.

Re-calculation η

$$\frac{d\sigma}{dcos\theta} = \frac{G_F^2 M_Z^6 \beta}{16\pi} \frac{1}{D_Z(s)} (v_e^2 + a_e^2) \left[1 + \frac{s\beta^2}{8M_Z^2}(1 - cos^2\theta) + \eta \frac{v_e a_e}{v_e^2 + a_e^2} \frac{2s\beta}{M_Z^2} \cos\theta + \eta^2 \frac{s^2\beta^2}{4M_Z^4} \left(1 - sin^2 \frac{\theta}{2} \right) \right]$$

※

$$\begin{cases} v_e - a_e = \dfrac{e}{\cos\theta_w \sin\theta_w} \left(-\dfrac{1}{2} + \sin^2\theta_w \right) \\ v_e + a_e = \dfrac{e}{\cos\theta_w \sin\theta_w} (-\sin^2\theta_w) \end{cases}$$

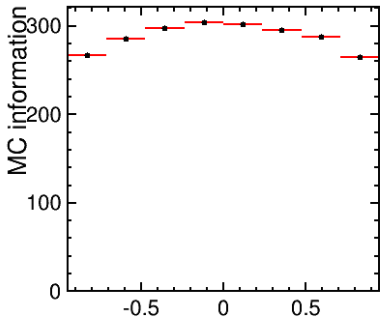
When define coefficients of pol2 of cosθ distribution as p_1 and p_2, η can be expressed as following.

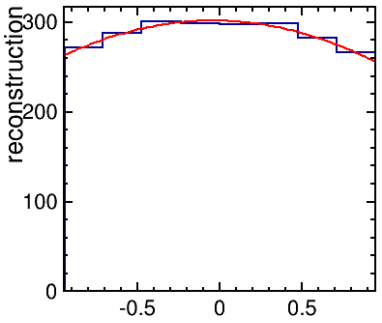
$$\eta = \frac{M_Z^2}{2s} \left[-\frac{16}{\beta} \frac{v_e a_e}{v_e^2 + a_e^2} \pm \sqrt{\frac{16^2}{\beta^2} \left(\frac{v_e a_e}{v_e^2 + a_e^2} \right)^2 - \frac{4s}{M_Z^2} \frac{p_1}{p_2}} \right] = 0.06654 \times \left[-2.411 \pm \sqrt{5.811 - 30.06 \times \frac{p_1}{p_2}} \right]$$

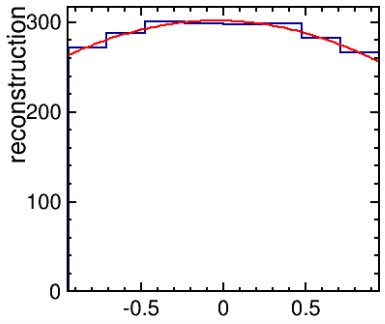
$$\eta = -\frac{\beta}{16} \frac{v_e^2 + a_e^2}{v_e a_e} \frac{p_1}{p_2} = -0.4148 \ldots \times \frac{p_1}{p_2}$$

Result

- Expression from re-calculation is used.
- Former half events are used as training sample.
- Using expression with $O(\eta^2)$ term,
  $\eta = -0.0398$



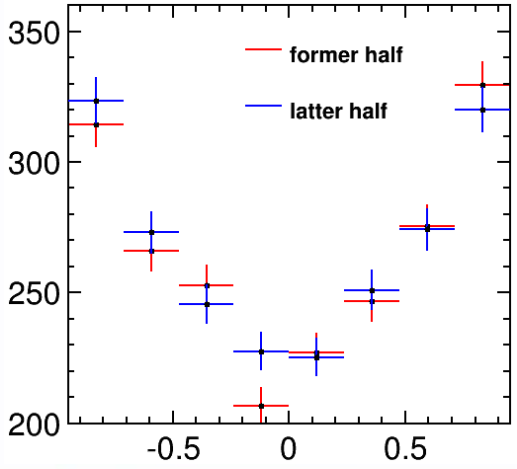




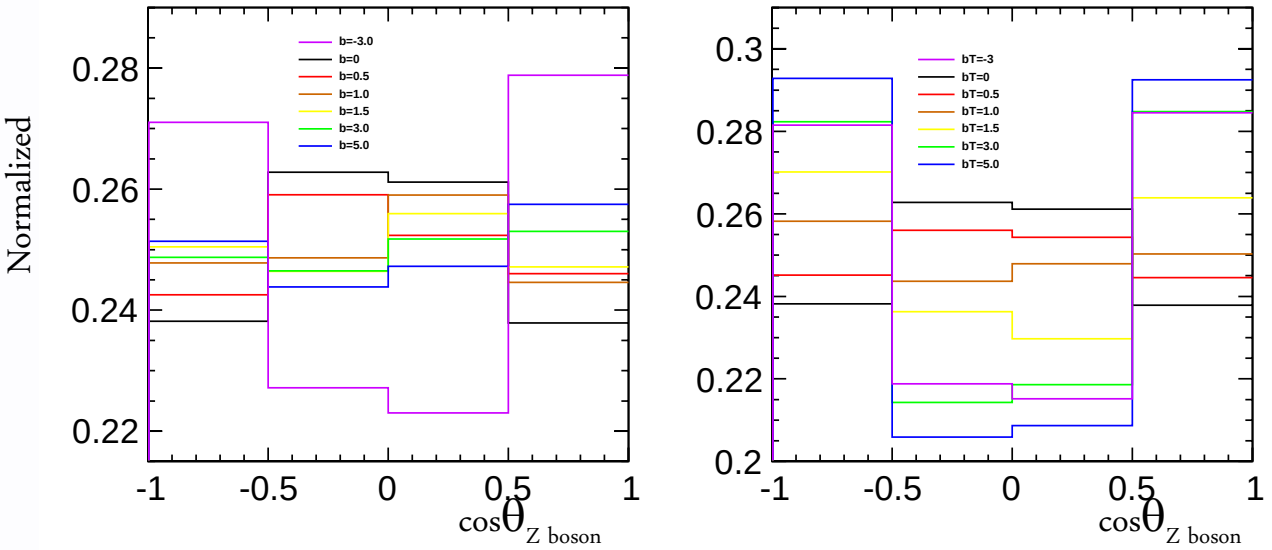
η = -0.0694
+- 0.1569

About Relation b/w η and a, b, $\tilde{b}$

- a, b, $\tilde{b}$ are parameters of H->WW decay, so it seems to be difficult to compare with ZZH coupling simply.
- HWW coupling may not include only Higgs CP-mixture, but also additional new physics.
- It is good to fit distribution in MC to know actual η value rather than calculate η from a, b, and $\tilde{b}$ parameters.
- Right figure is $\tilde{b}$=3 ($\tilde{b}$ may shift peak position of cosθ). It has no peak and inconsistent with $d\sigma/d\cos\theta$ expression using η (p_2>0 always).



How b, b~ Changes cosθ?



- A parameter of b or b~ is changed for trial separately.
- Except parameters are fixed to zero.
- b~ obviously changes curvature of parabola (right figure).
- b seems to change curvature also, but may be more complicated (left)?
- Calculated A_{FB} := ($N_{\cos\theta<0}$ - $N_{\cos\theta>0}$) / ($N_{\cos\theta<0}$ + $N_{\cos\theta>0}$) is following.

b or b~ value	-3	0	0.5	1.0	1.5	3.0	5.0
$A_{FB}(b)x10^3$=	3.65	1.96	3.20	-7.15	-6.25	-9.55	-9.50
$A_{FB}(b\tilde{})x10^3$=	0.650	1.96	2.30	3.75	12.9	-6.80	-2.50

Next Plan

- Estimate “correct” η error.
- Find optimal value of a, b, $b^{\sim}$ to analyze sensitivity to η.
- After that, it may be good to aim the analysis with Higgs decay plane.

- Start to write master thesis outline soon.
  - “An analysis of mass, cross section, and CP mixing of the Higgs particle at the International Linear Collider”