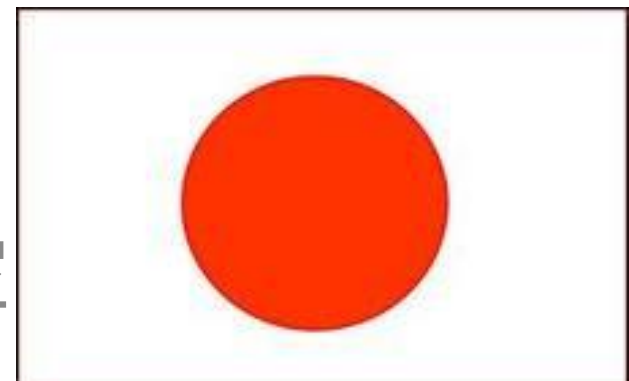




S/N Separation method for Low-mass Higgs search



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素粒子実験研究室



Higgs Production

$$q\bar{q} \rightarrow WH$$

Figure 2.1: The most important processes for Higgs production at hadron colliders. Gluon fusion (a), vector boson fusion (b), Associative production with W (c) and an example of the diagrams having associative production with a top pair (d).

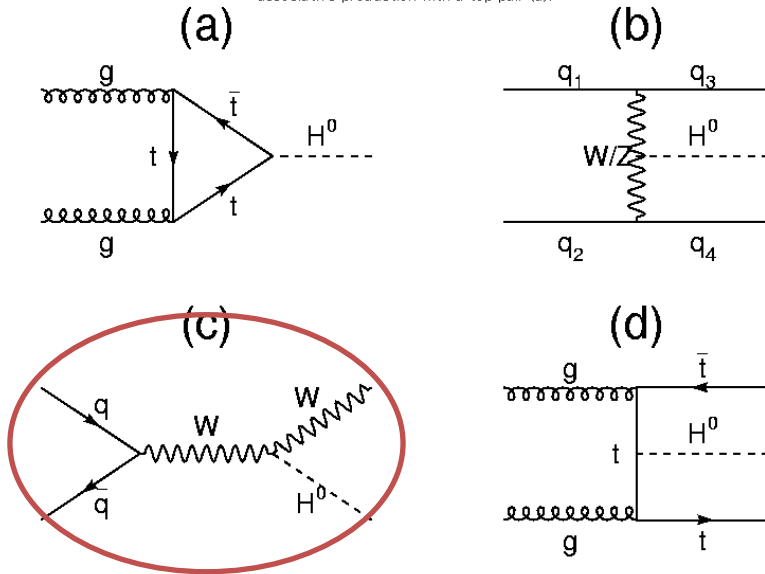
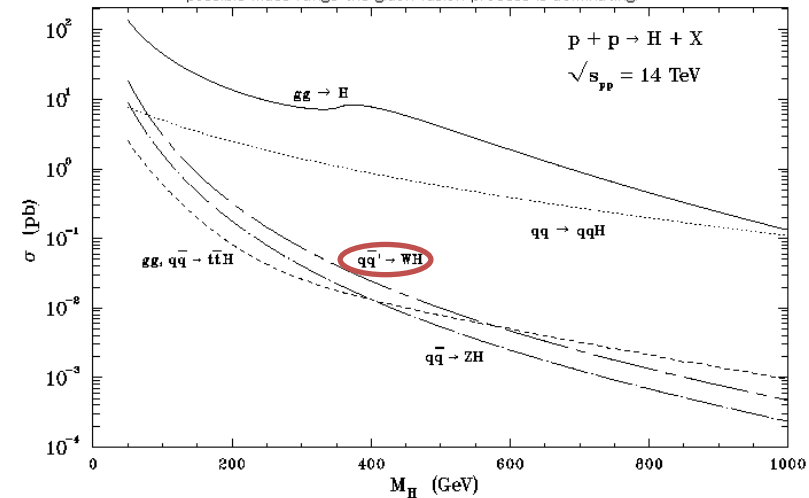


Figure 2.2: The production cross section of the standard model Higgs boson. Across the complete possible mass range the gluon fusion process is dominating.



Advantage

▪ Backgroundとの分離が簡単

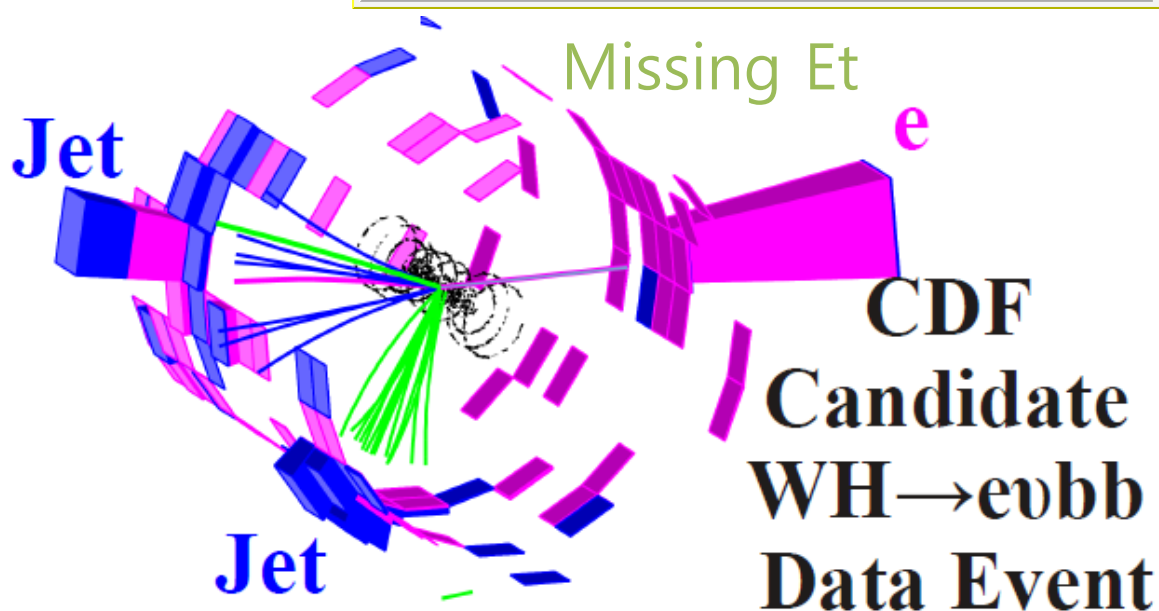
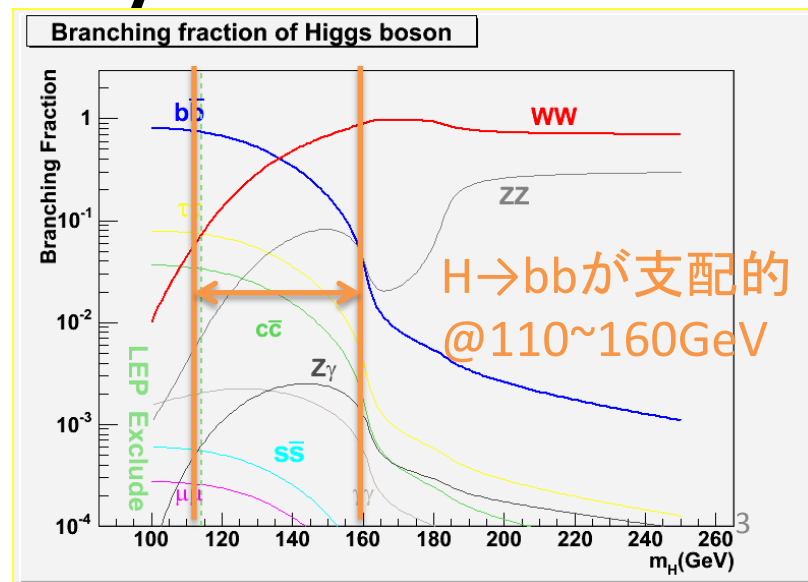
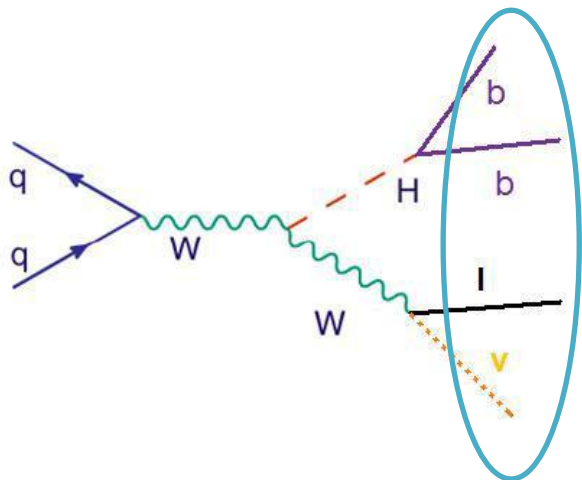
Disadvantage

▪ Cross sectionが比較的小さい

Higgs Decay

$$q\bar{q} \rightarrow WH \rightarrow b\bar{b}l\nu$$

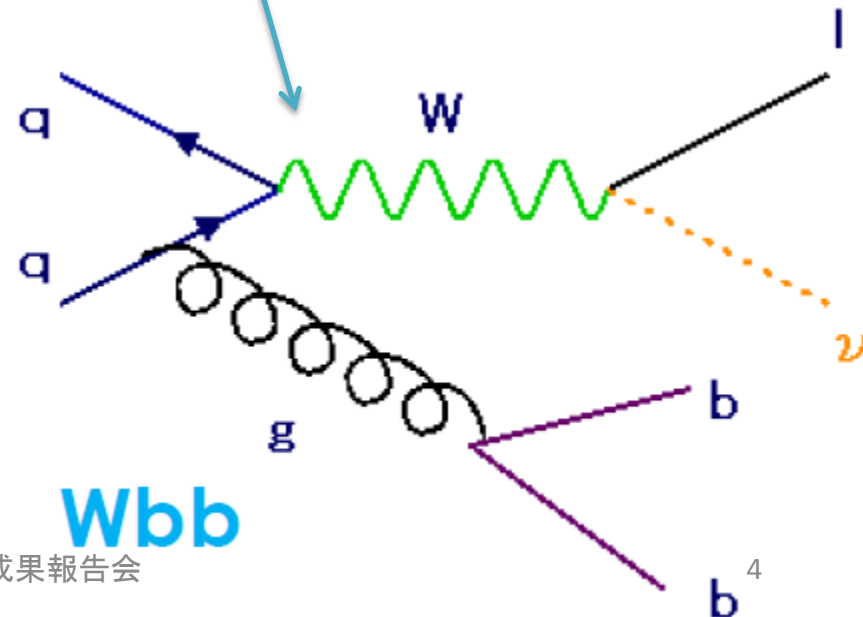
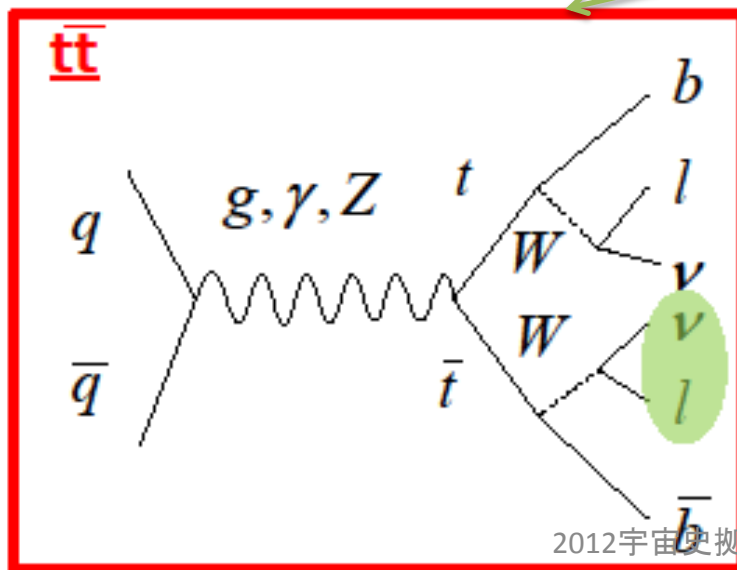
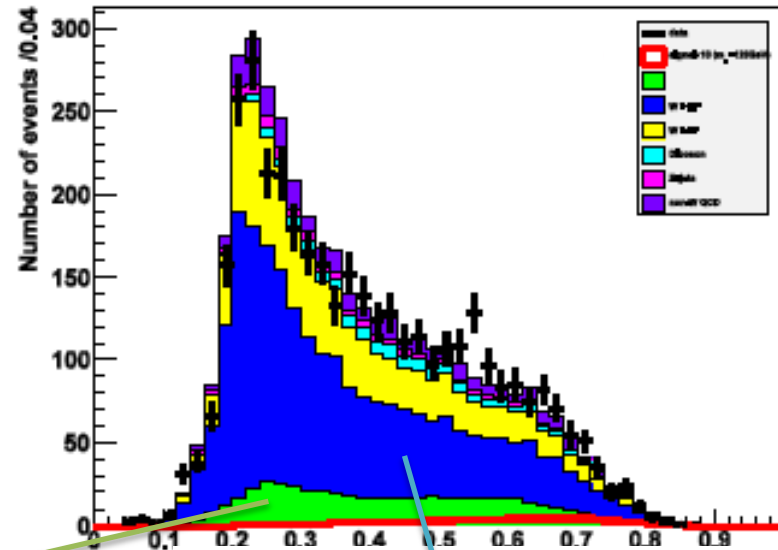
120GeV、140GeVのHiggsに対して解析を行う



Background

主なbackgroundは
Wbb, ttbar

→分布の違いから、
signalとbkgを分離する



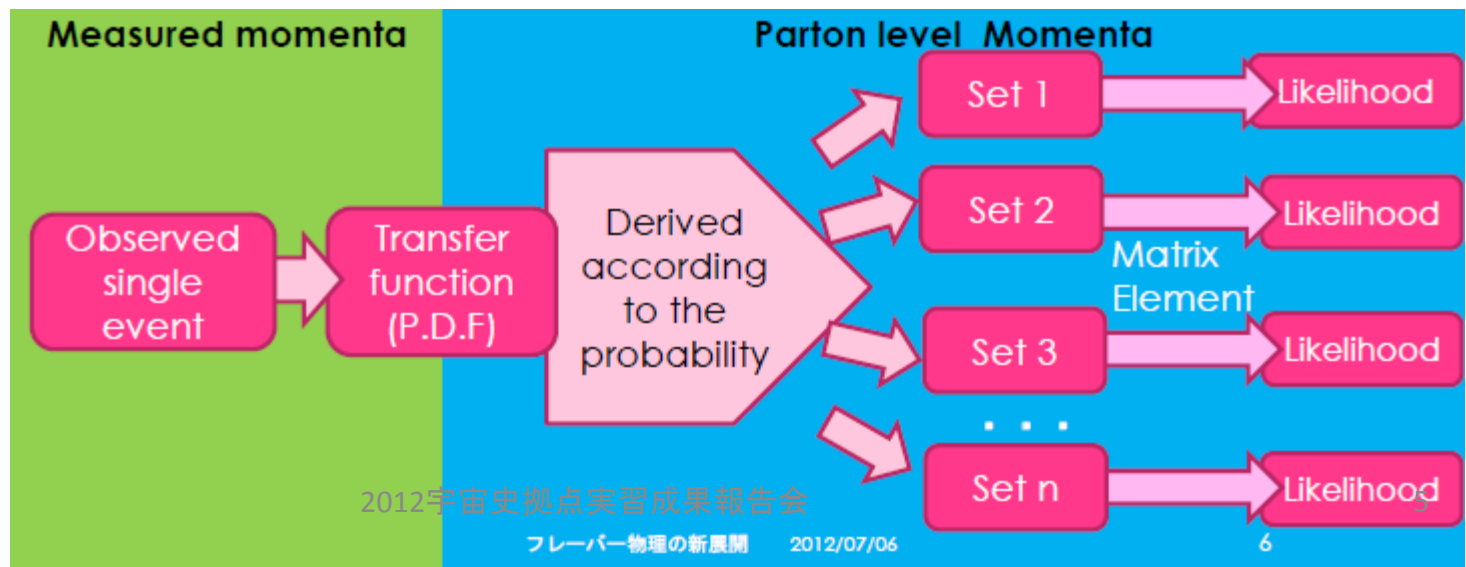
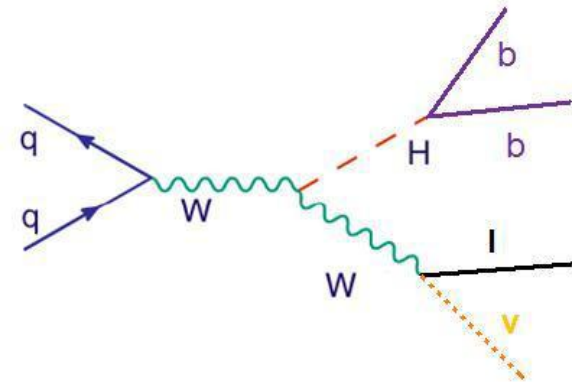
Dynamical Likelihood Method

$$L = \frac{d\sigma}{d\Omega} w(x | y)$$

$w(x | y)$: Transfer function

値 x が観測された時の真の値 y の確率分布

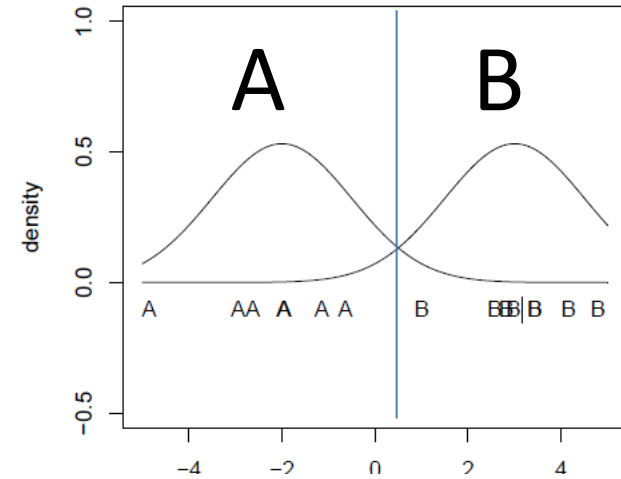
1eventから n セットの運動量を取得
→任意のHiggs massをparameterにした
likelihoodの分布



Discriminant Analysis

分布の違いから、signalとbackgroundを分離

training sampleで分布を作成
→test sampleを適用して判断させる

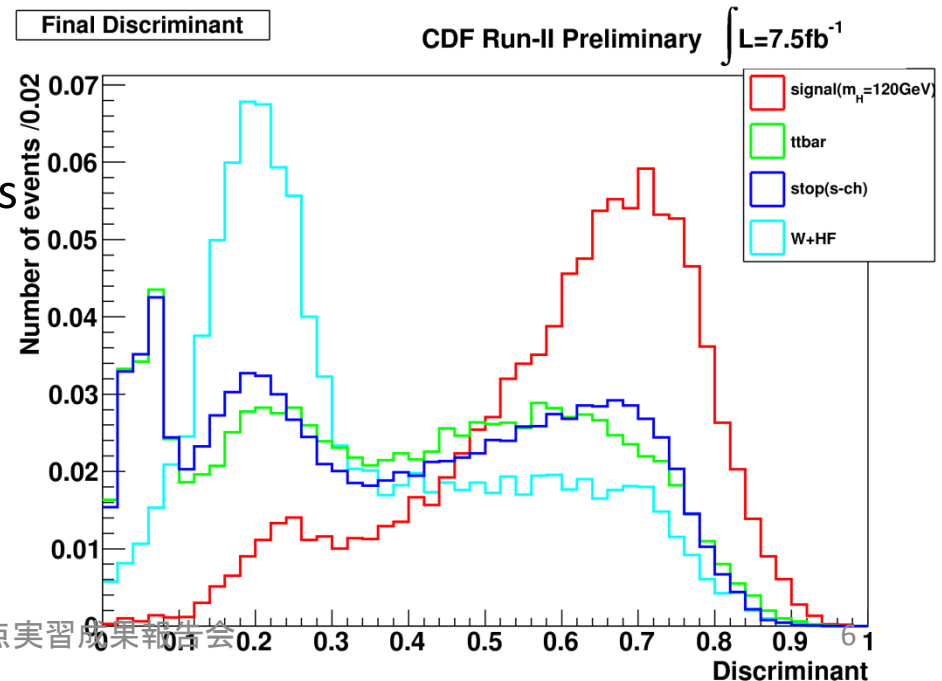


Discriminant分布の作成

Likelihoodを元にした複数のinput variables
“signalらしさ”をパラメーターにした分布

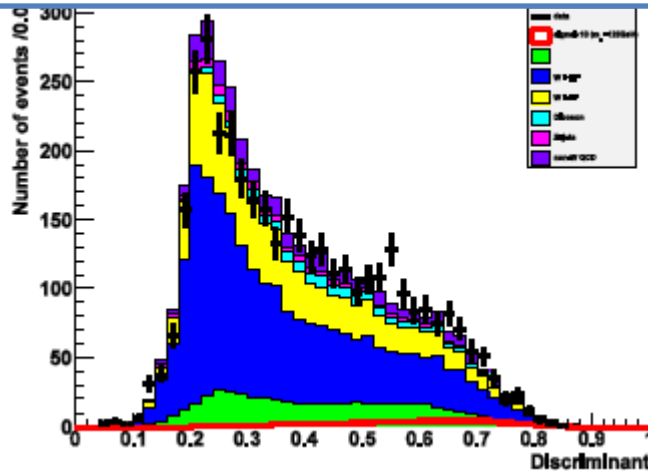
Final discriminant

Wbb vs signal → ttbar contamination



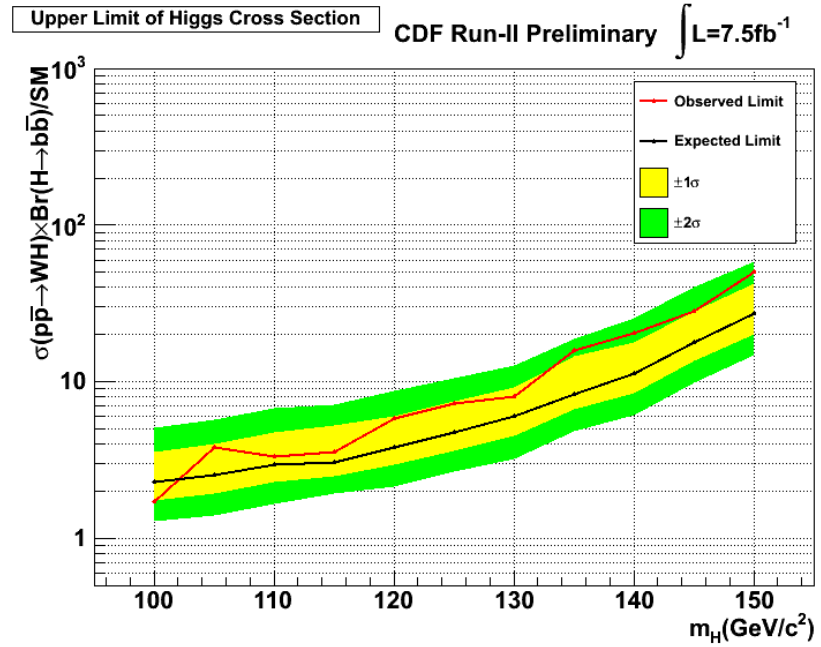
MC Limit calculation

Final discriminant分布を元にrandom eventを作成(pseudo experiment)



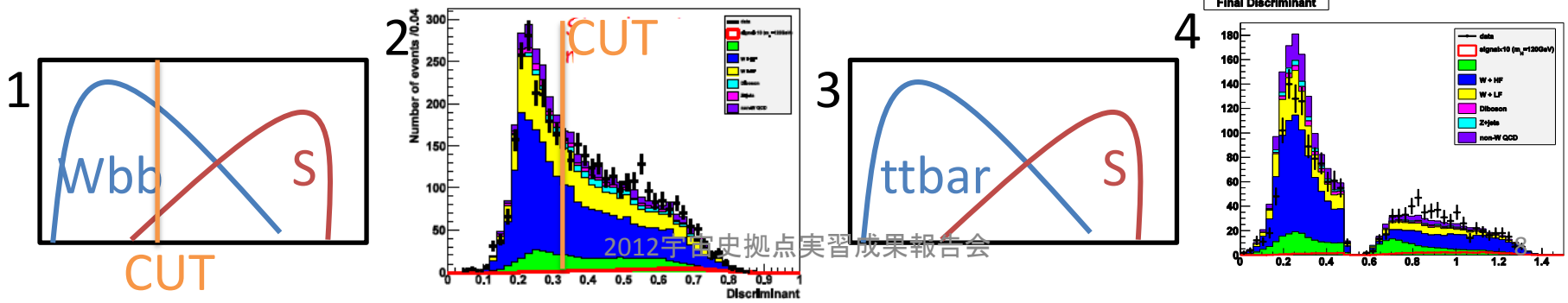
各bin毎にS/Nをとり、likelihoodから95%C.L.となるcross sectionを求める

SMのcross sectionとのずれを見積もる

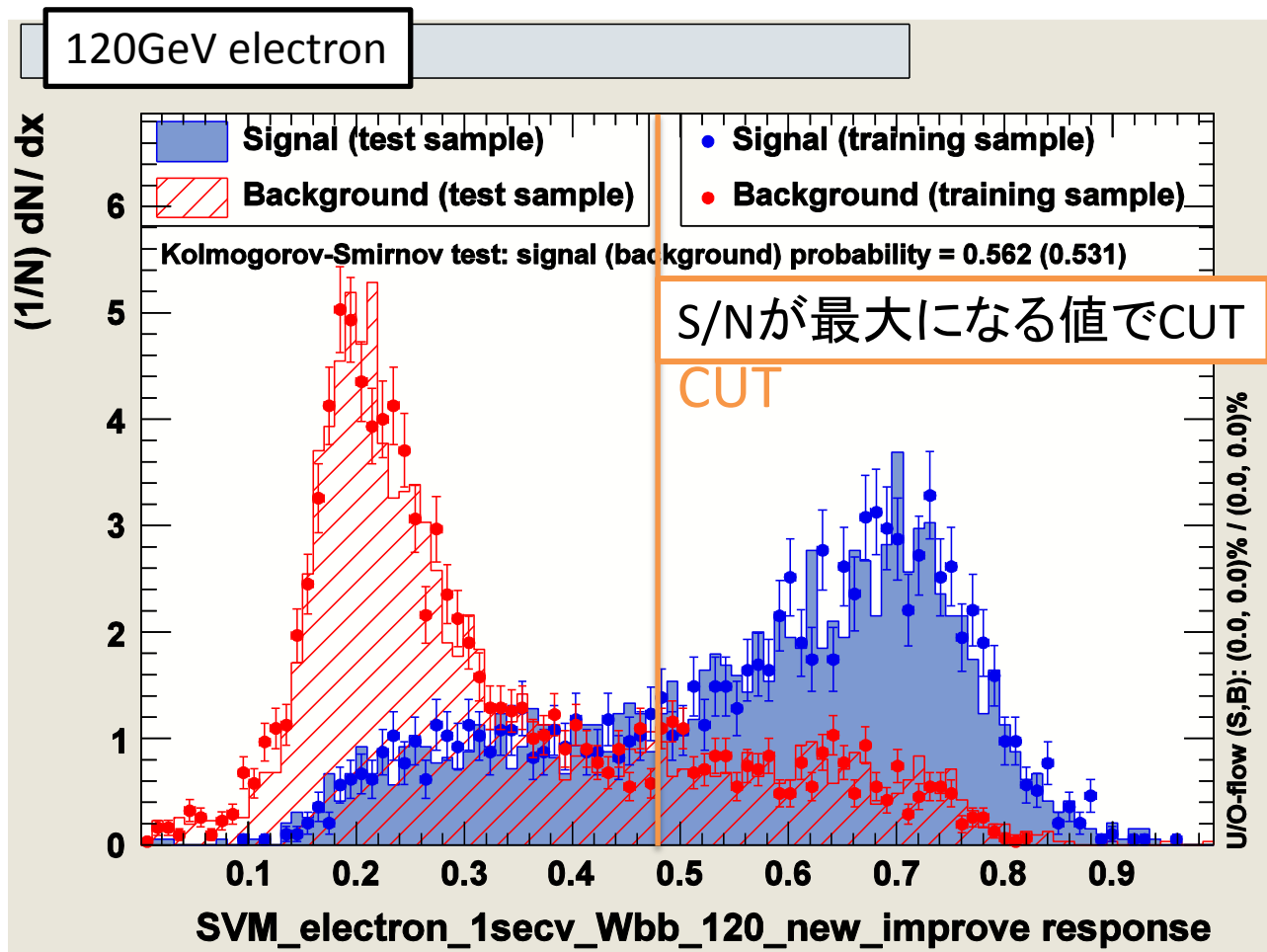


Analysis flow

1. signal vs Wbbでtrainingし、CUT値を設定
2. overall data全体に適用し、CUT
3. CUT後のHigh score sampleでsignal vs ttbar の training
4. Low scoreとHigh score(ttbar trained)のFinal discriminant作成
5. Higgs massのLimit計算

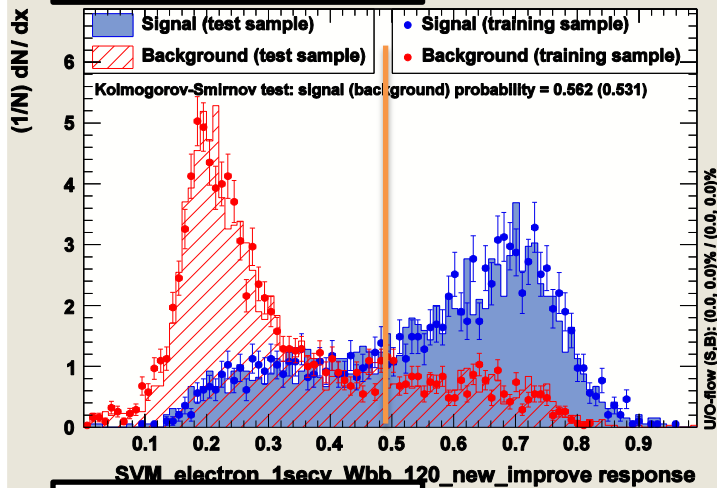


Signal vs Wbb Discriminant

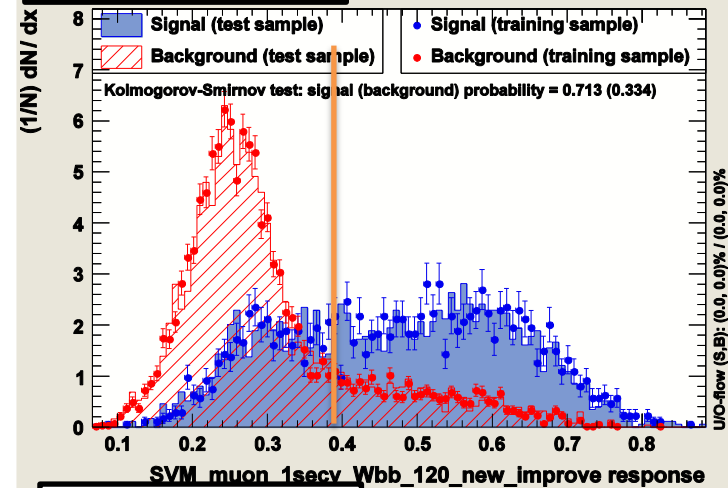


Signal vs Wbb Discriminant

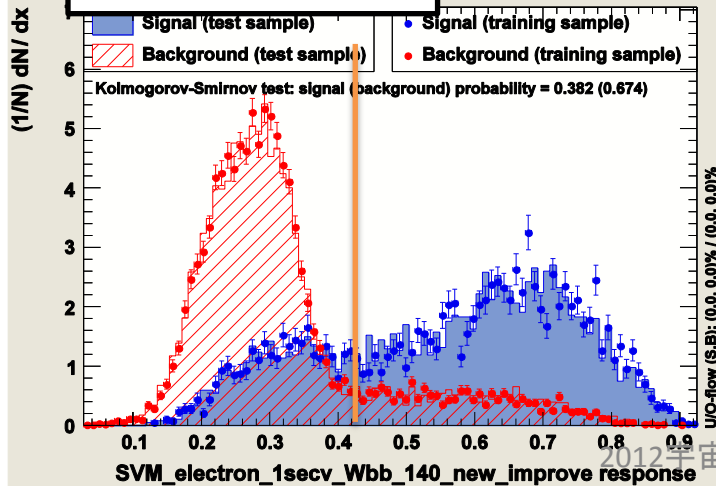
120GeV electron



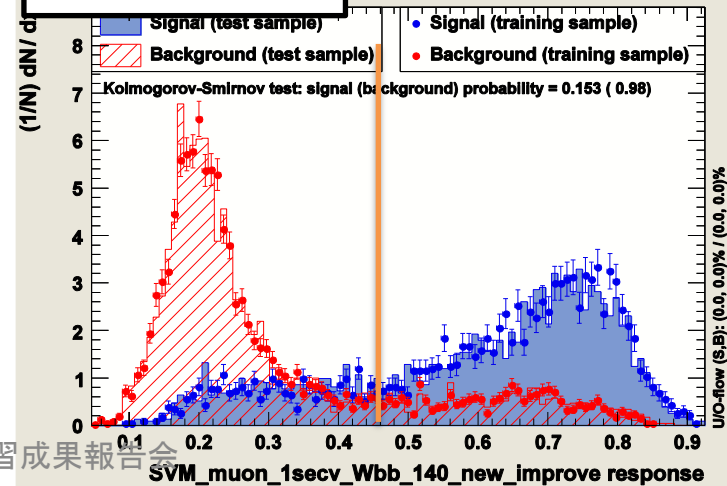
120GeV muon



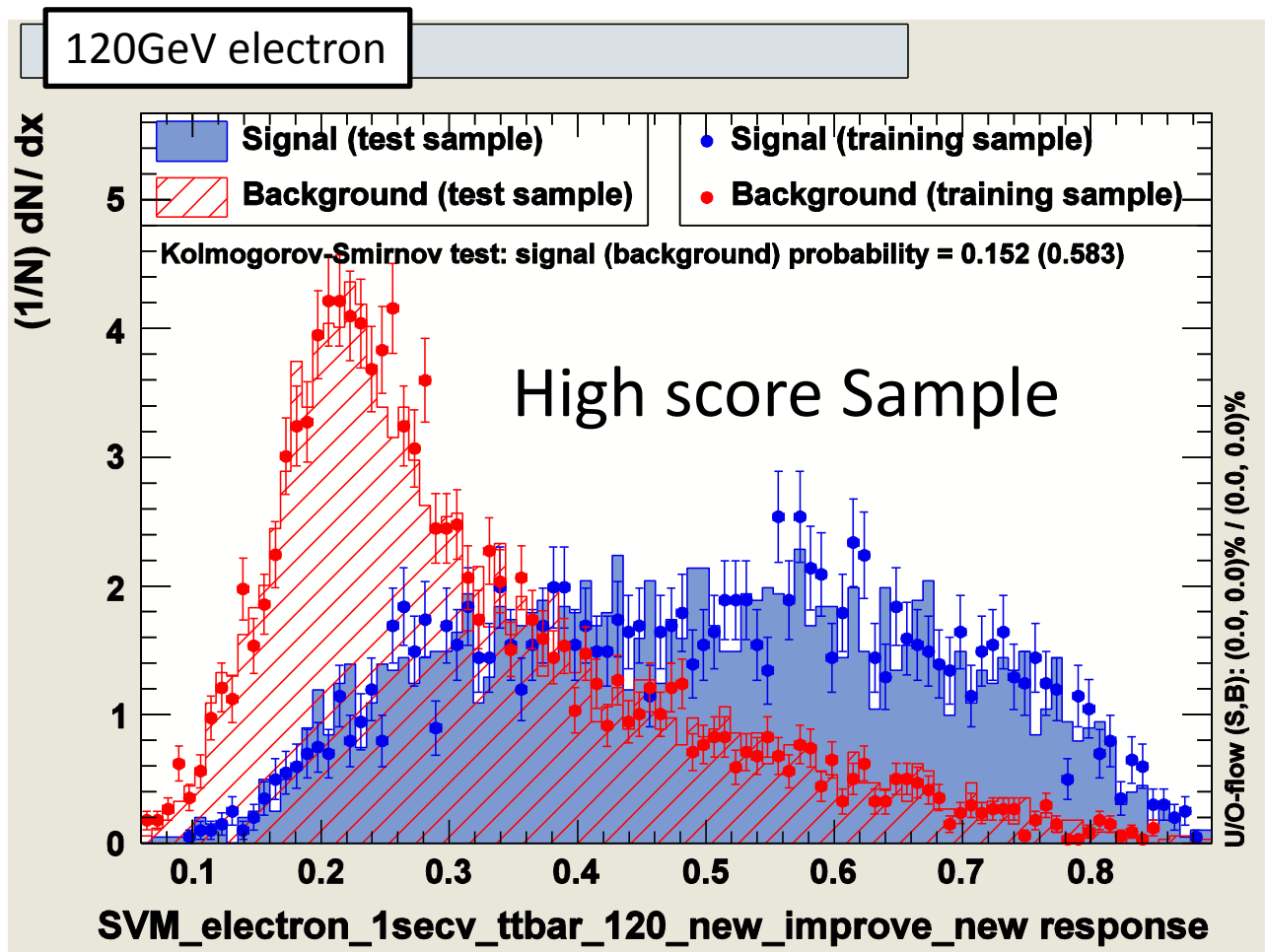
140GeV electron



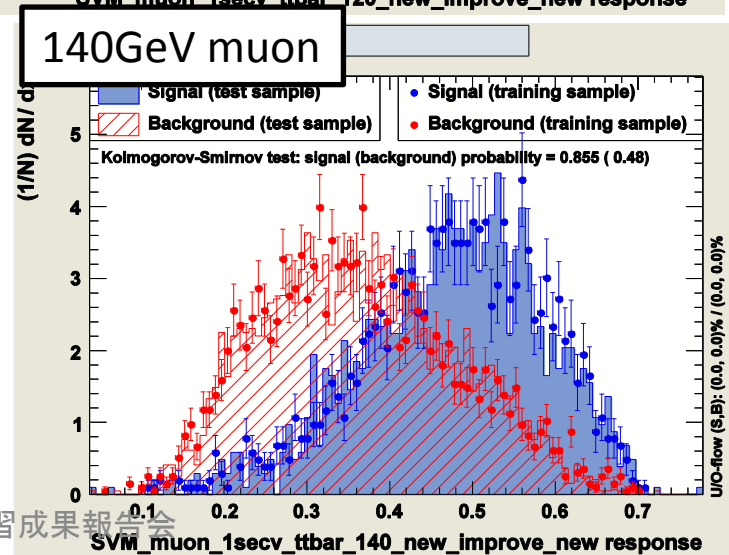
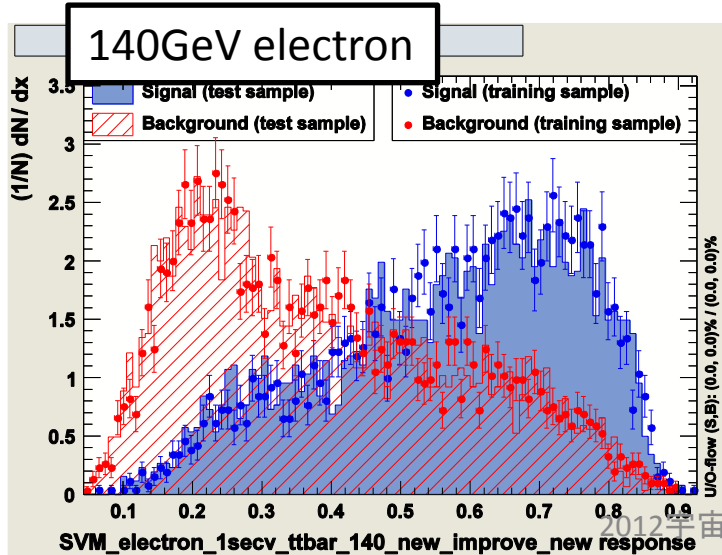
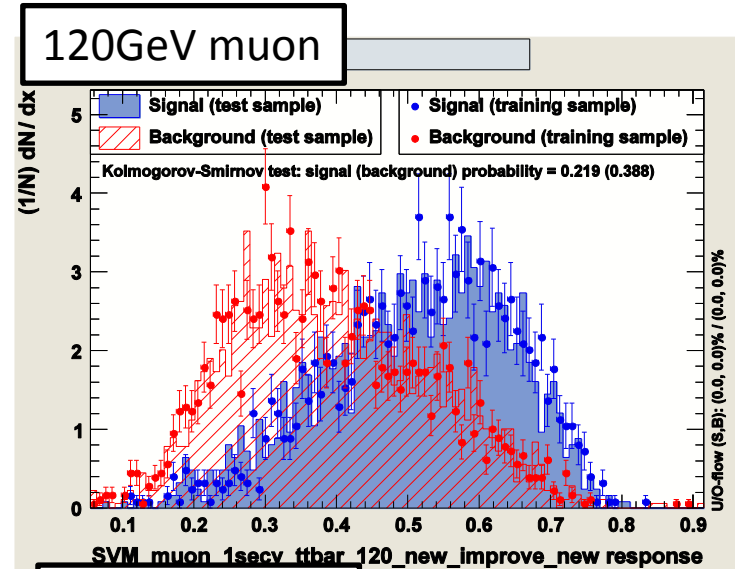
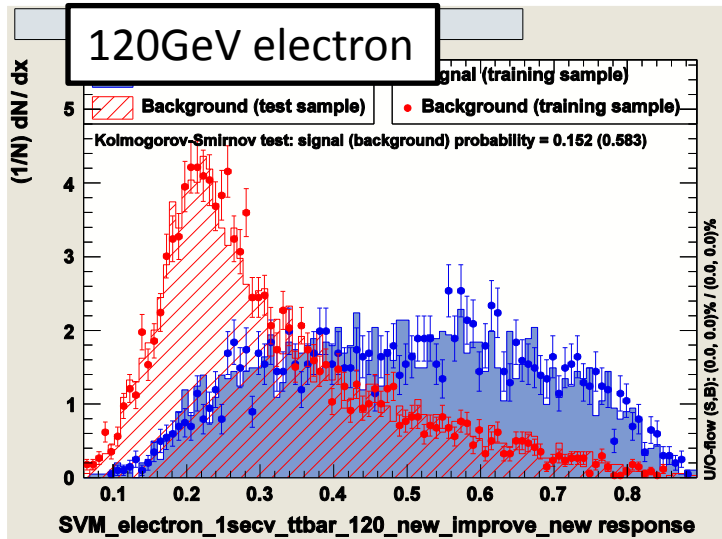
140GeV muon



Signal vs ttbar Discriminant



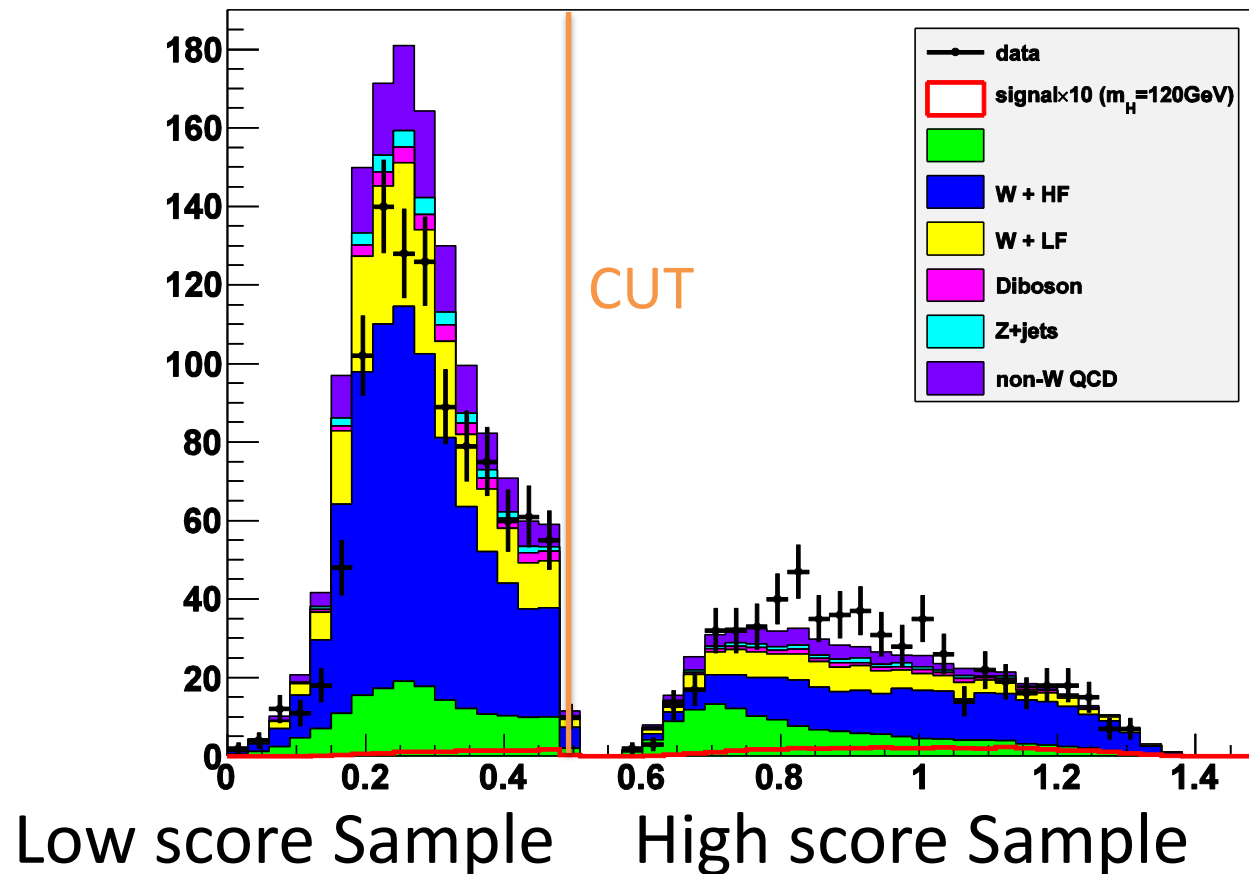
Signal vs ttbar Discriminant



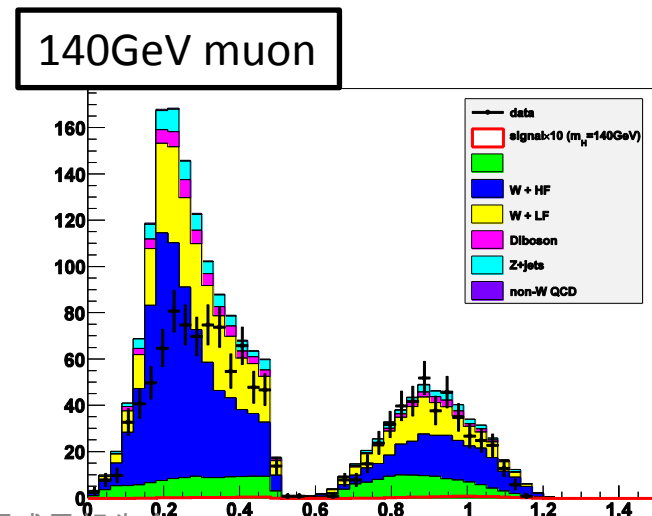
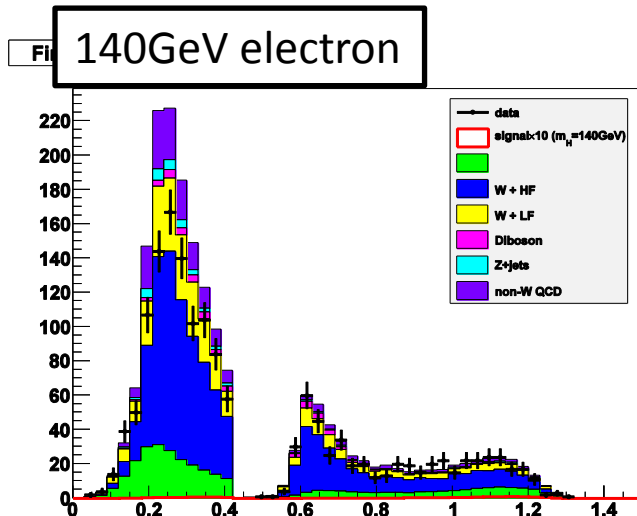
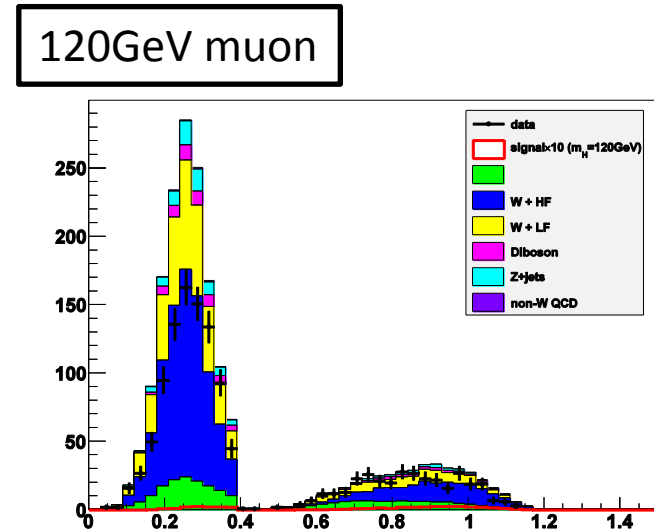
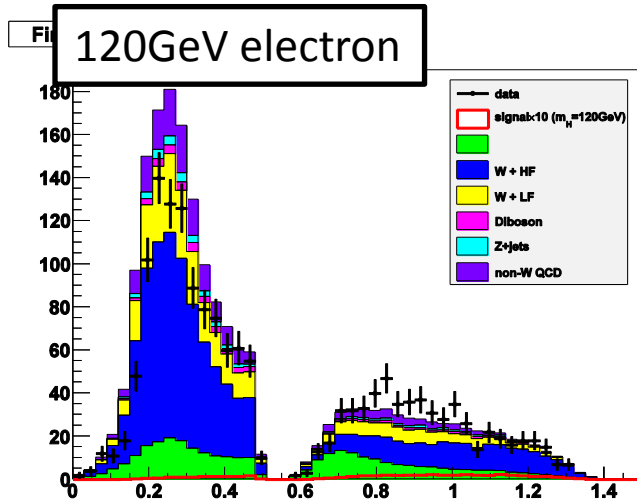
Final Discriminant

Final Discriminant

120GeV electron



Final Discriminant



Higgs mass limit

Limit was improved!

$m_H = 120 GeV$	-2σ	-1σ	Mean	$+1\sigma$	$+2\sigma$
Mr.Kurata analysis	7.61	9.89	13.94	19.35	26.65
My analysis	5.78	7.78	10.94	15.40	21.02

$m_H = 140 GeV$	-2σ	-1σ	Mean	$+1\sigma$	$+2\sigma$
My analysis	18.05	25.01	34.74	49.06	63.53

Summary

- Low mass Higgsのbackgroundとなる Wbb 、 $t\bar{t}b\bar{b}$ 事象をsignalと分離するために、2段階のDiscriminant解析を行った。
- 得られたmass limitは1段階での結果よりも良い結果になった。
- Discriminant作成の際のtune upをすることで、さらなる結果の向上が期待される。

Thank you



Backup

Support Vector Machine

Input variables

Maximum Likelihood

event by eventでLikelihoodが
Maximumとなる m をとる

Higgs-part Likelihood

$H \rightarrow b\bar{b}$ 部分でのmaximum
likelihood

W-part Likelihood

$W \rightarrow l\nu$ 部分でのmaximum
likelihood

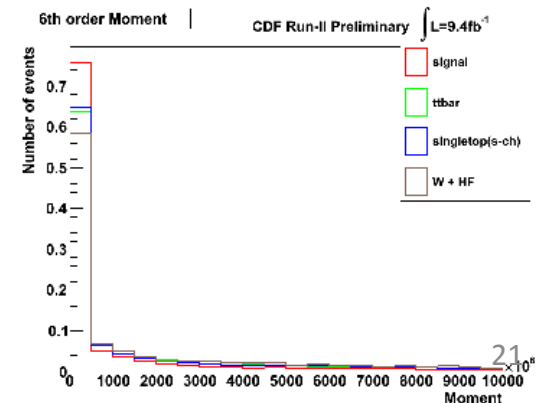
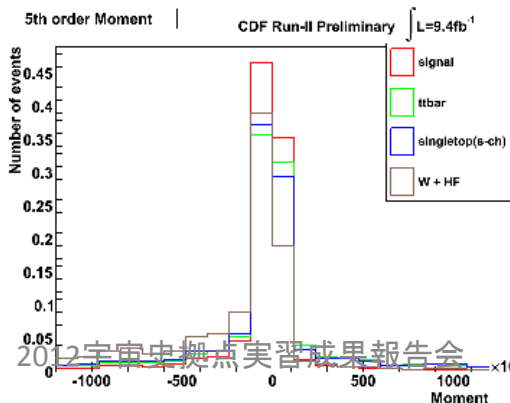
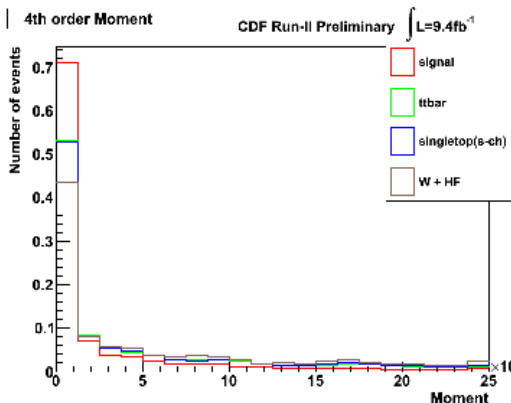
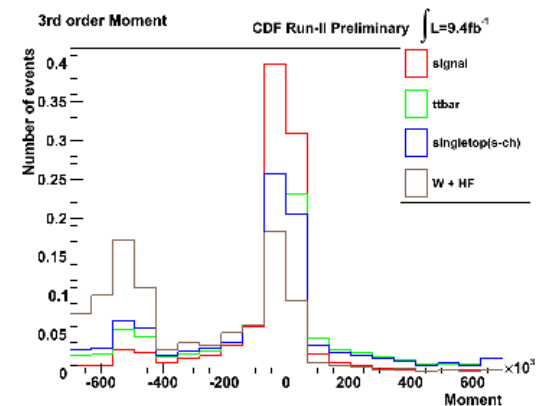
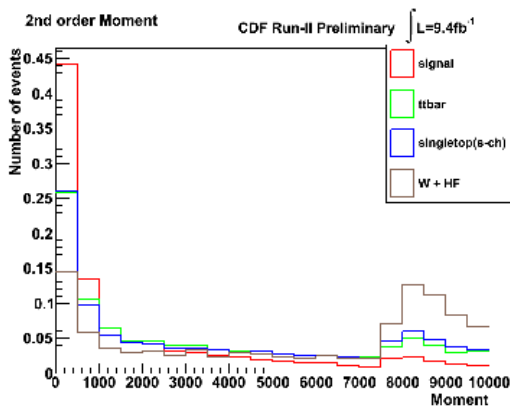
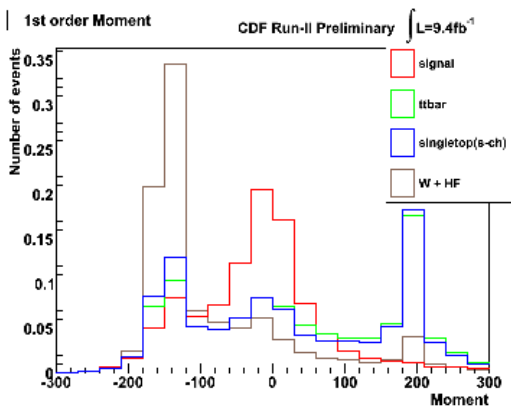
p-part Likelihood

各event毎のmaximumが
meanとどれくらいずれている
か

Input variables

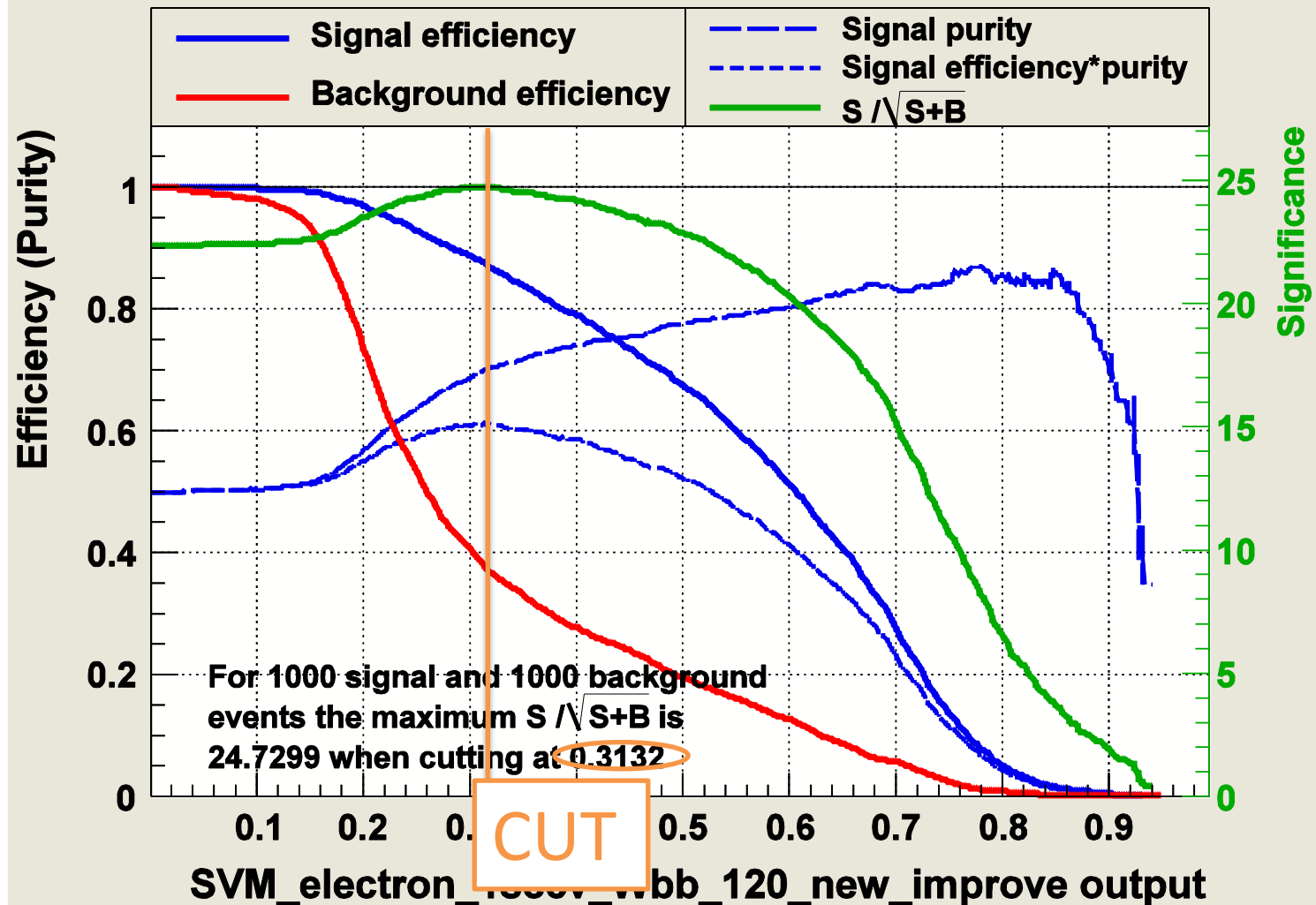
n次のモーメント $\int (m - m_0)^n f(m) dm$

signal事象は0になりやすい

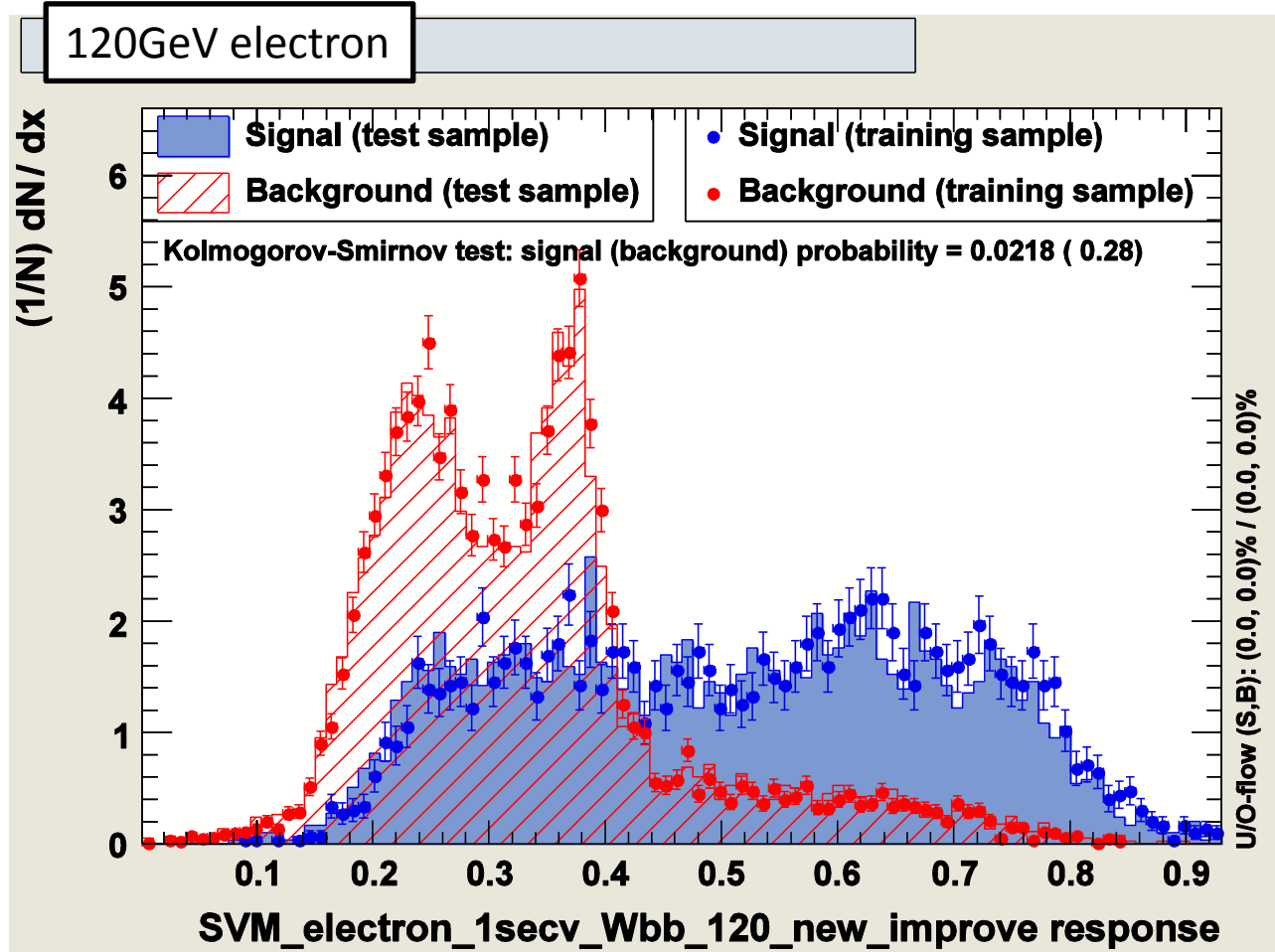


CUT

Cut efficiencies and optimal cut value



$t\bar{t} \rightarrow \text{CUT} \rightarrow Wbb$



Final Discriminant

