ToyMC using gauss distribution

- To confirm the calculation results of the mass limit, we created a toyMC using a Gaussian distribution, performed a fit, and verified the results.
- To sum over all bins & all polarization patterns (total of 6), useing the following formula:
- *No charge id 1bin & charge id 2bin(forward-backward)*

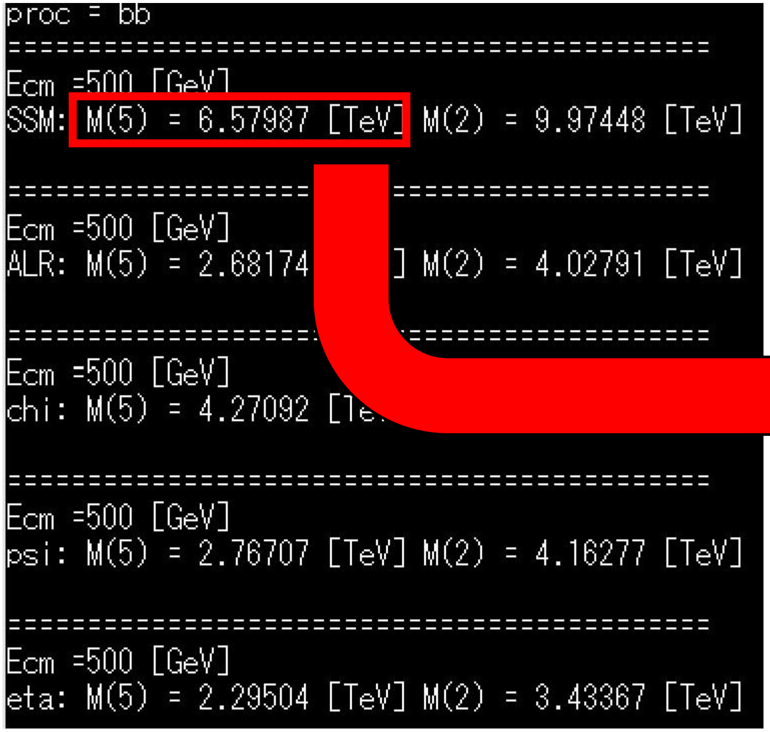
$$\sum\left(\frac{(\boldsymbol{gaussian\ random\ number}\ with\ mean:\ \delta\sigma,\ sigma:\ error)}{error}\right)^2$$

$\delta\sigma = \frac{\delta\sigma_i(BSM)}{\sigma_i(SM)}$: Deviation of the differential cross－section from the Standard Model for the i－th bin (0 for the Standard Model)

$error = \frac{\sqrt{S_i + N_i}}{S_i}$: **S_i: the number of signal event, N_i: the number of background event in each bin**

- We repeat this process 10,000 times and create two plots: one for the Standard Model in the bb channel and another for the Z' model (SSM) in the same channel.
- We perform a chi-squared fit for the Standard Model and a Gaussian fit for the Z' model.
- To determine the probability of the Standard Model chi-square function at the mean value of the Z' model Gaussian function and check if it corresponds to a 5-sigma significance.

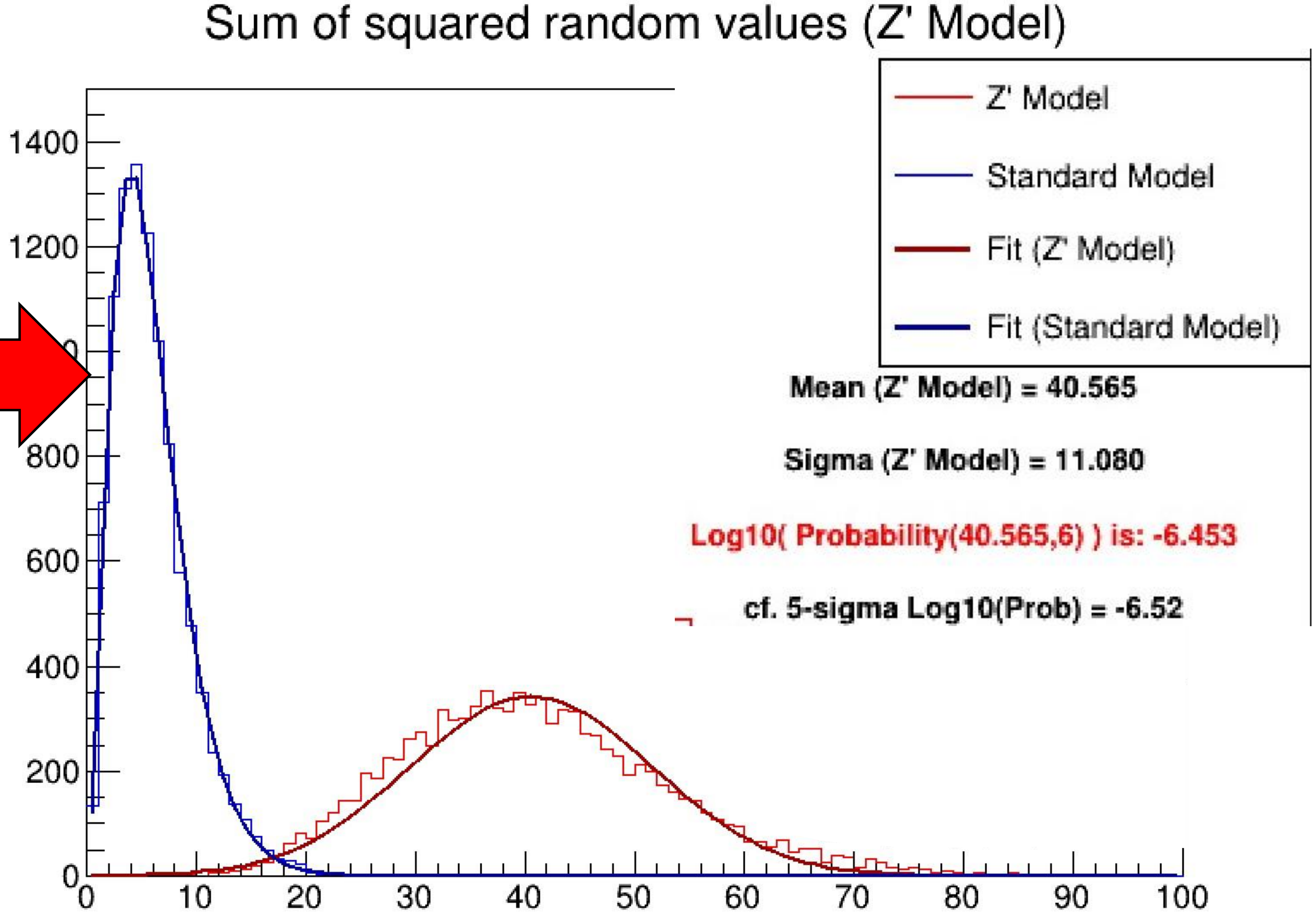
ToyMC using gauss distribution



Mass Limit

5-sigma -> discovery reach
2-sigma -> 95% CL lower limit

Z' Model ->SSM



$\mathbf{Z'}$の識別性能の評価

- ILCにおける$\cos\theta$分布のi番目のビンの精度$(\delta\sigma_i/\sigma_i(SM))$
（今回はforward-backwardの２ビンに分けた）

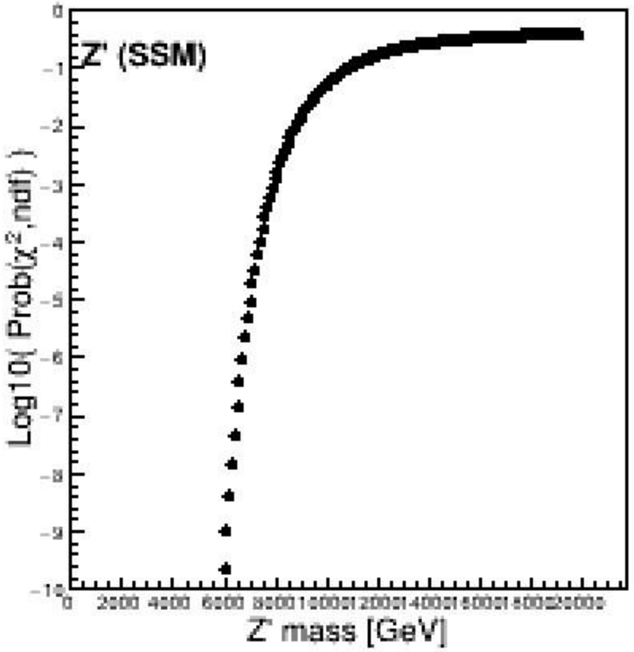
$$\frac{\delta\sigma_i}{\sigma_i(SM)} = \sqrt{\left(\frac{\sqrt{S_i + N_i}}{S_i}\right)^2 + {\sigma_{syst}}^2}$$

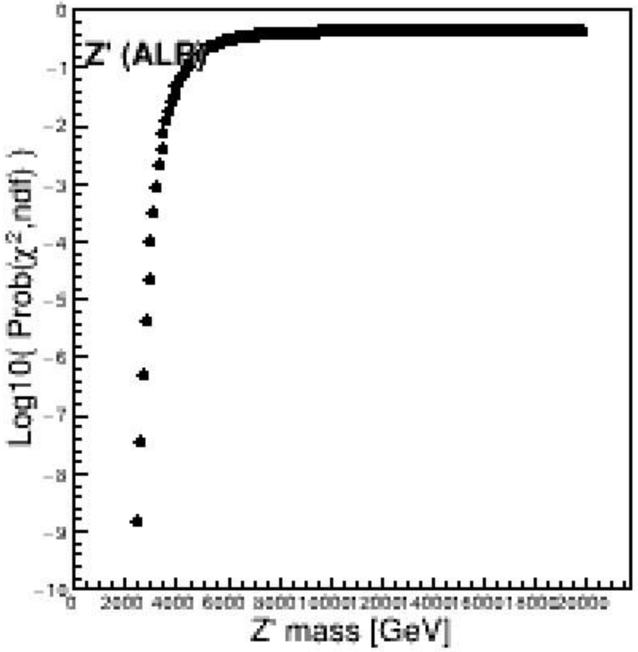
$\boldsymbol{S_i}$: **the number of signal events**
$\boldsymbol{N_i}$: **the number of background events** **in each bin.**
In this evaluation, **systematic errors of 0.0 for b and 0.0 for c** are assumed.

- このi番目のビンに対する標準模型と各モデルによる微分断面積の偏差$(\delta\sigma_i(BSM)/\sigma_i(SM))$ を計算し、

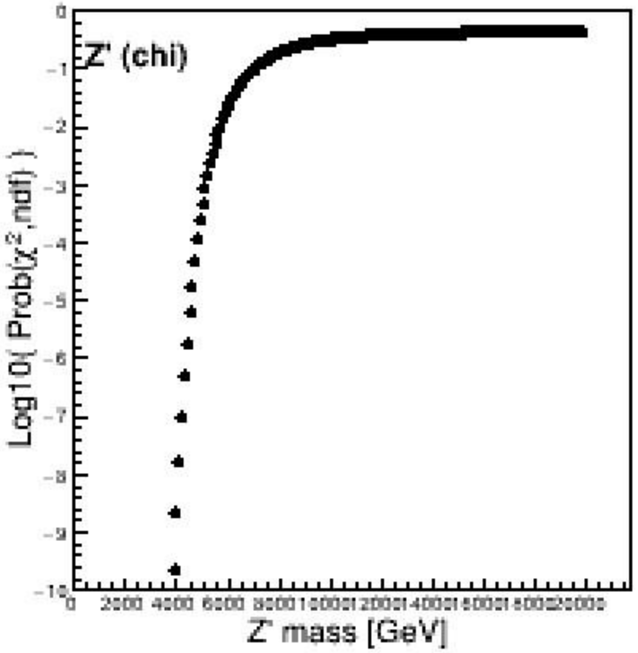
$$\chi^2(BSM) = \sum_i \left\{\left(\frac{\delta\sigma_i(BSM)}{\sigma_i(SM)} / \frac{\delta\sigma_i}{\sigma_i(SM)}\right)^2\right\}$$

から、χ^2 が得られる



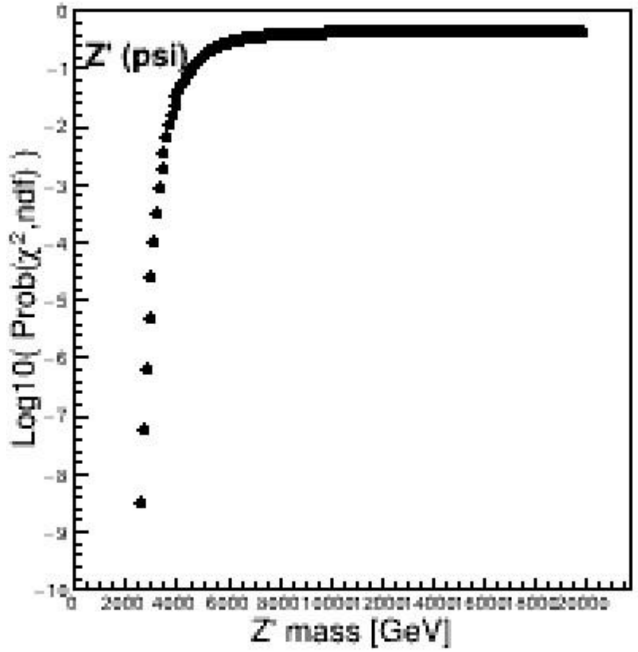


-10~0

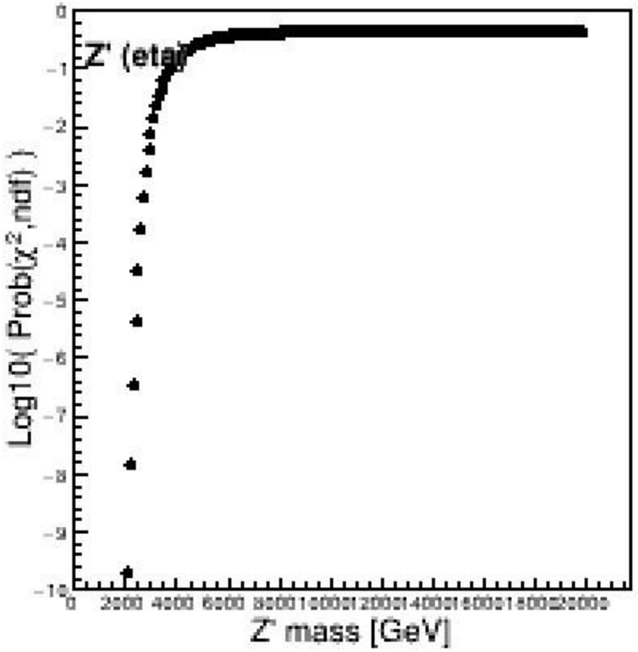


1000~20000

Graph



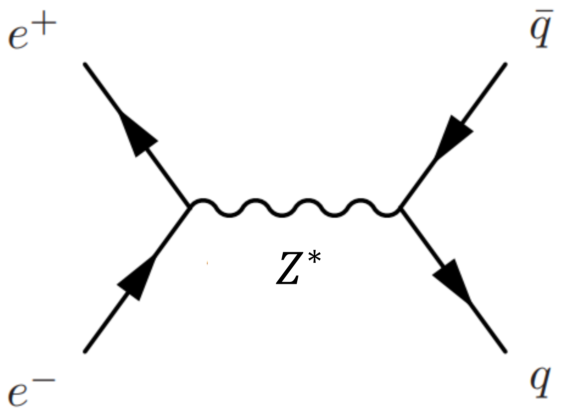
Graph



We calculated the overall significance of the Z' model in the bb channel by scanning the mass of the Z' and determined the mass limit.

Using events

- ILDフルシミュレーション(v02-00-01)を用いたクォーク事象@500GeVの生成
- **Signal Events**:
  - $e^{+}e^{-} \rightarrow q\bar{q}$ (Z^{*} true mass≥450 GeV)
- **Background Events**:
  - 2-fermion background
    $e^{+}e^{-} \rightarrow q\bar{q}$ (Z^{*} true mass<450 GeV)
  - 4-fermion background
    hadronic events (mainly W/Z-derived)
    semileptonic events (mainly W/Z-derived)



Polarization	**Luminosity**
e^{-}: ∓80% , e^{+}: ±30%	1600 fb^{-1} each

Efficiencyの計算($\cos\theta$分布)

- $b\bar{b}$、ccイベントの各ビンのシグナルイベント数S_i は

$$S_i = cross\ section \times luminocity \times efficiecny$$

である。Efficiencyは$\cos\theta$に依存し、Charge IDの可否も含めて計算する。

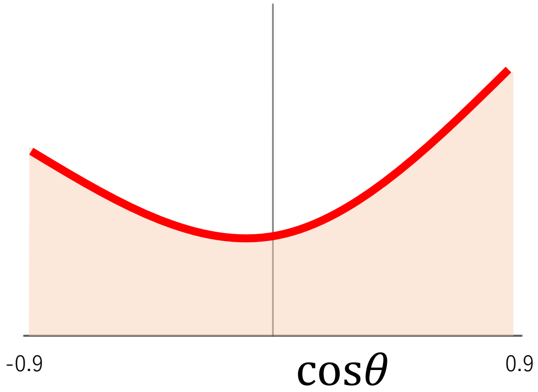
- $b\bar{b}$の場合($c\bar{c}$の場合も同様):

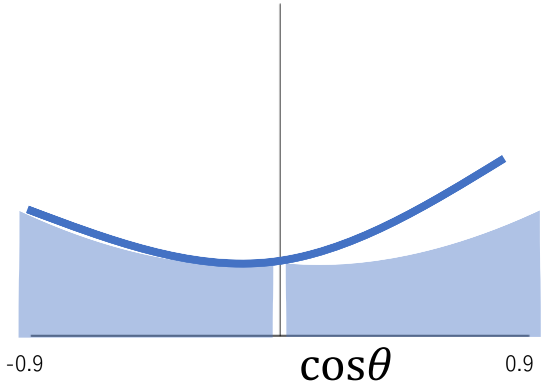
$$efficiency\_angle = \frac{\#\ of\ (true\ b\bar{b})\ w/\ eventcut}{\#\ of\ (true\ b\bar{b})\ w/o\ eventcut} \times \frac{\#\ of\ predicted\ b\bar{b}}{\#\ of\ predicted\ total} \times Charge\ ID\ efficiency$$

Charge IDされなかったイベントのtotal cross sectionに対するefficiencyとして以下の式を使う。

$$efficiency\_noChargeID = \frac{\#\ of\ (true\ b\bar{b})w/\ eventcut}{\#\ of\ (true\ b\bar{b})\ w/o\ eventcut} \times \frac{\#\ of\ predicted\ b\bar{b}}{\#\ of\ predicted\ total} \times (1 - Charge\ ID\ efficiency)$$

Charge IDされなかった場合、各偏極でのtotal cross sectionを用いた





Charge IDされた場合、costheta>0とcostheta<0に分けて評価した