Current Status of ZH→eeX Analysis: Event Generation

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LAL ORSAY

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- GUINEA-PIG to PYTHIA Interface
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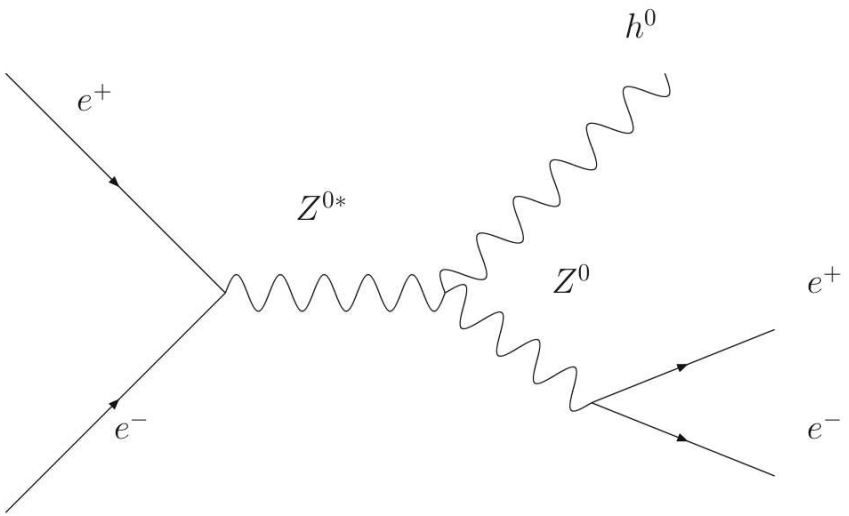
Motivation

Higgs-Strahlung Process:



Higgs Recoil Mass:

$$m_{h^0}^2 = s + m_{Z^0}^2 - 2E_{Z^0}\sqrt{s}$$

Cross Section and Coupling Strength Measurement:

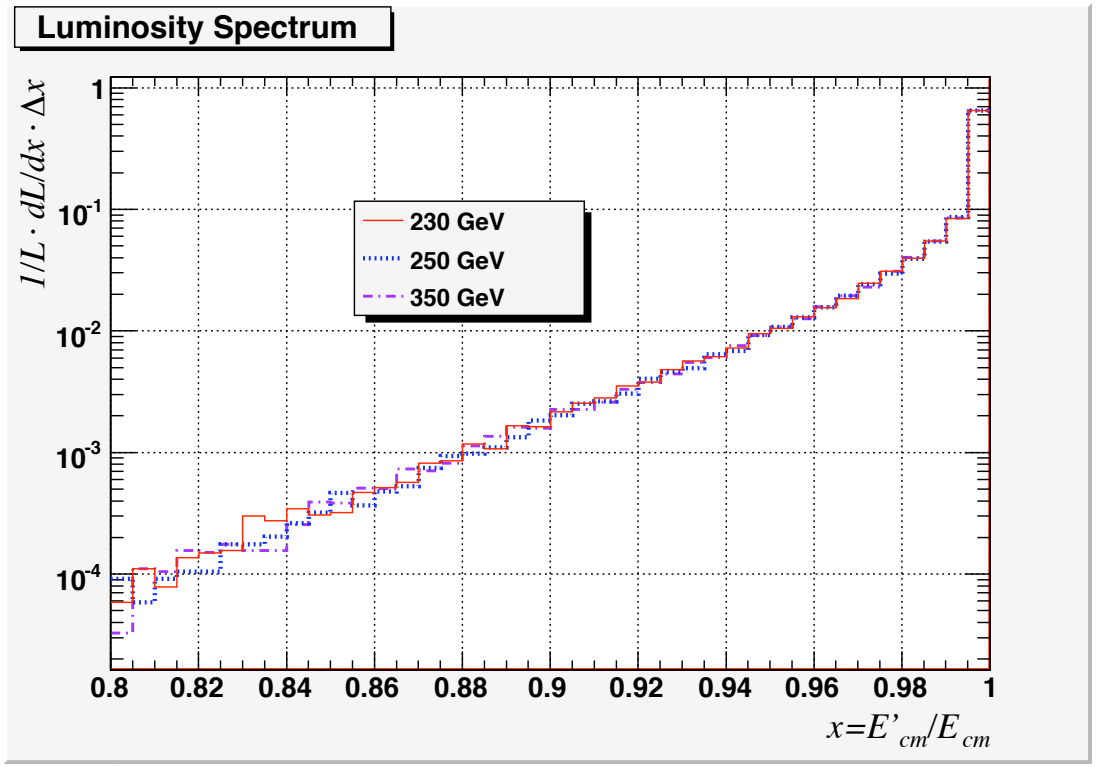
$$g^2 \propto \sigma = N/L\epsilon$$

$$E_{CM} = 230\ GeV$$

$$M_{Higgs} = 120\ GeV$$

Beam Simulation: GUINEA-PIG

Luminosity Spectrum Resulting from Beamstrahlung



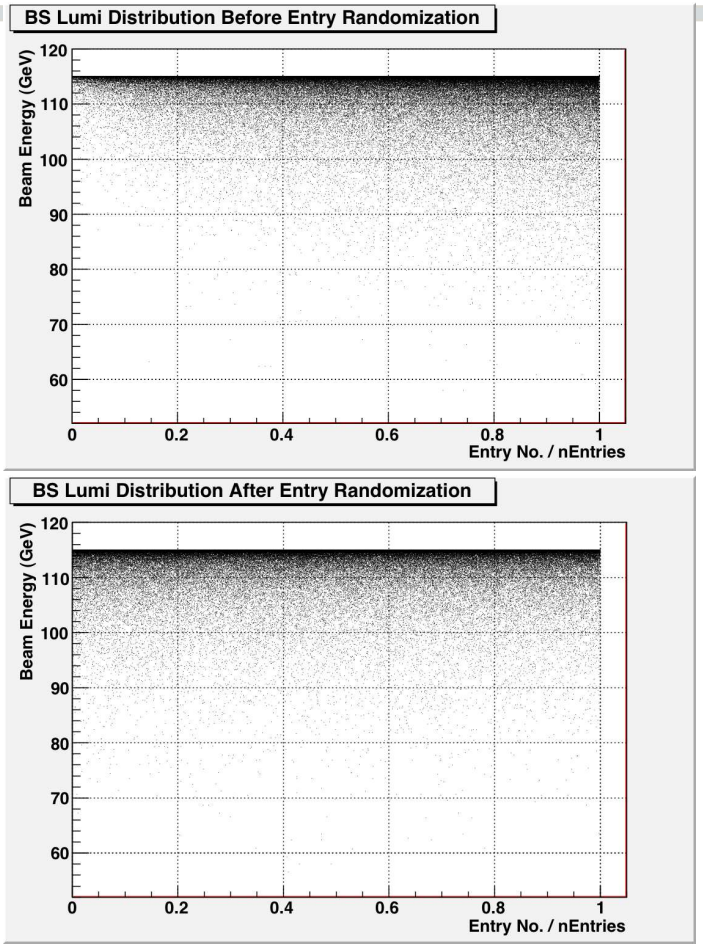
Beam Parameters *

Ecm (GeV)	230	250	350
energy (GeV)	115	125	175
$sigma_x$ (mm)	639	639	639
$sigma_y$ (mm)	5.7	5.7	5.7
$sigma_z$ (μ m)	138	150	210
$Beta_x$ (mm)	9.2	10	14
$Emitt_y$ (10^{-6}m•rad)	0.04	0.04	0.04

*From M. Ruan, to keep persistence with his muon channel study.

GUINEA-PIG to PYTHIA Interface

- Methods:
  - 1) Randomize lumi_file entries before passing it to the generators
    - BeamRand: (Hengne Li) to randomize the lumi_file
    - Beams: (Yuanning Gao), to read lumi_file in generators
  - 2) Randomly pick up the entries from the complete lumi_file
    - CALYPSO*: (Daniel Schulte), randomly read and pass lumi_file entries to generators, from the author of GUINEA-PIG



* Machine-Detector Interface at CLIC / Daniel Schulte, (CERN) : CERN-PS-2001-002-AE; CLIC-Note-469

Cross Section Evaluation of Signal and Backgrounds

	Process	σ [fb](N_{EVT})		
		PYTHIA	WHIZARD	BHWIDE
Signal	$e^+e^- \to Z^0h^0 \to e^+e^-X$	6.31(3155)	6.34(3170)	
Background	$e^+e^- \to e^+e^-\gamma_s$ [1)]	2531$[pb]$ (1.266×10^9)		2408$[pb]$ (1.204×10^9)
	$e^+e^- \to \tau^+\tau^- \to e^+\nu_e\bar{\nu}_\tau e^-\bar{\nu}_e\nu_\tau$	4753.5 (2.376×10^6)		
	$e^+e^- \to W^+W^- \to e^+\nu_e e^-\bar{\nu}_e$	18.97(9485)		
	$e^+e^- \to Z^0Z^0 \to e^+e^- f\bar{f}$ [2)]	120.72(60360)		
	$e^+e^- \to Z^0Z^0 \to e^+e^-e^+e^-$ [3)]	2.836(1418)		

- Results consider beamstrahlung, ISR and FSR, for Ecm=230GeV
- For Backgrounds, angular acceptance of $|\cos\theta| < 0.995836$ (LDC01_05Sc, with at least 6 hits in FTD) is considered in the cross section evaluation
- For Signal, the fraction of final state two electrons within angular acceptance is 0.9892
- Expected N_{EVT} is for an integrated luminosity of 500 fb^{-1}

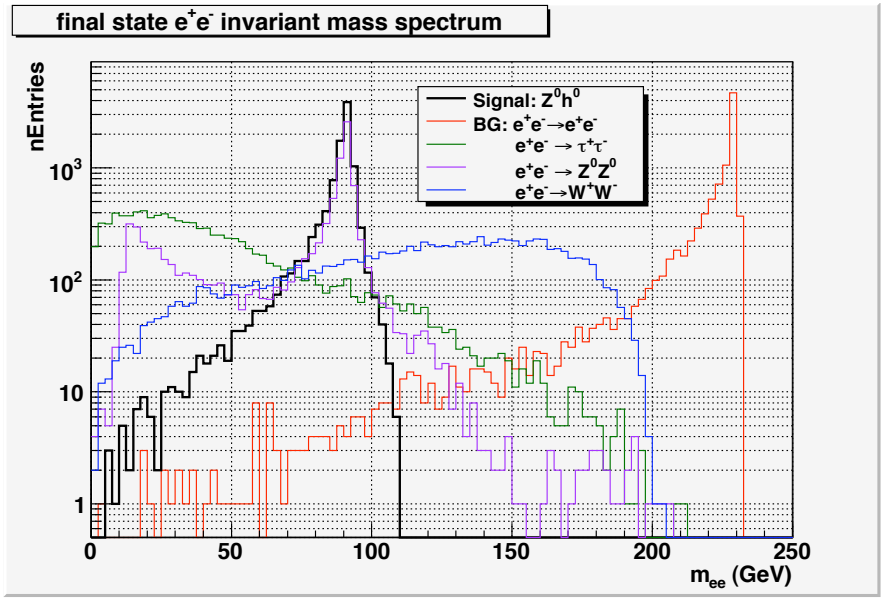
[1)] Including both γ^* and Z^0 neutral currents, where, PYTHIA considers only t-channel exchange, while BHWIDE considers both t-channel and s-channel exchanges.

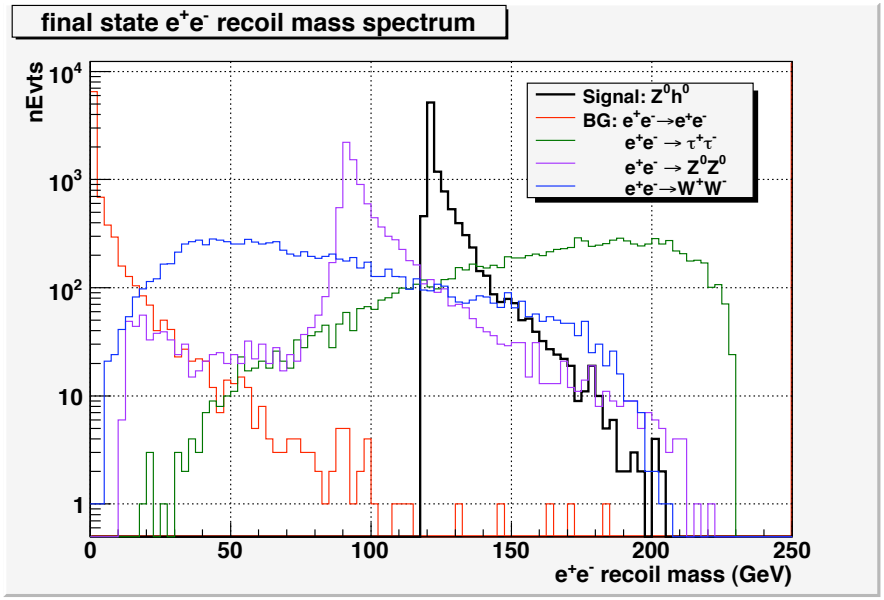
[2)] $f\bar{f}$ here excludes $Z^0 \to e^+e^-$.

[3)] At least one pair of the final state e^+e^- within the angular acceptance range.

Variables For Event Selection

- ✧ 10k events for each type of reactions
- ✧ All the plots are in log view.





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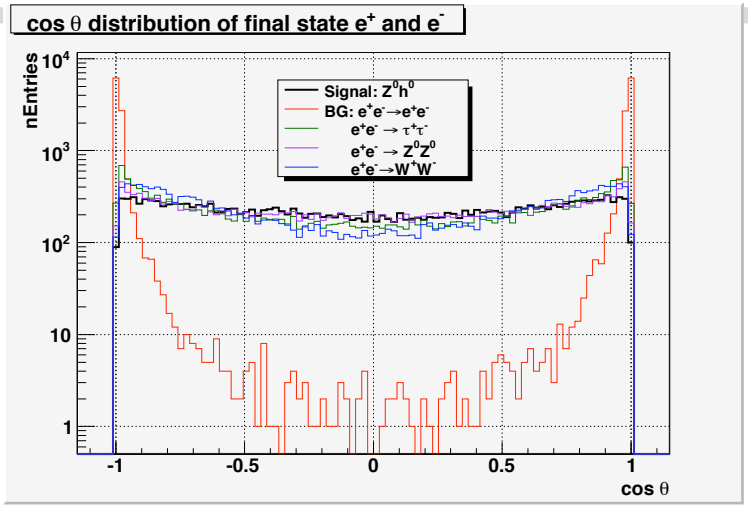

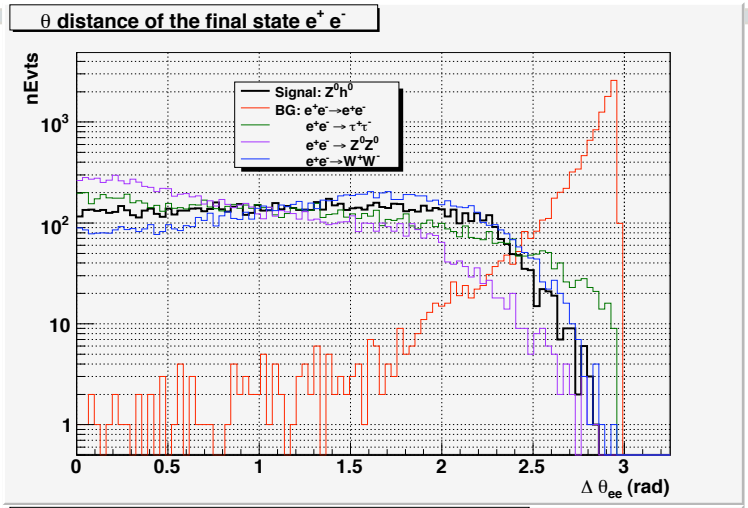

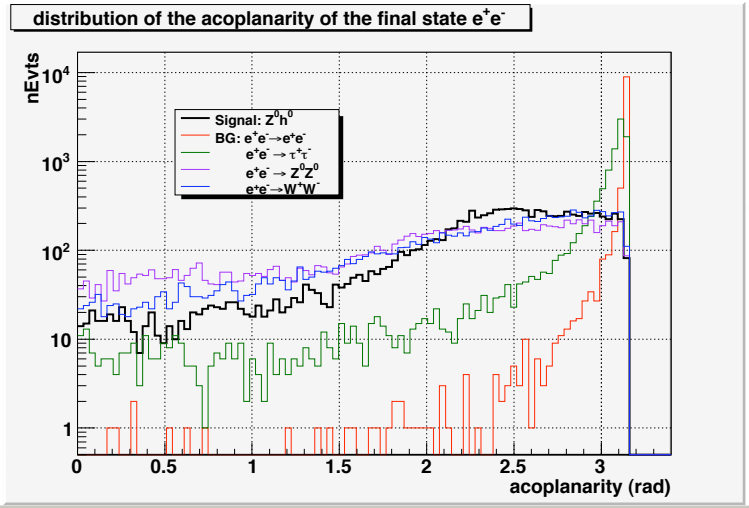

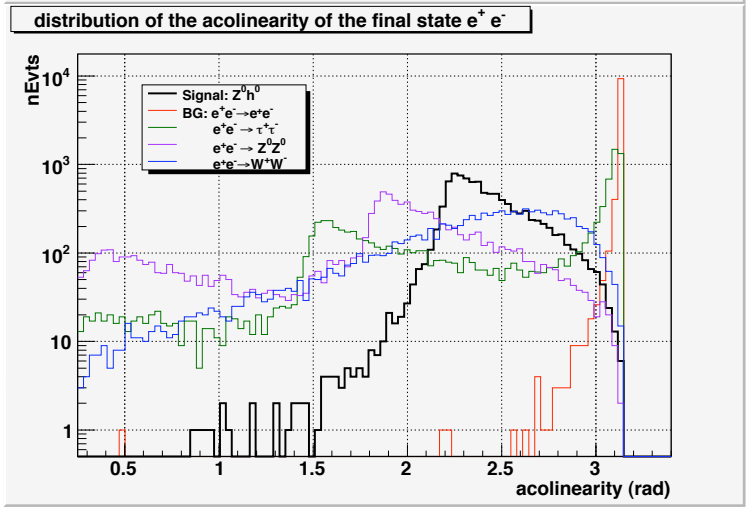

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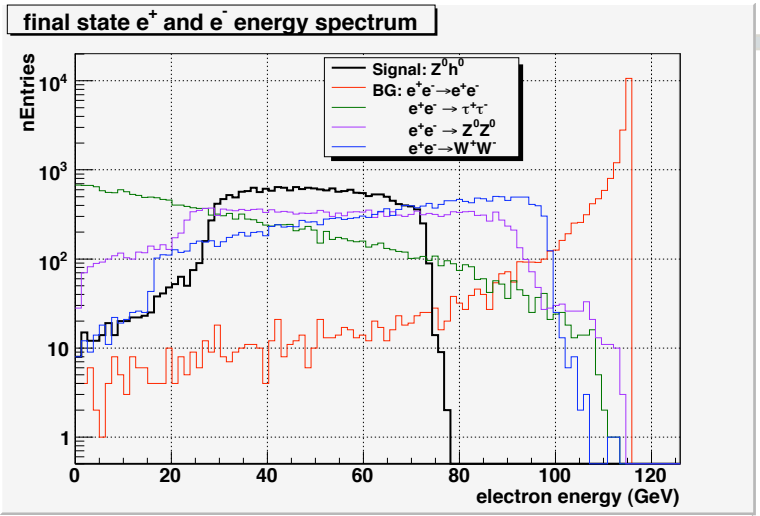

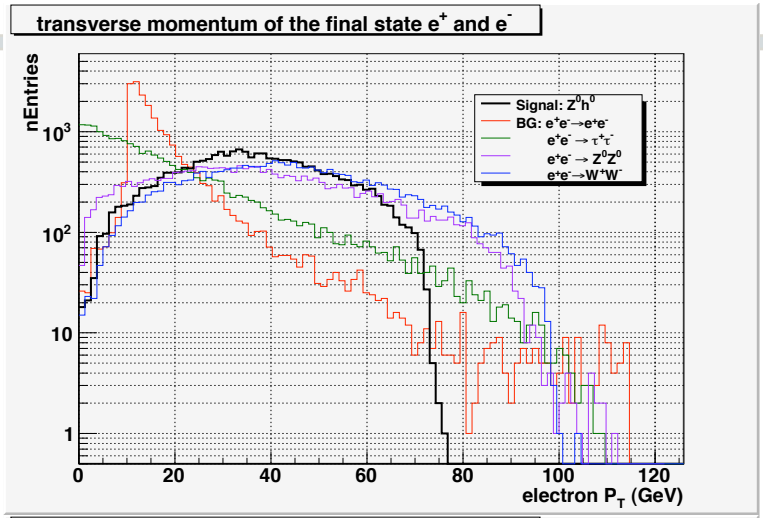

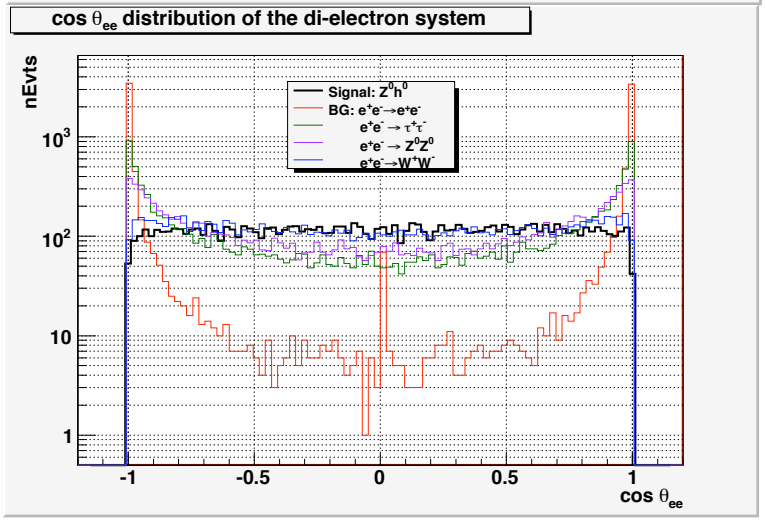

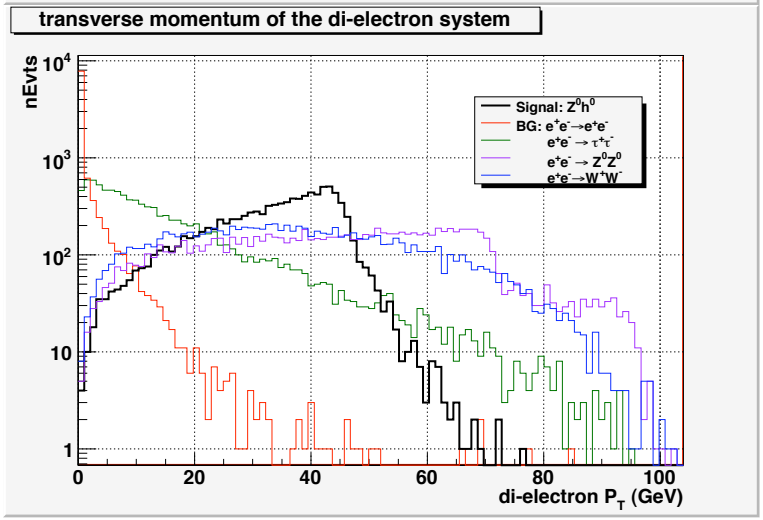

Discussions

- Pre-selection is needed to reduce backgrounds to save the simulation time, e.g. bhabha scattering has a cross section 6 orders of magnitudes larger than the signal
- The kinematic cuts are not safe in the pre-selection for electrons.
  - Due to bremstrahlung, electron reconstruction inaccuracy may migrate the background events into the signal window, e.g. page 9 first plot, which means if kinematic cuts applied, the backgrounds rates may be underestimated.
- But, if angular cuts do not enough for the rejection, can the kinematic cuts be used? How to avoid the underestimation of the backgrounds?
- Event weights should be applied to reduce the simulations
- Some Central Simulations Are Needed, at least for the well know backgrounds such as Bhabha scattering because its cross section is too large!