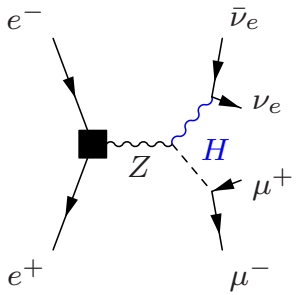
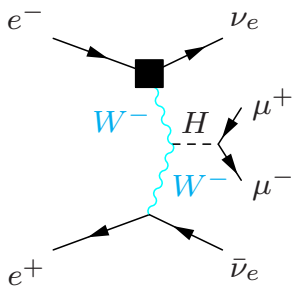
$\mathrm{H} \longrightarrow \mu\mu$ @ 1 TeV Update

C. Calancha (KEK, IPNS)
Weekly Physics & Software Meeting

November 16th, 2012





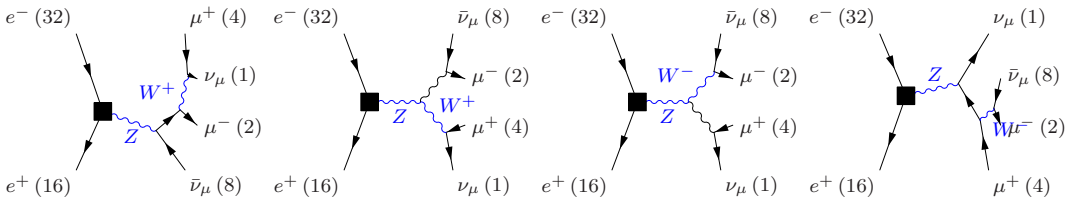
→ I learned this week how to write Feynman diagrams! No poor resolution anymore ;-)

$H \to \mu\mu$

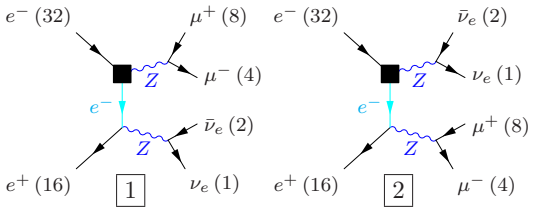
- E=1 TeV
- cross section: 748.4 fb^{-1}(lr), 5.905 fb^{-1}(rl)
  - $\approx$ 45 events with L=500 $\mathrm{fb}^{-1}$and (e^{-1},e^{+1})=(-0.8,$+0.2$)
  - $\approx$ 4 events with L=500 $\mathrm{fb}^{-1}$and (e^{-1},e^{+1})=($+0.8$,-0.2)
- ILCSOFTv16
- No overlay $\gamma\gamma \to$ hadrons

Main Background Sources

- Main background: $ZZ(WW) \longrightarrow \nu\nu\mu\mu$,$Z \longrightarrow \nu\nu\mu\mu$



$$ZZ(WW) \longrightarrow \nu\nu\mu\mu$$



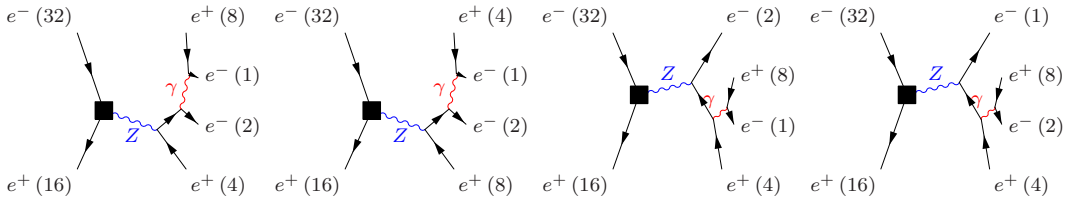
$$Z \longrightarrow \nu\nu\mu\mu$$

- Only showed a few of the total Feynman diagrams.
- same final state as the signal.

Other Background Sources

Other sources considered:

- $\mu\mu e^+e^-$ (leptons being forward)



- $Z \rightarrow \mu\mu$
- 4f_sw_l
- 4f_ww_l
- 4f_zz_l
- Effect from $\gamma\gamma \rightarrow \mu\mu$
  - I received several good suggestions about this in last ILD meeting and it is currently under investigation.

Preselection

2 Muons

- $E > 15$ GeV
- $E_{calE}/(E_{calE} + E_{calH}) < 0.5$
- $(E_{calE} + E_{calH})/|\vec{P}| < 0.3$

H candidate

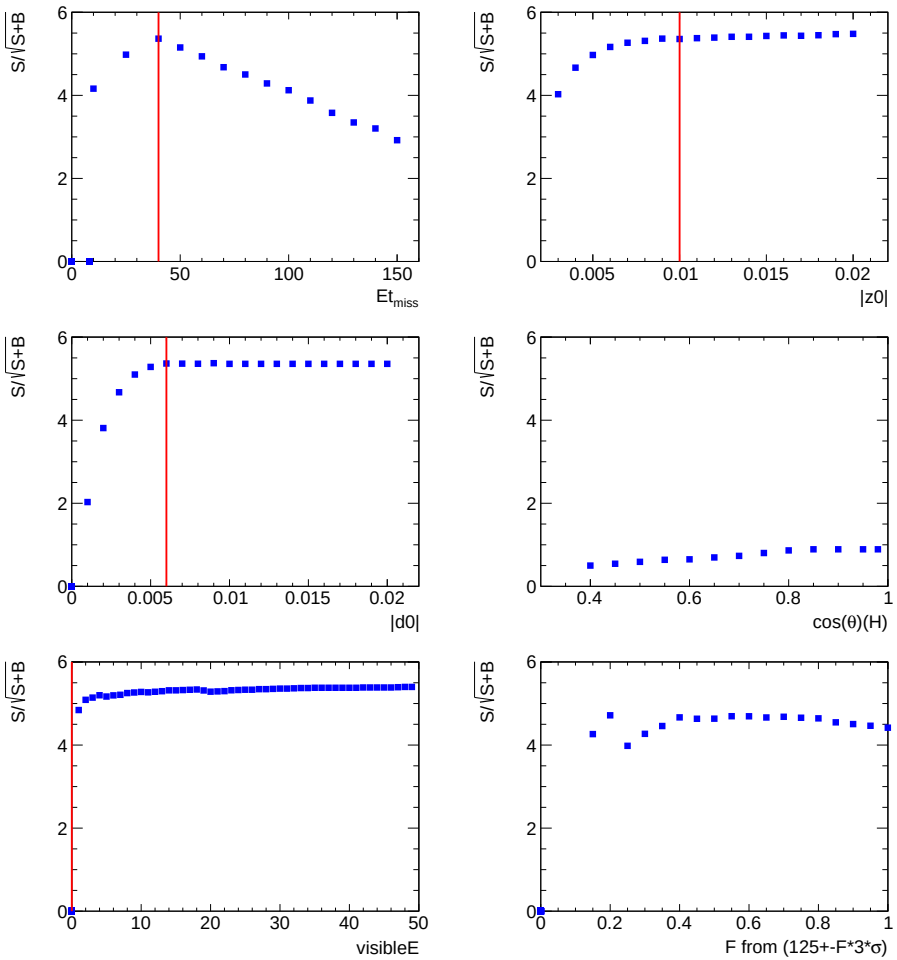
- $E_{muon1} + E_{muon2} < 400$ GeV
- $|M(\mu^+, \mu^-) - 125| < 30$ GeV/c^2

- No isolation requirement.
- Received comment about maybe my preselection of muons a little loose.

Optimization

Vars. to optimize (in order)

Et_{miss}	O	> 40 GeV
$\|z_0(\mu_i)\|$	O	< 10 μm
$\|d_0(\mu_i)\|$	O	< 6 μm
$\|cos(H)\|$	X	no cut
$visE$	?	stable curve
sig. Window	O	$(124.53, 125.47)$



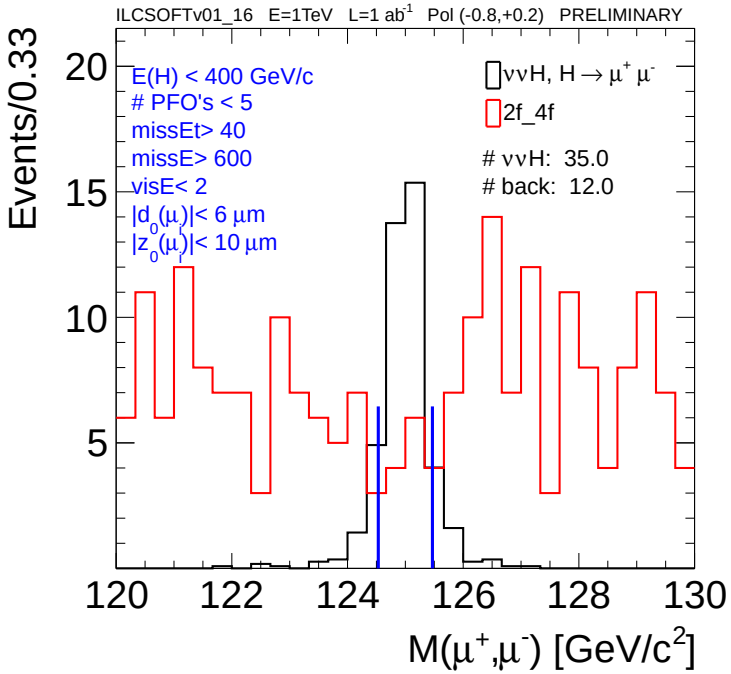
→ In addition following cuts are required:

- # PFO's < 5
- $E_{miss} > 600$ GeV

Selection Cuts (Rectangular cuts)

cuts

- # PFO's < 5
- $E_{miss} > 600$ GeV
- $Et_{miss} > 40$ GeV
- $|z_0(\mu_i)| < 10$ μm
- $|d_0(\mu_i)| < 6$ μm
- $visE < 2$ GeV

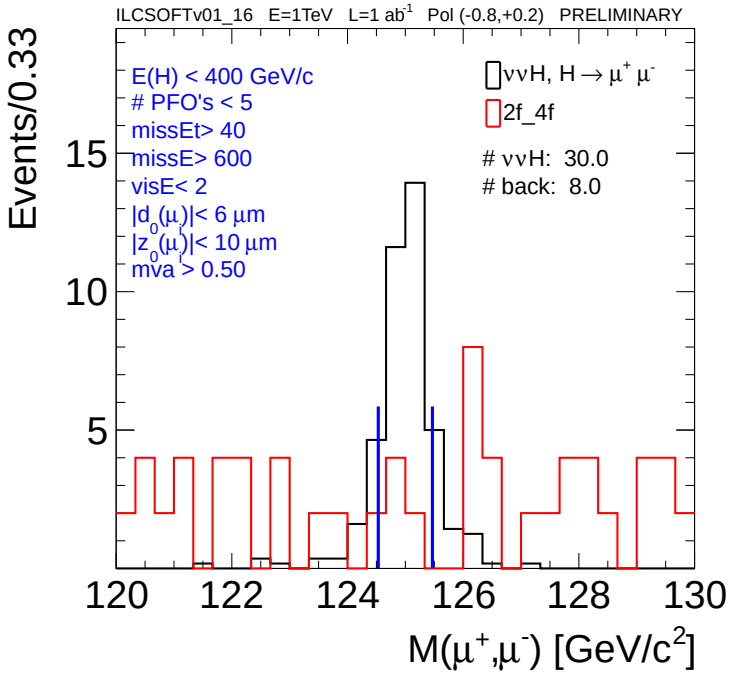


- Some of the cuts would be no suitable when overlaying $\gamma\gamma \rightarrow$ hadrons events (# PFO's or visibleE, for instances)
- Yields evaluated just counting events inside signal window (suggested not proper method with my low statistics level).
- I want to use same strategy as CLIC CDR
- Fitting background shapes, and perform average of yield over many toy mc experiments.

Selection Cuts (Rectangular cuts + NN)

cuts

- # PFO's < 5
- $E_{miss} > 600$ GeV
- $Et_{miss} > 40$ GeV
- $|z_0(\mu_i)| < 10$ μm
- $|d_0(\mu_i)| < 6$ μm
- $visE < 2$ GeV
- $mva > 0.5$



- Trainned NN to separate signal from *sznu_l* channel with variables:
- visibleE, ptmuon1+ptmuon2, $|pzmuon1| + |pzmuon2|$, $\beta_H = P_H/E_H$, cos^*, $|d_0|$, $|z_0|$
- cos^*, $|d_0|$, $|z_0|$ refers to the muon from $\mathrm{H} \longrightarrow \mu\mu$ high higher energy

Selection

Rec. cuts VS Rec. cuts + NN

- Similar $\Delta(\sigma\mathrm{Br})/\sigma\mathrm{Br}$ ($\approx$ 20 %)
- Selection with NN improves S/N (3.75 VS 2.92)

DBD stuff:

- I will submit to Ono-san my part today or tomorrow.

Summary

$\mathrm{H} \to \mu\mu$

- No overlay $\gamma\gamma \to \mathrm{hadrons}$ showed in this talk.
  - I have been instructed to include them.
  - Requested more data with the $\gamma\gamma \to \mathrm{hadrons}$ overlay (it is comming next week).
- Received several nice suggestions to improve this analysis on last ILD meeting.
- $\Delta(\sigma\mathrm{Br})/\sigma\mathrm{Br} \approx 20\,\%$.
  - Adding NN in the selection similar $\Delta(\sigma\mathrm{Br})/\sigma\mathrm{Br}$ but better S/N.
- Writting of DBD:
  - I will send to Ono-san today or tomorrow.

Back up

Request for more data

- 1 ab^{-1} stdhep available for every process (4 ab^{-1} for vvh_mumu)
- Only sim/rec around 1/43 ab^{-1}
- At least for the first 3 process i wish the whole 1 ab^{-1} to be reconstructed.

Process	tag	crossSec	Requested events
4f_zzorww_l	l200073	352.95	1 ab^{-1} = 352948
4f_zzorww_l	l200074	7.32	1 ab^{-1} = 7321
4f_sznu_l	l200079	471.58	1 ab^{-1} = 471580
4f_sznu_l	l200080	5.84	1 ab^{-1} = 5833
4f_ww_l	l200071	341.90	1 ab^{-1} = 341898
4f_ww_l	l200072	1.44	1 ab^{-1} = 1439
4f_sze_l	l200034	8684.92	1/21 ab^{-1} = 413567
4f_sze_l	l200036	8435.42	1/21 ab^{-1} = 401686
4f_sze_l	l200033	8343.33	1/21 ab^{-1} = 397301
4f_sze_l	l200035	8386.42	1/21 ab^{-1} = 399353
vvh_mumu	l37582	748.40	10000
vvh_mumu	l37583	5.905	10000