Update of $h \to \mu^+\mu^-$ Analysis

Shin-ichi Kawada (DESY)

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Software/Analysis Meeting

Reminder (copy of my AWLC2017 talk)

Showed first results of $h \to \mu^+\mu^-$ at 250/500 GeV based on ILD full simulation for the first time

Table 7: Obtained precision $\frac{\Delta(\sigma \times \mathrm{BR})}{(\sigma \times \mathrm{BR})}$

500 GeV	$q\bar{q}h$	$\nu\bar{\nu}h$
left-handed	26% (1600 fb^{-1})	31% (1600 fb^{-1})
right-handed	36% (1600 fb^{-1})	61% (1600 fb^{-1})
250 GeV	$q\bar{q}h$	$\nu\bar{\nu}h$
left-handed	29% (1350 fb^{-1})	—
right-handed	45% (450 fb^{-1})	—

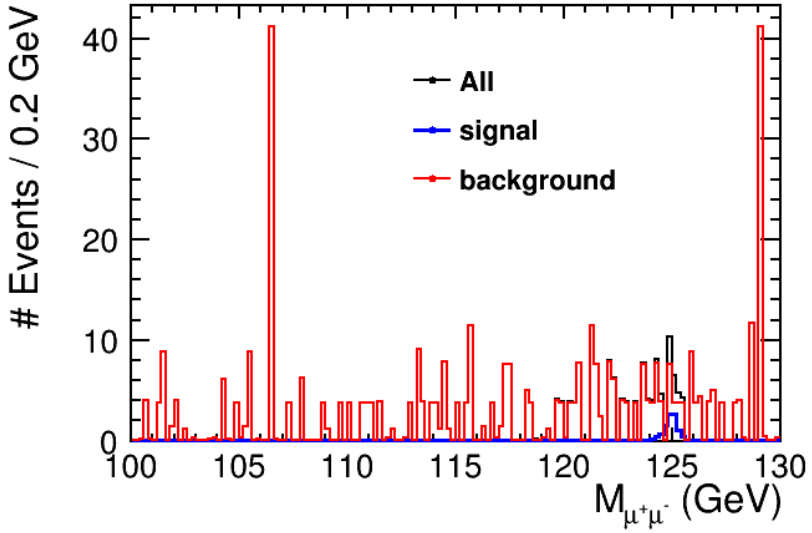
preliminary

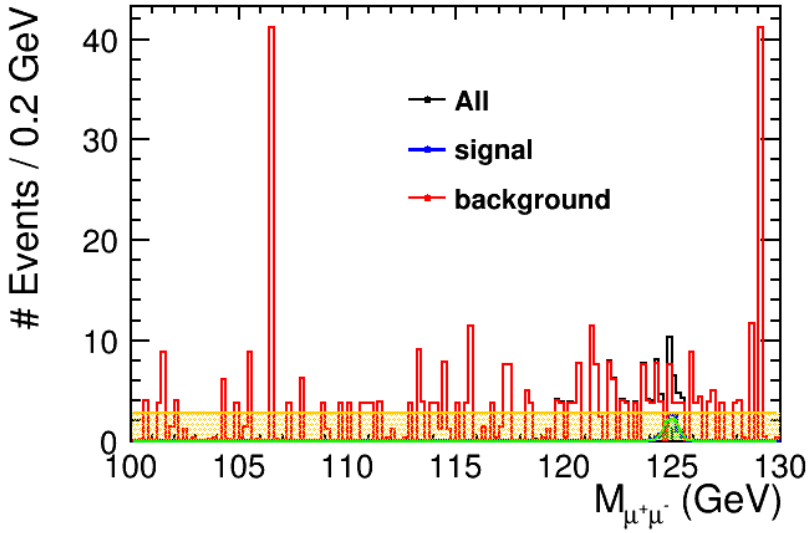
Everything is better than extrapolation results
Combine everything gives **14%** precision:
almost same precision expected at the HL-LHC

Quick Introduction

- Obtained several first numbers based on real analysis
  - 500 GeV: qqh, nnh
  - 250 GeV: qqh
  - presented at AWLC2017
- Problem: huge uncertainties due to limited MC statistics
  - sometimes event weight ~ 20 (~ 40 with TMVA) when we assume H20 running scenario
  - technically impossible to increase SM background
- Solution: toy MC
  - perform toy MC study for all channels to obtain more reliable results

One Example: qqh500-L (1)





$M_{\mu^+\mu^-}$ spectrum after precuts + BDTG cut

beautiful spikes due to low MC statistics

N_S = 11 and N_B = 422 at this point

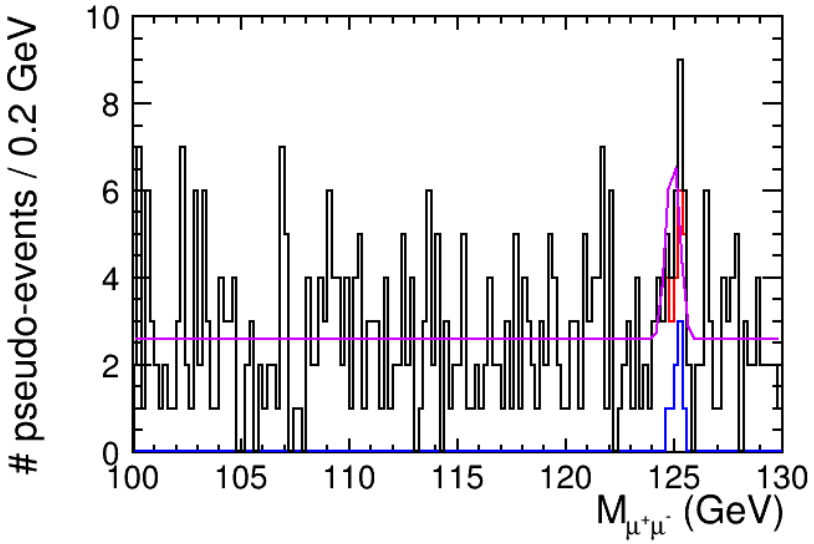
determine model function by fitting

f_S: normalized Gaussian (green)

f_B: constant (yellow)

※background fitting is performed with log-likelihood method (default is χ^2 method in ROOT fitting)

One Example: qqh500-L (2)



do pseudo-experiment

blue: pseudo signal data (N_S w/ Poisson fluc.)

red: pseudo background data (N_B w/ Poisson fluc.)

black: blue + red

purple: fit result to black with $f = Y_S f_S + Y_B f_B$

free parameters: Y_S and Y_B

fit with log-likelihood method

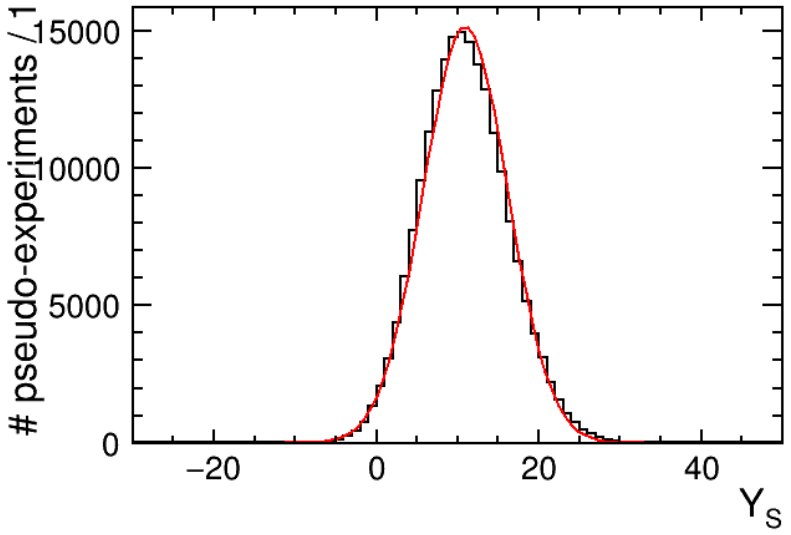
normalization considered

repeat pseudo-experiment 200000 times

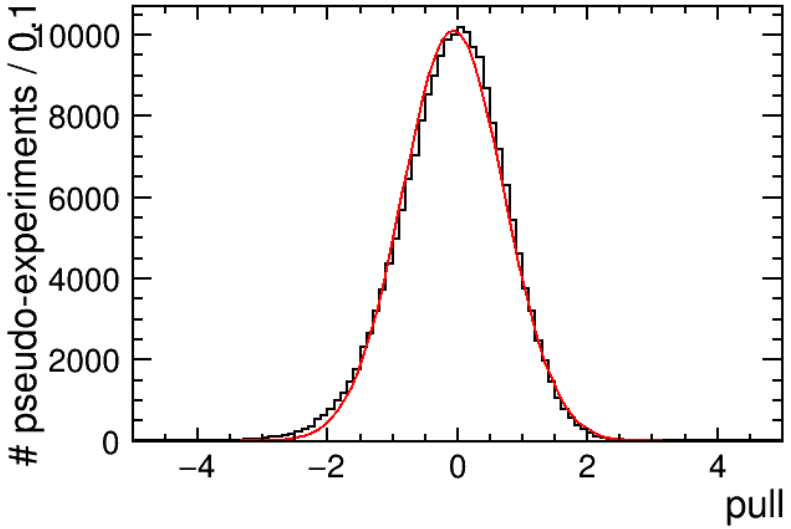
(takes 3-4 hours)

obtain Y_S distribution

One Example: qqh500-L (3)



Y_S distribution
Gaussian fit result
mean: 10.927 +- 0.012
sigma: 5.2265 +- 0.0079
precision = sigma/mean = 47.8%



pull distribution
pull = $\frac{Y_S - Y_{\text{true}}}{\Delta Y_S}$
Gaussian fit result
mean: -0.0711 +- 0.0019
sigma: 0.7791 +- 0.0012

Toy MC Study: Results

	qqh500	nnh500	qqh250
left	47.8%	39.2%	30.0%
right	52.1%	71.5%	52.5%

All details are available at:
http://desy.de/~skawada/MyAnalysisNote/Analysis08_EN.pdf
(47 pages, 200 figures, 7 tables, (crazy length))
Pull distribution is asymmetric: bias?

Combined precision: **17.9%**
HL-LHC: 14% (ATLAS-PHYS-PUB-2013-014)

Summary

- Performed toy MC studies and modified results for all channels
  - asymmetric pull distribution: bias?
  - all results are worse than previous, but still similar combined precision can be reached compare to HL-LHC

- Started nnh250 analysis, and llh250/llh500 in near future
  - should be summarized into a paper in future