Some Updates of $h \to \mu^+\mu^-$ Analysis

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2019/January/30

ILD Analysis/Software Meeting

General Status

- DBD-paper: reactivated, working on v01 -> v02, probably some re-do is necessary
- LCWS2018 proceedings: done in soon
- benchmark analysis: start to use IsolatedLeptonTagging without using impact parameter information
- IDR note: in parallel with benchmark analysis
- IDR itself: nothing

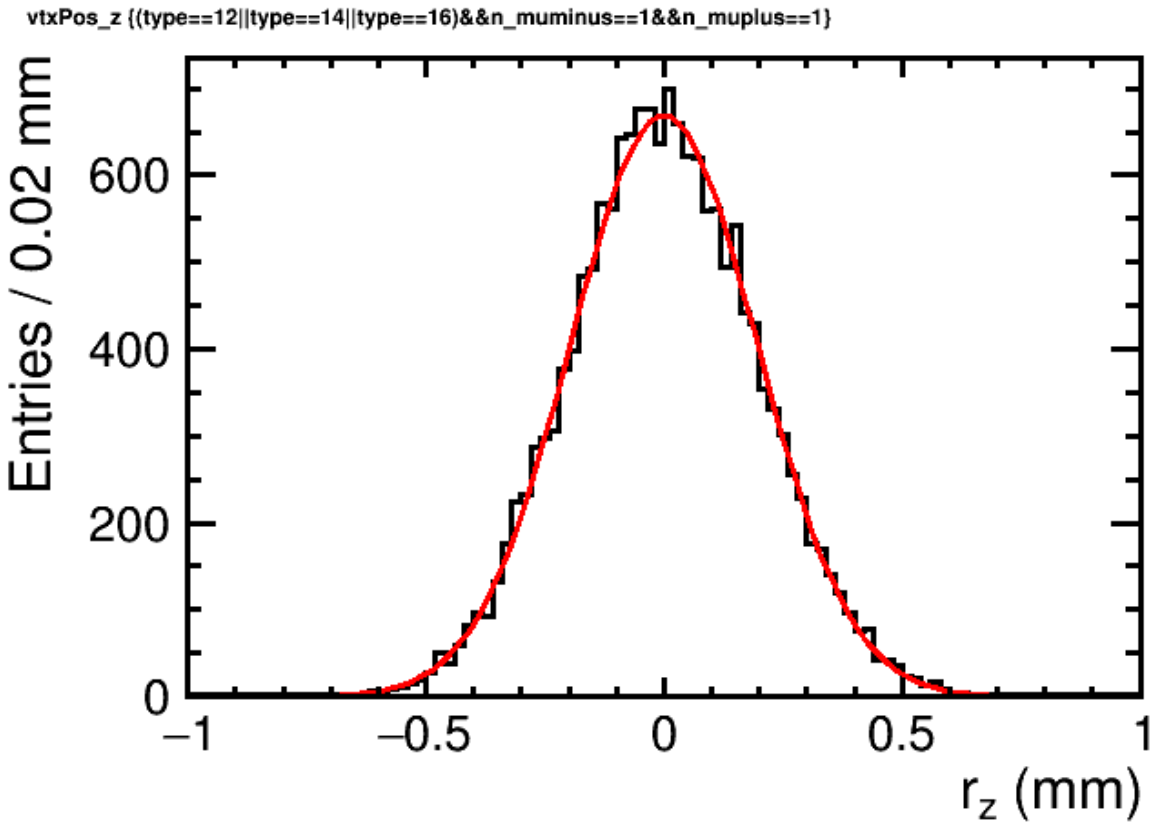
Benchmark Analysis: Overview

- IDR samples with v02-00-01, further analysis with v02-00-02
- Use IsolatedLeptonTagging (w/o impact parameter and yoke) and VertexInfo
- Cut-based analysis (preselection)
- TMVA (BDTG)
- Toy MC

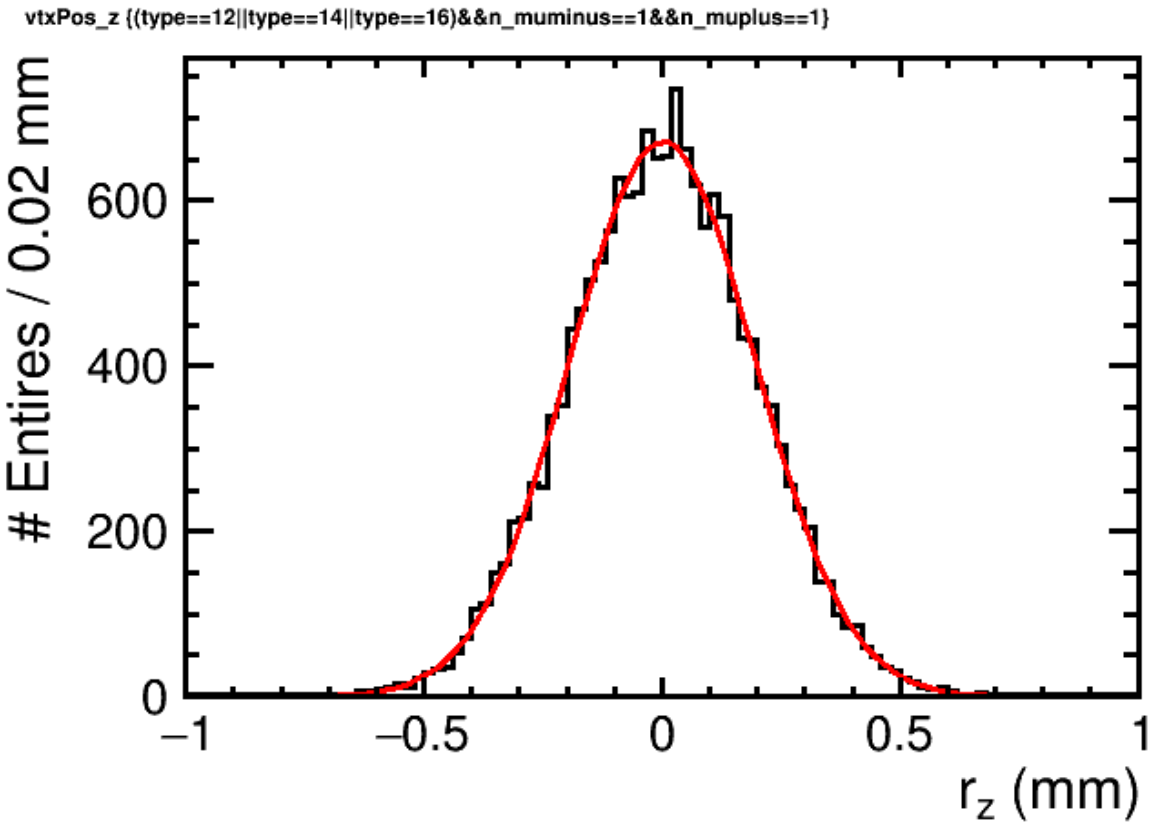
Benchmark Analysis

- Now impact parameter and yoke information are not used in IsolatedLeptonTagging
- IsolatedLeptonTagging -> VertexInfo
  - $E_{CAL}/p < 0.5$, $p > 10$ GeV, MVA cut > 0.8
  - eff. = 96.0%/95.7% for l5/s5 (95.2% in DBD, ~92% in previous)
  - 2 muon tracks are subjected to VertexInfo
  - with beam spot constraint: (x, y, z) = (150e-6, 5e-6, 0.2) [mm]

With Constraint (x, y, z) = (150e-6, 5e-6, 0.2) [mm]

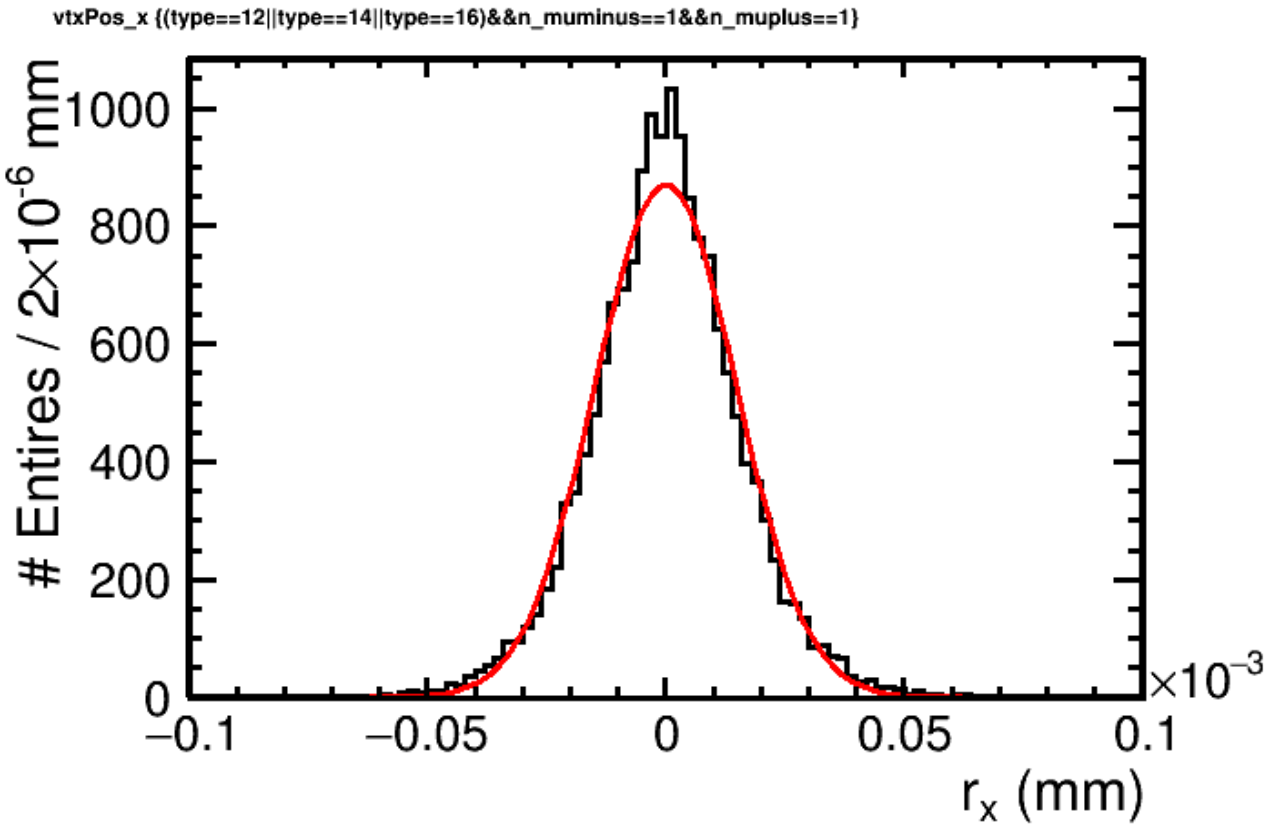


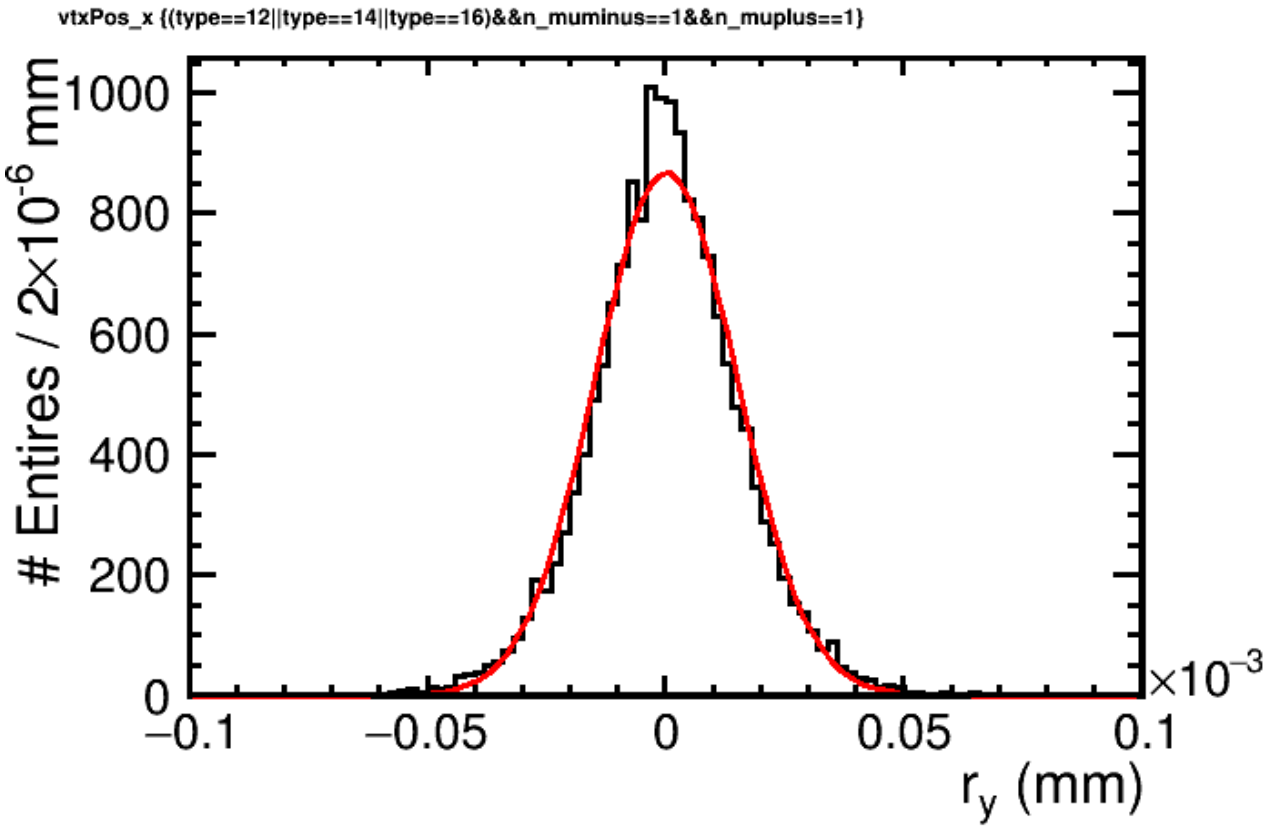
l5, Gaussian fit
width = 0.1964+-0.0011 mm



s5, Gaussian fit
width = 0.1949+-0.0011 mm

With Constraint (x, y, z) = (150e-6, 5e-6, 0.2) [mm]

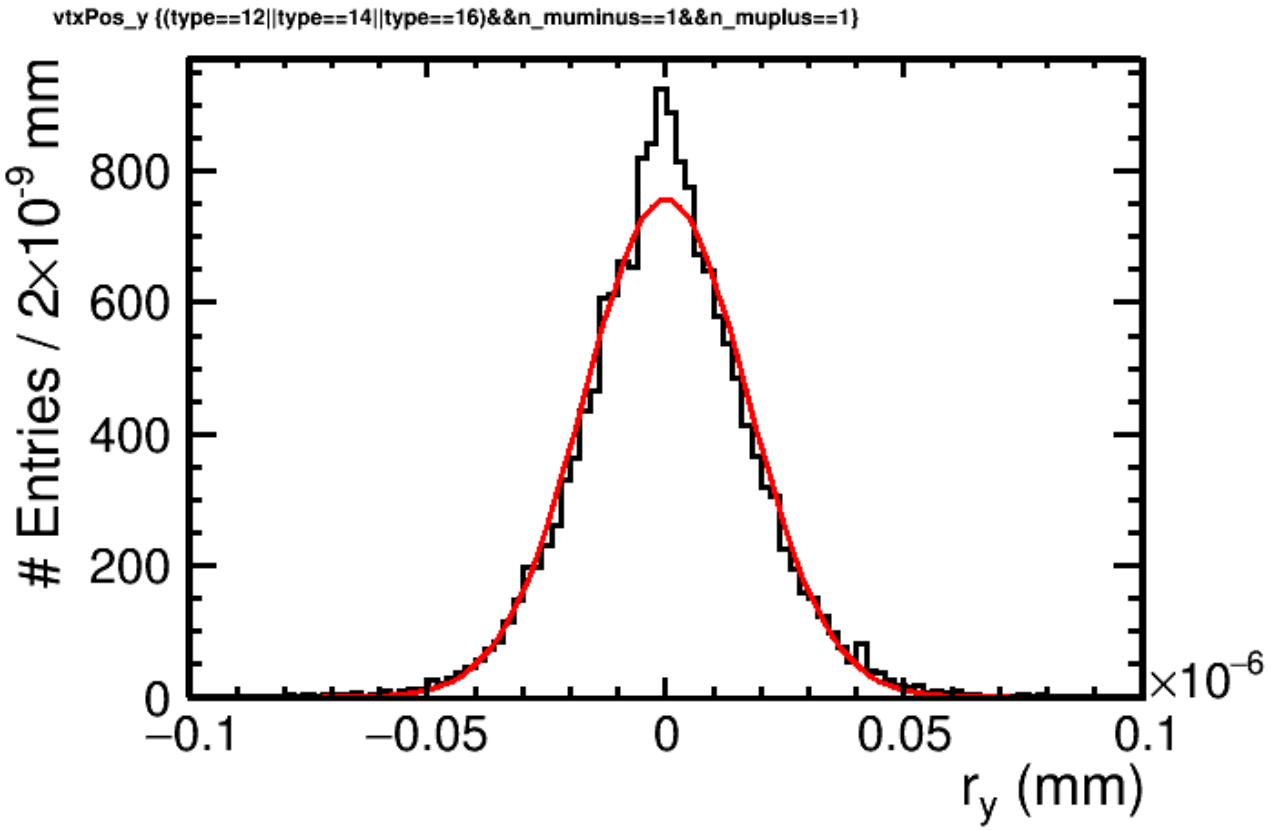




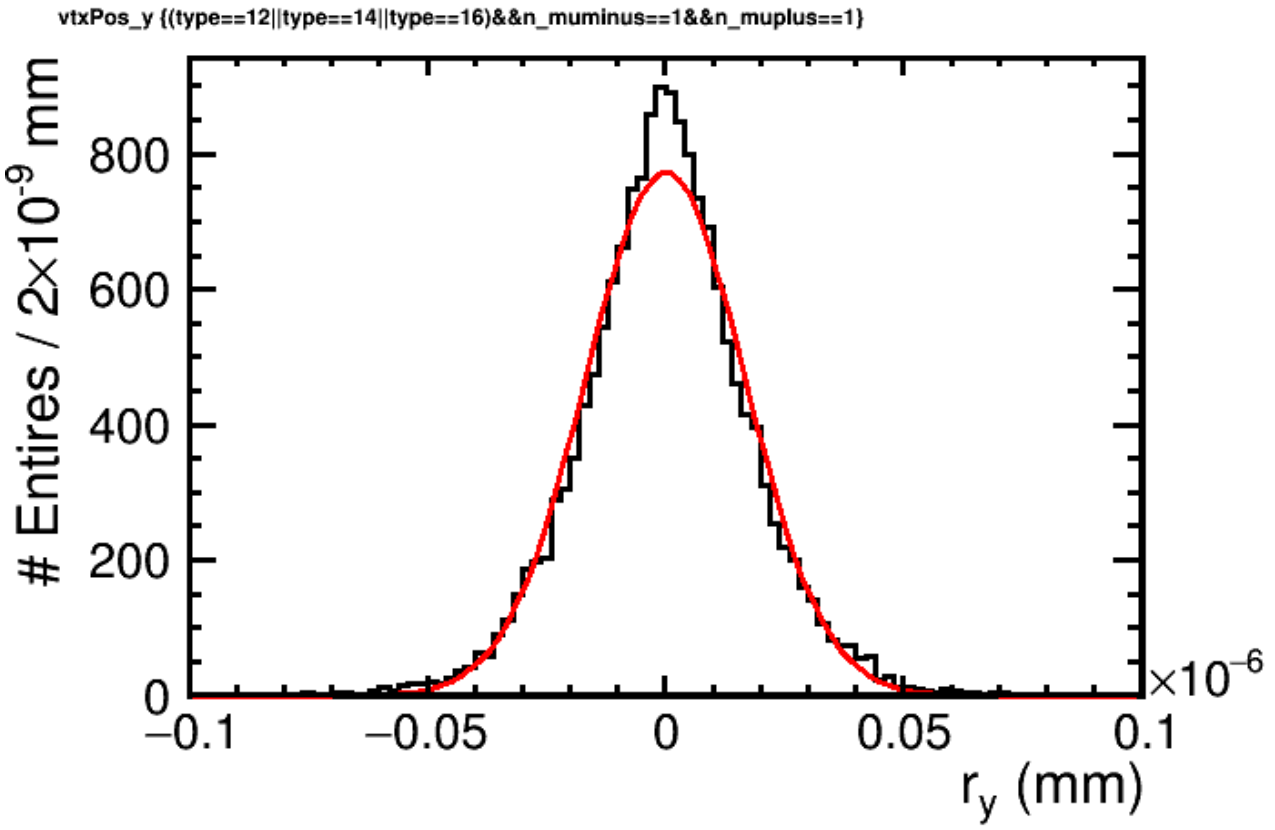
l5, Gaussian fit
width = (1.483+-0.010)*10^{-5} mm

s5, Gaussian fit
width = (1.488+-0.010)*10^{-5} mm

With Constraint (x, y, z) = (150e-6, 5e-6, 0.2) [mm]

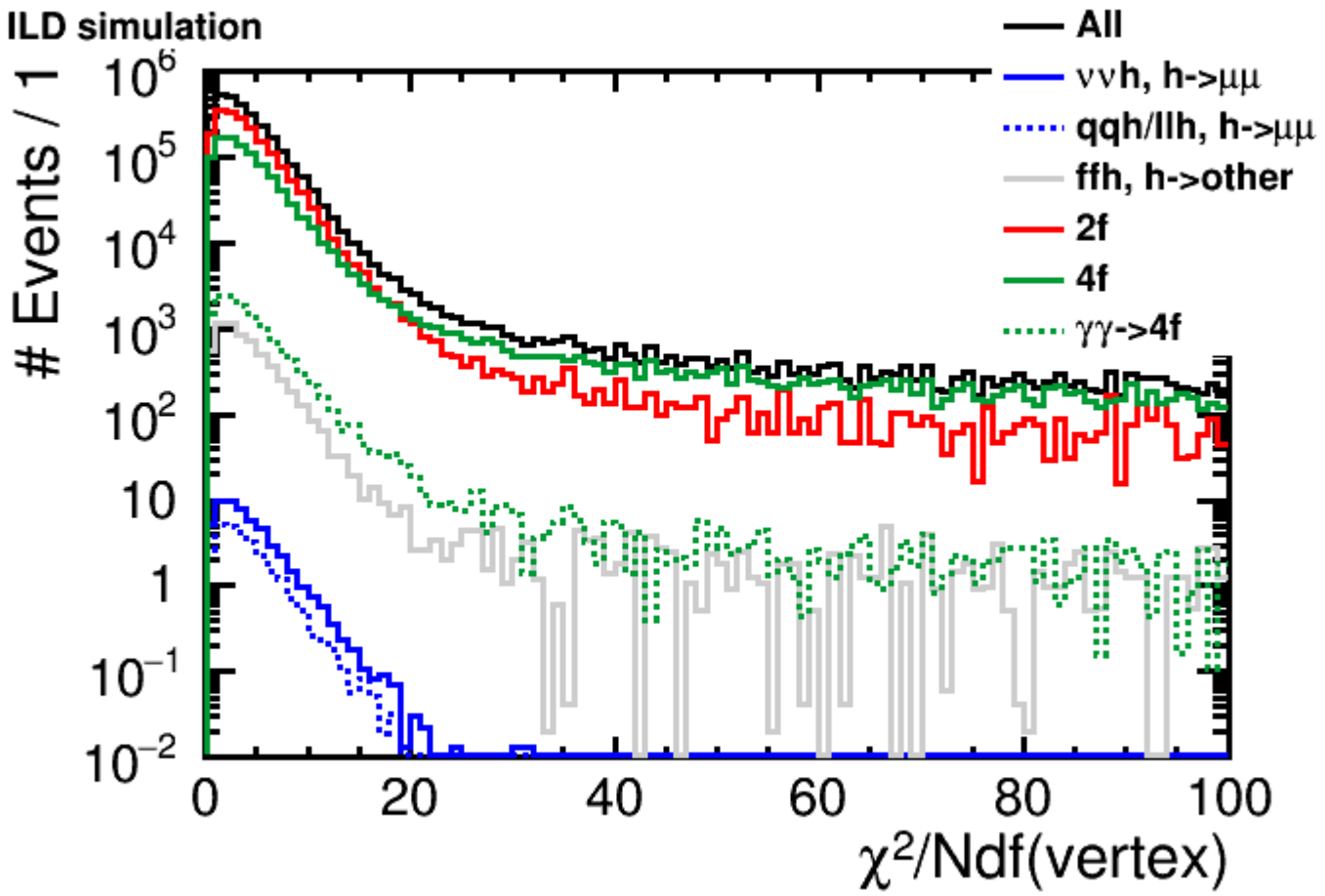


l5, Gaussian fit
width = (1.709+-0.012)*10^{-8} mm



s5, Gaussian fit
width = (1.670+-0.012)*10^{-8} mm

Chisquare of vertex finding



badly fitted events will be rejected by this cut requiring < 20

Preselection

Table 5: List of selection cuts. Definition of variables are written in the text.

#	variable	cut
0	nothing	no cut
1	# $\mu^{\pm}$	$= 1$
2	$\chi^2/\mathrm{Ndf}(\mu^{\pm})$	$0.5 - 1.5$
3	$\chi^2/\mathrm{Ndf}(\mathrm{vertex})$	< 20
4	$\lvert r_z \rvert$	< 0.5 mm
5	$\sigma(M_{\mu^+\mu^-})$	< 1 GeV
6	$M_{\mu^+\mu^-}$	$100 - 130$ GeV
7	$\cos\theta_{\mu^+\mu^-}$	< 0.55
8	N_{P_t}	$= 0$
9	E_{vis}	$125 - 300$ GeV
10	missing P_t	> 5 GeV
11	$\lvert\cos\theta_{\mathrm{miss}}\rvert$	< 0.99

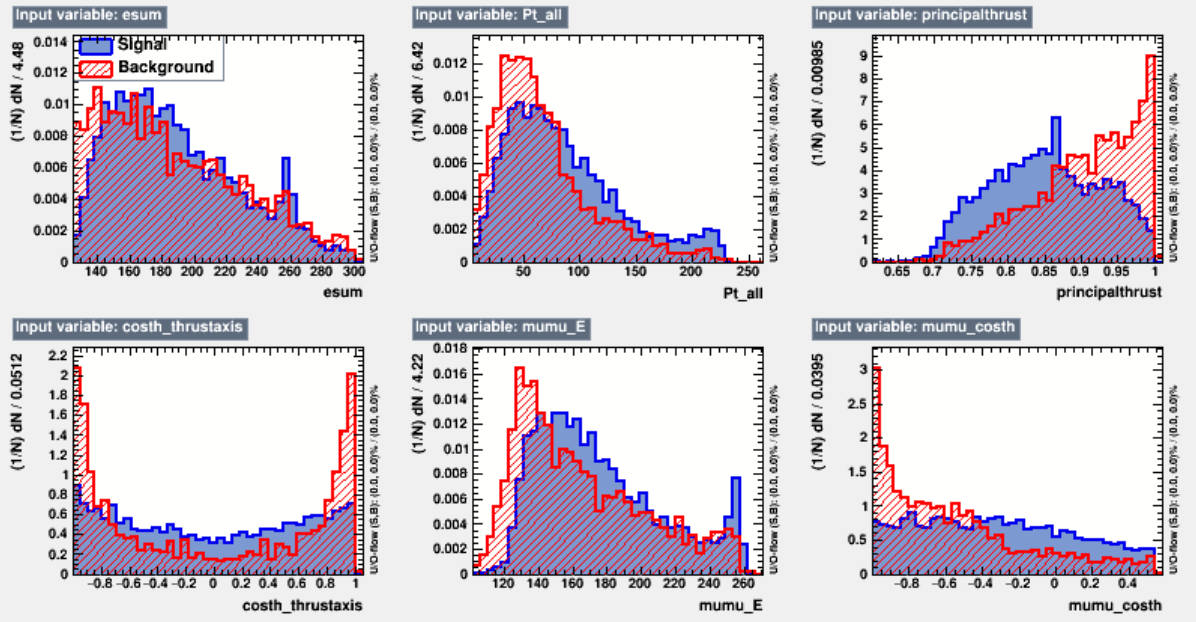
Table 6: Cut table of nnh500-L-l5.

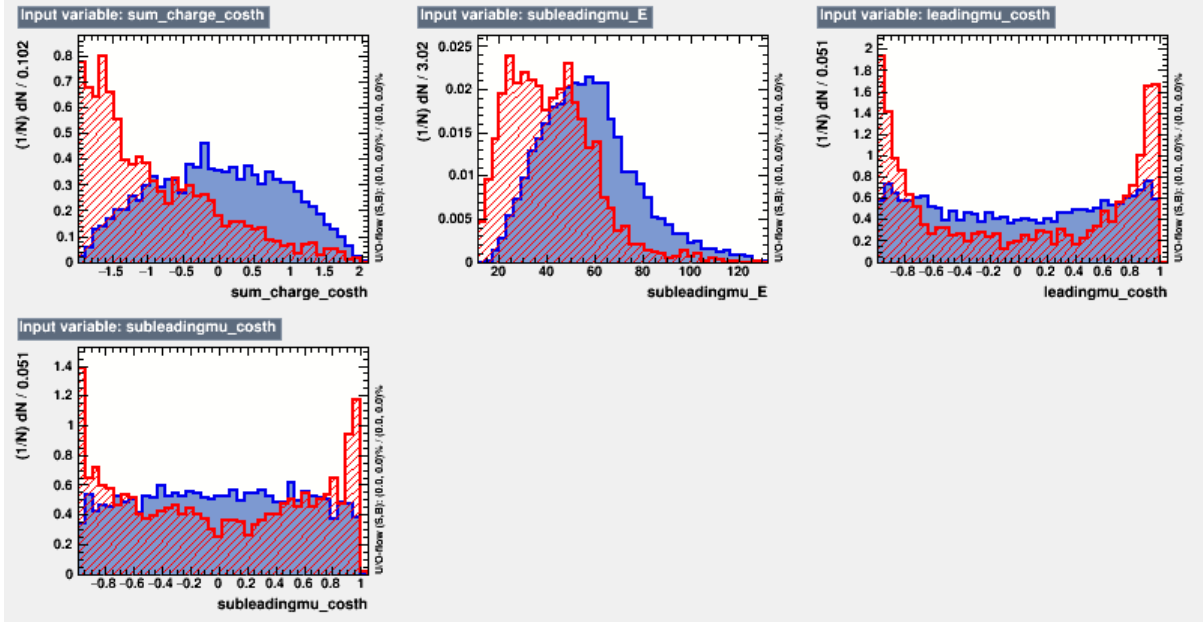
#	$\nu\bar{\nu}h$ $h \to \mu^+\mu^-$	$q\bar{q}h/\ell^+\ell^-h$ $h \to \mu^+\mu^-$	$f\bar{f}h$ other	2f	4f	$\gamma\gamma \to$ 4f
0	57.54	31.12	4.122×10^5	1.084×10^7	3.808×10^7	3.329×10^5
1	55.15	28.15	7102.10	2.141×10^6	1.214×10^6	1.683×10^4
2	53.94	27.69	6976.17	1.971×10^6	1.072×10^6	1.447×10^4
3	53.57	27.53	6207.86	1.916×10^6	9.844×10^5	1.377×10^4
4	53.04	27.21	6139.05	1.895×10^6	9.744×10^5	1.367×10^4
5	52.27	26.66	6051.78	1.434×10^6	9.142×10^5	1.326×10^4
6	50.91	25.99	162.69	4.045×10^4	3.030×10^4	372.08
7	50.90	25.95	121.27	2.560×10^4	2.887×10^4	371.53
8	50.74	0.17	3.66	2.510×10^4	1.684×10^4	200.61
9	50.12	0.03	2.56	1.261×10^4	1.152×10^4	166.30
10	49.94	0.02	2.56	975.81	1.095×10^4	150.45
11	48.90	0.01	2.56	123.25	9914.68	140.71

Table 8: Cut table of nnh500-L-s5.

#	$\nu\bar{\nu}h$ $h \to \mu^+\mu^-$	$q\bar{q}h/\ell^+\ell^-h$ $h \to \mu^+\mu^-$	$f\bar{f}h$ other	2f	4f	$\gamma\gamma \to$ 4f
0	57.54	31.12	4.122×10^5	1.084×10^7	3.808×10^7	3.348×10^5
1	54.99	28.08	7080.17	2.144×10^6	1.216×10^6	1.679×10^4
2	53.64	27.58	6943.93	1.968×10^6	1.071×10^6	1.445×10^4
3	53.30	27.42	6196.70	1.912×10^6	9.840×10^5	1.373×10^4
4	52.74	27.14	6131.87	1.891×10^6	9.736×10^5	1.362×10^4
5	52.17	26.70	6066.94	1.518×10^6	9.256×10^5	1.330×10^4
6	50.75	26.06	161.71	4.405×10^4	3.062×10^4	376.44
7	50.74	26.02	117.62	2.724×10^4	2.918×10^4	375.89
8	50.57	0.19	3.70	2.660×10^4	1.688×10^4	208.01
9	49.98	0.03	2.56	1.385×10^4	1.166×10^4	170.06
10	49.82	0.01	2.56	1094.75	1.111×10^4	156.76
11	48.80	0.01	2.56	67.04	1.005×10^4	144.83

TMVA input


Input variable: esum
Signal
Background
(1/N) dN / 4.48
esum
Input variable: Pt_all
(1/N) dN / 6.42
Pt_all
Input variable: principalthrust
(1/N) dN / 0.00985
principalthrust
Input variable: costh_thrustaxis
(1/N) dN / 0.0512
costh_thrustaxis
Input variable: mumu_E
(1/N) dN / 4.22
mumu_E
Input variable: mumu_costh
(1/N) dN / 0.0395
mumu_costh
U/O-flow (S,B): (0.0, 0.0)% / (0.0, 0.0)%


Input variable: sum_charge_costh
(1/N) dN / 0.102
sum_charge_costh
Input variable: subleadingmu_E
(1/N) dN / 3.02
subleadingmu_E
Input variable: leadingmu_costh
(1/N) dN / 0.051
leadingmu_costh
Input variable: subleadingmu_costh
(1/N) dN / 0.051
subleadingmu_costh
U/O-flow (S,B): (0.0, 0.0)% / (0.0, 0.0)%

Result (preliminary)

- Perform preselection, TMVA(BDTG), toy MC
- l5: 41.1% (last time 38.2%)
- s5: 39.78% (last time 42.8%)

- I think all results have rather large uncertainty (not checked, could be +-5%?), because statistics of SM background is limited.
  - need to loose preselection? ---> more statistics, probably more stable TMVA and toy MC