SUSY point 5
chargino & neutralino: part I

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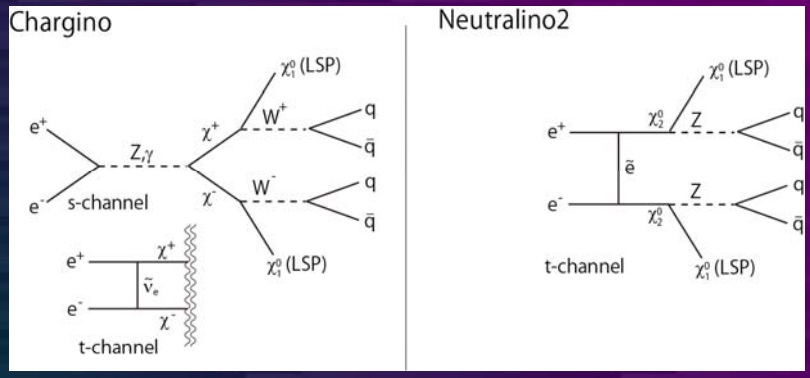
- SM separation cuts
- Cross section analysis by 2D fit
- Mass fit
- Summary

Physics process for optimization

Benchmark processes:

Processes ($e^+e^-\rightarrow$)	$\sqrt{s}$ (GeV)	Observables	Comments
$ZH, ZH\rightarrow e^+e^-X,$	250	σ, m_H	m_H=120GeV, test materials and γ_{ID}
$\rightarrow\mu^-\mu^+X$	250	σ, m_H	m_H=120GeV, test $\Delta P/P$
$ZH, H\rightarrow cc, Z\rightarrow\nu\nu$	250	$Br(H\rightarrow cc)$	Test heavy flavour tagging and anti-tagging of light quarks and gluon
$, Z\rightarrow qq$	250	$Br(H\rightarrow qq)$	Same as above in multi-jet env.
$Z^* \rightarrow \tau^+\tau^-$	500	$\sigma, A_{FB}, Pol(\tau)$	Test π^0 reconstruction and τ rec. aspects of PFA
$tt, t\rightarrow bW, W\rightarrow qq'$	500	σ, A_{FB}, m_{top}	Test b-tagging and PFA in multi-jet events. m_{top}=175GeV
$\chi^+\chi^-, \chi_2^0\chi_2^0$	500	$\sigma, m\chi$	Point 5 of Table 1 of BP report. W/Z separation by PFA

Events (Signal & Background)

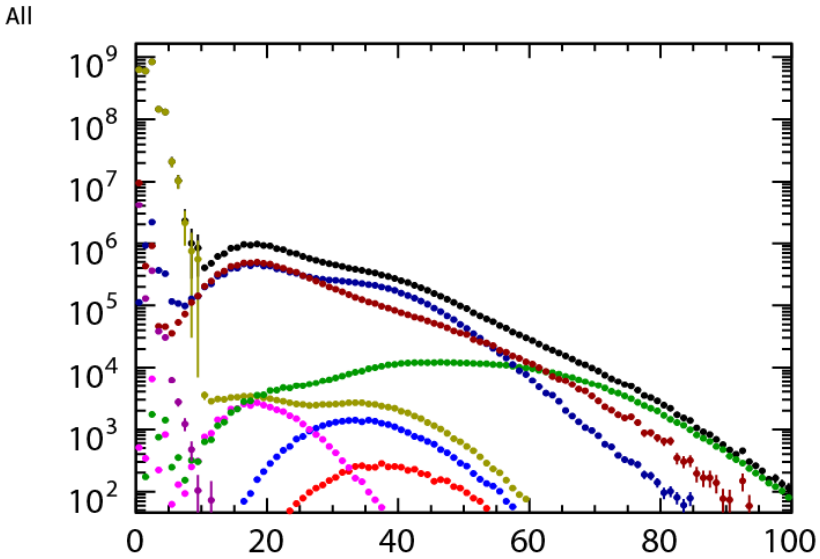


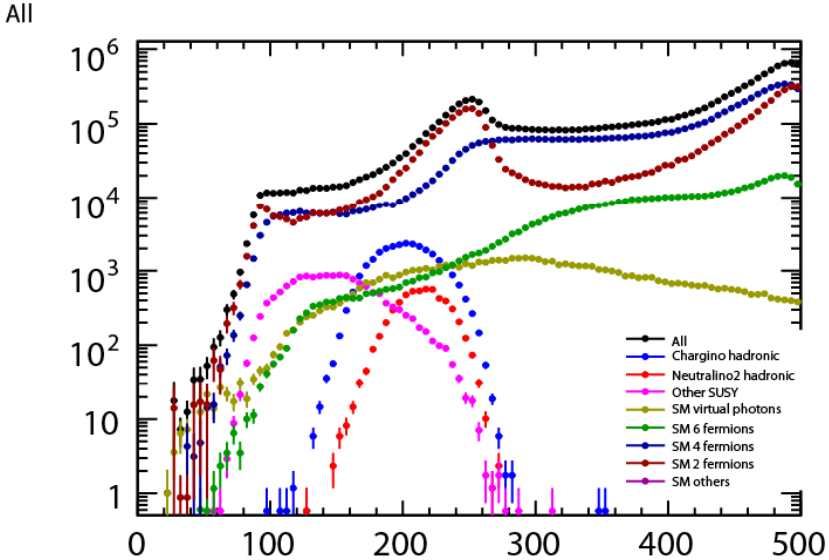
- Signal: SUSY point5
  - ch1ch1->WW->qqqq
  - ne2ne2->ZZ->qqqq
  - Distinguish those by W/Z invariant mass.
- Background (for example):
  - Other SUSY: leptonic mode, ne1ne2 production
  - SM 4jet: e+e- -> WW/ZZ
  - SM 6jet: e+e- -> WWZ -> qqqq + leptons
  - SM 2photons to WW

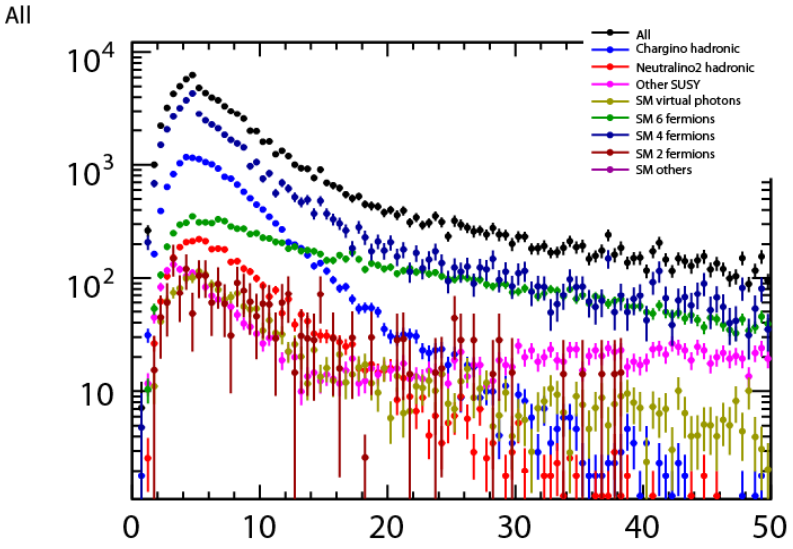
SM Rejection cuts

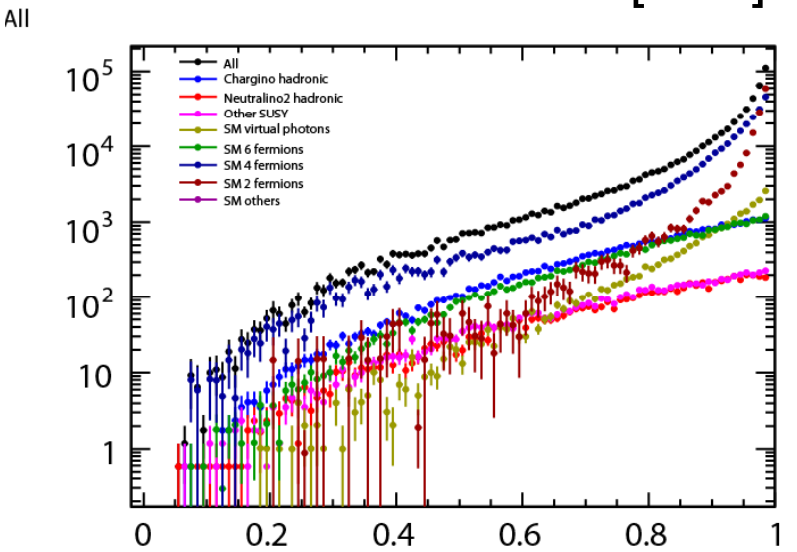
- Common preselection
  - # of tracks >= 20
  - 100 GeV < Evis < 300 GeV
  - All jet > 5 GeV
  - $|\cos(\theta)| < 0.99$ for all jets
- Additional cuts
  - y_{34} (Durham threshold between 3- and 4- jets) > 0.001
  - # of track for each jet is >= 2
  - $|\cos(\theta)|_{miss} < 0.99$
  - Lepton (>20GeV) veto
- Optional
  - $|\cos(\theta)| < 0.9$ for all jets

Cuts


All
tracks


All
All
Chargino hadronic
Neutralino2 hadronic
Other SUSY
SM virtual photons
SM 6 fermions
SM 4 fermions
SM 2 fermions
SM others
Evis [GeV]


All
All
Chargino hadronic
Neutralino2 hadronic
Other SUSY
SM virtual photons
SM 6 fermions
SM 4 fermions
SM 2 fermions
SM others
Elepton [GeV]

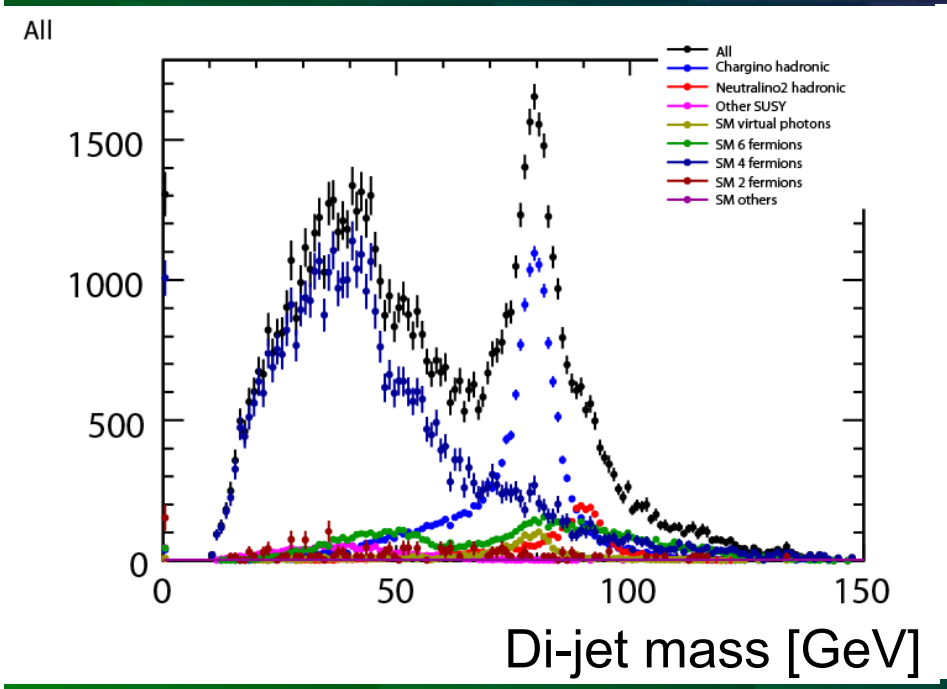

All
All
Chargino hadronic
Neutralino2 hadronic
Other SUSY
SM virtual photons
SM 6 fermions
SM 4 fermions
SM 2 fermions
SM others
Cos(theta) of a jet

Cut results

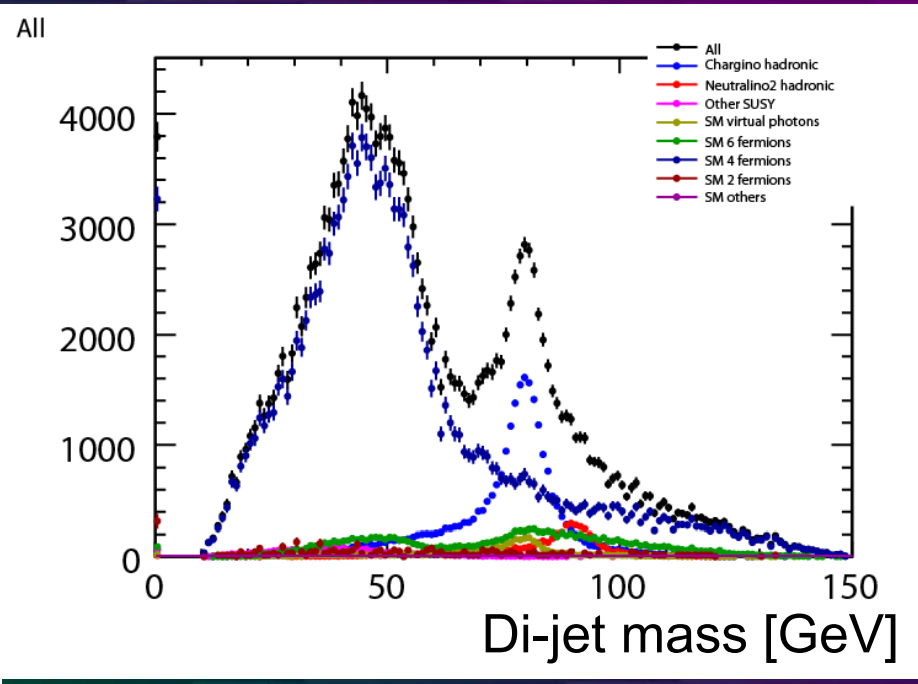
	ch1 had	ne2 had	other SUSY	SM gg	SM 6f	SM 4f	SM2f	SM other
nocut	28529.4	5488.42	43458.4	2.38E+09	520918	1.48E+07	2.07E+07	4.76E+06
ntrack>=20	27896.5	5449.08	15260.7	66772.9	495002	6.68E+06	5.33E+06	0
100<evis<300	27894.7	5449.09	14431.1	33502.1	44414.8	950652	1.56E+06	0
ejet>5	27888.8	5446.16	13688.2	33082.4	44119.4	907594	1.47E+06	0
|cos(theta)|<0.99	26557.3	5239.69	12837.5	26308.9	41136.5	670243	875694	0
yminus>0.001	26417.4	5218.15	10864.1	24476.1	38682.3	416115	166358	0
#track >= 2 / jets	25716.4	5145.92	5656.12	19652.5	22817.8	249306	145328	0
|misscos(theta)|<0.99	25462.6	5099.45	5604.72	5077.23	22383.2	187591	4050.97	0
elepton<20	24729.5	4856.27	2420.98	2929.1	12654.9	144660	3324.55	0
|cos(theta)|<0.95	20631.3	4116.74	2047.65	2182.8	10230.3	76437.6	2412.59	0
|cos(theta)|<0.9	16272.8	3291.77	1660.26	1624.64	7791.32	44891.5	1791.08	0

- SM4f is the main background.
- SM4f can be reduced by tight |cos(θ)| cuts while part of signal is also lost

Mass distribution after cuts



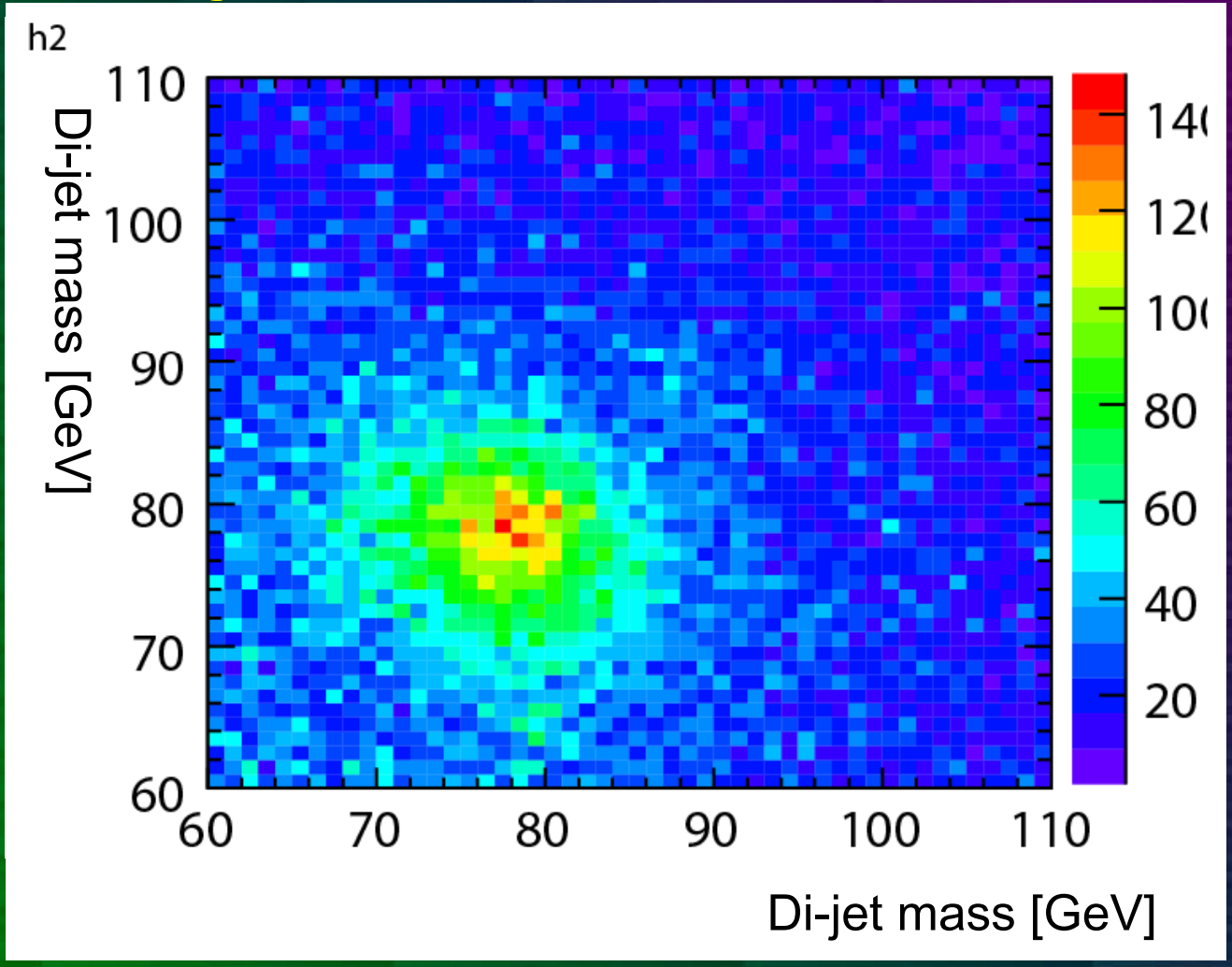
Tight cos(θ) cut (<0.9)



Loose cos(θ) cut (<0.99)

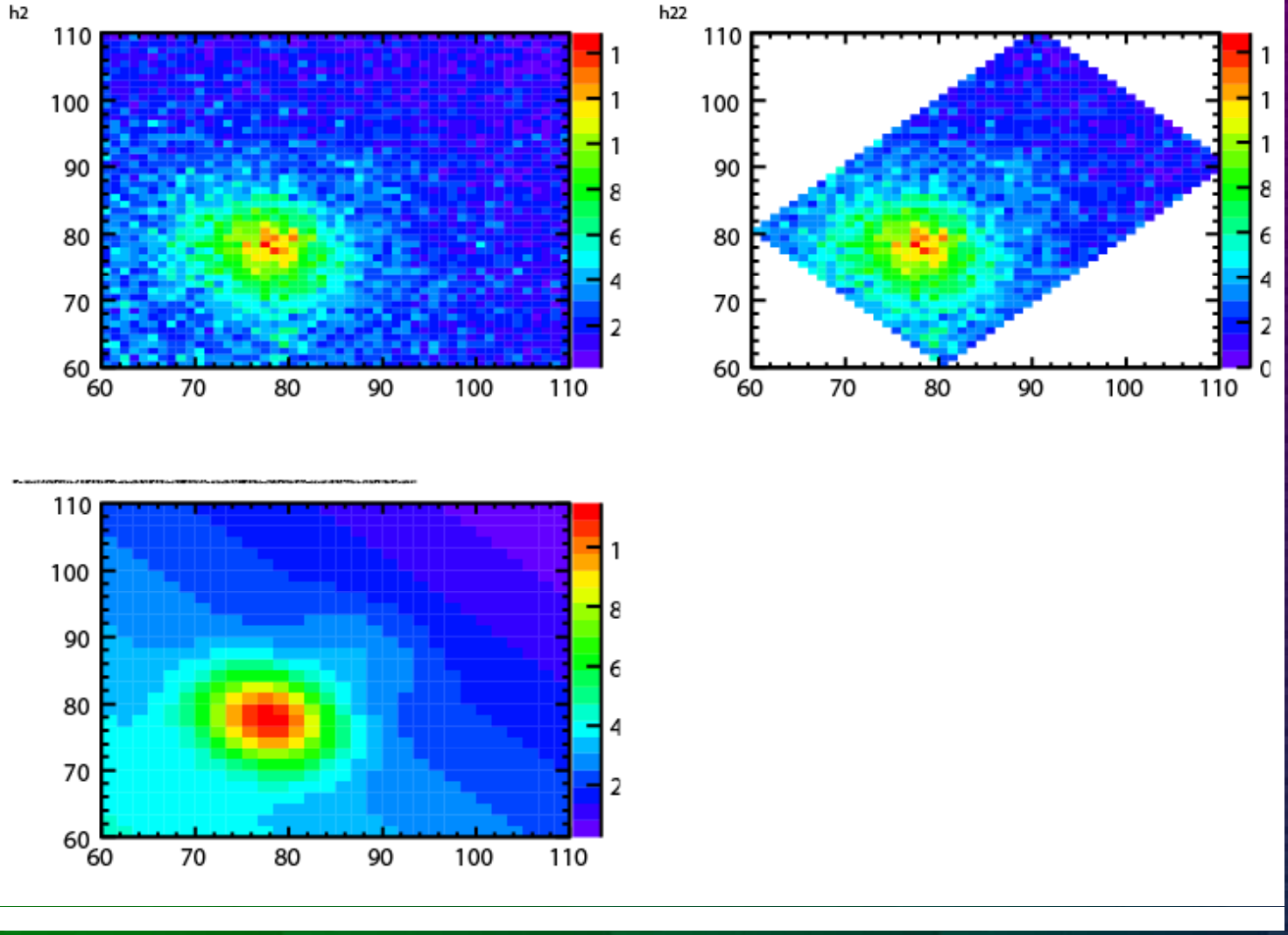
- Kinematic fit result (details shown by Jenny).
- SM rate can be suppressed below signal level.

Dijet-mass distribution



- Loose |cos(θ)| cut

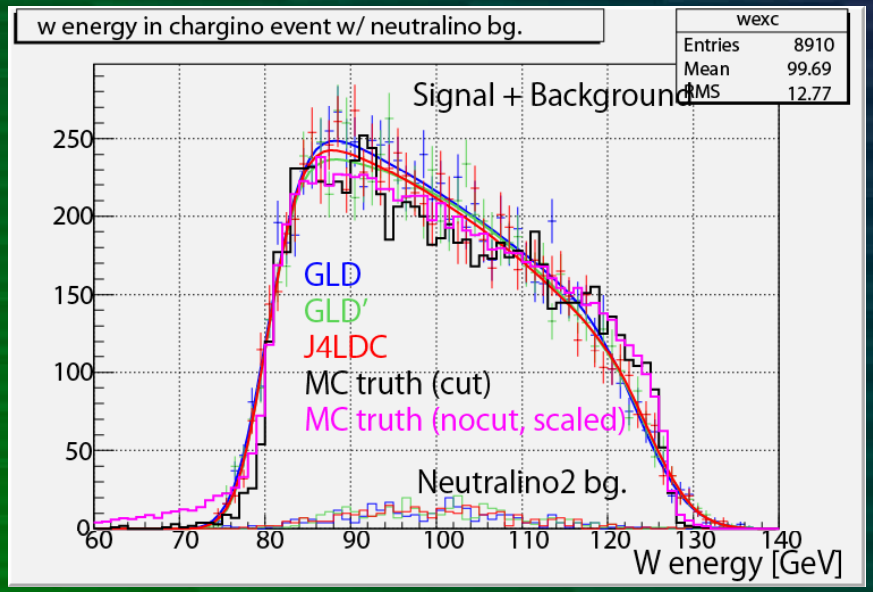
Fitting result

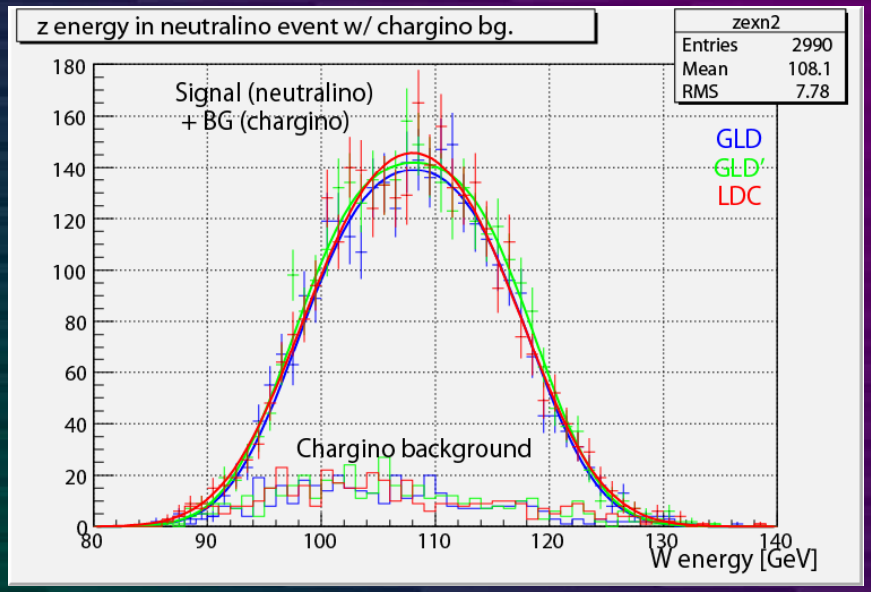


Fitting performance

- Function
  - NDF=8; Gaussian center(2), peak height(2), width(2, m1+m2 direction & m1-m2 direction), background(2, pol1)
- Statistical error
  - Loose cut: ch1: 1.6%, ne2: 6.8%
  - Tight cut: ch1: 2.1%, ne2: 7.1%
  - All 8 parameters are float, gives better result if some of parameters are fixed.
- Works to do
  - Ratio of chargino/neutralino differs from MC input. Need to improve fitting function.
  - Suppress chi2/NDF (about 1.3 ~ 2 now)

Mass fit (not yet for ILD_00)





- No progress since Cambridge
- Fit func: 3rd poly x error func (combolution)
- Mass error is ~ 1 GeV level
- To be applied to ILD_00 (very soon!)

SUSY summary

- SM separation cuts are developed and now discussing.
  - WW is the main remaining background, but on the invariant-mass distribution the background amount is lower than signal.
- Cross section fit was applied to di-jet mass distribution
  - Preliminary results are obtained in ILD_00
  - Need to improve, esp. for ch1/ne2 ratio
- Mass fit is soon reprocessed with ILD_00.