SUSY Point 5: Chargino / Neutralino Separation

Jenny List

DESY Hamburg

ILD Meeting, Seoul, 15. Februar 2009

Benchmark Analysis

Two Analyses:

- T. Suehara (separate talk today)
- J.L. with M. Berggren and D. Käfer
- referees for both analyses: F. Richard and T. Takeshita
- writing common note
- yesterday: agreed on common preselection - not yet reflected in results shown today ;)
- Polarisation: main results for $P(e^+, e^-) = (+30\%, -80\%)$, $P(e^+, e^-) = (+60\%, -80\%)$ for comparison

Status for todays results

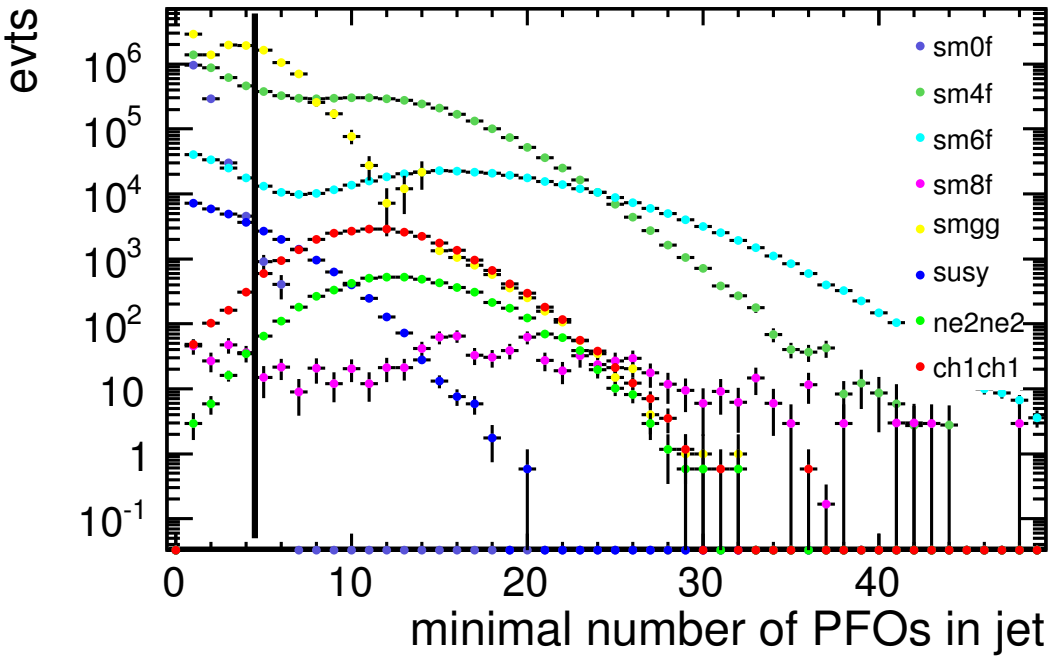
based on ILD_00 DST samples

- SUSY: all $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ and $\tilde{\chi}_2^0\tilde{\chi}_2^0$ events included, no other SUSY processes yet (DSTs not yet produced)
- SM: all but
  - $\gamma\gamma$: few files missing due to crashed job
  - $e\gamma$: DSTs still in production
  - 2f not yet processed in analysis

Jet selection

Ensure 4 well reconstructed jets:

- force event into 4 jets
- $E_{\mathrm{jet}} > 5$ GeV
- $|cos(\theta_{\mathrm{jet}})| < 0.99$
- $N_{\mathrm{jet}}^{\mathrm{PFO}} > 4$
- $y_{34} > 0.001$



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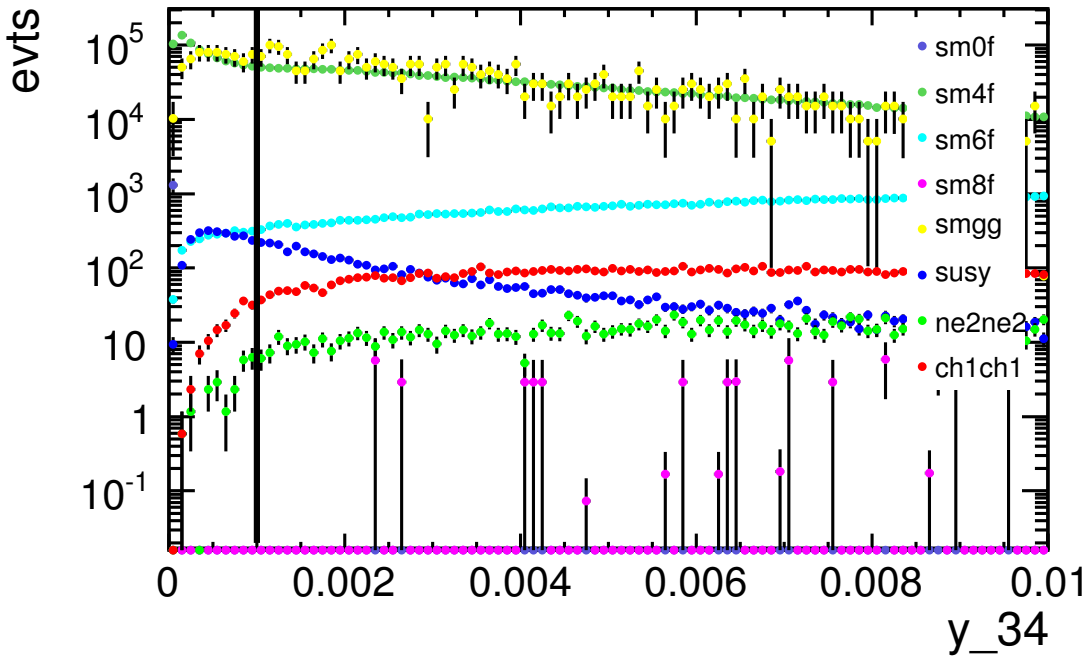
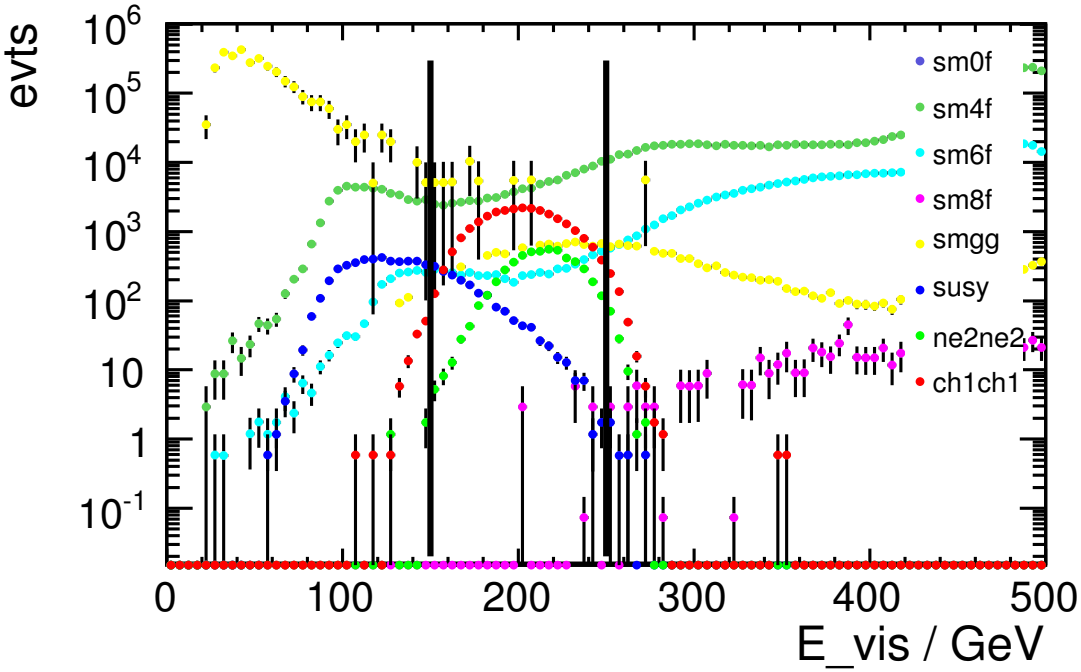


Missing energy selection

two escaping LSPs, two visible Ws / Zs

- 150 GeV $< E_{\mathrm{vis}} <$ 250 GeV
- $|cos(\theta_{\mathrm{miss}})| < 0.95$
- $E_{\mathrm{lepton}} < 25$ GeV



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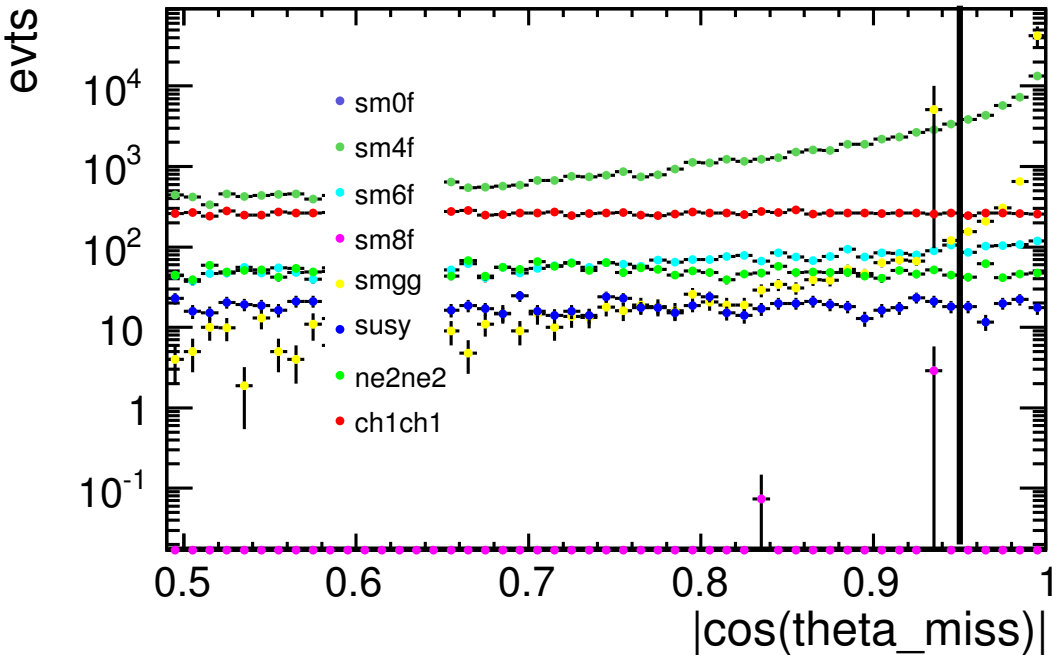

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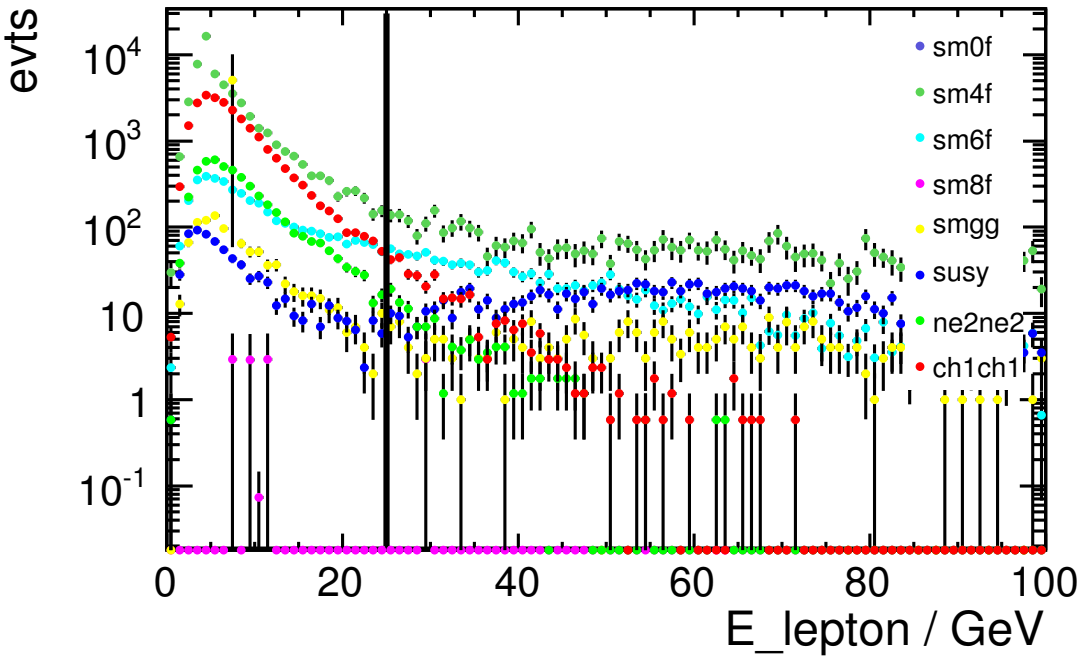
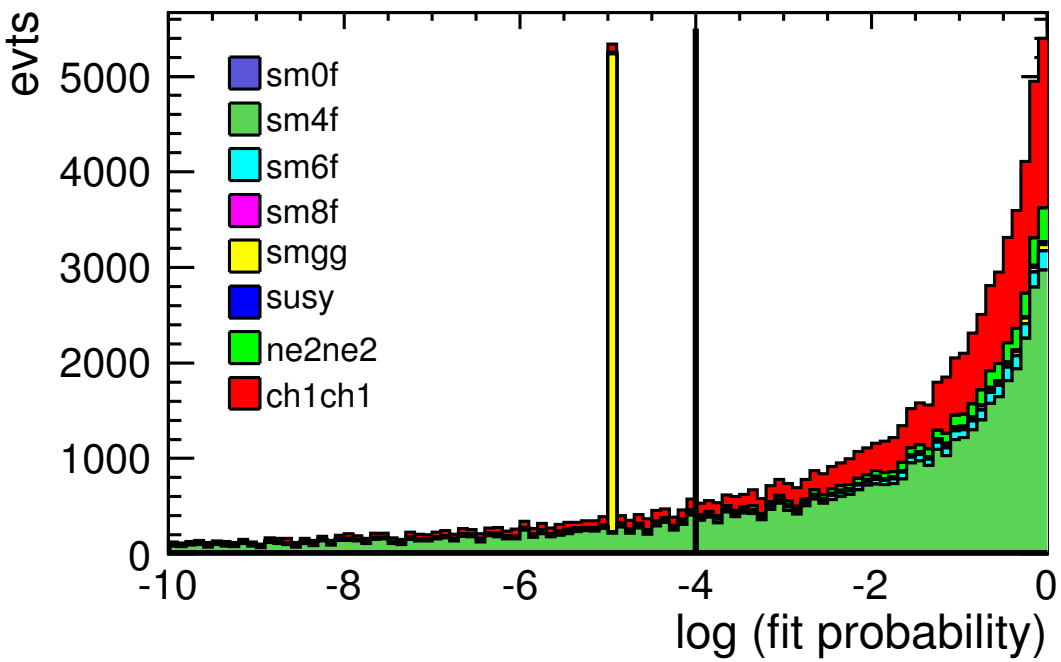


Jet Pairing and Kinematic Fit

...using MarlinFinfit

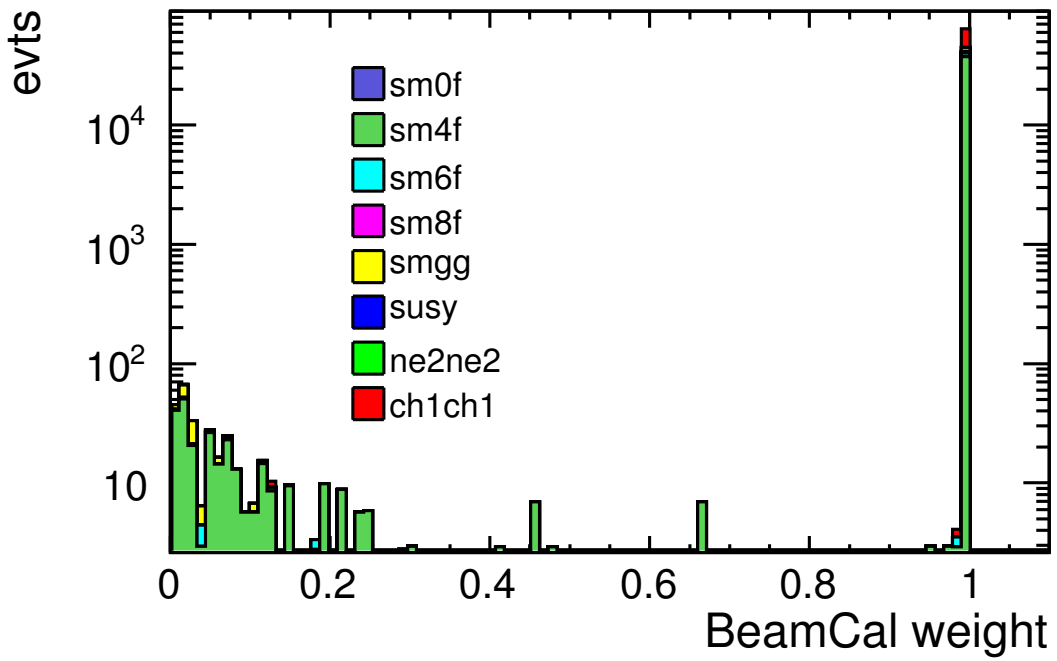
- have either 2 W or 2 Z bosons
- fit jet momenta while constraining $M_{ij} = M_{lk}$ for all three permutations
- chose jet pairing by highest fit probability
- require $log(P_{\mathrm{fit}}) > -4$



BeamCalVeto

... using MarlinAna/BeamCalEfficiency

- extrapolate MC γ, $e^{\pm}$ to BeamCal z-position
- evaluate local energy density due to pair background
- look up efficiency as parametrised from detailed studies
- weight events with 1-prob(to detect $e^{\pm}$)



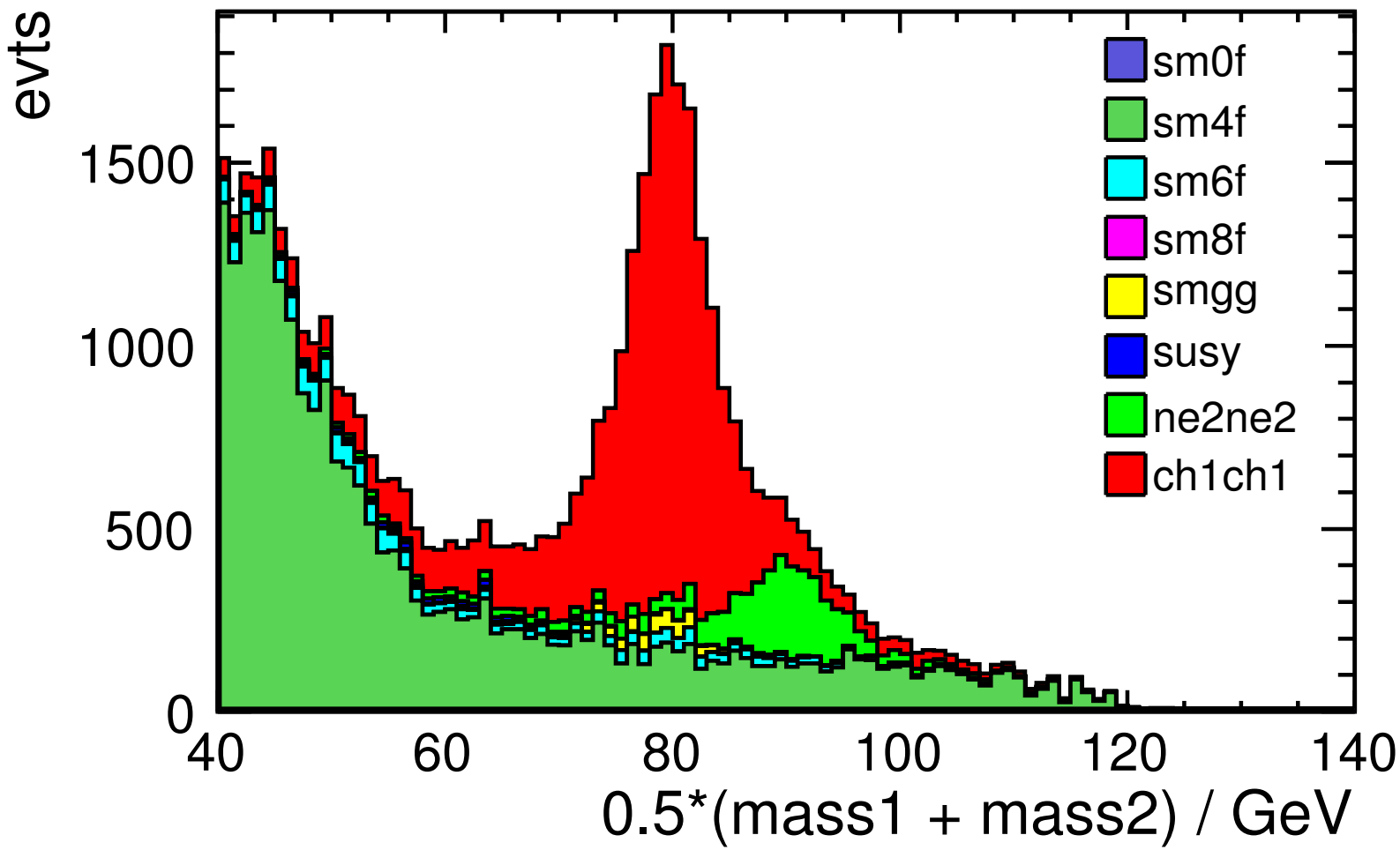
Cutflow for 500 fb^{-1}, $P(e^+, e^-) = (30\%, -80\%)$

	$\tilde{\chi}_1^+\tilde{\chi}_1^-$		$\tilde{\chi}_2^0\tilde{\chi}_2^0$		SUSY	SM $\gamma\gamma$	SM 8f	SM 6f	SM 4f
	N	ϵ	N	ϵ	N	N	N	N	N
no cut	28529	1	5488	1	43458	2.77e+09	945	521004	1.16e+07
jet cuts	26501	0.93	5216	0.95	8578	3.96e+06	754	365867	3.84e+06
y_{34}	26356	0.92	5193	0.94	6228	3.31e+06	754	363397	3.04e+06
E_{vis}	25794	0.90	5080	0.93	1813	49991	12	5668	94286
$\lvert\cos(\theta_{\mathrm{m}})\rvert$	24501	0.86	4840	0.88	1723	6299	12	5149	59765
E_{lepton}	24176	0.85	4731	0.86	682	5980	9	3840	54271
$\log(P_{\mathrm{fit}}) > -4$	19234	0.67	3634	0.66	431	741	6	2608	37856
BeamCal veto	19232	0.67	3634	0.66	431	701	6	2600	37593

...last rows for $P(e^+, e^-) = (60\%, -80\%)$:

	$\tilde{\chi}_1^+\tilde{\chi}_1^-$		$\tilde{\chi}_2^0\tilde{\chi}_2^0$		SUSY	SM $\gamma\gamma$	SM 8f	SM 6f	SM 4f
	N	ϵ	N	ϵ	N	N	N	N	N
E_{lepton}	29753	0.85	5823	0.86	840	5979	11	4704	66612
$\log(P_{\mathrm{fit}}) > -4$	23672	0.67	4473	0.66	530	740	7	3196	46451
BeamCal veto	23669	0.67	4473	0.66	530	700	7	3186	46127

now look at the invariant mass distribution



Cross section measurement

Options

- cut in invariant distribution, do „counting experiment“
- fit 1D invariant mass distribution (background + $\tilde{\chi}_1^+\tilde{\chi}_1^- + \tilde{\chi}_2^0\tilde{\chi}_2^0$)
- fit 2D invariant mass distribution à la Taikan

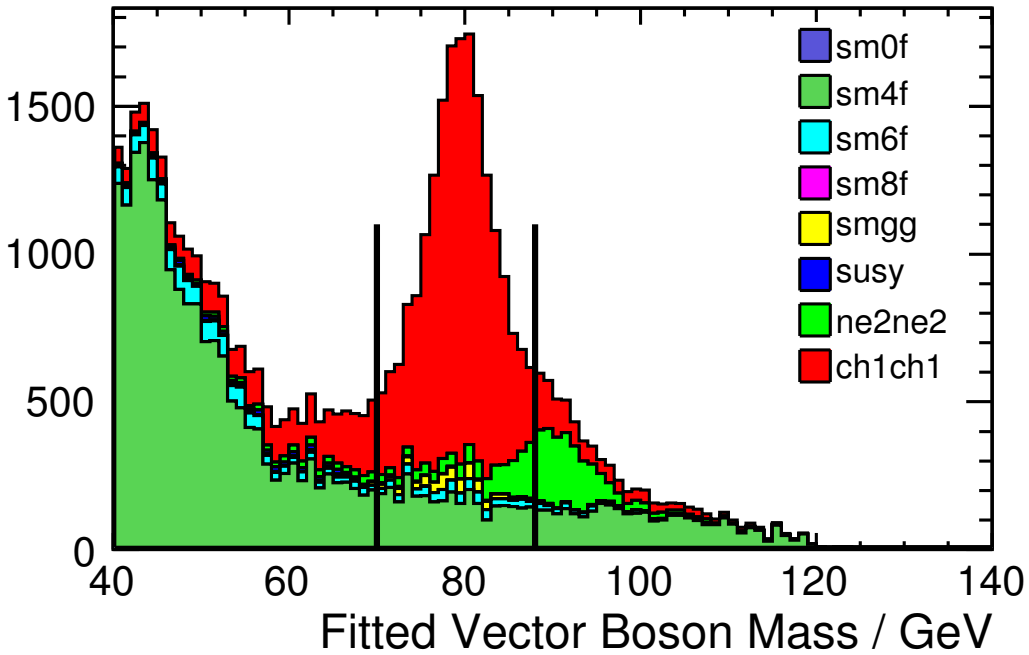
„Counting Experiment“

Charginos

- 70 GeV $< M <$ 88 GeV
- $\epsilon = 49\%$, $\pi = 73\%$
- $\Rightarrow \delta\sigma(\tilde{\chi}_1^+\tilde{\chi}_1^-) = 1.0\%$

Neutralinos

- 88 GeV $< M <$ 95 GeV
- $\epsilon = 33\%$, $\pi = 45\%$
- $\Rightarrow \delta\sigma(\tilde{\chi}_2^0\tilde{\chi}_2^0) = 3.8\%$



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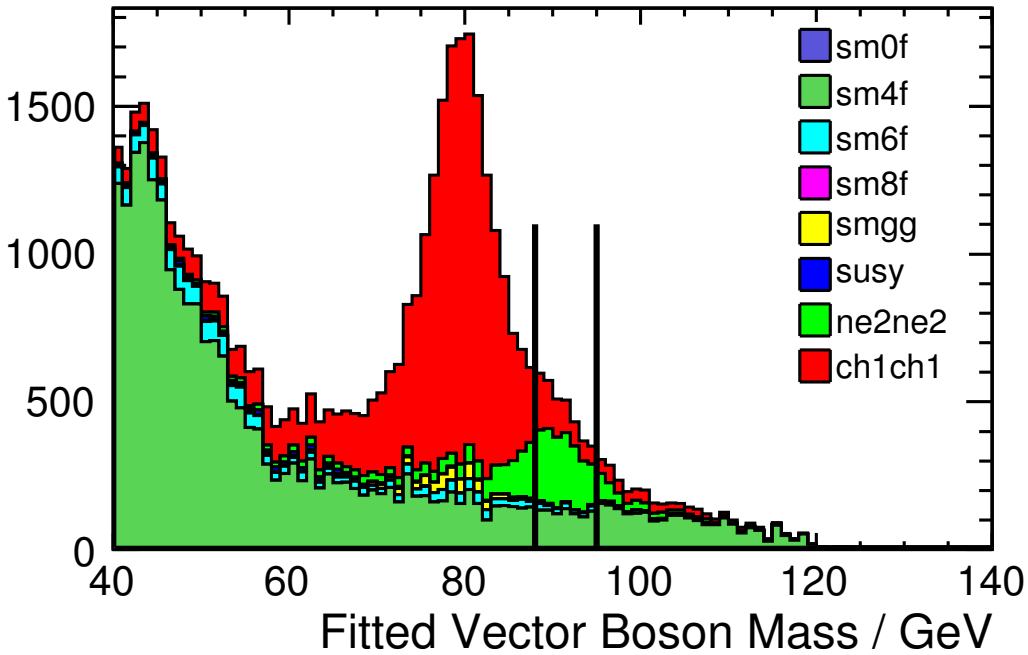


1D fit to mass spectrum

not ready yet :(

Mass section measurement

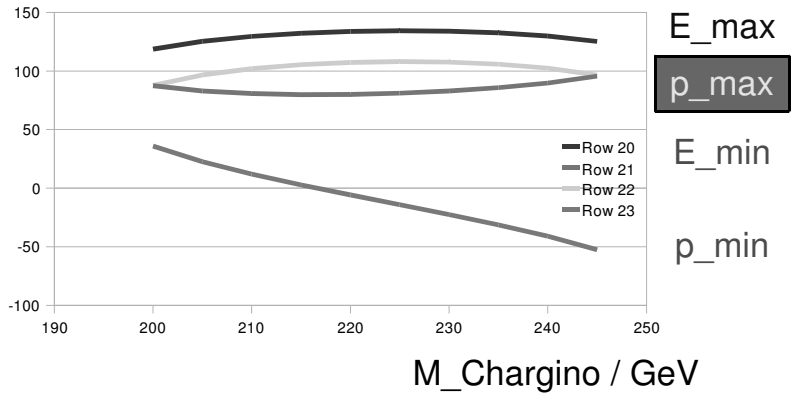
Options

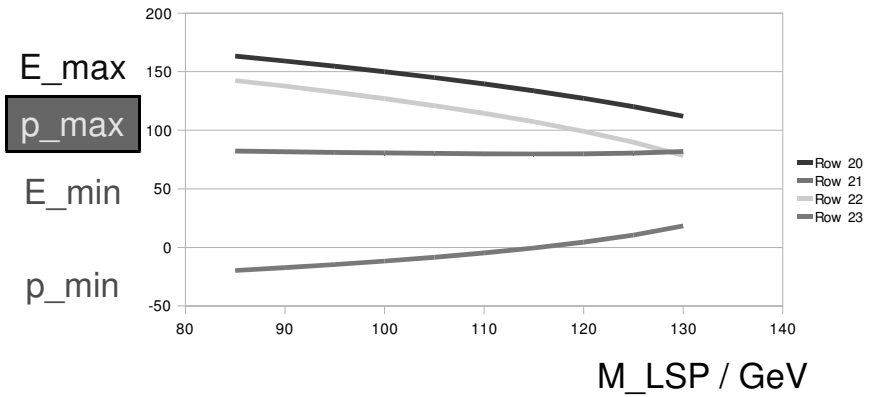
- fit edges in vector boson energy spectrum
- fit edges in vector boson momentum spectrum
- fit „ad-hoc“ parametrisation, i.e. error function
- fit physics motivated parametrisation, i.e. box folded with W/Z lineshape, beam energy spectrum, detector resolution,...

Energy vs Momentum

Which is more sensitive?

- calculate $E_{\mathrm{max/min}}(M_\chi, M_{\mathrm{LSP}})$, $p_{\mathrm{max/min}}(M_\chi, M_{\mathrm{LSP}})$
- evaluate for several $(M_\chi, M_{\mathrm{LSP}})$
- $\Rightarrow$ around benchmark point, E_{min} is independent of M_χ and M_{LSP}
- p_{min} shows nice nearly linear dependency on both

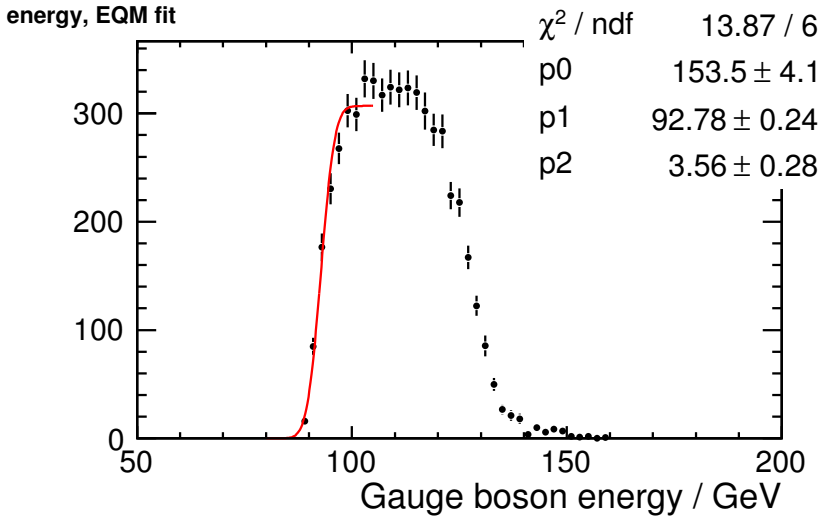


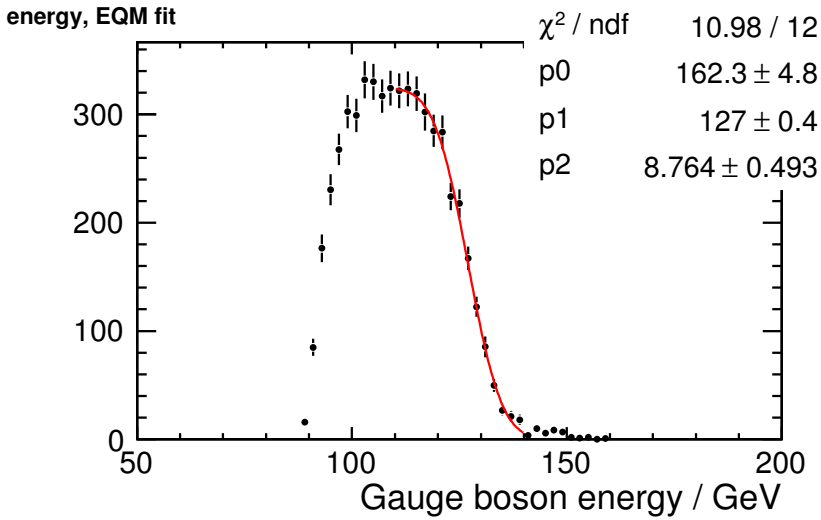


„ad-hoc“ fit on energy spectra

Neutralino mass

- $E_{\text{min}} = 92.8 \pm 0.24$ GeV
- $E_{\text{min}}^{\text{true}} = 93.2$ GeV
- $E_{\text{max}} = 127.0 \pm 0.4$ GeV
- $E_{\text{max}}^{\text{true}} = 129.8$ GeV
- $\Rightarrow E_{\text{max}}$ many sigma away from truth, needs calibration?
- convert to error on masses:
  - $\delta M(\tilde{\chi}_2^0) = 0.72$ GeV
  - $\delta M(\tilde{\chi}_1^0) = 0.5$ GeV

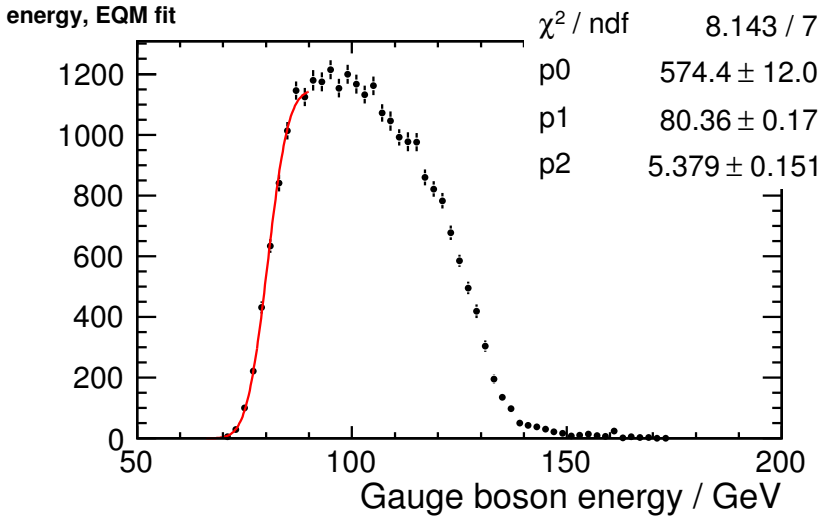


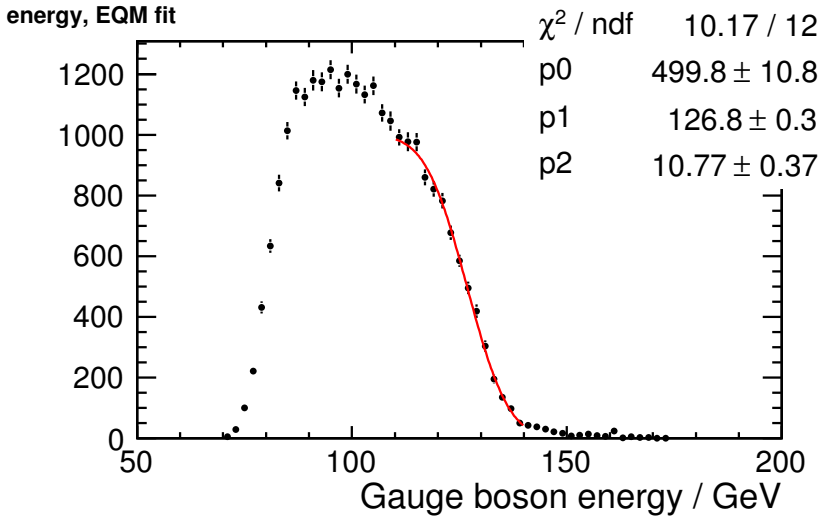


„ad-hoc“ fit on energy spectra

Chargino mass

- $E_{\mathrm{min}} = 80.36 \pm 0.17$ GeV
- $E_{\mathrm{min}}^{\mathrm{true}} = 79.8$ GeV
- $E_{\mathrm{max}} = 126.8 \pm 0.3$ GeV
- $E_{\mathrm{max}}^{\mathrm{true}} = 132.8$ GeV
- $\Rightarrow$ many sigma away from truth, needs calibration?
- convert to error on masses:
  - $\delta M(\tilde{\chi}_1^{\pm}) = 47$ GeV (!)
  - $\delta M(\tilde{\chi}_1^{0}) = 13$ GeV (!)





Physics motivated fit

not ready yet :(

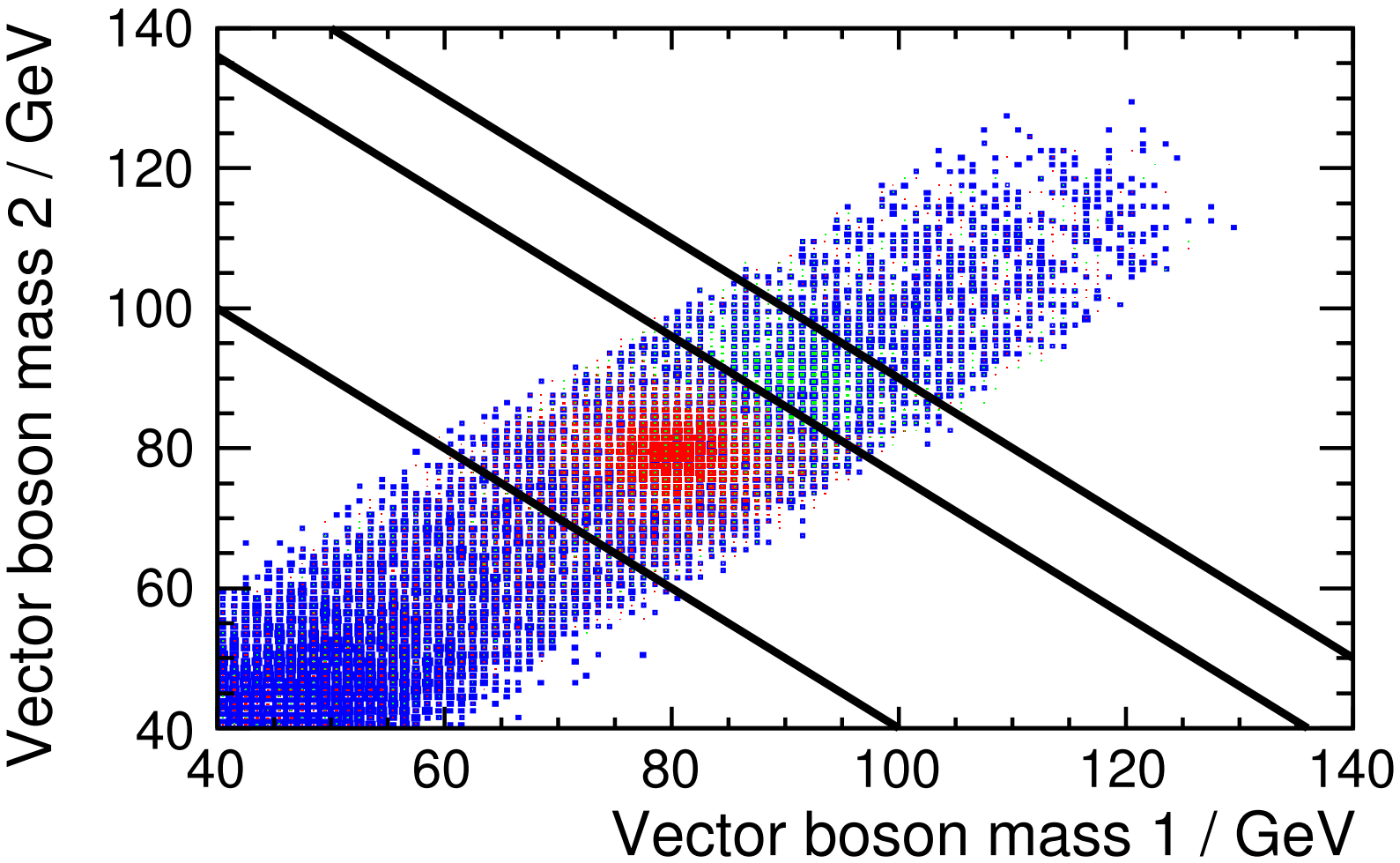
Summary

- first results established
- „naïve “ methods
- cross-section results
  - $\delta\sigma(\tilde{\chi}_1^+\tilde{\chi}_1^-) = 1.0\%$
  - $\delta\sigma(\tilde{\chi}_2^0\tilde{\chi}_2^0) = 3.8\%$
- mass results
  - $\delta M(\tilde{\chi}_2^0) = 0.72$ GeV
  - $\delta M(\tilde{\chi}_1^0) = 0.5$ GeV
  - $\delta M(\tilde{\chi}_1^\pm)$: no sensible result yet

Outlook

- add missing MC files
- apply common preselection with Taikan's analysis
- fit momentum spectrum for Charginos
- cross-section fit ?
- physical mass fit ?

2d mass distribution



2d mass distribution, no kinematic fit