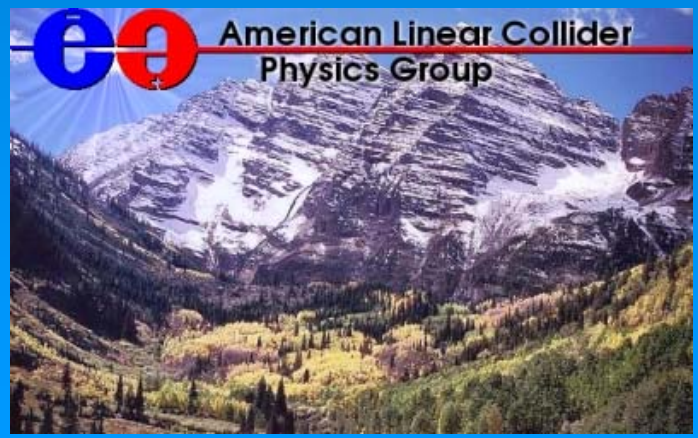
2005 International Linear Collider Physics and Detector Workshop
and Second ILC Accelerator Workshop
Snowmass, Colorado, August 14-27, 2005

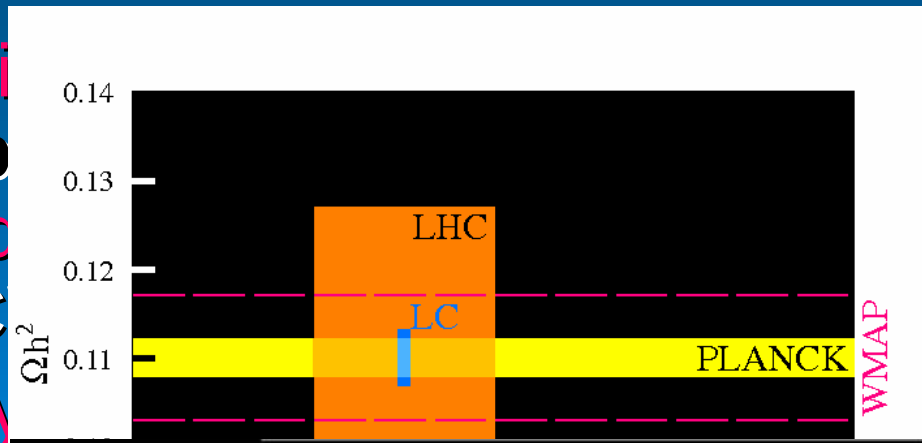
DM with (very) heavy SUSY scalars at ILC

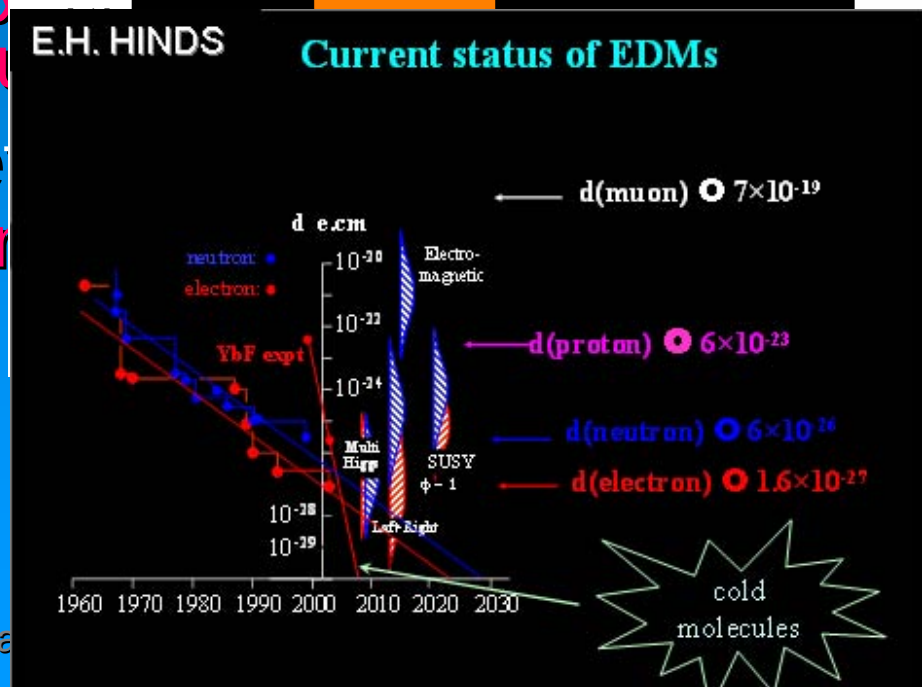
Orsay – Paris VI-VII Collaboration



DM with heavy sleptons

- 1st phase on co-annihilati
  challenging analyses hep
  evaluations of the forwarc
  veto eff.) presented at LC
- 2nd phase assumes heavy
  by flavor constraints: Focu
- 6 SUSY scenarios are de
  on experimental indicatio





Goals of this Study

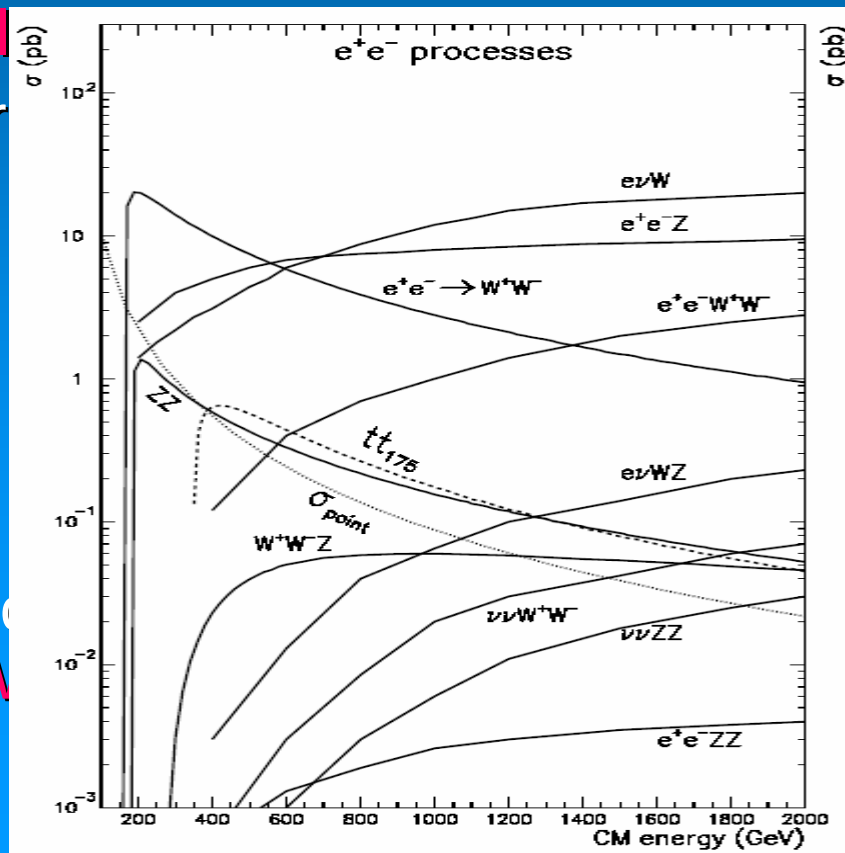
- Working points chosen to illustrate the ILC potential
- Can one maintain the 2% on DM even if the full gaugino spectrum is not observed (μ or M2 not directly accessible) ?
- How sensitive is ILC to a heavy sl
- Theoretical inputs: based on 3 'Fr

  Susygen, Suspect, Micromegas
- Experimental inputs:

  $\sigma(\chi\chi')$<< WW, Wev,$\chi^+\chi^-$

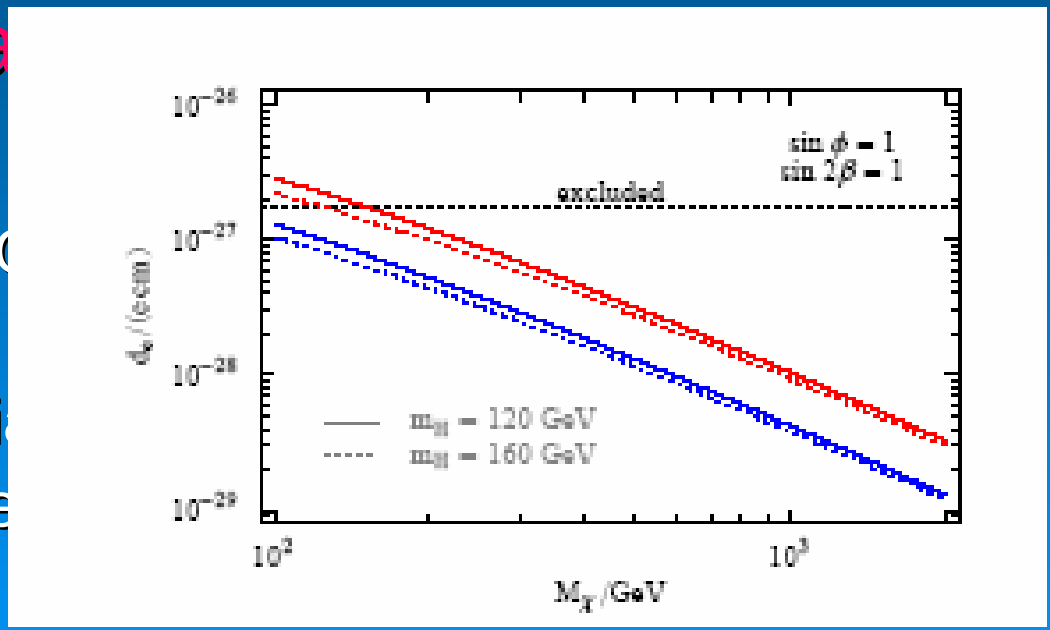
  -> $\chi\chi'$ selection through Z->bbar, needed

  -> ~10^6 $\chi^+\chi^-$ requires ultimate pre pol ?) and on luminosity and low



Theoretical Motivations

Accommodate la



- Focus Point within mSU
  - large m_0 ~10 TeV
  - gaugino spectrum parti

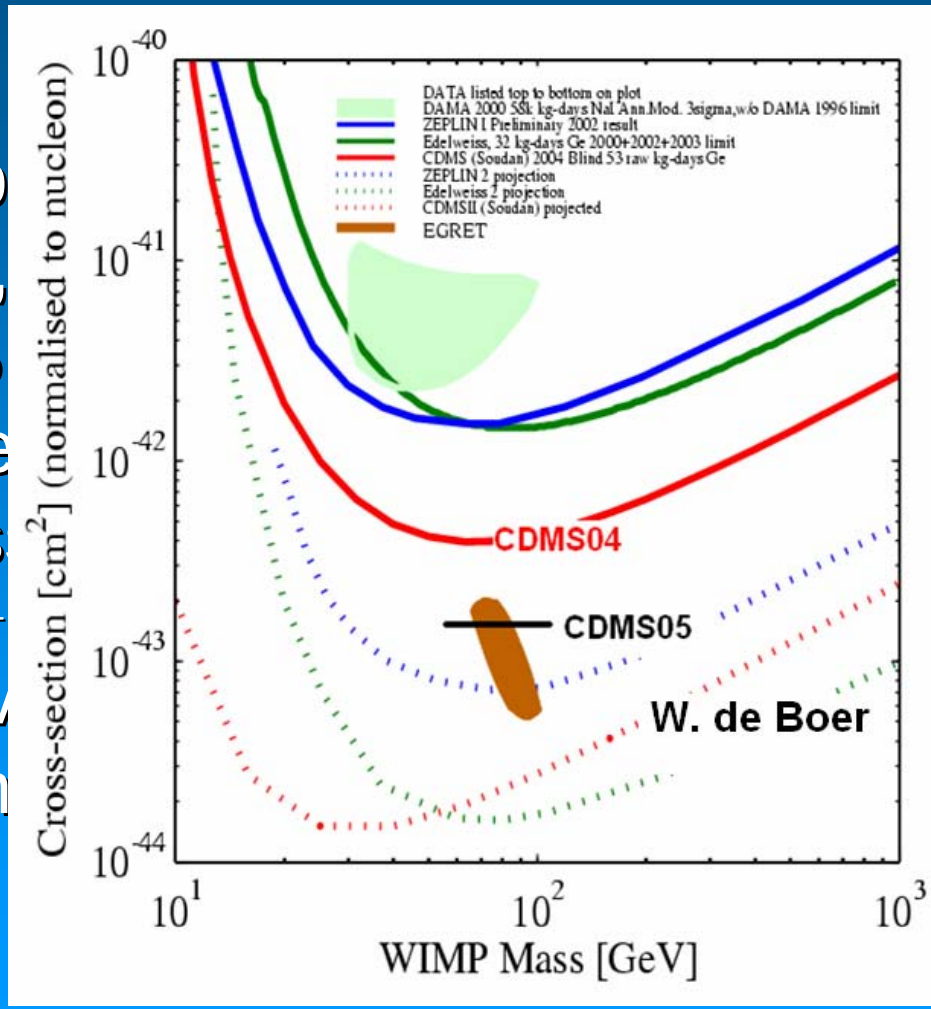
-> polarization allows to me
  ~1 TeV for gauginos,
  ~ few TeV for sneutrinos!

- Split SUSY N. Arkani-Hamed et al. $m_0=10^6$ TeV mh=160 GeV
- h-annihilation mLSP~mh/2

critical on SUSY parameters 0.1 GeV-> 10% on DM

Experimental motivation

- EGRET excess of γ interp
  -> all gaugino accessible,
  HA accessible -> tanβ =5
- LEP h(98)Z+H(114)Z 'see
  -> 2nd chargino not acces
- Degenerate scenario mχ^+
  ISR technique valid in sev
  LSP pure wino or Higgsin
  Monday by Z. Zhang)



Extraction of SUSY parameters

gaugino masses
chargino σL,R + AFB (mixing)
s dependence (sneutrino mass)
Higgs sector (tanβ)

M1, M2, μ, m0, tanβ

e.g. EGRET with all gaugino+Higgses

-> What about other cases?

Focus

- M2 large, 2nd chargino missing, only hZ
- $\phi_{L,R}$ from σ_R and charge asymmetry
- M1 from χ_1 , μ from χ_2
- $\phi_{L,R}$ + μ -> M2 to 5% and tanβ>3
- $\phi_{L,R}$ + σ_L -> m_0> 3 TeV 90% CL
- DM known to 2%

-> Small impact of M2 and tanβ errors

h-annihilation

- 2nd chargino known, only h
- AFB~cosϕ_L–cosϕ_R + chargino masses:

$$\tan\beta = \sqrt{\frac{4m_W^2 - (m^2_{\tilde{\chi}_2^\pm} - m^2_{\tilde{\chi}_1^\pm})(\cos 2\phi_L - \cos 2\phi_R)}{4m_W^2 + (m^2_{\tilde{\chi}_2^\pm} - m^2_{\tilde{\chi}_1^\pm})(\cos 2\phi_L - \cos 2\phi_R)}}$$

tanβ=5±0.8 -> DM to 40%

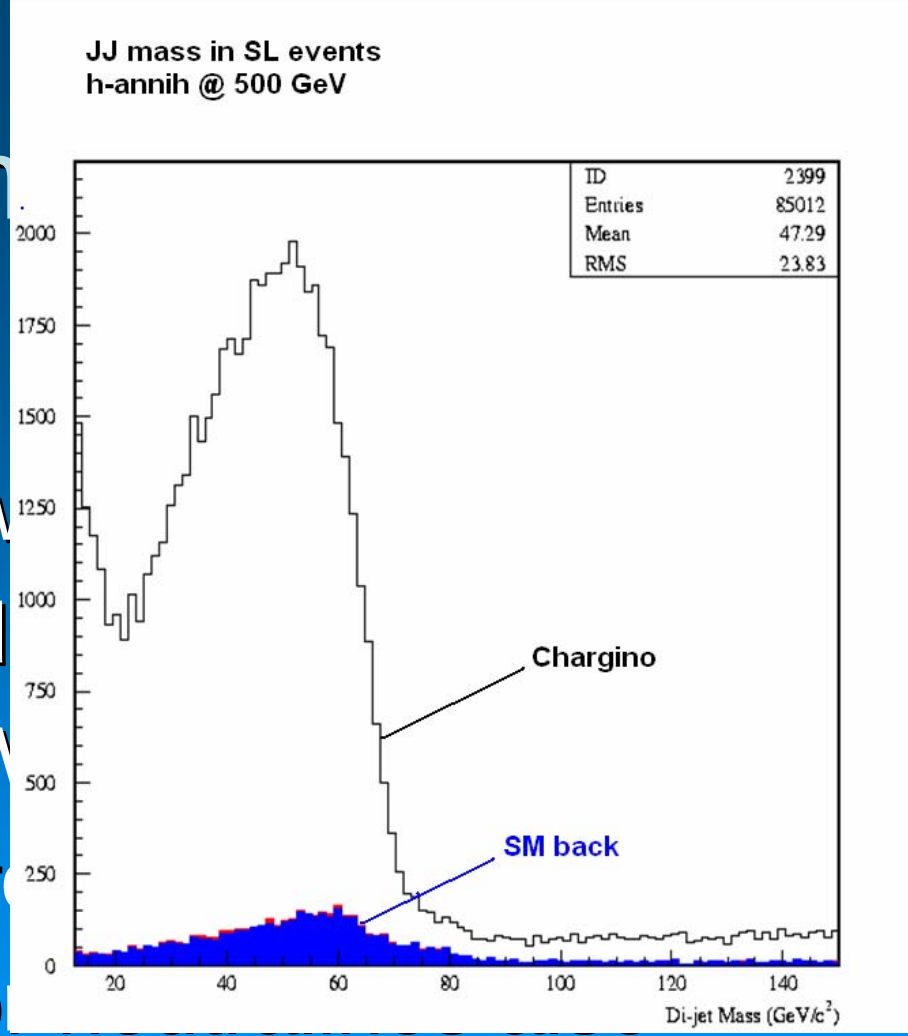
- challenging precision requested

$\chi\chi$->h very sensitive to mixing parameters

- LSP mass also critical ±100 MeV 10% on DM

Experimen

- How to measure A_{FB}
  WW contamination w
-> Detailed study need
- LSP mass from $\chi^{\pm} \rightarrow$
  $m\chi^{\pm} - m\chi$ from W hadr
- B-tagging aspects fo
  requires detailed studies

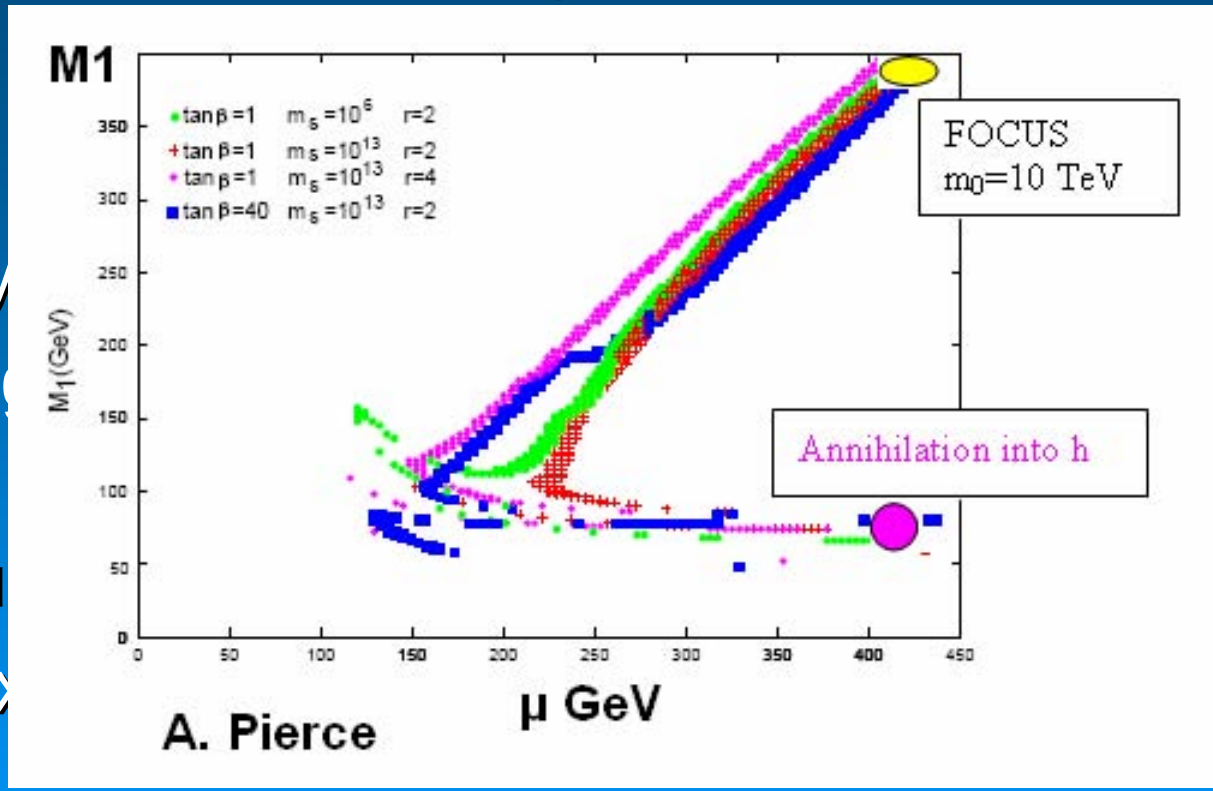


Detailed results (preliminary!)

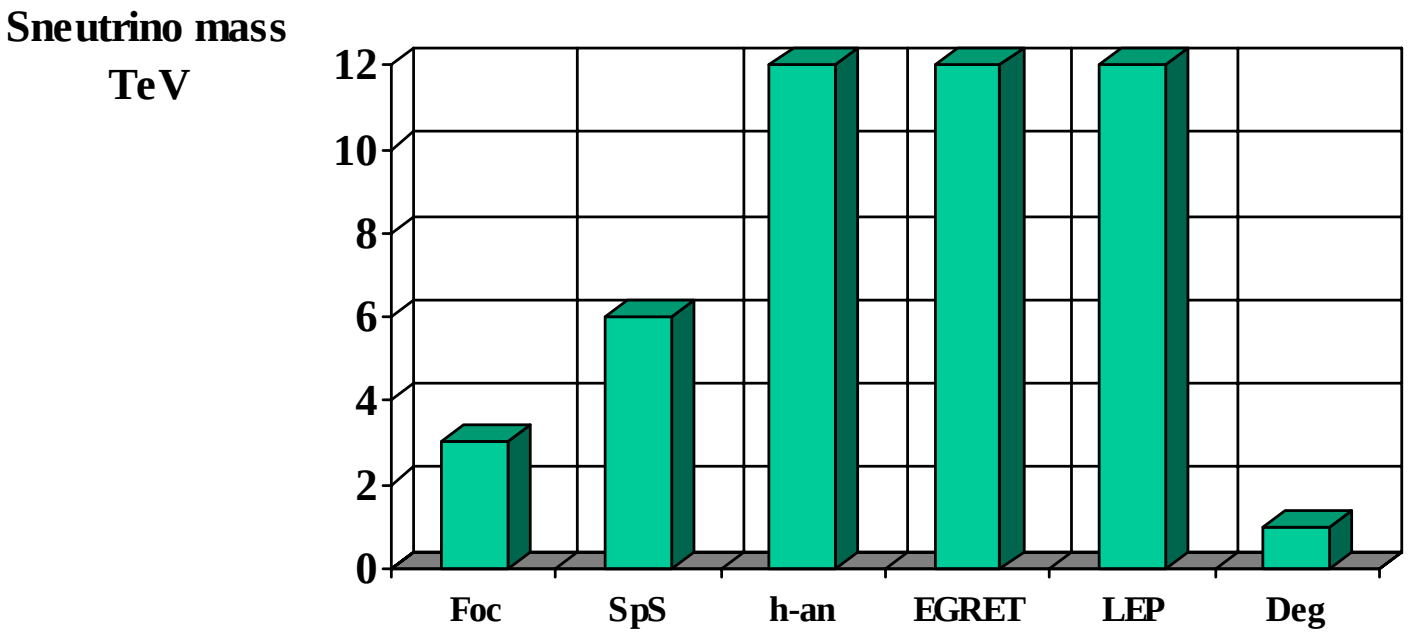
SUSY Param/ Scenarios	LSP	M2	M1	μ	tanβ	sneutrino mass and bound TeV	Features	Overall effect Ωh^2_{DM} (origin)
I Focus	378±0.5	724±40	407±3	427±2	10 >2.8	12.5 >3	mh=130	1%
II SpS1	261±0.4	560±1	281±1	340±1	5±1	10^6 >6	mh=160 from SpS	1%
III h-ann	79.5±0.1	156±1	78±1	–400±1	5±0.8	10^6 >12	mh=163 from SpS	40% (tanβ)
IVEGRET	64± 0.2	128±1.9	68±0.2	212±2.5	51 48<tanβ<54	1.4±0.014 >12	HA accessible	2%
V LEP	59.6±0.1	117±1	60±0.1	μ=900±100	20±0.5	2±0.1 >12	H,A,h Accessible	30% (μ)
VI Degen	299±1	5 TeV >4 TeV (β=π/2) <7.5 TeV (β=π/4)	5 TeV $< \infty$ (β=π/2) >2.2 TeV (β=π/4)	300±1	20 No limit	Pure Higgsino	$m\chi^+ - m\chi^0$ to ±2%	1.2%

Sensitivity of the chargino channel to the sneutrino exchange

- To distinguish
  high sensitivity
- LHC can only
  sneutrinos
- DM often requ
  -> Sneutrino ex
  component
- This component can be seen through energy dependence and/or polarization effects



Mass limits on sneutrinos



Conclusions

- Ultimate (P, $\mathcal{L}$, background) ILC accuracy needed to cover the various scenarios presented
- $\chi^+\chi^-$ give indirect access to large masses

-> ~10 TeV sneutrinos

-> μ, $M_2 \sim 1$ TeV

- DM h-annihilation very sensitive to LSP mass and to mixing parameters (μ, tanβ)
- Detector properties crucial: p-flow, b-tagging
- Good hope to control, in most cases, the SUSY parameters at the right precision