



Concluding Remarks

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Black December

- UK : 11-Dec-08, STFC Delivery Plan
 - 'We will cease investment in the international linear collider'

- US : Appropriations Act, Division C
 - ITER, NOvA → 0
 - 'In the current constrained environment and without CD0',
ILC/SCRF → about 1/4 : Already spent!



TILC08



- More than 200 registered
 - By far the largest of the past Asian regional ILC workshops
 - More than 1/2 from Europe and Americas
- Strong political support
 - Congressman Kawamura's talk
- Realistic progress on strategy
 - Accelerator and detectors

Scientific value of ILC remains valid

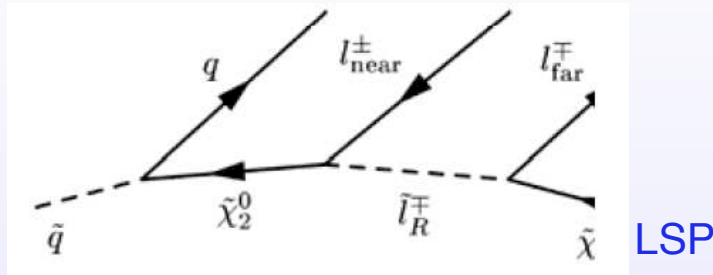


LHC

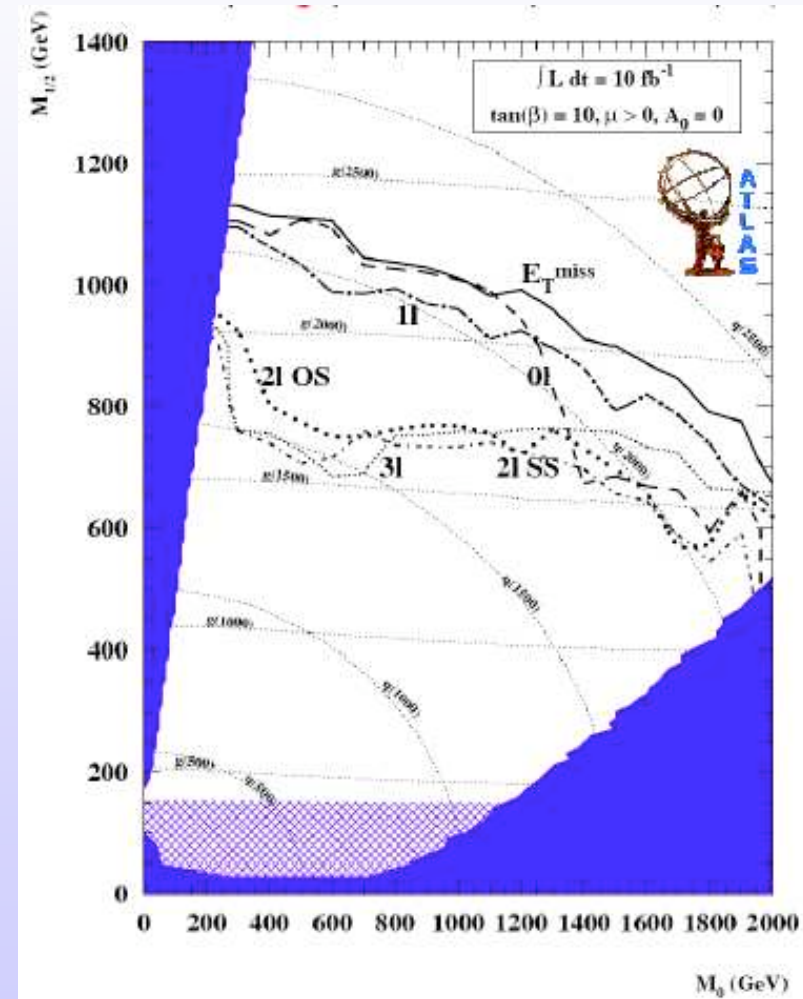


- Possible running scenario
 - 14 GeV CM
 - 2008 end : $1\text{fb}^{-1}/\text{exp}$
 - 2009 end : $10\text{fb}^{-1}/\text{exp}$
 - ~2025: 28 TeV CM?
- 14 TeV CM, p+p
- Run starts this summer !
- Preparation on schedule

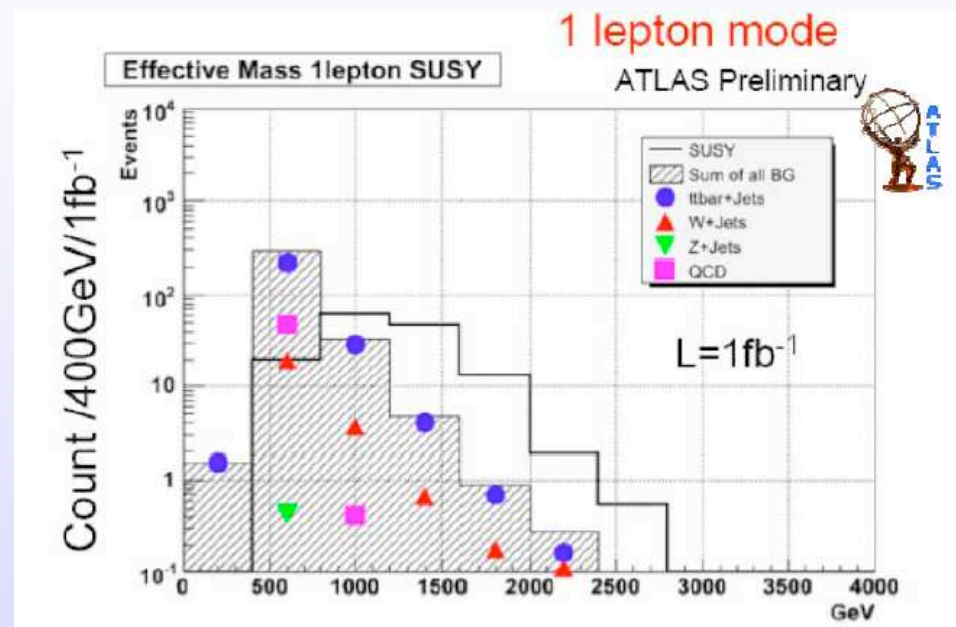
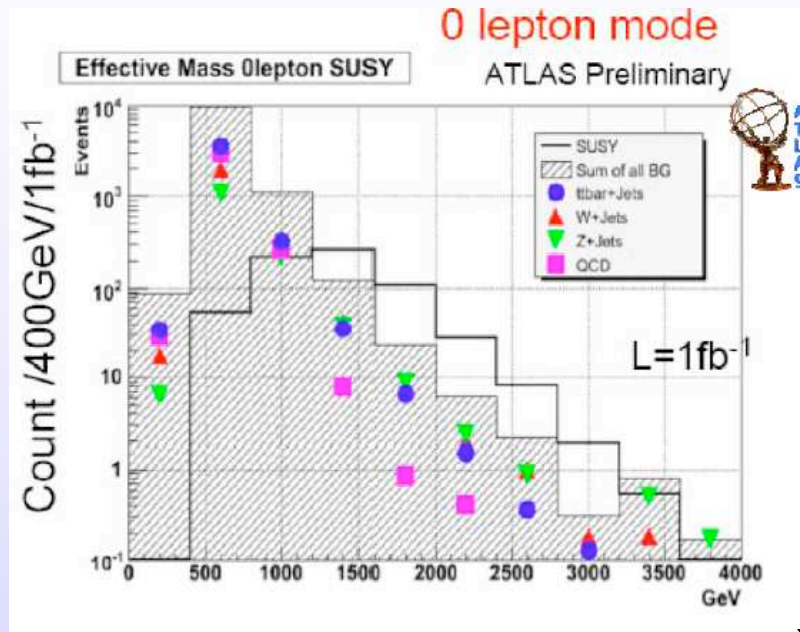




- Colored sparticles copiously created (they tend to be heavy)
- Typically a long cascade of squark or gluino decay
- Missing energy at the end (LSP)
- Leptons (e, μ, τ)
- 10fb⁻¹ searches up to ~ 1.5 TeV



LHC SUSY search



$$M_{\text{eff}} = \sum_{i=1,4} \left| \vec{p}_{T\text{jet}_i} \right| + E_{T\text{miss}}$$

- SUSY is detected as a global feature
- Is this really SUSY?



LHC Mass Determination



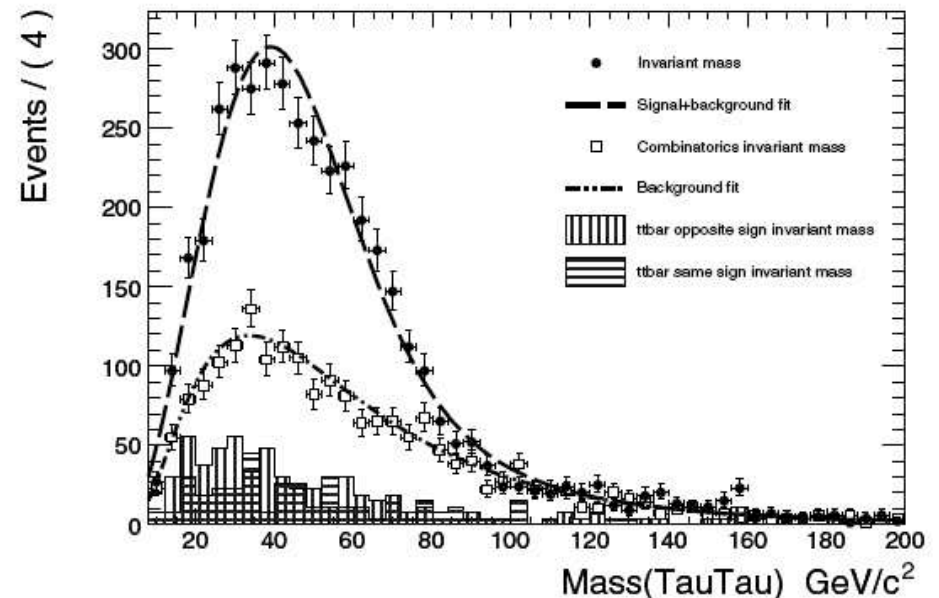
$$\tilde{q} \rightarrow q\tilde{\chi}_2^0 \rightarrow q(\tau\tilde{\tau}) \rightarrow q(\tau(\tau\chi_1^0))$$

- Signal: $\tau^+ \tau^- j + E_{T\text{miss}}$
- Endpoints: $M_{\tau\tau}$, $M_{\tau\tau j}$, $M_{\tau_1 j}$, $M_{\tau_2 j}$, $M_{\tau_1 j} - M_{\tau_2 j}$
- Solve for 4 sparticle masses

CMS : 40 fb⁻¹

$M(\tilde{\chi}_1^0)$ (GeV)	$147 \pm 23(\text{stat}) \pm 19(\text{sys})$
$M(\tilde{\chi}_2^0)$ (GeV)	$265 \pm 10(\text{stat}) \pm 25(\text{sys})$
$M(\tilde{\tau})$ (GeV)	$165 \pm 10(\text{stat}) \pm 20(\text{sys})$
$M(\tilde{q})$ (GeV)	$763 \pm 33(\text{stat}) \pm 58(\text{sys})$

Multiple solutions





ILC running scenario

(<http://www.fnal.gov/directorate/icfa/para-Nov20-final.pdf>)



- 1st stage
 - Energy 200-500 GeV, scannable
 - e^- polarization $> 80\%$
 - 500 fb^{-1} in first 4 years

- 2nd stage
 - Energy upgrade to $\sim 1\text{TeV}$
 - 1000 fb^{-1} in 3-4 years



ILC options



- Additional 500 fb⁻¹ at 500 GeV in 2~3 years
 - Depends on results from LHC, ILC phase 1.
- e⁺ polarization 50% or more
 - 30% polarization is in the baseline
- $\gamma\gamma$, γe^- , e⁻e⁻ colliders
 - γ generated by inverse Compton scattering
- Giga-Z (running on Z-pole)
 - 10⁹ Z's in a few months



Supersymmetric Particles at ILC

- ILC can pair-create SUSY particles

$$e^+e^- \rightarrow \tilde{\mu}_R^+ \tilde{\mu}_R^-, \tilde{\mu}_R \rightarrow \mu \tilde{\chi}_1^0$$

$$e^+e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W^+ \tilde{\chi}_1^0$$

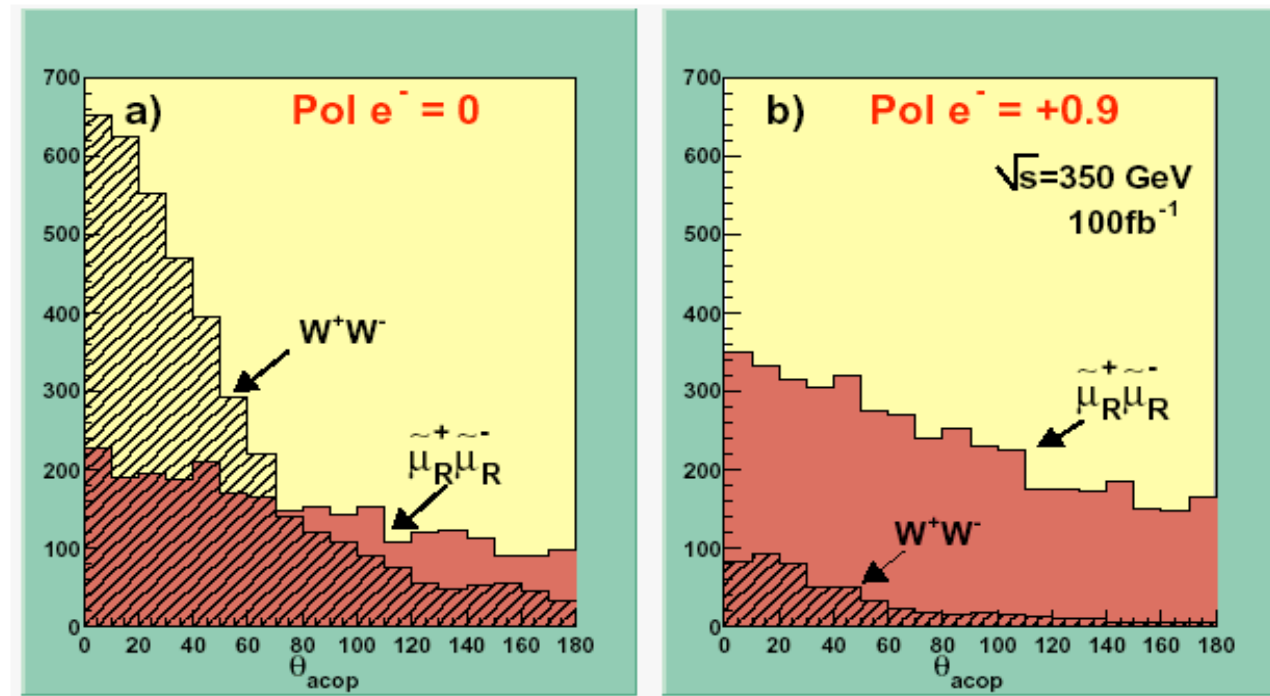
etc.

- Precision measurements of **masses and mixings**
- Determination of **spin, hypercharge** etc.
- **Beam polarization** useful. It can also reduce backgrounds



Smuon detection

$$e^+e^- \rightarrow \tilde{\mu}_R^+ \tilde{\mu}_R^-, \tilde{\mu}_R \rightarrow \mu \tilde{\chi}_1^0$$

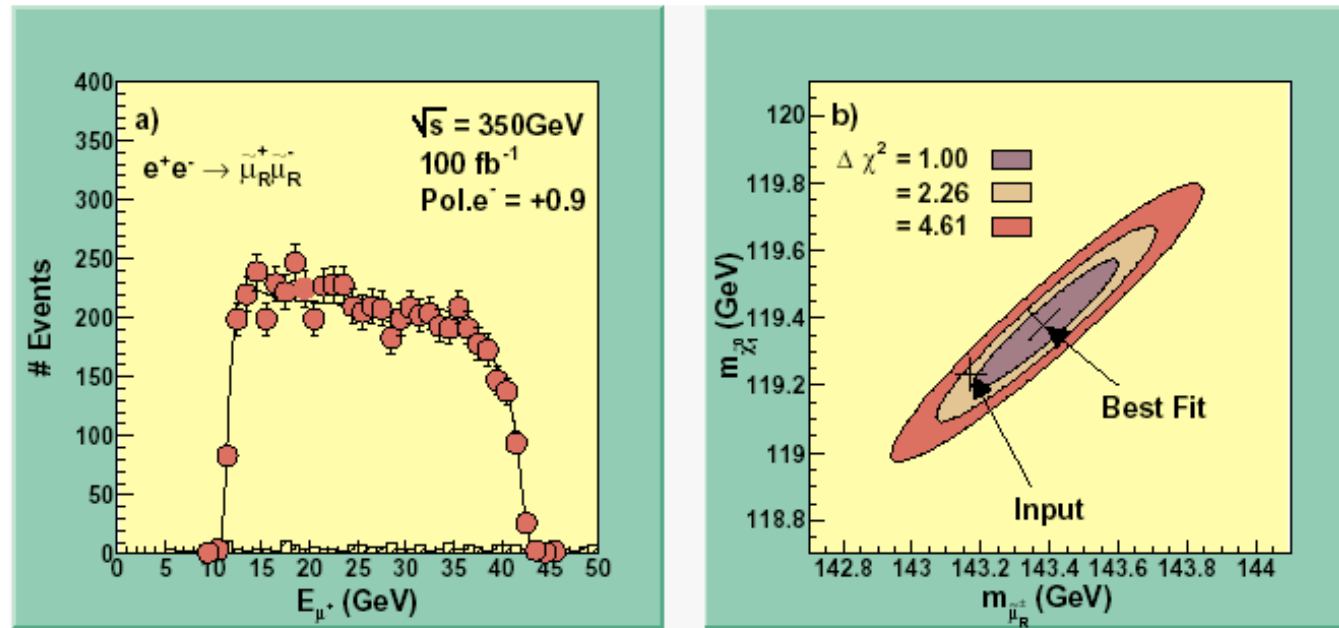


- Signal : $\mu^+\mu^-$ and nothing. Plot acoplanarity of $e^+e^- \mu^+\mu^-$.
- Polarized e^- (R) can reduce $W^+ W^-$ background.

Masses of smuon and LSP



$$e^+e^- \rightarrow \tilde{\mu}_R^+ \tilde{\mu}_R^-, \tilde{\mu}_R \rightarrow \mu \tilde{\chi}_1^0$$

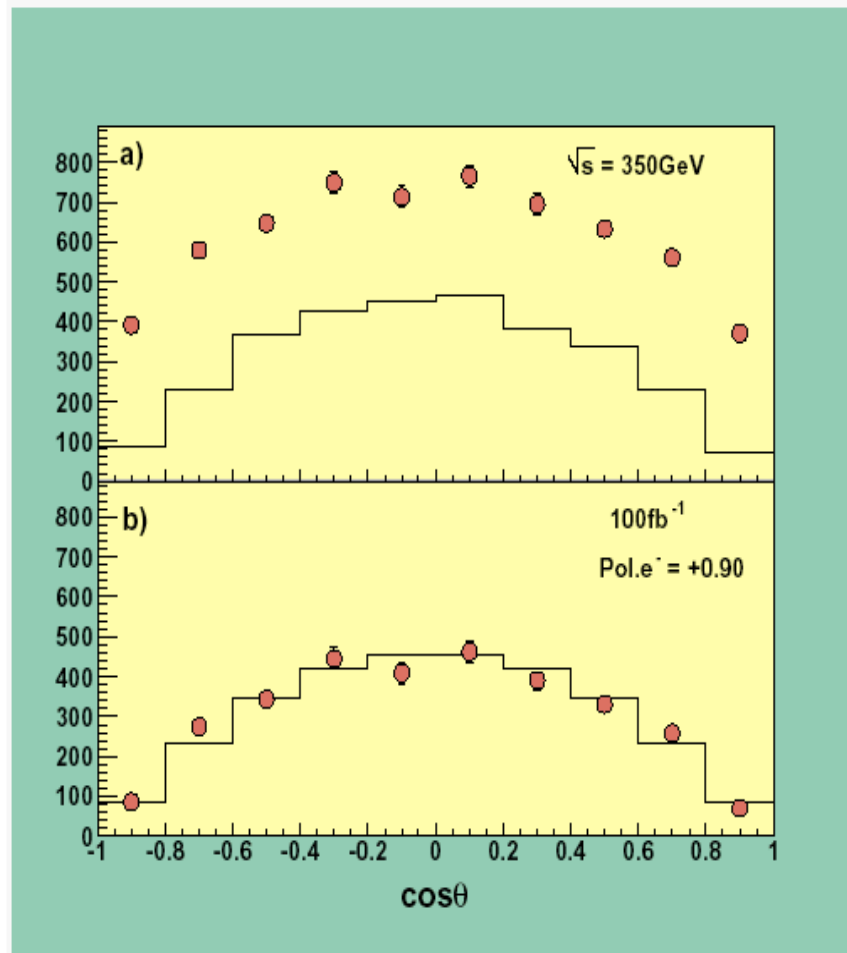


- Known smuon pair 4-momentum
- Use the endpoints of μ^\pm for simultaneous determination of $m(\tilde{\mu}_R)$ and $m(\tilde{\chi}_1^0)$

Smuon spin determination



$$e^+e^- \rightarrow \tilde{\mu}_R^+ \tilde{\mu}_R^-, \tilde{\mu}_R \rightarrow \mu \tilde{\chi}_1^0$$



- Smuon production angle
 - Quadratic solutions
 - Wrong solution \sim flat
 - $\sin^2\theta \rightarrow$ spin0

- Similarly for

$$e^+e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^-$$

SUSY parameter determination



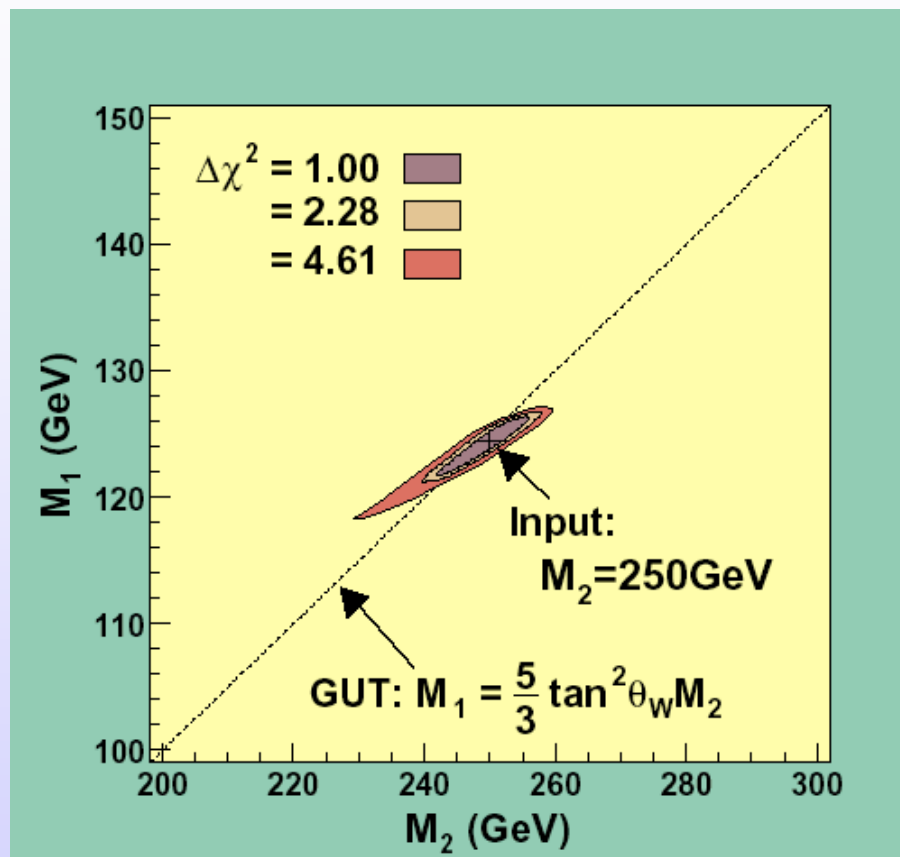
- Charginos are mix of Wino and Higgsino with mass terms :

$$(\tilde{W}^+, \tilde{H}_u^+) \begin{pmatrix} M_2 & \sqrt{2}m_W \cos \beta \\ \sqrt{2}m_W \sin \beta & \mu \end{pmatrix} \begin{pmatrix} \tilde{W}^- \\ \tilde{H}_d^- \end{pmatrix}$$

- Use polarized beam (e^-_R)
 - Only Higgsino component of chargino contribute to chargino pair creation
 - Right-handed selectron pair production depends on Bino in S channel only
- Perform global fit of $(M_1, \tan \beta, M_2, \mu)$ to

$$\begin{array}{cc} \sigma(e^+ e^-_R \rightarrow \tilde{e}^+_R \tilde{e}^-_R) & \sigma(e^+ e^-_R \rightarrow \tilde{\chi}^+_1 \tilde{\chi}^-_1) \\ m(\tilde{\chi}^+_1) & m(\tilde{\chi}^0_1) \end{array}$$

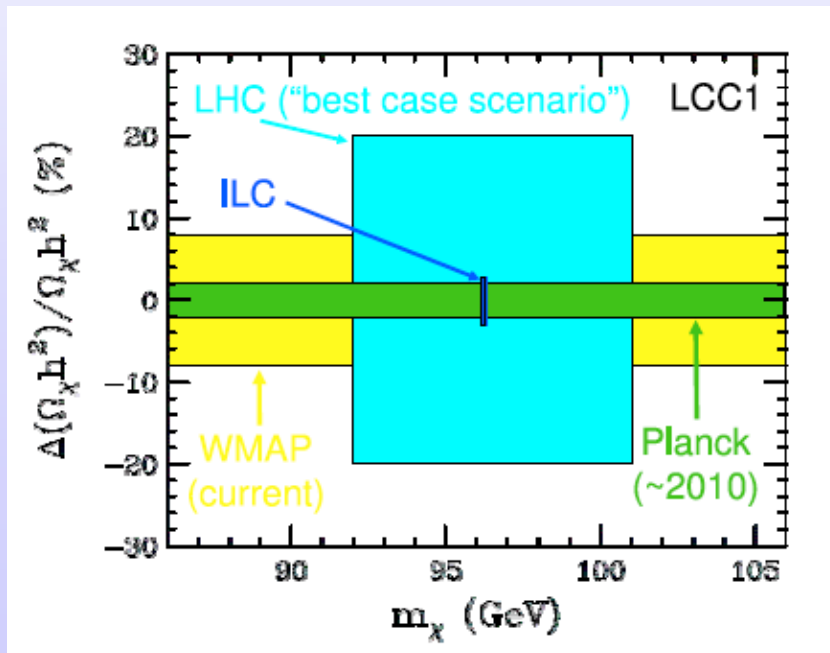
SUSY parameters (cont'd)



- $E_{\text{cm}} = 500 \text{ GeV}, 50 \text{ fb}^{-1}$
- Serves as a test of GUT relation (or other mechanism)
- Lagrangian reconstruction



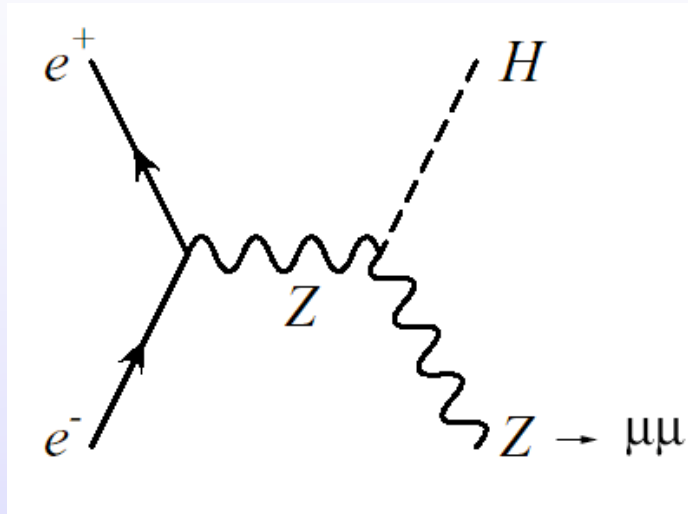
- Key question: can it explain the ‘23%’? (relic density)
- Production + annihilation rate \rightarrow relic density
- Need to know all interactions contributing to LSP annihilation



Relic density estimation by
LHC and ILC
(mSUGRA SPS1a)



Higgs at ILC



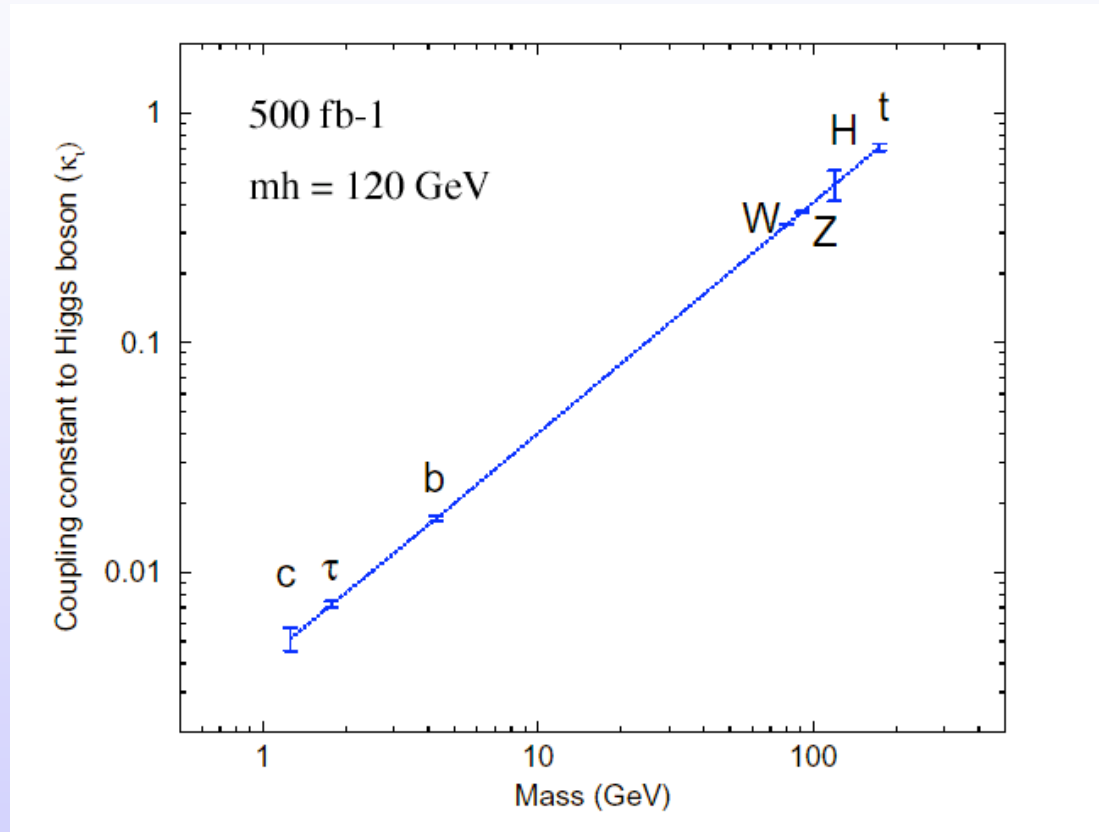
Golden channel :
'Higgs-strahlung'

$$e^+e^- \rightarrow Zh, Z \rightarrow \mu\mu, ee$$

- Measurement of Higgs mass and production rate - independent of Higgs decay modes
- Then detect Higgs decays - absolute Brs (including invisible mode)
- **Tagged Higgs Factory!**



Higgs coupling measurements

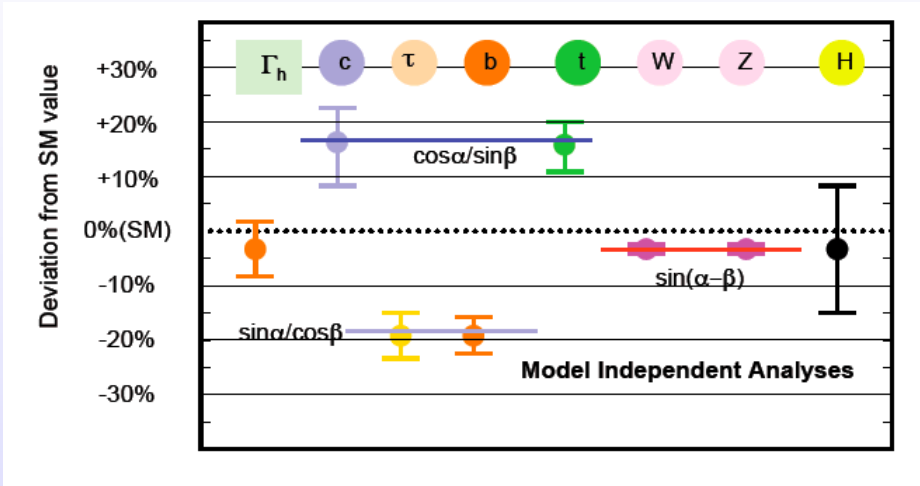


SM Higgs : coupling \propto mass

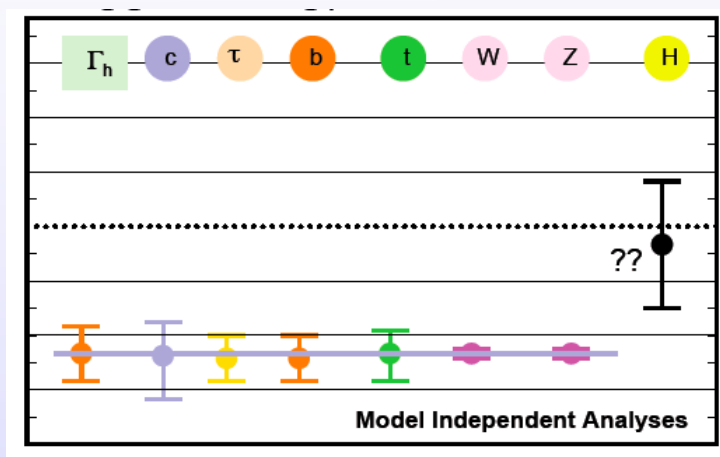
Deviations from SM



(By S. Yamashita)



SUSY
(2 Higgs Doublet Model)

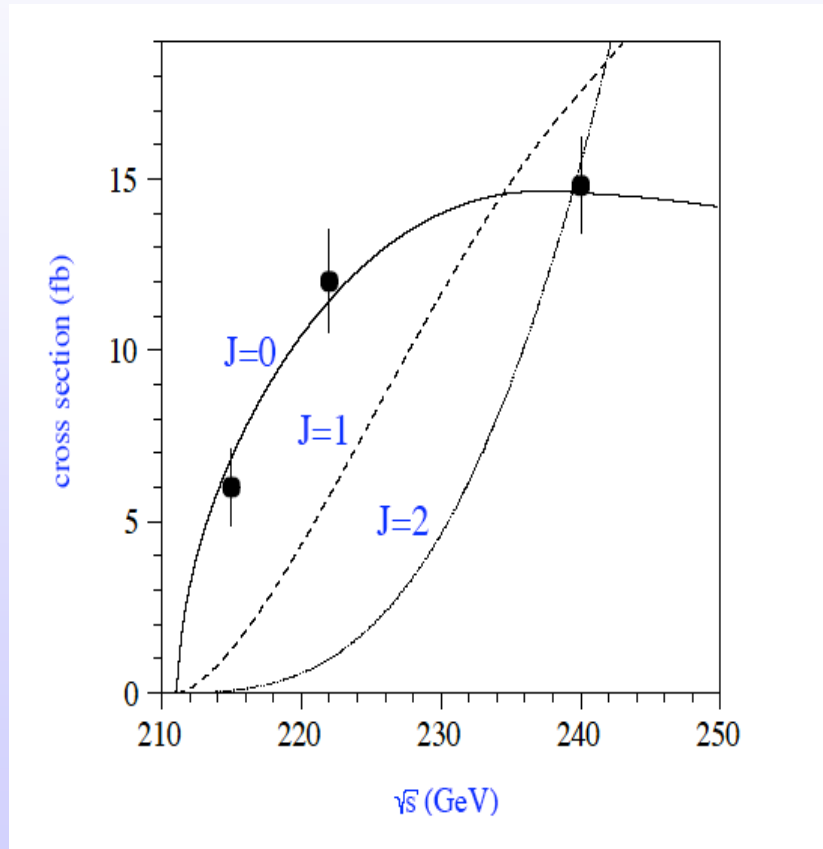


Extra dimension
(Higgs-radion mixing)



Measurement of Higgs parameters

$$e^+e^- \rightarrow Zh, Z \rightarrow \mu\mu, ee$$



- Higgs mass
 - $\sigma(m_h) = 40 \text{ MeV}$
- Higgs spin
 - Threshold scan
 - Higgs decay distribution
 - Zh angular dist.
 - $\sim \sin^2\theta$ if J=0+



Strategy

- Maintain momentum
- Focus on critical R&Ds
- Get all the help we can get
- Prepare for LHC results



GDE Timeline

- TDP I : 2010
 - Technical risk reduction
 - Cost risk reduction
 - Global design
- TDP II : 2012
 - RD unit test (KEK)
 - Complete necessary technical designs (exceptions)
 - Project plan by consensus
- Detailed engineering will follow before construction



Collaborations



- XFEL, US generic SCRF, Project-X
 - SCRF
- CLIC
 - Components (Sources, DR, BDS, etc.)
 - Detector
 - CERN expertise → ILC
 - ILC experience (costing) → CLIC
 - Enhances credibility of each (broader community)



Detector Timeline



- Detector Design Phase I : 2010
 - Focus on critical R&Ds
 - LOI validation by IDAG
(March 31 09 LOI deadline)
 - Update physics performance
 - MDI

- Detector Design Phase II : 2012
 - React to LHC results
 - Confirm physics performance
 - Complete necessary R&Ds
 - Complete technical designs
 - Cost (reliable)



PAC

ILCSC



IDAG

WWS organizers

Executive Board
RD
Regional Contacts

GDE

Lol-representative

Common task representative

Phys.&Exp. Board

L
O
I
C
B
A

MDI-D
Engineering Tools
R&D panel
R&D Collab.
Software panel
Physics Panel
Outreach Panel

IR Integration

Th's



Responding to LHC



- Systematic studies needed
 - When are we likely to know what from LHC?
 - Possible LHC discovery scenarios
 - For each scenario
 - What physics modes to study at ILC
 - What kind of machine to build
 - What kind of detector to build
 - Priorities and timescale
 - Cost and political realities to be included



Responding to LHC



- Rethinking of the machine parameter will be needed.
 - Energy (250 GeV, 360 GeV, 500 GeV, 800 GeV...)
 - Luminosity
 - Upgrade path
- Accelerator and physics/detector community should have close and intensive discussions
 - Cost and politics
 - GDE + the RD structure (we need name)



Coming workshops



- GDE meeting - ILC conventional facilities and siting workshop
 - Dubna, June 4-6, 2008
- ECFA workshop
 - Warsaw, June 6-9, 2008
- CLIC08 workshop
 - CERN, Oct 14-17, 2008
- LCWS workshop
 - Chicago, Nov 16-20, 2008



Summary

- Black december: No domino effects seen.
- We need to focus R&Ds in accelerator and detectors
- Open collaborations with CLIC and other projects
- Establish organizational mechanism to respond to LHC results, and start systematic preparation.
 - Accelerator + Physics/Detector



- Administrative support
 - Otsuka, Toyomura, Shirakata, Miura
- Technical support
 - Takayama, Nakajima, Hanada
- Students
 - Horii, Ito, Kusano, Sasaki,
 - Itagaki, Okamoto, Sato, Suzuki, Yoshida
- Faculty/Staff
 - Sanuki, Nagamine, Tamae, Takubo
- Communicators/public relations
 - Takahashi, Kobayashi, Barbara, Perrine



- Vishnu Zutsi G.P.Yeh, Marcel Demarteau
 - Please see the registration desk before you leave.