Summary: BSM/Cosmology Sessions

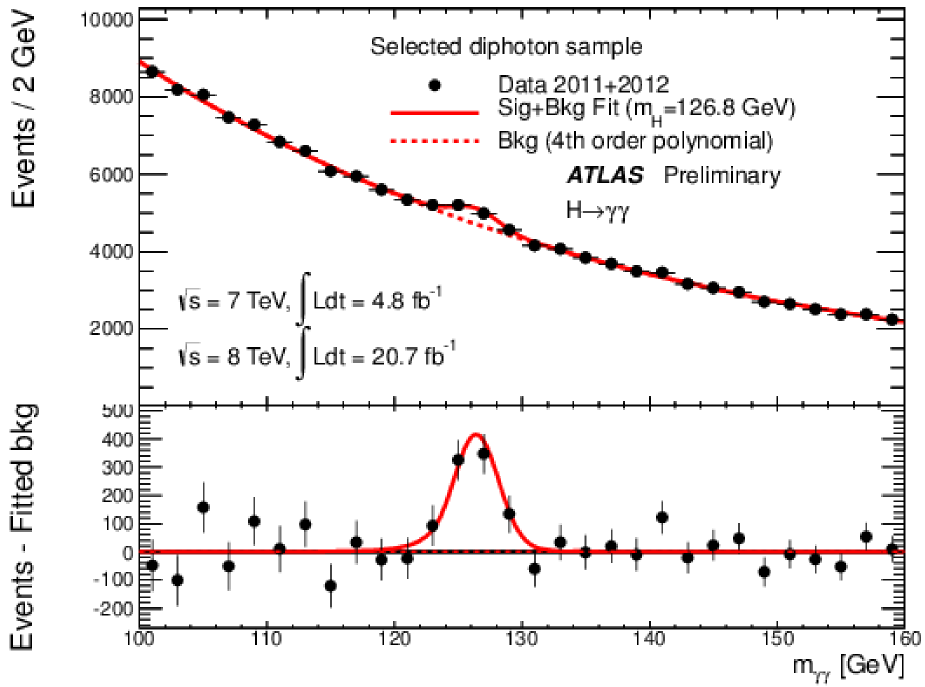
Christian Grefe (CERN)

on behalf of the BSM/Cosmology Conveners

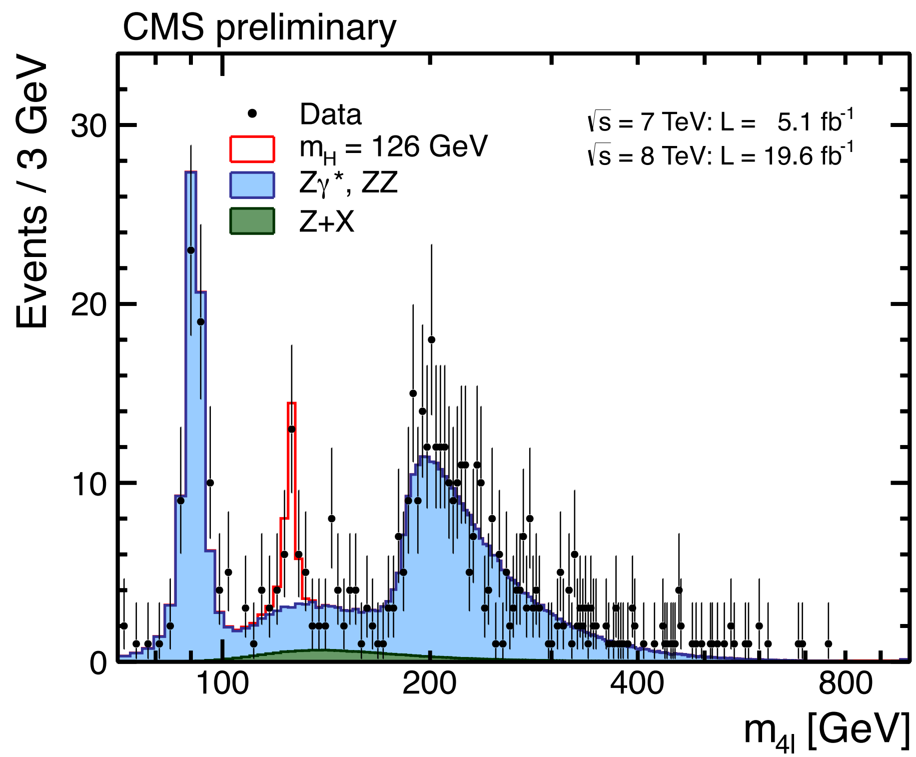
15. November 2013
Linear Collider Workshop, Tokyo

19 talks in 5 sessions

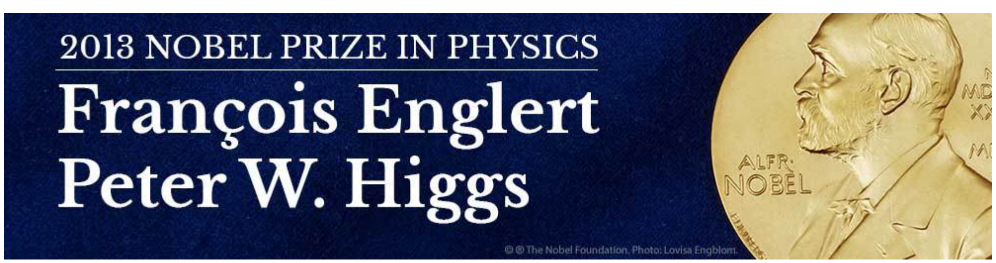
ATLAS, $H \to \gamma\gamma$



CMS, $H \to ZZ \to 4l$

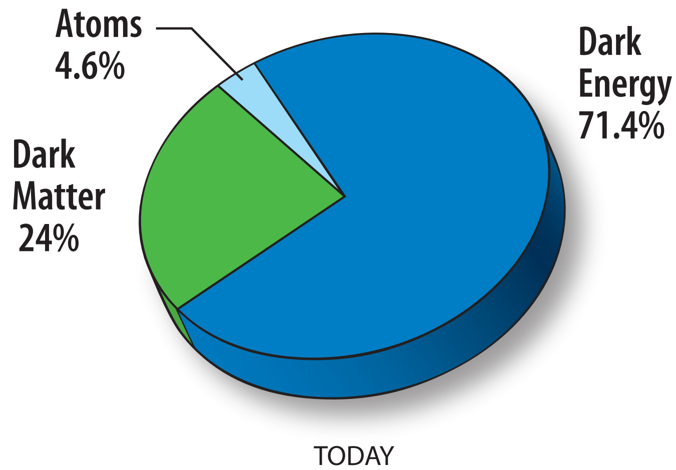


- Discovery of $\sim 126\,\text{GeV}$ SM like Higgs boson $\Rightarrow$ **SM is complete!**



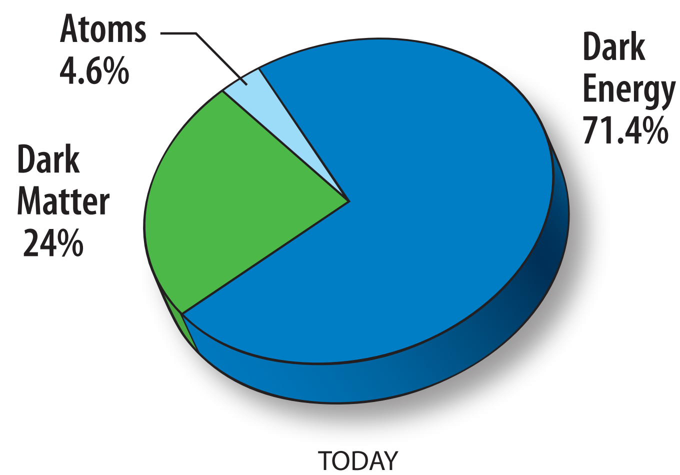
Open Questions

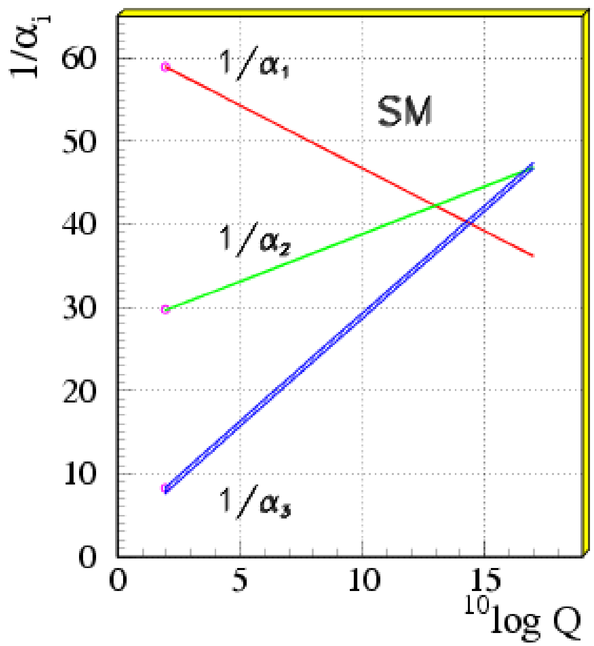
- No candidate for dark matter in SM
- What is dark energy?
- Source of Baryon asymmetry?
- Cause for inflation in the early universe?
- ...



Open Questions

- No candidate for dark matter in SM
- What is dark energy?
- Source of Baryon asymmetry?
- Cause for inflation in the early universe?
- ...

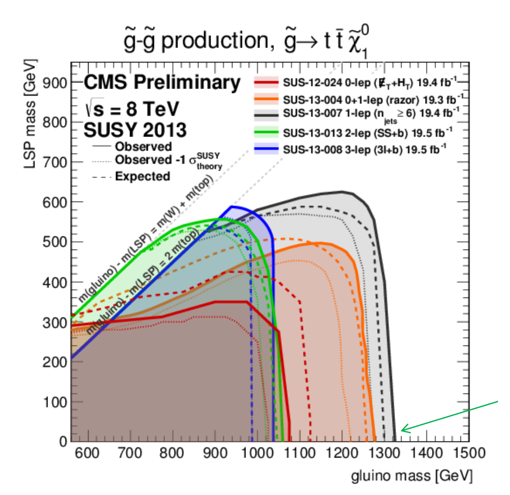




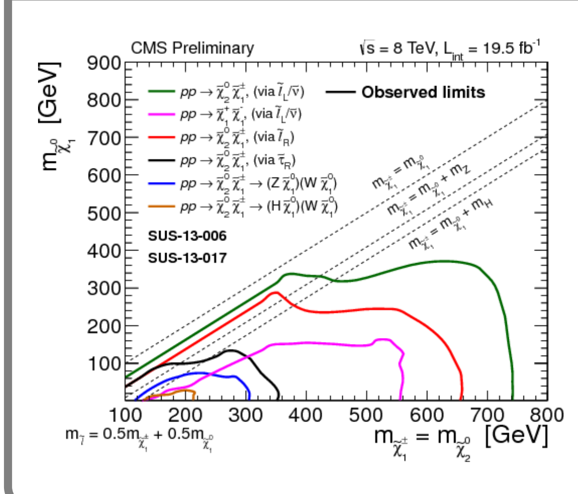
- Hierarchy problem
- Neutrino masses
- Unification of couplings?
- Measurement of $g-2$
- ...

SUSY Searches at the LHC

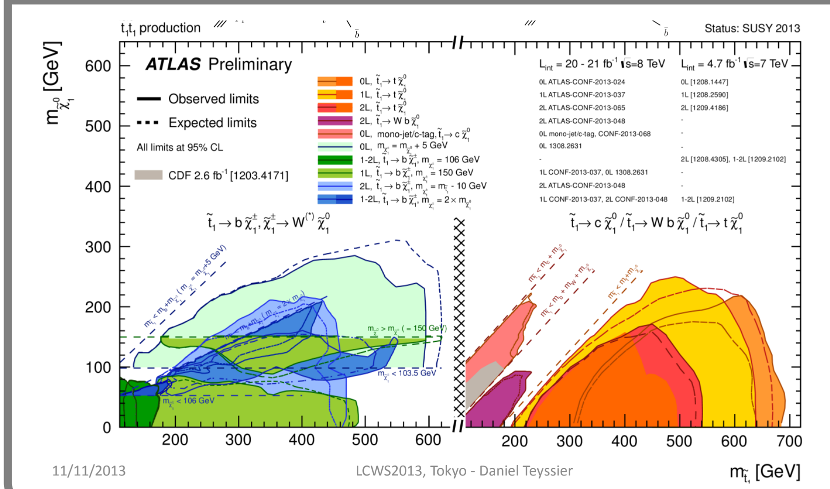
$\tilde{g}\,\tilde{g}$ Production



EWKino Production



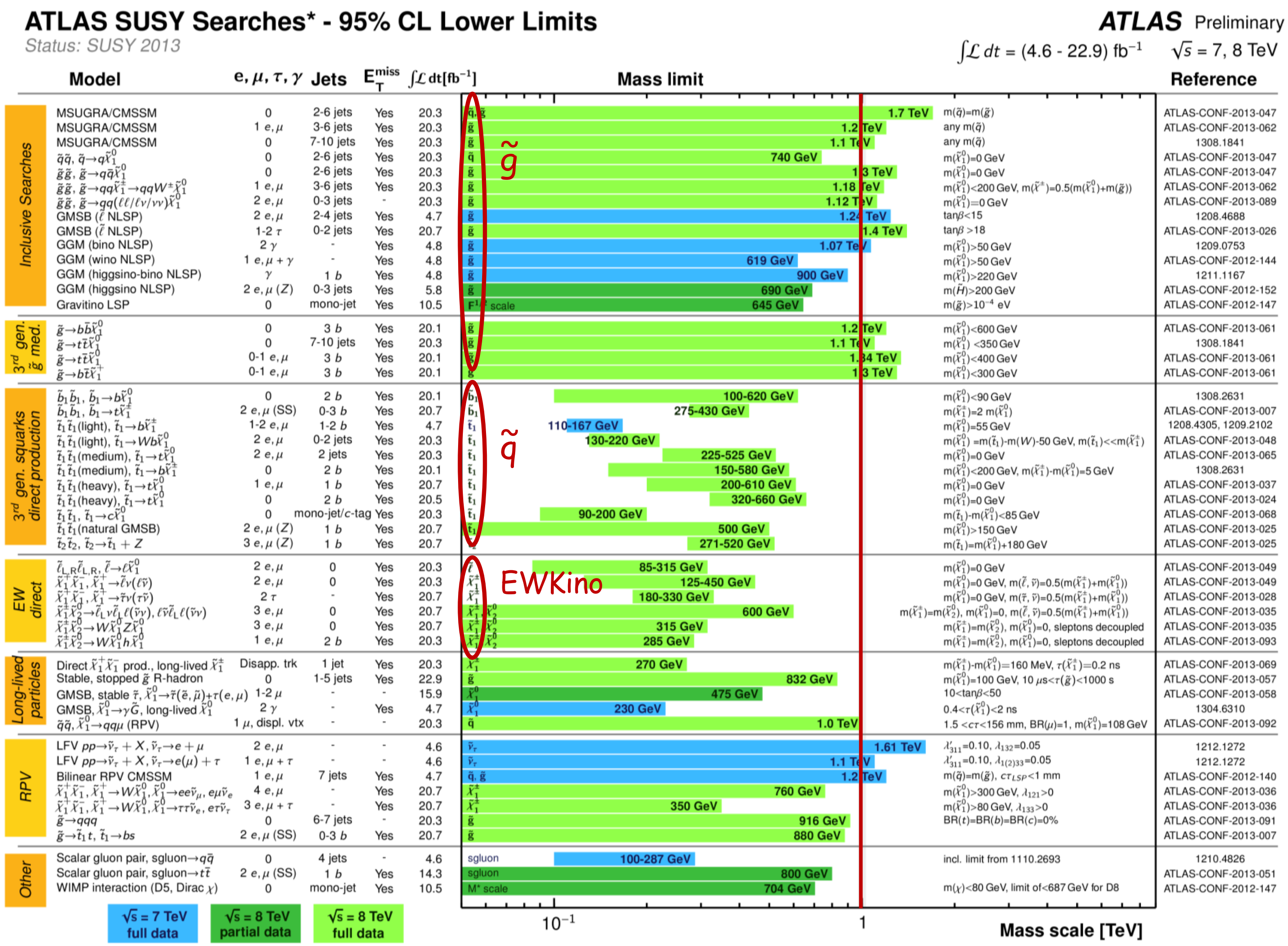
$\tilde{t}_1\tilde{t}_1$



- Search for simplified SUSY models: dominant cascade assuming 100% BR
- Models described by masses and cross sections
- 95% exclusion limits

D. Teyssier - LHC results and prospects: Beyond the Standard Model

SUSY Searches at the LHC

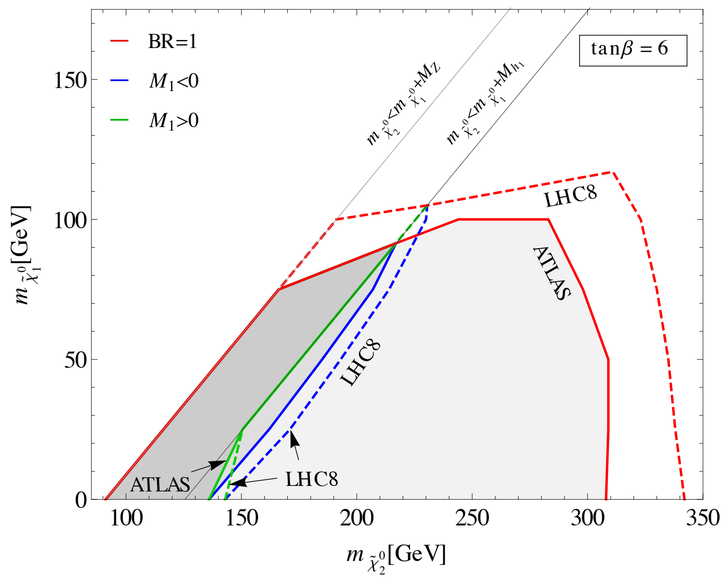


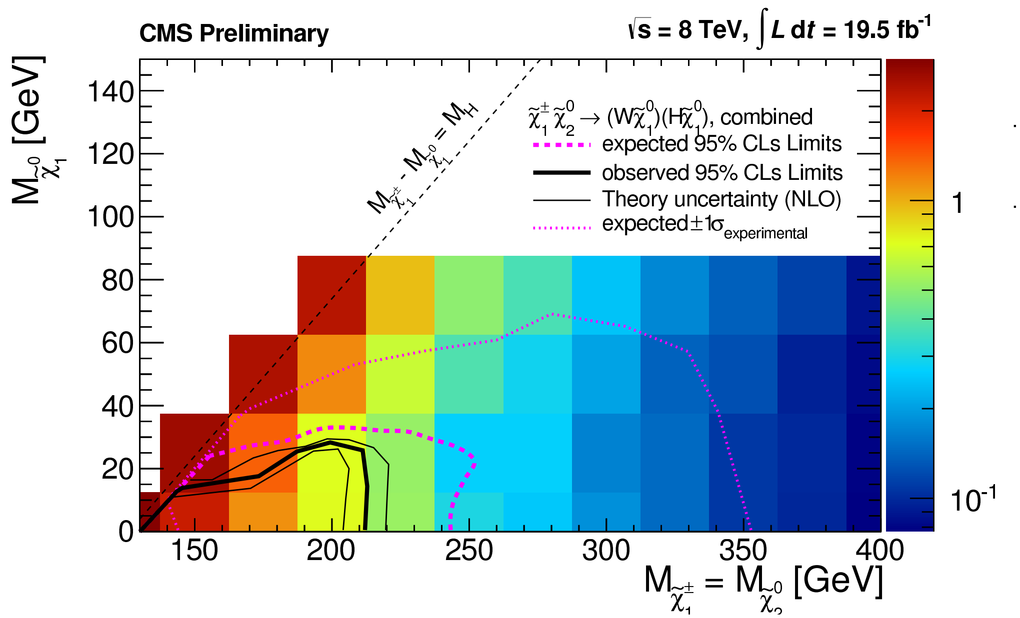
15

⇒ **D. Teyssier** - LHC results and prospects: Beyond the Standard Model

Is SUSY already Excluded at ILC Energies?

- Need to investigate realistic decay chains (BR $\neq$ 1)
- Include for example: $\tilde{\chi}_2^0 \rightarrow h\tilde{\chi}_1^0$ (weak bounds)





⇒ **S. Heinemeyer** - Does the LHC exclude SUSY particles at the ILC?

- Controlling systematic uncertainties is crucial and might lead to low sensitivity even for LHC at 14 TeV and 300 fb^{-1}

⇒ **D. Krücker** - Non-Simplified SUSY:A Stau-Coannihilation model at LHC and ILC

BSM Models Accessible at the LC

- Anomaly in $g-2$ explained by Gaugino contribution

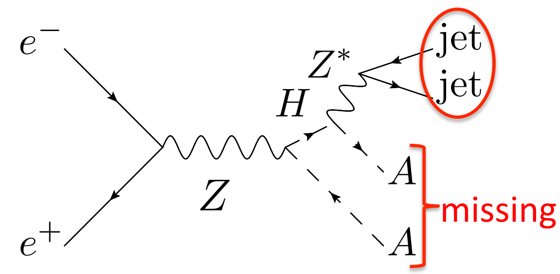
⇒ **M. Endo** - Reconstructing SUSY Contribution to Muon g-2 at ILC

⇒ **N. Yokozaki** - A practical GMSB model for explaining the muon g-2 with gauge coupling unification

- NR charged Wino pairs produced will annihilate before decay

⇒ **K. Ichikawa** - Threshold Production for Wino Dark Matter at a LC

- H is inflation and A is DM candidate



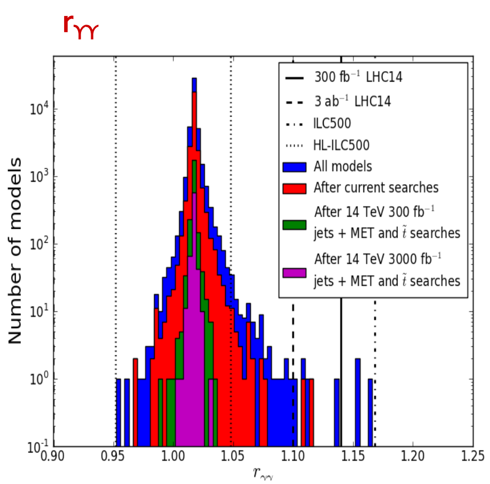
⇒ **T. Matsui** - Higgs inflation scenario in a radiative seesaw model and its testability at the ILC

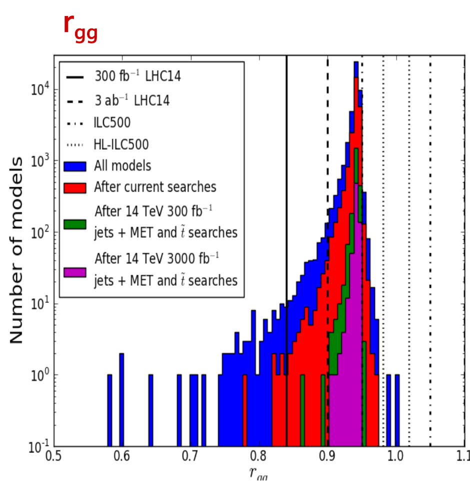
- Split Stop ($m\tilde{t}_1, m\tilde{b}_1 \ll m_{\tilde{t}_2}, m_{\tilde{b}_2}$) can avoid detection at LHC with $300\,\mathrm{fb}^{-1}$ → discovery at LC

⇒ **T. Kon** - Signatures at One-loop Order of Split Stops Scenarios using GRACE/SUSY

What is the Expected SUSY Reach for the LC?

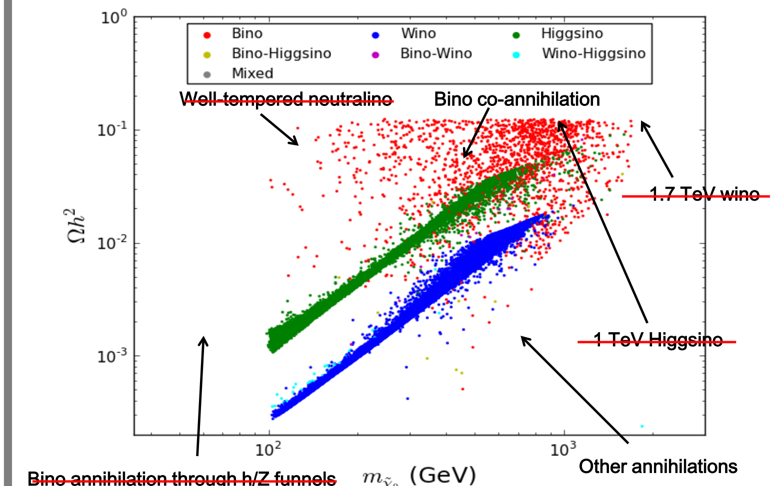
- 10M points in (almost) unconstrained pMSSM to estimate SUSY reach (19 parameters)
- Sizable fraction of models remains out of reach even for $3\,\mathrm{ab}^{-1}$ LHC
- LC can rule out most models by measuring Higgs BR





⇒ **J.L. Hewett** - Constraints on Higgs Properties and SUSY Partners in the pMSSM

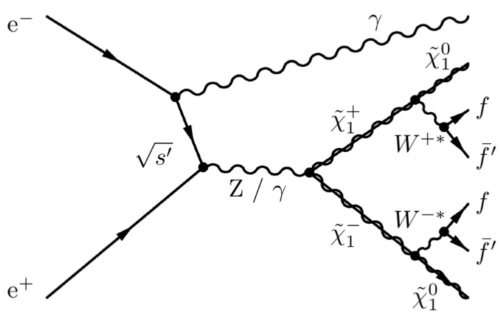
- Direct and indirect DM searches help to constrain pMSSM parameter space if LHC finds nothing
- Require LC to measure model parameters

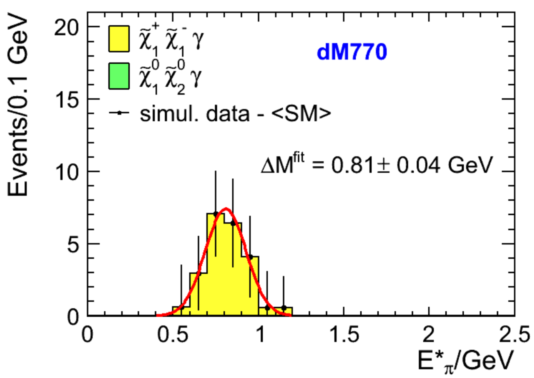


⇒ **T. Rizzo** - Complementarity and Searches for Dark Matter in the pMSSM

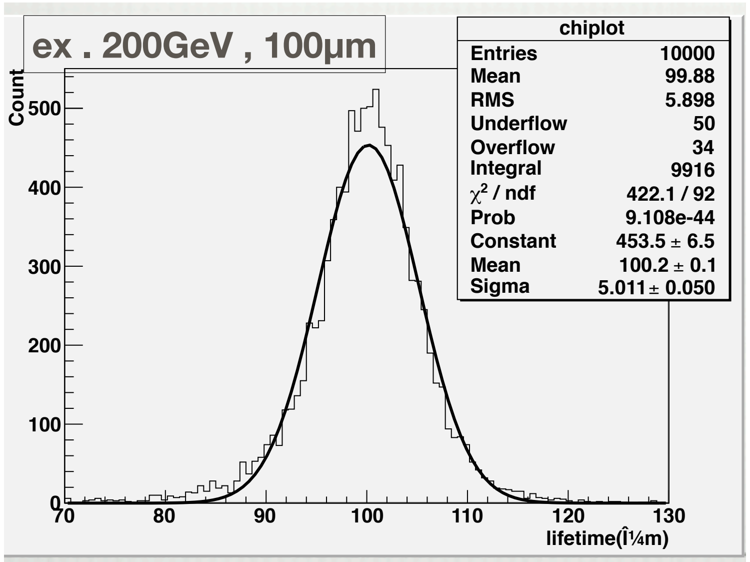
Measuring BSM Parameters at the LC

- Only access to light $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^0$, $\tilde{\chi}_2^0$
- Fit parameters M_1, M_2 and μ from mass and polarized cross section measurement





⇒ **H. Sert** - Tackling Light Higgsinos at the ILC



⇒ **T. Mori** - Stau NLSP Pair Production at the ILC

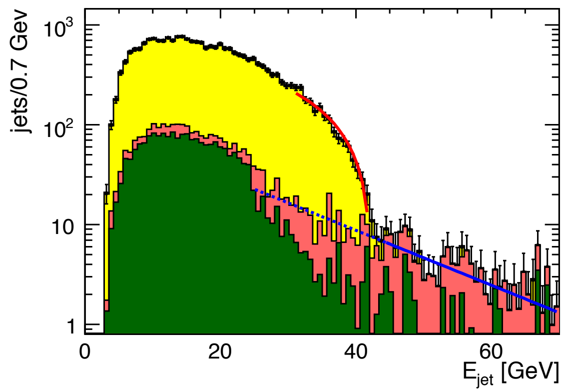
Measuring BSM Parameters at the LC

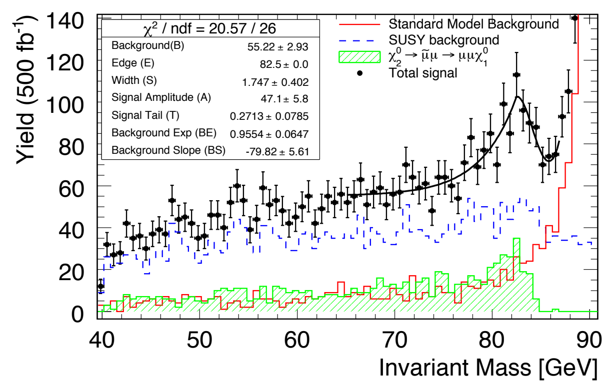
particle	Mass(GeV)	accuracy
A_H	81.9	1.3%
W_H	369	0.20%
Z_H	368	0.56%
e_H	410	0.46%
ν_H	400	0.10%

⇒ **E. Kato** - Little Higgs with T-parity measurements at the ILC

- Complete study of SPS1a/STC4 benchmark point

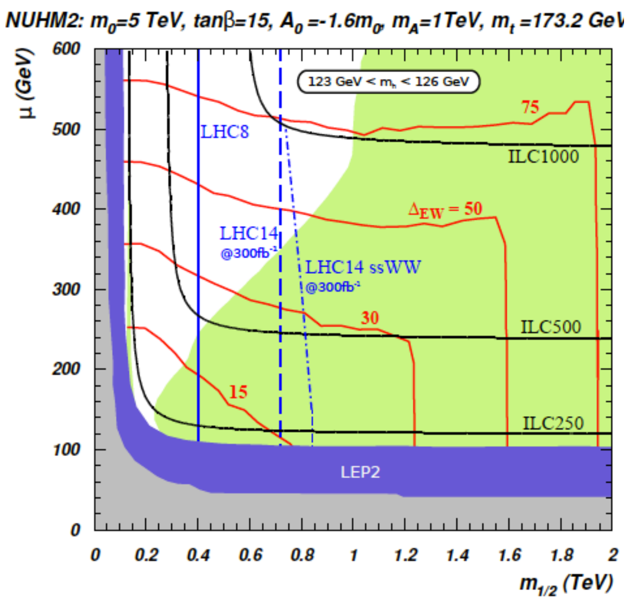
⇒ **M. Berggren** - SUSY precision studies at the ILC





Is SUSY the right Theory?

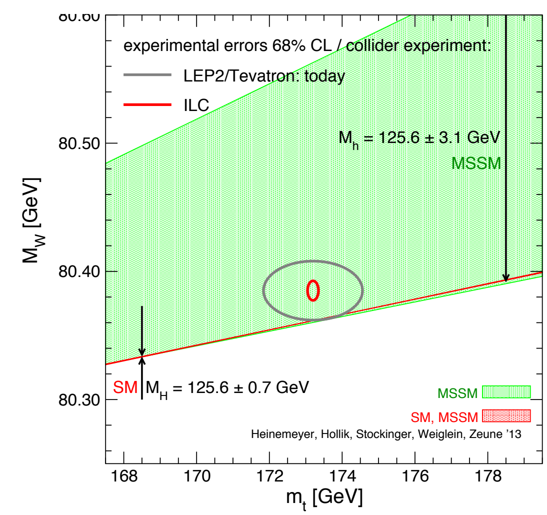
- Fine tuning in an effective theory does not imply fine-tuning of the fundamental theorie



- Only need to give up naturalness if there are no light higgsinos

⇒ **H. Baer** - How conventional measures overestimate EW finetuning in SUSY theory, and why this implies we must build ILC

- Using the measured Higgs mass to interpret the electroweak precision data in terms of MSSM models



⇒ **S. Heinemeyer** - M_W in the MSSM

Separating Different SUSY Models

- Need renormalization of the full cMSSM to determine correct BR
- NLO corrections on cross sections of up to 20%

⇒ **S. Heinemeyer** - Higgs and DM Production via SUSY Decays at the LC

- Distinguish Majorana (MSSM) from Dirac (MRSSM) sparticles
- Gluinos accessible at LHC $\rightarrow$ need ILC for neutralinos

⇒ **S. Y. Choi** - Probing the nature of neutralinos at the ILC

- M_1, M_2 and μ determined from precise measurements (tree level)
- Inclusion of NLO corrections allows access to $m_{\tilde{t}}$ and $\cos\theta_t$

⇒ **J. Kalinowski** - Determining SUSY parameters from chargino production: including NLO corrections

- Using polarized beams to distinguish MSSM from NMSSM

⇒ **S. Porto** - How to distinguish NMSSM and MSSM?

- Still many open questions
  $\Rightarrow$ the SM is not the end of the story
- Read the fine print when interpreting LHC exclusion limits!
- The Higgs discovery allows new ways to constrain physics beyond the Standard Model
  $\Rightarrow$ the linear collider is the ideal tool to explore this new territory