Signals in the Co-annihilation Region of Supersymmetry at the LHC

- Supersymmetry and Dark Matter -

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Outline

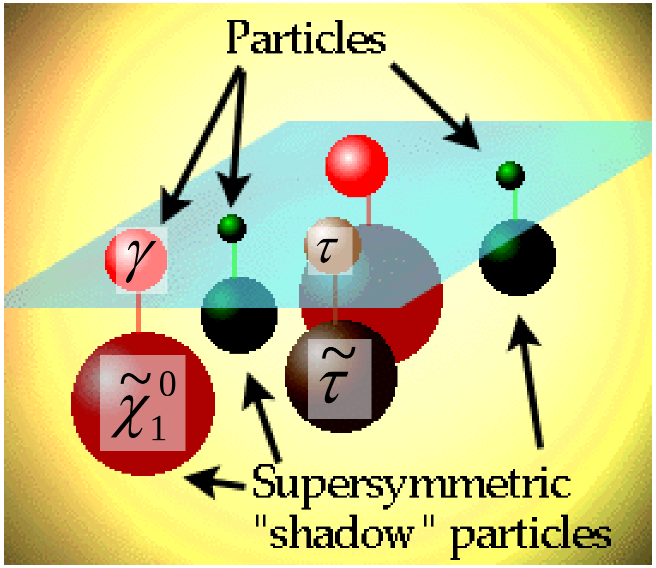
- Supersymmetry (SUSY) and Cosmology
  - Supersymmetric particles
- How to measure a small $\tilde{\tau} - \chi_1^0$ mass difference (ΔM)
- The analysis
- Results
- Conclusions and future plans

Introduction

- Cosmology says: most matter is cold dark matter (CDM)
- CDM is important in the formation of structure in the universe
- SUSY for Grand Unification of forces: Supersymmetric particles
- SUSY provides a valid CDM candidate $\tilde{\chi}_1^0$

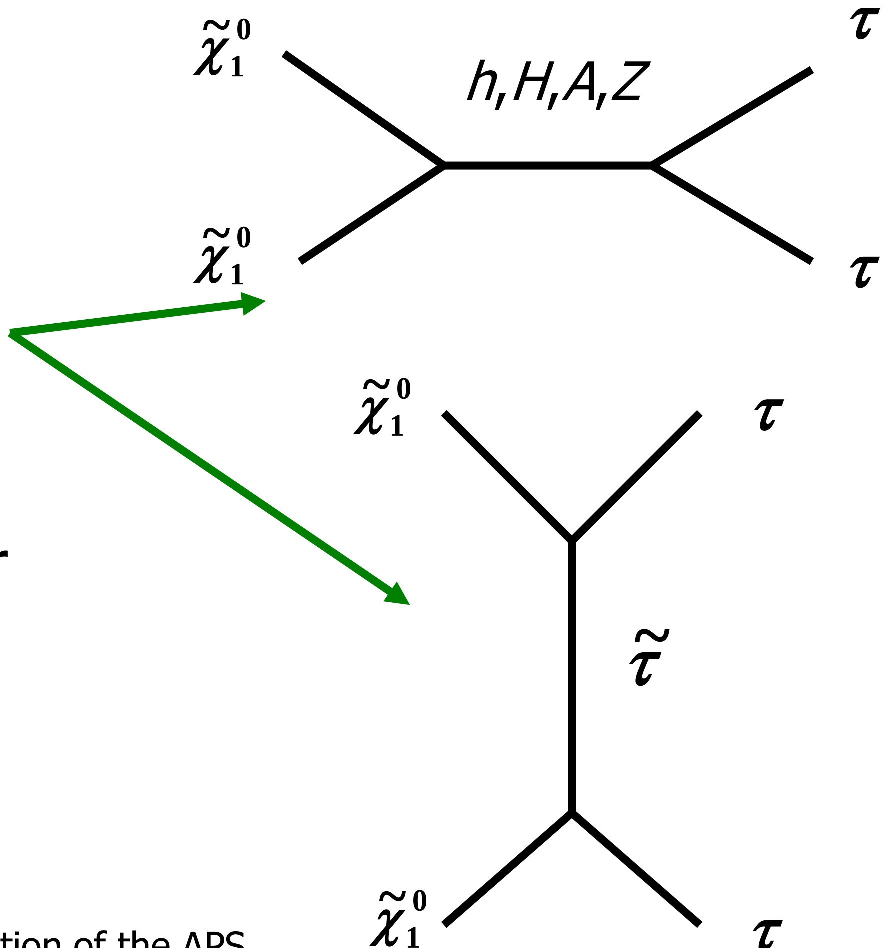
Supersymmetric Particles

- Every standard model particle has a corresponding SUSY particle
- Parameters of SUSY tells us the masses and coupling of these particles
- Recent cosmological data point to parameters in the "co-annihilation region



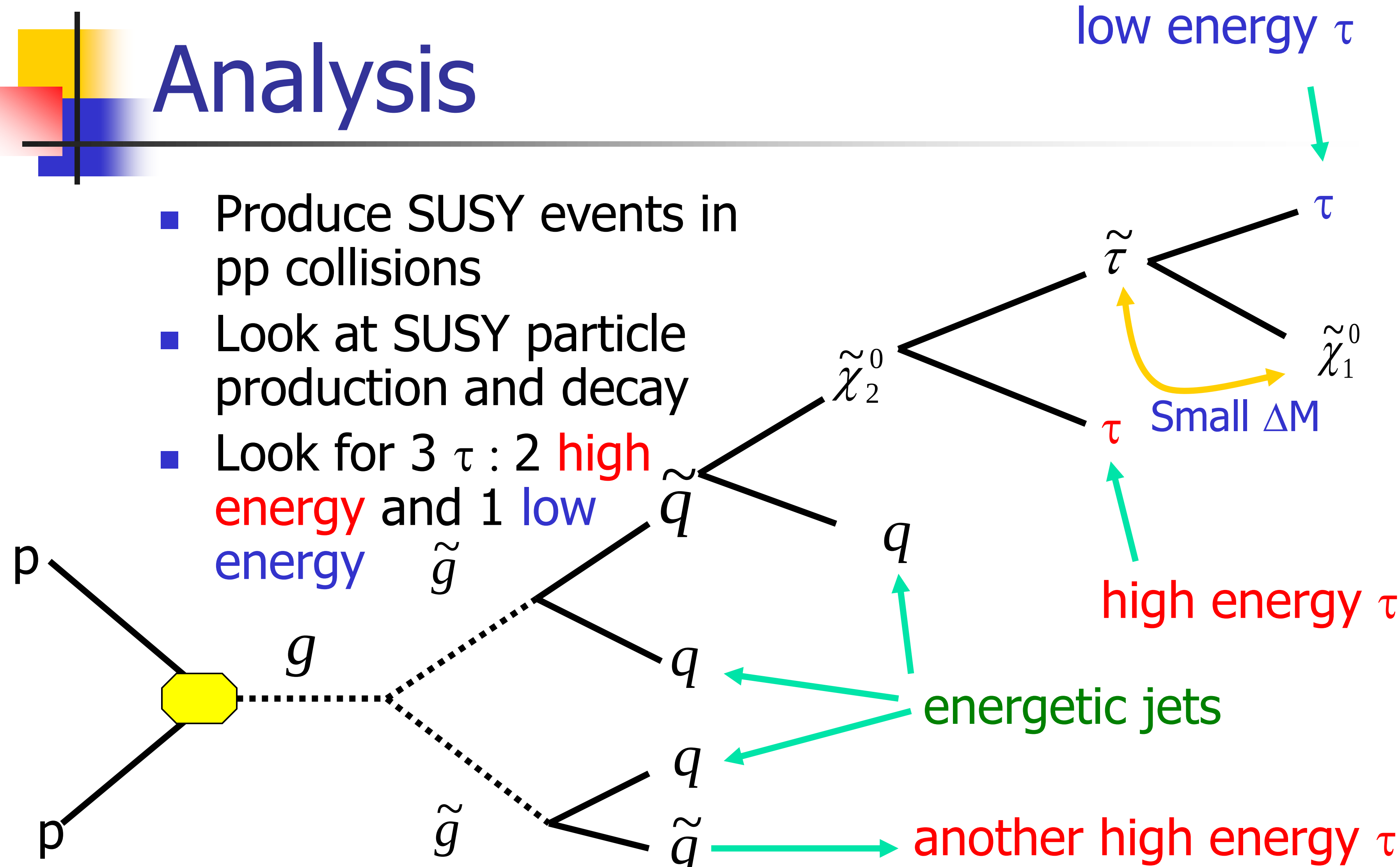
Co-annihilation Region

- The $\tilde{\tau}$ and $\tilde{\chi}_1^0$ are nearly degenerate: ΔM < 15 GeV
- Two Feynman diagrams determine the amount of the CDM ($\tilde{\chi}_1^0$) in the universe
- We can measure ΔM down to ~3 GeV at a future e^+e^- linear collider
- Can we measure ΔM at the LHC?



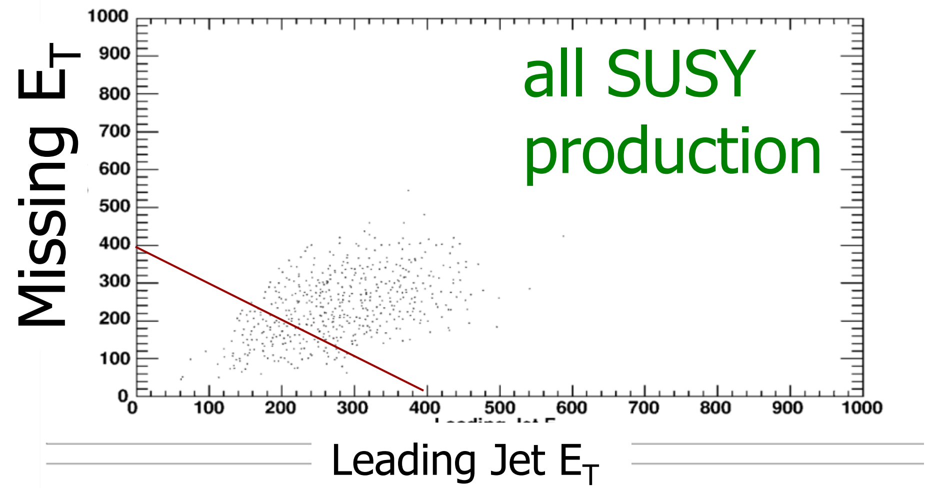
Analysis

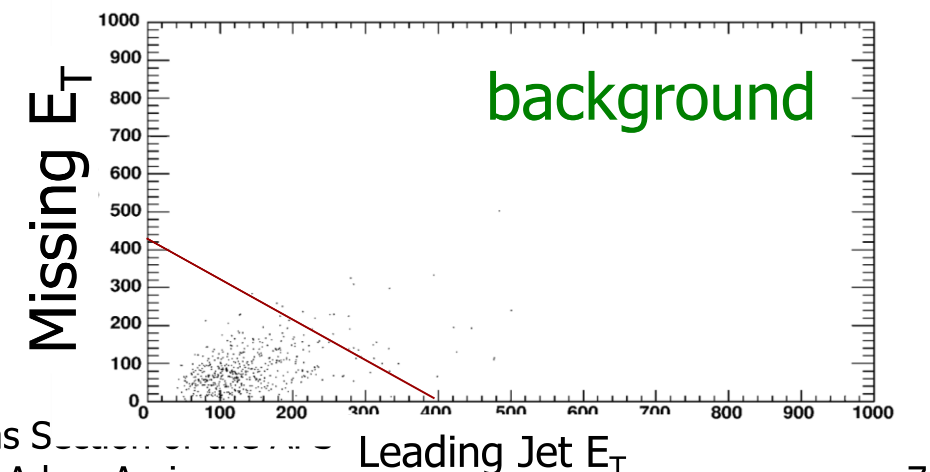
- Produce SUSY events in pp collisions
- Look at SUSY particle production and decay
- Look for 3 τ : 2 high energy and 1 low energy



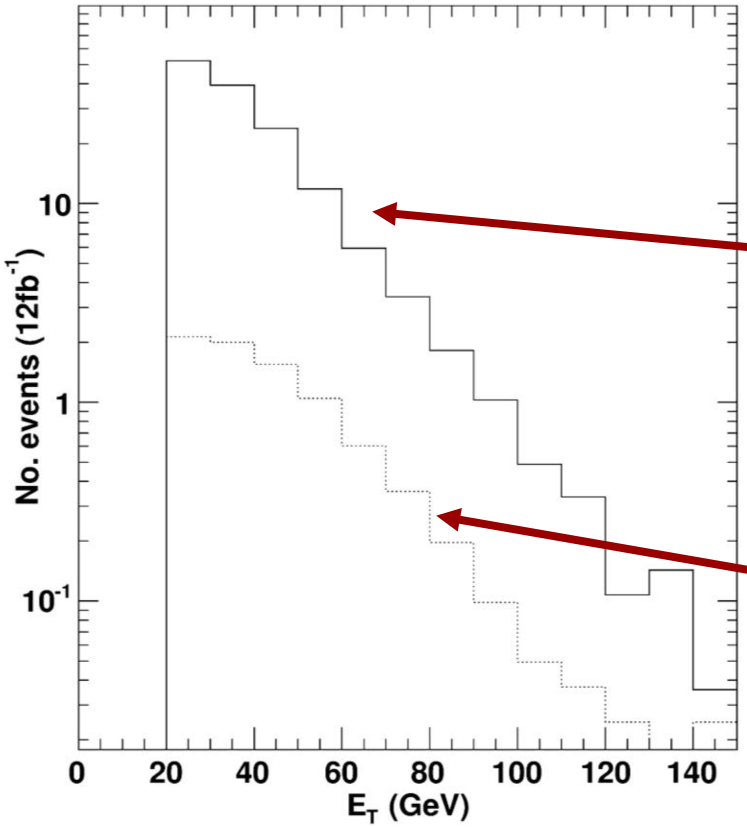
Analysis (cont.)

- Very little standard model background with 3 τ's
  - Require an extra jet from squarks and large missing E_T from $\tilde{\chi}_1^0$ just in case
- Leading jet E_T + missing E_T > 400 GeV





E_T Spectrum of Third τ

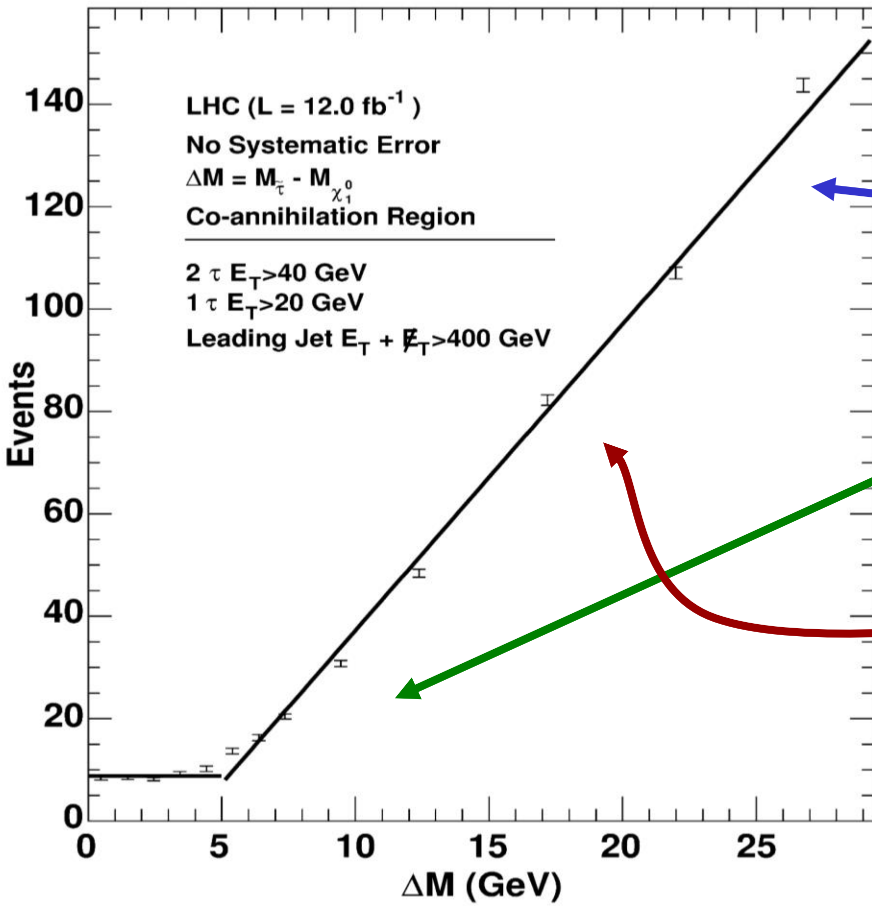


- The third τ contains the mass difference information

<u>Large ΔM</u>
→ large τ energy
→ lots of events pass threshold

<u>Small ΔM</u>
→ small τ energy
→ few events pass threshold

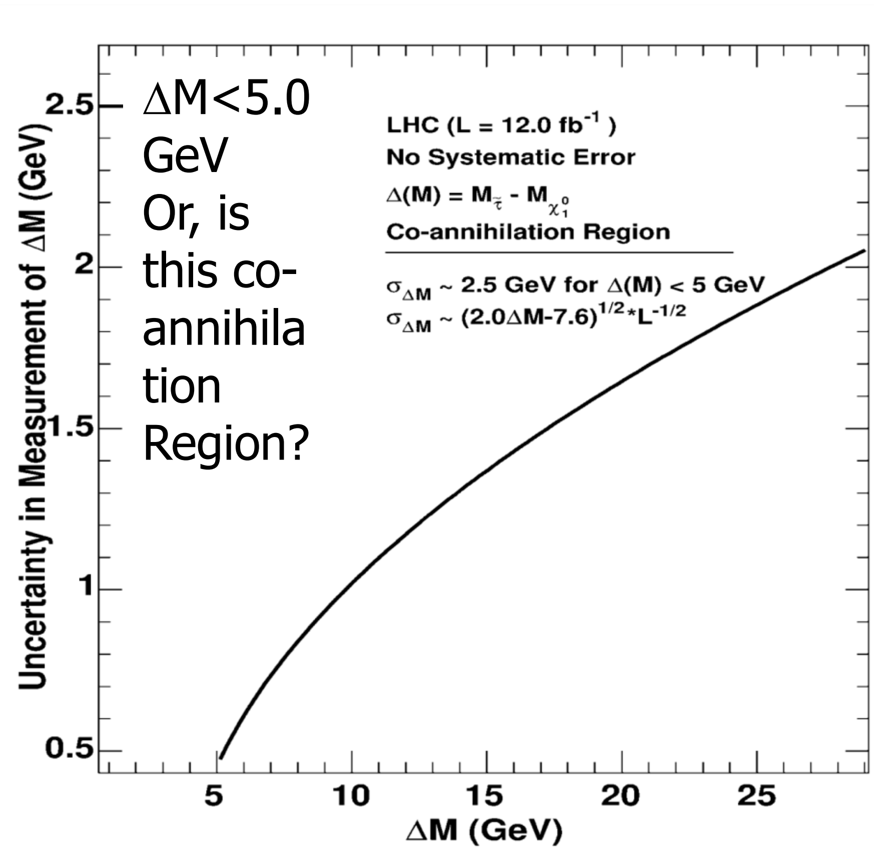
Event Rate vs. Mass Difference



Straight forward to separate large masses from small masses

approximately linear

ΔM Measurement



- Uncertainty calculated based on a linear fit
- No systematic error
- We can measure ΔM at the LHC with this accuracy within a year of running (similar to LC)

Conclusions and Future Work

- For cosmological reasons, the co-annihilation region is an important place to study
- Our new method may help us measure the $\tilde{\tau} - \tilde{\chi}_1^0$ mass well
- Analysis of systematic error is underway
- We are investigating ways to do even better