SUSY searches in Leptonic Final States with CMS

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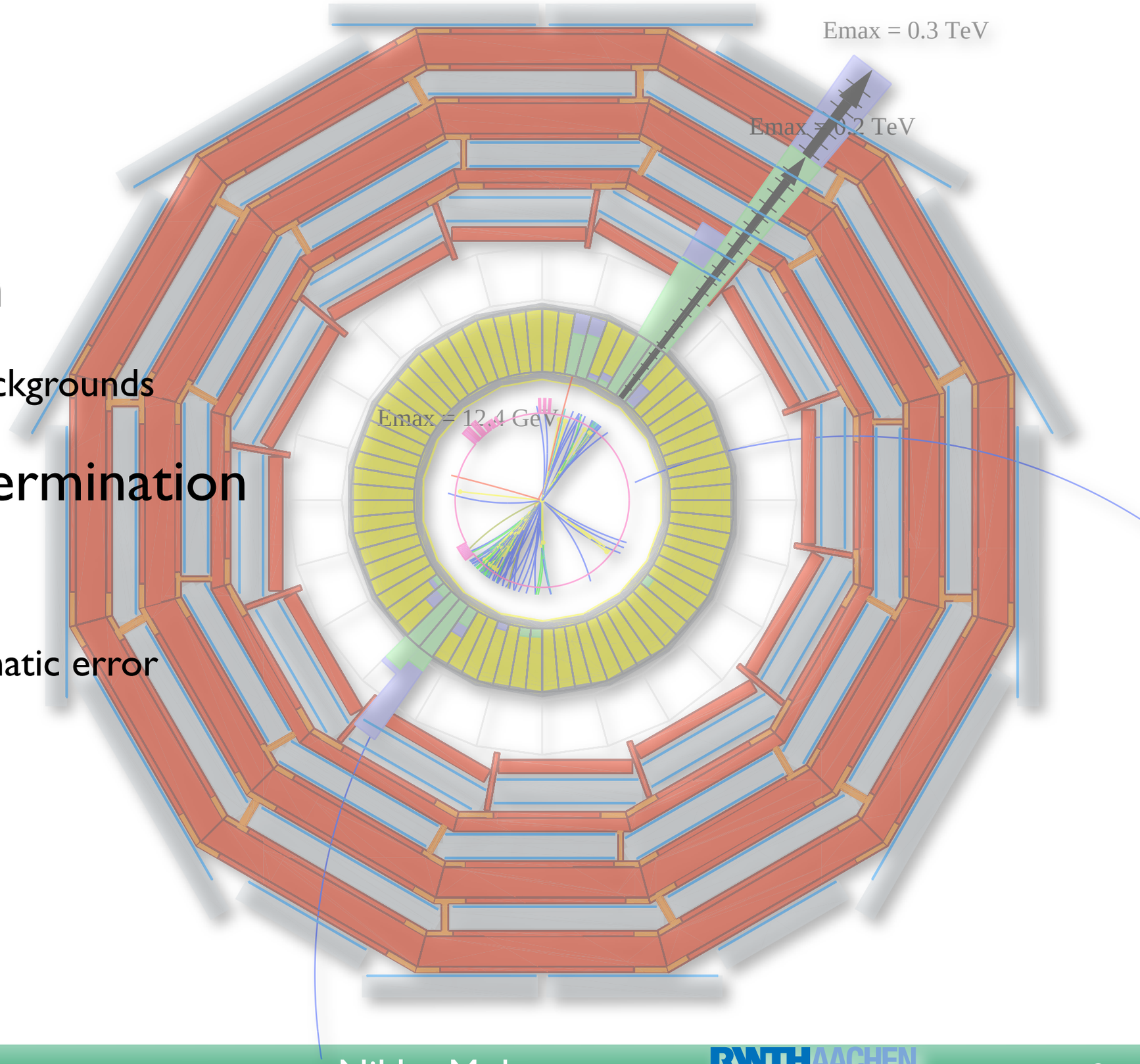
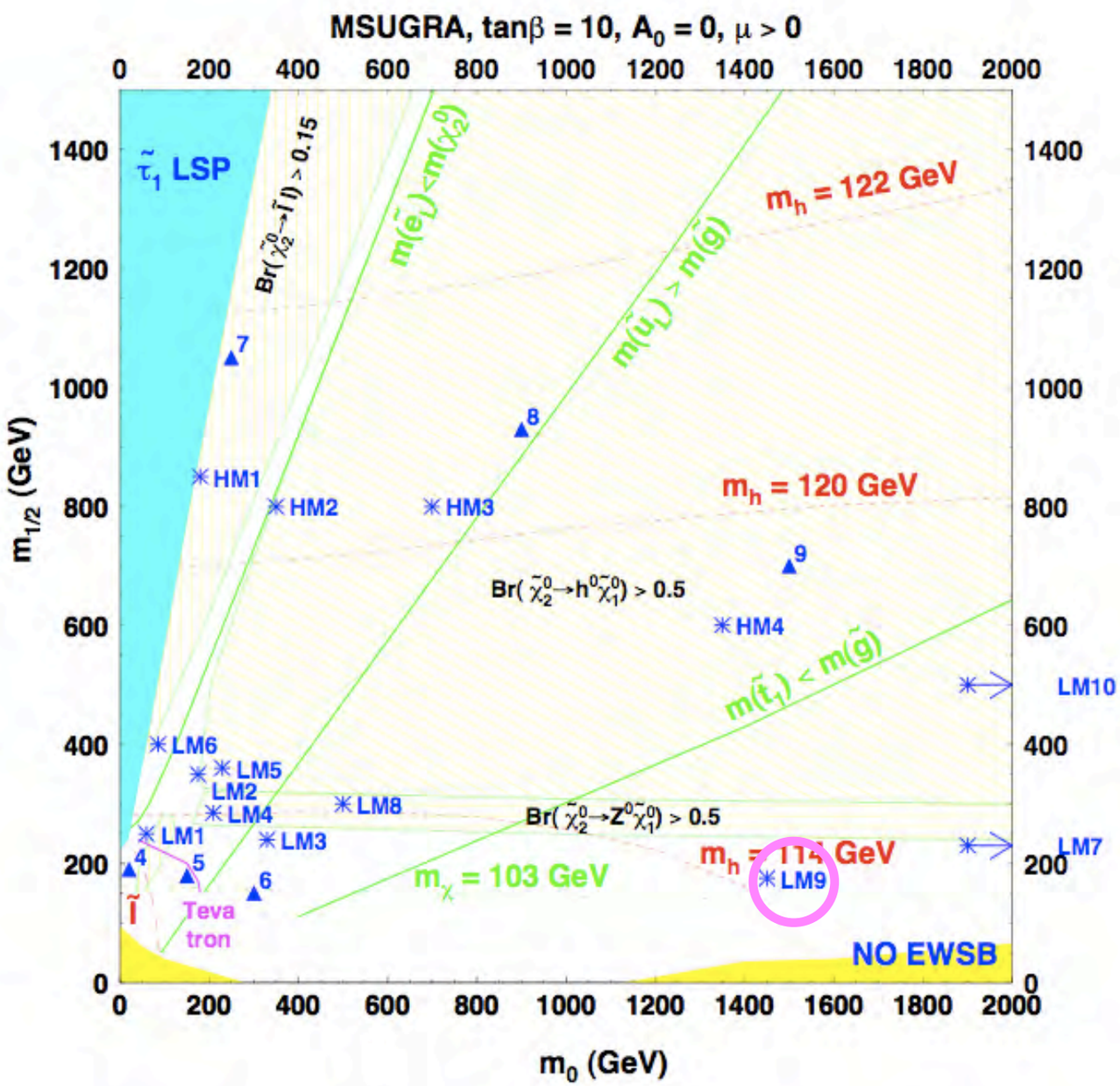
Outline

- Introduction
- Event selection
  - Standard model backgrounds
- Parameter determination
  - Fit model
  - Statistic and systematic error
- Summary



Leptonic final states in mSUGRA



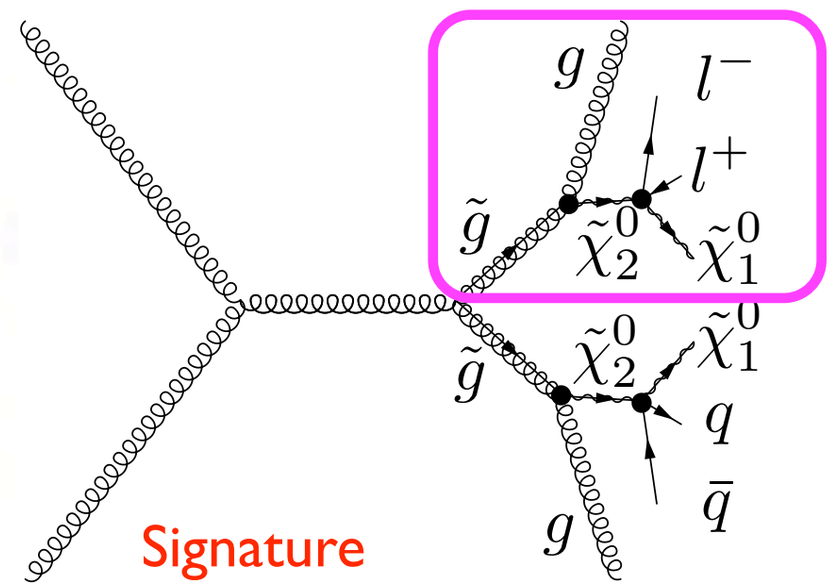
m_0	$m_{1/2}$	tanβ	A_0	sgn(μ)
1450 GeV	175 GeV	50	0 GeV	+1

LM9 benchmark point

- High production cross section
- σ_{SUSY} = 43 pb (Prospino 2 NLO)

$$\sigma_{\tilde{g}\tilde{g}} = 36.7 \text{ pb}$$

$$\tilde{g} \rightarrow q\bar{q}/g + \tilde{\chi}_2^0 \rightarrow q\bar{q}/g + \tilde{\chi}_1^0 + l^+l^-$$



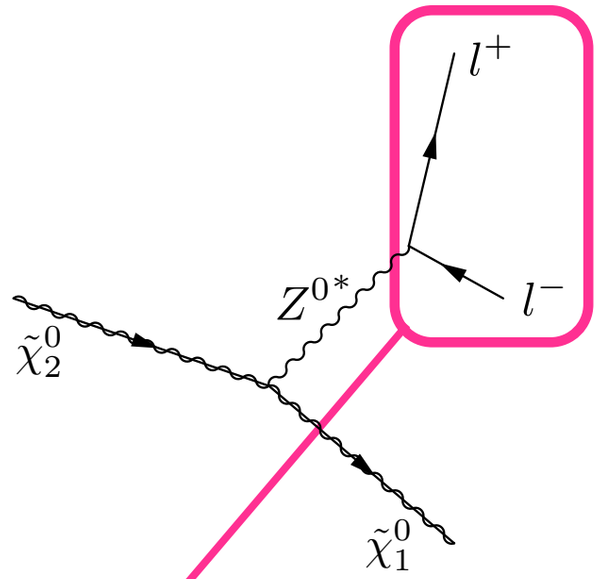
$BR = 2.3\%$

Signature

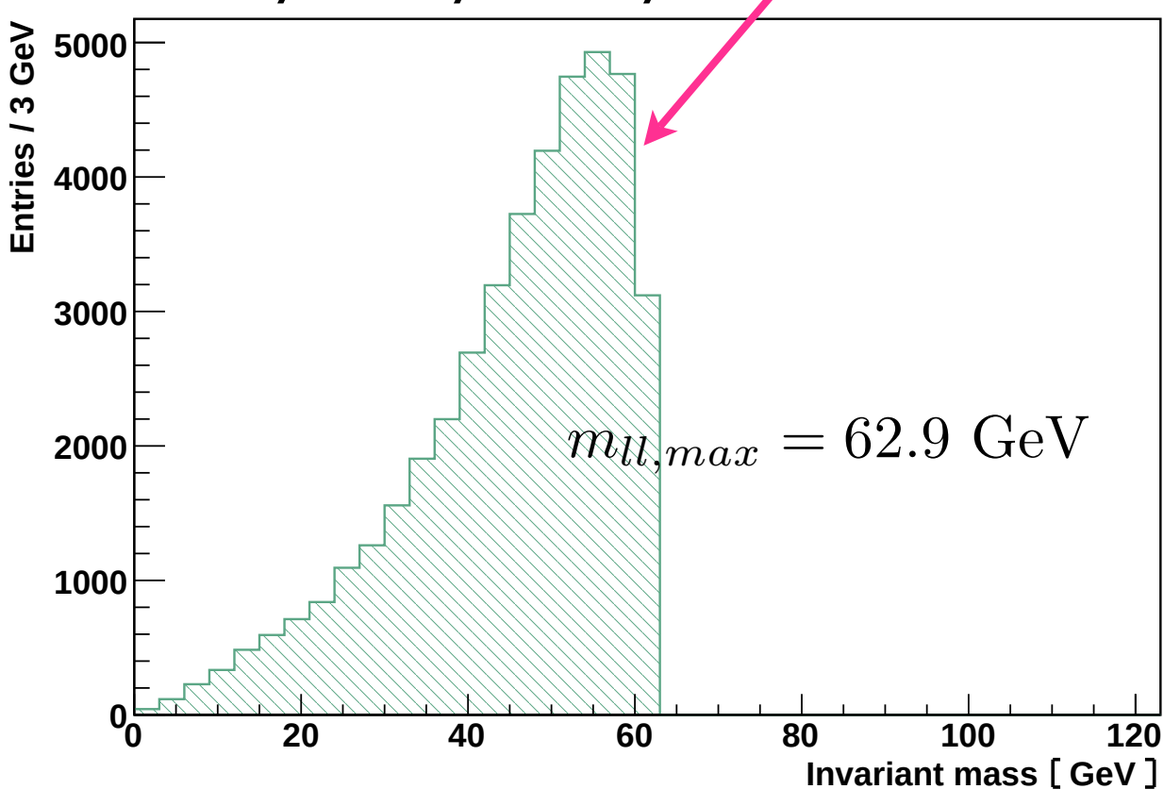
- Two same flavour oposite sign leptons
- High number of hard jets (2-4 Jets)
- Missing transverse energy

Leptonic mass edge

- 3-body decay
- Only numerical calculations of the shape exist



Softsusy + Susyhit + Pythia

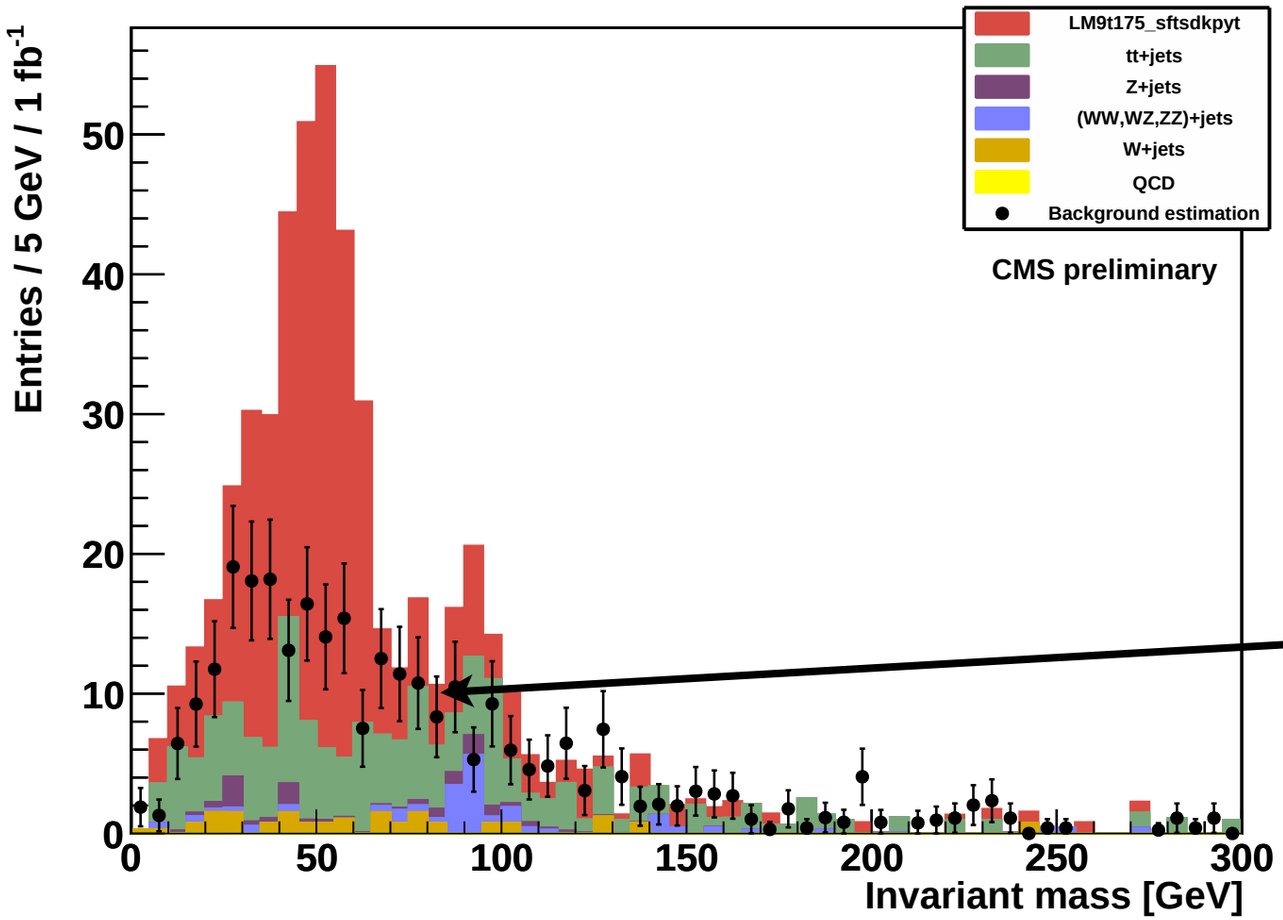


- Endpoint represents the mass difference of the neutralinos

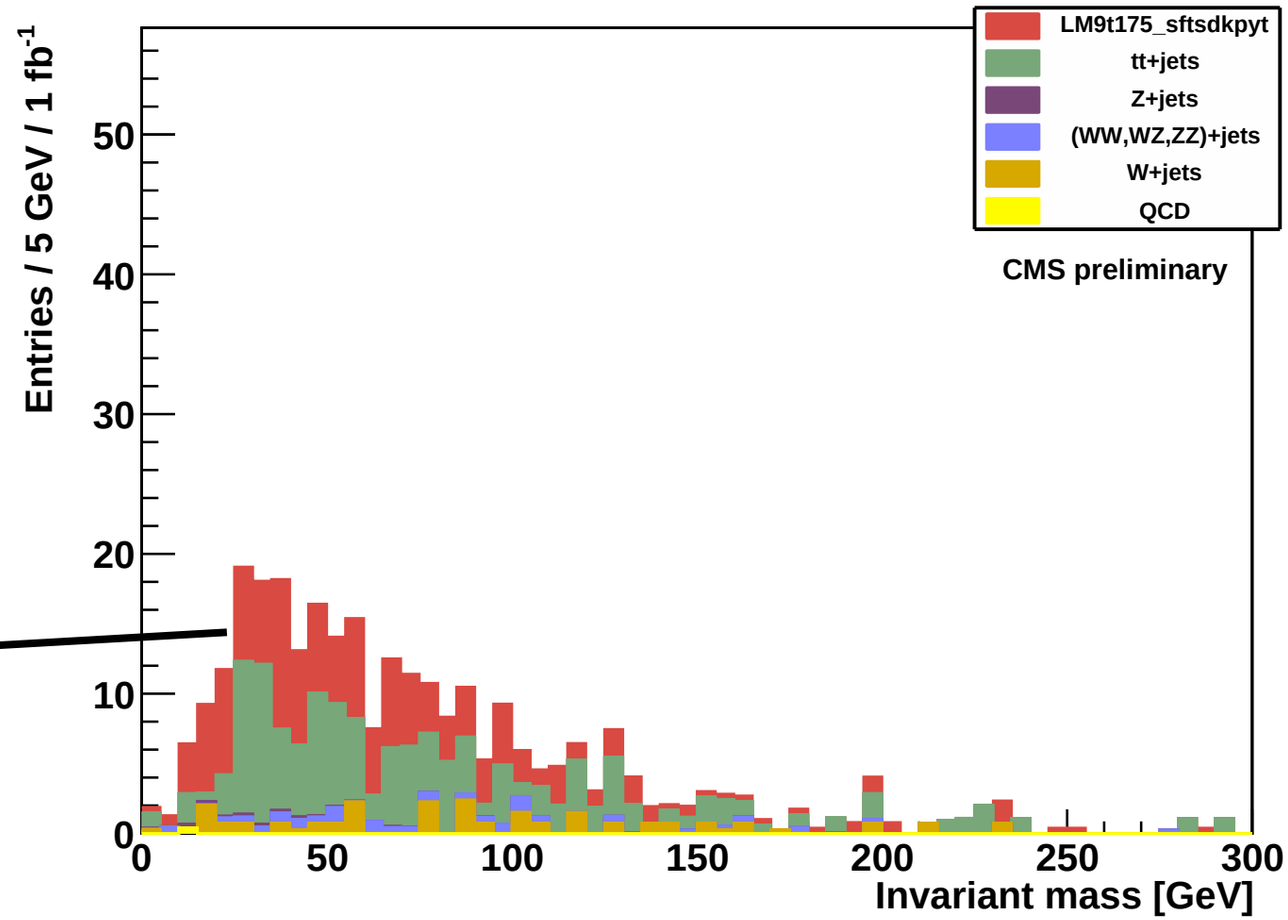
- General setting
  - 14 TeV
  - 1 fb^{-1} of MC events
  - Misaligned and miscalibrated using 100 pb^{-1} constants
- Main Standard Model backgrounds
  - tt+jets, Z+jets, W+jets
  - Diboson+jets
  - QCD
- Weighted at NLO
- Require two isolated leptons to suppress the QCD background

Event selection

$e^+e^-, \mu^+\mu^-$ pairs



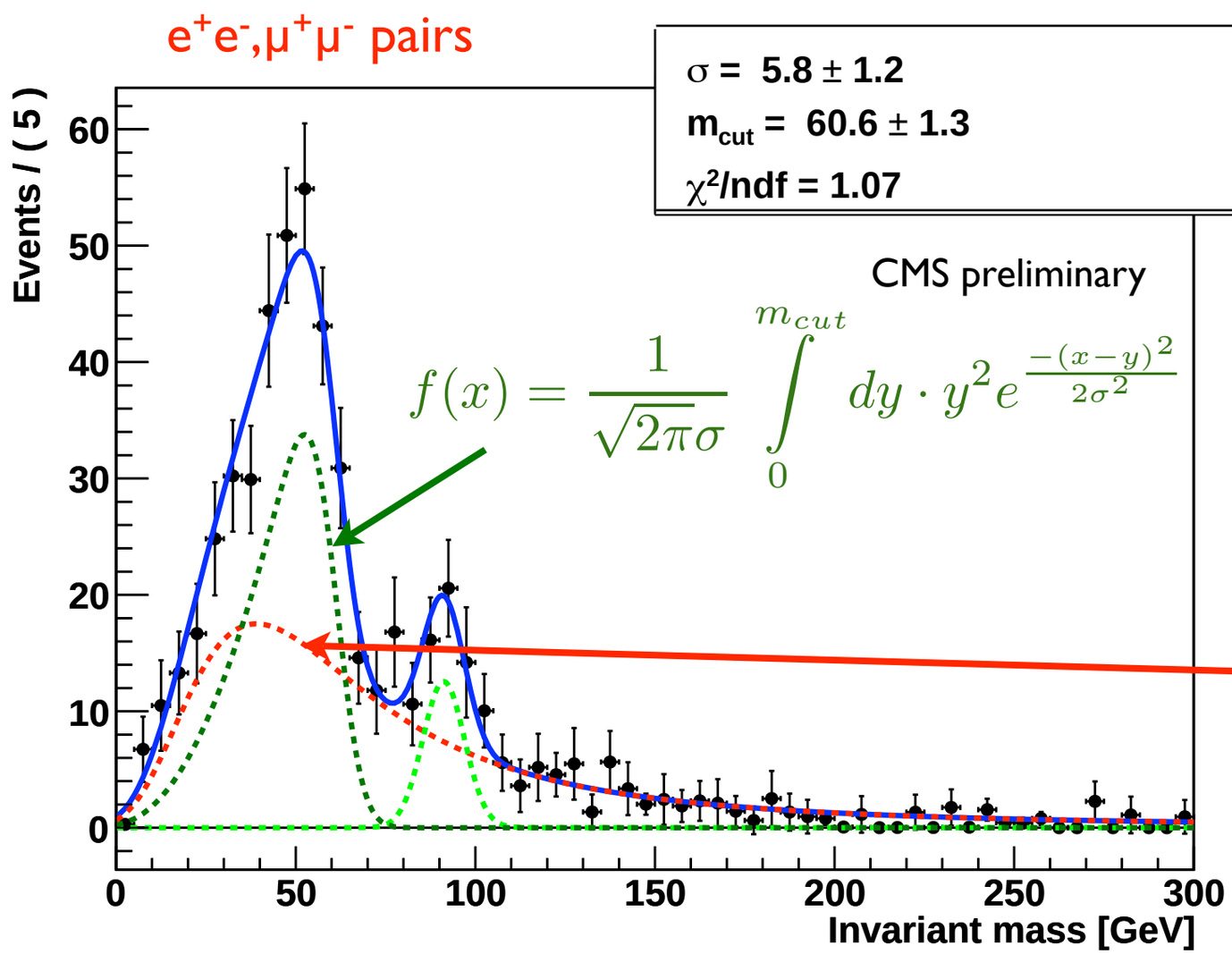
$e^+\mu^-, \mu^+e^-$ pairs

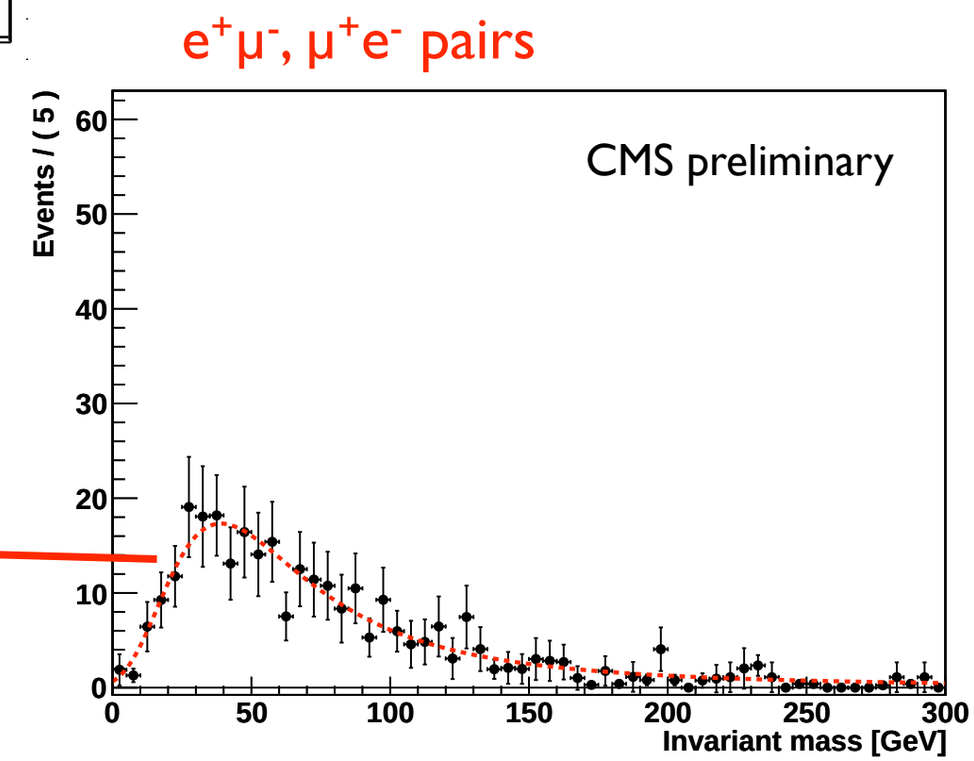


- Two isolated (p_T in Tracker cone of $\Delta R = 0.3$ less than 1.2 GeV) leptons of opposite charge
- 3 Jets > (120,80,80) GeV
- MET > 100 GeV

- Main remaining background
  - tt+jets
- Electron and muon pairs are uncorrelated
- Used to measure the background from data

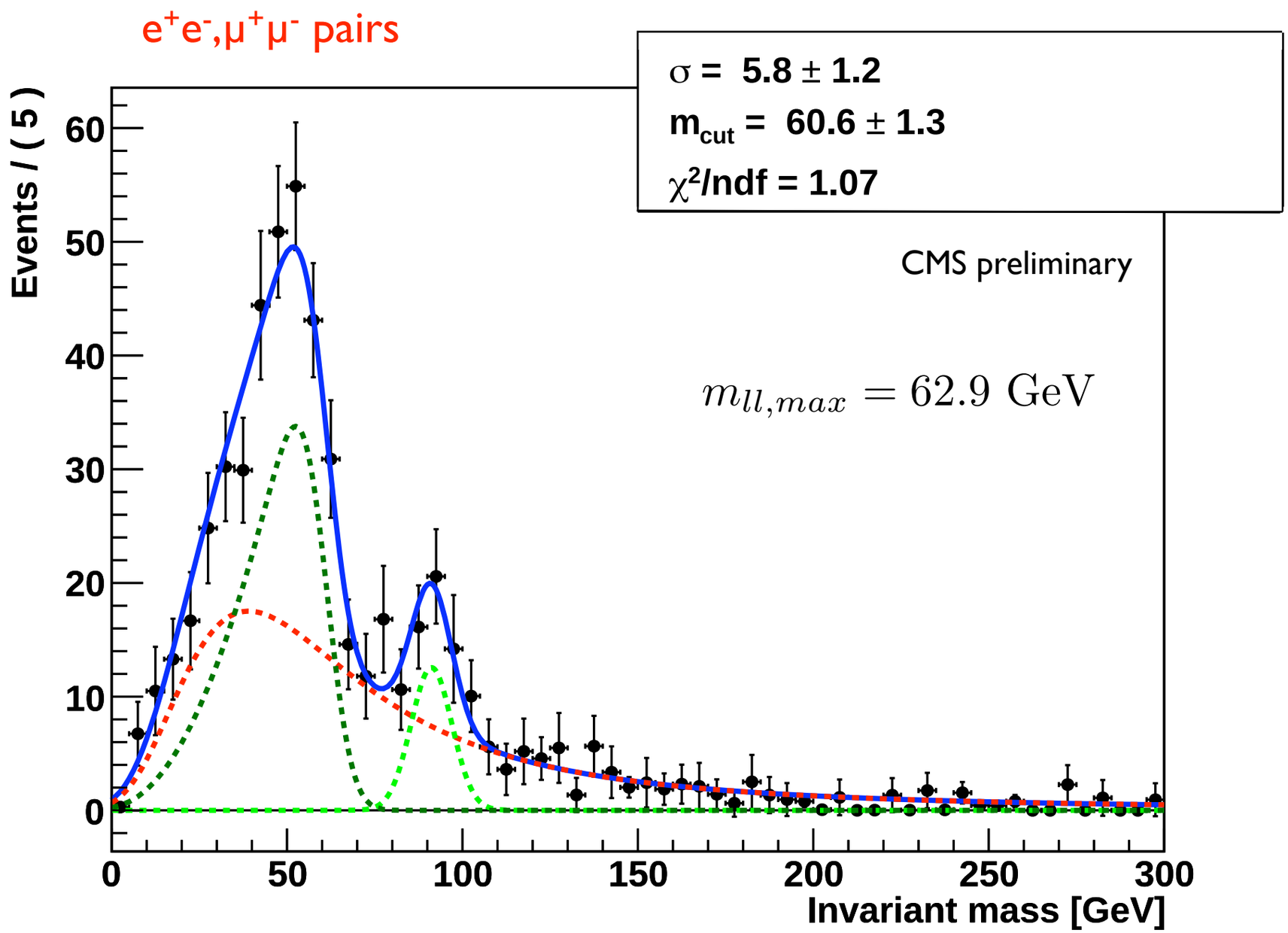
Fit method





- Flavour symmetric background can be fitted from data
- Used as a template in the fit of the mass edge (Background)
- Model consists of a quadratic term convoluted with a gaussian (SUSY signal)
- Breit-Wigner convoluted with a gaussian (Z peak)

Combined fit of the mass edge



$$\Delta m_{\tilde{\chi}_2^0 - \tilde{\chi}_1^0} = \left(63.2 \pm 1.2_{stat.}\ ^{+1.4}_{-1.7}{}_{syst.}\right)\ \text{GeV}$$

- Relies only on the knowledge of the lepton reconstruction efficiency
- Endpoint can be reproduced
- In this case the mass difference can be directly measured
- Systematic uncertainties include a severe (10 pb^{-1}) misalignment of the tracker (conservative)

Summary

- The decay of the next to lightest neutralino into two leptons can be observed with the CMS experiment
- It can be reconstructed with 1 fb^{-1} of integrated luminosity
  - Precision of 3% can be reached with the first LHC data if SUSY is realised in such a scenario with low mass

Things to be done for first LHC data

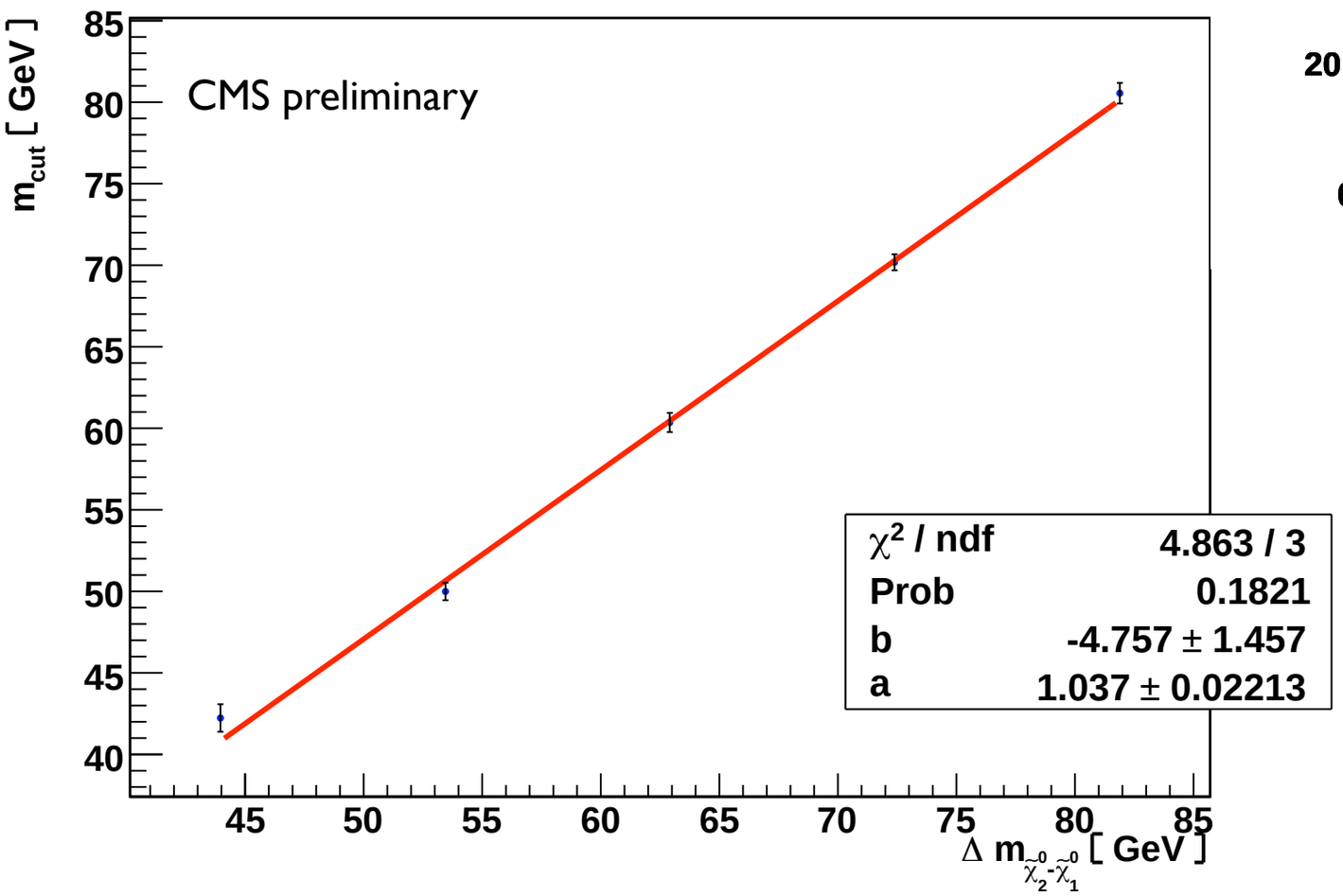
- Adopt to early scenario 200pb^{-1} @ 10 TeV
- Measure lepton reconstruction efficiencies from data using Tag and Probe methods for electrons and muons

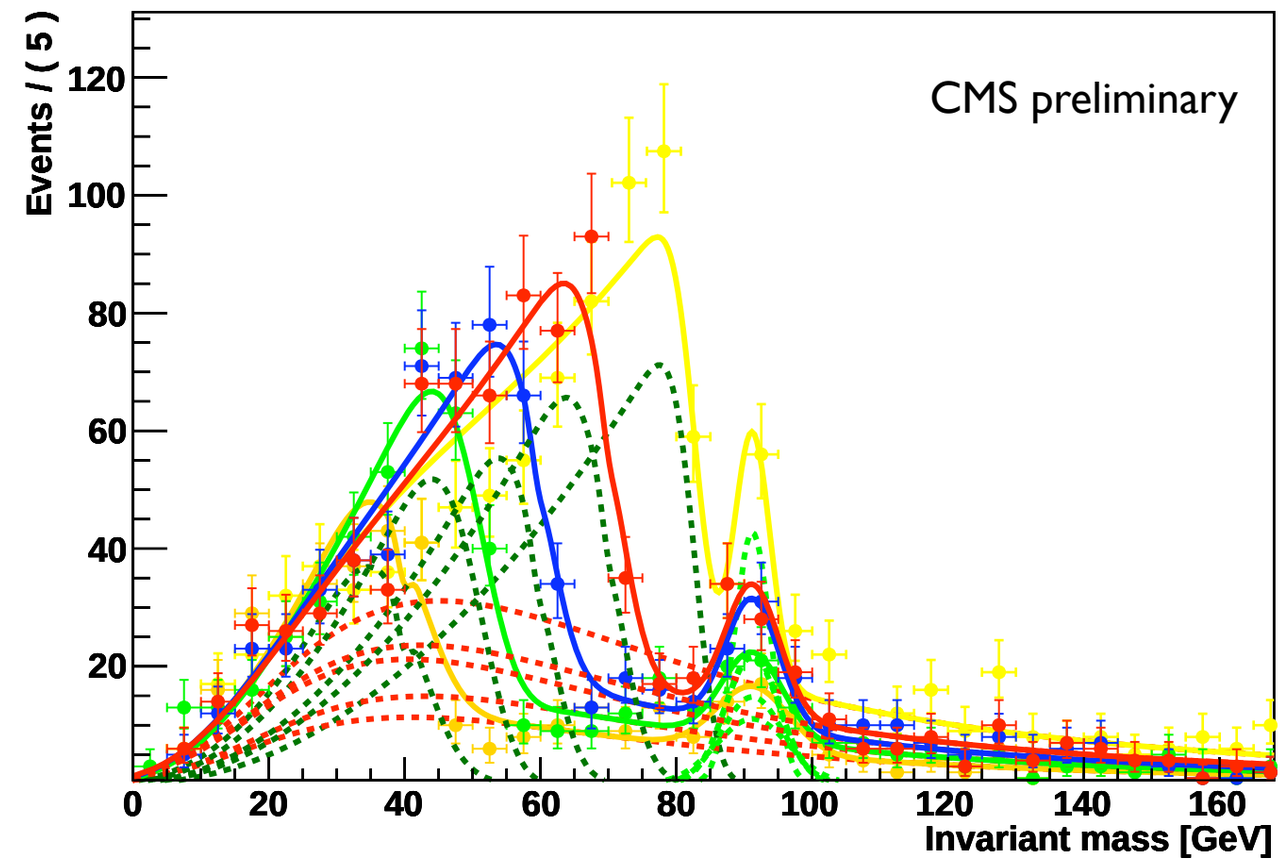
Backup

Fit function and calibration

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} \int_0^{m_{cut}} dy \cdot y^2 e^{\frac{-(x-y)^2}{2\sigma^2}}$$

- 3 free parameters
  - a, σ and m_{cut}
- m_{cut} is the estimator for the mass difference





- 5 mSUGRA points (Fast simulation)
- Variation of $m_{1/2}$ to obtain different mass differences
- Calibration of m_{cut}