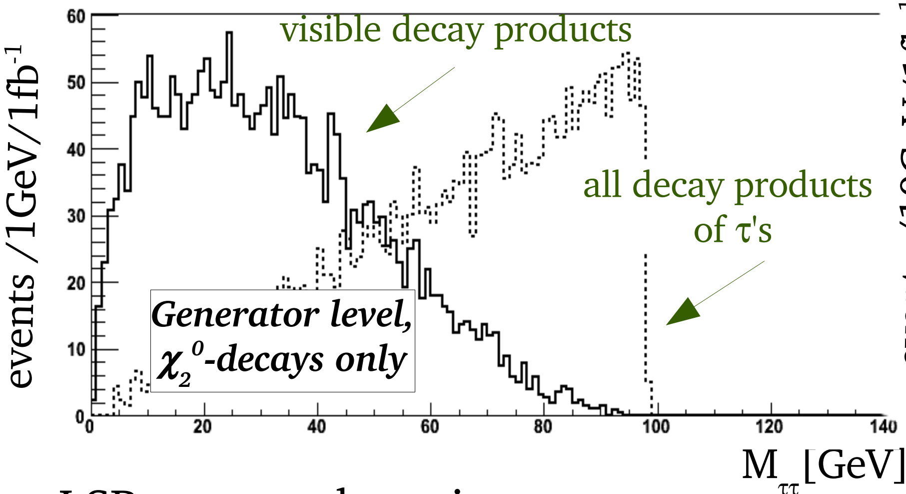
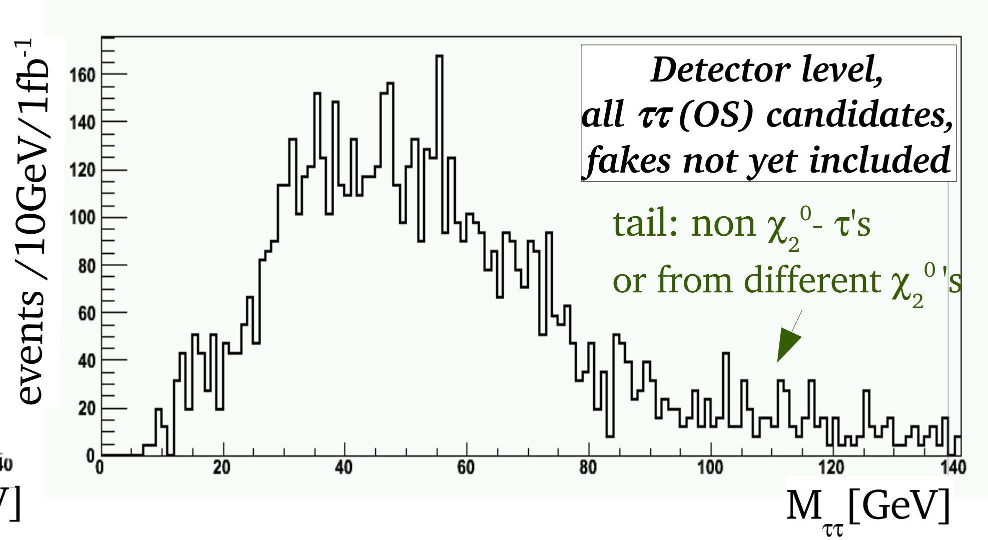
$\tilde{\chi}^0_2 \rightarrow \tilde{\tau}_1 \tau \rightarrow \tilde{\chi}^0_1 \tau \tau$: Endpoint determination of ditau invariant mass in SU3 (Atlfast-study with full BG)

Peter Wienemann, Carolin Zendler
University of Bonn

Last presentation:

- $\tilde{\chi}_2^0 \rightarrow \tilde{\tau}_1 \tau \rightarrow \tilde{\chi}_1^0 \tau \tau$ is important channel for SUSY





- LSP escapes detection
  -> no mass peak
- kinematic endpoint at

$$m_{\tau\tau}^{max} = \sqrt{\frac{(m(\tilde{\chi}_2^0)^2 - m(\tilde{\tau}_1)^2) \cdot (m(\tilde{\tau}_1)^2 - m(\tilde{\chi}_1^0)^2)}{(m(\tilde{\tau}_1)^2)}}$$

- endpoint smeared out for τ's
  due to neutrinos

ATLFAST data samples

SU3: 1.4 M ev. $\simeq$ 73 fb^{-1} : *11.0.42, Herwig 6.5*
BG: subsample of official data: *11.0.41, Alpgen*
Z+Jets: (~ 140 fb^{-1}), **W+Jets**: (~ 22 fb^{-1}),
tt+Jets: (~ 48 fb^{-1}), **bb+Jets**: (~ 0.3 fb^{-1}),
MultiJets: (~ 0.007 fb^{-1})
+ DiJets (Jn): 10k/Jn: *10.0.4, Pythia 6.2*

Tau-ID / fake taus:

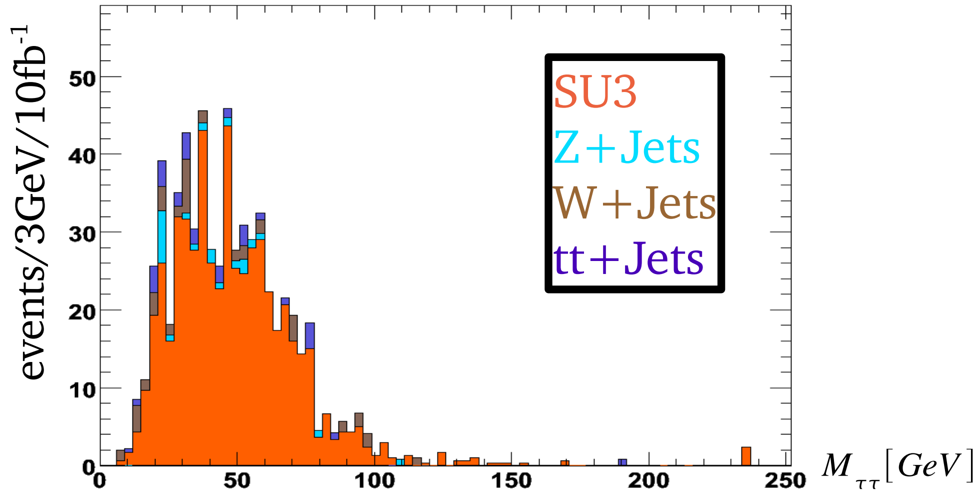
Atlfast 11.0.4 parameterization with efficiency = 50%

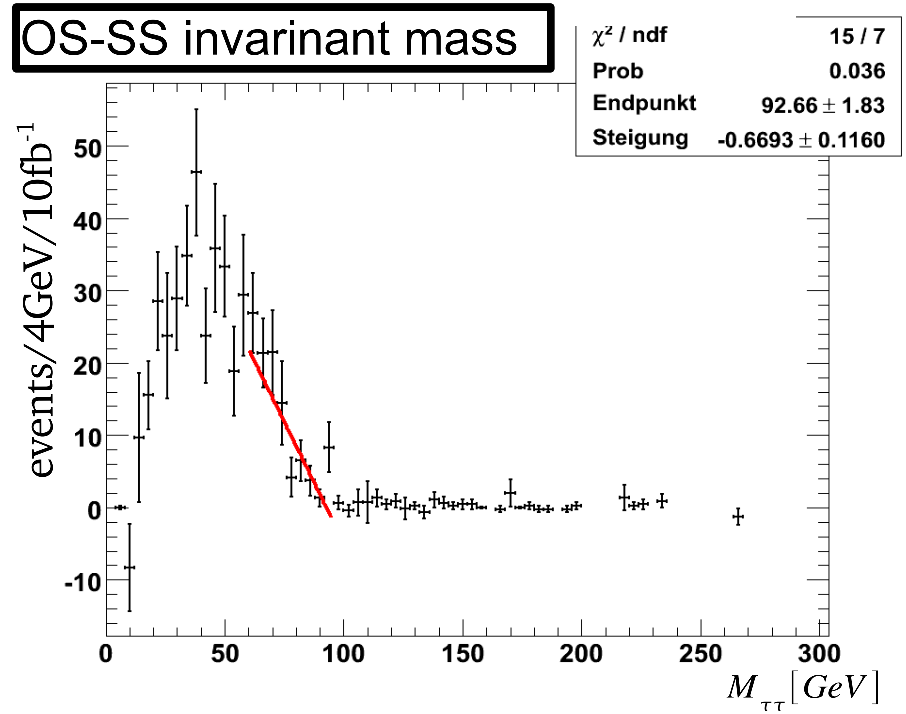
Cuts for SU3:

- $p_{T,miss} > 230$ GeV
- at least 4 jets: $p_T > 30$ GeV
- at least 3 jets: $p_T > 50$ GeV
- at least 1 jet: $p_T > 220$ GeV
- $\Delta R(\tau\tau) < 2$

Linear Fit:

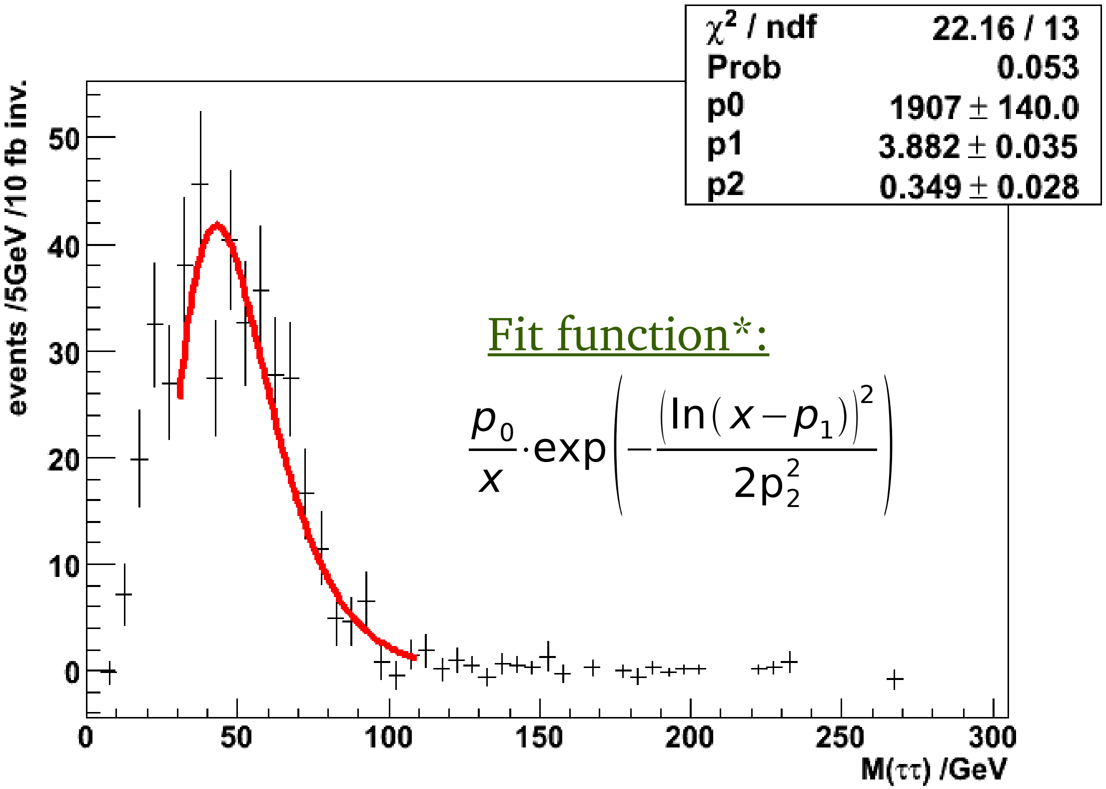
- endpoint from linear fit very susceptible to fit range
- bad approximation of shape at the edge





New approach:

- approximate shape
- extract endpoint from other trait



Fit function*:

$$\frac{p_0}{x} \cdot \exp\left(-\frac{\left(\ln(x-p_1)\right)^2}{2p_2^2}\right)$$

* modified adoption from: CMS NOTE 2006/096

measure **inflection point**

-> more stable to change of fitting range or binning

-> need calibration for endpoint:

-> change involved masses $m(\tilde{\chi}_2^0), m(\tilde{\tau}_1), m(\tilde{\chi}_1^0)$

-> measure inflection point as function of known endpoint

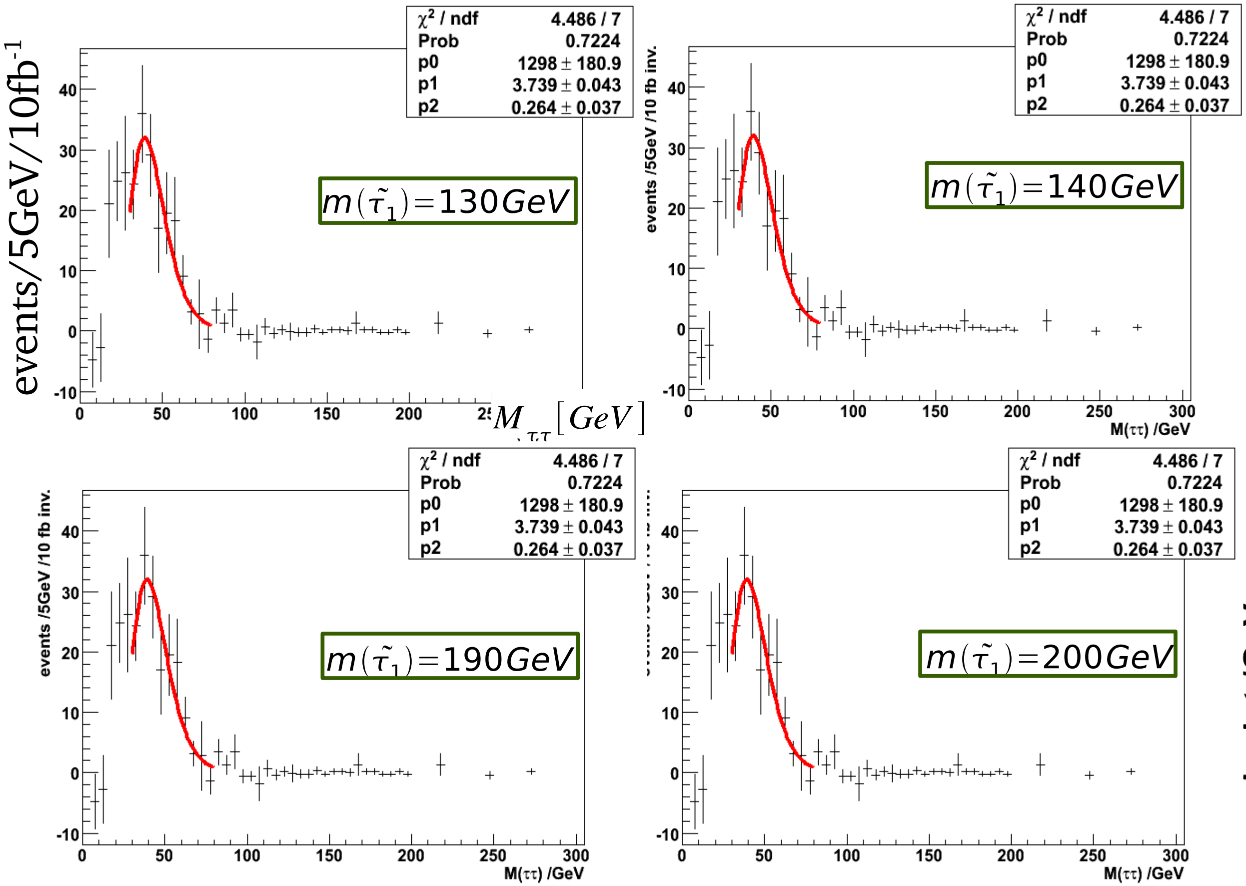
inflection point:

$$x_{IP} = \exp\left(\frac{1}{2} p_2^2 \left(3 + \sqrt{\left(1 + \frac{4}{p_2^2}\right)}\right) + p_1\right)$$

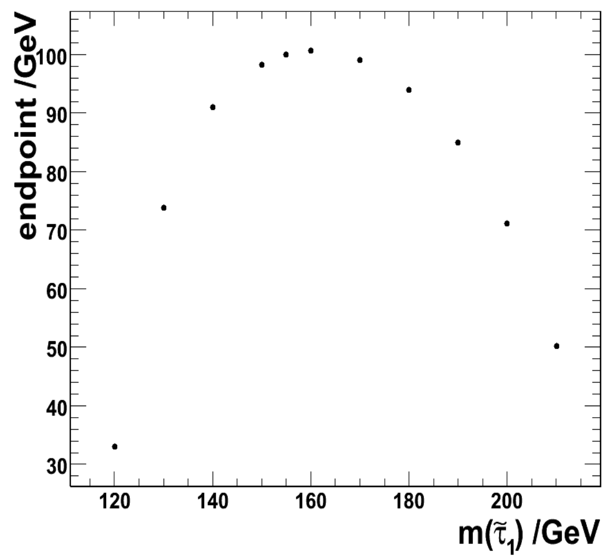
error:

$$s_x^2 = s_{p1}^2 \left(\frac{\partial x}{\partial p_1}\right)^2 + s_{p2}^2 \left(\frac{\partial x}{\partial p_2}\right)^2 + 2\,cov(p_1, p_2) \left(\frac{\partial x}{\partial p_1}\right)\left(\frac{\partial x}{\partial p_2}\right)$$

Calibration: example of variation of $\tilde{\tau}_1$-mass (SU3: 150 GeV) for fixed $m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0)$



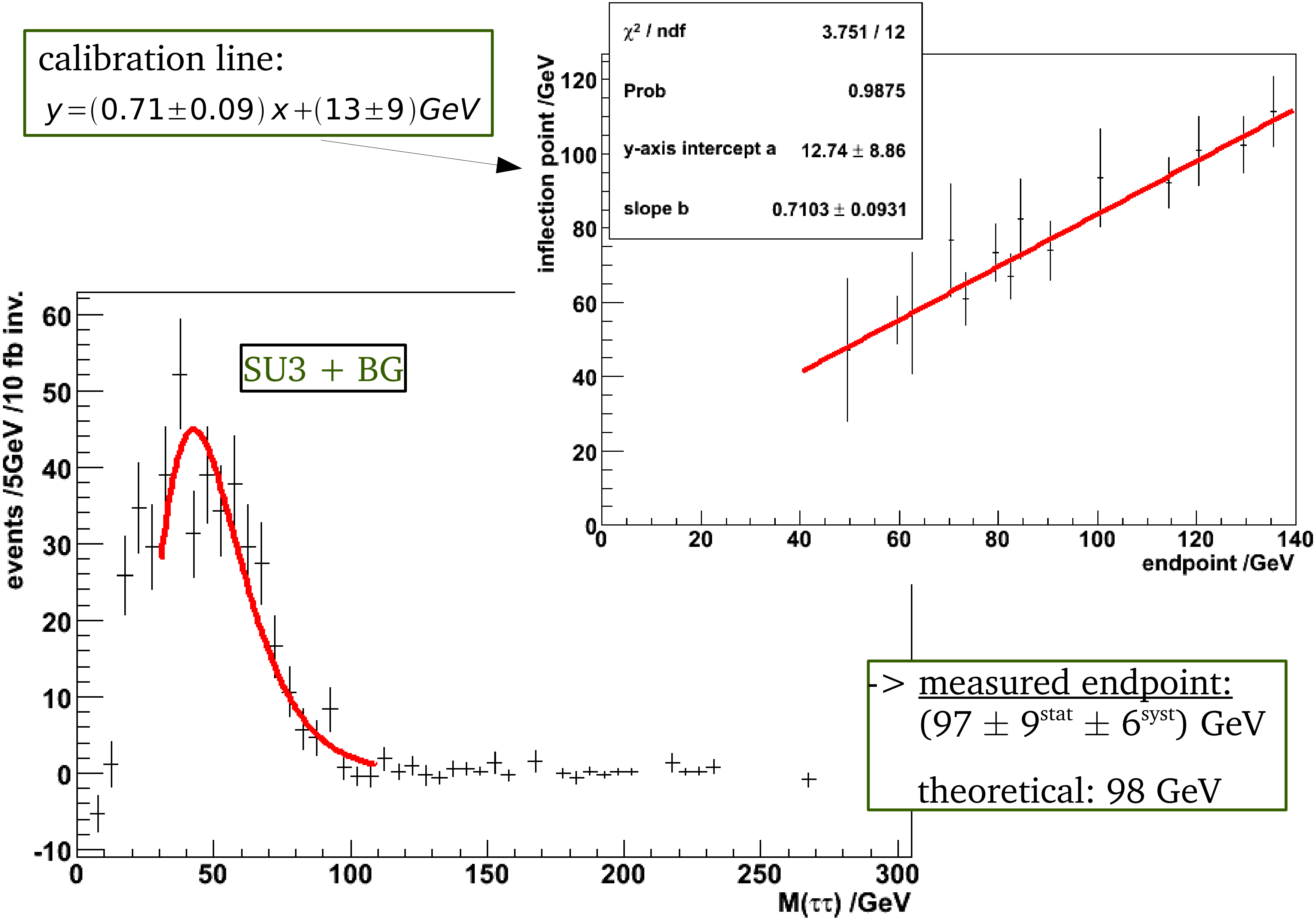
$$m_{\tau\tau}^{max} = \sqrt{\frac{(m(\tilde{\chi}_2^0)^2 - m(\tilde{\tau}_1)^2)\cdot(m(\tilde{\tau}_1)^2 - m(\tilde{\chi}_1^0)^2)}{(m(\tilde{\tau}_1)^2)}}$$



$m(\tau_1)$ [GeV]	endpoint (theoret.) [GeV]	Inflection point [GeV]
130	74	61 +- 7
140	91	74 +- 8
160	101	94 +- 13
190	85	83 +- 11
200	71	77 +- 15
210	50	47 +- 19

calibration line:

$y = (0.71 \pm 0.09)\,x + (13 \pm 9)\,GeV$



-> measured endpoint:
$(97 \pm 9^{stat} \pm 6^{syst})$ GeV

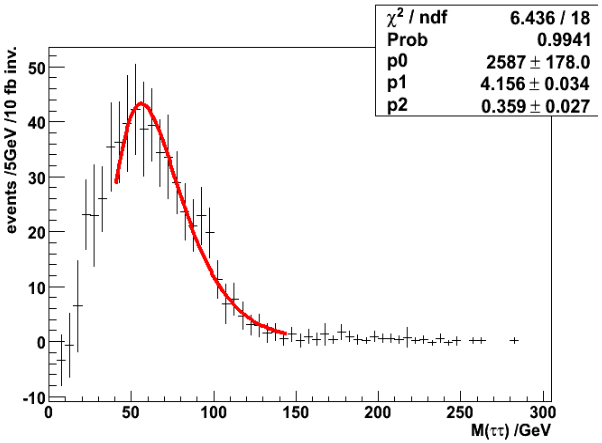
theoretical: 98 GeV

Conclusion:

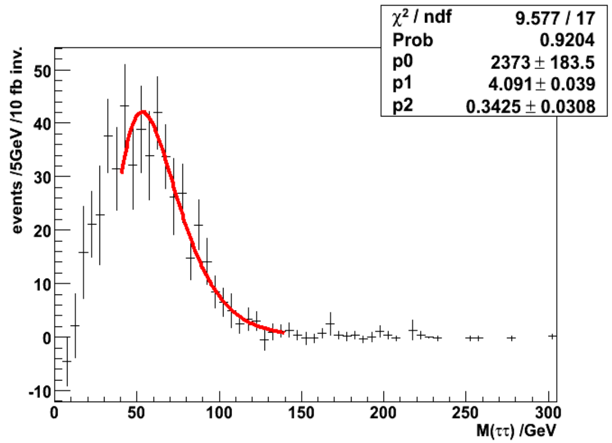
- inflection point method is applicable for endpoint determination
- at 10 fb^{-1}: endpoint can be measured in SU3 with 15% precision

backup

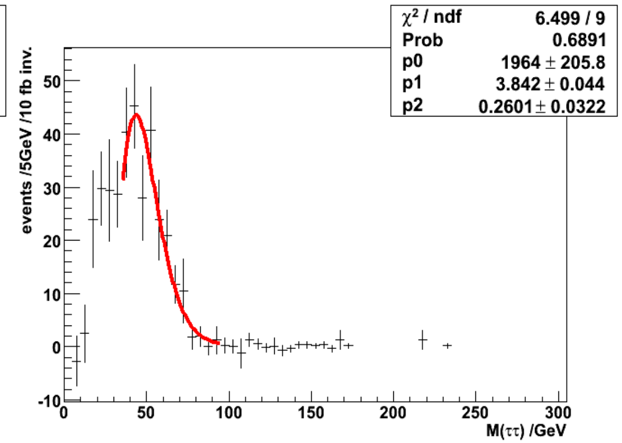
variation of $\tilde{\chi}_1^0$-mass (SU3: 150 GeV) for fixed $m(\tilde{\chi}_2^0), m(\tilde{\tau}_1)$



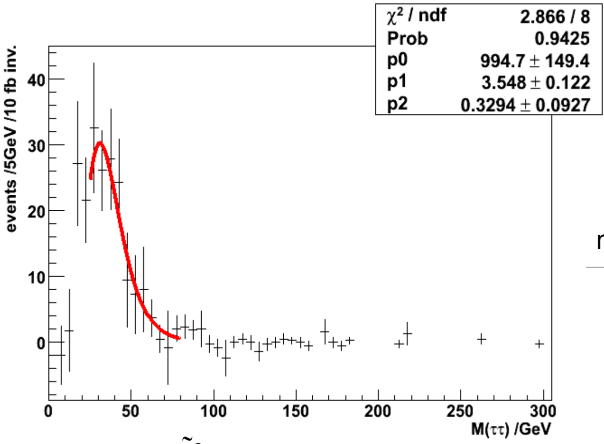
$m(\tilde{\chi}_1^0)=77.9\,GeV$



$m(\tilde{\chi}_1^0)=97.9\,GeV$

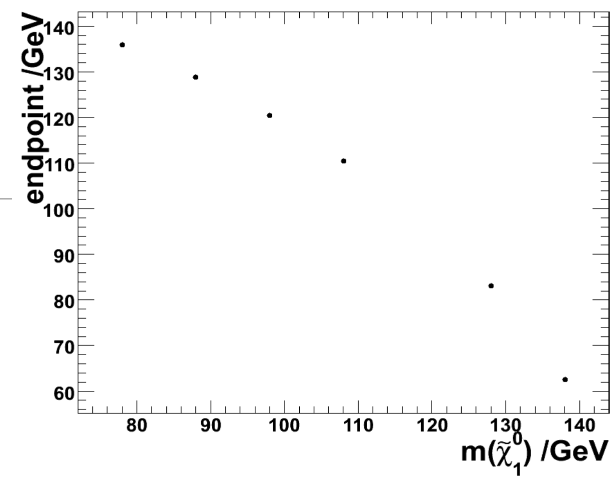


$m(\tilde{\chi}_1^0)=127.9\,GeV$

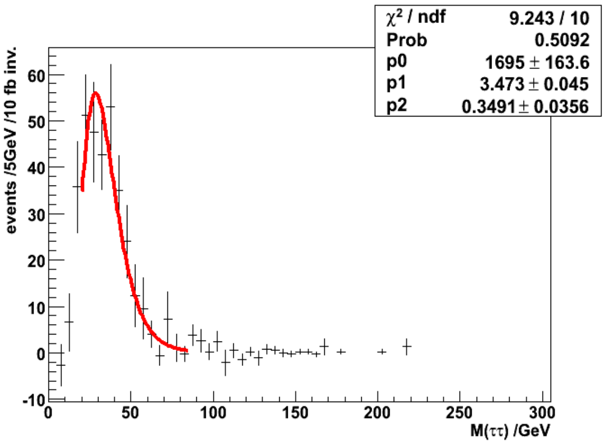


$m(\tilde{\chi}_1^0)=137.9\,GeV$

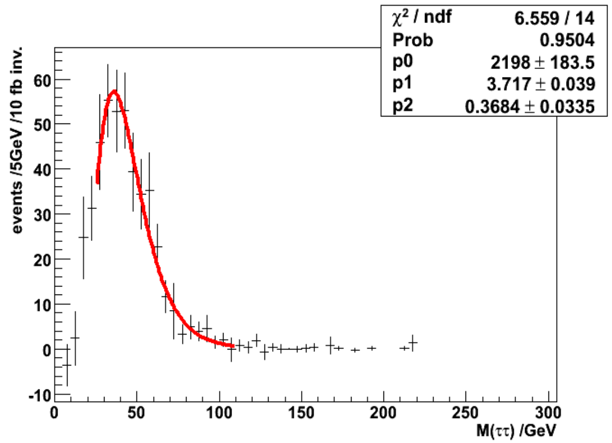
$m(\chi_1)$ [GeV]	endpoint [GeV]	Infl. point [GeV]
77.9	136	112 +- 9
97.9	121	101 +- 9
127.9	83	67 +- 6
137.9	63	57 +- 16



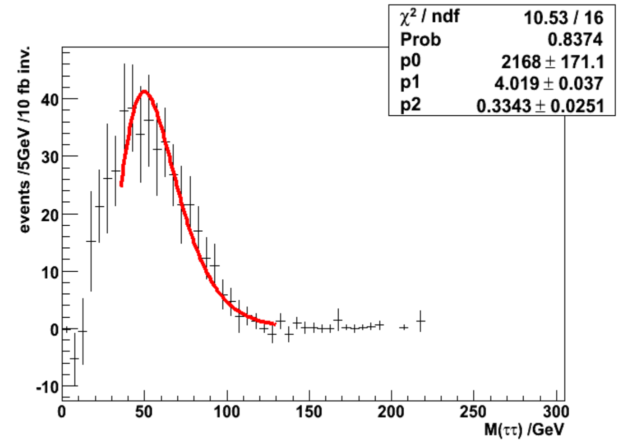
variation of $\tilde{\chi}_2^0$ -mass (SU3: 150 GeV) for fixed $m(\tilde{\tau}_1), m(\tilde{\chi}_1^0)$



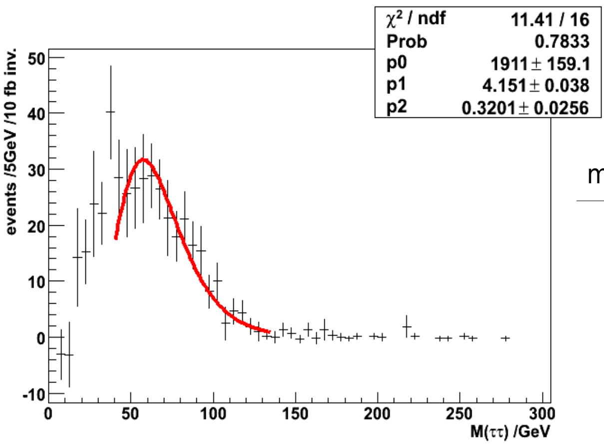
$m(\tilde{\chi}_2^0) = 178.6\,GeV$



$m(\tilde{\chi}_2^0) = 198.6\,GeV$



$m(\tilde{\chi}_2^0) = 238.6\,GeV$



$m(\tilde{\chi}_2^0) = 258.6\,GeV$

$m(\chi_2)$ [GeV]	endpoint [GeV]	Infl. point [GeV]
178.6	60	55 +- 6
198.6	80	73 +- 8
238.6	115	92 +- 7
258.6	130	102 +- 8