W Identification in the full hadronic supersymmetric decay chain

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und Forschung

outline

1. *introduction*
2. *matching efficiency of the W/Z*
3. *cut-based analysis*
4. *the TMVA Package*
5. *summary and outlook*

the mSugra parameter space

LM4:

$M_0 = 210\,GeV$

$M_{1/2} = 285\,GeV$

$A_0 = 0\,GeV$

$\tan\beta = 10$

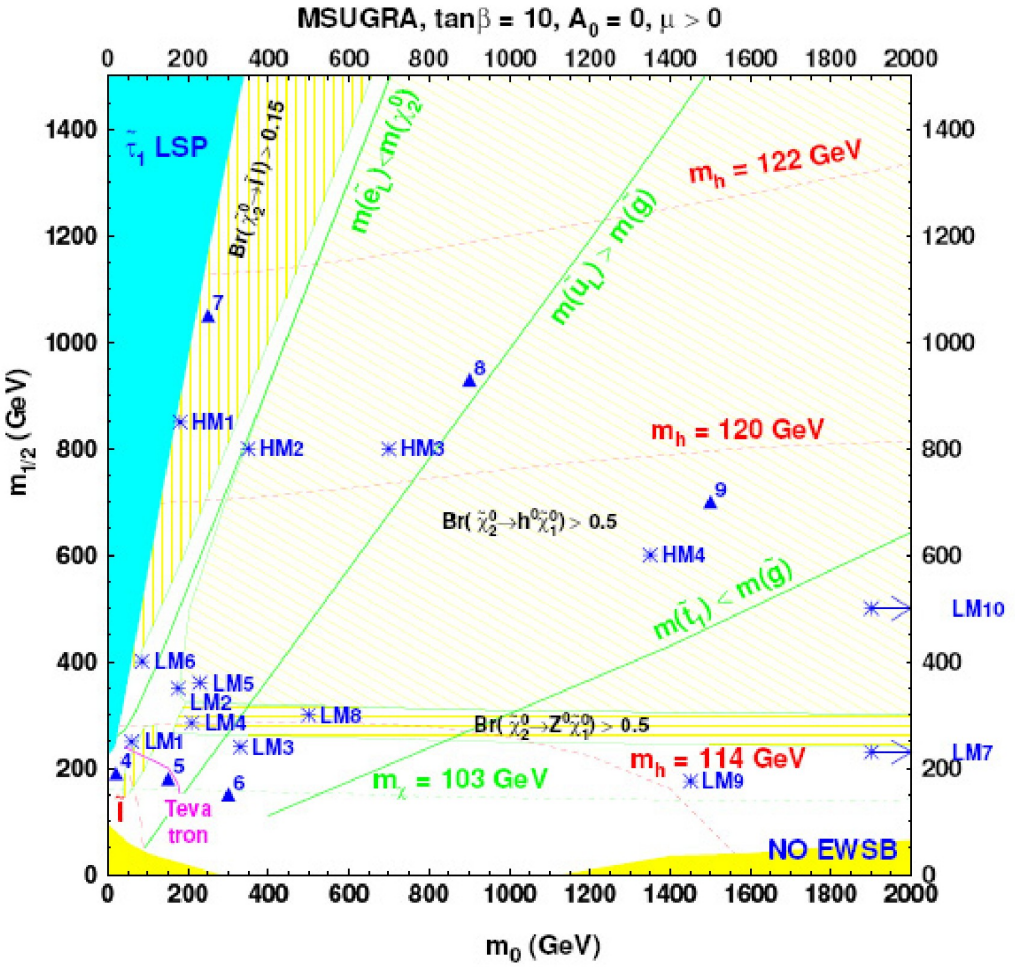
$sign(\mu) = +$

$M_{\tilde{g}} = 695\,GeV$

$M_{\tilde{q}} \sim 660\,GeV$

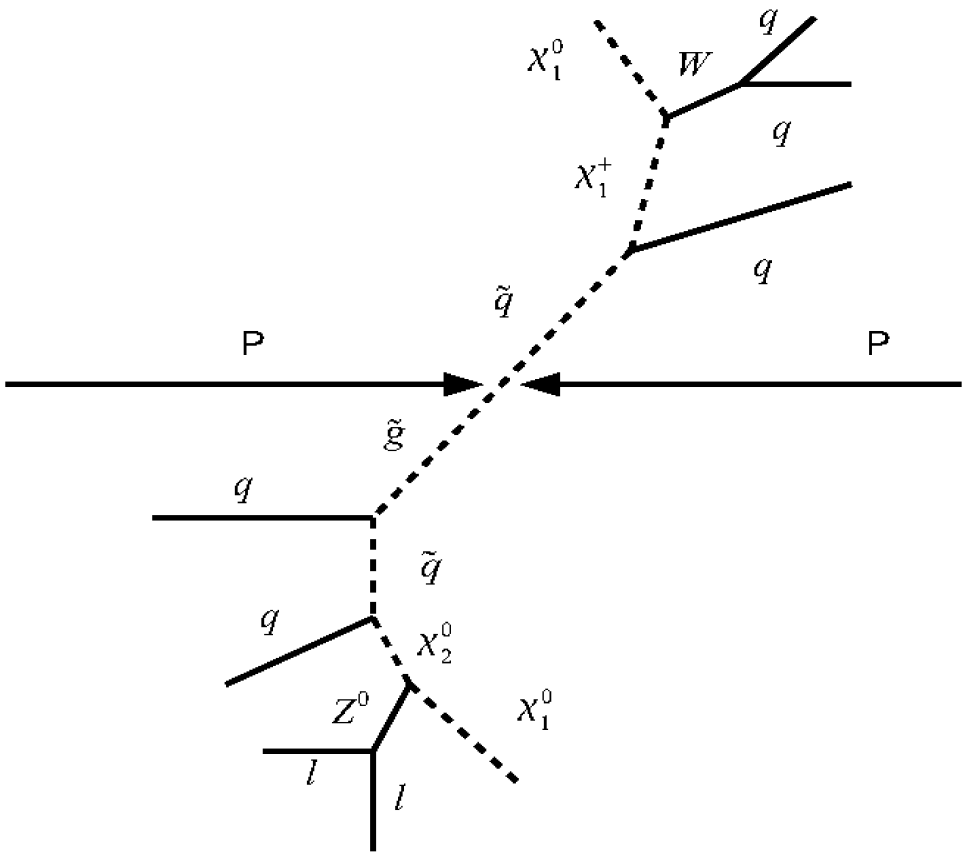
$M_{\chi_1^-} = 210\,GeV$

$M_{\chi_1^0} = 110\,GeV$



PTDR, Vol2

supersymmetric events

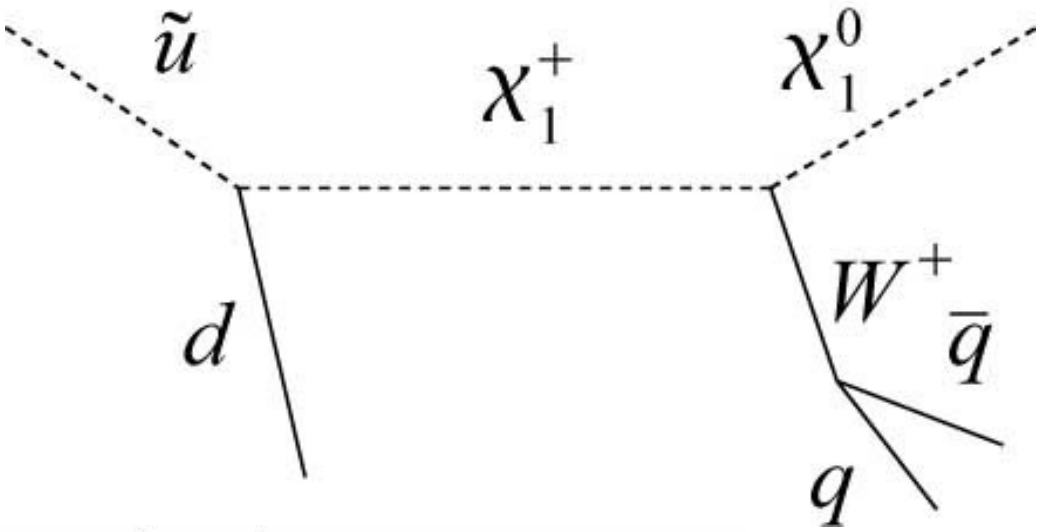


R-Parity conserving:

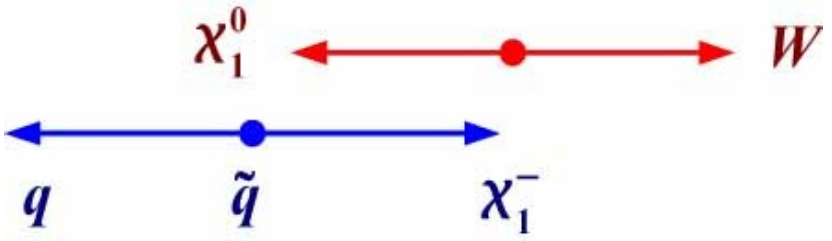
Always 2 Sparticles will be produced

In every cascade there will be 2 Lightest Supersymmetric Particles (LSP)

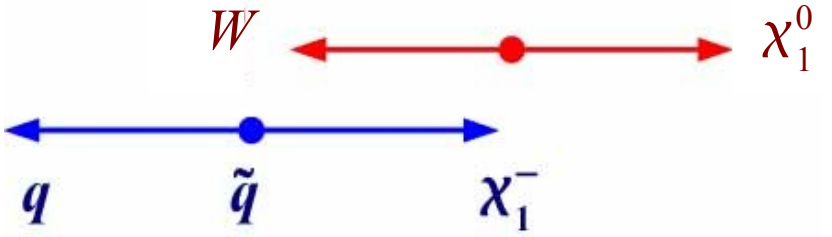
example cascade



$$(M_{qW}^{max})^2 = M_W^2 + \frac{M_{\tilde{q}}^2 + M_{\chi_1^-}^2}{2M_{\chi_1^-}^2}(M_{\chi_1^-}^2 - M_{\chi_1^0}^2 + M_W^2 + \sqrt{(M_{\chi_1^-}^2 - M_{\chi_1^0}^2 - M_W^2)^2 - 4M_{\chi_1^0}^2 M_W^2})$$



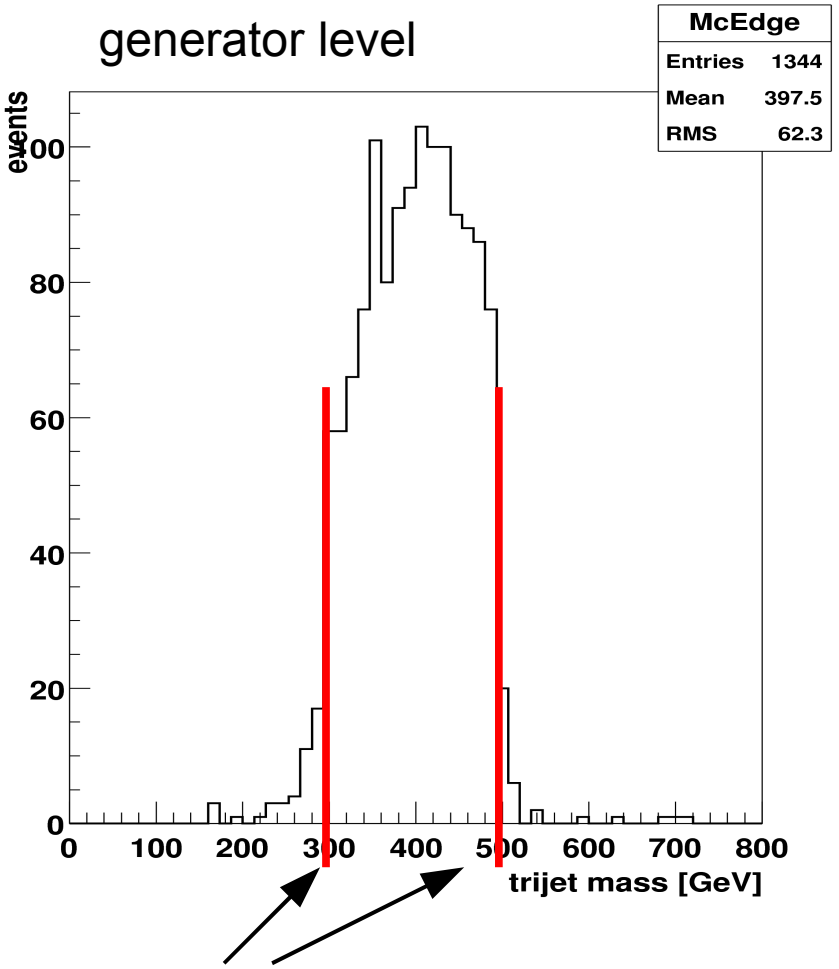
$$(M_{qW}^{min})^2 = M_W^2 + \frac{M_{\tilde{q}}^2 + M_{\chi_1^-}^2}{2M_{\chi_1^-}^2}(M_{\chi_1^-}^2 - M_{\chi_1^0}^2 + M_W^2 - \sqrt{(M_{\chi_1^-}^2 - M_{\chi_1^0}^2 - M_W^2)^2 - 4M_{\chi_1^0}^2 M_W^2})$$



CMS IN 2006/012, L.Pape

mass edges

generator level



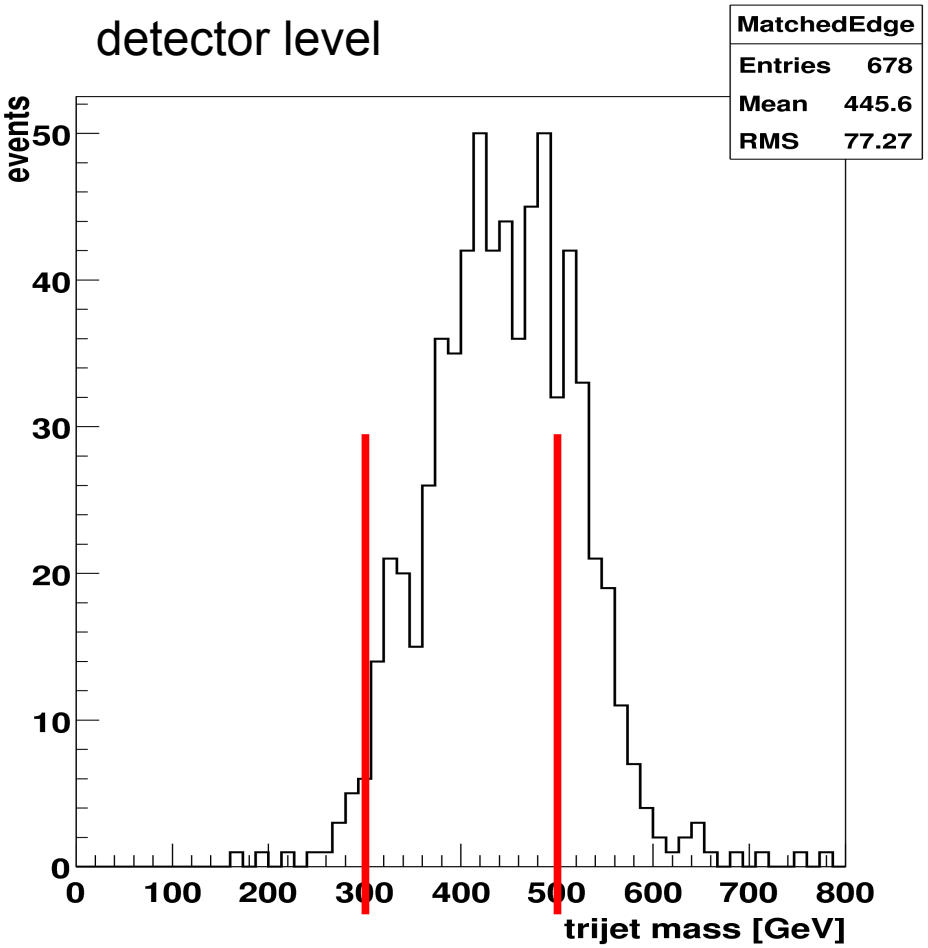
analytic:

$$M_{qW}^{max} = 508\,GeV$$

$$M_{qW}^{min} = 306\,GeV$$

fastjet D=0.6 is used
energy is smeared because of finite resolution
also 10% overcorrection

detector level



W/Z matching efficiency

X² matching:

Fastjet, D = 0.6

Jet cuts:

$p_{t,jet} > 20\,GeV$

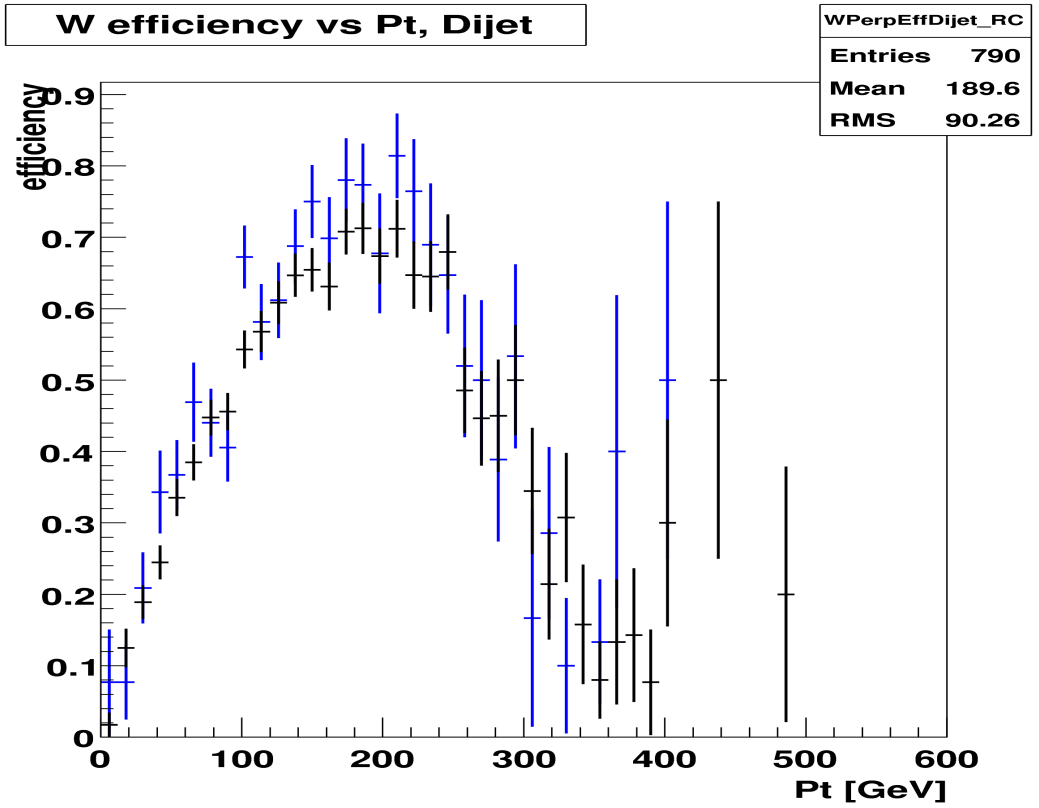
$|\eta| < 2.5$

$$\delta E = \frac{E_{gen} - E_{calo}}{E_{gen}} \qquad \delta R = \sqrt{(\eta_{gen} - \eta_{calo})^2 + (\phi_{gen} - \phi_{calo})^2}$$

$$\chi^2 = \left(\frac{\delta E}{\sigma_E}\right)^2 + \left(\frac{\delta R}{\sigma_R}\right)^2 < 4$$

$\sigma_E = 0.5$

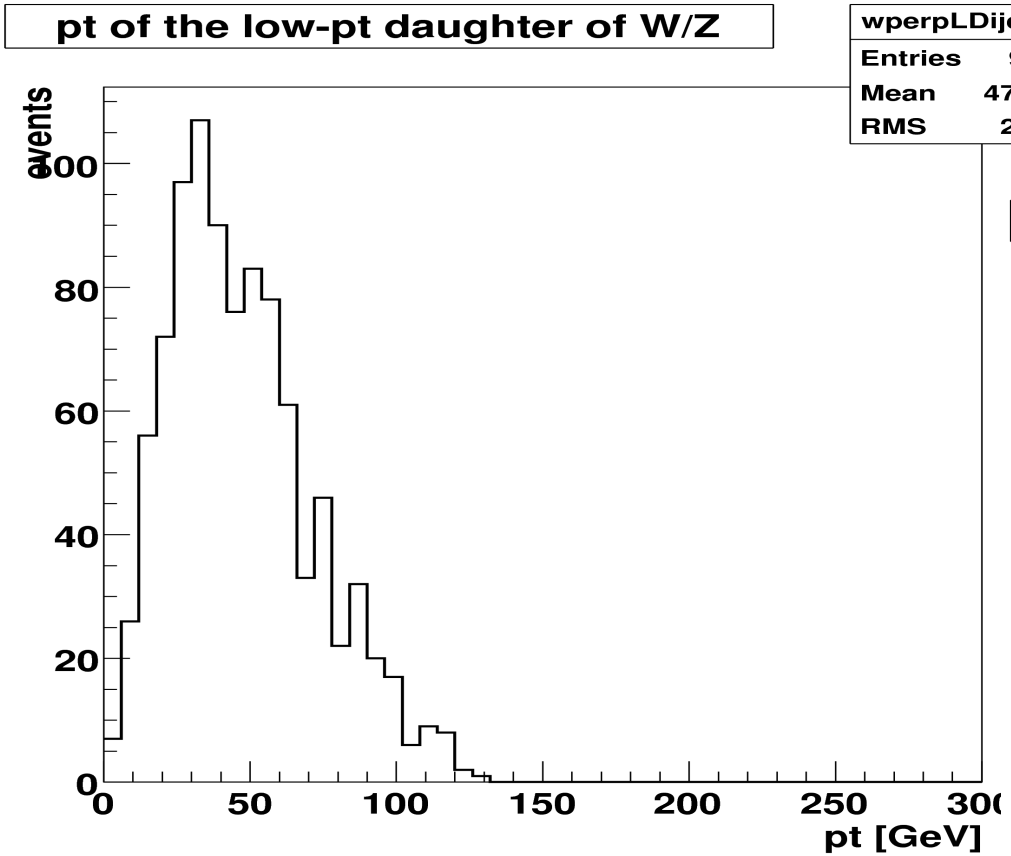
$\sigma_R = 0.15$



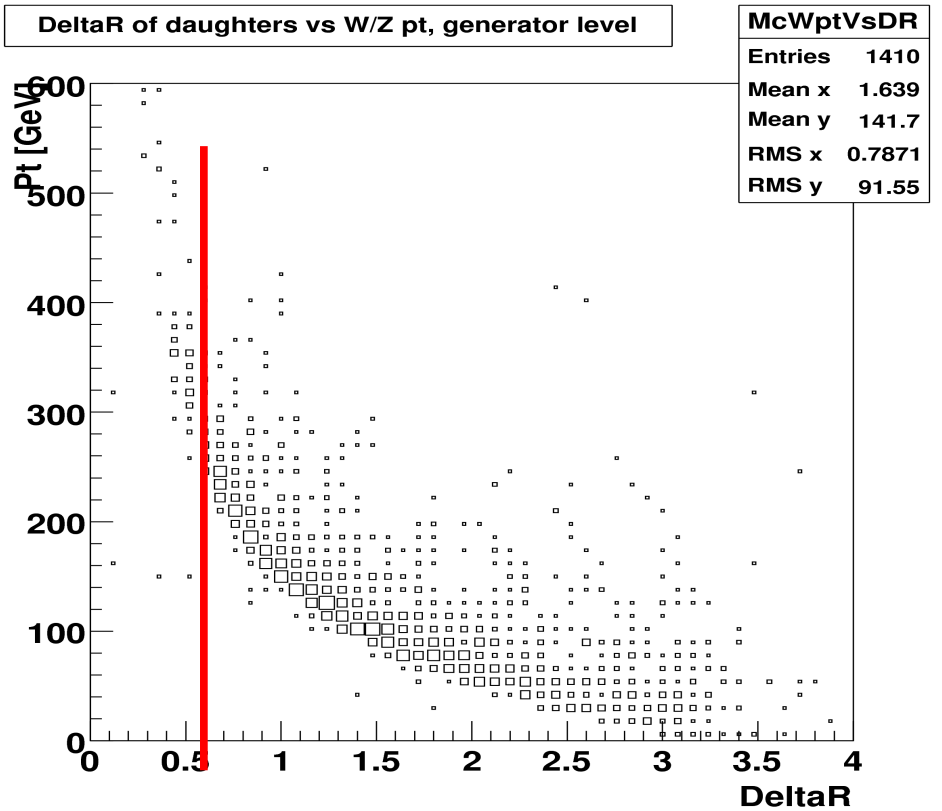
$$\epsilon = \frac{Number\ of\ W_{matched}}{Number\ of\ W_{Gen}} \sim 50\,\%$$

W/Z matching efficiency

generator level



daughters that are lying close together are merged by the Jet-algorithm



daughter with pt <20 GeV will not be found because of Jetcut

Jet reconstruction efficiency for 20 GeV Particles is ~ 50%

fastjet D = 0.6

deltaR of the daughters

cut-based analysis

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cut-based analysis

reminder: in every event there will be two cascades. This means a lot of Jets wich do not belong to the W/Z

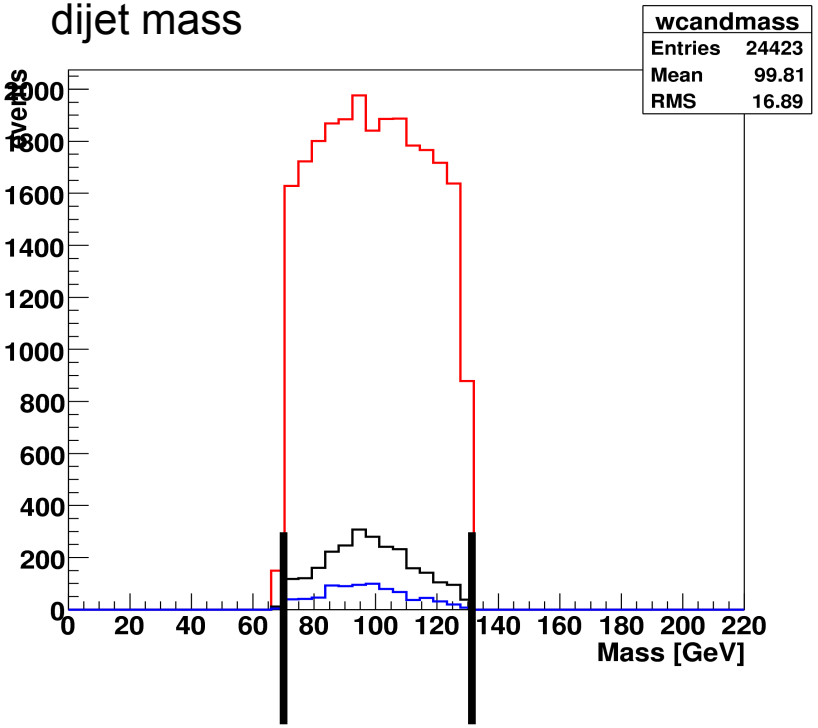
→ combinatorical background

all W/Z candidates

all matched W/Z

matched W from the example cascade

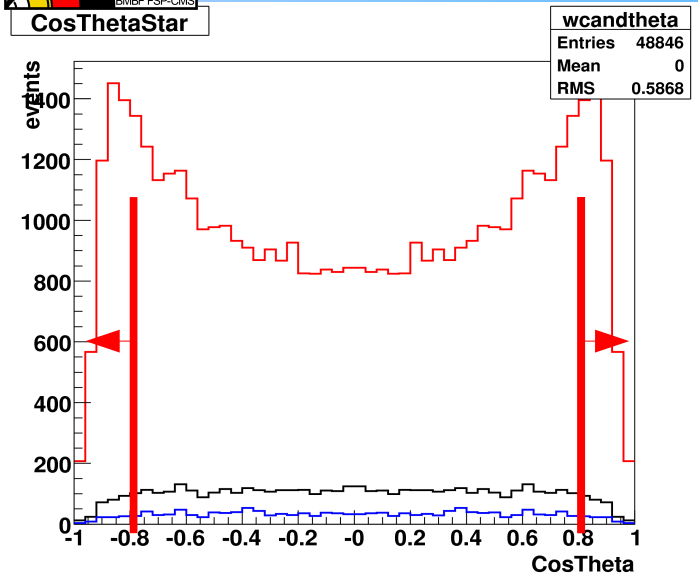
dijet mass

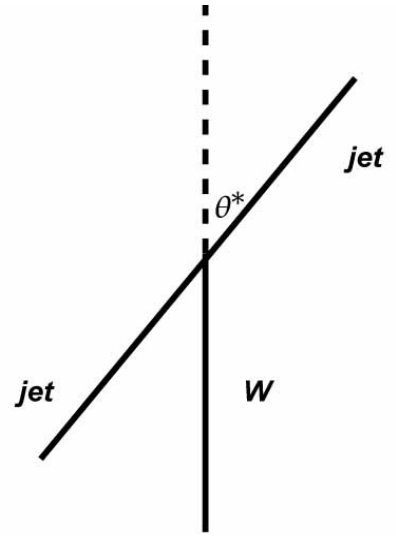


70 GeV >m>130 GeV

W/Z Candidates: every dijet mass lying between 70 GeV and 130 GeV

cut-based analysis





all W/Z candidates

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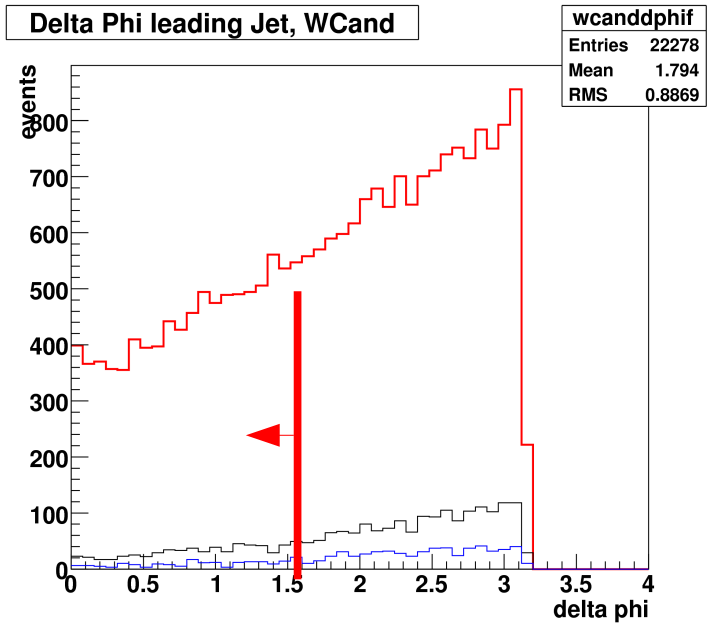
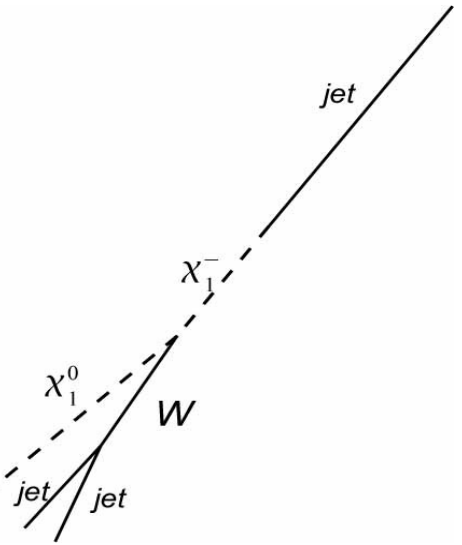
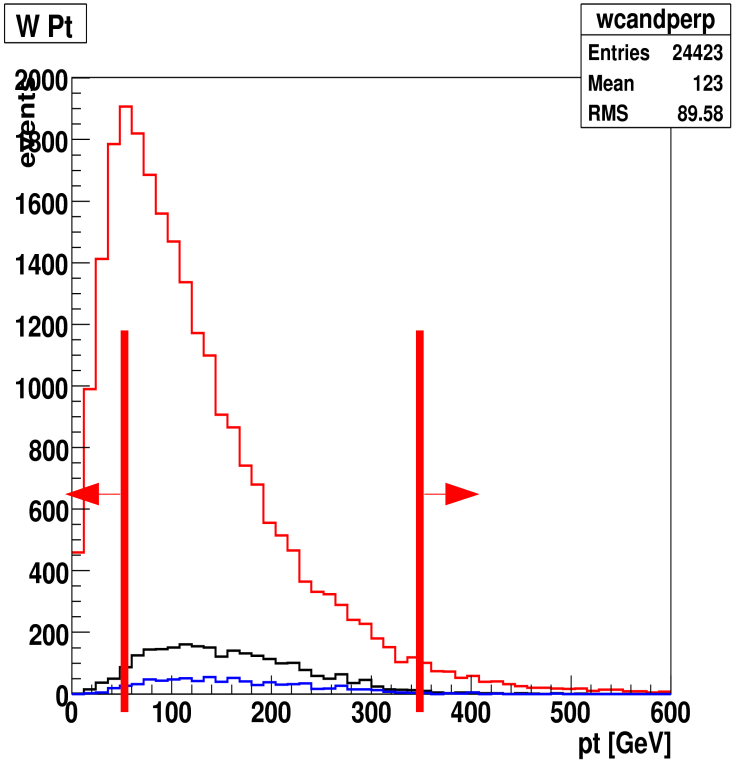
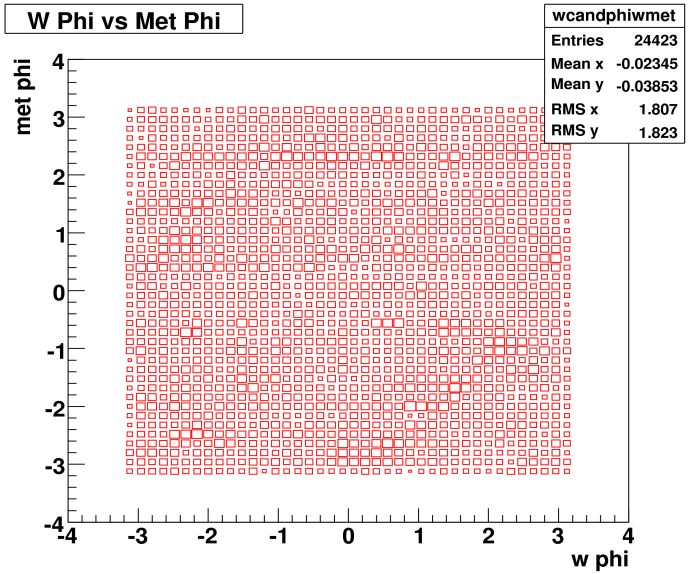
matched W from the example cascade

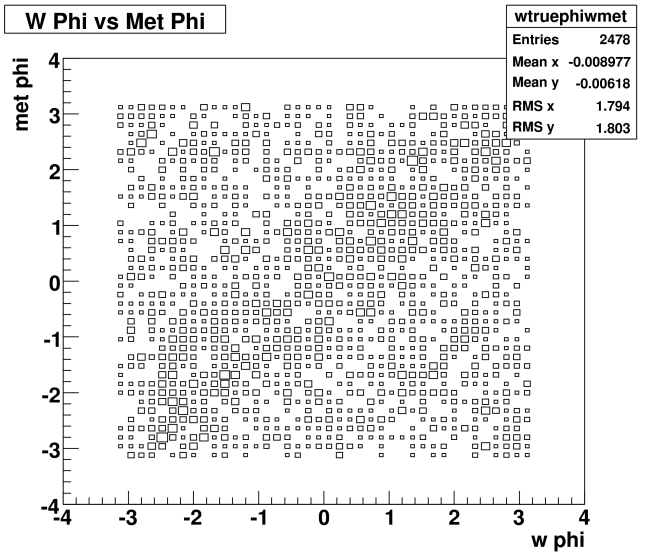






cut-based variables



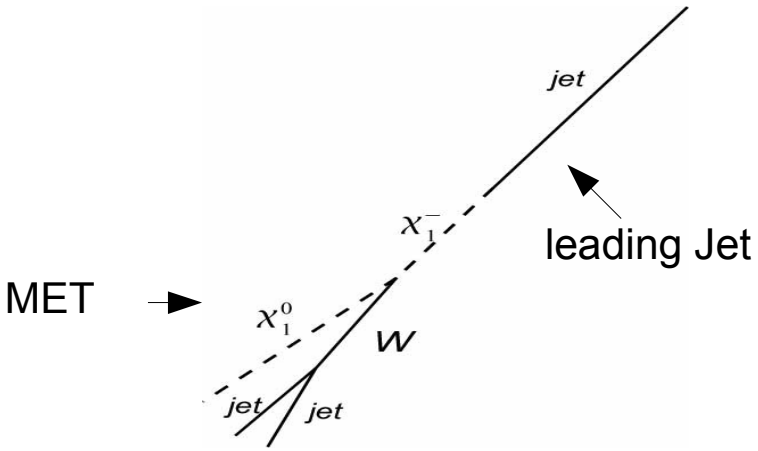


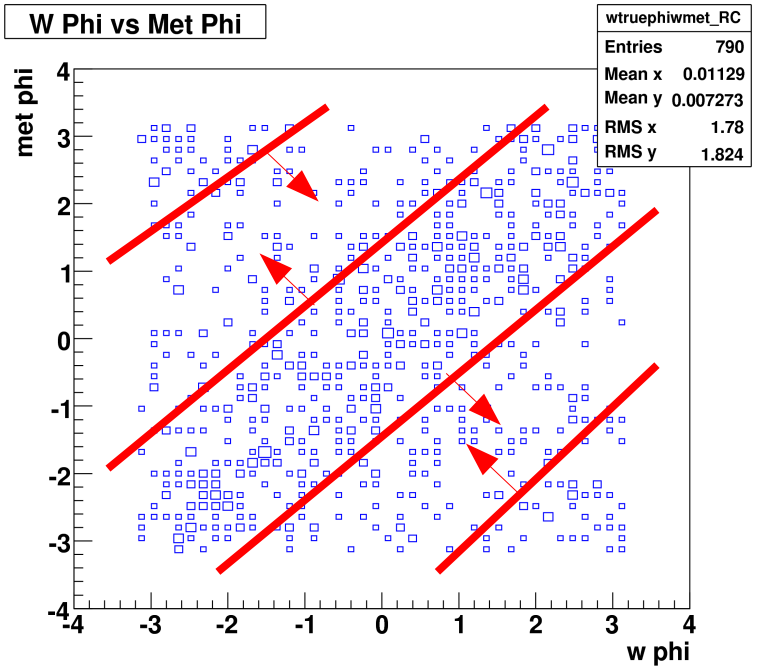
all W/Z candidates

all matched W/Z

matched W from the example cascade

$$QCD\ rejection\ Cut : \delta\phi\left(Met, J_{1(2)}\right)$$

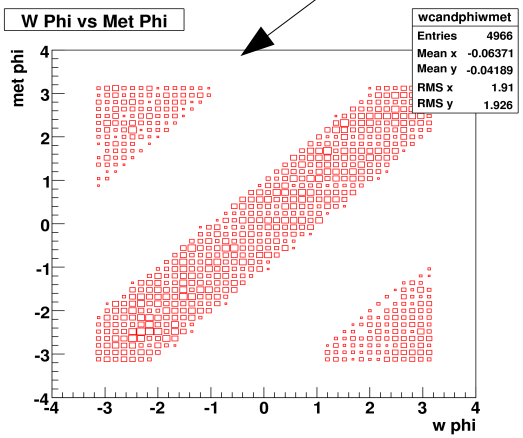




cut-based analysis

background: combinatorical bg, formed by the jets from both decay chains
SM – background assumed under control
Cascade: example Cascade producing a W

Cuts		# W		Signal Efficiency		# W Cand	bg rej	Purity	
		All	Cascade	All	Cascade			All	Cascade
None		2478	790	100.0%	100.0%	24423	0.0%	10.2%	3.3%
Theta*	<0.8	2250	720	90.8%	91.1%	19606	20.9%	11.5%	3.6%
Wpt	>60 && <350	2081	672	84.0%	85.0%	14099	45.2%	14.8%	4.8%
Dphi J,W	>1.6	1395	490	56.3%	62.0%	8118	69.4%	17.2%	6.0%
Dphi Met,W		949	344	38.3%	43.0%	4966	81.7%	19.1%	7.0%



$$\epsilon_{signal} = \frac{number\ of\ W_{found}}{number\ of\ W_{NoCuts}}$$

$$rej_{bg} = 1 - \frac{number\ of\ bg-events}{number\ of\ bg-events_{NoCuts}}$$

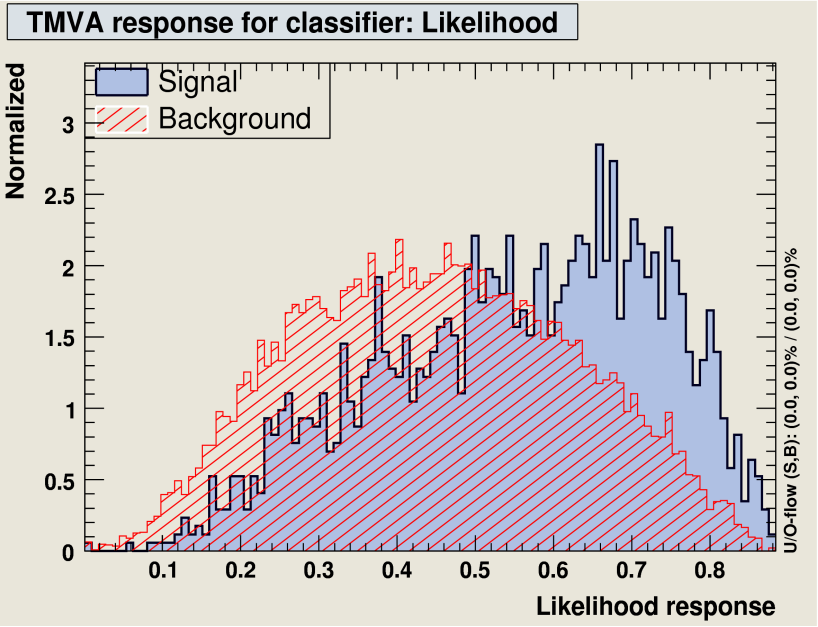
$$pur = \frac{number\ of\ W_{found}}{number\ of\ W_{cand}}$$

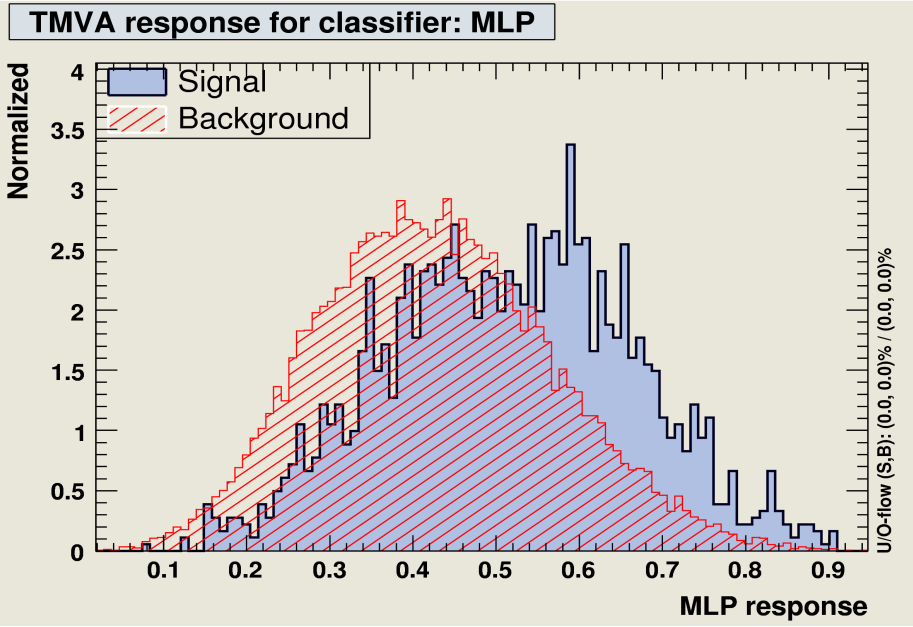
the TMVA package

the Toolkit for MultiVariante data Analysis is an enviroment for processing and parallel evaluation of multivariant classification methods (Likelihood, Artificial Neural Networks, Boosted Decision Trees, ...).

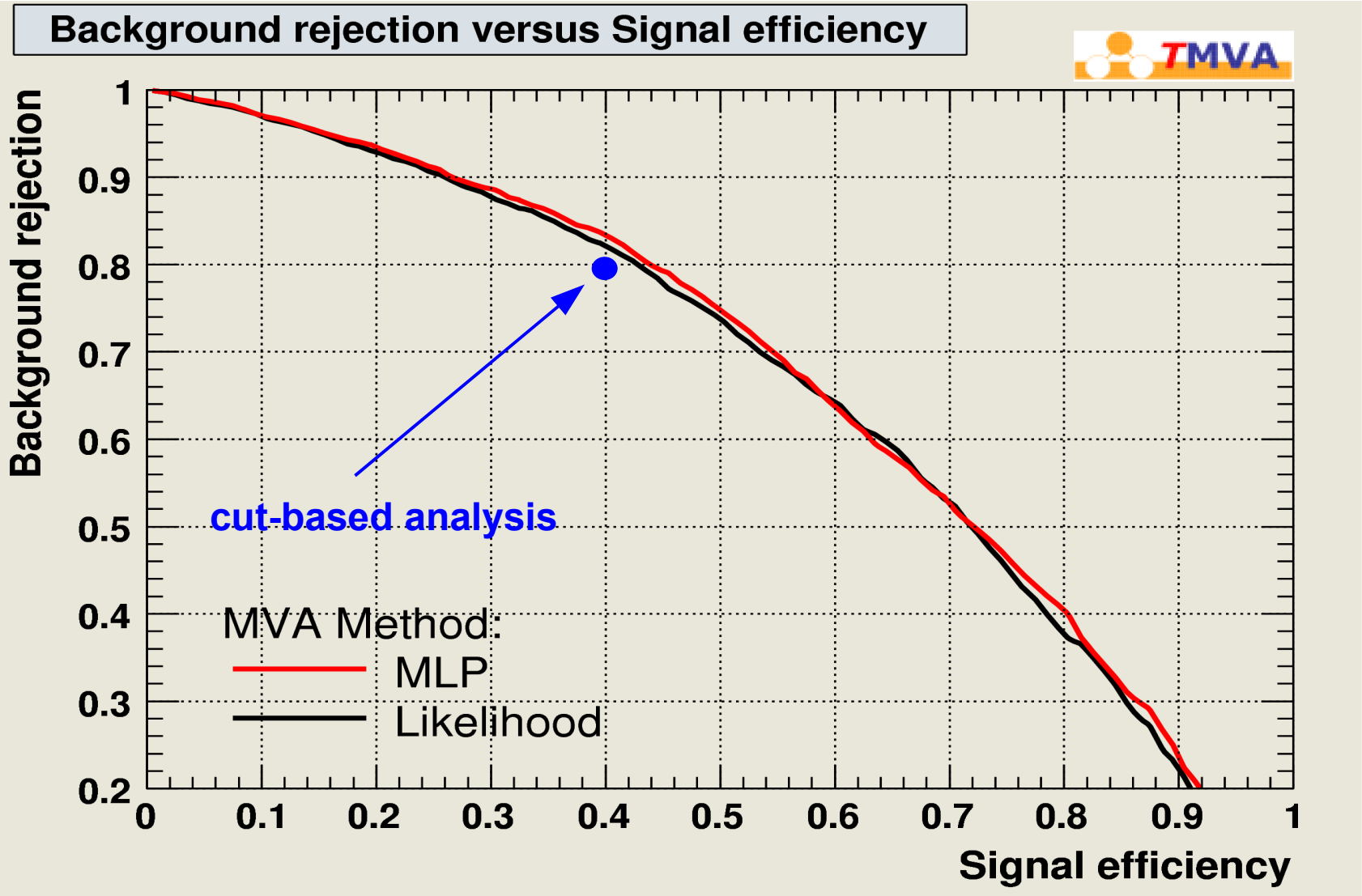
all classifier see the same training and test data

advantage: the input variables will be decorrelated and condensed to one single scalar output variable, which is used for discriminate between background and signal





the TMVA package



http://tmva.sourceforge.net/

summary and outlook

summary:
in large parts of the mSugra phase space a lot of W and Z are produced. To measure mass edges in a full hadronic decay chain it will be important to find those.

to distinguish between the W/Z and the combinatorical background a cut-based analysis was tested and compared to a generic.

outlook:
the Particle Flow-algorithm is expected to have a better performance in low Pt Jet reconstruction than CaloTower Jets

optimise variables and find new ones for cut-based analysis and TMVA

consider standard model-background: QCD, ttbar, W+Jets, Z+Jets ...