Developing Data-driven Methods to estimate the QCD background for SUSY searches

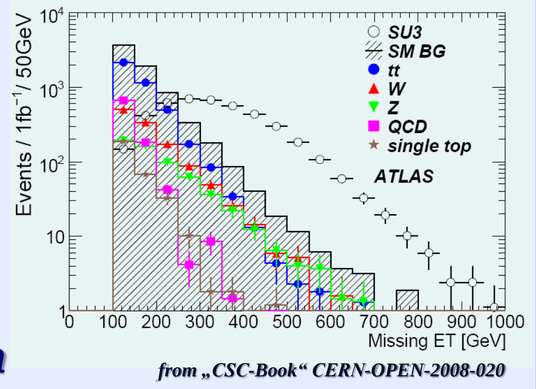
Kathrin Störig, Z. Rúriková, S. Caron, G. Herten
University of Freiburg, Germany

Motivation

LHC offers excellent opportunities to **search for new physics** beyond Standard Model, e.g. **Supersymmetry**
- discovery of **new particles** within TeV-range expected

→search for **deviations from Standard Model** in various channels (N *jets* + M *leptons* + $\not{E}_T^*$+ …)

- Most promising for **model-independent searches**: **0lepton-channel:** highest discovery potential, but knowledge of **QCD background crucial**, which is hard to determine
- Although smallness of QCD background indicated by preliminary Monte-Carlo studies, in early data **not possible to rely on these MC predictions**

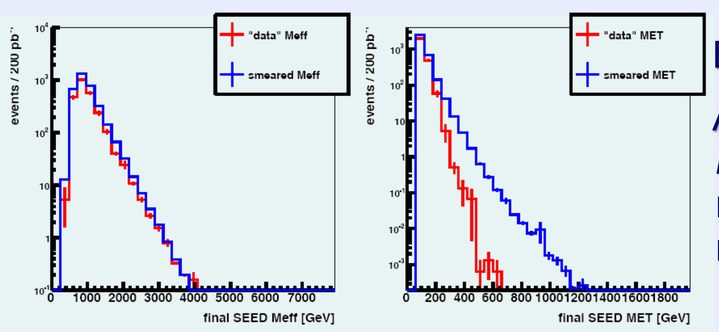


from „CSC-Book“ CERN-OPEN-2008-020

Goal:
- Determine the QCD background for events with large $\not{E}_T$ with **data-driven methods**
  - **Use** the QCD background estimate a la **CSC (Sheffield et al.)** – based on the measurement of an **calorimetric response function** from *photon+jets-* and *QCD-data* – for SUSY searches in 2, 3 and 4-jet channels, adapt method to new centre-of-mass energy, **optimize** cuts
  - Develop **alternative approaches** to existing method in order to have a **cross-check**
- **With „improved/new“ simulation, estimate key variables within SUSY signal region.**

*Missing Transverse Energy, $\not{E}_T$

First Results “CSC”



Example: 4jet-0lepton

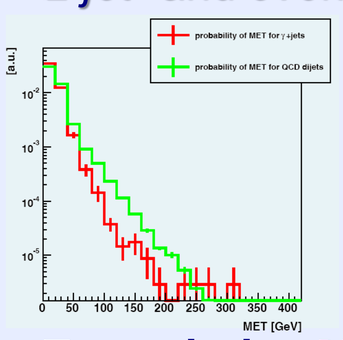
Although prediction of M_{eff} seems promising, modeling of $\not{E}_T$ does not work optimally

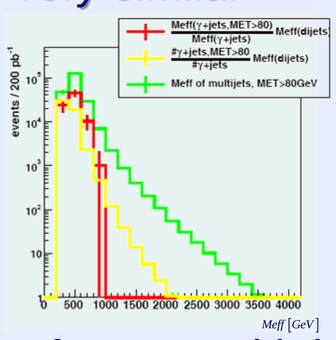
→ under investigation

- Previous steps successfully redone, however some problems encountered (no anti-parallel selection in step 2, step 4 very time-consuming, in general procedure very complicated, background contamination possible) → try to find alternatives

Alternative approach

- Ansatz
  - **probability to have** $\not{E}_T$ in *photon+2-jet-* and *2-jet-* and *events* very similar





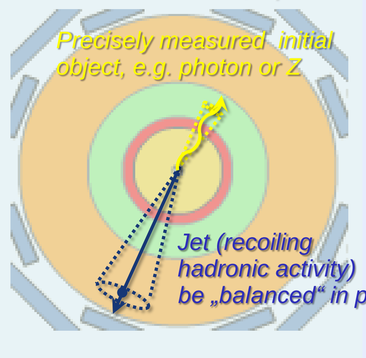
$\overset{?}{\propto} Meff\,(dijets, \not{E}_T > 80GeV)$

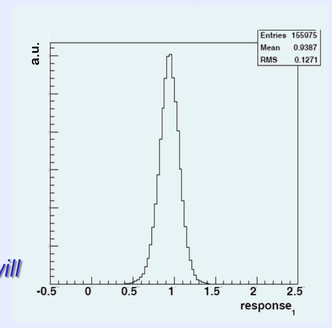
prediction of M_{eff} up to roughly 1TeV without Monte-Carlo corrections seems possible…

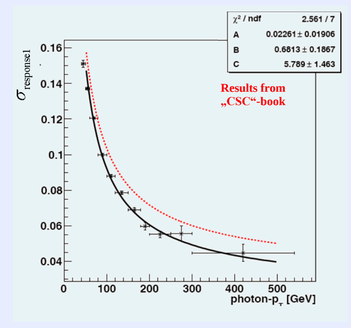
  - Try to **derive M_{eff}** of events with high $\not{E}_T$ by scaling *QCD 2-jet-events* with *“MET-probability”*
- Possible improvements:
  - **Reweighting** of *photon+jets* jet-p_T and $-\eta$ distributions to *QCD 2jet-events*
  - **Take into account** $\mathrm{prob}\left(\varphi\left(jet, \not{E}_T\right) > 0.2\right)$ assuming factorization

“CSC-Method”

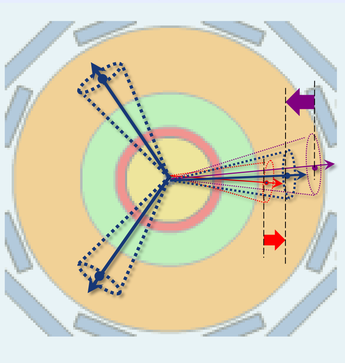
1. Obtaining **Gaussian part** (width σ) of calorimetric response function R_1 as function of **photon** momentum p_T from *photon+jet-events*

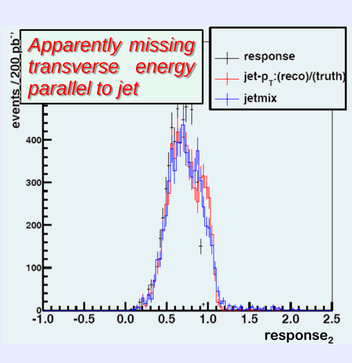


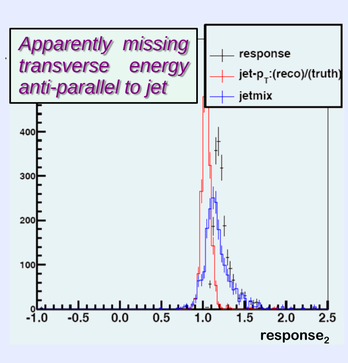




2. Derive **non-Gaussian parts** from *3-jet-QCD-events* with so called **“Mercedes”**-configuration, where $\not{E}_T$ is clearly related to a mis-measurement of one jet

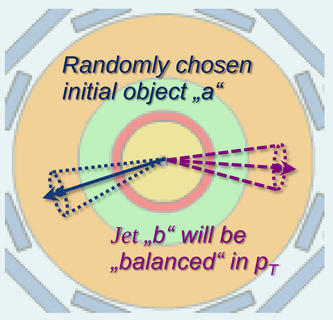


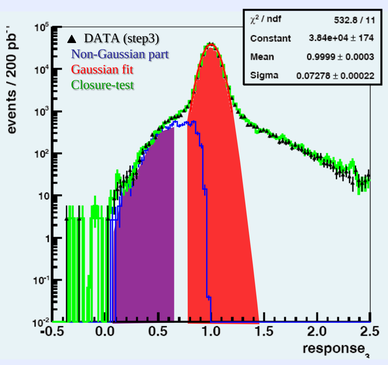




3. Combine results and determine **normalization** $N_{non\text{-}Gaussian} / N_{Gaussian}$ from *2-jet-QCD-events* (cf. step 1)

work in progress





4. In order to estimate $\not{E}_T$ and M_{eff} for SUSY searches, select well-measured SEED events with low $\not{E}_T$-*significance and* smear events (especially jets and $\not{E}_T$)

Conclusions/Outlook

- **First results** of both methods look **promising**
- Include potential backgrounds like top-decays, W, Z, SUSY, use newer MC samples…
- CSC-method: reviewing of complicated sub-steps, optimization of selection, remodeling of $\not{E}_T$-estimate, estimate uncertainties of method…
- Alternatives: verify applicability and usefulness, compare (dis-)advantages