Status of Physics Studies

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Bottom Line:

- Using ORCA for available production samples: learning process to extract correct information.
- Analysis from favourite channels yet to be finalised.

Software issues

- ORCA-87X series meant for DST and Digi files since December ’04.
  Stable version for PTDR studies is yet to come out.
- ORCA has RootAnalysis package built in.
- Working version of FAMOS (fast detector simulation), not tuned completely though, is available.

- Using facilities at CERN only.

Crisis at the moment

- Currently ORCA implements multiple algorithms for jet finder, MET reconstruction and several scenarios of JetMET analysis.
- Correction and calibration is process-dependent and there is no single parameter and constant set which work well for various final states.

- Minor problem: Trigger tables are too old to be applied on-line.
  $\Longrightarrow$ do off-line cut-based analysis, re-determine efficiencies wrt. threshold values.
- The temporary goal is to set up the whole machinery, get the feel for how things are to be done using mostly Digi(tised data).
- Once the DST files and stable ORCA version is available, final analysis can be done.

Invisible Higgs via Vector Boson Fusion

- Signal characteristics: $\mathrm{qq} \rightarrow \mathrm{qqH}$
  2 Forward/backward energetic jets + Missing $\mathrm{E_t}$ in central region .
- Backgrounds: QCD multijet events, W/Z + 2jets.
- Digitised event samples for Higgs signal available for several masses.

Strategy to be followed

- Once we know how to select leptons, jets and missing energy correctly, physics analysis will not take too much time.
- Example: Invisible Higgs channel needs: lepton veto, jet veto in central region, large missing energy in central region, topological cuts for forward-backward jets.

- Presently we have to reconstruct events from digitised data. $\Longrightarrow$ need to know the *correct* ORCA methods.
- Background samples (0.4M events of 10 different types) generated (HEPEVT ntuples) with pre-selection, yet to be digitised.
- FAMOS level studies are needed for large statistics.

Jets Reco: best method

IterativeConeAlgorithm searches the maximum transverse energy object and throws a cone around its direction. Any object within that cone will be merged to form a proto-jet. The proto-jet direction is calculated from the energy weighted directions of the constituents, and a cone is thrown around the new direction to form a new proto-jet. The procedure is re-

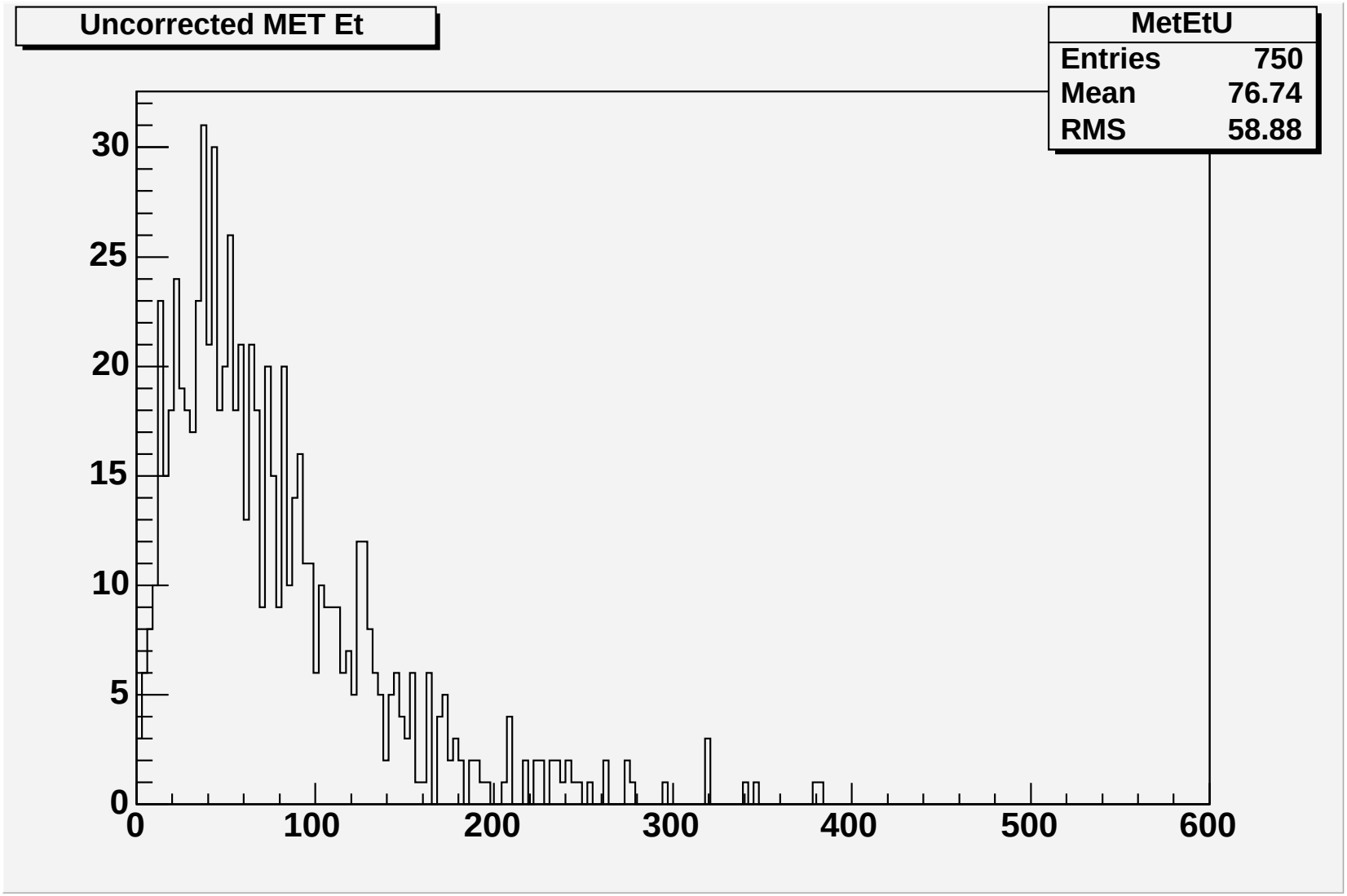
peated until the proto-jet does not change significantly between two iterations. ie., the jet energy change is smaller than a tunable value. The constituents are removed from the list of objects, and the procedure is repeated until no object is left in the list.

Jets for invisible Higgs

- ORCA code for jet reconstruction working with Digi files for Invisible Higgs. JetCalibration method to be finalised.
- ExRootAnalysis package has been tried with same samples.
- topological cuts to be implemented in analysis.

MET for invisible Higgs

- Definition of *correct* Missing Transverse Energy (MET) approved by all PRS groups *missing*.
  $\Longrightarrow$ study carefully different options.
- Corrected MET defn. checked by several (Higgs) groups:
  $\not\!\!E_t$(corr.)=Σ E_t(towers) + Σ [E_t(jet,cal) - E_t(jet,raw)]


Uncorrected MET Et
MetEtU
Entries 750
Mean 76.74
RMS 58.88
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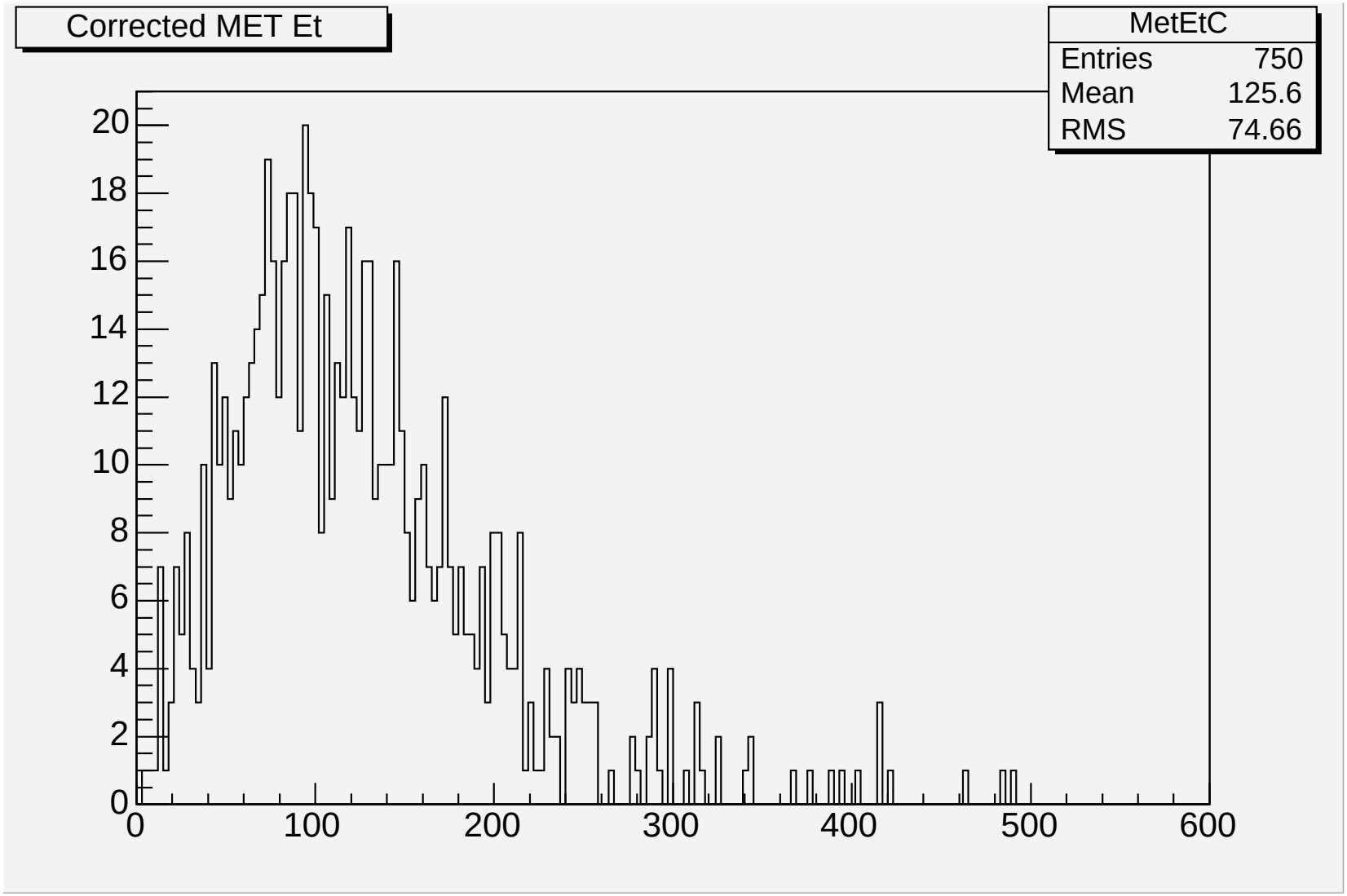
25
20
15
10
5
0
0
100
200
300
400
500
600


Corrected MET Et
MetEtC
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RMS 74.66
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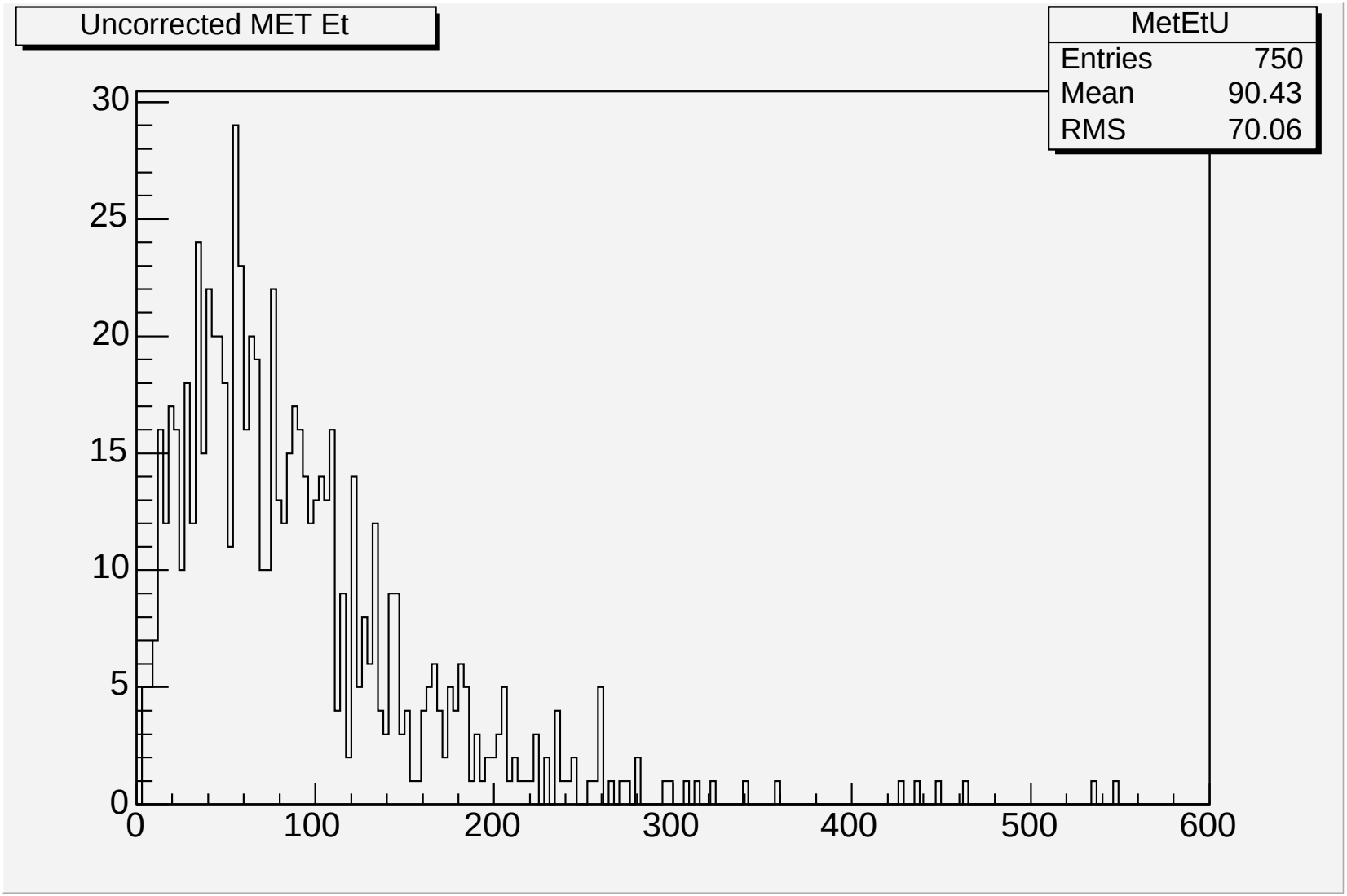
4
6
8
10
12
14
16
18
20
0
100
200
300
400
500
600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200
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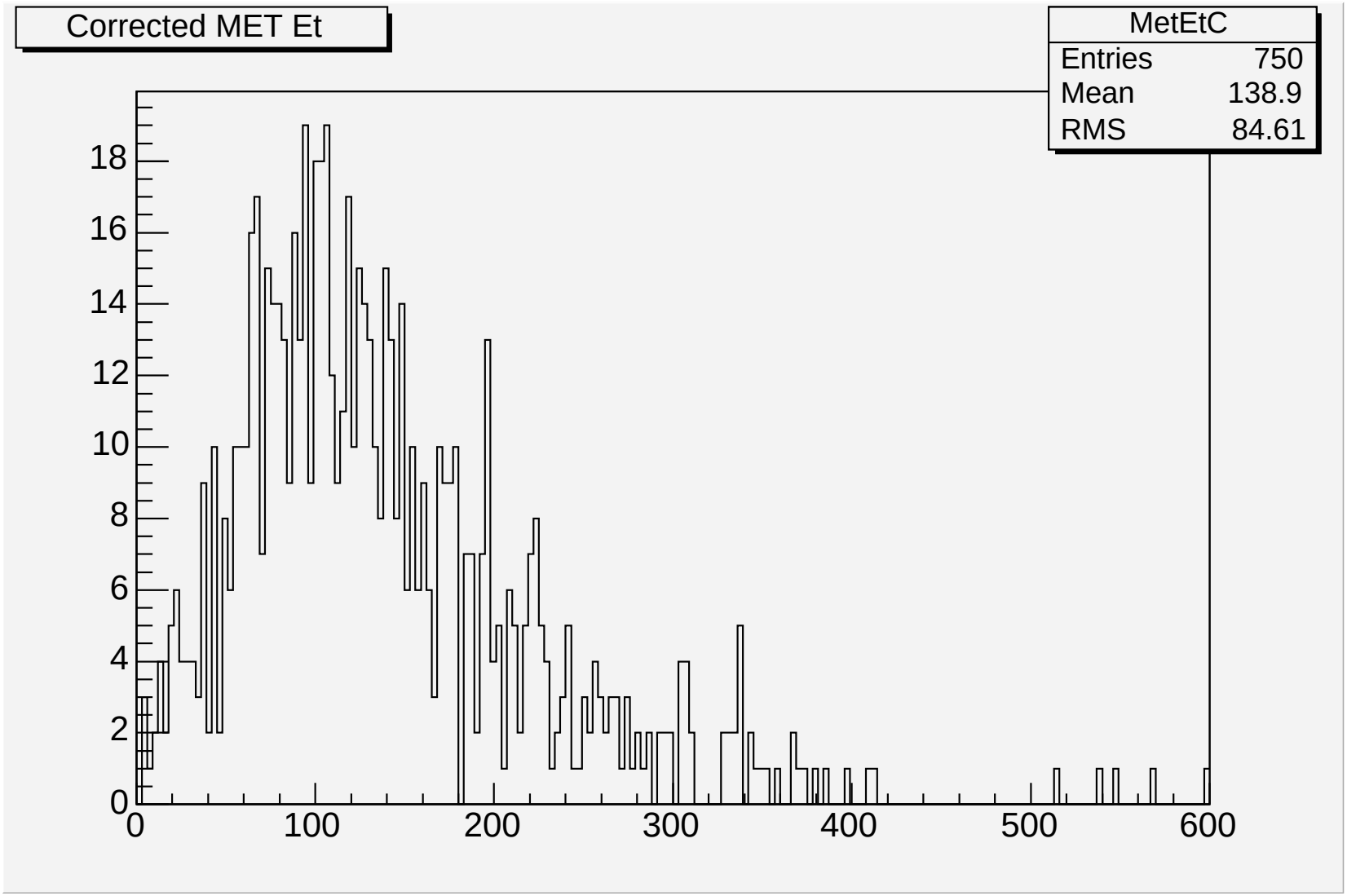
400
500
600


Corrected MET Et
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RMS 84.61
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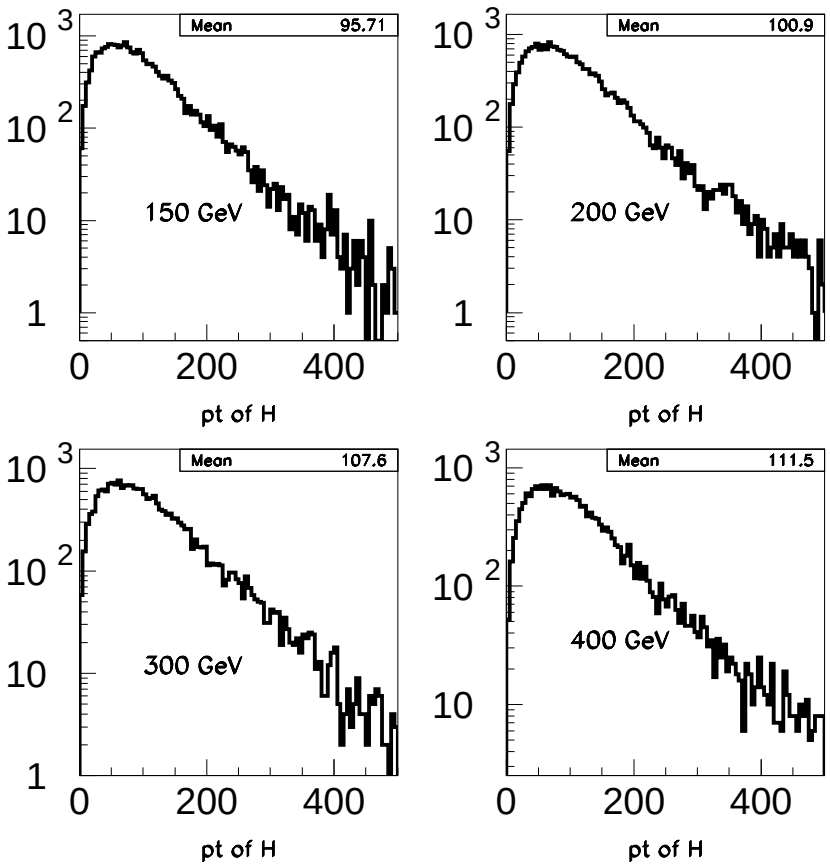
16
18
0
100
200
300
400
500
600

Pt spectrum of Higgs at Generator level



Transverse Momentum and Energy of Higgs

Higgs mass (GeV/c^2)	Mean Pt (GeV/c)	Mean Et (GeV)
150	96	120
200	101	136
300	108	164
400	112	186

In the signal event Higgs momentum is balanced by two outgoing jets in opposite directions.

Plan of Action

- Get *correct* MET distribution.
- Resolve the issue of jet calibration.
- Code for offline analysis with root tree.

Should be possible during next one month.
All info in: http://cms-project-invis-higgs.web.cern.ch/project-invis-higgs/

Discovery of SuperSymmetry in pure lepton channel

- Production of SUSY particles $\Longrightarrow$ excess in number of events in channels, like m leptons + n jets + $\not{E}_t$.
- With R-parity conservation and $\tilde{\chi}_1^o$ as the LSP, the pair of $\tilde{\chi}_{1,2}^o$, $\tilde{\chi}_1^{\pm}$ will be produced copiously in LHC.
- 2- or 3-body decay of $\tilde{\chi}_2^o$ to leptons $\Longrightarrow$

dilepton invariant mass has a kinematic upper limit $\Longrightarrow$ first signature of SUSY: observation of sharp edge.

Status of trilepton channel with ORCA

- Familiarity of handling leptons being acquired.
- Used DST with $WZ \rightarrow 3$ leptons DST sometimes back, can't be found any more! Utilising other DSTs with leptons in final state: potential backgrounds
- Need to look at DST at one of the SUSY points, though it has problems.

W + n-jets events in CMS

- W + n-jets, (n=1,2,3, ...), with $\mathrm{W} \rightarrow \ell\ \nu$ are some of the most abundant events at LHC. Also very important backgrounds for many searches.
- Jointly being studied by KM and Chandigarh group.

- Good progress in recent times. Event rates checked at 2 centres, good match.

- Started with CMS software chain.

W + n-jets cross-section values

Couplings	W^+ +1jet	W^- +1jet	W^+ +2jets	W^+ +2jets	W^- +2jets	W^- +2jets
QCD	1	1	2	0	2	0
QED	1	1	1	3	1	3
cross-section	47 nb	34 nb	27 nb	88 pb	19 nb	73 pb

Studies for Physics TDR

- Determination of trigger efficiency.
- Issues in measurement of jets, soft leptons, missing energy.
- Evaluation of statistical uncertainties reachable with 1 fb^{-1} etc.

Theoretical systematics

Variation of accepted cross-section with

- parton-density-function
- scales of renormalisation, factorisation,
- initial/final state radiation,
- uncertainty in α_s etc.

Little Higgs Model

- Key feature: natural mechanism to cancel divergences in Higgs mass (at 1-loop).
- New particles of TeV mass range, eg.,new heavy top-like quark of charge 2/3: **T**.
- Suitable channel: $\mathrm{T} \to \mathrm{tZ}$:Br=0.25
  $\mathrm{Z} \to \ell^+\ell^-, \mathrm{t} \to \mathrm{bW}, \mathrm{W} \to \mathrm{qq}$
  $\Longrightarrow 2\ell^{\pm}$ + 1-bjet + 2 light-jets

Status

- Home made DST for signal is starting to be analysed.
- Finally, this channel has to be studied with FAMOS, being accessible only with high luminosity.
- Able to use FAMOS with pythia subprocesses. Next: HEPEVT ntuples as input.