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Status of the Higgs and SUSY Analyses at MPI

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Outline

Higgs and SUSY group at MPI are currently concentrating on the contributions to several ATLAS CSC Notes.

General goal: update of the ATLAS detector/physics performance.
Requirement: use the common, centrally produced Monte Carlo data.

- Only validated Monte Carlo generators.
- Full detector simulation of millions of events, in the frame of the Computing System Commissioning (CSC).
- This allows (helps) for getting transparent and reliable results.

  Ongoing adventure for almost a year now, Athena releases (were) not stable.

In this report:

- Status of the central CSC data production.
- Higgs analyses and a few results.
- SUSY analyses and a few results.

Status of the CSC production

1. Release 12.0.31.x (x<4 → G4 range cut = 30 μm):
   simulate calibration samples with ideal geometry (DONE),
   obtain calibration constants using ideal geometry (DONE).
2. Release 12.0.31.x (mostly x≥4 → G4 range cut = 1 mm):
   simulate physics samples with misaligned geometry (DONE).
3. Release 12.0.6.1:
   reconstruct physics samples with the same misaligned geometry, using calibrations obtained in step (1) (DONE, March 2007).
   BUT, calibration constants not compatible for "1mm"-data in (2):
   - electromagnetic energy scale affected:
     electrons: 2-3%, central jets 1%, forward jets 5%.
   - muons, τ-jets, missing energy shouldn't be affected.

"1mm"-bug: observed only after step (3), too late. Workaround:

- Cannot re-simulate all data again with the "30 μm"-cut
- Re-simulate only a small fraction of samples, for the comparison.
- Apply offline corrections for the rest (on AOD-s, using 12.0.6.4).

4. Still problems with pile-up and cavern background: Rel. 12.0.6.5?.

Higgs Group Activities

Higgs: Contribution to the CSC Notes

CSC goal of the Higgs Working Group:
up-to-date official plot for the signal significance with all key channels.
Latest official result so far: TDR-plot (1999).

- Many institutes working on the same channels → coordinate and combine results.
- Use the experience from the previous studies (before CSC).
- Add the missing pieces: trigger, pile-up, systematic effects.

Higgs Working Group CSC Notes	MPI Contributors	Previous work (before CSC)
HG 1: (VBF) $H \to \gamma\gamma$	I.Potrap	-
HG 2: $H \to ZZ \to 4\ell$	N.Benekos, S.H., O.Kortner	Fullsim 10.0.4.
HG 3: VBF $H \to \tau\tau$	M.Groh, S.H., S.M.-Möck, (C.Valderanis)	Atlfast
HG 4: (VBF) $H \to WW$	S.H., S.Kaiser, O.Kortner, J.Yuan	-
HG 5: $ttH, H \to bb$	S.Kotov, J.Yuan	Fullsim 10.0.4
HG 6: $ttH, H \to WW$		
HG 7: $H/A \to \tau\tau$	G.Dedes, S.H.	Atlfast
HG 8: $H/A \to \mu\mu$	N.Benekos, G.Dedes, S.H. (co-editoring)	Fullsim 10.0.4
HG 9: $H \to$ *invisible*		
HG10: $H^{\pm} \to \tau^{\pm}\nu$	T.Ehrich, S.M.-Möck	-

Higgs: Status of the CSC analyses at MPI

Last few months:

Preparatory work on the pre-CSC data (11.0.42, 12.0.3):

- Local Monte Carlo production (FZK, RZG, MPI).
- Data validation (efficiencies, fake rates, resolutions).
- Comparison: ATLFAST $\leftrightarrow$ full simulation.
- Selection of reconstructed objects:
  - $\star$ lepton identification and isolation, missing energy, jet performance, τ-reconstruction...
- Start of new analyses (HG1, HG4, HG10).
  Cut optimizations for all analyses.

March 2007:

Analysis on the official CSC data started.
First results shown at CERN.
Planned presentations: TP Week, ATLAS Overview Week, EPS conference.
Schedule: complete by the end of August.

Near future:

First meeting with MPI theory on 02.05.2007. (S.Dittmaier et al.)
Topics of common interest identified, work for next months.

Higgs: Collaboration with MPI theory group

NLO (NNLO) calculations are essential for all Higgs searches. There is a need for a systematic implementation of the newest theoretical calculations into present analyses.

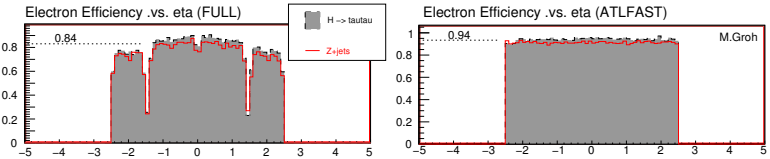
- Using mainly the K-factors for signal so far, background wanted.
- Not only K-factors, but rather differential distributions needed (for $H \to 4\ell$, VBF).

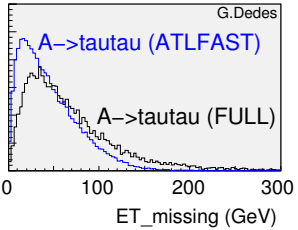
Common fields of work with theory group at MPI:

- $H \to ZZ, WW \to 4f$: NLO EW+QCD MC generator (PROPHECY4f).
  - ⋆ One of a kind, essential for the measurement of Higgs properties.
  - ⋆ Plan: official implementation into Athena.
- $pp \to H + 2jets(VBF)$: NLO EW+QCD MC generator, in progress.
  - ⋆ EW corrections exist only at MPI, could affect jet distributions.
  - ⋆ Plan: study of systematic effects in VBF $H \to WW, H \to \tau\tau$.
- Experience with NLO cross-sections for ttH, bbH, $ttbb$, $tt + jets$

Higgs: Comparison FULL SIM. ↔ ATLFAST

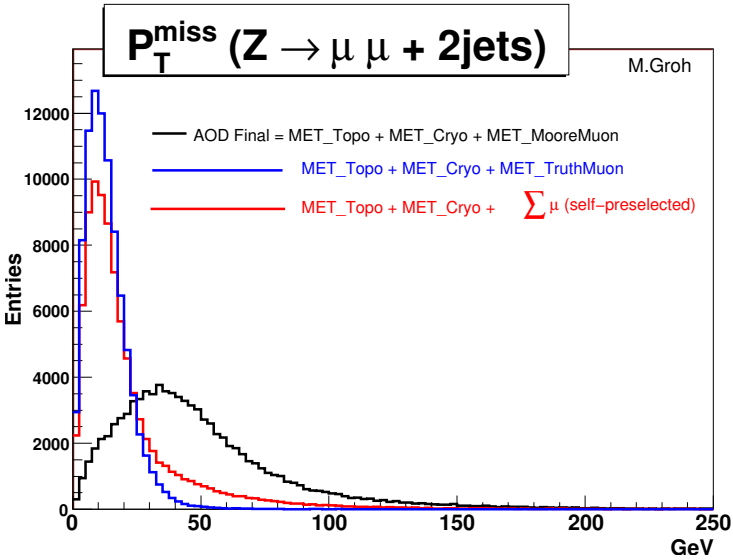
Some analyses cannot be performed with fully simulated data: important to identify differences w.r.t. ATLFast.





- Electron efficiency overestimated in ATLFAST.
- Missing energy resolution worse in FULL SIM.

Higgs: Missing energy (full simulation)



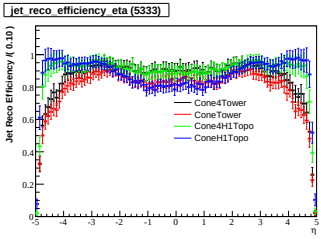
- In AOD container: wrong muon contribution to p_T^{miss}.

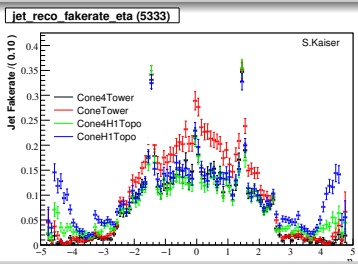
$\Rightarrow$ Calculating muon part offline from the reconstructed muon tracks.

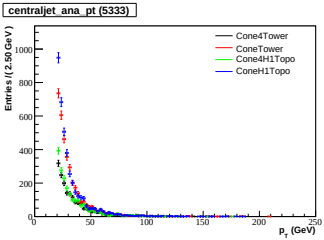
Higgs: Jet performance studies (VBF channels)

In collaboration with S.Menke and Bonn (I.Rottländer).

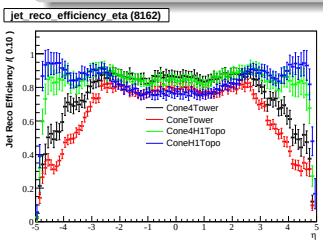
$H \to \tau\tau \to ll$ (5333, 3070 fb^{-1})

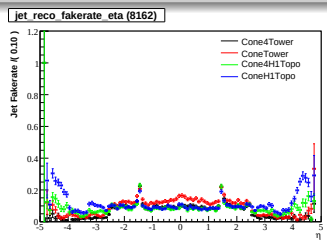


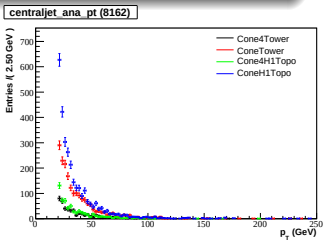




$Z + 2jets, Z \to \tau\tau \to ll$ (8162, 19 fb^{-1})







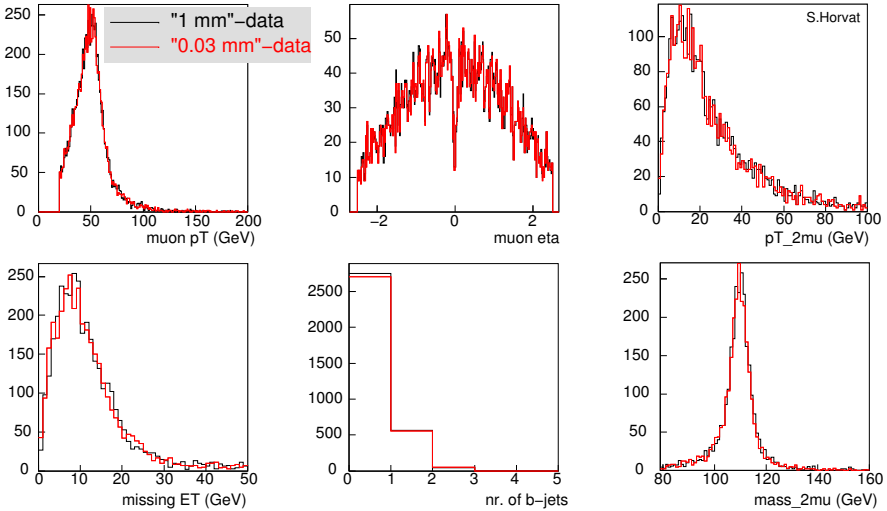
After presenting these results:

Cone4H1Topo selected for the baseline analysis of VBF $H \to \tau\tau$.

Higgs: "1 mm"-data versus "30 μm"-data

Channel: $bbA, A \to \mu^+\mu^-$ (m_A=110 GeV).

No differences, as expected for this channel
(only muons, b-jets and E_T^{miss} in the final state).



SUSY Group Activities

SUSY: Contribution to the CSC Notes

One of the main CSC topics of the SUSY Working Group:
how to estimate the most important backgrounds from the real data.

- Work at MPI started beginnig of this year.
- Concentrating on the inclusive searches,
  signatures with 1 or 2 leptons ("1-lepton" or "2-lepton" SUSY).
- Started with ATLFast (usually used in the SUSY WG),
  now extending to the full detector simulation.
  First results shown at CERN.
- Near future: specialized meeting with the theory group.

CSC Notes	Topic	MPI Contributors
SUSY 2	"Data-driven estimation of the top background to SUSY"	
	• Di-leptonic $t\bar{t}$-contribution in "1-lepton SUSY"	X.A.Zhuang, V.Zhuravlov
	• Di-leptonic $t\bar{t}$-contribution in "2-lepton SUSY"	F.Legger
SUSY 3	"Data-driven estimation of the QCD background to SUSY"	
	• Fast Shower Parametrisation	F.Legger
	• LHC machine/Cosmics background	J.Dubbert, J.v.Loeben

SUSY: Fast Shower Parametrization

Many SUSY studies have to rely on the fast simulation,
since the backgrounds are large, impossible to fully simulate.

(A) ATLFast: parametrized detector performance, or

(B) Fast Shower: GEANT4-based fast simulation tool.

- Ultimate goal: gain about a factor 10 of CPU time w.r.t. full sim., while having a "reasonable" physics performance (still far away).

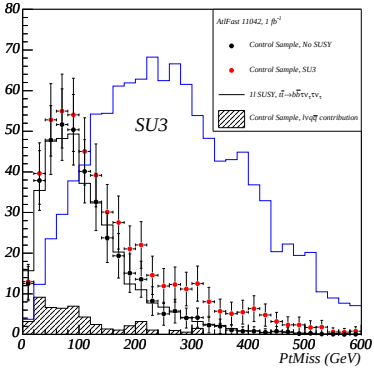
Method	Description	Time gain	Status
LAr parametrisation	- use predefined showers	55%	poor E_T^{miss}
Production cuts	- when a particle is produced below a given range, track energy deposited instead	30%	almost free cuts
UserLimits	- stop a track when it drops below a given energy	30%	premature code
Time cut Neutrino cut Stepper change	- remove particles created after a certain time - remove all neutrinos - used by G4 to determine next position of a particle in B-field	10%	free cuts
Muon cuts	- remove particles in dead material of the muon spectrometer, which are not likely to pass to sensitive regions	0% ???	check muon distributions

SUSY: $t\bar{t} \to b\bar{b}\ell\nu\ell\nu$ contribution to "1-lepton" SUSY

Why could we miss one lepton in $t\bar{t} \to b\bar{b}\ell\nu\ell\nu$?

- Not in the acceptance; Close to a jet (not isolated);... or ... Lepton is a τ-lepton:

1. Extract a clean $t\bar{t} \to b\bar{b}\ell\nu\ell\nu$ *Control Sample* from data ($\ell \equiv e, \mu$):
   - 2 high-p_T leptons (one electron, one muon)
   - 4 jets
   - $E_T^{miss} > 100$ GeV
2. Substitute one lepton by τ, decay τ, recalculate E_T^{miss}.



Results: Expected from $tt \to bb\ell\nu\tau\nu$ sample: 180 events

- Estimated from the Control Sample (No SUSY): 176 events
- Estimated from the Control Sample (SU3, i.e. with SUSY): 292 events