

Introduction

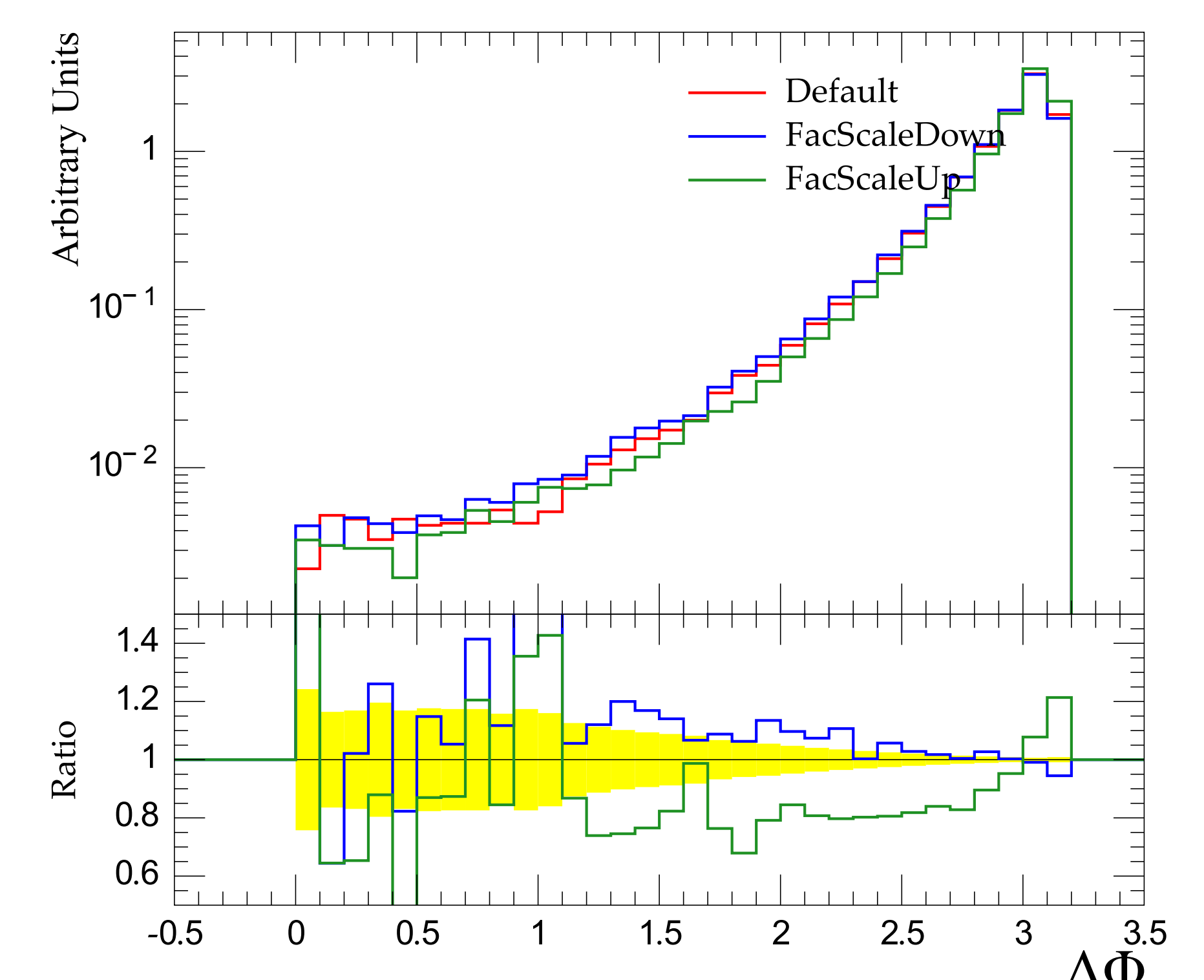
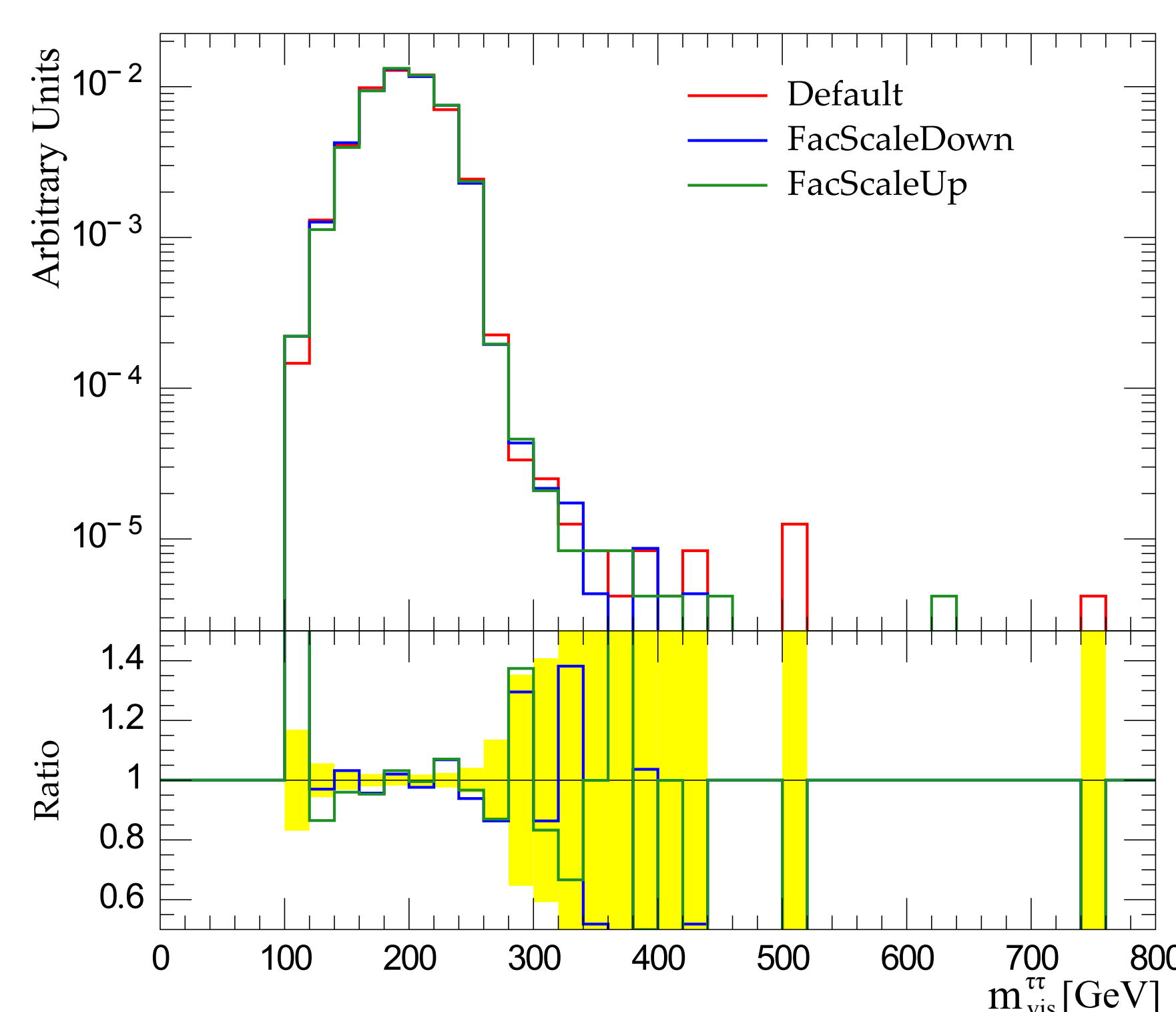
The super-symmetric extension of the Standard Model of particle physics leads to a complex Higgs sector, which is expected to be responsible for the electroweak symmetry breaking mechanism. In context of the Minimal Supersymmetric Standard Model (MSSM) one expects five observable Higgs bosons: two charged ($H^\pm$, $H^\mp$) and three neutral ones (h, H, A). The main production channels at the LHC are the gluon fusion and the production in association with b quarks. The decay channel into two τ leptons is the most dominant leptonic decay channel of the neutral Higgs boson and allows a direct observation of the Higgs coupling to leptons. For this study only the decay channel where both τ 's decay hadronically was considered, since this is the channel with the highest branching ratio.

Measurements

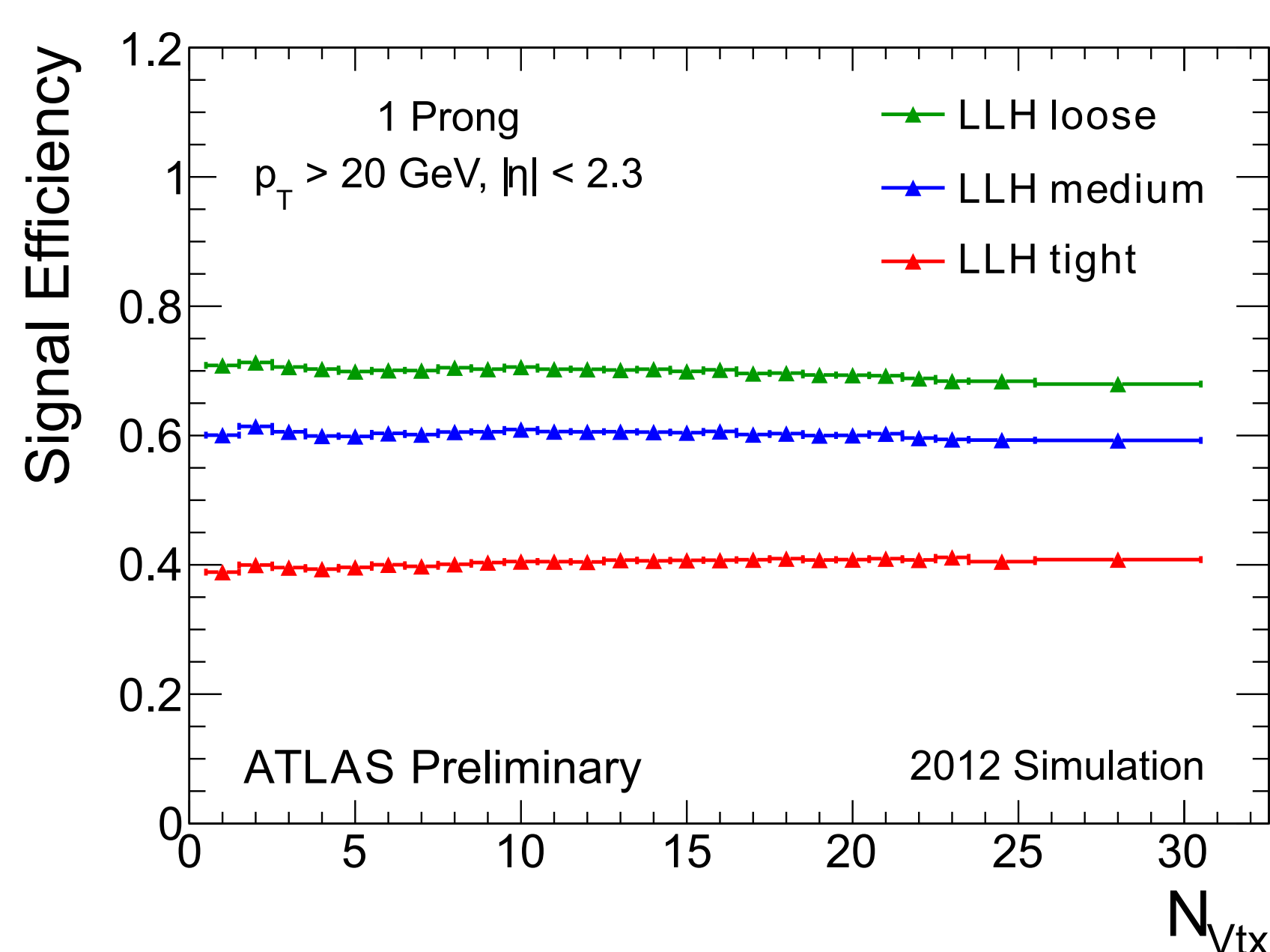
The search for the MSSM Higgs boson in the di-tau channel will require the identification of at least two τ 's, both with a minimum transverse momentum above 50 GeV. A dedicated study was performed to improve the log-likelihood identification method and increase the robustness against a higher pileup environment. Since all variables can be effected by the increased pileup environment, the PYTHIA8 Monte Carlo event generator was tuned to provide a good description of pileup events. This selection is then the baseline for the estimation of the acceptance uncertainty due to variation of Monte Carlo event generator parameter. These studies are performed on particle level and compared to results, which are obtained after a full detector simulation.

Acceptance Uncertainties

The evaluation of systematic uncertainties on the acceptance of the MSSM Higgs boson search is important to interpret the observed cross-section limits against model predictions. The Monte Carlo event generators provide additional parameters, which cannot be calculated from first principles and need to be set by the user. The variation of the acceptance due to variations of these parameters is estimated and considered as a systematic uncertainty. The following parameters are studied: factorization and renormalization scale, the cutoff parameter of the CKKW matching scale and the influence of the parton density function. Two examples for the effect of the factorization scale are presented on the middle and right plot, showing the visible mass of the reconstructed di-tau system and the azimuthal between the two τ 's respectively. The red line is the default value and the green and blue line represent the effects of variations on the scale parameter. The yellow shaded background shows the statistical error of the default sample.

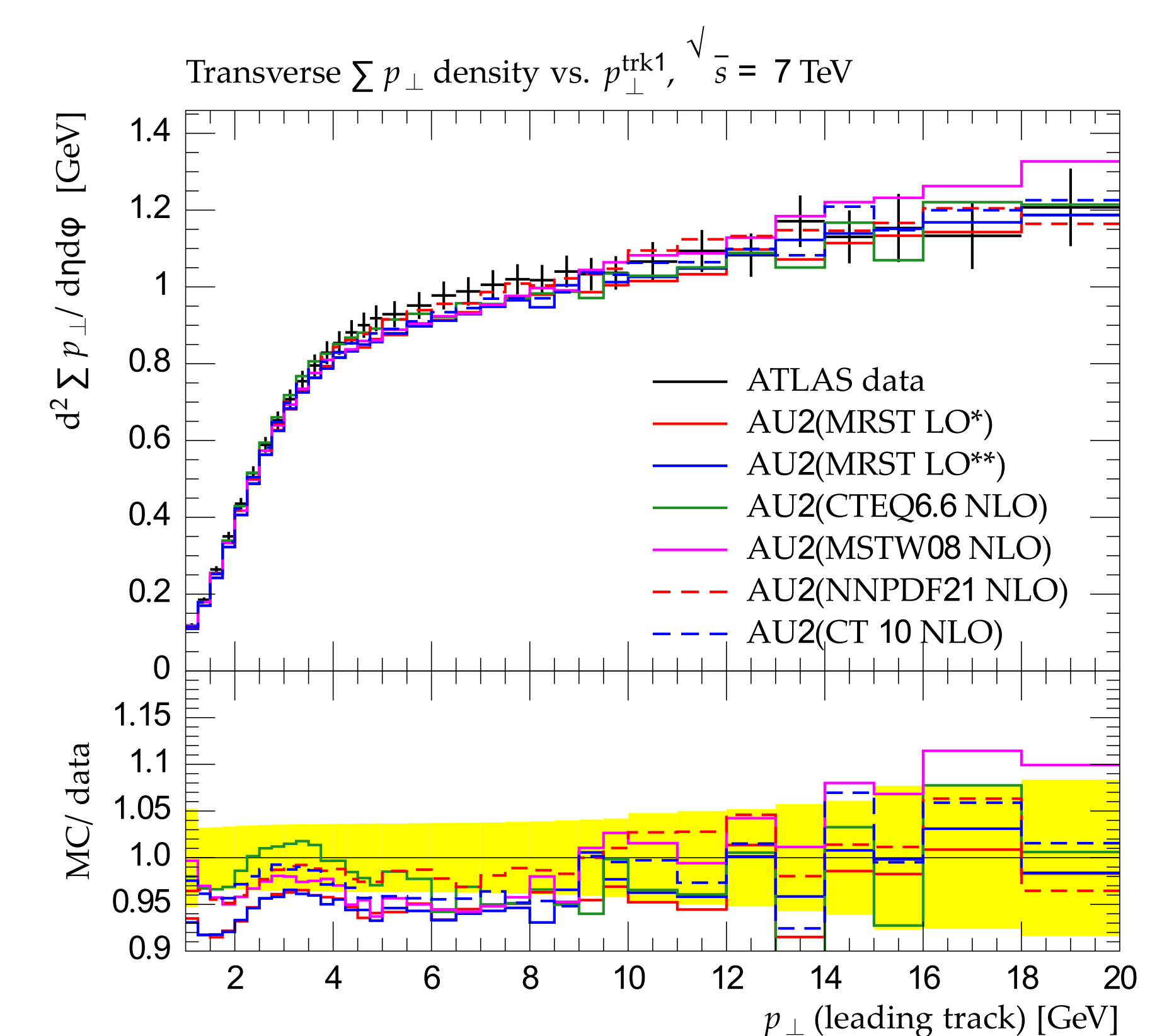


Results for Tau Identification and Tuning



An important step in the search for the MSSM Higgs boson in the di-tau decay channel is the identification of τ leptons and rejection of QCD jets. To perform the separation, the shower

profiles of jets and τ 's were studied and used as an input for a log-likelihood method, which is used as final discrimination variable. The input variables were selected depending in the number of charged particles in the τ decay products (1 or 3 prong) and the τ identification efficiency was trained to be independent against the visible transverse tau momentum and against the number additional pile-up vertices, as shown on the left plot. Another essential requirement for the analysis is a good simulation of the pile-up environment at the LHC. Therefore the PYTHIA8 event generator was tuned to minimum bias and underlying event measurements [1] performed by the ATLAS experiment at 900 GeV and 7 TeV. The tune was performed for a various number of leading order, modified leading order and next-to-leading order parton density functions. The right plot shows the underlying event tune for modified leading order and next-to-leading order PDFs for the transverse momentum sum of charged particles, which was measured in a region sensitive to soft QCD interactions.



Publications

- [1] The ATLAS collaboration, *Summary of ATLAS Pythia 8 tunes*, <https://cdsweb.cern.ch/record/1474107>
[2] The ATLAS collaboration, *The underlying event in jet events at 7 TeV with the ATLAS experiment*, <https://cdsweb.cern.ch/record/1497185>

- [3] Sebastian Wahrmund, *Physics with Tau Lepton Final States in ATLAS*, <https://cdsweb.cern.ch/record/1476084>
[4] Sebastian Wahrmund, *The ATLAS Monte Carlo tuning system*, <https://cdsweb.cern.ch/record/1421938>

Selected Talks

- MPI@LHC 2011, Hamburg(DESY), 21 - 25.11.2011, The ATLAS Monte Carlo tuning system
- Graduate School Mass, Spectra, Symmetry: Spring Block Course 2012, Krippen, 13.03.2012, Underlying Event Studies at ATLAS
- MPI@LHC 2012, CERN, 03 - 07.12.2012, ATLAS tunes for MPI
- International Symposium on Multiparticle Dynamics, Kielce, 16 - 21.09.2012, Physics with Tau Lepton Final States in ATLAS

Profit from the GK

- Further education in the regular block-courses
- GK supported the participation to different conferences and workshops, e.g: DPG Frühjahrstagung 2011 and ATLAS HSG4 TAU Workshop 2012

Contact Details and further Information

PhD student: Sebastian Wahrmund, sebastian.wahrmund@tu-dresden.de
PhD advisors: Jun. Prof. Dr. Arno Straessner, Dr. Klaus Mönig

WWW: <http://www.iktp.tu-dresden.de/>

January 12, 2013