Towards a cross section measurement with a likelihood discriminant at the ATLAS experiment

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GEFÖRDERT VOM
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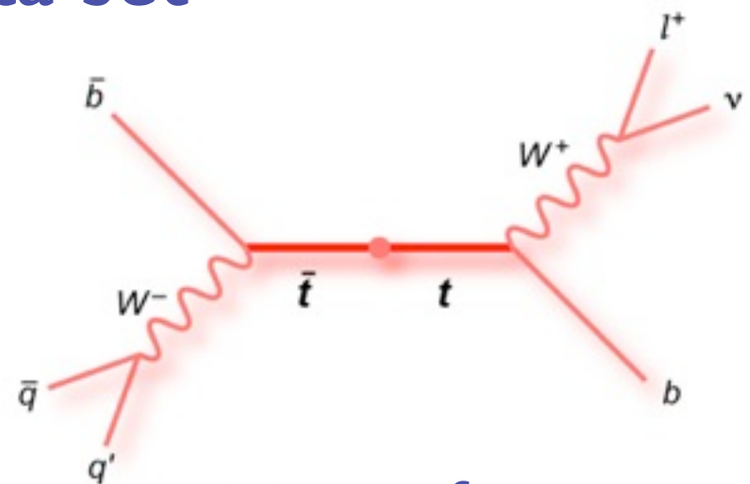
für Bildung
und Forschung

FSP 101
ATLAS

PHYSICS
AT THE
TERA
SCALE
Helmholtz-Alliance

Introduction & Idea

- aim: measure σ_{tt} on full 2010 ATLAS data set ($35\text{-}40pb^{-1}$)
- lepton + jets channel - here only μ+jets



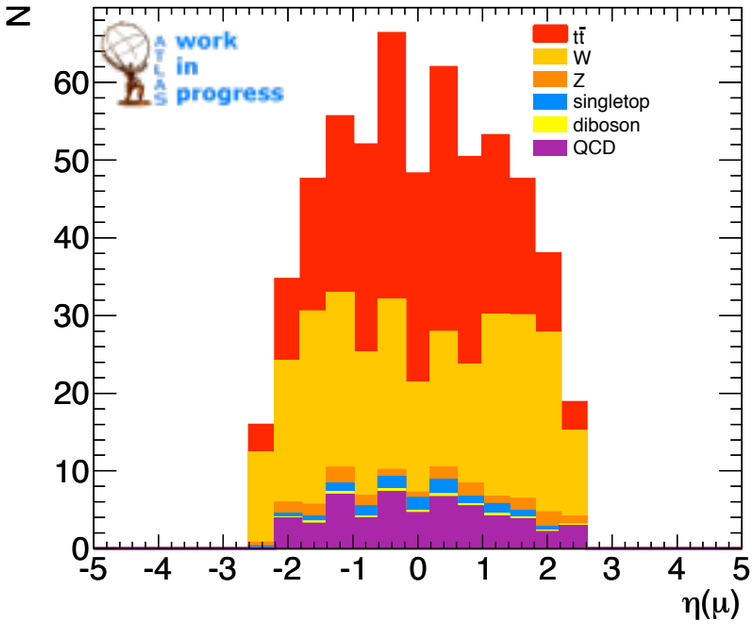
- idea:
  - combine information from kinematic quantities of single objects and the topology of the event
  - create Likelihood discriminant from small set of well modelled variables
  - allows for simultaneous fit of signal and background
  - reduced statistical uncertainty

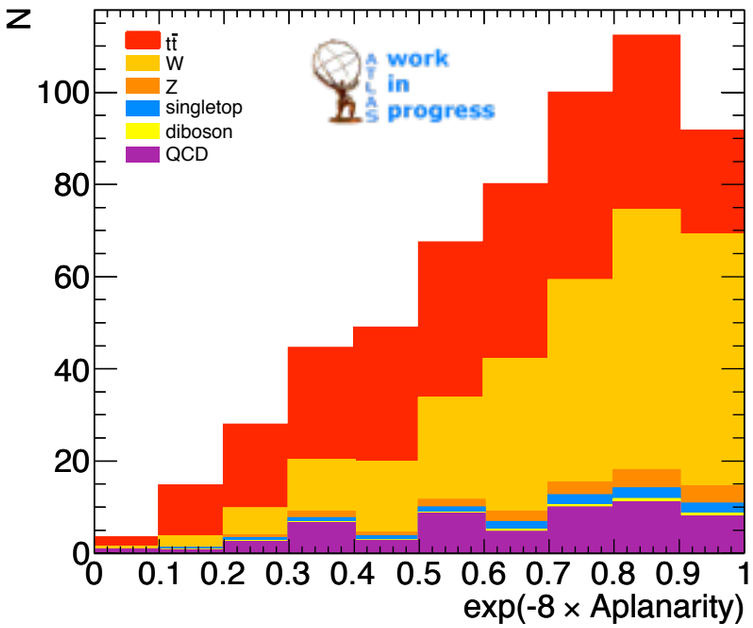
Ingredients & Selection

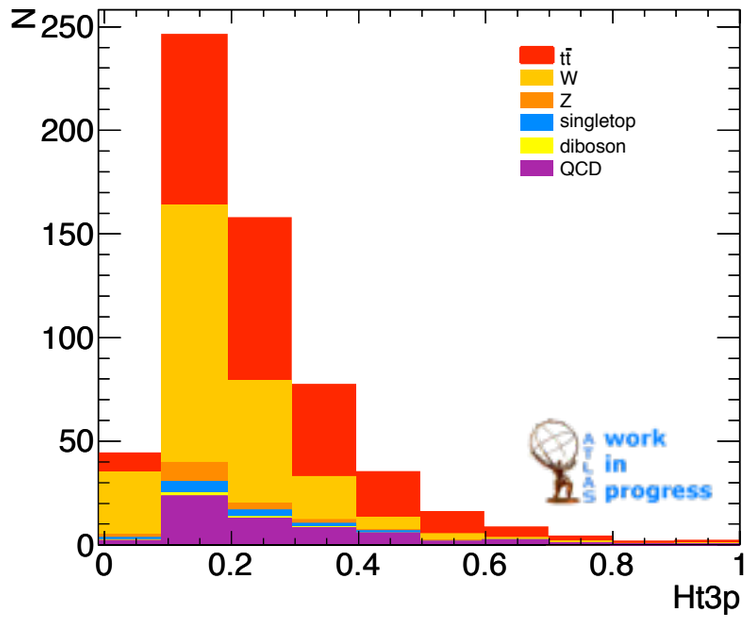
- based on selection for first top cross section measurement (see previous talk by C.Lange)
  - ≥ 4 AntiKt jets with p_T > 25 GeV
  - missing transverse energy > 20 GeV
  - additional topological cut to reduce QCD
  - exactly 1 isolated μ with p_T > 20 GeV
  - no b-tag requirement
- QCD estimate on rate and shape from matrix method for first measurement - scaled to higher integrated luminosity
- signal-to-background ratio ~0.8

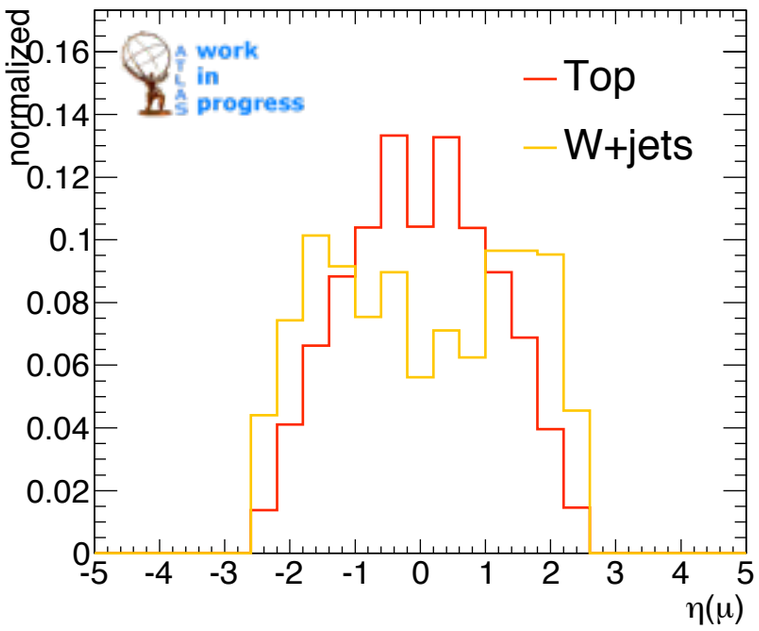
Variables (I)

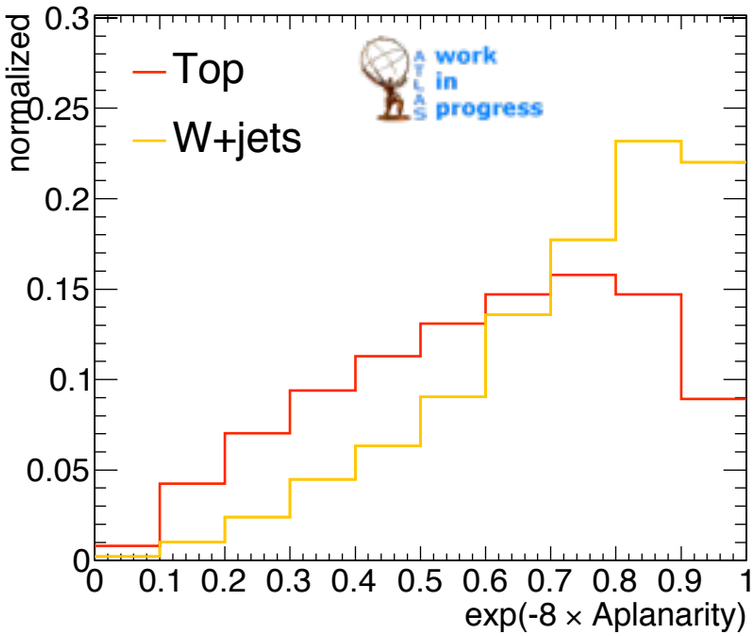
- combine kinematic & topological quantities
- give best separation power and are well described in data

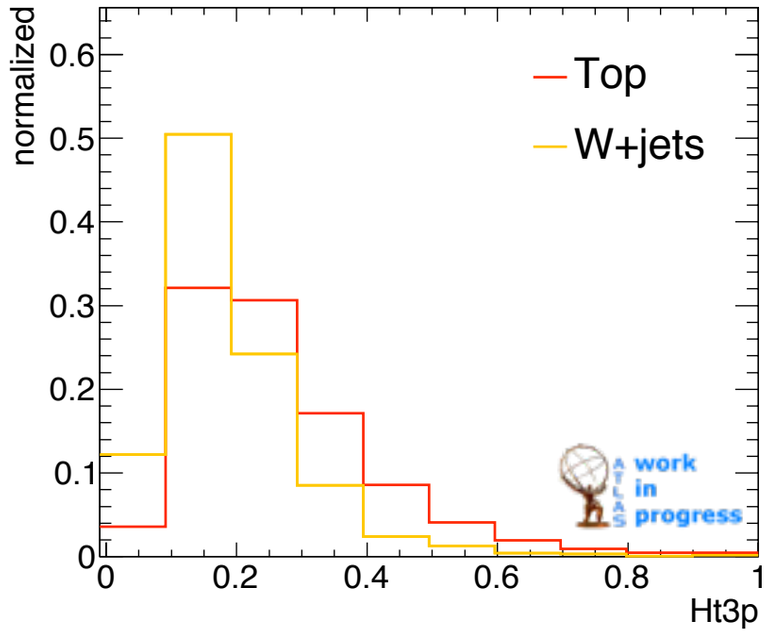






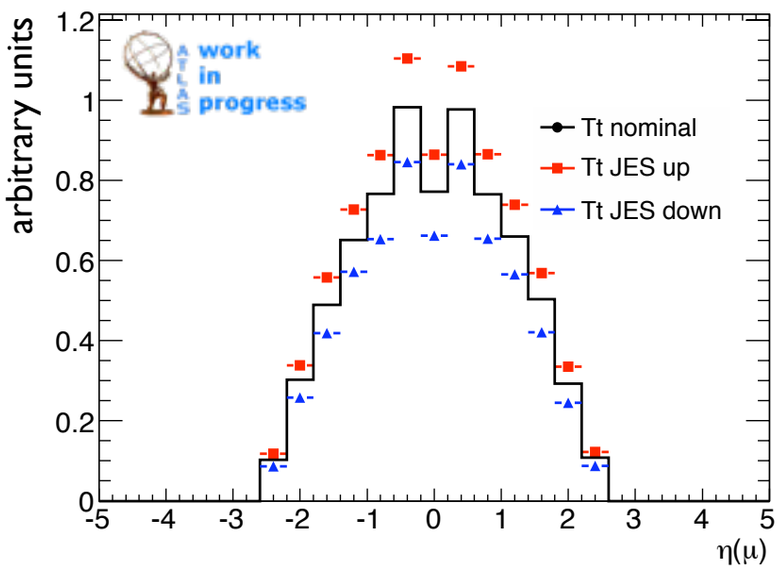


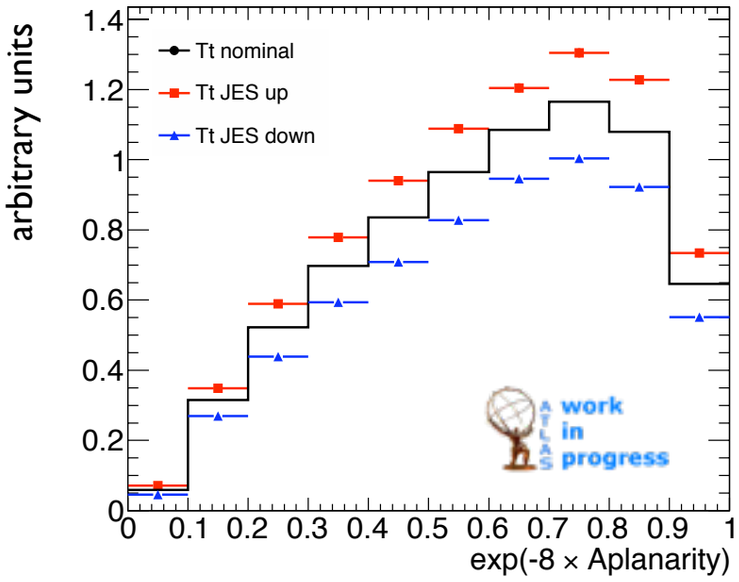


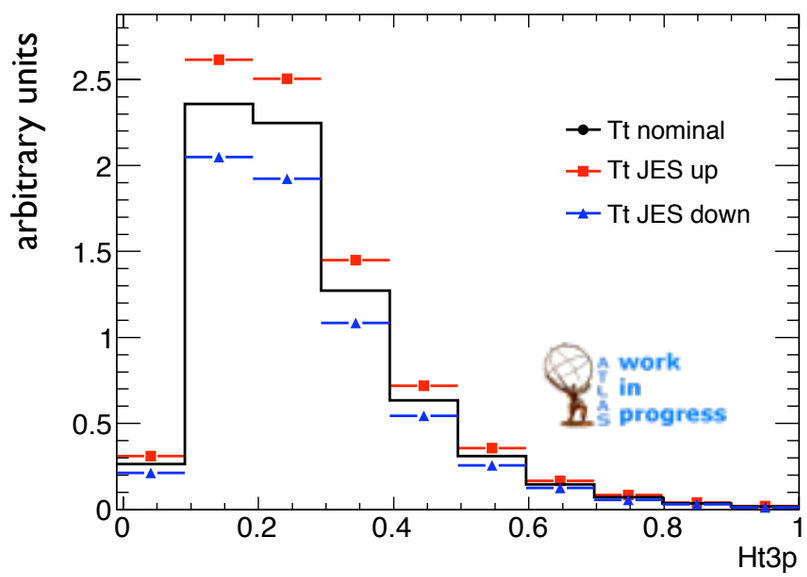


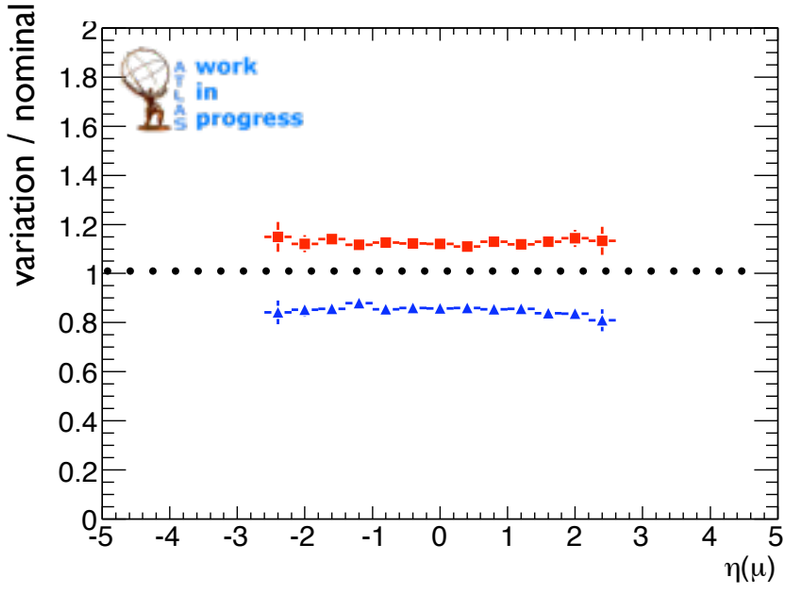
Variables (II)

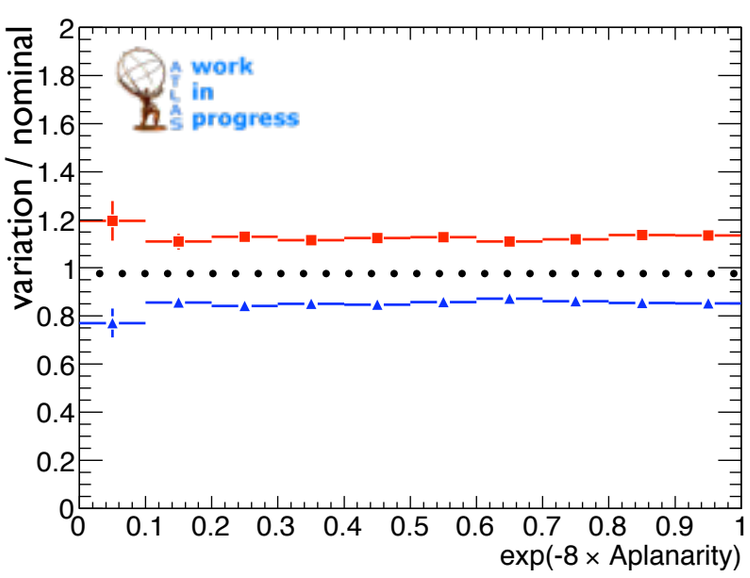
- chosen to have small sensitivity in shape to jet energy scale shifts

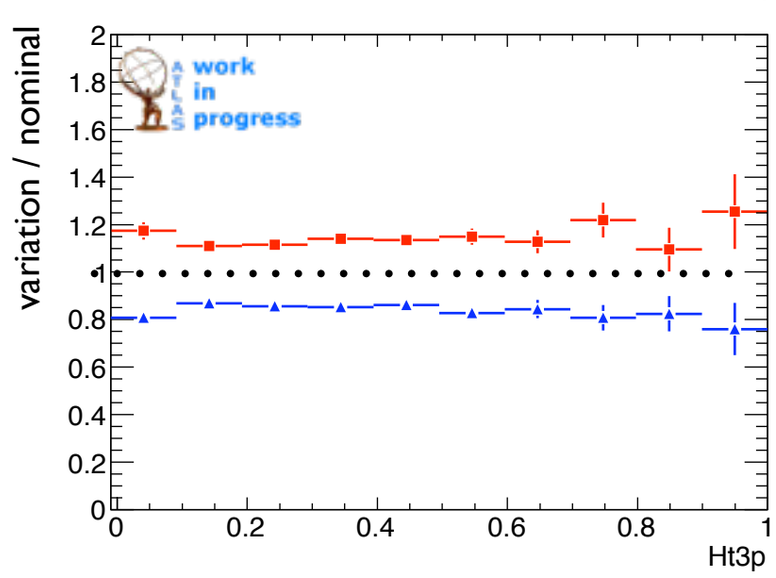








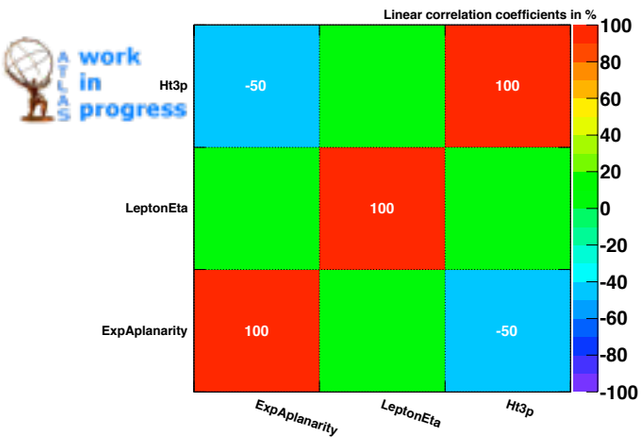




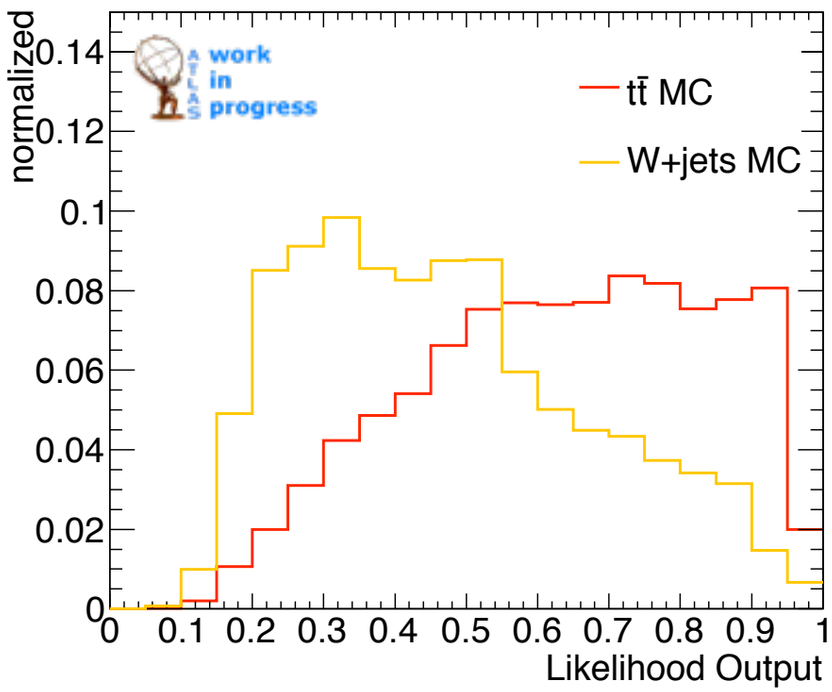
Likelihood Distribution

- combine variables to likelihood distribution

$$L = \frac{\prod_i P(x_i|S)}{\prod_i P(x_i|S) + \prod_i P(x_i|B)}$$



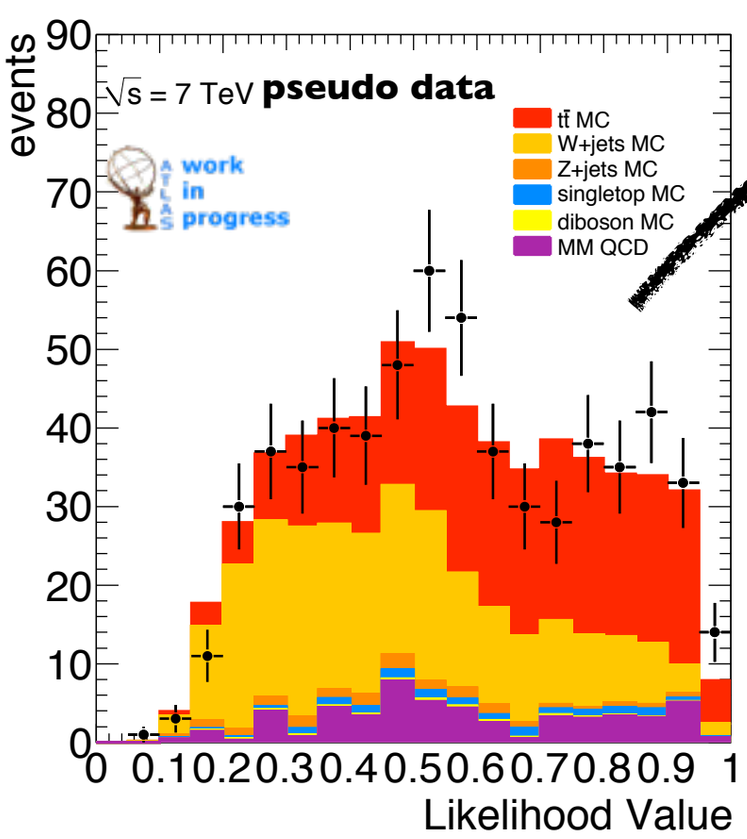
- using TMVA (in ROOT 5.26)
- decorrelation method used to solve linear correlations
- use 50% of Monte Carlo statistics for Tt and W+jets events to create distributions
- evaluate with other 50% and 100% of other backgrounds & data

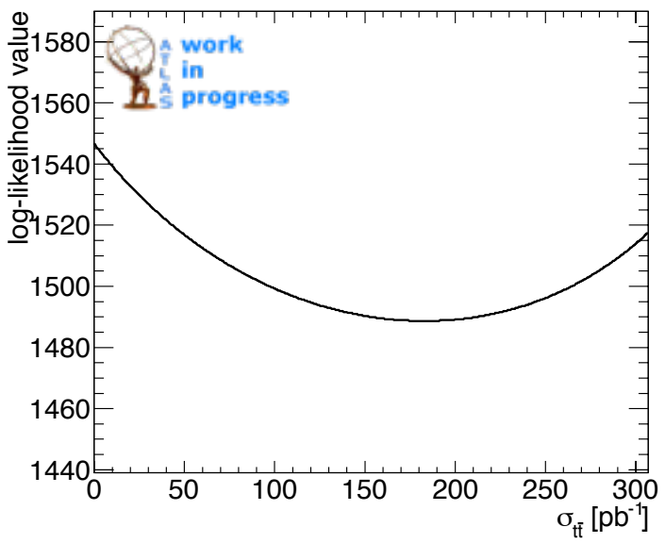


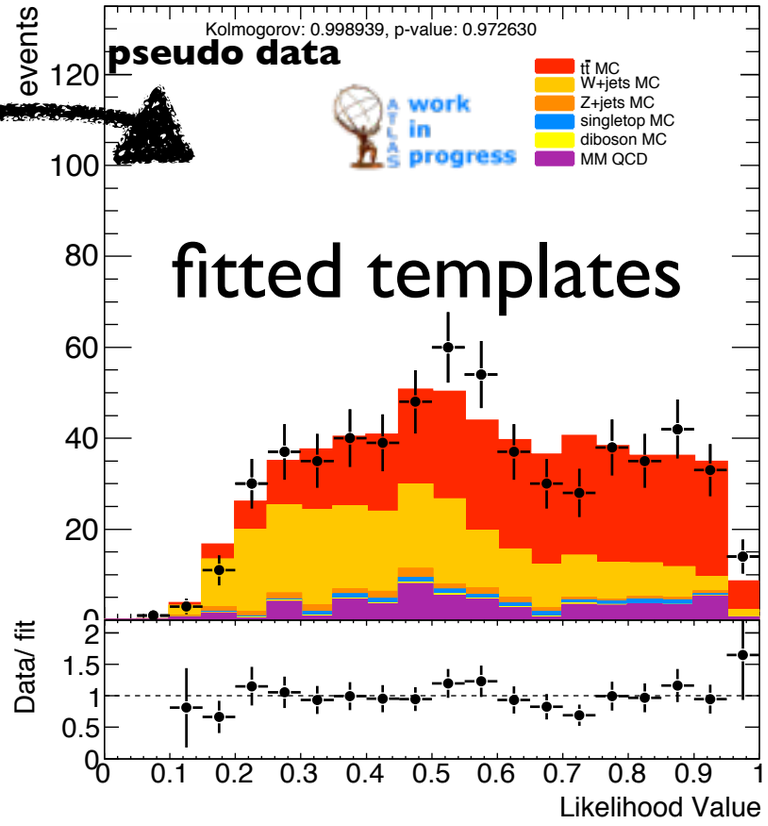
Fitting the Cross Section

- extract the cross section minimizing

$$F(\theta) = -\sum_{j=1}^{J} ln(\frac{\mu_j^n e^{\mu_j}}{n_j!}) = -\sum_{j=1}^{J} n_j ln(\mu_j) + \sum_{j=1}^{J} \mu_j + \sum_{j=1}^{J} ln(n_j!),$$



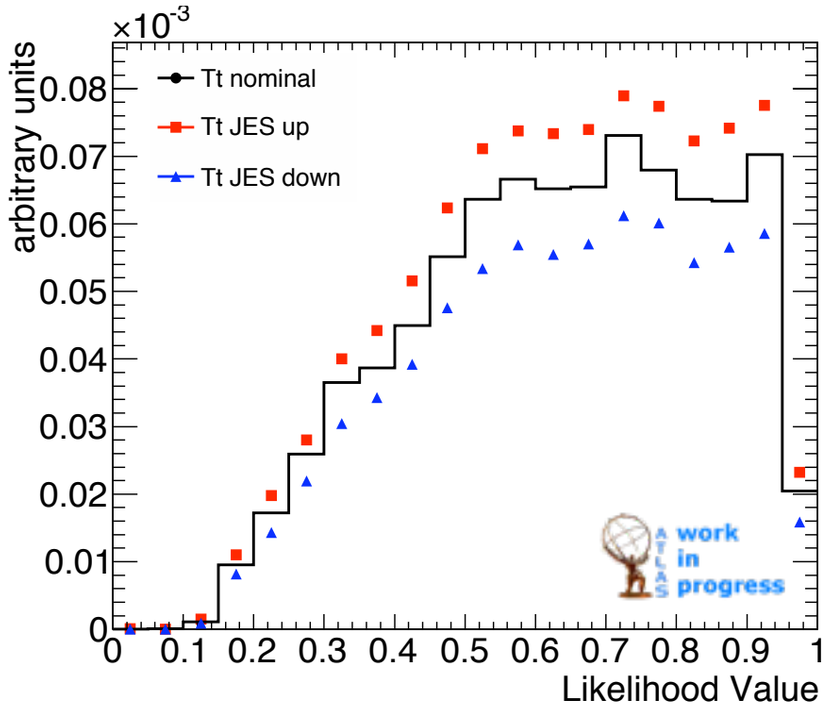




- pseudo-data from templates to show functionality!

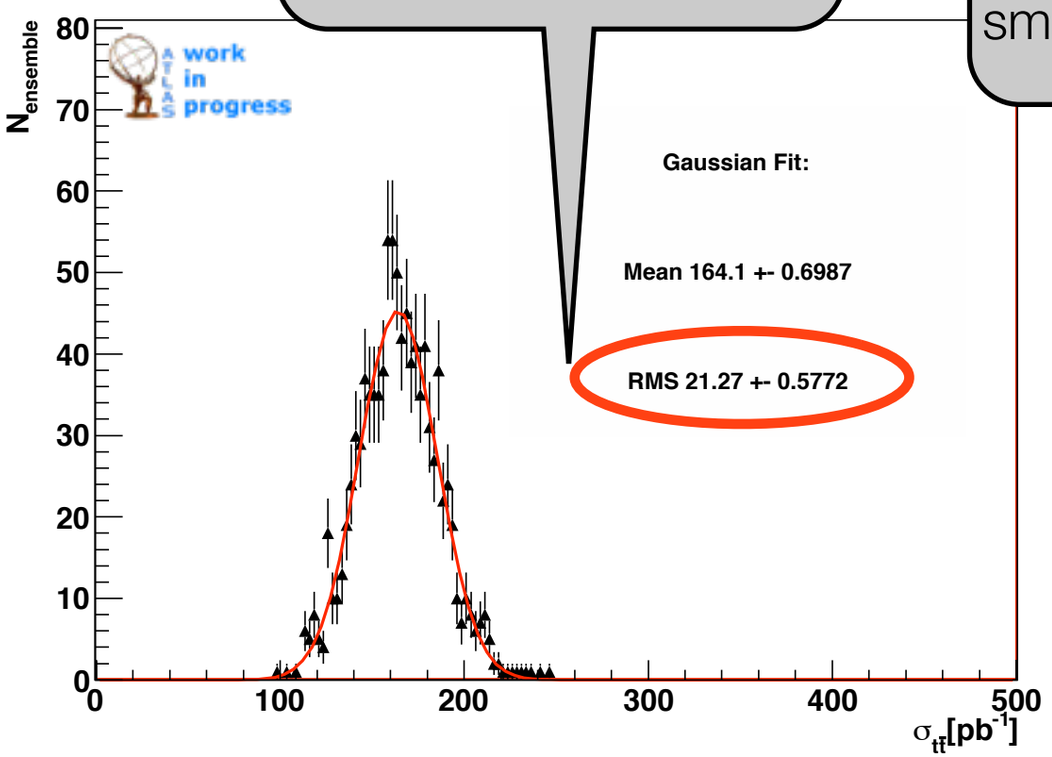
Ensemble Testing

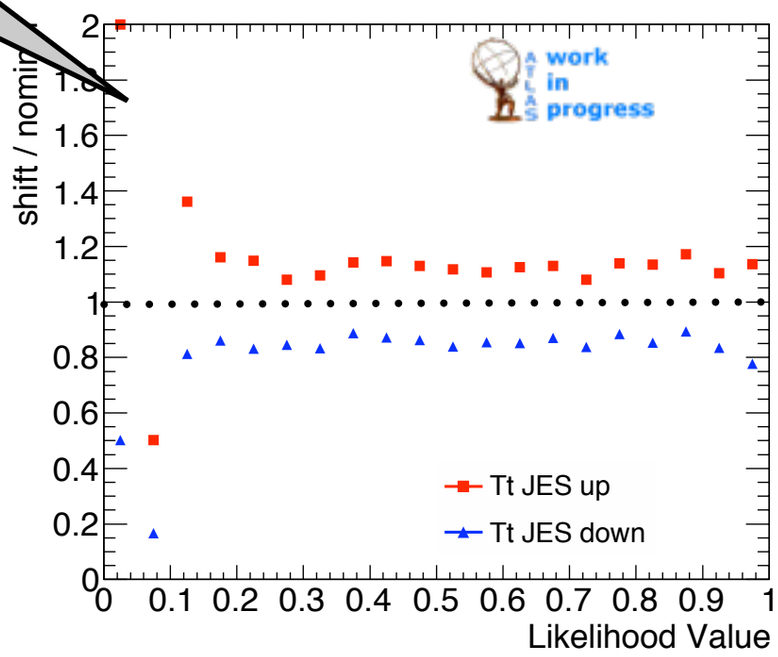
- create pseudo data sets from templates and extract cross section from them
- to test method:
  - statistical uncertainties
  - systematic uncertainties
  - linearity of method



relative stat. uncertainty on $\sigma_{tt} \approx 13\%$

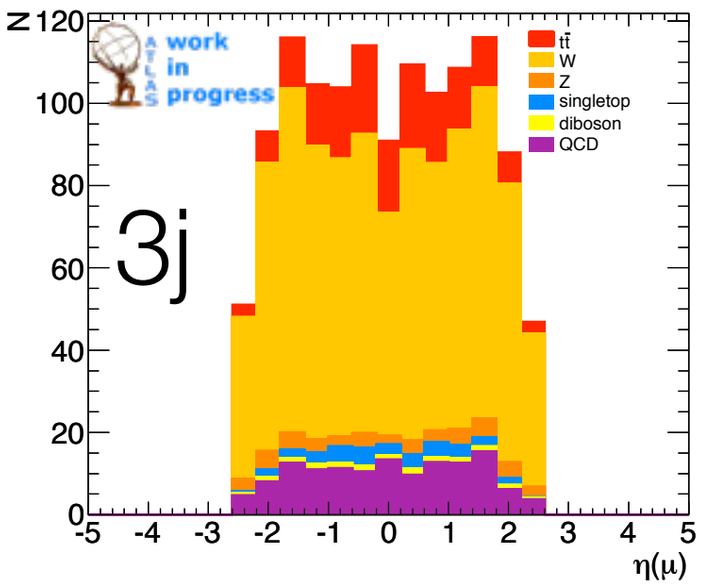
small sensitivity to JES!

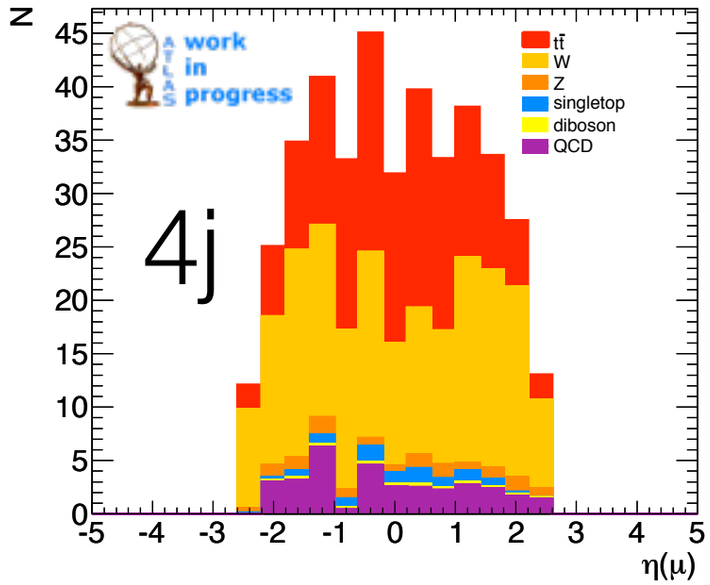


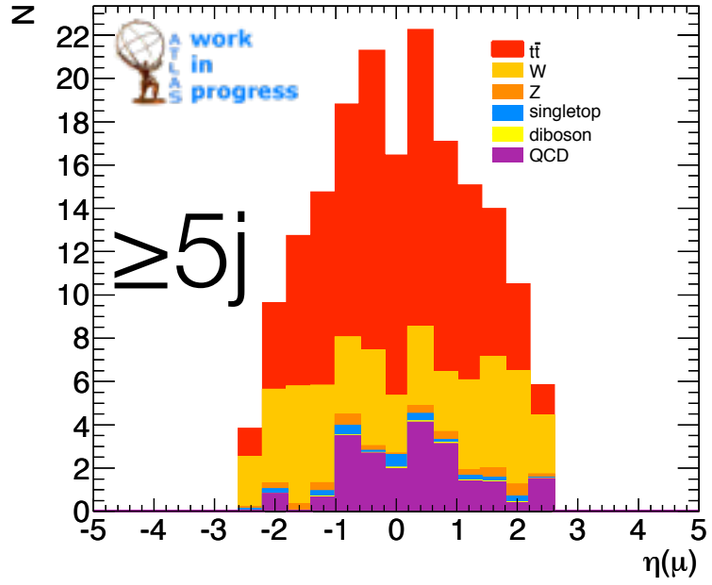


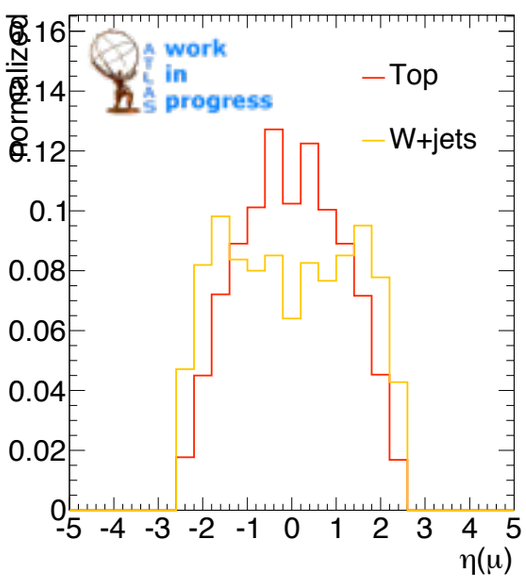
Separation of Jet Bins (I)

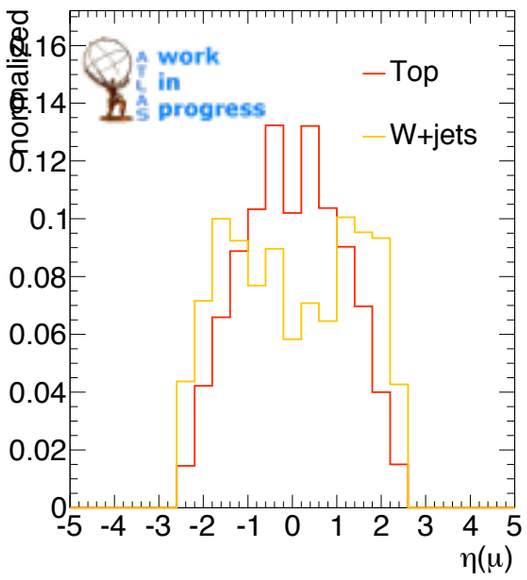
- extend analysis to events with 3 jets, 4 jets, and ≥5 jets
- fit σ_{tt} simultaneously, together with N_{bkg} in each channel
- keep same set of variables

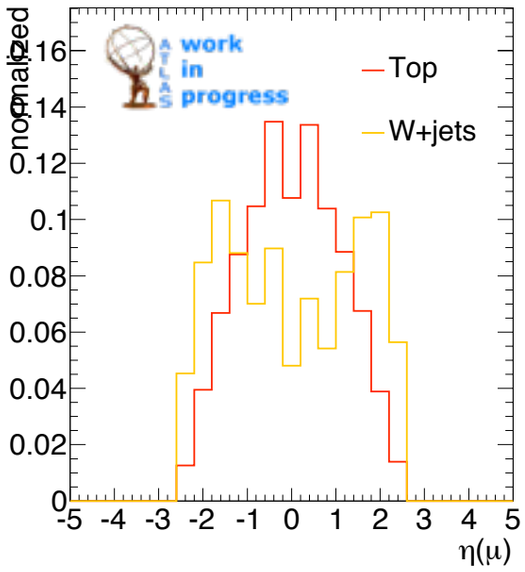






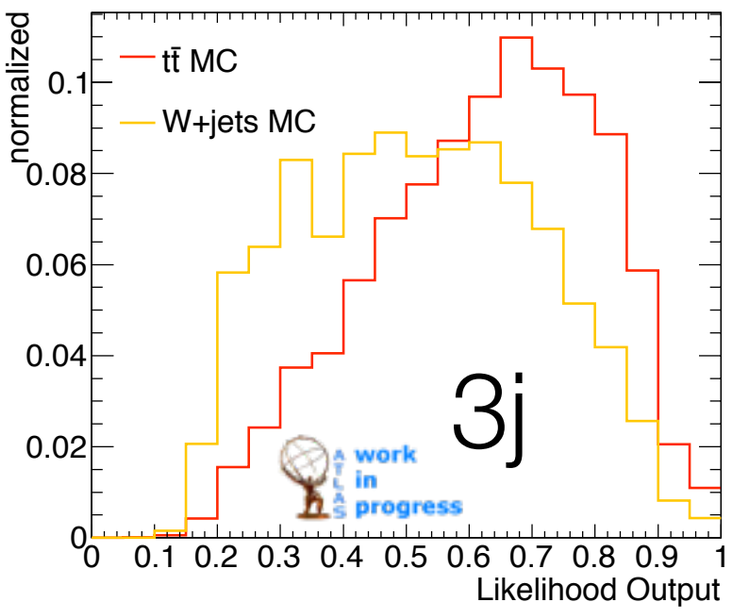


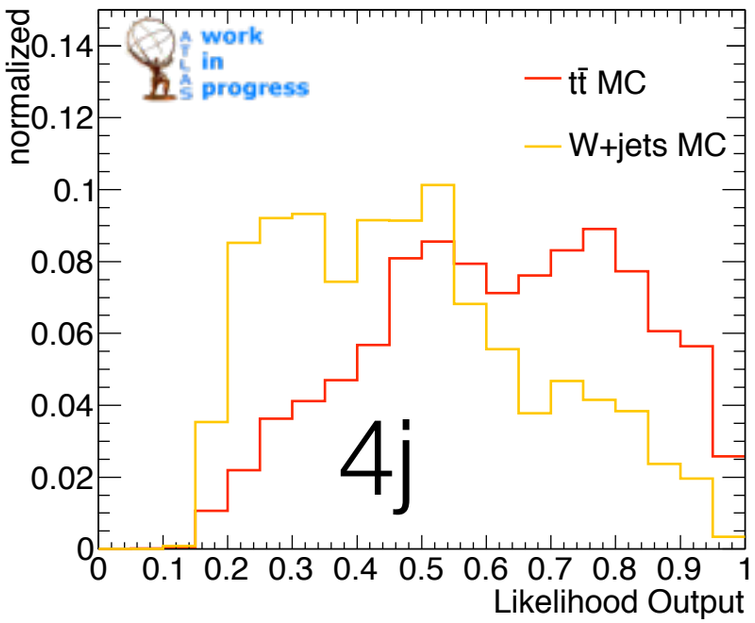


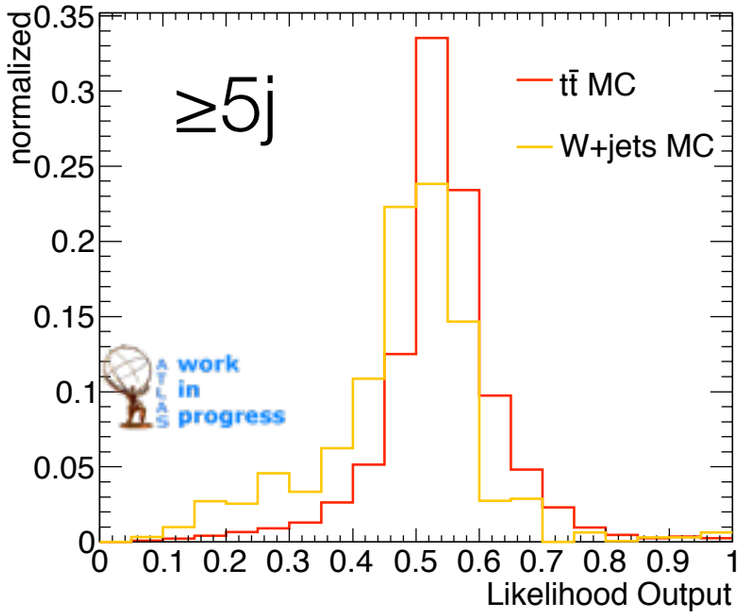


Separation of Jet Bins (II)

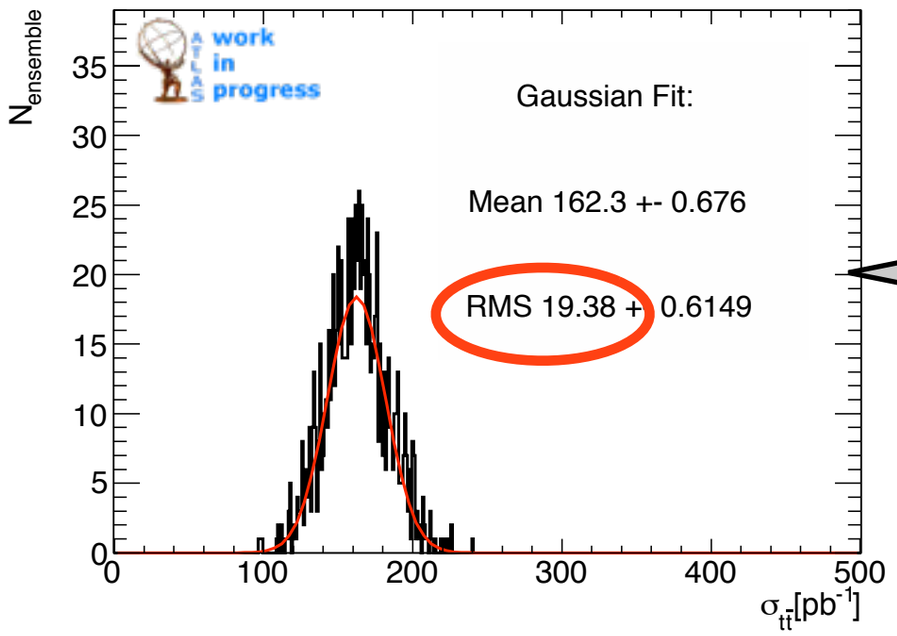
- likelihood distributions with pseudodata







- stat. uncertainty on cross section from ensemble tests



relative stat. uncertainty on $\sigma_{tt} \approx 12\%$

Conclusion & Outlook

- analysis working & in place to measure σ_{tt} on full 2010 data set
- can improve sensitivity when adding events with 3 jets and perform combined fit
- combination with e+jets (Adam Roe) straightforward

- cross-checks, improvements and evaluation of all systematic uncertainties ongoing
- analysis will be dominated by systematic uncertainties
  - but chose set of stable and JES independent variables

- collaboration with DESY Berlin group for overall analysis