

“Physics commissioning”: Standard Model WG



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- SM aspects
- Proposed signatures
- Data samples/statistics
- First SM measurements
- Next steps

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Standard Model Aspects



- Use present (future – 2007) knowledge of Standard Model to understand/calibrate ATLAS performance
 - Work done by the combined performance groups
 - e.g. using Z-mass constraint
 - SM + MC groups (+others) to provide reference?
 - e.g. generator version, pdf version, tuned parameters, ...
- Understand basic event properties and collect signature data base information for pp collisions at $\sqrt{s} = 14$ TeV
 - Properties of minimum bias events, features of the underlying event
 - Basic cross-sections (e.g. background normalization)
 - MC generator tuning
 - PDF constraints
 - Map out also small statistics (tail) regions
- Improve knowledge of Standard Model doing the flagship precision measurements
 - Beyond first years, needs perfectly understood detector

Proposed signatures



- Establish a basic list of signatures
 - Measure kinematical properties and cross-sections for all of these
 - Something like a signature data base
 - Aim for signatures which get contributions from just a few processes or ideally are dominated by a single process
 - Note: SM and also non-SM processes might contribute
 - Investigate use of tools for automatic comparisons and more
 - HZTOOL, JetWeb
- Concentrate here on non-diffractive interactions
 - Need to get handle on contributions from diffractive processes as well!
 - Additional (forward) detectors most beneficial for this

Proposed signatures (cont'd)



- initial cross-section error (i.e. absolute normalisation)
 - will most likely be limited by luminosity accuracy!
- Minimum bias event structure
 - Energy flow, (identified) particle spectra, particle correlations
 - Event selection with zero-bias (random) trigger
 - Tune MC generators
 - Large cross-section, high rates
 - But care about rare fluctuations as well!
 - Measure double (and triple?) parton scattering
 - Using e.g. photon + 3 jet production
 - Investigate and understand production of mini-jets
 - very low p_T jets, relevant for jet veto
- Features of underlying event in hard interaction
 - Energy flow / particle production inside a high p_T jet from additional parton scatterings in the same event

Proposed signatures (cont'd)



- High p_T signatures
 - Inclusive spectra (p_T, η, \dots) of single objects
 - $e, \mu, \tau, \gamma, \text{jet}$ (without and with flavour tag), ...
 - Di-lepton spectra (M_{ll}, p_T, η, \dots) from Drell-Yan production
 - Multi-jet production ($p_T, \eta, \text{angular distributions}, \dots$)
 - Inclusive spectra (p_T, η, \dots) of resonances
 - $Z, W, Y, J/\psi, \eta, \pi^0, \dots$
 - W/Z + N jet rates
 - Inclusive heavy flavour production (tt, bb, \dots)
- Use the above (and more) to assess validity of generators
 - Need for $N^{(n)}$ LO corrections etc.
 - Tuning of generator parameters
- Use the above to validate/constrain/re-measure pdf's
 - And add more specific processes / signatures ...

Proposed signatures (cont'd)



- Parton distribution functions

- Need to carefully constrain and determine this non-perturbative input to hard scattering calculations
- To understand possible signs of new physics to happen at large Q^2
 - Need to measure pdf's at the same Bjorken x values but at lower Q^2 → QCD evolution to the relevant Q^2 scale
- Relevant processes/signatures include
 - W/Z production → quarks and anti-quarks
 - γ (+jet) production → gluons
 - Drell-Yan lepton pairs → quarks and anti-quarks
 - Jets → quarks and gluons
 - Want to have these at the same p_T (i.e. Q^2)
 - But for different s of the hard scattering
- Understand issue of validity of factorization and the predictive power of QCD for multi-scale phenomena

Conditions / Statistics required



- Reminder
 - For 10^7 events → 1 year @ 1 Hz or 3 days @ 100 Hz
- Need to run with 1 interaction/bunch crossing
 - Limits luminosity to about $10^{33} \text{ cm}^{-2} \text{ s}^{-1}$
 - And disfavors 75 ns bunch spacing
- Specific comments for some signatures
 - Minimum bias events
 - 10^7 events → 10^5 events/bin for 100 η bins @ <1%(stat.)
 - More than sufficient → allows for (η, p_T) binning, e.g. 30×30
 - Expect to reach transverse momenta of up to 10 GeV
 - High p_T spectra
 - For $0.1/1/10 \text{ fb}^{-1}$ → 10 di-jet events with $M_{jj} > 3.5/4.6/5.8 \text{ TeV}$
 - For $0.1/1/10 \text{ fb}^{-1}$ → 10 direct γ events with $p_T(\gamma) > 400/500/600 \text{ GeV}$
or for 0.1 fb^{-1} → 10^3 events with $p_T(\gamma) > 100 \text{ GeV}$
 - For 0.1 fb^{-1} → $10^6 W \rightarrow e\nu$ and $10^5 Z \rightarrow ee$

Data samples/Statistics (cont'd)



- Need to worry about adequate MC samples as well
 - esp. NLO (or NNLO) calculations / event generators take a lot of time
 - Explore possible variations in α_s , pdf's, parameters
 - If possible, allow for weighting of different contributions to the signatures
- Use of detector simulations
 - A fast detector simulation (tuned to the appropriate detector behaviour) seems to be adequate for "physics commissioning"
 - Not for precision measurements

First measurements / "papers"



- 1st collisions, inelastic event structure
 - Basic energy flow and charged/identified particle spectra
- Inclusive lepton spectra
 - Constrain production processes and pdf's
- Inclusive production of W and Z boson
 - Ratio of production cross-sections, lepton flavours
 - $p_T(Z)$, $p_T(l)$ for W, $p_T(W)$ from recoil
- Observation of high mass Drell-Yan lepton pairs
- Inclusive jet production
 - Angular distributions, multi-jet production
 - Observation of jets with $E_T > 1$ TeV or $M(j,j) > 1$ TeV
- Inclusive photon production
- Heavy flavour (bb, tt) cross-sections
 - Together with top/B-physics groups
- First attempts for precision physics
 - TGC production of ZZ/Z γ (largest gain due to \sqrt{s} increase)

Next steps



- Survey of initial “physics commissioning” from Standard Model point-of-view
 - Concentrate on signature based measurements
- Need to start an iterative loop involving
 - Combined performance groups
 - Realistic estimate for initial performance
 - Physics working groups
 - Needs for background process measurements
 - Trigger groups
 - Ensure selection coverage
- Define further requirements and develop tools for the first year data taking

Summary

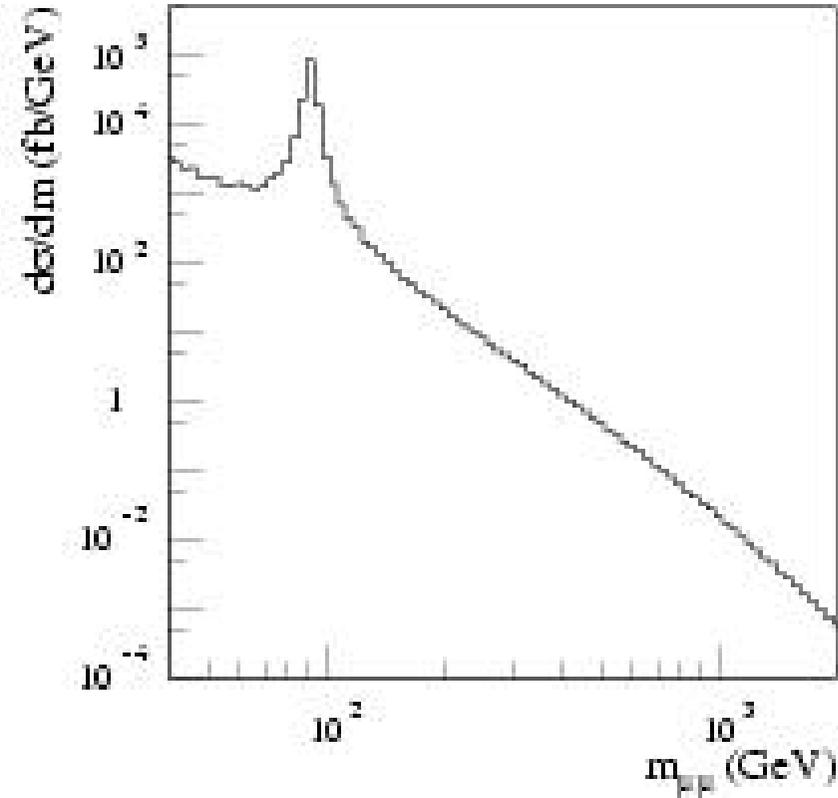
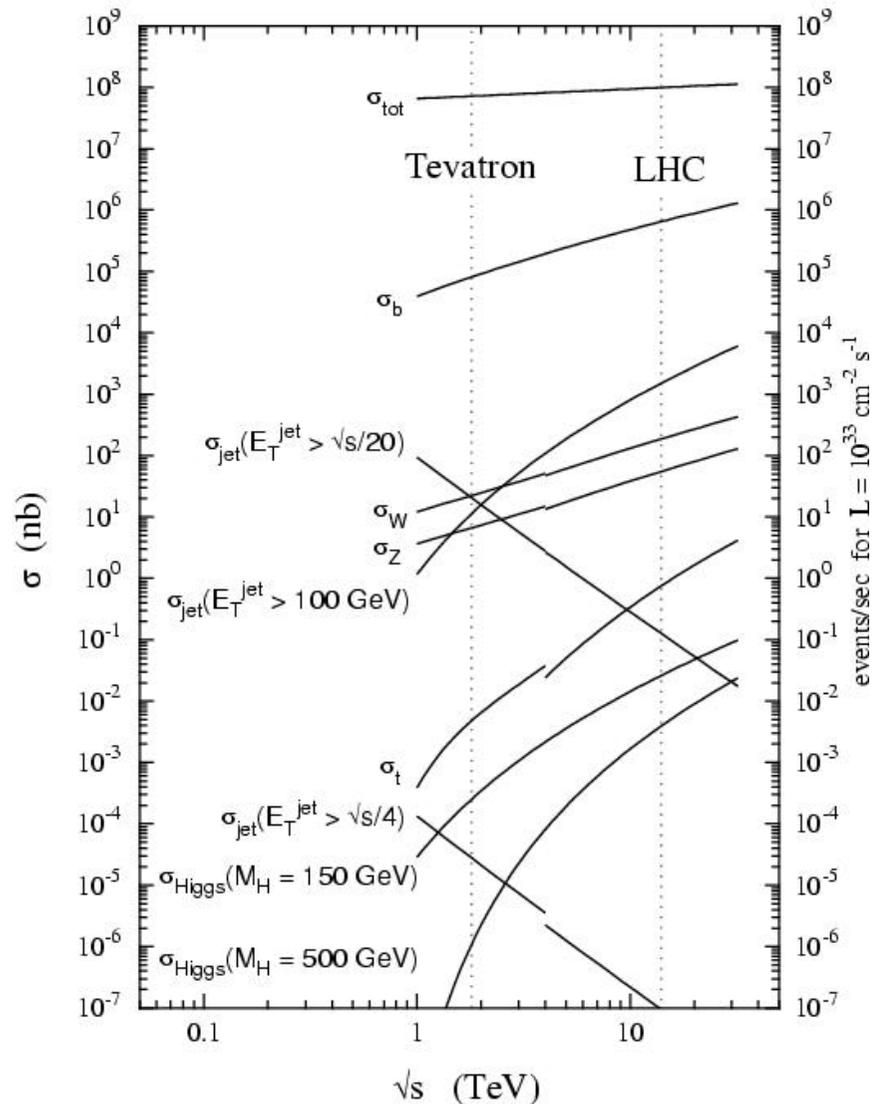


- Standard Model physics will be of utmost importance in the first year(s) of physics running
 - Need to understand pp collisions at $\sqrt{s} = 14$ TeV
 - Will give us the data for the first publications
 - To be followed by the discoveries ...
- Even if you are mostly interested in new physics
 - You are going to work on Standard Model physics aspects and contribute to the first ATLAS publications
 - Why not start already now and help us to make sure that we are prepared to analyse the data once they arrive

Cross-sections and Drell-Yan



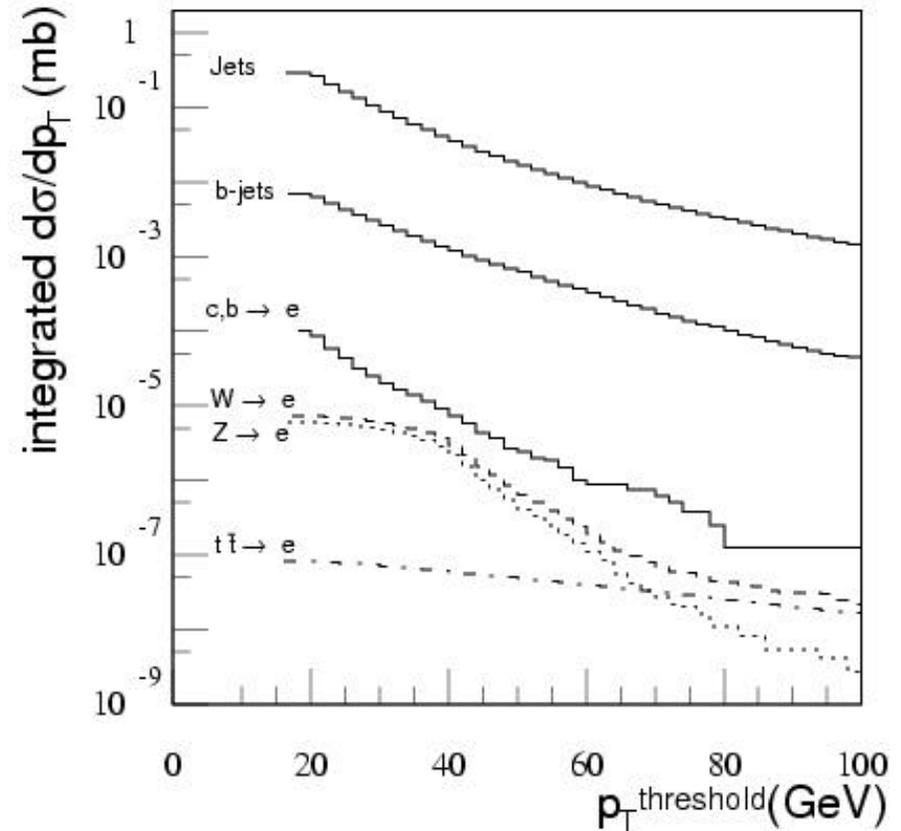
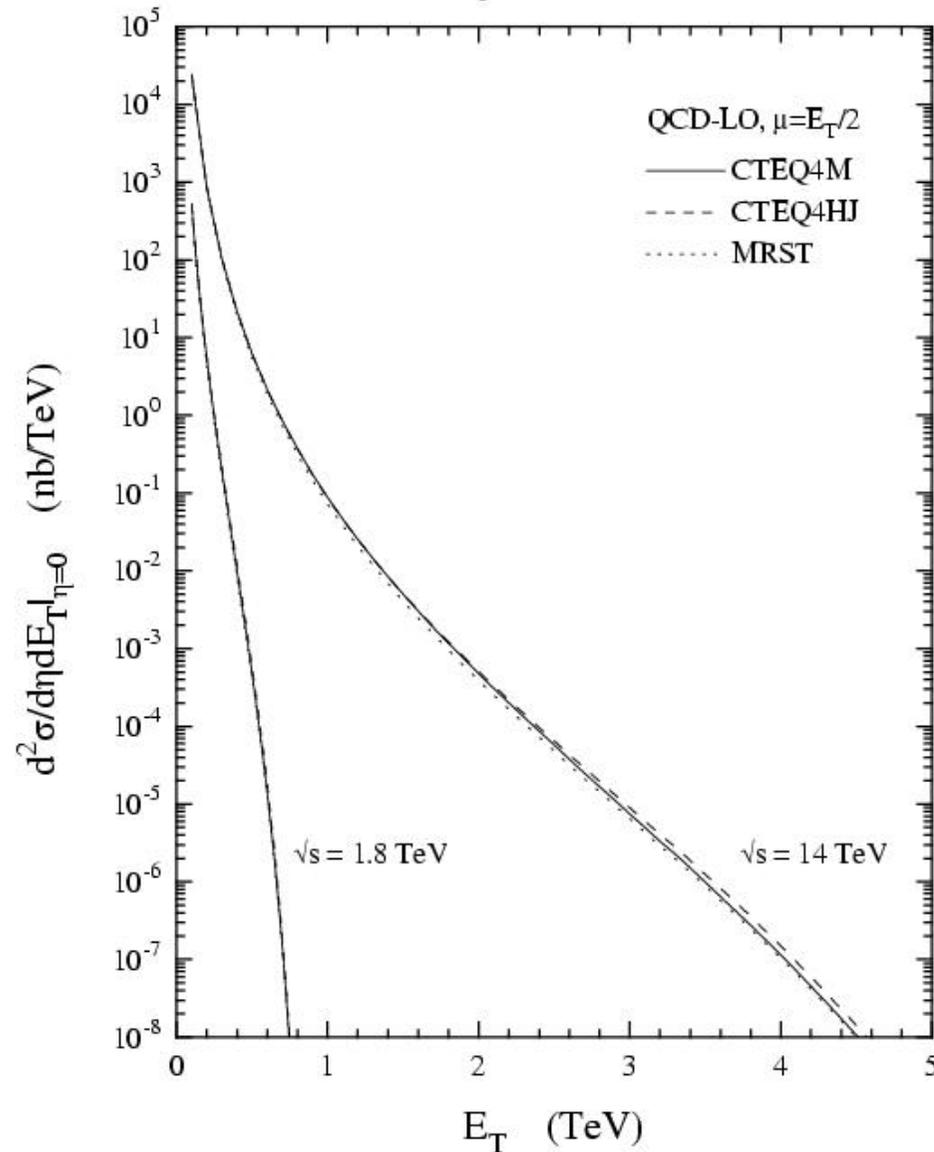
proton - (anti)proton cross sections



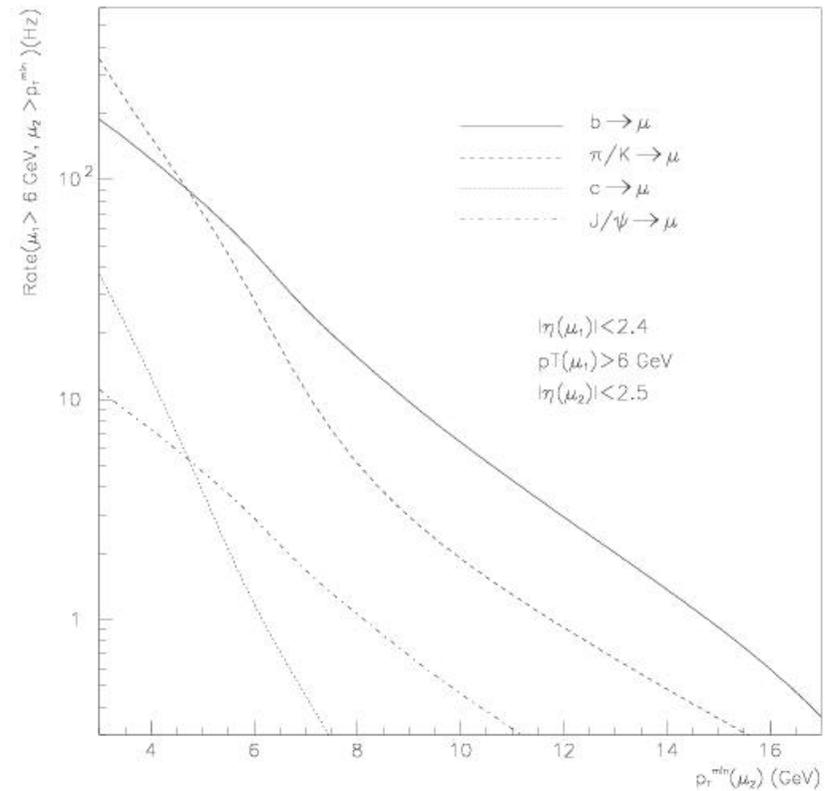
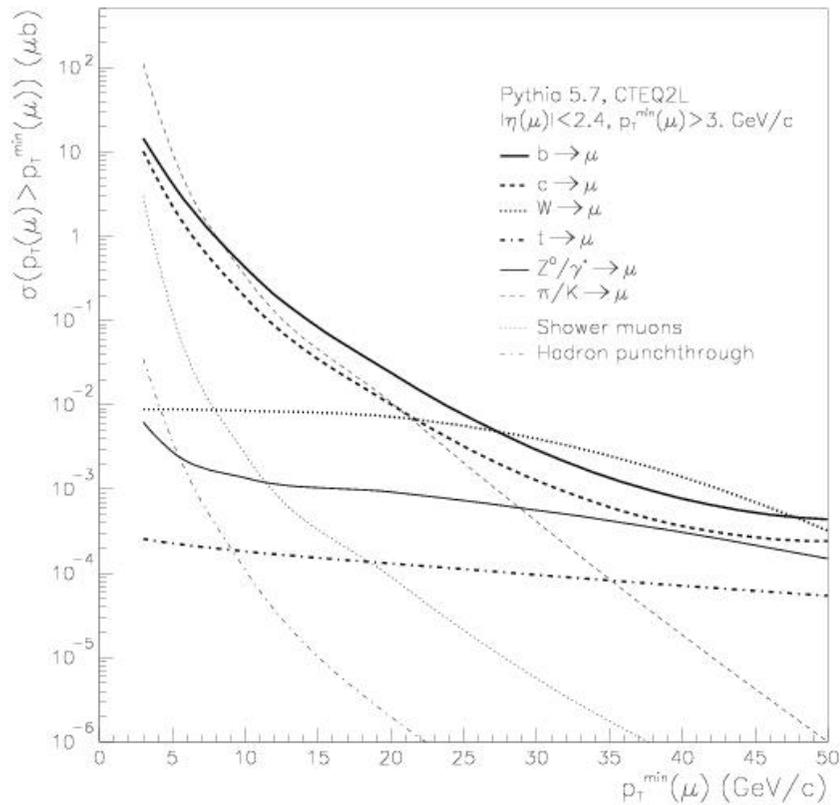
Jet cross-sections



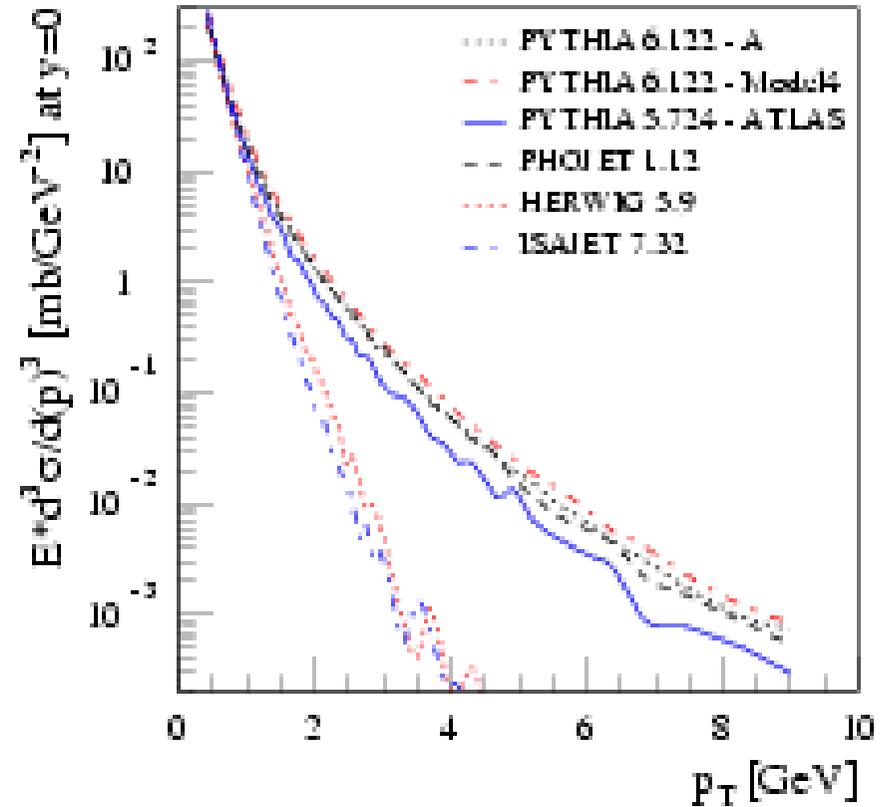
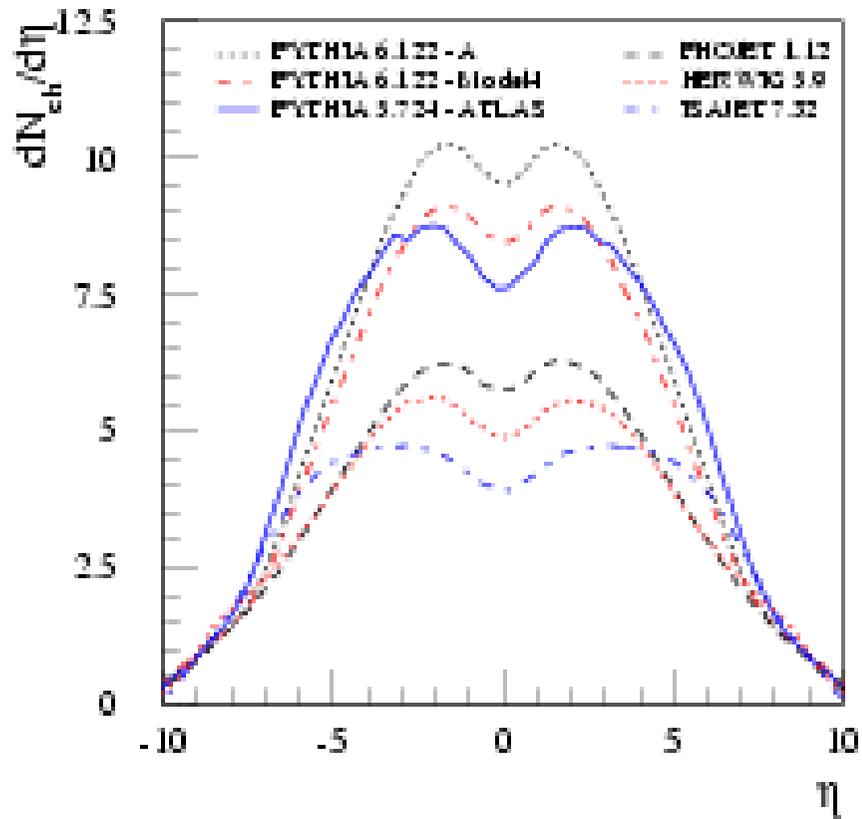
inclusive jet cross section



Muon cross-sections



Minimum bias events



Photon cross-sections

