Jet studies : Status Report

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High E_T parton jets in hard QCD

Phase I

- **High Q^2 final states at LHC will be dominated by inclusive jet production. QCD hard scattering-large momentum transfers - production of jets - One essential physics measurements at the LHC.**
- **Not many ideas on how to improve the knowledge of α_s at the LHC !**
- **Some results from Tevatron jets up to 450 GeV show excess at large E_T and that the results**

agree with theory at the level of 30 %. Also there is some dependence on PDF chosen.

- **Obvoius that LHC-experiments will allow accurate consistency checks with QCD predictions for the E_T dependent jet xsections extending from today's E_T values from $\sim$ 450 GeV upto roughly a factor of ten xsections extending into the multi-TeV domain.**
- **The use of high E_T data, sensitive to a variety of exotic new phenomena.**
- **Direct implications on the prediction of cross-sections for processes which produce potential background in the search of new**

phenomena.

- **Testing connections between jet algorithms at the parton level and at the detector level, ME Monte Carlo matching at LO and NLO and extrapolation to LHC energy provide a potential source of information. Important for MC tunes at start of LHC data.**

Jet Production Rates

- **PYTHIA6205**
- **15 million events at 14 TeV (LHC)**
- **10 million events at 1.8 TeV(CDF/D0)**
- **10 million events at 0.63 TeV**

(UA1/UA2)

- **Parton Jets in $2 \rightarrow 2$ hard QCD processes**

Results

- **Measurement of b-jets should be possible up to a few TeV.**
- **combining large cross-sections and the expected b-tagging capabilities of tracking detectors and the possibilty to measure inclusive muon production from and beauty, it might eventually be possible to measure the flavor dependent x-sections with CMS**
- **Also one might reach (optimistic !) efficiencies of 50 % for b–jets. Thus potential b-signal to**

background ratio should not be too different.

- **It might thus be interesting in the near future to investigate this possibility in a complete CMS simulation.**

Observations

- **Expected number of events for L=100 fb^{-1}(one year of LHC); different η intervals. Super high E_T (> 1.5 TeV) jets will be produced only in the central part of the detector ; $-2 < \eta < 2$.**

- **Flavor dependent jet x-sections. For $E_T >$ a few hundred GeV $\sim$ 2% of all jets are beauty flavored**

and $\sim$ 3% are charm flavored ; fractions essentially E_T independent up to 1–2 TeV.

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Phase – II

- The next step is to include detector effects and if possible higher order QCD corrections. For various detailed experimental studies, one needs to include systematics from jet reconstruction and resolution with CMS, including fragmentation effects, jet algorithms and uncertainties from PDF's.
- PYTHIA – Multi-process PSEG – LO
- HERWIG – – PSEG – NLO

- **ISAJET – – PSEG**
- **Approximate through evolution equations and initial parton conditions. Essentially limited to the simulation of $2 \rightarrow 2$ processes.**
- **New particle searches in Higgs and SUSY sector require simulation of $2 \rightarrow 4$, $2 \rightarrow 6$, $2 \rightarrow 10$ jet processes for which a precise knowledge of the SM background process is mendatory.**
- **Better multi-parton event generators – improve the simulation of the PS by introducing ME corrections and implement the complete multi-parton hard scattering ME process.**

- **ALPGEN, MADGRAPH, COMPHEP, GRACE etc.**
- **Inclusive xsections studies for Particle jets using PYTHIA has been done.**
- **Inclusive x-sections studies using ALPGEN for parton jets as well as for particle jets is in progress. Still lot of optimisation problems with ALPGEN !**

TARGETS :

- **Parton jet x-section studies (ALPGEN, MADGRAPH): End-of-March**
- **Inclusive jets from fully simulated data – to follow.**
- **Effect of PDFs.**

Inclusive jet x-sections(log)

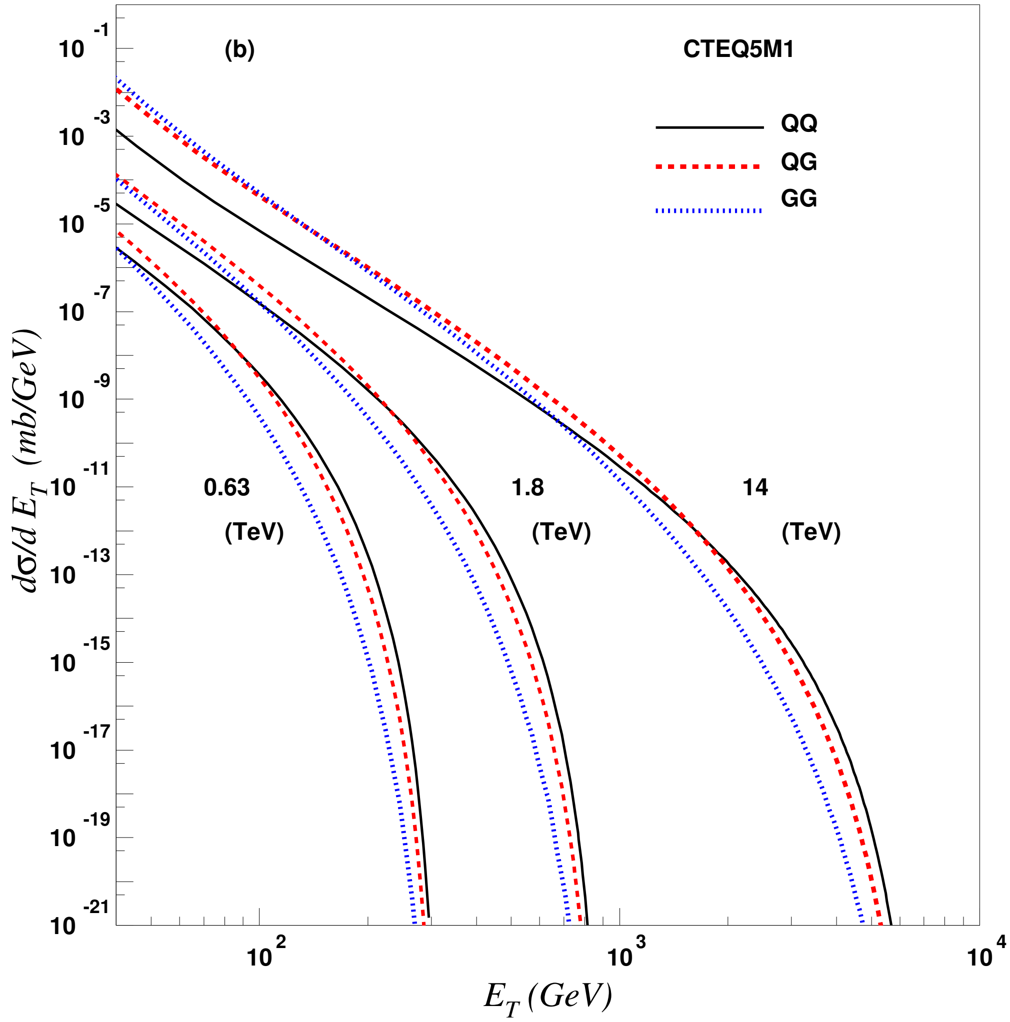

Figure 1: Inclusive jet-xsection (log-scale) of qq, qg,gg scatterings at different c.m.energies

Quark/Gluon Contributions

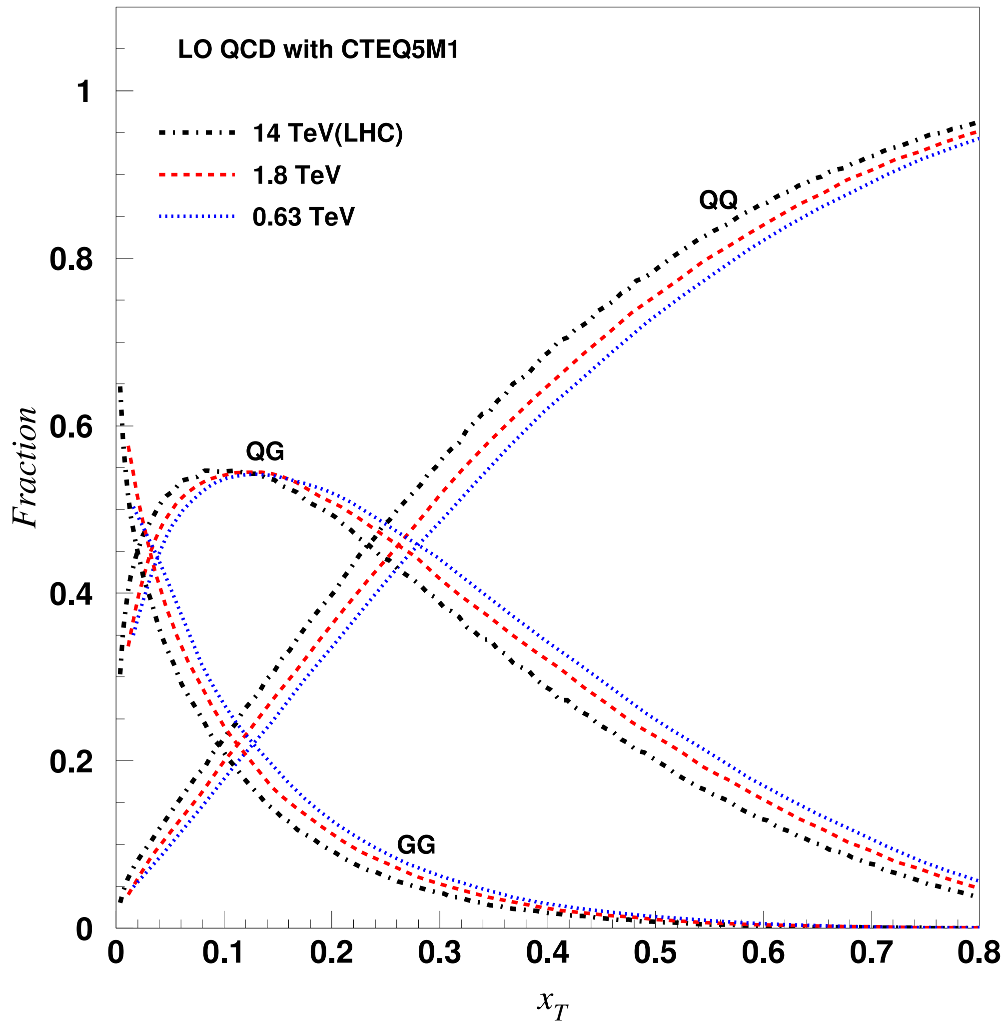

Figure 2: contribution to jet cross sections from different quark and gluon scatterings

Expected No. of events with $E_T < 1000$ GeV for one year of LHC

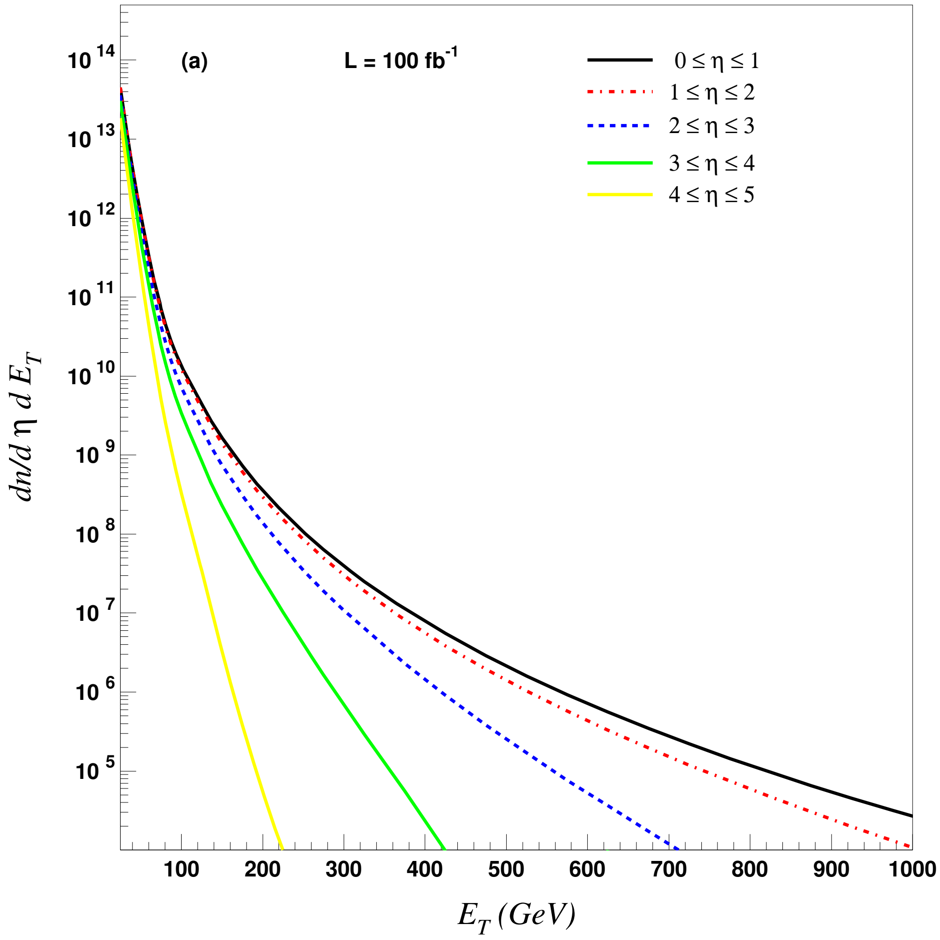

Figure 3: Jet x-sections for different rapidity intervals

Expected No. of events with $E_T > 1000$ GeV for one year of LHC

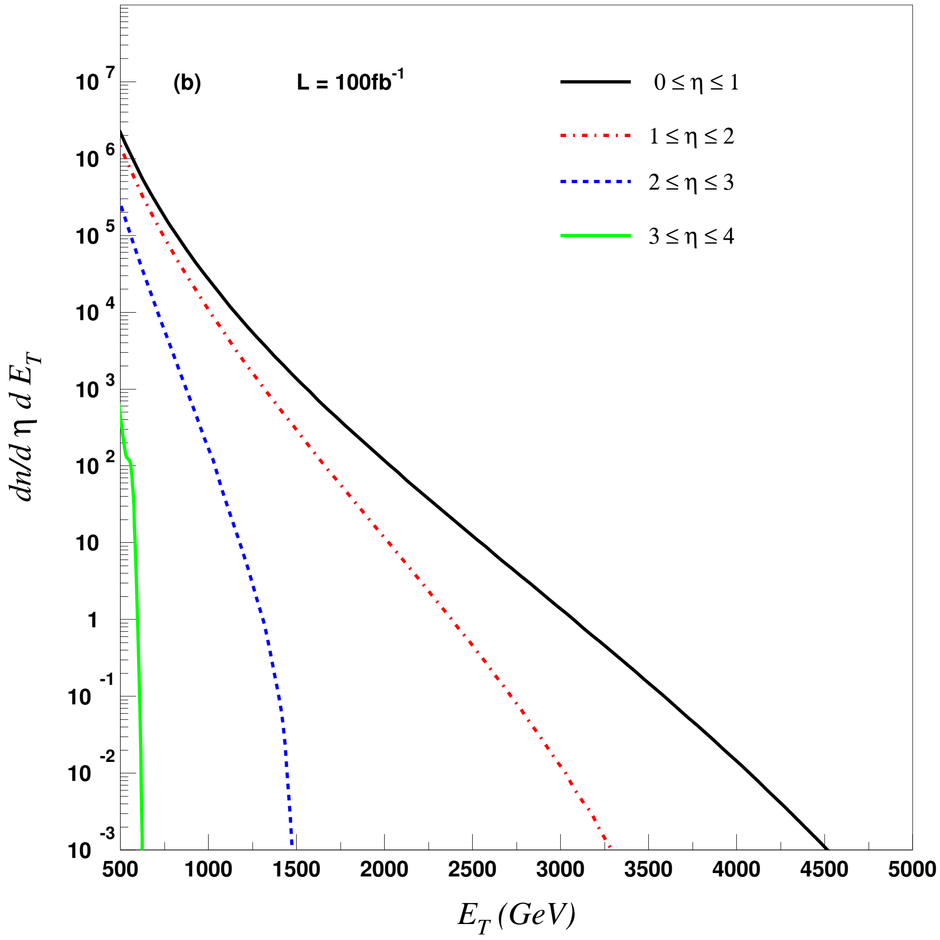

Figure 4: Jet x-sections for different rapidity intervals

Expected No. of events for 100 fb^{-1} (one year of LHC

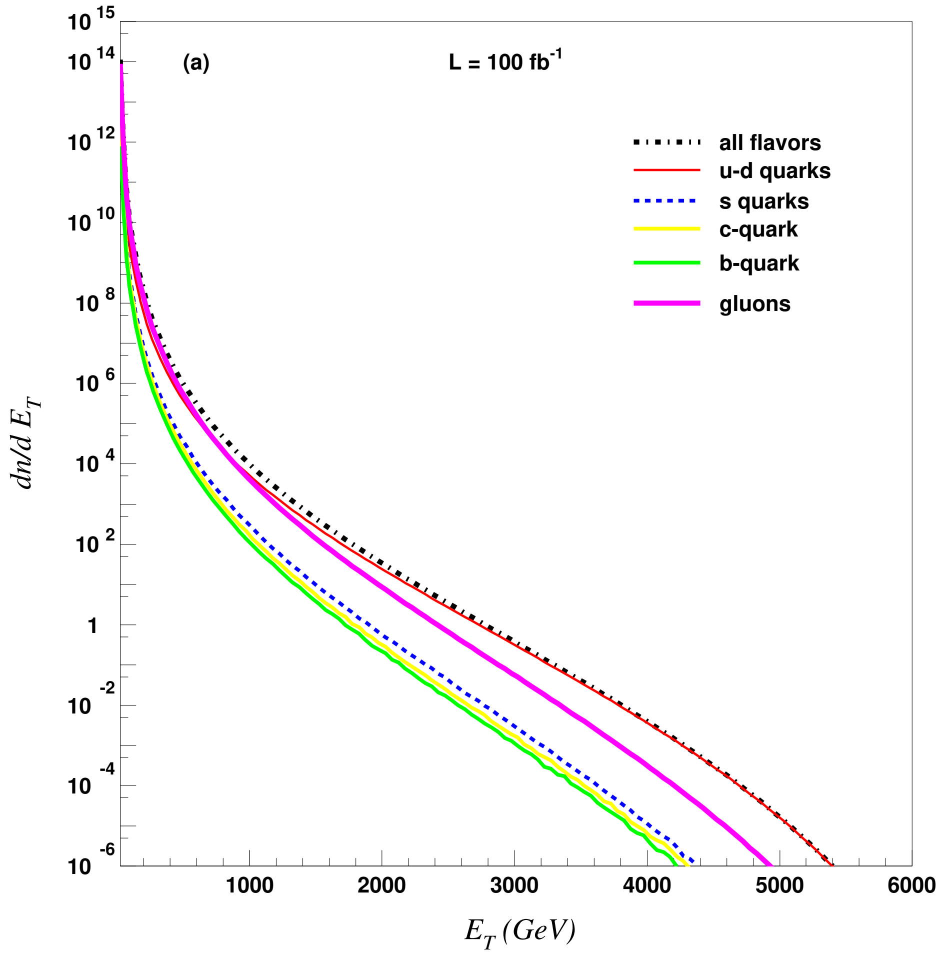

Figure 5: x-sections for different jet flavors

Expected No. of events for 100 fb^{-1} (one year of LHC

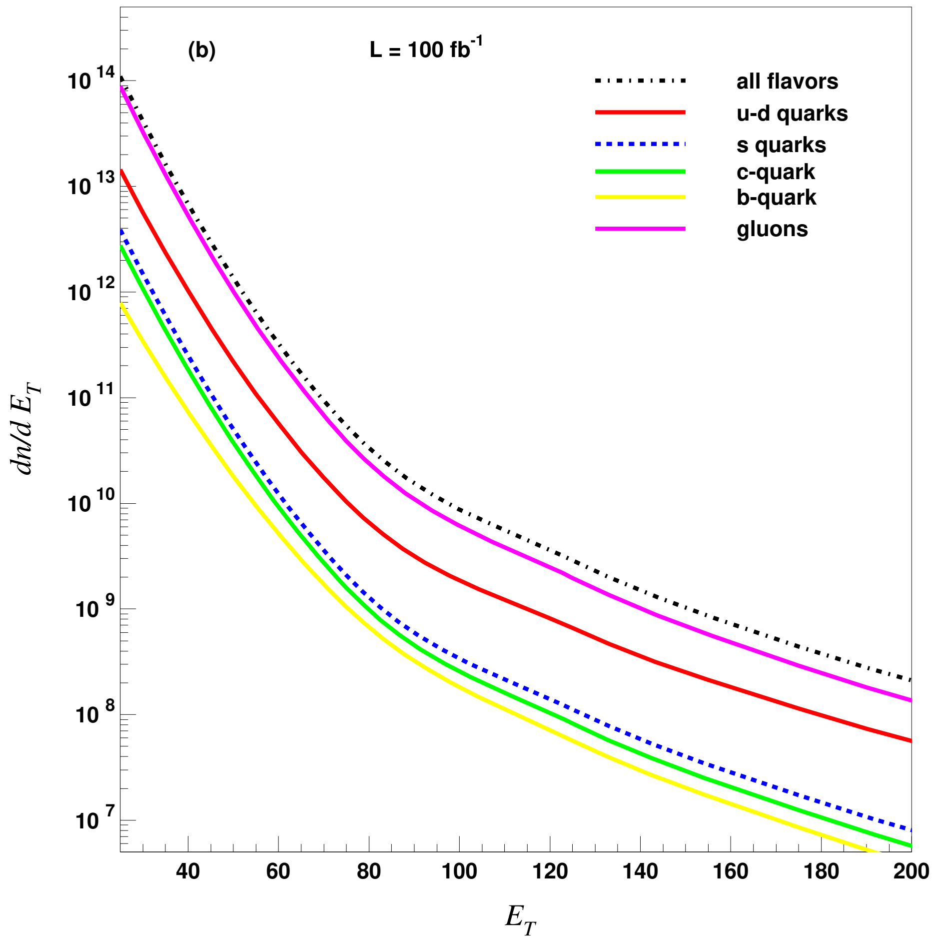

Figure 6: x-sections for different jet flavors

Study of W + jets using ALPGEN

- Matrix element for a lepton + neutrino final state is calculated.
- Subprocesses include all configurations with upto two light quark pairs.
- Kinematical configurations are generated by defining cuts on the PT of the jet, η of the jet and Δ R between the pair of jets.
- We have defined these cuts and calculated the xsections for W + 1jet and W + 2jets. The results are fairly close to the values given for some benchmark programs.

(Of cousre fixing the number of iterations and events for grid optimisation is tricky !!)

- **The work is in progress and we are trying to separate out the w+ and W- components and evaluate corresponding xsections by interfacing with PYTHIA.**