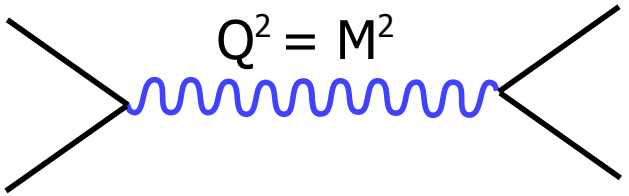
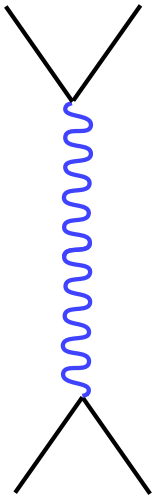
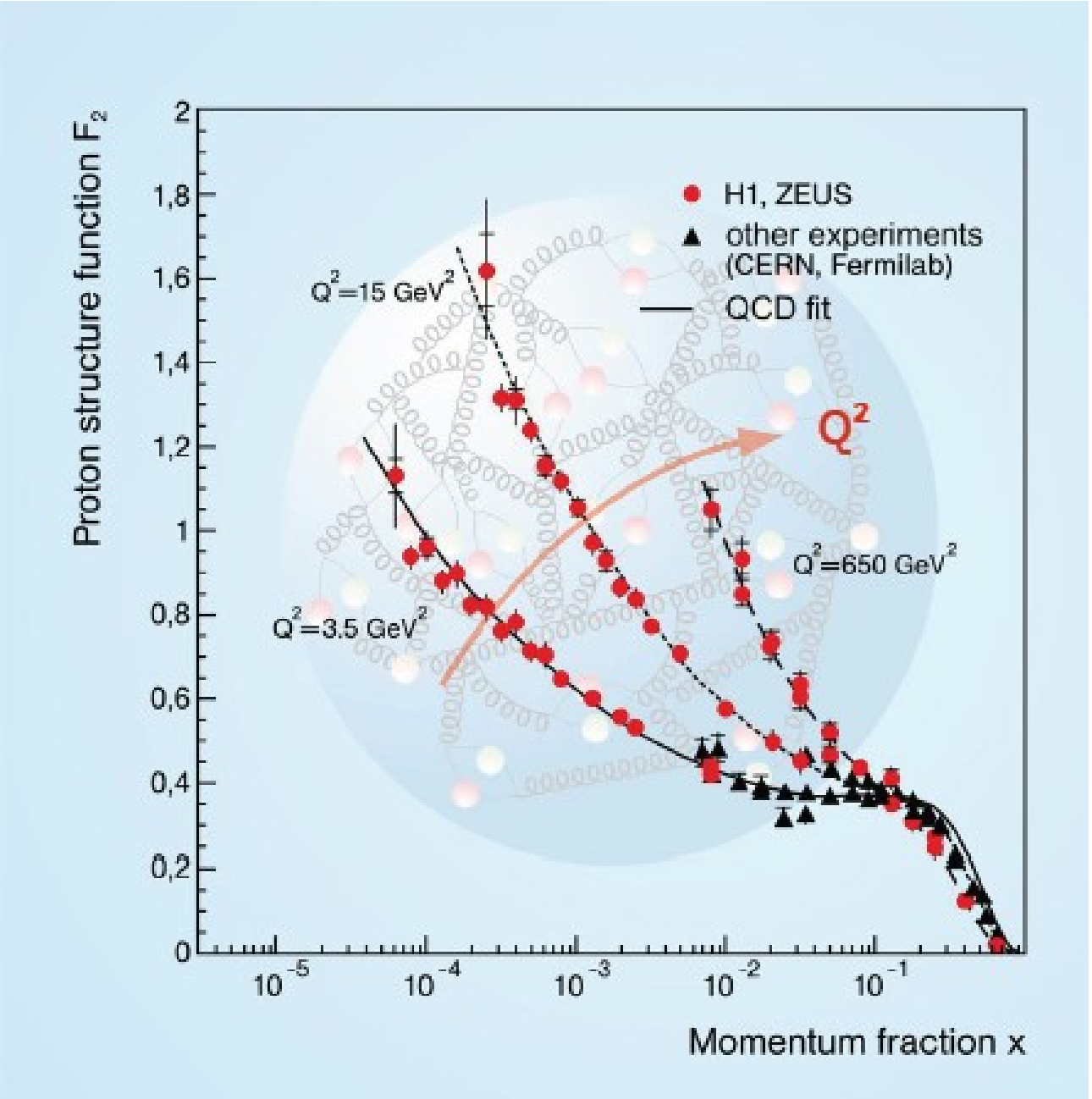
Low Mass Drell–Yan Production at LHC

- Motivation
- Measurement Feasibility
- Next Steps



- Drell-Yan production: q-qbar annihilation -> gamma/Z0 -> f - fbar pairs
- Large cross section in high q density environment
- Excellent testing ground for QCD dynamcics
- All f-fbar pairs are produced
- When Q^2 close to Z0 mass cross section dominated by Z0 pole
- Relationship to DIS is obvious...





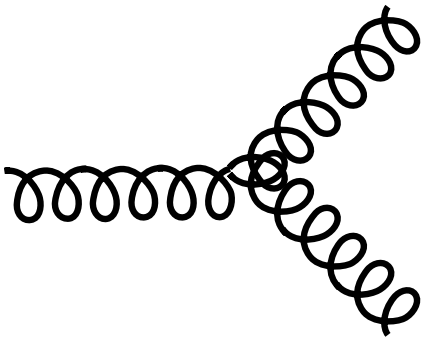
$$F_2 = x\sum_i e_i^2 \left[q_i + \overline{q}_i\right]$$

Most precise measurements of structure of matter

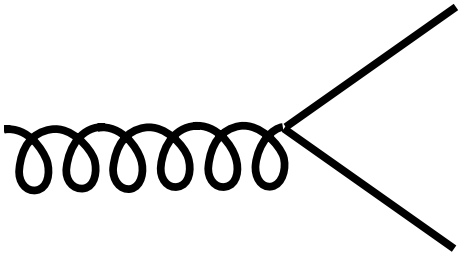
At high Q^2 number of quarks & gluons dramatically rises

Gluons constantly forming quark / anti-quark pairs and annihilating

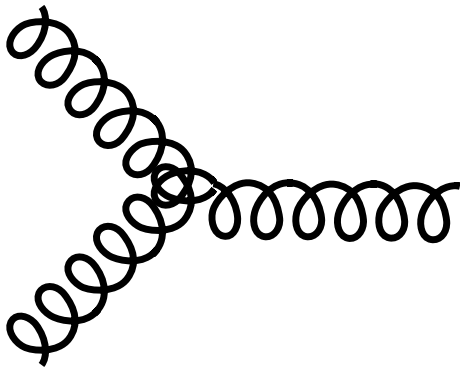
- Perturbative QCD is known in approximate form: DGLAP evolution
- Describes HERA data very well across whole perturbative regime
  4 decades in x and Q^2
- DGLAP: Given f(x) at Q_0^2 PDF Q^2 evolution is determined
- DGLAP sums pQCD expansion terms like $\alpha_s^n . \ln^m(Q^2)$
- Corresponds to gluon (and quark) splittings e.g.:



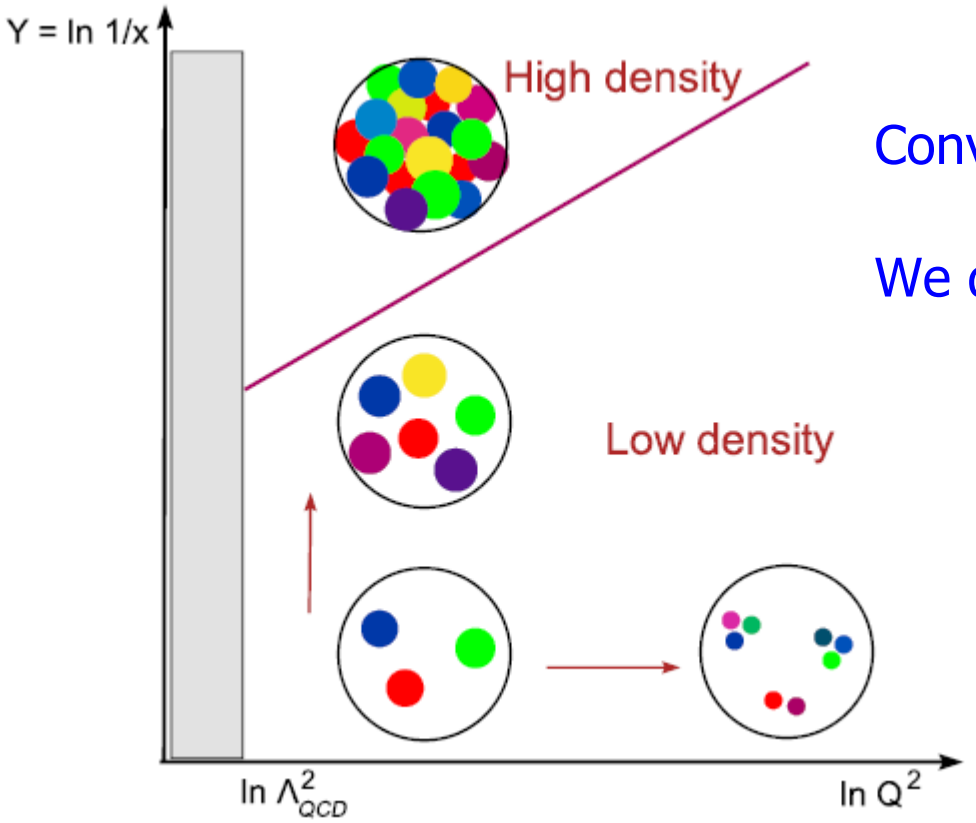
g -> gg
g -> q qbar



- At very small x (and high enough Q^2) other logs become large e.g. $\alpha_s^n.\ln^m(1/x)$
- BFKL: sums large logs in 1/x
- No firm evidence this regime has been reached in HERA data
- In regime of high gluon density recombination effects must appear

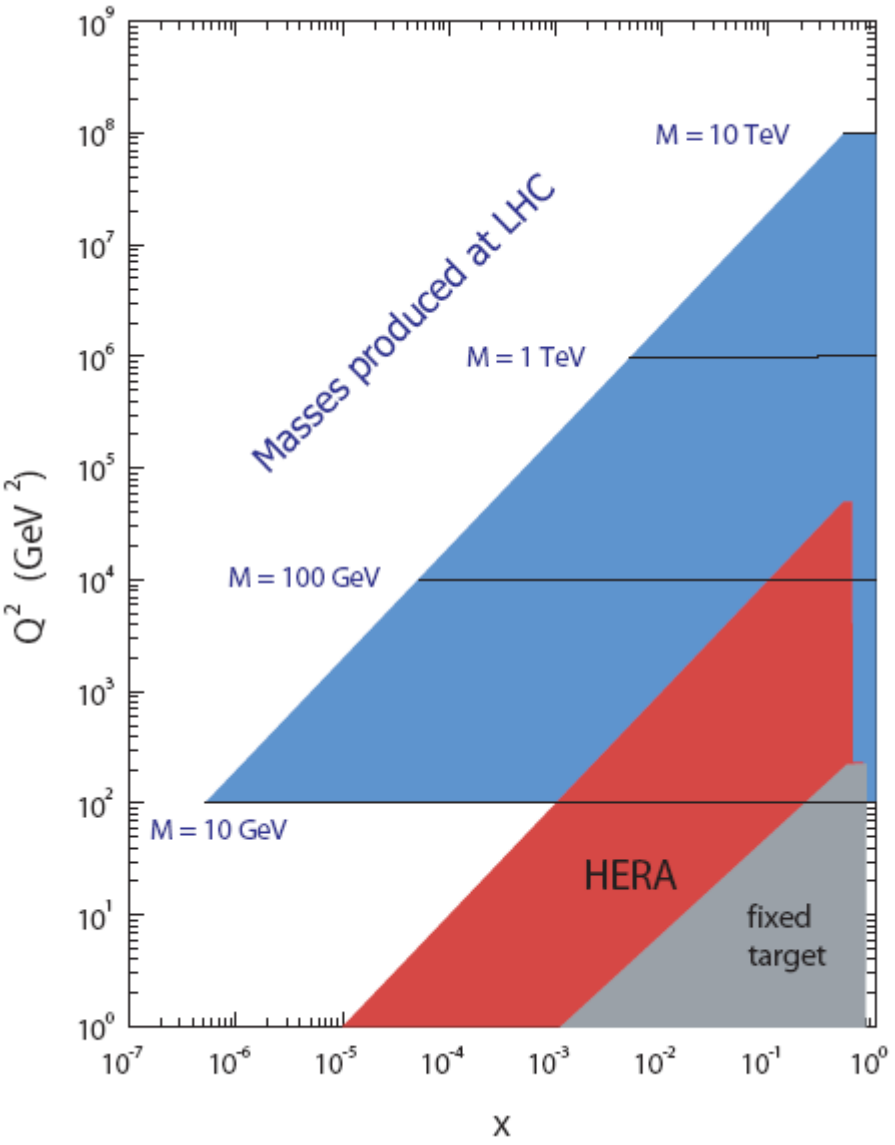


Again, no firm evidence for this in HERA data



Convenient pictorial representation

We do not know where the boundaries are



LHC opens up the low x regime at high Q^2

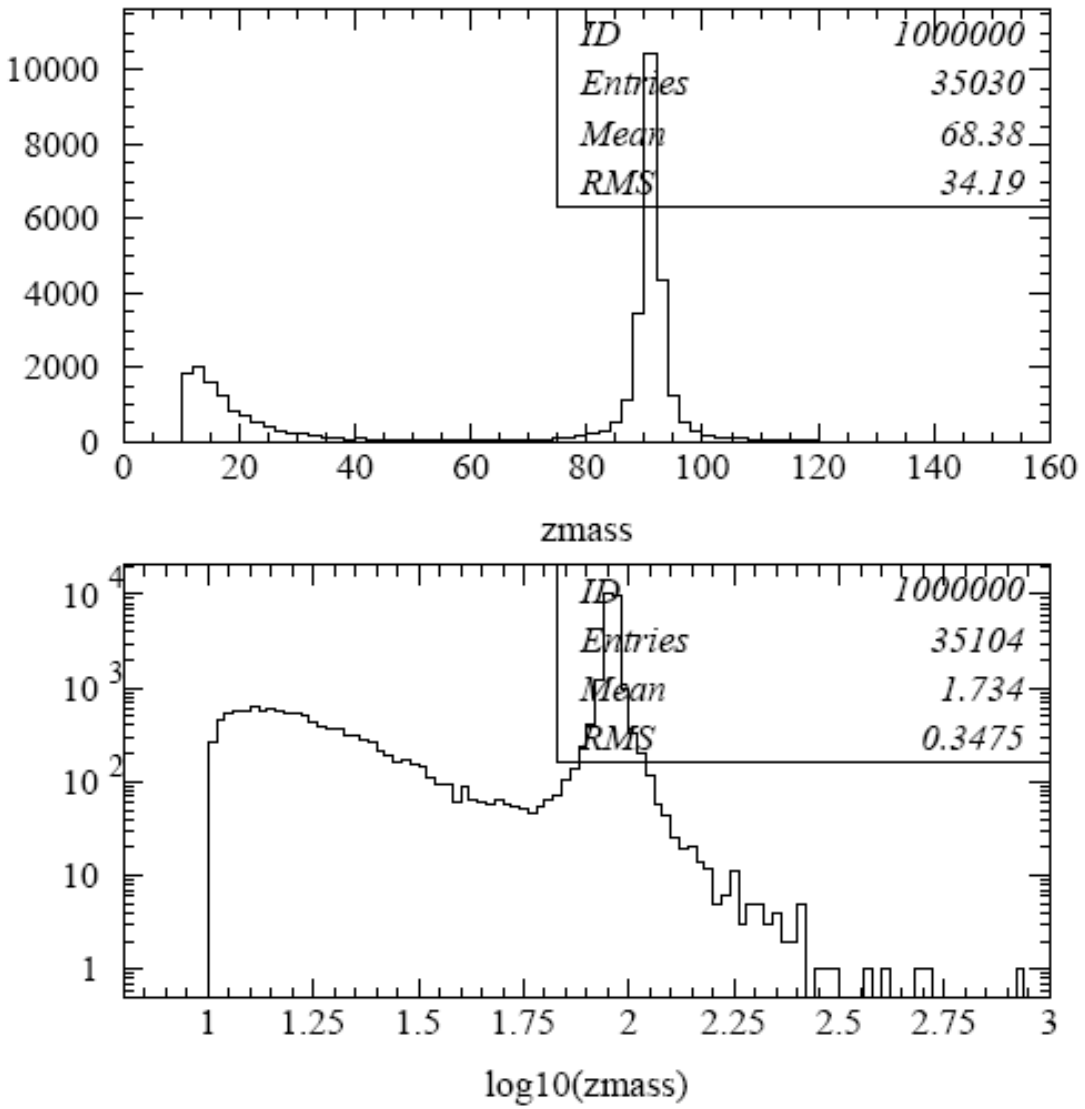
Can reach $x \sim 10^{-5}$ at $Q^2 \sim 100$ GeV^2

Can we see the need for new pQCD dynamics?

Measurement of Drell-Yan production samples low x PDFs

Most sensitive away from Z0 pole

Need to measure low Q^2 to access lowest x



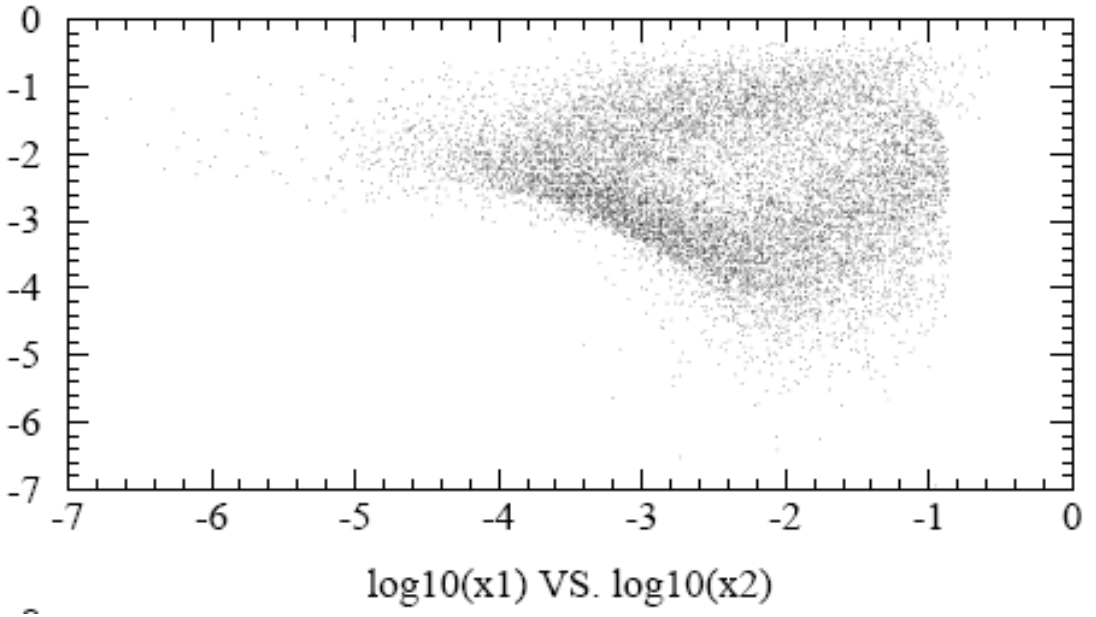
Generator level study only

35k pythia events $P_{T,min}$ = 5 GeV

Select Drell-Yan production channels

Look at di-muon channel

Cross section dominated by Z0 peak



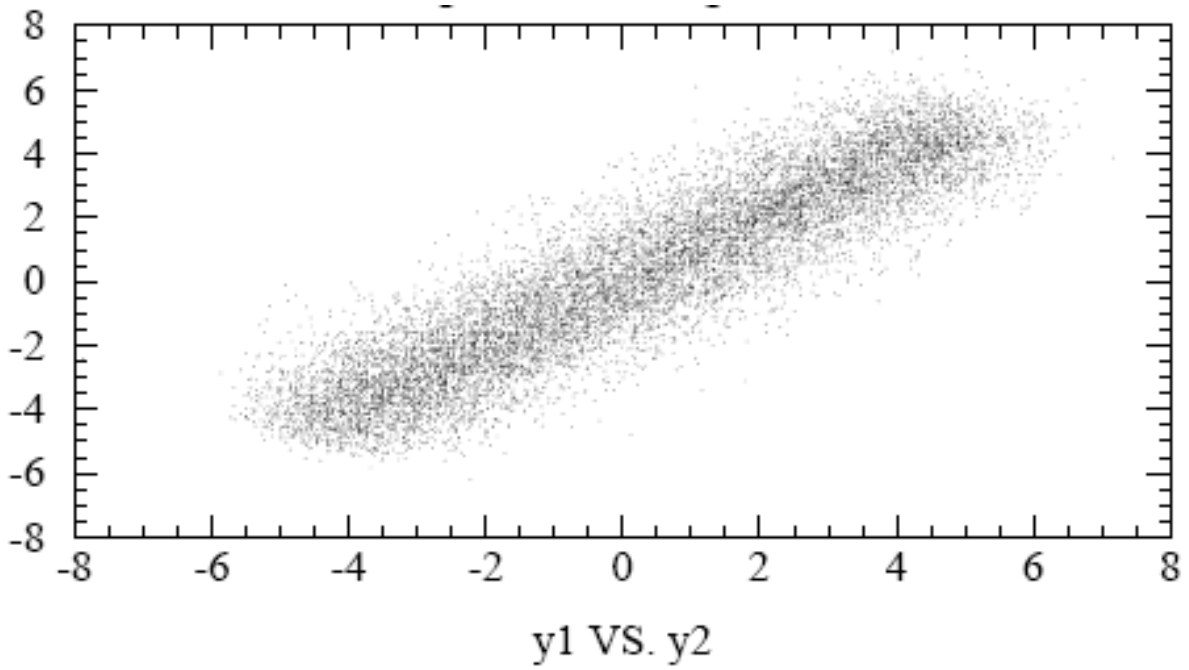
Region of kinematic reach: $x \sim 10^{-5}$ at $Q^2 = 100$ GeV^2

$x_f = 2P_L/Scms$

$Q^2 = M^2$

$\tau = Q^2 / Scms^2$

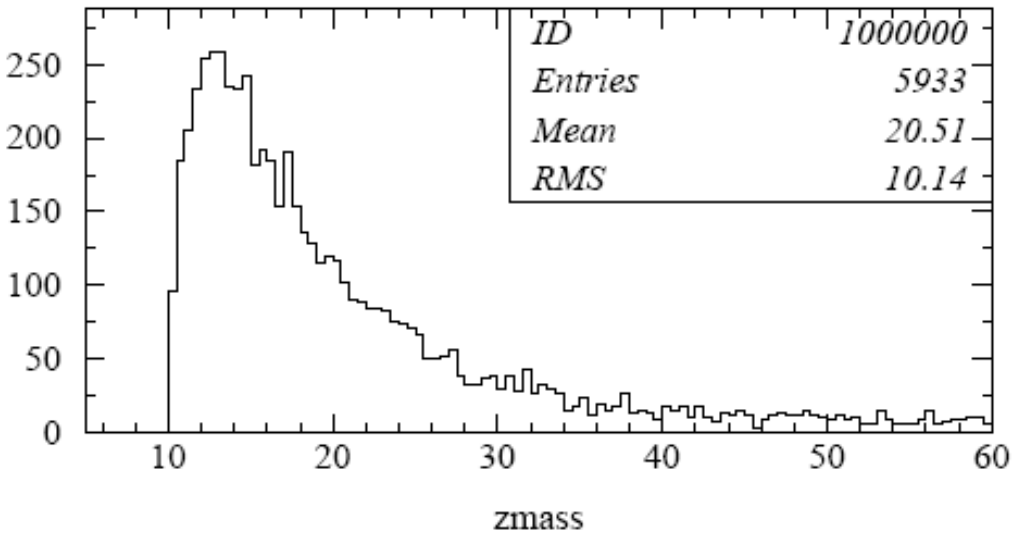
$x_{1,2} = \frac{1}{2} \sqrt{(x_f+4\tau)} \pm x_f$



Rapidity correlation of produced fermion pairs 1,2

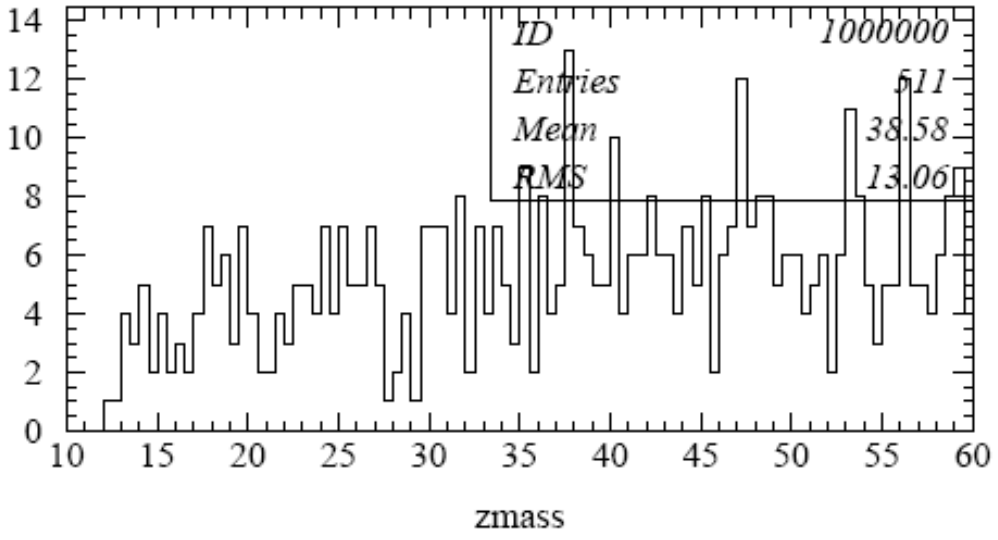
y=0 corresponds to $x_1=x_2$ of initial partons

Produced Q^2 (Mass) distributions



After P_T > 6 GeV for one fermion

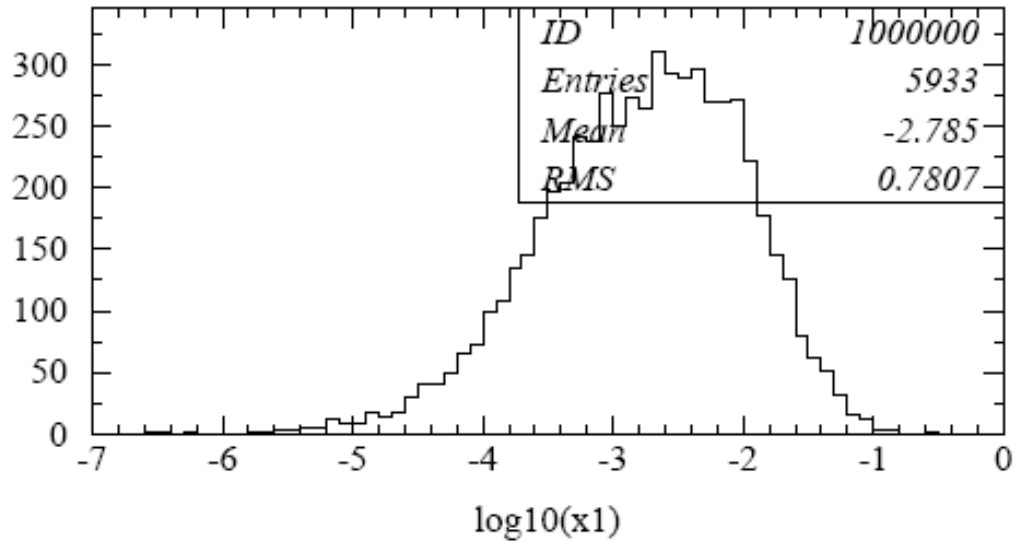
Can reach Q^2 ~ 100 GeV^2



After P_T > 20 GeV for one fermion

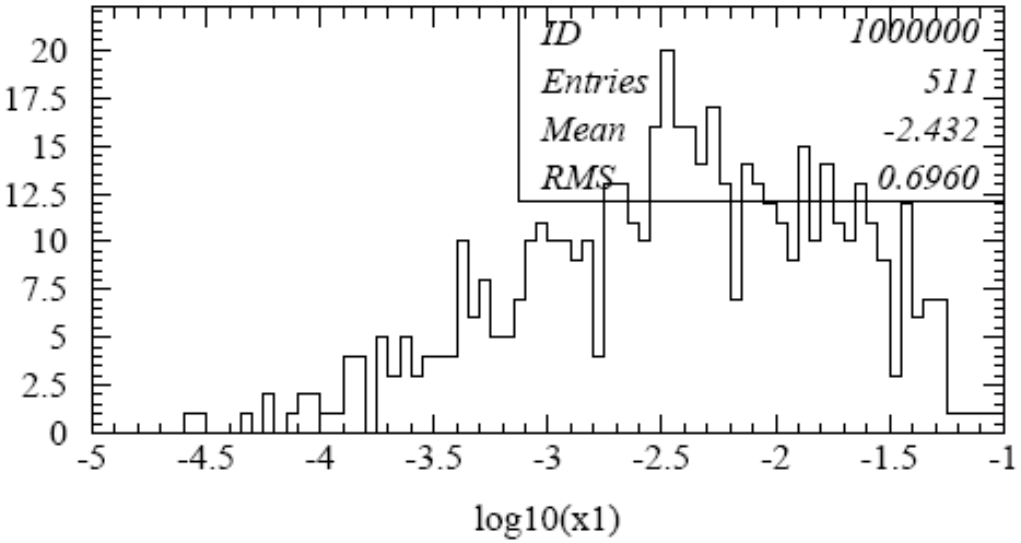
Need low P_T trigger

x of parton producing Drell-Yan pair



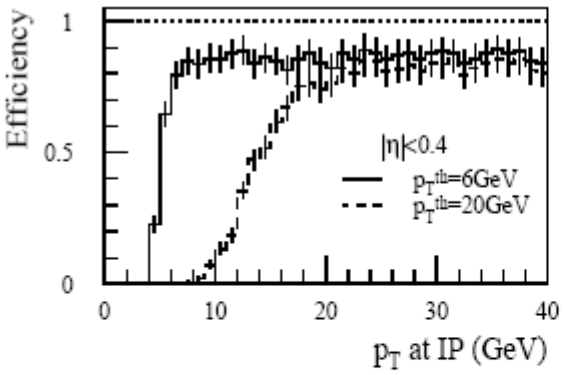
After P_T > 6 GeV for one fermion

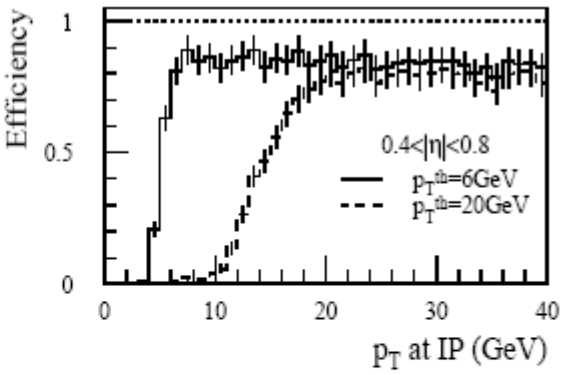
Can reach $x \sim 10^{-5}$



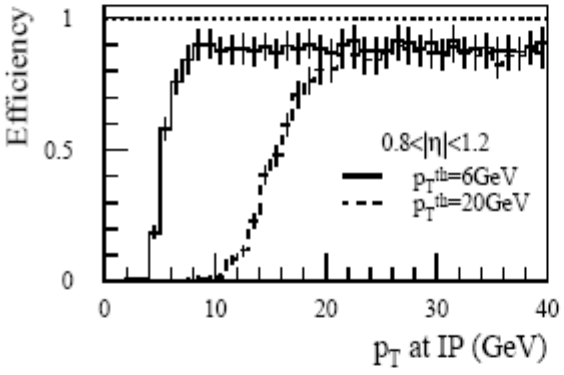
After P_T > 20 GeV for one fermion

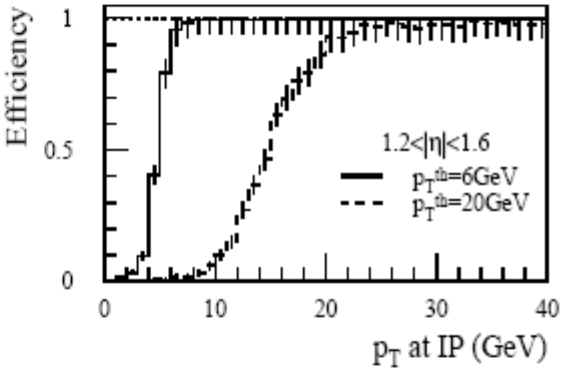
Need low P_T trigger





From ATLAS TDR:
Muon trigger efficiency

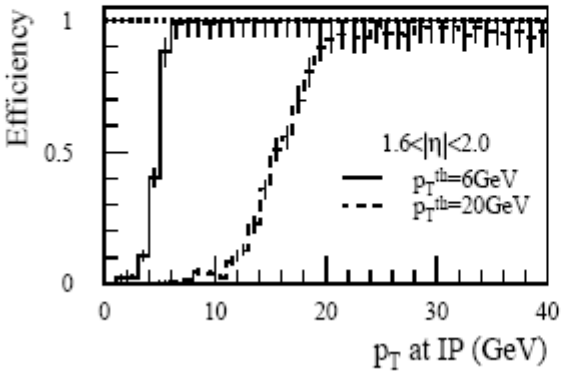


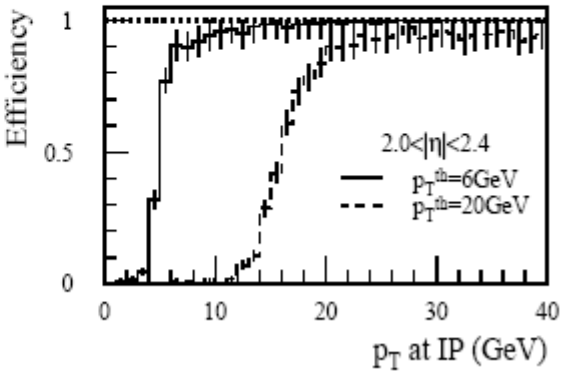


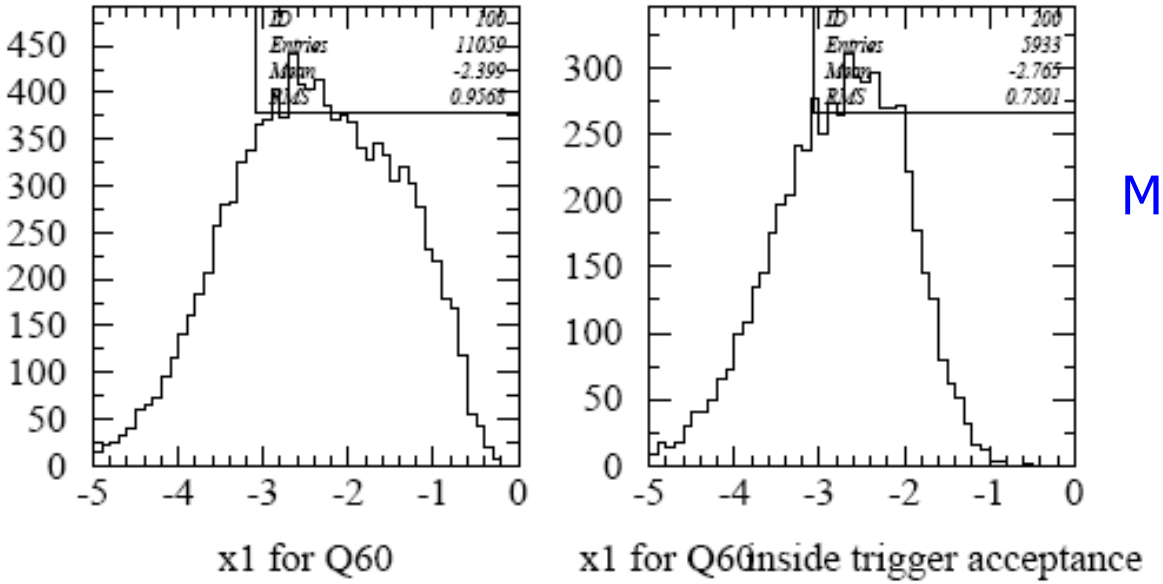
Muon triggers lowest Pt threshold:
6 & 20 GeV

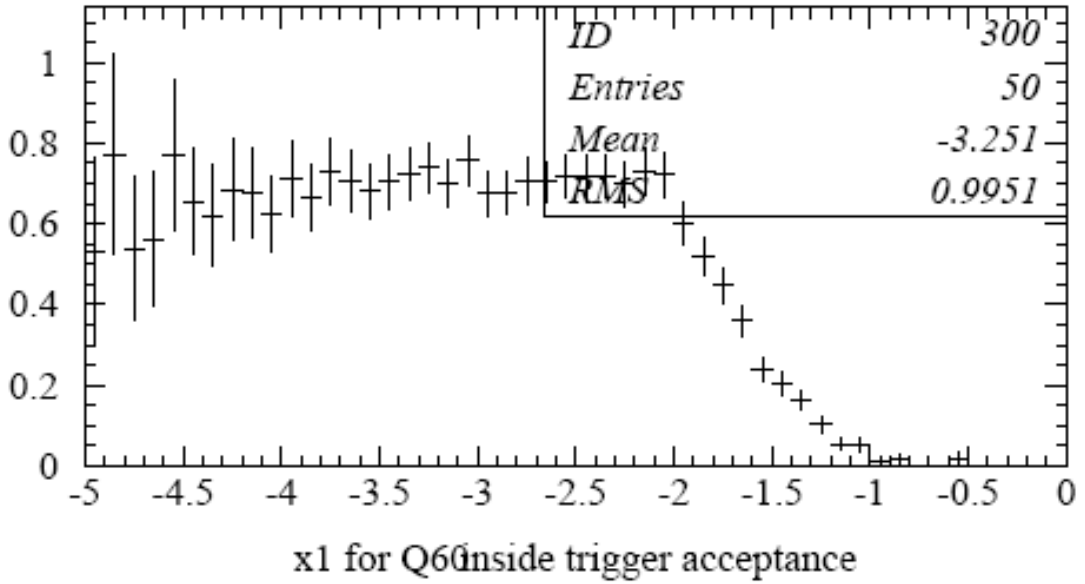
High efficiency: >90% at high η

Need low Pt to access lowest x physics









Muon trigger acceptance: $|\eta| < 2.5$

Trigger acceptance in η and P_T is constant for $\log(x) < 10^{-2}$

Measurement looks feasible

Next steps:

- use ATLFAST simulation - do we have exisiting samples?
- get absolute cross section estimate - contribution of b/g processes
- quantify precision needed for QCD testing ~ 5-10% measurement possible?