α_s determination at LHeC from inclusive ep data and jets

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α_s from DIS

- HERA inclusive: Eur.Phys.J.C21:33-61,2001
  - H1 and BCDMS data
  - $\alpha_s(M_Z)=0.1150\pm0.0017(exp)^{+0.0009}_{-0.0005}(mod)\pm0.005(NLO\ scale)$
  - 1.5% exp error (4.5% w/o BCDMS)
- HERA jets: DESY 09-032
  - H1 data
  - $\alpha_s(M_Z)=0.1168\pm0.0007(exp)+0.0046(th)\pm0.0016(PDF)$
  - 0.6% exp error

„Data“sets

Selection of data sets as provided by Max, from http://hep.ph.liv.ac.uk/~mklein/simdis09/

config.	E(e)	E(N)	N	∫L(e^+)	∫L(e^-)	|Pol|	L/10^{32}	P/MW years	type
A	20	7	p	1	1	-	1	10	1	SPL
B	50	7	p	50	50	0.4	25	30	2	RR hiQ^2
C	50	7	p	1	1	0.4	1	30	1	RR lo x
D	100	7	p	5	10	0.9	2.5	40	2	LR
E	150	7	p	3	6	0.9	1.8	40	2	LR
F	50	3.5	D	1	1	--	0.5	30	1	eD
G	50	2.7	Pb	0.1	0.1	0.4	0.1	30	1	ePb
H	50	1	p	--	1	--	25	30	1	lowEp

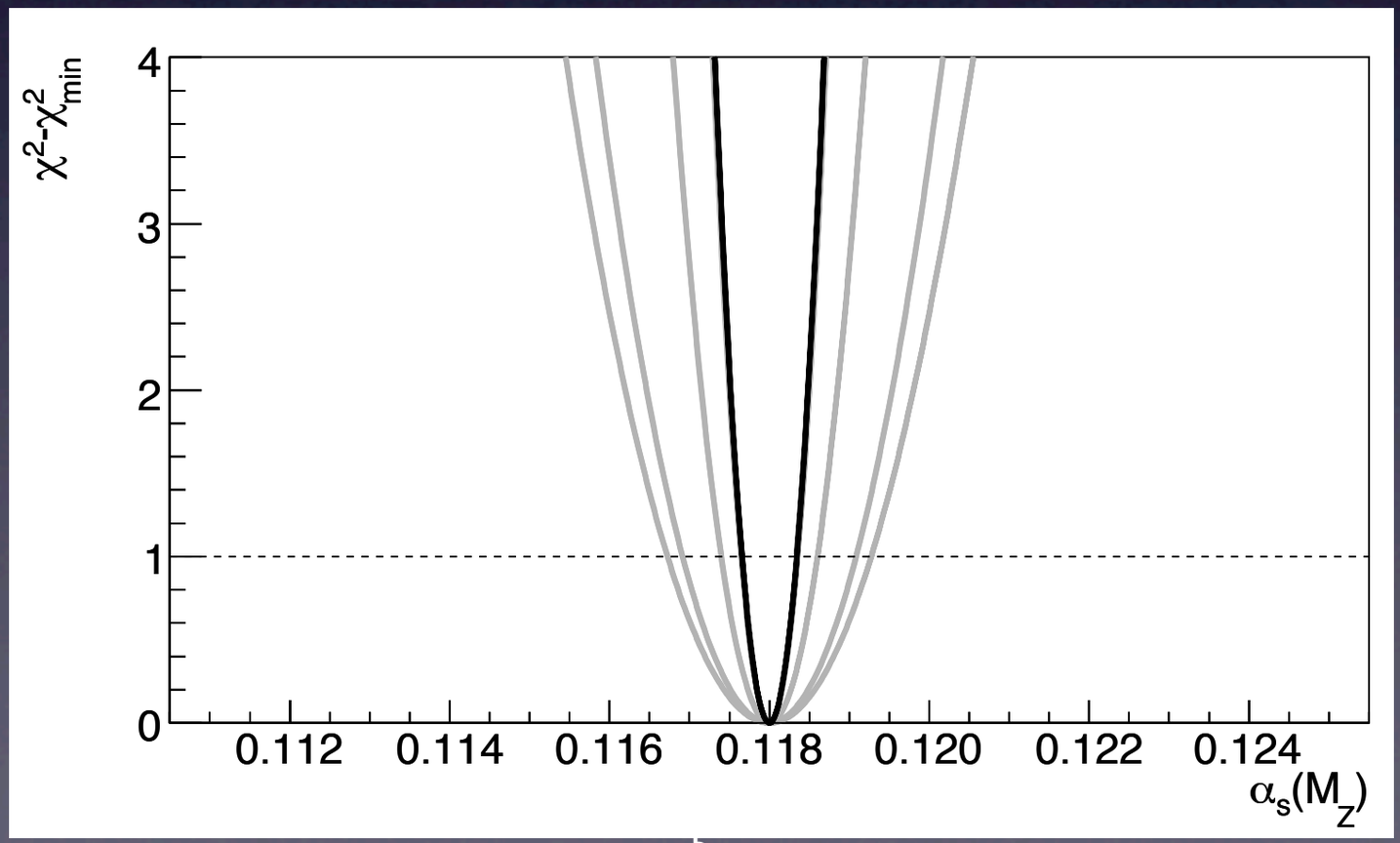
Fit Method

- Use H1 fit program (QCDNUM based)
- Simultaneous PDF and α_s fit
- Parameterisation and χ^2 like H12000 PDF
- Move data points to central PDF and $\alpha_s(m_Z)=0.118$ -> only errors enter
- Smear by statistical error, shift by correlated uncertainty, no cross correlation
- Luminosity 0.5%, half correlated btw datasets

B+C+H+F, NC+CC

Using all data, inclusive:

Uncertainty: 0.29%



Potential from inclusive Data

- LHeC has potential for O(1‰) experimental precision on $\alpha_s(m_Z)$ with inclusive data alone
- challenge for theory to keep up
- angular acceptance of the detector crucial, low E_p run also helps

Next Studies

- study impact of individual datasets
- impact of Q^2_{min} : 2;5;10 GeV^2
- Θ cut: 5° ; 10°
- systematic uncertainty from model, m_{charm}
- add jet cross sections, total fit, E_T bins for running

First look at DIS jets

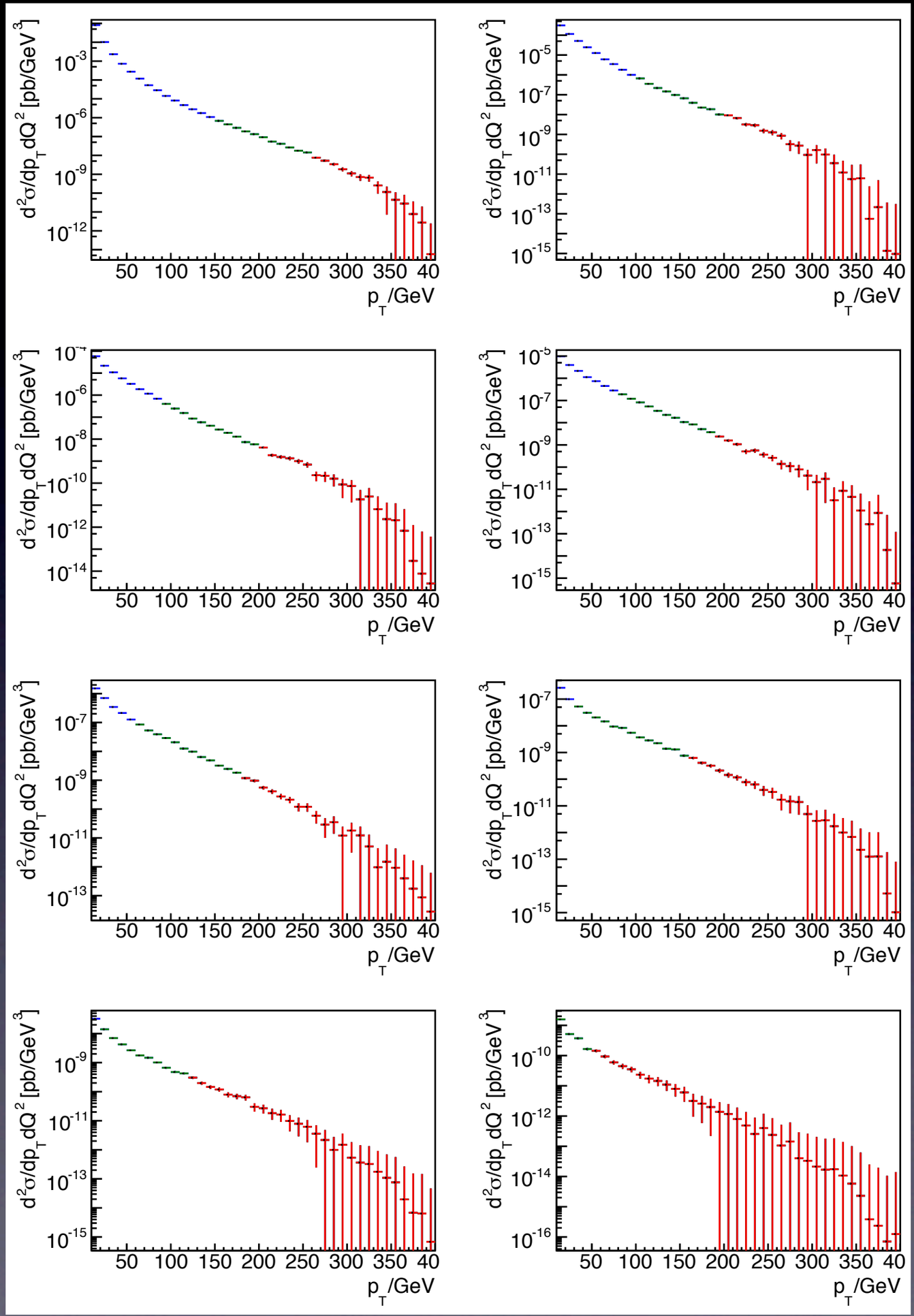
- NLOJET++ 4.0.1 (fastNLO)
- inclusive jet cross section
- incl. k_T jet algorithm in Breit frame
- PDF used : CTEQ66
- $s=4 \cdot 7000 \cdot 50$, $y=0.1...0.9$, $170° < \Theta_{lab} < 10°$
- $L=200 fb^{-1}$

Q^2 Regions

5-5000 Gev^2	5000-10000 Gev^2
10000-20000 Gev^2	20000-40000 Gev^2
40000-80000 Gev^2	80000-160000 Gev^2
16000-320000 Gev^2	320000-640000 Gev^2

p_T Binning

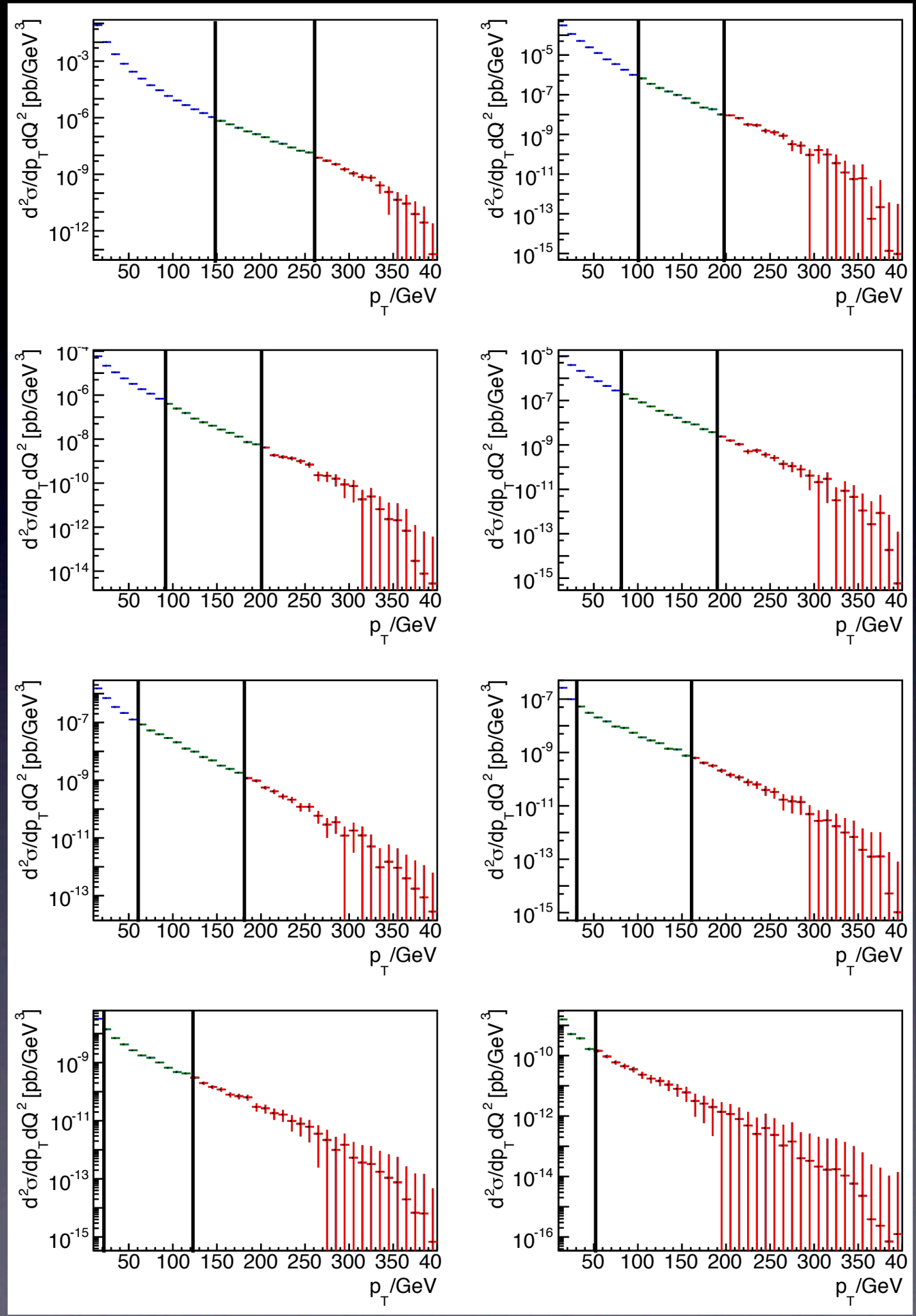
10Gev from 10GeV to 400GeV



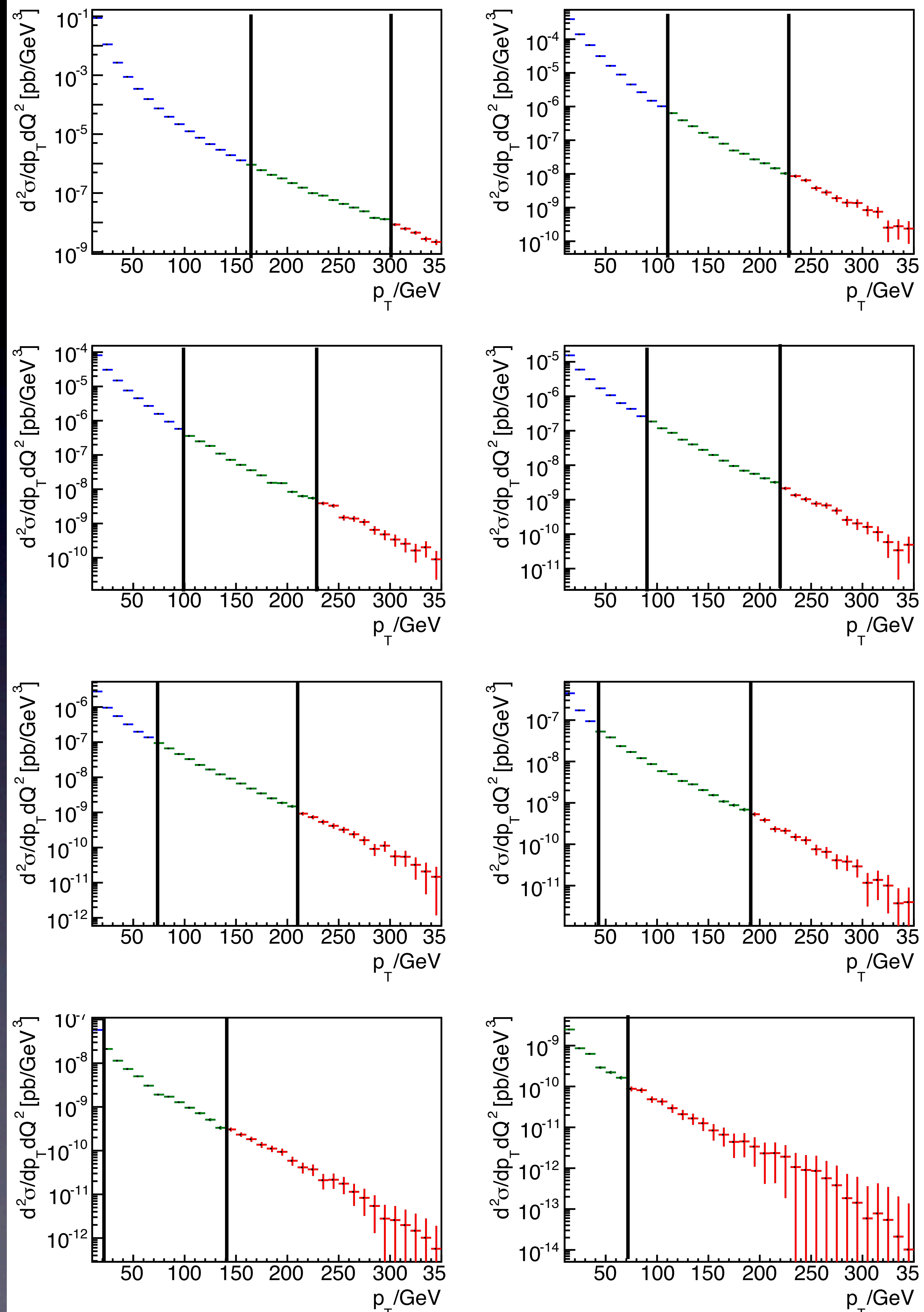
What is the reach in jet transverse momentum? (this is LO)

blue < 1% stat. error
green < 10% “
red >10% “

„Challenging“ to study slope of $\alpha_s(p_T)$ at m_{top} with 200fb^{-1}

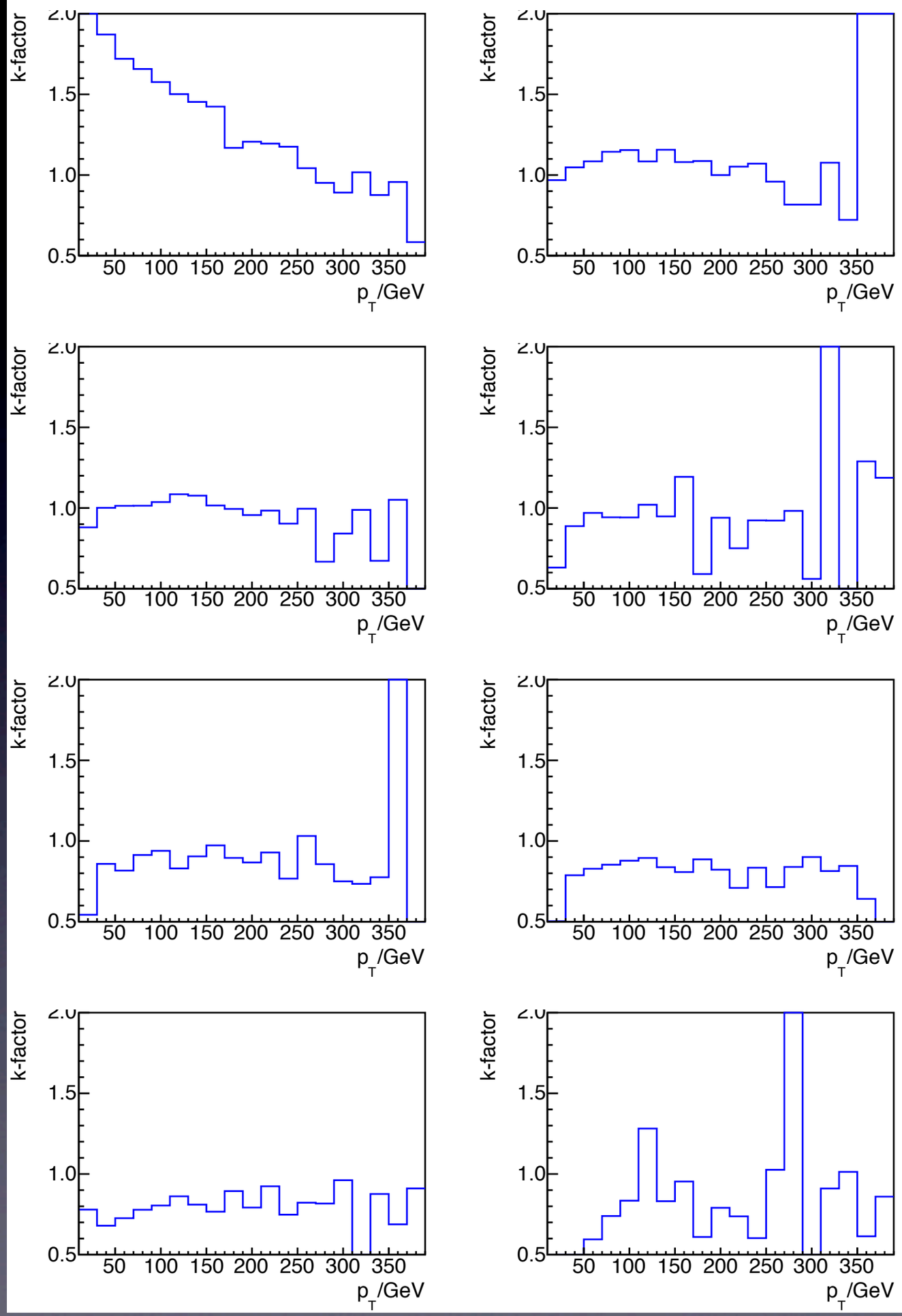


Same with 179°<Θ_{lab}<1° (p_T scale only to 350GeV!)



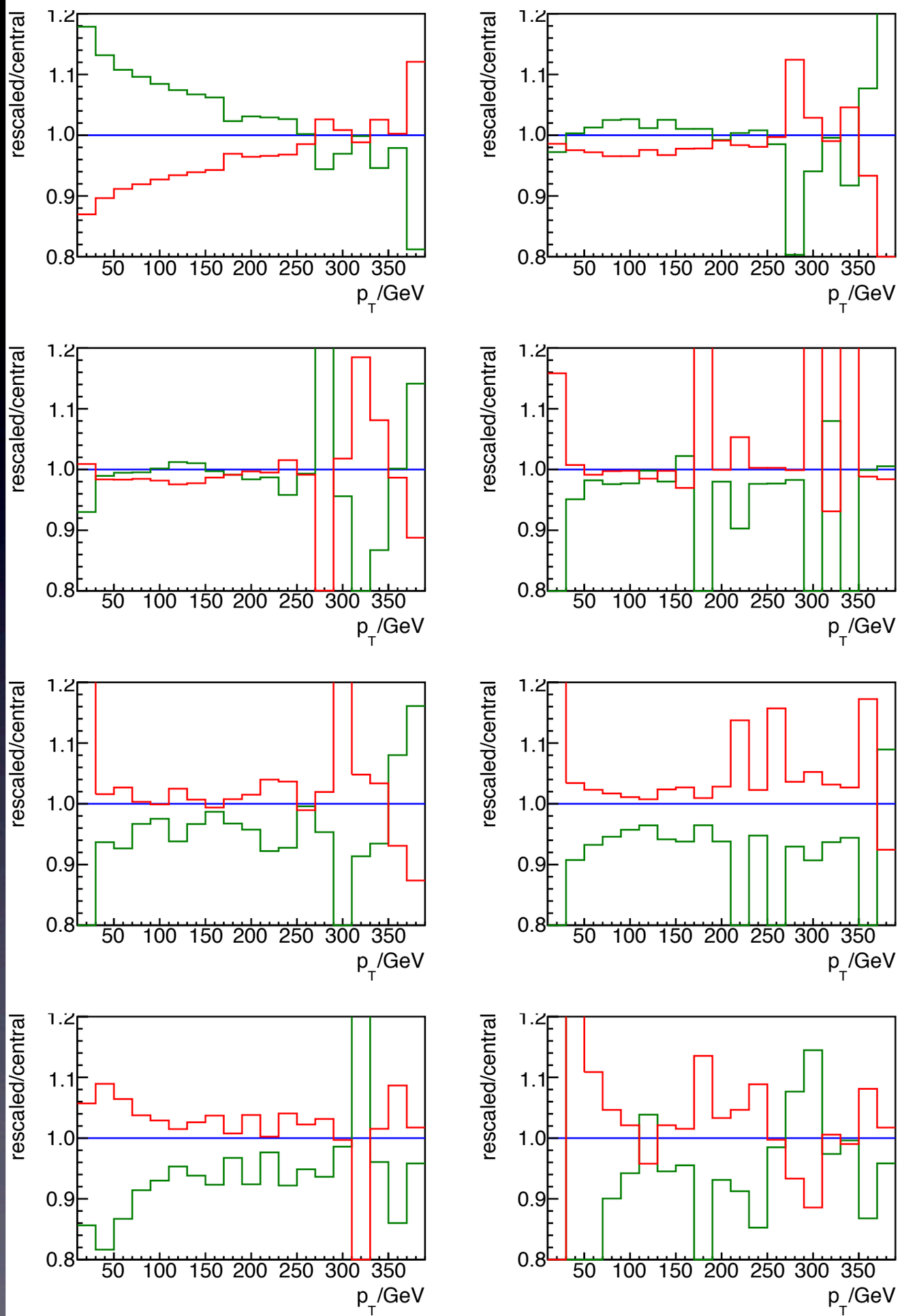
check k-factors

- lower Q^2: stronger effect
- intermediate Q^2: quite low over whole p_T range
- looks like NLO could be trusted



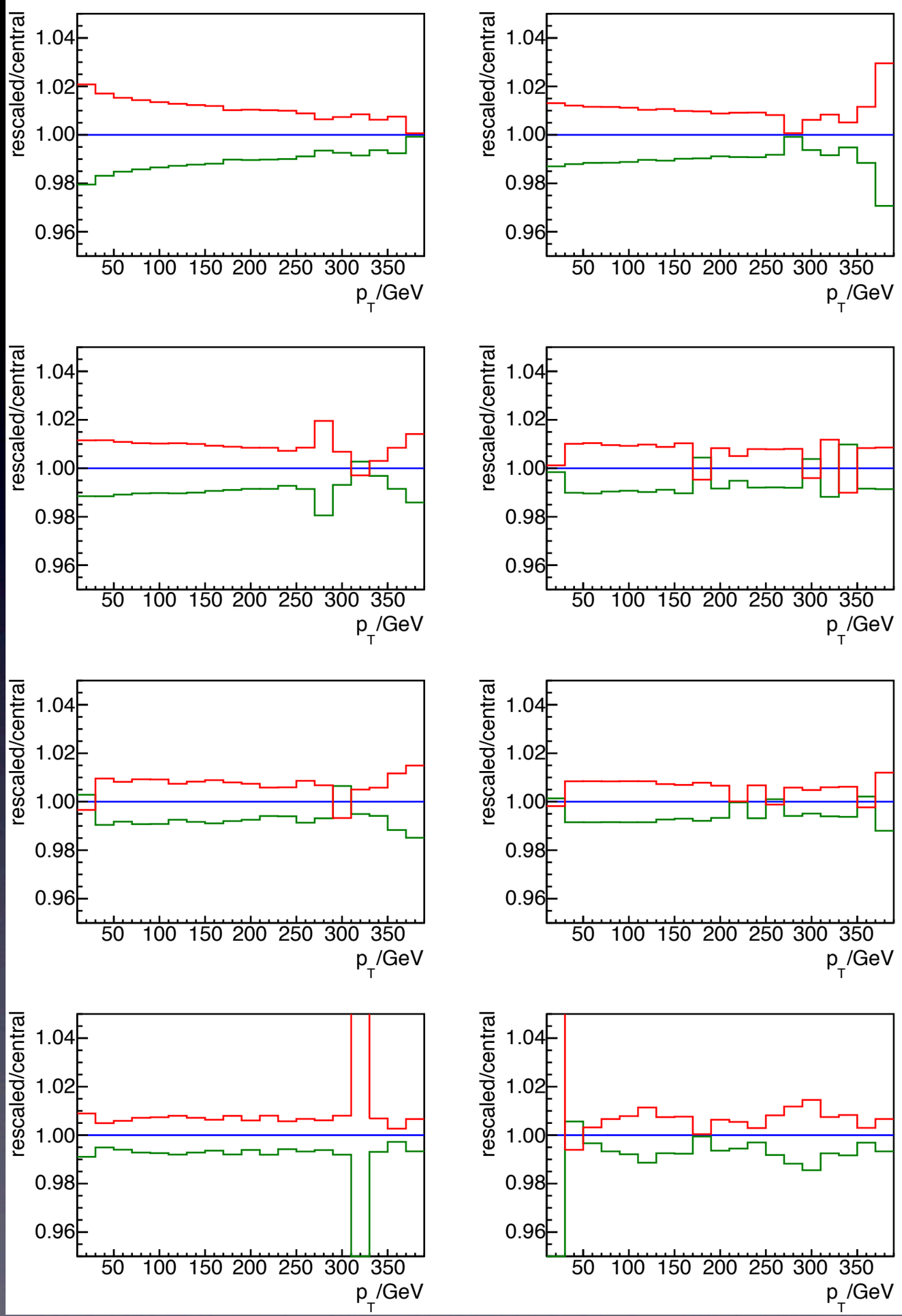
check scale uncertainty

- vary conventional $\cdot \frac{1}{2}$, $\cdot 2$
- lower Q^2: stronger effect
- intermediate Q^2: quite low over whole p_T range
- might be fluke, need scan of μ_r
- looks reasonable, but finally want NNLO!



check α_S sensitivity

- vary α_S by 1% at fixed PDF
- low Q^2: stronger than linear dependence
- higher Q^2: just linear
- does jet multiplicity play a role here?



Next Steps with Jets

- fake data: calculate incl. jets with PDF from LHeC fit
- add data set to inclusive fit
- assume O(1%) uncertainty on jet energy scale
- fit $\alpha_s(m_Z)$ and running $\alpha_s(p_T)$