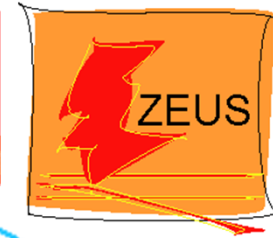


# The ZEUS experiment at HERA



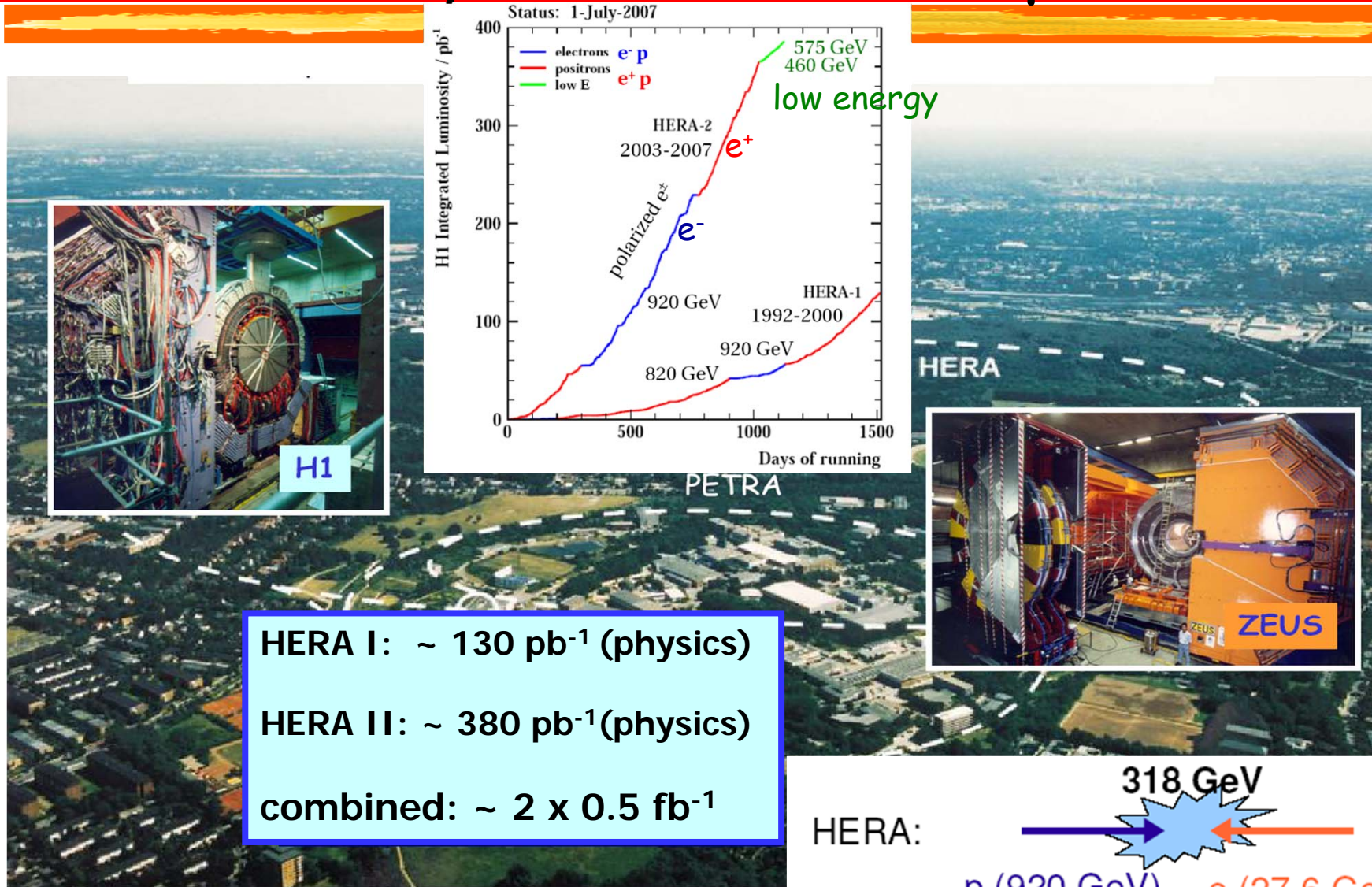
Achim Geiser, DESY Hamburg  
special colloquium for Summer Students

DESY = host lab for  
~50 institutes worldwide



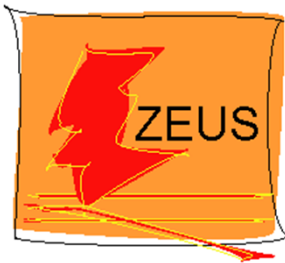
- Introduction
- Examples for physics topics
  - close collaboration with H1      -> further examples
  - relation to physics topics at LHC

# The HERA ep collider and experiments

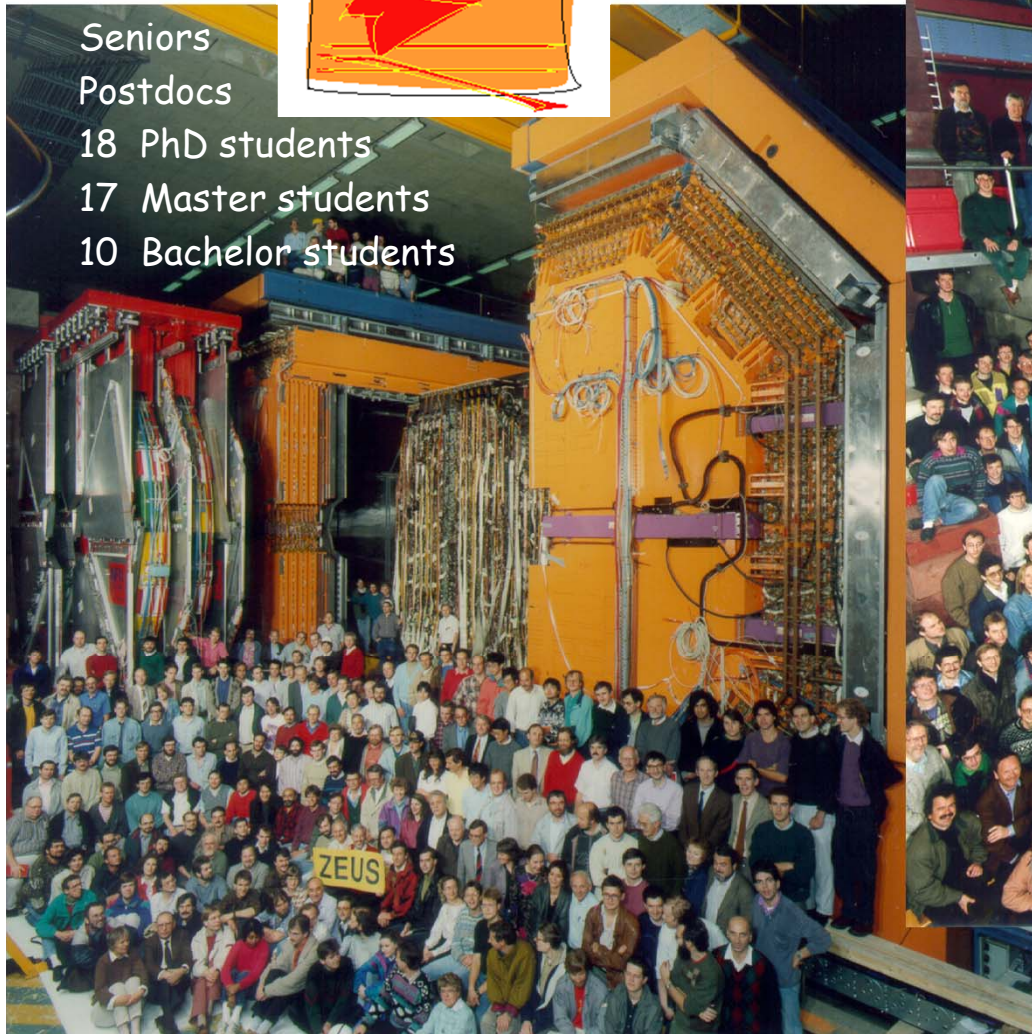




# Particle Physics = People



Seniors  
Postdocs  
18 PhD students  
17 Master students  
10 Bachelor students



**Analysis ongoing !**

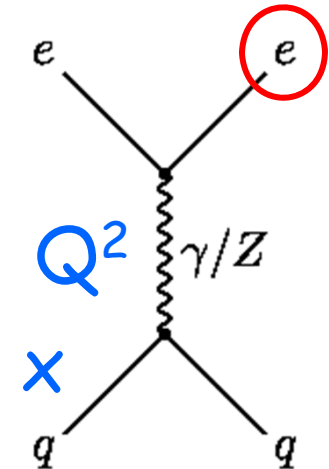
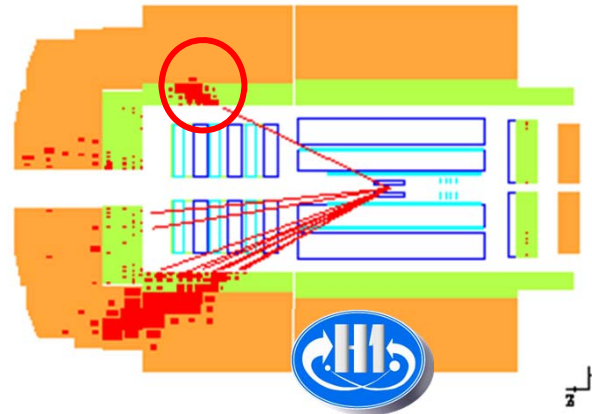
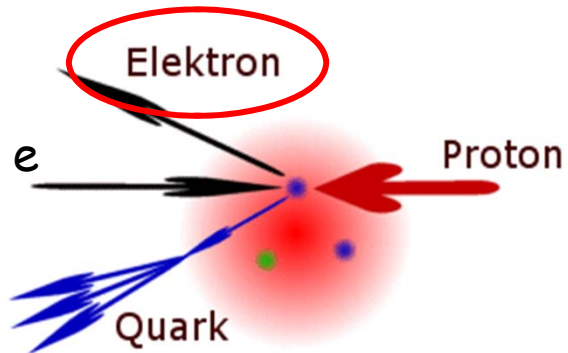
23.8.11

A. Geiser, The ZEUS experiment

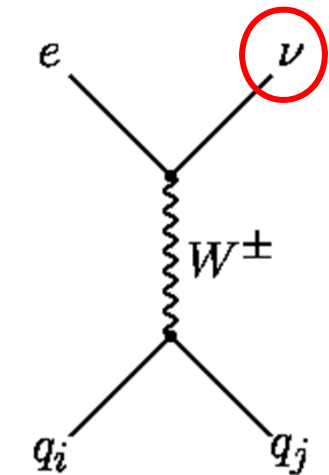
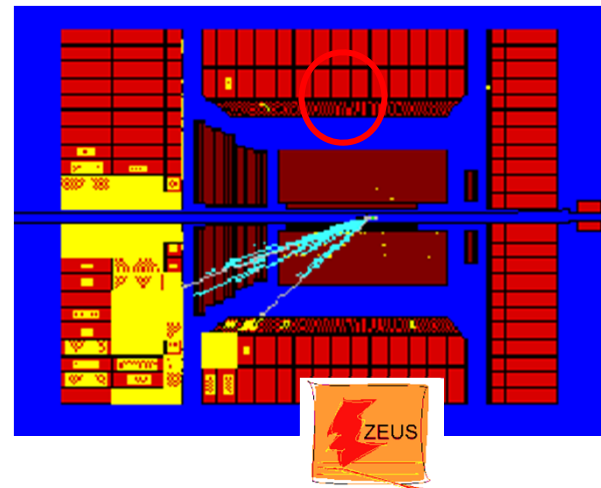
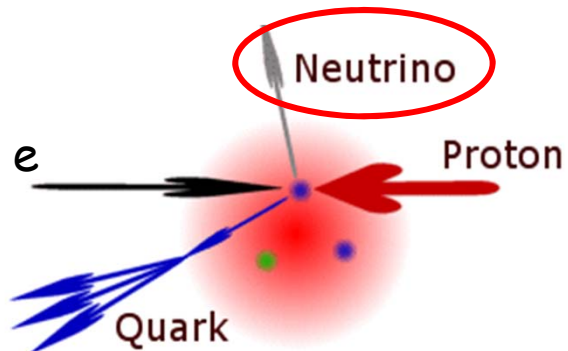
3

# Electroweak Physics at HERA

Neutral Current (NC) interactions



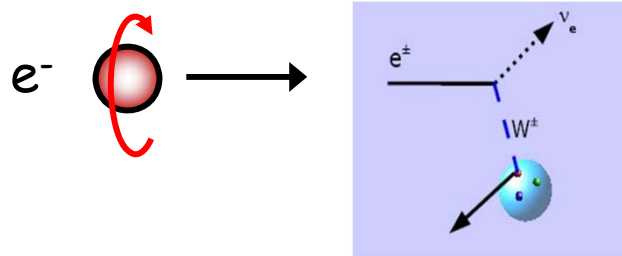
Charged Current (CC) interactions



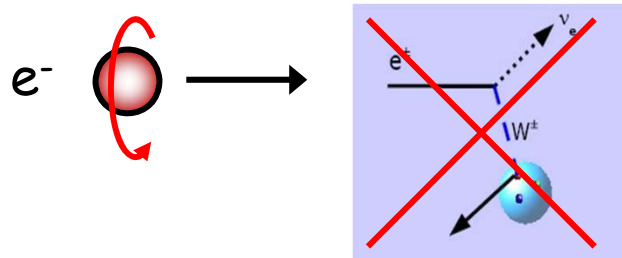


# Weak interactions are "left-handed"

- left-handed electrons interact (CC)



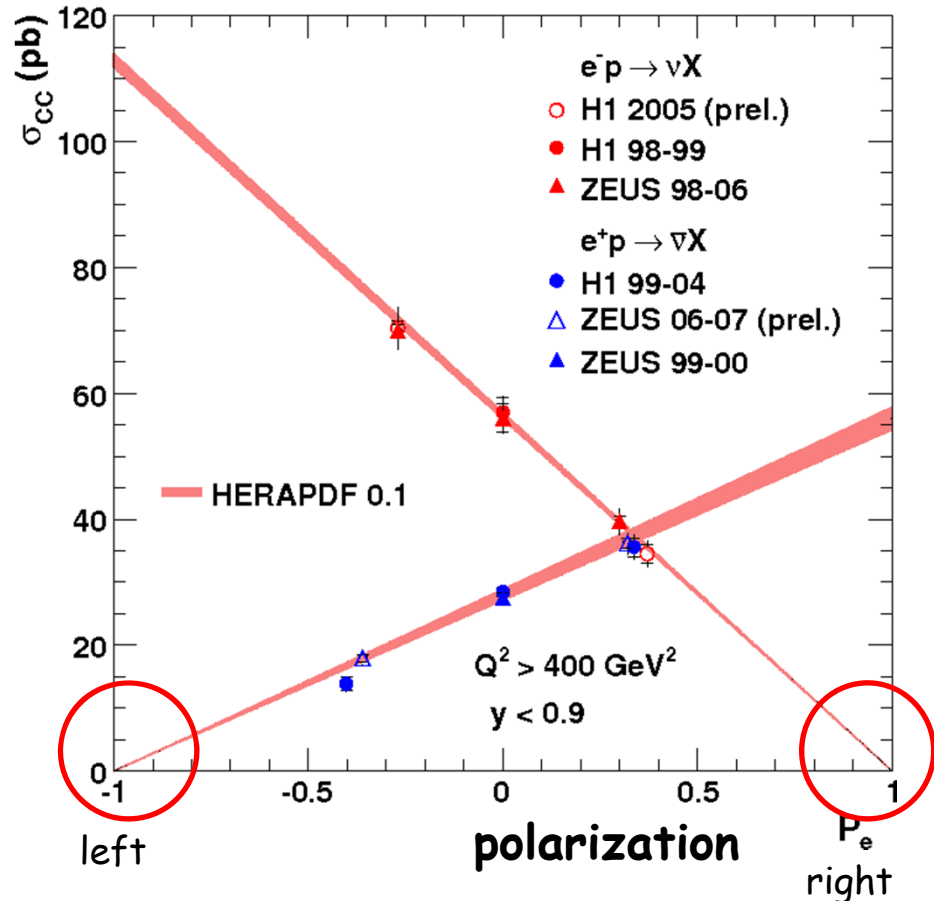
- right-handed electrons do not!



- cross section linearly proportional to polarization

$$\sigma_{polCC}^{e^\pm p} = (1 \pm P_e) \cdot \sigma_{unpolCC}^{e^\pm p}$$

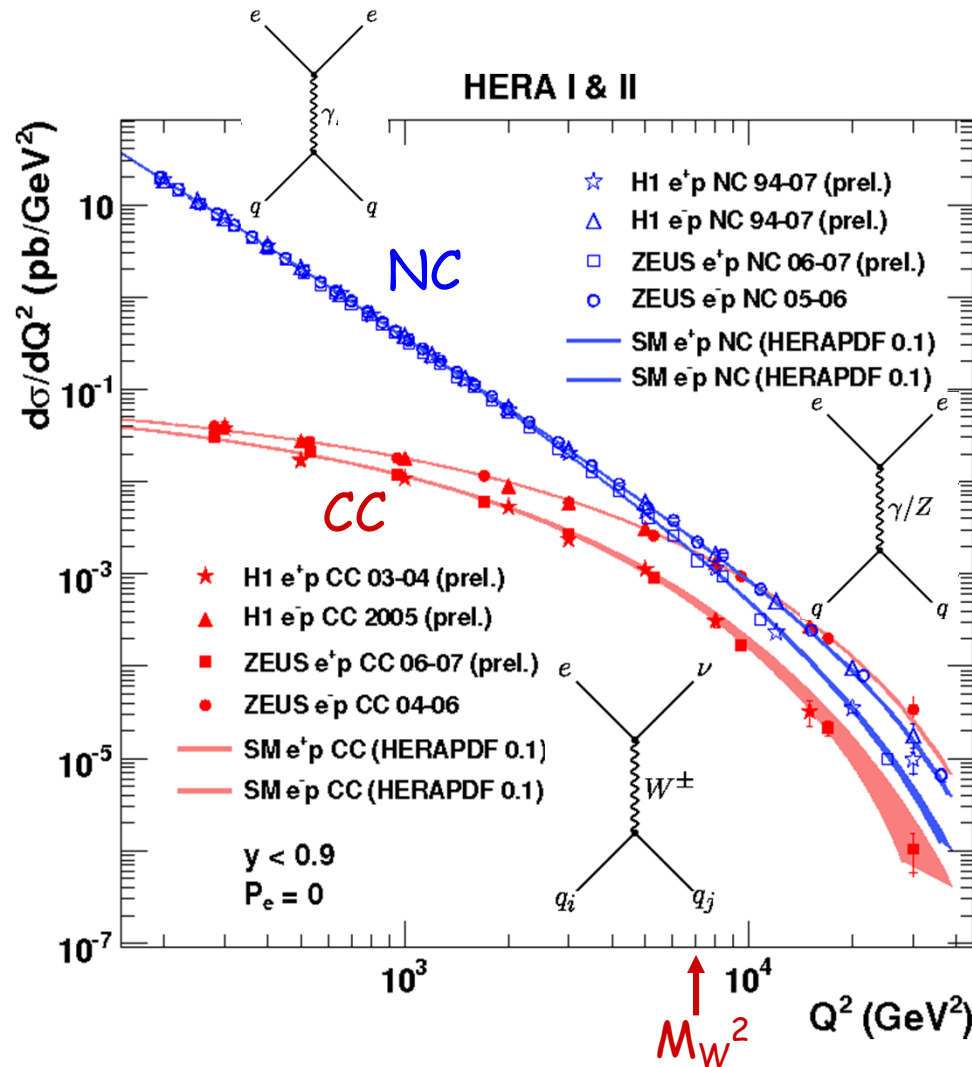
## Polarized CC Cross Sections



**It works!**



# Electroweak Unification

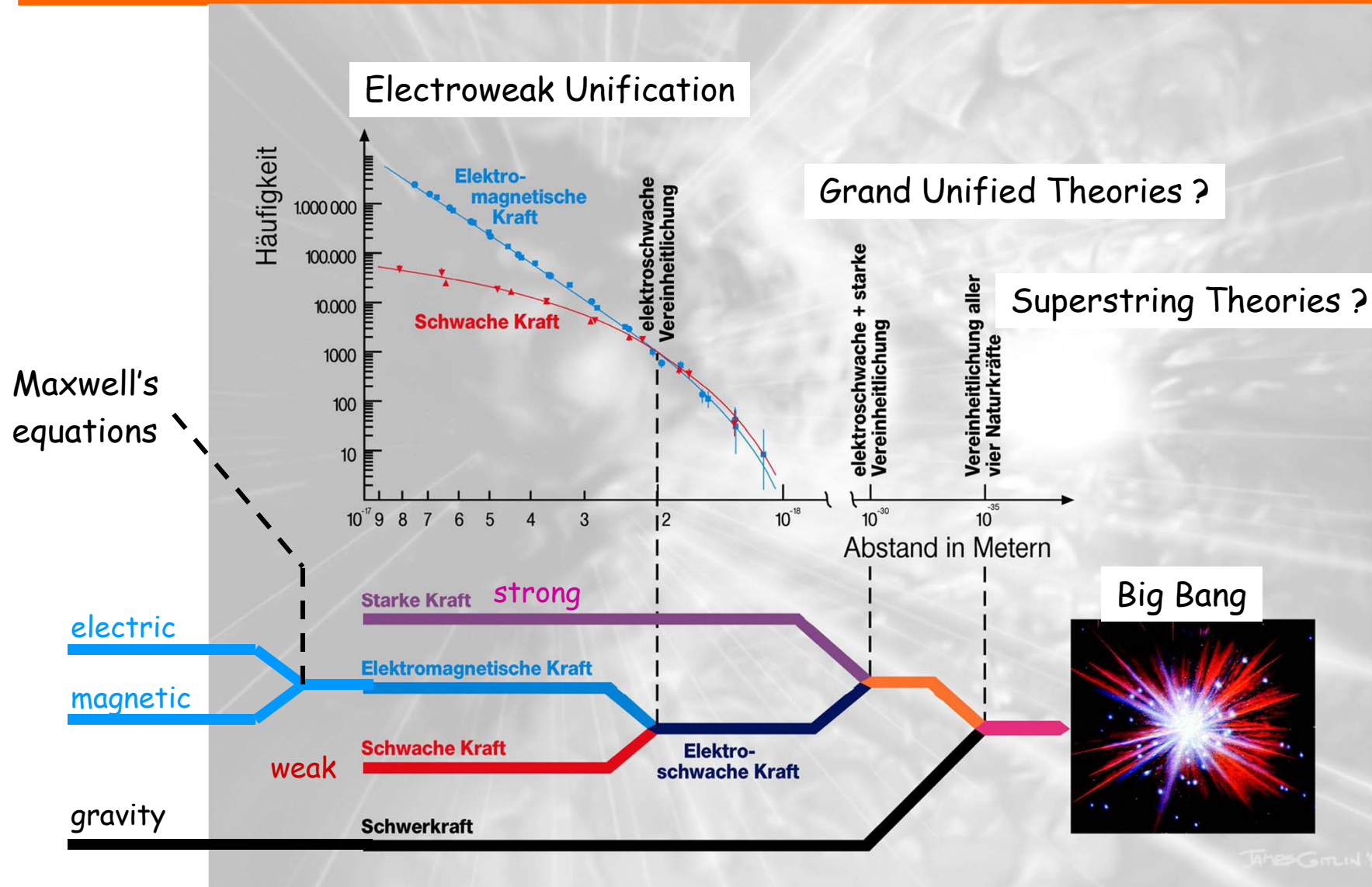


**Strength of weak and  
electromagnetic  
forces become similar  
at scale  $Q^2 \sim M_W^2$**

$$\frac{d^2\sigma_{NC}}{dQ^2 dx} \sim \alpha^2 \frac{1}{Q^4} \frac{1}{x} \Phi_{NC}(x, Q^2)$$

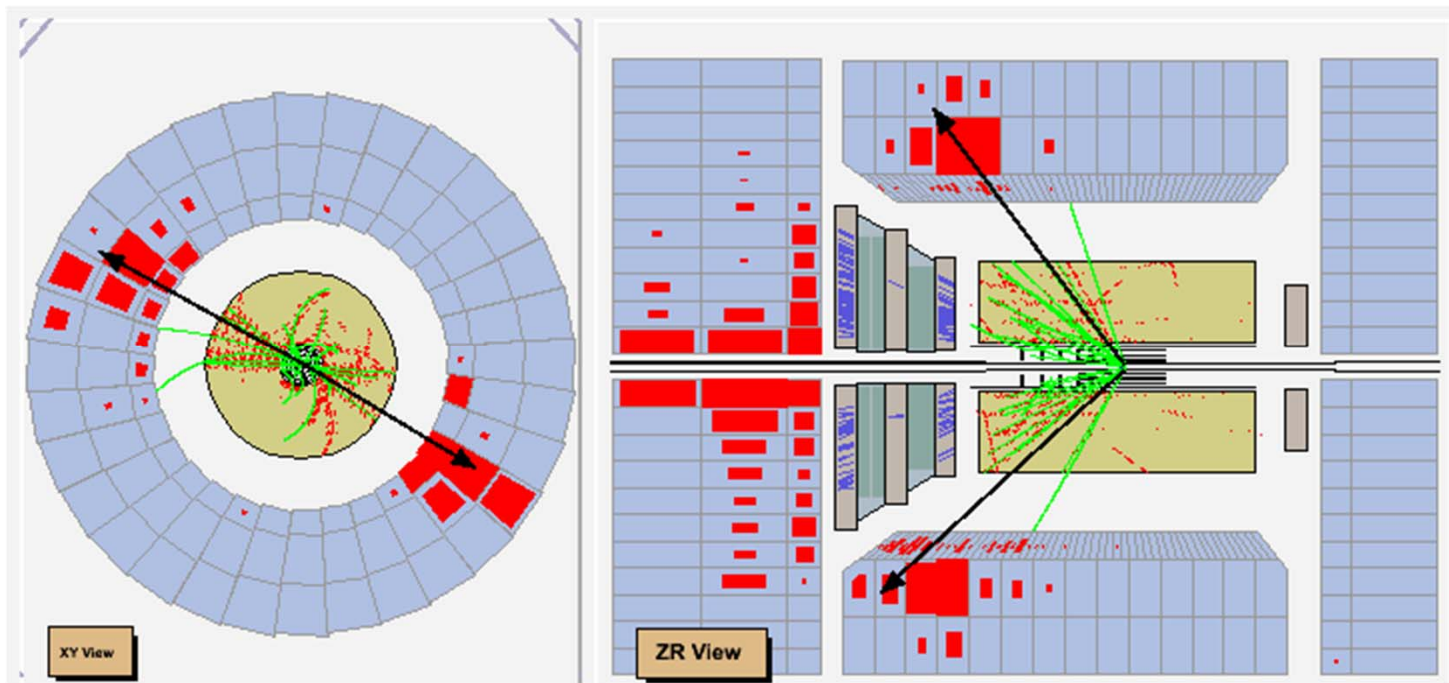
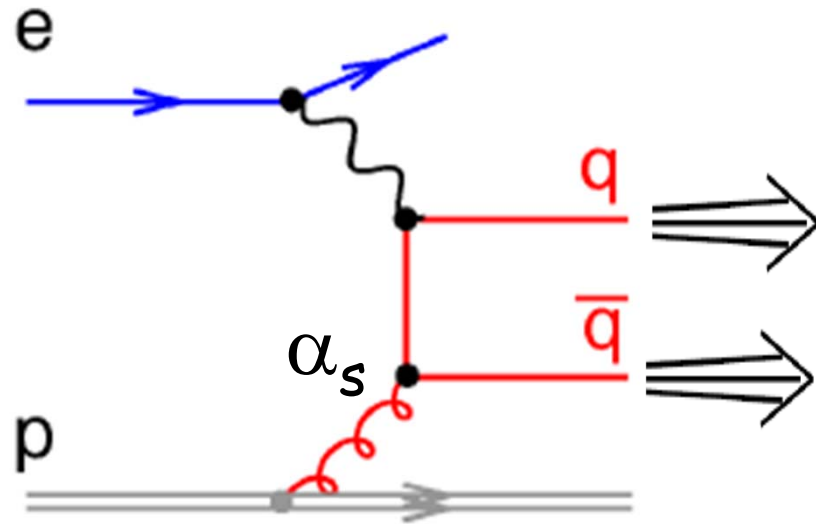
$$\frac{d^2\sigma_{CC}}{dQ^2 dx} \sim G_F^2 \left( \frac{M_W^2}{M_W^2 + Q^2} \right)^2 \frac{1}{x} \Phi_{CC}(x, Q^2)$$

# The Quest for Unification of Forces



# Jets and $\alpha_s$

Quantum Chromodynamics  
(QCD)



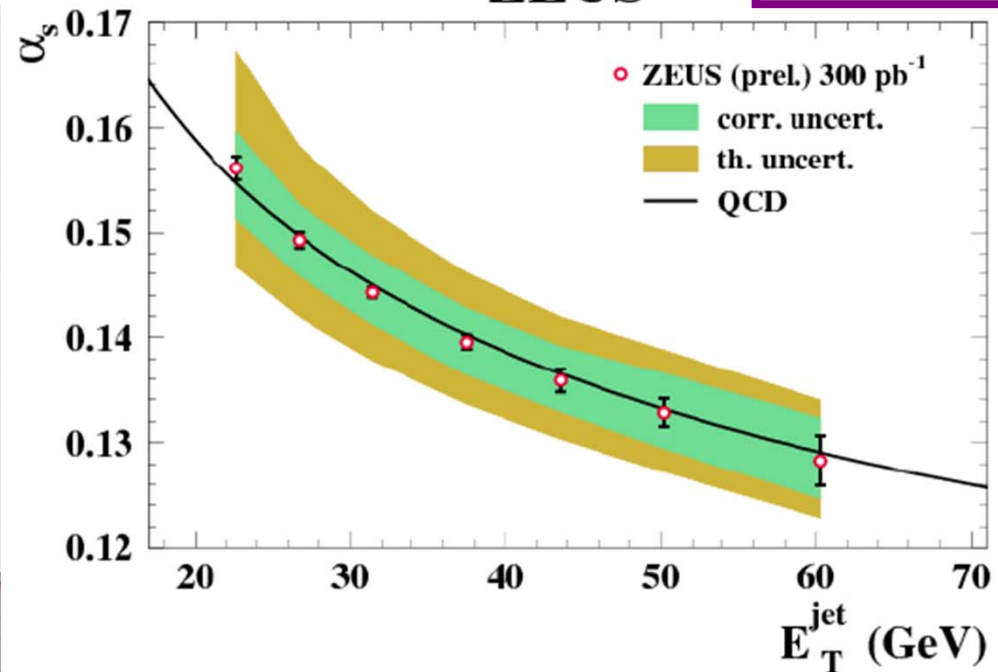
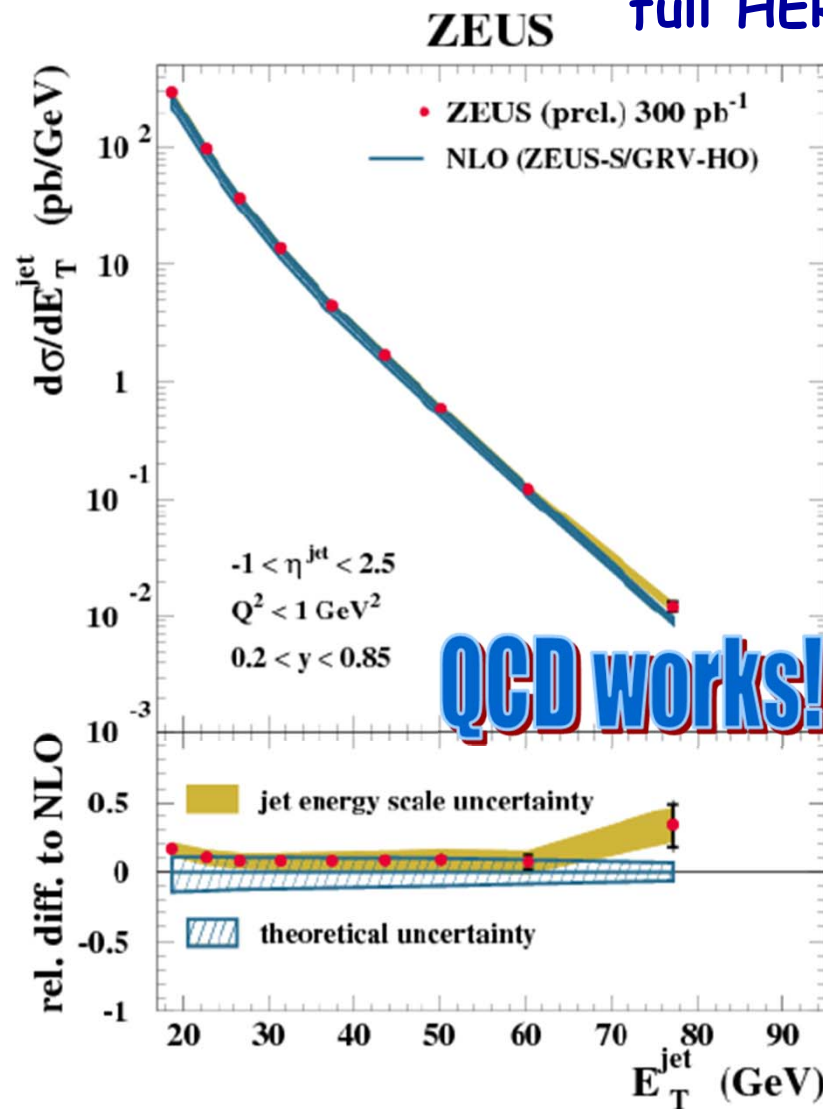


# Inclusive jet production and $\alpha_s$



full HERA II statistics

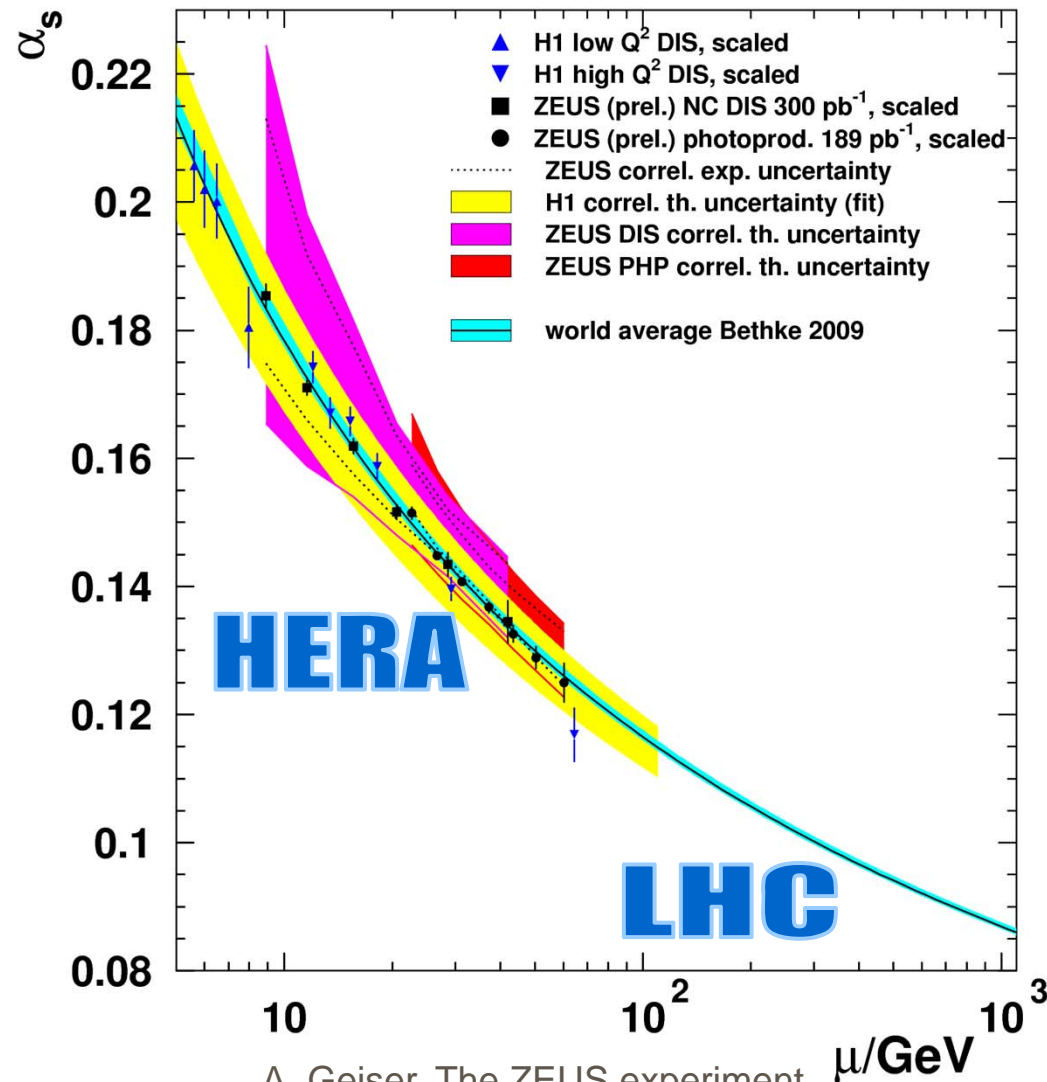
Master thesis



$$\alpha_s(M_Z) = 0.1206 \quad {}^{+0.0023}_{-0.0022}(\text{exp.}) \quad {}^{+0.0042}_{-0.0033}(\text{theo.})$$

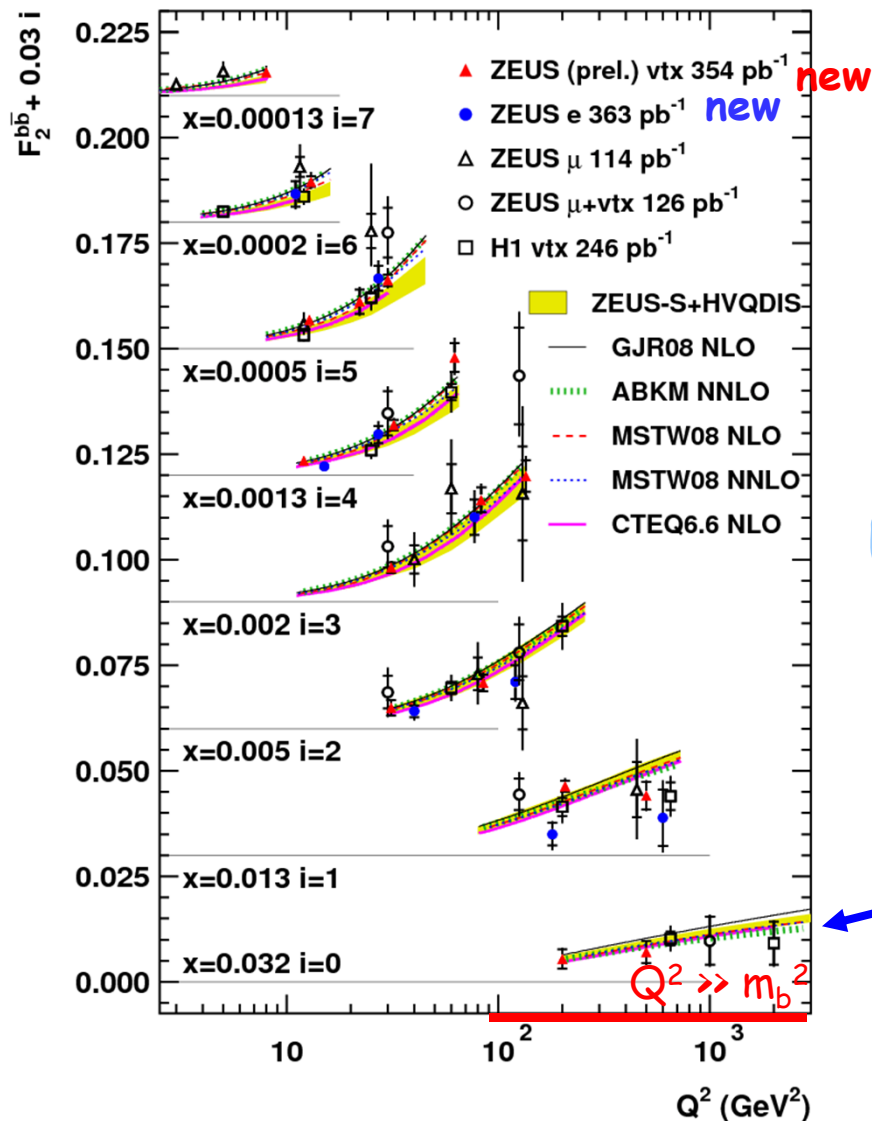
running of  $\alpha_s$  consistent with QCD expectations

# $\alpha_s$ from the HERAscale to the Terascale



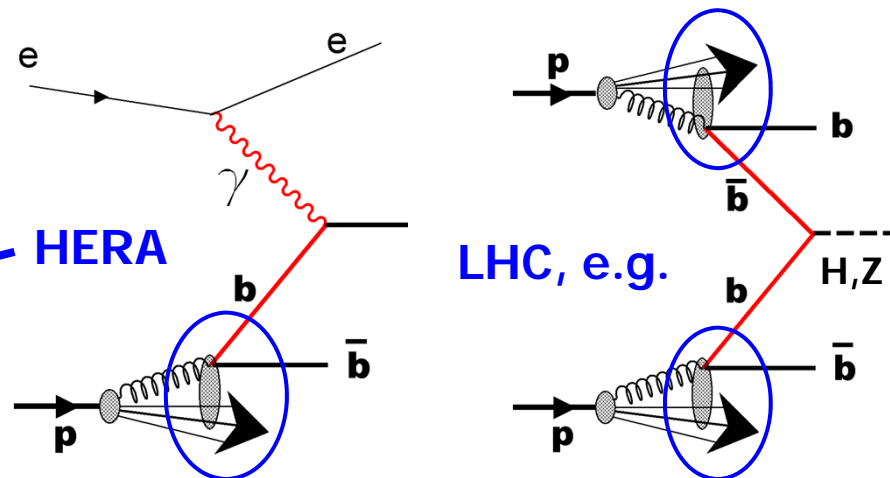
# beauty contribution to p structure function $F_2$

PhD thesis



check  $b$  mass treatment in QCD:  
in agreement with data,  
further improvements possible

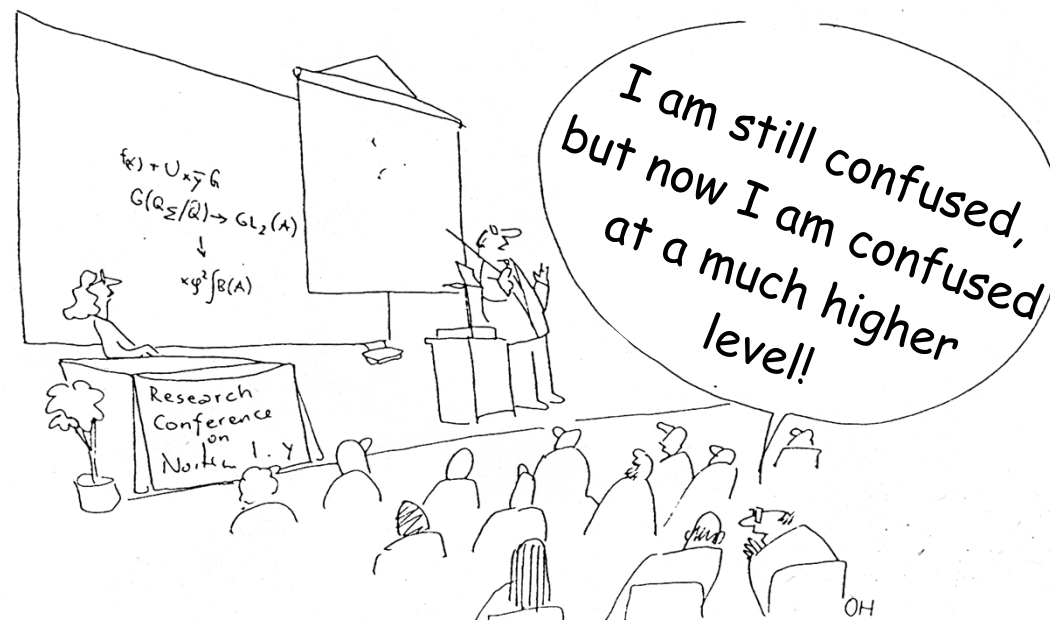
check „ $b$  in proton“ for LHC: Z, Higgs





# Particle Physics at HERA is exciting!

- We already know a lot, but many open issues



- Many further physics insights (~50 ZEUS papers) expected for the coming decade!

**Join the Fun!**