Experiments of the last 60 years

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- The early years
- Neutrino experiments
- High-energy colliding-beam experiments (and some fixed-target results)

Early years

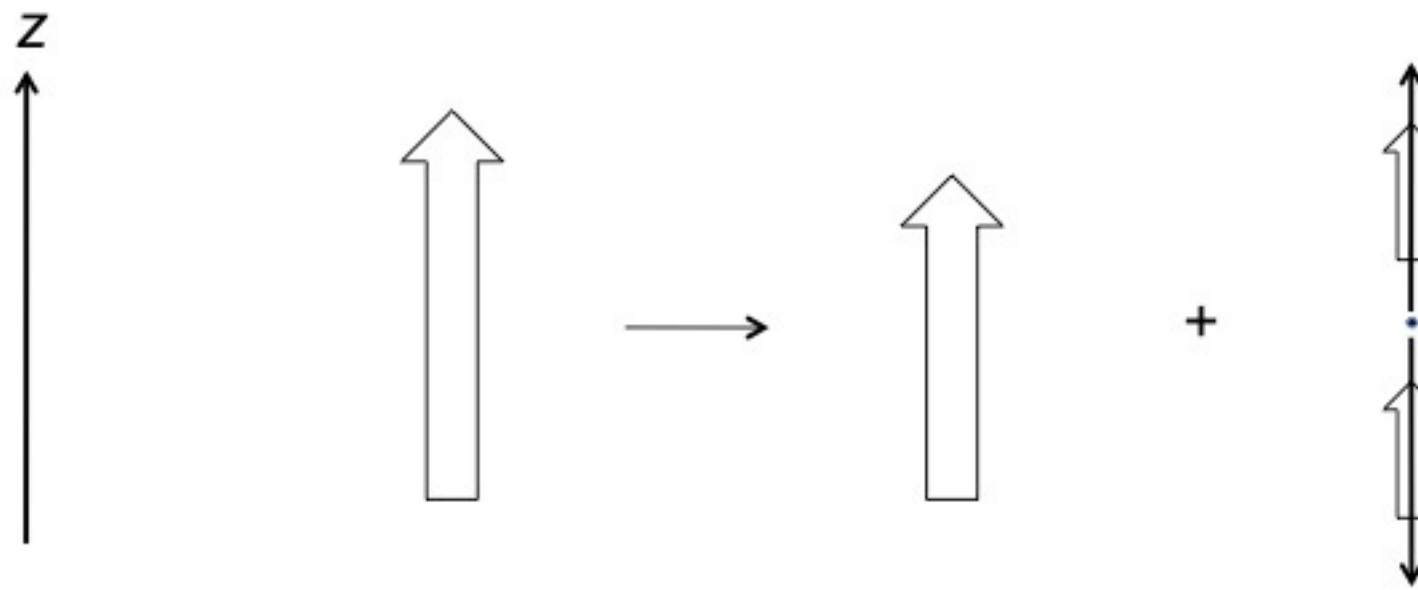
$$\pi^+ + P \xrightarrow{\Delta^{++}} \pi^+ + P$$

$$\gamma + P \xrightarrow{\Delta^{+}} \gamma + P$$

$$\pi^+ \rightarrow \mu^+ + \nu$$

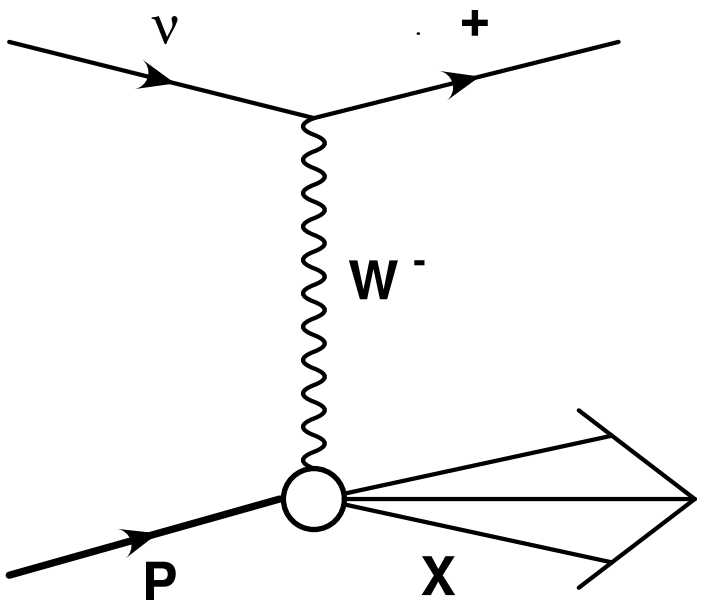
$$\mu^+ \rightarrow e^+ + \overline{\nu}_\mu + \nu_e$$

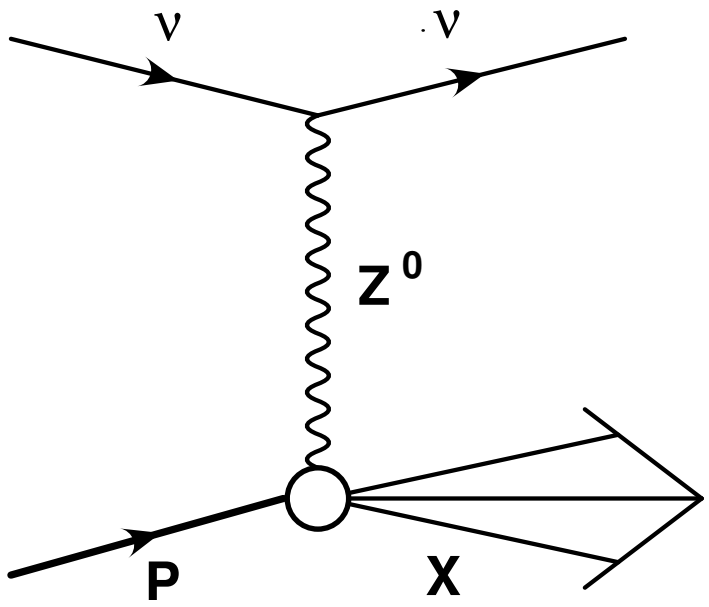
Parity violation



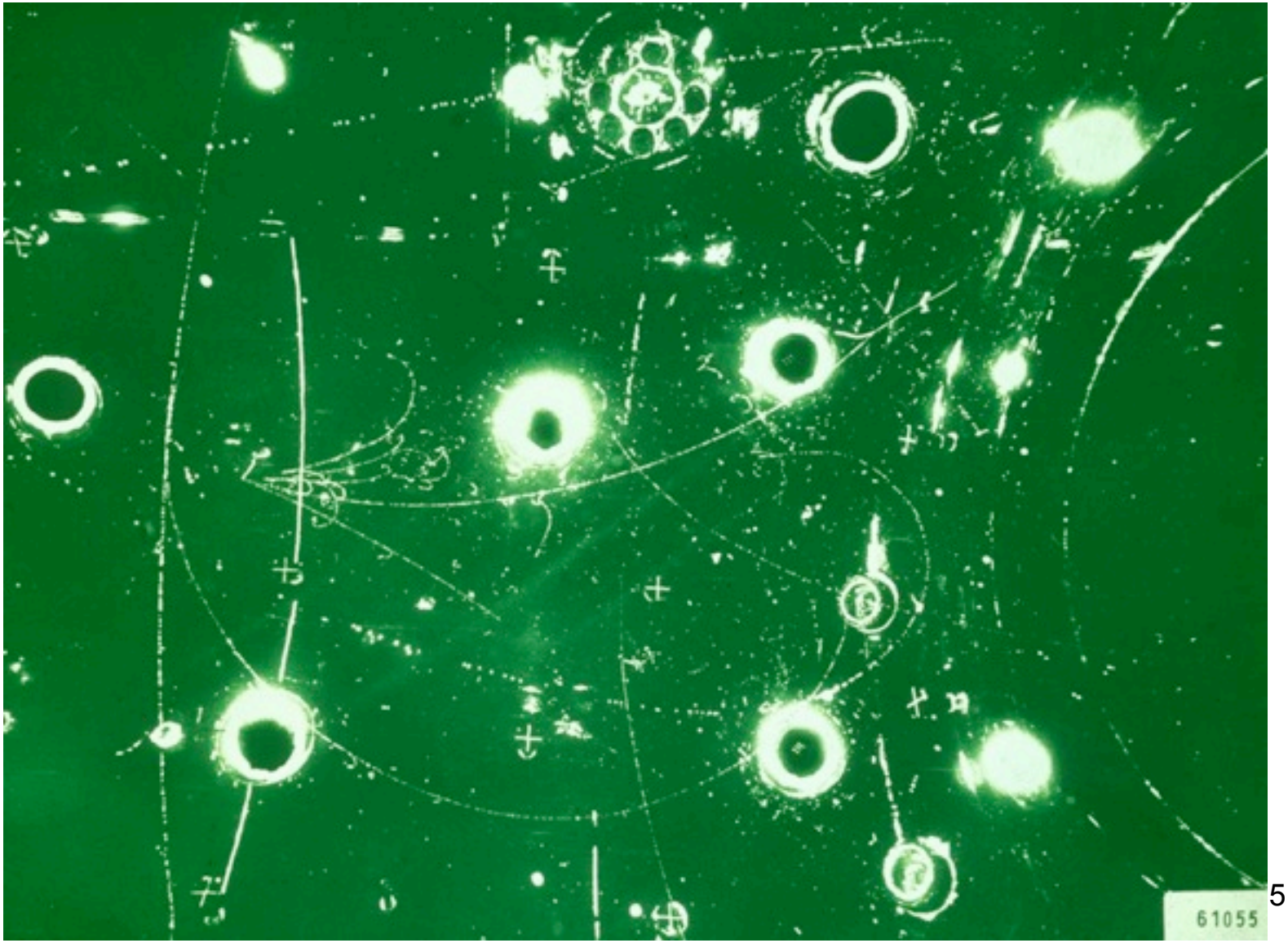
$^{60}Co \longrightarrow {}^{60}Ni^{*} + (e^{-})_L + (\bar{\nu})_R$

Discovery of neutral currents





A Gargamelle event



The neutrino problem

Solar neutrinos :

$$P + P \rightarrow d + e^{+} + \nu_e$$

Atmospheric neutrinos :

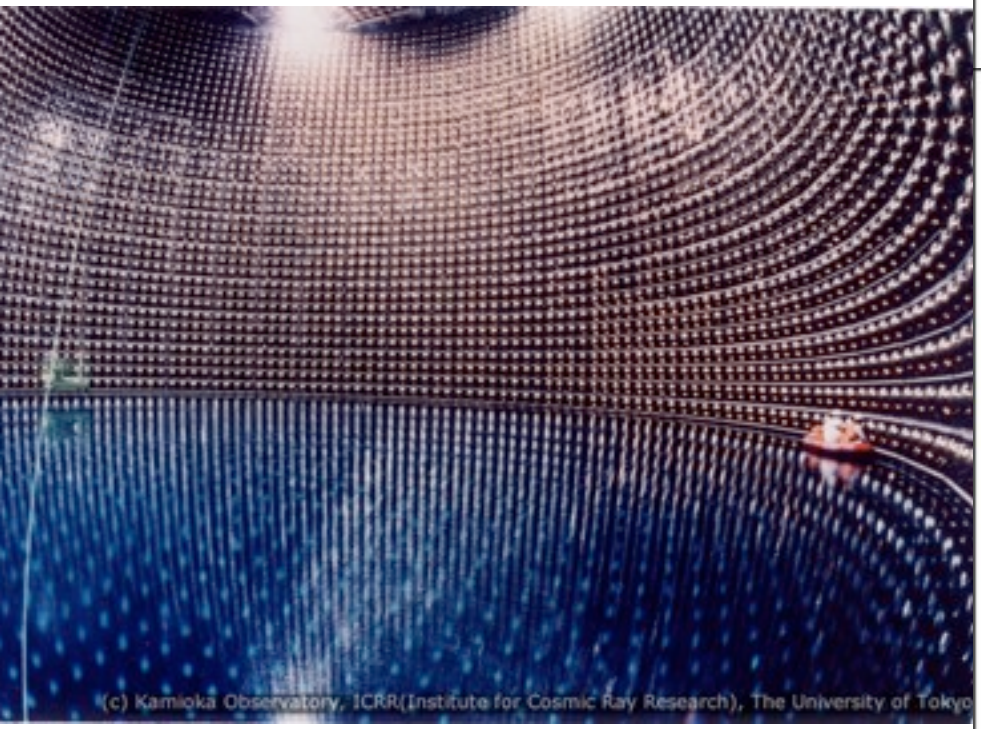
$$P + N \rightarrow \pi^{+}(K^{+}) + H$$

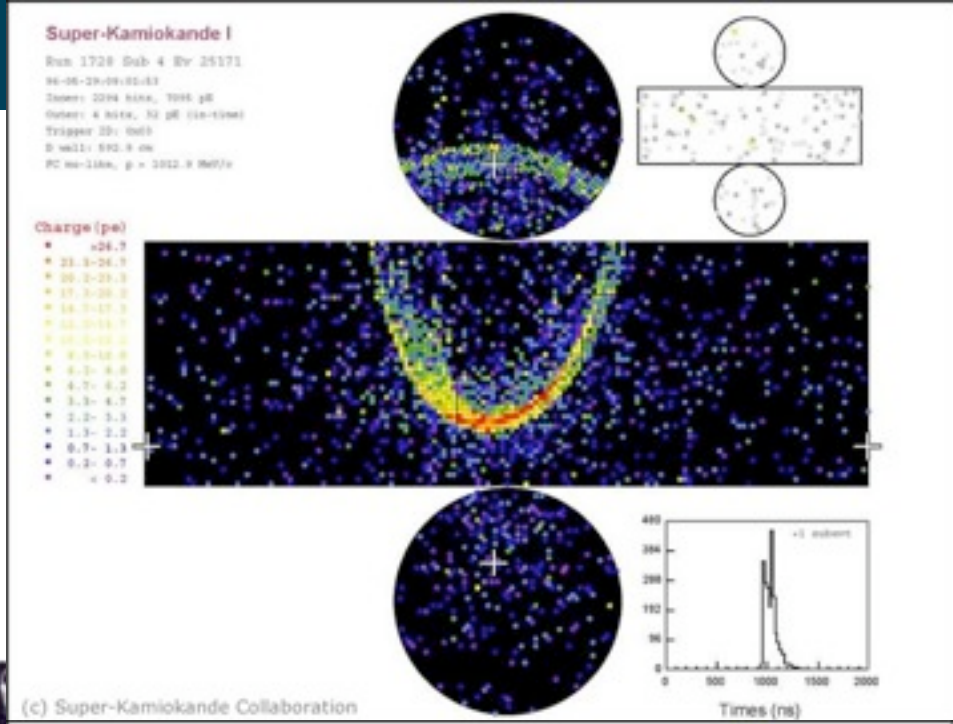
$$\text{with} \quad \pi^{+}(K^{+}) \rightarrow \mu^{+} + \nu_\mu$$

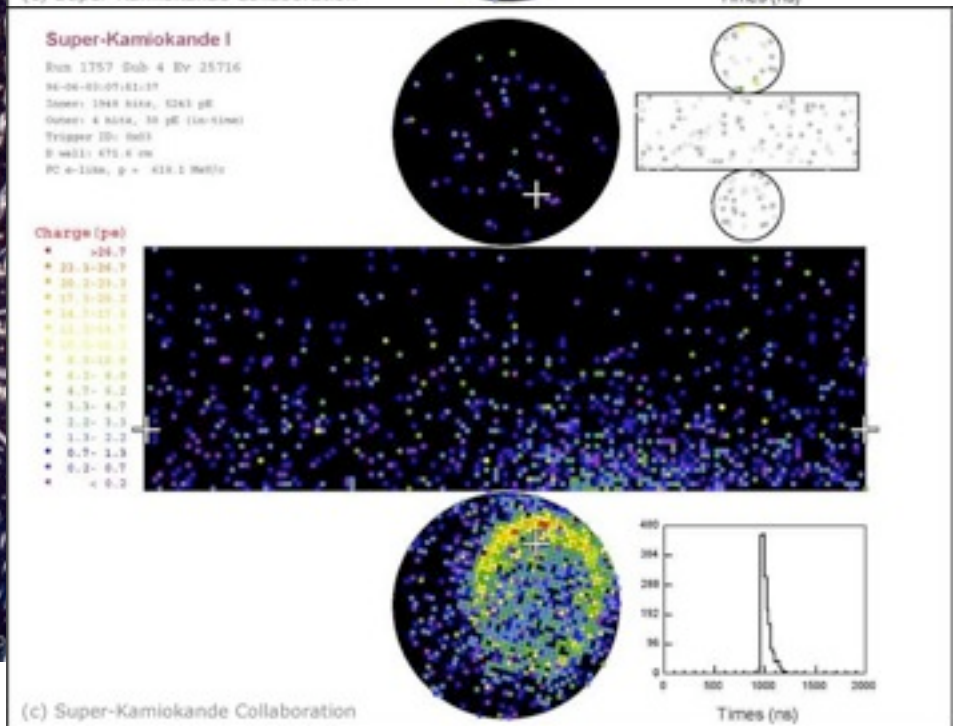
$$\text{with} \quad \mu^{+} \rightarrow e^{+} + \overline{\nu}_\mu + \nu_e$$

SuperKamiokande

$$\nu_\mu + N \rightarrow \mu^- + H$$
$$\nu_e + N \rightarrow e^- + H$$





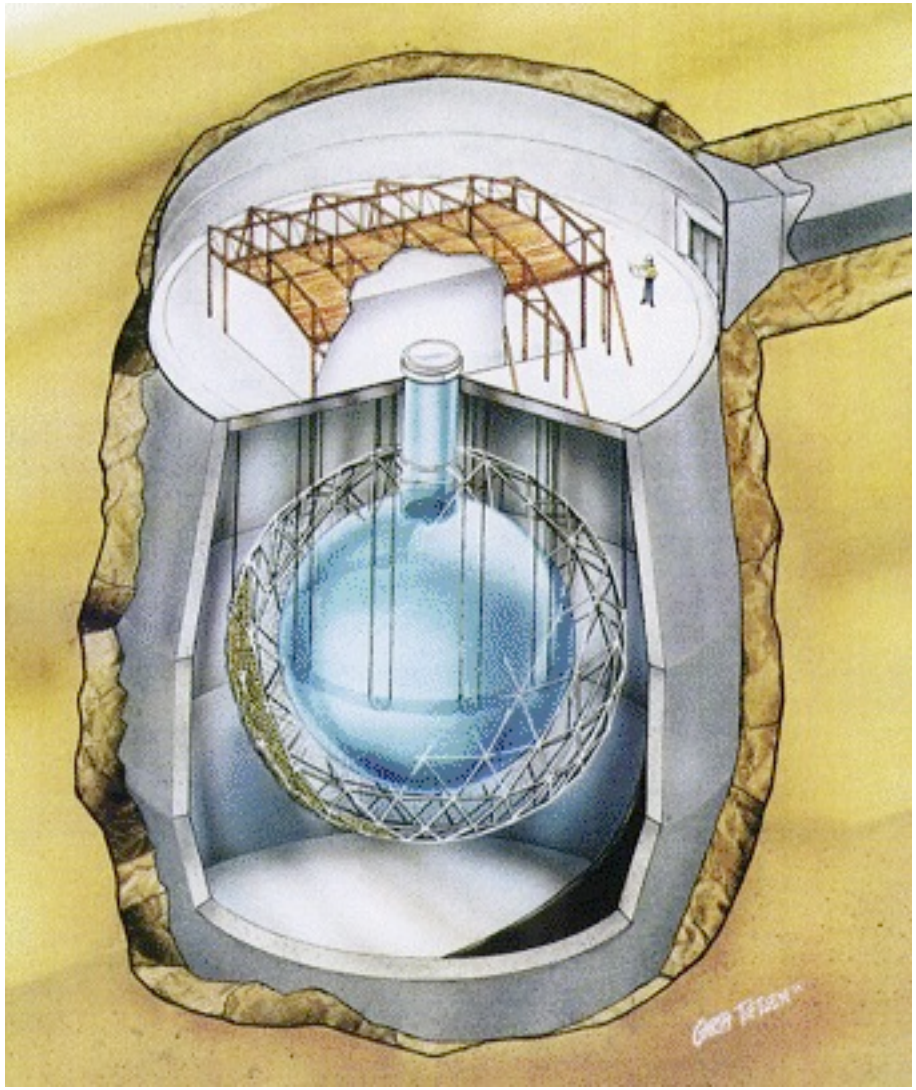


SNO

$$\nu_e + n \rightarrow e^- + P$$

$$\nu_{e/\mu/\tau} + n \rightarrow \nu_{e/\mu/\tau} + n_{\text{scat}}$$

$$\text{then} \quad n + {}^{35}Cl \rightarrow {}^{36}Cl + \gamma\,.$$



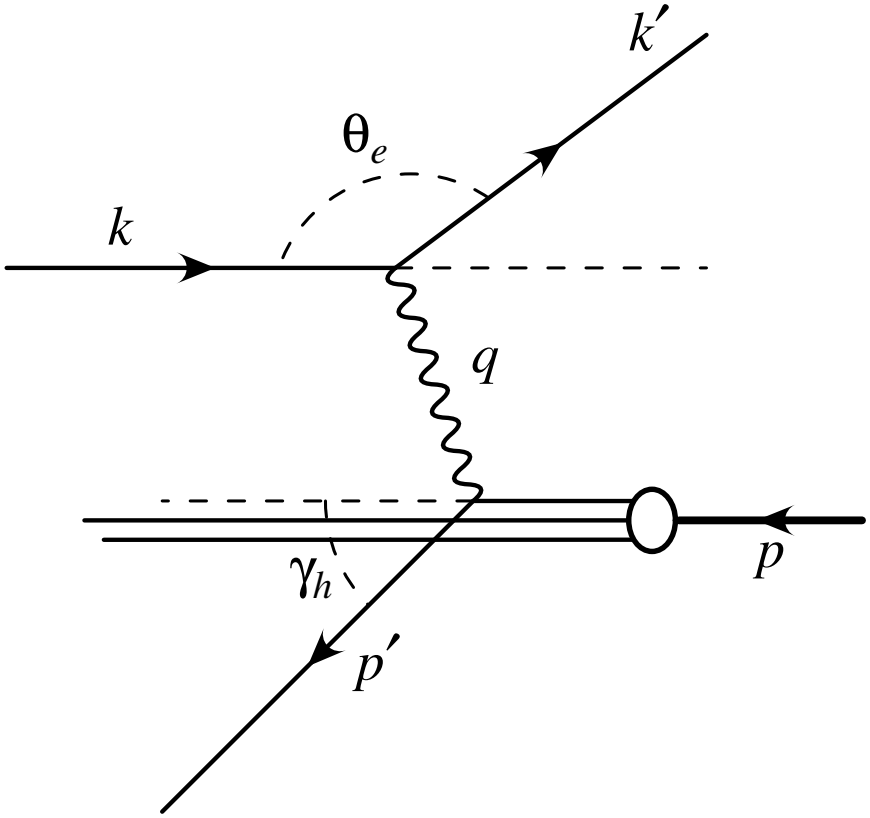
High energy colliders (and fixed-target)

1. *e*+*e*− : purely leptonic, controlled centre-off mass energy, clean. Discovery potential and precision physics. Limited by synchrotron radiation; need linear collider.

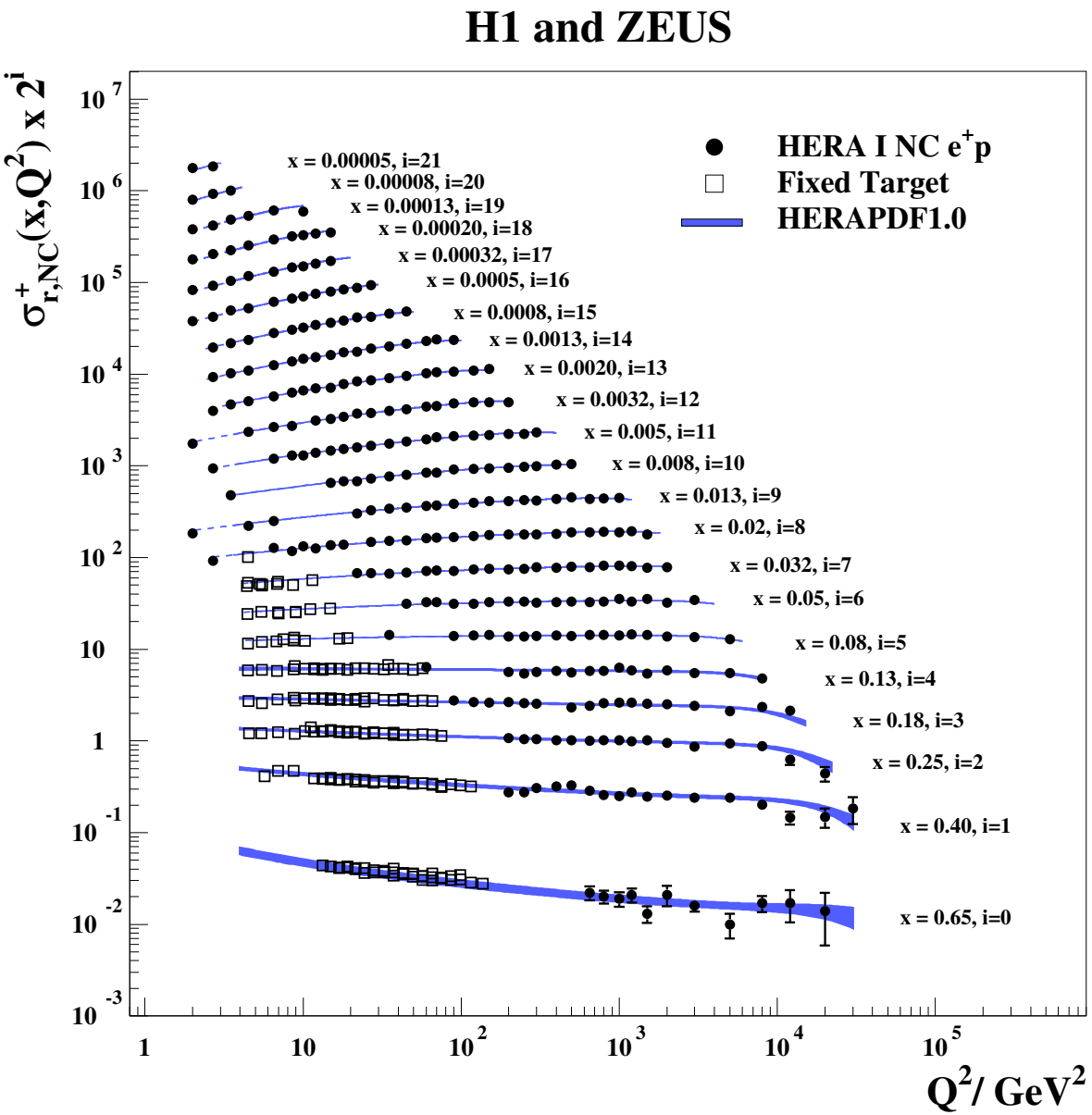
2. *NN(pp)* : highest energy and largest discovery potential. Messy.

3. *lN* : mixture of the two. One probe and one structured object.

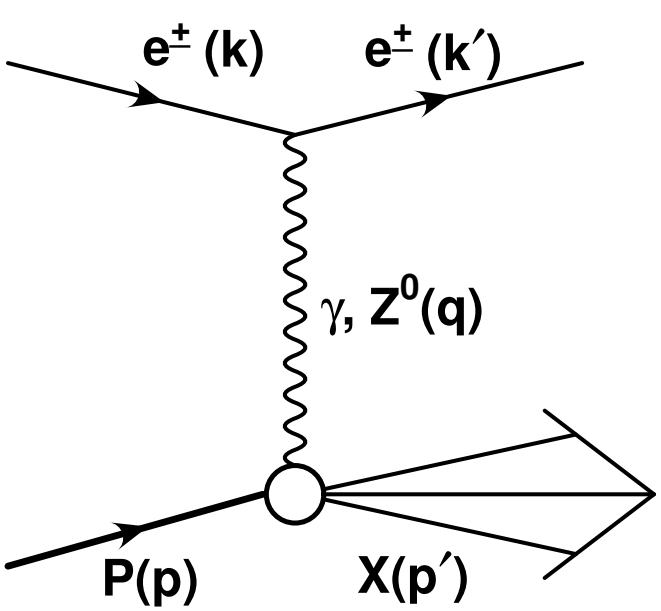
Deep inelastic scattering

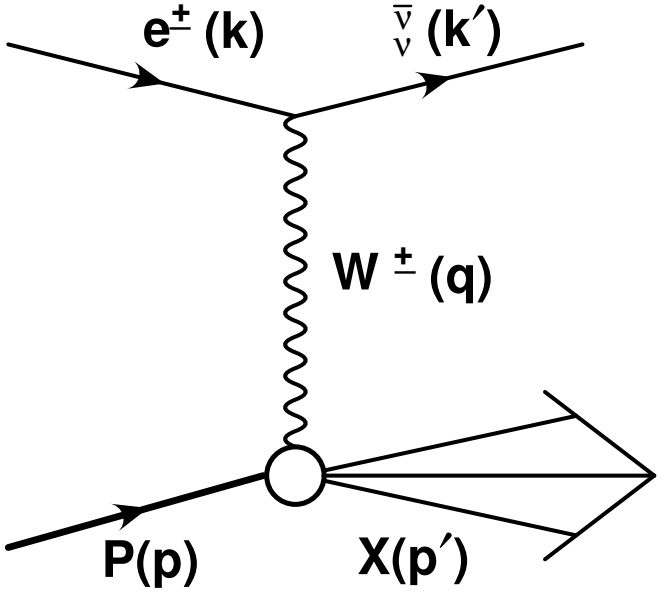


The structure of the proton

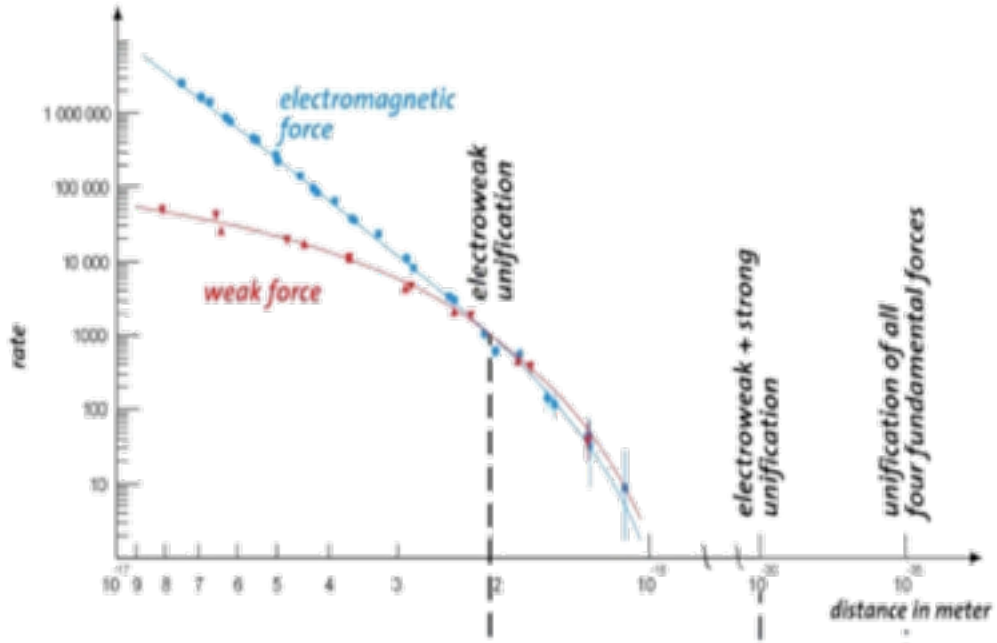


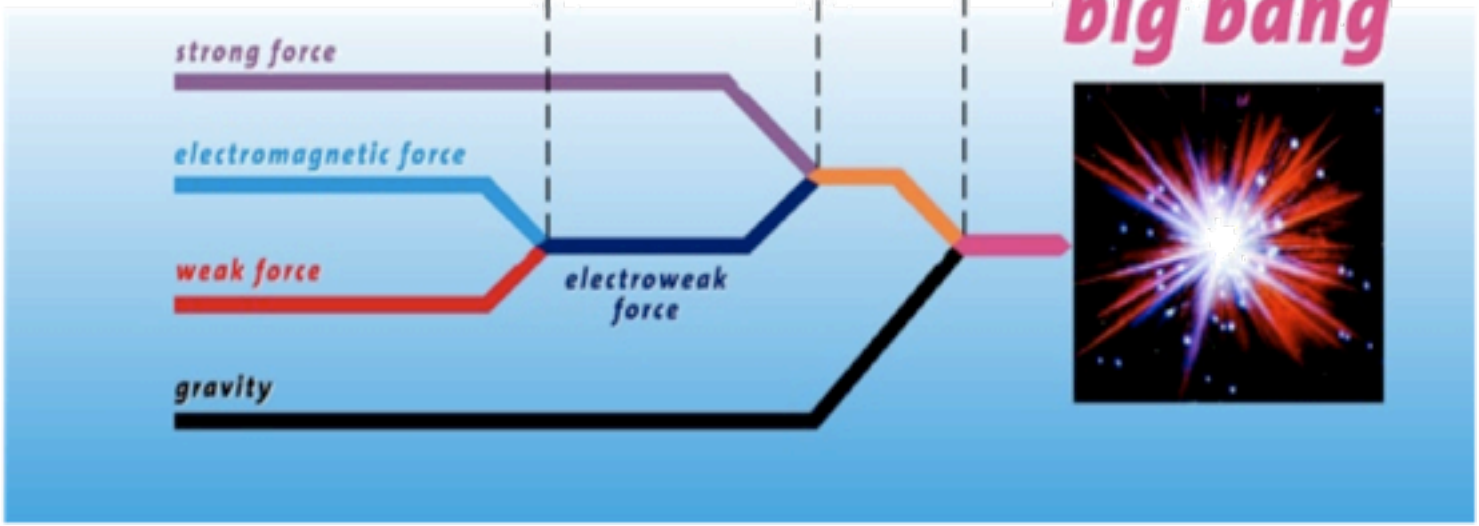
Neutral and charge current reactions



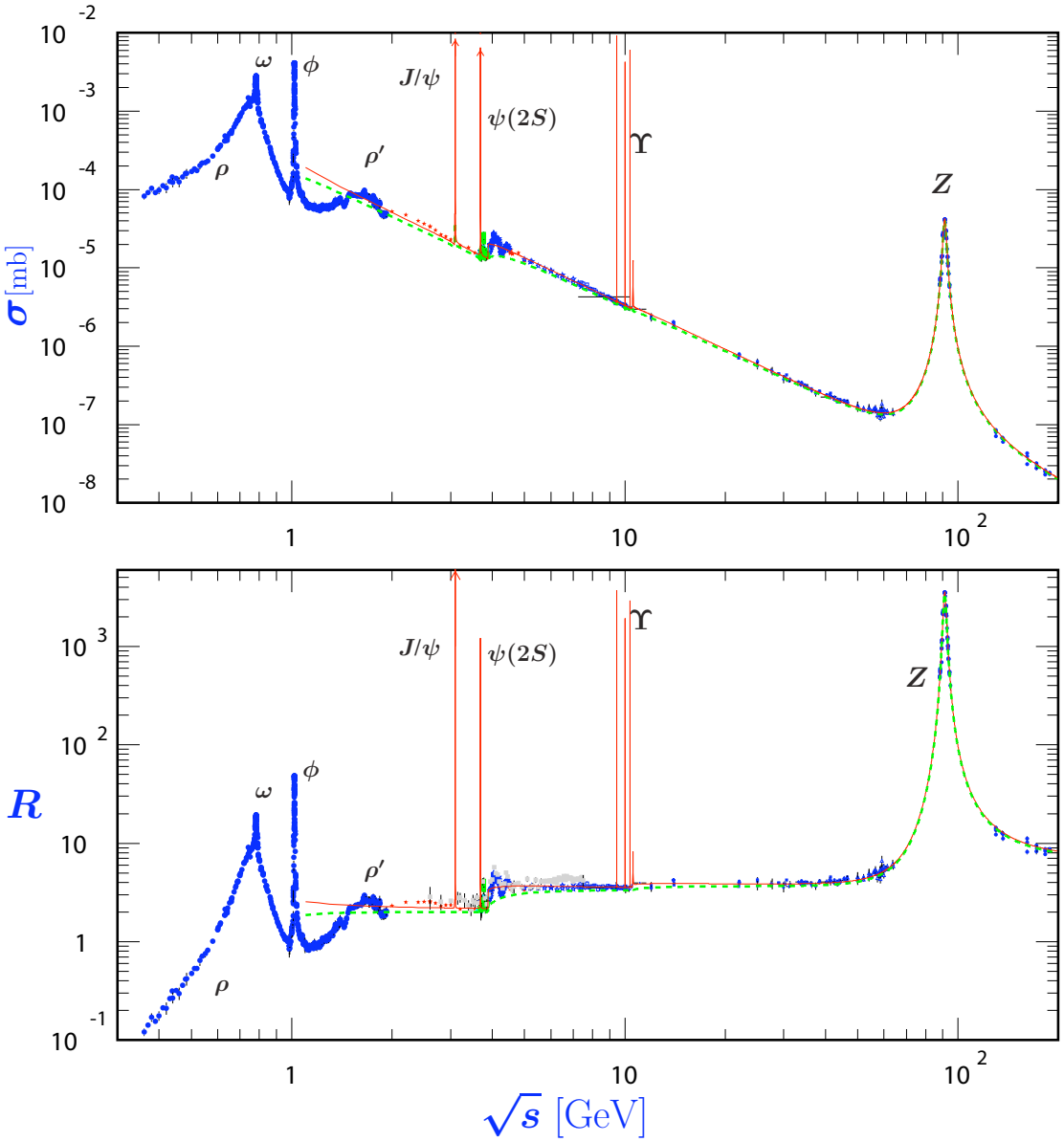


Electroweak unification

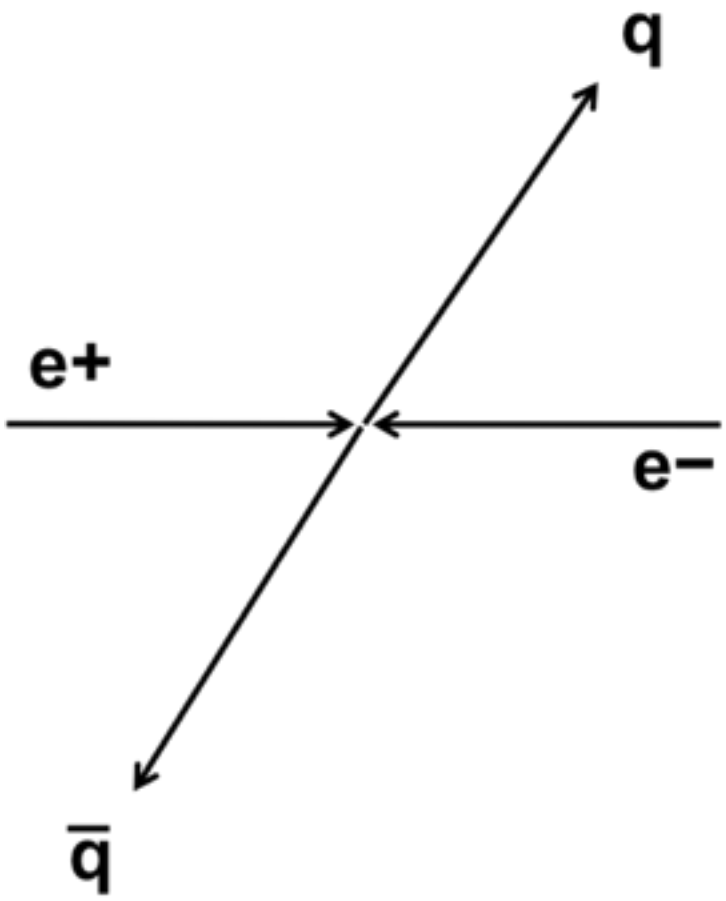


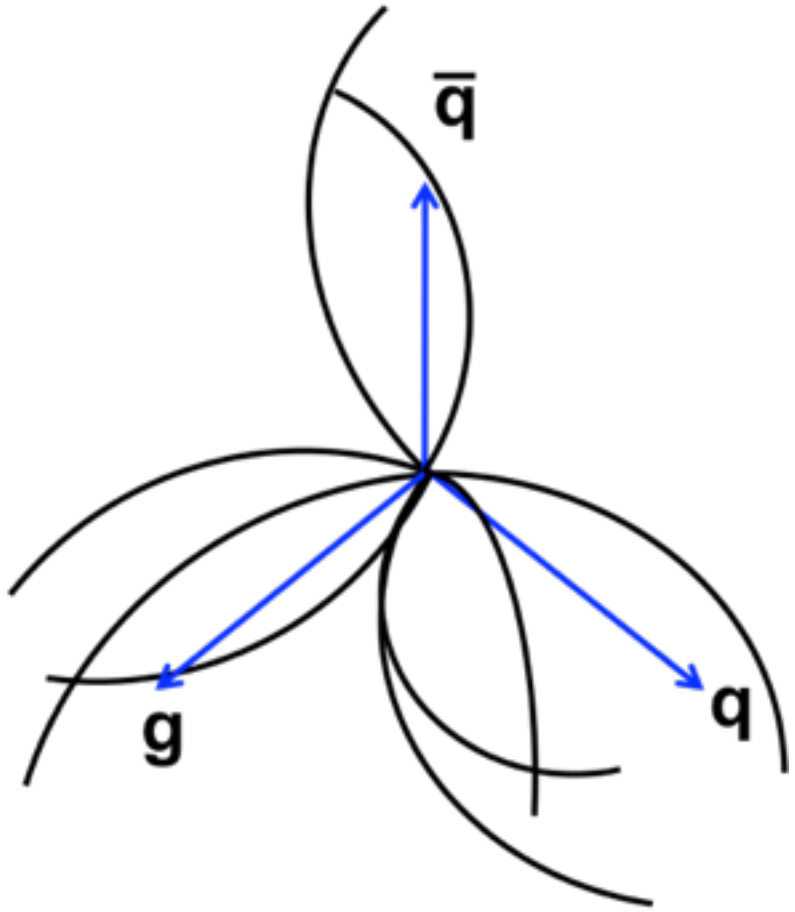


e^+e^- colliders

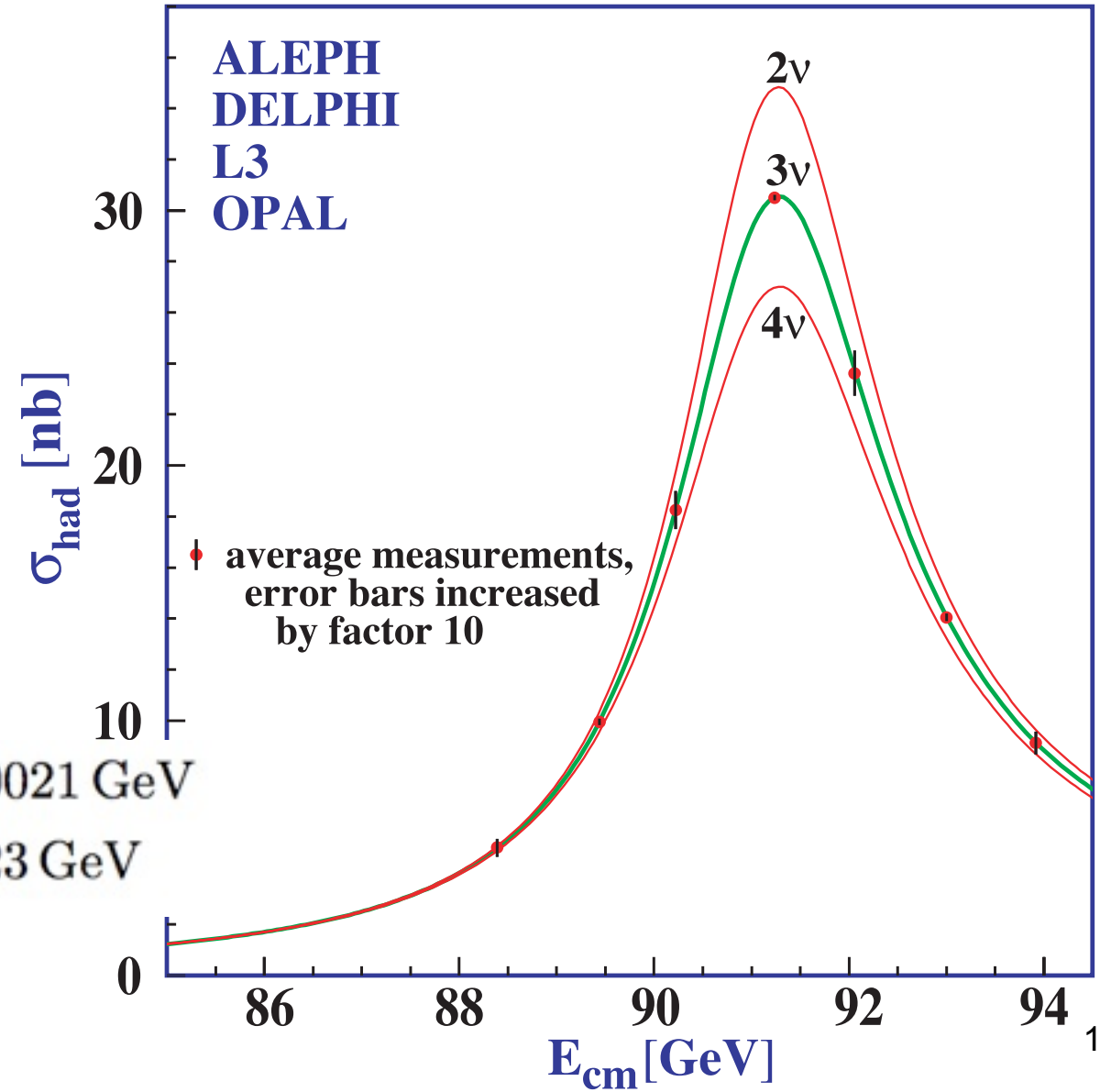


Discovery of gluon





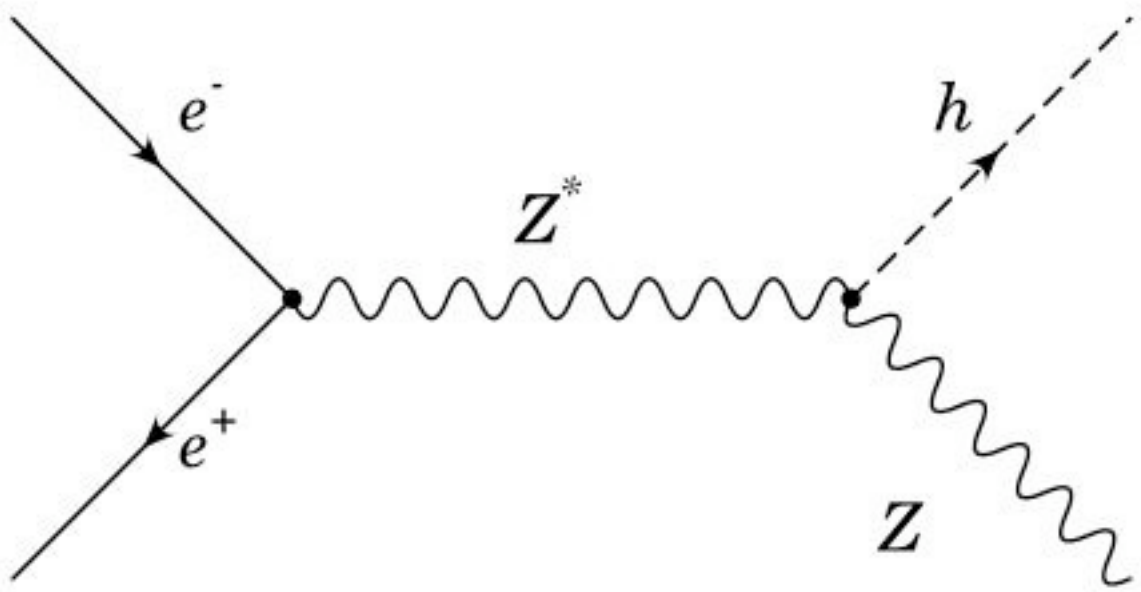
The *Z* pole and three neutrinos



$$M_Z = 91.1876 \pm 0.0021\,\text{GeV}$$

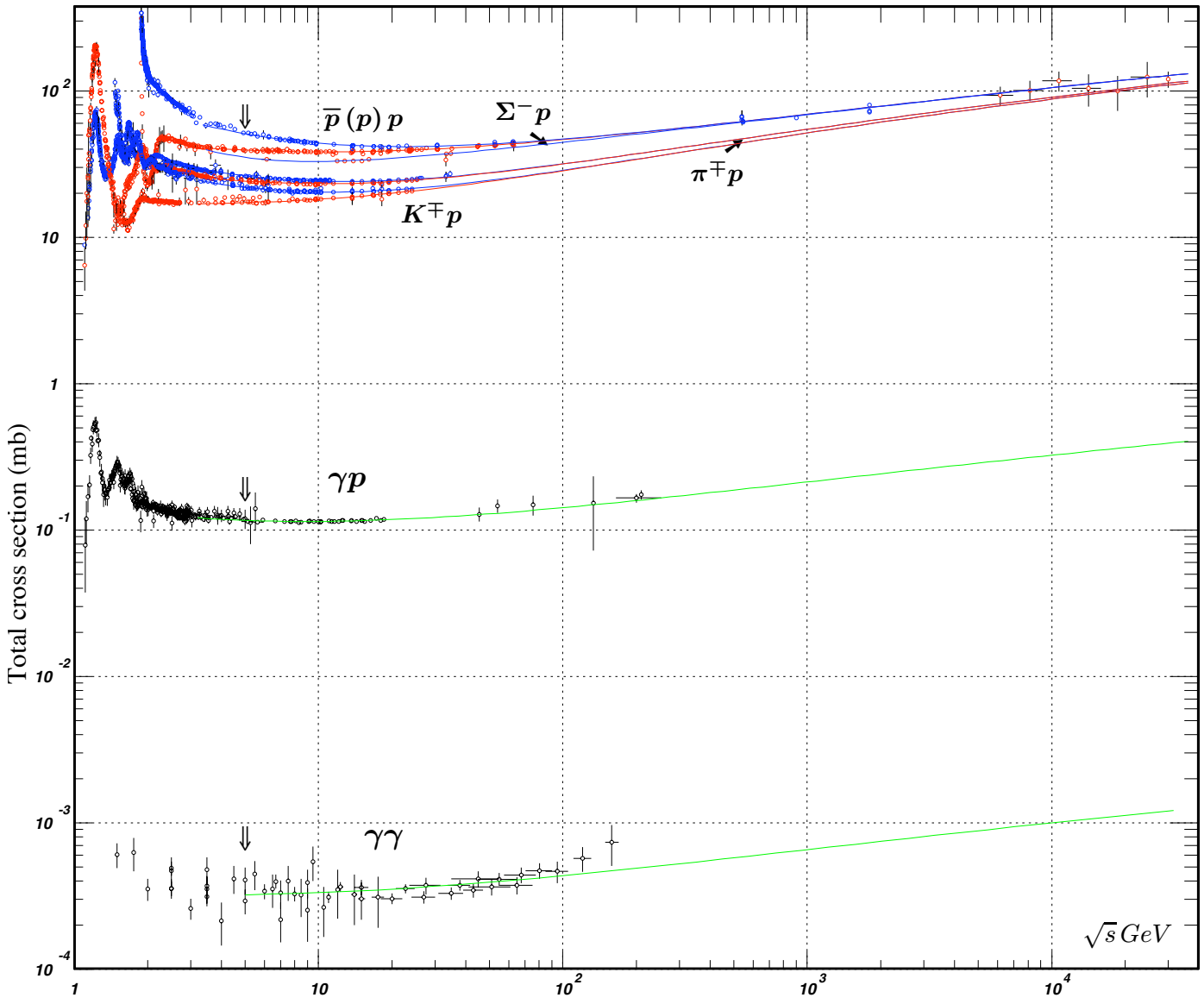
$$M_W = 80.399 \pm 0.023\,\text{GeV}$$

Search for the Higgs Boson

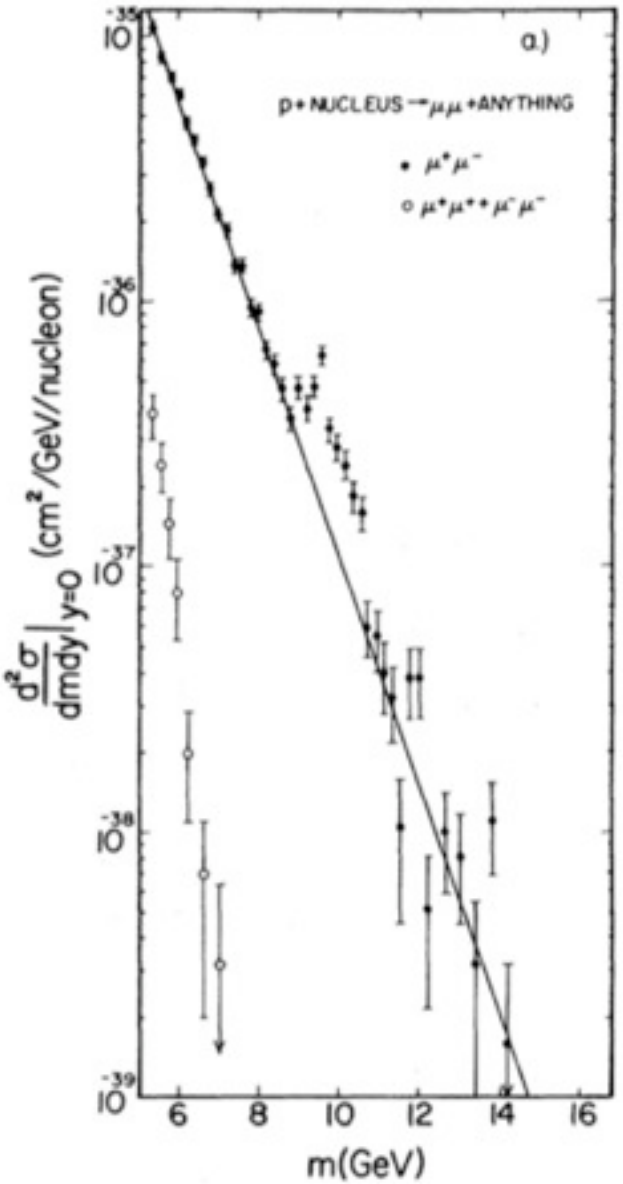


$$\sqrt{s} > M_H + M_Z$$

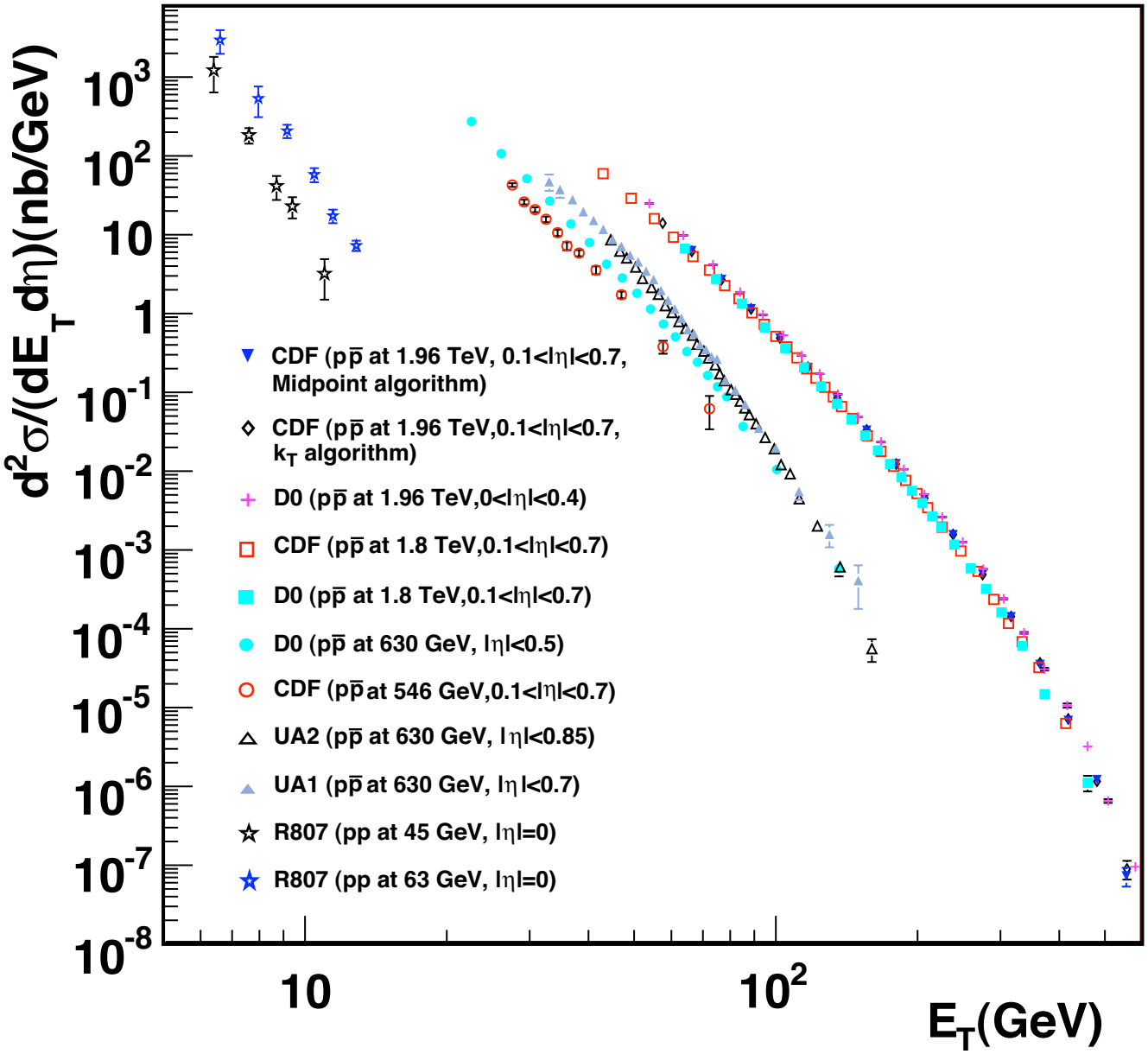
Total cross sections



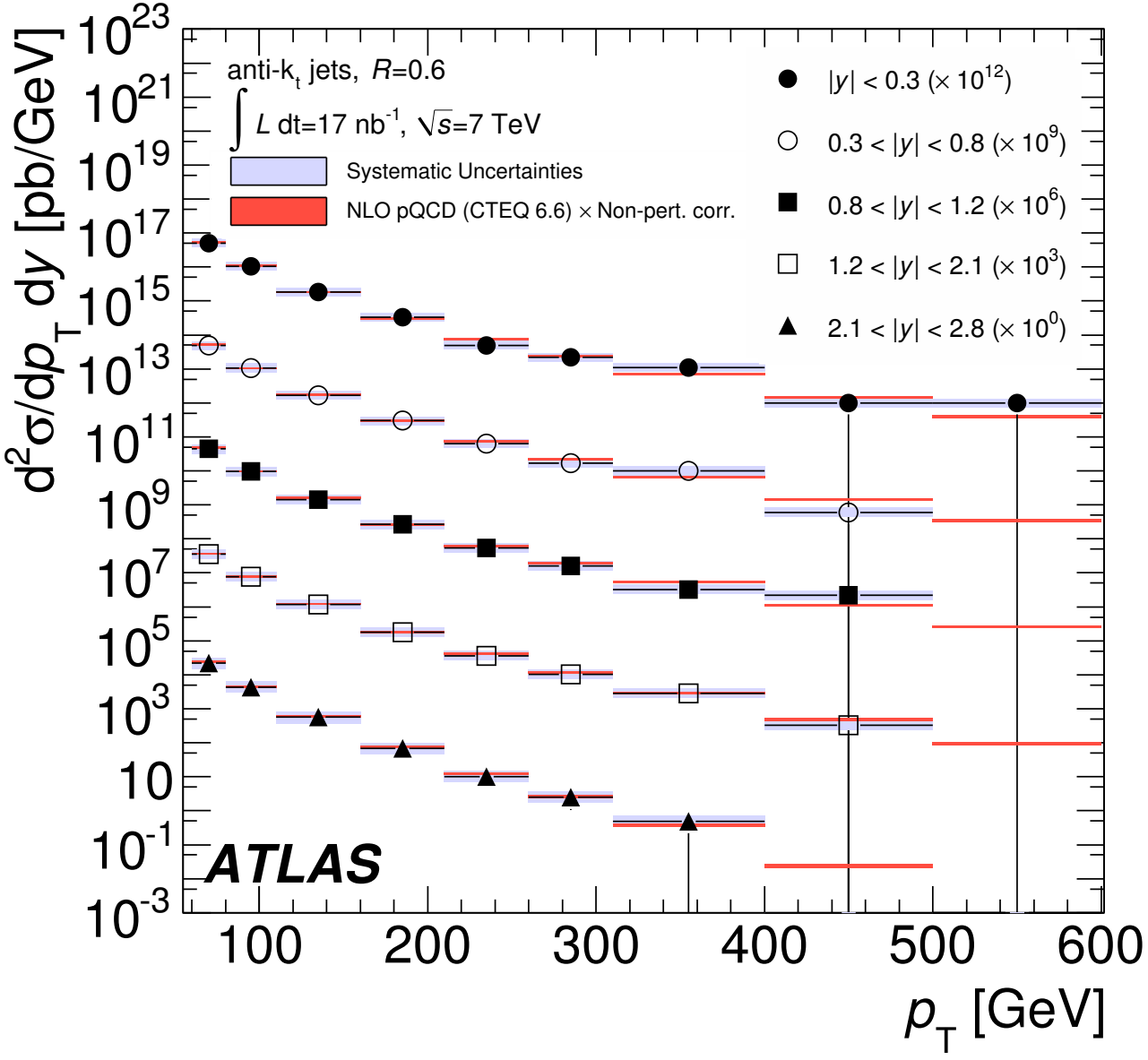
Discovery of bottom quark



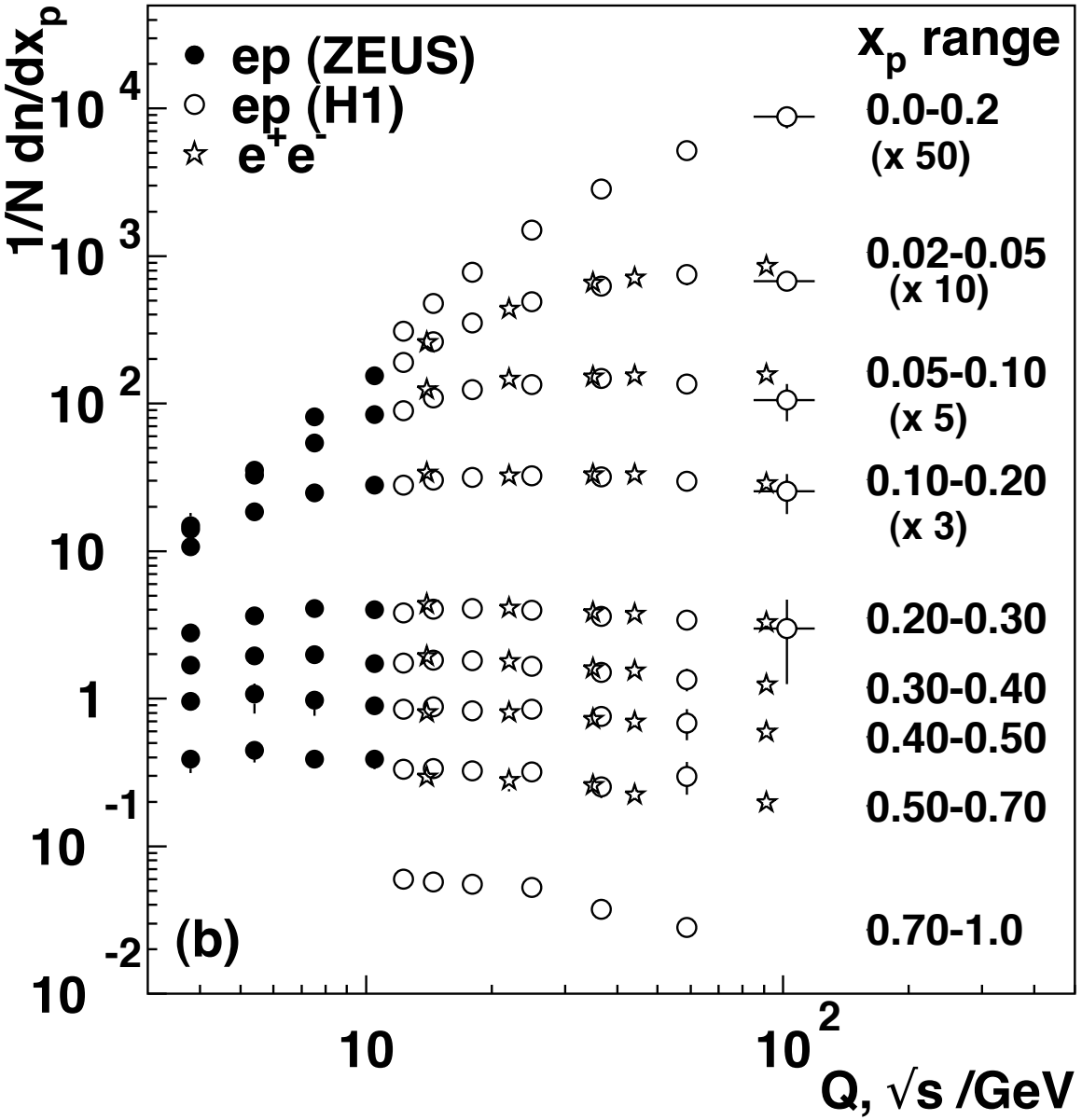
Inclusive jet cross section



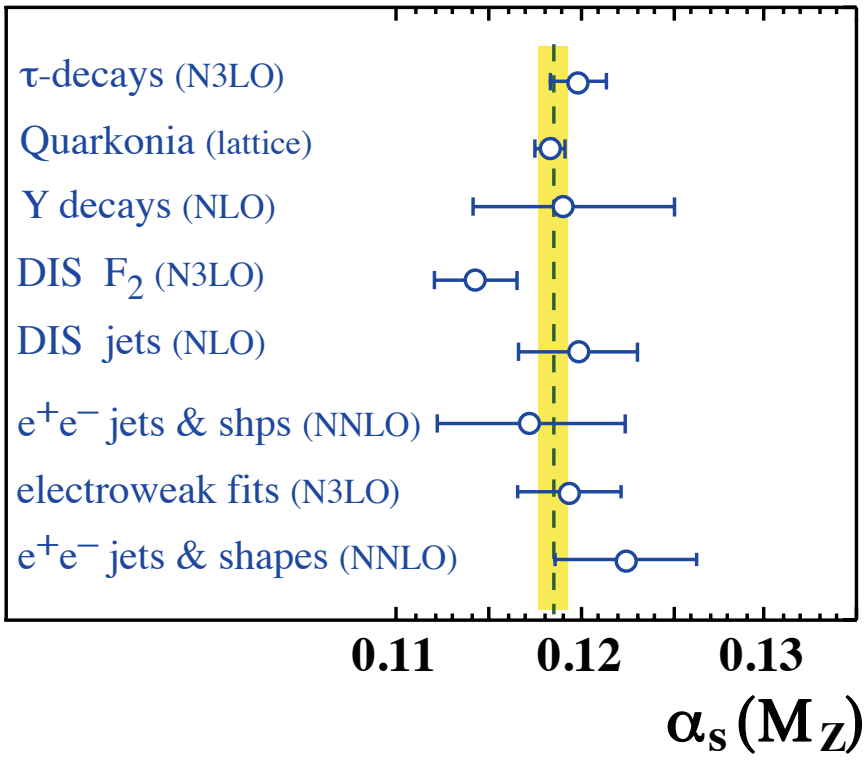
Inclusive jet cross section

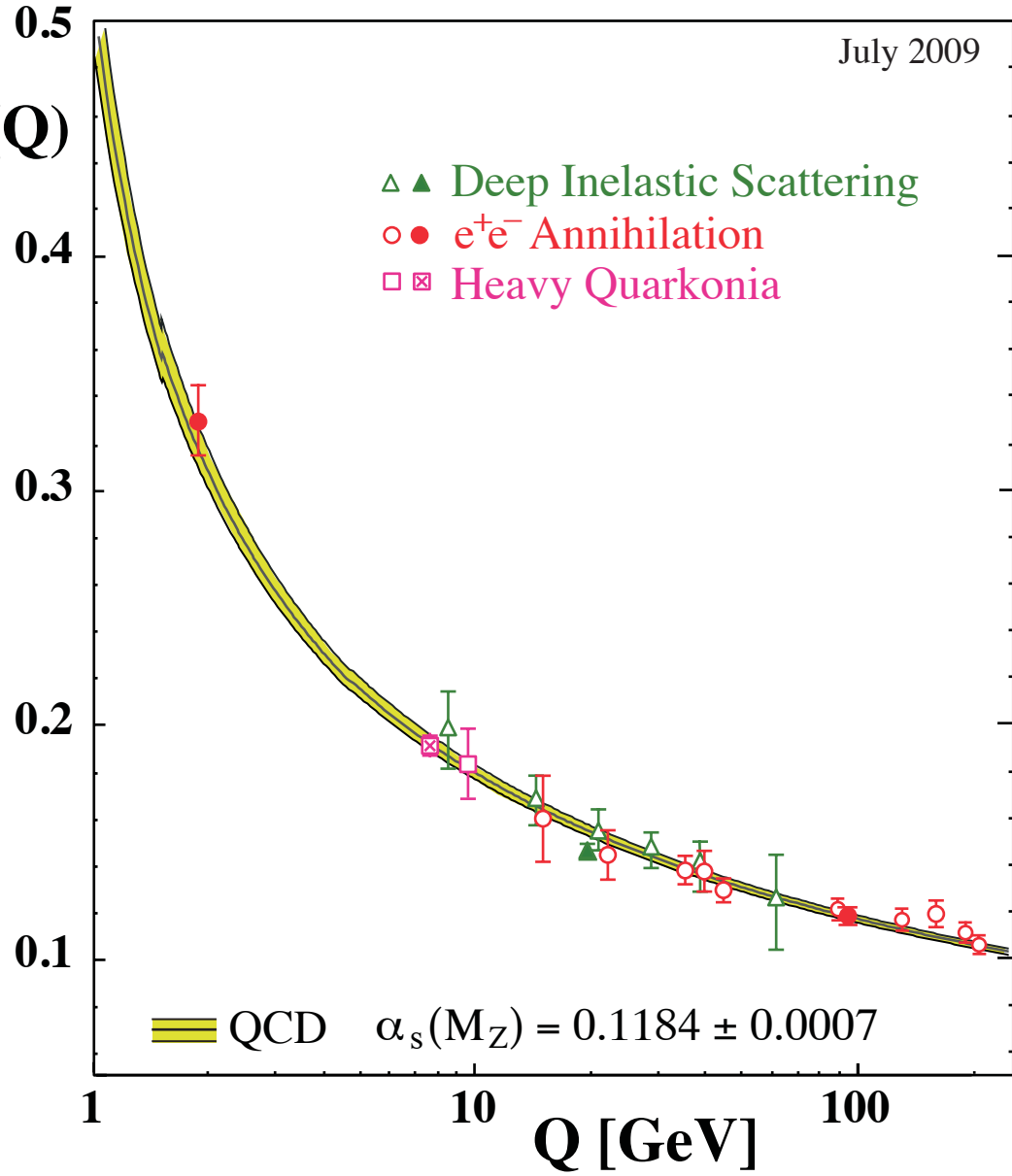


Fragmentation universality



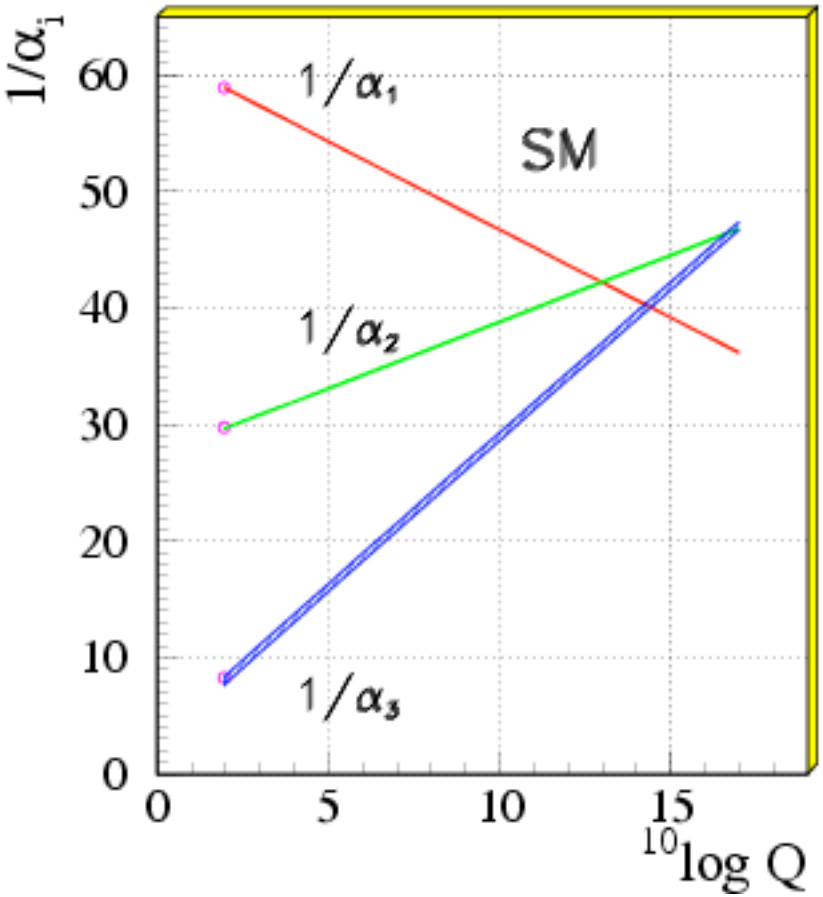
Combination : α_s

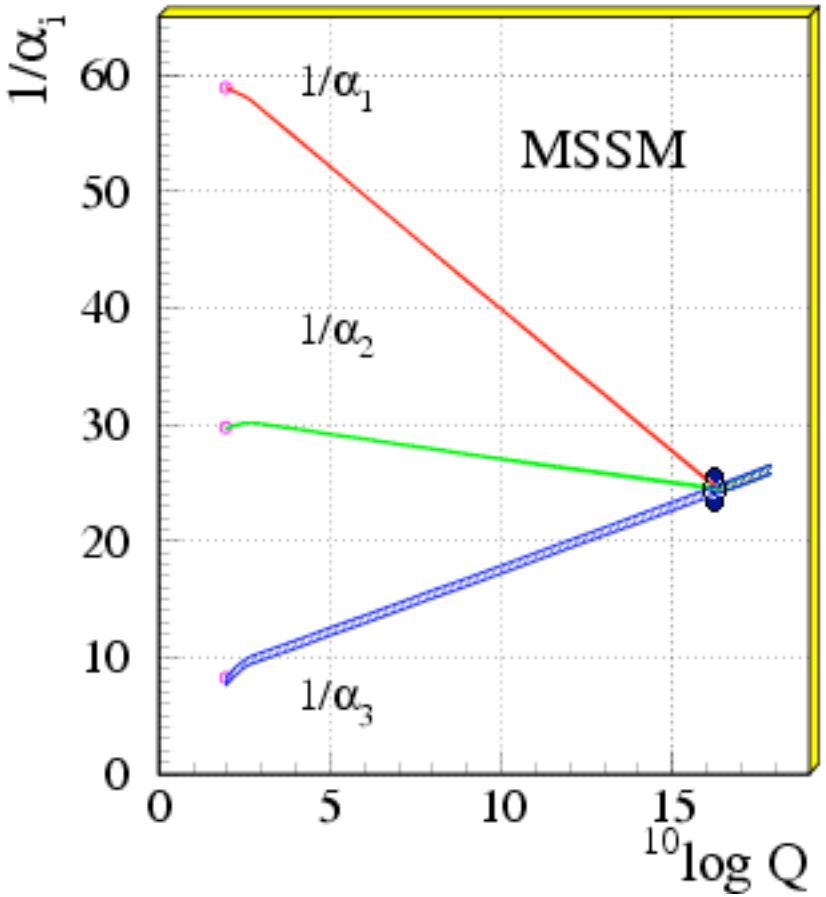




$\alpha_s\,(M_Z) = 0.1184 \pm 0.0007$

Grand unification





Higgs search