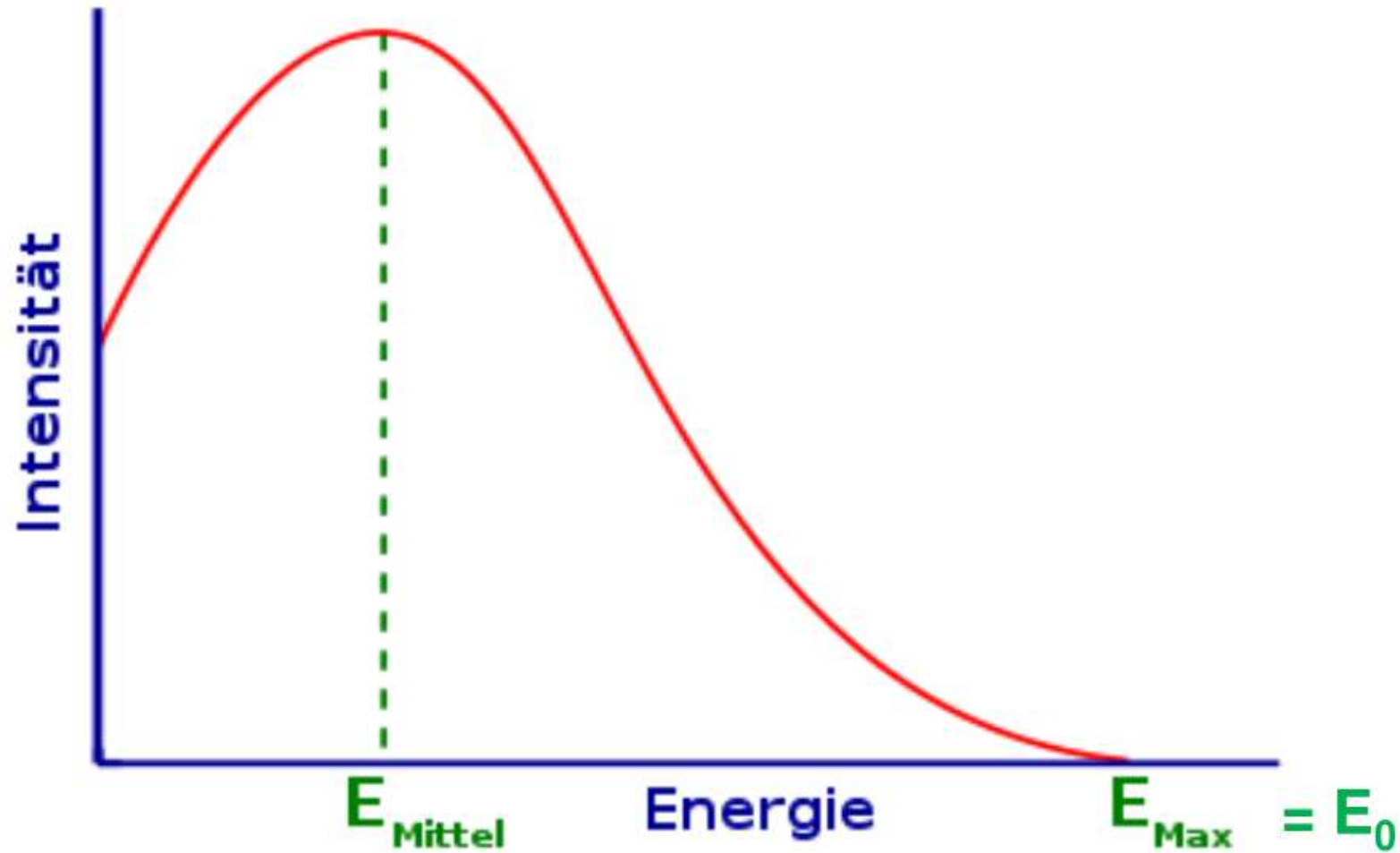


Energieverteilung des Elektrons (Positron) im β Zerfall



Lebensdauer von β Zerfällen

Fermi's goldene Regel: Übergangsrates $\omega = \frac{2\pi}{\hbar} |\mathcal{A}_{fi}|^2 \rho(E_f)$

E_f : Energie E_0 , die in dem Zerfall frei wird

$$E_0 = E_e + E_\nu + E_{Rueckstoss} \text{ (vernachlässigbar)} \quad \mathcal{A}_{fi} = \langle \psi_f | H | \psi_i \rangle$$

3-Teilchenphasenraum (siehe Kapitel 2.2.2):

$$\rho(E_0) = \frac{V^2}{(2\pi\hbar)^6} \frac{d}{dE_0} \int p_e^2 dp_e d\Omega_e p_\nu^2 dp_\nu d\Omega_\nu$$

(Normierungsvolumen $V=1$ gesetzt) mit $E_\nu = p_\nu c$

$$\begin{aligned} d\rho(E_0) &= \frac{(4\pi)^2}{(2\pi\hbar)^6 c} p_e^2 dp_e p_\nu^2 \frac{dE_\nu}{dE_0} \\ &= \frac{(4\pi)^2}{(2\pi\hbar)^6 c} p_e^2 p_\nu^2 dp_e \end{aligned}$$

Lebensdauer von β Zerfällen

$$d\rho(E_0) = \frac{(4\pi)^2}{(2\pi\hbar)^6 c} p_e^2 p_\nu^2 dp_e$$

$$\text{mit } p_\nu^2 = (E_0 - E_e)^2 / c^2$$

$$d\Gamma = d\omega = \frac{1}{2\pi^3 c^3 \hbar^7} |\mathcal{A}_{fi}|^2 p_e^2 (E_0 - E_e)^2 dp_e$$

Sobald das e^- den Kern verlässt, spürt es das Coulombpotential des Kerns

\Rightarrow Coulombkorrektur $F(\pm, Z, E_e)$ (für kleine Z-Werte ist $F \sim 1$)

$$\begin{aligned} \Gamma &= \frac{1}{\tau} = \int d\omega \\ &= \frac{1}{2\pi^3 c^3 \hbar^7} \int |\mathcal{A}_{fi}|^2 F(\pm, Z, E_e) p_e^2 (E_0 - E_e)^2 dp_e \end{aligned}$$

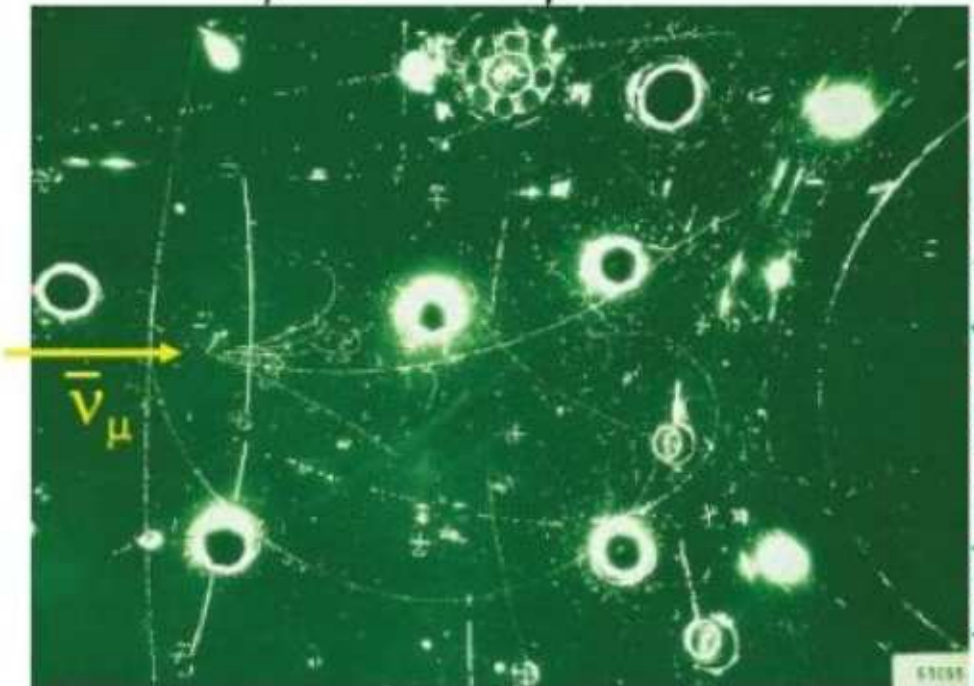
... (siehe Übungsblatt 12) ...

$$\Rightarrow \tau \propto \frac{1}{E_0^5} \quad \text{Sargent-Regel}$$

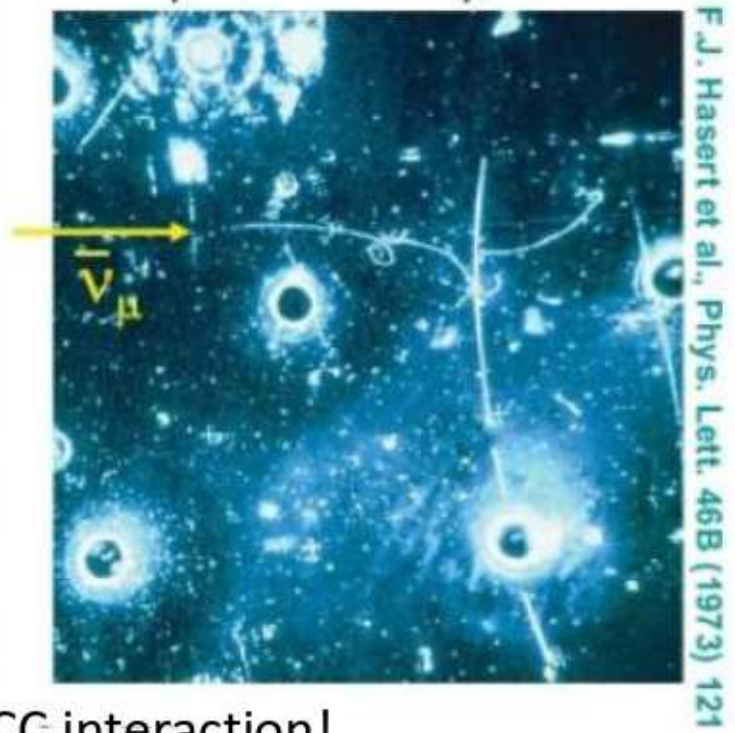
Nachweis des Z^0

Weak Neutral currents observed in Gargamelle bubble chamber in 1973:

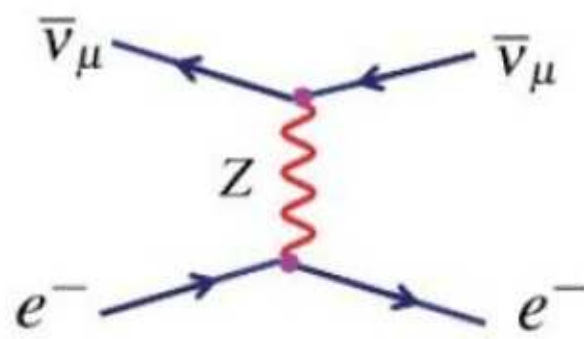
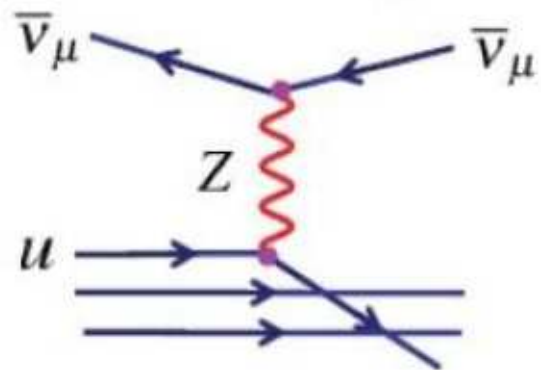
$$\bar{\nu}_\mu + N \rightarrow \bar{\nu}_\mu + \text{hadrons}$$



$$\bar{\nu}_\mu + e^- \rightarrow \bar{\nu}_\mu + e^-$$

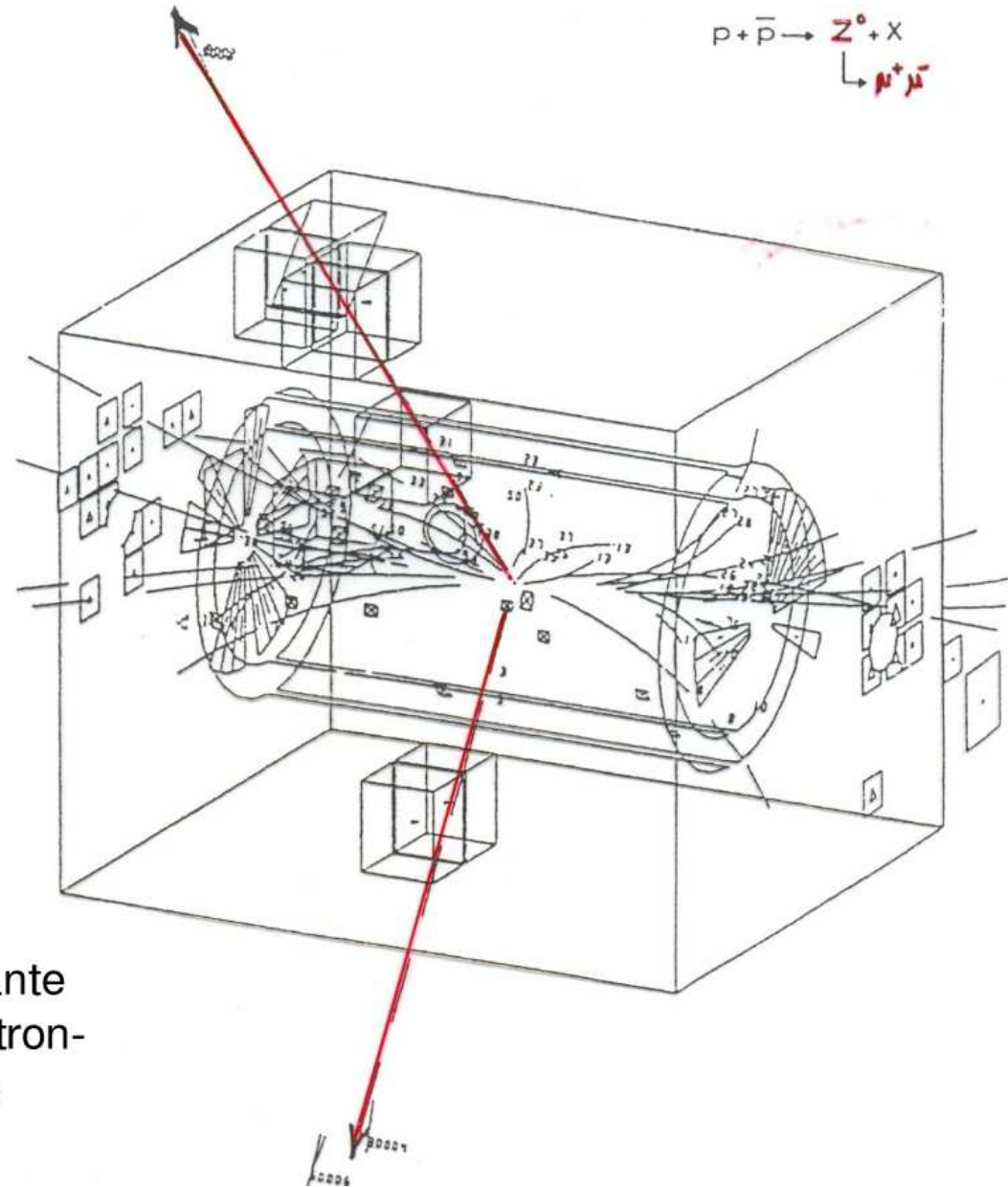
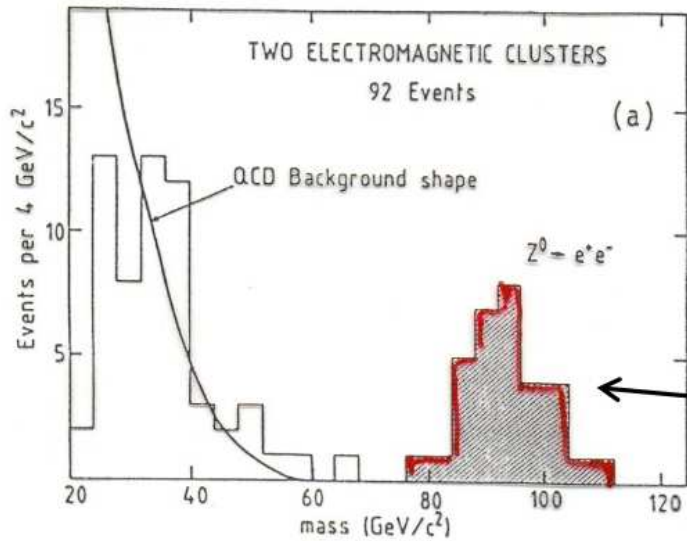
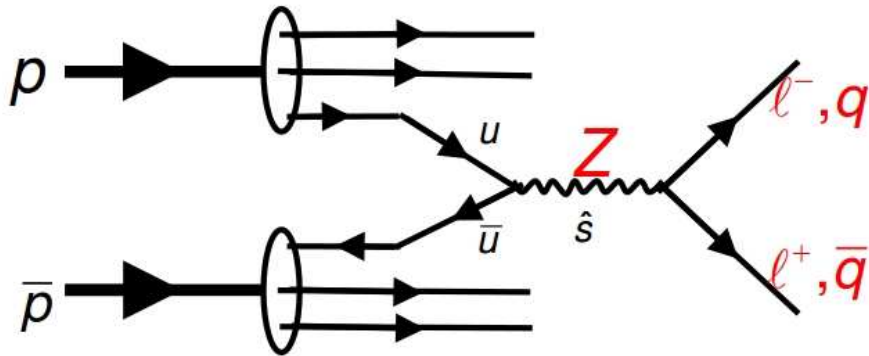


No muon in the final state, thus cannot be a CC interaction!



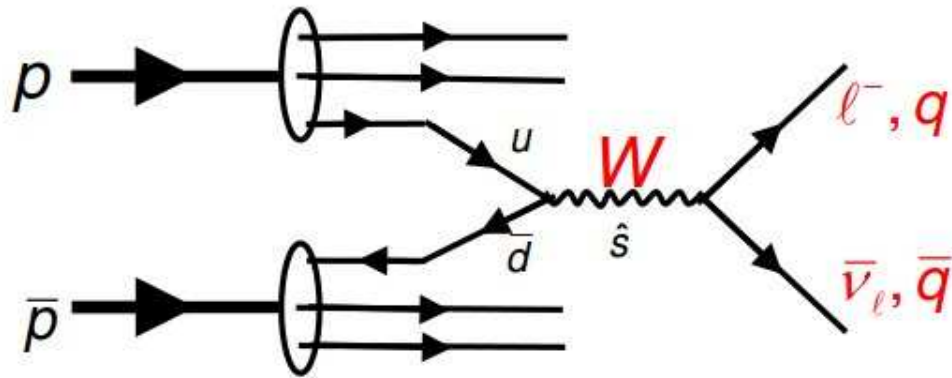
Entdeckung des Z^0

$$p\bar{p} \rightarrow Z \rightarrow f\bar{f} + X$$

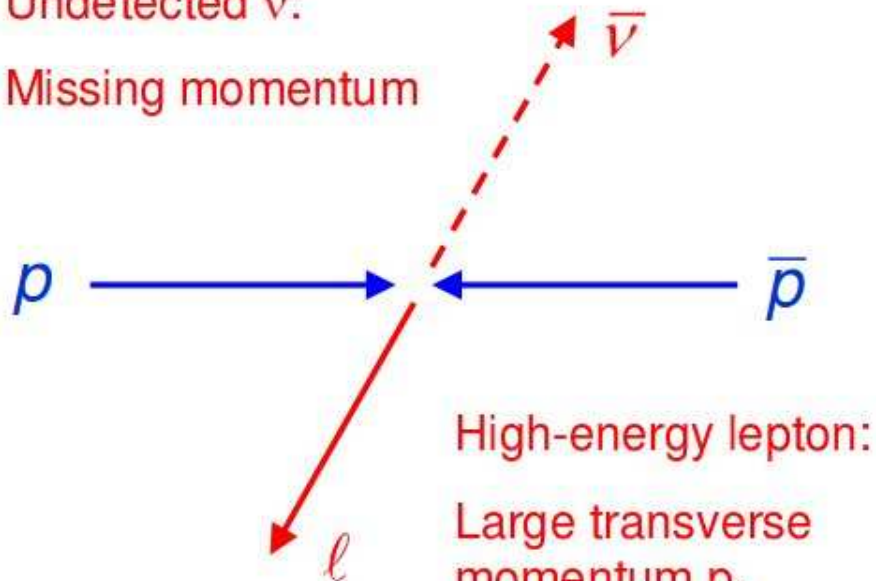


Entdeckung des W^0

$$p\bar{p} \rightarrow W \rightarrow \ell \bar{\nu}_\ell + X$$



Undetected ν :
Missing momentum



$$W^- \rightarrow e \bar{\nu}$$

