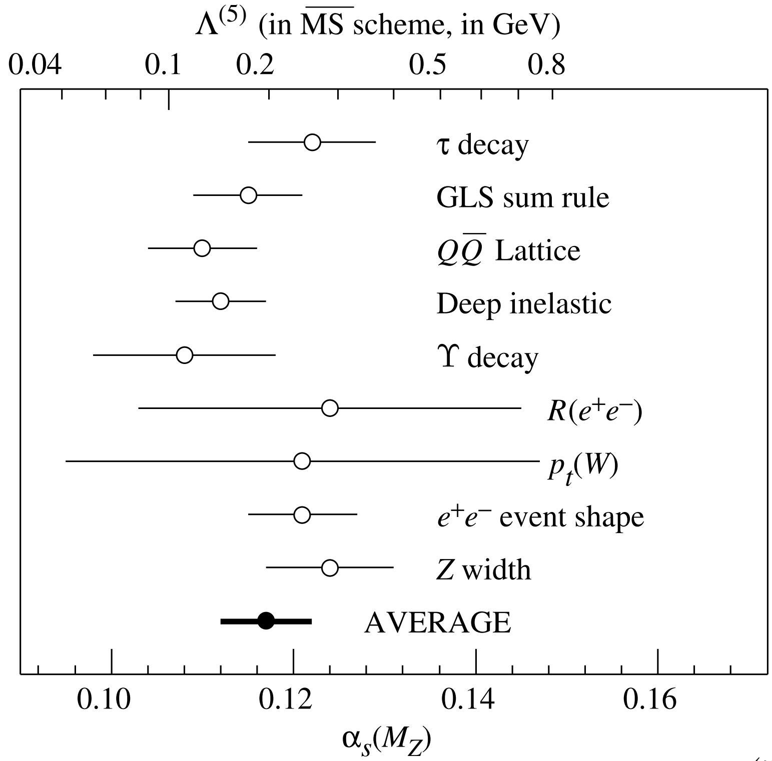

Figure 25.1: Summary of the values of $\alpha_s(M_Z)$ and $\Lambda^{(5)}$ from various processes ordered from top to bottom by increasing energy scale of the measurements. The values shown indicate the process and the measured value of α_s extrapolated up to $\mu = M_Z$. The error shown is the *total* error including theoretical uncertainties. The weighted average is obtained from the above values using the method discussed in the text.

related to the imaginary part of the photon self energy. However it is more inclusive than R since it involves an integral

$$R_\tau \sim \int_0^{m_\tau^2} \frac{ds}{m_\tau^2}(1-\frac{s}{m_\tau^2})^2 \mathrm{Im}(\Pi(s)) \ .$$

Since the scale involved is low, one must take into account nonperturbative (higher-twist) contributions which are suppressed by powers of the tau mass. The nonperturbative terms are estimated using sum rules [28]. In total they are estimated to be -0.007 ± 0.004 [29]. This estimate relies on there being no term of order Λ^2/m_τ^2 (note that $\dfrac{\alpha_s(m_\tau)}{\pi} \sim (\dfrac{0.5\ \text{GeV}}{m_\tau})^2$). The a, b and c can be determined from the data [30] by fitting to moments of the $\Pi(s)$. The values so extracted [31] are consistent with the theoretical estimates. If the nonperturbative terms are omitted from the fit, the extracted value of $\alpha_s(m_\tau)$ decreases by ~ 0.02.

Using the experimental average [32] for R_τ of 3.6174 ± 0.034 gives $\alpha_s(m_\tau) = 0.360 \pm 0.031$ using the experimental error alone.