



PDG α_s update 2025



Joey Huston (MSU)
Klaus Rabbertz (KIT)
Giulia Zanderighi (MPI)



- The selection of results from which to determine the world average value of $\alpha_s(m_Z^2)$ is restricted to those that are
 - ➔ published in a peer-reviewed journal at the time of writing this report, (“accepted” might be ok, too; never had this case so far)
 - ➔ based on the most complete perturbative QCD predictions of at least NNLO accuracy,
 - ➔ accompanied by reliable estimates of all experimental and theoretical uncertainties.
- Deadline for our submission to PDG is end of August in impair years
 - **end of August 2025** was our deadline for this year’s report.
- Even when all conditions are fulfilled, we might consider fresh input as **not yet mature enough** when a lot of activity (**good!**) is going on.
 - happened this year for e^+e^- category

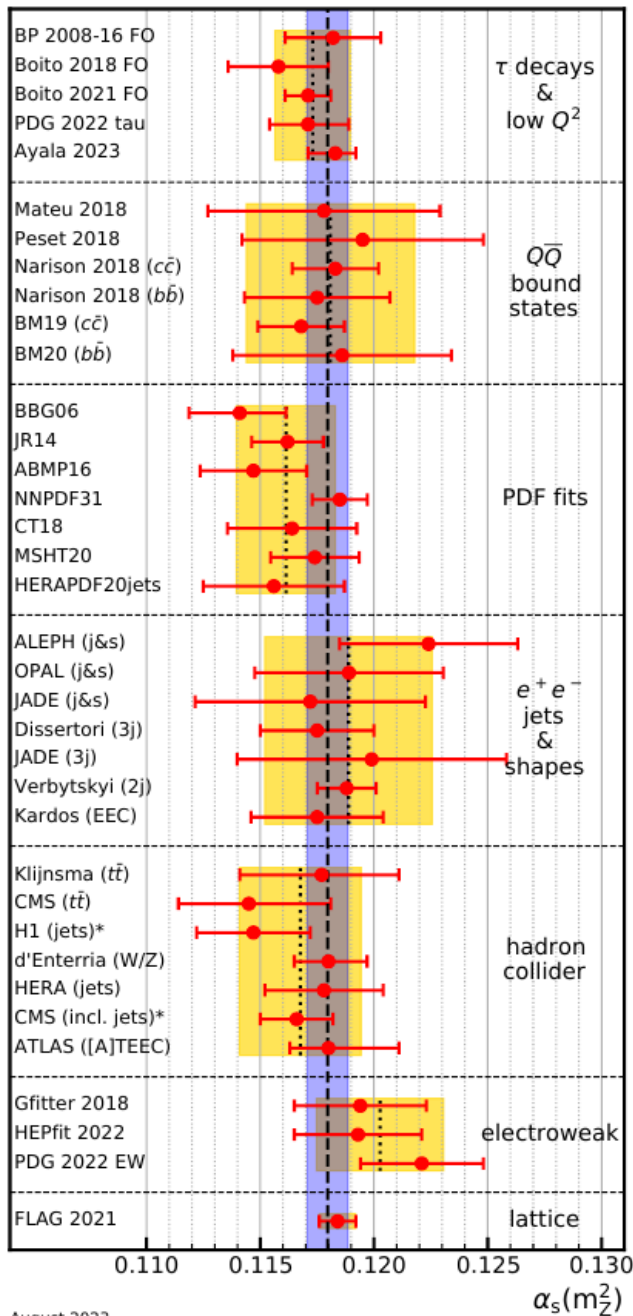


Recap: Averaging

- **Pre-averaging** of $\alpha_s(m_Z^2)$ in six “independent” fields, see next slide:
 - ➔ central value from unweighted average of entries
 - ➔ total uncertainty from unweighted average of uncertainties
 - ➔ asymmetric uncertainties are symmetrised beforehand by using the larger of the two numbers
 - ➔ values from very similar analyses of similar or the same data are pre-averaged beforehand (example: BP 2008-16 FO in the tau-low Q^2 category)
- These pre-averages are combined using **χ^2 averaging**:
 - ➔ not to be mistaken with “PDG recommendations” from the “Probability” or “Statistics” review in PDG
 - ➔ if $\chi^2 / \text{ndof} < 1$, introduce correlation ρ until unity is reached
 - ➔ PDG average **without** lattice gauge theory (FLAG)
- Finally **unweighted average** with latest FLAG estimate; uncertainty averaged from the two values



PDG α_s averaging in 6 groups

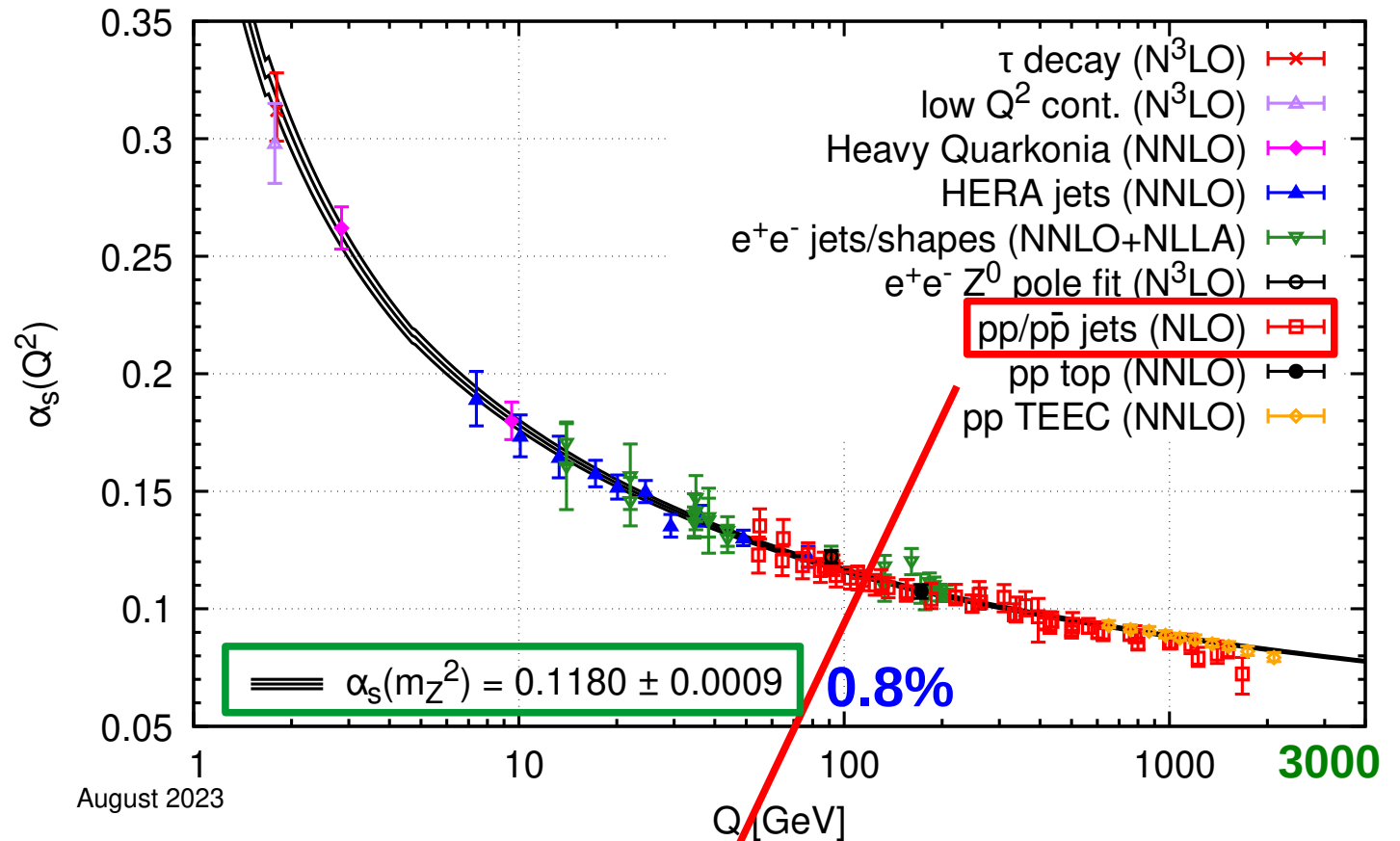
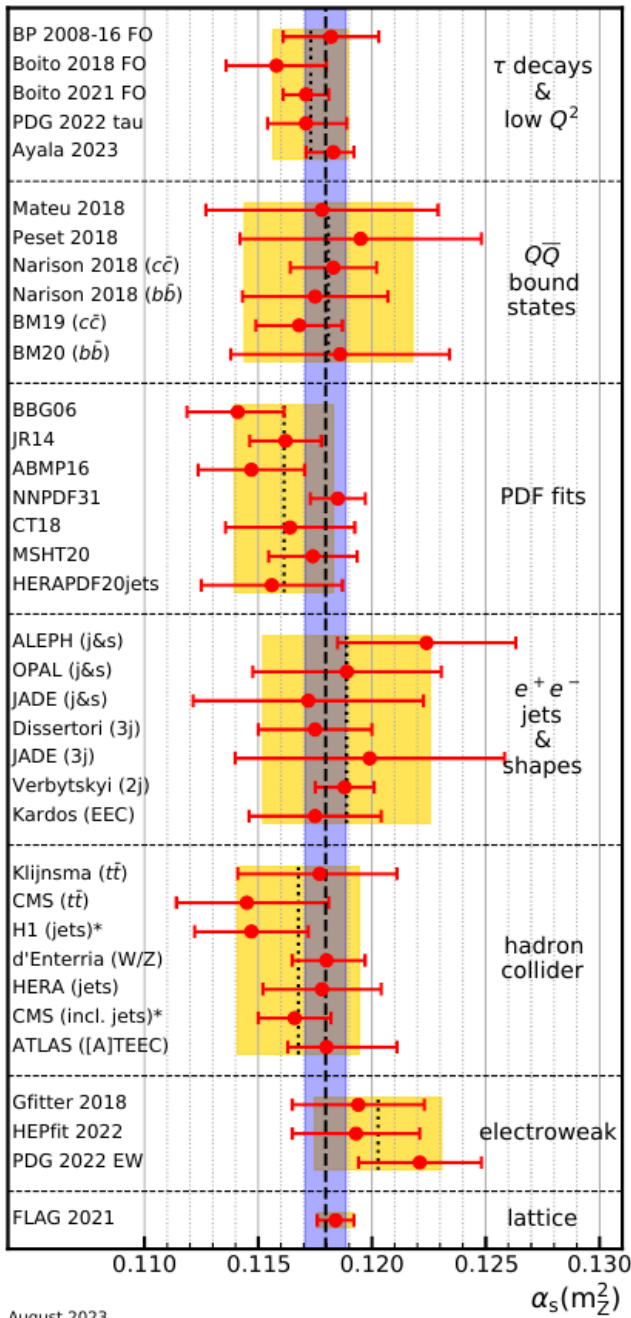


August 2023

- τ hadronic decay widths & spectral functions
- heavy quarkonia decays
- global fits of proton structure & α_s
- event shapes & jet rates in e^+e^-
- observables from hh collisions & DIS
- electroweak fits
- FLAG estimate from lattice calculations**



PDG α_s average 2023



For visibility only subset of points.

Not yet available at NNLO accuracy in pQCD.

PDG, PRD 110 (2024) 030001.

Altarelli '89: ~10%



PDG update 2025



Online 01.12.2025

2025 Reviews plus extended API available



SHORTCUTS ▾ CITATION CONTACT ABOUT ▾

Reviews, Tables & Plots

S. Navas *et al.* (Particle Data Group), Phys. Rev. D 110, 030001 (2024) and 2025 update

Files can be downloaded directly by clicking on the icon:

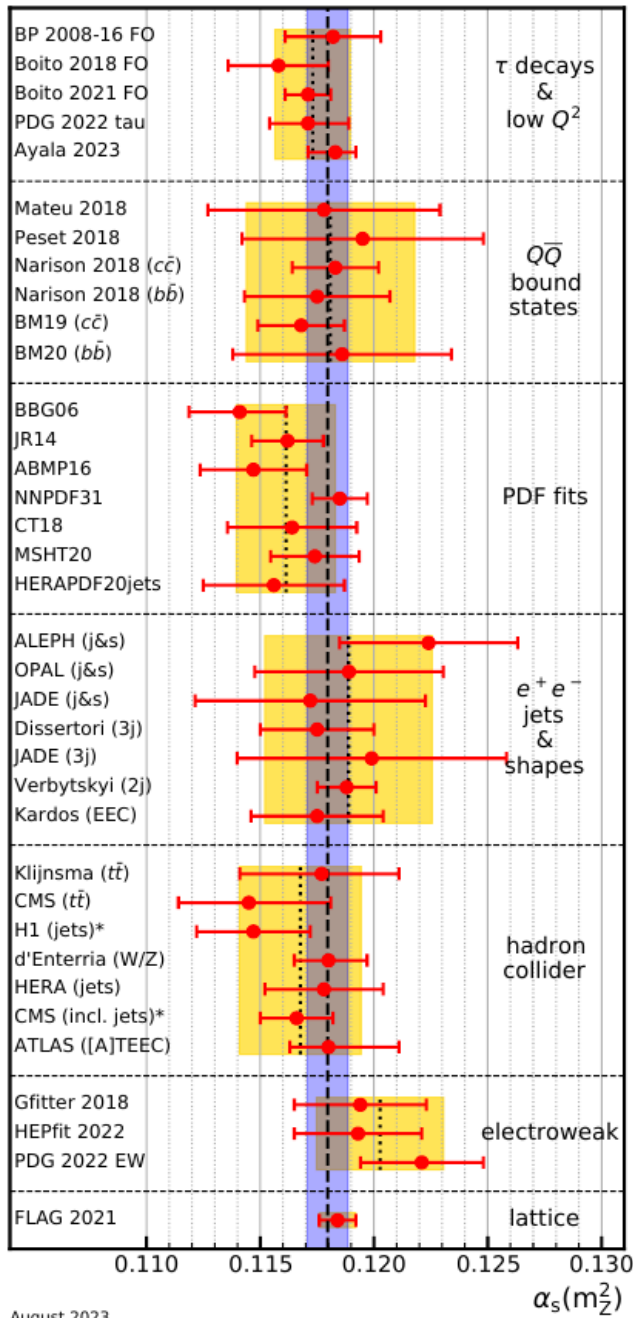
Expand/Collapse All

Introduction, History plots, Online information		+
Constants, Units, Atomic and Nuclear Properties		+
Standard Model and Related Topics		-
9	Quantum chromodynamics (rev.)	
10	Electroweak model and constraints on new physics (rev.)	
11	Higgs boson physics, status of (rev.)	
12	CKM quark-mixing matrix	

https://pdg.lbl.gov/2025/reviews/contents_sports.html



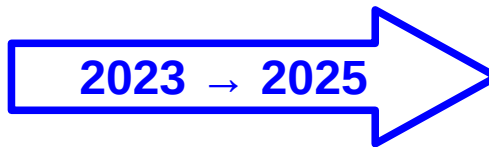
PDG α_s average 2023 \rightarrow 2025



- update PDG and Boito results

- no new result

- no change yet

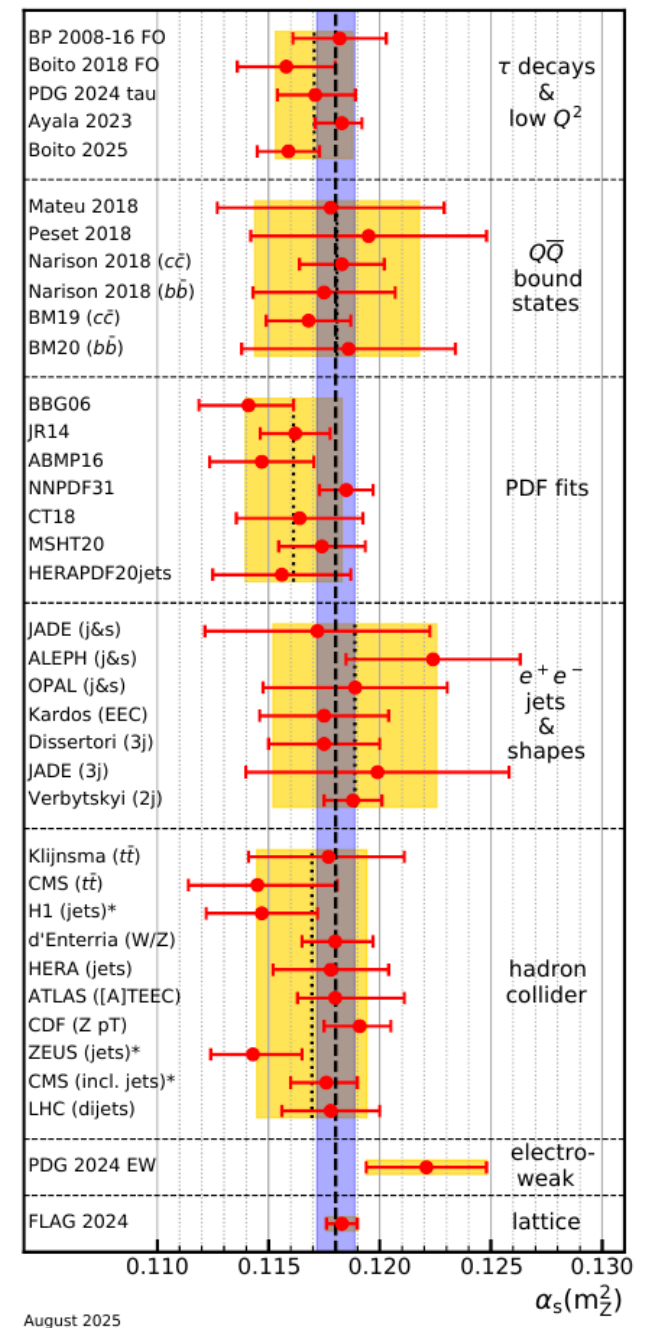


- no change yet

- update 1, add 3 new results

- update PDG, remove 2 outdated

- update FLAG estimate



August 2023

August 2025



More detailed changes

- **τ decay widths**
 - ➔ Updated results to PDG'24 and Boito '25
- **PDF fits**
 - ➔ Important new results available, ABMtt, MSHT, NNPDF, but either with incomplete NNLO uncertainty, considered pre-mature, or not published in time.
- **e^+e^- event shapes (thrust, C parameter)**
 - ➔ Many interesting new results, but considered not yet to be yet fully conclusive
- **Hadron collider**
 - ➔ CMS incl. jets updated (more data)
 - ➔ New results from CDF Z pT, ZEUS jets, LHC dijets
- **Electroweak**
 - ➔ Updated to PDG'24; removed Gfitter & HepFit not considering recent devs.
- **FLAG**
 - ➔ Updated to 2024 estimate



averages per subfield	unweighted
τ decays & low Q^2	0.1171 ± 0.0017
$Q\bar{Q}$ bound states	0.1181 ± 0.0037
PDF fits	0.1161 ± 0.0022
e^+e^- jets & shapes	0.1189 ± 0.0037
hadron colliders	0.1170 ± 0.0025
electroweak	0.1221 ± 0.0027
PDG 2025 (without lattice)	0.1178 ± 0.0010

Final average including lattice (FLAG2024):

$$\alpha_s(m_Z^2) = 0.1180 \pm 0.0009$$

Unchanged, rel. uncertainty: 0.76%

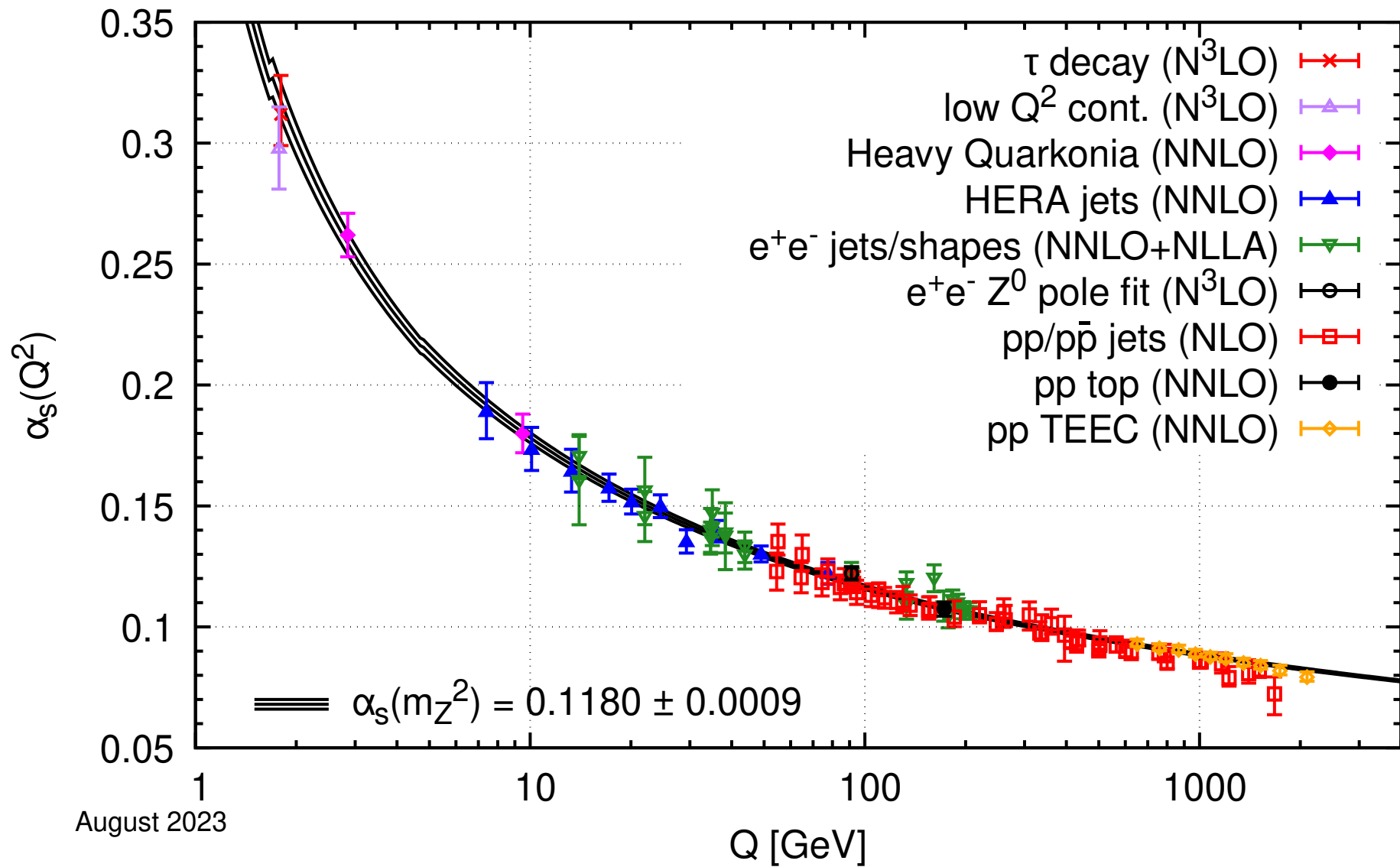


Table 9.1: Unweighted and weighted pre-averages of $\alpha_s(m_Z^2)$ for each subfield in columns two and three. The bottom line corresponds to the combined result (without lattice gauge theory) using the χ^2 averaging method. The same χ^2 averaging is used for column four combining all unweighted averages except for the subfield of column one. See text for more details.

averages per subfield	unweighted	weighted	unweighted without subfield
τ decays & low Q^2	0.1171 ± 0.0017	0.1172 ± 0.0011	0.1181 ± 0.0012
$Q\bar{Q}$ bound states	0.1181 ± 0.0037	0.1177 ± 0.0011	0.1177 ± 0.0010
PDF fits	0.1161 ± 0.0022	0.1168 ± 0.0014	0.1182 ± 0.0011
e^+e^- jets & shapes	0.1189 ± 0.0037	0.1187 ± 0.0017	0.1177 ± 0.0011
hadron colliders	0.1170 ± 0.0025	0.1173 ± 0.0017	0.1179 ± 0.0011
electroweak	0.1221 ± 0.0027	0.1221 ± 0.0027	0.1171 ± 0.0011
PDG 2025 (without lattice)	0.1178 ± 0.0010	0.1177 ± 0.0006	n/a

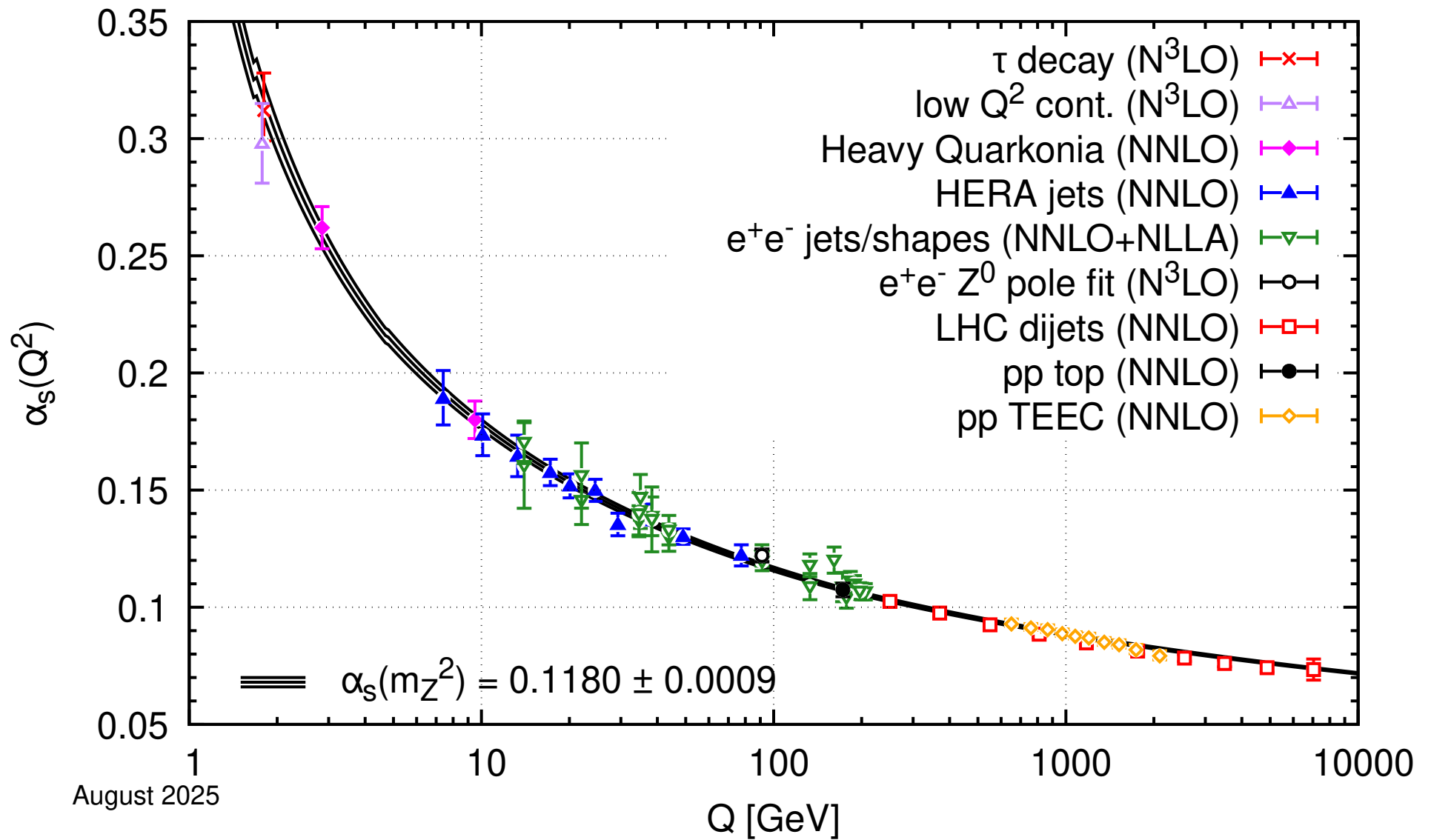


PDG 2023 α_s running





PDG 2025 α_s running





Open discussion