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Metascience and meta-analysis of particle physics

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The Particle Data Group (PDG) performs meta-analysis on a large scale, ingesting thousands of particle physics experiments and producing point estimates and confidence intervals for thousands of quantities. This allows us to study both the empirical "distribution" of experimental results in particle physics, and how to best perform a meta-analysis. We first show that experiments in particle physics have better between-study consistency than any other field and surprisingly good calibration at the 68.3% level (1σ), though poor calibration at higher confidence levels. Next we show results from a retrospective analysis, showing that intervals from almost any meta-analysis method applied to old experiments do not cover modern values with the desired coverage level. Finally, we present proposed revisions to the PDG's meta-analysis methods. Our proposal is to define a likelihood function that incorporates all the nuances of PDG meta-analyses (asymmetric errors, correlations, shared auxiliary constants, nonlinear fits, and others), then perform inference via Wilks' theorem. This resolves several issues with the PDG's current methods, but questions remain about the new method's calibration and theoretical properties.