# Procedure for Adding PDF and $\alpha_S$ Uncertainties.

PDF4LHC Steering Committee

**Simple idea for proposal**.

Adding PDF uncertainty in quadrature with the uncertainty entirely due to $\alpha_S(M_Z^2)$ (with PDFs left free) always gives approximately the same answer as more sophisticated methods, and in some procedures exactly the same answer.

Therefore for ease of calculation (and presentation), and with no very obvious lack of accuracy, suggest:

Find overall best value and PDF uncertainty of quantity $\sigma^0 \pm \delta\sigma^{\rm PDF}$ from combination of PDFs (in some manner, e.g. current envelope prescription, replicas generated from each group, Meta PDFs, ...) at an agreed central value of $\alpha_S^0(M_Z^2)$.

At $\alpha_S^0(M_Z^2) \pm \delta\alpha_S(M_Z^2)$ calculate best prediction for quantity based on combination of the same PDFs. Difference between this and $\sigma^0$ is $\pm\delta\sigma^{\alpha_S}$

Define total uncertainty $\qquad \delta\sigma = \sqrt{(\delta\sigma^{\rm PDF})^2 + (\delta\sigma^{\alpha_S})^2}$.

Independent of means of combining PDFs at a particular $\alpha_S(M_Z^2)$.

At present propose that common value $\alpha_S^0(M_Z^2) = 0.118$ is taken at both NLO and NNLO, though these values, particularly at NLO, will possibly be subject to change in a future update.

Also propose that $\delta\alpha_S = 0.0012$ for continuity with existing PDF4LHC proposal. Again potentially subject to change in future updates.

If $\delta\alpha_S(M_Z^2)$ is not automatically the separation between PDFs at $\alpha_S^0(M_Z^2)$ and available PDF sets, e.g $\delta\alpha_S(M_Z^2) = 0.0012$ while PDF sets are available with separations of 0.001, then rescale $\pm\delta\sigma^{\alpha_S}$ by the desired change in $\alpha_S(M_Z^2)$ divided by actual change in $\alpha_S(M_Z^2)$, i.e. $0.0012/0.001 = 1.2$ in our example.

Likely only to be a small correction, and in practice cross section dependence on $\alpha_S^0(M_Z^2)$ is usually quite linear in vicinity of best fit.

Alternatively, if an issue in future prescriptions, once $\delta\alpha_S(M_Z^2)$ is decided each group makes a central set with $\alpha_S^0(M_Z^2) \pm \delta\alpha_S(M_Z^2)$ available.