

Supplementary Material: Operational Constraints on Ethically-Weighted Quantum Measurement

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1 Higgs invisible likelihood approximation

CMS reports a best-fit invisible branching fraction and asymmetric uncertainties for the 2012–2018 combination [1]. In the main text we approximate the one-dimensional profile likelihood ratio by an asymmetric Gaussian in the scanned parameter B :

$$q(B) \approx \begin{cases} \left(\frac{B-B_-}{\sigma_-}\right)^2 & B < B_- \\ \left(\frac{B-B_+}{\sigma_+}\right)^2 & B \geq B_+ \end{cases}.$$

This reproduces the published 95% CL upper limit to good approximation and avoids reliance on plot digitization.

2 QRNG shot-noise scaling

For a balanced two-outcome QRNG (Born baseline $P(1) = P(0) = 1/2$) and a small log-odds shift $\eta\Delta E$, the induced probability shift is $\delta p \approx \eta\Delta E/4$. The count difference $N_1 - N_0$ has standard deviation \sqrt{N} at $p = 1/2$, yielding $\sigma_\eta \approx 2/(\sqrt{N}\Delta E)$ as used in Eq. (9) of the main text.

References

- [1] CMS Collaboration, “Search for invisible decays of the Higgs boson produced via vector boson fusion in proton-proton collisions at $\sqrt{s} = 13$ TeV,” *Phys. Rev. D* **105**, 092007 (2022), arXiv:2201.11585.
- [2] J. G. Lee, E. G. Adelberger, T. S. Cook, S. M. Fleischer, and B. R. Heckel, “New Test of the Gravitational $1/r^2$ Law at Separations down to $52\ \mu\text{m}$,” *Phys. Rev. Lett.* **124**, 101101 (2020), arXiv:2002.11761.
- [3] M. Born, “Zur Quantenmechanik der Stoßvorgänge,” *Zeitschrift für Physik* **37**, 863–867 (1926).
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