Modeling of GERDA Phase II data

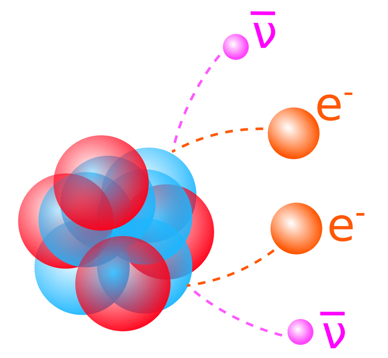
L. Pertoldi[1], K. von Sturm[1], A.-K. Schütz[2] and T. Wester[3] — for the GERDA Collaboration

[1] Universitá degli Studi di Padova and INFN Sezione di Padova, [2] Eberhard Karls Universität Tübingen, [3] Technische Universität Dresden

$2\nu\beta\beta$ and $0\nu\beta\beta$ decay

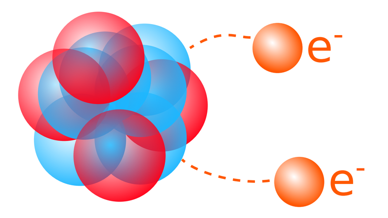
$$(A, Z) \to (A, Z-2) + 2\,e^- + 2\,\bar{\nu}_e$$

two-neutrino double beta ($2\nu\beta\beta$) decay
→ allowed in the standard model

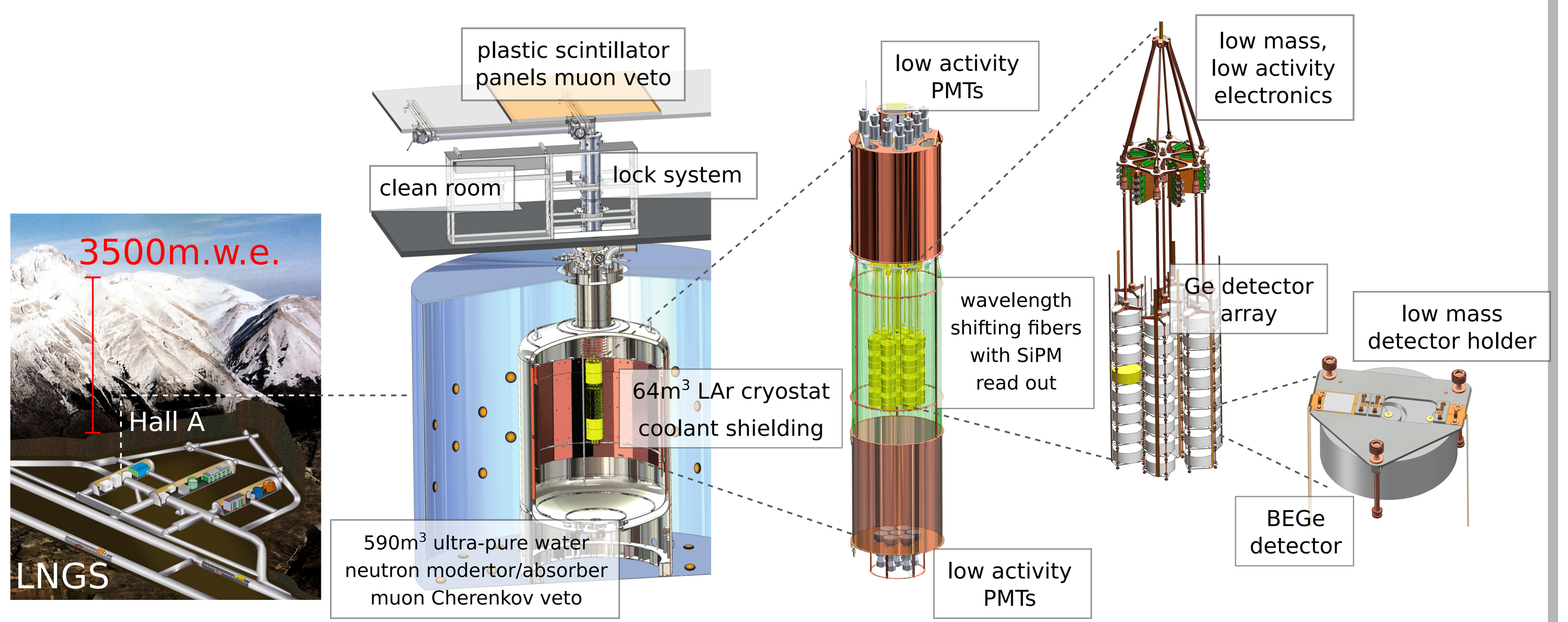


$$(A, Z) \to (A, Z-2) + 2\,e^-$$

neutrinoless double beta ($0\nu\beta\beta$) decay
→ physics beyond the standard model

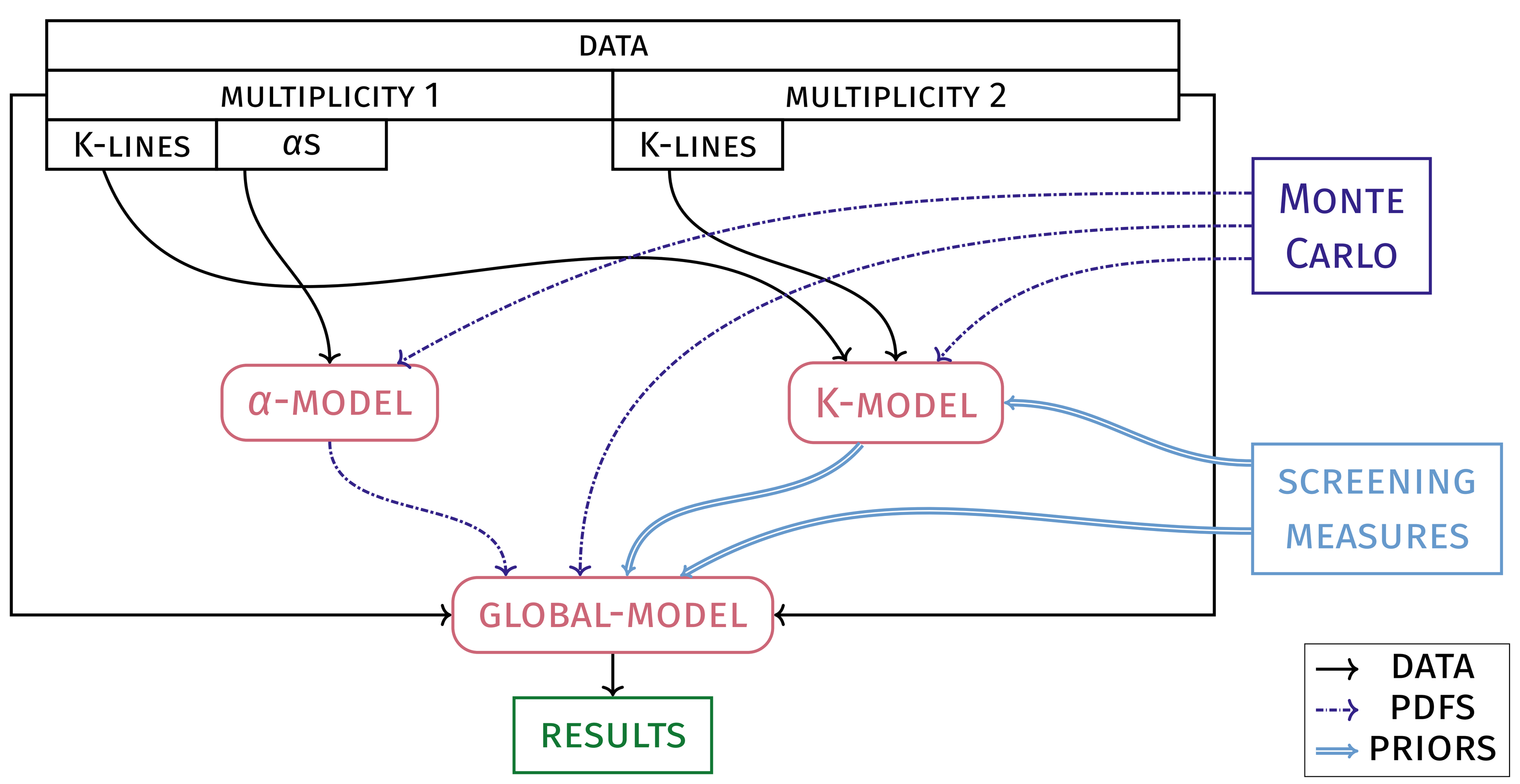


The GERmanium Detector Array — GERDA

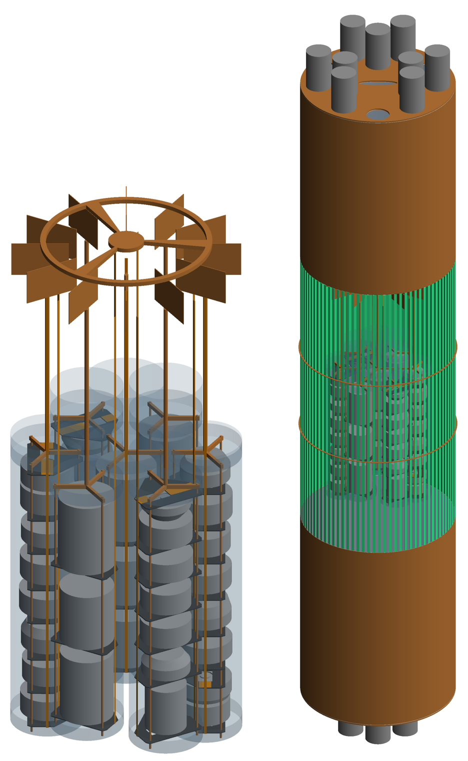


- The GERDA experiment [1][2] for the search of $0\nu\beta\beta$ decay of the isotope ^{76}Ge
- Data taking from November 2011 until November 2019 at Laboratori Nazionali del Gran Sasso (LNGS)

Background modeling workflow

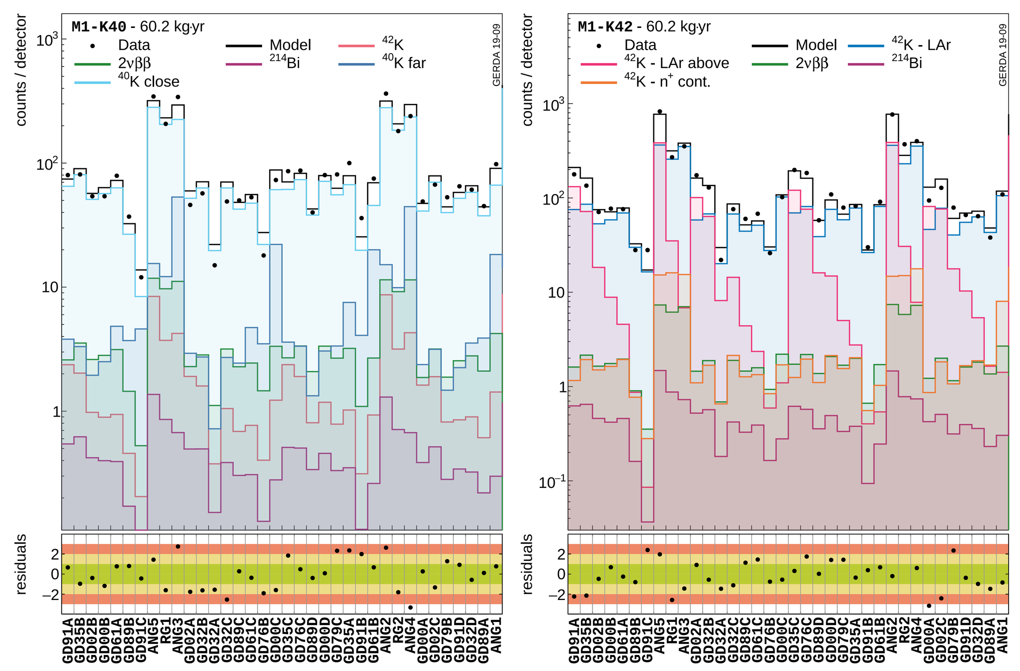


Monte Carlo simulations



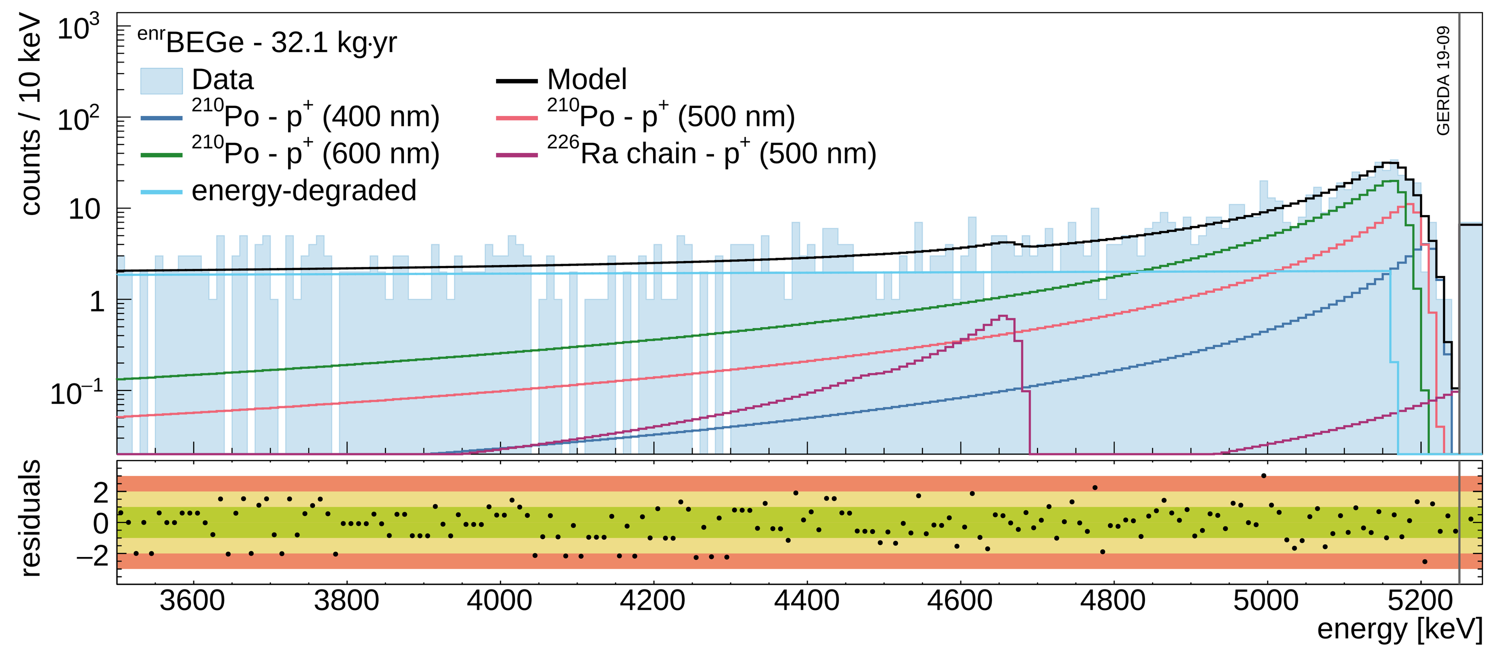
- Geant4 based Monte Carlo simulations with MaGe [3]
- In materials close to detector array
- Isotopes from the U and Th decay chains, ^{60}Co, ^{42}K, ^{40}K and detector intrinsic $2\nu\beta\beta$ events
- Apply energy resolution, detector properties and run configuration in post-processing to build probability density functions (PDFs)
- Use each simulated event only once in order to avoid statistical bias

K-model — ^{40}K and ^{42}K



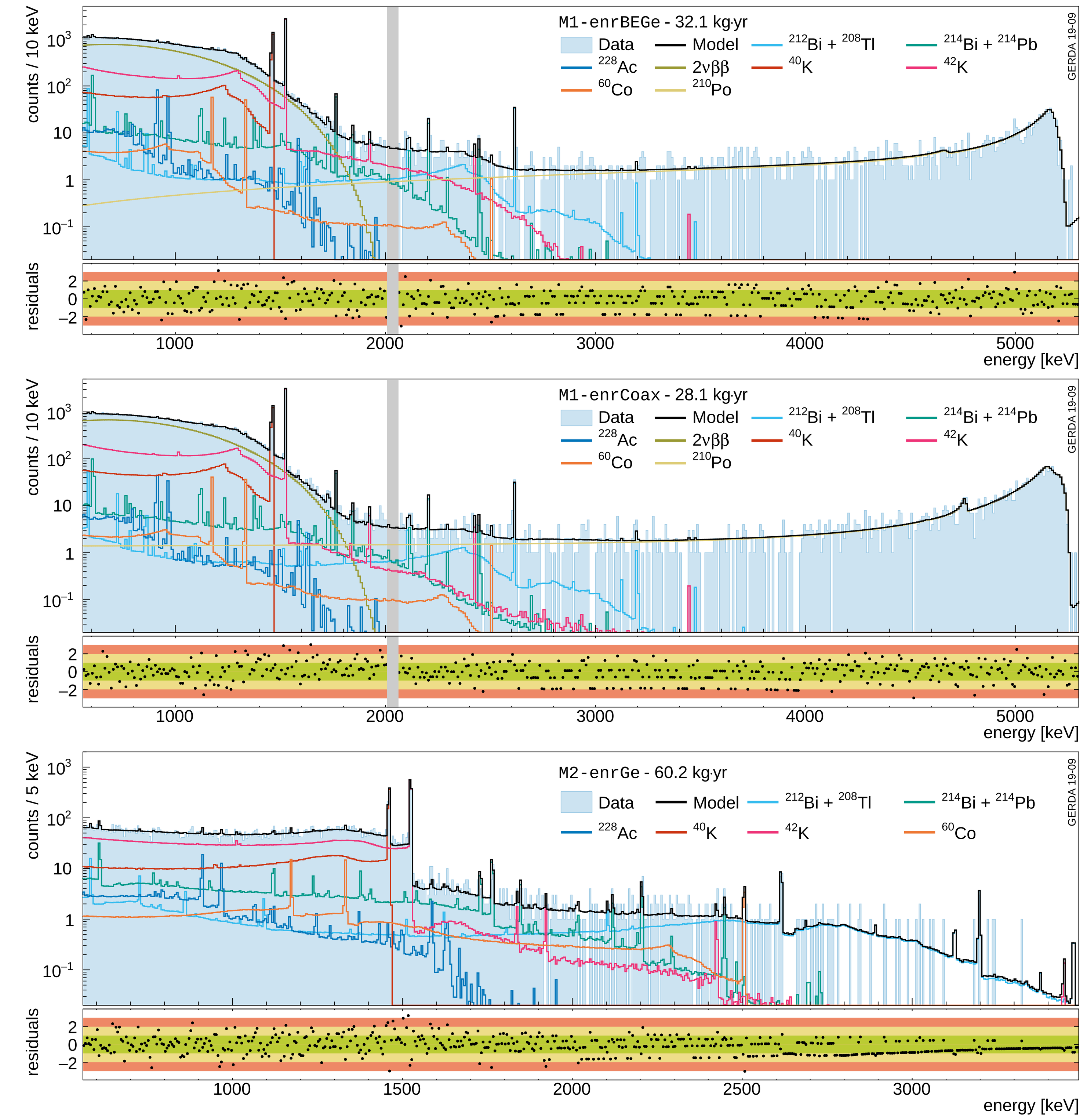
- ^{40}K and ^{42}K high statistics γ lines can be fit in counts/detector
- More information on spatial distribution

α-model



- Spectra above 3.5 MeV dominated by ^{210}Po decays on detector p$^+$ contacts
- ^{210}Po maximal energy depends on contact thickness
- Energy degraded component approximated with linear fit function

Global-model



Simultaneous Bayesian maximum likelihood fit of multiplicity 1 (^{enr}BEGe and ^{enr}Coax data sets) and multiplicity 2 (^{enr}Ge data set) PDFs to data using priors from available screening measurements. Software implementation via the Bayesian Analysis Toolkit BAT [4].

Conclusions

- Fit results compatible with material screening
- We find more ^{40}K than expected from material screening
- Spectra dominated by decays originating in close vicinity of the detectors

References

[1] K.-H. Ackermann *et al.*, Eur. Phys. J. C (2013), 10.1140/epjc/s10052-013-2330-0
[2] M. Agostini *et al.*, Eur. Phys. J. C (2018), 10.1140/epjc/s10052-018-5812-2
[3] M. Boswell *et al.*, IEEE Trans. Nucl. Sci. (2011), 10.1109/TNS.2011.2144619
[4] A. Caldwell *et al.*, Comput. Phys. Commun. (2009), 10.1016/j.cpc.2009.06.026
[5] M. Agostini *et al.*, J. High Energ. Phys. (2020), 10.1007/JHEP03(2020)139