

## Exercises for Modern Experimental Physics III (Experimental Particle and Astroparticle Physics) Summer term 2025

### Exercise sheet Nr. 2

To be worked on until 22.05.2025

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In this exercise sheet you will learn how to simulate elementary particle interactions with matter using the GEANT4 [1–3] software package. GEANT4 is a very powerful tool and is used in almost any high energy physics experiment, as well as in medical and space sciences.

For this exercise sheet we will use the computer resources and software environment provided via the Jupytermachine from the Department of Physics. You need to have an active account to access the machine in order to work on the exercises. You can find additional information on how to work with Jupyter notebooks here.

To start working on the exercises connect to <https://jupytermachine.etp.kit.edu>, login with your KIT credentials and select the **Geant4** container. The exercise notebook and software are provided by a GIT repository ([https://gitlab.etp.kit.edu/Lehre/modexph3\\_forstudents](https://gitlab.etp.kit.edu/Lehre/modexph3_forstudents)). Clone the repository by opening a terminal (**New > Terminal**) followed by the command:

```
git clone https://gitlab.etp.kit.edu/Lehre/modexph3_forstudents
```

The individual exercises are outlined in the notebook `Exercise_02.ipynb` where you can also find specific places to work and an interactive introduction to the software.

**Exercise 1: Interaction of photons with matter** (6 points)

**Exercise 2: Electromagnetic showers** (8 points)

**Exercise 3: Calorimeter calibration** (6 points)

## References

- [1] GEANT4 Collaboration, “GEANT4—a simulation toolkit”, *Nucl. Instrum. Meth. A* **506** (2003) 250–303. doi:10.1016/S0168-9002(03)01368-8.
- [2] J. Allison et al., “Geant4 developments and applications”, *IEEE Trans. Nucl. Sci.* **53** (2006) 270. doi:10.1109/TNS.2006.869826.
- [3] J. Allison et al., “Recent developments in Geant4”, *Nucl. Instrum. Meth. A* **835** (2016) 186–225. doi:10.1016/j.nima.2016.06.125.