Helmholtz-, solenoidal, and toroidal coils –
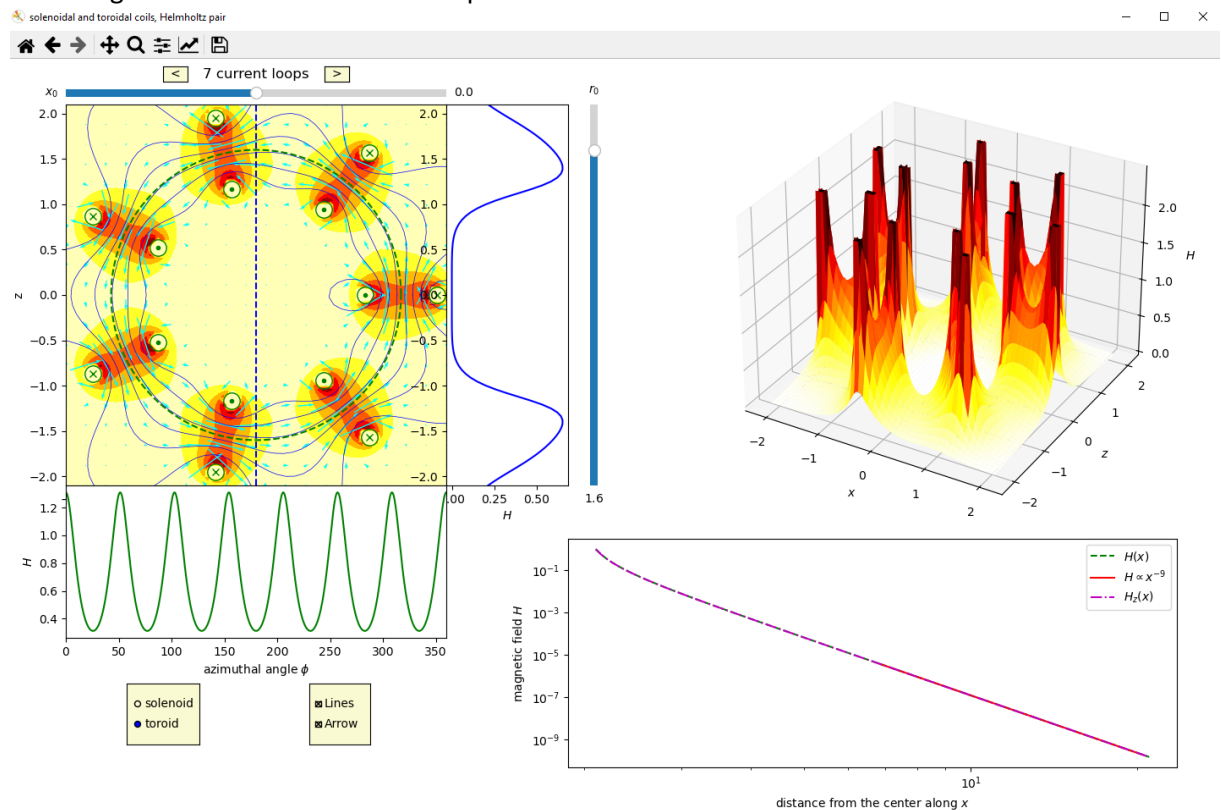
Python animation

Version 2.0, the display option for solenoids, toroids, and the Helmholtz pair of coils are integrated into one single animation. It allows investigating the superposition of the fields of n current loops, with n ranging from 1 to 40. In addition to previous versions, the slider control is improved, and the decay of the field $H(r)$ outside the coil is indicated in an additional window. It demonstrates the remarkable feature that the field decays with $H(r) \sim r^{-(n+2)}$ in the toroidal arrangement, in analogy to the corresponding magnetic dipole cluster illustrated by https://doi.org/10.5281/zenodo.10084574

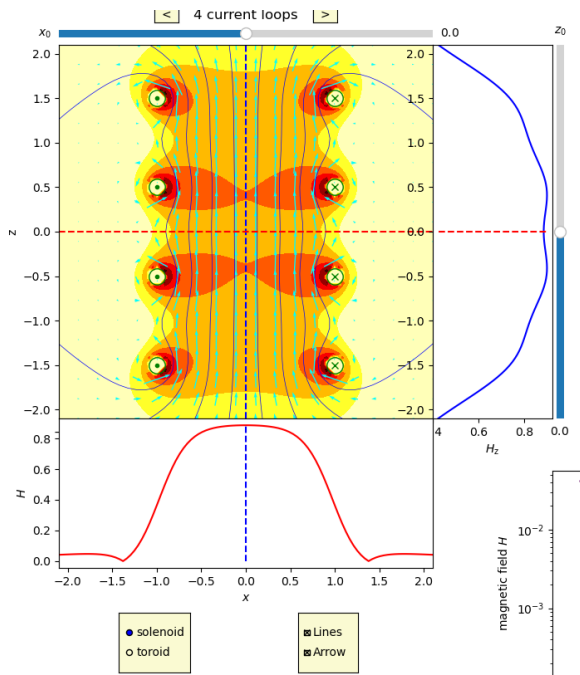The package "coils V2_0.zip" contains two scripts:

1) **coils_toroidal.py**
   Interactive exploration of the fields in solenoidal and toroidal coils, with special emphasis of the finite size effects and the decay of the outer field. Notice that the coils are modelled as an arrangement of circular current loops.
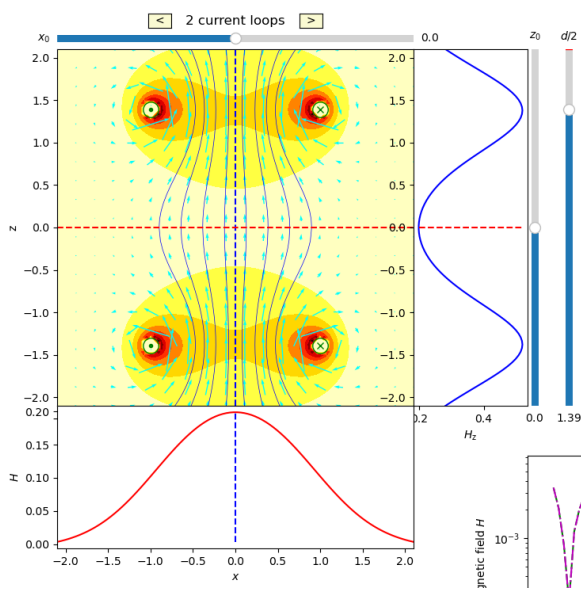

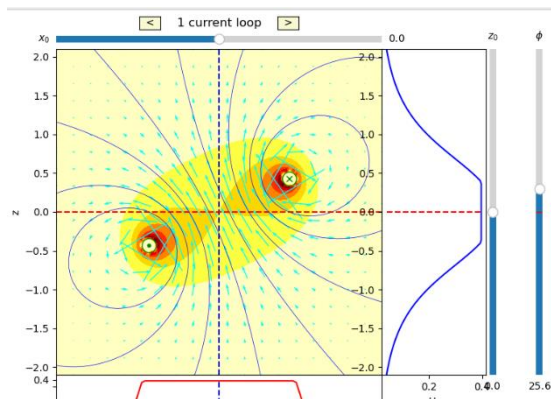*Screenshot for 7 current loops in toroidal arrangement.*

The vertical and horizontal sliders manipulate the location of the cross section. The field H along the corresponding lines are indicated as $H(z)$ and $H(\phi)$. The double logarithmic plot $H(x)$ on the right hand side unveils a decay with the 9th power in this particular case.

Solenoidal arrangement of 4 current loops. The plot $H_z(z)$ emphasises the finite size effects in this geometry.

Choosing 2 current loops provides an additional slider for a graphical illustration of the Helmholtz configuration by playing with the distance d.
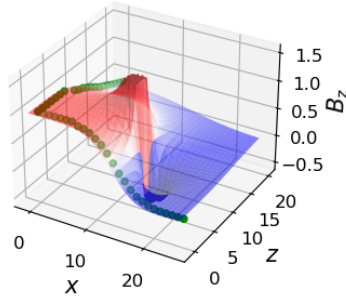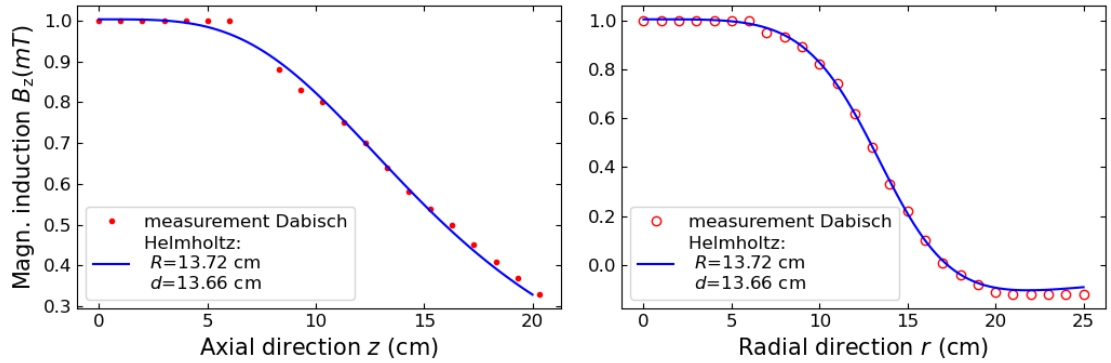

Choosing 1 current loop in the solenoidal configuration provides an additional slider for turning the current loop.

2) **combo_helmholtz_fit.py**

Evaluation of data obtained from a Helmholtz pair, using the same software package as for the animation described above. These data are similar to a classroom demonstration presented during a physics course at the University of Bayreuth.

Mr. T. Dabisch, University of Bayreuth, provided the data.

I tested the code with Python 3.9.18

I gratefully acknowledge - and highly recommend - the use of Anaconda and Spyder.

Ingo Rehberg,
https://de.wikipedia.org/wiki/Ingo_Rehberg