Making optics modular. One cube at a time.

openUC2

CoreBOX

1. Experiment **Overview**
2. Experiment **Deepdive**

Overview

The **CoreBOX** is our base educational product and focuses on 3 things:

1. **Basic *Optics* understanding**
   Helping students to understand and experience basic optics.

2. **Basic *Microscopy* understanding**
   Helping students to understand and experience first microscopic experiments.

3. **Basic *UC2* component understanding**
   Deliver an understanding of our cube system as a base to build more complex setups with our more sophisticated boxes.

Part 1:

Basic *Optical* Experiments

Overview

Which experiments are possible?

The experiments are split in two groups: **Optics & Microscopy**. With the parts included in the CoreBOX, at least 8 experiments can be performed.

Optics

1. Magnifying Glass
2. Focal Lengths
3. Projector
4. **Telescope 1:** Galilean Telescope
5. **Telescope 2:** Kepler Telescope

Microscopy

1. **Microscope 1:** Infinity Microscope
2. **Microscope 2:** Finite Microscope with Z-Stage
3. **Microscope 3:** Smartphone Microscope

Experiment 1: Magnifying Glass

NECESSARY PARTS

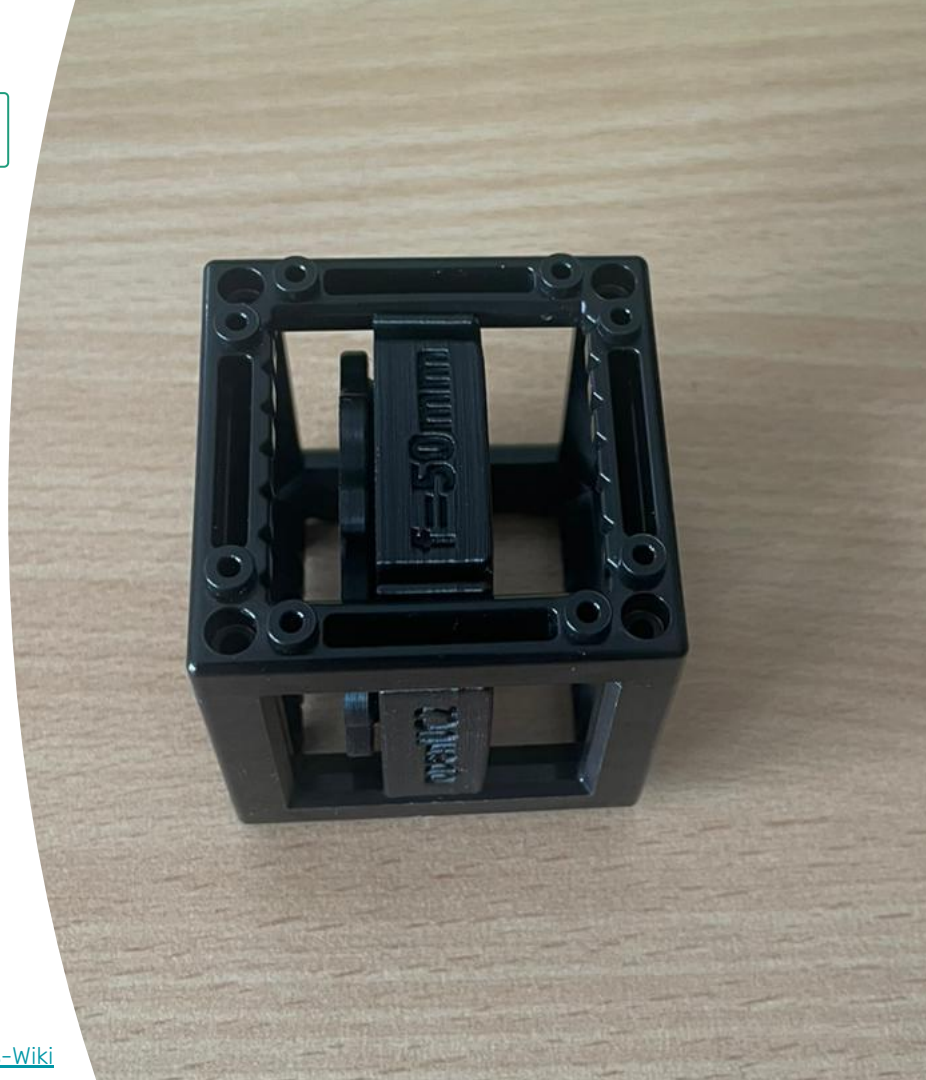
- 50mm lens

SETUP

This is very simple and does not have a real setup at all. Students take out one of the 50mm lenses and look through it.

GOAL:

In this experiment students see, how a lens magnifies what they look at.



More details can be found here: Lens-Wiki

Experiment 2: Focal Lengths

NECESSARY PARTS

- 50mm lens
- 100mm lens
- -50mm lens

SETUP

Now we need two more lenses, but still there is no assembly needed.The student choose a fixed geometry, for example a letter on the user-guide card and look at it through the different lenses

GOAL:

Students should realise how the different focal lengths impact what they see through the lens. This understanding is the base to understand how the distance between different lenses affects the setups we will build later.

More details can be found here: Lens-Wiki

Experiment 3: Projector

NECESSARY PARTS

- Sample holder with probe
- 50mm lens
- Torch
- Torch holder
- 4x Puzzle piece
- 50mm lens

SETUP

Put the sample holder on a puzzle piece and put a sample in. Add a second puzzle piece. Put the lens on top of it. Put 2 puzzle pieces on top for stability. Put the torch into the torch holder. Put everything on a table, so you don't have to hold the torch.
Shut off the lights and find a wall to project on.

GOAL:

We have a first "Aha"-Moment: The sample can be seen on the wall. Students should also experiment with what happens if the torch is closer or further away or if they move the sample holder or lens forward or backward in their cubes.

More details can be found here: Lens-Wiki

Experiment 4: Galilean Telescope

NECESSARY PARTS

- 100mm lens
- **-50mm** lens
- 4x Puzzle piece

SETUP

Put the 100mm lens on a puzzle piece. Add a second puzzle piece. Put the -50mm lens on that. Add 2 puzzle pieces on top.
Find a distant object to look at and look through the side with the -50mm lens. Adjust lens distance if necessary (aprox. distance 50mm)

GOAL:

This is the first time we combine two lenses. The goal here is to give students an understanding of how these work together and how the distance between the lenses effects the sharpness of the image. Discuss with them, what would happen, if you chose the 50mm lens instead of the -50mm.

More details can be found here: Telescope-Wiki

Experiment 5: KEPPLER Telescope

NECESSARY PARTS

- 100mm lens
- **50mm** lens
- 8x Puzzle piece

SETUP

Add a puzzle piece at the bottom and top of both lens cubes. Take one and add two puzzle pieces to it. Put other lens at the and. Add two puzzle pieces on the upper side for stability.
Look through 50mm lens. Adjust lens distance if necessary (aprox. distance 150mm)

GOAL:

There should be a second aha-moment, wenn students realise, that the image stands on its head. Discuss why that happens.

More details can be found here: Telescope-Wiki

Part 2:

Basic *Microscope* Experiments

Next Level — How to re-assemble a cube:

Now we've finished the basic optical experiments. Students should have a **basic understanding of how lenses work** and what needs to be taken into consideration when combining them.

They should also have gained a first grasp of **how our cubes work**. But to move forward to microscopy, we need to work a bit differently with them.

Because: You can not just stack them together. You can **also open them up and change what optical equipment is inside them** - or which way it is inside them. And this is exactly what we do now with one of our 50mm lenses.

Take off the upper cube-part

Take out the lens

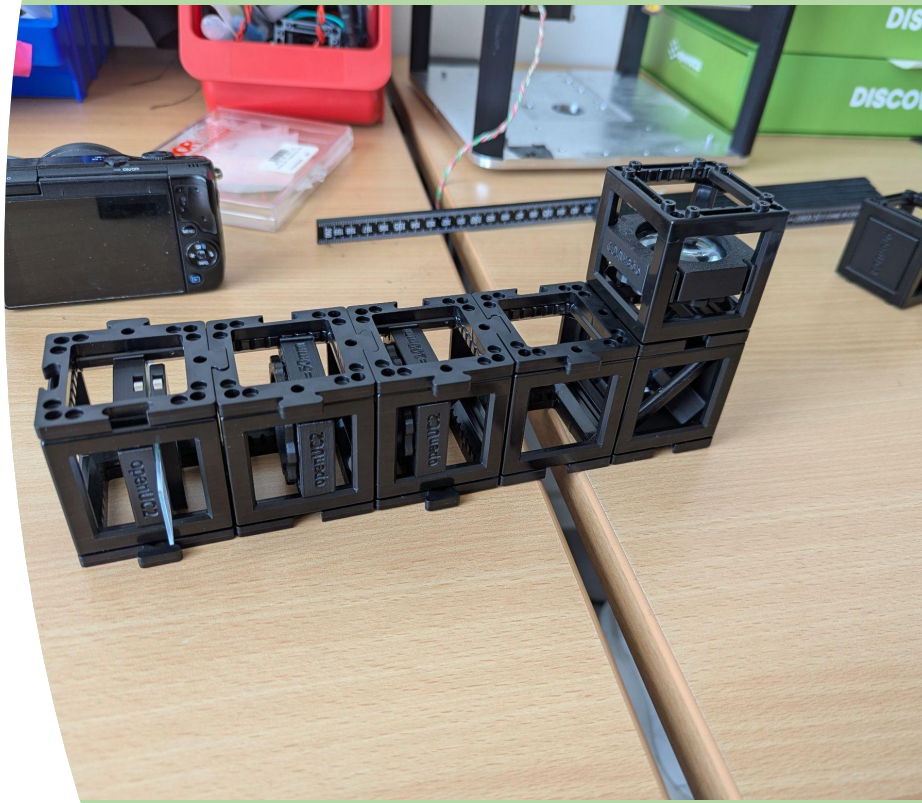
Put in the lens as shown

Put the cube back together

Experiment 6: Infinity Microscope

NECESSARY PARTS

- classic 50mm lens
- changed 50mm lens
- 100mm lens
- Sample Holder
- 45° Mirror
- 10x Puzzle piece



SETUP

Take all cubes except the reassembled 50mm lens, put them on puzzle pieces and put them together as shown. Add a layer of puzzle pieces on top. Put the reassembled 50mm lens on top of the 45° mirror. Look through this cube. Adjust lens distances if necessary.

GOAL:

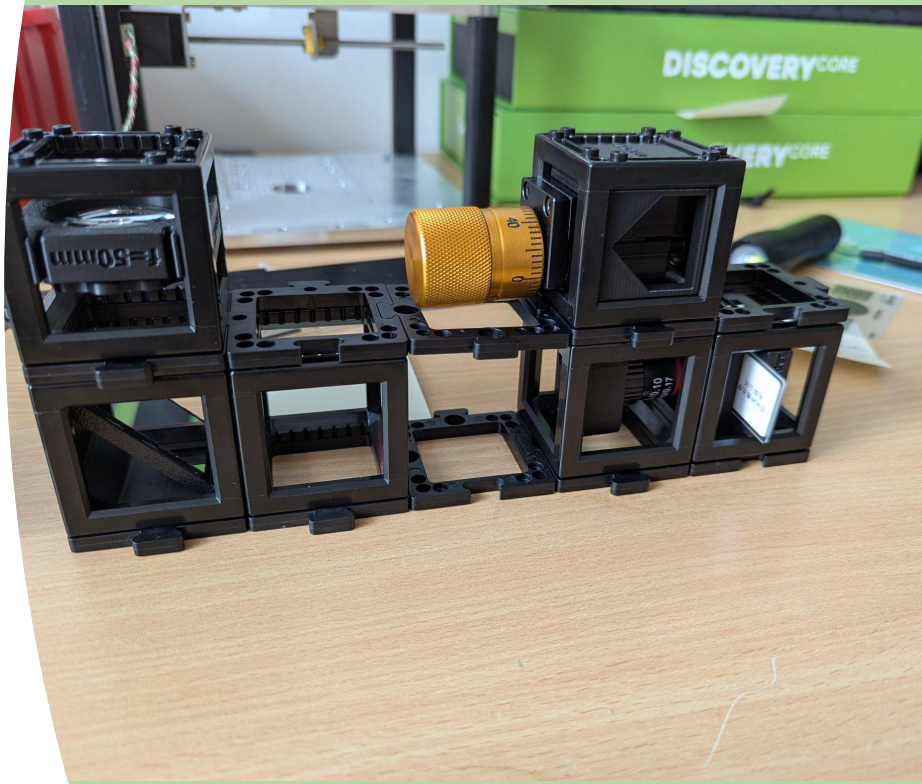
Now students first see, what a microscope actually does. They also will see, how it is very important in this setup to have the correct distances between the lenses and that you only see something if your eyeline is lined up very specifically.

More details can be found here: Microscope-Wiki

Experiment 7: Finite Microscope

NECESSARY PARTS

- 50mm lens
- 45° Mirror
- 2x empty cube
- Sample Holder with probe
- Linear stage
- Objective
- 10x Puzzle piece



SETUP

Put the 50mm lens on top of the 45° mirror and at an empty cube as shown. Lay down 3 more puzzle pieces. Add sample holder on the last piece. Screw objective into the Z-Stage and add Z-Stage to the setup as shown. Adjust lens and objective distance if necessary.

GOAL:

While we moved the lenses by hand so far, the Z-Stage allows now to move the objective more precisely. Experiment with what happens if you turn it and try to get a sharp image.

More details can be found here: Microscope-Wiki

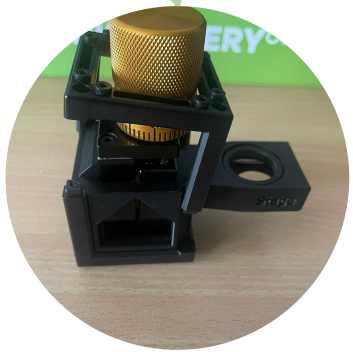
Next Level — How to re-assamble the Z-Stage?

You have learned how to re-assamble or empty a cube. For the next experiment, we need to change the direction of a more complex part: The Z-Stage. This is how you do it:

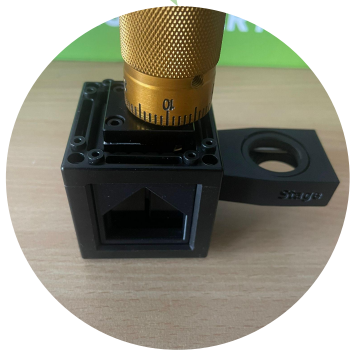
Take the Z-Stage and turn it, so it stands as in picture 2.

Take off both cube parts.

Put the upwards Z-Stage on top of one cube part.



Put the other cube part on top. This needs precision.



Make sure everything sits tight.

Experiment 8: Smartphone Microscope

NECESSARY PARTS

- 100mm lens
- 50mm lens
- 3 empty cubes
- Sample holder & sample
- Smartphone Holder
- Eyepiece
- 10x Puzzle piece
- Smartphone
- Torch holder & torch
- 2x 45°-Mirrors
- Z-Stage
- Objective

SETUP

Setup guide would be too long here, can be found online:
Smartphone Microscope

GOAL:

This is the last and most complex setup. It should create a huge Aha-Effect when students see a high resolution picture of the sample on their own smartphone - check it out on the next slide!

More details can be found here: Smartphone-Microscope-Wiki

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