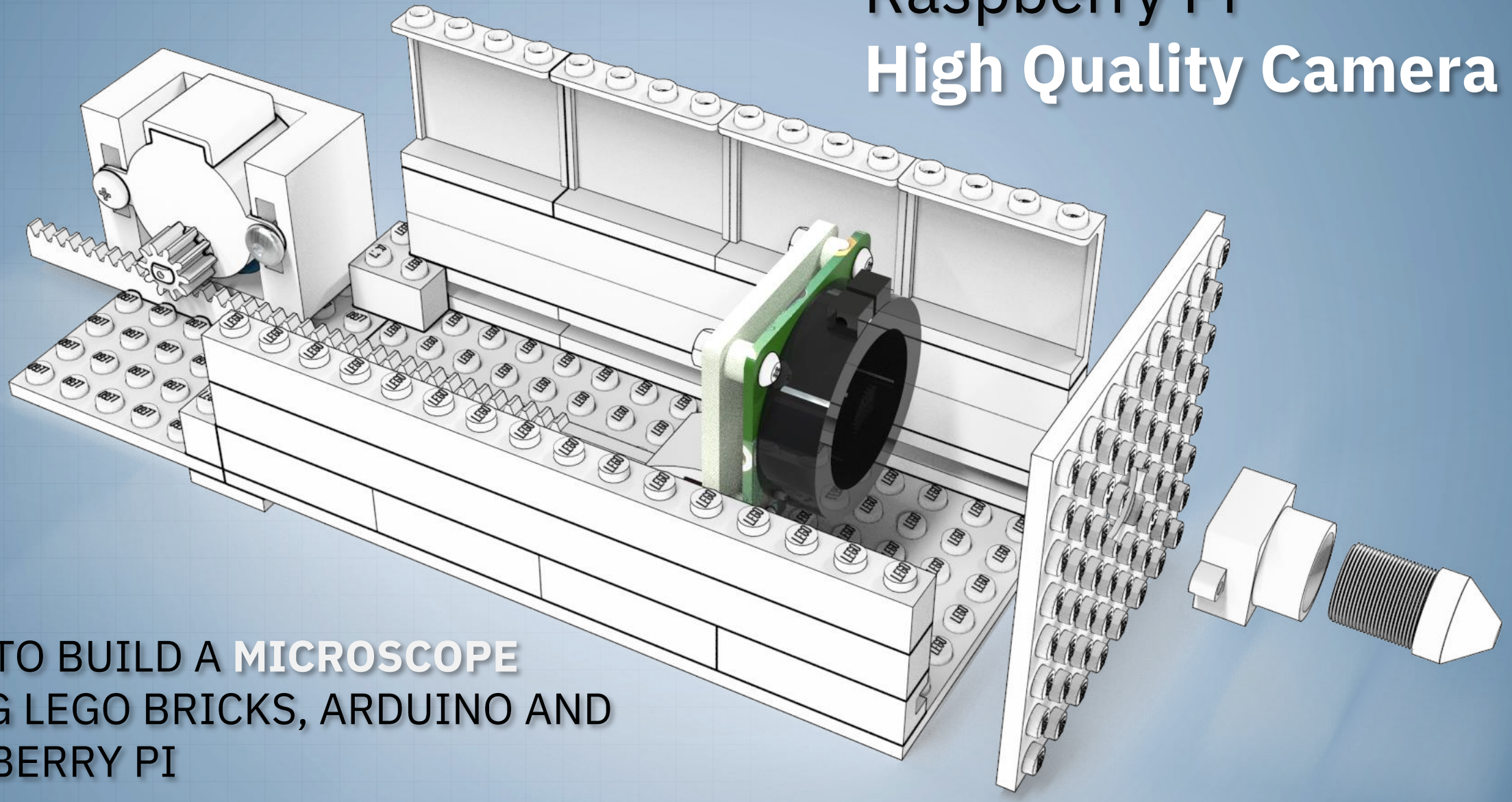
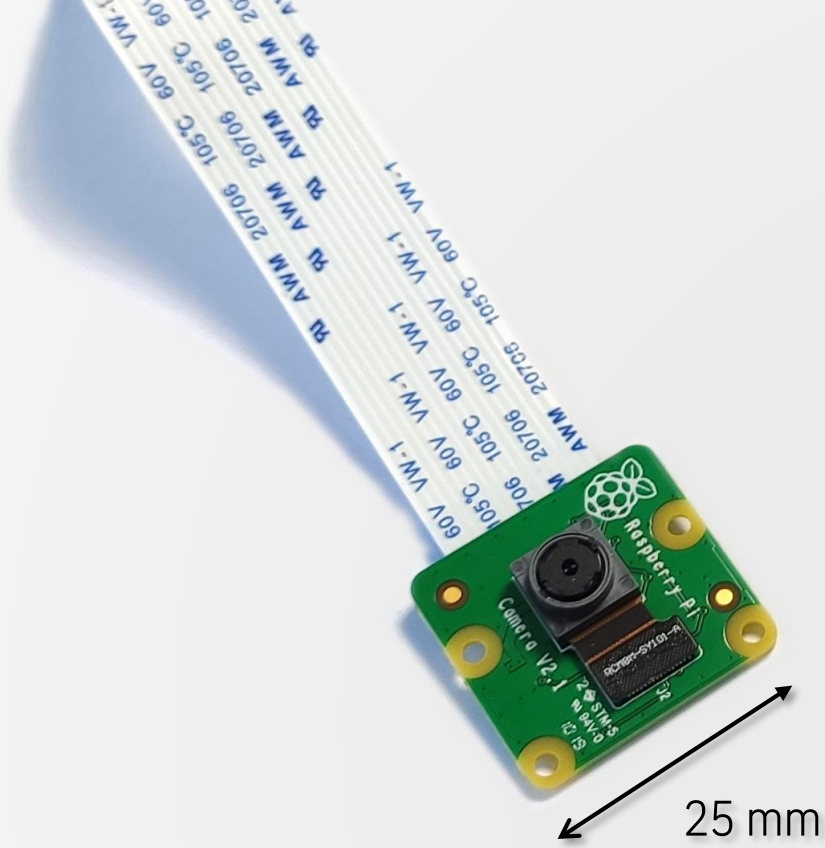
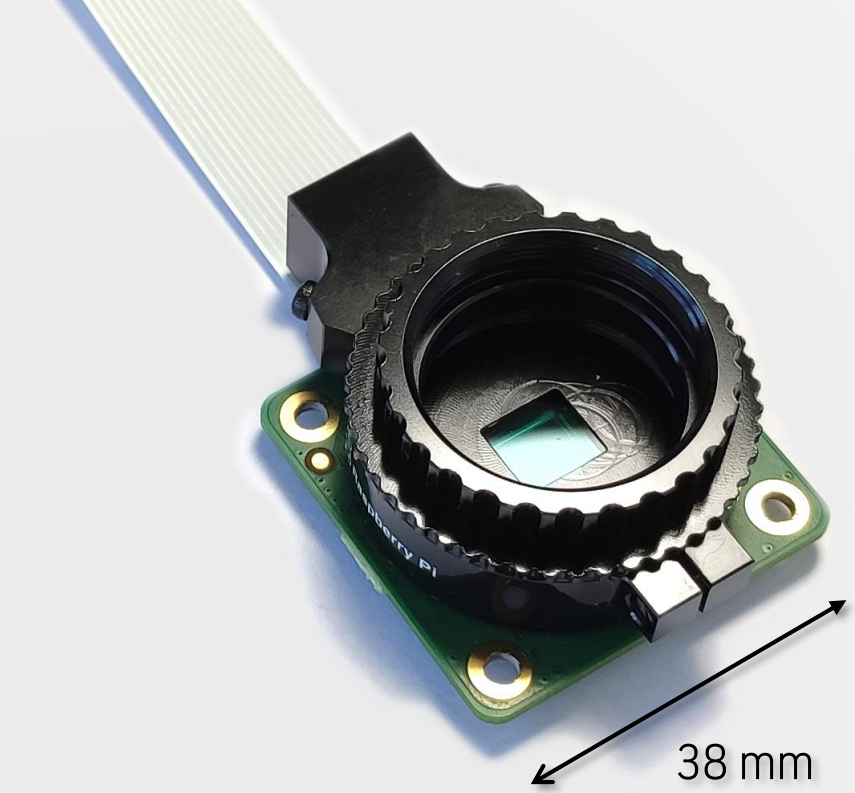
Raspberry Pi
High Quality Camera



HOW TO BUILD A **MICROSCOPE** USING LEGO BRICKS, ARDUINO AND RASPBERRY PI

IBM Research - Zurich





Camera Module v2

$25

8MP (3280 ×2464)

Sensor area: 3.68 × 2.76 mm

HQ camera

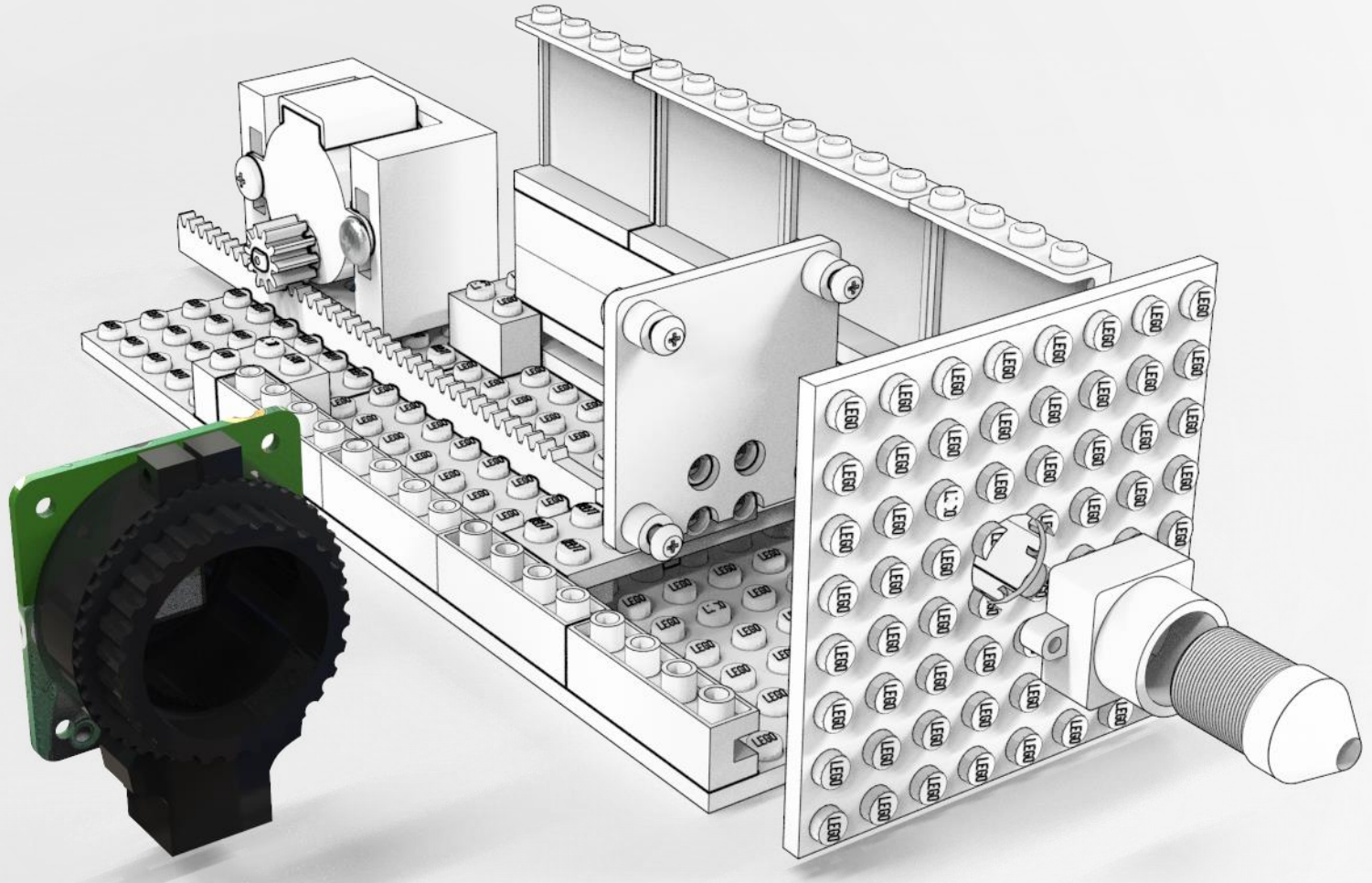
$50

12MP (4056 ×3040)

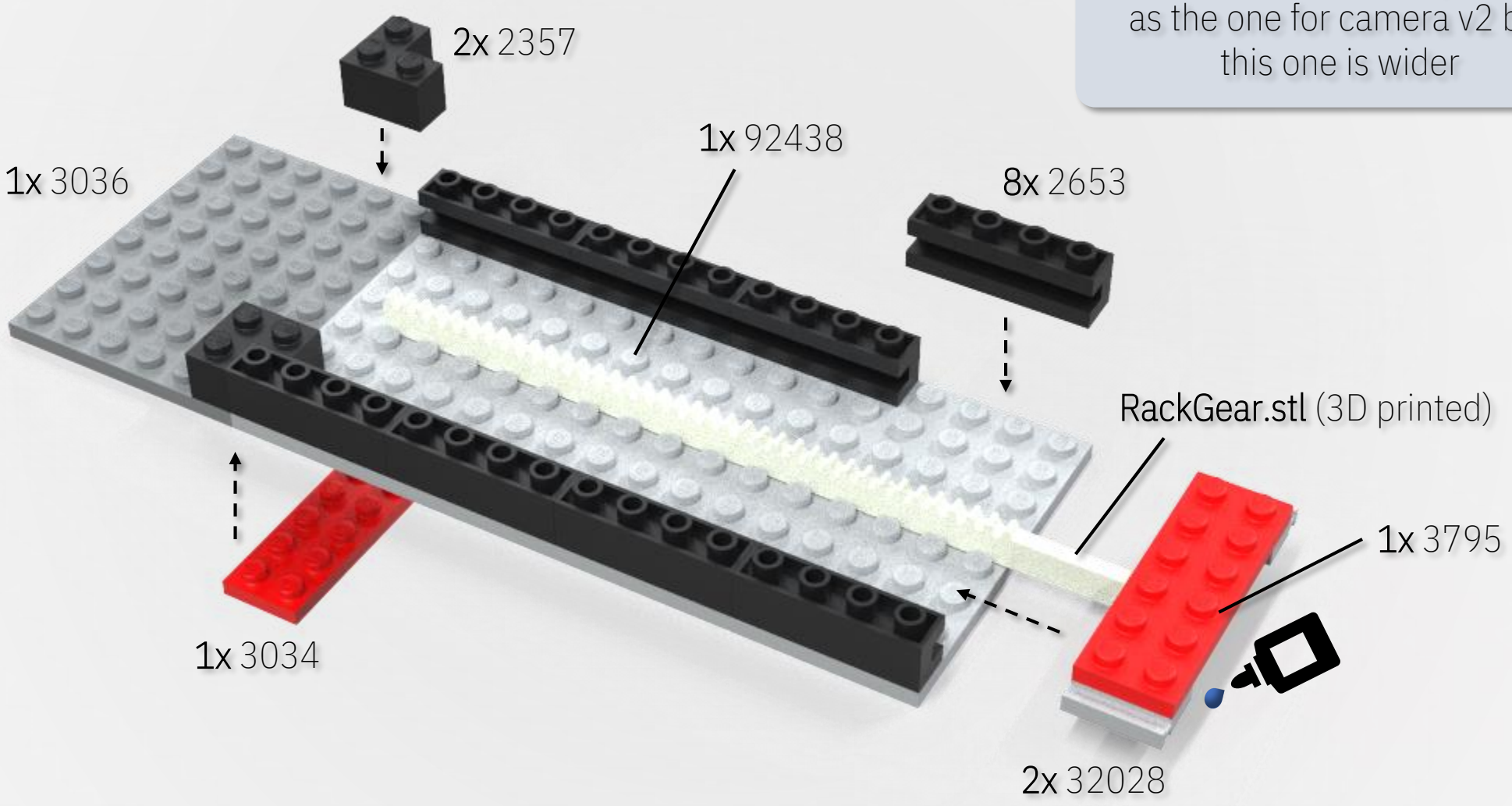
Sensor area: 6.287 × 4.712 mm

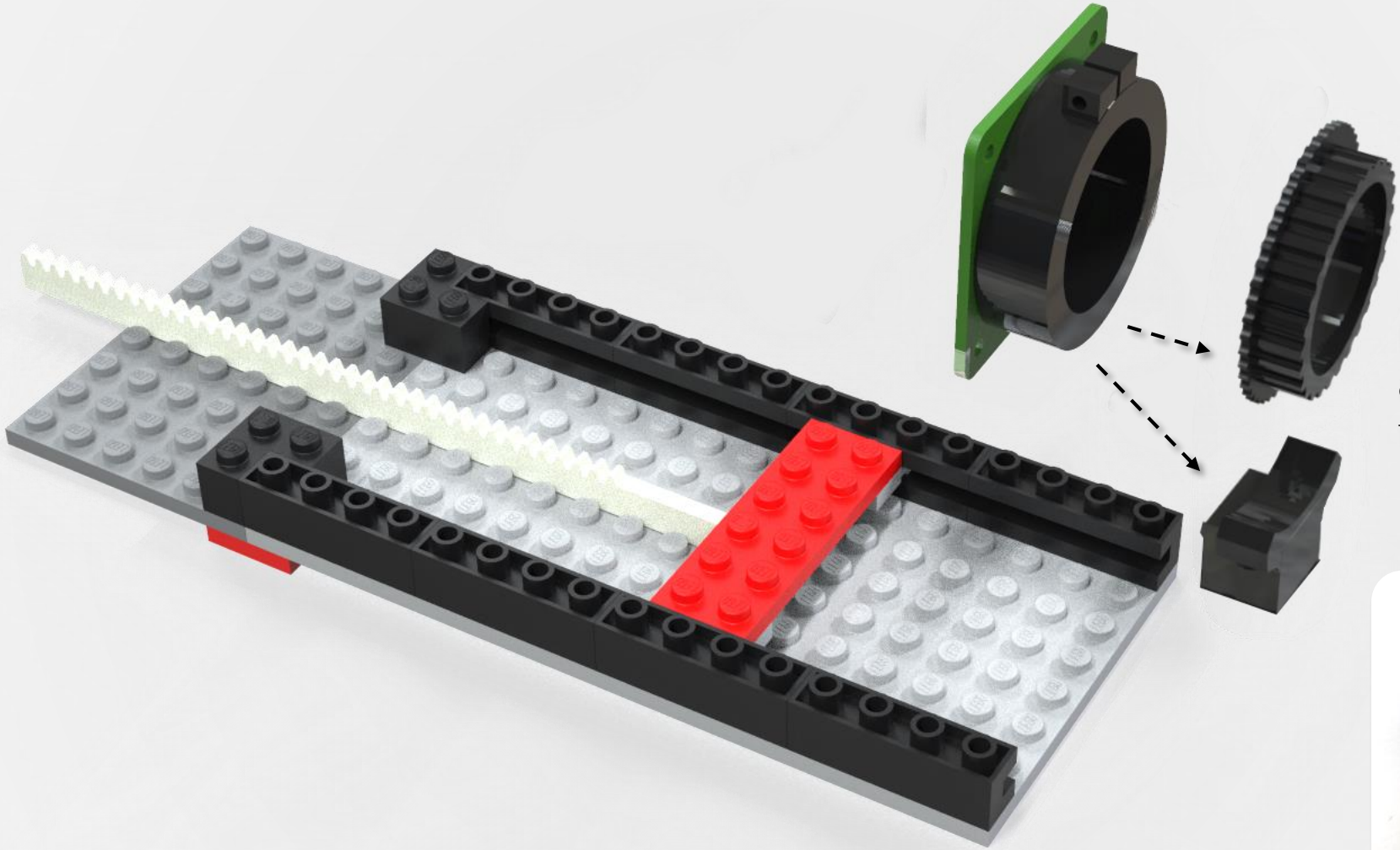
Important notes:

- HQ camera is 50% larger than camera module v2
- Therefore, the Lego housing had to be larger and heavier than the one for the camera module v2
- This challenged the tilting stage, so more supports and glue were needed
- Zoom range of the HQ camera was lower than that of camera module v2
- Overall, the advantage of the HQ camera is marginal for this microscope because the quality of images is anyway limited by other factors

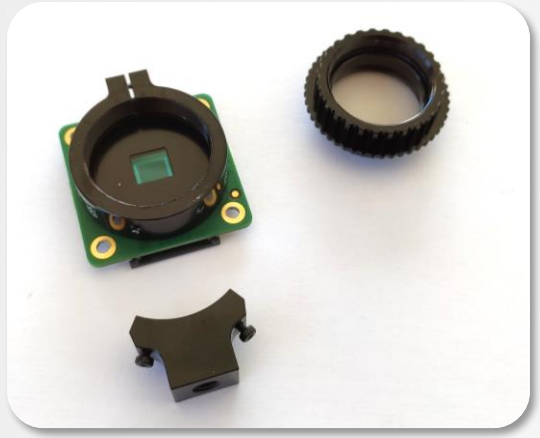


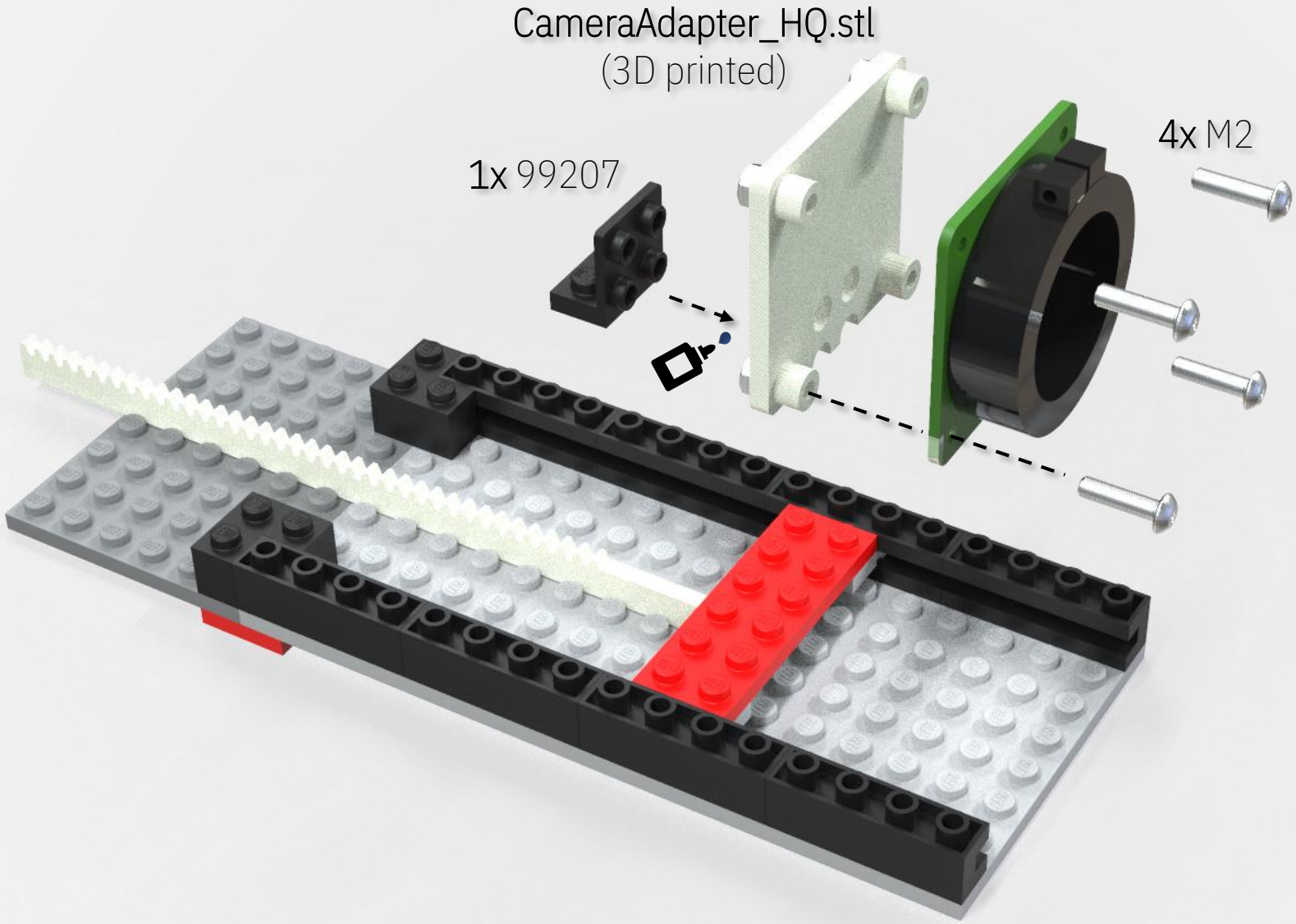
The linear actuator for **HQ camera** has the same principle as the one for camera v2 but this one is wider

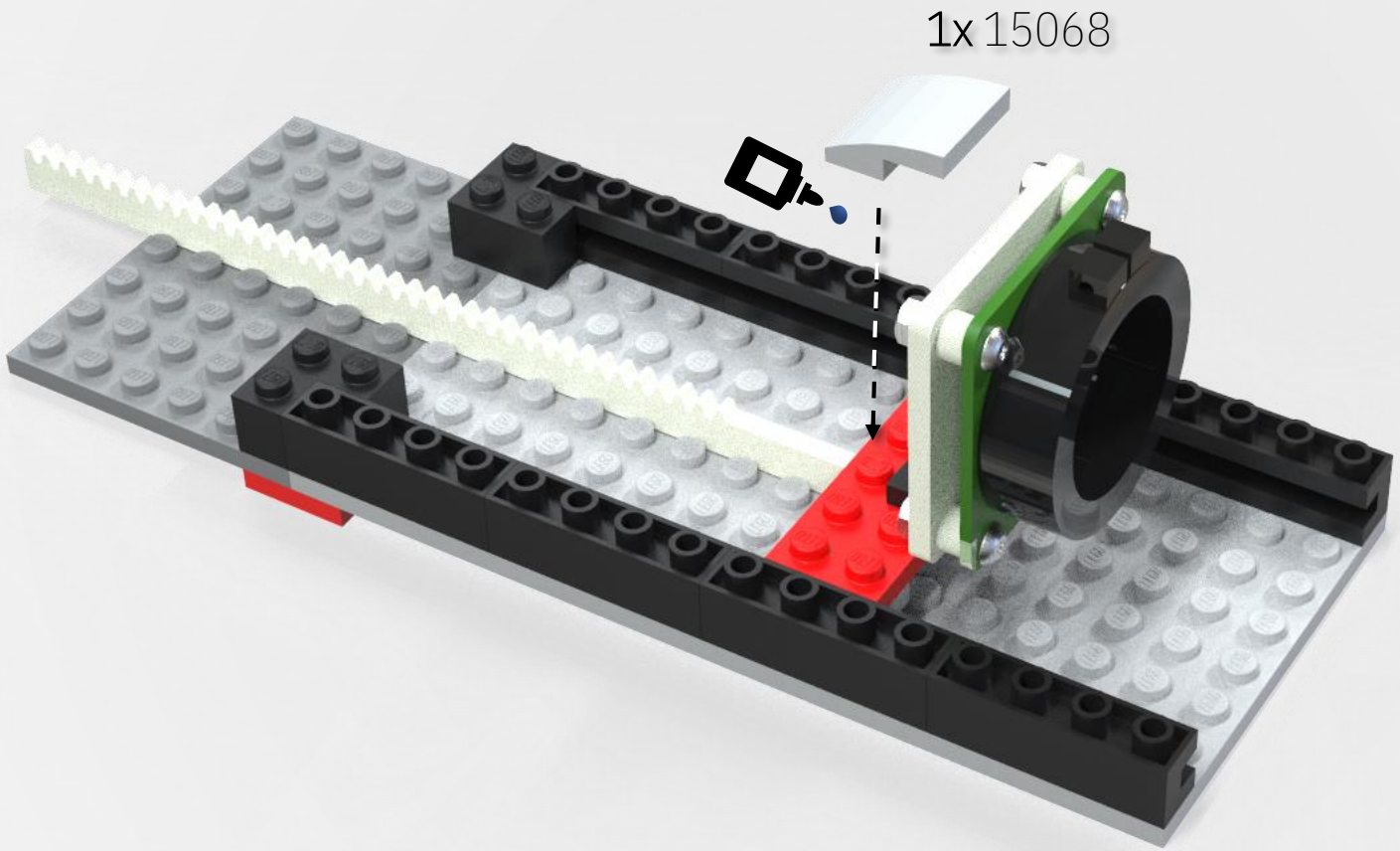


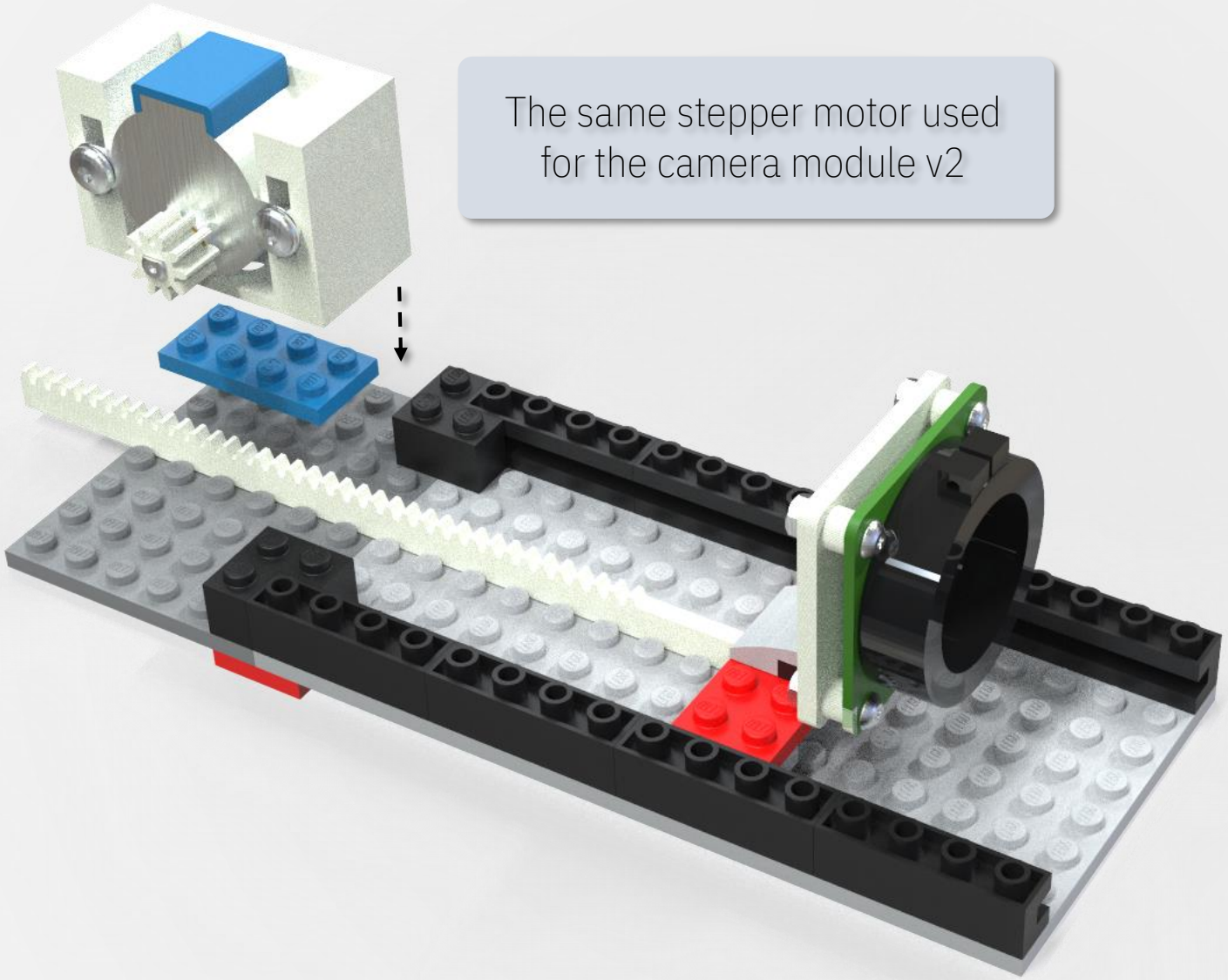


Remove the adapter and the tripod mount

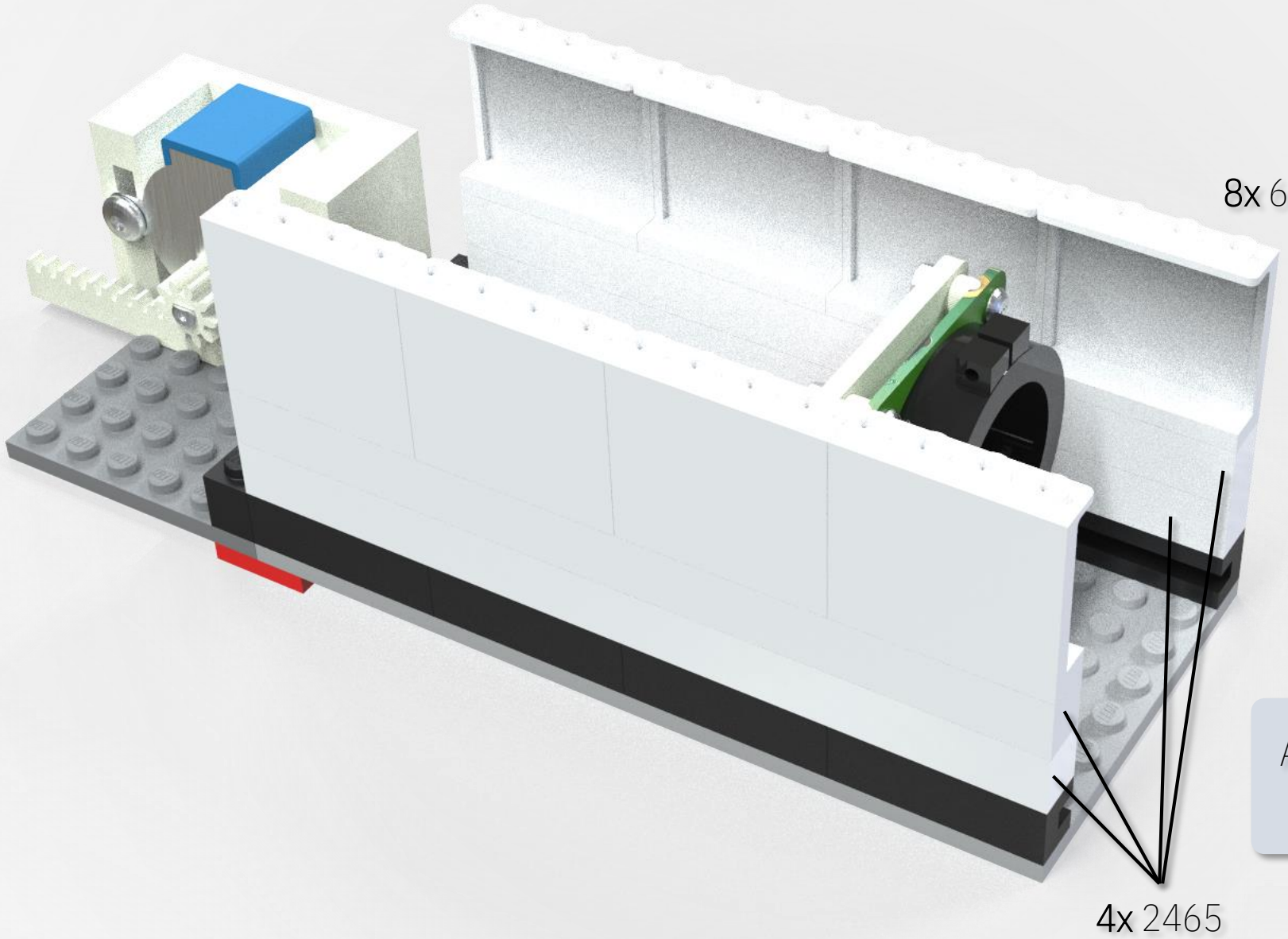




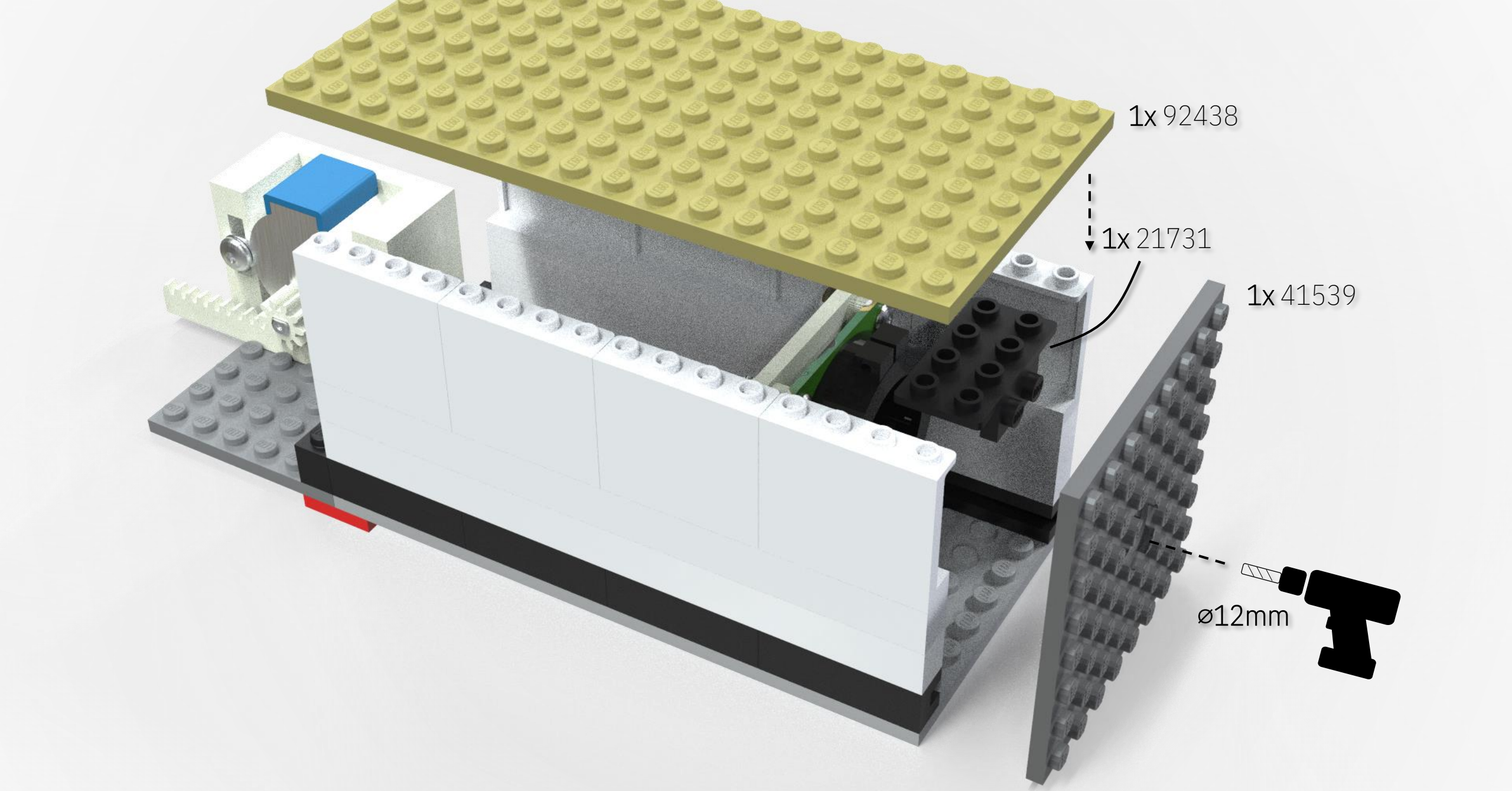


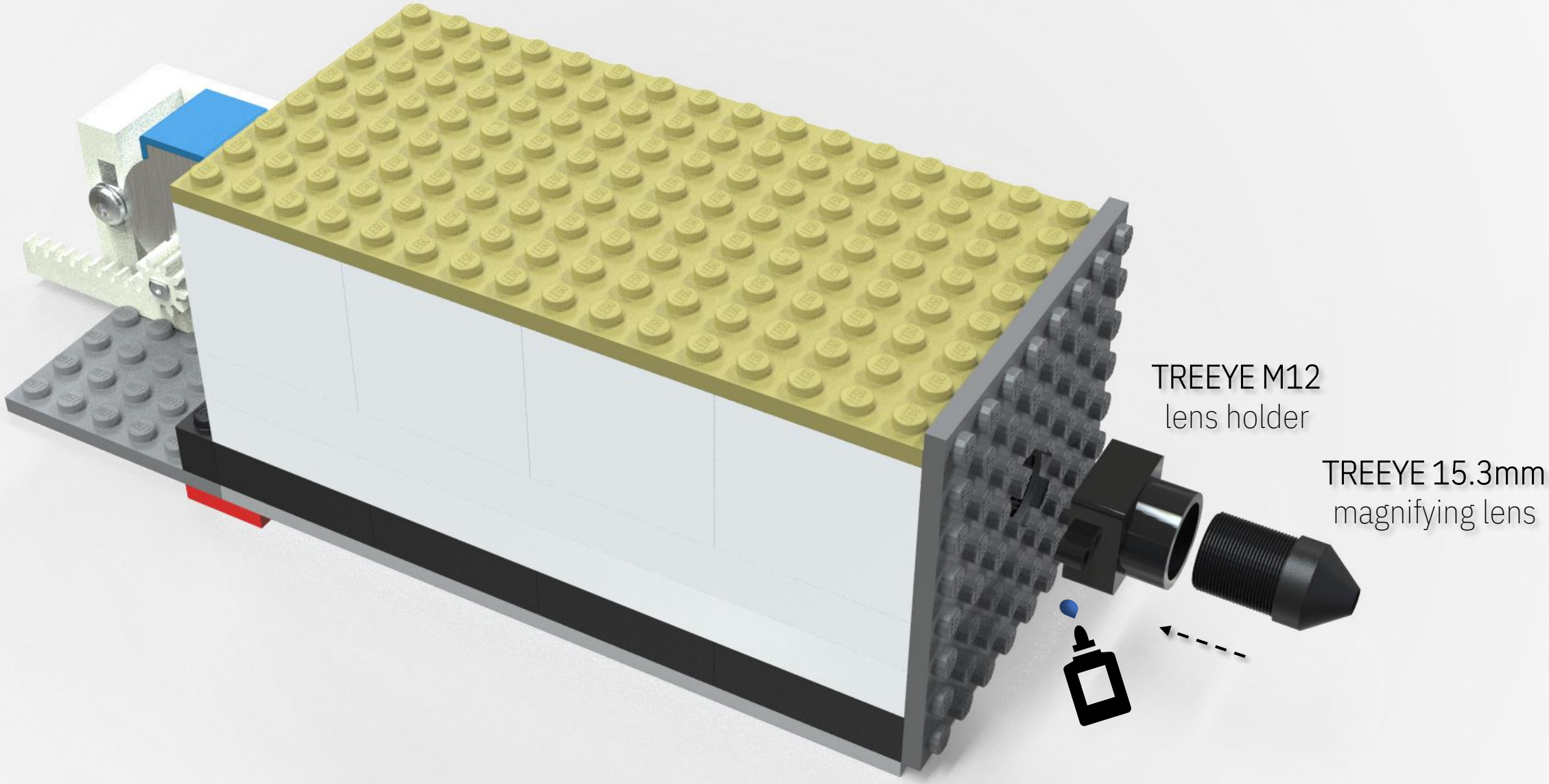


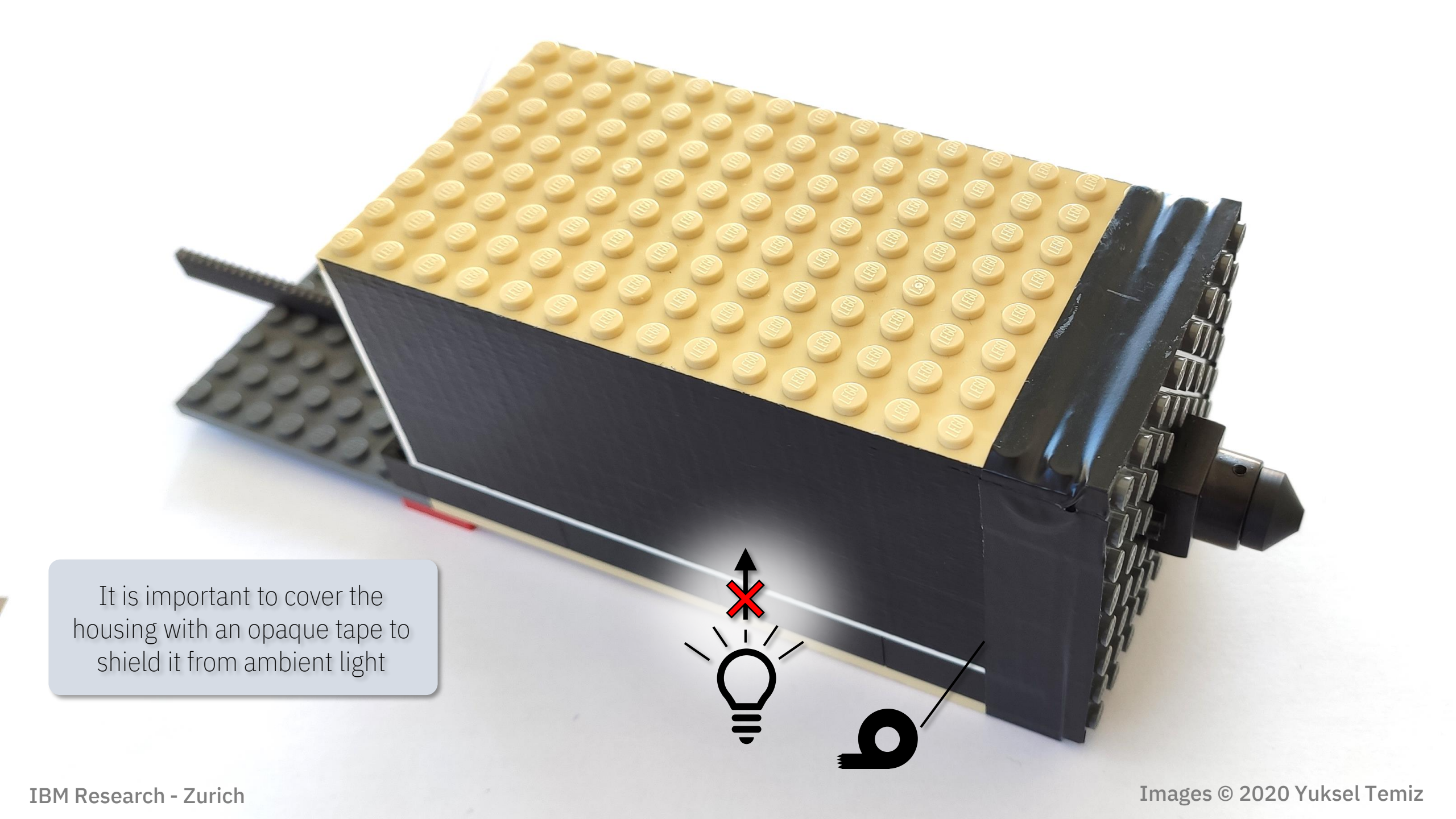
The same stepper motor used for the camera module v2



Additional bricks were used to make the housing higher

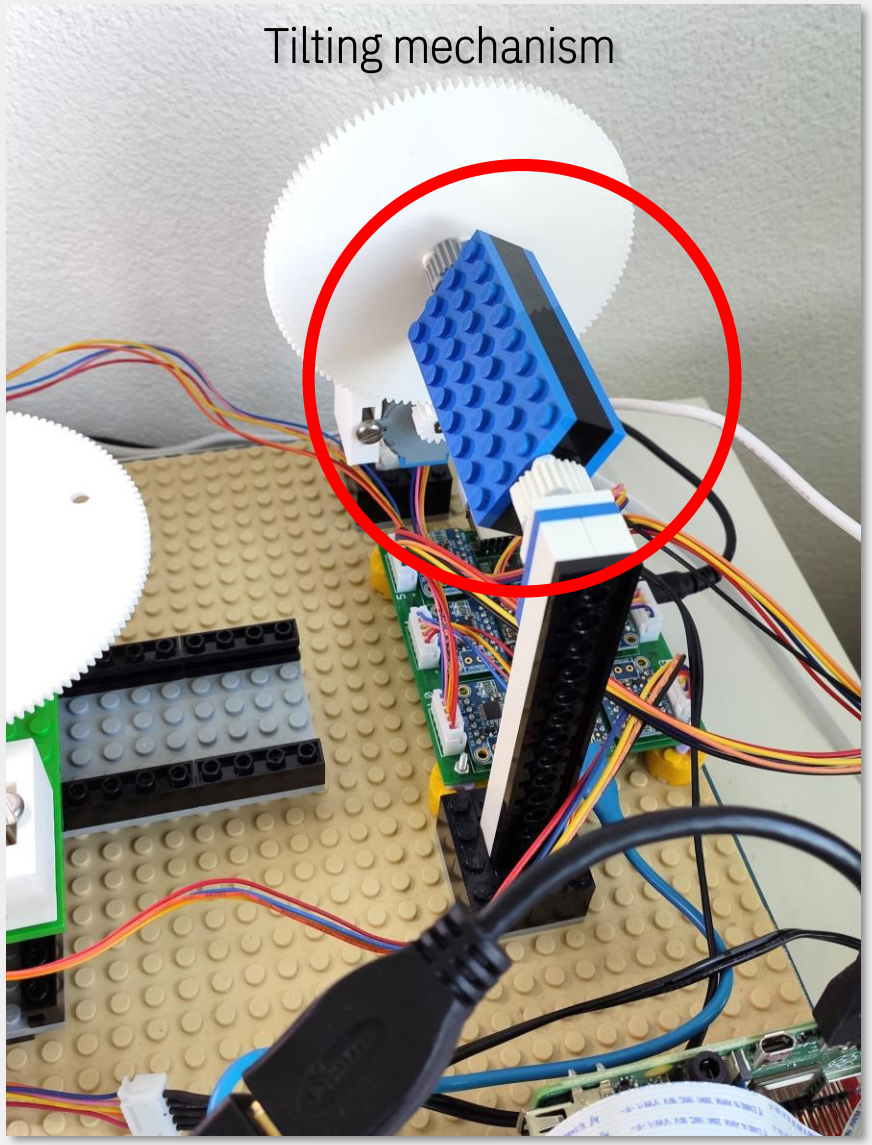


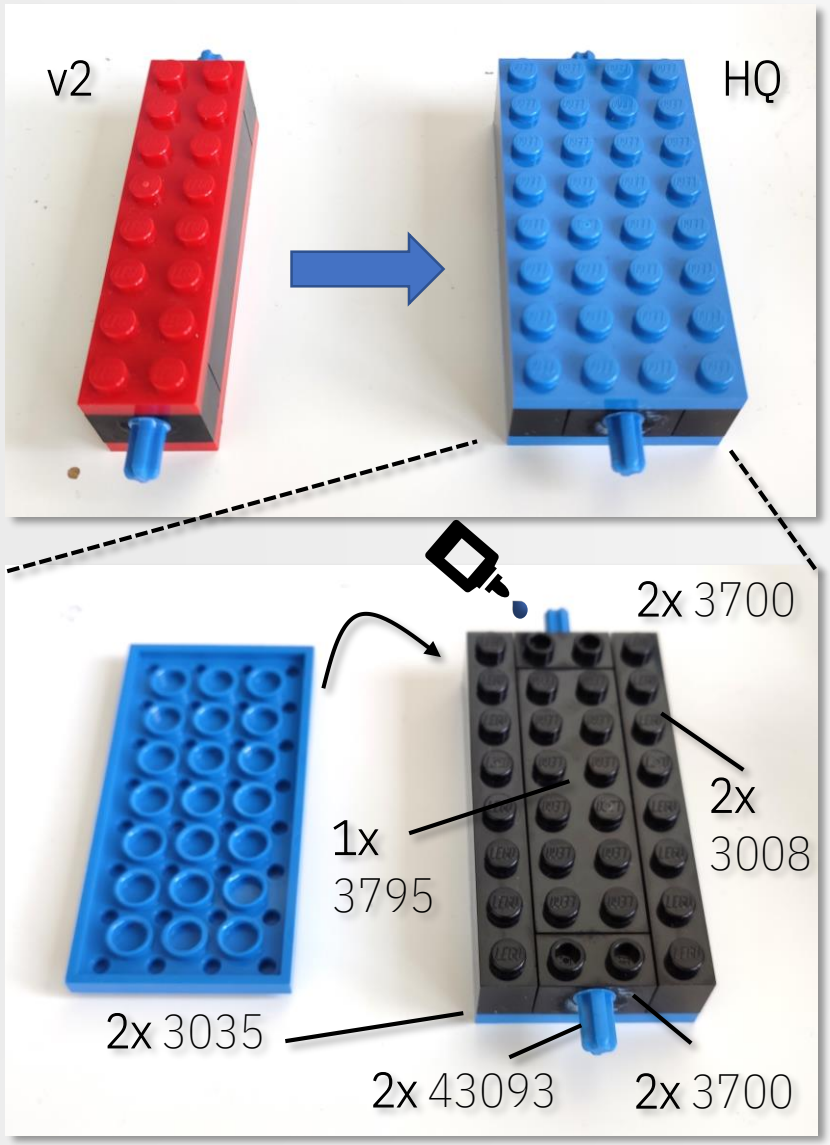


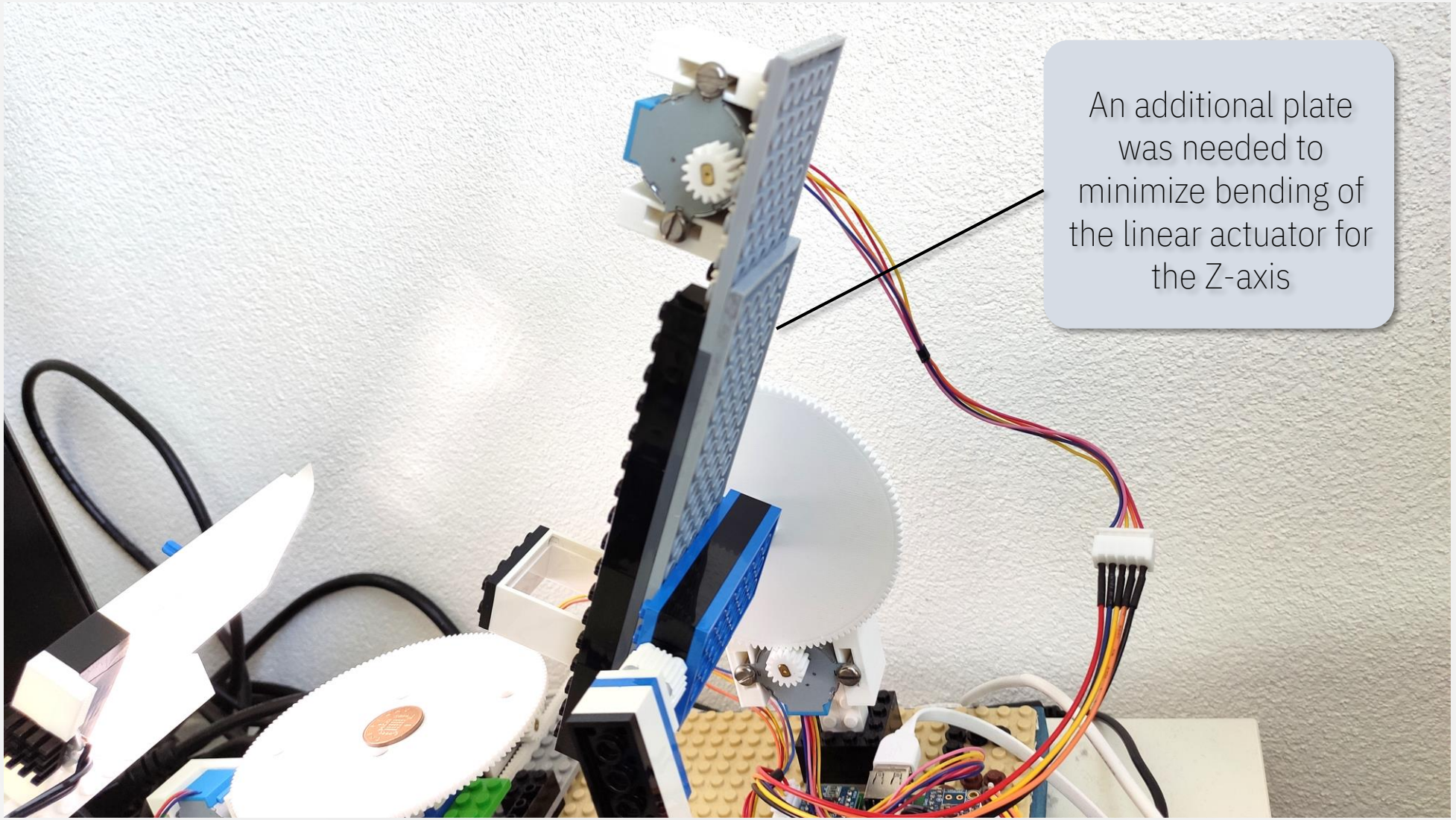


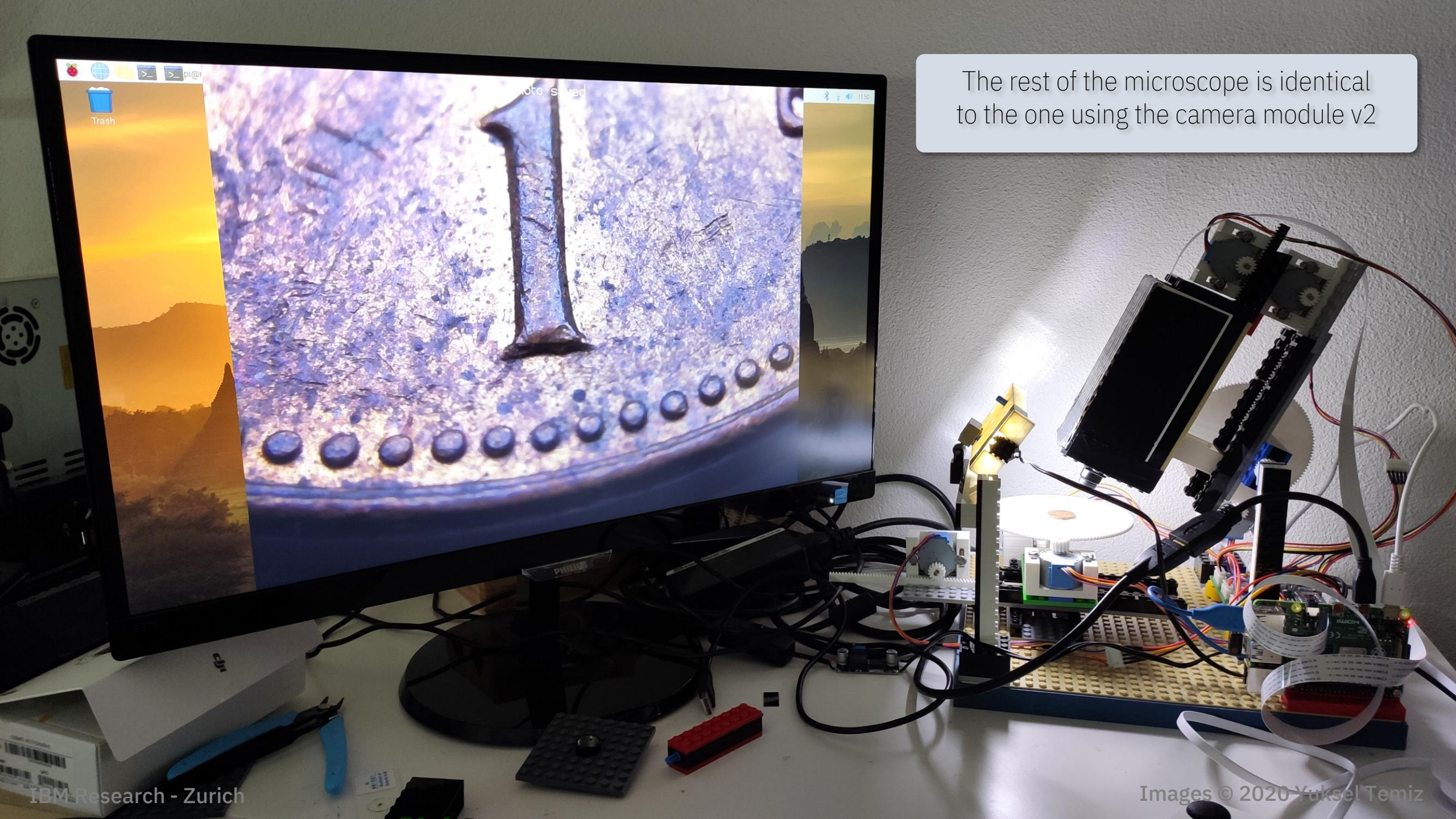
It is important to cover the housing with an opaque tape to shield it from ambient light

The microscope with a heavier camera module required stronger Lego connections and supports



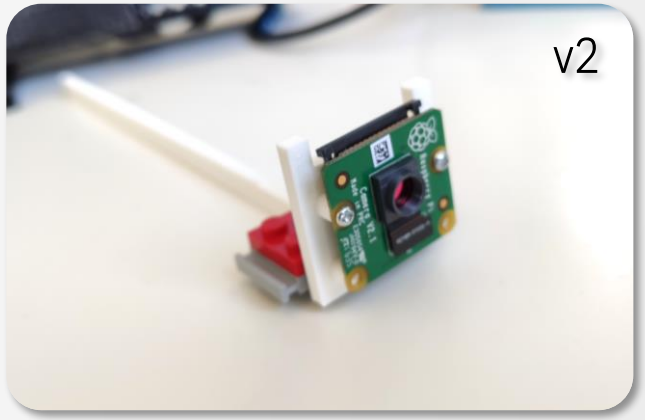


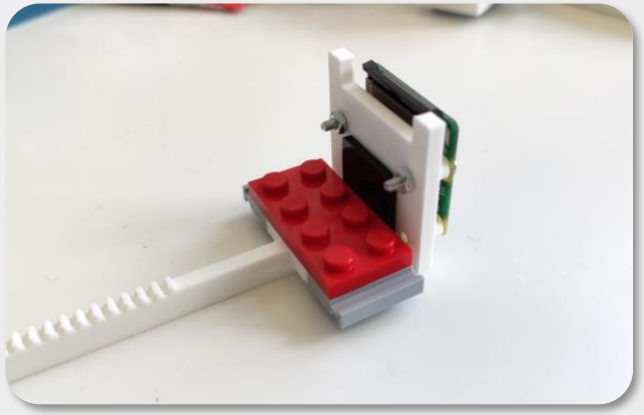


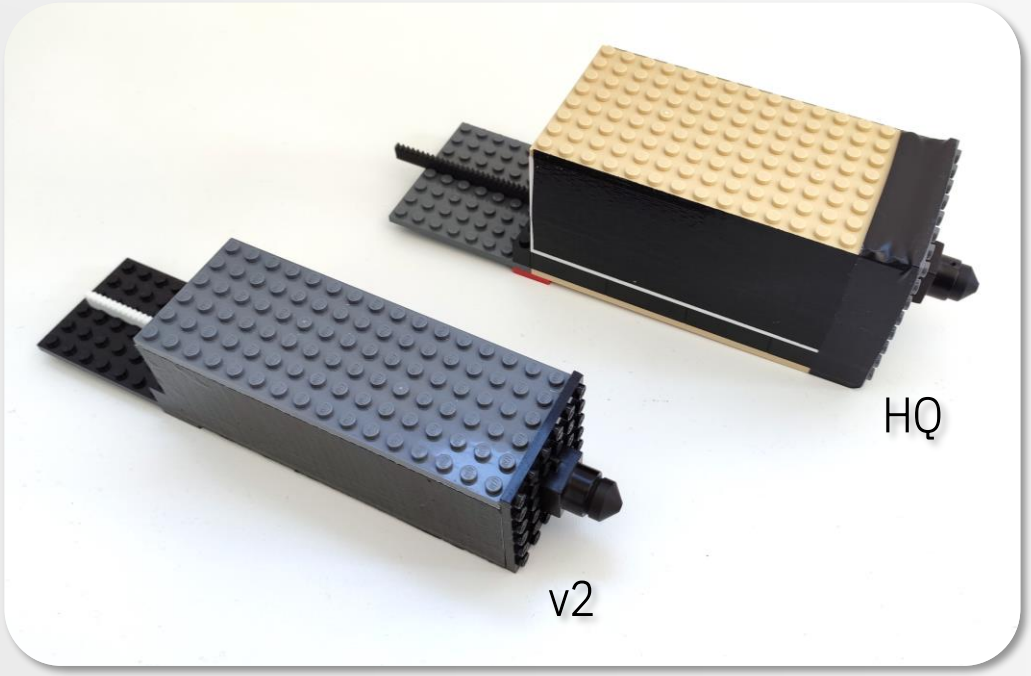


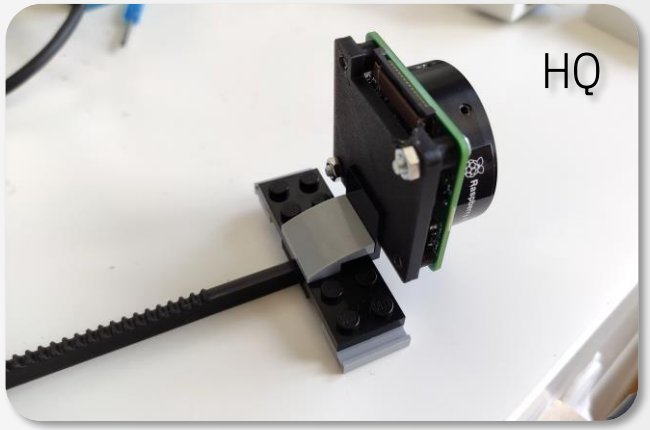
The rest of the microscope is identical to the one using the camera module v2

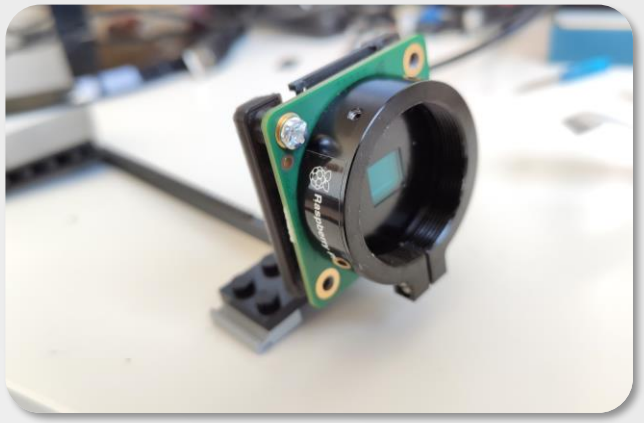
Camera module v2 vs HQ camera

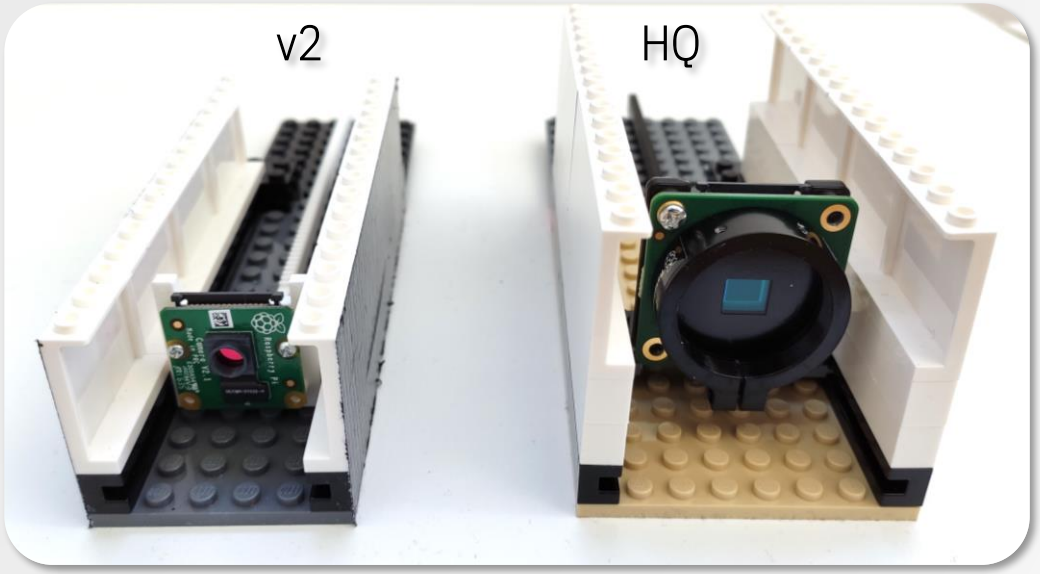










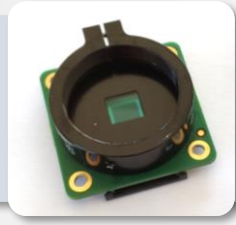


One-cent coin (minimum magnification comparison)

Camera Module v2

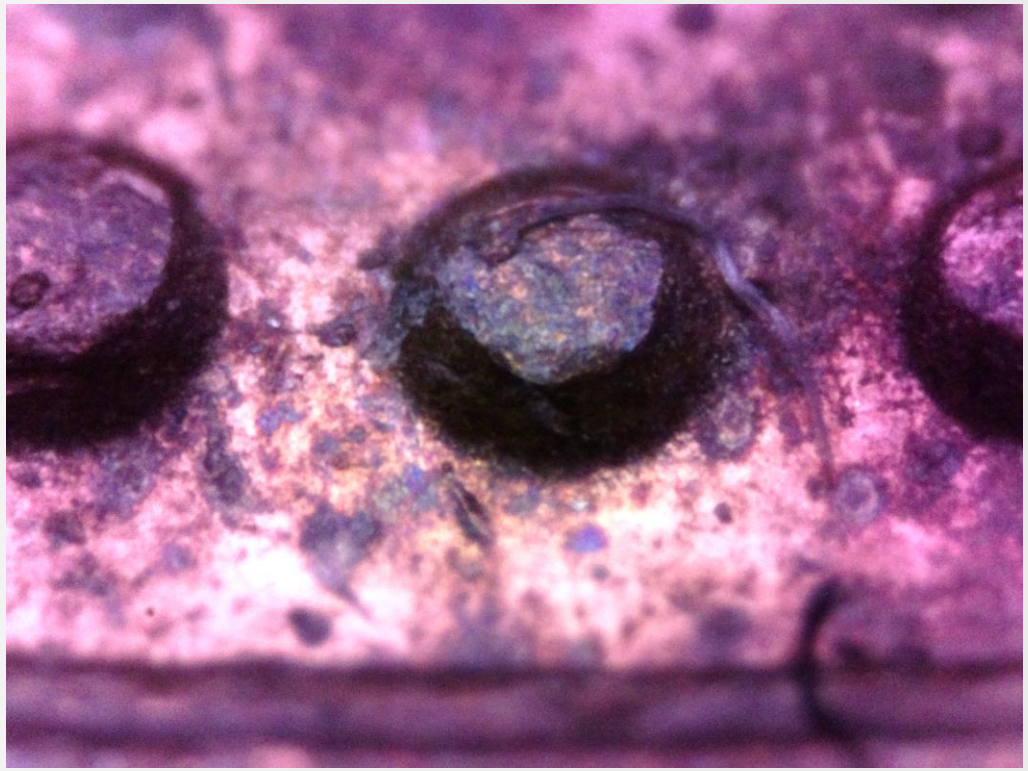
HQ camera

The minimum zoom level in the HQ camera was limited because the plastic housing in the HQ camera limits the closest distance between the CMOS sensor and the objective lens

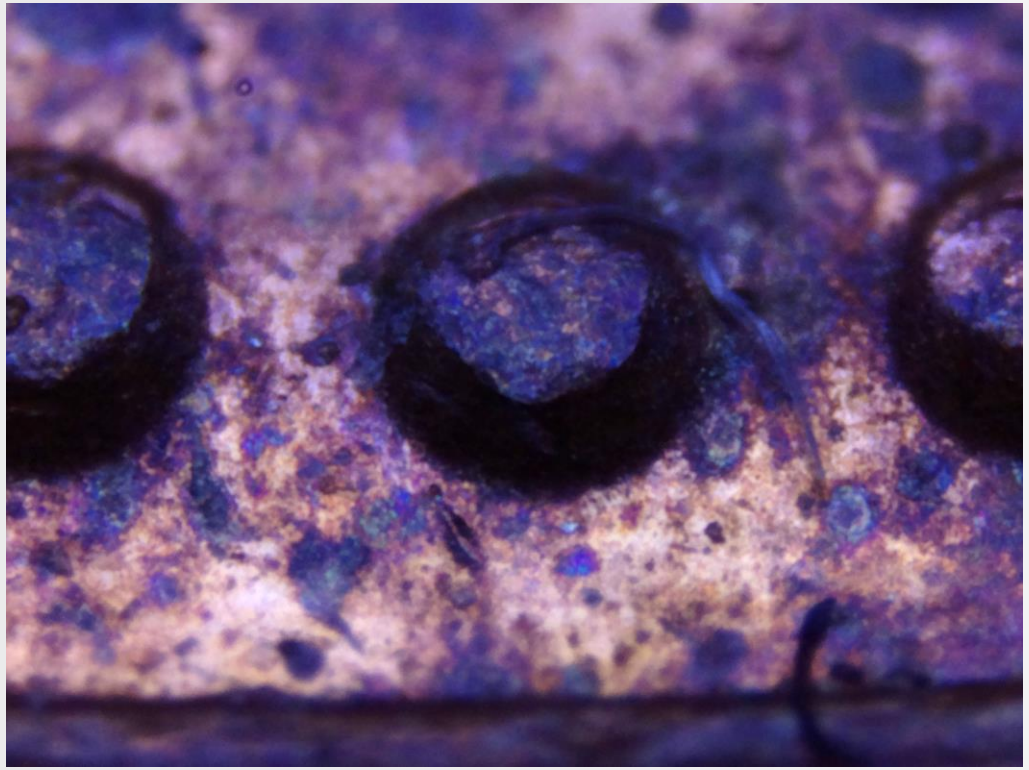


One-cent coin (maximum magnification comparison)

Camera Module v2

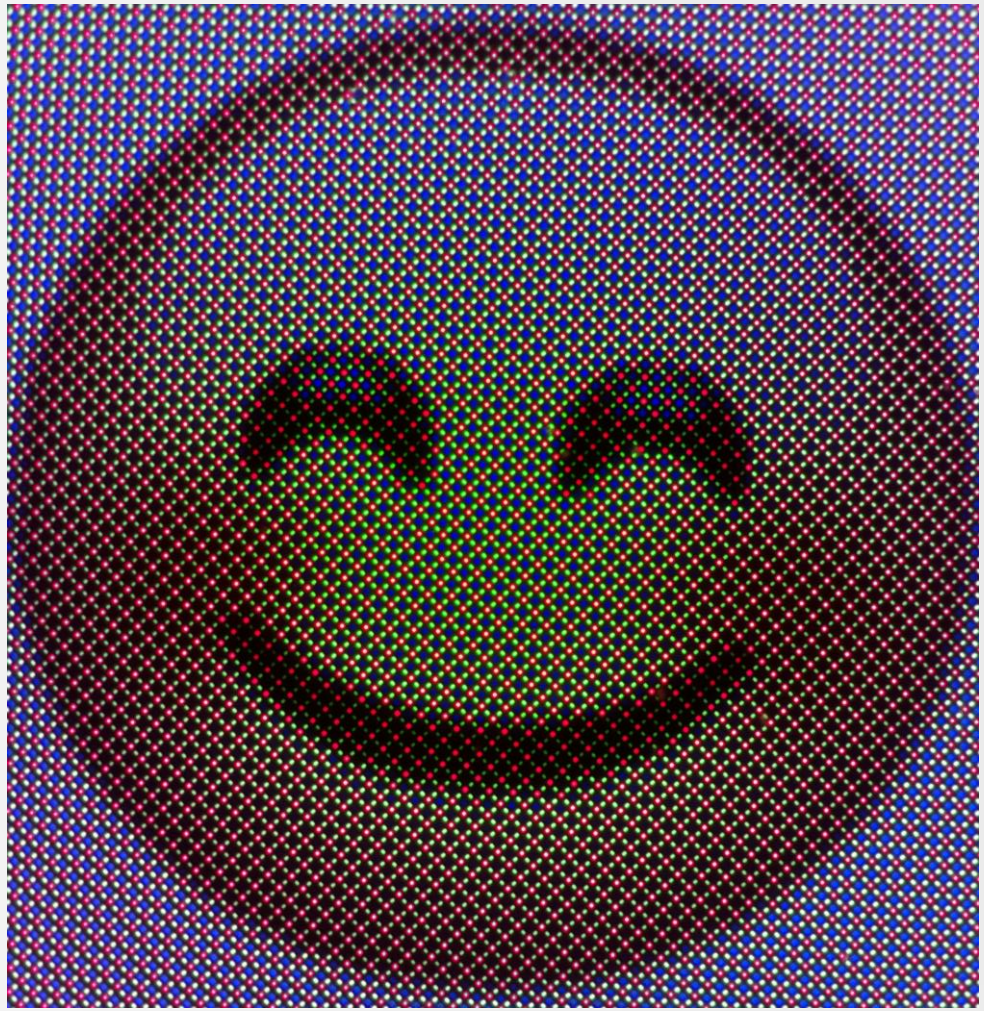


HQ camera



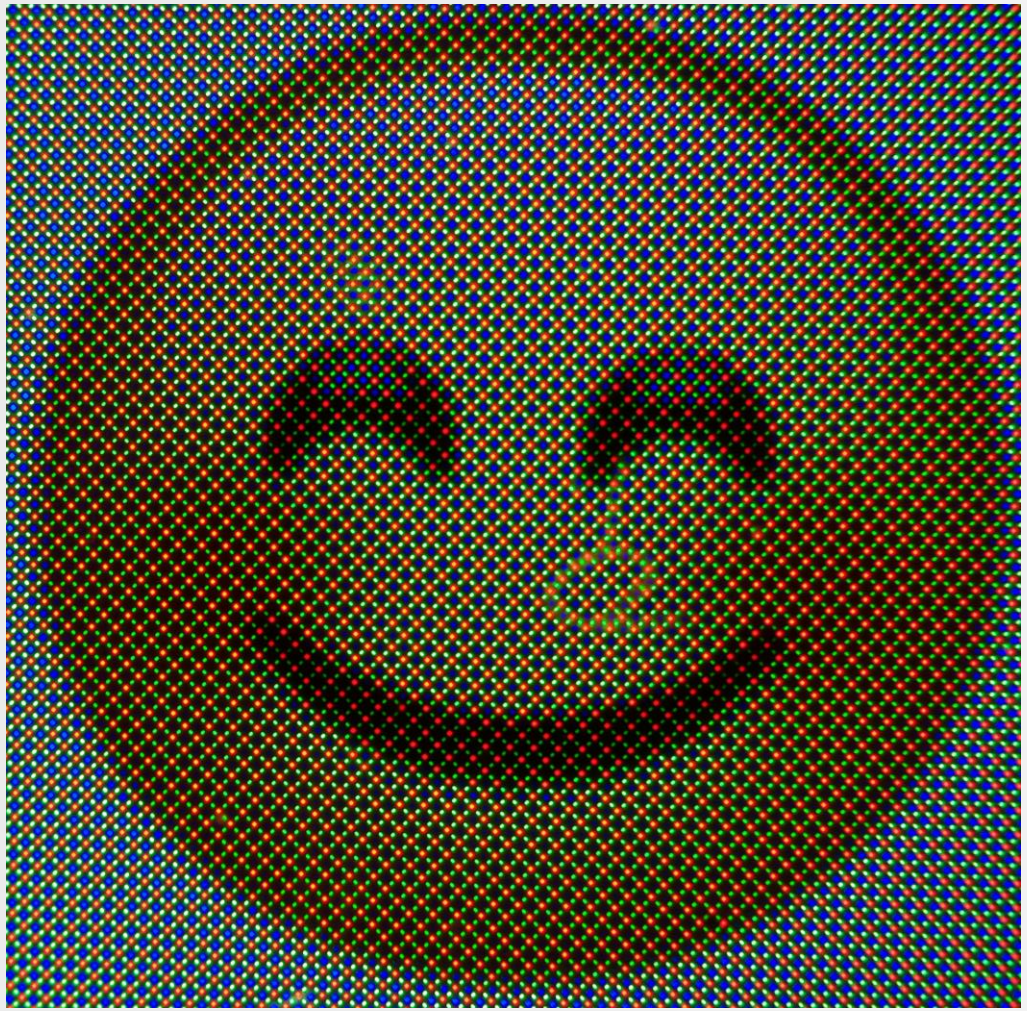
Smartphone AMOLED display

Camera Module v2



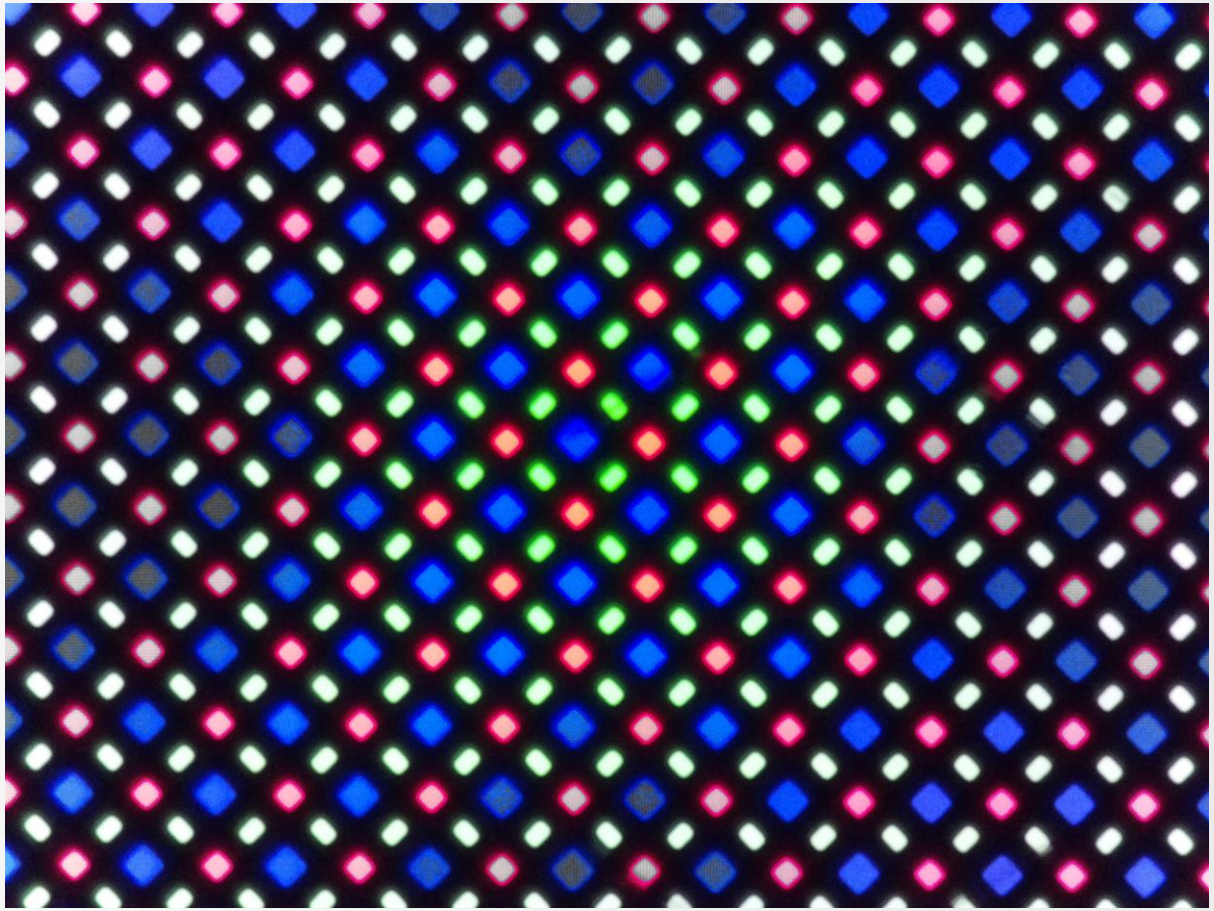
4 mm

HQ camera

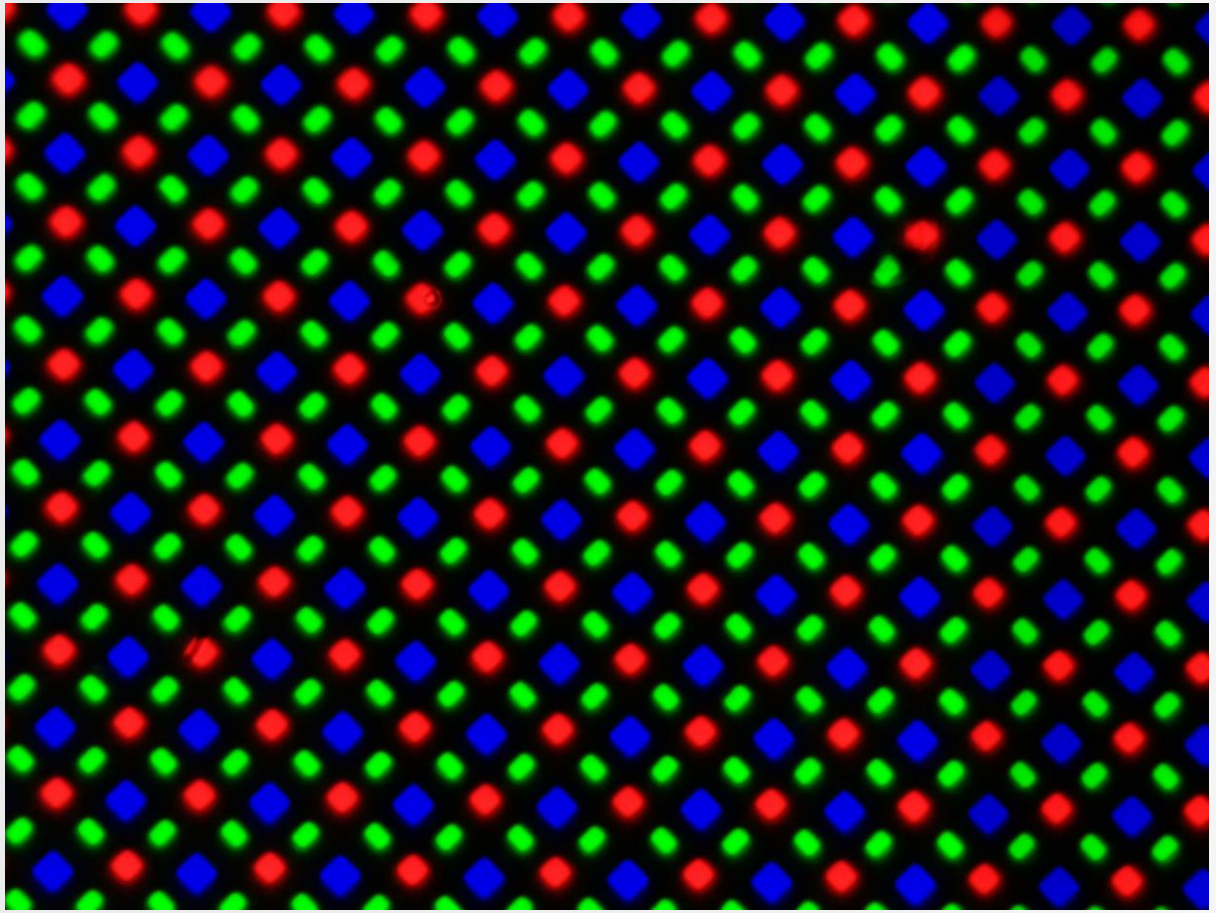


Smartphone AMOLED display

Camera Module v2

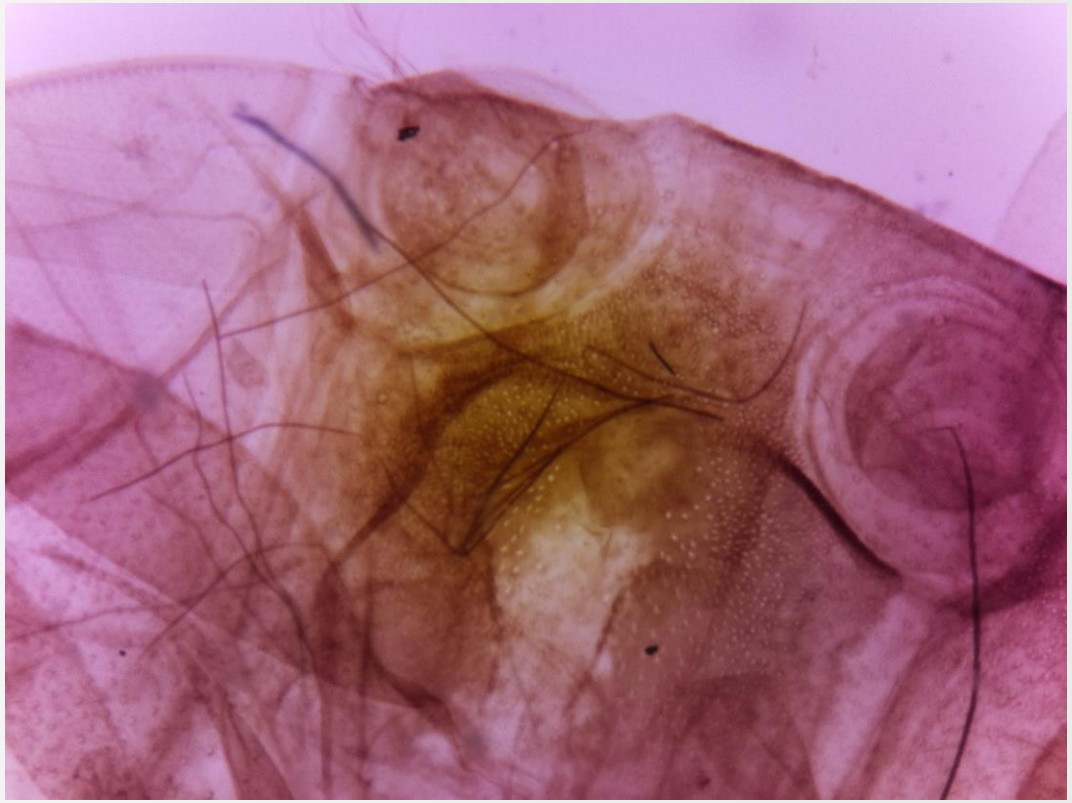


HQ camera

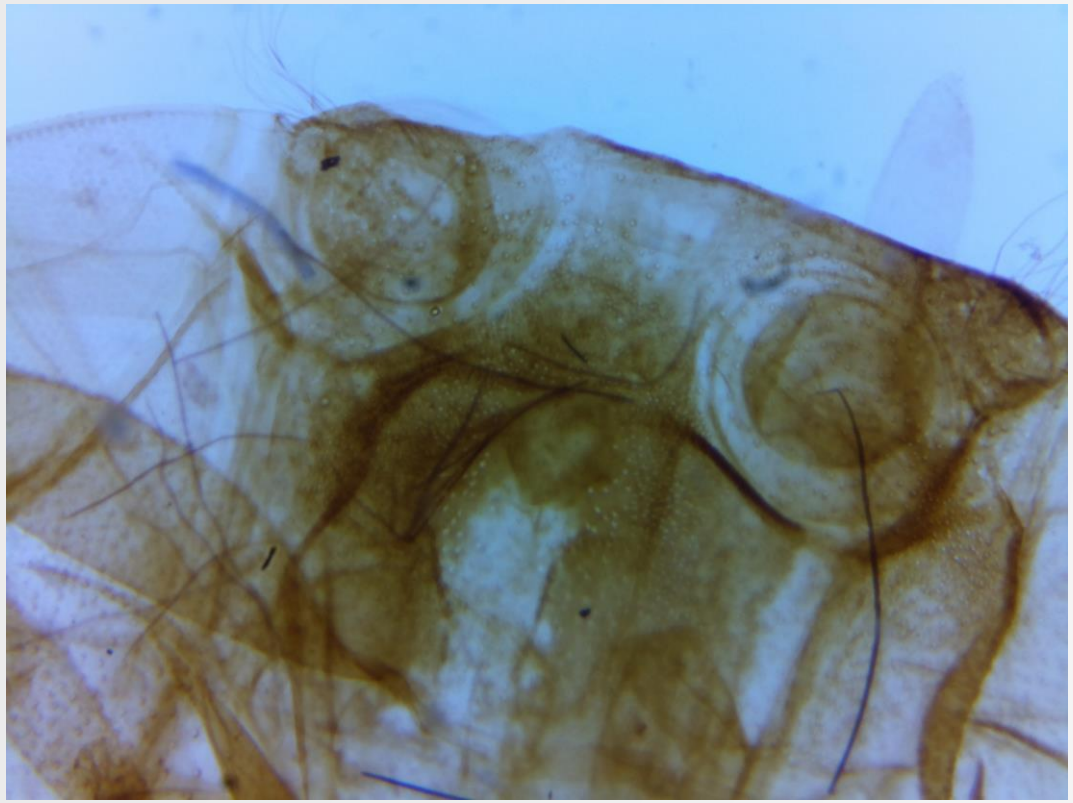


Butterfly (microscope sample)

Camera Module v2

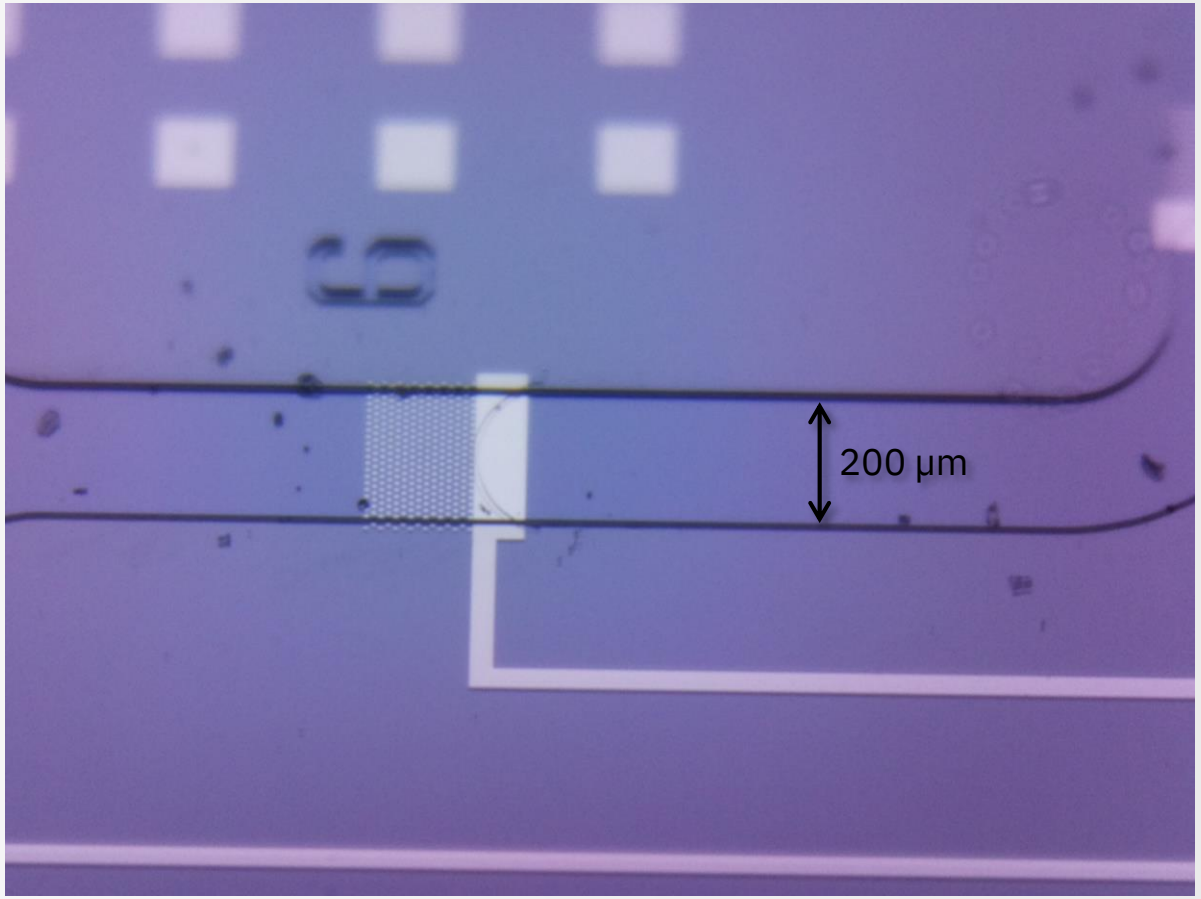


HQ camera

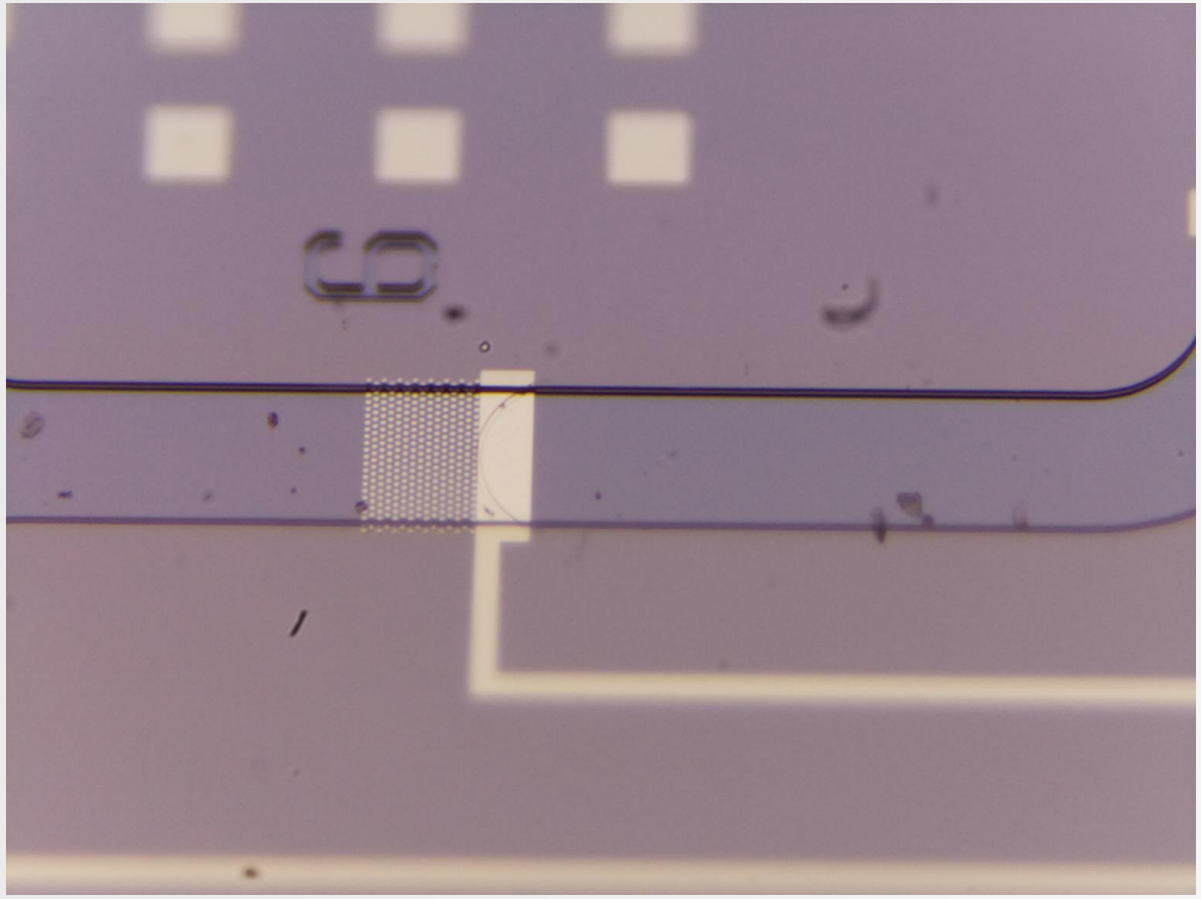


Microfluidic channels

Camera Module v2

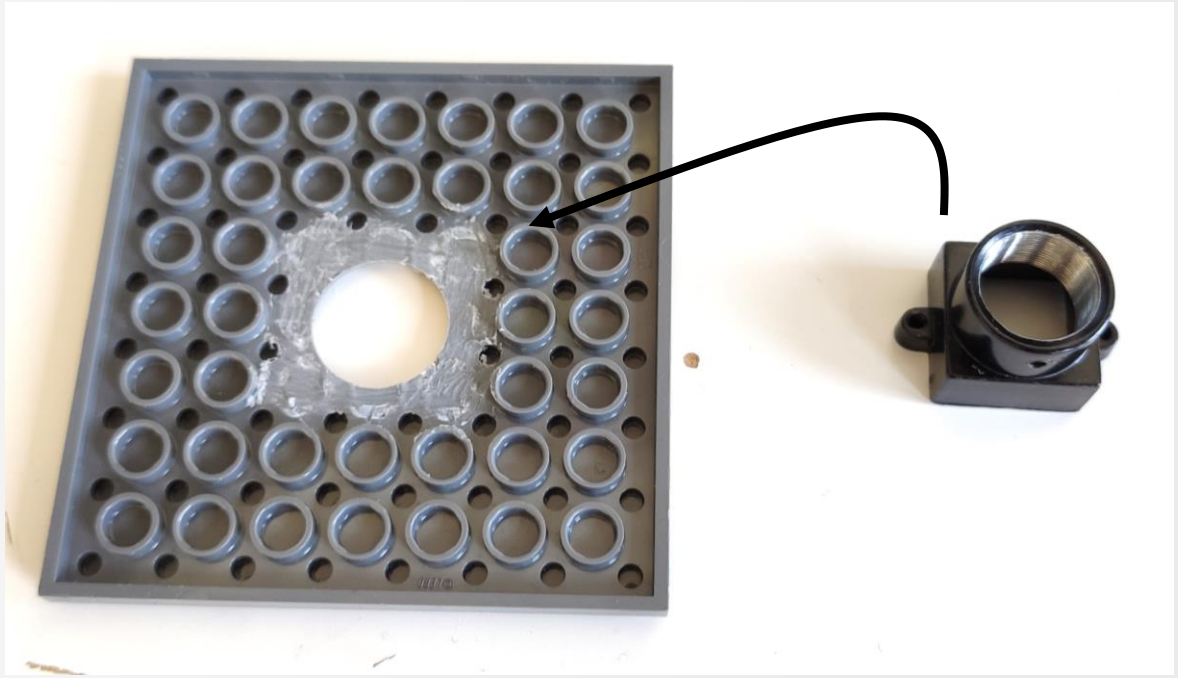


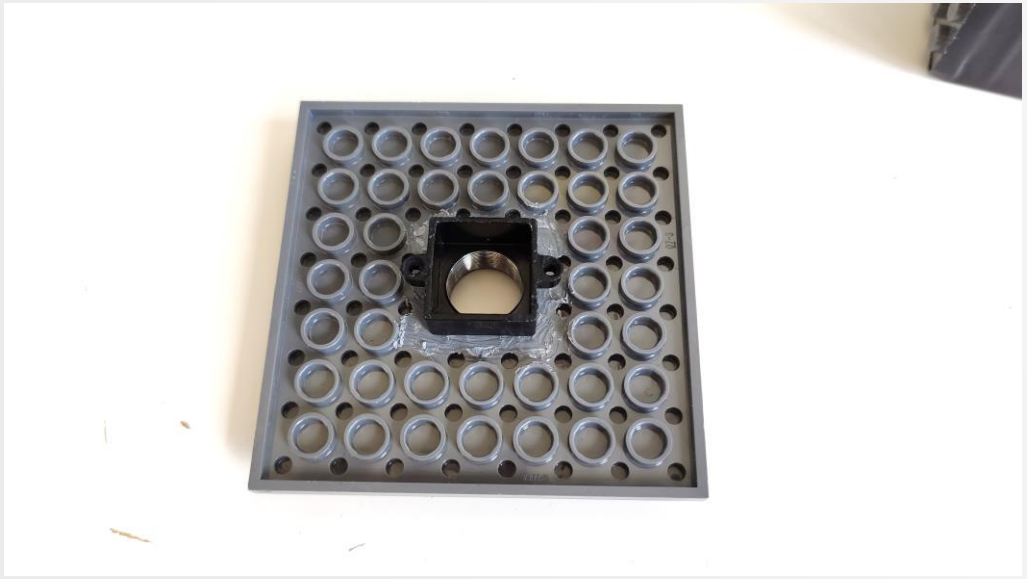
HQ camera



A trick to increase the field of view at the minimum magnification

Placing the lens holder from the other side of the Lego plate so that the objective lens can get closer to the CMOS sensor





A trick to increase the field of view at the minimum magnification