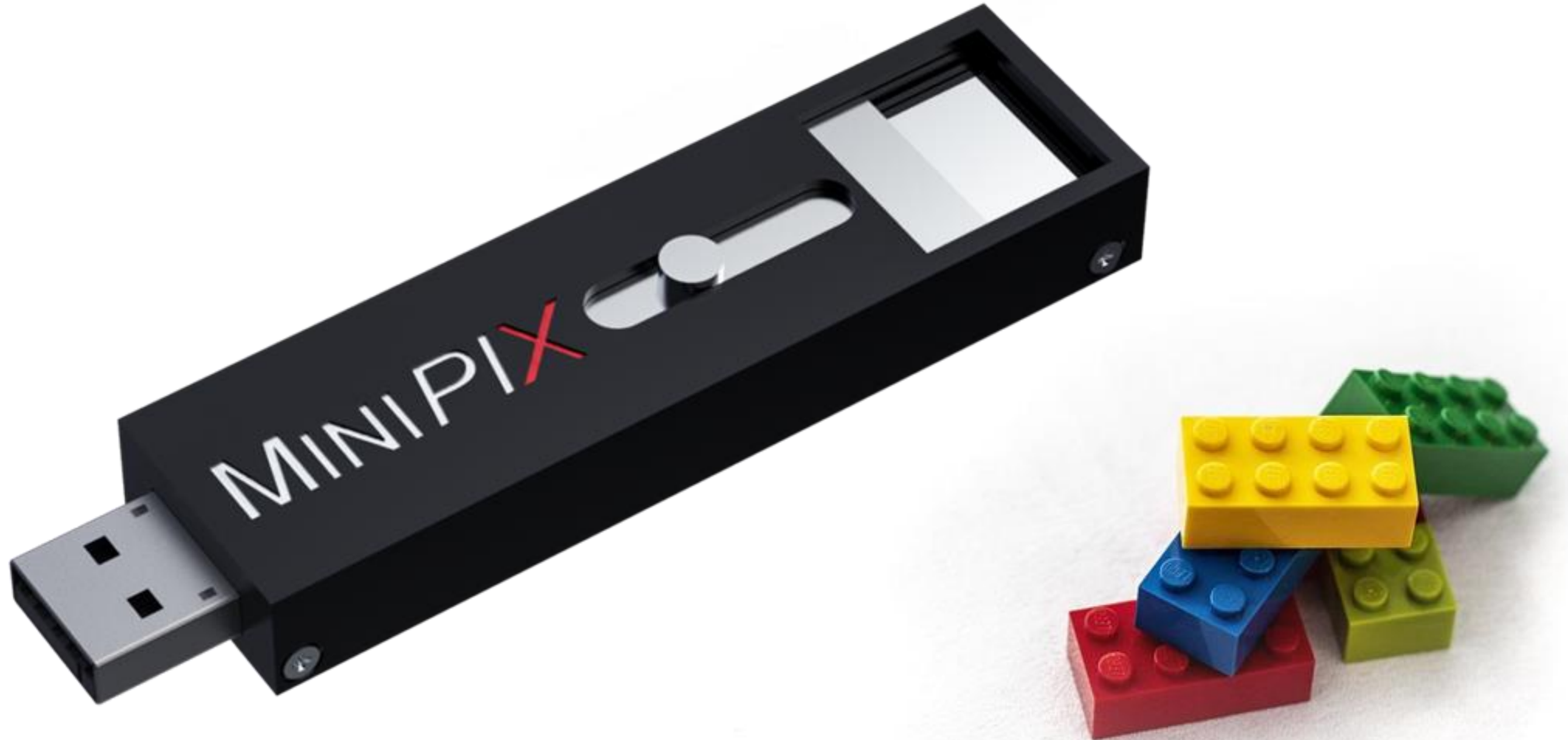


How to build a MiniPIX detector with LEGOs



What is the *MiniPIX* detector?

The *MiniPIX* (Mini because it is small and PIX because it is pixelated) is a radiation detector that basically works like a high-resolution camera. Instead of taking photos, it is able to take pictures of ionizing particles passing through it.

At the heart of the detector is a special chip made out of silicon, which you can imagine as a 256x256 grid of tiny squares (pixels), just like the pixels of your phone camera.

When particles like electrons or protons pass through the detector, they hit the pixels on the silicon chip. If these particles have enough energy, they interact with electrons along their path and free them from the silicon atoms, through a process called ionisation, creating electrons and holes (charge carriers). The electrons then all flow to one side of the detector due to an external electric field, creating an electrical signal.

The chip records where and when each particle hit the detector, as well as how much energy it lost from the interaction with the chip.

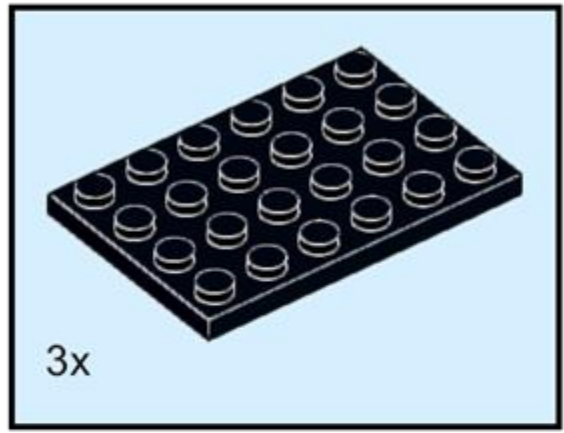
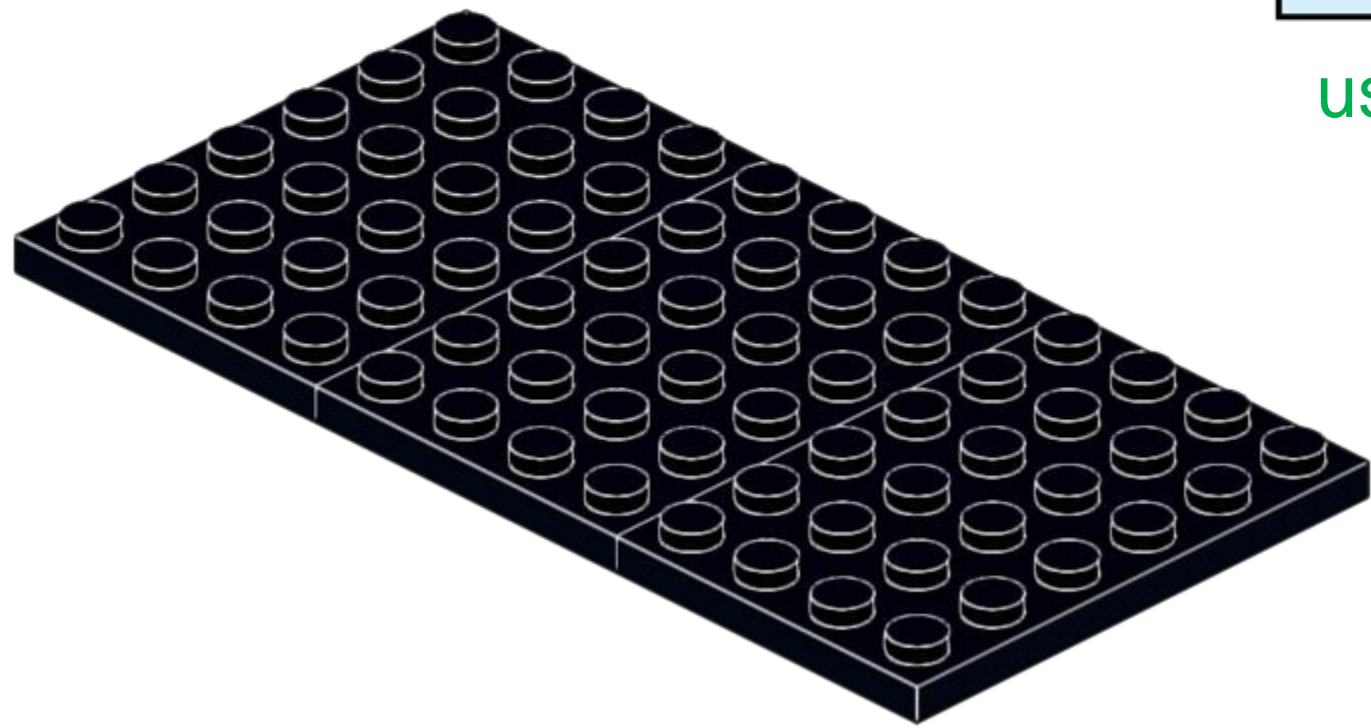
The silicon chip is attached to a USB-stick that can be plugged into a laptop. We can then read out the data with a special software.

By looking at the data, you can learn a lot about each particle: where it came from, how much energy it had, and what type of particle it may be.

**Follow the instructions and build a MiniPIX detector
with LEGOs.**

At each step, identify the different components of this detector.

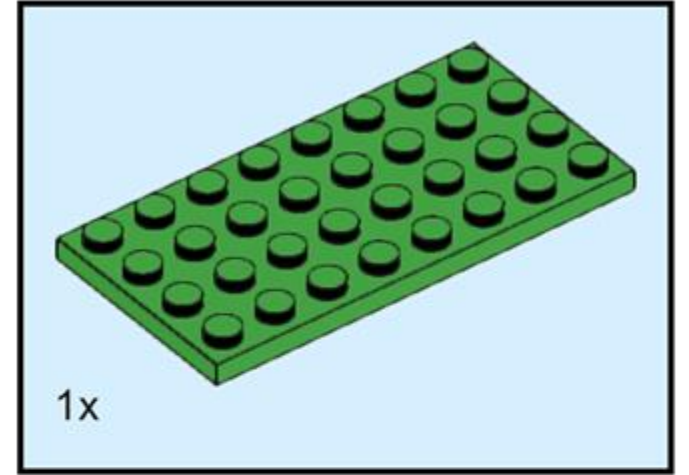
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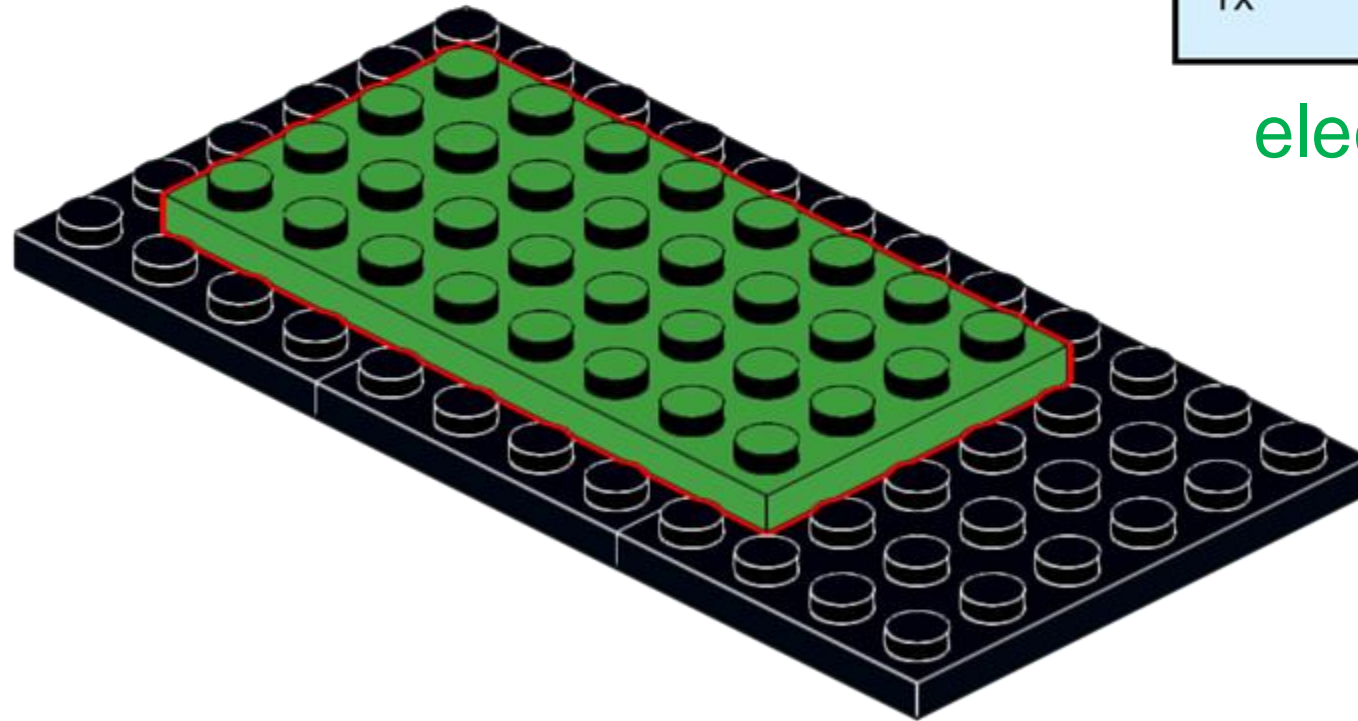
usb-stick case

2

This chip connects all the pixels and readout cells, collecting and organizing the signals they produce.



electronics chip

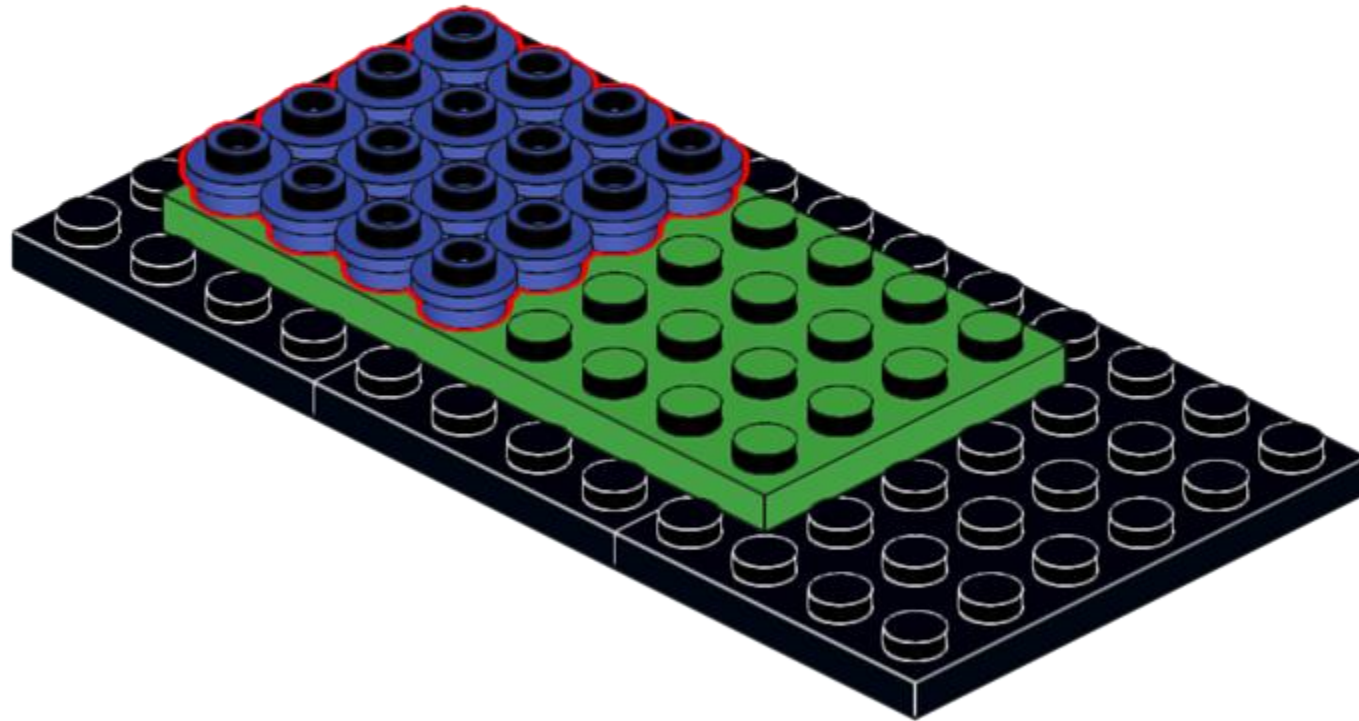


3

Each pixel has its own tiny circuit that reads the signal created when a particle hits.

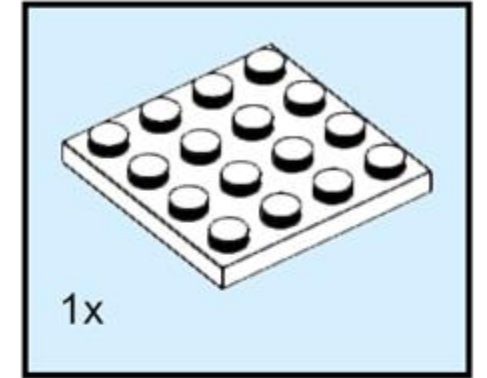
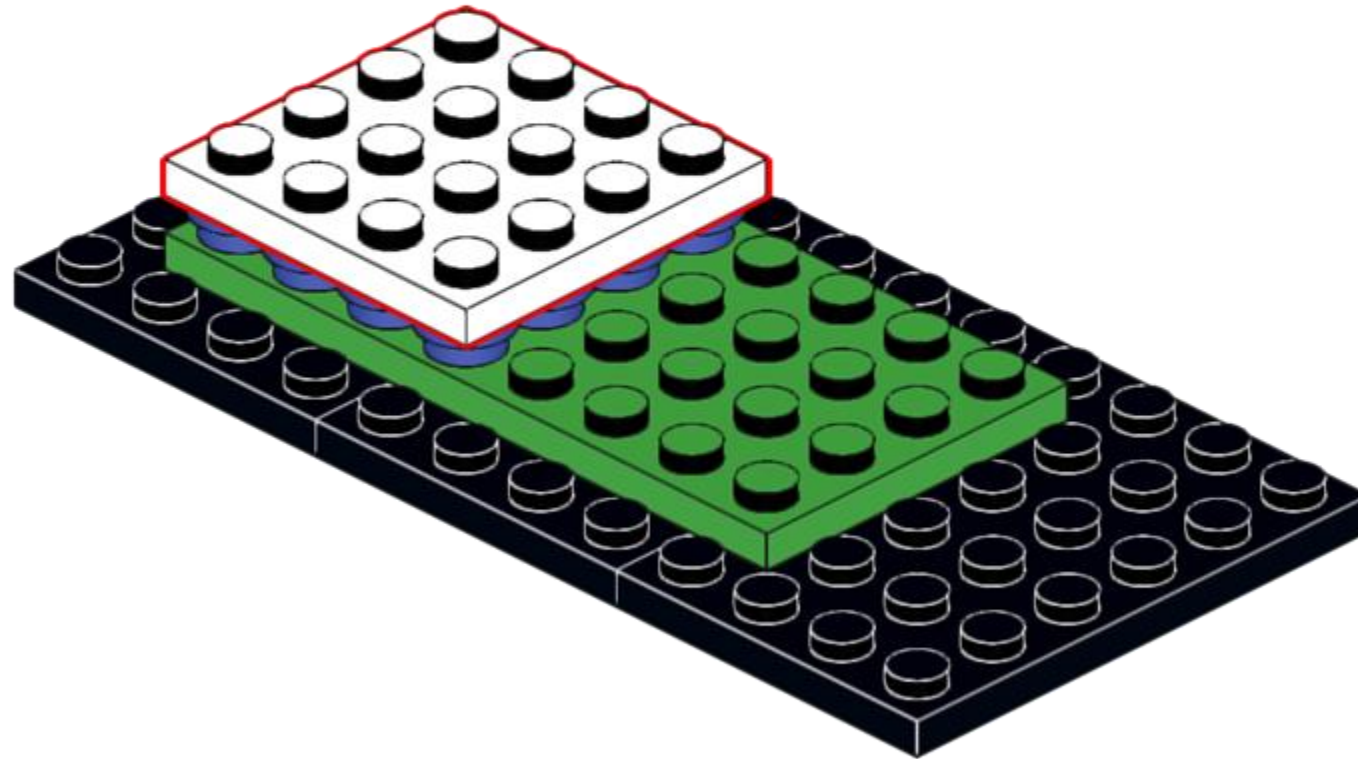


single pixel
read-out cell



4

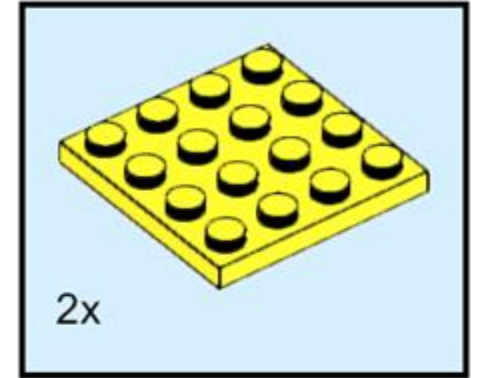
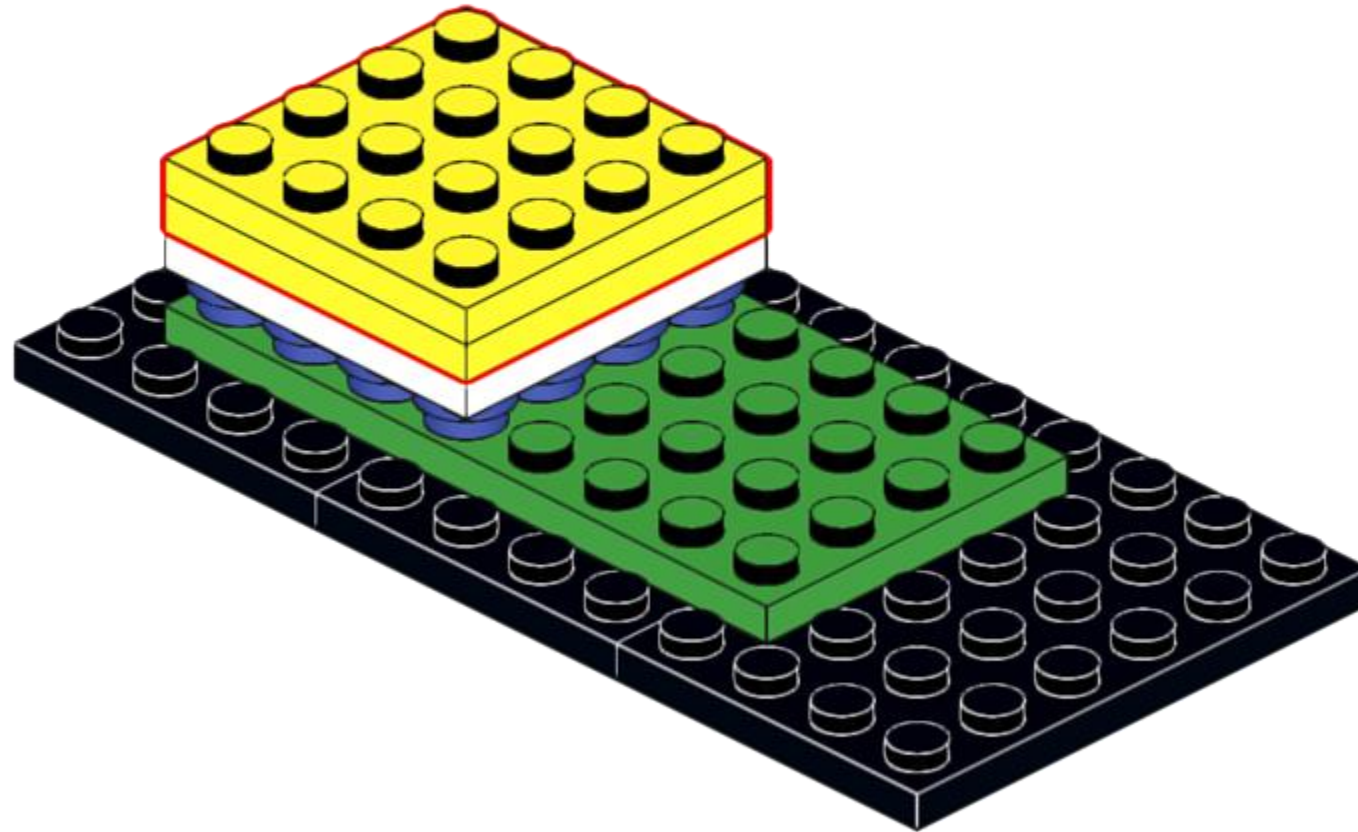
The material of this layer is missing electrons (has extra "holes") to help detect radiation particles (p stands for positive). Imagine this layer as a field with empty spots (holes) where electrons can move when a particle hits, creating an electrical signal.



p-type silicon
implantation

5

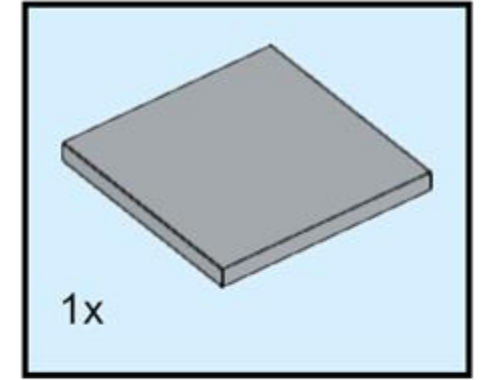
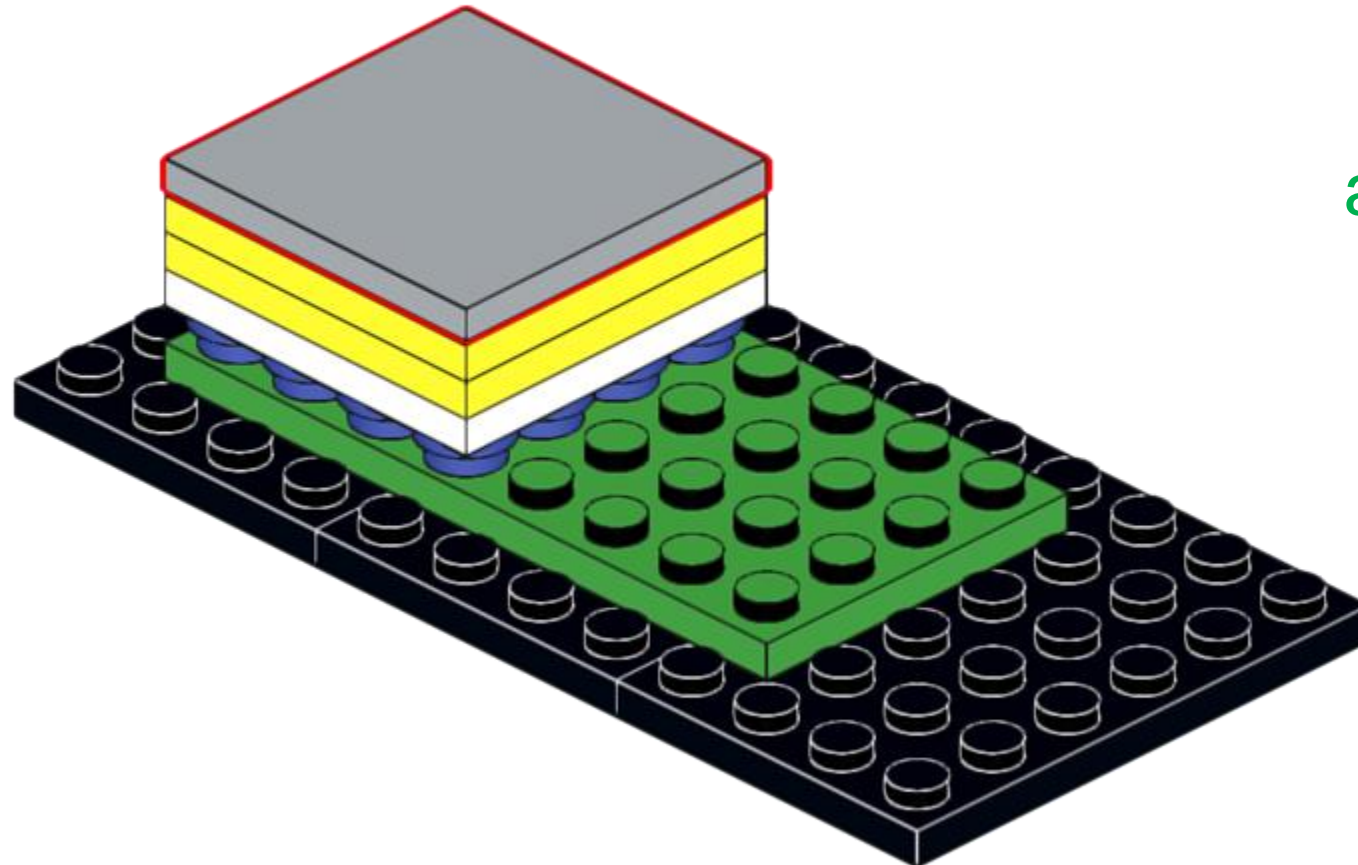
This layer has extra electrons to help detect radiation particles. Think of this layer as a field with extra players (electrons) ready to move when a particle hits, contributing to the electrical signal.



n-type silicon layer

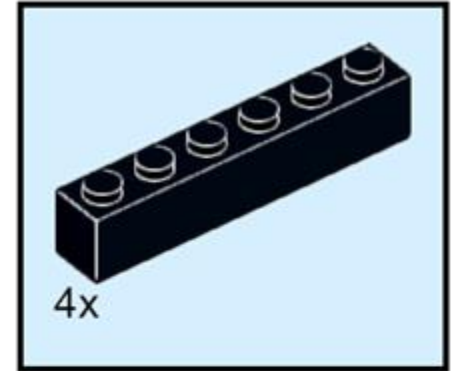
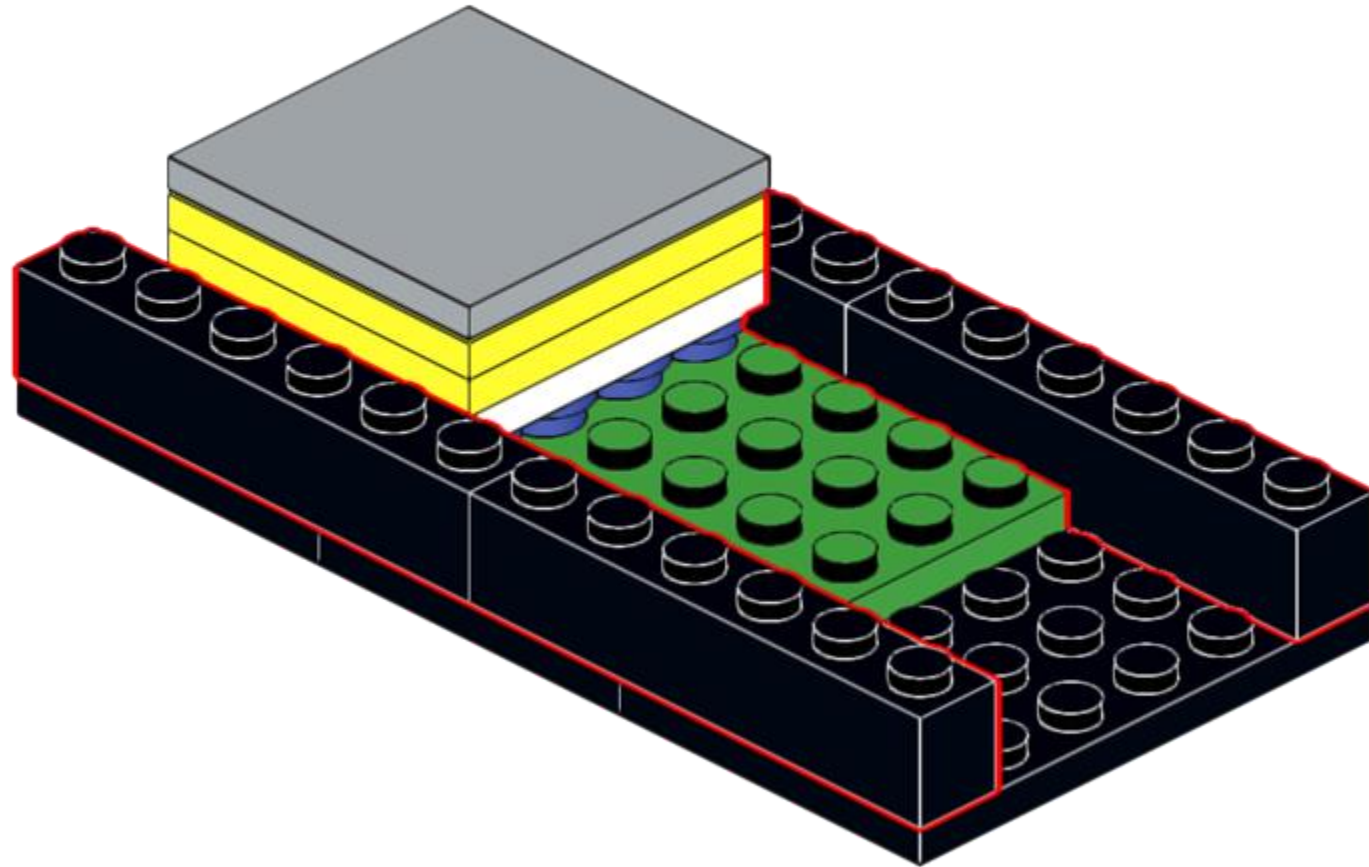
6

The aluminium layer protects the sensor and helps conduct electricity. Think of it as a protective skin that also helps the sensor work better by allowing electrical signals pass through.



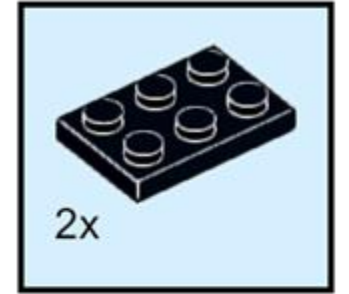
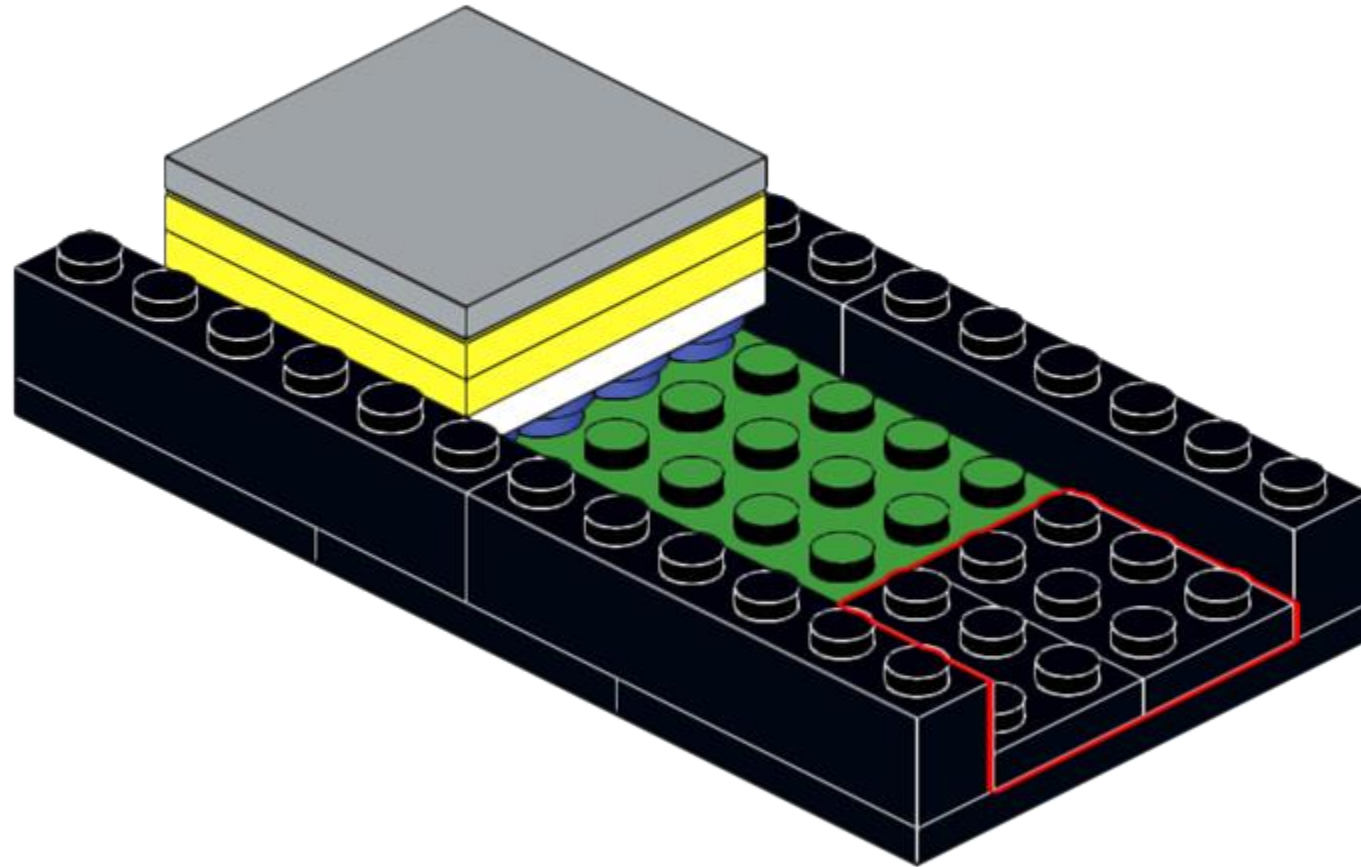
aluminium layer

7



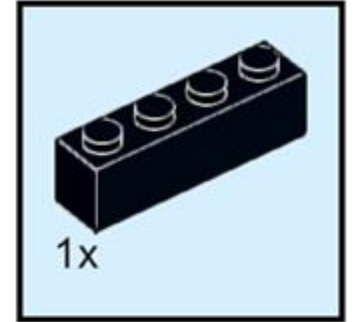
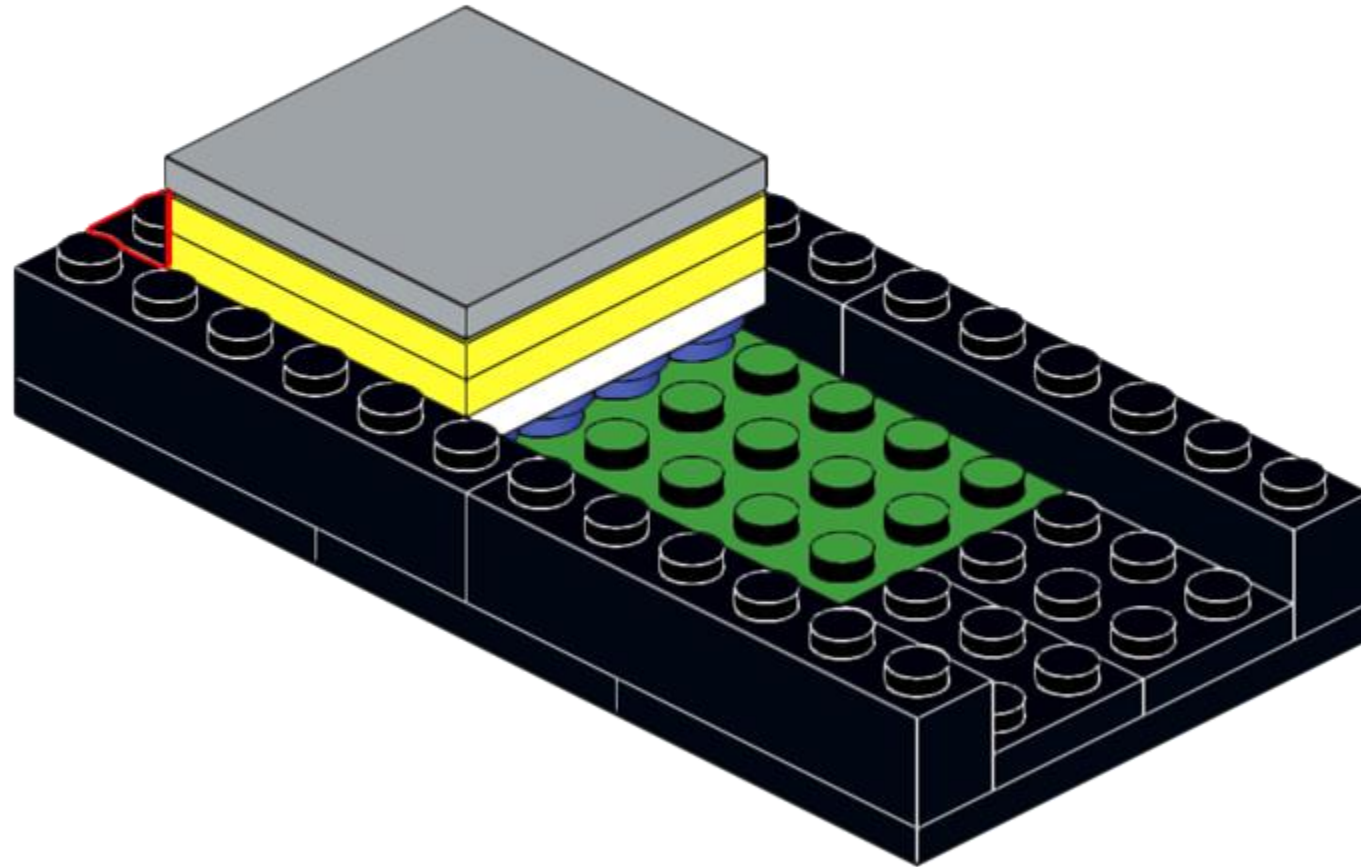
usb-stick case

8



usb-stick case

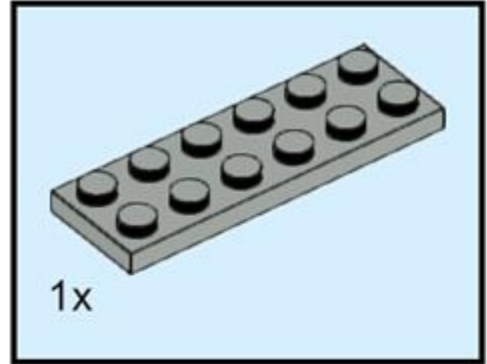
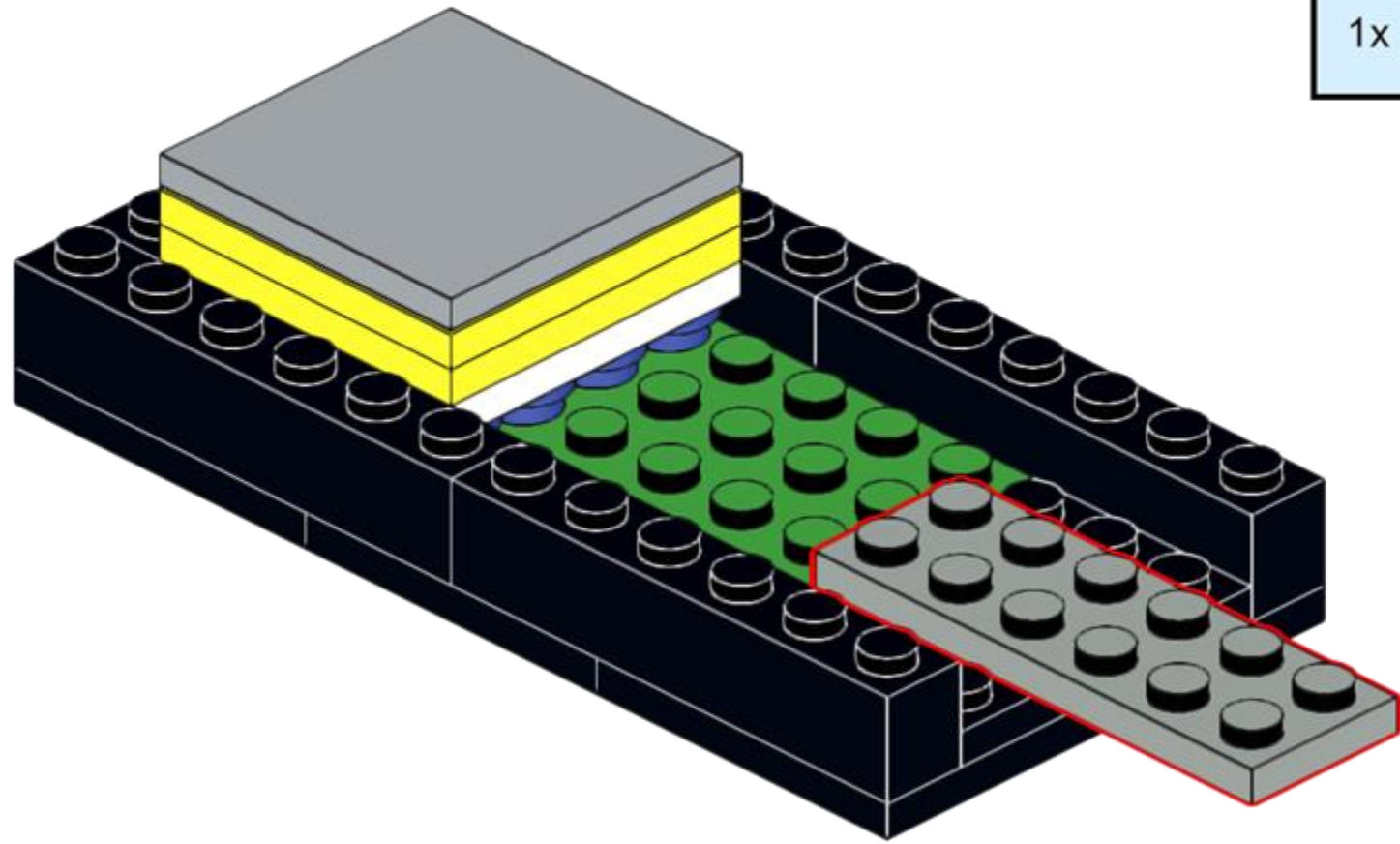
9



usb-stick case

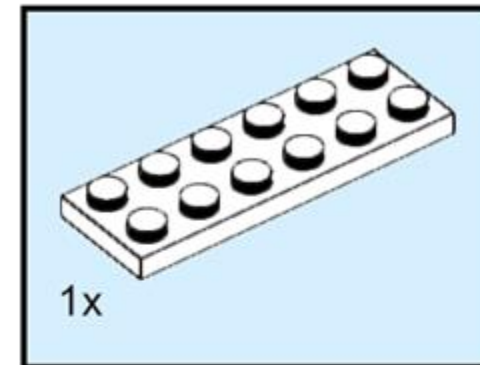
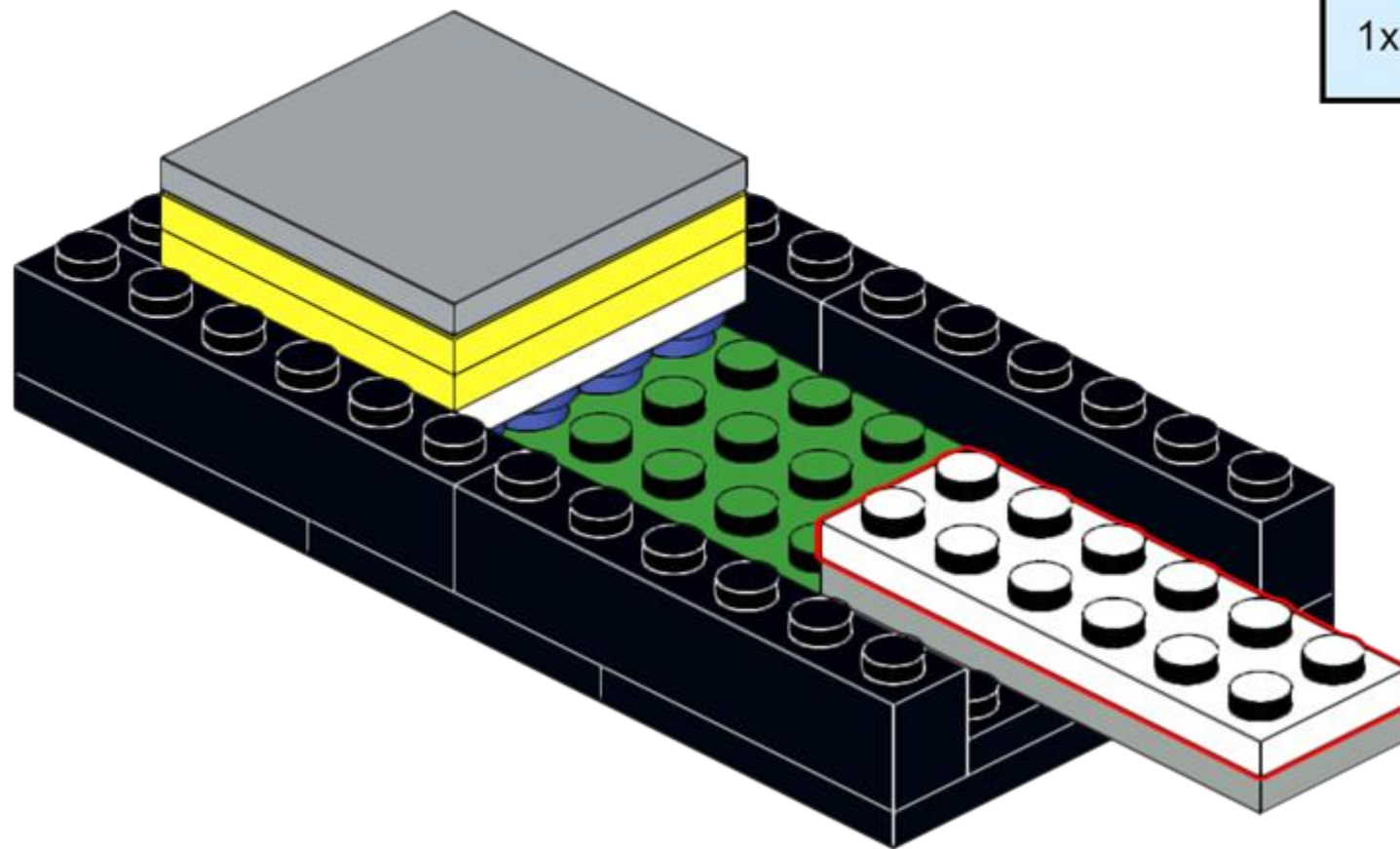
10

The MiniPix detector will be connected to a computer with a USB stick.



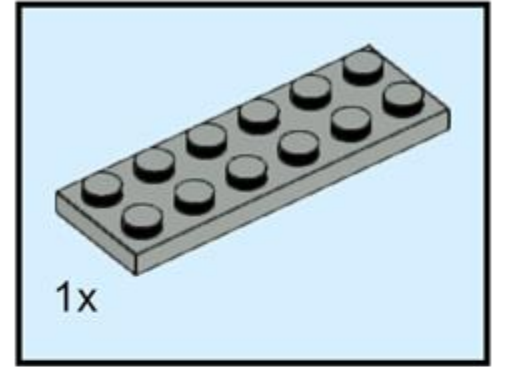
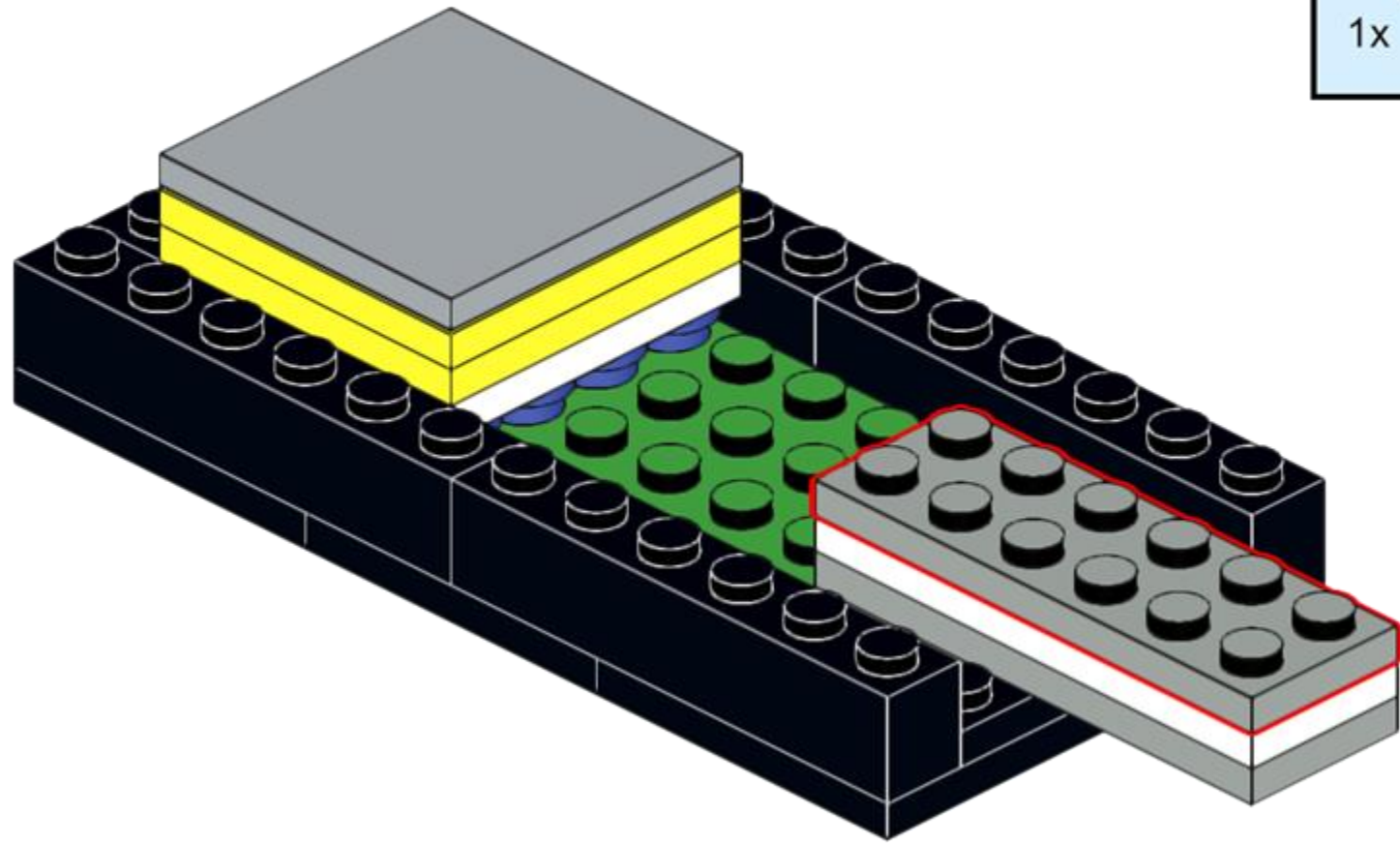
usb-stick

11



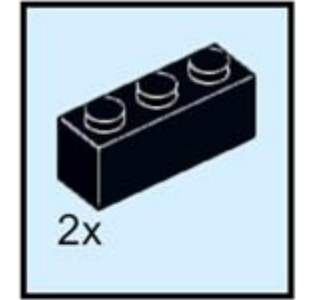
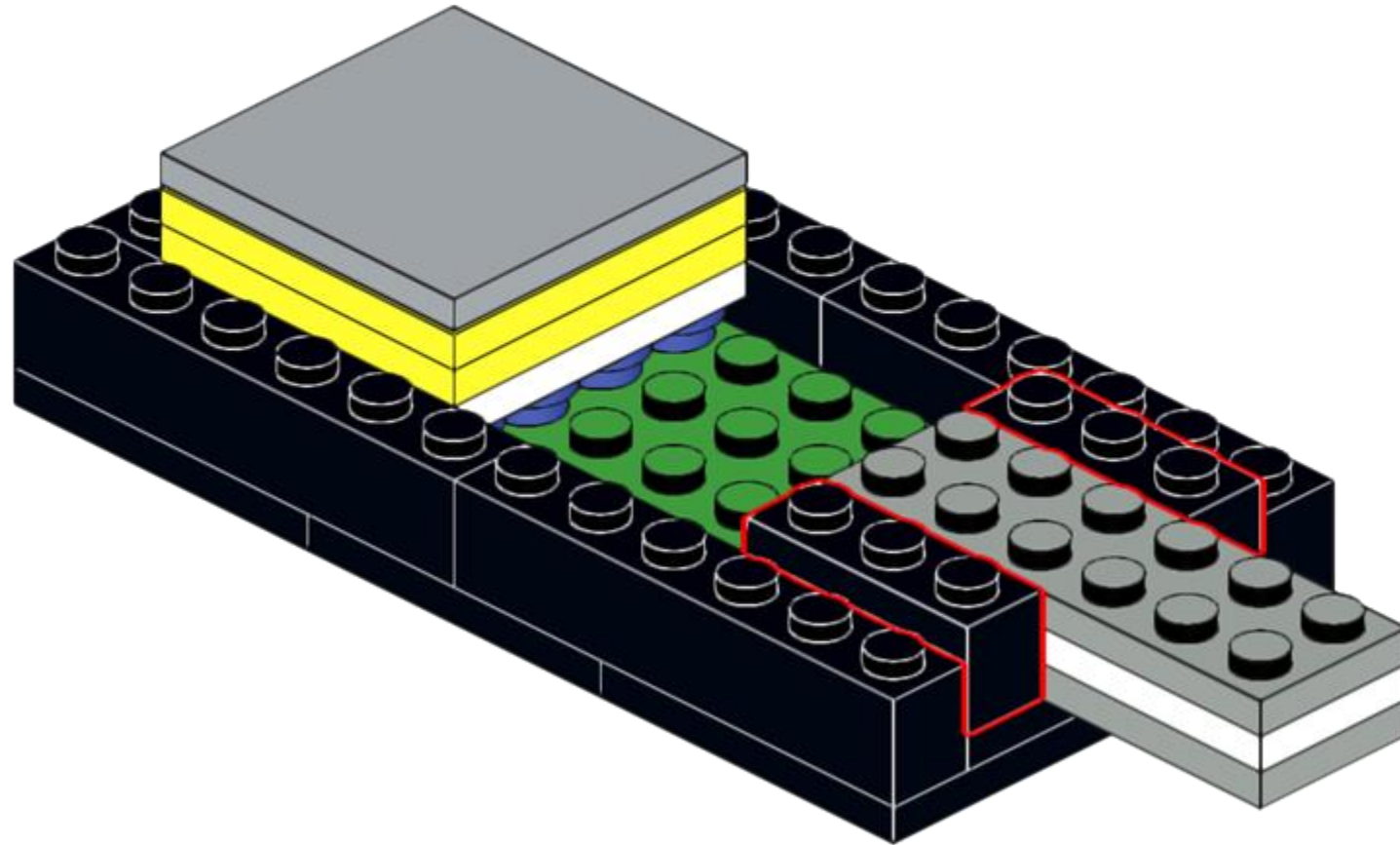
usb-stick

12



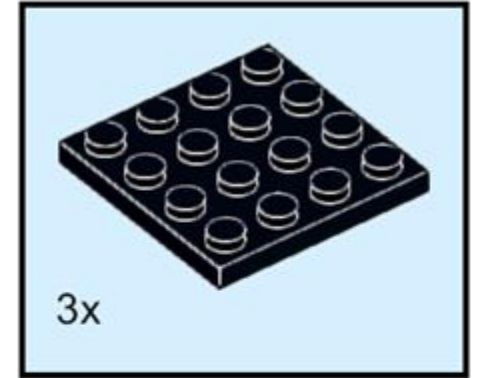
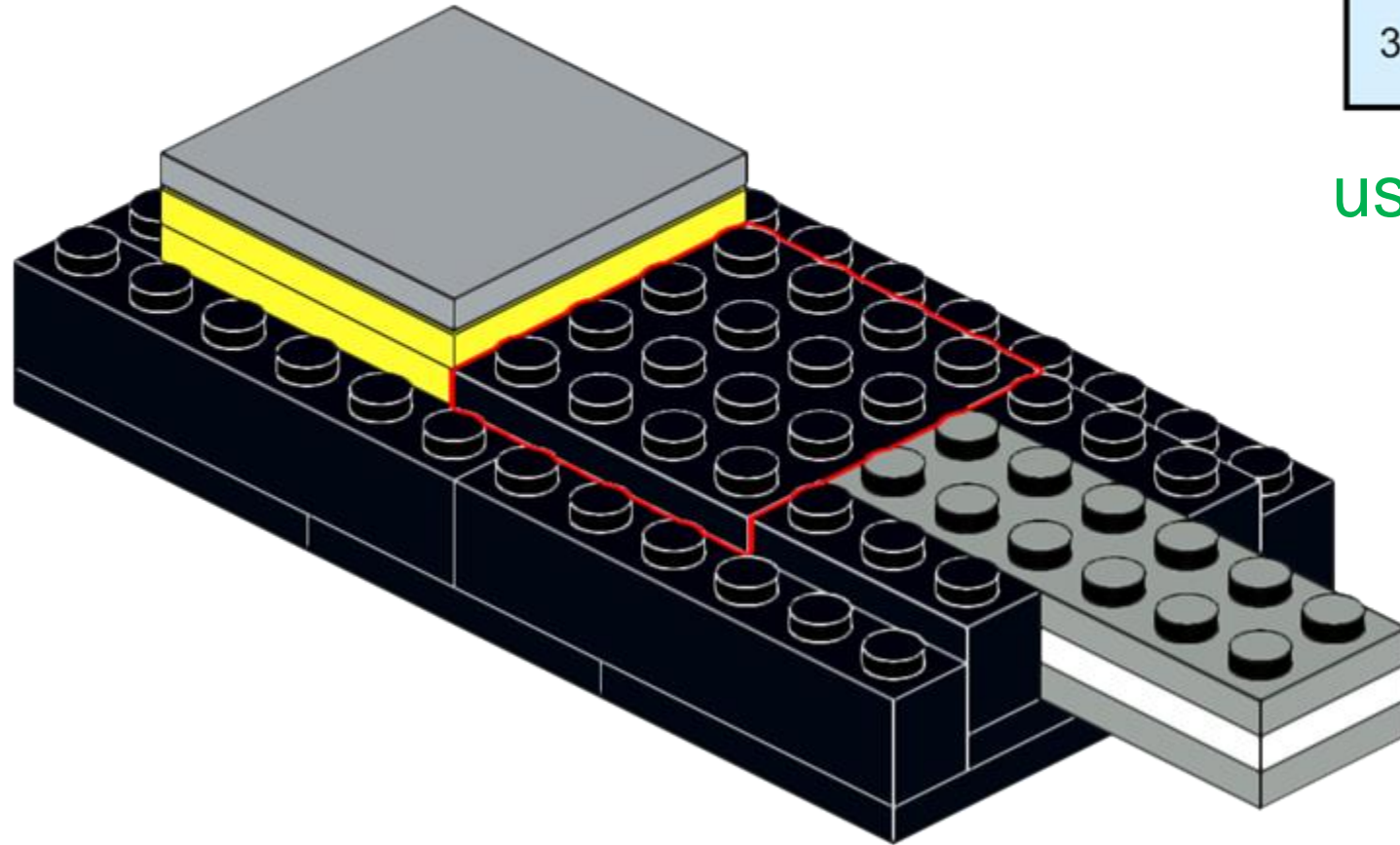
usb-stick

13



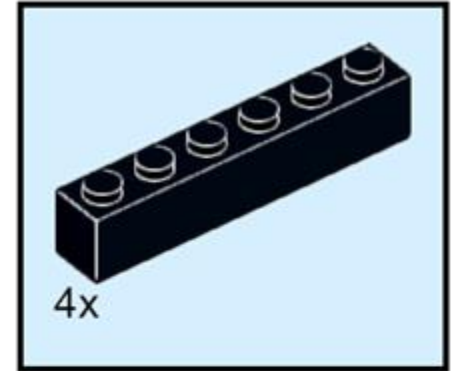
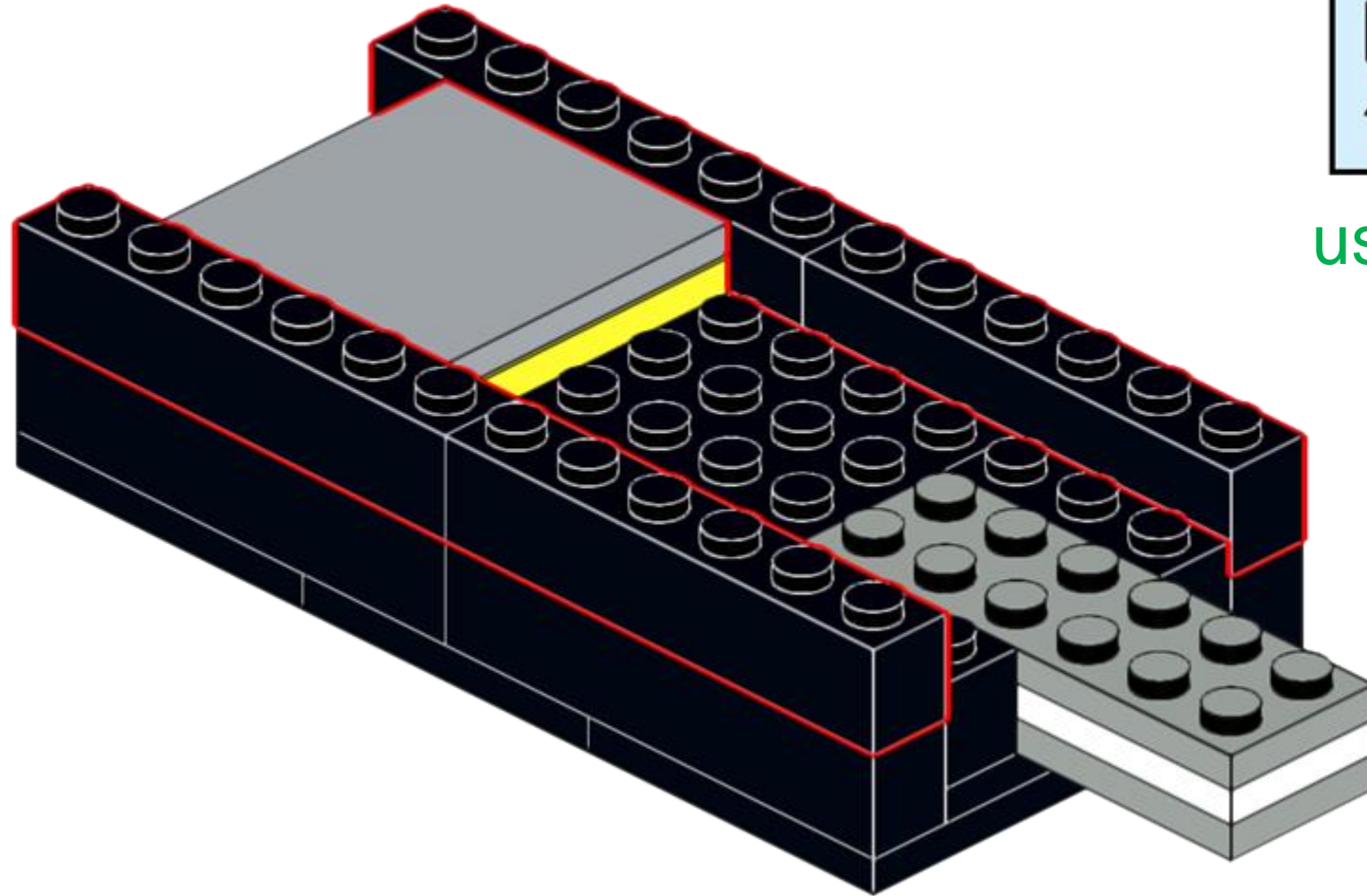
usb-stick case

14



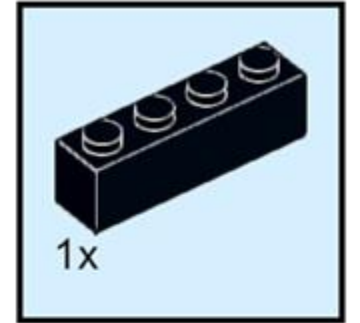
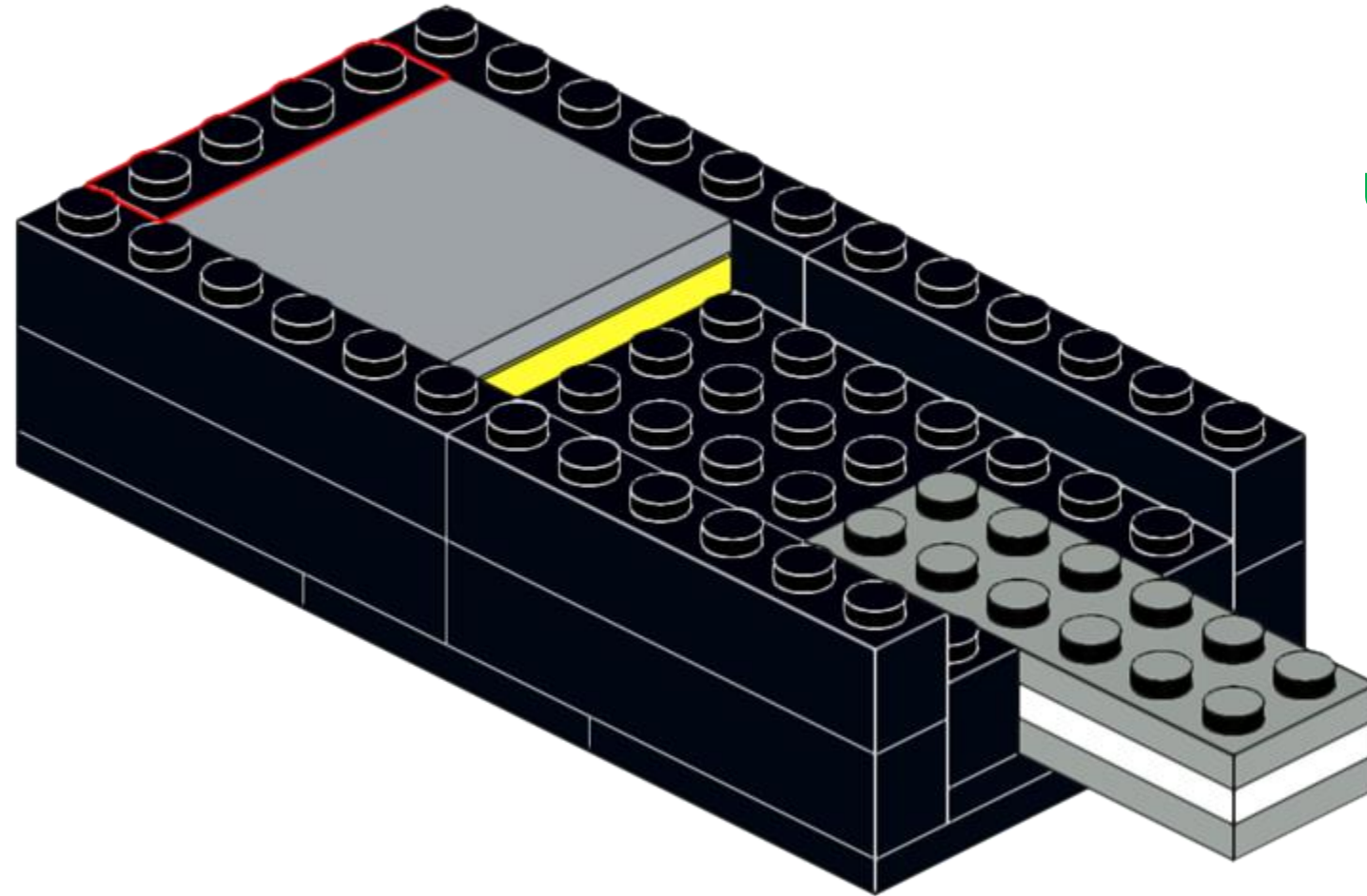
usb-stick case

15



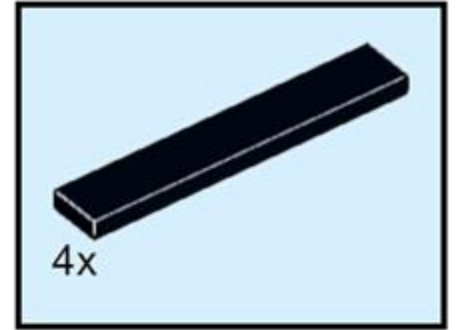
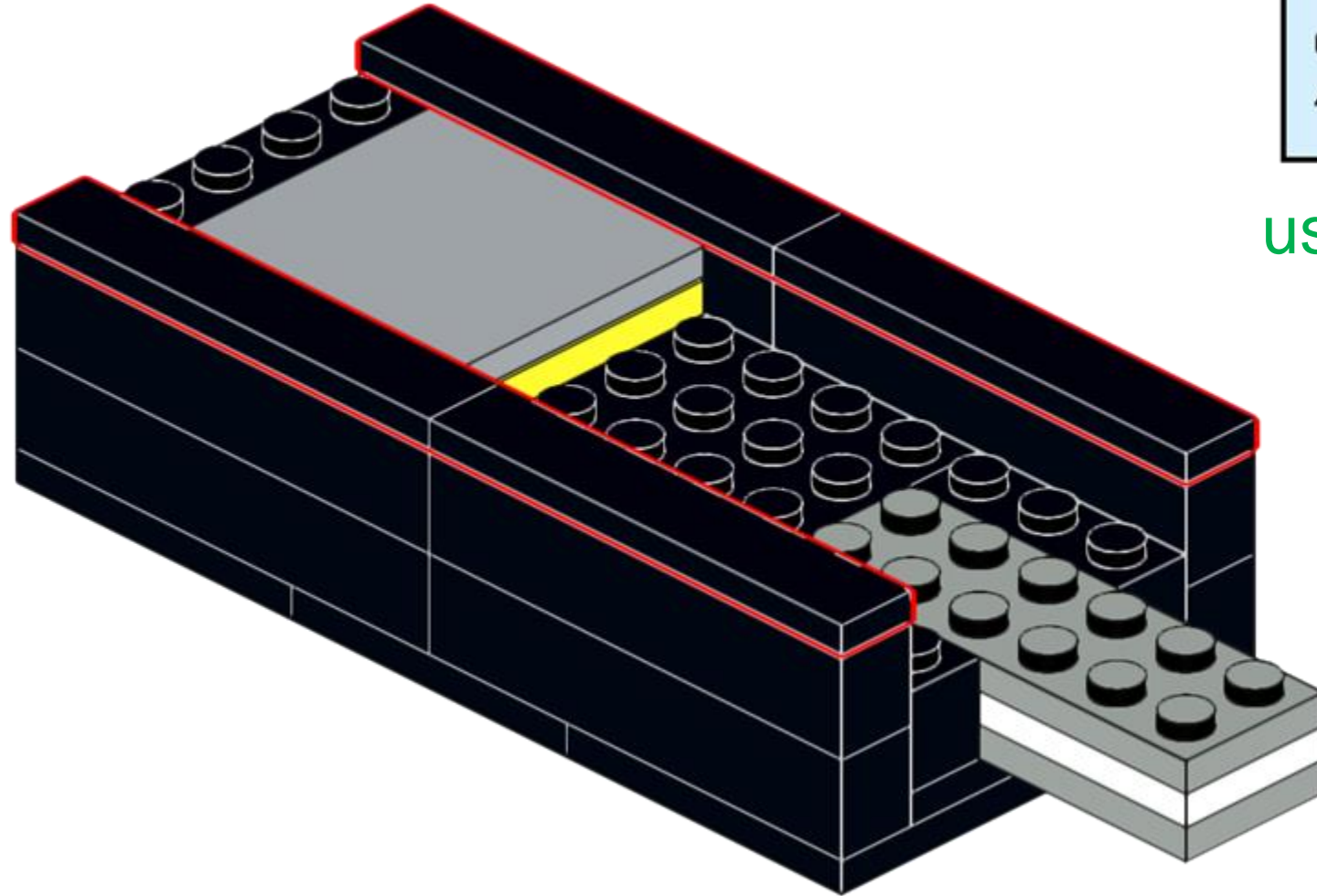
usb-stick case

16



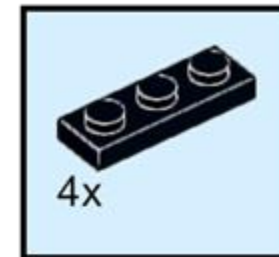
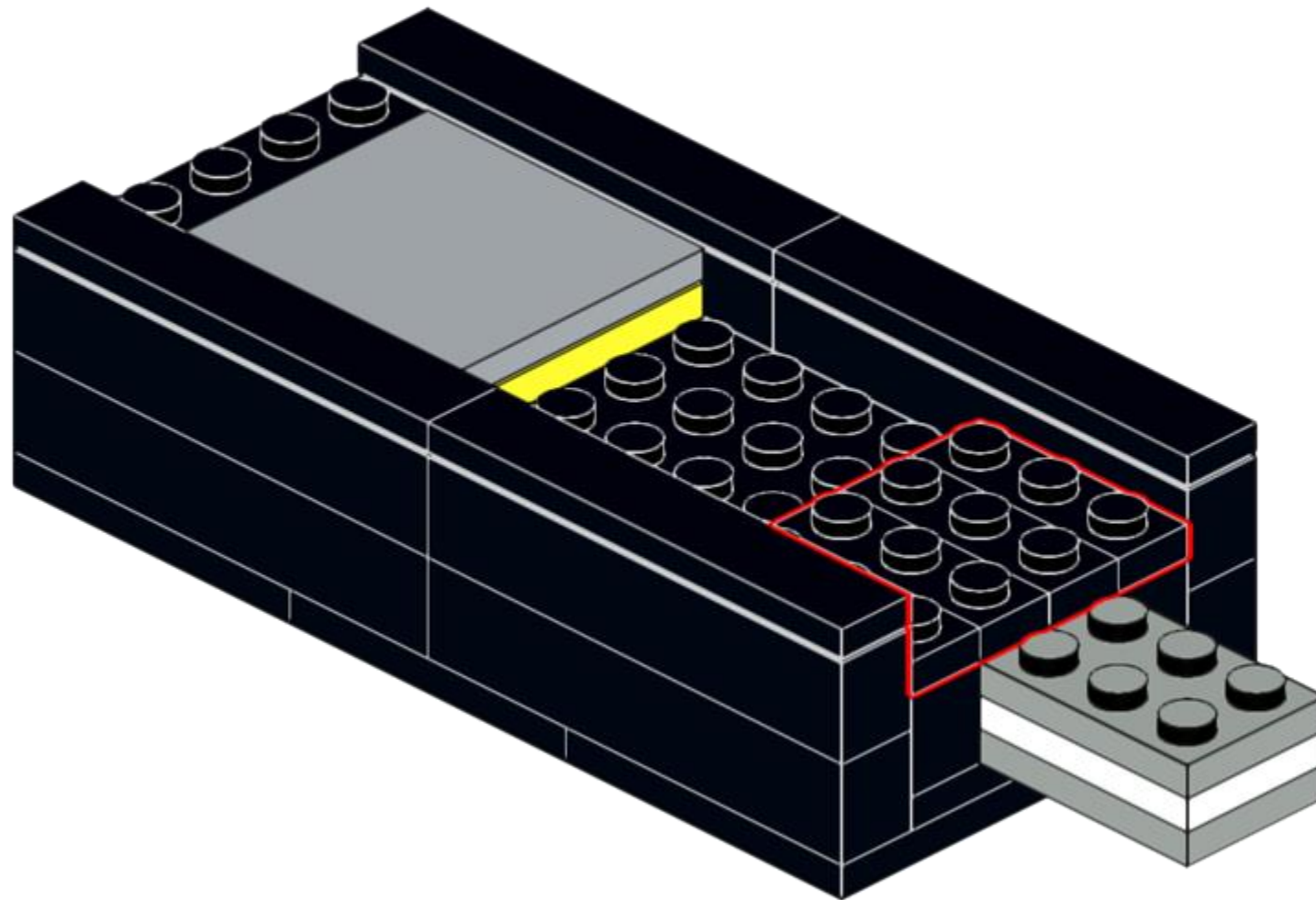
usb-stick case

17



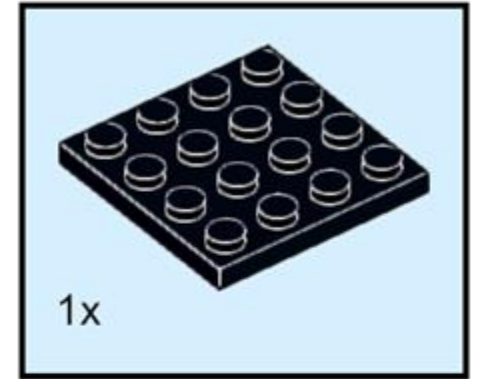
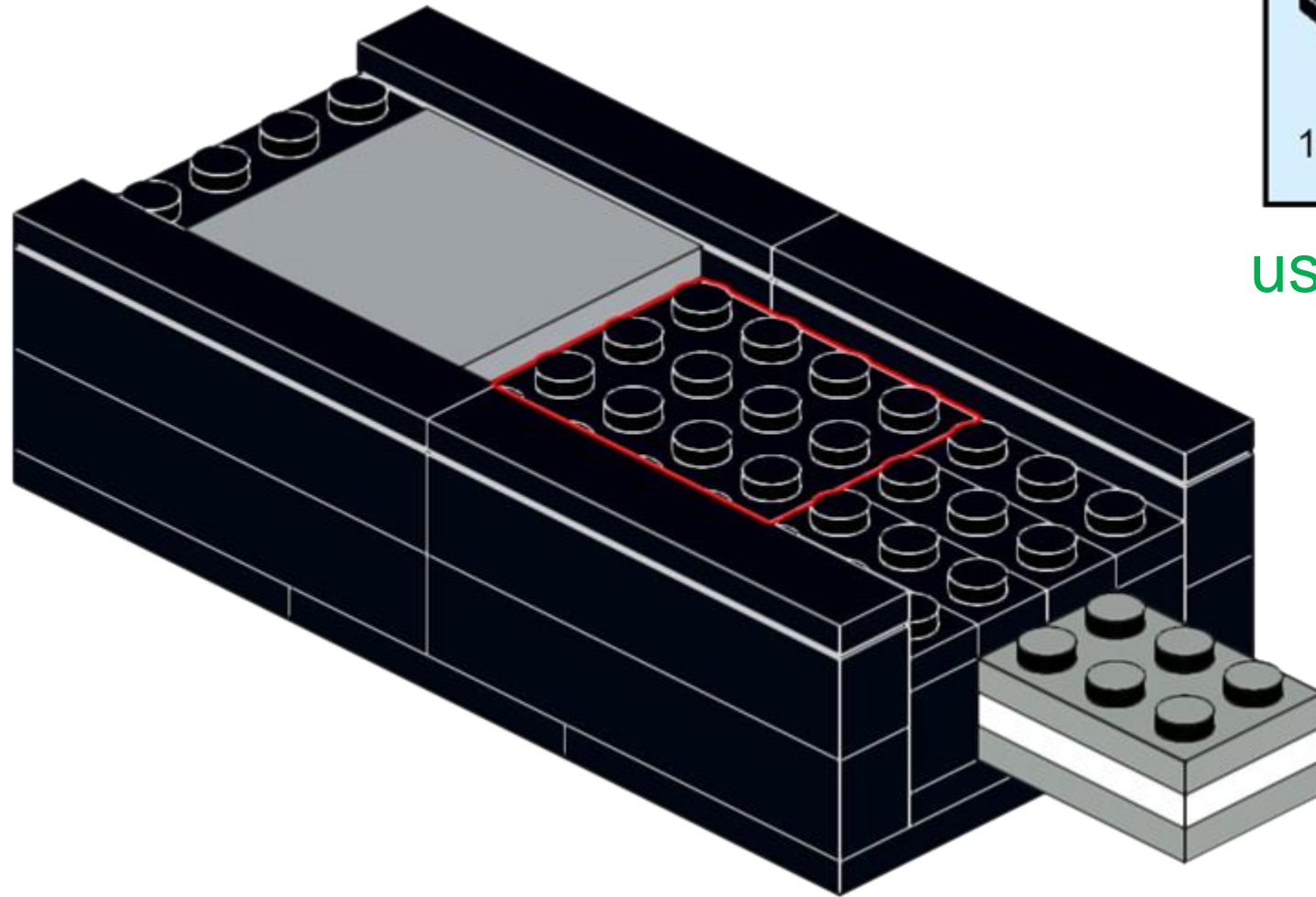
usb-stick case

18



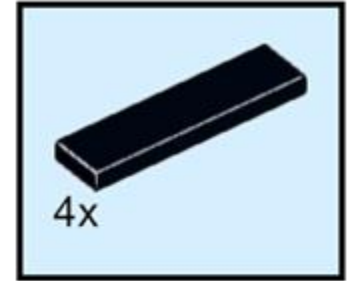
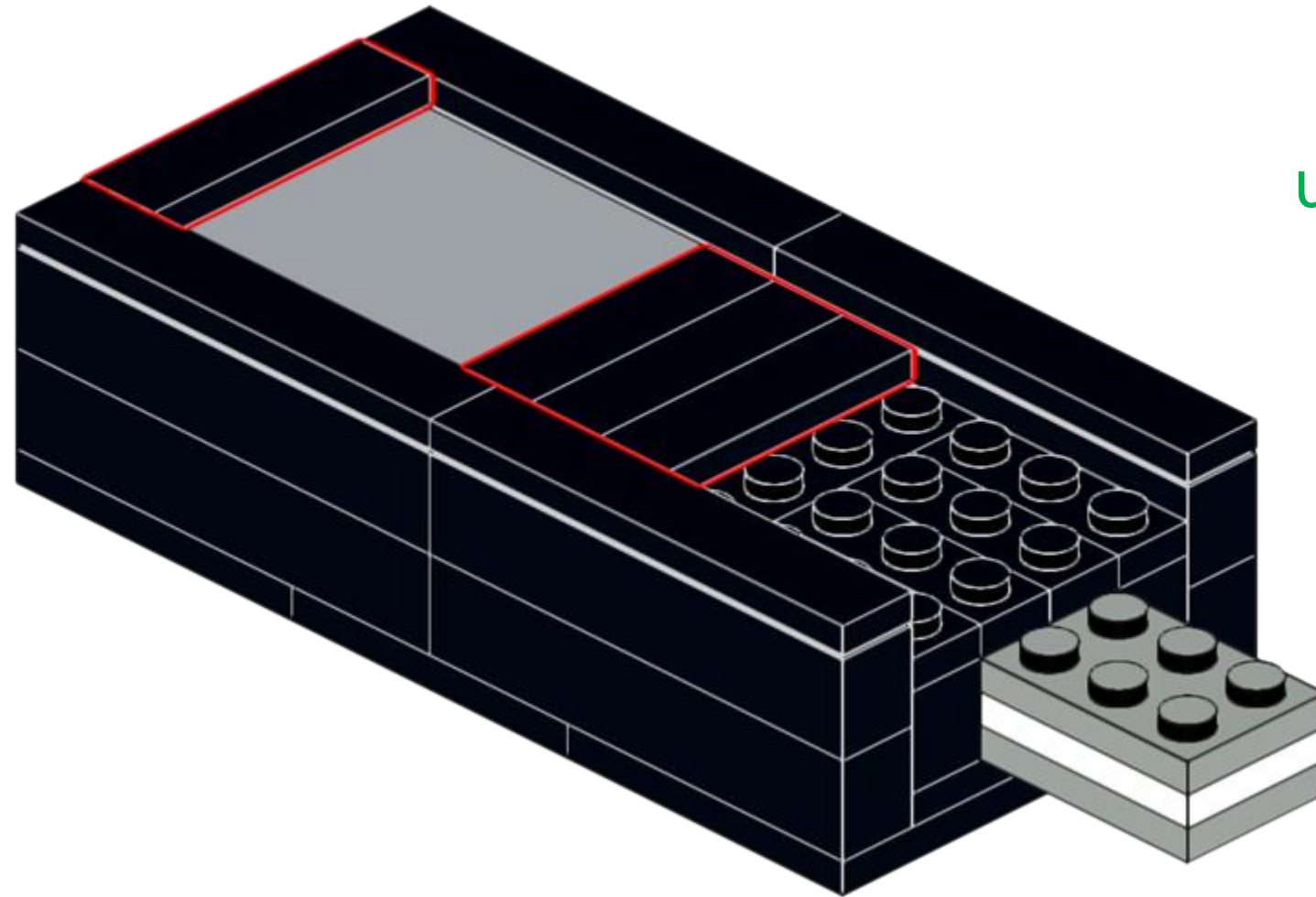
usb-stick case

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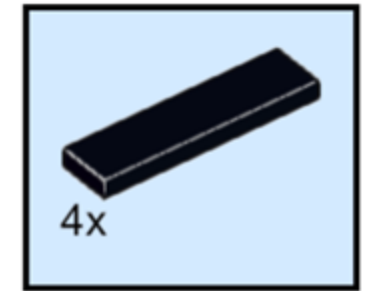
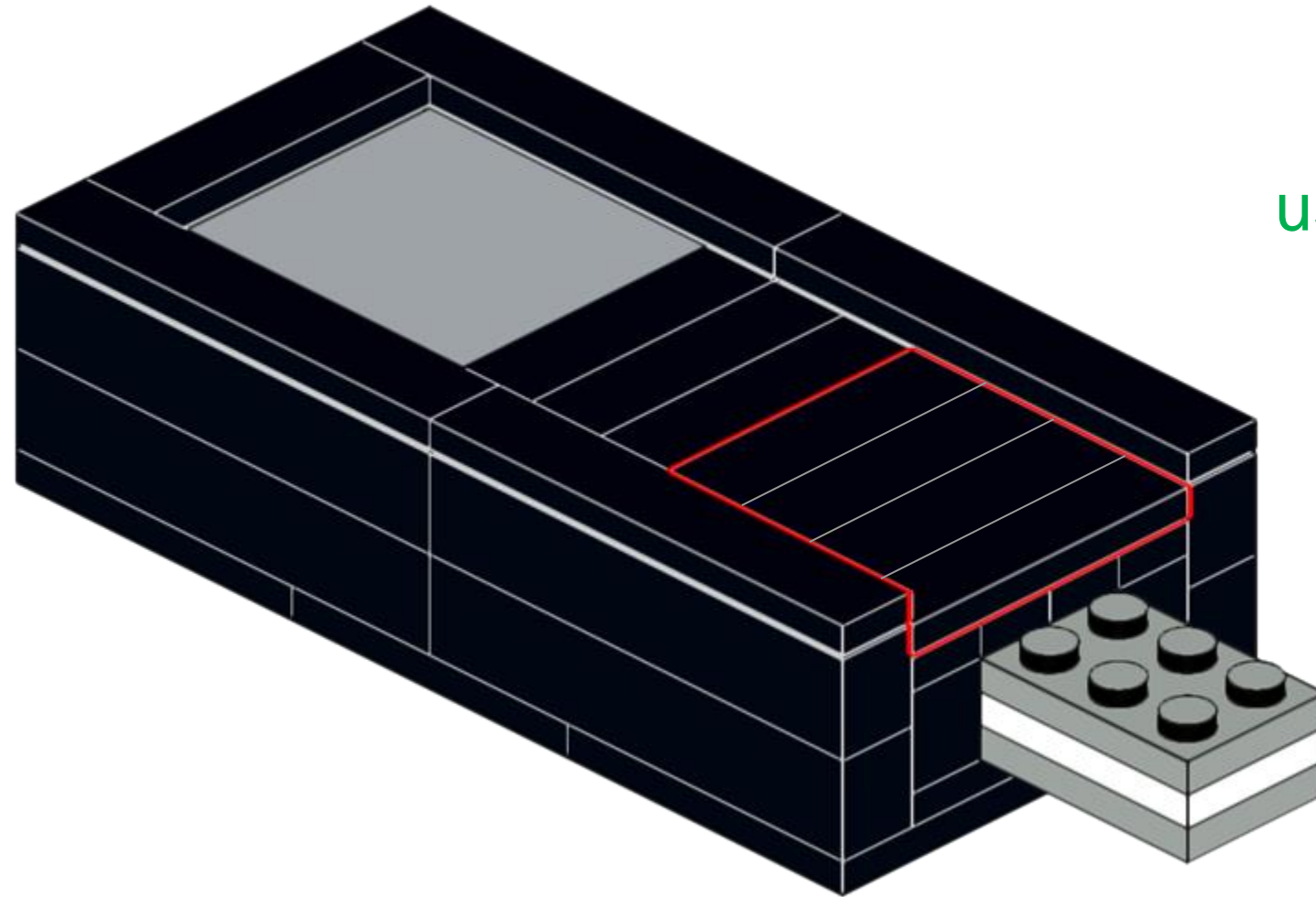
usb-stick case

20



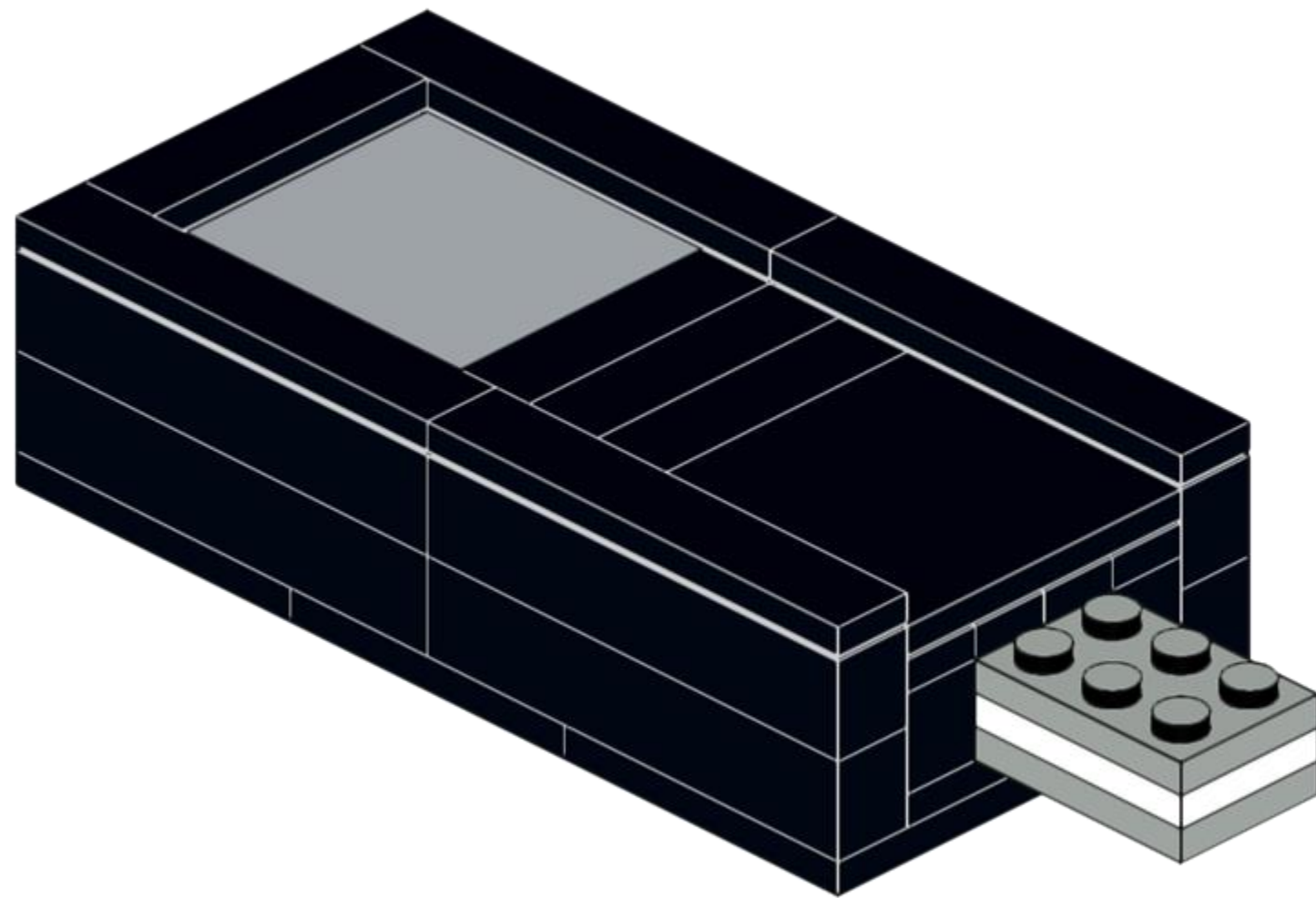
usb-stick case

21



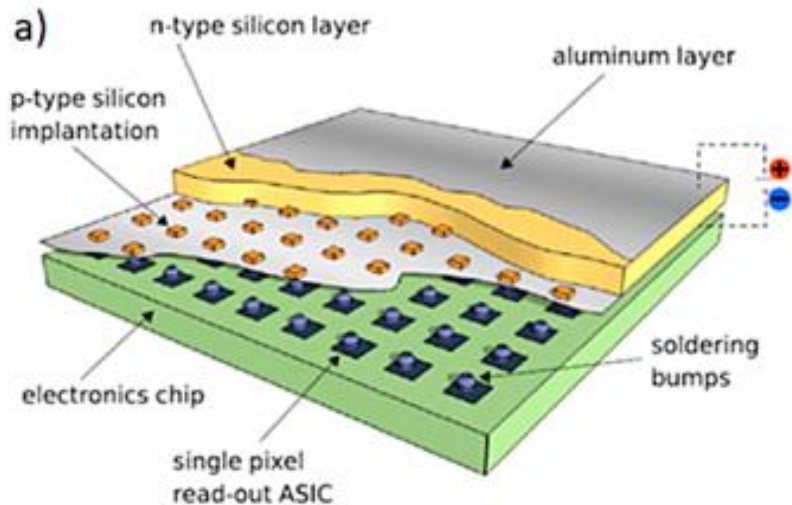
usb-stick case

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Well done!

Here's an illustration of the MiniPIX chip, with some details about each layer:



- ❑ Top layer: aluminium layer. It collects and transmits the electrical charge.
- ❑ Middle layers: n-type & p-type silicon layers. It creates and guides the flow of charge when particles hit.
- ❑ Bottom layers: 256x256 pixel layer, and readout electronics. Each pixel has its own electrode to collect charges. It captures and processes the electrical signals to create a visual map of particle interactions.

