Risø NaI(Tl) Gamma Spectrometer

Installation Manual

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READ THIS MANUAL CAREFULLY BEFORE YOU START TO DO ANYTHING!

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1 Read This Before Opening the Box

1.1 Do Not Open Your Box Right Away!

The NaI scintillator in the gamma detector is very sensitive to the temperature changes, so a large sudden temperature change could possibly crack the scintillation crystal and damage the gamma detector.

Therefore, it is always necessary to wait for at least 24 hours after your instrument box is delivered to your lab, before you can open it!

1.2 Suggestions for Lab Construction

1. Even though it is not necessary to cool the NaI gamma spectrometer by liquid N_2 when in use, it is always a good idea to install the NaI gamma spectrometer in a laboratory with a room temperature as stable as possible (all day and all year around).
2. Some air conditioners stop running when the set temperature is reached and only start to run again when the room temperature is out of its set temperature range. This will cause significant fluctuation in the room temperature, which will broaden the spectrum and thus reduce the measurement accuracy. If so, then we advice that you use an external temperature logging device, e.g., USB TC-08 from Pico Technology Limited (www.picotech.com) to monitor the variation of the room temperature.
3. The total weight of the 80 lead bricks of the lead shield is about 900 kg. Thus, it is advisable to install the gamma spectrometer in a laboratory located on the ground floor. If this is not possible, then please consult your construction engineer to verify the load capacity of the floor.
4. After installation, the dimension of the lead shield, together with sliding lid of the gamma spectrometer is 752 mm wide, 526 mm deep and 611 mm high. Therefore, user has to prepare a lab space larger than these dimensions.

1.3 Now You Can Open Your Box!

After your box has been delivered to you lab for 24 hours, you can open it.

There are two compartments in your box.

<u>The top compartment contains:</u>

(i) the Risø Gamma Spectrometer (with USB cable),
(ii) the 3D-printed plastic detector holder designed to hold the detector facing upward,
(iii) an aluminium mould,
(iv) 12 calibration standards.

<u>The bottom compartment contains:</u>

(v) the metal sliding lid (base and lid itself; only supplied if lead shield has been ordered through DTU Physics)
(vi) A custom lead brick with a milled slot for the USB cable.

Remove all items from the box.

2 Lead Shielding

2.1 Tools and Accessories

In order to assemble the lead shield properly, you should have the following tools and accessories available:

- Vinyl or latex disposable gloves.
  This is to prevent the direct contact with the lead bricks, which may cause health issue.
- A rubber hammer
  You will need to use it to straighten the wall of the shielding during laying lead bricks.
- Adhesive book cover or cling wrap
  After you have finished laying the lead bricks, you can use adhesive book cover to wrap around the lead bricks to avoid direct contact with the lead.
- A spirit level (bubble level).
- A set of Allen Wrench (hex keys)

2.2 USB Cable

A USB cable is used to connect the detector with the PC. This USB cable will pass through a special lead brick with milled slot (bottom compartment). This brick must be installed in the third layer from bottom.

2.3 Building the Lead Shield

1. The lead bricks in the two first (bottom) layers from bottom should be placed as shown in Fig. 1.

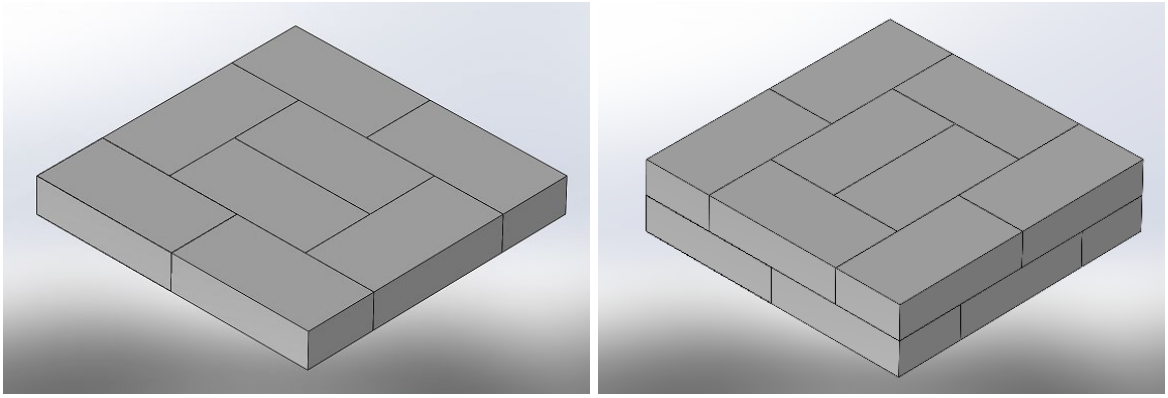
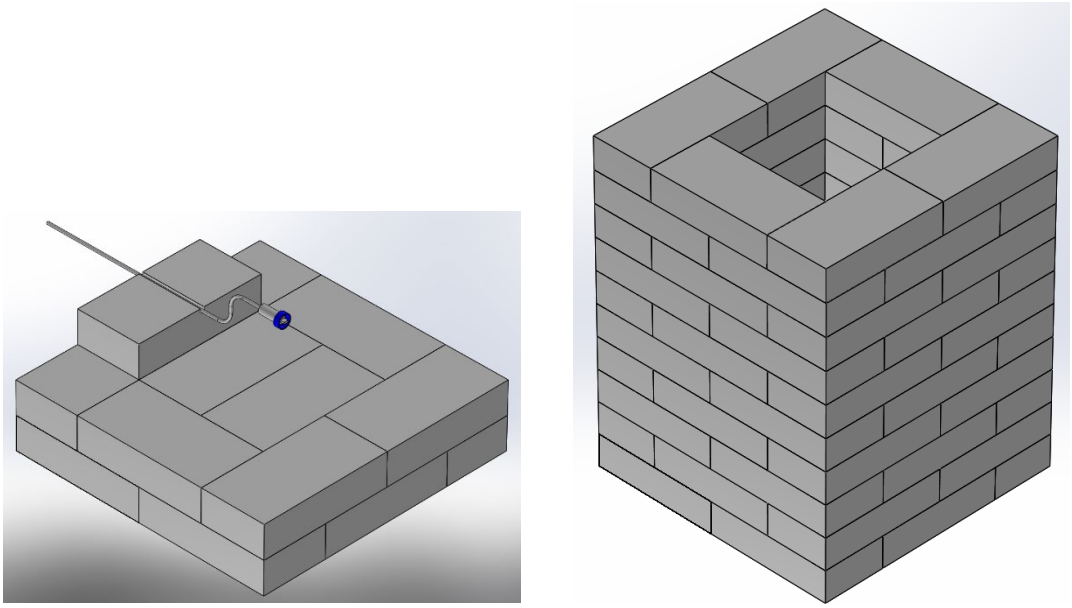


Fig. 1: First and second bottom layers of the lead shield.

2. In the third layer from bottom, place the special lead brick with the milled USB slot. This brick is included in the delivery box. Pass a USB cable through the slot of the brick and leave the blue USB connector locking screw inside, as shown in Fig. 2a.
3. Then you place the rest of the eight brick layers of the shield to form a cavity (200 mm × 200 mm) for the gamma detector (see Fig. 2b).

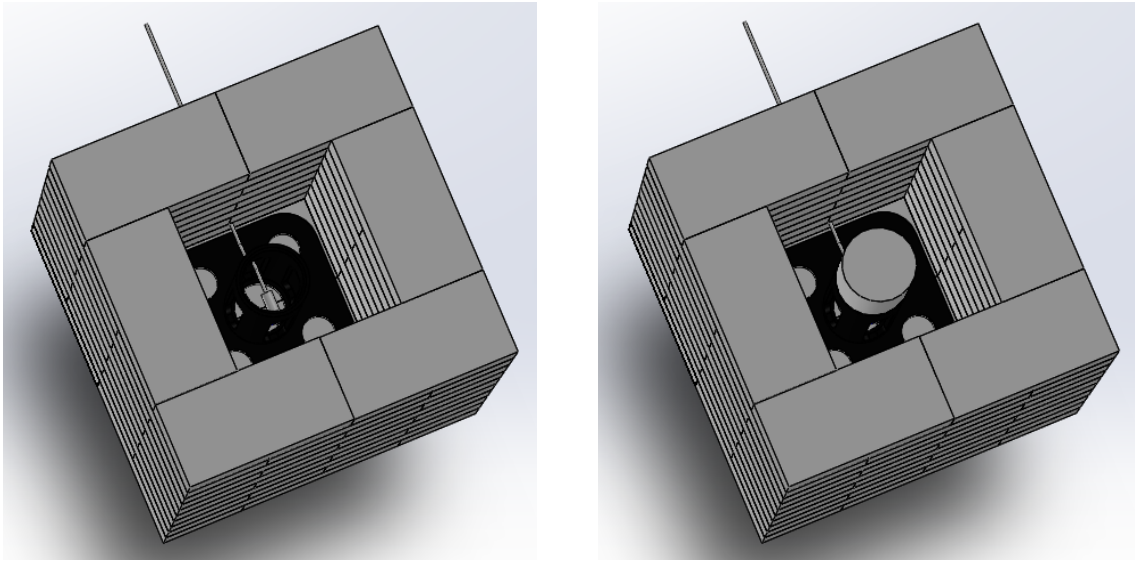


(a) (b)

Fig. 2 (a): Placing the lead brick with the milled slot for the USB cable. (b): Schematic drawing of the complete shield.

4. Wrap lead the shielding. Since the dust of oxidized lead from the surface of the lead bricks would endanger the health of the user, it is necessary to cover the entire exposed lead surface (both inside and outside) with e.g. adhesive book wrapper.

5. Place the plastic detector holder in the middle of the lead shield, as shown in Fig. 3a, and pull the USB cable gently upward to connect to the detector and lock it with the blue USB cable lock. Then place the gamma detector itself gently in the plastic holder, as shown in Fig. 3b. Remove the red plastic protection cover from the detector.



(a) (b)

Fig. 3 (a): Insert plastic detector holder in the lead shield. (b): Connect the USB cable to the detector and insert detector.

6. Fill the cavity in the lead shield with foam.
    a. The foam is only supplied with the detector by DTU Physics if the lead shield is ordered from DTU Physics.
    b. If the lead shield is not supplied by DTU Physics, users are suggested to find some dense but easy-to-cut foam to fill the space around the detector as much as possible, but leave a space for the gamma cup on the top of the detector. Fig. 4 shows a possible configuration. In the bottom there are four layers of 50 mm thick foam with a hole of 85 mm in diameter (same as the out diameter of plastic detector holder). On the top of these four layers, there is a single layer of 30 mm thick middle layer with a hole of 85 mm in diameter. Then on the top of this 30 mm thick layer, there are two layers of 50 mm thick with a hole of 110 mm in diameter. The top foam layer is 60 mm thick without the big hole and you cover it after you load your sample on the sample by grabbing two small holes on the top.

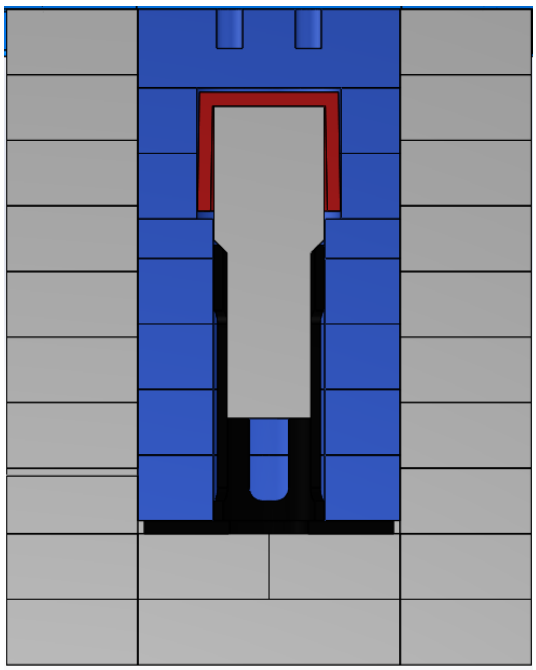


Fig. 4: A possible configuration on the foam filling in the cavity of lead shield.

The foam filling in the cavity of lead shielding has three purposes: (i) to expel, as much as possible, the air and radon from the cavity, and (ii) to prevent air circulation between outside and inside of the cavity, i.e. the air inside the cavity is not replaced, which is important for radon equilibrium, (iii) to keep the detector insulated, such that the detector temperature does not change too much if there is a sudden change in lab temperature.

2.4 Prepare Sliding Lid

Note that the sliding lid is only supplied by DTU Physics is lead has been ordered through us.

1. Fix the two legs onto the base part of the sliding lid using the four provided nuts.
2. Place the sliding base on the top of the lead shield and align the square hole to cavity in the lead shield (see Fig. 5).

3. Adjust the height of the base using the adjustable feet, so the top surface of the sliding lid base is horizontal (use a spirit level).
4. Place the sliding lid on top of the base part, as shown in Fig. 6.
5. Place two layers of lead bricks on top of the sliding lid, as shown in Fig. 7(a) and (b).
6. Wrap the lead bricks on top of the sliding lid with adhesive book wrapper.

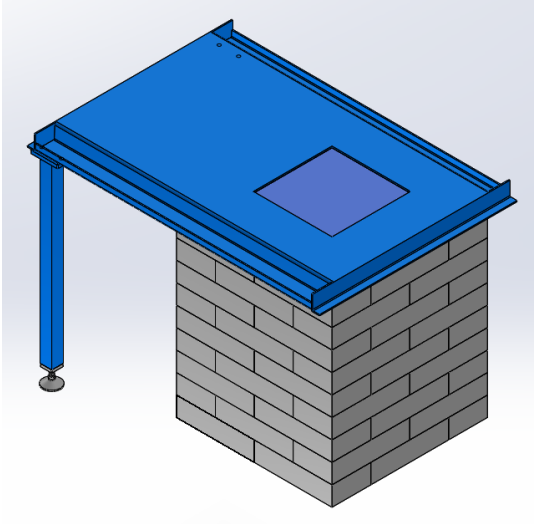


Fig. 5: Place and adjust the sliding lid base.

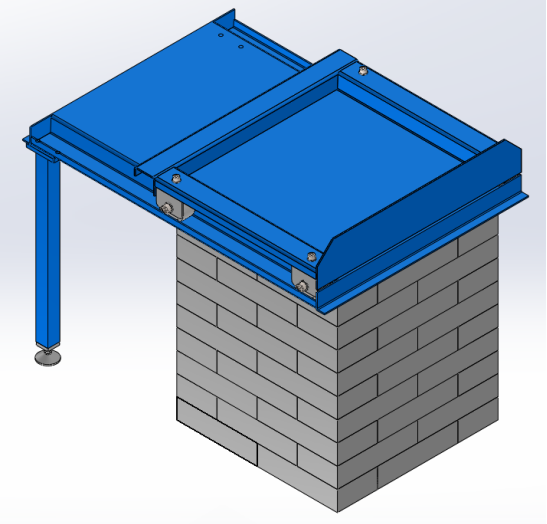
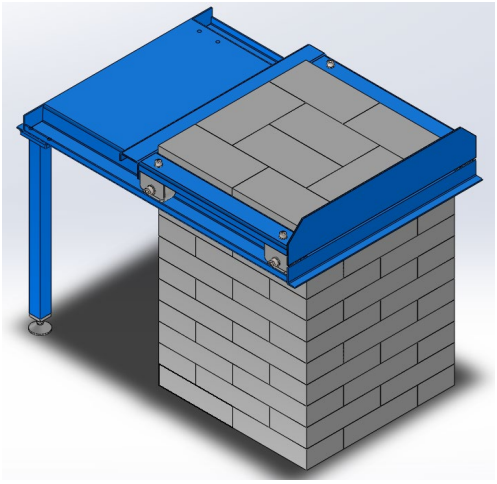
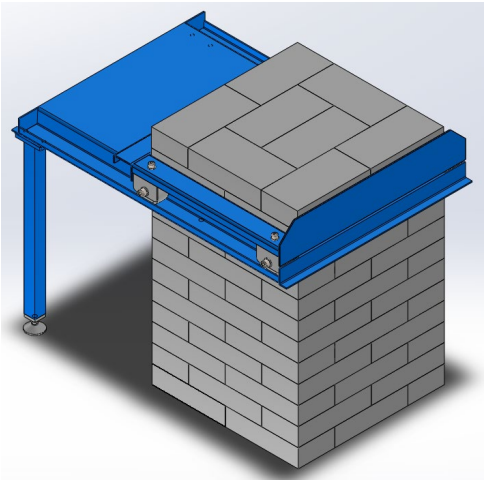


Fig. 6: Place the sliding lid on the lid base.



(a)



(b)

Fig. 7: Place lead bricks on top of the sliding lid. (a) The first layer. (b) The second layer.

3 Remarks on the Installation of the Gamma Spectrometer

3.1 Detector Holder

The plastic detector holder is 3-D printed, and thus a little fragile. Thus care should be taken when it is mounted in the lead shield. Pull the USB cable gently upwards first, before you place the holder inside the lead shield. Place the USB cable in the centre of the holder using one of the holes on the side and ensure that the detector holder is placed in the centre of the cavity. Pull the USB cable again gently to the top of the detector holder.

3.2 Gamma Spectrometer

The gamma spectrometer is a very sensitive instrument with sensitive components, such as a NaI crystal, a PMT and electronics. Thus, it must be handled carefully. Connect the USB cable to the USB connector on the detector and fix it with the blue locking screw.

3.3 Insulation Material

The insulation foam in the lead shielding cavity is not a mandatory part of the detector. We suggest to use it nonetheless to improve the long-term stability of the measurements independent of seasonal factors.

4 Calibration Cups

- The calibration cups must be handled with care. These wax cups are delicate, easily deformed and may break, e.g. if dropped on the floor.
- Radon progeny sticking on the surface of the wax cups will cause low measurement accuracy for the radioactivity and dose rate of the sample, especially for the samples with low activities. Therefore, it is recommended to always keep the calibration cups in the provided plastic containers when the cups are not being counted.