**Experiment 23**

# X-Ray Computed Tomography

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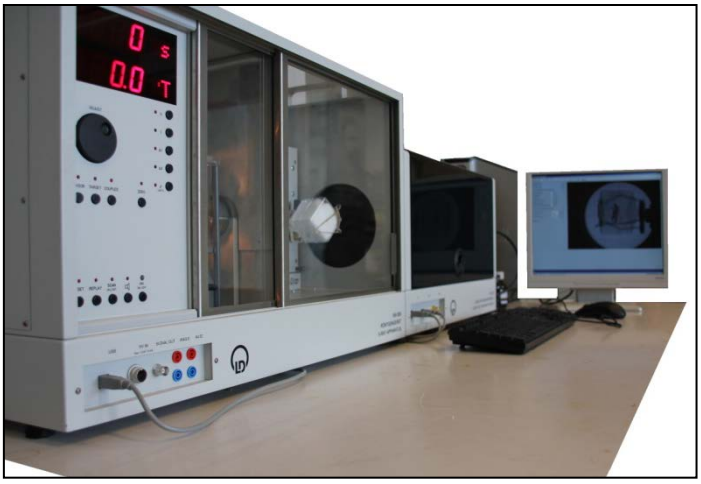
## Aim

To observe some properties of X-ray computed tomography.

## Set-up

The X-ray tube is contained in a case with a front of lead glass. This glass absorbs almost all of the X rays emitted by the tube. The X-ray device will be switched off when the front is opened. The case contains a holder for inserting objects. This holder can rotate over 360° in adjustable steps. The computer screen shows the tomogram of an object in 3D (when wearing special 3D glasses) or in 2D. In both cases, also any desired cross section of the object can be selected for viewing on the screen.



Read the introduction on page 28 of the booklet *ISP Experiments* about X-ray computed tomography.

## Observations

**1** Switch on the computer and start up the CT software. Use “lead peak” when the computer asks for a password. In the start-up screen you can adjust the recording settings, such as, for example, the number of steps in which the holder with the object rotates over 360°, and the voltage and current of the X-ray tube in the device.

Insert object A (a walnut) in the holder. Set the device to one single step: ‘X Rays’ ▼ > ‘Size of the Computer Tomogram’ > ‘Number of Projections … angles’. Set the device’s voltage and current to 30 kV and 1 mA: > ‘X rays’ > ‘High Voltage: 30 kV’ and ‘Anode Current: 1 mA”. Instead of using the start-up screen, you can also set the voltage and current with the buttons on the device. Start the recording with the start button C►, and arrange its storage in the computer memory with ‘Save As’: enter the file name as your own name with extension 1 (the 1 of a recording in 1 step).
Click on 3D. On the screen a 3D image will appear. This image can be seen from all sides by moving the mouse while continuously pressing its left-hand button. Put on the 3D glasses, and look at the 3D image. What do you observe? How do you explain these observations?

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**2** Leave object A in the holder. Set the device with the button ☼ of ‘Change settings’ to subsequently 4, 15, 45 and 90 steps for a full rotation of the object. Leave the voltage at 30 kV and the current at 1 mA. Save the recordings as indicated above, using another number in the file name.
Look at the subsequent 3D images, and compare their quality. What conclusion can be drawn? How is this conclusion to be explained?

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**3** In the computer memory, an image of object A has been stored. This image has been made with 360 steps for a full rotation of the object (so, with steps of 1°). Open this image: click on ‘Open Map’ and open the file ‘Noot 30kV 360 stappen’. **Note**: You can also have this image recorded by the device, but this will take a measuring time of about 12 minutes. Then there is not much time left for the remainder of the experiment.

Look at the 3D image. Explain whether or not your conclusion drawn in the previous task is justified.

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**4** Leave the image of object A on the screen. Rotate the image until you see the walnut in a way that is suitable for measuring its two characteristic dimensions (length and diameter). Then, by shifting the pointer on the scroll bar at the bottom of the screen, remove layers from the 3D image until you see a longitudinal cross section of the walnut on the screen.
From this image of the longitudinal cross section, measure the characteristic dimensions of the walnut and the thickness of the shell of the walnut. Do this by mouse clicking on the start and end points.

Dimensions: ……. and ……. cm

Wall thickness: ……. mm

**5** Leave object A in the holder. Set the device to 15 steps for a full rotation of the object. Set the device's voltage to subsequently 15, 20 en 25 kV. Leave the device's current at 1 mA. Save the recordings. **Note**: the higher the voltage is, the larger is the energy of the X-ray photons.
Look at the subsequent 3D images, and compare their quality. What conclusion can be drawn? How is this conclusion to be explained?

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**6** Insert one of the objects B to E in the holder. Set the device to 180 steps (measuring time 6 minutes) for a full rotation of the object, a voltage of 30 kV and a current of 1 mA. Save the recordings.
Look at the 3D image, and try to identify the object. And if there is enough measuring time left: repeat this for another object.

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