

External dose rates

In the Risø TL/OSL reader samples can be irradiated *in situ* using a beta irradiator located above the sample carousel. The irradiator accommodates a $^{90}\text{Sr}/^{90}\text{Y}$ beta source, which emits beta particles with a maximum energy of 2.27 MeV. The half life is 30 years. The source strength is usually about 1.48 GBq, which gives a dose rate in quartz at the sample position of approximately 0.1 Gy/s.

The source is placed inside the irradiator, and backed by a 20 mm thick aluminum spacer, a 20 mm thick lead spacer, a spring washer, and finally a 25 mm thick aluminum spacer. The source is mounted inside a rotating stainless steel wheel which is pneumatically activated. When the source is “off” (default position) it points upwards directly at a 10 mm carbon absorber. When the source is “on” (activated position) it points downwards towards the measurement chamber.

The external dose rate originates entirely from bremsstrahlung due to interaction of beta particles in the surrounding materials. All dose rates reported in Table 1 were measured using an Automess Scintomate 6134A (a calibrated plastic scintillation detector), specifically intended for measuring dose rates from photons down to 40 keV. Figure 1 shows the locations where the dose rate measurements were carried out.

The measurements were carried out in a room with a background dose rate of $\sim 0.15\mu\text{Sv/h}$.

- When the source is not activated the dose rate at a distance of 1 m from the front surface of the Risø reader (“A₂” in Figure 1) is $< 0.4\mu\text{Sv/h}$. When the source is activated the dose rate is $< 0.5\mu\text{Sv/h}$.
- The dose rate directly on the surface of the irradiator (“C” in Figure 1) is $< 5\mu\text{Sv/h}$ both when the source is activated and not activated.
- The maximum dose rate directly on the side of the reader (“B₁” in Figure 1, the side closest to the irradiator) increases from $5\mu\text{Sv/h}$ to $< 100\mu\text{Sv/h}$ when the source is open. It is not possible to be situated close to this side of the reader (the $100\mu\text{Sv/h}$ drops to $17\mu\text{Sv/h}$ even 10 cm from the surface), but nevertheless this dose rate can readily be reduced to $<< 1\mu\text{Sv/h}$ by placing one cm of lead shielding along this side of the reader (covering “B₁” in Figure 1). However, we do not regard it as necessary to shield either the front or the other sides of the reader.

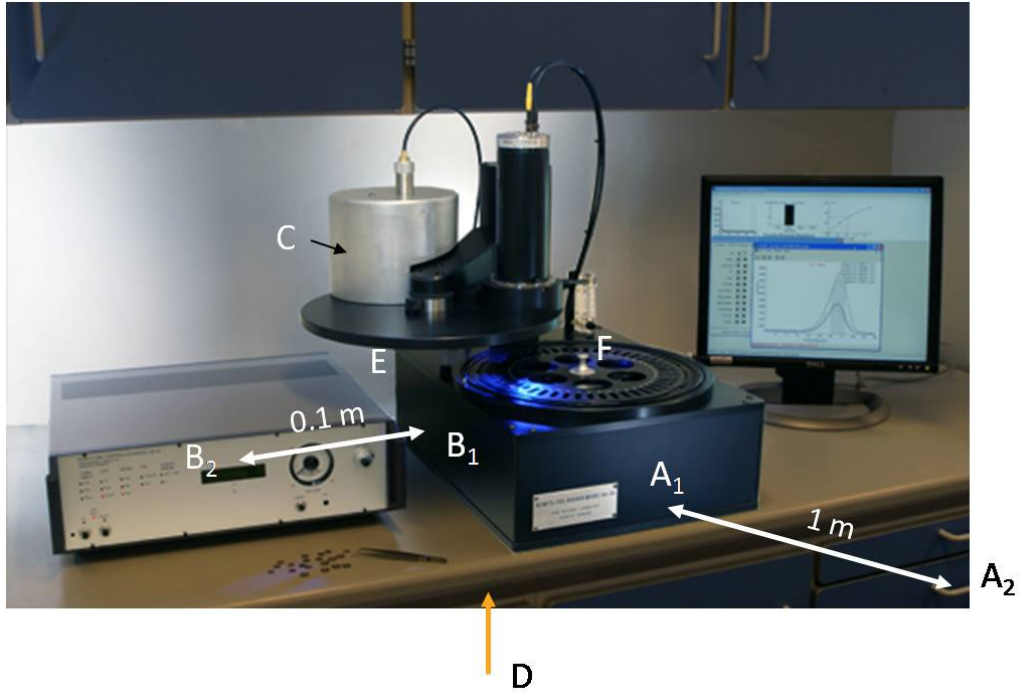


Figure 1: Picture of the Risø TL/OSL reader showing where the dose rate measurements listed in Table 1 were carried out.

- We also recommend that the reader is positioned in such a way that the space underneath is inaccessible. The dose rate underneath a wooden table with a thickness of 25 mm (“D” in Figure 1) is $< 3 \mu\text{Sv/h}$ when the source is inactivated and $< 40 \mu\text{Sv/h}$ when the source is activated.
- The activation of the source is electromechanically interlocked so that it is impossible to activate the source remotely while the lid is open. Thus, whenever the lid is open (during loading and unloading) the source is always inactivated. When the lid is open (and so the source inactivated) the dose rate directly below the aperture of the irradiator is $< 40 \mu\text{Sv/h}$ (“E” in Figure 1). However, this is not the dose rate to which the radiation worker will be exposed. The dose rate applicable to the operator is significantly smaller. During normal operation the lid opens and the sample carousel is placed on the sample turntable in the measurement chamber. During this operation the hand will be exposed to a maximal dose rate of $0.5 \mu\text{Sv/h}$ (“F” in Figure 1).

The lid is both electronically and mechanically inter-locked so it cannot be opened while the source is energized. If the lid is forced open software

1.48 GBq $^{90}\text{Sr}/^{90}\text{Y}$	Lid closed				Lid open
	“off”	“on”	“off”+Pb	“on”+Pb	“off”
Bg	0.15	0.25	0.15	0.5	
A ₁	0.8	13			
A ₂	0.4	0.5			
B ₁	5	100			
B ₂		17			
C	5	4			
D	3	40			
E					40
F					0.5

Table 1: External dose rates [$\mu\text{Sv/h}$] for the Risø TL/OSL reader equipped with a 1.48 GBq $^{90}\text{Sr}/^{90}\text{Y}$ source. All dose rates were measured using an Automess Scintomate 6134A. “Bg” is the background dose rate measured approximately 2 m away from the reader. The designations “A₁, A₂, B₁, B₂, C, D, E and F” are shown in Figure 1. When the source is “off” it points directly at a 10 mm carbon absorber. When the source is “on” (activated position) it points downwards towards the measurement chamber. In the “off/on”+Pb measurements a 5 mm thick Pb brick has been positioned at B₁.

and hardware interlocks will de-energize the irradiator and return the source to its default safe position. An external indicator positioned next to the irradiator glows red when the source is activated and green when the source is de-energized.