Ancient TL

www.ancienttl.org · ISSN: 2693-0935

Sanderson, D., 1985. *An automated beta irradiatior using a Sr-90 foil source.* Ancient TL 3(3): 26-29. https://doi.org/10.26034/la.atl.1985.096

An automated beta irradiator using a Sr^{90} foil source

D. C. W. Sanderson and D. A. Chambers,
Department of Physics,
Paisley College of Technology,
High Street,
Paisley, PA1 2BE.

Introduction

A new off plate beta irradiator has been constructed for the Paisley TL laboratory based on a 4 cm^2 extended area 40 mCi Sr^{90} foil source with a 50μm silver window (type SIQ 9, Amersham International PLC). The design requirements were to maintain external dose rates at below 0.75 mR hr^{-1}, to improve the irradiation geometry and stability compared with previous designs used in this laboratory and to provide an accurate automatic delivery and recording system.

The irradiator features a shutterless irraditation cavity, a linear transport mechanism ensuring uniform distribution of transit dose, and a simple control system based on a cheap home computer with a minimum of external components.

Description

The layout of the irradiator and its central cross-section are shown in figures 1 and 2.

Up to 12 samples on 1 cm discs are mounted on a brass carrier bar which passes through the cylindrical irradiator on a linear track. The central part of the irradiator consists of two interlocking stainless steel sections with a cylindrical cavity on the central axis above which the source is located in a steel capsule.

Stainless steel tubing welded in the central sections encloses a set of lead inserts to provide shielding. We had originally intended to convolute lead into the outer part of the central sections, however to simplify machining an external lead collar was used to sheild this area.

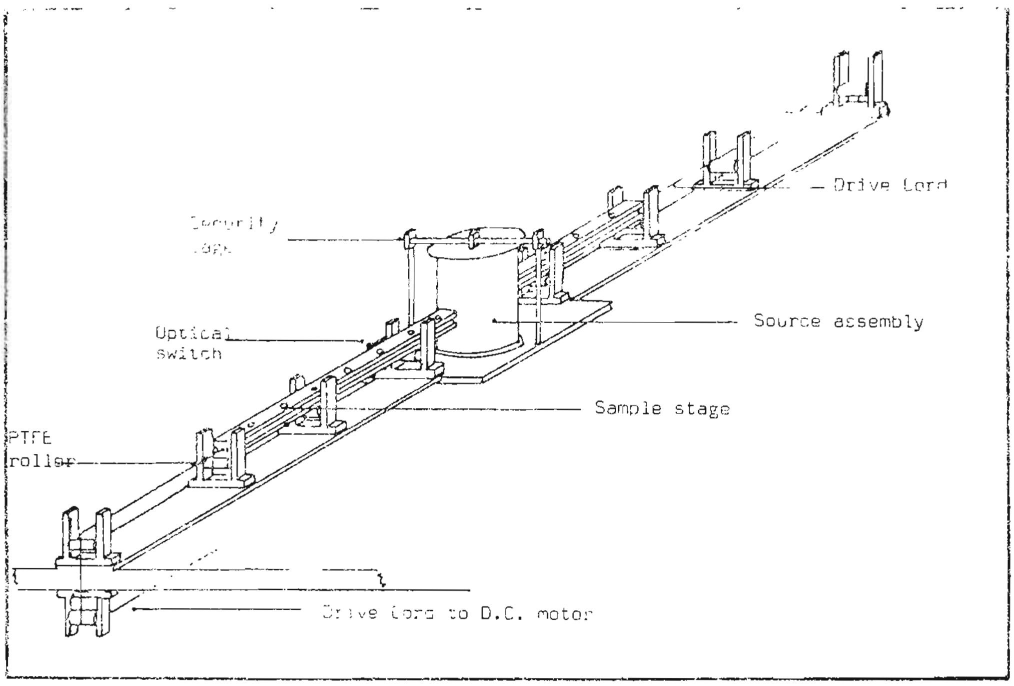

Figure 1: Layout of the beta irradiator.

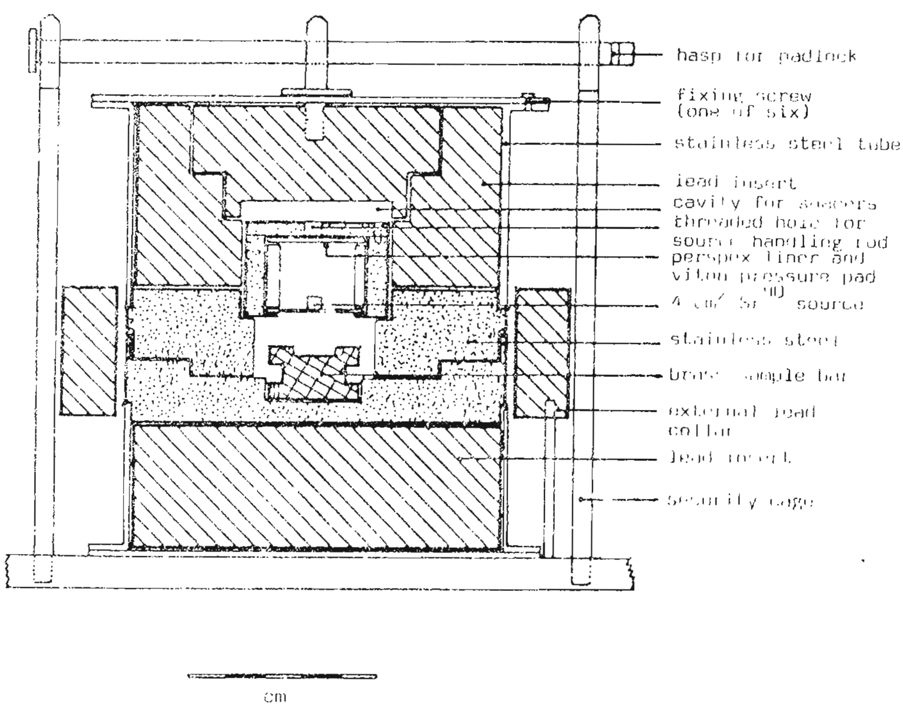

Figure 2: Central cross-section of the source assembly.

The source itself can be loaded and removed on a threaded rod with minimal handling time and a security cage with a padlock prevents unauthorised access to it. Spacer rings can be inserted to alter the source-sample separation.

The sample carrier itself is located by keys on the outside edge of the lower stainless steel section and supported along its track by a series of PTFE rollers whose height is adjusted by shims. A drive cord joins both ends of the carrier to a 12 V reversible d.c. motor mounted underneath the source holder. A series of indexed holes along one edge of the bar are used in conjunction with an optical switch to control the sample position for exposure.

All the central components and the sample carrier were machined to high precision such that the source-sample distance varies by less than 25μm across all 12 positions. Materials in these critical areas were chosen with this in mind and to be self lubricating.

The surface dose rates around the irradiator have been monitored using a calibrated Berthold meter and fall within the 0.75 mR hr^{-1} limit.

Control

A simple, and cost effective controller has been built using a Sinclair ZX Spectrum home computer with an 'Interspec' interface (DCP Microdevelopments Ltd., 2 Station Close, Lingwood, Norwich NR13 4AX) and a CPI ROM card (CML Products, 1 Milton Road, Cambridge, England). The only external electrical components are a 12 V power supply and d.c. motor, a cross-over relay and a Schmidt triggering switch.

The control program is stored in ROM and provides facilities for fixed, incremental exposure sequences accounting for the transit dose to each sample as part of the exposure. A dot matrix printer keeps a permanent log of each exposure which would be particularly useful if an overnight sequence were interrupted by a power cut.

Calibration and Performance

The source has been calibrated using a series of gamma irradiated quartz and CaF_2 samples exposed to an accurately calibrated Co^{60} source at Harwell, and also by intercomparison on two separate occasions with beta sources in the Oxford laboratory. The smallest dose which can be delivered is the transit dose received by a sample passing directly through the irradiation chamber. We have also measured the vertical and lateral fall offs of dose rate from the centre of a sample disc using a similar technique to that described by Bailiff (1980).

These results and the calibrated dose rates to 100 μm quartz grains on 0.25 mm stainless steel discs, with their respective random errors, are tabulated below. We believe that the overall error in the calibration is within ± 5%.

Source-Sample Separation (mm)	Transit Dose/m Gy	Static Dose Rate/m Gy s^{-1}	Vertical Fall off %/mm	Lateral Fall off (at edge of 1 cm disc)
9.75	290 ± 5	32.6 ± 0.4	7%	-3%
14.75	212 ± 4	23.9 ± 0.3	4%	-

Using the SIP type Sr^{90} source most commonly used for TL dating, Bailiff reports a lateral fall off of 10% when comparing dose rates 5 mm off axis and a vertical fall off of some 14% per mm with a source-sample separation of 14.82 mm. The larger area source reported here gives a modest improvement to both parameters.

Conclusions

The larger source has provided an improvement in the beta irradiation geometry compared with our previous sources and with those which we believe are most commonly used elsewehre. The external dose levels around the unit are below the 0.75 mR hr^{-1} level allowing access to non-designated persons. While a linear delivery system is less compact than a turntable design it is easy to machine to high precision and when combined with type of control system described is both cost effective and reliable.

References

I. K. Bailiff (1980) A beta irradiator for use in TL dating, Ancient TL, 10, 12-14.

Acknowledgements

We should like to acknowledge the help of A. McCafferty and R. Cherry (this department) in transferring the control program to read-only-memory, and also to thank Martin Aitken for his help with intercalibration

Reviewed by the Editor.