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IMRP2016

VANCOUVER
BC, CANADA

A wide-angle photograph of a cityscape, likely Vancouver, featuring modern high-rise buildings, a bridge over a body of water, and mountains in the background under a clear blue sky.

A new application for electron beam: Calibration of radiation survey meters

Braking rays of an electron beam allows the calibration of radiation survey meters through large ranges of energy and dose rate without radioactive source.



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Calibration of radiation survey meters

Context

Periodic calibration control consists in measuring the characteristic quantities of an instrument, provided by its **calibration certificate**.

For instruments without permanent control system, the frequency of the periodic calibration control is triennial in France by decree of 21 May 2010.

Periodic calibration control is currently made using a **radioactive source** while we present here an innovative method that use **braking rays** provided by an **electron beam**.



Calibration of radiation survey meters

Context

Calibration source

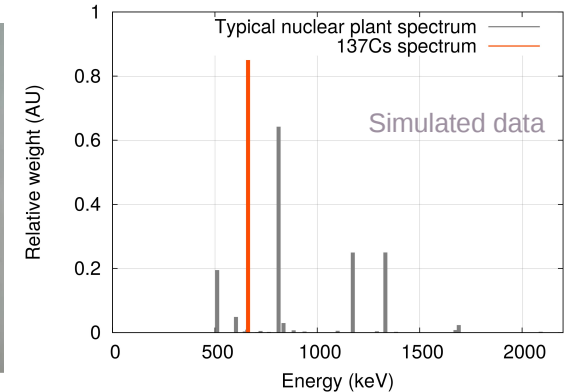
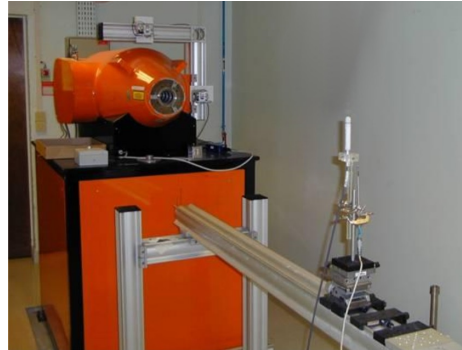
⇒ ^{137}Cs standard

Advantages:

- proven method,
- standard method (ISO-4037),

Disadvantages:

- risk of accidental exposure,
- low productivity,
- narrow energy range.



Calibration of radiation survey meters

Method

Goal:

propose a calibration method to calibrate radiation-meters through large ranges of energy and dose-rate.

Objective:

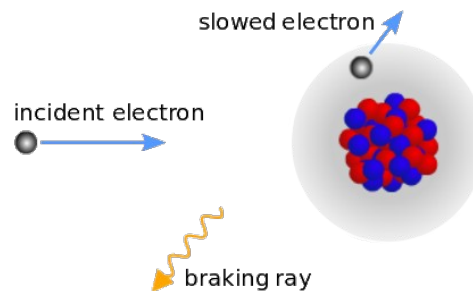
avoid radioactive sources with activities larger than their exemption threshold.

Intended way:

use the bremsstrahlung of electrons accelerated to a few MeV as a calibration source.

Bremsstrahlung:

due to interaction of charged particles in an electric or magnetic field (can be of nuclear type), electron's loose of energy \Rightarrow **production of X or γ rays.**



Calibration of radiation survey meters

Method

Calibration source

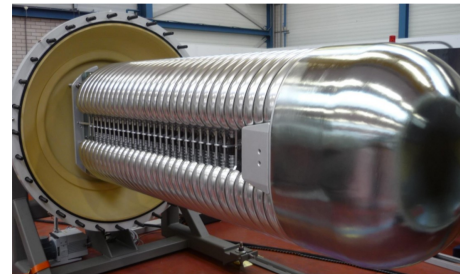
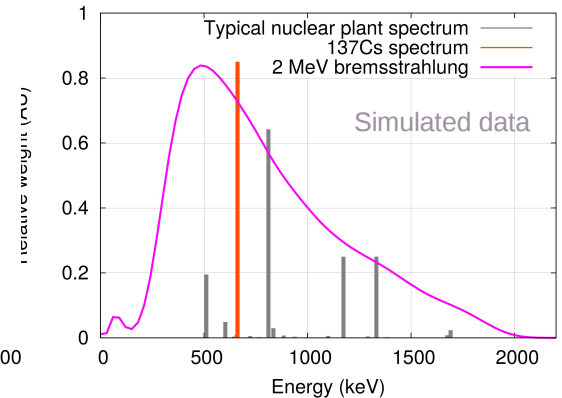
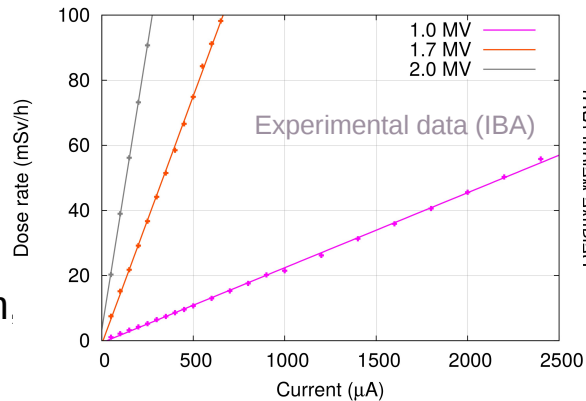
⇒ Bremsstrahlung

Advantages:

- representative energy spectrum,
- dose-rate \propto beam intensity,
- no radioactive source,
- higher productivity.

Challenges:

- stability/reproducibility of the source,
- large dose-rate range (0.1 μ Sv/h – 100 Sv/h),
- homogeneity of the irradiation field,
- automation of the method.



Calibration of radiation survey meters

Method

Calibration of the source:

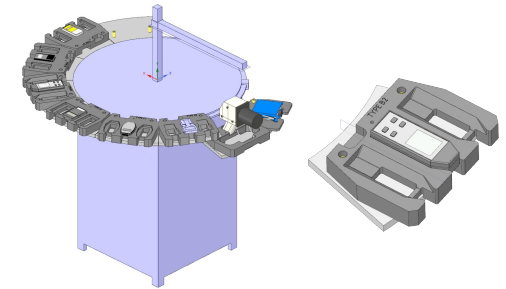
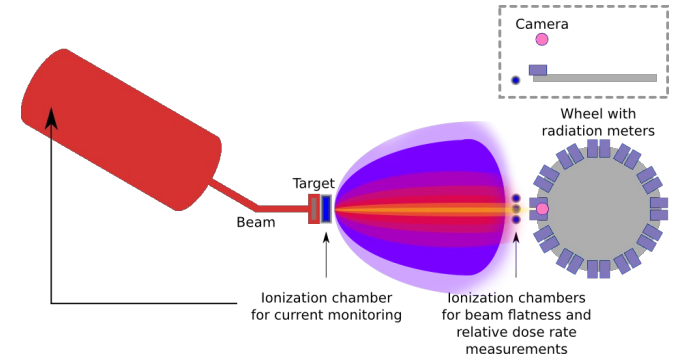
- absolute measurement of Kerma in air,
- **traceability to a primary source** (national standard),
- processed by CEA/LNHB¹.

Transfer ionisation chambers to:

- control homogeneity of the field,
- **measure dose-rate** to be compared to the measurement of radiation-survey meters.

At the carousel:

- camera to read the measurement of radiation-survey meters.



¹ national metrology laboratory in the field of ionizing radiation.



Calibration of radiation survey meters

Conclusion

Thanks to this work, we show that **calibration of radiation survey meters** is possible **without radioactive source**, resulting in a process **safer for workers and environment**.

For this purpose, we use the **bremstrahlung of electrons accelerated to a few MeV** as a calibration source, which presents furthermore a **more representative energy spectrum**.

It is possible to control the source with an accuracy good enough to **reach less than 5% of error** on the calibration result on a **large dose-rate range**, from 0.1 $\mu\text{Sv/h}$ to 100 Sv/h.

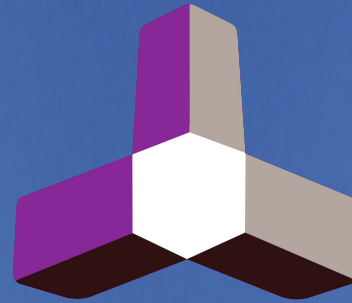
Stability and reproducibility of the method are guaranteed by **automation of the process** (carousel, cameras, transfer ionisation chambers).



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Discussions,
Questions and Answers

Thank you for your
kind attention!



ARION

METROLOGY

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