Individual Monitoring with the RPL Dosimetry System and New Procedures for COVID-19 Protection

Yasuhiro Koguchi

Chiyoda Technol Corporation, Japan

Contents

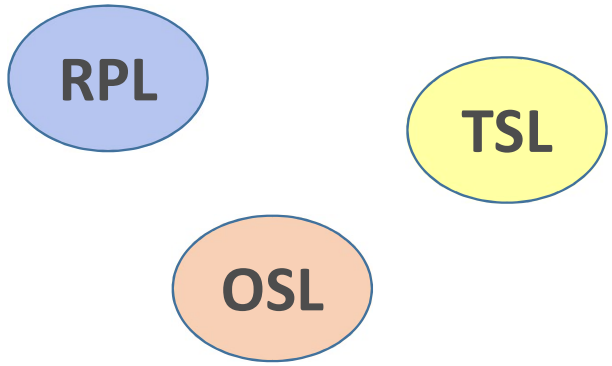
- Individual monitoring with the RPL dosimetry system
  - ✓ Principle of RPL dosimetry
  - ✓ RPL dosemeter
  - ✓ How to evaluate the dose equivalent
  - ✓ Features of RPL dosimetry
  - ✓ Procedure of RPL dosimetry
- New procedure for COVID-19 protection
  - ✓ Our dosimetry service
  - ✓ Our measures

Individual Monitoring with the RPL Dosimetry System

What is RPL ?

Radio-photoluminescence (RPL)

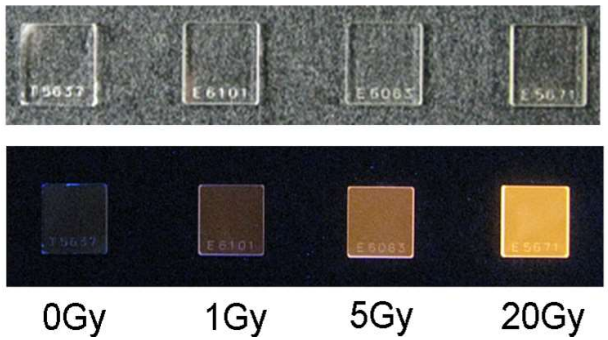
is a luminescence phenomenon.



History:

1921:	Przibram	First report of the RPL phenomenon
1949:	Weyl *et al*,	Discovered an RPL phenomenon in an Ag-activated glass
1951:	Schulman *et al*,	Creation of a new luminescence center
1961:	Yokota *et al*,	Developed a new RPL material
2000:	Chiyoda Technol	Started IMS by using RPL glass

RPL phenomenon

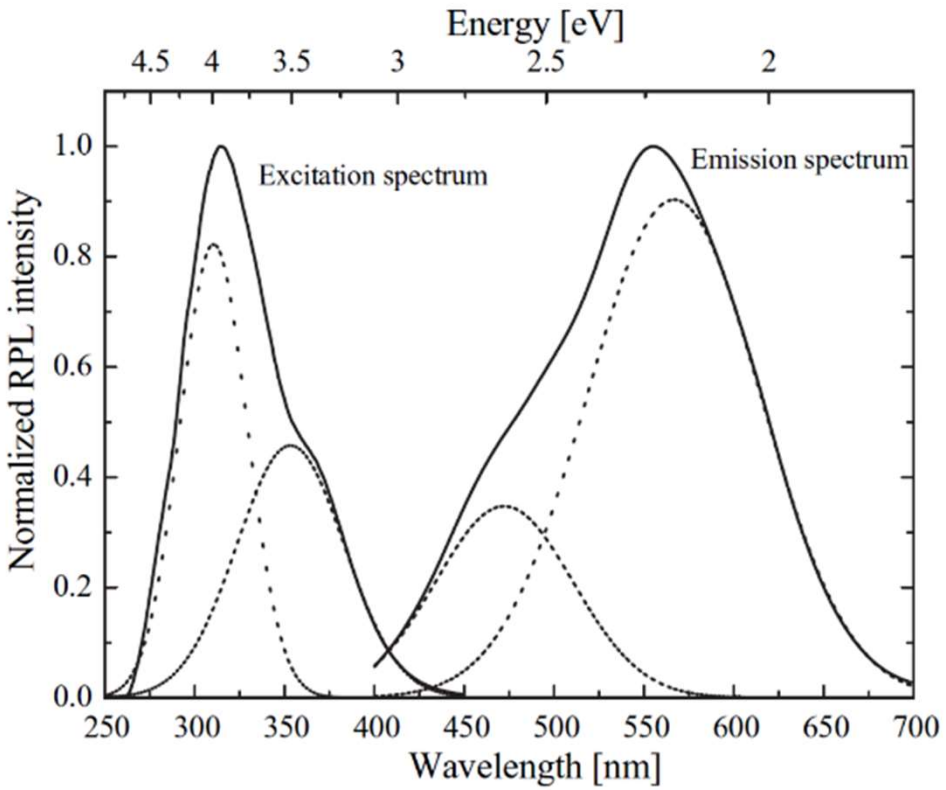


UV: Off

UV: On

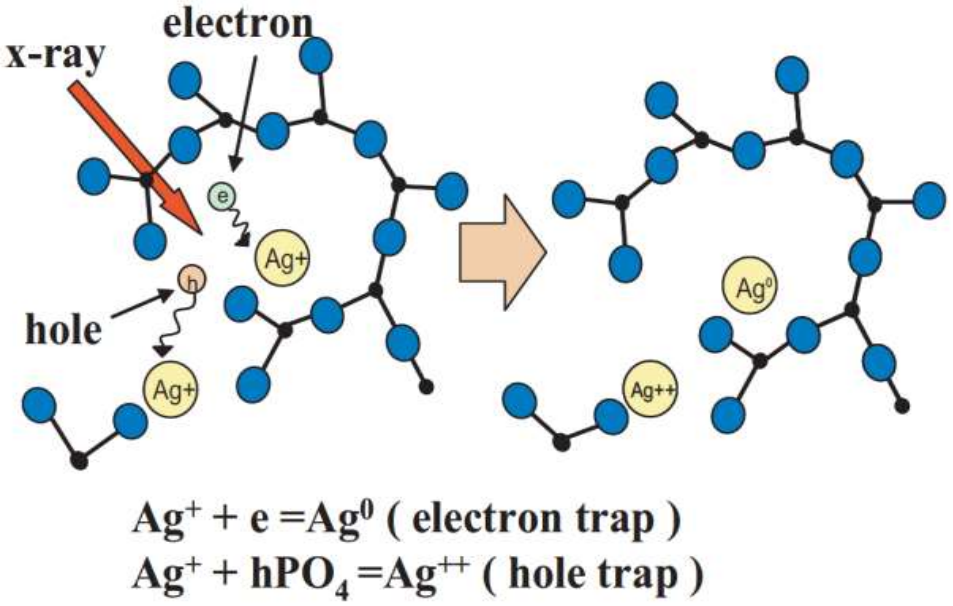
The X-ray induced Ag^{++} color center emits 630 nm luminescence (orange) by UV irradiation.

(Miyamoto *et al*., 2011)



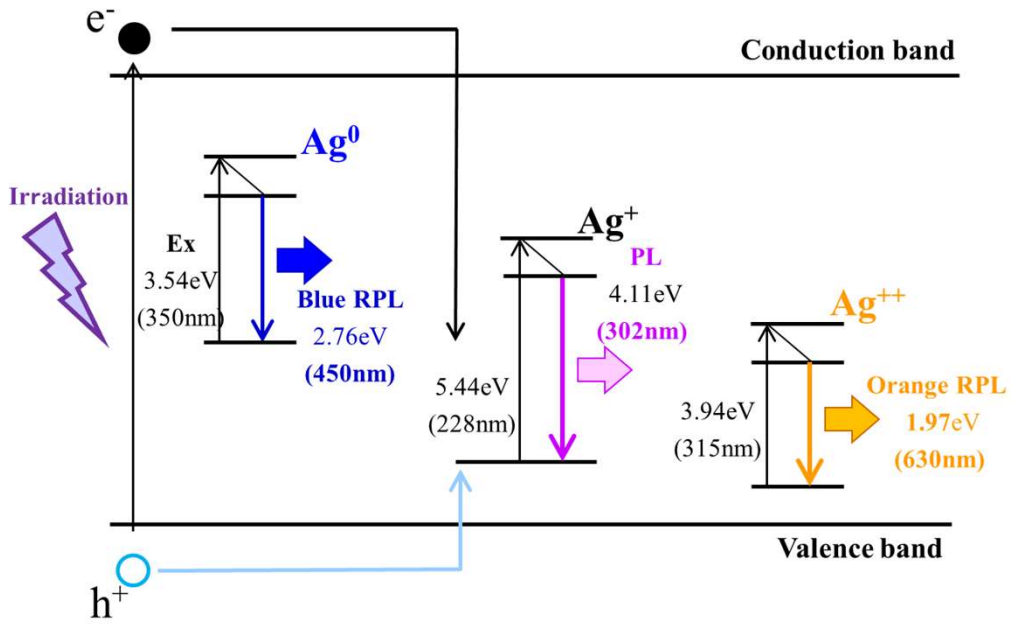
(Miyamoto *et al*., 2008)

Luminescence model of the RPL



(Miyamoto *et al*., 2010)

RPL emission model of Ag+-activated phosphate glass



(Miyamoto *et al*., 2011)

RPL dosemeter（Glass Badge）

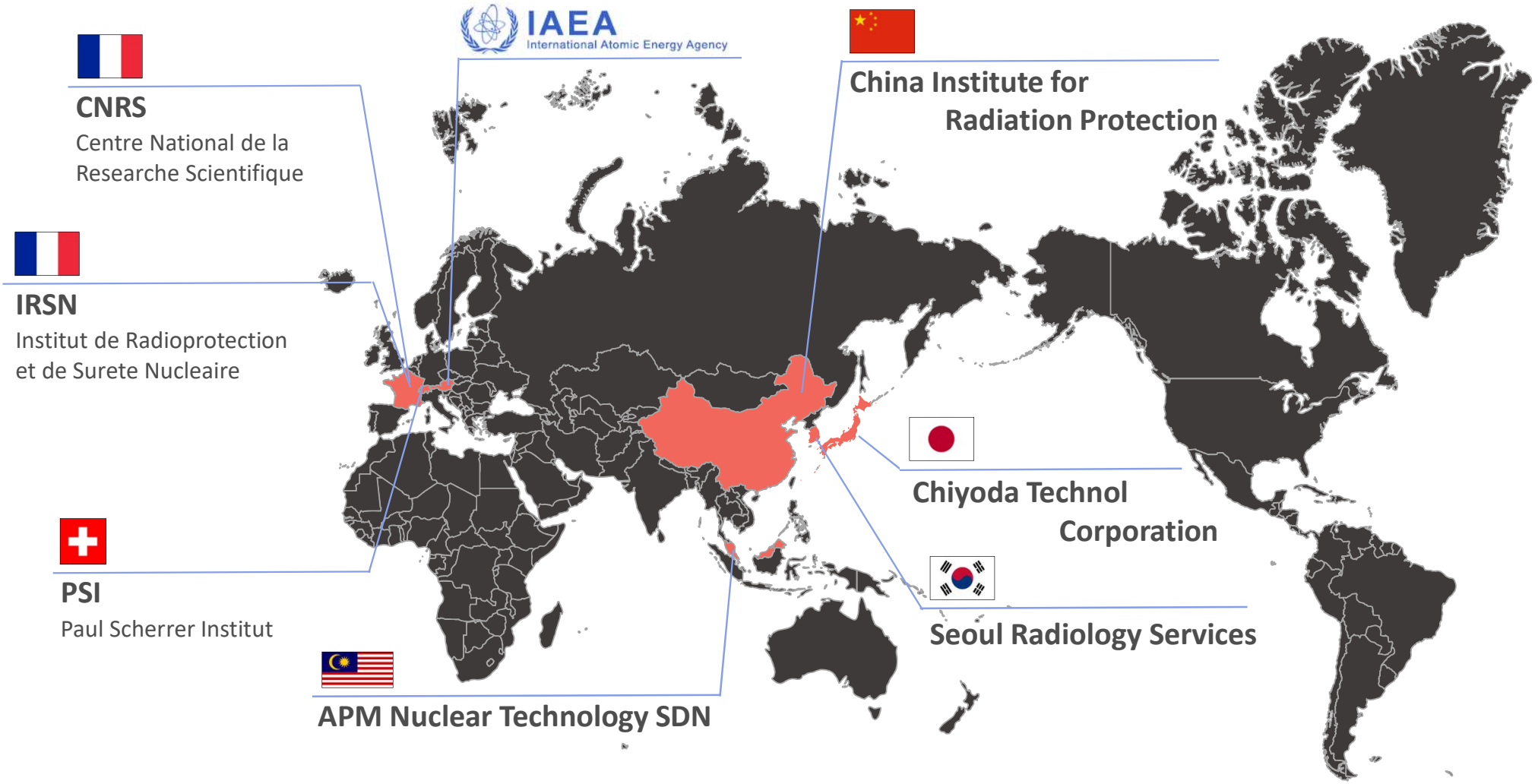
- Radio-photoluminescence (RPL) glass detector
- CR-39 Solid State Track Detector (SSTD)
- Conformity with relative international standards:
  - IEC 62387 (photon & beta radiation) *2G, 3G
  - ISO 21909-1 (neutron) *3G

1st Generation (2000～)

2nd Generation (2007～)

3rd Generation (2013 ～)

RPL dosimetry in the world



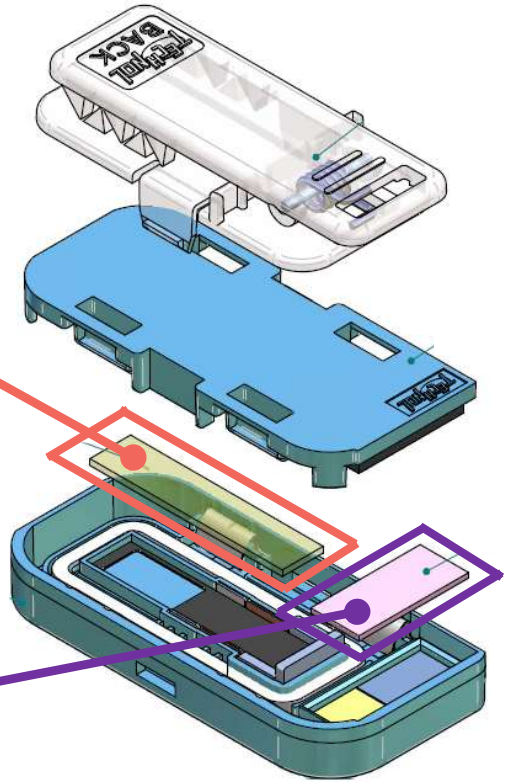
RPL dosemeter（Glass Badge）

RPL glass detector

- Ag+ activated phosphate glass
- Sensitive to photons and beta radiation
- Insensitive to neutrons

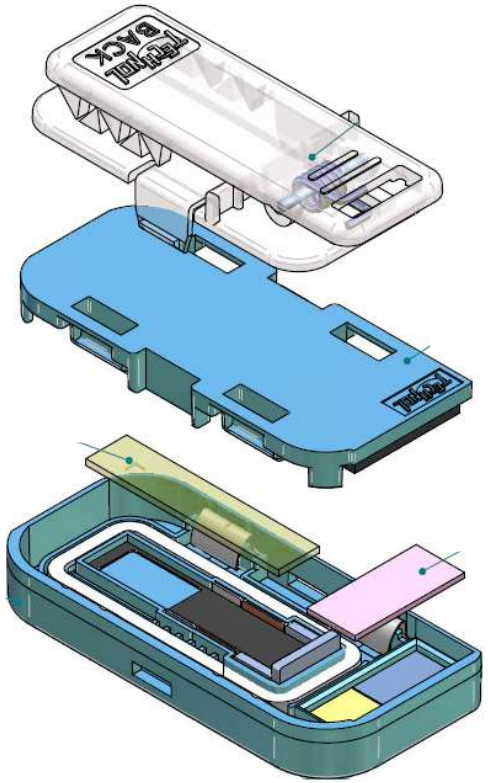
Solid State Track Detector

- Allyl diglycol carbonate plastic (CR-39)
- Sensitive to neutrons via conversion filters
- Insensitive to photons and beta radiation

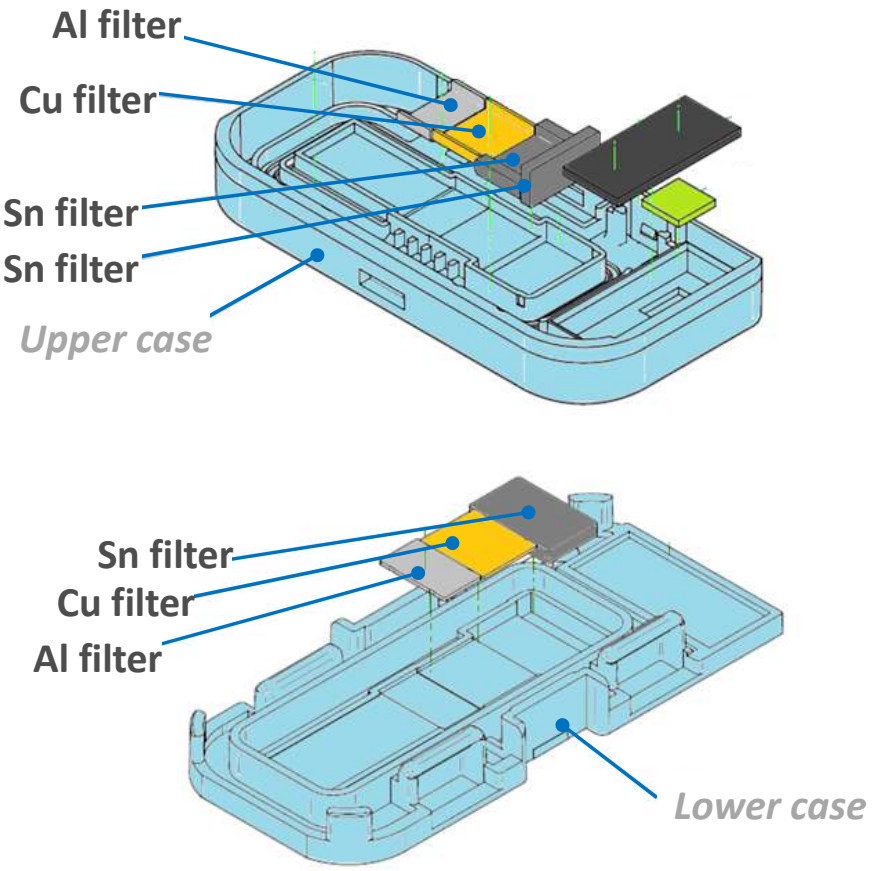


Specifications of the RPL dosemeter

		
Measurement quantities		$H_p(10)$, $H_p(0.07)$ $H^*(10)$
Measurement energy range	photon beta neutron	16 (12) keV～6.4 MeV 0.2 MeV (^{85}Kr) ～0.8 MeV ($^{90}Sr/^{90}Y$) 0.025 eV～15 MeV
Measurement dose range	photon beta neutron (th) neutron (f)	0.1 (0.05) mSv～10 Sv 0.1 mSv～10 Sv 0.1 mSv～8 mSv 0.1 mSv～60 mSv
Compatible standard		**IEC 62387** (photon, beta) **ISO 21909-1**（neutron）



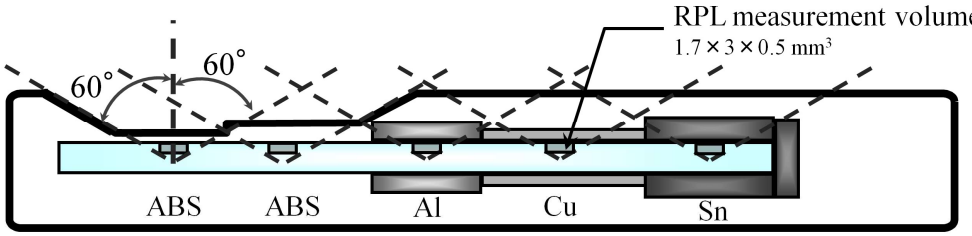
How to measure the dose equivalent



Ag+ activated phosphate glass (RPL glass):

Z_{eff} = 12.4

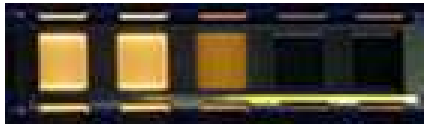
Schematic diagram of the cross section of the dosemeter



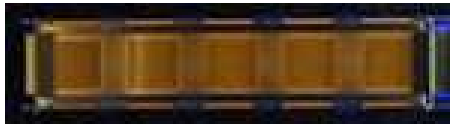
Thickness (mm)	0.05	0.5	0.4	0.3	1.4

(Maki *et al.*, 2015)

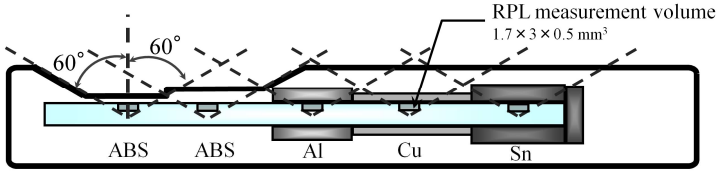
Calculations of the dose equivalent

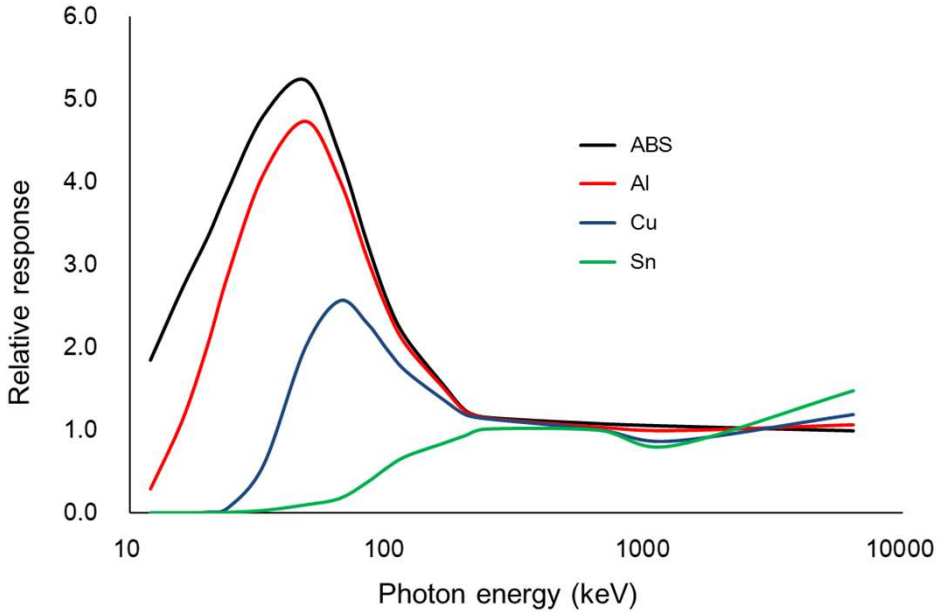


20 keV X-ray



^{60}Co γ-ray





Calculation formula of the dose equivalent:

$$H_p(\mathrm{d}) = \sum_i (NADi \cdot Ri)$$

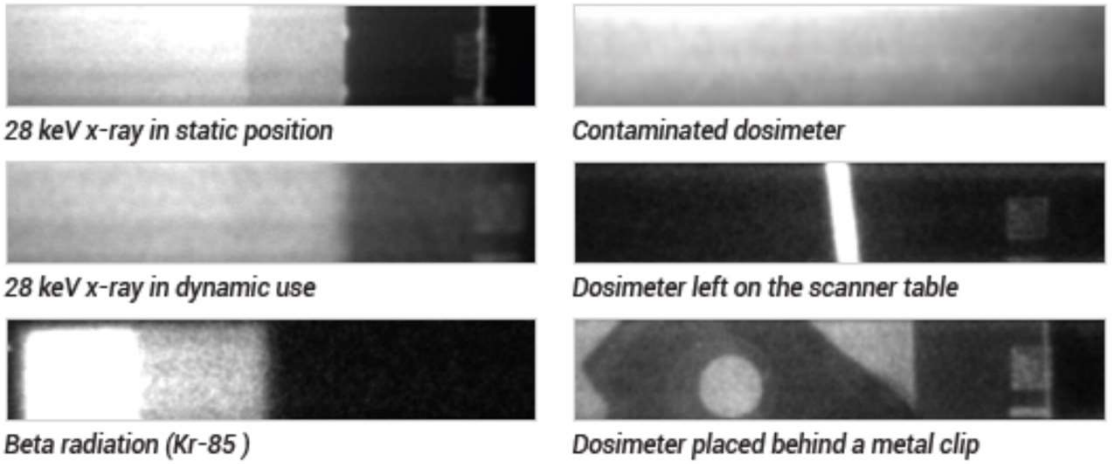
$NADi$: Luminescence intensity of the glass detector under the filter *i* (mGy)

Ri : Constant for each filter *i* (mSv/mGy)

Features of RPL dosimetry

The RPL glass has good characteristics such as:

- Stability of the sensitivity
- Repeatable readout
- Negligible fading effect
- Excellent reproducibility
- Can be imaged



http://dosimetrie.irsn.fr/en-us/Documents/Product%20files/RPL%20EN%20WEB.pdf

Procedure of RPL dosimetry

Wearing the dosemeter

Returned from customer

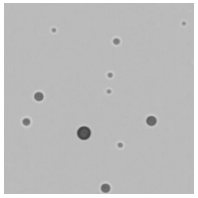
Disassemble dosemeter package (RPL, CR-39)

RPL (photon, beta)

- Pre-heating
- Measurement
- Dose calculation
- Annealing to initialize
- Pre-dose measurement

CR-39 (neutron)

- Etching
- Measurement
- Dose calculation



Dose report

Assemble dosemeter package (RPL, CR-39)

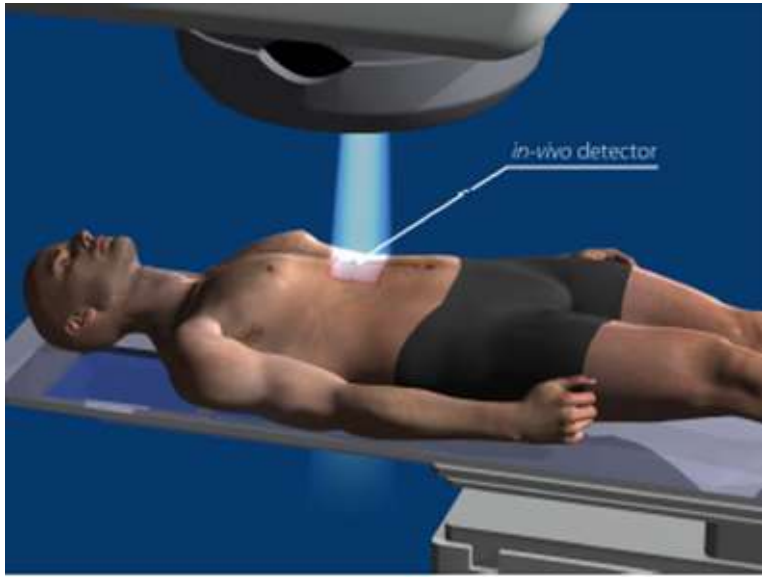
Sent to customer

Other applications

The RPL dosimetry system is used in other applications:

- In-vivo dosimetry for medical
- Postal dose audit service
- Space radiation measurement

Reader Controller PC



New Procedures for COVID-19 Protection

Our Dosimetry Service

- Dosimetry services for:
  - ✓ Medical
  - ✓ Veterinary
  - ✓ Industrial
  - ✓ Research & Education
  - ✓ Nuclear (power plant, fuel production)
  - ✓ Decontamination
  - ✓ Public

- Number of services (dosemeters)
  - ✓ Whole body dosemeters (p/β): 390 000 /month
    (n) : 45 000 /month
  - ✓ Extremity dosemeters : 10 000 /month
  - ✓ Eye lens dosemeters : 200 /month

Our measures

Before pandemic

- Facility cleaning (every working day)
- No shoes in facility
- Flu vaccination

In preparation of the pandemic

- More frequent facility cleaning
- Sterilization of doorknobs, etc.
- Body temperature measurement
- Wearing a mask
- Avoid the “Three Cs”

Special measures and considerations

- Sterilization of envelopes and dosemeters
- Delivery of dosemeters
  - ✓ Customers' self lock-down
  - ✓ Temporary suspension of postal services
- Information provided to customers
- Consideration of BCP
  - ✓ If staff member is infected
  - ✓ Change of measurement period

Summary

- Individual monitoring with the RPL dosimetry system
  - ✓ Principle of RPL dosimetry
  - ✓ RPL dosemeter
  - ✓ How to evaluate the dose equivalent
  - ✓ Features of RPL dosimetry
  - ✓ Procedure of RPL dosimetry
- New procedure for COVID-19 protection
  - ✓ Our dosimetry service
  - ✓ Our measures

Yasuhiro Koguchi
koguchi-y@c-technol.co.jp