

Radiation processing in Serbia - a brief prospect of current situation

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Institute of Nuclear Sciences “Vinča”



The Vinca Institute of Nuclear Sciences is largest scientific institute in Serbia.

It was founded in 1948.

There are about 800 employees, half of them are researchers, 250 with a PhD degree.

There are 19 departments in Institute:
- of physics, atomic physics, radioisotops, molecular biology, radiation chemistry and physics...

Radiation processing facilities in Republic of Serbia

Just one radiation processing unit – gamma radiation facility
at Institute of Nuclear Sciences “Vinca”

It has operated since 1978.

The facility core is cobalt-60 gamma irradiator with wet storage working in batch mode.

Services are mainly provided for industry (sterilization of medical products, irradiation of food), and for scientific research in Institute.

Current activity of source is around 120 kCi.

Facility is designed for the maximum value of 1 MCi.

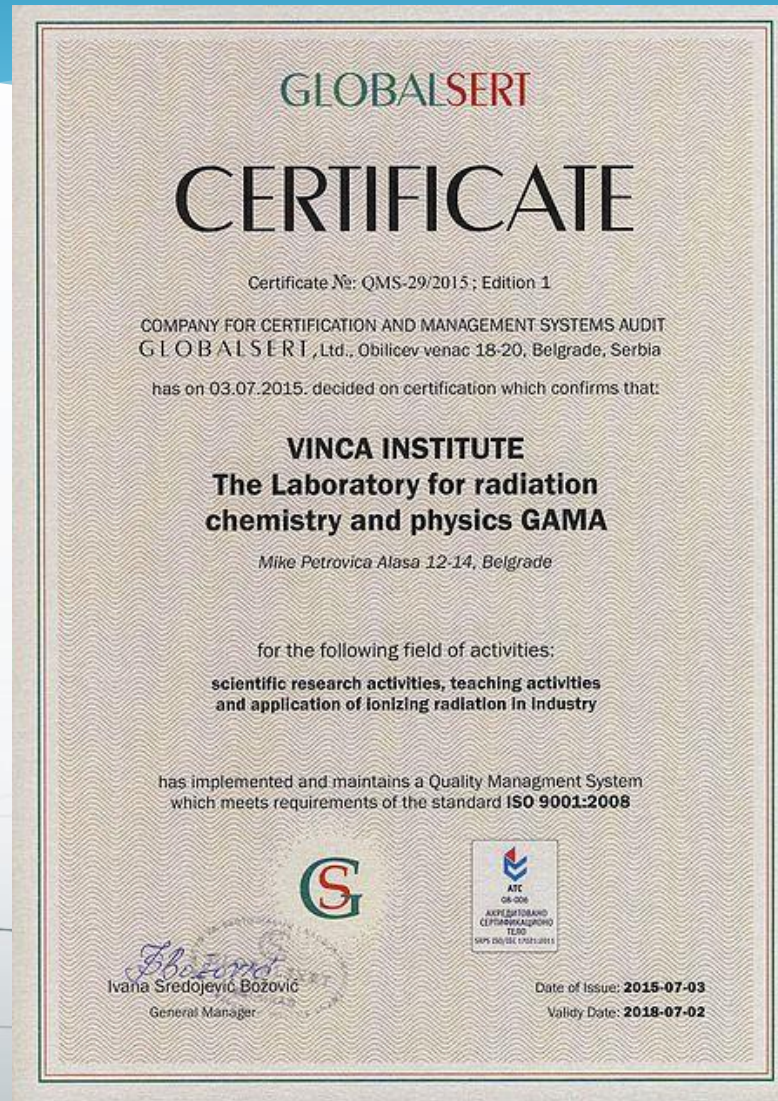
Gamma radiation facility



Certification of services

- * In June 2015 we implemented ISO 9001:2008 for Quality management system.
- * Goal: Implementation ISO 13485 (Medical devices), ISO 11137 (Sterilization of health care products).
- * Preparing documentation is in progress.

ISO 9001:2008



Research program and capacities

- Laboratory of radiation chemistry and physics Gamma supports research related to radiation processing and dosimetry.
- There are about 40 researchers in laboratory (20 with PhD) .
- Scientific programs are mainly related to materials, radiation effects in materials and detection of radiations (scintillators and dosimetry research).

Dosimetry systems used at irradiation facility

- * Dosimetry system in routine use at irradiation facility:
Ethanol-monochlorobenzene (ECB) dosimeter
- * Dosimetry system used for measure low doses :
Fricke dosimeter solution
- * Recent plans are related to alanine EPR dosimetry

Ethanol-monochlorobenzene (ECB) dosimeter

- * Measurement of absorbed dose using the ECB dosimetry system is carried out in accordance with:
- * **ISO/ASTM 51538:2009**
- * Procedure for use the ECB dosimetry system

Ethanol-monochlorobenzene (ECB) dosimeter

- * Based on a process of radiolytic formation of hydrochloric acid (HCl) in aqueous ethanolic solutions of chlorobenzene by ionizing radiation
- * The absorbed dose that is measured is the dose absorbed in the dosimeter. Absorbed dose in other materials irradiated under equivalent conditions may be calculated

Ethanol-monochlorobenzene (ECB) dosimeter

- * Dosimeter solutions may contain any concentration of monochlorobenzene. We use dosimeter solution with a 24% chlorobenzene in ethanol.



Measuring equipment for ECB

Measurement is performed using the instrument OK-302/2 type oscillogrator of Radelkis (Budapest, Hungary).

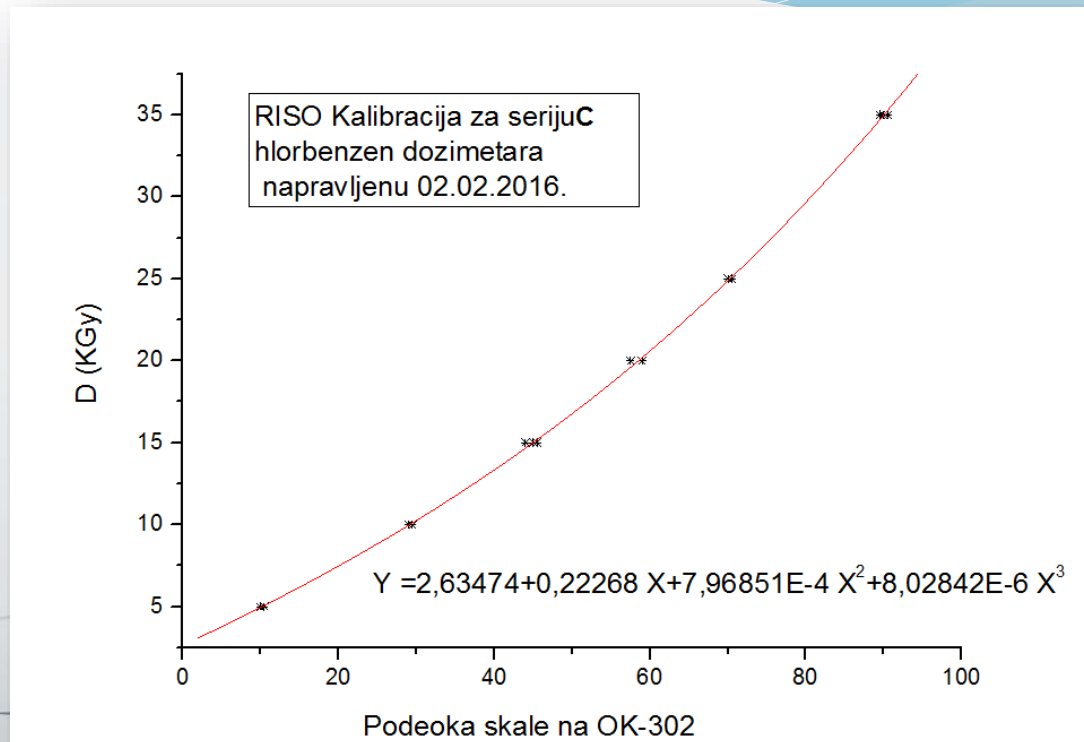
The oscillogrator consists of the reader including controls and the oscillator, which is built together with the ampoule holder.

Ampoules are placed in a holder and value is read on the scale.



Calibration curve

Absorbed dose is determined through measurement results and calibration curve.



X-axis: measured value of units; Y-axis: absorbed dose

Traceability

- * Calibration curve is based on the values obtained from reference laboratory Risø High Dose Reference Laboratory (Denmark).
- * For each lot of ampoules we sent 18 non-irradiated ampoules in a laboratory Risø for calibration.
- * In the laboratory Risø, the ampoules are irradiated to required doses, 5 kGy, 10 kGy, 15kGy, 20 kGy, 25 kGy and 35 kGy (three ampoule for each dose).
- * These doses are used for forming a calibration curve and for the traceability with the Reference Laboratory

Irradiation Certificate



DTU Nutech



CAL Reg. nr. 266

HDRL

High Dose Reference Laboratory
DTU Nutech
Technical University of Denmark
DK 4000 Roskilde
Denmark

Tel +45 4677 4224
Fax +45 4677 4959
e-mail armig@dtu.dk

Riso High Dose Reference Laboratory is
accredited by *DANAK - Danish Accreditation*

Irradiation Certificate

Certificate no.: 16C-19

Irradiation of samples by cobalt-60 gamma irradiation
according to instruction HDRL-I-02

Customer: Vinca Institute of Nuclear Sciences
Laboratory Gamma
Mike Petrovica Alasa 12 – 14, Vinca
11001 Belgrade
Serbia

Order no/ref: Slobodan Masic

File 16C-19 Vinca ECB
Date 2016.02.23

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Signature

Arne Miller
Head of Riso HDRL



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Dosimeter data:

Dosimeters: ECB dosimeters in ampoules
Batch number
Requested doses: 5, 10, 15, 20, 25, 35 kGy
Number of ECB dosimeters per dose: 3

Irradiation data:

Irradiation facility: Cobalt-60 gamma cell 3
Latest calibration: 2016.01.-
Method: Reference transfer dosimeters
Reference lab.: National Physical Laboratory, UK
Irradiation geometry: In standard Riso HDRL dosimeter holder
4 pellets per holder
Irradiation temp: 25°C
Environment:
Temperature: 19°C
Relative humidity: 23 %

Irradiation Certificate



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Nominal doses and irradiation times:

Requested dose kGy	Given dose kGy	Number of dosimeters	Total Irradiation time	Dates of irradiation
5	5	3	2111 s	2016.02.23
10	10	3	4226 s	2016.02.23
15	15	3	6342 s	2016.02.23
20	20	3	8457 s	2016.02.23
25	25	3	176.2 m	2016.02.22
35	35	3	246.7 m	2016.02.22

All doses are specified as dose to water.

Uncertainty of the nominal dose

at $k = 2$: Non-random: 2.6%
 Random: 2.2% Combined: 3.4%

The reported expanded uncertainty is given as the standard uncertainty multiplied with the coverage factor $k=2$ so that the coverage probability is approximately 95%

The nominal dose is defined as the dose given in the reference geometry (see HDRL Quality Manual). The dose to the dosimeter may be different from the nominal dose if other geometries are used. The value of the nominal dose is traceable to the National Physical Laboratory, UK.

Dosimeters received at Riso: 2016.02.12
Date of shipment to Vinca: 2016.02.24
Shipped by: Courier



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HDRL Procedures and Instructions:

HDRL-1-02a Irradiation of dosimeters at the Riso Cobalt-60 gamma cell 3.

DANAK, Danish Accreditation has been assessed by EA, European cooperation for Accreditation, and DANAK is one of the signatories of the EA multilateral agreements on the equivalence of calibration certificates and test reports issued by accredited laboratories.

Certificates and tests reports issued by laboratories accredited by these organizations adhere to the International Standard

EN ISO/IEC 17025: *General requirements for the competence of testing and calibration laboratories.*

The work described in this report has been carried out according to the General Provisions for Commissioned work of Riso National Laboratory.

The data in this report relates only to the items tested.

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Fricke dosimeter solution

- * Measurement of absorbed dose using the Fricke dosimetry system is carried out in accordance with:
- * **ISO/ASTM 51026:2015**
- * Procedure for the use of the Fricke dosimetry system

Fricke dosimeter solution

- * The chemical species of interest is the production of Ferric ions (Fe^{3+}) from Ferrous ions (Fe^{2+}).
- * The Ferrous ions are in solution.
- * The maximum absorbed dose that can be measured is about 400 Gy.
- * We use Fricke very rarely because we mainly use high doses both for research purposes and for sterilization and conservation.

Fricke dosimeter solution



Measuring equipment for Fricke solution

- * **UV-VIS: Thermo Scientific Evolution 600 Uv-Vis Spectrophotometer**



Alanine/EPR dosimeter system

- * Recent plans are related to alanine dosimetry.
- * We have acquired EPR.
- * Goal: to install equipment; train personal and produce protocols for measurment.

EPR Spectrometer

- * EPR Spectrometer MiniScope 300, Magnettech, Berlin, Germany





THANK YOU!