# CALIBRATION SOURCES FOR NUCLEAR MEDICINE MANUFACTURING AND R&D

RITVERC

Isotopenprodukte

www.ritverc.com

info@ritverc.com

+7 812 297-44-63

+7 812 297-22-69

+7 812 591-68-68

$^{60}Co$ $^{137}Cs$ $^{65}Zn$ $^{133}Ba$ $^{90}Y$ $^{109}Cd$ $^{124}I$ $^{125m}Te$ $^{139}Ce$ $^{22}Na$ $^{147}$

$^{109}Cd$ $^{124}I$ $^{125m}Te$ $^{139}Ce$ $^{22}Na$ $^{147}Pm$ $^{151}Sm$ $^{88}Y$ $^{154}Eu$ $^{153}$

RITVERC was founded in 1993 by experts in manufacturing and application of radioactive isotopes.

The main areas of activity are:

- R&D in the field of applied radiochemistry, new radioisotope products designs and solutions;
- producing cyclotron and reactor radionuclides;
- preparation of high-purity radionuclide materials;
- manufacturing of sealed radionuclide sources for various application;
- development and production of transport shielding containers;
- transportation of Class 7 dangerous goods;

The quality management system in RITVERC JSC meets the requirements of the international standard ISO 9001:2015.

# CONTENT

# SOURCES FOR MOLECULAR VISUALIZATION

## Calibration sources for PET-CT

RITVERC produces specialized sources for calibration of Positron Emission Tomography (PET) scanners. The sources are designed for General Electric Healthcare, Siemens Healthineers, Phillips Medical Systems equipment.

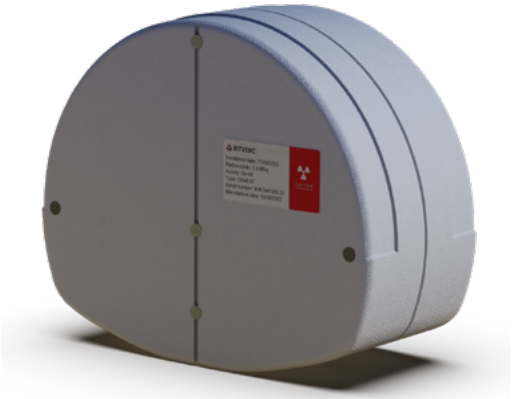
RITVERC is ready for coopertions on development of new sources. Please, contact our sales department for quotations.

## Volume phantom

Ge-68 Cylindrical phantoms are used for 2D and 3D normalization and in test images of PET and PET-CT systems. Radioactive element is uniformly filled in the cylindrical cast.

## Linear Sources (Pin)

Ge-68 and Na-22 line sources are tubes made of high quality stainless steel. Each line source is sealed on its ends by the process of precise laser welding and tested for activity and uniformity.



## VQC phantom

The VQC phantom is used for the primary installation of GE PET-CT scanners. The source consists of several spherical active parts fixed in the volume of the phantom.


## Multimodal source

A point active is sealed in a plastic capsule with CT-visible elements. They are used to check the alignment of PET and CT subsystems.

# Application Guide

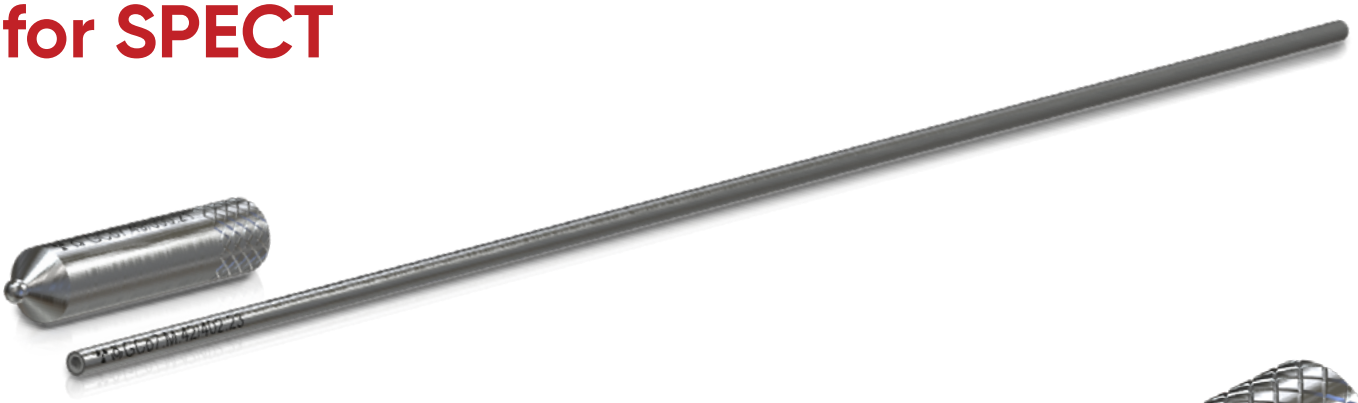
| System manufacturer | System model | Source type | Source model | Activity | | Qty | RRC, mo | RWL, mo |
|---|---|---|---|---|---|---|---|---|
| | | | | mCi | MBq | | | |
| Ge HealthCare | Discovery ST&STE PET/CT | Pin | GGe8.52.3 | 1,49 | 55,1 | 1 | 12 | 18 |
| | Discovery 690/690 ELITE | Pin | GGe8.52.2 | 0,50 | 18,5 | 1 | 12 | 18 |
| | | Phantom | GGe8.57 | 0,10 | 3,5 | 1 | 12 | 18 |
| | Discovery 600 | Pin | GGe8.52.1 | 0,27 | 10,0 | 1 | 12 | 18 |
| | | Phantom | GGe8.57 | 0,10 | 3,5 | 1 | 12 | 18 |
| | Discovery 710/710 ELITE | Pin | GGe8.52.2 | 0,50 | 18,5 | 1 | 12 | 18 |
| | | Phantom | GGe8.57 | 0,10 | 3,5 | 1 | 12 | 18 |
| | Discover IQ | Phantom | GGe8.50 | 1,50 | 55,5 | 1 | 12 | 18 |
| | | Phantom | GGe8.57 | 0,10 | 3,5 | 1 | 12 | 18 |
| Siemens Healthineers | ECAT ACCEL & HR | Pin | GGe8.61 | 5,00 | 185,0 | 3 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 3,30 | 122,1 | 1 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 1,19 | 44,0 | 1 | 12 | 18 |
| | | Pin | GGe8.61 | 1,00 | 37,0 | 1 | 12 | 18 |
| | ECAT EXACT HR+ | Pin | GGe8.61 | 4,00 | 148,0 | 3 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 3,30 | 122,1 | 1 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 1,20 | 44,4 | 1 | 12 | 18 |
| | | Pin | GGe8.61 | 1,0 | 37,0 | 1 | 12 | 18 |
| | ECAT EXACT 47 | Pin | GGe8.61 | 3,00 | 111,0 | 3 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 3,30 | 122,1 | 1 | 12 | 18 |
| | ECAT ART | Pin | GGe8.61 | 1,00 | 37,0 | 1 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 1,20 | 44,4 | 1 | 12 | 18 |
| | Biograph NonPico | Pin | GGe8.61 | 1,00 | 37,0 | 2 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 1,20 | 44,4 | 1 | 12 | 18 |
| | Biograph Pico | Pin | GGe8.61 | 1,00 | 37,0 | 2 | 12 | 18 |
| | | Phantom | GGe8.60.1 | 2,00 | 74,0 | 1 | 12 | 18 |
| | Biograph True V & MCT | Pin | GGe8.61 | 1,00 | 37,0 | 2 | 12 | 18 |
| | | Pin | GGe8.61 | 1,25 | 46,3 | 2 | 12 | 18 |
| | | Phantom | GGe8.60.2 | 2,00 | 74,0 | 1 | 12 | 18 |
| | | Phantom | GGe8.60.2 | 2,50 | 92,5 | 1 | 12 | 18 |
| | Biograph mMR | Pin | GGe8.61 | 1,50 | 55,5 | 2 | 12 | 18 |
| | | Phantom | GGe8.60.3 | 3,00 | 111,0 | 1 | 12 | 18 |
| Philips Healthcare | Gemini | Pin | GNa2.29 | 0,10 | 3,7 | 1 | 24 | 24 |
| | TF | Spot Marker | GNa2.28 | 0,01 | 0,37 | 6 | 24 | 24 |
| | GXL | Spot Marker | GNa2.28 | 0,01 | 0,37 | 6 | 24 | 24 |

Qty – System requires quantity

RRC – Recommended Replacement Cycle

RWL – Recommended Working Life

# Calibration sources for SPECT



RITVERC manufactures a wide range of sources for Single Photon Emission Computed Tomography (SPECT) studies. The nuclides, activities and dimensions are manufactured in accordance to OEM Systems manufacturer specifications. RITVERC can manufacture SPECT sources for custom needs too. Please, contact RITVERC sales department for product availability and additional information.


## Application Guide

| System manufacturer | Radionuclide | Product code | Activity | | Qty | RRC, mo | RWL, mo |
|---|---|---|---|---|---|---|---|
| | | | mCi | MBq | | | |
| Siemens Healthineers | Co-57 | GCo7.49 | 3,15 | 117,3 | 1 | 12 | 18 |
| | Sn-113 | GSn3.49 | 3,00 | 111 | 1 | 12 | 18 |
| | Se-75 | GSe5.49 | 4,25 | 259,0 | 1 | 12 | 18 |
| Spectrum dynamics medical | Co-57 | GCo7.42 | 12,00 | 420,0 | 1 | 12 | 18 |

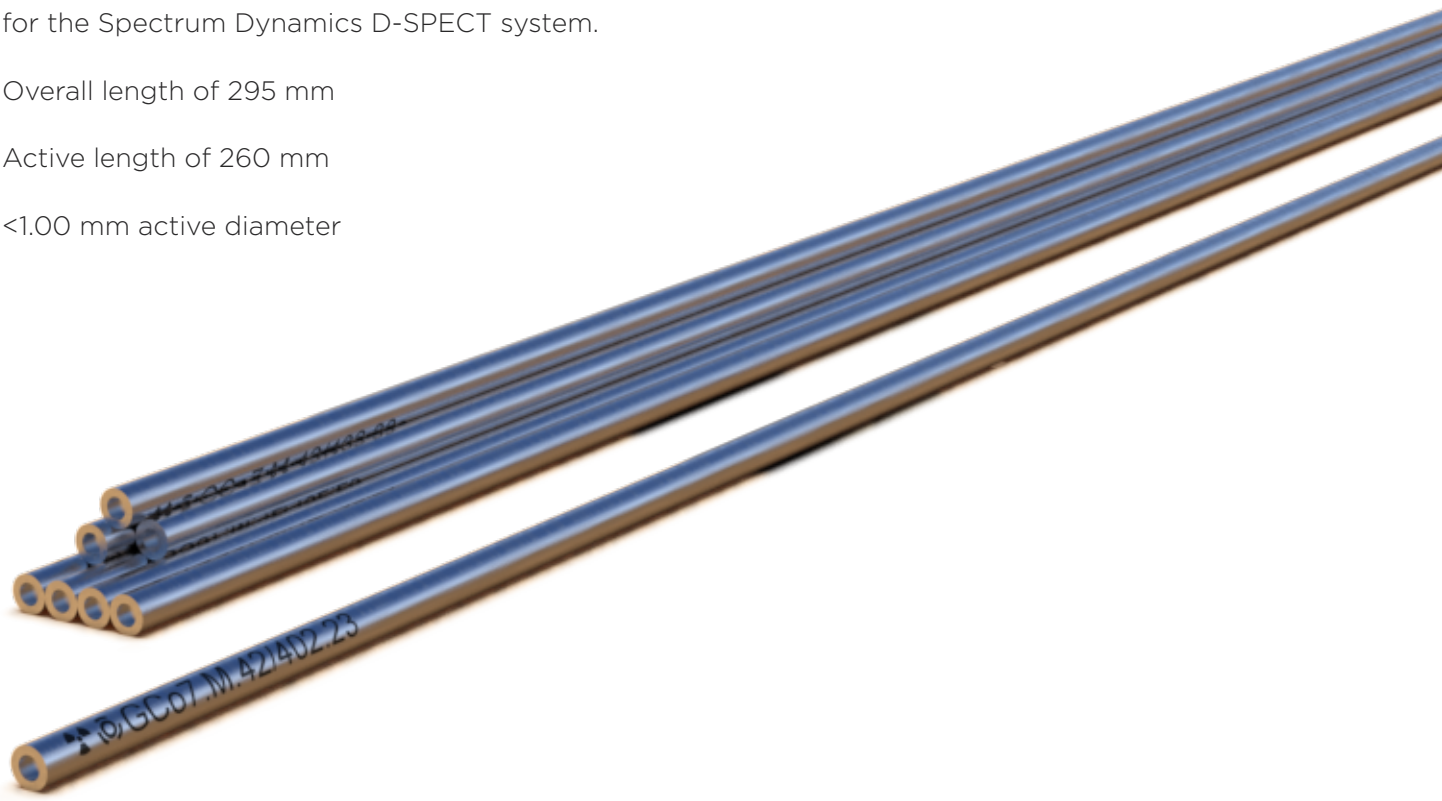
Qty – System requires quantity

RRC – Recommended Replacement Cycle

RWL – Recommended Working Life

## Spectrum Dynamics
## D-SPECT calibration source

- Co-57 line source designed specifically for the Spectrum Dynamics D-SPECT system.
- Overall length of 295 mm
- Active length of 260 mm
- <1.00 mm active diameter



## SIEMENS xSPECT
## Quant Calibration Source

- Stainless steel sealed, Co-57 (Sn-113, Se-75 on request)
- QUANT source designed specifically for the Siemens xSPECT systems.
- Overall length of 45,4 mm
- Active length of 1 mm
- 1.00 mm active diameter
- Activity calibration uncertainty ±3% (0.95)

# Multimodal source


RITVERC offers a range of Multimodal Sources for hybrid PET-CT and SPECT-CT imaging. The nuclides, activities and dimensions are manufactured in accordance to OEM Systems manufacturer specifications.

RITVERC can manufacture multimodal sources for custom needs too. Please contact RITVERC Customer Service for product availability and additional information.

These sources can be used as fiducial markers to improve image coregistration in sequential scans with standalone scanners of different modalities, or for anatomical or position marking with visibility in both images of a hybrid scanner. CT targets in the clinical sources are designed to mimic cortical bone density with 120 kVp x-rays.

## GNa2.M03.64

- Capsule:
  1" x 0.25" (D x H)
  clear cast acrylic with etched crosshairs for laser alignment
- Active dimensions:
  1mm diameter sphere
- CT target:
  2mm OD bone-equivalent ring (surrounds active element)
- Suggested use:
  Multimodal fiducial marker for clinical image coregistration.

## GNa2.M02.63

- Capsule:
  1" x 0.25" (D x H)
  clear cast acrylic
- Active dimensions:
  1.5mm x 1.5mm cylinder
- CT target:
  1/4" OD bone-equivalent ring (surrounds active element)
- Suggested use:
  Multimodal fiducial marker for clinical image coregistration

## GNa2.M09.62

- Capsule:
  1 x 1 x 1 cm cast acrylic cube
- Active dimensions:
  0.25mm sphere centered in capsule
- Suggested use:
  NEMA NU4 resolution testing


Pm $^{151}$Sm $^{88}$Y $^{154}$Eu $^{153}$Gd $^{169}$Y
Gd $^{169}$Yb $^{177}$Lu $^{192}$Ir $^{85}$Kr $^{207}$Bi

# Marker pencil source

## Design

The GCo7.11 source is fixed in an aluminum alloy holder. The holder is made collapsible for easy storage and transportation.

## The active part

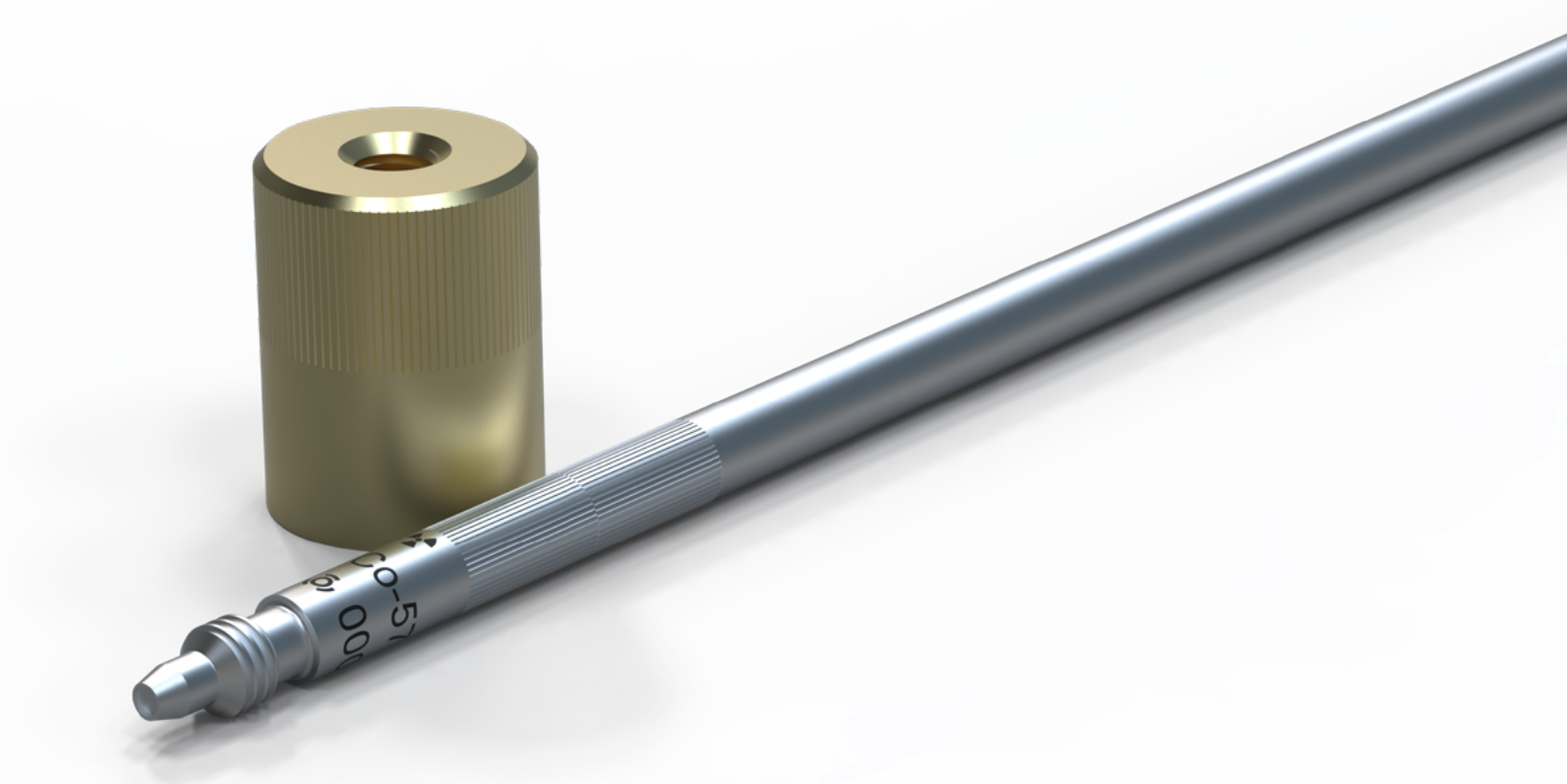
Cylinder 2.1 mm x 1.2 mm

## Activity

3,7-370 MBq of Co-57 (determined by the customer, based on the sensitivity of the camera and the collimator used.

## Application

Highlighting points or areas during SPECT-CT scans.



# SOURCES FOR CALIBRATION MEASURING EQUIPMENT

## DOSE CALIBRATOR CHECK SOURCES (DCGS)

The sources are manufactured in 2 standard sizes, corresponding to 10 ml (type 2) and 20 ml (type 1).

A radionuclide preparation with precisely measured activity is homogeneously distributed in the volume of epoxy resin. The bottle is sealed with epoxy resin. The resin is colored according to the introduced radionuclide.

DCGS can be supplied either as control sources with uncertainty of measured result of ±5% or as reference sources with uncertainty of measuring result ±3% (0.95), with certification done by D.I. Mendeleev Institute if metrology (VNIIM), CIPM MRA participant.

Sources are used to check the daily stability of dose calibrators in in accordance with the recommendations of IEC 61303:1994/ COR1:2016


## DCGS type 1

| Radionuclide | Activity | | Color code | Source code |
|---|---|---|---|---|
| | mCi | MBq | | |
| Na-22 | 0,05 – 0,2 | 1,85 – 7,4 | Yellow | RNa2.1 |
| Co-57 | 5 – 10 | 185 – 370 | Red | RCo7.1 |
| Co-60 | 0,05 – 0,2 | 1,85 – 7,4 | Blue | RCo0.1 |
| Ba-133 | 0,05 – 0,25 | 1,85 – 9,25 | Black | RBa3.1 |
| Cs-137 | 0,1 – 0,25 | 3,7 – 9,25 | Green | RCs7.1 |

## DCGS type 2

| Radionuclide | Activity | | Color code | Source code |
|---|---|---|---|---|
| | mCi | MBq | | |
| Co-57 | 5 – 10 | 185 – 370 | Blue | RCo7.2 |
| Co-60 | 0,05 – 0,2 | 1,85 – 7,4 | Green | RCo0.2 |
| Ba-133 | 0,05 – 0,25 | 1,85 – 9,25 | Brown | RBa3.2 |
| Cs-137 | 0,1 – 0,25 | 3,7 – 9,25 | Yellow | RCs7.2 |

# Reference point gamma sources (OSGI)

## OSGI-RT

OSGI-RT sources are designed for verification and calibration of semiconductor and scintillation spectrometers and radiometers, ionizing chambers, etc. by energy and activity.

The source is a flat aluminum ring with a diameter of 25 mm (29 mm on request) and a thickness of 3 mm. The active part of the source is thermally sealed between two polyimide films with a total thickness of 100 ± 10 microns. The diameter of the active part is within 3 mm.

Custom multinuclide sources can be produced on request.

In this source design are available following levels of metrology certification: control sources without certification with an uncertainty on activity ± 7% (0.95) certified on activity with an uncertainty of ± 3% (0.95) or certified on activity with a standard deviation ± 1,5-2% (0,95). Certification is done by D.I. Mendeleev Institute of metrology (VNIIM), CIPM MRA participant.

## OSGI-RT specification

| Radionuclide | Nominal activity, kBq | Uncerntainty, % (0.95) | Nominal activity, kBq | Standard deviation, % (0.95) |
|---|---|---|---|---|
| Na-22 | 1 – 1000 | 3 | - | - |
| Ti-44 | 1 – 300 | 3 | - | - |
| Mn-54 | 1 – 1000 | 3 | 50 | 1,5 |
| Fe-55 | 1 – 1000 | 3 | - | - |
| Co-57 | 1 – 1000 | 3 | - | - |
| Co-60 | 1 – 500 | 3 | 50 | 1,5 |
| Zn-65 | 1 – 1000 | 3 | - | - |
| Y-88 | 1 – 1000 | 3 | 80 | 1,5 |
| Cd-109 | 1 – 1000 | 3 | - | - |
| Sn-113 | 1 – 500 | 3 | - | - |
| Ba-133 | 1 – 1000 | 3 | 50 | 1,5 |
| Cs-134 | 1 – 300 | 3 | - | - |
| Cs-137 | 1 – 1000 | 3 | 50 | 1,5 |
| Ce-139 | 1 – 1000 | 3 | - | - |
| Eu-152 | 1 – 1000 | 3 | 50 | 1,5 |
| Bi-207 | 1 – 100 | 3 | - | - |
| Th-228 | 1 – 100 | 3 | 50 | 2 |
| Am-241 | 1 – 300 | 3 | 50 | 2 |
| Am-243 | 1 – 50 | 3 | - | - |

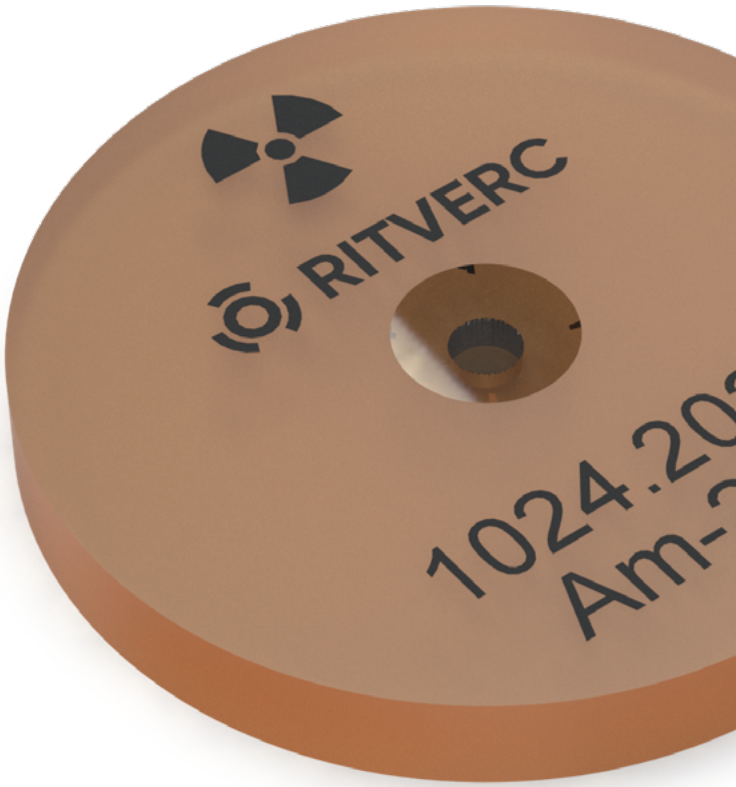
## OSGI-P

OSGI-P sources are used for efficiency and energy calibration of gamma-spectrometric equipment, testing of ionizing chambers and scintillation counters. Robust design is suitable for “in field” calibrations and tests.

### Description

Source is a transparent disc with diameter 25 mm and height 3 mm. Radionuclide is deposited on active part made of light ceramic pellet. Active part is mounted in center of acrylic capsule and sealed with epoxy resin. Dimensions of active part are 2 mm in diameter and 1 mm in height.

Sources can be supplied without calibration as control sources or as reference sources with activity calibration done by D.I. Mendeleev Institute of metrology (VNIIM), CIPM MRA participant.



## OSGI-P specification

| Radionuclide | Principal line, keV | Radionuclide activity, kBq | Transmission coefficient to principal line |
|---|---|---|---|
| Na-22 | 1274,54 | 5–1000 | 0,988 |
| Ti-44 | 67,884 | 5–100 | 0,963 |
| Mn-54 | 834,848 | 5–1000 | 0,985 |
| Co-57 | 122,061 | 5–3700 | 0,967 |
| Co-60 | 1332,5 | 5–3700 | 0,988 |
| Zn-65 | 1115,55 | 5–1000 | 0,987 |
| Y-88 | 1836,066 | 5–1000 | 0,991 |
| Cd-109 | 88,034 | 5–1000 | 0,965 |
| Sn-113 | 391,71 | 5–1000 | 0,978 |
| Ba-113 | 356,014 | 5–3700 | 0,977 |
| Cs-134 | 604,7 | 5–300 | 0,982 |
| Cs-137 | 661,66 | 5–1000 | 0,983 |
| Ce-139 | 165,86 | 5–1000 | 0,969 |
| Eu-152 | 1408,006 | 5–1000 | 0,988 |
| Gd-153 | 97,431 | 5–500 | 0,965 |
| Bi-207 | 569,7 | 5–100 | 0,982 |
| Pb-210 | 46,54 | 5–200 | 0,960 |
| Th-228 | 2614 | 5–50 | 0,998 |
| Am-241 | 59,537 | 5–370 | 0,962 |
| Am-243 | 74,66 | 5–50 | 0,964 |

# OTHER CONDITIONS

## General conditions for the activity of supplied sources.

The catalog indicates the nominal activity of the radionuclide at the date of manufacture. The nominal value of the radionuclide activity in the source within the specified limits is set by the consumer when ordering the source. The tolerance of activity from the nominal value should not exceed:

- OSGI-RT: ± 20%.
  Confidence limits of measurement error (0.95) of reference sources in the rank of working standards of 1st category: ±3% -5%. For secondary reference sources , the total standard deviation of the radionuclide activity measurement result is: ± 1,5% -2,0%.
- OSGI-P: -10 % + 30 %.
  In the case of an order source-with a calibration certificate, the extended uncertainty (for 0.95) is ±3% - 5%.
- DCGS: ± 15%.
  In the case of ordering sources with a calibration certificate, the extended uncertainty (for 0.95) is ±3% - 5%.
- Calibration and verification of sources is carried out by D.I. Mendeleev Metrology institute (VNIIM) using the State Primary Standard GET-6-2016.

The confidence limits of the error in measuring the activity of non-reference products are ± 7% (0.95).

Please take this into account when preparing import permits.

## Sales process

For order, please contact the sales department, sales@ritverc.com , + 7 812 297 22 69.

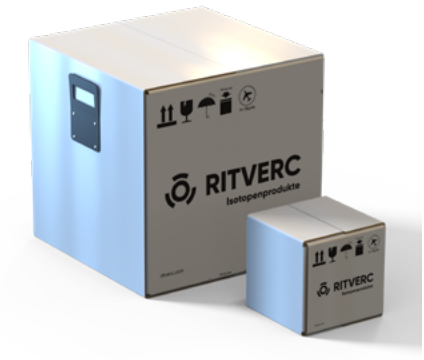
In case of international deliveries, our distributor in the destination country will be involved for conducting bidding procedures, for import operations and delivery. We will request an end user license and government permission to import.

If local distributors are not available in the country, we can deliver the products on the terms CPT nearest international airport.

## Delivery

The supplied sources are transported in packages that have been tested for compliance with type «A» requirements. Packaging marking UN2910 and UN 2915, depending on the dose rate and transported activity.

Typical package sizes are 22 x 22 x 23 cm, 48 x 48 x 48 cm. Detailed description and current certificates on the website (https://ritverc.com/en/products/packaging).




## Package contains

- Product
- Proforma Invoice
- Test report
- Source integrity certificate
- Safety instructions
- Calibration certificate for reference products

# R&D

Today RITVERC is a full-cycle high-tech enterprise: from an idea to a finished product. We have our own technologies and great capabilities:

- precise CNC processing
- high-temperature induction soldering of x-ray windows
- site for the manufacture of ceramic and epoxy matrices
- leak test area (incl. helium mass spectrometry)
- precision laser welding and marking
- department of spectrometric and metrological studies
- testing and isotope laboratories
- technologies for manufacturing sources based on at least 28 radionuclides

RITVERC Development Center has invaluable experience in the design, manufacture, and research of custom sources, radiation protection devices, packaging and accessories.


www.ritverc.com

info@ritverc.com

+7 812 297-44-63

+7 812 297-22-69

+7 812 591-68-68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Isotopenprodukte