Krotov S.A., postgraduate student,
Institute of chemistry SPbSU, Radiochemical Department

NRC KI “Petersburg Nuclear Physics Institute “
2016

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«Status of radioisotope complex RIC-80 and target development for medical radionuclide production»

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2016

Cyclotron C-80

Cyclotron C-80, first floor of experimental hall of PNPI synchrocyclotron C-1000

Proton beam extraction - **2016**

Beam intensity increase up to 100 μA – **2016**

Three beam lines to the target stations of RIC-80 manufacture - **2016**

RIC-80 complex construction is planned in **2017 - 2019**

Cyclotron complex RIC-80

Three beam lines of RIC-80

Three target stations have been planned for manufacture:

1) for **traditional radiochemical** method of extration;

2) target station for **high temperature method extraction;**

3) target station of **mass-separator for a high purity separated isotope production**.

Radionuclides planned for production at RIC-80

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Isotope	$T_{1/2}$, days	Target material	Irradiation time, h	Target activity, Ci
Ge-68	270.8	Ga	240	2
Sr-82	25.55	Rb	240	14
In-111	2.8	Cd	25	25
I-123	0.55	Te	5	11
I-124	4.17	Te	200	10
Tb-149	0.17	Gd	12	3
Ra-223	11.4	ThC	240	4
Ra-224	3.66	ThC	240	0.5

It's planned in the second stage of the project production of radionuclides Cu-64, Cu-67, Rb-81, At-211 as well.

New method of radionuclide separation

New developed method of produced radionuclide separation is based on the element different desorption energies from the surface, kept at a high temperatures.

The target material atoms and atoms of wanted radionuclide should have considerably **different vapor pressure** or different desorption energies a temperature high enough to evaporate separately or the target material, or produced radioactive species for a suitable period of time.

High temperature separation method

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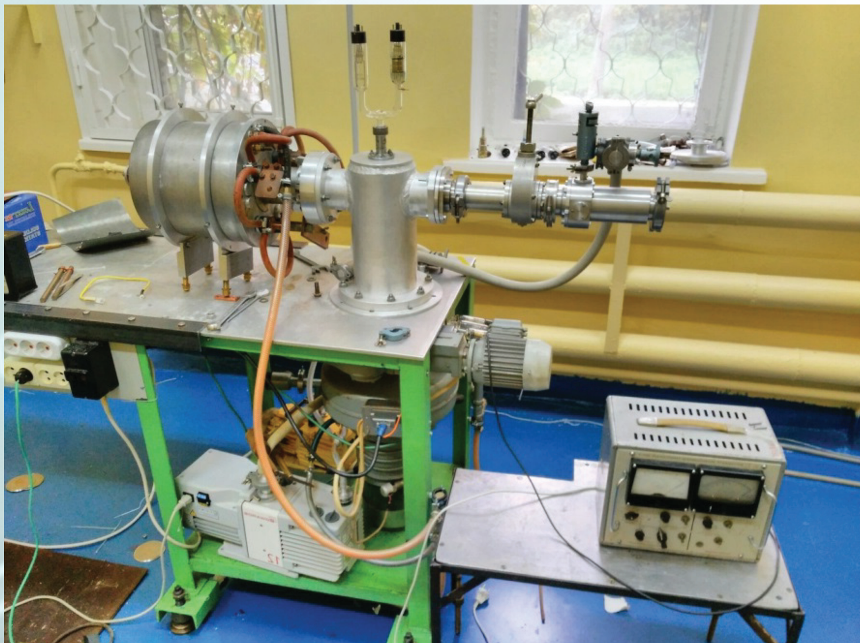
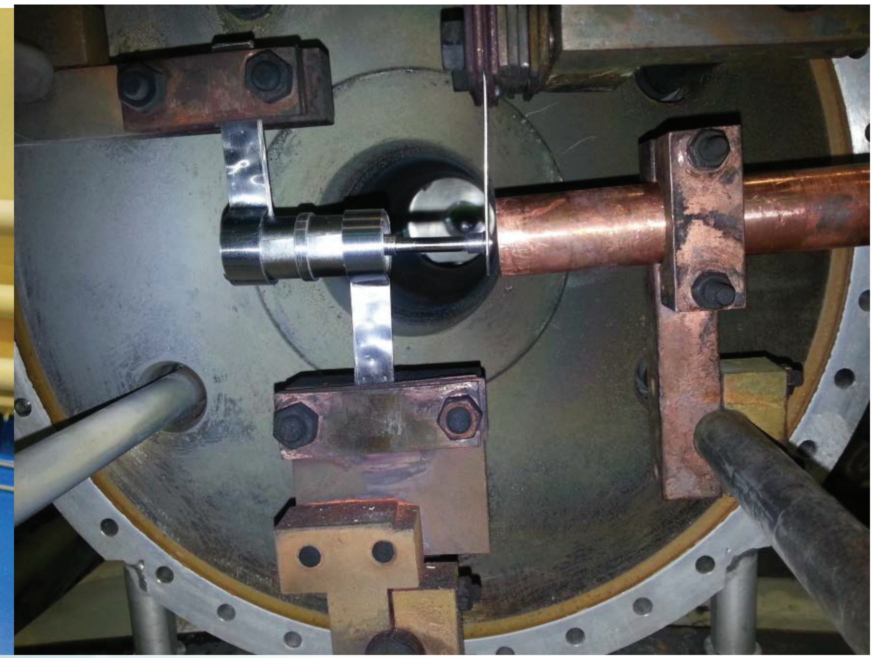


A high vacuum test bench for the target material and produced radionuclide separation



A high temperature Ta-W container for the target material heating

High temperature separation method

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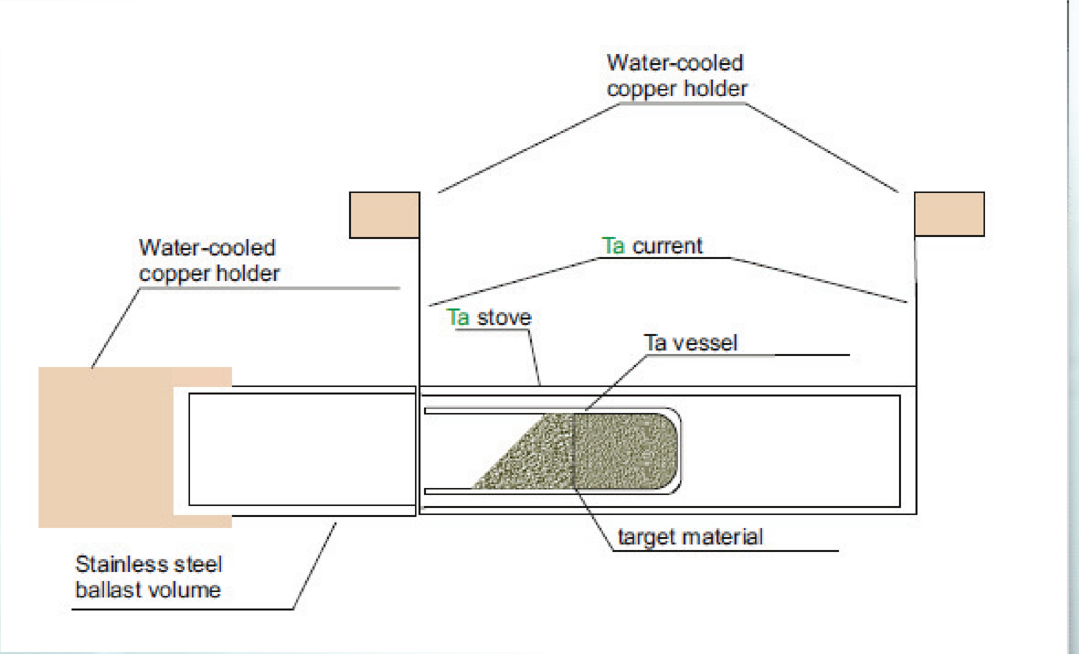
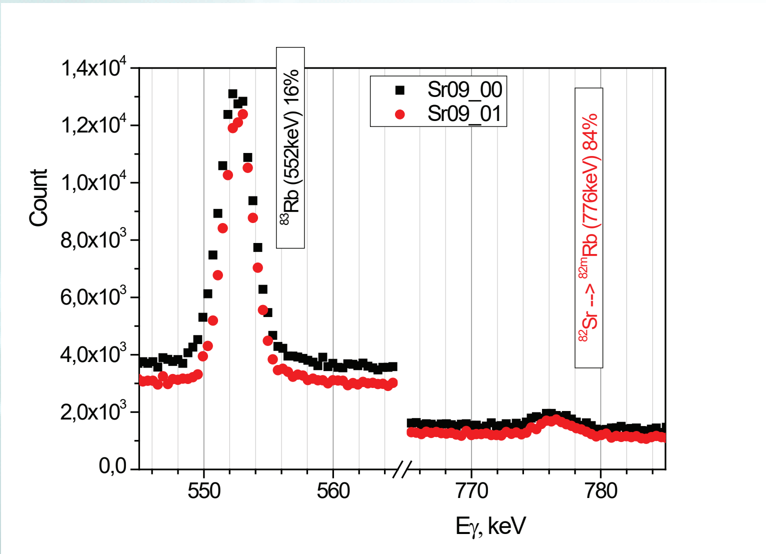
Vessel with irradiated RbCl before and after heating at a temperature lower 800 ° C

Vessel after heating at a temperature higher 900 ° C. Target material was completely evaporated

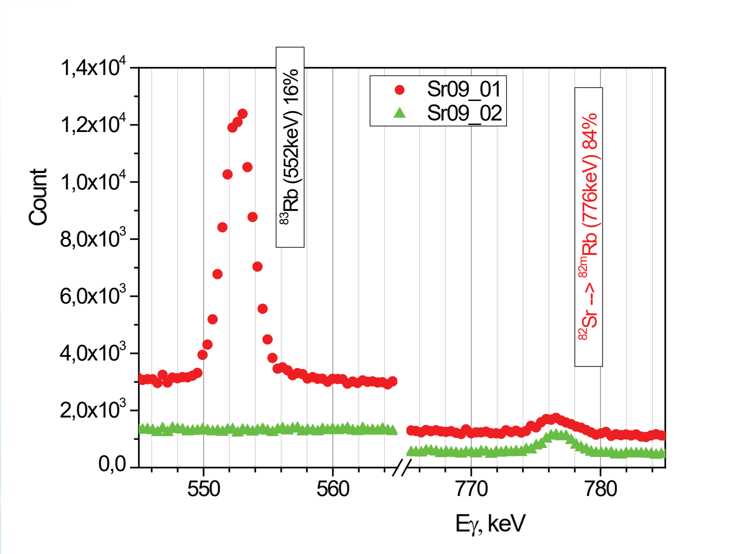


Highly-effective target device prototype

Sr-82 separation from irradiated RbCl target



Part of gamma spectra of irradiated RbCl before and after heating in a high vacuum at a temperature lower 800° C for 1hour.



Part of gamma spectra of irradiated RbCl before and after heating in vacuum at a temperature higher 900° C for 1hour.

Separation and extraction efficiency was controlled by gamma spectra measurements before and after the vessel with the target material heating

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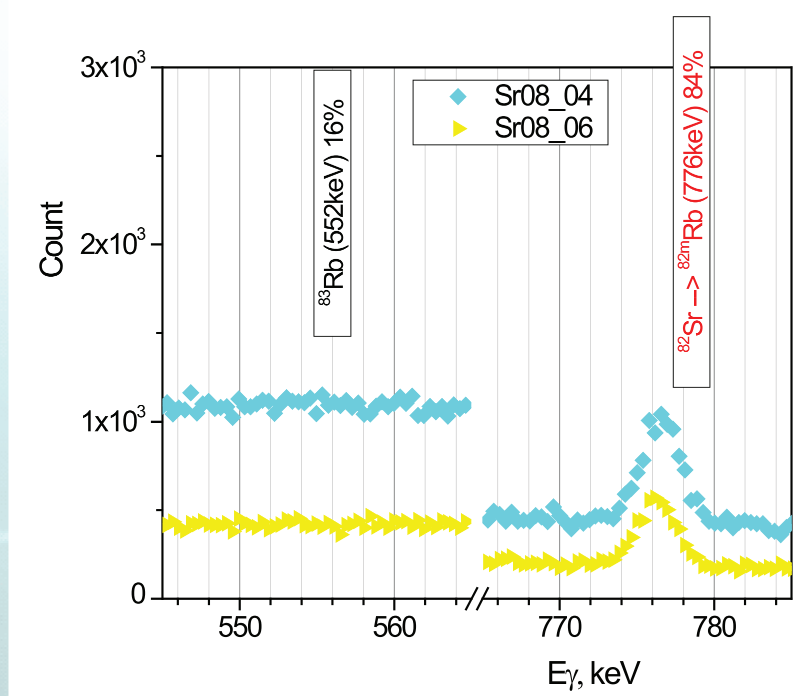
Sr-82 separation from irradiated RbCl target

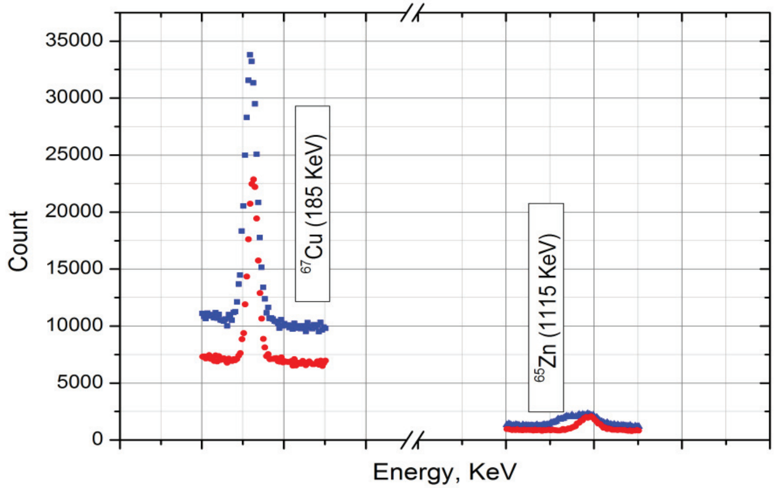
HCl solution with washed Sr-82



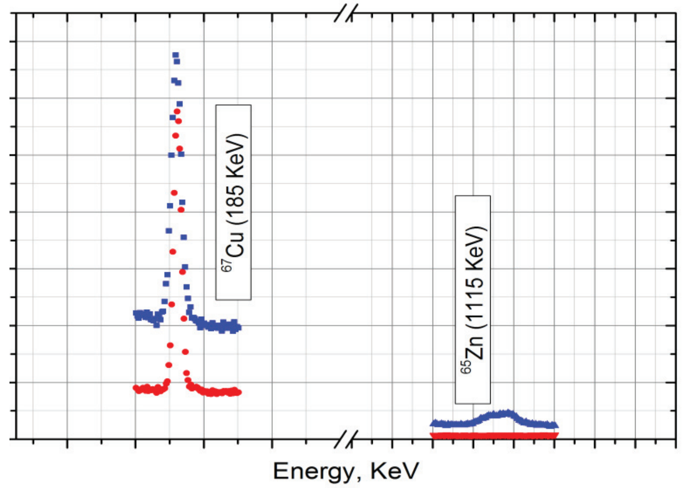
Gamma-line of Sr-82 after vessel heating in vacuum at a temperature higher 900° C and gamma-line of Sr-82 in the 10% solution of HCl, after washing the vessel internal volume

Efficiency of ^{82}Sr extraction is about 95%
Selection from the target material-better than 99.9 %

High temperature separation of Cu-67 from metal Zn target



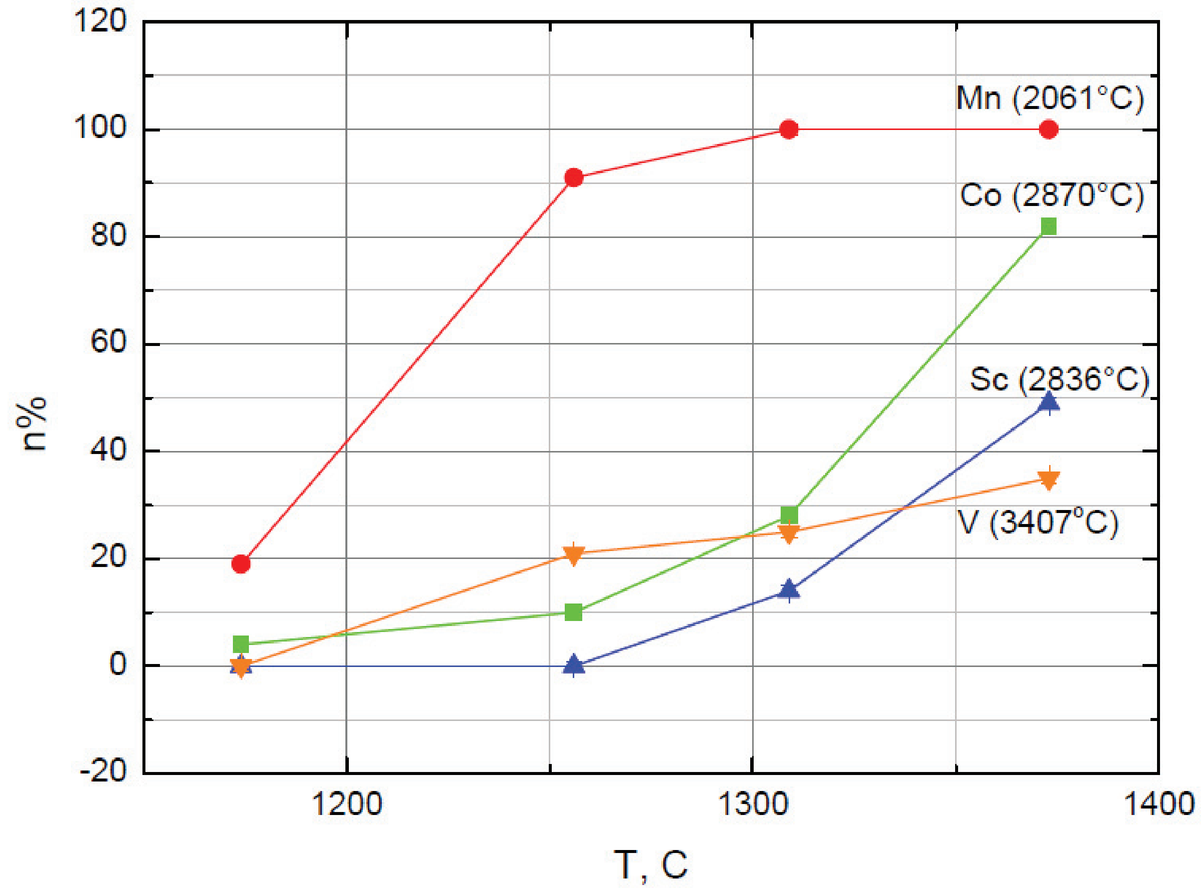
Part of gamma spectra of irradiated Zn before and after heating in vacuum at a temperature about 700 ° C for 2 hours.



Part of gamma spectrum of irradiated Zn before heating and γ- spectrum of extracted Cu-67 at cold collector after target material heating at a temperature about 1400 ° C

Preliminary result:
Separation from the target material ~ 90%
Collection efficiency ~ 100%

High temperature separation of radionuclides from Cu target material



Evaporation of radionuclides from Cu target

n – volatility fraction

$$n = \frac{A_1 - A_2}{A_1} * 100\%,$$

A_1, A_2 – activity of radionuclide before and after heating

Conclusions

For radioisotope complex RIC-80:
Cyclotron C-80 was launched. Obtained beam intensity was 100 μA;
Beam lines to the target stations of RIC-80 have been manufactured.

For the target prototypes for radioisotope complex RIC-80:
First results have been obtained on different radionuclide separation from the target material, making use of a “dry” high temperature method.

As it was demonstrated, this method works for different combinations of target materials and separated radionuclides which have essentially different vapor pressure and different values of desorption energy at the same temperature.

The value of selection of produced radionuclides from the target material is better than 99,9%;
Extraction efficiencies obtained for Sr and Cu from RbCl and Zn targets are higher 90%.