MICROTRON LABORATORY
for fundamental and applied research

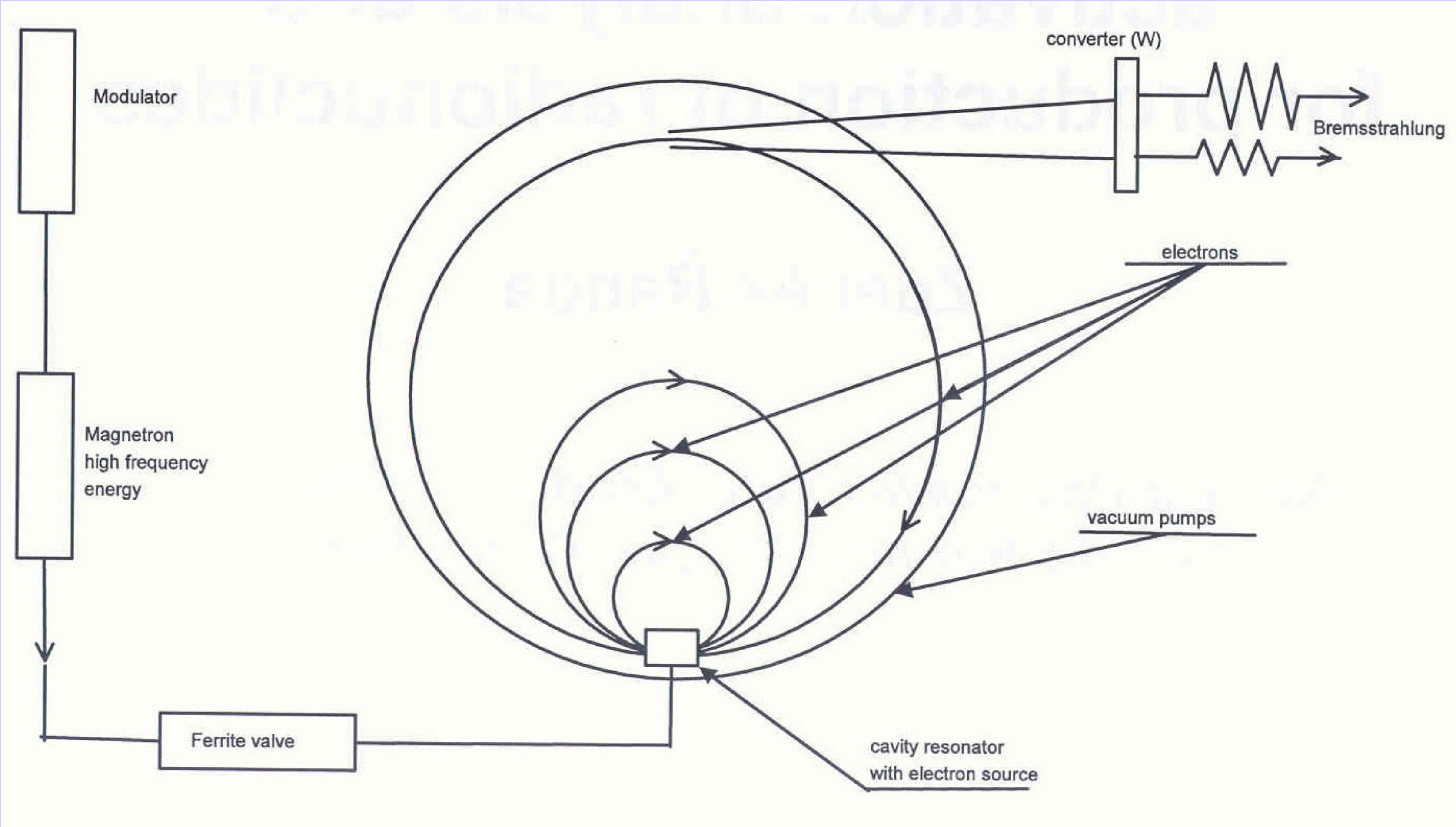
Joint project

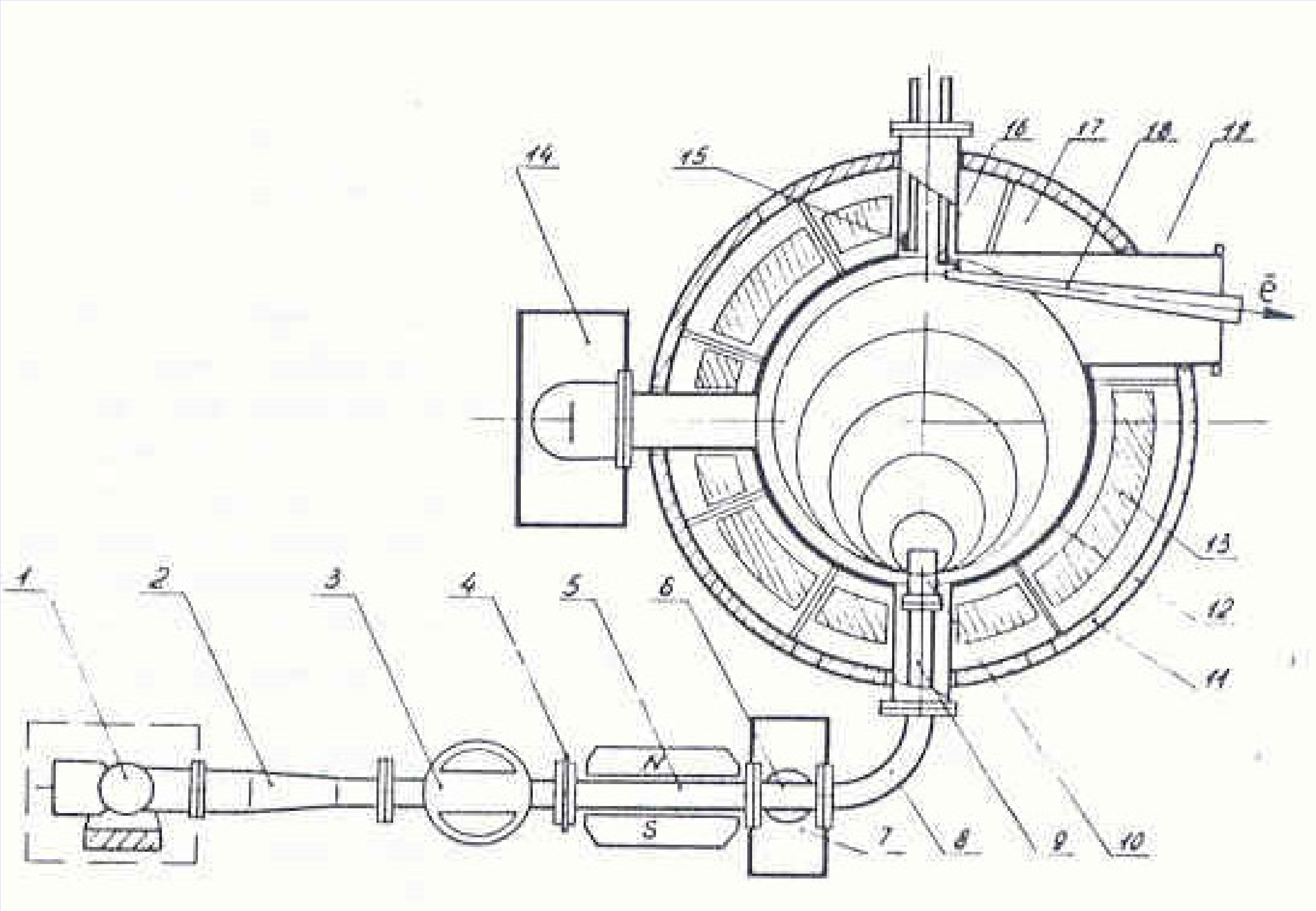
Institute for Nuclear Research and Nuclear Energy
and
Plovdiv State University “Paisi Hilendarski”

Microtron

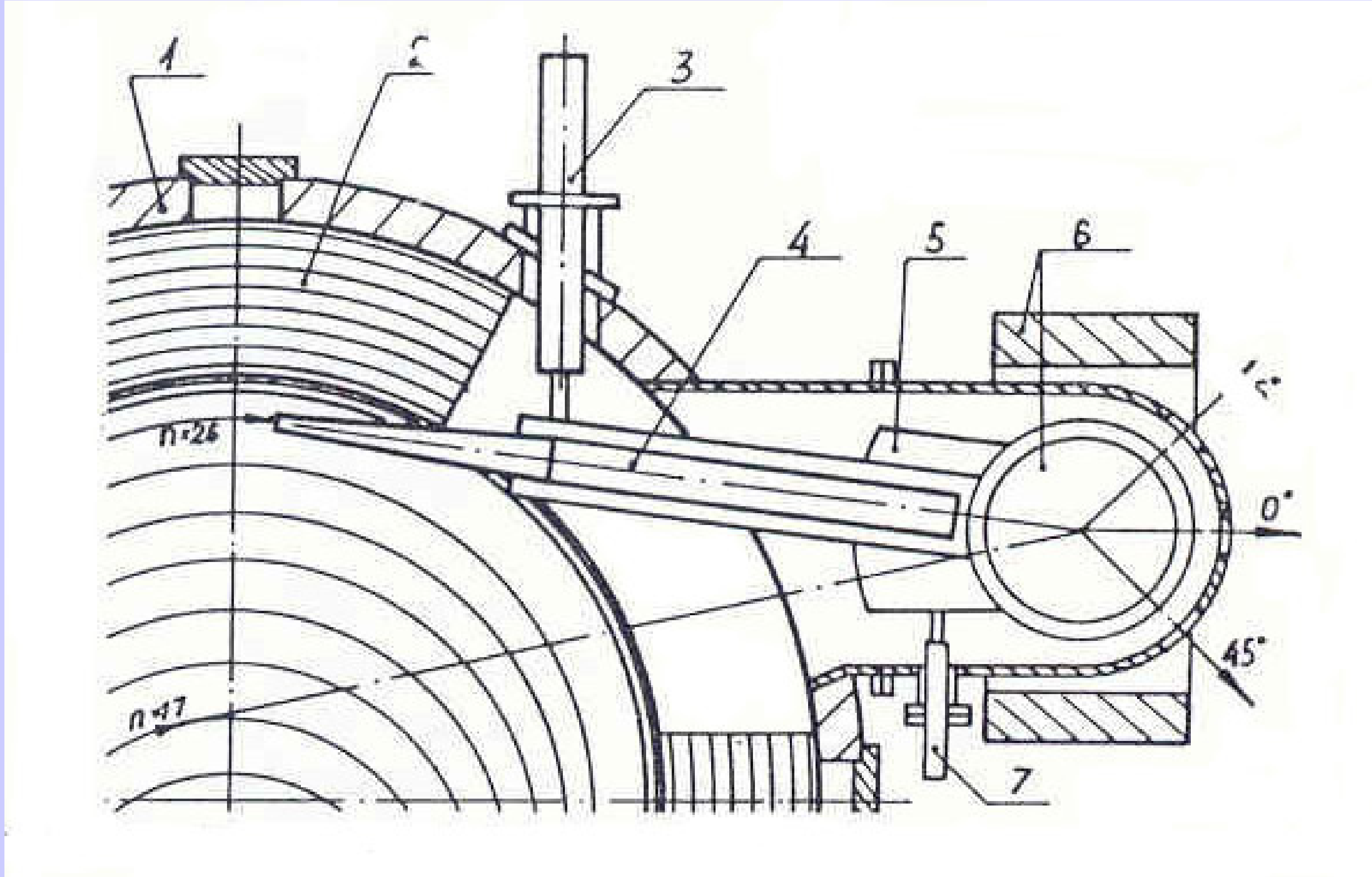
Cyclic HF-electron accelerator invented 1944 by V.Veksler

Basic principle $2\pi r_n - 2\pi r_{n-1} = \text{integer} \times \lambda$





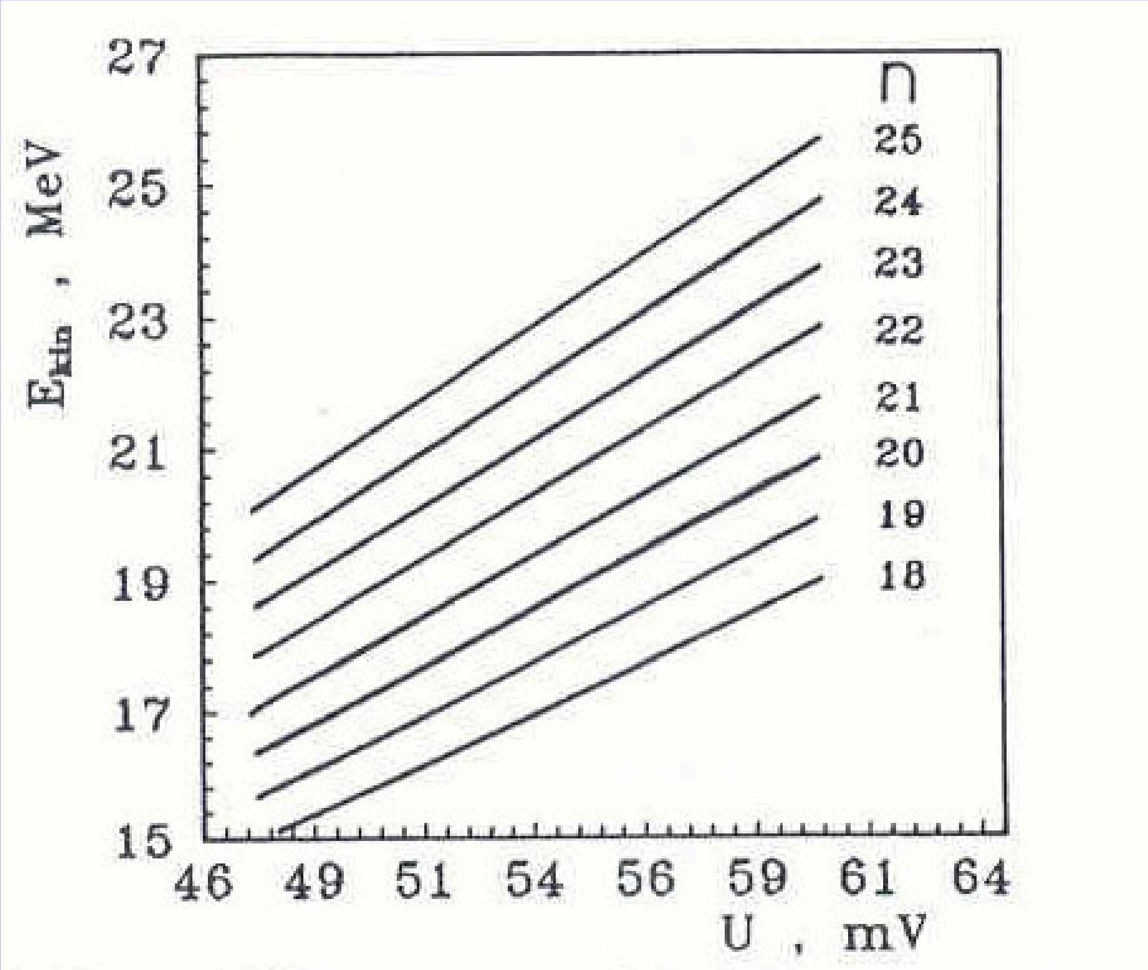
MT-25 Microtron: 1 - Magnetron, 2 - Wave shape transformer, 3 - Phase regulator, 4 - Quartz window, 5 - Ferrite valve, 9 - Resonator holder, 10 - Resonator and electron source



Beam extraction unit: 4 - Electron-beam guide, 6 - Bending magnet, n - Electron orbits,

Microtron chamber opened

FLNR, JINR-Dubna

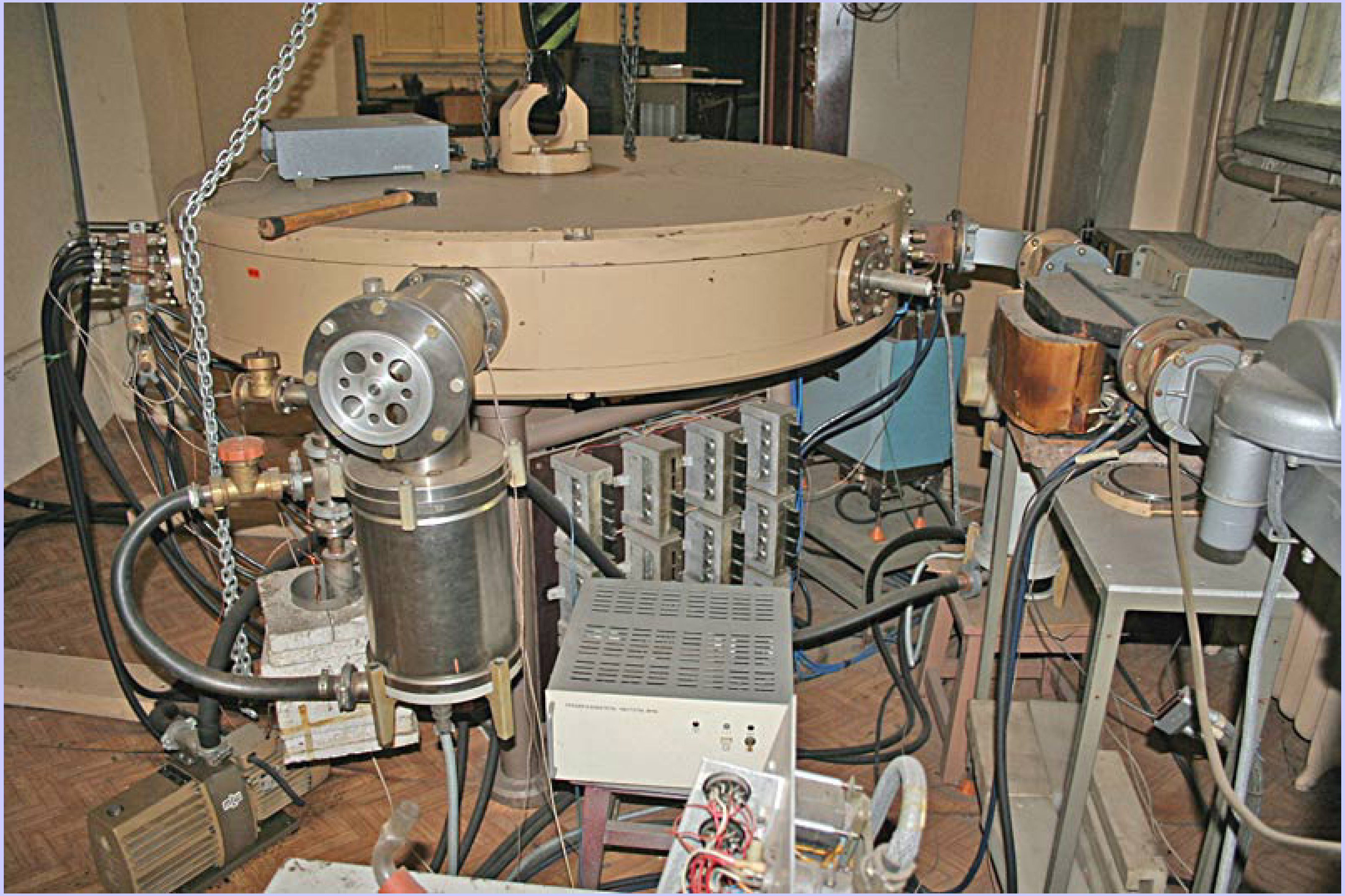


Electron orbits - Beam energy

MT-25 PHYSICAL PARAMETERS

Max.number of orbits	25
Energy range	8 to 25 MeV
Pulsed beam current	20 mA (20μA)
Gamma-ray flux	10^{14} pps
Fast neutron flux	10^{12}pps
Thermal neutron flux dens.	10^{9}pps cm^{-2}
Power consumption	20 kW
Magnet weight about	2,5t

(Personnel - 3 people)



Fields of application:

fundamental research
activation analysis
dosimetry
radiochemistry
production of radionuclides
radiation theraphy
defectoscopy

Investigations on ^{137}Ba, ^{139}Ce, ^{141}Nd, ^{143}Sm

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Population of isomers in the decay of the giant dipole resonance

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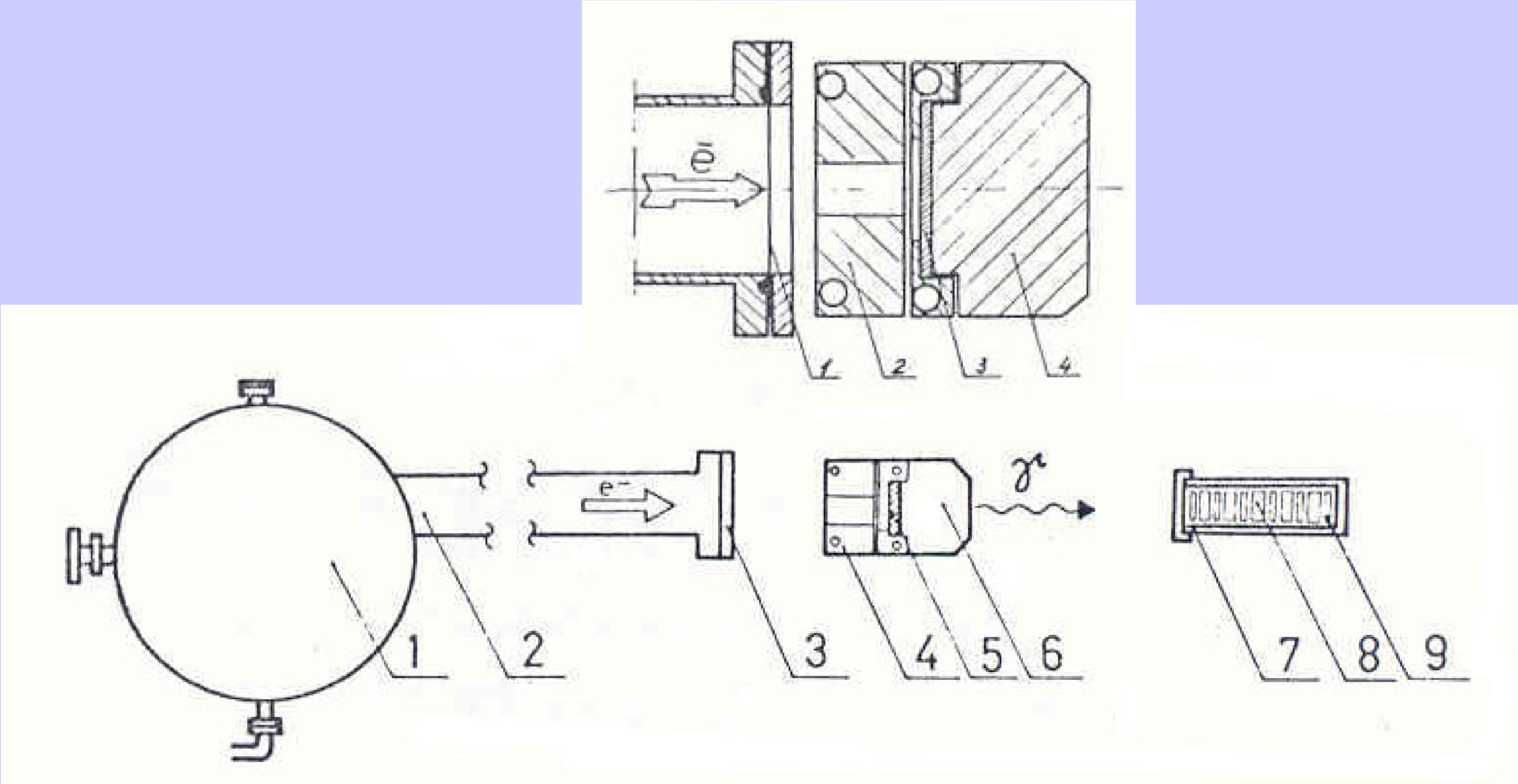
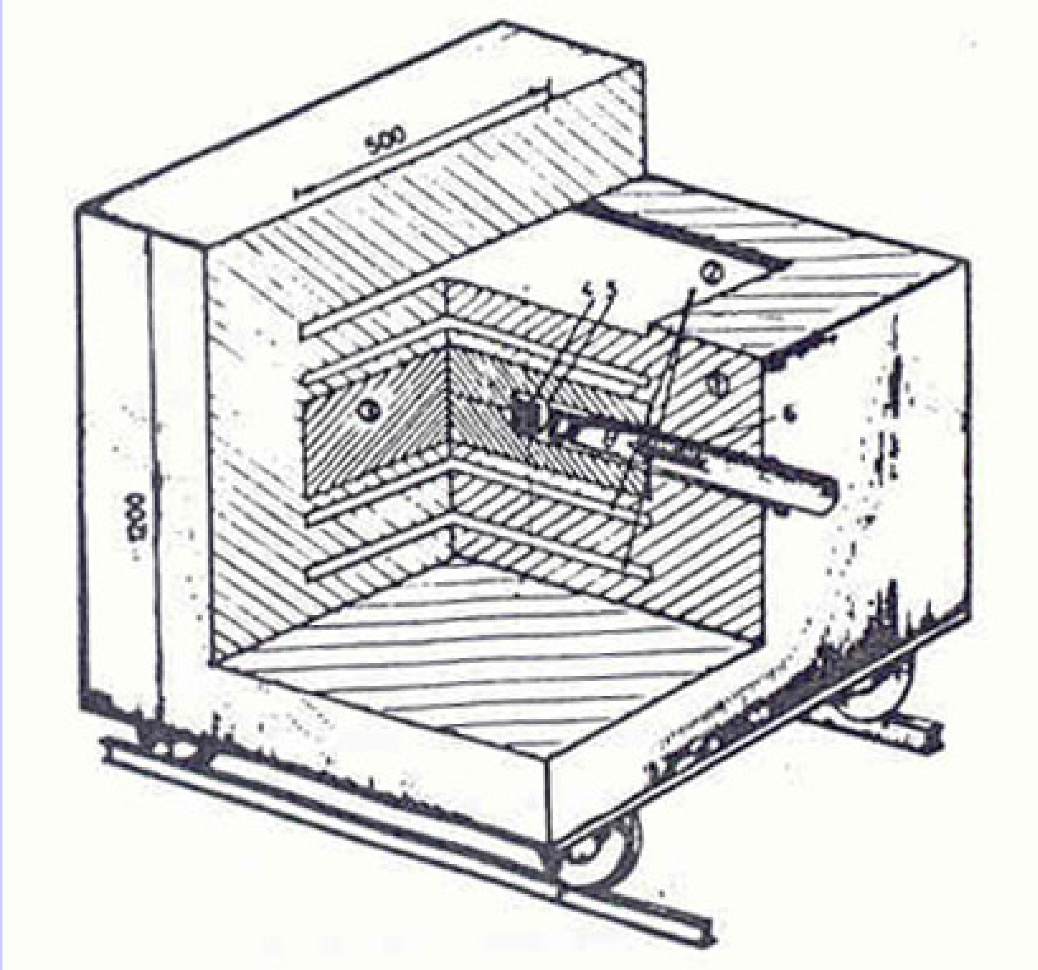
The value of an isomeric ratio (IR) in $N=81$ isotones (^{137}Ba, ^{139}Ce, ^{141}Nd, and ^{143}Sm) is studied by means of the (γ,n) reaction. This quantity measures a probability to populate the isomeric state in respect to the ground state population. In (γ,n) reactions, the giant dipole resonance (GDR) is excited and after its decay by a neutron emission, the nucleus has an excitation energy of a few MeV. The forthcoming γ decay by direct or cascade transitions deexcites the nucleus into an isomeric or ground state. It has been observed experimentally that the IR for ^{137}Ba and ^{139}Ce equals about 0.13 while in two heavier isotones it is even less than half the size. To explain this effect, the structure of the excited states in the energy region up to 6.5 MeV has been calculated within the quasiparticle phonon model. Many states are found connected to the ground and isomeric states by $E1$, $E2$, and $M1$ transitions. The single-particle component of the wave function is responsible for the large values of the transitions. The calculated value of the isomeric ratio is in very good agreement with the experimental data for all isotones. A slightly different value of maximum energy with which the nuclei rest after neutron decay of the GDR is responsible for the reported effect of the A dependence of the IR.

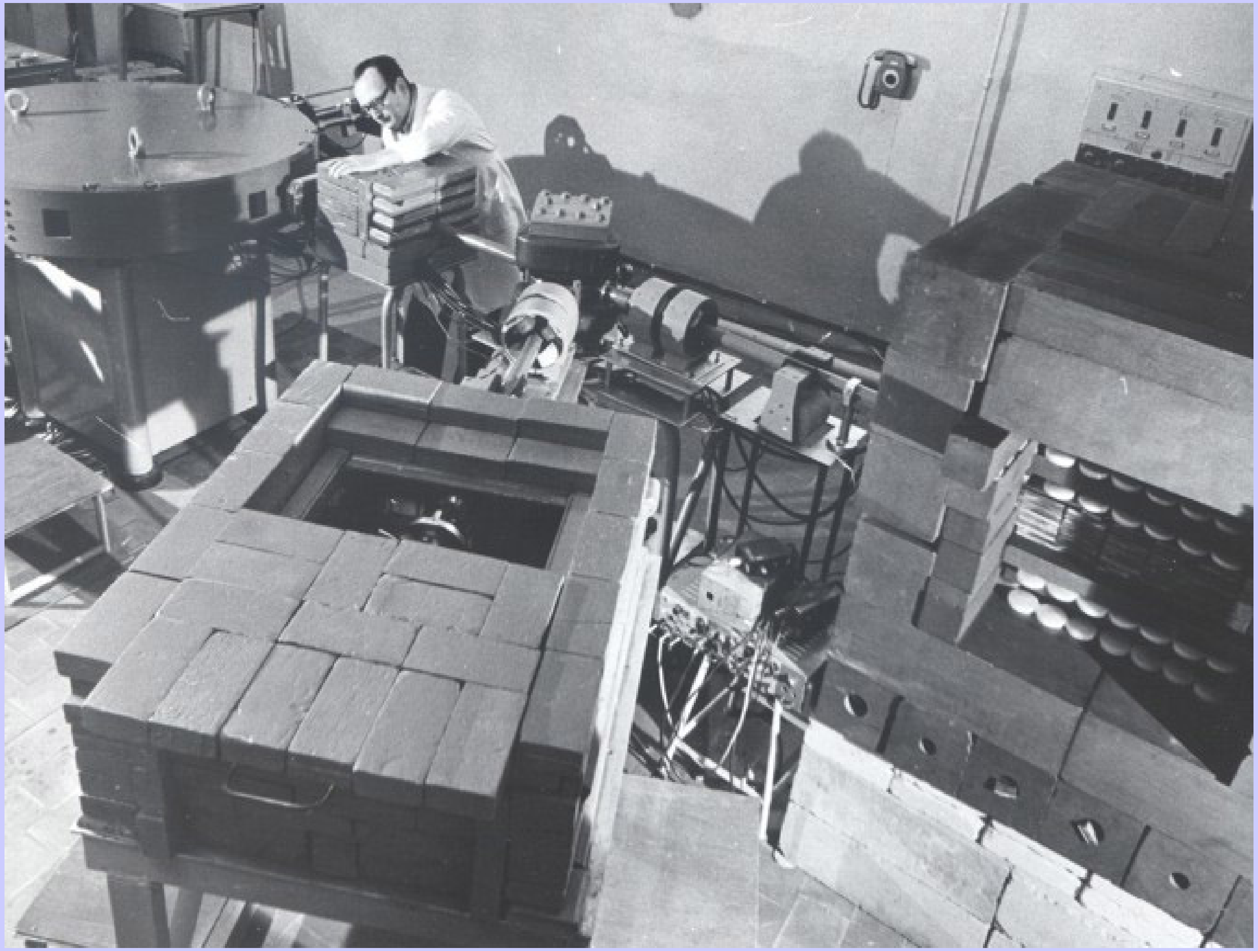


Irradiation setup for photon-activation analysis:

1 - Microtron, 2 - Beam guide, 3 - Exit window (100 μmAl-foil /1/),
4 - Bremsstrahlung unit, 5 - Bremsstrahlung target (tungsten /3/),
6 - Electron absorber (Al /4/), 7 - Sample holder (polyetilen),
8 - Samples, 9 - gamma-ray beam monitor



Irradiation block for neutron-activation analysis:
1 - Graphite, 2 - Cavities, 3 - Berillium, 4 - Uranium convertor, 5 - Diaphragm, 6 - Electron-beam guide

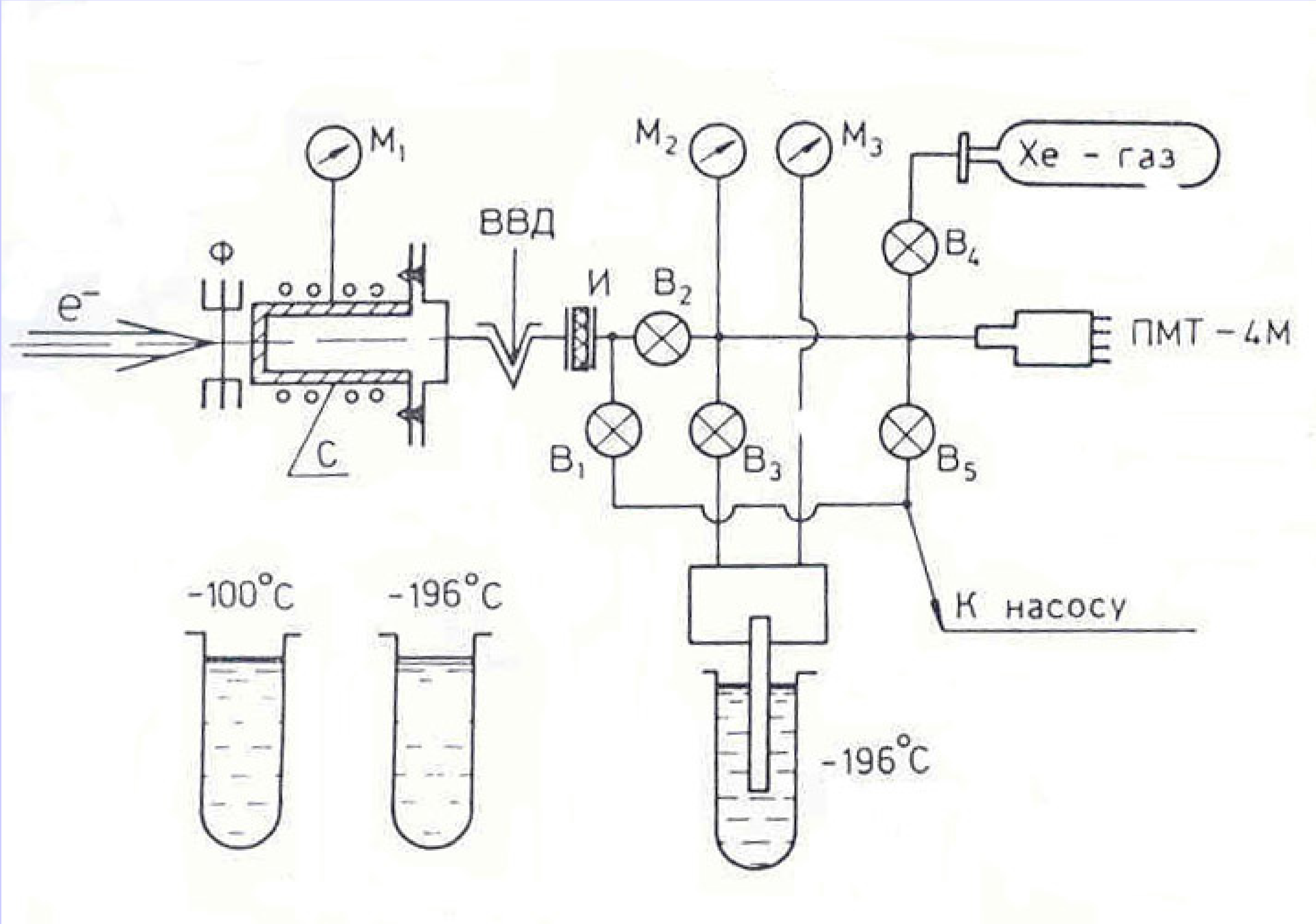


Irradiation setup for neutron- and gamma-activation analysis (MK-25, FLNR, JINR-Dubna,)

H 10^{-4}						H 10^{-4}	He		
Li	Be	B	C	N 10^{-7}	O 10^{-6}	F	Ne		
Na $2\cdot10^{-4}$	Mg $2\cdot10^{-4}$	Al	Si	P	S	Cl $5\cdot10^{-6}$	Ar		
K	Ca $2\cdot10^{-4}$	Sc $8\cdot10^{-7}$	Ti 10^{-4}	V	Cr $5\cdot10^{-6}$	Mn $4\cdot10^{-7}$	Fe 10^{-3}	Co 10^{-6}	Ni 10^{-6}
Cu 10^{-5}	Zn $5\cdot10^{-6}$	Ga 10^{-5}	Ge	As $5\cdot10^{-7}$	Se	Br	Kr		
Rb $2\cdot10^{-6}$	Sr $2\cdot10^{-7}$	Y $2\cdot10^{-6}$	Zr $6\cdot10^{-7}$	Nb 10^{-6}	Mo 10^{-6}	Tc	Ru	Rh	Pd
Ag 10^{-6}	Cd $5\cdot10^{-6}$	In 10^{-7}	Sn 10^{-5}	Sb $5\cdot10^{-7}$	Te	I	Xe		
Cs $5\cdot10^{-7}$	Ba $5\cdot10^{-6}$	La	Hf	Ta $5\cdot10^{-8}$	W 10^{-7}	Re $7\cdot10^{-7}$	Os	Ir	Pt
Au $2\cdot10^{-8}$	Mg $5\cdot10^{-7}$	Tl $7\cdot10^{-7}$	Pb $2\cdot10^{-6}$	Bi	Po	At	Rn		
Fr	Ra	Ac	Ku	Ns	106	107	108	109	110

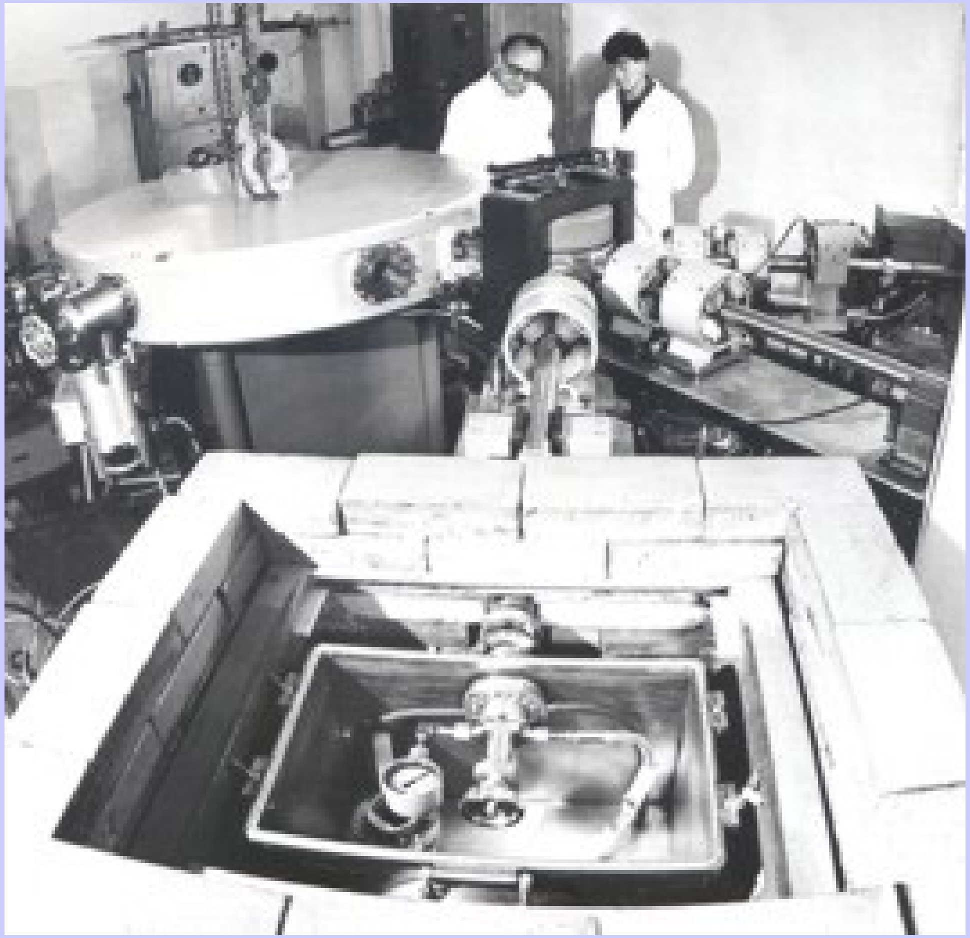
Ce 10^{-6}	Pr	Nd $2\cdot10^{-6}$	Pm	Sm $5\cdot10^{-8}$	Eu	Gd	Tb	Dy	Ho	Er 10^{-7}	Tm	Yb	Lu
Th $5\cdot10^{-8}$	Pa	U $5\cdot10^{-8}$	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	103

Chemical elements analyzed using the MT-25 microtron. Detection limit given in g/g



^{123}I production, cross-sect. 0,5 barn (15 MeV)

Eγ = 159 keV, efficiency 20 mCi/h, 100 patients/d



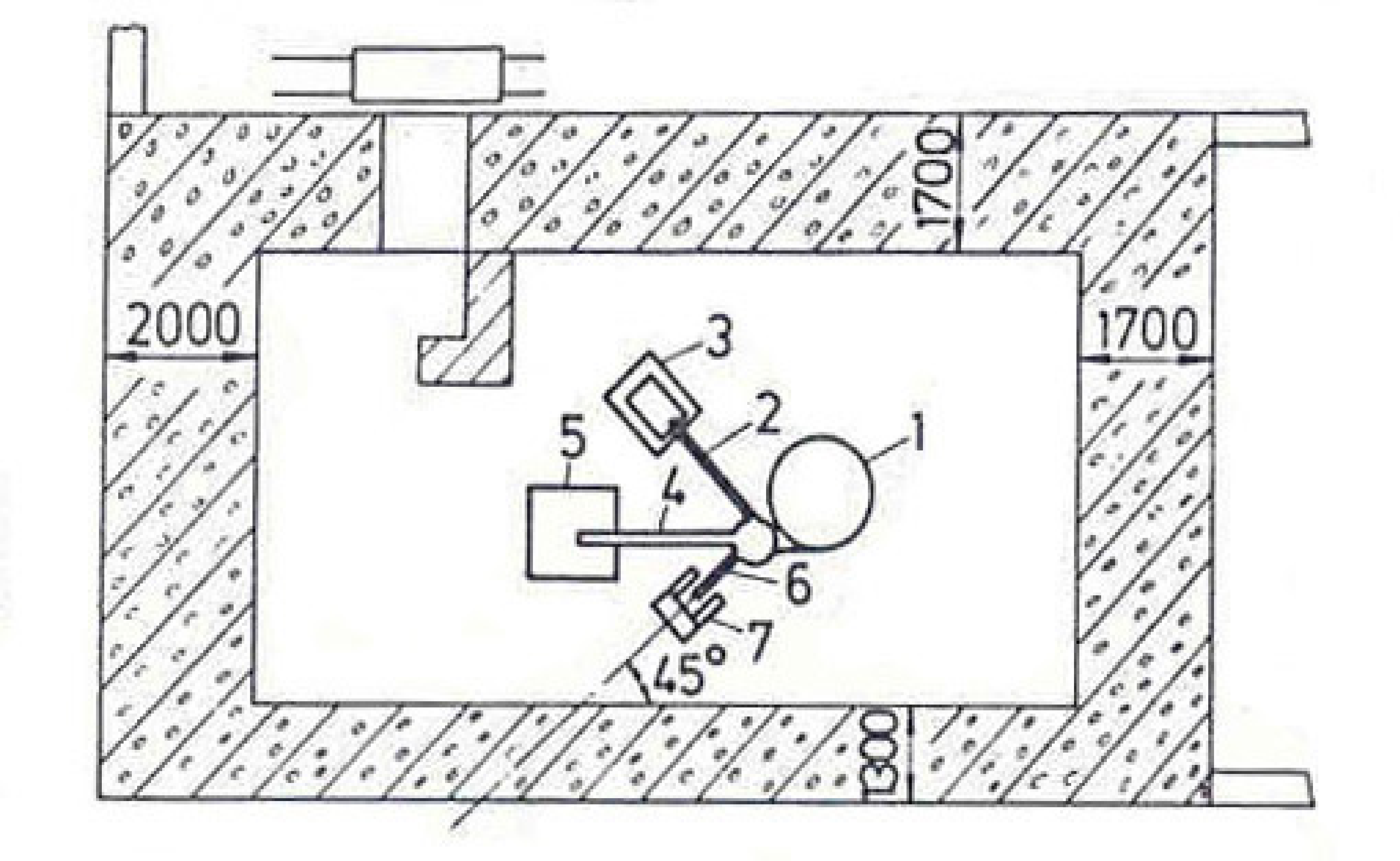
Production of ^{123}I

(MK-25, FLNR, JINR-Dubna,)

Modernisation and Upgrading

HF-Source
Power Supply
Computerized operation
Vacuum Pumps

Foreign experts



Laboratory building

1 - Microtron, 2, 4, 6 – electron-beam guides,

3, 7 - lead shielding, 5 - graphite cube

Conclusions

1. **A laboratory could be established on the basis of the existing MT-25 Microtron. The objectives are based on the experience of INRNE and Plovdiv State University. The project is economically valuable due to the existing hardware, scientific experts, and trained personnel - a new accelerator with comparable technical parameters will costs 7-9 Mil US$.**

2. **The project will create new positions, will enlarge the level of technology in the region and will solve, at least partly, the brain drain problem of the region**

3. **Additional financial support has to be found within FP6 and FP7. The total amount of the additional founds is 700000 euro.**

4. **The new laboratory will improve the research infrastructure in Bulgaria and will stimulate the integration of the Bulgarian nuclear physics community in the European research area.**

5. **The new facility will enlarge the nuclear physics activity of SEENet but also within EWON and will create international collaborations involving laboratories active in field of Microtron research and application.**