XXIV RuPAC Obninsk 2014

THE ACCELERATOR COMPLEX BASED ON DC-60 CYCLOTRON

Zdorovets M.V.

INP, Kazakhstan

INSTITUTE OF NUCLEAR PHYSICS

Founded in 1957

Staff: **633 people, including 73 Doctors and Candidates of Science, the mean age is 45**

The main site:

- **Alatau, 20 km from Almaty**

Branches:

- **Astana**
- **Aksai**
- **Azgir**

DC-60 ACCELERATOR IS TECHNOLOGICAL TEST SITE FOR THE KAZAKHSTAN'S NUCLEAR INDUSTRY

DC-60 accelerator is the research and educational site with a low initial nuclear radiation level, significant technological potential in the field of ion implantation doping and the materials structure and properties modification.

The choice of the DC-60 accelerator's technical parameters and its placement was based on:

- Significance and prospects of scientific and practical applications;
- Requirement to ensure comfortable conditions for the educational process which is intimately connected with scientific, technological, and engineer work.

The idea of creating the Interdisciplinary laboratory complex to solve problems in the fields of Physics, Chemistry, and advanced technologies

The «DC-60 cyclotron» project presentation

DC-60 accelerator's opening

VIRIBUS UNITIS - OUR STRENGTH IS UNITY

2001 **2003** **2006**

Institute of Nuclear Physics (Almaty)

National Nuclear Center of Kazakhstan (Kurchatov)

The LN.Gumilyov Eurasian National University (Astana)

Joint Institute for Nuclear Research (Dubna)

Memorandum on the establishment of the International innovative educational consortium on the base of Interdisciplinary scientific complex

Opening the International Department of Nuclear Physics, New Materials, and Technologies at the LN.Gumilyov ENU

Opening the Engineering Laboratory on the base of DC-60 accelerator

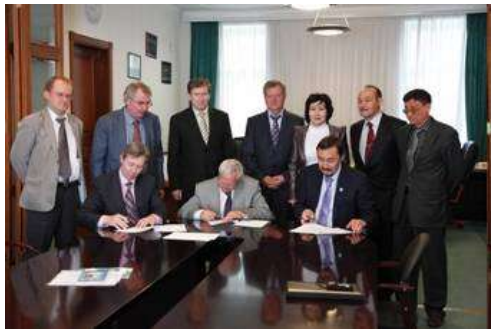
VIRIBUS UNITIS - OUR STRENGTH IS UNITY

2007

2008

The Quadripartite Agreement on Double major was signed (JINR, ENU, NNC, «Dubna» University)

The Memorandum on the ENU cooperation with the world's leading research centers in the field of nuclear physics was signed



The Agreement on cooperation in the field of Grid-technologies development was signed

VIRIBUS UNITIS - OUR STRENGTH IS UNITY

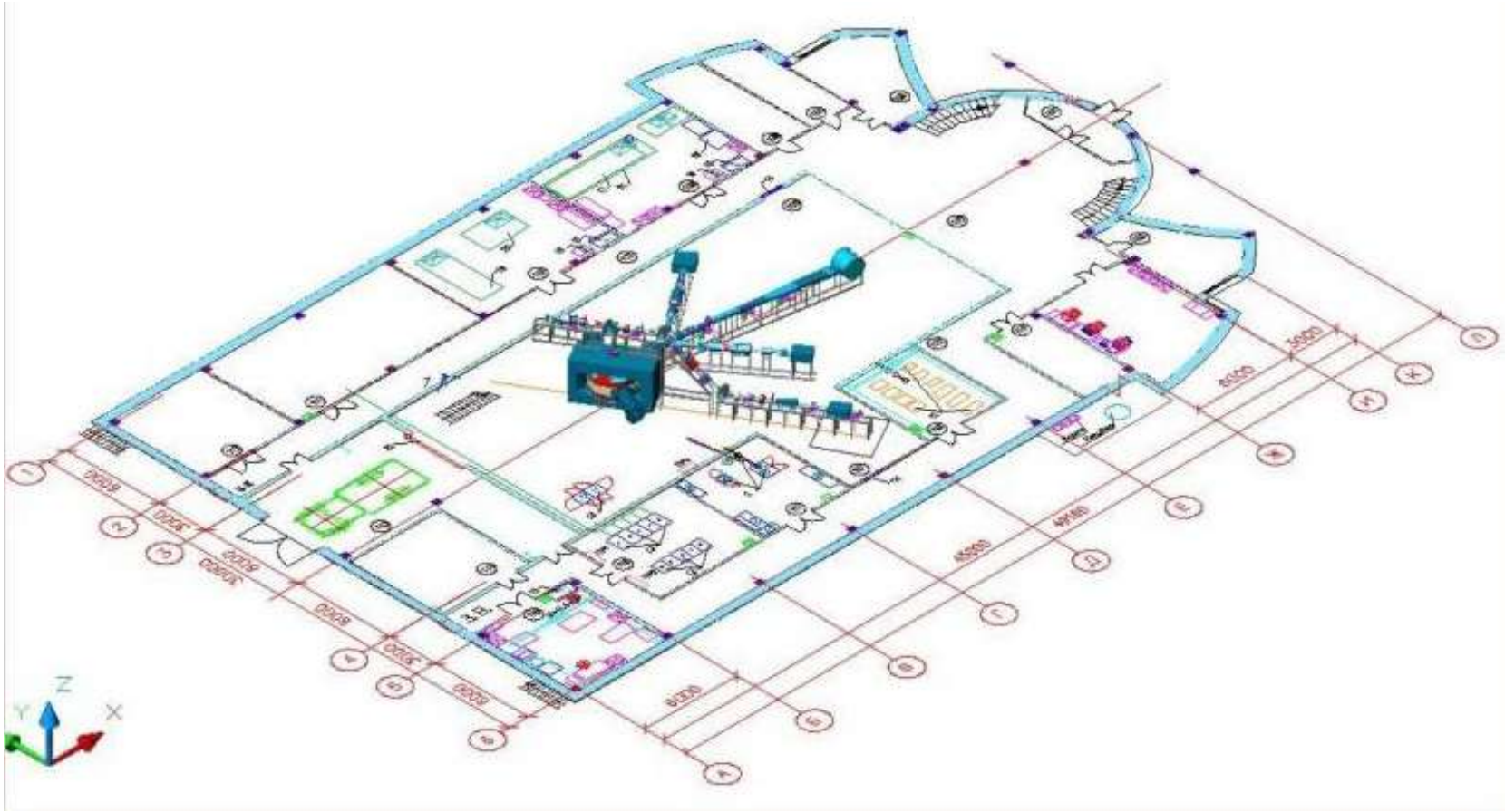
2009 **2010** **2011**

DC-60 CYCLOTRON

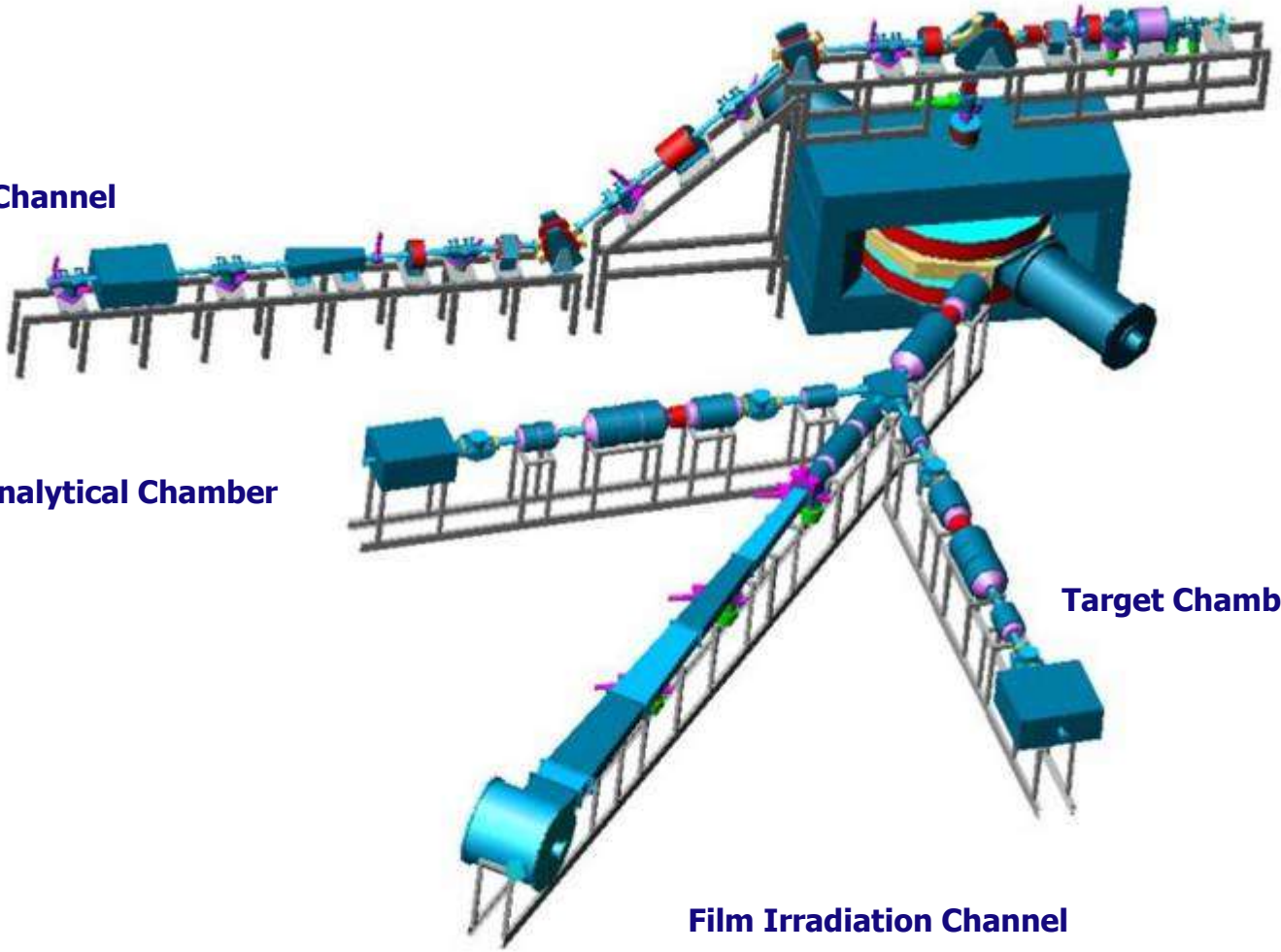
THE ACCELERATOR COMPLEX COMPONENTS:

- DC-60 CYCLOTRON
- ECR-TYPE EXTERNAL ION SOURCE
- BEAM AXIAL INJECTION SYSTEM
- LOW-ENERGY ION CHANNEL (ECR SOURCE BEAMS)
- 3 CHANNELS OF ACCELERATED ION BEAMS
- TECHNOLOGICAL EQUIPMENT

DC-60 CYCLOTRON
Location in the Interdisciplinary complex



DC-60 CYCLOTRON
View



DC-60 CYCLOTRON
The basic parameters of the high-energy channel

The parameters of the accelerated ion beams	
Ion type	Li Xe
A/Z	6 12
Accelerated ions energy	0,35 1.75 MeV/nucleon
Energy dispersion	2 %
Discrete change in the ion energy	Due to ion charge changes (A/Z)
Smooth variation of the ion energy	-30 % / +30% due to magnetic field variation

DC-60 CYCLOTRON
The basic parameters of the low-energy channel

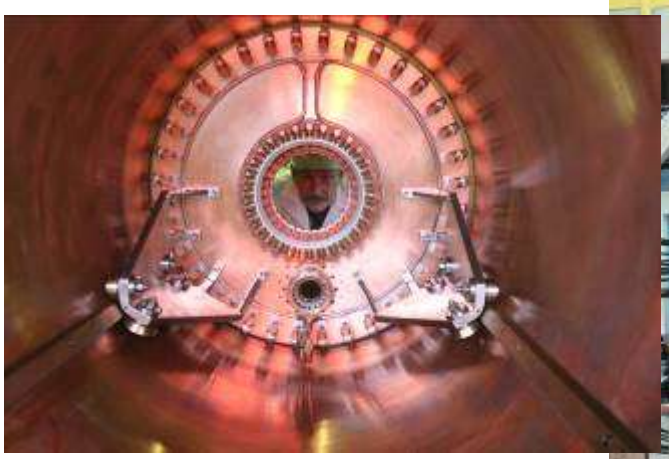
The parameters of the low-energy ion beams	
Ion type	Li Xe
A/Z	2 20
ECR source ions energy	10 20 keV/charge
Energy dispersion	0,1 %
Discrete change in the ion energy	Due to ion charge changes (A/Z)
Smooth variation of the ion energy	Due to variation of the ECR source extraction potential

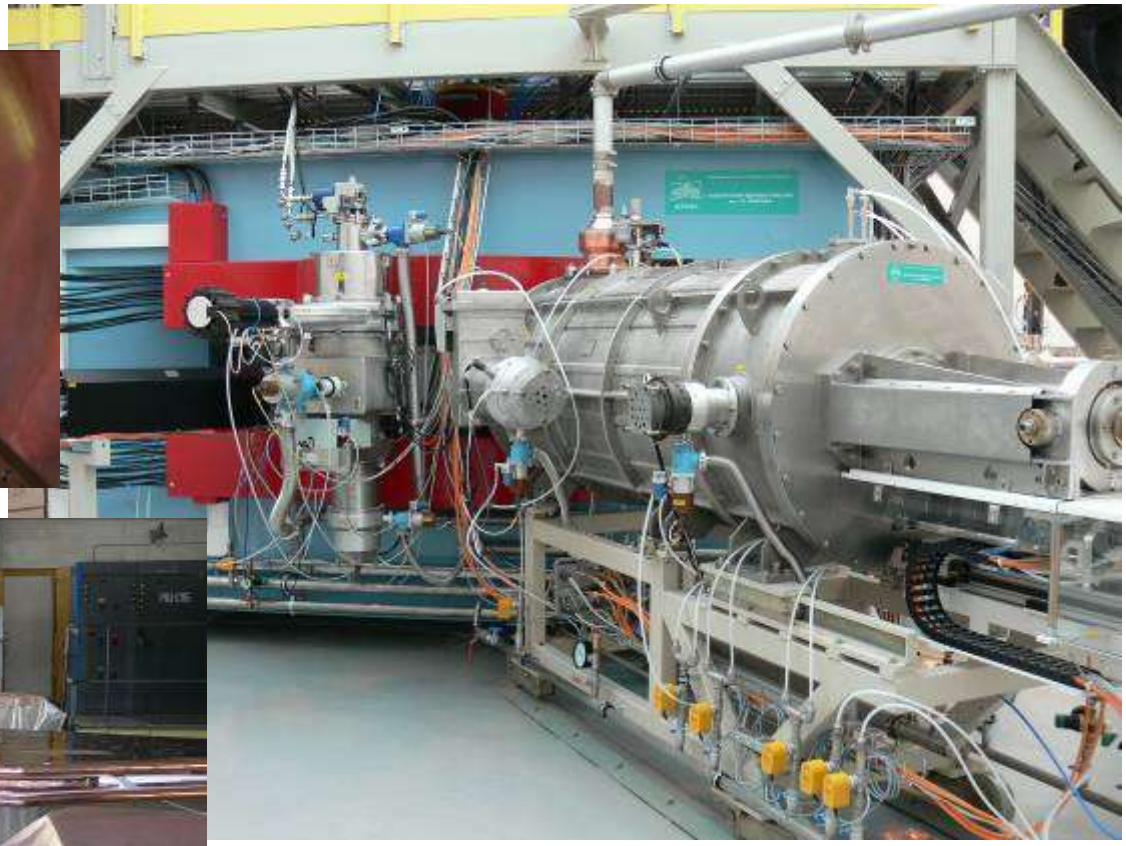
DC-60 CYCLOTRON

Plain view in the accelerator hall

DC-60 CYCLOTRON

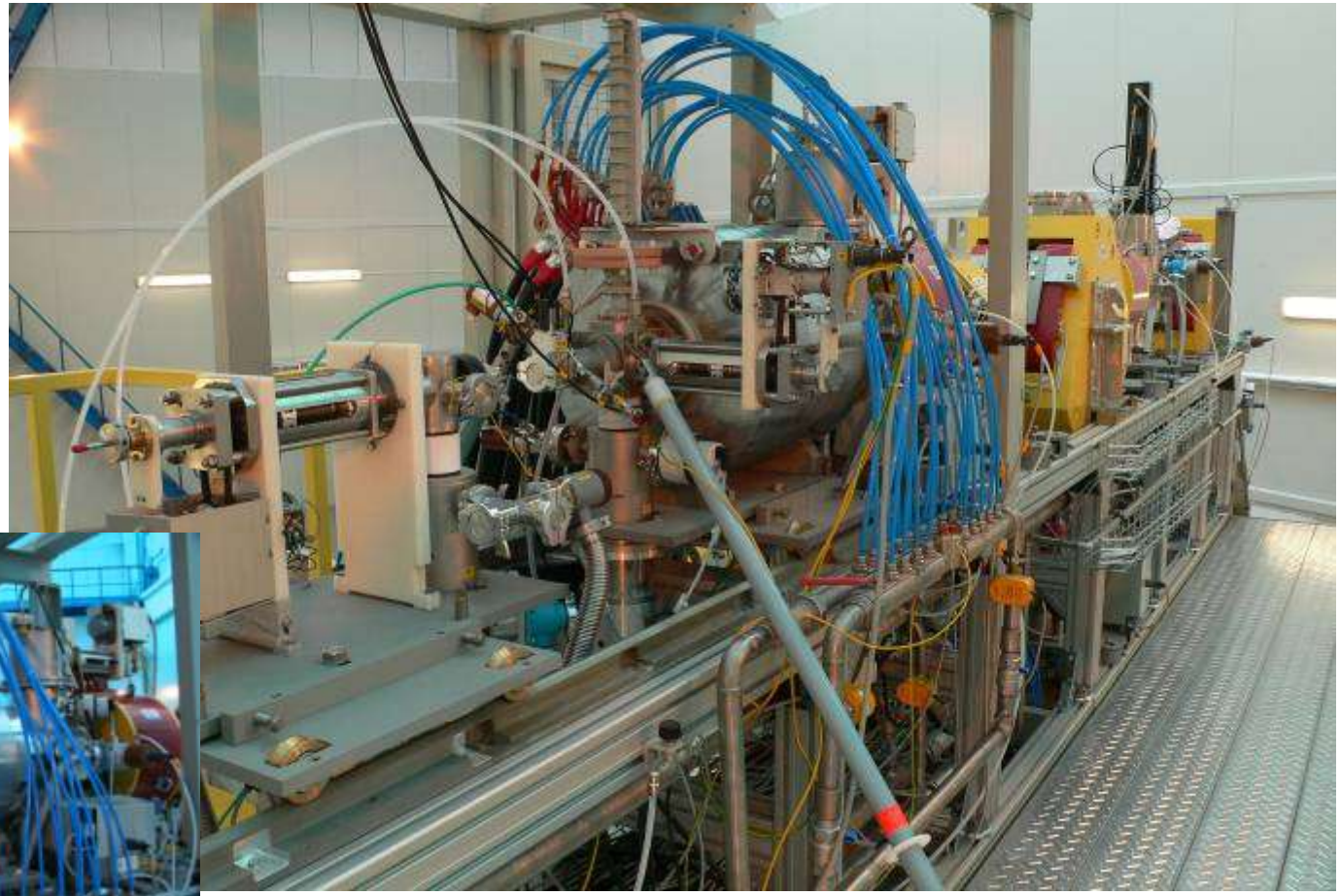
HF-system





DC-60 CYCLOTRON

THE SOURCE OF MULTICHARGED HEAVY IONS
ON THE BASE OF ELECTRON-CYCLOTRON RESONANCE



DC-60 CYCLOTRON

THE ION-OPTICAL CHANNELS

DC-60 CYCLOTRON

PROCESS CHANNEL
for nuclear track membranes irradiating

DC-60 CYCLOTRON

OPERATING CONSOLE

VACUUM SYSTEM

Required and derived vacuum

	Required	Derived
Injection channel	$1 \cdot 10^{-7}$ Torr	$(3\text{-}5) \cdot 10^{-8}$ Torr
Low-energy ion channel	$1 \cdot 10^{-7}$ Torr	$(3\text{-}5) \cdot 10^{-8}$ Torr
Cyclotron chamber	$(1\text{-}2) \cdot 10^{-7}$ Torr	$4 \cdot 10^{-8}$ Torr
High-energy ion channel	$5 \cdot 10^{-6}$ Torr	$5 \cdot 10^{-7}$ Torr

Vacuum pumping tools

1 stage – forvacuum pump ~ 10^{-3} Torr

2 stage – turbo molecular pump ~ 10^{-6} Torr

3 stage – cryogenic pump ~ 10^{-7} Torr

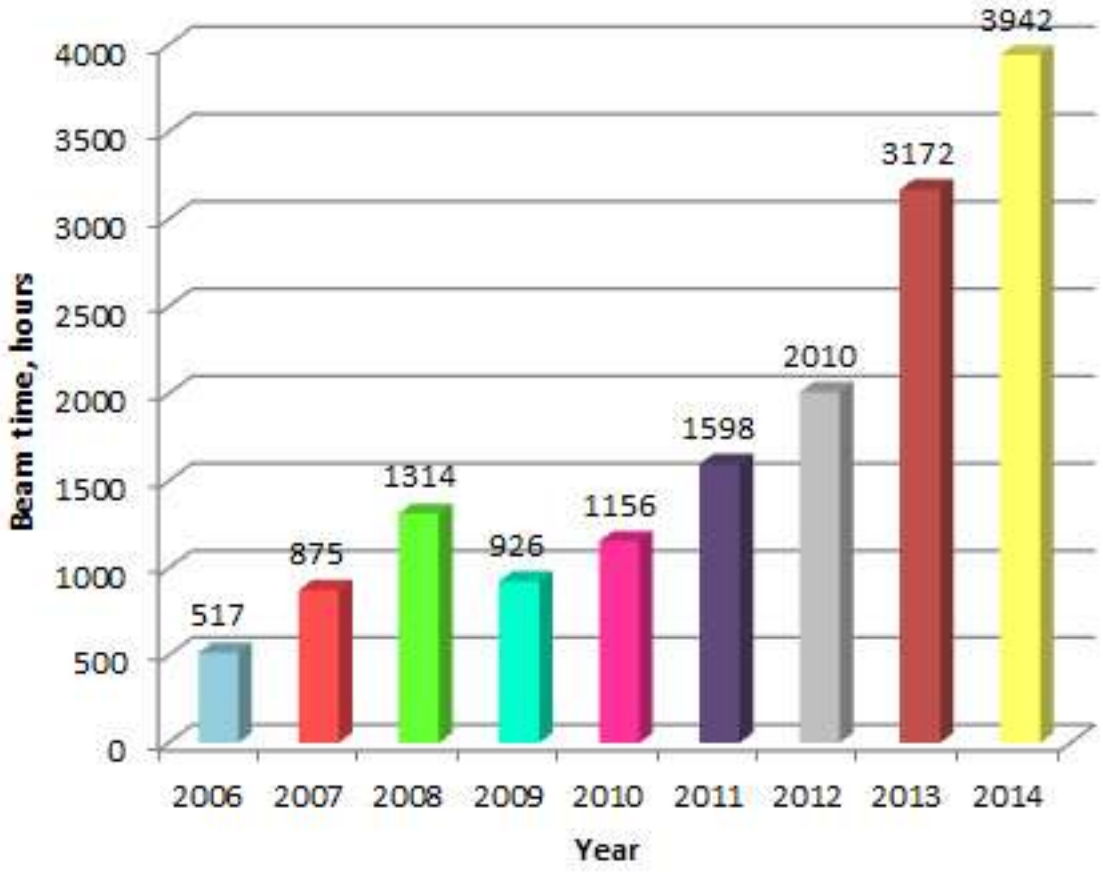
Parameters of the ion beams accelerated at the DC-60 in the course of the set-up works

Ion	A/Z	Energy, MeV/nucl.	Beam current ECR, μA	Extracted beam current, μA
$^{14}N^{2+}$	7	1	74	10.3
$^{14}N^{2+}$	7	1.35	74	3.75
$^{40}Ar^{3+}$	8	0.59	24	0.64
$^{40}Ar^{4+}$	10	0.49	44	0.9
$^{40}Ar^{7+}$	5.7	1.16	42	1.83
$^{40}Ar^{4+}$	10	0.66	37	1.4
$^{40}Ar^{7+}$	5.7	1.75	45.1	1.0
$^{84}Kr^{12+}$	7	1	11.4	2.5

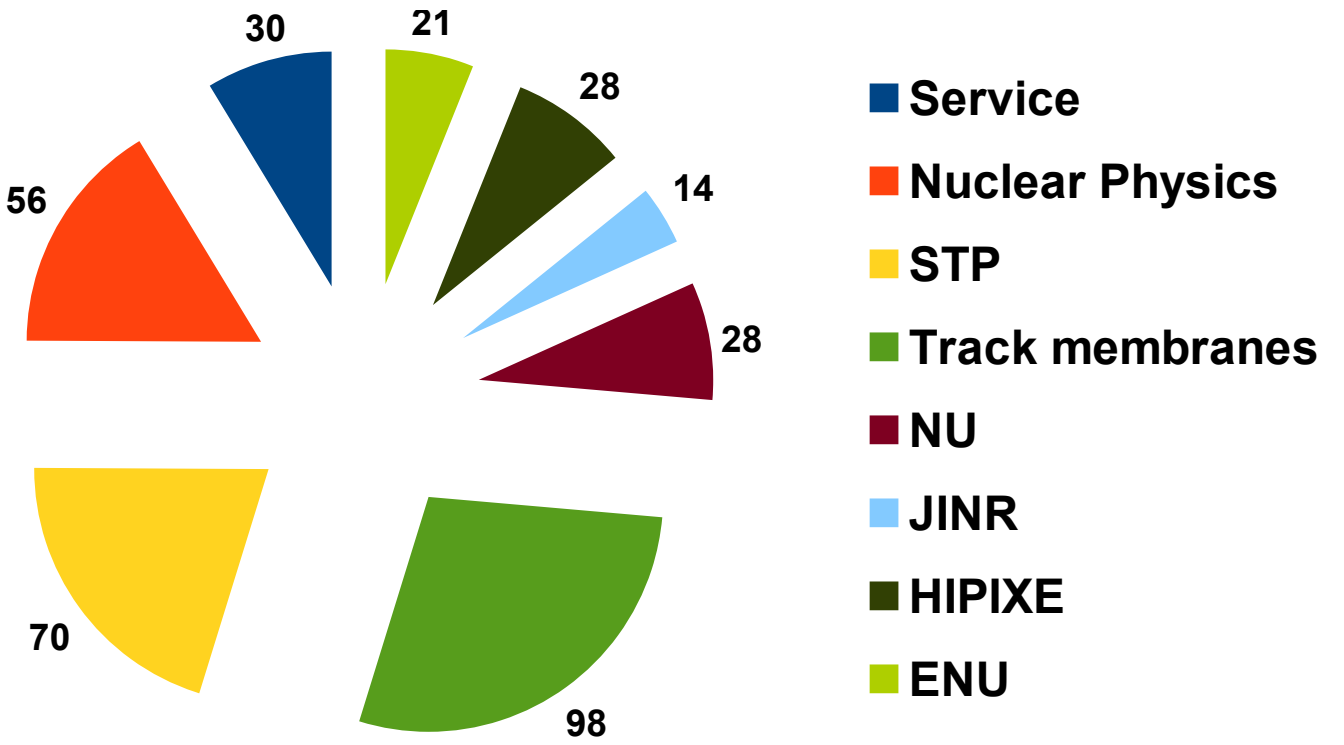
Parameters of the ion beams accelerated at the DC-60 on service

Ion	A/Z	Energy, MeV/nucl.	Beam current ECR, μA	Extracted beam current, μA
$^{7}Li^{1+}$	7	1.32	110	2.2
$^{12}C^{1+}$	12	0.40	63	0.6
$^{12}C^{2+}$	6	1.00	147	1.7
$^{12}C^{2+}$	6	1.25	150	1.5
$^{12}C^{2+}$	6	1.50	170	2.1
$^{12}C^{2+}$	6	1.75	140	1.7
$^{13}C^{2+}$	6.5	1.25	18.1	0.7
$^{13}C^{2+}$	6.5	1.50	19.9	0.6
$^{13}C^{3+}$	4.3	1.75	16.3	0.5
$^{14}N^{2+}$	7	0.4	84	0.9
$^{14}N^{2+}$	7	1.0	134	1.5
$^{14}N^{3+}$	4.6	1.4	325	2.0
$^{14}N^{3+}$	4.6	1.5	320	2.7
$^{14}N^{3+}$	4.6	1.75	120	1.9
$^{16}O^{2+}$	8	1.0	90	1.08
$^{16}O^{3+}$	5.3	1.25	85	1.1
$^{16}O^{3+}$	5.3	1.4	112	0.9
$^{16}O^{3+}$	5.3	1.5	95	0.8
$^{20}Ne^{3+}$	6.67	1.08	106.0	1.03
$^{20}Ne^{3+}$	6.67	1.4	95.8	1.56
$^{20}Ne^{4+}$	5	1.75	76.4	2.0
$^{32}Se^{6+}$	5.33	1.75	61.1	0.8
$^{40}Ar^{4+}$	10	0.48	44.6	0.67
$^{40}Ar^{4+}$	10	0.64	37.2	0.84
$^{40}Ar^{5+}$	8	0.58	24.2	0.4
$^{40}Ar^{7+}$	5.7	1.1	42.7	1.2
$^{40}Ar^{7+}$	5.7	1.75	45.1	1.0
$^{84}Kr^{9+}$	9.3	0.4	47.6	0.25
$^{84}Kr^{10+}$	8.4	0.7	49.8	0.4
$^{84}Kr^{12+}$	7	1	34.3	1.7
$^{84}Kr^{15+}$	5.6	1.4	26.2	1.9
$^{84}Kr^{15+}$	5.6	1.75	28.6	2.1
$^{132}Xe^{14+}$	9.42	0.6	11.8	0.14
$^{132}Xe^{15+}$	8.8	0.4	10.7	0.25
$^{132}Xe^{17+}$	7.7	1	21.2	0.45
$^{132}Xe^{20+}$	6.6	1.5	22.6	0.56
$^{132}Xe^{22+}$	6	1.75	16.5	0.41

TOTAL CYCLOTRON BEAM TIME IN THE YEARS 2006 - 2014



Implementation of the «DEVELOPMENT OF THE INTEGRATED RESEARCH IN THE FIELDS OF PHYSICS, CHEMISTRY, BIOLOGY, AND ADVANCED TECHNOLOGIES ON THE BASE OF THE DC-60 HEAVY ION ACCELERATOR» program



NUCLEAR TRACK MEMBRANES PRODUCTION ON THE BASE OF DC-60

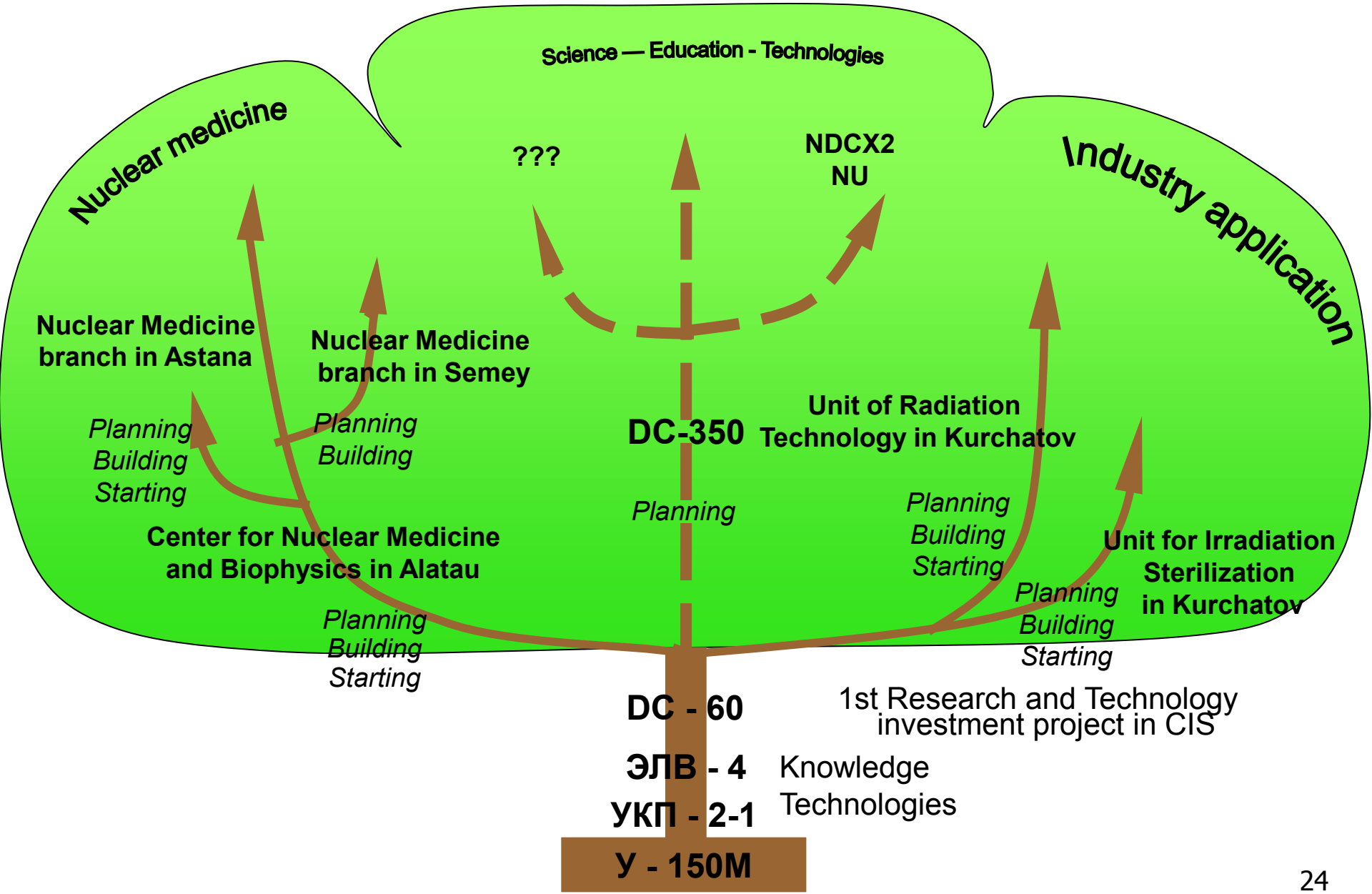
Irradiation of polymer films, formation of latent tracks

UV — sensibilization and chemical etching

IMPLEMENTATION OF COMMERCIAL CONTRACTS ON THE POLYMER FILM IRRADIATION

- ✓**2011** – 7 500 m
- ✓**2012** – 120 000 m
- ✓**2013** – 140 000 m
- ✓**2014 (plan)** – 80 000 m

THE DC-60 PROJECT'S BENEFITS




THANK YOU FOR YOUR ATTENTION!