1. Operation of the cyclotron during 2007

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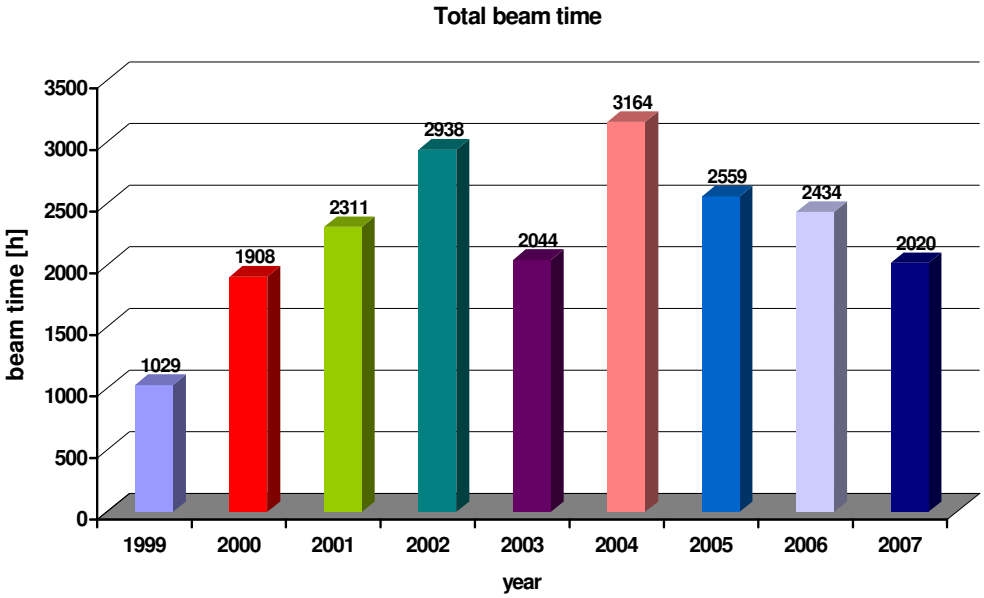
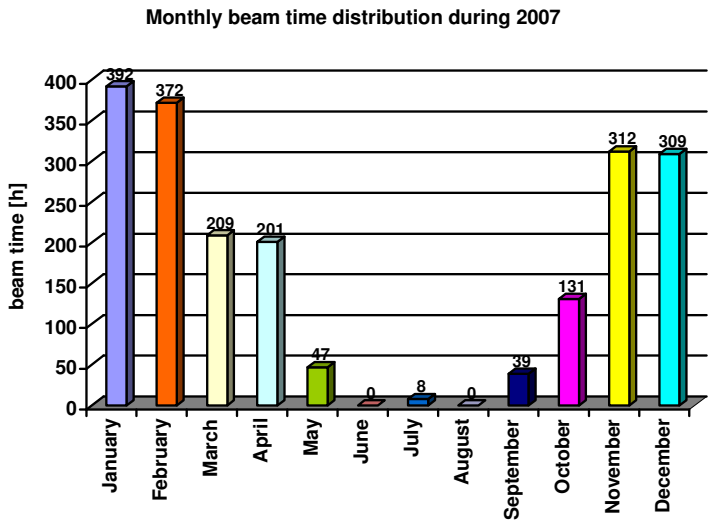
Cyclotron facility

In 2007 the cyclotron delivered a total of 2020 hours of beam-on-target. The figure below shows the usage of cyclotron beams over the last nine years.

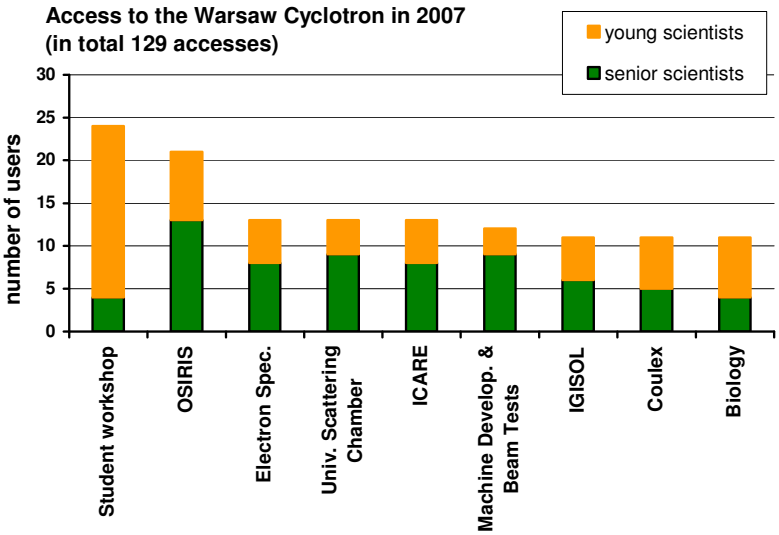


A decrease in the number of hours as compared to previous years was caused by severe technical problems, which could not be solved immediately and therefore strongly reduced the time when the accelerator was fully operational. The most important problem was related to the cyclotron water cooling system. The successive extension of the heat exchange system, performed at the beginning of 2007 by an external firm, proved insufficient again and Laboratory was forced to curtail some of the experiments scheduled for late spring and summer because of overheating problems. In September the heat exchange system was replaced completely. We have re-established the previous design of the cooling system and the proper cooling was restored, assuring again an undisturbed performance of the machine. Furthermore, the automatic control of water levels in primary and secondary cooling circuits was installed and put into operation.

Monthly distribution of the beam time during 2007 is presented in the following figure. The above-mentioned problems with water cooling system were responsible for the long break during summer months.



Participation of undergraduate and graduate students in experimental campaigns strongly reinforces the experimental teams currently working at HIL and helps them maintaining the research momentum. Involvement of young researchers is illustrated by the figure below, which shows the number of participants for each of the research projects performed in 2007 on beams of the Warsaw Cyclotron (see Table 1). Detailed description of experimental set-ups can be found at the Heavy Ion Laboratory website.



Despite the fact that basic nuclear physics research consumed most of the beam time, a fair share of it was allocated to other areas: the programme of radiobiological studies using heavy-ion beams was continued with three new measurements, and a week of beam time was assigned for the student workshop.

More detailed data concerning the development of the apparatus for research projects can be found in articles describing the on-going activities, published further in this section. The first experiment performed with the ICARE set-up on the upgraded line D is especially worth mentioning. The histogram and table with the number of hours used for various projects in 2007 are presented below.

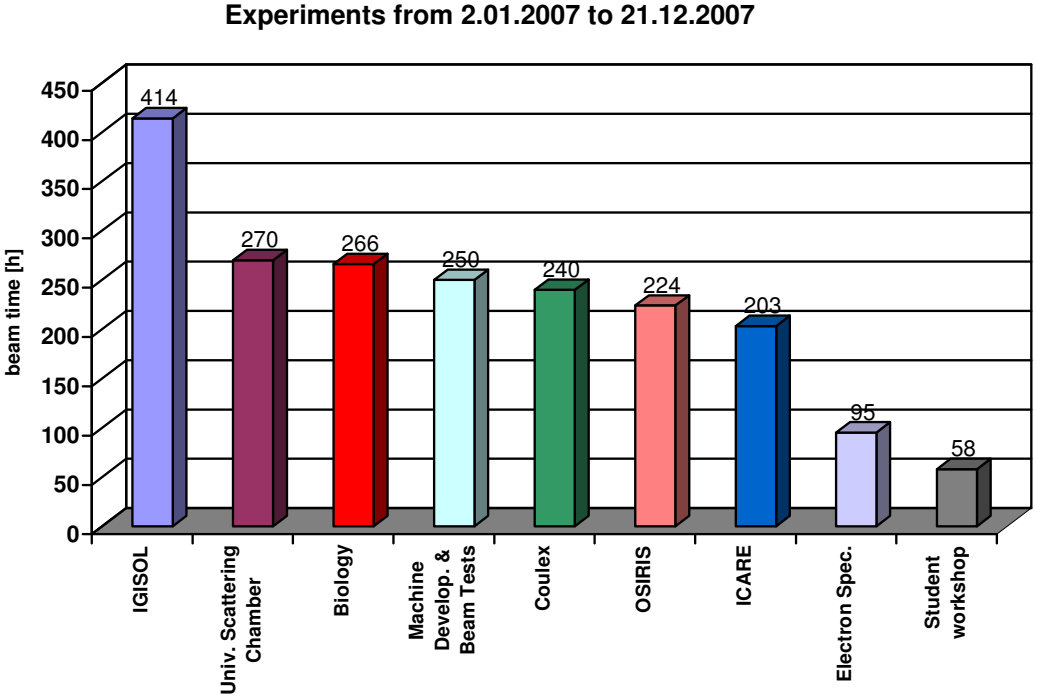


Table 1. Experiments from 02.01.2007 to 21.12.2007

Dates	Ion	Energy [MeV]	Experiment	Leading institution	Collaborating institutions
15.01 - 26.01	$^{40}Ar^{+8}$	208	OSIRIS	HIL	IEP UW, DP UŁ, INS Świerk, INP Kraków
29.01 - 02.02	$^{12}C^{+2}$	50	Biology	IEP UW, IB AŚ Kielce	HIL, IP AŚ Kielce, INS Świerk
05.02 - 16.02	$^{20}Ne^{+3}$	52 - 76	Machine dev. & test	HIL	
19.02 - 02.03	$^{18}O^{+4}$	117	Univ.Scat. Chamber	INR Kiev	INS Świerk, INP Kraków, HIL, NU Kharkiv
05.03 - 09.03	$^{16}O^{+3}$	85	IGISOL	IEP UW	HIL, INS Świerk, IPN Orsay, JYFL
13.03 - 15.03	$^{16}O^{+3}$	60	Student workshop	HIL	
16.04 - 20.04	$^{12}C^{+3}$ $^{20}Ne^{+3}$	50 118	Biology	IEP UW, IB AŚ Kielce	HIL, IP AŚ Kielce, INS Świerk
23.04 - 27.04	$^{16}O^{+3}$	79	Electron Spec.	DP UŁ	HIL, IEP UW, INS Świerk
10.05 - 23.05	$^{16}O^{+3}$		Machine dev. & test	HIL	
04.07 - 05.07			Machine dev. & test	HIL	
14.09 - 27.09	$^{20}Ne^{+3}$	52 - 76	Machine dev. & test	HIL	
02.10 - 10.10			Machine dev. & test	HIL	
18.10 - 19.10	$^{16}O^{+3}$		Machine dev. & test	HIL	
22.10 - 26.10	$^{16}O^{+4}$	96	IGISOL	IEP UW	HIL, INS Świerk, IPN Orsay
06.11 - 07.11	$^{16}O^{+3}$		Machine dev. & test	HIL	
08.11 - 09.11	$^{14}N^{+3}$	84	ICARE	HIL, IPHC Strasbourg	IEP UW, INS Świerk, INP Kraków
12.11 - 16.11	$^{18}O^{+4}$	102	IGISOL	IEP UW	HIL, INS Świerk
19.11 - 30.11	$^{14}N^{+3}$	83	ICARE	HIL, IPHC Strasbourg	NU Kharkiv, US Katowice, UB
02.12 - 14.12	$^{32}S^{+5}$	84	Coulex	HIL	FP UAM, DE&IT WUT, IP UMCS CEA Saclay, SE&T UB
17.12 - 21.12	$^{12}C^{+3}$	50	Biology	IEP UW, IB AŚ Kielce	HIL, IP AŚ Kielce, INS Świerk

Abbreviations used in Table 1:

CEA Saclay	CEA Saclay, IRFU/SPhN, Gif-sur-Yvette, France
DE&IT WUT	Dep. of Electronics and Information Technology, Warsaw University of Technology
DP UŁ	Department of Physics, University of Łódź, Łódź
HIL	Heavy Ion Laboratory, Warsaw University, Warsaw
IB AŚ Kielce	Institute of Biology, Świętokrzyska Academy, Kielce
IEP UW	Institute of Experimental Physics, Warsaw University, Warsaw
IP AŚ Kielce	Institute of Physics, Świętokrzyska Academy, Kielce
FP UAM	Faculty of Physics, Adam Mickiewicz University, Poznań
INP Kraków	The Henryk Niewodniczański Institute of Nuclear Physics, Polish Academy of Sciences, Kraków
INR Kiev	Inst. For Nuclear Res., Ukrainian Nat. Ac. Of Science, Kiev, Ukraine
INS Świerk	The Andrzej Sołtan Institute for Nuclear Studies, Świerk
IPHC Strasbourg	IPHC Strasbourg, France
IPN Orsay	Institute Physique Nucléaire, Orsay, France
IP UMCS	Institute of Physics, M. Curie-Skłodowska University, Lublin
JYFL	Department of Physics, University of Jyväskylä, Finland
NU Kharkiv	National University, Kharkiv, Ukraine
UB	University of Białystok
US Katowice	University of Silesia, Katowice

Plans of development

		Estimated completion time
1.	Cyclotron	
1.1	Simulations of a new injection beam line	2008
1.2	Design of a new injection beam line to connect the two external ECR ion sources to the cyclotron	2009
2	Experimental hall	
2.1	Upgrade of the beam line on line “D”	First half of 2008
2.2	Installation of a new vacuum control system	2008
3	Power supplies	
3.1	Design of a new interface for existing quadrupole power supplies	2009

4	ECR ion source	
4.1	Installation of the new buncher	First half of 2008
4.2	Execution of the contract for a new ECR ion source	2008
4.3	Factory test of the new ECR ion source	Second half of 2008
5	RF generators	
5.1	Project of a new synthesizer with DDS (Direct Digital Synthesis) for RF signals	2009
5.2	Phase and amplitude noise compensation system for the RF power amplifiers	2009
5.3	Design and installation of a new water leak detection system for the RF generators	2008
6	Vacuum system	
6.1	Installation of the diffusion pump drivers	2008
7	PET	
7.1	Design of the PET radiopharmaceutical production centre	First half of 2008
7.2	Construction works	Second half of 2008
7.3	Beginning of assembling of the PET equipment	Second half of 2008
7.4	Conclusion of the project	February 2009

2. Activity report of the ECR group

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In 2007 ECR ion source worked smoothly, delivering the following ions to the cyclotron:

Ion	$^{12}C^{+3}$	$^{14}N^{+3}$	$^{16}O^{+3}$	$^{16}O^{+4}$	$^{18}O^{+4}$	$^{20}Ne^{+3}$	$^{20}Ne^{+4}$	$^{35}S^{+5}$	$^{40}Ar^{+8}$
Current on the inflector [eμA]	95	134	100	132	102	100	115	85	50

Apart from routine maintenance and cleaning of the ion source, the ECR team was involved in tests of the new buncher. The tested buncher was equipped with a cylindrical electrode of about 50 mm length, designed for ions with q/m ratio in the 0.15 – 0.18 range. For comparison, the buncher presently used at HIL has an electrode of 36 mm length, suitable for q/m ranging from 0.18 to 0.25. The ion current obtained with the new electrode was about four times larger than without the buncher (test performed with Ne^{+3} ions).