Accelerator Operation Report

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This report describes the operation statistics of the accelerator facility in the year 2005. The data has been collected with the help of the program PROST [1].

1. General overview

Altogether there were four beam periods scheduled in 2005. Operating time started on January 12th with a beam period of about nine weeks. The second block of operation started after a three week shutdown at the beginning of April and ended on June 9th. After a short shutdown of two weeks the third period started on June 22nd and lasted until August 25th. The following three weeks were used for shutdown and upgrade work again. The last beam period started on September 14th and was initially supposed to last until the end of November. Because of extensive experiment requests for additional beam time this block was prolonged until December 15th.

	Total beam time 2005	Target time 2005	Target time 2004
UNILAC	7208 h	6132 h	5449 h
SIS	8361 h	6315 h	5885 h
ESR		1374 h	1225 h

Table 1: Overall beam time of the accelerator facility

Table 1 shows total beam time and achieved target time for different experimental areas. In 2005 accelerator operating time (number of working hours) increased by 40 days compared to 2004, now amounting to 6928 hours, the equivalent of 866 accelerator operation shifts. The former annual maximum was 800 shifts. Thus the increased operation time has led to a considerable higher amount of target time for both accelerators.

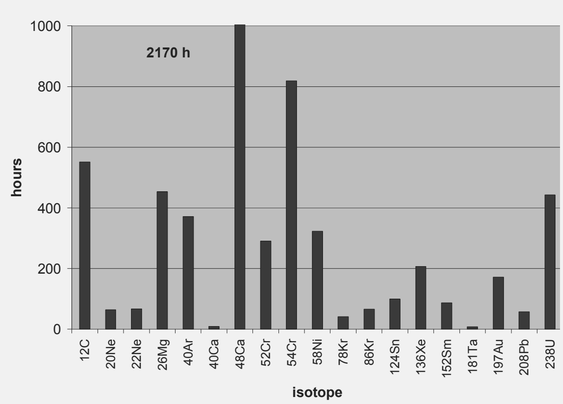

Figure 1:
Accelerated isotopes for UNILAC experiments

Over the year ion beams of 30 different isotopes from hydrogen to uranium were accelerated and delivered to 21 low energy experiments at UNILAC and 38 high energy experiments at SIS. As shown in Figure 1 UNILAC experiments mainly requested medium heavy elements. The synchrotron users preferred carbon and uranium beam (Figure 2).

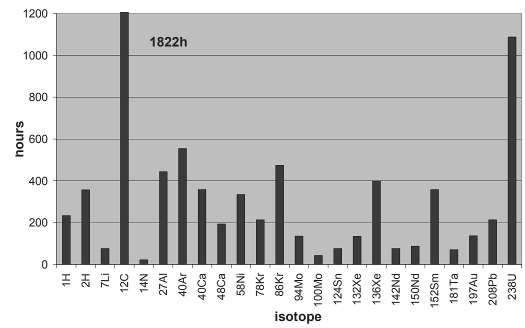

Figure 2:
Accelerated isotopes for SIS experiments

2. UNILAC Operation

The beam time for the UNILAC experiments is summarized in table 2. The ratio of "number of hours for listed category" to "total amount of beam time" is expressed as a percentage and indicates the efficiency of accelerator operation.

The increase in operation time and the reduction of unscheduled downtime by a factor of 2 led to a higher amount of beam time available for the experiments. The necessary tuning time remained on the same level as last year. The time for accelerator development was on the rise again in 2005, as it had been in 2004.

A closer look at the unscheduled down time reveals that it

	(h)	Percentage
Target time for exp. runs	6132	85%
Beam for experiment tests	14	0,2%
Accelerator development	236	3,3%
Accelerator tune-up	415	5,7%
Ion source replacement	112	1,6%
Unscheduled down time	209	2,9%
Retuning	70	1,0%
Stand-by	20	0,3%
Total beam time	7208	

Table 2: Beam delivered to UNILAC experiments

can be attributed to failures of rf-amplifiers (63h), injectors (30h), computer control (2h), beam diagnostics (3h) vacuum system (16h), magnet power supplies (37h), infrastructure (21h), and others (42h). Compared to 2004 the down time for rf system and injectors is significantly lower. Instabilities of beam position (mainly at the end of the poststripper section) sometimes led to difficulties in operation. Problems with the beam chopper and a vacuum leak in the RFQ at the High Charge State Injector caused changes of the beam time schedule in the 4th block. Besides this no major problems had to be reported.

	(h)	Percentage
Beam available for SIS injection	9025	92,2%
Accelerator development	39	0,4%
Ion source replacement	104	1,1%
Accelerator tune-up	282	2,9%
Unscheduled down time	317	3,2%
Retuning	21	0,2%
Total beam time	9788	

Table 3: UNILAC beam delivered to SIS in 2005

Table 3 displays the beam time provided by the UNILAC for SIS injection. Beam availability grew by 2.8 % compared to 2004, less time for tune up was needed and the share of down time decreased.

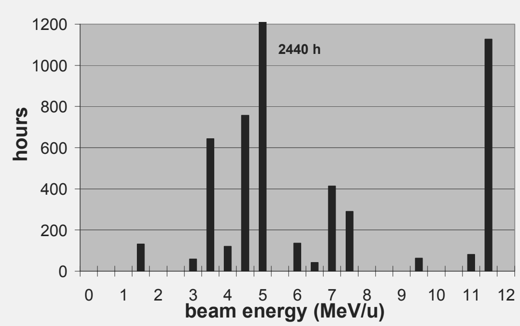

Figure 3: Beam energies of the UNILAC experiments

In Figure 3 the target time of the UNILAC experiments (without beam injected into SIS) is displayed versus beam energy. Beam energies in the range from 4 to 5 MeV/u mainly resulted from experiments for super heavy element synthesis, nuclear chemistry experiments took place at 7 MeV/u and energies at 11.4 MeV/u were used for material science, biology and plasma physics experiments.

3. SIS Operation

Operation statistics for SIS are shown in table 4. Compared to last year the total target time considerably increased. The amount of beam time for the ESR and for patient treatment remained constant. The time for SIS accelerator development increased as it did at the UNILAC.

The main part of down time was related to problems with magnet power supplies, at least 108 h. Vacuum down time was 42 hours in this year. Other categories of technical problems led to the following loss in beam time: infrastructure (21h), rf-amplifiers (increased to 22h), beam diagnostics (2h), controls (15) and others (80h). A four day operation break due to a vacuum leak at the end of the transfer channel to SIS is not included in down time statistics, because the experiments could be shifted. There were a lot of shorter breaks due to low reliability with the flow meters of magnet cooling in the beamlines behind SIS. Fluctuations in the spill structure (below 1µsec) have to be reduced at high intensities. At the moment there is unfortunately no tuning concept, but beam diagnostics were installed to investigate the behavior of the beam concerning time structure of the spill.

	(h)	Percentage
Beam for target area	5079	60,7%
Therapy	1236	14,8%
Beam for experiment tests	0	0,0%
Target time	6315	75,5%
Beam delivered to ESR	1374	16,4%
Accelerator development	248	3,0%
Accelerator tune-up	134	1,6%
Unscheduled down time	290	3,5%
Total beam time	8361	

Table 4: SIS operation time in 2005

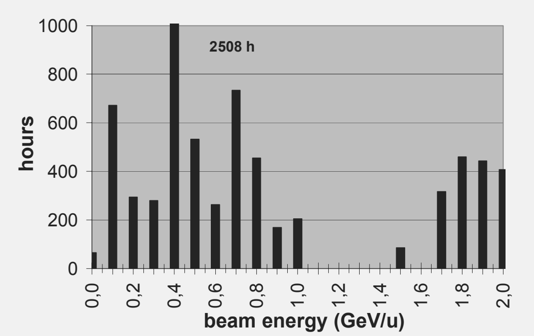

Figure 4: Beam energies of the SIS experiments

Figure 4 shows the beam time versus energy for the SIS experiments. The high amount of target time at energies at about 400 MeV/u stems from the acceleration of 12C beam for cancer therapy. As main users of gold, lead and uranium the ESR got beams with energies up to 500 MeV/u and the fragment separator up to 1GeV/u. The highest energies were delivered for pion production and for atomic physics experiments.

References

[1] **PR**ogramm für **O**perating und **ST**atistik