Operation Report of UNILAC and SIS

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The statistics of the accelerator operation in 2000 were collected with the help of the program **PROST** [1]. The topics of accelerator development and experiments are described in separate contributions [2], [3] and [4] to this annual report.

1. General overview

In 2000 the new operation capabilities of the High Current Injector (HSI) determined the accelerator operation. After its start of operation in November 1999 a lot of experiences have been made concerning the pulse to pulse operation with up to three ion sources (see Figure 1 for the multiplicity of accelerated isotopes). The new operation possibilities allow to satisfy better the growing demands of the experiments concerning time sharing operation and beam intensity, but to satisfy them a careful scheduling of the beam time becomes more and more essential.
There was three longer beam periods in this year of over 2 month length and a shorter one (the second) of one and half month length. A four week shut down in September were used for maintenance of the Alvarez I cavity and the vacuum system behind the SIS.

Table 1: Overall beam time of the accelerator facility

	Total beam time ´00 (h)	Target time ´00 (h)	Target time ´99 (h)
UNILAC experiments	6013	4854	3806
SIS experiments	8166	5118	4255
ESR experiments		1031	1081

The total beam time in comparison with the achieved target time is given in table 1 for the different experimental areas. The operation time of the accelerator facility (number of working hours), 6088 h in 2000, were two shifts shorter than in the last year. The main reason for the higher values of target time at the UNILAC and the SIS experimental area is due to the more extensive use of the time sharing operation. The value for the ESR accelerator remains nearly constant.
As shown in Figure 1 beams of 25 different isotopes (twice as much as in the last year) were accelerated. They were delivered to 20 low energy experiments at the UNILAC and to 29 high energy experiments behind the SIS. Ion beams from the Penning terminal with a mass to charge ratio below 20 (high duty cycle) were due to the low terminal voltage difficult to handle. This led sometimes to unstable beam parameters at the experiments. The planed installation of a new power supply for the preacceleration gap should solve this problem in 2001.

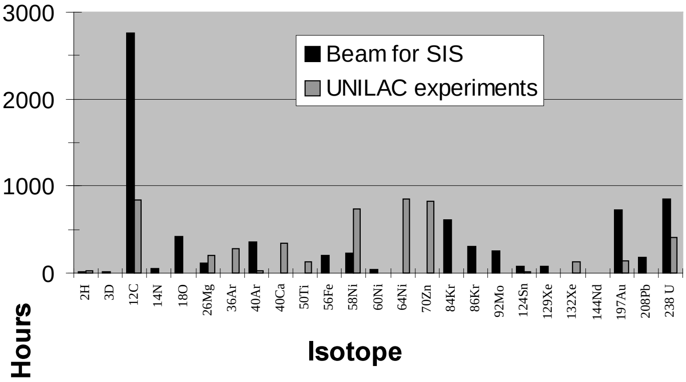

Figure 1: Accelerated isotopes in 2000

2. UNILAC Operation

The beam time for the UNILAC experiments is summarized in table 2. The column „performance“ indicates the efficiency of the accelerator operation. It contains the ratio (in percent) between the corresponding number of hours and the total beam time. The difference between operation time and total beam time is due to the time sharing operation of the accelerator.

Table 2: Beam delivered to UNILAC experiments in 2000

	(h)	Performance
Target time for experiment runs	4854	80,8%
Beam for experiment tests	33	0,5%
Accelerator development	108	1,8%
Accelerator tune-up	496	8,2%
Ion source replacement	103	1,7%
Unscheduled down time	311	5,2%
Retuning	52	0,9%
Stand-by	56	0,9%
Total beam time	6013	

The sum of beam time for experiment (including tests) is higher as in 1999. The 108 hours for accelerator development result to a large fraction from the commissioning of the new High Current Injector.
The unscheduled down time was due to failures of injectors (36h), rf-amplifiers (78h), magnet power supplies (48h), beam diagnostics (3h), vacuum system (38h), computer control (12h) and others (96h).

Table 3 displays the provided beam time of the UNILAC for SIS injection. The operation of the new stripper section in the beam transfer line to SIS allows the injection of stripped and unstripped ions into the SIS in the time sharing mode. Technical problems due to different field values of the dipole magnets in this operation mode made a permanent correction of the settings necessary. By installation of Hall probes in the corresponding magnets (scheduled in 2001) this problem should be solved.

Table 3: UNILAC beam delivered to SIS in 2000

	(h)	Performance
Beam available for SIS injection	7261	88,9%
Accelerator development	79	1,0%
Ion source replacement	106	1,3%
Accelerator tune-up	238	2,9%
Unscheduled down time	439	5,4%
Retuning	43	0,5%
Total beam time	8166	

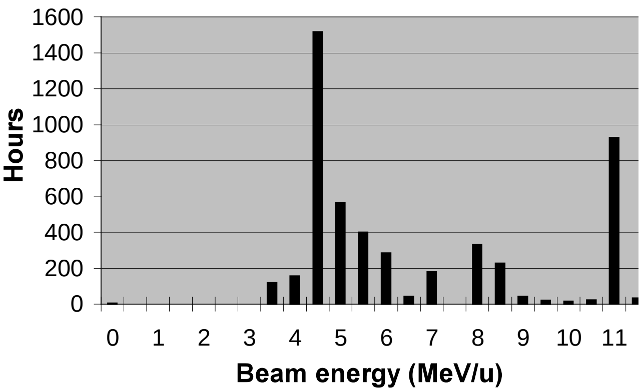

Figure 2: Beam energies of the UNILAC experiments

In Figure 2 the target time of the UNILAC experiments (without beam injected into SIS) is displayed versus energy. The upgrading of the phase control unit reduced the number of the available single gap resonators, so the energy range was restricted. The beam energies in the range from 4 to 6 MeV/u mainly result from the experiments for superheavy element synthesis and nuclear physics. Energies around 8 MeV/u were used for nuclear chemistry experiments and above 10 MeV/u for material science and for the plasmaphysics experiments.

3. SIS Operation

In table 4 the operating statistics for the SIS is given. The total target time is about 400 h higher compared to last year.

Table 4: SIS operation time in 2000

	(h)	Performance
Beam for target area	3681	54,8%
Therapy	1437	21,4%
Beam delivered to ESR	1031	15,3%
Beam for experiment tests	6	0,1%
Total target time	6155	91,6%
Accelerator development	141	2,1%
Accelerator tune-up	70	1,0%
Unscheduled down time	354	5,3%
Total beam time	6720	

The loss in beam time due to technical failures distributes to power supplies (43h), rf-amplifiers (20h), beam diagnostics (5h), computer control (23h), vacuum system (149h) and others (114h). A leak caused by a broken vacuum window in an experimental setup is mainly responsible for the high number of vacuum loss hours.

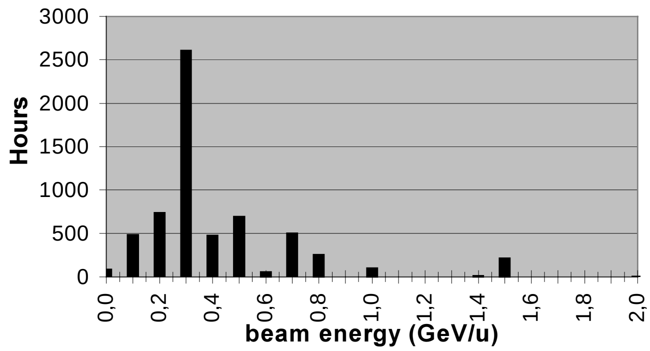

Figure 3: Beam energies delivered to the SIS experiments

Figure 3 shows the beam time versus energy for the SIS experiments. The high fraction of target time at about 400 MeV/u results as well as in the last year from the acceleration of ^{12}C beam for the cancer therapy. The lower range of energy was also used (Figure 3) to provide beam for the ESR and for plasma physics experiments.

References

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

[2] J. Klabunde et. al. UNILAC Status and Developments

[3] K. Blasche et. al. SIS Status Report

[4] M. Steck et. al. ESR Operation and Development