

Operation, Maintenance and Developments of the LNL accelerators in the year 2001

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I. THE XTU-ALPI COMPLEX

In the year 2001 the XTU-ALPI Complex furthermore increased its performances reaching a maximum energy in excess of 630 MeV with medium heavy ions like $^{82}\text{Se}^{17+}$ (7.7 MeV/u). A maximum specific energy of 20 MeV/u was also reached with a beam of $^{12}\text{C}^{6+}$.

The ions accelerated with the XTU-ALPI Complex during the last two years are shown in *Table 1* together with the number of cavities used and the average energy gain per charge and per cavity (low-beta cavities were never been used in those runs).

The new performances were the result of the strong activity of the up-grading programme to the Sputtered Niobium QWRs (from Pb on Copper QWRs) which put in operation five up-graded cryostats.

As a result of the up-grading programme with sputtered Niobium QWRs, the average energy gain per unit charge in each cavity increased continuously in the two years reaching a value of 0.563 MeV/unit charge-cavity with a $^{56}\text{Fe}^{6+}$ beam. The energy gain per unit charge is also a function of the ion velocity. That is the origin of the relatively lower value of 0.526 reached recently with the $^{12}\text{C}^{6+}$ beam with a relativistic beta not well matched to the QWRs optimum beta of the medium beta section ($\beta_{\text{opt}}=0.11$). In this case the acceleration efficiency is poor (low transit time factor) and the energy gain per unit charge is reduced.

Fig. 1 shows the accelerating fields of the different ALPI QWRs at the end of the year (CR16 was ready to be install). The overall average field along the post-accelerator reached 4.3 MV/m with an average field of about 6 MV/m for the up-graded cavities of the high-beta section (CR19 and CR20).

The up-grading programme was carried on taking also advantage of the maintenance programme on each cryostat that was necessary in order to solve few problems coming both from cryogenics (failures in the immersed valve) and from X-ray deterioration of the sealing of the beam pipe sectioning valve.

In order to complete the up-grading programme with the sputtered Niobium QWRs, four more cryostats (CR12, CR13, CR14 and CR18) will be up-graded in the next year with an average accelerating field in excess of

4 MV/m hopefully available all along the post-accelerator.

The XTU tandem was able to reach 15 MV during all the year in stable conditions and to deliver more than 5600 hours of beam on the experimental targets. About 25% of the beam on target were delivered from ALPI after post acceleration.

The cryogenic system of the ALPI post-accelerator worked in a reliable way after the implementation made in the previous year. As a result of the higher reliability of the cryogenic system all the scheduled runs with ALPI was completed without failures. The Wet Expander was also further tested in different conditions and showed to be unable to work properly in an automatic way as refrigerator with the RF cavities switched on. During the test the Wet Expander worked at frequencies not higher than 2.3 Hz.

Further tests were performed on the cooling possibility of the low beta cryostats without success. The tests put in evidence that, in addition to the poor cooling capability of the distribution lines, also failures on the 5 K cryogenic valve (output of L-He vessel) of two cryostats. This implies a serious maintenance work on two valve boxes that will have to be done as soon as possible. At the same time, in order to solve the G-He distribution problem an up-grading programme on the valve boxes in the high energy branch of ALPI is also under development. The programme foresees the design of a new section of the G-He distribution line just at the exit from the cold-box with proportional valves instead of on-off valves in order to better balance the high energy and low energy branch.

II. THE CN-7 MV VAN DE GRAAFF

The up grading initiatives on the CN-7 MV Van de Graaff accelerator were carried on also for the year 2001. In particular continued the attention to develop subsystems able to allow for the operation of the machine with large fluxes of neutrons (10^{10} n/sr.sec on the target) and to increase the number of working hours.

In order to increase the beam on target time, a new automatic conditioning system was developed (A. Zanon) and implemented on the accelerator. The

software was developed with the Visual Basic Package together with Measurement Studio of National Instrument.

With the new automatic conditioning system the machine is usually left under conditioning during the week-end and therefore it is ready to start at the chosen voltage in the first working hour of Monday. The automatic conditioning works also during the night allowing to increase significantly the beam on target time that reaches a total of 1415 hours for 29 different experiments.

III. THE AN2000-2 MV VAN DE GRAAFF

In the year 2001, 27 experiments was research groups

from national and international research institutions used the AN2000-2.5 MV Van de Graaff for a total 2240 hours Beam on Target in the framework of the Large Scale Facility of the European Union. The micro-beam facility delivered beam on target for more than 550 hours.

The major maintenance work on the machine during the year involved the beam pipe inside the analysing dipole where the implanted deuterium together with a leak on the palladium valve on the ion source (parasitic deuterium beam) was producing a high level of neutron radiation. The beam pipe was changed with a new one with a sliding external wall allowing easy future substitution.

Table 1: Accelerated beams with ALPI in the years 2001-2002

DATE	ION	RF Cavities	b _{in}	b _{out}	Energy Gain/ Charge Cavity (MeV/ch.un cav)	Output Energy (MeV)	Output Specific Energy (MeV/u)
21FEB00	³² S ¹²⁺	25	0.107	0.142	0.435	300	9.4
27FEB00	³² S ¹²⁺	29	0.101	0.140	0.449	328	9.1
02MAR00	⁶² Ni ¹¹⁺	14	0.088	0.105	0.428	316	5.1
14MAR00	⁴⁸ Ca ⁹⁺	18	0.079	0.097	0.436	206	4.3
14NOV00	³² S ¹²⁺	31	0.107	0.153	0.477	350	10.9
22NOV00	⁵⁸ Ni ¹⁵⁺	29	0.084	0.114	0.340	330	5.7
04FEB01	⁵⁸ Ni ¹³⁺	13	0.087	0.100	0.395	267	4.6
14FEB01	⁵⁸ Ni ¹³⁺	29	0.087	0.118	0.456	380	6.5
22FEB01	⁸² Se ¹⁷⁺	41	0.079	0.123	0.502	590	7.2
03MAR01	⁸² Se ¹⁷⁺	43	0.079	0.128	0.537	631	7.7
15JUN01	³² S ⁹⁺	22	0.093	0.117	0.429	230	6.4
29JUN01	⁷⁴ Se ¹⁸⁺	22	0.085	0.111	0.439	422	5.7
07JUN01	⁸³ Se ¹⁶⁺	32	0.074	0.110	0.487	464	5.6
12JUL01	⁶⁵ Cu ¹⁵⁺	12	0.079	0.093	0.374	260	4.0
05NOV01	¹² C ⁶⁺	43	0.137	0.208	0.526	240	20.0
13NOV01	⁵⁶ Fe ⁶⁺	32	0.083	0.120	0.563	380	6.8

ALPI 2001 (December)

Resonator Accelerating Fields at 7 W

