Update
Status of Charissa at Strasbourg

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The Charissa beamline at Strasbourg was commissioned with a series of tests followed by a short feasibility study during the period 21st-25th October 1996. The outcome of these tests is presented in this document with a summary of the current status of Charissa's experimental capability at Strasbourg. Please refer to the report CH/Tech/96/04 by Bob Cunningham for technical details regarding the beamline equipment.

1 Beam Tests

A 104 MeV ^{16}O beam was provided for the initial testing of the beamline equipment. Firstly, the tuning of the beam from the Vivitron through the 8 mm (vertical) $\times$ 3 mm (horizontal) diagnostic box aperture was investigated. All elements upstream of the diagnostic box are controlled by the Vivitron operators. It was not possible to focus the beam through this aperture without the quadrupole (QSW) upstream of the switching magnet steering the beam in the vertical direction. When the beam was set-up through this quadrupole such that application of power to the magnets did not introduce any steering, the beam was too high at the diagnostic box aperture position and had to be steered down a little. When that was done, however, it was clear that the spot size was not bigger than the aperture because, even though the beam fluctuated in intensity and position, the current intercepted by the aperture did fall to zero for a good fraction of the time. These tests indicate that the components of the Vivitron beamline prior to the Charissa line are not optimally aligned and also that the angle of the beam directed towards QSW is not optimum.

During the commissioning, run, there was only one set of H/V steerers (the ones upstream of QSW) available for steering the beam after the object waist for QSW. Normally, there should be two sets: one before and one after QSW. Having both of them available would, in principle, (but not easily) allow a better line to be chosen for the beam entering the switcher and then on to the diagnostic box. As it is, reproduction of beams using old machine parameters is imperfect (since one relies upon some vertical steering of the beam upstream of the quadrupole where the electric steerers have an imprecise readout). The setting up of beam to this point is then more difficult than is desirable. If the diagnostic box aperture is used to define the beam for all experiments this does not present any problem. A little practise by the operators should hopefully speed up the beam set-up time.

1.1 The Charissa Beam Line

All elements of the Charissa line worked correctly. A little steering was required on the electric X-Y steerers (in Y). This reflects the problem discussed above. A small correction to the beam was required as it emerged from the diagnostic aperture angled vertically. The beam line was set up through the magnetic axis of the quadrupole without difficulty (i.e. non steering quadrupole) through a 2mm $\times$ 2mm scintillator aperture at the target position and onto the chamber Faraday cup. The beam transmission on the line (between the diagnostic and Faraday cups) was $\simeq 100\%$. The beam optics were found to be slightly better than those calculated (by Tom Aitken using emittance information more appropriate for heavier ions than oxygen) where the calculations indicate a 3 mm $\times$ 3 mm beam spot at the target and are representative of what may be expected for heavier ions. The beam divergence was also tested by winding the line slits in and reading off the current at various distances. The beam size at the slits was approximately 7 mm (vertical) by 5 mm (horizontal). These slits are positioned immediately downstream of the last quadrupole doublet in the line at a distance of 4 m from the target.

The line was also tested with two other beams. The magnet settings were found to scale approximately with the relative analyzing magnet B fields when going to 84 MeV ^{16}O and then 50 MeV ^{7}Li. A summary of the beams tested is given in table 1. The energies of these beams are calculated (as provided by the Vivitron operator). The range of beam dump currents shown represents the large fluctuation in measured beam current. This fluctuation is dramatic and periodic and believed to result from the join in the belt charging system. The fluctuations can be reduced by defocussing the beam through the machine, which also reduces the maximum intensity and presumably the beam quality (in terms of energy). The absolute energy calibration is not at all clear. The analyzing magnet object point does not appear to be well defined and probably accounts for the fact that improved stability can be gained by analyzing a defocussed beam.

The beam energy change from 104 MeV ^{16}O to 84 MeV took just over 1 hour and highlighted some possible difficulties in procedure. A reduced beam current is desirable during set-up so as to avoid destroying the diag-

Beam	Calculated Energy	Rough Beam Dump Current
^{16}O (6+)	104 MeV	0-25 enA
^{16}O (6+)	84 MeV	0-8 enA
^{7}Li (3+)	50 MeV	0-10 enA

Table 1: Summary of the Beams tested.

nostic scintillator (and detectors when tuning down the beam line). It is usual to increase the beam current after the initial tuning. This control over intensity is difficult to achieve at present and not usually performed. In addition, the analyzing magnet was not "cycled" to avoid hysteresis. The "odd" beam energies are a result of requesting 100 and 80 MeV beams without emphasizing the importance of the absolute energy. The result was the setting of the terminal voltage as the priority not the energy of the analyzed beam. With some experience it is expected that the time to change beam energy could be halved at best. A change of beam species requires at least one day and is subject to the availability of the source operator.

1.2 Transmission Tests

A request was made for the rough variation of beam transmission with machine terminal voltage to be measured. A summary of the results is given in Table 2. Note that two different injection currents were used in the tests using ^{16}O and that the analyzed beam is measured immediately after the analyzing slits. There is clearly a large drop in beam intensity as the terminal voltage is reduced. The machine transmission for ^{16}O at 15 MV is $\simeq$10$\times$ that at 9 MV.

1.3 Particle detection

Two surface barrier detectors were mounted in the chamber during the tests. One was used to measure beam scattered from the target (and possibly elsewhere), the other to measure α-particles following the activation of a ^{208}Pb target with a ^{7}Li beam in a feasibility study of the (possible) breakup modified Lithium fusion cross section. The results of this study will be reported by J. Lilley. The beam energy resolution was better than could be measured in these tests. The measured resolution was entirely accounted for by contributions from the electronics and detector. Negligible background scattered beam was observed.

Terminal Voltage	Injected Current	Analyzed Current		
Ion	terminal volts (MV)	LE beam (enA)	HE beam (enA)	analyzed beam (enA)
^{16}O	9	100	50/ 90	4/ 8
	10	100	70/120	5/ 15
	11	100	110/130	10/ 25
	12	100	110/150	10/ 30
	12	200	280/320	10/110
	13	200	300/350	10/130
	14	200	300/350	20/150
	15	200	300/400	20/150
^{7}Li	12.5	36	20	10(max)
	11	30	17	9
	10	32	18	8
	9	28	16	6

Table 2: Beam Transmission tests for the analysis of ^{16}O and 7Li ions.

2 Problems to be Solved Before Running

Some work needs to be carried out on Charissa equipment at Strasbourg before any experiments can be mounted. In addition some minimum improvements to the beam are required before a wider programme of experiments can begin (although feasibility studies and certain specific experiments should be possible). These problems are outlined in the sections below.

2.1 Charissa Equipment

1. The arm drive mechanism needs some maintenance. The control system does not supply the +12 V to the drive motors when requested.

2. Some backlash on the target angle movement needs checking.

3. The present chamber cables are too thick and hinder arm movement. These need replacing.

4. Chamber arm patch panels need to be installed for the cabling.

5. No electronics in Strasbourg!

6. No D.A. system in Strasbourg! Even obtaining a single channel spectrum is near impossible using equipment available locally.

2.2 The Beam

1. The current stability needs improving. Large fluctuations of current on target are typical. The resulting signal pile-up and D.A. rate clogging would present serious problems and prevent running.

2. Cannot run the machine at low terminal volts (Not clear how serious the technical difficulty for low voltage operation is). Above ~ 9 MV is the preferred operating range. Low beam energies therefore require gas stripping (at present unavailable).

3. Little control over beam intensity. Difficult to stop back the beam at the source. More control over this is required to provide the optimum (and adjustable) beam currents on target.

4. Beams are of low intensity where the transmission drops rapidly with terminal voltage.

5. Only a few beam species have actually been produced. It is estimated (by the source operator) that beam transmissions for the Vivitron (inclined field tube) would be typically 1/2 that given by a HV tube (i.e. the MP) and 1/4 that for an NEC tube. Clearly some empirical data are required.

6. It is not clear what the energy calibration is! One needs to be able to specify a beam and an energy and have at least some numerical idea as to the expected error.

2.3 Miscellaneous Difficulties

Some of the other perceived difficulties and operating restrictions are listed here.

1. Local Maintenance and Support are required for both running and idle periods to keep the beamline equipment in good service. A local "expert" on the Charissa equipment would be useful. There appears to be no clear delegation of responsibility for this at present.

2. With all experimental lines in the same hall access time for setting up requires careful scheduling.

3. The Vivitron operators based in the control room have limited knowledge of the source and can perform remote operations on it only. In fact the source can only be set-up for new beam etc. during the hours (approx. 7am to 5pm) when the source operator is on duty. Careful timetabling of experiments is therefore required.

4. Learn French! Seriously, communication is a BIG problem. Without a local guide to who's who running would be impossible.

3 Summary & Recommendations

The commissioning of the Charissa beamline at Strasbourg is complete. The minimum work remaining before an experiment can be mounted includes the installation of a D.A. system and associated electronics. Some minor investigation and maintenance of faults in the chamber control system are also required. At the present time only a few beam species have been produced at the Vivitron with severely reduced intensities at the lower terminal voltages 9-10 MV. Extreme fluctuations in beam current at the target would also make any experiment extremely difficult. These problems are under investigation. However, even when they are solved it remains clear that experiments requiring many changes of beam energy or species will not be possible. There is little empirical data available upon which to base a feasibility report for running at the Vivitron. A programme of tests of desired beams is required. Beyond the technical difficulties there is also the wider problem of communication between the user and operator. Language differences aside, the beam requirements for charged particle spectroscopy were found to be not well appreciated by the personnel providing the beam during the commissioning period. Some discussion is required to overcome this problem.

Neil Rowley has called for proposals or at least letters of intent to be submitted as soon as possible. Direct requests for specific beams will provide a framework for improvements to be made and hopefully some of the desired criteria will be met in the near future. It is strongly recommended that Charissa proposals be forwarded NOW in order to indicate our requirements and allow some room for the laboratory to plan and manoeuvre. IN2P3 will be discussing the status of the Charissa programme at Strasbourg in April '97. The directors of the Vivitron have requested that (if possible) Charissa make some further level of commitment (of equipment and running) by this date.