CLIC TEST FACILITY

Summary of Meeting held on 20 July 1988

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1. Introduction

The purpose of the CLIC Test Facility (CTF) is explained by K. Hübner[1]). The first objective is to develop at CERN an injector producing high-intensity, ultra-short electron bunches. The aim is to eventually reach the parameters of the CLIC drive bunch ($N = 4 \times 10^{11}$ to 10^{12} per bunch, bunch-length $\sigma_z = 1$ mm $\equiv 3$ ps). This will require some effort as presently achieved performances are quite far from these values and as one can judge from the very slow progress in other laboratories working in this field since quite some time.

For example the powerful conventional system of SLC (thermo-ionic gun, subharmonic buncher, normal buncher yields $n = 5 \times 10^{10}$ with $\sigma_t = 6$ ps. Los Alamos (LANL) is developing an injector for FELs using a laser illuminated photocathode in an r.f. cavity. This is the most promising scheme which we also propose to use. They achieved $N = 1.7 \times 10^{11}$ with $\sigma_t = 23$ ps.

The second objective is to use these short bunches for interaction tests with ClIC structures which have their fundamental frequency at 30 GHz. The bunches will be accelerated to about 60 MeV or higher with the 4.5 m long 3 GHz LIL spare accelerating structure so that they stay relativistic even at the end of deceleration in the passive CLIC structures. This high energy beam is also smaller in transverse size and, thereore, can be threaded more easily through the structures. Although acceleration by LIL S-band ($\lambda = 10$ cm) precludes the production of a real CLIC Drive Train (10 bunches with 1 cm spacing), operation with a single bunch permits a number of valuable measurements. i) Transfer structure in the beam: measure power out, study output coupler, higher order mode picked up by loops, r.f. pulse transfer to accelerating structure; ii) main linac structure in the beam: energy loss of bunch ($\Delta U = 6.3$ MeV for $N = 10^{11}$) yields information on shunt impedance, couple power to another main linac structure and measure there energy gain of a beam from a small e^- gun, higher order modes; iii) CLIC instrumentation as pick-ups etc. can be tested with this beam.

LIL will also benefit from this facility decoupled from LEP operation:

- a 3 GHz power source for testing of accelerating sections and components becomes available;

- tests of the spare gun and, eventually, of a spare buncher are possible.

The opportunity to work at an advanced linac project will keep people with linac expertise around LIL and the gain in know-how through CTF will be profitably applied to LIL.

The necessary laser development is explained by K. Geissler. At first, the existing Excimer laser of EF will be used to pump a dye laser being built. This combination will produce 5 ps, 100 μJ pulses in the 390 to 480 nm range at about 10 Hz. This system will be used for photocathode research with d.c. voltages. Since this laser cannot be synchronized with the 3 GHz r.f., a synchronizable UV laser has to be developed. Possible developments leading to 1 ps, 5 mJ pulses at 308 nm or 248 nm are described.

The initial cathode material is very likely Cs_3Sb which gives a high current density and was used successfully in Los Alamos. Unfortunately, it must be prepared nearly in situ and it needs frequent reconditioning. other materials as Yttrium and Samarium are also considered and we are closely following the relevant research at BNL.

It could turn out that it is essential to decrease the effective work function of the metallic cathodes by shining prior to and during the emission polarized CO_2 laser light onto the surface with a grazing angle so that the electric field vector is perpendicular to the surface. The effective illumination and triggering is then by a short UV laser pulse impinging perpendicularly onto the cathode surface.

W. Schnell says that all experimental CLIC work with beams at CERN will be concentrated at CTF. The high gradient required in the r.f. gun needs a high r.f. power. At CERN the only frequency where such a power is available is at 3 GHz, hence, it is logical to use the LIL frequency.

G. Brianti points out that it is vital to get started though the priorities of CERN and the exact budget situation in 1990 and later are not yet very well known.

2. <u>Budget</u>

The estimated expenditure [2]) for CTF is discussed. Apart from the CLIC budget one would have to get money from

- LPI consolidation budget (request is being elaborated) for a LIL modulator, which would be a second spare for LIL (the first spare is under construction in the LIL klystron gallery) and for a LIL 35 MW S-band klystron;

- PS for the preparation of the test zone;

- EF for the laser lab of CTF.

Other foreseen contributions are:

- the existing spare LIL S-band accelerating section;

- the 100 kV and 400 kV HV generators of the PS.

It is understood that LEP operation has the priority as far as LIL spares are concerned. In order to get started quickly, we must order the items which have a long lead time as soon as possible.

The budget estimate foresees the purchase of a streak camera as RAL will continue to use the camera bought by CERN. This camera has also only 5 ps resolution, which is insufficent to study our bunches being in the 3 ps range.

The ClIC budget is 1 MF (88), 2 MF (89), 3 MF (90); development work of transfer and main linac structures, of alignment techniques, and of final focus elements must also be paid from it apart from travel costs (W. Schnell).

G. Brianti points out that at least the budgets for 88 and 89 are fixed, and solutions have to be found within the existing budget envelopes. An operations budget cannot be considered as other R & D work in CERN must also do without it. The use of the LPI consolidation budget for the purchase of one modulator klystron set is not excluded. J.H.B. Madsen points out that it would be advantageous for CERN to order the klystron in 1988, exercising the option in the existing contracts with industry.

3. <u>CTF Location</u>

Various places in the PS are under consideration (e.g. North Hall) but studies are not completed. The ISR tunnel is also mentioned as a possbility where plenty of extension space would exist in case one would want to accelerate the bunches with a 350 Mhz superconducting cavity as foreseen in CLIC. The d.c. supply for the 350 MHz klystron would be close (Bldg. 112). If the LHC test string were put into the ISR, a He-liquifier would become available.

4. Conclusions

A new budget estimate will be prepared by middle of August respecting the budget constraints. This paper could then be the basis for a discussion in the directorate. G. Brianti and W. Schnell will discuss the proposal with C. Rubbia.

K. Hübner

cc: participants
Y. Baconnier

References:

1) Y. Baconnier et al. "A CLIC Injector Test Facility", CLIC Note 65

2) Y. Baconnier et al. "CTF Cost Evaluation and Spending Profile", Note PS/LP 88-54