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(Preliminary Phase)

CTF3 PRELIMINARY PHASE COMMISSIONING REPORT ON FIRST WEEK, 17-21 SEPTEMBER 2001

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Abstract

In this note, we describe the beam studies done during the first week of commissioning of the Preliminary Phase of CTF3, from September 17th to September 21st 2001. The beam was transported up to the end of the accelerating structures, and most of the beam diagnostics was tested in the first part of the linac.

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1 Goals

The goal of this first week was to transport the beam in the linac up to the last available section (section 34) and perform all necessary checks on the hardware equipments and the diagnostic tools. We mainly worked with single pulse operation, but checked that multi-pulse operation was available.

2 Start-Up

2.1 Gun

The CLIO gun was tested during dedicated sessions before and during the week of operation. The detailed studies are available in the ”CTF3 CLIO GUN” log-book, and the status of the gun is summarised in [1].

2.2 Power Supplies

The power supplies were unlocked up to WL.DQNF31.3H (before the WL.QNFC family). Cross-checks were performed between the control system, the power supplies and the magnets, to make sure of the correspondence between the control and the magnets in the machine. Some of the power supplies in the front-end had to be renamed in the control database. The final lists for the nomenclature of the power supplies and the magnets is available in [2]. The currents corresponding to the nominal theoretical optics in the linac are summarised in Table 1.

Magnet	Current (A)
WL.SNA25	0.5
WL.SNB25	64
WL.SNC25	112
WL.SNC26	113
WL.SNW26	221
WL.SNF26	59.68
WL.QSA27.1	0.85
WL.QLA27	0.82
WL.QSA27.2	0.75
WL.QNM27.1	0
WL.QNM27.2	0
WL.QNM27.3	0
WL.QLB28	0
WL.QLB29	5.0
WL.QNFA	0
WL.QNFB	20.0
WL.QNFC	50.0
WL.QNF35.1	70
WL.QNF35.2	-72.69
WL.QNF35.3	54.65
WL.QNF37.1	-162.87
WL.QNF37.2	198.11

Table 1: Currents in the magnets of the linac for the nominal optics.

2.3 Beam Diagnostics

The first diagnostic tools are located in the front-end. The WL.ECM25 gave an intensity signal close to 400×10^8 electrons per pulse, thus corresponding to a current of 1 A, as set in the gun, for the nominal pulse length of 6 ns.
The wall current monitor WL.WCM26 also gave a signal which remains to be calibrated with respect to the other diagnostics.
The camera WL.MTV27 was changed at the beginning of the week and then gave an image of the beam (however it was not possible to control the camera on remote). The screen was used to estimate the beam energy at the output of the front-end (see Section 3).
The gate for the acquisition in the UMAs was synchronised to the beam, and the multi-pulse operation was tested to check the delays of 420 ns between each acquisition. The calibration of the UMAs was performed up to WL.UMA34 using the calibration pulse which was sent 500 ns before the beam and for which the intensity read in the UMAs is 36×10^8 electrons, the horizontal displacement +33 mm, and the vertical one -33 mm. After the calibration and the optimisation of the beam transport, the typical intensities read in the UMAs are 267×10^8 in WL.UMA26 and 228×10^8 in WL.UMA34, thus corresponding to a transport efficiency of 85% between the end of the bunching system and the end of the accelerating sections. During multi-bunch operation, the base line for the UMAs is shifted up after each bunch (the electronics only checks for the zero level at the beginning of the whole pulse, and not between each bunch).

2.4 RF production

The RF conditioning was done in the pre-buncher and the buncher using MDK25, in the accelerating structures 27 to 30 using MDK27 and in the accelerating sections 31 to 34 using MDK31. The nominal powers in the three klystrons are given in Table 2 in order to reach the nominal energy of 350 MeV at the end of the linac.

	MDK25	MDK27	MDK31
P (MW)	4	33.5	34
Δ E (MeV)	~ 4	173	173

Table 2: Theoretical powers and energy gains in the linac for the Preliminary Phase.

We reached the power levels of 6 MW in MDK25 (PFN=21.5 kV) and 35 MW in MDK27 (PFN=36.7 kV). In MDK31, after the repair of a water leak on the cooling system of the RF combiner, and the change of the PFN line, the power of 30 MW was reached (PFN=35 kV).
Some power drops are recorded on the peak power meter of klystrons 27 and 31. They are thought to originate either from the baby klystron, or from the klystron interlock system. Figure 1 shows some RF signals recorded during the setting-up.

2.5 Timing

The timing of the RF signals from the baby klystron and the MDKs had to be delayed with respect to the gun timing in order to be synchronised with the start gun timing. The Start Klystron, Start RF and End RF timing were therefore delayed. The first pulse of the train now occurs after the filling time of the buncher (See Figure 2).

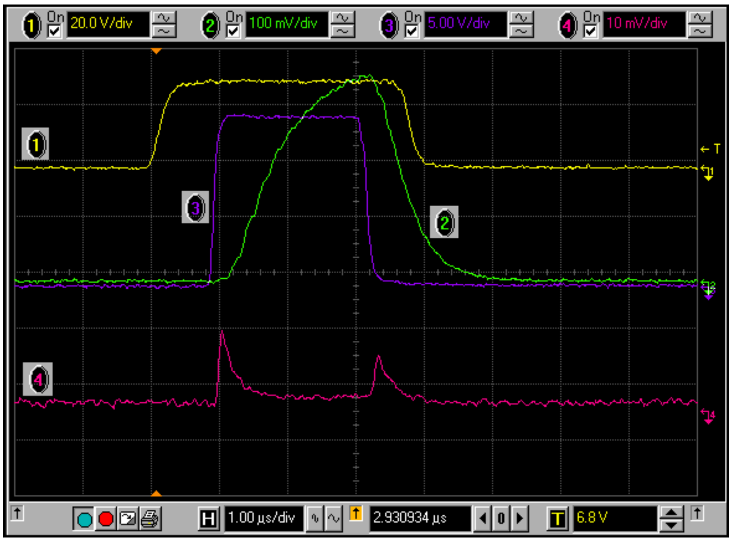

Figure 1: RF signals: 1-Baby klystron pulse, 2-Buncher loop (MDK25), 3-Forward power in MDK27, 4-Reflected power from pre-buncher (MDK25)

3 First Measurements

Figure 2 shows the signals of the first CTF3 beam in single pulse operation and Figure 3 shows the first CTF3 beam in multi-bunch operation with three bunches (five bunch mode was also successfully tested).

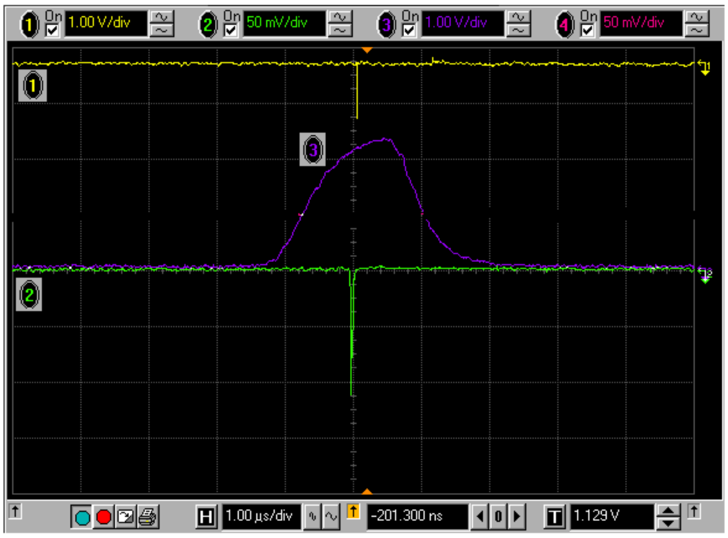

Figure 2: First CTF3 beam single pulse: 1-ECM signal, 2- UMA26 signal, 3-Buncher loop.

An estimate of the beam energy was found using the screen of the camera WL.MTV27 as a spectrometer, and by varying the current in the correction dipole WL.DQSA27.2H in order to move the beam. At the exit of the front-end, for the nominal energy of 4.3 MeV, the simulation code gives a displacement of 1.33 mm on the screen of WL.MTV27 for a 1 A current variation in WL.DQSA27.2H. We measured a displacement of 3.6 ± 0.5 cm for a current variation of 34 A. The measured energy range is therefore:

$$4.7 \text{ MeV} \lesssim E \lesssim 6.3 \text{ MeV} \quad \text{for} \quad P_{\text{MDK25}} = 4.5 \text{ MW}. \tag{1}$$

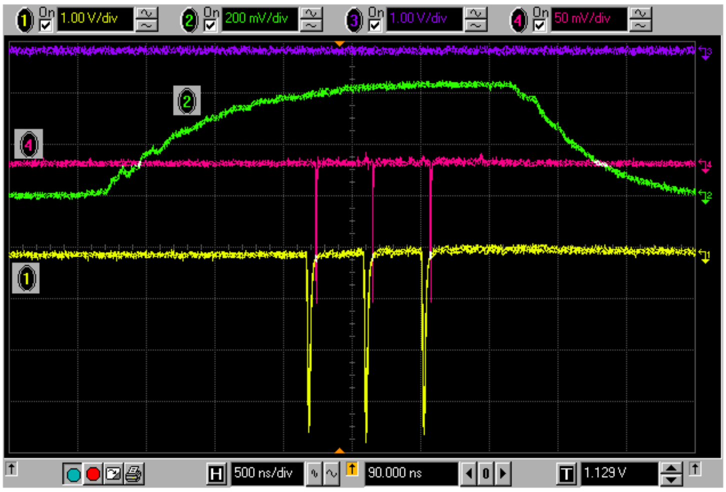

Figure 3: First CTF3 beam multi-pulse: 1-ECM signal, 2-Buncher loop, 4- WCM26 signal.

The wire scanner WL.WBS28 was tested with success but no systematic optics studies took place. However, some preliminary trajectories measurements were performed in the first part of the linac. Figure 4 shows an example of measured difference trajectory. Detailed studies have begun to compare these trajectories with the linac model behaviour.

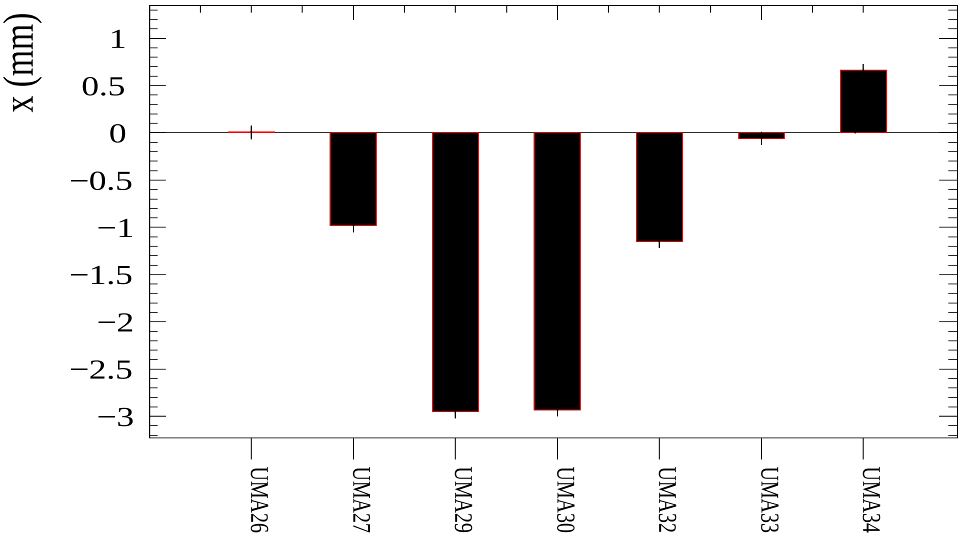

Figure 4: Measured difference trajectory in the horizontal plane using -0.5 A in WL.DQSA27.2H.

4 To Do List

- Investigation on the power drops seen on the peak power meters of MDK27 and MDK31 (timing inhibit, baby klystron instability).
- Calibration of the ECM, the WCM and the UMAs for different beam currents.
- Complete testing of the wire scanner WL.WBS31.
- Check the cavities filling time synchronism with the beam.
- The phase inversion was delayed since the LIPS cavities are not used any more. The relative positions in time of the phase inversion and the new RF timings have to be checked. Some RF timing references also have to be taken.

References

[1] R. Pittin, “Etat du canon CTF3 Phase Preliminaire”, to be published.
[2] L. Rinolfi, P. Royer, “Magnets and Power Supplies Nomenclature for the Preliminary Phase of CTF3”, CTF3 Note 031, PS/AE Note 2001-013.