Profile Measurements in 10 ms Intervals using the LA 48 Linear Array

I. Introduction

The LA48 option for PTW water phantoms is well-known and well-established all over the world. This option is shown in Figure 1 and comprises the following components:

- LA 48 linear ionization chamber array of 47 ionization chambers.
- ME 48 preamplifier.
- MULTIDOS electrometer.
- MEPHYSTO software module.

In this configuration the MEPHYSTO software is able to display a complete beam profile on the computer screen approximately every second. It should be pointed out that the actual measurement in the electrometer is done much faster, with a sampling frequency of 100 Hz. The time constant of the ME 48 preamplifier is 50 ms.

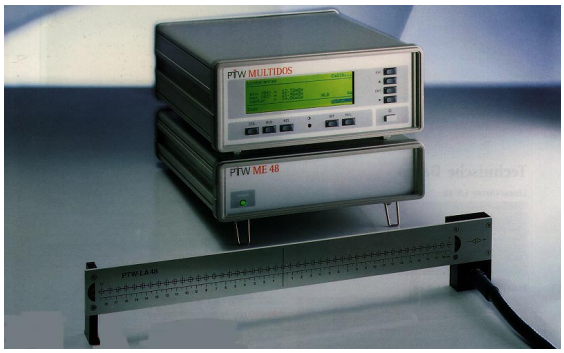

Figure 1: *LA 48 linear chamber array with MULTIDOS electrometer and ME 48 preamplifier*

In the recent past more and more medical physicists are wondering how their LINACS behave during the first one or two seconds after the beam is switched on (see for instance Med. Phys. 25 (4), April 1998, 493-495). For accurate measurements of this start-up behaviour the preamplifier should be faster than the ME 48 preamplifier. This fact has been pointed out by some of PTW-Freiburg's competitors, although their own equipment features an inadequate time constant of 100 ms.

II. The ME 48F System

PTW-Freiburg has responded to the request for fast profile measurements by developing a fast version of the ME 48 preamplifier, the ME 48F Fast Preamplifier.

The ME 48F Fast Preamplifier features a time constant of 10 ms, i.e. it is able to correctly follow very fast input signals. The measuring time for all 47 signals is 2 ms in total, to be followed by a 8 ms processing time interval. Thus, profiles can be measured every 10 ms (or up to 100 profiles/s) while keeping the measuring time itself as short as 2 ms.

As an accessory, an interface and power supply is required. Both devices, the ME 48F Fast Preamplifier and the power supply, are located in the treatment room in the vicinity of the LA 48 linear array. A connection cable of 25 m length connects this measuring equipment to a special data acquisition board (DAB) that plugs into a PC to acquire the measuring data. A special software package allows the measurement of up to 100 profiles/s as well as the storage of the profiles in an MEPHYSTO export file. MEPHYSTO can import up to 250 profiles at the same time for further evaluation.

The above option for fast measurements, consisting of ME 48F Fast Preamplifier, ME 48F interface, data acquisition board, data acquisition software and 25 m connection cable is available from PTW-Freiburg under order number L981080 at a price of DEM 23.530,-- (price list 1998, PC not included).

The PC in which the DAB is to be installed, should be an Intel Pentium Processor with 233 MHz running Windows 95 or Windows NT 4.0.

Figures 2 - 5 depict measuring results on a Siemens MDII accelerator.

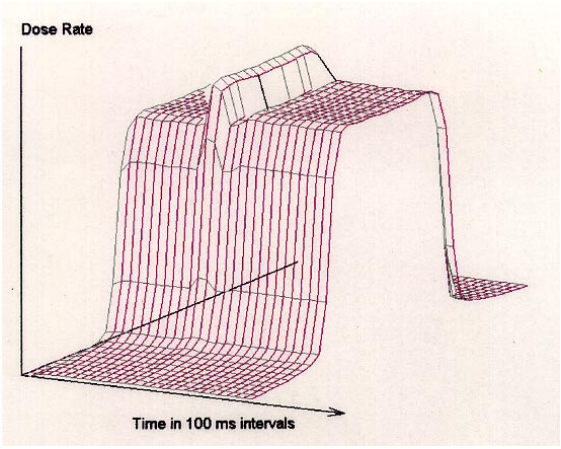

Figure 2: *Start-up behaviour for 6 MV photons. Measuring time was 2 ms for every profile of 47 points.*

Figure 2 shows the dose rate as a function of time and profile coordinate. 100 profiles/s have been measured, figure 2 shows only every tenth measured profile. It can be seen from figure 2 that for the first second the accelerator runs with default parameters, the final dose rate is attained after the control circuits have been activated, resulting in a temporary dose rate overshoot.

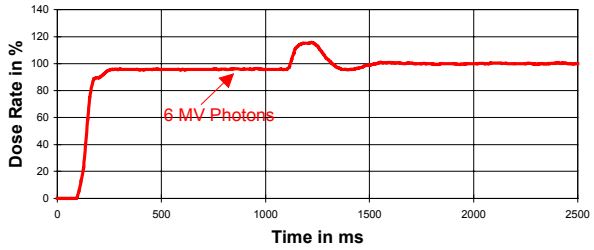

Figure 3: *Time dependence of the central detector signal for 6 MV photons.*

Figure 3 shows the signal of the central ionization chamber versus time.

Figure 4 shows the start-up behaviour for 14 MeV electrons. Note that the axes have been swapped compared with figure 2. The time dependence of the central detector signal is shown in figure 5 for both 14 MeV and 8 MeV electrons. It is interesting to see that the start-up behaviour of the same LINAC depends on the nominal electron energy.

It is frequently said that the start-up behaviour of a LINAC is becoming more and more important because of the growing importance of conformal radiation therapy. It should be noted, however, that the start-up behaviour of the beam presented in figures 2 - 5 is different from the "beam on" behaviour of the beam during subsequent treatment intervals in conformal therapy. While according measurements are not available at the time being, they could easily be made using the above described system.

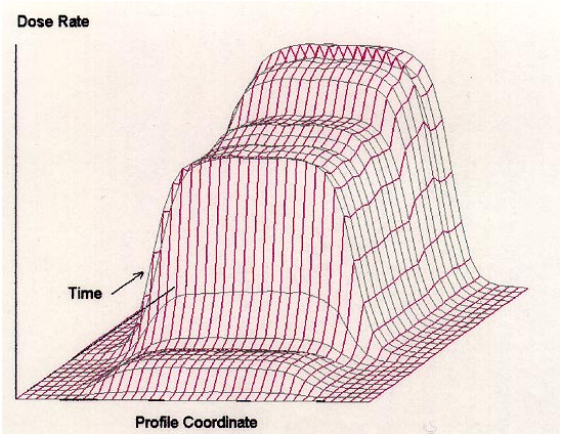

Figure 4: *Start-up behaviour for 14 MeV electrons. Compared to Figure 2, the time and coordinate axes are swapped.*

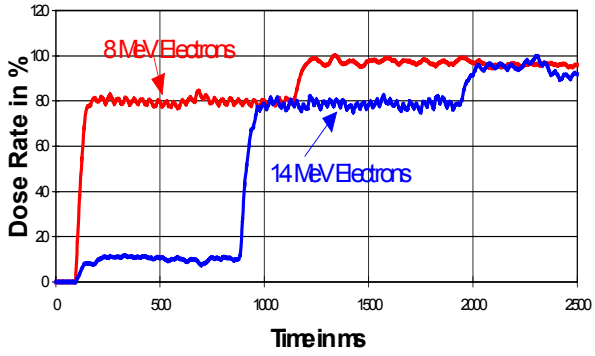

Figure 5: *Time dependence of the central detector signal for 8 MeV and 14 MeV electrons.*

III Low-cost Option

It should be pointed out that the ME 48F Fast Preamplifier cannot be connected to the MULTIDOS electrometer. On the other hand, users with a smaller budget could use their standard ME 48 instead of the ME 48F Fast Preamplifier, allowing the measurement of up to 10 profiles/s with a time constant of 50 ms.

For such cases option L981081 is available at a list price of DEM 9.830,-- (price list 1998, PC not included). This option comprises the ME 48F interface, the data acquisition board, data acquisition software and a 25 m connection cable. It is assumed that the LA 48 linear array and the ME 48 preamplifier are available.

PTW FREIBURG
PHYSIKALISCH-TECHNISCHE WERKSTÄTTEN
DR. PYCHLAU GMBH

PTW-FREIBURG
LÖRRACHER STRASSE 7
D-79115 FREIBURG, GERMANY
☎ +49-761-49055-0
Fax +49-761-49055-70
E-Mail ptw@ptw.de
URL http://www.ptw.de