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Quick tool for phantom and collimator scatter factors table generation

Autores: Nicolás Larragueta, Federico Bregains

nicolas.larragueta@cemener.org.ar

Fundación Centro de Medicina Nuclear y Molecular Entre Ríos (CEMENER), Oro Verde, Argentina

CEMENER DIAGNÓSTICO Y TRATAMIENTO

Introduction –

One of the measures that has to be done when a linear accelerator (linac) is commissioned is the output factor table. This table takes into account changes in scattering properties of the medium (water phantom) and the head of the linac (X and Y Jaws mainly), commonly normalized with the dose in a 10x10 cm2 field at some defined depth. Varian Eclipse™ TPS requires to determine in open and wedged fields with several field sizes including rectangular ones in order to take into account the collimator exchange effects.

Conventionally, the output factor table determination can spend one entire week of 8 hours a day to complete only the energies with Flattening filter, and one more day to do the flattening filter free (FFF) energies output factor tables in a TrueBeam with 5 photon beam energies available. On the other hand, the measure with automation takes 2 and a half days period to complete all energies. The main objective of this work was to develop a quick tool for phantom and collimator scatter factors table generation.

Materials and Methods –

The output factor measurements were done in a Sun Nuclear 3D Scanner™ with a SNC125c™ ionization chamber with 0.108 cm3 sensitive volume combined with a PC Electrometer™ in Data Logging mode, taking one data every 0.5 sec (see Figure 1).

A plan was created in Varian Eclipse™ treatment planning system (TPS) with all field sizes to be measured and exported in DICOM RTPlan standard file. The linac used was a Varian TrueBeam™ V2.5 irradiating 50MU per beam with automation mode. This allows the machine to hold the beam when the field size is changed by automatic sequencing in the treatment plan.

Once the delivery is complete, a data log file is generated. This file is interpreted by a software developed in our institution in two different modes: charge and current.

In charge mode, the software integrates the current with a user-defined threshold in each pulse. The use of a high threshold can derive an erroneous output factor because the impact of despise the area below the threshold differ from low pulses than a high ones.

There is a problem when field sizes between pulses are similar. The field size is changed so fast (<0.5s) that the PC Electrometer does not have sufficient time and the signal in data logging does not fall off, and superimposed with the next field size measurement as shown in Figure 2. One possible solution to this problem is disorder field sizes in order to spend more time in jaw positioning and let the electrometer to obtain the complete pulse.

In current mode, the software averages the current in central 80% of the pulse. This is another solution for the superimposed pulses, by choosing a bigger threshold the pulses can be determined and the current averaged in central 80% without losing of information.

Once the values are determined, the software orders the results and assigns field sizes to any pulse by using the DICOM RTPlan utilized to irradiate in the treatment machine as shown in Figure 3.

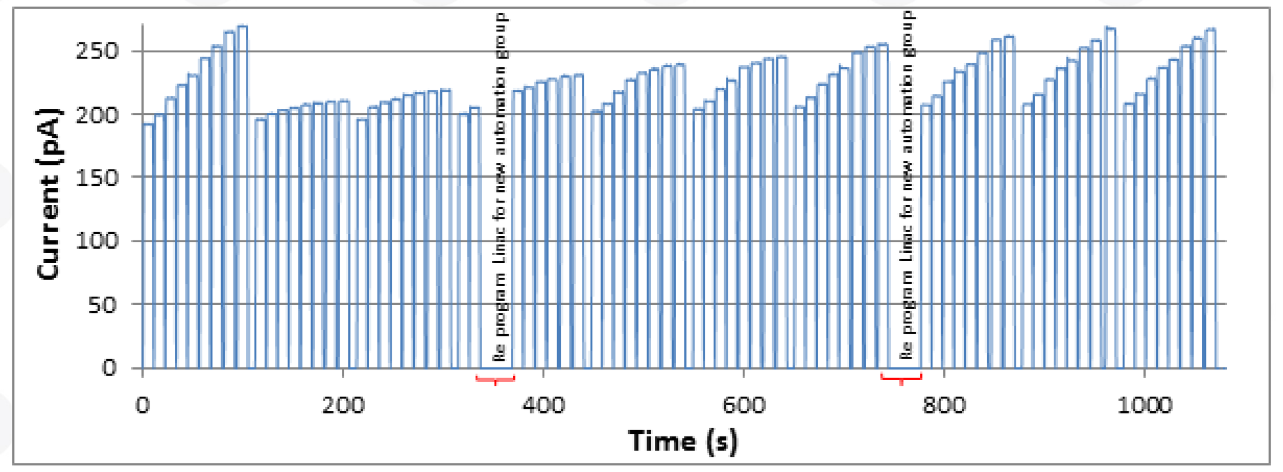

Fig. 1: Data Logging.

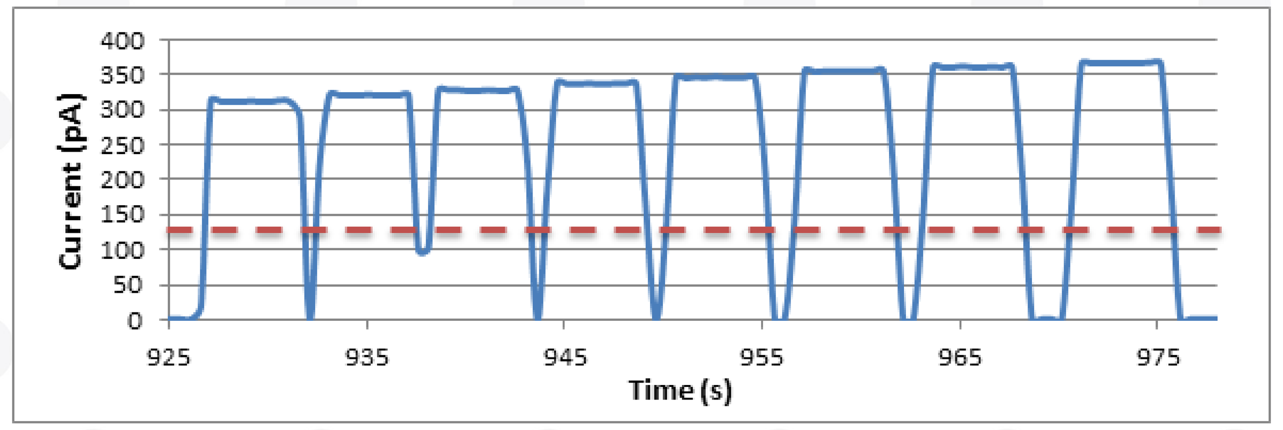

Fig. 2: Pulses superimposed for similar field sizes between pulses. Dashed line shows a bigger threshold that can be used for the pulse determination with current mode to output factor table generation.

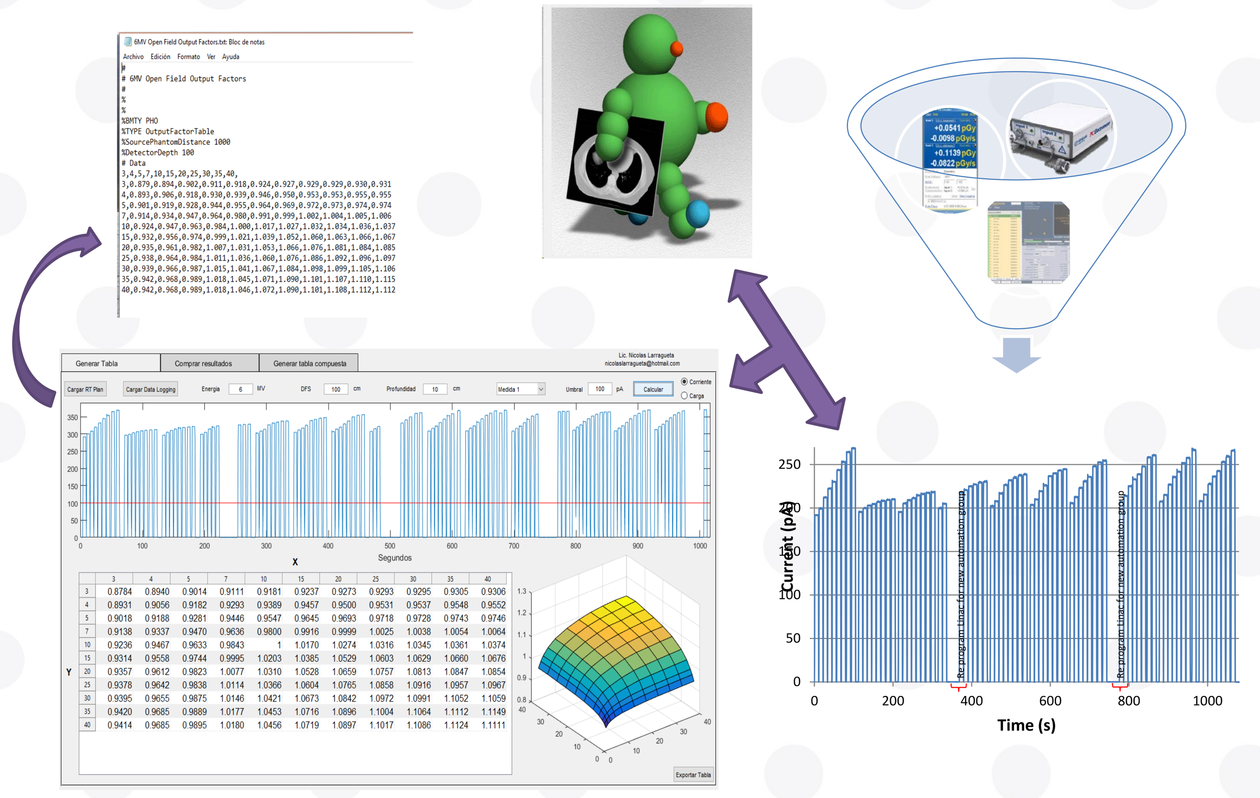

Fig. 3: Output factors table generation.

Results -

27 output factor tables were generated including open, wedged and FFF fields. All tables were compared with TrueBeam Representative Data with maximum differences below 0.7%, and 0.2% in mean as shows in Figure 4.

Time to do an entire table for each energy and beam modifier were measured and compared with time spend in a regular way (Fig 5).

Open field table with automation were compared with point by point readings obtaining differences below 0.5%.

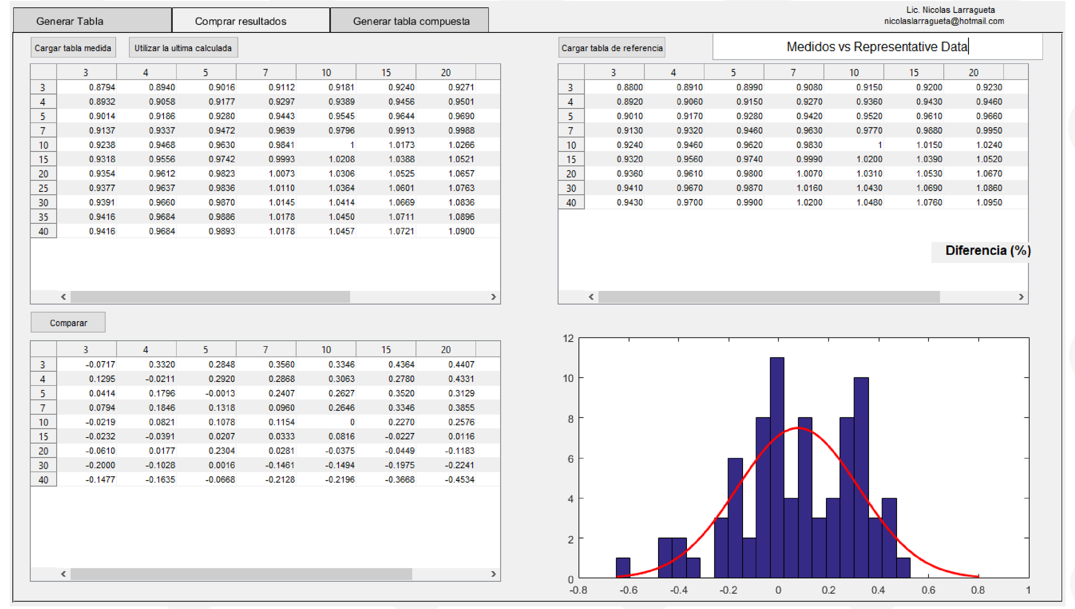

Fig. 4: Output factors table comparision (Measured vs Representative Data).

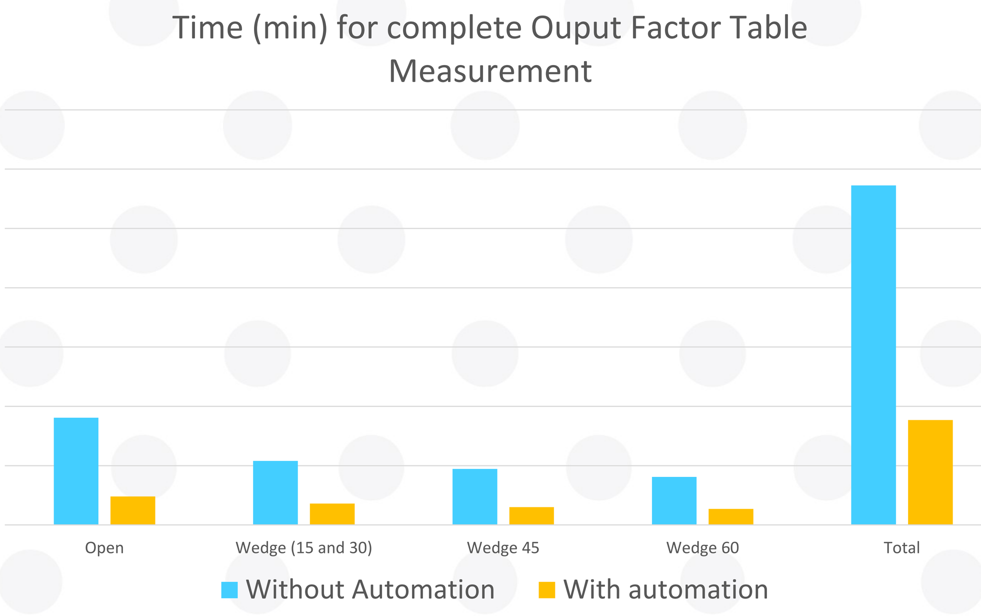

Fig. 5: Time comparison with and without automation.

Conclusion –

The Output Factor table determination is a time-consuming task and susceptible to errors in a commissioning process. The method with data logging in the electrometer and automation in the linac show an excellent option to reduce the time involved in the Output Factor table determination and automate the process.