

METHOD FOR RADIOTHERAPY TREATMENT VERIFICATION

A. Bocci¹, M. A. Cortés-Giraldo², M. I. Gallardo², J. M. Espino², R. Arráns³, M. A. G. Alvarez^{1,2}, Z. Abou-Haidar¹, J. M. Quesada², A. Pérez Vega-Leal⁴, F. J. Pérez Nieto⁵

DITANET



¹ Centro Nacional de Aceleradores (CNA), 41092 Seville, Spain.

² Department of Atomic, Molecular and Nuclear Physics (FAMN), University of Seville, 41012 Seville, Spain.

³ Hospital Universitario Virgen Macarena, 41007 Seville, Spain

⁴ Escuela Superior de Ingenieros, 41092 Seville, Spain

⁵ Instalaciones Inabensa S.A., 41014 Seville, Spain

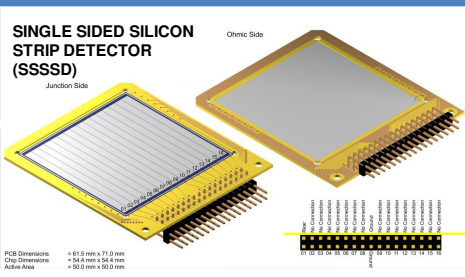
CNA
Centro Nacional de Aceleradores

UNIVERSIDAD DE SEVILLA

INABENSA

U

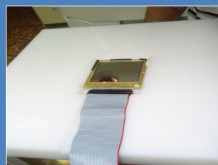
The Detector



- Commercial, relatively low cost detector from Micron Semiconductor Ltd, UK
- Single sided 16 strips (3.1 mm pitch)
- Active area 50 x 50 mm² & 500 μm thick
- Good radiation hardness

Phantoms

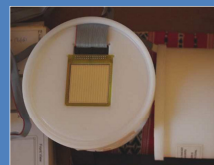
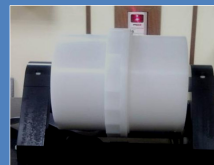
Slab phantom



Two phantom prototypes have been designed :

1. A slab phantom for detector characterization.
2. A cylindrical phantom for angular response measurements & for 2D dose measurements in IMRT planning verification

Cylindrical phantom



Clinical Linac 6-MV photon beams



Discrete electronics: 16 channels



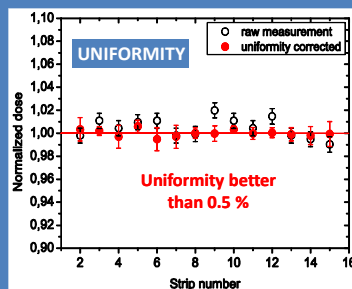
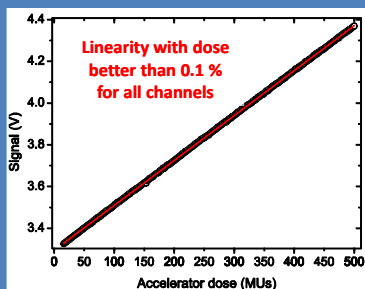
Charge integrators (electrometers) digitized (12 bits) and analyzed by a Digital signal processor (DSP). A PC allows to control and to retrieve data via an RS-232 serial bus (based on a LabVIEW software).

Setup with Slab Phantom:

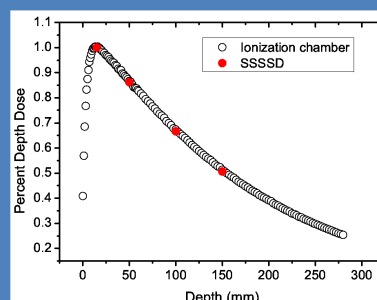
Detector plane perpendicular to the beam axis



LINEARITY

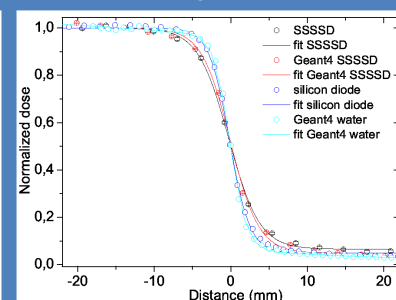


PDD



The difference between SSSSD and ionization chamber is 0.68 % at 10 cm and 0.73 % at 15 cm.

PENUMBRA

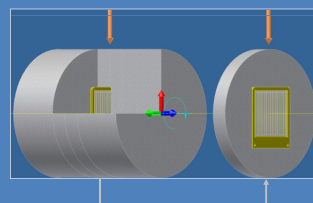


SSSSD data gives a penumbra value larger than the one obtained when using one channel silicon detector. This is mainly due to the SSSSD strip pitch of 3.14 mm. Geant4 simulations give compatible results.

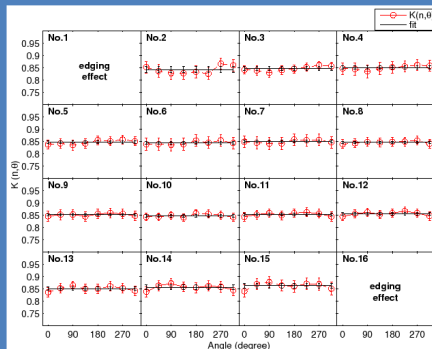
DOSIMETRIC MEASUREMENTS

Setup with Cylindrical Phantom:

Detector plane parallel to the beam axis



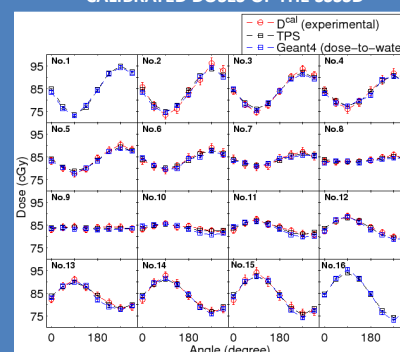
RATIO BETWEEN TPS CALCULATIONS and SSSSD DATA



Ratio between SSSSD data and TPS calculations with respect to the irradiation angle and curve fits. Strip numbers of measurements are reported on the top of each panel.

The figure shows that the ratio between TPS and experimental data at different angles is constant within error bars. The factors of calibration are independent both from strip numbers and from the irradiation angle between strips and the beam. These good results moreover simplify the detector calibration.

CALIBRATED DOSES OF THE SSSSD



Calibrated doses D^{cal} of the SSSSD are shown in the figure above and are compared to the TPS calculations and Geant4 simulations (dose-to-water case). The relative difference between the calibrated dose and TPS calculations was found better than 2 % for the strips at the edges of the SSSSD, and even better than 1 % for the central ones.

CONCLUSIONS

- Knowledge from nuclear reaction instrumentation has been transferred to medical applications.
- A prototype used to benchmark a novel method dedicated to IMRT pre-treatment dose verification has been designed, built and tested.
- The characterization of the SSSSD showed that the system has good characteristics to adopt it in a quality assurance (QA) IMRT verification plan.
- The final goal of the project is to employ this prototype for obtaining 2D dose maps by means of an in-house developed algorithm (patent pending), dedicated to verify IMRT treatment plans.
- Future improvements will be possible using a 2D silicon detector.

ACKNOWLEDGEMENTS

Work supported by the EU Initial Training Marie Curie Network "Diagnostic Techniques for future particle Accelerators NETWORK" (DITANET) under contract PITN-GA-2008-215080; by the Spanish Research Project FPA2009-08848; by the Consolider-Ingenio project CSD2007-0042; and by the RADIA2 project, a collaboration between Instalaciones Inabensa S.A. and University of Seville under contracts 68/83 0214/0129 (EU-Spanish), IAP-560610-2008-8 (Spanish), and 08/221 and 841190 (Andalusian).