## Optimization protocols for head CT scans using an adult and a newborn PMMA phantom

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### Introduction

Computed Tomography (CT) scans promote a higher dose deposition than conventional radiology exams. These tests significantly contribute to the increase the patient and collective dose, being a public health concern worldwide. Today, there is a need to improve protocols to seek lower doses while maintaining the image diagnostic quality. The development of phantoms allows testing different acquisition protocols. For that, the phantoms must present an absorption characteristic of the X-ray beam similar to the represented patient.

### Methods

In this work, two CT head phantoms were used, the standard head phantom and another with newborn head size. The objects are cylinders with 16 cm (standard adult) and 11 cm (newborn) in diameter and 15 cm in length, made of polymethyl-methacrylate (PMMA). Tests of acquisition protocols were performed on a Toshiba CT scanner, Aquilion Prime model with 80 channels. The central slice of the phantoms was irradiated successively, and using a pencil ionization chamber, measurements of CT air kerma index in PMMA (Ck,PMMA,100) were performed. From these results, the CT Dose Index values weighted and volumetric (CTDIw, CTDIvol) were obtained for 10 cm scans of the central region of the head phantoms, in helical mode. The scans were performed using different voltage values (80, 100 and 120 kV) and charge (mA.s).

### Results

The absorbed doses of the new protocols tested in the adult standard head phantom varied from 19.72 to 27.39 mGy, with the lowest dose occurring with the use of a voltage of 100 kV and 200 mA.s and a pitch of 0.813. The optimized 100kV protocol promoted a dose reduction in the patient of 31.65%. In the newborn phantom with 11 cm, the absorbed doses of the new protocols varied from 23.00 to 43.92 mGy, with the lowest dose occurring with the use of a voltage of 80 kV, 250 mA.s and a pitch of 0.813. This protocol promoted a dose reduction in the newborn phantom of 47.63%. In optimized protocols, the optimized charge value (mA.s) was adjusted to the point where the noise in the central slice was less than 1%.

### Conclusions

Proposed optimized protocols reduced the absorbed dose by up to 43.05% in the smallest phantom (newborn), with 11 cm in diameter. The results allowed to evaluate that, for the generation of images with the same diagnostic objective, the volumetric dose index showed a higher dose value in the newborn phantom, corresponding to a head with smaller volume, compared to the value measured in the standard head phantom.





## Dosimetric parameters and radiation tolerance of epitaxial diodes for diagnostic radiology and computed tomography X-rays

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### Introduction

Ordinary Si diodes are prone to radiation damage effects, which deteriorate their overall dosimetry performance with accumulated doses. This issue has been addressed by applying epitaxy technology to fabricate radiation-hard diodes with shallow, highly-doped monocrystalline layers. The dosimetry response and the radiation tolerance of these diodes for diagnostic radiology and computed tomography X-rays are reported in this work. Sensitivity calculations assuming the diode as a thin abrupt junction give theoretical support to the data.

### Methods

The $p^+$-n pad diode (5x5 mm$^2$) consists of a 0.6 µm front highly doped $p^+$ layer on a 50 µm n-type epitaxial layer grown on a 300 µm Cz Si substrate. The diode is housed in a light-tight probe with the front electrode ($p^+$) connected to the Keithley 6517B electrometer in a short circuit mode. Irradiations are performed with a Pantak/Seifert X-ray generator standardized by Radcal RC3-CT and RC6-RD ionization chambers. The current sensitivity, repeatability, reproducibility, dose-response linearity, and directional response are evaluated with the diode positioned at the center of an irradiation field of 12 cm diameter at 100 cm from the X-ray tube.

### Results

The current signals produced by photon beams of different qualities (50 -150 kV) are stable and characterized by repeatabilities better than 0.3%. The current response linearly depends on the dose rate (22-120 mGy/min). The dose-responses curves are also linear but slightly dependent on the photon energy. The angular dependence of the response for 70 kV and 120 kV reference photons is below 0.1% within an angle range of ± 5º. Investigations of the effects of radiation damage on the current response and the lifespan of the diode, assessed through measurements of its sensitivity as a function of increasing doses, are underway.

### Conclusions

All results so far obtained meet the requirements of the IEC 61674 norm, pointing out that the epitaxial diode might be a reliable online dosimeter for medical imaging dosimetry.