Measurement of incident air kerma (IAK) in computed tomography (CT)

General

The advantage of measuring **IAK** (***incident air kerma (IAK) at the skin of patients***) is that this quantity is directly comparable to the IAK measured in other x-ray modalities (such as mammography, fluoroscopy and radiography). In addition, the result is easy to understand for patients, medical doctors, technicians and physicists.

Required Accessories

For the measurement of the air kerma and the rotation time, a *QUART dido* meter with waveform function is required. To measure the beam width, the electronic ruler *QUART nonius* is the optimal tool. Apart from that, the distance from the focal spot to the isocenter of the device (*R*) must be measured or obtained from the DICOM header (tag “0018,1111”).

Application

Place *QUART dido* and *QUART nonius* on the patient couch and align them with the isocenter as indicated in Fig. 1. For this example, we will focus on the head protocol.

Select default parameters for a typical *head scan protocol* for *one single rotation*.

Perform the scan and save the results from the software of *QUART dido* and *QUART nonius*.

Fig. 1: *QUART nonius* and *QUART dido* in a CT

Data Evaluation

The software of *QUART dido* and *QUART nonius* directly provide the required data (Fig. 2).

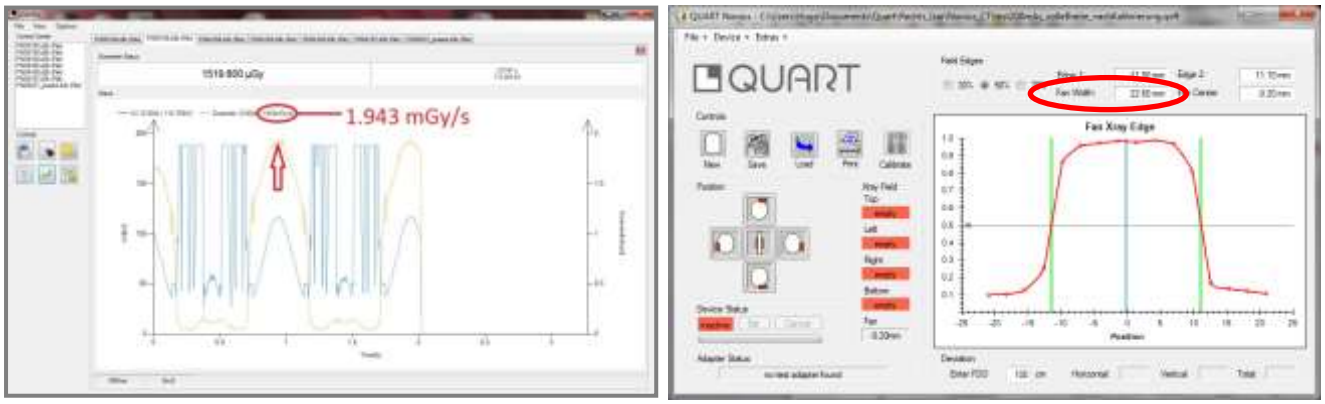

Fig. 2. Left: The waveform obtained with *QUART dido* provides the *maximum dose rate* and the *rotation time*. **Right**: the software of *QUART nonius* provides the *beam width*.at the isocenter.

The values obtained are introduced in the sheet “QUART_patient_IAK_CT_&_CBCT.xlsx”, which provides the value of the incident air kerma automatically (see details overleaf).

Active Radsys

The Excel sheet “QUART_patient_IAK_CT_&_CBCT.xlsx “ is described in the following.

From the software of ***QUART nonius***, the user obtains the fan width w_z.(see Fig. 2). From the software ***QUART didoPro***, the user obtains the largest recorded value of the dose rate $\dot{D}_{max}$ (see Fig. 2) and the rotation time t (in s). The incident air kerma (IAK) at the skin of a standard patient head (16 cm-diameter) is then calculated as

Beam width, w_z < 1 cm	Beam width, w_z ≥ 1 cm
$IAK = \frac{\dot{D}_{max}\, R\, t}{\pi\, w_z (R-8)}$	$IAK = \frac{\dot{D}_{max}\, R\, t}{\pi\, (R-8)}$

where R is also given in cm, and 8 is the “effective radius” for a typical patient head.

Note 1: Using this method, one can also **personalize the measurement of incident air kerma for patients *of any size***.

If you wish to use other protocols and obtain the personalized incident air kerma for patients of other sizes, the following formula applies:

$$IAK = \frac{\dot{D}_{max}\, P_w\, R\, t}{\pi\, 2r\, w_z (R-r)},$$

where P_w is the width of the patient, P_t is the thickness of the patient, and r is the effective radius of the patient section, $r = (P_w + P_t)/4$.

Note 2: The dose rate and the rotation time provide the CTDI free in air at the isocenter:

W_z < 1 cm	W_z ≥ 1 cm
$CTDI_{free-in-air} = \frac{\dot{D}_{max}\, t}{w_z}$	$CTDI_{free-in-air} = \dot{D}_{max}\, t$

Note 3: This measurement is especially easy using a dosimeter of 1 square centimetre (like ***QUART dido***). If you are planning to use a dosimeter of another size, please contact QUART for a corresponding modification of this application note.

Example from the Excel sheet for the calculation of the IAK from a CT device

Incident air kerma to a typical patient head (16 cm-diameter)				
CT				
beam width smaller than 1 cm:	***Bz < 1 cm***			*Data source*
Beam width at isocenter	Bz	0.61	cm	Nonius
Distance from source to isocenter	R	57	cm	DICOM
Measured max. DLP rate	DLPr,max	9.5	mGy cm /s	Dido
Rotation time	t	0.5052	s	Dido
Incident Air Kerma (IAK)		**2.91**	**mGy**	

Optional:

Lateral dimension	px	16	cm
Anterior-posterior dim:	py	16	cm