**ABSTRACT MPE08**

This module aims to help the future MPE acquire the knowledge, skills and competences necessary to exercise a leadership role within the profession in his own country and in Europe in the field of objective image quality assessment in CT imaging.
Assessment of CT scanners is crucial as the biggest part of medical radiation comes from CT exams. New technologies and techniques are being introduced. Today, scanners are also provided with several dose reduction options. While promising, their introduction in the radiology department should be well prepared and parameter settings should be optimized and subsequently justified with dose and image quality evaluations.
The standard methods for optimization in CT will be reviewed first. The concept of model observers will then be presented together with some background theory in psychophysics allowing the MPE to understand the strengths and weaknesses of the model observer approach. The ultimate aim is to develop a model observer that predicts the reading of human observers and that could therefore be used for application specific optimization without tedious human visual grading. Practical examples will be given to show how an MPE could propose a patient dose optimization scheme in CT. This course will also help MPE to fully interpret the characteristics of CT units provided by manufacturers and read or create specifications at the purchase of new CT scanners.

The course module consists of 2 parts, an on line preparation and a face-to-face.

During the online phase, advanced CT techniques will be reviewed as well as basic concepts of image quality assessment.

The face to face part will address into the following themes during interactive sessions, computer skills lab and discussions:

Image quality definitions
Usually image quality in CT is evaluated using standard metrics of signal theory. In this first part all the standard approaches and their basic assumptions will be reviewed: linear systems theory, types of contrast (subject, image and display), unsharpness (LSR, PSF, LSF, MTF), lag, noise (including sources, noise power spectra, effect of lag on noise, noise propagation in image subtraction), SNR (including Rose model), Wagner's taxonomy, CNR, NEQ, DQE and how these metrics behave as a function of dose. The strengths and the weaknesses of those quantities when they are applied to the current CT technology will be discussed.

Human vision characteristics
One challenge in patient dose optimization is to establish a link between the metrics emanating from signal theory to the ability to detect structures on actual images. This part of the course will describe the techniques that are currently used to assess image quality by human observers when willing to get a set of reliable and reproductive data.
The human visual characteristics and how they can be quantified (i.e. using an eye tracker) will be described first. Then the receiver operating characteristics (ROC), in particular the concepts of signal to noise ratio, sensitivity, specificity and predictive values in medical imaging, will be explained since ROC analysis is the standard statistical methodology to be used when willing to assess the diagnostic performance of imaging systems. To complete the description of human image quality assessment the Multi-Alternative Forced Choice studies (M-AFC), LROC, AFROC will be explained. Finally the image quality from psychophysical studies with human observers in CT will be evaluated and the uncertainties (i.e. curve fitting) of the outcomes will be presented.

ROC or M-AFC studies, in spite of allowing the assessment of the detection of structures on images, are too time consuming to be implemented in practice. An alternative is the use of (mathematical) model observers such as the ideal or anthropomorphic linear model observer.

Model observers
The last part, but the most important of our course, will present the theory behind model observers.
The course will explain how to assess the performances of different model observers (including ideal model to anthropomorphic model observers: NPW, NPWE, CHO…) using the currently used metrics (SNR, d', $d_A$, $d_{M\text{-}AFC}$, PC). The way to match the mathematical model observer outcomes with the ones of human observers will be also presented.

With these tools medical physicists will be able to balance a dose requirement with a level of low or high contrast detection. This is a pre-requisite for a patient dose-image quality optimization.

**Dates**: Lausanne 12 – 16 March 2018

**Teaching Language**: English

**Teaching Staff:** Prof. Francis R. Verdun, PhD

Prof. François Bochud, PhD

MSc. Julien Ott, (finishing his PhD training)

MSc. Damien Racine, (in PhD training)

MSc. Anaïs Viry

**The venue**:

Institute of Radiation Physics (IRA) - http://www.chuv.ch/ira

Rue du Grand Pré, 1

CH 1007 Lausanne – Switzerland

**Our expertise:**

- Service part
  - Ensure state an appropriate medical imaging physics knowledge
  - QA in screening mammography at national level
  - Medical physics tasks ensuring image quality and patient exposure optimization in the field of CT and fluoroscopy (contract with about 40 clinical practices)
  - Organizing surveys aiming at estimating the annual average dose delivered to the population from X-ray imaging and nuclear medicine.
- Teaching part
  - University of Lausanne (UNIL) : Pre-graduate level : Medical school students
  - Lausanne Hospital (CHUV) Post-graduate level : Users of X-ray image devices (radiologists, cardiologists, radiographers …)
  - IRA: general radiation protection

## Transportation:

**By Plane:**
The international airport is located in Geneva or Zurich. IRA is easy accessible by trains leaving directly from both airports to Lausanne city and by public transportation to IRA (we are not located in the hospital building but at the periphery of Lausanne – train stop from Lausanne: Prilly - Malley).

**By train:**
The train network offers direct and regular connections to all big cities of Switzerland. For any detailed information visit http://www.sbb.ch/en/home.html

**Lausanne SBB by train:**
Geneva - Lausanne: about 1hour
Zürich – Lausanne: 2 hours 30 min

## Housing:

For any detailed information visit: http://www.lausanne-tourisme.ch/en/hebergement/hotels.html

## Lausanne tourism:

For any detailed information visit http://www.lausanne-tourisme.ch/en/