AbstractID: 2560 Title: PET/CT imaging: a physicist's viewpoint

Despite considerable progress in the treatment of malignant disease, early detection still offers the best chance of a favourable prognosis. For patients with cancer, the anatomical identification of lesions by Computed Tomography (CT) has been used extensively to provide a differential diagnosis, following the onset of clinical symptoms. However, by the time abnormal tissue has grown sufficiently to appear positive on CT, the disease may well have progressed to a stage where successful treatment is, at best, difficult and at worst, impossible. The key is to identify a concentration of cancer cells at the earliest possible stage in the disease development.

In the past few years, Positron Emission Tomography (PET) with ^{18}F-fluoro-deoxyglucose (FDG) has become increasingly widely used to both diagnose and stage malignant disease. Fusion imaging that combines CT and PET obviously offers the best of both worlds: functional abnormalities can be accurately localized with CT and the functional status of anatomical abnormalities can be assessed with PET. While software fusion techniques provide accurately-aligned images of the brain, for the remainder of the body, patient positioning and involuntary internal organ movement present a difficult challenge. The recent introduction of hardware fusion using dual-modality combined PET/CT scanners has resolved many of the difficulties inherent to the software approach. With the combined scanner, the patient remains on the same bed for both CT and PET scans and a simple axial translation of the couch transports the patient from the CT to the PET imaging fields. A single scan session thus provides accurately aligned anatomical and functional image sets.

Even though combined PET/CT scanners have been in production for only four years, the technology is undergoing rapid evolution. For PET, the introduction of new scintillator materials, detector concepts and electronics is resulting in performance improvements in count rate, spatial resolution and signal-to-noise. At the same time, the increasing number of detector rows and reduction in rotation time are transforming whole-body CT performance. The combination of high performance CT with high performance PET is a powerful imaging platform for the diagnosis, staging and therapy monitoring of malignant disease. Over 90% of PET sales are now PET/CT with the prediction that PET-only scanners could be replaced entirely by PET/CT in the future. It is also anticipated that there will be a demand for a mid-range design that offers less performance at less cost. Since the performance of the PET components is the limitation on the overall imaging time, institutions requiring high throughput and large patient volumes will always demand the highest PET performance. Nevertheless, a 4 or 8-slice CT scanner should be adequate for oncology, while a 16 or 64-slice CT will be more appropriate for cardiac applications. As the current PET/CT technology becomes more widespread, appropriate designs implementing this concept will doubtless emerge in the future.

Learning objectives:

1. Summarize the rationale for combined PET/CT

2. Review recent advances in PET/CT designs
3. Discuss the future potential for the technology