Positron Emission Tomography (PET) imaging of the fluorodeoxyglucose (18F-FDG) has been the workhorse of oncologic nuclear medicine as it allows for the detection of most cancer lesions with high sensitivity and specificity. However, for the purpose of radiation therapy treatment planning, it is important not only to detect the disease but also to define its extent and, potentially, the subvolumes characterized by different levels of radioresistance. Correspondingly, for PET-based treatment planning it is not the uptake of the tracer in the lesion as a whole but rather the spatial pattern of the tracer uptake that is used to derive the spatial characteristics of the prescribed dose. Therefore, demonstration of positive correlation between PET SUV value and a certain histopathological measure across a cohort of patients is not sufficient to validate the use of PET tracer for treatment planning. Instead, validation of PET tracers has to include a step demonstrating spatial concordance of the tracer uptake pattern with the distribution of the feature of interest, i.e. hypoxia, proliferation, etc.

The presentation will demonstrate that direct imaging of any tumor microenvirionmental parameter in detail is not achievable with any clinically-relevant non-invasive imaging modality, as the required resolution would have to be under 100micron. Instead, PET image obtained with any tracer represents a convolution of the point spread function of the imaging device with the tissue viability, PET tracer delivery (availability), and, finally, the specificity of the tracer. Correspondingly, utilization of “functional PET volume” delineation techniques for defining therapeutic targets should be approached carefully. A non-binary dose-painting approach using a well characterized tracer might constitute a more robust method of utilization of biological information that can be obtained with PET.

Learning objectives:

1. Become aware of the role played by the highly heterogeneous nature of tumor microenvironment in the formation of PET image.
2. Understand the importance of the spatial distribution of the tracer as opposed to a single-value characteristic such as maximum or average SUV when PET image is to be used for radiation treatment planning.
3. Learn about alternative non-binary ways of utilization of PET imaging in radiation treatment planning.