PMOD Example Applications

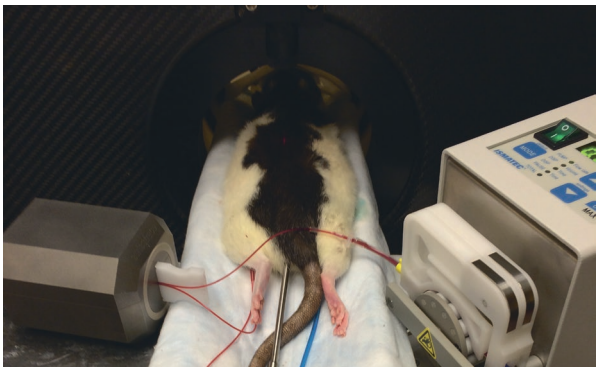
PMOD supports all kinds of biomedical modalities and their formats. The image viewing, image processing and volume-of-interest definition functionality goes much beyond the scope of other imaging software and provides unmatched flexibility. This strong basic functionality is complemented by dedicated quantification tools.

PMOD, the Swiss knife for quantification of biomedical images.

Characterization of New Radioligands

Newly developed radioligands have to undergo rigorous testing. PMOD tools support all characterization steps after the in-vitro assays:

- PMOD allows all images to be brought into a common analysis environment. By applying suitable registration methods, data from different sources can be fused for joint evaluation.
- Biodistribution is readily assessed and documented in PBAS or PSEG. The comprehensive set of contouring and segmentation methods leverages fast and reproducible regional uptake measurements.
- The kinetic modeling tools PKIN and PXMOD provide all state-of-art methods needed to evaluate ligand binding characteristics and develop a robust quantification methodology.
- PKIN's simulation capabilities can be leveraged in the development of an optimal data acquisition protocol and to assess the sensitivity of the results.
- Variability assessed in test-retest studies is crucial in estimating the detectable effect size. The R console in PBAS offers boxed scripts for the statistical analysis of such kinetic group results.

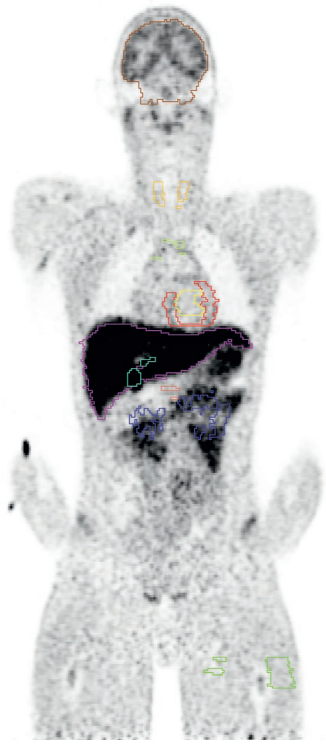


PET scan of rat with simultaneous online blood sampling

Radiation Dosimetry

Internal radiation dose estimation is an essential requirement for novel radiotracers. It is based on the cumulated radioactive decays in the critical organs. PMOD offers a tailored workflow for the necessary pre-processing steps using the base tool PBAS and the kinetic modeling tool PKIN.

A sequence of static images can readily be combined into a dynamic series with common decay correction. After organ outlining, their activity time course is calculated and transferred to the modeling tool. There, decay correction is undone and the activity curve integral calculated. The resulting cumulated organ activities are finally exported into files directly compatible with OLINDA or IDAC.



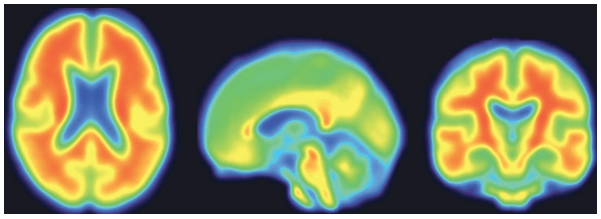
Outlines of organs and representative tissue

Disclaimer: PMOD is a software FOR RESEARCH USE ONLY (RUO) and must not be used for diagnosis or treatment of patients.

Large-scale Brain Data Processing

While studies within individual research centers typically include a limited number of subjects, there is a trend towards multi-center studies with large sample sizes and pooled repositories. Automated procedures are required for the efficient, yet objective, analysis of such data.

The PNEURO tool is ideally suited to the batch processing of research PET and MR brain data. The AV45 PET data, for more than 600 subjects, in the ADNI database (www.adni-info.org) was used to study the spatial distribution of Aβ deposition at different stages of disease. Using AV45 normalization templates, the SUVR was calculated in PNEURO, with and without partial volume correction. The statistics were transferred to the PMOD R console and analyzed with the linear mixed effects method.



AV45 normalization template for AD subject images, now also available from ADNI.

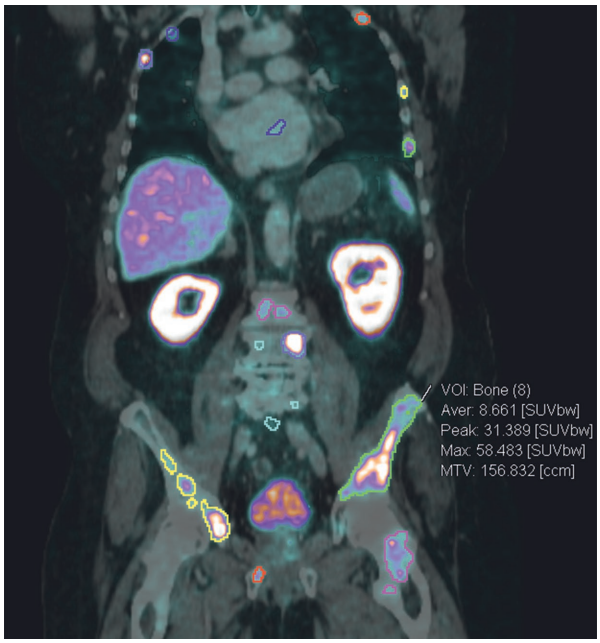
Lesions in Oncology PET

Oncology is the most prevalent application domain of PET scanning. Oncologic lesions typically show up in PET images as bright areas of high uptake. Over the years, many approaches have been described to quantify severity and spatial extent of such lesions.

PMOD provides flexible implementations of such methodologies to objectively assess tumor burden and therapy response for research. Whereas the PSEG module features a complete oncologic workflow, the general VOI environment of PMOD already includes a rich set of tools for segmenting and assessing lesions.

Iso-contouring in a restricted neighborhood is a widely applicable segmentation method. Hereby, specification of the contouring threshold is the critical element. PMOD supports absolute thresholds specified in SUV units, adaptive thresholds in percentage of SUVmax or SUVpeak in the neighborhood, and relative thresholds determined from reference or background tissue.

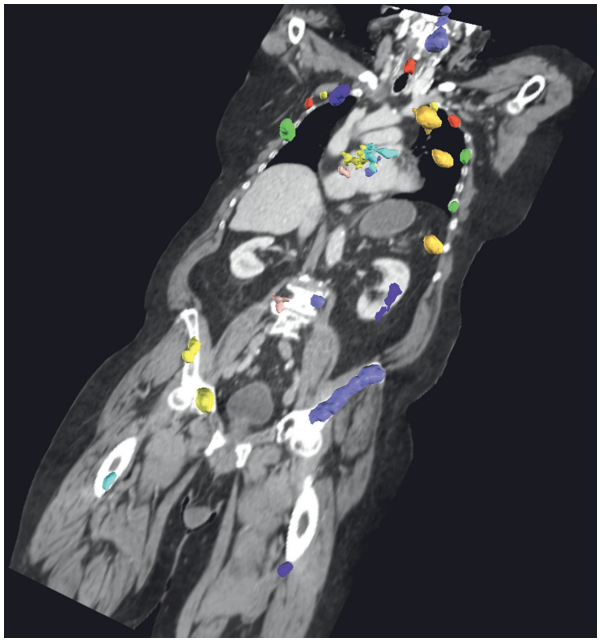
Using quick MIP navigation and hot-key driven segmentation, lesion assessment becomes a fast and objective process. An exhaustive set of measures is calculated from the uptake within the segments, including SUVmean, SUVpeak, SUVmax, MTV, sphericity and longest diameter. These measures can be displayed next to the lesions for convenient documentation, as well as leveraged for sorting the lesion order.



Lesions obtained by iso-contouring of PSMA PET scan at an absolute SUVbw threshold.

Texture analysis quantifies the variability of pixel intensities within a segmented lesion. A large number of texture metrics have been described for in vivo lesion characterization, which might provide predictive information. PMOD offers a collection of the 25 indexes which have been found to be most valuable in the context of PET imaging. They can readily be calculated in addition to the more standard VOI statistics, giving PMOD users an easy handle to radiomics research.

In addition to numeric assessment, the lesions can be visually explored in many ways. As an example, the PSMA bone lesions are rendered as 3D surfaces and shown together with a coronal plane of the CT scan in the illustration below.



Rendering of segmented lesions in the PMOD 3D tool.