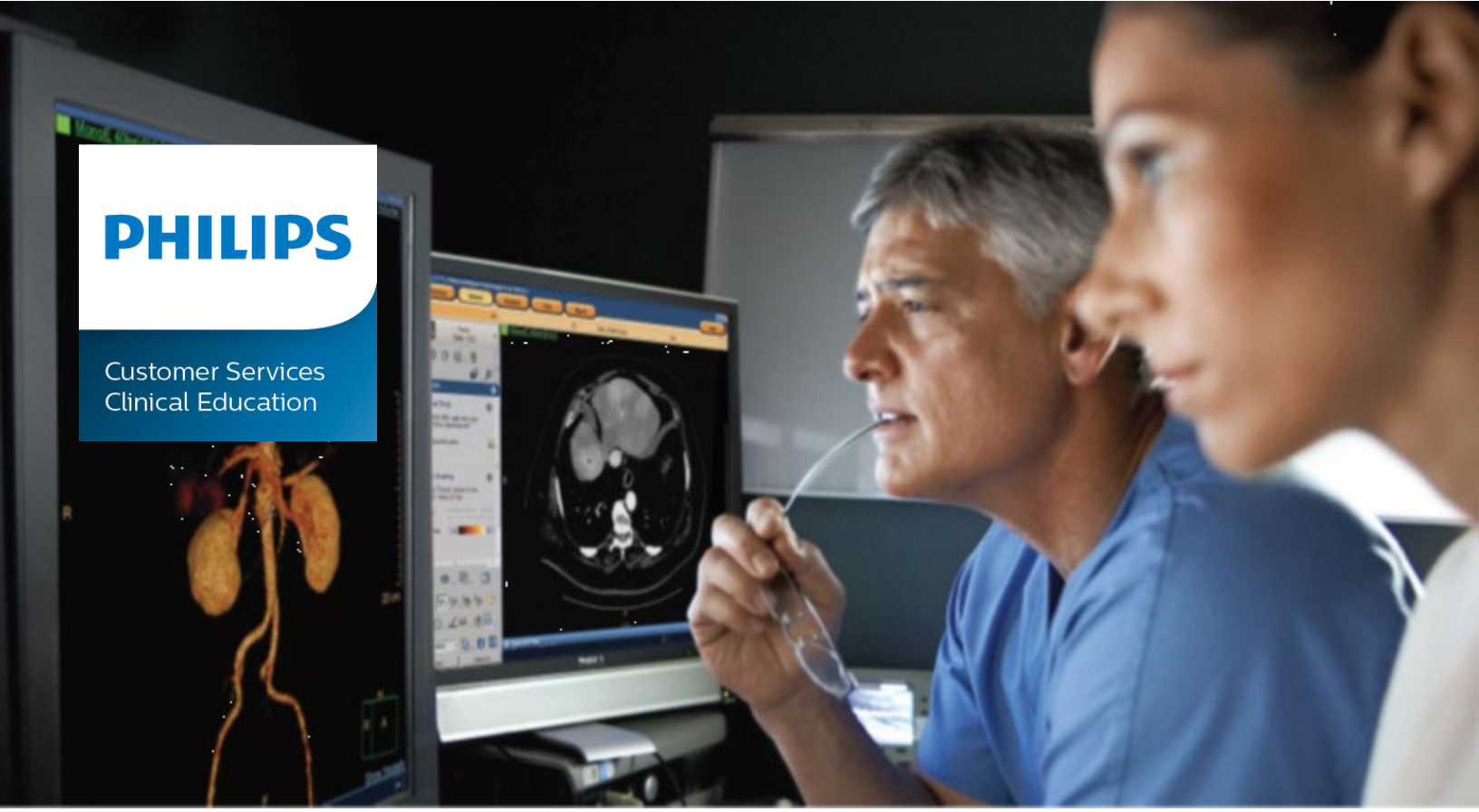


MR Permeability

Purpose

The MR Permeability package allows the analysis of a contrast bolus passing through the tissue.

The package assesses the permeability differences between tissues according to the Tofts Model.

The purpose of the package is twofold:

1. Generating parametric maps

   The package generates parametric maps (in color or grayscale and with or without an underlay) that reflect different parameters describing the time intensity curve per pixel.

2. Detailed analysis of parametric maps calculated by the Permeability pack

Before you begin

Valid image series

MR Permeability has the following acquisition requirements.

Three series are required as follows:

- A Dynamic Contrast-Enhanced (DCE) series with 20 dynamics or more is needed, typically with high temporal resolution and flow artifact reduction.
- Two reference series.

To calculate the baseline T1 relaxation time per pixel (baseline T1 map), two T1-FFE reference series with different flip angles (for example, 5 and 15 degrees) are required. The two reference series should be identical to the DCE series in terms of field of view, orientation, resolution, slice thickness, and number of slices.

The two reference series should fulfill the following criteria:

- They should not be a dynamic series.
- TR about 10 ms (should be identical for reference series 1 and reference series 2).
- TE about 2 ms (should be identical for reference series 1 and reference series 2).
- Reference series 1 has a flip angle of 5 degrees.
- Reference series 2 has a flip angle of 15 degrees.

In exceptional cases, a single reference series can also be used. But in that case the TR and the TE of the reference series and the DCE series have to be identical. And they still need to have different flip angles.

Arterial Input Function (AIF)

The calculation of permeability characteristics can be done based on a model-based AIF or based on a manual AIF. The model-based AIF can have 3 different bi-exponential shapes. The different shapes are controlled by the user selected injection duration which is a property of the injection preset and can be set to:

- short (less than 5 s)
- medium (from 5 to 10 s)
- long (longer than 10 s)

Other properties affecting the results

Hospital dependent injection properties affecting the calculation of permeability characteristics are the contrast relaxivity, which depends on the contrast agent in use, and the injection dose. Since the contrast relaxivity is field strength and contrast agent dependent, per field strength and contrast agent a different injection preset is required if applicable. The hematocrit value is a patient dependent parameter, that has a default value of 45%.

Workflow

Select a suitable permeability study and click **MR Permeability** to start the analysis. 

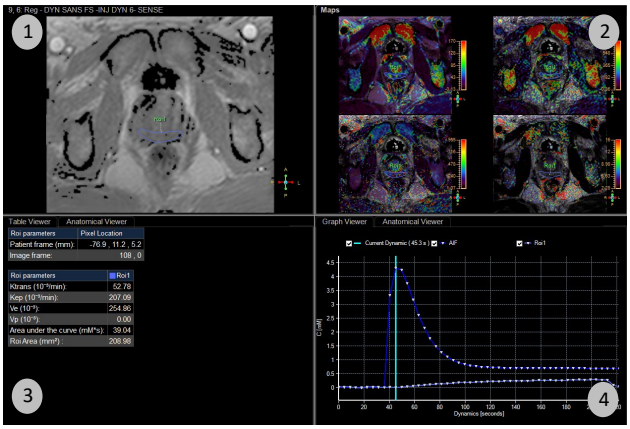
Scroll through the images

Through dynamics
In the image viewport, drag to the left or right.

Through slices
In the image viewport, drag up- or downwards.

Through maps
In the map viewport, drag to the left or right.

Layout

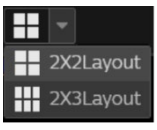


1. **Reference Series**
2. **Parametric Real Time Permeability Maps**
3. **Table Viewer**
4. **Graph Viewer**

Options

Click any menu item to enable/disable this option.

The menu offers functionalities such as Select Reference Series, Save Layout Preset, Delete Layout Preset.



To select another screen layout, click the drop-down arrow and select 2x2 or 2x3 Layout

Select the Analysis method

Select from:

- Model based AIF
- Manual AIF

Verify parameters match acquisition

- Magnetic Field Strength
- Contrast relaxivity
- Injection dose
- Injection duration
- Hematocrit

Verify & adjust data quality (optional)

To adjust parameters for spatial smoothing, expand the selection for **Verify & adjust data quality**.

Apply Spatial Smoothing

For spatial smoothing of the resulting maps

Possible settings are: None (no smoothing), Weak, Medium, or Strong. Spatial smoothing smooths the maps and the original images. In such a way, spatial smoothing has an effect on the numerical results.

Apply Temporal Smoothing

For temporal smoothing of the resulting maps

Possible settings are: None (no smoothing), Weak, Medium, or Strong.

Define the mask (optional)

This optional workflow step serves to adjust the mask and to enable the display of the mask while adjusting. Setting a threshold mask will exclude background pixels from the functional map calculations. All pixels with values below the mask value will be displayed blue and will be excluded from the calculation. Only pixels with intensity above the mask value are used for the calculations.

- Right-click and drag in the source image to adjust the mask.

Select Maps

Select the maps in the task guidance panel for real-time calculation and display, and for the generation of new imaging series.

Select the checkbox of a map to display this map.

The display of the real-time calculated maps updates accordingly.

Ktrans	Transfer constant between blood plasma and Extravascular Extracellular Space (EES), also called vascular permeability
Kep	Rate between EES and blood plasma (also called Tracer Efflux Rate)
Ve	Extravascular Volume fraction (Leakage space) Defined as Ktrans / kep
Vp	Plasma Volume fraction (Vp)
Area Under the Curve	Area Under the Curve of all time curves

Measure ROIs

Draw one or more ROIs to focus on a specific Region of Interest

Select Underlay

You can select an MR series as underlay of the parametric maps allowing for better visualization. To optimize the display, you can also adjust the opacity of the overlaying parametric maps.

Generate Series

To export maps as a new image series, click **Generate Series.** Select from:

- Secondary Capture
- Secondary Capture RGB