WHOLE BODY

32 MIBG Quantification

32.1 General

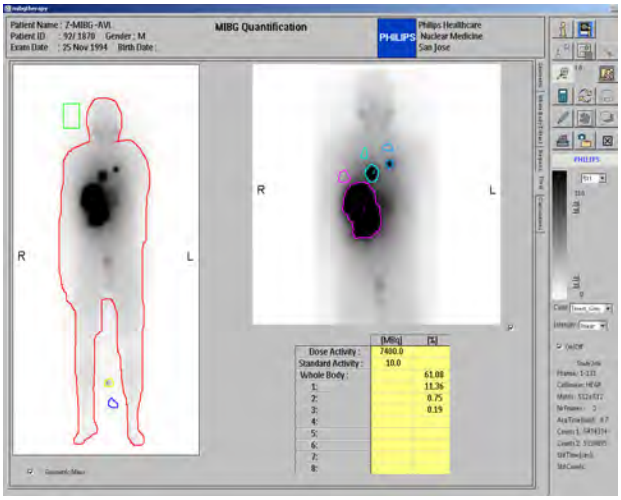


Figure 304 MIBG Quantification application

This application allows calculation of the uptake of MIBG in the total body and in up to 8 regions. The method was developed at the Antoni van Leeuwenhoek institute in Amsterdam. Their method requires acquisition of a standard and whole body image. You can acquire the standard image as a separate image or together with the whole body image.

32.2 Acquisition

32.2.1 MIBG Quantification (3.7 - 7.4 GBq.) Acquisition Parameters

- 512 x 512 static, 512 x 1024 or 1024 x 1024 whole body images
- Scanspeed = 25 cm/min
- I-131 intrinsic floodcorrection on
- Standard: 8 to 10 MBq in 1ml, in a tube
- Standard (tube) is placed in a Plexi-glass cubicle container that has been placed between the lower legs.
- Total acquisition time (ant and post) about 20 min. (single head).
- HEGP collimator.
- I-131 peak at 364 KeV.

32.2.2 MIBG Diagnostic Acquisition Parameters

- 512 x 16 Static images
- I-131 intrinsic floodcorrection on
- Standard: 8 to 10 MBq in 1 ml, in a syringe
- Place the standard (syringe) in a plexiglass cubicle container, and acquire as a separate static image
- Acquisition time: 10 min./image
- HEGP collimator
- I-131 peak at 364 KeV

32.3 Processing

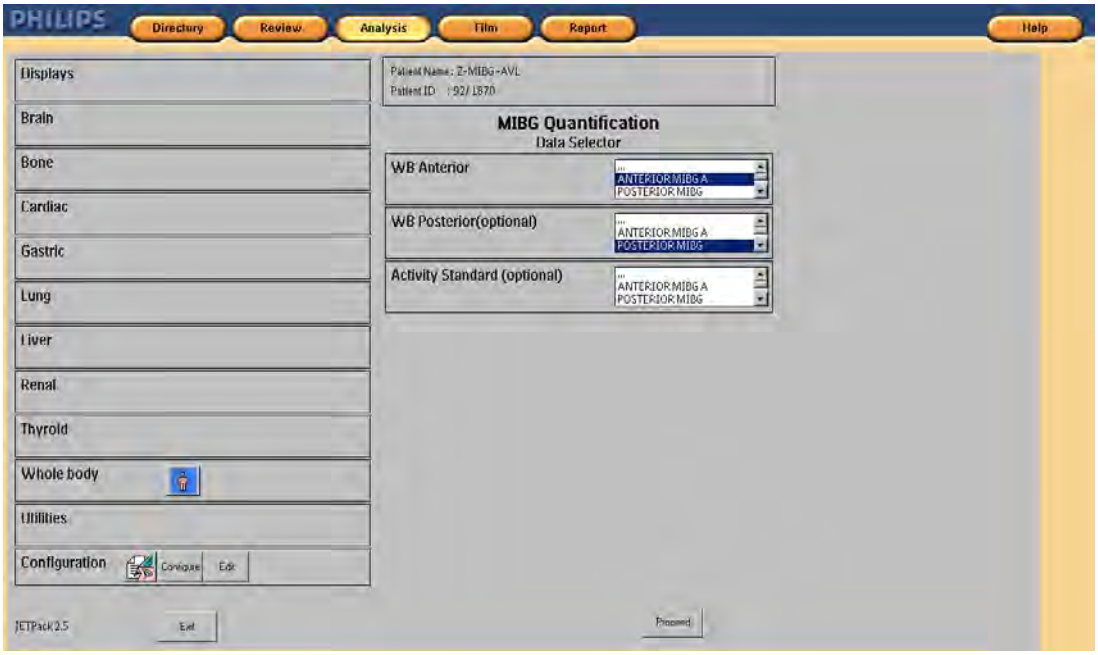


Figure 305 JETPack panel, MIBG Quantification application selected

If required adjust the selected file in the data bucket and click **Proceed**.

Select the anterior whole body image and optional posterior whole body image. The matrix size of the images can be 512 x 512, 512 x 1024, or 1024 x 1024. If you select both anterior and posterior images, the geometric mean image is produced and all calculations are done on that image.

If you acquired a separate image for the standard activity, then select that image as well.

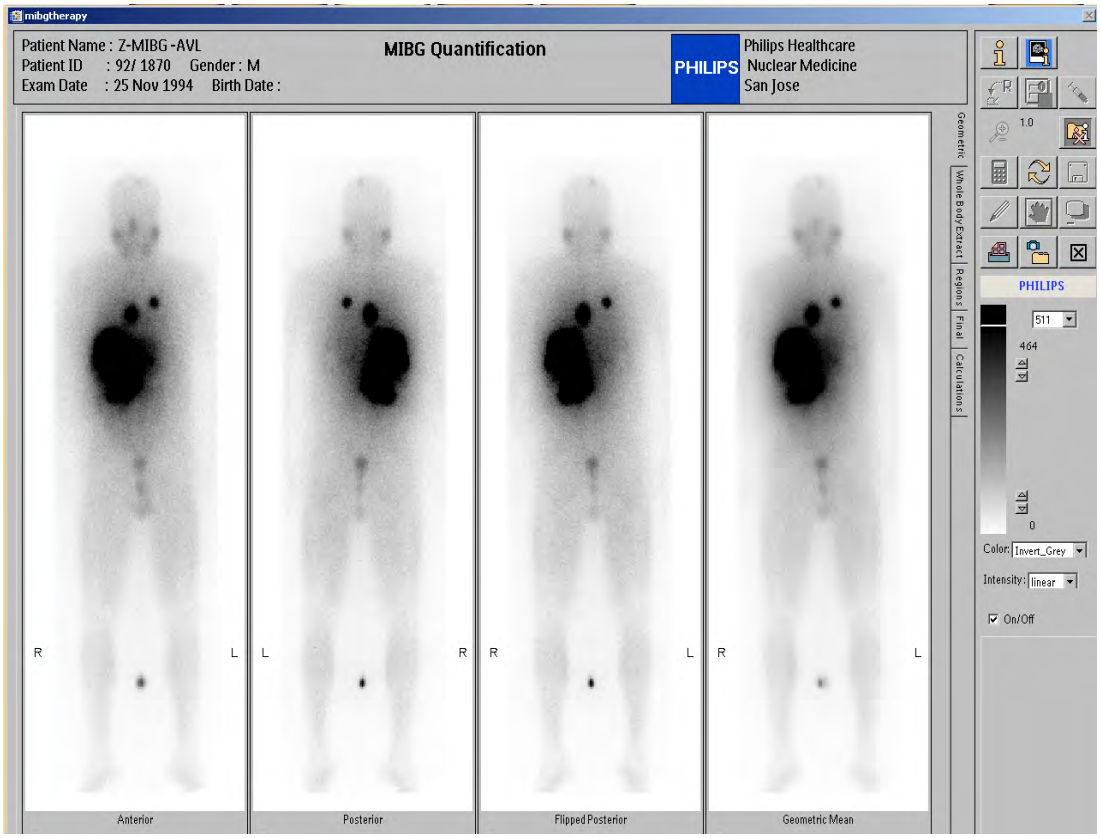


Figure 306 Anterior and posterior whole body images selected

Figure 306 shows the **Anterior, Posterior, Flipped Posterior** (flipped about the Y axis) and the **Geometric Mean** or conjugated image. The geometric mean of the anterior is generated pixel by pixel by calculation of the square root of the product of a pixel in the anterior image with the corresponding pixel in the flipped posterior image. This page is empty when you select only the anterior whole body.

32.4 Button Panel, Image Controls, and Annotation

See Chapter 1, “Getting Started.”

32.5 Whole Body Extract and Activity Page

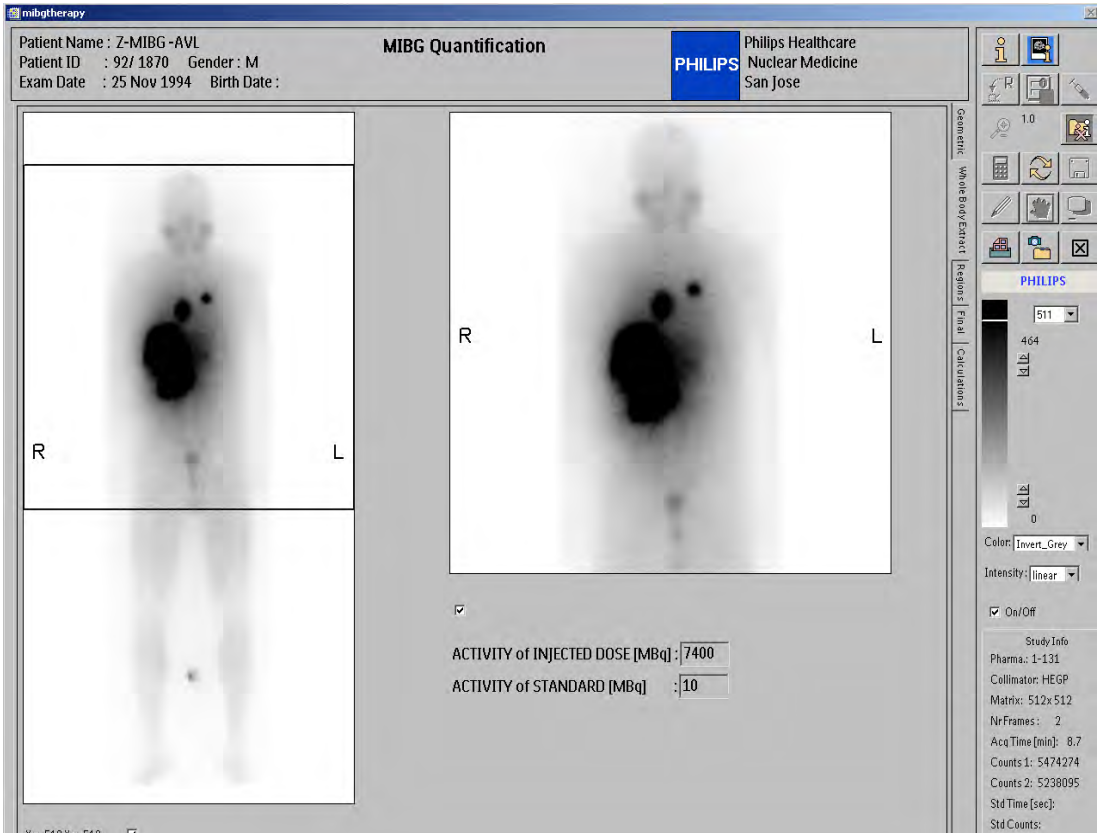


Figure 307 Whole body Extract and Activity page

Enter the activity of the injected dose and that of the standard in Figure 307. If omitted, selection of the regions page causes an error message: Cannot determine Applied dose and/or Standard, Please check input.

Drag the box region on the whole body image to the desired area. The extracted square image at the right side follows the region marker lines on the whole body.

Once the extracted image has the right area displayed, continue to the regions page.

32.6 Regions Page

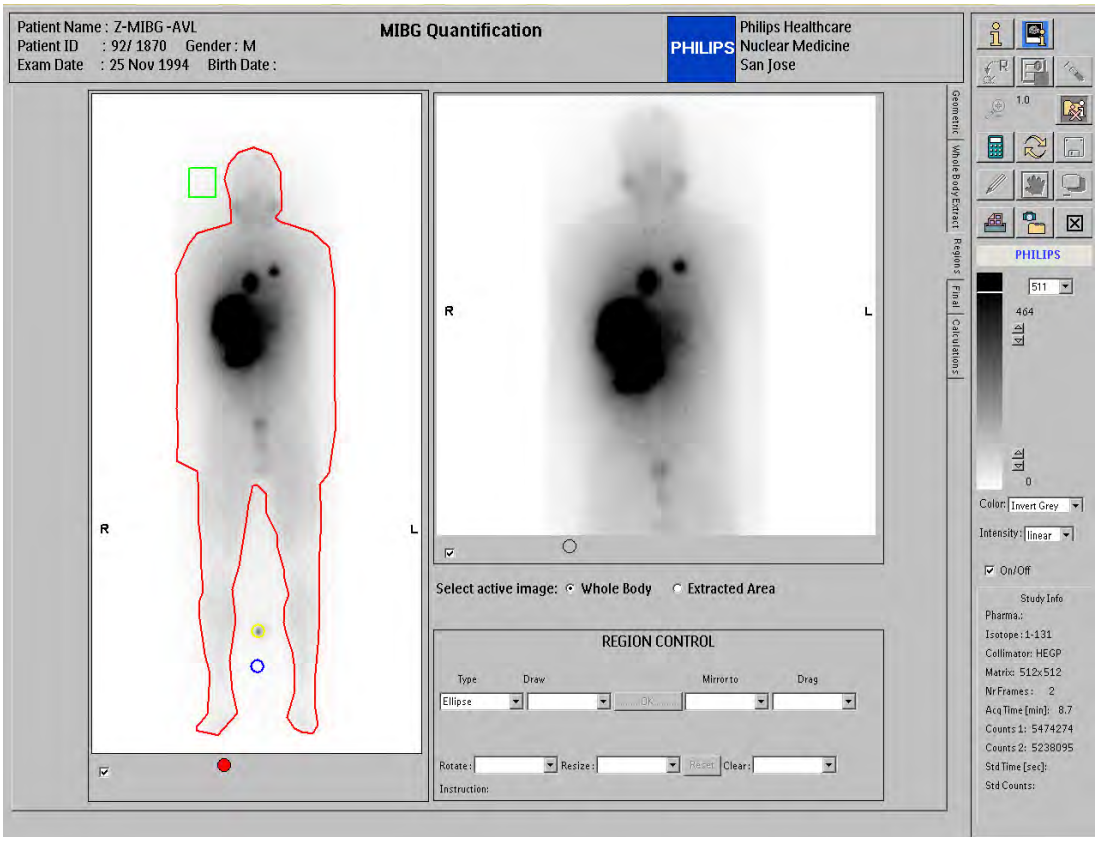


Figure 308 Regions page: whole body image displayed

On the Regions page, select the image you want to work on with one of the radio style buttons; whole body or extracted area image or standard image (if available).

The region control allows **Polygon**, **Freehand**, **Iso Free**, **Box,** and **Ellipse Type** regions. You must draw the following regions: whole body, whole body background, standard and standard background.

After you complete all four regions, the **Calculate & Display** button becomes available. Click that button to calculate the results and move to the final page or draw optional regions on the extracted image.

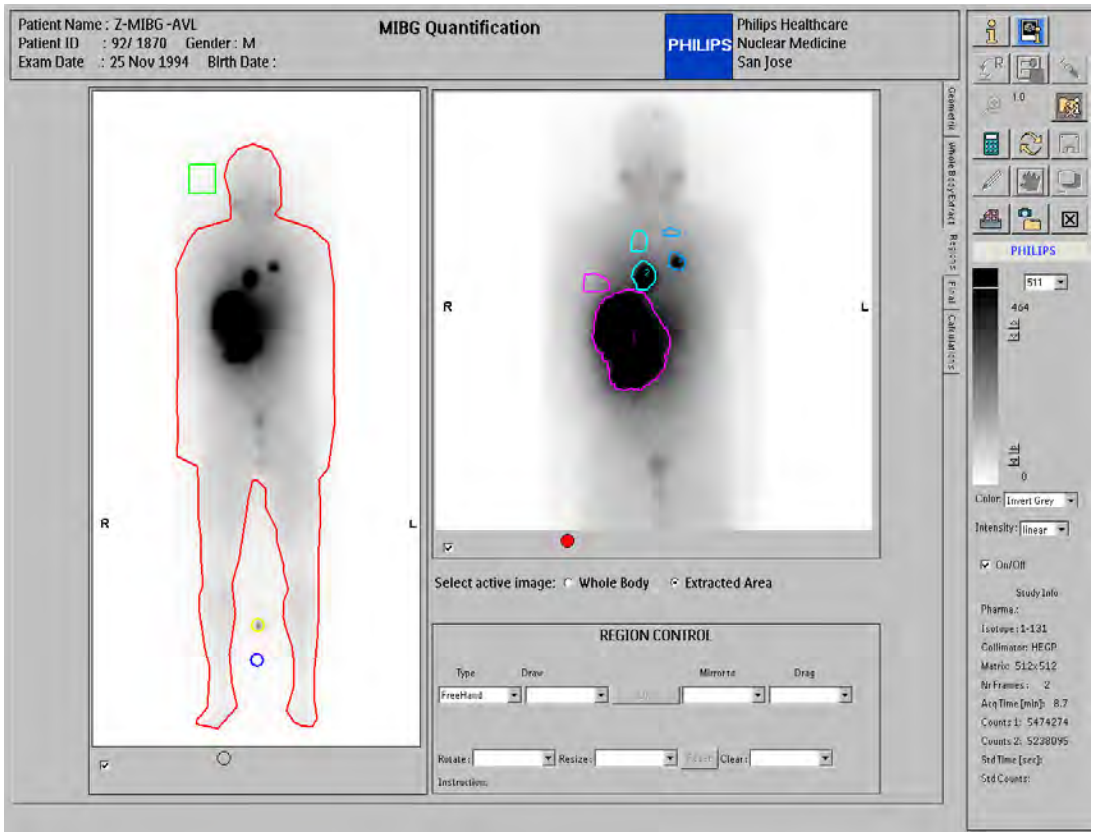


Figure 309 Regions page: Extracted image displayed

It is possible to draw up to eight additional nodal regions with each region having an accompanying background region on the extracted image. The uptake per region is determined and appear on the final page.

When you have drawn all desired regions, click **Calculate & Display** to switch to the final page with the results of the uptake calculations.

32.7 Final Page

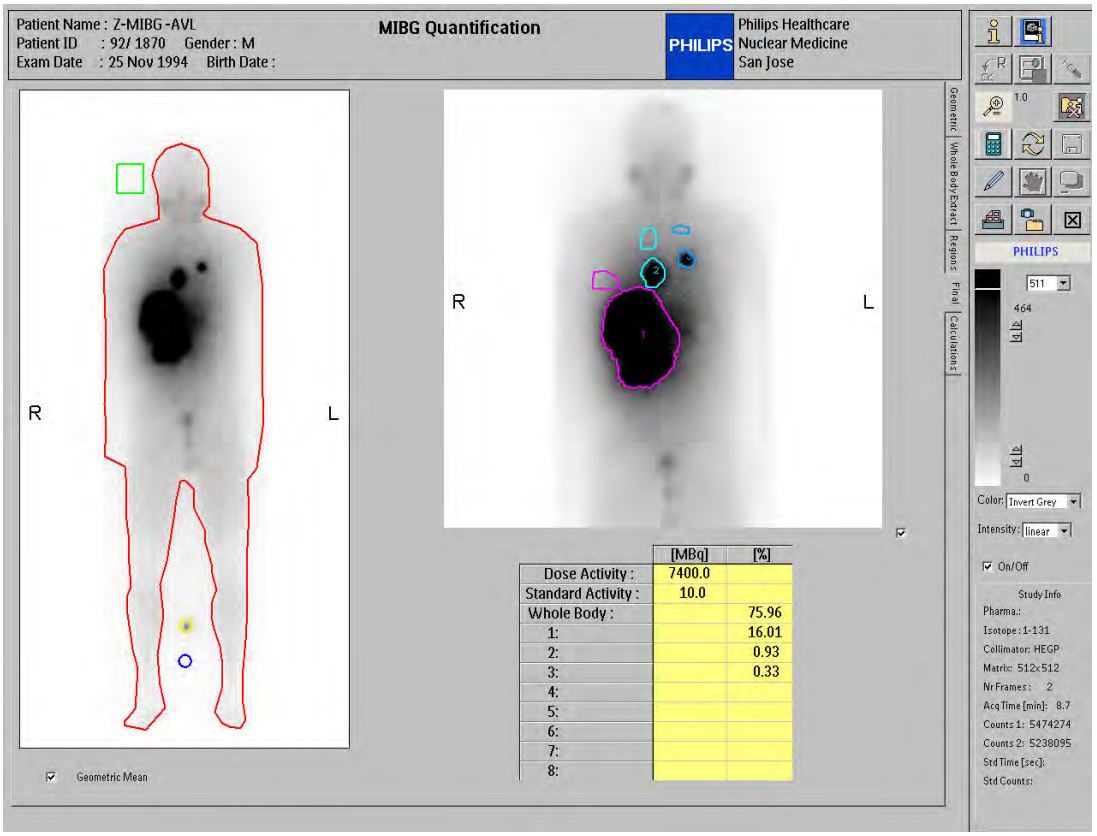


Figure 310 Final page

The results of the calculations appear in the table. For more details, see “Calculations ” on page 388.

The whole body and extracted image may be annotated with text and arrows using the annotation controls as described on page 40. You can apply Image contrast controls to both images individually.

Also, the display of the **Study info** near the right bottom corner controlled by the **More** button.

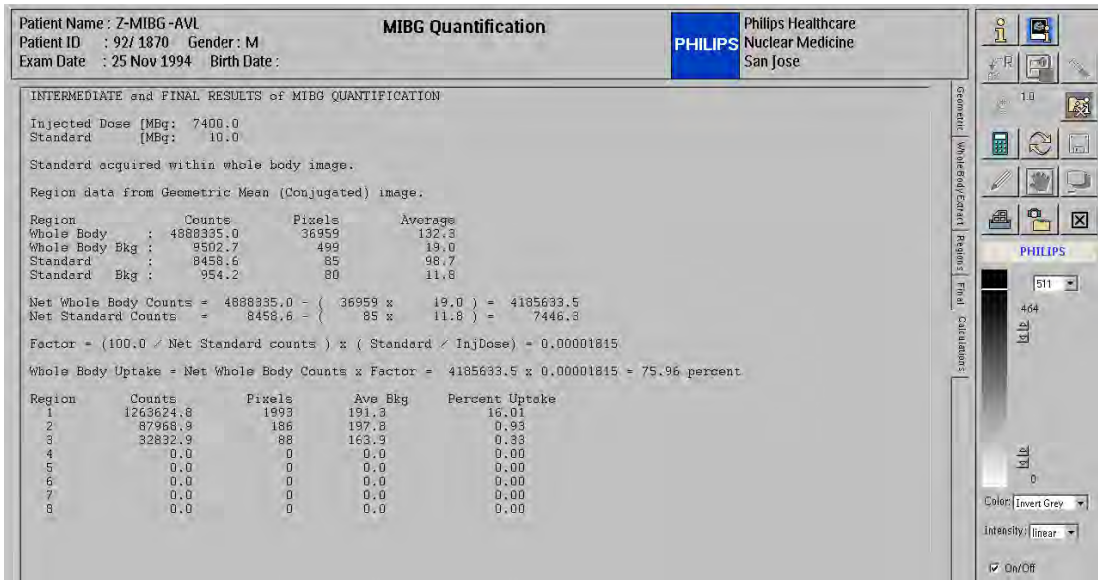


Figure 311 Calculations page

32.8 Calculations

The counts and pixels of all regions are determined. Each parent region has an accompanying background region. The counts per background region are area-normalized to the size of their parent region and then subtracted from each parent region. For instance, the counts of the whole-body-background region are multiplied by the following factor:

$$\frac{\text{WholeBodyRegionPixels}}{\text{WholeBodyBackgroundRegionPixels}}$$

to normalize the whole body background counts to the size of the whole body region. The normalized whole body background counts are then subtracted from the raw whole body counts to yield the net whole body counts. The same applies for all regions sets: standard activity and all optional nodal regions of interest. All regions counts are corrected for their area-normalized background counts.

A factor is determined as:

$$\text{Factor} = \frac{100\%}{\text{Net Standard Counts}} \times \frac{\text{Standard Activity [MBq]}}{\text{Injected Dose [MBq}}$$

The net counts of each region are then multiplied by this Factor to determine the percentage uptake for each region, including the whole body region.

33 Whole Body Ileo-Sacrum

33.1 General

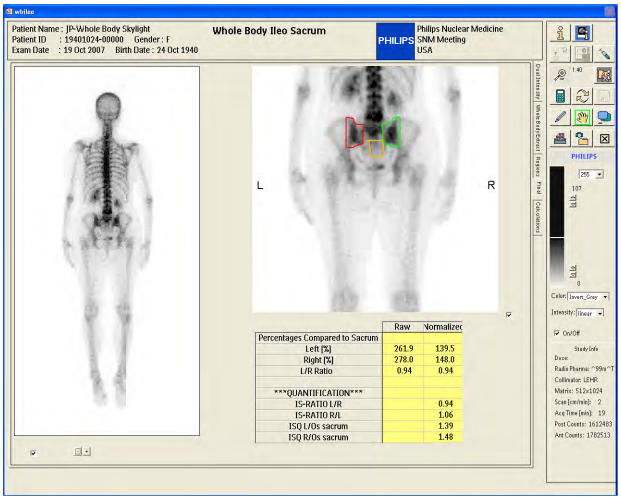


Figure 312 Bone: Whole Body Ileo-Sacrum application

This application calculates the ratio of the left and of the right ileo-sacrum joint with respect to the sacrum (sacrum = 100%) from either a static or whole body image. Whole body anterior and posterior images appear in dual intensity.

33.2 Acquisition

- Static image: e.g. 700 kCnts, 300 sec, 512 x 512 x 16
- Whole body image: sizes allowed: 256 x 1024, 512 x 1024, 512 x 2048, 384 x 1024, and 1024 x 1024
- Whole body anterior and posterior for dual intensity display.

Philips Healthcare 300006193291 A

33.3 Processing

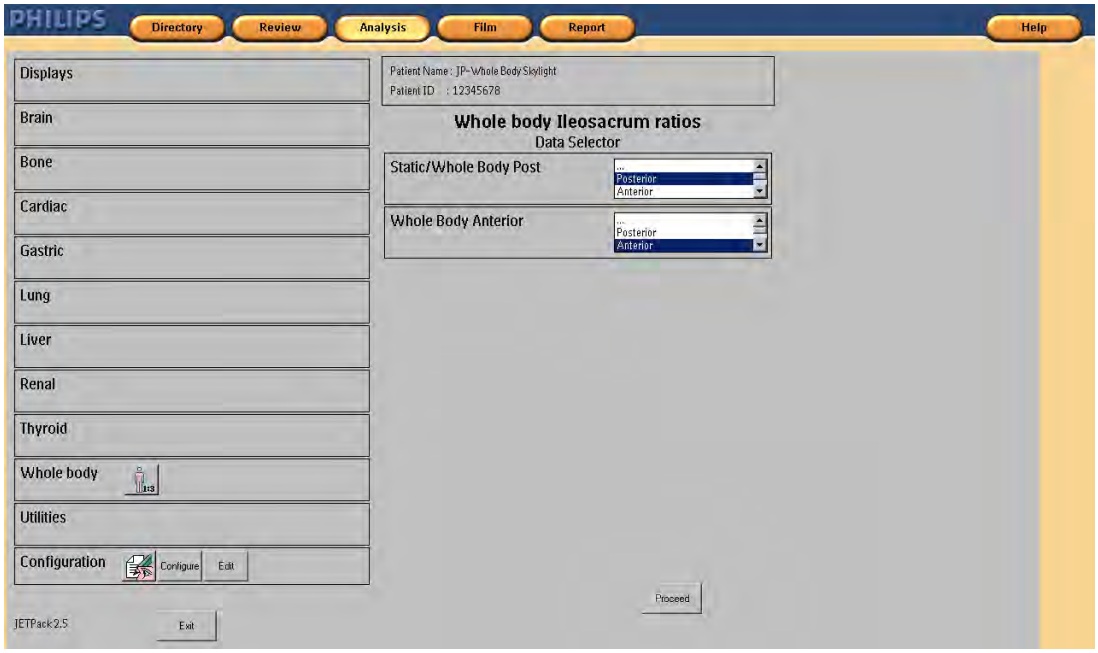


Figure 313 ISP JETPack panel, Whole Body Ileosacrum application selected

If required adjust the selected file in the data bucket and click **Proceed**.

33.4 Dual Intensity Page

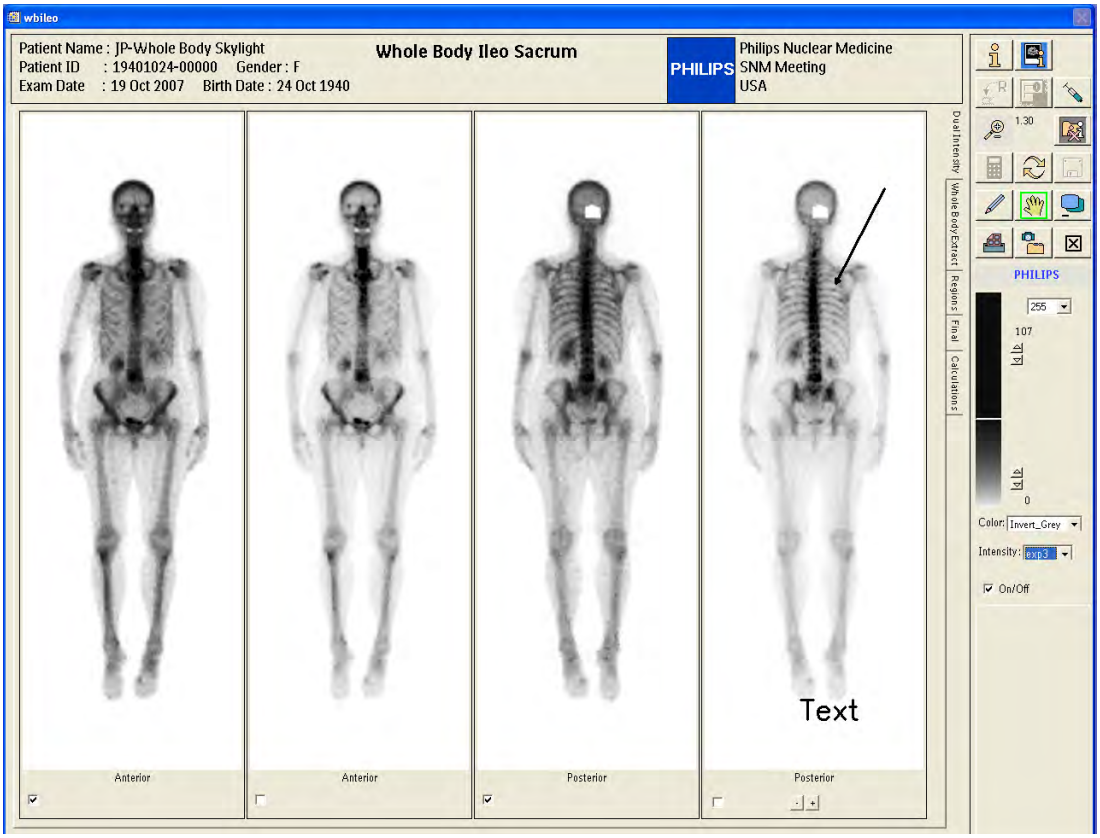


Figure 314 Dual Intensity page

Both Anterior and Posterior whole body images, when loaded are displayed as shown in Figure 314. By means of the image checkboxes the individual images can be enabled for adjustment of window setting, color map, and Intensity (log, exp) to obtain a dual intensity dual view display.

In the case that only the Posterior whole body image is loaded the same page will display the Posterior dual view on the right side of the page in the same manner as just described.

33.5 Button Panel

See Chapter 1, “Getting Started.”

Annotation, drag, and mask buttons act like radio buttons. Only one selection of the three is possible at a time as indicated here by the highlighted pan button.

Annotation: You can place text and arrows on certain images. When selected, a panel below the window sliders becomes visible. See Figure 314 for an example.

Drag image, panning: Click and drag any of the four whole body images on this page to another position.

Mask image: Click on the anterior or posterior image, then draw a region of interest around the area that you need to mask. Upon completion, the data inside the region area is set to zero, giving you the ability to remove undesired hot areas from the image.

33.6 Whole Body Extract Page

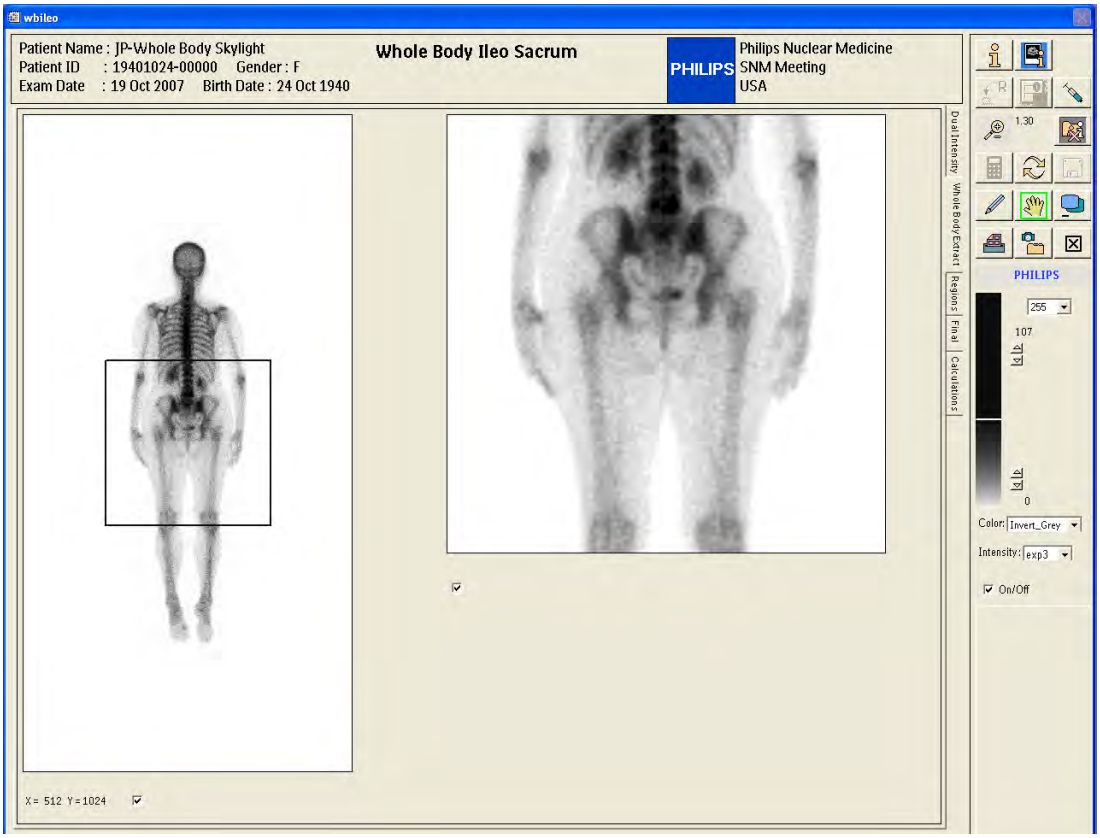


Figure 315 Whole body Extract page.

Drag the box region on the whole body image to the desired area. The extracted square image at the right side follows the region on the whole body.

Once the extracted image has the correct area displayed, click the **Regions** tab.

33.7 Regions Page

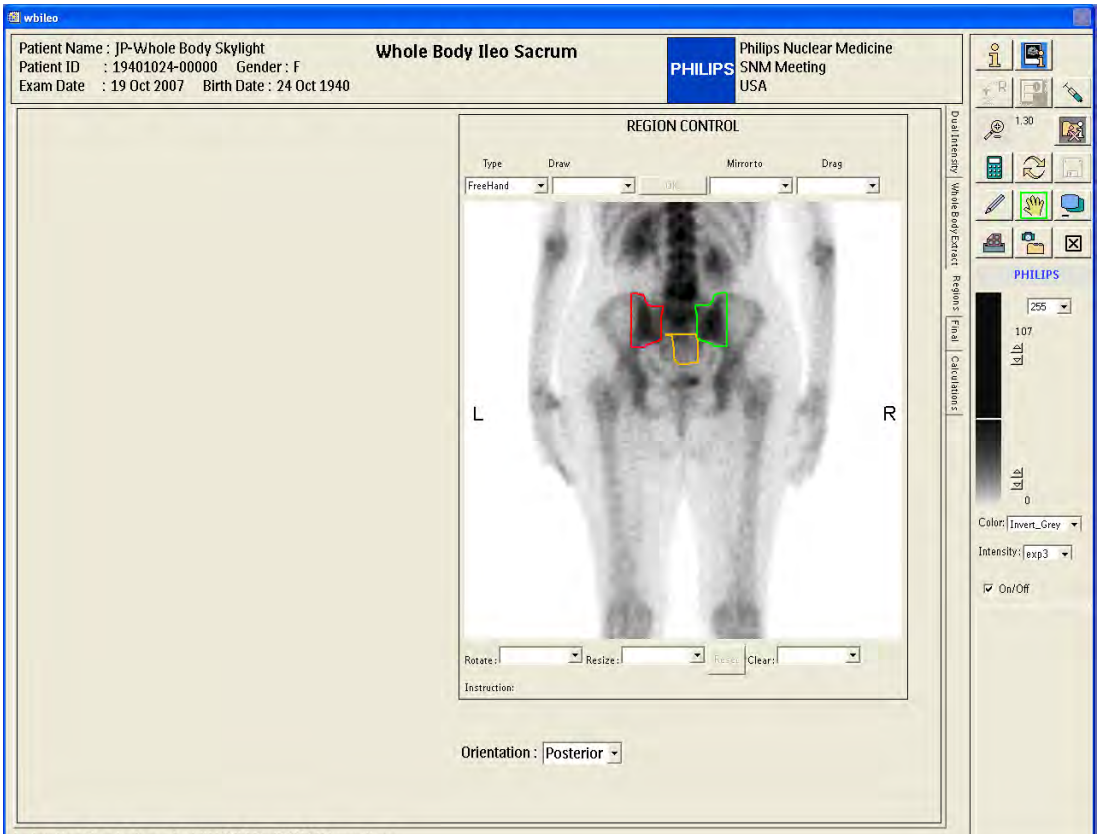


Figure 316 Regions page

On the **Regions** page, select the correct orientation from the drop down menu, either **Posterior** or **Anterior**. The selection displays an L and R letter on the image to indicate the orientation.

The Region control allows Polygon, Freehand, Box, and Ellipse Type regions. You must draw the following regions: left SI joint, right SI joint, and sacrum.
Upon completion of all three regions, the Calculate & Display button becomes available. Press that button to calculate the results and move to the final page.

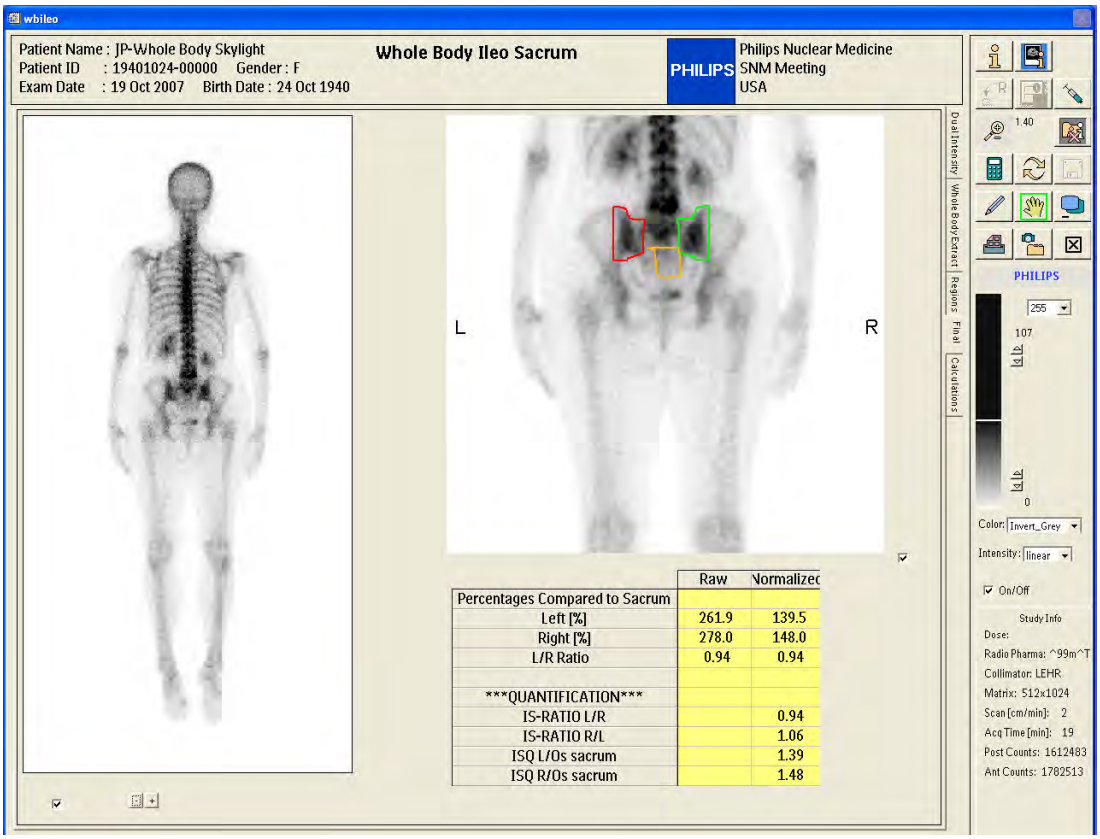


Figure 317 Final page

The results of the calculations appear in the table. For more details, see “Calculations” on page 395.

You can adjust the whole body image using Annotation, Pan, and Masking. Image controls are available for both images.

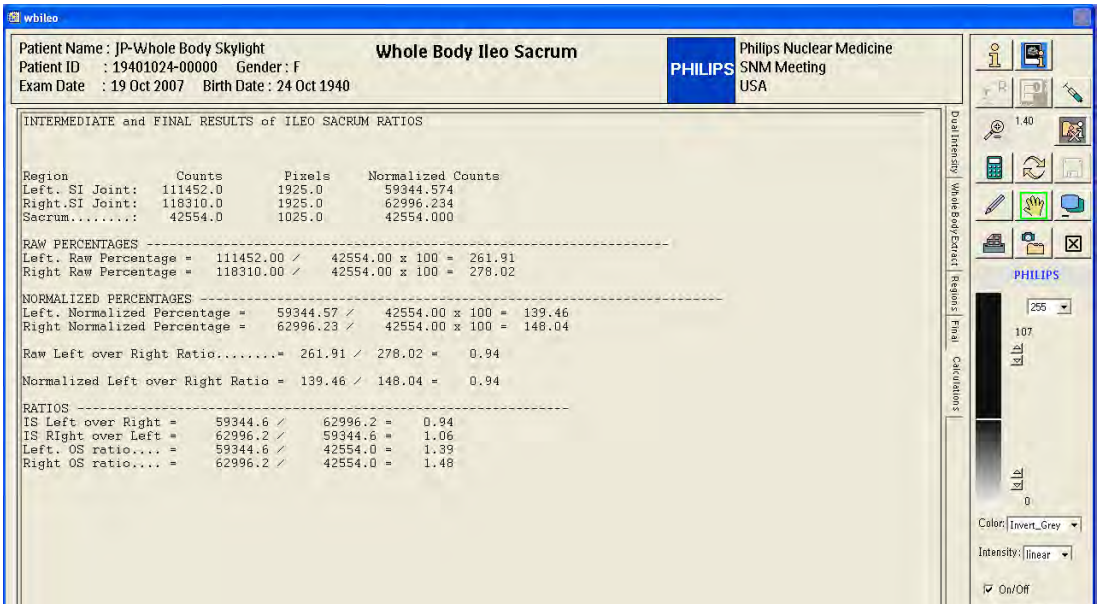


Figure 318 Calculations page

33.8 Calculations

The counts and pixels of the three regions are determined, then the Normalized counts for Left and Right SI joint regions are calculated by normalizing the region sizes to the size of the Sacrum.

Or: Normalized Left counts = (Pixels sacrum / Pixels Left Joint) x Left Counts.

Raw percentages take the un-normalized raw counts:

Left percentage raw =(Raw Left SI counts / Raw Sacrum counts) x 100%

Normalized percentages take the normalized counts:

Left Normalized Percent =(Norm. Left SI counts / Raw Sacrum counts) x 100%

Ratio Raw Left over Right = Left percentage Raw / Right percentage Raw

Ratio Normalized Left over Right = Normalized Left percentage / Normalized Right Percentage.

IS Left/Right = Normalized counts Left / Normalized counts Right.

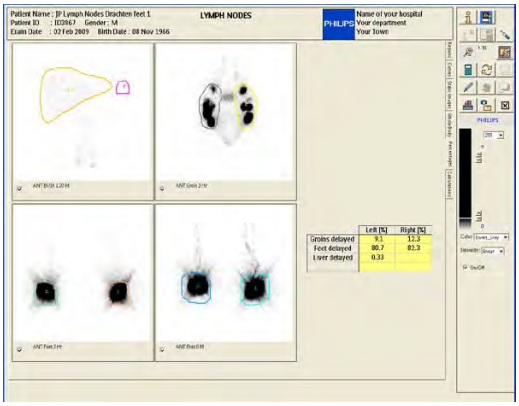
IS Right /Left = Normalized counts Right / Normalized counts Left.

Left OS Ratio = Normalized counts Left / Sacrum counts

Right OS ratio = Normalized counts Right /Sacrum counts.

34 Lymph Nodes Legs/Arms

34.1 General



The Lymph nodes application determines the percentages uptake from four or five static images of the legs, groins and liver in “Legs” mode or from the arms, axilla and liver in “Arms” mode. Whole body images or static images can be displayed on separate pages. A dynamic image can be selected for curve generation of the left and right groin areas.

34.2 Acquisition Scenarios

The application can handle a number of scenarios:

1 **Dynamic mode** (Drachten method) : Legs or Arms

Four Static images, matrix 256x256, duration 180 seconds of the

- Feet or Hands at 0 hr
- Feet or Hands Delayed (at 2 Hr)
- Groins or Axilla Delayed (at 2 Hr)
- Liver Delayed (at 2 Hr)

Dynamic image , matrix 256x256 of the Groins or Thorax area, 40 frames @ 30 sec/frm.

Four Whole body images of the legs including feet and groins or of the Arms including hands and Axilla , Anterior + Posterior views at 30 min and at 2 hr.

2 **Static mode** (Maastricht, UCM/AZM Method) : Legs or Arms

Five Static images, matrix 128x128, varying duration,of

- Feet or Hands 0 (0 hr) : 12 sec
- Feet or Hands Late (2 hr) : 60 sec

- Groins or Axilla at 45 min : 180 sec
- Groins or Axilla Late at 2 Hr or 6 Hr : 60 sec
- Liver Late at 2 Hr or 6 Hr : 300 sec

Four Static images of the upper and lower legs or arms at 45 minutes and at 2 hours

p.i. all acquired for five minutes.

3 **Four static images** of the legs or arms

Four Static images, matrix 128x128 or 256x256, varying duration.

34.3 Processing

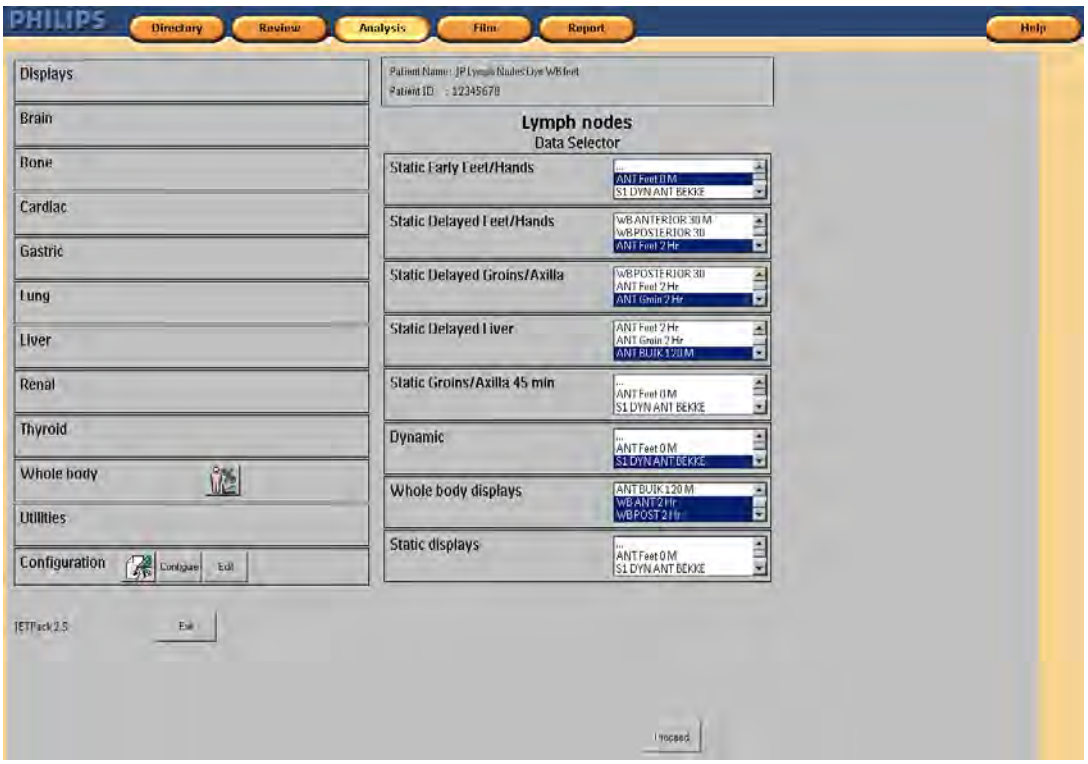


Figure 319 ISP JETPack panel, Lymph Nodes application selected. Data buckets loaded for the Dynamic mode.

The Dynamic Legs selection consists of static images of feet at 0 hr, feet at 2 hr, groins at 2 hr, liver at 2 hr, a dynamic image of the groins area and four whole body images of the legs anterior+ posterior at 30 min and at 2 hr. The whole body images are manually picked in the correct sequence, WB ant 0, WB Post 0, WB ant 2 hr, WB post 2 hr and added one by one to the multiple objects bucket labeled “Whole body Displays”

For the Dynamic Arms method static images of the hands at 0 hr, hands at 2 hr, thorax (axilla) at 2 hr, liver at 2 hr, a dynamic image of the thorax area (including axilla) and four whole body images of the anterior + posterior at 30 min and at 2 hr are used.

The whole body images are optional in both situations.

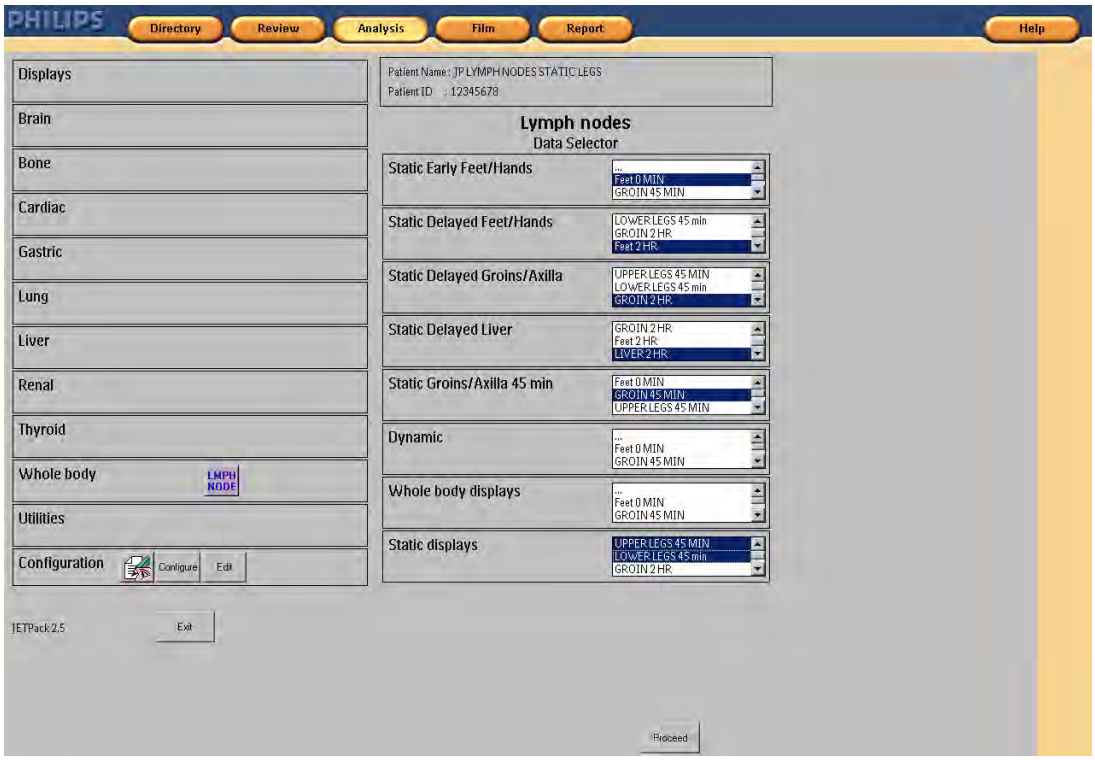


Figure 320 ISP JETPack panel, Lymph Node application selected. Data buckets loaded for Static mode.

The Static mode selection for “Legs” consists of the feet 0, feet 2hr, groins 2hr, liver 2hr and groins 45 min images. Static images of upper and lower legs at 45 min and 2 hr are picked in the sequence; upper 45 min, upper 2hr, lower 45 min and lower 2hr to get a display where upper and lower at 45 min and at 2hr are displayed vertically.

For Static mode processing of the images acquired for “Arms”, the selection consists of Depots 0, Depots 6 hr, Arms 6 hr, Thorax or Axilla at 6 hr, Axilla at 45 min.

34.4 Button Panel and Region Control

See the General description for an explanation of the various buttons.

34.5 Regions page, dynamic mode, Legs study

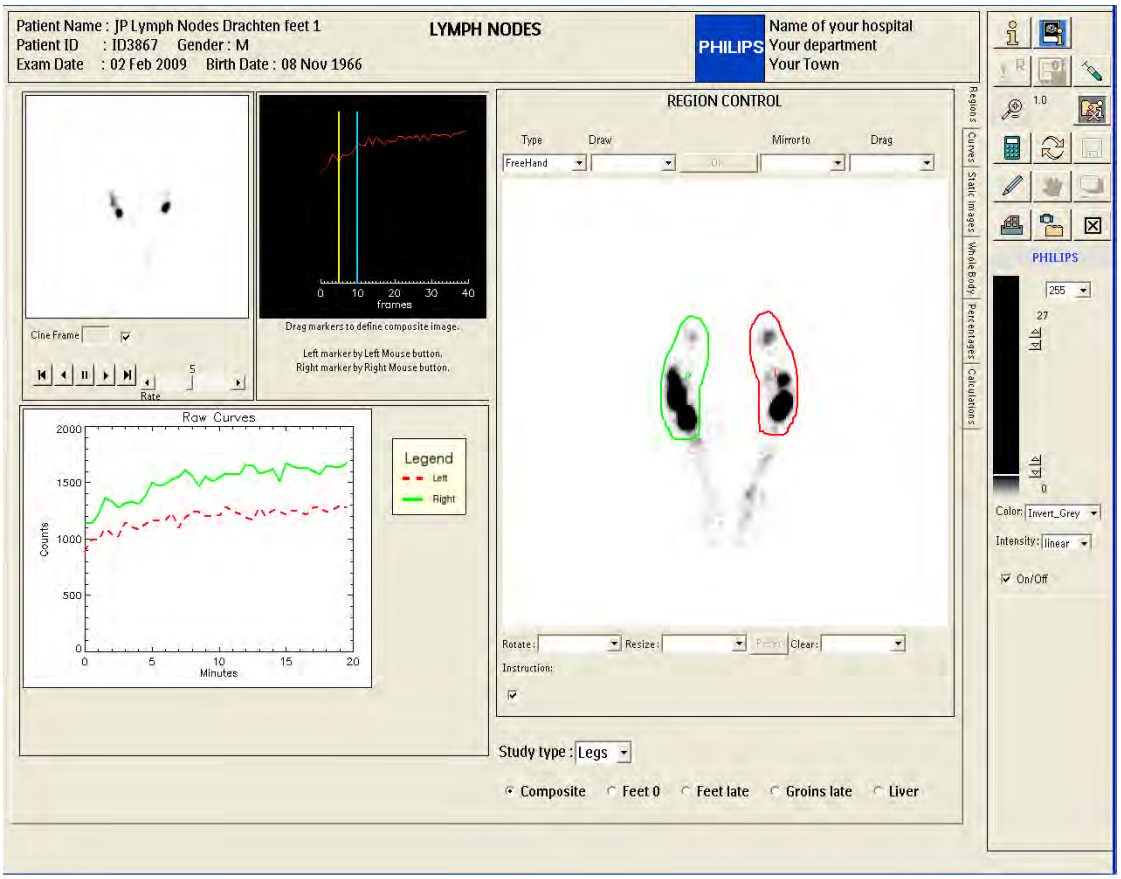


Figure 321 Regions page with ROIs selected on the anterior image of the groins.

After loading the images the first thing to set is the selection for Study type Legs or Arms,

This will change the labels of the buttons accordingly, see the figures below.

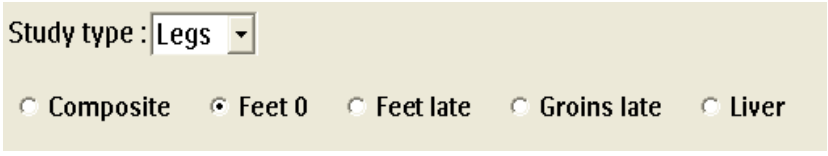


Figure 322 Dynamic mode, Study type is Legs

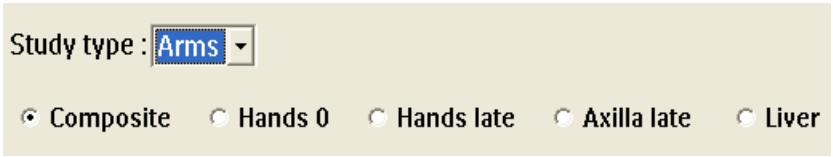


Figure 323 Dynamic mode, Study type is Arms

The radio-button set allows you to select the Composite, Feet 0, Feet late, Groins late and Liver image in the Legs study type situation or the Composite, Hands 0, Hands late , Axilla late or Liver image if the study type is “arms”. For the Composite image you can adjust the yellow and blue markers on the curve at the top of the screen to determine a different range of frames in the dynamic image to build this image. Draw the Left and Right Groin or Axilla ROIs on the Composite image. The ROIs can be of the type box, ellipse, freehand or isofree.

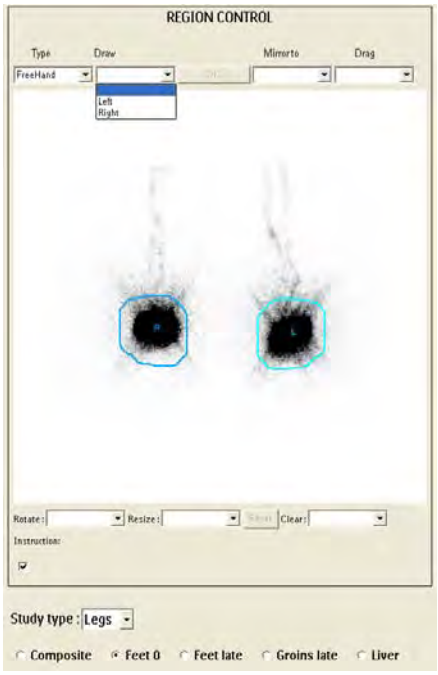


Figure 324 ROIS selected on the Feet 0 min image

On the Feet 0 Hr image the left and right ROIs are placed around the areas of injected activity.

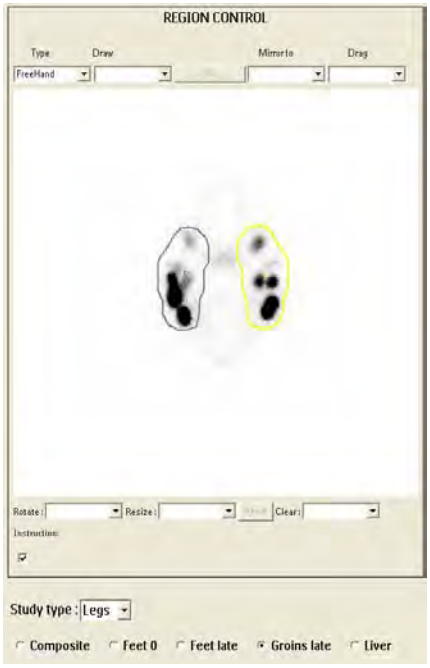


Figure 325 Feet late image with ROIs

On the delayed Feet image the left and right ROIs are placed around the areas of injected activity.

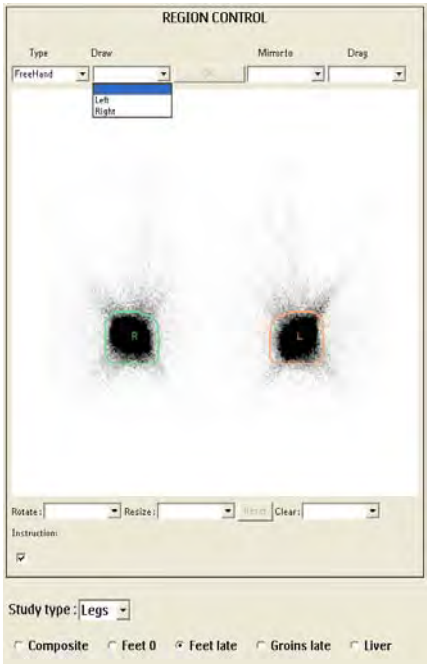


Figure 326 ROIs on the delayed Groins image

The left and right ROIs anterior view) are drawn around the lymph nodes in the groin areas.

Figure 327 Liver and background ROIs on the Liver image

When all ROIs, two per image, have been drawn the Calculate&Display button will be enabled. Click on that button to generate the Left and Right curves of the lymph nodes from the dynamic study.

34.6 Curves page, dynamic mode, legs study

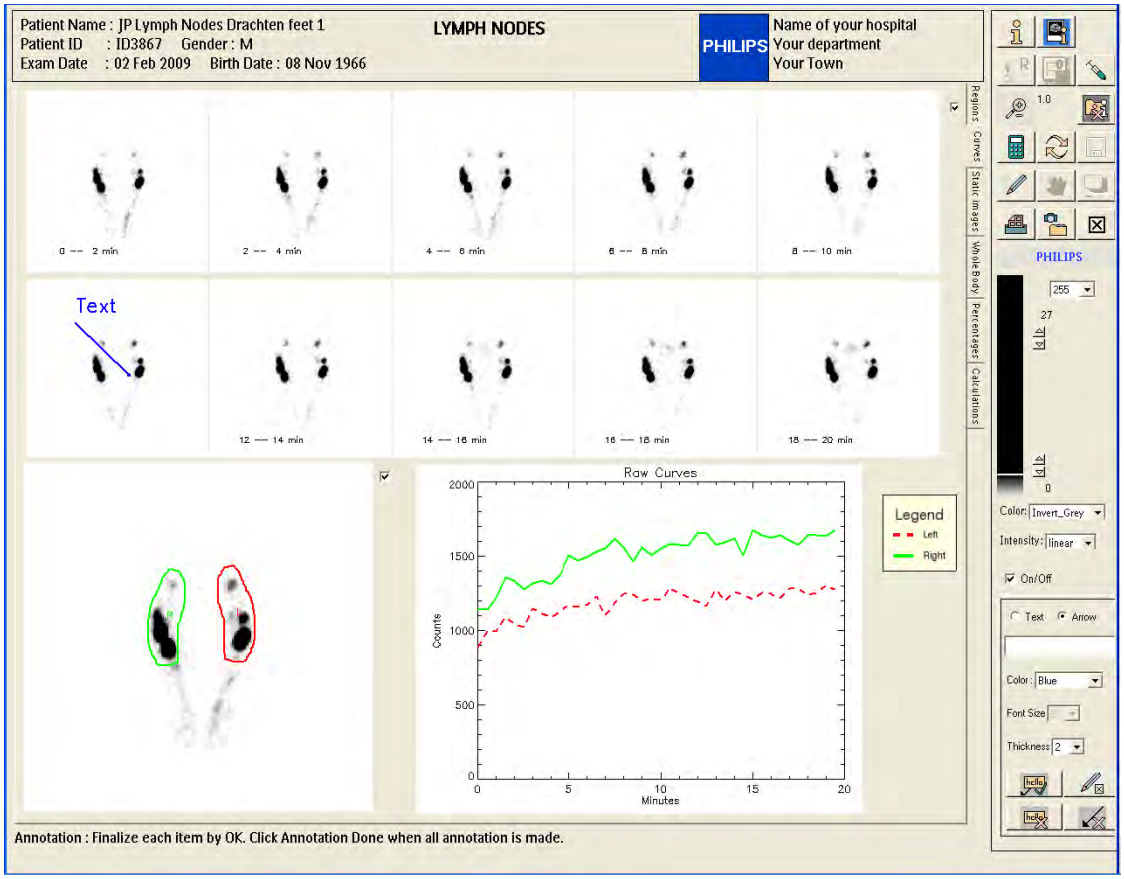


Figure 328 Curves page

On the Curves page the Dynamic image is displayed as a series of ten composite images with time range indication. The composite image with ROIs superimposed and the left and right curves are displayed at the lower half of the screen. You can use the Zoom in/out to enlarge the images. Use the checkbox to freeze an image display if you need to adjust image size or contrast independently.

Click the button with the pencil picture to add text and /or arrows to the images.

34.7 Static Images page, dynamic mode, legs study

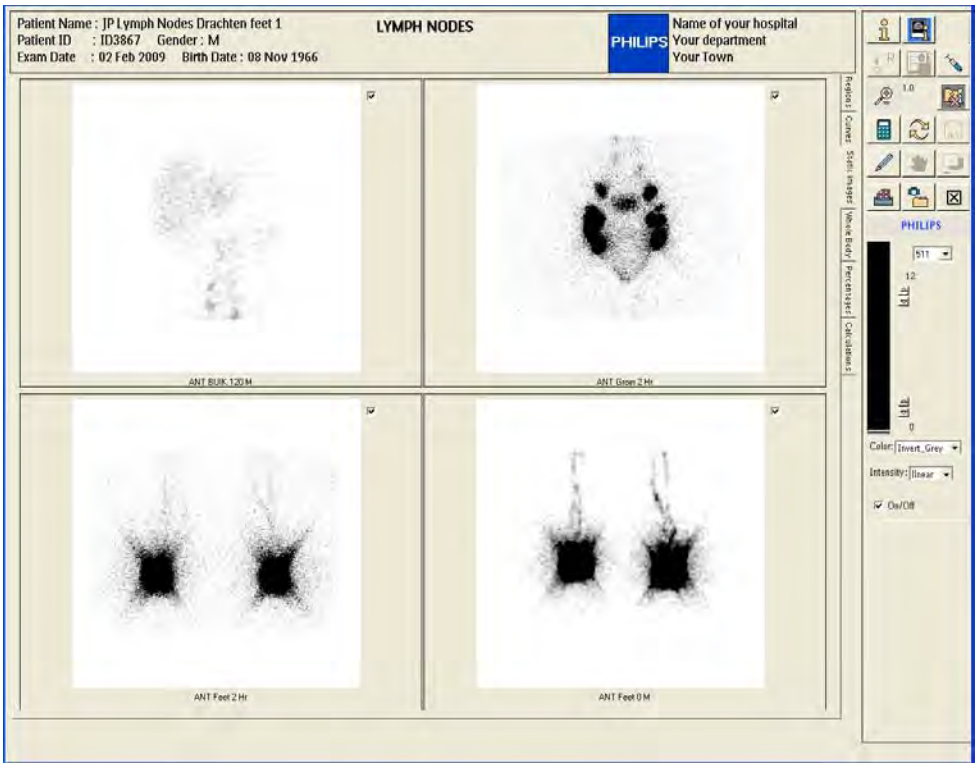


Figure 329 Static images page

The Liver delayed, Groin delayed, Feet delayed and the Feet at 0 hr images are displayed without any ROIs. Use the zoom, annotation and image contrast controls to enhance the screen for printout or secondary captures.

34.8 Whole body page, dynamic mode, legs study

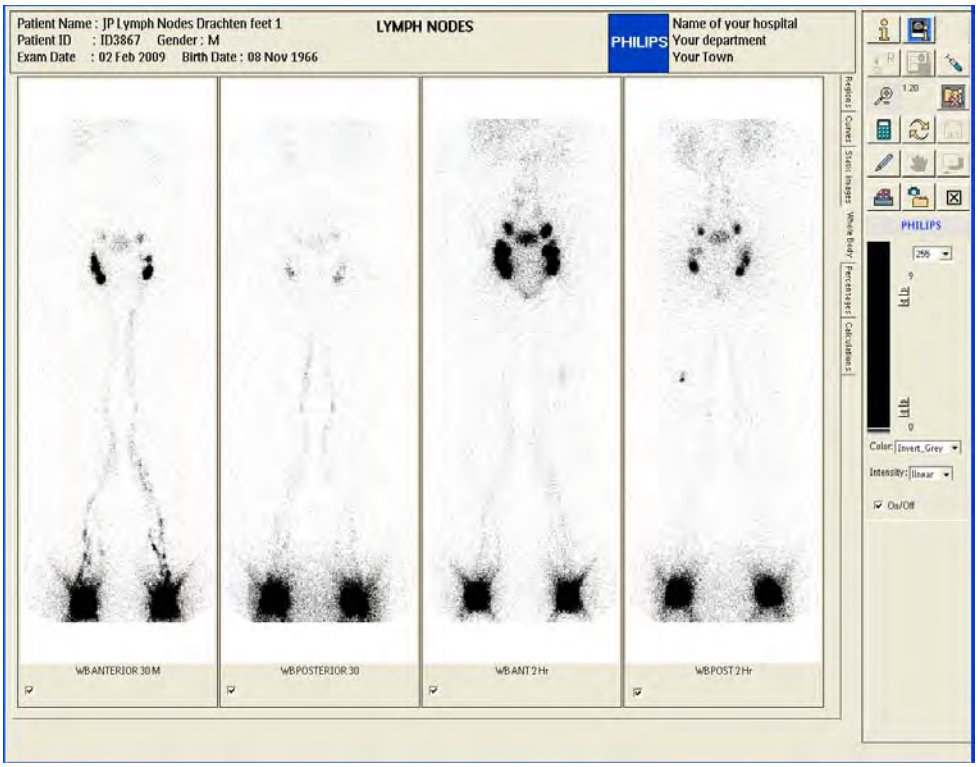


Figure 330 Whole body page, legs

The Whole body page displays the whole body images in the sequence as selected from the database.

34.9 Final Page, dynamic mode, legs study

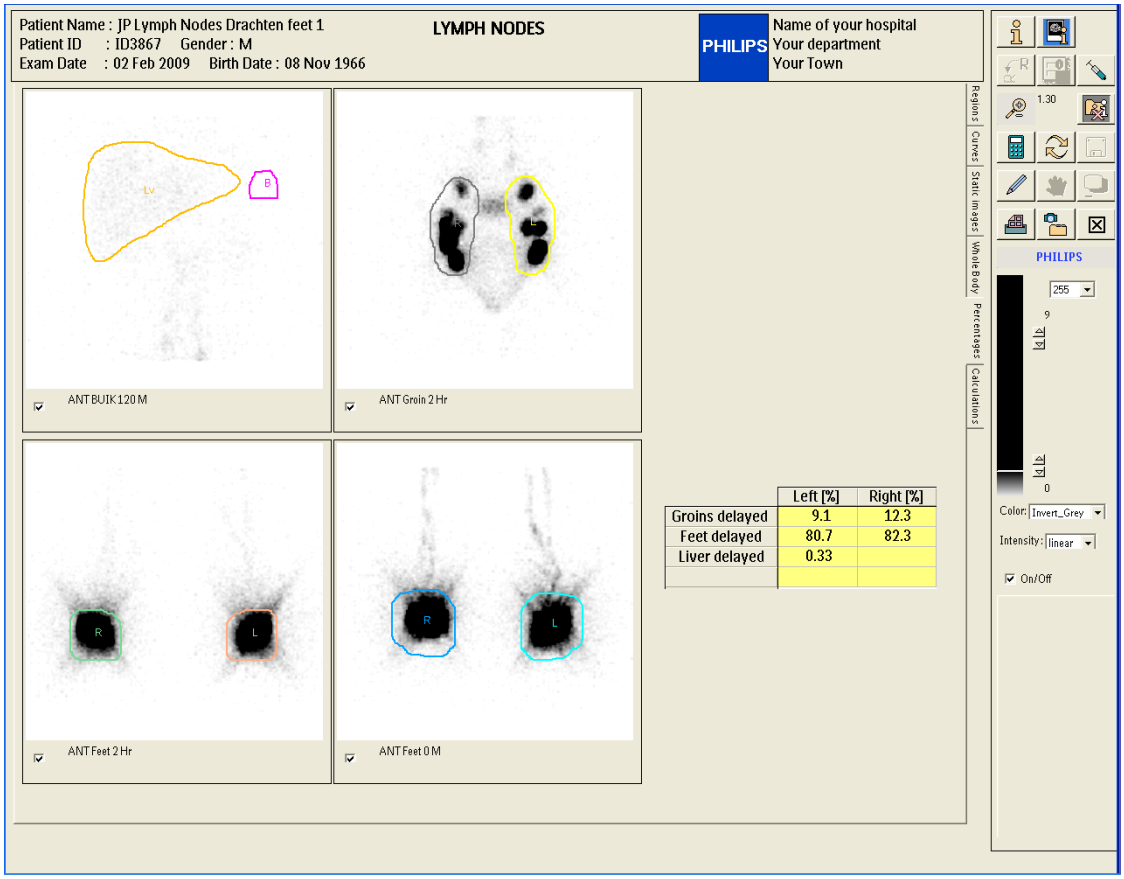


Figure 331 Final page: Input images, ROIs and calculated results.

The final page shows the four input images with the ROIs as selected. The table at the right side of the screen displays the delayed uptake for the Groins and Feet, e.g. at 2 hours, as a percentage of the injected activity per leg. For instance, the left groin percentage is the delayed activity as compared to the activity injected in the Left foot at 0 hours.

The uptake percentage of the liver is expressed as the activity with respect to the sum of left and right injected activity in the feet at 0 min.

The images on the final screen may be zoomed in and/or out and Annotated using the standard tools provided.

34.10 Calculations Page, dynamic mode, legs

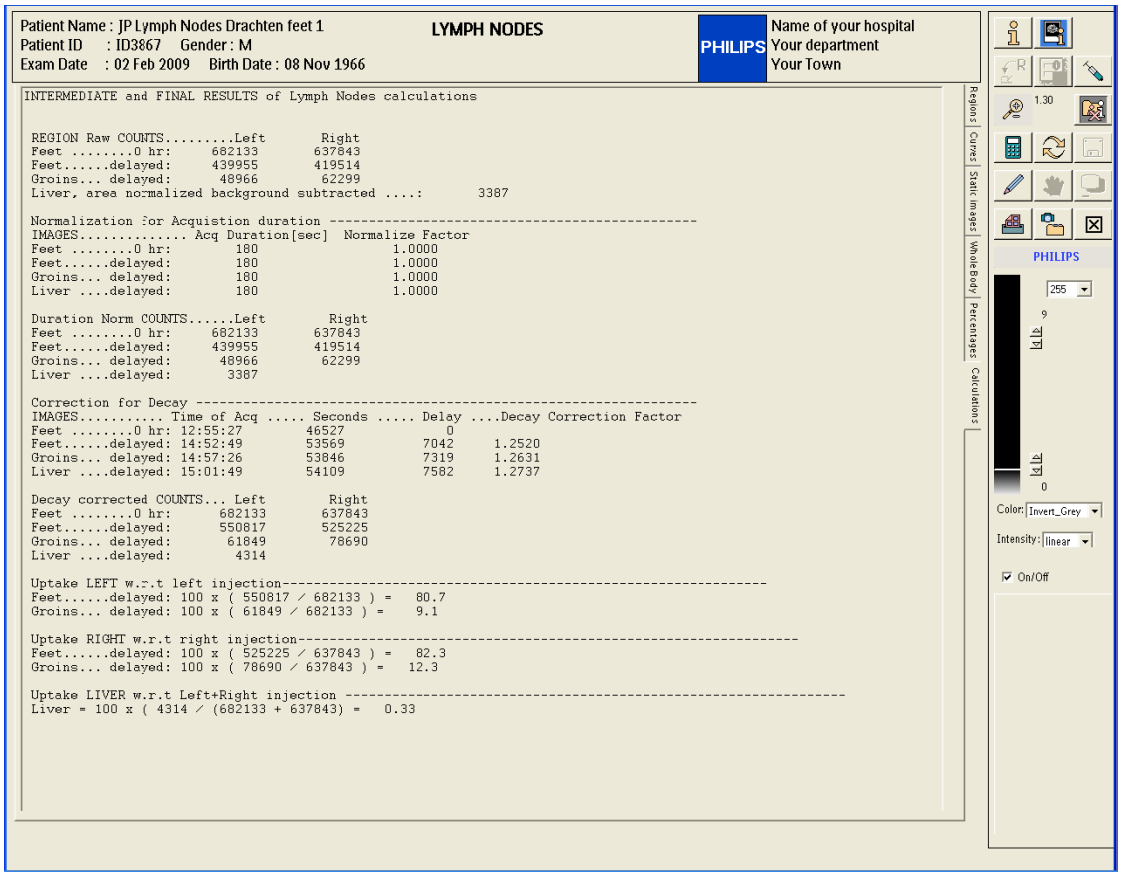


Figure 332 Calculations page

The Calculations page allows you to verify the result data as displayed on the Final screen.

Dynamic mode, Arms study

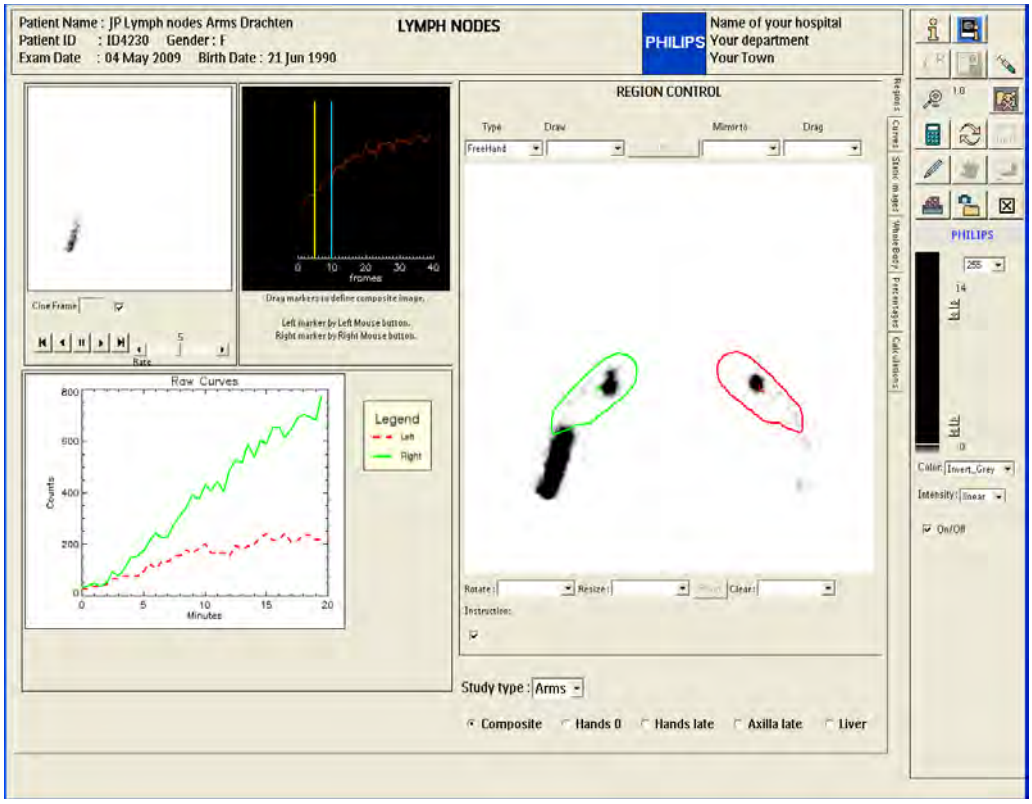


Figure 333 Dynamic mode, regions page, study type is Arms

Notice the labels of the radio button set for the Arms mode.

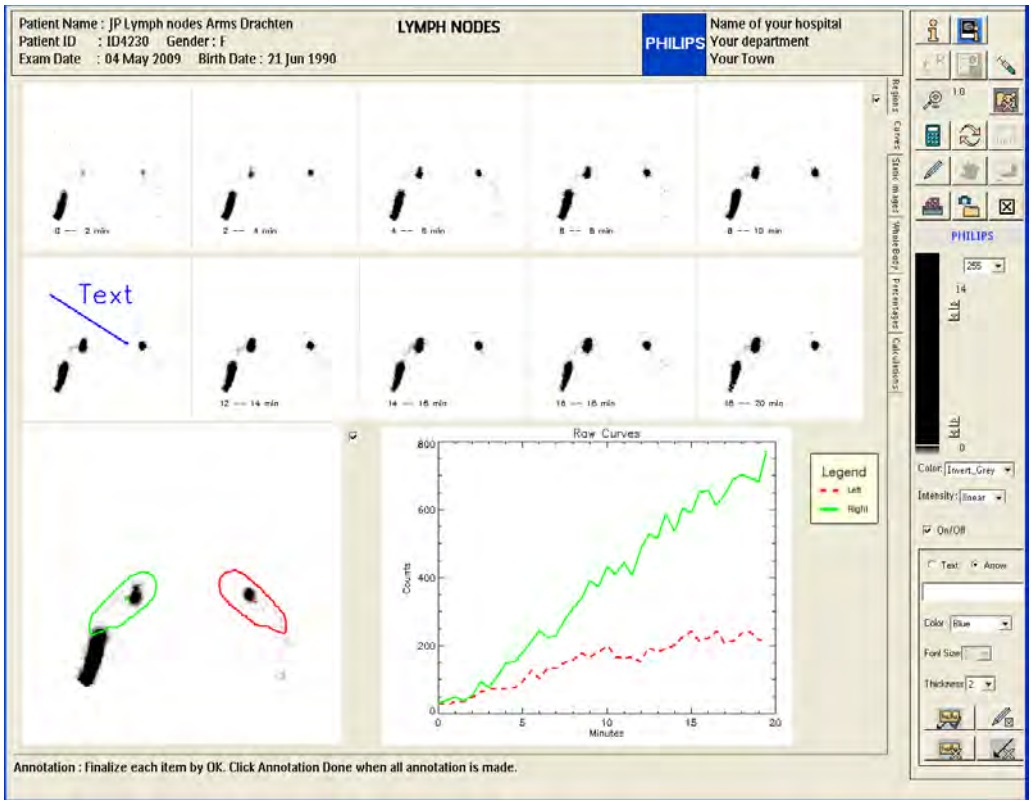


Figure 334 Curves page showing curves of left and right axilla ROIs

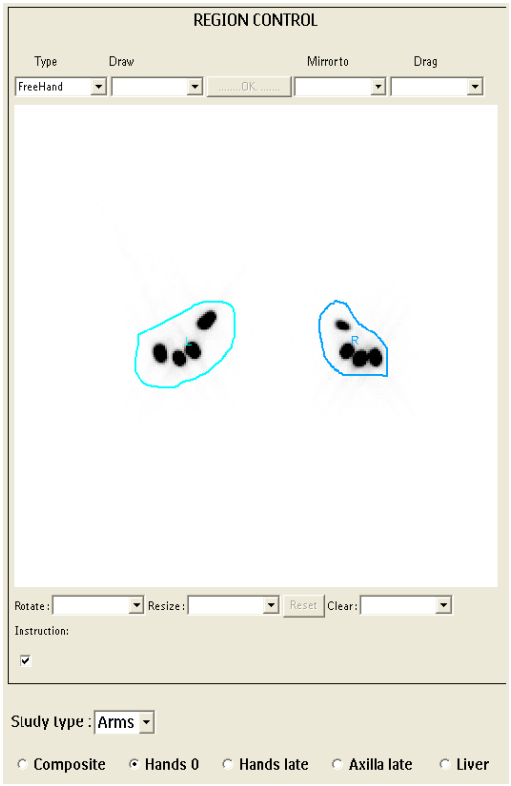


Figure 335 Dynamic, Arms method, Hands 0 hr image with left and right ROIs

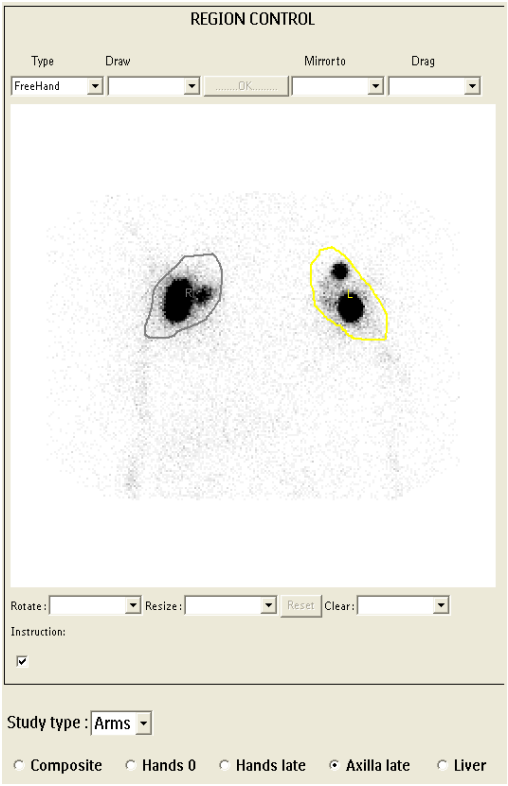


Figure 336 Dynamic, Arms method, delayed Hands image with left and right ROIs

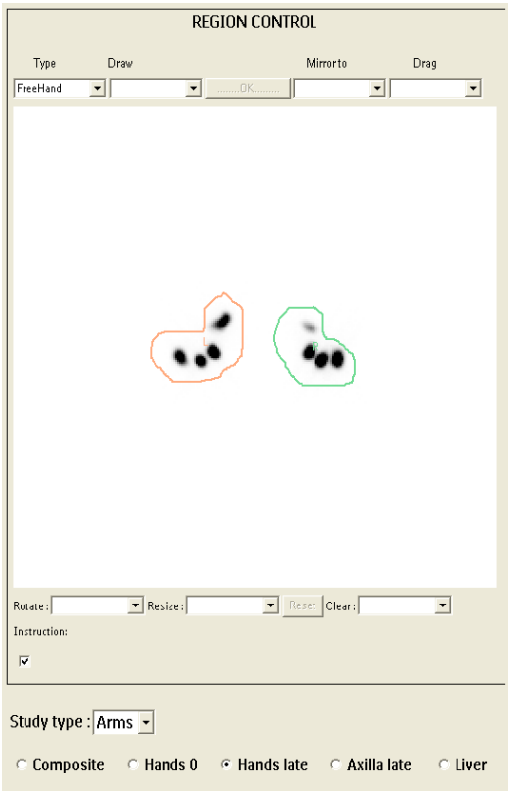


Figure 337 Dynamic, Arms method, delayed Axilla image with left and right ROIs

Figure 338 Dynamic, Liver image with liver and background ROIs

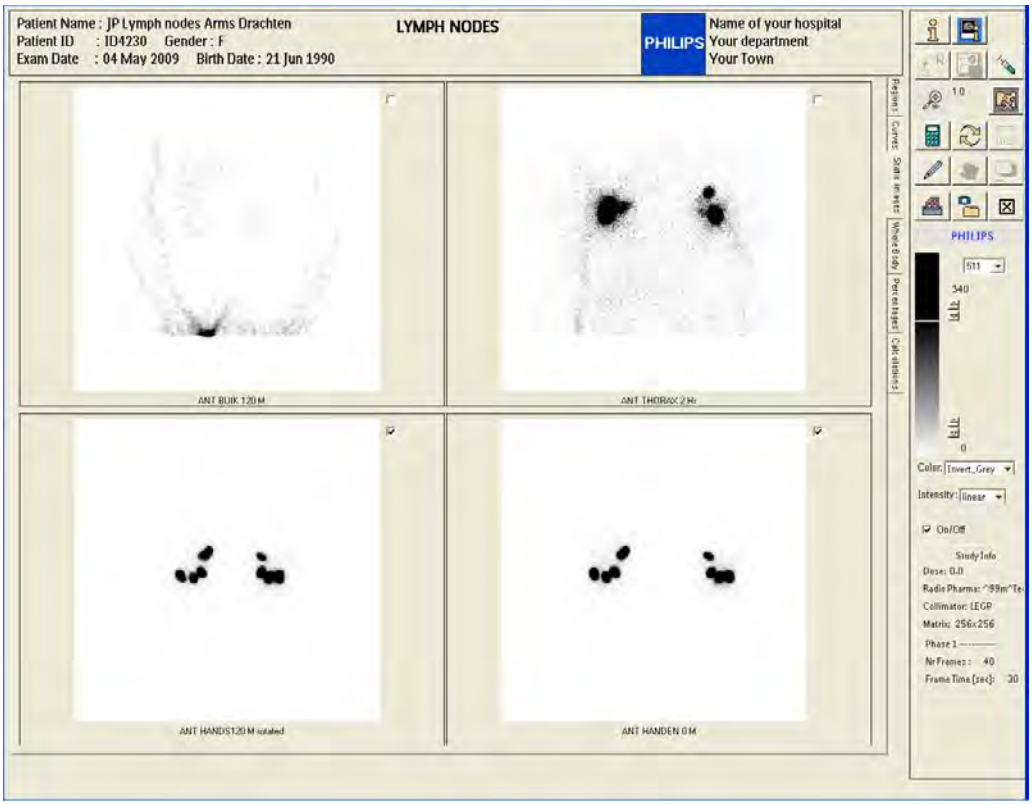


Figure 339 Static images page, dynamic mode, Arms study

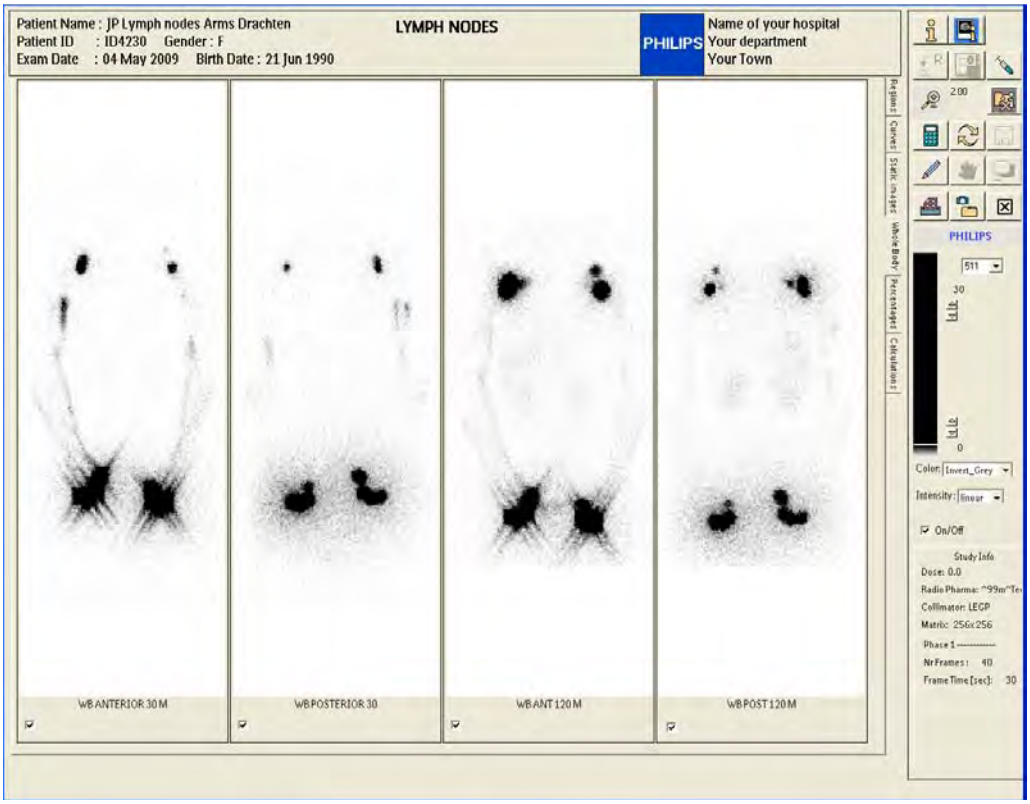


Figure 340 Whole body page, Arms study, dynamic mode

Figure 341 Final page, dynamic mode, Arms study

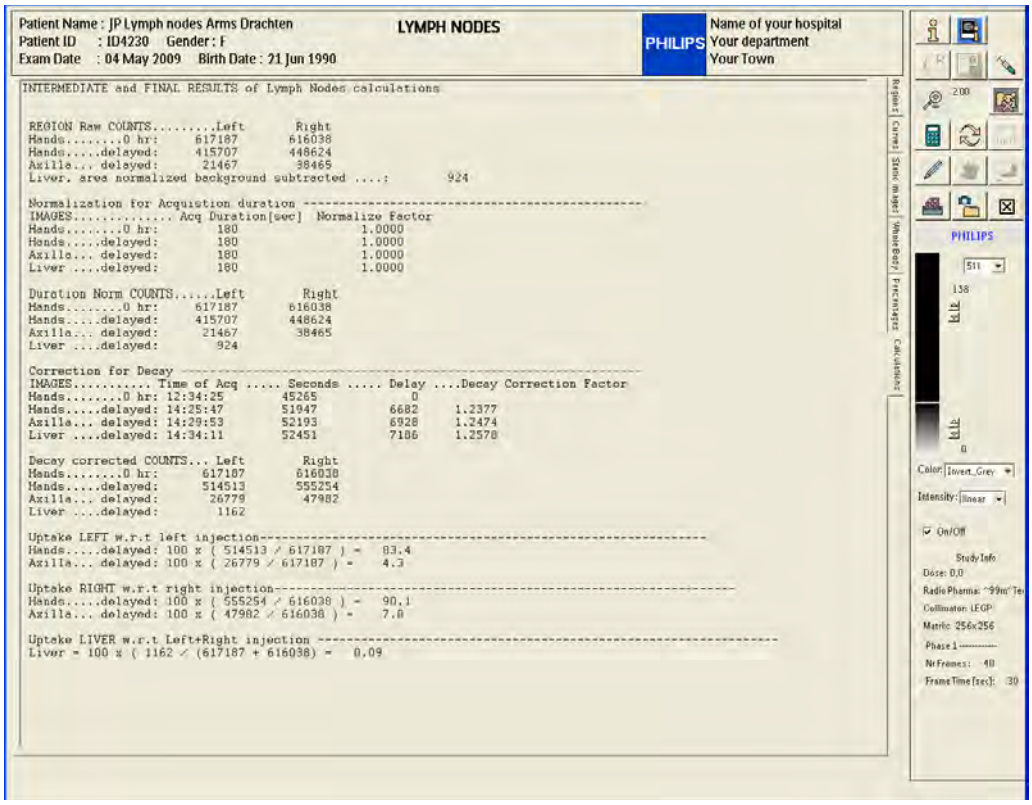


Figure 342 Calculations page, dynamic mode, Arms study

Regions page, Static mode, Legs study

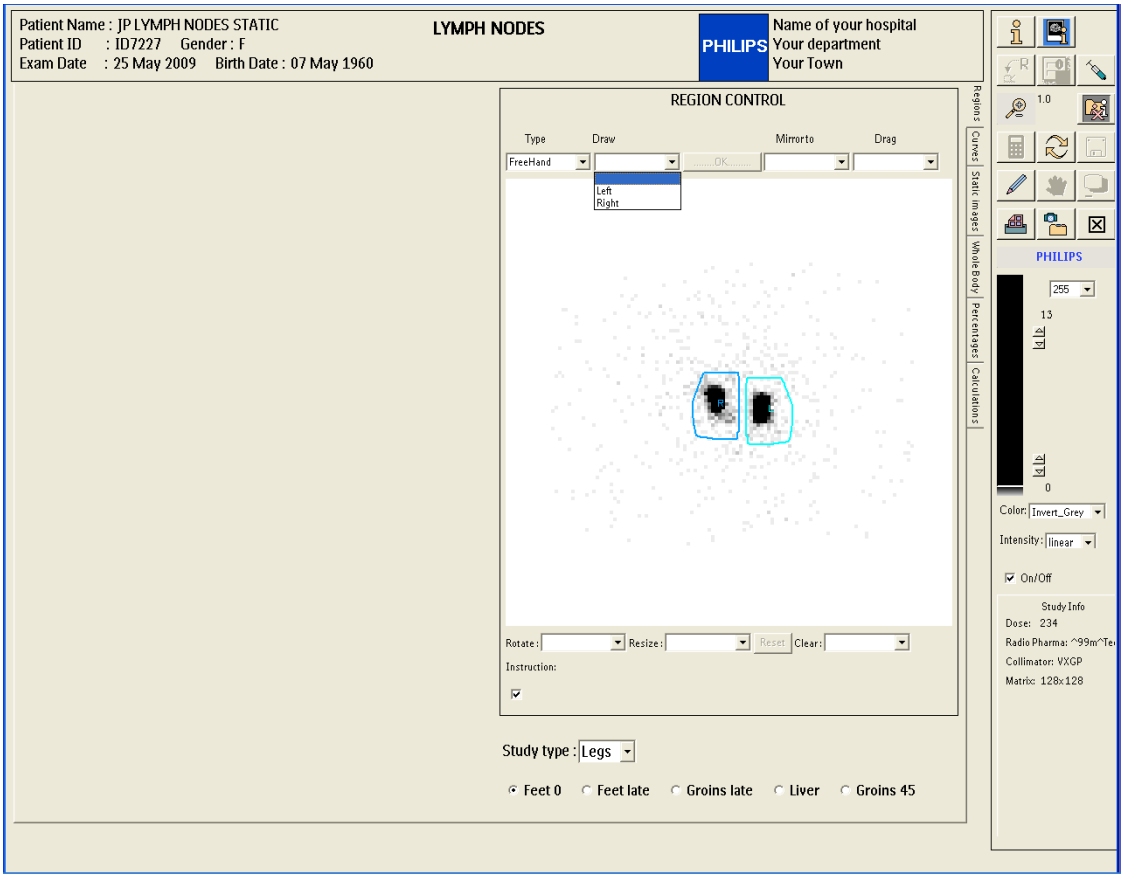


Figure 343 Regions page, Static mode

Notice that the Regions page, when using static images only, does not have the section to generate curves. Before anything else you must select the Study type Legs or Arms. This will change the labels of the buttons accordingly. See the figures below.

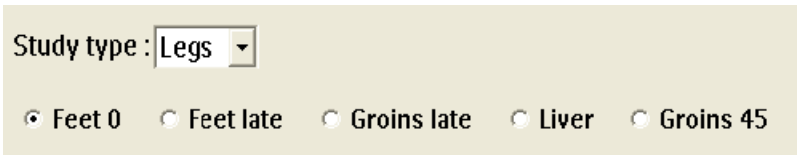


Figure 344 Static mode, study type is “Legs”

The left and right ROIs are selected on the Feet 0, delayed Feet, delayed Groins, Liver and Groins at 45 minutes images.

Figure 345 Static mode, study type is “Arms”

For “Arms” study type the left and right ROIs are drawn on the Hands 0, delayed Hands, delayed Axilla, Liver and Axilla at 45 minutes images.

34.11 Static images page, Static mode, study type Legs

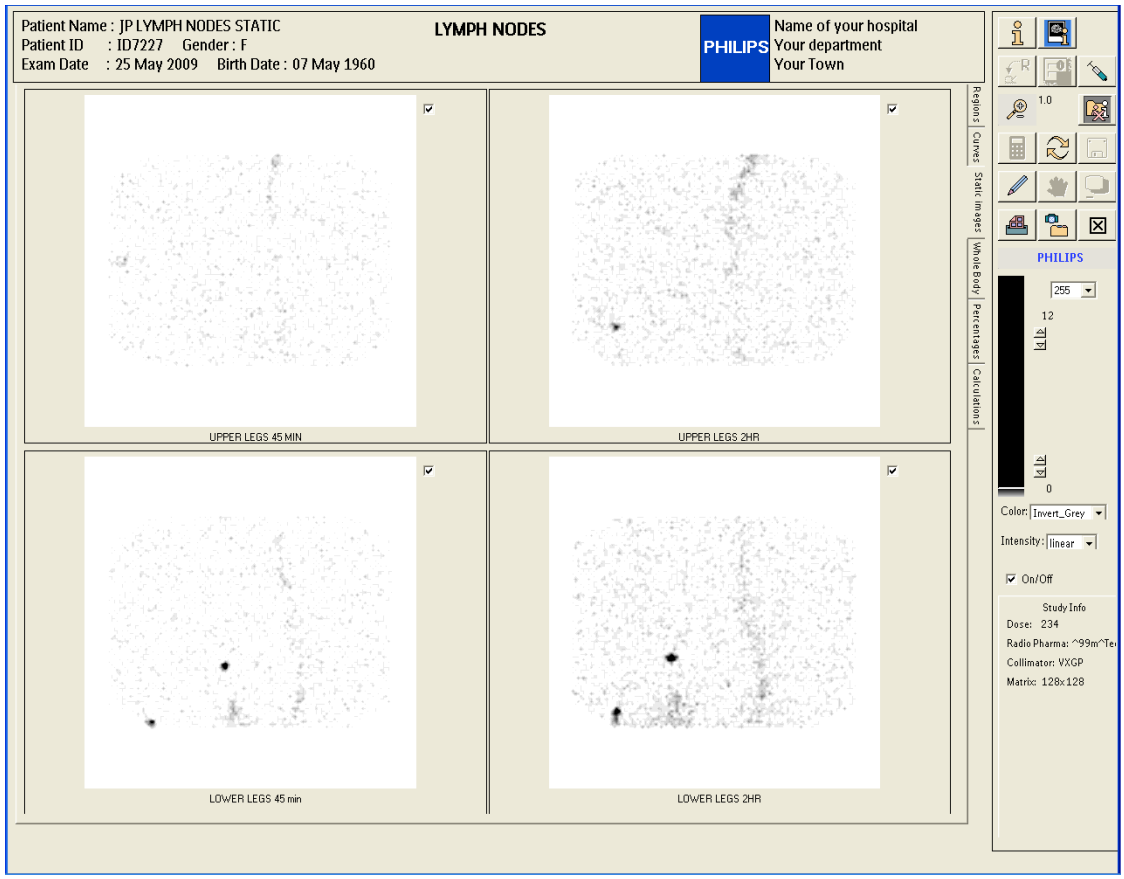


Figure 346 Static images page, Static mode

The static images have been selected in the following sequence: Upper legs 45 min, Upper legs 2 hrs, lower legs 45 min, lower legs 2 hrs. When you use this way of selecting the static images the upper and lower part of the legs are aligned vertically.

34.12 Final page, Static mode, study type Legs

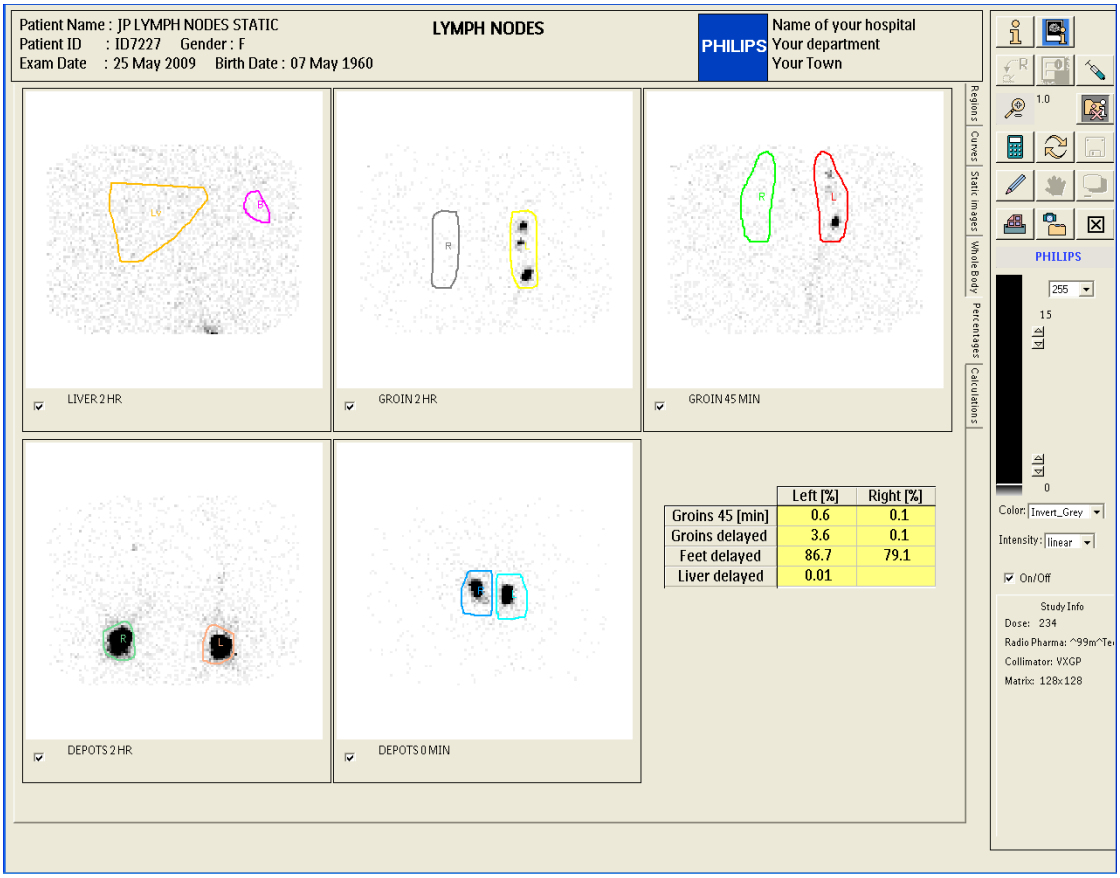


Figure 347 Final page, Static mode, study type legs

The final page shows for the Legs method the images, ROIs and results for groins at 45 min, delayed groins, delayed feet and liver.

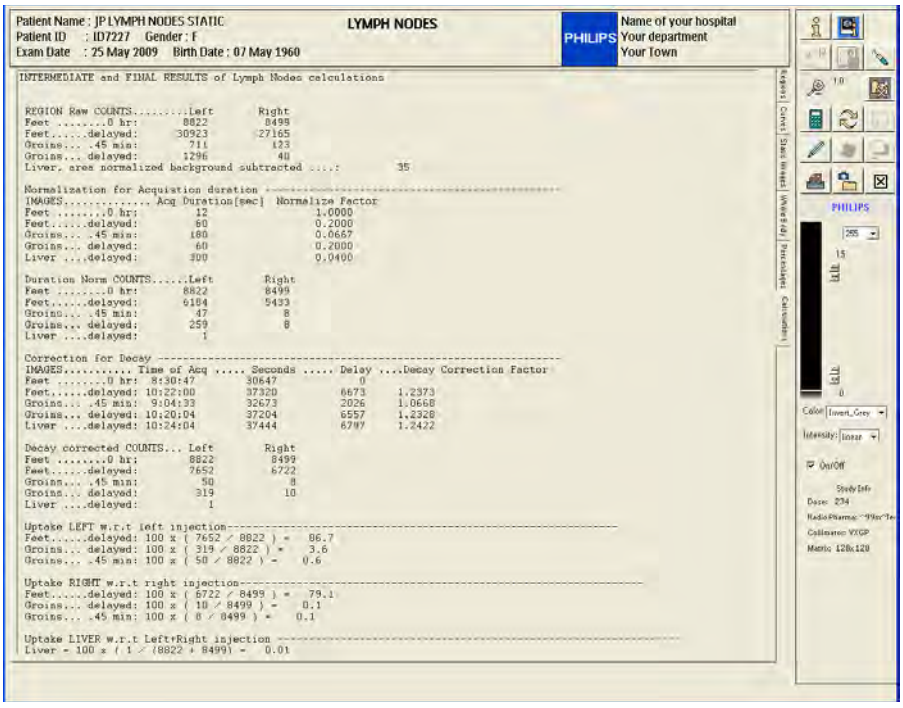


Figure 348 Calculations page, Static mode for Legs

The calculations page shows intermediate and final calculations for the Feet 0 hr, delayed feet, Groins at 45 min, delayed groins and liver images.

34.13 Final Page, Static mode, study type Arms

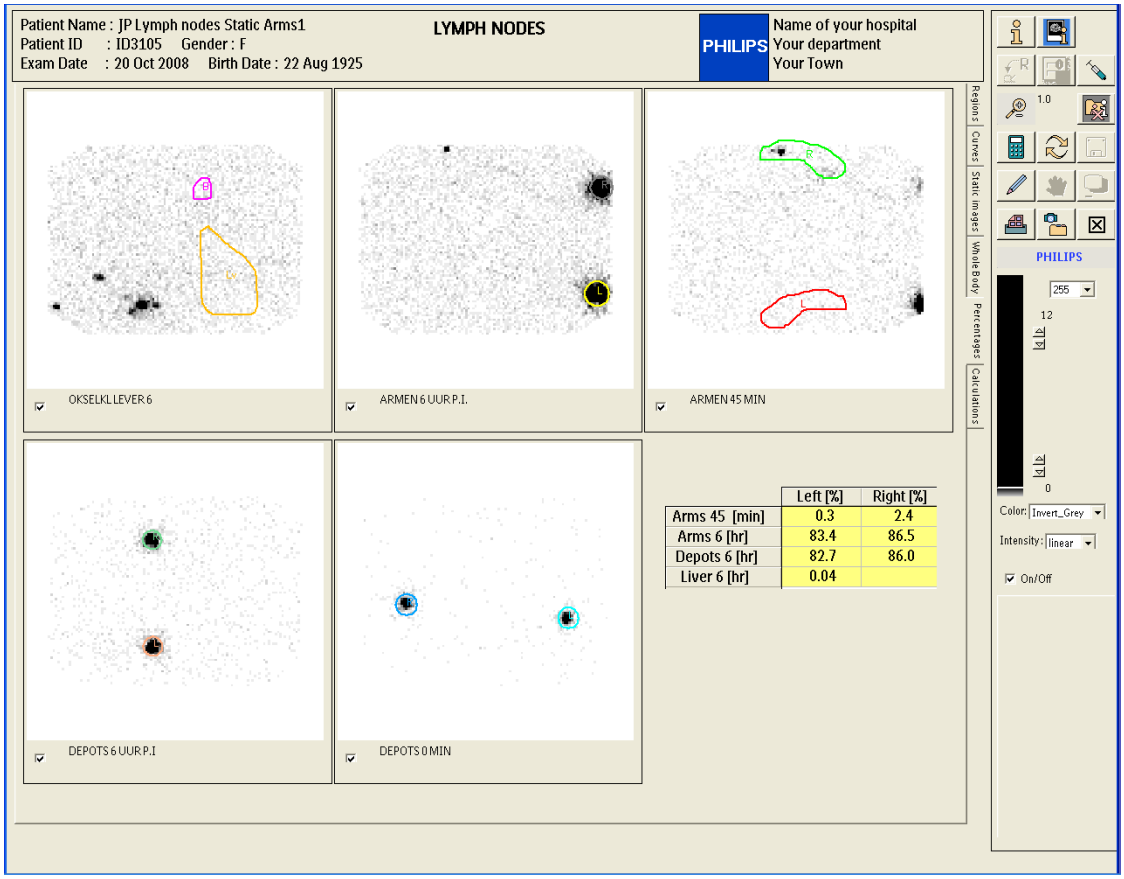


Figure 349 Example final screen , Static mode, study type Arms

34.14 Reference

1: Carena M, Campini R, et.al. Quantitative lymphscintigraphy. Eur. J Nucl Med 1988; 14:88-92

2: Lofferer O, Mostbeck A. Nuclear medicine techniques in the diagnosis and differential diagnosis of swollen arms and legs. In: Lymphangiography Stuttgart; Schattauer Verlag; 1983:723-740

3: Virgil Fairbanks, W Newlon Tauxe e.a. Scintigraphic visualization of abdominal lymph nodes with 99mTc-pertechnetate-labeled sulfur colloid.

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Calculations:

The counts and number of pixels of all ROIs on the Feet 0 hr, delayed Feet image, delayed Groins and Liver images are determined .

The activity of the background is area-normalized to the size of the liver ROI before being subtracted.

The start time of acquisition and the acquisition duration of the images is obtained from the image headers and used to;

1; Normalize the counts in the ROIs to the acquisition duration of the Feet 0 hr image.

2: Correct the counts for decay from the time of acquisition of the Feet 0 hr image to time of acquisition of each acquired image.

The percentages uptake of the left foot at 2 hr (delayed) and Groin at 2 hr (delayed) are determined as percentages of the injected activity in the Left foot (injection at 0 min). Similarly the percentages of the right foot at 2 hours and Groin at 2 hours are calculated from the activity with respect to the right foot at t = 0.

The percentage uptake in the liver is expressed as activity in the liver compared to the sum of the activities in the left and right foot at t = 0 min.

The calculations for the Arms study type are very similar in that the images of the feet are replaced by images of the hands and images of the groins by images of the axilla.