

## 11 3D ACQUISITION PROCEDURE

### 11-1 Introduction

According to system configuration, this optional procedure available on LCA+, LCV+ and LC+ allows the three-dimensional (3D) reconstruction of images acquired using the pivot which follows a specific RAO/LAO rotation of 180°.

The 3D reconstruction is carried out on a remote Advantage workstation, and the user can then manipulate the 3D image using various utilities (MIP, surface imaging, electronic scalpel, virtual endoscopy, etc.) included in the 3D analysis software package.

The C-arm can be automatically positioned in conjunction with the 3D image position in order to acquire an optimized image of the region of interest.

The 3D Acquisition procedure is performed in two steps:

- 3D calibration acquisition using the helix phantom (definition of volume reference points) and a calibration grid (correction of image distortion).
- Acquisition of patient images according to a specific 180 degree rapid rotation protocol around the patient.

Once calibration and patient images have been acquired, they are automatically transferred from the DLX to the Advantage Workstation.

The 3D image reconstruction and display software runs automatically (manual start possible).

A few minutes are required for the 3D display of the final image, if the Workstation processor is not overloaded with other tasks.

For further information on the use of the 3D reconstruction software, refer to the Advantage 3D XR Operator Manual.



- **The Advantage 3D XR program has been validated for 3D reconstructions of vessels from selective intra-arterial injections only.**
- **This program may only be used on sequences from a GEMS vascular room with the 3D acquisition option.**
- **The Advantage 3D XR program gives a 3D representation of the interior of vessels and may not under any circumstances be used for studies of vessel walls.**
- **DICOM compliance: In order to prevent data loss during the transfer of images from the DLX to the AW, data should only be transferred via servers with a DICOM compliance level of at least two.**

#### Reminder on the Acquisition Procedure for Patient Images

- Before acquisition, check on the AW that there is a calibration available to reconstruct the acquisition to be performed.
- The patient must be properly centered and remain still throughout the acquisition sequence, and, if necessary, until the end of automatic repositioning if this is active. Use an appropriate restraining method.

- Use appropriate injection parameters (delay, rate, volume) in order to obtain proper vessel opacification throughout opacified image acquisition time.
- Check that the correct image sequence has been acquired (3D Spin, 44 pairs of images, masks + opacified images, proper opacification).

### Reminder on the Acquisition Procedure for Calibration Images

- Check that the calibration phantoms used are in a perfect condition (clean, free from visible damage, etc.).

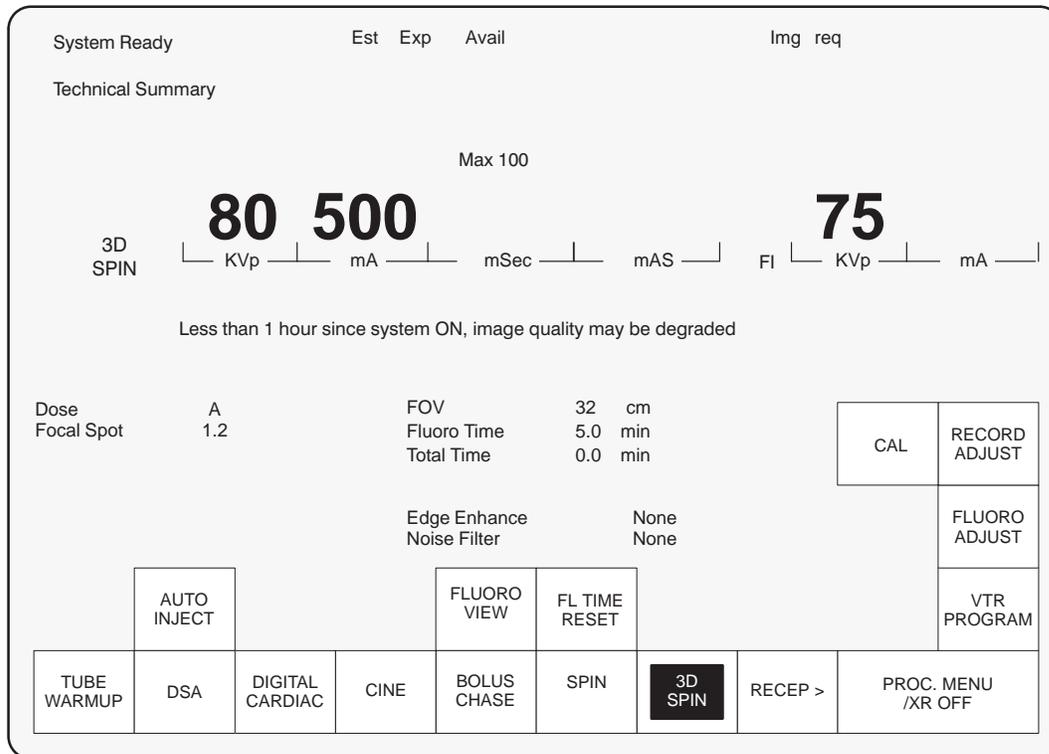
### Observing Reconstructed 3D Images:

- Since 3D reconstructed views are a post-processing display based on subtracted images, artifacts may arise due to the reconstruction algorithm and user selected parameters. For diagnostic purposes or when performing analyses and measurements, consider the 3D views and results only as a support for these diagnostics or measurements and always correlate their findings with the original 2D X-ray images used to perform the 3D reconstruction.
- Images must be inspected under the supervision of a radiologist.
- The presence of metal parts such as clips or coils near vessels may cause artifacts in the 3D images.
- Correct selection of threshold values is very important when images are being observed in Surface Rendering mode or when using Navigator.
- When using Surface Rendering or Navigator, a MIP view of the original object (i.e. a MIP view produced without any thresholding or modification of the original 3D model generated by Advantage 3D XR) should always be used for comparison, in order to detect potential defects in Surface Rendering or Navigator images that may be due to an incorrect setting of thresholds.

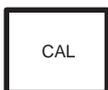
## 11-2 Selection of 3D Spin Mode

Display the 3D Spin Technical Menu screen on the Advantx console by selecting 3D Spin mode from any Technic Summary screen. Illustration 187 shows a typical 3D Spin Technic Summary screen.

**ILLUSTRATION 187 – 3D SPIN TECHNICAL SUMMARY**



All buttons in the 3D Spin Technic Summary screen have exactly the same functions as the buttons displayed in other acquisition modes.



Touch this button to select the 3D calibration screen.



Touch this button to select the Record Technic Adjust Screen.



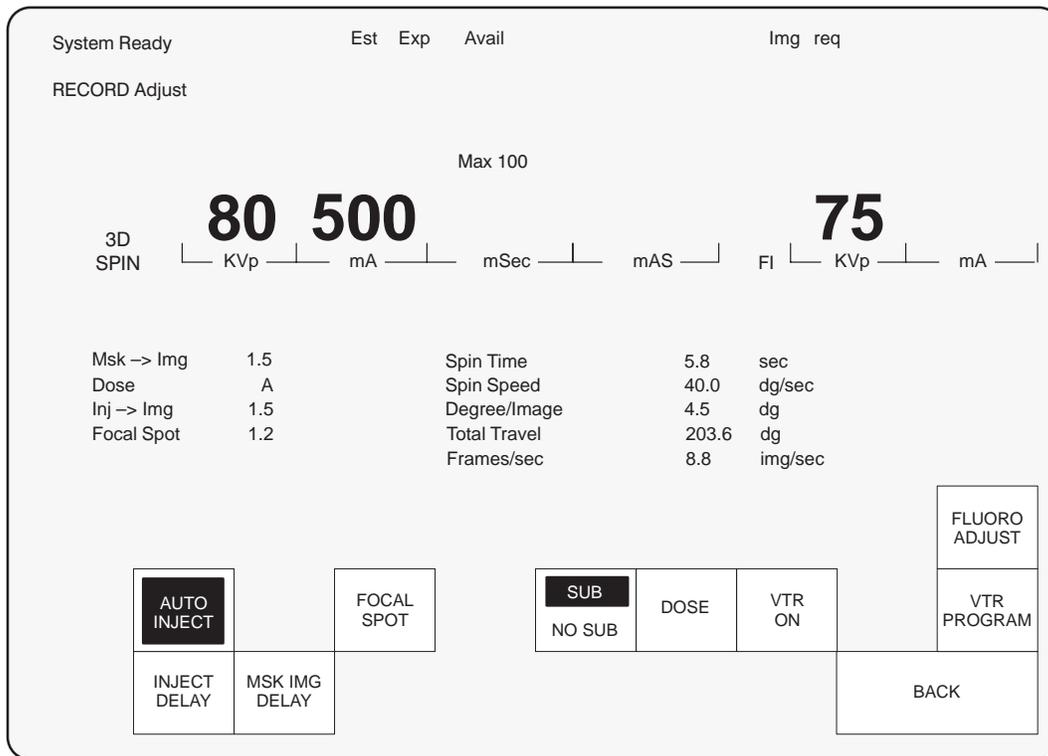
Press this button to select the Fluoro Technic Adjust Screen.

**Note:** In order to allow the system temperature to stabilize, it is recommended that the 3D procedure is not performed during the first hour after system start-up. During this period, when the 3D spin screen opens, the message “Less than 1 hour since system ON, image quality may be degraded” is displayed on the Advantx console.

### 11-3 Selection of the 3D Spin “Record Technic Adjust” Screen

Select 3D Spin Radiography Technical Adjustment Screen by touching Record Adjust in the 3D Spin Technical Menu screen or in the 3D Spin “Record Technic Adjust” screen. Illustration 188 shows the 3D Spin “Record Technic Adjust” screen.

**ILLUSTRATION 188 – 3D SPIN RADIOGRAPHY ADJUST SCREEN**



OPTIONS

Almost all the buttons in this screen have the same functions as the buttons displayed in other acquisition modes. Only those buttons specific to the 3D Spin mode are described below.



Once Automatic Injection Mode has been selected, it displays the delay between injection and acquisition. Injection is not permitted after the start of acquisition. The default value for the delay between injection and acquisition is 1.5 s.



Touching **Dose** and rotating the Console Knob changes dose values. Both the button, the word Dose, and the selected dose (A or B) are back lit during adjustment. A is the lower. Remember that a decreased dose may increase noise.

The dose values are in Average micro Gy/exposure and are measured in the conditions given in Chapter 1, section 3-11. In that section, measures concern 20 cm and 30 cm plexiglass phantoms. The values hereafter are calculated using 20 cm phantoms only.

The doses are measured using the following parameters:

FOV =Nominal (depending on II size)

Focal Spot = 0.6

Frame rate =1 s

These settings give a dose B equal to 600  $\mu$ Gy (for 22 and 32 cm II) and 550  $\mu$ Gy (for 40 cm II).



Only Mask Before Mode is authorized. The delay between Mask and Image is selected in the same way as for Spin mode from a range of between 0 and 45 s. The default value is the same as that for the delay between injection and acquisition.

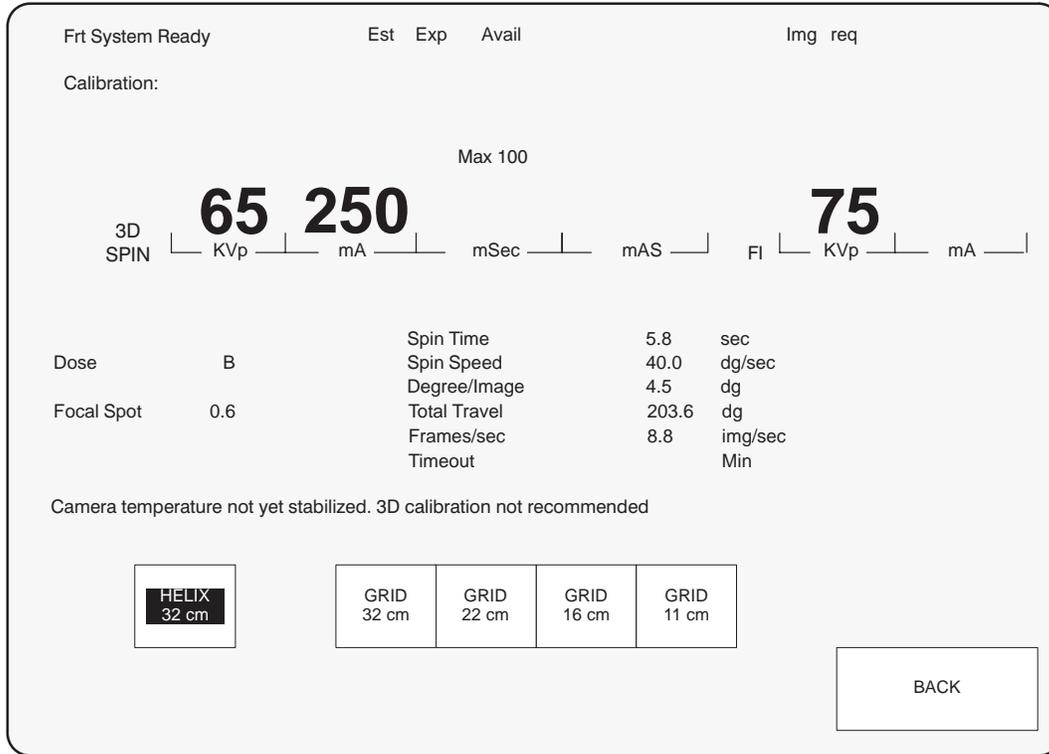


Touch this button to return to the 3D Spin Technic Summary screen.

### 11-4 Selection of the 3D Spin Calibration Screen

From the 3D Spin “Technic Summary” screen, press CAL to select the 3D Spin Calibration screen. Illustration 189 shows the 3D Spin Calibration screen. The calibration procedure is automatic and is performed by following instructions displayed on the examination room monitor.

**ILLUSTRATION 189 – LCV+ 3D SPIN CALIBRATION SCREEN**



OPTIONS

**Note:** In order to allow the system temperature to stabilize, it is recommended that the calibration procedure is not performed during the first hour after system start-up. During this period, when the calibration screen opens, the message “Camera temperature not stabilized, 3D calibration not recommended” is displayed on the Advantx console.



Selects the calibration acquisition for the helix phantom. This button is illuminated as soon as you enter the calibration screen and indicates that the calibration procedure must begin with the helix. This button will be labeled 40 cm for LCA+ configurations, 30 cm for LCV+ configurations and 22 cm for LC+ configurations.



**Touching this button during a procedure resets it, so that the procedure must be restarted from helix calibration.**



Selects acquisition of the calibration grid in the field of view indicated by the button. The illuminated button indicates the field of view to be calibrated. These buttons will be labelled from 40 cm to 16 cm for LCA+ configurations, from 30 cm to 11 cm for LCV+ configurations and from 22 cm to 11 cm for LC+ configurations.

DONE



Display of corresponding calibration status. Illuminated when calibration has been properly performed. Triggers the request for the next calibration. When all DONE cells are illuminated, the calibration procedure is complete.



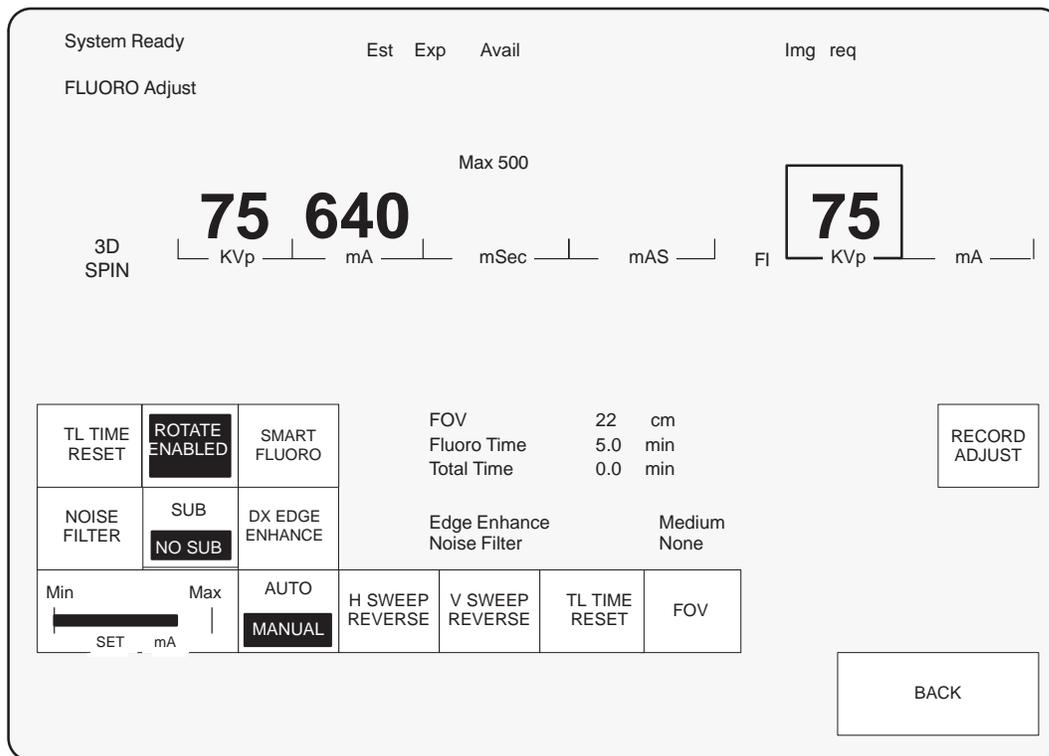
For reasons of accuracy, all calibration acquisitions must be performed within a 30 minute period. After this time the entire calibration procedure will have to be repeated. A timer is permanently displayed indicating the time remaining to complete the calibration procedure.

OPTIONS

### 11-5 Selection of the 3D Spin “Fluoro Technic Adjust” Screen

Select the 3D Spin Fluoroscopy Technical Adjust screen by touching Fluoro Adjust in the “3D Spin Technic Summary” screen or in the 3D Spin Record Adjust screen. Illustration 190 shows the 3D Spin “Fluoro Technic Adjust” screen.

**ILLUSTRATION 190 – 3D SPIN “FLUORO TECHNIC ADJUST” SCREEN**



Almost all the buttons in this screen have the same functions as the buttons displayed in other acquisition modes. Only those buttons specific to the 3D Spin Mode are described below.

- The Rotate Enabled, H Sweep Reverse, and V Sweep Reverse buttons are disabled for the duration of the radiography acquisition. These buttons return to their normal state after the release of the Record Adjust button.

## 11–6 Performing 3D Spin Calibration Acquisitions

### 11–6–1 Introduction

The 3D Spin Calibration Acquisition procedure is performed in two steps:

- Calibration acquisition using the helix phantom.
- One or more acquisitions of the calibration grid (depends on the fields of view used for the 3D Spin Mode).

The calibration procedure is always performed in the same order: helix phantom followed by calibration grids. It is performed as followed:

- Performance of a low–speed test rotation (10 degrees/s), to check for any collision problems,
- Fast rotating acquisition (35 degrees/s LCA+ and 40 degrees/s LCV+, LC+) of images (helix or calibration grid) and return to initial position.

**Note:** Before use, check that the phantoms (helix or grid) are in good condition (clean, no artifacts).

To maintain maximum accuracy during 3D image reconstruction, calibrations are valid for only seven days. After this period, the Advantage Workstation will refuse to perform 3D image reconstruction.

For this reason, a full calibration procedure must be performed each week.

Similarly, for optimum accuracy, all calibration acquisitions must be performed within a 30 minute period. If the complete calibration procedure is not finished within this time, the entire calibration procedure must be repeated.

**Note:** It is recommended that the calibration procedure is not performed during the first hour after system start up, in order to allow the system temperature to stabilize. When the calibration screen is opened, the message "Camera Temperature not stabilized, 3D Calibration not advised" is displayed on the Advantx console during the first hour after system start up.

To maintain maximum accuracy during 3D image reconstruction, it is recommended that the calibration procedure be performed during or at the end of the day.

**Note:** To maintain maximum accuracy during 3D image reconstruction, it is recommended that the calibration procedure be performed during or at the end of the day.

### 11–6–2 Preparation of DLX

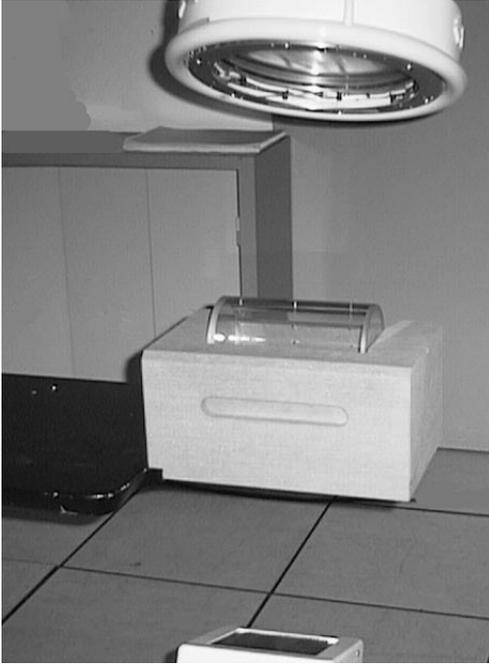
The DLX must be ready for image acquisition. Create a new patient with any name (e.g., Calibration).

Enter patient and examination data and click Start Exam.

### 11–6–3 Preparation of Positioner

Remove the anti–scatter grid from the image intensifier (if present).

Place the helix phantom and its holder on the tabletop headrest (Illustration 191).

**ILLUSTRATION 191 – HELIX IN POSITION**

Position the helix at the C–arm isocenter, and center lengthwise so that the two axes at the helix ends are no longer visible in the image.

**11–6–4 Calibration Acquisition**

The calibration procedure is automated, and is performed by following instructions displayed on the examination room monitor.

On the Advantx console, select 3D Spin Mode from the “Technic Summary” screen, then press CAL. The 3D Spin Calibration screen is displayed: the HELIX button illuminates, and the message “Helix Calibration” is displayed.

The Test button flashes on the Control Panel.

Press and hold down the Test button on the Control Panel. The Positioner, after its initialization phase, performs a low–speed test rotation. The message “3D test calibration in progress” is displayed for the duration of the test. Release the Test button after the Positioner has stopped moving. The message “Ready. Clear rotation zone” is displayed.

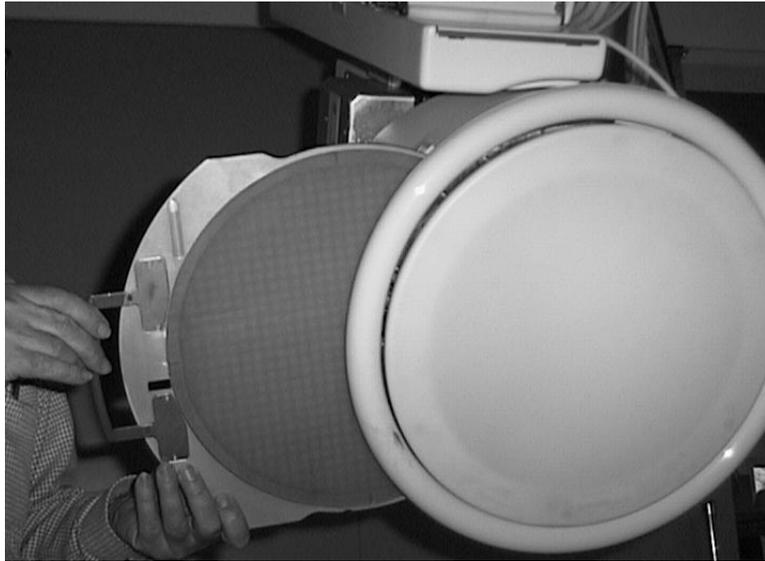
Using the Record Adjust button, perform a calibration acquisition on the helix phantom. The Positioner performs a 180 degree rotating acquisition then returns to its initial position. Release the Radiography button after the Positioner has stopped moving.

On the Advantx console, the DONE button above Helix, and the first Grid button lights up. The message “Calibration grid” is displayed.

Remove the helix phantom, and place the calibration grid (refer to Illustration 192) on the C–arm image intensifier.



**After the helix phantom has been centered, the tabletop should not be moved, since doing so would interrupt the calibration procedure, which would then have to be repeated from the start (Helix Calibration).**

**ILLUSTRATION 192 – INSTALLING THE CALIBRATION GRID**

Press and hold down the Record Adjust button to perform the grid calibration acquisition until the Positioner has stopped moving.

On the Advantx console, the DONE button above Grid, and the next Grid button light up.

Repeat the above acquisition procedure until calibration grid acquisitions have been performed for all FOVs used in 3D Mode.

At the end of the calibration procedure, all DONE buttons on used Helix and Grid boxes are lit. The message “Calibration complete” is displayed on the screen and the system is ready for 3D Spin patient image acquisition.

## **11–7 Performing 3D Spin Patient Image Acquisition**

### **11–7–1 Introduction**

The acquisition procedure for 3D Spin images is identical to that in Spin Mode, and follows the same sequence of steps:

- Low-speed (10 degrees/s) test rotation to check for any collision problems.
- Fast spin (35 degrees/s LCA+ and 40 degrees/s LCV+, LC+) image acquisition prior to injection (mask) and rapid (30 degrees/s) return to initial position.
- Fast spin (35 degrees/s LCA+ and 40 degrees/s LCV+, LC+) image acquisition after injection with real-time subtraction.



- **Special attention must be paid to the patient immobilization during the Spin or 3D Spin acquisition sequence. Any patient motion during the fast rotation of the gantry could injure the patient and will reduce the quality of the subtracted images and the 3D reconstruction, if any.**

It is advised, particularly if the patient is not anesthetized, to use appropriate restraining devices to completely immobilize the patient (head, arms, legs) in order to keep the patient, and so the region of interest, perfectly still throughout the acquisition sequence (mask images + return + opacified images).

- **Use appropriate injection parameters (volume, rate, delay) in order that vessels are properly opacified during the entire injected image acquisition phase.**  
(flow rate = injected volume /6)

Example for selective intra-cranial injection:

SELECTIVE INTRA-CRANIAL INJECTION	LCA+	LCV+/LC+
injected volume	18 ml	15 ml
injected rate	3 ml /s	3 ml /s
inject/image delay	1.5 s	1.5 s

- **Before Patient image acquisition, check that the calibration data is present and valid (date not expired) on the Advantage Workstation for the 3D reconstruction to be performed.**
- **Before transferring a Patient acquisition to the Advantage Workstation, check that the right number of images has been acquired; 44 opacified image/mask pairs, or a total of 88 images.**

### 11-7-2 Preparation of DLX

The DLX must be ready for image acquisition.

Enter patient and examination data, and click <Start Exam>.

### 11-7-3 Preparation of Positioner

Using Fluoroscopy, position the patient region of interest at the C-arm isocenter.

### 11-7-4 Practical Advice

#### Contour Filter Adjustment

Contour filters prevent glare areas from appearing on the images, which reduce the quality of 3D reconstructions and can artifacts to appear.

The use of contour filters is mandatory for 40 cm and 32 cm FOVs, required very often for 22 cm FOVs and for certain 16 cm and 11 cm FOV examinations.

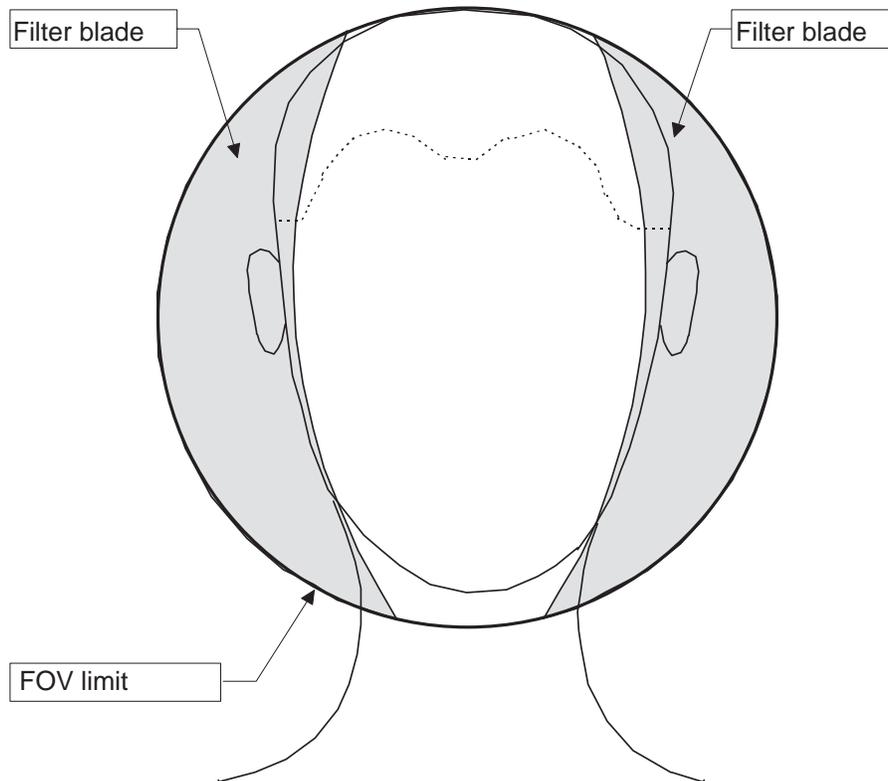
The two filter blades must be adjusted to a symmetrical position, because their position in relation to the patient is reversed as the positioner rotates.

Center the patient in the FOV, then perform the adjustment from the front, in Fluoroscopy mode. Do not readjust the setting from the side but readjust the table height if necessary.

Illustration193 shows an example of (concave) blade adjustment for a neurological acquisition.

**Note:** Blade adjustment does not have to be repeated if the FOV is changed, since the adjustment depends only on the patient (size, shape) and patient centering.

**ILLUSTRATION 193 – EXAMPLE OF FILTER BLADE ADJUSTMENT FOR A NEUROLOGICAL ACQUISITION.**



### 11-7-5 Image Acquisition

The acquisition procedure is automated, and is performed by following instructions displayed on the examination room monitor.

On the Advantx console, select the 3D Spin Mode from the “Technic Summary” Menu screen. The message “Ready for test spin” is displayed on the examination room monitor. The Test button flashes on the Control Panel.



**Check that the Omega IV and V table is rotationally centered.**

Press and hold down the Test button on the table Control Panel. The Positioner, after its initialization phase, performs a low-speed test rotation. The message “Test spin in progress” is displayed for the duration of the test. Release the Test button after the Positioner has stopped moving. The message “Ready. Clear rotation zone” is displayed.

Using the Record Adjust button, perform patient image acquisition. Hold this button down until the Positioner has stopped moving, after the two rotation phases (mask and image acquisition).

**Note:** Reconstruction of the 3D Spin series will only be possible if at least 40 injected images have been acquired.

## 11–8 Transfer of Acquired 3D Data to the Advantage Workstation

The acquired calibrations and patient images must be transferred to the remote workstation for processing.

In the standard configuration, each calibration and Patient image sequence is automatically transferred from the DLX to the Advantage Workstation when acquisition is complete.

It is also possible to run a manual transfer using the DLX Network transfer function. To do this, select the sequence to be transferred and click Network to start transfer.

For more detailed information, refer to Chapter 7 of this manual, which describes DLX operation (See Network Transfer Option).

- Note:** In the automatic transfer configuration, automatic transfer will only take place if:
- all 44 calibration images have been acquired for each calibration acquisition.
  - at least 40 injected images have been acquired during one 3D Patient image acquisition.

## 11–9 Processing 3D Images on the Advantage Workstation

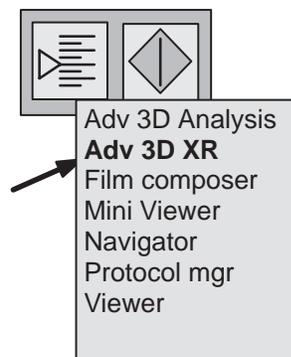
In the standard configuration:

- The calibration software begins automatically when calibration acquisition series (helix and grid) are received.
- 3D reconstruction and display of the Patient acquisition series begins automatically.

It is also possible to begin calibration and reconstruction manually using the Advantage Workstation controls.

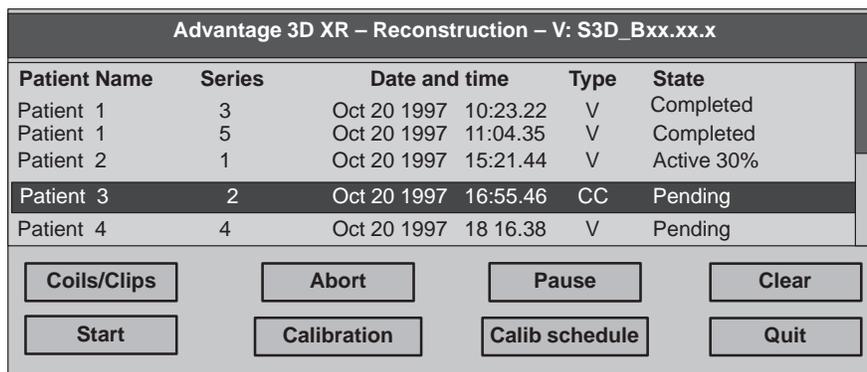
- Select the Patient and series to be reconstructed from the list in the workstation.
- Select Adv 3D XR from the list of utilities available on the workstation.

### ILLUSTRATION 194 – UTILITIES MENU



The 3D Reconstruction window opens on the following screen.

**ILLUSTRATION 195 – 3D ANGIOGRAPHIC RECONSTRUCTION WINDOW**



Click the START button in this window to begin reconstruction of the selected series.

**Note:** The presence of metal objects (clips, coils, etc.) in or near vessels may lead to the appearance of reconstruction artifacts in the 3D image.  
The choice of threshold is very important for proper visualization of the 3D image in surface view or Navigator mode.

For additional information on the use of the image processing software, refer to the Advantage 3D XR Operator Manual.

**11–10 Automatic C–Arm Positioning**

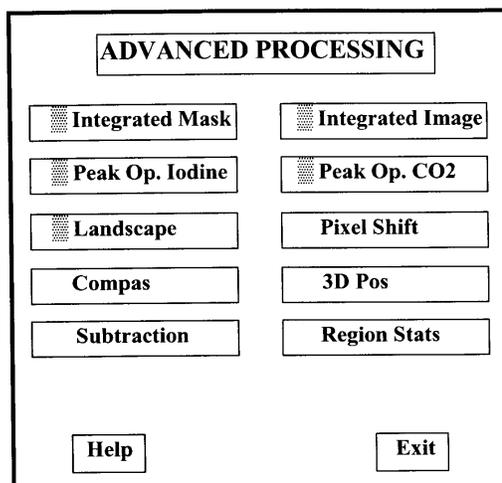
The C–Arm can be positioned automatically to match the position of the 3D image so that the acquired image shows the best view of the region of interest.

On the Advantage Workstation, position the 3D image so that the region of interest is as clear as possible.

With the 3D image open, use the right mouse button to open the pop–up menu and select “Send angles to DLX”. If the angles are accessible to the positioner, they are sent to the DLX. The user is requested to confirm inaccessible angles (due to mechanical collision) before sending.

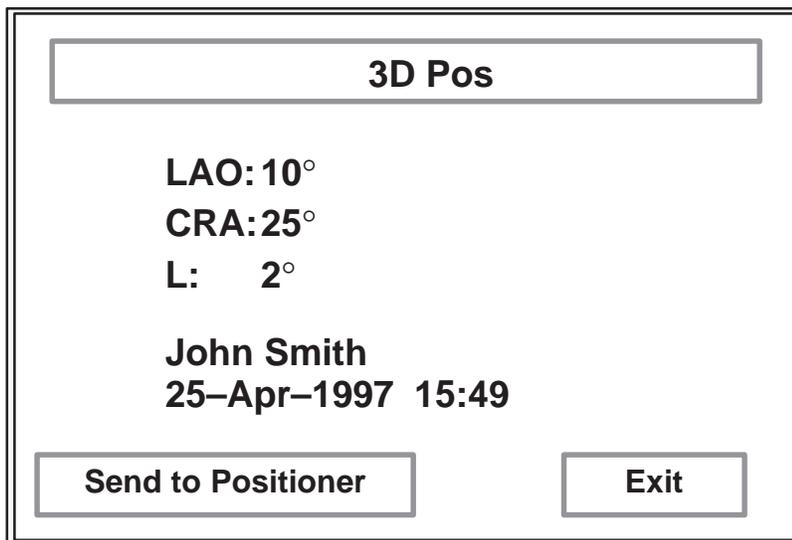
On the DLX flat screen, call up the Advanced Processing menu and select 3D Pos.

ILLUSTRATION 196 – ADVANCED PROCESSING SCREEN



OPTIONS

ILLUSTRATION 197 – 3D POS WINDOW



In the 3D Pos window, select “Send to positioner”.

The angles stored in the Advantage Workstation are sent to the Auto-Positioner control on the right side of the Control Panel, Operator 0, Position 1.

Move the positioner joystick UP or DOWN to move the positioner to the selected angles.

An acquisition can then be performed to obtain the best 2D view of the region of interest.

**Note:** The best view will only be obtained if the Patient remained still throughout the examination procedure. All appropriate restraining devices should be used to prevent the Patient from moving during the examination.

## 12 ADVANTAGE PASTE RECONSTRUCTION PROCEDURE

### 12-1 Introduction

The optional **Advantage Paste** application displays the whole leg to a very high quality from a digital acquisition of the arteries of the lower limbs.

It can be used on sequences acquired with the **LCA+/LCV Bolus Chasing** protocol (with masks Before) which is the protocol which is best suited for examinations of lower limbs. All sequences of this type which are sent to the **Advantage Window AW** console are automatically processed (auto start).

Once the pasted image (representing the whole of the legs) has been processed, it is saved into the **AW** database and can be displayed, processed and reproduced on one or more films, with or without reference images obtained from the series of digitized images.

Sequences acquired using a protocol other than Bolus Chasing and Mask Before, or on a system which is not a LCA+/LCV+ system, cannot be processed by the Advantage Paste application.

### 12-2 Operation

Advantage Paste automatically combines a series of digitized images acquired during a lengthwise table movement (step by step or progressive) of a radiology table into a single image.

The resulting image (which has non-standard dimensions) is stored on the image disk of the workstation (**AW**) as a new series in the same patient exam folder as the original series. This image, called a *pasted image* in this manual, can be viewed, processed and filmed in the same manner as any other image.



**The program has been designed and validated only for pasting lower limb exams using an intra arterial injection. Results are not guaranteed if the program is used for bone structure, upper limb or venous examinations.**

### 12-3 Acquisition

#### 12-3-1 Bolus Chasing with Masks Before

Perform an acquisition using the **Bolus Chasing Masks Before** protocol of the **LCA+/LCV** positioner, with the following recommendations:

- Center the patient properly on the table,
- Avoid saturation by using correct filters around the patient leg or legs and proper collimation,
- Prevent patient movement by using appropriate means,
- Adapt table movement to ensure that the central horizontal strip of the acquired image is always well opacified. If necessary, scan each leg separately.

#### 12-3-2 Field of View (FOV)

Advantage Paste operates only with Bolus Chasing examination series acquired on a 32 or 40 cm field of view.

### 12-4 Transfer

Select the series and click Network on the DLX to transfer the Bolus Chasing series from the DLX to the workstation.