High Resolution Research Tomograph

USER COMMUNITY

HRRT_U 1.1 Test Procedure

1. General

This test procedure describes verification tests to validate a HRRT_U 1.1 build against the specifications (document HRRT_U_1_1 Specifications).

1.1. Required Dataset Files

Dataset file	**Format**
Emission	Listmode
Transmission	Listmode
Normalization	Listmode, Sinogram

Table 1:Required dataset files.

1.2. Required Hardware and OS

The software should be installed on a Microsoft Windows XP 32 or 64 bit computer. The computer should have 2GB RAM for 32bit OS and 4GB or more for 64bit OS. An additional computer with similar specifications is required to test the cluster reconstruction. The first computer is called **reconserver** and the additional one(s) are called **node**(s).

1.3. Software Installation

The software is distributed as a self-install executable HRRT_U_1_1.exe and should be installed on the ACS and reconserver. For 64bit reconserver computers, rename the default 32bit executable (hrrt_osem3d.exe, gendelays.exe, lmhistogram_u.exe, norm_process.exe, hrrt_gapfill.exe, hrrt_sinocor.exe, ecat_3drp.exe and gen_delays.exe) to xxx_x32.exe (e.g rename hrrt_osem3d.exe hrrt_osem3d_x32.exe) and rename 64bit executables (hrrt_osem3d_x64.exe, gendelays_x64.exe, lmhistogram_x64.exe, norm_process_x64.exe, hrrt_gapfill_x64.exe, hrrt_sinocor_x64.exe, ecat_3drp_x64.exe and gen_delays_x64.exe) to default (e.g. rename hrrt_osem3d_x64.exe hrrt_osem3d.exe).

1.4. Test Preparation

Download test data set (20cm germanium water phantom) if necessary from HRRT User Community portal ftp://hrrt.rh.dk/HRRT_U/HRRT_U_Test_data/ . The file content is described in table below:

File	Description
2007.02.09-norm7_span9.n	Span 9 normalization sinogram
2007.02.09-norm7_span9.n.hdr	Span 9 normalization sinogram header with scatter parameter

	LBER=18.0
Scan-Blank-24624-2007.11.12.10.17.50_TX.zip	Compressed Blank sinogram
Scan-Blank-24624-2007.11.12.10.17.50_TX.s.hdr	Blank sinogram header
Uniform-Phantom-28661-2007.11.27.12.59.33_TX.s.zip	Compressed transmission sinogram
Uniform-Phantom-28661-2007.11.27.12.59.33_TX.s.hdr	Transmission sinogram header
Uniform-Phantom-28661-2007.11.27.12.59.33_TX.i.zip	Compressed mu-map image, germanium in water solution (mu=0.096) as opposed to usual epoxy germanium phantom (mu=0.103)
Uniform-Phantom-28661-2007.11.27.12.59.33_TX.i.hdr	Mu-map image header
Uniform-Phantom-28661-2007.11.27.12.59.33_TX.a	Attenuation map sinogram
uniform-phantom-19832-2007.11.26.11.9.20_em.s.zip	Compressed prompt span 9 sinogram
uniform-phantom-19832-2007.11.26.11.9.20_em.tr.s.zip	Compressed true span 9 sinogram
uniform-phantom-19832-2007.11.26.11.9.20_em.s.hdr	Prompt span 9 sinogram header
uniform-phantom-19832-2007.11.26.11.9.20_em.tr.s.hdr	True span 9 sinogram header
uniform-phantom-19832-2007.11.26.11.9.20_em.ch	Coincidence histogram for random smoothing
uniform-phantom-19832-2007.11.26.11.9.20_em_sc.s	Scatter span 9 sinogram
uniform-phantom-19832-2007.11.26.11.9.20_em_ra_smo.s	Random smoothed span 9 sinogram
uniform-phantom-19832-2007.11.26.11.9.20_em_3D_256_i06.i	Image reconstructed with the original Siemens cluster software; OP-OSEM3D, 6 iterations, 16 subsets

uniform-phantom-19832-2007.11.26.11.9.20_em_3D_256_i06.i.hdr	Image header from the original Siemens cluster software; OP-OSEM3D, 6 iterations, 16 subsets
uniform-phantom-19832-2007.11.26.11.9.20_em_HRRT_u.i	Image reconstructed with users software HRRT_U 1.0 ; OP-OSEM3D, 6 iterations, 16 subsets
uniform-phantom-19832-2007.11.26.11.9.20_em_HRRT_u.i.hdr	Image header from users software HRRT_U 1.0
uniform-phantom-19832-2007.11.26.11.9.20_em_HRRT_u_101.i	Image reconstructed with users software HRRT_U 1.0.1 ; OP-OSEM3D, 6 iterations, 16 subsets
uniform-phantom-19832-2007.11.26.11.9.20_em_HRRT_u_101.i.hdr	Image header from users software HRRT_U 1.0.1
HRRT_U_test_winscript_template.txt	A windows batch template to perform OSEM reconstruction tests outside ReconGUI_u Graphical User Interface
HRRT_U_3drp_test_winscript_template.txt	A windows batch template to perform 3DRP (FBP) reconstruction tests.
HRRT_U_lmhistogram_test_winscript_template.txt	A windows batch to perform LMhistogram_u testing.

The image uniform-phantom-19832-2007.11.26.11.9.20_em_3D_256_i06.i reconstructed with the original Siemens cluster software is referred to as **image0**.

2. hrrt_osem3d

2.1 Build Date

Execute hrrt_osem3d with no argument in a command window to get the build ID and fill the field 'Build date' below.

Build date	

Table 2.1: hrrt_osem3d build date.

2.2 tests

Start ReconGUI_u to execute tests in table below.

Tag	Spec Trace	Verification	Expected results	Actual results	Pass / Fail
T2.1	S5.1	Configure OP-OSEM with 16 subsets, 6 iterations to reconstruct data files downloaded in 1.4 (Test Preparation) and execute reconstruction only and verify that hrrt_osem3d is used. Image is referred to as **image1**.	Display image0 and image1 in Vinci and compute the ratio. The ratio image values range inside the phantom should be 1.0±0.01.		
T2.2	S5.2	Configure OP-OSEM 16 subsets, 10 iterations with PSF checked to reconstruct data files created in 1.4 and verify that hrrt_osem3d is used with -B 0,0,0 option. Image is referred to as **image2**.	Display image2 in Vinci and verify if the quality is better than image1 and RoI average is the same on both images within 1%.		
T2.3	S5.3	Configure the scatter process step and push execute all to run both scatter correction and reconstruction (without PSF, 6 iterations). Image is referred to as **image3**.	The scatter file size is 59MB. The ratio image1/image3 values range inside the phantom should be 1.0±0.01.		
T2.4	S5.4	Delete the random smoothed sinogram (_ra_smo.s) and push execute reconstruction only and verify that the .ch file is used as delayed file. Image is referred as **image4**.	The ratio image4/image0 values range should be 1.0±0.01 (some artifacts outside the phantom is expected).		
T2.5	S5.5	Configure and run the reconstruction using the trues sinogram (.tr.s) and select ANW with 16 subsets and 2 iterations, no PSF, use scatter and attenuation. Image is referred as **image5**.	Image 5 should be similar to image 2 (the ratio image5/image0 values range should be 1.0±0.2)		

Table 2.2: hrrt_osem3d tests.

Alternatively, run the commands in the file HRRT_U_test_winscript_template.txt to create the images image1 .. image5 and use vinci comparison above.

3. e7_sino_u

3.1 Build Date

Execute “e7_sino_u -v” in a command window to get the build ID and fill the field ‘Build date’ below.

Build date	

Table 3.1: e7_sino_u build date.

3.2 Tests

Tag	Spec Trace	Verification	Expected results	Actual results	Pass/fail
T3.1	S4.1	Open recongui.log in c:\cps\log directory; locate the command e7_sino_u and verify that –os2d was used in test T2.3.	Yes		
T3.2	S4.1	Remove “–os2d” from e7_sino_u command (T3.1) and execute in a command window.	The output sinogram should be the same as the one created in test preparation (see 1.4) within 1%.		
T3.3	S4.2	Open recongui.log in c:\cps\log directory; locate the command e7_sino_u and verify that –lber was used in test T2.3.	The value used for front and back layer energy background is printed at the end e7_sino_u log. Open the log file and verify that the values - crystalLayerBackgroundErgRatio(0/1) - are the specified ones.		

Table 3.2: e7_sino_u test.

4. Cluster Reconstruction

4.1 Build Dates

Execute “clc_u -v”, “clq_u -v”, and “clcrecon” in a command window to get the build IDs and fill the

fields build date below.

Executable	Build date
clc_u	
clq_u	
Clcrecon	

Table 4.1: cluster components build dates.

4.2 Cluster configuration

- Create the directory c:\cps\cluster_u on the reconserver if it does not exist.
- Edit the cluster and queue configuration files ClusterConfig.txt and QueueConfig.txt in c:\cps\cluster_u. See specifications for format.
- Install the cluster and queue service with the commands “clc_u -i” and “clq_u -i”; or update with the commands “clc_u -U” and “clq_u -U” if the services are already installed.
- Download clcrecon.exe to the nodes with the command “clc_u -d clcrecon.exe”
- Download hrrt_osem3d.exe to the nodes with the command “clc_u -d hrrt_osem3d.exe”.
- Download gendelays.exe to the nodes with the command “clc_u -d gendelays.exe ”

4.3 Tests

Tag	Verification	Expected results	Actual results	Pass/fail
T4.4	Run clc_u -V	All cluster computers should report the same revision as in 4.1		
T4.4	Run clq_u -V	The command reports the version of the current exe and the running ClusterQueue service. Both revisions should be the same as in 4.1		
T4.5, T4.6, T4.7	Configure an start a multi-frame reconstruction in ReconGUI_u	ReconGUI_u should create corre-sponding clcrecon reconstruction jobs in the cluster directory. Open the job files with notepad and verify that the files start with “#! clcrecon”, the delayed file is the .ch file and the scatter file is in the new 2D format.		
T4.8	N/A	Open c:\cps\cluster_u\serverlog.txt and verify that hrrt_osem3d was started on the nodes with the correct		

		UNC paths.		

Table 4.2: cluster reconstruction tests.

5. Component-Based Normalization: norm_process

5.1 Required Data File

Acquire rotating ^{68}Ge rod normalization scan listmode; minimum 1h with a new rod and 2h for with old rod.

Histogram the listmode in true mode span 9 by drag on drop of the listmode file onto the LMHistogram shortcut on the ACS desktop. Then drag and drop the created sinogram file on the compute_norm shortcut to create the direct normalization and rotation dwell parameters.

5.2 Build Date

Execute “norm_process” without argument in a command window to get the build ID and fill the field ‘Build date’ below.

Build date	

Table 5.1: norm_process build date

5.3 Tests

Tag	Verification	Expected results	Actual results	Pass/fail
T5.1	Default arguments	Drag and drop the listmode on norm_process.exe in C:\CPS\USERS_SW (or a shortcut to it). Norm_process uses the listmode directory for the rotation dwell parameter files, creates span9 normalization and crystal efficiencies files (in the folder of the input file).		
T5.2	Create span3 norm: run norm_process with the crystal efficiencies file created above and “-s 3,67” and “-o norm_span3.n”	norm_process creates a span3 norm from the crystal efficiencies.		

T5.3	-d duration (e.g. -d 1800)	Specify the duration of the listmode to be processed in sec (e.g. 1800). Norm_process displays the listmode time as it is computing the fansum. Verify that only the specified duration is used.		
T5.4	Create Low-Resolution norm: Run norm_process with the crystal efficiencies and "-L 2 -o norm_LR.n"	norm_process creates a low resolution norm_LR.n (56MB).		Fail

Table 5.2: norm_process tests

Arguments -L 1, -g, -I, -M, -c, -K, -R, -T are only included in the Specifications document for debugging, not for this test.

6. hrrt_rebinner_lut

6.1 Build Date

Execute hrrt_rebinner_lut with no argument in a command window to get the build ID and fill the field 'Build date' below.

Build date	

Table 6.1: hrrt_rebinner build date.

6.2 tests

open a DOS command prompt and execute tests in table below.

Tag	**Spec Trace**	**Verification**	**Expected results**	**Actual results**	**Pass/Fail**
T6.1	S2.1	Type the command "hrrt_rebinner_lut –o em.lut" to create an emission LUT and compare the file with the distribution file using the command "fc /b em.lut c:\cps\users_sw\hrrt_rebinner.lut"	no differences		
T6.2	S2.4	Type the command "hrrt_rebinner_lut –t tx.lut" to create a transmission LUT and compare the file with the distribution file using the command "fc /b tx.lut c:\cps\users_sw\hrrt_rebinner_tx.lut"	no differences		
T6.3	S2.2	Type the command "hrrt_rebinner_lut –o	no differences		

		em_koln.lut -k" to create an emission LUT and compare the file with the distribution file using the command "fc /b em_koln.lut c:\cps\users_sw\hrrt_rebinner_koln.lut"			
T6.4	S2.2	Type the command "hrrt_rebinner_lut –t tx_koln.lut" to create a transmission LUT and compare the file with the distribution file using the command "fc /b tx_koln.lut c:\cps\users_sw\hrrt_rebinner_koln_tx.lut"	no differences		

7. lmhistogram_u

7.1 Build Date

Execute lmhistogram_u without arguments in a command window to get the build ID and fill the field 'Build date' below.

Build date	

Table 7.1: lmhistogram_u build date

7.2 Tests

Run the commands in the file HRRT_U_lmhistogram_test_winscript_template.txt (change path settings in the file, change the file type to bat and run) to create the images lmtest_image0 – lmtest_image2 and use Vinci for the comparison below.

Tag	**Spec Trace**	**Verification**	**Expected results**	**Actual results**	**Pass/ Fail**
T7.1	S3.1 S3.2 S3.3 S3.4 S3.5	Make sure that image lmtest_image0.i and lmtest_image1.i were created	Display lmtest_image0.i and lmtest_image1.i in Vinci and compute the ratio. Large ROI average in ratio image should be 1.0±0.01.		
T7.2	S3.6	Make sure that image lmtest_image2.i was created	Verify that the prompt sinogram is in span3 and		

			trues sinogram used for scatter is in span9. Display lmtest_image1.i and lmtest_image2.i in Vinci and compute the ratio. Large ROI average in ratio image should be 1.0±0.01.		
T 7.3		To be done	To be done		
T 7.4		To be done	To be done		

Table 7.2: lmhistogram tests.

8. ReconGUI_u

8.1 Build Date

Start ReconGUI_u and fill the build date below with the date displayed in the window title.

Build date	

Table 8.1: ReconGUI_u build date

8.2 Tests

Exit ReconGUI_u, edit C:\cps\USERS_SW\recon.ini to change Mu Zoom and TX Scatter factors as below:

Mu Zoom : 2,1
TX Scatter Factors: -0.1,1.18

Restart ReconGUI_u to execute tests in table below.

Tag	**Spec Trace**	**Verification**	**Expected results**	**Actual results**	**Pass/Fail**
T8.1	S9.1	Done in T2.1	See T2.1	See T2.1	
T8.2	S9.2	Done in T2.1	See T2.1	See T2.1	
T8.3	S9.3	Done in T4.5 – T4.7	See T4.5-T4.7	See T4.5-T4.7	
T8.4	S9.4	Done in T2.2	Done in T2.2	See T2.2	

T8.5 T8.6	S9.5 S9.6	Configure Transmission Process without segmentation and push 'Execute Only' to create the mu-map.	e7_atten_u is executed with "—uzoom 2,1". and "—txsc –0.1, 1.18" , verify in log file c:\cps\log\recon_gui.log		
T8.7	S9.7	Configure Transmission Process, enable segmentation and select TX_TV3Dreg method !!!WARNING: TEST ONLY, TX_TV3Dreg IS VALID FOR HUMAN SCANS ONLY!!!!!!	1) e7_atten_u is executed without segmentation and that TX_TV3Dreg program is executed to process the mu-map created by e7_atten_u 2) The segmentation method is in the image header and the value is TX_TV3DReg		
T8.8	S9.8	Configure Transmission Process, enable segmentation and select MAP-TR method	The segmentation method is in the image header and the value is MAP_TR		
T8.9	S9.9	N/A	Verify in e7_atten_u log file created in T8.8 that e7_atten_u is executed without scatter correction (no –txsc)		
T8.10	S9.10	N/A	verify in the log file created in T8.8 that e7_atten_u is executed with the option –txblr val, where val is the ratio blank_speed/TX_speed (ratio between expected counts for TX and for blank)	See T3.3	
T8.11	S9.11	Done in Test T3.3	See T3.3	See T3.3	
T8.12	S9.12	Configure Attenuation Process and push 'Execute Only'	Verify that log files: e7_atten_u (T8.5), e7_fwd_u (T8.11), e7_sino_u (T3.3), hrrt_osem3d (T2.1) are created in the log sub-		

			directory in the patient directory.		
T8.13	S9.13	N/A	Verify that the QC files e7_atten_u (T8.5), e7_sino_u (T3.3) are created in QC sub-directory in the patient directory.		

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9. if2e7

9.1 Build Date

Execute “if2e7 --version” in a command window to get the version and build date and fill the ‘Test version’ field below. If you are already using if2e7, fill the fields for both the current and the new test version.

Current version and build date	
Test version and build date	

Table 9.1: if2e7 version and build date

9.2 Tests

Tag	**Verification**	**Expected results**	**Actual results**	**Pass/Fail**
T9.0	If you are already using if2e7, run the old version and the new version with the same arguments. Output files are referred to as image0.v and image1.v	Display image0.v and image1.v in Vinci and compute the ratio. The ratio image values range should be 1.0±0.01.		
T9.1	Use –F option to create image2.v with your insitution in the facility name field.	Verify in Vinci InfoView that the facility name is correct.		
T9.2	Use –D dirname	The output file is duplicated in dirname		
T9.3	-T	The output image is truncated , empty slices are discarded.		

Table 9.2: if2e7 tests

10. calcringroiratio

10.1 Build Date

Execute calcringroiratio without arguments in a command window to get the build ID and fill the field 'Build date' below. If you are already using calcringroiratio, fill the dates for current and the new test version.

Current version build date	
Test version build date	

Table 10.1: calcringroiratio build date

10.2 Tests

Tag	Verification	Expected results	Actual results	Pass/Fail
T10.0	If you are already using calcringroiratio, run this version and the new version with same arguments.	The computed ratio should be the same within 0.1%.		

Table 10.2: calcringroiratio tests

11. e7_atten_u

11.1 Build Date

Execute e7_atten_u –v to get the build ID and fill the field 'Build date' below.

Build date	

Table 11.1: e7_atten_u build date

11.2 Tests

Tag	Spec Trace	Verification	Expected results	Actual results	Pass/Fail
T11.0	S8.0	Done in 8.8	See 8.8		

T11.1	S8.1	Done in 8.5	See 8.5		
T11.2	S8.2	Done in 8.10	See 8.10		

Table 11.2: e7_atten_u tests

12. 3D-RP (3D-FBP) reconstruction

12.1 Build Dates

Execute ecat_3drp, hrrt_sinocor, hrrt_gapfill with no argument to get the build ID and fill the build date below. Right click on the file "c:\cps\users_sw\hrrt.fil" to open the properties window and note the modification date in the build date table below.

Executable	**Build date**
ecat_3drp	
hrrt_sinocor	
hrrt_gapfill	
Hrrt.fil	

Table 12.1: 3drp files build date

12.2 Tests

Run the commands in the file HRRT_U_3drp_test_winscript_template.txt (change path settings in the file, change the file type to bat and run) to create the images 3drp_image1 – 3drp_image5 and use Vinci for the comparison below.

Tag	**Spec Trace**	**Verification**	**Expected results**	**Actual results**	**Pass/Fail**
T12.1	S13.1. [1-7]	Create image 3drp_image1.i, referred as 3drp1	Display image0 and 3drp1 in Vinci and compute the ratio. Large ROI average in ratio image should be 1.0±0.02.		
T12.2	S13.1.2	Create image 3drp_image2.i, referred as 3drp2	Display 3drp1 and 3drp2 in Vinci and compute the ratio. The average of a large ROI in the ratio image should be 1.0±0.02.		
T12.3	S13.1.2	Create image 3drp_image3.i, referred as 3drp3	Display 3drp1 and 3drp3 in Vinci and compute the ratio.		

			The average of a large ROI in the ratio image should be 1.0±0.02.		
T12.4	S13.2. [1-8]	Create image 3drp_image4.i, referred as 3drp4	Display image0 and 3drp4 in Vinci and compute the ratio. The average of a large ROI in the ratio image should be 1.0±0.02.		
T12.5	S13.2.7	Create image 3drp_image5.i, referred as 3drp5	Display image0 and 3drp5 in Vinci and compute the ratio. The average of a large ROI in the ratio image should be 1.0±0.02.		

Table 12.2: 3D-RP tests

13. scanit _u

13.1 Build Date

Start scanit_u and fill the build date below with the date displayed in the window title.

Build date	

Table 13.1: scanit_u build date

Scanit_u is installed in c:\cps\USERS_SW. Copy configuration files c:\cps\bin*.cfng and c:\cps\bin*.ini and db.cfg to c:\cps\USERS_SW.

13.2 Tests

Tag	Spec Trace	Verification	Expected results	Actual results	Pass/Fail
T13.0	S14.0	Acquire an emission list-mode and verify that the listmode header contains	yes		

		the start time with milli-seconds.			
T13.1	S14.1	If the scan time has single digits (hour,min or sec) verify that 2 digits are used in the filename. Acquire a second scan if needed.	yes		
T13.2	S14.2	Verify that the entries in the serial line log communications log files “Serial com logfile-*.txt” in SCS_SCANS\log directory have time stamps	yes		

Table 13.2: scanit_u tests