

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) 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) 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	Compressed 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.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-	Image reconstructed with users software HRRT_U 1.0 ; OP-

phantom-19832-2007.11.26.11.9.20_em_H RRT_u.i	OSEM3D, 6 iterations, 16 subsets
uniform- phantom-19832-2007.11.26.11.9.20_em_H RRT_u.i.hdr	Image header from users software HRRT_U 1.0
uniform- phantom-19832-2007.11.26.11.9.20_em_H RRT_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_H RRT_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 outside

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. hrirt_osem3d

2.1 Build Date

Execute hrirt_osem3d with no argument in a command window to get the build ID and the fill the field build date below.

Build date	Jul 16 2009 11:09:28 (32bit)	Jul 16 2009 11:08:53 (64bit)
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Table 2.1: hrirt_osem3d build dates.

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 should be 1.0 ± 0.01 .	$1.0 \pm .004$	pass
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.	RoI avg $1.0 \pm .003$	pass
T2.3	S5.3	Configure the scatter process step and push execute all to run both scatter correction and reconstruction. Image is referred to as image3 .	The scatter file size is 59MB. The ratio image1/image3 values range should be 1.0 ± 0.01 .	RoI avg $1.0 \pm .001$	pass
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/image2 values range should be 1.0 ± 0.01 .	Lines (5%)outside the cylinder	Fail
T2.5	S5.5	Configure and run the reconstruction using the trues sinogram (.tr.s) and select ANW with 16 subsets and 2 iterations. Image is referred as	Image 5 should be similar to image 2 (the ratio image5/image2 values range should be 1.0 ± 0.2)	Roi Avg $1.0 \pm .02$	Pass

		image5.		
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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 the fill the field build date below.

Build date	Aug 26 2008 10:02:04
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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	No change, See 1.0 test results	
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).	No change, See 1.0 test results	
T3.3	S4.2	Add the option –lber b to e7_sino_u command (T3.1) and execute in a command window.	The values used for front and back layer energy background are printed at the end and are the specified ones.	No change, See 1.0 test results	

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 the 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 doesn't 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 and start a multi-frame reconstruction in ReconGUI_u	ReconGUI_u should create corresponding clcrecon reconstruction jobs in the cluster directory. Verify if 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.		
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Table 4.2: cluster reconstruction tests.

5. Component-Based Normalization: norm_process

5.1 Required Data File

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 and drag and drop the created 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 the fill the field build date below.

Build date	
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Table 5.1: norm_process build date

5.3 Tests

Tag	Verification	Expected results	Actual results	Pass/fail
T5.1	Shortcut on desktop	The installation procedure creates a shortcut to norm_process.exe		
T5.1	Shortcut on desktop	The installation procedure creates a shortcut to norm_process.exe		
T5.1	Default arguments	Drag and drop the listmode on norm_process shortcut. 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).		
T5.1	Create span3 norm:	norm_process creates a span3 norm		

	run norm_process with the efficiencies file created above and “-s 3,67” and “-o norm_span3.n”	from the crystal efficiencies.		
T5.2	-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.		
T5.3	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).		

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 the fill the field build date below.

Build date	
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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	no differences		

		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”			
T6.4	S2.2	Type the command “hrrt_rebinner_lut -o 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”	no differences		
T6.5	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_tx_koln.lut”	no differences		

7. Imhistogram_u

7.1 Build Date

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

Build date	
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Table 7.1: Imhistogram_u build date

7.2 Tests

Start ReconGUI_u to execute tests in table below.

Tag	Spec Trace	Verification	Expected results	Actual results	Pass/Fail
T7.1	S3.1 S3.2 S3.3 S3.4 S3.5	Configure mu-map, attenuation, scatter and OP-OSEM reconstruct (16 subsets, 6 iterations) from test listmode files (emission and transmission) and	Verify in the histogramming log file (patient log directory) that c:\cps\users_sw\hrrt_rebinner.lut is used. Emission is histogrammed		

		execute “execute all”. Image is referred to as image6 .	with –pr option and the random sinogram “_ra.s” is not created. Display image1 and image6 in Vinci and compute the ratio. The ratio image values range should be 1.0 ± 0.01 .		
T7.2	S3.6	Select span3 in ReconGUI_U interface. Configure the scatter process with the emission listmode and “start execute only”.	Verify that the prompt sinogram is in span3 and trues sinogram used for scatter is in span9.		
T 7.3		Execute lmhistogram with –“L 1”	Open the header and verify that sinogram size is 160x144, the bin size is 2mm, the plane separation is 2.4375mm the span is 7 and maximum ring difference is 38.		
T 7.4		Execute lmhistogram with –“L 2”	Open the header and verify that sinogram size is 128x144, the bin size and plane separation are 2.4375mm, the span is 7 and maximum ring difference is 38.		

Table 7.2: lmhistogram tests.

7. ReconGUI_u

7.1 Build Date

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

Build date	
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Table 7.1: ReconGUI_u build date

7.2 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
T7.1	S9.1	Done in T2.1	See T2.1	See T2.1	
T7.2	S9.2	Done in T2.1	See T2.1	See T2.1	
T7.3	S9.3	Done in T4.5 – T4.7	See T4.5-T4.7	See T4.5-T4.7	
T7.4	S9.4	Done in T2.2	Done in T2.2	See T2.2	
T7.5 T7.6	S9.5 S9.6	Configure and execute mu-map processing.	Verify that e7_atten_u is executed with “—uzoom 2,1”. and “—txsc -0.1, 1.18”		

8. if2e7

8.1 Build Date

Execute “if2e7 –version” in a command window to get the build ID and the fill the field build date below. If you are already using if2e7, fill the dates for current and the new test version.

Current version build date	
Test version build date	

Table 8.1: if2e7 build date

8.2 Tests

Tag	Verification	Expected results	Actual results	Pass/Fail
T8.0	If you are already using if2e7, run this version and the new version with same arguments. Output files are referred 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 .		
T8.1	Use -F option to create image2.v with your insitution	See T2.1	See T2.1	

	in the facility name field.			
T8.2	Use -D dirname	The output file is duplicated in dirname		
T8.3	-T	The output image is truncated , empty slices are discarded.		

Table 8.2: if2e7 tests

9. calcingroiratio

9.1 Build Date

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

Current version build date	
Test version build date	

Table 9.1: calcingroiratio build date

9.2 Tests

Tag	Verification	Expected results	Actual results	Pass/Fail
T9.0	If you are already using calcingroiratio, run this version and the new version with same arguments.	The computed ratio should be the same within 0.1%.		

Table 9.2: calcingroiratio tests

10. e7_atten_u

10.1 Build Date

Execute e7_atten_u -v to get the build ID and the fill the field build date below.

Build date	
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Table 10.1: e7_atten_u build date

10.2 Tests

Tag	Spec Trace	Verification	Expected results	Actual results	Pass/Fail
T10.0	S8.0	Done in 6.2.	See 6.2		
T10.1	S8.1	Done in 7.5	See 7.5		
T10.2	S8.2	Done in 7.6	See 7.6		

Table 10.2: e7_atten_u tests

11. 3D-RP (3D-FBP) reconstruction

11.1 Build Dates

Execute ecat_3drp, hrrt_sinocor, hrrt_gapfill with no argument to get the build ID and the 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 11.1: 3drp files build date

11.2 Tests

Run the commands in the he file HRRT_U_3drp_test_winscript_template.txt to create the images 3drp_image1 .. 3drp_image5 and use vinci comparison below

Tag	Spec Trace	Verification	Expected results	Actual results	Pass/Fail
T11.1	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 .		
T11.2	S13.1.2	Create image 3drp_image2.i, referred as 3drp2	Display 3drp1 and 3drp2 in Vinci and compute the ratio. Large ROI average in ratio image should be		

			1.0±0.01.		
T11.3	S13.1.2	Create image 3drp_image3.i, referred as 3drp3	Display 3drp1 and 3drp3 in Vinci and compute the ratio. Large ROI average in ratio image should be 1.0±0.01.		
T11.4	S13.2. [1-8]	Create image 3drp_image4.i, referred as 3drp4	Display image0 and 3drp4 in Vinci and compute the ratio. Large ROI average in ratio image should be 1.0±0.02.		
T11.5	S13.2.7	Create image 3drp_image5.i, referred as 3drp5	Display image0 and 3drp5 in Vinci and compute the ratio. Large ROI average in ratio image should be 1.0±0.02.		

Table 11.2: 3D-RP tests

12. scanit_u

10.1 Build Date

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

Build date	
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Table 10.1: scanit_u build date

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

10.2 Tests

Tag	Spec Trace	Verification	Expected results	Actual results	Pass/Fail
T10.0	S8.0	Done in 6.2.	See 6.2		
T10.1	S8.1	Done in 7.5	See 7.5		
T10.2	S8.2	Done in 7.6	See 7.6		

Table 10.2: e7_atten_u tests