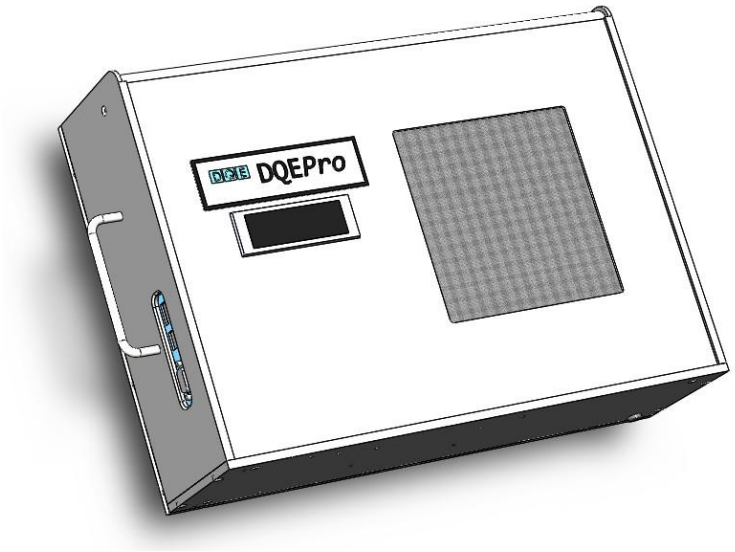
DQE instruments

DQE*Pro*

Radiography DQE Sample Report

- CsI system
- Clinical-environment testing



DQE Instruments Inc., London, Canada
www.dqeinstruments.com

This report was generated automatically by DQE*Pro*. The report summarizes the MTF and DQE performance of a clinical CsI-based flat-panel detector. The full DQE assessment was completed in 15 minutes in the x-ray room of a busy clinical department.

Observations:

1. The detector has a zero-frequency DQE value of 58% at an air KERMA of 1.0 μGy (0.12 mR) using an RQA-5 spectrum. Resolution is limited by pixel size at 3.5 cycles/mm.

2. Detector response is linear. The quantum-noise limit is 0.23 μGy, indicating that any exposure above that level is quantum noise limited. Expect the DQE to drop by 50% at the quantum-noise limit and more below it.

3. All exposure-pulse shapes are rectangular with sharp on/off edges, indicating proper generator function with no evidence of arcing or cable capacitance. A 60 Hz modulation of pulse height indicates a single-phase generator. Sharp rising and falling edges indicate no evidence of tube arcing or cable capacitance.

DQE Report

DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

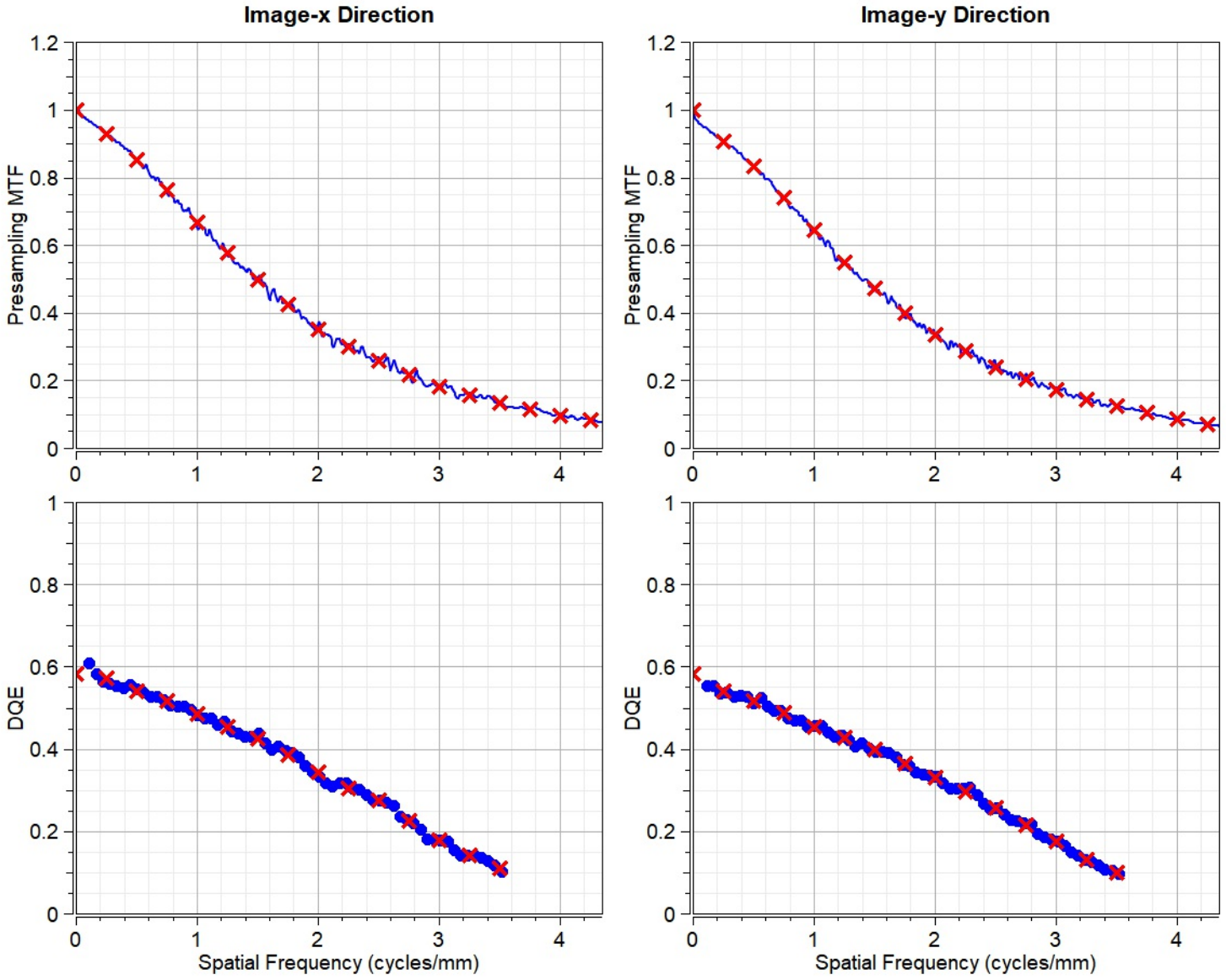
Study comment: Sample study
Grid:
X-ray spectrum: Radiography, RQA-5 (70 kV)
Half-value layer: 7.1 mmAl
Set technique: 74 kV, mA not specified, 1.3 mAs
Image-plane air KERMA, exposure: 1.01 uGy, 0.115 mR
Pixel size in image plane, x y: 140 x 140 um (Measured by DQEPro)
System response: Offsetlinear (linearized)
Average system gain: 1478 DV/mR; 169 DV/uGy
Average quantum gain: 0.0056 DV/(q/mm2); 0.29 DV/q
Quantum-noise limit: 0.23 uGy, 0.026 mR
Quantum-noise limit: 6.79e+03 incident q/mm2 133 incident q/pixel
Area under DQE curve, x y: 1.33 1.25 cycles/mm

Zero-frequency DQE sample values are extrapolated from low-frequency values. Review plots to confirm accuracy.

Warnings were generated that may affect accuracy of results. See Message Summary Report for details.

Sample MTF and DQE Values:

cy/mm	x-MTF	x-DQE	cy/mm	y-MTF	y-DQE
0.00	1.00	0.58	0.00	1.00	0.58
0.25	0.93	0.57	0.25	0.91	0.54
0.50	0.85	0.54	0.50	0.83	0.52
0.75	0.76	0.52	0.75	0.74	0.49
1.00	0.67	0.49	1.00	0.64	0.46
1.25	0.58	0.45	1.25	0.55	0.43
1.50	0.50	0.42	1.50	0.47	0.40
1.75	0.42	0.39	1.75	0.40	0.36
2.00	0.35	0.34	2.00	0.33	0.33
2.25	0.30	0.31	2.25	0.29	0.30
2.50	0.26	0.27	2.50	0.24	0.26
2.75	0.22	0.23	2.75	0.20	0.21
3.00	0.18	0.18	3.00	0.17	0.17
3.25	0.16	0.14	3.25	0.14	0.13
3.50	0.13	0.11	3.50	0.12	0.10
3.75	0.12		3.75	0.10	
4.00	0.10		4.00	0.09	
4.25	0.08		4.25	0.07	



Presampling x-MTF Report

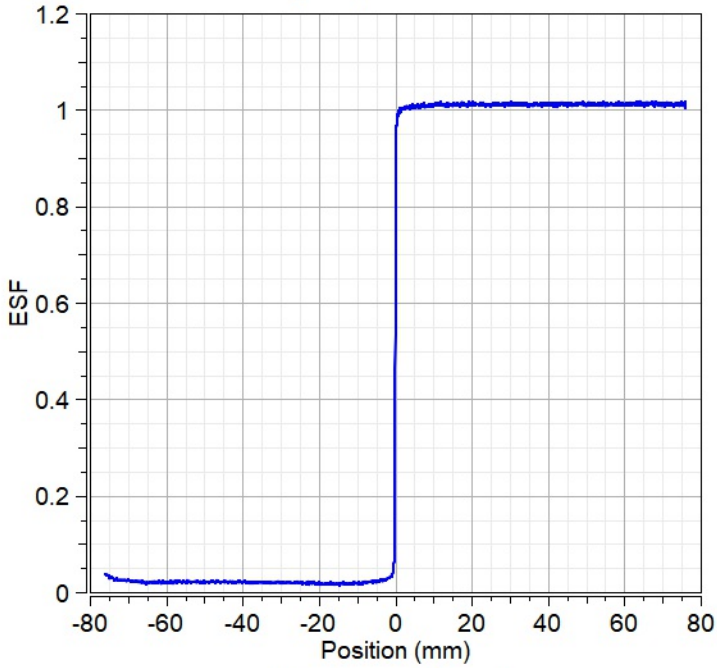
Study comment: Sample study
X-ray spectrum: Radiography, RQA-5 (70 kV)
Image-plane air KERMA, exposure: 1.01 uGy, 0.115 mR
Window width: 100 mm
Pixel size in image plane: 140 um (Measured by DQEPro)
Sampling cut-off frequency: 3.6 cycles/mm
MTF 50%, 10% and 5% frequencies: 1.5 4.0 5.2 cycles/mm
Estimated low-frequency drop: 1.0%

The dashed green line in the MTF plot illustrates a sinc function corresponding to the aperture MTF for the stated pixel size.
Images have been linearized for a Offsetlinear response in this analysis.

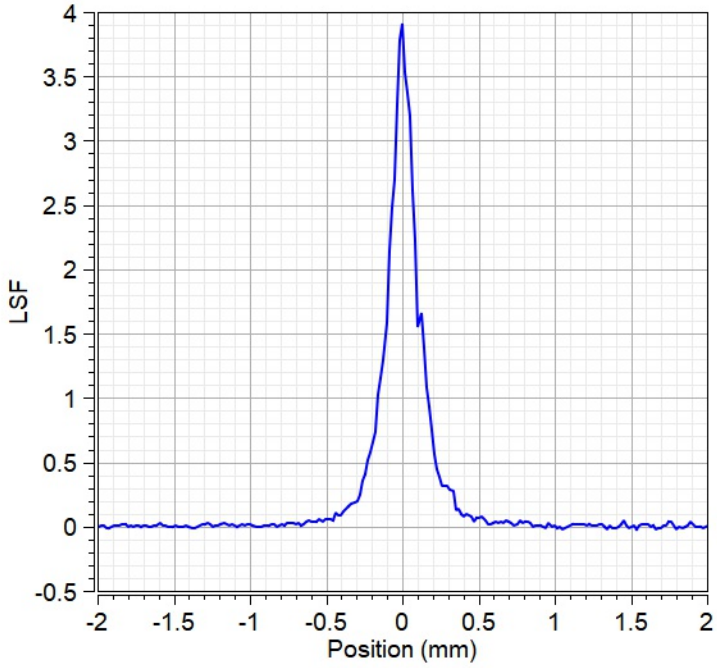
Selected MTF Values:

cycles/mm	MTF
0.00	1.00
0.25	0.93
0.50	0.85
0.75	0.76
1.00	0.67
1.25	0.58
1.50	0.50
1.75	0.42
2.00	0.35
2.25	0.30
2.50	0.26
2.75	0.22
3.00	0.18
3.25	0.16
3.50	0.13
3.75	0.12
4.00	0.10
4.25	0.08
4.50	0.07
4.75	0.06
5.00	0.05
5.25	0.05
5.50	0.04
5.75	0.04
6.00	0.04
6.25	0.04
6.50	0.03
6.75	0.03
7.00	0.03
7.25	0.02

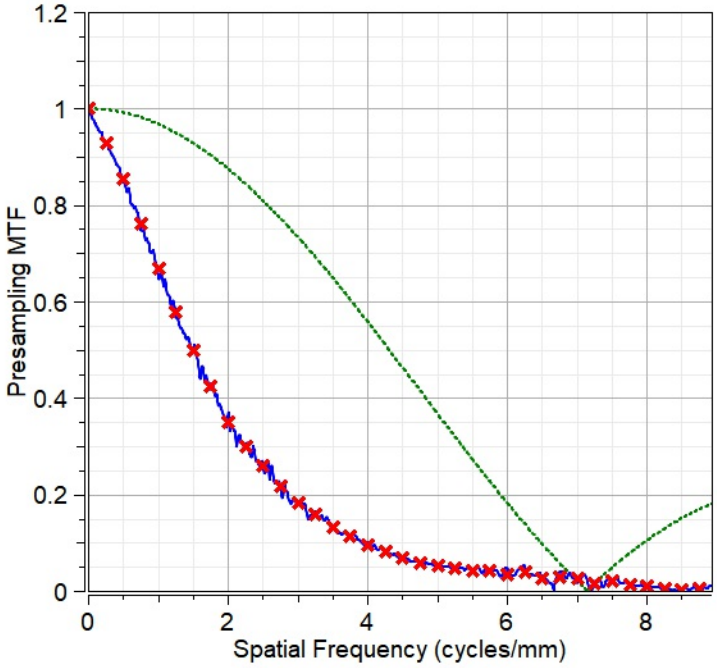
Edge-Spread Function



Line-Spread Function



Modulation Transfer Function



Presampling y-MTF Report

DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

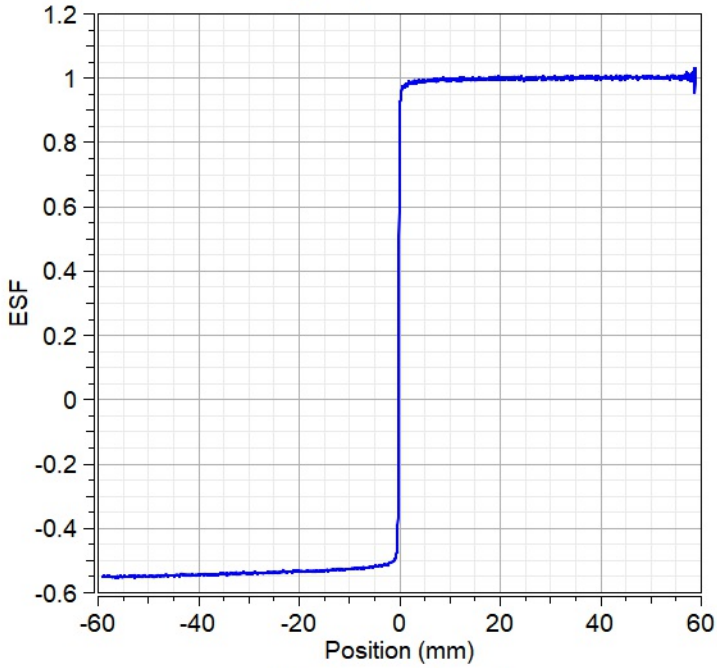
Study comment: Sample study
X-ray spectrum: Radiography, RQA-5 (70 kV)
Image-plane air KERMA, exposure: 1.01 uGy, 0.115 mR
Window width: 100 mm
Pixel size in image plane: 140 um (Measured by DQEPro)
Sampling cut-off frequency: 3.6 cycles/mm
MTF 50%, 10% and 5% frequencies: 1.4 3.8 4.8 cycles/mm
Estimated low-frequency drop: 3.3%

The dashed green line in the MTF plot illustrates a sinc function corresponding to the aperture MTF for the stated pixel size.
Images have been linearized for a Offsetlinear response in this analysis.

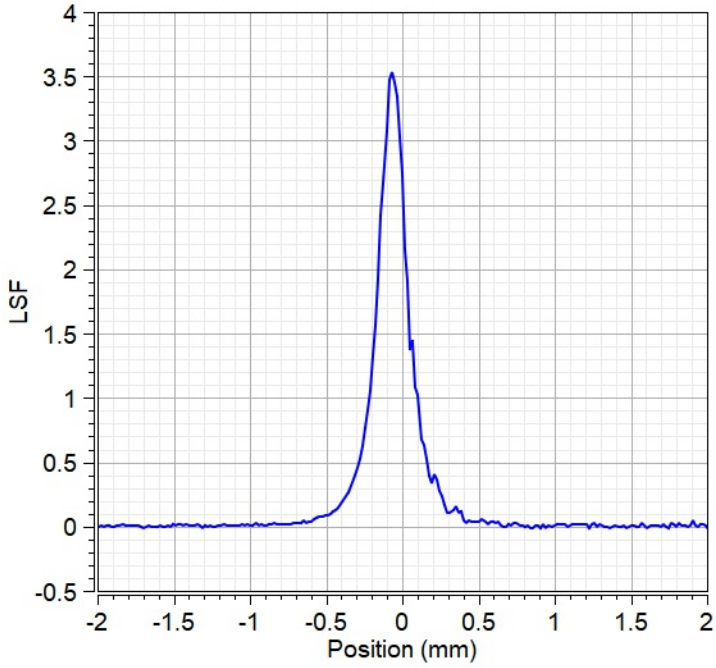
Selected MTF Values:

cycles/mm	MTF
0.00	1.00
0.25	0.91
0.50	0.83
0.75	0.74
1.00	0.64
1.25	0.55
1.50	0.47
1.75	0.40
2.00	0.33
2.25	0.29
2.50	0.24
2.75	0.20
3.00	0.17
3.25	0.14
3.50	0.12
3.75	0.10
4.00	0.09
4.25	0.07
4.50	0.06
4.75	0.05
5.00	0.04
5.25	0.03
5.50	0.02
5.75	0.02
6.00	0.02
6.25	0.02
6.50	0.02
6.75	0.02
7.00	0.01
7.25	0.01

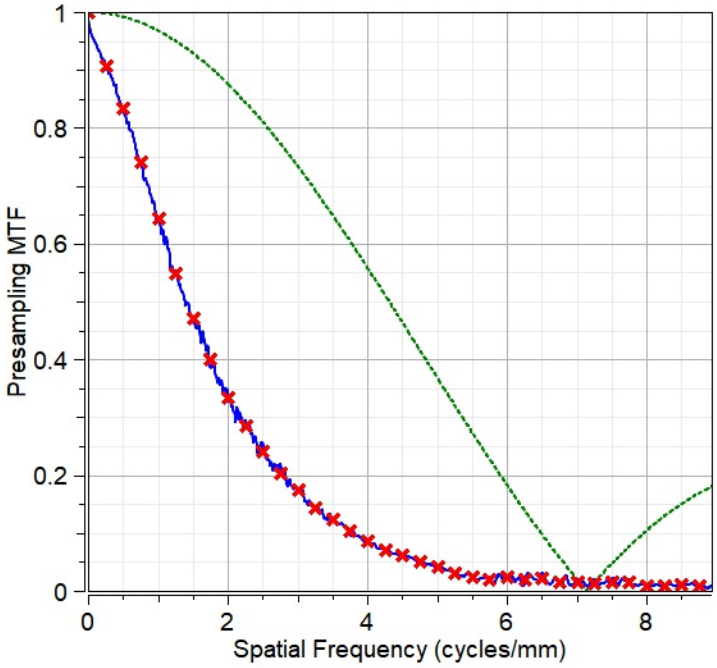
Edge-Spread Function



Line-Spread Function



Modulation Transfer Function



Wiener NPS Report

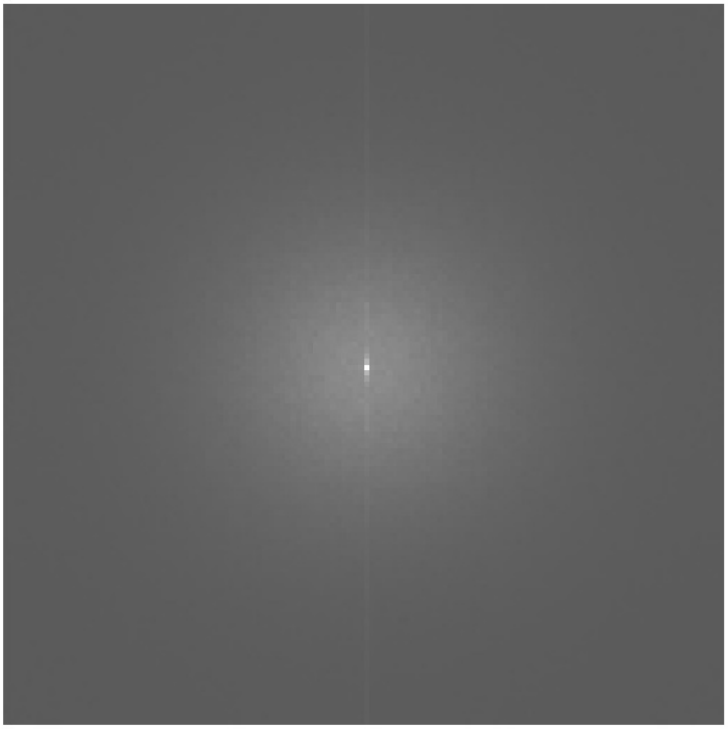
DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

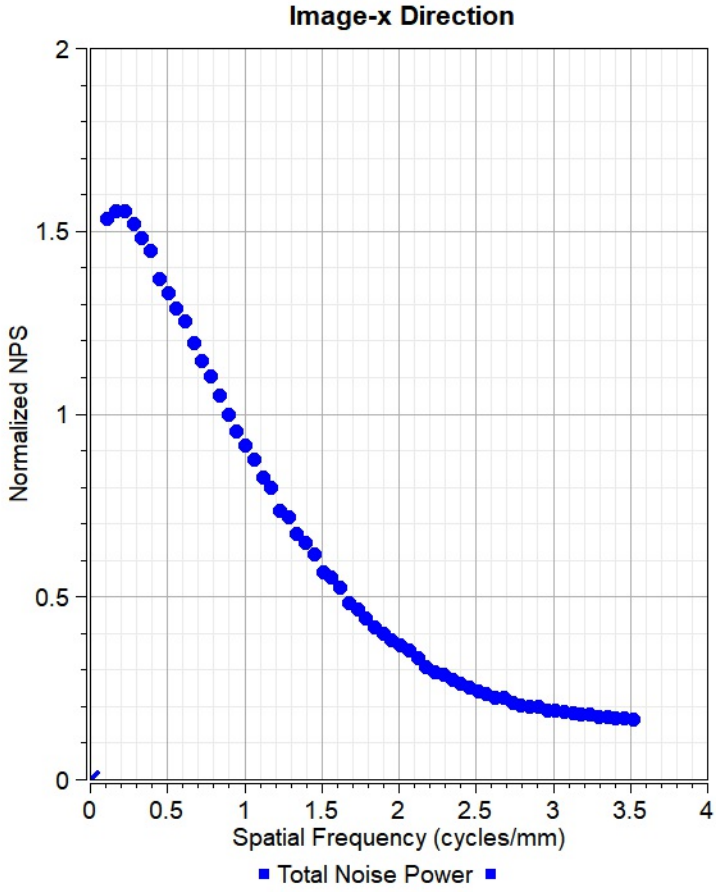
Study comment: Sample study
X-ray spectrum: Radiography, RQA-5 (70 kV)
Image-plane exposure, air KERMA: 0.115 mR, 1.01 uGy
Pixel size in image plane: 140 x 140 um (Measured by DQEPro)
Average dark and open pixel values: 71.9 239.0
System response: Offsetlinear (linearized)
Average linearized dark and open pixel values: 0.0 169.6
Zero-frequency normalized NPS value: 0.00

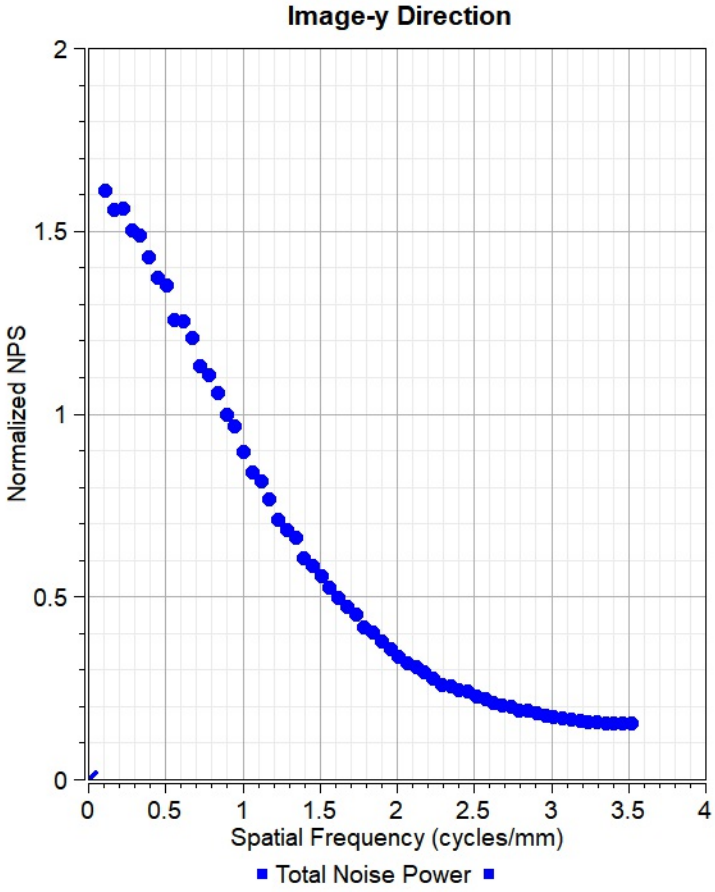
Two-dimensional Wiener NPS is shown on the right with zero-frequency in the center.

Normalized NPS has been scaled by (incident-q/mm2) / (mean-pixel-value)^2 (x 1.055017) such that an ideal detector has unity zero-frequency NPS.

In the NPS plots below, blue markers indicate total image noise. Detector readout noise was not calculated because there were less than two dark images acquired.







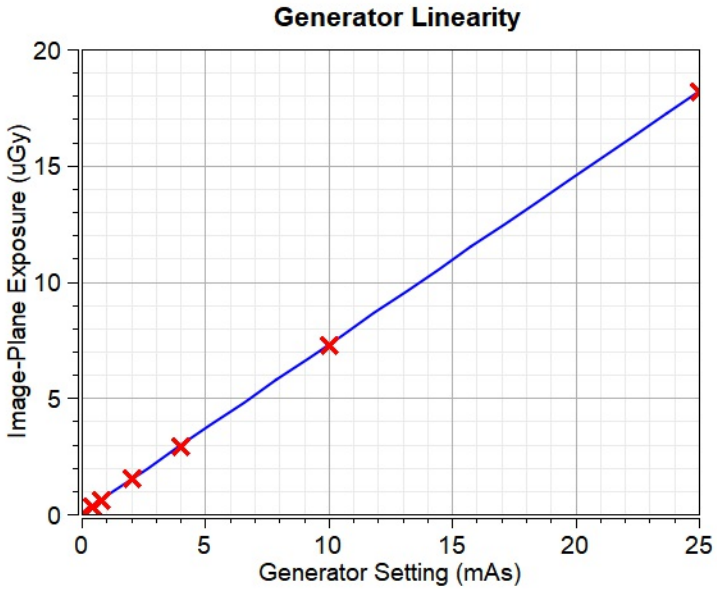
Linearity Report

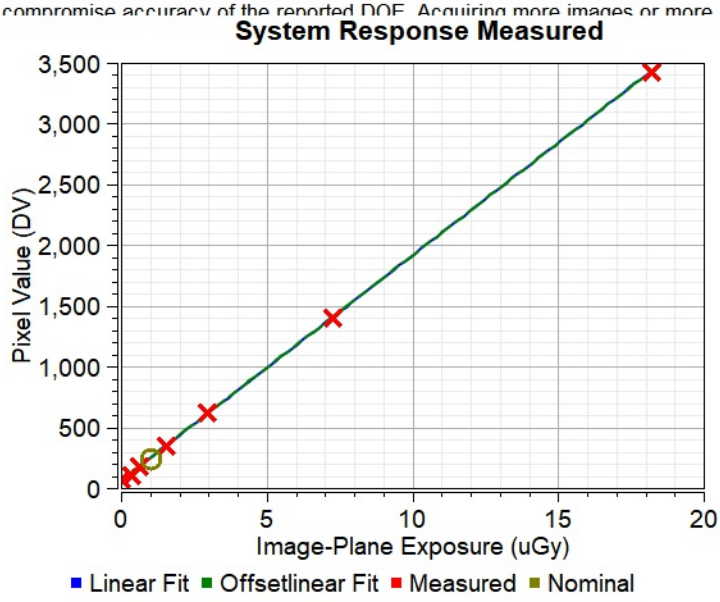
DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

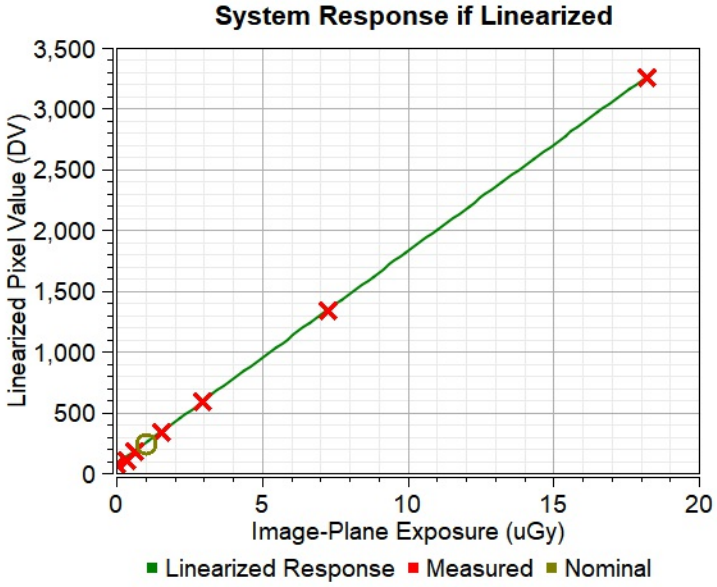
X-ray spectrum:
Half-value layer: 7.1 mm Al
Linear fit RMS error (DV): 8.3 (poor fit)
Offset-linear fit RMS error (DV): 4.3 (poor fit)
Linear fit gradient relative RMS error: 0.21
Offset-linear fit gradient relative RMS error: 0.02
Best fit: Linear
Nominal image air KERMA, exposure: 1.01 uGy, 0.115 mR
Average open pixel value (DV): 246.0
Average dark pixel value (DV): DVd = 69.5
Response: DV = DVd - 4.7 + 184.95 K
Gradient: dDV/duGy = 184.9
where K is image uGy
Local (linear) gradient at nominal (DV/uGy): 1623.0
Local (offsetlinear) gradient at nominal (DV/uGy): 1620.9
Ratio of offsetlinear-fit gradient to linear at nominal: 1.00
DQE error at nominal exposure if not linearized: 0.3%

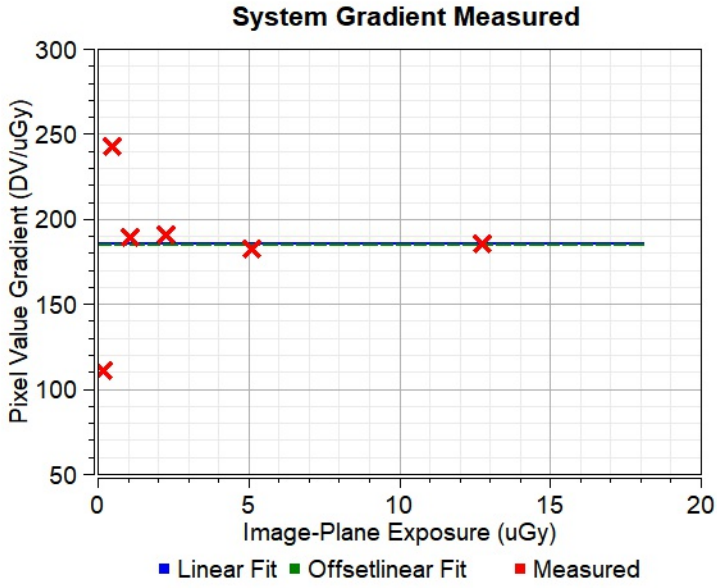
This system has a linear response if the first few measurements are ignored. Linearization is recommended.

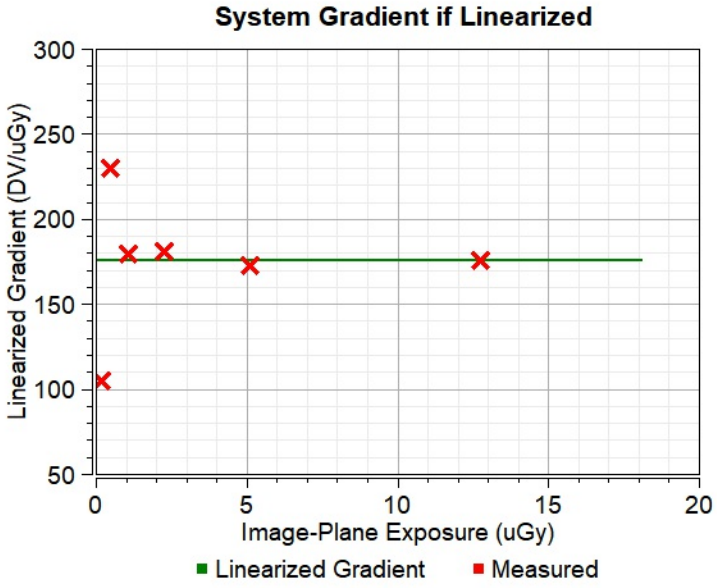
Mean pixel values at 0.4 mAs vary by more than 10%. This may be due to using a low exposure or may indicate an issue with the detector that may compromise accuracy of the reported DQE. Acquiring more images or more









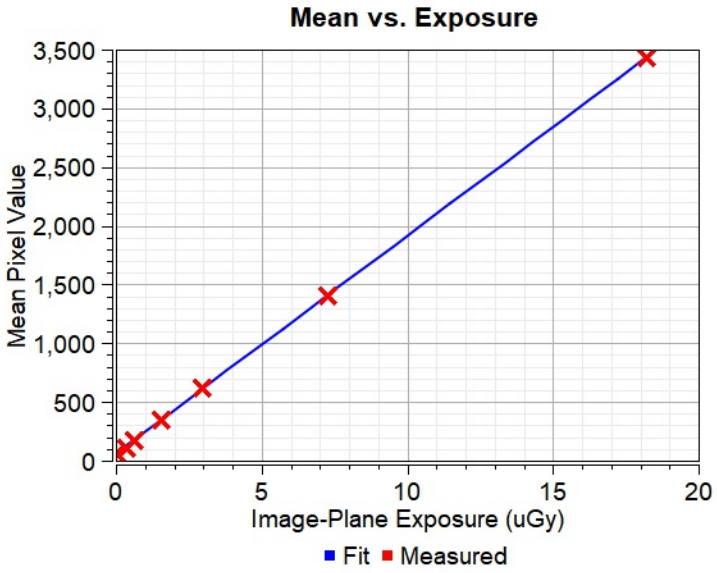


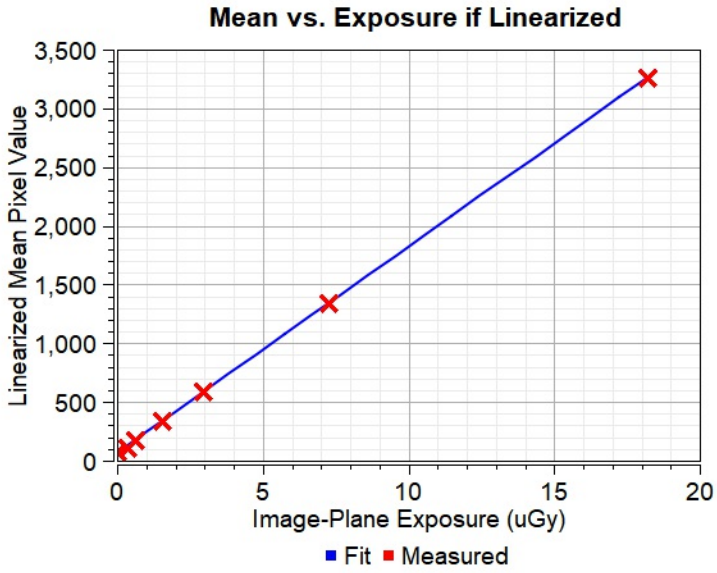
Quantum Noise Report

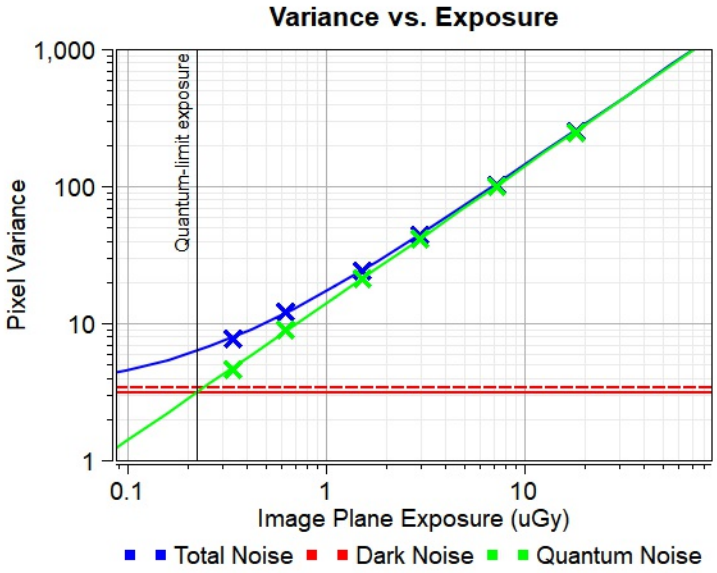
DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

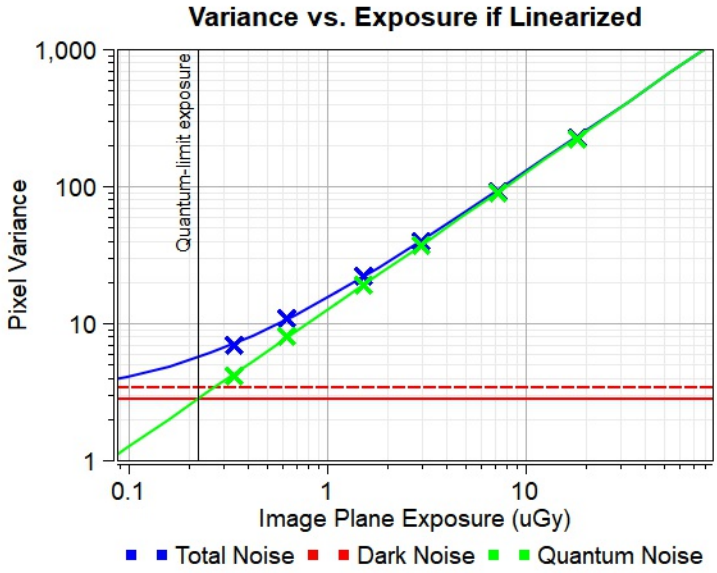
X-ray spectrum:
Half-value layer: 7.1 mm Al
Number of ignored pixels in ROI signal calculation: 0 of 1114112
Number of ignored pixels in ROI dark noise calculation: 0 of 264654
Measured dark-image noise variance: 3.4
Measured dark-image noise variance if linearized: 3.4
Dark noise variance from analysis: 3.1
Dark noise variance from analysis if linearized: 2.8
Quantum-noise limit: 0.23 uGy, 26 uR, 6.8e+03 incident q/mm2
Quantum-noise limit if linearized (exposure): 0.23 uGy, 26 uR, 6.8e+03 incident q/mm2

Solid red line in plots shows dark noise variance determined by analysis. Dashed red line (if present) shows noise measured in dark images. These lines should be similar.







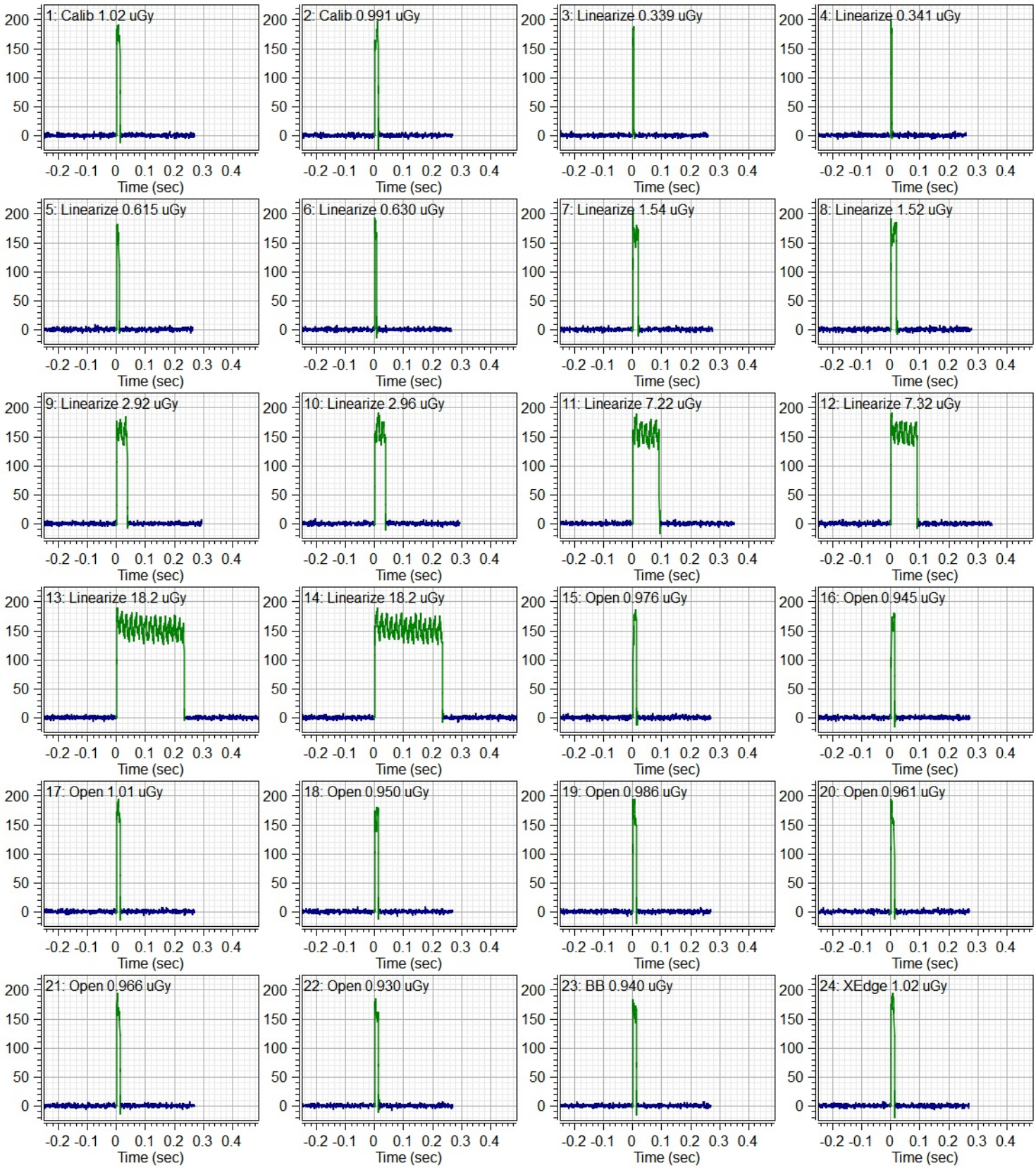


Waveform Report

DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

Data folder: \Users\DQE\data

These waveforms show x-ray exposure profiles measured by DQEPro. Green line segments correspond to identified exposure pulses. Leading and trailing baselines are dark blue and inter-pulse baselines are light blue. The first pulse should start at 0 sec. Ensure pulses are correctly identified and free of undesirable artifacts that may indicate problems with the x-ray generator or tube. Exposure values correspond to image plane based on Pro-image distance entered on panel. Double-click on any waveform to open a review window.



Waveform Report - 2

Data folder: \Users\DQE\data

These waveforms show x-ray exposure profiles measured by DQEPro. Green line segments correspond to identified exposure pulses. Leading and trailing baselines are dark blue and inter-pulse baselines are light blue. The first pulse should start at 0 sec. Ensure pulses are correctly identified and free of undesirable artifacts that may indicate problems with the x-ray generator or tube. Exposure values correspond to image plane based on Pro-image distance entered on panel. Double-click on any waveform to open a review window.

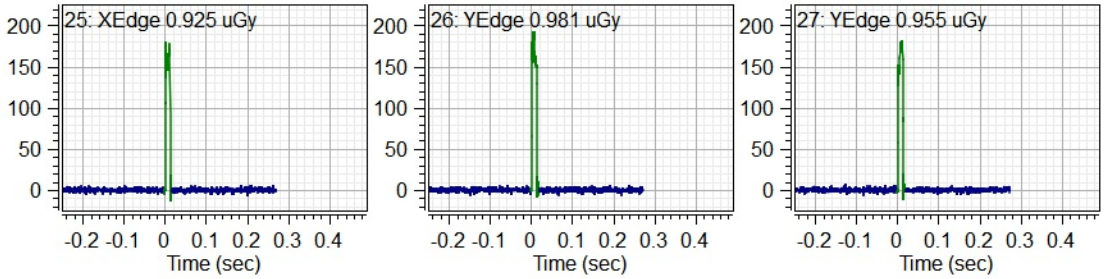


Image Details Report

DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

Image data folder: \Users\DQE\data\images

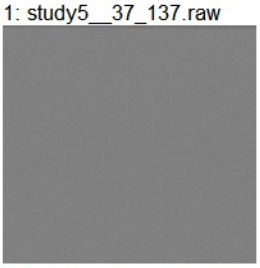
	FileName	Format	Width	Height	Depth	bits	kV	mA	msec	mAs	SID	Pixel um
1:	study5__37_137.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
2:	study5__37_138.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
3:	study5__37_139.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
4:	study5__37_140.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
5:	study5__37_141.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
6:	study5__37_142.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
7:	study5__37_143.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
8:	study5__37_144.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
9:	study5__37_145.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
10:	study5__37_146.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
11:	study5__37_147.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
12:	study5__37_148.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
13:	study5__37_149.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
14:	study5__37_150.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
15:	study5__37_151.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
16:	study5__37_152.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
17:	study5__37_153.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
18:	study5__37_154.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
19:	study5__37_155.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
20:	study5__37_156.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
21:	study5__37_157.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
22:	study5__37_158.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
23:	study5__37_159.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
24:	study5__37_160.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]
25:	study5__37_161.raw	vw2560x307	[2560	3072	1]	0	0	0	0	0.0	0	[0 0]

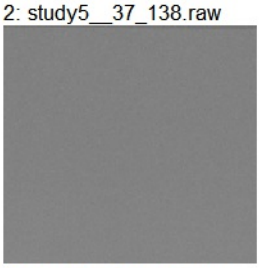
ROI Thumbnail Report

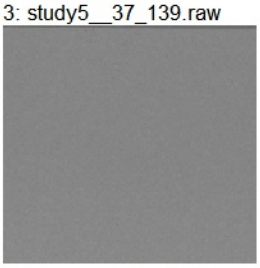
DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

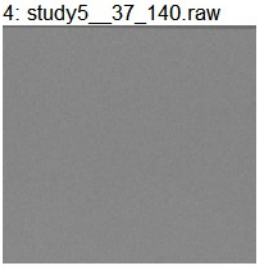
Image data folder: \Users\DQE\data

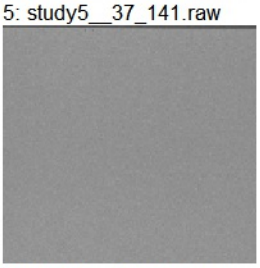
These images are thumbnail illustrations of each image. For dynamic systems, only the first few images are shown for each exposure. Ensure each image is free of undesirable artifacts that may indicate problems with the x-ray system. Double-click on thumbnail to open review window.

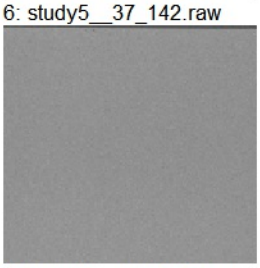
1: study5__37_137.raw


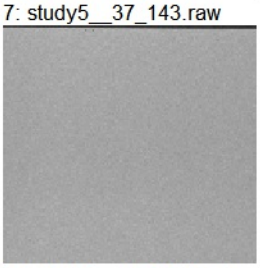
2: study5__37_138.raw


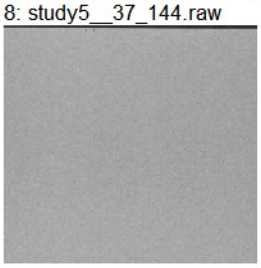
3: study5__37_139.raw


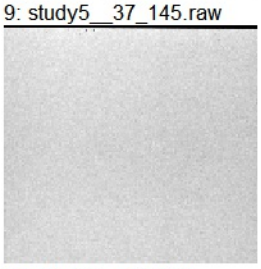
4: study5__37_140.raw


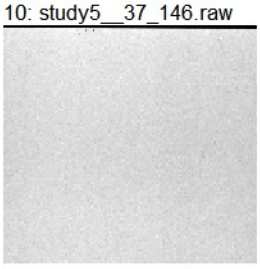
5: study5__37_141.raw


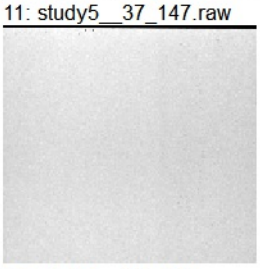
6: study5__37_142.raw


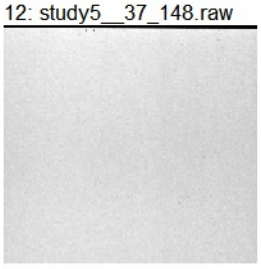
7: study5__37_143.raw


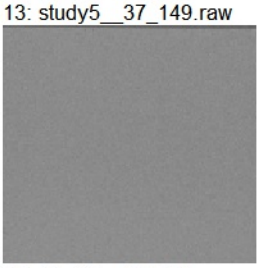
8: study5__37_144.raw


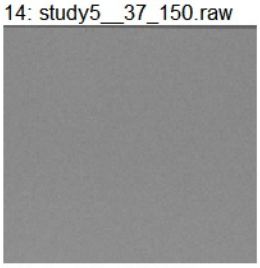
9: study5__37_145.raw


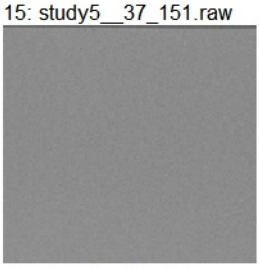
10: study5__37_146.raw


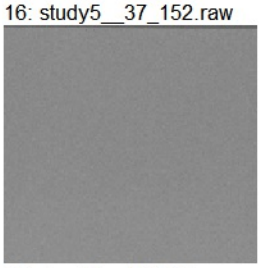
11: study5__37_147.raw


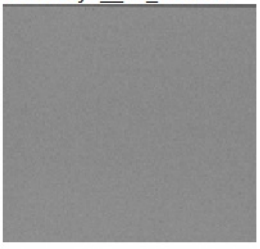
12: study5__37_148.raw


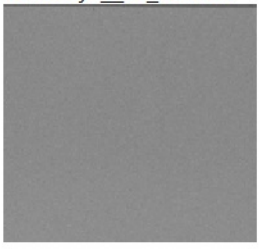
13: study5__37_149.raw


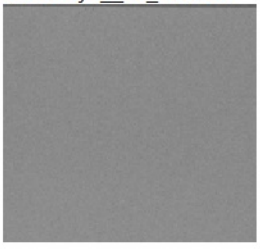
14: study5__37_150.raw


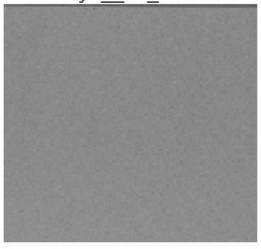
15: study5__37_151.raw


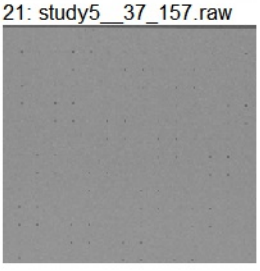
16: study5__37_152.raw


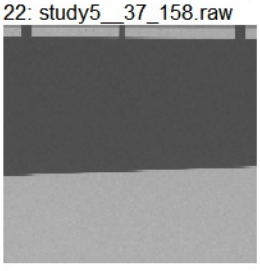
17: study5__37_153.raw


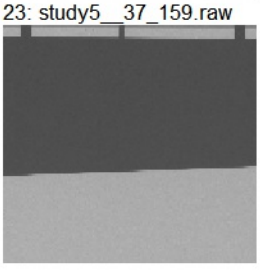
18: study5__37_154.raw


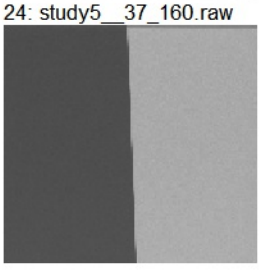
19: study5__37_155.raw


20: study5__37_156.raw


21: study5__37_157.raw


22: study5__37_158.raw


23: study5__37_159.raw


24: study5__37_160.raw


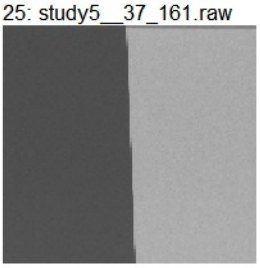
ROI Thumbnail Report - 2

DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

Image data folder: \Users\DQE\data

These images are thumbnail illustrations of each image. For dynamic systems, only the first few images are shown for each exposure. Ensure each image is free of undesirable artifacts that may indicate problems with the x-ray system. Double-click on thumbnail to open review window.

25: study5__37_161.raw

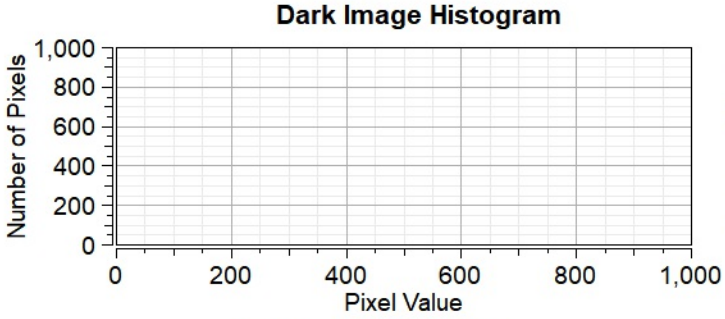


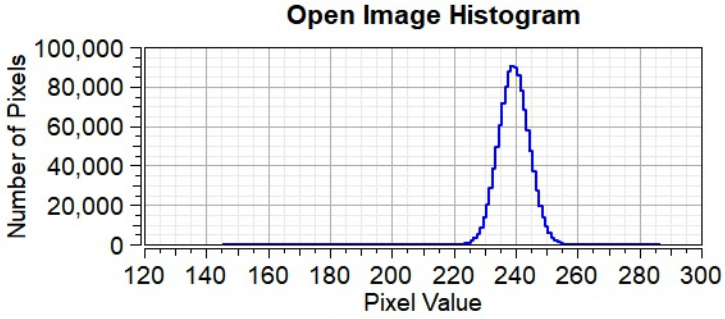
Defects Report

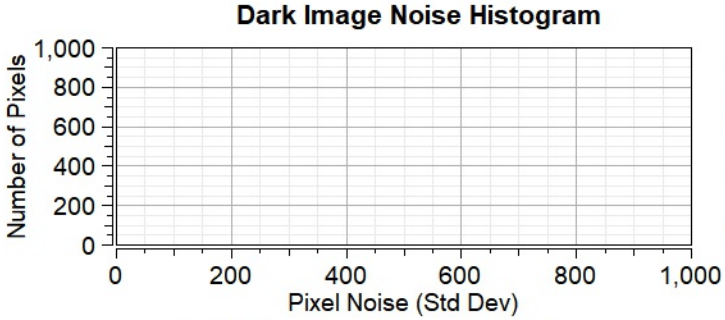
DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

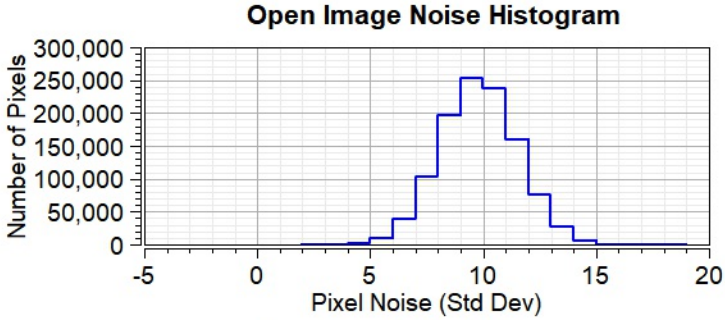
Study comment: Sample study
Detector:
Detector SN:
Possible defects include real defects and pixels obscured from x-ray beam.
Number (fraction) of possible defects in ROI: 0 of 1114112 (0.0E+00)
Number (fraction) of zero dark pixels in ROI: 0 of 0 (0.0E+00)
Dark image pixel mean and standard deviation: 0.0 0.0
Dark image pixel mean and standard deviation, non-zero and non-defect pixels: 0.0 0.0
Open image pixel mean and standard deviation: 239.0 10.0
Open image pixel mean and standard deviation, non-defect pixels: 239.0 10.0
ADC quantization-noise test: Pass

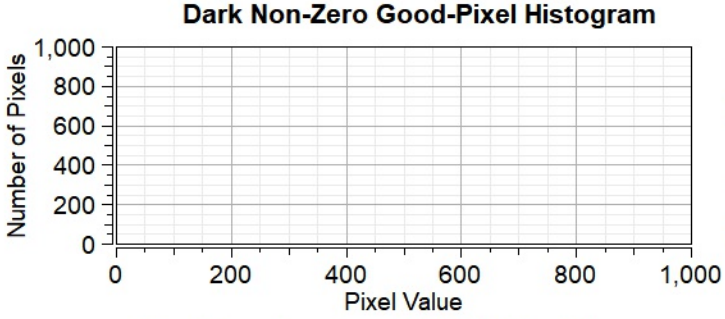
Too few dark images acquired to calculate dark-image noise

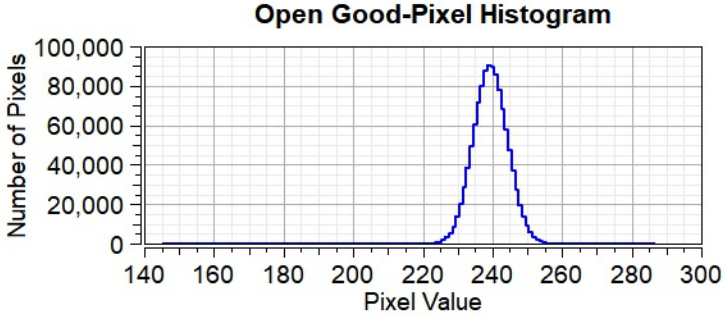


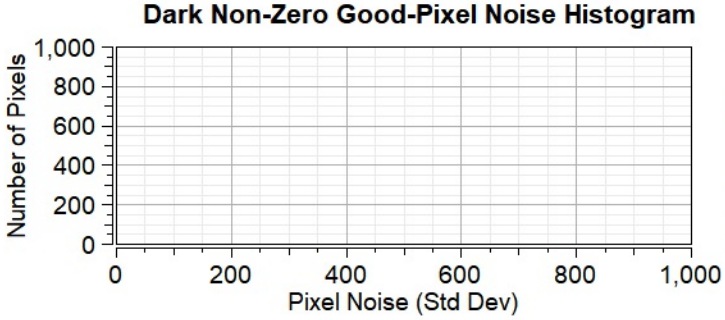


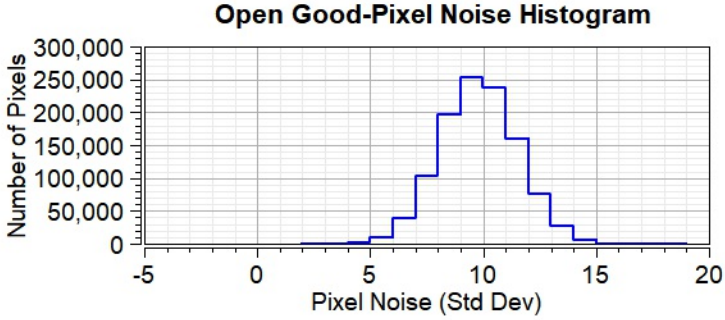








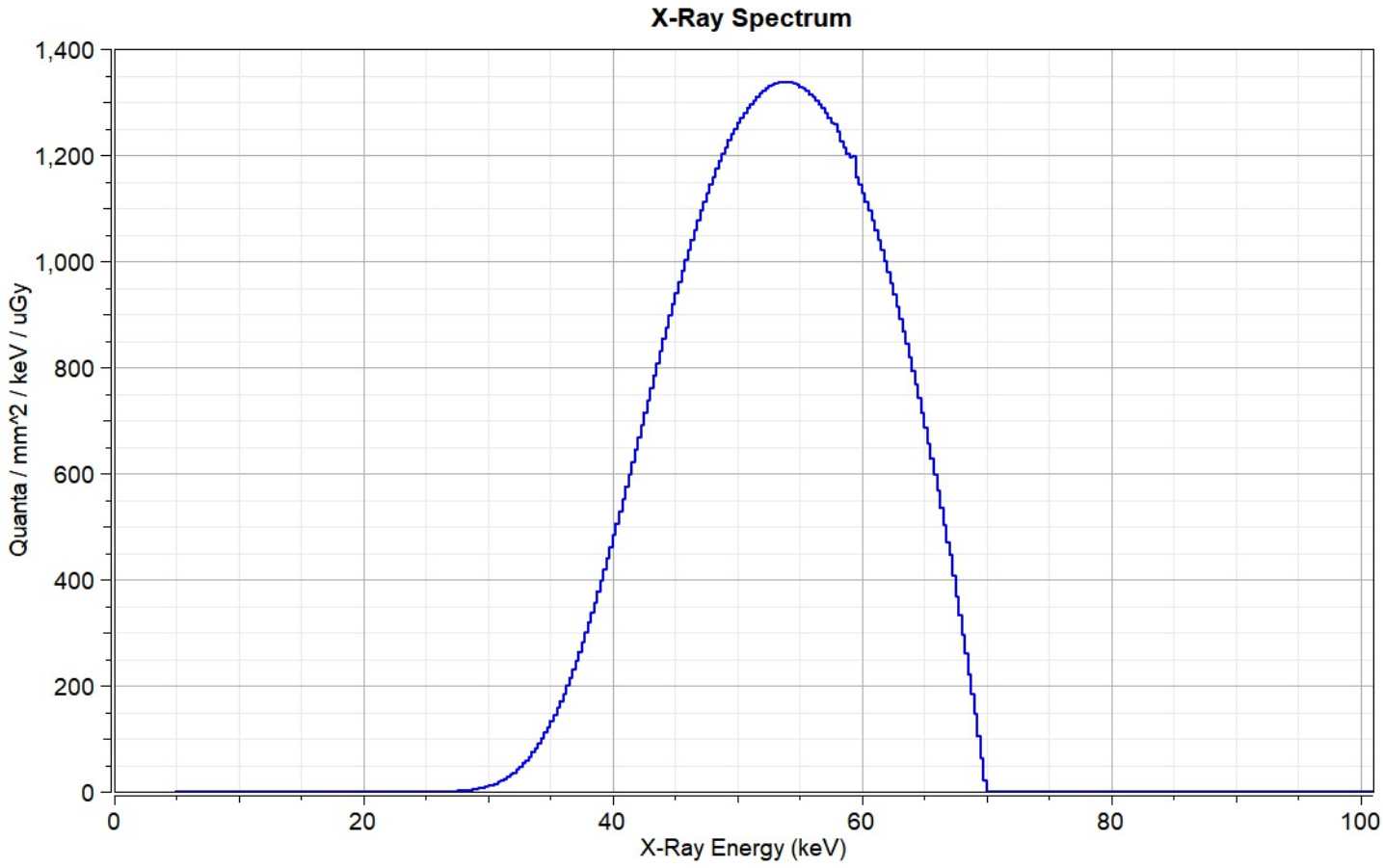




X-Ray Spectrum Report

DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

X-ray spectrum: Radiography, RQA-5 (70 kV)
Target material: W
Set kV: 74
Set mAs: 1.25
Half-value layer: 7.1 mmAl
Mean photon energy: 53.1 keV
Spectrum Q_o: 30.2 q/mm^2/nGy



Message Summary Report

DQEPro 4.7.0-rc7 00000000
DQE Instruments
Study: Mon 03 Dec 2018 19:07:08
Analysis: Mon 03 Dec 2018 19:07:22

Study comment: Sample study
DQEPro acquistion version: 4.3.4-rc1, Mac64 10.8 (Mountainlion) hostname username
DQEPro analysis version: 4.7.0-rc7, Windows-64bit Windows 10 Cunningham-spectre icunning
DQEPro hardware version: 2.3, 000000
DQEPro firmware version: 2.18.5
Grid:
X-ray spectrum: Radiography, RQA-5 (70 kV)
Half-value layer: 7.1 mmAl
Set technique: 74 kV, mA not specified, 1.3 mAs
Air Temperature and Pressure: 21.7 C, 103.8 kPa
Waveform sampling rate: 4.0 kHz
Image-plane exposure, air KERMA: 0.115 mR, 1.01 uGy
Source-image distance: 143.0 cm (DQEPro)
Specified DQEPro-image distance: 1.0 cm
DQEPro-image distance: 1.0 cm (Specified by user)
Angle of DQEPro with respect to image pixel grid: -0.6 degrees
Alignment of DQEPro axes with respect to image axes: Perpendicular
Pixel size from image headers, x y: NA
Pixel size in image plane, x y: 140 140 um (Measured by DQEPro)
System response: Offsetlinear (linearized)
Data Folder: \Users\DQE\data
Image Folder: \Users\DQE\data\images

Warnings:
1: Mean pixel values at 0.4 mAs vary by more than 10%. This may be due to using a low exposure or may indicate an issue with the detector that may compromise accuracy of the reported DQE. Acquiring more images or more slowly, to allow complete detector refresh, may help. Please review the linearity report.

2: Images are linearized using the measured Offsetlinear fit.

3: Images were saved in a non-dicom format. This means we cannot confirm "For Processing" or "Raw" images are used and that only linear post processing has been applied to image data according to NEMA standard XR 27-2012. The user must ensure only linear processing has been used to ensure IEC accuracy in results. In particular, noise-suppresion algorithms and lossy compression may cause unpredictable results and must not be used.

4: The y-direction edge profile appears to span pixel values between 378 and 1032, but should be closer to 0 and 1000. We will rescale the edge profile and continue, but this may indicate imperfect dark-image subtraction or a problem with detector linearity or reproducibility from one exposure to the next. Please review images and ensure all open images have similar pixel values to the unattenuated region of the edge images.

5: The average dark-subtracted open-image pixel value varies by more than 10% relative to the mean. This generally indicates a drift or instability in detector response. We will continue, but NPS and DQE results may be inaccurate. Please review images and check for a problem with detector performance. One common reason for this condition is incomplete resetting of detector readout electronics or excessive phosphor lag. Try increasing delay time between exposures.