thermoscientific

Talos Arctica G2

System Acceptance Test

PN 106681

Revision D • 7-Sep-18

ThermoFisher SCIENTIFIC

Contents

1 Introduction

As integral part of the delivery and install of a Talos Arctica G2 system, Thermo Fisher Scientific engineers perform a set of tests (together called the System Acceptance Test or SAT) to verify and prove that the Talos Arctica G2 system has been installed successfully. After passing the SAT, the installation phase can be closed and the system can be handed over to the customer.

1.1 Archiving procedure

All SAT test results must be archived in a service folder on the Talos Arctica G2 PC. Every test should have its own sub-folder with corresponding test number. Images must be stored as recorded. All computed test result(s) must be archived in a text file and stored in the corresponding sub-folder.

1.2 System Acceptance Test Certificate

The System Acceptance Test Certificate is available at the end of this document. In total three copies are required: one certificate must be provided to the customer, one to the local Thermo Fisher Scientific organization and one to the Supply Center. After all SAT tests have been performed, a System Acceptance Test Certificate is to be signed both by the customer and by the Thermo Fisher Scientific Service engineer.

Note	**To keep track of the progress, sign each portion of the test as you complete it. This is also useful if the test is interrupted for any reason or if the participants change.**

1.3 Common test conditions

The System Acceptance Test (SAT) is performed at the maximum high tension of the Talos Arctica G2.

All system acceptance tests are to be performed when the room and system temperature as well as holder temperature has been stabilized.

Note	**The system setting for SAT tests is mentioned in appropriate chapter below. These settings are guidelines, no ‘hard’ settings.**

The specifications are being shown only in combination with the ‘dominant’ holder, unless specified otherwise. The dominant holder is the holder which is ranked highest on the list below and part of the system configuration as ordered.

1.4 Specimens required

To carry out these acceptance tests, you need a basic, fully installed system and the following specimen:

Specimen	Used for	Order Code	Supplier
Cross grating (2160 lines/mm)	Information limit, EDS, …	5322 695 14974	Agar S106
Combined test specimen	Cryo/ HRSTEM	4022 264 91361	Agar S142
Platinum Iridium sample	Cryo/ HRSTEM	1000643	Agar S114
Quantifoil R2/2	Transmission loss measurement	4022 268 02148	SPI S173
Polystyren latex gold shadowed	STEM resolution	5322 695 14749	S128B

2 Probe current 1 nm spot

The probe current measurement demonstrates the system does deliver a high current into a small probe, therefore ensuring also a sufficient brightness of the gun.

During this test, the condenser system is set up such that it focuses a high current probe (≥ 1.5 nA) towards the sample plane. The image of the probe at the sample plane is then magnified using the projection system of the microscope, and projected onto the TEM camera.

Because the beam current is large and fully focused towards a small area of the camera, the probe will be scanned in two directions over the camera, and the Full- Width-at-Half-Maximum (FWHM) of the intensity distribution of the image of the probe will be measured. For both directions the measured FWHM must be recorded to be ≤ 1.0 nm.

2.1 Test Conditions

Microscope settings	
High Tension	Maximum
Extraction Voltage	X-FEG: $V_{optimal}$
C1 Aperture	2000 µm (optional)
Mode	Nanoprobe
Gun Lens	4
Spot Size	5
Specimen	None
Magnification	~SA 500kx
C2 Aperture	70 µm
SA and Obj Aperture	Retracted (out of the beam)

2.2 Specifications / Measurements

X-FEG Probe current Specification	**Measured**
Probe current 1nm spot ≥ 1.2 nA	~~1.26~~ XXX1.23 nA

PassedXXXXX **Failed**_____**Waived**_____

11/12/2018 _____**Date Completed**

Jeremy Scott _____**Service Engineer**

_____**Reviewed by Customer**

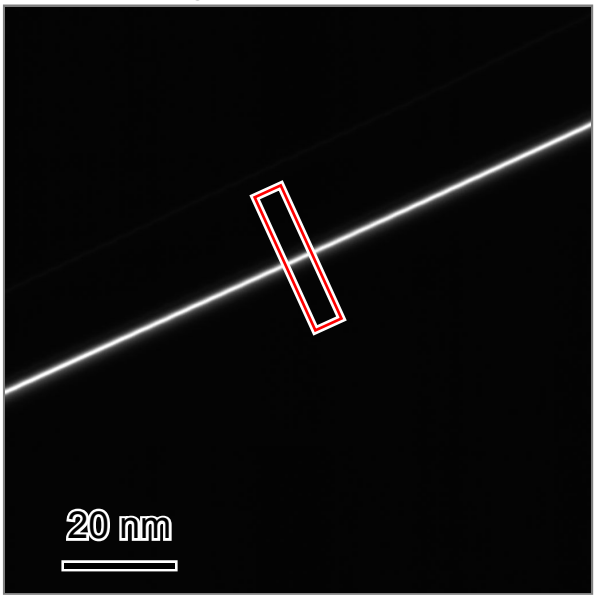
SPOT SIZE AND CURRENT (1 NM)

Measurement performed	11/12/2018
Microscope serial number	9950512
Microscope type	Talos Arctica G2
	Indiana University US
Recorded at magnification	390 kx

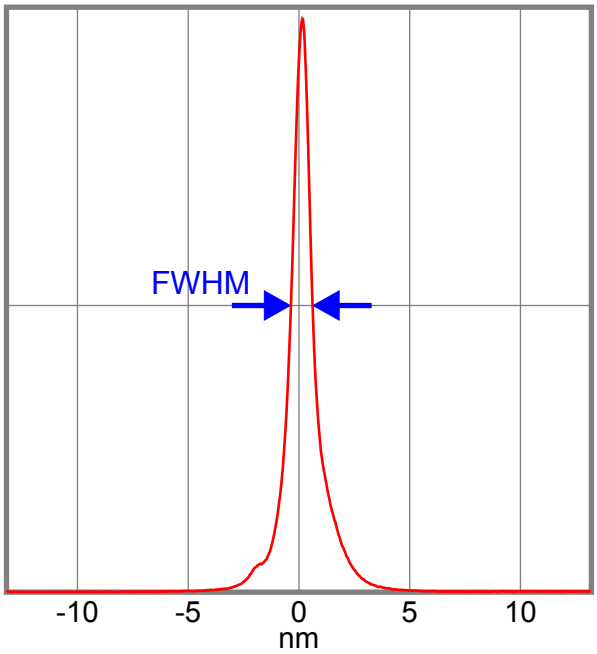
Specification	Beam current 1.2 nA, spot size <1 nm
Measured	Beam current 1.23 nA Condenser aperture 70 um

The probe performance is tested by measuring the spot current with the aid of a Faraday cup and recording the beam shape by scanning the spot over the CCD along two directions.
The scanning is used because the spot is too intense to be recorded on the CCD while stationary.

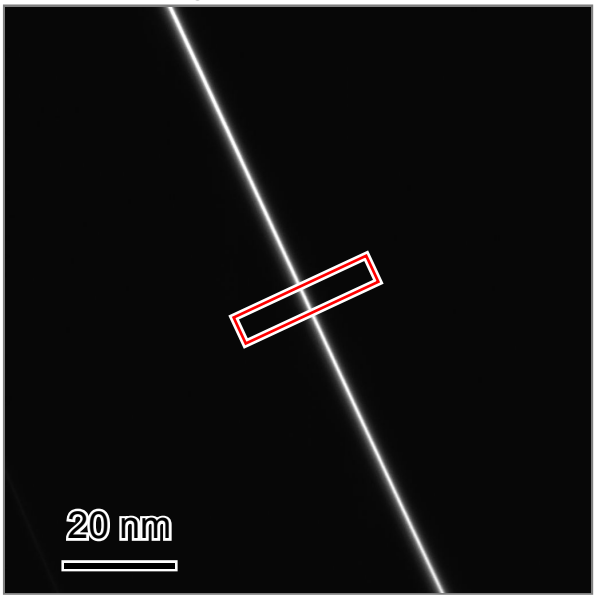
Spot X image



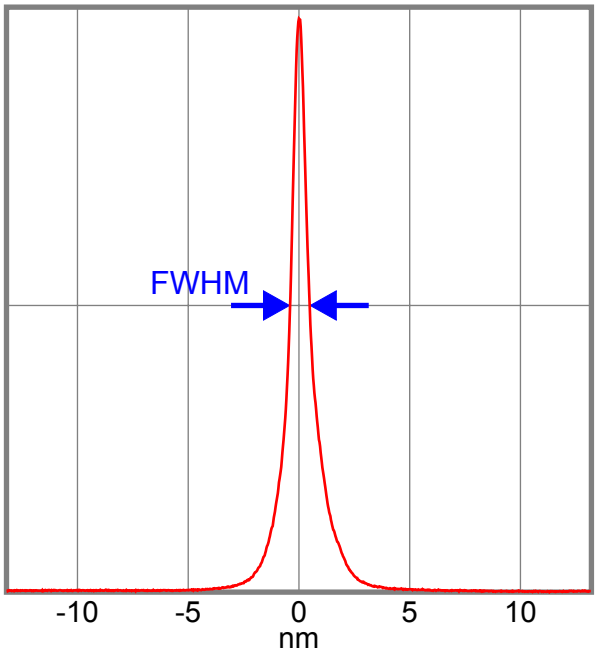
Profile spot X FWHM 0.98 nm



Spot Y image



Profile spot Y FWHM 0.88 nm



3 Information Limit

This test demonstrates the high resolving power of the system in TEM imaging mode.

During this test, a high resolution TEM image of the sample will be recorded on the High resolution TEM camera. A suitable objective lens defocus is applied, in the range of 3 - 4x Scherzer defocus. Next, by wobbling the TEM electron beam over the camera, a destructive interference fringe pattern can be created on top of the TEM sample image. The resulting so-called Youngs fringe pattern does enable to detect the maximum spatial frequency that is being transferred from the sample towards the TEM camera.

After applying the wobble in one direction, the test is repeated with a wobble in the perpendicular direction. In both cases the visibility of the Youngs fringes must meet or exceed the specified Information Limit.

3.1 Test Conditions

Microscope settings	
High Tension	200 kV, for at least 10 hours
Mode	Microprobe - TEM
Extraction voltage	XFEG: $V_{optimal}$
Gun lens	1
C1 aperture	2000 µm (optional)
Specimen	Cross Grating (allow to stabilize for at least 1 hour}
Magnification	Maximum for at least 1 hour
Cooling	Cooled with LN_2 for at least 2 hours.
C2 aperture	100 µm
Spot Size	3

3.2 Specifications / Measurements

Information Limit Specification	Measured
Young's Fringes visible at 0 specimen tilt till: ≤ 0.23 nm	< 0.23 nm
Young's Fringes visible at + 70 ° specimen tilt till: ≤ 0.34 nm	< 0.34 nm
Young's Fringes visible at - 70 ° specimen tilt till: ≤ 0.34 nm	< 0.34 nm

Passed XXXXX **Failed**_____ **Waived**_____

11/12/2018 **Date Completed**

Jeremy Scott **Service Engineer**

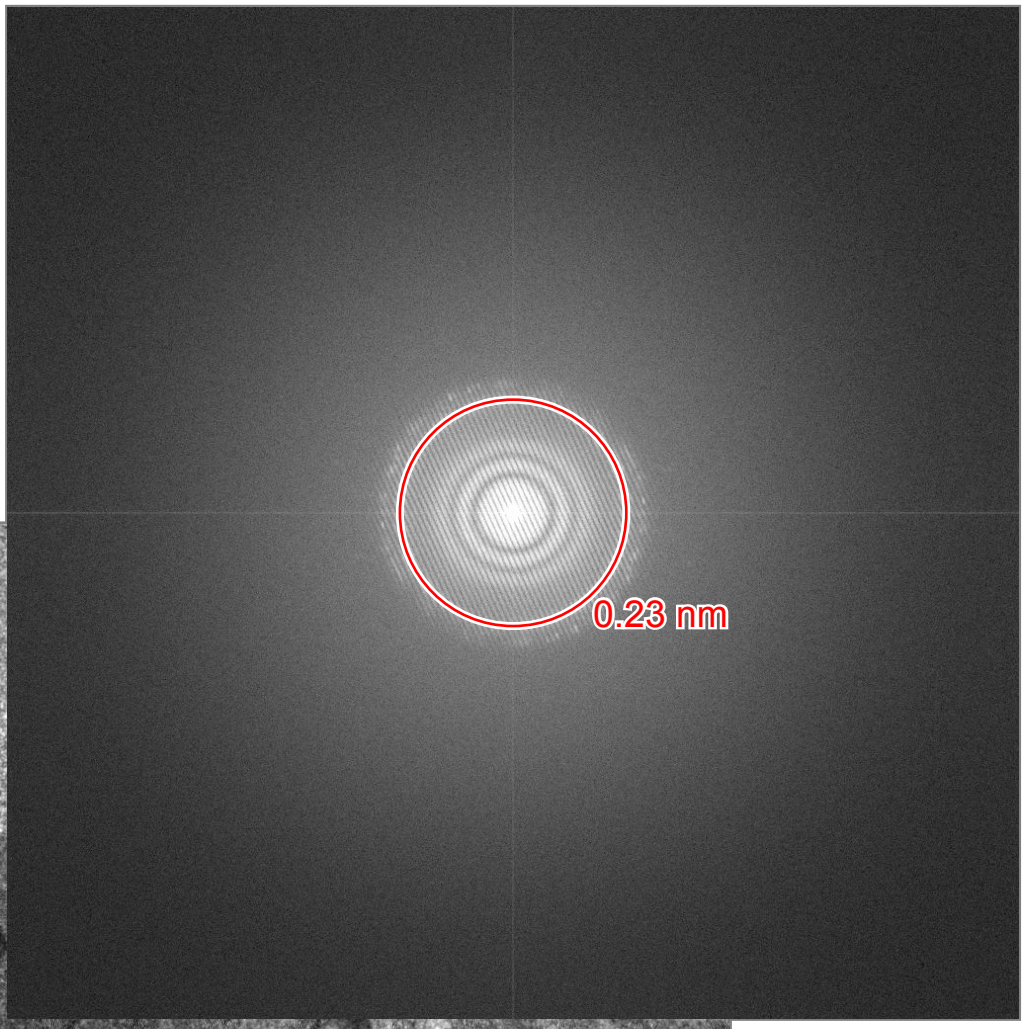
_____ **Reviewed by Customer**

INFORMATION LIMIT @ 0° TILT

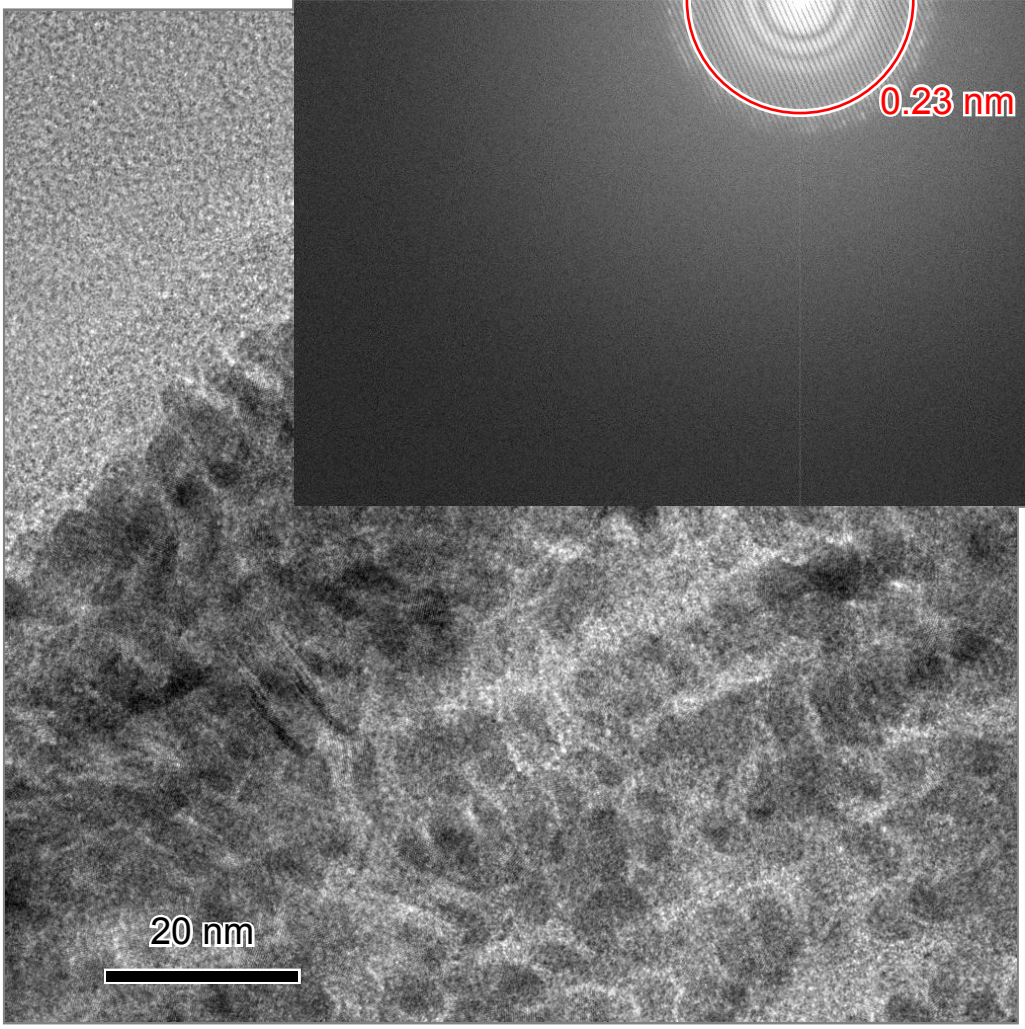
Measurement performed	11/9/2018		
Microscope serial number	9950512		
Microscope type	Talos Arctica G2		
	Indiana University US		
Recorded at magnification	390 kx	Camera used	BM-Ceta

The information limit is a measure of the highest frequency that is transferred through the optical system.
During exposure of the CCD the image is shifted ~2nm to produce Young's fringes in the FFT.
The extent of the fringes is a measure of the information limit.

Diffractogram



Original image

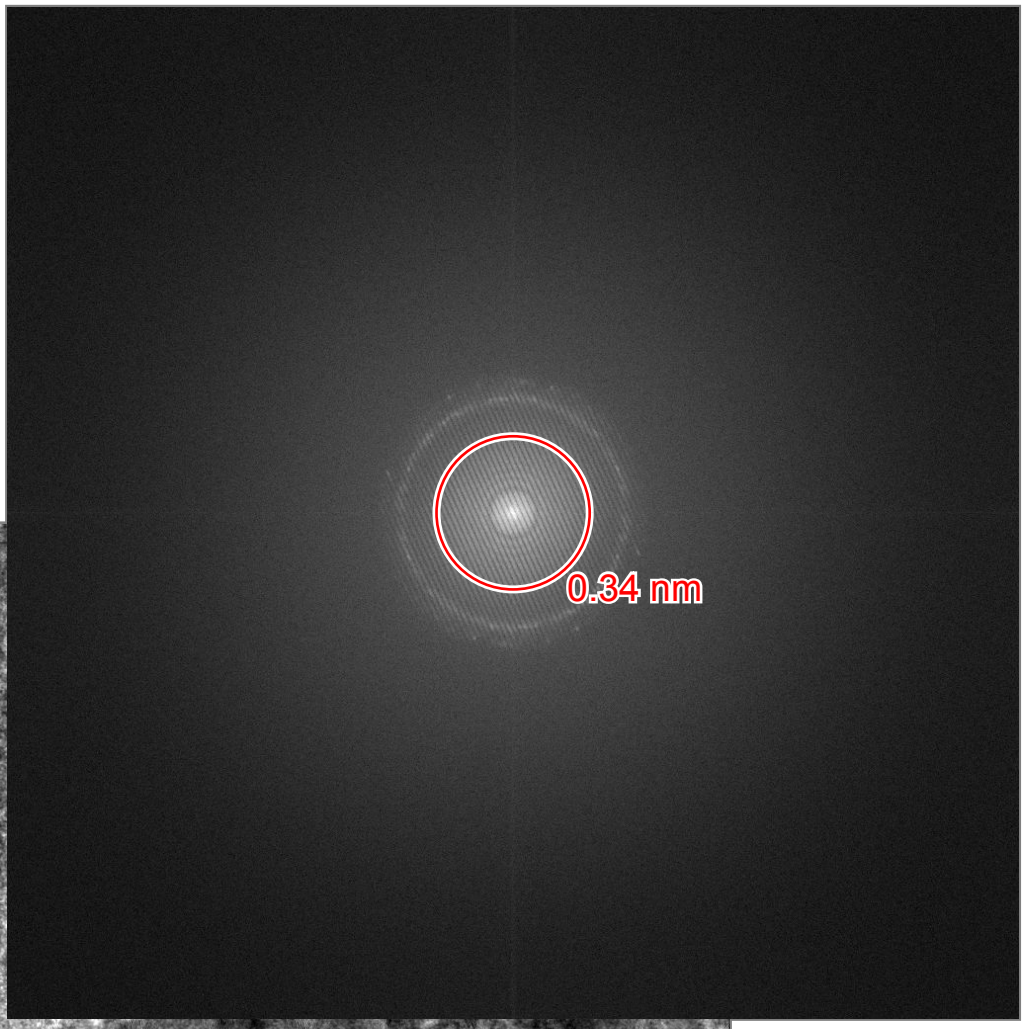


INFORMATION LIMIT @ 70° TILT

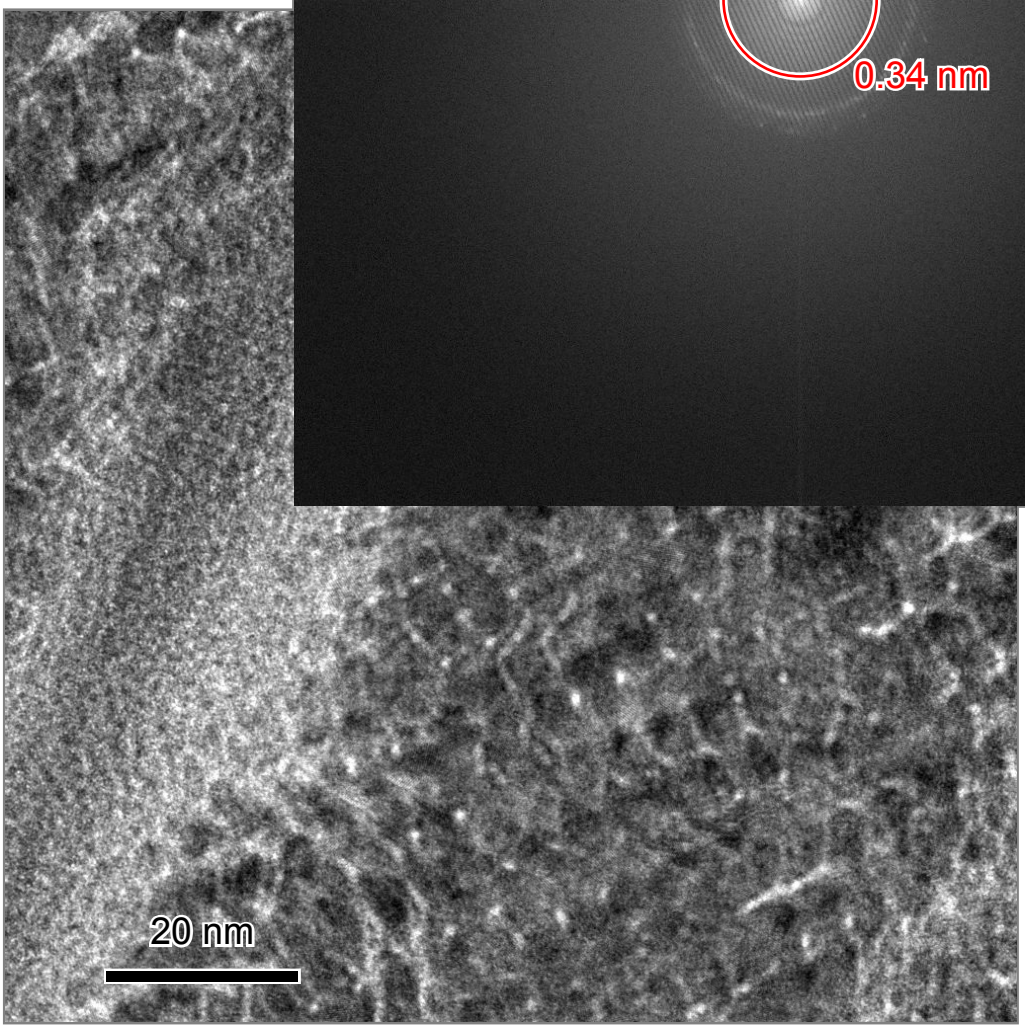
Measurement performed	11/9/2018		
Microscope serial number	9950512		
Microscope type	Talos Arctica G2		
	Indiana University US		
Recorded at magnification	390 kx	Camera used	BM-Ceta
Stage alpha	70°		

The information limit is a measure of the highest frequency that is transferred through the optical system.
During exposure of the CCD the image is shifted ~2nm to produce Young's fringes in the FFT.
The extent of the fringes is a measure of the information limit.

Diffractogram



Original image

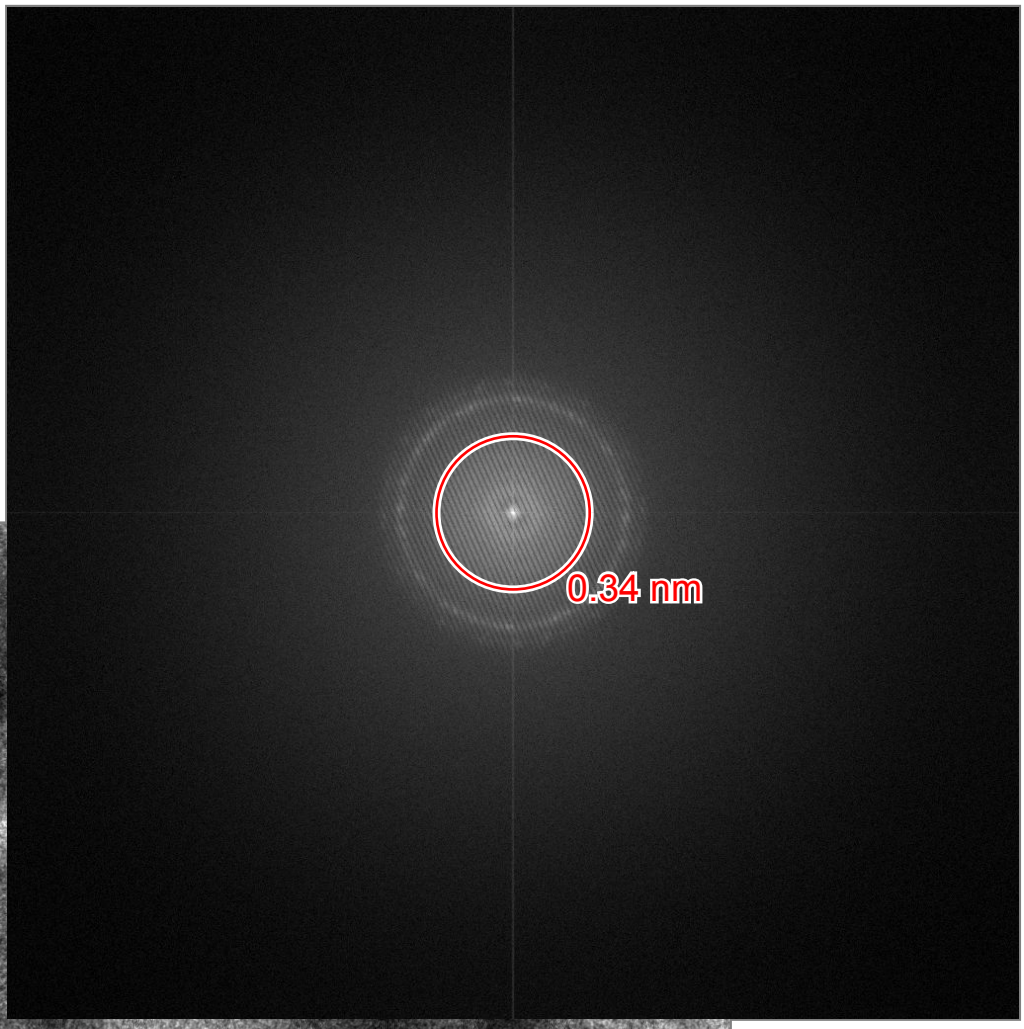


INFORMATION LIMIT @ -70° TILT

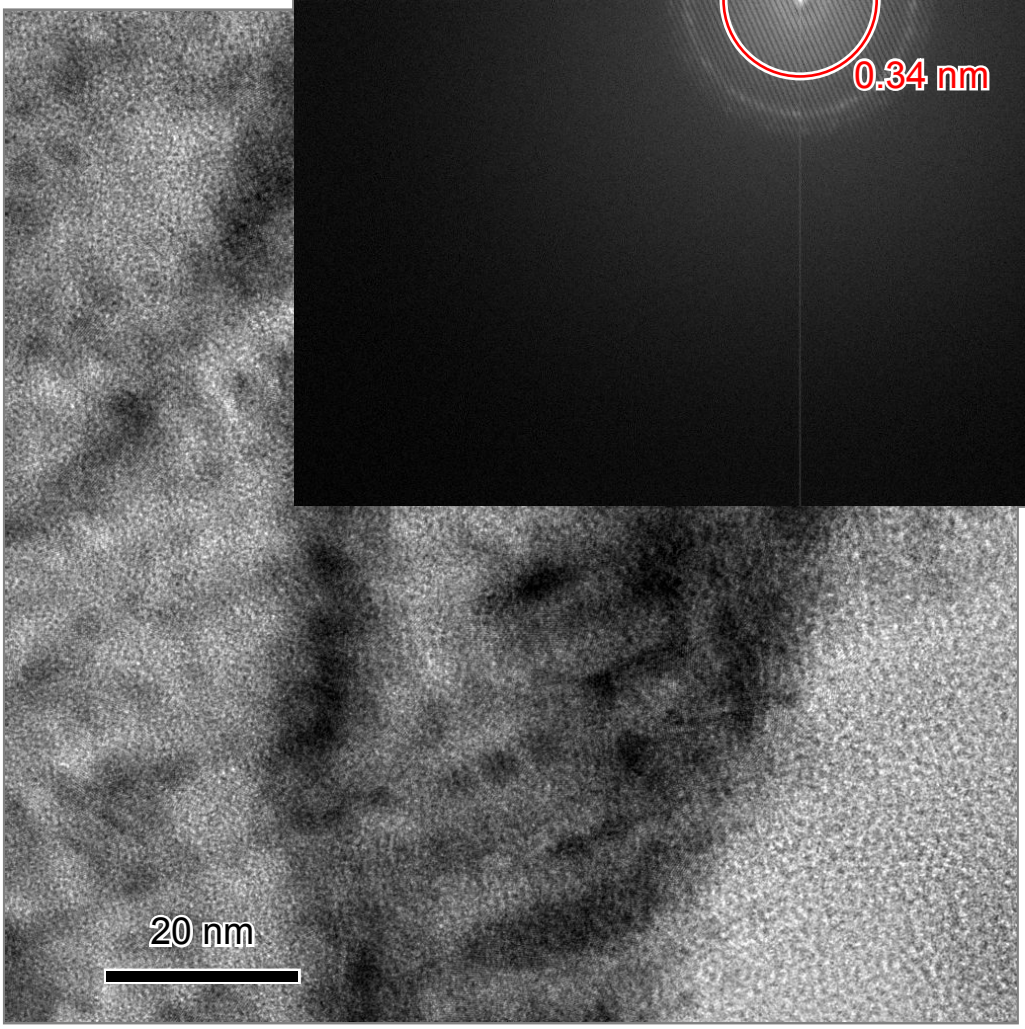
Measurement performed	11/9/2018		
Microscope serial number	9950512		
Microscope type	Talos Arctica G2		
	Indiana University US		
Recorded at magnification	390 kx	Camera used	BM-Ceta
Stage alpha	-70°		

The information limit is a measure of the highest frequency that is transferred through the optical system.
During exposure of the CCD the image is shifted ~2nm to produce Young's fringes in the FFT.
The extent of the fringes is a measure of the information limit.

Diffractogram



Original image



4 Contrast at high defocus (Thon rings)

Thon rings demonstrate the transfer of contrast by the microscope using the parallel illumination at the defocus value that is commonly used for single particle data acquisition.

4.1 Test Conditions

This test will be skipped if no CCD or laser bench is available.

Microscope Settings	
High Tension	Highest HT possible, for at least 1 hour
Mode	μprobe
Extraction Voltage	4 kV
Gun Lens	5
C1 Aperture	2 mm (if present)
Specimen	Ptlr, pre-cooled
Cooling	Cooled down for at least 1 hour
Magnification	200k x for at least 1 hour
C2 Aperture	100 μm
Spot size	1, centered and stigmated
Defocus	- 2 μm
Exposure time	≤ 5 sec.

4.2 Specifications / Measurements

Follow the detailed instruction in the Installation Manual.

Specification	Measured
Thon rings visible beyond a spatial frequency of 2.7 nm^{-1} (corresponding to 0.37 nm resolution) in the rotationally averaged power spectrum of an image of a PtIr specimen at - 2 μm defocus.	< 0.37 Thon rings

PassedXXXXX **Failed**_____**Waived**_____

11/13/2018 **Date Completed**

Jeremy Scott **Service Engineer**

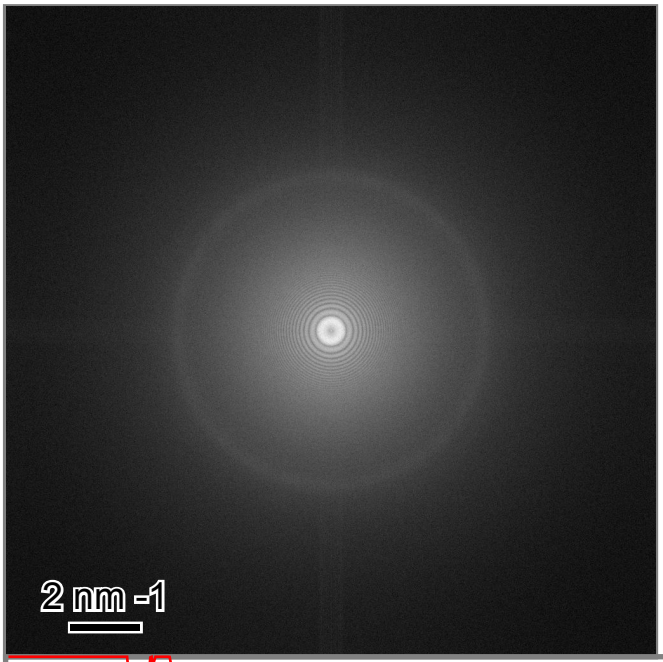
_____**Reviewed by Customer**

THON RINGS

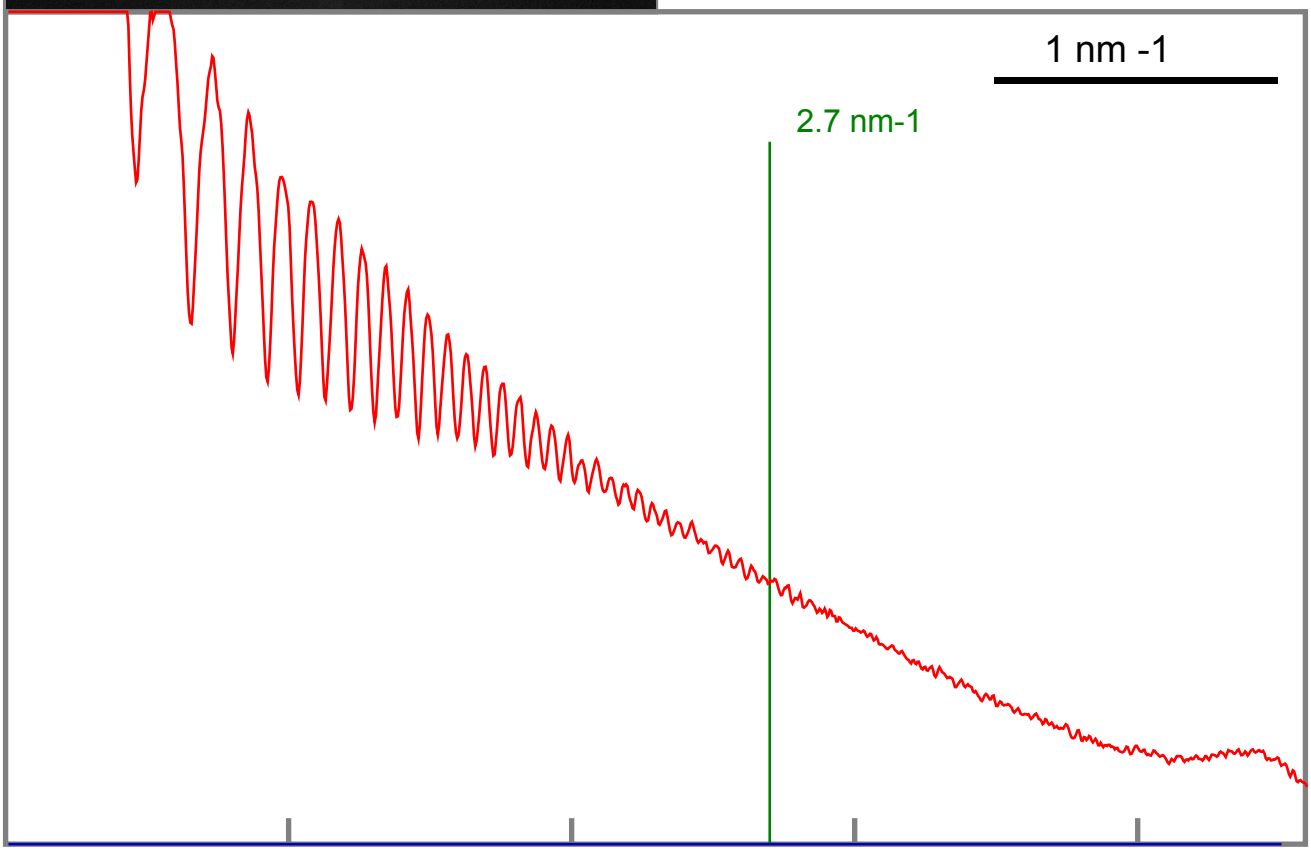
Measurement performed	11/12/2018		
Microscope serial number	9950512		
Microscope type	Talos Arctica G2		
	Indiana University US		
Recorded at magnification	190 kx	Camera used	BM-Ceta
Defocus	-2.00 um		

The Thon ring profile is calculated from the FFT of a high-resolution image.
The profile itself is a radial average of one quadrant.
The difference profile is the subtraction of the radial averages of two adjacent quadrants. A significant difference profile is an indication of too much astigmatism or coma in the image.

Specification: Thon rings visible in rotationally averaged power spectrum beyond 2.7 nm-1 (corresponding to 0.37 nm resolution).



Thon ring FFT



5 Drift after Specimen Exchange

The drift after transfer measurement (5 minute running average) is performed immediately after specimen exchange. It demonstrates the behavior under normal use conditions.

The drift values correspond to typical use-case requirements for:

1. Creating a low magnification grid overview.
2. Defining target areas for acquisition.
3. Starting tomography.
4. Starting single particle data acquisition.

5.1 Test Conditions

This test will be skipped if no CCD or laser bench is available.

Microscope Settings	
High Tension	Highest HT possible, for at least 12 hours
LN_2 Cooling	Cooled down for at least 2 hours
C2 aperture	100 μm
Magnification	SA (max. 200k x), at least 40 minutes in this setting
Specimen	Gold on carbon, Graphitized carbon or MEMS chip with gold (1072676) if you have NanoEx-i/v holder, inserted for at least 2 hours
Magnification	Maximum for at least 1 hour

5.2 Specifications / Measurements

Specification	Measured
Maximum Drift values after:	
5 min: 1.2 nm/s (Grid Atlas)	0.076 nm/s
15 min: 0.45 nm/s (Target Areas)	0.042 nm/s
30 min: 0.25 nm/s (Start Tomo)	0.029 nm/s
60 min: 0.035 nm/s (Start EPU)	0.007 nm/s

Passed XXXXX **Failed**_____**Waived**_____

11/13/2018 **Date Completed**

Jeremy Scott **Service Engineer**

_____**Reviewed by Customer**

DRIFT AFTER TRANSFER

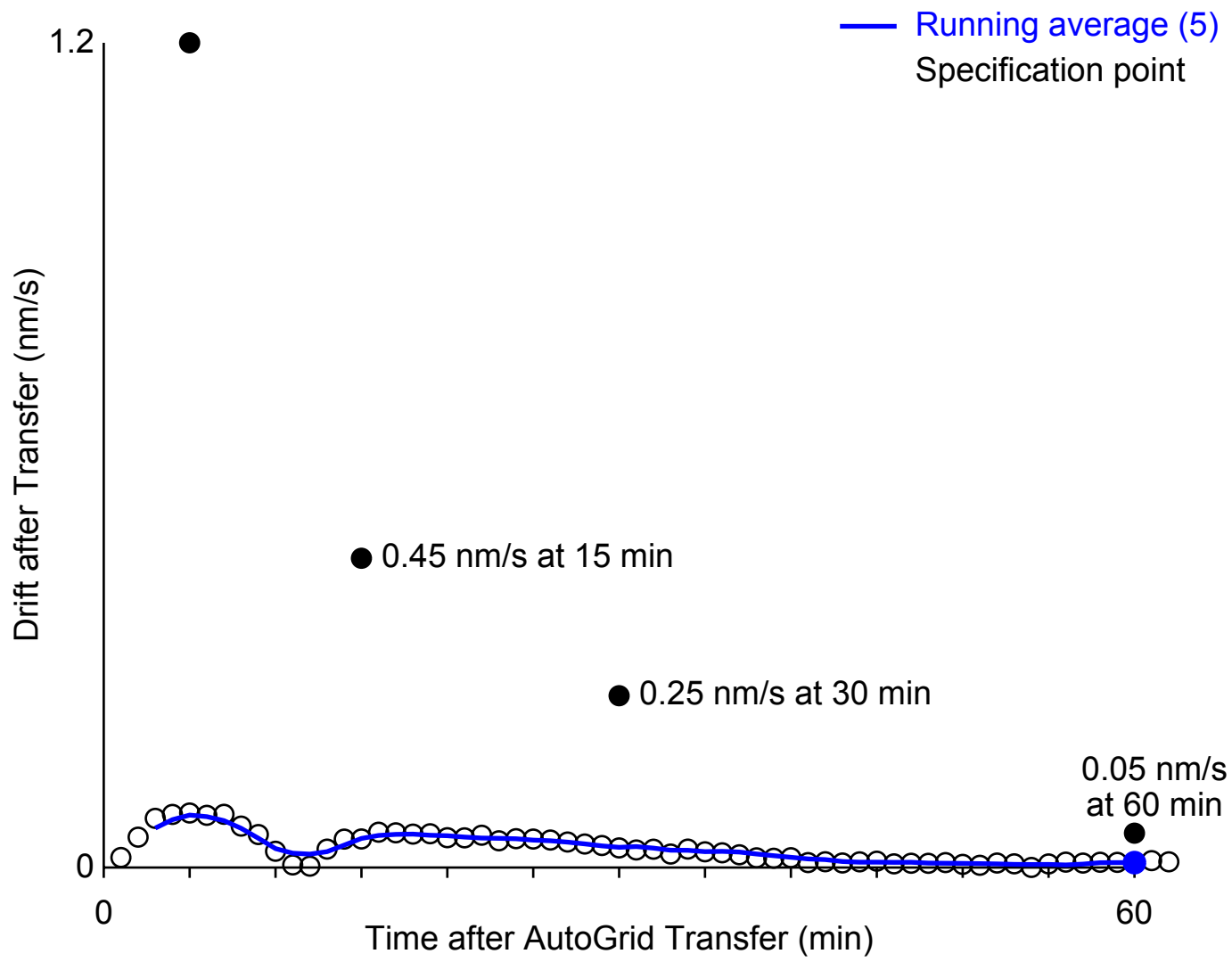
Measurement performed	11/13/2018
Microscope serial number	9950512
Microscope type	Talos Arctica G2
	Indiana University US
Recorded at magnification	150 kx

Drift is measured during an hour (plus 2 minutes), starting immediately after the transfer of an AutoGrid into the column. The running average using 5 datapoints of the measured data should lie below the four specified values:

- 1.2 nm/s after 5 minutes (sufficient for the creation of a low magnification grid overview)
- 0.45 nm/s after 15 minutes (sufficient for setting up batch tomography acquisition)
- 0.25 nm/s after 30 minutes (sufficient for starting tomography data acquisition)
- 0.05 nm/s after 60 minutes (sufficient for starting single particle data acquisition)

Measurement results

Specification	Measured (running avg 5)	Result
1.2 nm/s at 5 min	0.076 nm/s	Passed
0.45 nm/s at 15 min	0.042 nm/s	Passed
0.25 nm/s at 30 min	0.029 nm/s	Passed
0.05 nm/s at 60 min	0.007 nm/s	Passed



DRIFT AFTER TRANSFER

Measurements

Time after transfer	X	Y	Length	Angle	X cum	Y cum	Len. cum	Ang. cum
01:00	0.76	-0.44	0.88	330	0.76	-0.44	0.88	330
02:00	0.07	2.65	2.65	89	0.82	2.21	2.36	70
03:00	-0.34	4.28	4.29	95	0.48	6.49	6.51	86
04:00	0.35	4.62	4.64	86	0.84	11.12	11.15	86
05:00	0.44	4.74	4.76	85	1.27	15.86	15.91	85
06:00	0.55	4.53	4.56	83	1.82	20.38	20.46	85
07:00	0.51	4.62	4.65	84	2.33	25.00	25.11	85
08:00	0.33	3.60	3.62	85	2.66	28.60	28.73	85
09:00	0.63	2.81	2.88	77	3.28	31.42	31.59	84
10:00	0.45	1.35	1.42	71	3.73	32.76	32.98	83
11:00	0.19	0.12	0.23	32	3.93	32.88	33.12	83
12:00	-0.02	-0.12	0.12	259	3.91	32.77	33.00	83
13:00	-0.17	-1.60	1.61	264	3.74	31.17	31.39	83
14:00	-0.15	-2.48	2.48	266	3.58	28.69	28.91	83
15:00	-0.47	-2.45	2.49	259	3.12	26.24	26.42	83
16:00	-0.38	-3.06	3.08	263	2.73	23.18	23.34	83
17:00	-0.30	-3.02	3.03	264	2.43	20.16	20.31	83
18:00	-0.45	-2.88	2.92	261	1.99	17.28	17.39	83
19:00	-0.41	-2.92	2.95	262	1.57	14.36	14.44	84
20:00	-0.47	-2.56	2.60	260	1.10	11.79	11.85	85
21:00	-0.44	-2.56	2.59	260	0.66	9.24	9.26	86
22:00	-0.55	-2.77	2.82	259	0.12	6.47	6.47	89
23:00	-0.43	-2.30	2.34	259	-0.31	4.18	4.19	94
24:00	-0.40	-2.49	2.52	261	-0.71	1.69	1.83	113
25:00	-0.34	-2.46	2.49	262	-1.04	-0.78	1.30	217
26:00	-0.20	-2.39	2.40	265	-1.24	-3.17	3.40	249
27:00	-0.60	-2.15	2.23	254	-1.84	-5.31	5.63	251
28:00	-0.33	-2.03	2.05	261	-2.17	-7.34	7.66	254
29:00	-0.30	-1.90	1.92	261	-2.48	-9.24	9.57	255
30:00	-0.28	-1.69	1.71	261	-2.76	-10.93	11.27	256
31:00	-0.50	-1.45	1.53	251	-3.26	-12.38	12.80	255
32:00	-0.20	-1.59	1.60	263	-3.46	-13.97	14.39	256
33:00	-0.25	-1.15	1.18	258	-3.71	-15.12	15.57	256
34:00	-0.26	-1.59	1.61	261	-3.96	-16.71	17.18	257
35:00	-0.45	-1.30	1.37	251	-4.42	-18.01	18.54	256
36:00	-0.36	-1.24	1.29	254	-4.77	-19.25	19.83	256
37:00	-0.20	-1.10	1.11	260	-4.97	-20.34	20.94	256
38:00	-0.27	-0.80	0.85	251	-5.24	-21.14	21.79	256
39:00	-0.31	-0.75	0.81	247	-5.56	-21.89	22.59	256
40:00	-0.31	-0.80	0.86	249	-5.87	-22.69	23.44	256
41:00	-0.25	-0.35	0.43	235	-6.11	-23.05	23.85	255
42:00	-0.22	-0.46	0.51	245	-6.33	-23.51	24.34	255
43:00	-0.23	-0.32	0.40	235	-6.56	-23.83	24.72	255
44:00	-0.37	-0.33	0.50	222	-6.93	-24.16	25.14	254
45:00	-0.52	-0.21	0.56	202	-7.44	-24.37	25.48	253

DRIFT AFTER TRANSFER

Measurements, continued (2)

Time after transfer	X	Y	Length	Angle	X cum	Y cum	Len. cum	Ang. cum
46:00	-0.29	-0.14	0.32	205	-7.74	-24.51	25.70	252
47:00	-0.13	-0.35	0.38	249	-7.87	-24.86	26.08	252
48:00	-0.25	-0.28	0.37	228	-8.11	-25.14	26.42	252
49:00	-0.42	-0.10	0.43	194	-8.53	-25.24	26.65	251
50:00	-0.24	-0.14	0.28	211	-8.77	-25.39	26.86	251
51:00	-0.04	0.19	0.20	101	-8.81	-25.19	26.69	251
52:00	-0.32	0.23	0.39	144	-9.13	-24.96	26.58	250
53:00	-0.28	-0.16	0.32	209	-9.41	-25.12	26.82	249
54:00	0.00	-0.01	0.01	257	-9.41	-25.13	26.83	249
55:00	-0.21	0.24	0.32	131	-9.62	-24.89	26.69	249
56:00	-0.31	0.35	0.47	132	-9.94	-24.54	26.47	248
57:00	-0.22	0.32	0.39	124	-10.16	-24.22	26.26	247
58:00	-0.33	0.32	0.46	136	-10.49	-23.90	26.10	246
59:00	-0.23	0.39	0.45	120	-10.72	-23.51	25.83	245
60:00	-0.18	0.34	0.38	118	-10.90	-23.17	25.60	245
61:00	-0.19	0.58	0.60	108	-11.08	-22.59	25.16	244
62:00	-0.30	0.40	0.50	127	-11.38	-22.19	24.94	243

6 Transmission Loss Measurement

Note **This measurement is commonly known as Ice Growth measurement.**

The effect of ice growth is quantified by the decrease of measured intensity of the specimen in the images. The measurements are performed for at least 8 hours and fitted to an exponential model and the result is reported as transmission loss per 24 hr.

6.1 Test Conditions

This test will be skipped if no CCD or laser bench is available.

Microscope Settings	
High Tension	Highest HT possible, for at least 10 hours
Mode	TEM
Extraction voltage	X-FEG: $V_{optimal}$
Gun Lens	3
C1 aperture	30 µm
SA aperture	Removed
Specimen	Quantifoil
Magnification	1 700 x (for Falcon), 1 150 x (other cameras)
Cooling Device	Cooled with LN_2 for at least 2 hours
C2 aperture	100 µm

6.2 Specifications / Measurements

Measure ice contamination rate according to the standard Thermo Fisher Scientific Transmission loss measurement procedure listed in the Installation Manual.

Specification	**Measured**
Transmission loss ≤ 5% per 24 hr	0.02 %

PassedXXXXX **Failed**_____**Waived**_____

11/13/2018 _____**Date Completed**

Jeremy Scott _____**Service Engineer**

_____**Reviewed by Customer**

ICE GROWTH

Measurement performed	11/12/2018
Microscope serial number	9950512
Microscope type	Talos Arctica G2
	Indiana University US
Recorded at magnification	3 kx

Ice growth on the specimen gives rise to an increase in scattering contrast in the microscope, which can be measured quantitatively. We assume that the transmission, defined as the ratio between transmitted and incident electrons, varies over time according to I/I_0 = A exp(-Bt), with I and I_0 the image intensities in areas with and without the specimen present, A representing the initial transmission of the substrate, and B the scattering of the growing ice layer. Note that for a measurement of the time dependence of the transmission exp(-Bt), it does not matter if the substrate already includes an initial ice layer, as this is included in the initial transmission A.
The image intensities are recorded over time (two specimen areas are averaged to reduce noise) and fitted to the model. From the fit parameters, the transmission loss per 24 hr is calculated from the additional ice scattering according to the definition 1 – exp(-24*B) and presented in units % per 24 hours.

Specification : Transmission loss <7% per 24 hr

Reference image

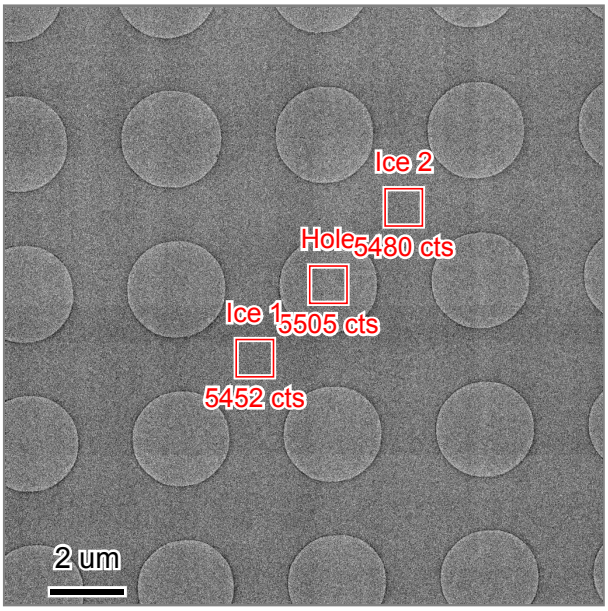
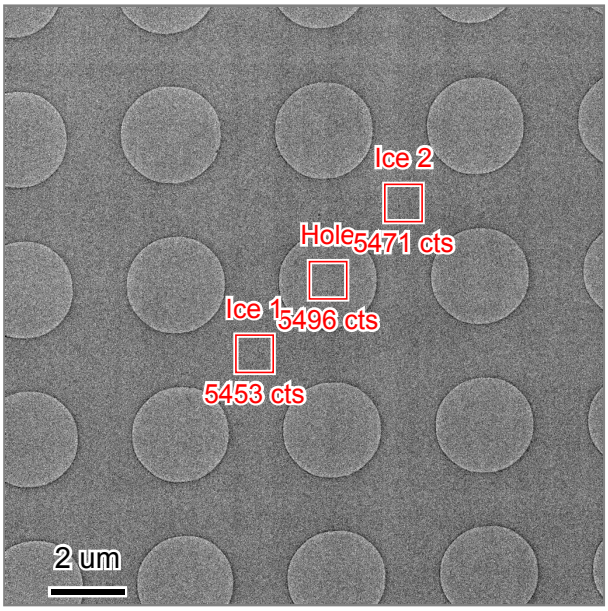
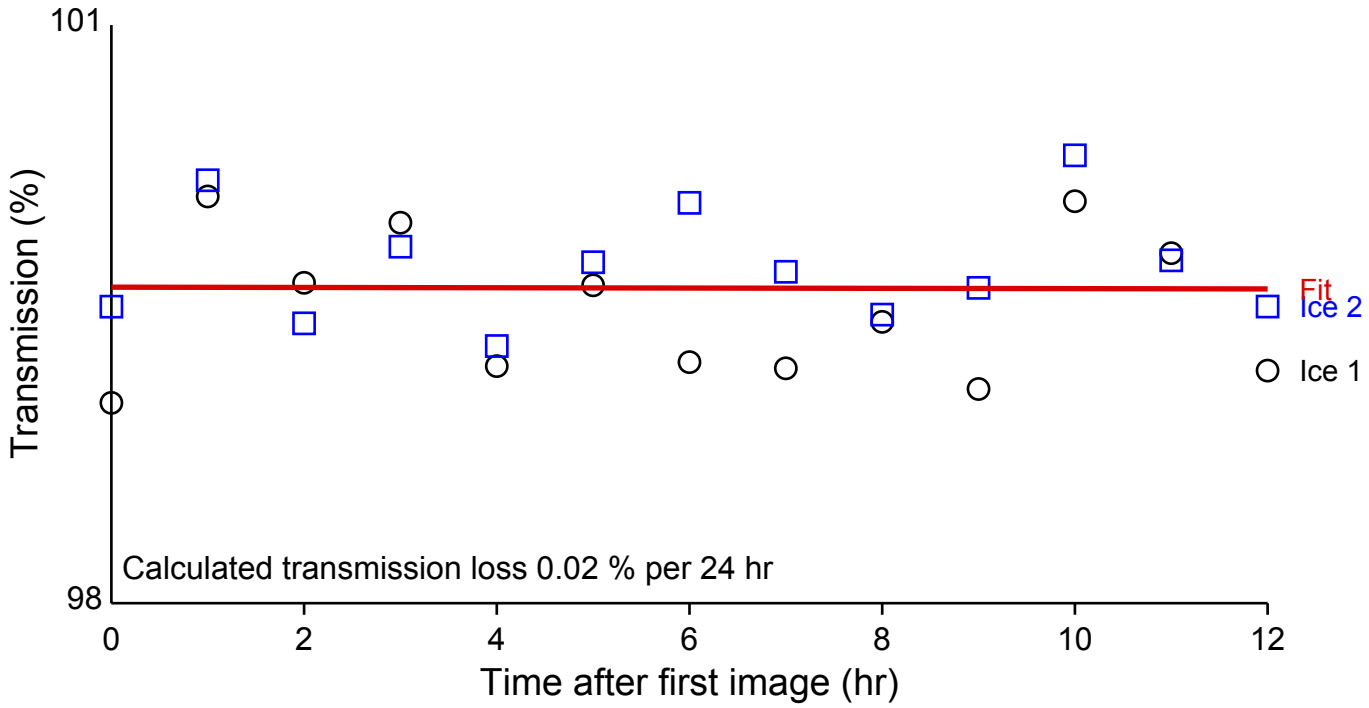


Image 12 @ 12:00 hr:min



Fit Parameters : Initial transmission A = 99.64 % Ice transmission factor B = 0.000008 /hr



ICE GROWTH

Time after first image (hr:min)	Hole average	Ice 1 average	Ice 2 average
00:00	5504.99	5452.12	5479.60
01:00	5464.26	5470.30	5474.89
02:00	5473.12	5454.64	5443.13
03:00	5481.20	5479.79	5472.97
04:00	5506.28	5463.89	5469.63
05:00	5467.89	5448.72	5455.27
06:00	5494.80	5453.63	5499.05
07:00	5487.18	5444.31	5471.79
08:00	5496.67	5466.98	5469.05
09:00	5503.43	5454.54	5483.42
10:00	5427.80	5432.45	5445.38
11:00	5480.58	5470.51	5468.47
12:00	5496.23	5452.64	5470.90

7 Autoloader Performance

7.1 Test Conditions

The Cassette is filled with 6 Autogrids and docked. Next, an inventory is made and each Autogrid is loaded into the Column once.

Tools / Materials:

2 x Capsule

2 x Cassette

12 x Autogrids

Preconditions

- Autoloader and Autofill must be mounted and operational.
- Autoloader must be cooled down.
- Autoloader is initialized.
- Compustage is enabled.
- Slot positions 1 to 12 of the cassettes are alternately filled and empty.

7.2 Specifications / Measurements

1. Test Cassette 1 & 2 in combination with Capsule 1.
2. Test Cassette 1 & 2 in combination with Capsule 2.
3. Perform the following test for every Cassette:
    a. Make sure the Autoloader is cooled down (in all nitrogen state).
    b. Place a Autogrid in every even slot of the Cassette.
    c. Place the Cassette in the Capsule and fill the Capsule with LN2.
    d. Dock the Cassette.
    e. Perform an inventory.
    f. For each Autogrid in the Cassette do a load and unload action once

Specification	All autogrids loaded and unloaded (passed/failed)
Cassette 1 in combination with Capsule 1	Pass
Cassette 2 in combination with Capsule 1	Pass
Cassette 1 in combination with Capsule 2	Pass
Cassette 2 in combination with Capsule 2	Pass

PassedXXXXX **Failed**_____**Waived**_____

11/09/2018 **Date Completed**

Jeremy Scott **Service Engineer**

_____**Reviewed by Customer**

8 Resolution STEM (Option)

8.1 Test Conditions

Microscope settings	
High Tension	200 kV, for at least 24 hours
Cooling	Cooled with LN_2 for at least 2 hours.
Extraction Voltage	XFEG: $V_{optimal}$
Gun Lens	Start with Gun Lens 4; adjust to reach beam current of 30-50 pA
C1 Aperture	2000 µm (Optional)
C2 Aperture	70 µm
Spot Size	9
Specimen	Cross grating
Camera length	HAADF: ~200 mm or * BF/DF: ~200 mm (or less)
Magnification	1 Mx
Scan frame	512X512
Dwell time	29 µs
Scan Synchronization	external

*depending on the system configuration use the HAADF or the Thermo Scientific On-Axis BF/DF, DF4 detector

8.2 Specifications / Measurements

1. Use a clean (preferably a new) sample of cross grating.
2. Align the image corrector (i.e. find the optical axis) by minimizing the aberrations. Make sure that the aberrations are in the same order of magnitude as listed in the service and application Image corrector documents.
3. Make a screen dump of the result window of the CEOS software showing an image of the final Phase plate and the aberration values (no spec!).
4. The image corrector performance can be shown by acquiring an information limit at focus. Due to the low Cs value (few micron), the delta underfocus is not needed anymore to obtain minimized dampening of the CTF envelope function. The information limit in focus shows that the Cs component is minimized and thus there is no “focus ring” visible in the FFT, and point resolution = Information Limit.

8.2.1 SAT Procedure

1. For a properly aligned system, press Eucentric Focus and adjust z-height until specimen is in focus (this should be close to the eucentric height of the Compustage).
2. Look for the highest concentration of gold (normally one can look around the sample to find the highest concentration, for example in a corner of a square).
3. Make sure there is no contamination.

Note	**Contamination can be detected by moving the sample slightly, a dark circle in the shape of the C2 aperture will be visible. You will need either a clean sample or you will have to plasma-clean the Column.**

4. Fine tune the High resolution image with focus and stigmation (use for fine tuning the stigmator OCX). In contrast to non-image corrected systems, make sure that focus is exactly “in focus” seen on the real image of DM/TIA.

5. Setup the image shift to get the Youngs fringes:
   a. open the image shift ocx and select in X or Y direction an image shift setting of about 0.00012 micron. Using this method, one has to switch in the ocx from position “0 shift” to “shift” when the exposure is half way. (In DM the blue bar indicates the exposure timing). Or acquire 2 shifted images and subtract these using the acquisition software.
   b. Alternatively, one can switch on the image wobble, using “Microscope test” OCX, selecting “Info limit”. This generates continues Young fringes in the image.
   c. For wobbling with Image Corrector: use the tab ‘Wobbling’ in the Image Corrector UI. Follow instructions in the Corrector UI (to be found in the tab). Use ISh in the Internal Single Channels tab. ii. Use frequency 1Hz, Amplitude 1 bit 0.
   d. For all methods, the amount of image shift will determine the width of the Young fringes.

Note	**Make sure that the specimen is not drifting (i.e. specimen drift should not be the limiting factor!).**

6. Make sure the camera is cooled and is stable at the setpoint for at least 30 minutes. For Ceta camera check in Microscope Software Launcher > Camera and Detector > Ceta Service Tool.
7. Make sure new gain references are created.
8. Acquire the image using the camera settings given below and try to get about 20000 counts/pixel or more:

Camera	**Magnification** **Flu-screen down/up**	**Settings**	**Acquisition time (sec.)**
Ceta	Pixel size should be at least a factor 4 smaller than the desired info limit result. E.g. 0.0143 nm pixel size at 0.07 nm info limit (Mh range)	Sampling: 2, Read-out area: “full”, Frames summed: 1, Bias/gain corr.: Bias/Gain, Readout mode: High Quality	more than 20.000 counts average (go to spot 2 if needed)/ 1 - 2 sec

9. Check the magnification calibration by measuring the diameter(!) of the first diffraction ring of the gold particles. This diameter should correspond to a real space distance of 0.117 nm. (Please note that this corresponds to the 0.234 nm gold spacing – since the diameter is measured you have to take half of this value.) Calculate 1/x of the measured 1/nm value.

Specification	**Measured**
Maximum Resolution ≤ 0.14 nm	_____ nm

Passed_____ Failed_____Waived_____

_____Date Completed

_____Service Engineer

_____Reviewed by Customer

9 Tomography TEM/STEM 4.x (Optional)

During these tests, the system behavior is characterized while using automated and semi-automated tilt-and-shift schemes. During this procedure, calibration parameters (such as focus calibrations) are being set in software, and also the stage recall accuracy and eucentric-tilt axis position are being determined. Eucentric performance is also logged in the specification table below.

9.1 Test Conditions

Two Tomography options are available: Tomography TEM and Tomography STEM. STEM Tomography can only be part of the microscope configuration in addition to the TEM Tomography. As the TEM Tomography procedure should be performed first and the same holder is used, the STEM holder calibration curves will not significantly differ from the ones obtained during the TEM acceptance procedure. Therefore the procedure below describes the acceptance test for TEM tomography and the functional test for the additional STEM tomography option.

9.1.1 Tomography TEM

Microscope Settings	
High Tension	Highest HT, for at least 4 hours
Extraction Voltage	$V_{optimal}$
Mode	TEM
Gun Lens	3
Spot Size	8 (can change later)
C1 Aperture	Largest
C2 Aperture	100 μm
Objective Aperture	The biggest in SA, retracted in LM
Magnification	Depends on the used camera
Specimen Holder	Tomography Holder
Specimen	Combined test specimen S142
Compustage	Centered (Alpha tilt "0" adjusted to symmetrical Field of View)

9.1.2 Tomography STEM

Microscope Settings	
High Tension	Highest HT, for at least 4 hours
Extraction Voltage	$V_{optimal}$
Mode	STEM
Gun Lens	7
Spot Size	8
C1 Aperture	The biggest
C2 Aperture	C2 that cuts the white ring on Ronchigram
Objective Aperture	Retracted
Convergence Angle	10 mrad in nP STEM
Large Screen Current	45 - 65 pA (or higher)
Camera Length	Depends on the used detector and the STEM mode (e.g. 180 mm HAADF for HR-STEM)
Specimen Holder	Tomography Holder
Specimen	Combined test specimen S142
Compustage	Centered (Alpha tilt "0" adjusted to symmetrical Field of View)

9.2 Specifications / Measurements

In general, the TEM tomography acceptance test procedure consists of the following steps:

- Preparations (this step includes mode dependent settings, acquisition and optics settings, image shift calibration and filter settings).
- Calibrations (this step includes autofunctions, Holder calibration including evaluation of 3 holder measurements, and Tomography-specific calibrations)
- Tilt series (acquisition of a simple tilt series to test the connection with the On-fly-reconstruction PC).

As for the STEM Tomography option, the assumption is that the TEM acceptance procedure is performed first and the same specimen holder is used. Therefore, the STEM holder calibration curves will not significantly differ from the ones obtained in TEM Tomography. Still, a test to show correct functioning of STEM tomography shall be performed. The content of the test is following:

- Preparations (this step includes mode dependent settings, acquisition and optics settings, image shift calibration and filter settings).
- Calibrations (this step includes autofunctions, one holder calibration and Tomography-specific calibrations)

Note **Refer to the installation manual for more detailed procedures**

Specification	**Measured**
Reproducibility X ≤ 0.4 µm, during alpha tilt from +70° to -70°	_____ µm
Reproducibility Y ≤ 0.4 µm, during alpha tilt from +70° to -70°	_____ µm
Eucentricity X ≤ 2 µm, during alpha tilt from +70° to -70°	_____ µm
Eucentricity Y ≤ 2 µm, during alpha tilt from +70° to -70°	_____ µm
Eucentricity defocus ≤ 4 µm during alpha tilt from +70° to -70°	_____ µm

Passed_____ **Failed**_____**Waived**_____

_____**Date Completed**

_____**Service Engineer**

_____**Reviewed by Customer**

10 EPU

10.1 Test Conditions

Microscope Settings	
High Tension	Highest HT possible, for at least 4 hours
Extraction voltage	X-FEG: $V_{optimal}$
Mode	TEM
Gun Lens	3
Spot size	5 (can change later)
C1 aperture	The biggest
C2 aperture	50 µm or bigger
Objective aperture	70 µm or bigger
Magnification	LM and SA range
Specimen	Quantifoil R2/2

10.2 Specifications / Measurements

The EPU acceptance procedure consists of the two preparation steps:

- General Acquisition and Optics Settings
- Image Shift Calibration

and four acceptance sub-tests:

- Grid Atlas (an overview of the sample acquired at low magnification)
- Grid Square Centering (centering of a selected grid square)
- Foil Hole Selection (localization of a selected foil hole)
- Data Acquisition (acquisition and inspection of a set of images of five selected holes)

Specification	Measured
Shift between tile edges < grid bar thickness of the Quantifoil R2/2 specimen	1/2 bar thickness

Specification	Measured
Click on grid square in Atlas should result in grid square image, centered within 20 % of its size.	Pass

Specification	Measured
Click on recognizable foil hole in grid square image should result in image with that foil hole closest to the center.	Pass

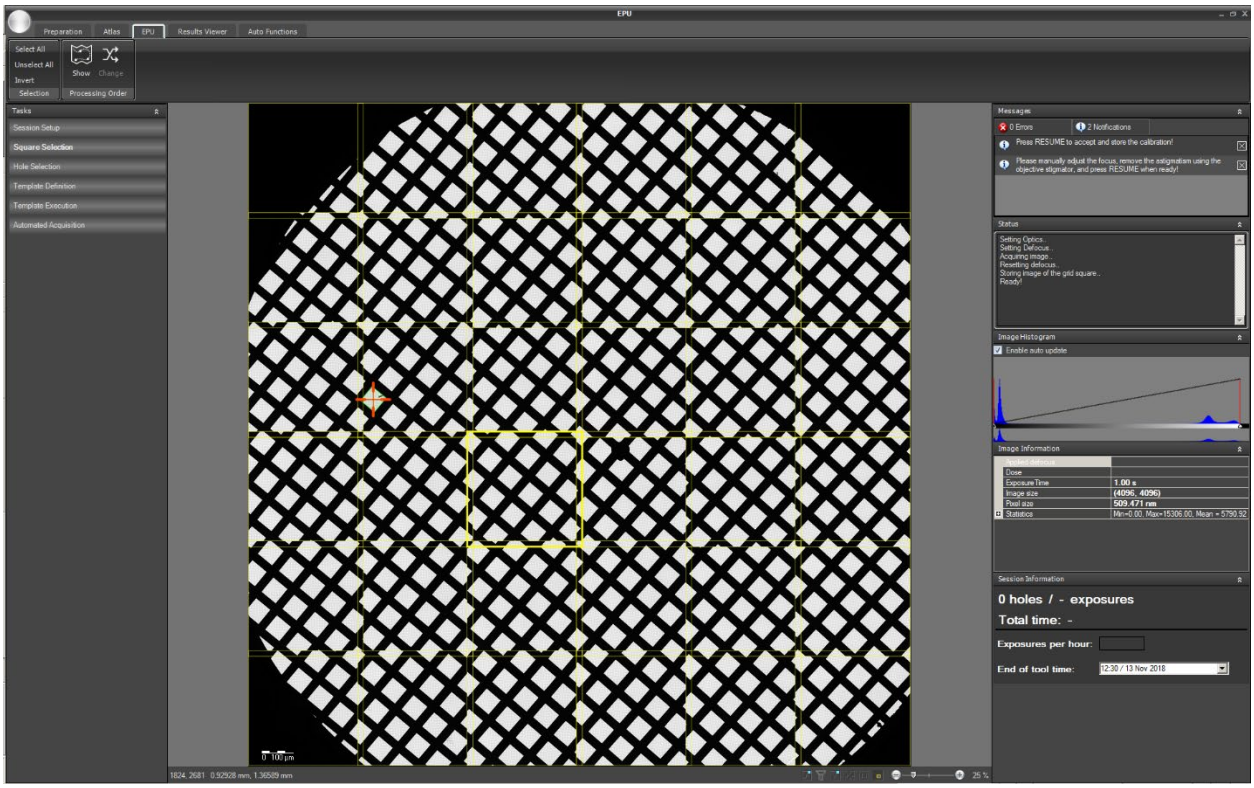
Specification	Measured
Data set of 15 images inspected with Results viewer should show images in accordance with the acquisition template (i.e. three images containing a part of the hole and one image of the amorphous carbon per one hole) and those areas should be in the same position and orientation for all five selected holes.	Pass

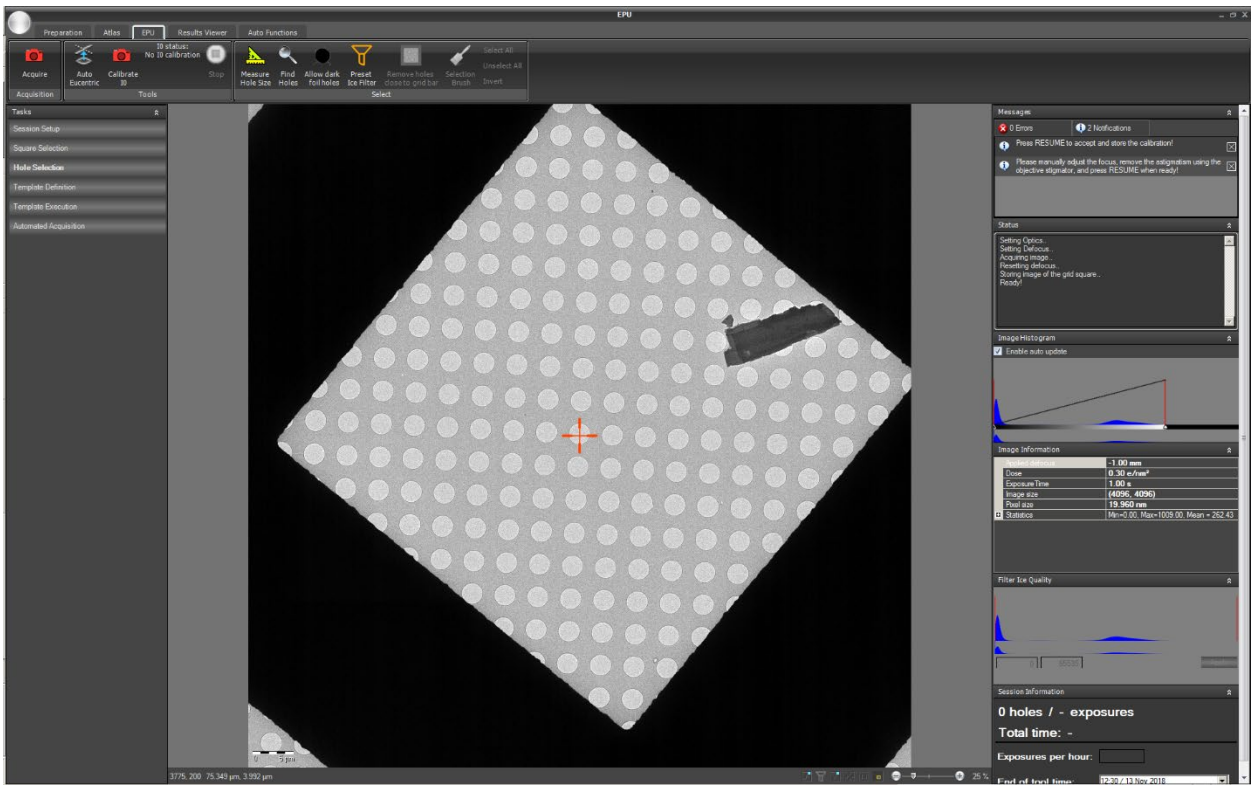
Passed XXXXX **Failed**_____ **Waived**_____

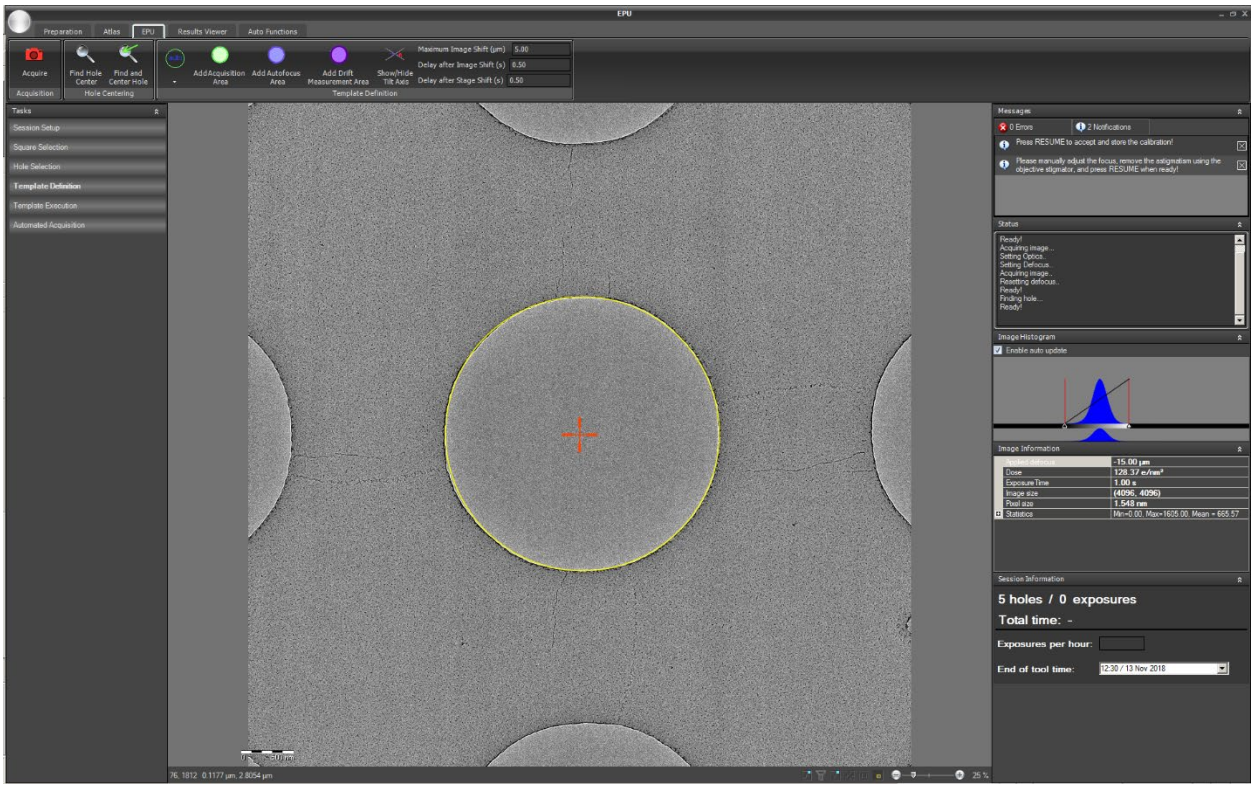
111/13/2018 **Date Completed**

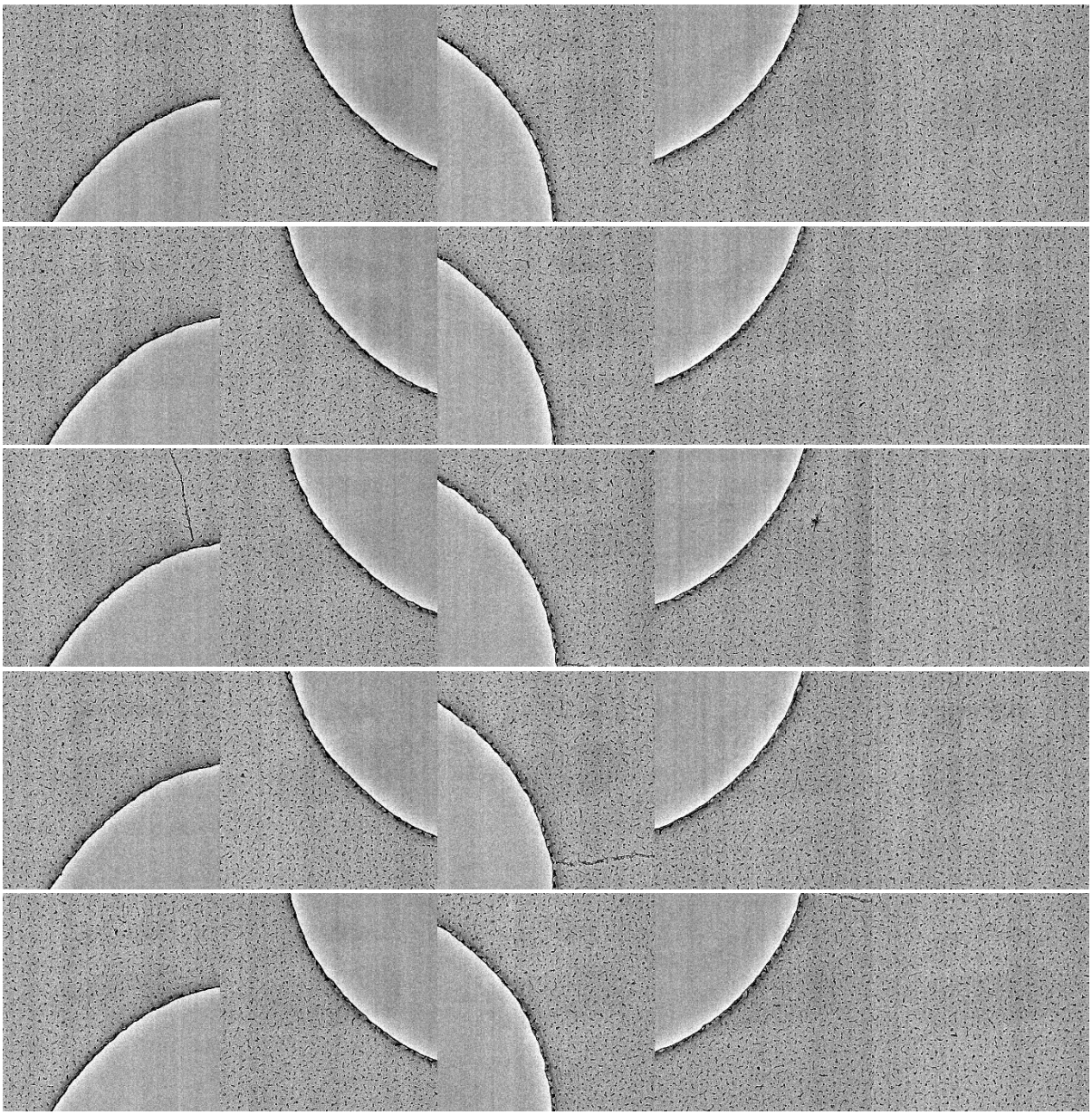
Jeremy Scott **Service Engineer**

_____ **Reviewed by Customer**


EPU
Preparation
Atlas
EPU
Results Viewer
Auto Functions
Select All
Unselect All
Invert
Show
Change
Selection
Processing Order
Tasks
Session Setup
Square Selection
Hole Selection
Template Definition
Template Execution
Automated Acquisition
Messages
0 Errors
2 Notifications
Press RESUME to accept and store the calibration!
Please manually adjust the focus, remove the astigmatism using the objective stigmator, and press RESUME when ready!
Status
Setting Optics...
Setting Defocus...
Acquiring image...
Resetting defocus...
Storing image of the grid square...
Ready!
Image Histogram
Enable auto update
Image Information
Dose
Exposure Time
1.00 s
Image size
(4096, 4096)
Pixel size
509.471 nm
Statistics
Min=0.00, Max=15306.00, Mean = 5790.92
Session Information
0 holes / - exposures
Total time: -
Exposures per hour:
End of tool time:
12:30 / 13 Nov 2018
0 100 µm
1824, 2681 0.92928 mm, 1.36589 mm
25 %


EPU
Preparation
Atlas
EPU
Results Viewer
Auto Functions
Acquire
Auto Eucentric
Calibrate 3D
3D status:
No 3D calibration
Stop
Measure Hole Size
Find Holes
Allow dark foil holes
Preset Ice Filter
Remove holes close to grid bar
Selection Brush
Select All
Unselect All
Invert
Acquisition
Tools
Select
Tasks
Session Setup
Square Selection
Hole Selection
Template Definition
Template Execution
Automated Acquisition
Messages
0 Errors
2 Notifications
Press RESUME to accept and store the calibration!
Please manually adjust the focus, remove the astigmatism using the objective stigmator, and press RESUME when ready!
Status
Setting Optics...
Setting Defocus...
Acquiring image...
Resetting defocus...
Storing image of the grid square...
Ready!
Image Histogram
Enable auto update
Image Information
-1.00 mm
Dose
0.30 e/nm²
Exposure Time
1.00 s
Image size
(4096, 4096)
Pixel size
19.960 nm
Statistics
Min=0.00, Max=1009.00, Mean = 262.43
Filter Ice Quality
Session Information
0 holes / - exposures
Total time: -
Exposures per hour:
End of tool time:
12:30 / 13 Nov 2018
3775, 200 75.343 µm, 3.992 µm
25 %


EPU
Preparation
Atlas
EPU
Results Viewer
Auto Functions
Acquire
Find Hole Center
Find and Center Hole
Add Acquisition Area
Add Autofocus Area
Add Drift Measurement Area
Show/Hide Tilt Axis
Maximum Image Shift (µm) 5.00
Delay after Image Shift (s) 0.50
Delay after Stage Shift (s) 0.50
Acquisition
Hole Centering
Template Definition
Tasks
Session Setup
Square Selection
Hole Selection
Template Definition
Template Execution
Automated Acquisition
Messages
0 Errors
2 Notifications
Press RESUME to accept and store the calibration!
Please manually adjust the focus, remove the astigmatism using the objective stigmator, and press RESUME when ready!
Status
Ready!
Acquiring image...
Setting Optics...
Setting Defocus...
Acquiring image...
Resetting defocus...
Ready!
Finding hole...
Ready!
Image Histogram
Enable auto update
Image Information
Applied defocus -15.00 µm
Dose 128.37 e/nm²
Exposure Time 1.00 s
Image size (4096, 4096)
Pixel size 1.548 nm
Statistics Min=0.00, Max=1605.00, Mean=665.57
Session Information
5 holes / 0 exposures
Total time: -
Exposures per hour:
End of tool time: 12:30 / 13 Nov 2018
76, 1812 0.1177 µm, 2.8054 µm
25 %



11 Non-Standard Request (NSR)

NSR Measurements

If a Non-standard request (NSR) needs to be tested on site, the procedure must be included in the NSR.

Please contact the responsible account manager if the required information is not present.

Code Number of NSR: _____

NSR Description of NSR: _____

Test	Specification	Measured	Sample
_____	_____	_____	_____

Passed_____ **Failed**_____**Waived**_____

_____**Date Completed**

_____**Service Engineer**

_____**Reviewed by Customer**

Code Number of NSR: _____

NSR Description of NSR: _____

Test	Specification	Measured	Sample
_____	_____	_____	_____

Passed_____ **Failed**_____**Waived**_____

_____**Date Completed**

_____**Service Engineer**

_____**Reviewed by Customer**

12 X-Ray Check

12.1 Test Conditions

Microscope settings	
High tension	200 kV
Gun lens	1
Specimen holder	Double tilt holder
Specimen	Platinum Pt
C1 / C2 aperture	Largest (optional) / Largest
Spot nr	1
Condenser astigmatism	Corrected
Screen current	75 nA

12.2 Specifications / Measurements

Measure the possible X-rays with a calibrated Victoreen 190 / RP1 sensor or other X-ray measurement device accepted by Thermo Fisher Scientific.

Note	**Be sure not to damage the cameras (if installed).**

1. Make sure the covers that are part of the X-ray safety are present.
2. Slowly measure the whole microscope at a distance of 10 cm (100 mm) from the surface.
3. Note the maximum "corrected" reading and where it was measured to the table below. The Corrective factor can be found on the energy response curve which belongs to the used Victoreen sensor.

Note	**Corrected value = measured value / energy response curve factor**
Note	**Conversion for the dose equivalent: 1 mSv/hr = 0.1 mrem/hr**

X-ray Specification	**Measured**
Maximum X-ray emission ≤ 1 uSv/hr at 0.1 m distance	<1 uSv/hr

Passed XXXXX **Failed**_____ **Waived**_____

11/14/2018 **Date Completed**

Jeremy Scott **Service Engineer**

_____ **Reviewed by Customer**

13 Anchoring Check

13.1 Specifications / Measurements

The System Frame must be permanently fixed to the ground by 1 bolt to prevent tilting. Without this bolt it is not safe to perform service actions on the System.

See the appropriate System Pre-installation Manual for details regarding the System Anchoring.

Note **The Customer is responsible for preparing a hole for the System anchoring.**

Procedure:

1. Locate the Anchoring bolt securing the Microscope frame to the floor.
2. Verify the proper mounting of the Anchor.

Specification	Measured
Microscope Frame anchored	Yes/No XX

PassedXXXXX___ **Failed**_____**Waived**_____

11/09/2018_____**Date Completed**

Jeremy Scott_____**Service Engineer**

_____**Reviewed by Customer**

14 Oxygen Detector Check

14.1 Specifications / Measurements

Thermo Fisher Scientific advises the installation of an Oxygen sensor in the Microscope room. The detection system prevents the risk of asphyxiation.

See the appropriate System Safety Manual for details regarding the oxygen detection.

Note	**The customer is responsible for obtaining an Oxygen detection service contract. Thermo Fisher Scientific merely checks the presence of the Oxygen Detection System during the installation of the microscope.**

Procedure:

Check the presence of the Oxygen sensor inside the Microscope room.

Specification	Measured
Sensor in the Microscope room	Yes/No XX

Passed_____ **Failed**_____**Waived** XXXXX

11/14/2018 **Date Completed**

Jeremy Scott **Service Engineer**

_____**Reviewed by Customer**

15 Pressure Vessel Statement

The Talos Arctica G2 System is equipped with one or more Pressure Vessels which may only be taken in or out of operation as well maintained by trained Service Engineers from Thermo Fisher Scientific.

By signing the SAT certificate on the next page you confirm that you understand the following points and are aware of the obligations coming from using such equipment.

As an End-customer:

- I understand that this System has one or more Pressure Vessels which might apply to maintenance or inspection according to the national law.

I am responsible for ensuring that the Pressure Vessel will operate according to the (national) law. Thermo Fisher Scientific cannot be held responsible for this.

- Every Pressure Vessel module for this System will be delivered with a set of hard-copy documents. I confirm that I received all of the following documents:
  - Pressure vessel material/traceability list
  - Pressure test and Leakage test records of the vessel(s)
  - User manual of the pressure vessel(s)
  - CE certificate of the vessel(s)
  - CE certificate of the system including vessel assemblies (if applicable)
  - Safety Relieve Valve 3.1 certification

16 Revision History

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Revision	Date	ECO number	Description of Changes
A	14-Feb-2017		Initial Release
B	03-Nov-2017		Re-branding
C	04-Jan-2018		Chapter 8 updated according to SDR13306.
D	07-Sep-2018		Corrections made according to SDR16291

17 Index

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