

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 1 OF 15

Quantitation using Agilent 2100 Bioanalyzer

1 Purpose

- 1.1 To quantify the amplified product of the mitochondrial hypervariable regions I and II, in order to establish the input of DNA for cycle sequencing. The DNA 1000 assay is capable of analyzing amplified DNA fragments in the range of 25-1000 bp, and in the concentration range of 0.5-20 ng/uL.

2 Preparing the documentation

- 2.1 Prepare a new Agilent Test Batch, and select samples for analysis.
- 2.2 Prepare output samples accordingly:
- 2.2.1 Exemplar samples and positive controls should be run at 2-fold (d2) and 5-fold (d5) dilutions.
 - 2.2.2 Hair and evidence samples should be run d1 (neat) and d2.
 - 2.2.3 Negative controls should be run d1 (neat).
- 2.3 Exemplar and evidence samples may be quantitated on the same Agilent run; however, they must be aliquoted for quantitation separately.
- 2.4 Load the samples on the load plate screen three samples at a time, horizontally. Alternatively, the samples can be added one at a time and saved after loading every sample. Save changes after loading is complete.
- 2.5 Download the plate record, and upload the .csv file from LIMS onto the Agilent instrument's computer.

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 2 OF 15

3 Preparing the samples

3.1 Follow the table below to prepare dilutions. Add H₂O first in all tubes where needed.

	Sample	Water
Neat	n/a	n/a
d2	1.5 neat	1.5
d5	1 d2	1.5
d10	1.5 d5	1.5
d100	1 d10	9

3.1.1 NOTE:

- Vortex or pipet up and down and centrifuge tubes between serial dilutions and before use.
- Aliquot all volumes less than 2 µL using a 2 µL pipette.
- When pipetting sample for dilution or quantitation, pick up from the top of the solution (directly on the meniscus) to avoid carrying sample on the outside of the tip.

****POWDER-FREE GLOVES ARE REQUIRED FOR THE HANDLING OF AGILENT CHIPS. POWDER FROM LATEX GLOVES COULD CLOG THE MICRO-CHANNELS ON A CHIP.**

4 Quantitation

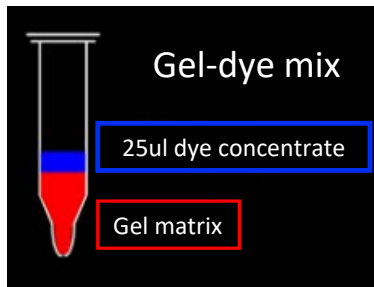
- 4.1 If the Gel-Dye mix is not prepared, proceed to SECTION 5.
- 4.2 If the Gel-Dye mix is already prepared, proceed to SECTION 6.8.
- 4.3 For analysis of data only, proceed to SECTION 7.

5 Preparing the gel-dye mix

- 5.1 Allow the DNA dye concentrate (**blue tube**) and the DNA gel matrix (**red tube**) to come to 37°C in the heat block.
- 5.1.1 **NOTE:** ALWAYS PROTECT THE DYE CONCENTRATE FROM THE LIGHT. It is important that all reagents are at room temperature before use.
- 5.2 Vortex the DNA dye concentrate (**blue tube**) and spin down. Add 25 µL of the dye concentrate (**blue tube**) to the DNA gel matrix vial (**red tube**).

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

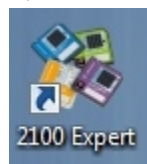
Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 3 OF 15



- 5.3 Vortex the mixture for 10 seconds to ensure complete mixing, and transfer the entire mixture to the top receptacle of a spin filter.
- 5.4 Centrifuge for 15 minutes at 6000 rpm. Discard the filter and label the gel-dye mix tube with the lot numbers of the DNA dye concentrate, the DNA gel matrix, and your initials and the date.
- 5.5 One tube of gel-dye mix is enough for 10 runs, and will last for 4 weeks. Discard the gel-dye mix 4 weeks after the date of preparation. Protect the gel-dye mix from light, and store at 4°C. Record the creation of the gel-dye mixture in LIMS.

6 Loading and running of the Agilent Bioanalyzer 2100

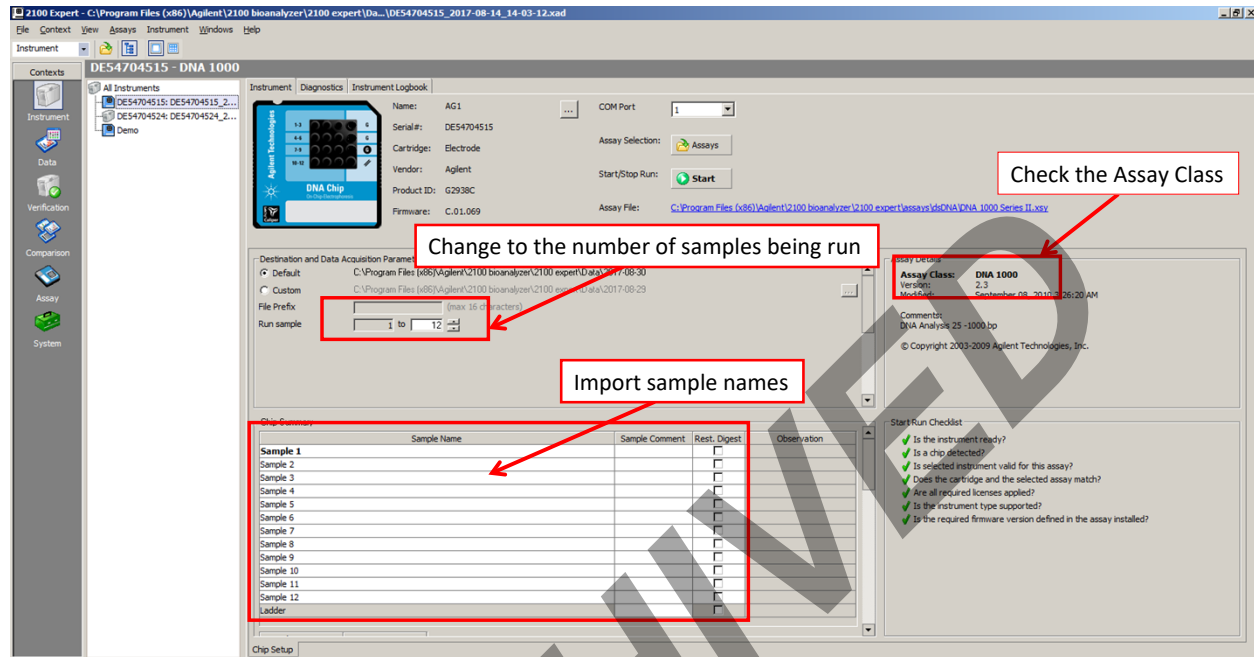
- 6.1 Start the collection software by clicking on the Agilent icon on the desktop.



- 6.2 Click on “instrument” on the left panel and place the cursor in one cell of the Sample Name column, click on the right button of the mouse, select import, choose the .CSV text file that was created for the run.

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

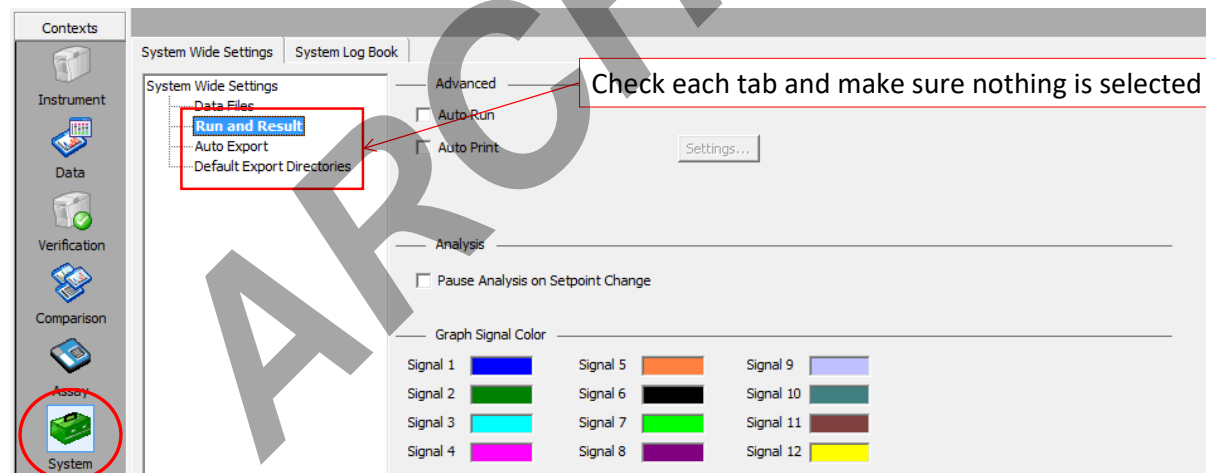
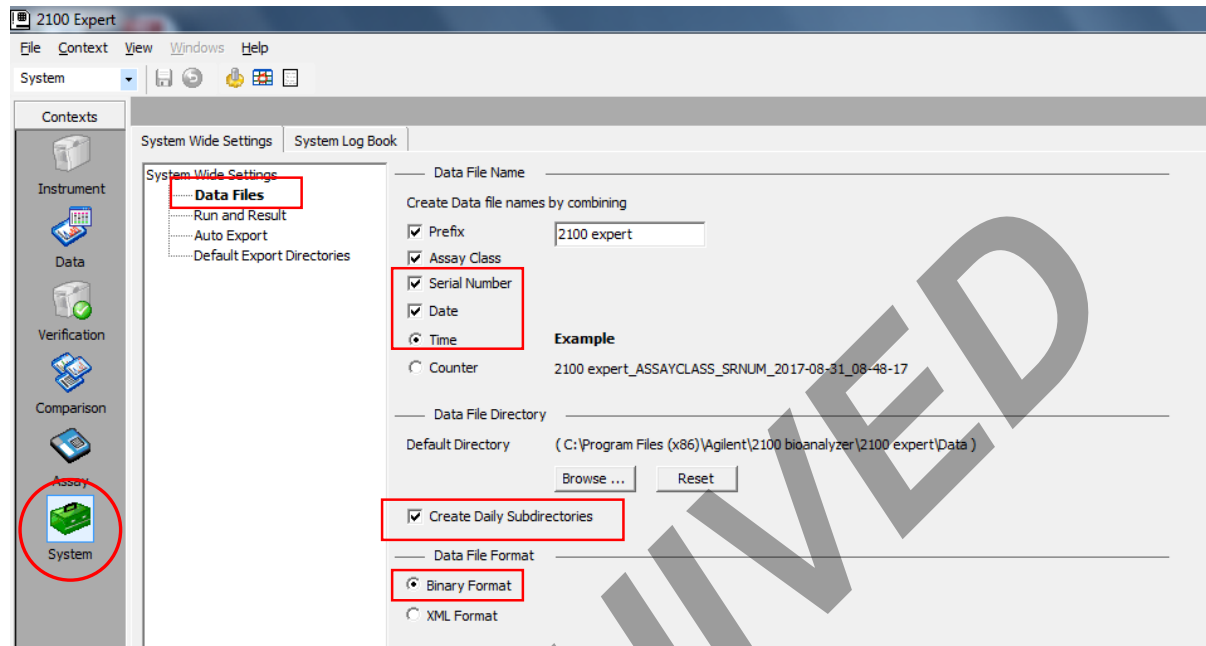
<p align="center">Quantitation using Agilent 2100 Bioanalyzer</p>		
<p>Status:Published</p>		<p>Document ID: 1174</p>
<p>DATE EFFECTIVE 09/25/2017</p>	<p>APPROVED BY mtDNA Technical Leader</p>	<p>PAGE 4 OF 15</p>



- 6.3 Once the machine is highlighted in the upper left-hand corner of the screen, open the lid. The icon should now show the lid open as well. Insert the DNA 1000 chip and carefully close the lid. The machine icon will now change to a blue chip on the screen. Make sure the “Assay Class” in the “Assay Details” panel (middle right panel) is “DNA 1000”. If the assay class is different than DNA 1000 see a supervisor before starting the run.
- 6.4 Adjust the sample # in the run sample field of the Destination and Data Acquisition Parameters section, if necessary.
- 6.5 **2100 Expert System Settings** (left inside of the window, click on “System”) are saved by default as:
 - 6.5.1 Data **Files Name**: serial number, data, time are checked.
 - 6.5.2 Data **Files directory**: “Create Daily subdirectories” is checked.
 - 6.5.3 Data **File format**: “Binary format” is checked.
 - 6.5.4 Nothing is checked in “**Run and Results**”, “**Auto Export**,” and, “**Default Export Directories**”.
 - 6.5.5 System → Data File → Data File Name/Data File Directory/Data File Format

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 5 OF 15



ALL PIPETTING INTO THE CHIP MUST BE DONE DIRECTLY ON THE GLASS AT THE BOTTOM OF THE WELL, NEVER ON THE SIDES OF THE WELL.

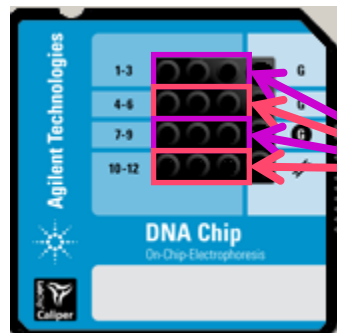
6.6 Allow the gel-dye mix to equilibrate to room temperature.

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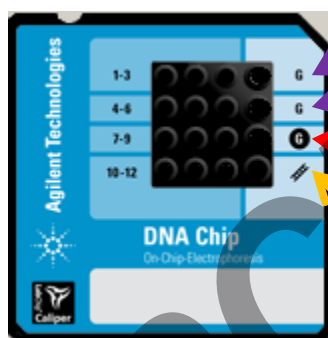
PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 6 OF 15



Samples are loaded
And
arranged in a
row of 3

- 6.7 **WITNESS:** Have a witness verify the input amp tube labels, and the output tube top names and dilution factor as they appear on the plate loading screen in LIMS. The load plate screen in LIMS should show the samples loaded three in a row.



9ul of gel-dye mix

9ul of gel-dye mix for priming

1ul of DNA ladder

- 6.8 Open a new Agilent DNA chip. Make sure it has not expired.
- 6.9 Pipette 9 μ L of gel-dye mix into the bottom of the well marked **G**. Make sure there are no bubbles; if any, use a 1 μ L pipette tip to remove them. This can also be accomplished by tapping the chip gently against the benchtop.



PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 7 OF 15

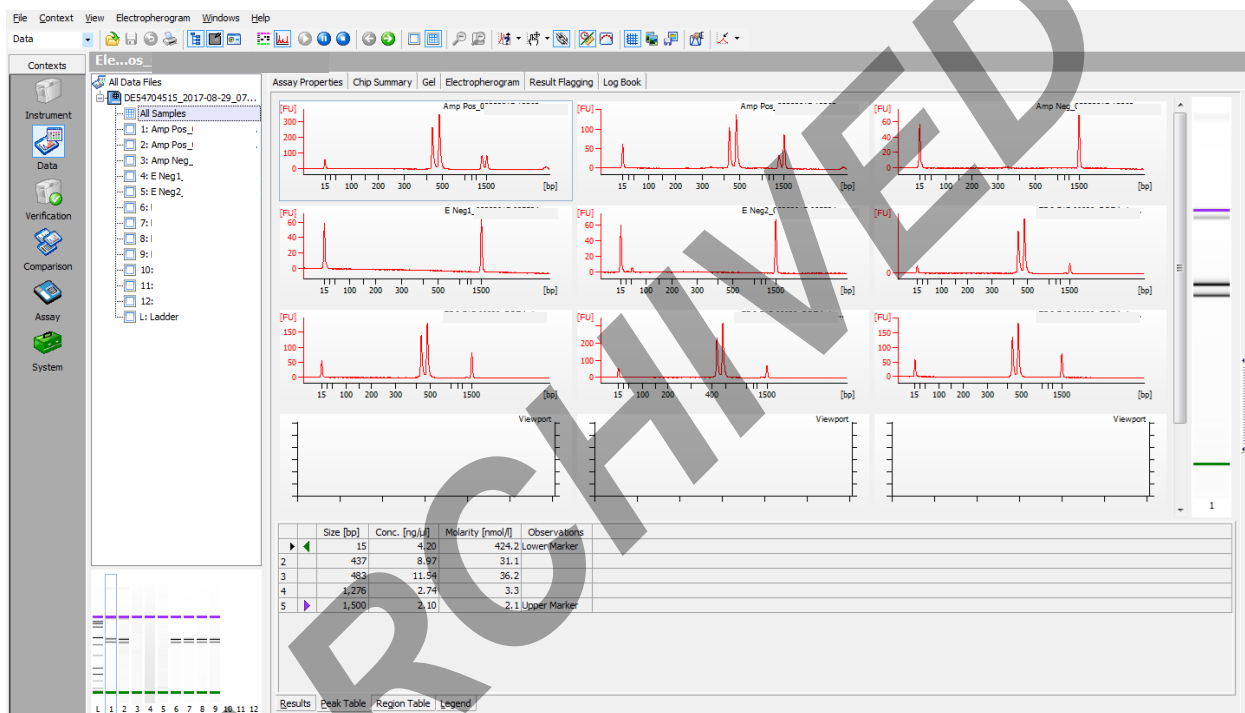
- 6.10 Place the chip in the priming station. Make sure the base plate of the station is set to position C, and the clip on the syringe trigger is set to the lowest position. Make sure the syringe piston is pulled back to the 1 mL mark, and close the lid of the priming station (listen for the “click”).
- 6.11 Grab the syringe with your index fingers under the fins on the syringe body and thumbs on the plunger. Swiftly and steadily, press down on the plunger until it locks under the silver trigger. Make sure your thumbs are not in the way of the trigger lock or it will not work. **Let the chip pressurize for 60 seconds.**
- 6.12 Release the syringe with the trigger, and make sure the syringe comes back to 0.3-0.4 mL. Wait for 5 seconds, pull slowly the syringe back to 1 mL, and open the chip priming station. Turn the chip over and inspect the capillaries for proper filling.
- 6.13 Record the priming station’s number in the comment section of the performed by tab in LIMS.
- 6.14 Pipette 9 µL of gel-dye mix into the two wells marked G. Make sure there are no bubbles; if any, use a 1 µL tip to remove them. This can also be accomplished by tapping the chip gently against the benchtop.
- 6.15 Vortex and spin down the DNA marker (green tube), and pipette 5 µL of marker into each of the 12 sample wells and the ladder well. **Each well must be filled, even if it will not be used.**
- 6.16 Vortex and spin down the DNA ladder (yellow tube), and pipette 1 µL of ladder into the lower right well, marked with the ladder symbol.
- 6.17 Add 1 µL of amplified DNA to each well. If a well is not used, add 1 µL of dH₂O into the well.
- 6.18 Place the chip in the IKA vortexer and vortex at ~2200 rpm for 60 seconds.
- 6.19 Run chips within 5 minutes.
- 6.20 Click on the START button. The run will begin to pre-heat and should take approximately 35-40 minutes for a full chip.
- 6.21 Record the run name in the LIMS QC Batch Parameters.
- 6.21.1 *Note:* the ladder sample will process first. It is a good idea to monitor this sample to make sure the upper 1500 bp and lower 15 bp markers come out.
- 6.22 After the run, remove the sample chip. The electrodes need to be cleaned with the clear electrode cleaner chip within 5 minutes after the run is done. To do this, begin by filling one of the large wells with 350 µL of deionized water. Place the cleaner chip in the Agilent 2100 Bioanalyzer and close the lid for approximately 10 seconds. Open the lid, remove the electrode cleaner chip, and let the pin set dry for another 10 seconds, then close the lid. Drain and dry the electrode cleaner chip.

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 8 OF 15

7 Data collection, analysis, electronic filing

- 7.1 When the Bioanalyzer 2100 run is complete, go to the Data & Assay field. The main window will show the gel image, sample list, and chip summary. Any problems detected by the software will be indicated with yellow triangles above the lanes in the gel image (see troubleshooting).



7.2 2100 Expert Software

- 7.2.1 On the Agilent computer, click on the “Data” folder on the desktop, click on the corresponding date and then copy and paste the run file into the following directory:
L:\FB\Instrument to LIMS\Agilent
- 7.2.2 On a networked computer, open M:\Mito_Data\AgilentArchive\[Year] and create a new folder with the run date and time.
- 7.2.3 Open L:\FB\Instrument to LIMS\Agilent and copy the run file into the newly created folder in the M: drive.
- 7.2.4 Open your desktop Agilent software and click on the “Data” button on the sidebar. Select “File”, “Open”, and select the run previously copied to the M: drive.

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PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

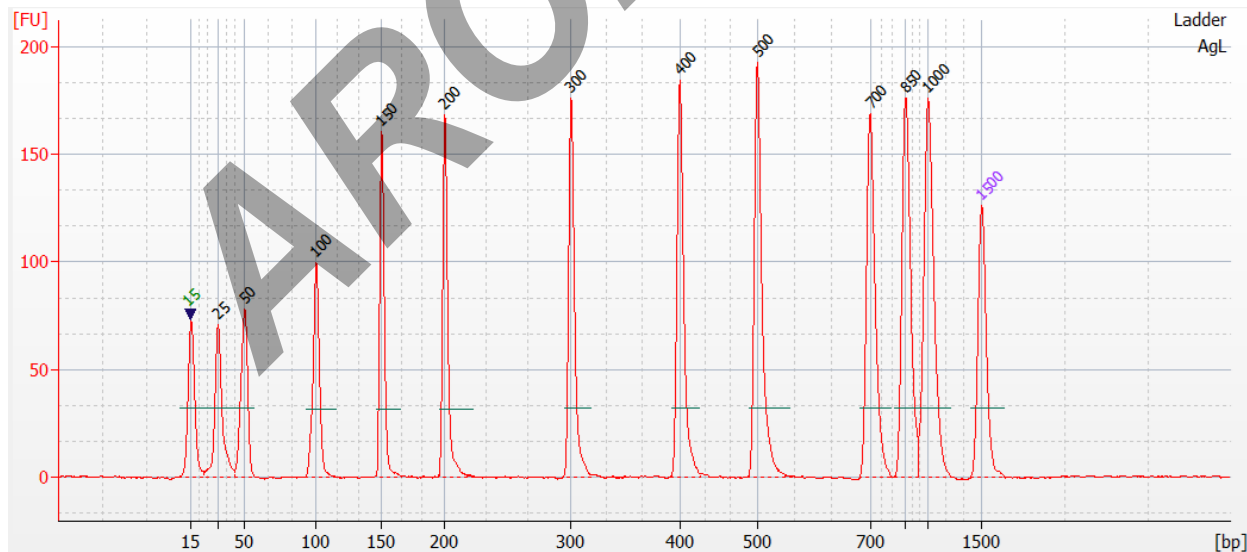
Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 9 OF 15

8 Analysis

8.1 Ladder:

- 8.1.1 Select the Ladder sample on the sample list. The main window should show the following peaks [11 ladder peaks plus lower (LM) and upper (UM) markers]:

15bp	Lower Marker
25bp	Ladder
50bp	Ladder
100bp	Ladder
150bp	Ladder
200bp	Ladder
300bp	Ladder
400bp	Ladder
500bp	Ladder
700bp	Ladder
850bp	Ladder
1000bp	Ladder
1500bp	Upper Marker



- 8.1.2 **Note:** Any additional peaks observed in the ladder that appear to be shoulder peaks or spikes may be manually edited (see manual editing section below).

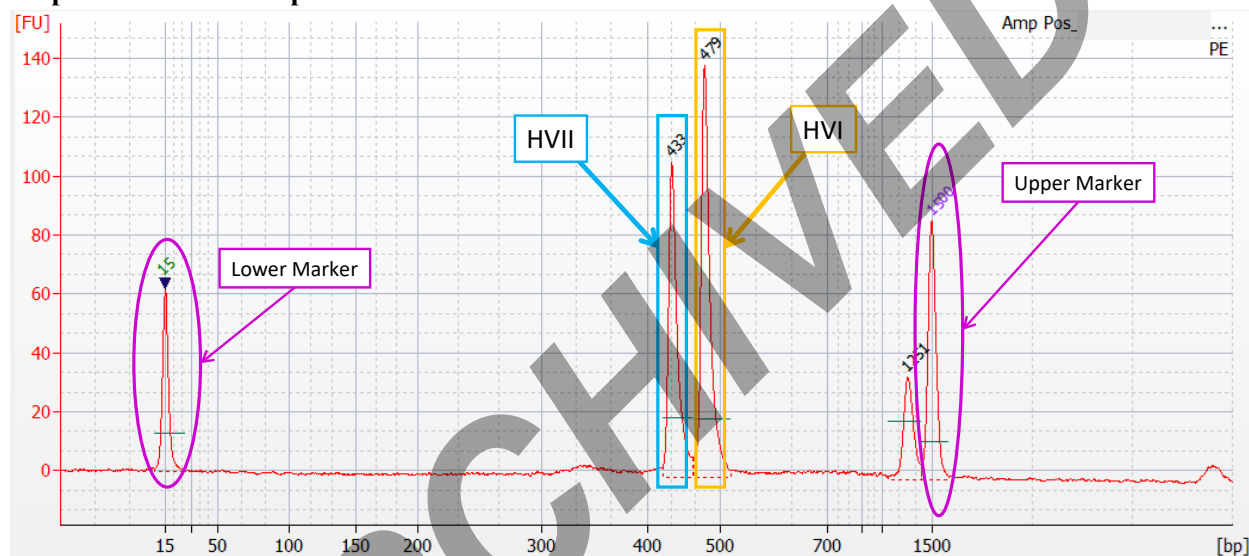
PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 10 OF 15

8.2 Samples:

- 8.2.1 Click on the individual sample on the sample list. The positive control and sample lanes should show two peaks, indicating the HVII and HVI amplified products (around 400-500 bp) for samples amplified with HVI and HVII multiplex primers. All samples, including negative controls, should have the lower marker (~15 bp) and upper marker (~1500 bp).

Amp Positive and Samples



Amp Negative and Negative Controls



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PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 11 OF 15

8.3 Manual Editing:

8.3.1 While manually editing peaks using the Agilent software, also open the run in LIMS and concurrently record these edits in the LIMS data entry table. Save these entries prior to importing the edited Agilent data into LIMS.

8.3.2 Agilent Editing Codes:

bp* : peak position manually called
bp** : peak position edited out manually
bp^ : spikes position manually removed
LM* : sample lower maker manually called
UM* : sample upper maker manually called

8.3.3 Indicate if editing is necessary for any sample, including the ladder, in the “Editing needed” column in the LIMS data entry table. If a sample is edited, enter the location in bp followed by one of the symbols from the table above in the “Edits” column in LIMS.

8.3.4 If the upper marker (UM) or lower marker (LM) is present but not labeled properly, right click on the peak cell “size bp” in the table and select “manually set upper marker” or “manually set lower marker”, respectively. Be sure to do this before making other edits, as resetting the marker will change the size of other peaks detected.

8.3.5 If a ladder peak, HVI and/or HVII are present but not labeled, or if an extra peak is present, right click on the peak, select “manual integration”, and add or remove peak at that position (bp).

8.3.6 Smaller amplified product peaks in samples with severely unbalanced HVI and HVII peak heights due to potential length heteroplasmy may be manually edited. Be sure to record any and all edits within the LIMS run documentation.

- If potential heteroplasmy is seen in either HVI or HVII, manually remove all peaks at the heteroplasmic region and change its value from “0” to “INC” in the LIMS data entry table.
- If potential heteroplasmy is observed in both HVI and HVII (and in both dilutions), examine the highest peaks for consistency. If they are approximately equal, use those values for both dilutions. Keep the two highest peaks and manually remove all other peaks.

8.3.7 Peaks below the calling threshold may be detected in negative controls. If this is observed, enter the peaks as “0” in the LIMS data entry table and make the following documentation in LIMS:

- “Peak(s) is/are present in [sample name] at the HVI [and/or] HVII region(s) that is/are

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 12 OF 15

below the calling threshold (<0.5 ng/uL). Therefore, the extraction/amplification negative passes. [Initial] and [date]”

8.3.8 Peaks below the calling threshold may be detected in one or both dilutions of a sample. If this is observed, attempt to manually call the peak(s) and determine if it is above the threshold.

- “Peak(s) is/are present in [sample name] at the HVI [and/or] HVII region(s) that is/are below the calling threshold (<0.5 ng/uL). [Initial] and [date]”

8.3.9 Sometimes the software may still call a peak that is below threshold. If this happens, keep the call as is in the Agilent file. On the LIMS data entry page, enter the peak as “0”. Document in LIMS the statement from above describing the presence of sample peaks that are below the calling threshold.

8.3.10 Once editing is completed, select “File” and “Save as”. Add an underscore followed by the analyst’s initials at the end of the run name. Save the revised file in the same folder as the original.

8.4 Create a PDF

8.4.1 Go to the “File” menu and select “Print”. When the Print window opens, select “Run Summary”, “Electropherograms”, and “Results Table”. Choose “all wells” if the chip was full, or fill in the well numbers of partially filled chips. Select “Include Ladder”, one per page, and PDF. Click on “...” to select the drive. Select the appropriate folder on the network. Click save.

8.4.2 Check that the PDF and .xad files are present in M:\MITO DATA\AgilentArchive\yyyy\yyyy-mm-dd-hh-mm-ss

8.5 Export edited data to the network

8.5.1 Go to the “File” menu and select “Export”. When the export window opens, make sure only the box for “Result Tables” is selected.

8.5.2 Save the exported file in the following directory: L:\FB\Instrument to LIMS\Agilent\[Instrument#]

8.6 Import edited data into LIMS

8.6.1 In the LIMS test batch, go to the data entry table for the output samples and click “Import Instrument Data”.

8.6.2 Click “Browse” and select the appropriate .csv file.

PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 13 OF 15

- 8.6.3 Click save and the data entry table will automatically populate.
- 8.7 Make sure all mandatory fields in the LIMS data entry table have been completed. This should have been done during the “Manual Editing” step above. The “Vol, used” and “Interpretation” columns will be completed in the following section.

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PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status: Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 14 OF 15

9 LIMS Data Entry:

9.1.1 Fill the “Interpretation” column following the guidelines in the table below:

one dilution				
HVII		HVI		Comments
[0.5-20]	[0.5-20]	HVII and HVI mean concentration will be used for further testing		USE
INC	[0.5-20]	non-INC peak concentration value will be used for further testing		USE
[0.5-20]	INC	non-INC peak concentration value will be used for further testing		USE
INC	INC	Rerun		RQ
2 dilutions				
				Comments
dilution A	pass	dilution A within $\pm 2.5 \times$ dilution B	use lower value	USE
dilution B	pass			-
dilution A	pass	dilution A outside $\pm 2.5 \times$ dilution B	Rerun	RQ
dilution B	pass		Rerun	RQ
dilution A	pass	n/a	use for further testing	USE
dilution B	INC		n/a	-
dilution A	INC	n/a	n/a	-
dilution B	pass		use for further testing	USE
dilution A	INC	n/a	Rerun at appropriate dilution	RQ, dx
dilution B	INC		Rerun at appropriate dilution	RQ, dx
appropriate dilution example 1				
dilution 2	<0.5	n/a	Rerun at appropriate dilution	RQ, d1
dilution 5	<0.5		Rerun at appropriate dilution	RQ, d1
appropriate dilution example 2				
dilution 2	>20	n/a	Rerun at appropriate dilution	RQ, d10
dilution 5	>20		Rerun at appropriate dilution	RQ, d100

If both dilutions are INC for any other reason than concentration value out of range, see supervisor

INC = sample inconclusive

USE = concentration will be used for further testing

RQ = sample will be requantified

dx = sample will be requantified at dilution x

9.1.2 The “Vol, Used” column in the LIMS data entry table refers to the volume aliquoted of the original amplified sample. Assign a “Volume used” only to the samples whose

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PROTOCOLS FOR FORENSIC MITOCHONDRIAL DNA ANALYSIS

Quantitation using Agilent 2100 Bioanalyzer		
Status:Published		Document ID: 1174
DATE EFFECTIVE 09/25/2017	APPROVED BY mtDNA Technical Leader	PAGE 15 OF 15

interpretation was “Use” (note that if two dilutions of a sample were prepared, then the “Volume used” for the sample designated as “Use” should be the *combined* volume used to prepare both dilutions of the sample). The “Volume used” for all other samples should be “0”.

- If the ladder fails (e.g., discrete bands) or upper or lower markers are not present (e.g., can’t be edited) the run is inconclusive, all samples have to be requantified, indicate as such in each sample Interpretation cell.
- If one or both markers in a sample are not called, the sample run is inconclusive, and the sample will have to be requantified. This should be indicated in the “Interpretation” column of the data entry table.
- If a sample peak concentration value is out of range it will appear as INC.
- If a sample was called INC for any other reason than the value range it will appear as INC. A comment can be added to explain why the peak was called INC in the “comments” of the test batch. In both cases the concentration of only one peak could be used for further testing instead of the mean concentration of both peaks.
- If the ladder fails, manually select “fail” as the “Ladder Result”; if not select “Pass”.
- If the ladder marker(s) fail(s), select “fail” as the “Ladder Result”; if not select “Pass”.

10 Review

- 10.1 The reviewer will review the documentation, as well as any comments based on the parameters as described above in the LIMS Data Entry section.
- 10.2 After review, the reviewer will indicate the appropriate samples for the next process step, as indicated by the Interpretation results of each sample.

11 Reruns

- 11.1 After review, the analyst will set up a new Agilent batch for the necessary samples that were indicated as reruns.

12 Troubleshooting

- 12.1 For troubleshooting, refer to the Agilent 2100 Bioanalyzer Maintenance and Troubleshooting Guide archived in MITO_DATA folder.