

# Duke University Libraries Multispectral Imaging

Updated: June 2019

## Project Title:

[Acts of the Apostles]  
[between 600 and 800 A.D.]  
Archival and manuscript

## Project Summary:

Multispectral file stack for [Acts of the Apostles] contains 7 image stacks created during imaging and processing of Greek language manuscript fragment dating from between 600 and 800 A.D. (date estimated from comparison to dated papyri written in similar hands). Text is from Acts of the Apostle. Recto text: Acts 7:26-30; verso text: Acts 4:27-31.

The purpose of this project is to conduct multispectral imaging capture of P.Duk.inv. 1377 recto and verso to increase legibility and identify material (i.e. identify pigment, ink, or other media).

This item is held at the David M. Rubenstein Rare Book & Manuscript Library at Duke University.

Item	Description	Dimensions	Capture
P.Duk.inv. 1377	Papyrus; Text from Acts of the Apostle: Acts 7:26-30	70-115 x 214-244 (97) mm	Recto
P.Duk.inv. 1377	Papyrus; Text from Acts of the Apostle: Acts 4:27-31	70-115 x 214-244 (97) mm	Verso

## Capture Information:

Capture Date	March 3, 2017
Coordination	Molly Bragg
Conservation	Henry Hebert
Capture	Henry Hebert
Processing	Ryan Baumann

### Conservation Details:

Prior to imaging, the object was removed from the glazing package by cutting the taped edges and mechanically releasing any attachment to the surface of the glass. The condition of the item was assessed by conservators to determine if any intervention or special handling needs were required for imaging. No conservation treatment was undertaken as part of this imaging request.

Following imaging, both interior and exterior surfaces of the glazing were cleaned with a 1:1 mixture of ethanol and deionized water, dried, and buffed with a cotton pad. The papyrus was secured to the lower pane of glass with small, toned Japanese paper mounts, precoated with sodium carboxymethylcellulose (SCMC) and reactivated with brush application of deionized water. Each edge of the glazing package was wrapped with Naschen Filmoplast SH linen tape.

### Methodology:

Multispectral Imaging (MSI) at Duke University Libraries is accomplished by using a Phase One IQ260 digital back in conjunction with an Equipoise filter wheel and light panels. The light panels contain LED lights of 12 specific wavelengths spanning a range of visible and non-visible light.

Two clear acrylic plates were placed at the edges of the object to secure it to the imaging surface and reduce movement during long exposures.

A single MSI capture produces an image stack that consists of 17 images. This image stack represents exposures captured at different wavelengths and wavelength/filter combinations. The Spectral XV software controls the lights, filter wheel and camera to produce a RAW image stack. This stack is then converted to the TIFF file format using Capture One software in preparation for further processing using ImageJ or an in-house script. Typically, recto and verso sides of a single item is captured during MSI and this generally produces multiple image stacks.

In addition to the multispectral image stack, a high resolution image of the item captured under full-spectrum light (natural light) is included in the workflow.

### Equipment and Software:

	<b>Description</b>
Digital Back (MSI)	Phase One IQ260 Achromatic, 60MP
Digital Back (Full Spectrum)	Phase One IQ180, 80MP
Camera	Phase One iXR
Lens	Phase One Schneider Kreuznach 120mm LS Macro f/4.0 AF

Filter Wheel	Motorized Filter Wheel module with Serial Interface and software
Illumination	Narrowband Multispectral EureLight Panels
Capture Software	Equipoise Imaging Spectral XV 2.0, Capture One CH 9.3
Processing Software	Equipoise Imaging Paleo Toolbox Image Processing Software

MSI Exposure Table:

Index	Wavelength	Filter	Shutter	Aperture	ISO
1	000 (Dark)	Clear (N)	8s	f/8	200
2	448 (Deep Blue)	Clear (N)	0.4s	f/8	200
3	476 (Blue)	Clear (N)	1/3	f/8	200
4	499 (Cyan)	Clear (N)	1/2	f/8	200
5	519 (Green)	Clear (N)	0.4s	f/8	200
6	598 (Amber)	Clear (N)	1/2	f/8	200
7	636 (Red)	Clear (N)	1/5	f/8	200
8	700 (IR1)	Clear (N)	0.6s	f/8	200
9	735 (IR2)	Clear (N)	0.6s	f/8	200
10	780 (IR3)	Clear (N)	0.8s	f/8	200
11	870 (IR4)	Clear (N)	2.0s	f/8	200
12	940 (IR5)	Clear (N)	13s	f/8	200
13	370 (UV)	LP400 (V)	50s	f/8	200
14	370 (UV)	LP515 (G)	50s	f/8	200
15	370 (UV)	LP590 (R)	50s	f/8	200
16	448 (Deep Blue)	LP515 (G)	50s	f/8	200

17	448 (Deep Blue)	LP590 (R)	50s	f/8	200
18	000 (Dark)	Clear (N)	5s	f/8	200
19	370 (UV)	Clear (N)	6s	f/8	200

### Lighting and Camera Geometry:

Angle of Incidence	47°/46°
Stand distance from lens axis	31 3/4 inches
Light panel aligned with lens axis	Yes
Spatial resolution	780

### Processing:

Files were converted from RAW to TIF using Capture One CH 9.3. The resulting file specifications are 16-bit Grayscale images with a Phase One Gray 2.2 (16bpc) profile. Files are then adjusted using a “flatfield” calibration process within ImageJ to correct for uneven light distribution. Basic RGB reconstructions were made after this calibration. The image stack was then cropped down to just the tablet before further processing, in order to maximize the assignment of dynamic range in the final visualizations. The resulting images were run through an automated process which produces a number of visualizations for analyzing the images/objects. This automated process operates by stacking the multispectral images by wavelength into a volumetric image, and then performing various volumetric measures/projections using the Teem image processing library. Further explanation, code, and a Docker image with all dependencies built-in for this processing can be provided upon request if researchers would like to do their own visualizations. PCA (Principal Component Analysis) images were also generated.

### Long Term Storage/Deliverable:

Stack Type	Number of Stacks	Files	Data Footprint (GB)
RAW	3	54	3.2
TIF	3	51	5.7
Cleaned Flats	1	17	1.9
Flattened	3	51	5.7

PCAs	1	2	2.6
Reg	2	34	1.6
Variations	3	90	6.4
Total	16	299	27.1

\*Includes json files

The delivered images are typically named according to the following filename convention:  
Stack type\_Collection\_Item-Side-WavelengthFilter\_Sequence number\_Processing State  
Sample filename: tif\_papyri\_PDukeInv1377-Recto-000N\_001\_R.tif

Files created during MSI imaging and processing will be preserved in the Duke Digital Repository for future use by scholars and researchers.