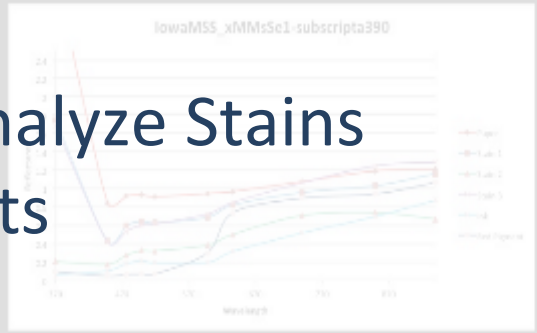
Library of Stains Project

Using Multispectral Imaging to Analyze Stains in Medieval Manuscripts



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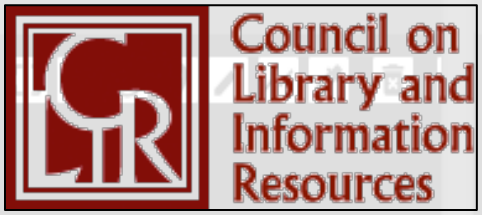

Labeculae Vivae, #StainAlive

Alberto Campagnolo, Postdoctoral Fellow, Library of Congress

Erin Connelly, Postdoctoral Fellow, Schoenberg Institute for Manuscript Studies, University of Pennsylvania Libraries

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Fenella France, Chief Preservation Officer at the Library of Congress

Michael Toth, R. B. Toth Associates

William Christens-Barry, Equipoise Imaging

Why stains?

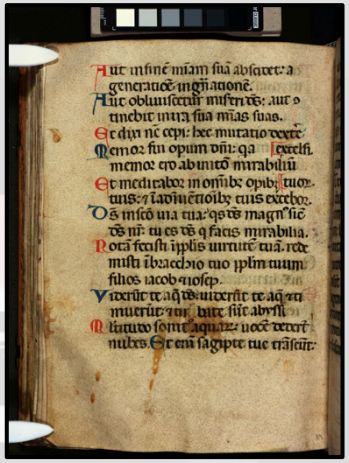
Because this…

From the Hyde Papers, many thanks to John Overholt

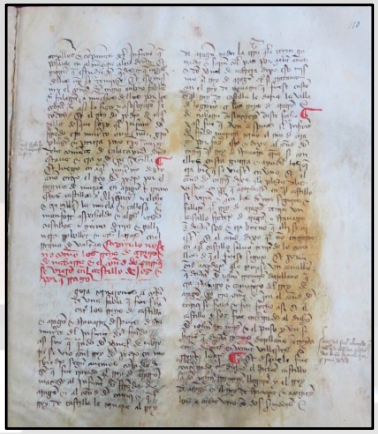
can become this…

Stains highlight the intimate human connection between the person who may have left a stain ring on a medieval manuscript and the person who accidentally left a coffee stain on the cover of their favorite book last week.

The Library of Stains project sampled manuscripts and early printed works from the Library of Congress, the University of Pennsylvania Schoenberg Institute of Manuscript Studies, the University of Wisconsin, Madison and the University of Iowa.



UI, Special Collections, xMMsPs3, f. 86v

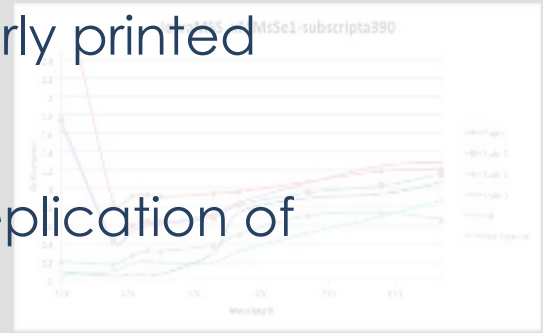


UW, Special Collections, MS 57, f. 110r

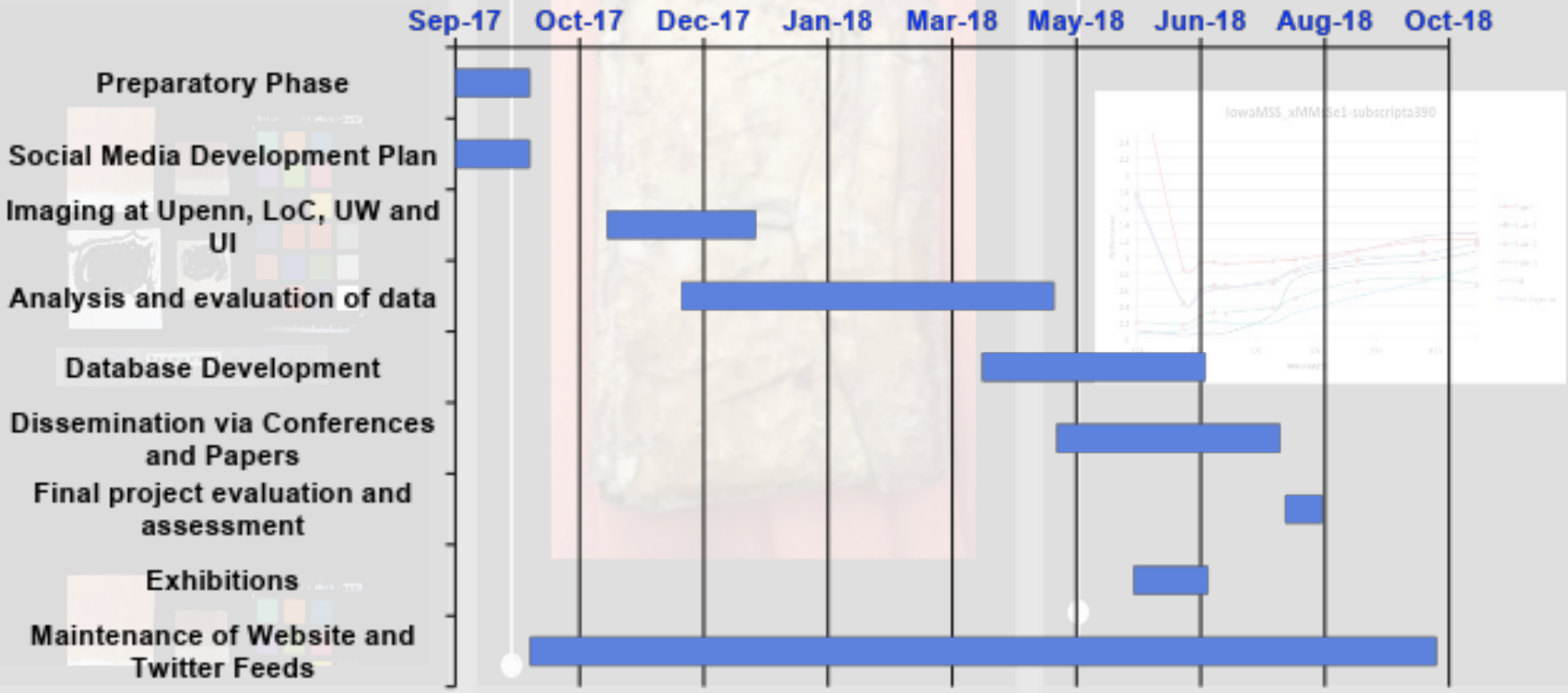
UI, Special Collections, xMMsBr2, f. 338r

Library of Stains Project Goals

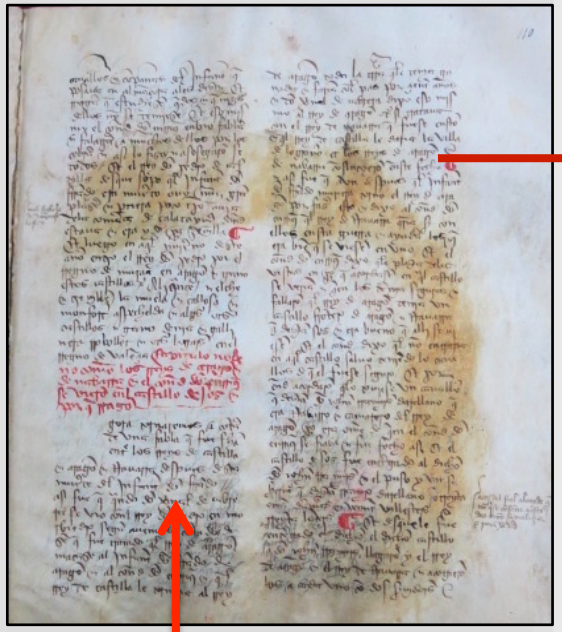
- Create the first dataset for characterized stains commonly found on manuscripts and early printed books.
- Develop a sound methodology for the replication of data gathering and analysis processes.
- Create and implement an open source, open access database applicable to manuscript studies and conservation work.
- Prioritize manuscripts and leaves that are often overlooked due to dirt, erasure, damage, and stains.



Library of Stains General Timeline



Methodology



Gather scientific data from stains using multispectral imaging and analysis

Image Processing

Data Analysis

Conference Presentations
Publication

Public engagement

Publish data in online freely-accessible database

Reference Library

Multispectral Image Capture Setup: Equipment thanks to Mike Toth and Bill Christens-Barry

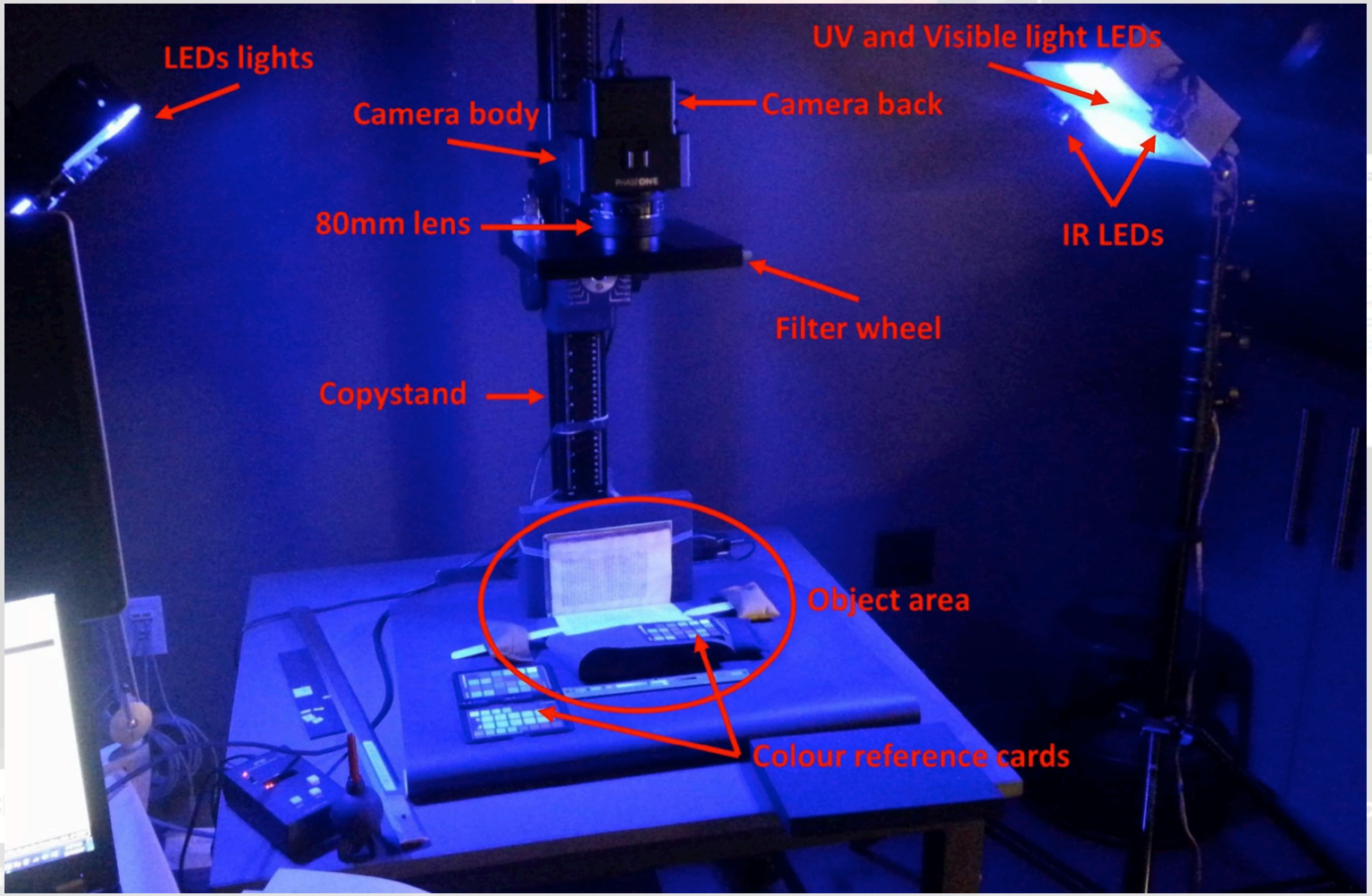
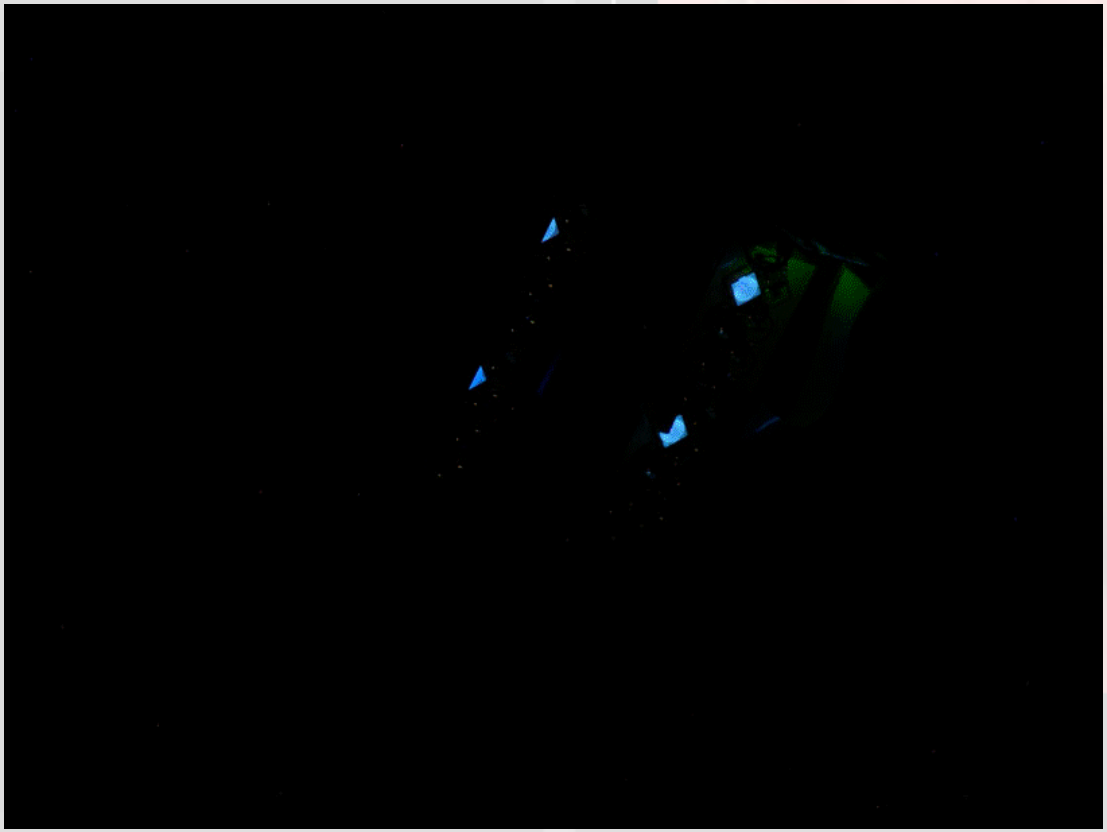


Image Capture: Ten different shots at the spectral wavelengths shown below for each imaged side



- 370 nm
- 740 nm
- 850 nm
- 940 nm

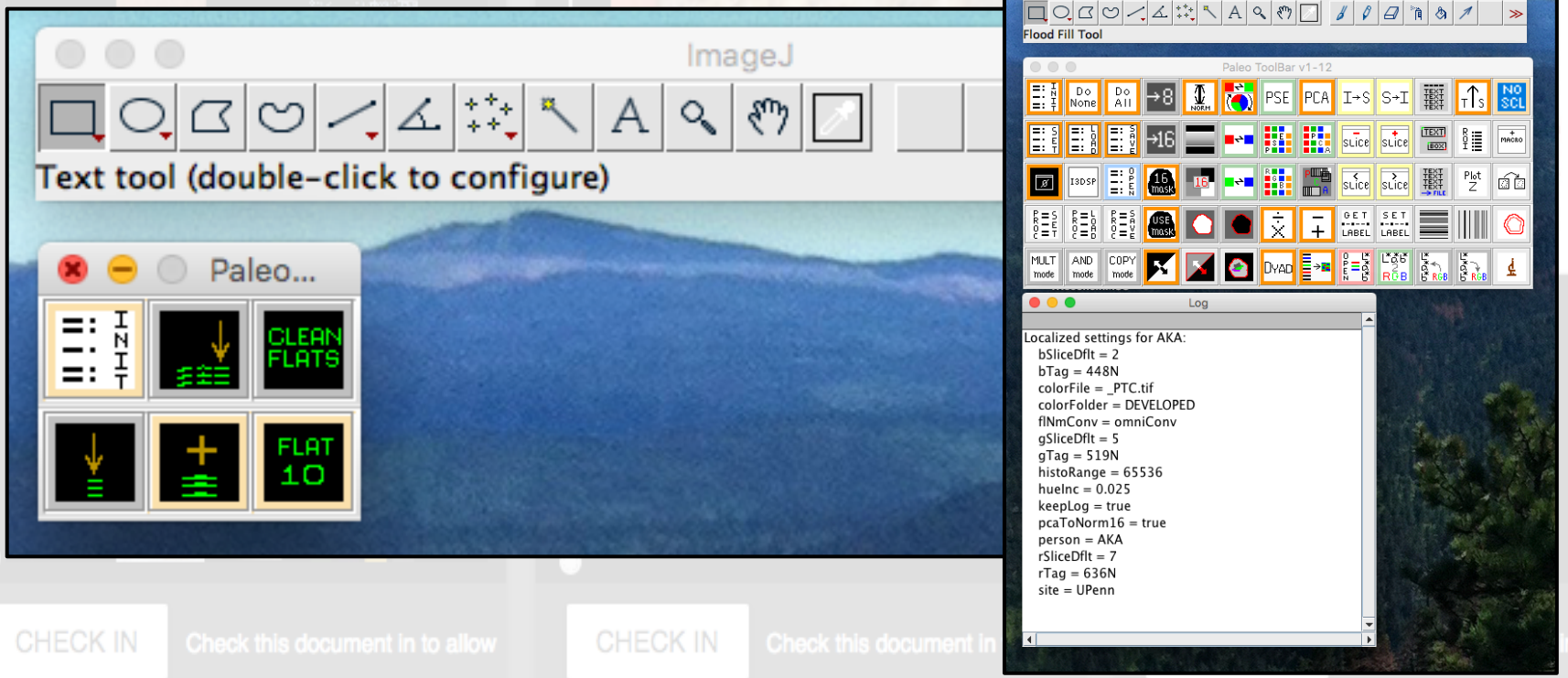
Ultra-Violet

370
448
476
499
519
598
636
740
850
940

Infrared

NON-Visible

Image Processing: *Image J Software* and the *Paleo PrepBox*, designed by Bill Christens-Barry of Equipoise Imaging



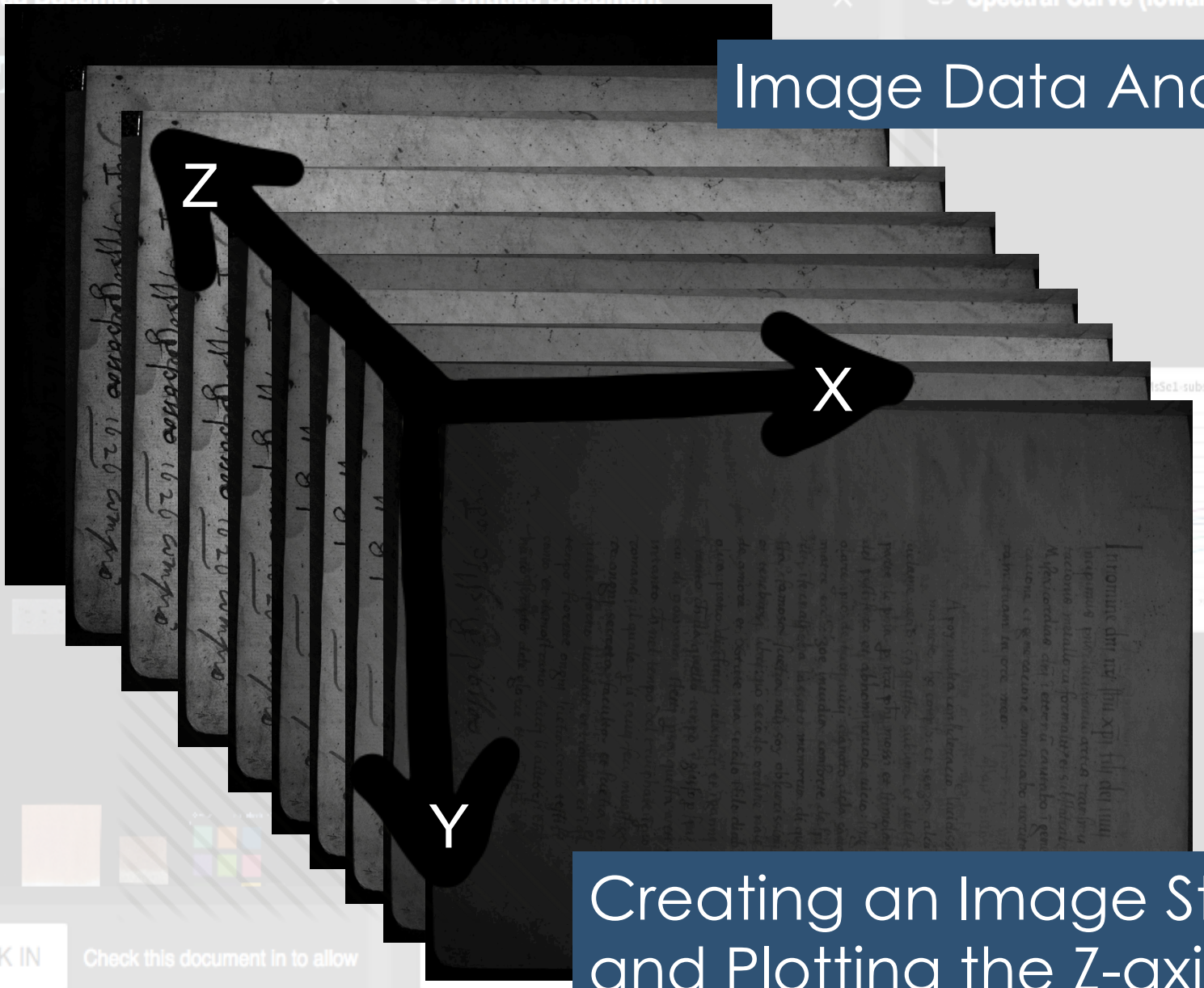
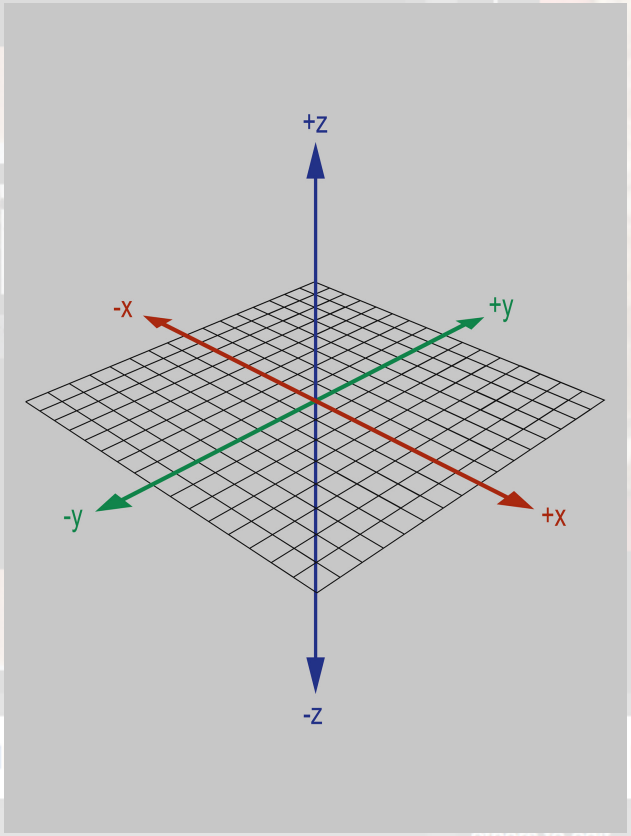


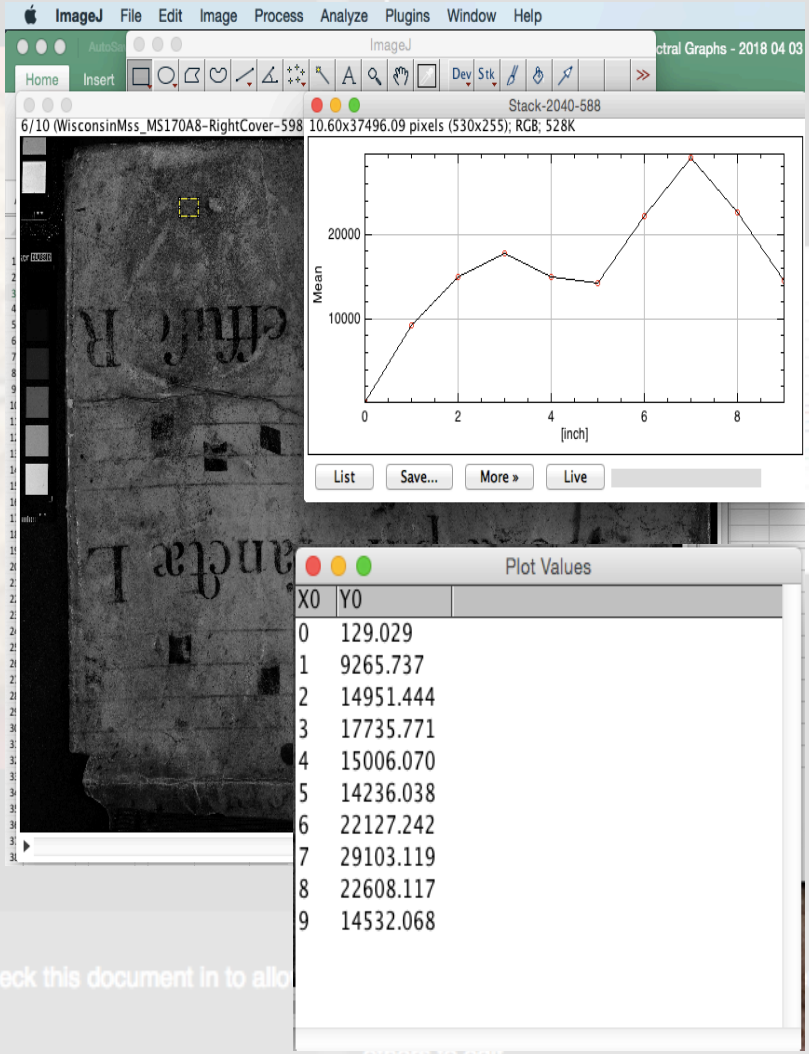
Image Data Analysis

Creating an Image Stack and Plotting the Z-axis

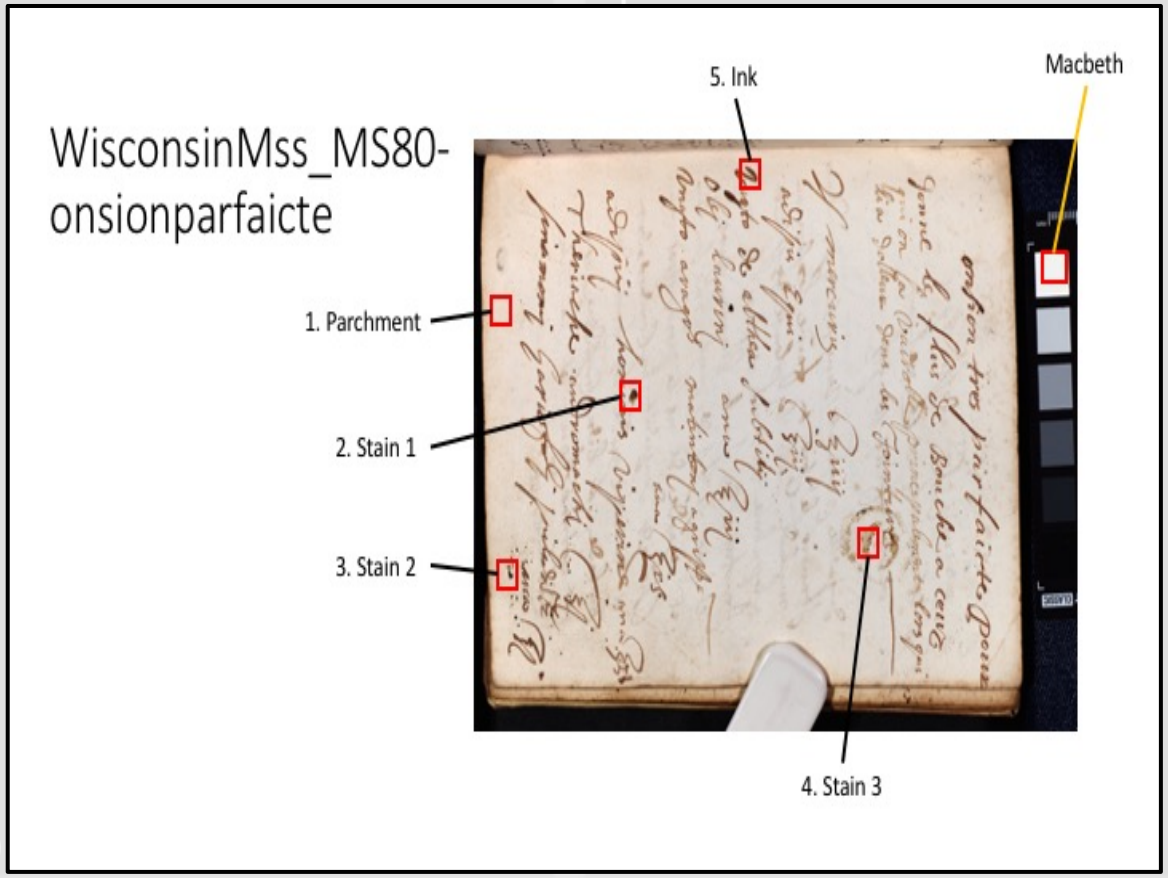
Data Analysis: Z-axis plotting of average pixel values for specific sample areas

- Plot Z-axis profile
- List of values





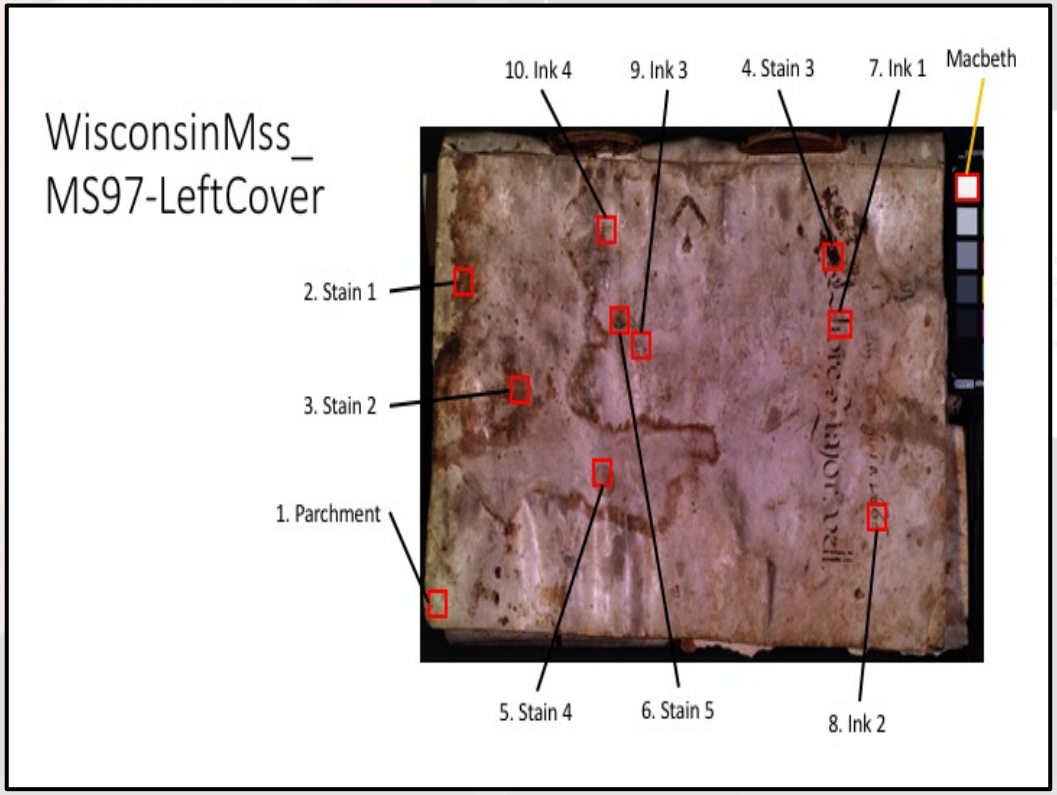
Data Analysis: Image Sample Areas



Sample areas included inks, red and blue pigments, paper or parchment substrate, and all interesting stains.

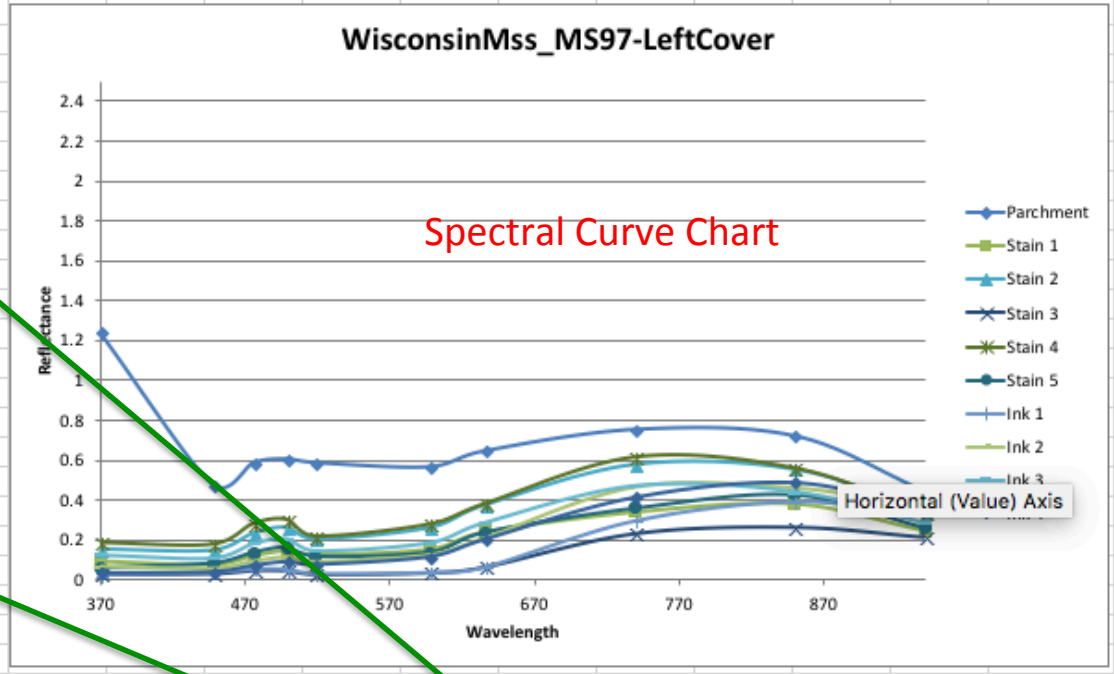
Data Analysis: Image Sample Areas

Sometimes, this meant analyzing several areas on a single side.



Data Analysis: Data Transfer to Excel Spreadsheet

	A	B	C	D	E	F
1	Wavelength (nm)		Pigment		MacBeth	Reflectance
2	Parchment					
3	370	0	632.517	0	508.122	1.244813254
4	448	1	28172.67	1	58880.414	0.478472689
5	476	2	36428.852	2	62053.664	0.587054005
6	499	3	37603.18	3	61982.324	0.606675865
7	519	4	37734.156	4	64191.508	0.587837195
8	598	5	28883.76	5	50958.242	0.566812332
9	636	6	36103.488	6	55787.559	0.647160203
10	740	7	43108.633	7	57041.402	0.755742873
11	850	8	35216.395	8	48695.344	0.723198403
12	940	9	21221.336	9	47820.094	0.443774452
13						
14						
15						
16						
17	Stain 1					
18	370	0	46.185	0	508.122	0.090893526
19	448	1	4289.675	1	58880.414	0.072854022
20	476	2	7372.366	2	62053.664	0.118806296
21	499	3	8878.359	3	61982.324	0.143240176
22	519	4	7983.993	4	64191.508	0.124377714
23	598	5	7724.212	5	50958.242	0.151579248
24	636	6	13395.246	6	55787.559	0.240111767
25	740	7	19532.262	7	57041.402	0.342422544
26	850	8	18705.021	8	48695.344	0.384123398
27	940	9	11788.289	9	47820.094	0.246513296



Spectral Curve Chart

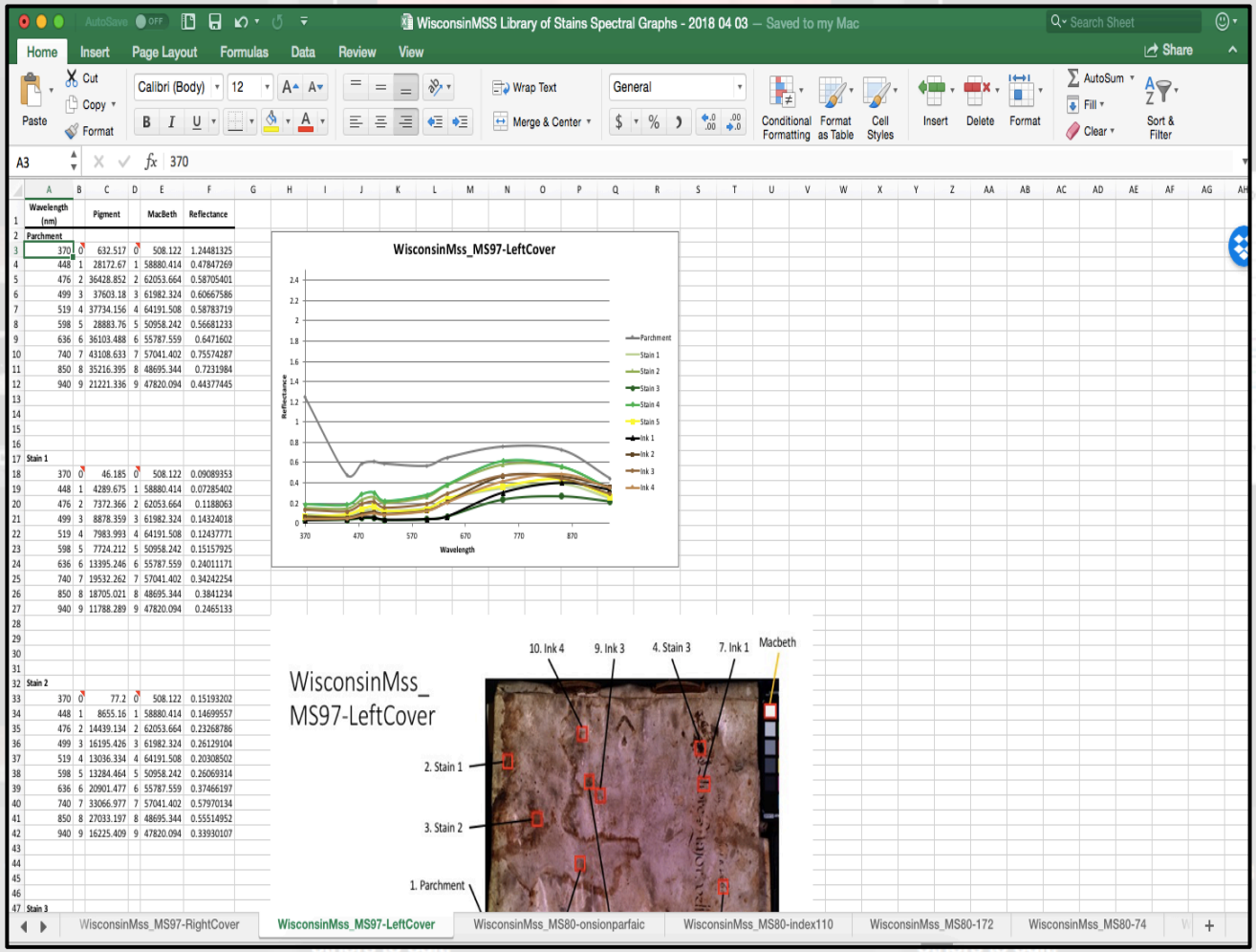
Pixel values for the parchment

Pixel values for the stain 1

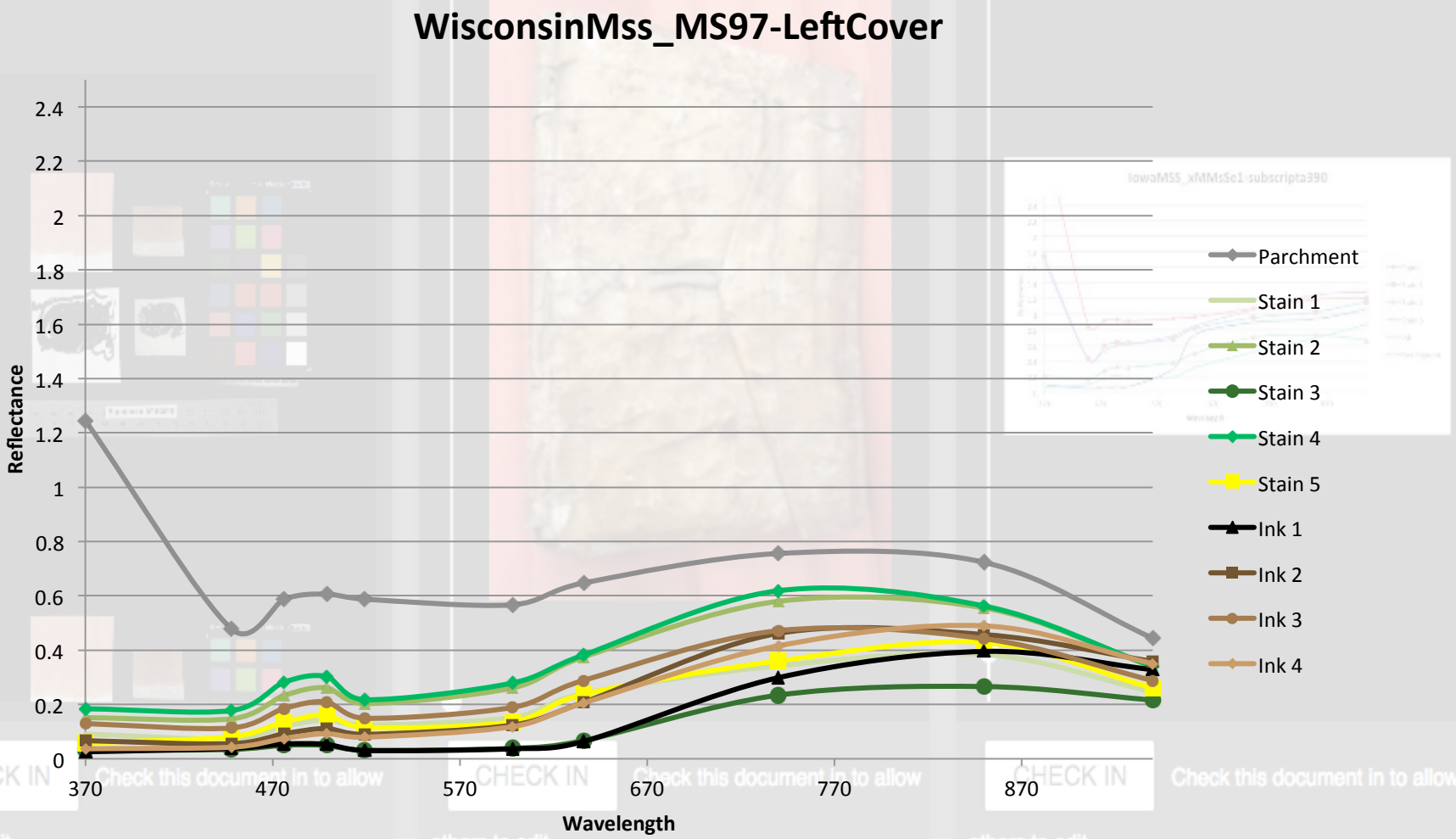
Pixel values for the white swatch on the color checker

Corresponding calculated reflectance values

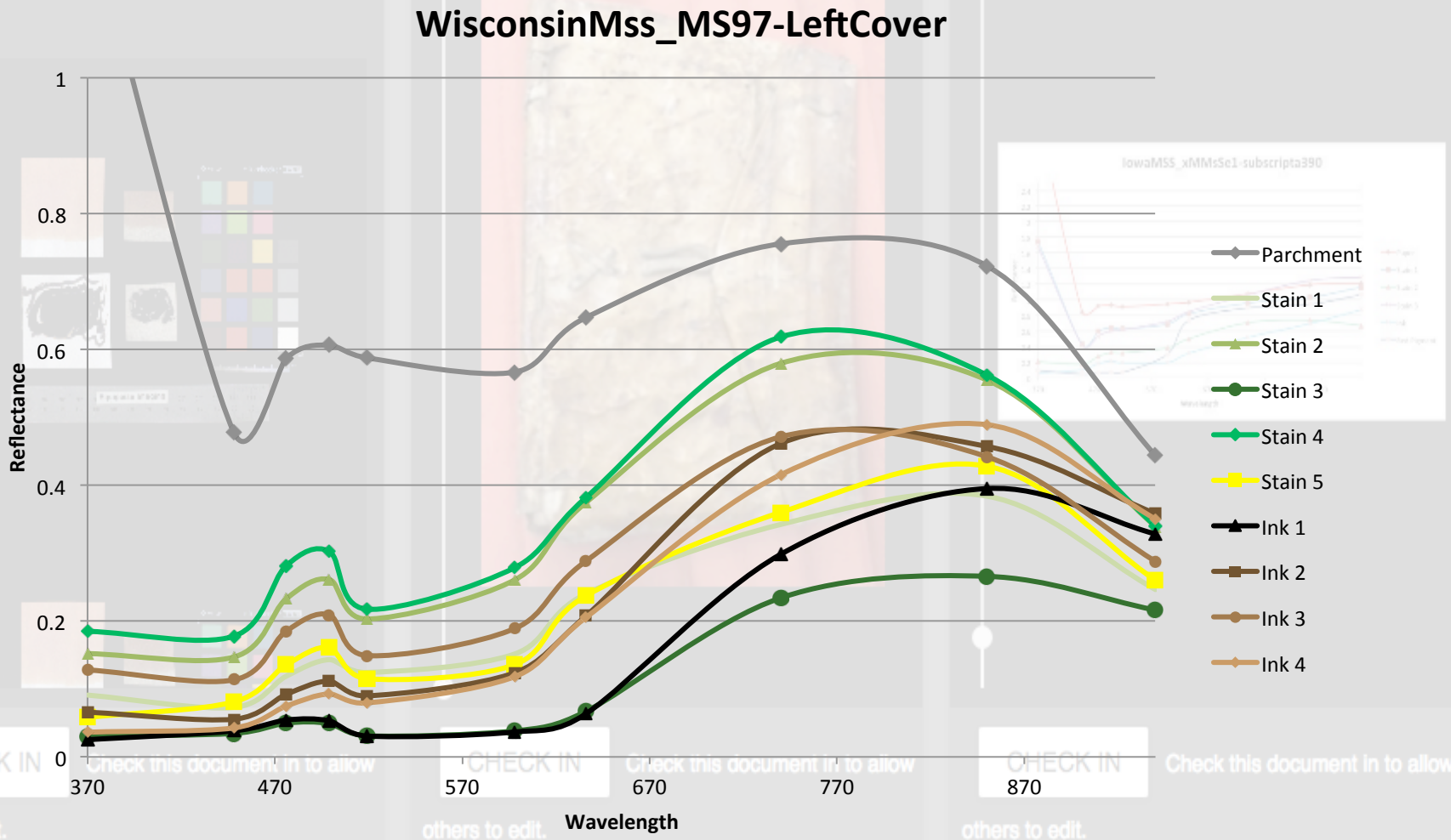
Sample Results from Wisc_MS97 in Excel Spreadsheet



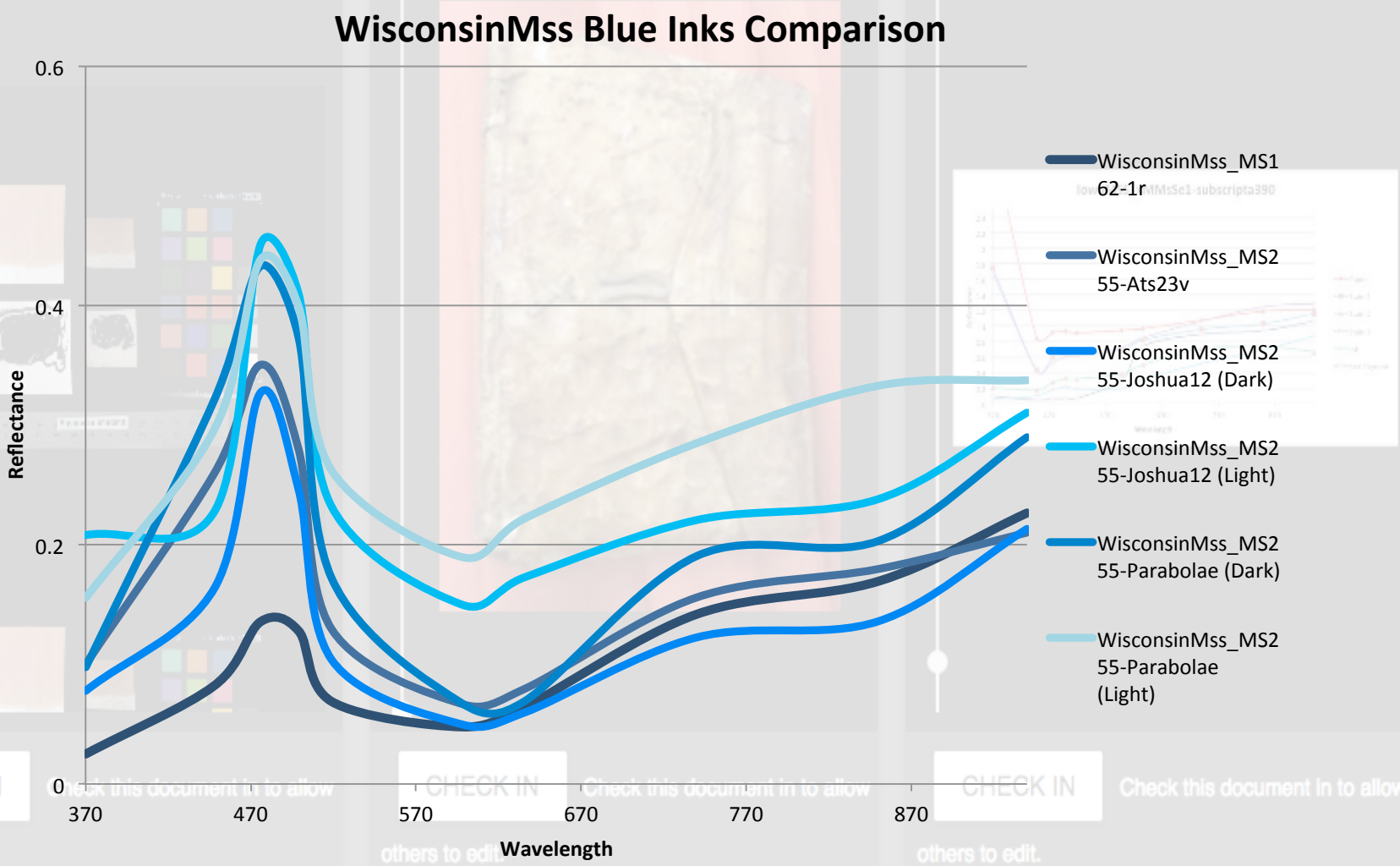
Sample Results of Wisc_MS97, Chart of Spectral Curves



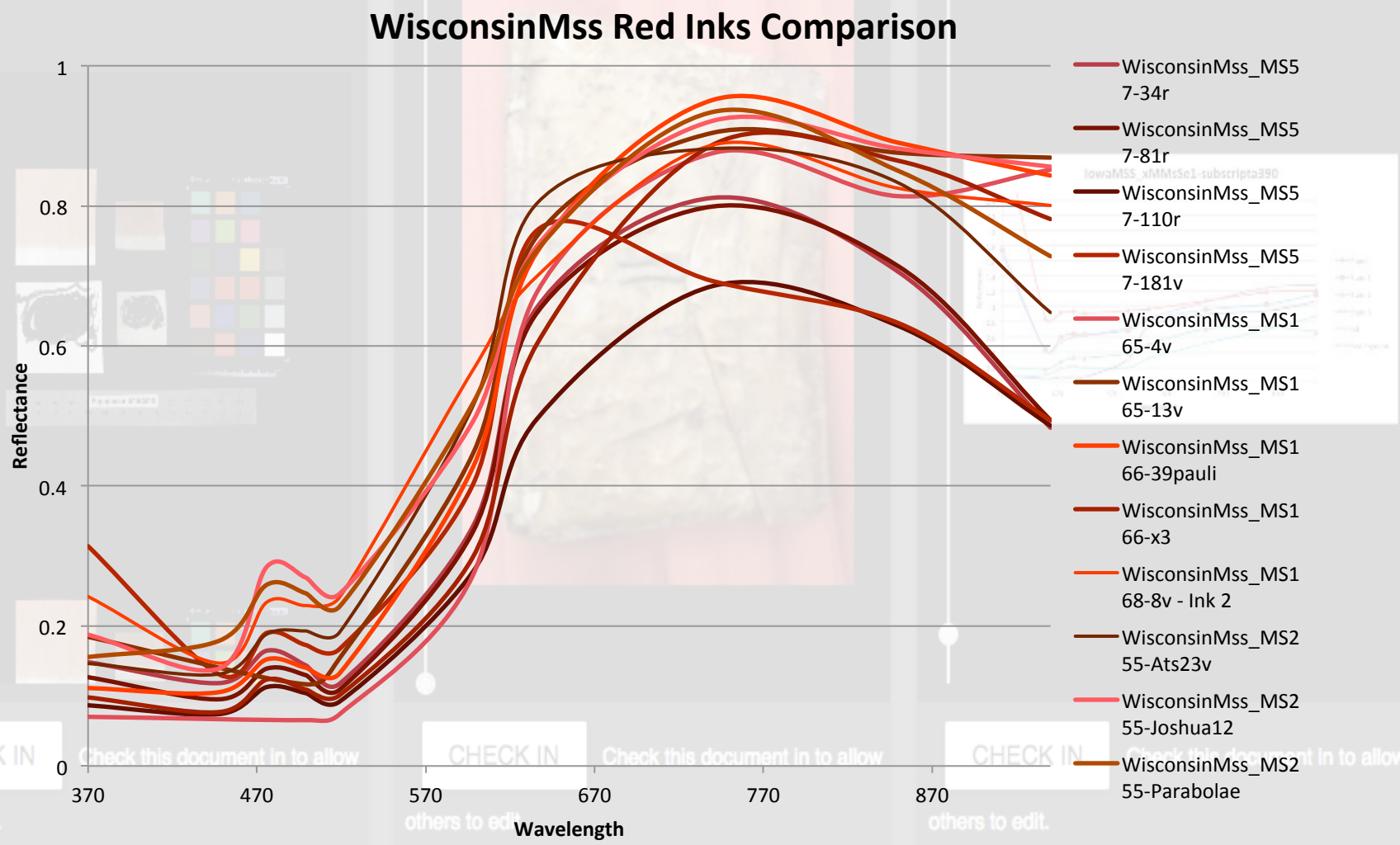
Sample Results of Wisc_MS97, Enlarged View of Spectral Curves



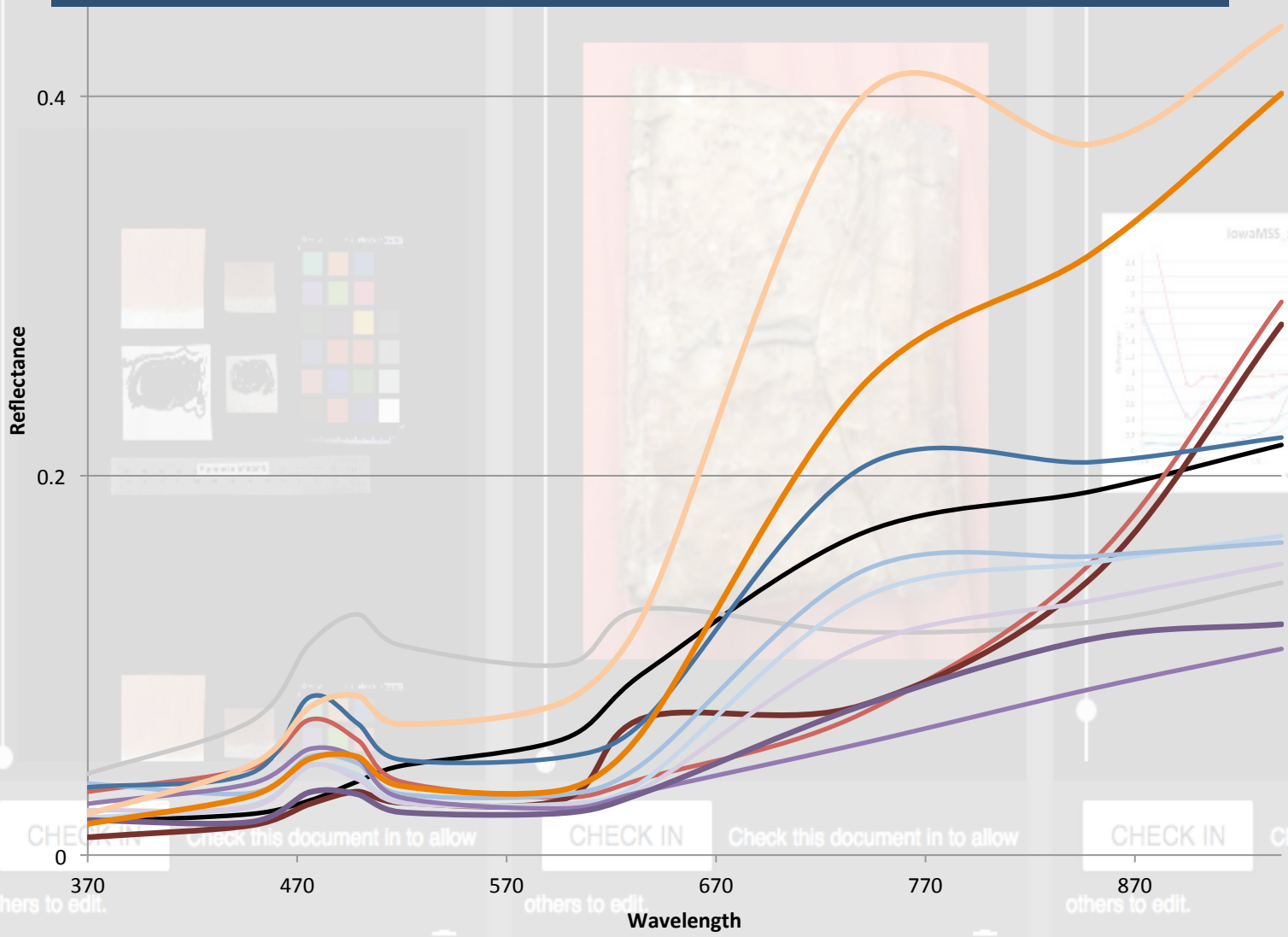
Sample Results of Blue Pigment Curves Across Six Different Wisconsin Folios/Sides



Sample Results of Red Pigment Curves Across Twelve Different Wisconsin Folios/Sides



Sample Results of Enlarged Comparison of Dark Black Inks in Wisconsin and Iowa MSS



Results Expressed in Stain Stories

- Stain stories are fragmentary narratives of a manuscript's history based on the spectral signatures of its inks and stains.
- For now, stain stories are always a hypothesis.
- For three complete stain stories see the '[Library of Stains]' site hosted in [Digital Mappa]:

1. 'A Wisconsin Music Folio Reused as a Binding'
2. 'Wax in Iowa Manuscripts'
3. 'The Ruling of Philadelphia, SHI, Othmer 1, f. 68'

Implications for Medieval Studies

- The study of medieval manuscripts is not just about language and literature, but also about the cultural and historical contexts in which texts are created, distributed, and received.
  - Where was a text made, used, or read? When? And by whom?

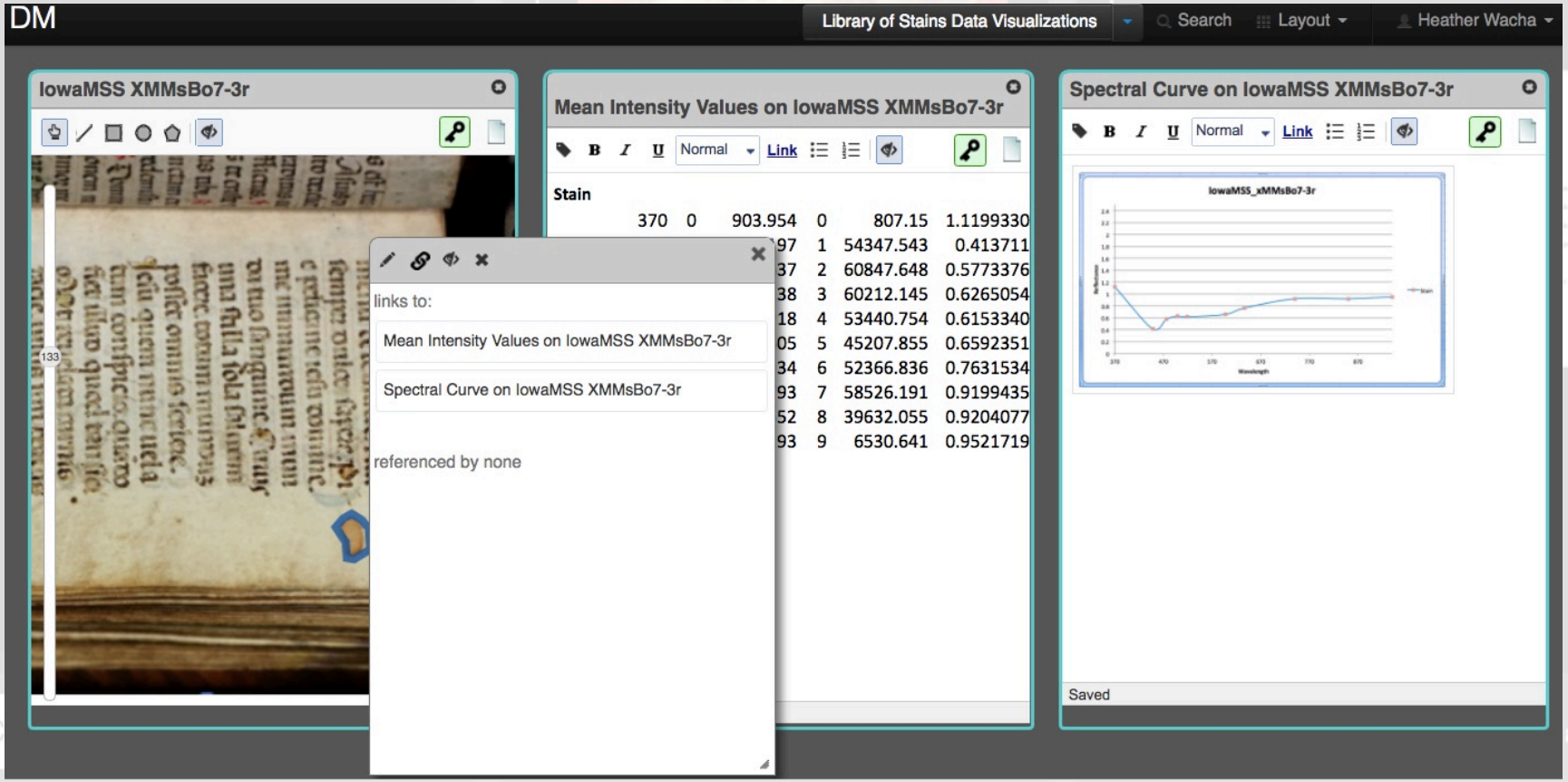
- More abstractly, this project concerns the *vehicle* of language and literature in the Middle Ages.
  - How were manuscripts treated as carriers of texts?
  - How were manuscripts/texts valued and to what degree?
  - How did people interact with the manuscripts they used?

Image Samples of Known Stains

#	Stain	Paper	Parchment	Code	Notes
1	Control	x		01-Co-pp	
2	Control		x	02-Co-pc	
3	Water	x		03-Wa-pp	
4	Water		x	04-Wa-pc	
5	Olive oil	x		05-Oo-pp	
6	Olive oil		x	06-Oo-pc	
7	Red wine	x		07-Rw-pp	
8	Red wine		x	08-Rw-pc	
9	Iron-gall ink	x		09-Ig-pp	
10	Iron-gall ink		x	10-Ig-pc	
11	Black tea	x		11-Bt-pp	
12	Black tea		x	12-Bt-pc	
13	Mould	x		13-Mo-pp	
14	Mould		x	14-Mo-pc	
15	Ammonia solution	x		15-As-pp	
16	Ammonia solution		x	16-As-pc	
17	Iron-gall ink on old parchm		x	17-Ig-op	

The Library of Stains Project includes the spectral data for a set of control stains imaged in 2017. The results we gathered from the medieval manuscripts allow us to 'characterize' curves that appear similar, but not attribute a specific identity. We had hoped that the data from the manuscripts could be compared to the sample control stains in order to move our results from 'characterization' to 'identification', but this study proved to be inconclusive. Further analysis will need to take place, taking into consideration the age factor between the manuscript stains and the control samples.

See the Library of Stains' Data Visualizations, hosted by Digital Mappa (DM), at http://app.digitalmappa.org/workspace/#beptu0pz



Follow the Library of Stains Project

Website and Blog: https://labeculaevivae.wordpress.com/

Twitter: @labeculaevivae #stainalive

Heather Wacha: @hgwacha
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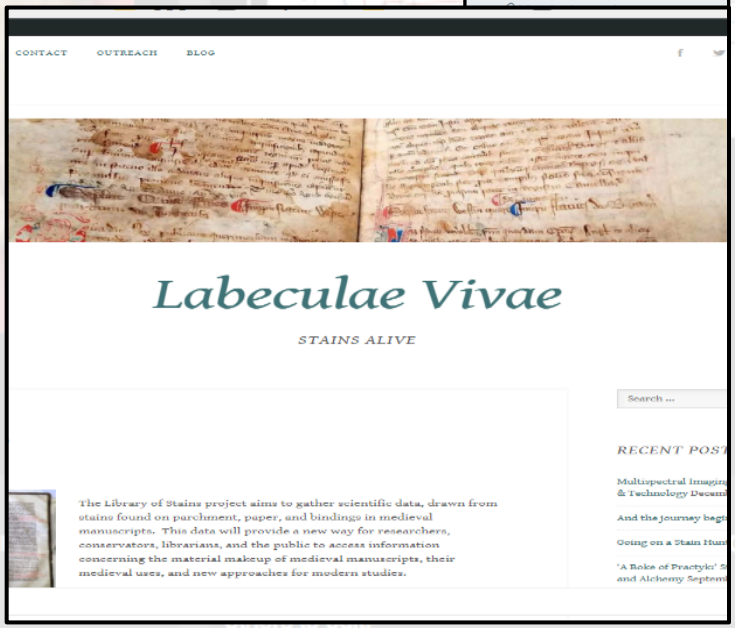
Erin Connelly: @efconnelly
Leah Pope Parker: @ParkerChronicle



Acknowledgements

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The multispectral imaging has been made possible thanks
to the support of Mike B. Toth and Bill Christens-Barry

Many thanks as well to Leah Parker, PhD Candidate, UW-Madison, for assisting with data analysis and Digital Mappa visualizations.