Watermark Wiki Submission
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The paper lab at the Art Institute of Chicago recently updated their protocol for beta radiography after the generous gift of a Konica Minolta Regius ΣII Scanner and Regius FP-1S phosphor-coated imaging plates. We have kept our beta plates as emission sources but the phosphor-coated imaging plates have replaced Kodak film and they offer several advantages including: a larger surface area, higher sensitivity to beta rays, lower sensitivity to visible light, and they are reusable. Practically, these features translate into significantly shorter collection times (between 10-40 minutes, depending on the thickness of the support), a setup that is safer for the art (i.e. does not have to be carried out in total blackness), and a digital image that is easily manipulated with basic Image Pilot Konica software. You can think of the imaging plate as the film and the scanner as the developer / reader. For the purposes of this Wiki, we would like to share the general parameters of our equipment and setup, an example of our results, and our thoughts about the pros and cons of this method of watermark imaging.

Products:

- Konica Minolta Regius ΣII Scanner
- Regius FP-1S plate [Deposited layer of (BaFBrI:Eu) on polyethylene terephthalate] in a Regius RC-300 cassette (available in the following dimensions: 14"x 17" / 14"x 14" / 11"x 14" / 10"x12" / 8"x10")
- Image Pilot software (Version 1.70R00E) and MicroDicom -Free DICOM Viewer (Version 0.1.5 Beta)

Scanner

Cassettes with phosphor plates inside

Setup:

Assistant conservator of Asian art, María Cristina Rivera Ramos, has refined our setup to maximize image consistency and clarity while minimizing collection time.[1] In accordance with her training at Buffalo State, she has found that in order to achieve a focused image, the beta plate should be weighted when possible. The diagram below illustrates our current setup, which is constructed inside of a solander box for a quick and easy "darkroom." Note that the setup can be arranged in the presence of low light or a red light without compromising the exposure of the plate.

Mylar and polished glass, precut to the size of the beta plate, has been the best way to apply the even pressure that is necessary for a sharp image.

The sensitivity of the plate has allowed us to cut our exposure time down to around 20 minutes for most works on paper of average thickness.

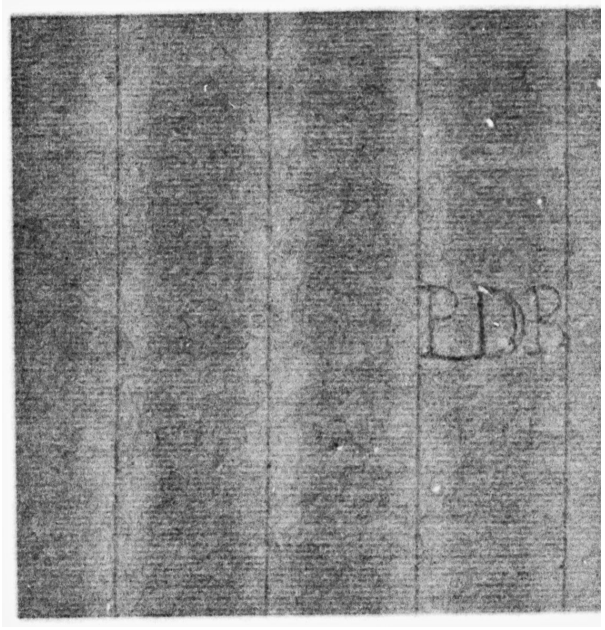
Once exposed, the plate can be removed and the setup can be deconstructed in low light or red light. The plate is inserted into a plastic cassette, pictured above, which creates a sealed environment. At this point, the plate is safe in the cassette and the lights can be on. It should be noted that the sensitivity of the plate allows it to collect ambient radiation over time and while the exposed plate can remain in the cassette, unread, for a couple of hours it is not recommended that it be left for more than 8 hours (based on the manufacturer's recommendation, but not tested) lest the image quality degrade. Plates should always be erased (run through the scanner) prior to exposure to eliminate this cumulative, ambient interference.

Operation of the scanning unit is very simple. The hardware and software used were designed for medical radiography, and their formats reflect this. The Konica Minolta scanner also provides

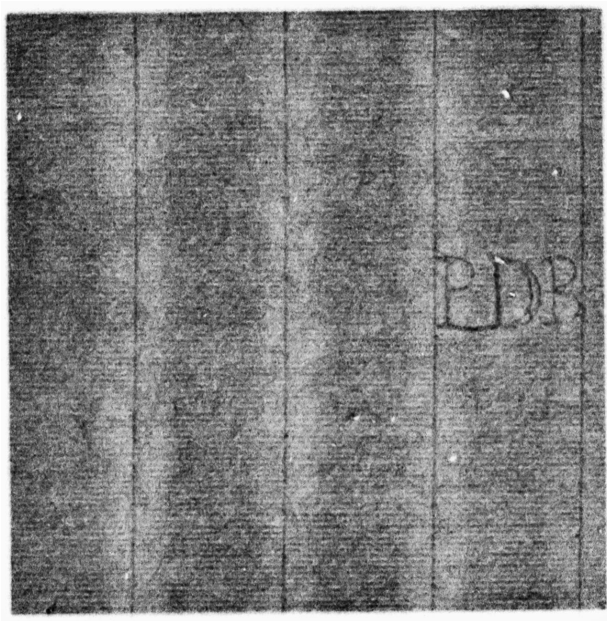
[1] Our current setup has been modeled after Buffalo State's recommendations for Beta radiography acquisition. Kushel, D. (2014) 'Bare Film (or bare CR IP) Radiographic Techniques: Grenz, Beta, Electron Transmission, and Electron Emission Radiography Setup and Applications' *CNS 604/605 Conservation Imaging: Technical Examination and Documentation III*. Art Conservation Department, SUNY-Buffalo State College. Unpublished.

a mixture of Frequency (HF) and Equalization (HE) processing as a standard function. This hybrid processing “corrects” the image density and applies sharpening. We have found this automatic enhancement process very convenient, and we usually leave it on for a quick, easy, and legible capture. However, this feature can be disabled if a more controlled image acquisition process is desired.

Our lab had a Konica Minolta technician set up a dedicated PC with the Image Pilot and MicroDicom software, hook up the scanner, and provide a brief tutorial on how to extract the plates from the cassettes (a special “key” is needed), how to insert the cassettes into the machine, and how to adjust the setting for scanning. A key thing to note about the scanning process is that it automatically erases the imaging plate as it scans. This means that an image can only be collected once from an exposed plate. María Cristina ran tests using both the Low (Standard 1) and the High (Standard 2) Image Processing Intensity (IPI) settings and found that both settings are useful for reading different paper features. Beta radiographs scanned at a low IPI are perfectly legible when the watermark is well defined. High IPI scans enhance contrast and are good for sharpening faint marks and pulling out laid and chain lines. Below you can see the difference in image quality between scans collected at low and high IPIs:



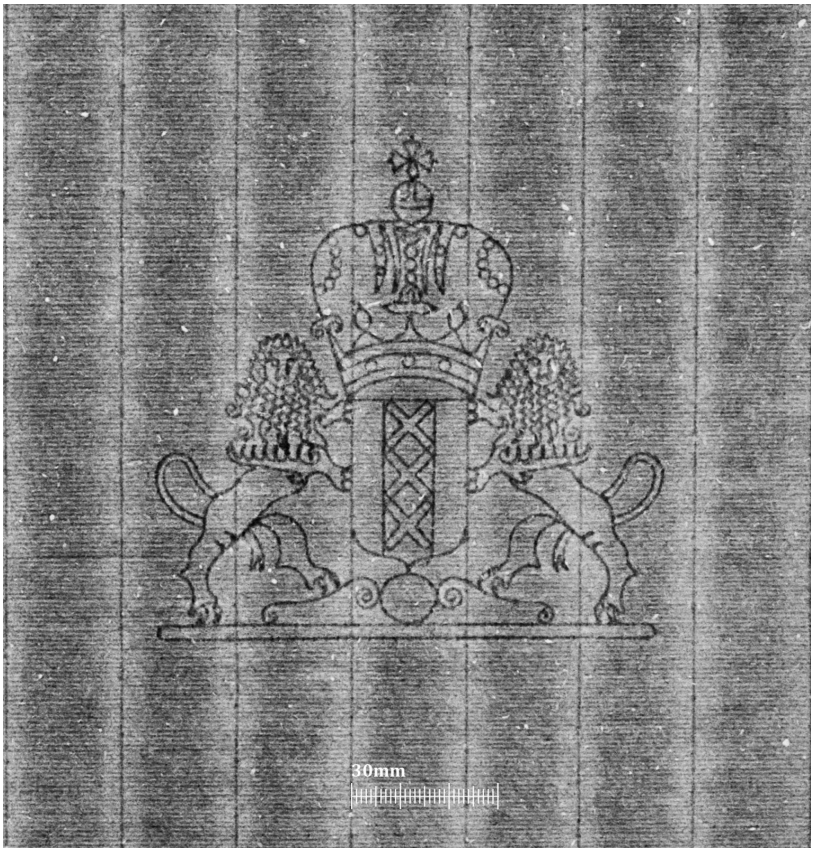
Beta radiograph of 0.16 mm thick paper sample, following the acquisition setup detailed in the diagram above, with an exposure time of 15 minutes, and scanned at “Low IPI”



Beta radiograph of the same sample, under the same acquisition setup and exposure time, scanned with the “High IPI” setting

Once the image has been acquired, the Image Pilot software provides a variety of tools that allow for basic image manipulation. Some of the adjustments that can be made using the software are: changes to the exposure and contrast of your image, reorientation, and the

addition of annotations including measurements. The image can then be exported as a .jpg or .TIFF. Image pilot also provides the option of exporting in .DICOM format, which can be opened and manipulated in a similar fashion with the MicroDicom software. Further image processing, such as incorporating a scale bar, can also be performed in photoshop.



Beta radiograph following the acquisition setup detailed in the diagram above, with an exposure time of 15 minutes, scanned at “Low IPI”, and processed in Adobe Photoshop

To summarize, we offer the following pros and cons of this process:

Pros:

- Short exposure times! Sheets that may have previously required 6 to 8 hours of exposure with film now typically take 20-30 minutes.
- No need for chemicals - no analogue photo lab setup required
- Safer for the art- while some of us may be experts at capturing radiographs in total darkness, the ability to have a dim/red work light present minimizes the chance of damage
- One-step digitization - no need to scan film and the software allows for basic manipulations without Photoshop

Cons:

- Cost: If you already have a viable analog setup, it might not be worth the money to switch. If purchased new, the scanning unit costs approximately $50,000.
- Resolution is not as high as film. Maximum resolution with the imaging plate is 4,020 × 4,892 pixels with the 14” x 17” cassette, at an 87.5µm reading mode.
- There can be variability between imaging plates. Plates can develop artifacts and variability over time. Always return the plate to the same, labeled cassette and keep track of which plate you have used.
- Phosphor-coated plates are delicate, they must be handled with care and they do wear out over time. New plates cost $600.00 —$700.00, depending on size.

While it must be said that the biggest downside to this setup is cost, it does offer a cheaper alternative to systems like the Kodak Industrex HPX-1, that have been successfully integrated into documentation studios at places like the Buffalo State conservation program and the Metropolitan Museum of Art.

If you have additional questions about this system, we can be reached at:

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