



[Carte de visite portrait of a baby standing kissing his reflection], Hector William Vaughan ca. 1855-95
(Source: Yale Collection of Western Americana)

The Use of Low-Cost Sensors to Measure Mercury Vapor from Tin-Mercury Amalgam Mirrors

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History and Manufacture



From *Diderot Encyclopedia: The Complete Illustrations 1762-1777*. Harry N. Abrams Inc. Publishers, 1978.

Historical representation of the mirror manufacturing process

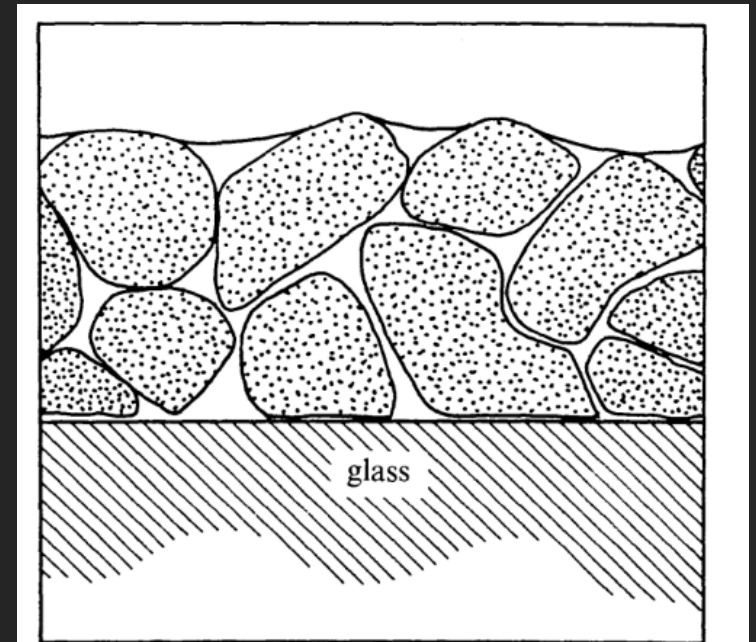


Figure 1 A sketch of the structure of the mercury-tin amalgam mirror.

Source: (Per Hadsund 1993)

The Degradation and Release of Mercury Vapor

Source: Per Hadsund, 1992

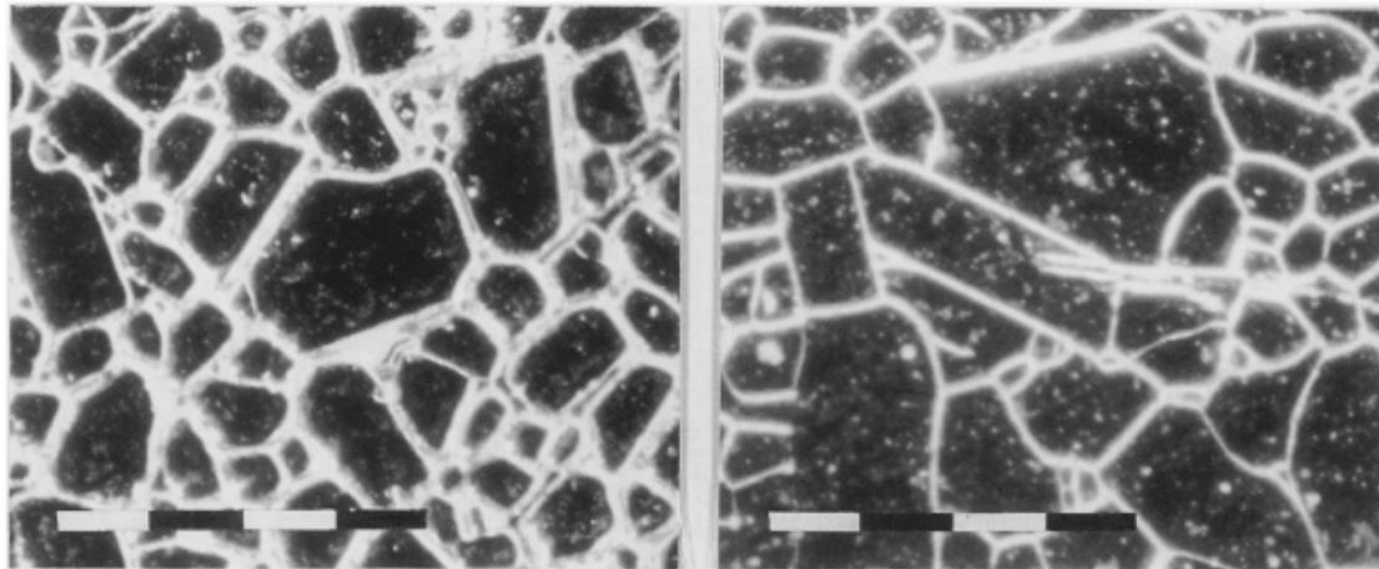


Figure 9 Macrophotos of amalgam from two old mirrors (nos. 2 and 6) with very large and flat crystals. Mercury evaporation has resulted in very narrow gaps between the crystals. Mirror no. 2 to the left and mirror no. 6 to the right. Scale bar: 0.1mm.

Source: Keith Dotson Photography



Winterthur Museum Garden & Library

Credit: (c) 2007 Derek Ramsey



Active Dripping and Mercury Cleanup



Source: William Donnelly

Mercury dripping from mirror at Winterthur



Source: Melissa King

Matt Mickletz collecting mercury droplets that fell from an actively dripping mirror at Winterthur

Previous Research at Winterthur

Source: Julia Commander



Leah Bright, WUDPAC
Class of 2017

Source: Rosie Grayburn



Catherine Matsen and Dr.
Rosie Grayburn analyzing
mirrors at Winterthur

Source: Rosie Grayburn

Percentage (of 243 total mirrors analyzed)	Mirror Composition
63%	Sn-Hg amalgam
34%	Inconclusive
3%	Silvered (Ag)

Research into Mercury Detection for Artisanal Gold Mining Industry

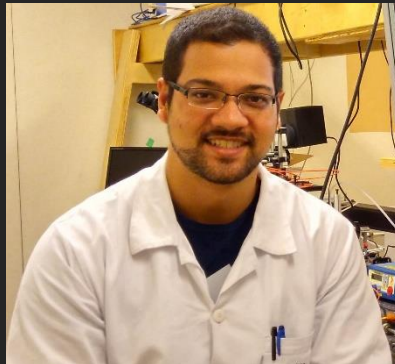
Barros Santos, E., Moher, P., Ferlin, S., Fostier, A.H., Mazali, I.O., Telmer, K., & Brolo, A.G. **“Proof of Concept for a Passive Sampler for Monitoring of Gaseous Elemental Mercury in Artisanal Gold Mining.”** *Scientific Reports* 7, no. 1 (December 2017)



Source: University of Victoria



Dr. Alexandre Brolo



Dr. Carlos Diego
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Source: Artisanal Gold Council



Dr. Kevin Telmer,
Artisanal Gold Council



Research into Mercury Detection for Artisanal Gold Mining Industry



Source: frontiermyanmar.net



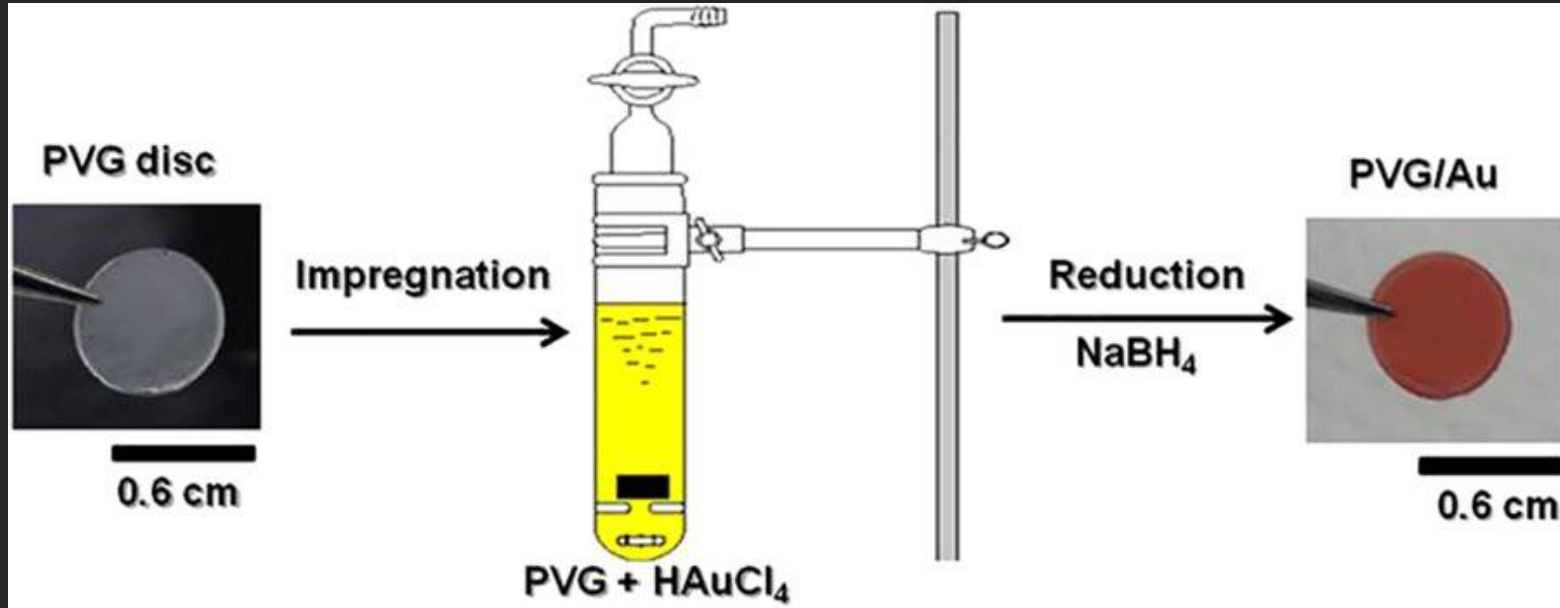
Source: Barrio Neal



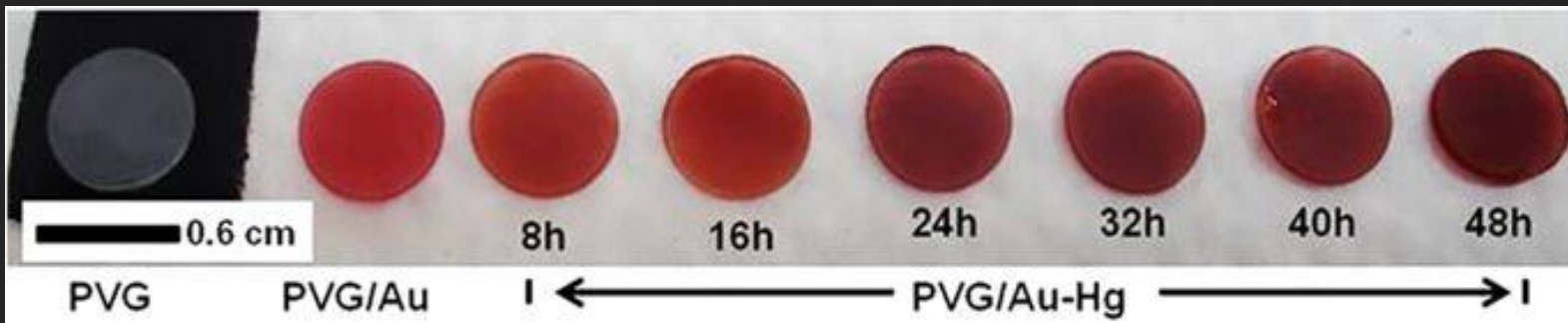
Source: Wikipedia.org

Research into Mercury Detection for Artisanal Gold Mining Industry

Source: University of Victoria



Source: Brolo et al. 2017



Source: Melissa King



Using the Sensors to Detect Mercury Vapor Near Mirrors

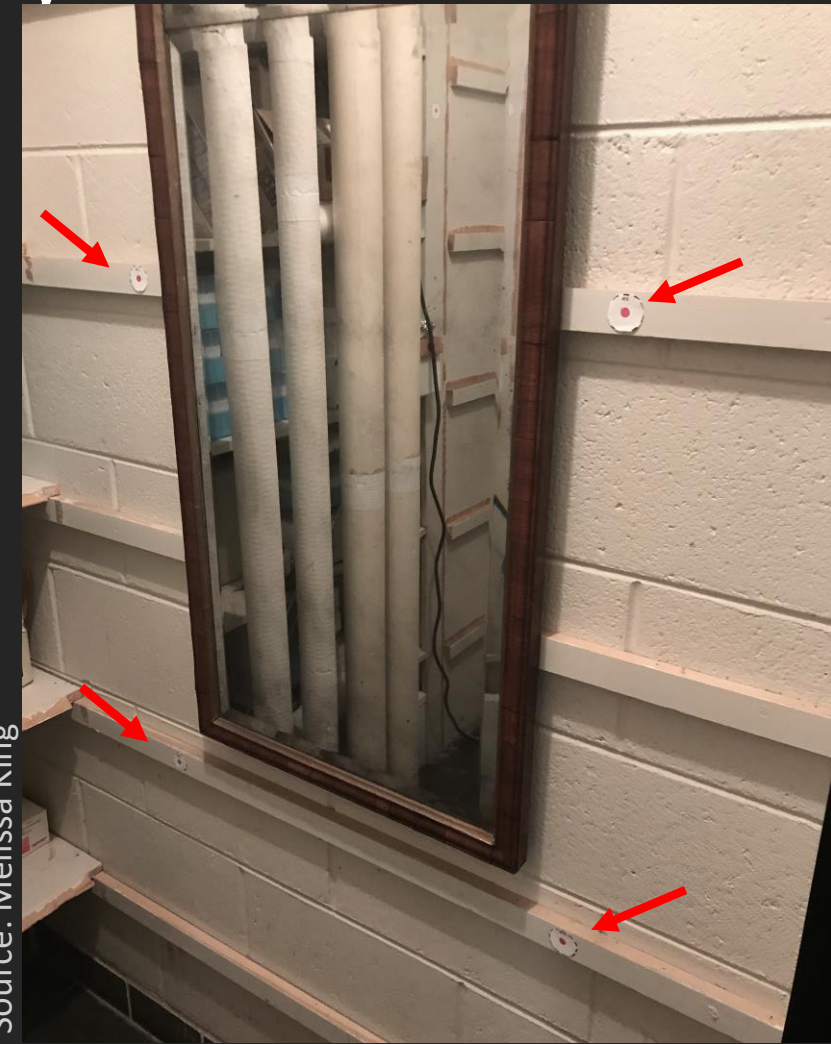
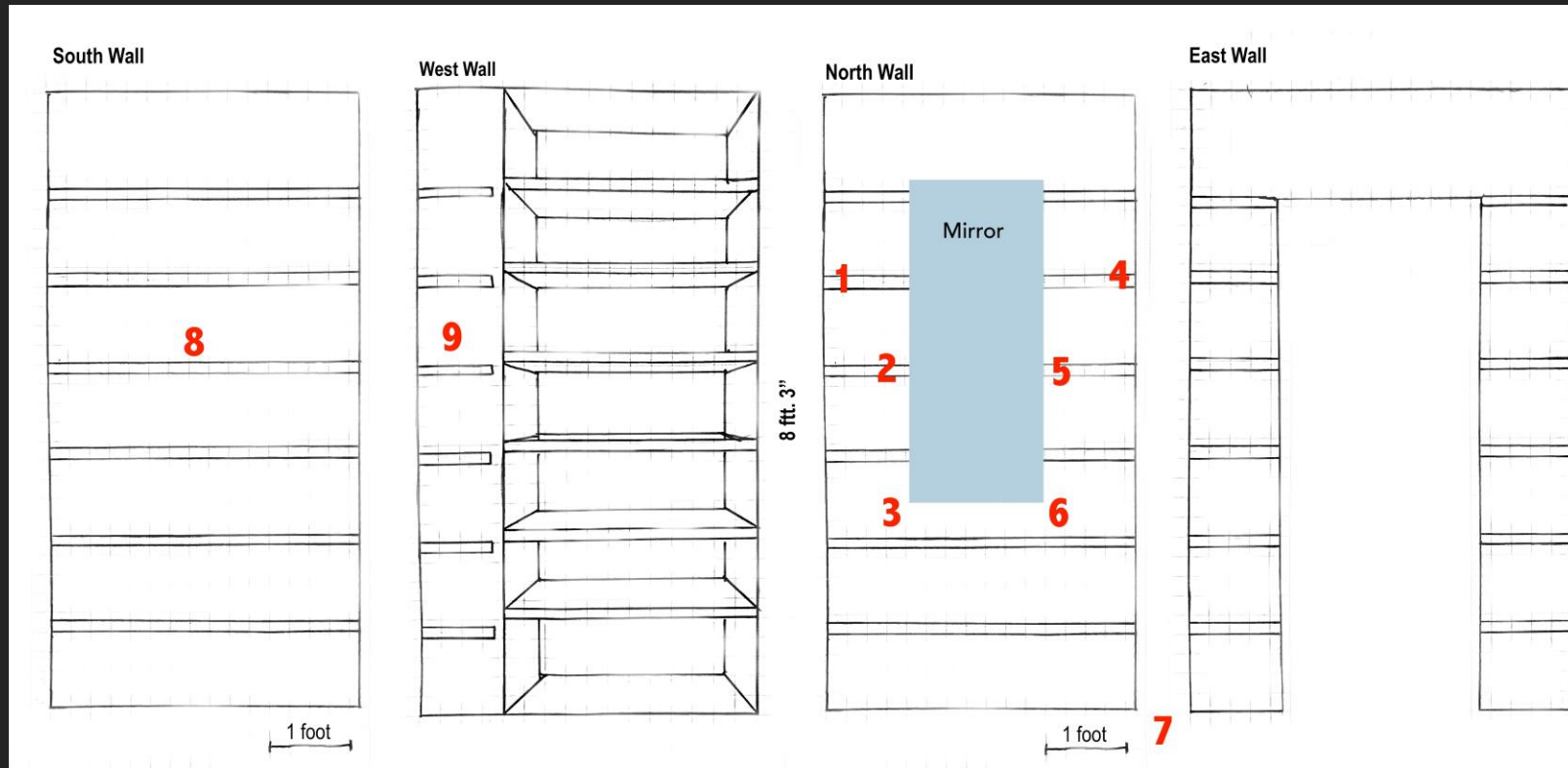


Diagram of storage closet and sensor locations relative to the mirror

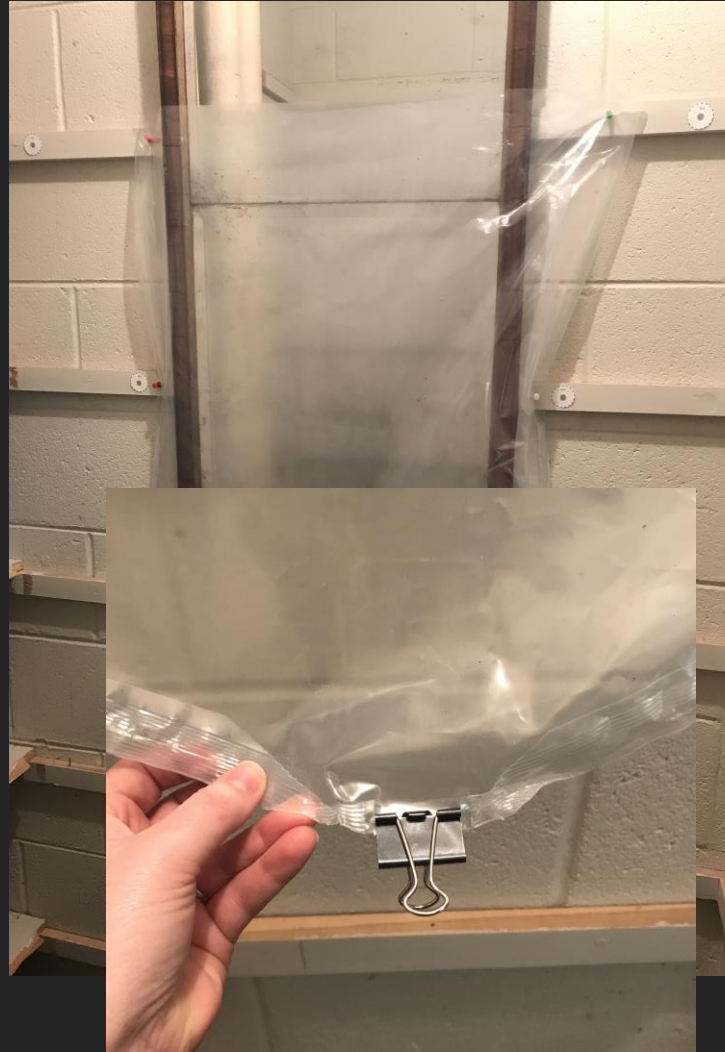
Sensors placed around the mirror

Using the Sensors for Monitoring Mercury Vapor Levels for Stored Mirrors



Source: Melissa King

CONTROL: Uncontained mirror with nothing to capture liquid mercury



Source: Melissa King

POSSIBLE STORAGE METHOD: Polyethylene sleeve with drainable capture location at the bottom

Measuring Mercury Vapor Levels



Source: Melissa King



Source: Melissa King

LIMITS:

OSHA PEL: 0.1 mg/m^3

NIOSH REL: 0.05 mg/m^3

ACGIH TLV: 0.025 mg/m^3

HIGHEST READING:

0.00265 mg/m^3

Brandon Calitree, UD Safety and Facilities Coordinator, using a Jerome J505 Mercury Vapor Sensor in the closet with the mirror

Using the Sensors for Monitoring Mercury Vapor Levels for Stored Mirrors



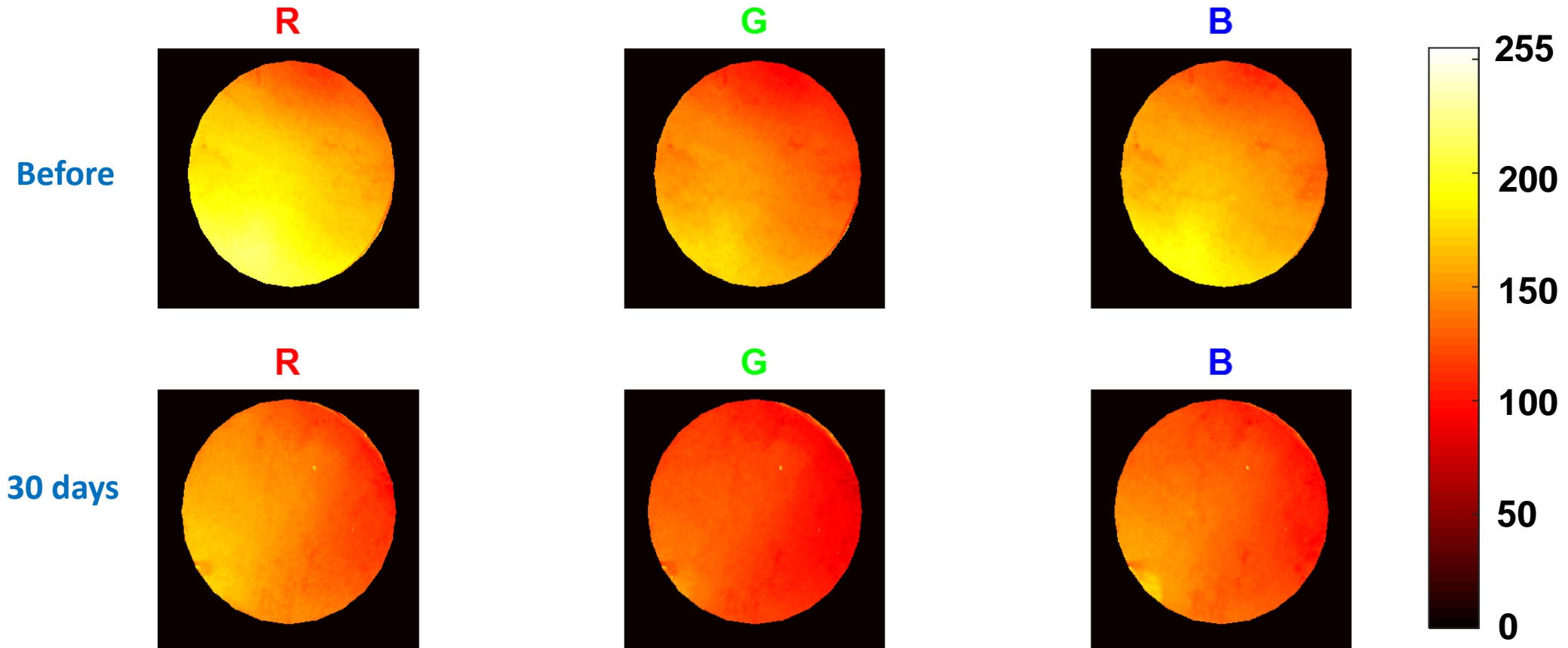
Source: Melissa King



Source: Katerina Acuna

- Regular photography of the sensors at specific times
- Up to 3 times a day and on some weekend days
- Each iteration of the study was about a month
- Required assistance from volunteers

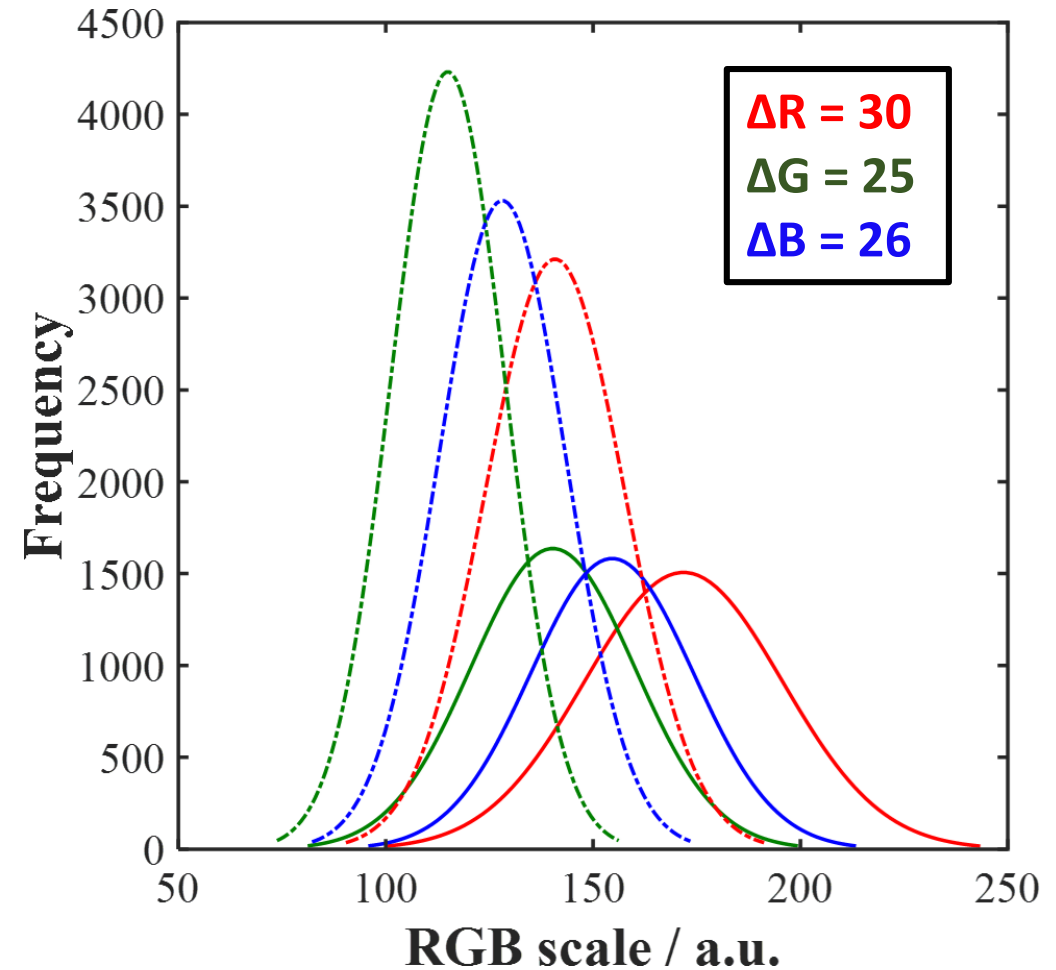
Data Processing



Preliminary results for sensor 6 showing the RGB values as a means of selecting a region of interest or "ROI" for further analysis

Data Processing

Source: Matlab



Gaussian fit for ROI images for sensor 6 before and after 30 days of Hg^0 exposure. The shifts in the RGB channels suggest the gold nanosensor was able to detect Hg^0 successfully.

Conclusions, Future Work

- Mercury levels were low, but appeared to be building up in plastic sleeve
 - Informed storage decision to avoid enclosure
- Future work:
 - Research other storage options
- Other applications:
 - Dosimeter for collections professionals working on or near mercury-containing collection items



Source: The Board of Trustees of the Science Museum

Sprinkler head with mercury mechanism

Acknowledgements

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- Leah Bright
- Catherine Matsen
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- Matt Mickletz
- Aaron Morris
- Jim Schneck
- Beth Parker Miller
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- Debra Hess Norris
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Thank You!

**Please contact Dr. Alexandre Brolo if
you are interested in experimenting
with these sensors:
agbrolo@uvic.ca**

ca. 1870 [daguerreotype portrait of woman looking into mirror] via the George Eastman House Collection