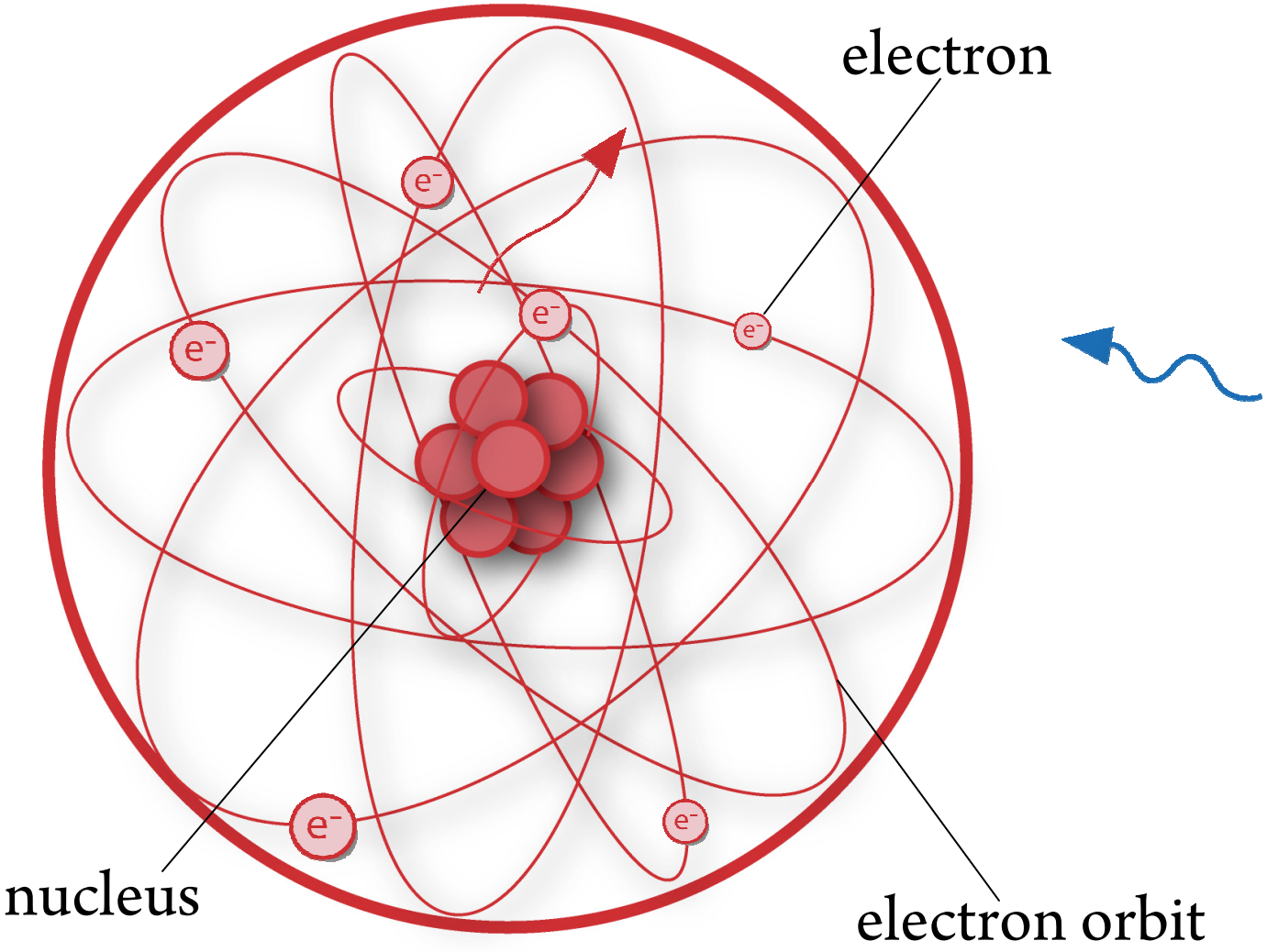
XRF Imaging: *Dinosaurs to Archimedes*

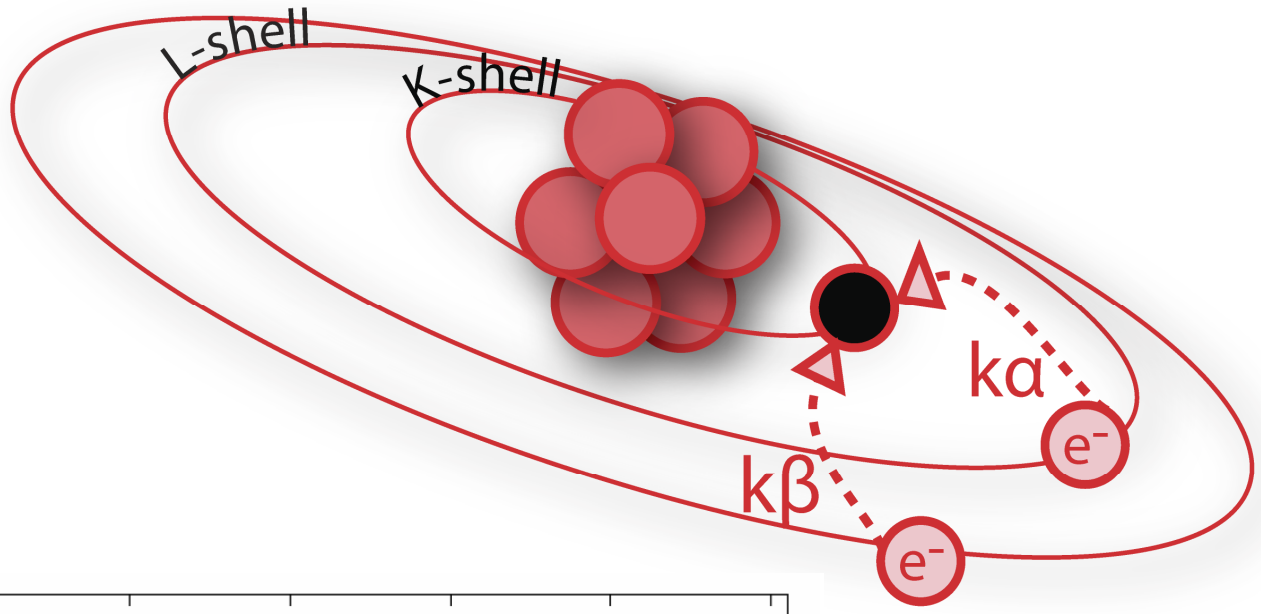
Bryce Cronkite-Ratcliff

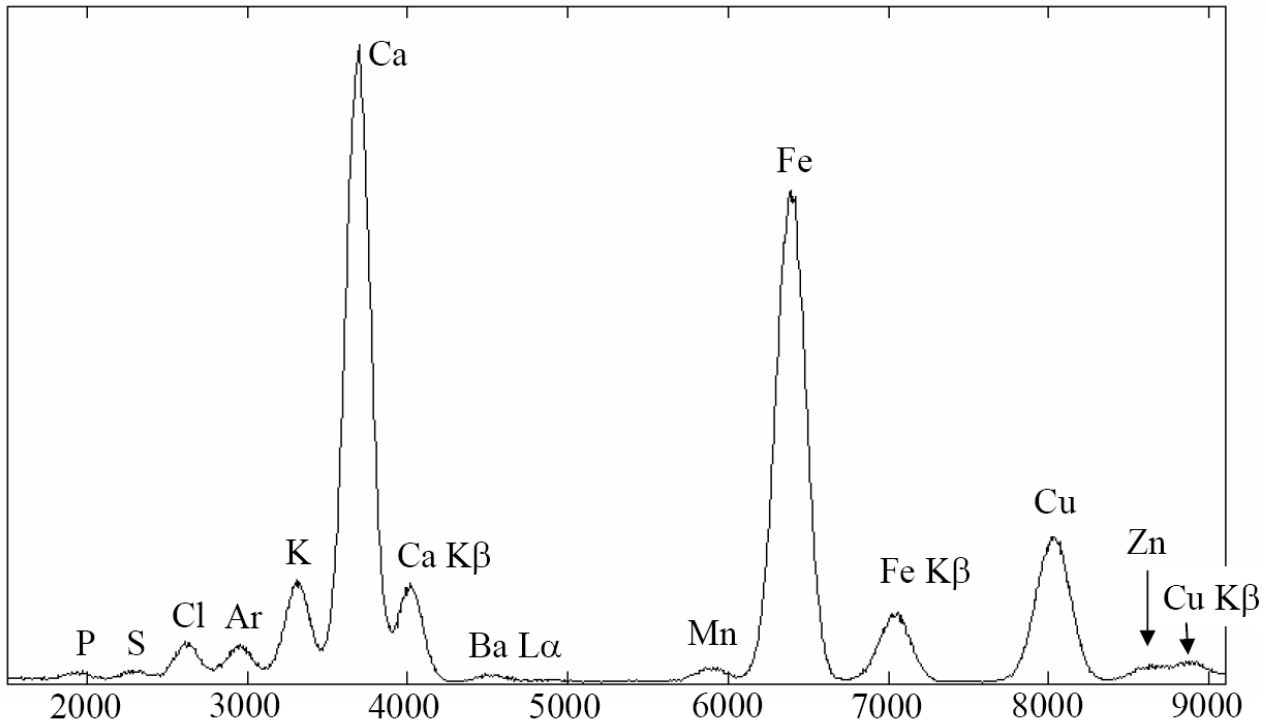
…XRF?

- Technique for imaging elemental trace concentration using Synchrotron X-ray Radiation
- Vast array of applications, including:
  - Archeology
  - Paleontology
  - Medicine

Flourescense



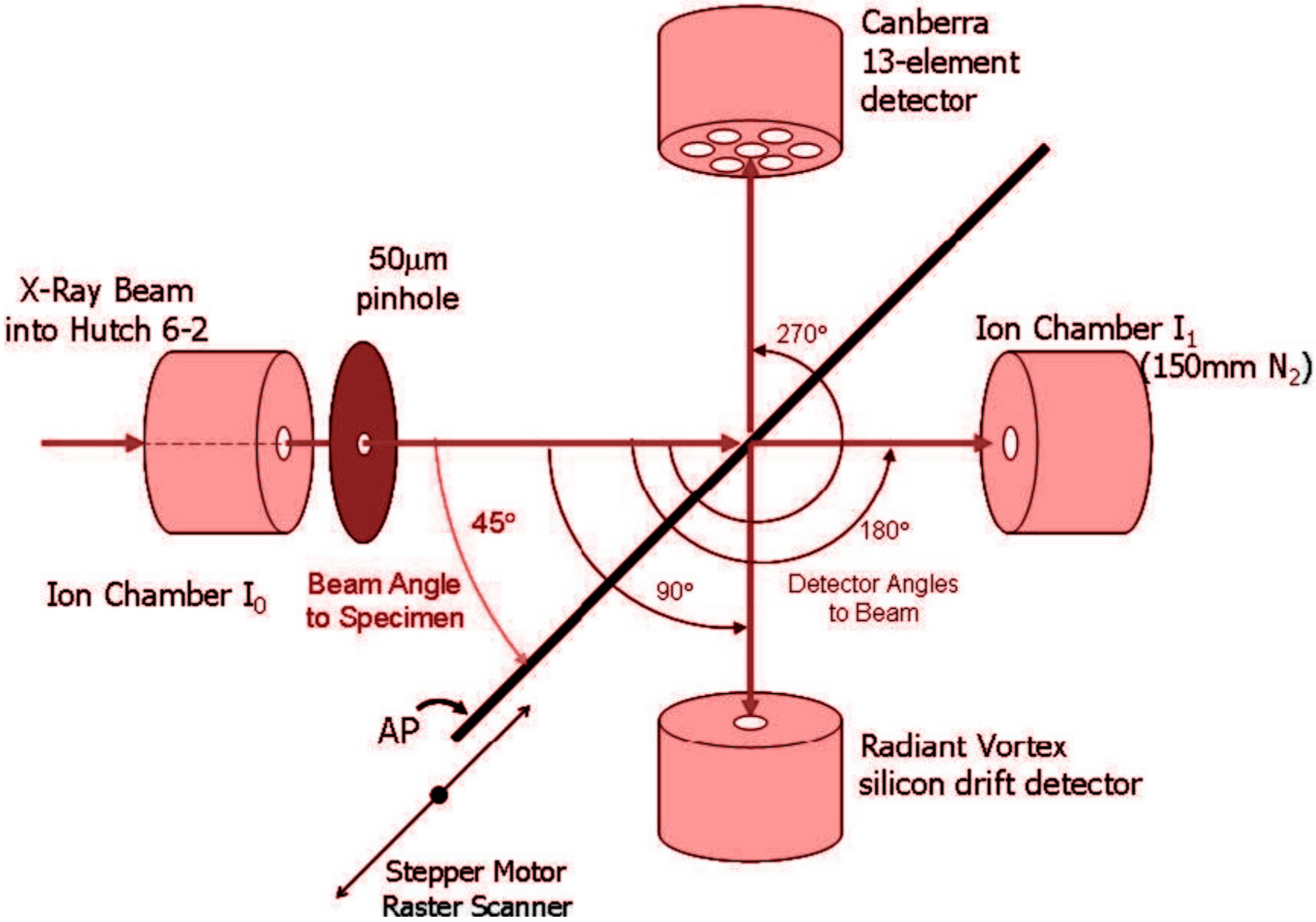

L-shell
K-shell
kα
kβ
e⁻
e⁻


Ca
Fe
K
Ca Kβ
Cu
Zn
Cu Kβ
Fe Kβ
Cl
Ar
P
S
Ba Lα
Mn
2000
3000
4000
5000
6000
7000
8000
9000

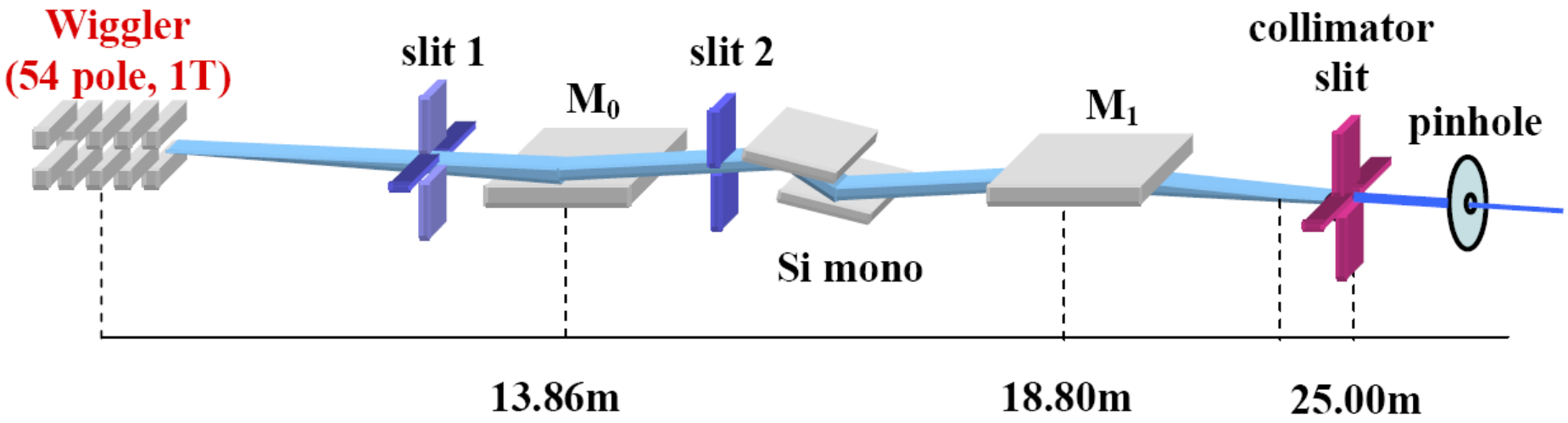
Requirements

- High-luminosity X-ray source
- Multi-channel detectors
  - separate channels detect disparate energy
  - “windows” to record different elements
- Motorized sample platform
- Rapid-scan technology

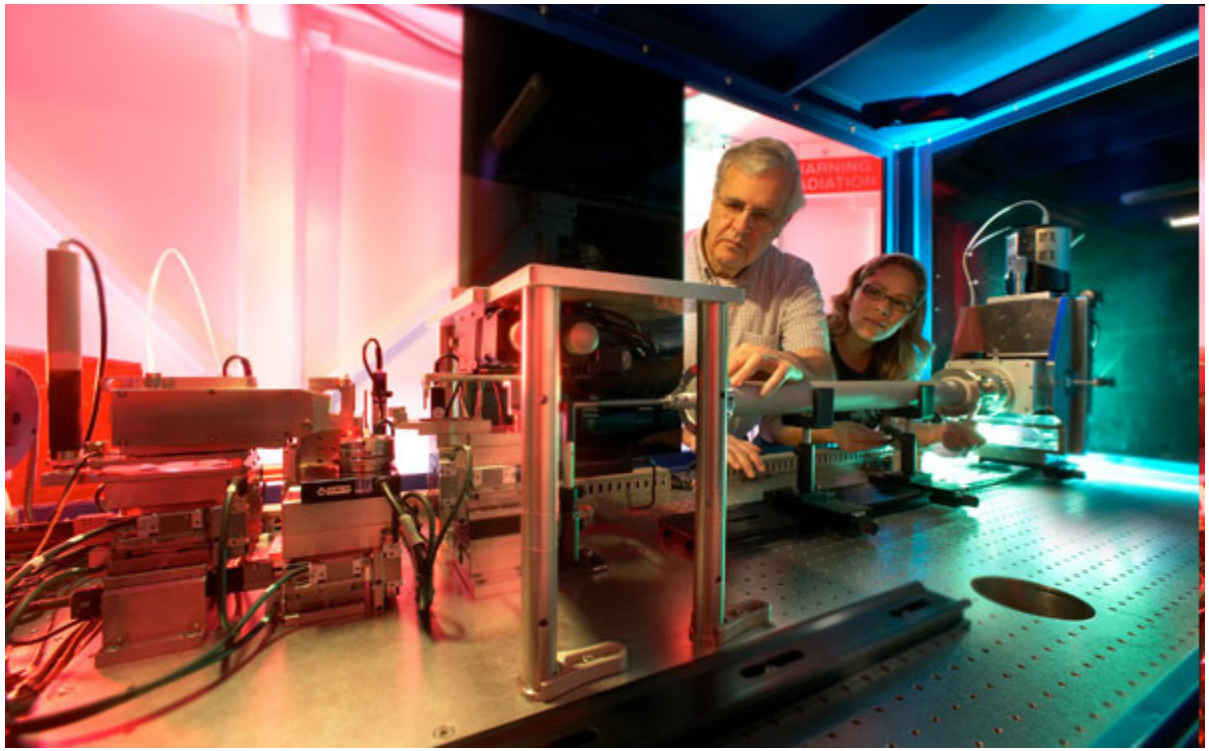
Basic Setup (top-down)



Beamline 6-2



Brightest beamline at SSRL in the relevant energy range



Rapid Scanning

Absolutely necessary for sizable samples:

Scanning time for 14 cm X 17 cm rectangle at 600 dpi ~
36 hours + readout time + motor direction change time

Hassle caused by beam top-off

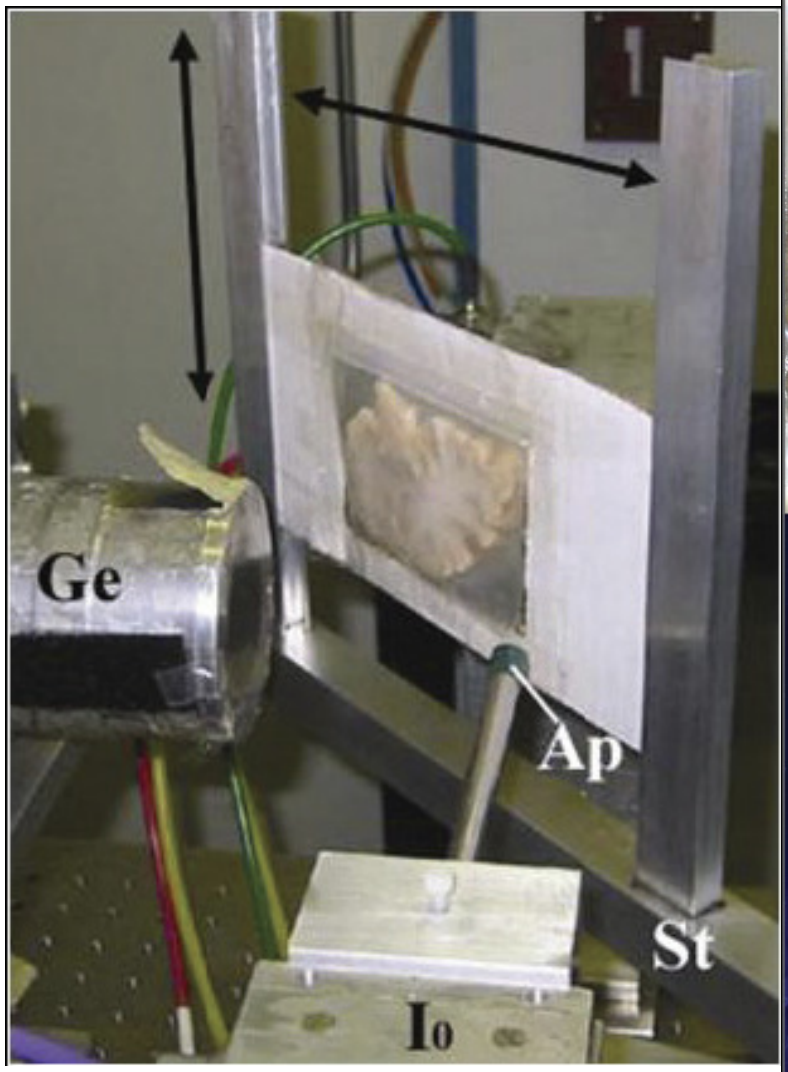
New hardware and software developed:

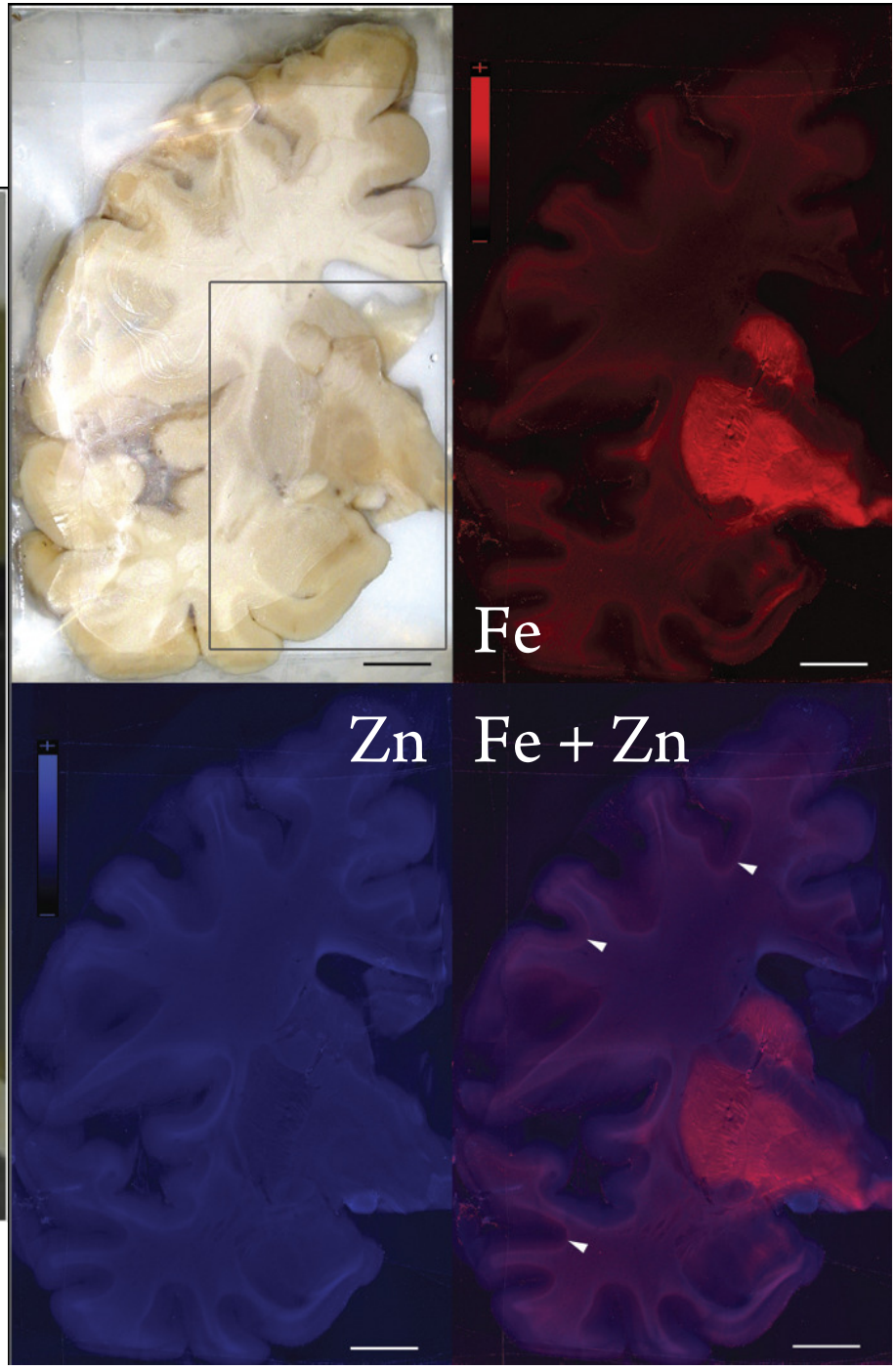
Stores scanned information locally while scanning,
dumping into a control computer at the end of each line.

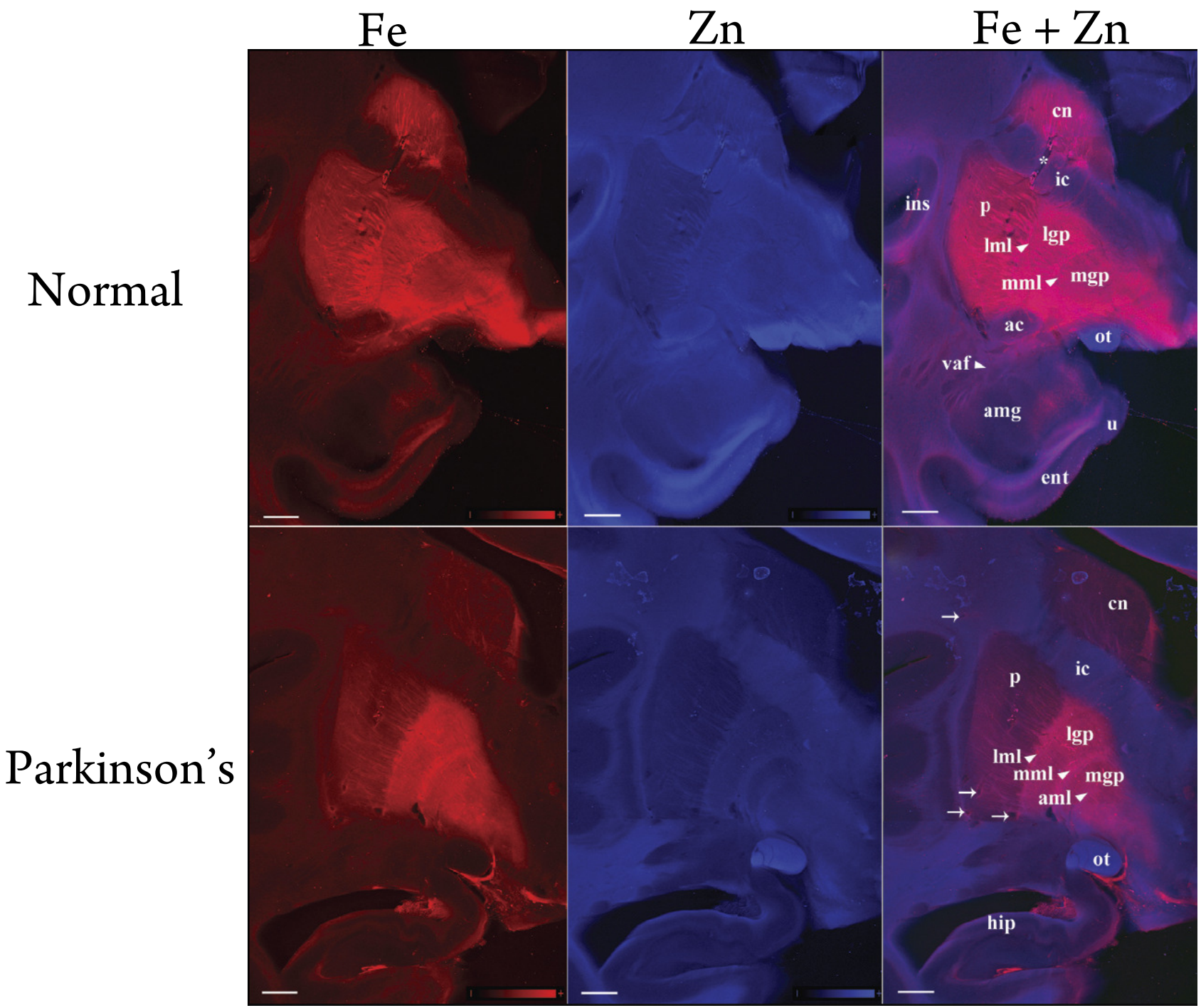
Decouples data processing time from scanning timeframe

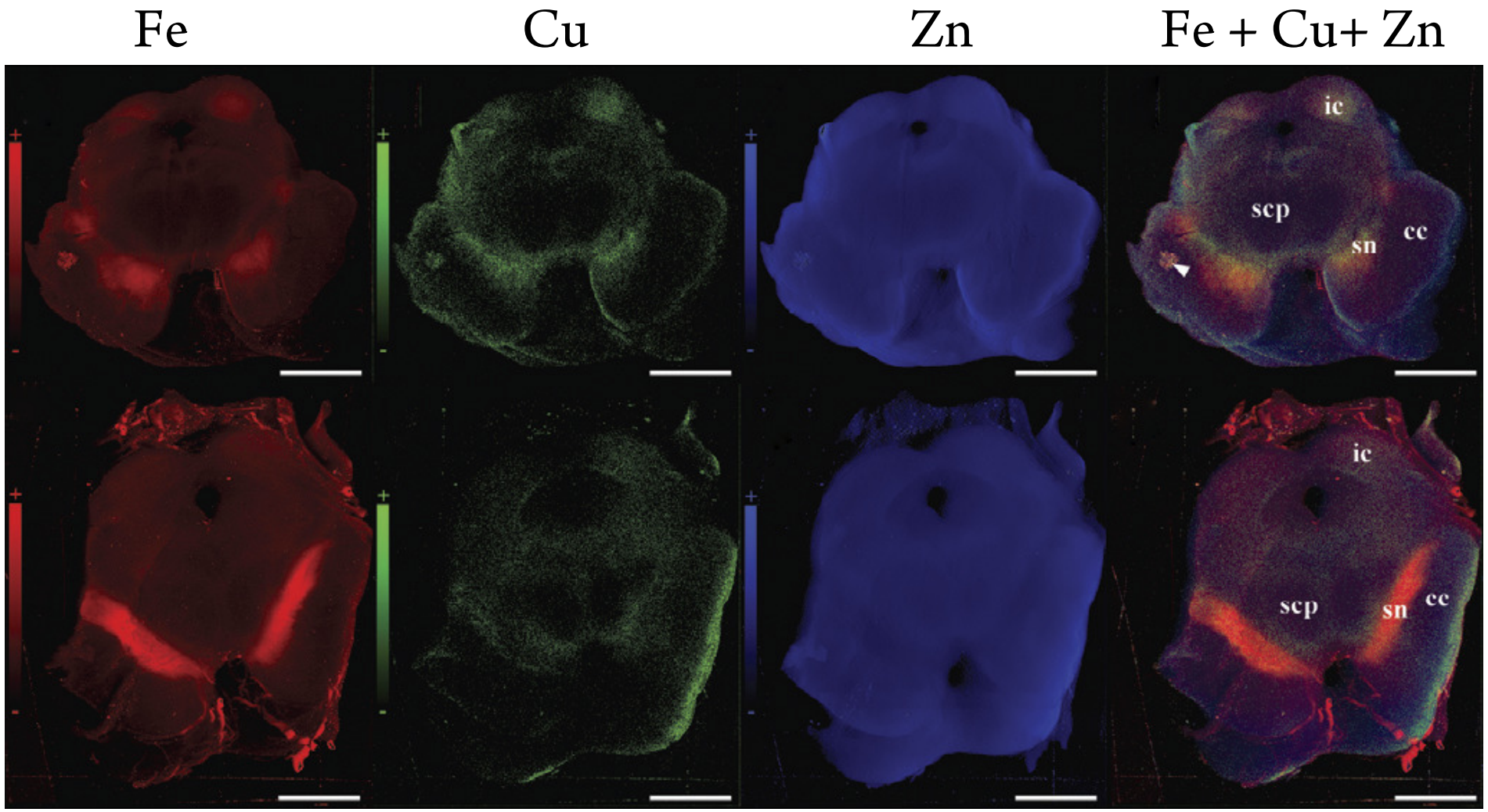
Enables live update of the image

Applications: *Parkinson's Cerebral Signature*


Ge
Ap
St
Io

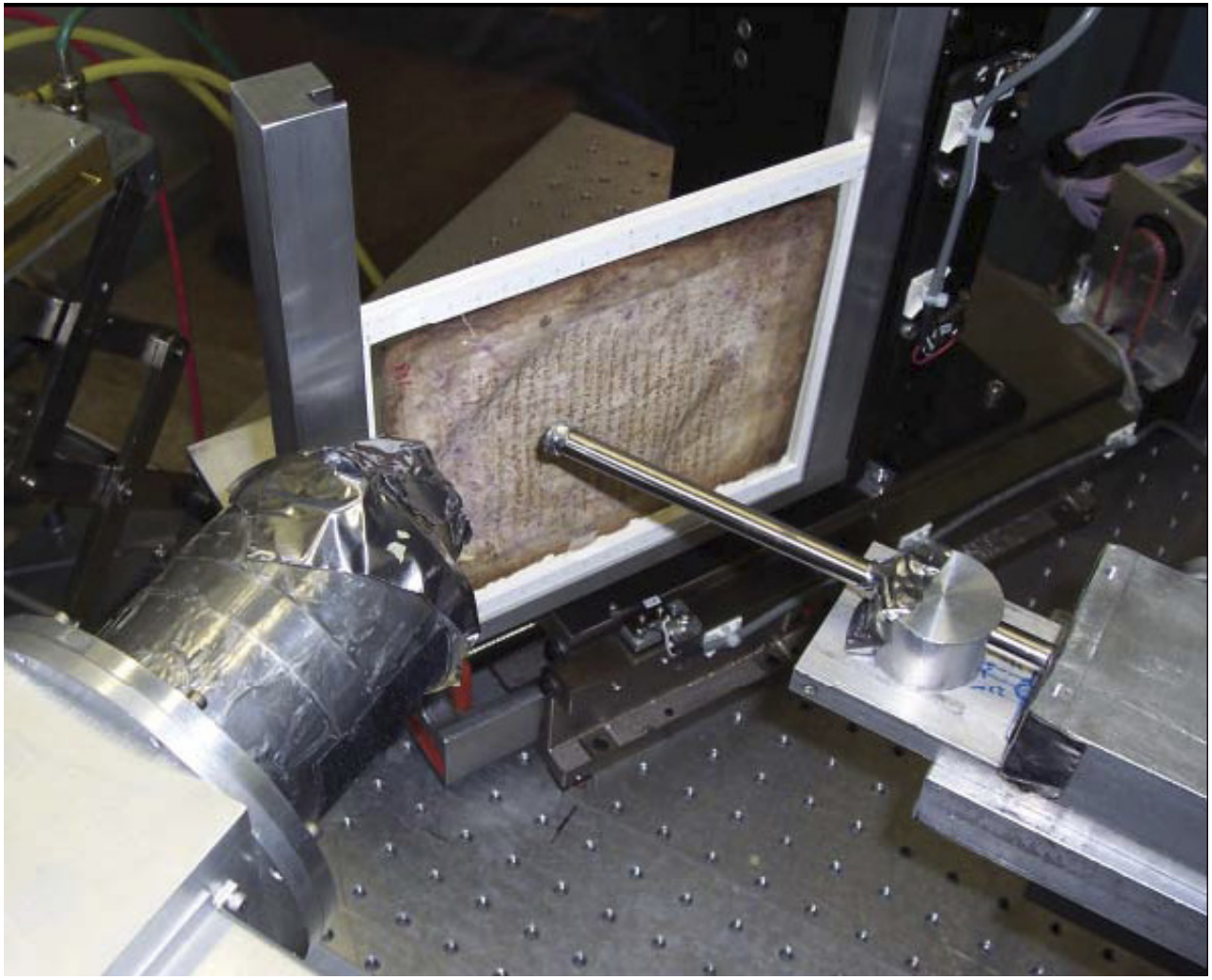

Fe
Zn
Fe + Zn


Fe
Zn
Fe + Zn
Normal
Parkinson's
cn
ic
ins
p
lml
lgp
mml
mgp
ac
ot
vaf
amg
u
ent
cn
p
ic
lgp
lml
mml
mgp
aml
ot
hip

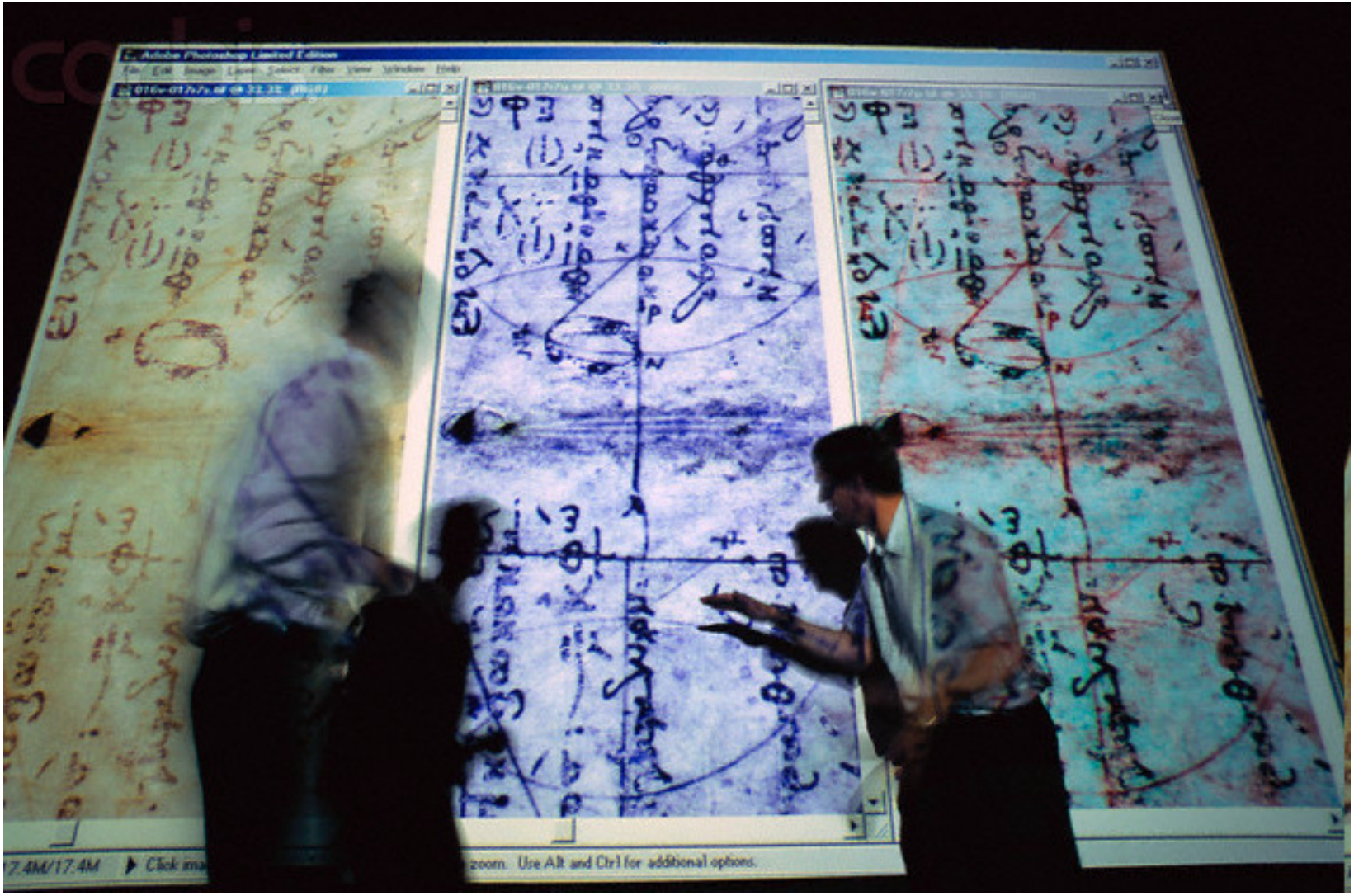

Fe
Cu
Zn
Fe + Cu+ Zn
ic
scp
sn
cc
ic
scp
sn
cc

Applications: *Archimedes Palimpsest*

Lost and Found



Forgeries Unforged


Adobe Photoshop Limited Edition
zoom. Use Alt and Ctrl for additional options.

Applications: *Chemical Fossils*


SB06-2
PENN

The End.

- http://www.archimedespalimpsest.org/
- Nichol, H. et al. *Mapping metals in Parkinson's and Normal Brain using rapid-scanning x-ray fluorescence.* Phys. Med. Biol. **54** (2009) 651–663
- Bergmann, U & K. Knox. *Pseudo-color enhanced x-ray fluorescence imaging of the Archimedes Palimpsest.* SPIE-IS&T/ Vol. 7247