Kaleidoscope: A Series Projection Visualization Tool for Review of DICOM Images for Protected Health Information

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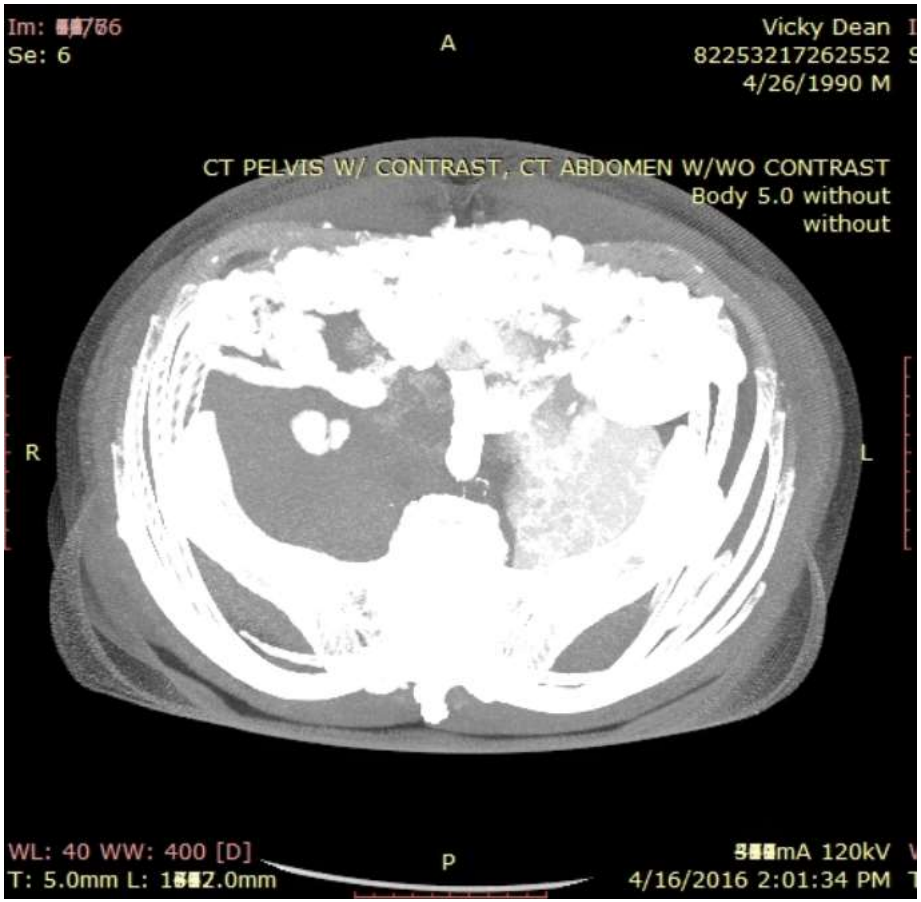
What's the Problem

- TCIA standard way of scanning for burned in PHI is:
  - Time consuming
  - Error prone
  - Therefore unreliable
- Not readily fully automated
- Running into scale issues
- Collection sizes are growing

What is “Burned in PHI” ?

- You know it when you see it
- (By the way. This is a pseudonym, not PHI)



Larger Collections:

collection	site	num_subjects	num_series	num_images
ACRIN-FLT-Breast	ACRIN	83	1498	678406
ACRIN-FMISO-Brain	ACRIN	45	4633	669638
HNSCC	MDA	887	3633	624957
MyelomaTT3aPET	UAMS	32	2185	610995
Phantom FDA	FDA	3	1800	596230
ACRIN-NSCLC-FDG-PET	ACRIN	193	3255	445397
LDCT	Lahey	267	1485	347432
NSCLC Radiogenomics	Stanford	211	1203	285260
Exceptional-Responders	NCI	79	1851	256161
Anti-PD-1_MELANOMA	MDA	47	1814	234113

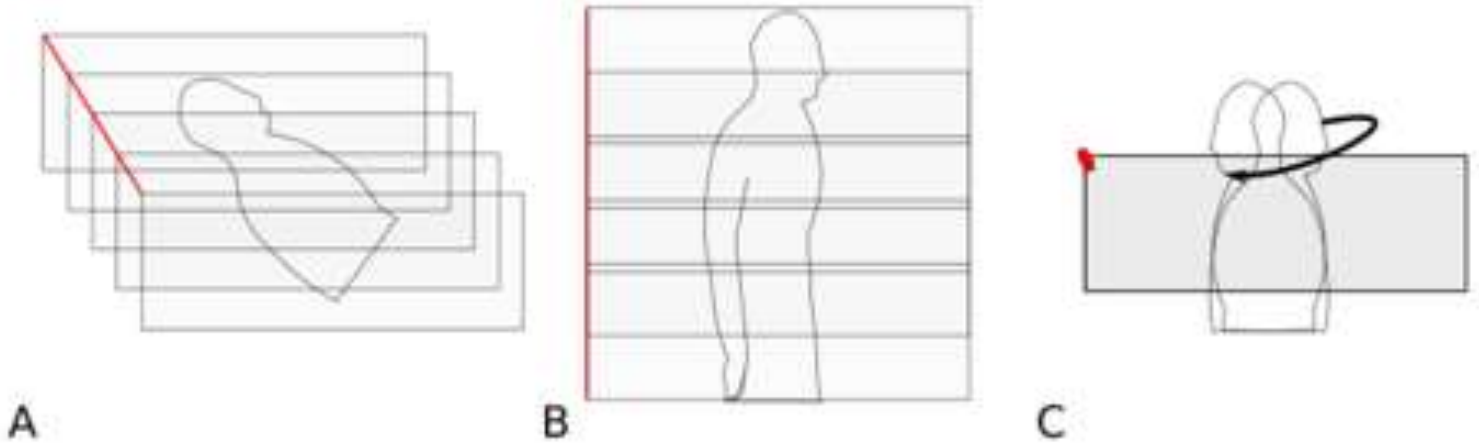
We Rejected Auto Text Detection

- Auto Text Detection
  - What's the source of truth?
  - Its what you don't see that hurts you
  - Didn't have time to validate
- Detection by DICOM tag
  - Not reliably populated
  - Secondary Captures you want to keep

What We Decided to Build

- Way to view series holistically
- Using Projections of the Series
  - Max Intensity
  - Min Intensity
  - Average Intensity
- Takes care of black on white vs white on black problem

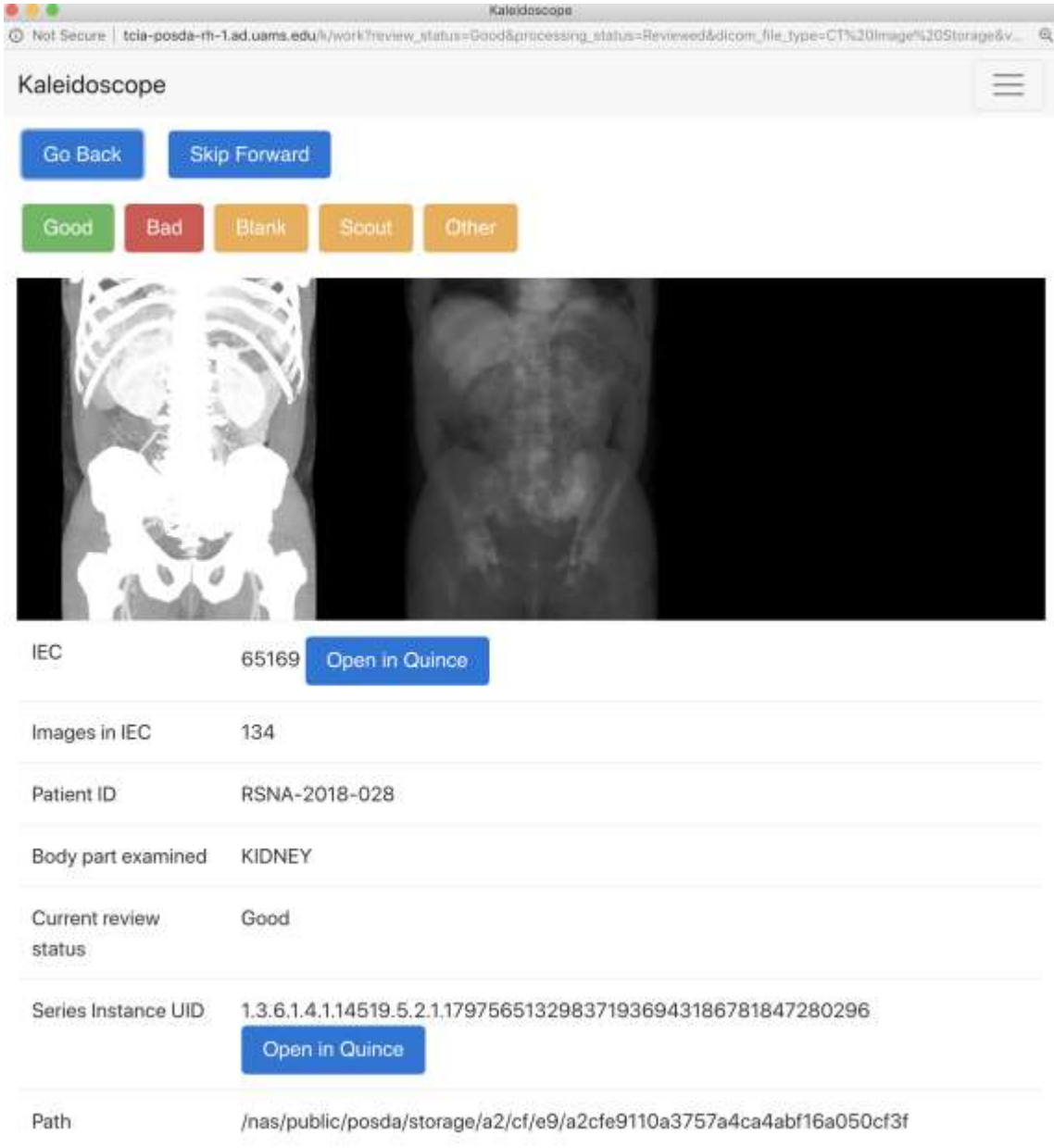
A Little Picture



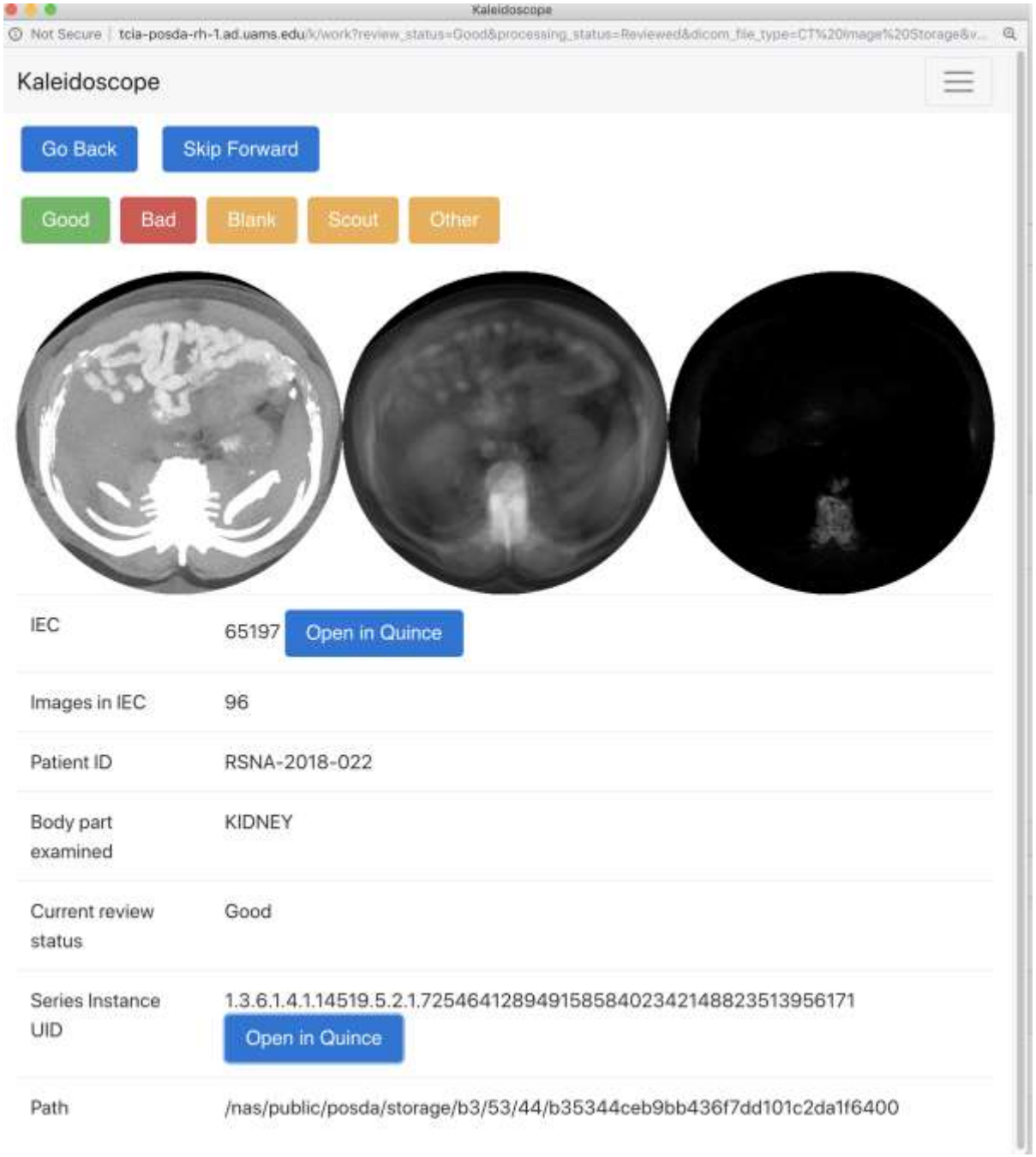
Posda/Kaleidoscope/Quince

- Web-based Curation Tools
- Interface is Browser
- Linked together for DICOM curation

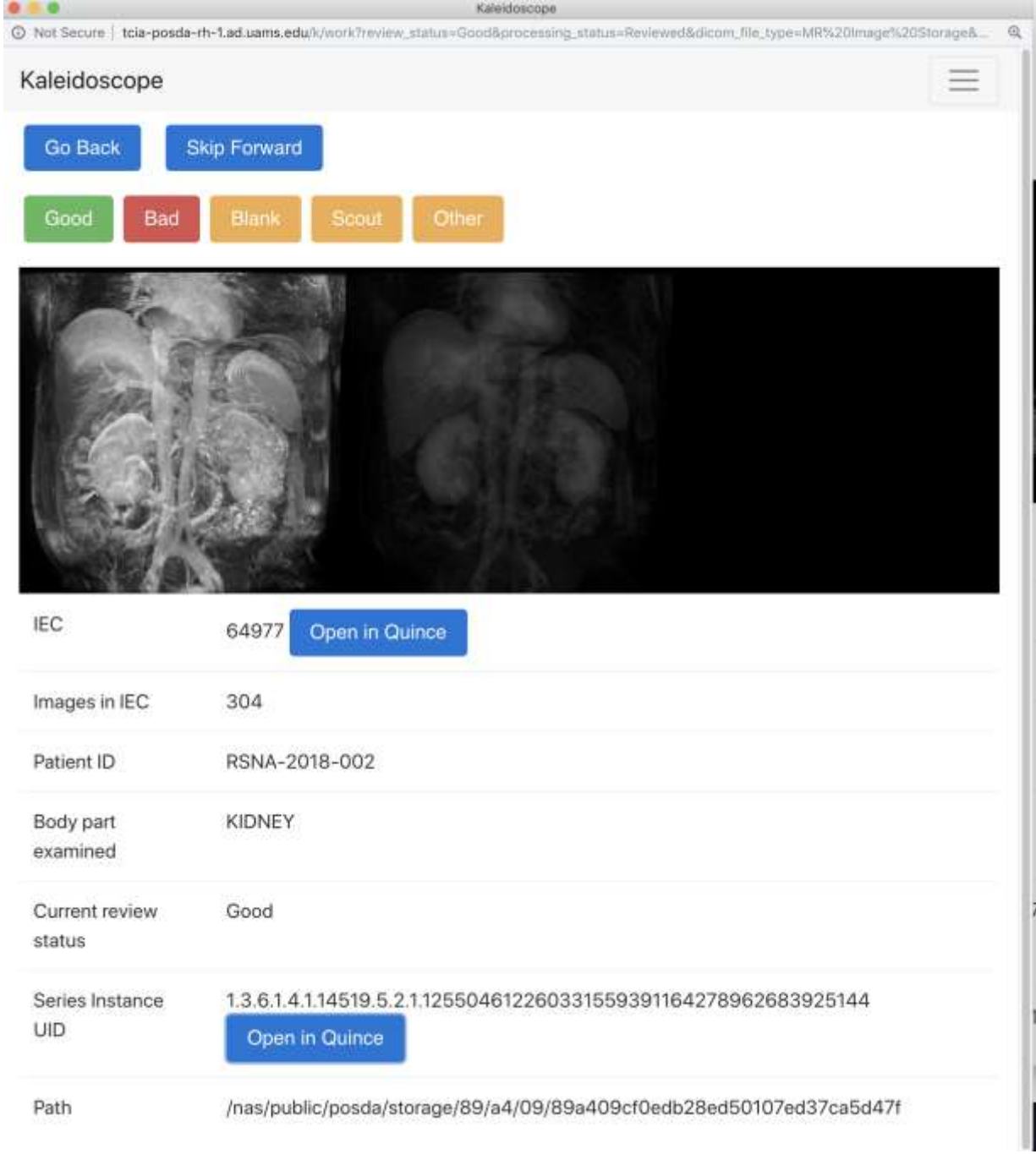
CT Coronal Reconstruction Series



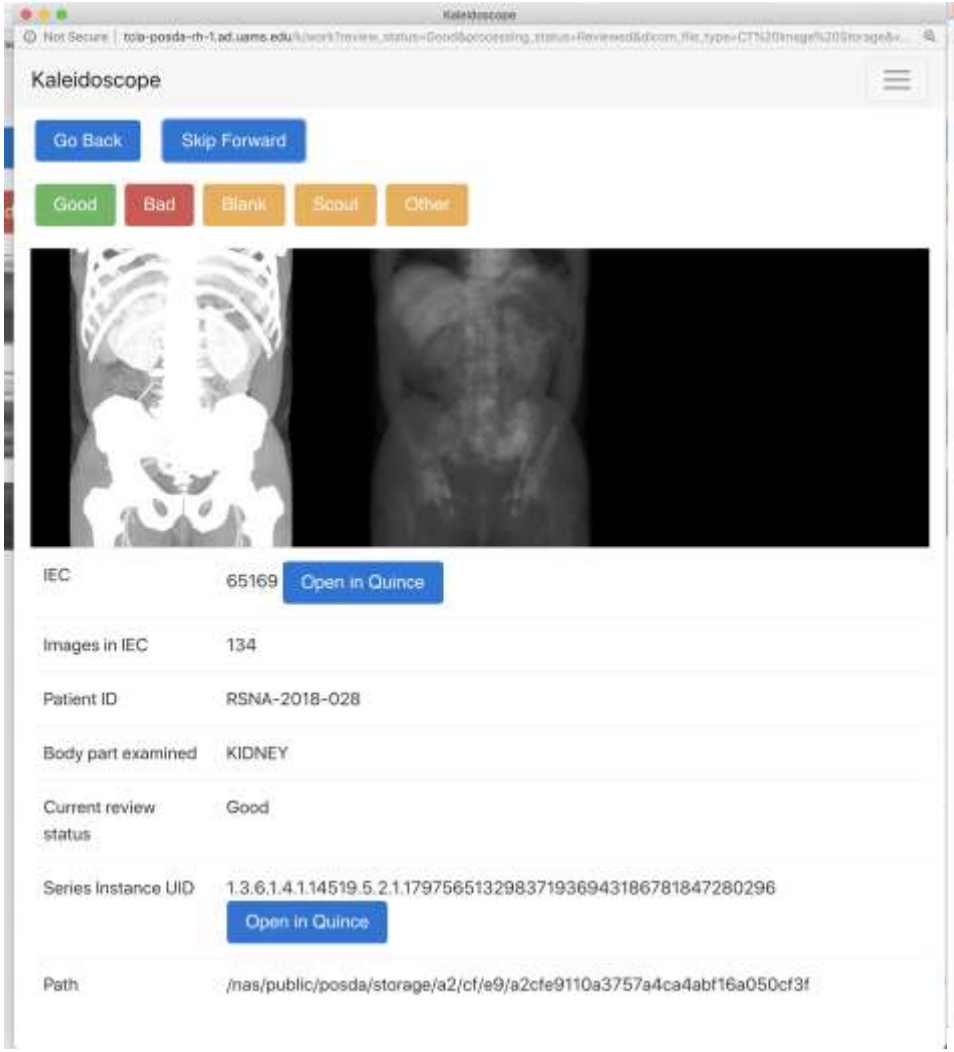
CT Axial Projection

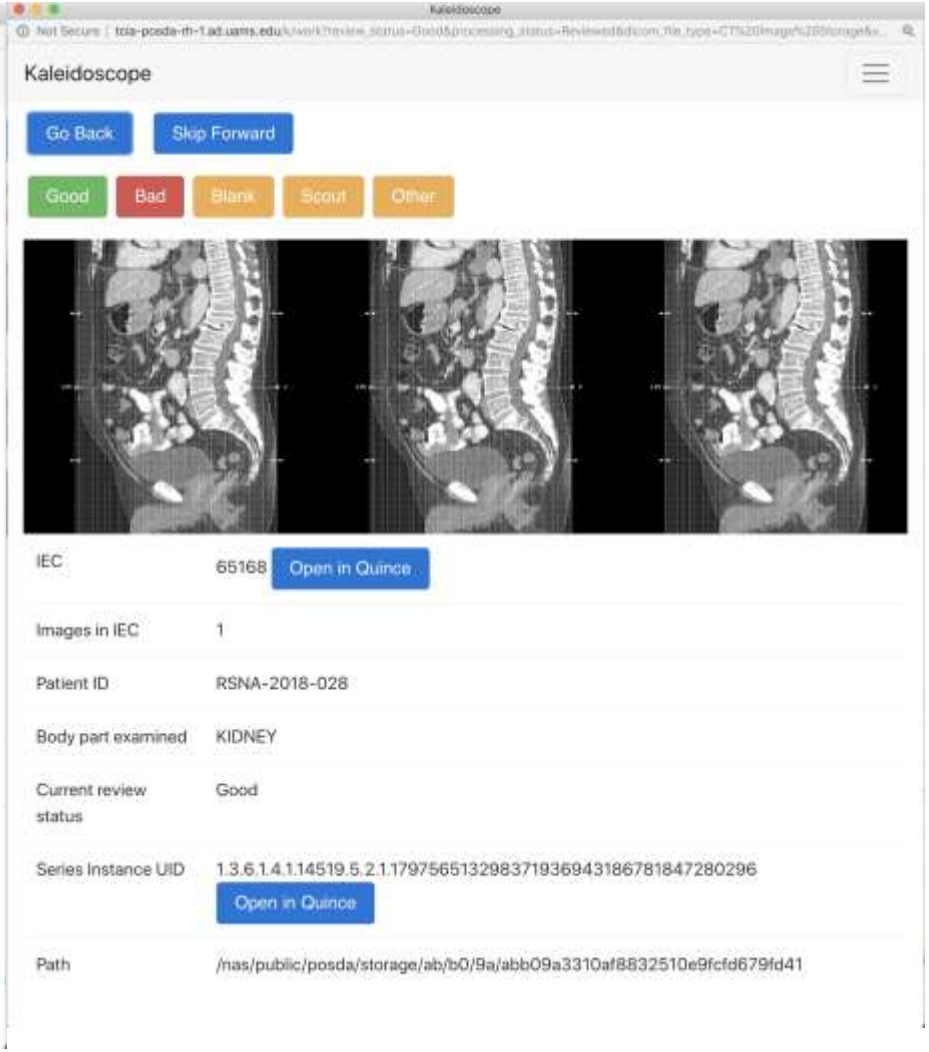


MR Coronal Projection

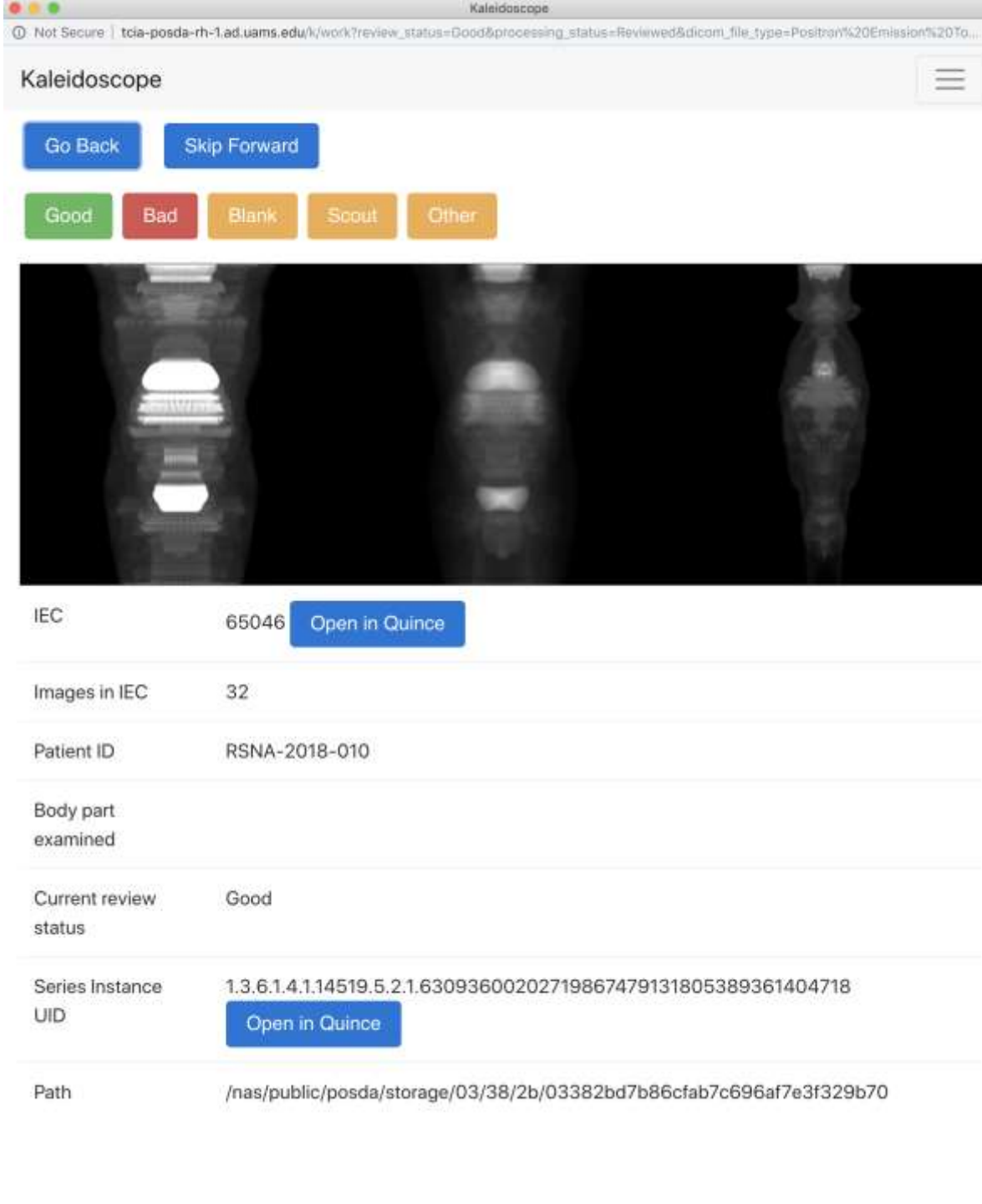


Equivalence Classes:

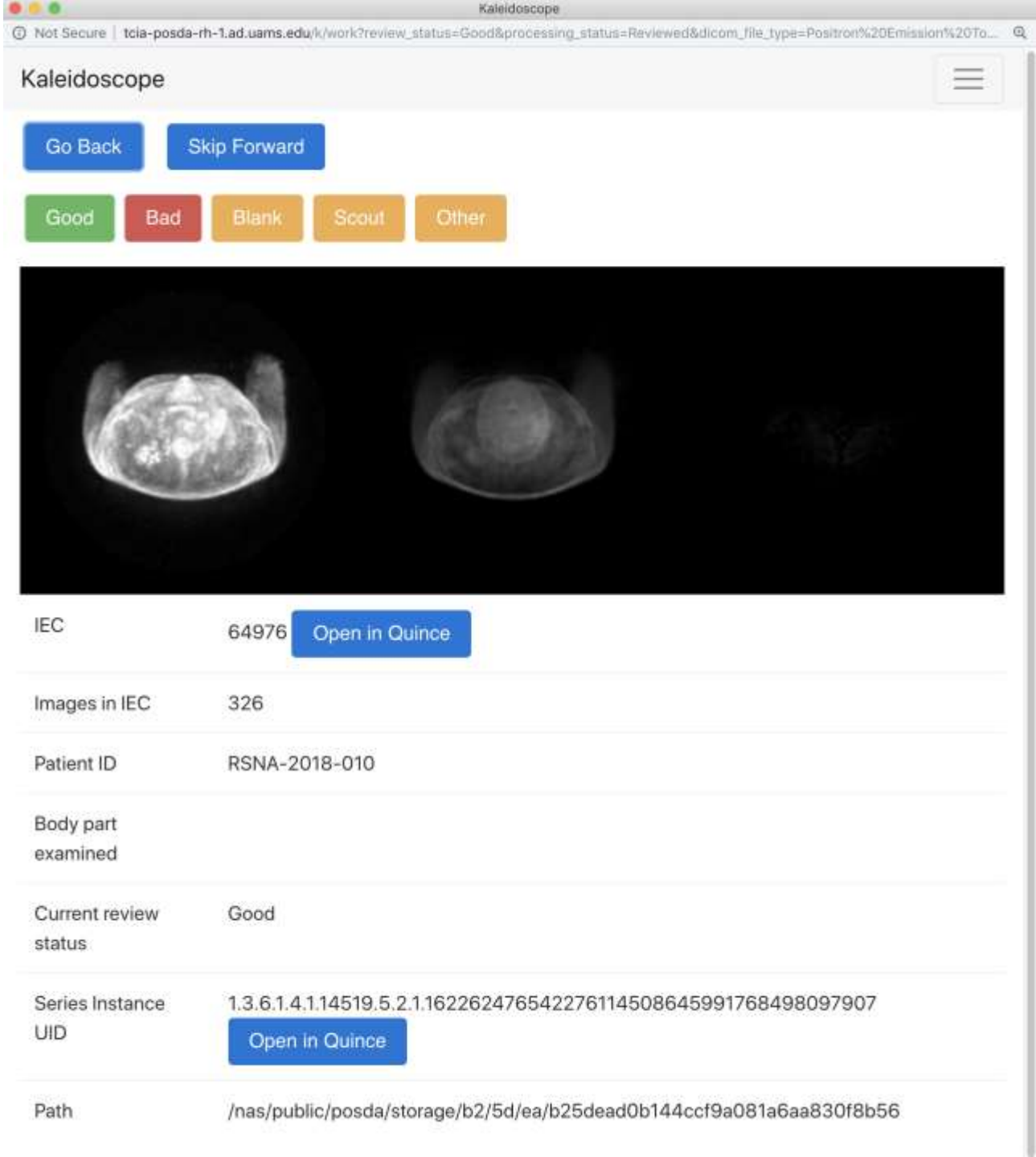




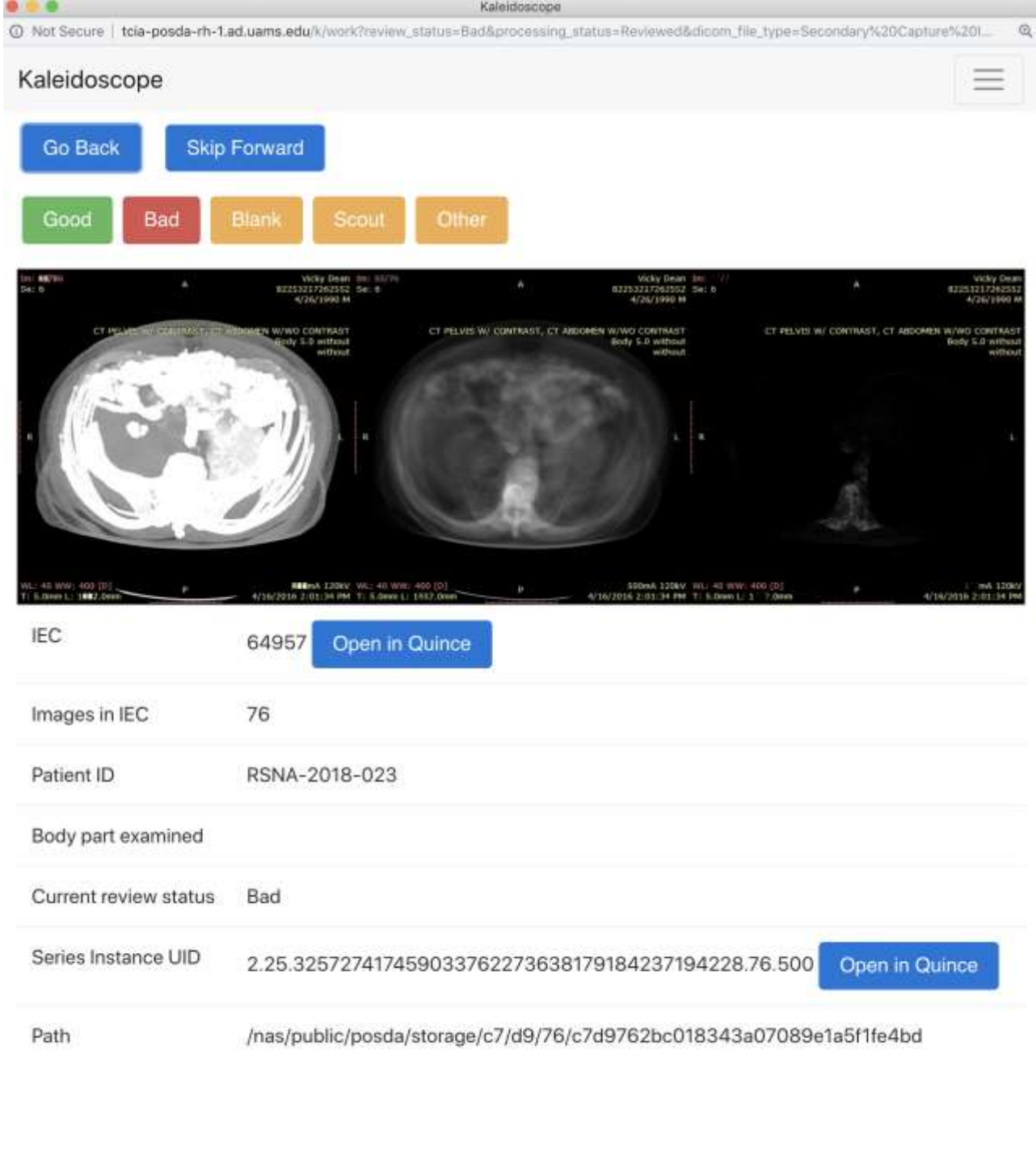
Pet Radial Projection



Another PET Projection



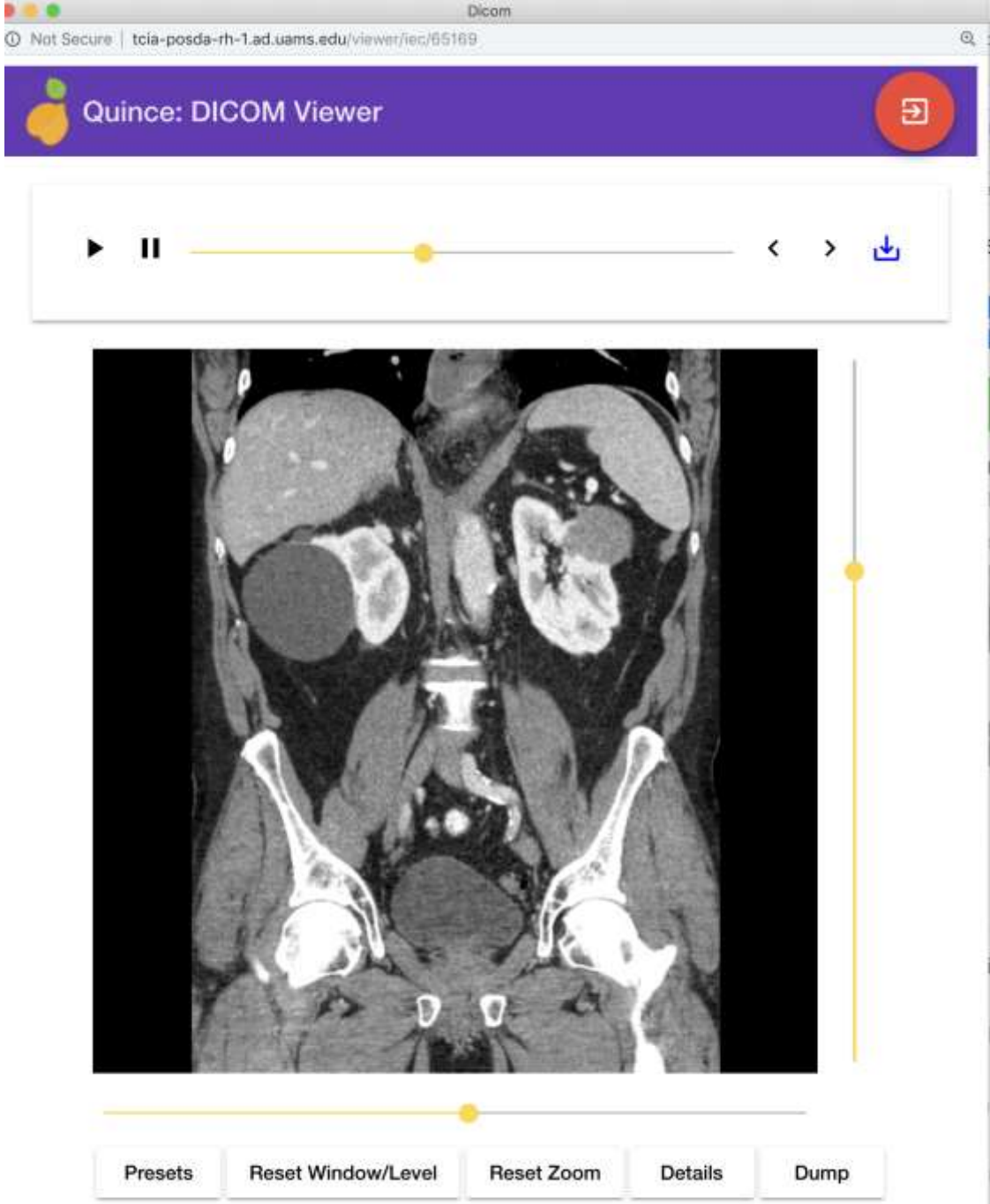
Secondary Capture with (Pseudo) PHI



Kaleidoscope Operations

- Mark Equivalence Class as Good
- Mark Equivalence Class as Bad
- Mark Equivalence Class as Blank (Indeterminate)
- Mark as “Scout” or “Other” (deprecated)
- View Equivalence Class in Quince
- View Series in Quince

Quince is a Simple Image Viewer



Quince Operations

- Window/Level
- Pan/Zoom
- Cine Images
- Series Information
- DICOM Dump
- Download Series as tgz
- Provides two levels of “Phone a friend”

Results

collection	site	num_subjects	num_series	num_images	Image (Days)	Projection (Hours)	Improvement
ACRIN-FLT-Breast	ACRIN	83	1498	678406	5.50	0.62	211.34
ACRIN-FMISO-Brain	ACRIN	45	4633	669638	5.43	1.93	67.45
HNSCC	MDA	887	3633	624957	5.06	1.51	80.28
MyelomaTT3aPET	UAMS	32	2185	610995	4.95	0.91	130.49
Phantom FDA	FDA	3	1800	596230	4.83	0.75	154.58
ACRIN-NSCLC-FDG-PET	ACRIN	193	3255	445397	3.61	1.36	63.86
LDCT	Lahey	267	1485	347432	2.81	0.62	109.18
NSCLC Radiogenomics	Stanford	211	1203	285260	2.31	0.50	110.66
Exceptional-Responders	NCI	79	1851	256161	2.08	0.77	64.58
Anti-PD-1_MELANOMA	MDA	47	1814	234113	1.90	0.76	60.23
Average							105.26

Two orders of magnitude faster on average!

Conclusion

- Visual Review of Image for PHI is no longer a bottleneck.
- More improvements in progress:
  - Support additional modalities (viz. “Enhanced” CT, MR; Segmentations, …)
  - Better Window/Level algorithm
- General rule of thumb: a quantitative order of magnitude indicates a qualitative improvement
  - Since we have around two order of magnitude, we potentially have an order of magnitude of qualitative improvement
  - We are still figuring out what to do with that

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