

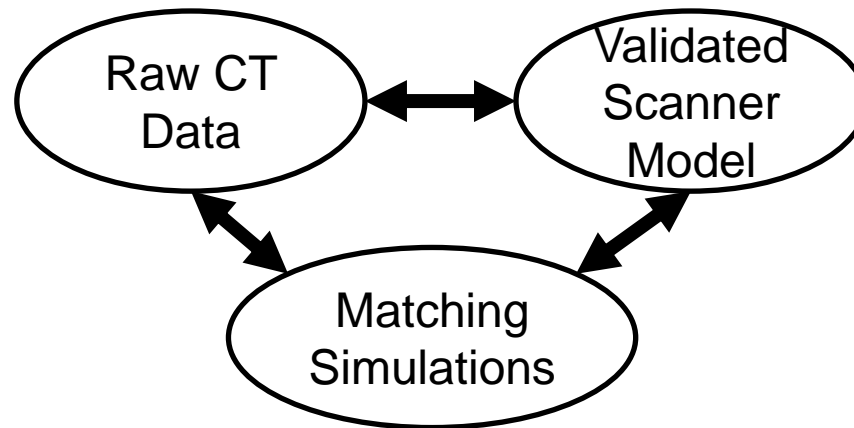
# The TO3 Data Resource: An Open Resource for CT Algorithm Development for Security

Clem Karl  
Boston University

# TO3 Data Resource Goals

1. Raw data, models, documentation in public domain
  - Allow third parties to develop advanced algorithms
2. Provide data for objects of interest
  - water, saline, rubber sheets, glass beads
3. Support generation of performance metrics
  - E.g. clouds, mean, std
  - Multiple scans of objects in different configurations, orientations, etc
4. Allow work on single and dual energy CT

# The TO3 Data Resource Overview



- The only open access X-ray security resource for third parties
- Based on Imatron C300 medical scanner
- 82 Gb of validated raw data, images, and software
- Mixed mono and dual energy
- Scanned data of “security interest” (i.e. not medical)
  - Imatron data team: Tip Partridge, Doug Boyd, Jon Harmon, Sam Song
- Validated scanner model
  - U. Chicago: Patrick La Riviere, Phillip Vargas
- Coupled validated simulation
  - Marquette University: Taly Gilat-Schmidt

# Imatron C300 Scanner

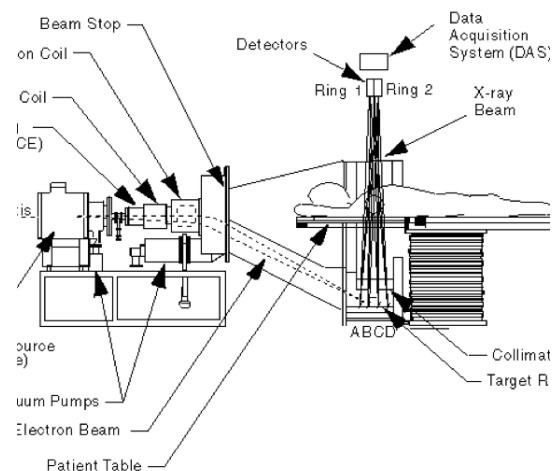
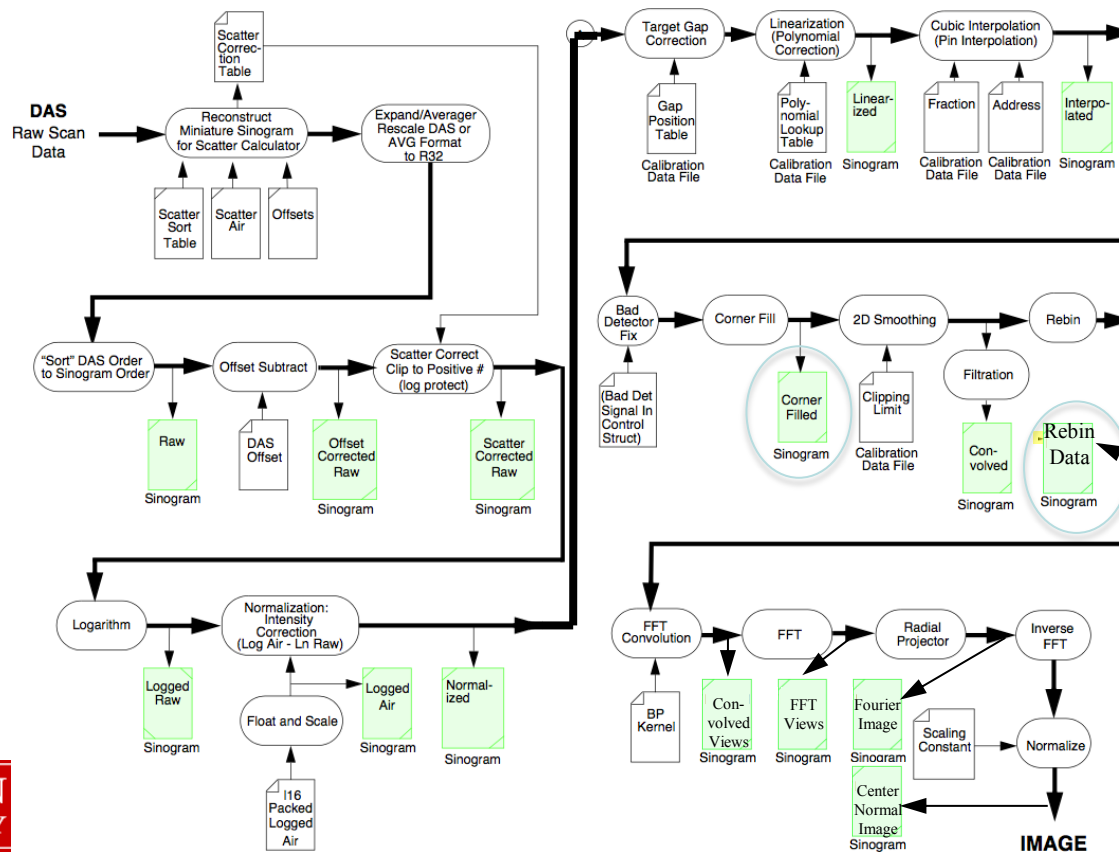


Figure 2 C300 Scanner Schematic Diagram

- Imatron C-300 Medical CT scanner
- Electron beam scanner
- Fixed detector rings, scanning electron beam to circumferential targets
- Native fan geometry
- Open access to machine details
- Bob Senzig (GE Healthcare) provided access to source code

# Imatron C300 Data and Software

- Access to software processing chain, raw sinogram data products and nominal reconstructions



Examples:

- Filled fanbeam
- Rebinned parallel
- Corresponding projection models

# TO3 Data Resource Scan Collection

- Validated OOI Scans
  - 61 scans
- High clutter scans of suitcase bag
  - 1 scans
- Scans of bottles with glass and plastic beads
  - 3 scans
- Al and Cu calibration objects, resolution phantoms, and a suitcase bag
  - 34 scans
- Resolution & multipin phantom, suitcase bags
  - 21 scans
- 95kV calibration scans
  - 11 scans
- Mixture of DE (95keV, 130keV) and SE (130keV) scans

# Scanned Objects

- Reference and calibration objects
  - (e.g. NIST 10010-A, Al steps, Cu steps, etc)
- Objects of interest
  - Small set of materials in different configurations for cloud generation
  - Distilled water in plastic, metal, large, small containers
  - Doped water (salt) in plastic, metal, large, small containers
  - Rubber sheets
- Other known materials in know configurations
  - Beads, graphite, teflon, PVC
  - cylinders, sheets, cubes
- Clutter objects
  - Cultural objects (e.g. pots, shoes, AC adapter, radio)
- Validated materials (McMaster Carr)

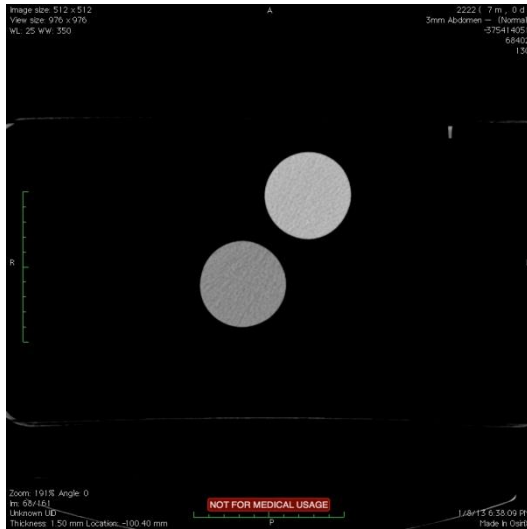
# Scanned configuration examples

- Multiple scans of objects in different configurations, orientations, etc for cloud

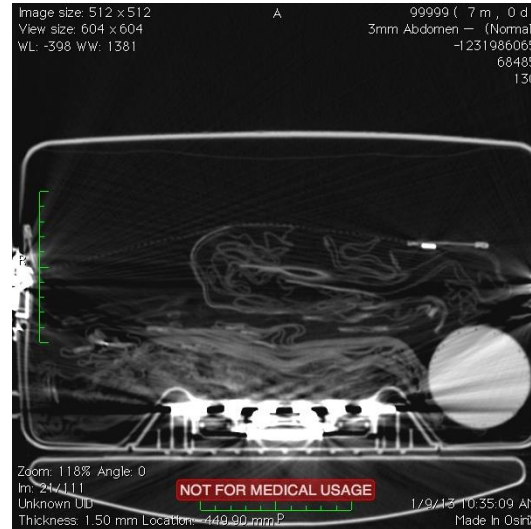




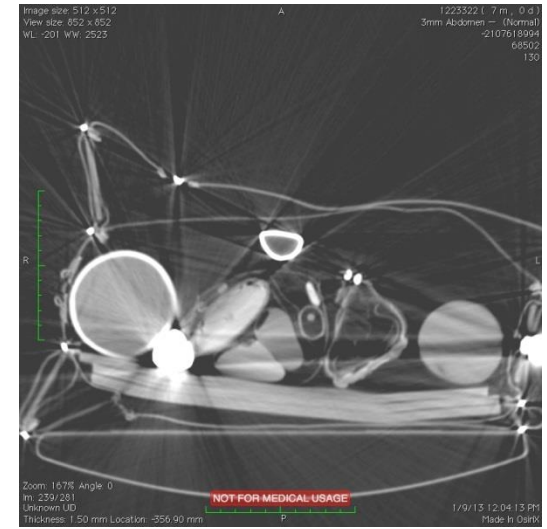
# Example Reconstructions



Clean



Medium Clutter



High Clutter

# Data share access

- Data Resource warehoused on networked BU server
  - Raw data, reconstruction software, documentation, scanner models, simulations
- Process for obtaining data
  - Request NDA from ALERT
  - Obtain account to access network data share site
  - Must agree to have publications reviewed (“REAP’ed”) for problematic wording
- Access to data is available after project ends
- Researcher results & documentation can be posted as well
- A reconstruction algorithm development clearing house

# Lessons Learned

- Imatron not a natural dual energy machine
  - Kv has to be switched between scans, requiring recalibration, slowing acquisition
- We were not careful enough planning the validation & recording
  - Can't uniquely identify some objects in some cases (e.g. water vs saline)
  - Material properties not what vendor claimed (e.g. beads)
- Improvements incorporated for TO4

# Acknowledgements

- Limor Martin for data validation, correction, and documentation
- Tip Partridge for technical assistance

# Conclusion

- TO3 Data Resource met original goal
- Open set of data, models, and simulation now exists for algorithm development
- TO3 project researchers used data to develop new algorithms
- New algorithms impact on clouds and metrics can be evaluated