Characterizing the Imatron C-300 Medical CT scanner and effort to develop matched FBP

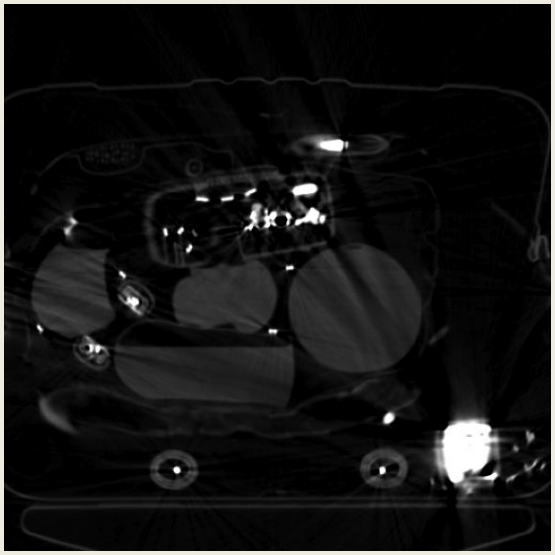
Patrick La Riviere and Phillip Vargas
University of Chicago

Objectives

- The goals of this project were
  1. To characterize the Imatron C300:
     - Understand geometry
     - Understand file formats
     - Understand data readout
  2. To develop open source offline code matching as closely as possible the output of Imatron's onboard gridding-based algorithm.
  3. More broadly, to demonstrate the feasibility and benefit of having a set of open/medical data together with a validated system model in the "public domain" that can be used for experimentation and collaboration.

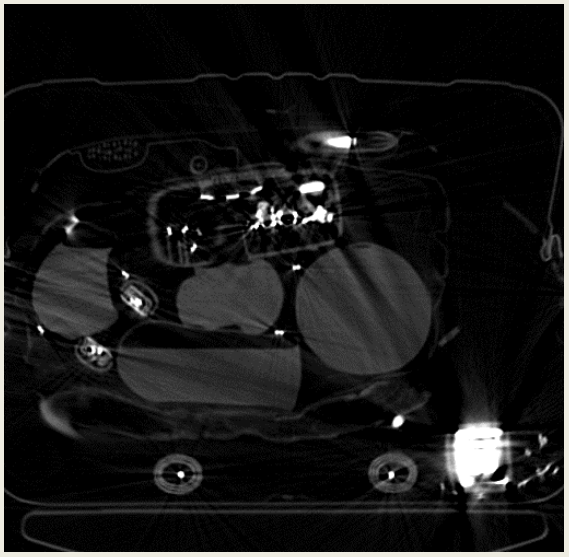
Results

Imatron xrec reconstruction

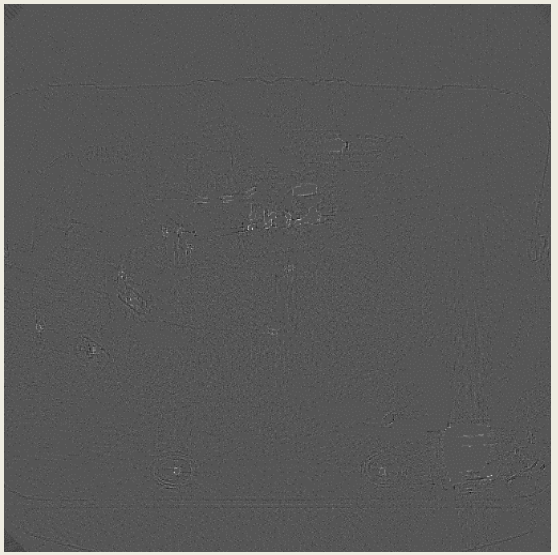


W: (-1000,3095)

UofC recon starting from "clipped" xrec sino



Difference



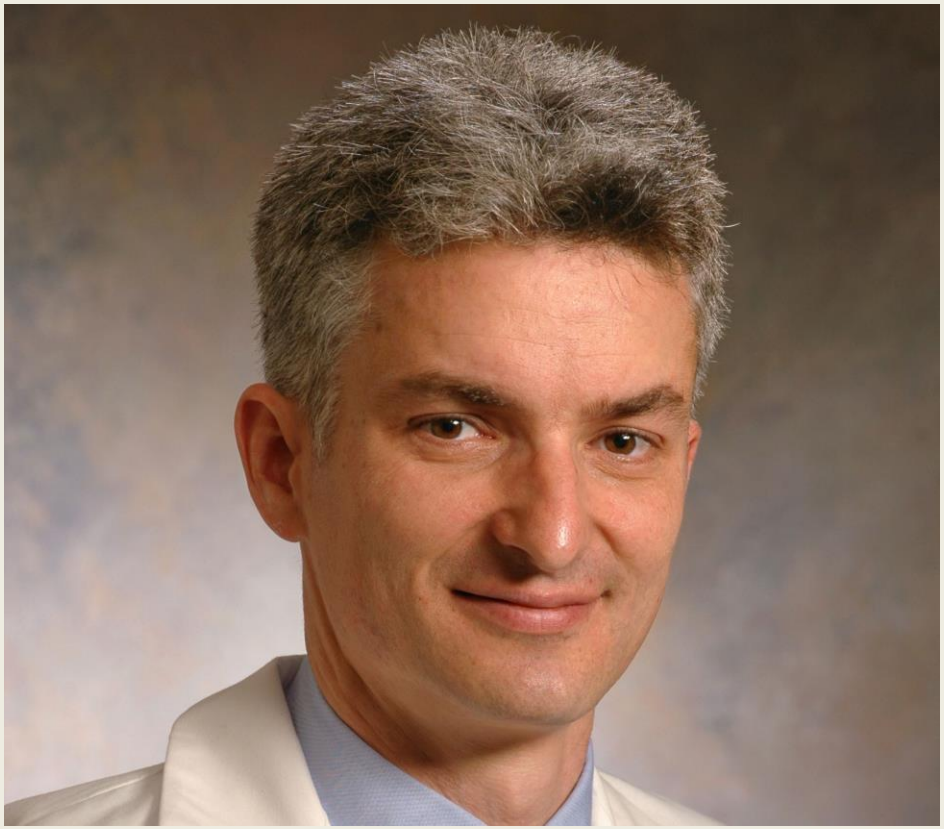
Average difference = 1.11 H.U
Max difference = 126.92 H.U

Take away: All researchers have been able to reconstruct data using their own algorithms based on characterization provided by the University of Chicago.

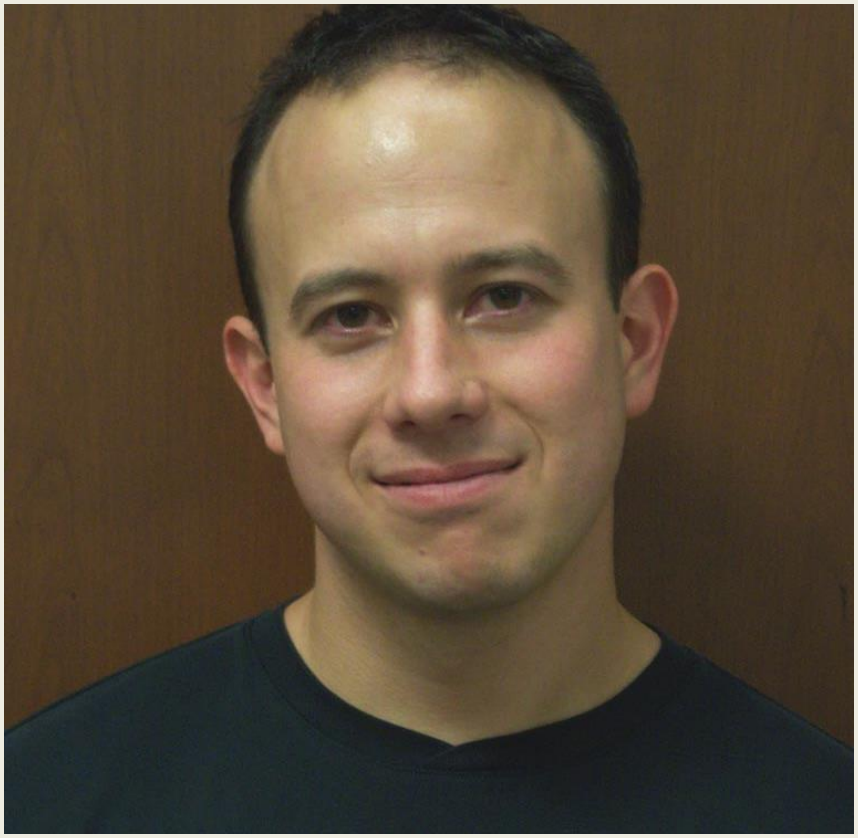
THE UNIVERSITY OF CHICAGO

The Committee on Medical Physics

Introduction to the team



Patrick La Riviere, Ph.D.
Associate Professor of Radiology
The University of Chicago



Phillip Vargas, M.S.
Assistant Professor
Harold Washington Community College
Part-time research specialist, U of Chicago

Imatron C300 System

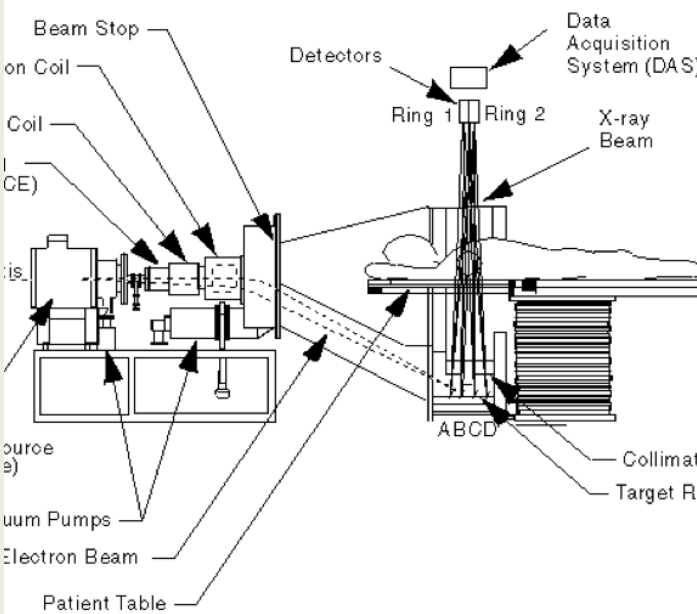
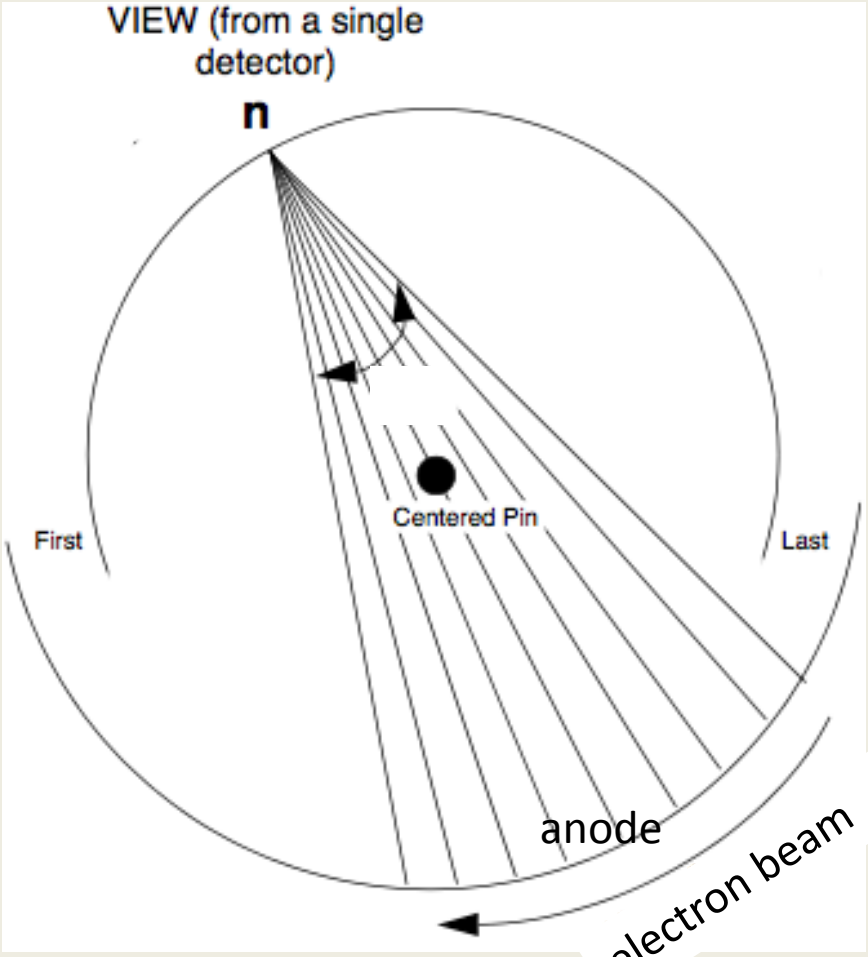


Figure 2 C300 Scanner Schematic Diagram

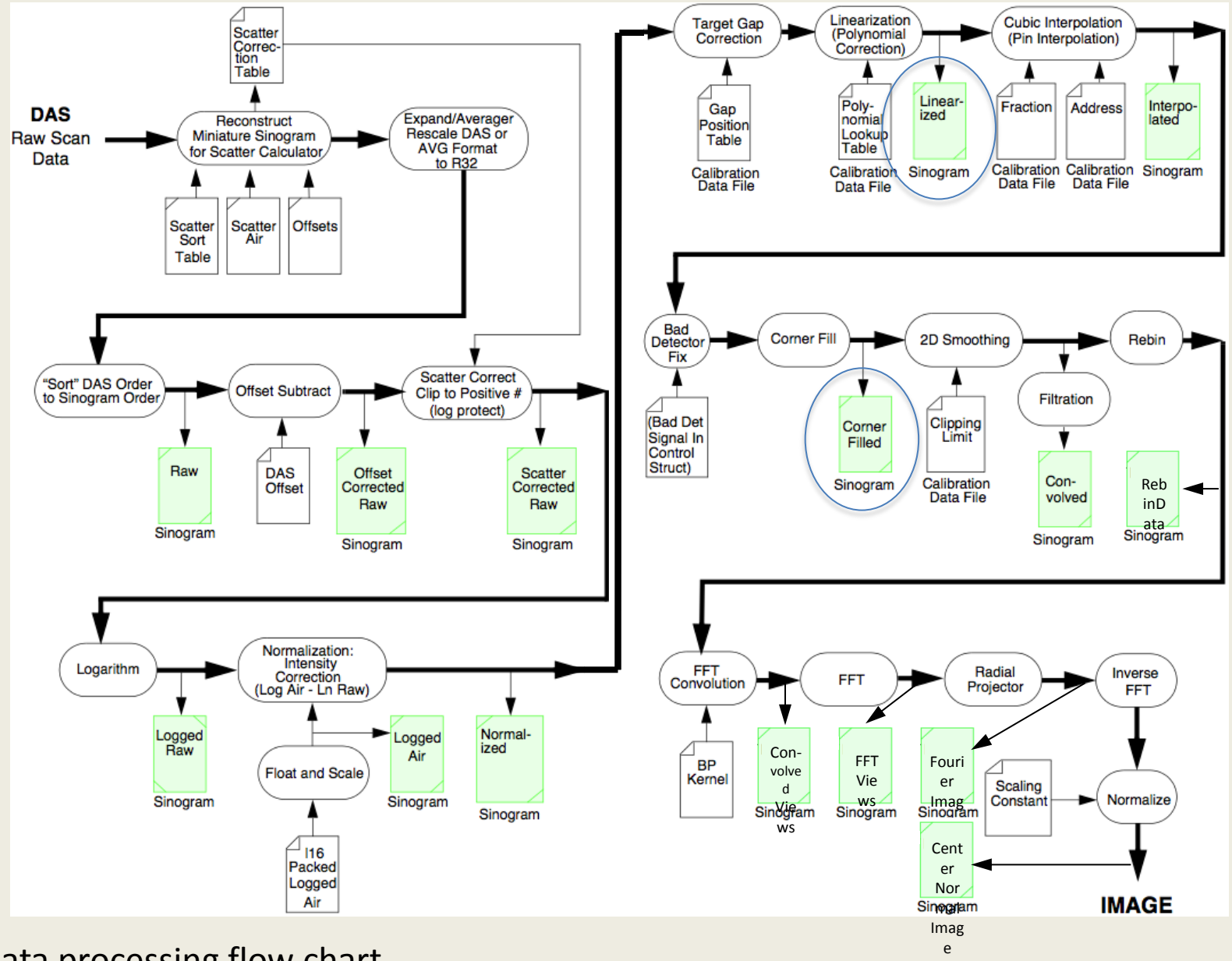
- This is an electron beam scanner that uses a fourth generation geometry in which detectors are fixed and subtend a large arc around the patient and electron source is scanned along large arc.
- This differs from clinical scanners based on third generation geometry where both source and detectors rotate. Imatron is faster (~50 msec) and good for cardiac.

Geometry – Single Slice Mode



- Focal length= 675.0 mm or 675.5 mm
- Number of true projection views= 864
- Number of effective projection views = 888 (augmented during corner filling)
- Angular range of 888 views is 222, which is Pi + fan angle
- Angular increment 0.25 degrees
- Fan angle = 41.26696016°
- Angle between fan channels= 0.0478180°
- Number of fan channels= 864
- Field of view at the isocenter = 475.0 mm

Xrec flow chart



- Xrec data processing flow chart.
- We characterized the various outputs and made recommendations about which sinograms researchers should consider working with. Only 1 or 2 were used.

Extracting and Reading Sinograms from xrec.exe

LINEARIZED	• -sino lin; Floating point data 864x888
INTERPOLATED	• -sino int; Floating point data 864x888
CORNER FILLED	• -sino cfl; Floating point data 864x888
REBINNED	• -sp; Floating point data 1024x720

Arrow denotes most commonly used sinograms.

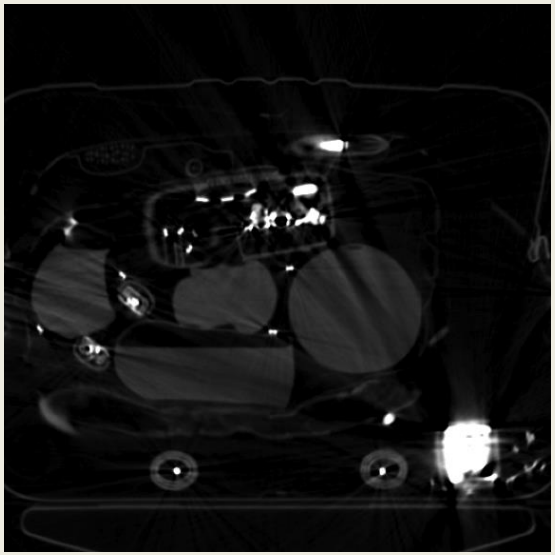
Basics of Imatron recon

- Imatron
  - Parallel rebinning from fan sinogram
    - One-dimensional cubic interpolation in columns
    - Apply Parker weights
    - One-Dimension cubic interpolation in rows
  - Gridding reconstruction

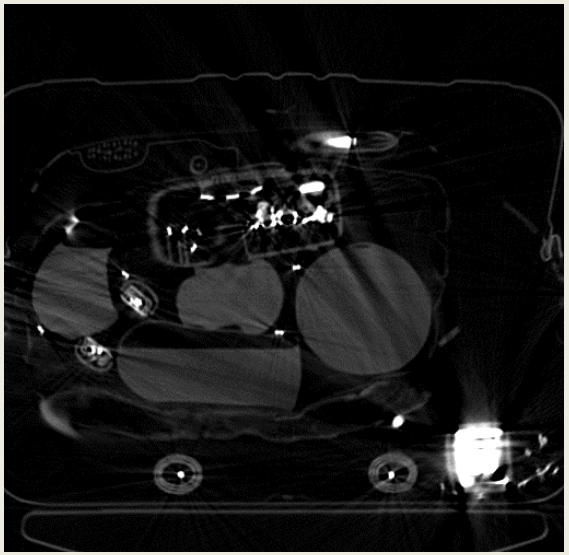
- Our efforts:
  - First FBP from parallel
  - Then FFBP from fan
  - Then gridding reconstruction from rebinned projections

Results: direct Fourier/gridding

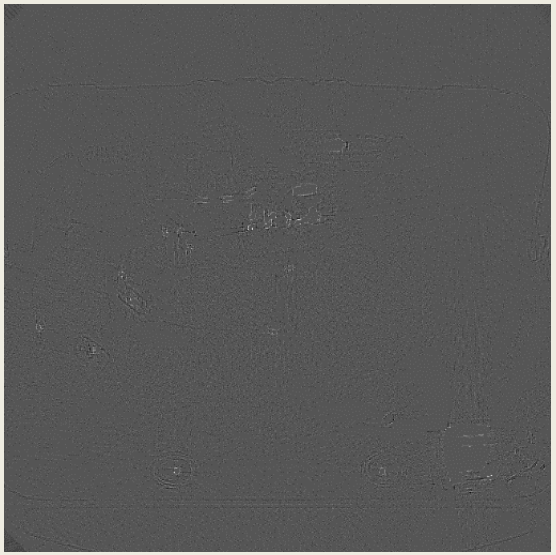
Imatron reconstruction



UofC reconstruction



Difference



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Strengths and weaknesses

- Overall we provided a very thorough description of the Imatron geometry and data format that was valuable to the other researchers involved.
- We came very close to exactly matching the Imatron reconstruction performance but small differences remained likely due to differences in interpolation kernels, numerical implementations, etc.

Recommendations for future work

- Develop more offline code to replicate earlier takeoff points of xrec.
- Develop more thorough physical models of scanner degradations (scatter, afterglow, crosstalk) to allow for more advanced model-based corrections and methods.

FTP site:

sftp://craw404@eng-filetransfer.bu.edu/eng_research_TO3/PatrickDocsandSinos/MatlabCode

Acknowledgments: The Imatron team (Tip Partridge, Doug Boyd, Jon Harmon) were EXTREMELY helpful in understanding the geometry and data format.