Medical Image Processing for Diagnostic Applications

About the History of CT

Online Course – Unit 29

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Topics

Parallel Beam Geometry

- Earliest acquisition geometry
- **Principle:** “Rotate & Translate”

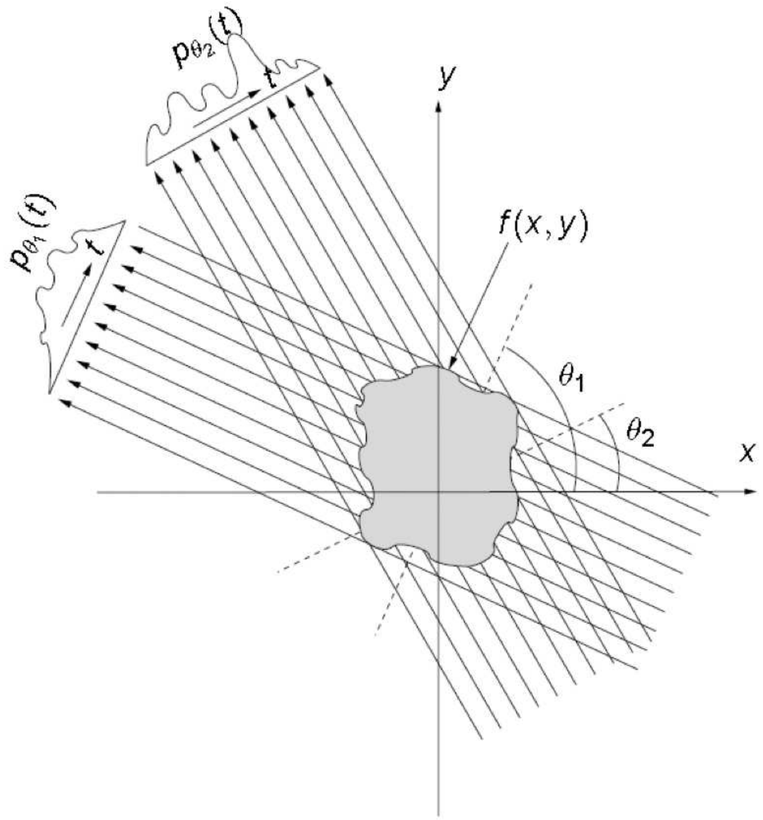


Figure 1: Parallel projection scheme with two different angles θ_1, θ_2 and the object $f(x,y)$

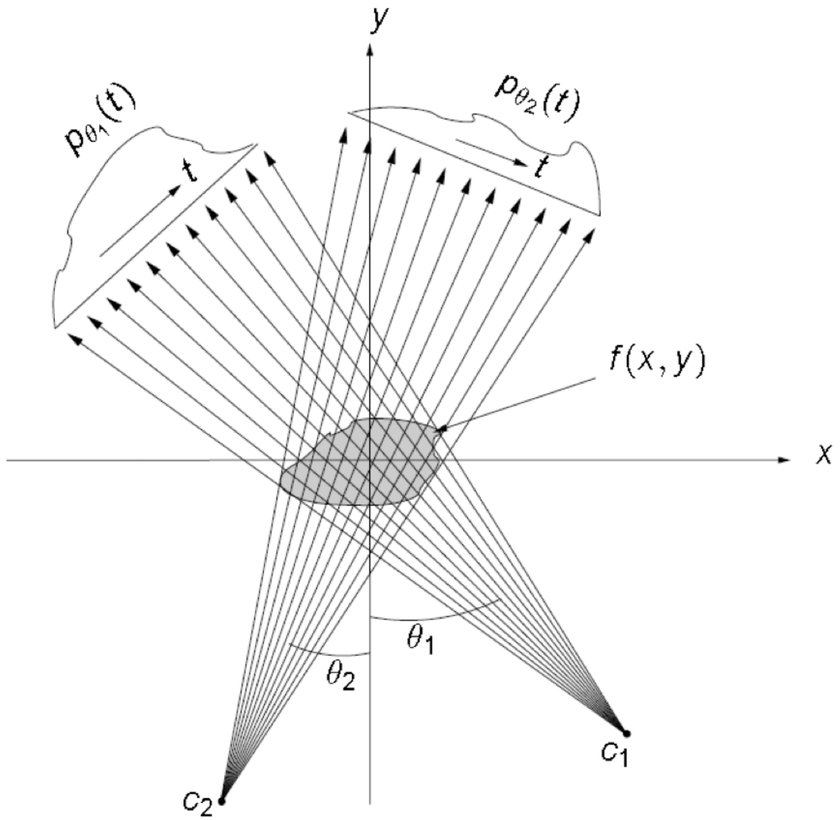
Parallel Beam Geometry

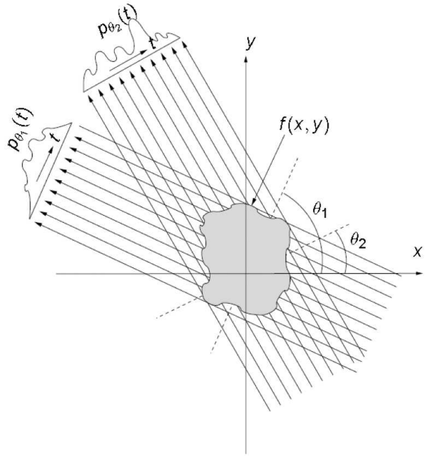
First CT scanner by EMI (1971)

- Acquisition took 5 minutes.
- Reconstruction took 30 minutes.
- Slice resolution was 80×80 pixels.

Figure 2: Image of the first commercial CT scanner model (Wikipedia)

Fan Beam Geometry





just one detector

Figure 3: Fan beam projection scheme with two different angles θ_1, θ_2 and the object $f(x,y)$

Fan Beam Geometry

- Fan beam scanners became available in 1975 (20 s / slice).
- Fast rotations became possible 1987 with slip rings (300 ms / slice).

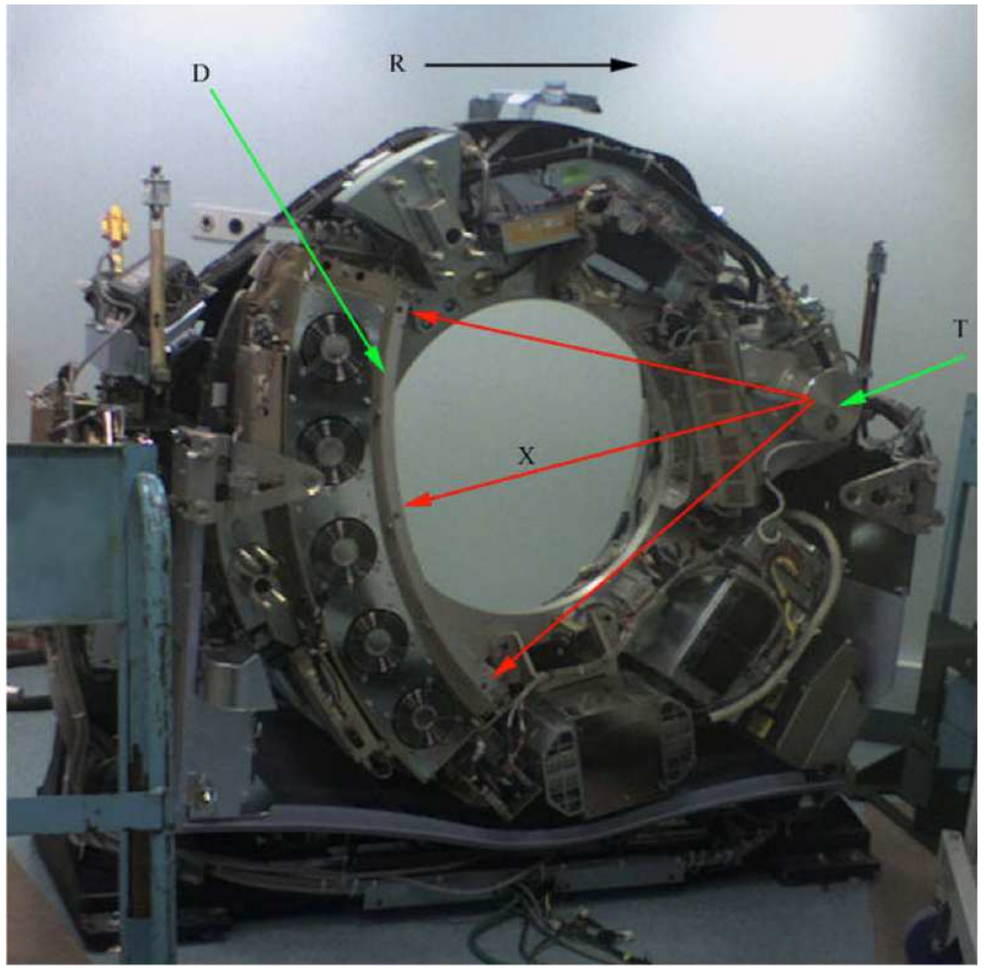
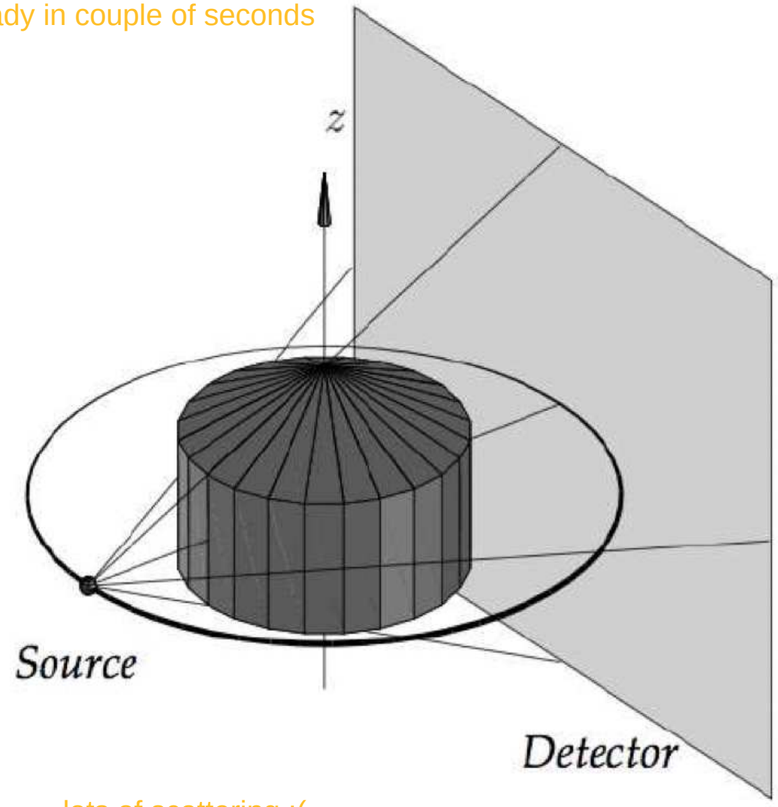


Figure 4: View inside a CT scanner (Wikipedia, GFDL)

Cone Beam Geometry

3D fan beam - scan hole boady in couple of seconds



lots of scattering :(

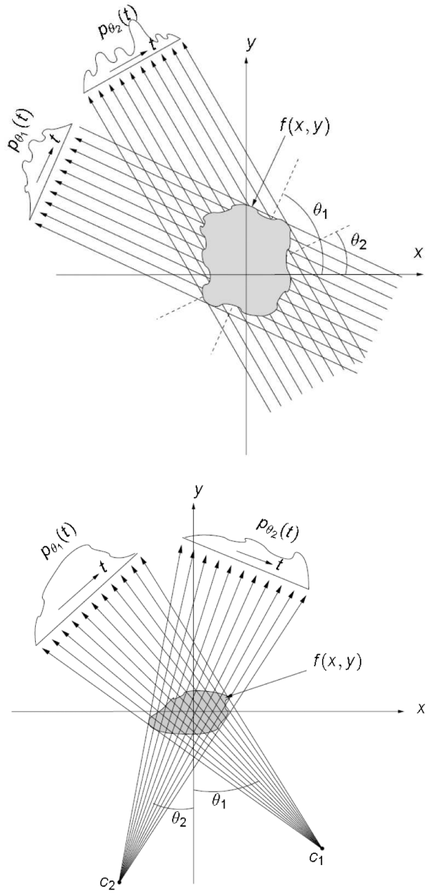


Figure 5: Cone beam projection scheme

Cone Beam Geometry

- Further increase in the number of rows did not take place so far.
- Physical effects such as scattered radiation currently limit the number of detector rows in CT.
- Flat panel detector technologies have even larger cone angles.

Figure 6: 320 Row Scanner by Toshiba (2007) (image courtesy of Toshiba)

3-D Reconstruction in Dual CT

- Dual source CT introduced 2005 dont need to rotate 360 degree
- Fast scanning (75 ms)
- Material decomposition possible since we have 2 sources

Figure 7: Dual CT scanner (image courtesy of Siemens AG)

3-D Reconstruction in Dental Medicine

Figure 8: Introduced in October 2006 (image courtesy of Planmeca Oy)

3-D Reconstruction in the Angio Lab

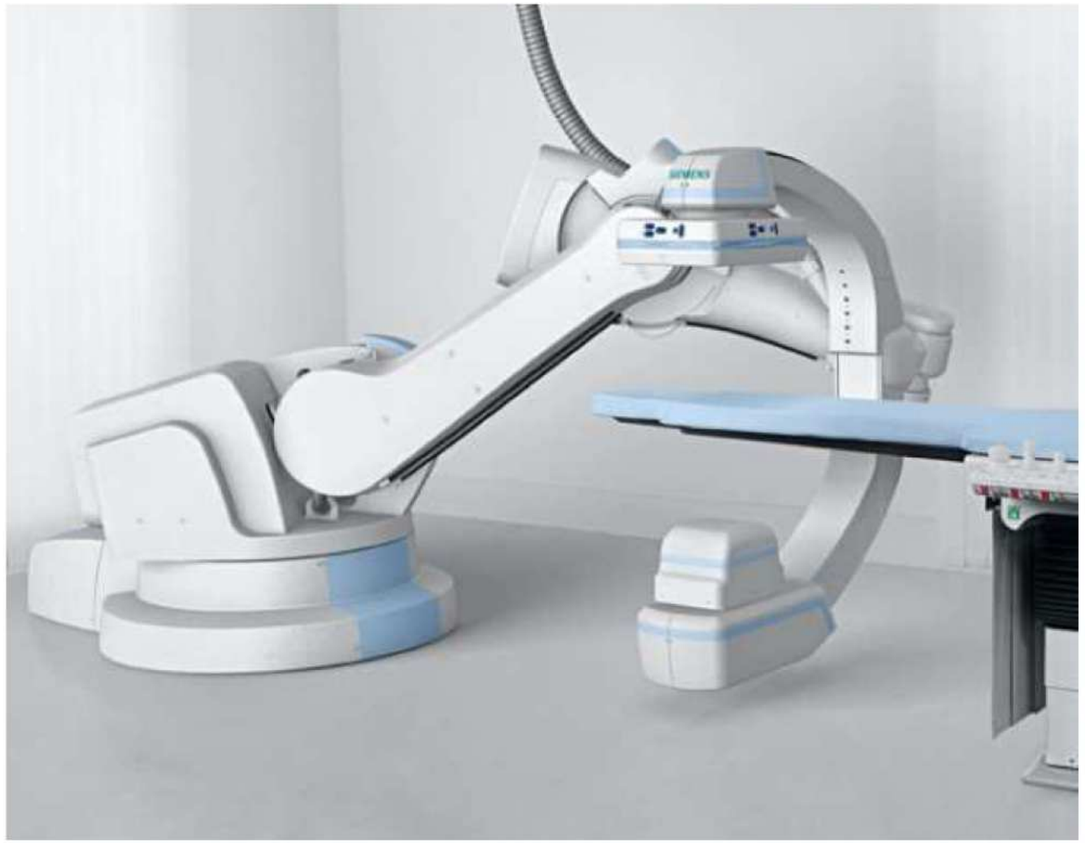


Figure 9: C-arm mounted on a robot system (November 2007) (image courtesy of Siemens AG)

3-D Reconstruction in the Neuro Lab

Figure 10: C-arm biplane device (image courtesy of Siemens AG)

like two c-arms

Topics

Take Home Messages

- Over the years the geometries used for tomography developed from parallel beam and fan beam to cone beam geometries.
- Meanwhile CT scanners and thus 3-D reconstruction can be found in many different medical fields.

Further Readings

Students learning about reconstruction should have a look at one of the following books:

- Gengsheng Lawrence Zeng. *Medical Image Reconstruction – A Conceptual Tutorial*. Springer-Verlag Berlin Heidelberg, 2010. DOI: 10.1007/978-3-642-05368-9
- Avinash C. Kak and Malcolm Slaney. *Principles of Computerized Tomographic Imaging*. Classics in Applied Mathematics. Accessed: 21. November 2016. Society of Industrial and Applied Mathematics, 2001. DOI: 10.1137/1.9780898719277. URL: http://www.slaney.org/pct/
- Thorsten Buzug. *Computed Tomography: From Photon Statistics to Modern Cone-Beam CT*. Springer Berlin Heidelberg, 2008. DOI: 10.1007/978-3-540-39408-2
- Willi A. Kalender. *Computed Tomography: Fundamentals, System Technology, Image Quality, Applications*. 3rd ed. Publicis Publishing, July 2011