

C-arm Flat Panel CT: Image Quality Considerations

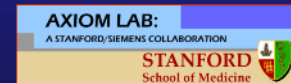


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Collaborators/Support

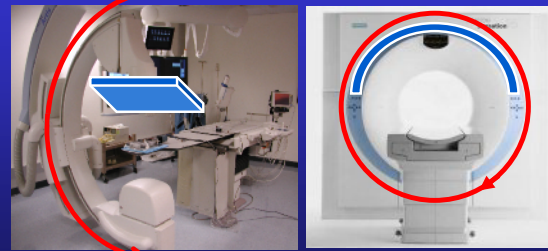
- o The Physics Gang:: 'Bob' R.L.Dixon, 'Tom' J. Payne, 'Rick' R.L. Morin
- o A. Ganguly, N. Strobel and T. Moore
- o L. Hoffman, N. Kothary, D. Sze, M. Marks, H. Do
- o Technical support : A. White, N.R. Bennett, J. Kneebone, M. Lozada-Parks, W. Baumgardner
- o Siemens Medical Solutions
- o NIH R01 EB003524
- o Lucas Foundation



Introduction

- o C-arm CT for visualization in 3D of vasculature and other high-contrast structures has become commonplace
- o The transition from XRIs to digital flat panels opened the doors to the possibility of low-contrast 3D CT imaging in the interventional suite
- o What doses are likely? How do current settings compare to clinical CT doses?
- o How is low-contrast visibility affected by choice of kVp?
- o How does the AEC system on the C-arm affect dose and low-contrast visibility?

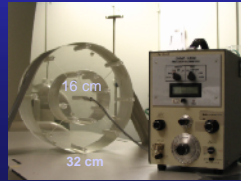
C-arm System :: CT System



half scan, area detector vs. full scan/narrow detector

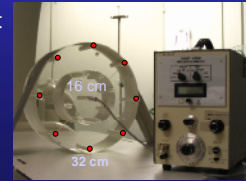
Dose Measurement

- o **small** 0.6cc Ion Chamber, measuring dose max.
- o CTDI phantom (16cm diameter, 15cm long)
- o Dose measured at center and eight peripheral positions for :
(30x40) cm detector format based on 543 views
- o Beam Size (iso-center):
Width: 26.67cm
Height: 20.00cm

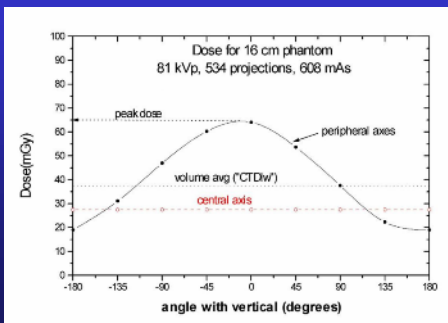


Dose Measurement

- o **small** 0.6cc Ion Chamber, measuring dose max.
- o CTDI phantom (16cm & 32cm diameter, 15cm long)
- o Dose measured at center and eight peripheral positions for :
(30x40) cm detector format based on 543 views
- o Beam Size (iso-center):
Width: 26.67cm
Height: 20.00cm

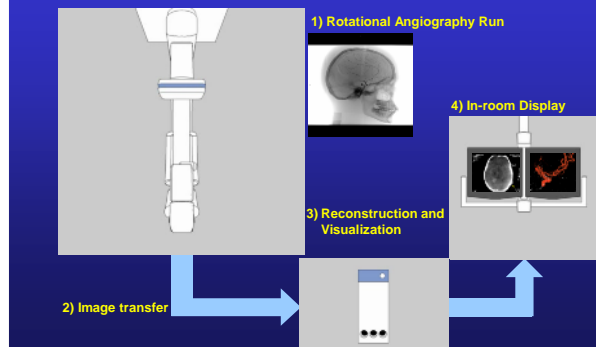


Dose Measurements: 81kVp

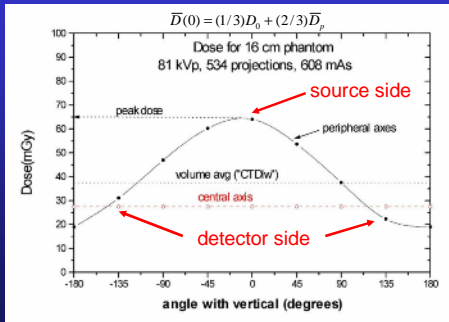


2/3
mean
peripheral
+
1/3 central

Creating 3D Images in the Interventional Lab



Dose Measurements: 81kVp



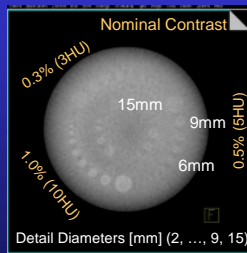
Measured Doses : 'Medium-High' dose requested

kVp	Total mAs	Detector dose (uGy/view)	Peak Dose (mGy)	Center Dose (mGy)	"CTDIw" (mGy)
70	1167	0.46	86	34	48
81	608	0.44	63	28	37
109	310	0.70	66	31	40
125	260	0.92	76	38	46

Variation in CTDIw in spite of AEC.
The EU guidelines for routine head CT scans specify a CTDIw of 60mGy.

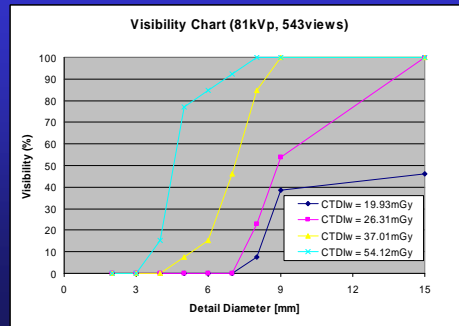
Visibility of Low-Contrast Objects?

- o Catphan Module CTP515 used as image quality phantom (20cm housing)
- o Acquired 543 views over 20sec at various dose and kVp settings, Zoom 0
- o Reconstructed soft tissue segment (smooth kernel, 10mm slice width)
- o Analyzed visibility of (outer) 5HU insets



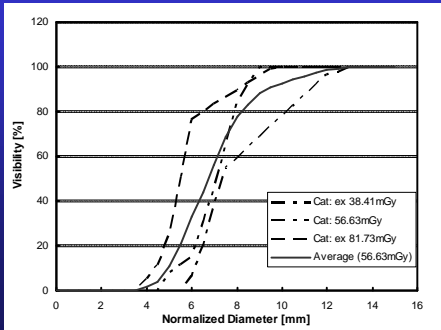
Scoring Question: What size "5HU" objects can you see?

Visibility vs. Dose



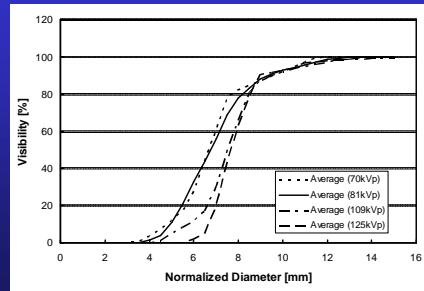
Normalized Visibility :

$$d_{ref} = \sqrt{\frac{\overline{D}(0)}{\overline{D}_{ref}(0)}} \cdot d$$



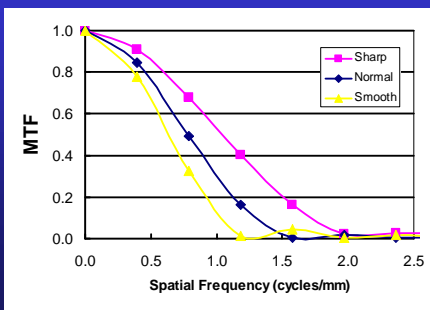
Visibility vs. kVp

$$d_{ref} = \sqrt{\frac{\overline{D}(0)}{\overline{D}_{ref}(0)}} \cdot d$$

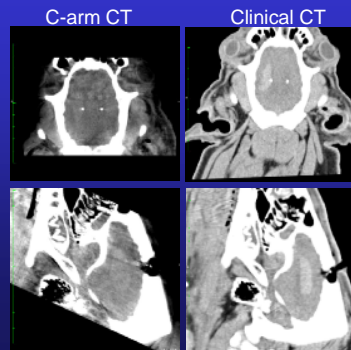


9mm scoring objects with contrast of 5HU visible in over 90% of all cases

MTF: 100 μm steel wire



Intracranial Imaging



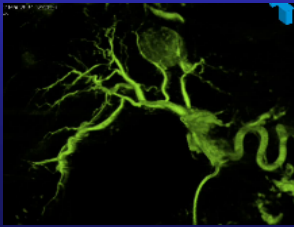
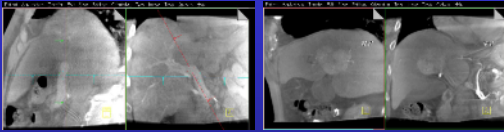
In vivo pig model,
Autologous blood,
NO iodine contrast

ARTIFACT:

Beam hardening
Scatter
Conebeam

M. Marks, H. Do et al.

Body Applications : TACE



ARTIFACT:

Truncation

L. Hoffman et al.

C-arm CT vs. Clinical CT

- | | |
|-------------------------|------------------------|
| ○ Intra-procedural | ○ Diagnostic |
| ○ Single circle scan | ○ Spiral scan |
| ○ 1000 slices | ○ 64 slices |
| ○ Rotation time 5-10s | ○ Rotation time 0.3s |
| ○ Volume in 5-10s | ○ Volume in 5-10s |
| ○ See better than 10 HU | ○ See better than 3 HU |

Conclusions

- Better visibility at lower energy (kVp) offers potential for image acquisition protocol optimization
- We can detect 9mm scoring objects (nominal contrast "5HU") in over 90% of all cases (70kVp through 125kVp)
- The dose applied to obtain this image quality performance is close to the EU guideline for CT head scans (60mGy)
- The in-plane spatial resolution of the system is excellent.