Image Diagnostic Technology Ltd
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Tel: +44 (0)20 8819 9158 www.idtscans.com email: info@idtscans.com

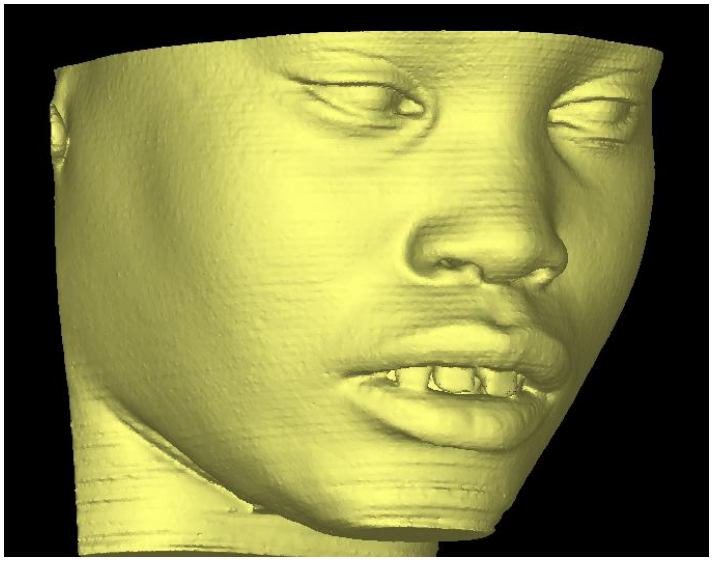
Diagnostic Imaging and Radiation Safety

Anthony Reynolds BA MSc PhD
Registered Clinical Scientist CS03469

Image Diagnostic Technology Ltd.

Who or what is IDT?

Image Diagnostic Technology Ltd aka "IDT Scans"



Specialising in:

- **arranging dental CT/CBCT scans**
- **3D processing**
- **radiology reports**
- **implant simulation**
- **3D models**
- **surgical drill guides**

30,000 scans processed since 1991

making the most IDT of your image™

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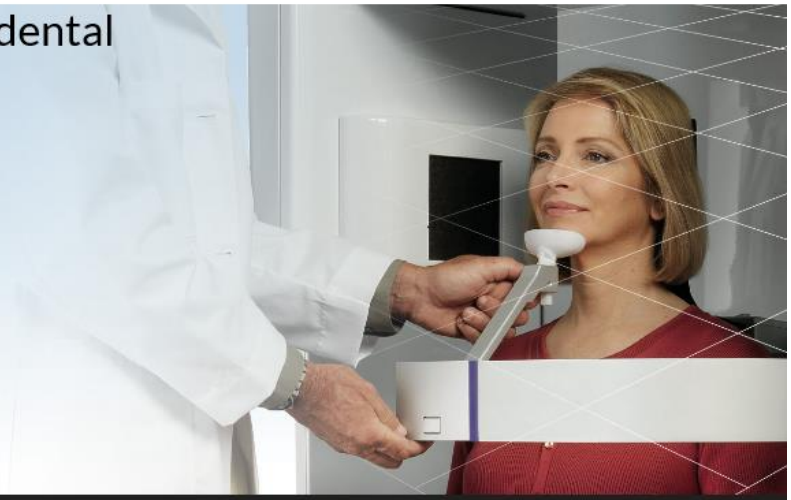
Get the most out of your dental CT/CBCT scans



IMPLANT SIMULATION

REFORMAT AN EXISTING SCAN

REQUEST A RADIOLOGY REPORT

REQUEST A NEW DENTAL CT SCAN

Choose a scanning site in the UK or Ireland

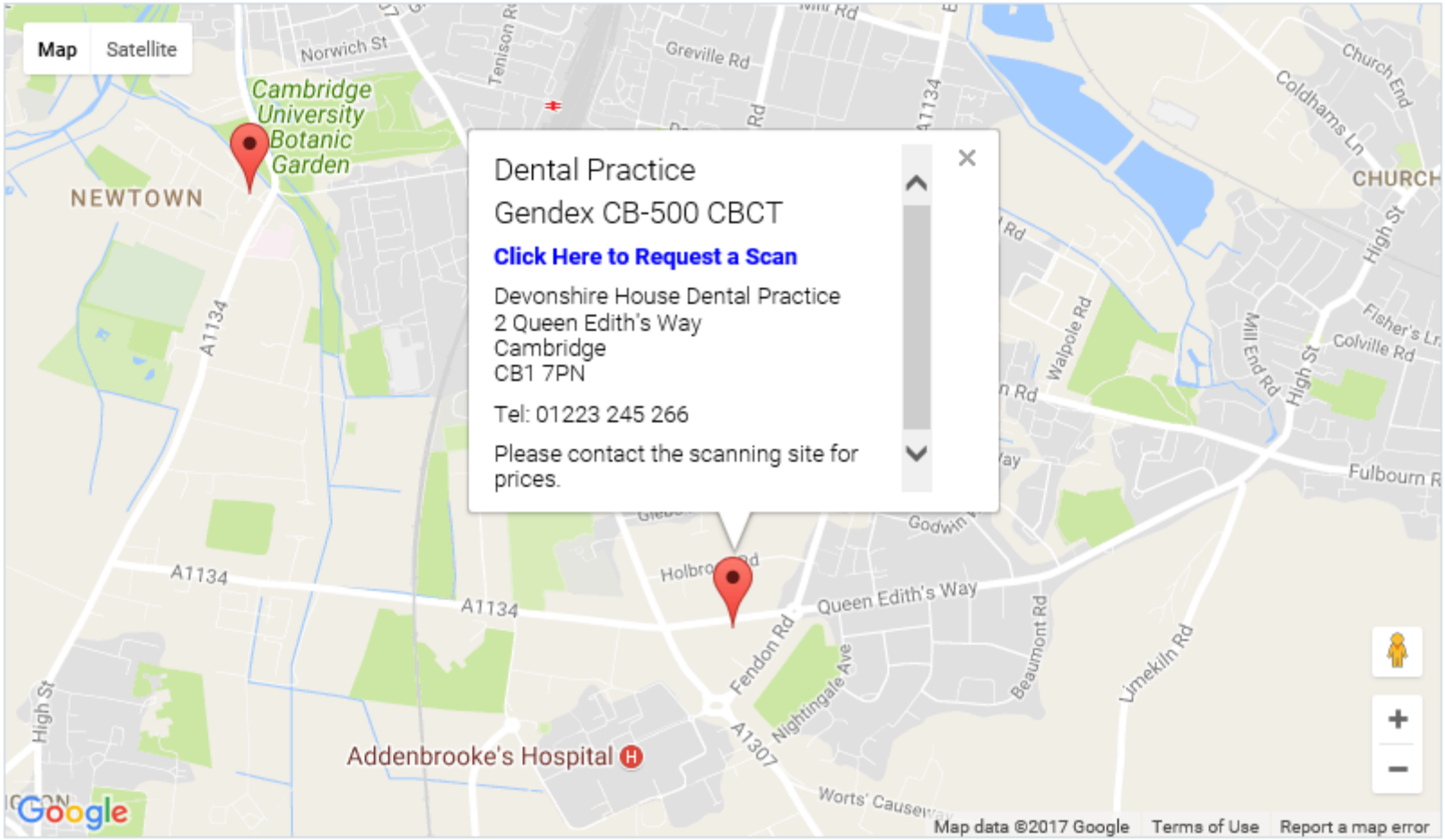
SEARCH

Scan Site Search

Location Keyword A-Z List

Cambridge 20 km Search

Click the icons for more information



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Outline of Presentation

- ✔ **Introduction / Disclosures**
- **Imaging for Dental Implants**
  - **Conventional Radiography**
  - **CT / CBCT Scans**
  - **Make Your Own Drill Guides**
- **Radiation Dose and Risk**
- **Rogues Gallery**
- **Quiz**

Imaging for Dental Implants

Need to be able to:

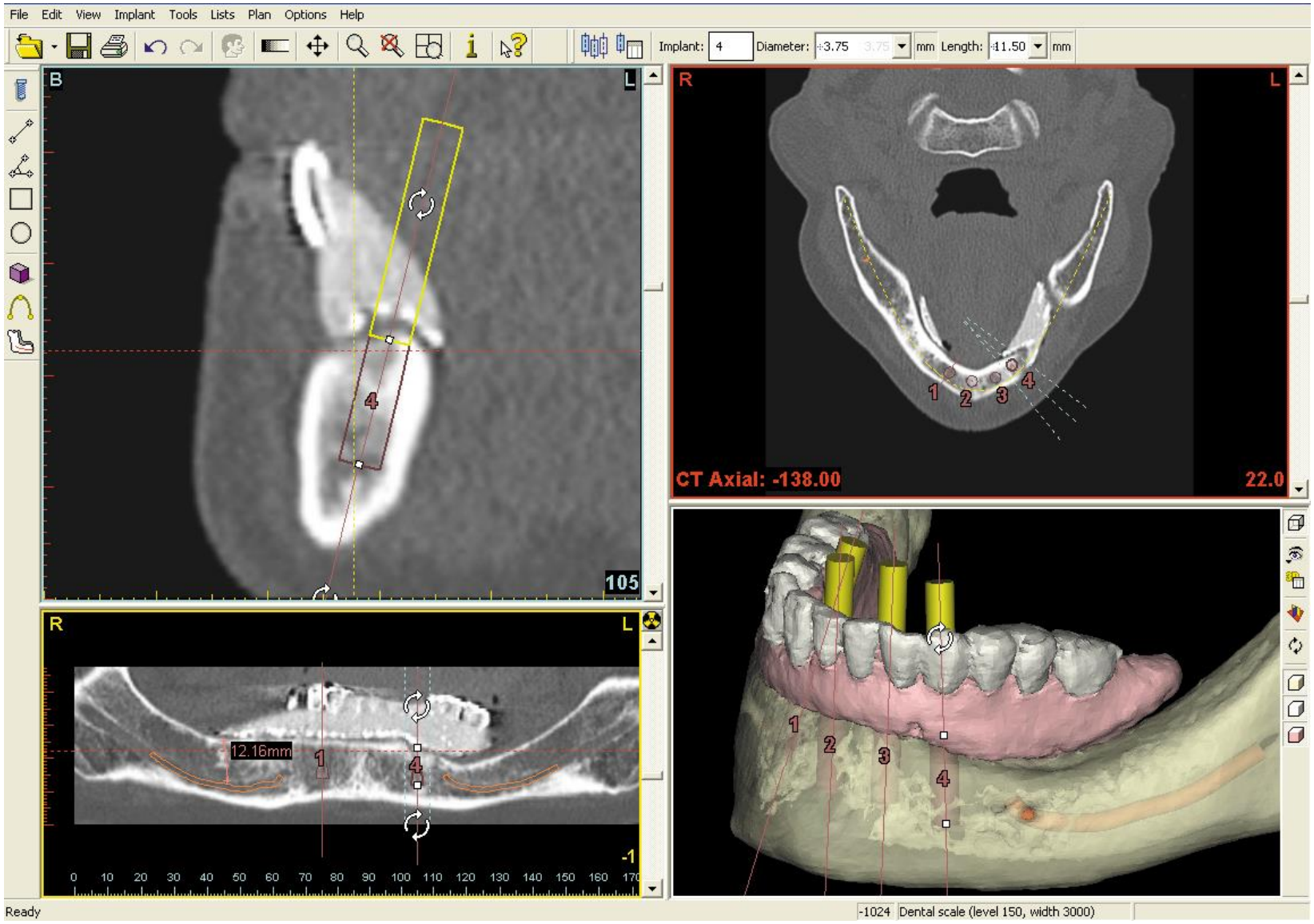
- **Review patient anatomy and pathology**
  - **diagnostic quality images**
- **Assess bone quantity and quality**
  - **quantitative assessment**
- **Decide where implants should go**
  - **accurate 3D measurements**
  - **avoid sensitive structures**
  - **must work mechanically and aesthetically**

Restoration-Driven Implant Planning

"Create a model of the desired result, then work backwards to determine how it can be achieved"

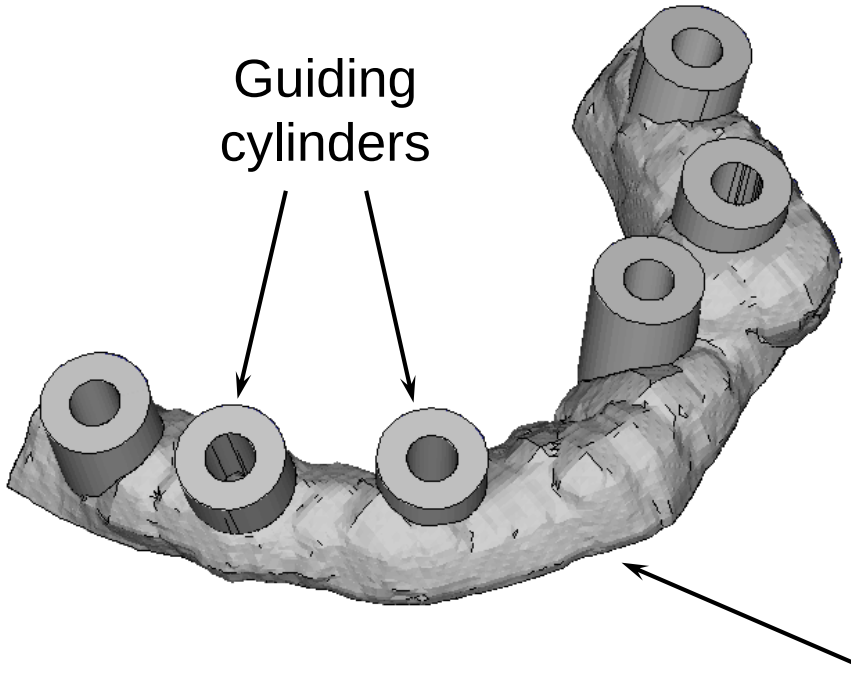
- ***Radio-Opaque Scanning Stents***
- ***3D Treatment Planning Software***
- ***Surgical Drill Guides***

SimPlant Computer Guided Implantology *interactive implant planning software*



SIMPLANT™ is a trademark of DENTSPLY Implants

SIMPLANT drill guide



The SurgiGuide controls:
- Position
- Orientation
- Depth

Guide resting on:
- Bone
- Mucosa
- Teeth

Software for planning Dental Implants

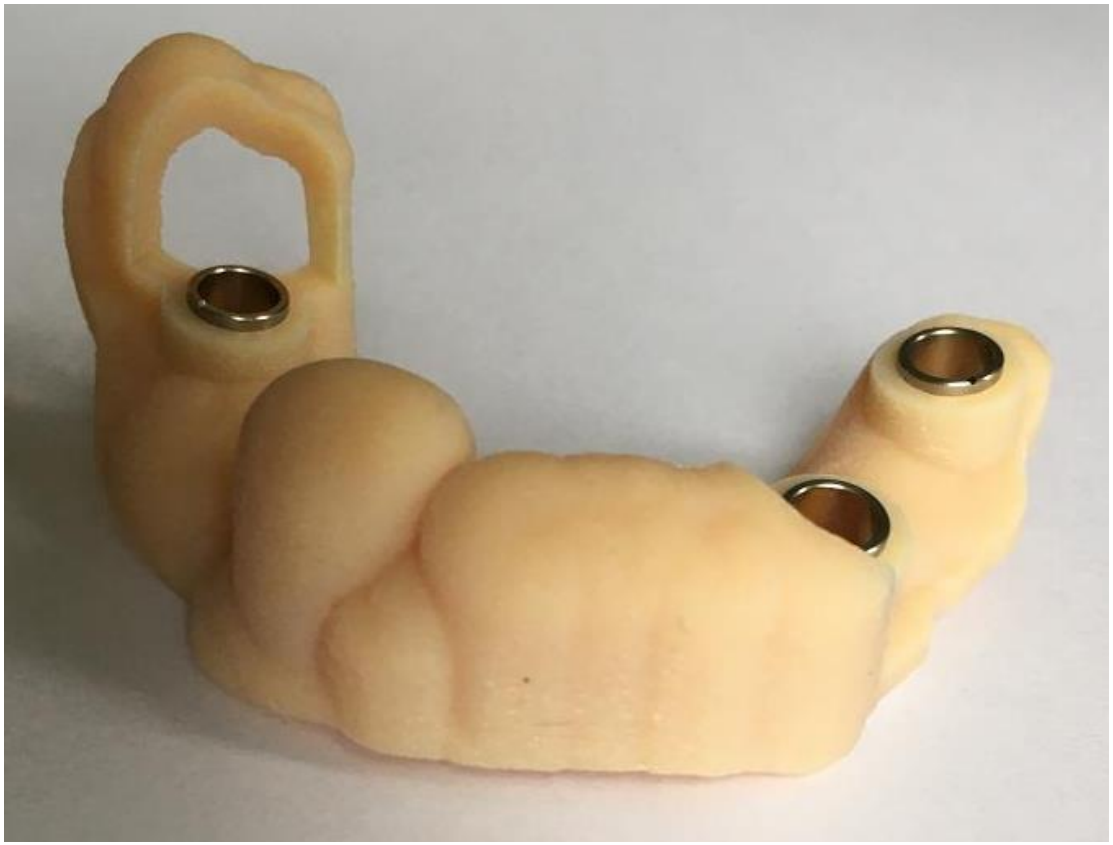
- **SIMPLANT (DENTSPLY Implants)**
- **Blue Sky Plan (Blue Sky Bio)**
- **Osirix (with Dental3D plugin)**
- **In Vivo Dental (Anatomage)**
- **Nobel Clinician (Nobel Biocare)**
- **coDiagnostiX (Straumann, Dental Wings)**
- **ImplantMaster (iDent)**
- **SICAT (Sirona)**
- **etc etc**

Blue Sky Plan

(Macintosh or PC)

- **Free Software produced by Blue Sky Bio**
- **Can be used with any implant system (but the implants are not realistic)**
- **Can import DICOM CT/CBCT data**
- **Can import STL files from optical scanners**
- **Can be used to design surgical drill guides**
- **Very powerful software, but not very user friendly!**

Surgical Drill Guides



The Ultimate Goal

Place implants so accurately that a (temporary) restoration can be fabricated before the surgery takes place

"The Immediate Smile" ***– DENTSPLY Implants***
"Teeth in an Hour" ***-- Nobel Biocare***
"Smart Implants" ***– Limplant Ltd***

The Ultimate Goal

Place implants so accurately that a (temporary) restoration can be fabricated before the surgery takes place

- To do this you have to rely on your imaging!

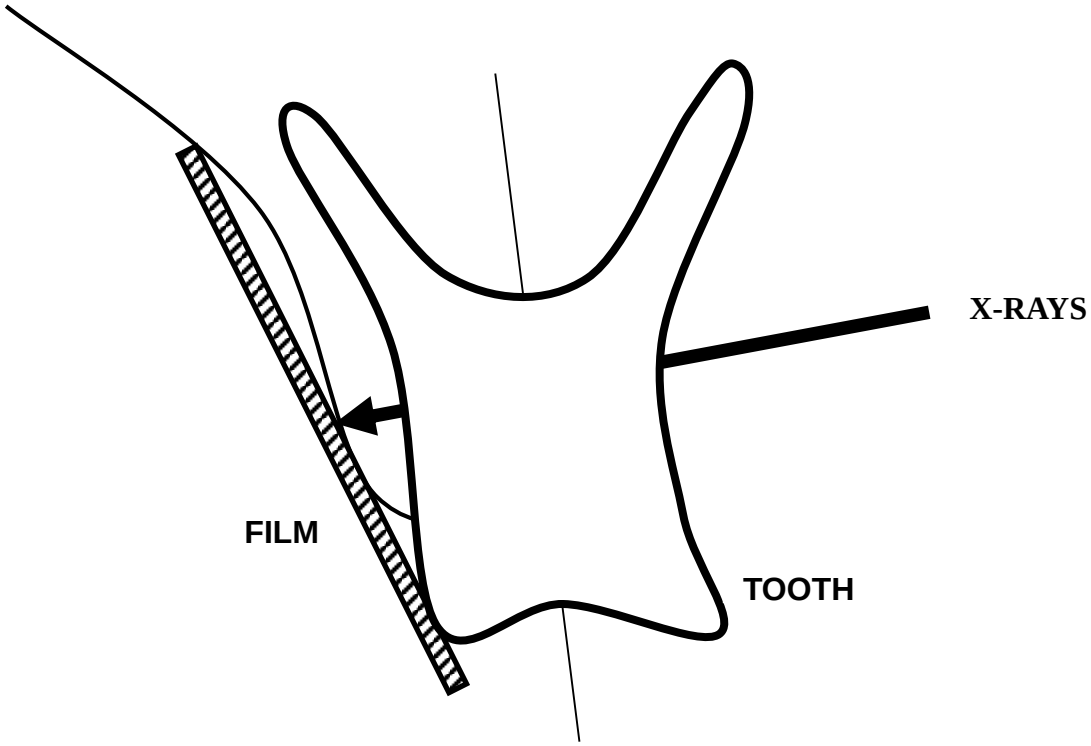
Which Imaging Modalities are best?

- ✔ **Intra-oral radiography**
  - **Occlusal films, bitewings, periapicals**
- ✘ **Extra-oral radiography**
  - **AP and Lateral cephs**
- ✘ **Conventional tomography**
  - **Dental Panoramic Tomography (DPT)**
  - **Linear / Complex Motion Tomography (CMT)**
- ✘ **Magnetic Resonance Imaging**
- ✔ **Medical computed tomography (CT)**
- ✔ **Cone Beam computed tomography (CBCT)**

Intra-oral Imaging

+ **Very high resolution (20 lp/mm)**
+ **Fast, convenient, low dose**
– **No bone width**
– **No (quantitative) bone quality**
– **Magnification / Distortion**

Distortion in intra-orals



Solutions:

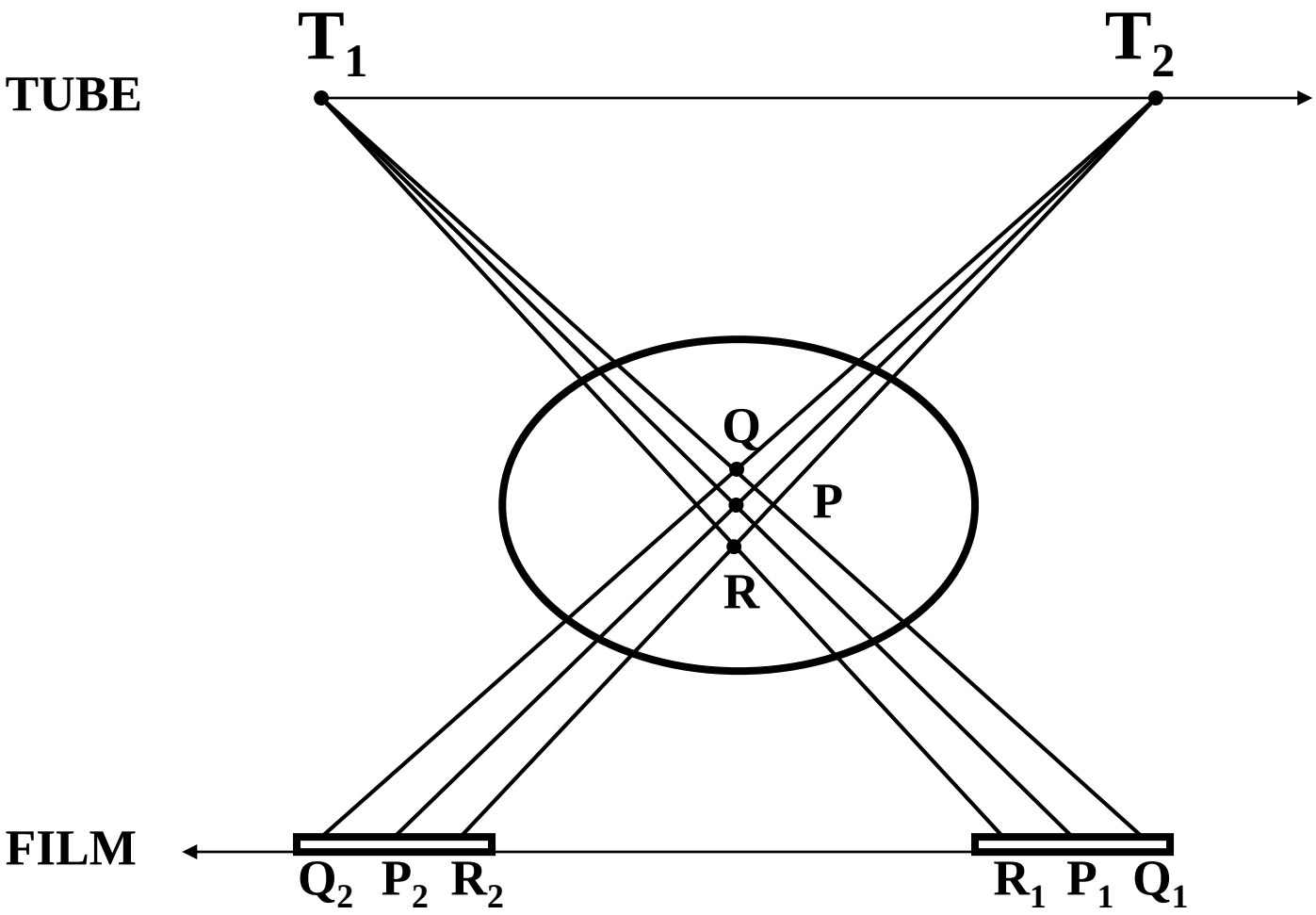
- bisecting angle ✗
- paralleling technique ✓

Extra-oral: Lateral Cephs

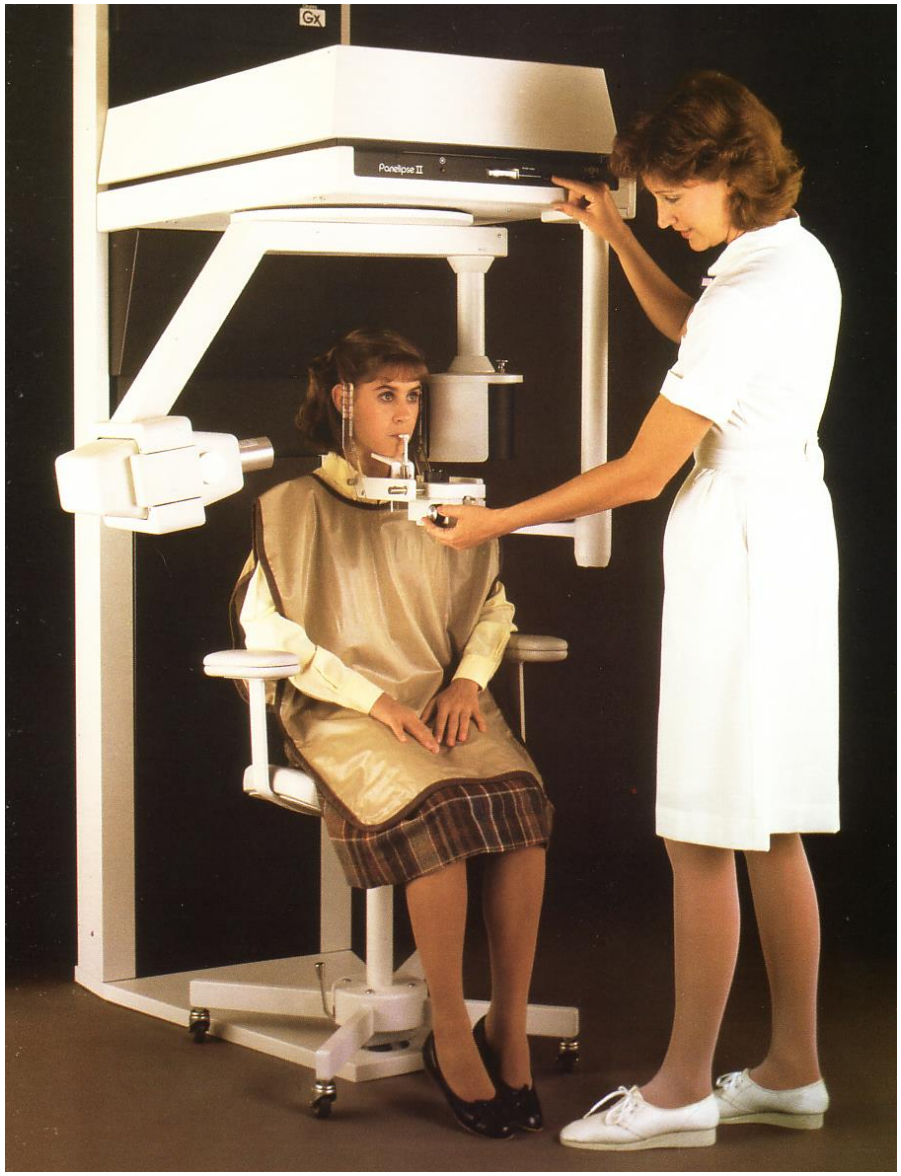
+ **Good overview**
– **Width and height on midline only**
– **No (quantitative) bone quality**

Conventional Tomography

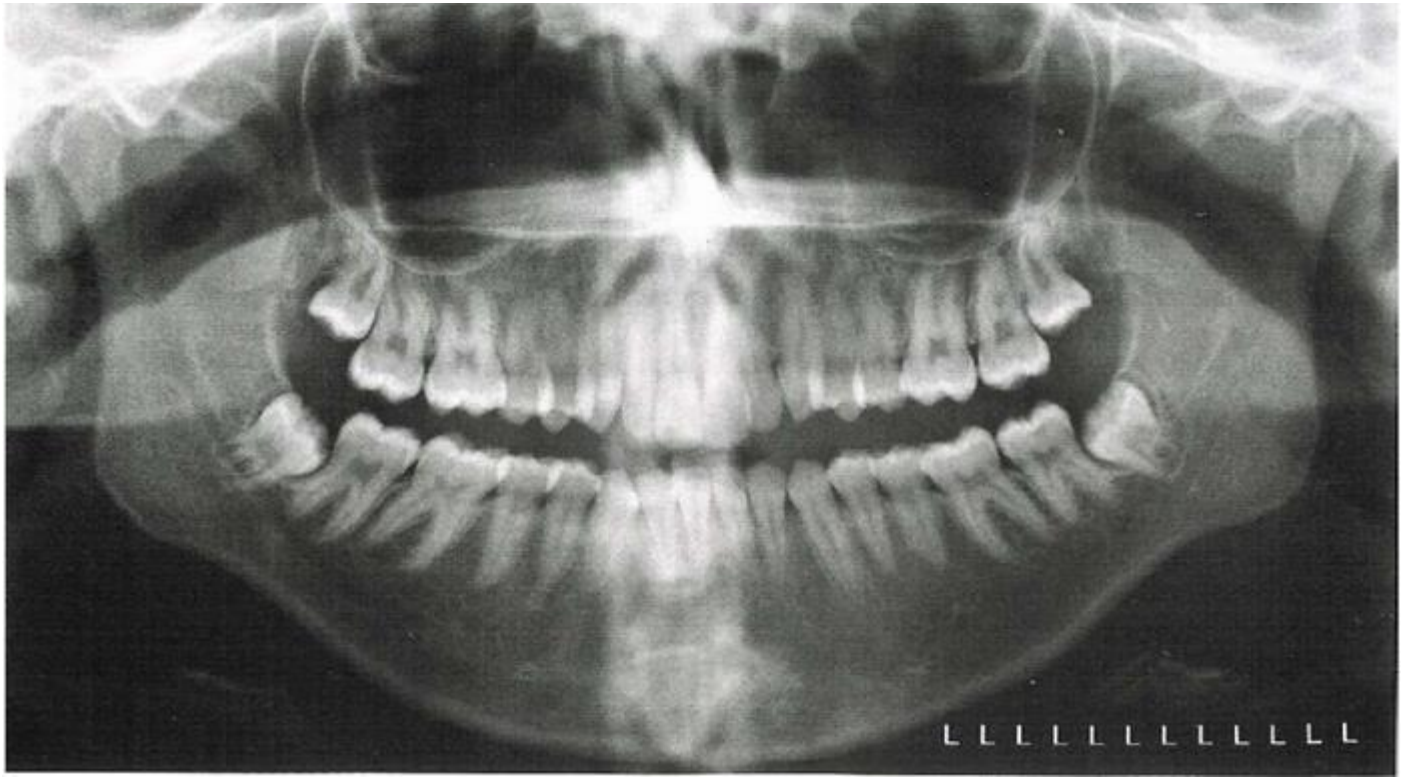
(tomography by blurring)



Dental Panoramic Tomography (DPT)



Dental Panoramic Tomography (DPT, OPG, OPT)



+ Very good overview
– No bone width
– No (quantitative) bone quality
– Variable magnification => distortion
– Patient positioning is crucial

DPTs are useful for:

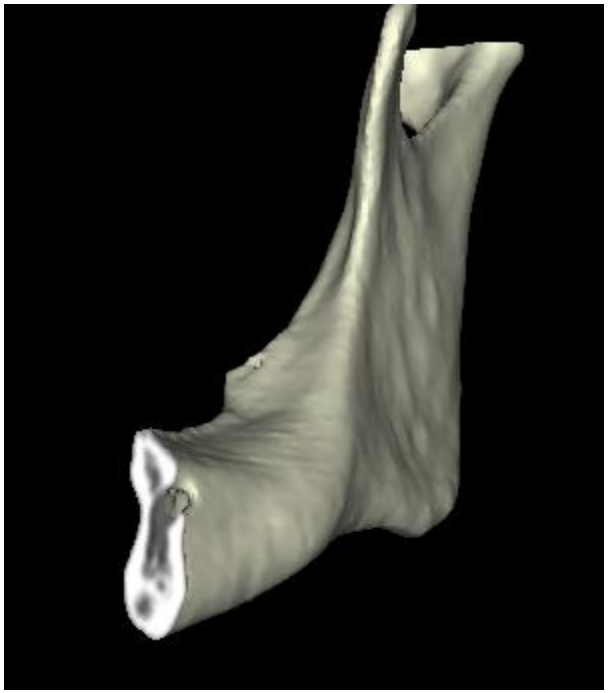
- Overall status of teeth and supporting bone
- Anatomical anomalies and pathological conditions
- Triage between:
  - Sites where placing implants will be straight-forward
  - Sites where grafting or distraction will be needed
  - Sites where implants are not advisable

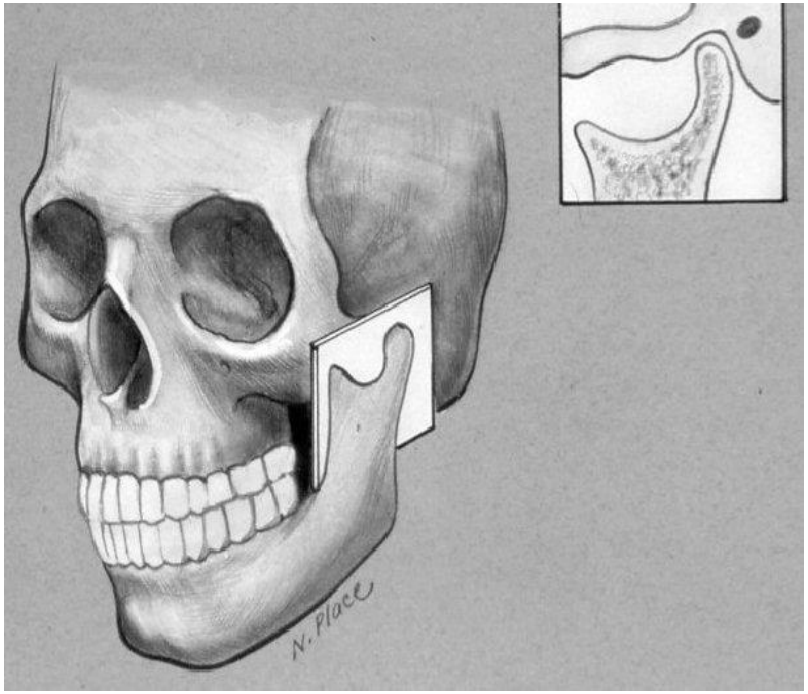
Measurements from DPTs are not accurate:

Reddy et al. Clin Oral Implants Res. 1994 Dec; 5(4):229-238

- Errors as large as 30% in estimating bone height from DPTs
- Bone width cannot be estimated at all.

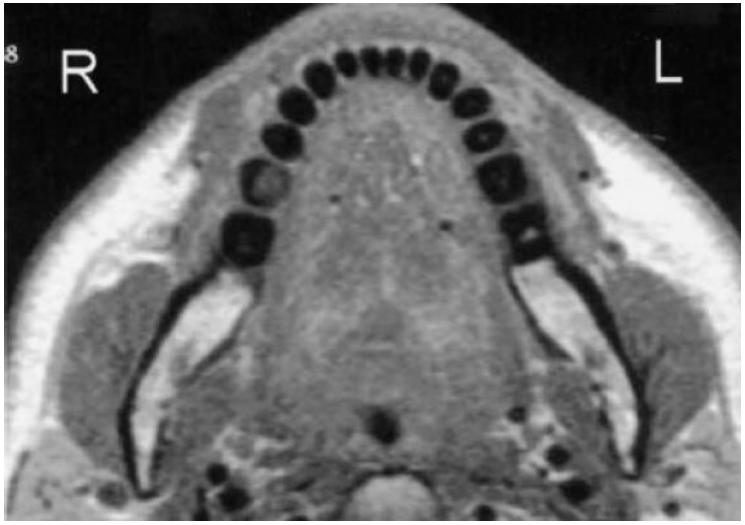
Cross-Sectional Imaging





- ~~Linear Tomography~~
- ~~Complex Motion Tomography (CMT)~~
- Magnetic Resonance Imaging (MRI)
- Computed Tomography (CT or CBCT)

Magnetic Resonance Imaging



+ no radiation dose
+ no metallic artefact
- large, expensive machine
- teeth generate no signal

Advanced imaging: Magnetic resonance imaging in implant dentistry

A review

Crawford F. Gray, Thomas W. Redpath, Francis W. Smith, Roger T. Staff

Article first published online: 31 JAN 2003

DOI: 10.1034/j.1600-0501.2003.140103.x

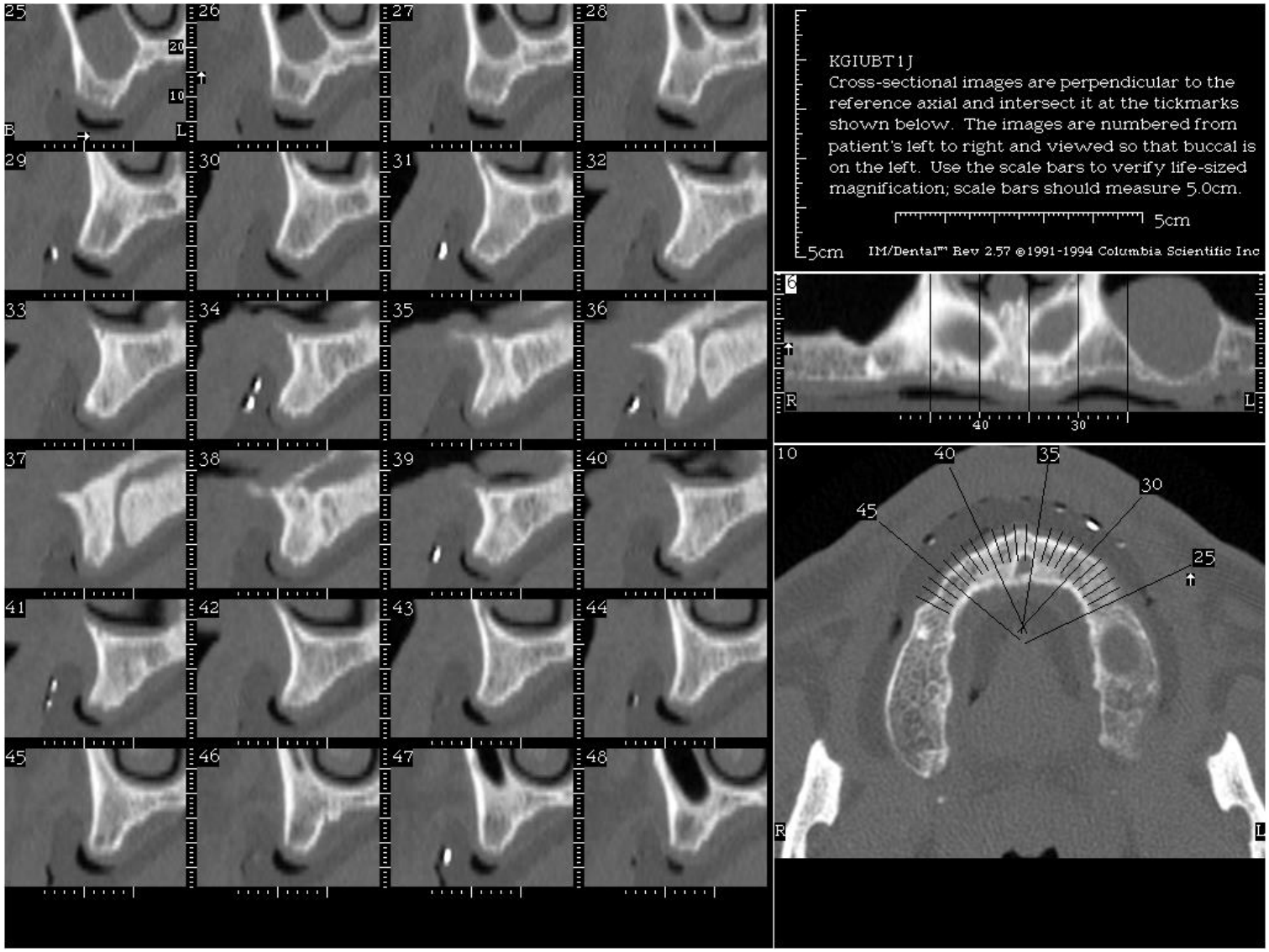
Issue

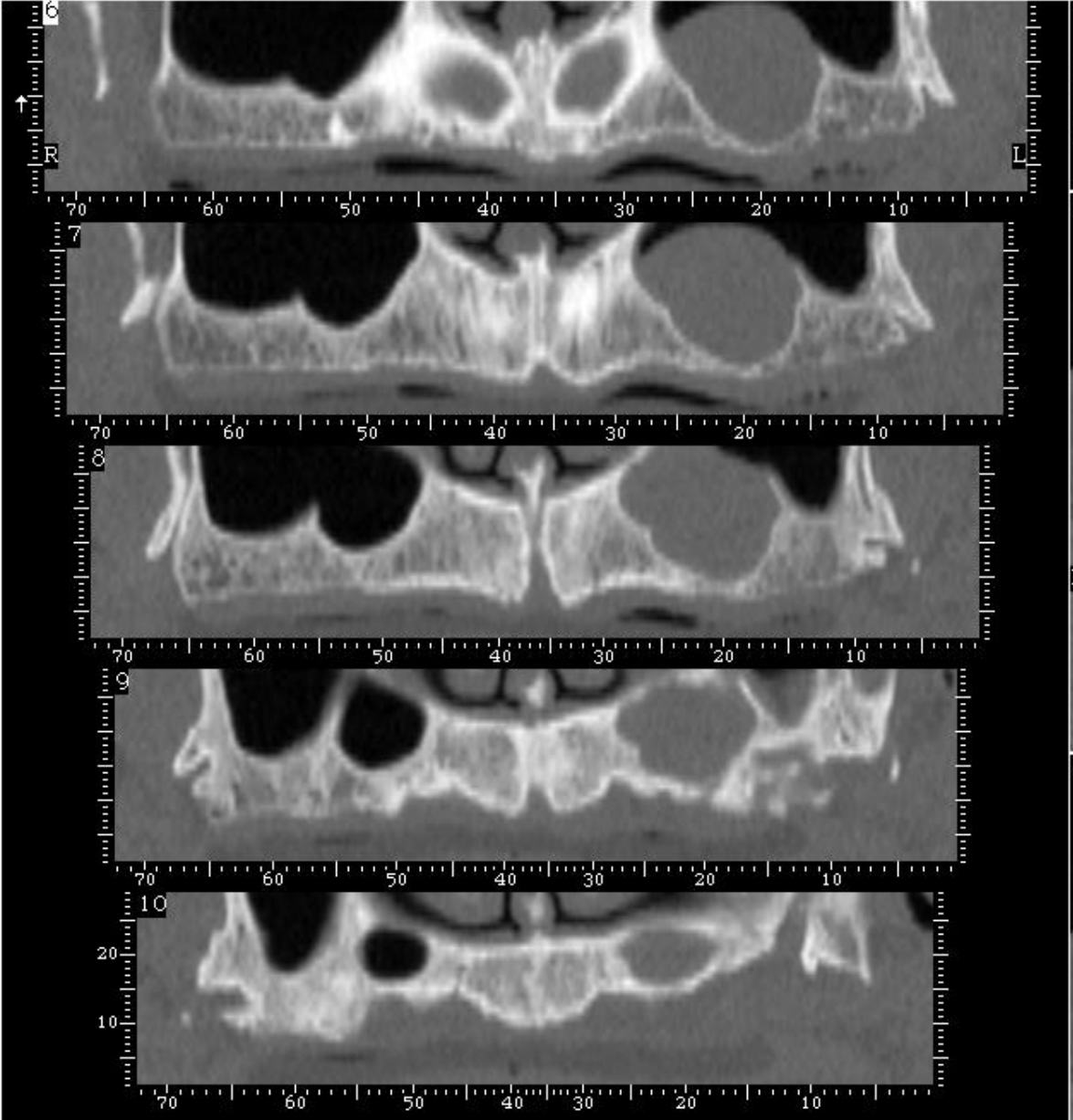
Clinical Oral Implants Research

Volume 14, Issue 1, pages 18–27, February 2003

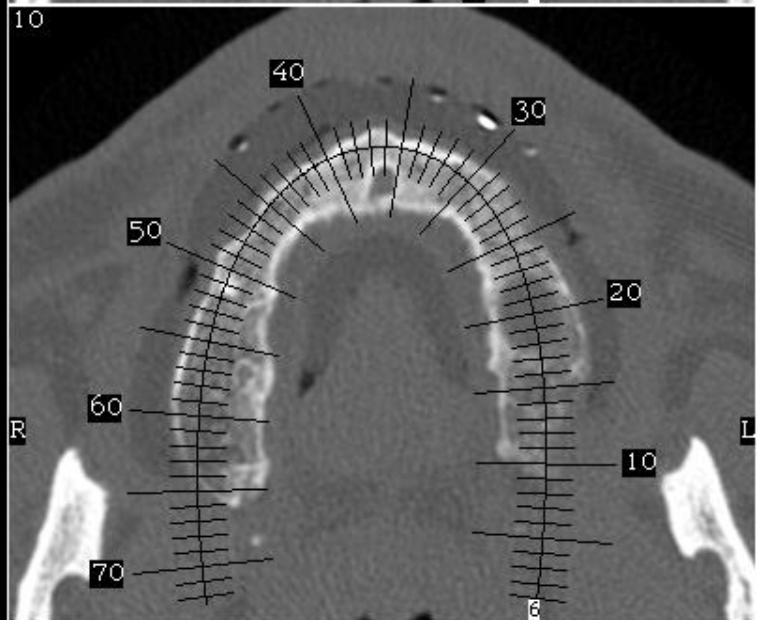
Computed Tomography (CT)

(tomography by computation)

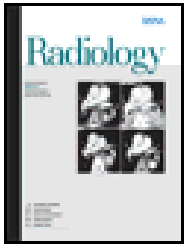




KGIUBT1J Panoramic images are perpendicular to the reference axial and intersect it at the curves shown below. Images are numbered from buccal to lingual and are viewed from buccal.



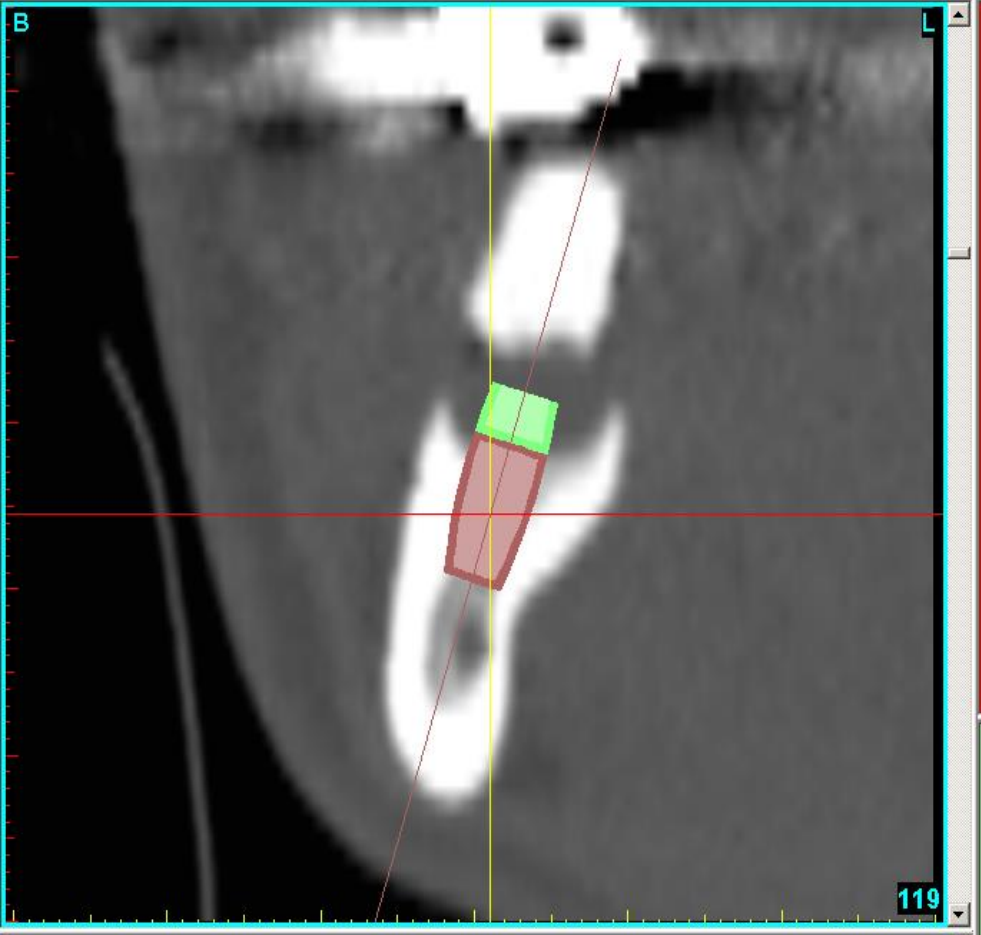
(First paper on dental reformatted CT)

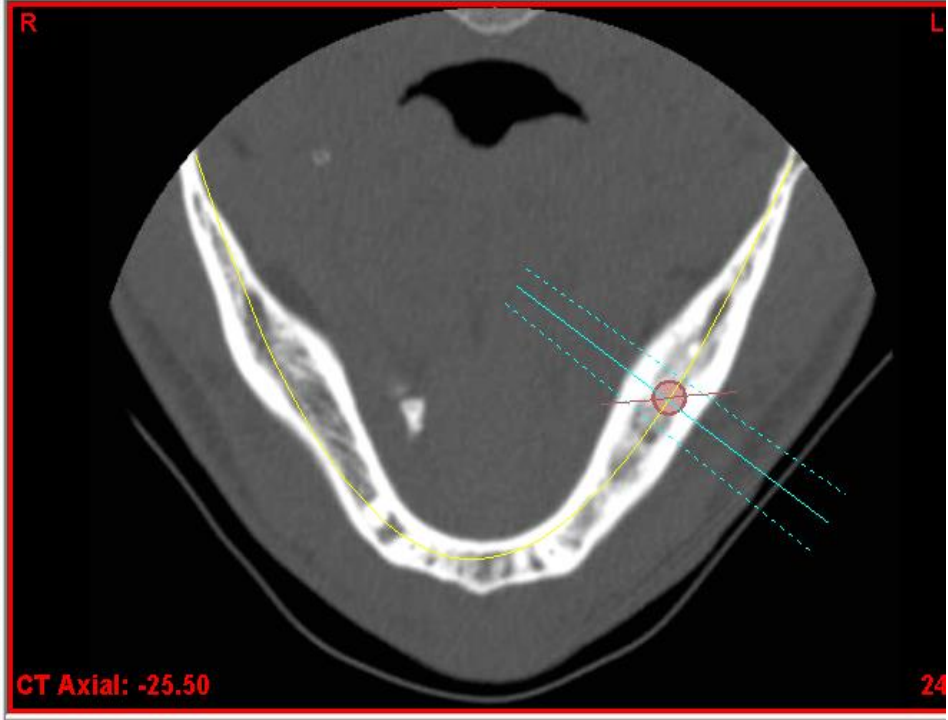


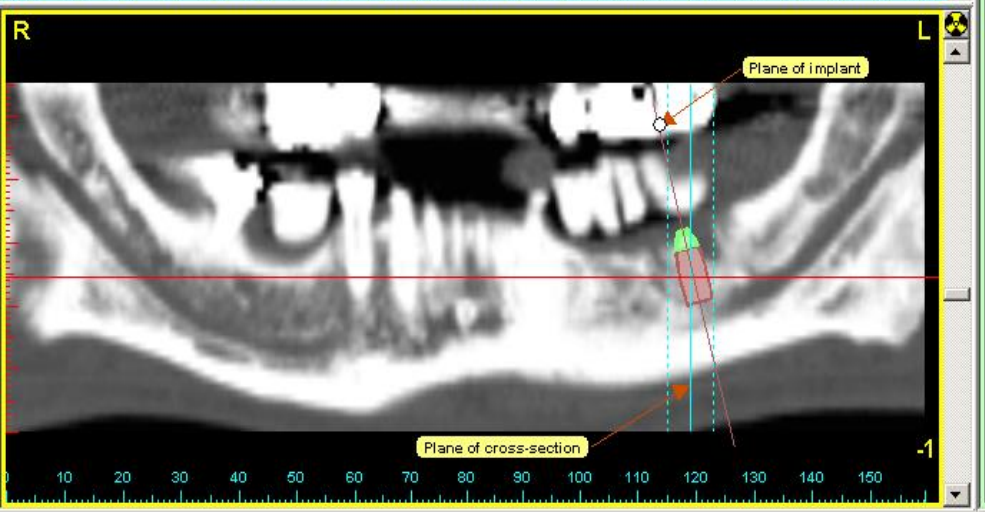
S L Rothman, N Chaftez, M L Rhodes, M S Schwarz and M S Schwartz

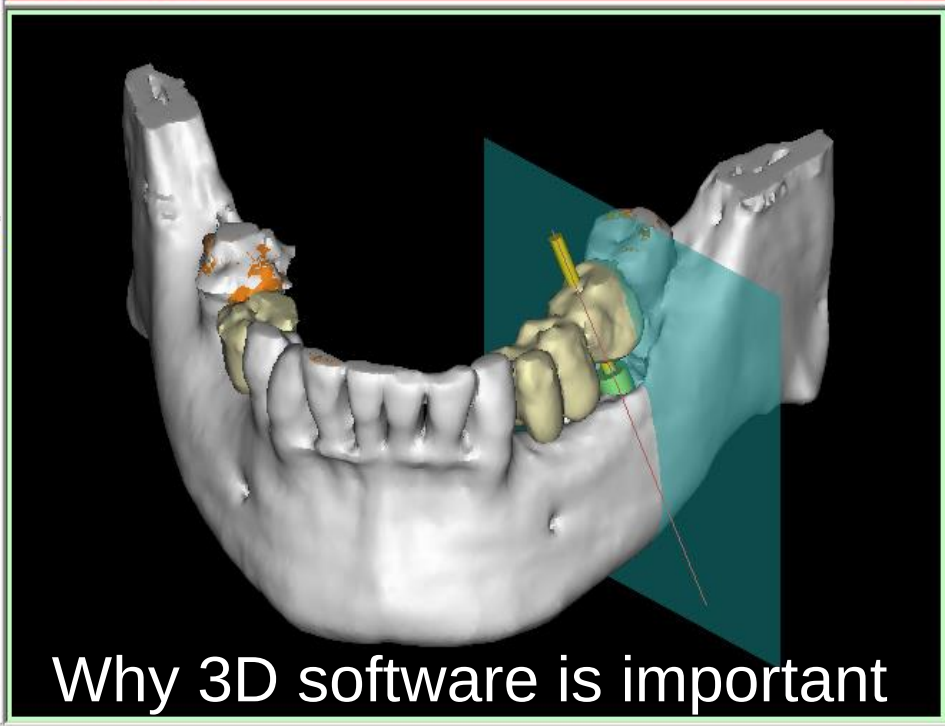
CT in the preoperative assessment of the mandible and maxilla for endosseous implant surgery. Work in progress.

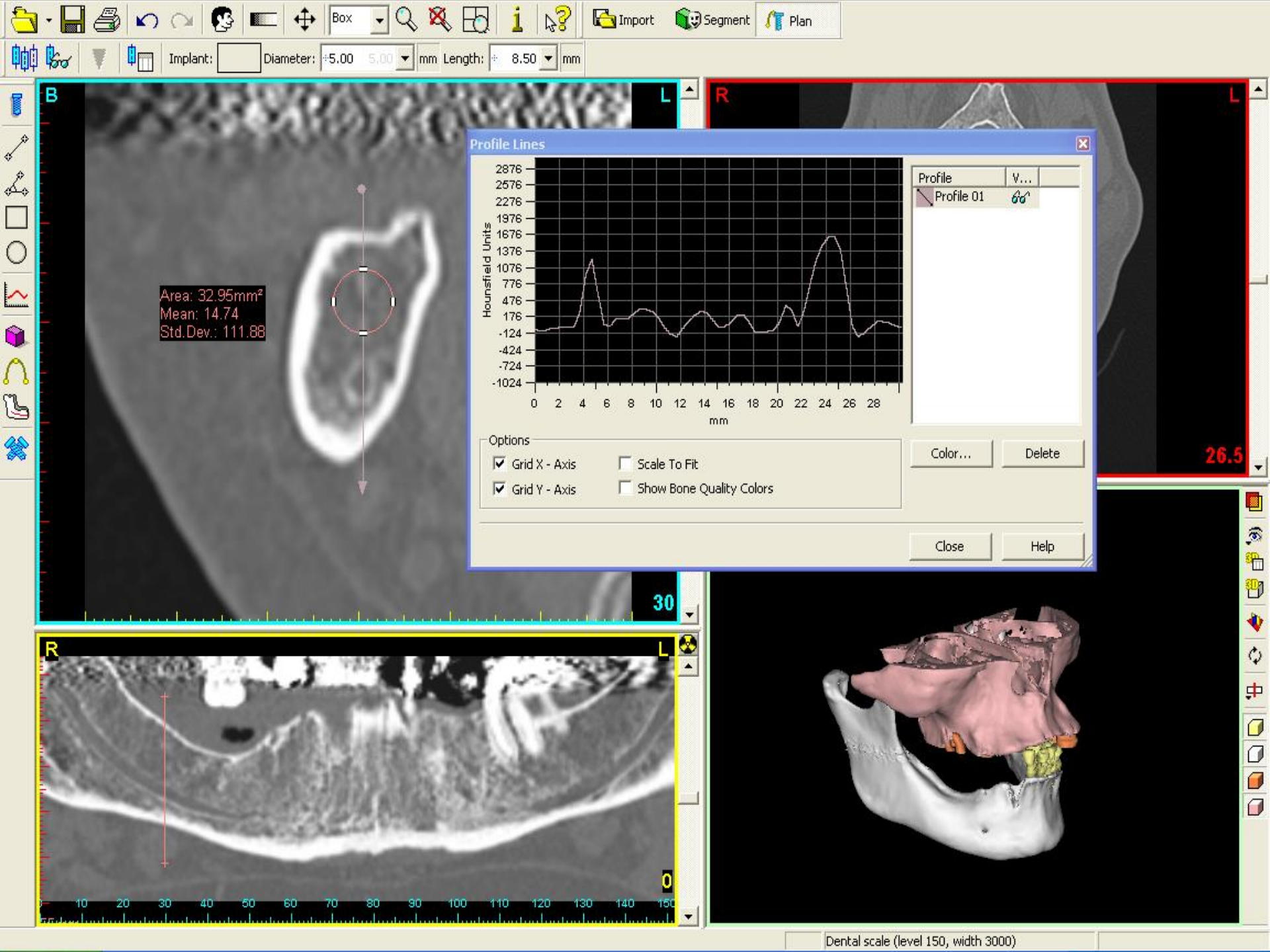
Radiology July 1988 168:171–175


B
L
119

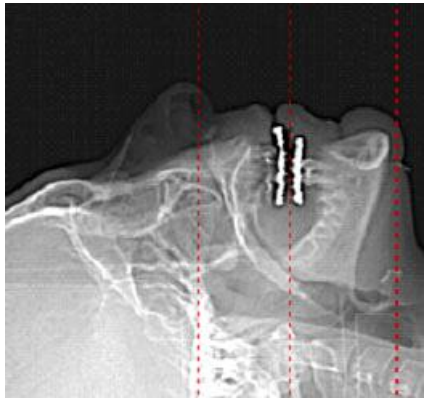

R
L
CT Axial: -25.50
24


R
L
Plane of implant
Plane of cross-section
-1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150


Why 3D software is important


Box
Import
Segment
Plan
Implant:
Diameter:
5.00
mm
Length:
8.50
mm
B
L
Area: 32.95mm²
Mean: 14.74
Std.Dev.: 111.88
30
R
L
26.5
Profile Lines
2876
2576
2276
1976
1676
1376
1076
776
476
176
-124
-424
-724
-1024
Hounsfield Units
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
mm
Profile
V...
Profile 01
Options
Grid X - Axis
Grid Y - Axis
Scale To Fit
Show Bone Quality Colors
Color...
Delete
Close
Help
R
L
0
10 20 30 40 50 60 70 80 90 100 110 120 130 140
Dental scale (level 150, width 3000)

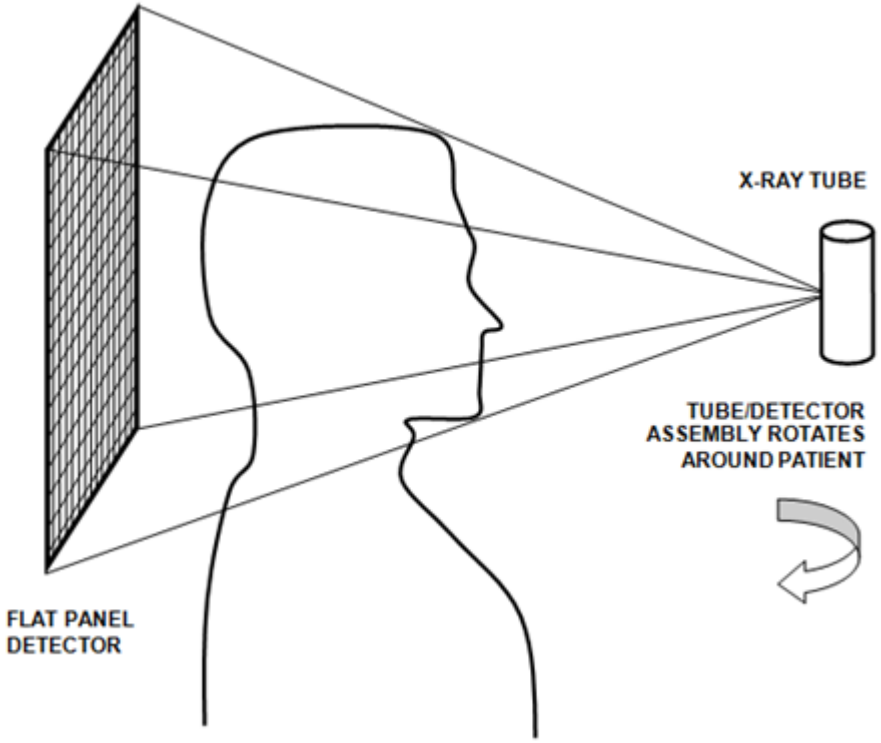
Dental (CB)CT Scans



- **Bony anatomy of Mandible, Maxilla, Zygomatic Arches**

- **Useful for:**
  - **impacted, supernumerary and abnormal teeth**
  - **root canals, root fractures**
  - **planning dental implants**
  - **periapical disease**
  - **cleft palate assessment**
  - **TMJ and airway analysis**

Cone Beam CT (CBCT) Scanner



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ELSEVIER
SAUNDERS

(Review Paper)

THE DENTAL
CLINICS
OF NORTH AMERICA

Dent Clin N Am 52 (2008) 707–730

What is Cone-Beam CT and How Does it Work?

William C. Scarfe, BDS, FRACDS, MS[a,*],
Allan G. Farman, BDS, PhD, DSc, MBA[b]

[a]*Department of Surgical/Hospital Dentistry, University of Louisville School of Dentistry, Room 222G, 501 South Preston Street, Louisville, KY 40292, USA*
[b]*Department of Surgical/Hospital Dentistry, University of Louisville School of Dentistry, Room 222C, 501 South Preston Street, Louisville, KY 40292, USA*

Int. J. Oral Maxillofac. Surg. 2009; 38: 609–625
doi:10.1016/j.ijom.2009.02.028, available online at http://www.sciencedirect.com

International Journal of
Oral & Maxillofacial Surgery

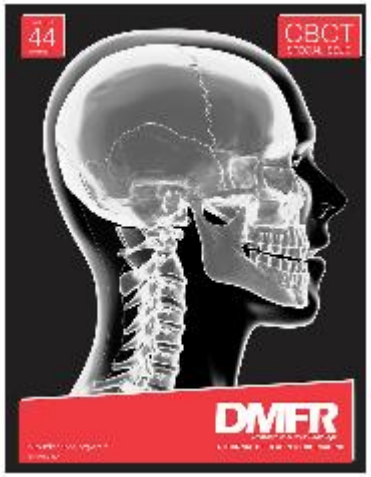
Invited Review Paper

Imaging

Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: A systematic review of the literature

W. De Vos[1], J. Casselman[2,3], G. R. J. Swennen[1,3]

[1]Division of Maxillo-Facial Surgery, Department of Surgery, General Hospital St-Jan Bruges, Ruddershove 10, 8000 Bruges, Belgium; [2]Department of Radiology and Medical Imaging, General Hospital St-Jan Bruges, Ruddershove 10, 8000 Bruges, Belgium; [3]3-D Facial Imaging Research Group, (3-D FIRG), GH St-Jan, Bruges and Radboud University, Nijmegen, 3-D FIRG, Ruddershove 10, 8000 Bruges, Belgium



DentoMaxilloFacial Radiology

VOLUME 44, ISSUE 1, 2015

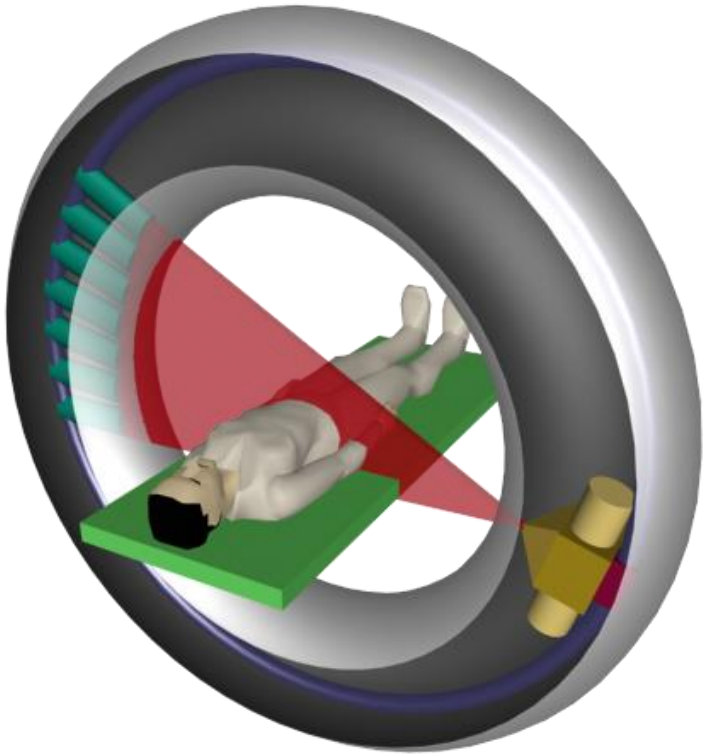
CBCT Special Issue

how CT works…

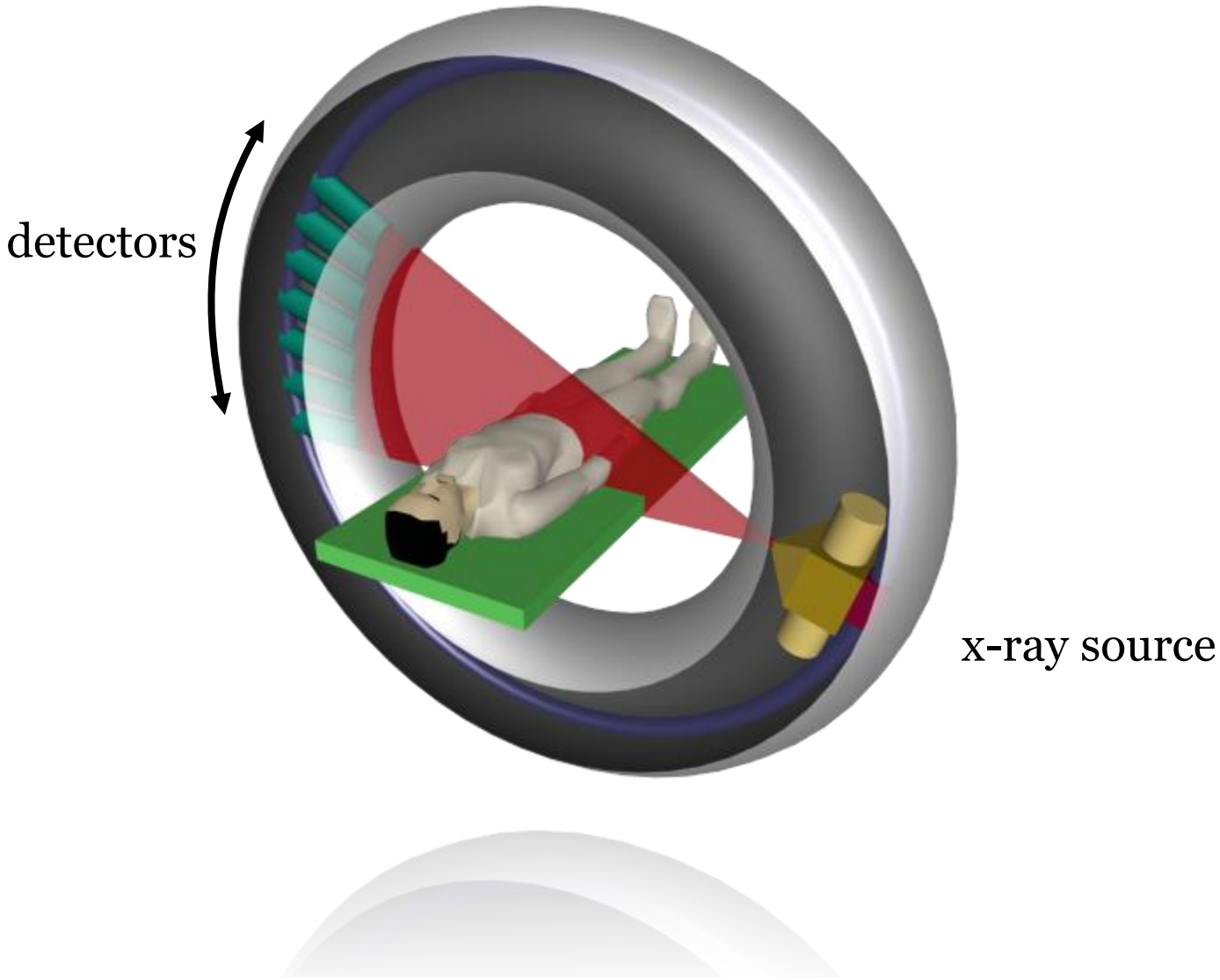
Godfrey Hounsfield

Allan Cormack

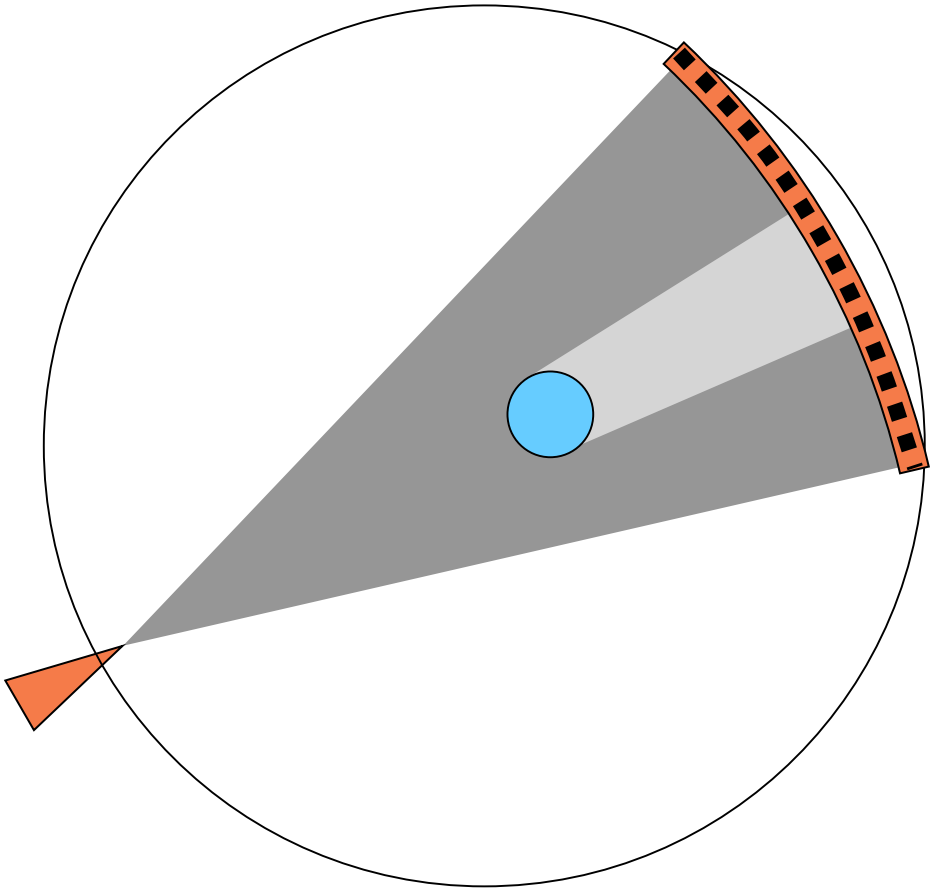
Nobel prize in Medicine, 1979



Animation courtesy of Demetrios J. Halazonetis
www.dhal.com

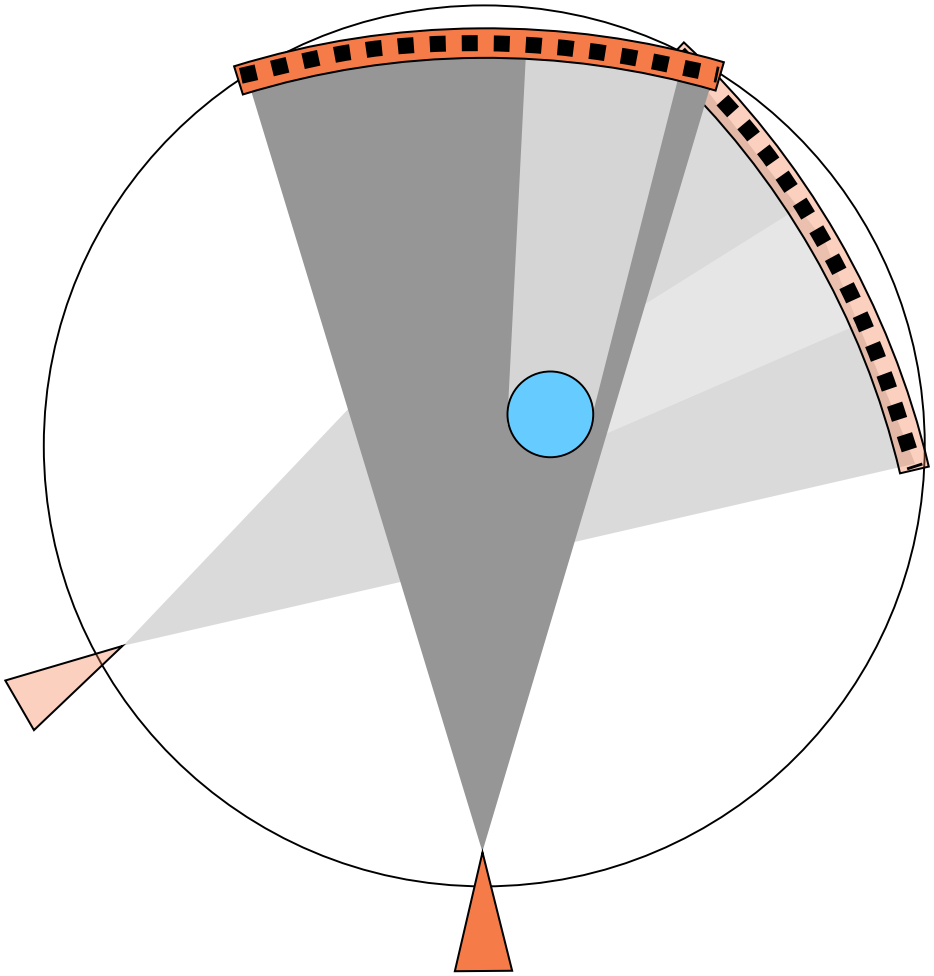

detectors
x-ray source

acquisition



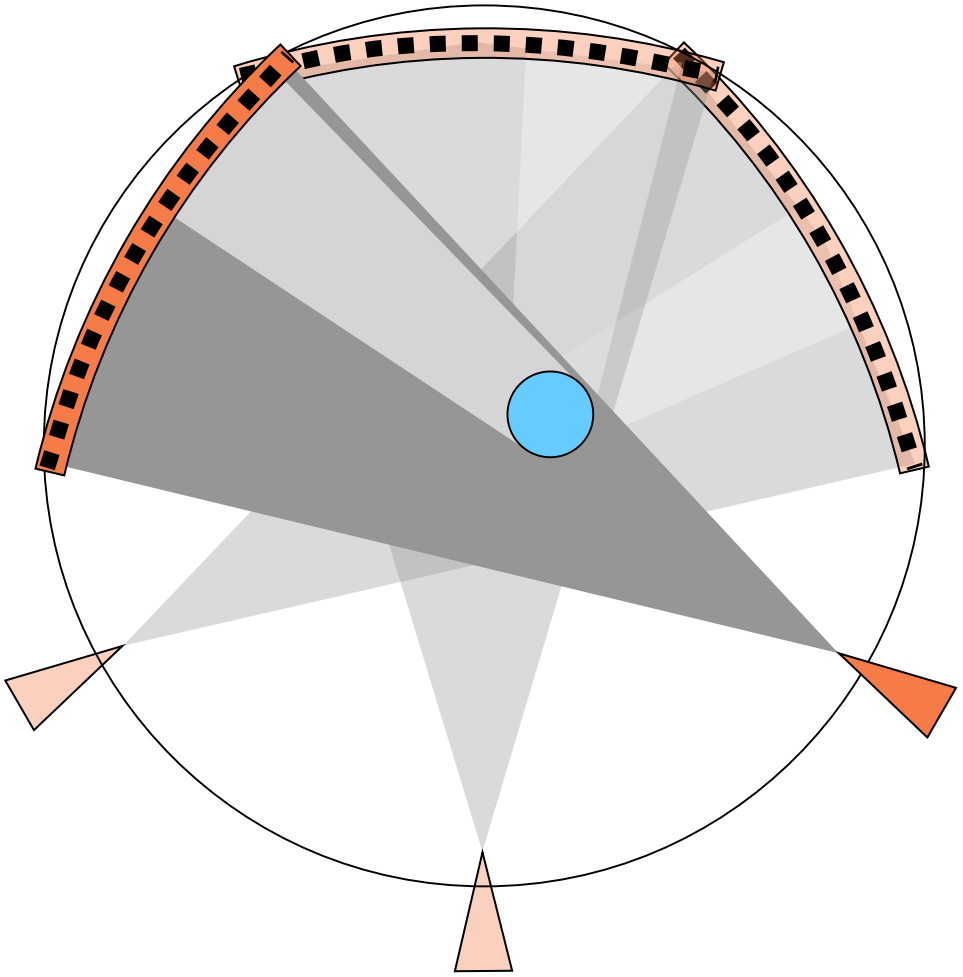
Animation courtesy of Demetrios J. Halazonetis

acquisition



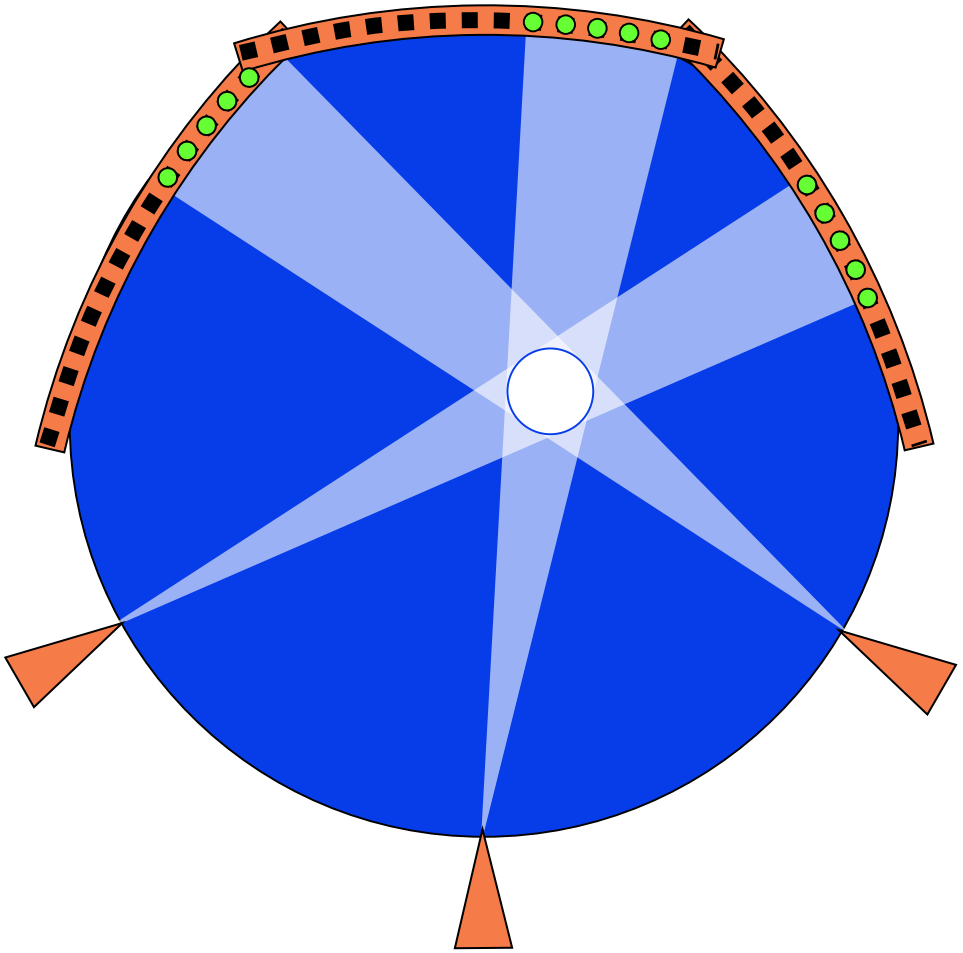
Animation courtesy of Demetrios J. Halazonetis

acquisition



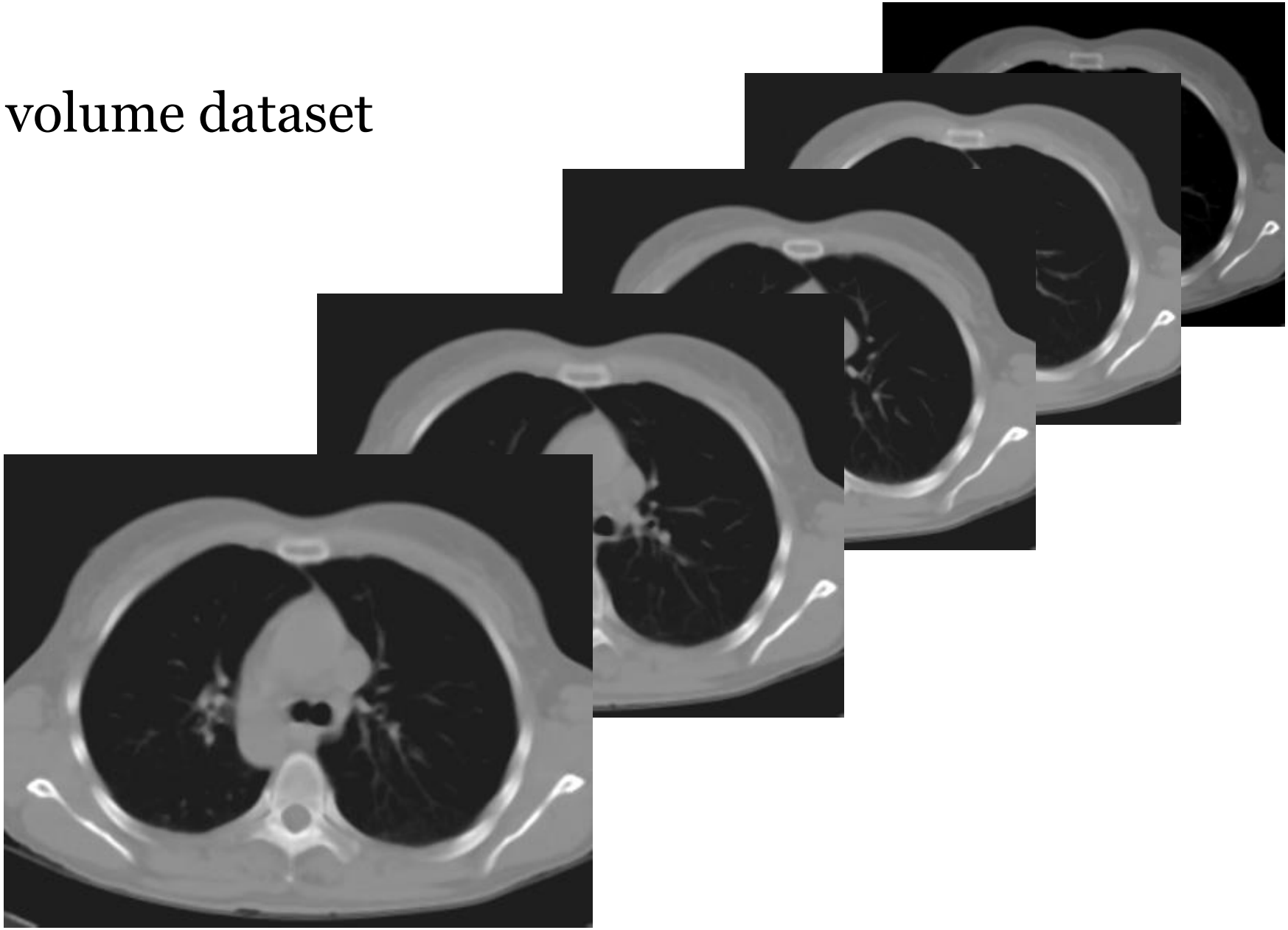
Animation courtesy of Demetrios J. Halazonetis

reconstruction

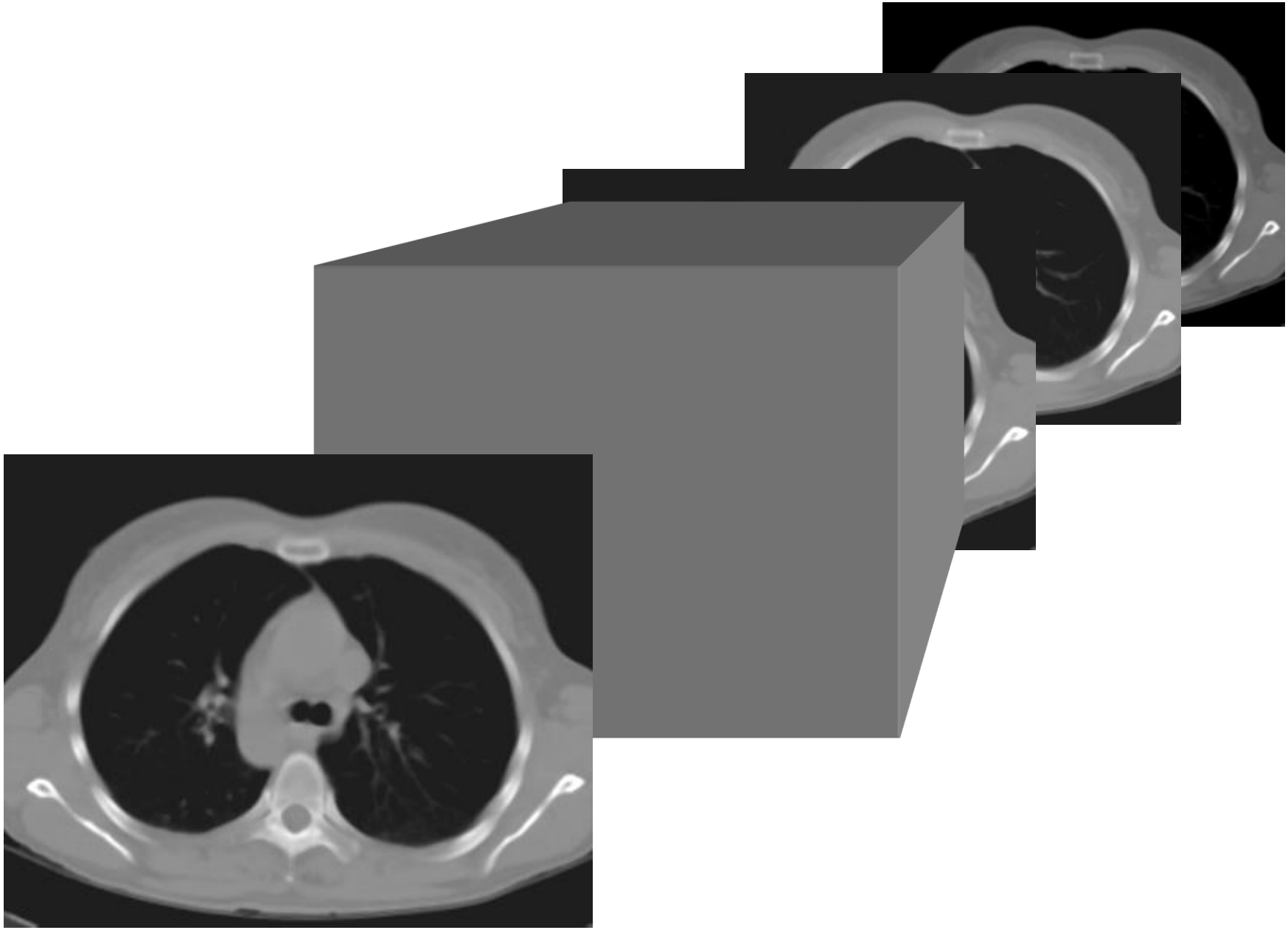


Animation courtesy of Demetrios J. Halazonetis

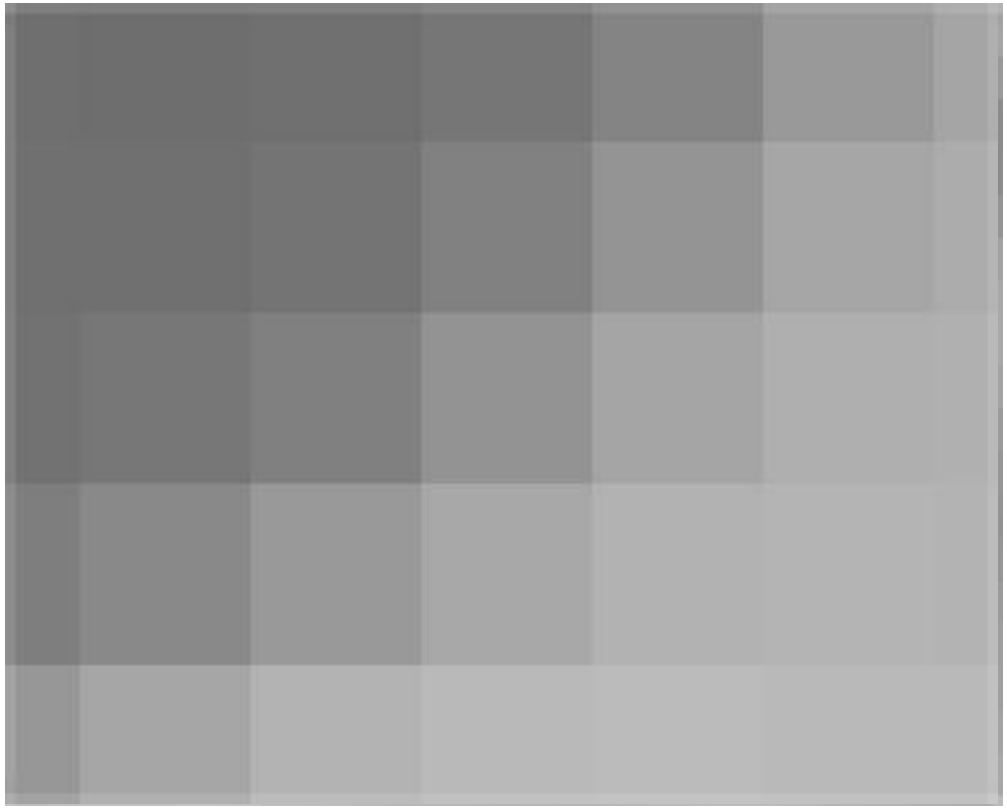
volume dataset



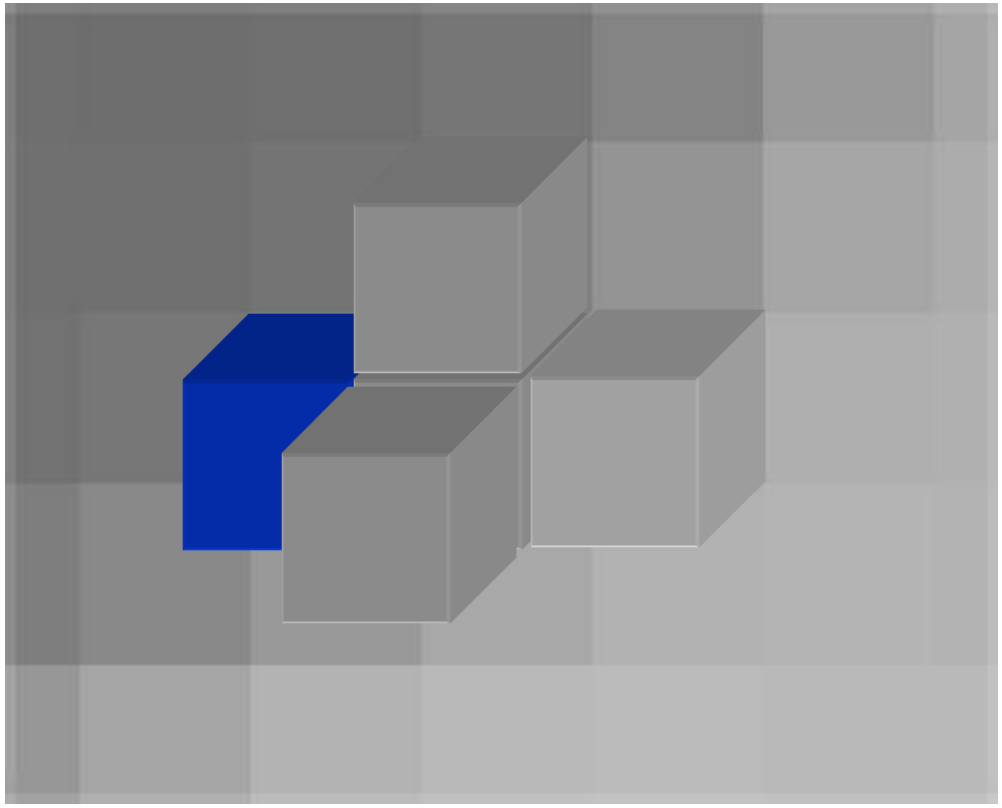
Animation courtesy of Demetrios J. Halazonetis



Animation courtesy of
Demetrios J. Halazonetis

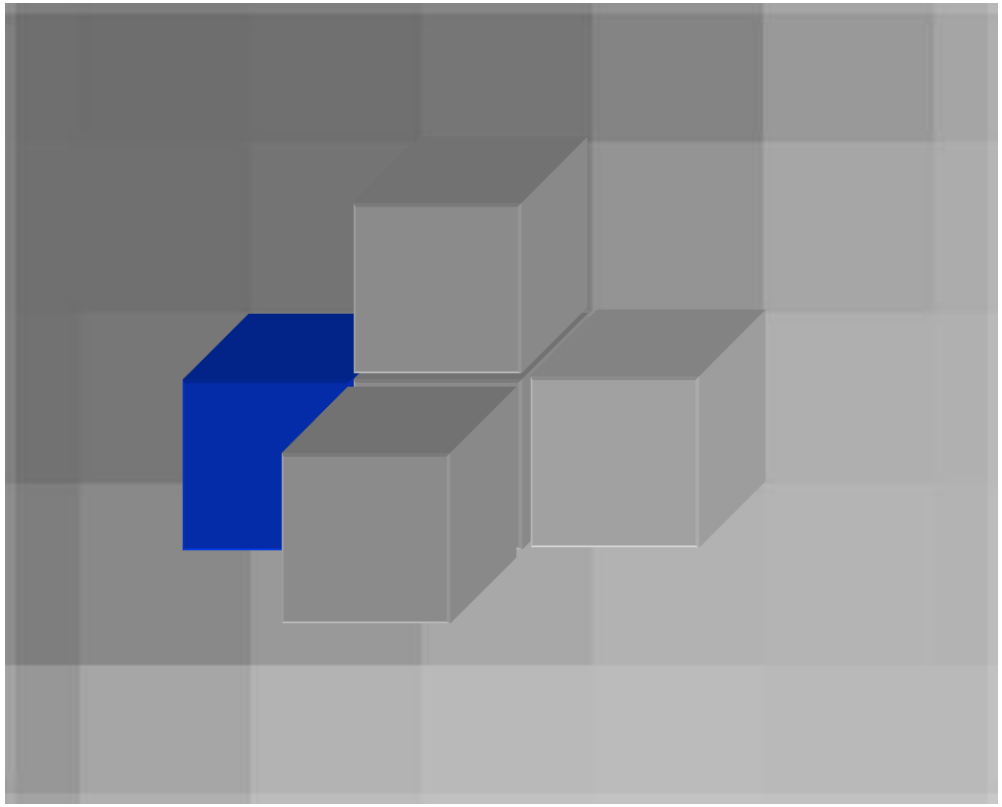


Animation courtesy of Demetrios J. Halazonetis



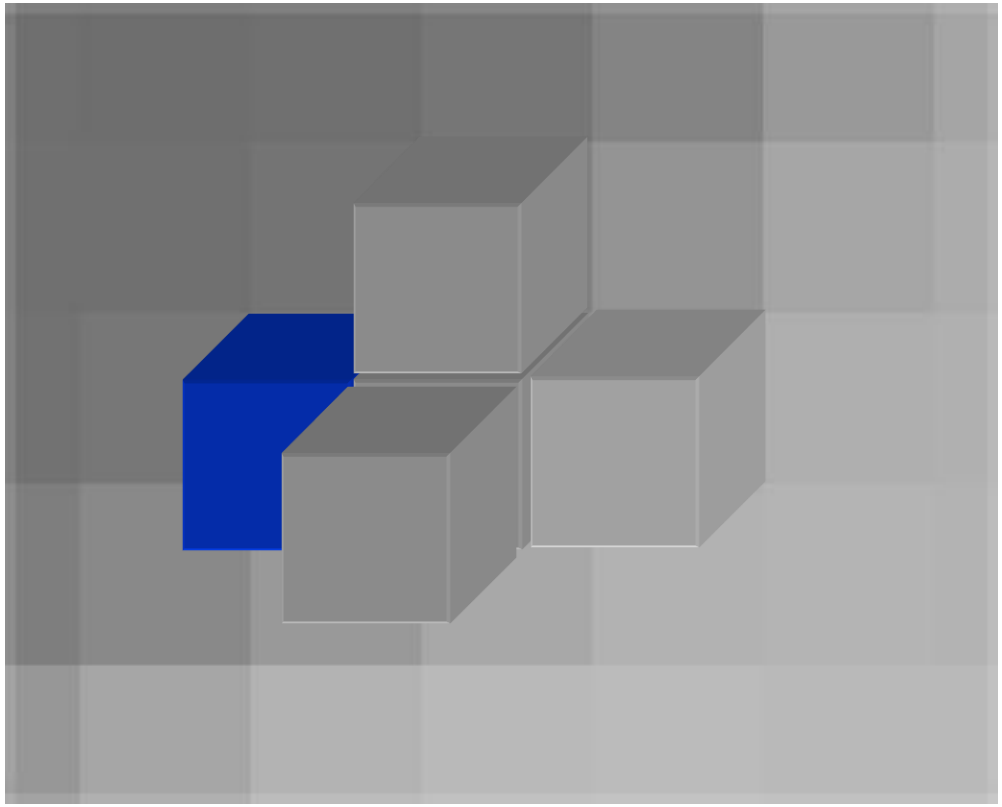
Animation courtesy of Demetrios J. Halazonetis

Voxels (**Vo**lume **el**ements)



Animation courtesy of Demetrios J. Halazonetis

Voxels (**Vo**lume **el**ements)

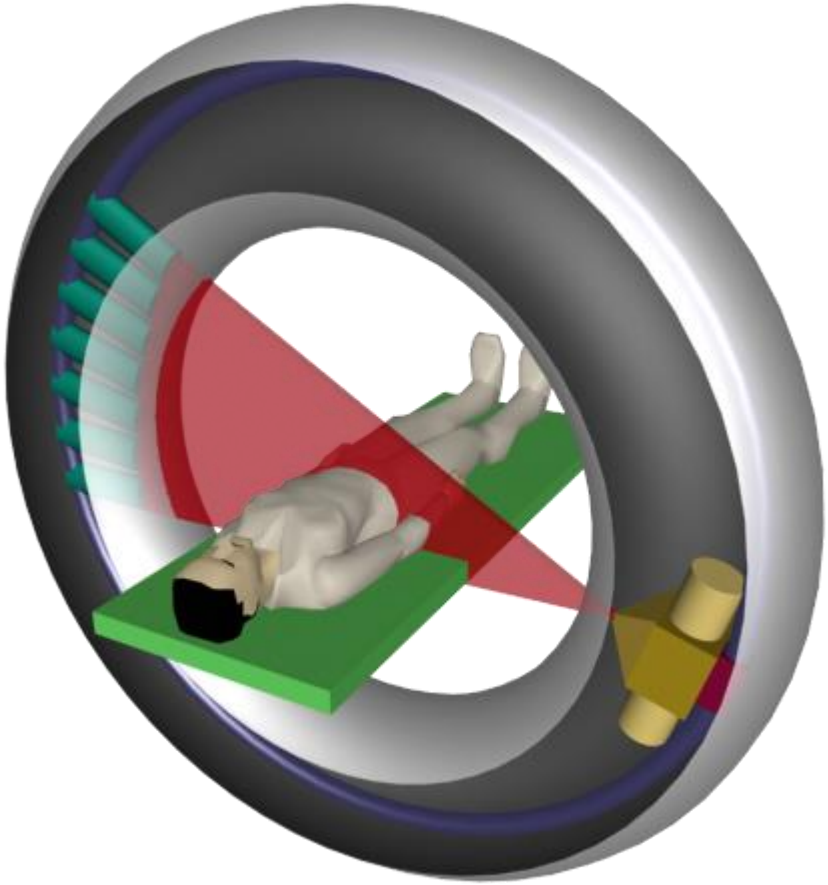


density:
0 - 4095

512 x 512 x $\frac{400}{\text{slices}}$ ≈ 100 million voxels (200 Mb)

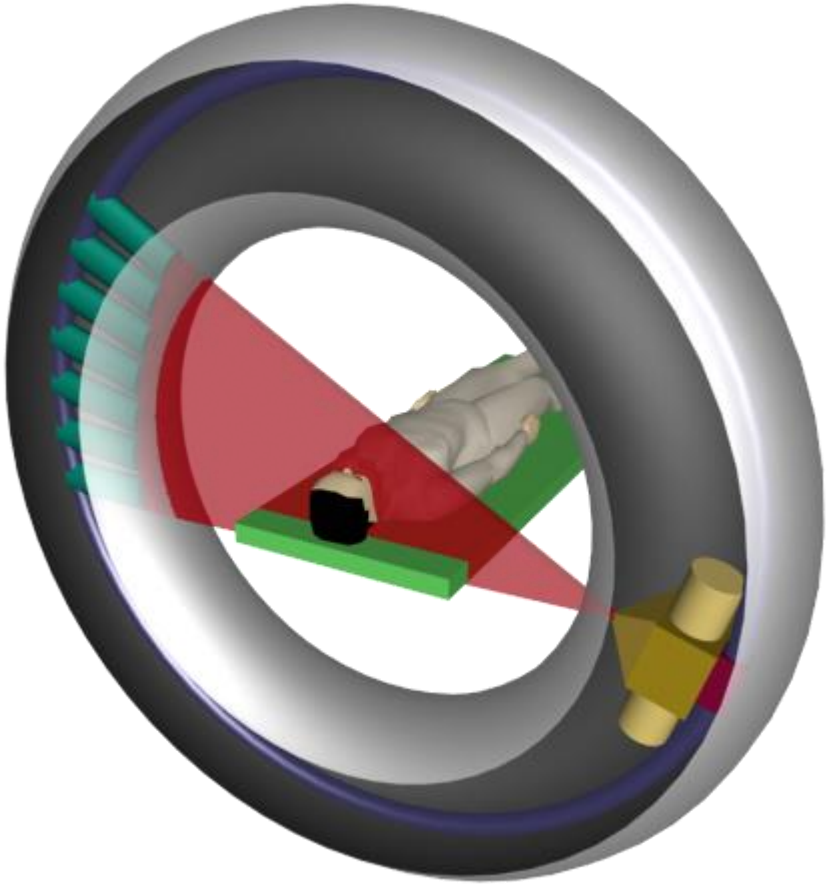
Animation courtesy of Demetrios J. Halazonetis

cone-beam CT (CBCT)



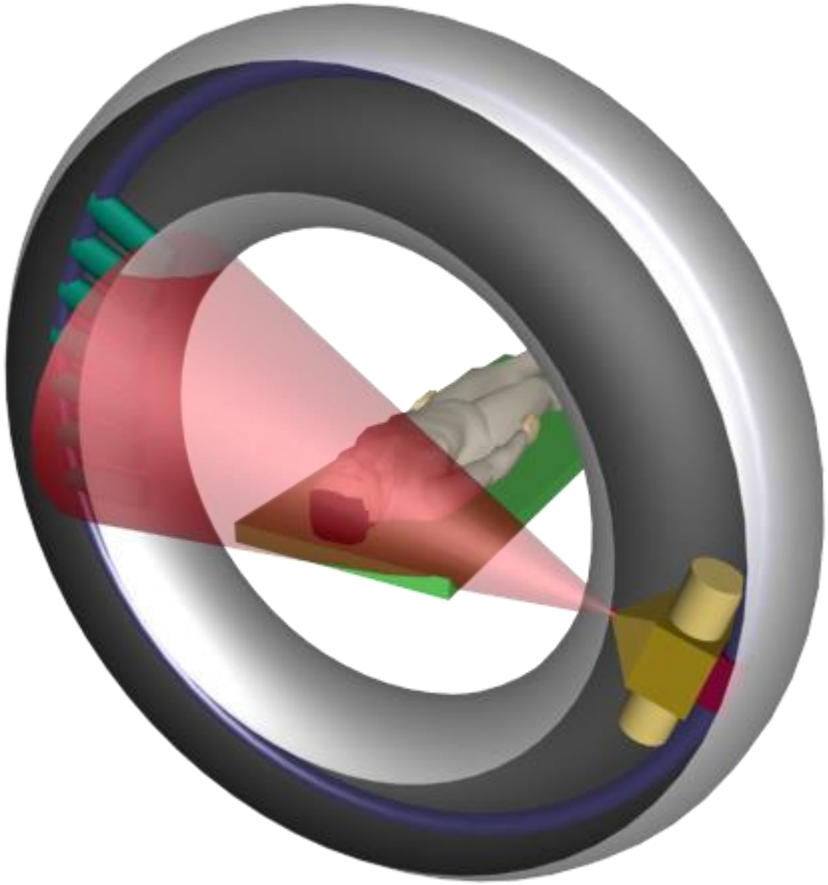
Animation courtesy of
Demetrios J. Halazonetis

cone-beam CT (CBCT)



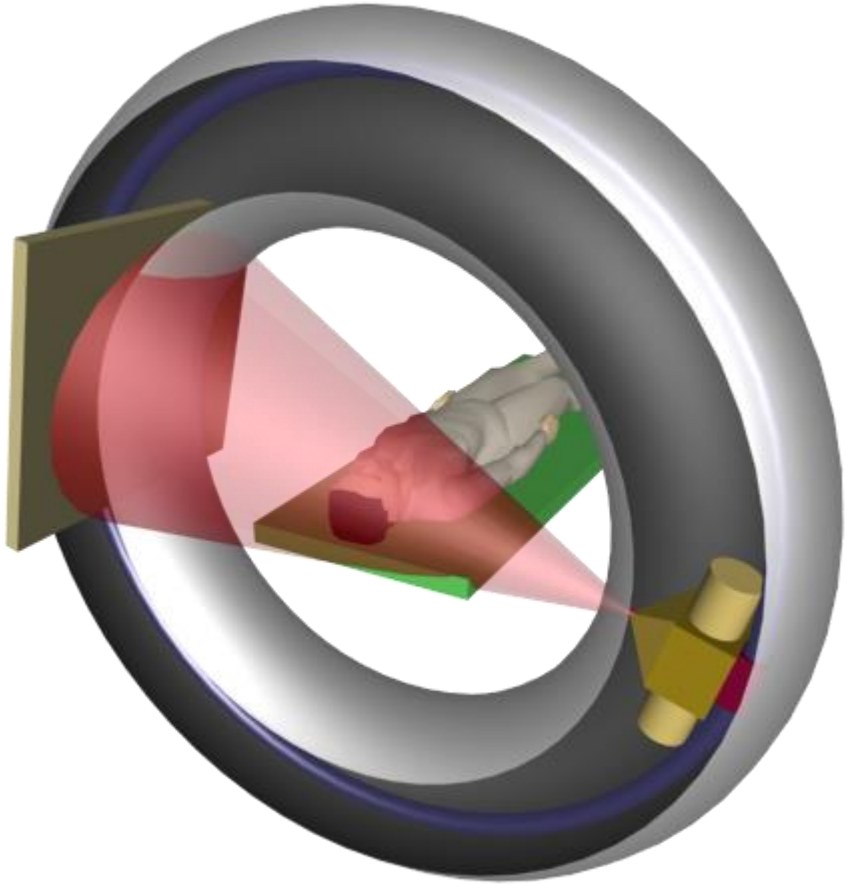
Animation courtesy of
Demetrios J. Halazonetis

cone-beam CT (CBCT)



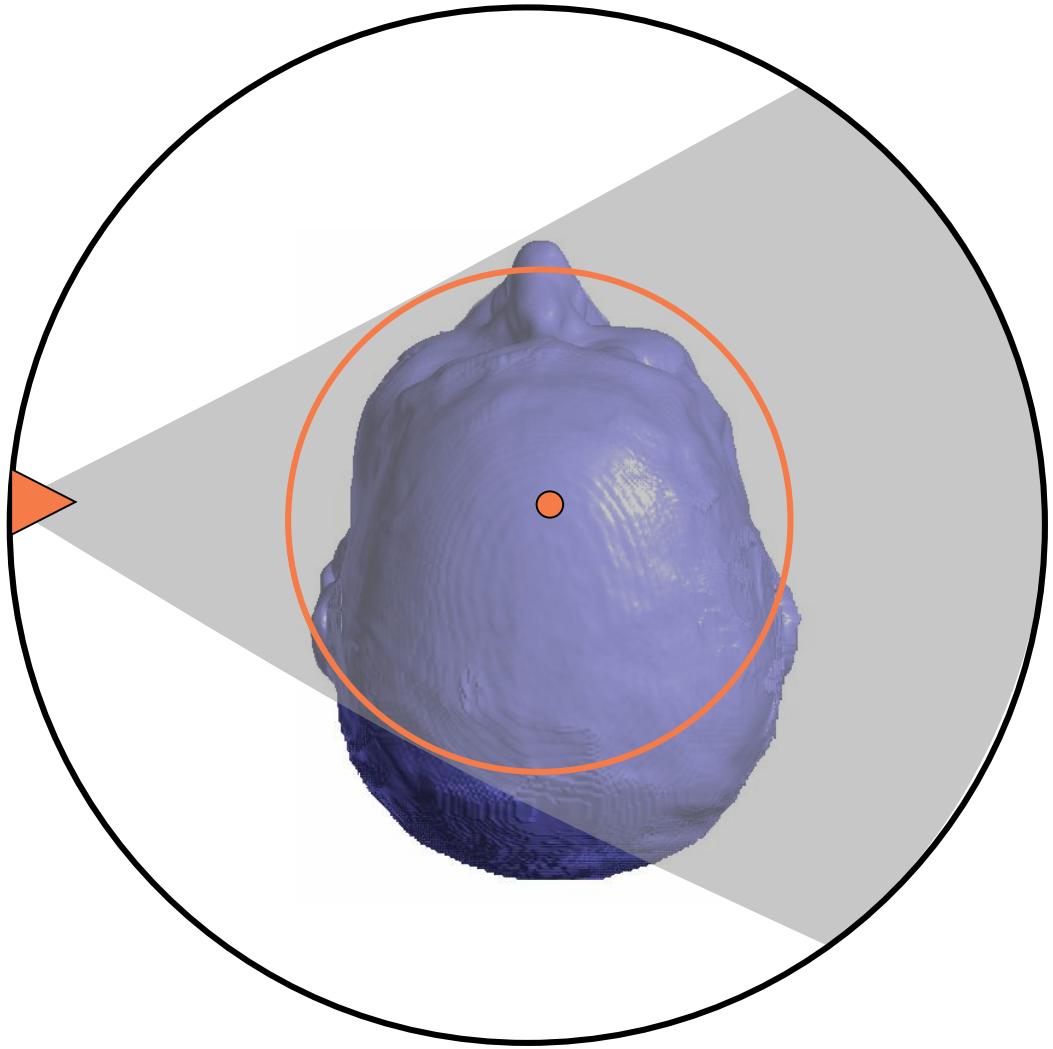
Animation courtesy of
Demetrios J. Halazonetis

cone-beam CT (CBCT)



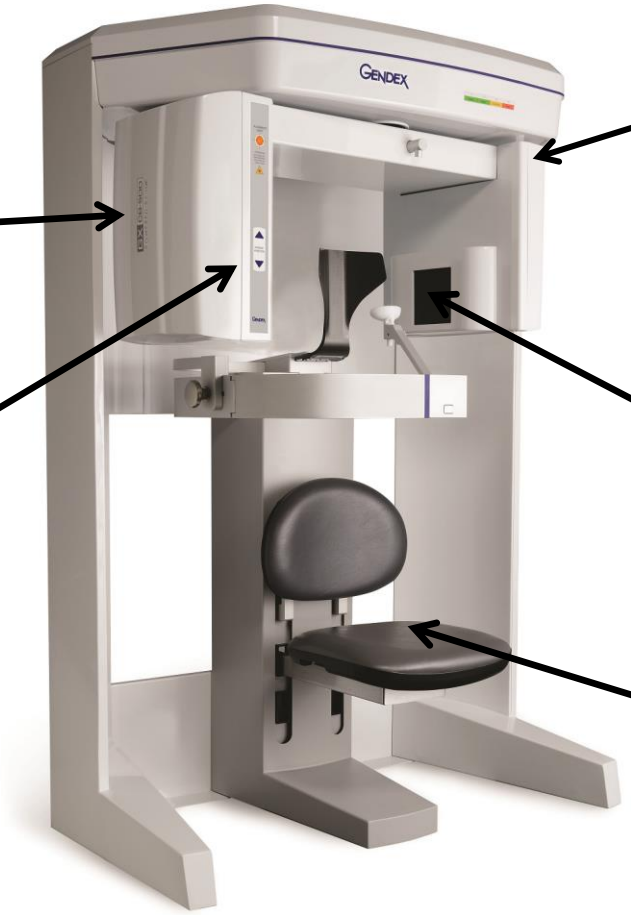
Animation courtesy of
Demetrios J. Halazonetis

cone-beam CT (CBCT)



Animation courtesy of Demetrios J. Halazonetis

CB-500 CBCT Scanner



fast scan times
4.8s to 23s

low dose
typical Mx 35µSv
typical Mn 60µSv

pulsed x-ray tube

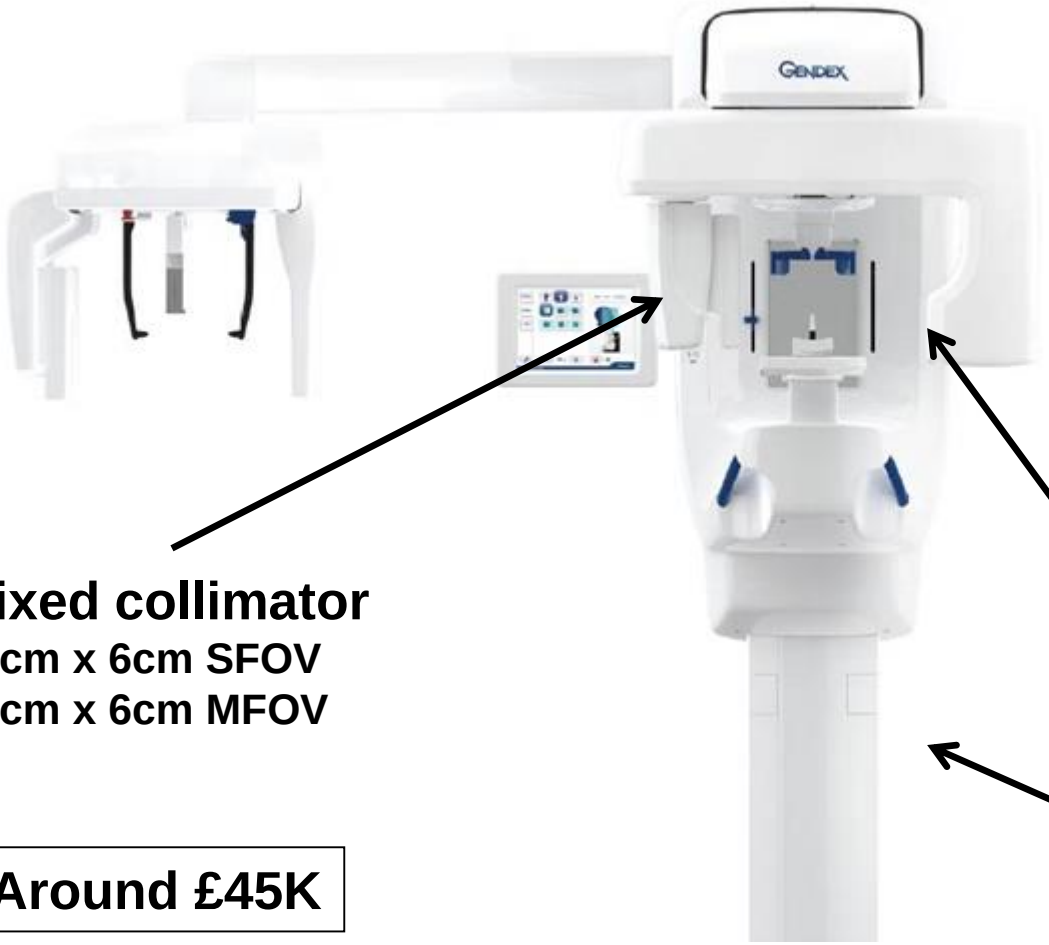
adjustable collimator
4 to 8.6 cm height
8.6 or 15.6 cm width

large detector
8cm x 8cm

adjustable chair

Around £90K

DP-700 CBCT Scanner



variable mA
fixed scan times
11s for SFOV
45s for MFOV

medium dose
typical Mx 60µSv
typical Mn 100µSv

fixed collimator
4cm x 6cm SFOV
8cm x 6cm MFOV

small detector

no chair

Around £45K

Cannot fit mandible into 8cm Field Of View

Toshiba Aquilion ONE medical CT Scanner

320 detector rows

operates in cone beam mode

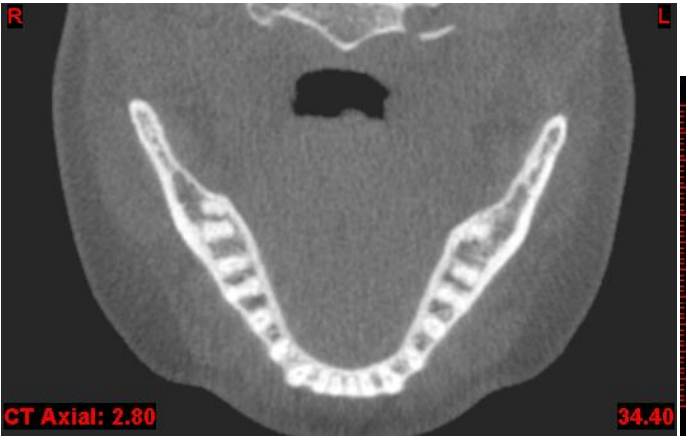
0.5s scan time

volume capture
24cm x 16cm max

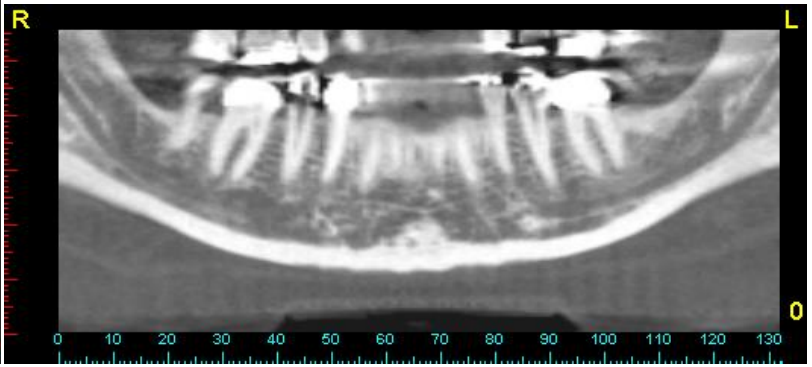
Effective doses
typical Mx 70µSv
typical Mn 160µSv

Around £1M

Basic CT images



Axials

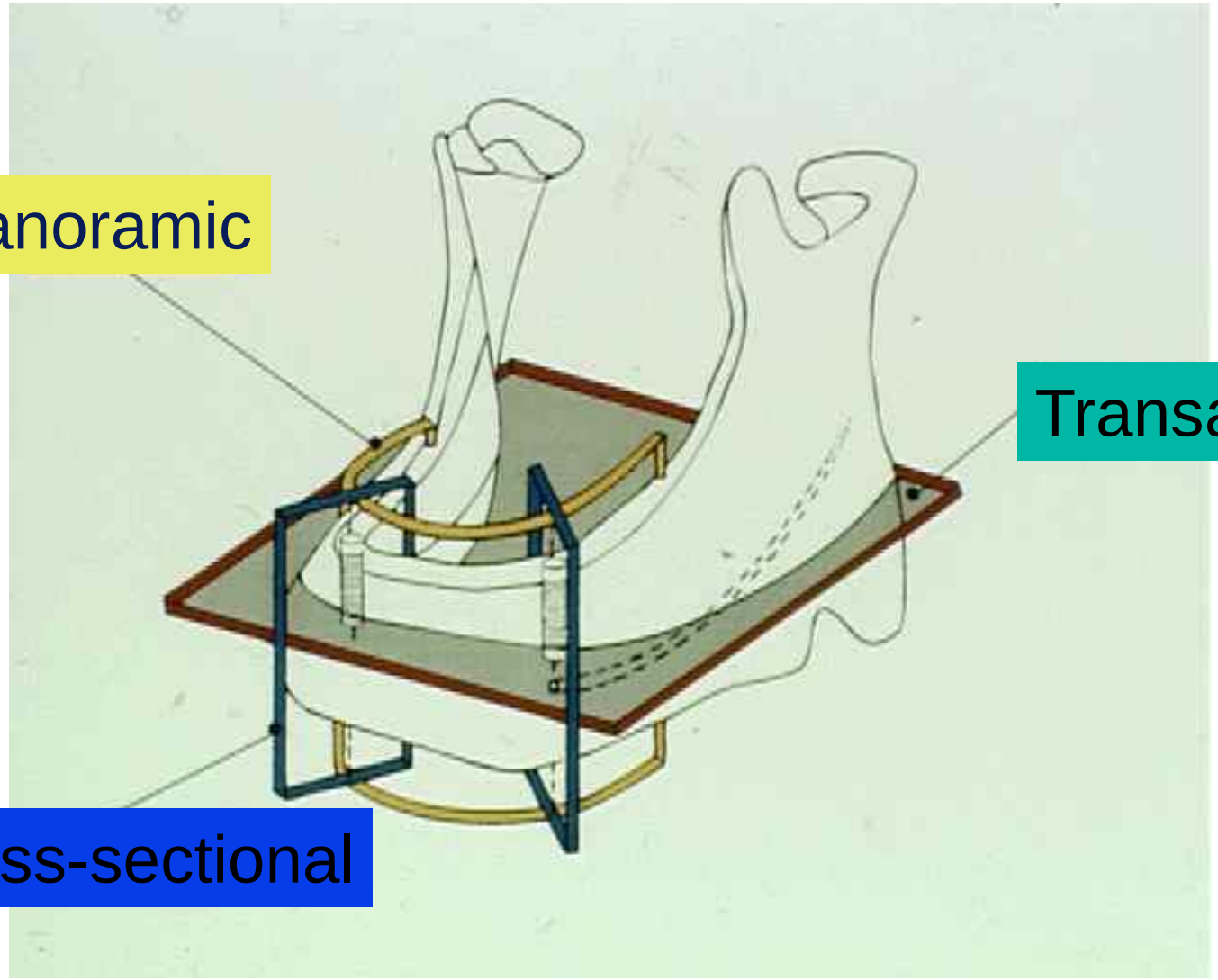


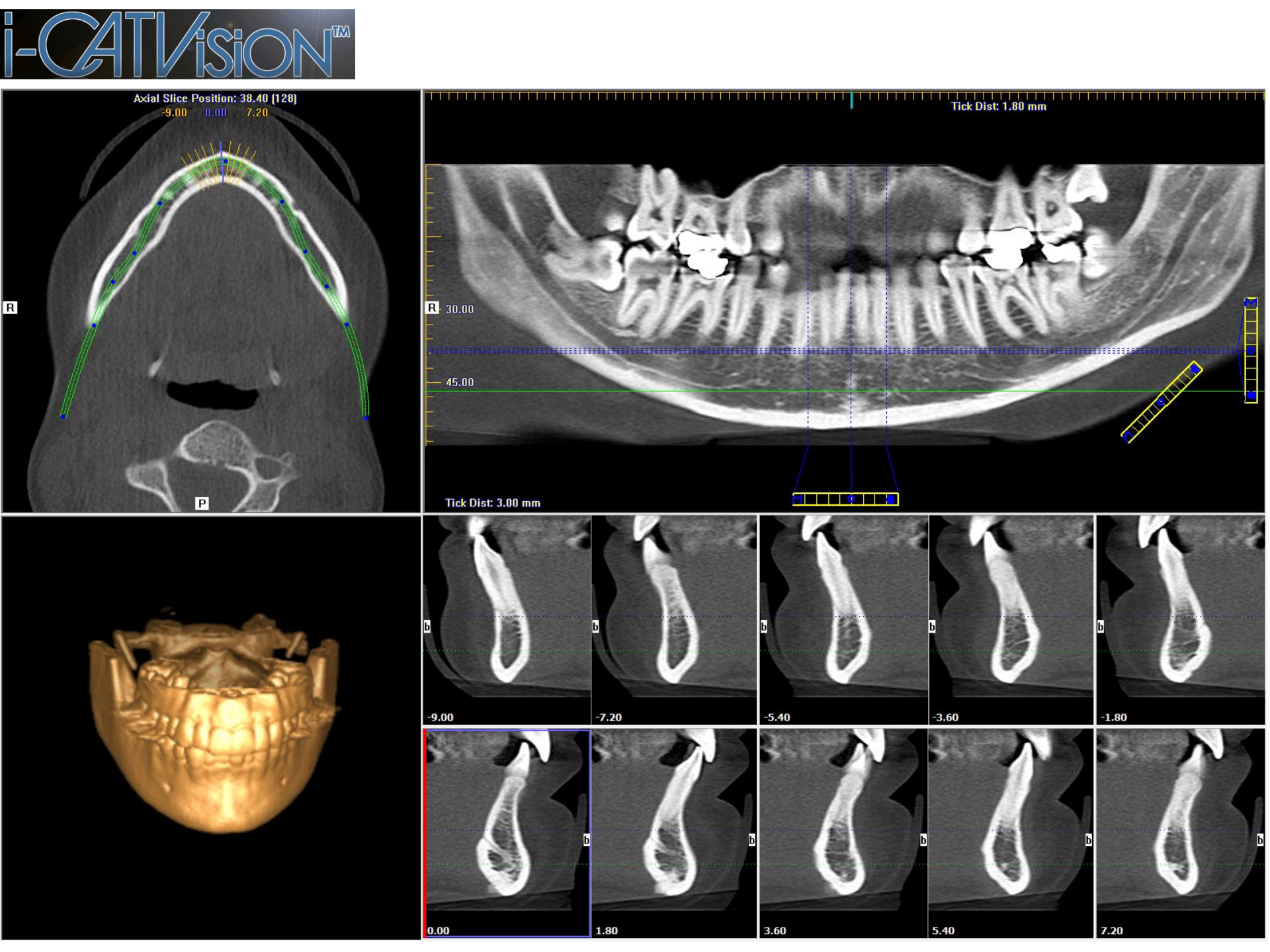
Panoramics

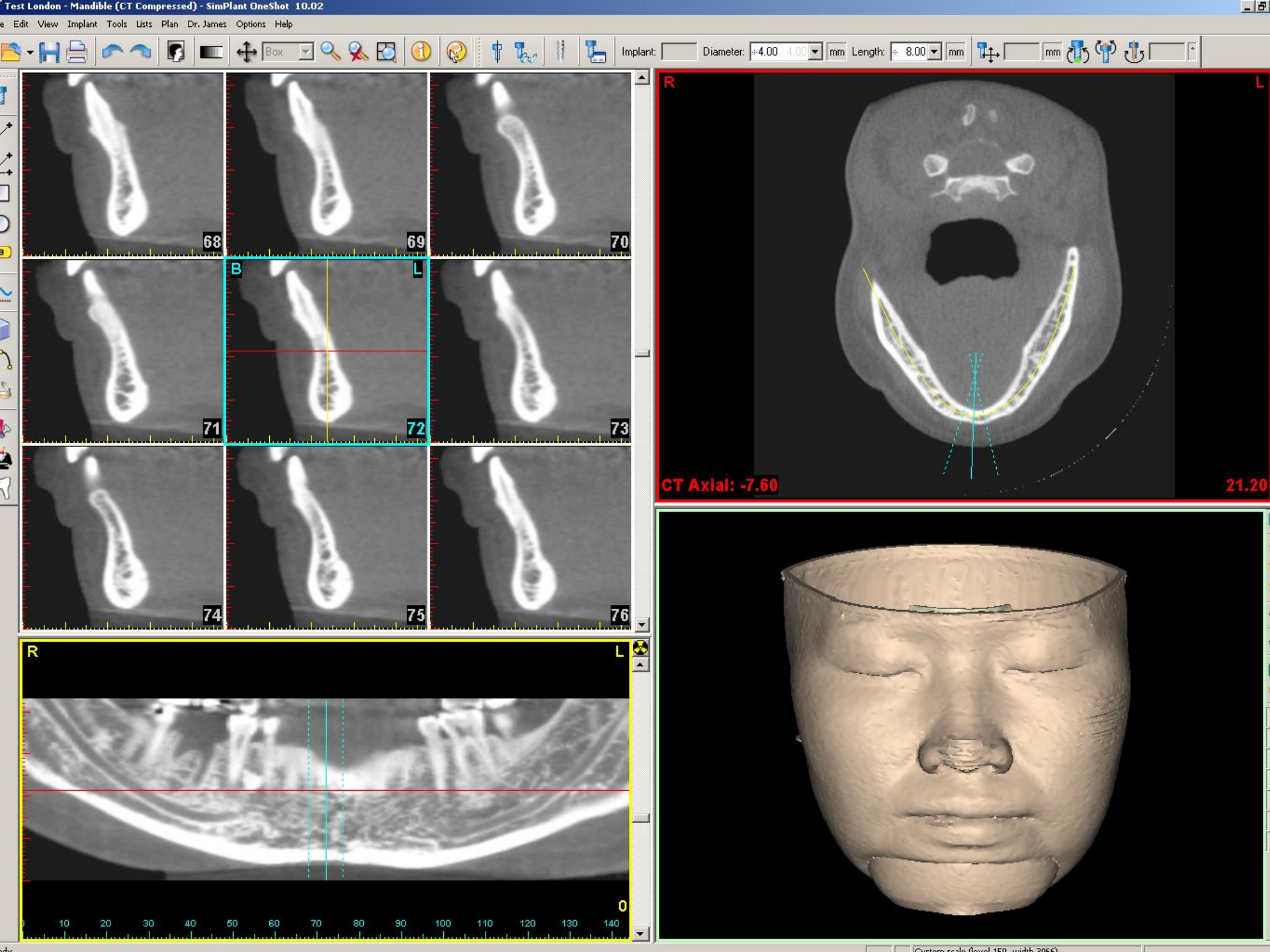
Cross Sections

Sagittal

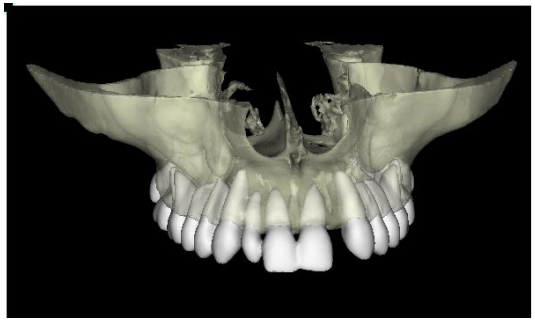
Coronal

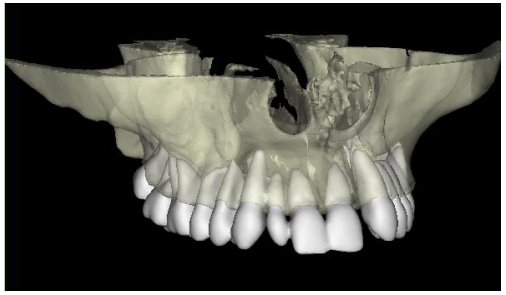

Panoramic
Transaxial
Cross-sectional

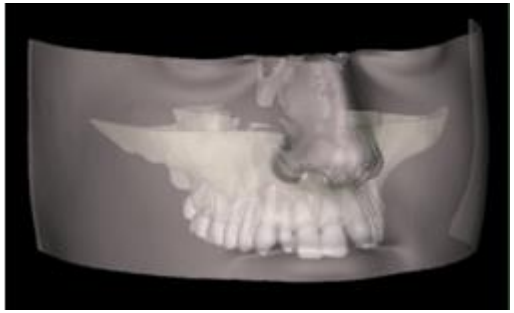

i-CATVision™
Axial Slice Position: 38.40 (128)
-9.00 0.00 7.20
R
P
Tick Dist: 1.80 mm
R 30.00
45.00
Tick Dist: 3.00 mm
b
-9.00
-7.20
-5.40
-3.60
-1.80
0.00
1.80
3.60
5.40
7.20

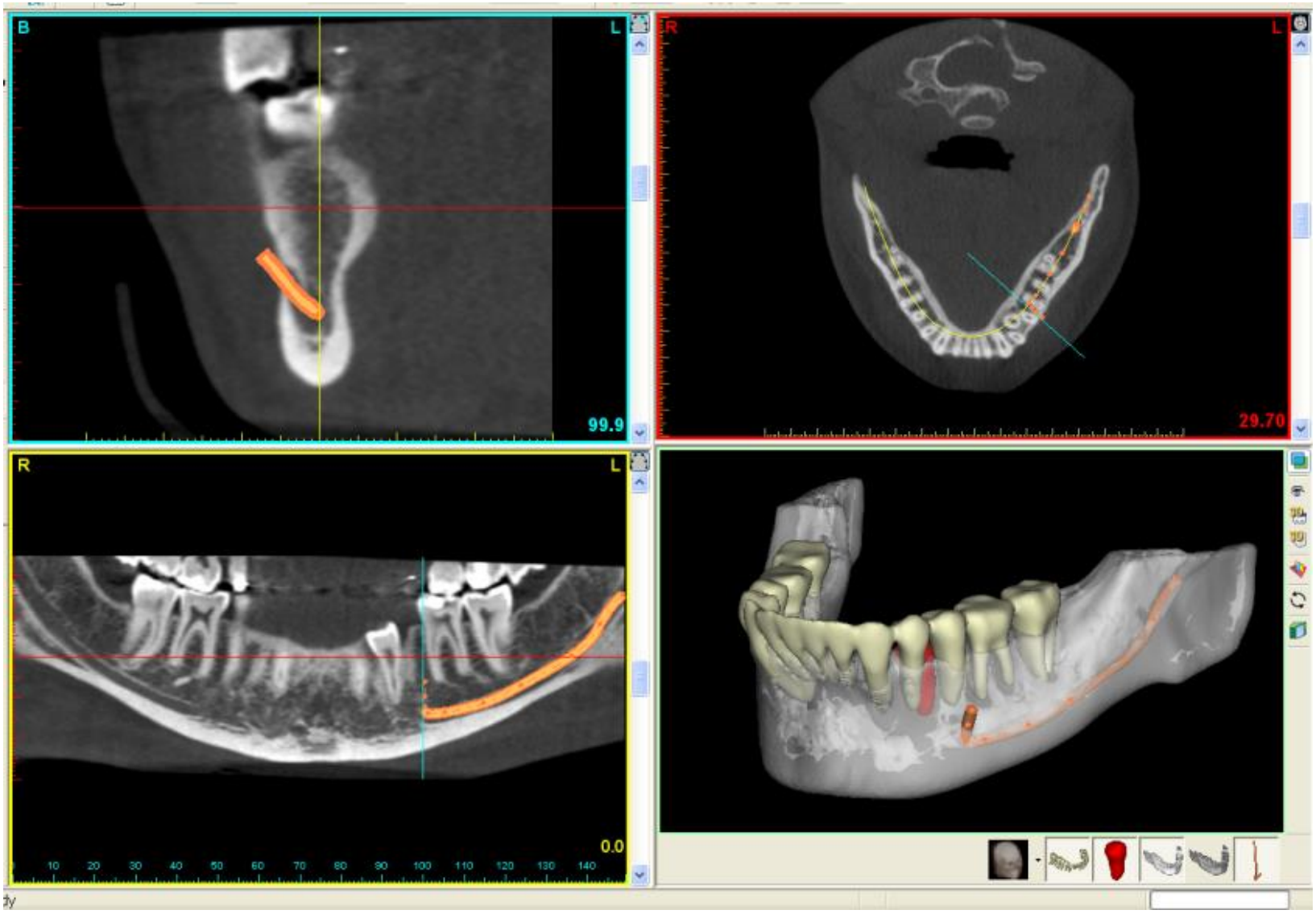

Test London - Mandible (CT Compressed) - SimPlant OneShot 10.02
Edit View Implant Tools Lists Plan Dr. James Options Help
Implant: Diameter: 4.00 mm Length: 8.00 mm
68 69 70
B L
71 72 73
74 75 76
R L
CT Axial: -7.60
21.20
R L
0
10 20 30 40 50 60 70 80 90 100 110 120 130 140

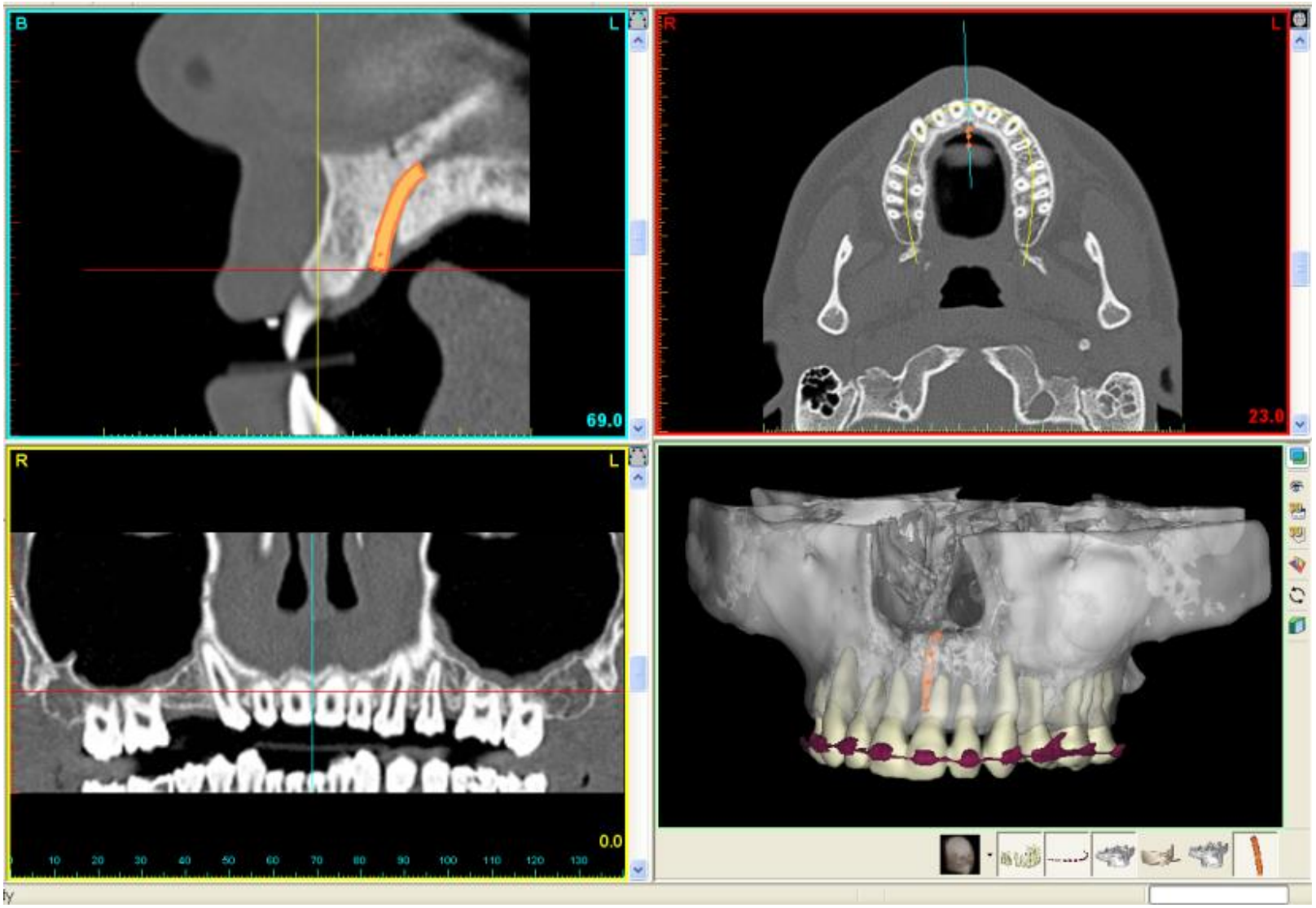
Segmentation



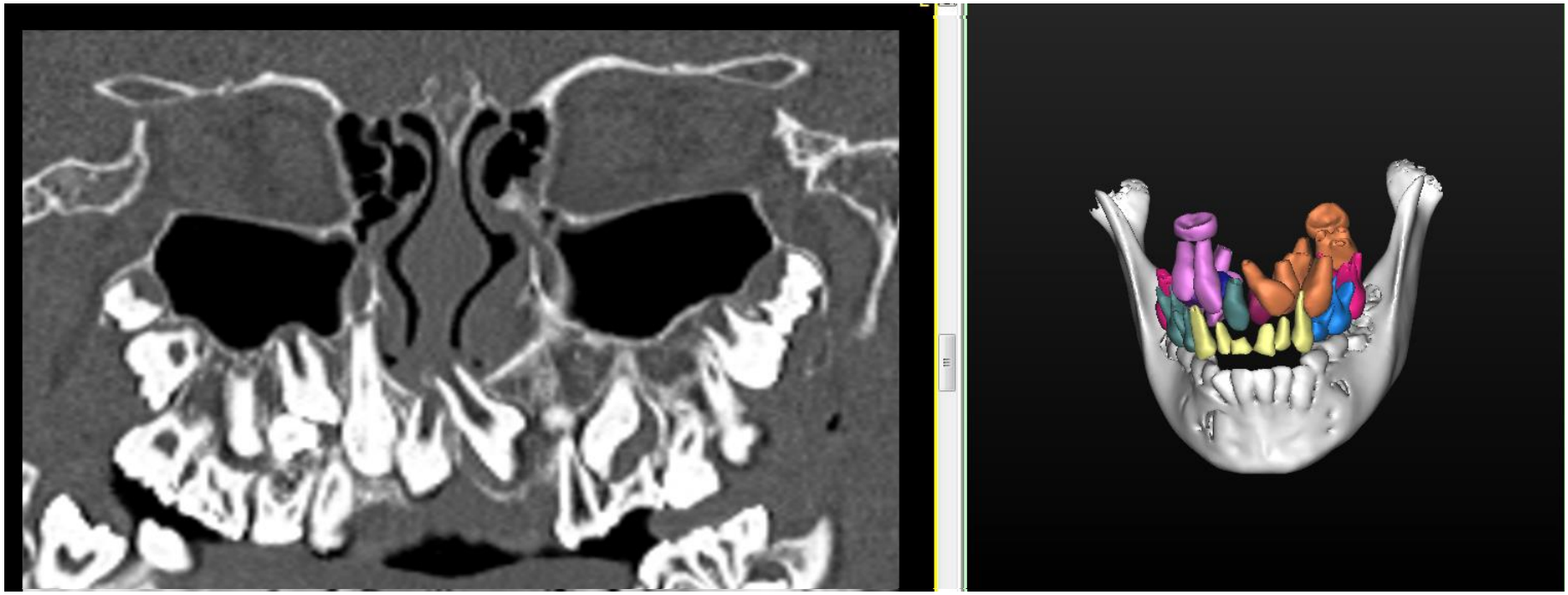




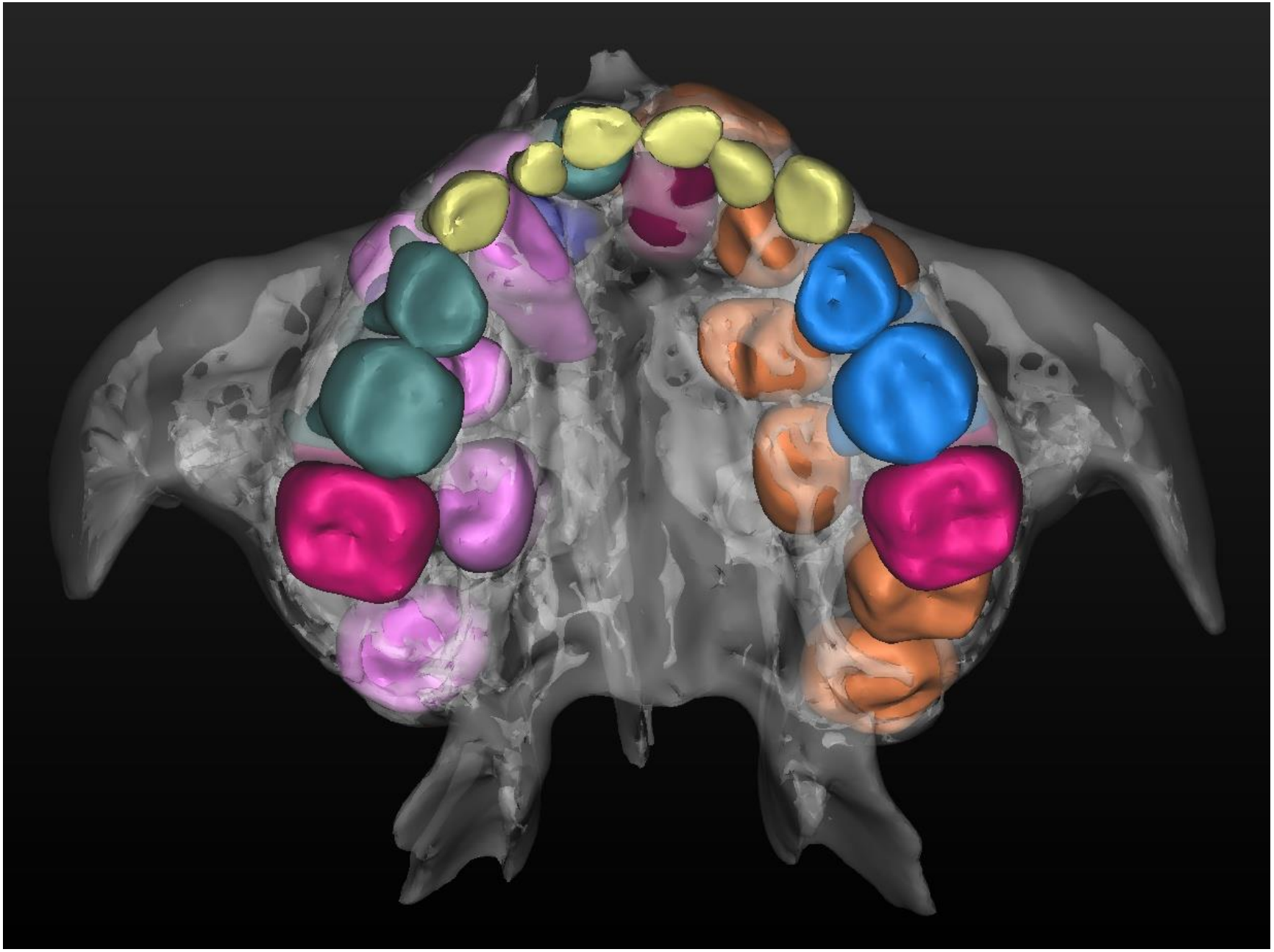

B
L
99.9
R
L
29.70
R
L
0.0
10 20 30 40 50 60 70 80 90 100 110 120 130 140


B
L
69.0
R
L
23.0
R
L
0.0
10 20 30 40 50 60 70 80 90 100 110 120 130

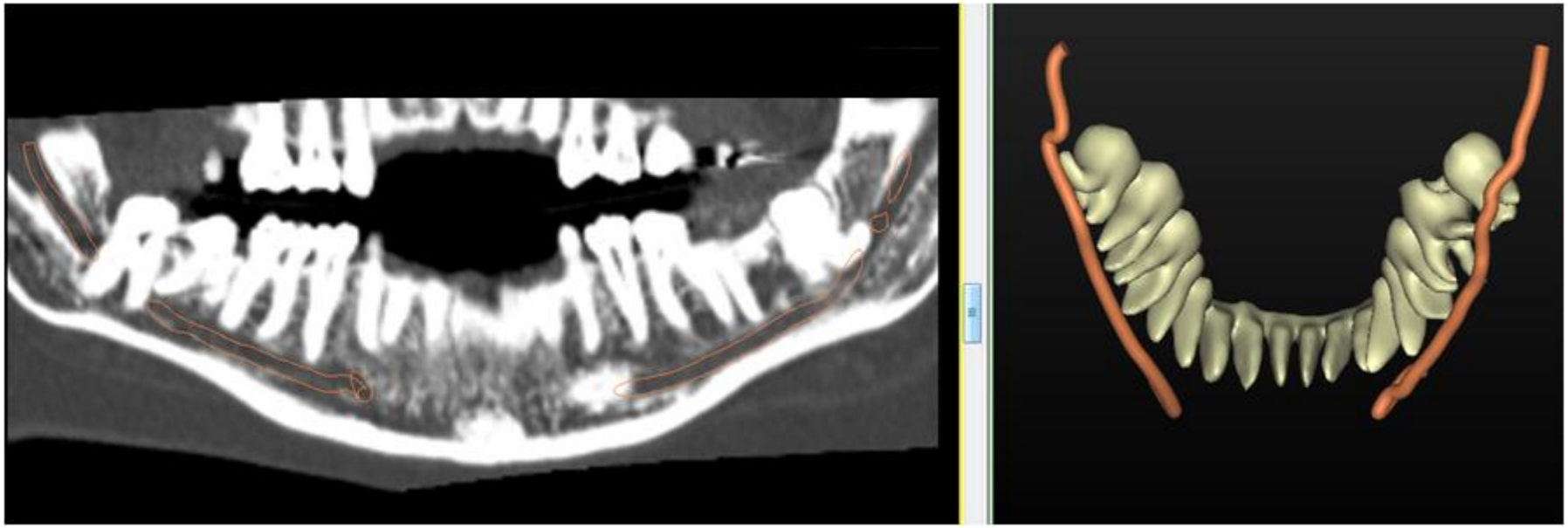
Hyperdontia



Courtesy of Nicolette Schroeder



Third Molars



Courtesy of Barry Dace

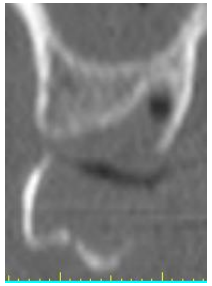
Advantages of using a Scanning Stent

- **Gives inter-arch stability for the patient during the scan**
- **Opens the bite slightly (a few mm) using occlusal stops**
- **Position and size of the desired restoration can be visualised in the CT images**
- **If the maxilla and mandible are scanned together the 3D image will illustrate the inter-arch relationship.**

Making a Scanning Stent

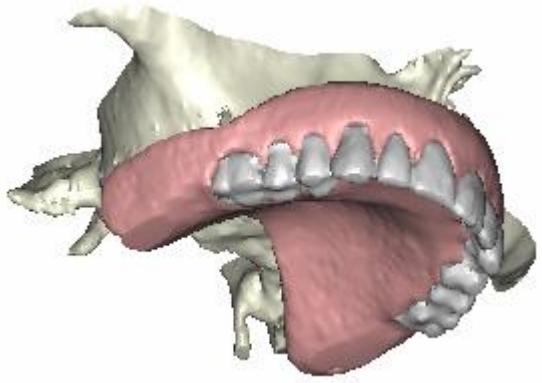
- **Plastic and clear acrylic does not show up on a CT scan.**

- **To make it show up, you can:**

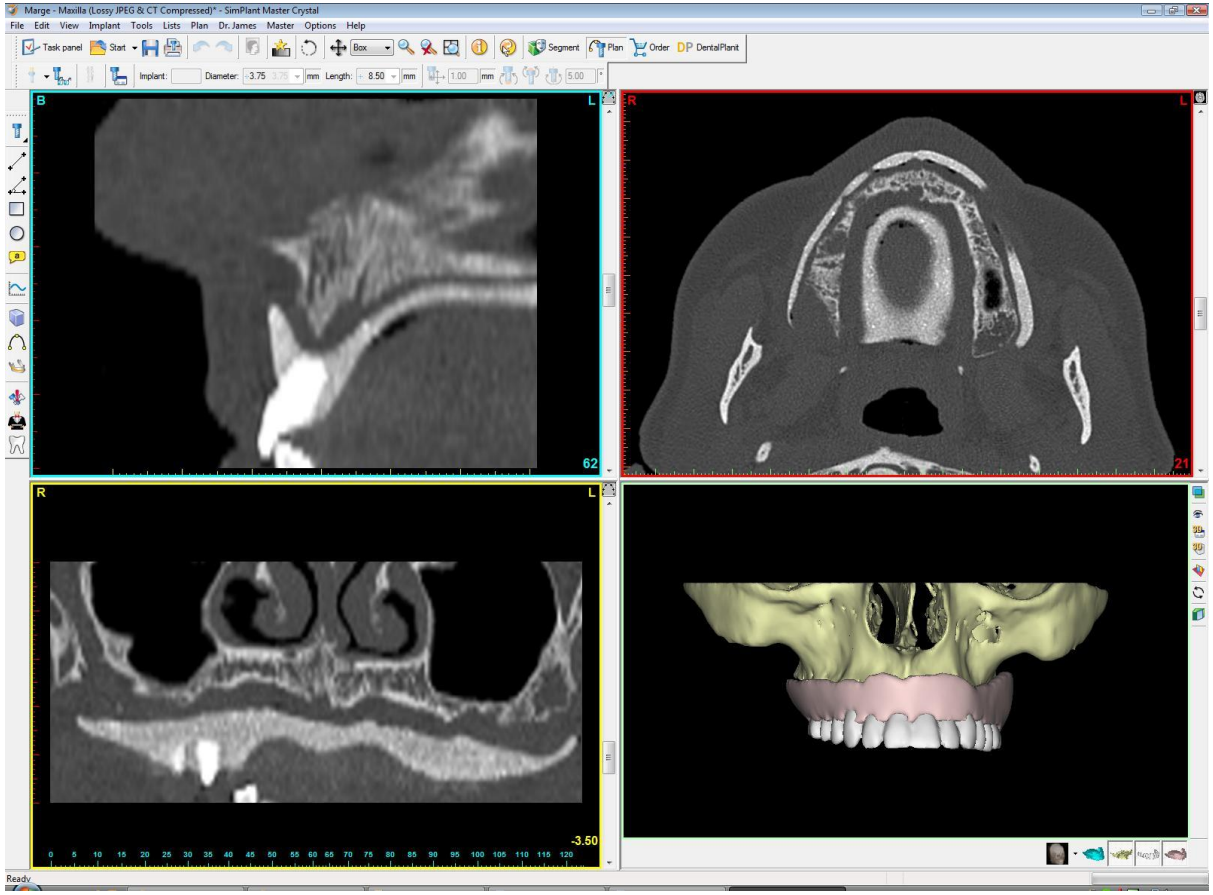


- **mix barium sulphate with the acrylic**
- **paint barium sulphate on the surface**
- **use radio-opaque teeth**
- **use markers made from a radio-opaque material**
  - **lab putty**
  - **gutta percha**
  - **glass ionomer**
- **use a dual-scan technique.**

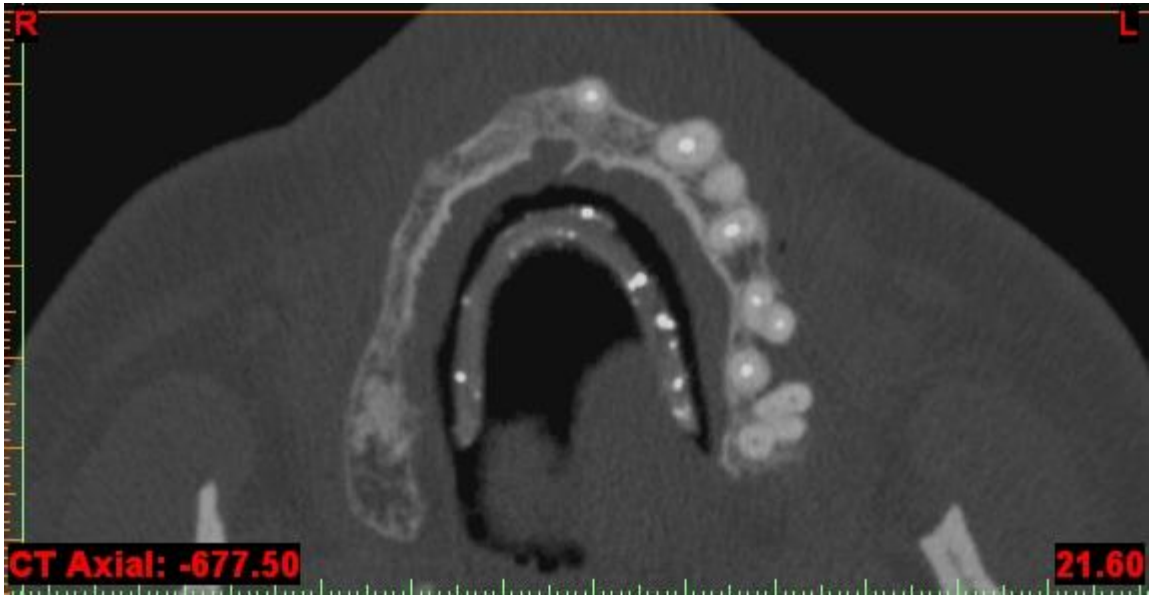
- **We recommend using a barium sulphate-acrylic mix for both the radio-opaque teeth and the baseplate.**
- **Use 15% barium sulphate in the teeth and 10% barium sulphate in the baseplate. This allows the teeth to be picked out separately.**
- **Do not use too much Barium Sulphate as it will cause an artefact.**
- **An accurate fitting stent with radio-opaque baseplate is usually the best option for mucosa-supported surgical drill guides.**



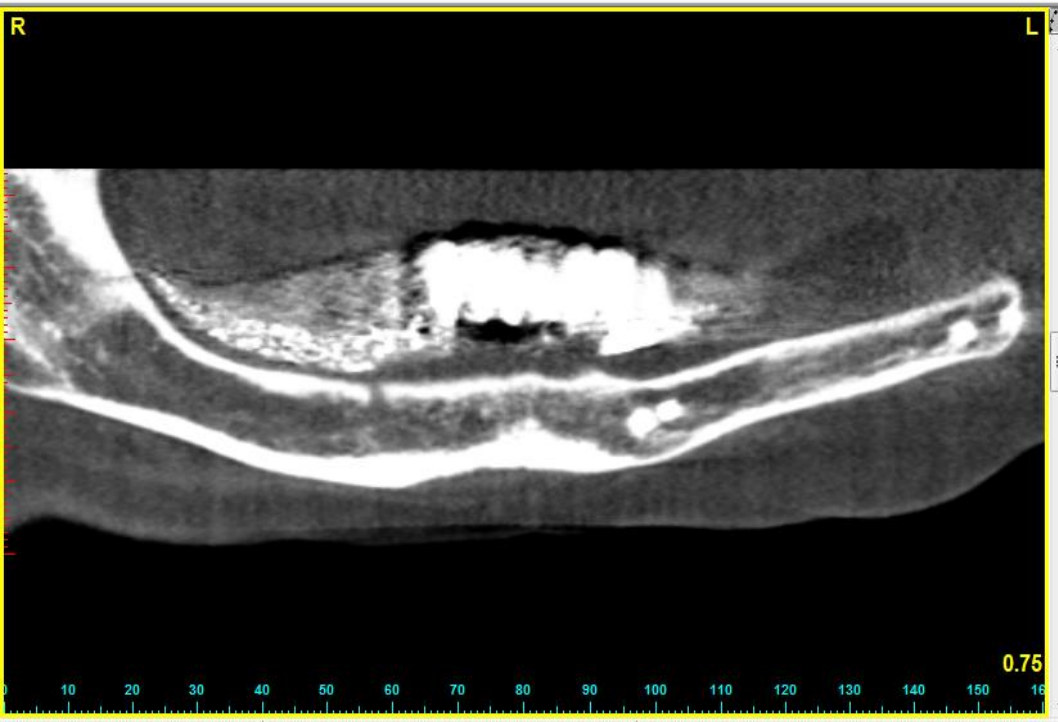
Good Stent

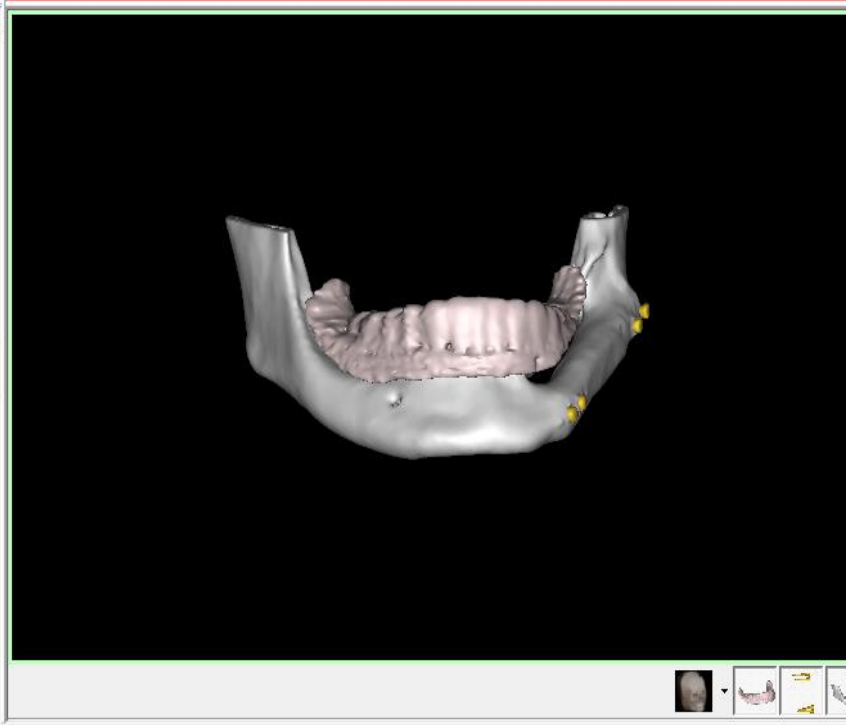

Marge - Maxilla (Lossy JPEG & CT Compressed)* - SimPlant Master Crystal
File Edit View Implant Tools Lists Plan Dr. James Master Options Help
Task panel Start
Segment Plan Order DP DentalPlanit
Implant: Diameter: 3.75 mm Length: 8.50 mm
B L
62
R L
21
R L
-3.50
Ready

Bad Stent

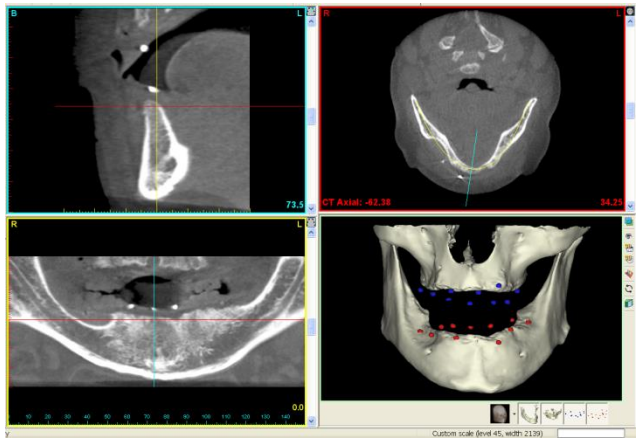


Worse than Useless Stent





Dual Scan Technique



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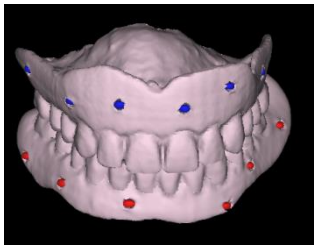

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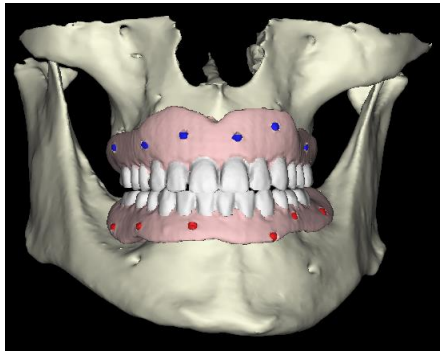
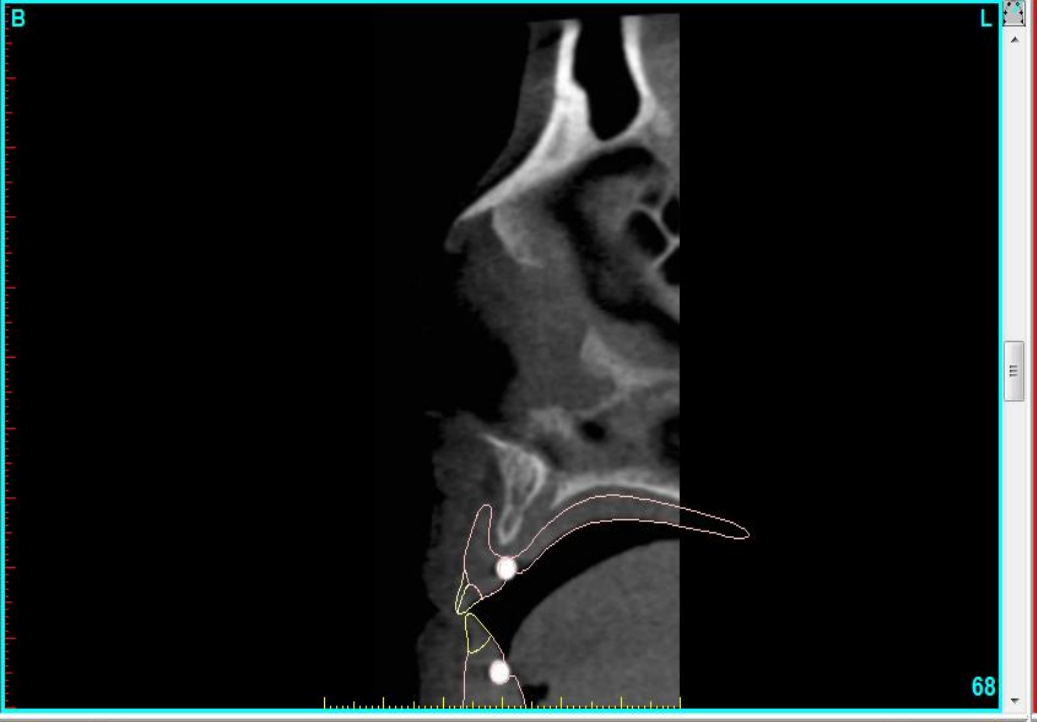
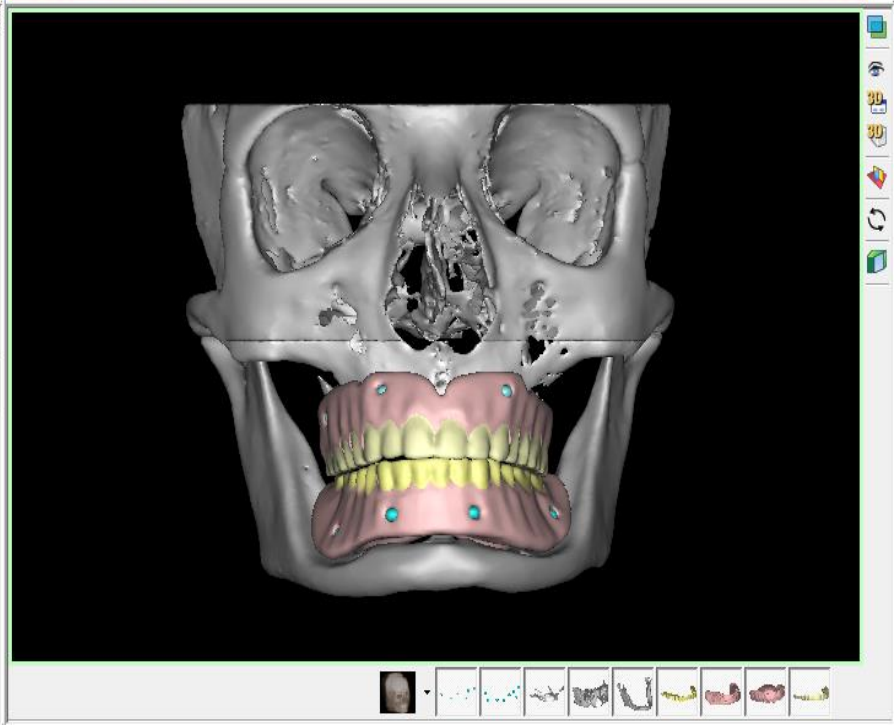


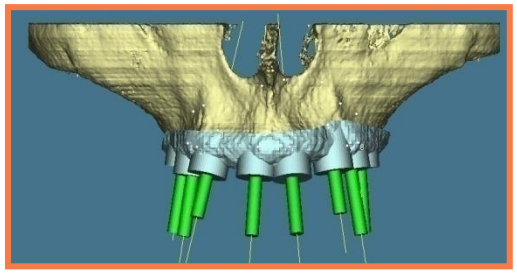

B
L
68


R
L
CT Axial: -50.25
50.10

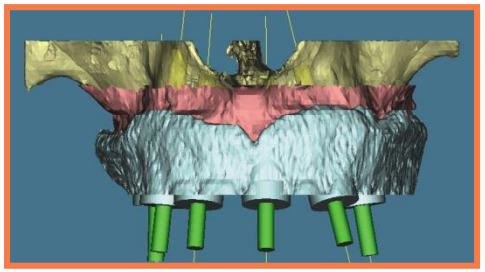

R
L
0.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130



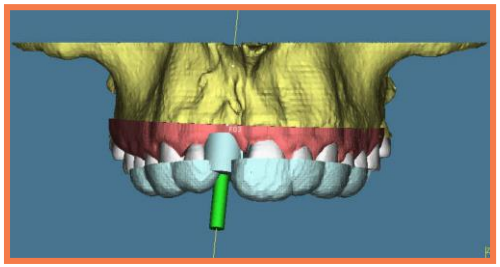
Make Your Own Surgical Drill Guide



Bone



Mucosa



Teeth

Bone Supported Guides:

- Bone crest must be clearly visible in the CT images and ≥ 3cm long

Mucosa Supported Guides:

- Patient must be scanned with a radio-opaque scanning stent in place

Tooth Supported Guides:

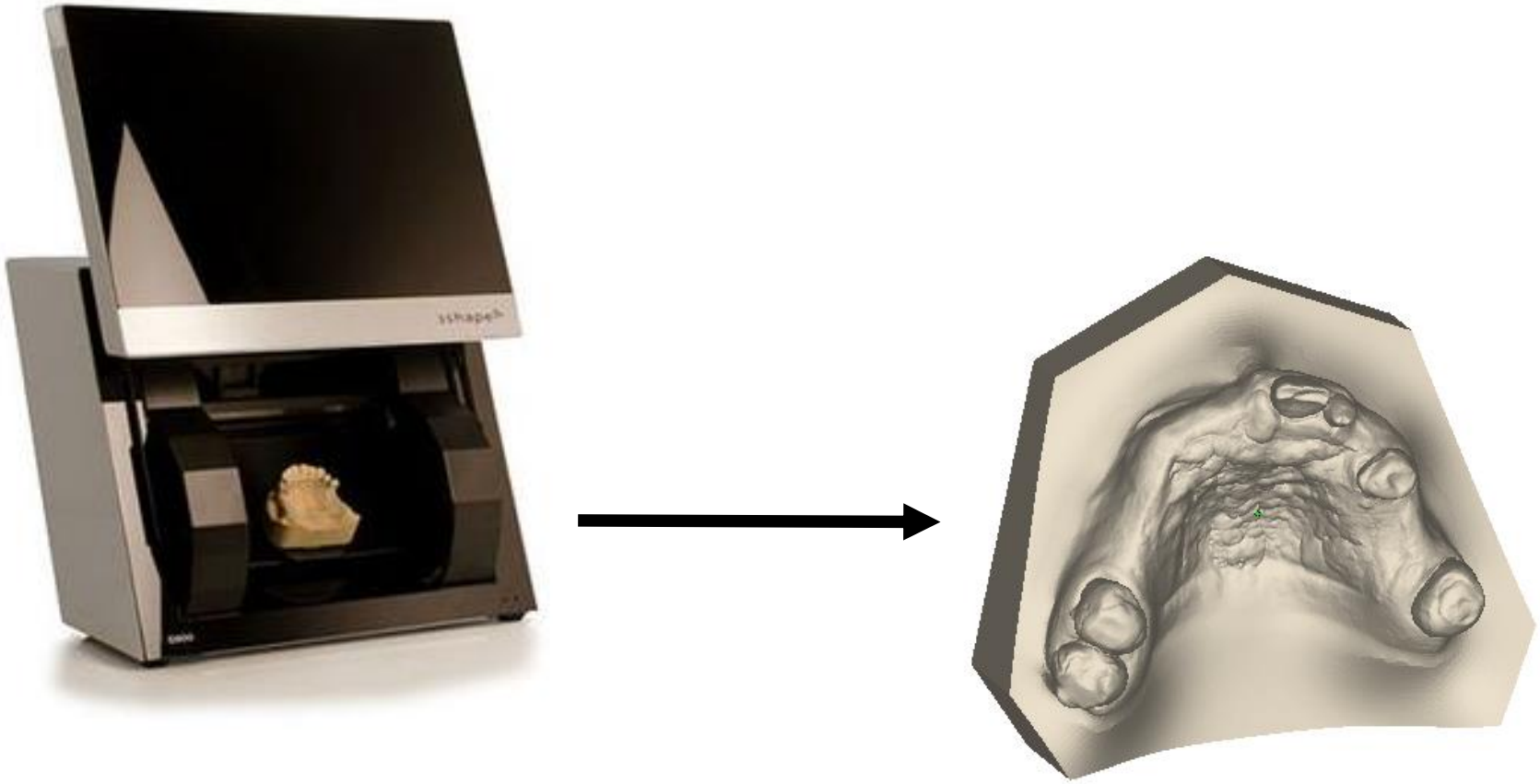
- Tips of teeth must be clearly visible in the CT images
- A recent and accurate plaster cast will be required

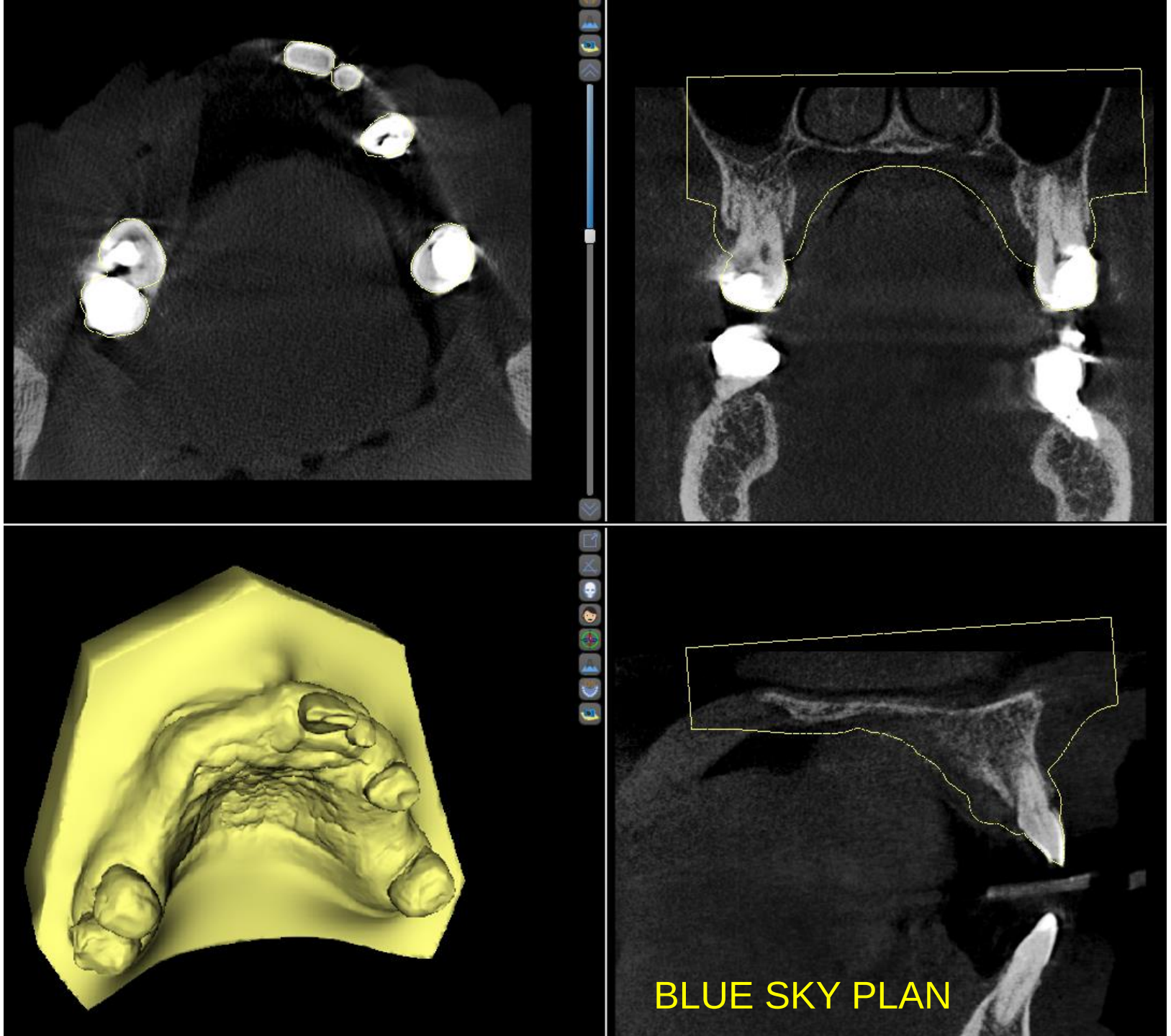
Need to think about the Guide before you request the CT Scan!

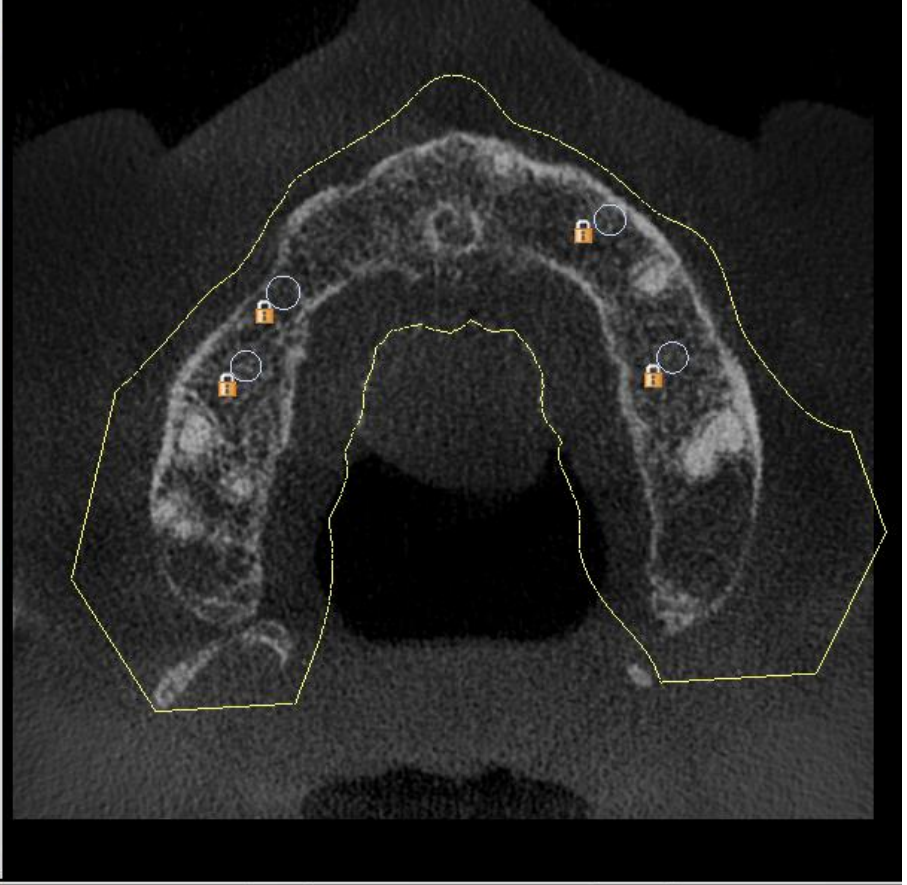
Tooth Supported Guides

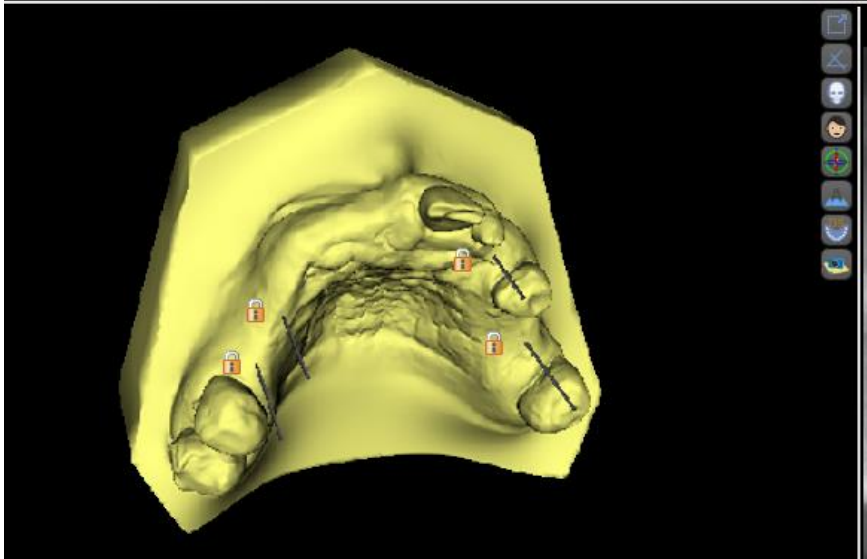
- **Drill Guide will be supported on patient's existing teeth**
- **Need a recent and accurate impression or plaster cast**
- **Optical (laser) scan of plaster cast**
- **Import optical scan into the implant planning software**
- **Guide will be designed to fit the plaster cast.**

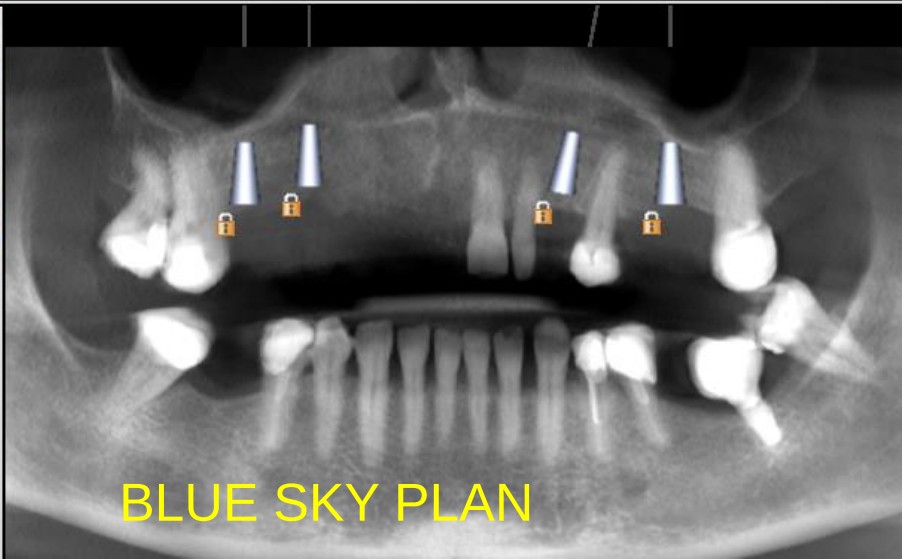
Optical Scan of Plaster Cast



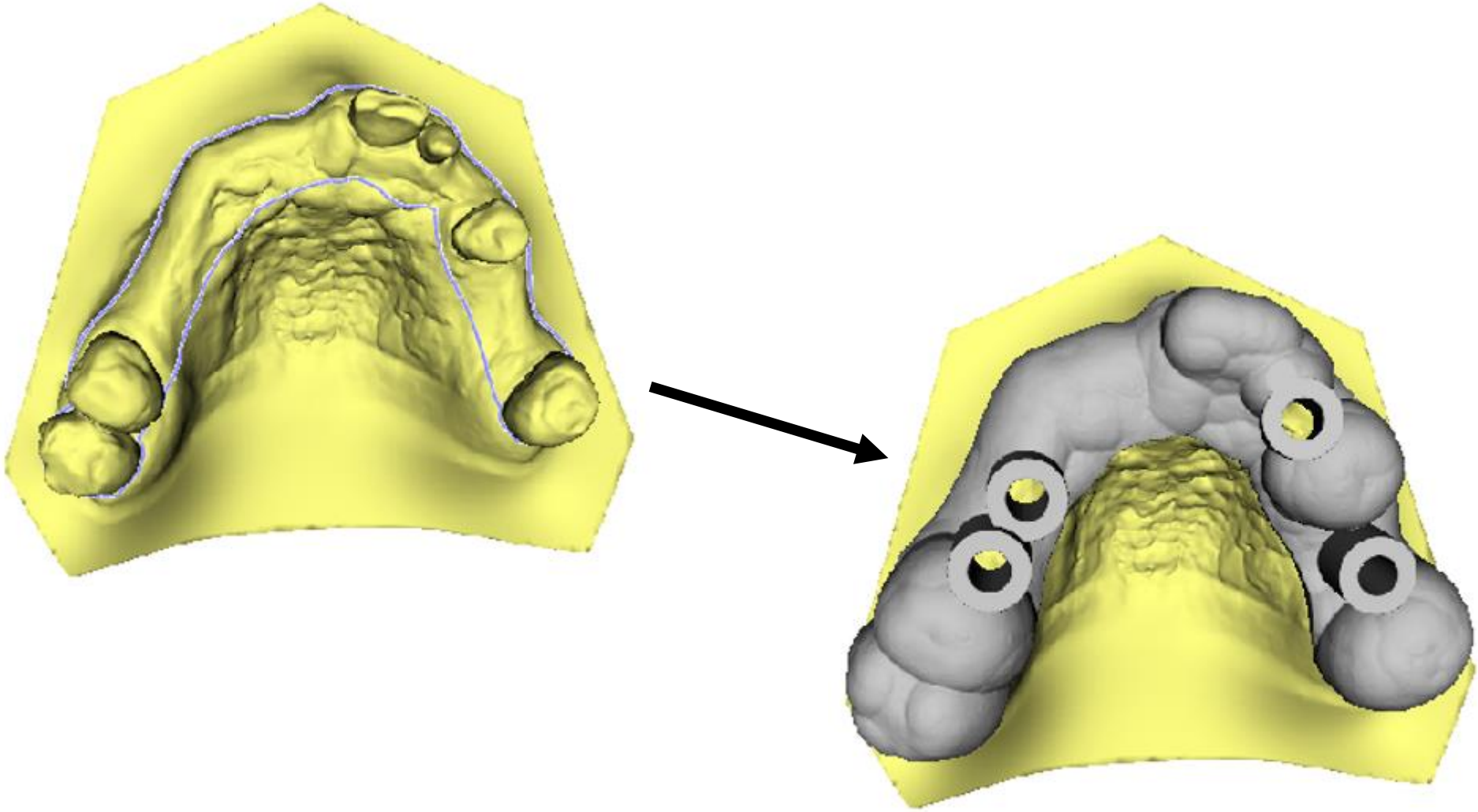

BLUE SKY PLAN

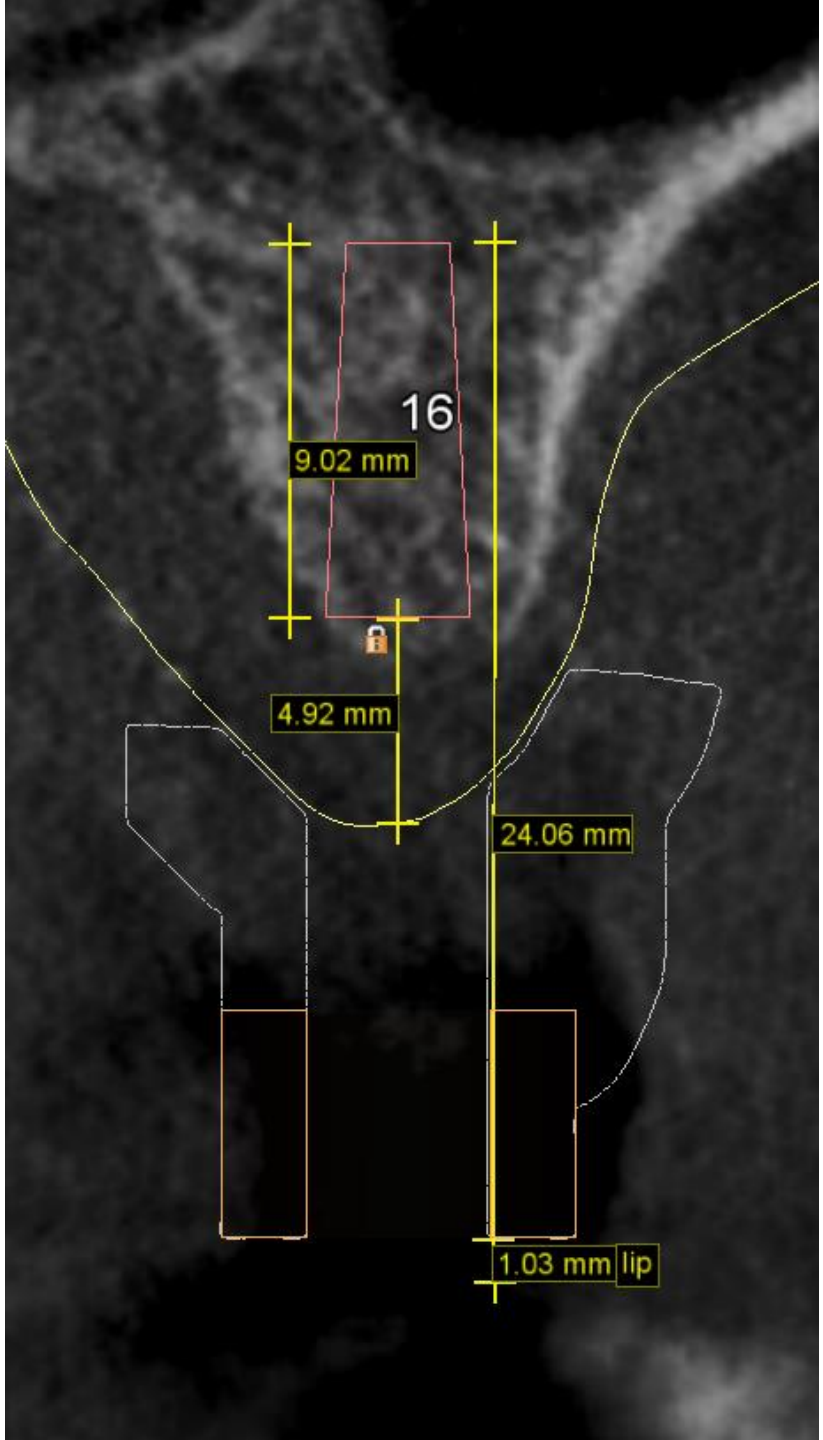


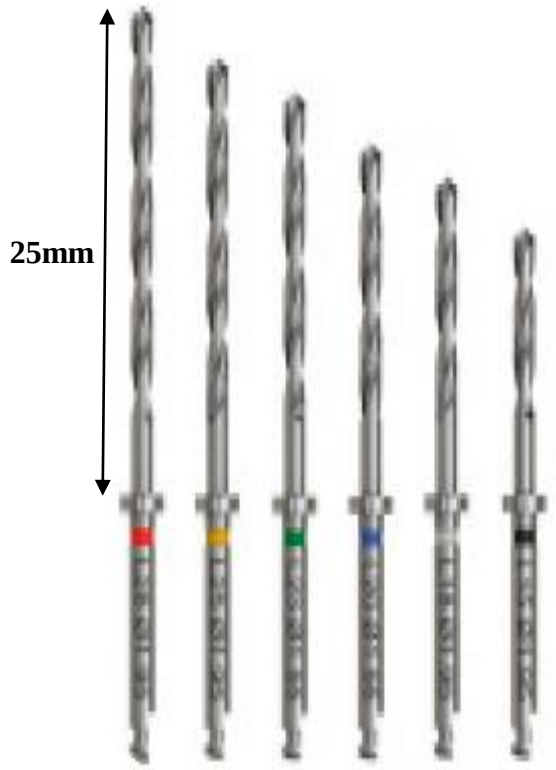



BLUE SKY PLAN

Designing the Guide







LENGTHS
15 mm
18 mm
20 mm
23 mm
25 mm
28 mm

Outline of Presentation

- ✔ **Introduction / Disclosures**
- ✔ **Imaging for Dental Implants**
  - **Conventional Radiography**
  - **CT / CBCT Scans**
  - **Make Your Own Drill Guides**
- **Radiation Dose and Risk**
- **Rogues Gallery**
- **Quiz**


ЧОРНОБИЛЬ

26 April 1986

14 June 2017


TERRA-P
1.35 µSv/h
OPERATIONAL MODES
GAMMA DOSE RATE
ALARM CLOCK
1
GAMMA DOSE
TIME
Solo

Dose Rate at Chernobyl (2017)

- 1.35 microSievert per hour

Dose Rate in the UK (Average)

- 0.3 microSievert per hour

Flight from the UK to Chernobyl

- 3 hours x 2.5 µSv/hr = 7.5 µSv

Dental x-ray (intraoral)

- 1 microSievert

CBCT scan (both jaws)

- 60 microSievert

What is radon - and how does it work?

In short - Gastein radon therapy stimulates the ability of your own cells to repair themselves. While you swim in thermal water, sweat in a radon vapor bath or relax in the Gastein Healing Gallery, your body absorbs radon through your respiratory passages and skin. In the process, the noble gas emits mild alpha radiation in your body, which in turn activates a special messenger substance, **reducing inflammation** and promoting **natural healing processes**. The result: The number of free radicals in your body drops and you have **less pain**.

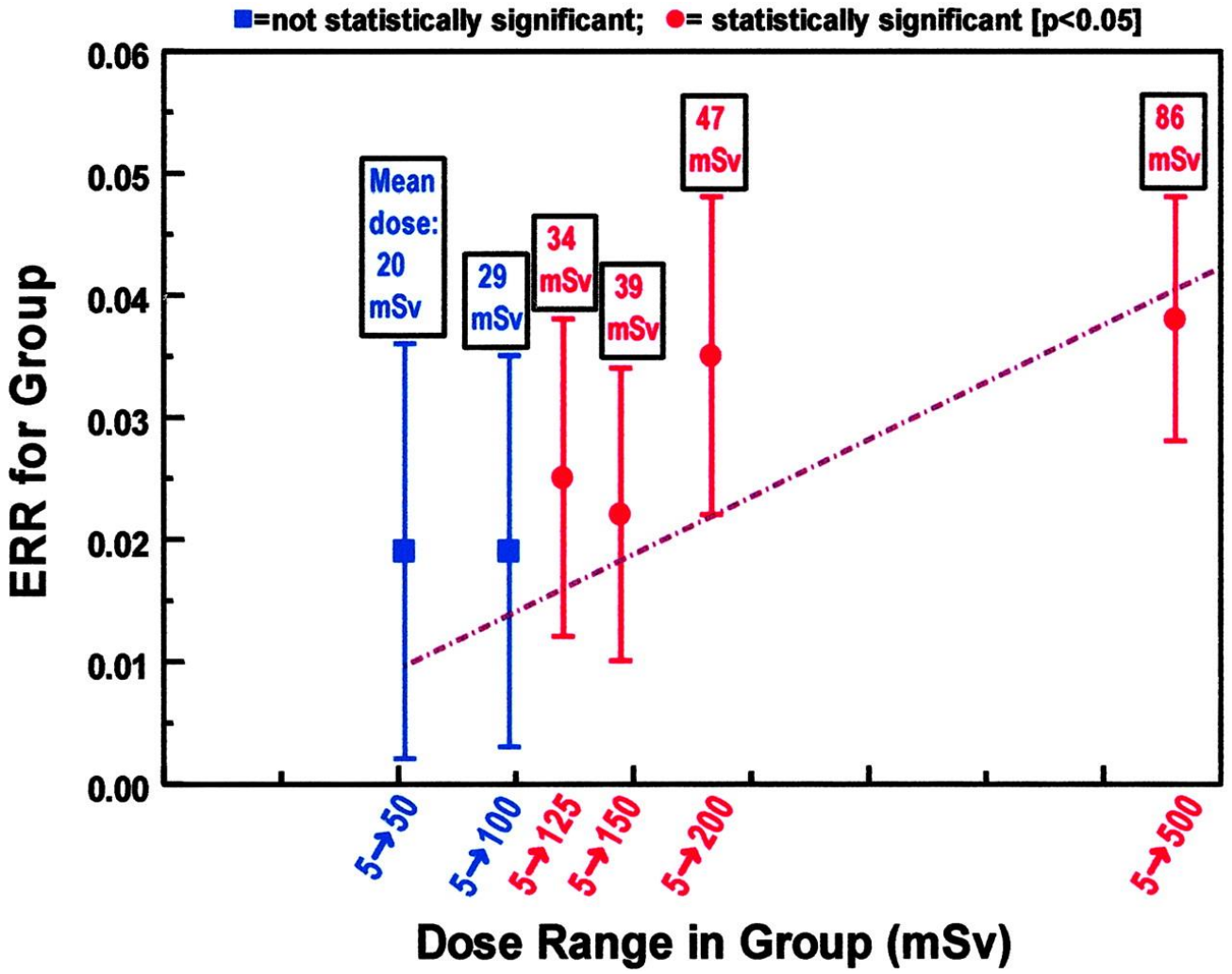
Principles of Radiation Protection

- **Justification** **(benefits must outweigh the risks)**
- **Optimisation** **(keep doses As Low As ~~Reasonably Achievable~~) Diagnostically Acceptable**
- **Dose Limits** **(1 mSv per year for members of the public)**
  (no dose limits for medical exposures)

Justification

- **Under IR(ME)R 2000 we have a duty to ensure the benefits of exposing the patient to radiation outweigh the risks.**
- **But how do we know what the risks are?**
- **How do we manage the tradeoffs between benefits and risks?**

Estimated excess relative risk (±1 SE) of mortality (1950–1997) from solid cancers among groups of survivors in the LSS cohort of atomic bomb survivors, who were exposed to low doses (<500 mSv) of radiation (2).



Brenner D J et al. PNAS 2003;100:13761-13766

The concept of Effective Dose

We know the risks from high doses of radiation

- **e.g. Atom Bomb survivors**

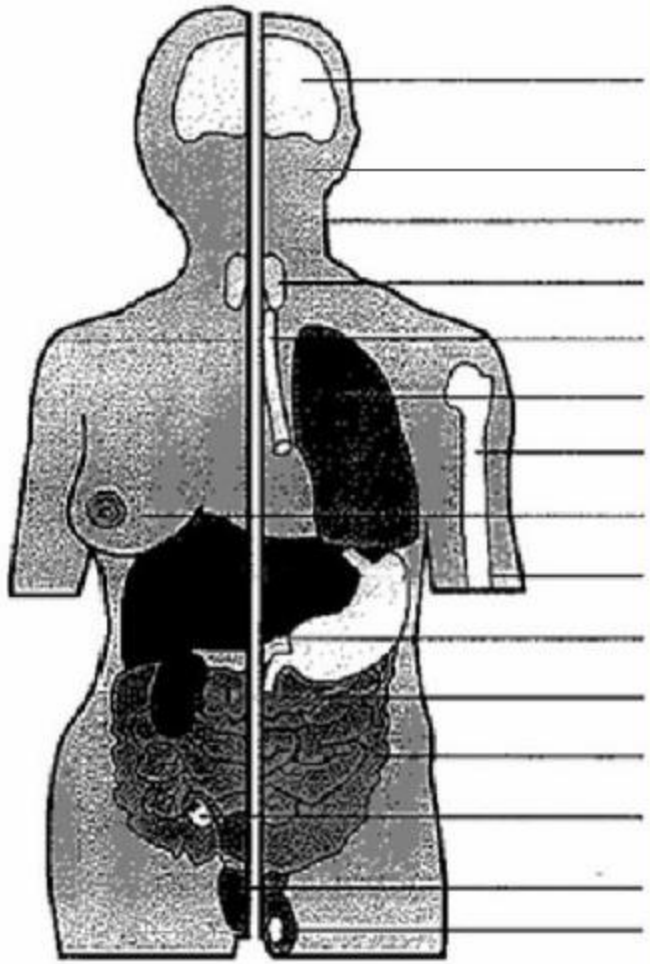
- **Atom Bomb survivors received whole body doses**
- **Dental patients receive doses to a very small region**
- **How can we relate the risks?**

Effective Dose **is a way of describing the dose to a limited region in terms of the whole body dose that would result in the same risk to the patient**

Effective Dose is a measure of risk!

More about Effective Dose

The Effective Dose calculation takes the size of the region and the body parts irradiated into account.



	w_T value ICRP103
Brain	0.01
Salivary glands	0.01
Skin	0.01
Thyroid	0.04
Oesophagus	0.04
Lung	0.12
Red bone marrow	0.12
Breast	0.12
Bone surface	0.01
Liver	0.04
Stomach	0.12
Colon	0.12
Ovary	0.08
Bladder	0.04
Testes	0.08
Remainder	0.12

Annals of the ICRP

PUBLICATION 103

The 2007 Recommendations of the International Commission on Radiological Protection

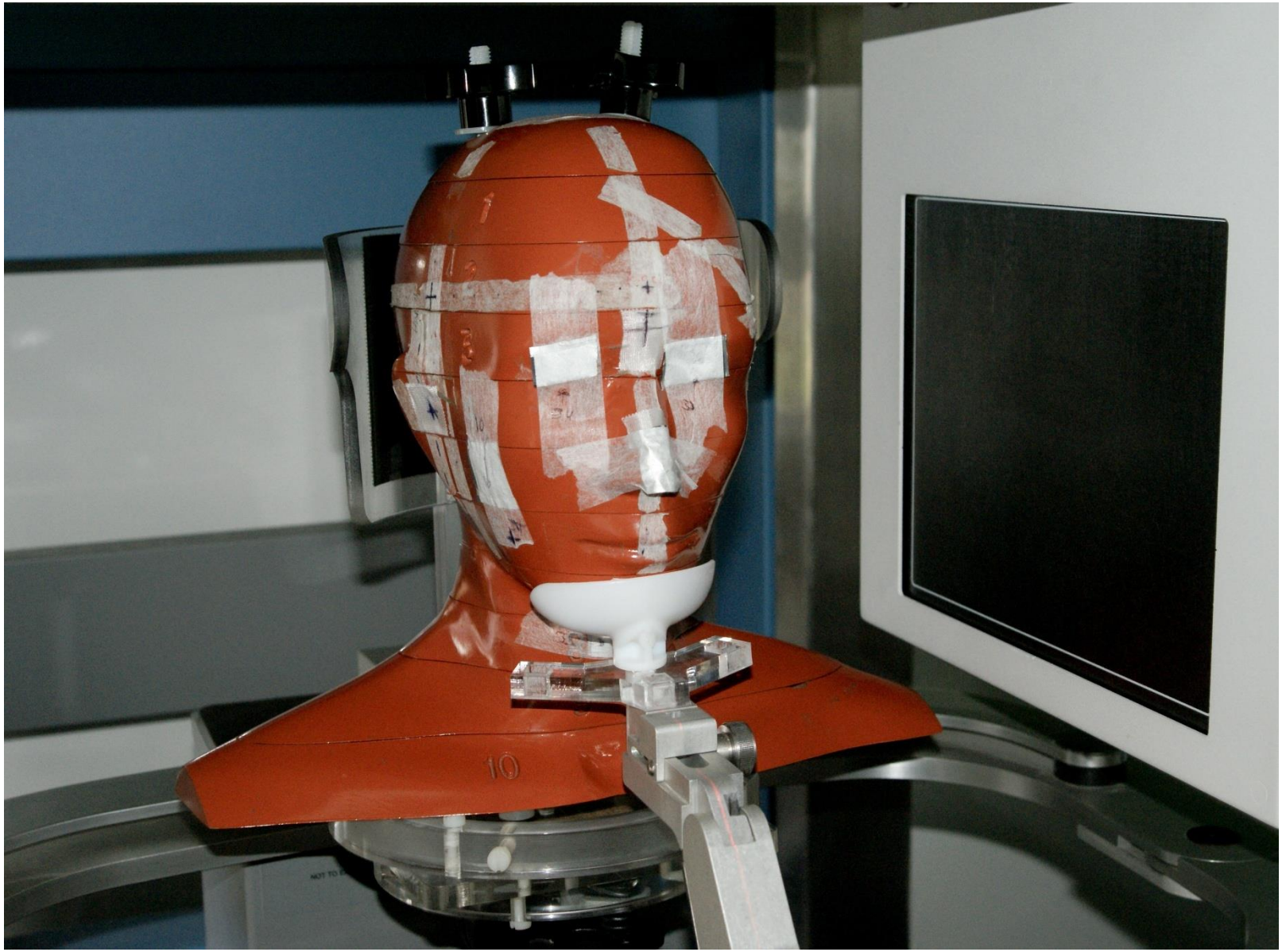
Editor
J. VALENTIN

PUBLISHED FOR

The International Commission on Radiological Protection

by

ELSEVIER


10

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journal homepage: www.elsevier.com/locate/ejrad

Effective dose range for dental cone beam computed tomography scanners

Ruben Pauwels[a,*], Jilke Beinsberger[a,1], Bruno Collaert[b,2], Chrysoula Theodorakou[c,d,3], Jessica Rogers[e,3], Anne Walker[c,3], Lesley Cockmartin[f,4], Hilde Bosmans[f,5], Reinhilde Jacobs[a,6], Ria Bogaerts[g,7], Keith Horner[d,8], The SEDENTEXCT Project Consortium[9]

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[b] Center for Periodontology and Implantology, Heverlee, Belgium
[c] North Western Medical Physics, The Christie NHS Foundation Trust, Manchester Academic Health Sciences Centre, UK
[d] School of Dentistry, University of Manchester, Manchester Academic Health Sciences Centre, UK
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[f] Department of Radiology, University Hospital Gasthuisberg, Leuven, Belgium
[g] Department of Experimental Radiotherapy, University Hospital Gasthuisberg, Katholieke Universiteit Leuven, Belgium

Eur J Radiol 81,2,267-271 (February 2012)

Dentomaxillofacial Radiology (2015) 44, 20140197

birpublications.org/dmfr

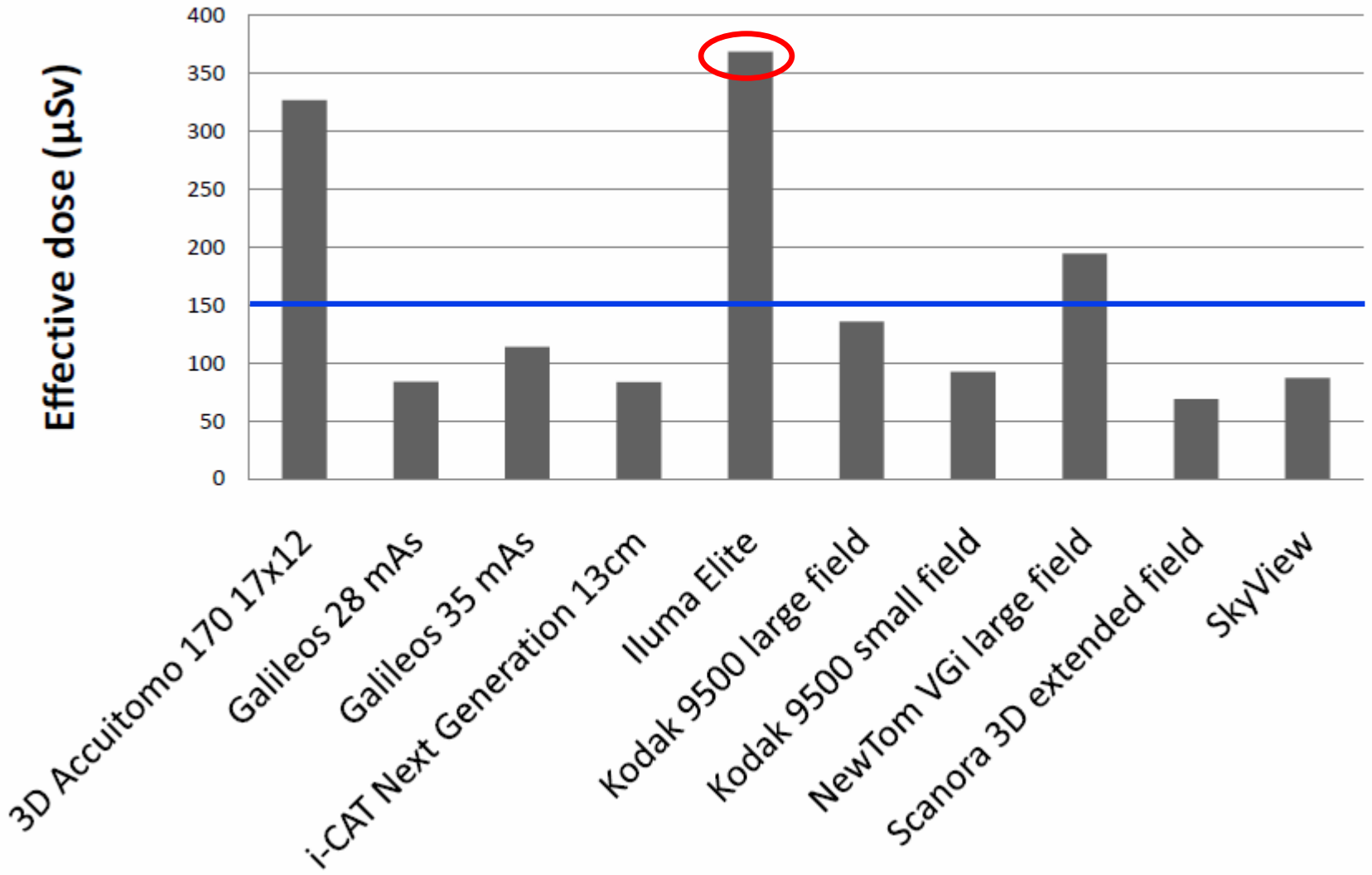
CBCT SPECIAL ISSUE: REVIEW ARTICLE

Effective dose of dental CBCT—a meta analysis of published data and additional data for nine CBCT units

[1]J B Ludlow, [2]R Timothy, [3]C Walker, [4]R Hunter, [5]E Benavides, [6]D B Samuelson and [6]M J Scheske

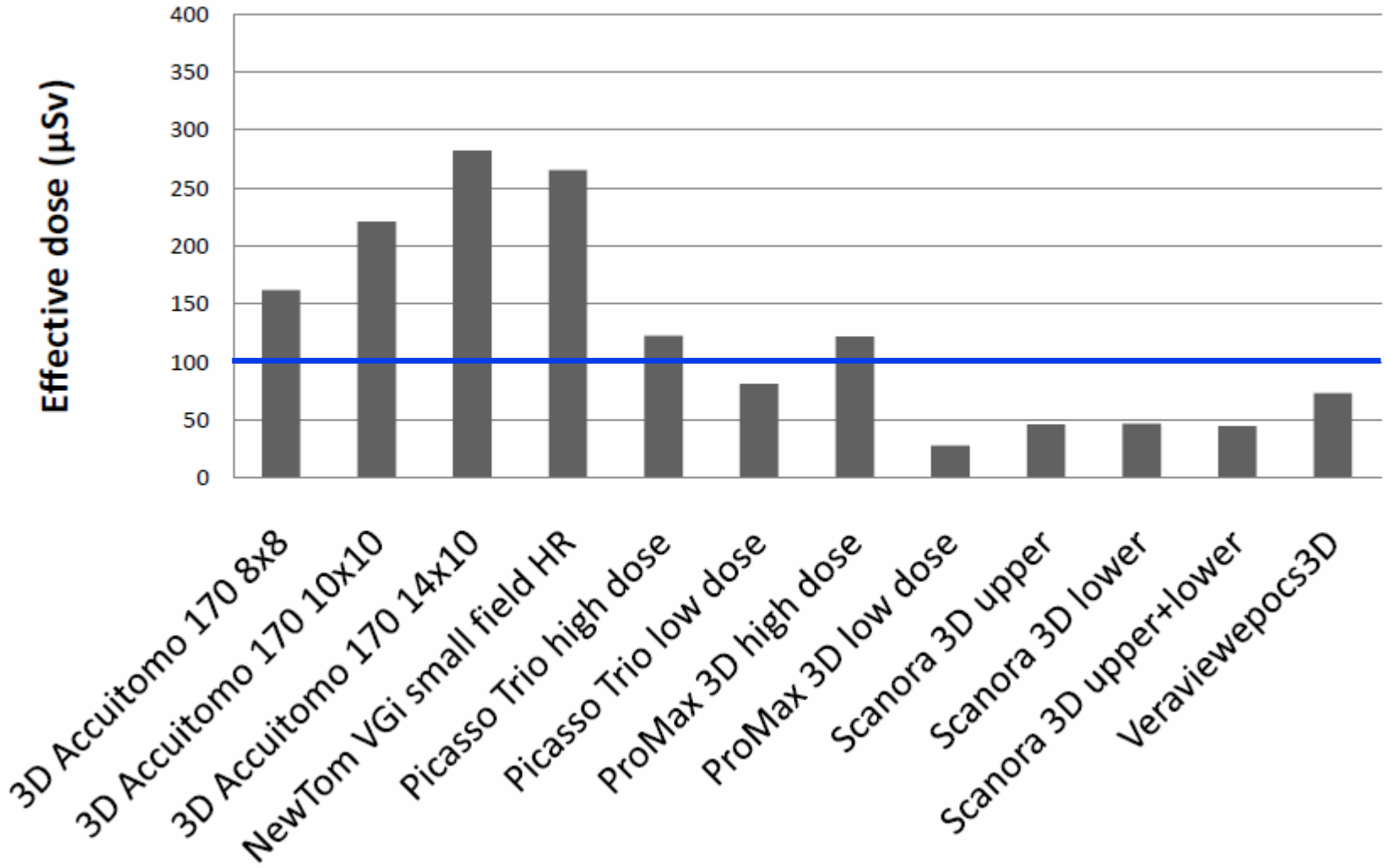
[1]North Carolina Oral Health Institute, Koury Oral Health Sciences, Chapel Hill, NC, USA; [2]Graduate Program in Oral and Maxillofacial Radiology, University of North Carolina, Chapel Hill, NC, USA; [3]Department of Orthodontics, University of Missouri, Columbia, MO, USA; [4]Private Practice of Orthodontics, Houston, TX, USA; [5]University of Michigan School of Dentistry, Ann Arbor, MI, USA; [6]University of North Carolina School of Dentistry, Chapel Hill, NC, USA

Effective dose for large field CBCTs



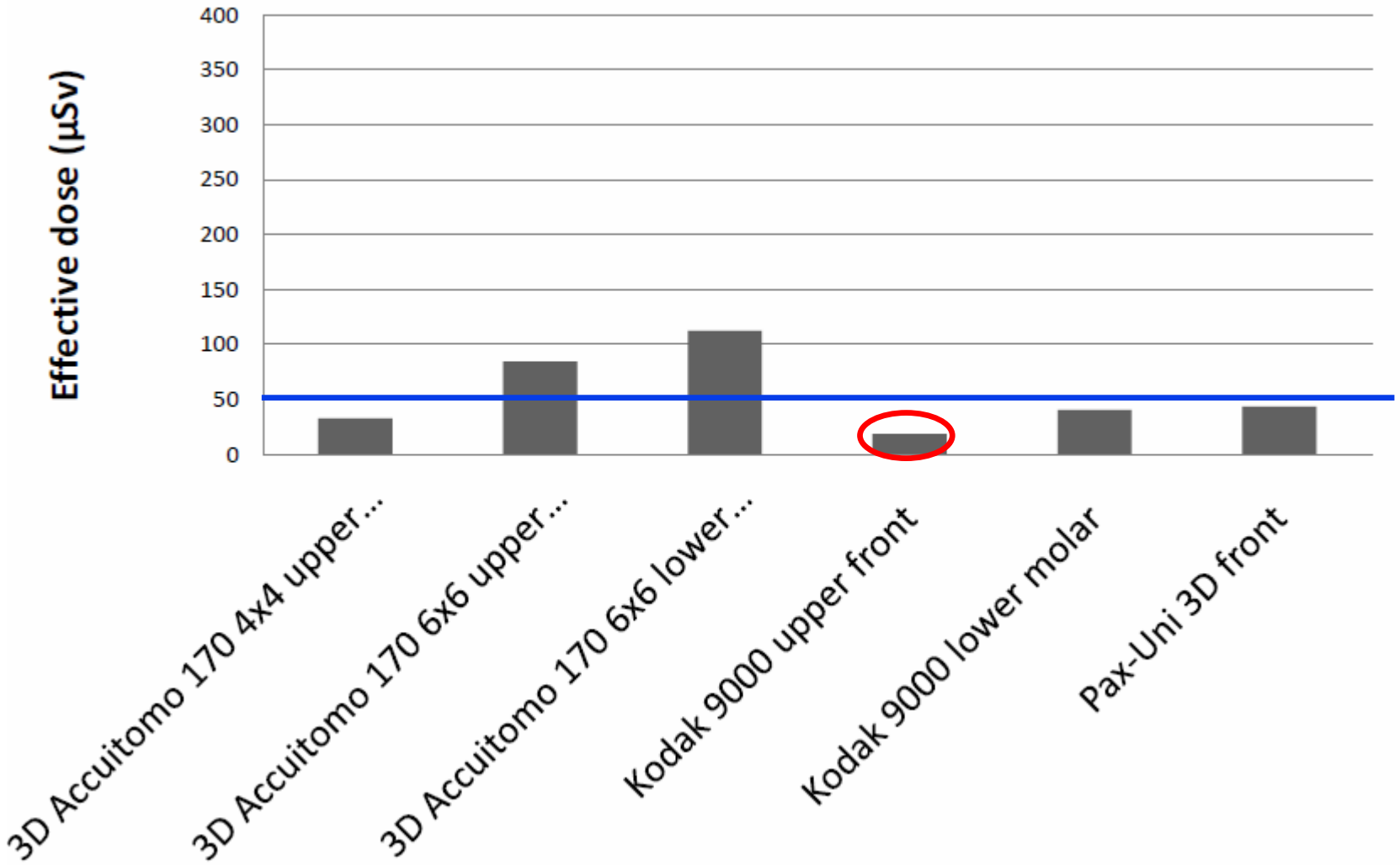
Prof. Ria Bogaerts, Katholieke Universiteit Leuven, March 2011

Effective dose for medium field CBCTs



Prof. Ria Bogaerts, Katholieke Universiteit Leuven, March 2011

Effective dose for small field CBCTs



Prof. Ria Bogaerts, Katholieke Universiteit Leuven, March 2011

Review

E.A.O. guidelines for the use of diagnostic imaging in implant dentistry 2011. A consensus workshop organized by the European Association for Osseointegration at the Medical University of Warsaw

David Harris[1,*], Keith Horner[2], Kerstin Gröndahl[3], Reinhilde Jacobs[4], Ebba Helmrot[3], Goran I. Benic[5], Michael M. Bornstein[6], Andrew Dawood[7] and Marc Quirynen[8]

Article first published online: 20 MAR 2012

DOI: 10.1111/j.1600-0501.2012.02441.x

Issue

Clinical Oral Implants Research

Volume 23, Issue 11, pages 1243–1253, November 2012

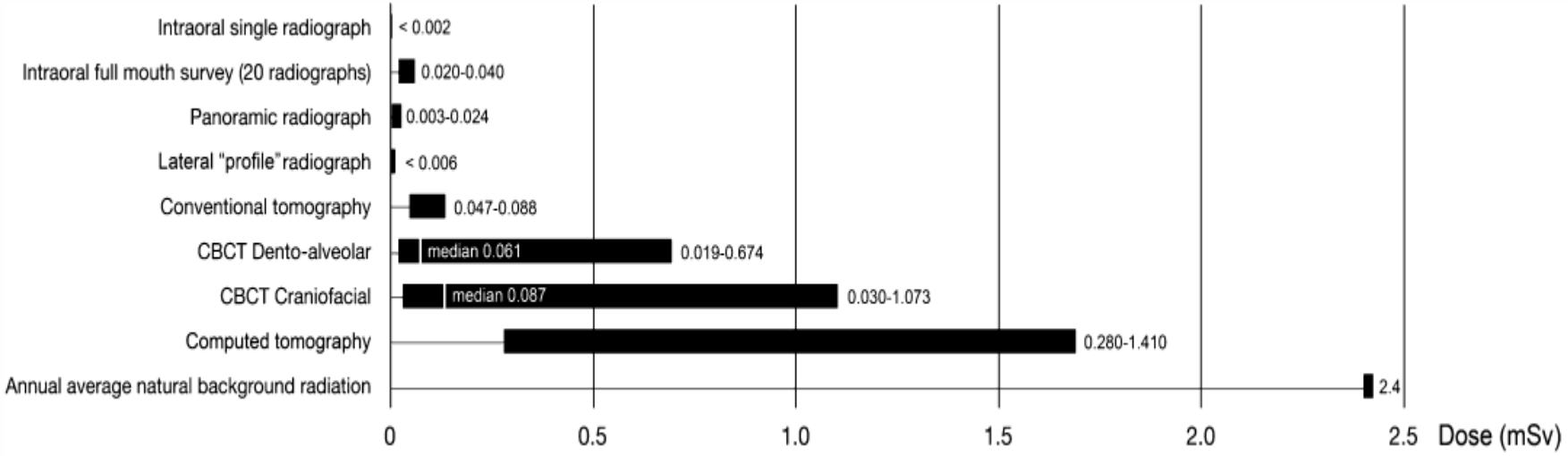


Fig. 1. Ranges of effective dose for the imaging modalities used in implant dentistry.

What is the Risk from a CBCT scan?

- **Assume adult patient, dento-alveolar scan, both jaws**
- **Effective Dose might be 60 microSieverts**
- **Risk that patient might develop fatal cancer in 20 years time**

  = 5% (1 in 20) per Sievert (from ICRP103)

  = 1 in 20 million for 1 microSv

  = 60 in 20 million for 60 microSv

  = 1 in 300,000 (roughly) for 60 microSv

Health & Safety people would call this a "Minimal Risk"

*** If your patient is a child the risk is 3x more**

Risk varies with Age

Age group (years)	Multiplication factor for risk
<10	x 3
10-20	x 2
20-30	x 1.5
30-50	x 0.5
50-80	x 0.3
80+	Negligible risk

5% per Sievert at age 30

RADIATION PROTECTION N° 172 A report prepared by the SEDENTEXCT project 2011

www.sedentexct.eu

Typical Doses from Dental X-Rays

	Effective Dose (µSv)	Risk
Intraoral (F speed, rect coll)	2	
Intraoral (E speed, round coll)	6	
Lateral Ceph	10	
Panoramic	3 to 24	
Cone Beam CT	19 to 1073	
Medical CT (using dental protocol)	280 to 1410	

Typical Doses from Dental X-Rays

	Effective Dose (µSv)	Risk	
Intraoral (F speed, rect coll)	**2**	**1 in 10 million**	**Negligible**
Intraoral (E speed, round coll)	**6**	**1 in 3.3 million**	**Negligible**
Lateral Ceph	**10**	**1 in 2 million**	**Negligible**
Panoramic	**3 to 24**	**1 in 6.7 million to 833 thousand**	**Negligible to Minimal**
Cone Beam CT	**19 to 1073**	**1 in 1.05 million to 1 in 19 thousand**	**Mimimal to Very Low**
Medical CT (using dental protocol)	**280 to 1410**	**1 in 71 thousand to 1 in 14 thousand**	**Very Low**

Cancer: science and society and the communication of risk

Kenneth C Calman

BMJ VOLUME 313 28 SEPTEMBER 1996

This article is based on the Calum Muir lecture, delivered in Edinburgh in September 1996.

Table 2—*Descriptions of risk in relation to the risk of an individual dying (D) in any one year or developing an adverse response (A)*

Term used	Risk range	Example	Risk estimate
High	≥1:100	(A) Transmission to susceptible household contacts of measles and chickenpox[6]	1:1-1:2
		(A) Transmission of HIV from mother to child (Europe)[7]	1:6
		(A) Gastrointestinal effects of antibiotics[8]	1:10-1:20
Moderate	1:100-1:1000	(D) Smoking 10 cigarettes a day[9]	1:200
		(D) All natural causes, age 40[9]	1:850
Low	1:1000-1:10 000	(D) All kinds of violence and poisoning[9]	1:3300
		(D) Influenza[10]	1:5000
		(D) Accident on road[9]	1:8000
Very low	1:10 000-1:100 000	(D) Leukaemia[9]	1:12 000
		(D) Playing soccer[9]	1:25 000
		(D) Accident at home[9]	1:26 000
		(D) Accident at work[9]	1:43 000
		(D) Homicide[9]	1:100 000
Minimal	1:100 000-1:1 000 000	(D) Accident on railway[9]	1:500 000
		(A) Vaccination associated polio[10]	1:1 000 000
Negligible	≤1:1 000 000	(D) Hit by lightning[9]	1:10 000 000
		(D) Release of radiation by nuclear power station[9]	1:10 000 000

Optimisation

Want to Optimise

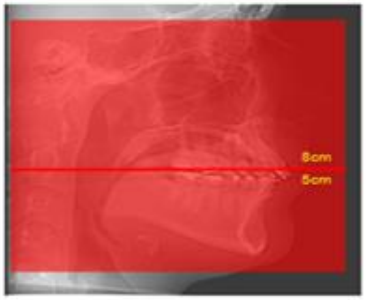
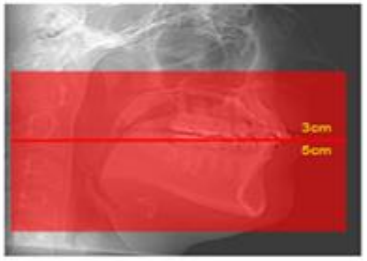
$$\frac{\text{Benefit to Patient*}}{\text{Risk to Patient}}$$

*** not to the dentist!**

Practical ways to Reduce the ~~Risk~~ Dose

1. **Reduce the Height (vertical collimation)**

   Reduces the risk without loss of benefit in most cases.

	**Full face** **13cm height x 16cm diameter** **83 microSieverts**
	**Both arches** **8cm height x 16cm diameter** **56 microSieverts** (interpolated)
	**Mandible** **6cm height x 16cm diameter** **45 microSieverts**

Absorbed Dose outside primary beam is effectively zero

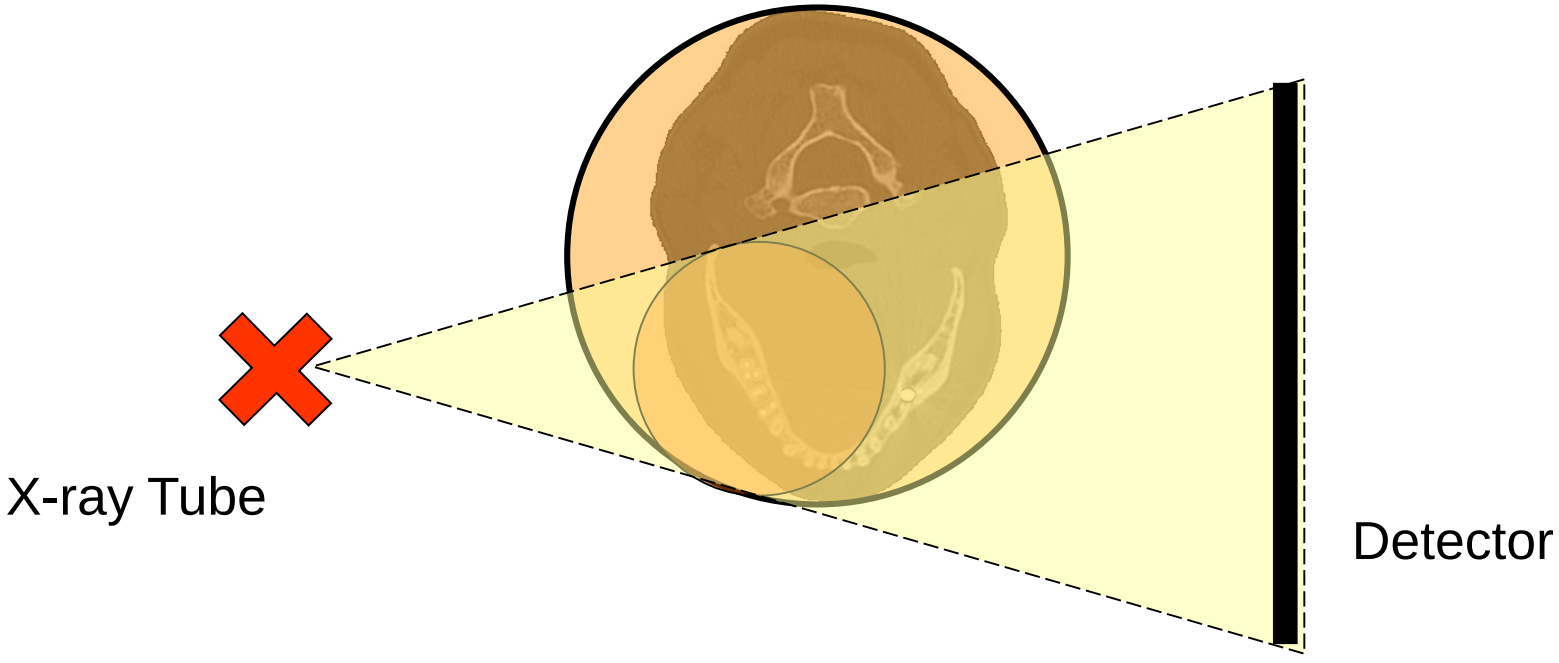
More ways to Reduce the Dose

2. **Reduce the mAs (tube current, scan time)**

- **Reducing the mAs may have a negative impact on image quality**

- **On some scanners, the voxel size is linked to the mAs**

3. Reduce the Width (horizontal collimation)



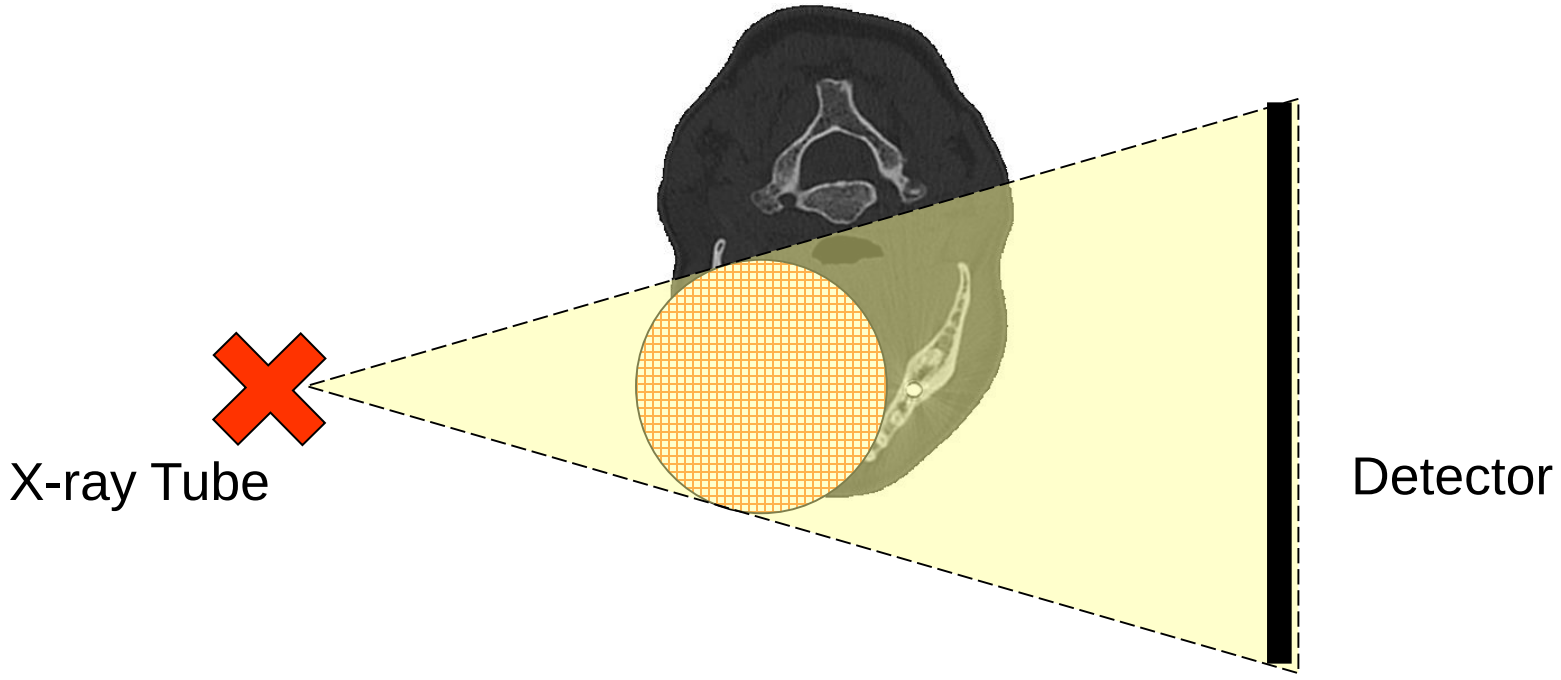
- **Absorbed Dose outside primary beam is not zero (about 50% from SEDENTEXCT measurements)**
- **There may be some loss of benefit**

Notes e.g. specific imaging parameters / protocols / concerns

PLEASE AVOID SCANNING THE SPINE

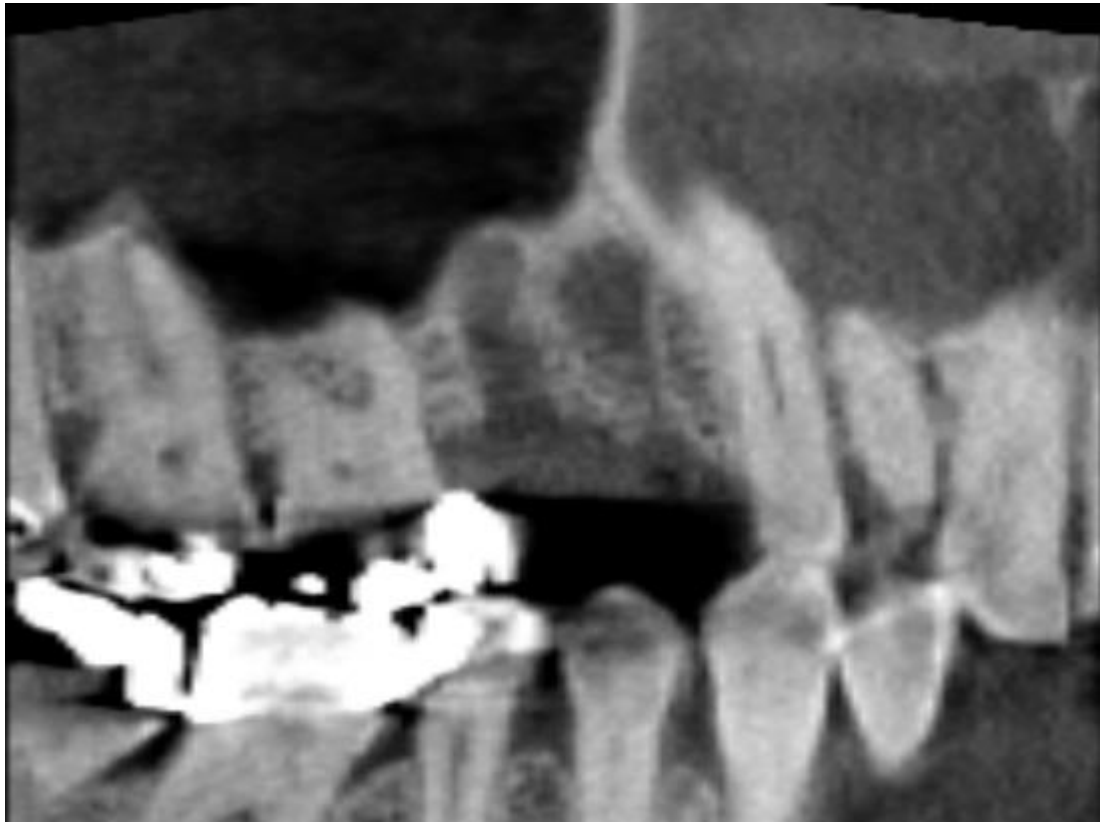
"Sorry mate – no can do!"

Fundamental Limitation of Small Field Of View



- **CBCT measures the density within the Field Of View only**
- **Material outside the Field Of View has an unpredictable effect**
- **Software corrections means pixels may change with updates**

Air should be black



Implant Surgery Complications: Etiology and Treatment

Kelly Misch, DDS,* and Hom-Lay Wang, DDS, MSD, PhD†

ISSN 1056-6163/08/01702-159
Implant Dentistry
Volume 17 • Number 2

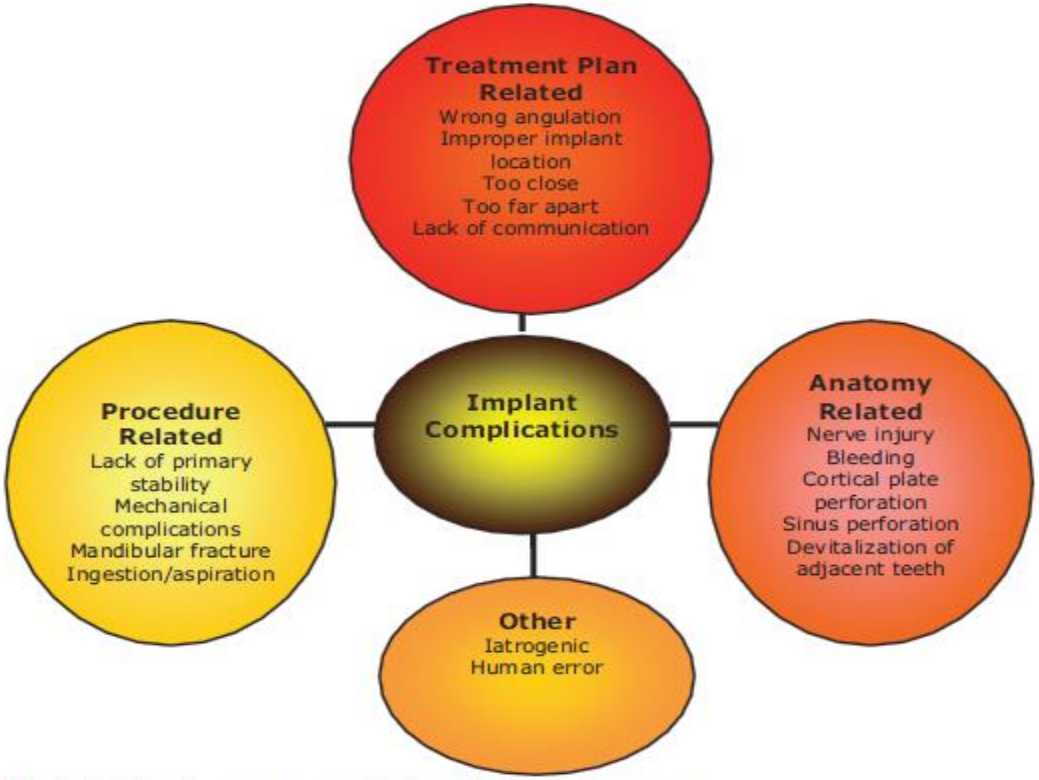
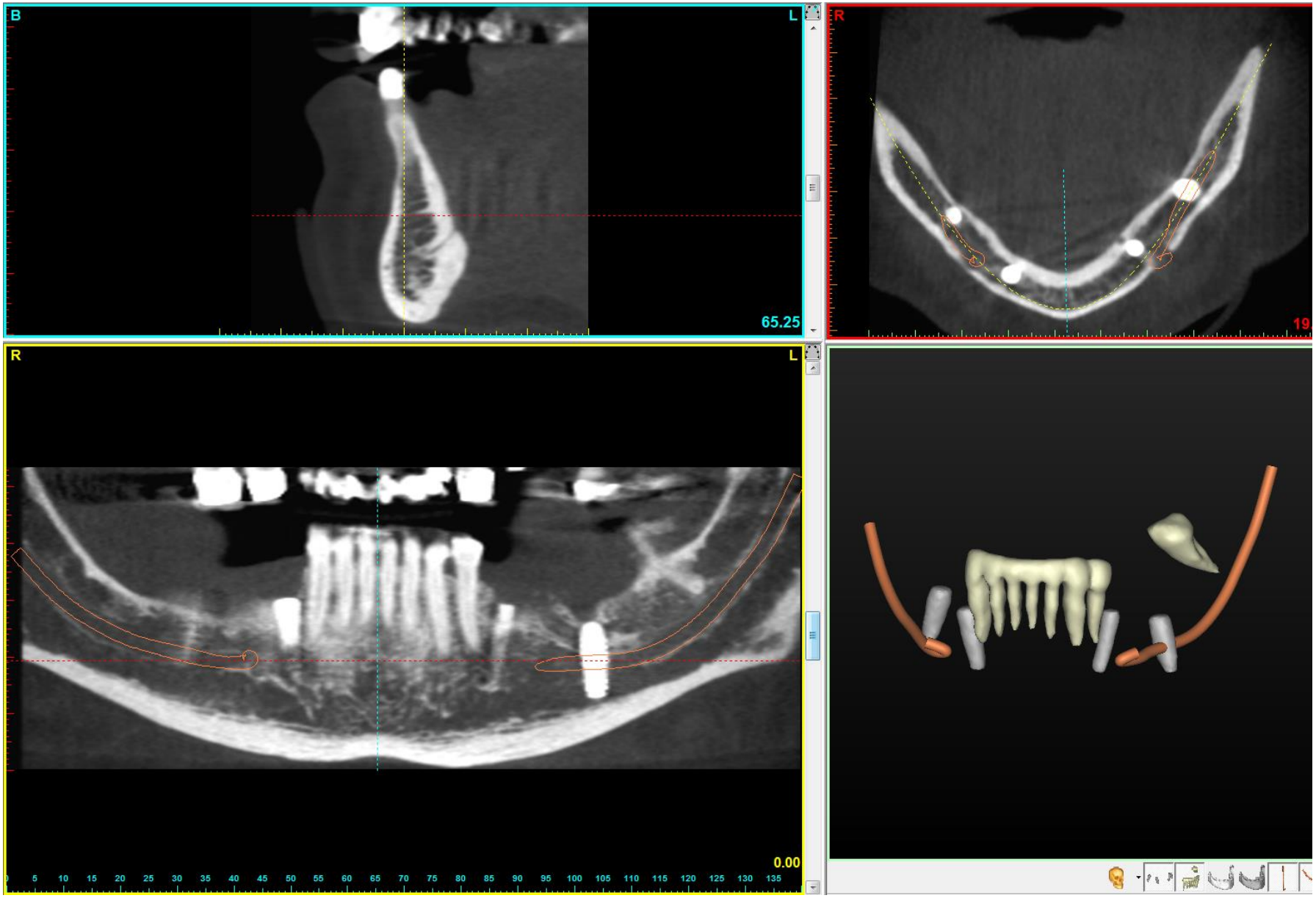


Fig. 1. Outline of common complications during implant surgery.

The Risk of Not Having a CBCT Scan



Take the CT Scan first, do the surgery second (not the other way around)!

Royal College of Surgeons
ADVANCING SURGICAL CARE

https://www.rcseng.ac.uk/education-and-exams/courses/

Saturday 19 November 2016

Dental CBCT Course for Referrers

Cone Beam Computed Tomography (CBCT) is increasingly common in hospital and general dental practice. This course is based on the Level 1 training criteria published in the latest European EADMFR guidelines. Upon completion participants will have fulfilled their legal and ethical responsibilities.

The course is hosted by the RCS and the British Society of Dental and Maxillofacial Radiology and is delivered by experienced consultant dental maxillofacial radiologists.

Royal College of Surgeons
ADVANCING SURGICAL CARE

https://www.rcseng.ac.uk/education-and-exams/courses/

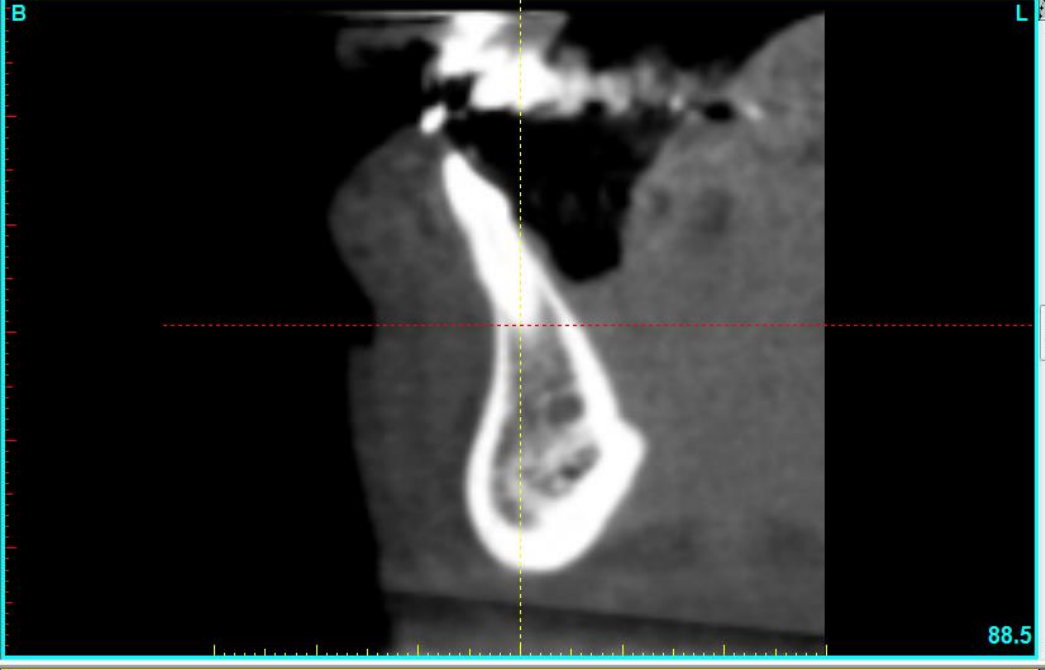
Friday 25 November 2016

Basics of Dentoalveolar CBCT Interpretation

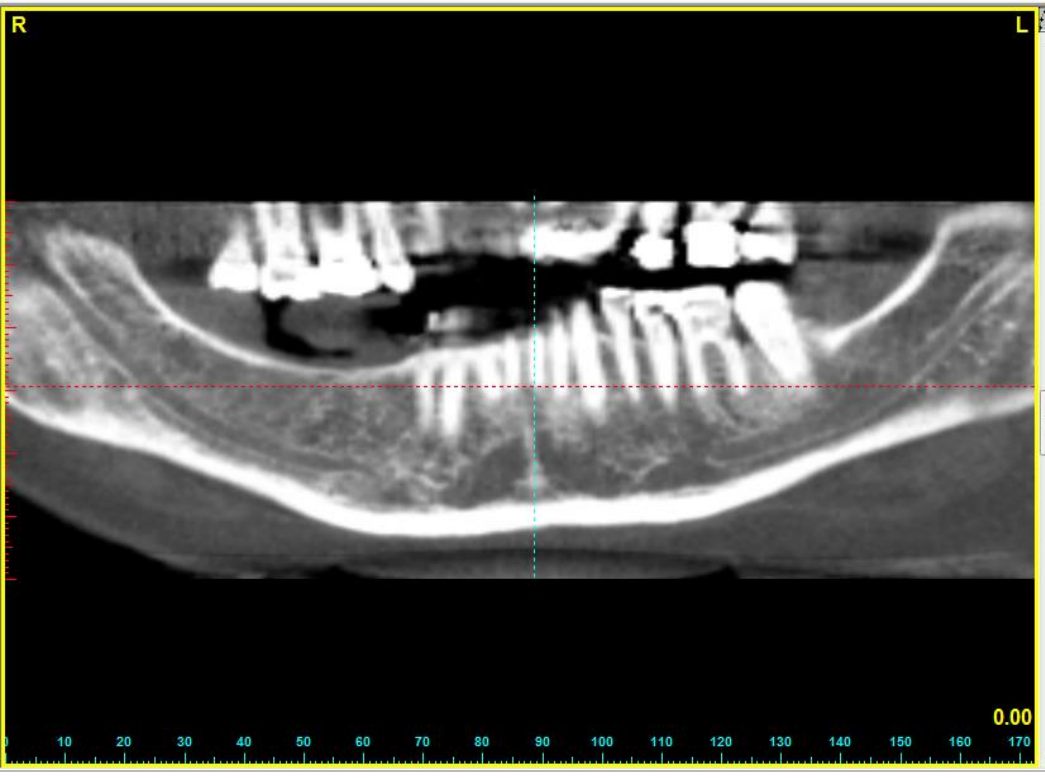
This hands-on course is designed to train dentists to interpret and write reports on CBCT scans limited to dento-alveolar regions. The course content is modified from the "Level 2" training criteria published in the latest European guidelines.

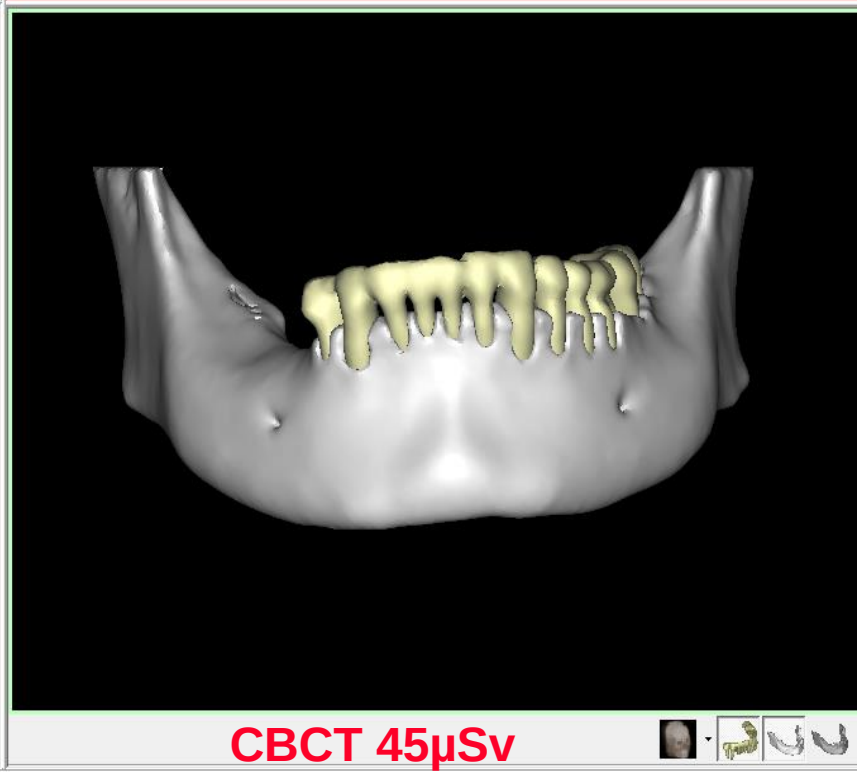
This course is jointly hosted by the British Society of Dental and Maxillofacial Radiology (BSDMFR) and the Royal College of Surgeons of England and is delivered by experienced consultant dental maxillofacial radiologists.

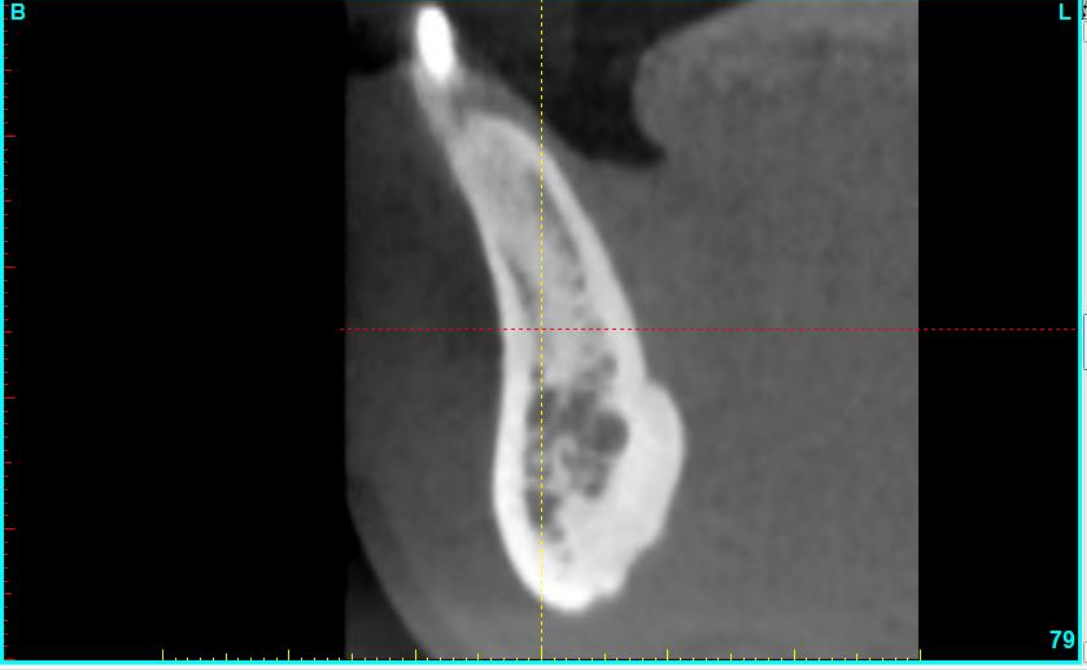
Rogues Gallery


B
L
88.5

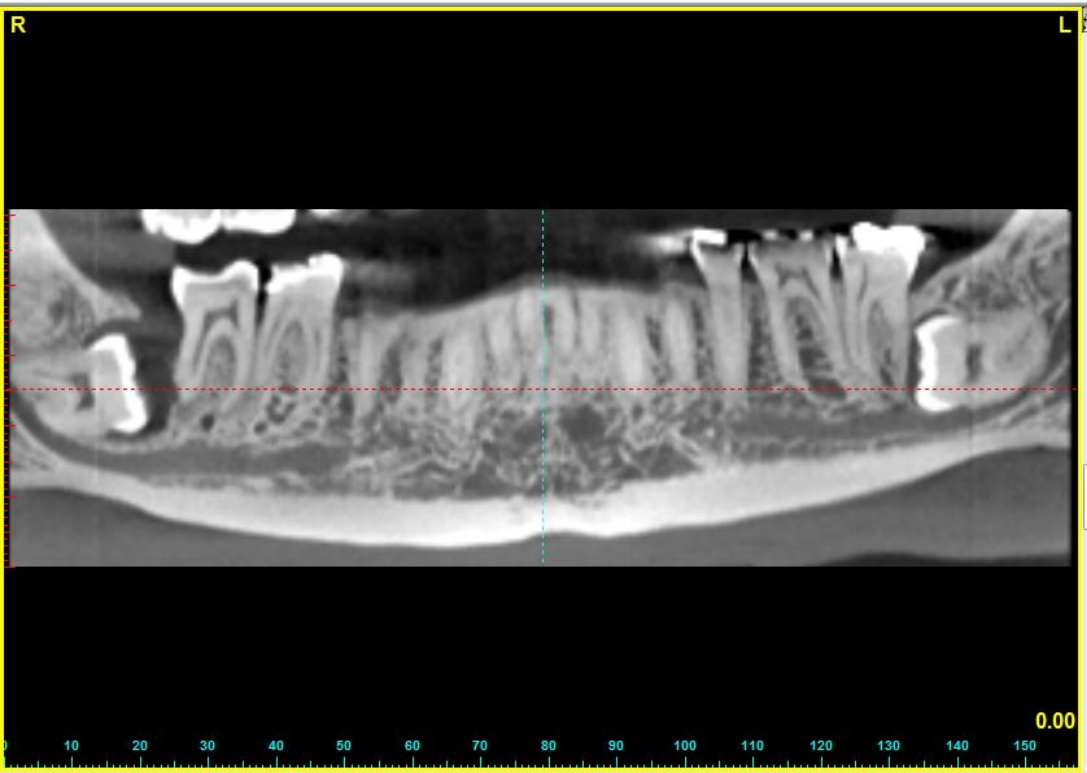

R
CT Axial: 70.00

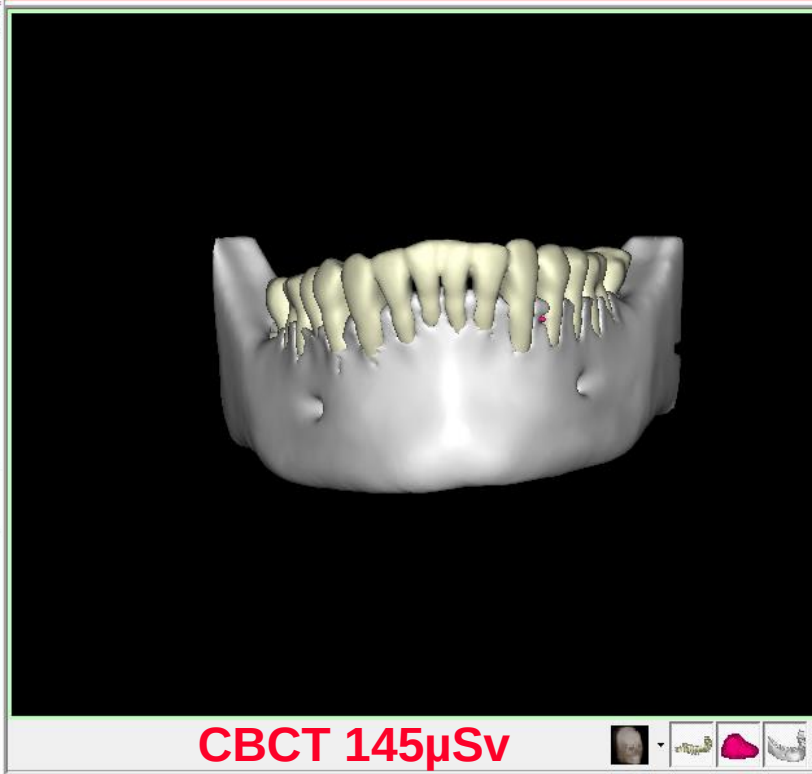

R
L
0.00
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170

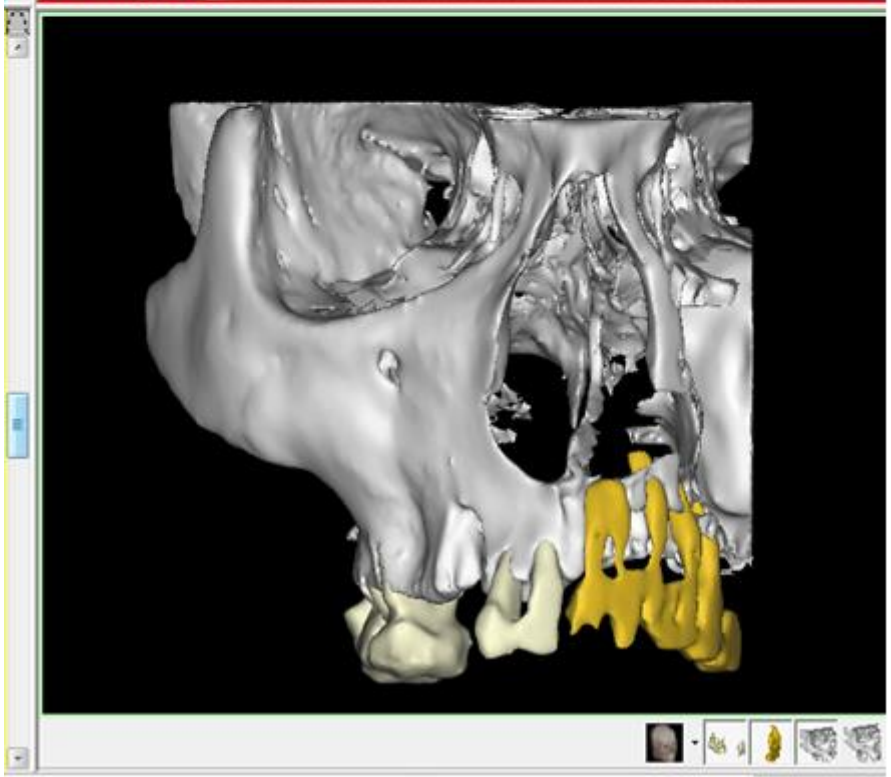

CBCT 45μSv


B
L
79


R
CT Axial: 0.00

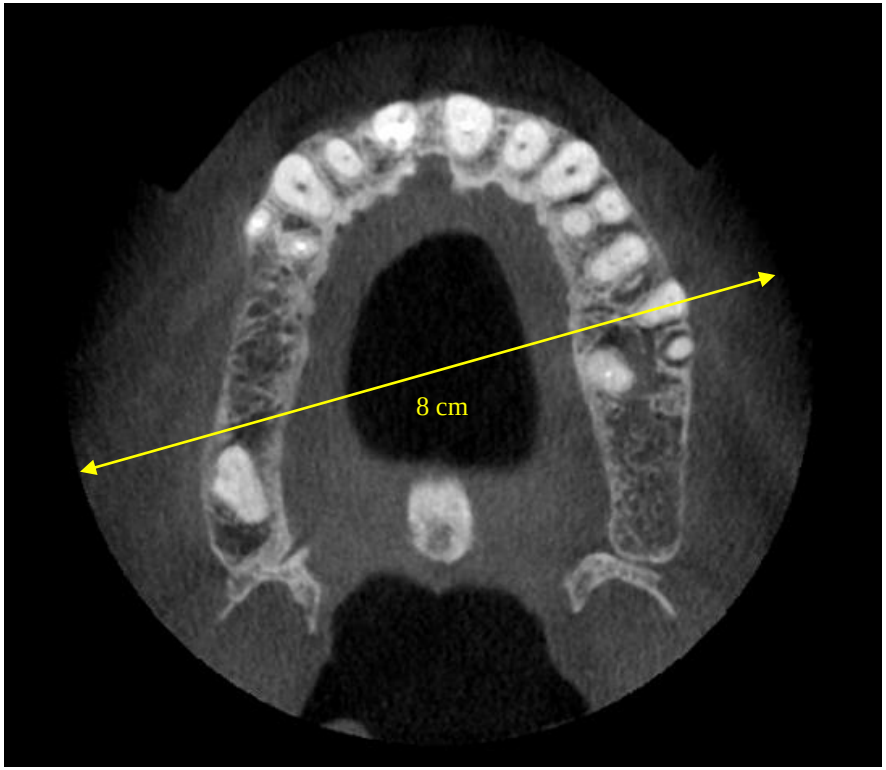

R
L
0.00
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150

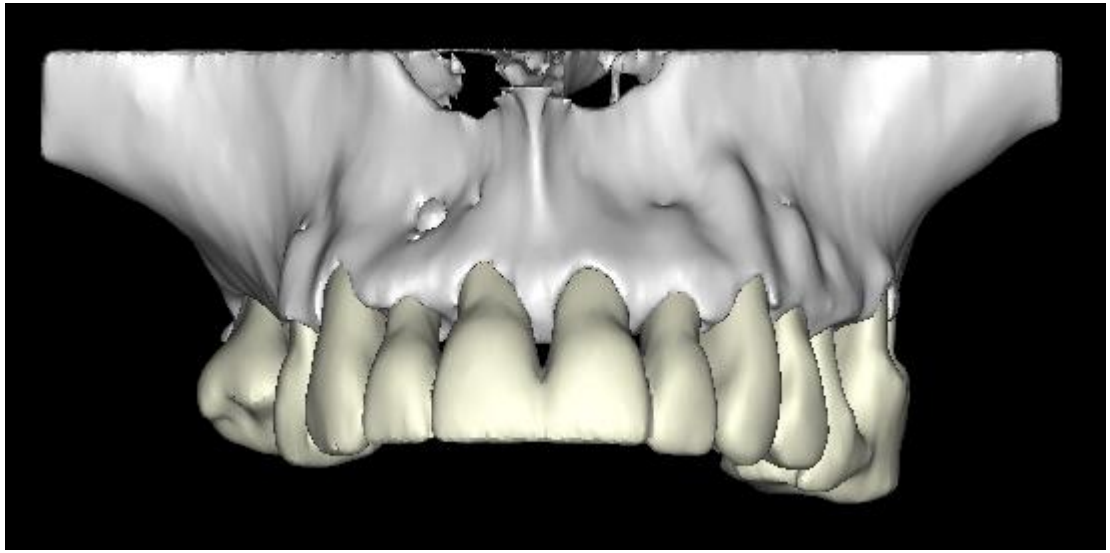

CBCT 145μSv



Moving patient to the side (without reducing the Field Of View) –

does it reduce the dose?

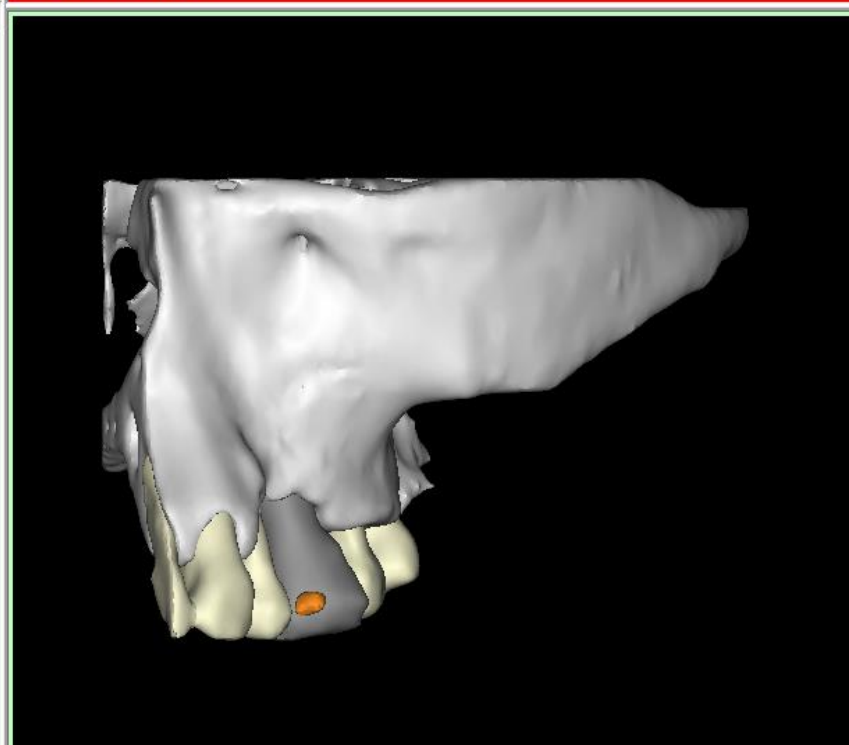

8 cm

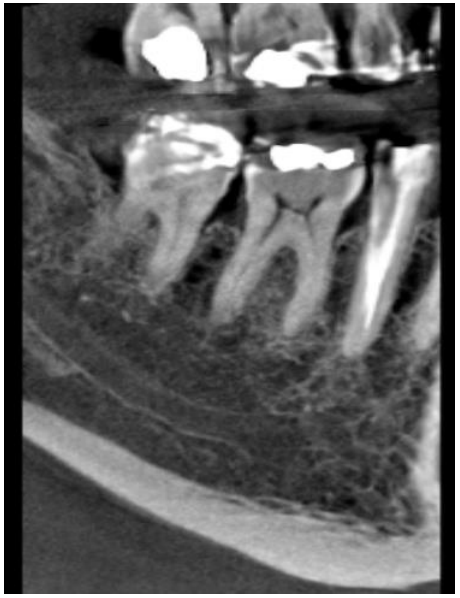



B
L
31


R
CT Axial: -27.38

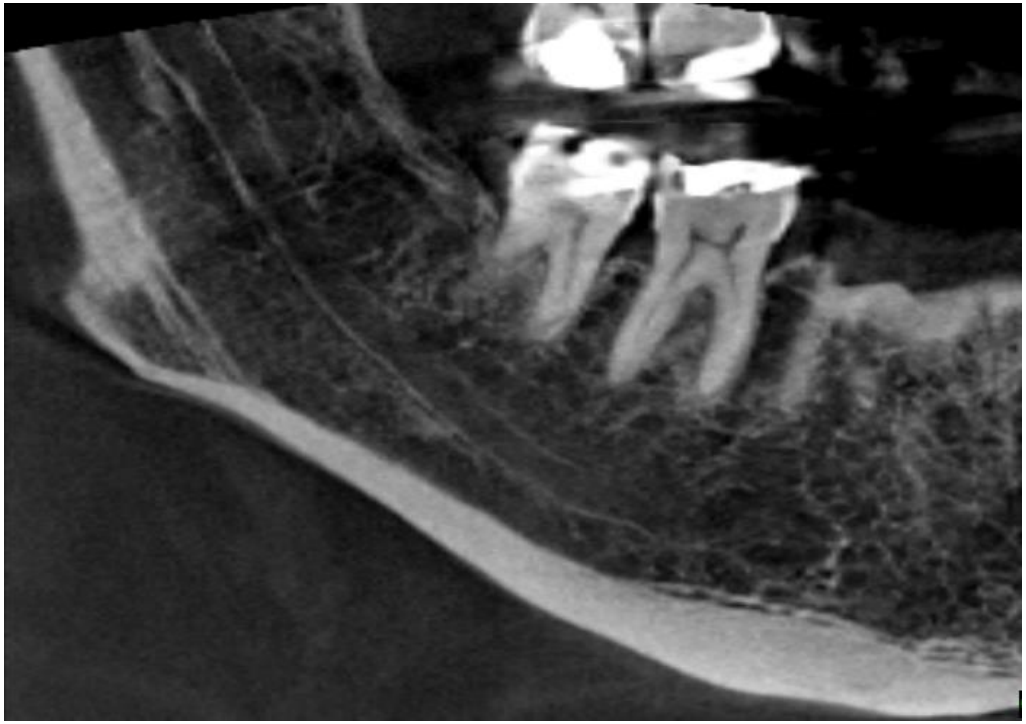

R
L



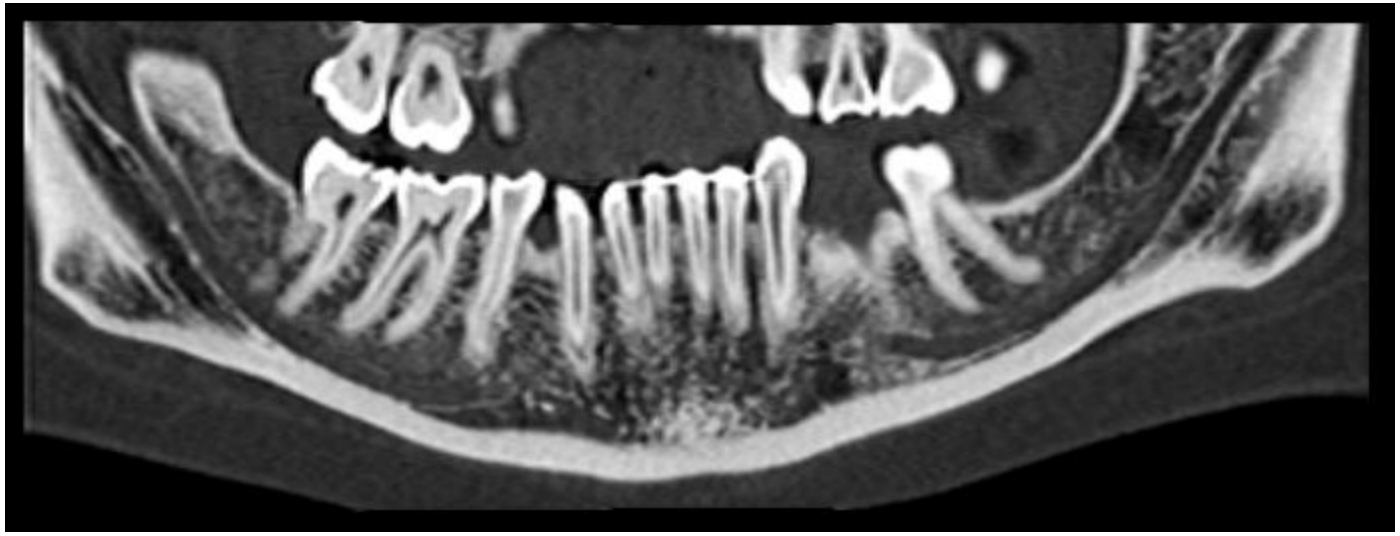


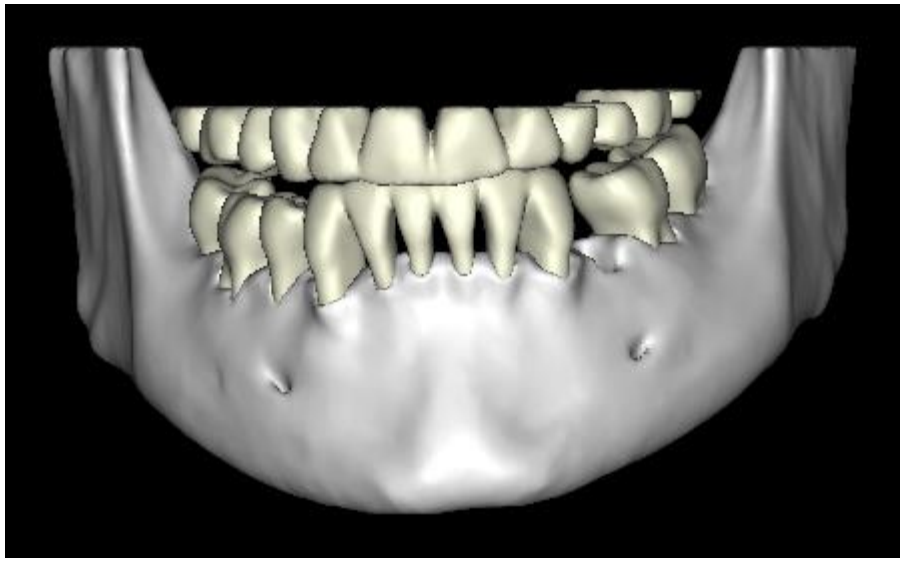
IDT29826

Gendex DP-700
4cm x 6cm
0.133mm voxels
79 mAs
DLP 35.9 mGy.cm
Effective Dose
150µSv approx.

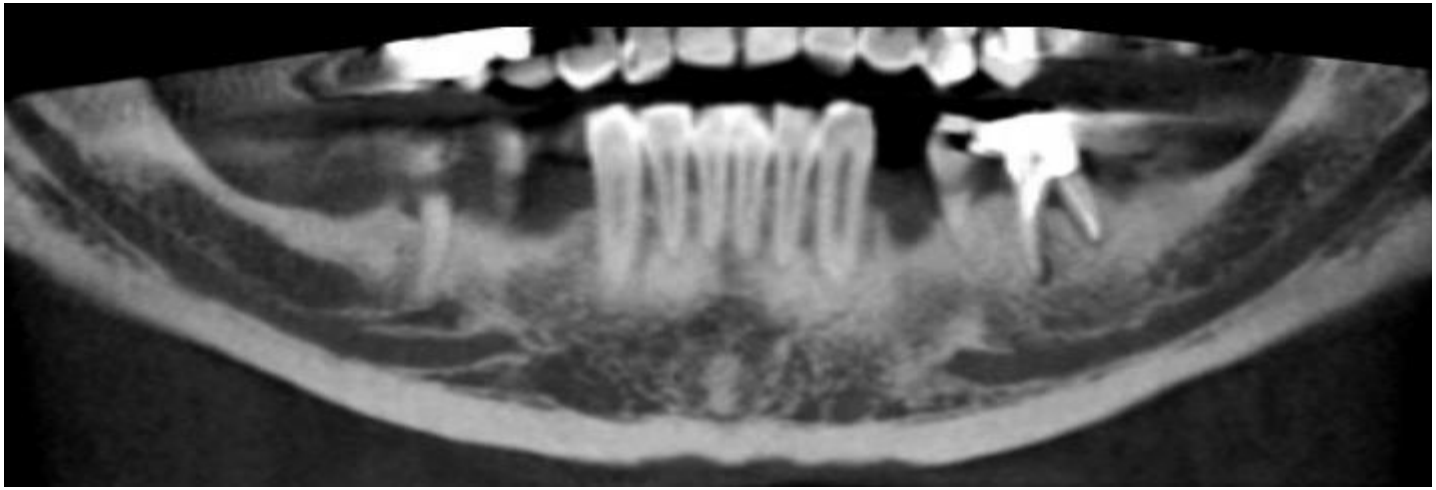


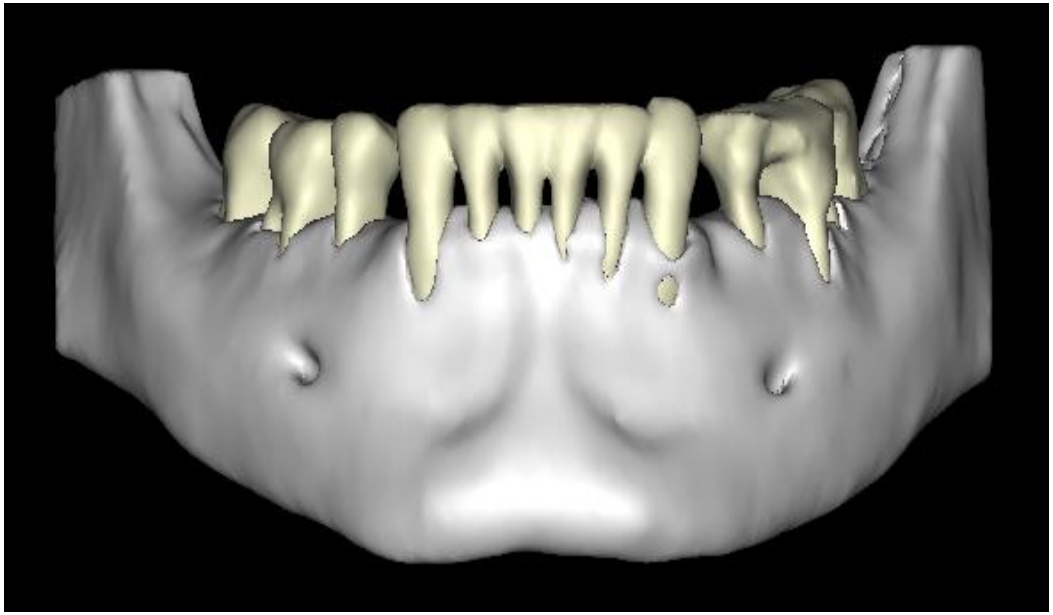
Gendex DP-700
8cm x 6cm
0.2mm voxels
132.5 mAs
DLP 58.5 mGy.cm
Effective Dose
230µSv approx.





Toshiba Aquilion ONE
12cm x 6cm
0.25mm voxels
DLP 54mGy.cm
Effective Dose 150µSv approx.





IDT27563
i-CAT Classic
9.5cm x 5.4cm
0.25mm voxels
DLP 13mGy.cm
Effective Dose 50µSv approx.

Quiz –
Which is the best way to reduce the dose?

1. **Reduce the Height**
   - **linear reduction in risk, no loss of benefit in most cases**

2. **Reduce the mAs**
   - **linear reduction in risk, some loss of benefit**

3. **Reduce the Width**
   - **less than linear reduction in risk, more loss of benefit**

Quiz – True or False?

1. **If I can't see it in the images it didn't receive any dose**
   FALSE

2. **If the Field Of View is small then the dose must be low**
   FALSE

3. **Even if the Effective Dose is high, it's just a small region so the risk is low**
   FALSE

4. **If I can't see it in the images I don't have to report on it**
   TRUE
   (benefits the dentist not the patient)

Quiz – True or False?

1. **Medical CT scanners should never be used for dental scans.**

NEVER SAY NEVER

2. **My CBCT scanner runs at 85kVp instead of 120kVp so that means a lower patient dose.**

FALSE

True or False?

1. **The smaller the Field Of View, the better.** NOT ALWAYS
2. **The smaller the voxel size, the better.** NOT ALWAYS
3. **The shorter the scan time, the better.** NOT ALWAYS
4. **Radiation damage is cumulative.** NOT FOR DIAGNOSTIC X-RAYS
5. **The risk of cancer increases with the number of scans.** TRUE AS FAR AS WE KNOW
6. **The CBCT scan was non-diagnostic but I shouldn't repeat it because of the dose.** FALSE
7. **My patient has had several CBCT scans already - she shouldn't have any more.** FALSE