

Univerzitet u Novom Sadu
FAKULTET TEHNIČKIH NAUKA

TRANSMISIVNE METODE 3D DIGITALIZACIJE

Metode 3D digitalizacije

Pasivne

Aktivne

Kontaktne

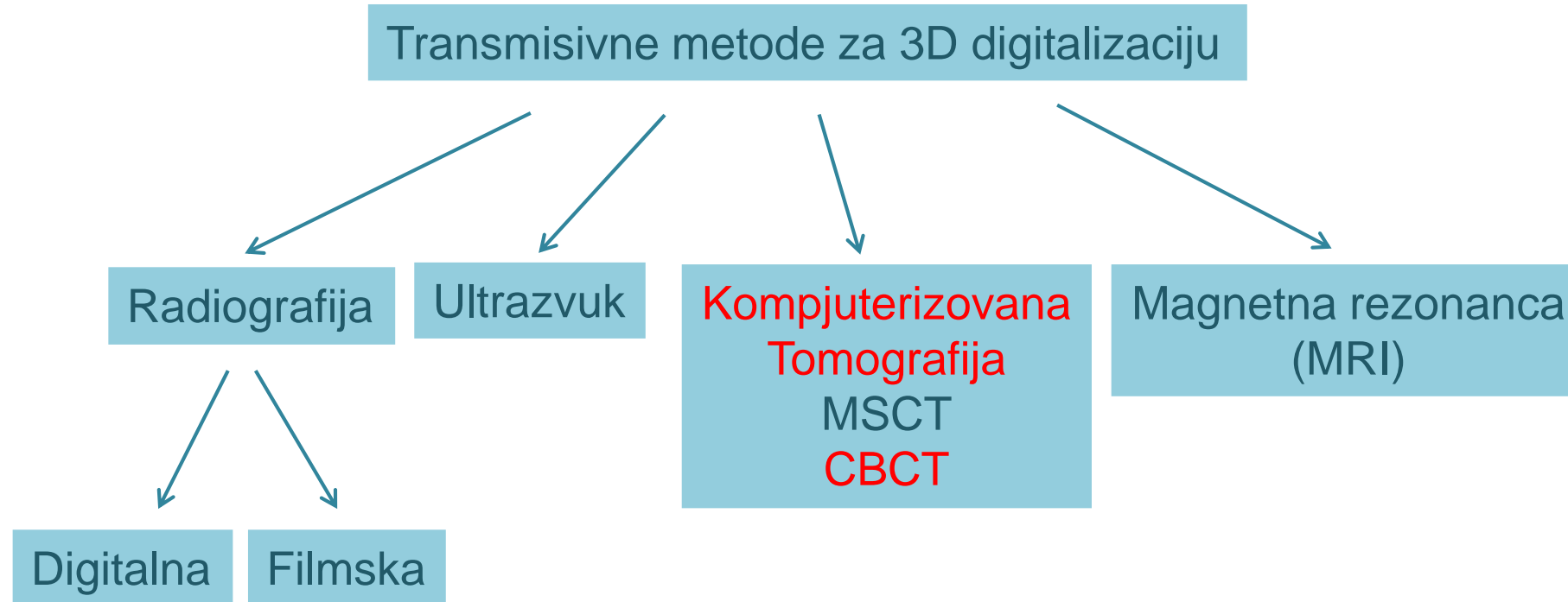
Beskontaktne

Refleksivne

Transmisivne

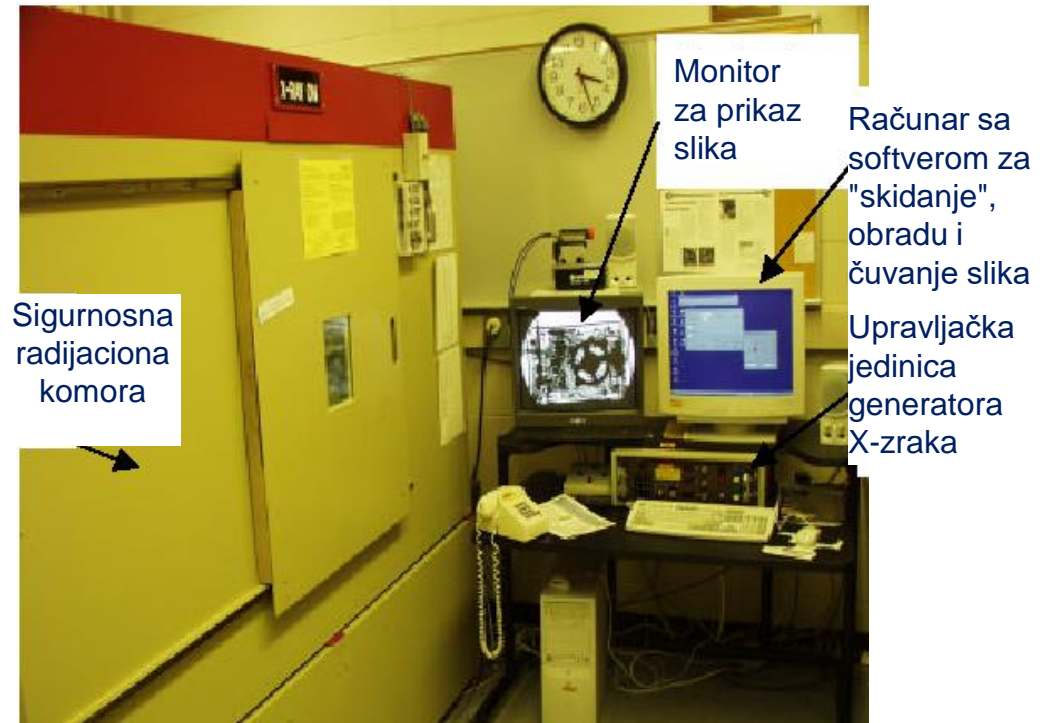
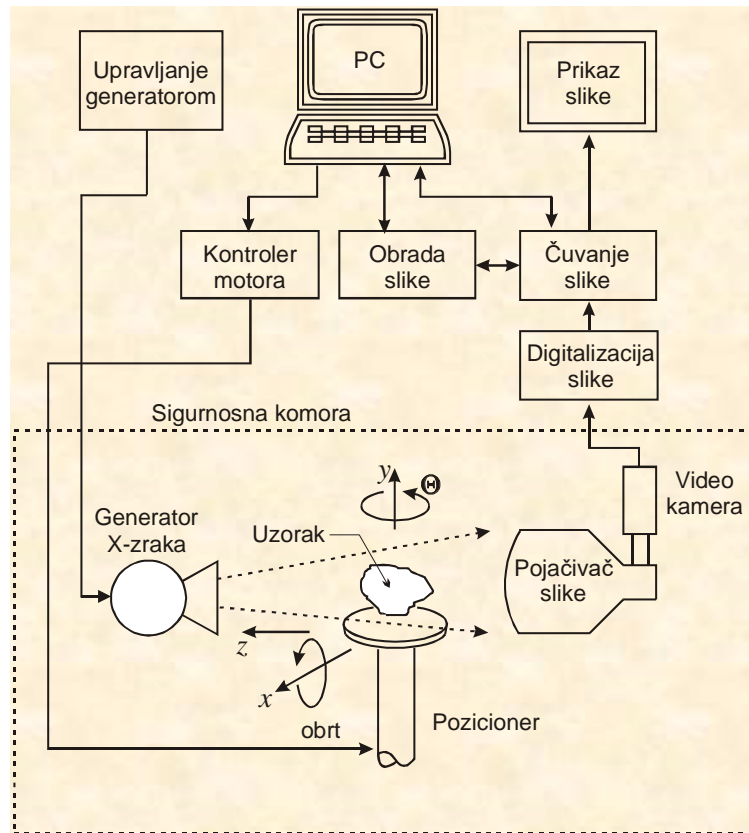
Optičke

Ne-optičke



Transmisivne metode detektuju atenuaciju (slabljenje) emitovanog signala nakon prolaska kroz objekat koji se 3D digitalizuje.

Digitalna radiografija (radiografija u realnom vremenu)

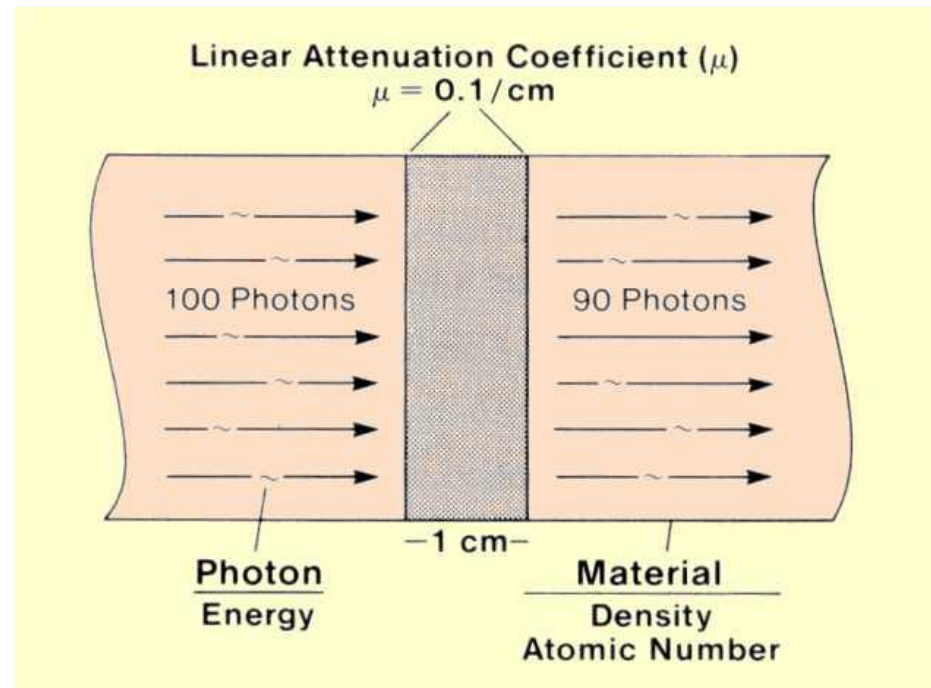


Kompjuterizovana tomografija: osnovni princip

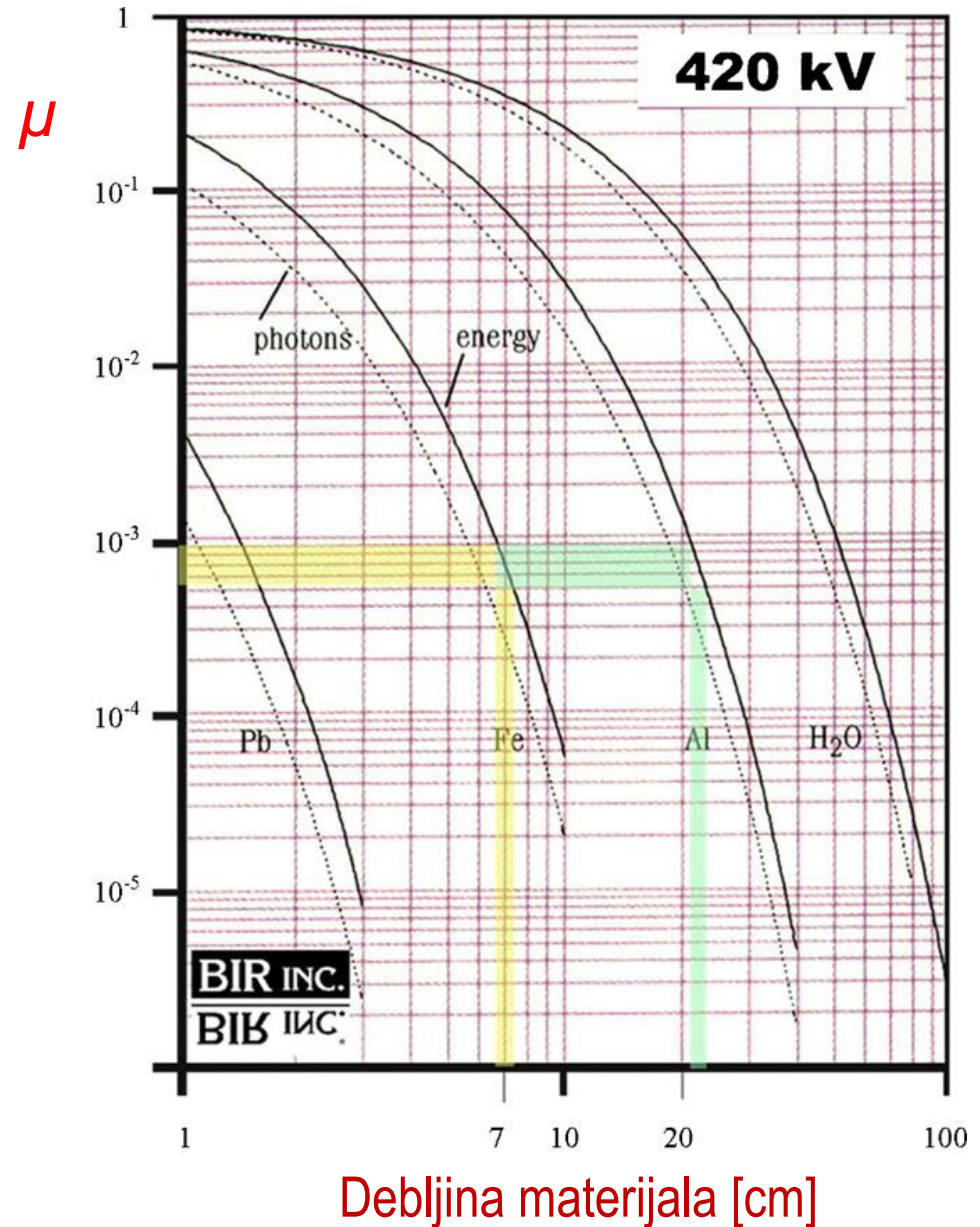
- ❑ Zasnovana na **X-zracima**.
- ❑ Pri prolasku kroz materijal dela, **X-zraci atenuiraju (slabe) usled apsorpcije ili rasejavanja**.

Nivo atenuacije zavisi od:

- ❑ **dužine puta koji prelaze unutar** apsorbirajućeg **materijala**,
- ❑ **strukture materijala** i njegove **gustine** (odnosno atenuacionog koeficijenta μ) i
- ❑ **energije X-zraka**.



Atenuacioni koeficijent materijala ograničava **max. debljinu materijala** koja može biti probijena.



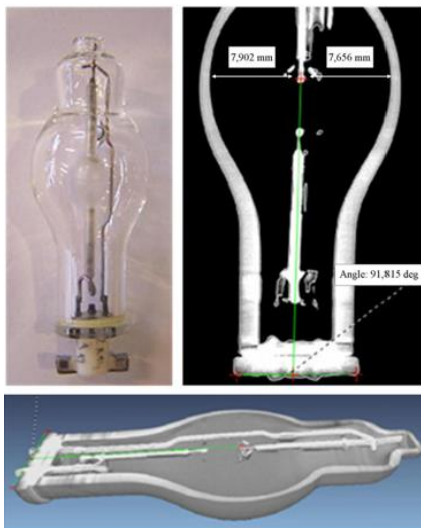
Kompjuterizovana tomografija: karakteristike i primena

CT je jedina tehnologija pomoću koje je moguće 3D digitalizovati objekte sa nedostupnim unutrašnjim površinama:

- proizvodi proizvedeni **aditivnom proizvodnjom**;
- proizvodi od više materijala:
 - dvo-komponentni proizvodi od plastike i
 - plastični delovi sa umetcima od metala;



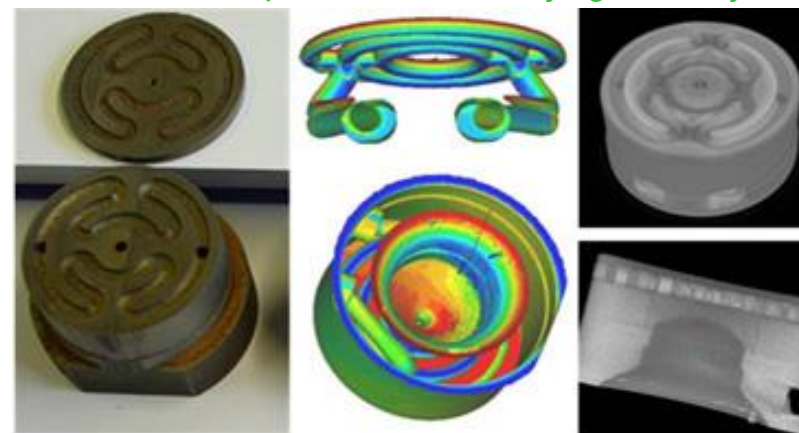
Sijalice od stakla



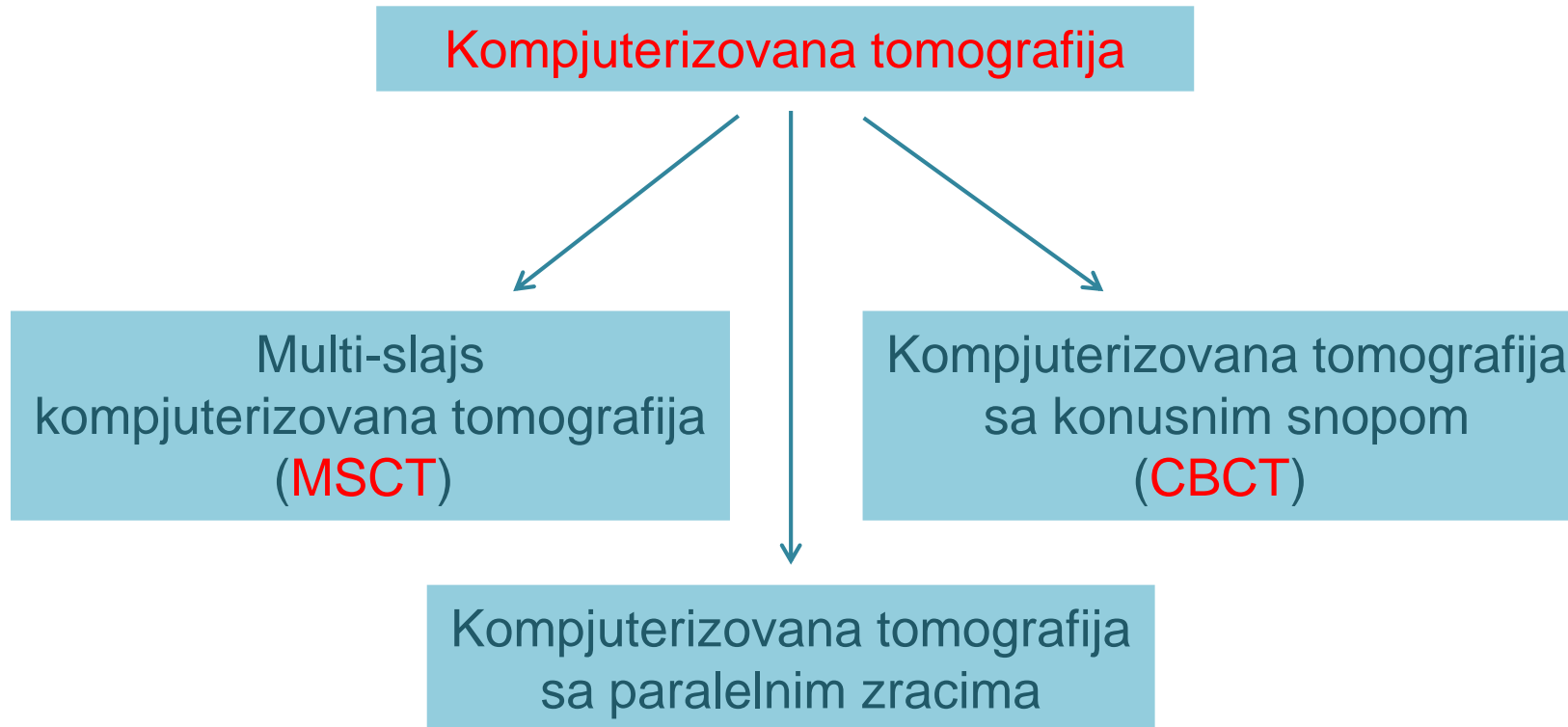
Multi-materijalni sklopovi

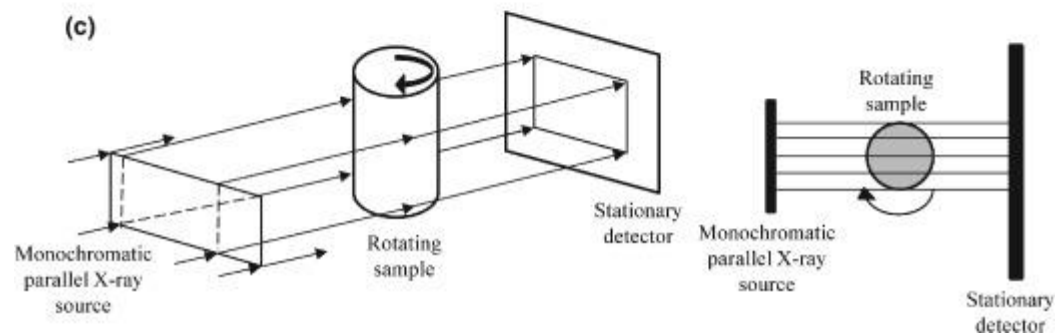
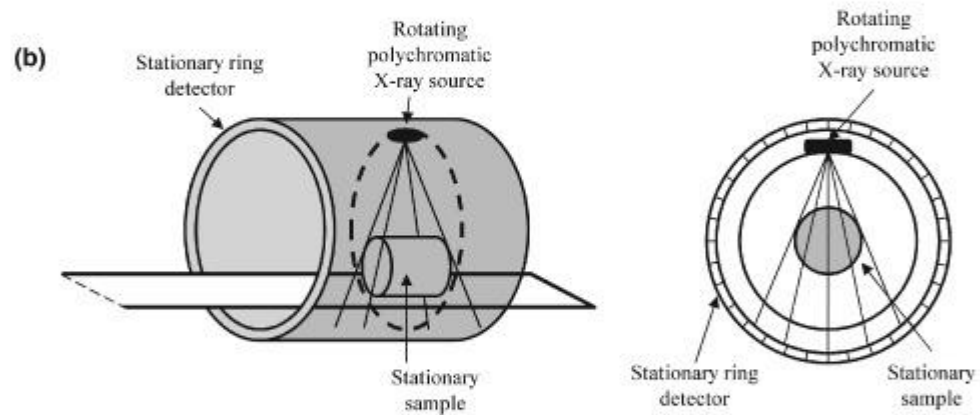
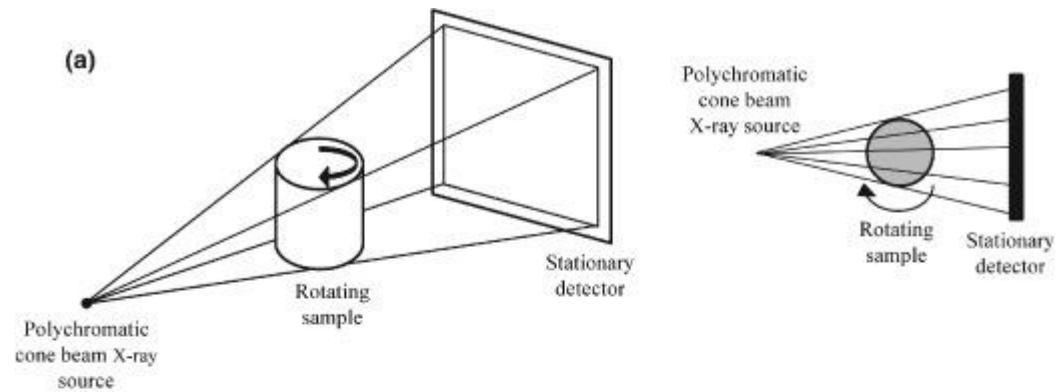


Delovi kompleksne unutrašnje geometrije

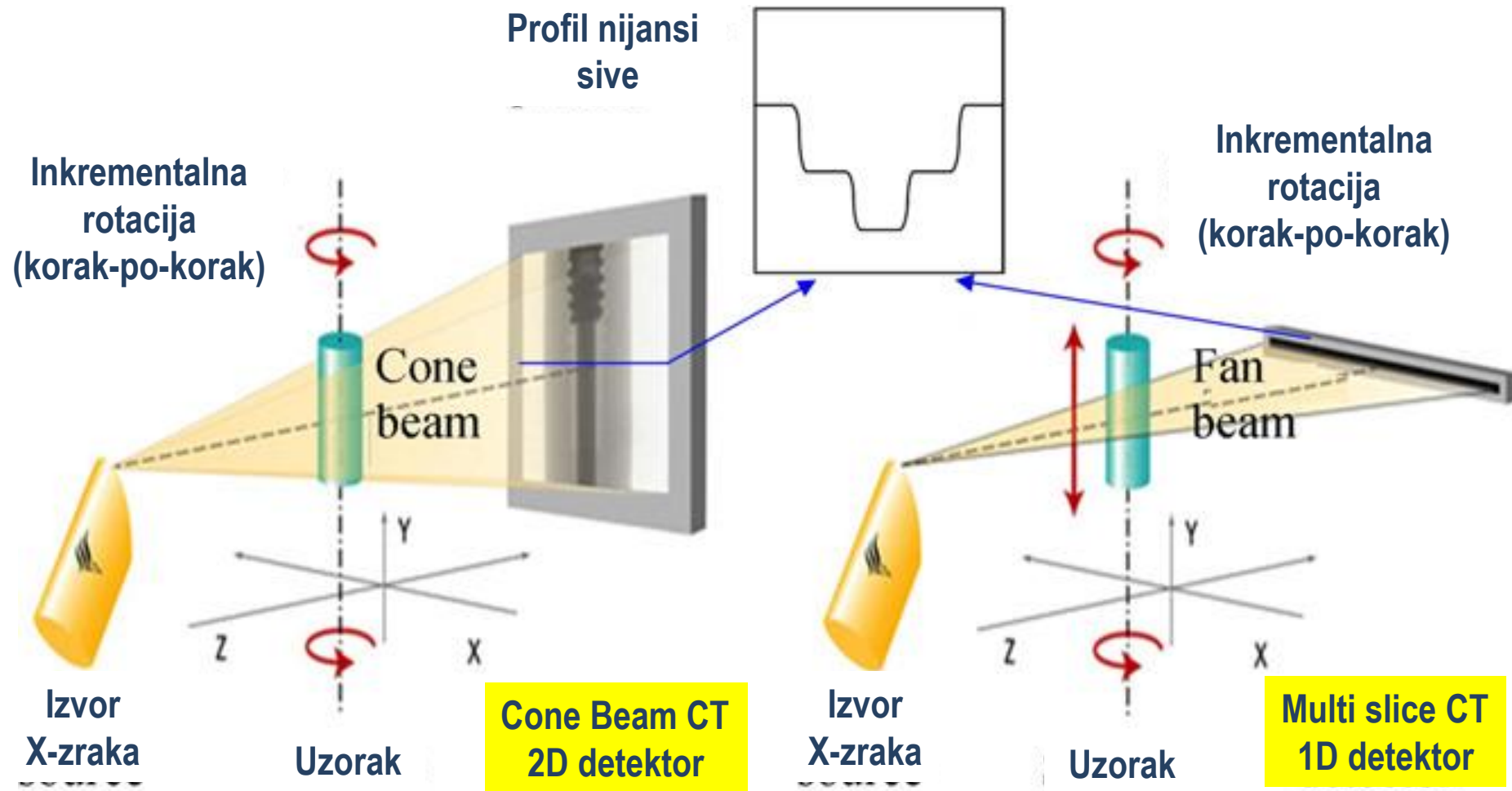


Kompjuterizovana tomografija: vrste

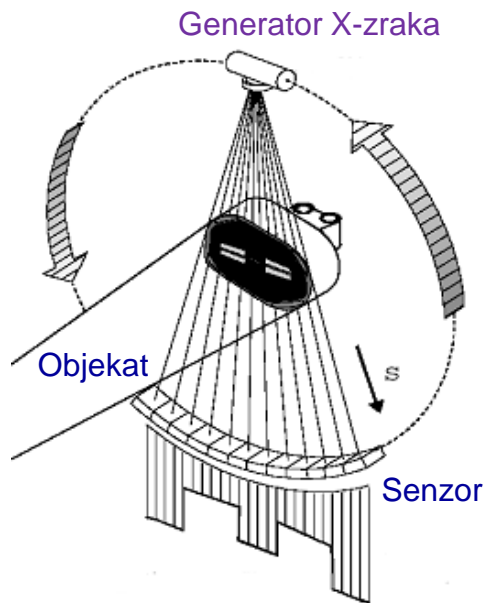
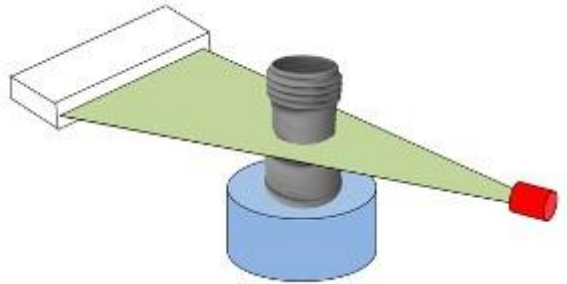




Kompjuterizovana tomografija: osnovni principi dve osnovne vrste

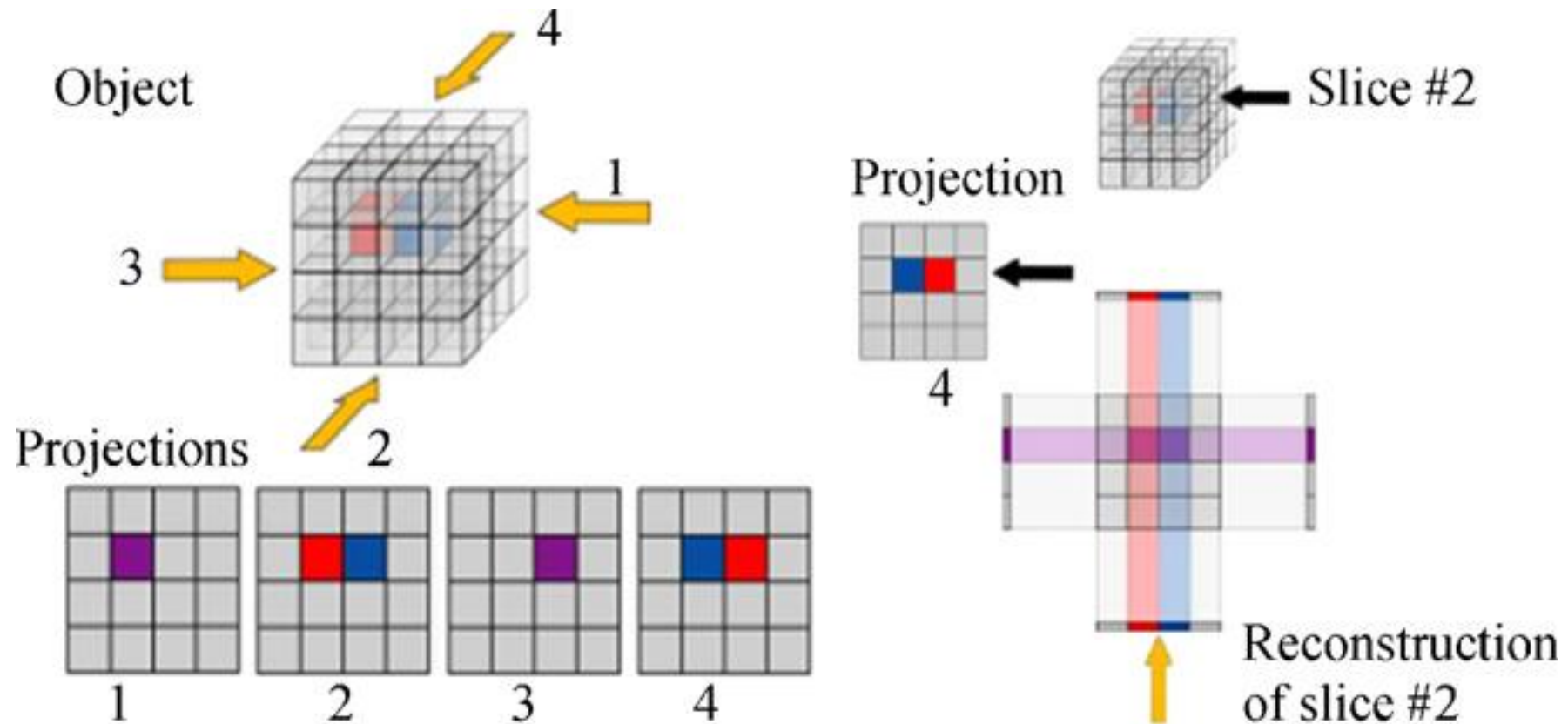


Linijska (multi-slice) kompjuterizovana tomografija (MSCT)



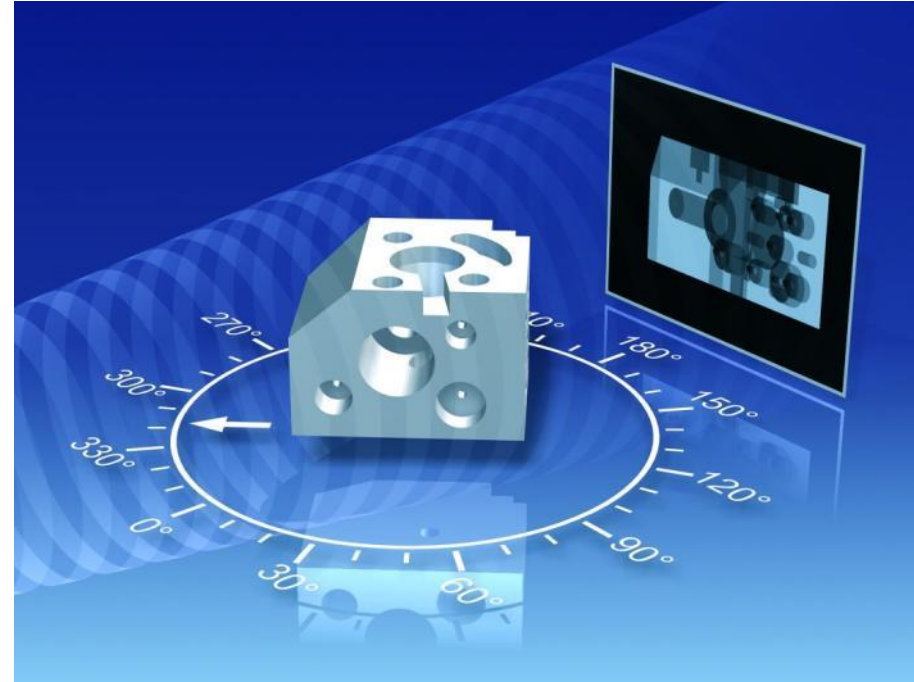
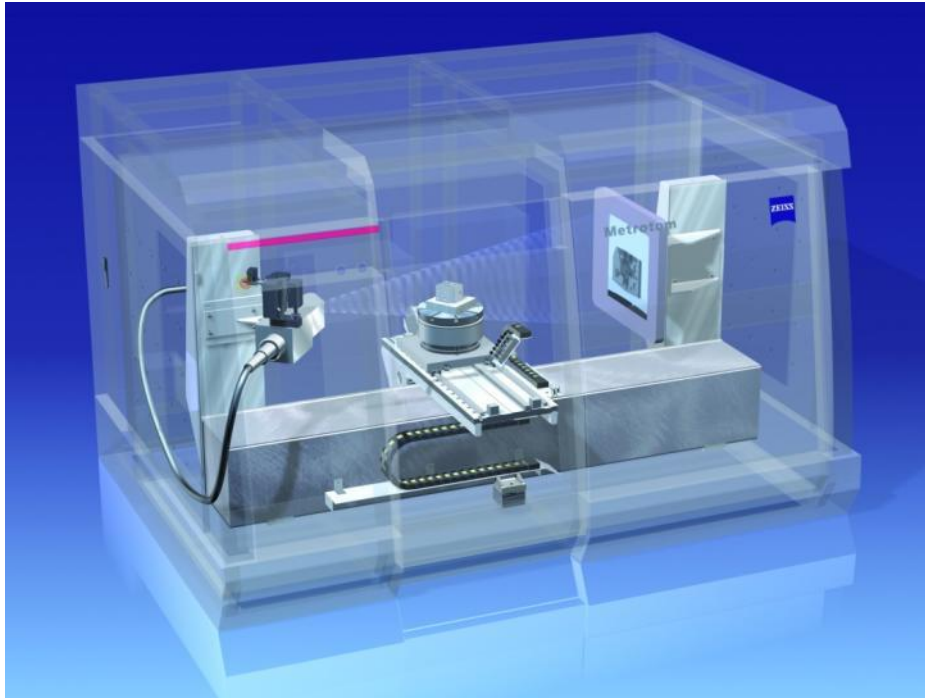
CT sistem TOSHIBA – TOSCANER 24200AV

Kompjuterizovana tomografija na bazi konusnog snopa



Kompjuterizovana tomografija na bazi konusnog snopa

Industrijski CBCT – Zeiss Metrotom

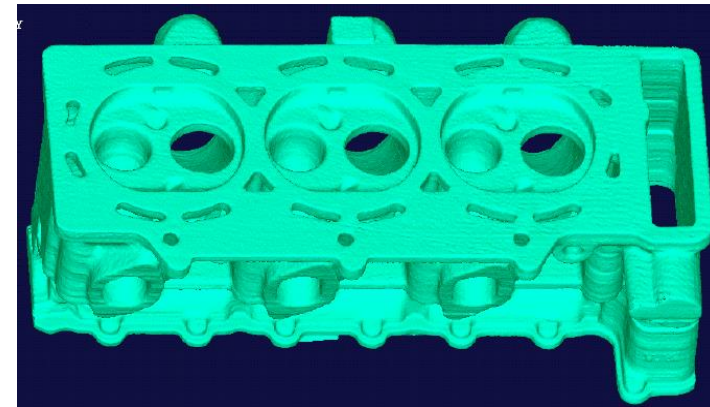
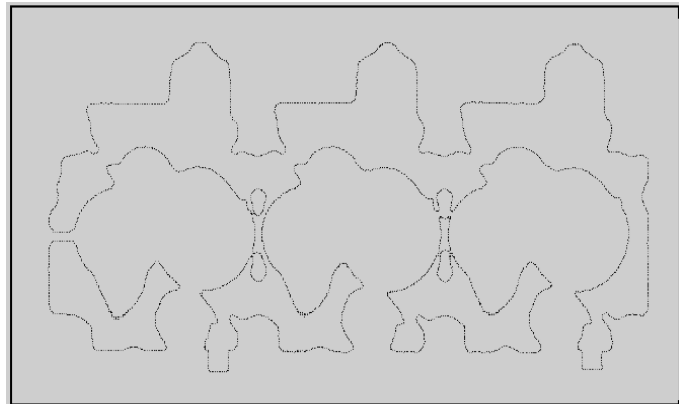
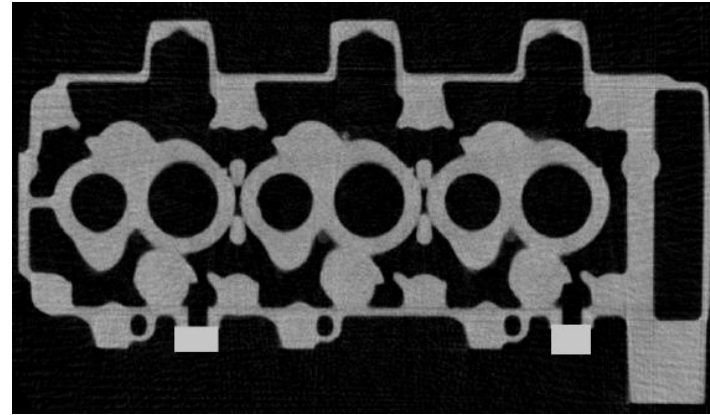


CBCT je u SAD počeo da se primenjuje od 2001. i do 2010. godine je u rad pušteno preko 3000 sistema.



Procedura primene: Nakon što se izvrši skeniranje, dobiju se **CT tomogrami** (CT slojevi) u nijansama sive boje. Zatim se realizuje **segmentacija**, tj. ekstrakcija kontura (ivica), na bazi detekcije odgovarajućih nijansi sive u okviru CT tomograma..

U finalnoj fazi se, na bazi segmentiranih slojeva, generiše 3D model.



Procedura CT na primeru bloka motora

Segmentacija

The screenshot displays the Able Software 3D-DOCTOR interface for a CT scan titled 'HeadCTHalf0001.lst'. The main window shows a large axial CT slice at level 40, where the skull and facial bones are segmented in red. To the right is a vertical stack of smaller axial slices, with slice 40 highlighted in red. An 'Interactive Segmentation' dialog box is open, showing the 'Image Thresholds' section with values 1211 and 4096. A blue callout box with arrows pointing to the threshold input fields contains the text: 'Tresholds: definisanje dijapazona obuhvaćenih nijansi sivih boja'. The dialog also includes options for 'Boundary Type' (Outline Only, All Boundary Lines, Skeleton Boundary) and 'Segment Image Planes' (Segment All, Segment Plane, Prev Plane, Set Object, Smooth Image, Delete Plane Seg, Next Plane, Finish, Use Connectivity). The status bar at the bottom shows the coordinates (245.60,0.00,40.00).

Able Software 3D-DOCTOR - HeadCTHalf0001.lst

File Edit View Image 3D Rendering Window Help

HeadCTHalf0001.lst

40

16 17 18 19 20 21 22 23

24 31

32 39

40 47

48 55

56 53

64 65 66 67 68 69 70 71

Interactive Segmentation

Image Thresholds

1211 Use Calibrated Value Refresh 4096

Color Show Image Prev Thresholds

Boundary Type

Outline Only All Boundary Lines Skeleton Boundary

Segment Image Planes

Segment All Segment Plane Prev Plane Set Object

Smooth Image Delete Plane Seg Next Plane Finish

Use Connectivity

For Help, press F1. Right mouse button for quick options.

(245.60,0.00,40.00)

Tresholds: definisanje dijapazona obuhvaćenih nijansi sivih boja

Prednosti

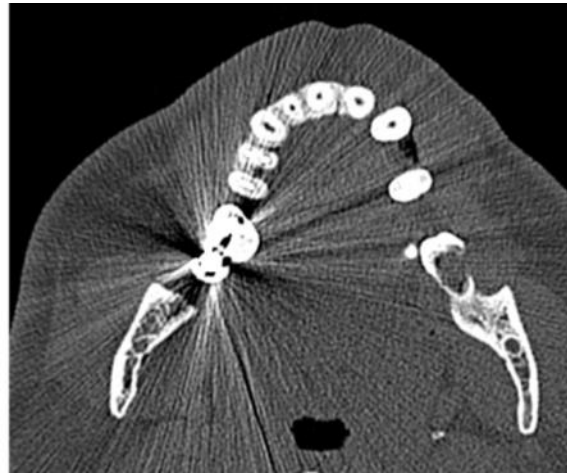
- ✓ Zahvaljujući relativno dobroj prodornosti X-zraka, kao i osetljivosti na gustinu materijala objekta, CT omogućava nedestruktivnu karakterizaciju i unutrašnjosti objekta.
- ✓ Zahvaljujući osobinama X-zraka, CT se podjednako dobro primenjuje na različitim materijalima (metal, plastika, organski materijali itd.), bilo glatkih ili teksturisanih površina, i to kako od solid (punih) tako i od vlaknastih materijala.
- ✓ CT je indiferentna na kvalitet obrađene površine.
- ✓ Ukupna geometrija objekta se dobija u samo jednom skenirajućem prolazu, čime se eliminise potreba za registracijom (uklapanjem) više oblaka tačaka.
- ✓ CT ne zahteva primenu pribora, a nije potrebno ni prethodno ni naknadno pomeranje objekta.

Prednosti

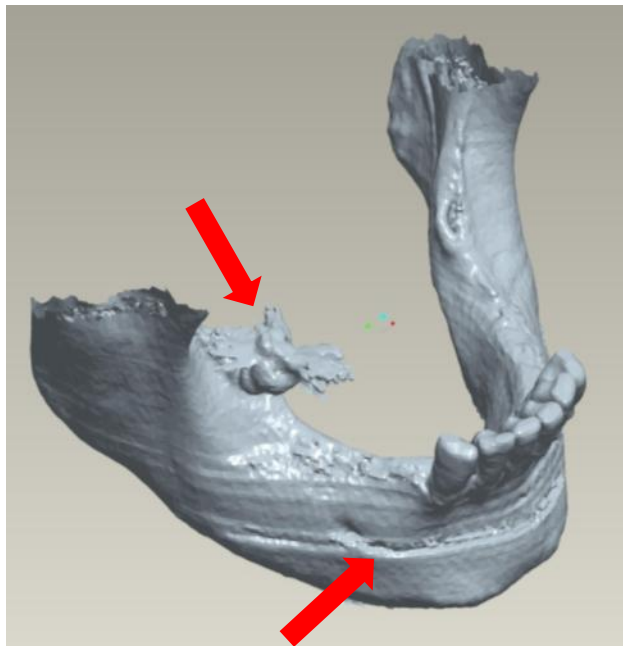
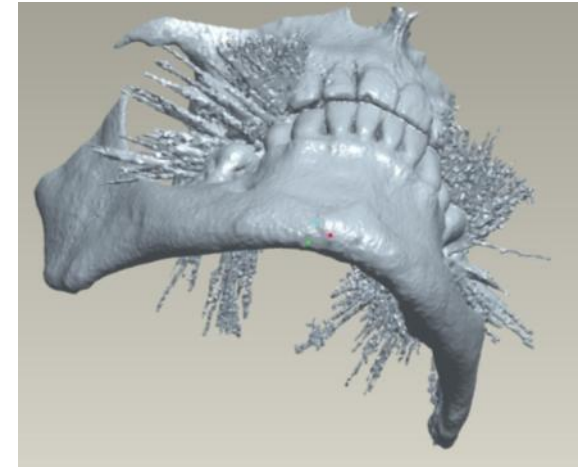
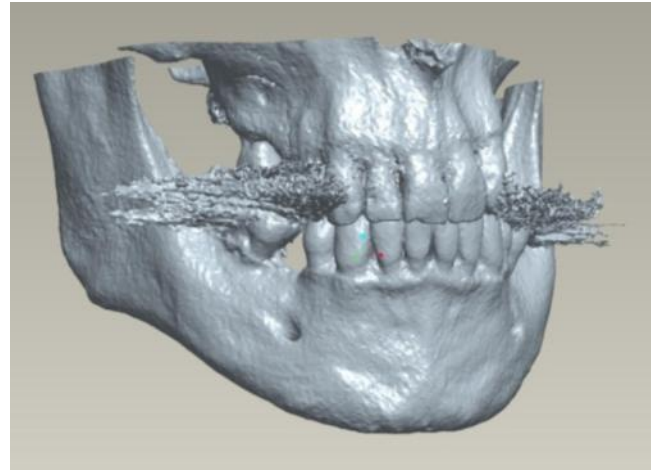
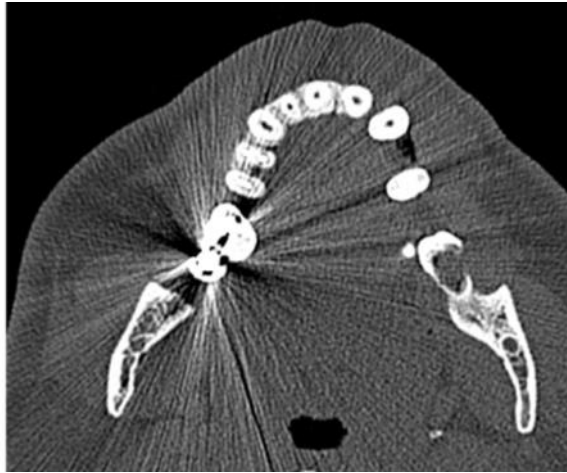
- ✓ Savremeni CT industrijski sistemi su dostigli nivo (preciznost i tačnost) da se mogu porediti sa KMM.
- ✓ Dve osnovne karakteristike CT skenera su rezolucija slika (tomograma) i energija X zraka.
- ✓ Rezolucija je funkcija debljine preseka, odnosno razmaka između dve uzastopne CT slike i kod novijih industrijskih skenera ona ide i ispod 10 μm.
- ✓ Izlazna digitalna informacija sada je dostupna u nekoliko standardnih formata za razmenu (IGES, STEP, STL itd.).
- ✓ Većina savremenih CT skenera sadrži i mogućnost integracije softvera za obradu CT informacija i kao rezultat daje kompletan 3D CAD model.

Nedostaci:

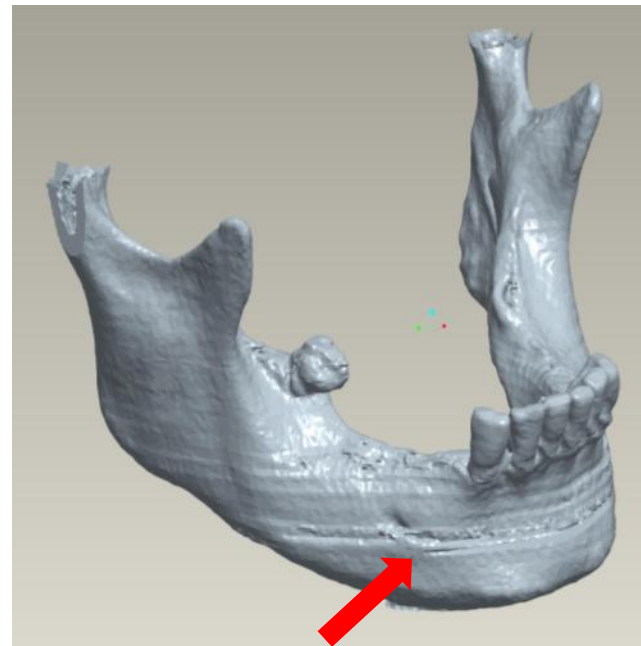
- 1) Radijacija
- 2) Artefakti



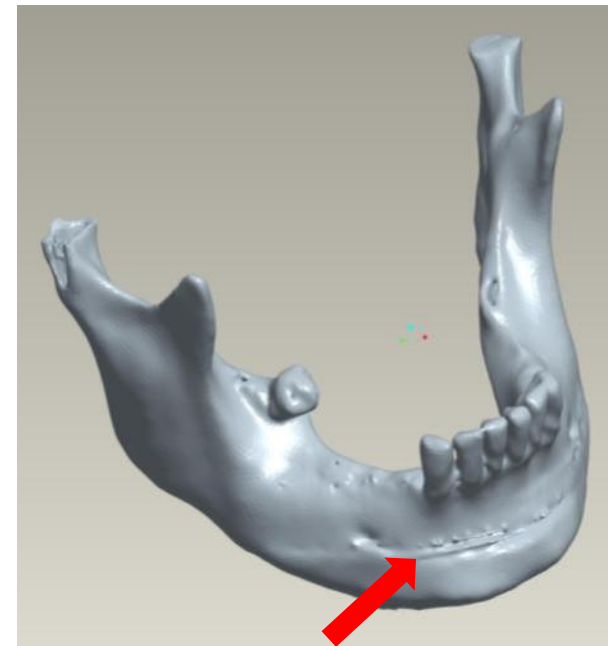
Problem šuma kod CBCT sistema



Model sa "šumom" od artefakata



Model očišćen od "šuma"



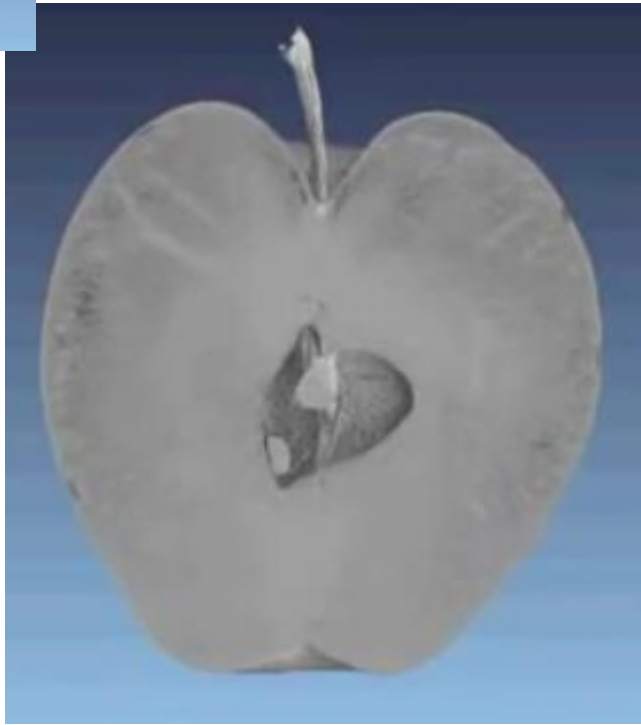
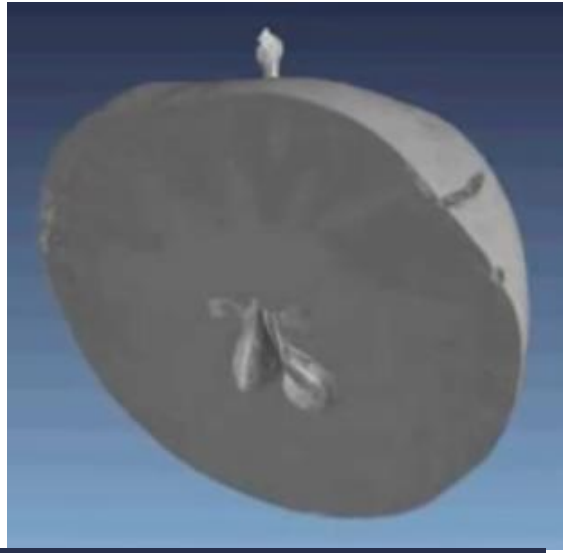
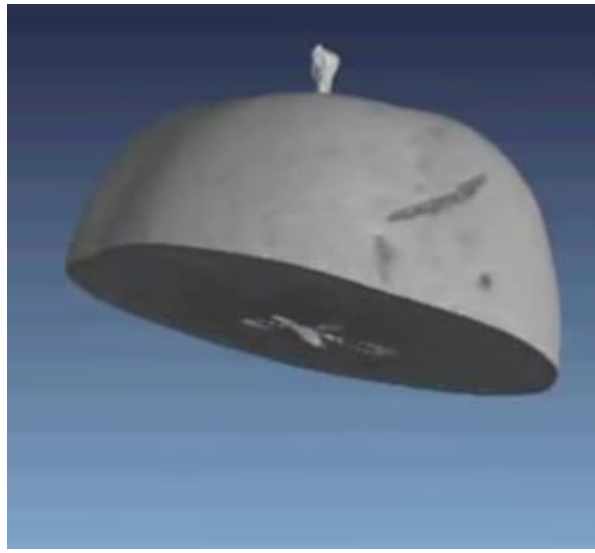
Model pripremljen za izradu

Primeri primene CBCT

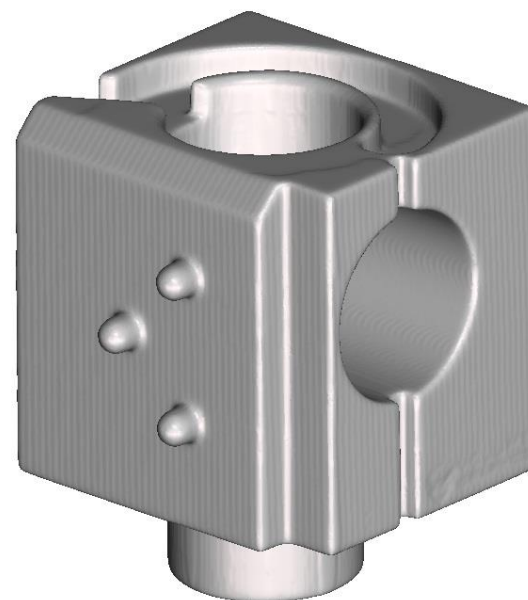
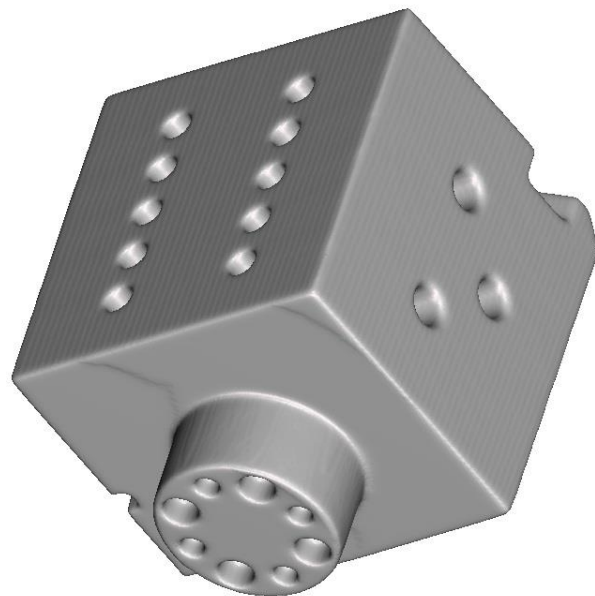
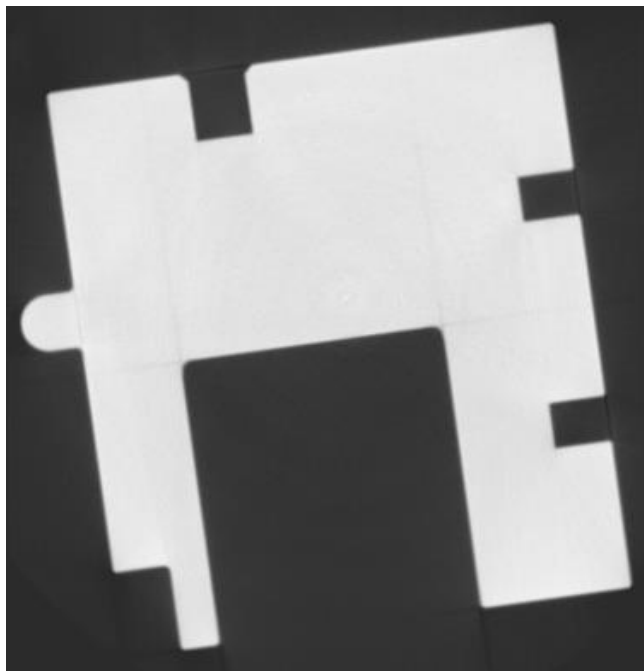


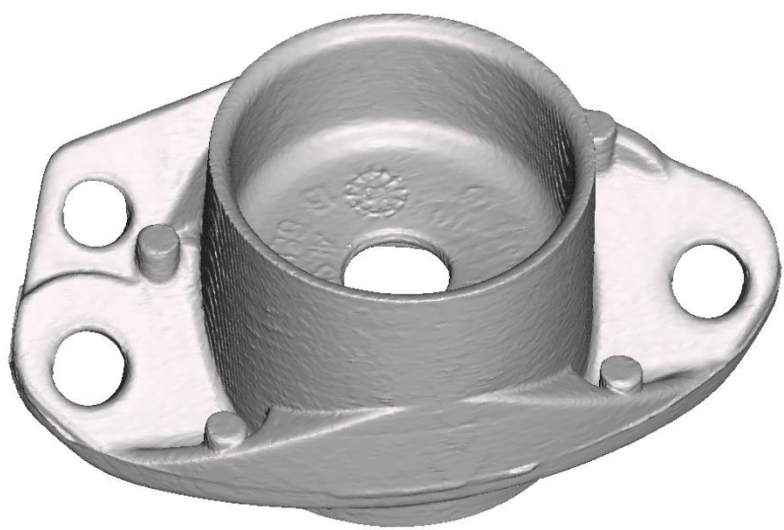
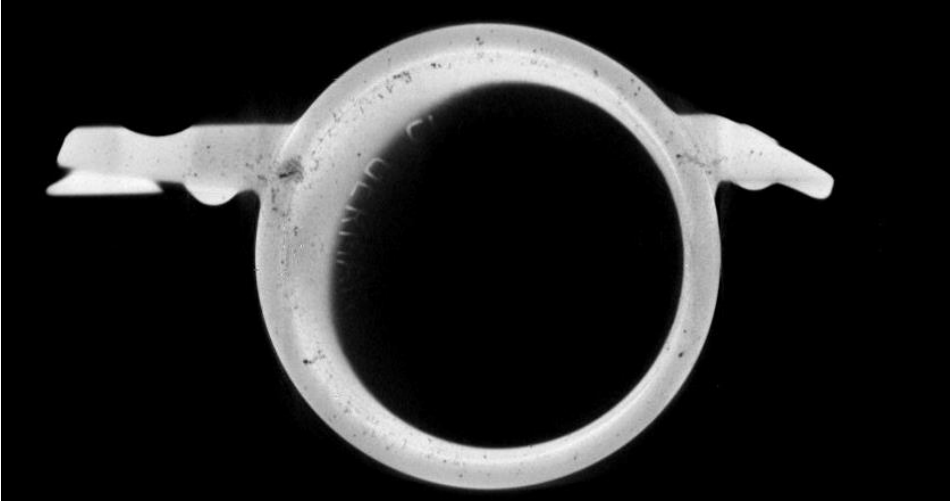
Jabuka

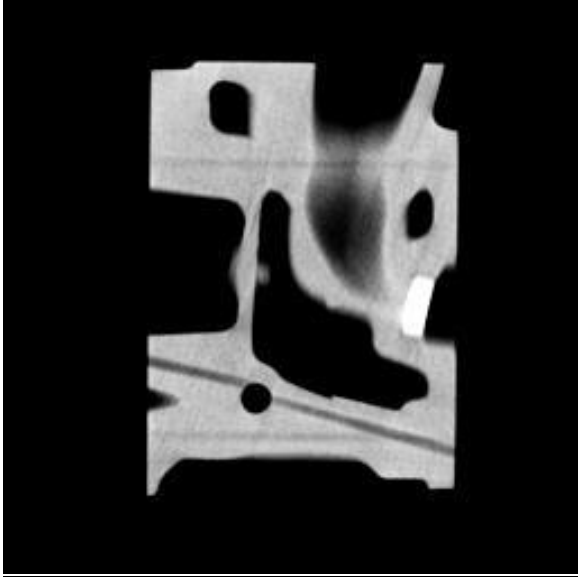




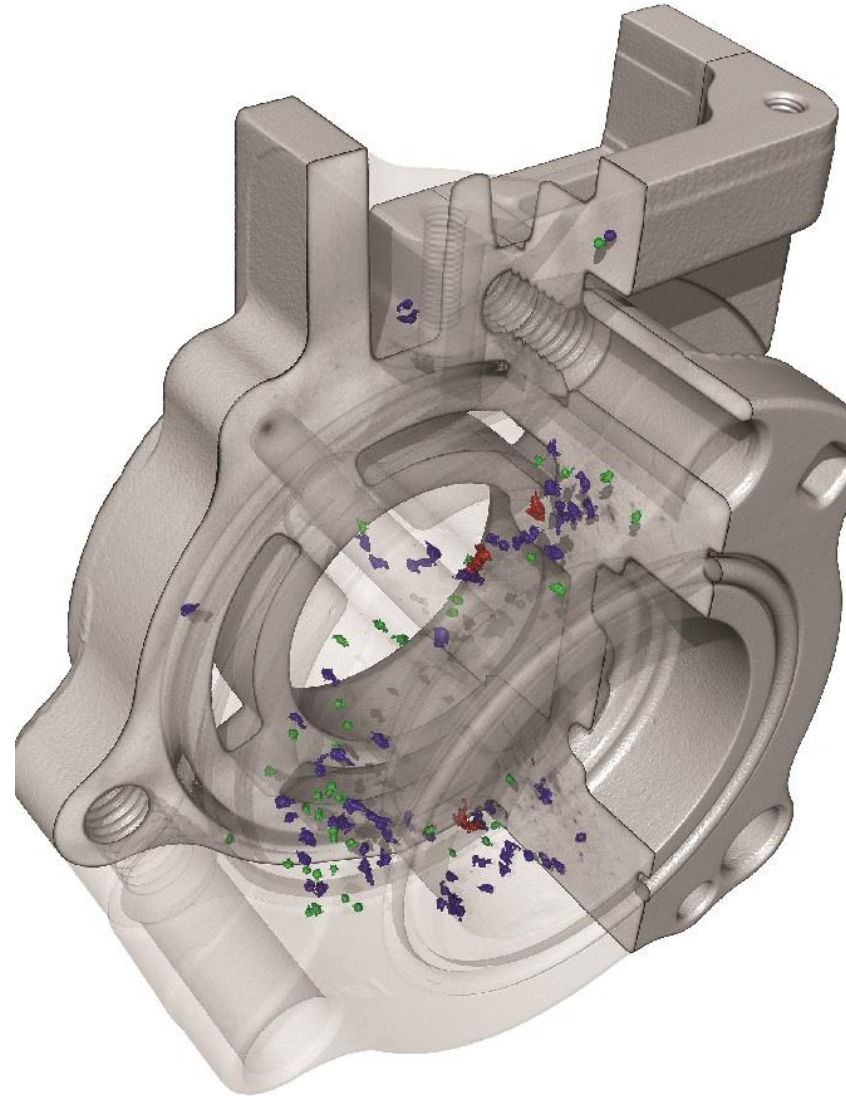
Delovi od metala



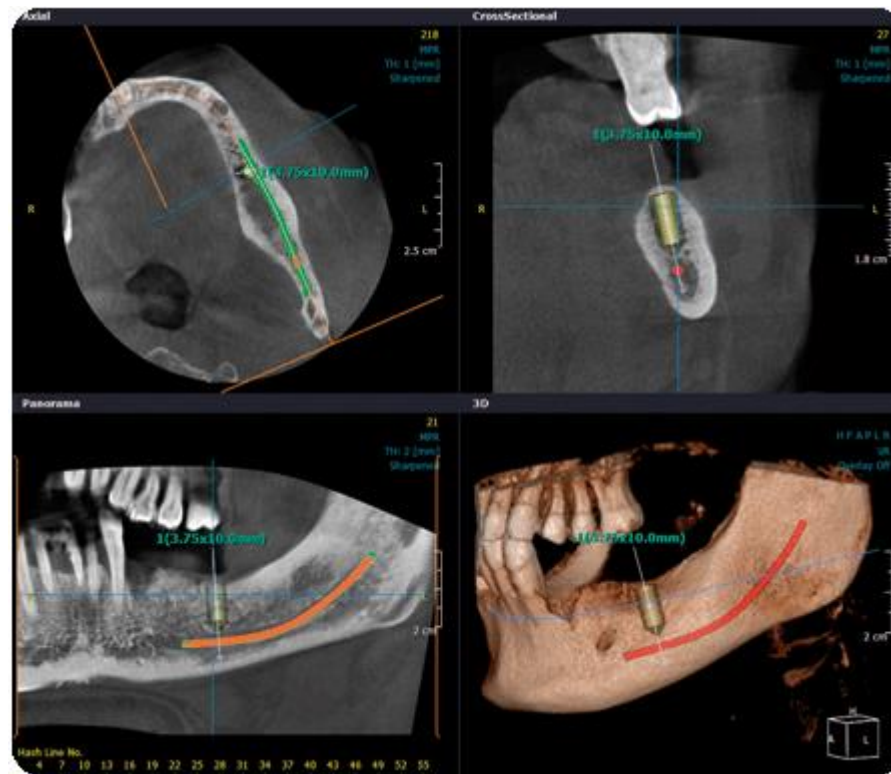




- ✓ Zahvaljujući tome što CT omogućava nedestruktivnu karakterizaciju i unutrašnjosti objekta, to ovu metodu 3DD čini vrlo pogodnom i za primenu u industrijskoj inspekciji.



Medicina i stomatologija



Dentalni CBCT Soredex Scanora 3D

DOSE COMPARISON

SCANORA® 3D



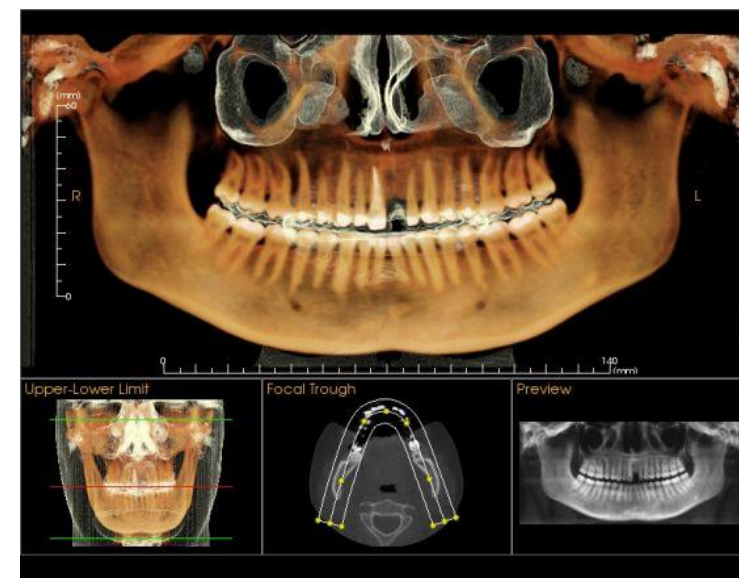
AVERAGE CBCT

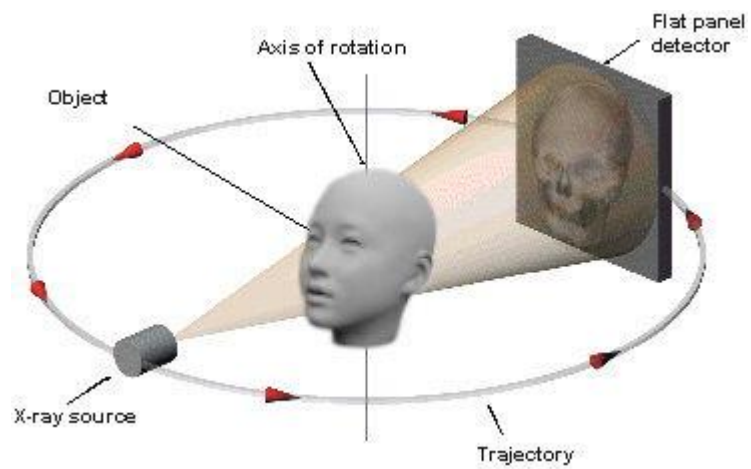


MEDICAL CT



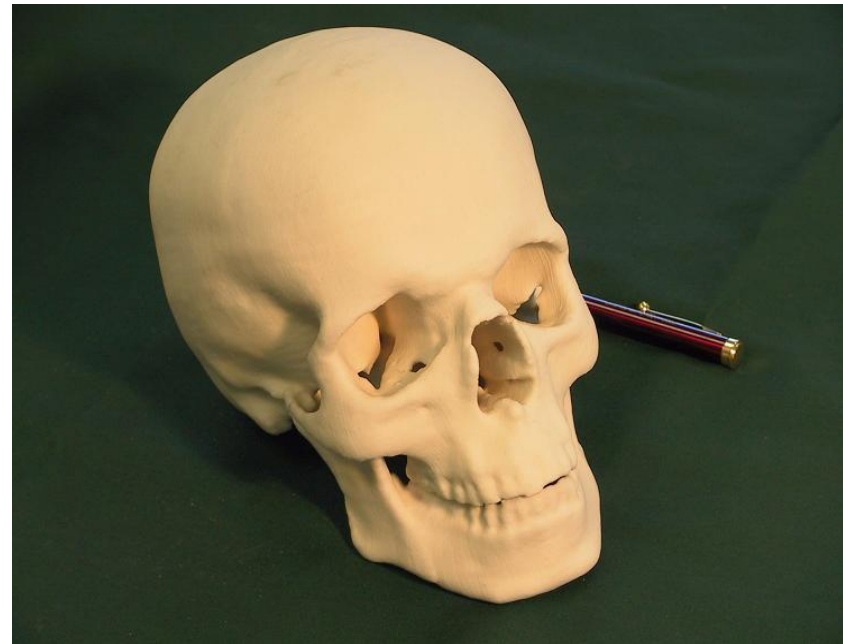
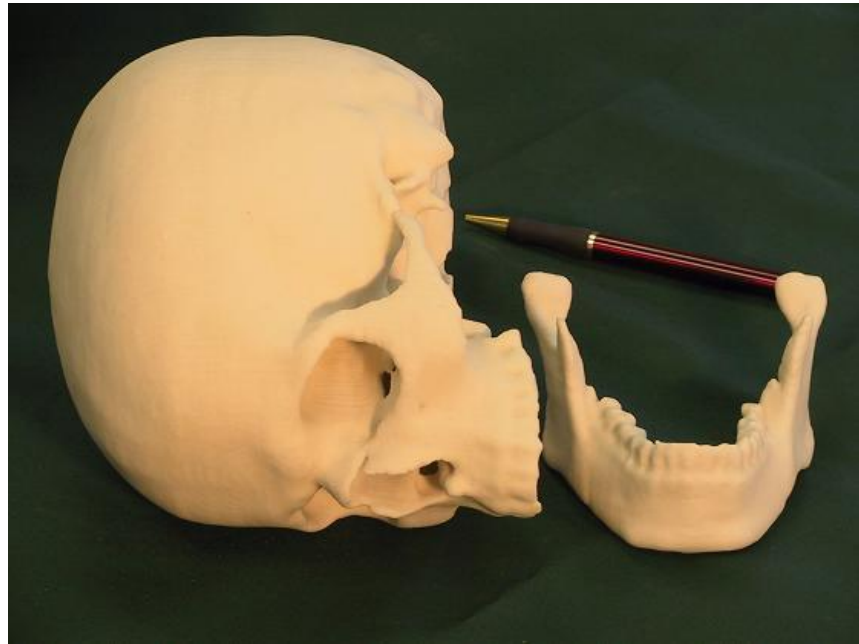
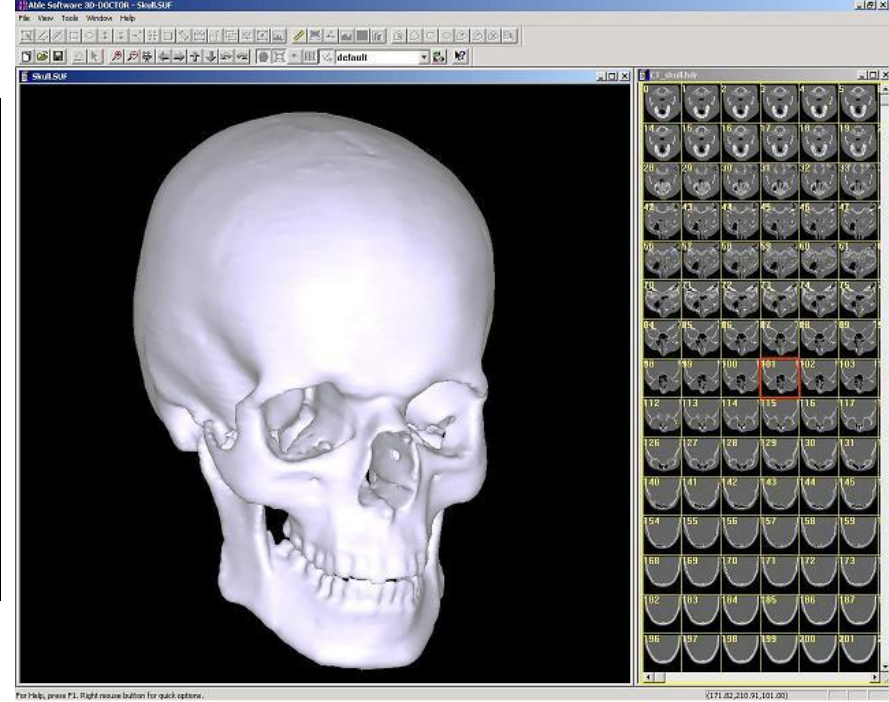
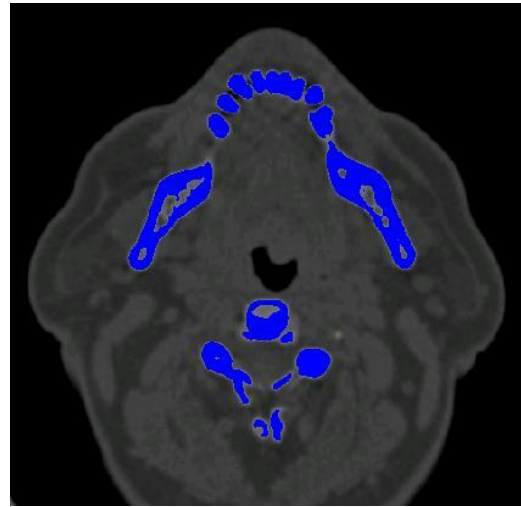
Dentalni CBCT i-CAT

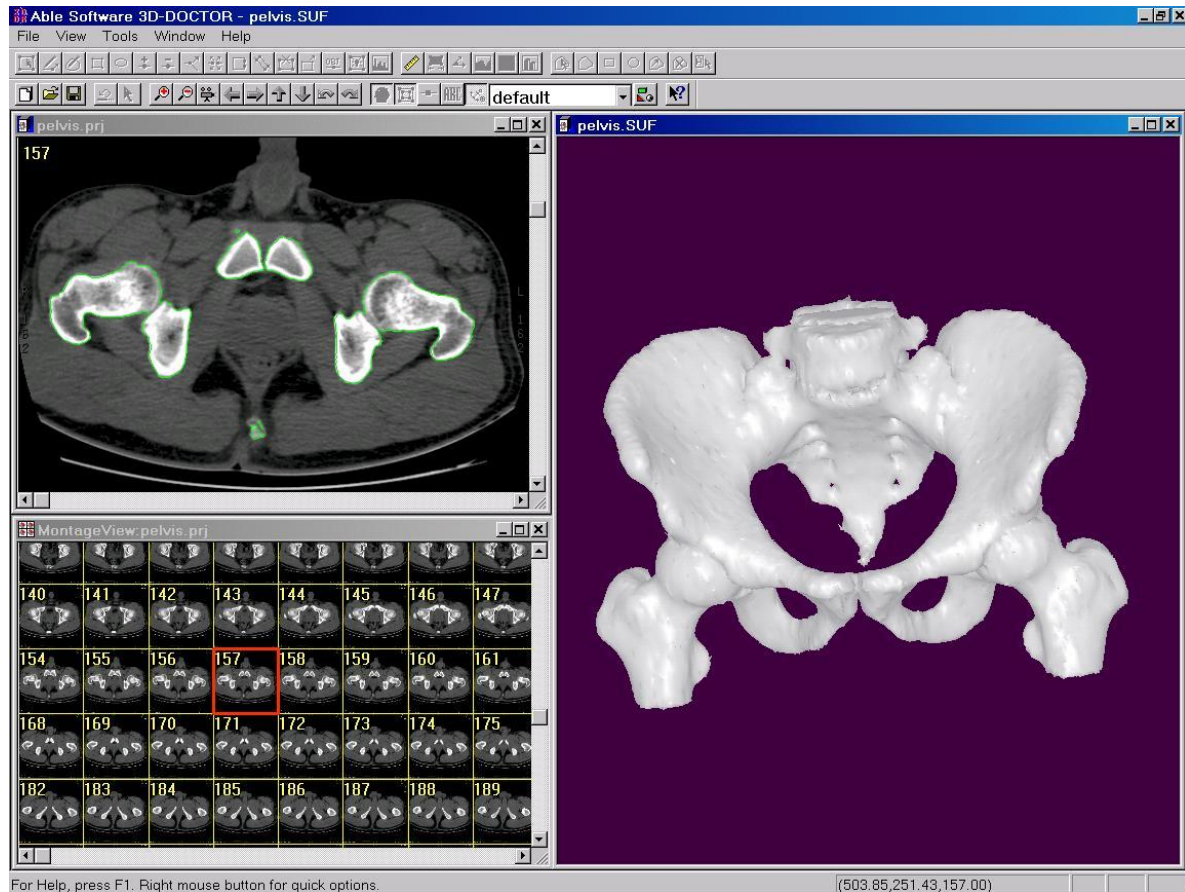
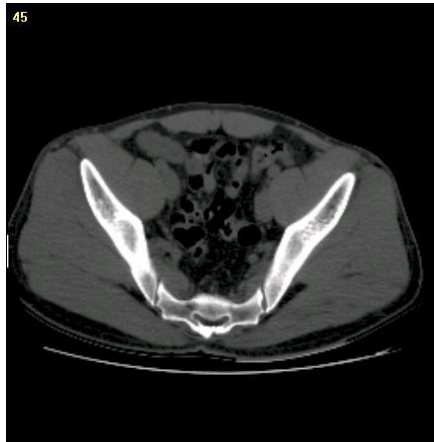




CBCT slike u DICOM formatu zapisa

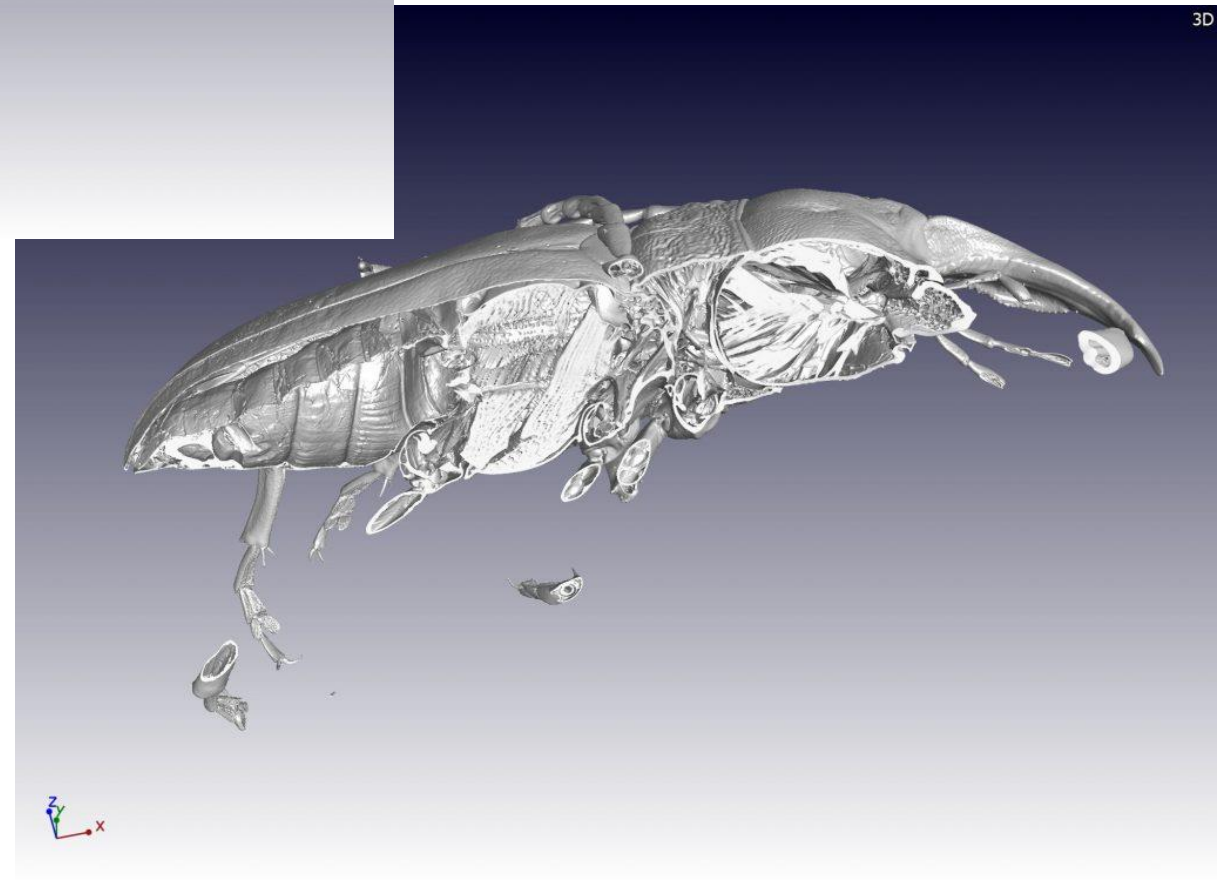




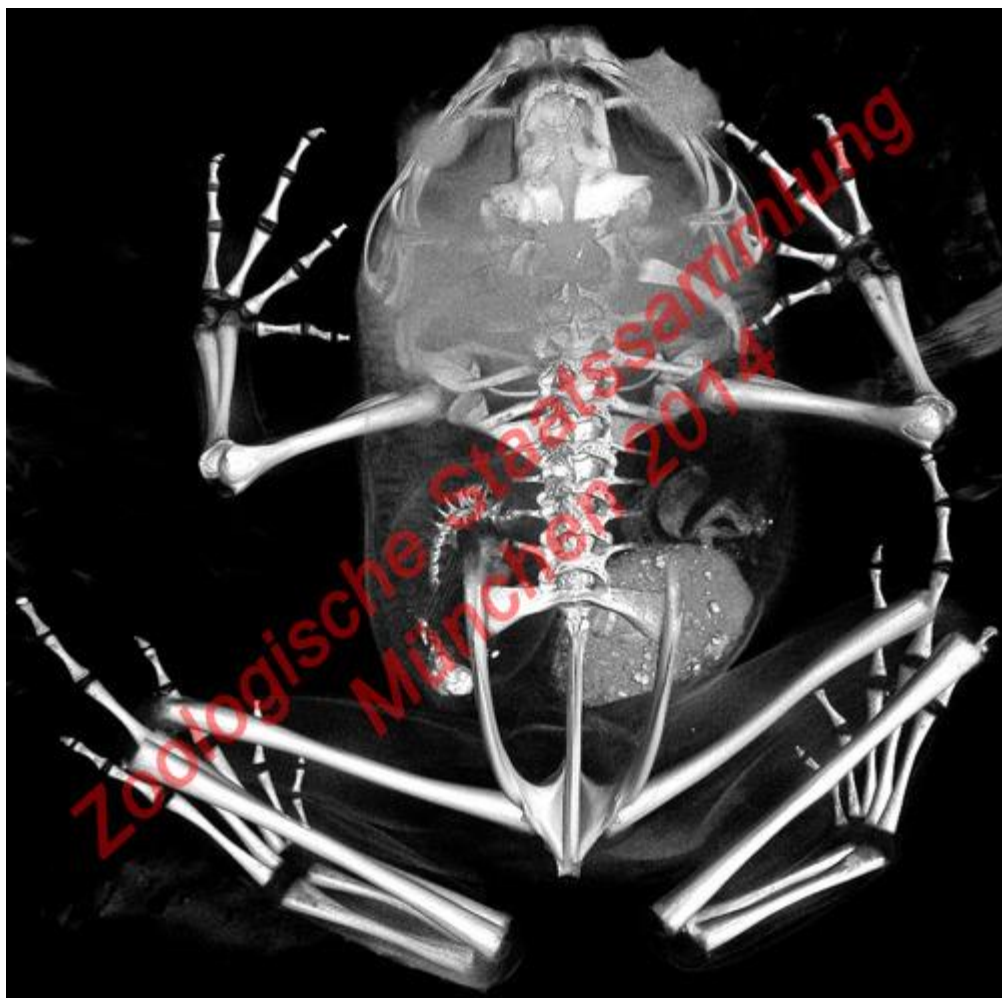


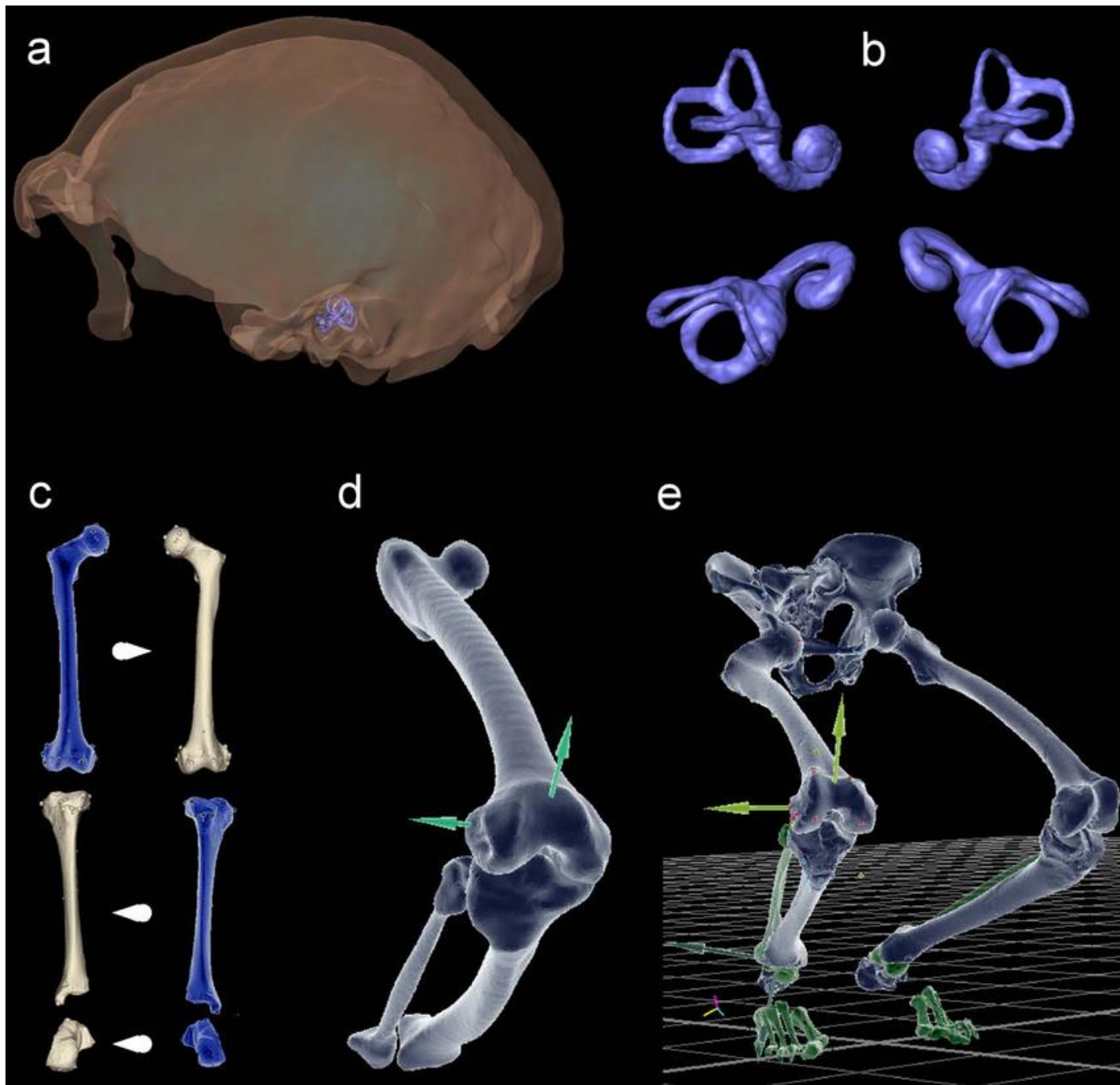
3D

Biologija



3D





HVALA NA PAŽNJI! :)