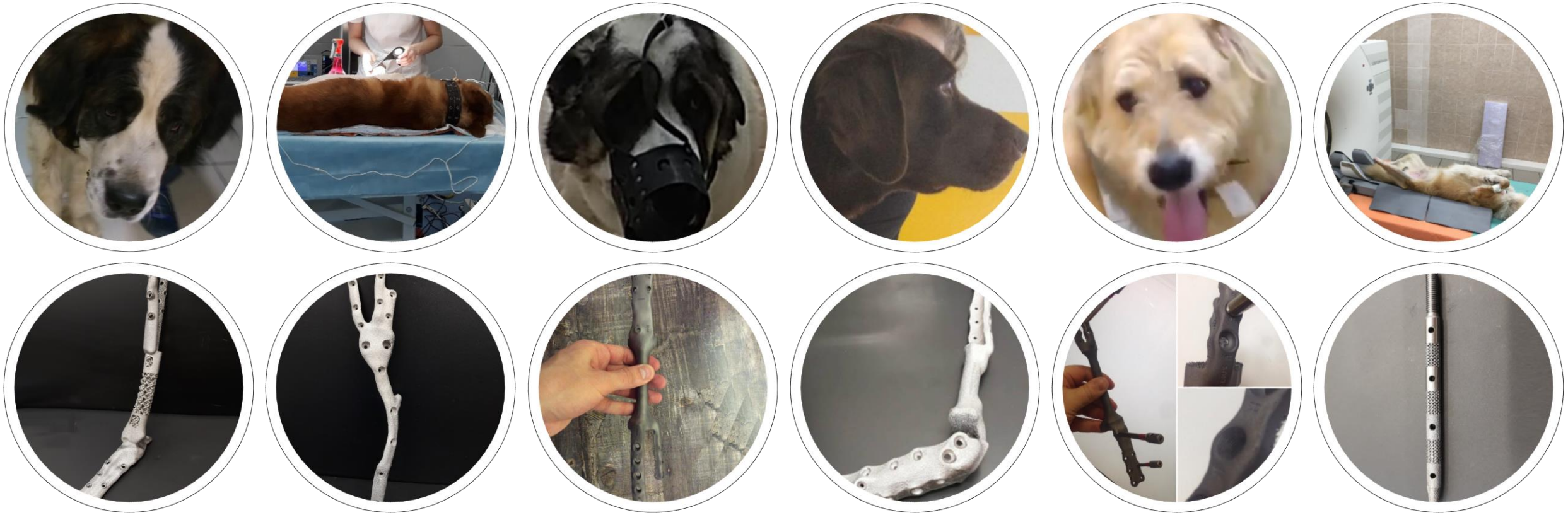
Applications of Metal Additive Manufacturing in Veterinary Orthopedic Surgery



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ADDITIVE MANUFACTURING CENTER

ARCAM A2X EBM Machine

Max. Build size 200 x 200 x 380 mm.

Build rate 5-8 mm height/hour (Ti-6Al-4V).

Operation: 3 kW electron beam successively melts **50-200µm** thick layers of metal powder particles

EOS M290 Laser Machine

Single Mode CW Ytterbium Fiber Laser with 400W platform-heater up to 200°C

Max. Build size 250x250x325 mm

IPCM-M- Semi Automatic Sieving Unit

MeltPool Monitoring Package

PowderBed (Camera inside the chamber), Laser Power Monitoring.

Kamsky G.V., Kolomiets A.A., Popov V.V., Review of the main producers of 3D-machines for metals, characteristics of the machines, and directions of development. Research Journal of International Studies, ISSN 2227-6017. Vol №8(50) **2016**

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CERTIFICATE

This is to certify that the Quality Management System of

ISRAEL INSTITUTE OF METALS - TECHNION

R&D FOUNDATION LTD.

Kiryat Ha'technion , Haifa , Israel

Has been audited and registered by SII-QCD as conforming to the requirements of :

ISO 13485:2003

This Certificate is Applicable to

Contract manufacturing of medical devices by electron beam melting.

ITHE STANDARDS INSTITUTION OF ISRAEL

IQNet

MGMT. SYS.
RvA C 096

Certificate No.:	84985	Certificate Issue Date:	20/04/2017
Initial Certification Date:	20/04/2017	Certification Expiry Date:	20/04/2018

SII-QCD assumes no liability to any party other than the client, and then only in accordance with the agreed upon Certification Agreement. This certificate's validity is subject to the organization maintaining their system in accordance with SII-QCD requirements for system certification. The continued validity may be verified via scanning the code with a smartphone, or via website www.sii.org.il. This certificate remains the property of SII-QCD.

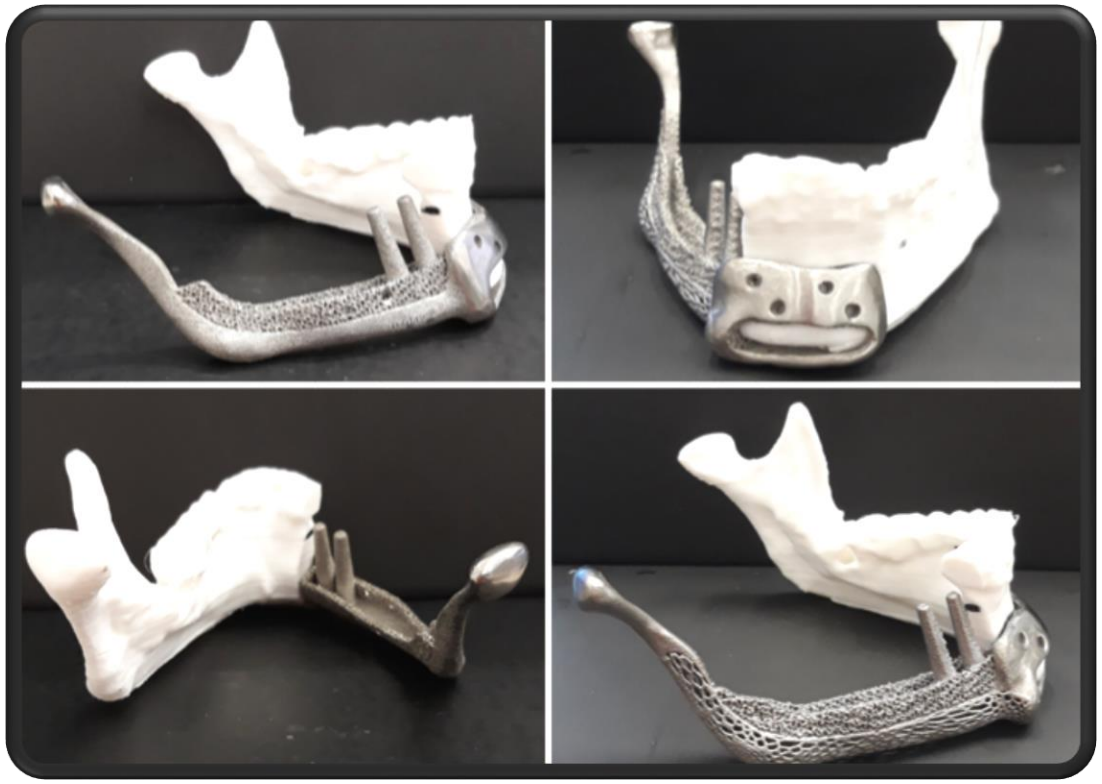
Pinhas Shahar
Director General

Eli Cohen-Kagan
Director, Quality & Certification Division

The Standards Institution of Israel

Page 1 of 1

Our Vision: To Enhance Both Global Competitiveness of our Services, with our Uncompromised Quality and Integrity



Popov V.V., Muller G., Kovalevsky A., Dzhenzhera G., Strokin E., Kolomiets A., Ramon J. Design and 3D-printing of titanium bone implants: Brief review of approach and clinical cases. Biomedical Engineering Letters. 2018 (under review).

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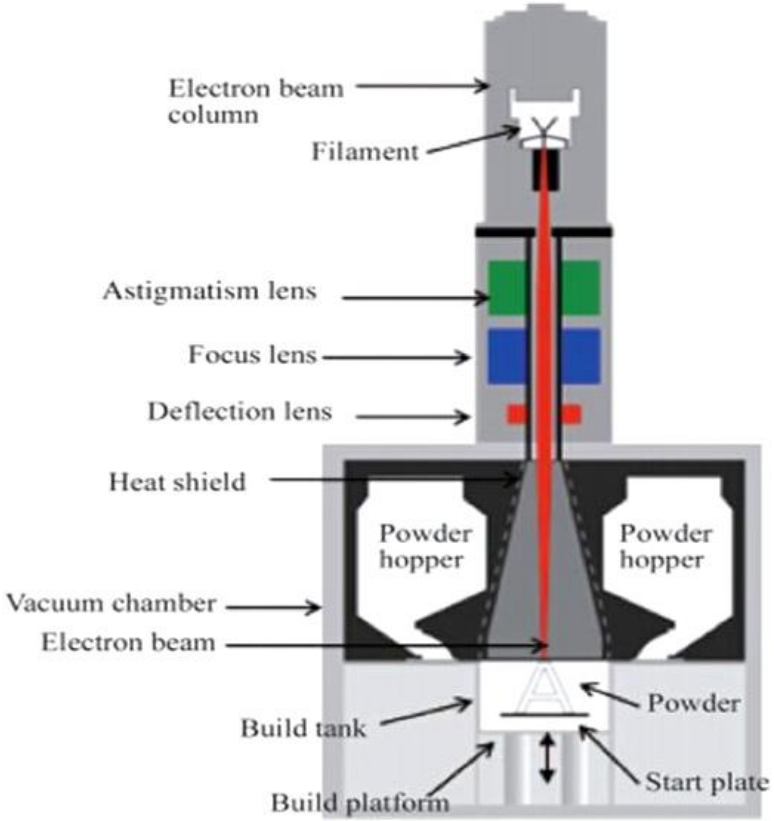
Selective Electron Beam Melting (SEBM)



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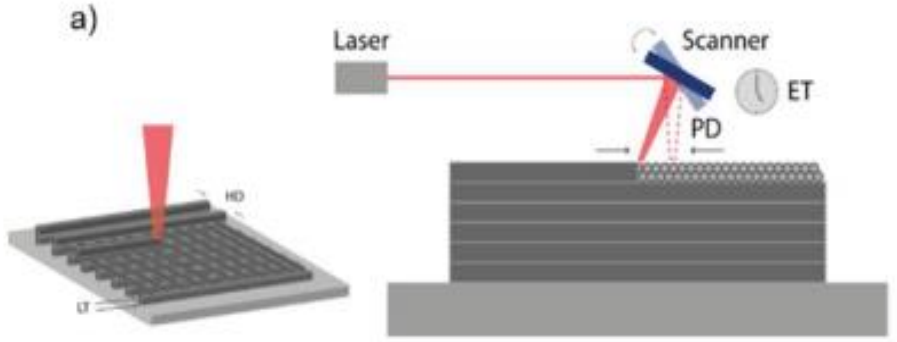
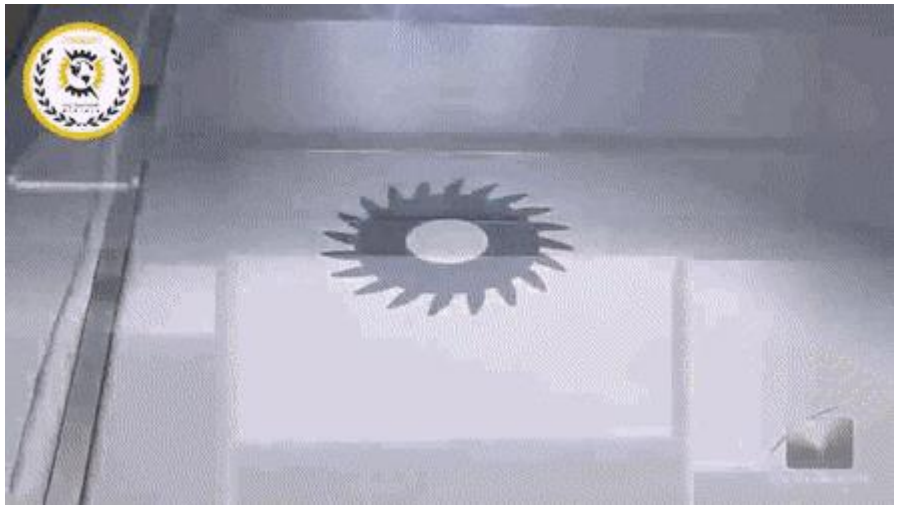
Selective Laser Melting (SLM)





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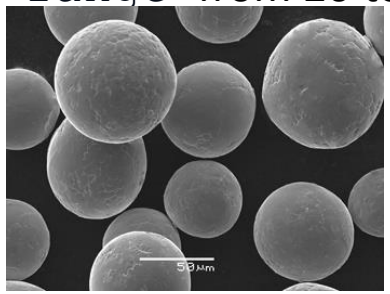
Powder Manufacturing

Argon Gas Atomizer

- Aluminum
- Titanium
- Stainless Steel
- Precious Metals

- Particle size range from 20 to 100



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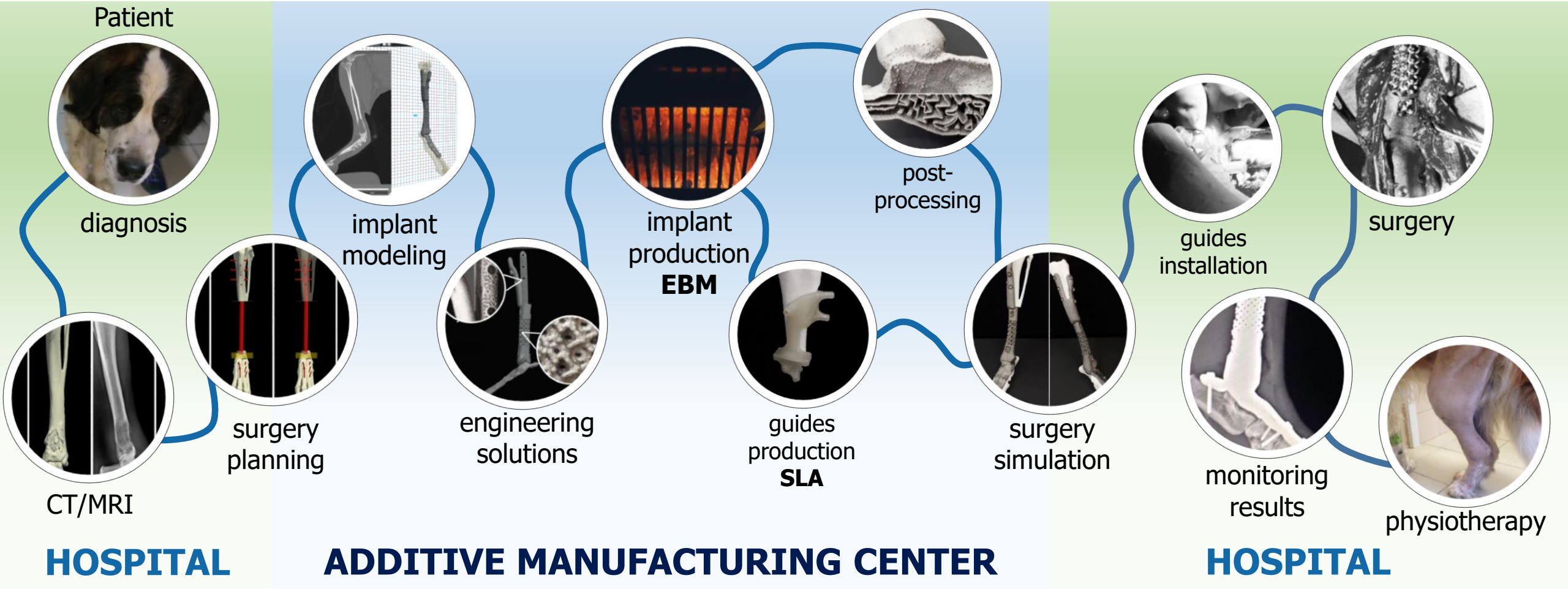
Patient Specific Implants in veterinary orthopedic surgery



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Patients

Breed – Moscow Watchdog
Age – 9 years
Sex – male
Weight – 50 kg

Baron

Breed – Alabai
Age – 9 years
Sex – male
Weight – 68 kg

Kairat

Breed – Labrador retriever
Age – 5 years
Sex – female
Weight – 30 kg

Pipa

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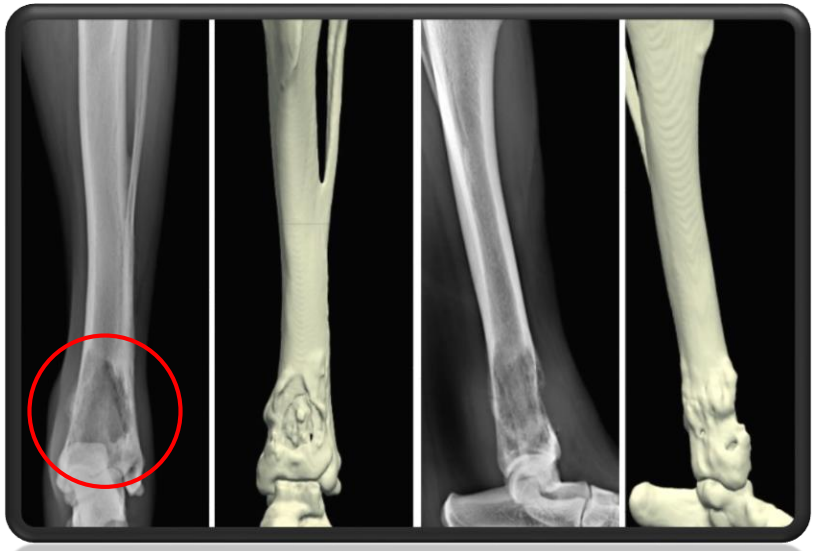
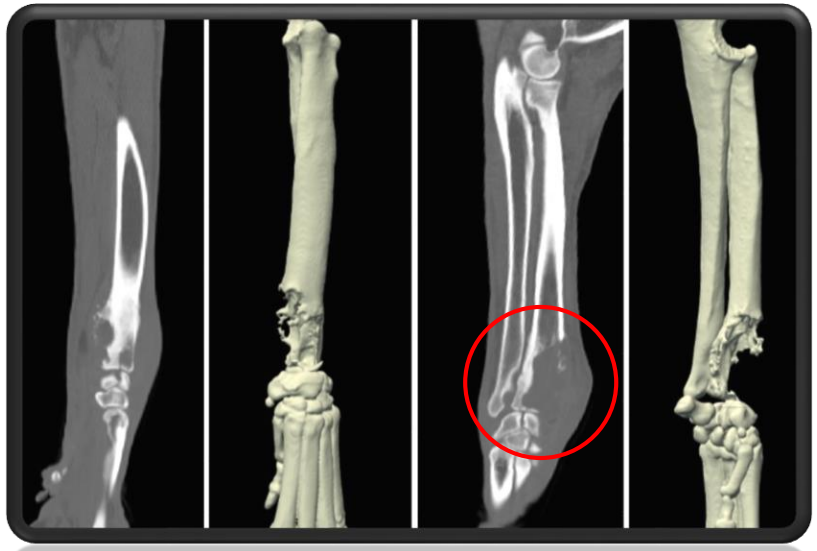
Computed Tomography (CT) – 3D visualization & segmentation



Diagnosis – osteosarcoma (hind limb)



Diagnosis – osteosarcoma (forelimb)

Diagnosis – osteosarcoma (knee-joint)

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optional slide

Computed Tomography segmentation

Slice

Bones

Tissue

Skin

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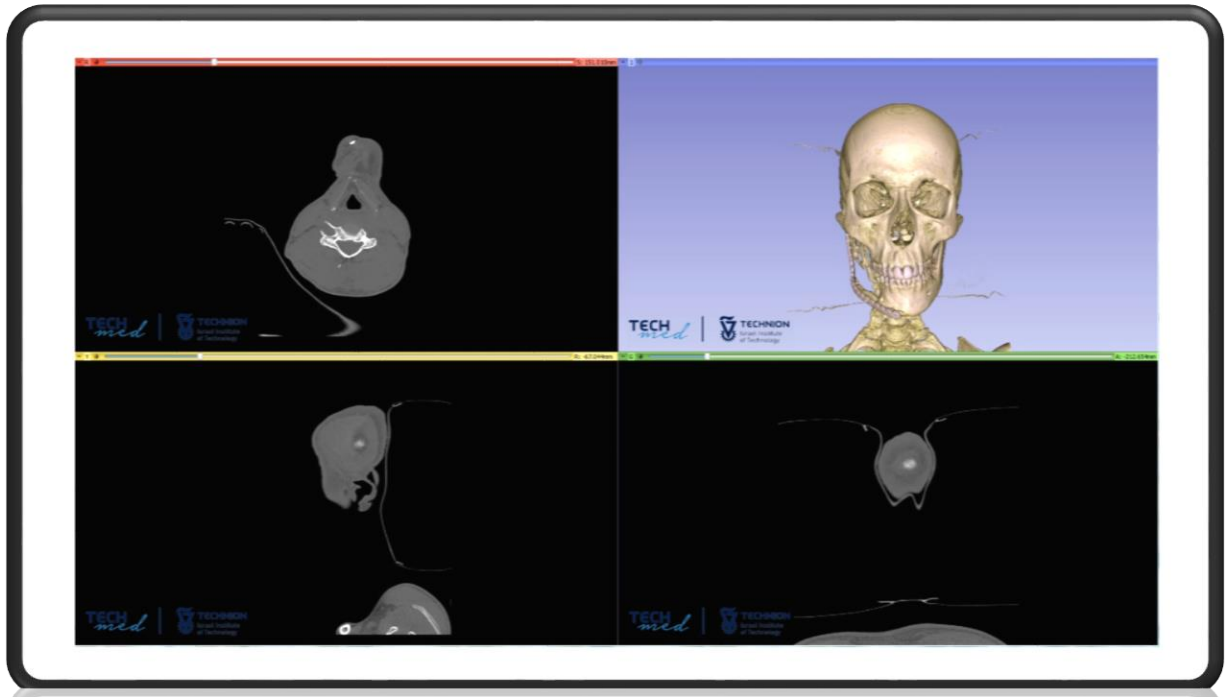
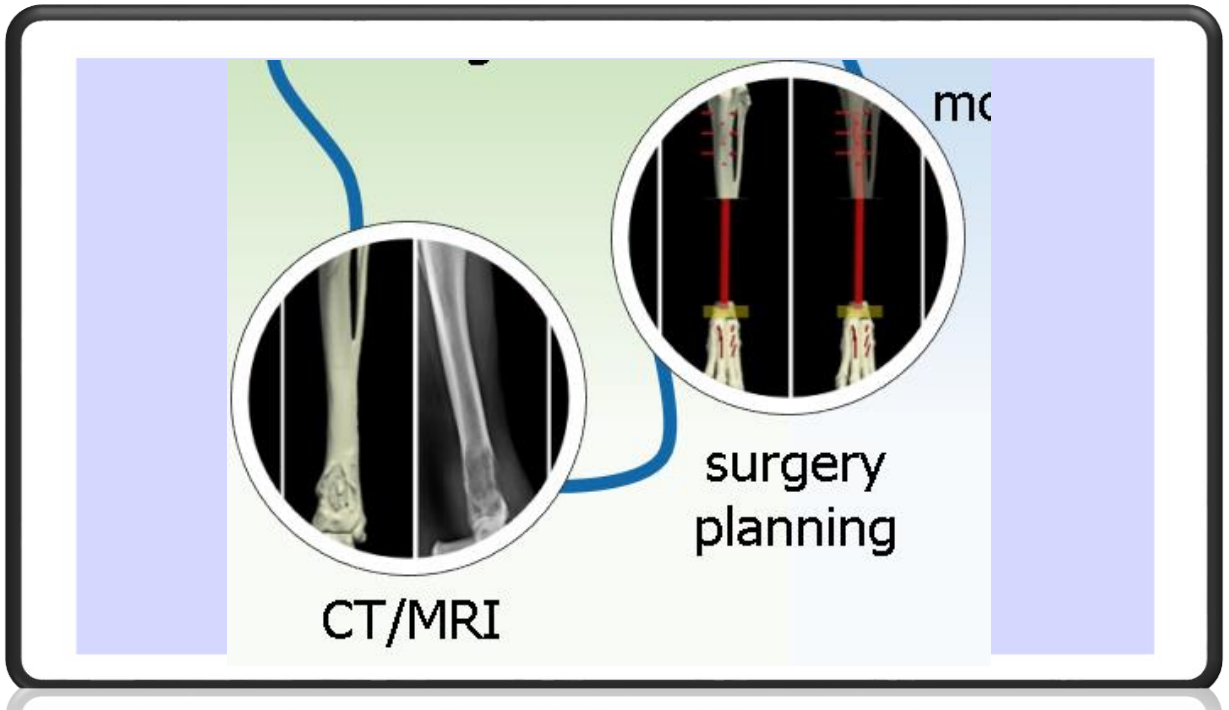
Computed Tomography segmentation





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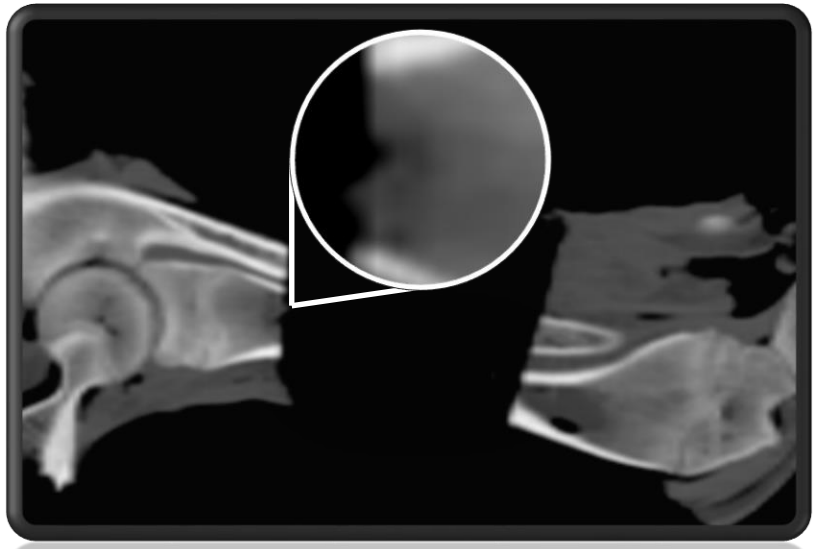
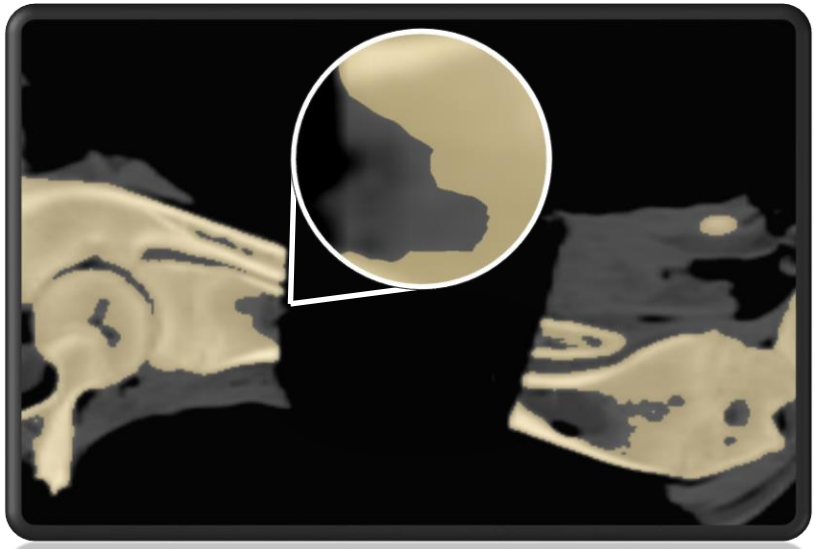
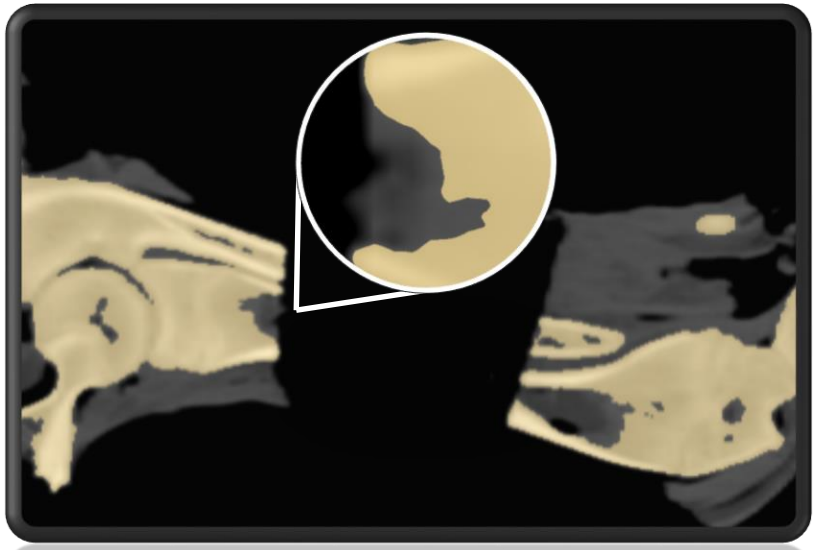
Computed Tomography segmentation





Threshold - 260



Threshold - 226

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optional slide

Computed Tomography segmentation

Threshold - 260

Threshold - 226

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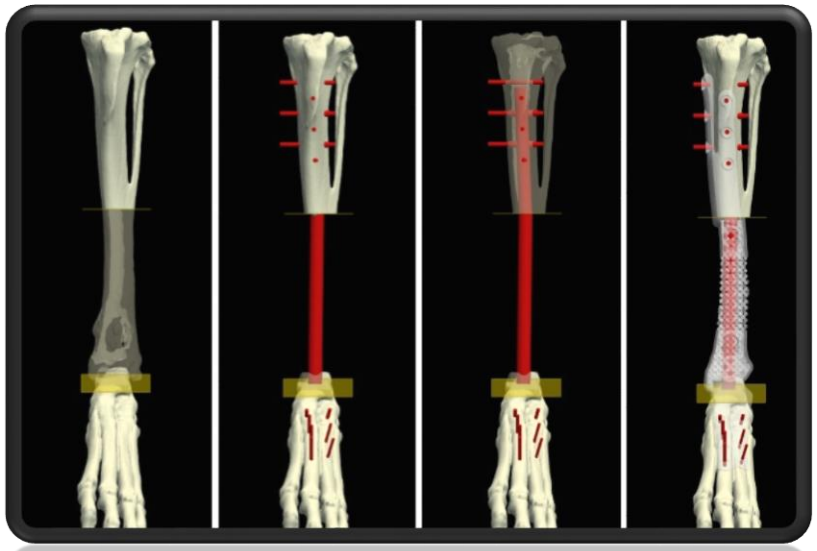
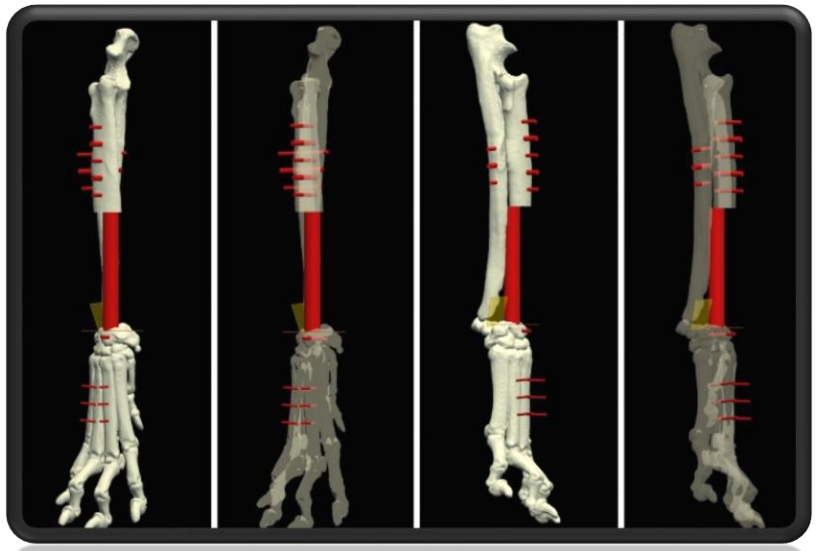
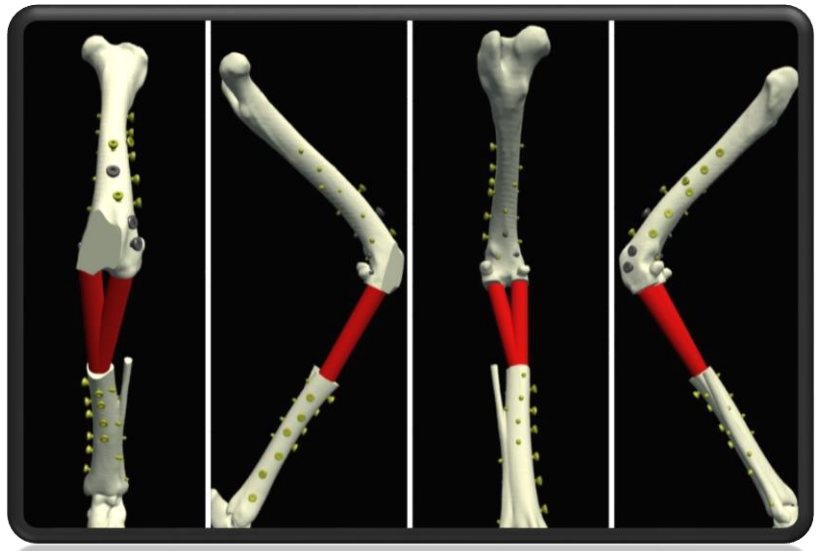
Surgery planning



Cutting plates



Central pin position



Screw orientation

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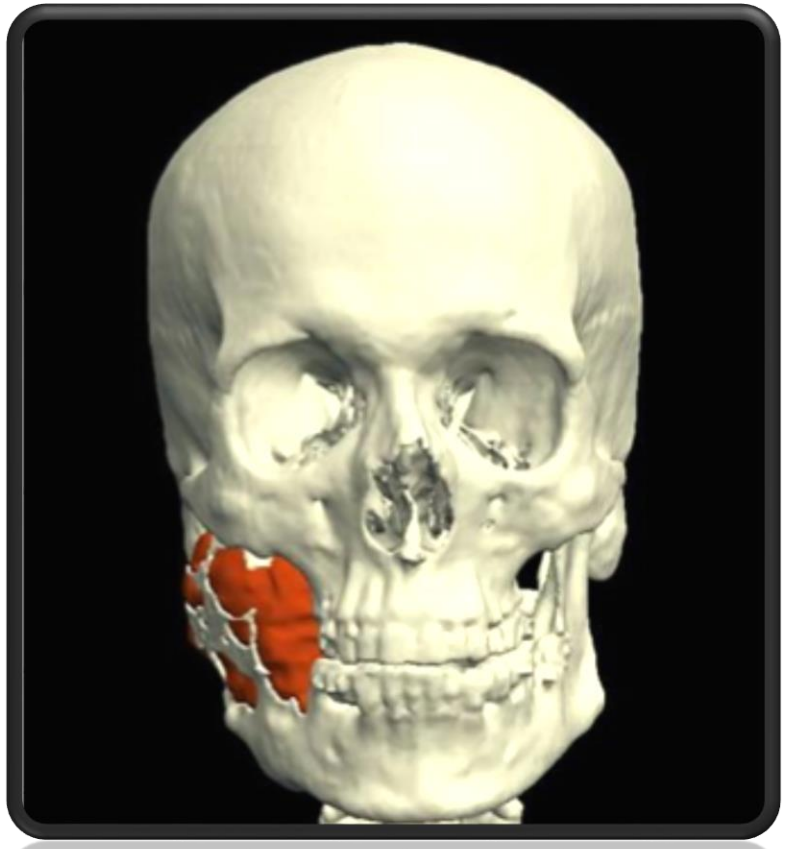
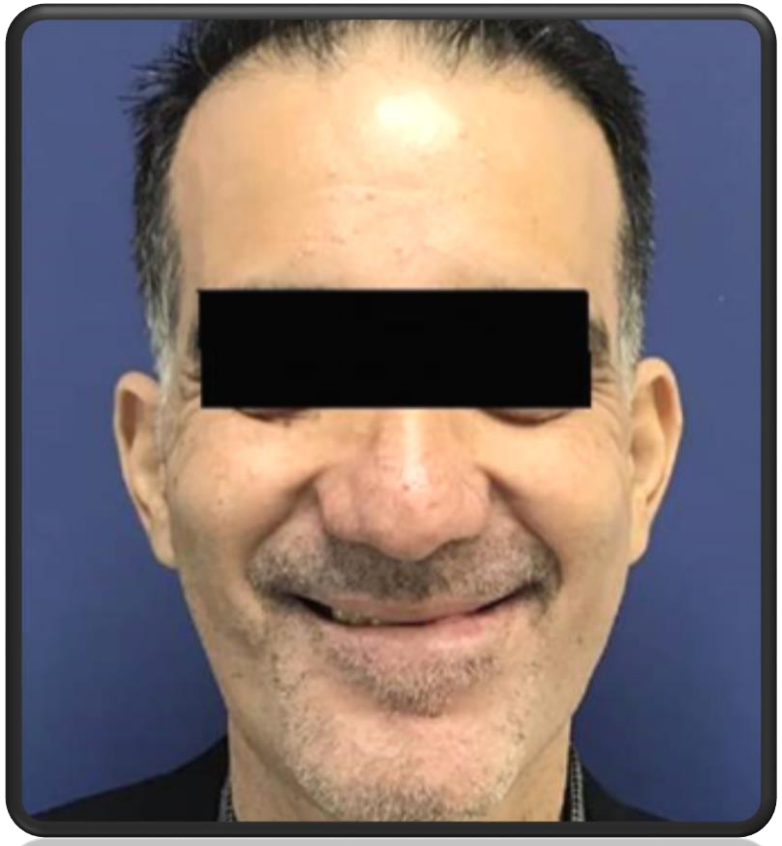
PME PLANNER

optional slide

Surgery planning



Before



After

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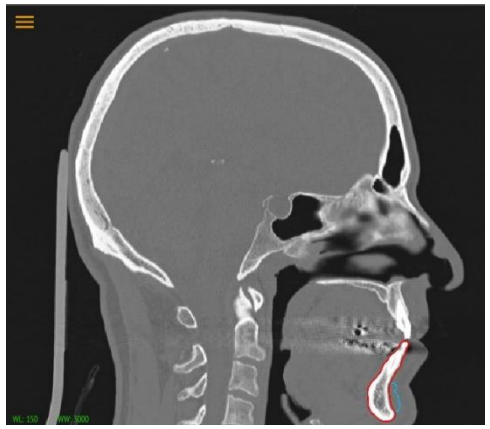
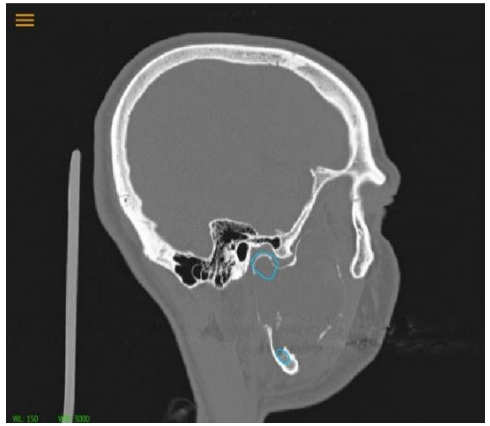
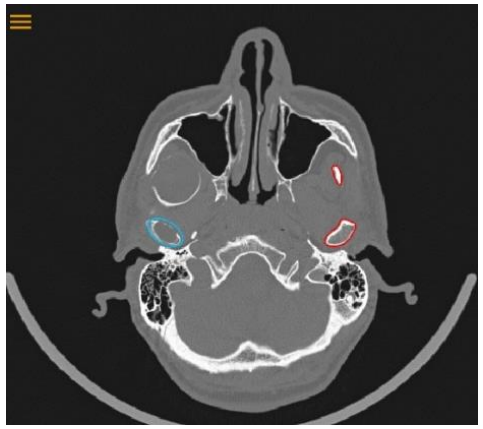
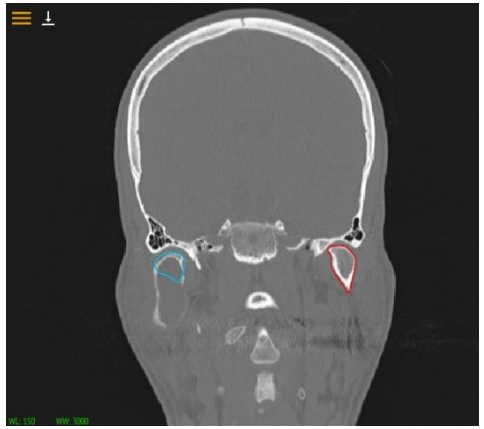
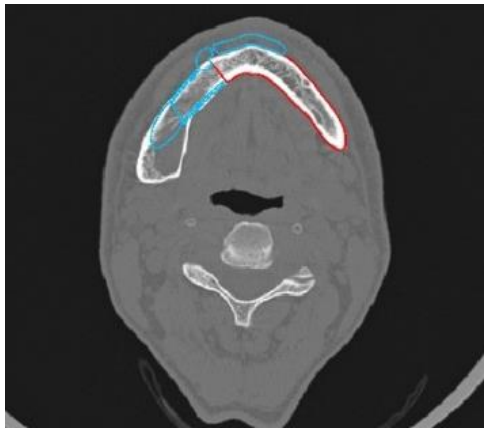
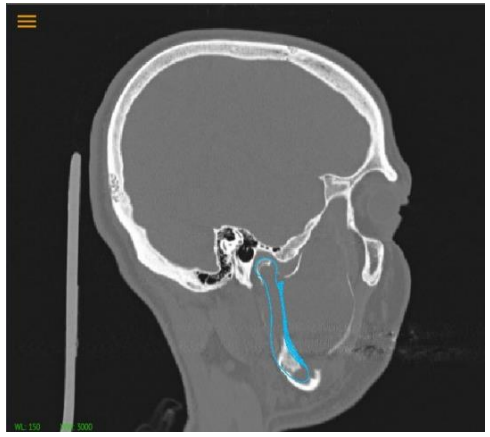
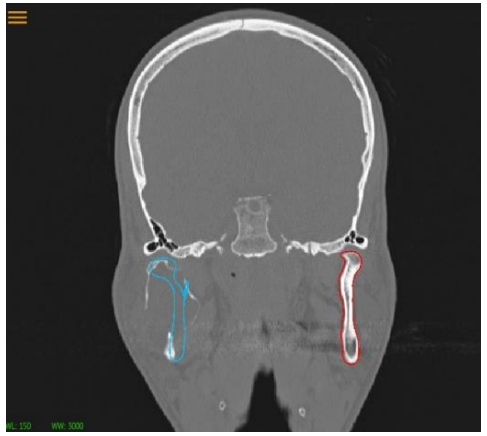
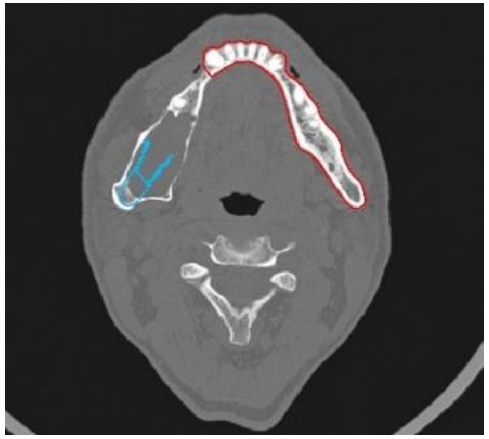
Surgery planning

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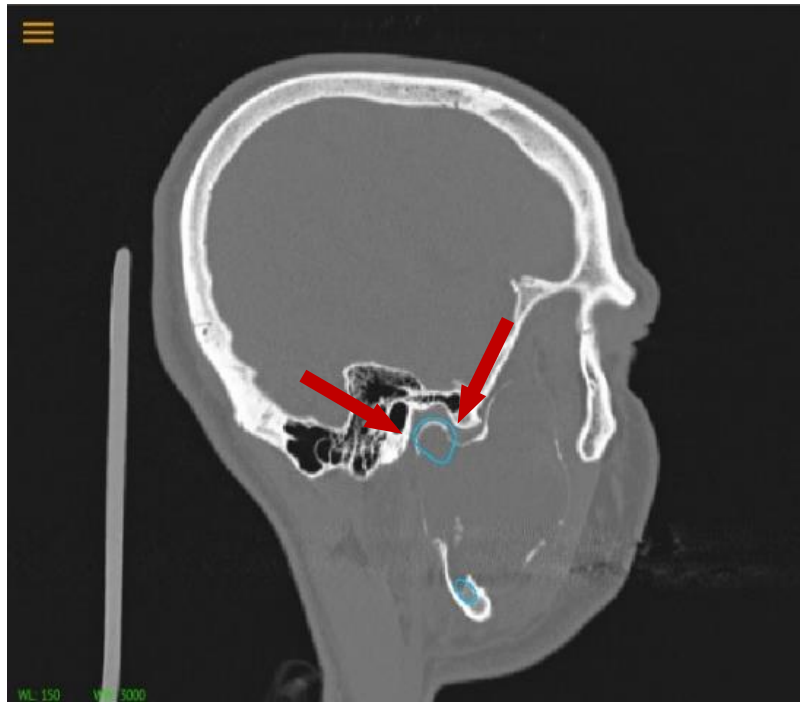
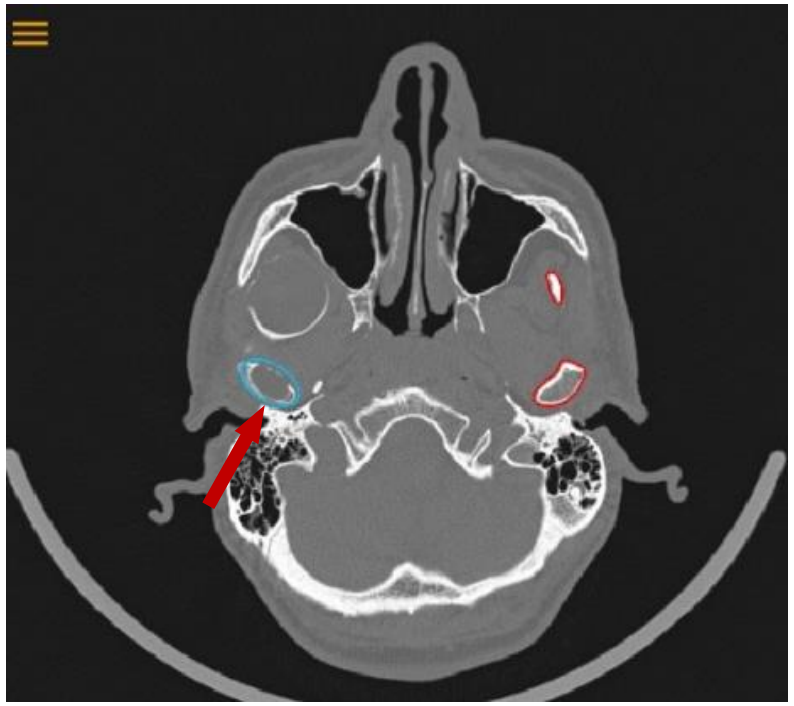
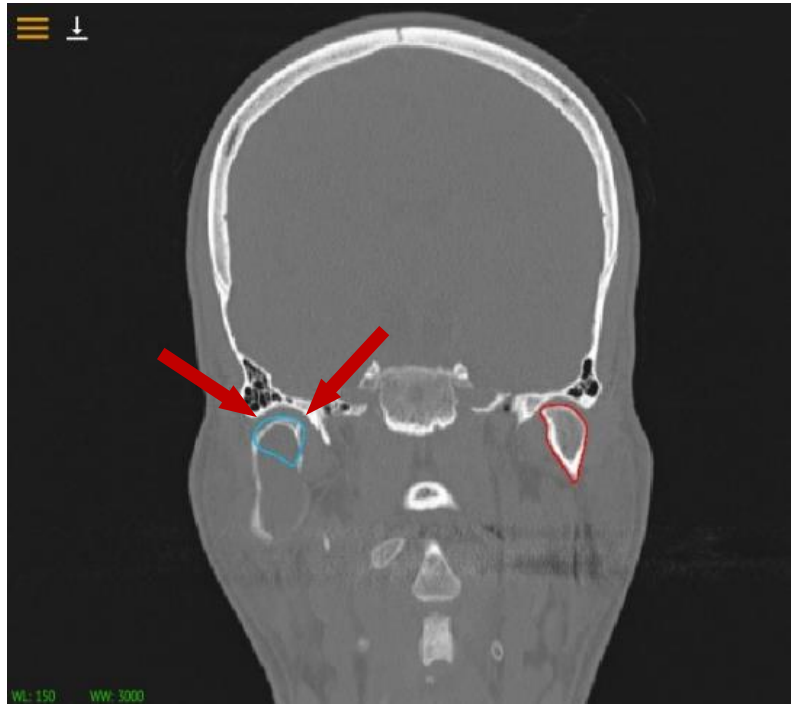
optional slide

Surgery planning







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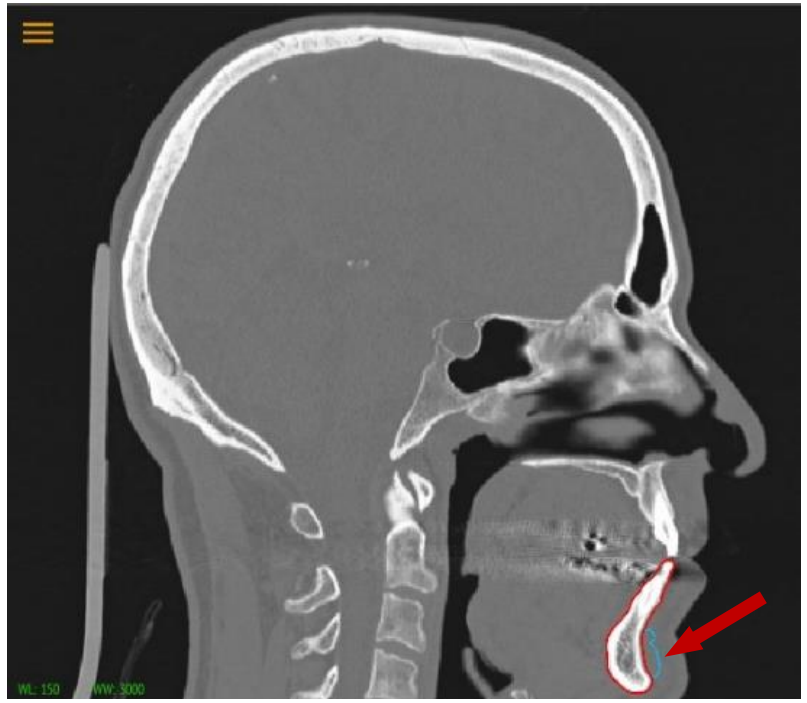
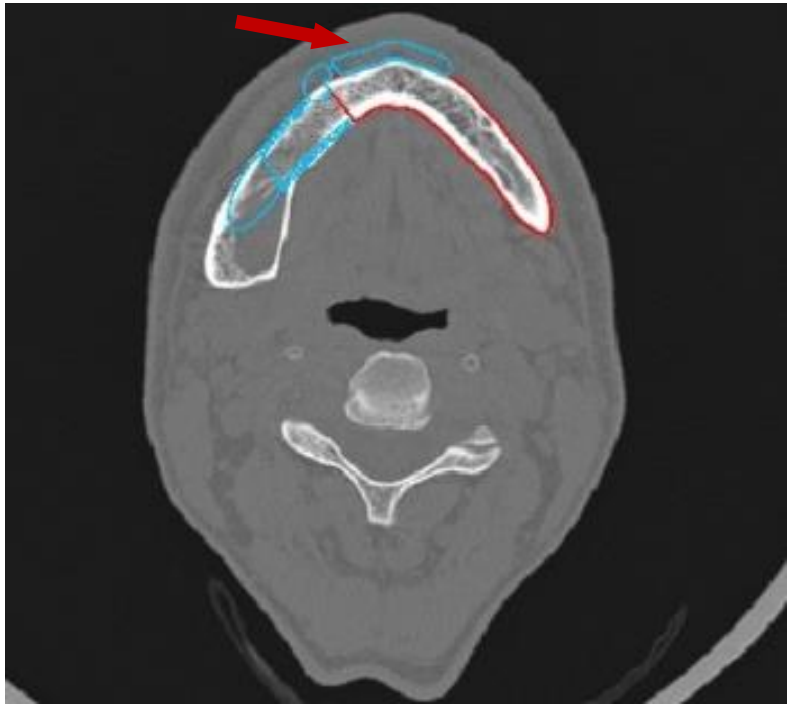
Surgery planning





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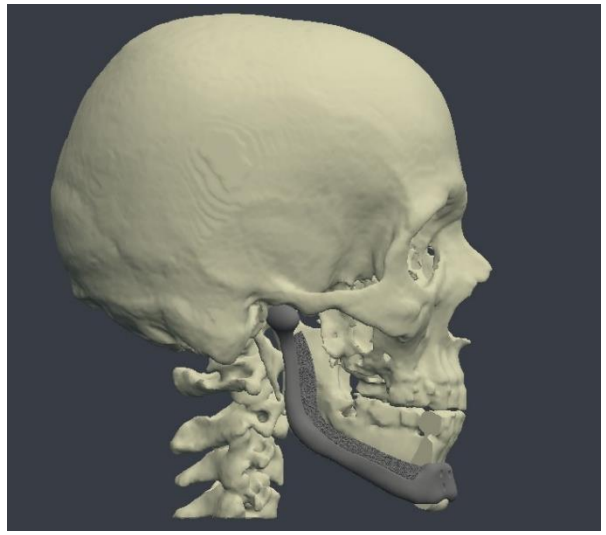
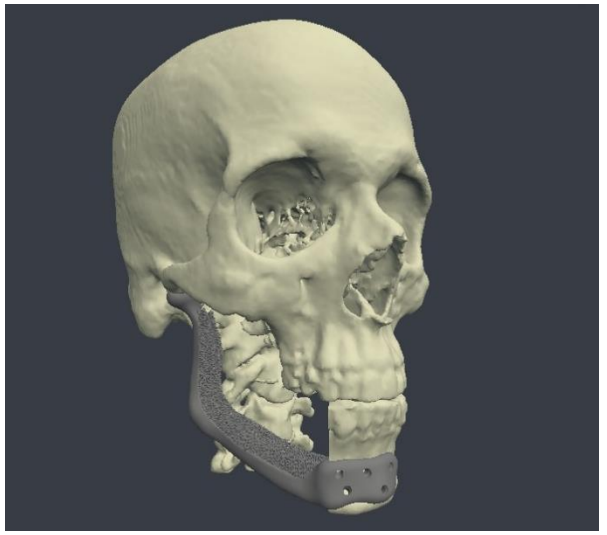
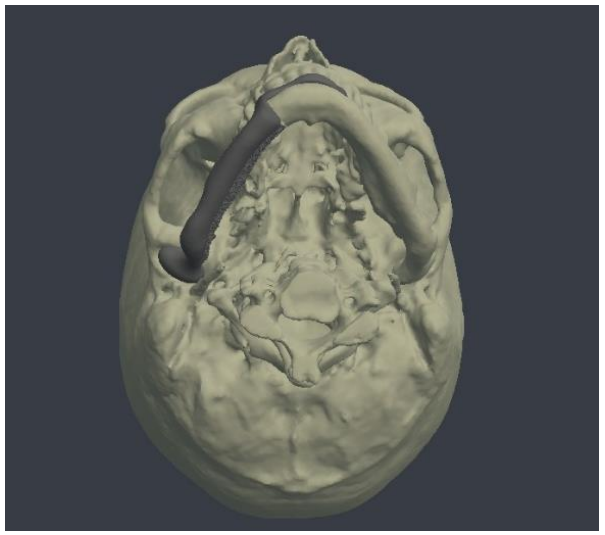
Surgery planning



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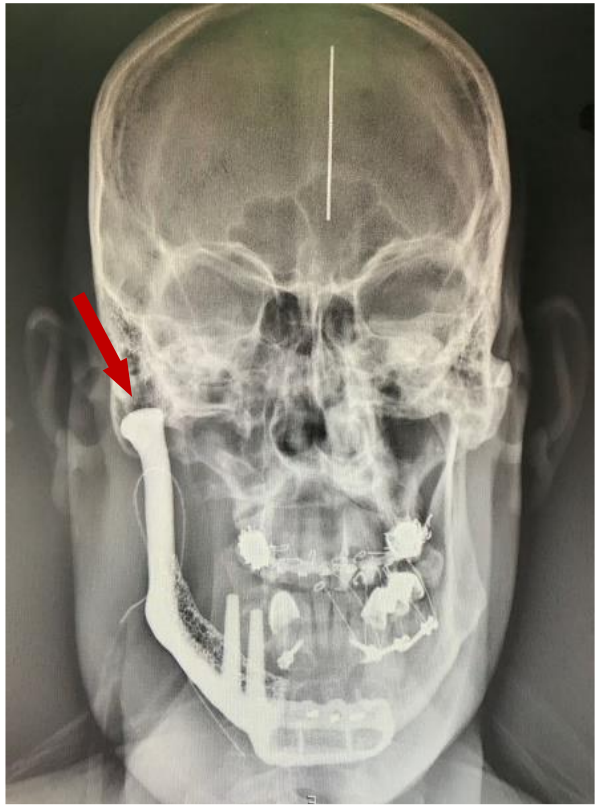
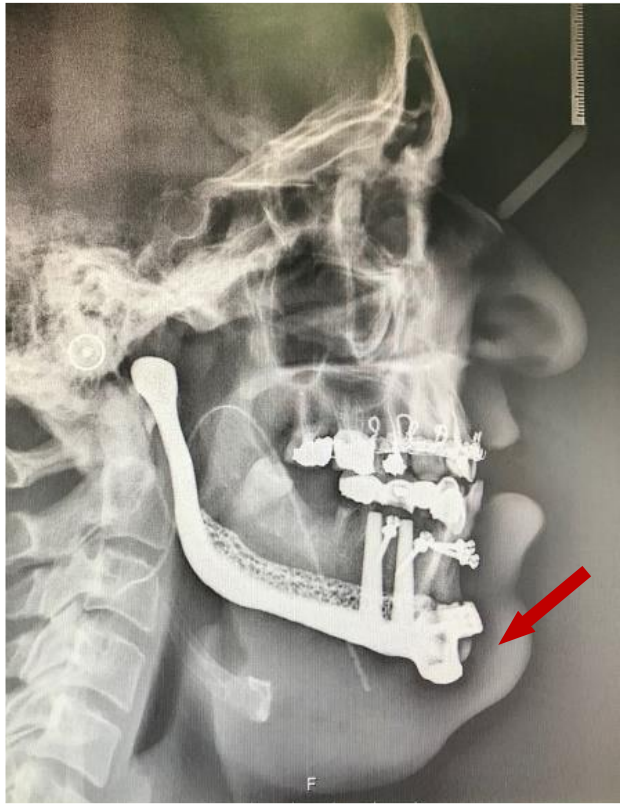
Surgery planning





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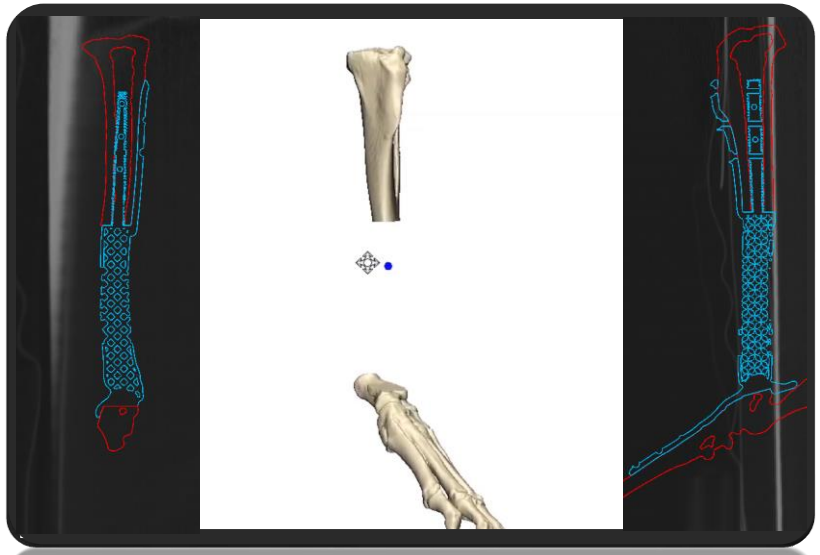
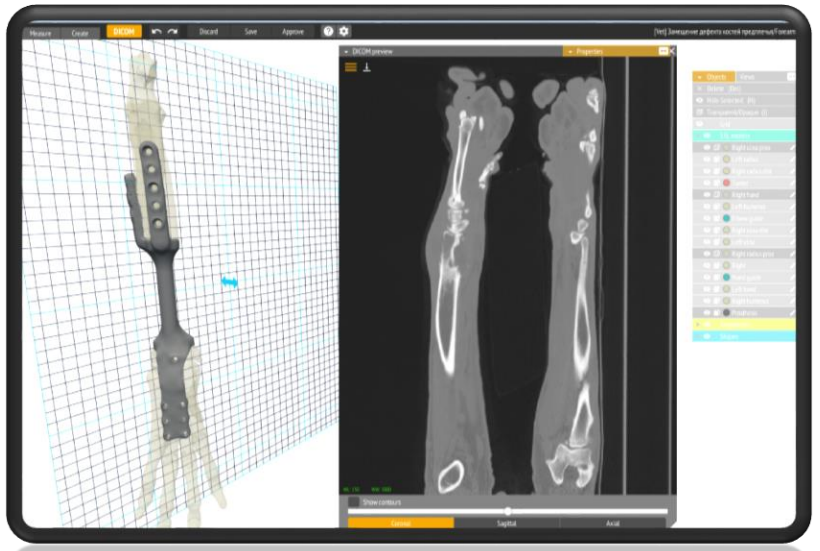
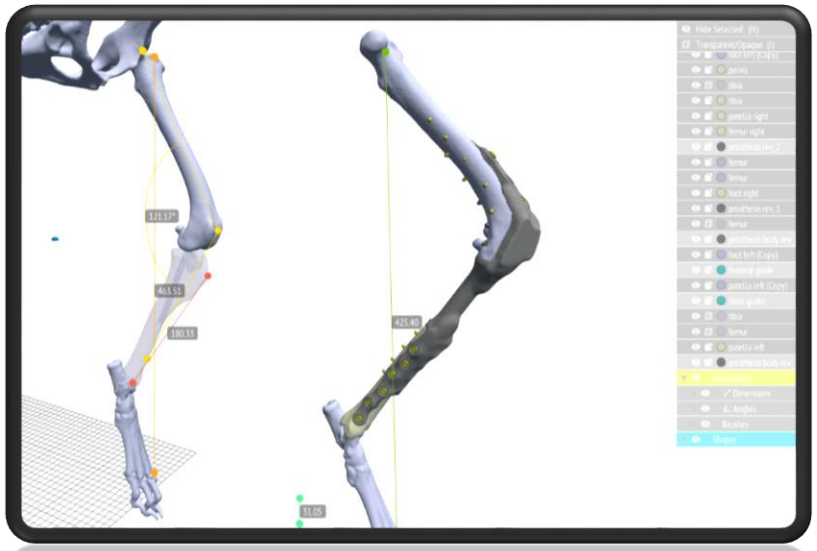
Implant modelling







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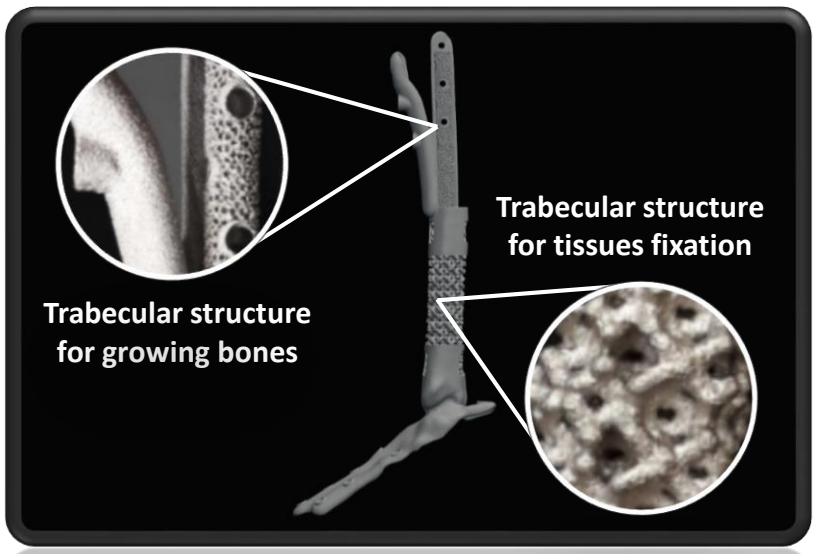
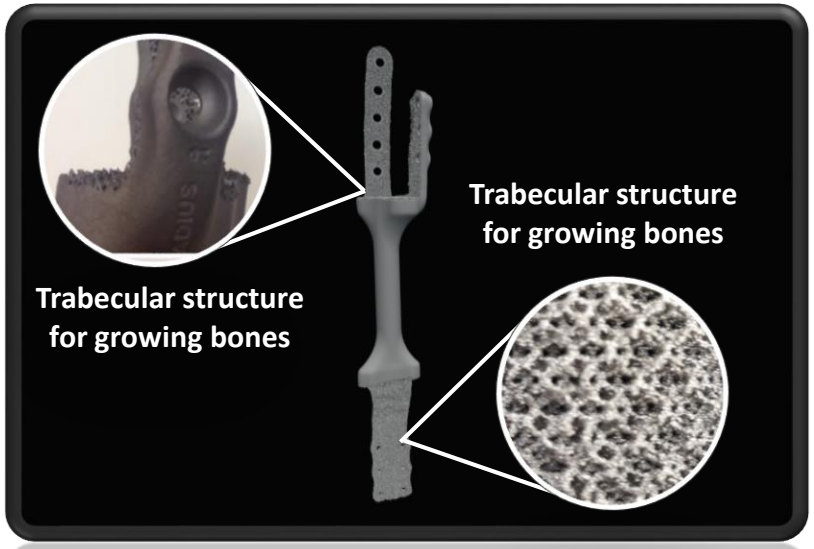
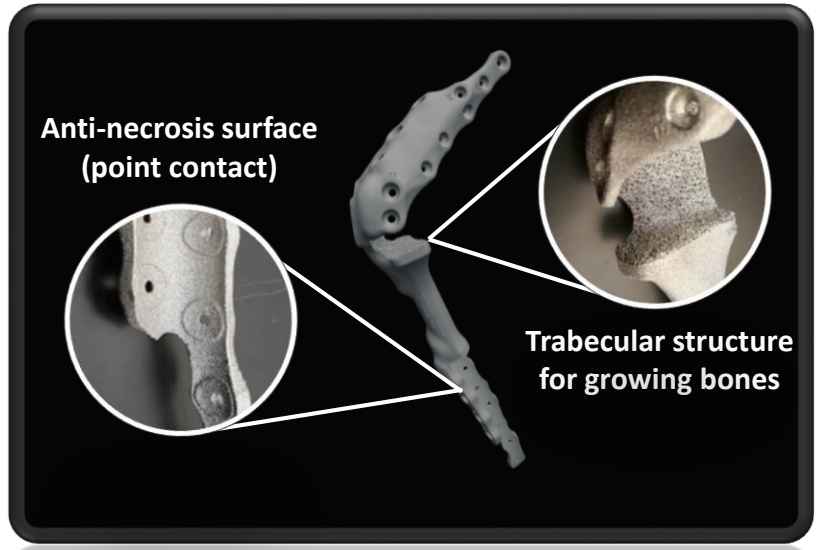
Application of net-shape structures and surface optimization



Bionic design with open cellular area



“Classical” design with trabecular structured inner surface



Minimal contact implant

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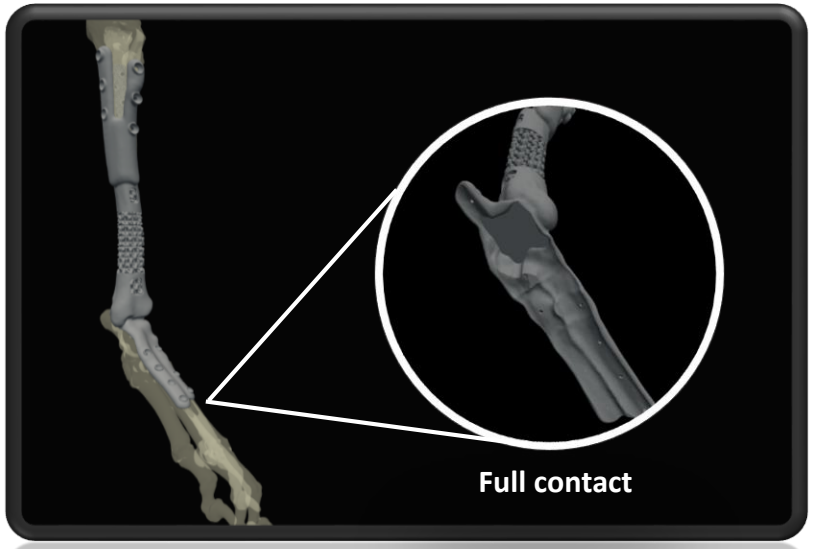
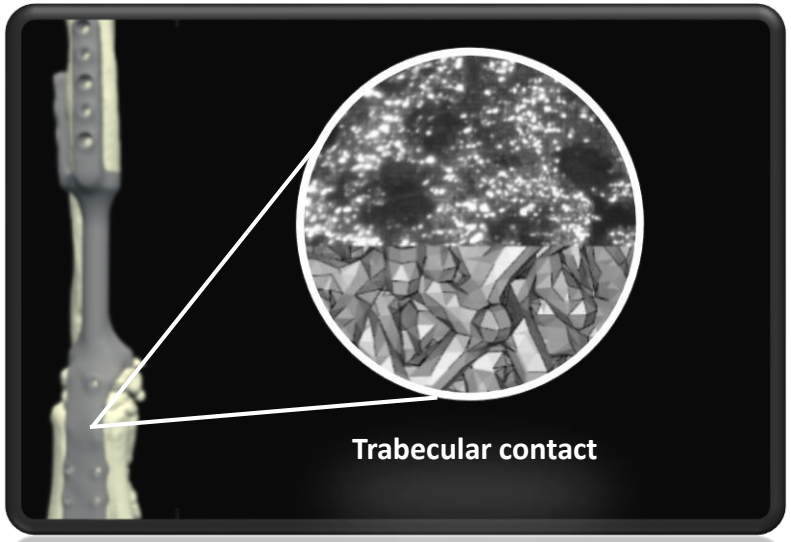
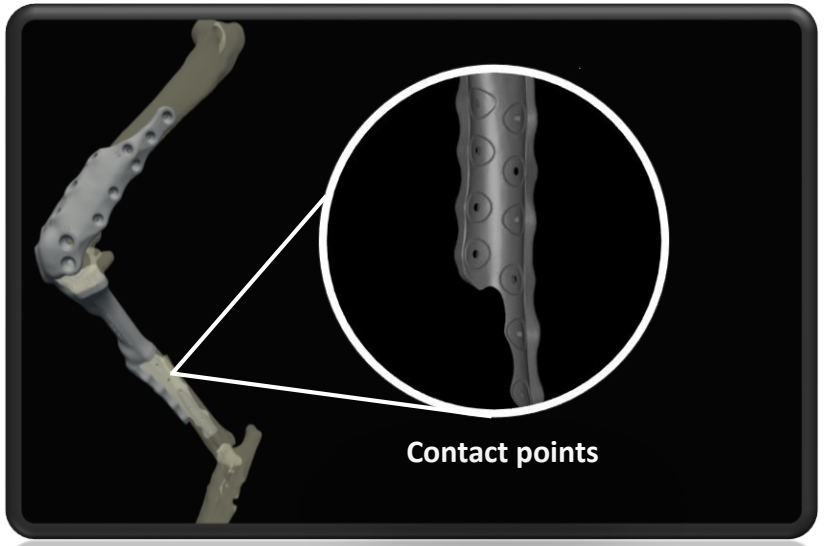
Application of net-shape structures and surface optimization







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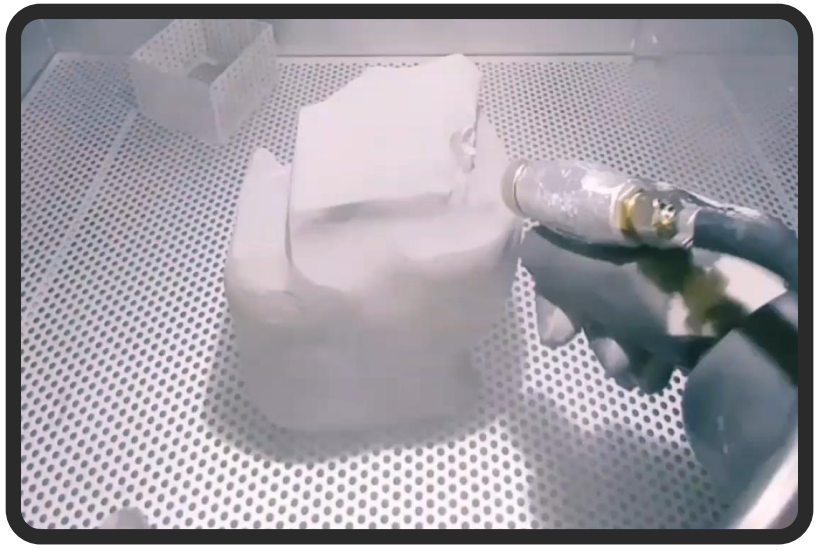
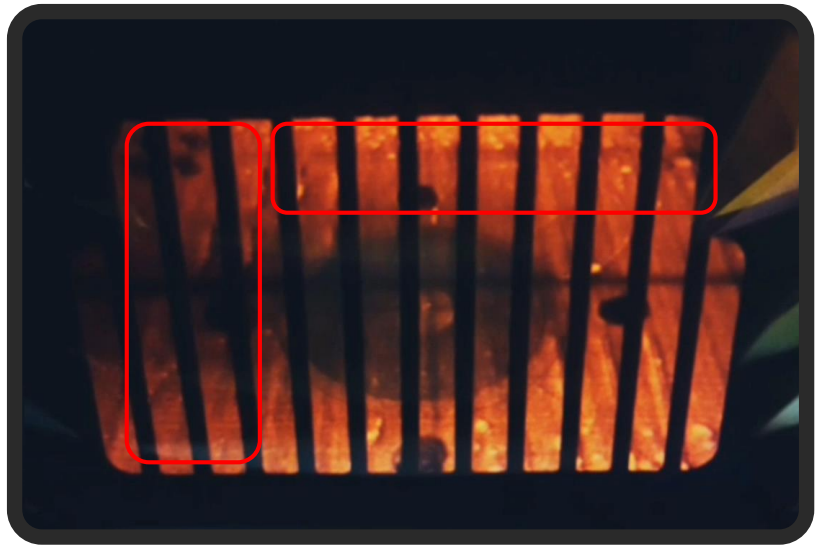
3D printing – EBM process (Ti6Al4V)




1. Popov V., Katz-Demyanetz A., Garkun A., Muller G., Strokin E., Rosenson H. Effect of Hot Isostatic Pressure treatment on the Electron-Beam Melted Ti-6Al-4V specimens, Procedia Manufacturing, Vol. 21, 2018, pp. 125-132, ISSN 2351-9789, https://doi.org/10.1016/j.promfg.2018.02.102.
2. Popov V., Katz-Demyanetz A., Kovalevsky A., Biletskiy R., Muller G., Strokin E., Garkun A., Bamberger M. Effect of the hatching strategies on mechanical properties and microstructure of SEBM manufactured Ti-6Al-4V specimens. Materials Performance and Characterization (2018)

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Post-processing of titanium implant

Removal of support structure

Machining

Polishing

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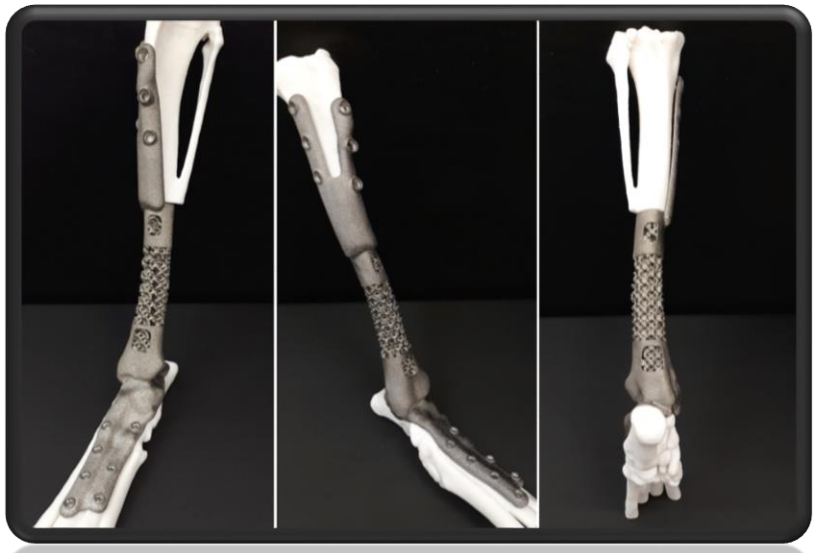
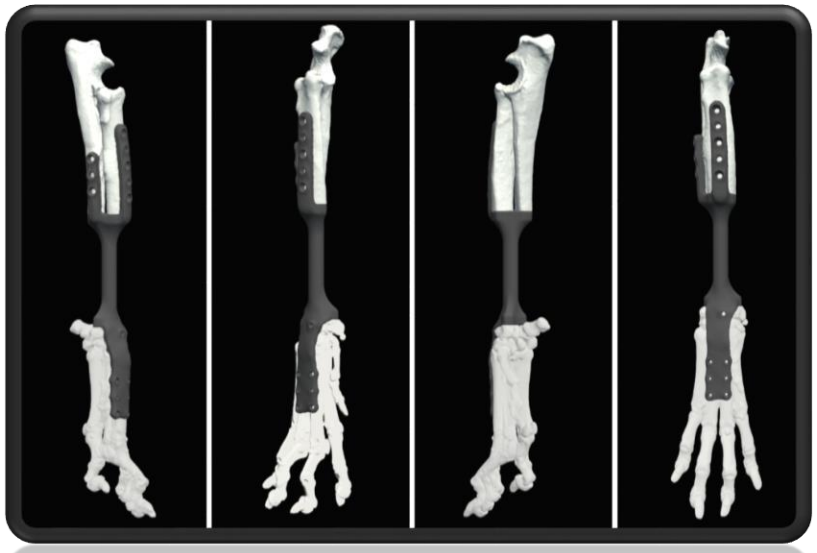
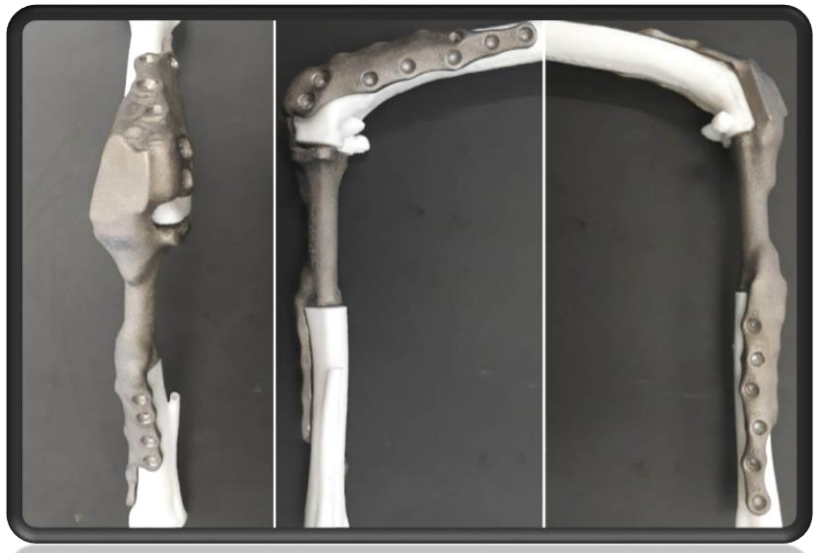
Surgery simulations



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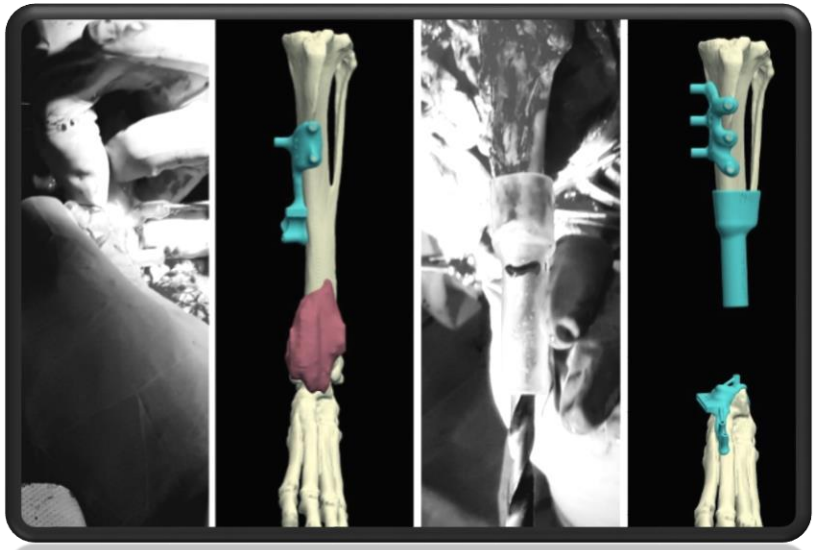
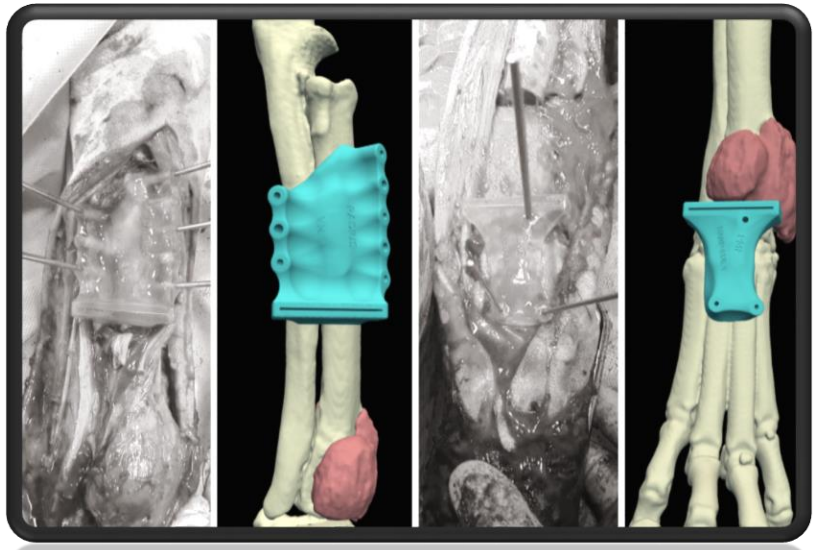
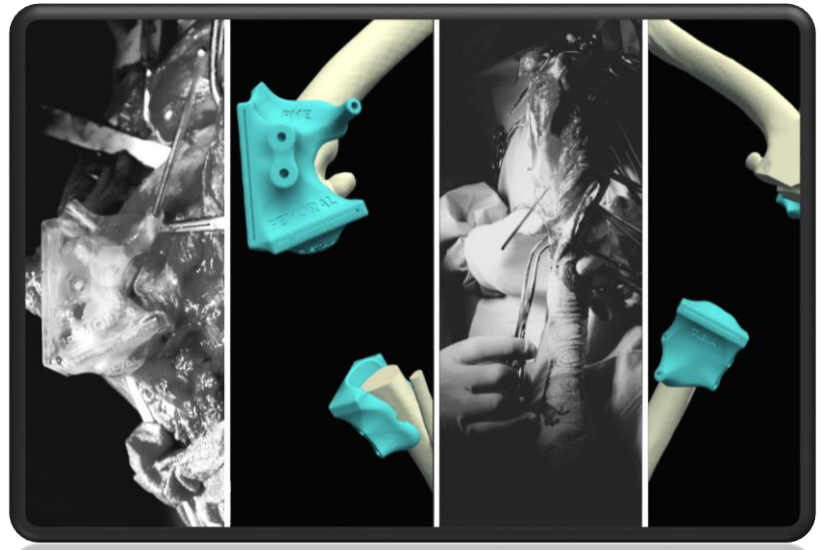
Cutting and drilling guides



Drilling guide (6 holes) – 1 pcs.
Cutting guide (5 holes)/(3 holes) – 2 pcs.
Intramedullary drilling guide – 1 pcs



Cutting guide (8 holes) – 1 pcs.
Cutting guide (2 holes) – 1 pcs.



Cutting guide 2 planes (4 holes) – 1 pcs.
Cutting guide (4 holes) – 1 pcs.

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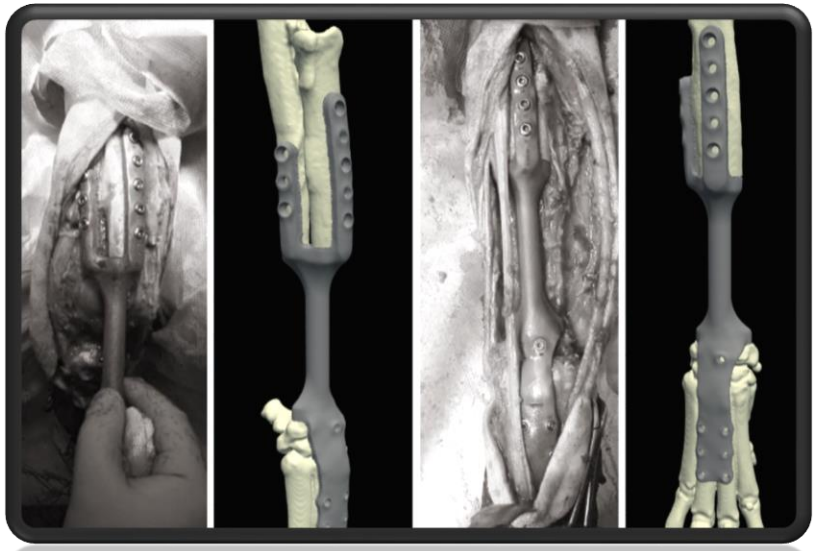
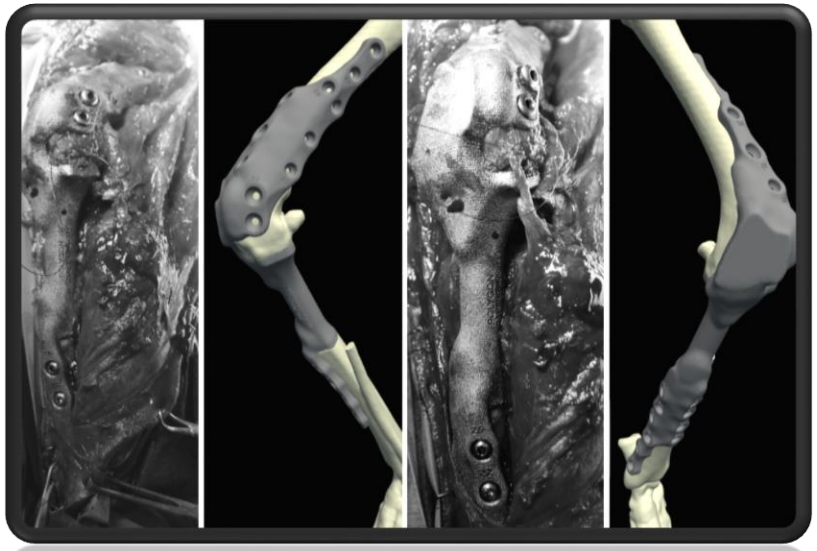
Surgery

Surgery date – 21/01/2018



Surgery date – 19/02/2018



Surgery date – 04/05/2018

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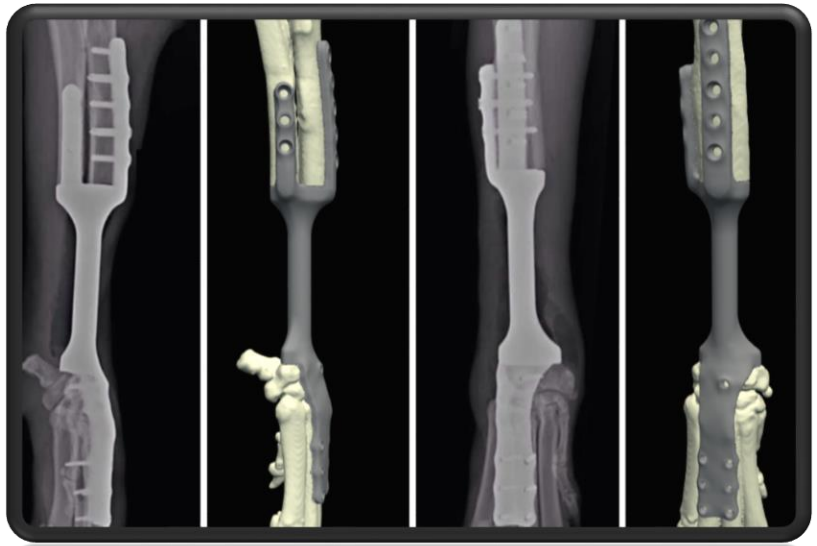
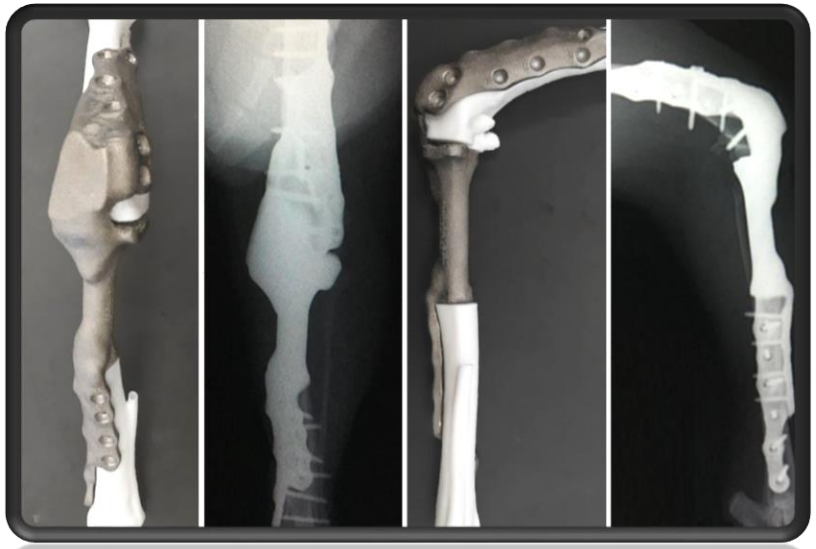
Surgery results (X-Ray)

Surgeon – Dr. Stas Usov
St. Petersburg, Russia



Surgeon – Dr. Stas Usov
St. Petersburg, Russia



Surgeon – Dr. Jorge Leite
Guimaraes, Portugal

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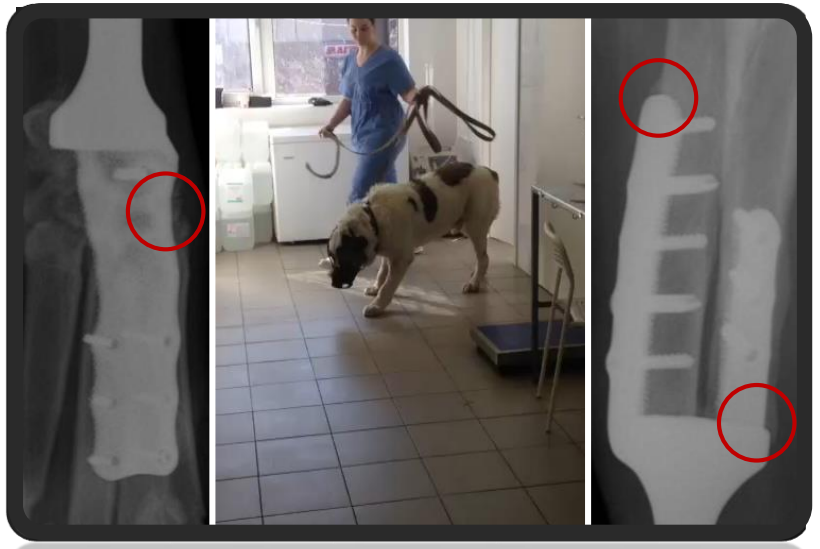
Follow-up results and Physiotherapy

5 days after surgery



60 days after surgery
Osseointegration results

20 days after surgery

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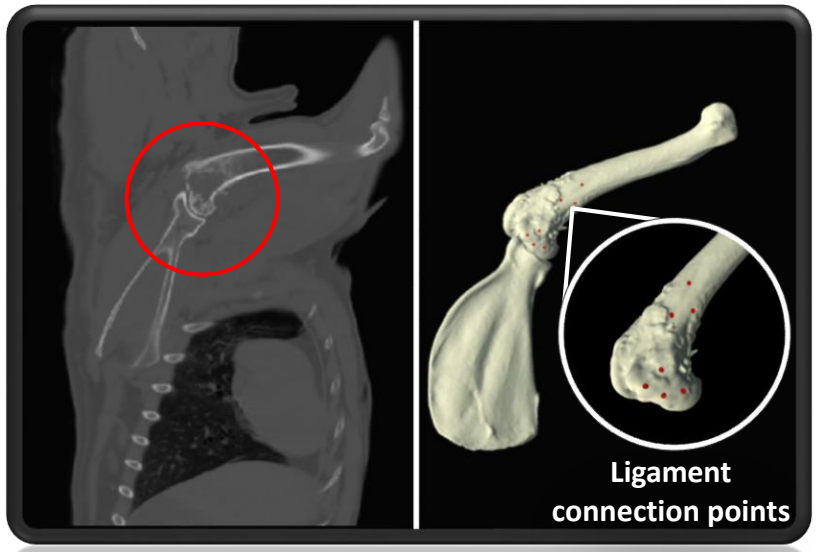
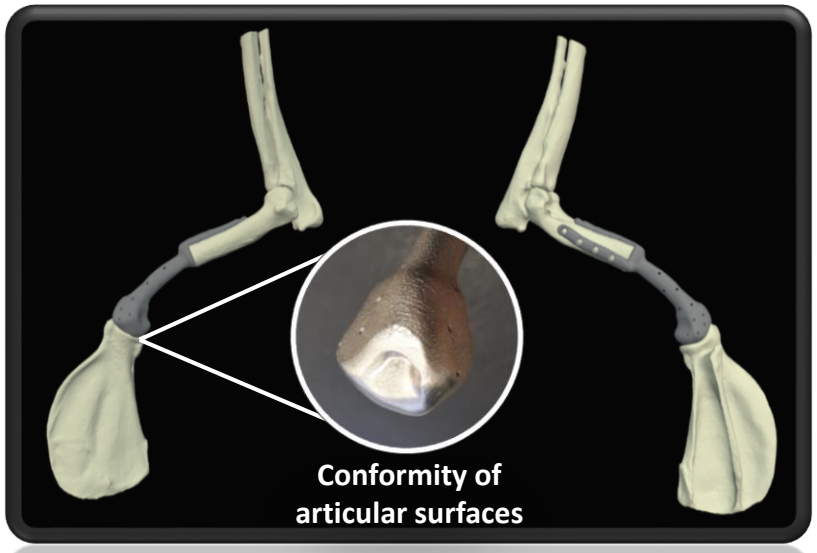
Movable connection of forelimb (titanium implant and muscles)

Breed – Dalmatian
Age – 10 years
Sex – male
Diagnosis – osteosarcoma



CT/3D visualization



Implant modeling

Surgery simulations

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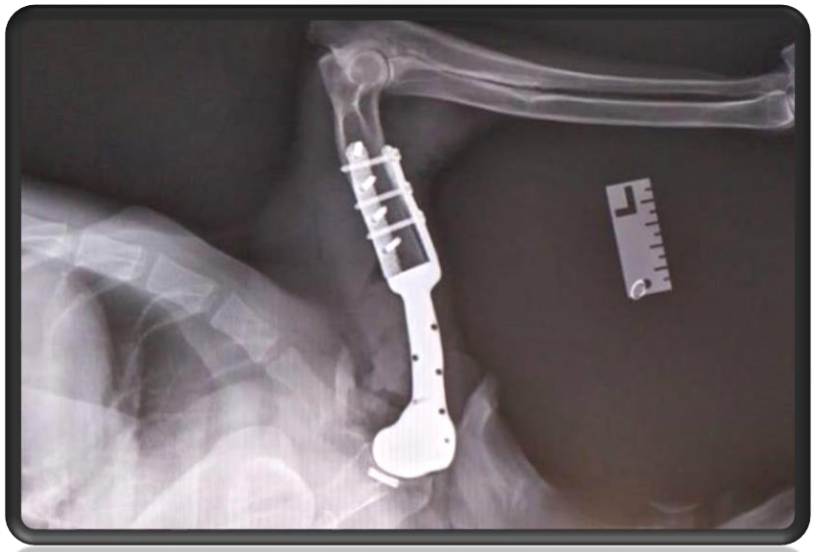
Movable connection of forelimb (titanium implant and muscles)

Surgery date – 22/06/2018



Surgeon – Dr. Anton Akimov
Moscow, Russia

Patient – Elf

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Software solution for individual implantations

Surgeon	Design engineer			Operator
VOLUME GRAPHICS	POLYGON MEDICAL ENGINEERING	Materialise Mimics	Materialise 3-matic	Materialise Magics
CT visualization	Planning	CT segmentation	Modeling	«Pre-print»

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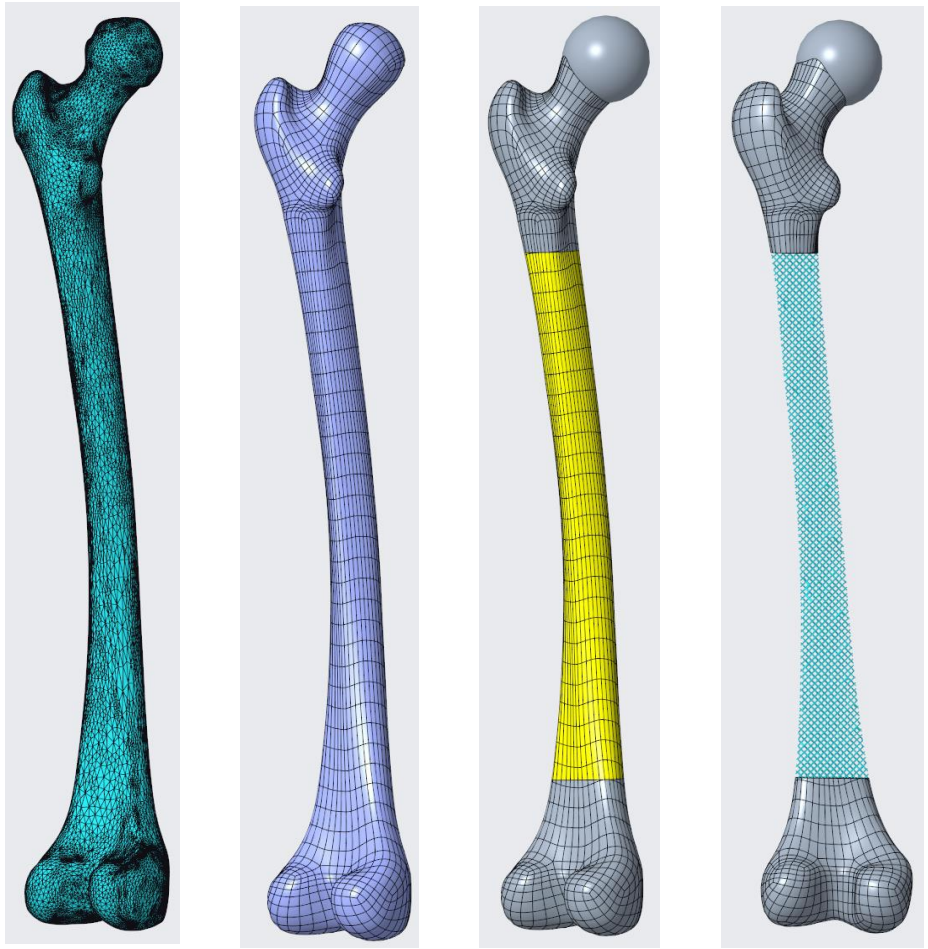
Design of Medical Implant – Femur bone

1 2 3 4

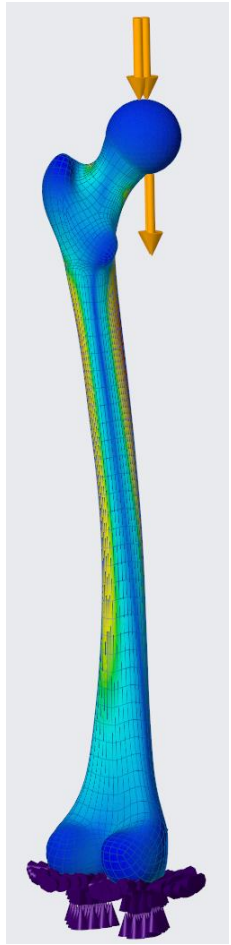


- Stage 1 – CT scan (STL model)
- Stage 2 – Convert from STL to CAD model
- Stage 3 – Define Implant Area
- Stage 4 – Replacing the area with a lattice

Metal AM

Design of Medical Implant – Femur bone

4



5

- Stage 4 – Tension and compression simulation
- Stage 5 – Creating optimized trabecular lattice