A Cone Beam Computed Tomography Annotation Tool for Automatic Detection of the Inferior Alveolar Nerve Canal

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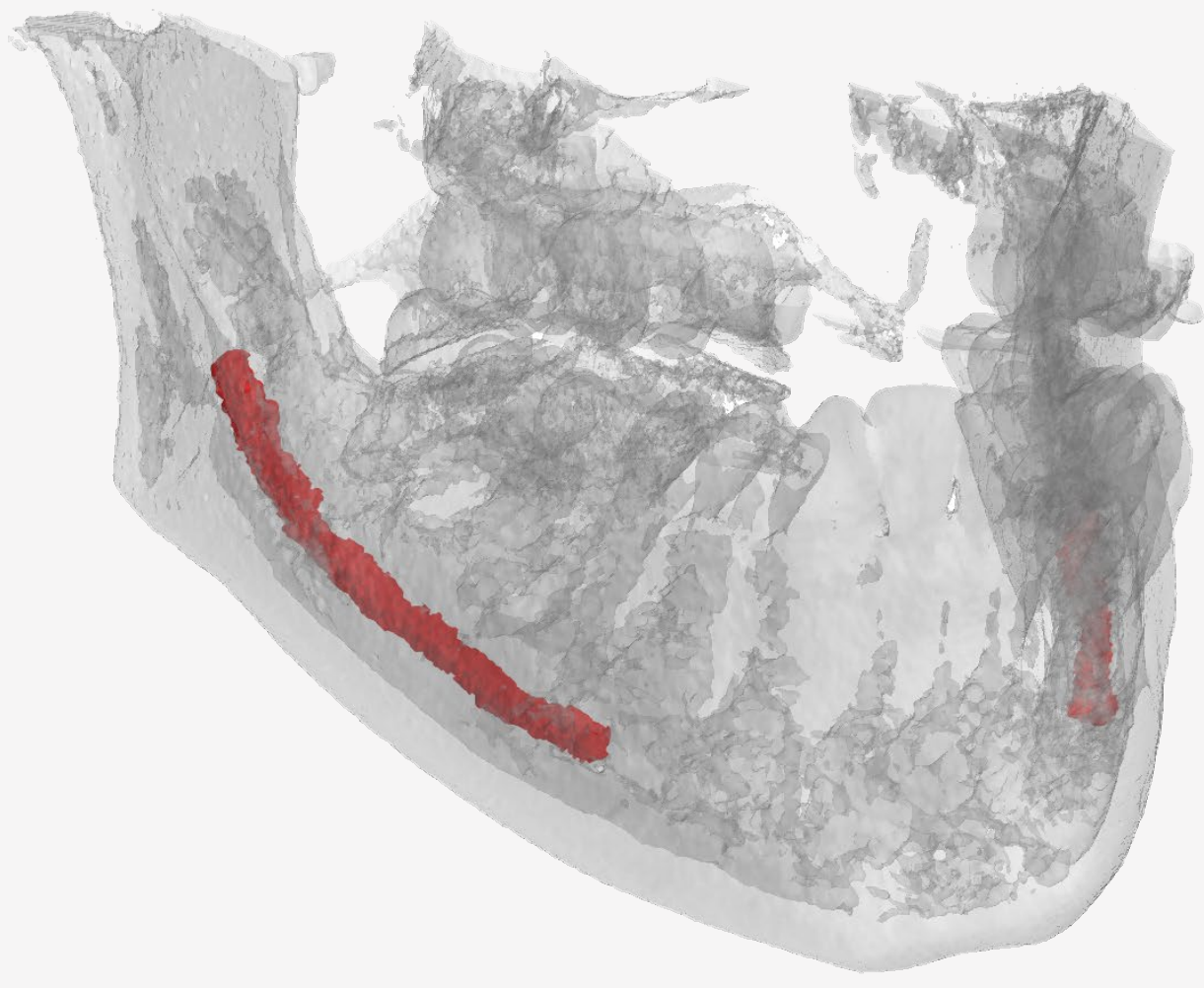
The Inferior Alveolar Nerve

- Knowing the position of the Inferior Alveolar Nerve (IAN) is essential in surgical operations.
- Traditional annotations are made on panoramic views using proprietary software.
- Labeling a 3D volume is tedious and discourages the creation of large datasets for further purposes (e.g. deep learning applications).

*This work proposes a **novel tool for creating 3D annotations** of the IAN with minimum effort and high precision.*

A Novel Annotation Tool

The proposed **graphic** tool allows experts to load volumes from DICOM files, interactively evaluate the best cutting strategies, label the IAN from 2D slices and export them as 3D annotations.
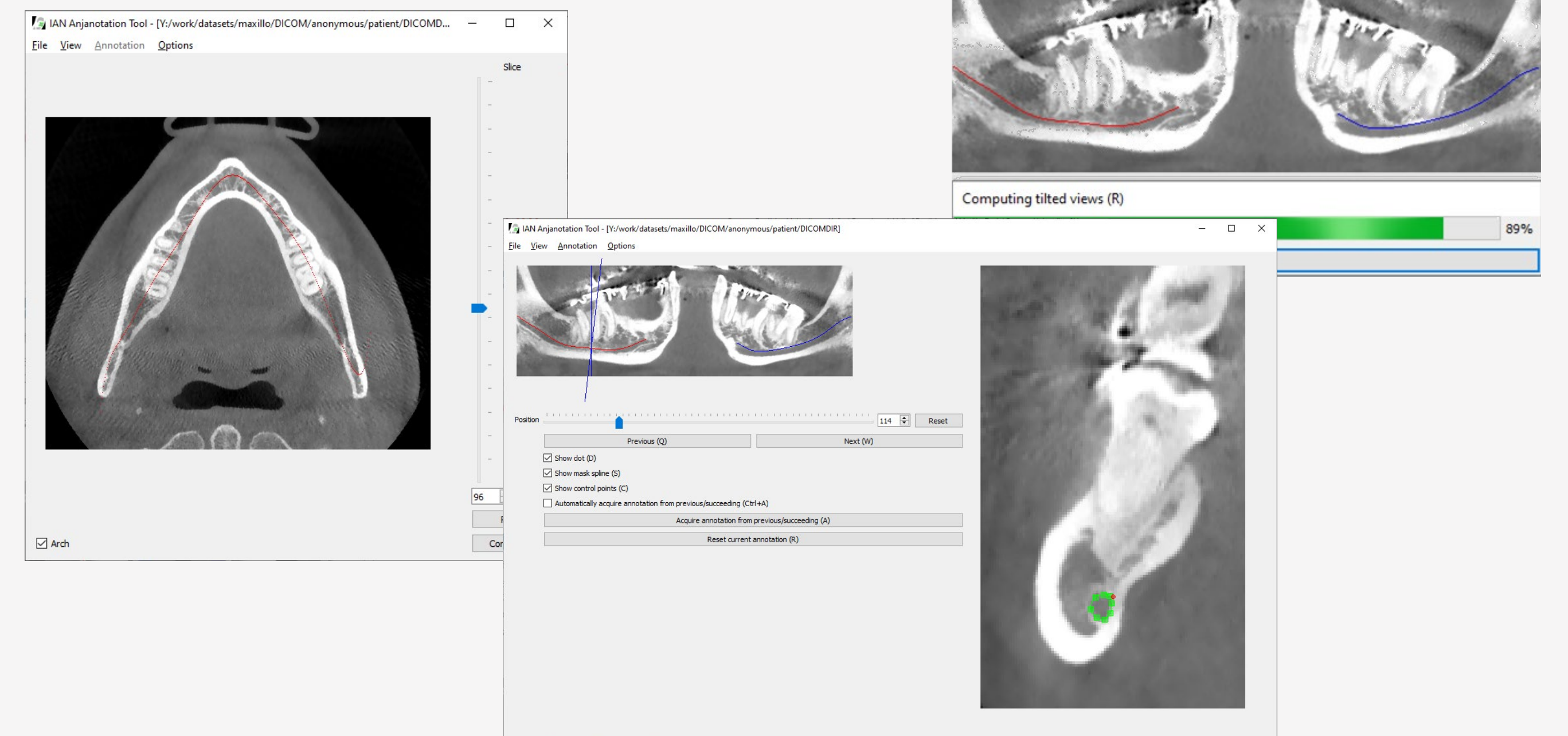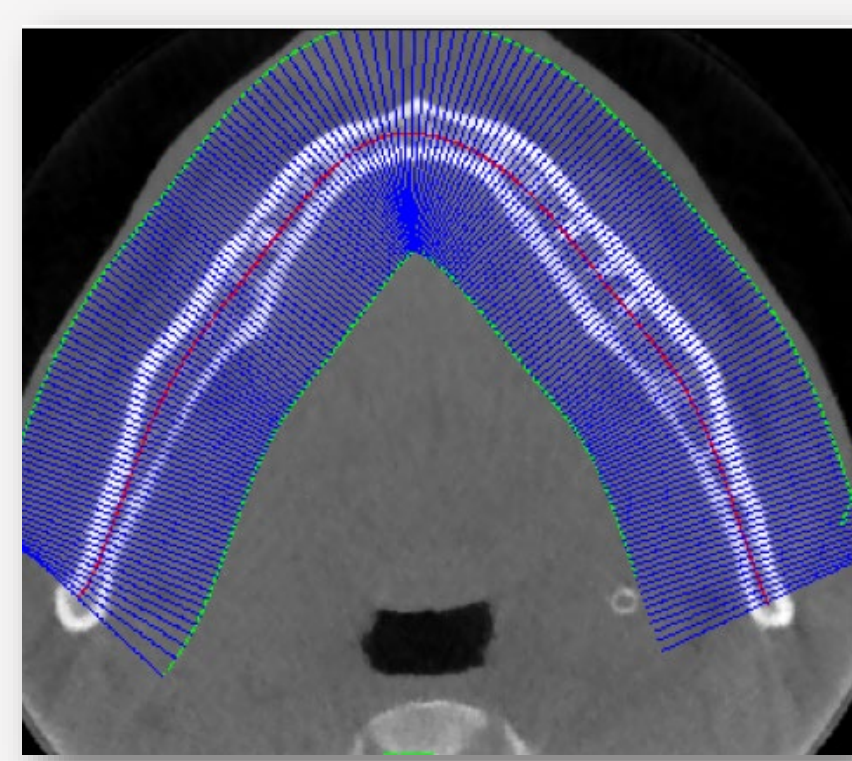

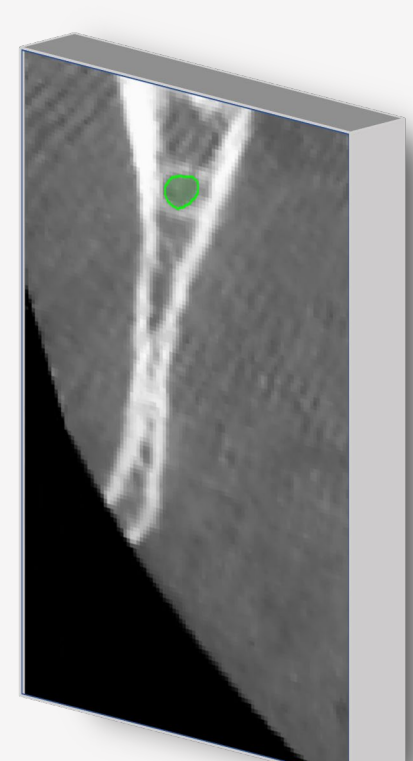## Cross-Sectional Views

Using the tool, an expert can:

(a) Create and edit the panoramic base **spline** on dental arch;

(b) Generate **straight cutting planes** orthogonal to the spline;

(c) Use planes to cut the volume and retrieve 2D CSVs. Annotate each view and get hints for the next one.
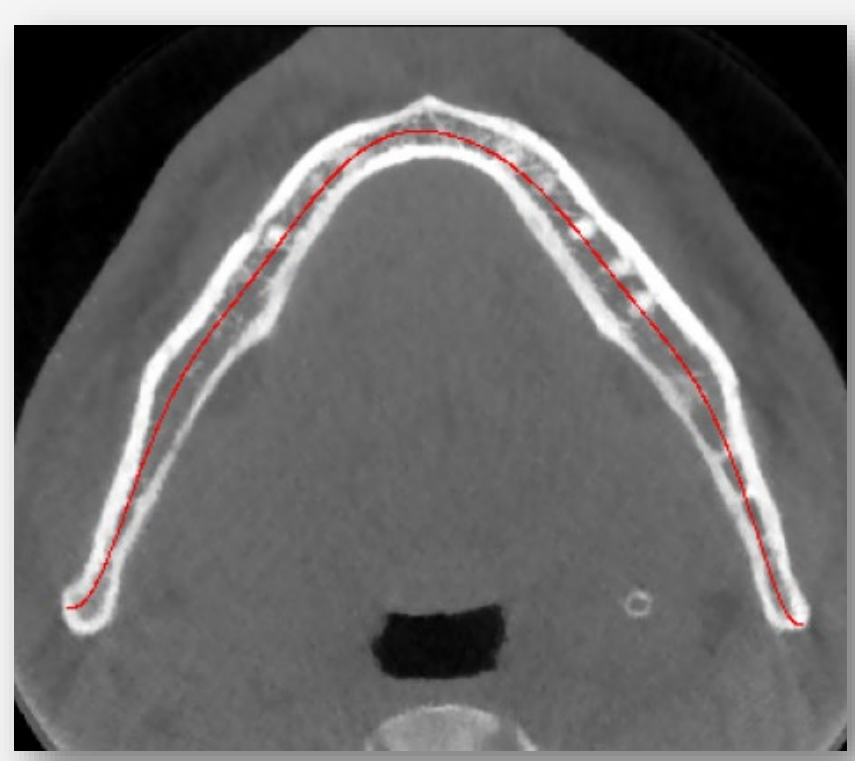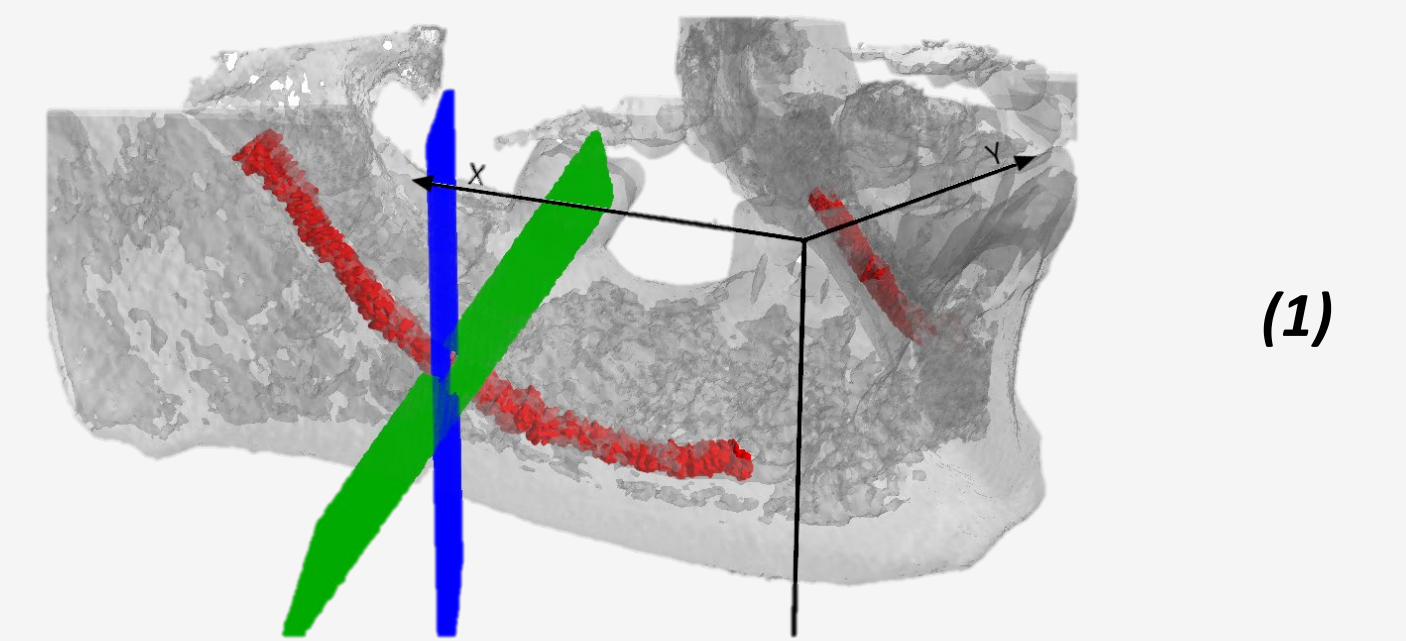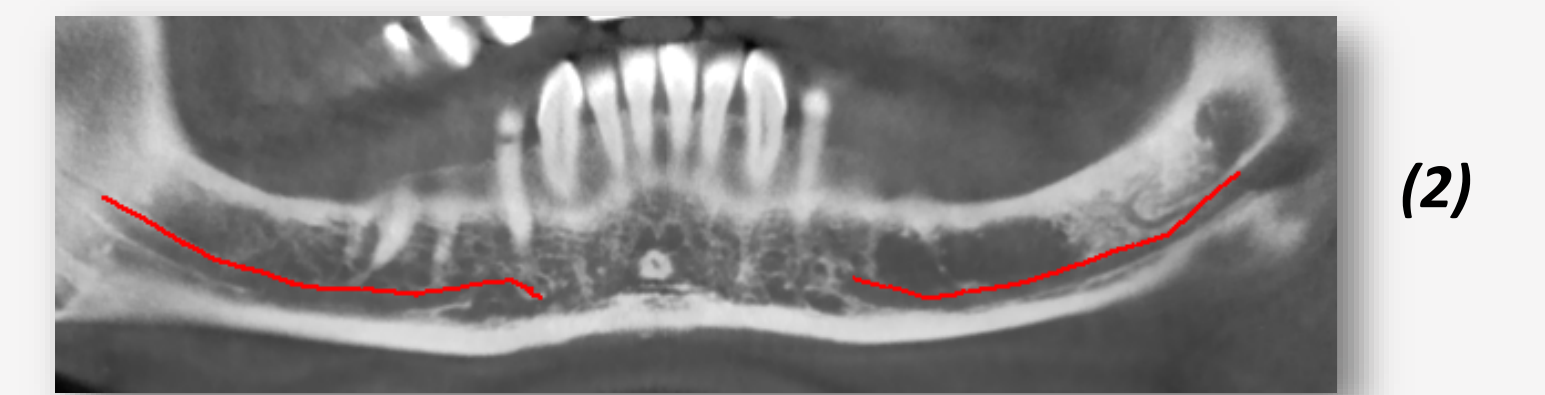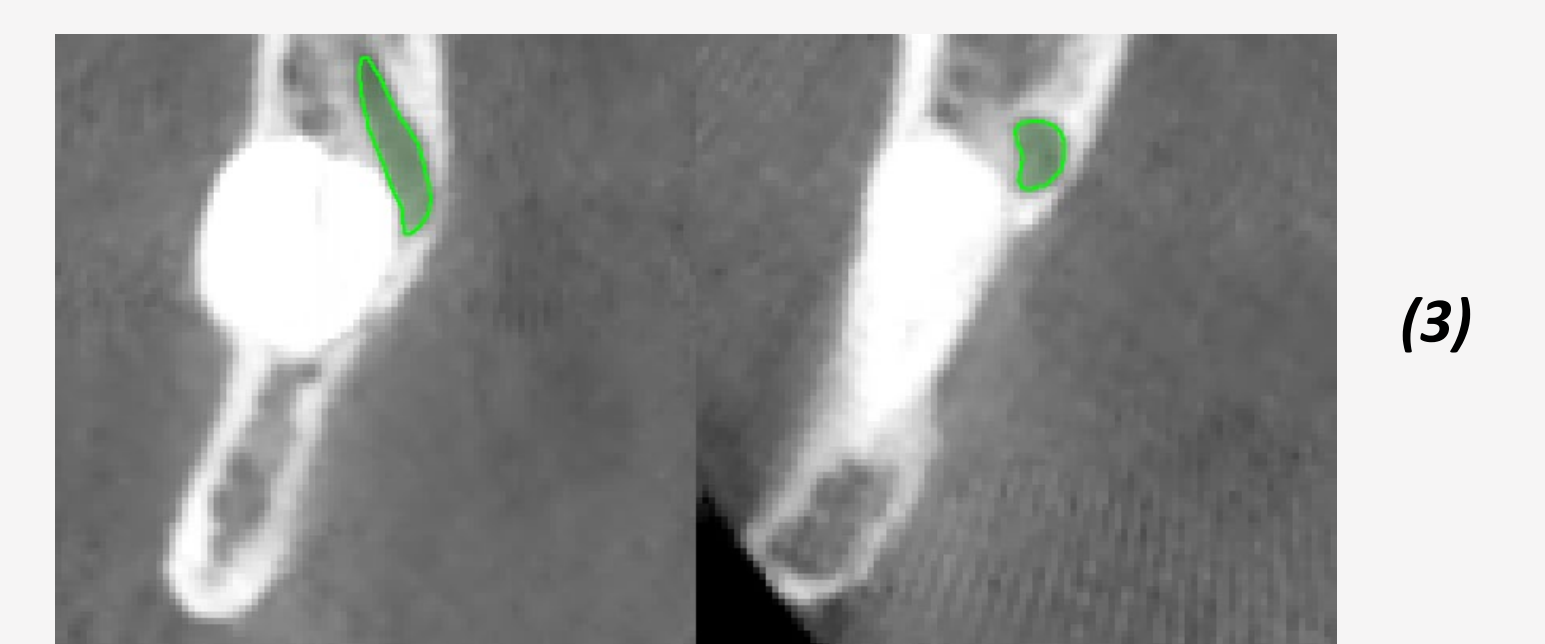

(a)   *(b)*   *(c)*

Cross-Sectional Planes

- **Tilted views** can be obtained by following the slope of the canal.
- Those views are generated by tilting the cutting planes *(1)*.
- The **slope** comes from a previous annotation on the panoramic view *(2)*.
- Those images guarantee stable circular annotations even in critical positions *(3)*.
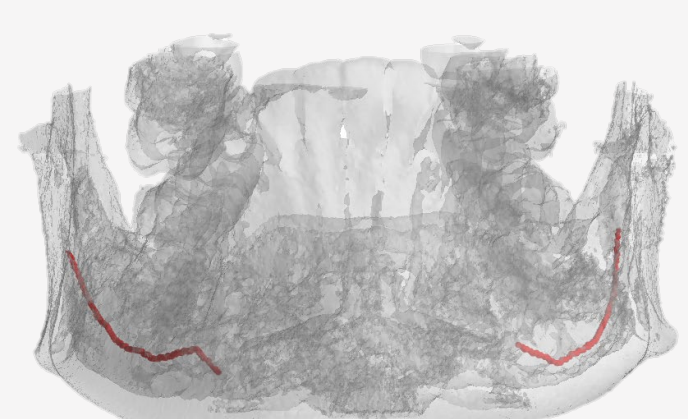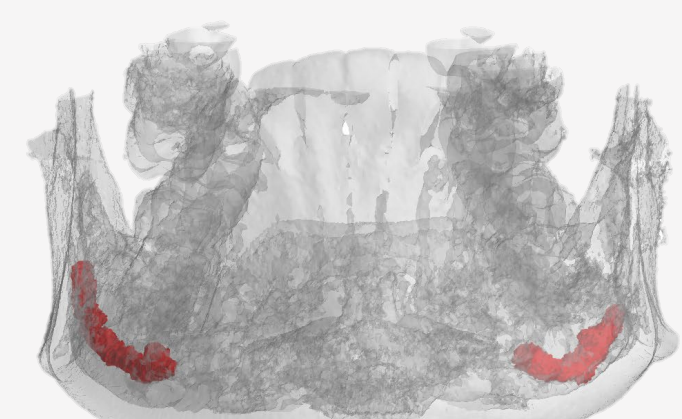

(1)

(2)

(3)

Cut using straight planes vs tilted planes in the proximity of a tooth

3D Reprojection and saving

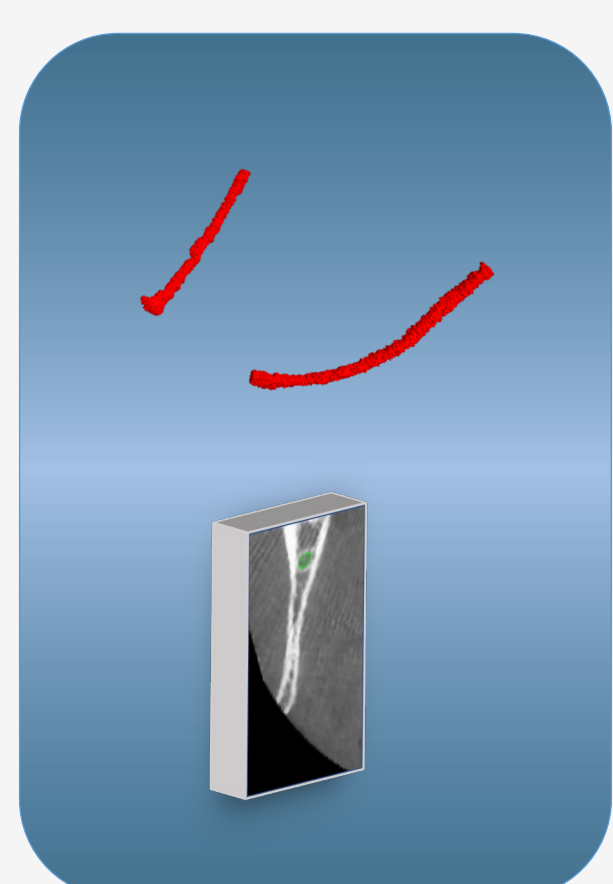2D views can be re-projected to the original volume as **3D labels**.

Traditional Annotated Volume   Our Annotation

Set of CSVs or 3D volumes can be exported in **different formats** for further purposes.


Use case and results

- Annotation tool evaluation is performed generating three datasets from four patients and training the classic UNet3D architecture for a segmentation task.
- The network is fed with blocks of consecutive slices.

	2 Labels			3 Labels		
	GTD	*GSD*	*ASD*	*GTD*	*GSD*	*ASD*
P1	0.67	0.68	0.63	0.54	0.55	0.51
P2	0.44	0.42	0.45	0.67	0.34	0.29
P3	0.59	0.42	0.41	0.63	0.26	0.26
P4	0.61	0.54	0.46	0.65	0.35	0.26

Results of the segmentation task: IoU (IAN for 2 labels) and mIoU (internal IAN and contour for 3 labels) of our network trained with slices generated by guided tilted planes (GTD), guided straight planes (GSD), and unsupervised straight planes (ASD).
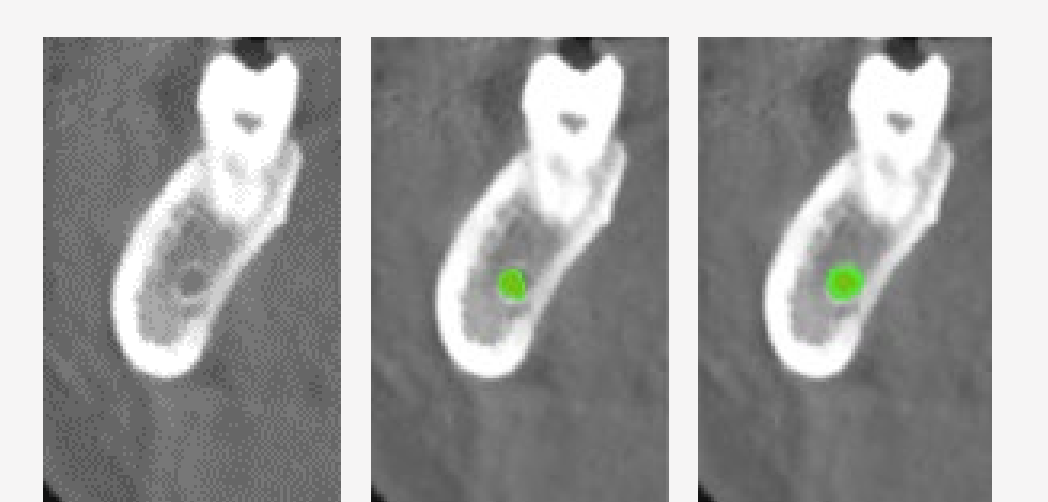
Qualitative result of a prediction. Original image on left, annotation from the tool in the middle, network prediction on the right.

- The annotation tool produces **valid datasets** for neural networks learning and generalization process.