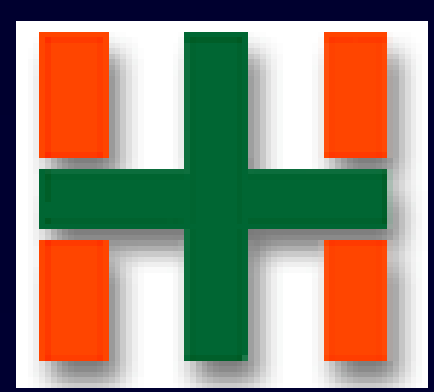




Technique Development:

Reproducibility of three-dimensional distal femur solid models using the same threshold level

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Introduction:

An important feature of CAD and medical visualization software is the possibility to fine-tune the image threshold. This enables the selection of tissue type in order to produce three dimensional reconstructed models. However, sometimes this adjustment leads to the addition of more pixels into the solid model in an inconsistent manner. As a consequence, the reproducibility of reconstruction will be different. Therefore, measurements are slightly higher due to the fact that a 1:1 ratio exists between pixels and millimeters. This study hypothesizes that if the same threshold level is always used, better reproducibility in each reconstruction can be obtained. Awareness of this situation is important to produce consistent reconstruction results in solid models. The aim of this study is to compare one group of 33 distal femurs using this new protocol of 3D reconstruction with the same threshold level, always against the same femurs using a threshold level and applying a linear dimensions measurement protocol.

New protocol for 3D accurate reconstruction of long bones applied in femurs (Bone CT threshold):

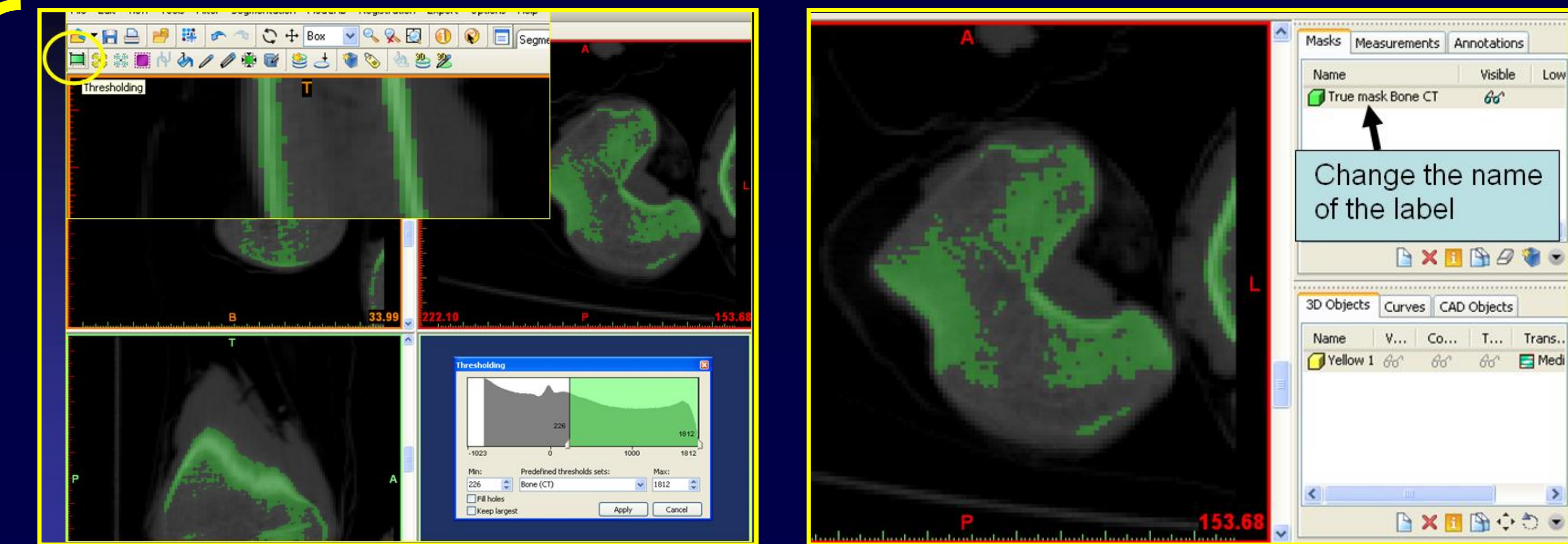
Material and Methods:

- Thirty-three fresh frozen femur allografts
- CT scanner (Toshiba Aquilion, Tochigi, Japan).
- 15 right and 18 left (age, 17-49 years; 22 M and 11 F).
- Mimics software v 11.1 (Materialise N.V., Leuven, Belgium)

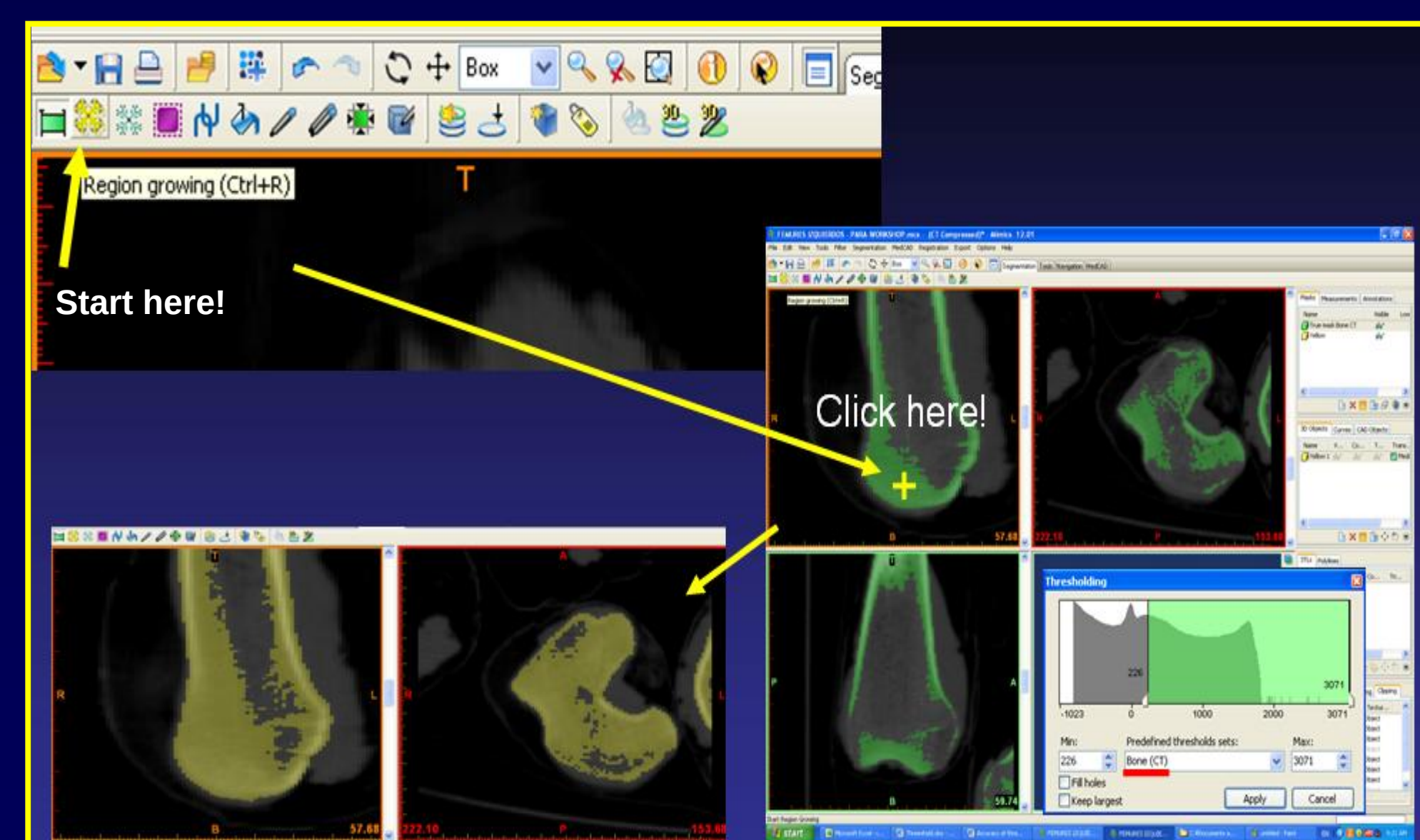
-Initially, all bones were reconstructed using an intuitive threshold level (by eye)

-After that reconstruction, the same data was subjected to the newly developed method described

1) Selection of the bone CT threshold
Keep track of each mask by labeling the mask "true mask Bone CT"

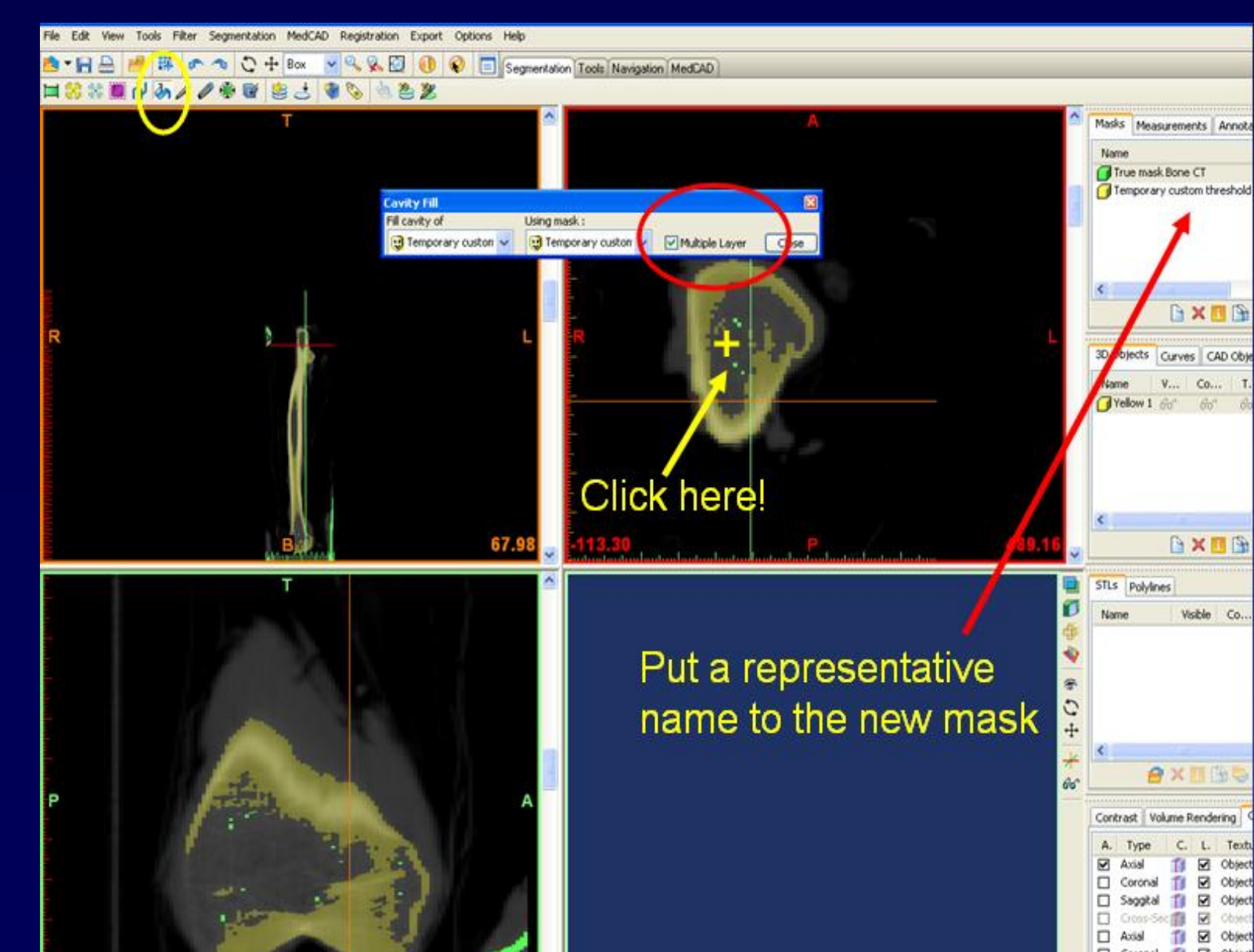


2) Use Region Growing to isolate and then change the threshold level. Add more pixels as a custom mask that allows for better visualization of the bone outer contours. This is only a temporary mask as a helper. Remember to label it as a new custom mask, called "Temporary custom threshold."

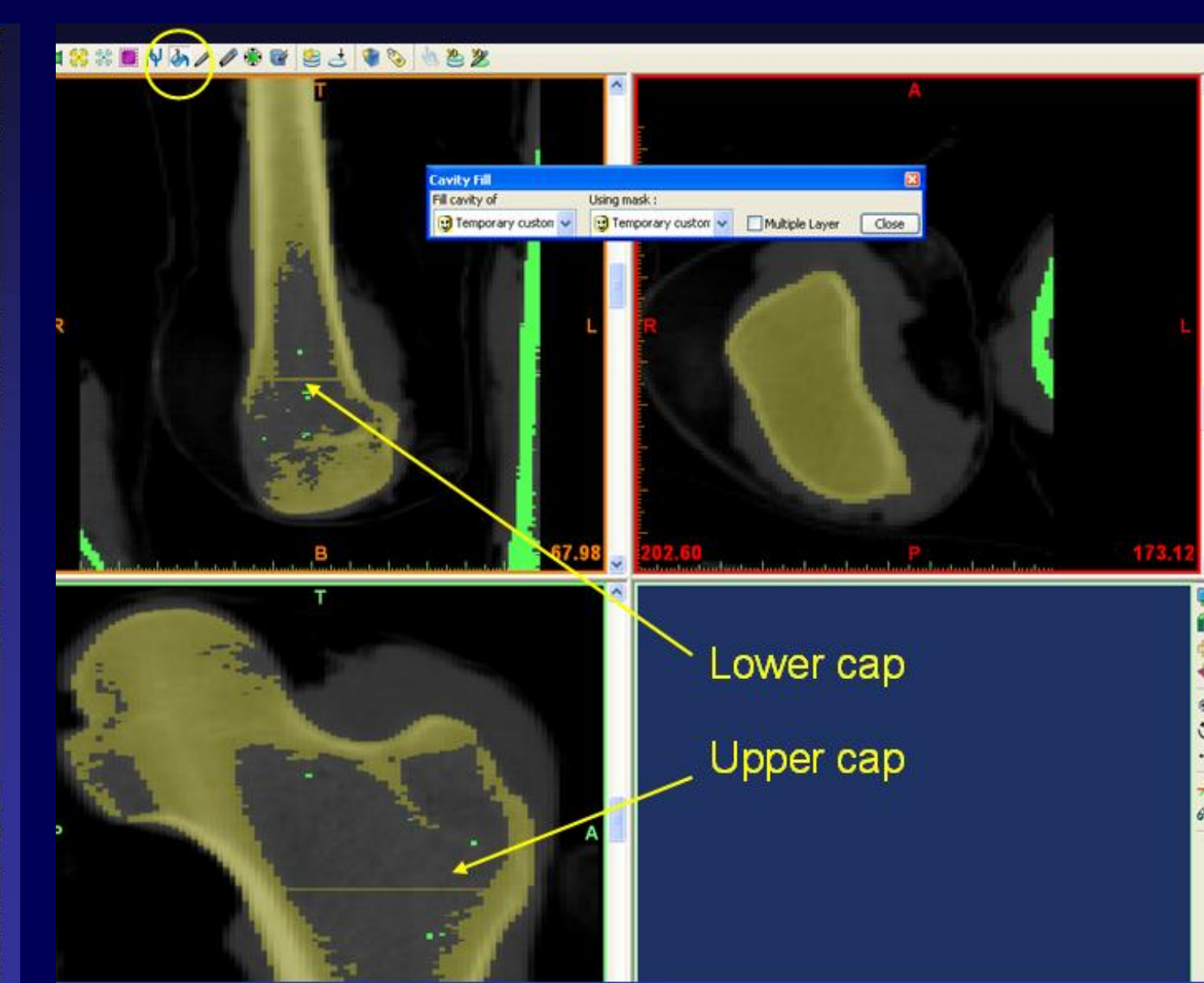


3) Reconstructing the femoral shaft: one smart method to reconstruct this structure is create two cap above and below the shaft tube, then fill the tube between both of them

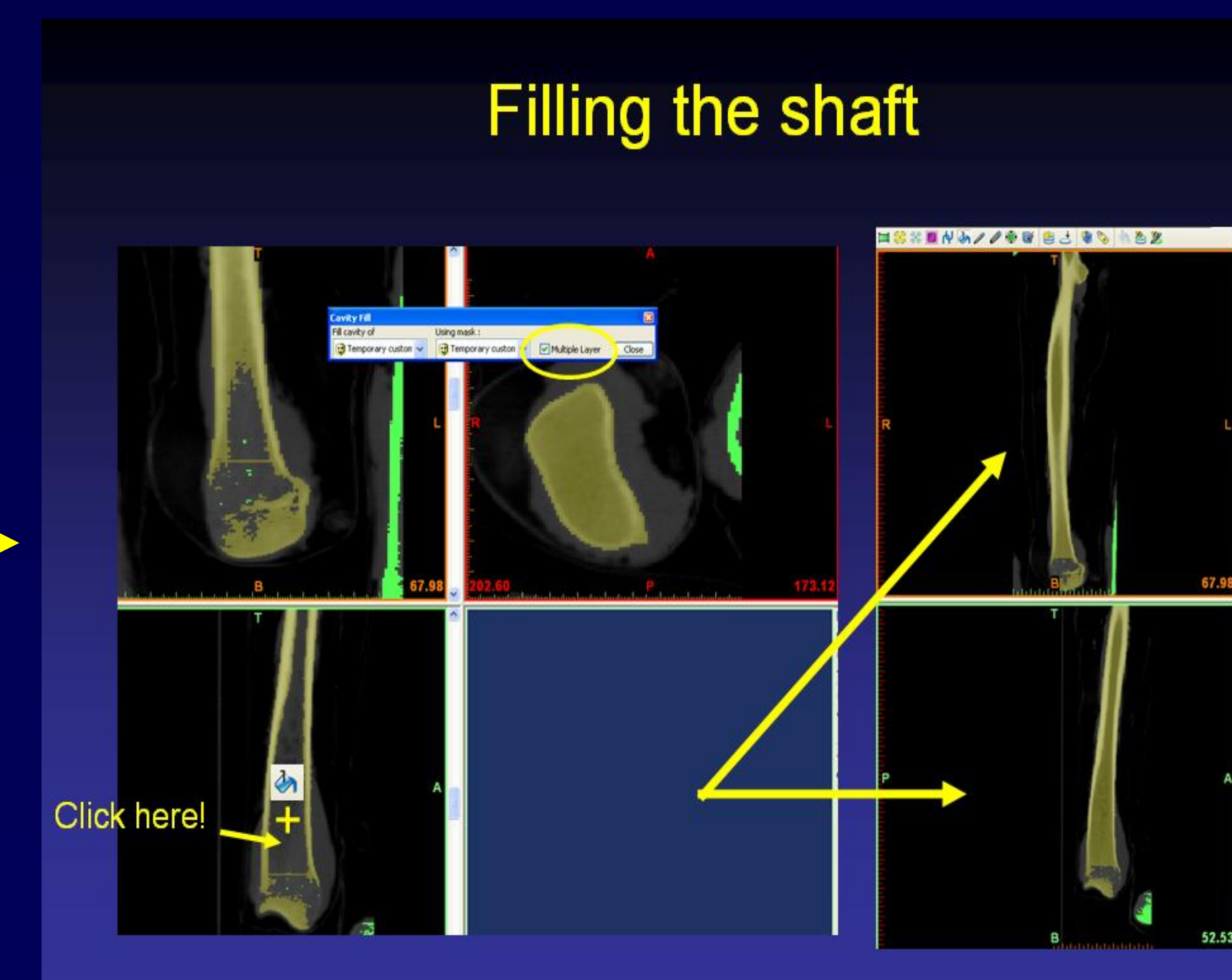
Make two caps. The first cap is shown in axial view



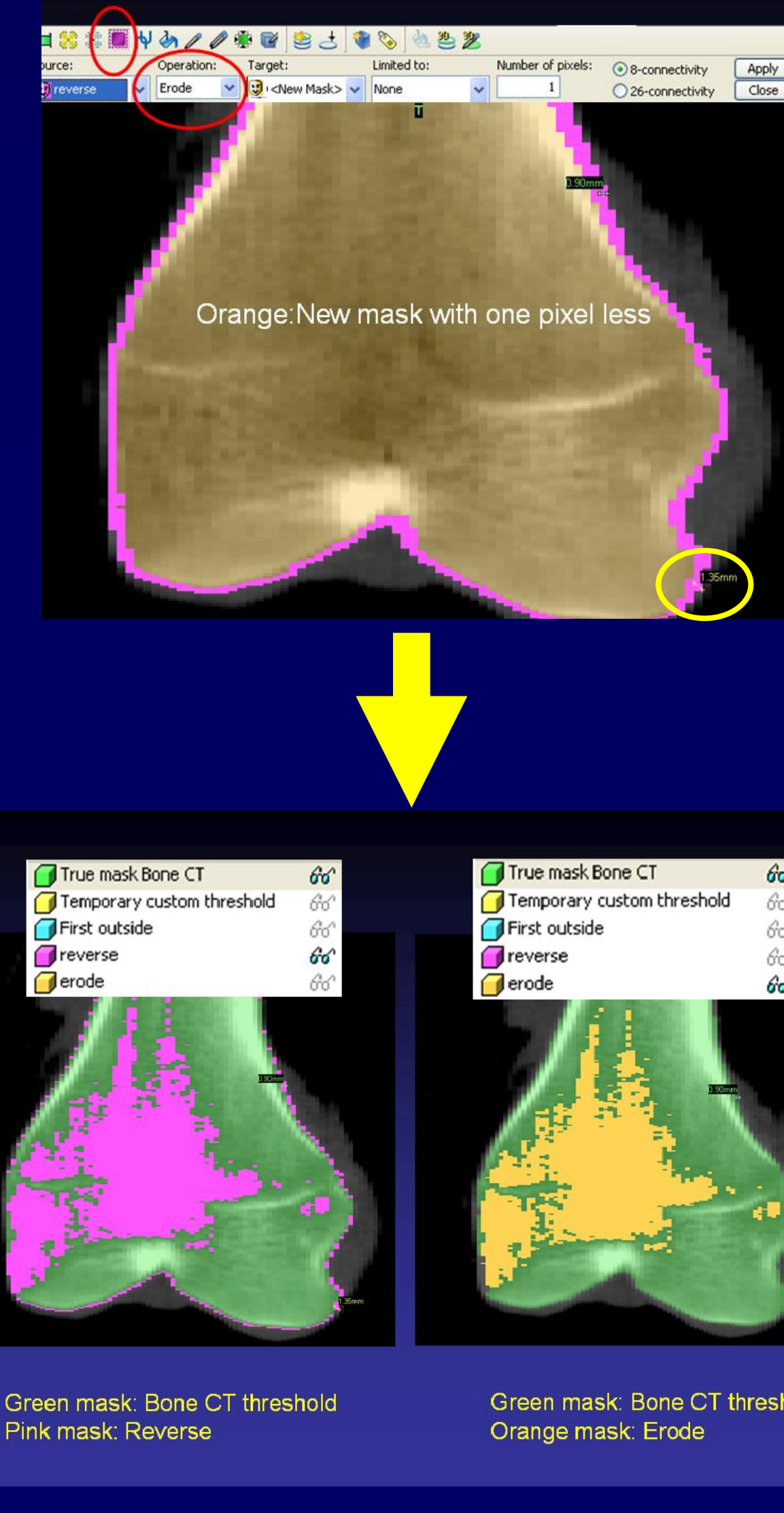
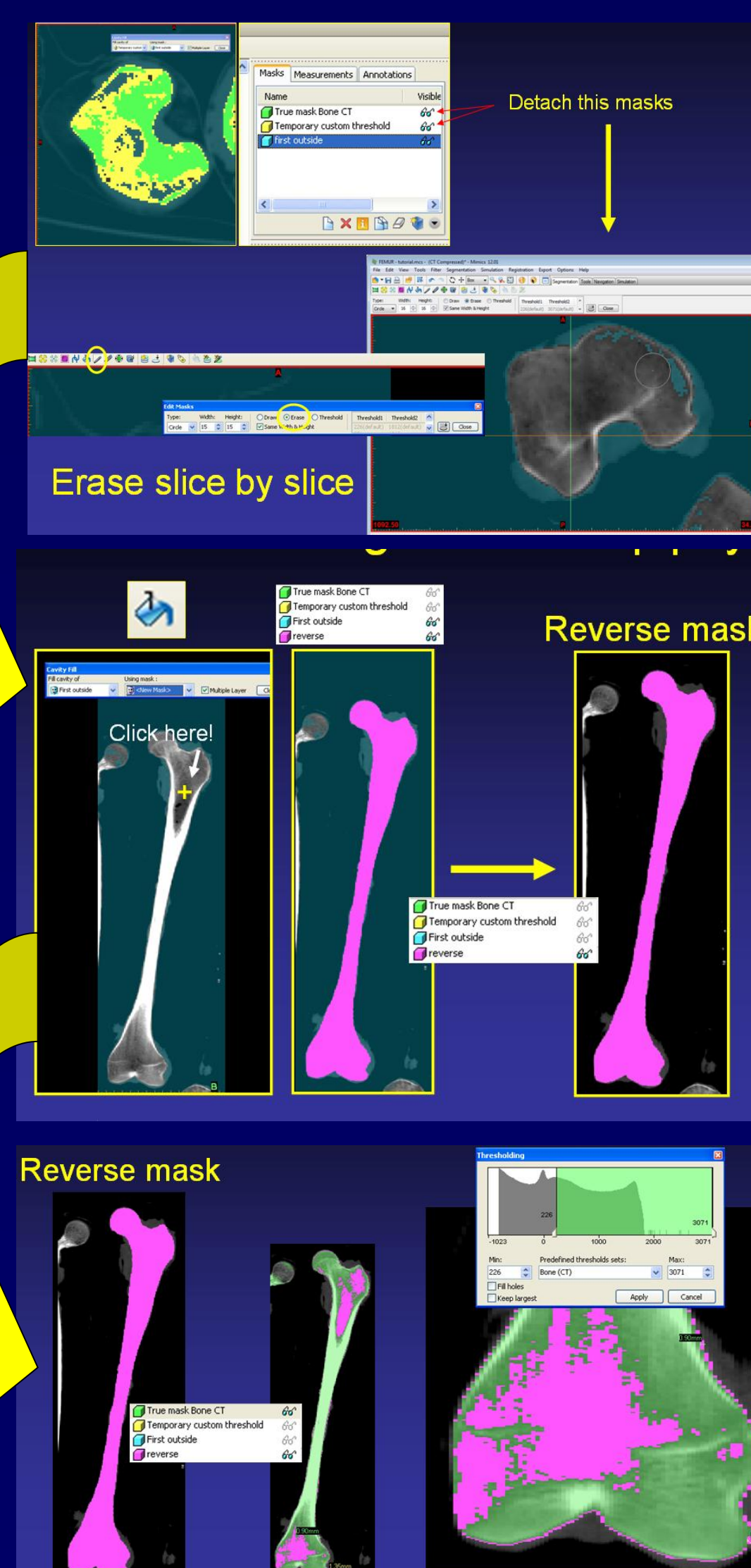
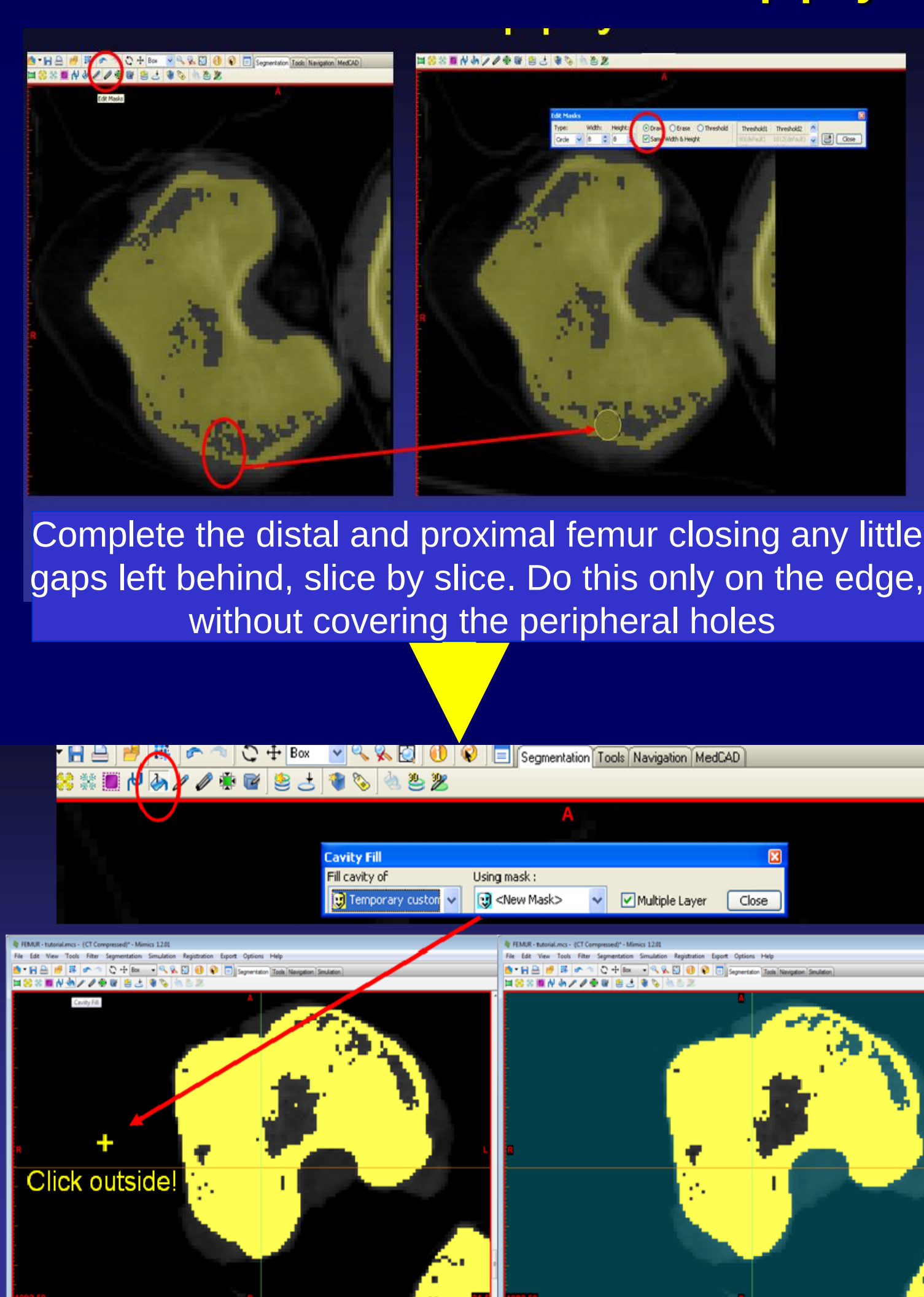
Apply the second cap at the order end



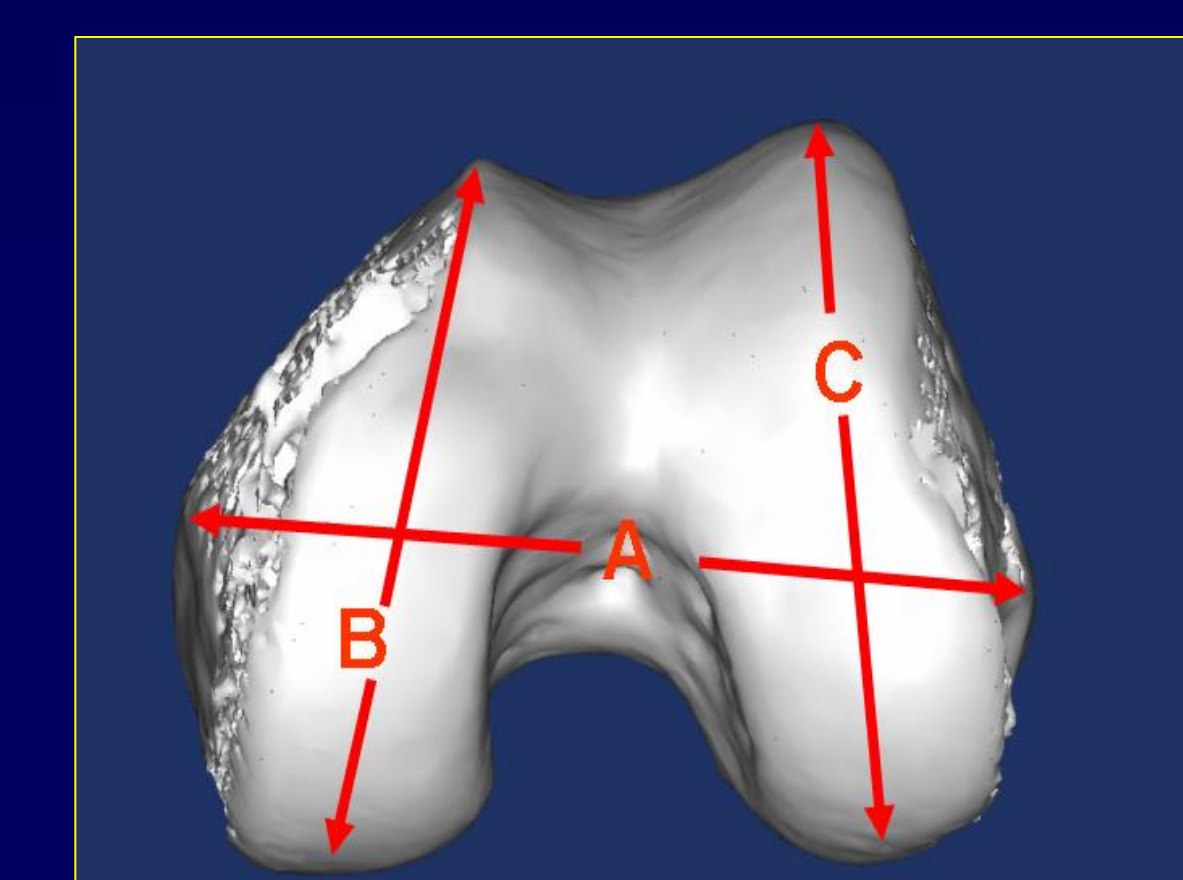
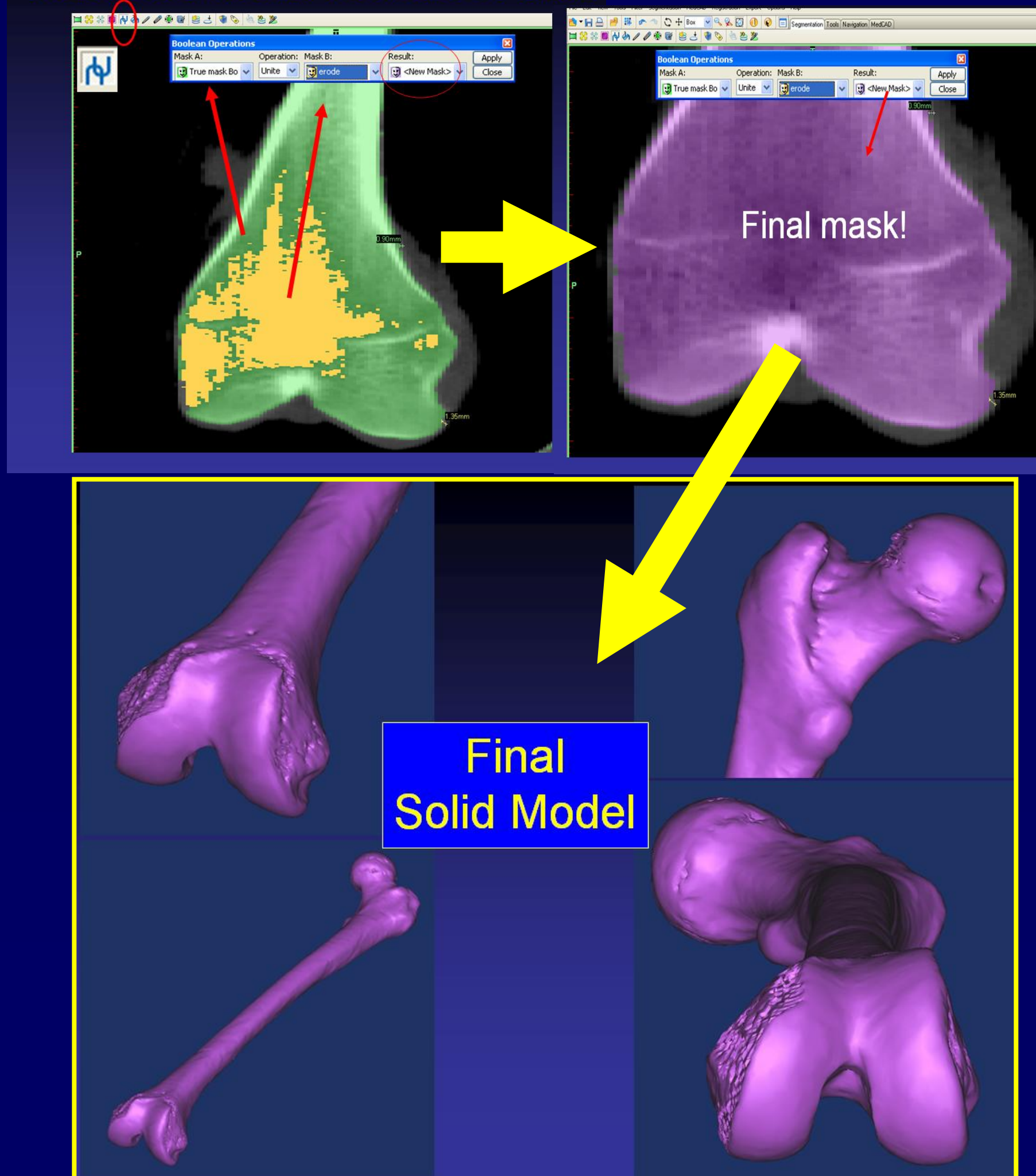
Filling the shaft



How to reconstruct the Femoral Epiphysis?



Fusion of erode and true bone CT mask



We used this measurement protocol (A-B-C) and which yielded an intraobserver error of 1.5mm.

Differences between 3D reconstruction of 33 bones using a custom threshold against Bone CT threshold were found only in 10 bones that exceed this value (1.49mm).

Rights femurs			
	Trans (A)	Med (B)	Lat (C)
1	0.31	0.78	0.95
2	1.4	1.68	0.99
3	0.48	1.28	-0.41
4	1.62	1.26	1.12
5	0.05	-0.05	-1.3
6	1.38	1.01	1.01
7	0.7	0.68	0.36
8	0.47	0.47	-0.8
9	0.87	1.89	0.86
10	0.41	0.61	0.44
11	2	1.1	1.55
12	2.44	2.57	1.8
13	0.8	-0.05	0.54
14	1.12	1.45	0.44
15	2.34	1.47	3.2
Left femurs			
	Trans (A)	Med (B)	Lat (C)
1	0.23	0.45	-0.08
2	1.38	1.29	0.91
3	-0.97	1.24	-0.48
4	0.87	1.01	0.55
5	0.55	-0.51	-0.37
6	1.4	1.68	0.12
7	1.19	0.23	0.8
8	0.6	0.66	-0.33
9	0.45	-0.9	0.6
10	0.7	0.43	0.01
11	0.94	0.87	3.18
12	1	0.62	0.66
13	0.73	0.87	0.71
14	0.89	0.75	0.12
15	0.44	1.08	1.84
16	1.22	-0.13	0.59
17	1.54	1.68	0.38
18	1.61	0.14	1.01

Conclusions : We cannot stress enough the importance of a consistent and repeatable protocol. By using the same threshold level, the use of a variable, case-by-case custom threshold can be avoided. This results in better reproducibility and reduced differences among intra- and inter-observer measured parameters.