Validation of breast volume measurement using 3D surface scanner

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Introduction

- Breast cancer treatment sequence: surgery, radiation therapy, reconstruction surgery
- Radiation therapy causes volume loss [Haykal 2013]
- Reconstruction surgeons must estimate the difference in volume
- Methods to compute breast volume generally require expensive scans or are invasive to the patient
- We propose to compute breast volume from a 3D surface scan

Objective

- Demonstrate the workflow to capture 3D surface of patient's chest
- Compute breast volume given surface scan as input

Methods

- Female mannequin represented the patient
- Ground truth breast volume was calculated by water displacement
- 3D Slicer (www.slicer.org) module was developed to visualize and manipulate the surfaces (Fig 1)
- Artec Eva 3D scanner was used to scan the patient (Figs 2, 3)
- Breast volume is computed by subtracting the chest wall from the scanned patient surface (Figs 4, 5)
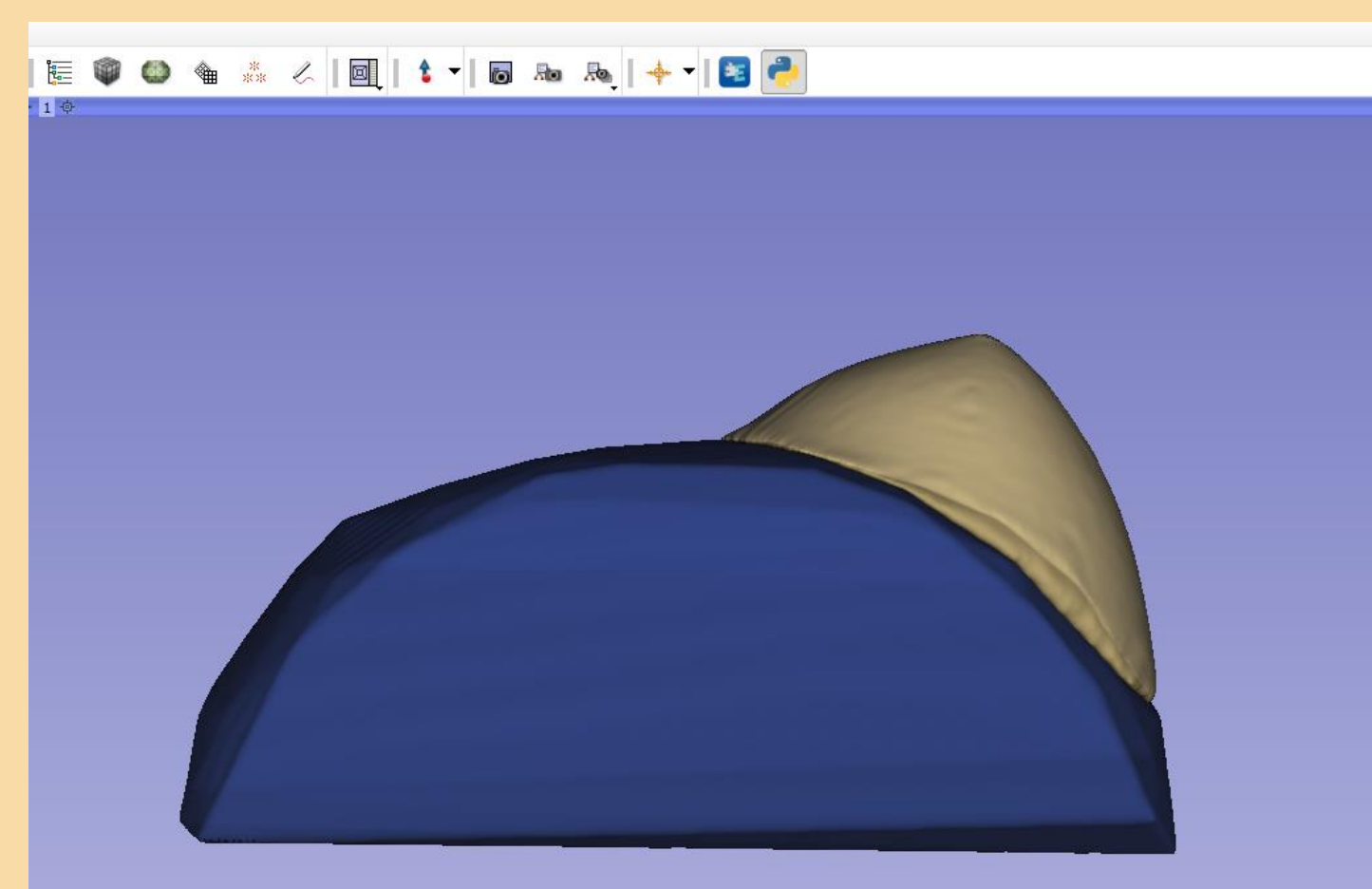

Fig 1. 3D Slicer screenshot of isolated breast and chest wall

http://www.aniwaa.com

Fig 2. The Artec Eva surface scanner

Fig 3. Female mannequin scanned with Artec Eva
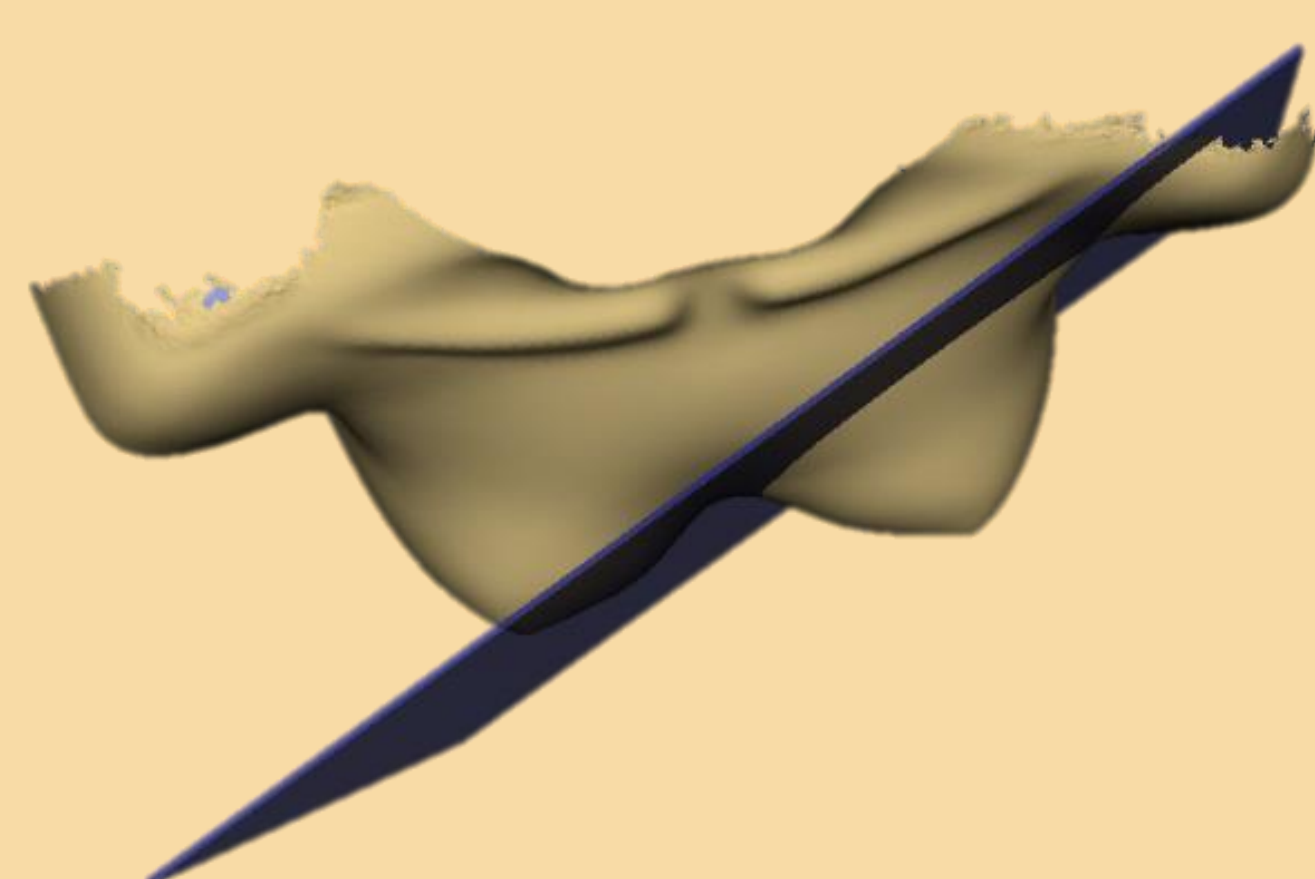
Fig 4. Visualization of flat cut plan to separate chest wall from breast

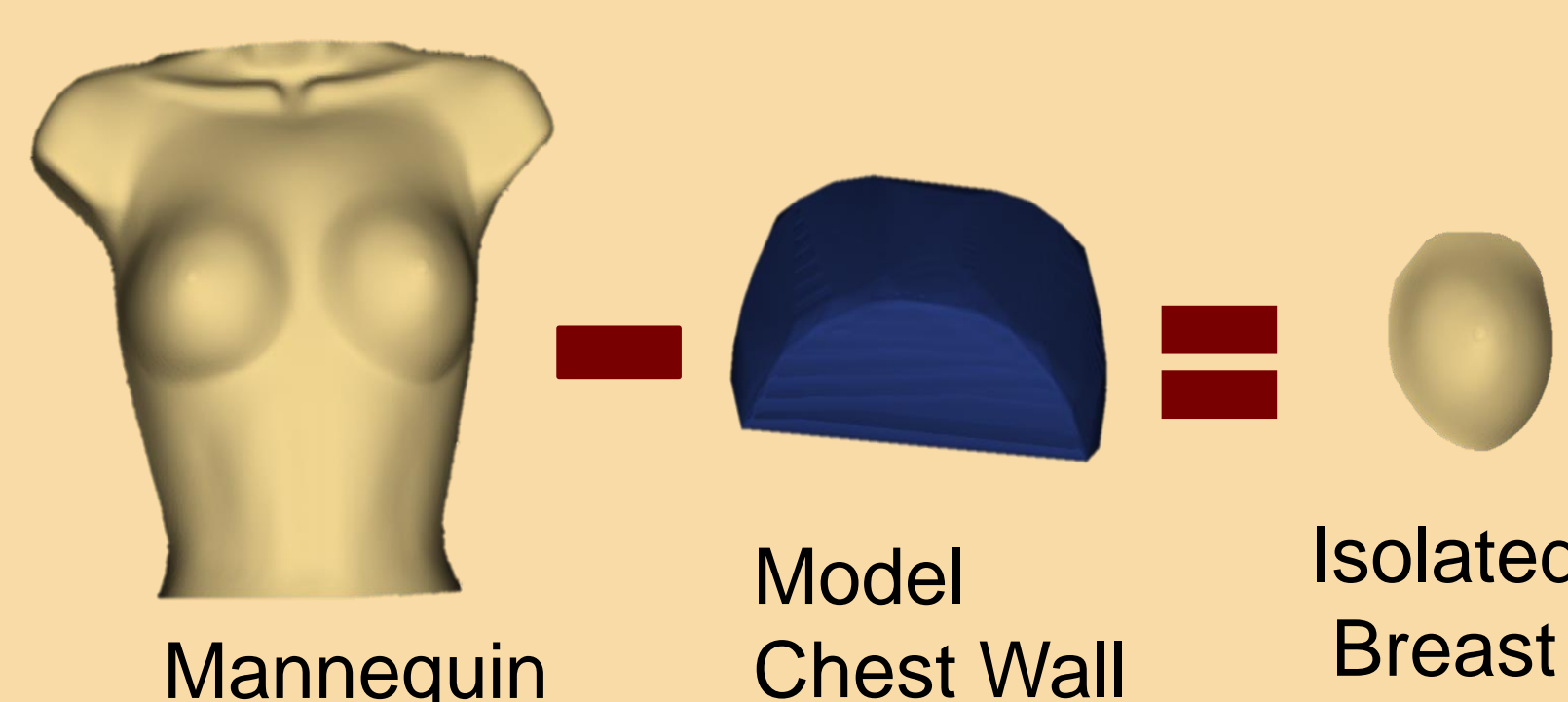Mannequin   Model Chest Wall   Isolated Breast

Fig 5. Chest wall model is subtracted from the surface scan to yield isolated breast

Results

- Scanning workflow was demonstrated on a female mannequin

	Breast Volume (mean +/- standard deviation)
Ground Truth *(n = 5)*	164 +/- 4.1 cc
Surface Scan *(n = 4)*	161 +/- 4.7 cc

Discussion

- A flat cut plane was used to separate the breast from chest, because water displacement was used to compute the ground truth breast volume
- Instead of a flat cut plane, better representation may be obtained from a patient specific CT, which is usually available from radiation therapy planning (Fig. 6)

Fig 6. Cross section of mannequin with model chest wall

- Standard deviation of the computed breast volume can be explained by having manually placed the cut plane in each trial, where small rotation or translation error leads to volume computation error
- To avoid this in the future markers visible to the Artec scanner can be placed on the patient in palpable locations before each scan (Fig. 7)
- These markers can be used to register each scan together and allow for the use of a single patient specific chest wall
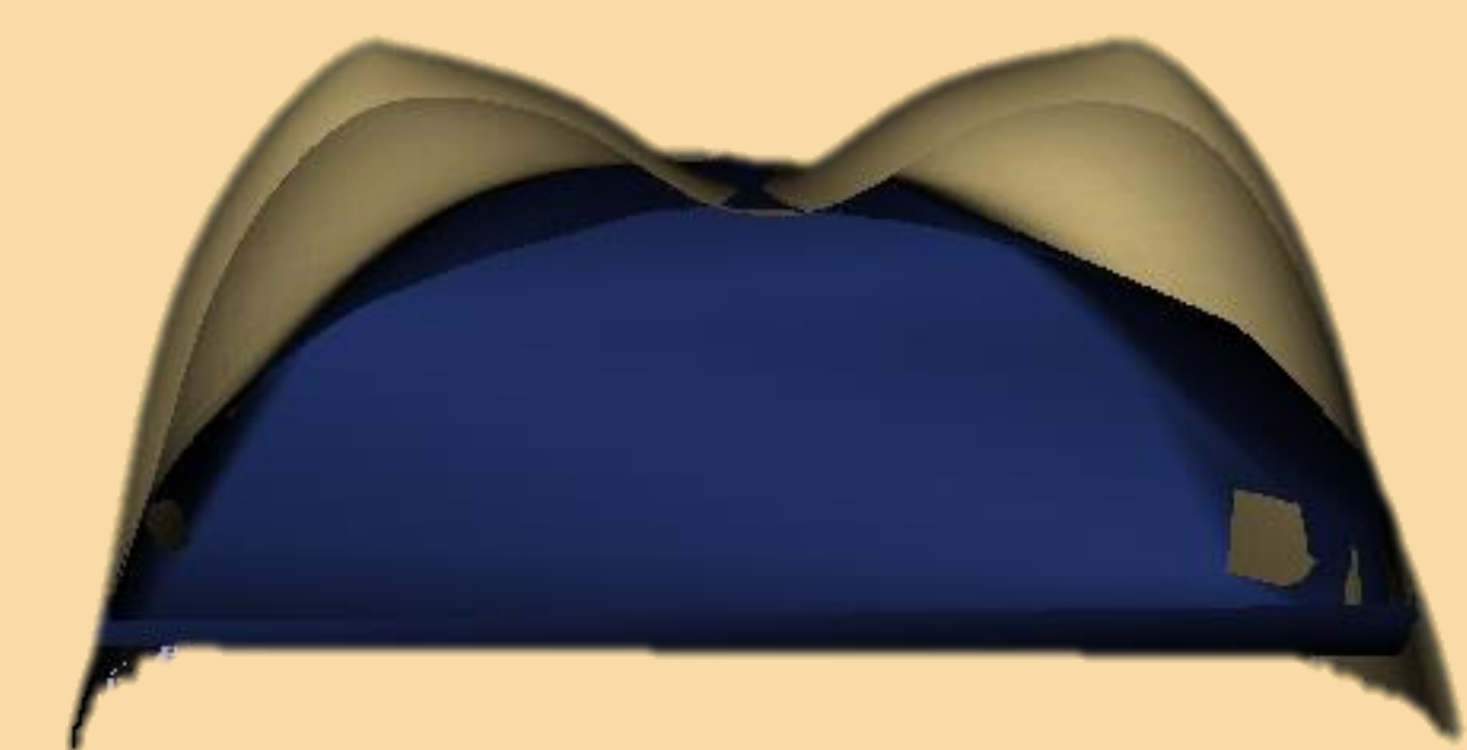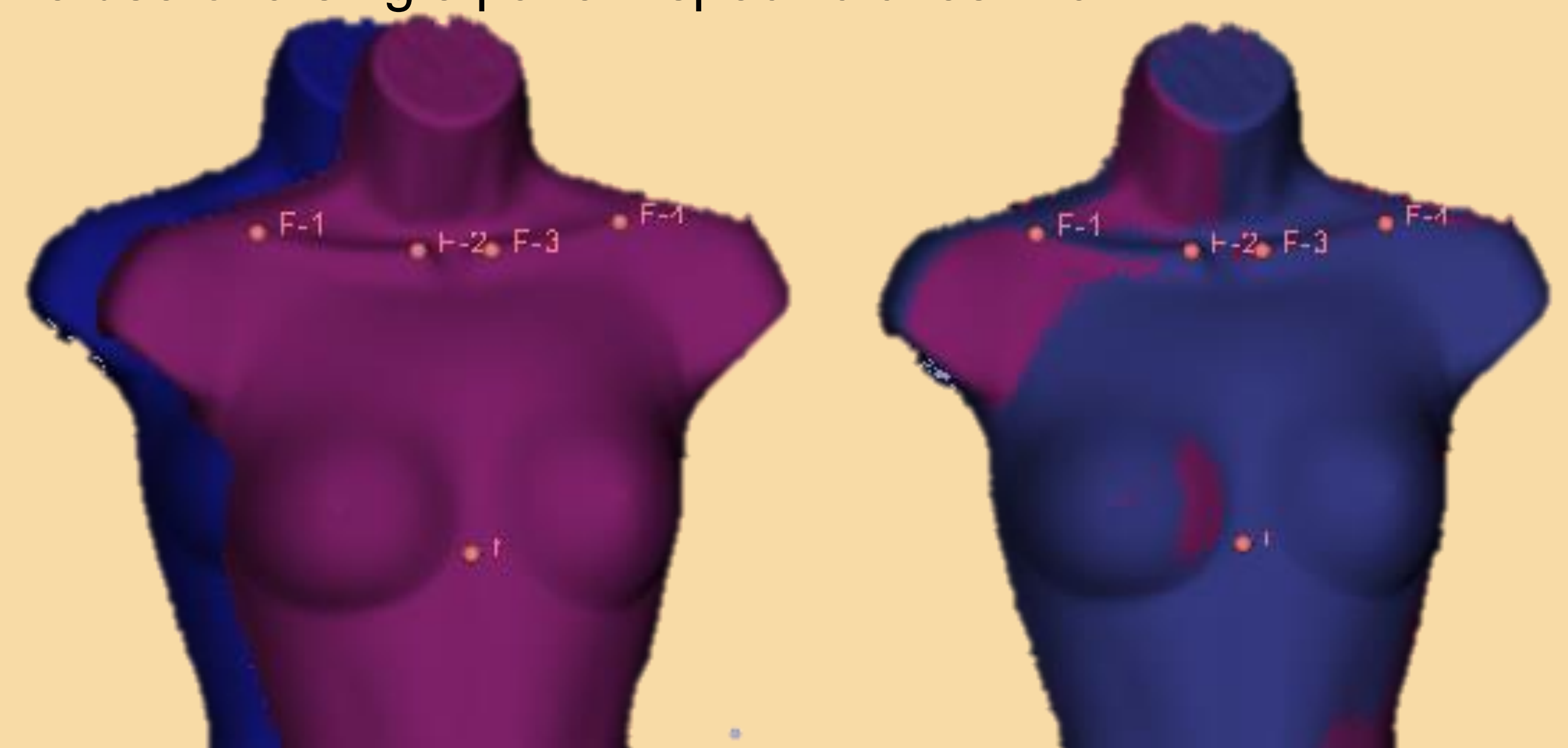

Fig 7. Example of marker placement on mannequin which can be used to register multiple scans together (left), alignment of two scans using markers (right)

Conclusion

- Using a 3D surface scanner provides a quick inexpensive way to compute breast volume
- Initial results suggest the software and workflow designed could aid a surgeon in the reconstruction process

Reference

Haykal, *et al.* "An estimation of volume loss after radiation therapy on free flap breast reconstruction." *Plastic and reconstructive surgery* 131.6 (2013): 937e-939e.