



FONDAZIONE SALVATORE MAUGERI
CLINICA DEL LAVORO E DELLA RIABILITAZIONE
I.R.C.C.S.

Reproducibility and Accuracy of Deep Inspiration Breath-Holds (DIBH) Breast Radiotherapy Based on Real-Time Positioning Management through Surgical Clips Localization

**G. Ivaldi¹, A. Fassi², M. Liotta³, P. Tabarelli³, I. Meaglia¹, C. Bocci¹,
M. Riboldi^{2,4}, P. Porcu¹, G. Baroni^{2,4},**

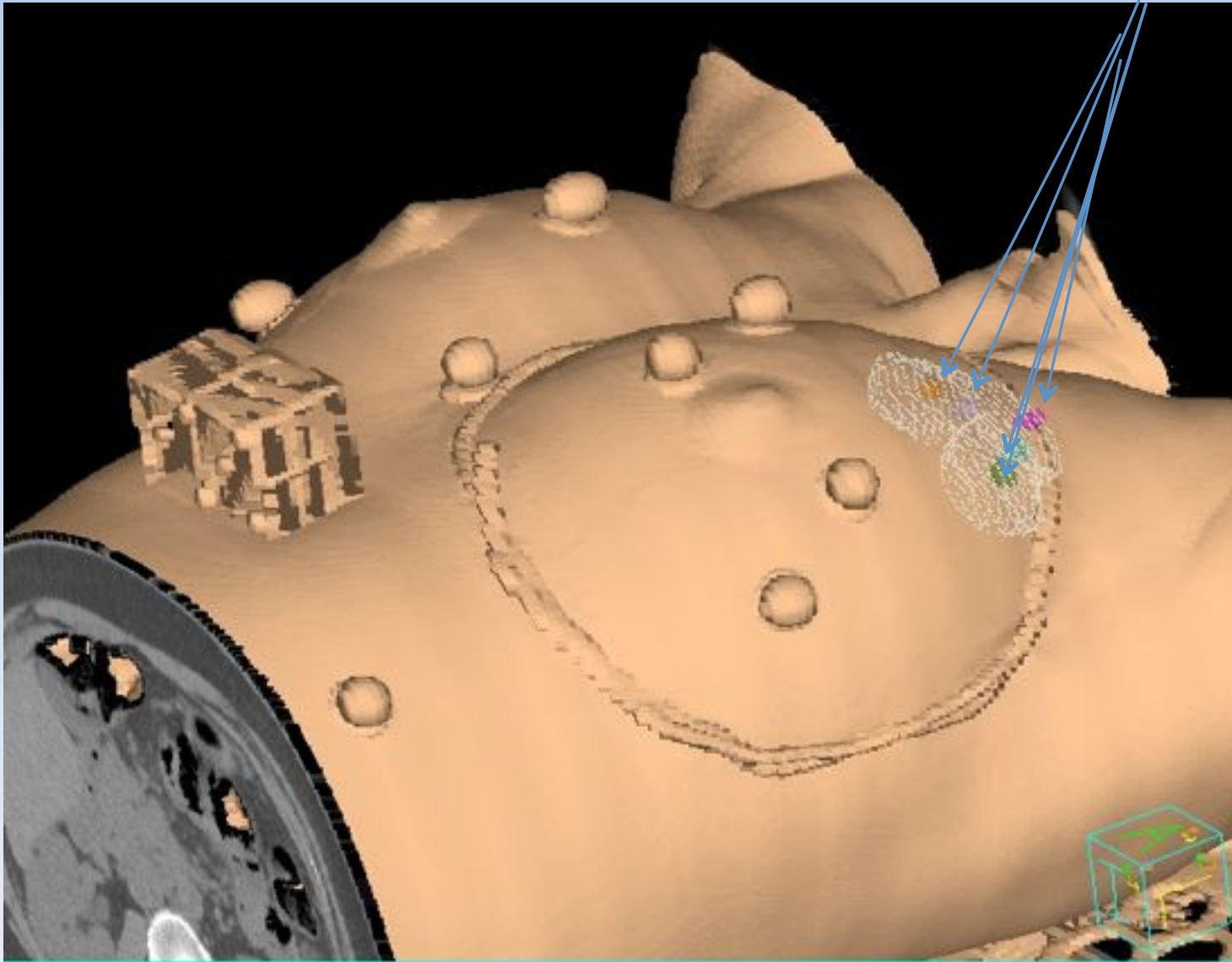
¹Fondazione Salvatore Maugeri, Department of Radiation Oncology, Pavia

²Politecnico di Milano, Dipartimento di Elettronica Informazione e Bioingegneria, Milano

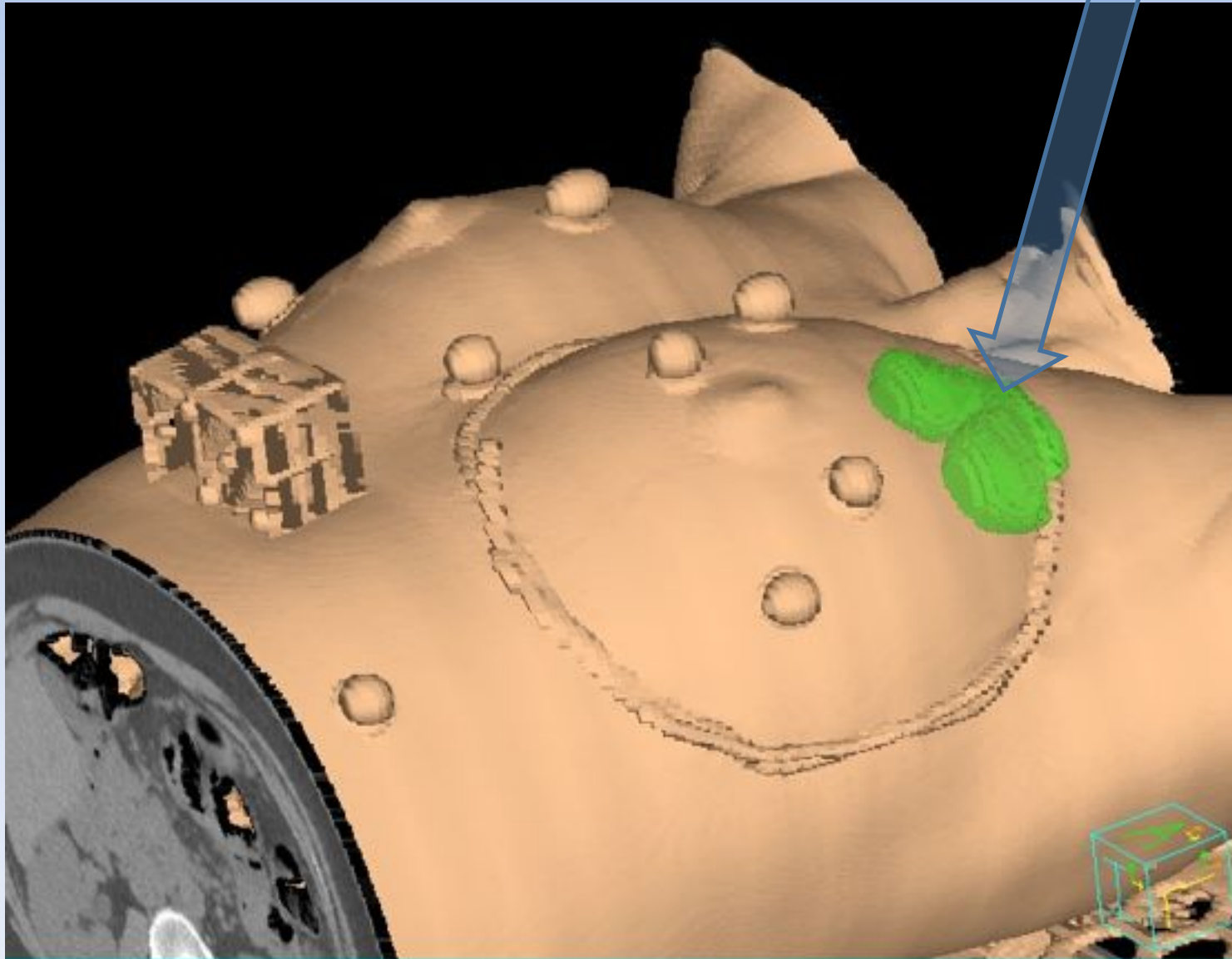
³Fondazione Salvatore Maugeri, Medical Physics, Pavia

⁴CNAO Foundation, Bioengineering Unit, Pavia

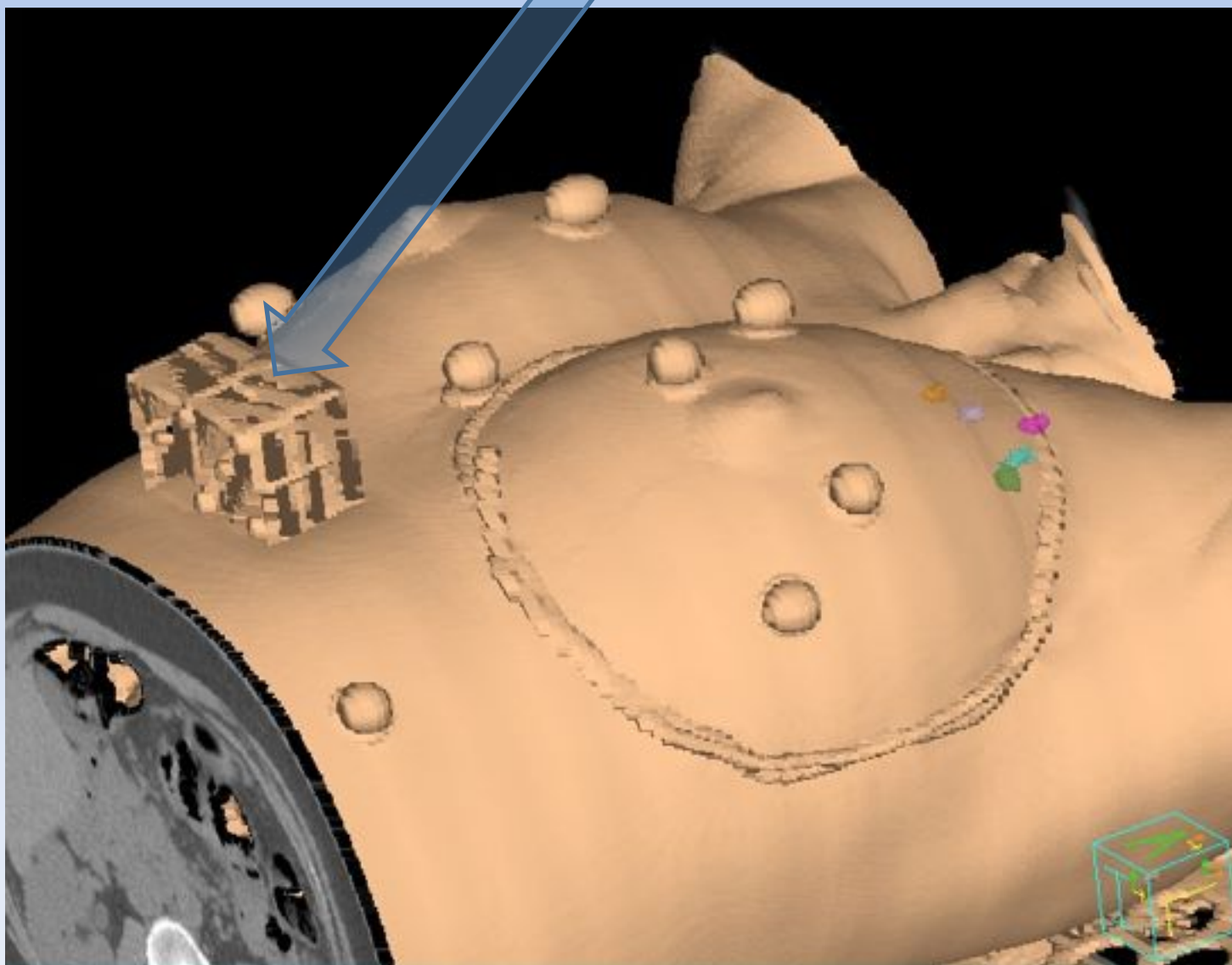
Using surgical clips implanted in the tumor bed we evaluated reproducibility and accuracy of the internal target position in repeated DIBHs performed under RPM control



Using surgical clips implanted in the tumor bed **we evaluated reproducibility and accuracy of the internal target position** in repeated DIBHs performed under RPM control

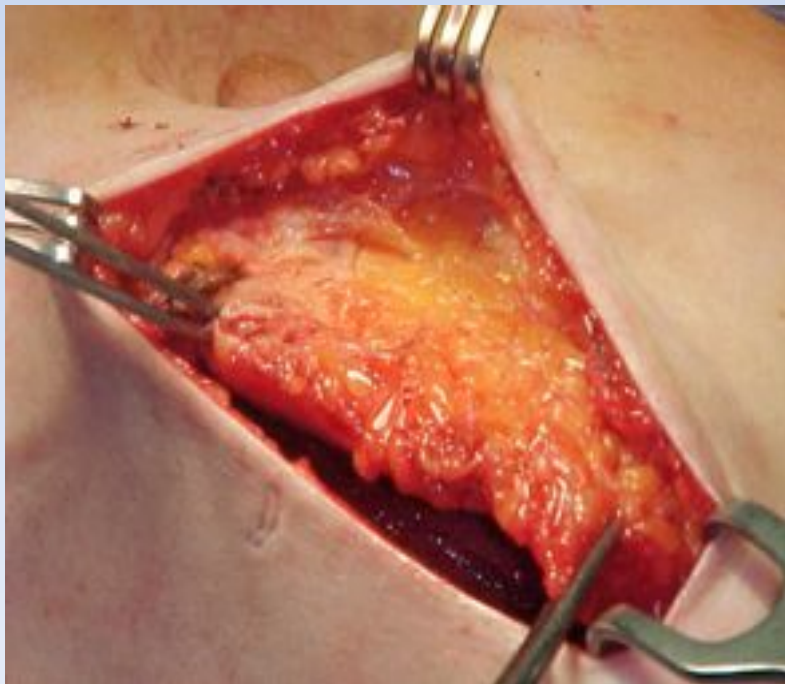


Using surgical clips implanted in the tumor bed we evaluated reproducibility and accuracy of the internal target position **in repeated DIBHs performed under RPM control**



MATERIALS/METHODS

- 8 left-breast cancer patients
- 3 to 6 titanium clips in the excision cavity walls
- Planning CT scan during single DIBH – RPM based

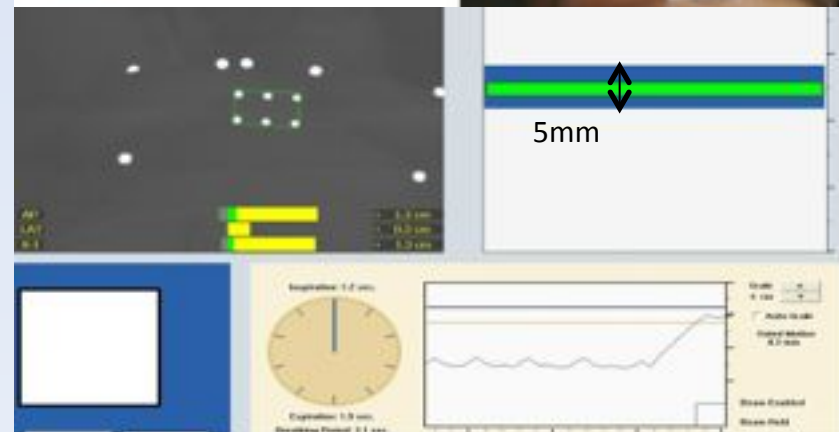
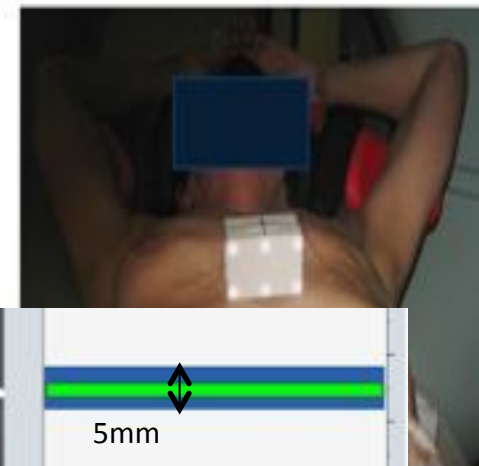


MATERIALS/METHODS

- whole-breast RT with tangential beams
- DIBH - Varian® RPM based
- **marker block** placed on the pts' abdomen
- 5 mm tolerance interval of the DIBH

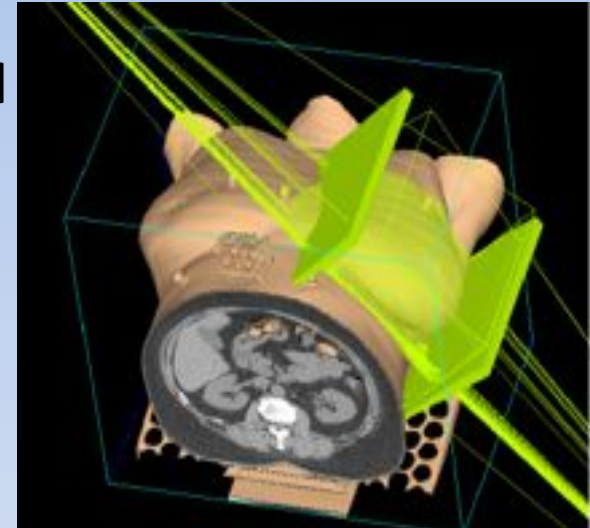


- External
- Not Invasive
- High patient compliance

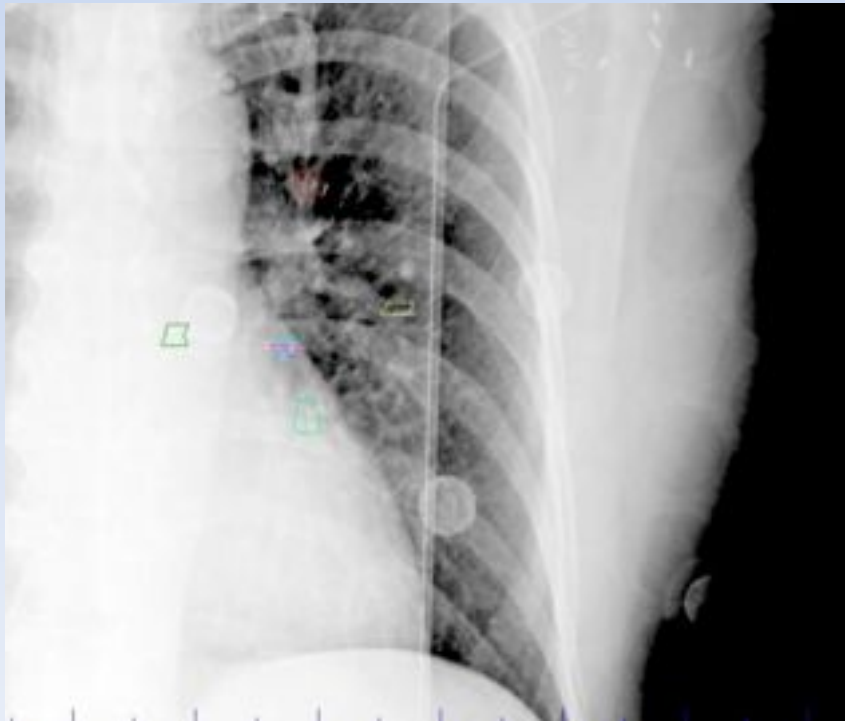


WORKFLOW

- 12-18 fx after EPID setup correction → DIBH
- 0°-315° kV-OBI images during DIBH for clips identification



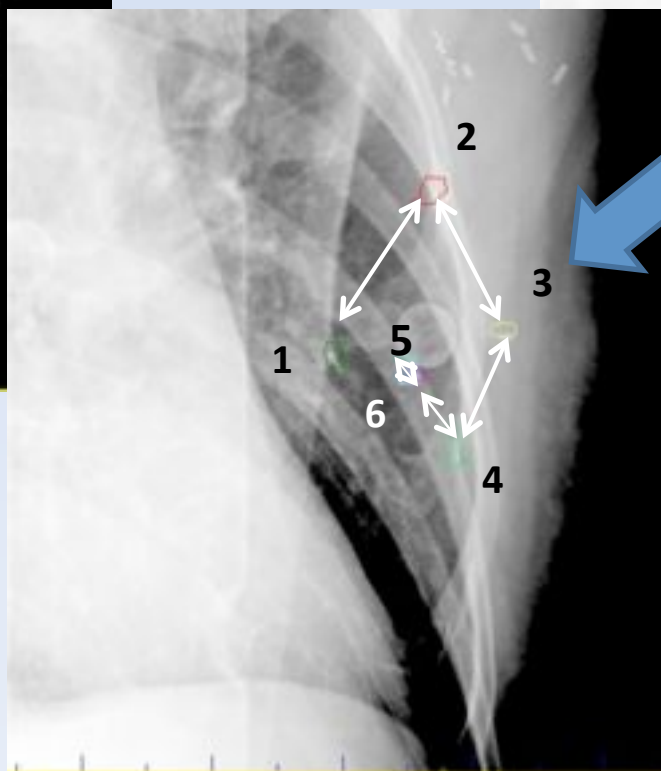
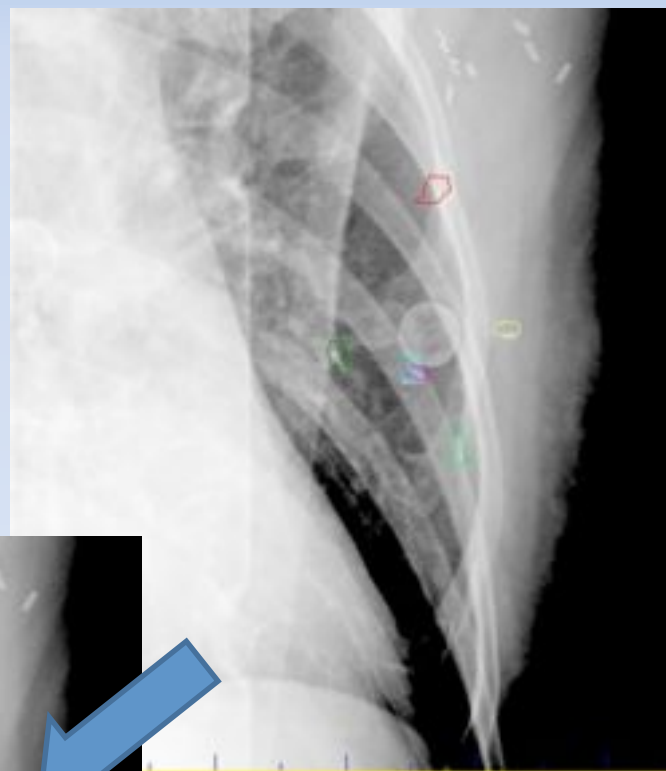
0°



315°

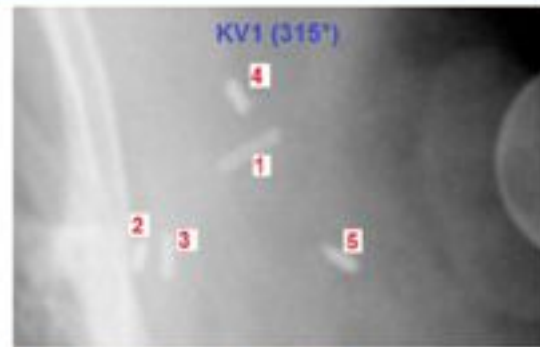


- Clips manual segmentation
- Inter-clips distance

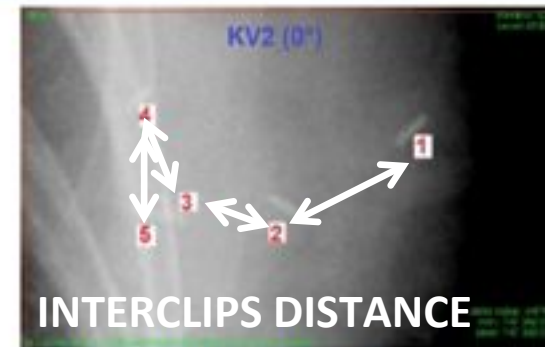




Manual selection of 2D clips position in the two acquired radiographic images



Radiographic image 1



INTERCLIPS DISTANCE

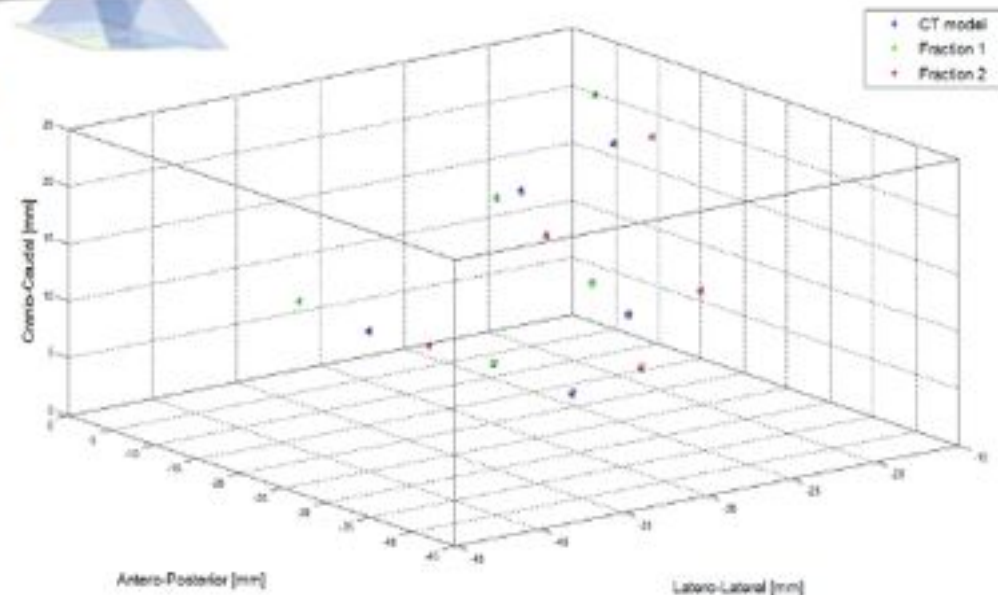
Radiographic image 2


Reconstruction of 3D clips position (triangulation technique)



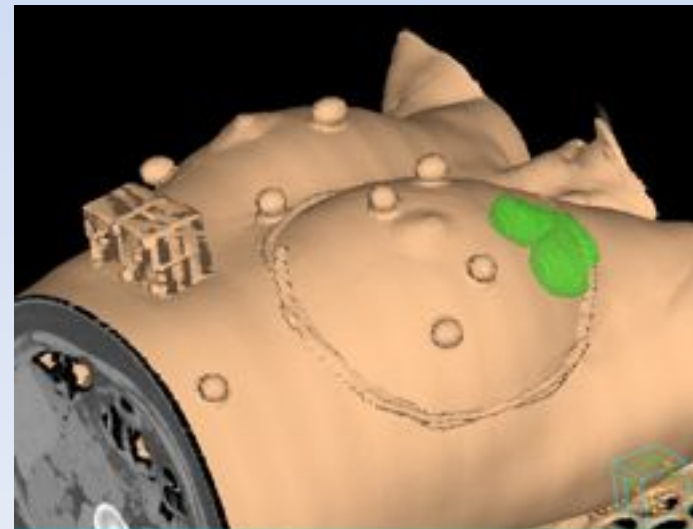
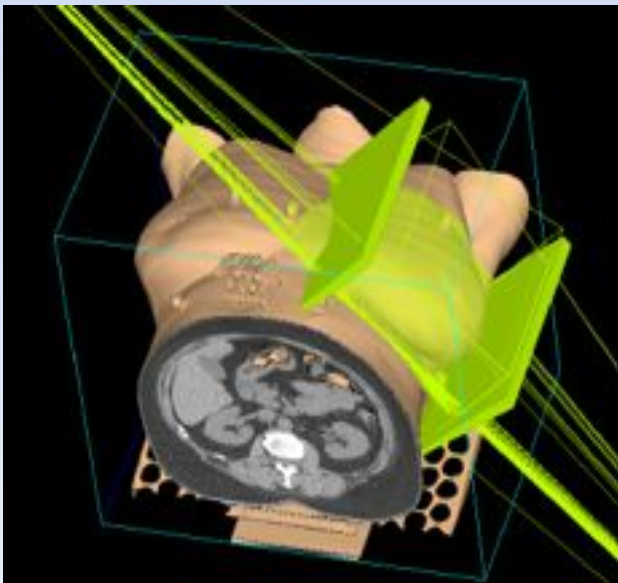
Detector

Calculation of 3D distance between treatment and CT model positions of internal clips



1.Reproducibility:  displacement around median value (fx 1,2,3.....)

2.Accuracy: displacement around reference value (fx 1 vs CT, fx 2 vs CT.....)



Results (I)

- Reproducibility: Median of SD of Clips Displacements
all fractions

Direction	Median of SD, all sessions (mm)
Latero-lateral	1.7 [range 1.3-3.0]
Antero-posterior	2.2 [range 1.7-3.2]
Cranio-caudal	2.8 [range 1.1-4.8]

- Accuracy: Absolute Clips Displacements from reference CT position

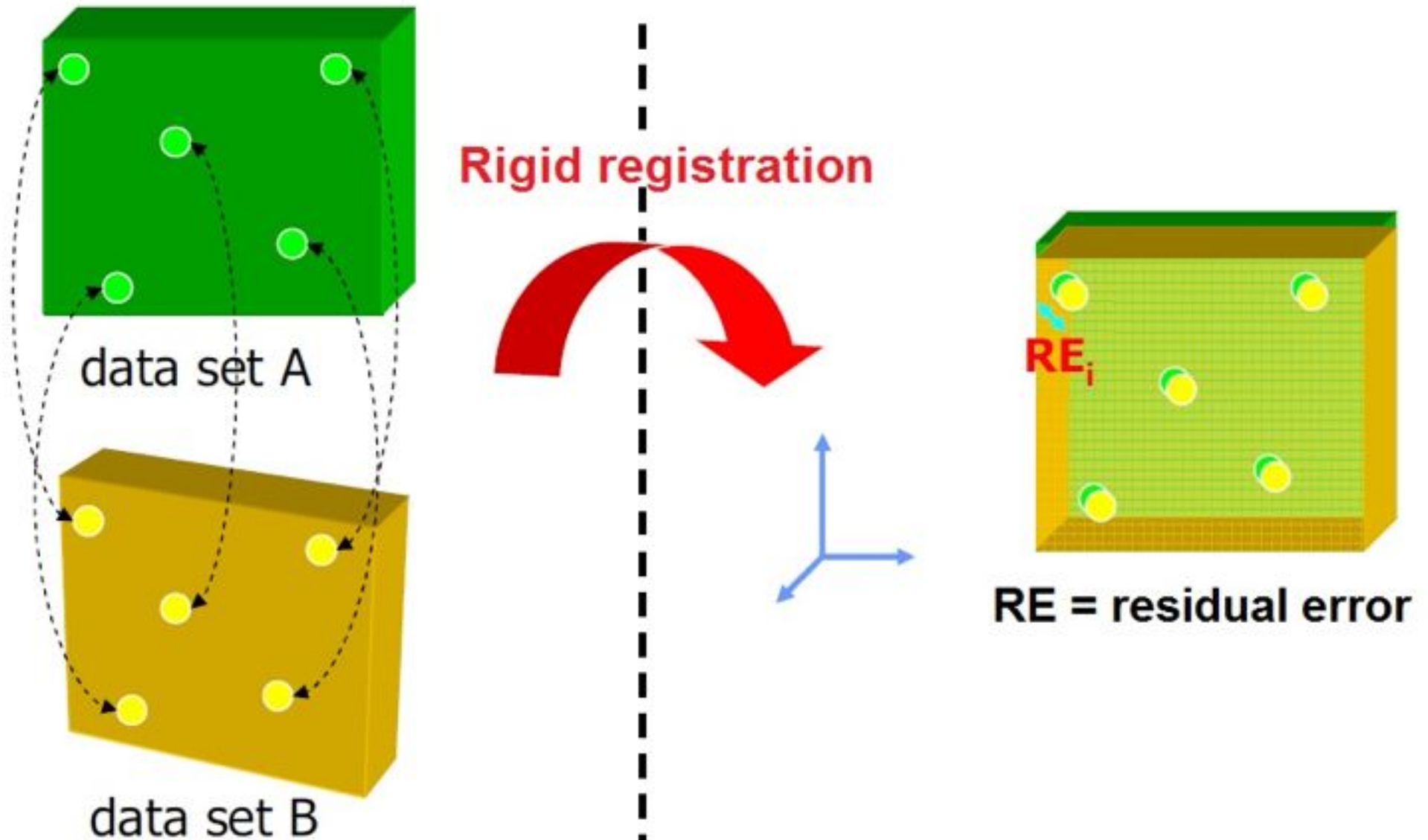
Direction	Mean all pts, all sessions (mm)
Latero-lateral	3.6 ± 1.7
Antero-posterior	2.6 ± 1.2
Cranio-caudal	2.8 ± 1.4

Conclusions (I):

RPM-based control for DIBH left-breast radiotherapy guarantees an adequate reproducibility and accuracy of the clips implanted in the surgical bed considering the adopted tolerance level

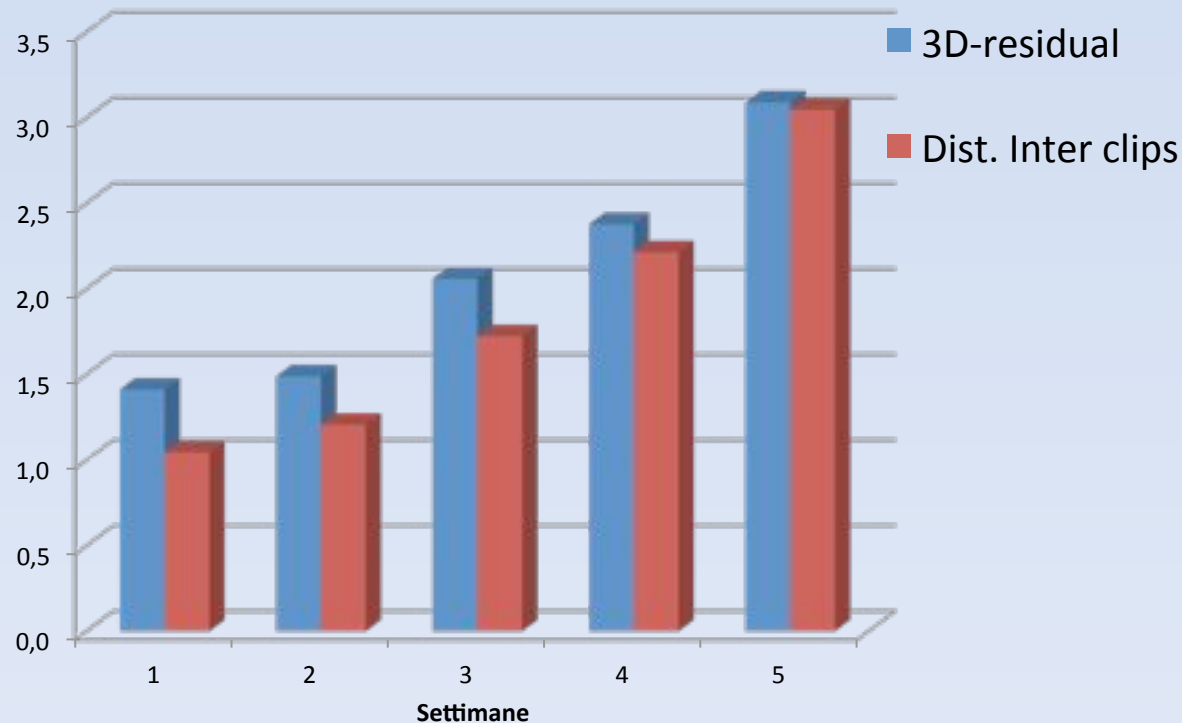
RIGID REGISTRATION \rightarrow 3D RESIDUAL ERROR

minimizing planning and treatment clips distance



Results (II)

3D Residual Error and Inter-Clips Distance



Conclusions (II):

The increasing residual error during therapy implies the possibility of lumpectomy cavity variation. As a matter of fact we observed a corresponding increasing variation of inter-clips distance

"The Discovery" 1956



Grazie

FUTURE RESEARCH

- Dosimetric implications for surgical bed
- Passive markers on skin surface →
- Deformable registration → CT volume and other structures
- Dosimetric implications for all CTVs and OAR