



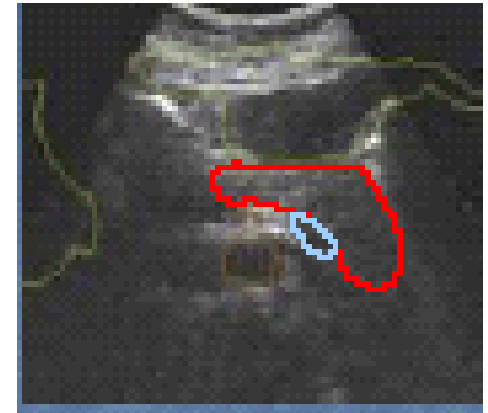
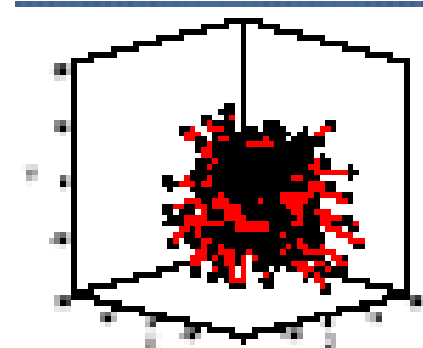
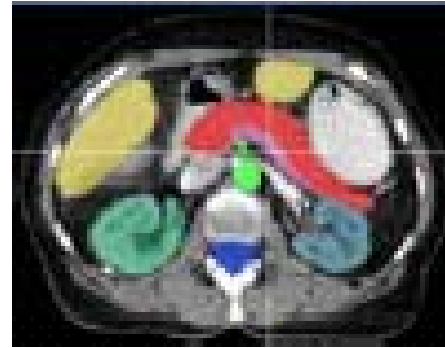
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Radioterapia Oncologica



XVII Convegno Regionale
AIRO Piemonte Valle d'Aosta

Asti 18 ottobre 2008

Hotel Salera
Via Monsignor Marella 19



Ultrasound Guided In-Room for daily target localization:

IGRT by Restitu Resonant

F. Muñoz

SCDU 1- Az. Osp. S. Giovanni Battista di
Torino. Università di Torino. Dir. Prof. U.
Ricardi



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Image Guided RadioTherapy

A Physician's Perspective

IGRT is not new!!!



Johns (1959)
Princess Margaret
Hospital

kV portal imaging
on a ^{60}Co Unit

To improve setup
accuracy



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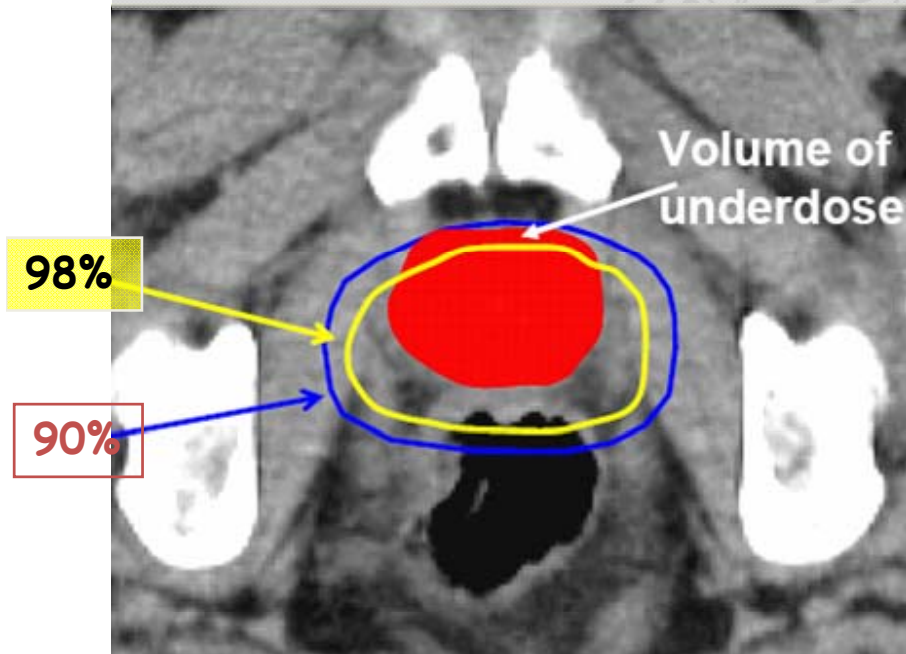
Image Guided RadioTherapy

A Physician's Perspective

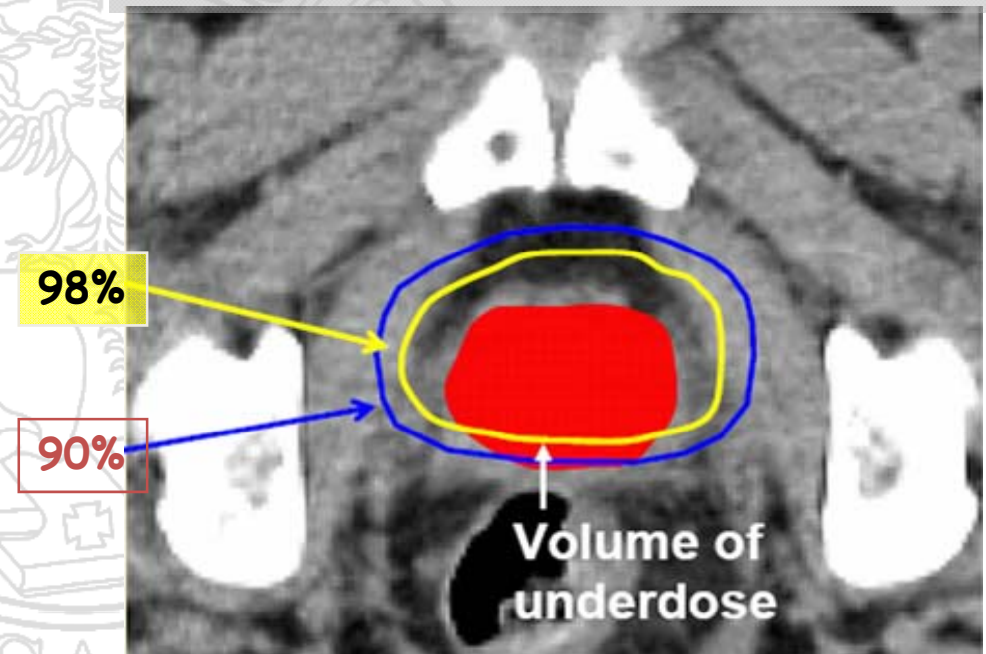


Potential dosimetric consequences of missing the target

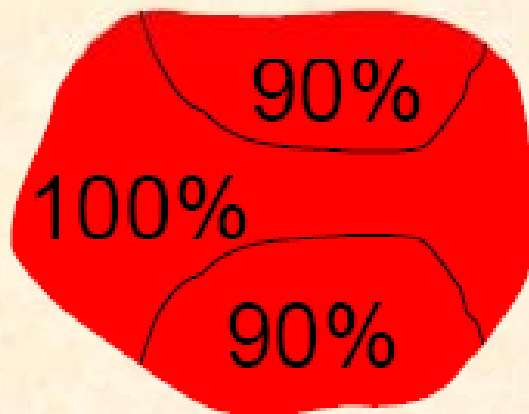
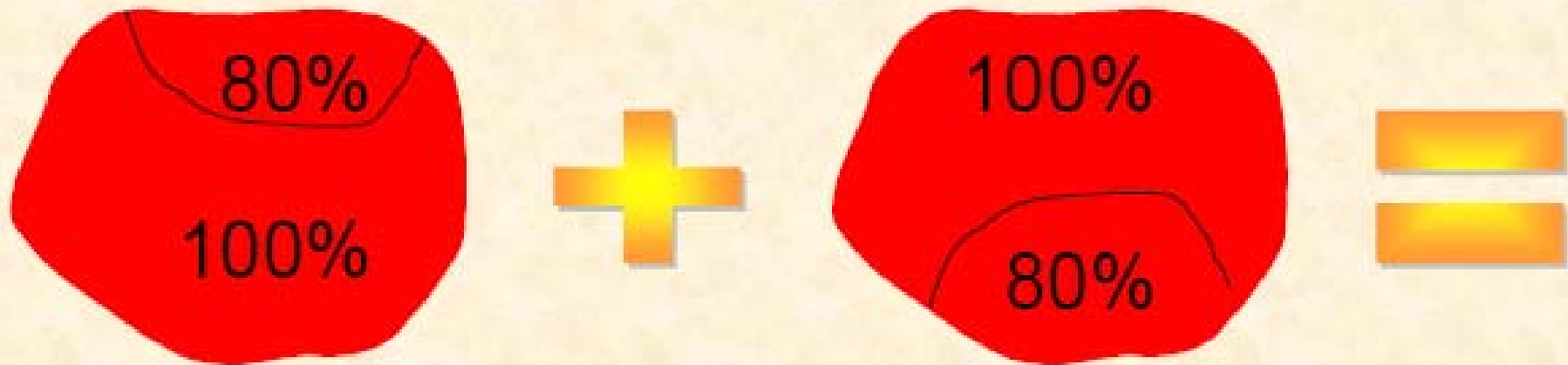
A more detailed look at the first day of treatment



A more detailed look at the second day of treatment



How do you add the prostate doses?

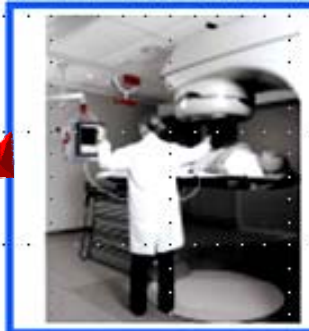


But only if you keep careful track of what part of the prostate got what dose.

Image-Guided RT Technologies



Ultrasound
BAT
SonArray
I-Beam
Restitu



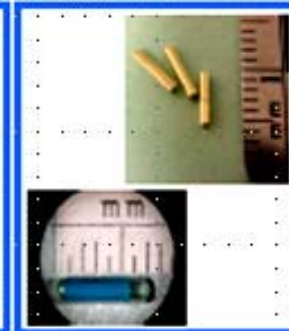
Ultrasound



kV Radiographic



Portal Imaging



Markers
(Active & Passive)



Siemens
PRIMATOM™

kV CT



TomoTherapy
Hi-Art™

MV CT



Elekta Synergy™

Varian OBI™

kV and MV Cone-beam CT



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METHODS OF CALCULATION

CROSS-MODALITY CALCULATION METHODS

Ultrasound
BAT
SonArray
I-Beam
Restitu



B-MODE-
BAT,
NOMOS

www.nasmedical.com



SONARRAY
VARIAN

www.varian.com



I-BEAM
CMS

www.cms-stl.com

INTRAMODALITY CALCULATION METHODS




RESTITU
RESONANT



CROSS-MODALITY CALCULATION METHODS

BAT SYSTEM, SANARRAY, E.BEAM

Two orthogonal 2D US images obtained immediately prior to treatment are compared to the position of the CT designed treatment planning volumes



CT-MRI image fusion for delineation of volumes in three-dimensional conformal radiation therapy in the treatment of localized prostate cancer

G L Sannazzari, MD¹, R Ragona, PhD¹, M G Ruo Redda, MD¹, F R Giglioli, PhD², G Isolato, MD¹ and A Guarneri, MD¹

A study of prostate delineation referenced against a gold standard created from the visible human data

Zhanrong Gao^{b,*}, David Wilkins^{a,b,c}, Libni Eapen^{a,c}, Christopher Morash^c, Youssef Wassef^c, Lee Gerig^{a,b,c}

^aDepartment of Radiation Oncology, The Ottawa Hospital Regional Cancer Centre, Ottawa, Canada, ^bDepartment of Physics, Carleton University, Ottawa, Canada, ^cDepartment of Medicine, University Of Ottawa, Ottawa, Canada

Radiotherapy and Oncology, 2007

Uncorrecte

VHP male
6 radiation oncologists, 120 delineations on KV CTs

CT volumes on average 30% larger than true volume

CT volumes encompassed, on average, 84% of the true volume.

Missed posteriorly
Extended too anteriorly

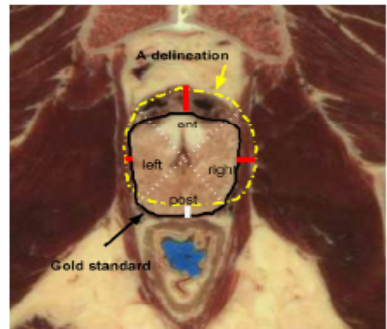


Fig. 2. An example of the difference between the gold standard contour and a representative CT based physician contour. Both are superimposed on the anatomical image and the "Gap" between the two in each of the four principal axes is shown.



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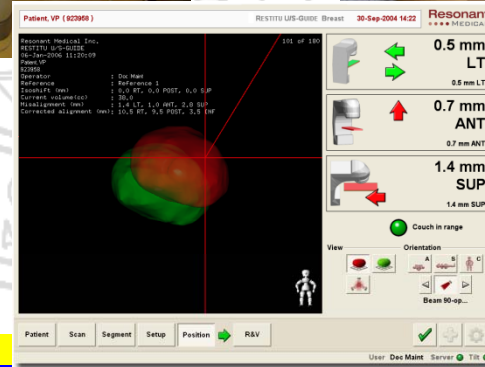
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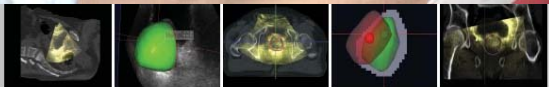
INTRAMODALITY CALCULATION METHODS

RESTITU

Compares the images obtained daily, before each fraction of RT, with an image of identical imaging modality obtained from the simulation day



RESTITU US



The RESTITU™ Platform

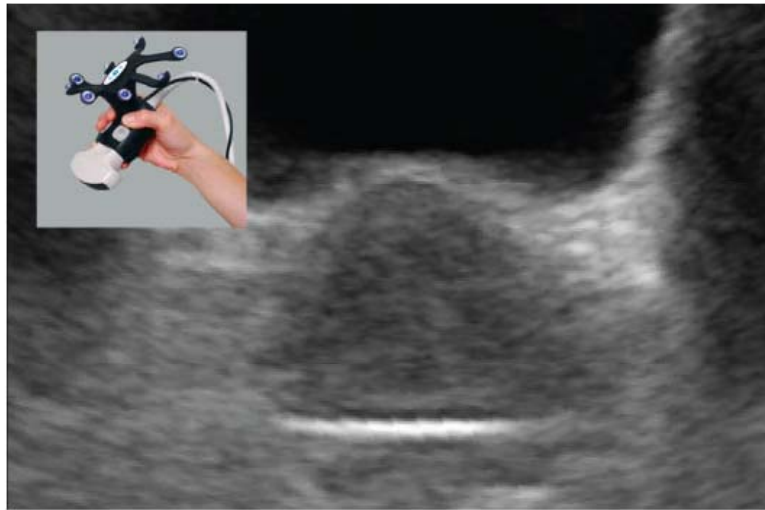
3D ultrasound image-guided adaptive radiotherapy

Resonant
MEDICAL



In-TC echography

US SIM



- acquisition quick and easy-non need to find the perfect 2D slice
- reconstruction of the 3D volume in any orthogonal plan



tracking unit





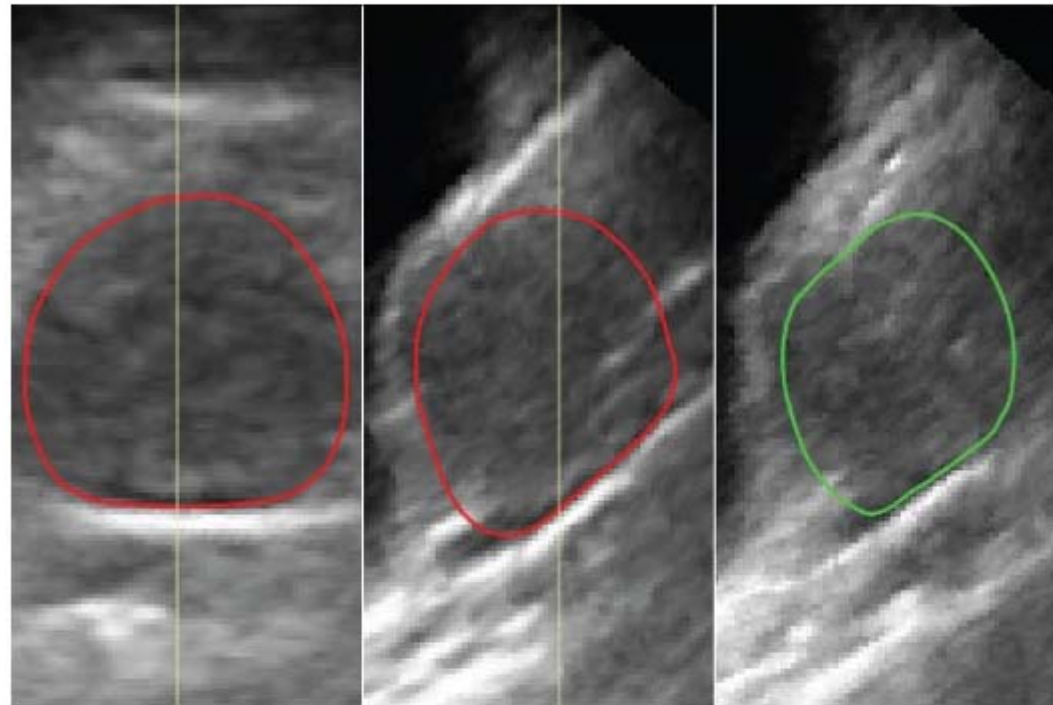
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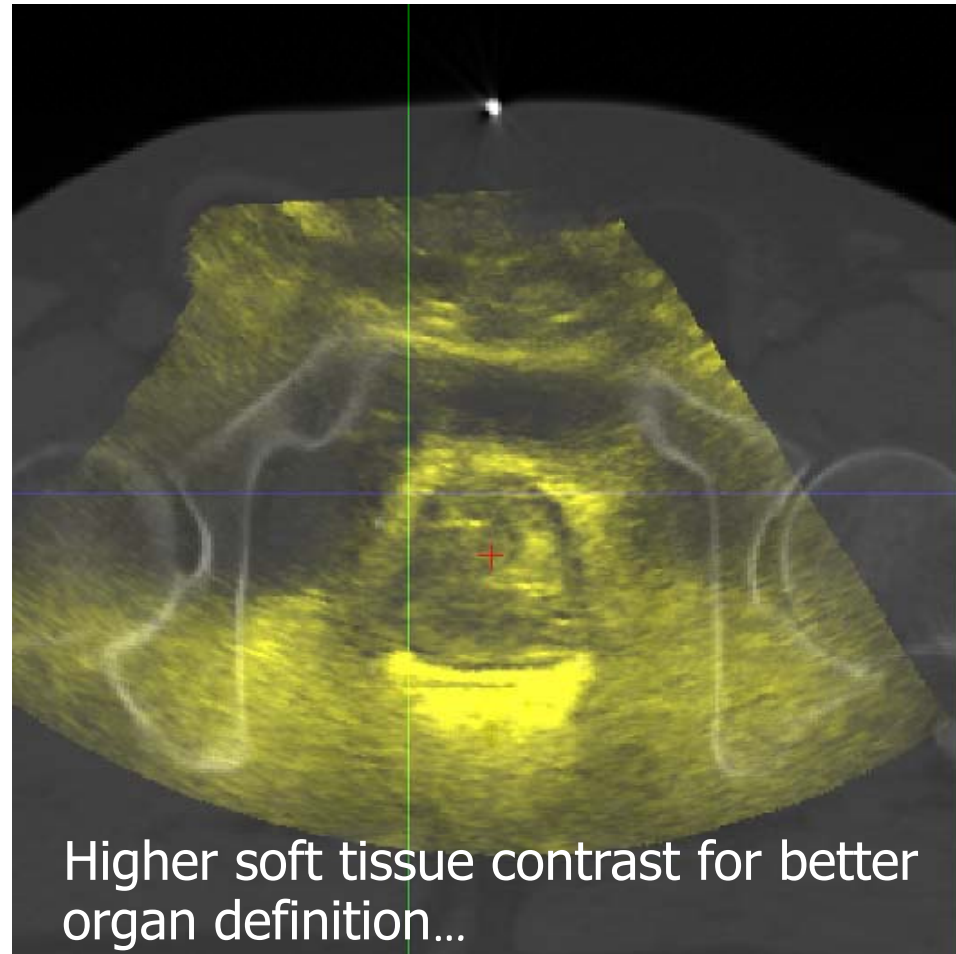
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- **Segmentation algorithms to extract a 3D surface a some seconds**
- **Reduction of inter-user variability**

RESTITU CT/US SIM

- Implicit Registration gives automatic CT-U/S fusion
- Better and consistent GTV and PTV contouring
- Complimentary imaging modality for treatment planning



delivered by US-SIM



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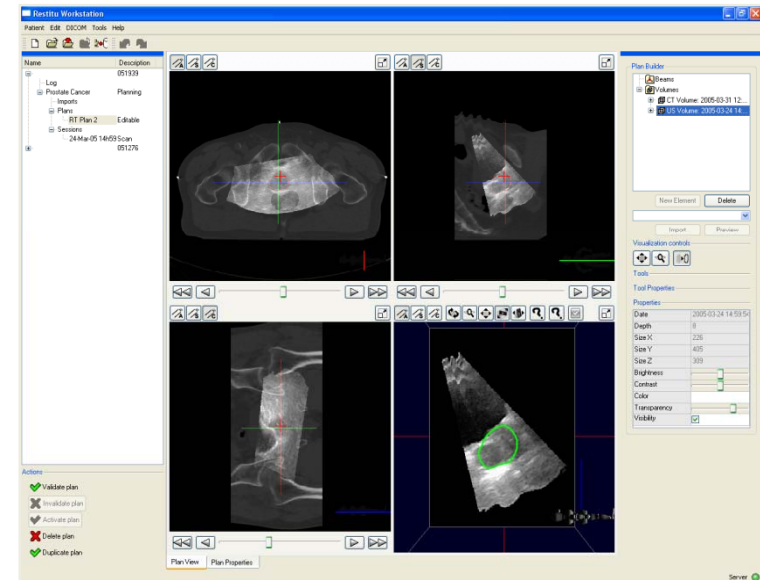
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Restitu Workstation

Functionality:

- Inter-modality fusion of CT and US image sets for treatment planning
- Import of CT based treatment plan
- Creation of reference volumes
- Data Administration

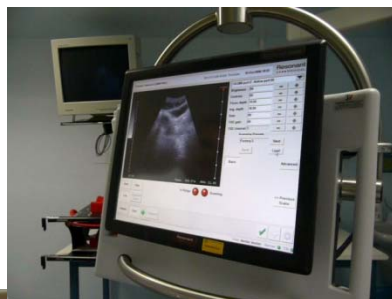


Restitu U/S Guide

- U/S-GUIDE is involved in daily treatment
- Data acquired here is compared to reference volume acquired on **U/S-SIM** to determine necessary shifts



In **CT-Sim room** RESTITU U/S allows more accurate target volume delineation on automatically generated US/CT fusion volumes



In the **treatment room**, RESTITU U/S-GUIDE makes organ position verification and patient positioning possible without compromising throughput.



RESTITU U/S-GUIDE delivers robust and reproducible 3D u/S imaging, tumor position verification and patient re-alignment in only 90 seconds.

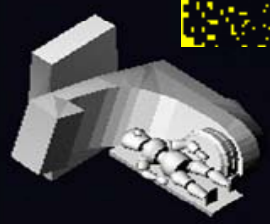
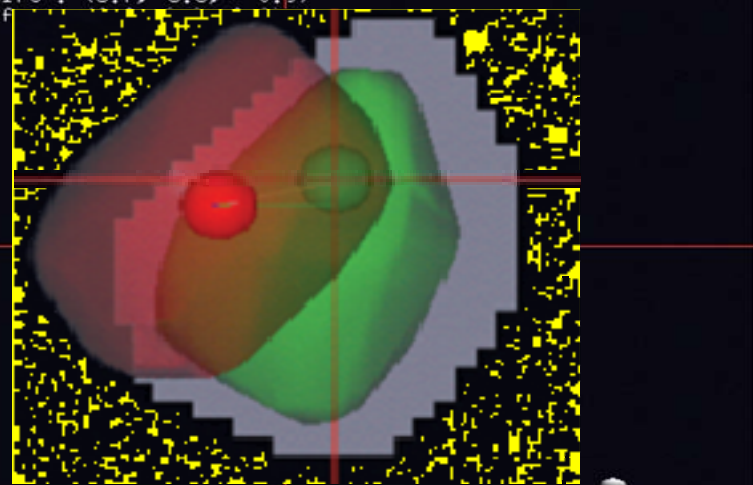
John, John (51)

May-08-2005 10:30

Resonant
MEDICAL

```
Test Bench      : Resonant Medical Inc.   Field      : 1 of 5
RsDevice 0001   :                        Field Name : 1.2RTL
1969/12/31 19:01:42 :                    Number of Leaves : 52
John, John     :                        Field Index  : 270.0
51              :                        Collimator   : 0.0
Operator       : Paul Provost
Plan          : Default Plan

Volume        : 41.6cc
Iso center shift : (3.7, 6.8, -0.9)
Iso center off
```

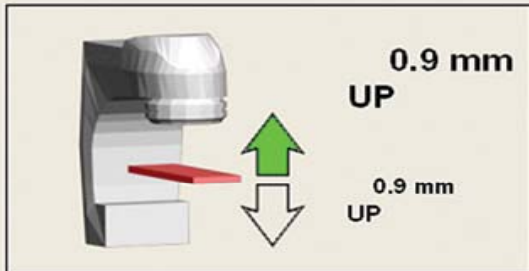
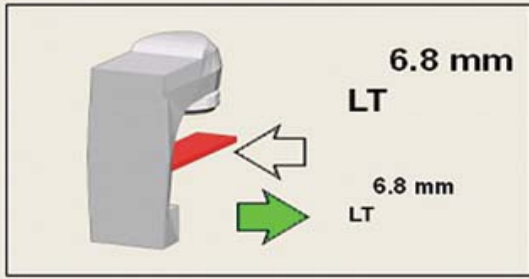


MLC

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Axis

- C
- A
- S



- Patient
- Scan
- Review
- Visualize
- Position

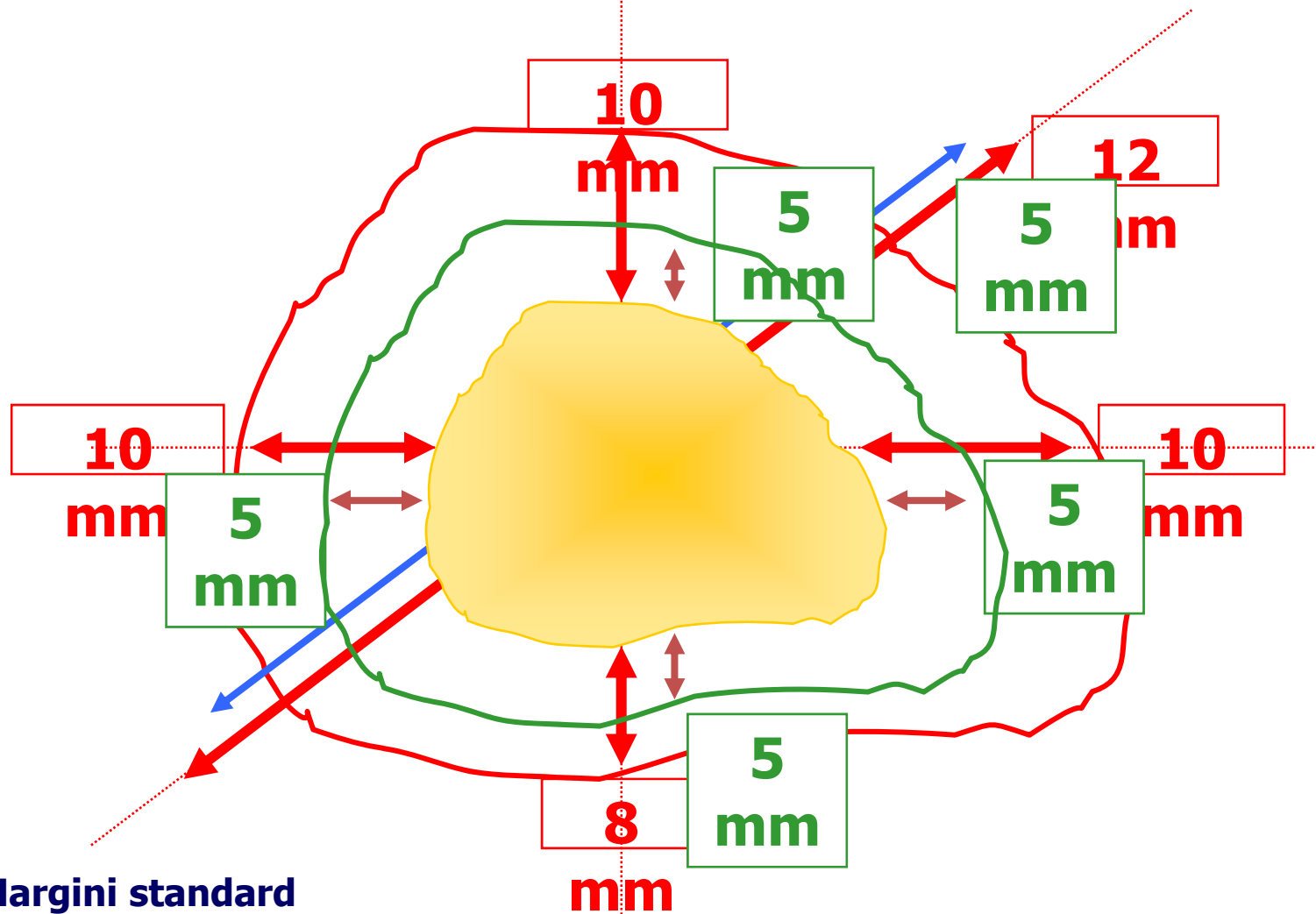
Done



Our experience in IGRT US-guided

- From 2007, 45 consecutive patients + 25 with gold-seed fiducial markers)
- Prostate adenocarcinoma, intermediated risk or high-risk (if LN risk between 15-35% by Roach recipe)
- Ipofractionation 70 Gy /2.7 Gy per fx
(BED₂ 84.4 Gy if $\alpha/\beta = 1.5$ Gy)
- Daily on-line target localization prior RT. Off-line correction for residual errors
- Empty of the rectum, full bladder and diet regime protocol

Definizione di un PTV paziente-specifico



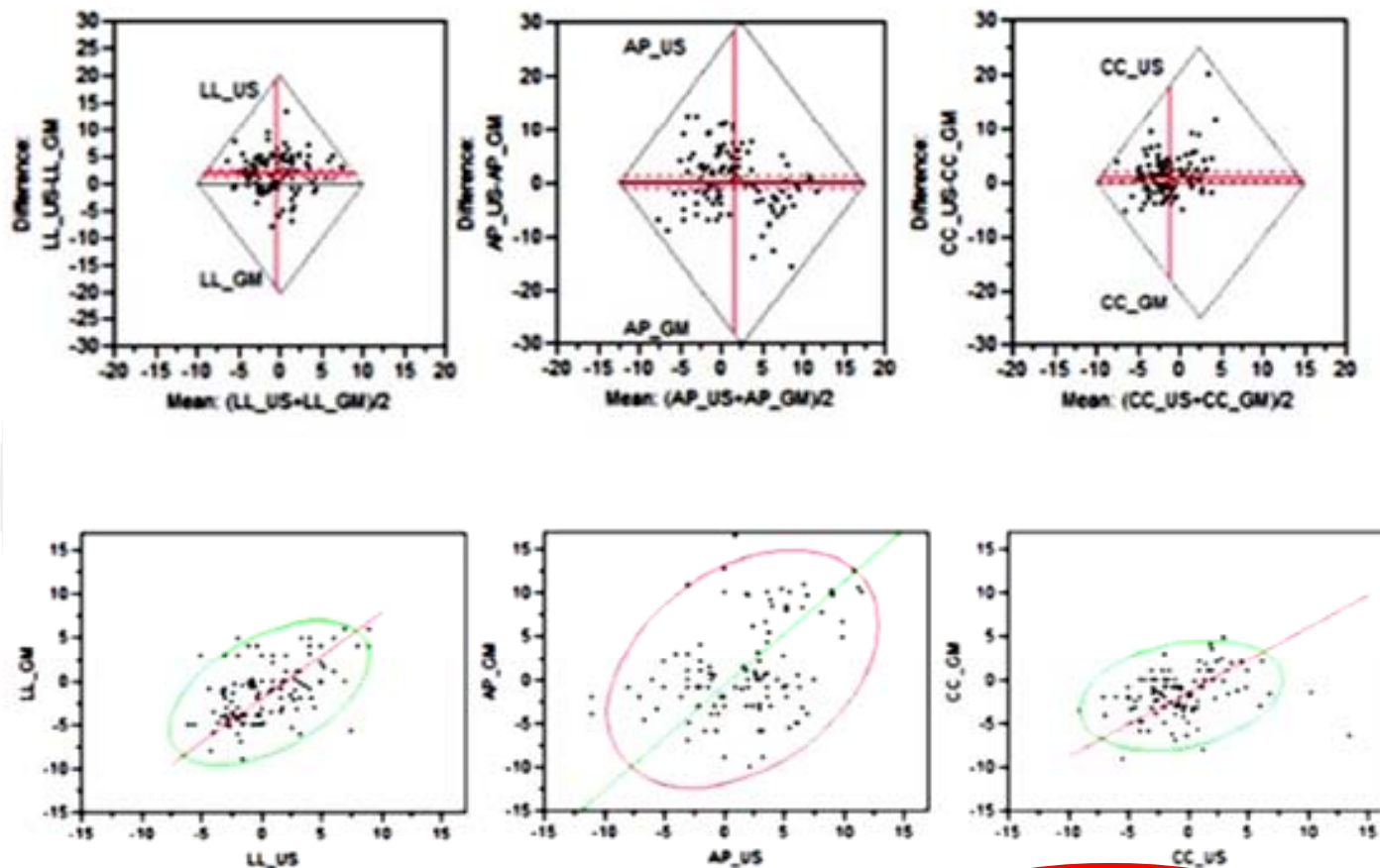
Margini standard

Margini sec formula Van Herck ($2.7\Sigma+0.7\sigma$)

Confronto semi-ecografia

Distribuzione
delle
misurazioni
ottenute con i
due metodi di
verifica
(467 coppie):
localizzazione
dei semi d'oro
e sistema
ecografico
Restitu.

RESULTS



p-value: LL = 0.124 AP = 0.643 **CC = <0.01**



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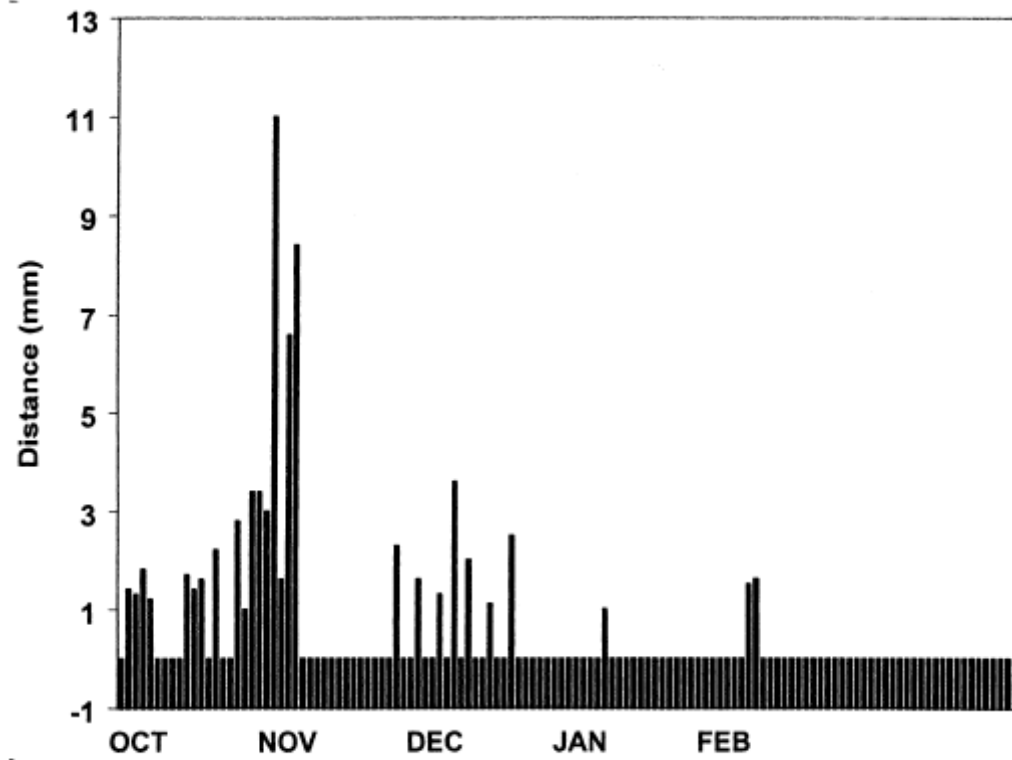
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LEARNING CURVE



Ultrasound : PRO AND CONTRA BALANCE

PROs		CONTRAS
1. FAST		1. OBESITY
2. NON-INVASIVE		2. LEARNING CURVE
3. EXCELLENT VISUALIZATION OF SOFT TISSUES STRUCTURES		3. BLADDER FILLING COMPLIANCE
4. NON-IONIZING METHODS		4. INTER-USERS VARIATIONS?
5. COST-EFFECTIVE		5. PROBE –INDUCED PRESSION?
6. NO OVERSTIMATES VOLUMES		
7. NO LINAC MODIFICATIONS		



 *Dong, Langen, Tomè*
 *Dong, McNeeley*



COMPARISON IGRT SYSTEMS

IGRT PROSTATE	US	CONE-BEAM CT (kV)
SYSTEM USER FRIENDLY	++++	+++
EASE OF INTERPRETATION IMAGES	++	++++
VISIBILITY OF SOFT TISSUES	++++	++
POST-ALIGNMENT VERIFICATION	+++	++
TIME CONSUMING	++++	++
INTEGRAL DOSE	++++	+
STORAGE REQUIREMENT	++++	+

Spatial resolution good
Image quality not ideal



Conventional CT

kV CBCT

TAKE HOME....

- fast \pm 90-120 seconds, complete procedure
- non invasive
- allows to account target size, shape and position
- "implicit Registration" by CT, MR and PET
- store capability to Record and verify systems of all records and alignments
- cost-efficacy
- not necessary LINAC modifies
- non-controlled studies suggests that it might improve outcome

