



UNIVERSITÀ
CATTOLICA
del Sacro Cuore

XXIII CONGRESSO
AIRO2013

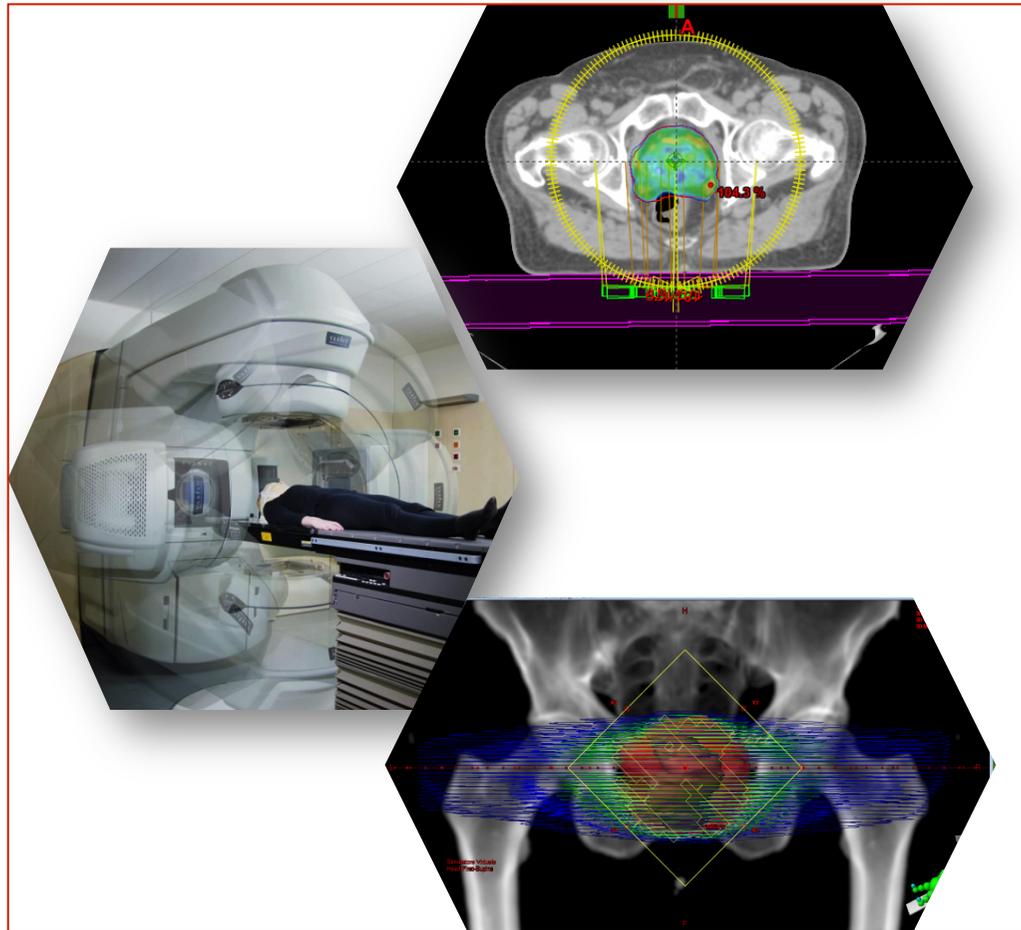


E' necessario l'impiego di un lettino robotico con sei gradi di libertà nei trattamenti delle neoplasie prostatiche con tecnica RapidArc?

S. Chiesa, L. Placidi, L. Azario, G.C. Mattiucci, G. Mantini, V. Frascino, C. Valentini,
B. Fionda, A. Piermattei, V. Valentini, M. Balducci

Giardini Naxos- Taormina- 27 Ottobre 2013

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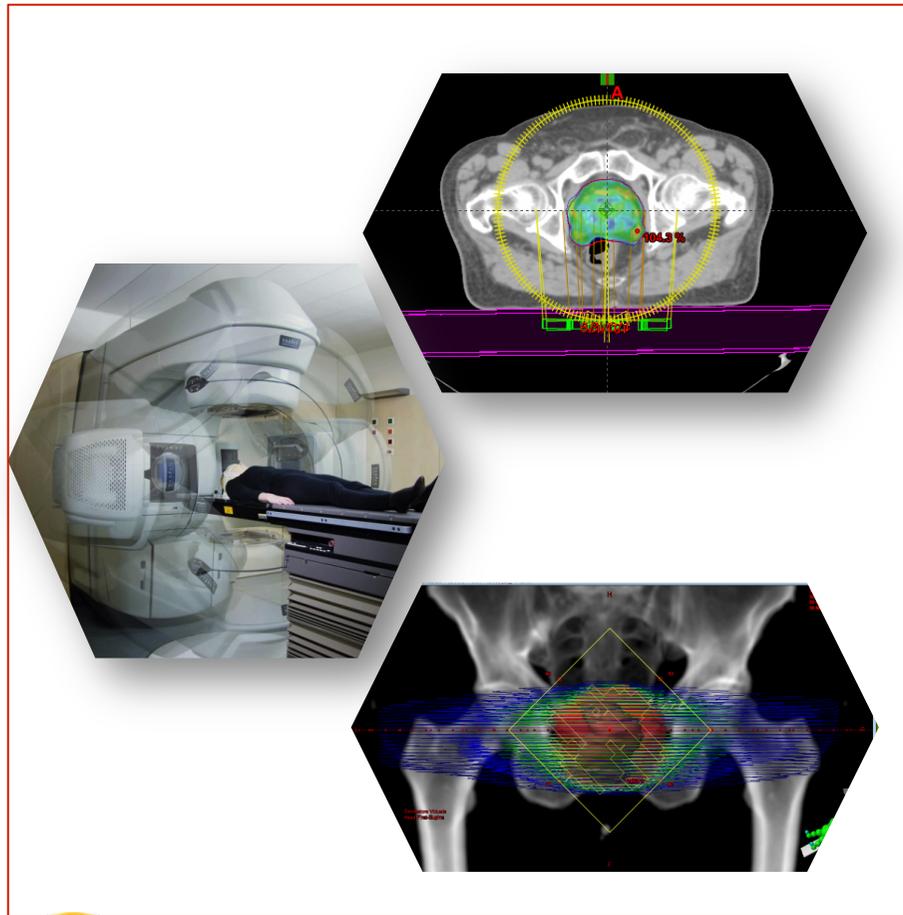


6 Degree Of Freedom (DOF): Why?

- Moderne tecniche di trattamento richiedono elevati livelli di **precisione** e di **accuratezza**.
- Necessità di un **accurato ri-posizionamento** del paziente
 - **Riproducibile**
 - **Time consuming**
 - Compromesso tra il corretto riposizionamento e la buona **compliance** del paziente

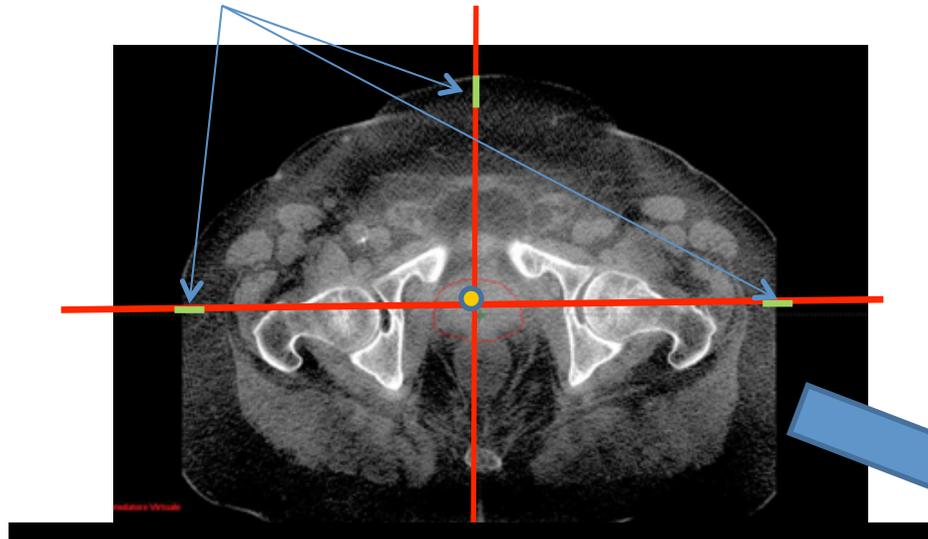
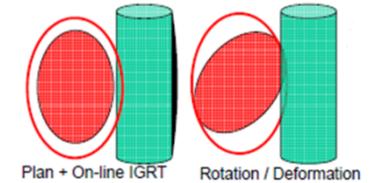


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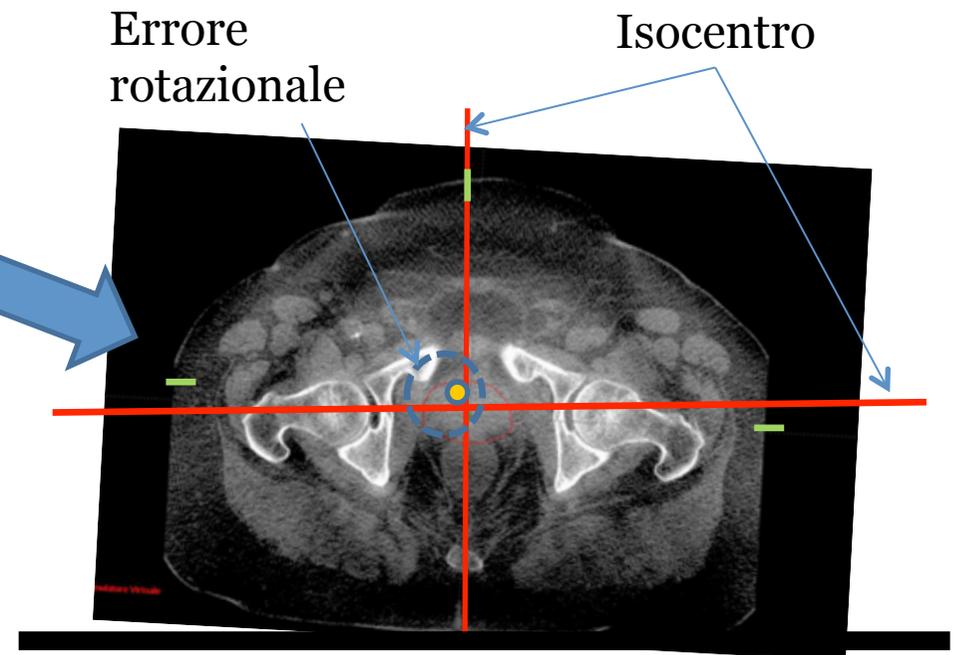


6 Degree Of Freedom (DOF): Why?

Benchmark for alignment



Simulazione



Set up



6 Degree Of Freedom (DOF): Why?

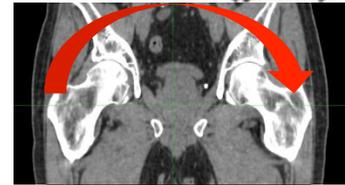
6 DEGREES OF FREEDOM

3 translational

3 rotational

● isocentrum

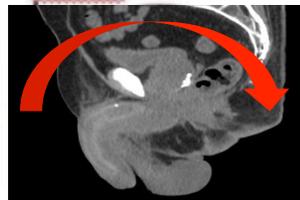
VRT axis
rotation (yaw)



frontal plane



LAT axis
pitch



sagittal plane

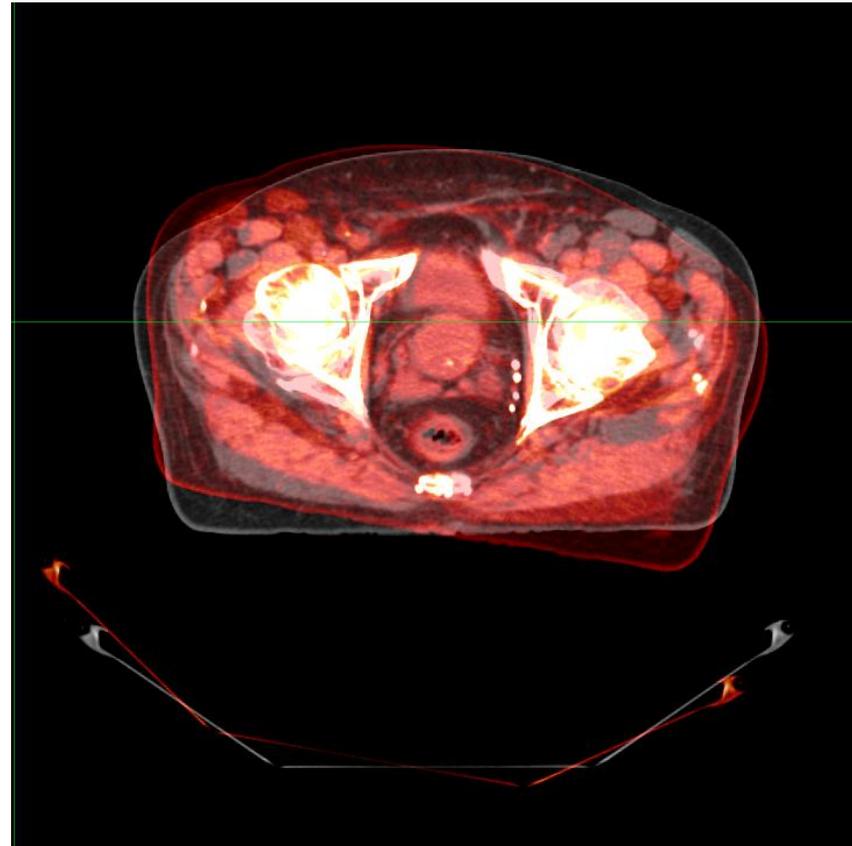
LNG axis
roll



transversal plane



Roll



LNG axis
roll



transversal plane



6 Degree Of Freedom (DOF): Why?

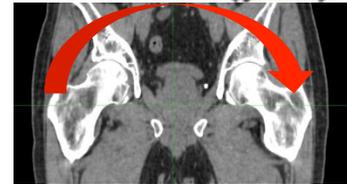
6 DEGREES OF FREEDOM

3 translational

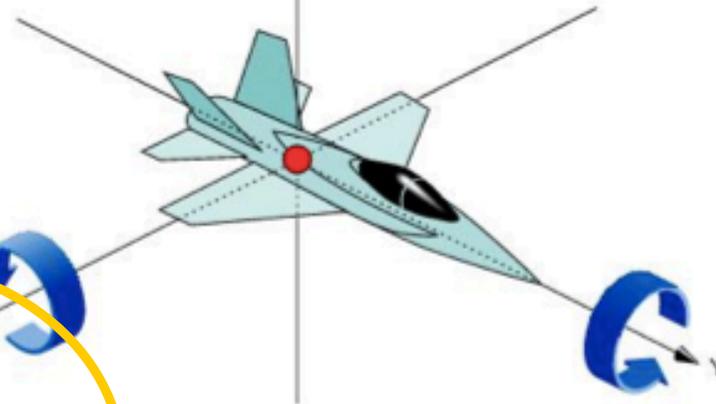
3 rotational

● isocentrum

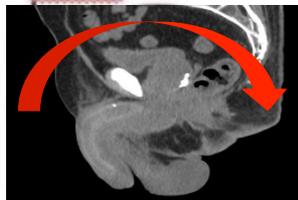
VRT axis
rotation (yaw)



frontal plane



LAT axis
pitch



sagittal plane

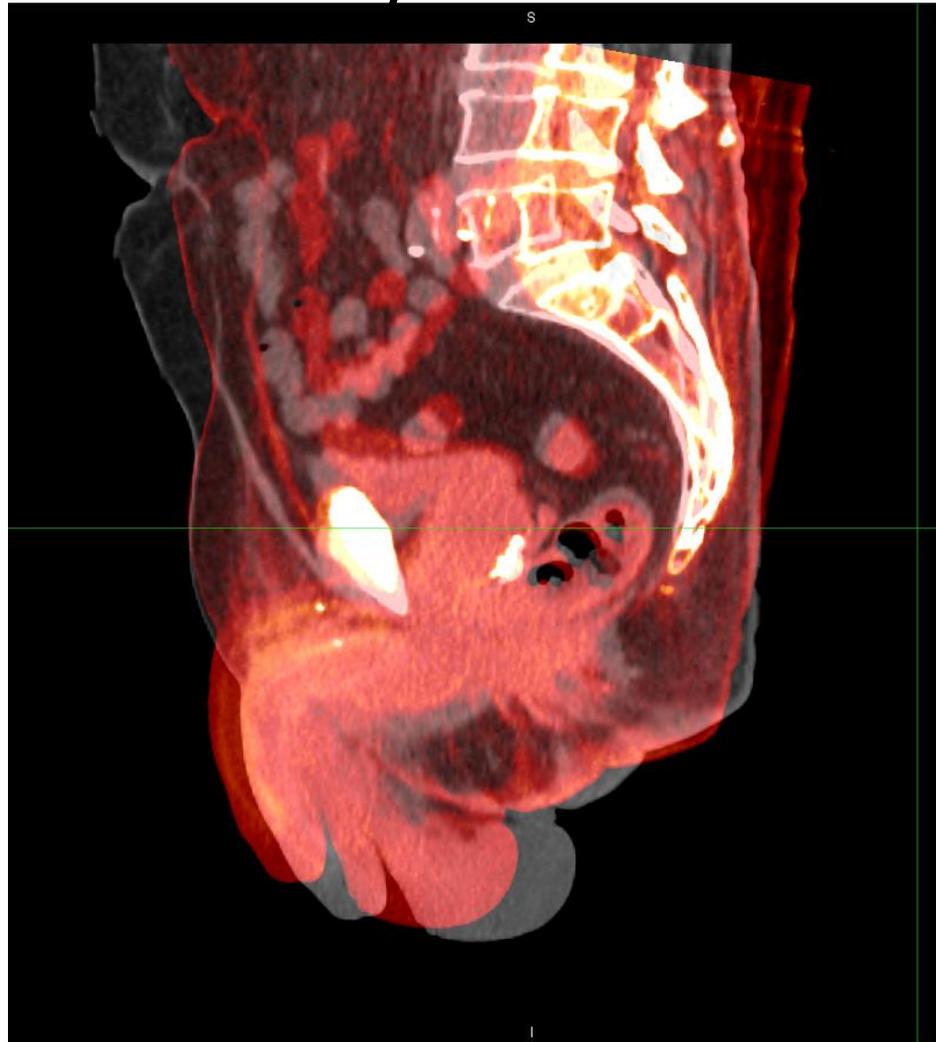
LNG axis
roll



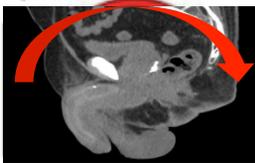
transversal plane



Pitch/Tilt



LAT axis
pitch



sagittal plane



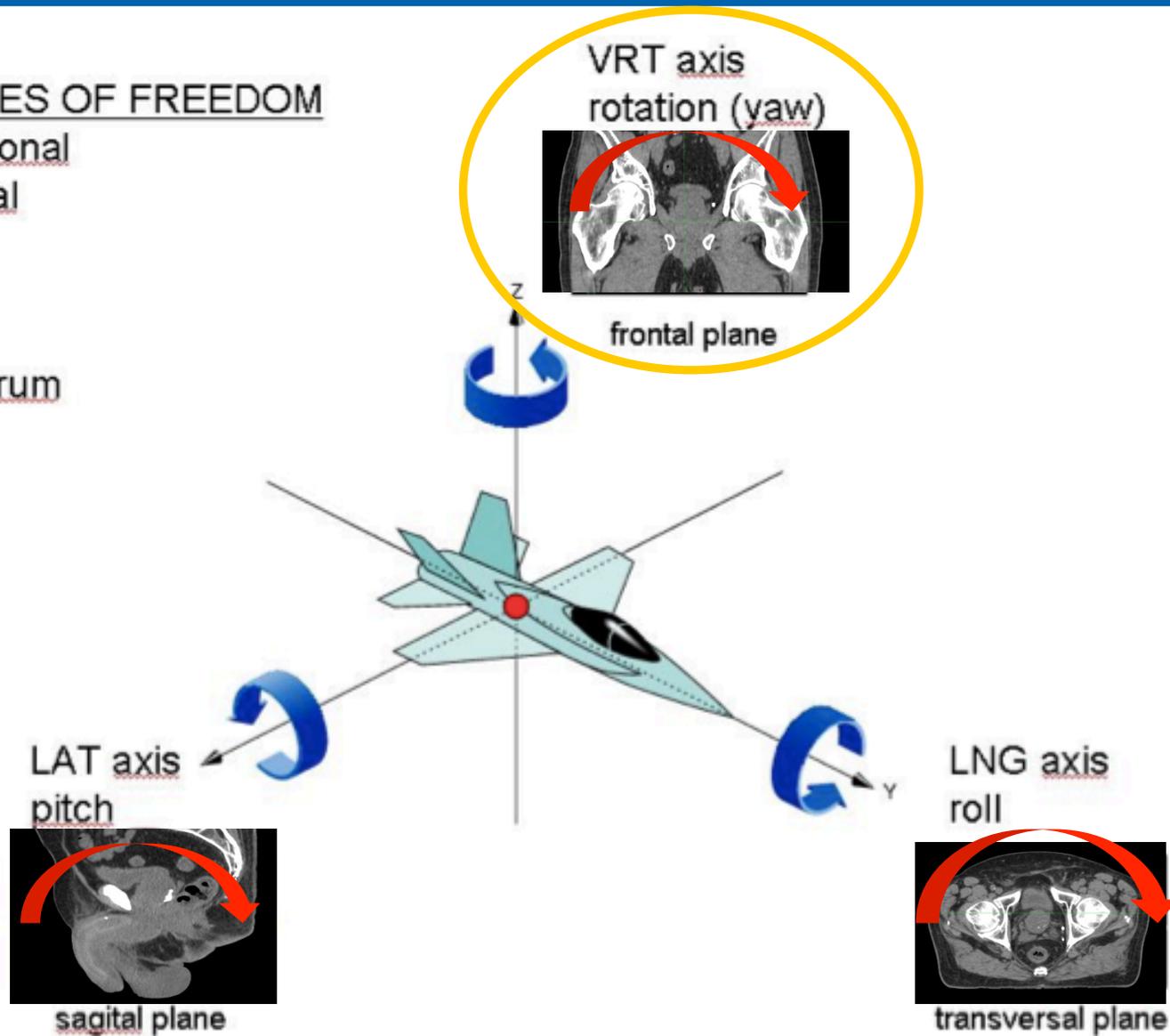
6 Degree Of Freedom (DOF): Why?

6 DEGREES OF FREEDOM

3 translational

3 rotational

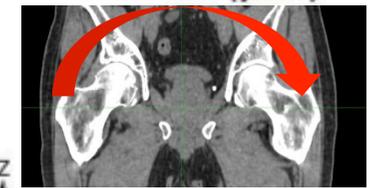
● isocentrum



Yaw/Rtn



VRT axis
rotation (yaw)



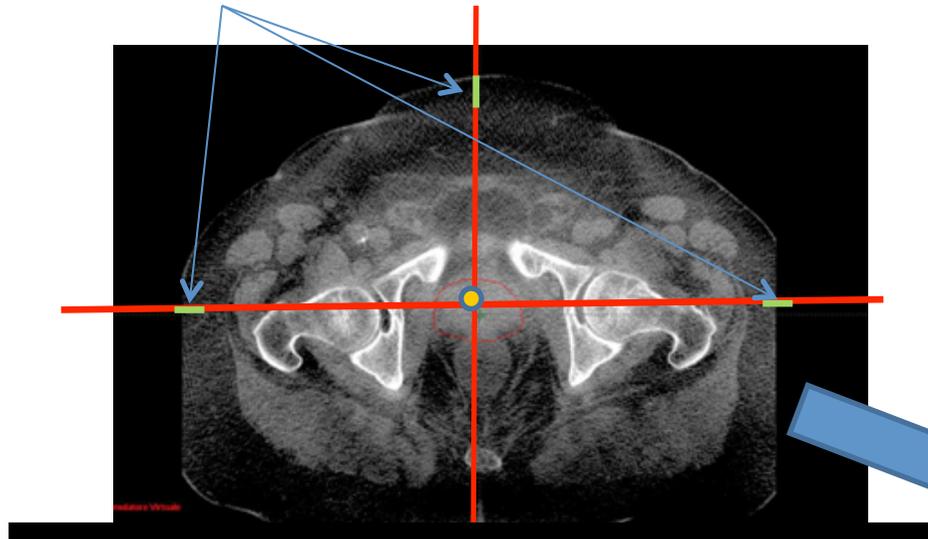
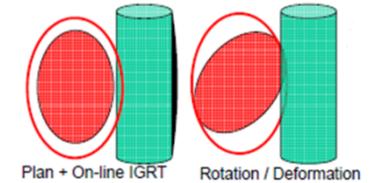
z



frontal plane

6 Degree Of Freedom (DOF): Why?

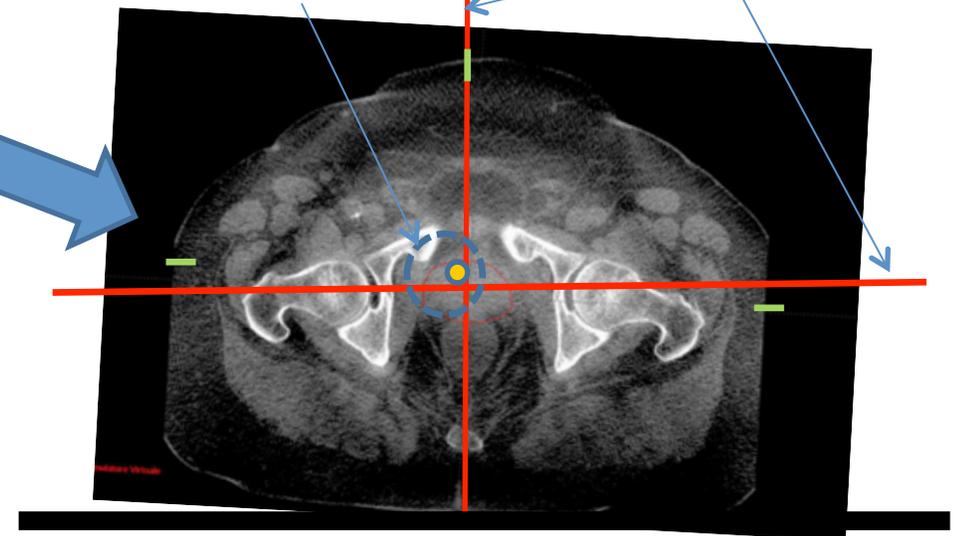
Benchmark for alignment



Simulazione

Errore rotazionale

Isocentro

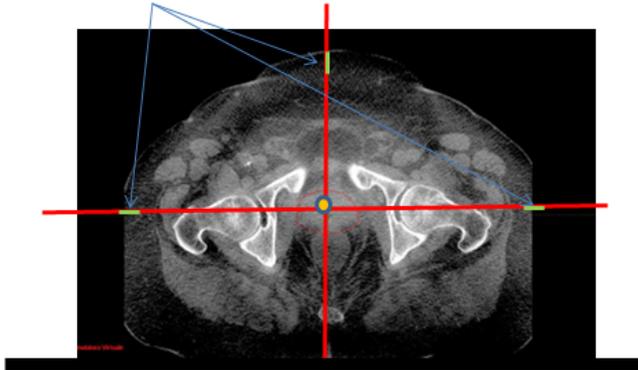


Set up



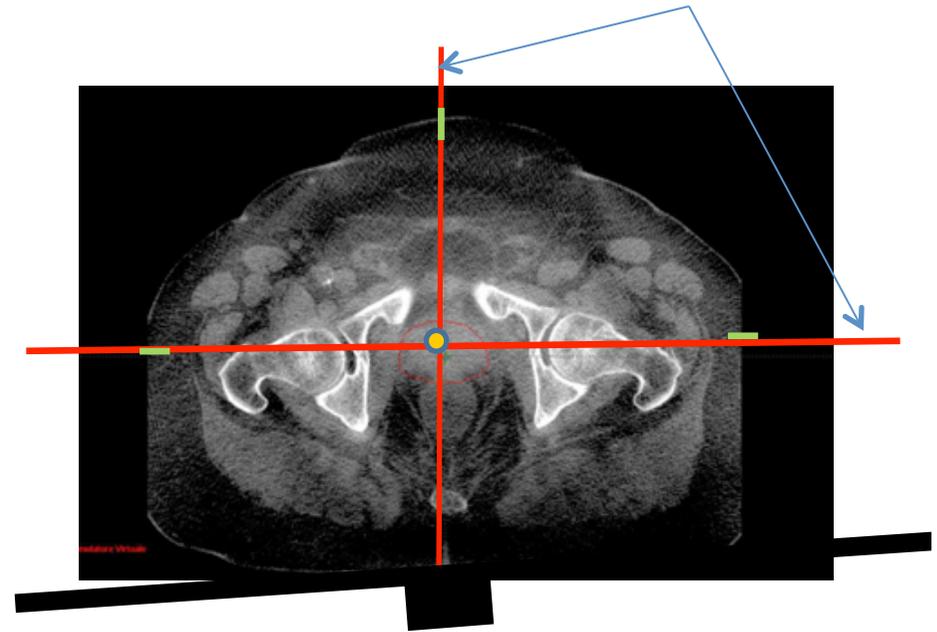
6 Degree Of Freedom (DOF): Why?

Benchmark for alignment



Simulazione

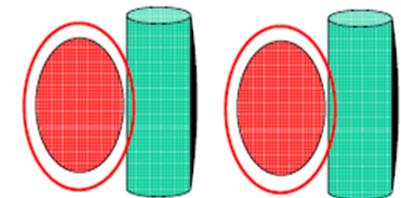
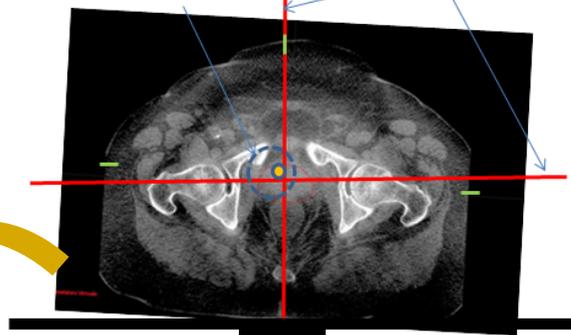
Isocentro



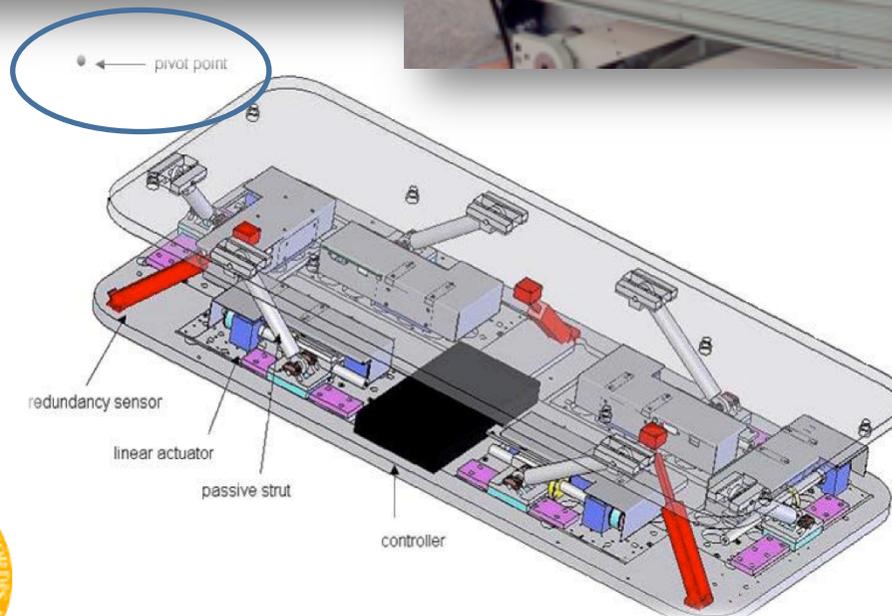
**Trattamento
Dopo correzione 6 DOF**

Errore rotazionale

Isocentro



CIVCO Protura™ 6DOF robotic couch



Rotation Range of motion

$\pm 3^\circ$ Roll, $\pm 3^\circ$ Pitch, $\pm 3^\circ$ Yaw

Obiettivo

CIVCO Protura project

*Evaluation of **impact** of Protura™ Robotic Patient Positioning System (CIVCO Medical Solutions) in an **high volume** Radiotherapy Centre, surving **geometrical, dosimetric, management and clinical parameters.***

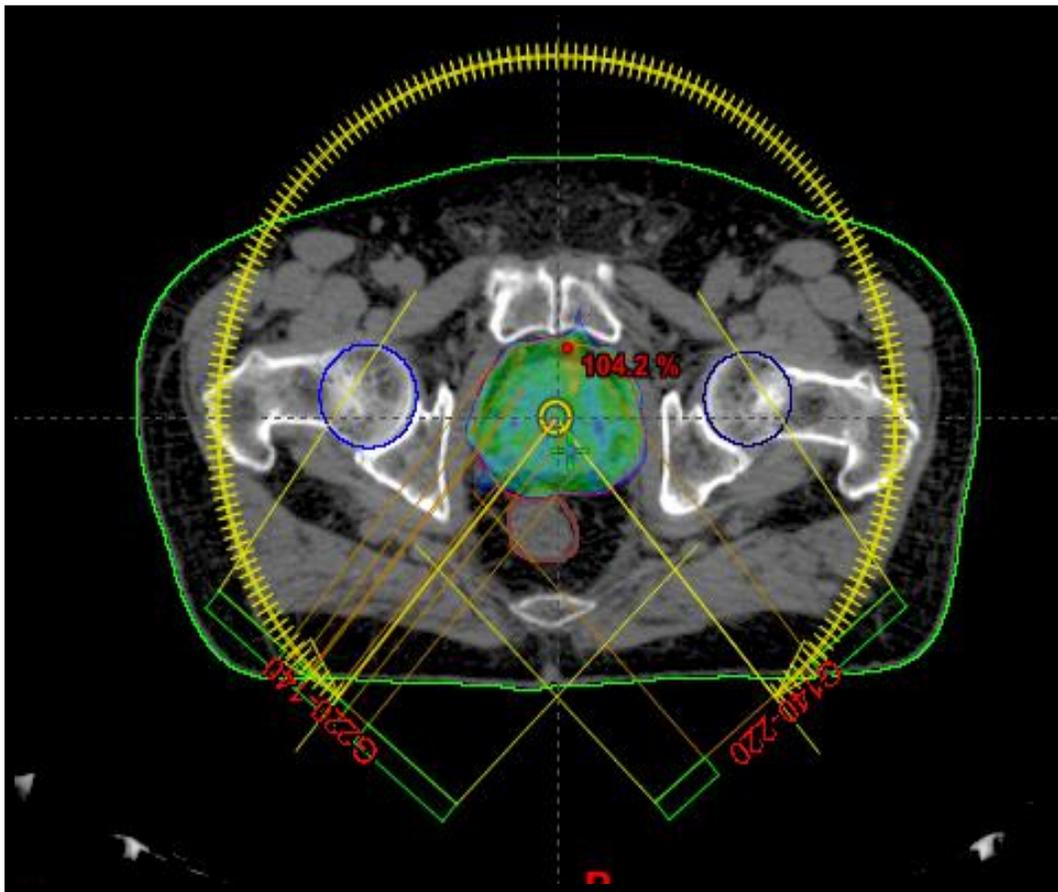
Valutare l'**entità** degli **errori traslazionali e rotazionali** e il loro **impatto dosimetrico** nei pazienti (pz) con tumore della prostata ad **alto rischio** avviati a trattamento **IMRT-SIB** con tecnica **RapidArc**.



Materiali & Metodi

Ca prostata
cT3aN0M0

IMRT-SIB
RapidArc



CTV1= prostata: **80Gy**
CTV2= base vescichette
seminali: **72 Gy**

PTV1=CTV1 +
12 mm Caudale
2 mm Craniale
7 mm Circonferenziale

PTV2= CTV2 + 7mm

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PHYSICS CONTRIBUTION

MAGNITUDE AND CLINICAL RELEVANCE OF TRANSLATIONAL AND ROTATIONAL PATIENT SETUP ERRORS: A CONE-BEAM CT STUDY

MATTHIAS GUCKENBERGER, M.D., JUERGEN MEYER, PH.D., DIRK VORDERMARK, M.D.,
KURT BAIER, M.SC., JUERGEN WILBERT, PH.D., AND MICHAEL FLENTJE, M.D.

Department of Radiation Oncology, University of Wuerzburg, Wuerzburg, Germany

24 pts
209 CBCT & 148 EPID

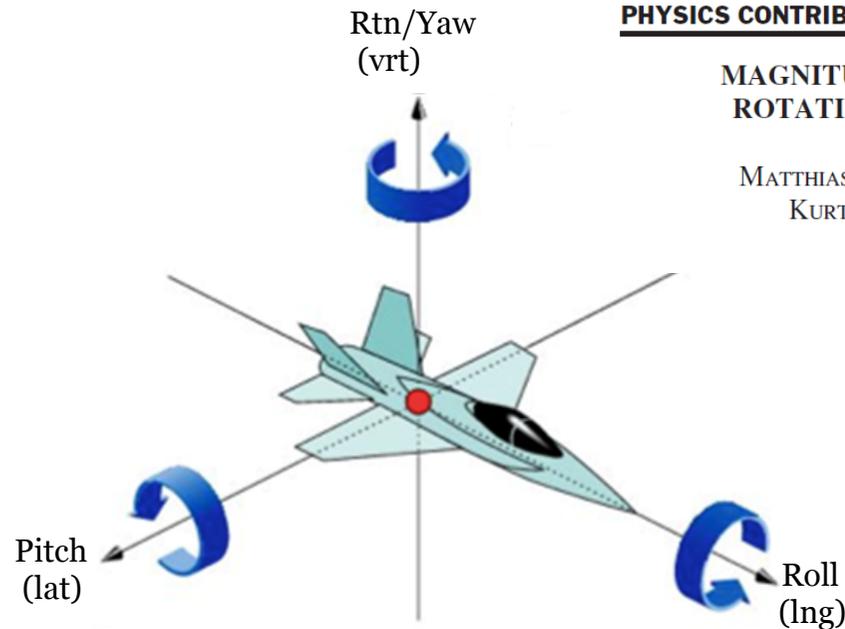
Table 1. Mean (systematic) \pm standard deviation (random) positioning errors for tumors located in pelvic, thoracic, and head-and-neck region

Location	Translational error (mm)			Rotational error ($^{\circ}$)		
	x axis	y axis	z axis	x axis	y axis	z axis
Pelvis ($n = 89$)	0.7 ± 2.6	1.1 ± 2.3	1.6 ± 3.3	0.6 ± 1.2	0.6 ± 1.0	0.4 ± 0.7
Thoracic ($n = 49$)	1.8 ± 2.9	2.0 ± 4.3	1.7 ± 3.2	0.9 ± 2.1	1.0 ± 2.1	0.9 ± 2.2
Head and neck ($n = 72$)	0.8 ± 1.4	0.9 ± 1.9	0.7 ± 1.2	0.7 ± 1.5	1.1 ± 1.4	1.1 ± 1.7

93,2%: < 2mm

> 2°
3,7% pelvis
26,4% thoracic
12,4% Head & Neck





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Department of Radiation Oncology, University of Wuerzburg, Wuerzburg, Germany

Fattibilità IGRT workflow

Rilevanza degli errori rototraslazionali

Tecniche RT ultraconformate

Results: Translational setup errors using the CB-CT scanner and an electronic portal imaging device differed <1 mm in 70.7% and <2 mm in 93.2% of the measurements. Rotational errors $>2^\circ$ were recorded in 3.7% of pelvic tumors, 26.4% of thoracic tumors, and 12.4% of head-and-neck tumors; the corresponding maximal rotational errors were 5° , 8° , and 6° . No correlation between the magnitude of translational and rotational setup errors was observed. For patients with elongated target volumes and sharp dose gradients to adjacent organs at risk, both translational and rotational errors resulted in considerably decreased target coverage and highly increased doses to the organs at risk compared with the initial treatment plan.

Conclusions: The CB-CT scanner has been successfully established for the evaluation of patient setup errors, and its feasibility in day-to-day clinical practice has been demonstrated. Our results have indicated that rotational errors are of clinical significance for selected patients receiving high-precision radiotherapy. © 2006 Elsevier Inc.



Materiali & Metodi 1

Set-up



CBCT



3D-Matching

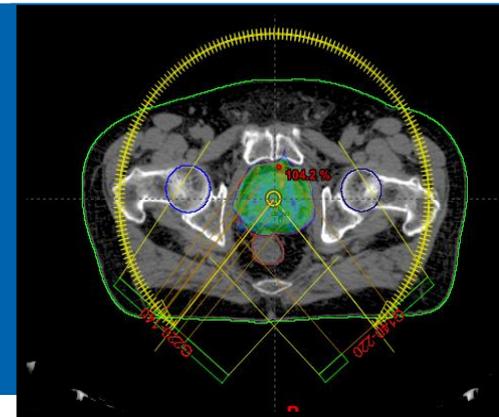
6 DOF Correction



Couch movement



Treatment



Risultati 1

12 pz Ca prostata
cT3aN0M0

Età mediana
76 anni, range 72-77aa

Pazienti -PROTURA

12/2012 -> 09/2013

91 pz

1066 CBCT

Pazienti arruolati nel PROTUA Project

Tot

36 pz

637 CBCT

Prostate

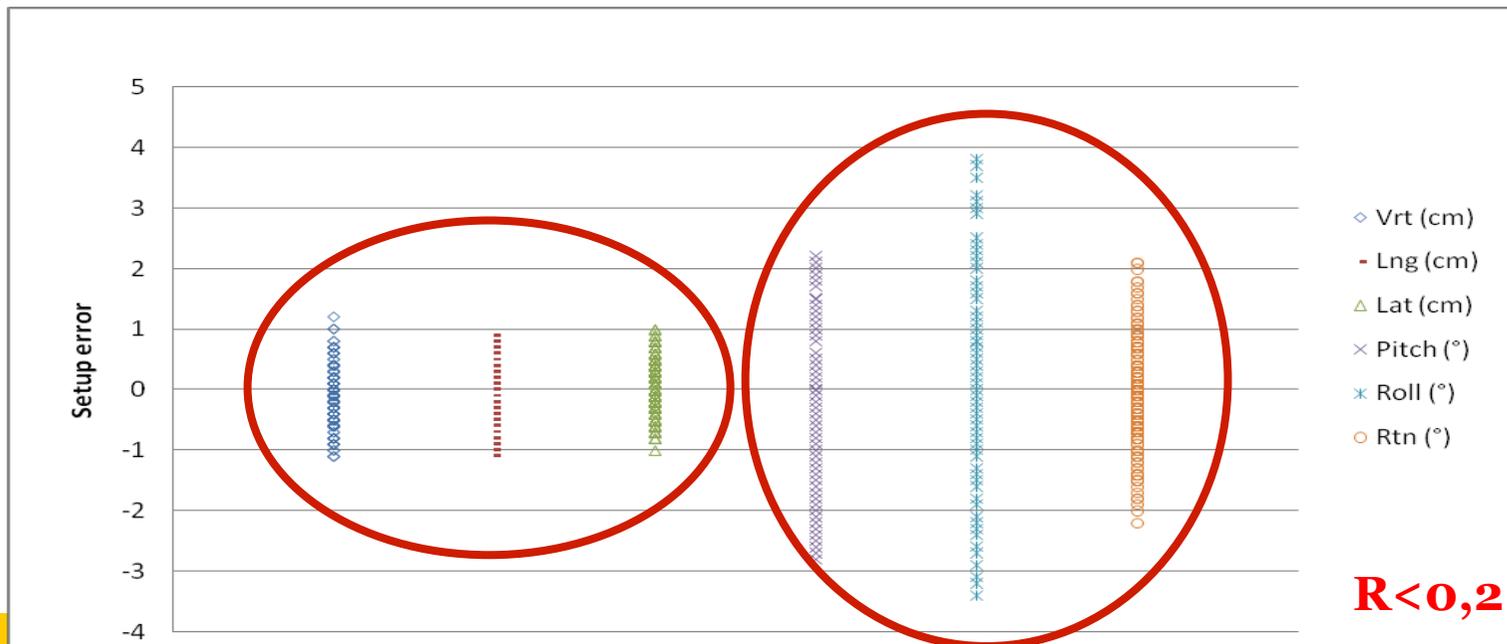
12 pz

329 CBCT

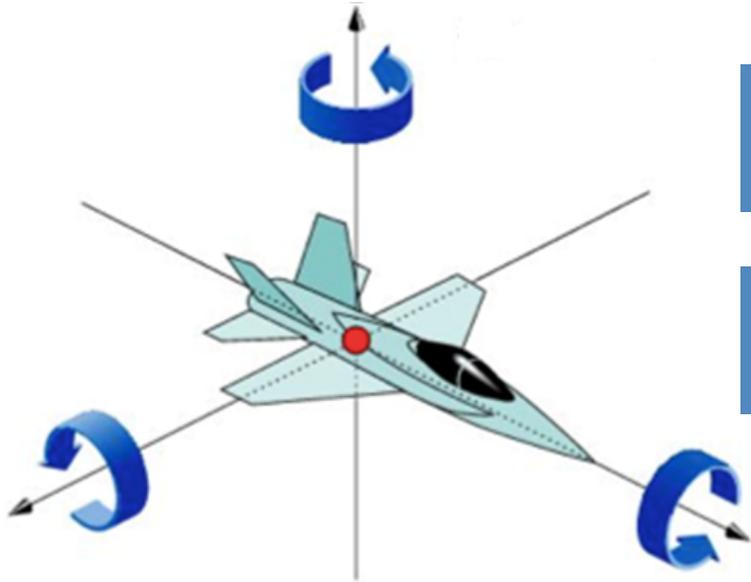


Risultati 1

Tipo	Errori Traslazionali (mm) Mean (\pm SD)			Errori Rotazionali ($^{\circ}$) Mean (\pm SD)		
	x axis (Lat)	y axis (Lng)	z axis (Vrt)	Pitch	Roll	Yaw
Nostra esperienza	0.5 \pm 3.6	-1.4 \pm 4.2	-1.8 \pm 4.1	-0.3 \pm 1.1	0.1 \pm 1.4	-0.1 \pm 0.7
Guckenberger	0,7 \pm 2,6	1,1 \pm 2,3	1,6 \pm 3,3	0,6 \pm 1,2	0,6 \pm 1	0,4 \pm 0,7



Conclusioni



➤ **Rilevanza** degli errori **rotazionali** in pazienti irradiati a livello della pelvi

➤ **UTILITA'** correzione del set up impiegando i **6 DOF**



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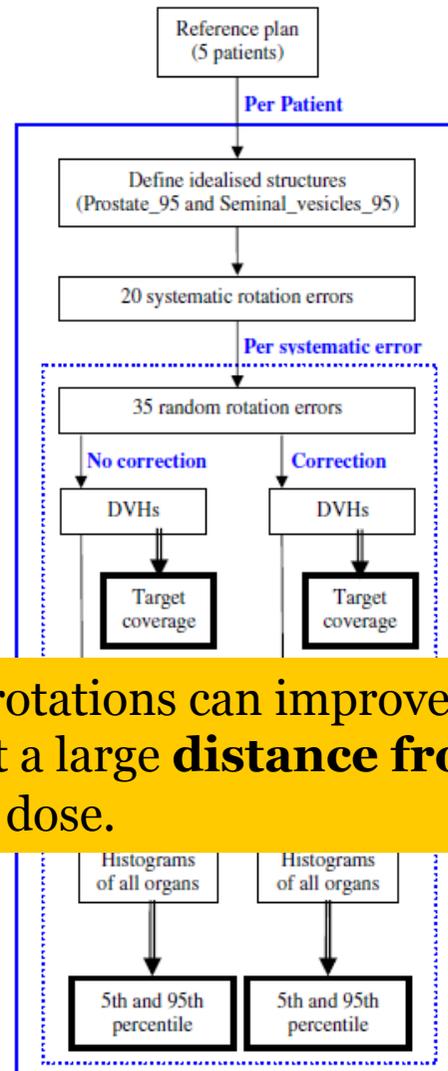


Dosimetric evaluation of prostate rotations and their correction by couch rotations

Yvonne R.J. van Herten*, Jeroen B. van de Kamer, Niek van Wieringen, Bradley R. Pieters, Arjan Bel

Radiotherapy and Oncology 88 (2008) 156–162

5 pZ Prostata IMRT
70 Gy/35 fr

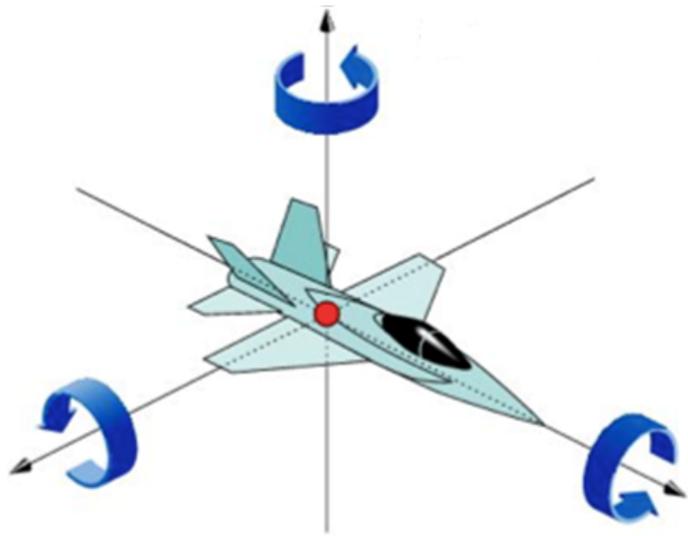


TARGET COVERAGE

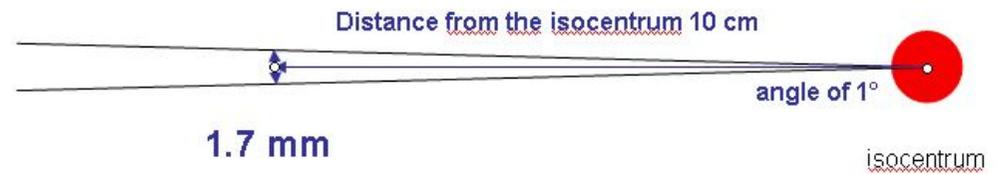
- Seminal vesicles: from 92.6% to 95.9%
- Prostate from 95.9% to 97.5%

On-line correction of rotations can improve **target coverage slightly**. For **organs at risk** at a large **distance from the isocentre** the result can be a significant increase in dose.





Distanza rispetto all' isocentro



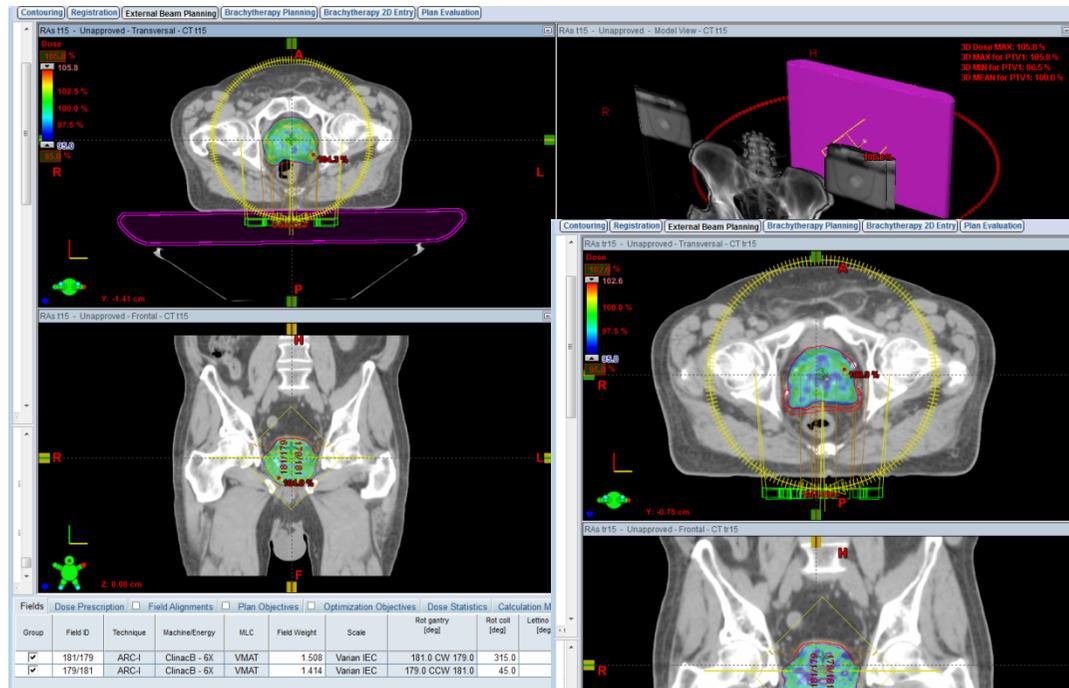
angle	distance from ISO	deviation
1°	5 cm	0.9 mm
1°	10 cm	1.7 mm
2°	10 cm	3.4 mm
2°	20 cm	6.8 mm
3°	10 cm	5.1 mm
3°	20 cm	10.2 mm



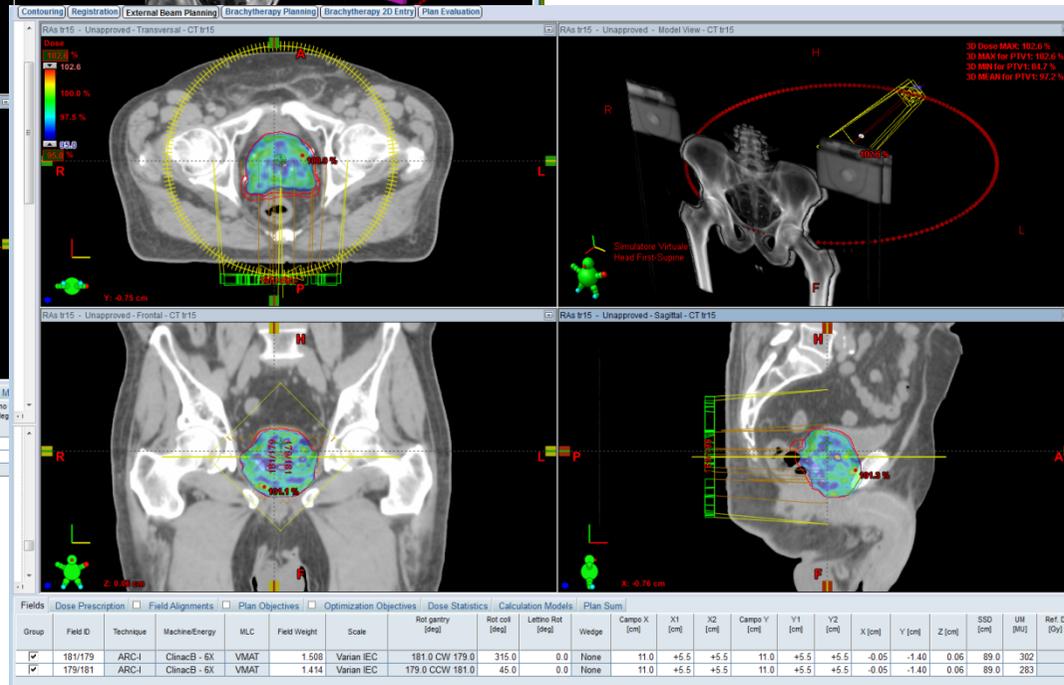
Materiali & Metodi 2

259 CBCT

259 PT t



259 PT tr



Materiali & Metodi 2



Pt t



Pt tr

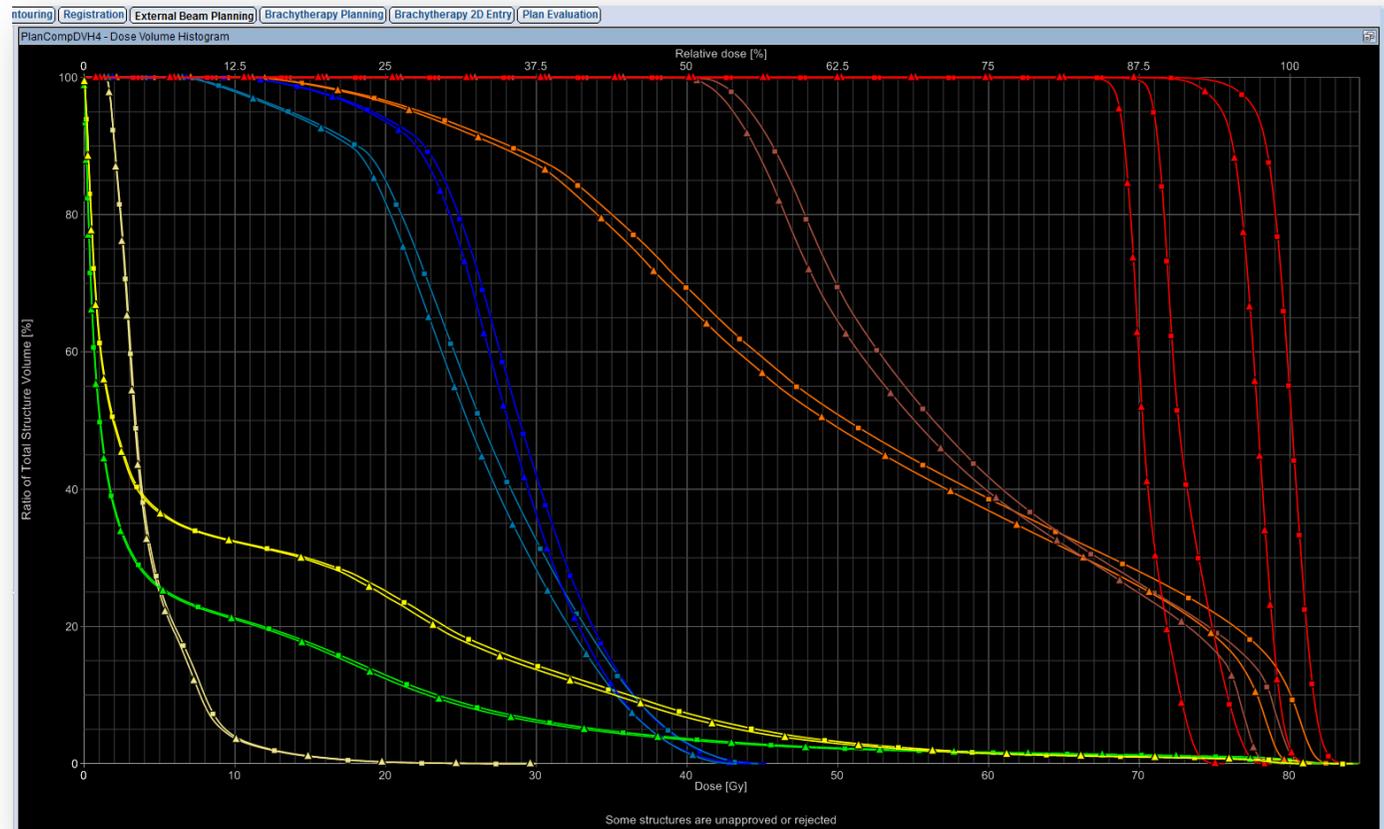
TARGET COVERAGE

V95% - 105% PTV1

- V95% and 105% of PTV2

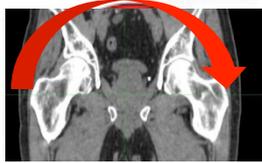
Risparmio OAR

- V50 Retto
- V max Vescica
- V20 teste femorali
- V45 intestino



Risultati 2

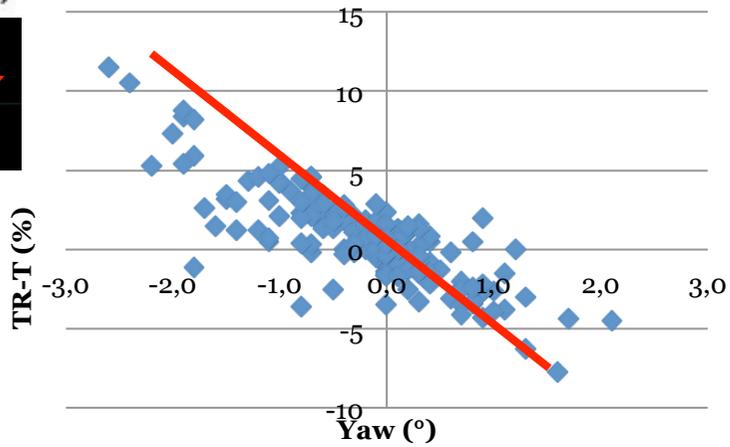
VRT axis
rotation (yaw)



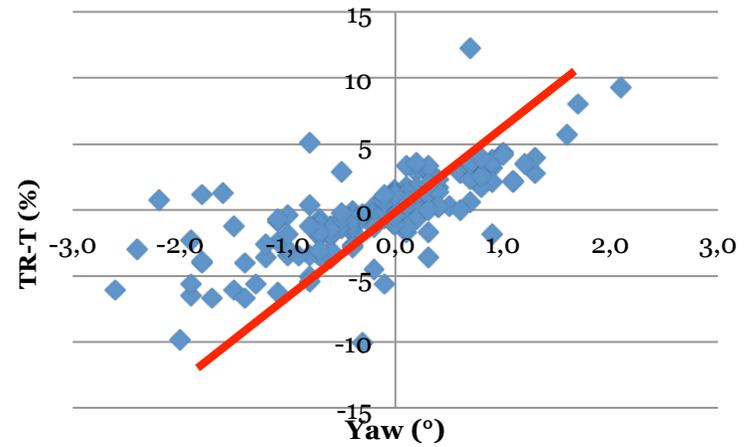
frontal plane



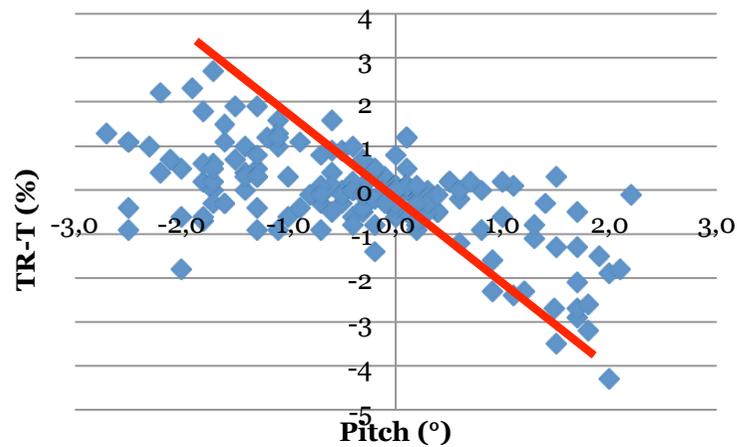
Fem dx V20 vs Rtn



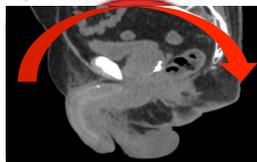
Femsx V20 vs Rtn



Rectum V50 vs Pitch



LAT axis
pitch

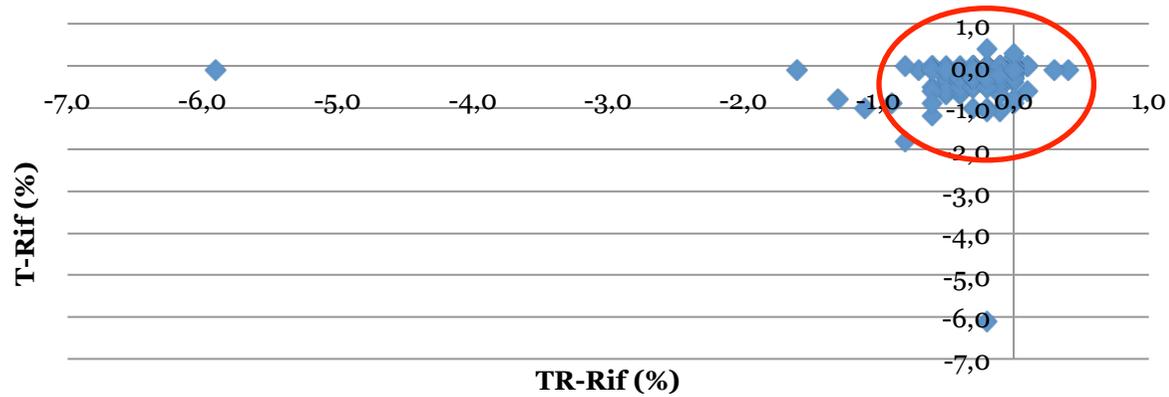


sagittal plane

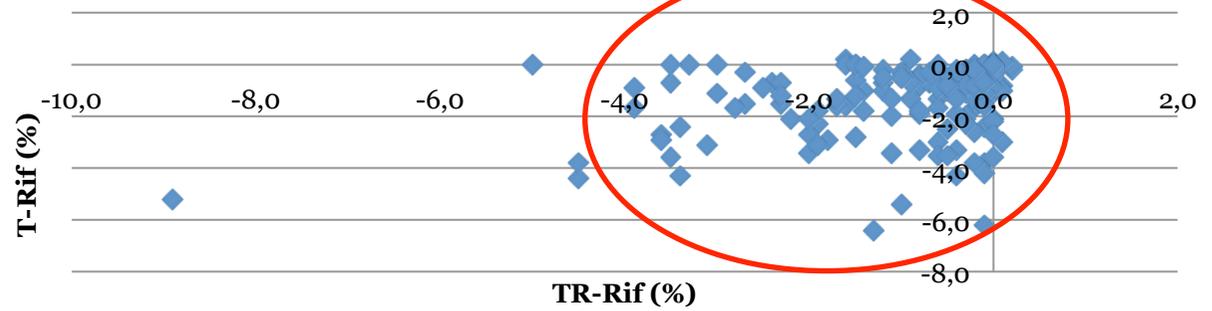


Risultati 2

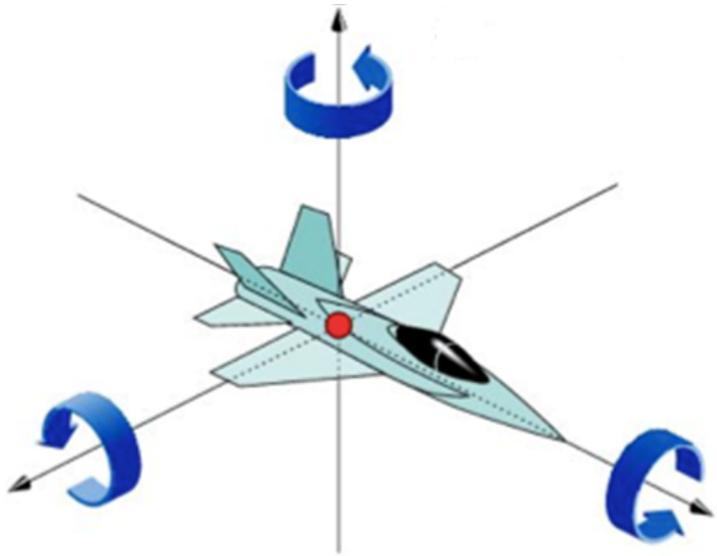
PTV1 V95%



PTV2 V95%



Conclusioni



➤ **Rilevanza** degli errori **rotazionali** in pazienti irradiati a livello della pelvi

➤ **UTILITA'** correzione del set up impiegando i **6 DOF**

➤ **Impatto** a livello **dosimetrico** probabilmente legato alla **forma**, alla **sede**, alla **dimensione** ed alla **distanza dall' isocentro**

➤ Necessarie **ulteriori analisi** per la valutazione della significatività dosimetrica e clinica degli errori rotazionali.

