Patient preparation for treatment

ICTP SCHOOL ON MEDICAL PHYSICS
Radiation Therapy:
Dosimetry and Treatment Planning
for Basic and Advanced Applications
ICTP, Trieste 2019

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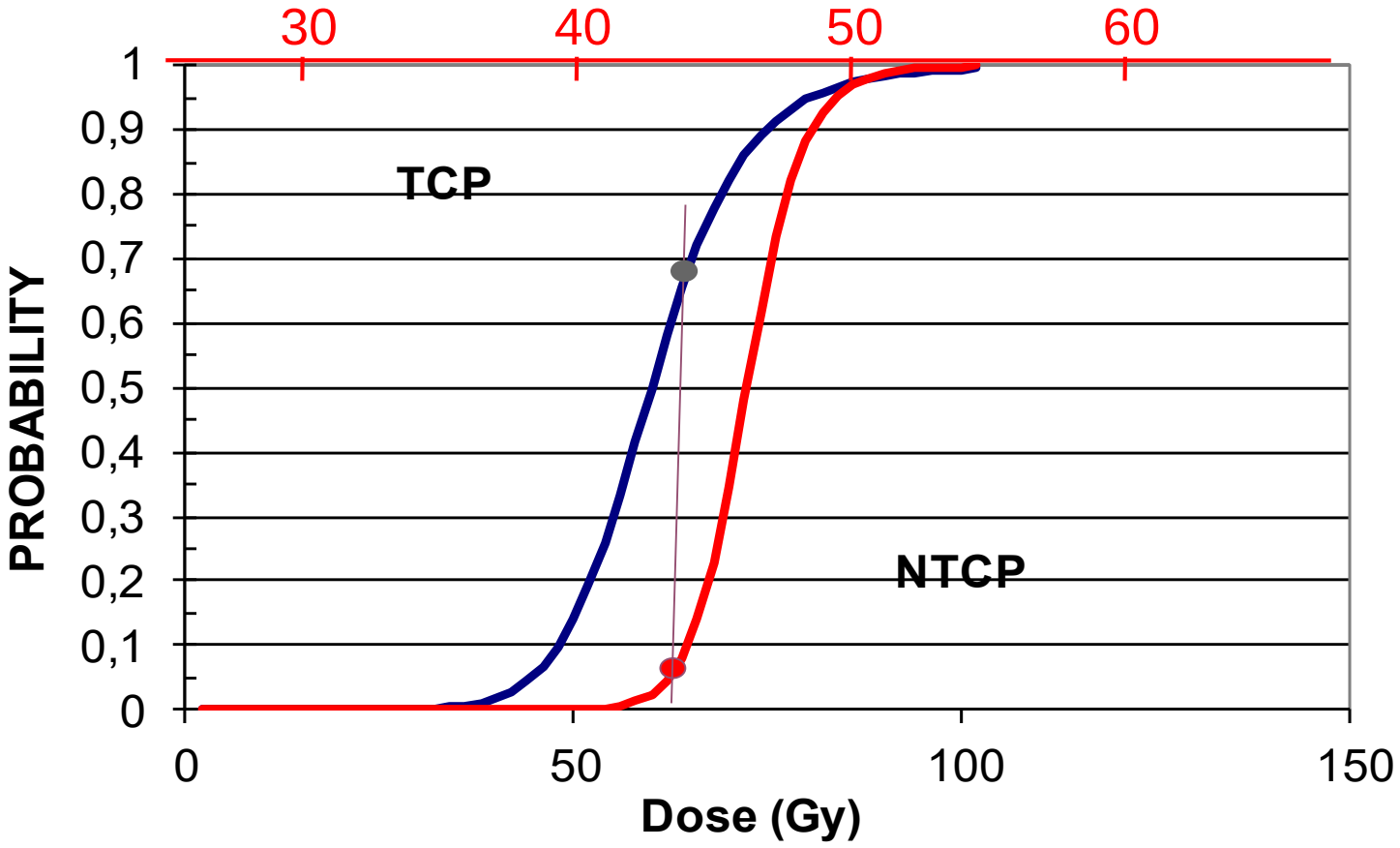
Preparation and Verfication of Radiotherapy Laboratory

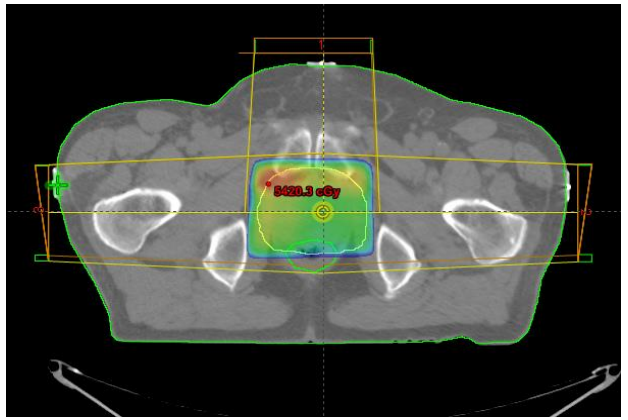
General rules

- The aim of preparation
  - To be able to deliver the prescribed dose to the PTV according to the treatment plan accepted by the radiotherapist,
    - to minimize the geometrical uncertainties of irradiation
- To ensure a smooth implementation of treatment,
  - to minimize the treatment irradiation time,
    - to minimize the intrafractional movement,
    - to avoid breaks in irradiation.

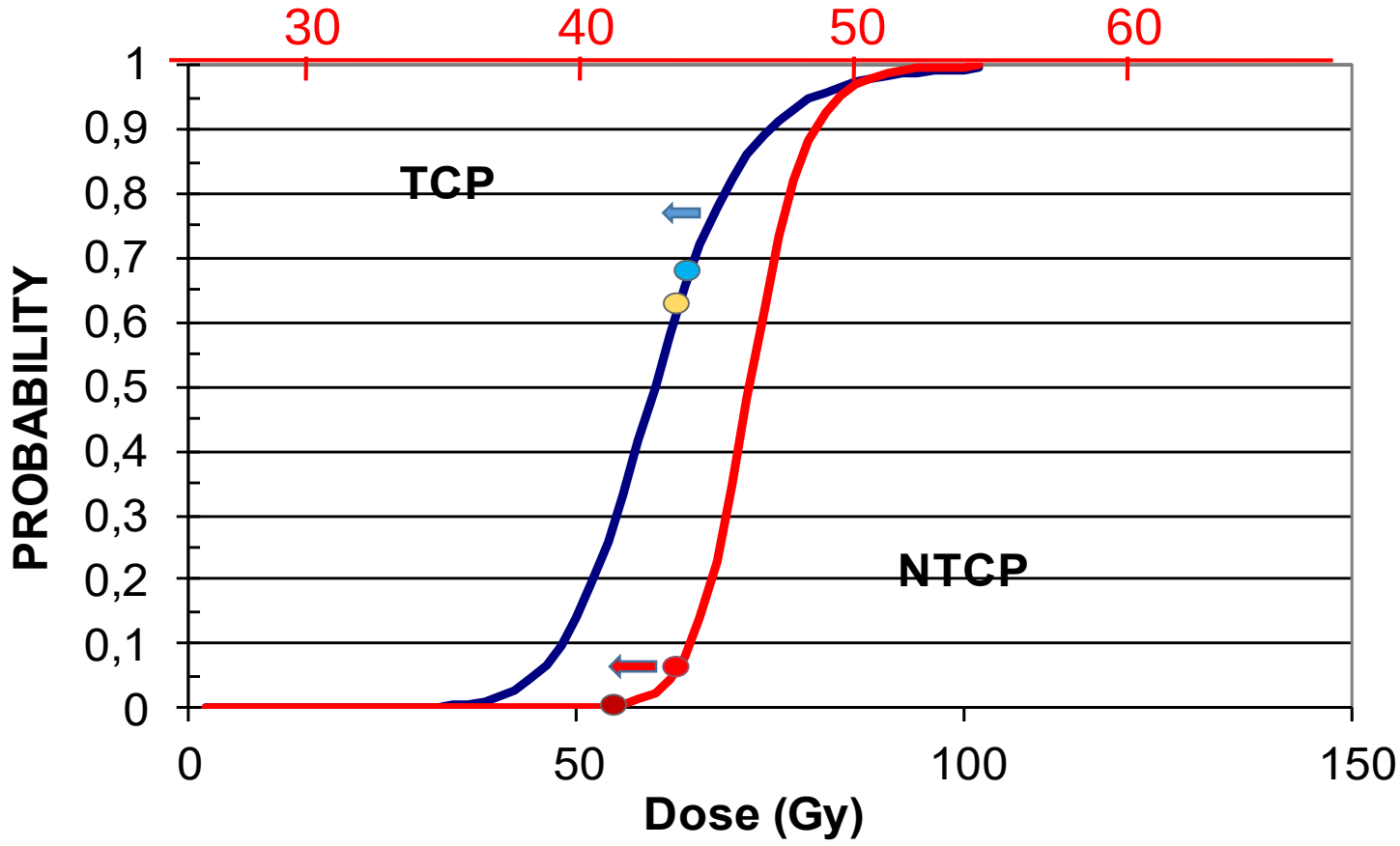
General rules

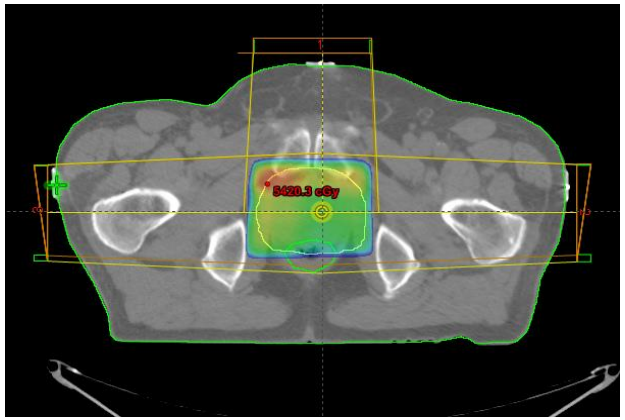


Accepted treatment plan



General rules





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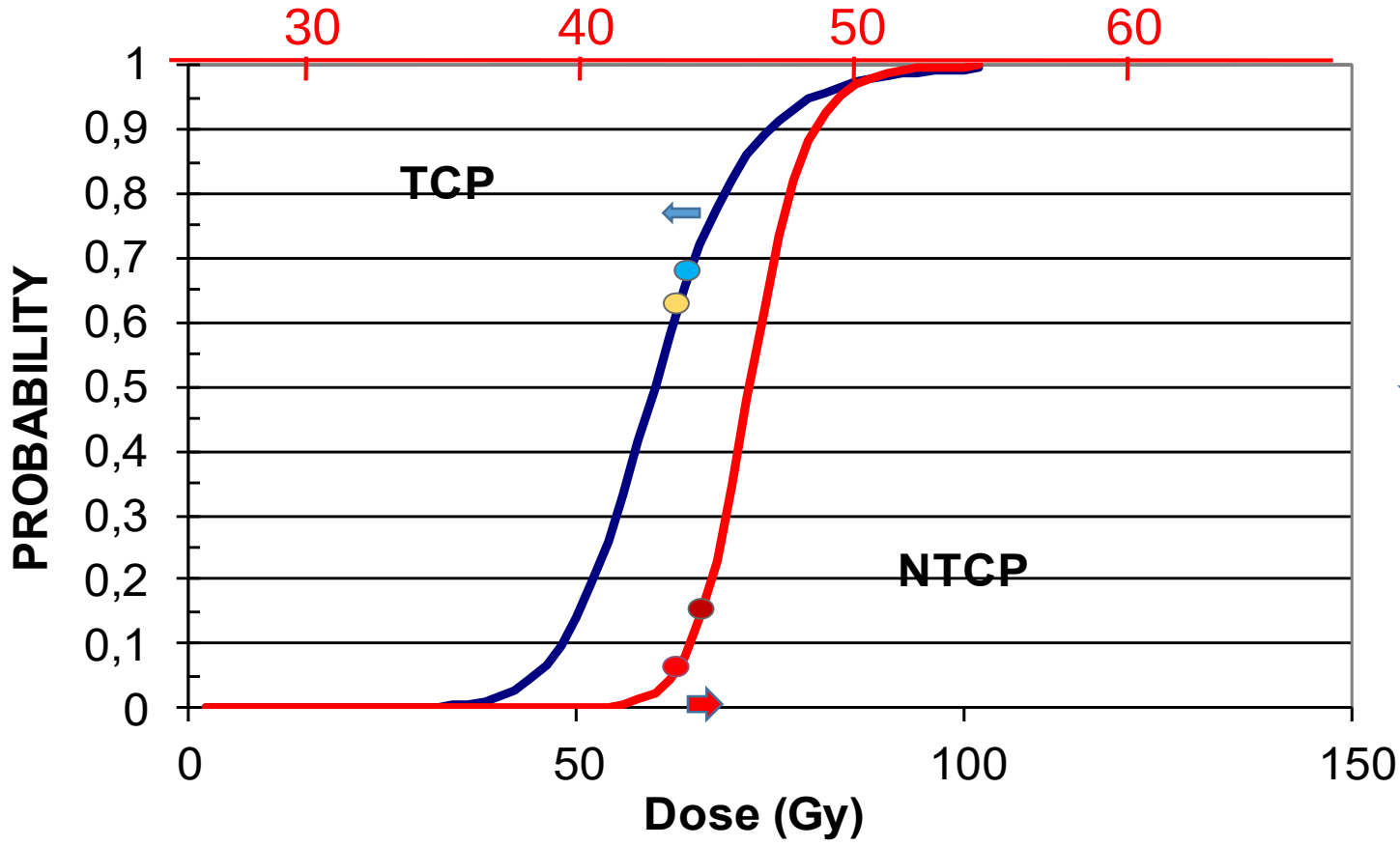
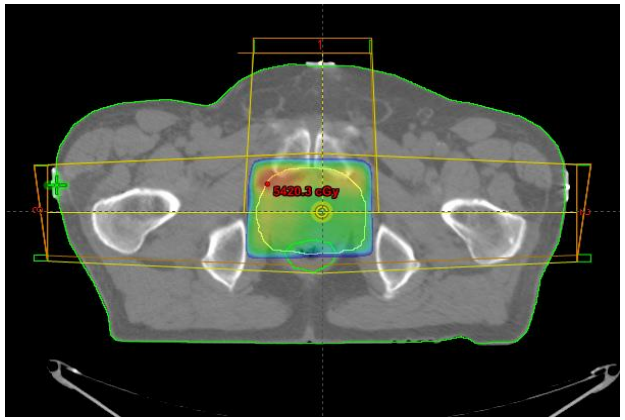




- TCP changes are cause by geometrical errors

>

- NTCP changes are caused by geometrical errors:

>

- TCP changes are cause by geometrical errors

  > (CTV-PTV) margin

- NTCP changes are caused by geometrical errors:

  ➢ any geometrical errors for serial organs

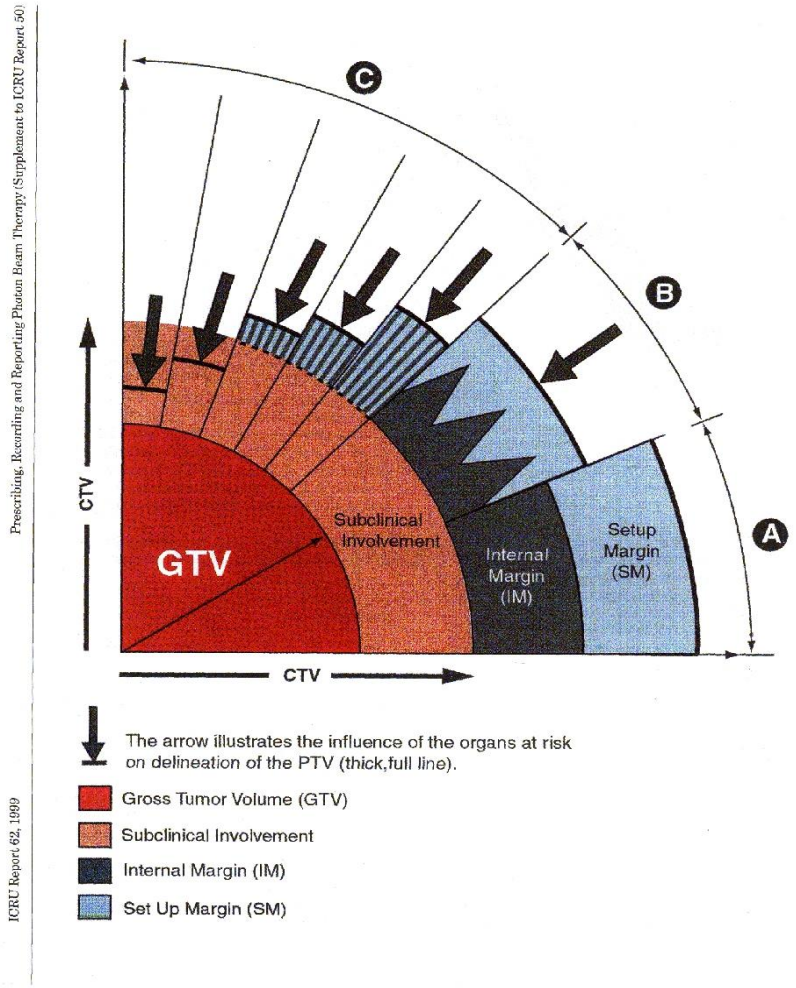
  (Planning Organ at Risk Volume)

  ??? geometrical errors for parallel organs

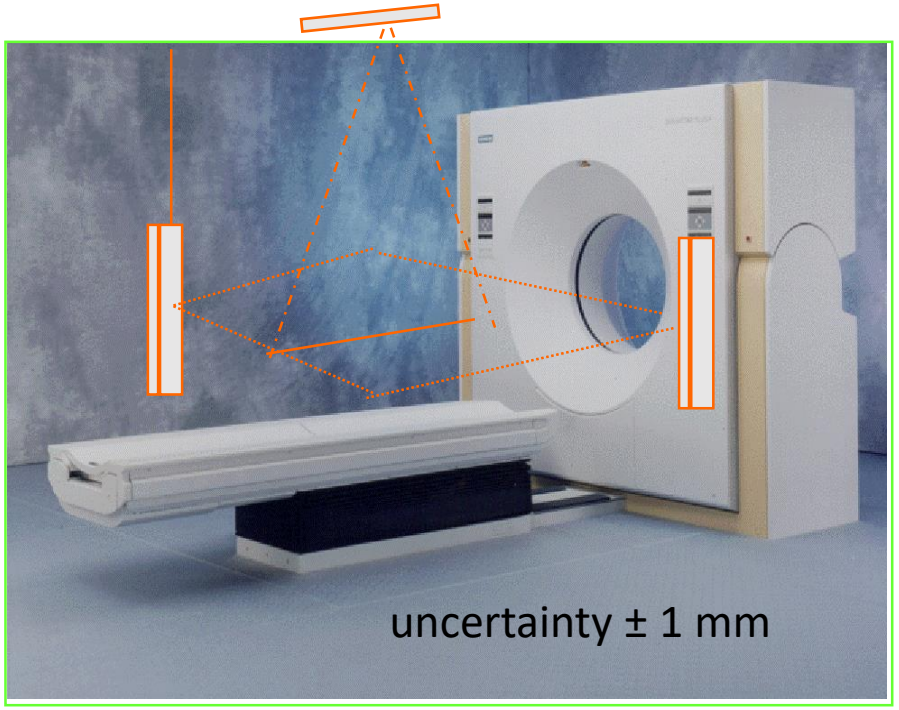
What should we know about

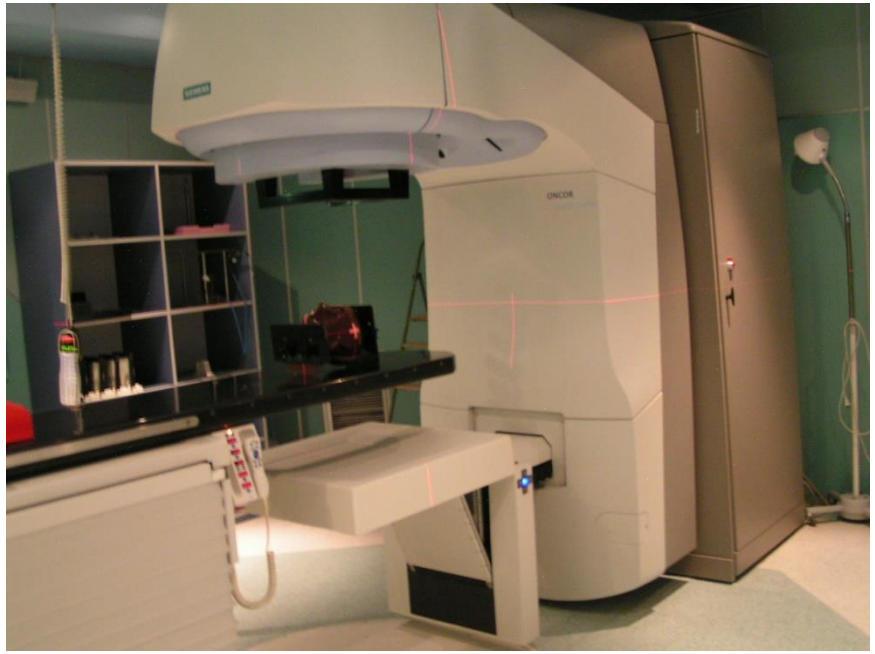
- Patient’s body is not a rigid object (there is one exception),
  - in the process of a patient preparation for irradiation we are looking for <u>the mean position</u> of his or her body,
    - it is impossible to avoid certain differences in a patient's position,
      - **a set-up margin** has to be added to the CTV
  - the position of the CTV with respect to anatomical landmarks might be not stable,
    - **an internal margin** has to be added.

ICRU 62
Definitions



To be ready for patient preparation

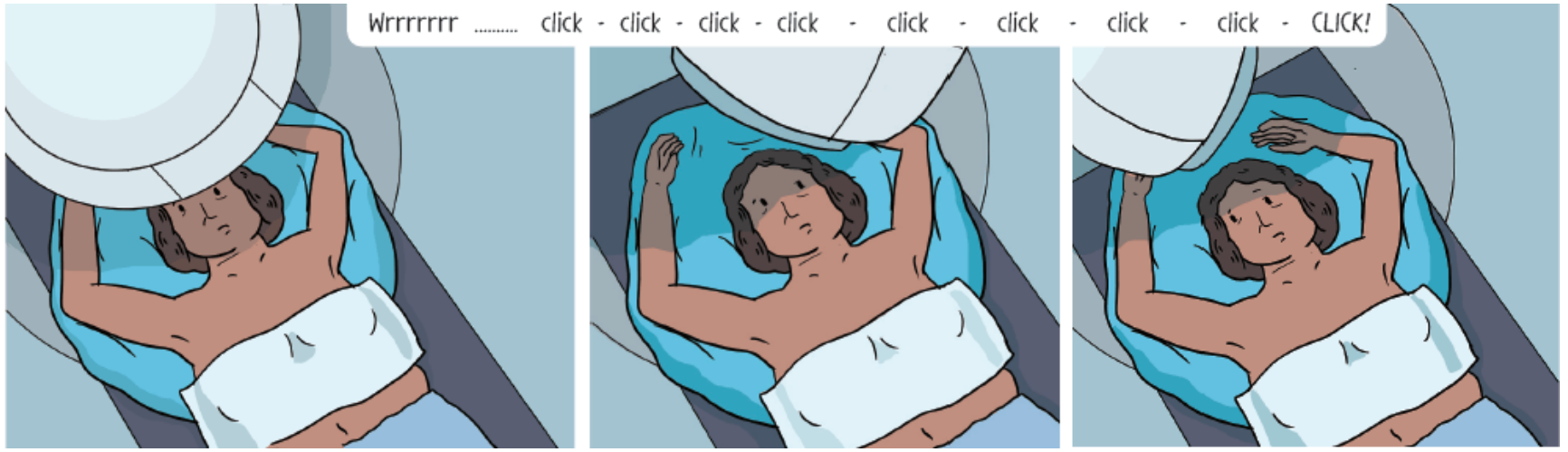




QA program has to be implemented!

What we should do?

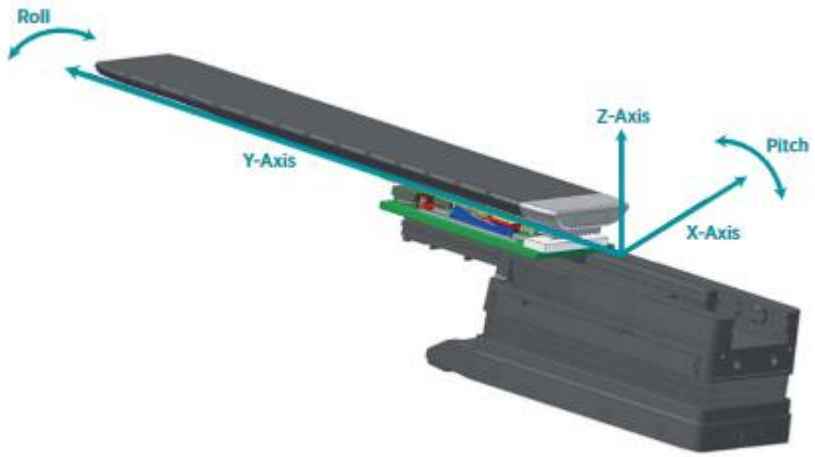
- to ensure a good cooperation with a patient,
  - explanation of what is radiotherapy – empathy,
  - an explanation of how preparation and irradiation will proceed,
    - the language (words) we are using, play a key role,
  - implementation (session) time matched to the general condition of each patient.



https://voices.uchicago.edu/roecsg/patient-education/

Special instructions

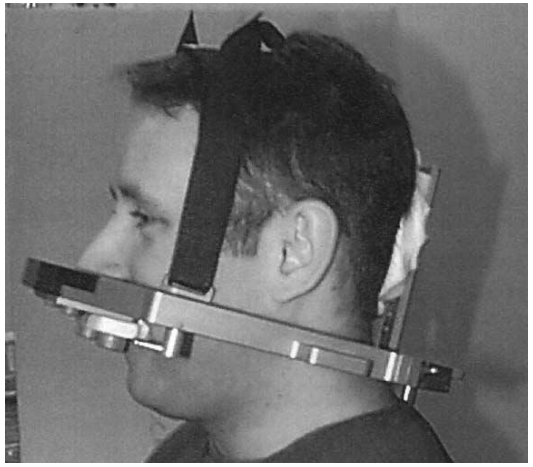
- In case of 6D table a special, detailed instruction must be given
  - the patient opposes changing the rotation of the table

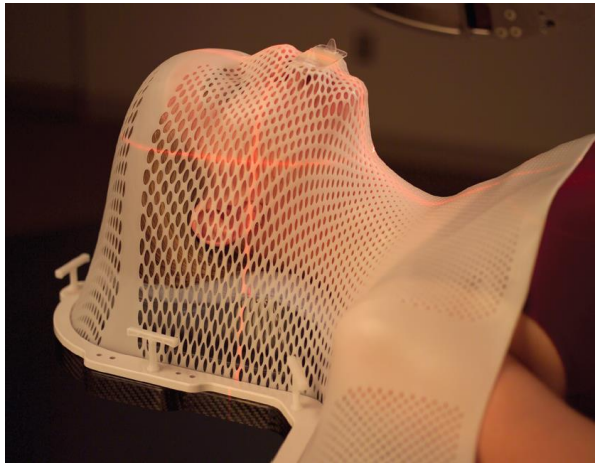


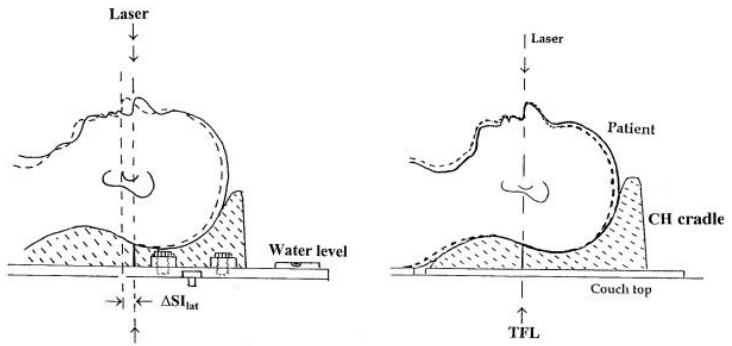
Perfect Pitch Table - Varian

Immobilization???

- Due to elasticity the patient's body cannot be immobilized!
  - "To ensure reproducibility"
    is better term to describe what we should do!
    - Reproducibility is achieved if the most convenient position of a body is achieved!
      - Avoid stretching a patient's muscles is important.
- Exception







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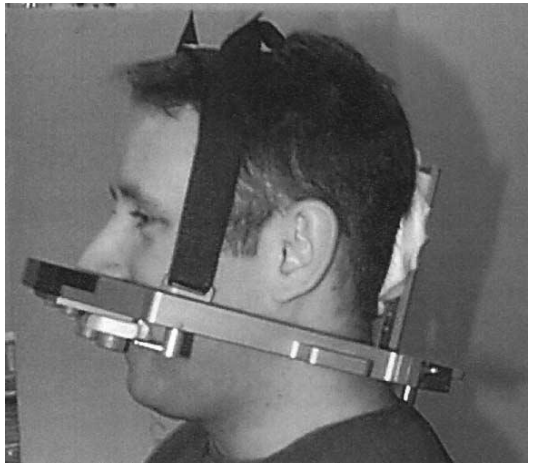
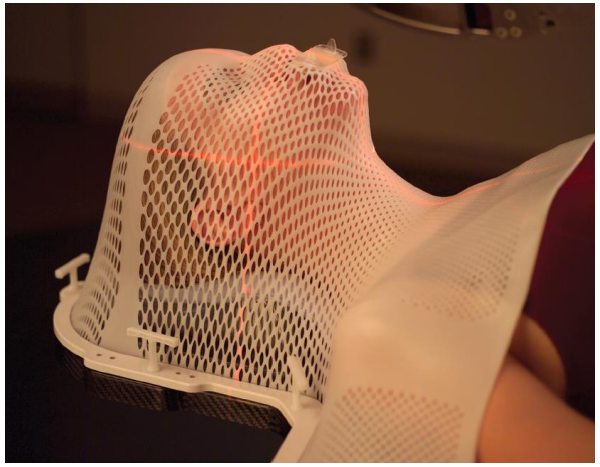
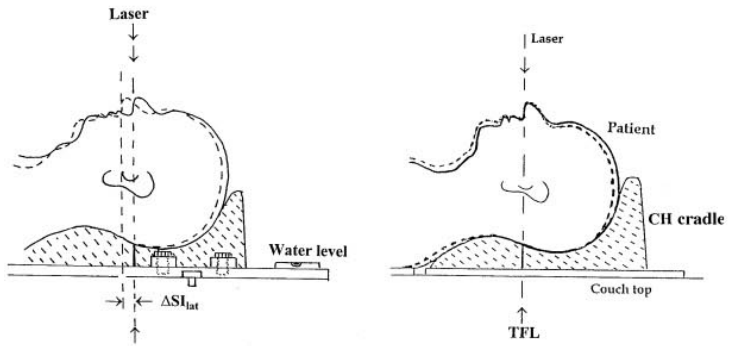
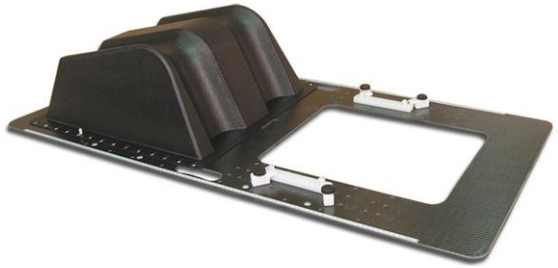




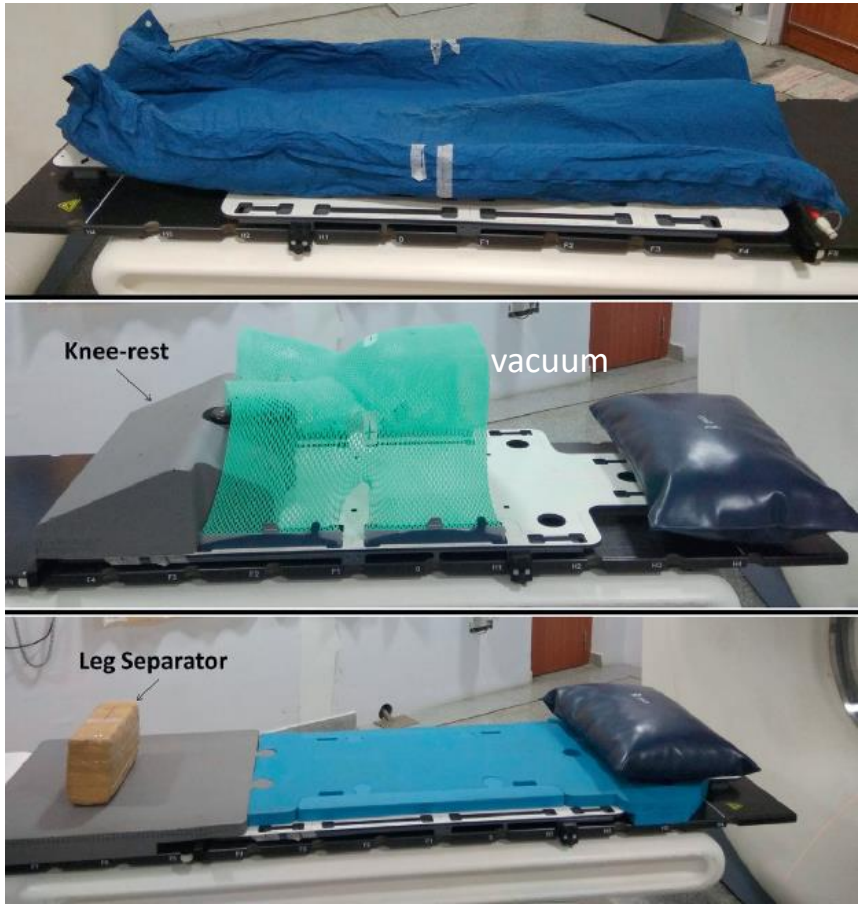


Muscles stretching problem



Int. J. Radiation Oncology Biol. Phys., Vol. 80, No. 1, pp. 281–290, 2011

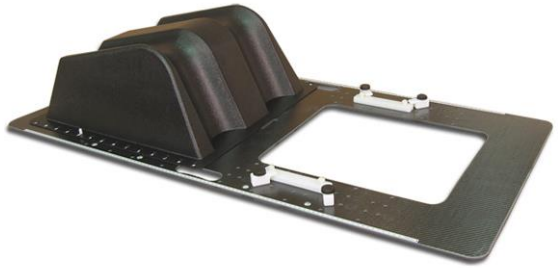
Orfit



Conclusions: Among the three techniques, no-immobilization technique with leg separator was the most reproducible technique with the smallest PTV margins. For obvious reasons, this technique is the least time consuming and most economically viable in developing countries.

REPORTS OF PRACTICAL ONCOLOGY AND RADIOTHERAPY 23 (2018) 233–241

Muscles stretching problem



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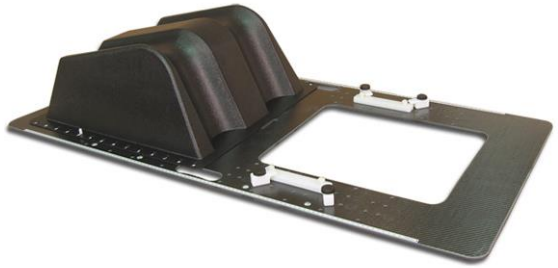

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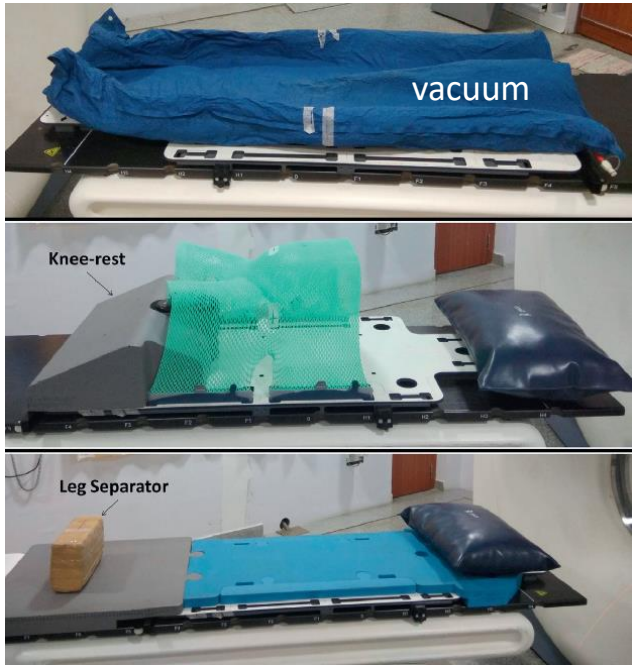


Orfit

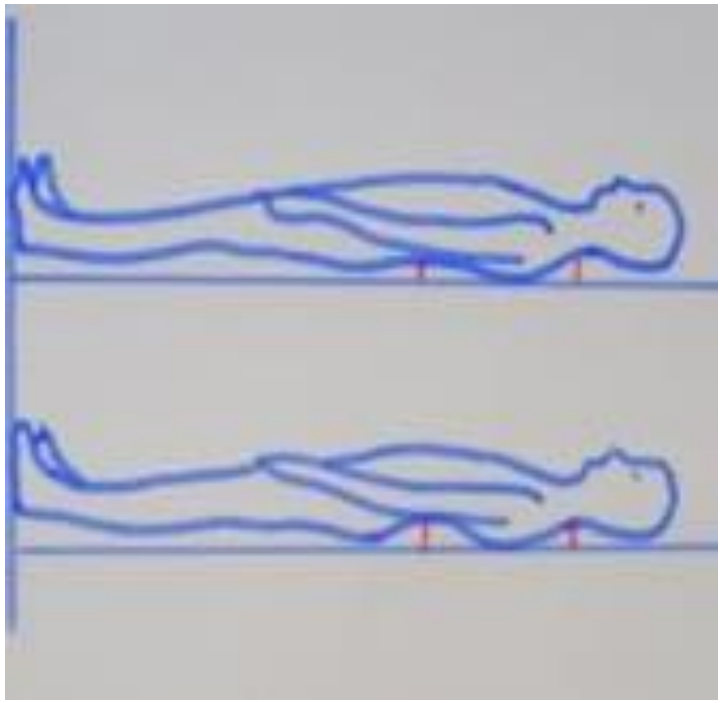
No - immobilization technique with leg sepeartor was the best

REPORTS OF PRACTICAL ONCOLOGY AND RADIOTHERAPY 23 (2018) 233–241

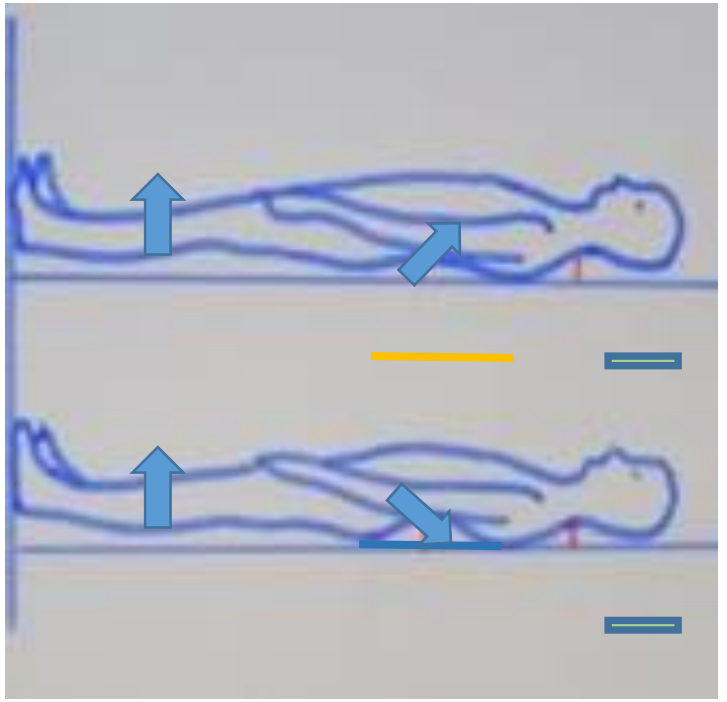
Comfortable position

- patient’s opinion is important

Not comfortable

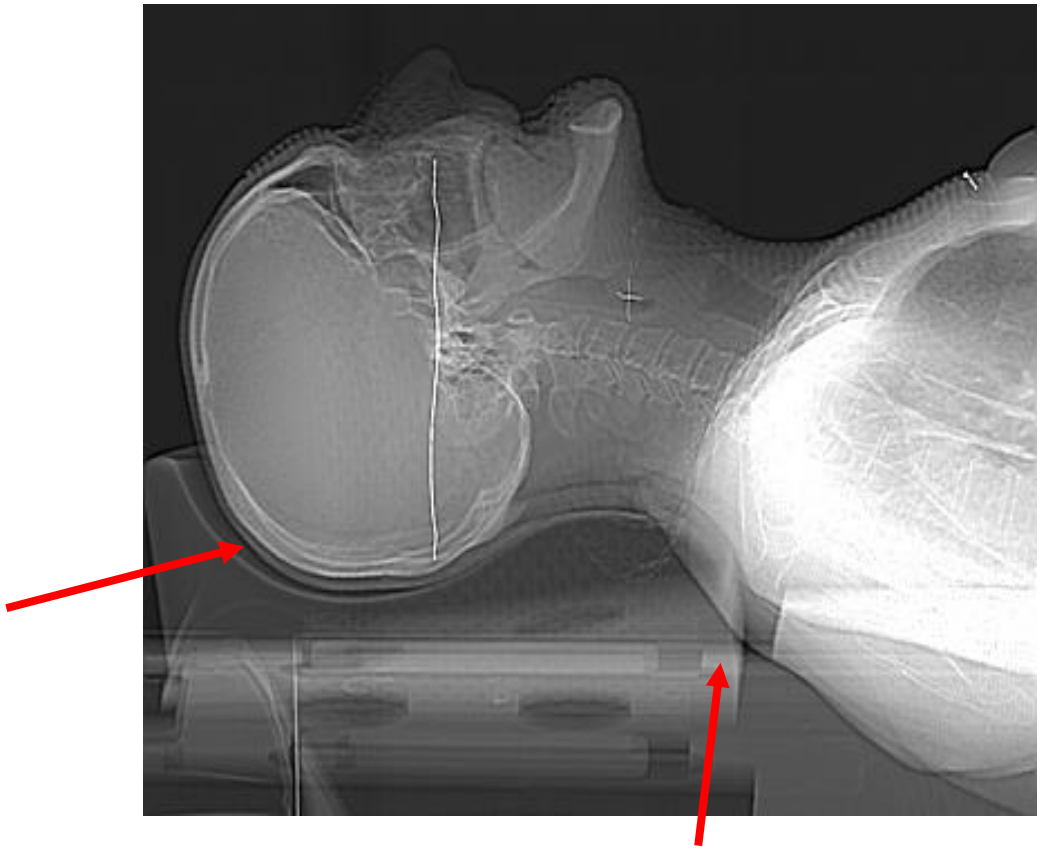


Much better



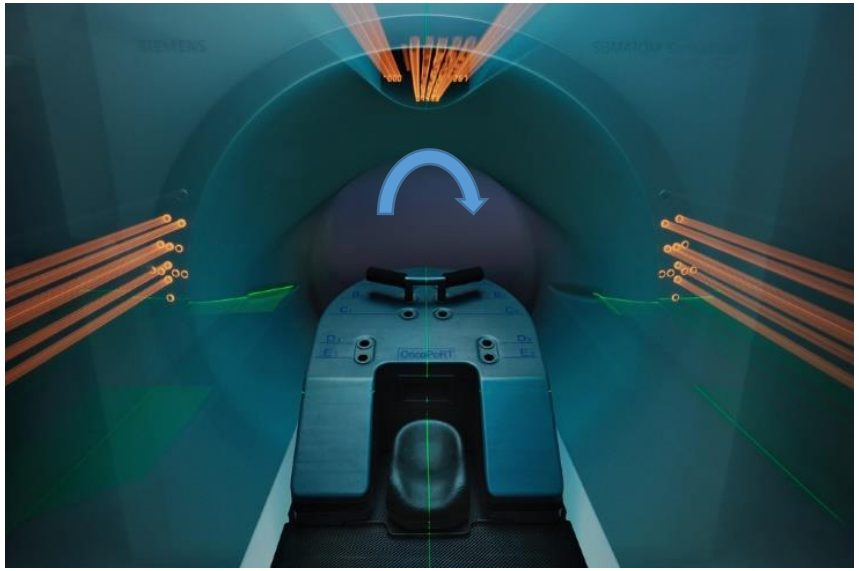
kyphosis problem

Errors in immobilization preapration

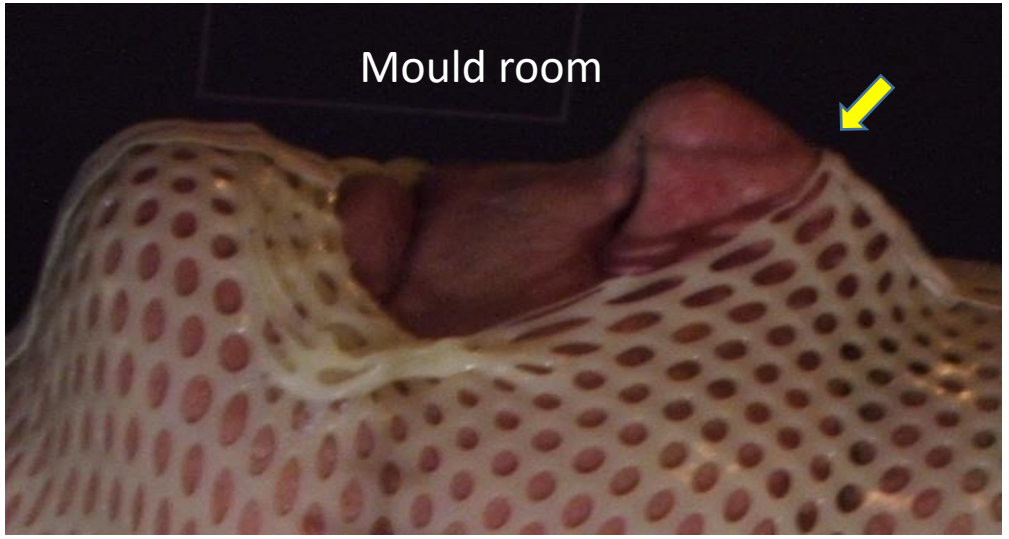


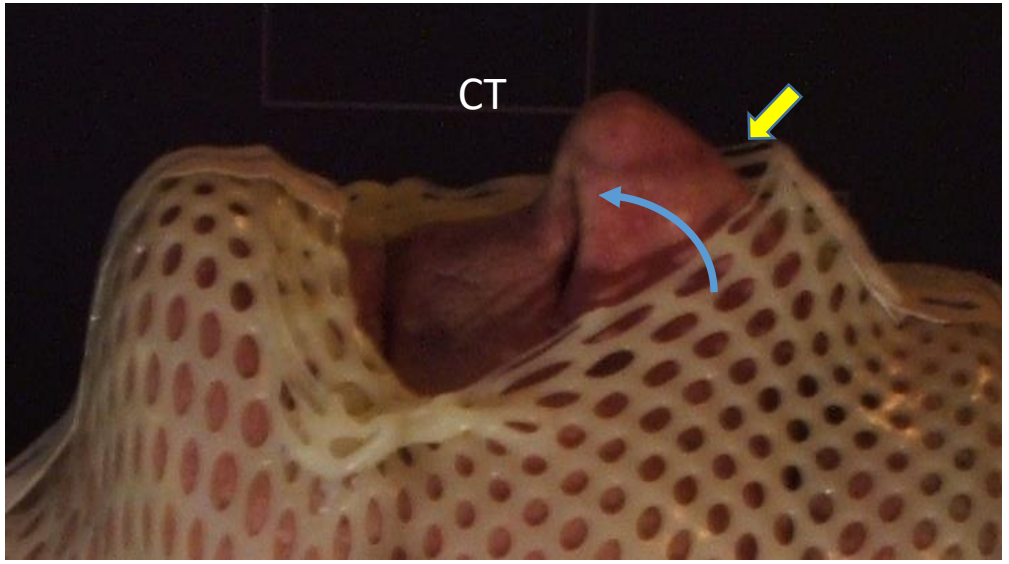
The edge of the immobilisation system is hurting

Rotations



System designed in our center for irradiation in the region of thorax





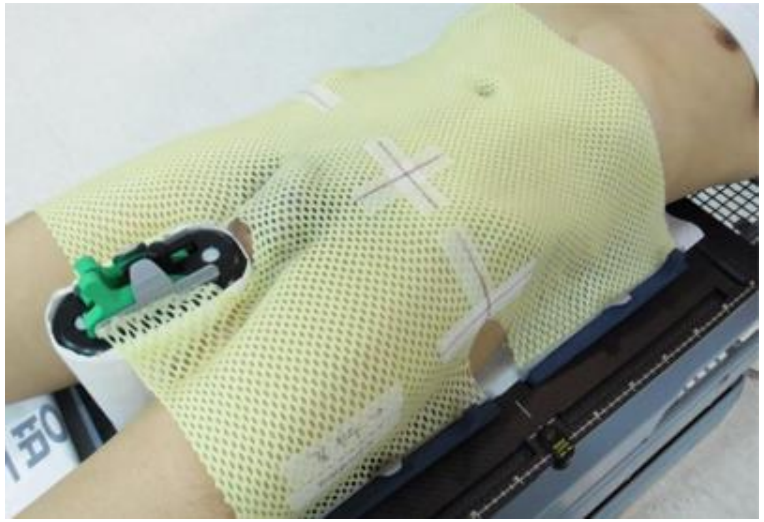
Individual vacuum support

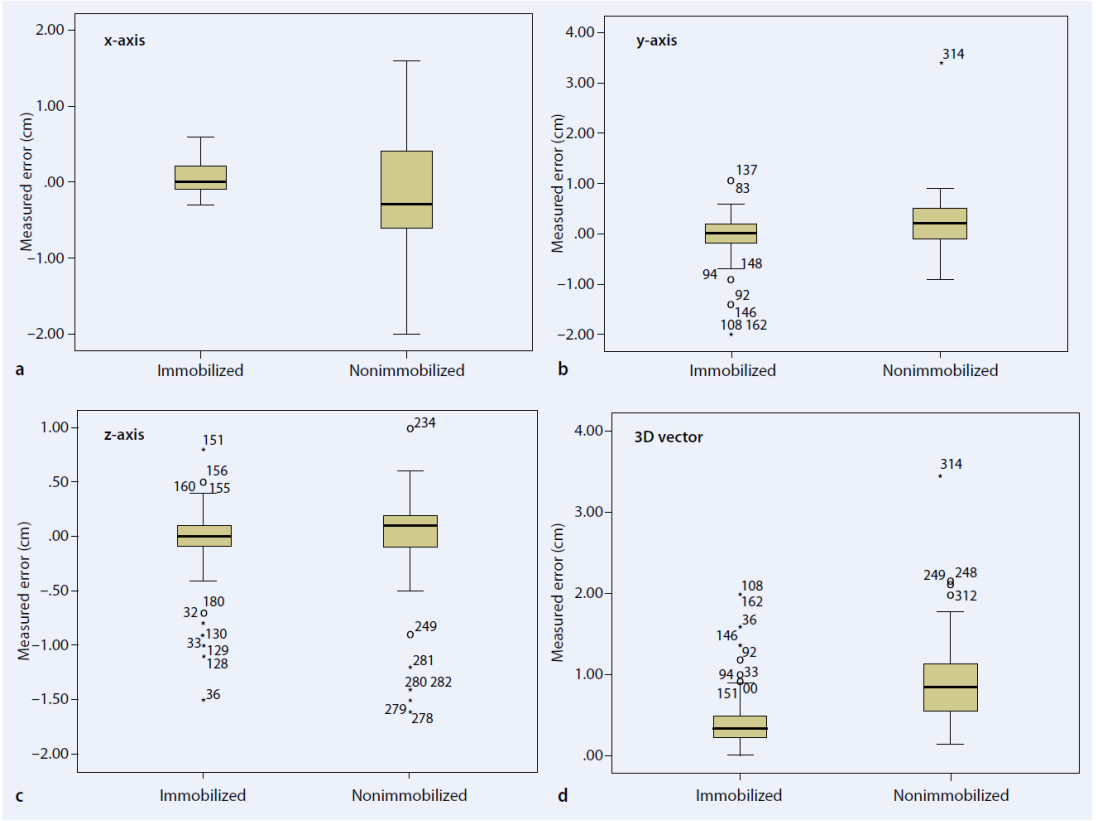
BodyFix

particularly useful for sarcomas patients

Patient’s body position should be reproducible

- Not the mask!

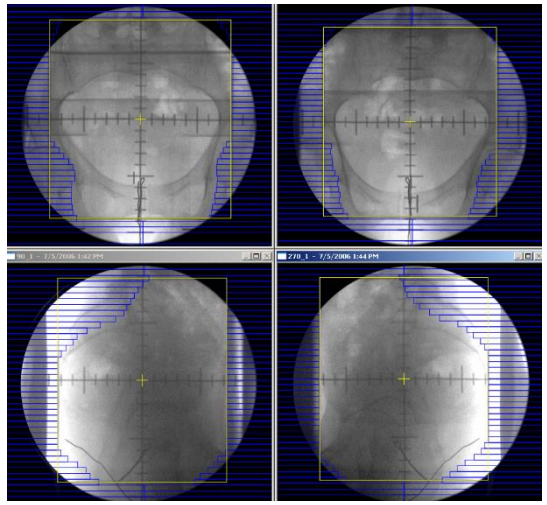




Lee, …Strahlenther Onkol 2014 · 190:94–99

Average (reproducible) position

- How to determine the average position?
  - It is just the mean position of several
- That's why
  - patient should be placed several times and his or her position should be checked if it is reproducible
    - comparison of several pairs of orthogonal images



Conventional simulator

Average (reproducible) position

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  - It is just the mean position of several positions!
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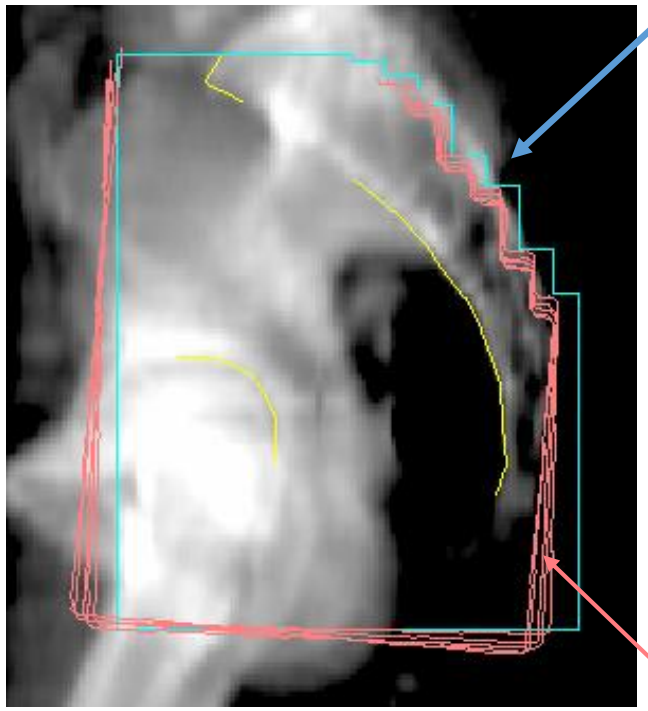
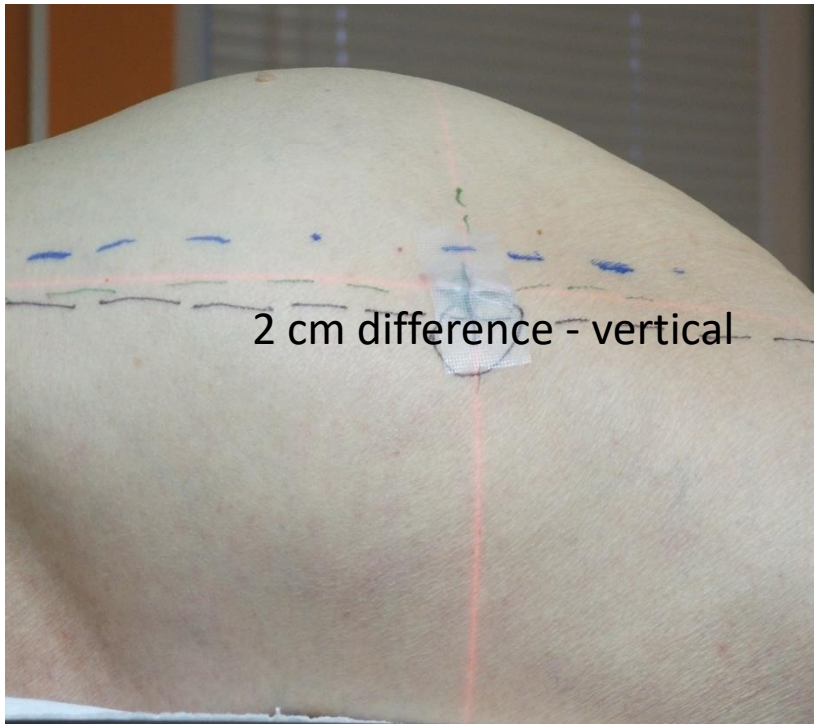
  - patient should be placed several times and his or her position should be checked if it is reproducible
    - comparison of several scount views

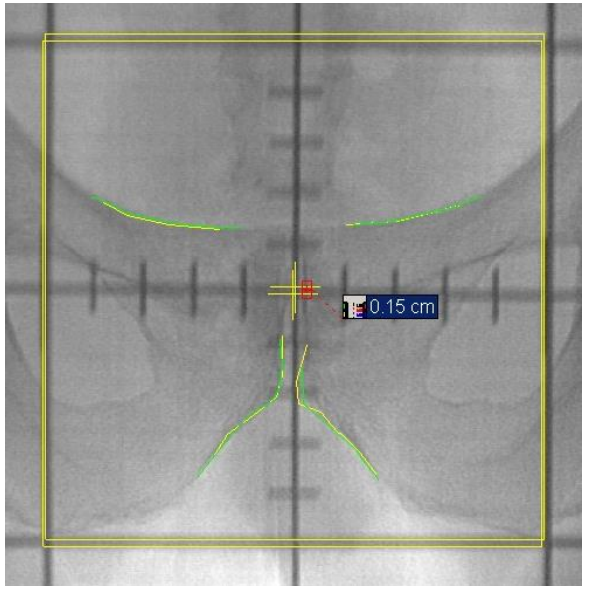


CT might be one of the most source of systematic errors

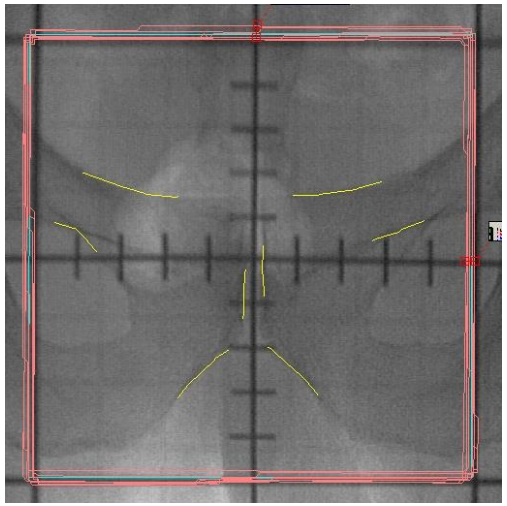
Average position preliminary simulation conventional simulator



second set-up: 8 minutes later

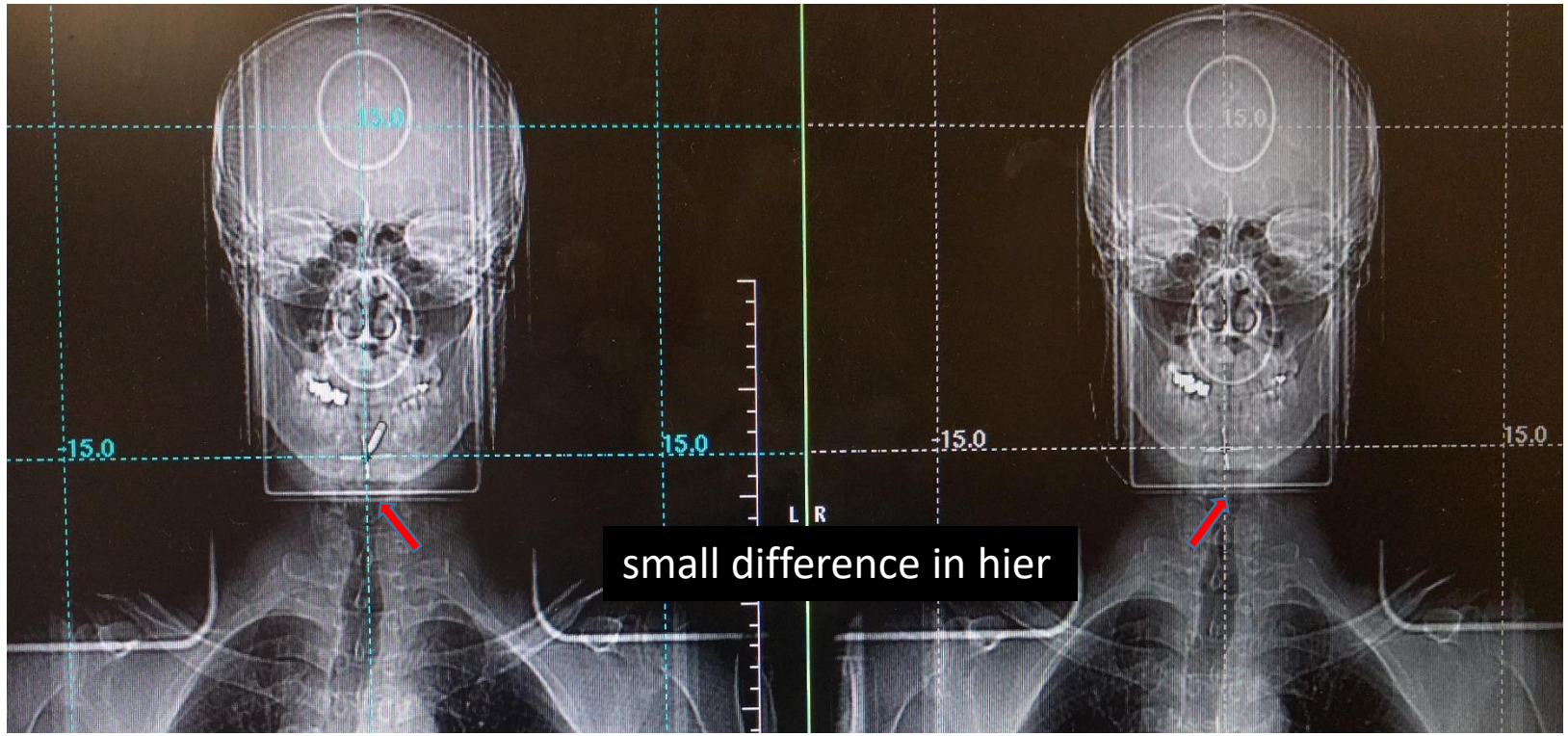


preliminary simulation: good result



portal control results

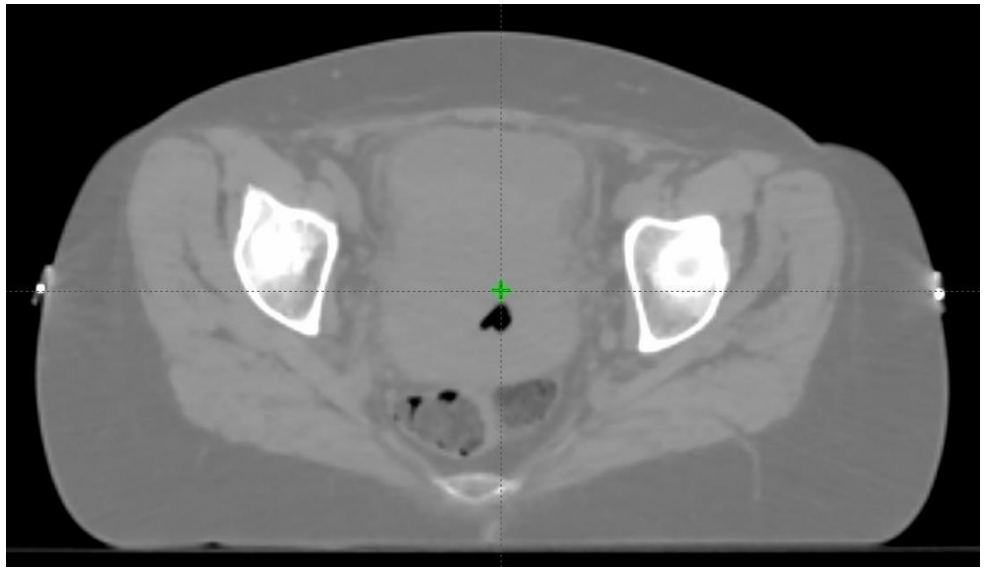
Average position
preliminary simulation
CT-simulation

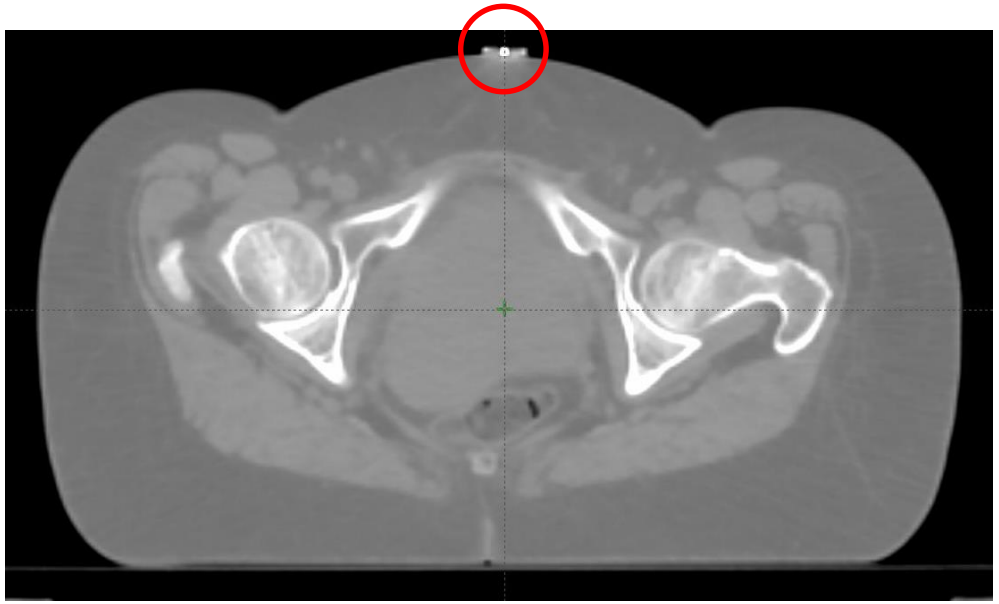


Two topograms (scount views)

Geometrical reference point

- Isocenter is defined with respect to
  - geometrical reference point
  - anatomical structures





Precise, unequivocal description of this point is a must!

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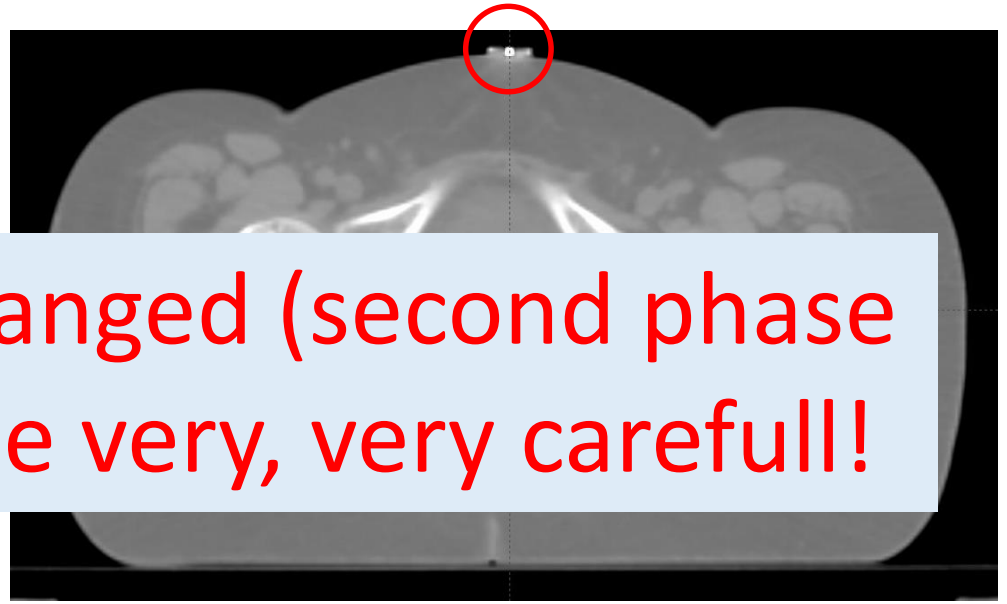
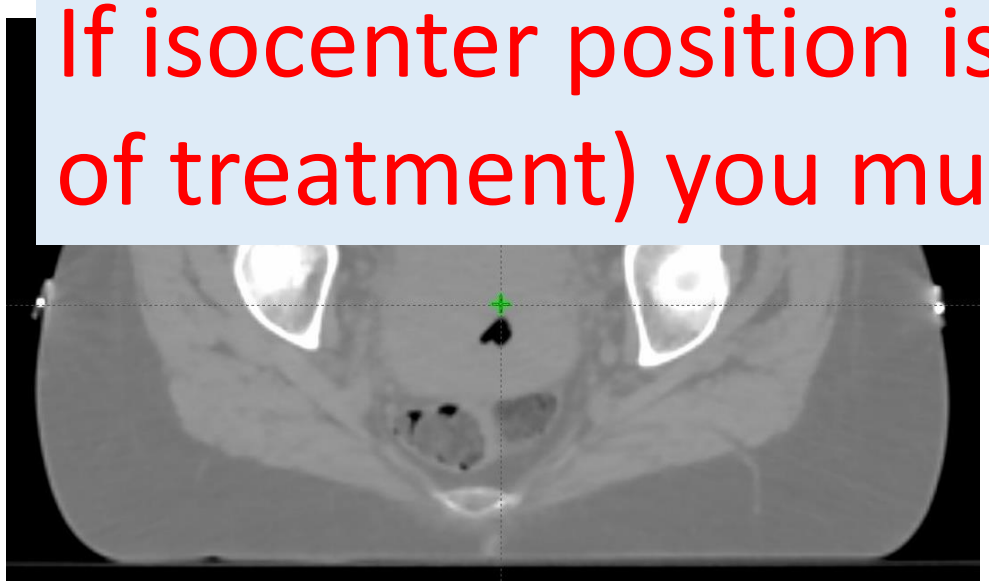


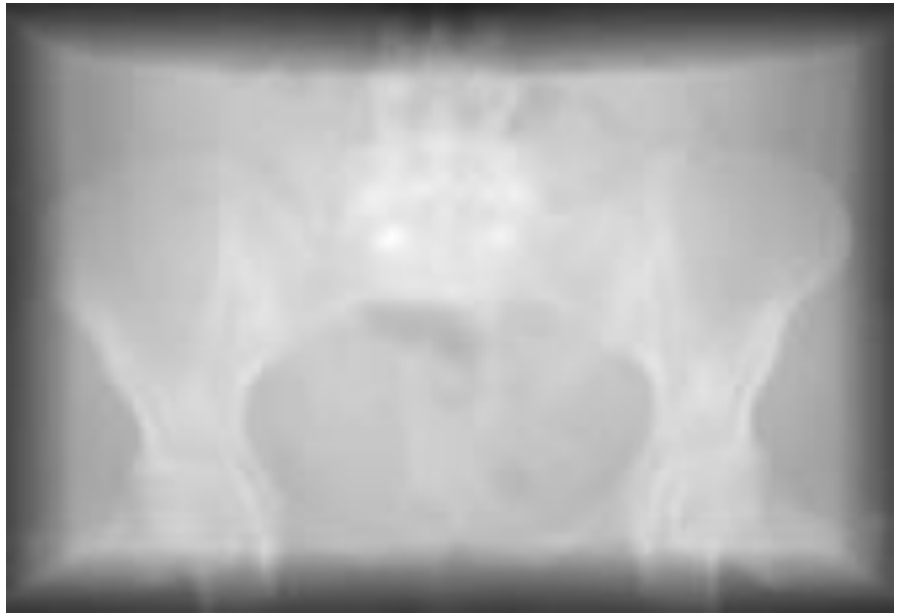


If isocenter position is changed (second phase of treatment) you must be very, very carefull!

Precise, unequivocal description of this point is a must!

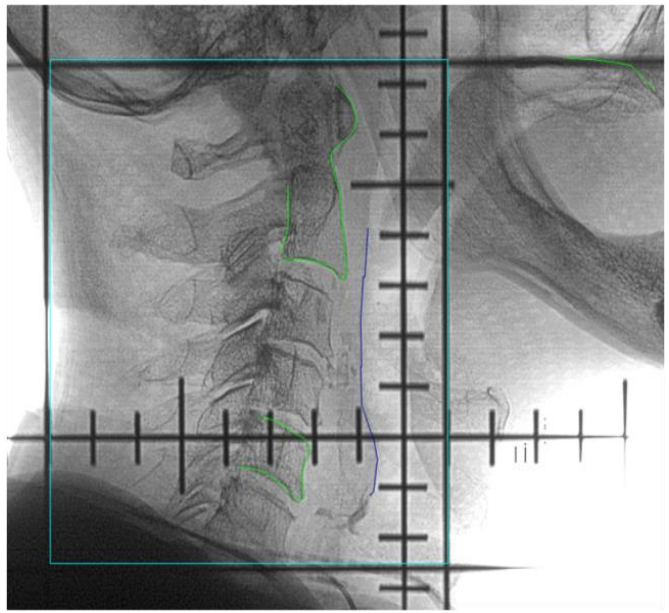
DRR for set-up verification

- Quality of DRRs depends on the slice thickness and separation
  - recommended are ≤3 mm/ ≤3 mm
    - spiral mode - reconstruction!
- It is recommended to place the geometrical reference point in the one of reconstructed slice



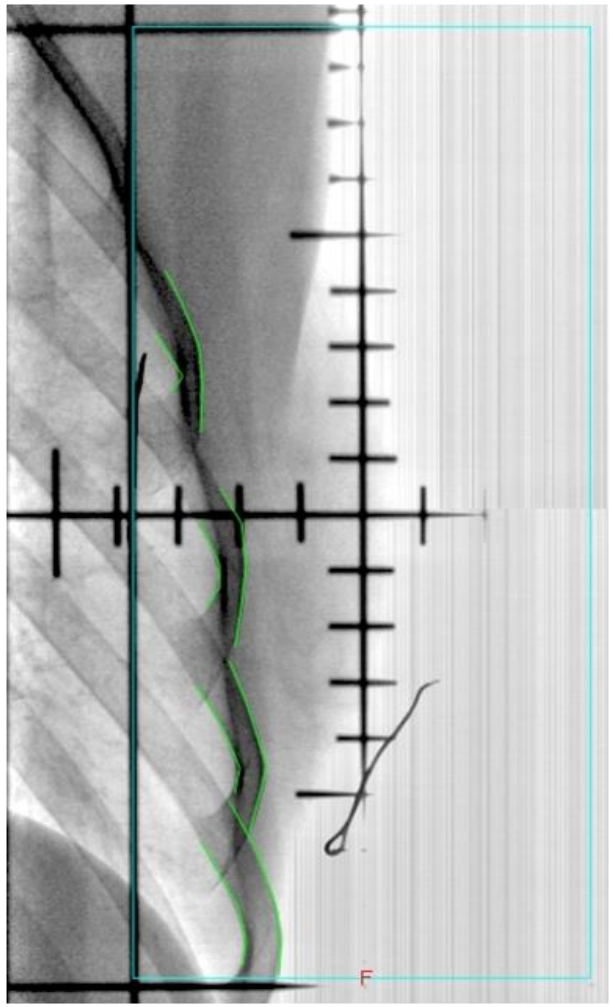
DRR preparation for set-up control

- The edges of anatomical structures should be delinetaed



H&N

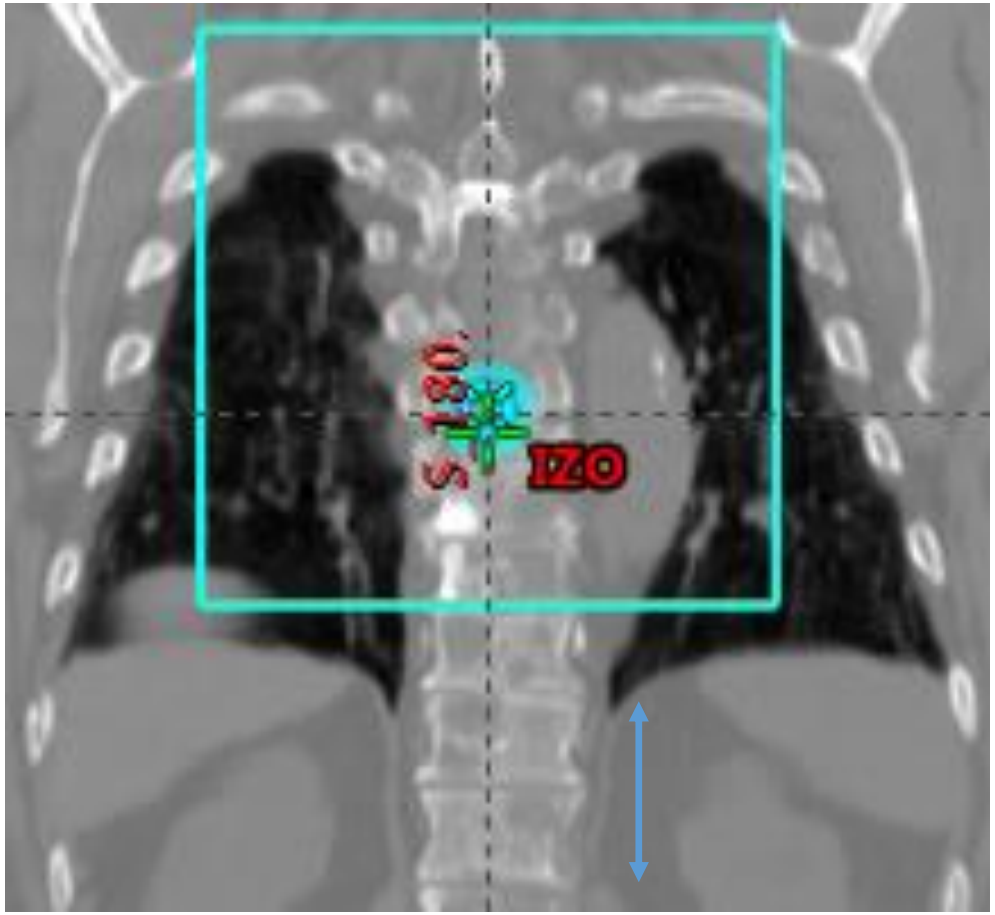
breast



DRR preparation for set-up control

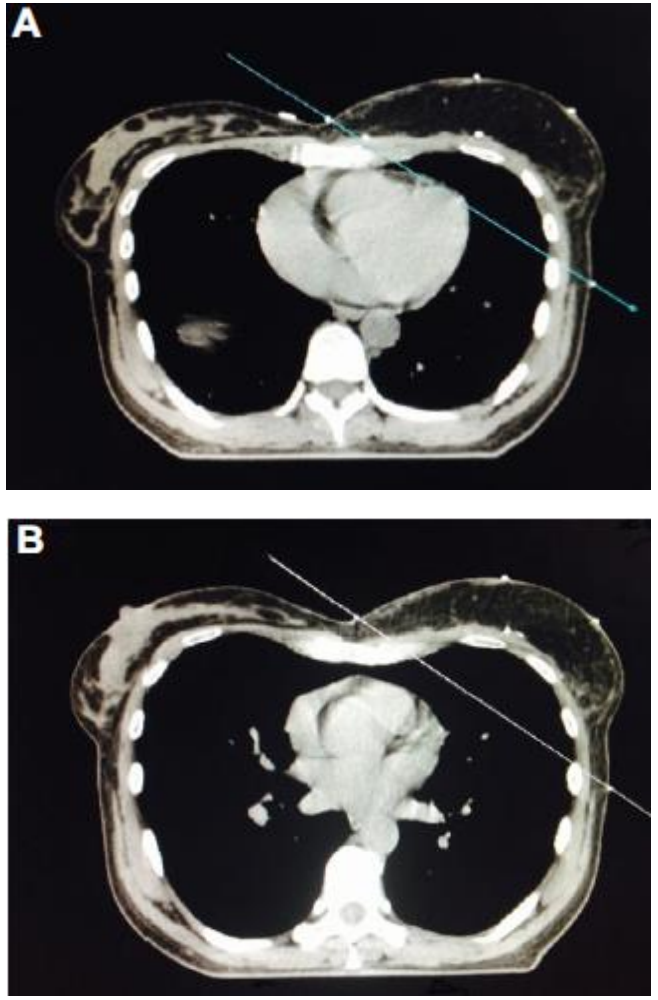
- Be carefull with symmetry!

Vertebrae are very similar to each other.



Special techniques

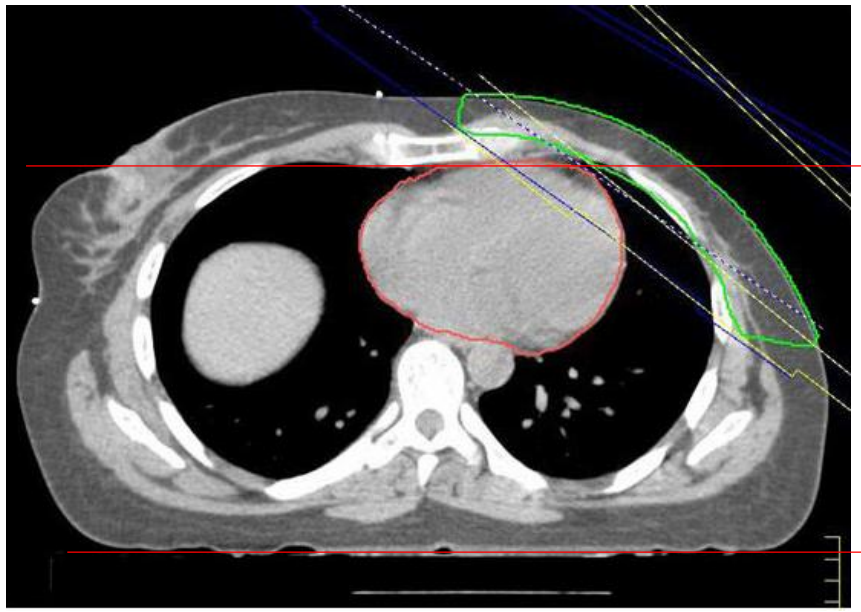
- Patient’s preparation for treatment
  - Deep Inspiration Breath Hold technique (DIBH)
  - Pelvis irradiation
    - Prostate
      - „gold markers”
      - spacers
    - Ginecology
      - bladder filling

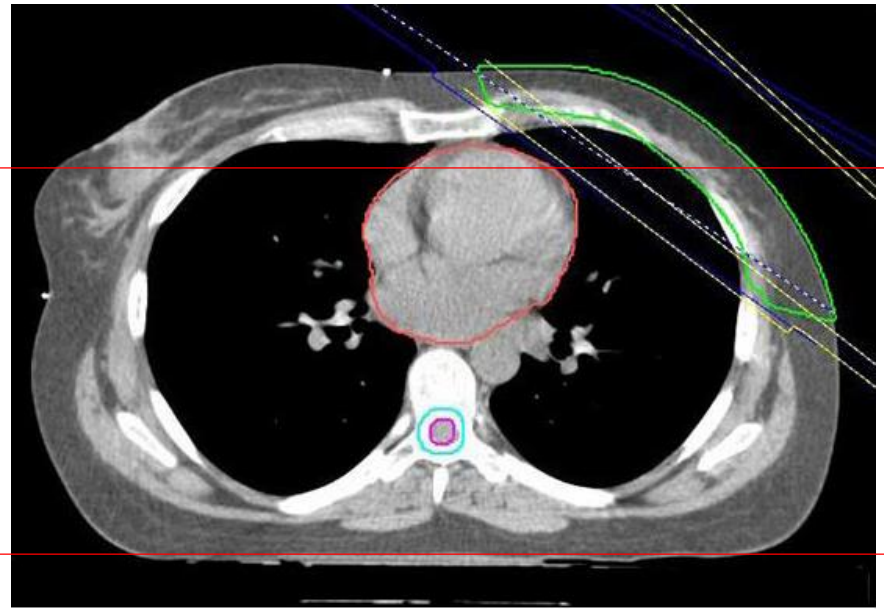


free breathing

deep inspiration breath hold

DIBH



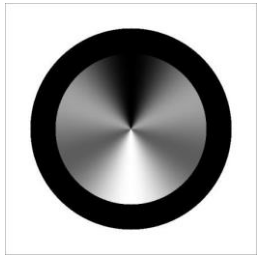


Deep Inspiration Breath Hold
for left breast cancer

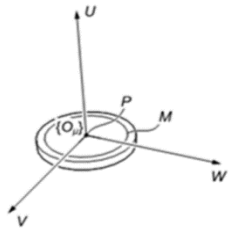
- To diminish the dose to heart

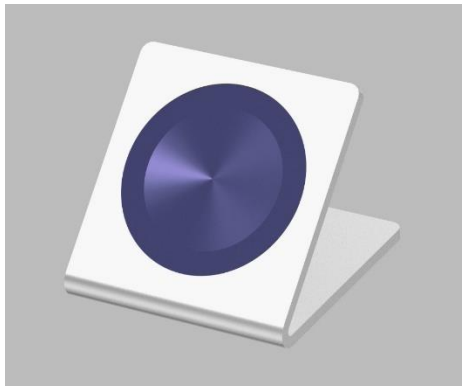
- In cooperation with Polish Company Optinav we designed the optical system for preparation of these patients for DIBH

2 optical cameras



marker





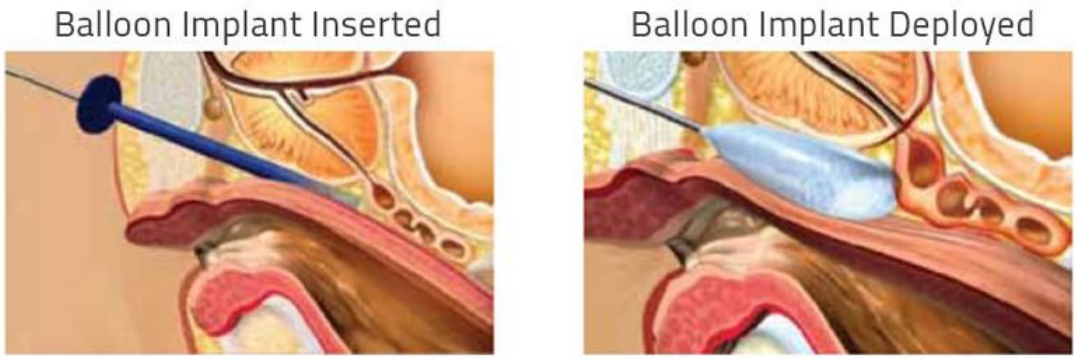
Preparation mould room

Before training

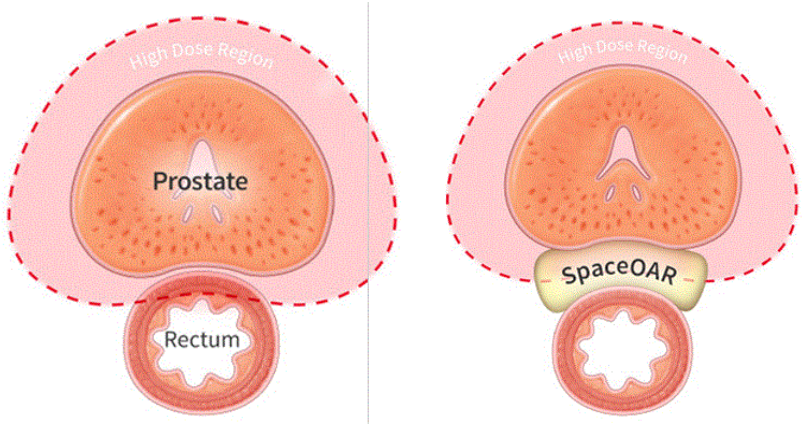
After training

Prostate - spacers

- Biomaterials placed between the prostatę and rectum
  - To reduce rectal dose



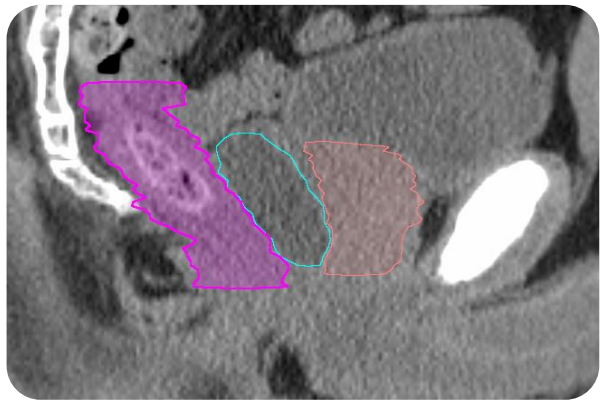
ProSpace™ Balloon (BioProtect Inc.)



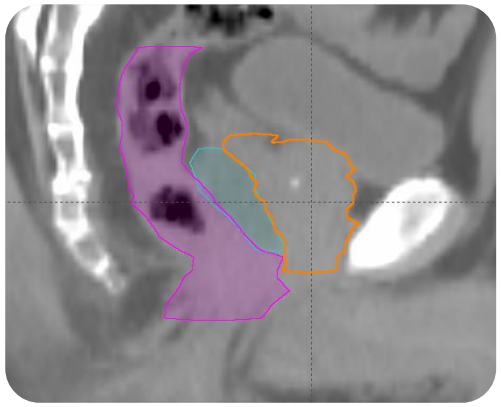
Expectations!

Prostate spacers

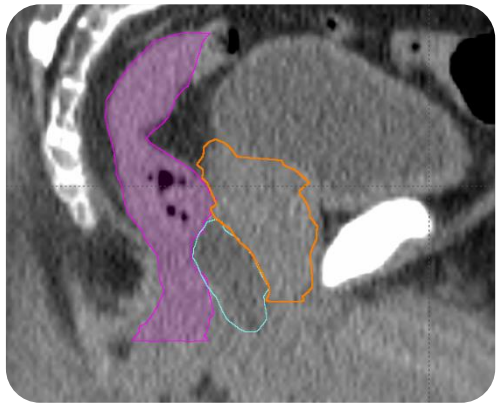
our experience – 8 first patients



Correct – 4 patients

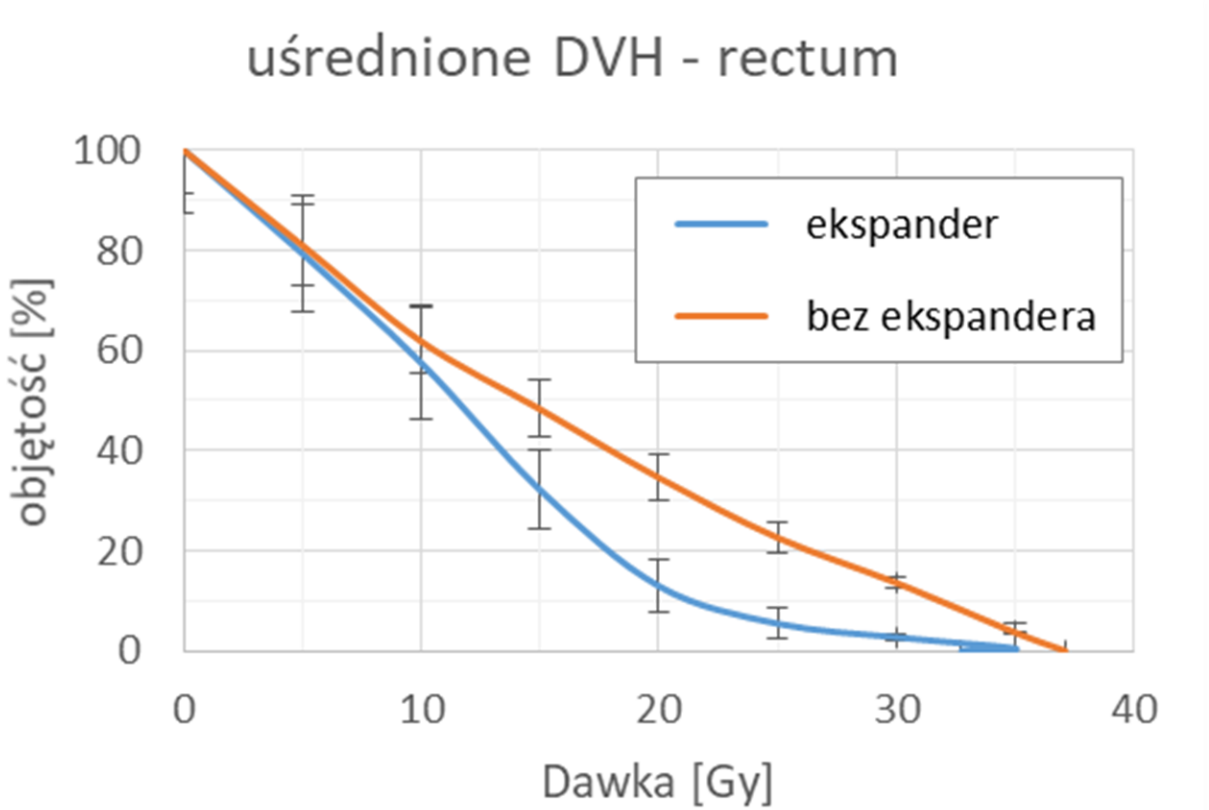


Little up – 3 patients

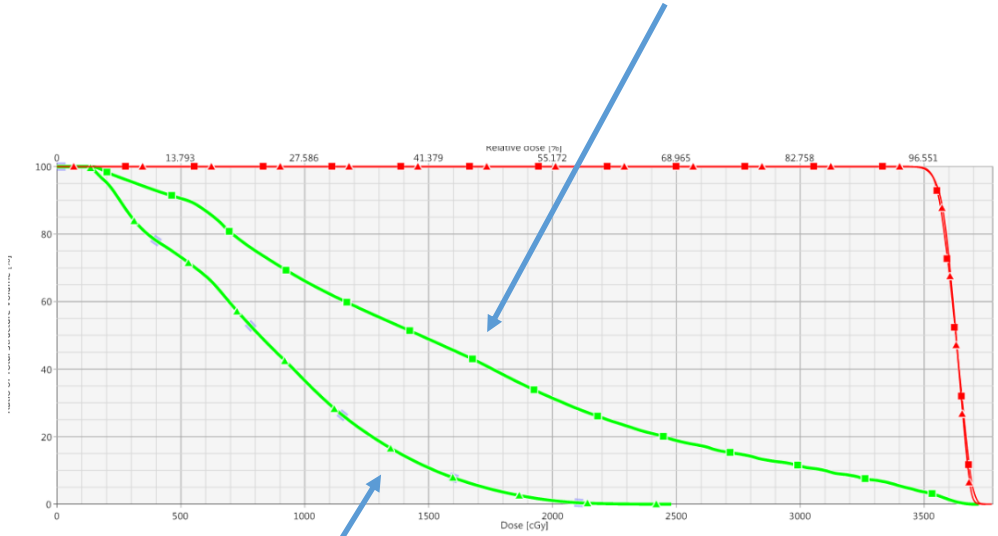


Little down – 1 patient

Advantage - dose to rectum



without spacer

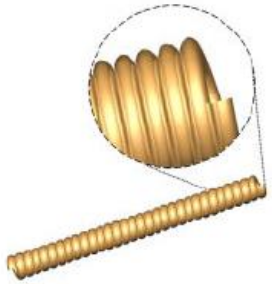


with spacer

Set-up control of prostate patients

- Position of the prostate is not well linked to the bone structures
  - traditional methods of setup control are not appropriate
    - „gold markers” as a surrogate of prostate position

Courtesy of CIVCO



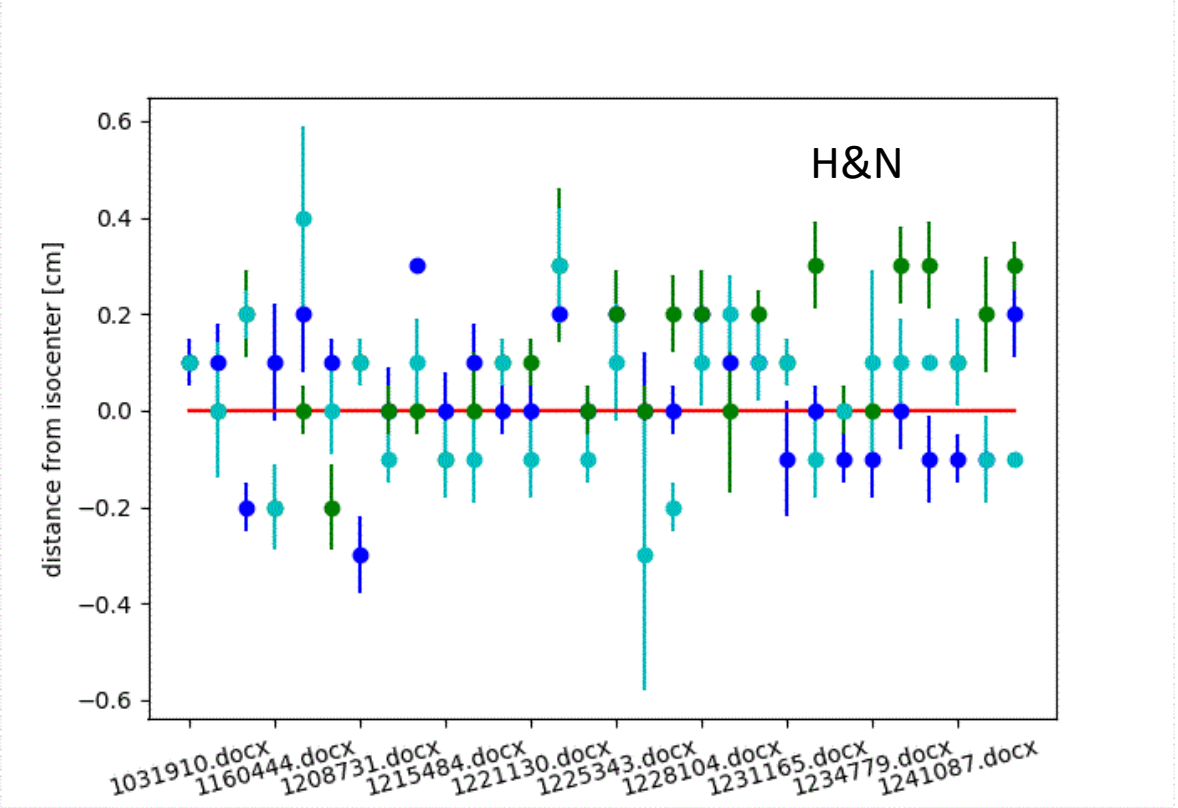
Courtesy of IBA

Courtesy of Naslund Medical AB

Courtesy of Varian

Preparation should be checked

- Portal control

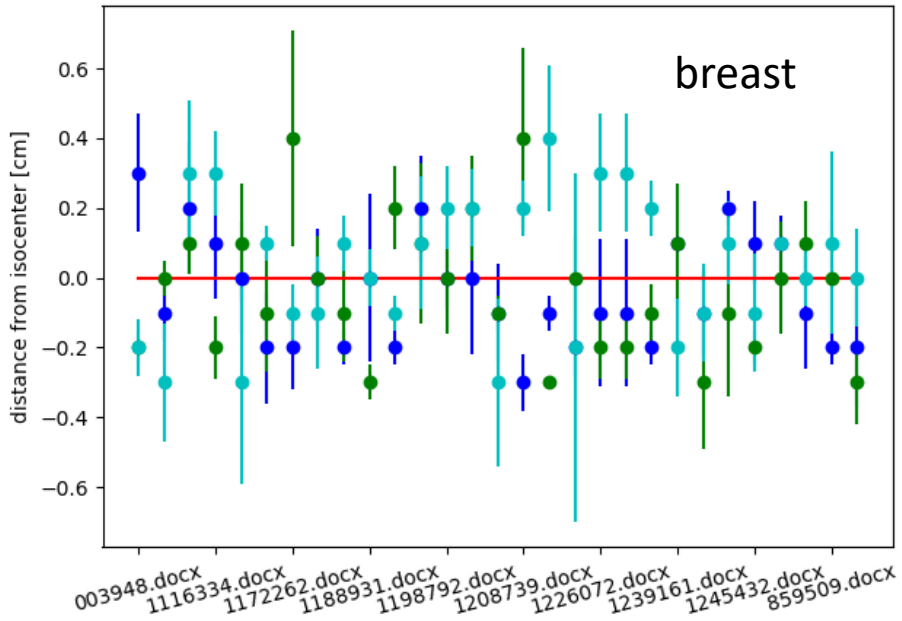


Population error

	Vertical [cm]	Longitudinal [cm]	Lateral [cm]	Rotational [cm]
Systematic error	0.0±0.13	0.1±0.14	0.0±0.15	0.1±0.34
Random error	0.08	0.07	0.08	0.41

Preparation should be checked

- Portal control



Population error

	Vertical [cm]	Longitudinal [cm]	Lateral [cm]	Rotational [cm]
Systematic error	0.0±0.15	0.0±0.19	0.0±0.2	0.2±0.57
Random error	0.12	0.13	0.15	0.48

Summary

- Every step in radiotherapy should be performer with high quality!

- Preparation plays a very important role in radiotherapy chain.
  - cooperation with a patient
  - applying the right solution for each individual situation

- Portal control gives the answers the patient's preparation

Preparation is very important!

Thank you very much for your listening!

A few tips

- Medical physicists play a very important role in radiotherapy
  - dosimetry
  - Quality Assurance (Quality Control)
  - Treatment Planning

but always

- The most important is: a critical look at the results.

- Please cooperate with radiation technologiests!
  - Your theoretical background is very needed!

PhD

- In different countries there might be different PhDs
- Phd might be very scientific
- Phd might be practical one
  - This one enables making treatment better!
- **Remember that you are serving your patients!!!**