



# VMAT in Mannheim



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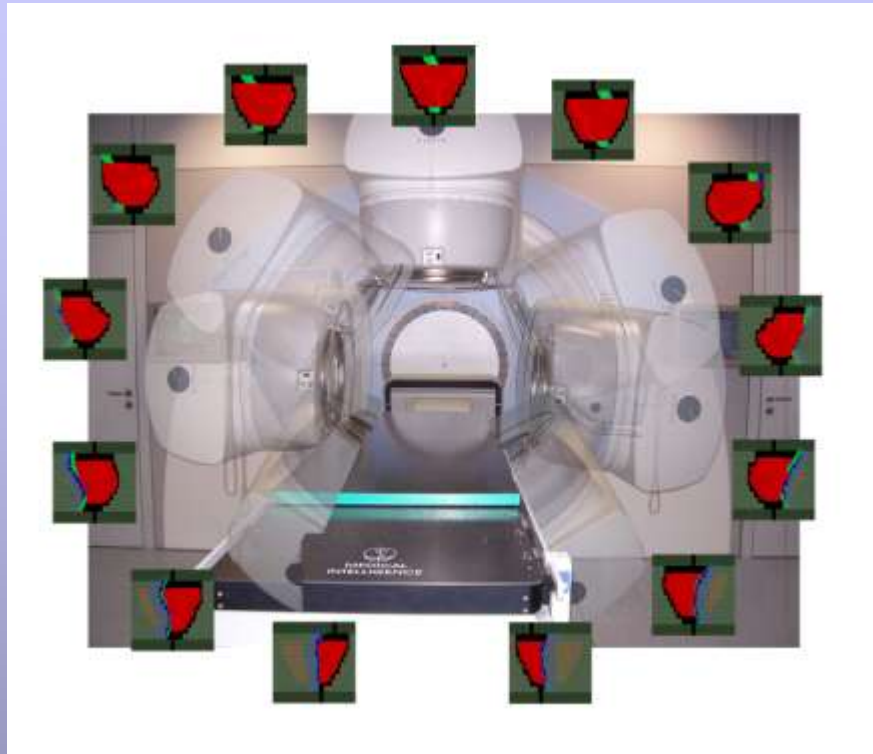
F. Lohr, M.D.





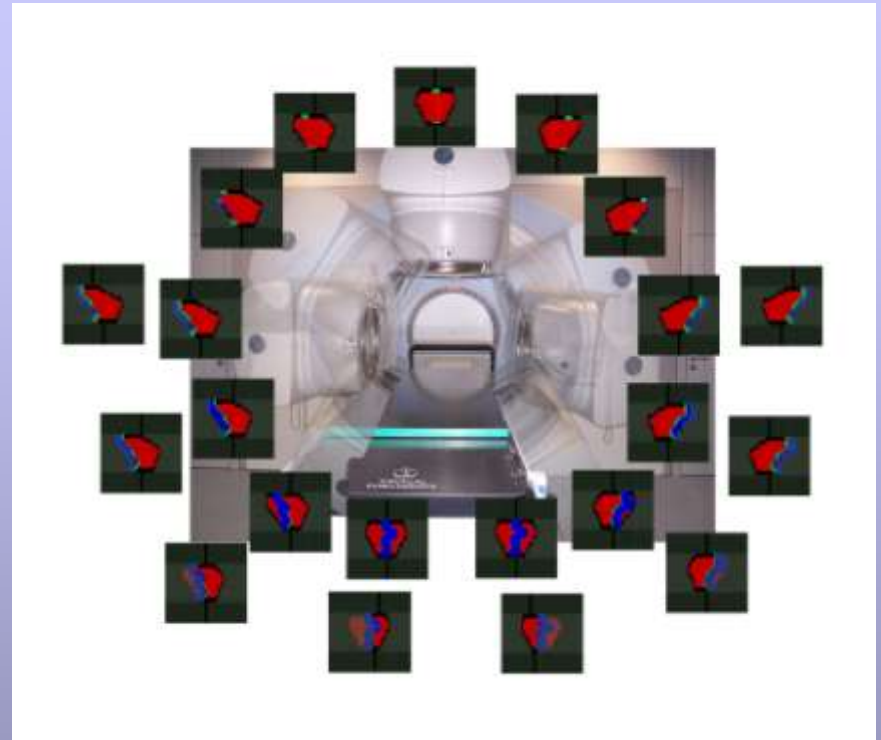
- **ERGO++** delivered in Sept. 2007, current version 1.7.1, DMS 2.6.2
  - Class solutions of treatment of pelvis, prostata and spinal cords developed
  - Currently development of class solutions for head and neck, breast and stomach
- **MONACO VMAT**
- **Desktop 7.01** installed in April 2008 (nonclinical version)
- **Mosaik 1.5** installation in September 2008 (for VMAT delivery)
- **Desktop 7.01** installed in December 2008 (clinical version)
- **Mosaik 1.6** installation in December 2008 (clinical Version for VMAT delivery)
- First Patient treated clinically in December 2008
- MONACO awaiting clinical comissioning
- Starting Monaco VMAT BETA

# Prostata carcinoma – VMAT rotation strategies



## VMAT 1 Rot:

- 1x 360° rotation with shielded OAR in front of target



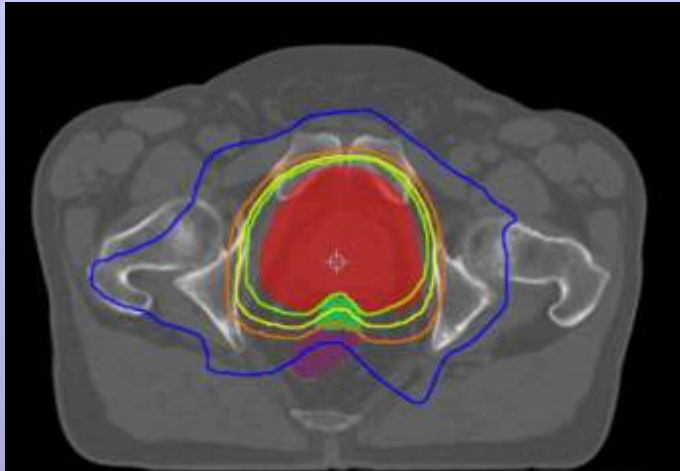
## VMAT 1,5 Rot.

- 1x 360° rotation on target
- 2x 100° rotation on target with shielded OAR

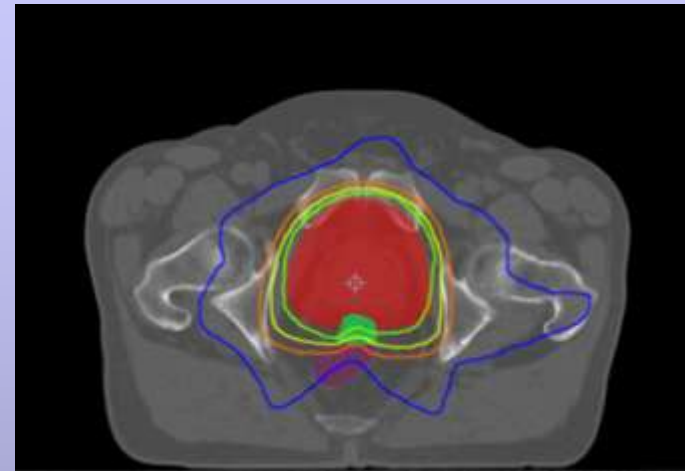
# Axial dose distribution



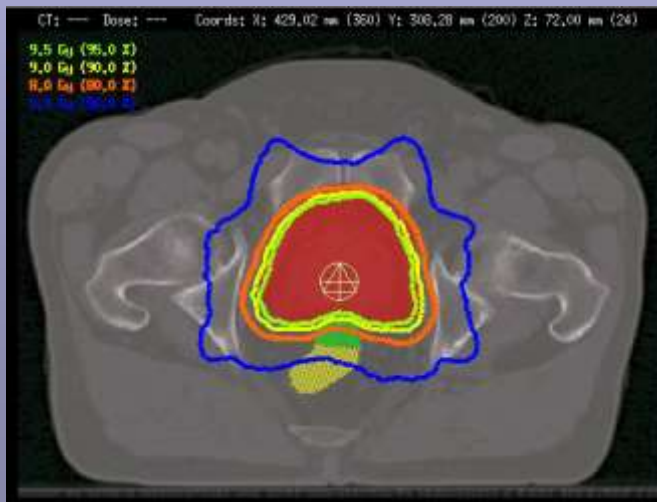
**VMAT  
1 Rot.**



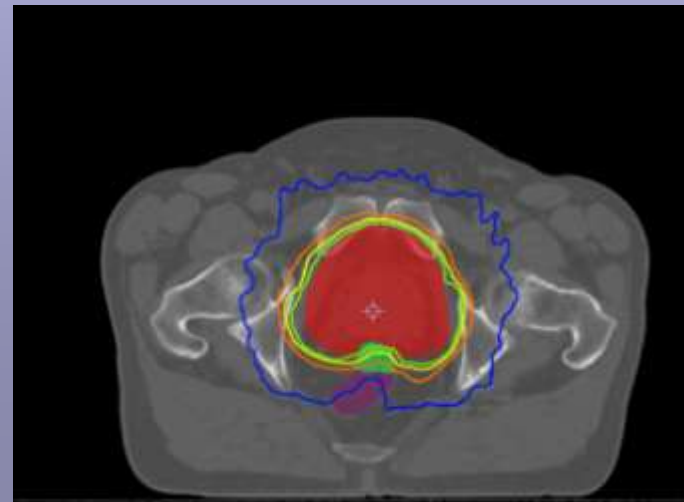
**VMAT  
1.5 Rot.**



**IMRT<sub>MLC</sub>**

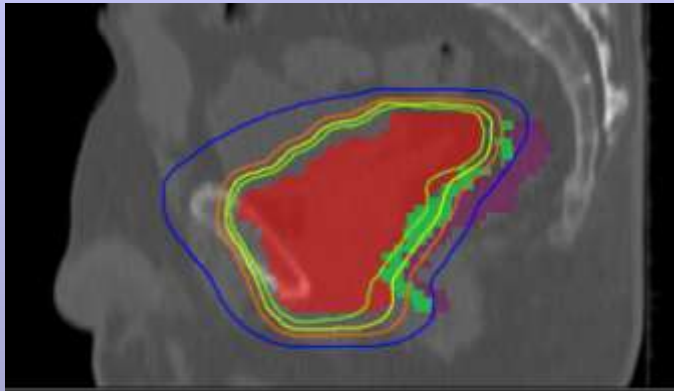


**MIMiC**

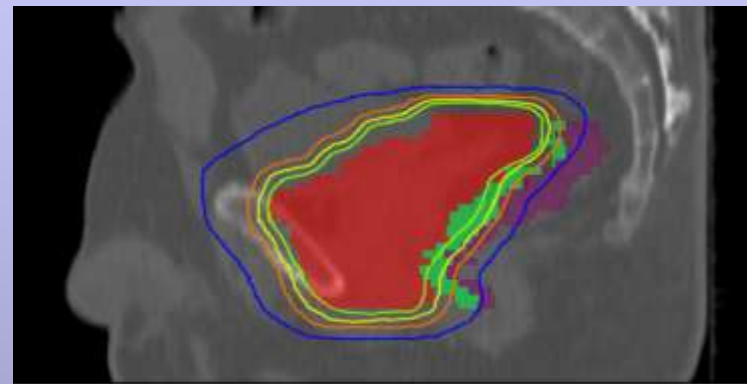




**VMAT  
1 Rot.**



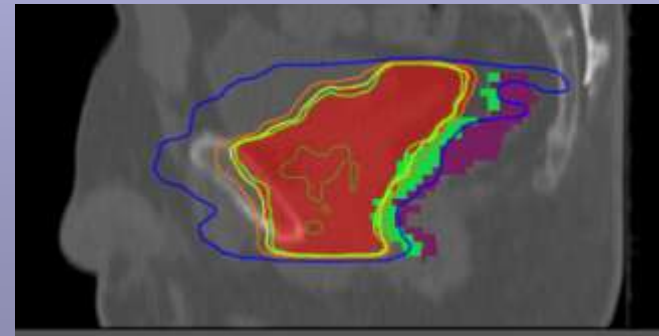
**VMAT  
1.5 Rot.**



**IMRT<sub>MLC</sub>**

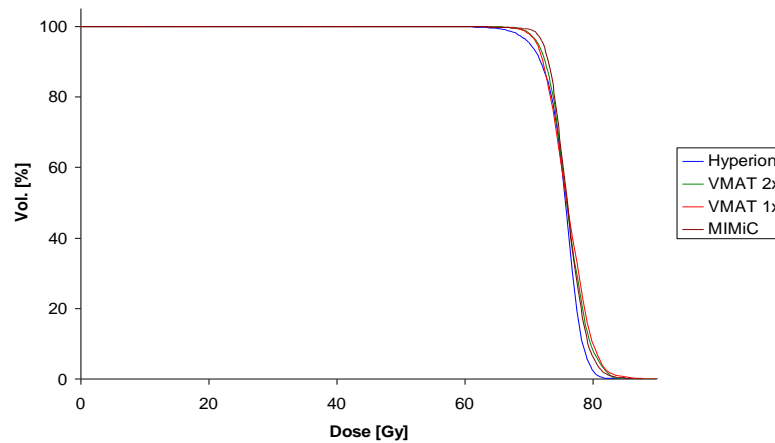


**MIMiC**

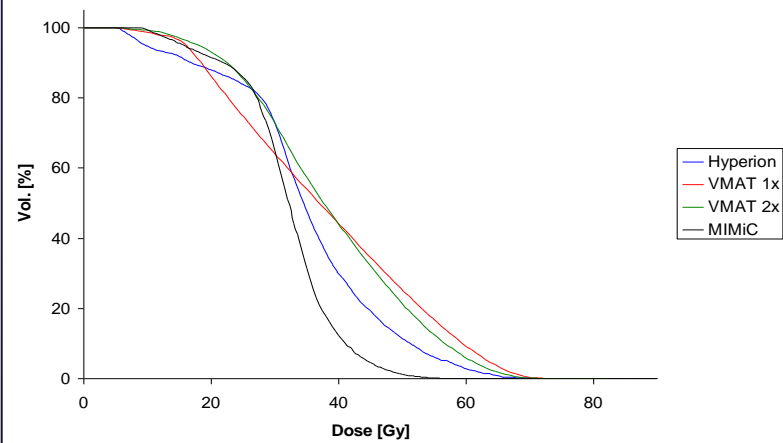




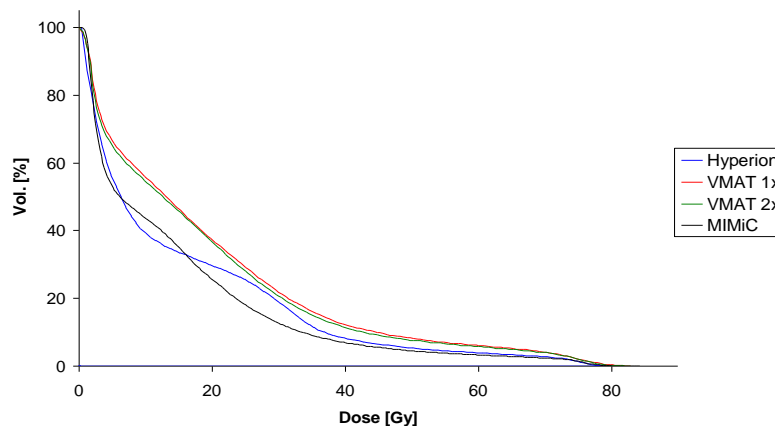
**DVH comparison for Target**



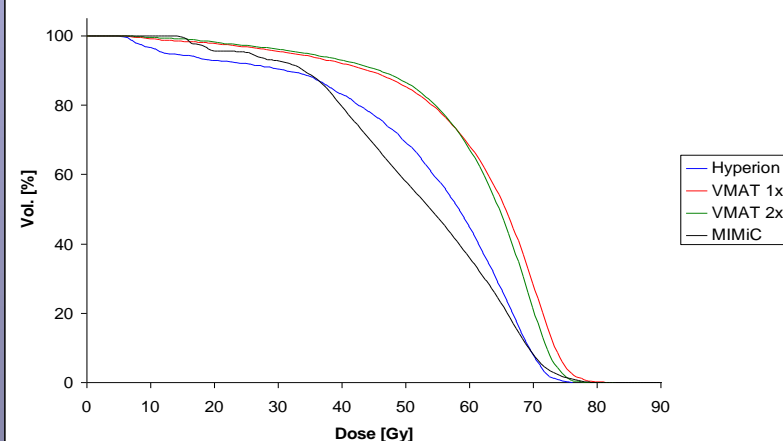
**DVH comparison for posterior Rectum**



**DVH comparison for normal Tissue**



**DVH comparison for anterior rectum**

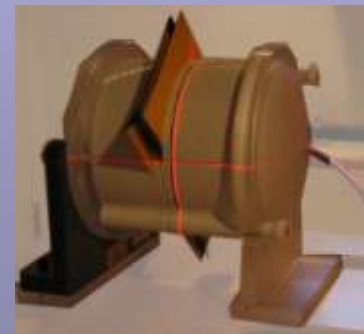
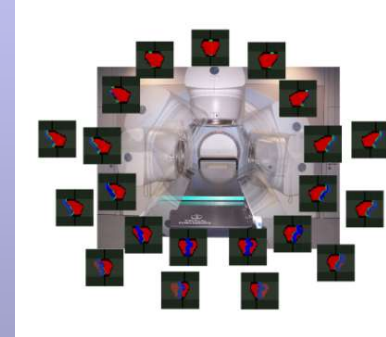
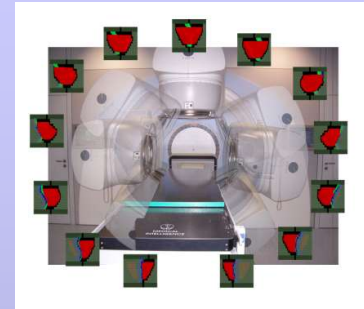


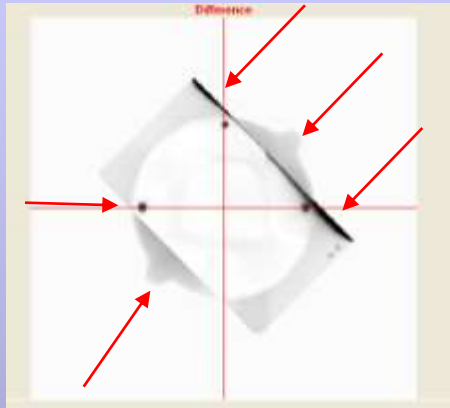


		VMAT 1x	VMAT 2x	IMRT <sub>MLC</sub>	MIMiC
<b>D<sub>mean</sub> Target</b>	[Gy]	75,96 0,06	75,93 0,06	75,73 0,13	75,89 0,28
<b>D<sub>95%</sub> Target</b>	[Gy]	71,59 0,49	71,7 0,59	70,51 0,86	71,85 0,85
<b>D<sub>mean</sub> Rectum post</b>	[Gy]	38,56 2,24	38,12 2	34,89 1,7	31,85 2
<b>D<sub>mean</sub> Rectum ant</b>	[Gy]	61,58 4,16	60,29 3,15	53,99 3,05	50,69 3,1
<b>V<sub>tissue 70%</sub></b>	[cm <sup>3</sup> ]	819 93	797 47	629 71	627 84
<b>V<sub>tissue 50%</sub></b>	[cm <sup>3</sup> ]	1546 191	1470 108	1278 201	1158 164
<b>V<sub>tissue 30%</sub></b>	[cm <sup>3</sup> ]	3753 494	3655 503	3759 726	3109 626
<b>CI</b>	[cm <sup>3</sup> ]	1,51 0,15	1,45 0,13	1,23 0,15	1,5 0,21
<b>HI</b>	[cm <sup>3</sup> ]	1,11 0,03	1,09 0,02	1,1 0,02	1,19 0,06
<b>TTT</b>	[min]	1,5	3	6 1	15 3
<b>MU</b>		389 31	371 32	544 53	2714 657

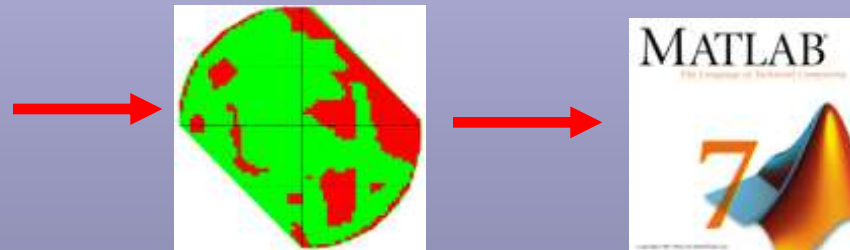
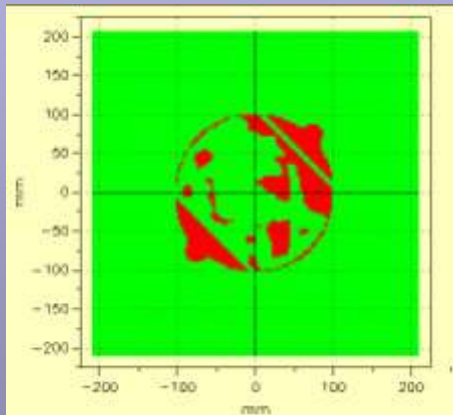


- 9 patients with prostate cancer
- for every patient: 2 plans (1rot and 1.5 rot)
- measurements with ion chamber + film
  - Ion chamber:  $0.125\text{cm}^3$
  - Film: KODAK edr2
  - homogenous H&N phantom
- Film analysis
  - $\gamma$ -Index for different pass and fail criteria
  - pixel count

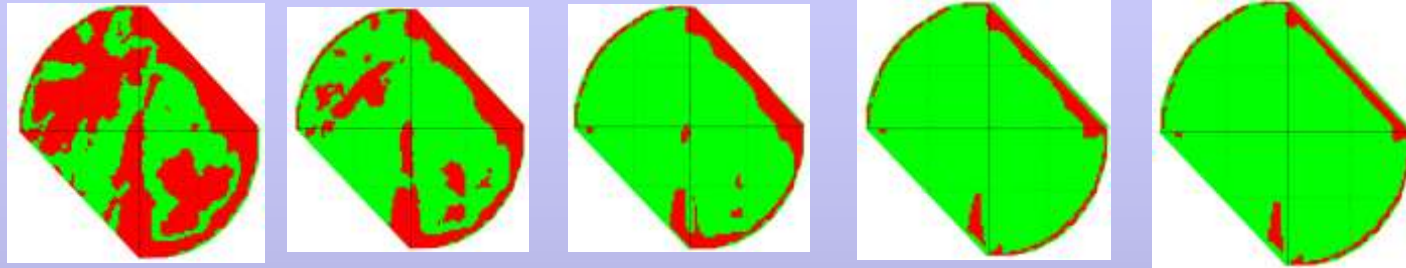




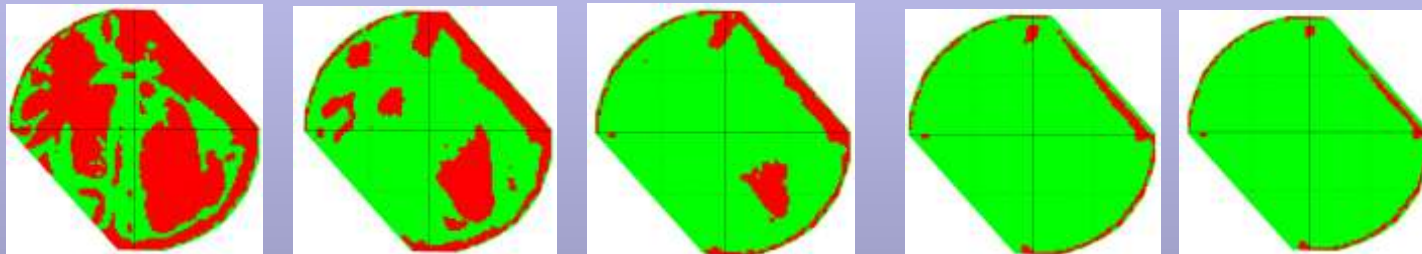
- errors by light exposure or no film are excluded by cutting-out the images of the  $\gamma$ -index
- the index for 10% / 5mm excludes errors by the markers and light exposure on the film border



**pixel count fail  
and pass**



**1 rot.**



**1,5 rot.**

**$\gamma$ -Index:**

1% / 1mm

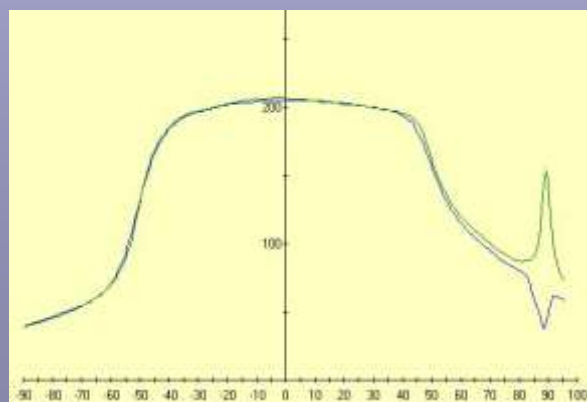
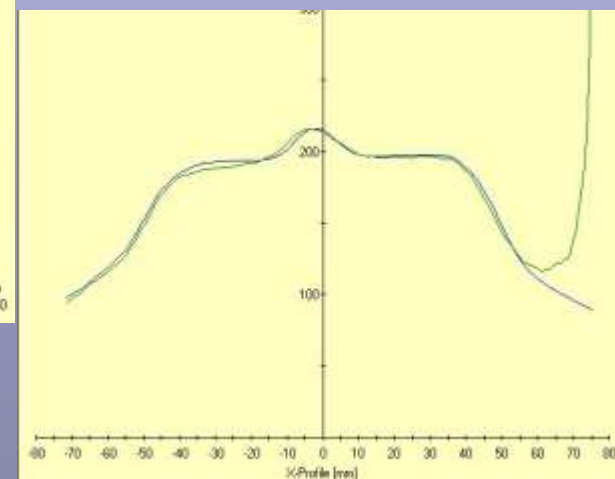
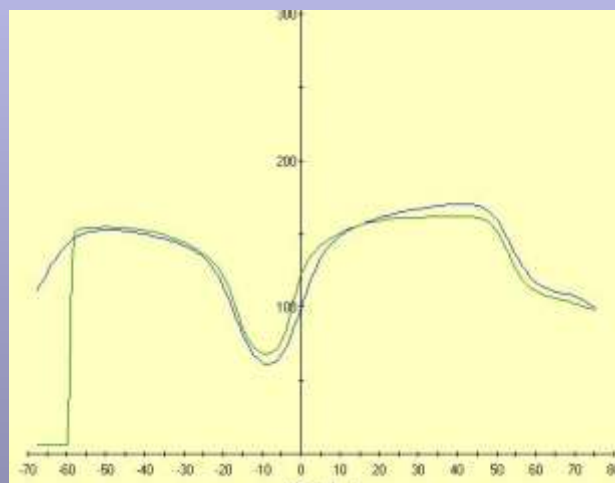
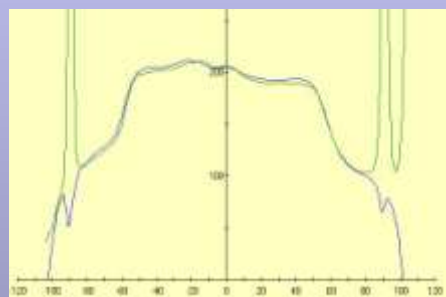
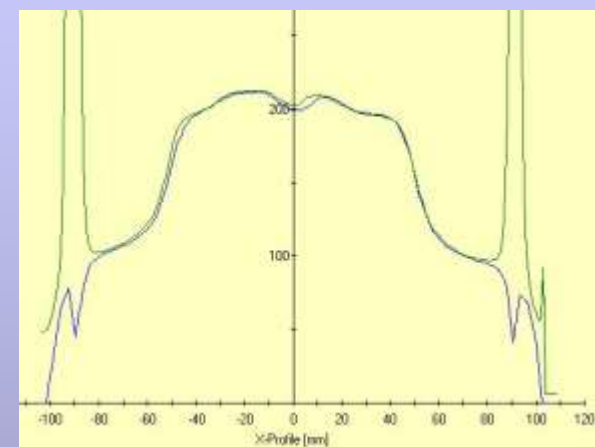
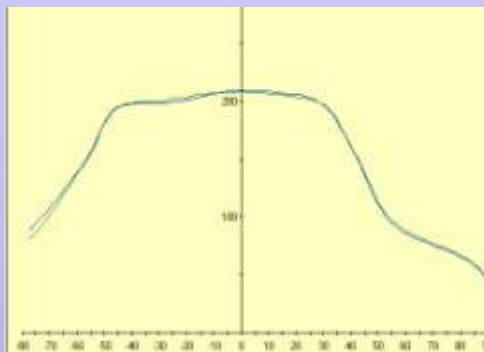
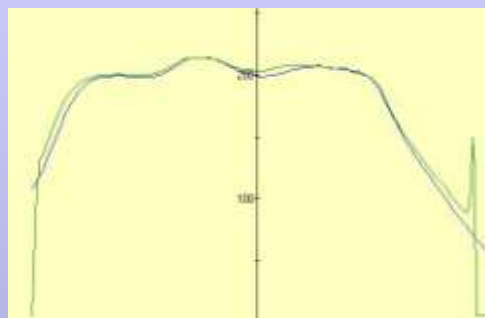
2% / 2mm

3% / 3mm

5% / 5mm

10% / 5mm

was calculated for each plan , here exemplary for pat 8



## Results of the measurements

- absolute dose of ion chamber  $\Delta_{\text{mean}} = 1,64\%$  1,14 (max: +3,7% min: -1,25%)
- good relative agreement between measured and calculated in film measurements
- Mean pass criteria for  $\gamma$ -Index:

1% / 1mm	40,9% 8,7	pass pixel (green)
2% / 2mm	69,3% $\pm$ 10,4	pass pixel (green)
3% / 3mm	84,8% $\pm$ 8,0	pass pixel (green)
5% / 5mm	97,2% $\pm$ 2,7	pass pixel (green)
10% / 5mm	is set to 100%	

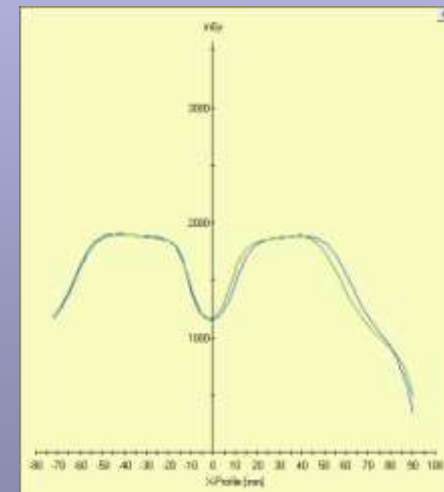
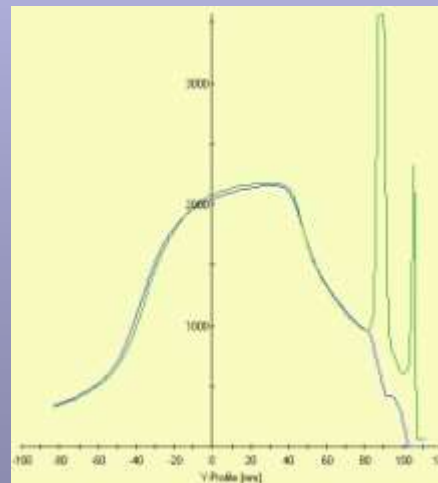
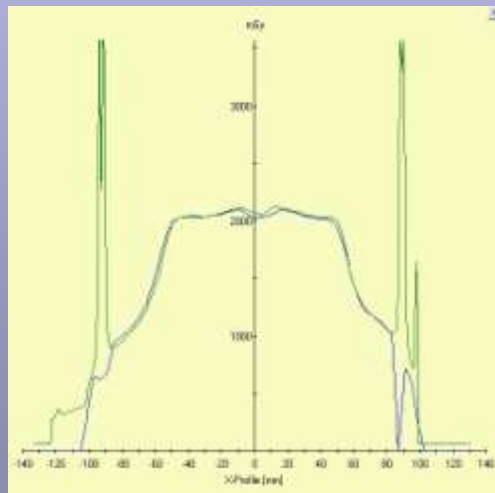
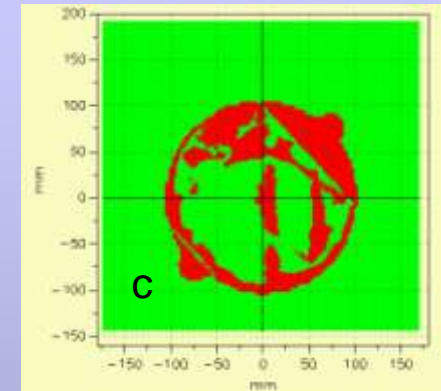
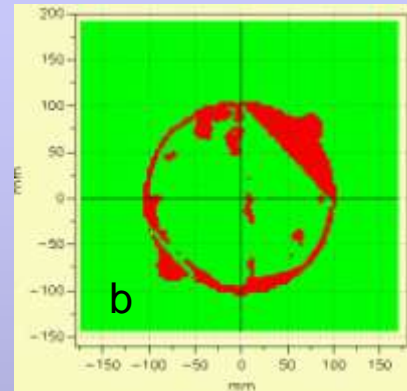
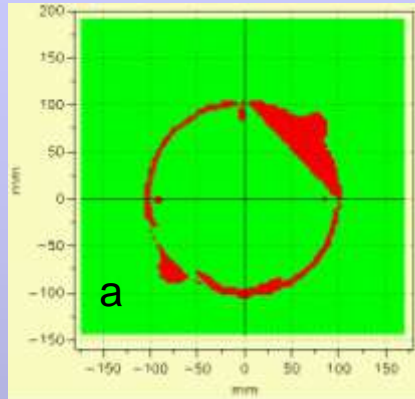


## $\gamma$ -Index

- a  $\rightarrow$  5%/5mm
- b  $\rightarrow$  3%/3mm
- c  $\rightarrow$  2 %/2mm

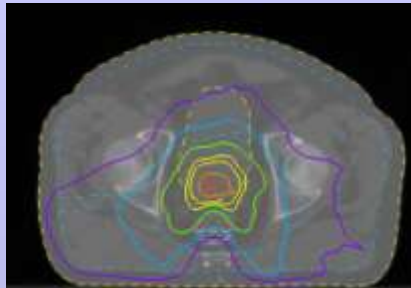
## Absolutdosis

-1,9%

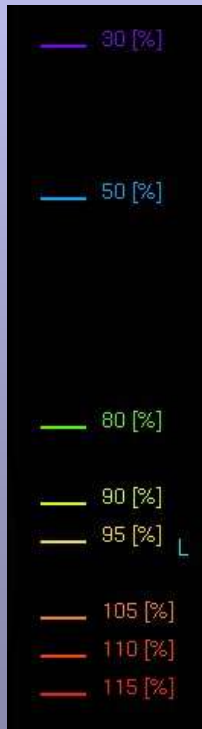
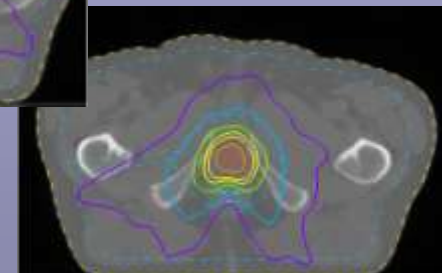
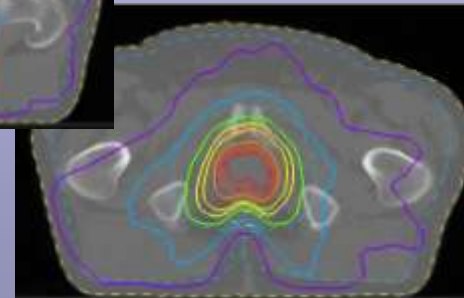
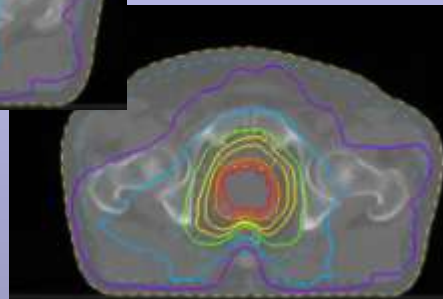
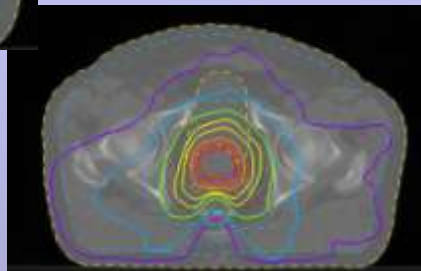




# First patient with 3 rotations

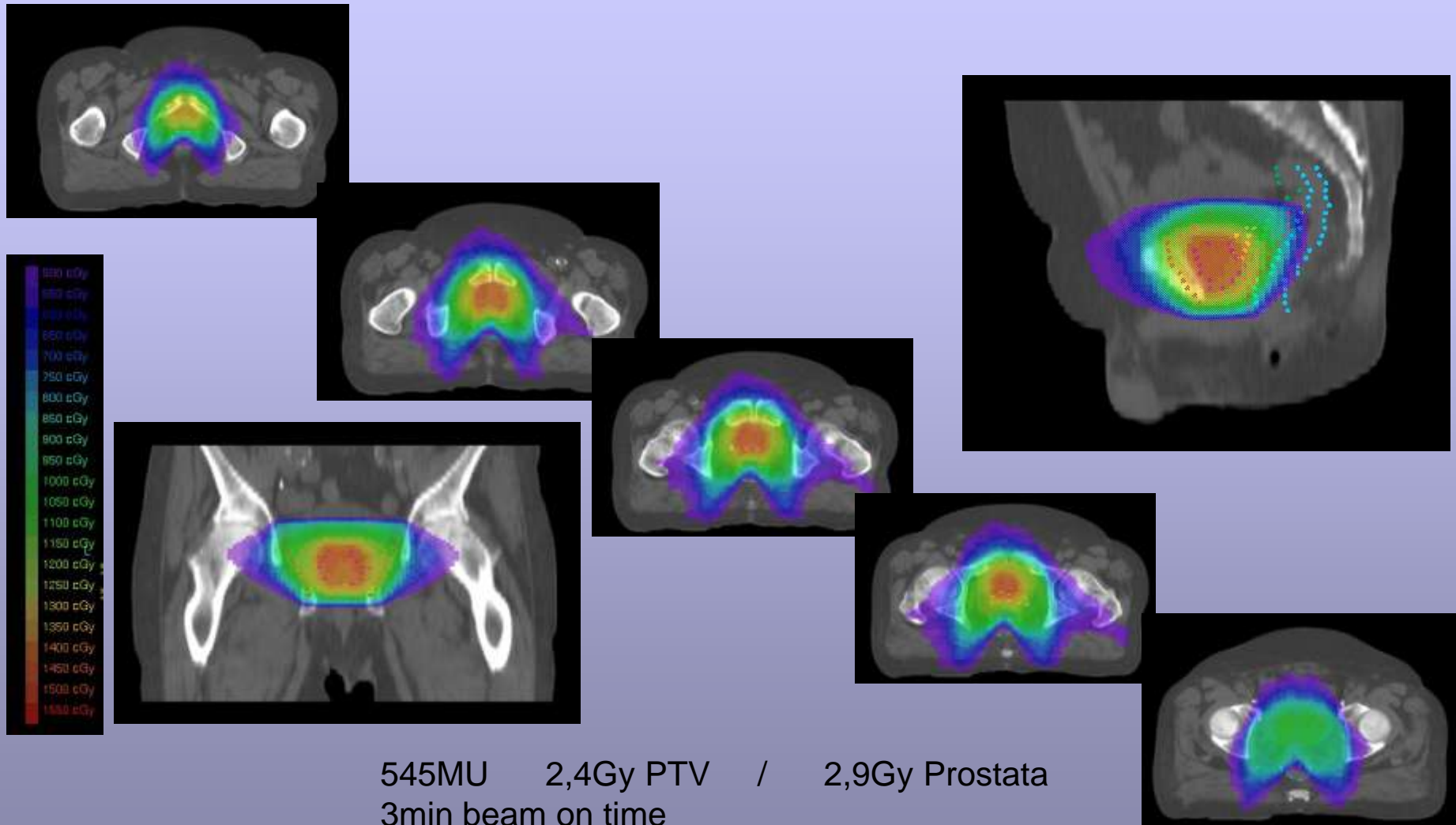


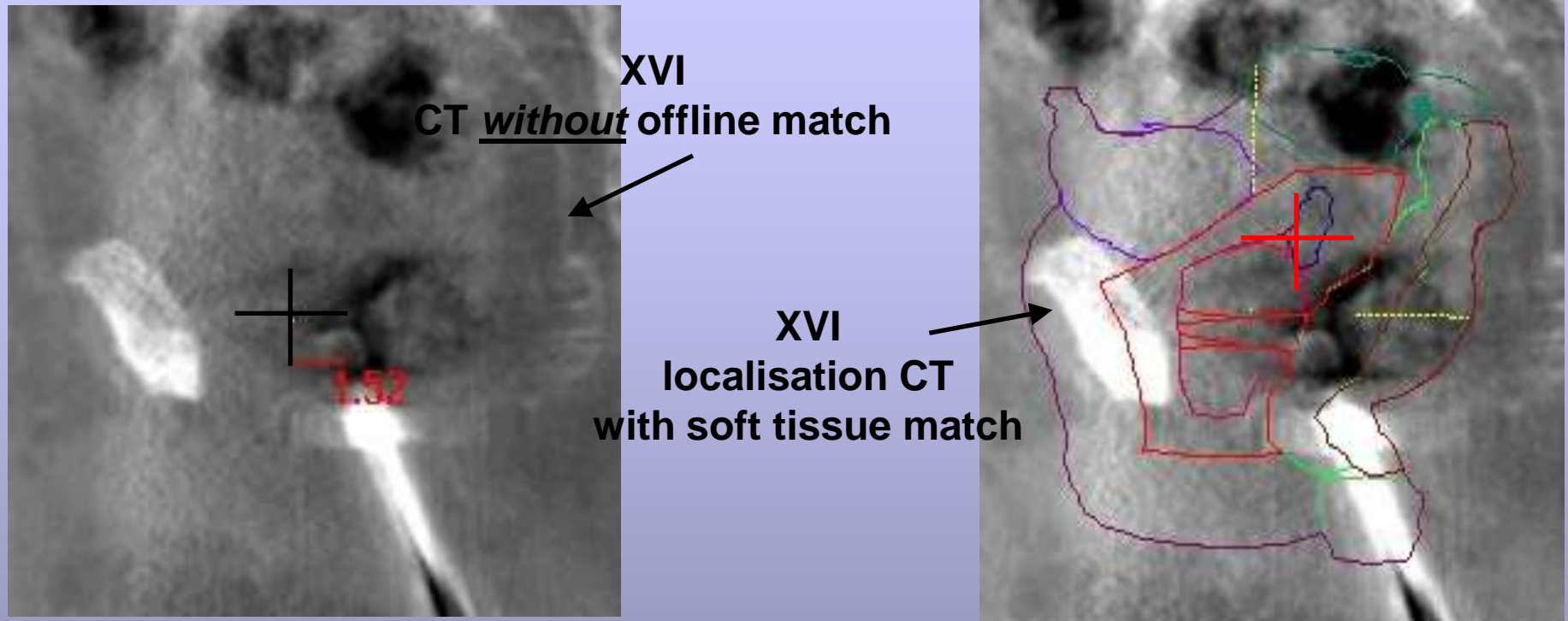
Plan#2, v07ca38e.D002  
Ref.=1250 cGy, 100%=1260 cGy, Max=1522 cGy  
Image 10, Z = -379.0 mm



507MU 2,5Gy PTV / 2,92Gy Prostata  
4,5 min beam on time

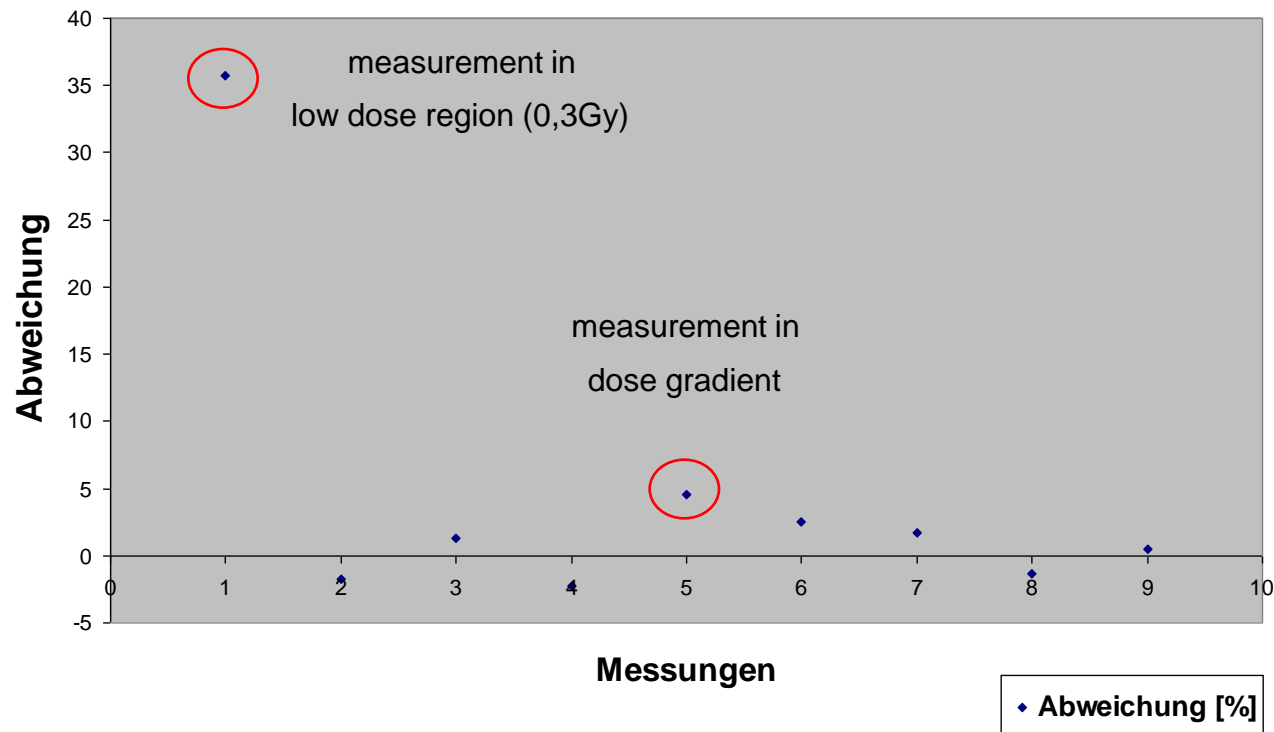
# Second patient with 2 rotations



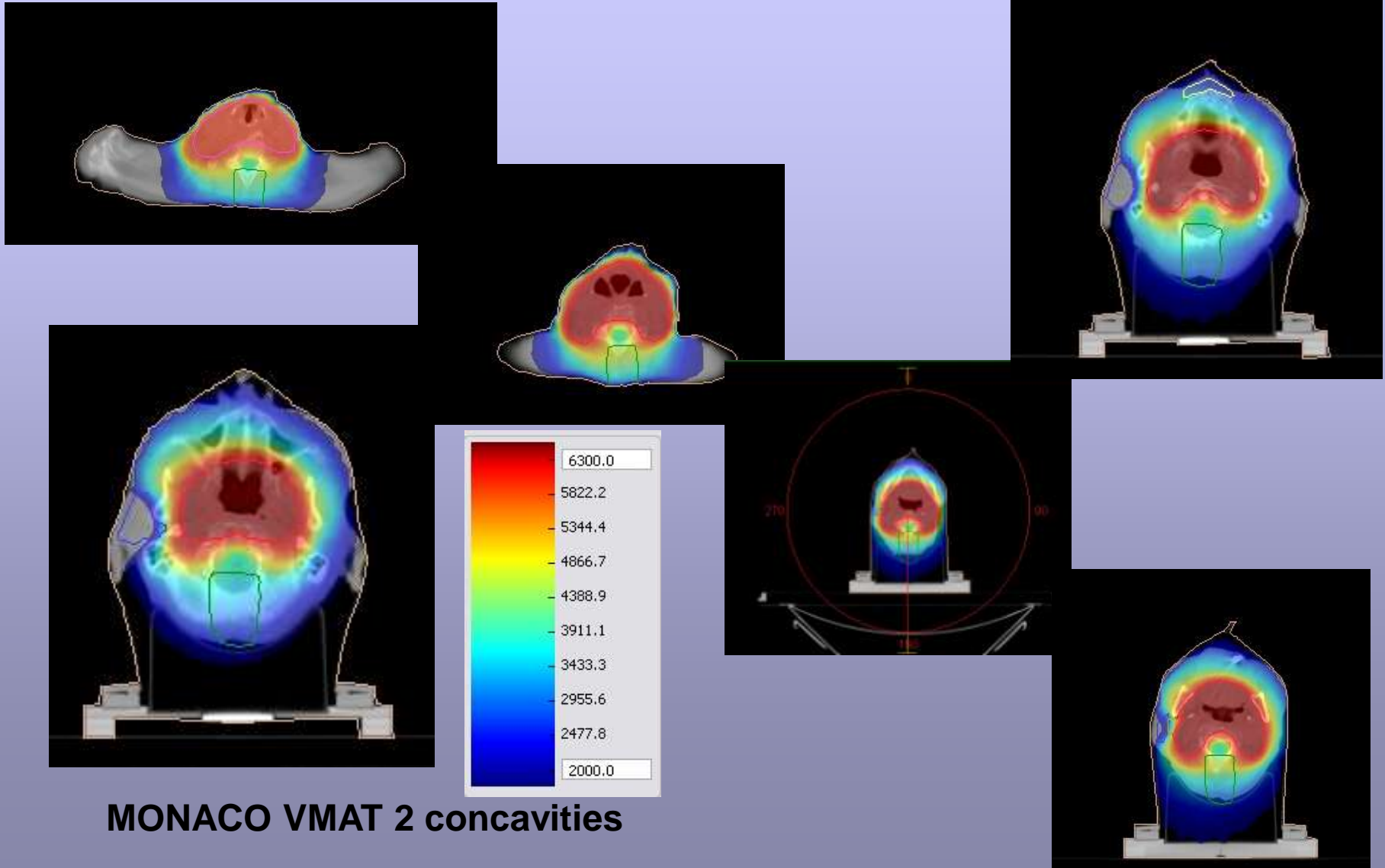


Point of measurement  
was transferred relative to *isocenter*  
of the treatment plan

### Abweichungen rel.Dosis



**9 measurements in first patient in the high dose region:  
All <2.5% (except 2) deviation from calculation**



**MONACO VMAT 2 concavities**



- Plans for the treatment of prostate and pelvis can be produced comparable plan quality to established modulated techniques
- Complex geometries (2 concavities) → MONACO VMAT
- Good agreement of calculation and measurement
- Shorter **treatment time** than step-and-shoot- IMRT and tomotherapeutic approach
- Low number of **monitor units**
- **No complex table movements** (like tomotherapeutic approach)
- VMAT needs no additional linac hardware
- 5 prostate patients were treated



# Thank you for your attention

Florian Stieler  
Frank Lohr  
Sven Claussen  
Jens Fleckenstein  
Brigitte Hermann  
Katarina Heim  
Volker Steil  
Frederik Wenz