

## WP5: Adaptive Treatment Planning

*ULICE annual workshop  
Stockholm 4-Sep-2010*

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# Collaboration

Table 1: Collaborators

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- Methods, Protocols, Software
- to improve operation of ion beam radiotherapy facilities
- by enhancing **existing** treatment planning
- **training, education,**  
~~> getting used to Ion Beam Radiotherapy

# Treatment Planning Tasks

- Patient recruitment (WP2,WP3,WP7)
- Imaging, positioning (WP3,WP4)
- Optimization of RBE-weighted dose (WP5)
  - ~> treatment planning system (TPS)
    - Siemens Syngo PT
    - CMS XIO (protons)
    - GSI TRiP98
      - (from pilot project ~> "research prototype")

# Deliverables/Milestones

Table 2: Reports

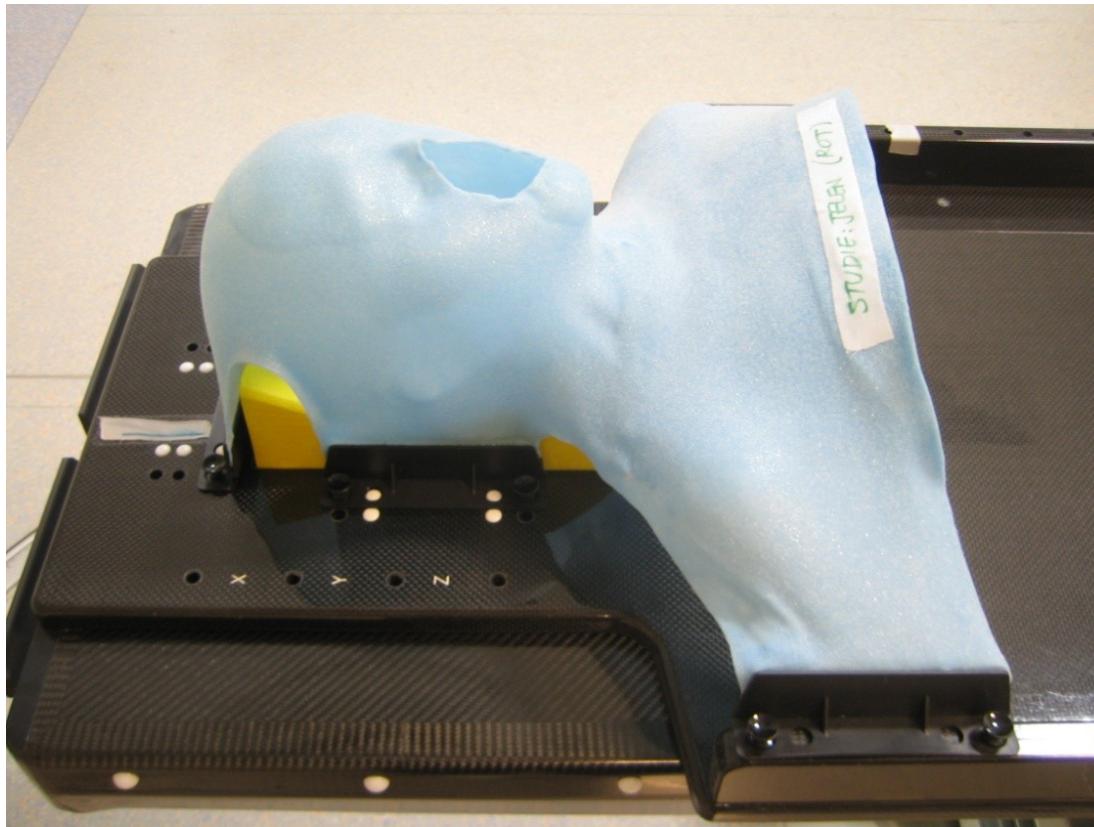
Deliverable	Due	Contributors
D5.1/WP5.4	Apr 2011	UNIMAR
D5.2/WP5.4	Apr 2011	MUW
M12	Apr 2011	GSI,UKL-HD,CNAO,Etoile,MUW
D5.3/WP5.1,2	Oct 2011	GSI,UKL-HD,ARC
D5.4/WP5.1	Oct 2011	GSI,UKL-HD
D5.5/WP5.2	Oct 2011	UKL-HD,CNAO,Etoile,MUW,GSI
D5.6/WP5.2	Oct 2011	UKL-HD,GSI
D5.7/WP5.2	Oct 2011	UKL-HD,GSI
D5.8/WP5.3	Oct 2011	UOXF,GSI,ARC
M27	Oct 2012	GSI,UKL-HD,ARC
M28	Oct 2012	GSI,UKL-HD,ARC
D5.9/WP5.4	Oct 2012	all?
D5.10/WP5.3	Nov 2012	UOXF,GSI

## Recommendations for organ depending optimised fixation systems

- head-and-neck treatments:  
thermoplastic mask fixation system,
- prostate RT:  
immobilization studies running,
- lung/liver treatments:  
breathing control, jet ventilation
- ↗ poster U.Jelen et al.

# *Head-and-neck: Immobilization equipment*

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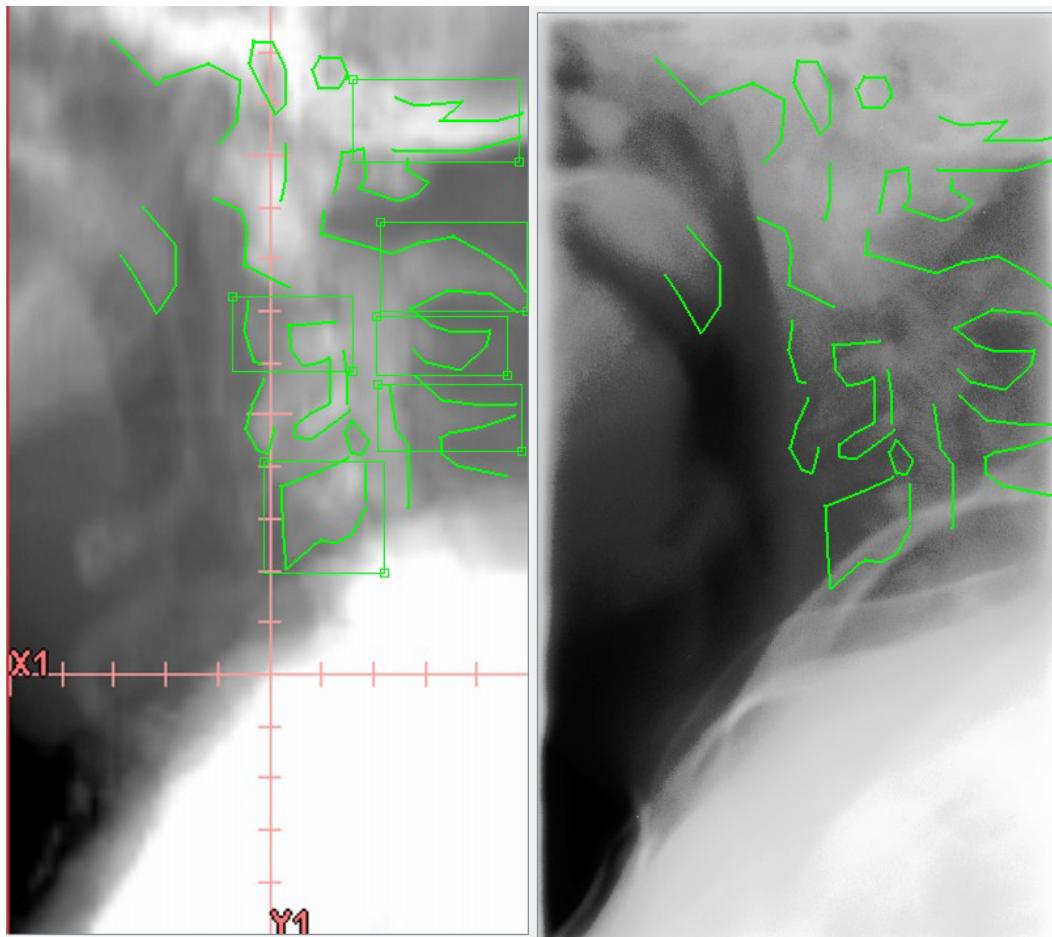
Two aspects under consideration:

- handling
- accuracy



[www.unger-medizintechnik.de](http://www.unger-medizintechnik.de)

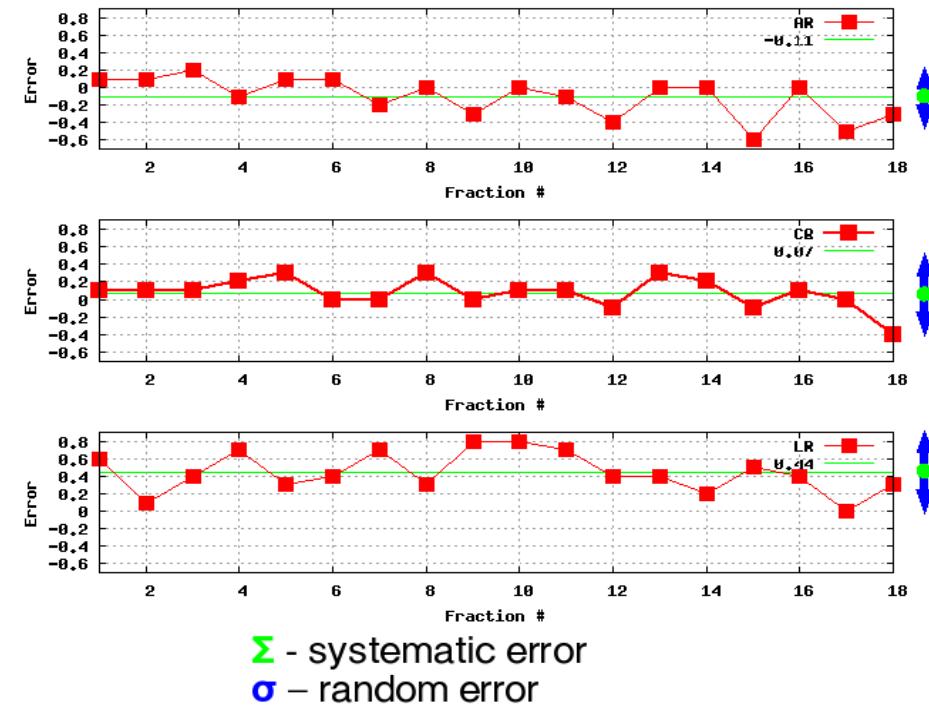
# Head-and-neck: Piecewise deformable registration



[Ammazzalorso et al](#), ESTRO 2007

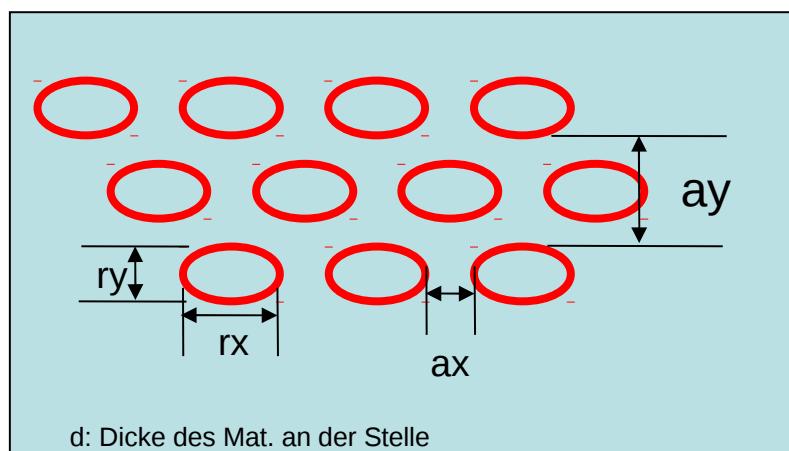
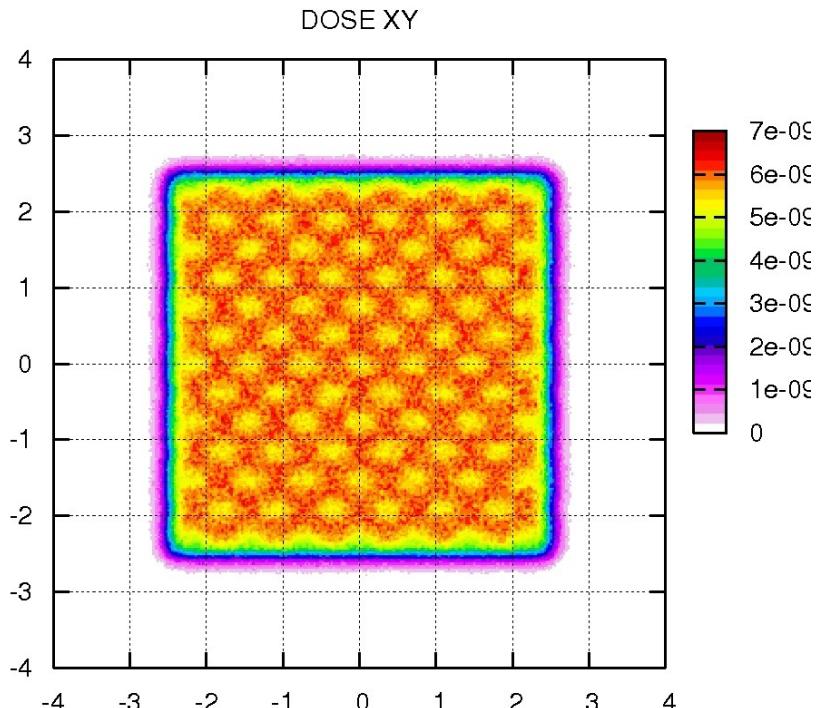
[Ammazzalorso et al](#), CAMP 2007

[Birkner et al](#), PMB 52(2007)

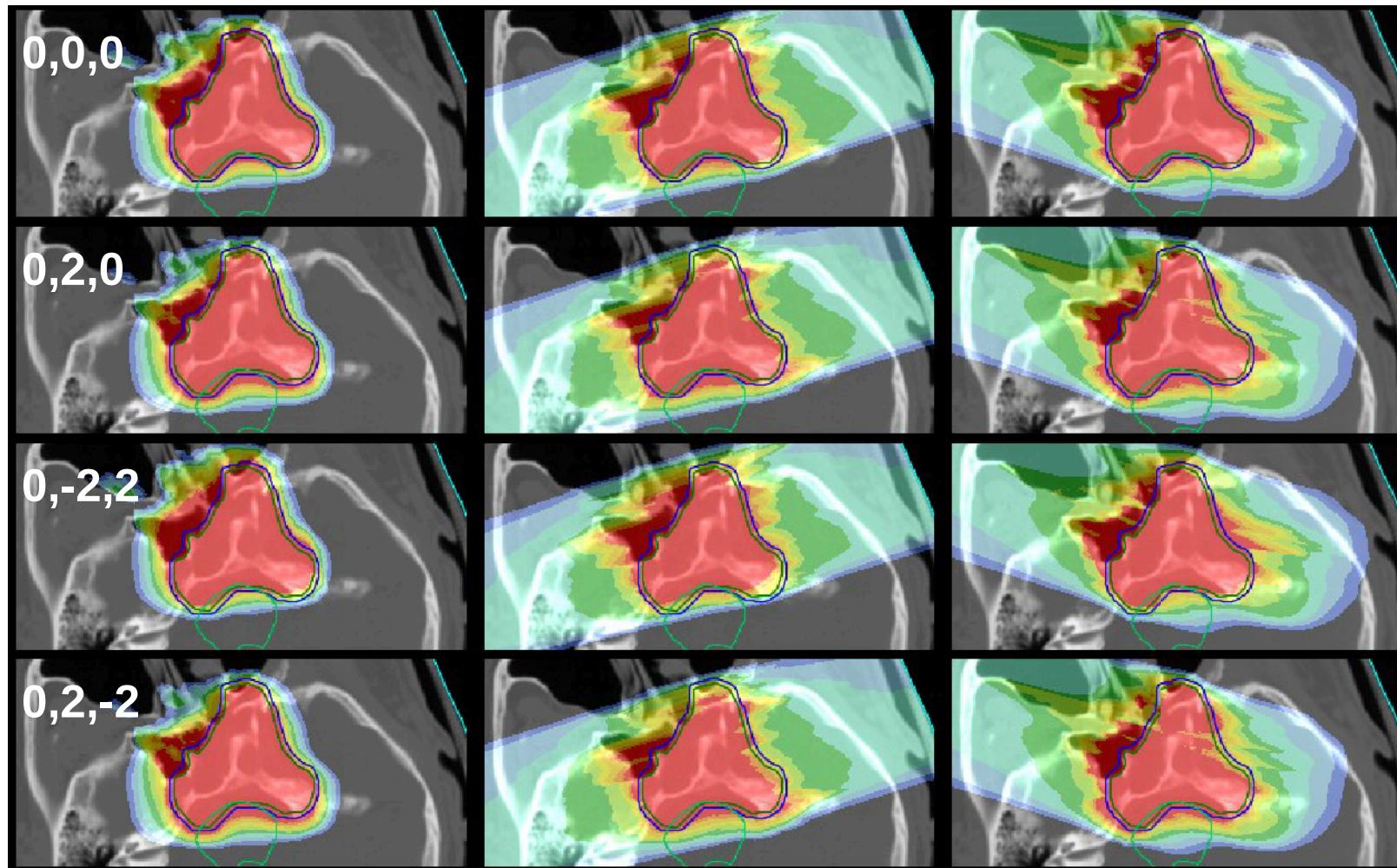


- EPs every second day
- in-house software tools (for analysis)
- TRiP, Syngo PT (dosimetric consequences...)

# Head-and-neck: dosimetric effects of the perforation



## *Head and Head-and-Neck: robustness*

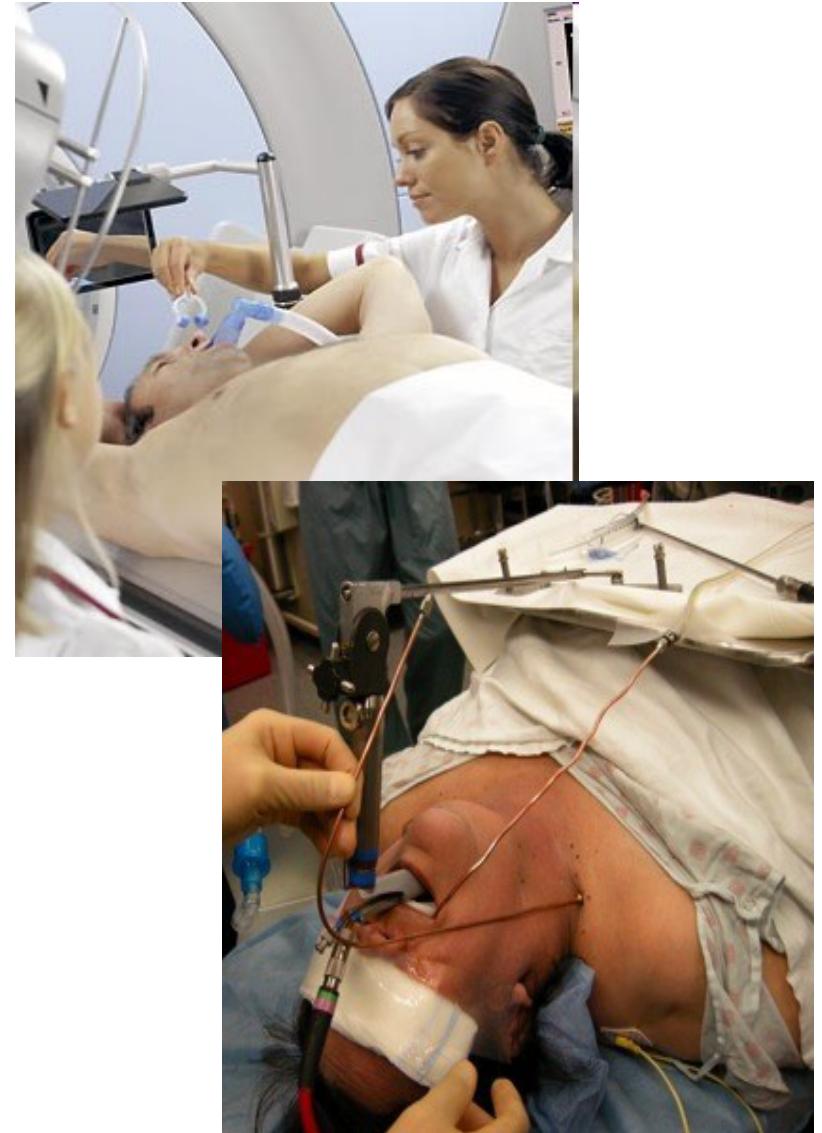


[Ammazzalorso et al](#), IBIBM 2009

[Ammazzalorso et al](#), ESTRO 2009

[Ammazzalorso et al](#), PTCOG 2009

- Reproducibility and stability of patient positioning in the vacuum bag (for fractionated lung stereotaxy) – doctoral dissertation Vogel
- Lung fixation approaches (current status: ethic commission):
  - ABC with in-house developed system
  - Jet-Ventilation



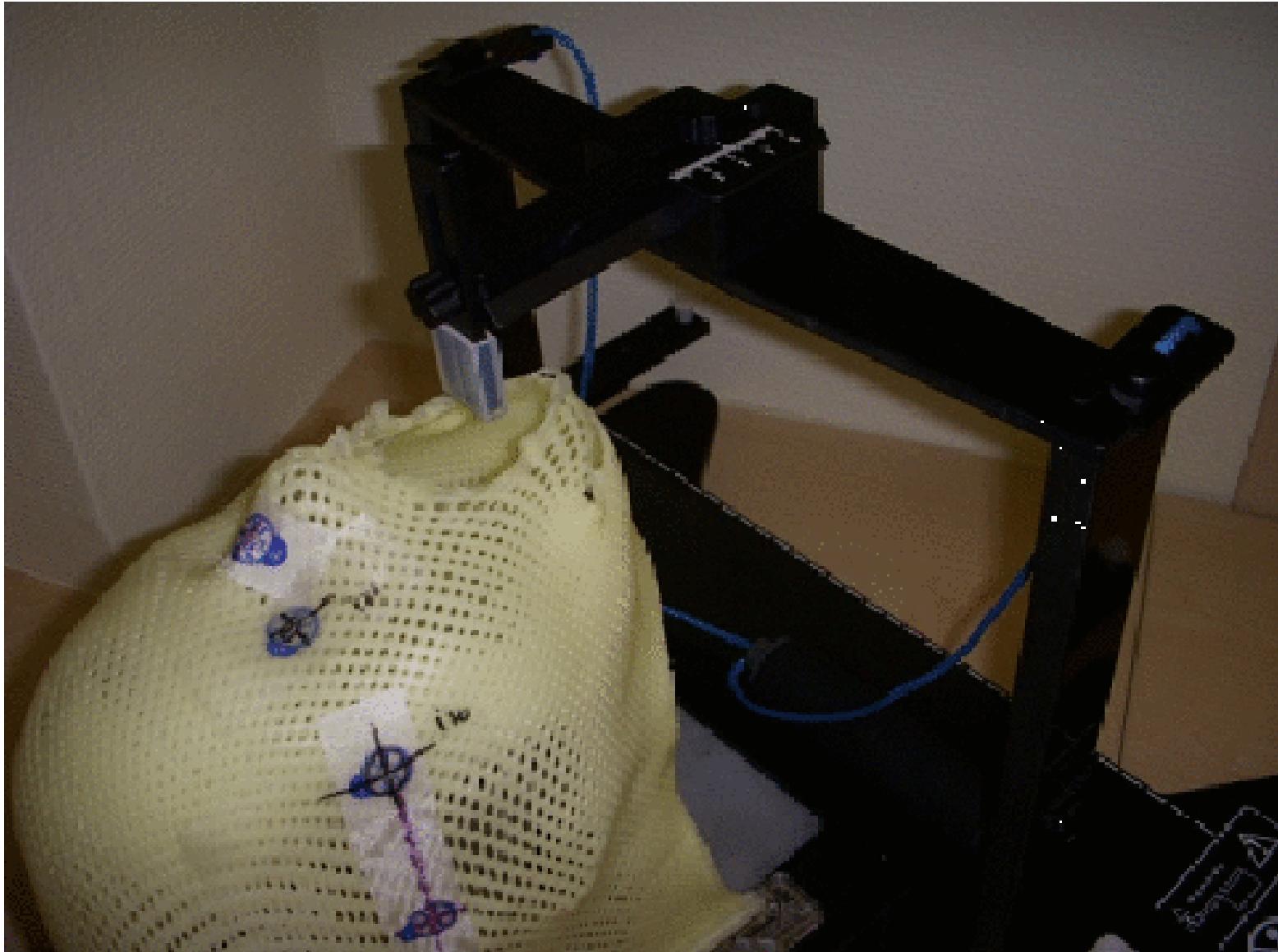
- Literature research on prostate movement and immobilization approaches
- Organ movement in “roll” position
- In-house feasibility tests
- Endorectal balloon (study running)
- Effect of anatomy changes on the dose distribution (study running)



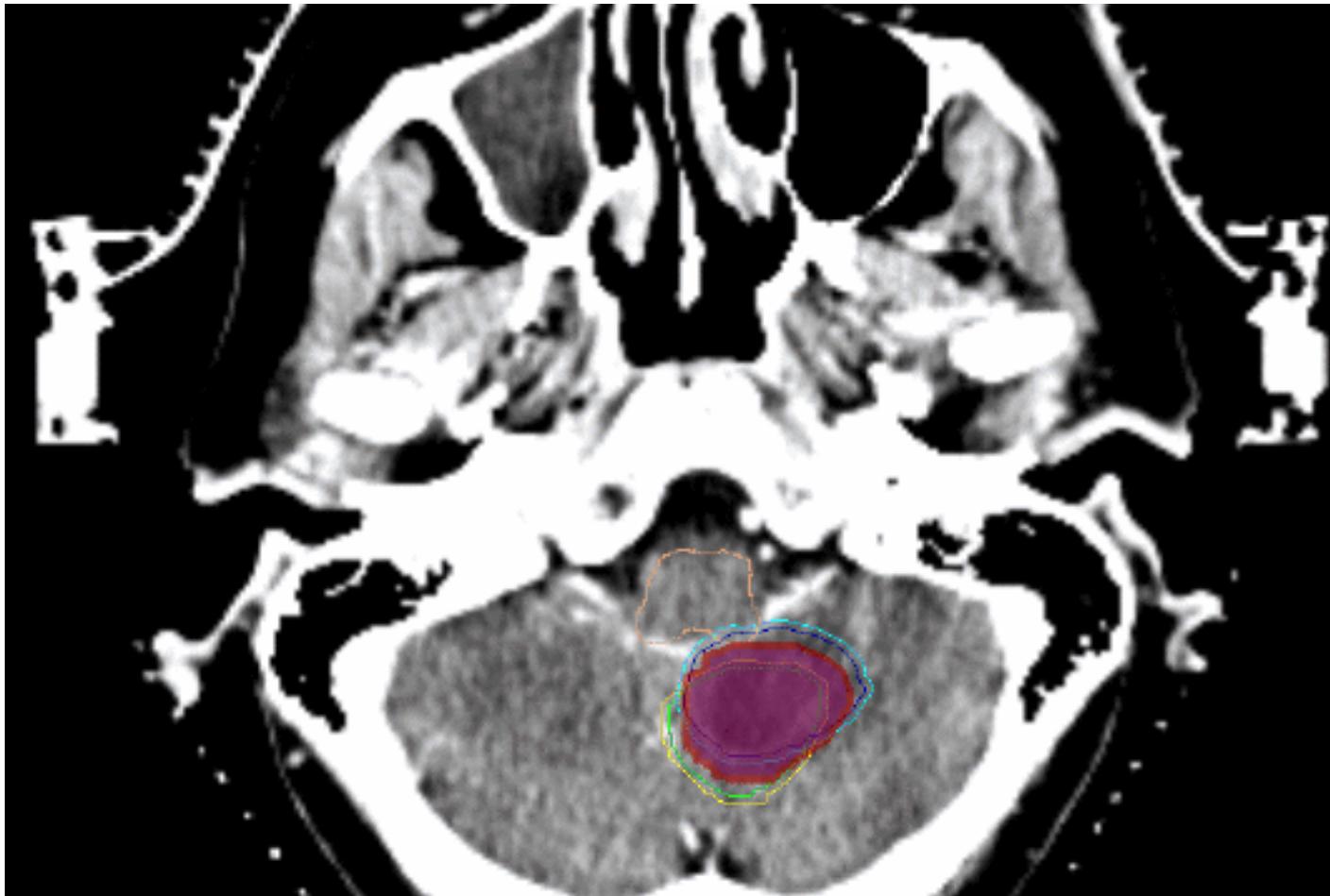
## Results of robustness test with respect to inter-fraction variations (J.Hopfgartner)

- 10 patients × 10 cbCT's (during photon RT)
- cbCT + plan fusion (Rigid Bone Registration)
- systematic/random errors (transl.,rotat.) derived  
    ~ safety margins (direction dependent)
- ~ displacements for planning scenarios
- proton plans ( CMS XIO )
- ( training TRiP98 )

# Mask system

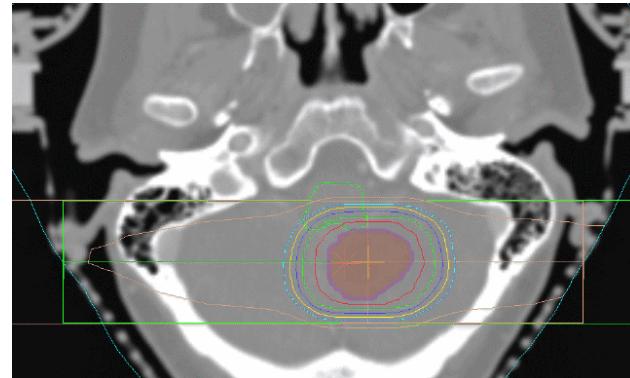


# Target shifts

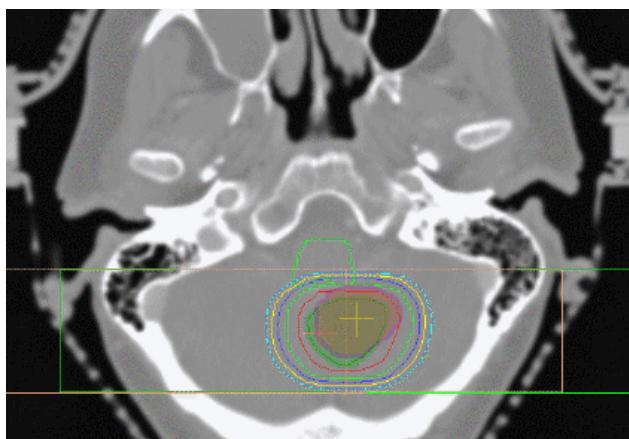


# Plans non/shifted

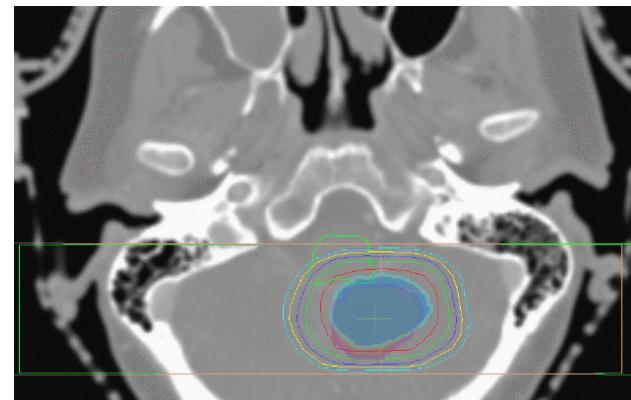
Unshifted



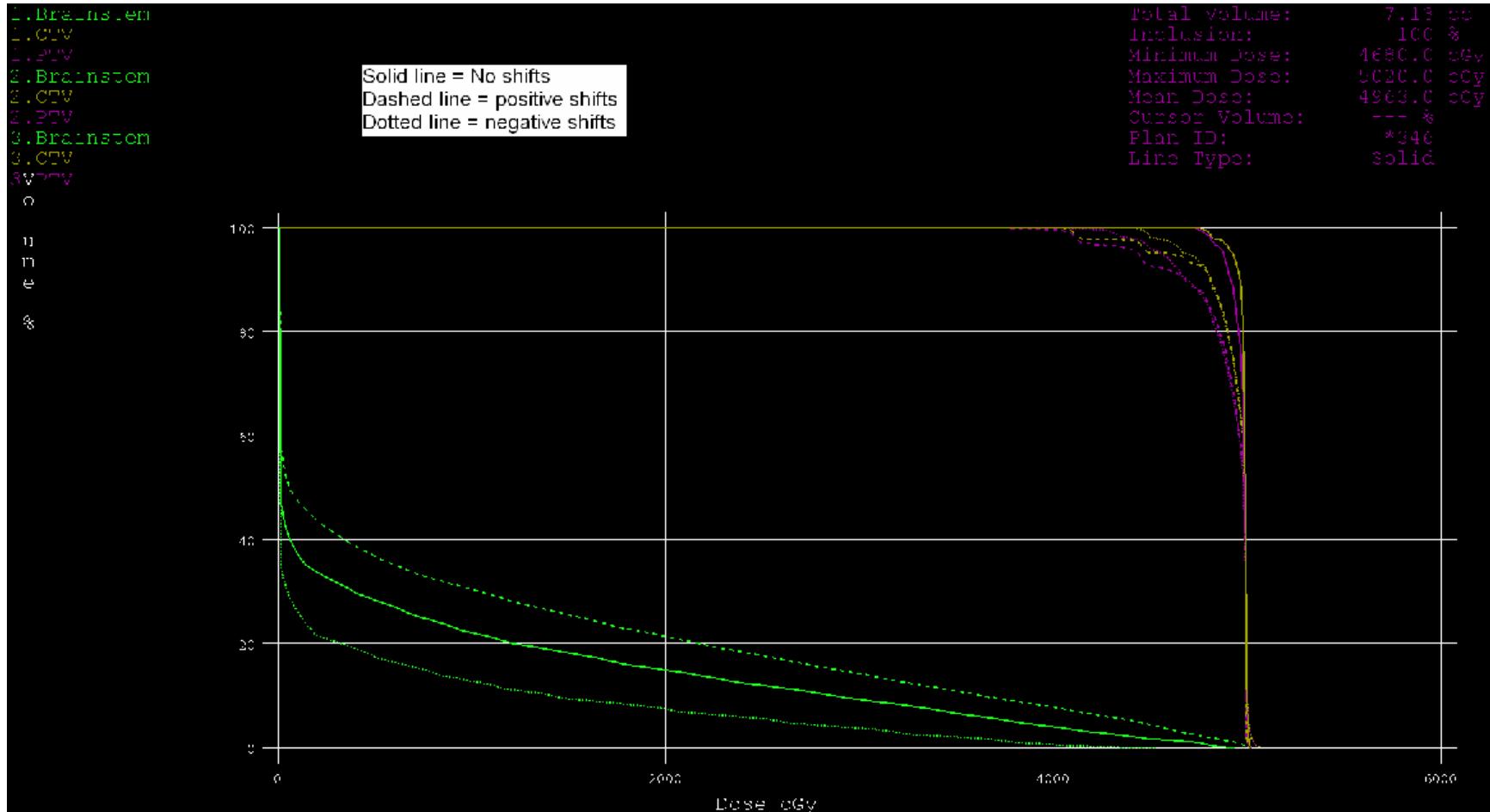
"Negative" shifts



"Positive" shifts



# DVH's



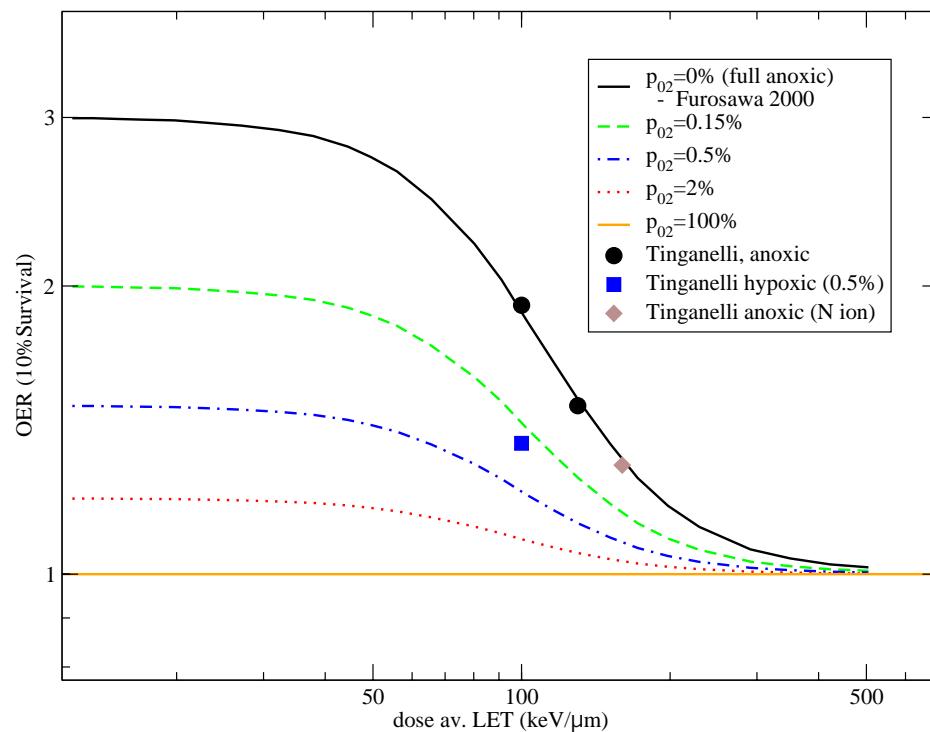
# D5.2/WP5.4 (MUW)

- PTV original: 50Gy (-2.8Gy,+0.6Gy)
- PTV shifted: 49Gy (-12Gy,+1.4Gy)
- more proton plans under study
- $^{12}\text{C}$  plans to follow (TRiP98)
- $\sim$  TPS enhancement needed: couch "roll/tilt" degree of freedom

## Documentation of the photon treatment systems used in the different facilities. Definition of interface.

- in preparation of combined photon/ion treatments
- data exchange
- TRiP98 import/export filters (CT,VOIs,Dose)
- CADPlan, IsoGray: native
- DICOM: via converter(s) (native under construction)

TRIP version including spatially variable radio-sensitivity (hypoxia) identifying hypoxic region (WP3), OER model description, dose optimization, cell experiments. (E.Scifoni)



- parametrize OER( $p_{O_2}$ ,LET)
- use OER on top of RBE/Survival
- optimize dose distribution as usual
- $\leadsto$  highly non-linear
- $\leadsto$  requires input from WP3:  $p_{O_2}$  distribution