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INVERSE PLANUNG BEI 3 VERSCHIEDENEN TPS – DER VERSUCH EINES VERGLEICHS

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INVERSE PLANNING IS A NEW PROCESS

- *"The emergence of IMRT and inverse planning posts a new challenge in RT" (JVD The Modern Techn. of Rad. Oncol)*
- *"The determination of parameters of an objective function that may be applied to all patients presenting with a class of indications is an important task, especially because the number of such parameters is large" (IJROBP 51, IMRT RT Collab. Work Group)*
- *"Objective functions and their parameters that are clinically more relevant need to be defined for each combination of treatment site and IMRT delivery technique" (IJROBP 51, IMRT RT Collab. Work Group)*

➢ *Are "these parameters" TPS specific?*

IMRT @ MUW

- *Department's history in IMRT*
  - *Started in 1999 with treatment planning and the design of QA procedures → 1st patient treated 2001 → class solutions ?*
- *Treatment Planning Systems with modules for inverse planning*
  - *OTP V 1.3; XiO V4.2, BrainScan V5.2;*
  - *(HELAX TMS V6.1)*
- *IMRT for all systems based on dose and DVH constraints*
  - *Different versions (2000 – 2004) with SW changes not always exposed to user*
  - *Earlier versions with max dose and mean dose constraints not considered*

METHODS

IMRT Indications at MUW

- *Prostate* *(localized prostate T2)*
- *Head & Neck* *(left tonsil Ca, postoperative, pT3N0M0)*
- *Cervix* *(definitive RT, EBT + BT)*
- *'Individual' treatments (Gloms-tumor)*

FIRST all IMRT plans carried out with OTP

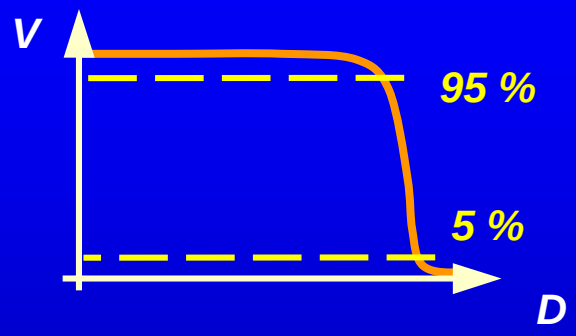
1. *First run with D & DVH constraints (defined by MP & RO)*
   - *Modified constraints until acceptable plan was achieved*
2. *Second run using artificial "help" structures to optimize best plan*

THEN *Steps 1 – 2 repeated on XiO and BrainScan using*

- *Start constraints from System 1*
- *Constraints of clinically accepted plan from System 1*

EVALUATION CRITERIA

Target



- Coverage 95 % PTV covered 95% isodose
- $D_{1\%}$ and $D_{99\%}$
- Homogeneity: $(D_{5\%} - D_{95\%}) / D_{pres}$
- Conformity PTV $V_{95\%} / V_{PTV}$
- TVV50 $V_{50\%} / V_{PTV}$

OAR

(Site dependent)

- $D_{1\%}$
- DVH of OAR and % of OAR receiving dose $\geq$ TD 5 / 5

Efficiency and Workload

- Number of "runs" to get an acceptable plan (time for treatment planning)
- Number of MU

DOSE & DVH CONSTRAINTS

IMRT Prescription

Structure	Type	Rank	Objective	Dose(cGy)	Volume(%)	Weight
ptv	Target	1	Maximum	5500	0	1000
			Goal	5000	100	
			Minimum	4500	100	1000
chiasma	OAR	2	Maximum	5000	0	250
			Dose Volume	4500	20	250
			Dose Volume	4000	100	250

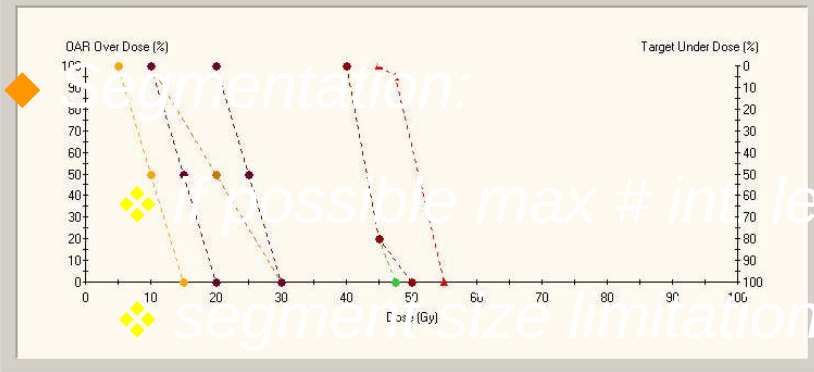
- *Max Dose*
- *Min Dose*
- *Prescr. (goal) dose*
- *DVH for OAR*
- *Max Dose for OAR*
- *Structure weight*

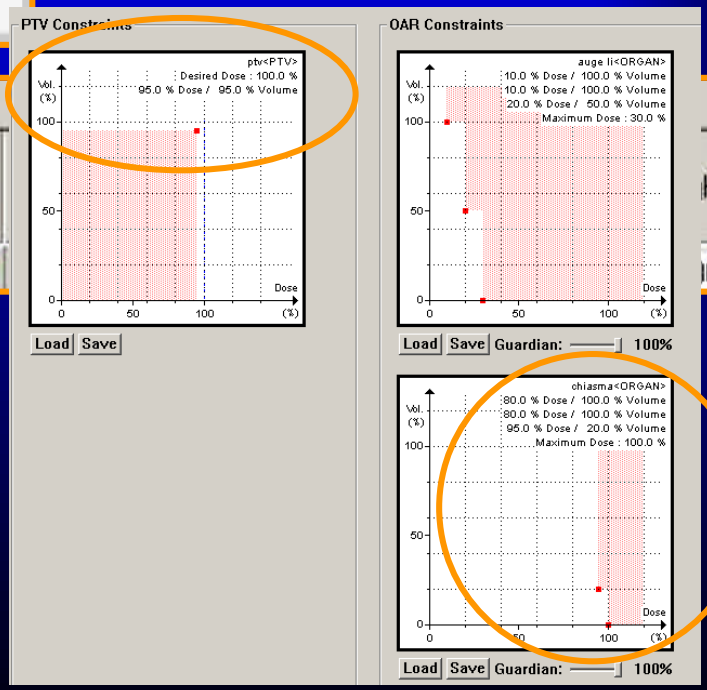
Organs At Risk

Visible	ROI Name	Full Vol Dose (Gy)	Max Dose (Gy)	Over Dose Vol (%)	Limit Dose (Gy)	Weight
☑	chiasma	40.00	45.00	20	50.00	250

Targets

Visible
☑

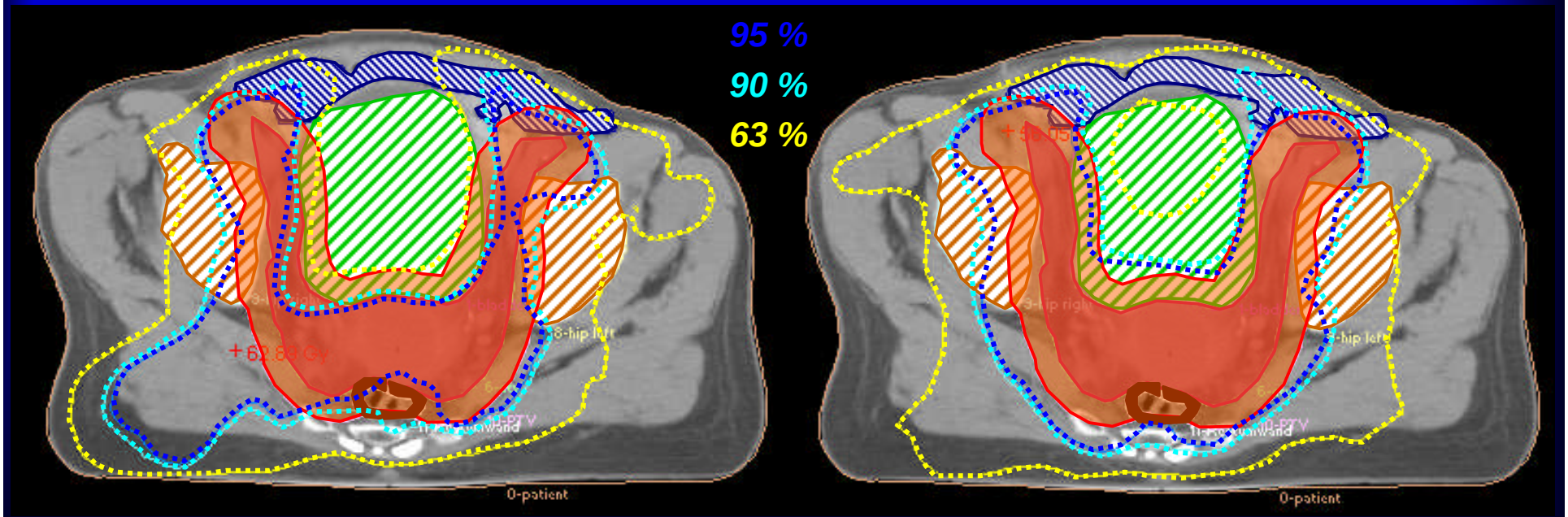




- *Segmentation:*
  - *If possible max # int levels 15*
  - *segment size limitation 1 cm*

NUMBER OF ITERATIONS

- *Inverse planning remains and iterative process (4 – 8 tries)*
- *Initial set of constraints? (defined by experience, publications, learning by doing, …)*
- *If a set of dose / DVH constraints was OK for one TPS it was as well "suitable" for other TPS*



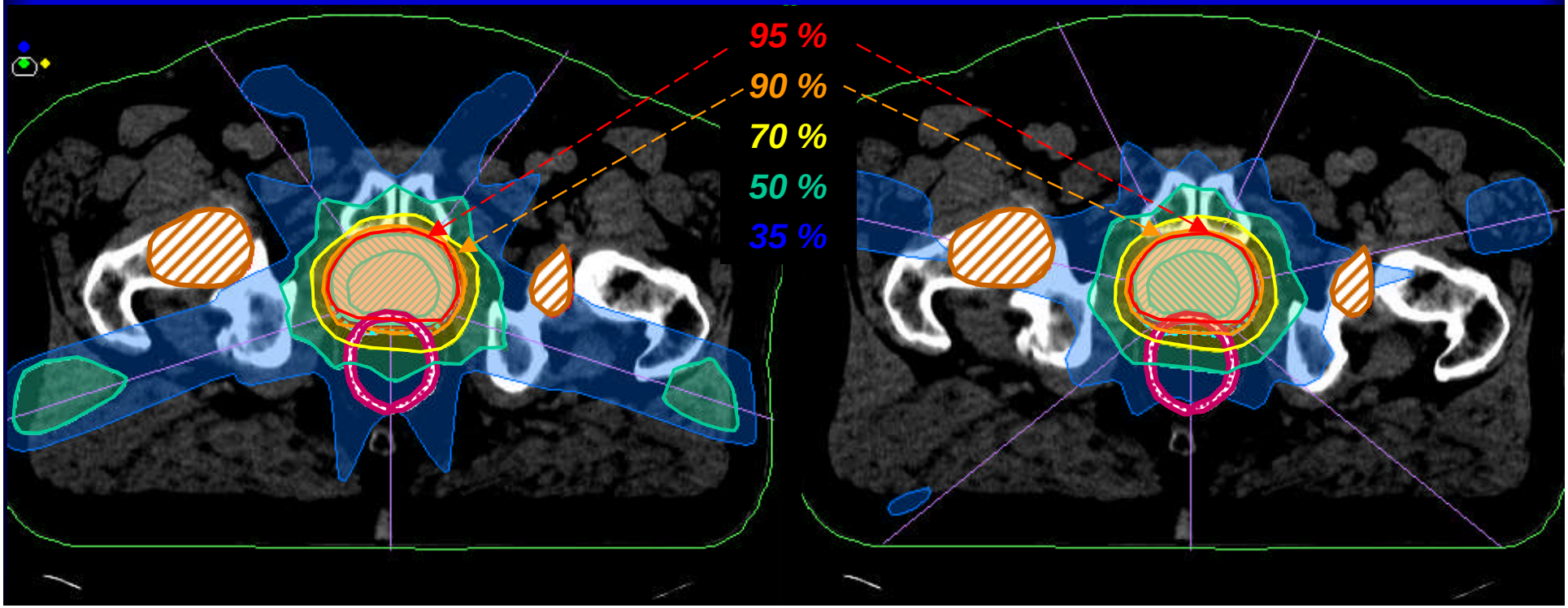
initial attempt: femoral heads, bladder constraints too strict

inverse plan #7: fulfilled criteria for PTV coverage

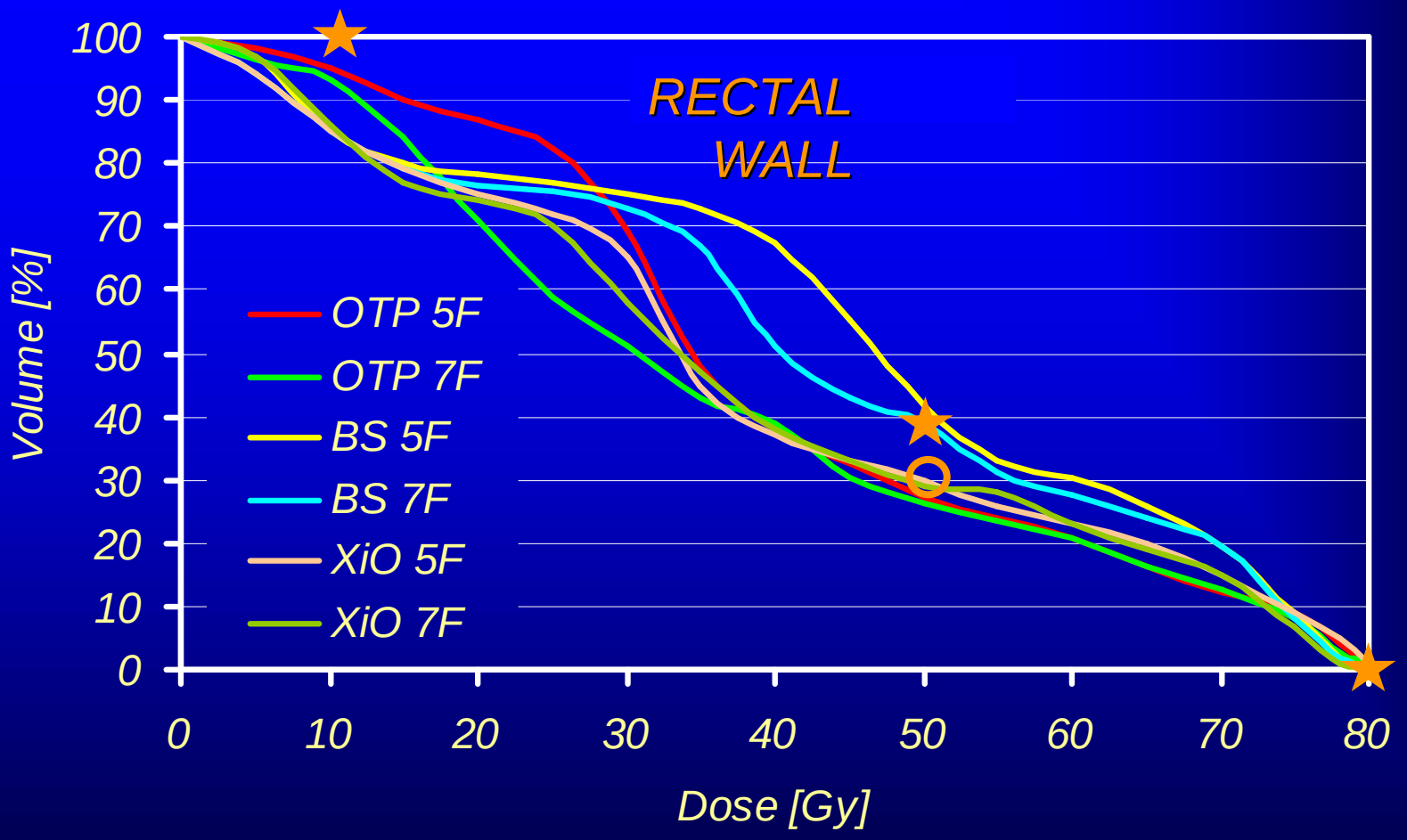
NUMBER OF BEAMS & INCIDENCE

e.g. Prostate

- *equidistant coplanar beams 5 F versus 7 F*
- *efficiency in delivery : number of MUs*
  - *increase 25 % for OTP but no increase for XiO*
- *geometry influences dose to normal tissue*



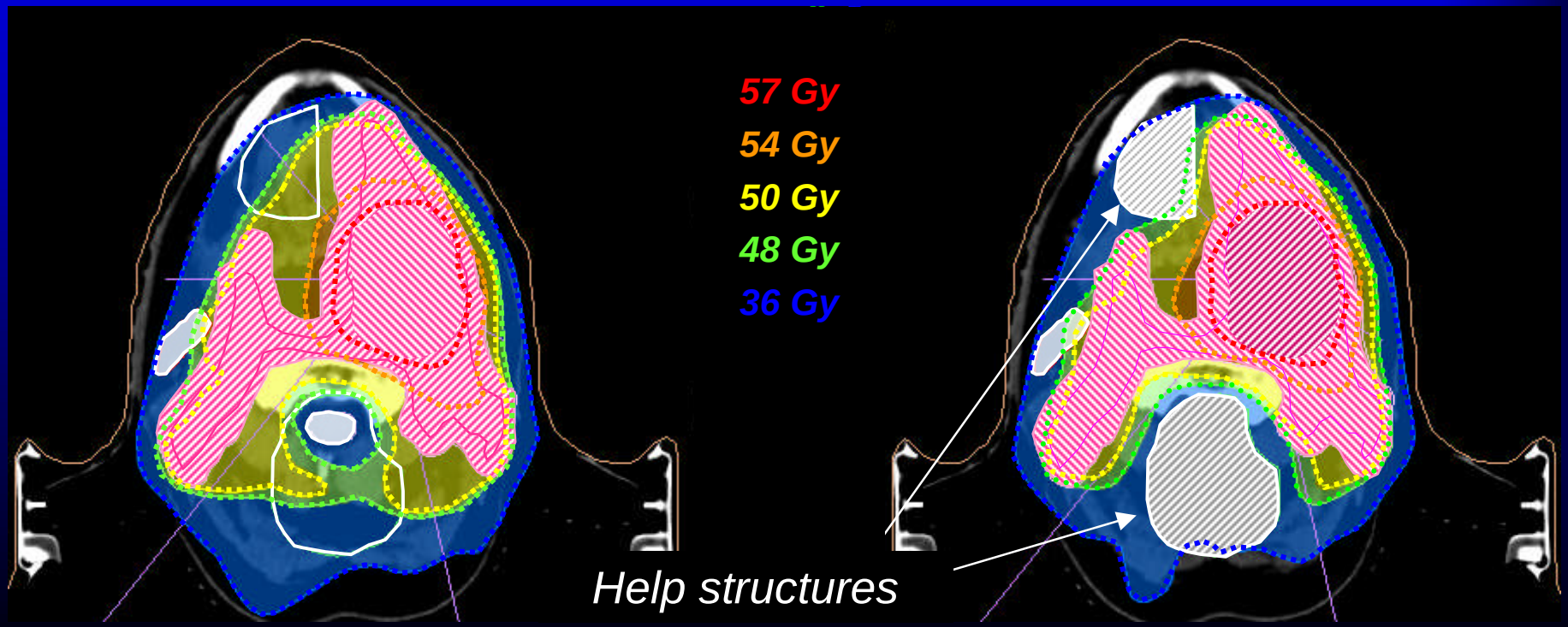
DVH for organs at risk



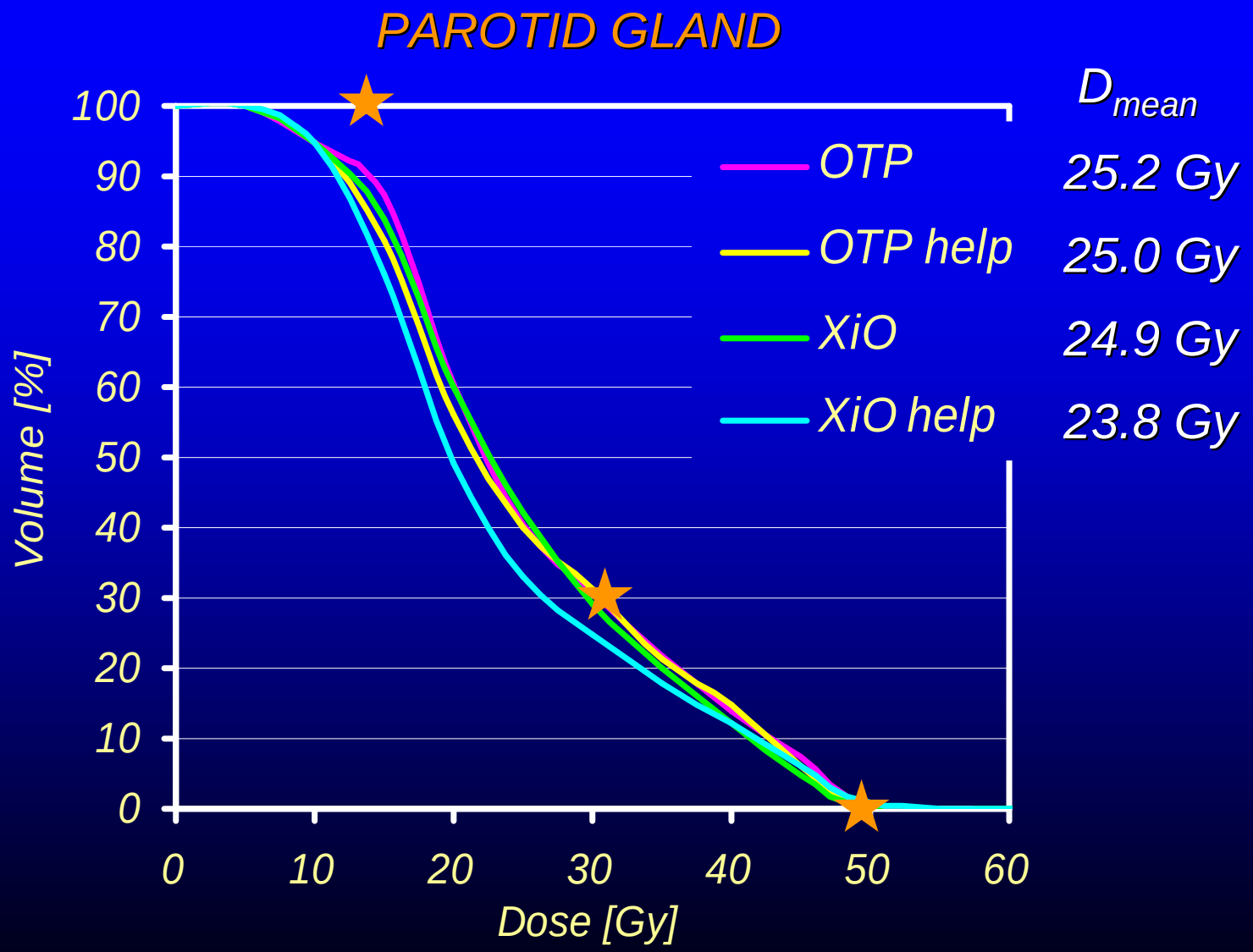
- *Beam set-up does not influence high dose region in DVH for OAR*
- *Review isodose distribution*

HELP STRUCTURES

- *Can be used to improve conformity*
  - *V_{48Gy} reduced ~ 75 – 120 cm³ for PTV 530 cm³ (dependent on TPS)*
  - *Similar $D_{1\%}$ and dose homogeneity, mean dose to parotid gland*
  - *Conformity for boost not altered*
  - *MU per fraction very similar (e.g. 511 MU versus 532 MU)*

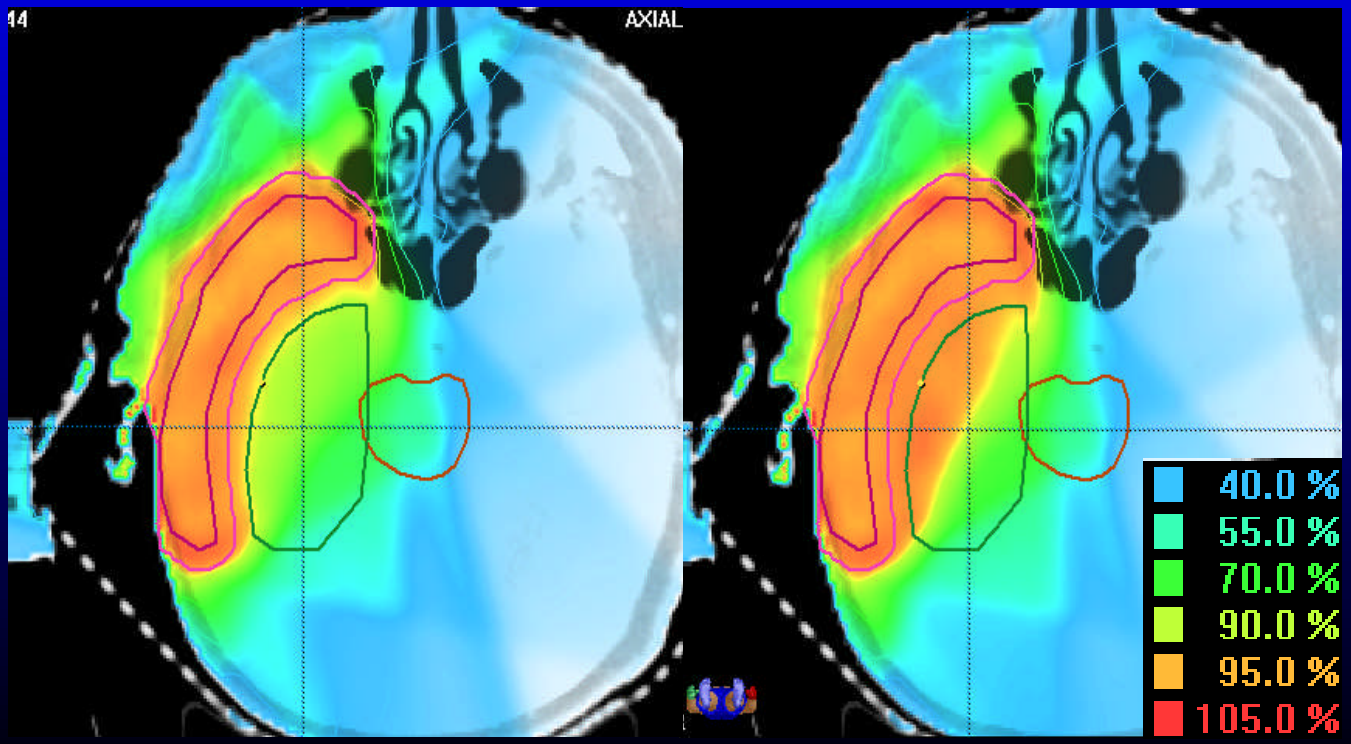


DVH for organs at risk



HELP STRUCTURES

- *Depend on target shape and size*
  - *Definition and use task of planner*
- *Margin to PTV*
- *Definition of constraints requires experience*



RESULTS - Overall

	HEAD & NECK	PROSTATE	HEAD	GYN
Coverage by 95% isodose	96.9 ± 1.5 %	97 ± 0.5 %	96.7 ± 0.5 %	97 / 96 %
Homogeneity	Boost ~ 13 – 14 % PTV ~ 33 %	~ 10 % MCL ~ 6 % mMLC	6 - 7 % MLC 3 % mMLC	13 / 8 %
Target dose $D_{1\%}$ $D_{99\%}$	67.1 ± 0.7 Gy 45.8 ± 1.0 Gy	83.0 ± 0.9 Gy 72.5 ± 1.8 Gy	52.9 ± 1.1 Gy 44.7 ± 1.3 Gy	51 / 49 Gy 41 / 41.3 Gy
Conformity PTV	1.58 var. > 10 %	1.30 var. > 5 -10 %	1.26 var. < 5 %	1.4 / 1.2
OAR $D_{1\%}$	~ 50 ± 1 Gy	~ 80 ± 1 Gy (~ 35 Gy fem. heads)	30 – 50 Gy ± 1 Gy 10 – 25 Gy ± 5 Gy	45 - 48 ± 0.5Gy (kidney ~ 35 ± 1Gy)
DVH for OAR in high doses region	similar	similar	similar	similar
Non-target tissue 50 % isodose	variations ~ 10 % (> 200 cm^3)	variations > 35 % (> 300 cm^3)	variations ~ 10 % (> 300 cm^3)	difference 1000 cm^3
MU	461 ± 62	510 ± 128 MLC ~ 420 mMLC ~ 650	435 ± 124 MLC ~ 300 – 400 mMLC ~ 600	624 / 843
COMMENT		Penile OAR needed as help structure	eye bulb and opt. nerve LOW DOSE	No need for help structures

CONCLUSION AND COMMENTS ...

- *Treatment site specific definition of parameters for dose and DVH based objective functions is feasible and applicable to various TPS*
  - *Important in terms of IMRT class solutions*
  - *Individual patients will remain challenging*
- *During the implementation phase of IMRT guidance for inverse planning is important*
  - *“Tips and tricks” (specific to TPS)*
  - *Experience in conformal planning is needed*
  - *(Too) Many degrees of freedom ….*

CONCLUSION AND COMMENTS ...

- *"IMRT solution" of commercial TPS for IMRT converge in terms of dose distribution*
- *Treatment efficiency of commercial solutions is different*
  - *Differences in segmentation for IMRT delivery*
  - *May have an impact on dose to non-target tissue*
- *Still dealing with first generation TPS for inverse planning*
  - *Next generation based on biological factors*
  - *More interactive planning process*

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