ESTRO

European Society for

RADIOTHERAPY

& ONCOLOGY

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Clinical Experience with Philips Auto-Planning

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Disclosure

- Danish Cancer Society
- Danish Cancer Research Fund
- Odense University Hospital University of Southern Denmark

Aims and challenges of automated planning

Aims

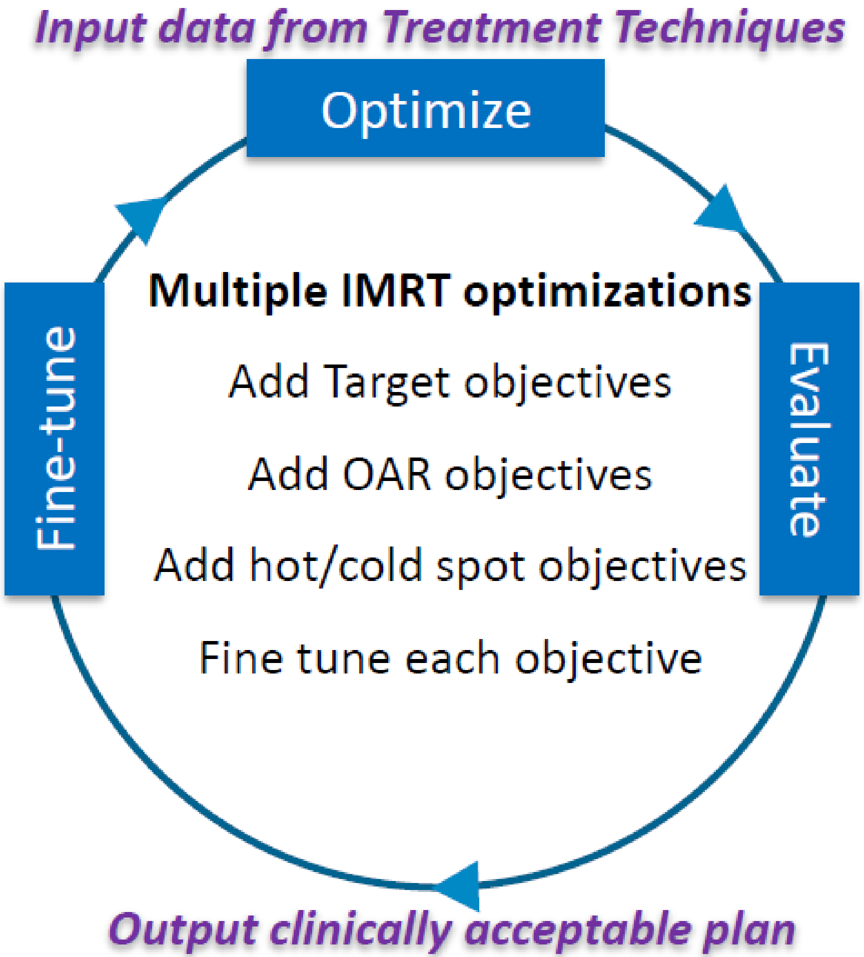
- Increase treatment plan quality
- Handle high treatment plan complexity
- Better efficiency
- Reduce inter planner variation

Challenges

- Multi center use of Autoplan
- Overlapping PTVs with OAR
- PTV target in air or near surface
- Large density differences in target areas
- Dose distribution and conformity for stereotactic patients

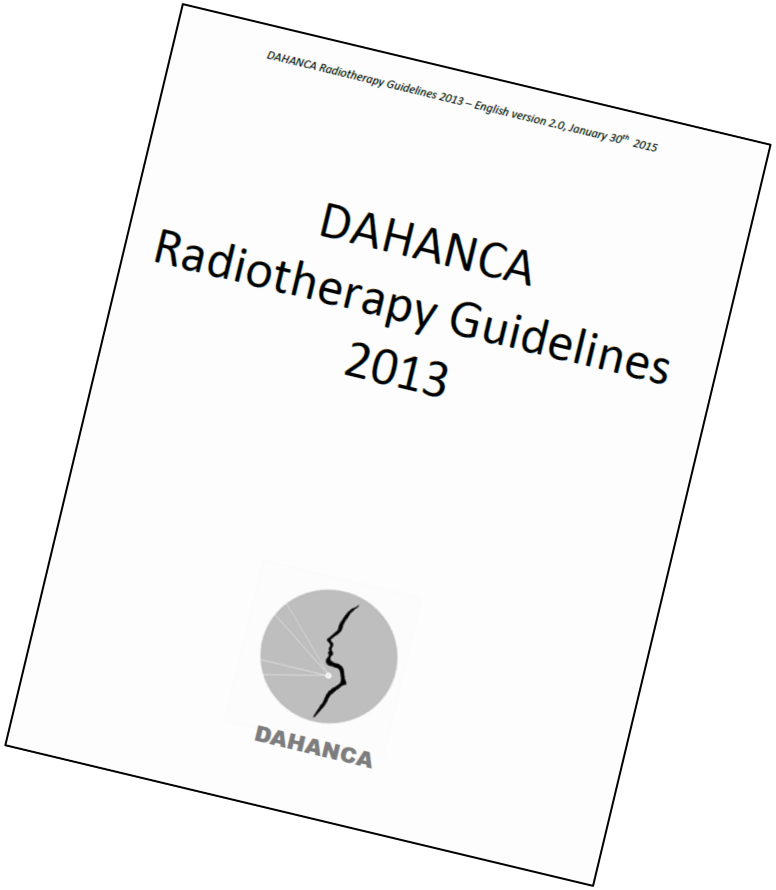
How does Autoplan work

- Mimic treatment planner
- Evaluate plan according to protocol
- Fine tune objectives



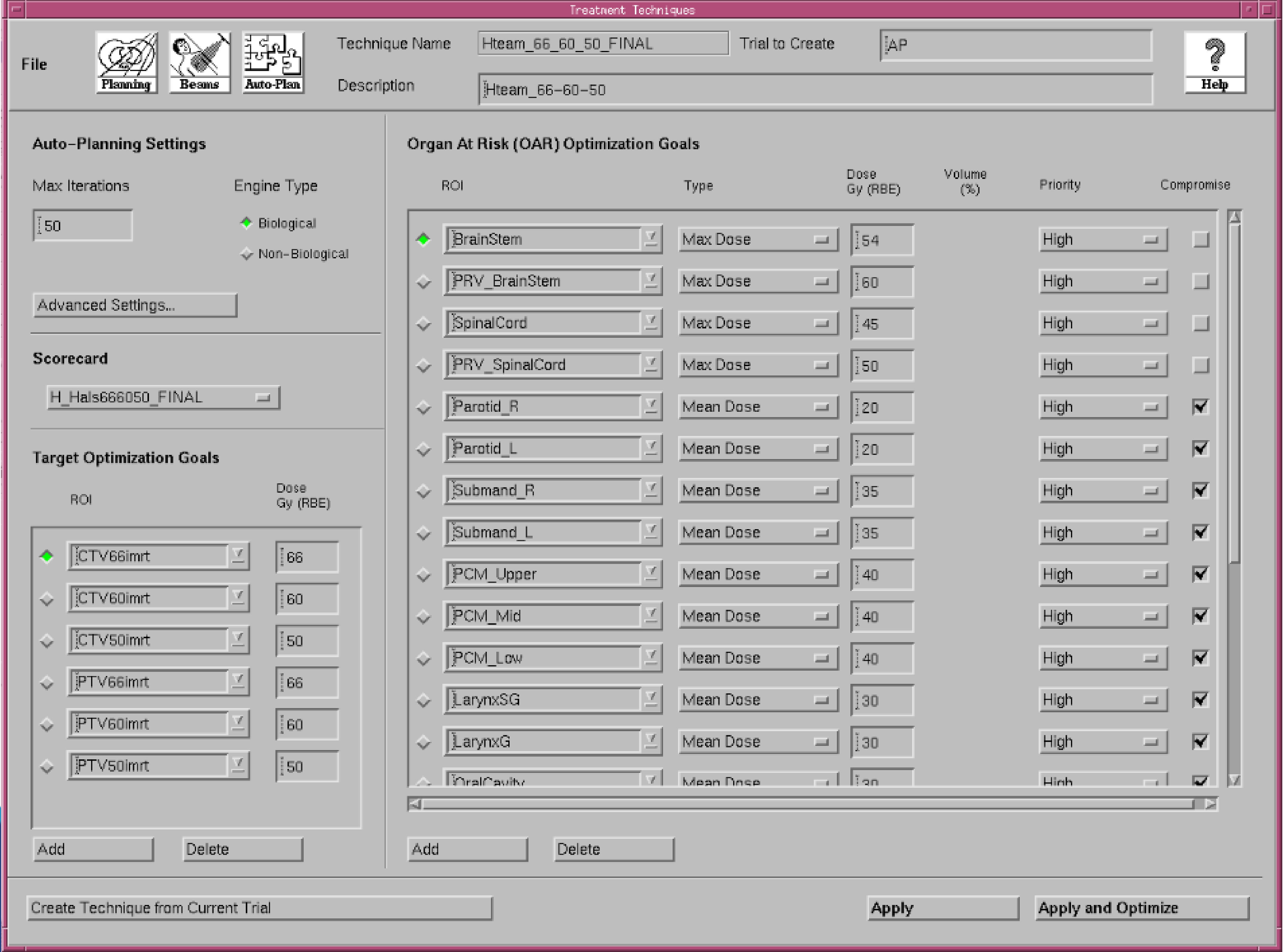
Courtesy Ian Norton (Phillips)

	Structure	Dose constraint OAR [Gy]
ABSOLUTE	Brain stem	$D_{max} \leq 54Gy$
	Spinal cord	$D_{max} \leq 45Gy$
MUST	Anterior eye (conjunctiva, lacrimal gland, cornea, iris)*	$D_{max} \leq 30Gy$
	Chiasm and optic nerve	$D_{max} \leq 54Gy$
	Posterior eye (retina)	$D_{max} \leq 45Gy$
SHOULD	Cochlea	$D_{mean} \leq 45Gy$ og $D_{5\%} \leq 55Gy$
	Parotid gland	1) Contralateral parotid: $D_{mean} \leq 20Gy$ 2) Both parotids: $D_{mean} \leq 26Gy$
	Mandible	Hotspots in the mandible should be avoided
CAN	Pituitary gland	$D_{mean} \leq 30Gy$
	Brain	$D_{max} \leq 60Gy$
	Submandibular gland	$D_{mean} \leq 35Gy$
	Oral cavity	$D_{mean} \leq 30Gy$ for non-involved oral cavity
	Lips	$D_{mean} \leq 20Gy$
	Larynx	$D_{mean} \leq 44$ Gy
	Thyroid gland	$D_{mean} \leq 40$ Gy
	Oesophagus	$D_{mean} \leq 30Gy$


DAHANCA Radiotherapy Guidelines 2013 – English version 2.0, January 30th 2015

DAHANCA
Radiotherapy Guidelines
2013

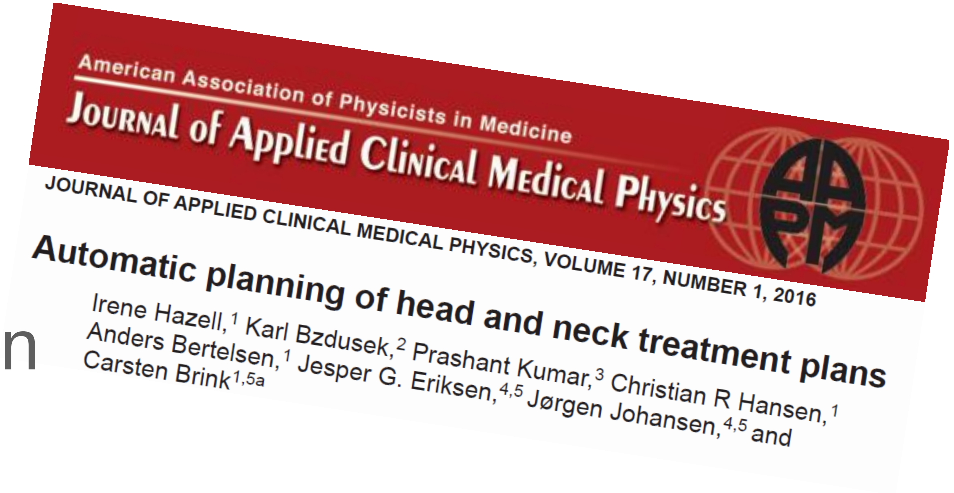
DAHANCA


Treatment Techniques
File
Planning
Beams
Auto-Plan
Technique Name
Hteam_66_60_50_FINAL
Trial to Create
AP
Description
Hteam_66-60-50
Help
Auto-Planning Settings
Max Iterations
50
Engine Type
Biological
Non-Biological
Advanced Settings...
Scorecard
H_Hals666050_FINAL
Target Optimization Goals
ROI
Dose Gy (RBE)
CTV66imrt 66
CTV60imrt 60
CTV50imrt 50
PTV66imrt 66
PTV60imrt 60
PTV50imrt 50
Add
Delete
Organ At Risk (OAR) Optimization Goals
ROI
Type
Dose Gy (RBE)
Volume (%)
Priority
Compromise
BrainStem Max Dose 54 High
PRV_BrainStem Max Dose 60 High
SpinalCord Max Dose 45 High
PRV_SpinalCord Max Dose 50 High
Parotid_R Mean Dose 20 High
Parotid_L Mean Dose 20 High
Submand_R Mean Dose 35 High
Submand_L Mean Dose 35 High
PCM_Upper Mean Dose 40 High
PCM_Mid Mean Dose 40 High
PCM_Low Mean Dose 40 High
LarynxSG Mean Dose 30 High
LarynxG Mean Dose 30 High
Add
Delete
Create Technique from Current Trial
Apply
Apply and Optimize

Autoplan Odense

- Autoplan is clinical standard for:
  - H&N
  - Brain
  - Esophagus
  - Bladder (adaptive triple plan generation)
  - Prostate
  - Cervix
  - Rectum
  - Hippocampus sparing whole brain
  - Conformal palliation
- Still challenging cases
  - Lung
  - SBRT Lung

H&N - step and shoot IMRT



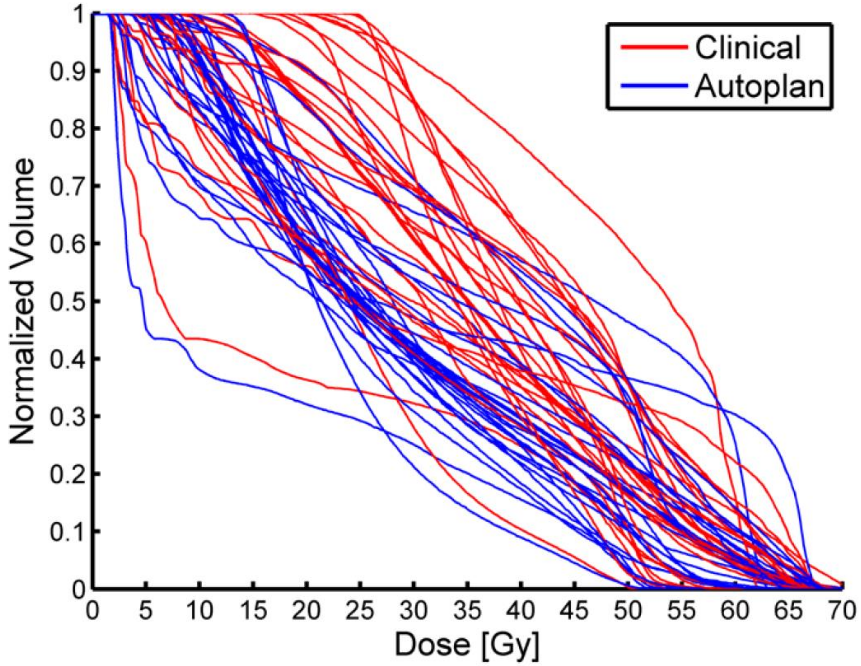
American Association of Physicists in Medicine
Journal of Applied Clinical Medical Physics

JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 17, NUMBER 1, 2016

Automatic planning of head and neck treatment plans

Irene Hazell,[1] Karl Bzdusek,[2] Prashant Kumar,[3] Christian R Hansen,[1] Anders Bertelsen,[1] Jesper G. Eriksen,[4,5] Jørgen Johansen,[4,5] and Carsten Brink[1,5a]

- 30 H&N patients
- Autoplan sparing OAR better
- Reduced inter planner variation



Hazell et al. J Appl Clin Med Phys. 2016

Blinded implementation of Autoplan on H&N


Contents lists available at ScienceDirect

Clinical and Translational Radiation Oncology

journal homepage: www.elsevier.com/locate/ctro

ELSEVIER

ctRO

Original Research Article

Automatic treatment planning improves the clinical quality of head and neck cancer treatment plans

Christian Rønn Hansen [a,*], Anders Bertelsen [a], Irene Hazell [a], Ruta Zukauskaite [b,c], Niels Gyldenkerne [c], Jørgen Johansen [b,c], Jesper G. Eriksen [b,c], Carsten Brink [a,b]

- First 30 clinical Autoplan patients
  - Manual VMAT plan create
  - Autoplan VMAT plan create
    - No comparison between the plans before after they were final

  - Blinded for evaluations
  - Best plan selected for treatment
  - 29 of 30 plans treated were Autoplan

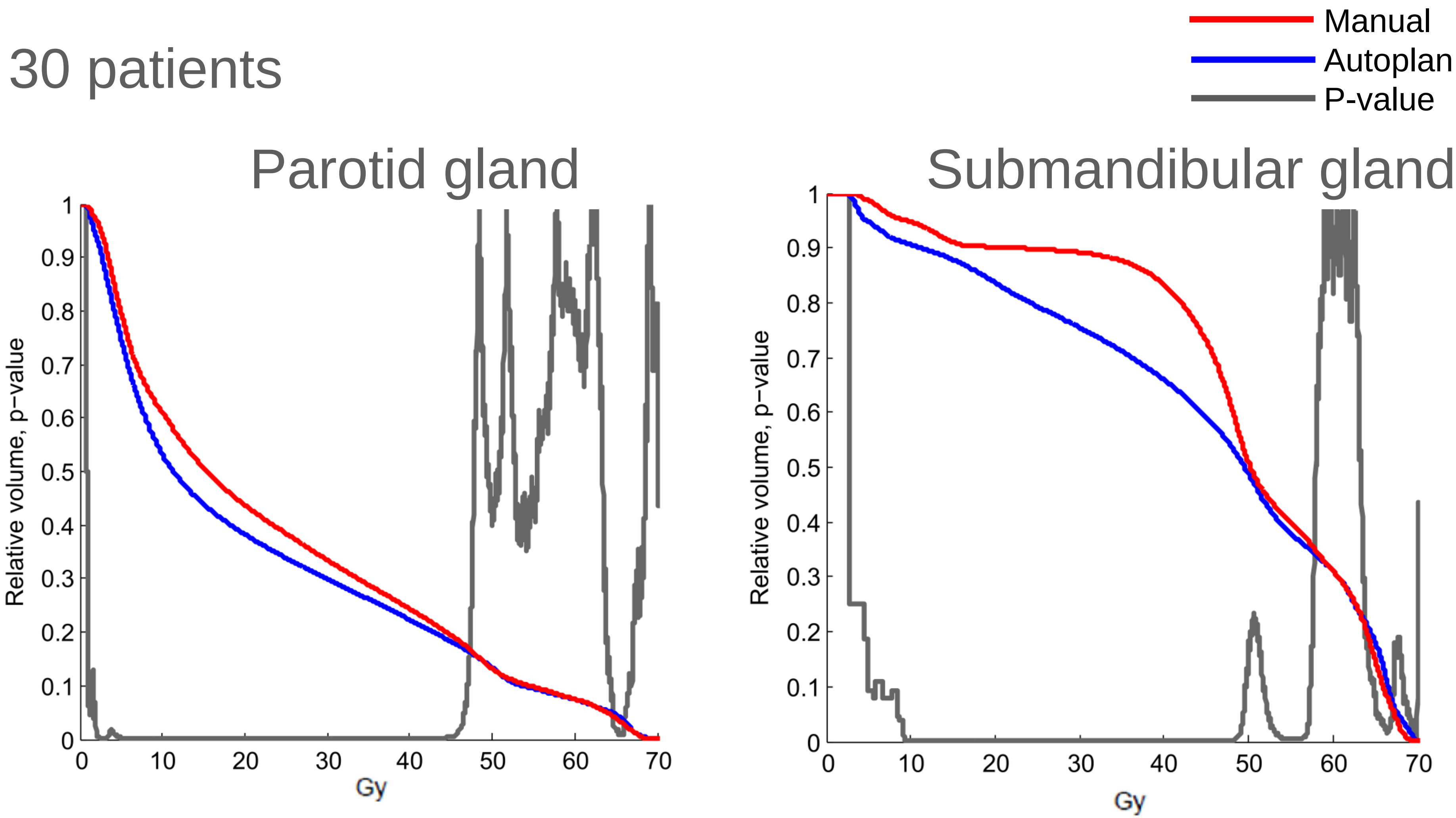
  - The operator time is reduced by a factor of 2 (60 min – 30 min)

Hansen et al. Clin Transl Radiat Oncol. 2016

H&N Manual vs Autoplan

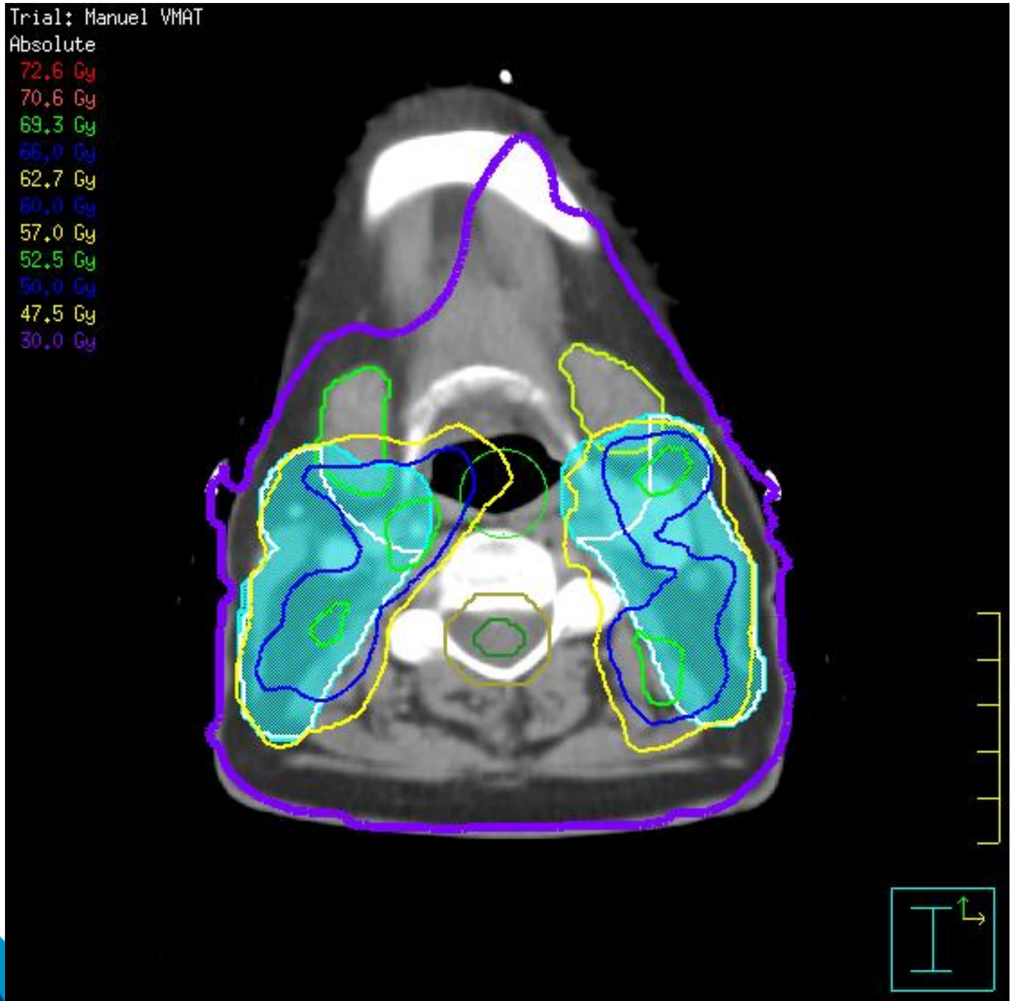
Population mean DVH

30 patients

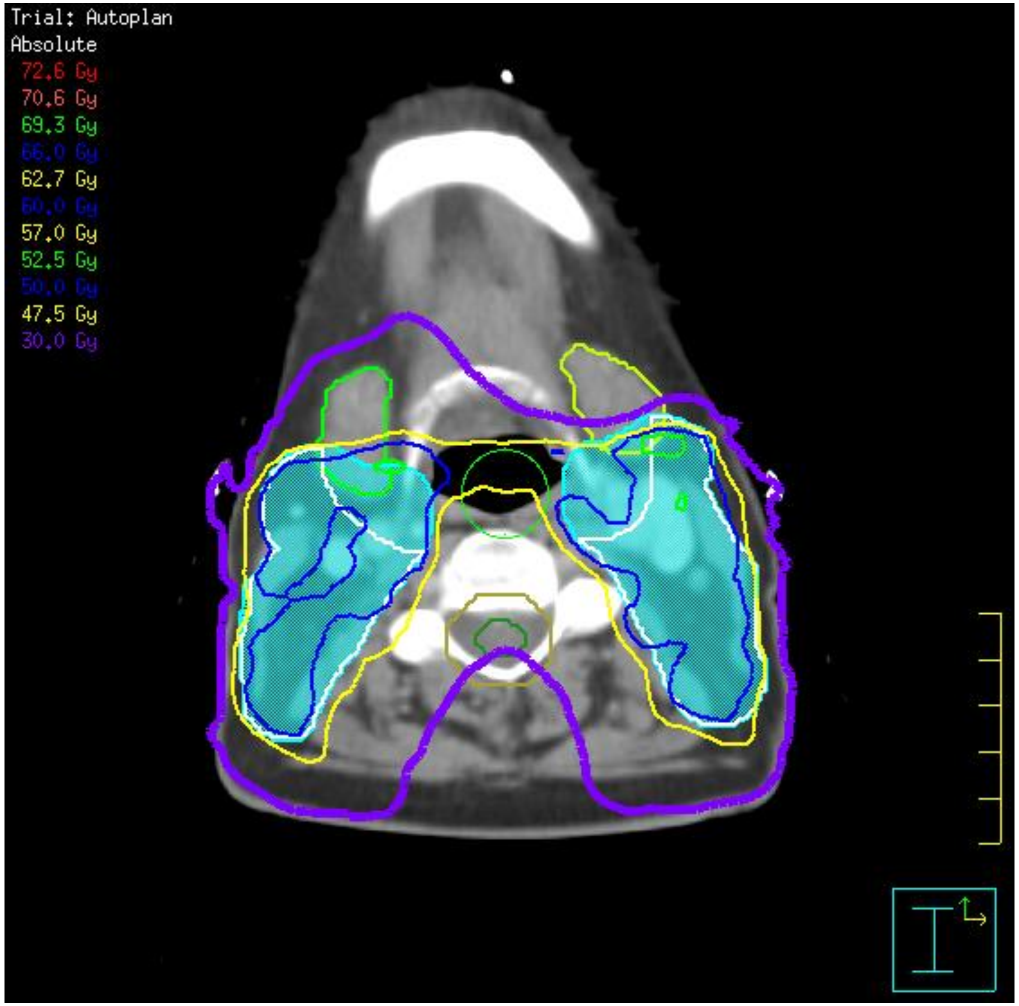


Plan comparison H&N

Manual



Autoplan



Sparing of Organ at Risk for H&N

		Autoplan		Manual			
OAR	Unit	Mean	STD	Mean	STD	Difference	P
Spinal cord	[Gy]	20.2	6.9	22.9	5.8	-2.7	<0.001
Brainstem	[Gy]	3.5	4.0	5.1	4.7	-1.6	<0.001
Oral cavity	[Gy]	31.6	13.3	34.3	12.8	-2.7	<0.001
Libs of mouth	[Gy]	12.3	7.7	15.2	6.8	-2.9	<0.001
Parotid gland ipsi*	[Gy]	23.4	16.4	25.5	15.7	-2.1	<0.001
Parotid gland con**	[Gy]	18.5	8.1	20.5	8.8	-2.0	0.004
Submandibular gland ipsi*	[Gy]	53.2	11.4	56.0	7.7	-2.8	0.01
Submandibular gland con**	[Gy]	34.0	19.2	40.5	18.9	-6.5	0.0001
Mandible	[Gy]	30.2	9.4	32.3	8.9	-2.1	0.0002
Thyroid gland	[Gy]	34.6	13.3	37.1	11.2	-2.5	0.0007
Larynx	[Gy]	39.1	9.4	44.8	8.7	-5.7	0.0004
Body	[Gy]	9.3	3.0	9.8	2.9	-0.5	<0.001

~10% dose reduction

Prostate

50 Patients

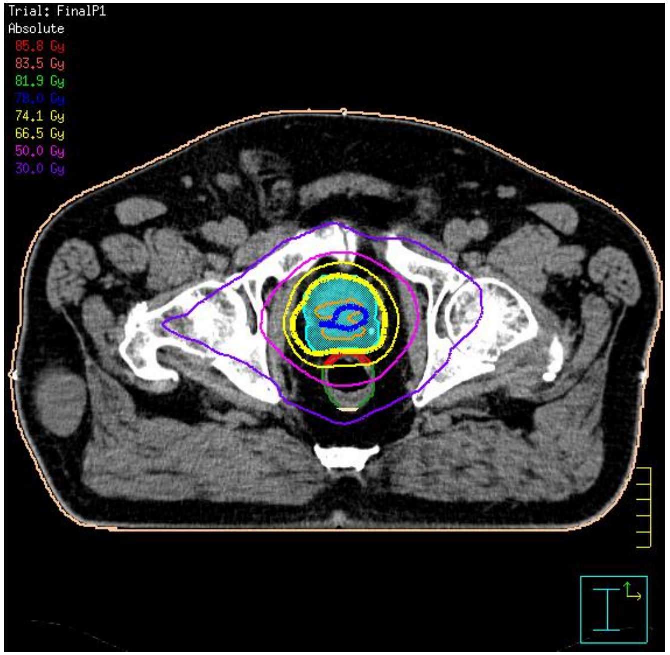
78 Gy in 39 fractions

Select Manual vs Autoplan

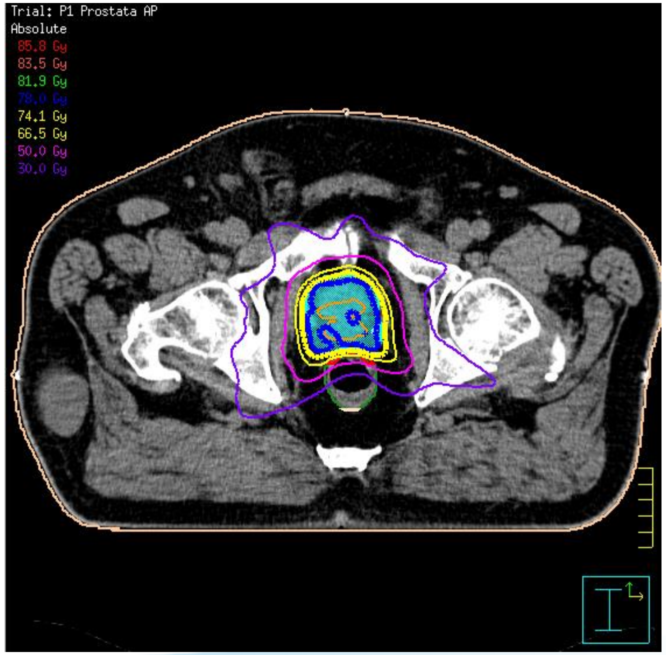
Results

- Gains like H&N
- Spare Rectum. Bladder. Bowel and femur head better

Manual



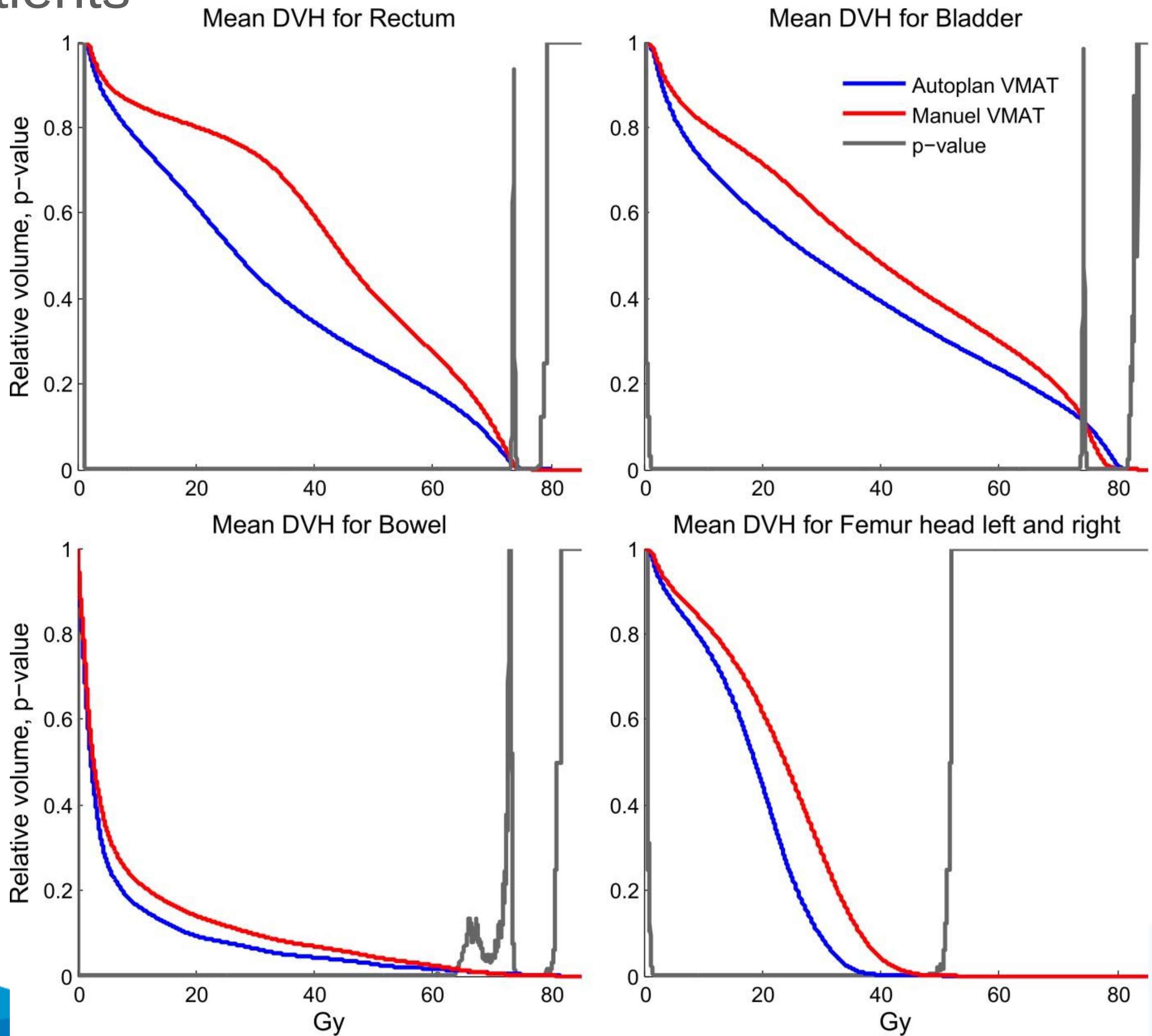
Autoplan



Prostate Manual vs Autoplan

Population mean DVH

50 patients



Autoplan for Esophagus

32 Patients

60-50 Gy in 30 fractions

Select manual vs Autoplan

Results

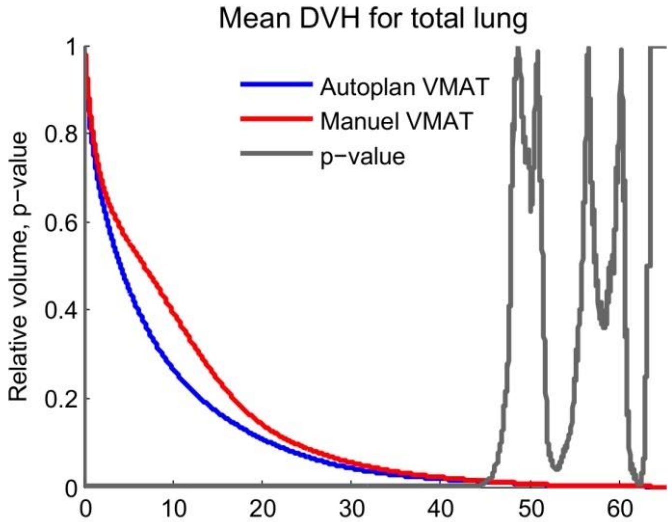
- 31/32 Autoplan were selected
- Spare lung much better.
- Heart dose can go up.
- Mean cord dose goes up.

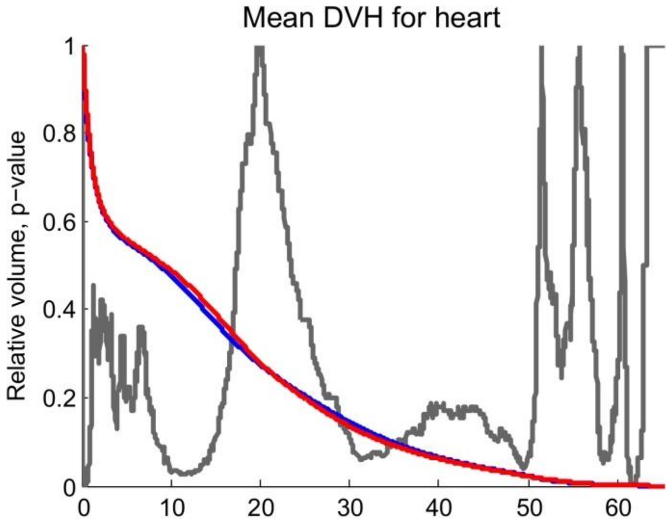
Hansen et al. Acta Oncol. 2017

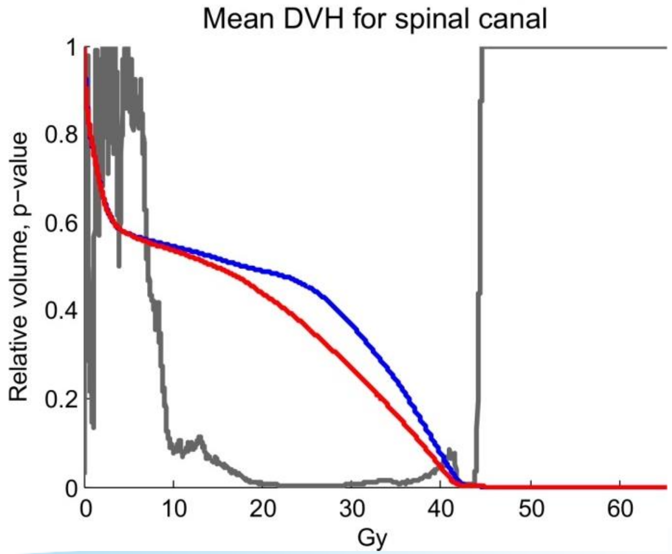
Esophagus organ at risk doses

Population mean DVH

- Autoplan selected in 31 of 32 pts
  - Reduction of lung dose
  - No difference in heart dose
  - Increased spinal canal dose





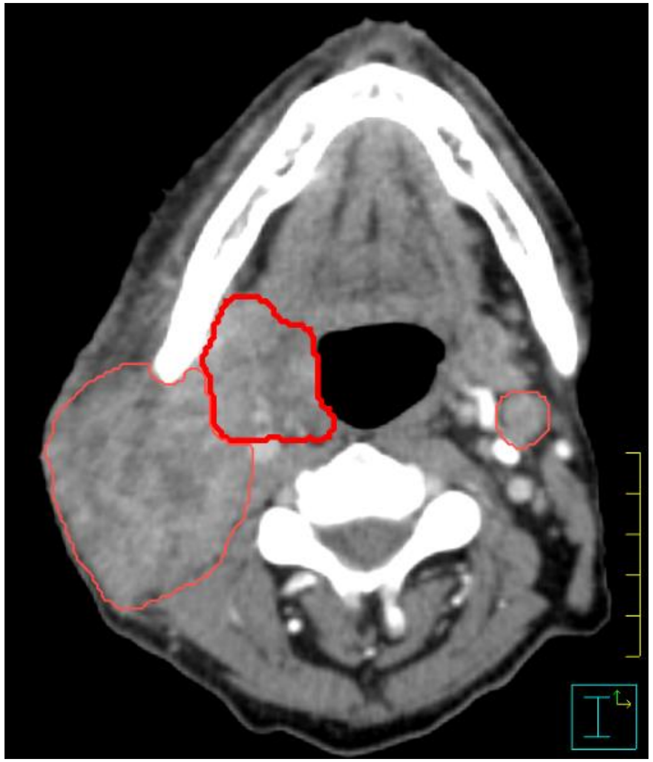


Challenges using Autoplan

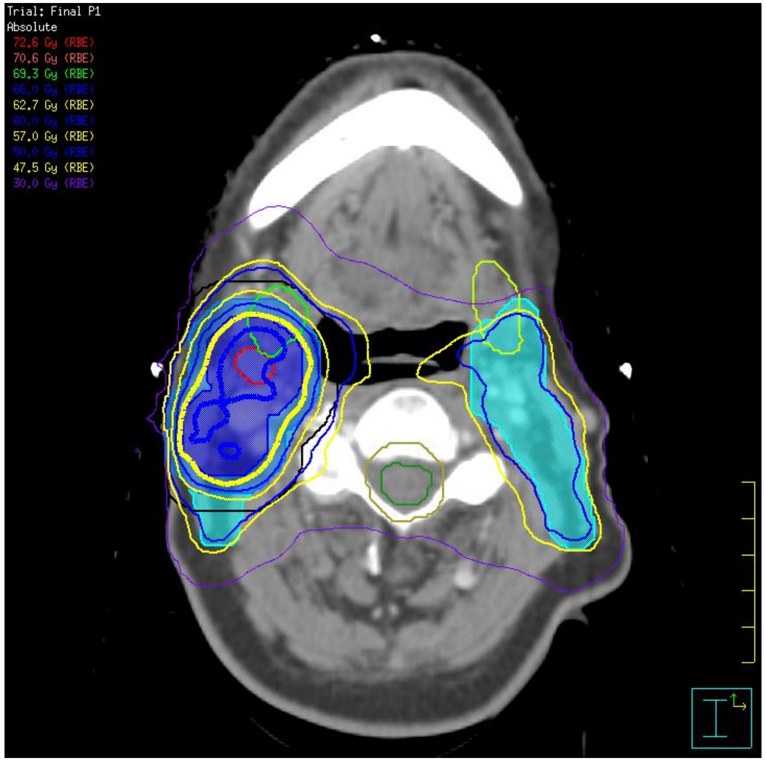
PTV target in air or near surface

- GTV near surface → 3D printed bolus
- CTV near surface → crop CTV to under the skin or 3D printed bolus
- PTV near surface → crop PTV to under the skin
  - Less robust to setup uncertainties, however VMAT treatment

GTV near patient surface



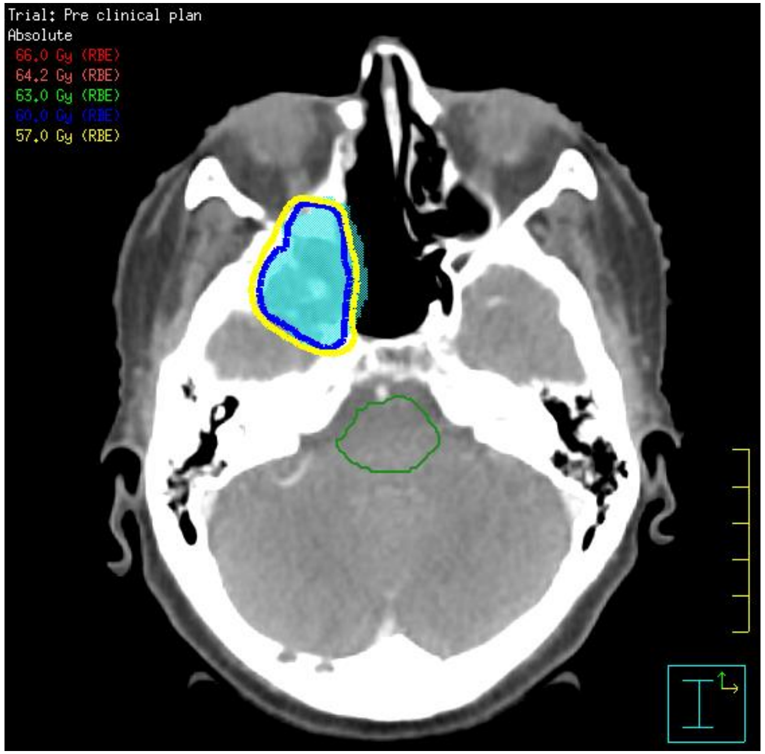
PTV near patient surface



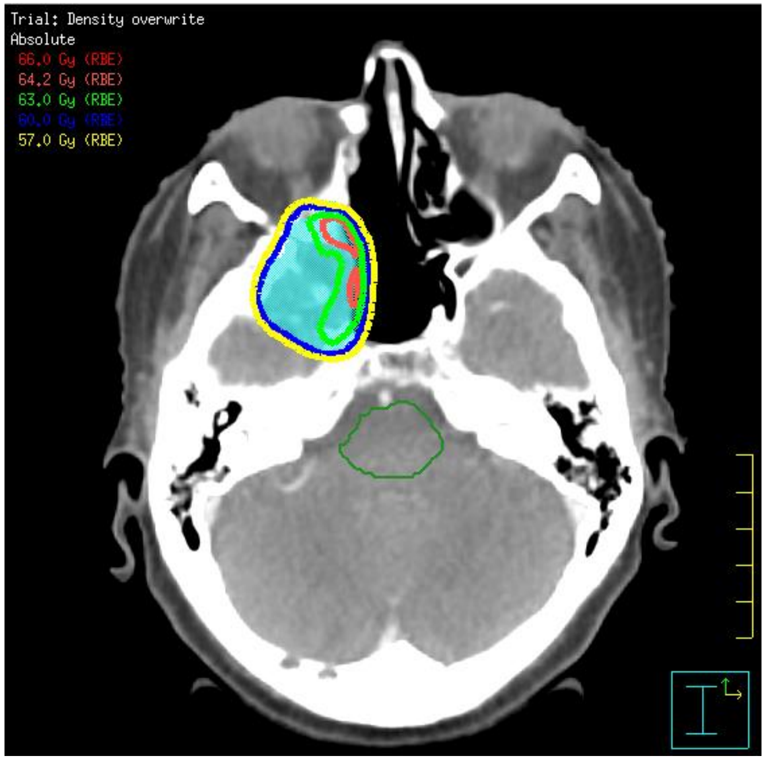
Large density differences in target areas

- Re-irradiation H&N cancer patient
- Danger of suboptimal beam fluence
- Hiding warnings of skin/density change boosts

Pre clinical Autoplan



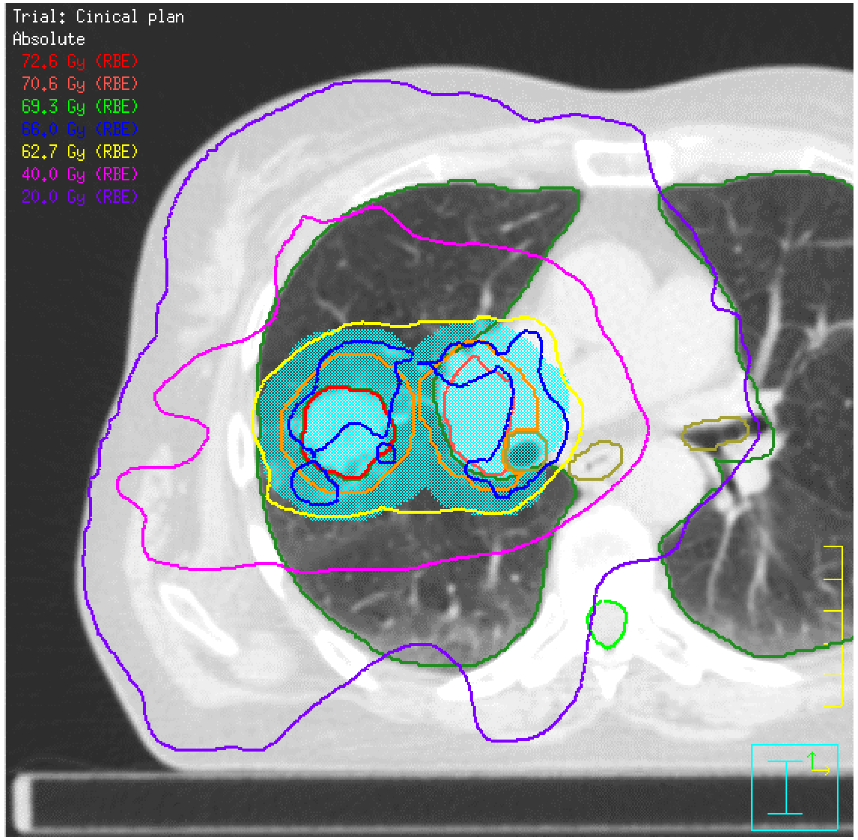
Autoplan with density overwrite



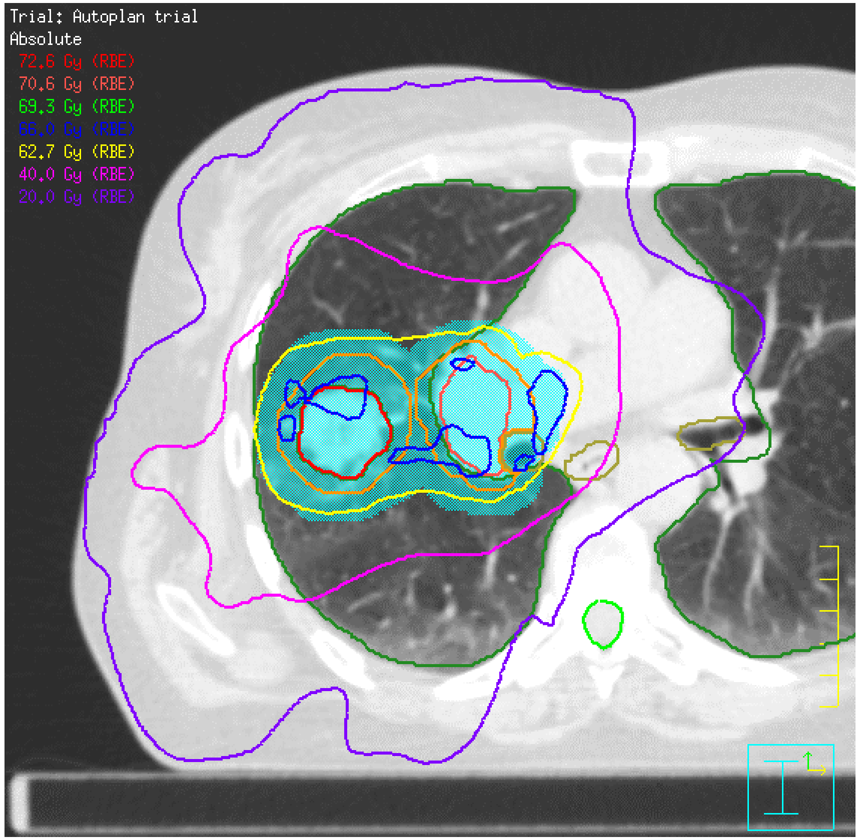
Large density differences in target areas

- Autoplan struggle with large density changes
  - ➢ Many pencil beam iteration
  - ➢ Difference between Collapsed-Cone and pencil beam calculation

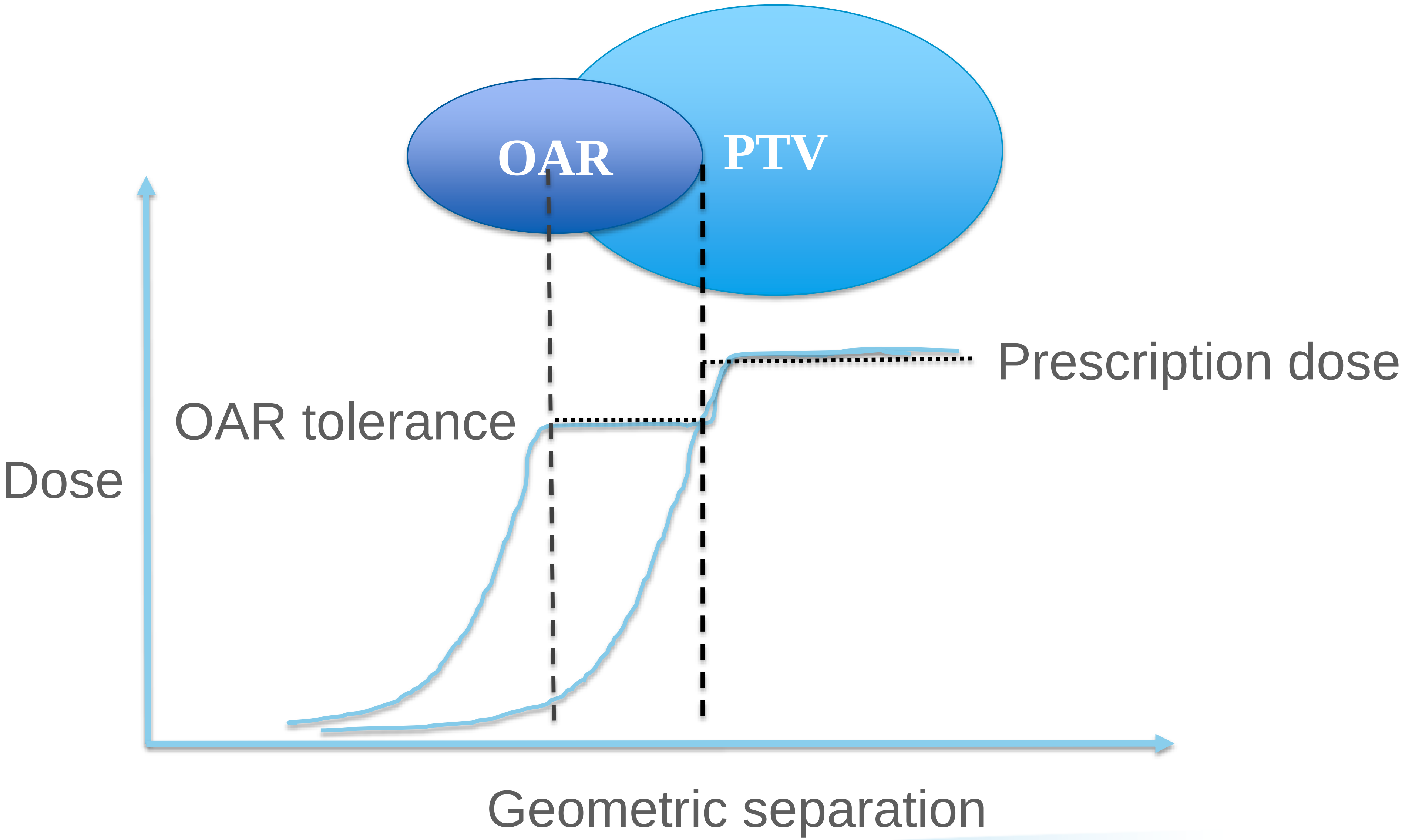
Clinical plan



Autoplan



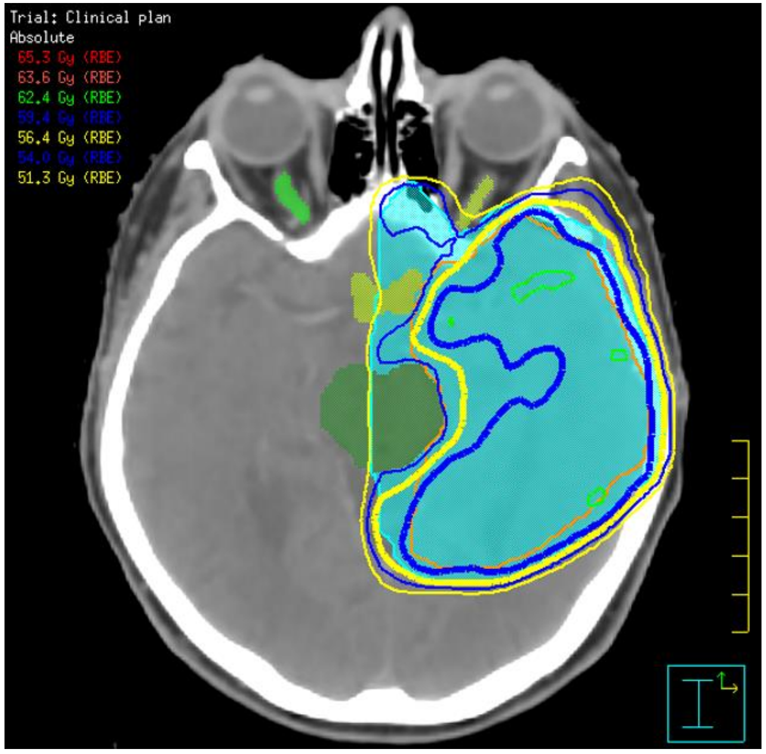
Overlapping PTVs with OAR



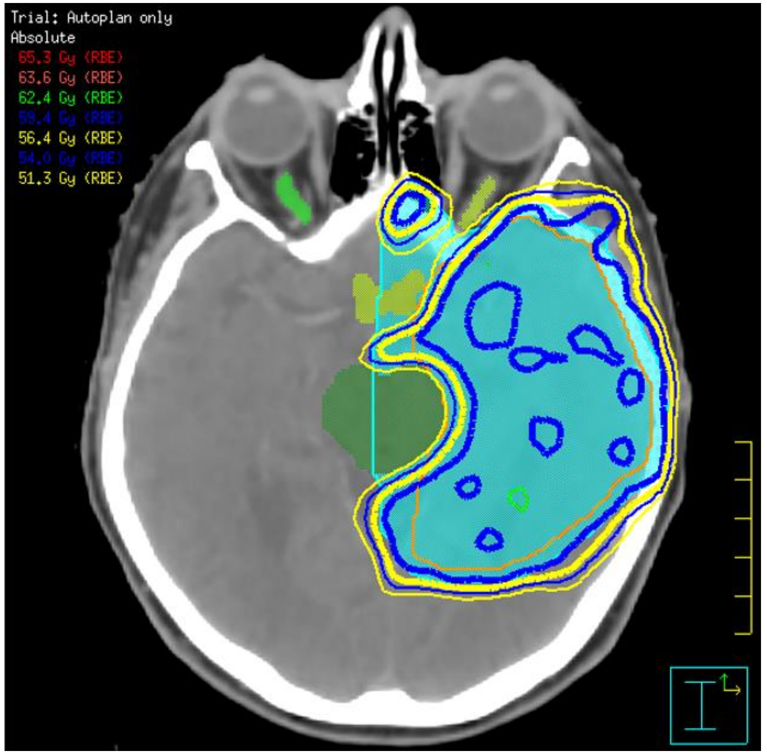
Overlapping PTVs with OAR

- PTV minimum 56.4 Gy (95% of prescription)
- Brainstem maximum 54 Gy
- PTV in brain stem minimum 51.3 Gy maximum 54 Gy

Clinical plan



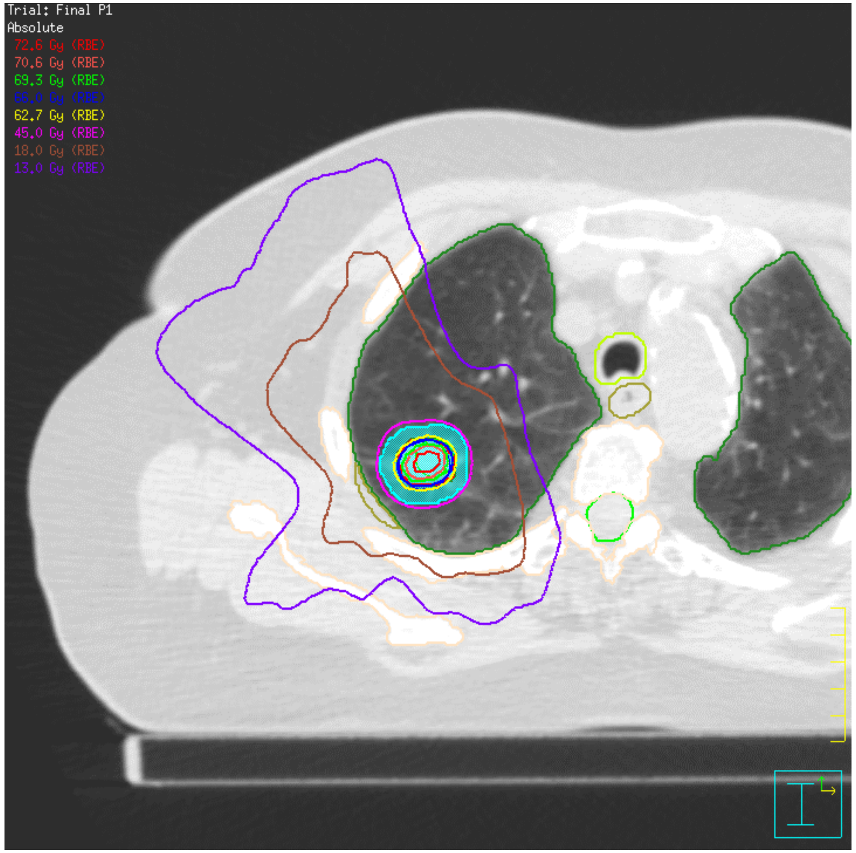
Autoplan no post optimisation



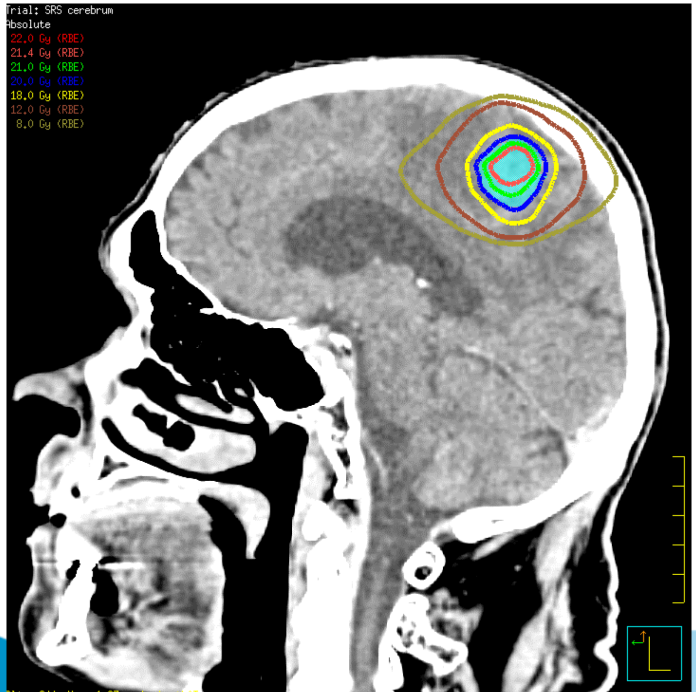
Conformity around stereotactic targets

- Target doses with high homogeneity
- High conformity not easy
- No constraints close to target

SBRT lung cancer patient



SRS brain metastasis patient



Multi center Autoplan study

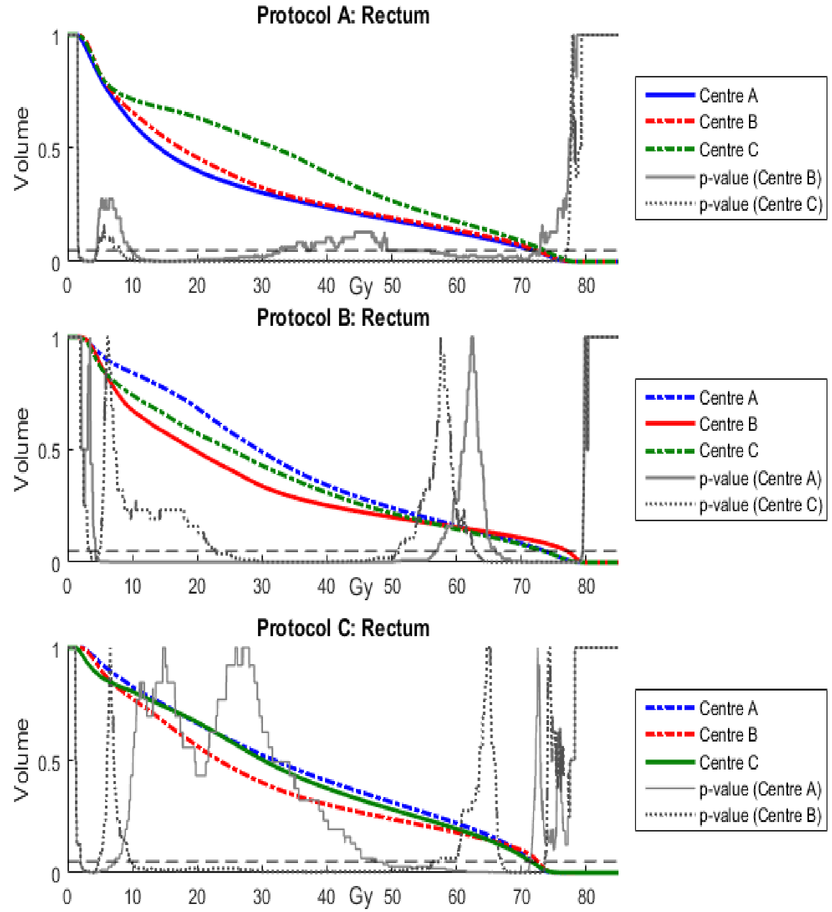
The Netherlands Cancer Institute, The Netherlands
Liverpool and Macarthur Cancer Therapy Centres, Australia
Odense University Hospital, Denmark

Study setup

- Three local protocols
- Create Autoplan techniques
- Test on 3 pilot patients
- Validate on 10 patients

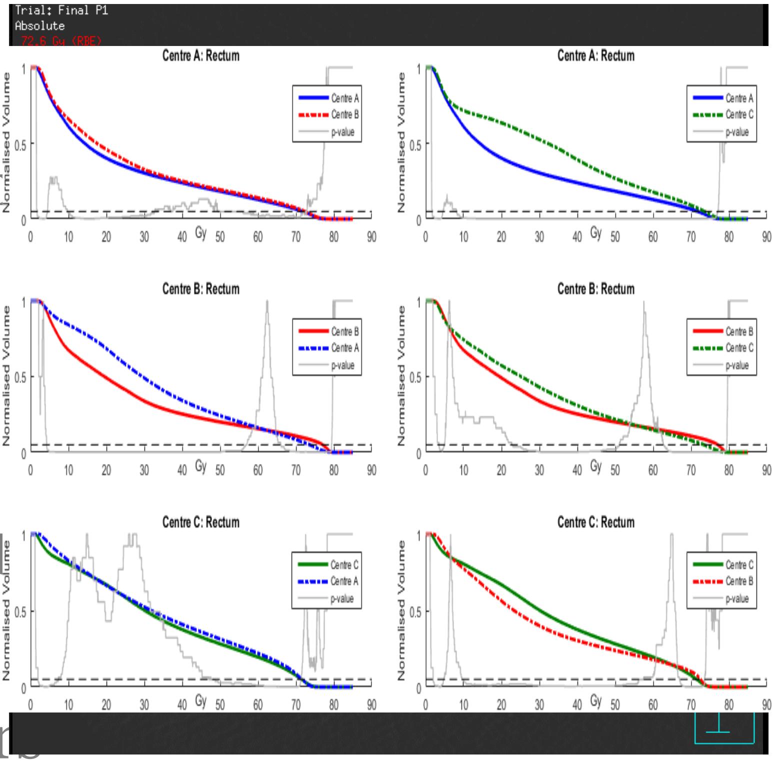
Conclusion

- Techniques are adaptable to multiple prostate radiotherapy protocols



Challenges using Autoplan

- Target in air or near surface
- Large density differences in target a
- Overlapping PTVs with OAR
- Conformity challenges for stereotact
- Using Autoplans across many centers



- User knowledge of the Autoplanning process

How to implement AP in a new center

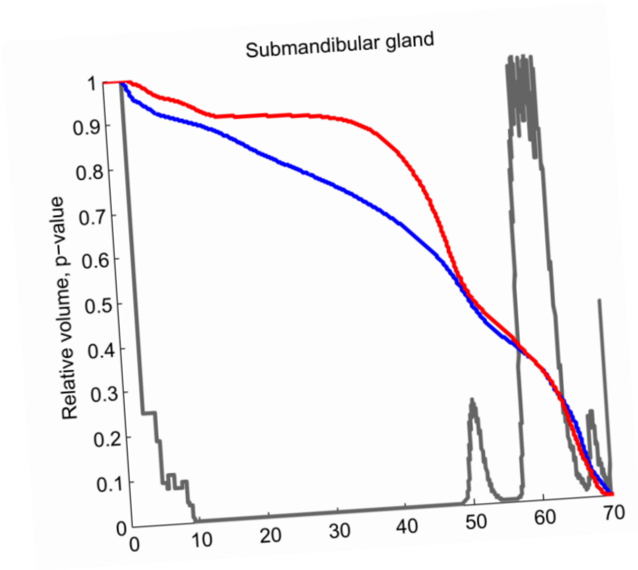
- Defined protocols
  - Target
  - OAR threshold limits
  - Priority target/OAR's
- Replan group of patients
- Configure Autoplan according to protocol
- Reconfigure for specific needs:
  - Overlapping targets and OAR
  - Priorities between competing OAR
- Validate on separate patient group

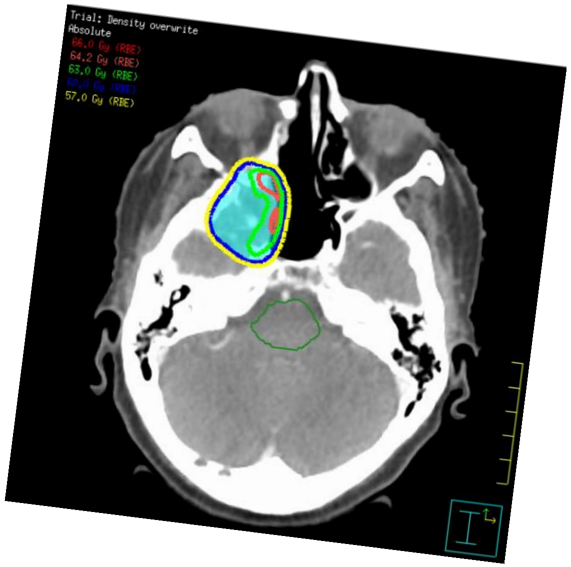
- Check deliverability of plans
- Estimated time required 50 hours

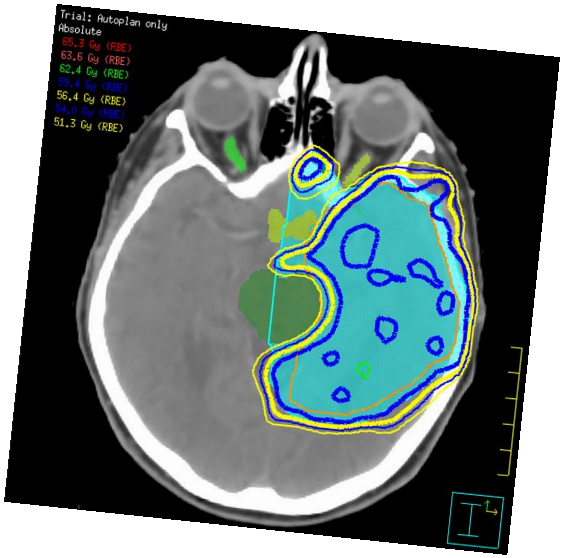
Conclusion

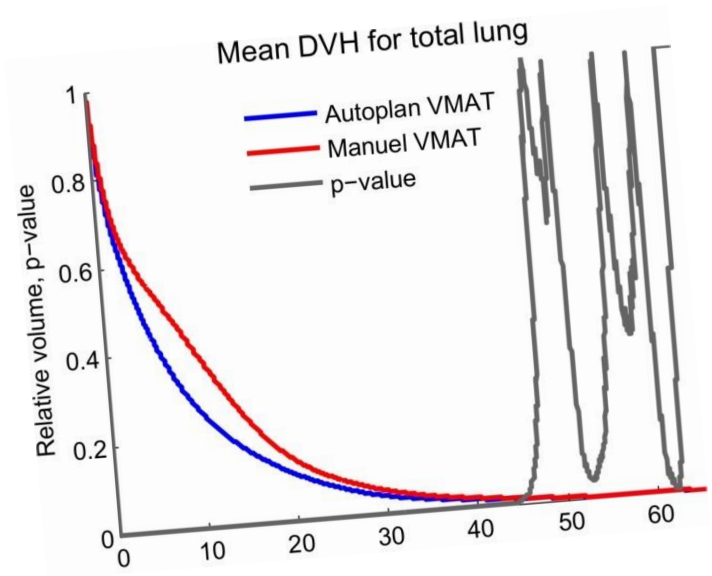
- Autoplan create plans of high and often better quality than manual plans
- Reduces doses to OAR
- Removes inter planner variability
- The implementation is relatively easy
- Mind the pitfalls of Autoplan

Thank you for your attention









ESTRO PHYSICS workshop

Science in development

26-27 October 2018
Malaga, Spain

REGISTRATION OPENS
Early May 2018

DEADLINES
Contributions on ongoing research:
27 June 2018

Early registration:
21 August 2018

Late registration:
20 October 2018

No onsite registration.

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& ONCOLOGY


ESTRO
38
26-30 April 2019
Milan, Italy
Targeting
optimal care,
together
DEADLINES
Abstract submission:
22 October 2018
Early registration:
16 January 2019
Late registration:
26 March 2019