

ROCOCO (<http://rococo.mistir.info>) Radiation Oncology Collaborative Comparison

Dose Escalation for the Multicentric In Silico ROCOCO Trial Comparing Photons and Protons for Radiotherapy of Non-Small Cell Lung Cancer

Erik Roelofs, Martijn Engelsman, Judith van der Stoep, Coen Rasch, Dirk de Ruyscher, Frank Verhaegen, Madelon Pijls-Johannesma, Philippe Lambin



Erik Roelofs

MAASTRO, GROW, MUMC+
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Partners

Maastricht Radiation Oncology (MAASTRO), GROW Research Institute, MUMC+, The Netherlands.

Netherlands Cancer Institute (NKI), The Netherlands.

University Medical Center Groningen (UMCG), The Netherlands.

University Hospital Ghent (UHG), Belgium.

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What is ROCOCO?

In silico (on a computer) planning study

- Emulation of phase III clinical trial
- Compare photons/protons/c-ions
- Lung, Prostate, H&N (25 each)
- Current clinical practice

Endpoints

- I: iso-effective tumor control
- II: dose-escalation
- III: hypo-fractionation
- IV: expand the project
(tumours/modalities)

Dataset

- 25 consecutive patients (no selection)
- Stage IA to IIIB NSCLC
- Mean CTV volume 180cc (s.e. 35cc)
- Individ. margins based on 4D CT/PET datasets
- PTV margins different for 3D-CRT
 - 95% isodose around CTV
 - range uncertainties 3.5% and 1 mm*
 - aperture expansion, range compensator smearing**

*Methodologies and tools for proton beam design for lung tumors.

Moyers MF, Miller DW, Bush DA, Slater JD. Int J Radiat Oncol Biol Phys. 2001 Apr

**Target volume dose considerations in proton beam treatment planning for lung tumors.

Engelsman M, Kooy HM. Med Phys. 2005 Dec

Planning parameters

Prescribed dose

- part I : PD 70 Gy (35 fr. @ 2 Gy)
- part II: max. 4 Gy/fr. (EQD2 = 163 Gy, $\alpha/\beta = 10$ Gy)
- PTV coverage: 95%-107% (ICRU50/62)

OAR limits

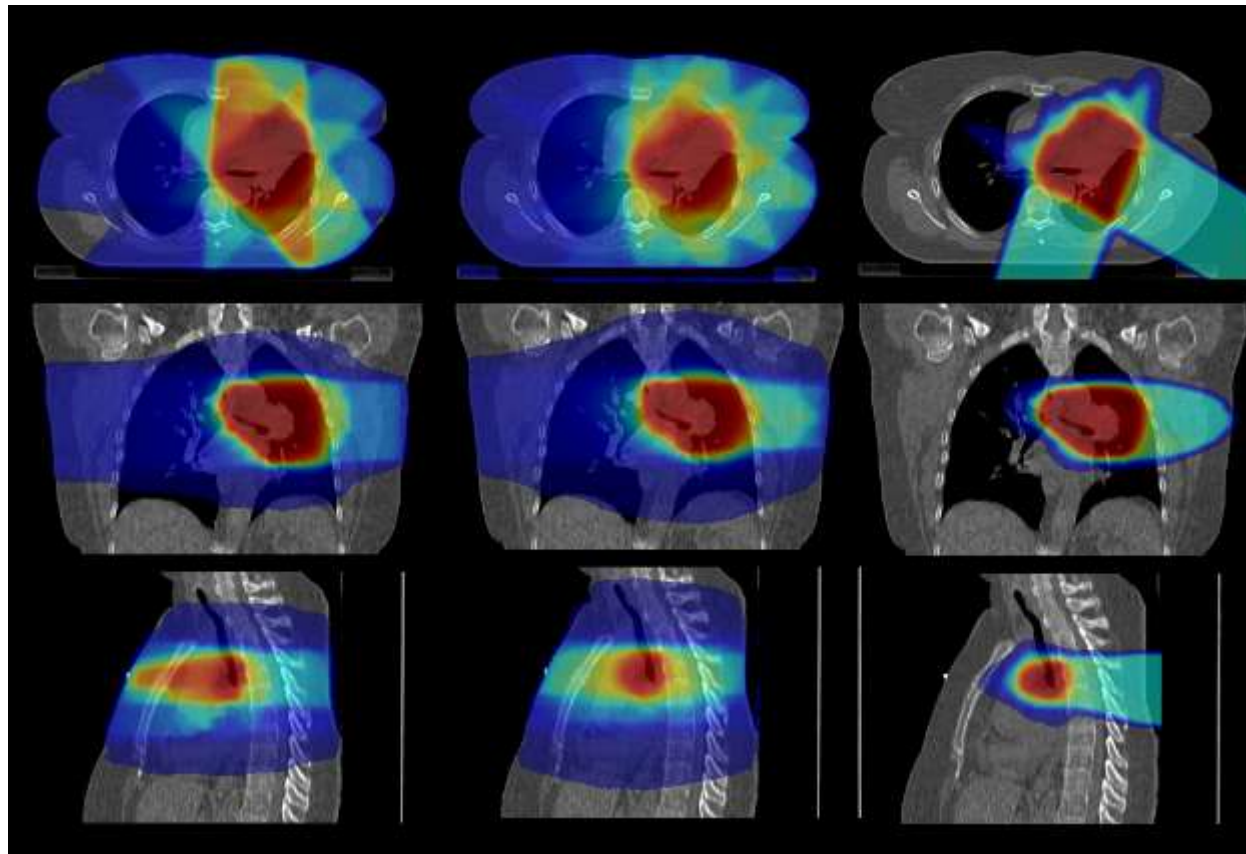
- Spinal cord: max. < 54Gy
- Lungs: MLD < 19 Gy
- Oesophagus: max. < 80 Gy
- Heart: V60 < 33%
V45 < 67%
V40 < 100%

Results pat. nr. 12

3D-CRT

IMRT

3D-CPT

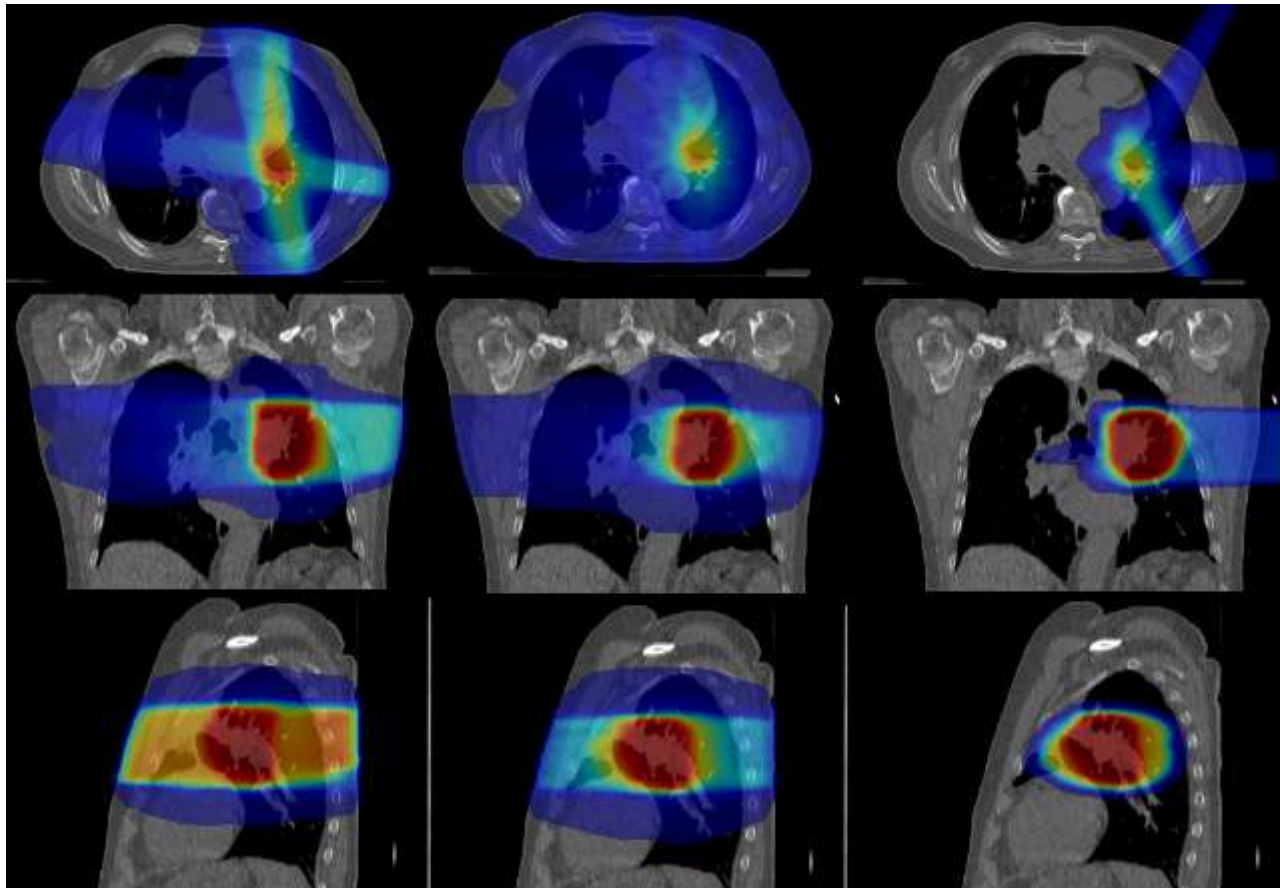


Results pat. nr. 32

3D-CRT

IMRT

3D-CPT



Max. tolerable dose

Modality	MTD [Gy]	Mean Dose [Gy]			Max Dose [Gy]		V40 [%]	V65 [%]
		CTV	MLD	Patient*	Spinal	Esophagu		
3D-CRT	62	63.2	14.9	8.3	38.2	57.4	10.2	1.1
IMRT	67	67.8	14.6	8.6	42.7	63.1	9.1	1.1
3D-CPT	64	64.6	11.1	5.6	34.5	60.6	6.5	1.6

- **Mostly limited by MLD**
- **Average < 19 Gy**
- **Room for escalation**

Escalation

Modality	Mean Dose [Gy]			Max Dose [Gy]			TI (MTD/MLD)
	CTV	MLD	Patient	Spinal Cord	Esophagus	Heart	
3D-CRT	95	15	8	27	60	45	6
IMRT*	93	14	8	39	66	36	7
3D-CPT	102	10	4	22	61	27	11

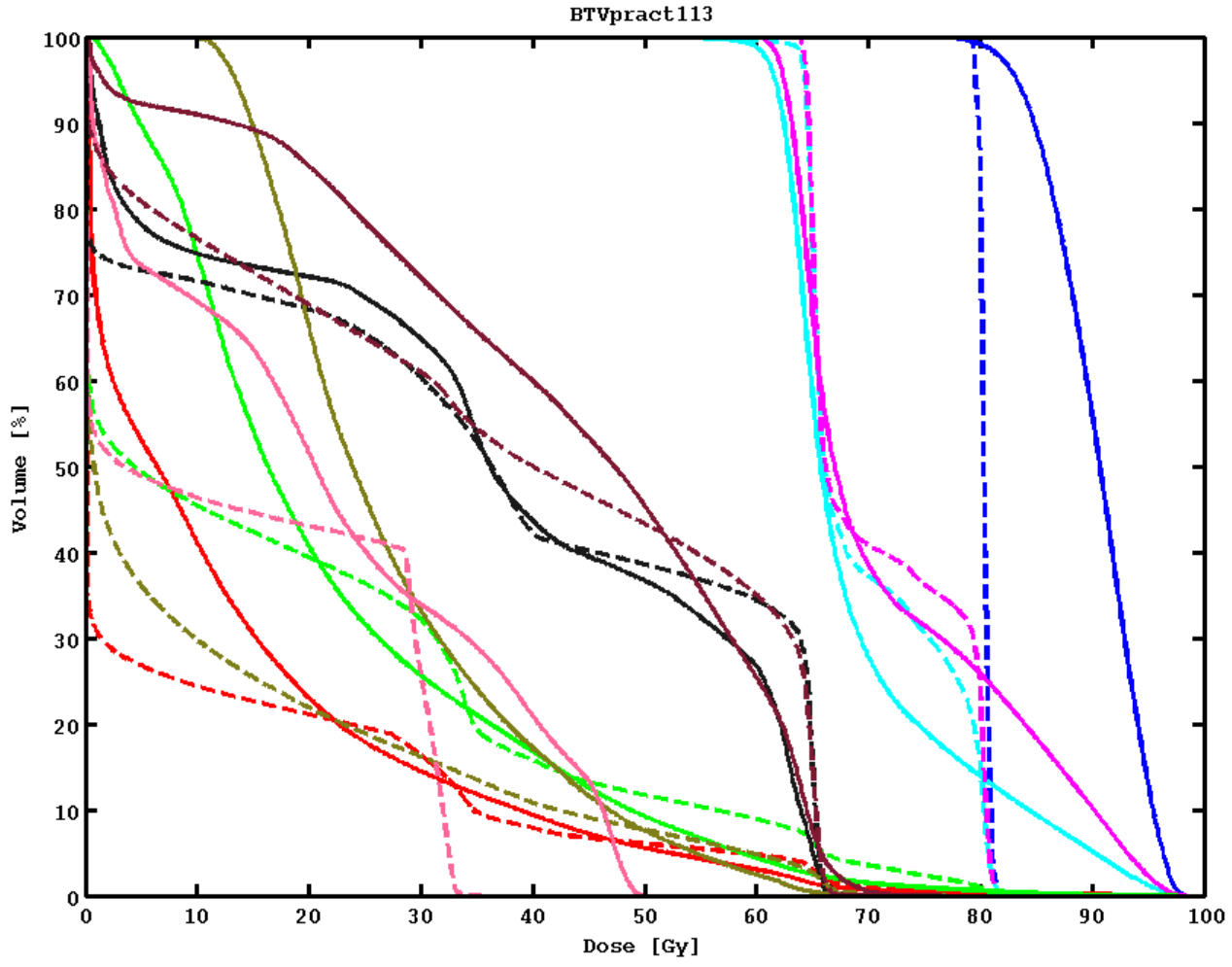
* results rescaled

- **5 cases, stage IIA-III B**
- **max 163 Gy (EQD₂)**
- **escalation to entire PTV**

Subboosting

- explorative: (tip of the) toe in the water
- 5 new datasets
- IMRT vs 3D-CPT
- subboosting on high uptake on PET

Subboosting

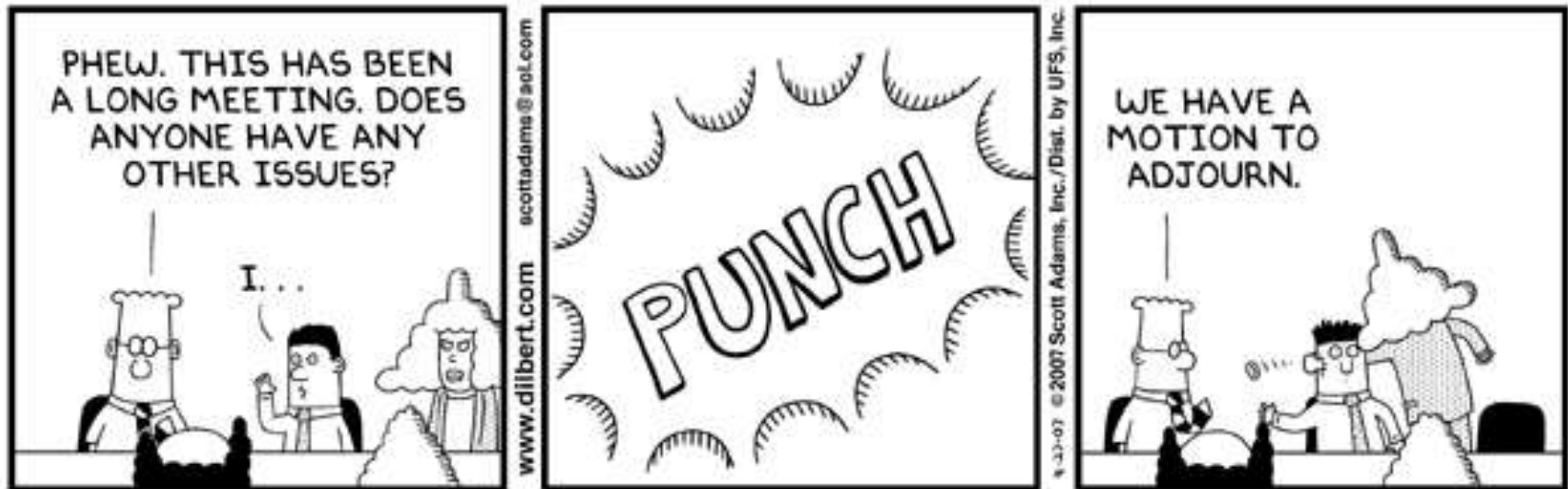


PRV (MST, MGH)	
mean :	42.21 37.27
min. :	0.04 0.00
max. :	73.18 76.32
Spinal cord (MST, MGH)	
mean :	21.22 13.40
min. :	0.18 0.00
max. :	49.79 35.25
Heart (MST, MGH)	
mean :	27.66 11.41
min. :	8.38 0.00
max. :	71.45 76.71
Esophagus (MST, MGH)	
mean :	35.07 34.54
min. :	0.21 0.00
max. :	68.36 66.85
MLD (MST, MGH)	
mean :	21.91 18.04
min. :	0.46 0.00
max. :	97.50 82.51
CTVs (MST, MGH)	
mean :	71.90 70.84
min. :	57.69 62.51
max. :	98.21 82.01
PTVtot (MST, MGH)	
mean :	68.95 70.03
min. :	45.80 43.95
max. :	98.23 82.41
PTVhigh (MST, MGH)	
mean :	89.96 80.28
min. :	73.46 78.60
max. :	98.22 82.02
Patient (MST, MGH)	
mean :	12.90 9.58
min. :	0.00 0.00
max. :	98.09 82.43

Conclusions

- Dose escalation was best with protons
 - highest MTD
 - lowest MLD
 - highest therapeutic index (MTD/MLD)
 - lowest integral dose
- Subboosting not possible without a robust pencil beam solution

Thank you for your attention!



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More info online: <http://rococo.mistir.info>

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