

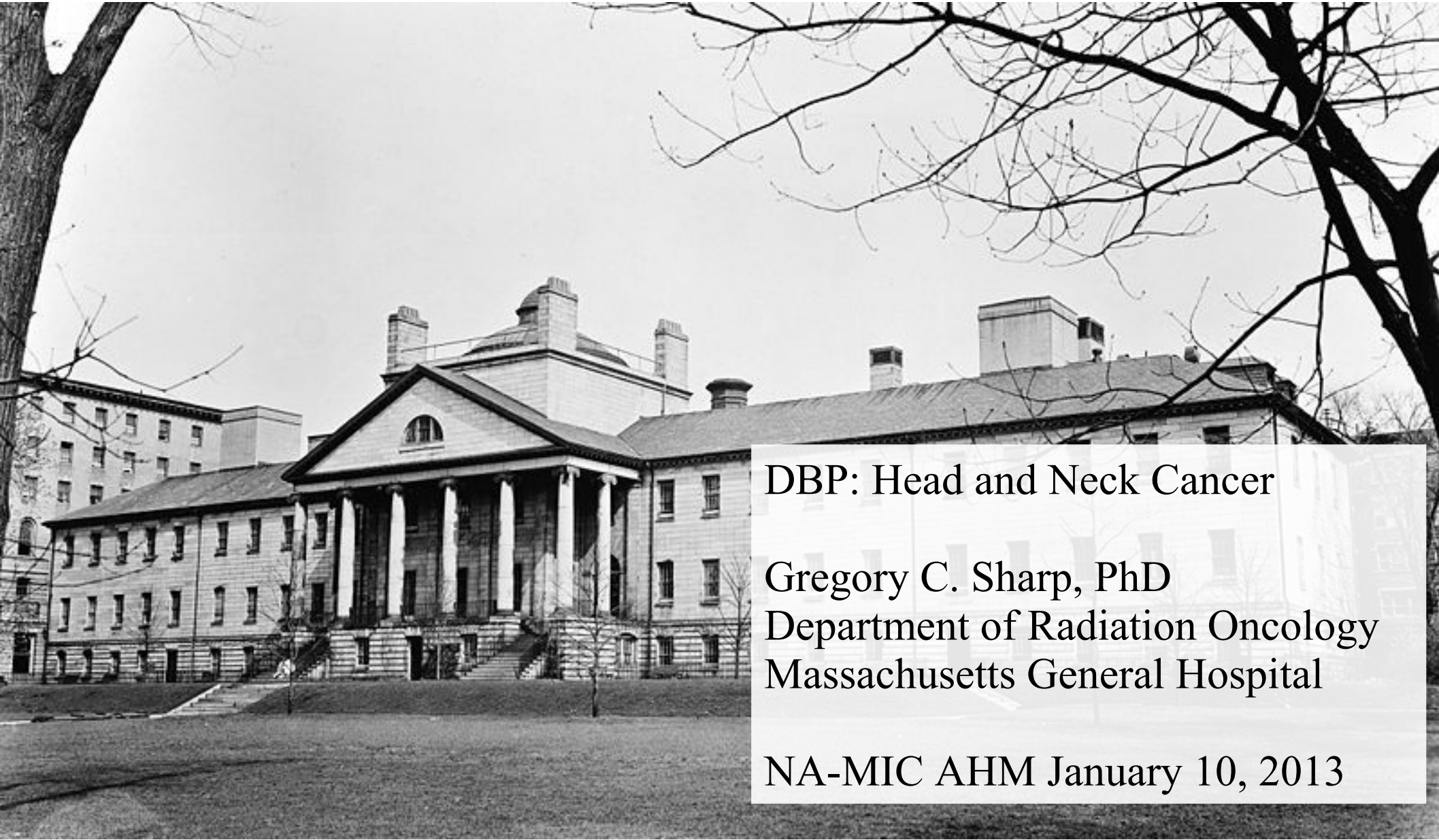


MASSACHUSETTS  
GENERAL HOSPITAL

RADIATION ONCOLOGY



*National  
Alliance for  
Medical Image  
Computing*



DBP: Head and Neck Cancer

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Department of Radiation Oncology  
Massachusetts General Hospital

NA-MIC AHM January 10, 2013

# Head & neck cancer: Statistics

- Between 4-6% of all new cancer cases
- About 60,000 new cases per year
- 60% present with advanced disease
- 5 year survival: 57%
- Multimodal treatment

# Head & neck cancer sites

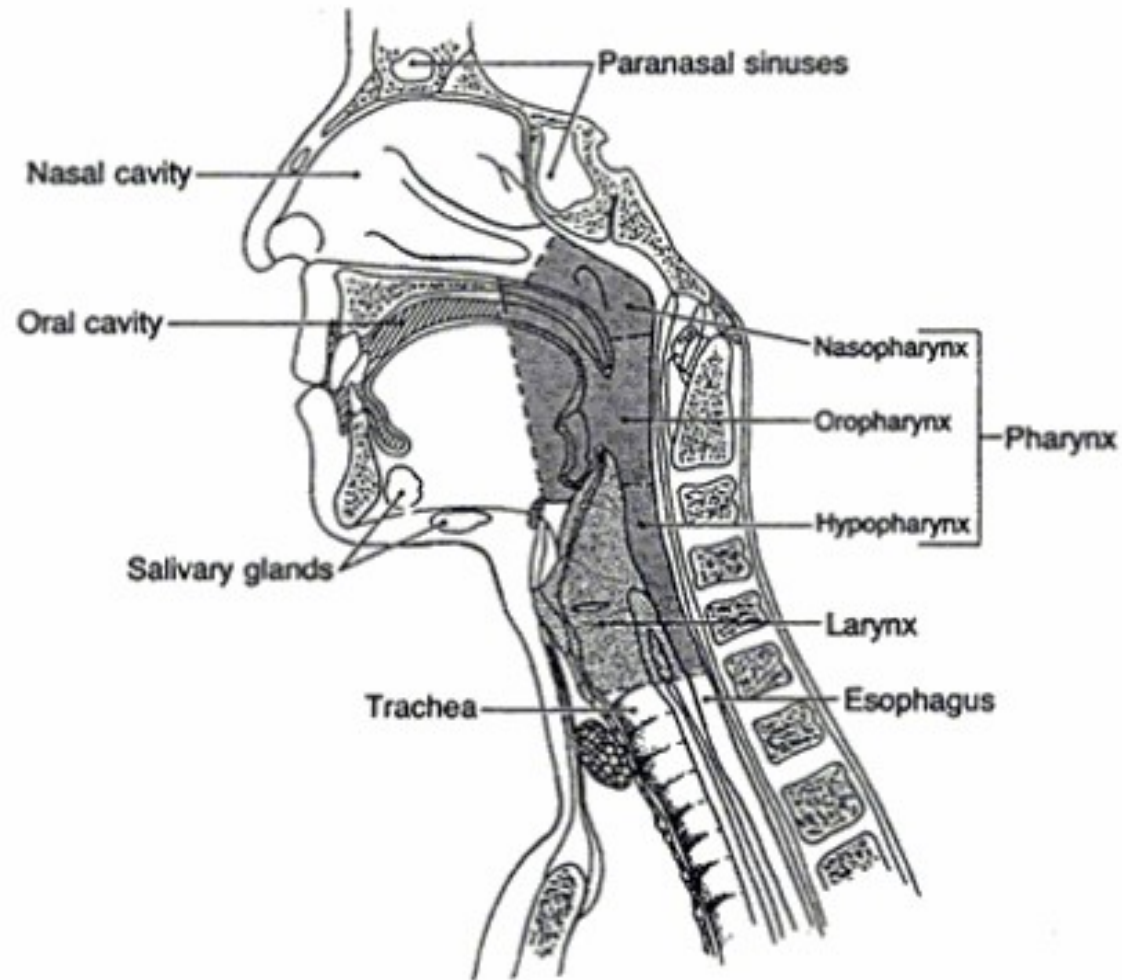
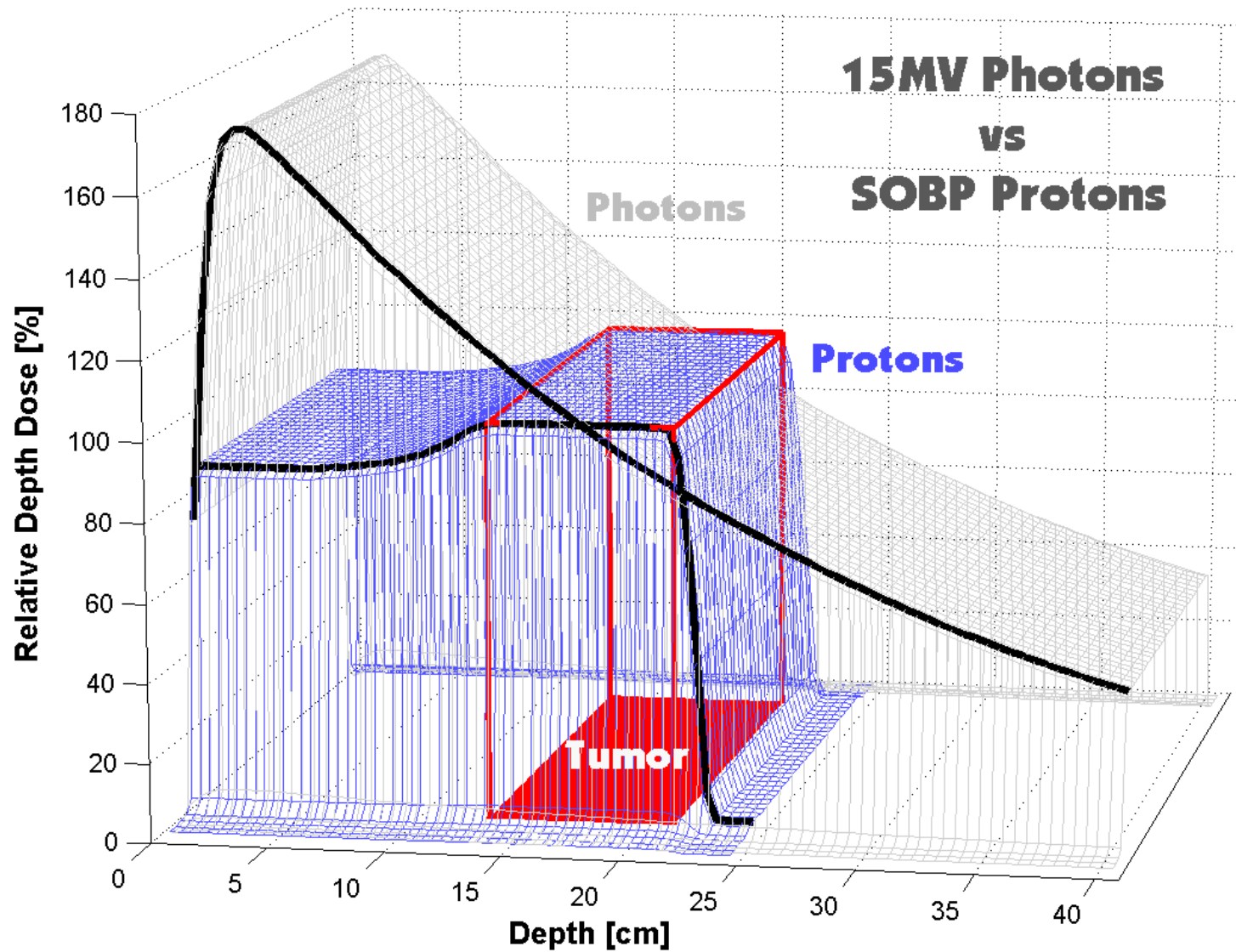


Image credit: American Cancer Society ([www.cancer.org](http://www.cancer.org))

# Proton therapy



# Proton therapy in the news...

THE WALL STREET JOURNAL.

## Costly Cancer Therapy Dinged

*Proton-Beam Treatment for Prostate Tumors No Better Than Radiation, Study Says*

CBSNEWS

**IMRT is best radiation for early prostate cancer, study finds**

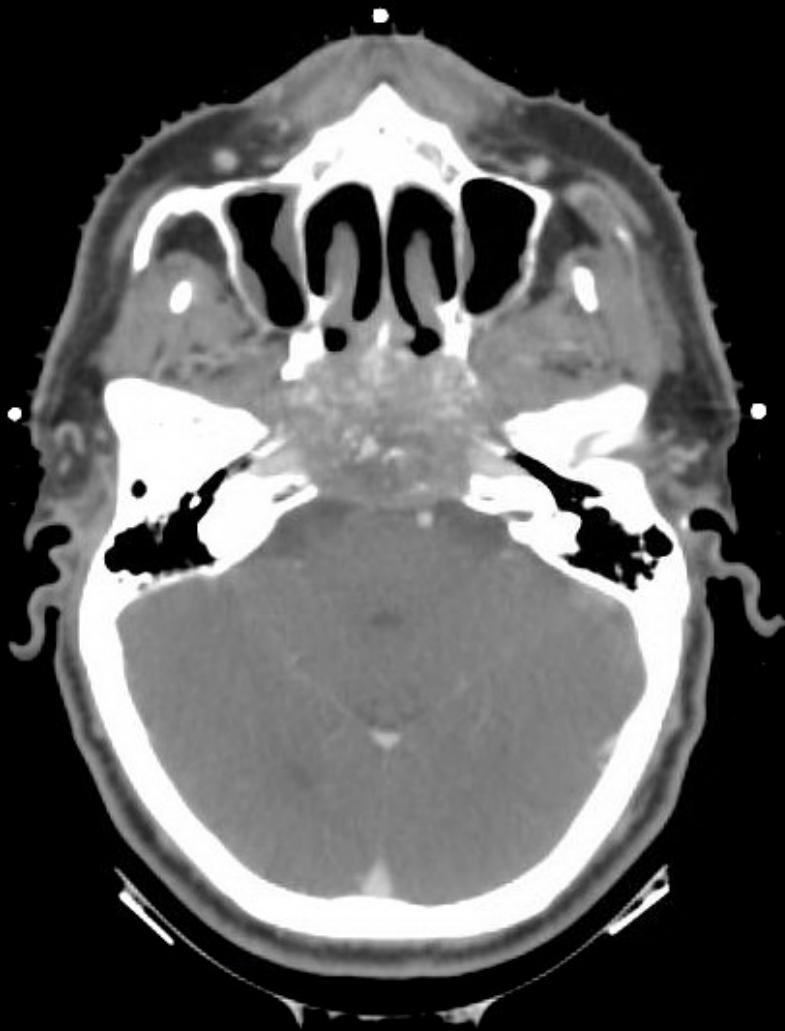
npr

Pricey Prostate Cancer Therapy Raises Questions About Safety, Cost

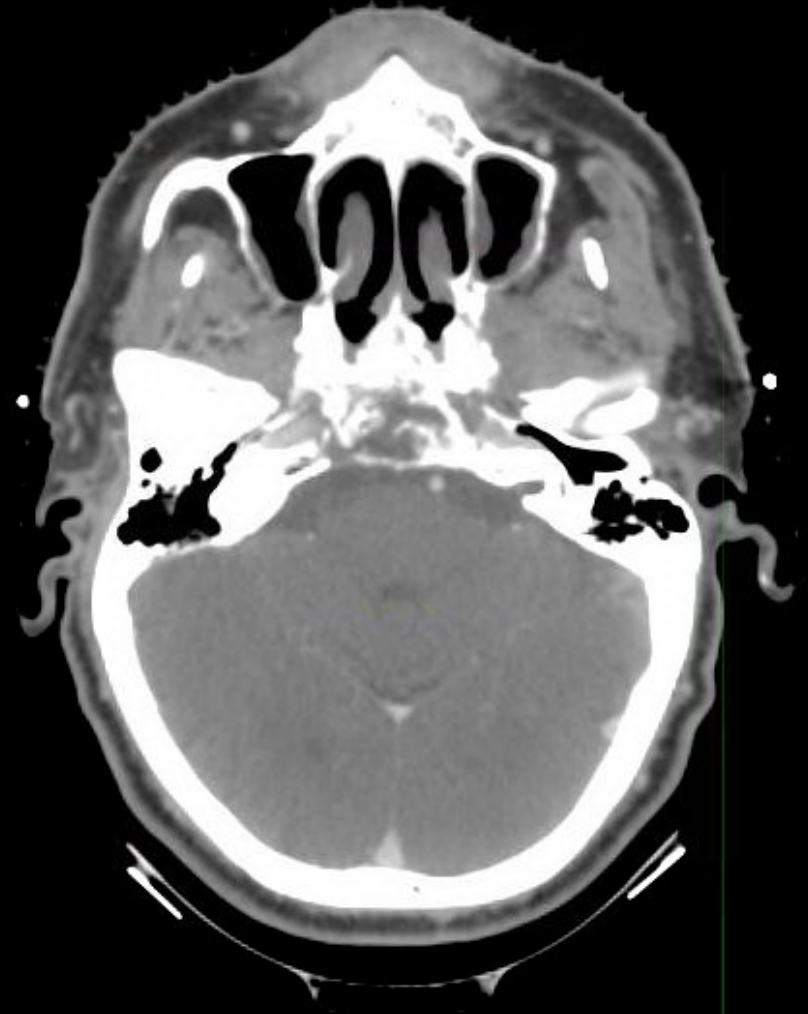
# Protons for sinonasal cancers

3D Protons	71.6 Gy, 88 % local control @ 6.6 yrs (Chan 2004) 65 Gy, 77 % local control @ 1 yr (Zenda 2011)
IMRT	63 Gy, 62 % local control @ 5 yrs (Hoppe 2006) 66 Gy, 64 % local control @ 2 yrs (Wiegner 2012)

# Rationale for adaptive radiotherapy

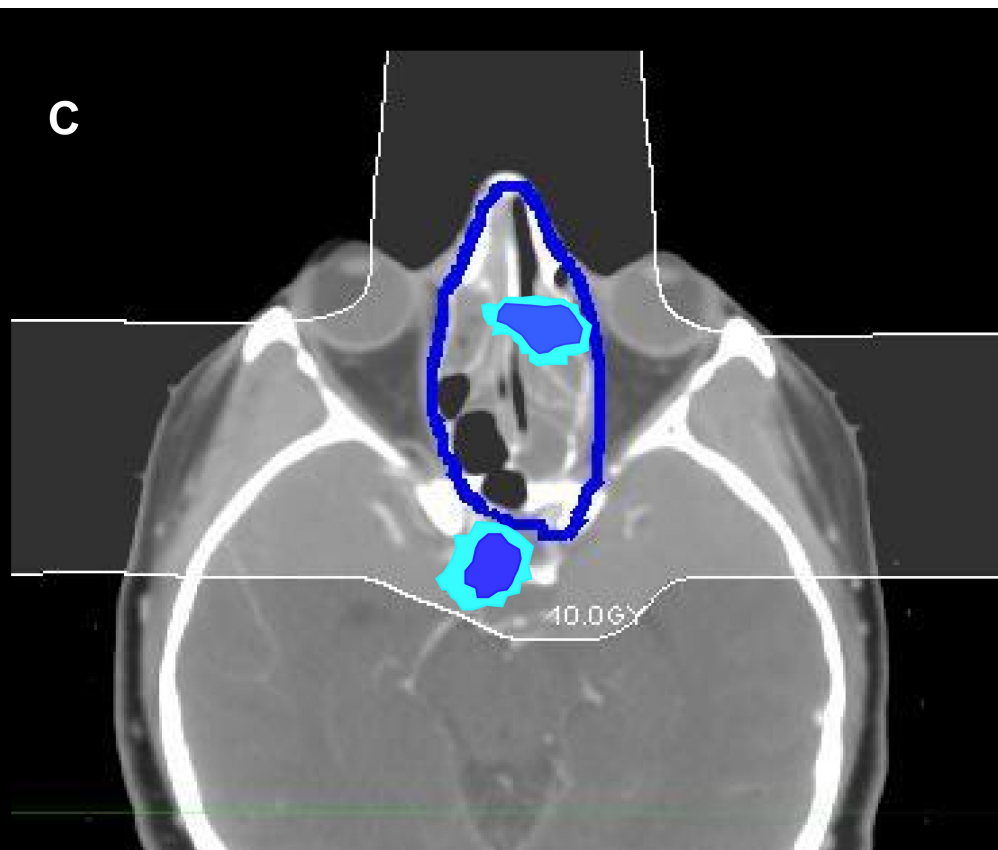
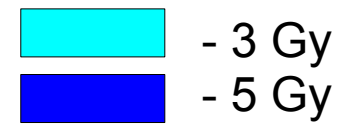


L R

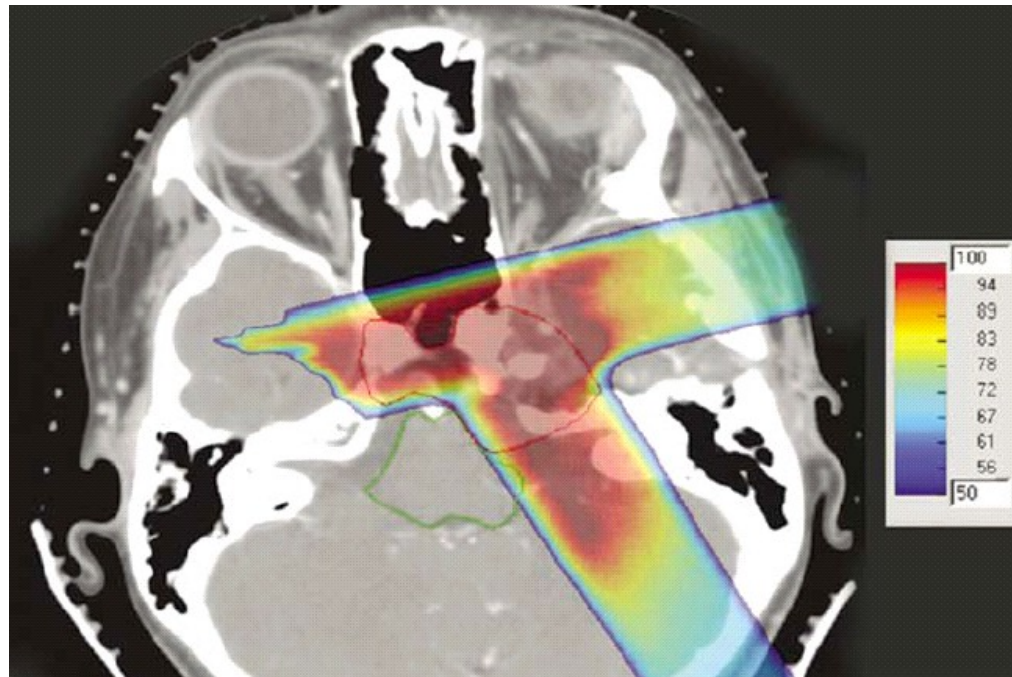
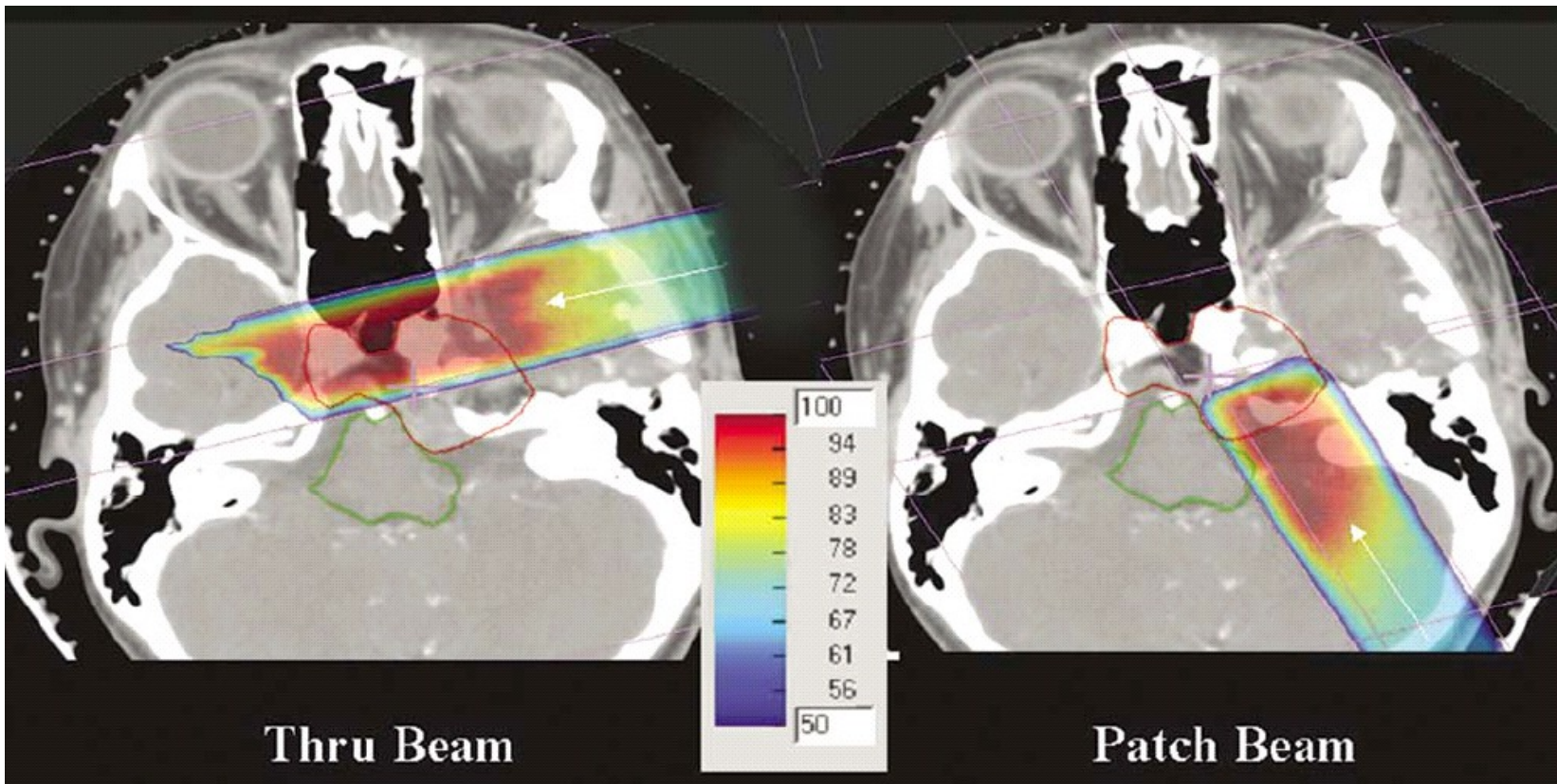


# Findings during 2012

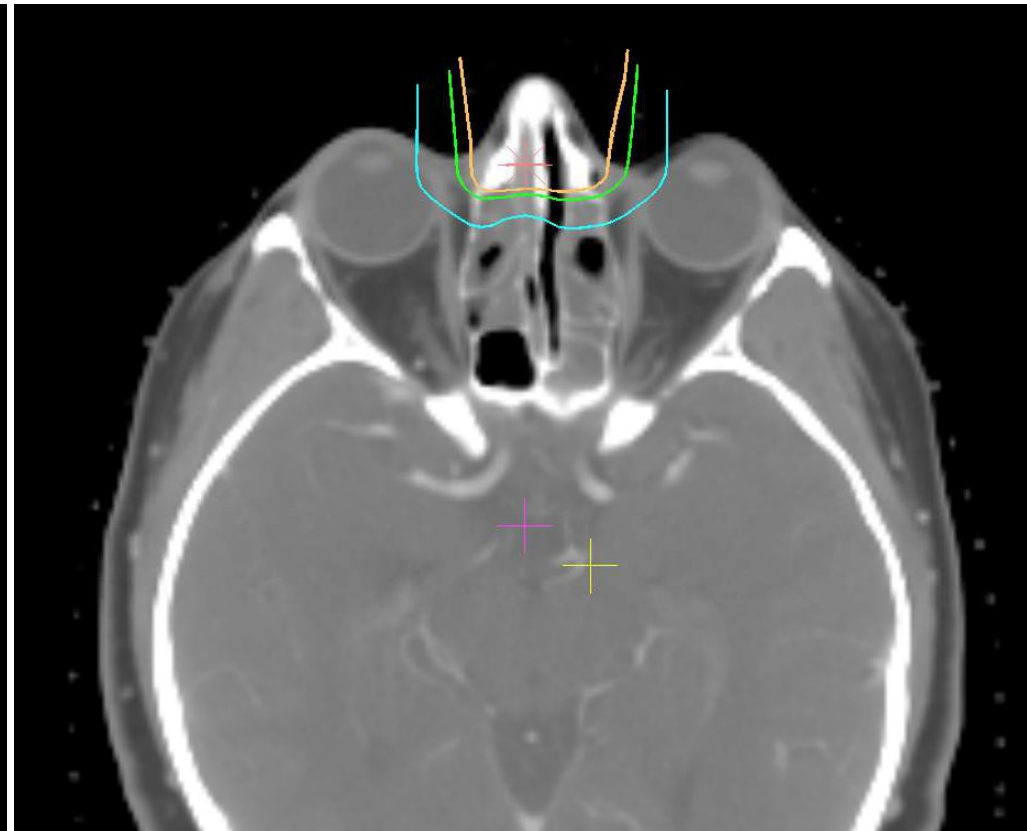
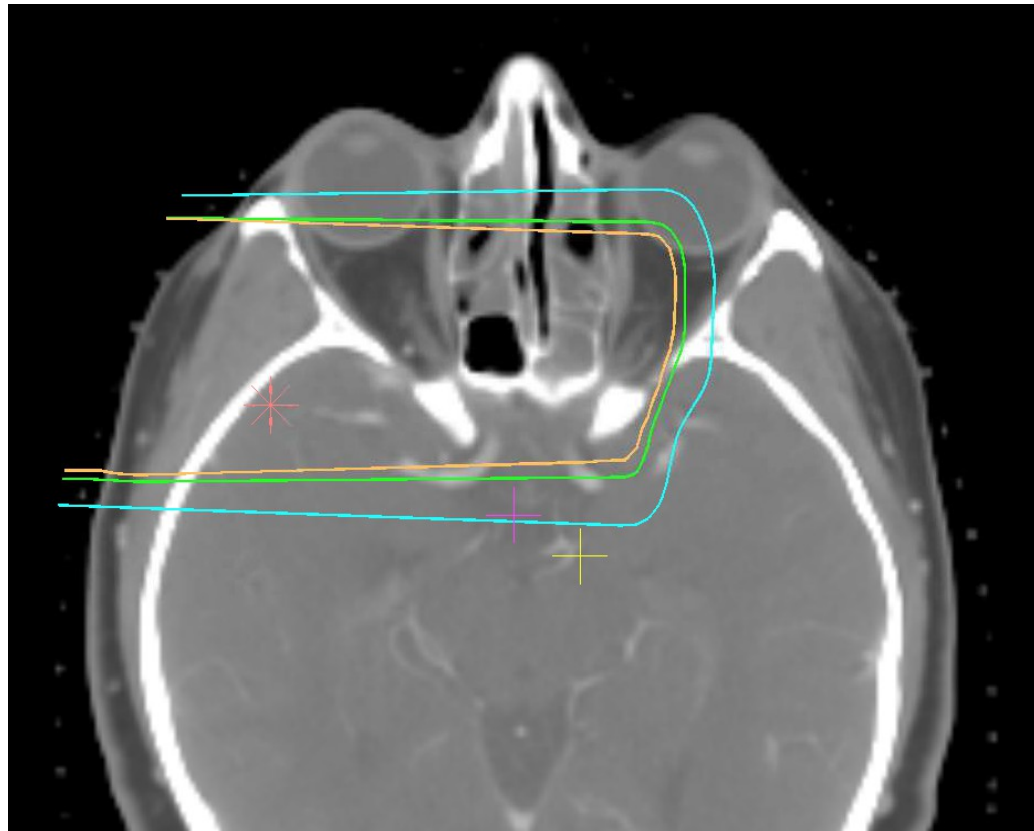
- Hot & cold spots in tumor



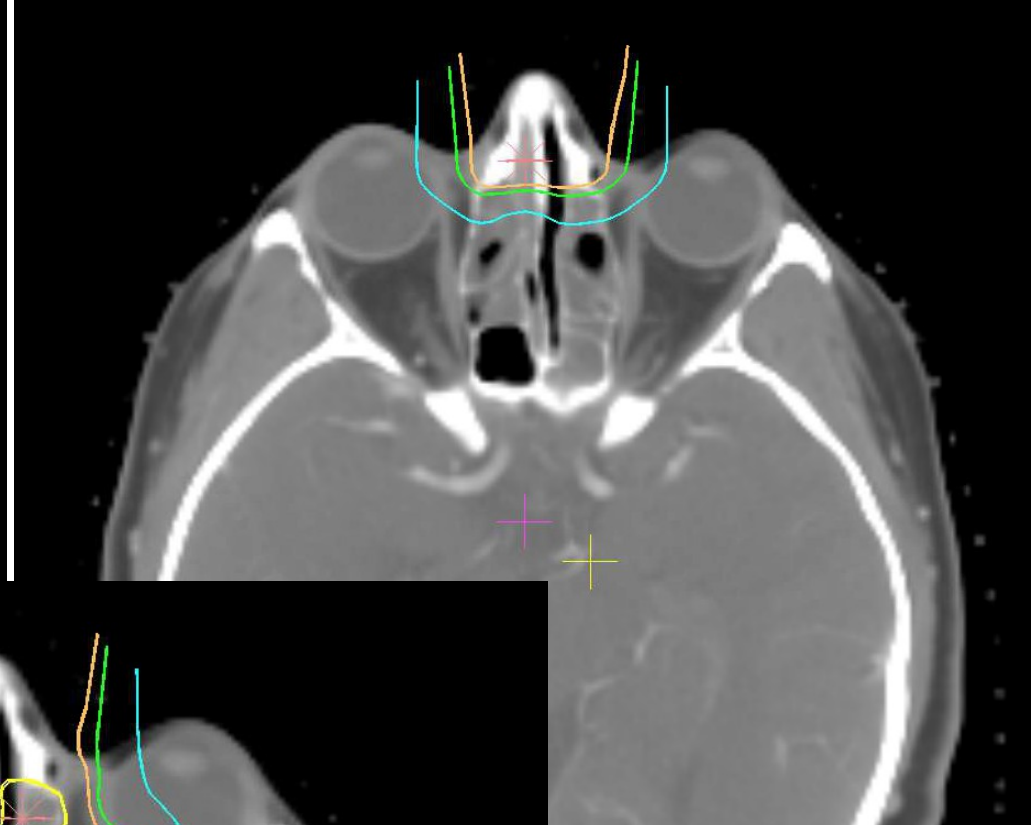
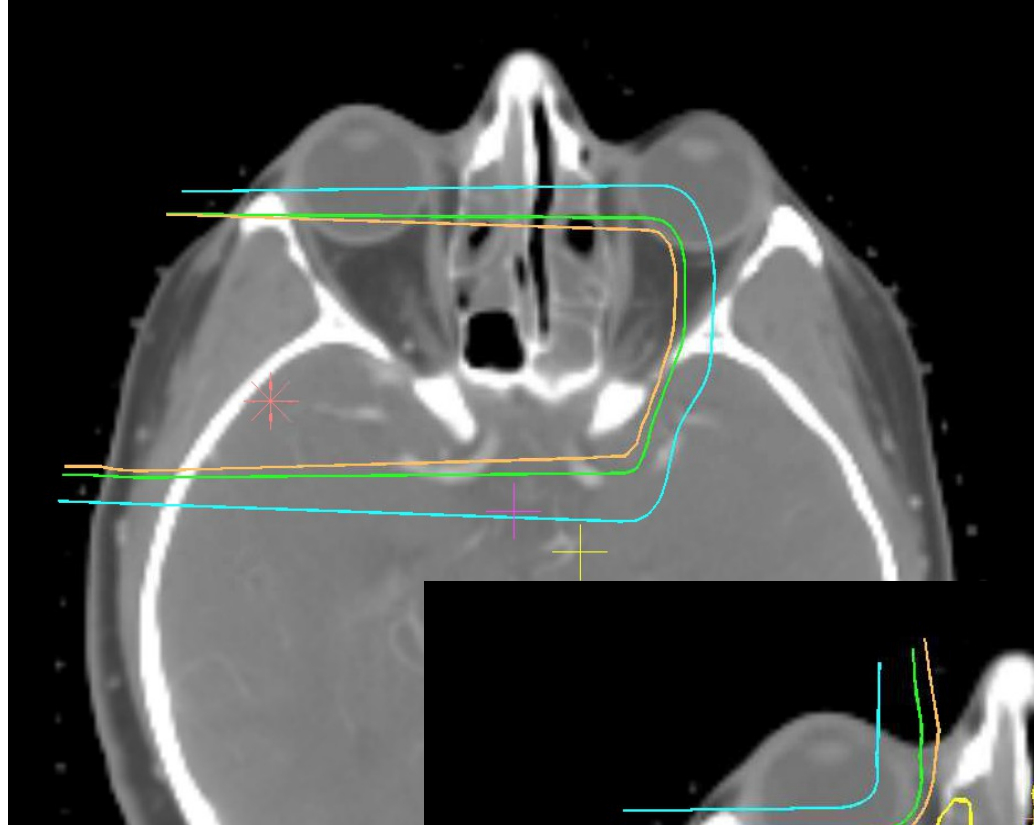




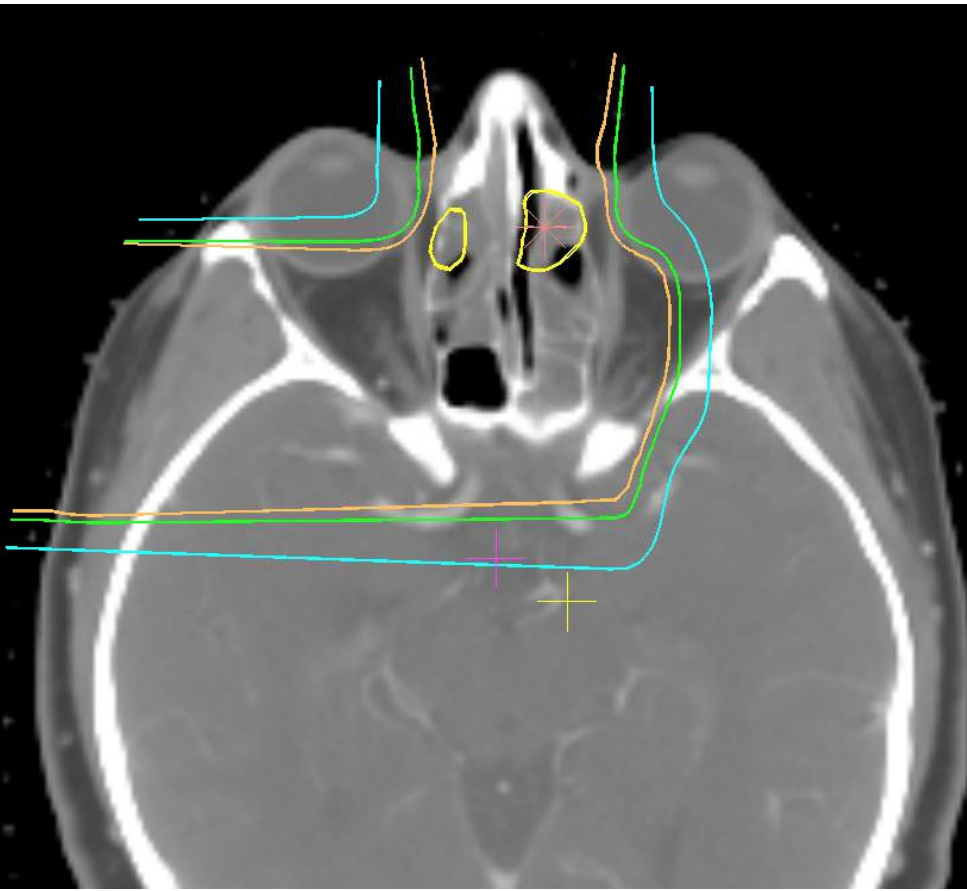
# Patching



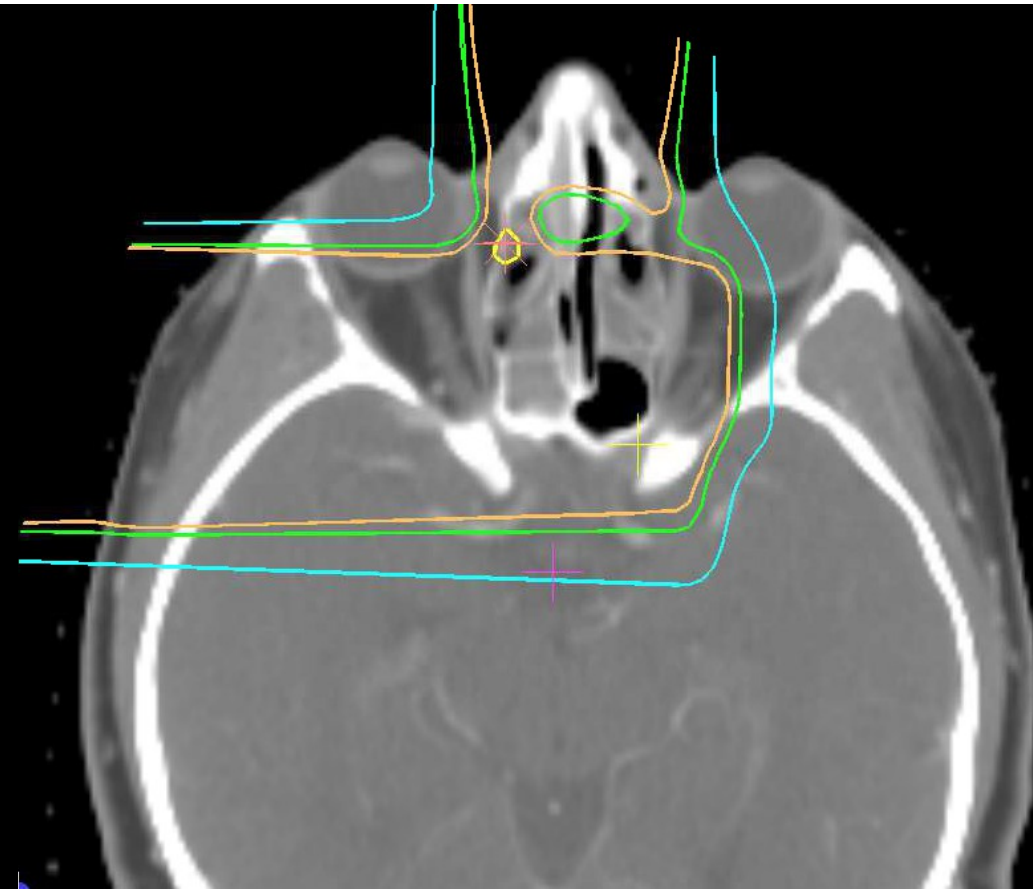
- 50%
- 90%
- 100%



# Patching

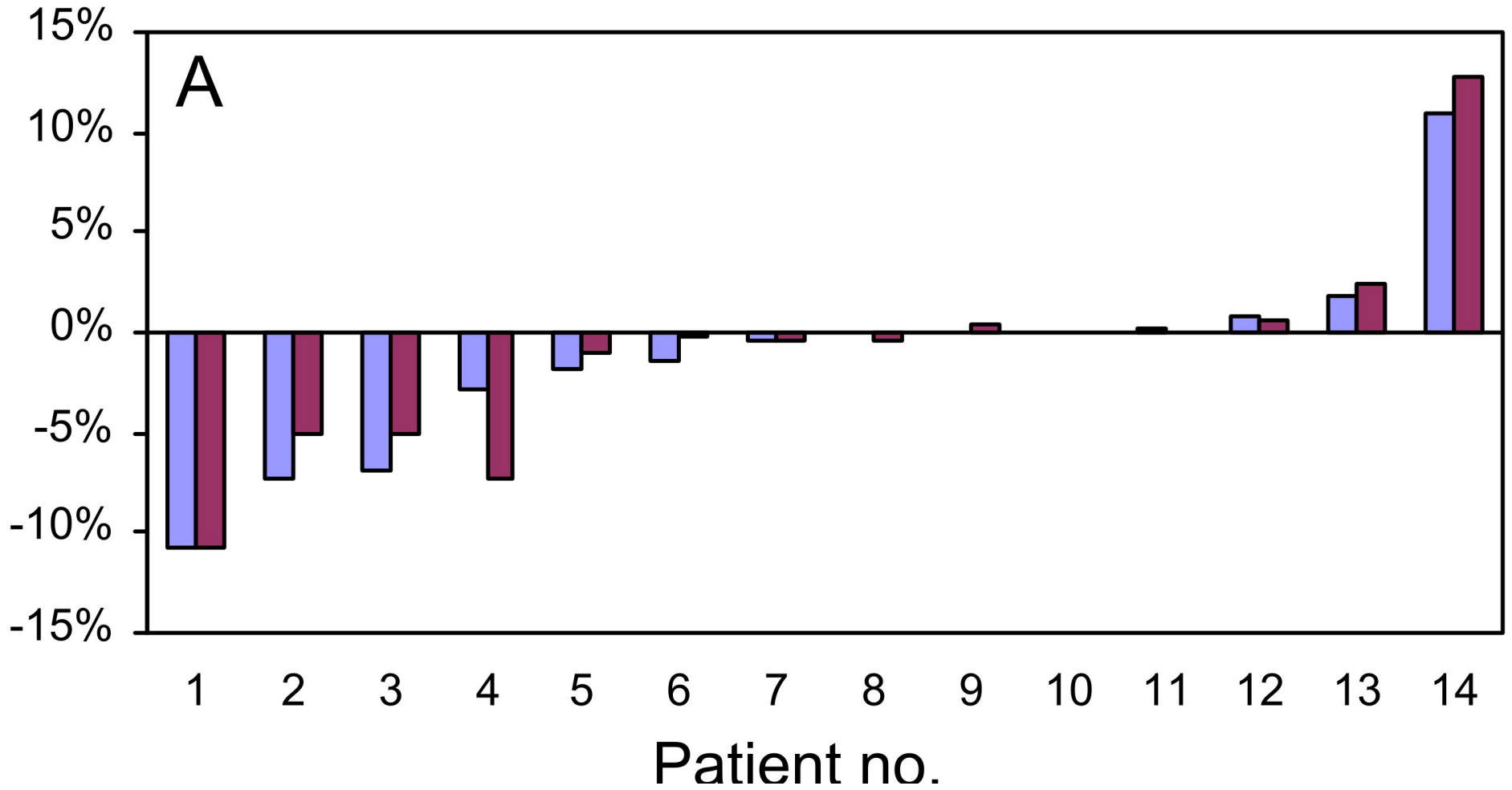


Pre-treatment

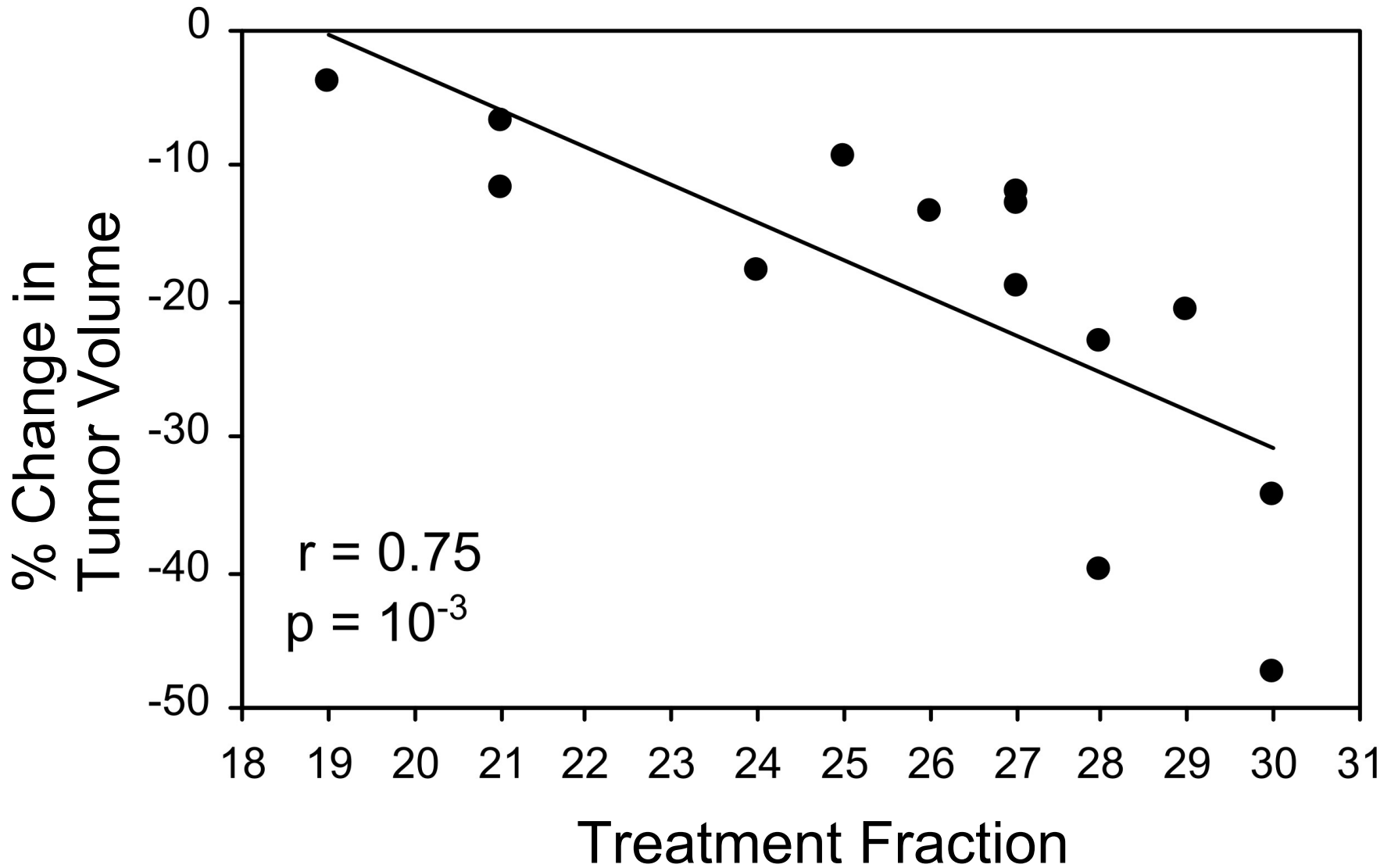


Mid-treatment

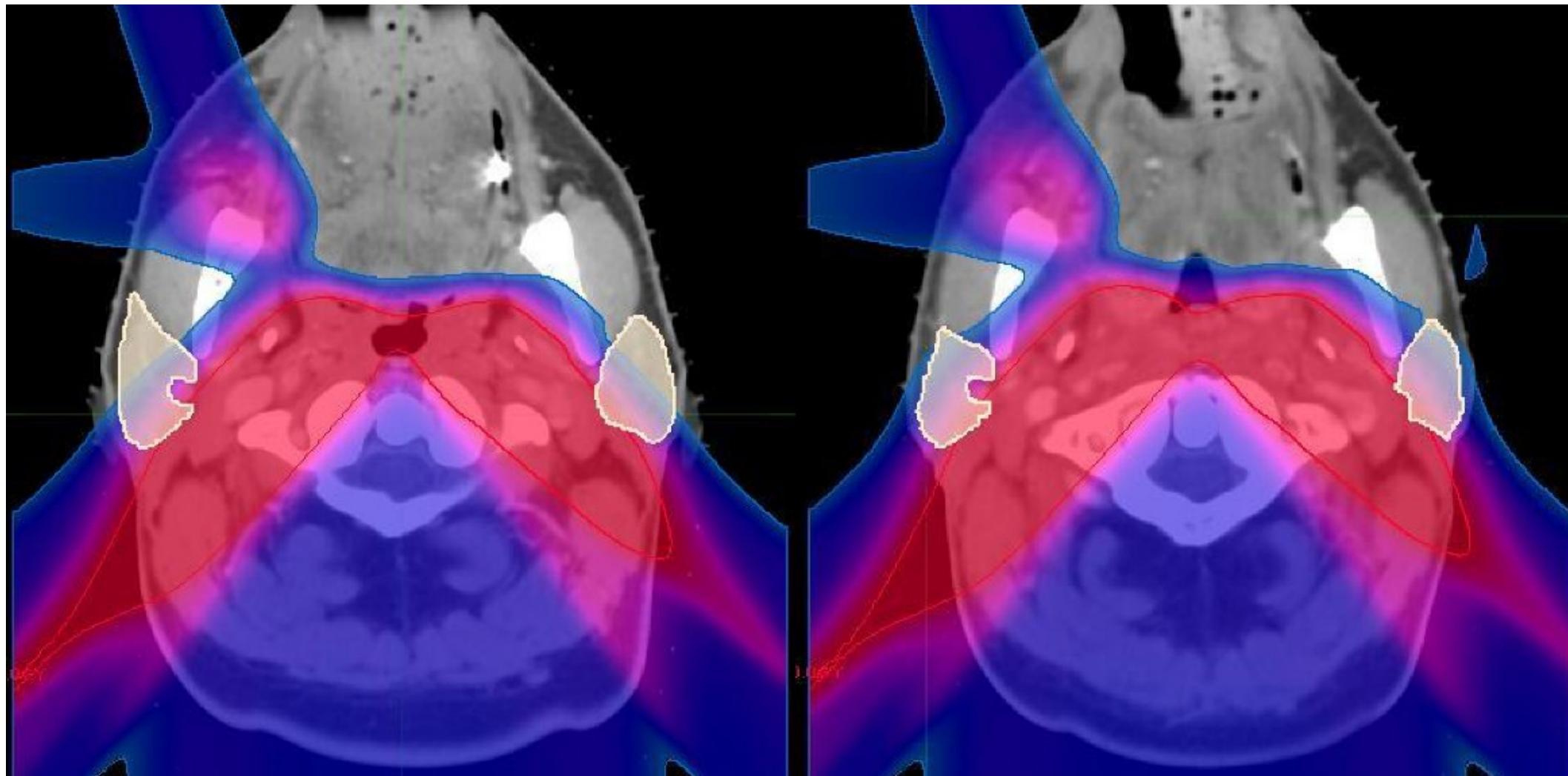
# Change of mean dose to CTV and GTV



# Progressive change



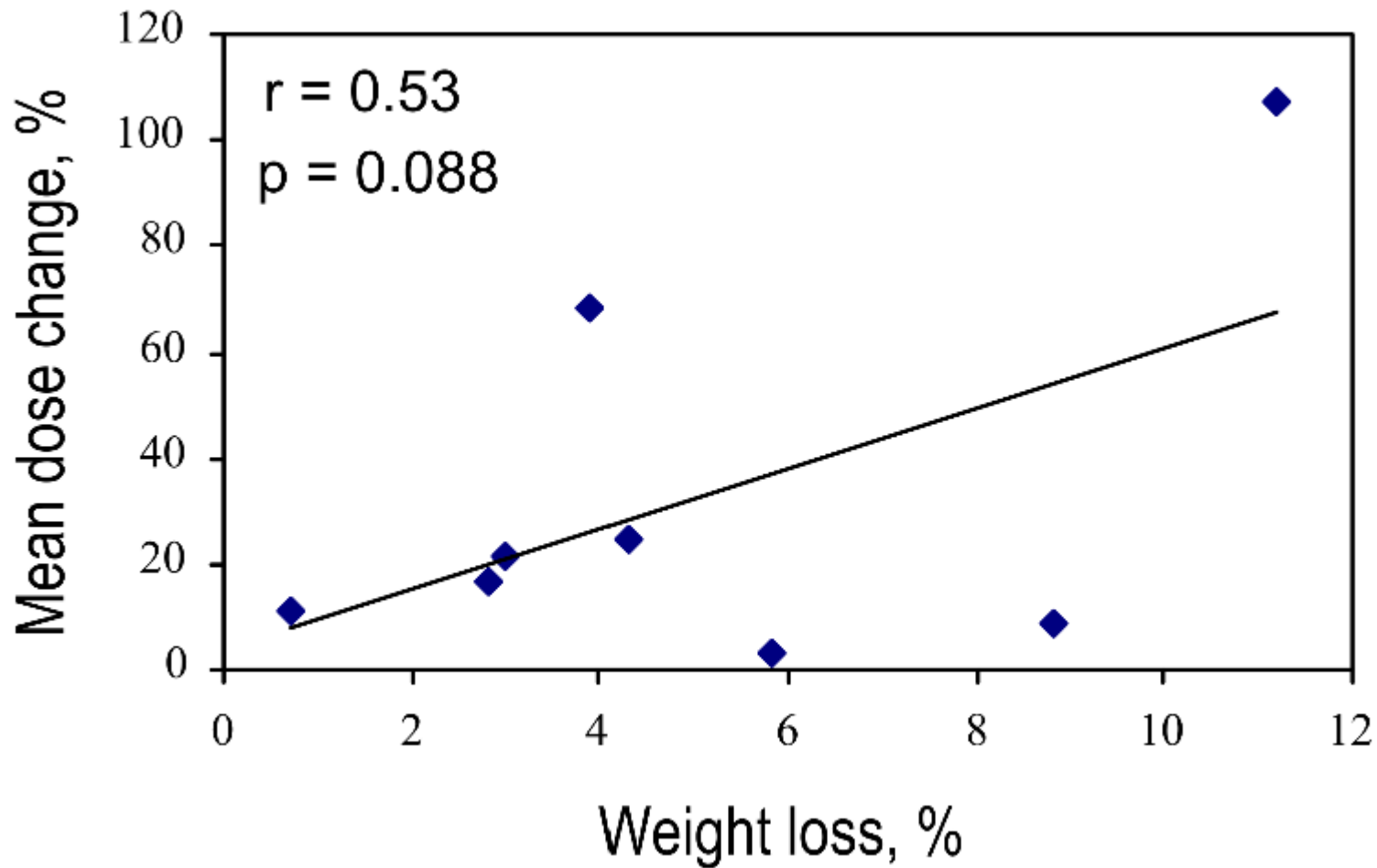
# Change in parotids



Pre-treatment

Mid-treatment

# Progressive change





# Plan for year 4

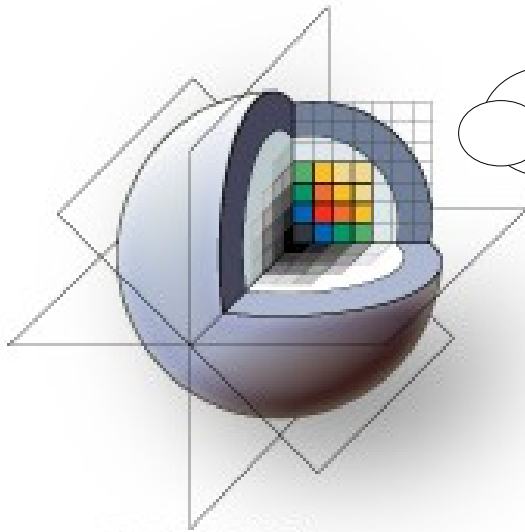
- Hybrid registration
- Atlas-based segmentation
- DICOM-RT improvements
- DIR validation suite
- Dissemination and training

# Hybrid registration

Problem Type	3D Slicer Module	Algorithm
Fully Automatic	BRAINS, plastimatch, HAMMER, ...	B-Spline, demons, etc.
Hybrid	?	?
Fully Manual	LANDWARP	Thin-plate spline, Wendland spline, Gaussian spline

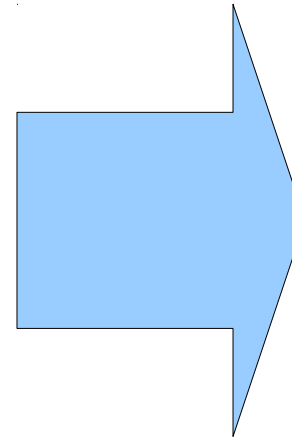
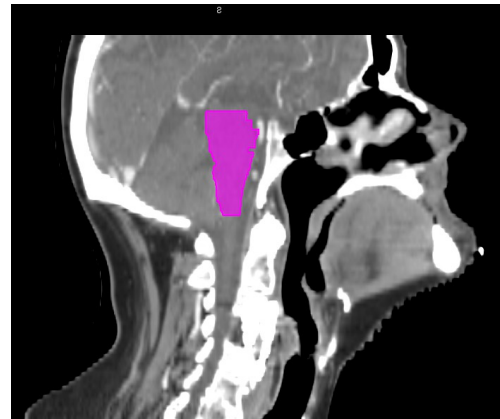
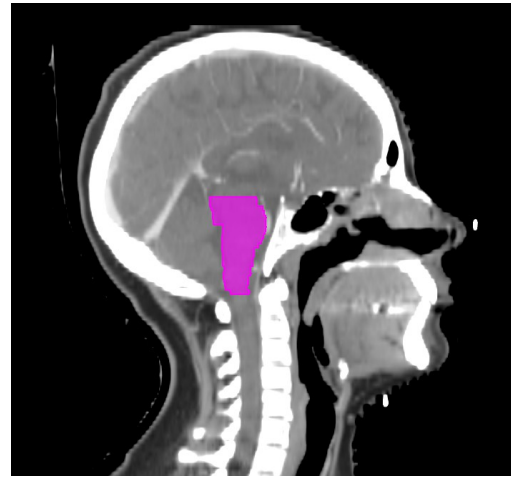
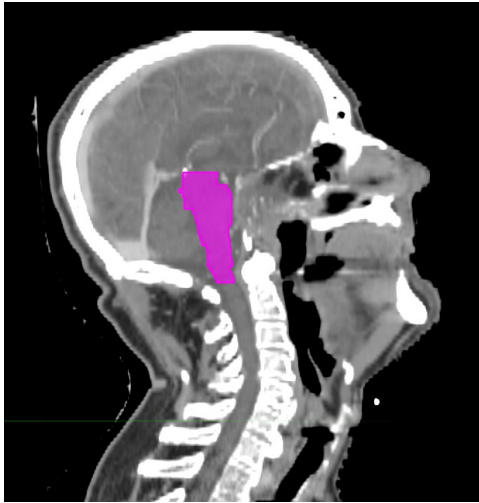
# Hybrid registration

Cost = image metric  
+  $\lambda$  landmark metric  
+  $\rho$  regularization metric



3DSlicer

# Atlas-based segmentation



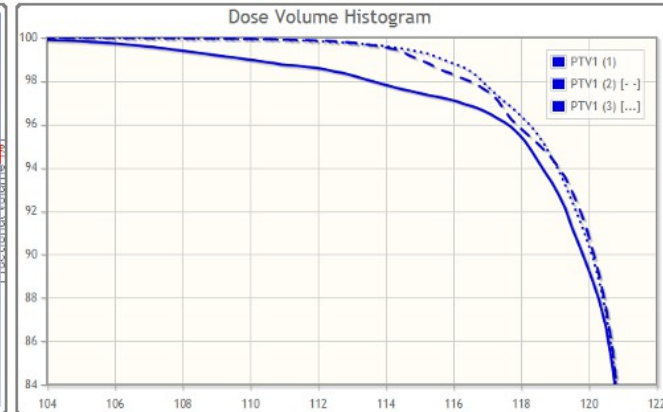
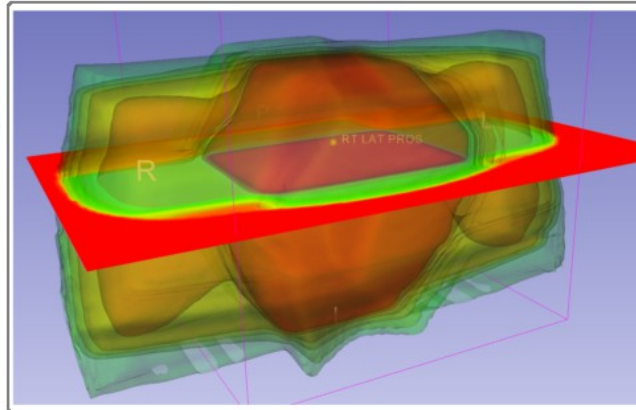
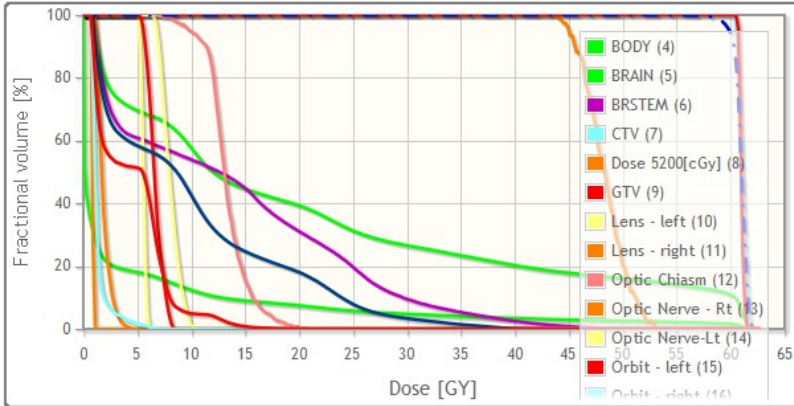
Peroni, Politecnico di Milano, 2012  
Arbisser, MIT, 2012

# Atlas-based segmentation

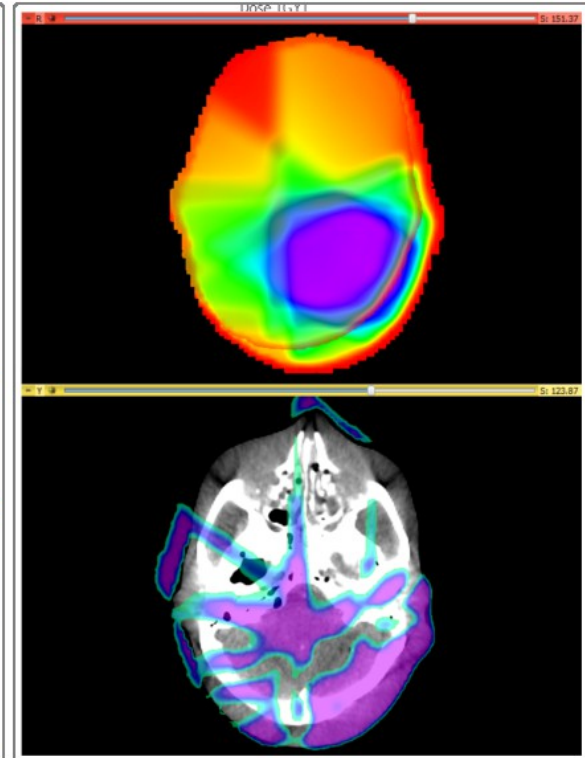
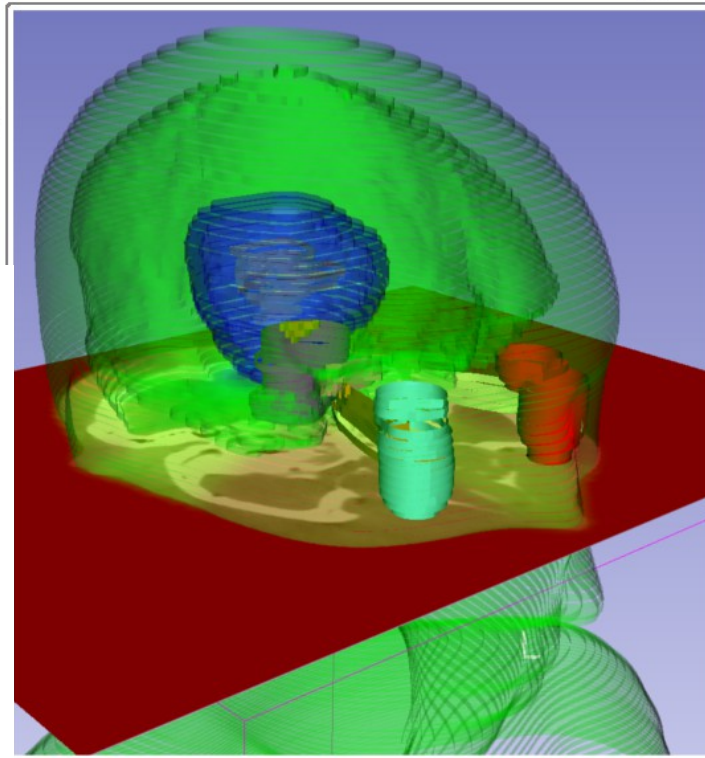
Structure	Overlap %	Overlap % (from literature)
Mandible	86 ( $\pm 4$ )	85-90 [X. Han et al., 2008] 78 $\pm$ 6 [R. Sims et al., 2009]
Spinal cord	81 ( $\pm 10$ )	70-80 [X. Han et al., 2008]
Left optical nerve	52 ( $\pm 11$ )	50 $\pm$ 17 [M. A. Deeley et al., 2011]
Left Eye	80 ( $\pm 6$ )	83 $\pm$ 9 [M. A. Deeley et al., 2011]
Left Parotid	70 ( $\pm 14$ )	85 $\pm$ 2 [Faggiano et al., 2011] 69 $\pm$ 9 [R. Sims et al., 2009]
Brainstem	77 ( $\pm 11$ )	83 $\pm$ 10 [M. A. Deeley et al., 2011] 58 $\pm$ 20 [R. Sims et al., 2009]

# DICOM-RT improvements

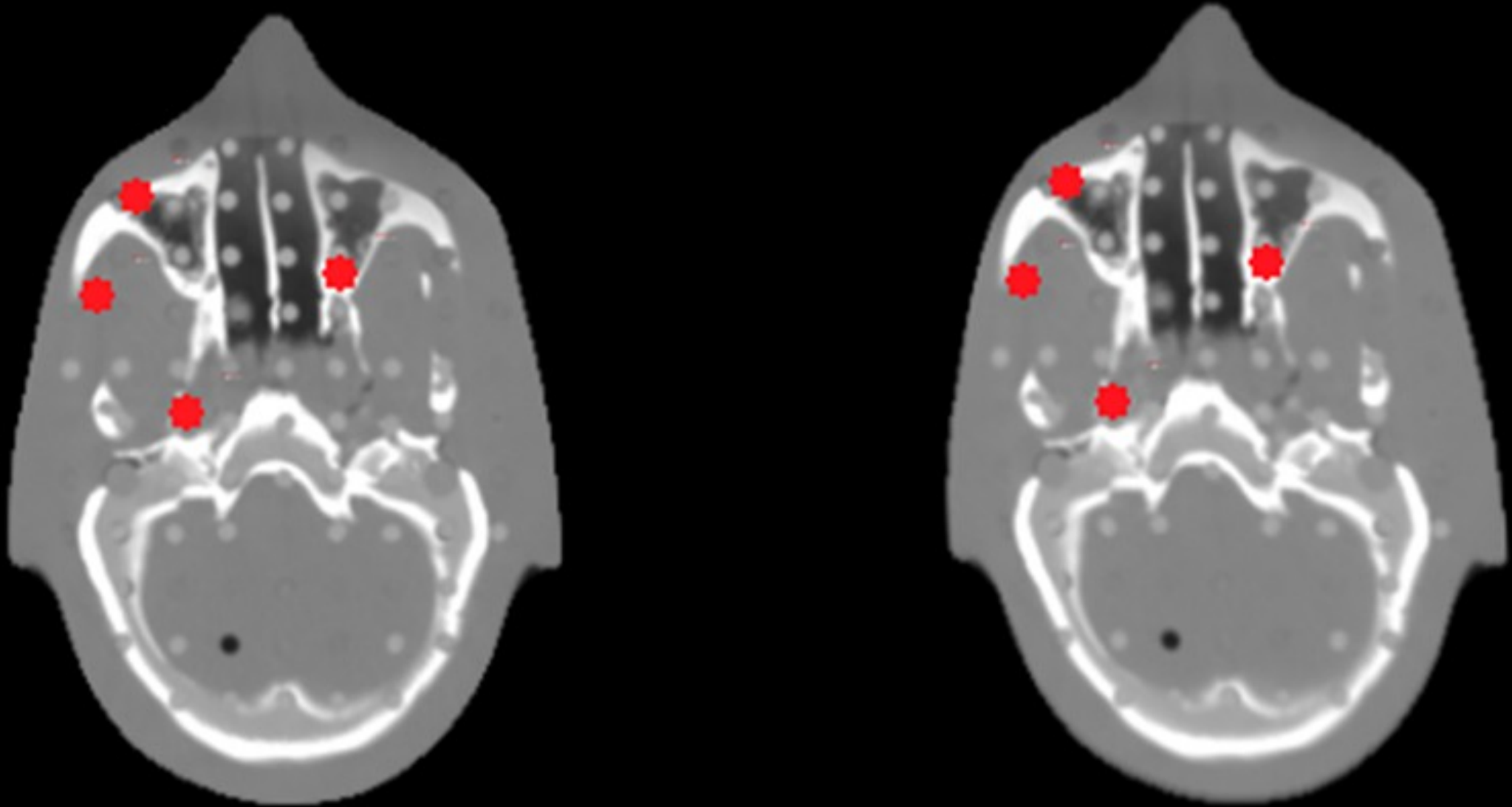
Structure	Volume name	Total volume (cc)	Mean dose (Gy)	Min dose (Gy)	Max dose (Gy)	V40 (%)	V50 (%)	V60 (%)	D90% (Gy)	D99% (Gy)	
1	PTV1	5: RTDOSE 1	126.957	60.9408	51.1546	62.6127	100.00	100.00	94.01	1.98	3.63
2	PTV1	5: RTDOSE 2	126.957	60.8105	49.3361	62.3971	100.00	99.99	90.55	2.15	5.21
3	PTV1	5: RTDOSE 3	126.957	59.6941	29.9264	62.3628	99.44	95.51	80.90	5.78	20.03



Name	Age	Scan	Date	Subject ID	Number	Institution	Referrer
TEST				TEST			
RANDO~PROSTATE				TEST PHYS PROS...			
RANDO~ENT				TEST PHYS ENT			
No description		CT	2011-09-20		1		
ENT IMRT			2011-09-20		0		
No description		RTSTRUCT					



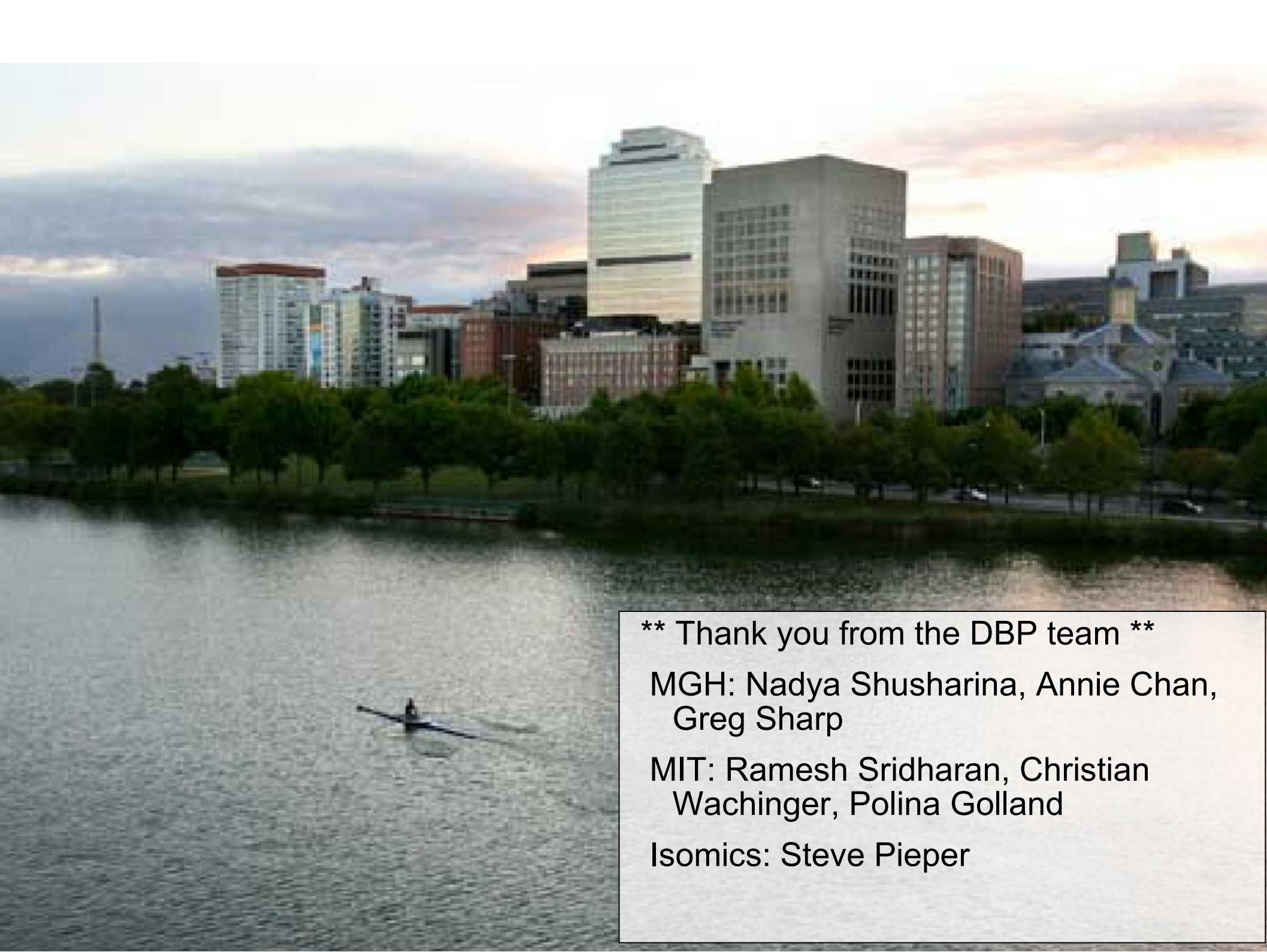
# DIR validation suite



# Dissemination and Training

- Documentation
- 3D Slicer user group at AAPM annual meeting
  - 2011, 2012, (2013, 2014)
- Module development training





**\*\* Thank you from the DBP team \*\***

**MGH: Nadya Shusharina, Annie Chan,  
Greg Sharp**

**MIT: Ramesh Sridharan, Christian  
Wachinger, Polina Golland**

**Isomics: Steve Pieper**