ACIBADEM

MR TABANLI TEDAVİLER: BİZE NE KAZANDIRDI?

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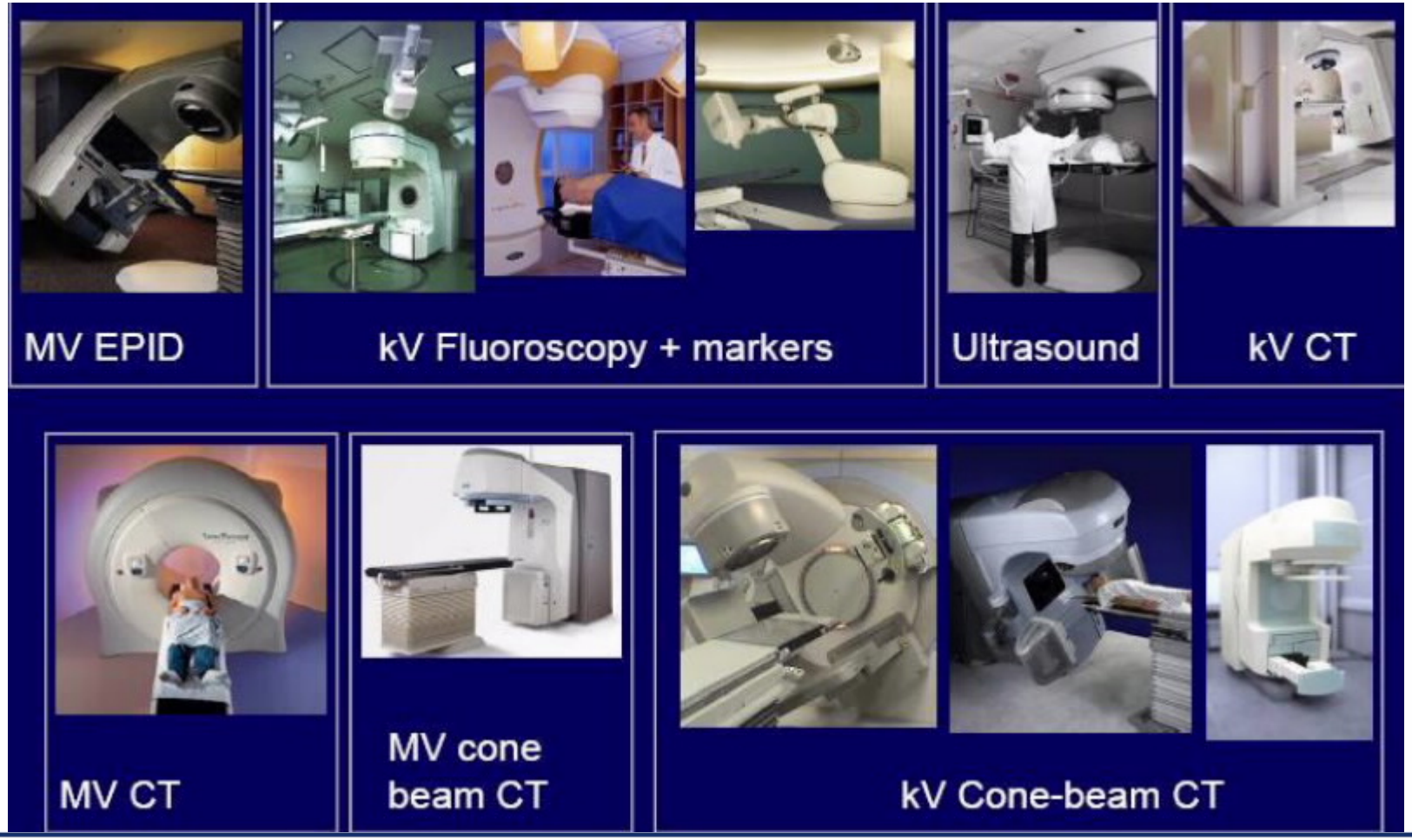
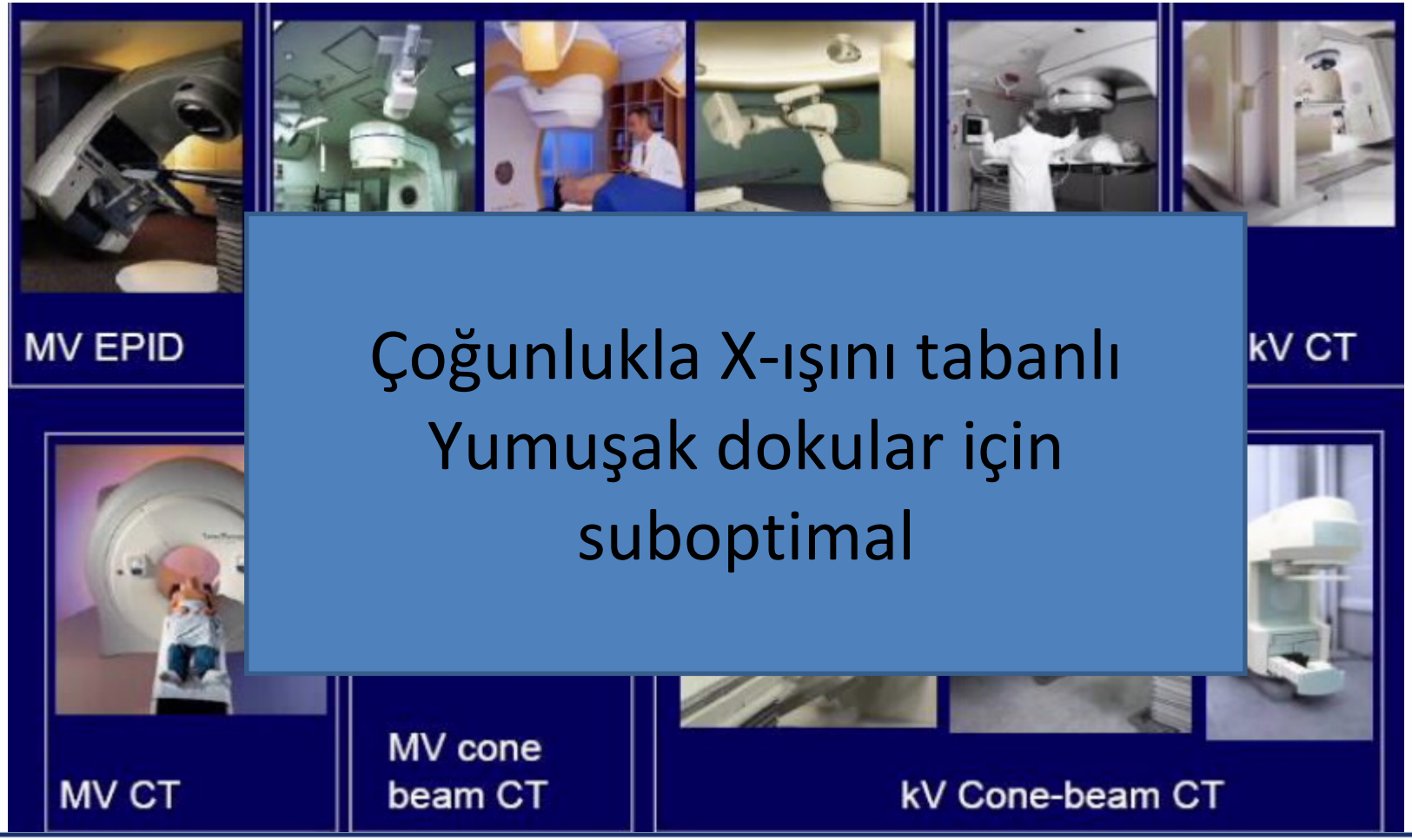
MR Kılavuzluğunda Tedavilerin getirdiği avantajlar

1. Görüntüleme
2. Adaptif Plan
3. Tümör takibi

IGRT Yöntemleri

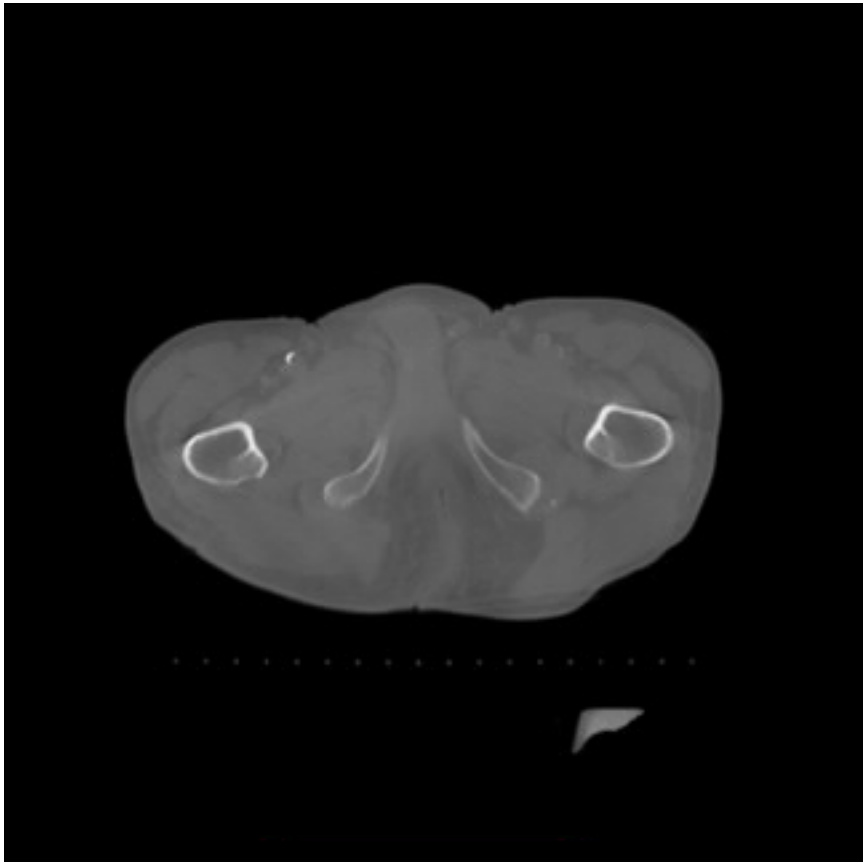


IGRT Yöntemleri



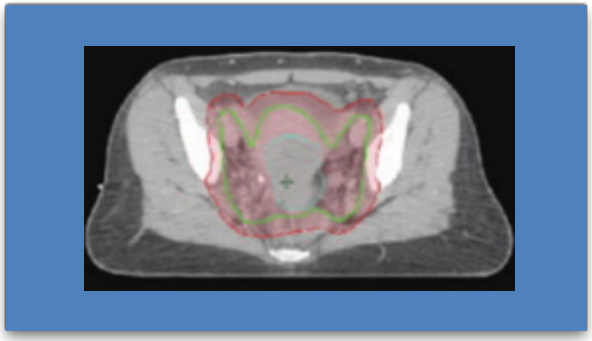
Çoğunlukla X-ışını tabanlı
Yumuşak dokular için suboptimal

MR öncesi en iyi IGRT yöntemi…



Hedefi tam görememenin telafisi

Sağlıklı dokuyu içeren marjinler verilmesi



Tümörün yerleşimini tahmin etmek için marker'lar

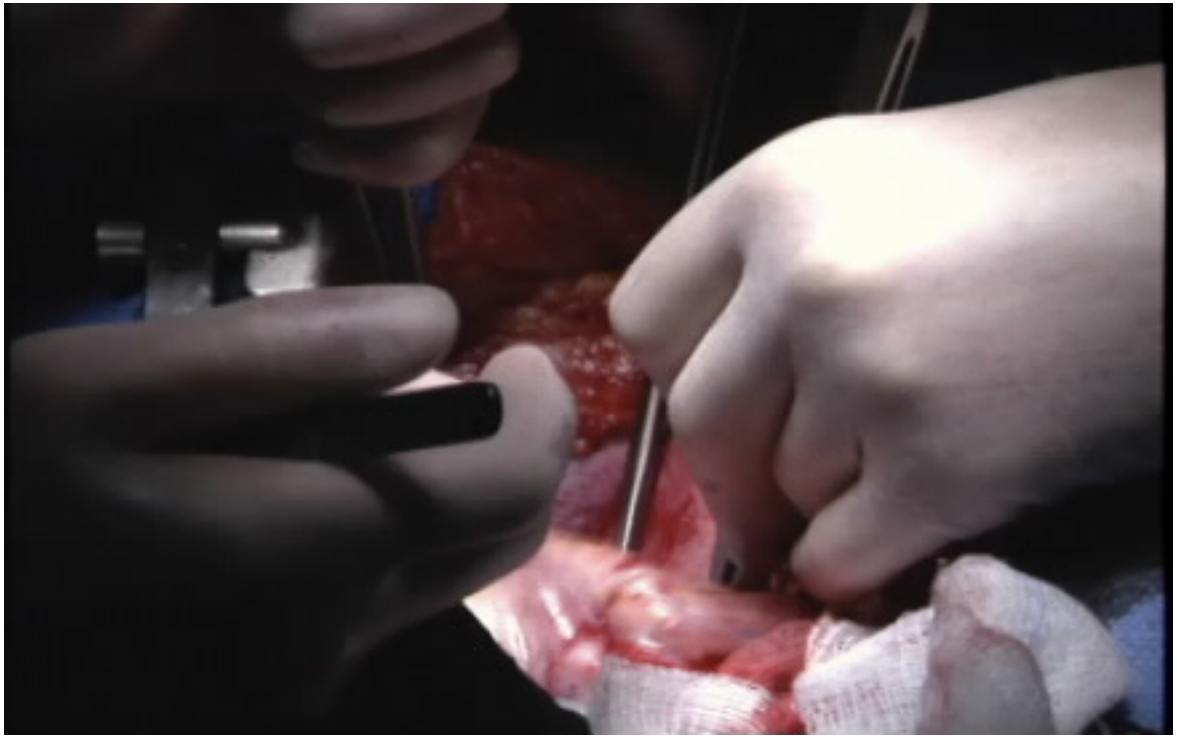
Tedavi sırasında hastanın pozisyonunu ve hareketini takip etmek için eksternal sistemler

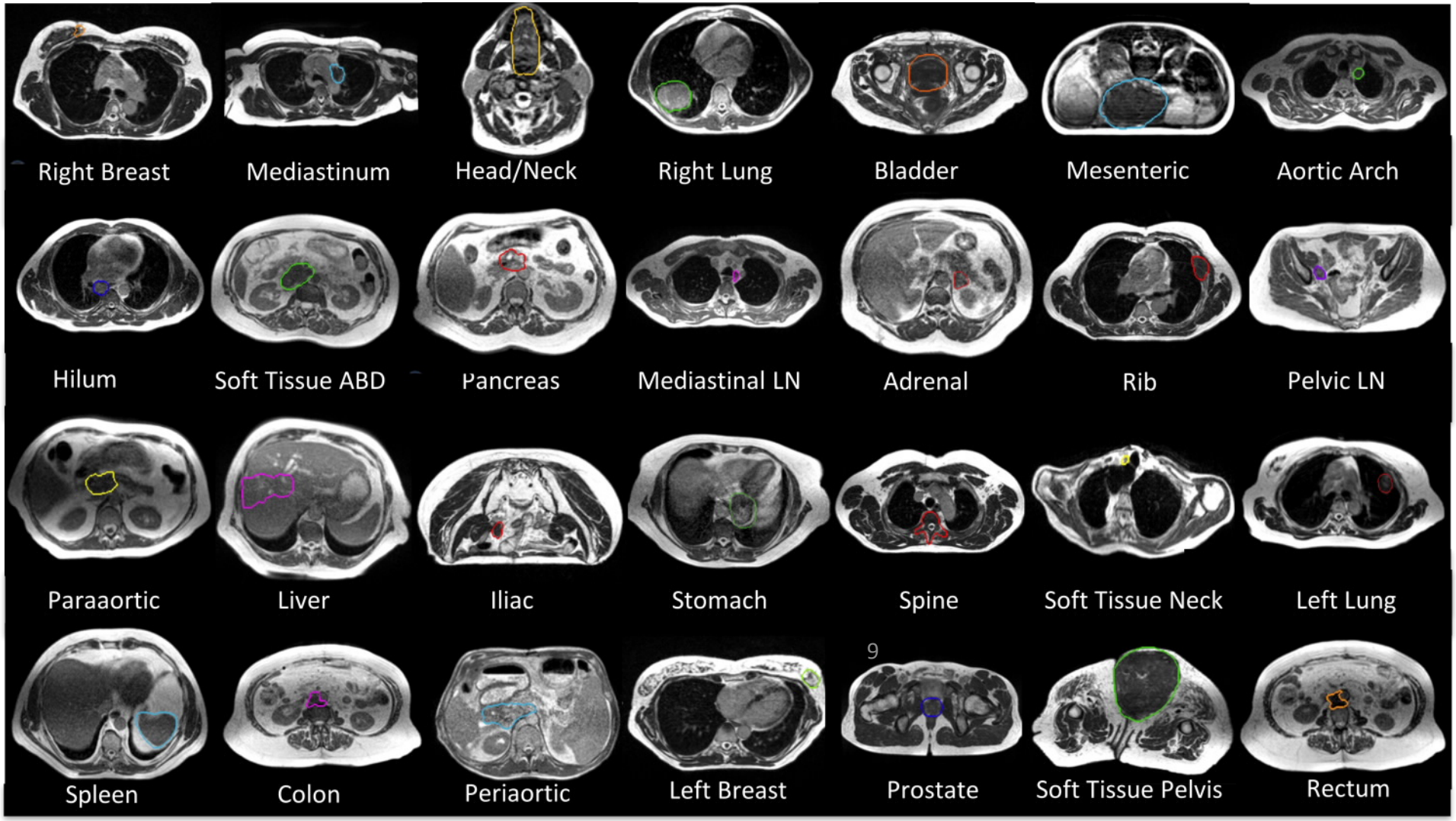
İmmbolizasyon için fiksasyon cihazları

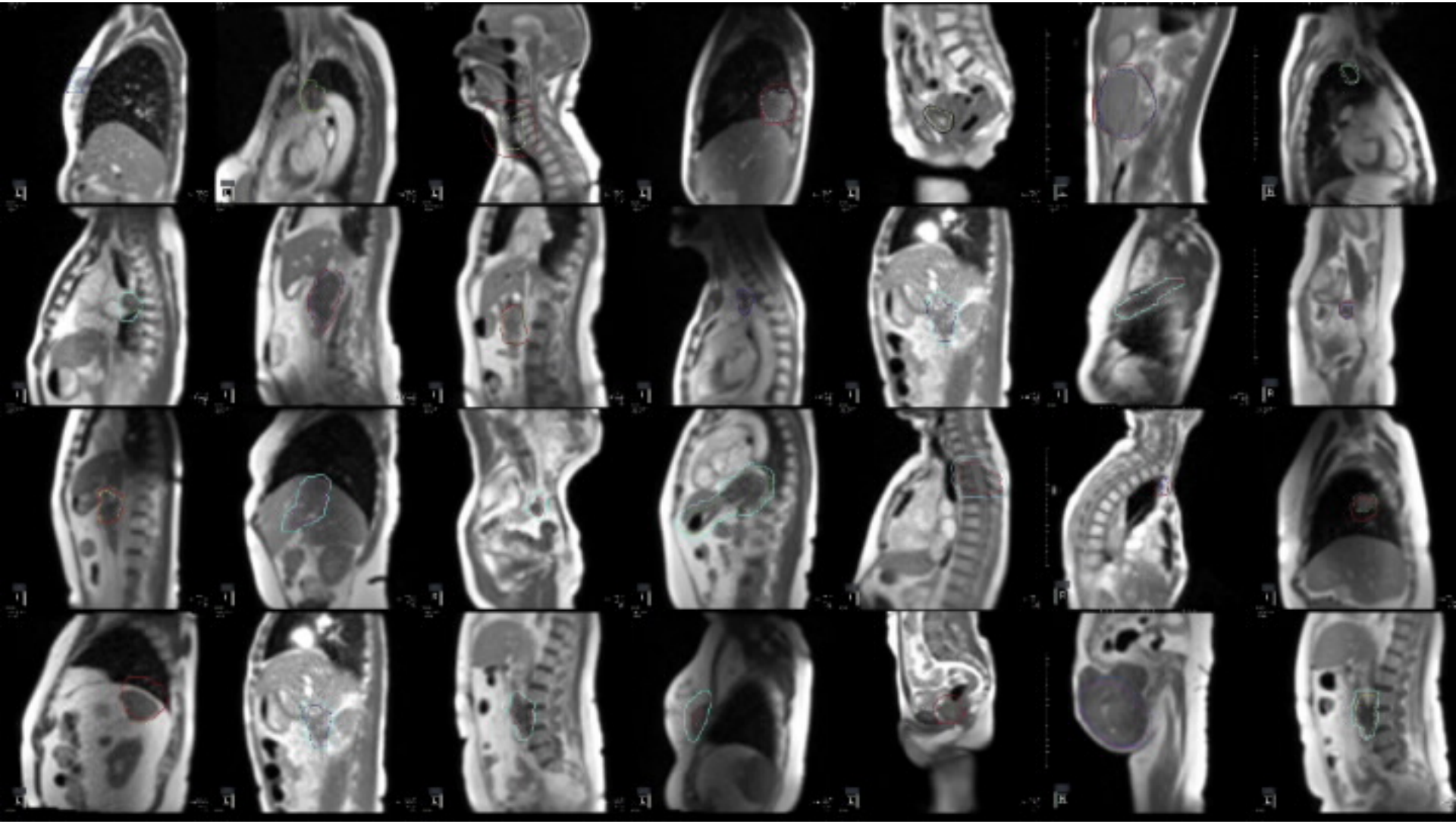
GÖRMEK !!!
CERRAHLARIN AVANTAJI

Surgeons cut open patients and see all of the motion and treat around it.

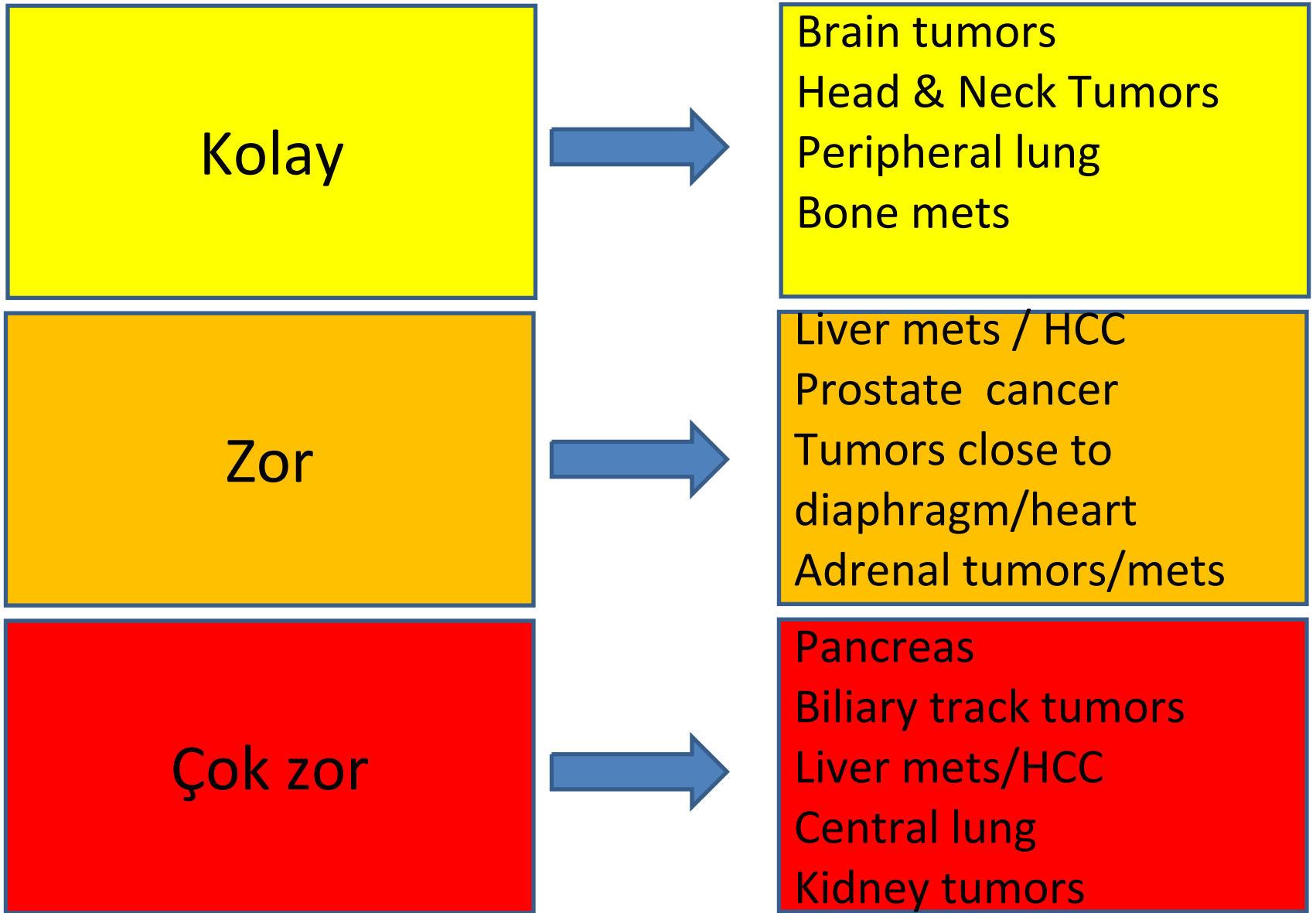
MRIdian LINAC brings real-time MRI vision to Radiation Medicine.




Right Breast
Mediastinum
Head/Neck
Right Lung
Bladder
Mesenteric
Aortic Arch
Hilum
Soft Tissue ABD
Pancreas
Mediastinal LN
Adrenal
Rib
Pelvic LN
Paraaortic
Liver
Iliac
Stomach
Spine
Soft Tissue Neck
Left Lung
Spleen
Colon
Periaortic
Left Breast
Prostate
Soft Tissue Pelvis
Rectum



Stereotaktik Radioterapi



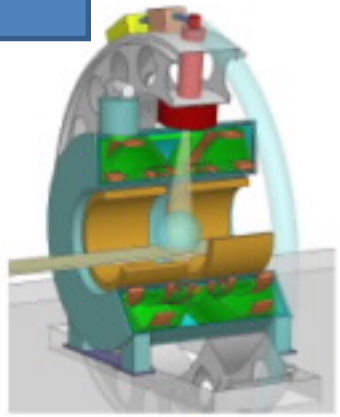
MRG Linac Tarihçesi

(collaboration UMCU, Elekta and Philip

Radiotherapy and Oncology. Vol 56, Sup 1, Pages S1-S255, 2000. 19th Annual ESTRO Meeting Istanbul, Turkey

MRI guided radiotherapy: a MRI based linear accelerator. J.J.W. Lagendijk, C.J.G. Bakker

1999
invention



2004
design

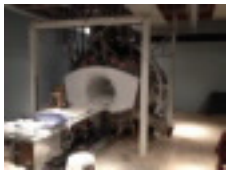
2009
1st prototype

2012
2nd prototype

2015
Clinical grade prototype

2016
Clinical prototype

VIEWRAY Tarihçesi



2003 — MR+RT DEVICE INVENTION DISCLOSED

2004 — VIEWRAY FOUNDED

2010 — FIRST PROTOTYPE BUILT

2011 — FDA CLEARANCE FOR TPS AND DELIVERY SW

2012 — CLINICAL RESEARCH BEGINS AT WASHINGTON UNIVERSITY

2012 — FDA CLEARANCE FOR MRIDIAN

2014 — FIRST PATIENT TREATED

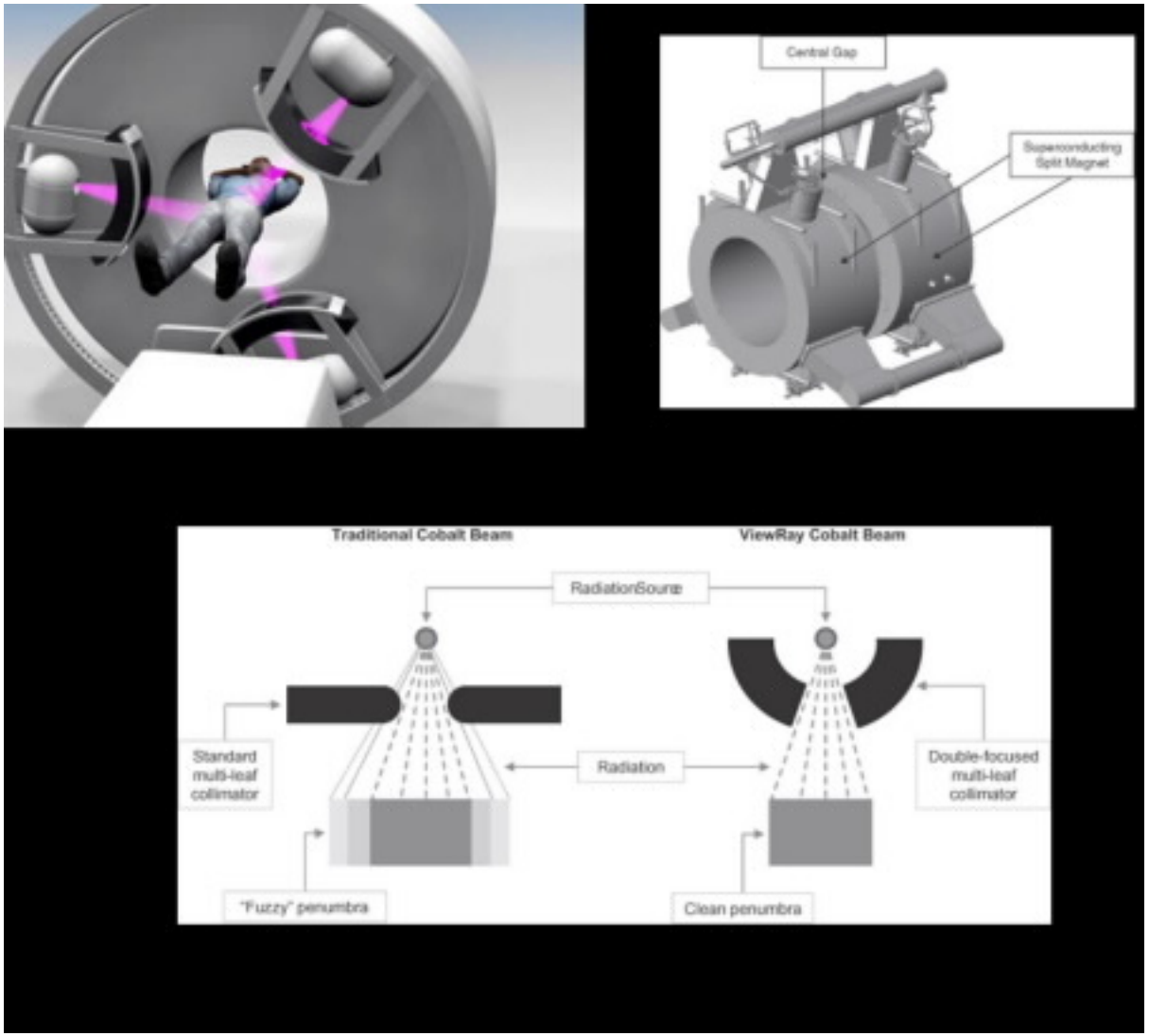
2014 — **FIRST ON TABLE ADAPTIVE RT**

2016 — CE MARK FOR MRIDIAN LINAC

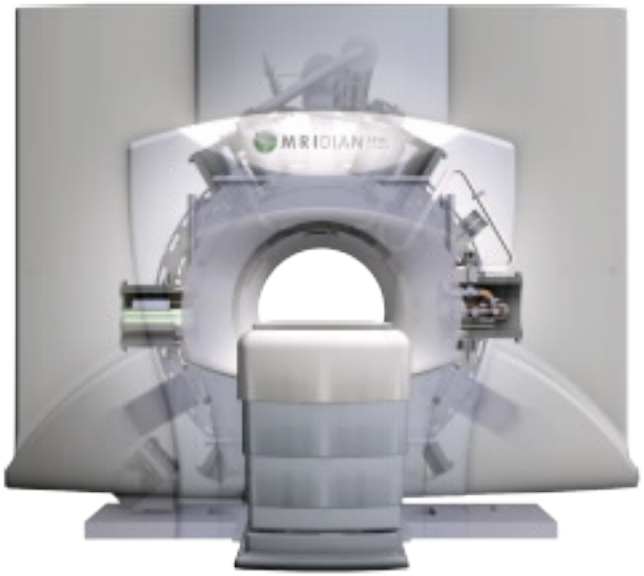
2017 — FDA CLEARANCE FOR MRIDIAN LINAC

2017 — **FIRST LINAC PATIENT TREATED**

MR-guided RT System: MRIdian



The MRIdian LINAC System



MRI

- 0.35 T
- 70 cm bore
- 50 cm FOV
- Real-time imaging 8 FPS

RT

- 6 MV FFF
- >600cGy/min
- Double-Focused Double Stacked
- Tx =27cmx24cm

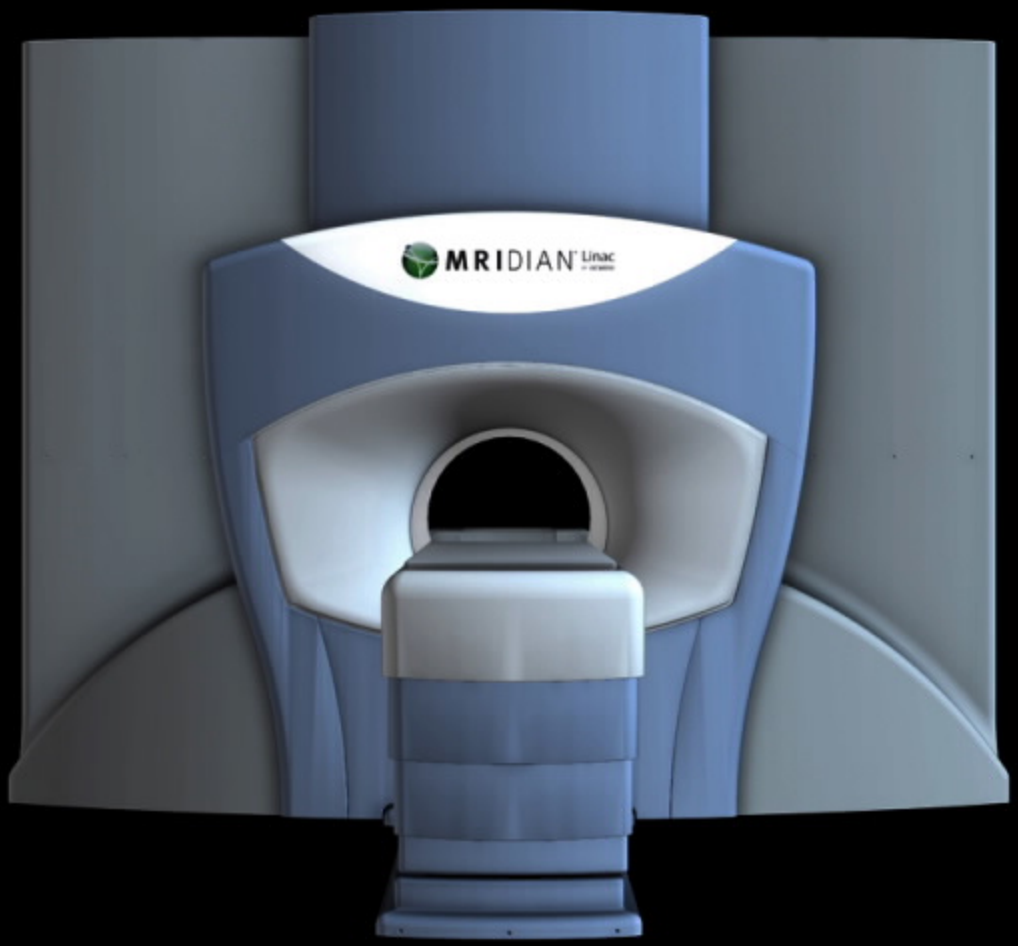
TPS

- Monte Carlo
- Very fast
- Online ART

ViewRay MR LINACs

İlk hasta alımı 10 Eylül 2018

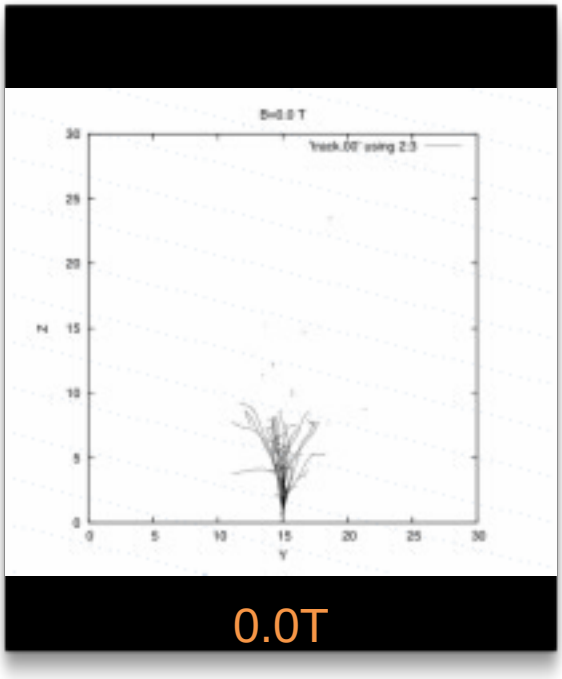
COMPACT
6 MV LINAC

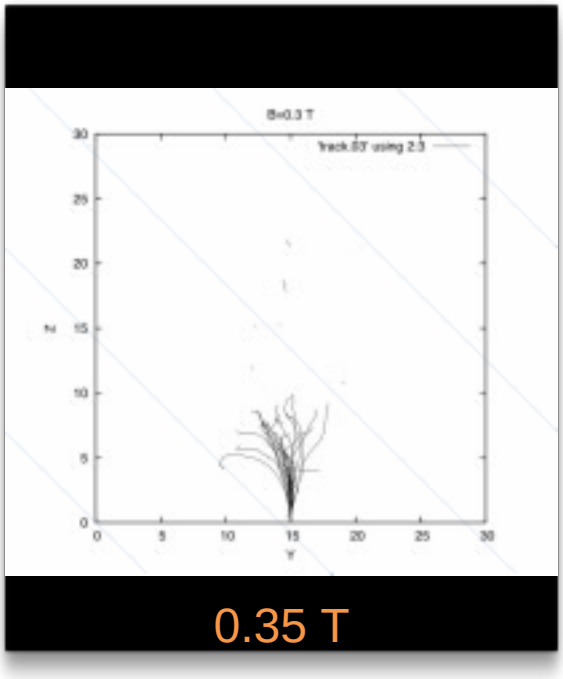


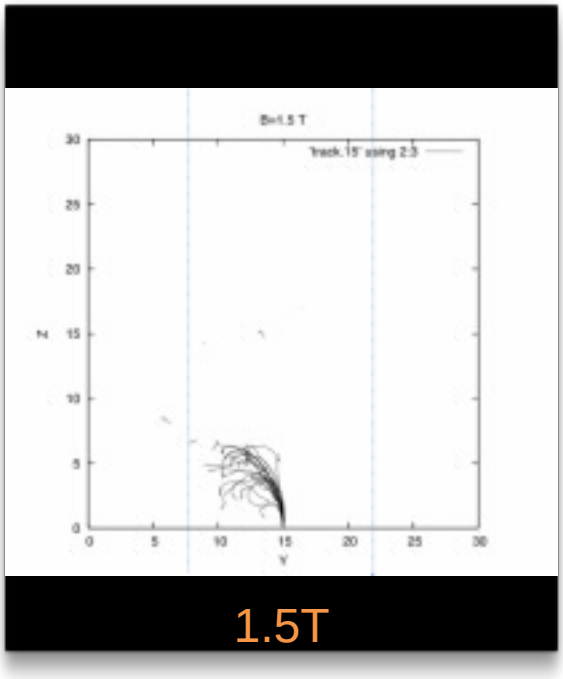
*SmartVISION™ is 510(k) pending clearance and not available for sale.

Bigger is Not Always Better: 0.35 T vs 1.5 T

Electron Return Effect Increases with Magnetic Field



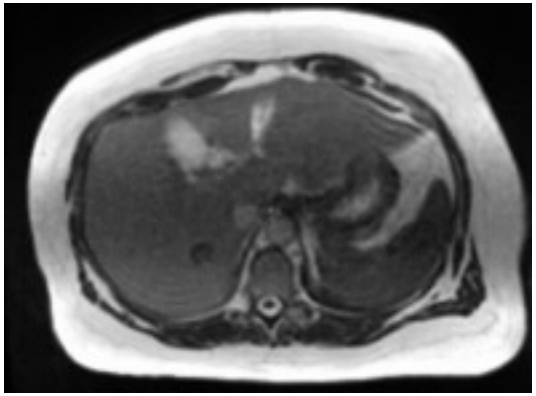




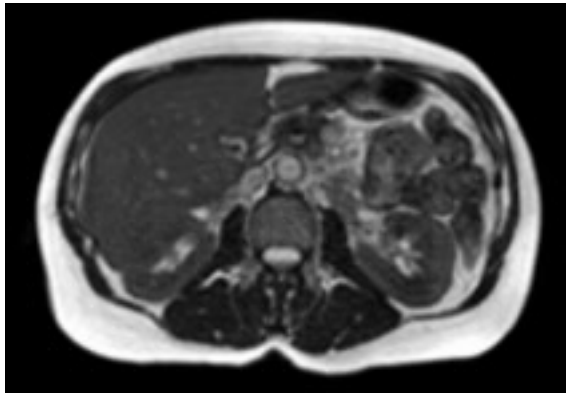
Electron Return Effect: return of electrons to the tissue at the beam exit point, leading to increased dose

Görüntüleme Kalitesi 0.35 T

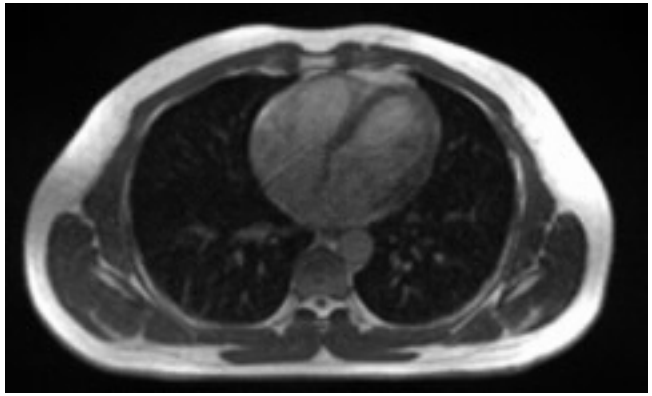
Liver

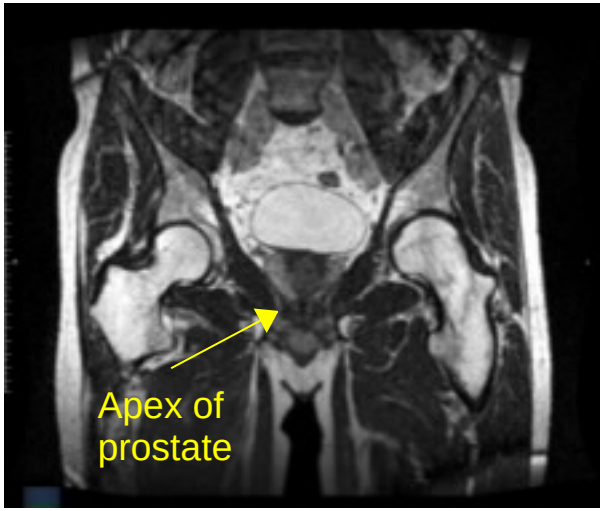


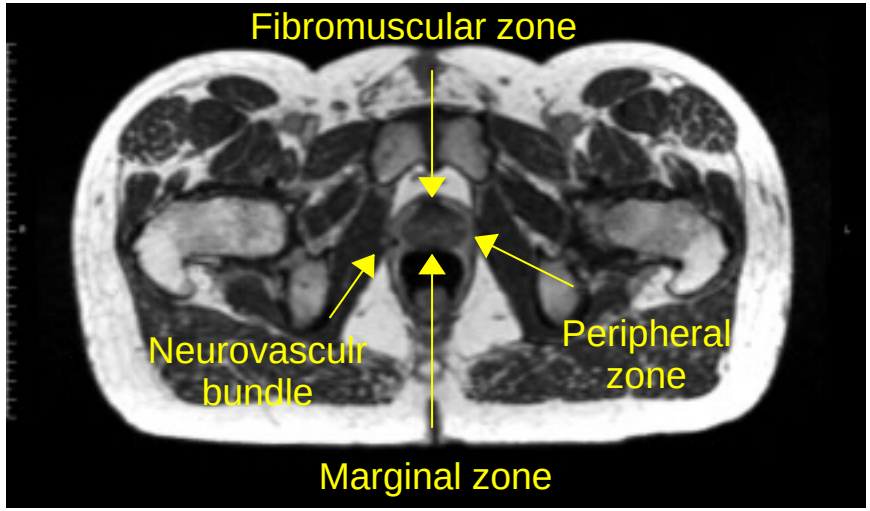
Pancreas



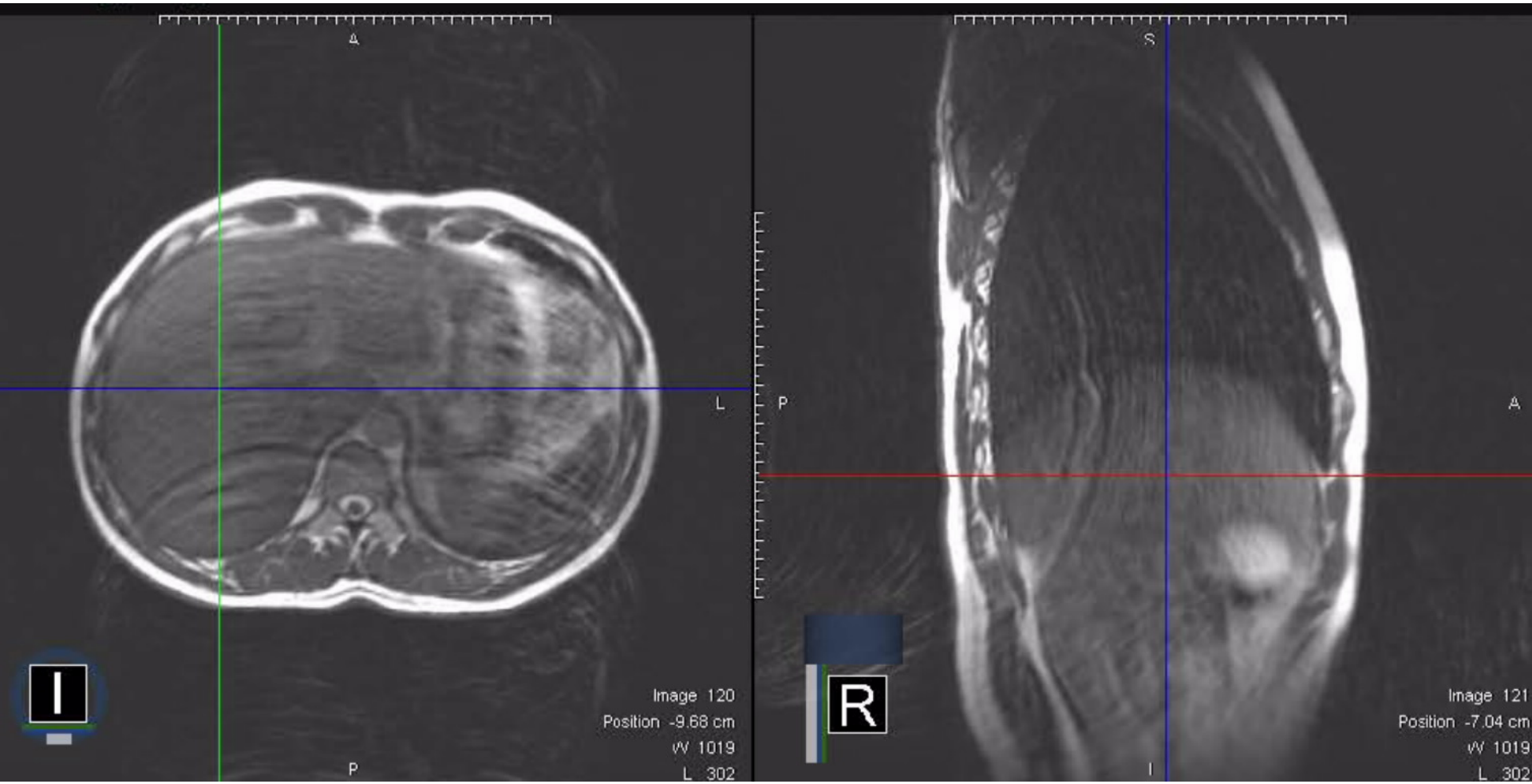
Lung

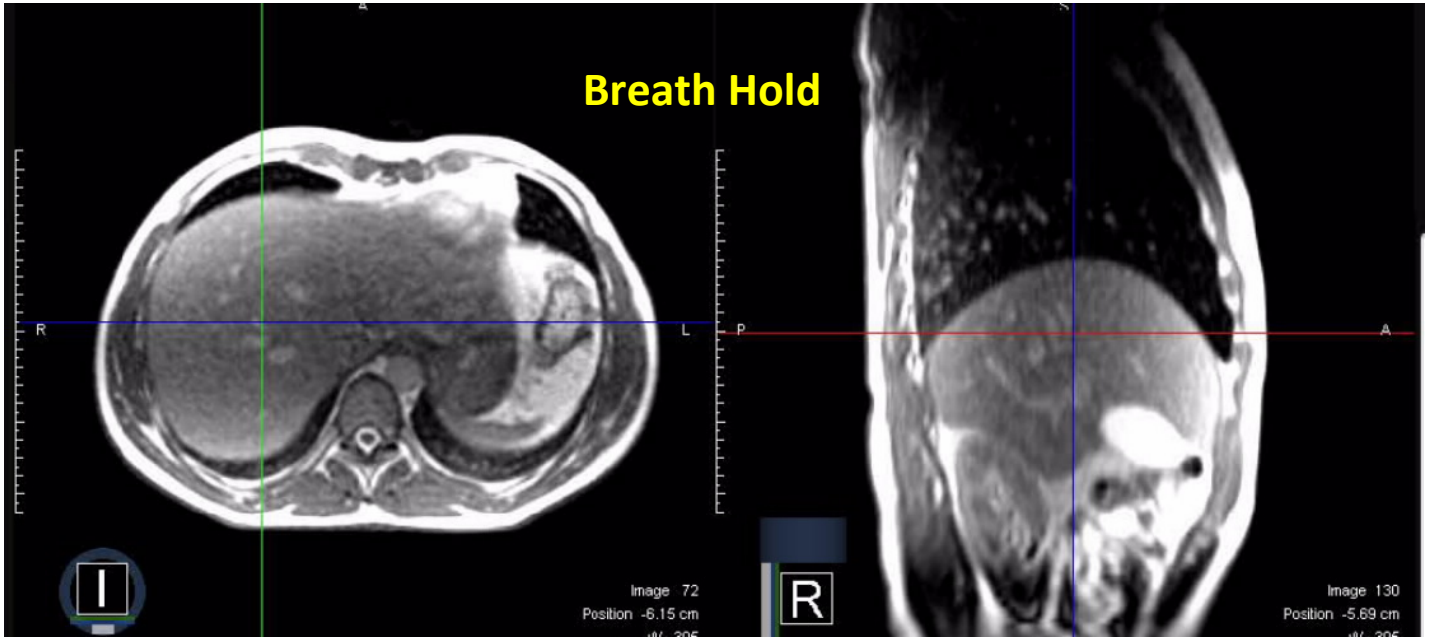


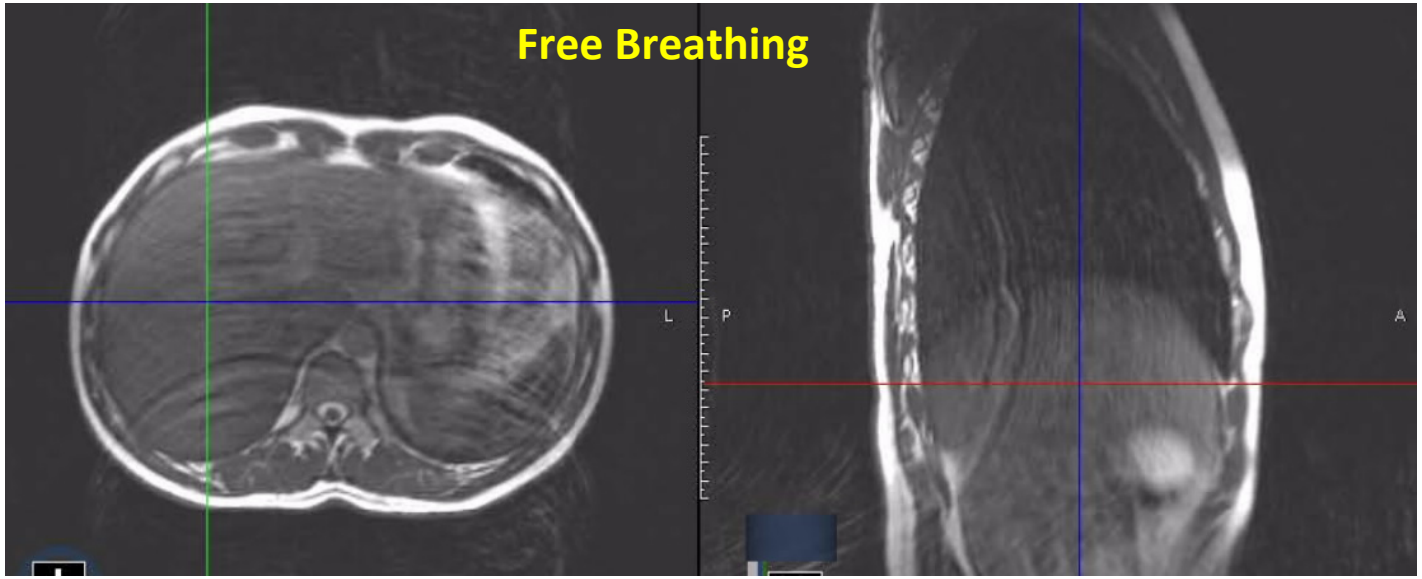


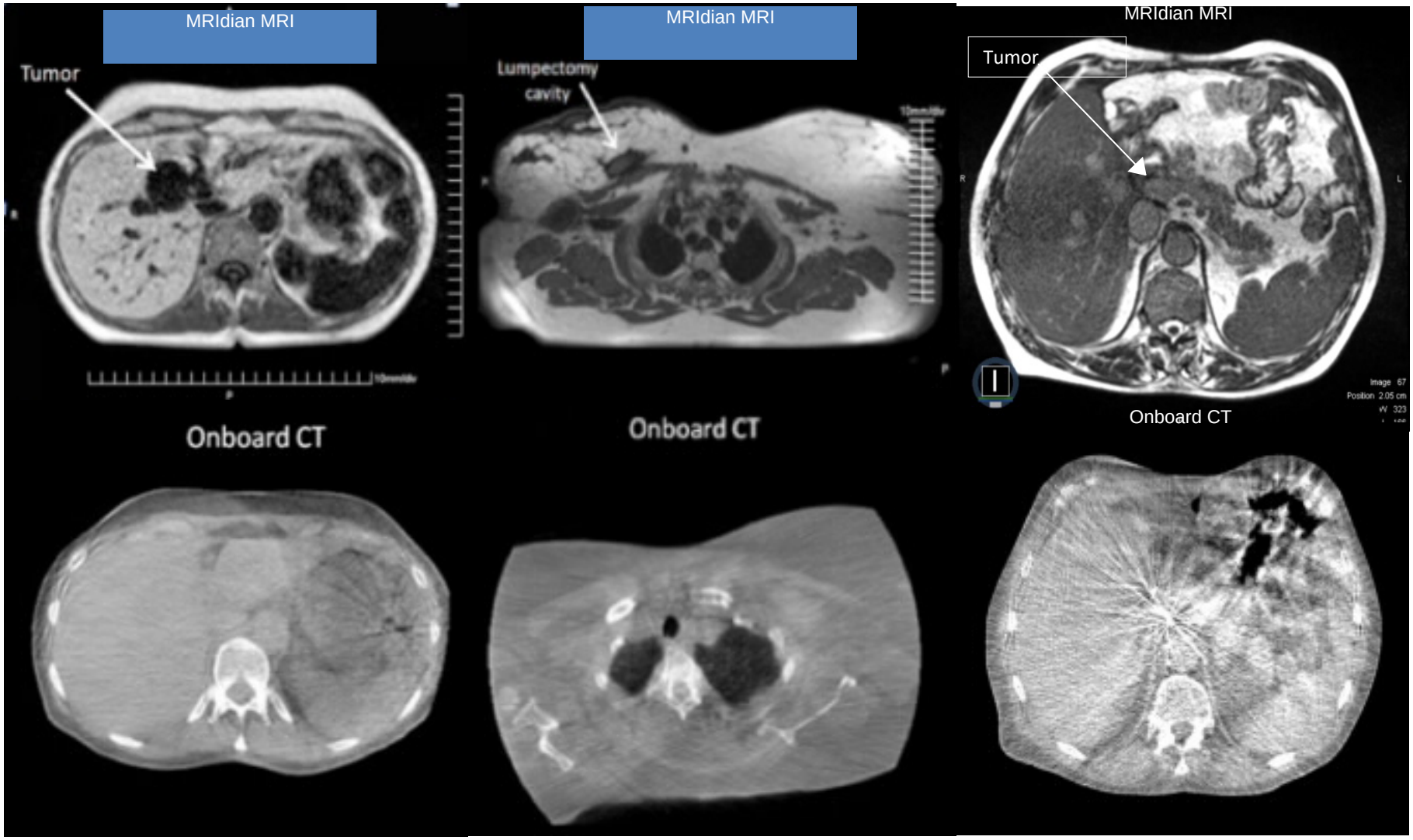


Serbest Solunum ile MR görüntüleme




Breath Hold
R
L
P
A
I
R
Image 72
Position -6.15 cm
Image 130
Position -5.69 cm


Free Breathing
L
P
A

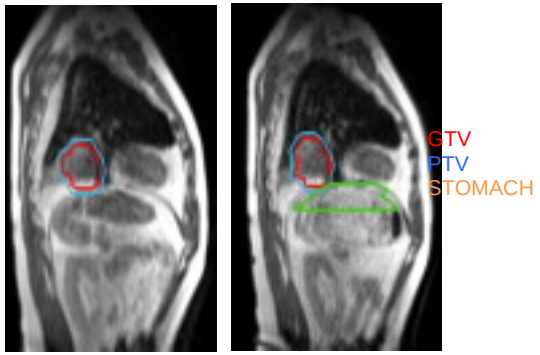

MRIdian MRI
Tumor
Onboard CT
MRIdian MRI
Lumpectomy cavity
Onboard CT
MRIdian MRI
Tumor
Onboard CT

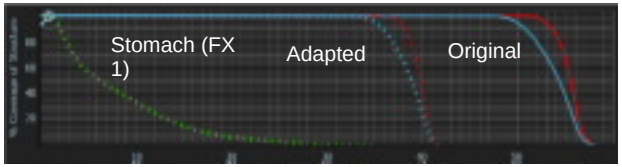
Here's how MRIdian® Vision makes a difference

MRIdian – MRI based setup

Most accurate soft tissue alignment today

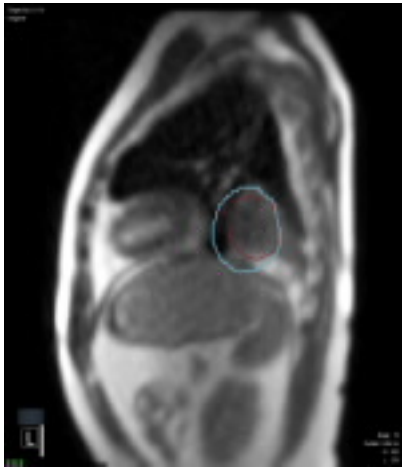
MRIdian® - MRI guided On-table Adapting





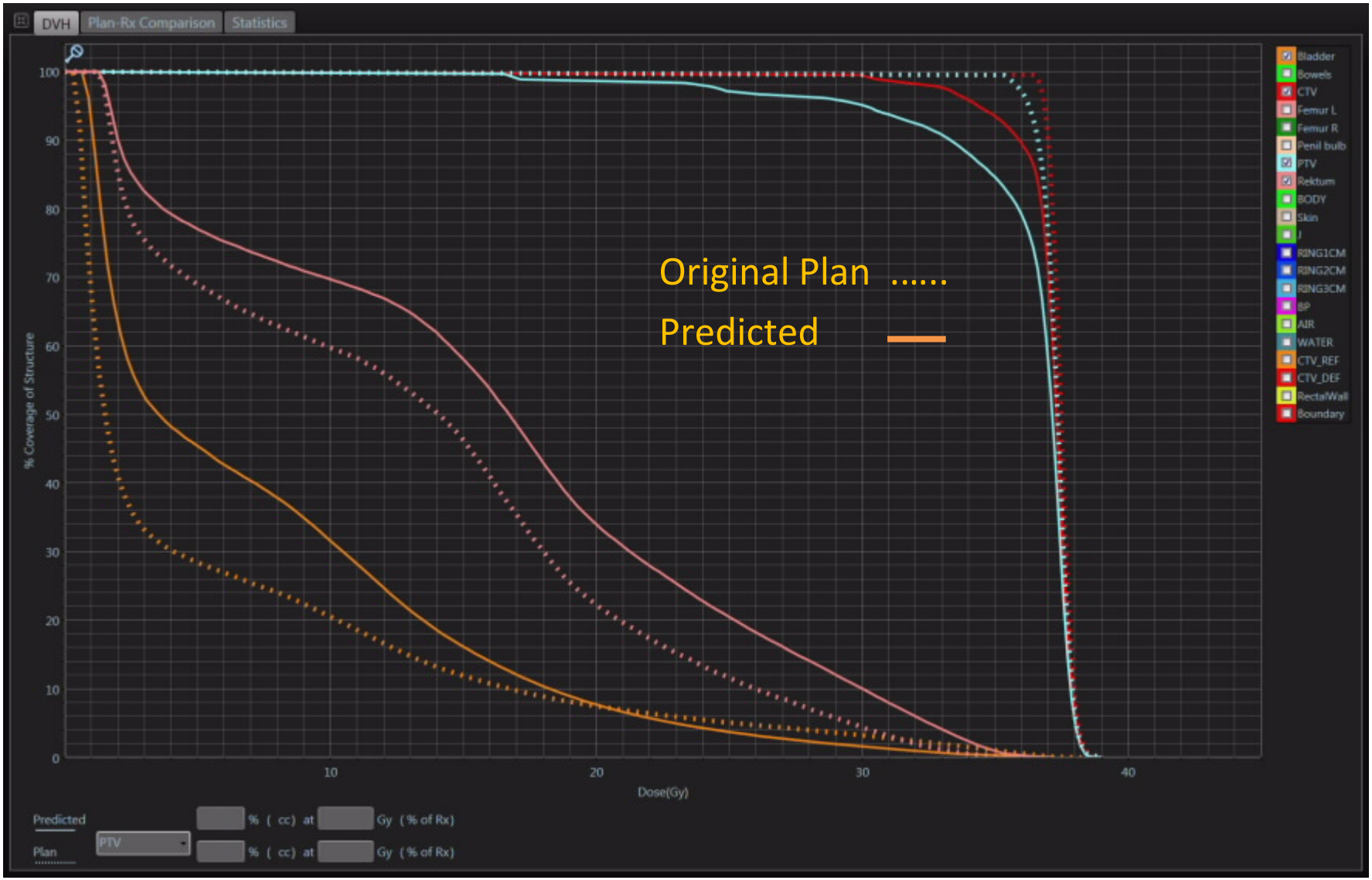
Make changes to match daily soft tissue anatomy

MRIdian® - MRI based tracking

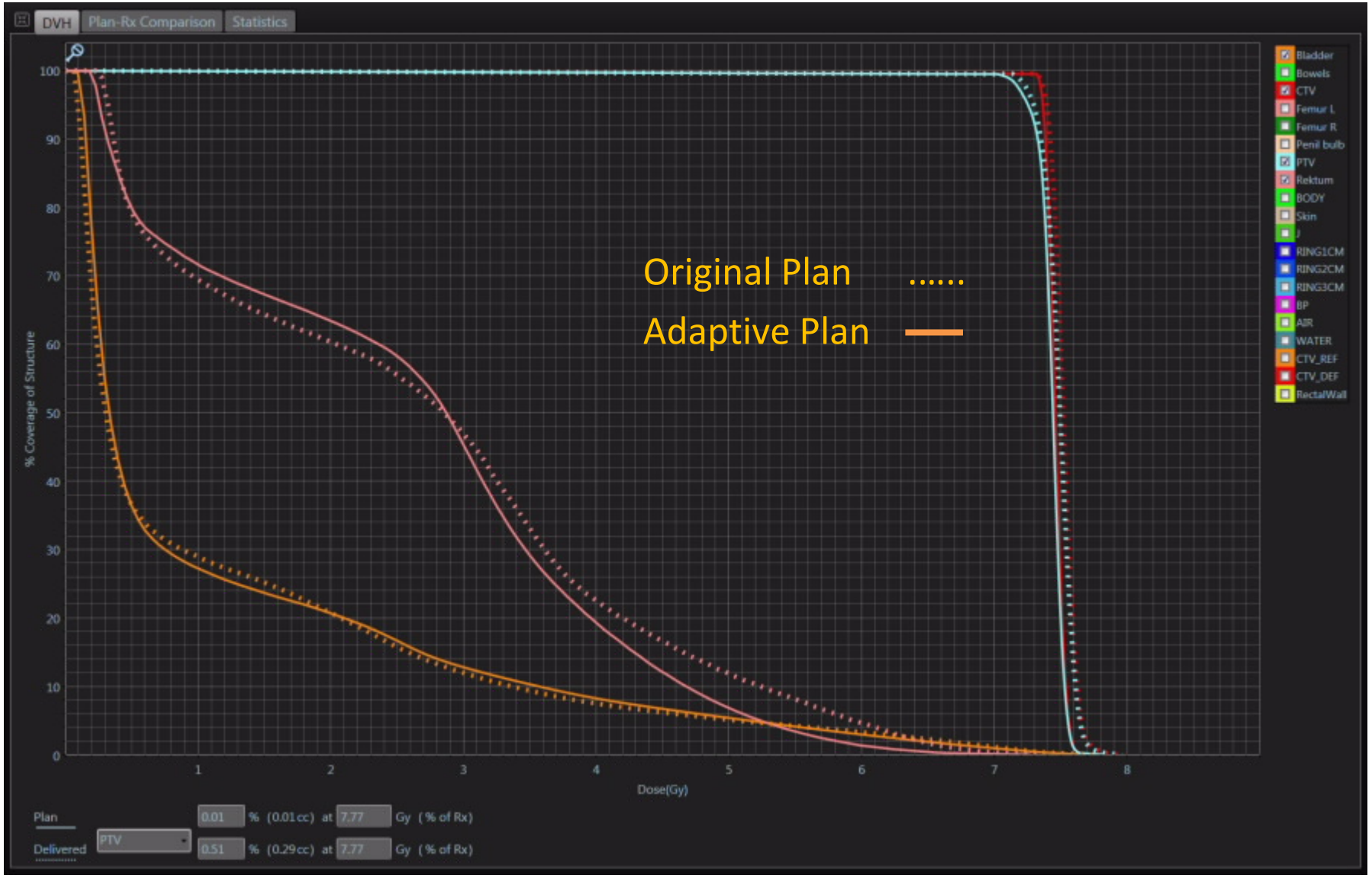


See what you treat while you treat it

Original Plan vs Predicted Plan w/oadaptation



Adaptive Plan vs Original Plan



OAR and Coverage violation

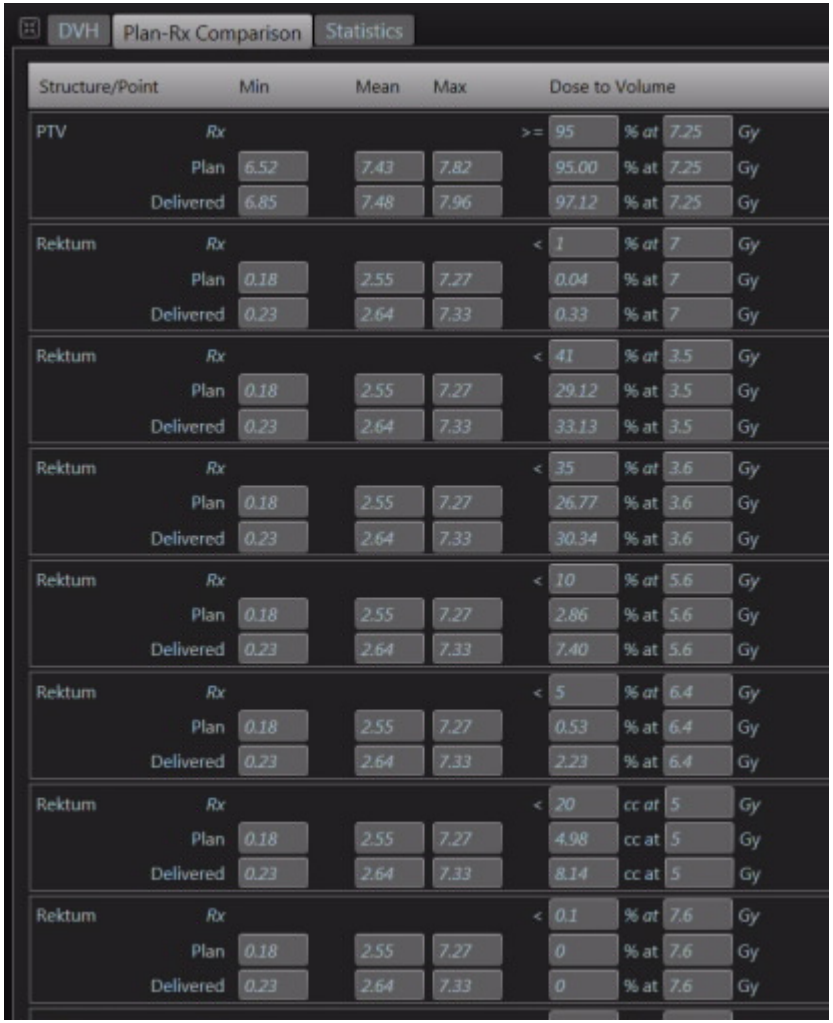
Decision for ADAPTIVE PLAN

DVH | Plan-Rx Comparison | Statistics

Structure/Point		Min	Mean	Max	Dose to Volume			
PTV	Rx				>= 95	% at	36.25	Gy
	Predicted	14.91	36.06	38.99	76.49	% at	36.25	Gy
	Plan	33.98	37.27	39.05	95.00	% at	36.25	Gy
Rektum	Rx				< 1	% at	35	Gy
	Predicted	1.27	15.97	37.21	0.89	% at	35	Gy
	Plan	1.23	13.06	36.35	0.18	% at	35	Gy
Rektum	Rx				< 41	% at	17.5	Gy
	Predicted	1.27	15.97	37.21	45.68	% at	17.5	Gy
	Plan	1.23	13.06	36.35	32.60	% at	17.5	Gy
Rektum	Rx				< 35	% at	18	Gy
	Predicted	1.27	15.97	37.21	42.93	% at	18	Gy
	Plan	1.23	13.06	36.35	30.09	% at	18	Gy
Rektum	Rx				< 10	% at	28	Gy
	Predicted	1.27	15.97	37.21	14.03	% at	28	Gy
	Plan	1.23	13.06	36.35	7.09	% at	28	Gy
Rektum	Rx				< 5	% at	32	Gy
	Predicted	1.27	15.97	37.21	5.91	% at	32	Gy
	Plan	1.23	13.06	36.35	1.97	% at	32	Gy
Rektum	Rx				< 20	cc at	25	Gy
	Predicted	1.27	15.97	37.21	12.74	cc at	25	Gy
	Plan	1.23	13.06	36.35	7.95	cc at	25	Gy
Rektum	Rx				< 0.1	% at	38	Gy
	Predicted	1.27	15.97	37.21	0	% at	38	Gy
	Plan	1.23	13.06	36.35	0	% at	38	Gy
Bladder	Rx				< 43	% at	17.5	Gy

Reoptimization

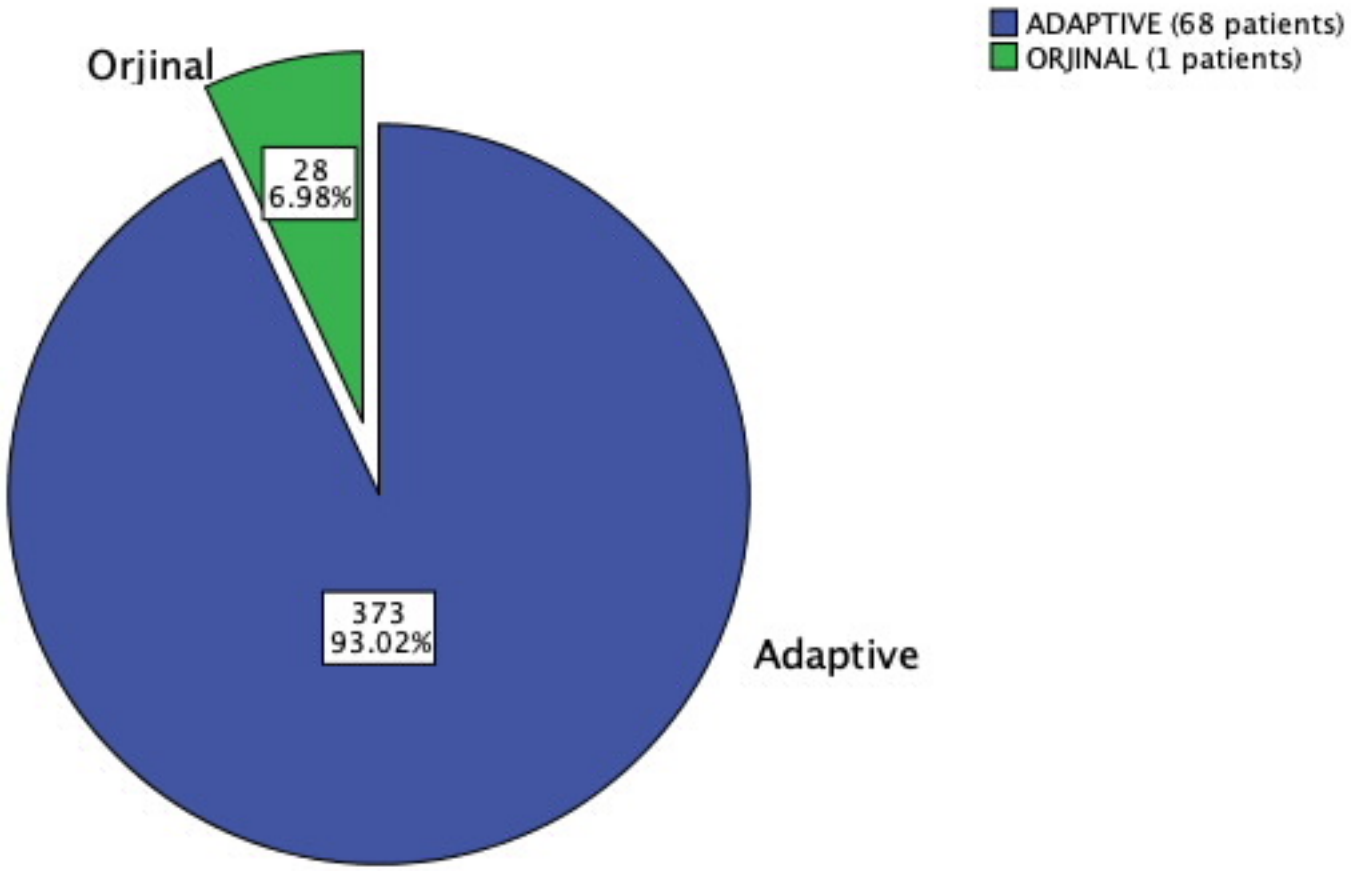
After ADAPTIVE PLAN



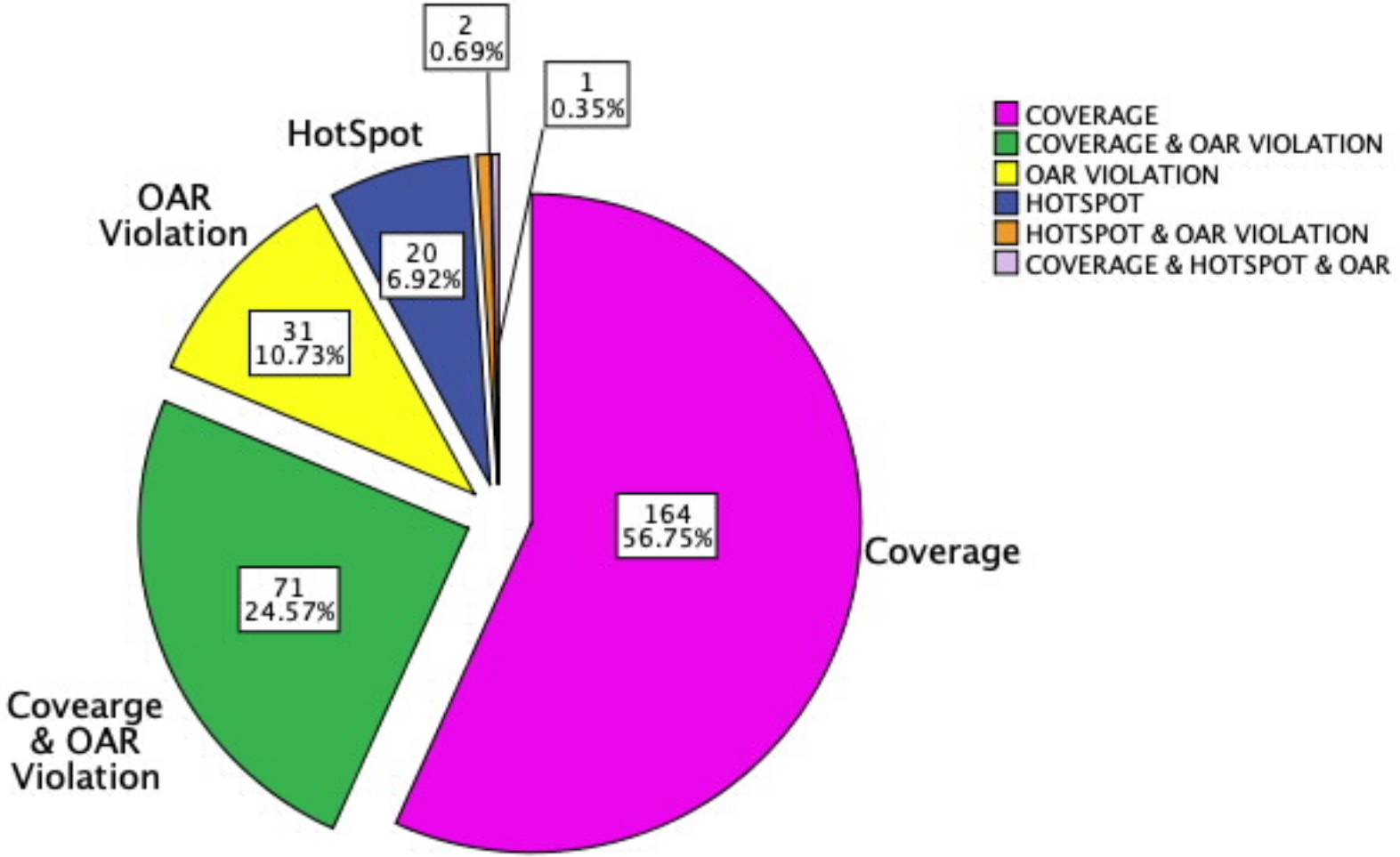
DVH | Plan-Rx Comparison | Statistics

Structure/Point		Min	Mean	Max	Dose to Volume			
PTV	Rx				>= 95	% at	7.25	Gy
	Plan	6.52	7.43	7.82	95.00	% at	7.25	Gy
	Delivered	6.85	7.48	7.96	97.12	% at	7.25	Gy
Rektum	Rx				< 1	% at	7	Gy
	Plan	0.18	2.55	7.27	0.04	% at	7	Gy
	Delivered	0.23	2.64	7.33	0.33	% at	7	Gy
Rektum	Rx				< 41	% at	3.5	Gy
	Plan	0.18	2.55	7.27	29.12	% at	3.5	Gy
	Delivered	0.23	2.64	7.33	33.13	% at	3.5	Gy
Rektum	Rx				< 35	% at	3.6	Gy
	Plan	0.18	2.55	7.27	26.77	% at	3.6	Gy
	Delivered	0.23	2.64	7.33	30.34	% at	3.6	Gy
Rektum	Rx				< 10	% at	5.6	Gy
	Plan	0.18	2.55	7.27	2.86	% at	5.6	Gy
	Delivered	0.23	2.64	7.33	7.40	% at	5.6	Gy
Rektum	Rx				< 5	% at	6.4	Gy
	Plan	0.18	2.55	7.27	0.53	% at	6.4	Gy
	Delivered	0.23	2.64	7.33	2.23	% at	6.4	Gy
Rektum	Rx				< 20	cc at	5	Gy
	Plan	0.18	2.55	7.27	4.98	cc at	5	Gy
	Delivered	0.23	2.64	7.33	8.14	cc at	5	Gy
Rektum	Rx				< 0.1	% at	7.6	Gy
	Plan	0.18	2.55	7.27	0	% at	7.6	Gy
	Delivered	0.23	2.64	7.33	0	% at	7.6	Gy

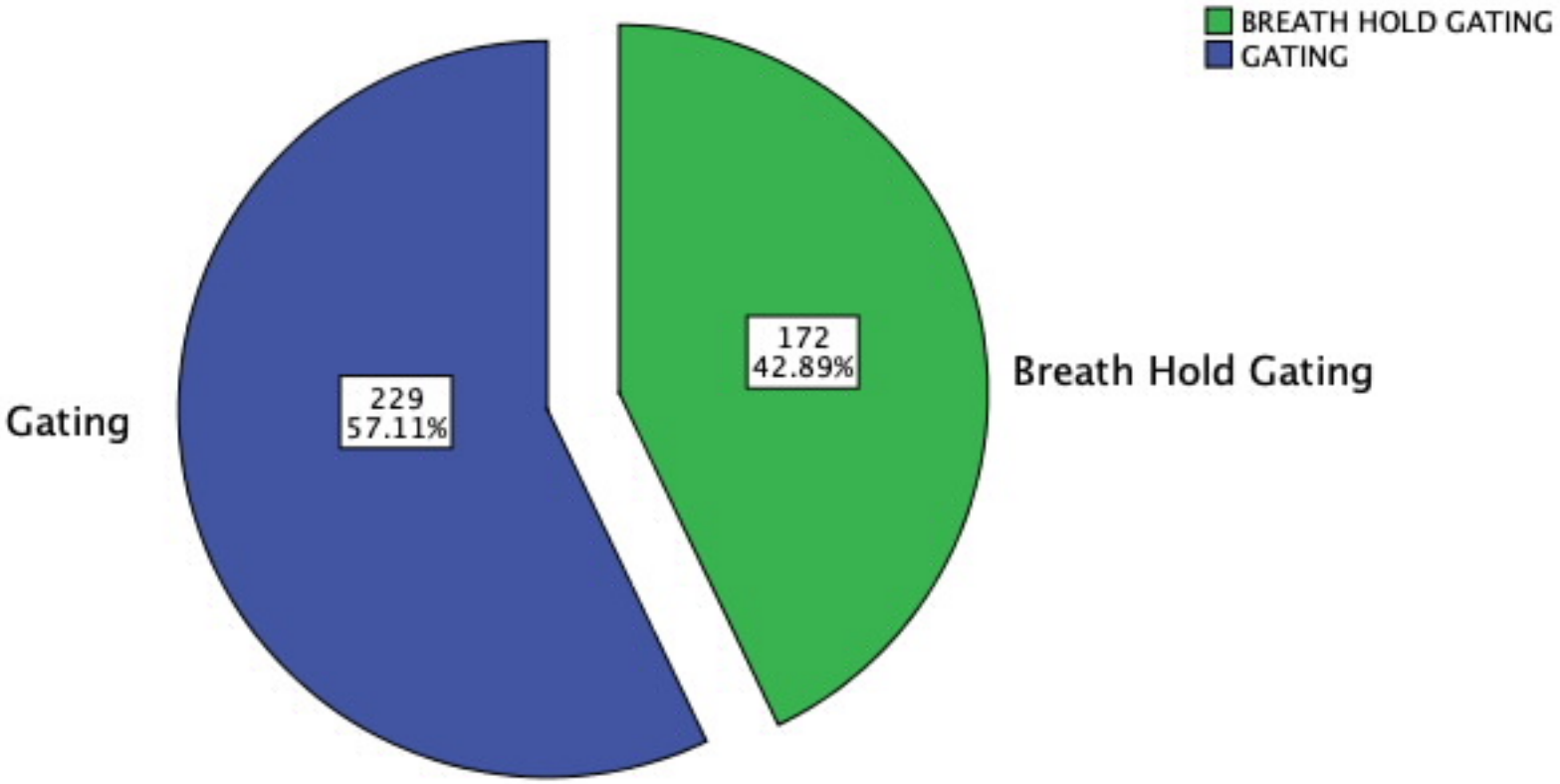
TREATMENT APPROACH OF 401 FRACTIONS



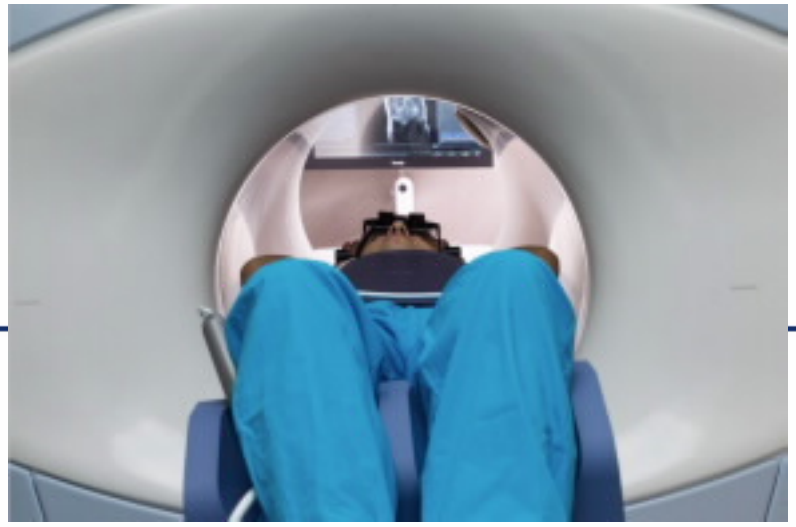
REASONS OF ADAPTIVE PLAN APPROACH



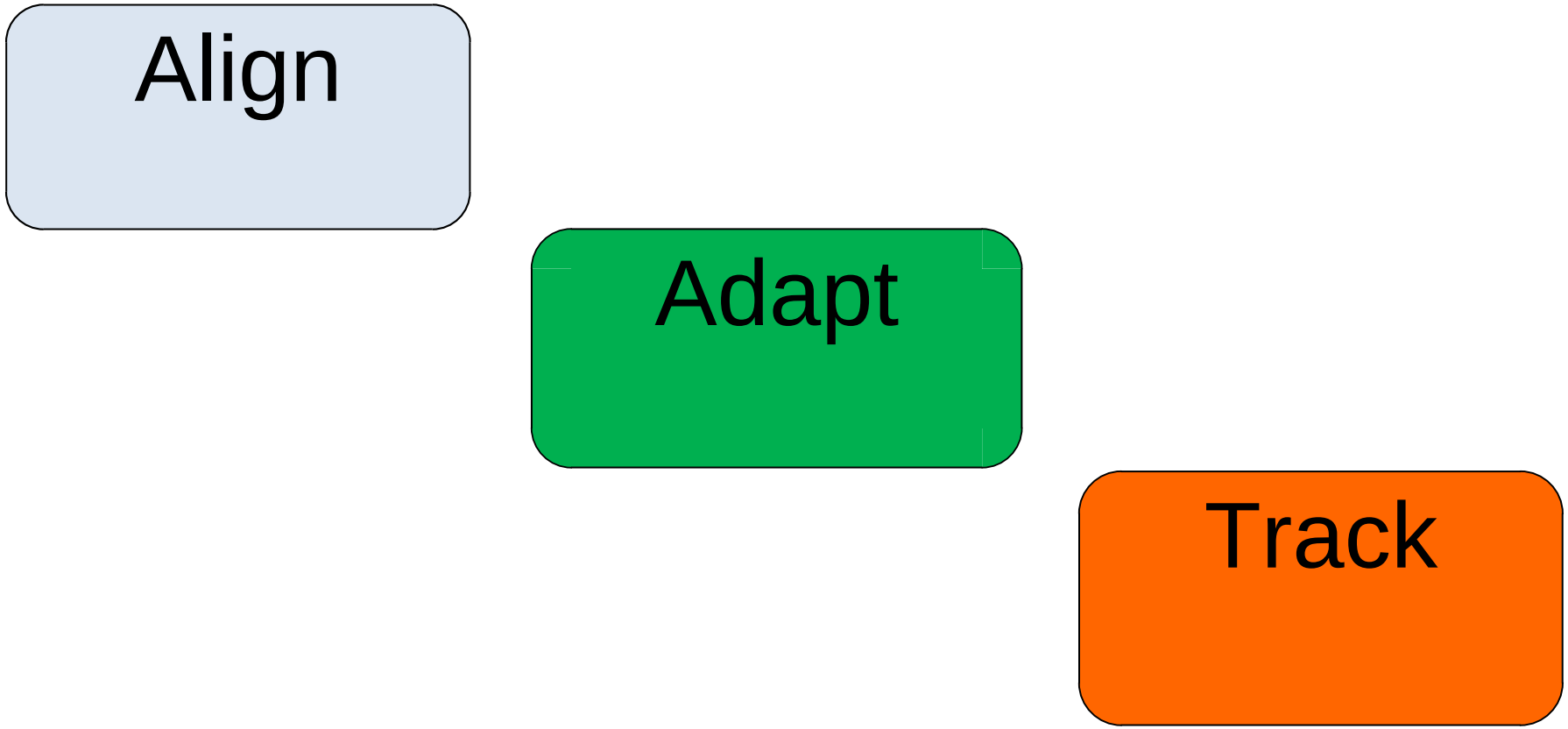
GATING DISTRIBUTION of 401 FRACTIONS



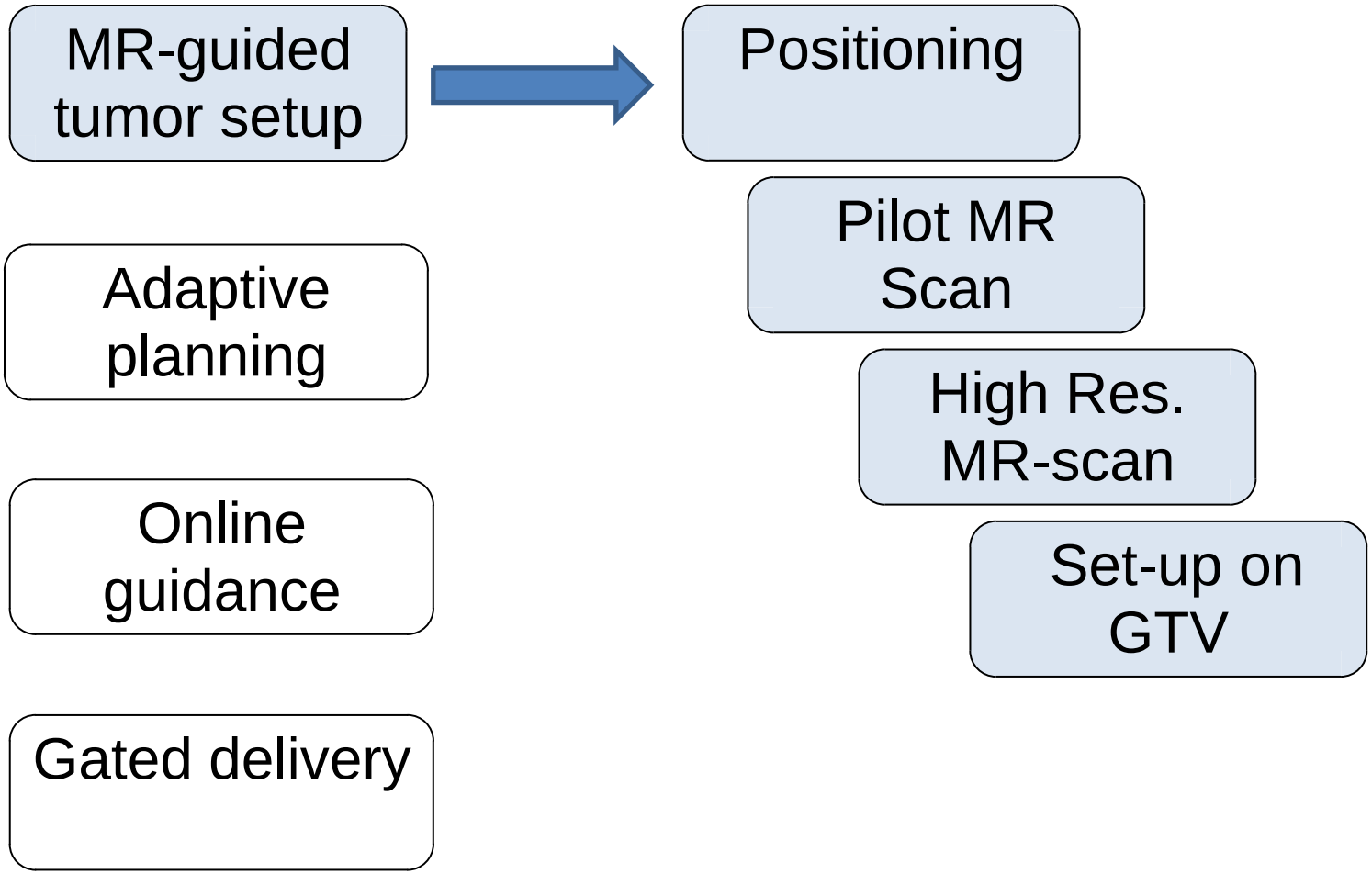
Visual Coaching for Respiratory Gating



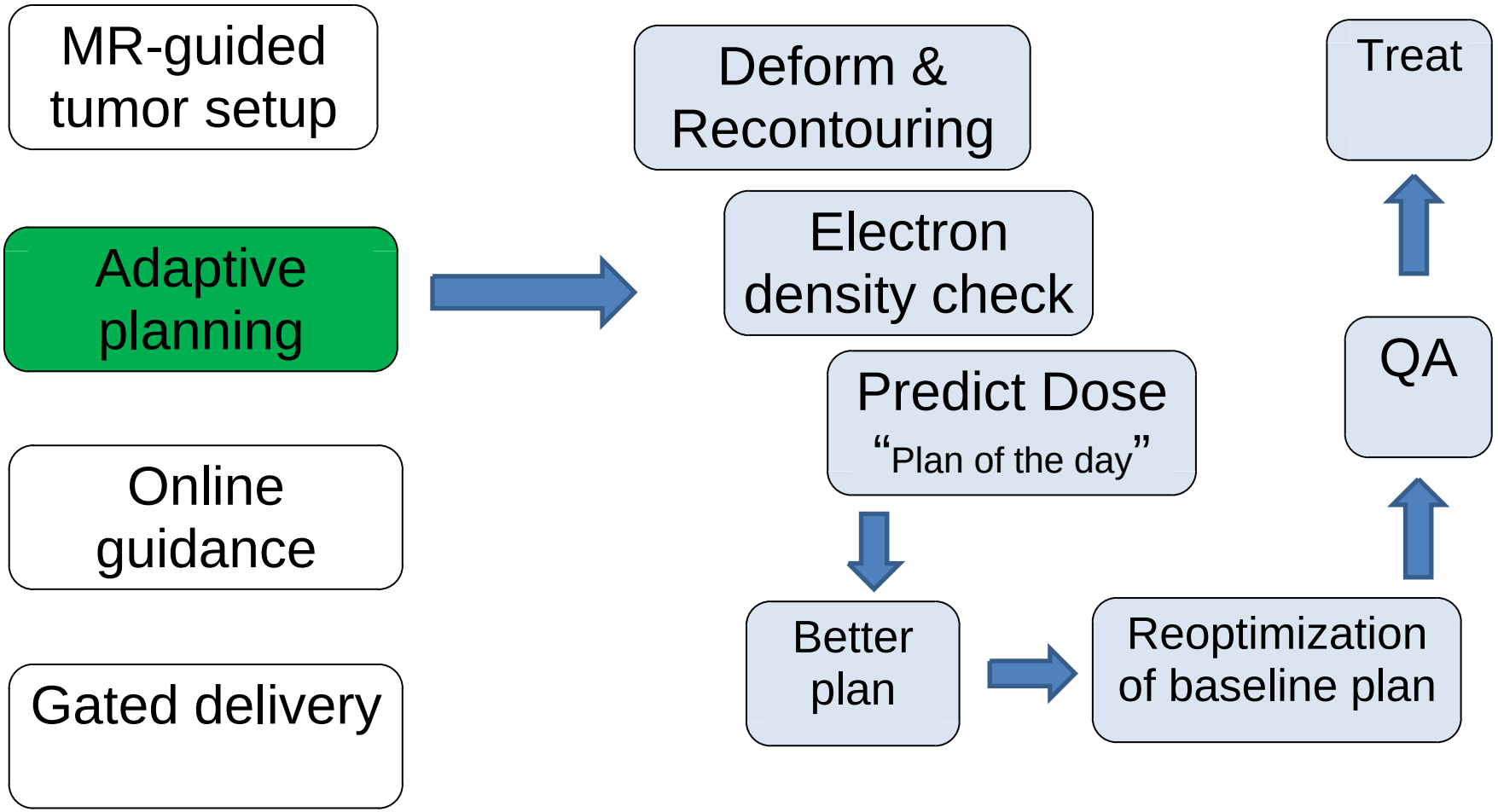
MR-Guided Radiotherapy Daily Treatment Workflow



MR-Guided Radiotherapy Workflow



MR-Guided Radiotherapy Workflow



MR-Guided Radiotherapy Workflow

MR-guided tumor setup

Adaptive planning

Online guidance

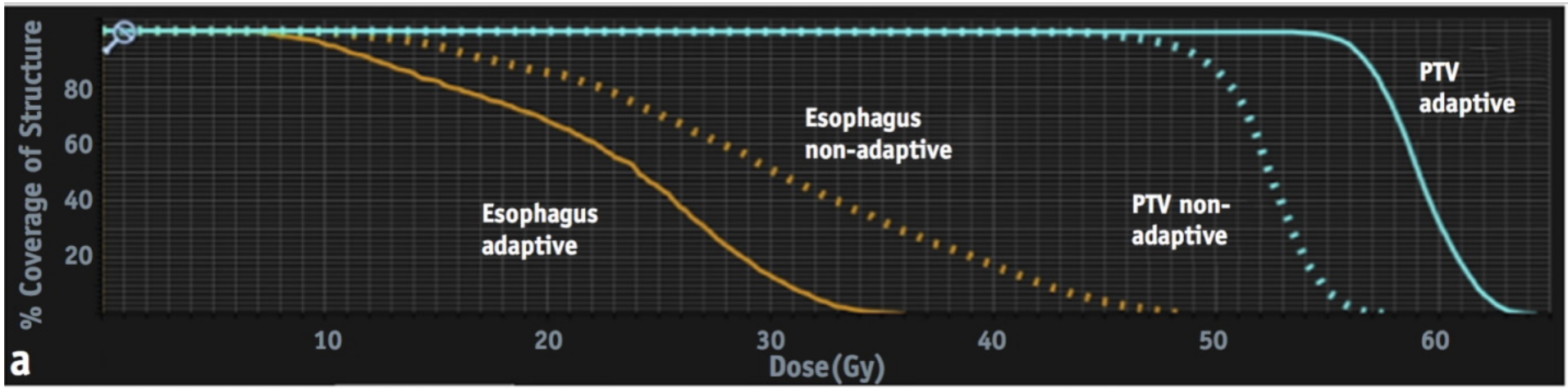
Deform & Recontouring

Electron density check

Predict Dose
"Plan of the day"

Treat

QA



MR-Guided Radiotherapy Workflow

MR-guided tumor setup

Adaptive planning

Online guidance

Gated delivery

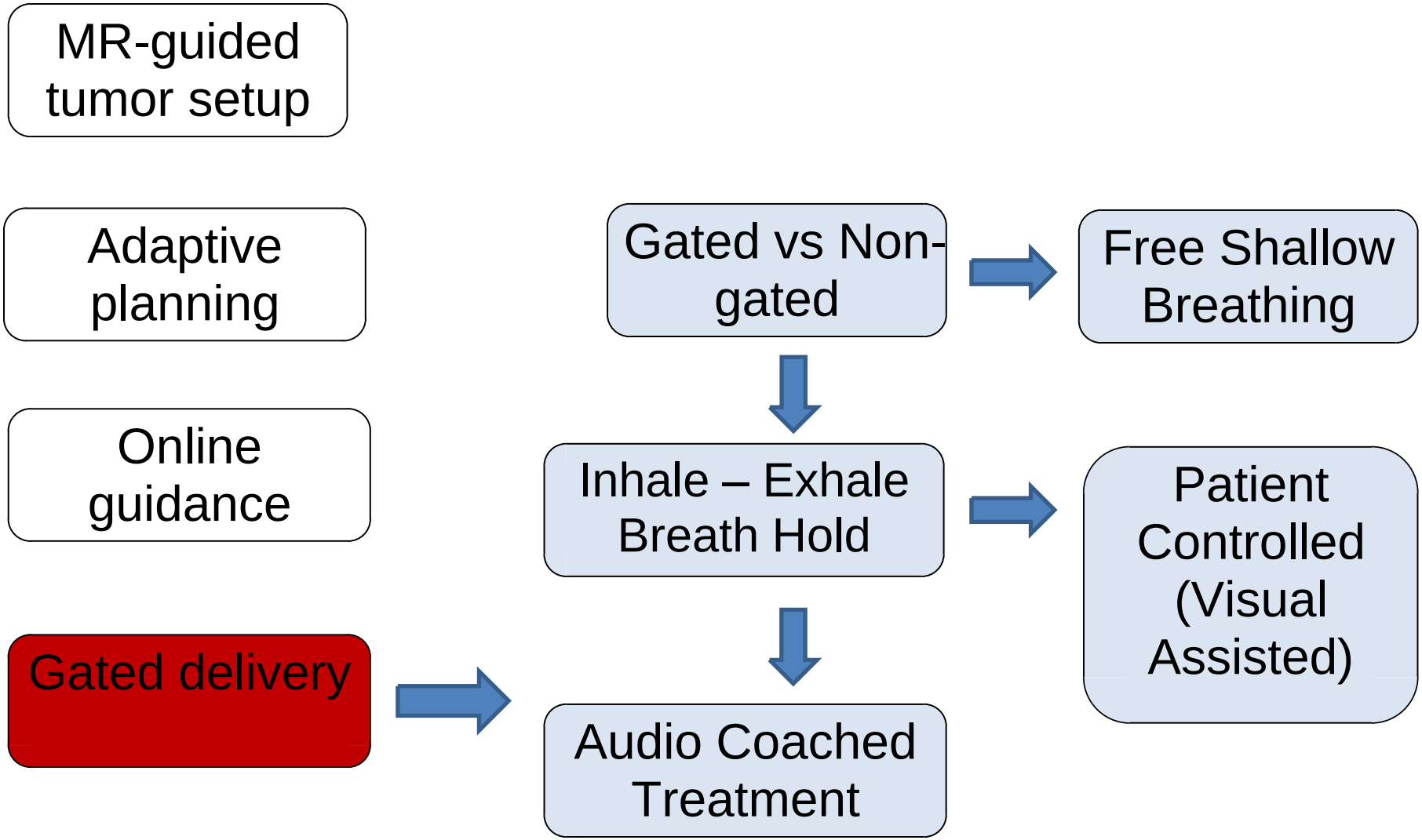
Boundary GTV / OAR

Online Real Time Tracking

Gated vs Non-gated Delivery

Treat & Track

MR-Guided Radiotherapy Workflow



Adaptive Treatment Planning

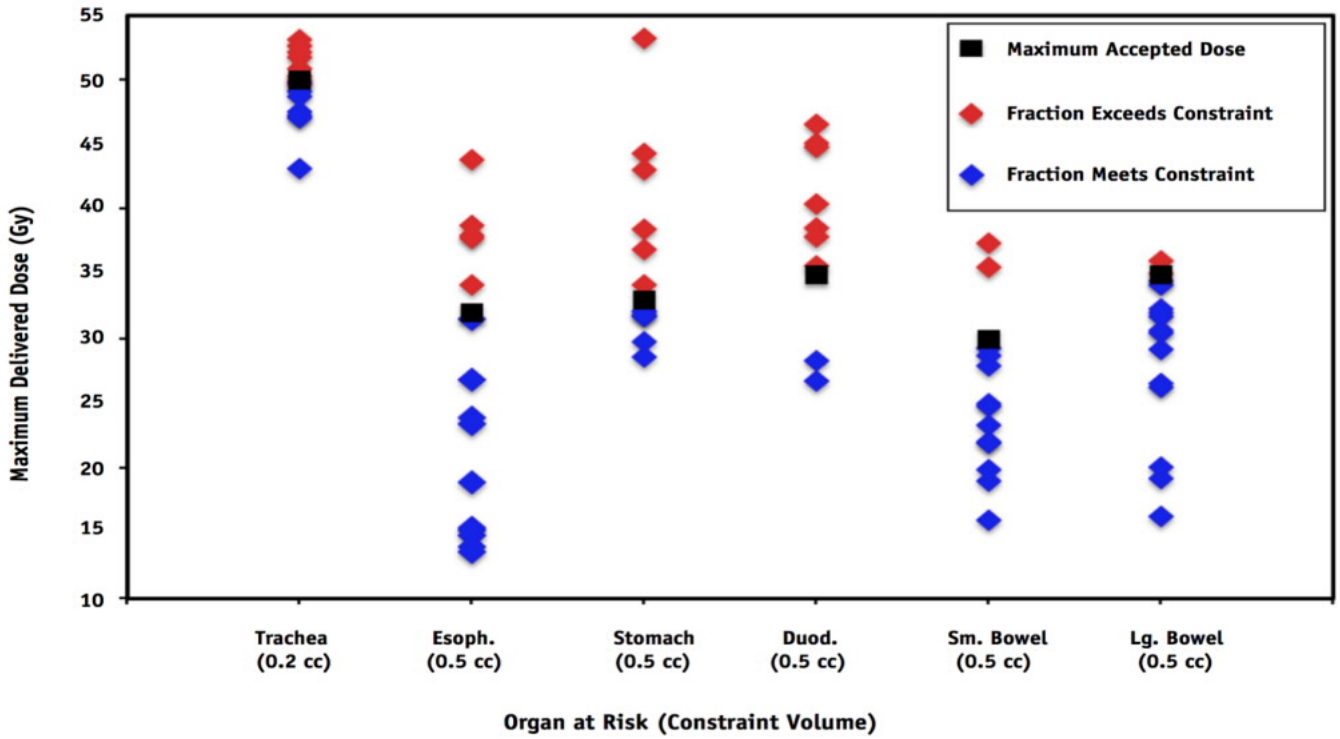
Original Plan

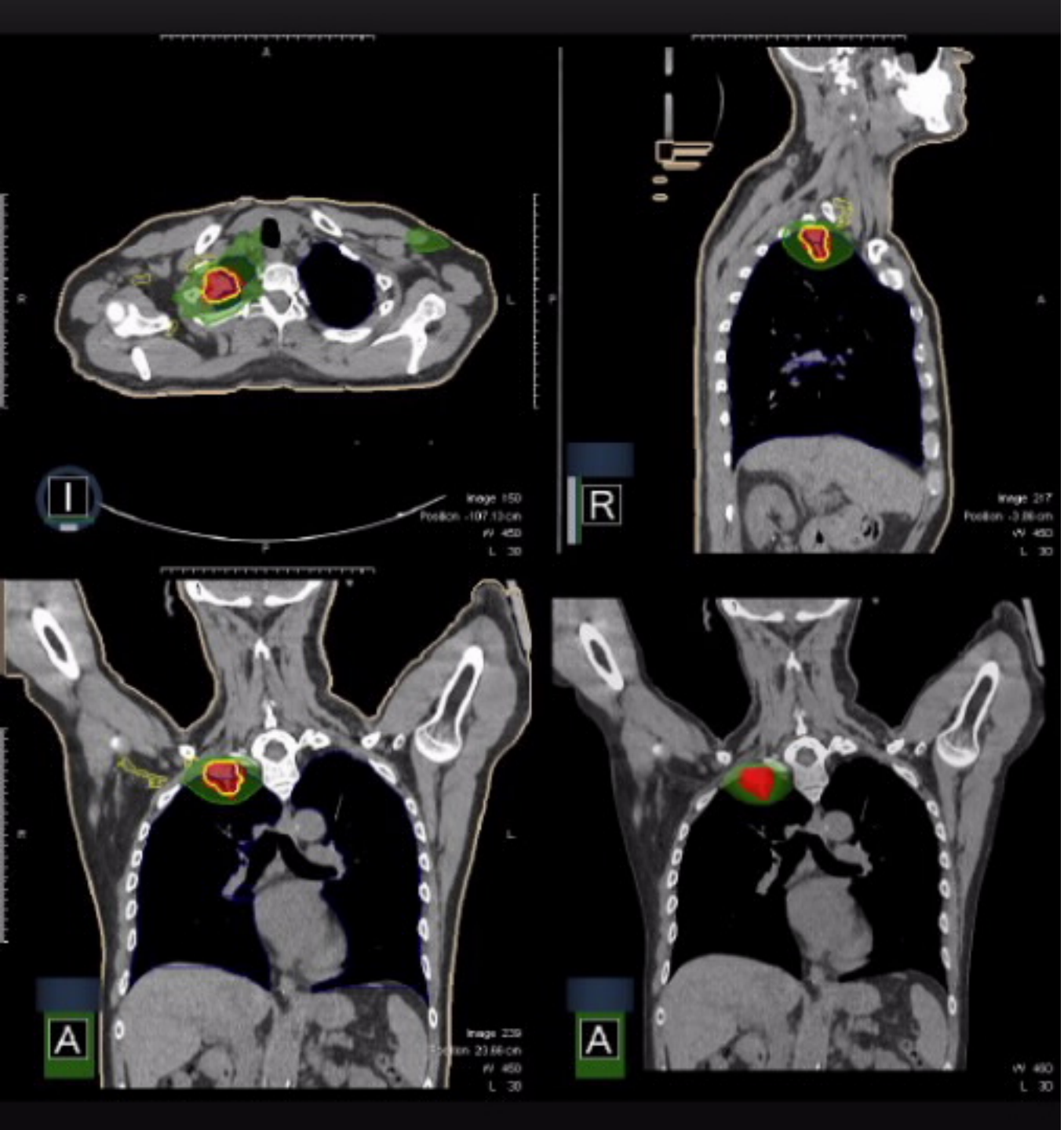
Day of Treatment

Adapted On-Table

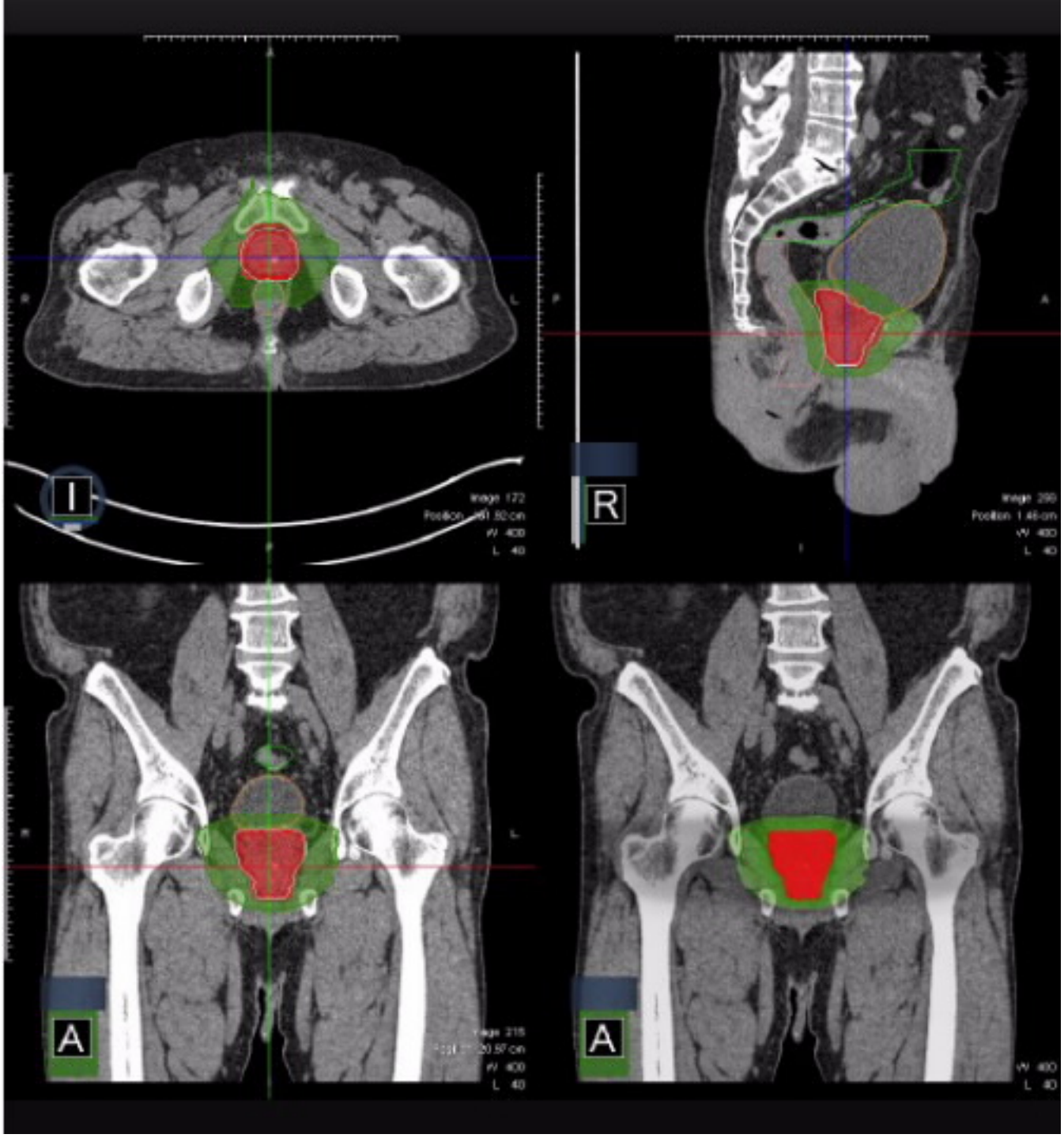
* Henke et al. Int J Radiation Oncol Biol Phys, Vol. 96, No. 5, pp. 1078-1086, 2016

Adaptive Treatment Planning

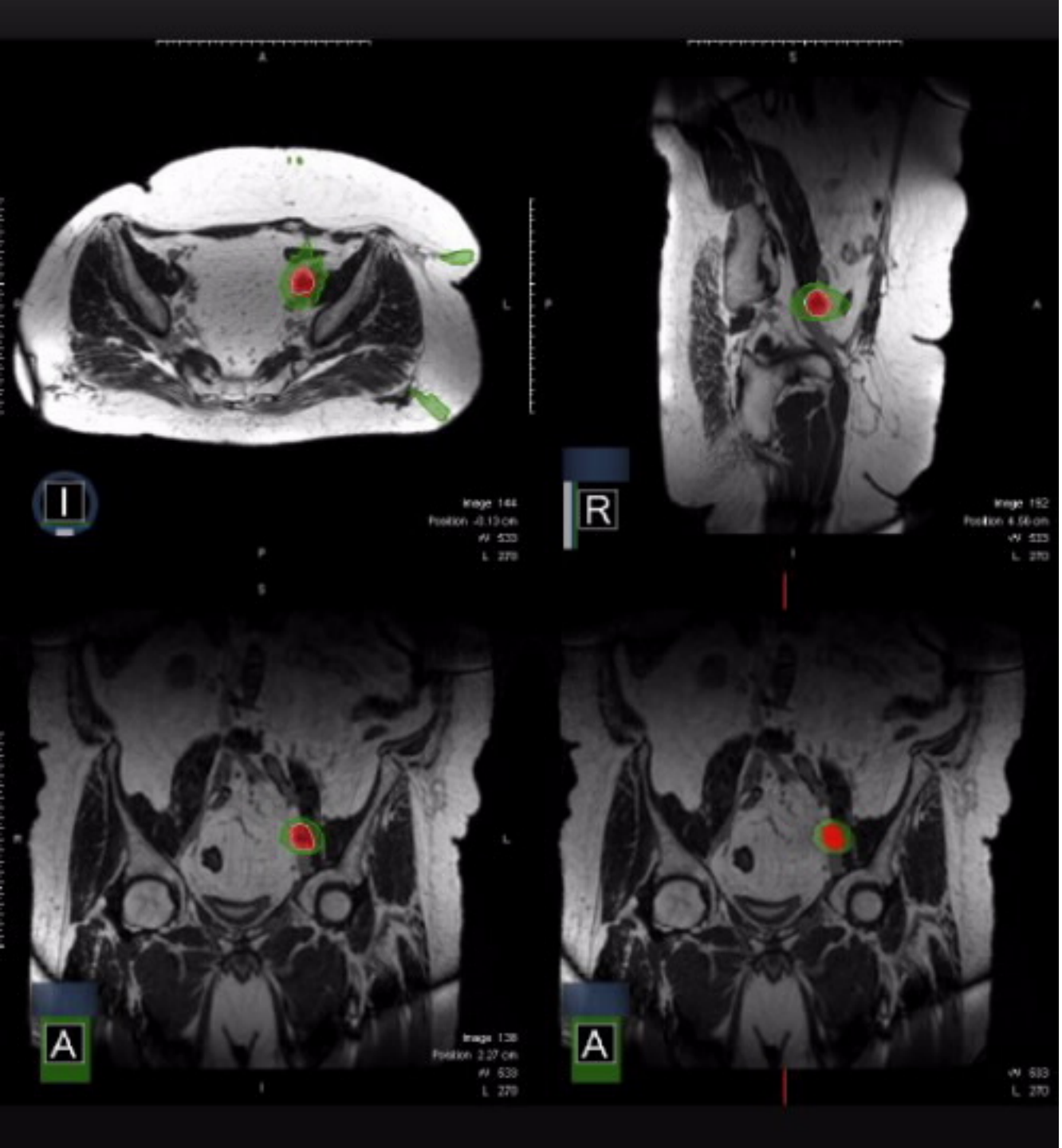




5x1000 cGy

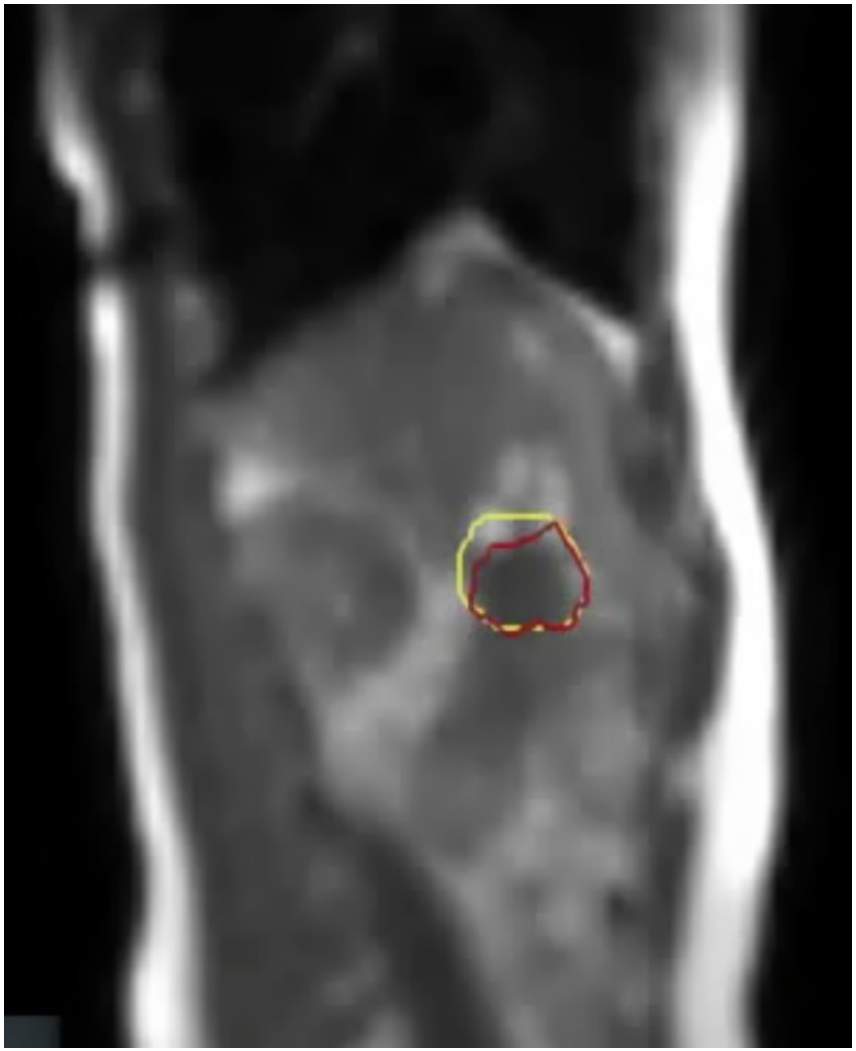


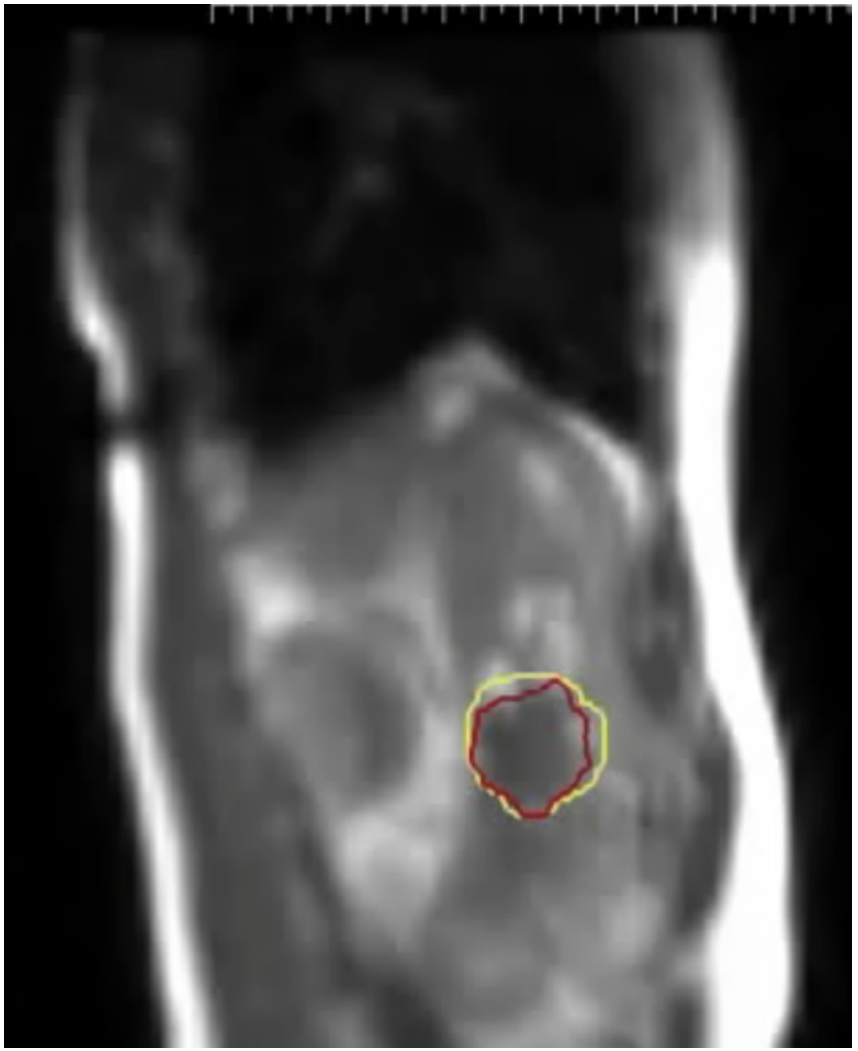
5x725 cGy



Pelvic LN
Re-RT
3x1000 cGy

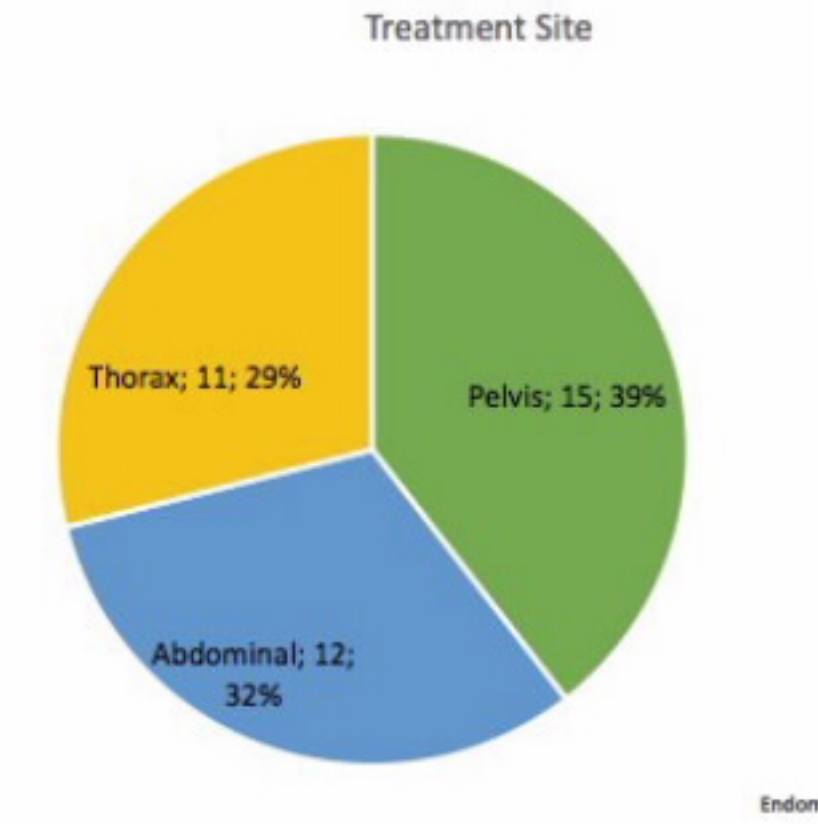
Deep Inspirium vs End-Exhale

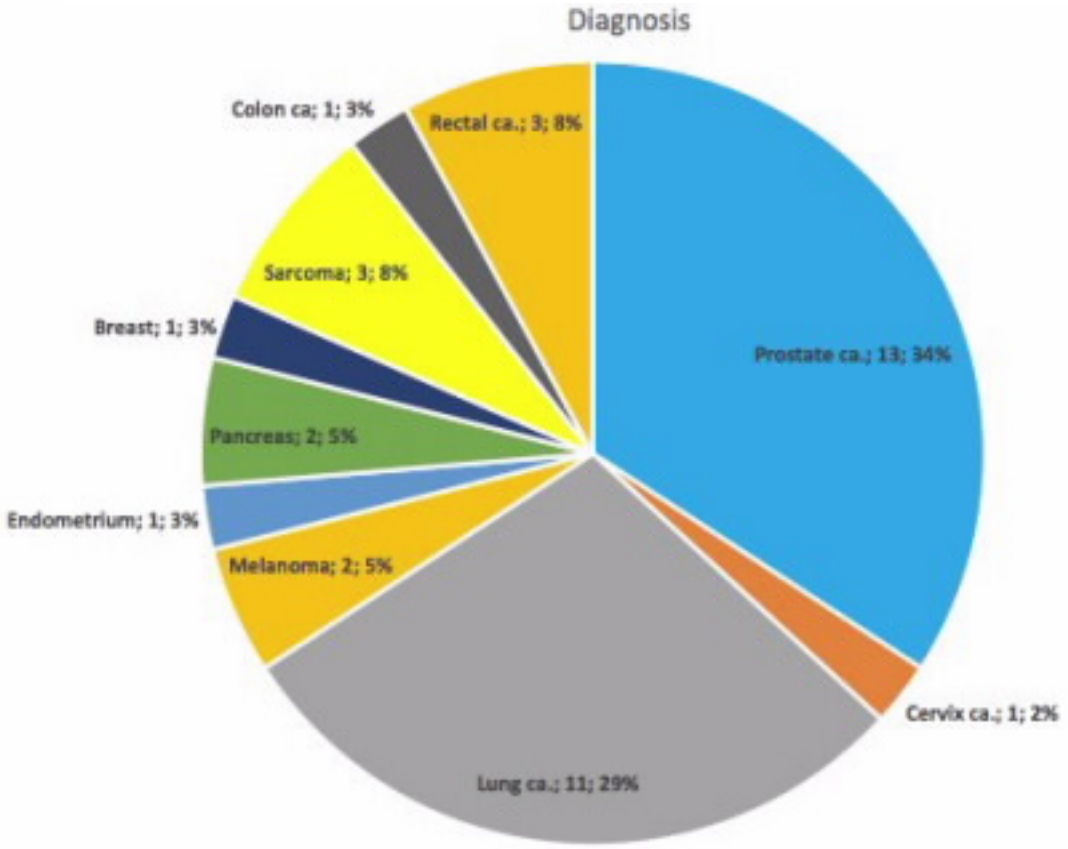




September – December 2018

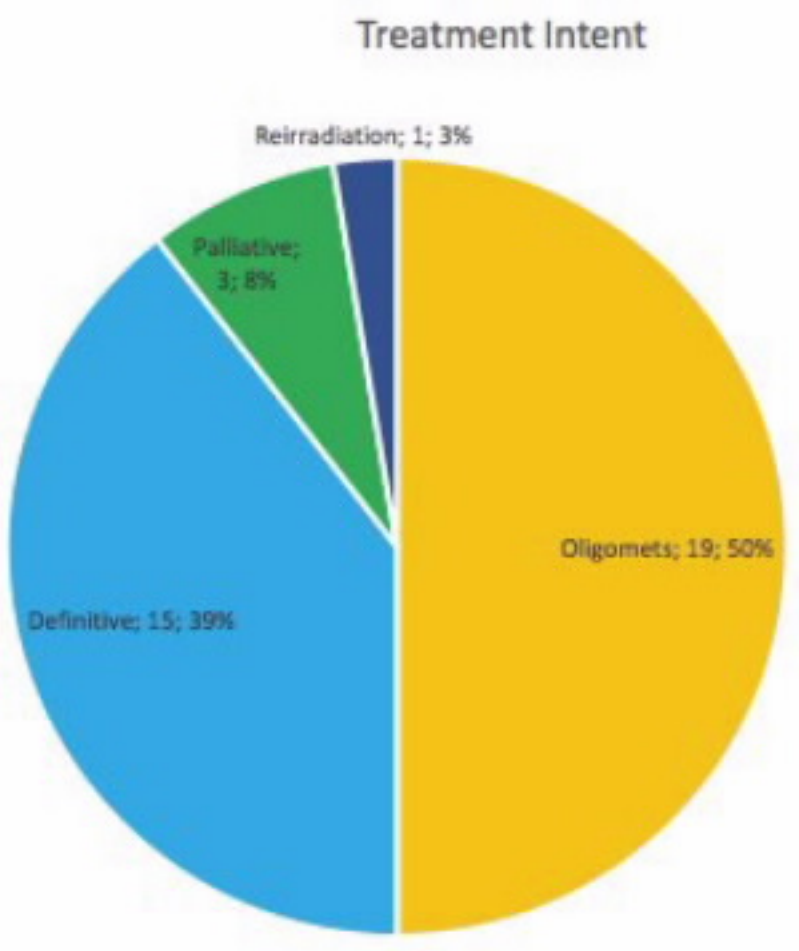
Patient Distribution (33 patients/38 fields/ 208 fractions)





September – December 2018

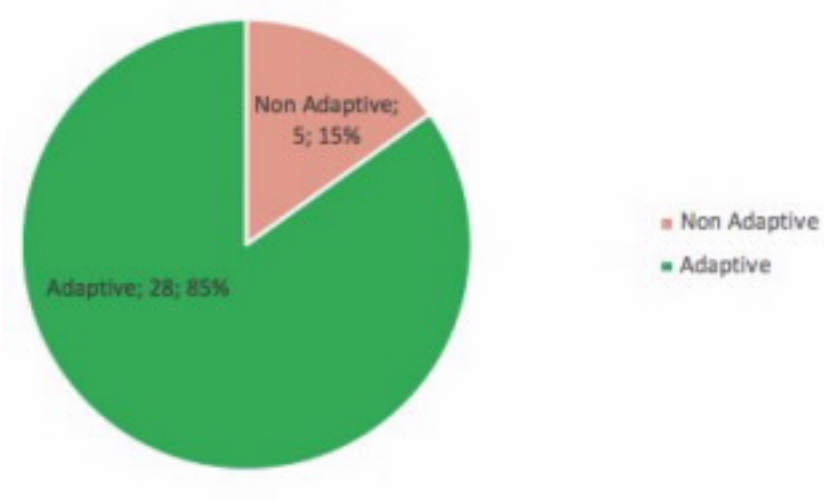
Patient Distribution (33 patients/38 fields/ 208 fractions)

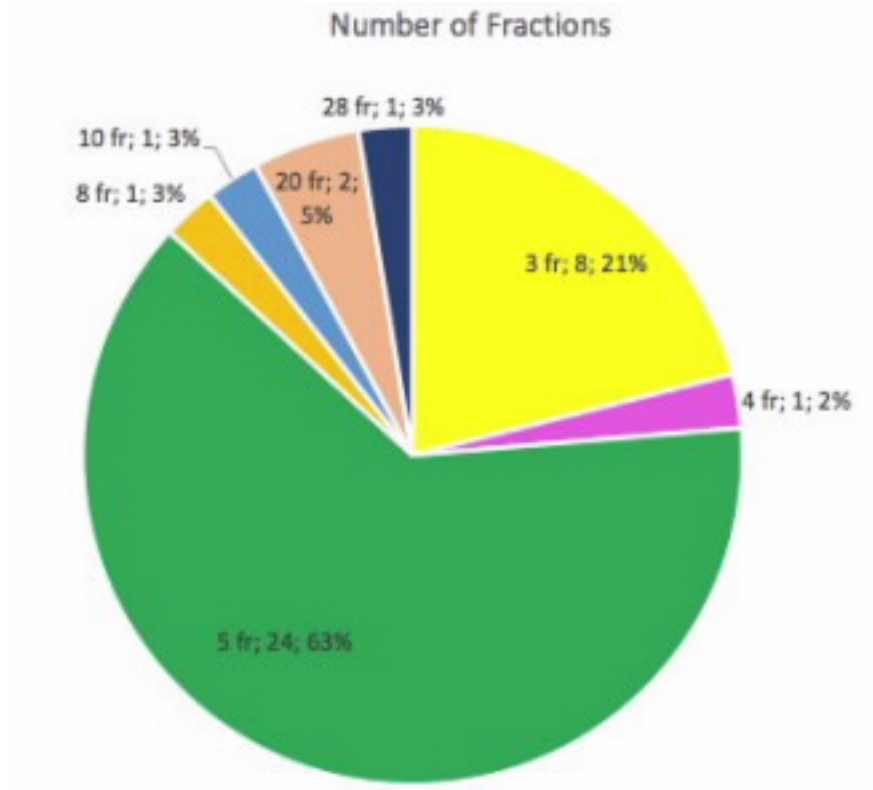


September – December 2018

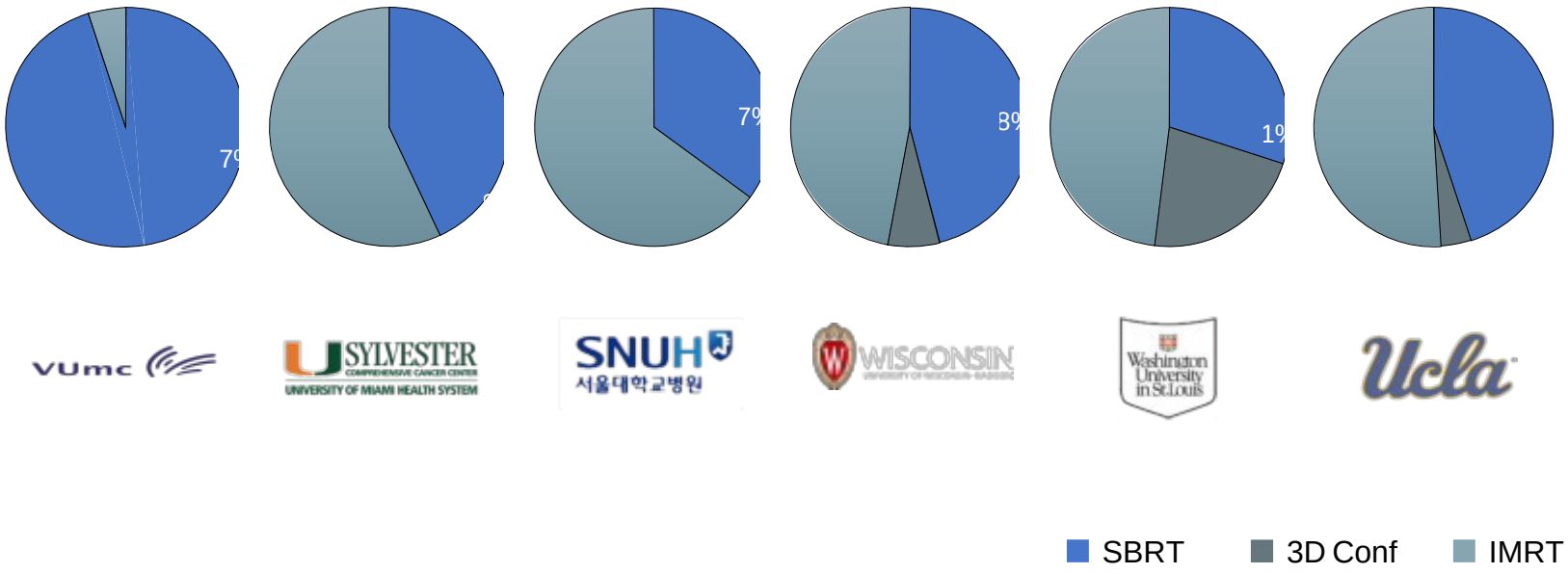
Patient Distribution (33 patients/38 fields/ 208 fractions)

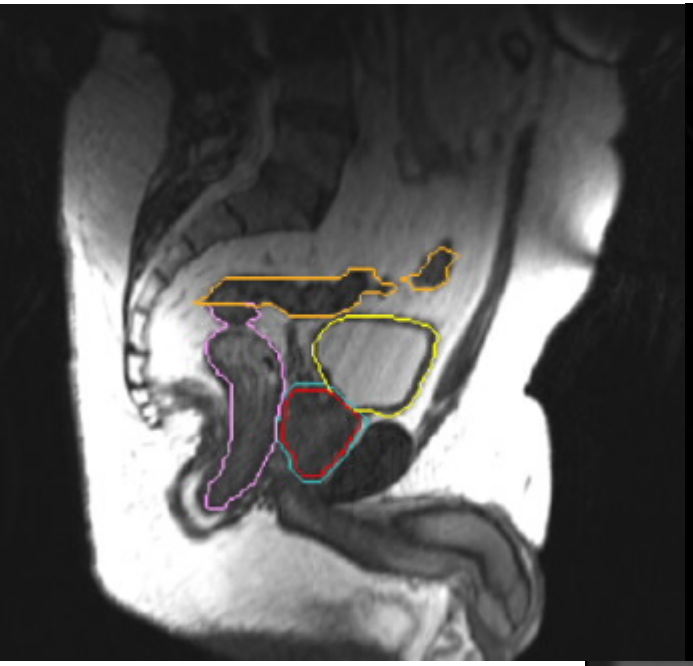
	Median	Range
Dose per Fraction (Gy)	7.25 cGy	2.5-18
Total Dose (Gy)	36.25	21-70
Fraction Number	5	3-28





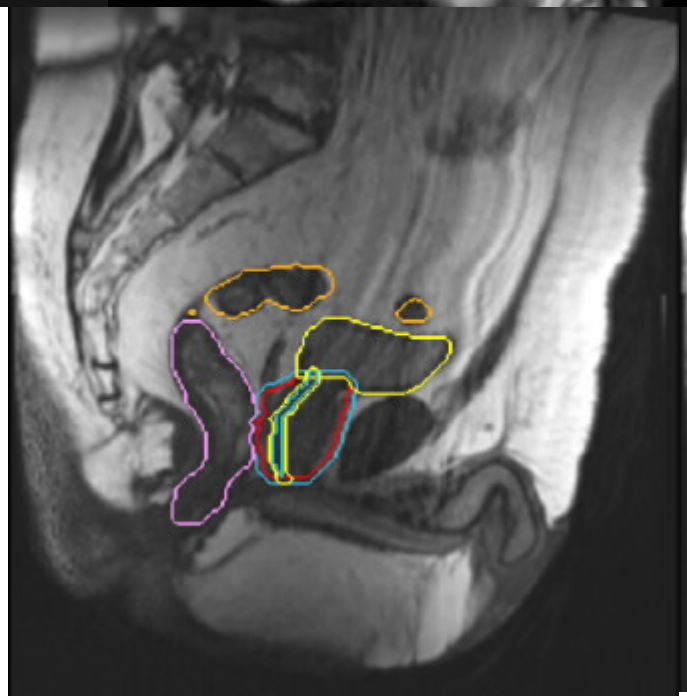
SBRT vs IMRT vs Conventional Radiotherapy

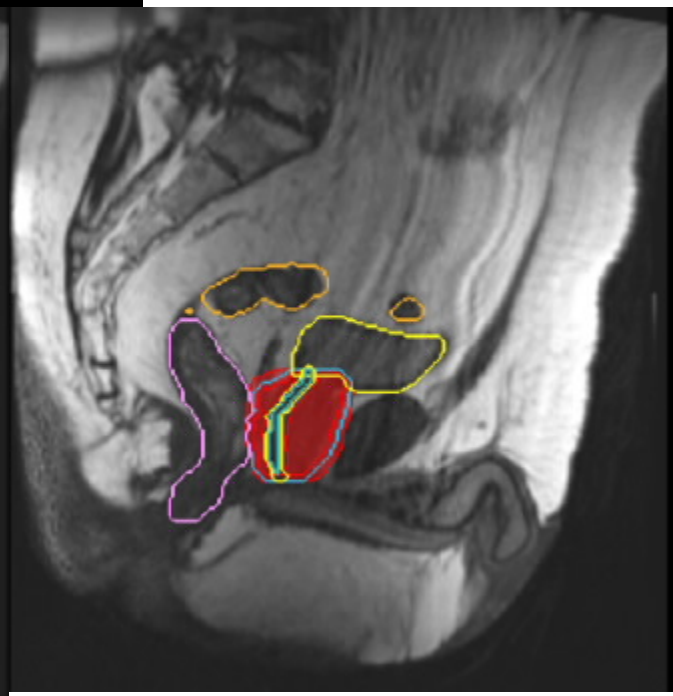




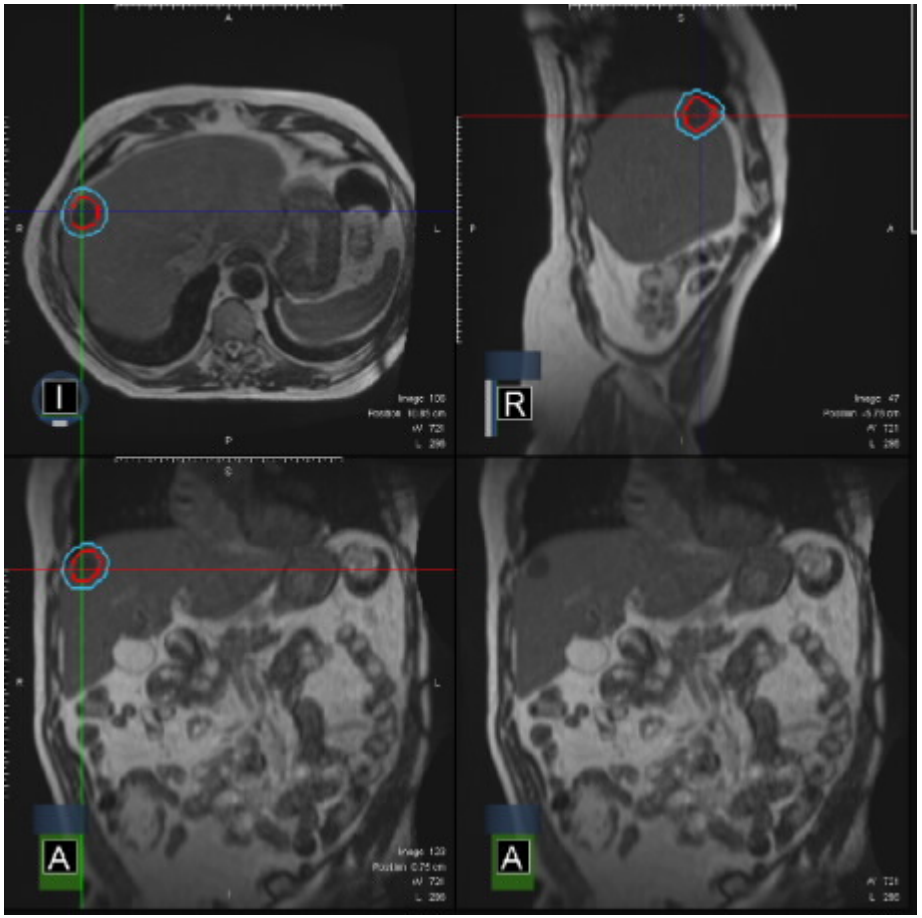
Prostate Cancer
SBRT 5x725 cGy

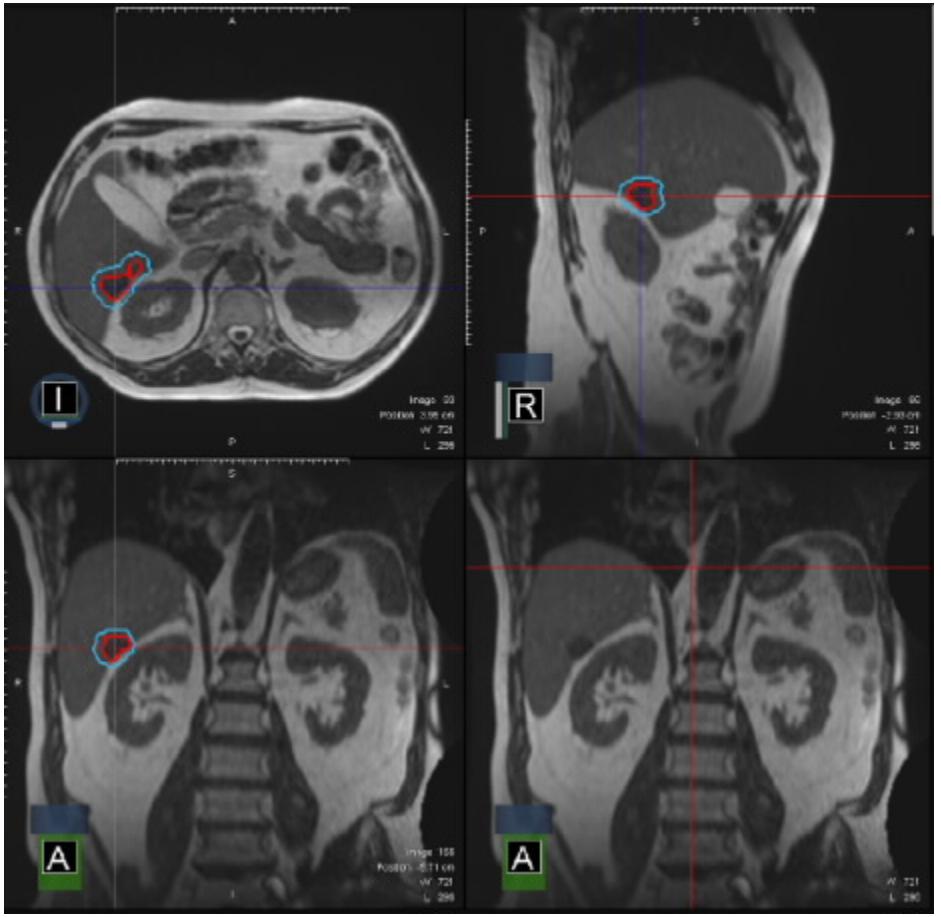
With or without
Urtehral
Sparing



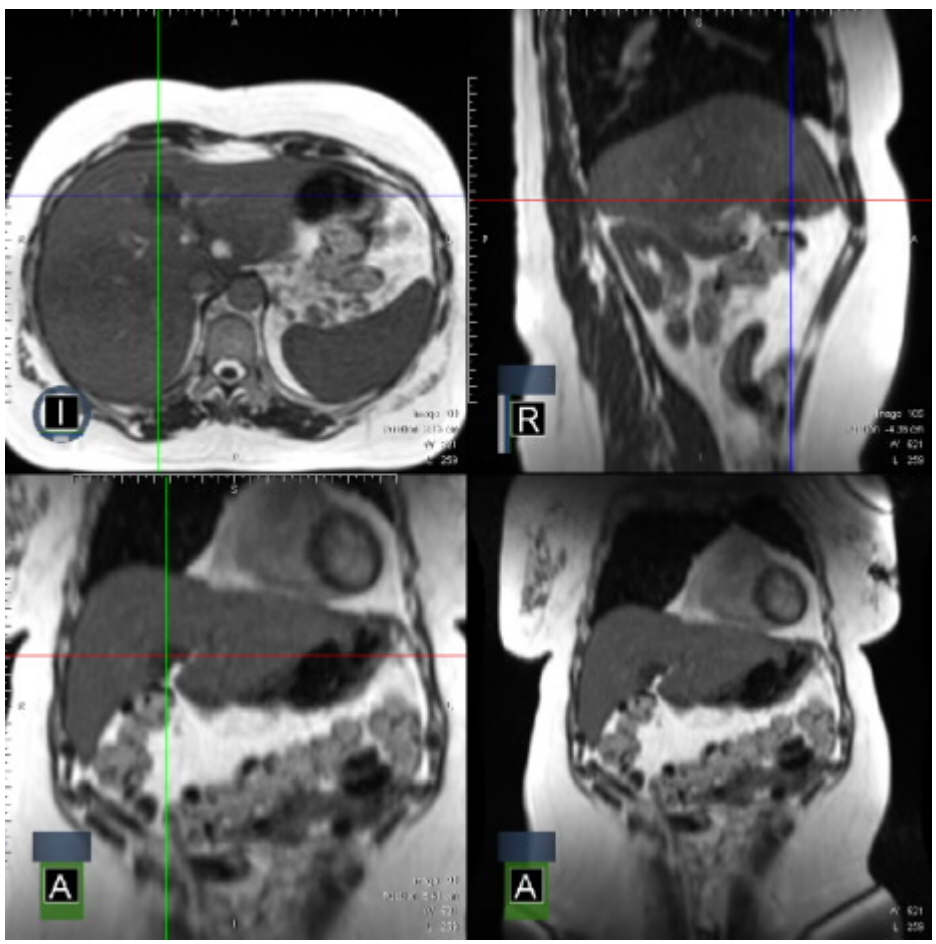


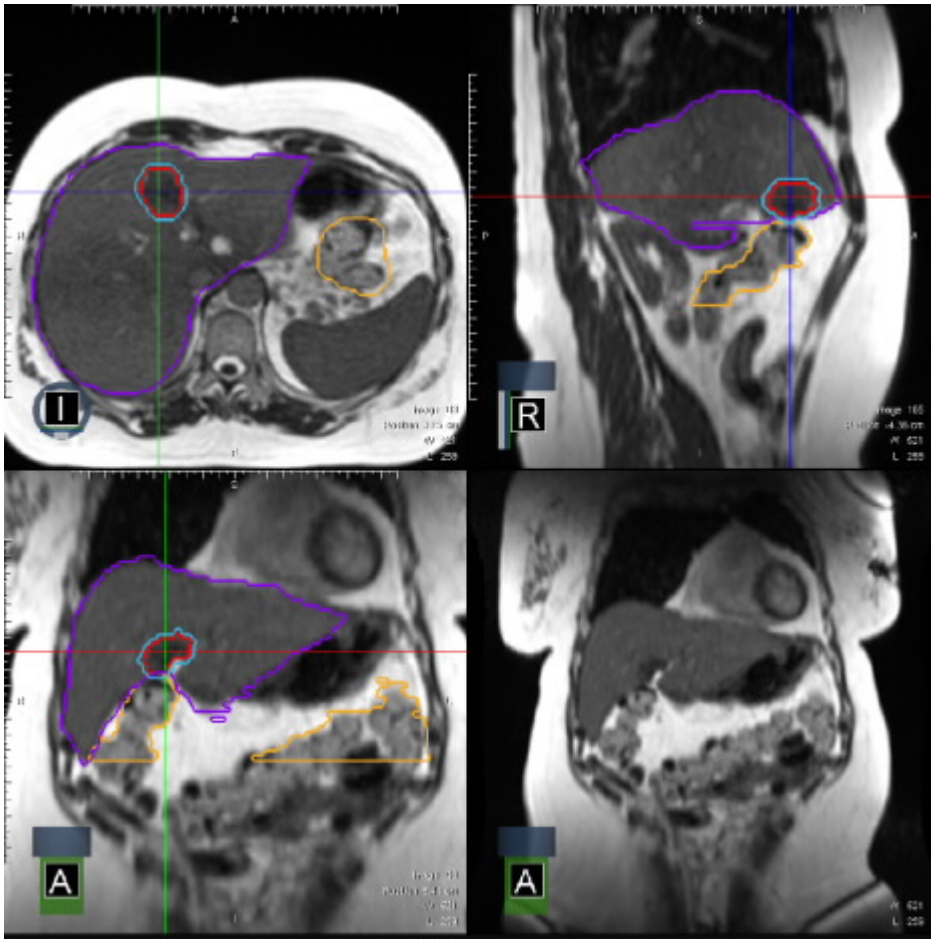
Liver Metastasis - 2 Lesions
SBRT 5x1000 cGy

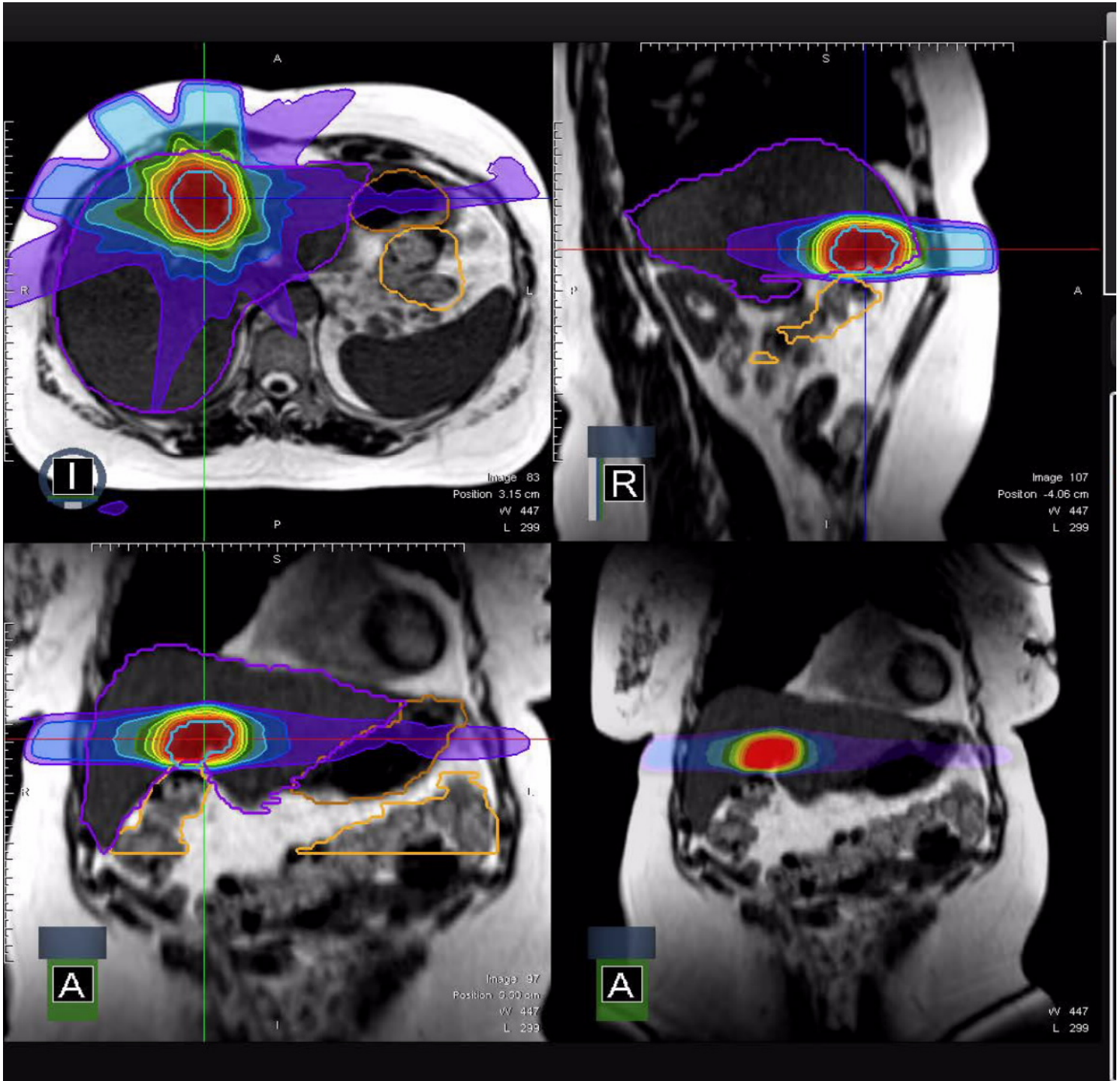




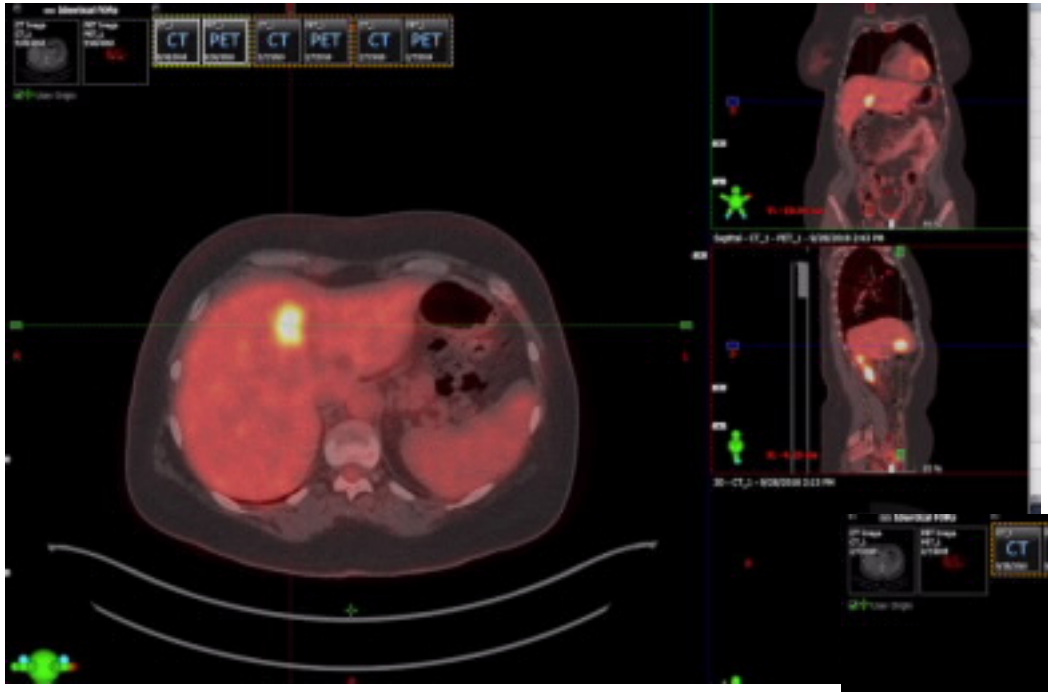
Liver Metastasis
SBRT - 8 x 750 cGy

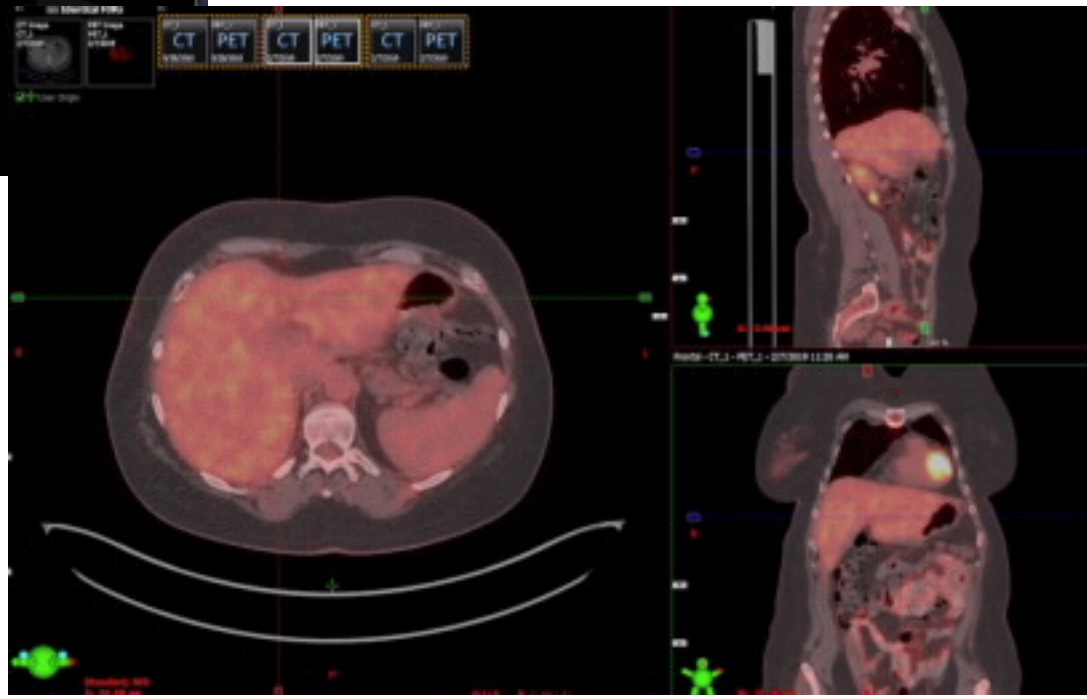




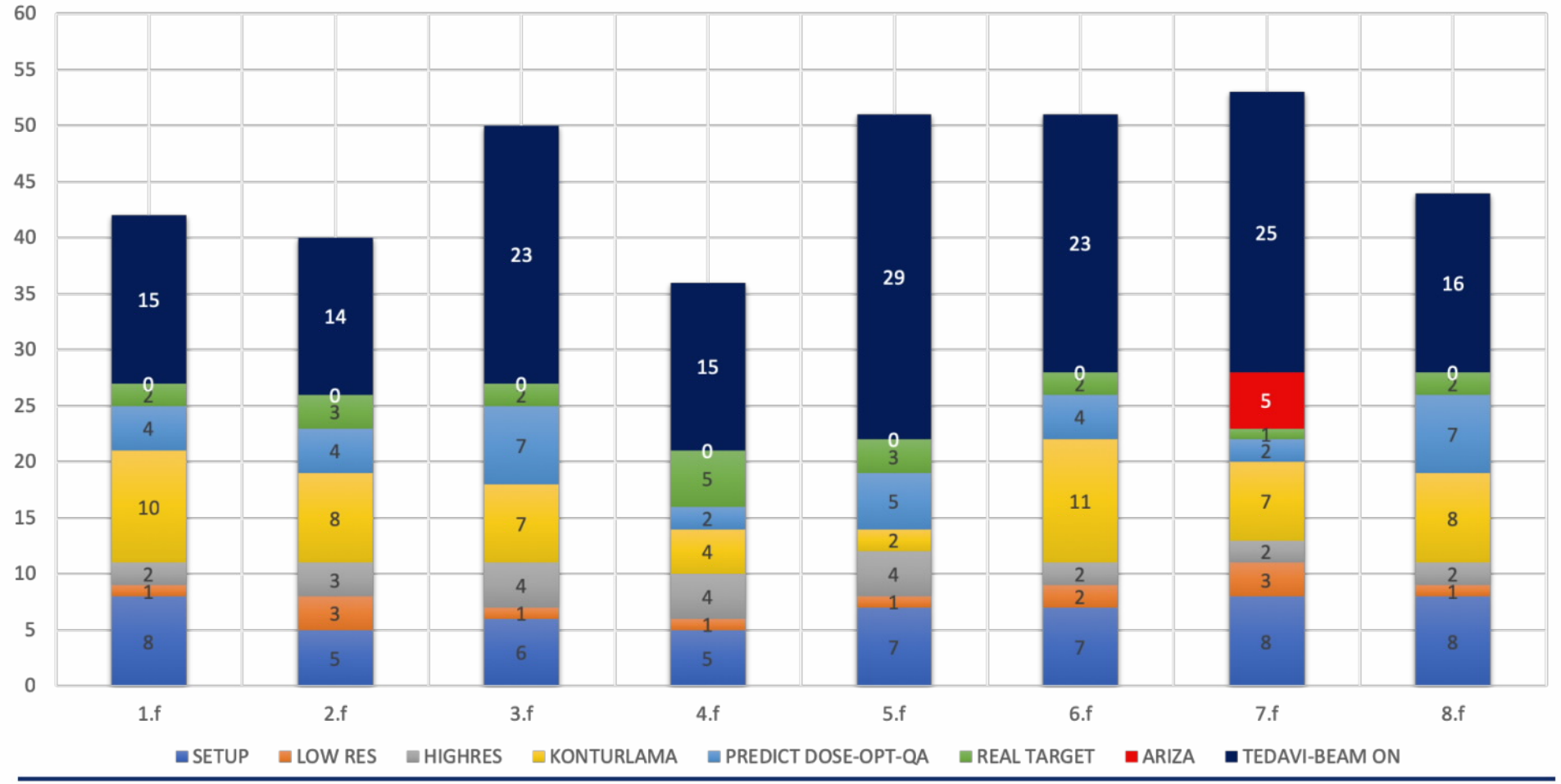

A
R
L
P
I
Image 83
Position 3.15 cm
W 447
L 299
S
P
A
I
R
Image 107
Positon -4.06 cm
W 447
L 299
S
R
I
A
Image 97
Position 0.00 cm
W 447
L 299
A
W 447
L 299

Post SBRT 3. month - CR



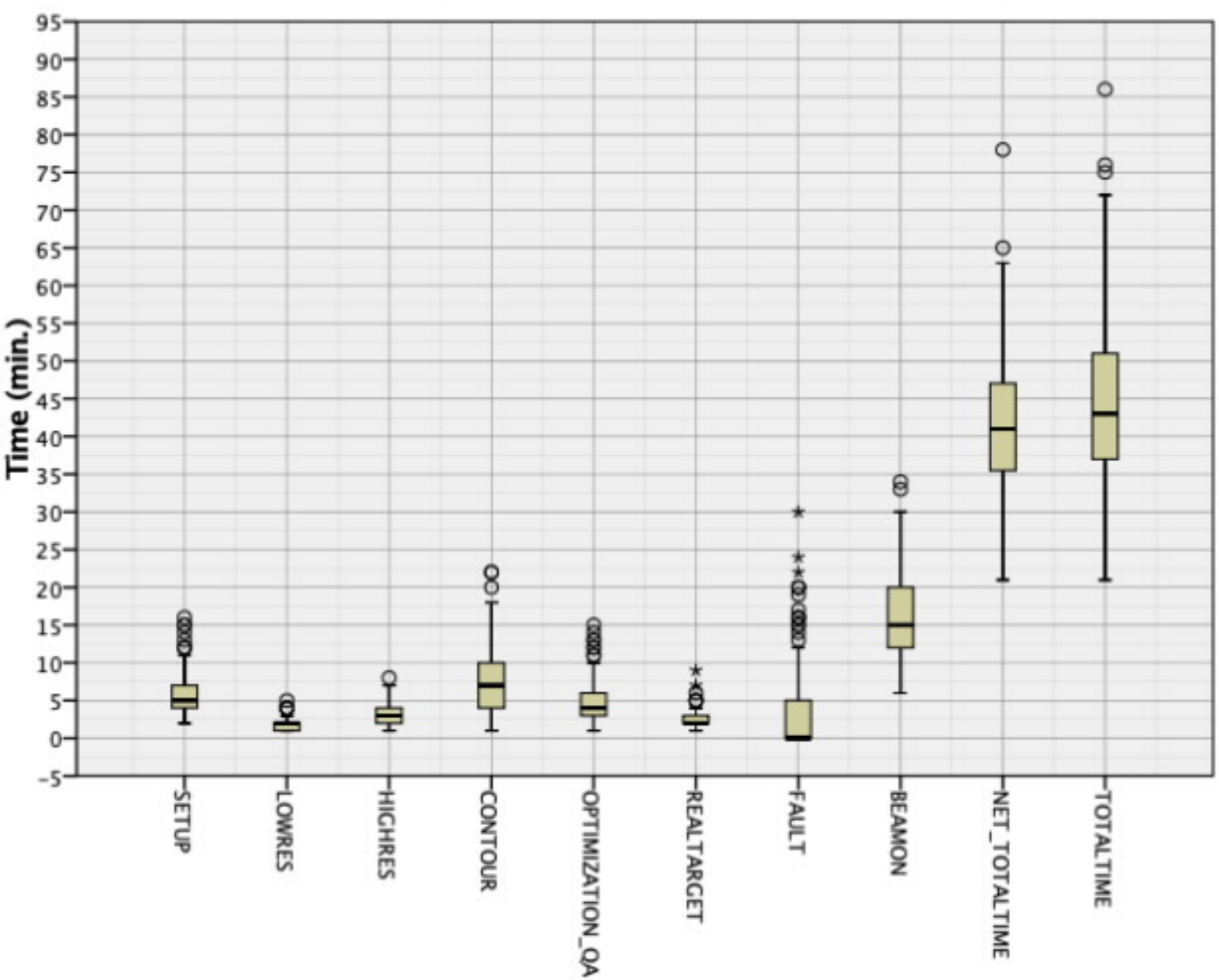


Overall Tx Time for 8 Fractions

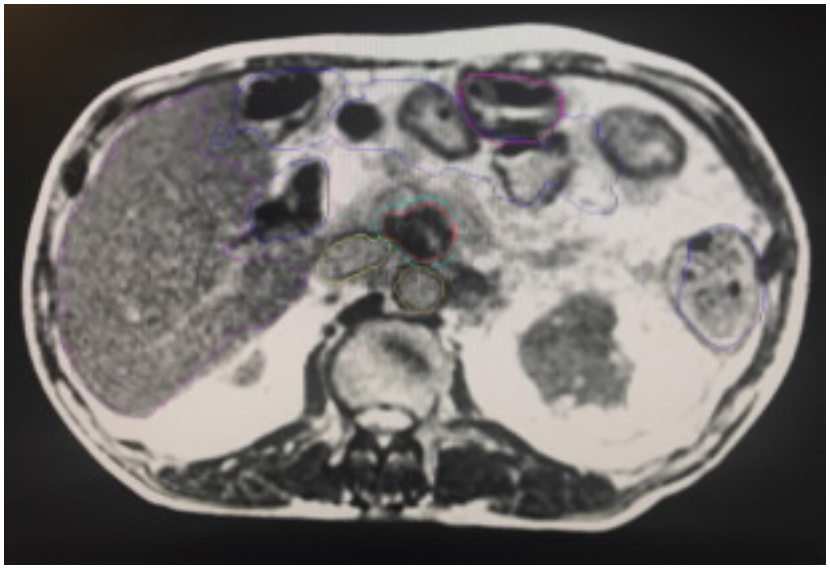


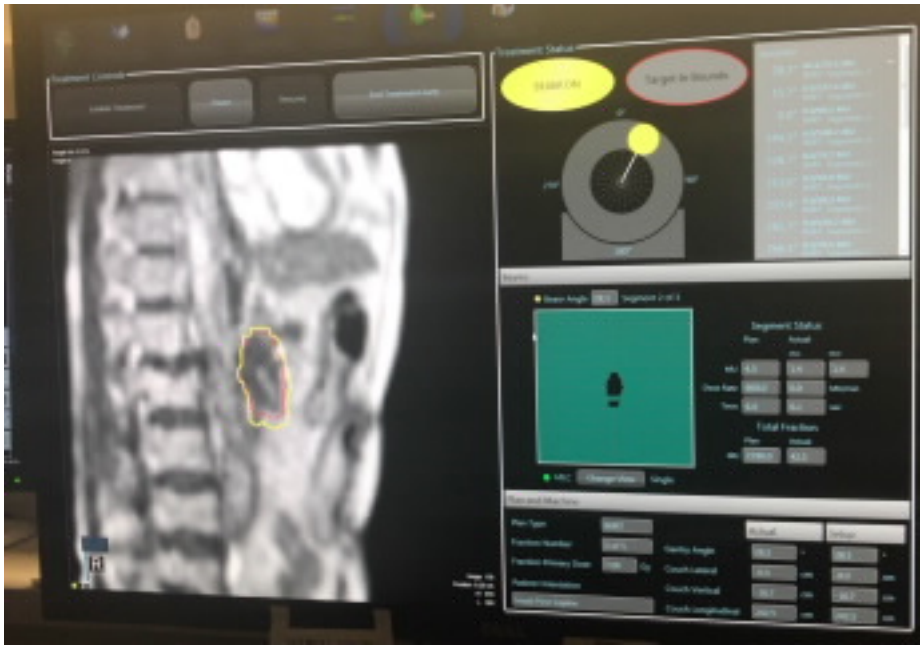
ACIBADEM MEHMET ALİ AYDINLAR UNIVERSITY

10 YEARS

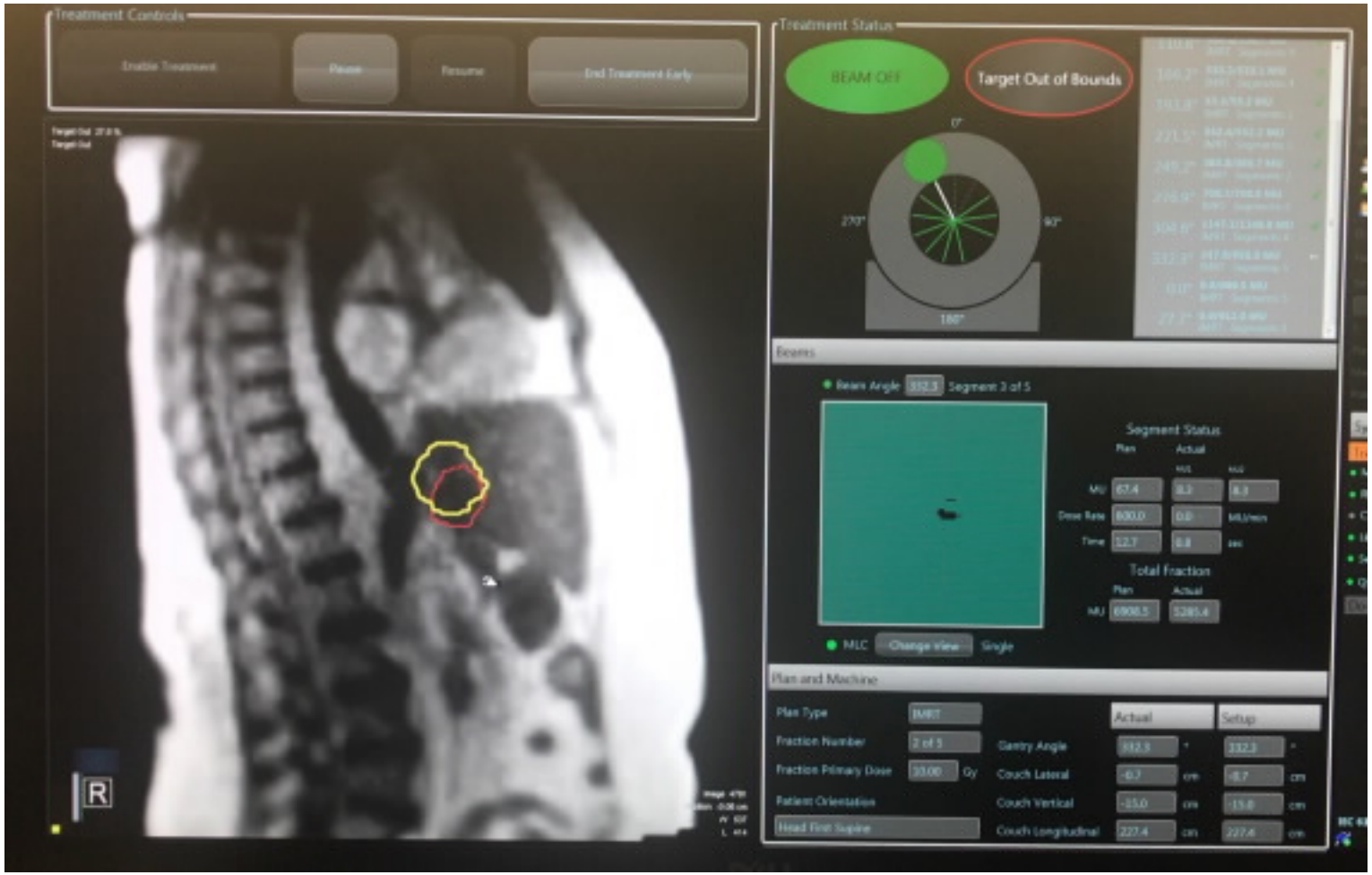

TIME ANALYSIS OF 208 TREATMENT FRACTIONS
Time (min.)
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
SETUP
LOWRES
HIGHRES
CONTOUR
OPTIMIZATION_QA
REALTARGET
FAULT
BEAMON
NET_TOTALTIME
TOTALTIME

Pancreatic cancer, local recurrence after Sx+CT+RT

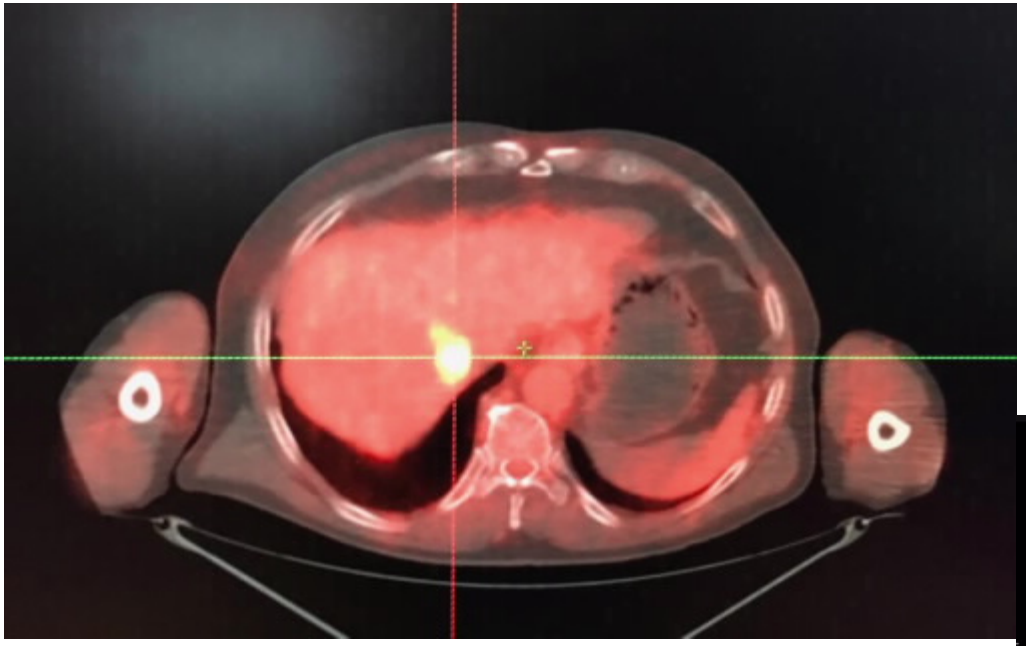


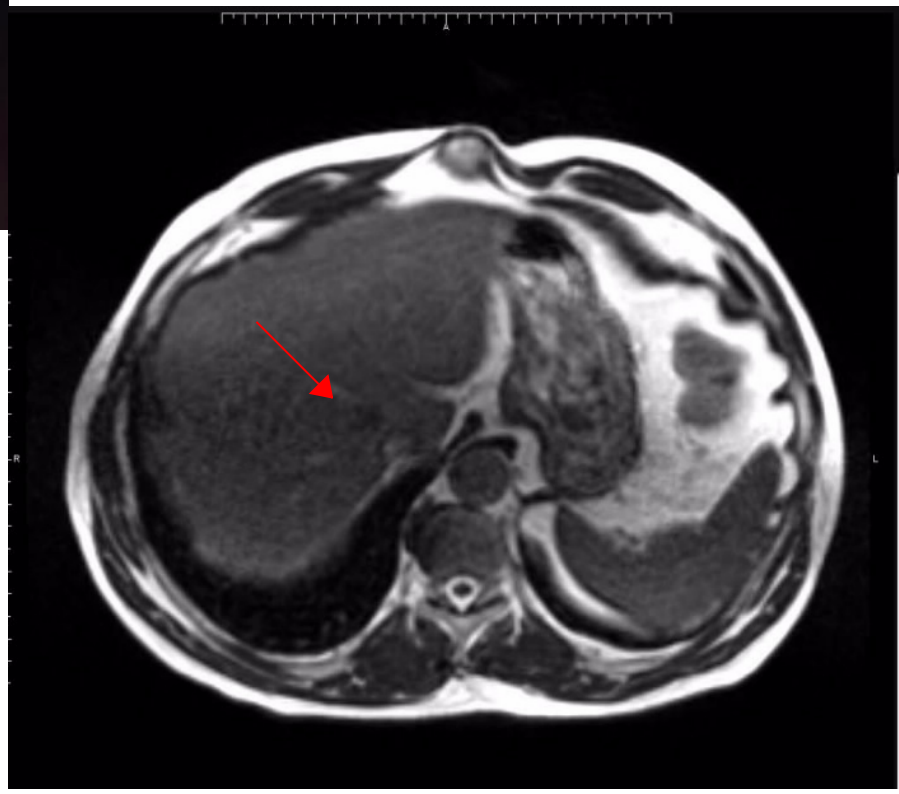


Ovarian ca, Liver met

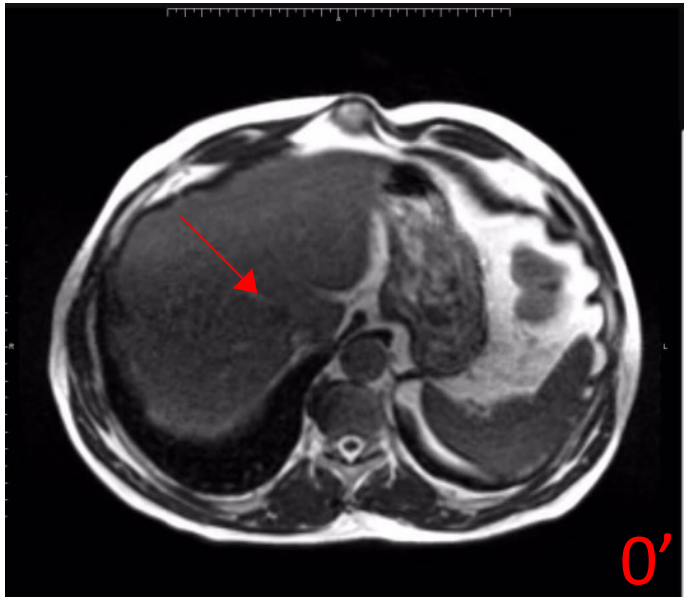


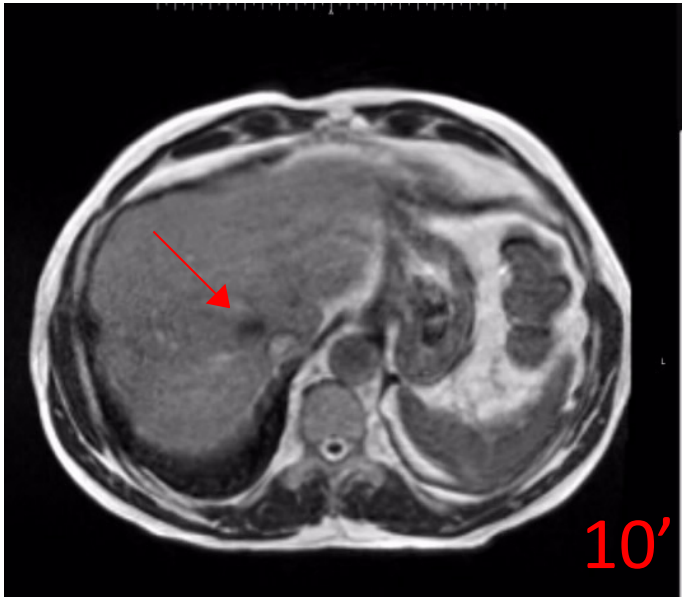
Invisible Liver Metastasis

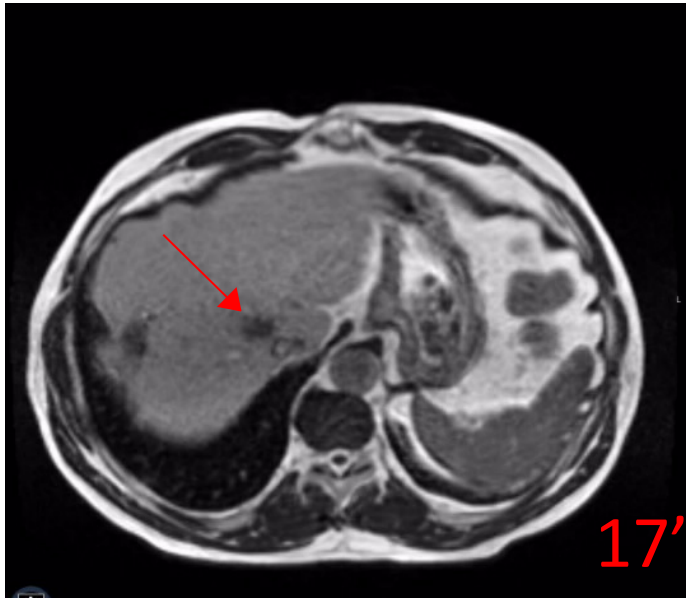


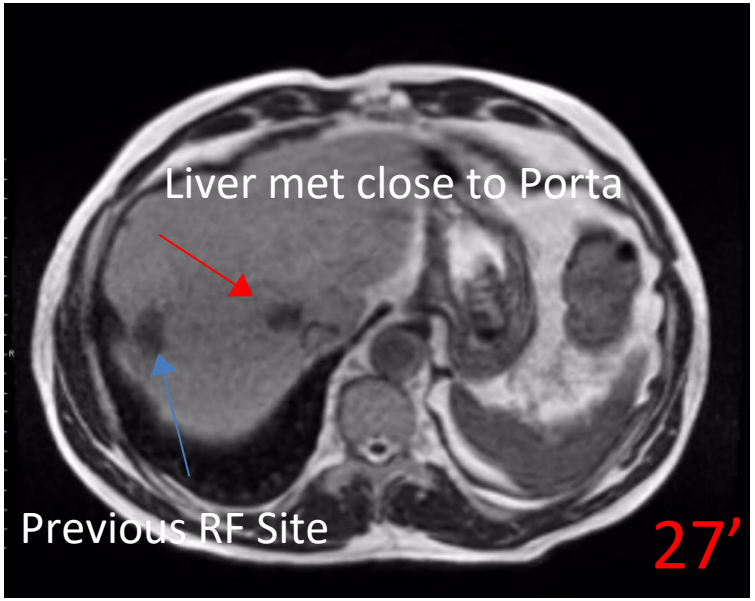


0-27 Minutes After Gadoxetate (Primovist)

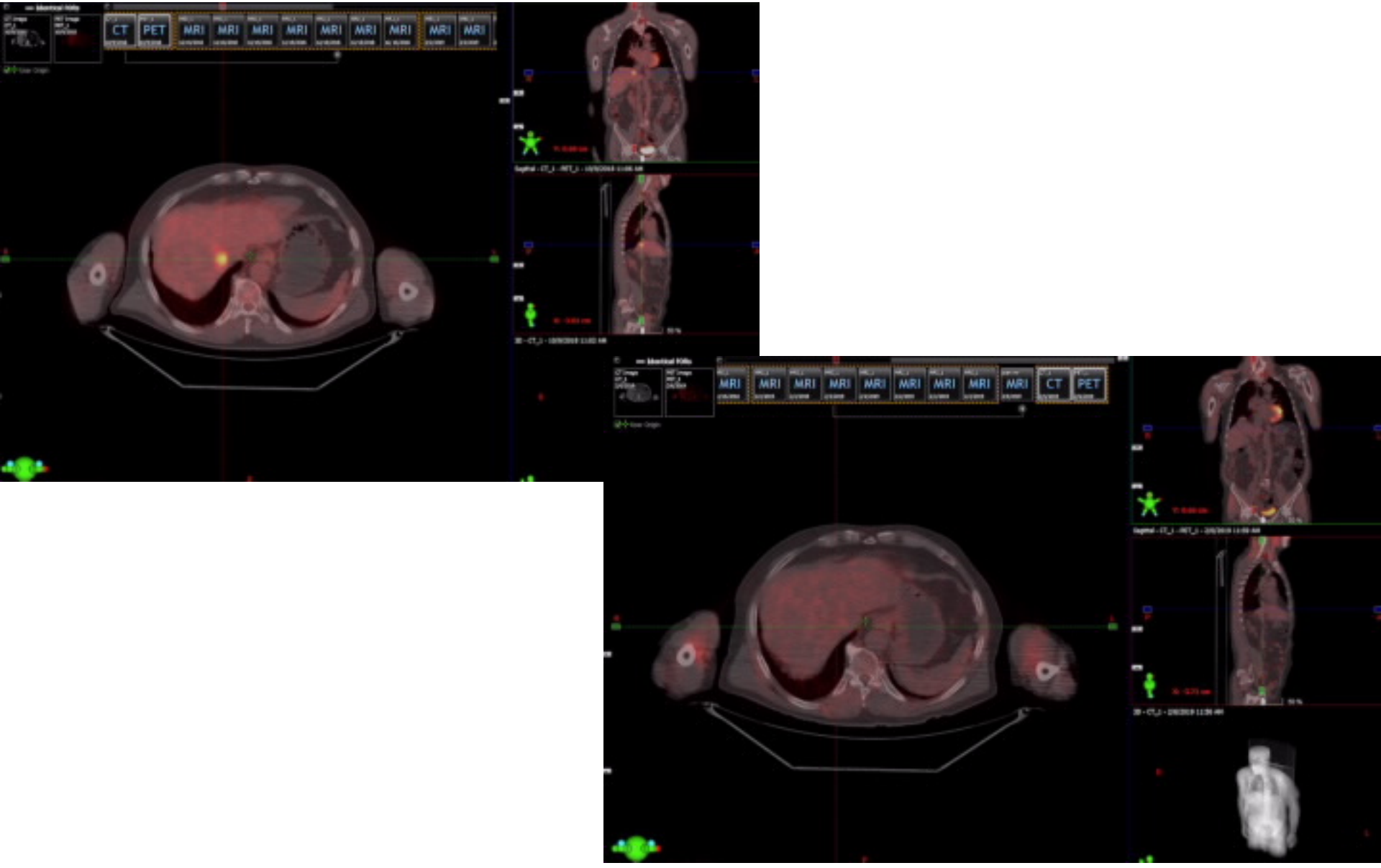




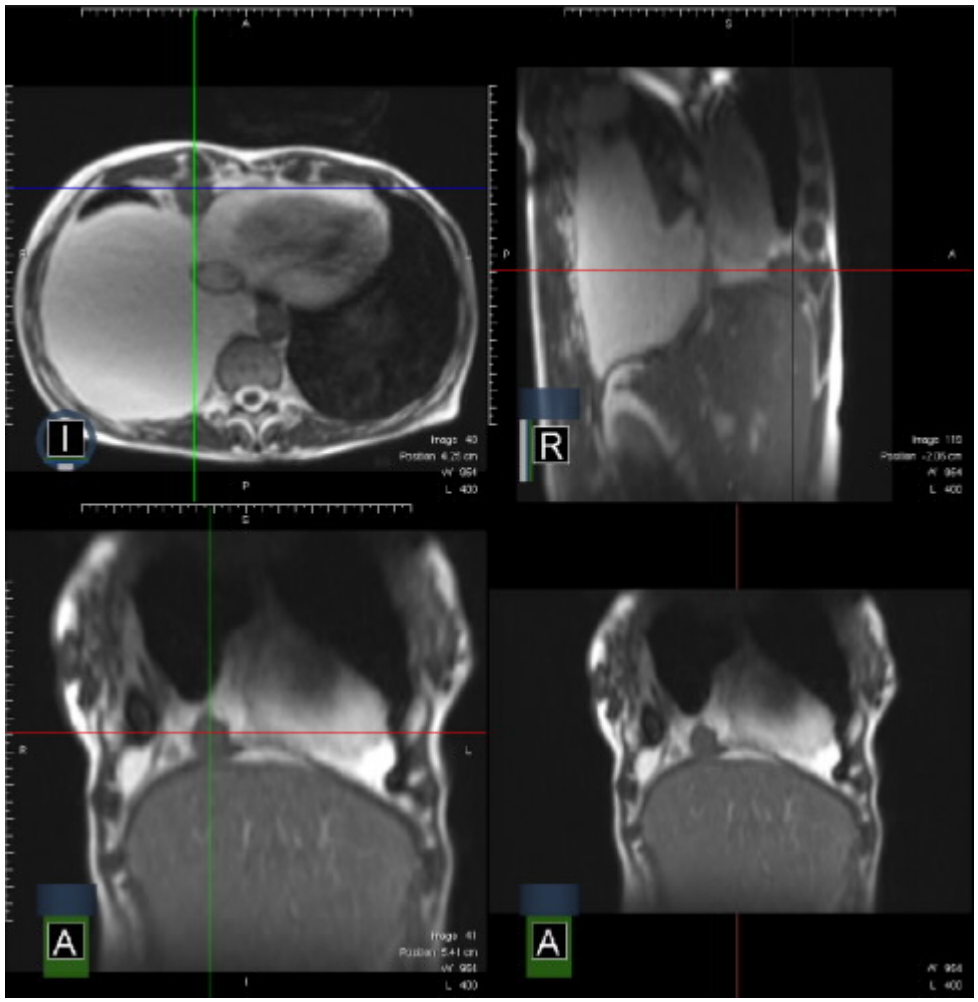


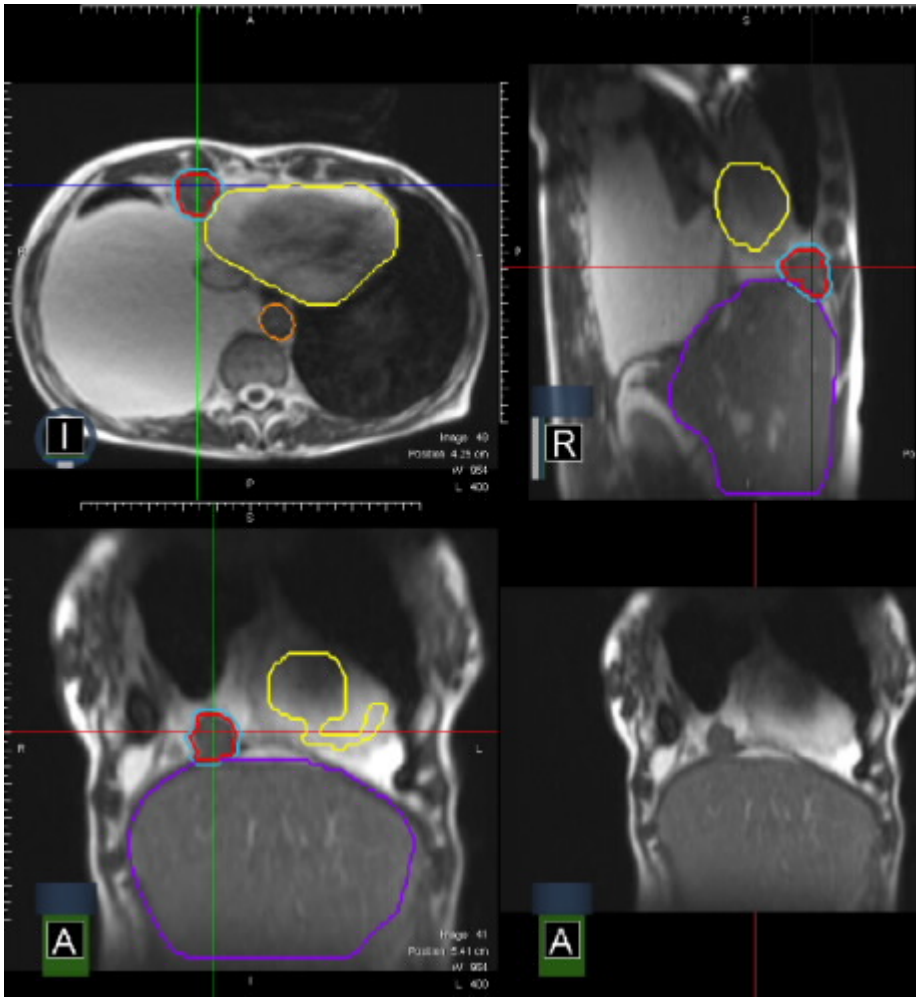


Post SBRT 3 months - CR

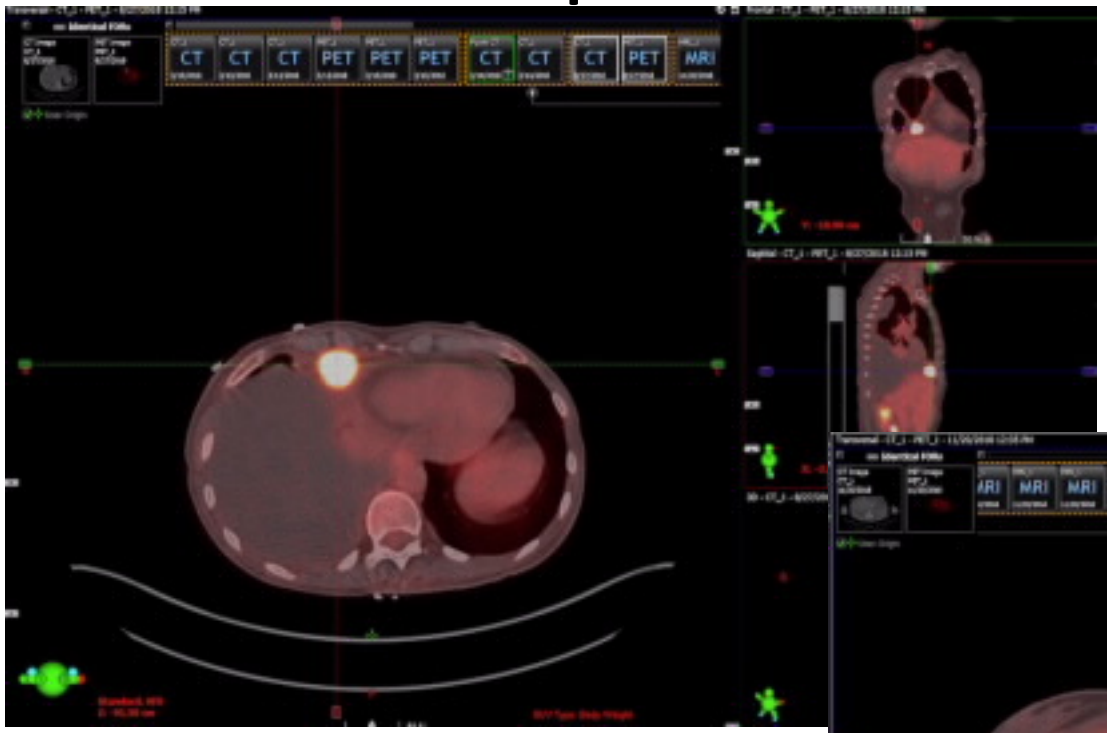


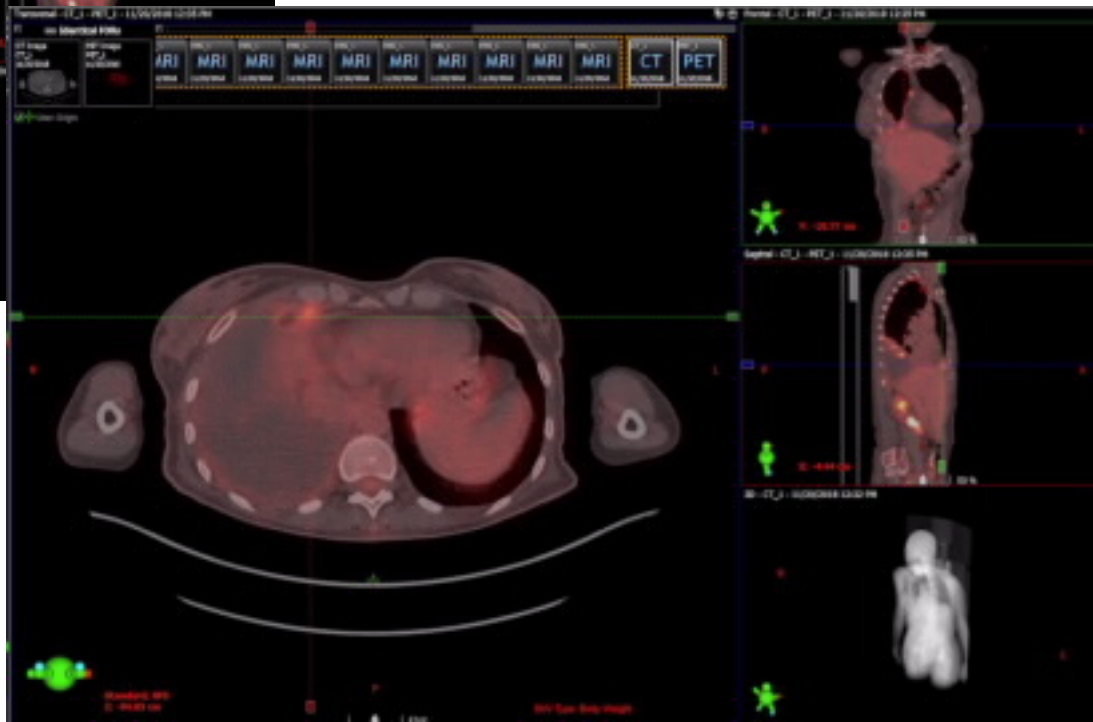
Oligometastatic Lung adenoca
SBRT





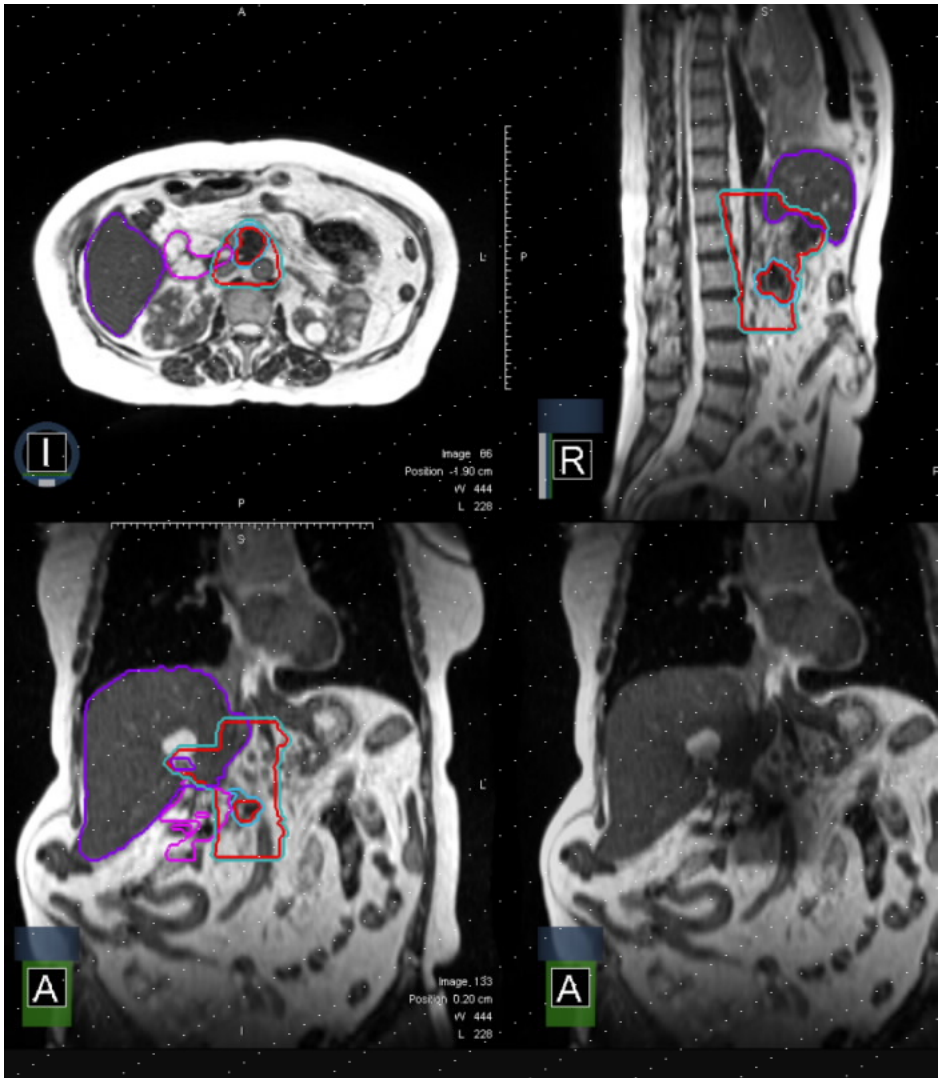
Oligometastatic Lung Adeno ca Response 3 Months Later

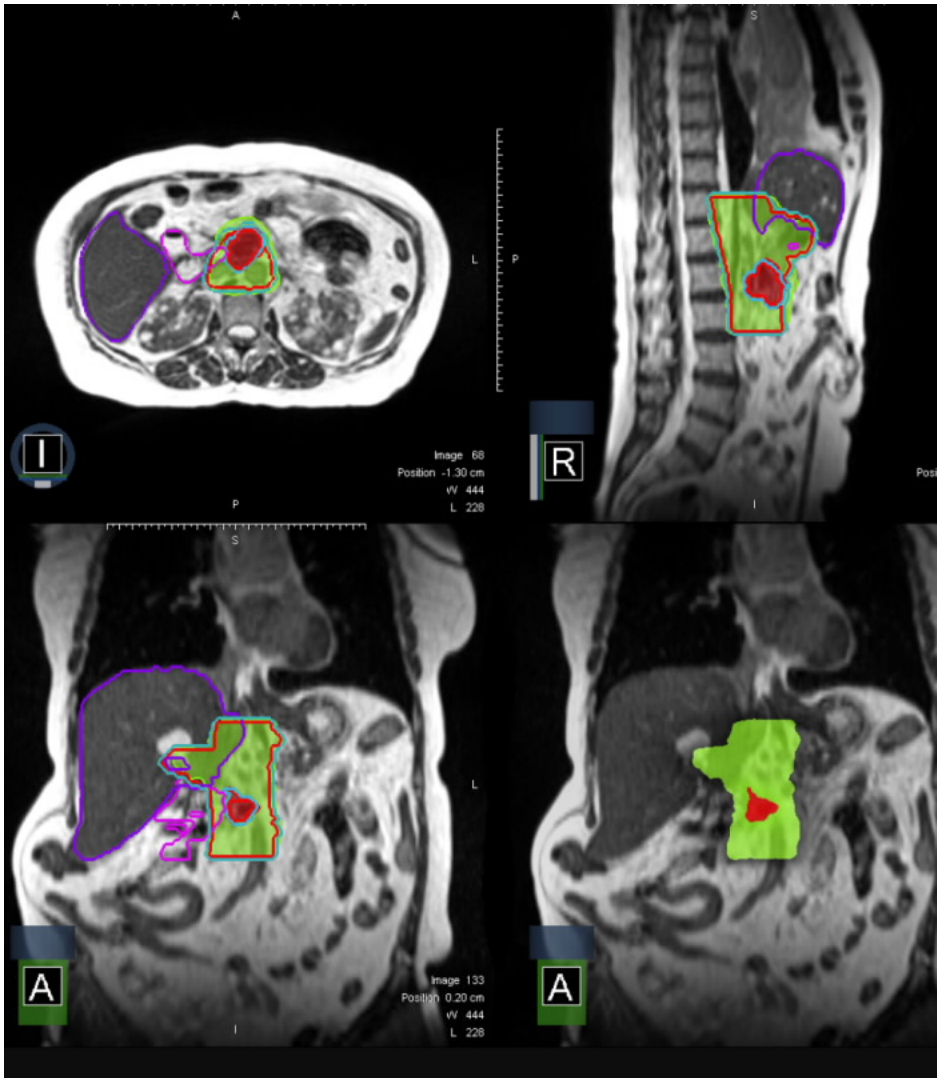




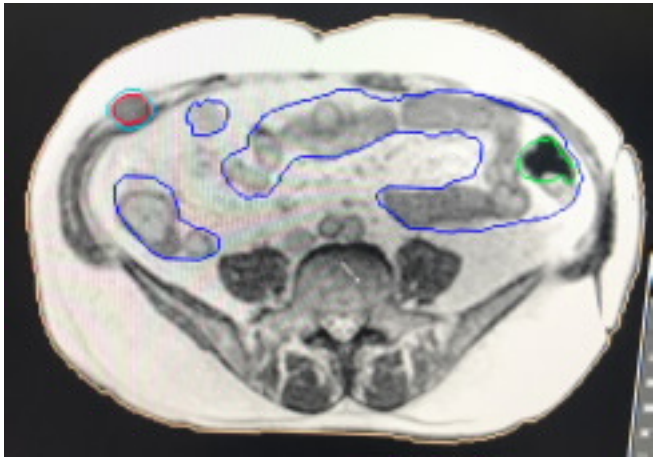
Pancreatic Cancer – SBRT 5 x 800 cGy

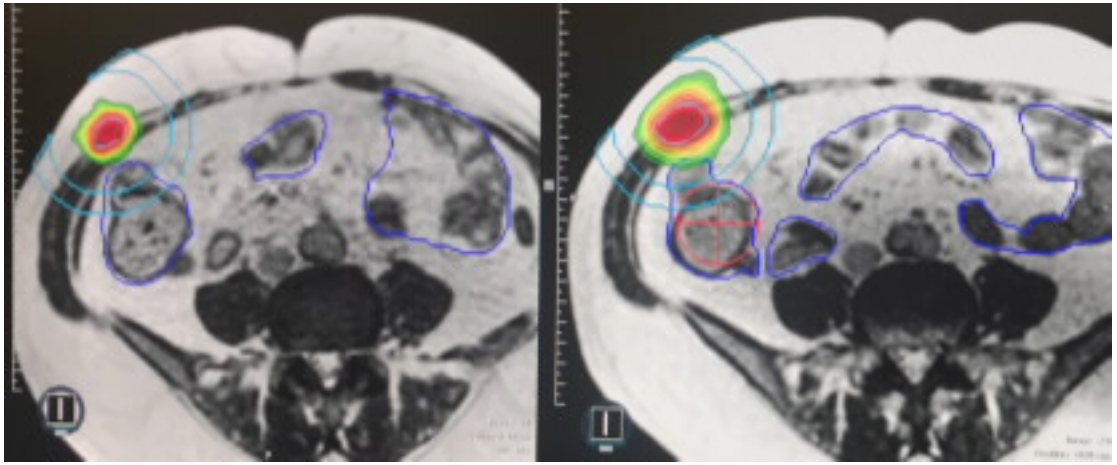
Ampullary Cancer, Postop Recurrent
SIB: 4/3 Gy x 15 Fr: 60/45 Gy + Capec.

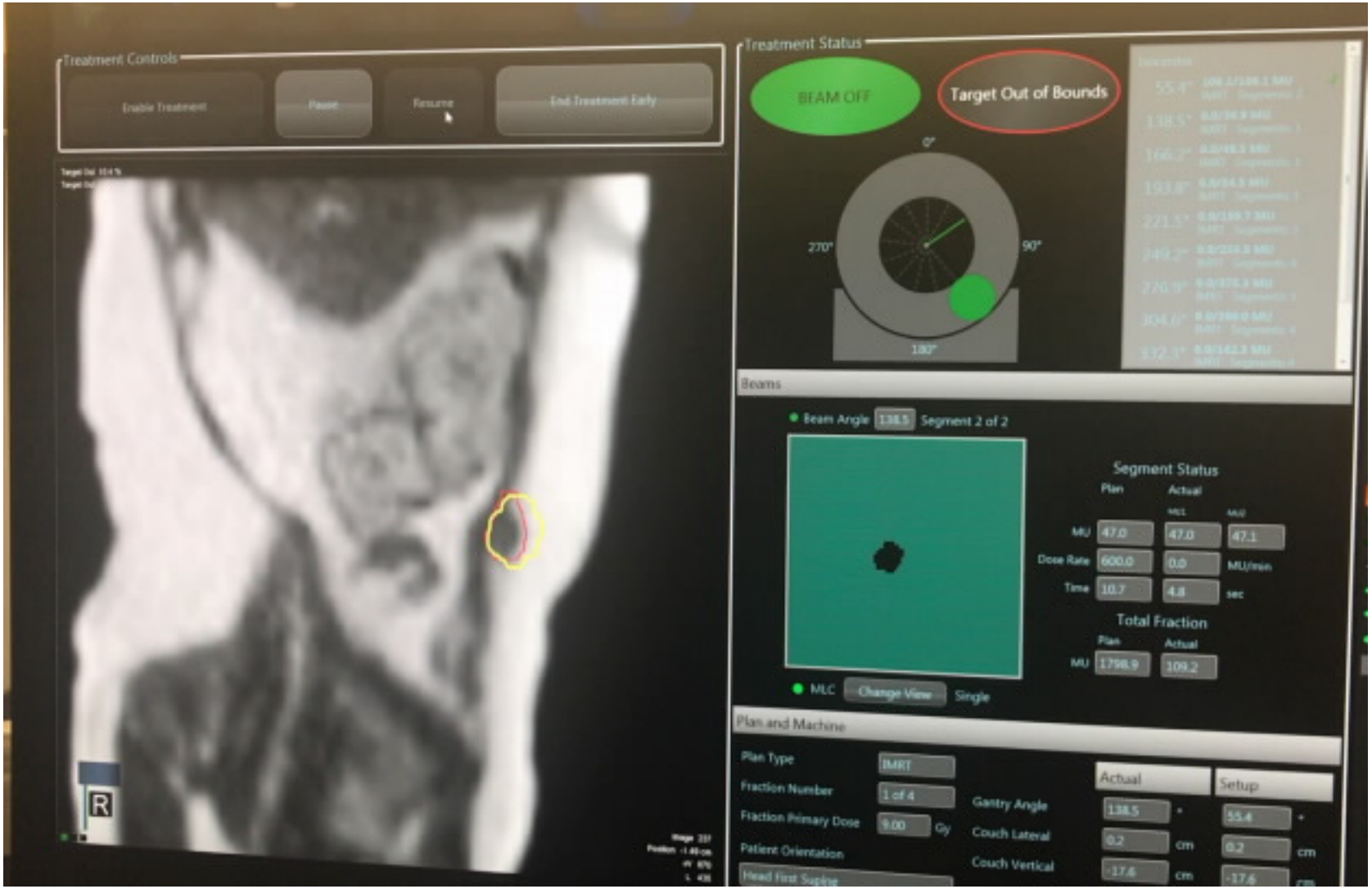




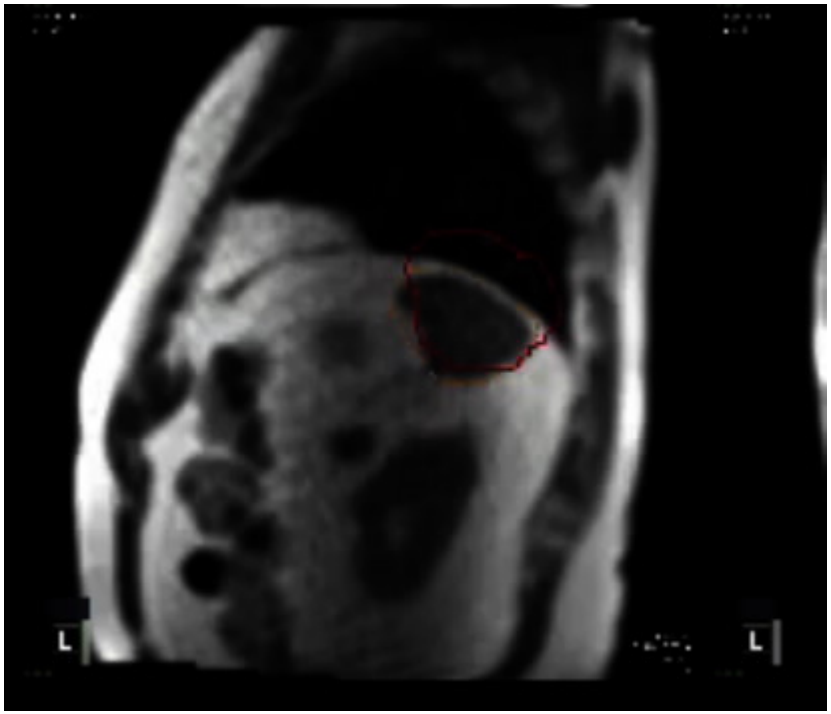
SCLC, rectus muscle met

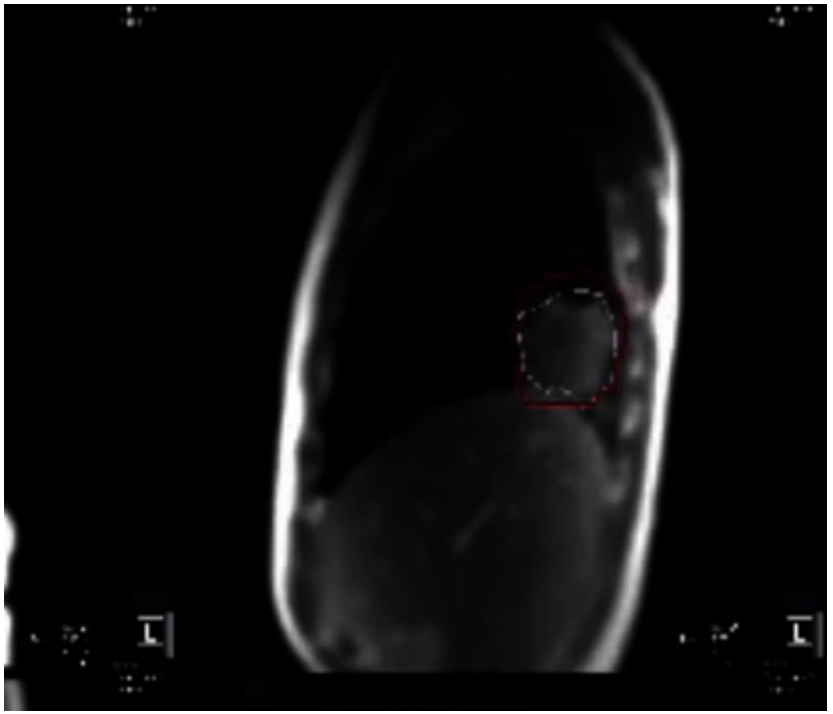





Treatment Controls
Enable Treatment
Pause
Resume
End Treatment Early
Treatment Status
BEAM OFF
Target Out of Bounds
0°
270°
90°
180°
Beams
Beam Angle 138.5 Segment 2 of 2
Segment Status
Plan
Actual
MU 47.0 47.0 47.1
Dose Rate 600.0 0.0 MU/min
Time 10.7 4.8 sec
Total Fraction
Plan
Actual
MU 1798.9 109.2
MLC
Change View
Single
Plan and Machine
Plan Type IMRT
Fraction Number 1 of 4
Fraction Primary Dose 9.00 Gy
Patient Orientation
Head First Supine
Gantry Angle
Couch Lateral
Couch Vertical
Actual
Setup
138.5 °
55.4 °
0.2 cm
0.2 cm
-17.6 cm
-17.6 cm
R

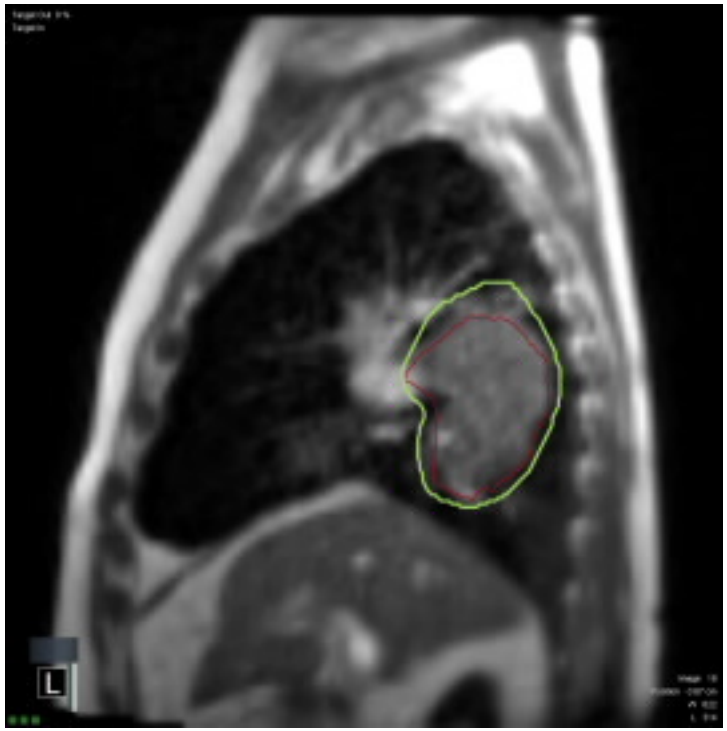
Online Tumor Tracking



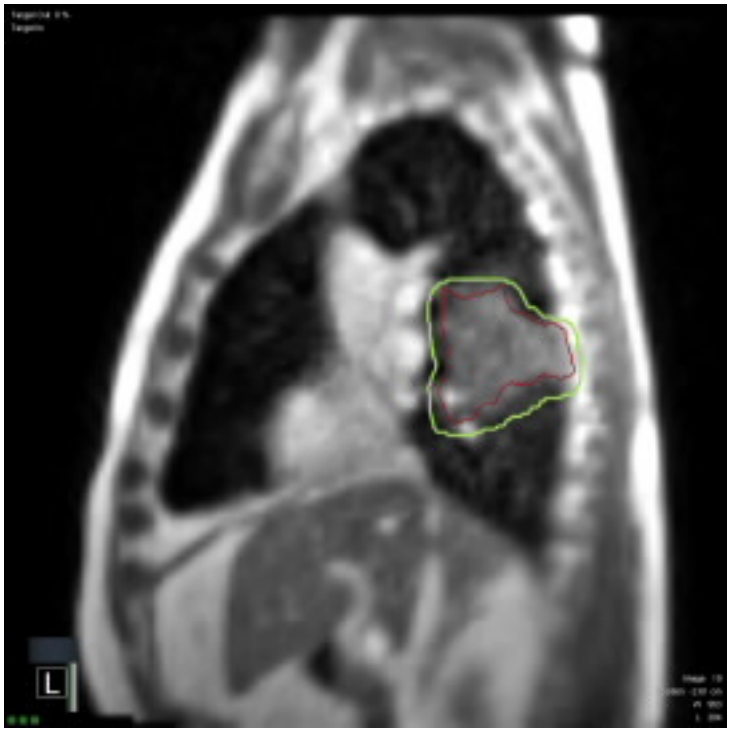


Lung Cancer
Adaptive Radiotherapy

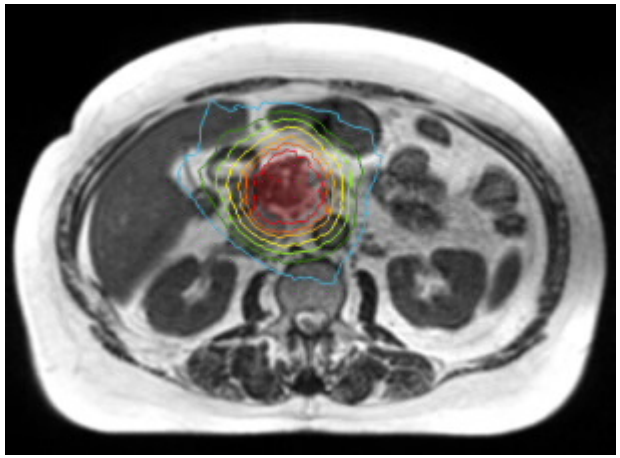
Fx 1

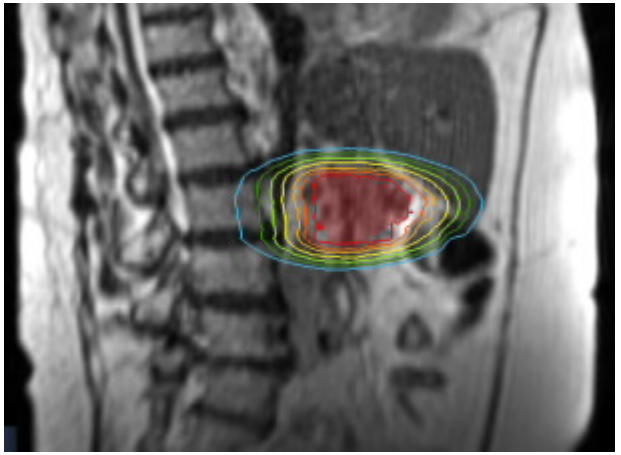


Fx 17



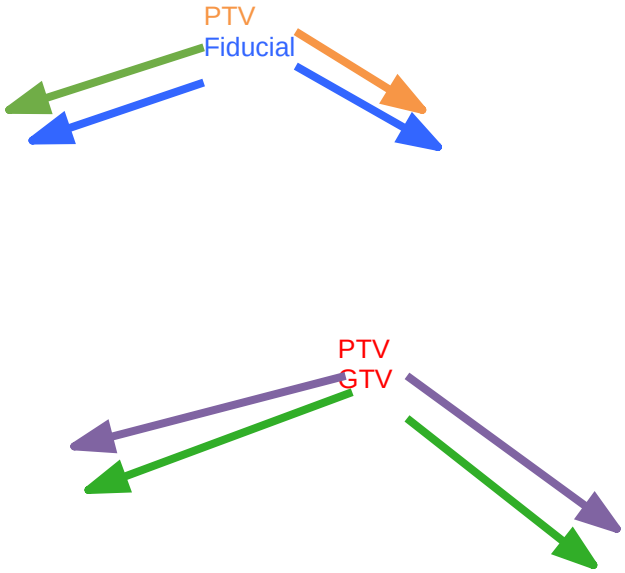
Pancreatic Cancer
Tumor Tracking





Pancreatic Cancer
Tumor Tracking

CBCT vs MRI IGRT

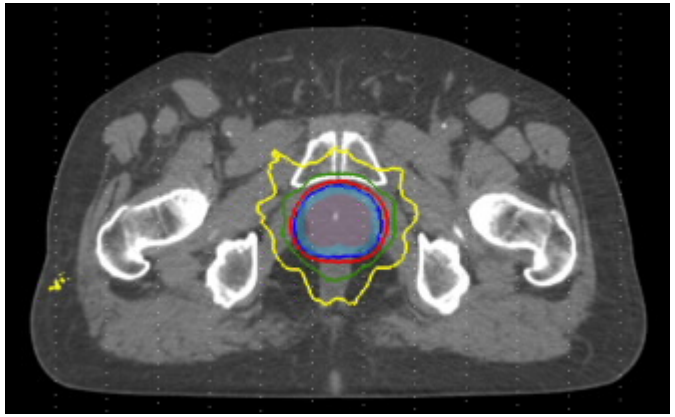


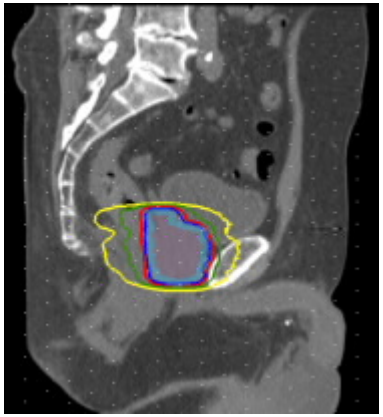
Real Time Online MRI Imaging

Prostate Cancer SBRT

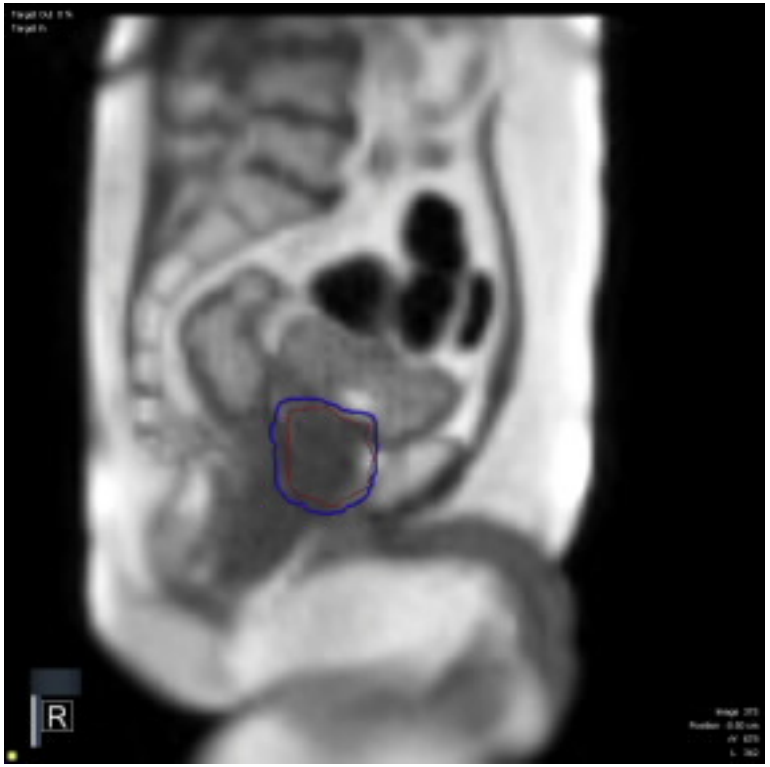
3625 cGy / 5 Fr

Planning CT





Real-Time Online Tracking



Flatulation during treatment and halting the treatment

Teşekkürler

ufuk.abacioglu@acibadem.com