



## MRI in RT Department - Initial Experience



**Region Syddanmark**







## **Odense University Hospital, Radiophysics Laboratory**





## Radio Physics Laboratory

14 Physicists  
13 Radiographers  
2 IT Employees  
7 Electronic Technicians  
1 Engineer  
1 Laboratory Assistant  
1 Secretary





# Radio Physics Laboratory & Radiotherapy Department

## 8 accelerators

- 2 Elekta Precise (iView GT, ABC)
- 3 Elekta Synergy (XVI 4.5)
- 1 Elekta “Versa HD” (Agility, [FFF, Response])
- 2 Elekta Versa HD (Agility, HexaPod, [FFF, Response])
  
- 2 CT-scanners (Siemens Volume Zoom and Philips Big Bore)
- Access to 4 PET/CT
- 1 MR-scanner (August 2013 – Philips Ingenia 1.5T)
- 1 Superficial kV-unit (Xstrahl 100)
- Afterloading – Elekta/Nucletron microSelectron PDR
- TPS – Pinnacle 9.10 (SmartEnterprise) + Oncentra Brachy
- Dosimetry – PTW, Sun Nuclear (Arc Check)
- Mosaic 2.4 and Data Director (PACS)



# Cancer Doctors need millions for equipment

26-09-2010

Head Physician Olfred Hansen

In contrast to patients in Vejle , Aarhus and Copenhagen there are as many as 200 cancer patients per year in Odense that receive only "second best treatment" because the cancer department lacks the necessary equipment





## **Region South Denmark Health Committee - Minutes 23-11-2010**

Point 6. Medico Technical means of cancer treatment specifically at OUH - Odense University Hospital

In reaction to the report of an Executive at the University Hospital in connection with their 2011 ranking of purchase medical devices, it is decided that an MRI simulator has been given first priority – it will therefore most likely be purchased and in operation at the University Hospital in the spring of 2011.



## **Comprehensive course of treatment**

Radiation Therapy/Department R will share the new MRI scanner with the Department of Radiology, where the scanner will be used for radiation planning, heart studies in collaboration with the Department of Radiology's diagnostic scans

The new scanner gives the department the possibility of increased use of MRI scans to several groups of patients who need radiation therapy.

The advantage of having an MRI scanner in the department, is that the entire treatment planning process takes place in our department





## **25. February 2011**

First department meeting  
MR requirement and specifications outlined

## **6. May 2011**

MR- requirements and specifications released for offers

## **Torsdag 18 August 2011**

Presentation of offers from three vendors

## **August/September 2011**

On site inspections



## Philips Ingenia 1.5 Tesla

Cost of seven million Danish krone

A further cost of eight million in software and other equipment.

Magnet weight 3060 kg

Open Bore diameter 70 cm

Maximum FOV 55 cm

Typical homogeneity to 55 x 55 x 50  
 $\text{cm} \leq 5 \text{ ppm}$

Typical homogeneity to 50 x 50 x 45  
 $\text{cm} \leq 1.8 \text{ ppm}$

Helium Save technology Yes (Zero boil-off)

Cryogen boil-off rate 0.0 l / hr \*





## **One last setback**

### **6th February 2012**

It has now been decided by the Executive Board that the renovation planned in connection to the upcoming MRI scanner should be postponed until department X can be relocated.

Hence delivery of the scanner is postponed until early 2013.

It is assumed that the building plans are completed so the project can easily be resumed in the autumn.

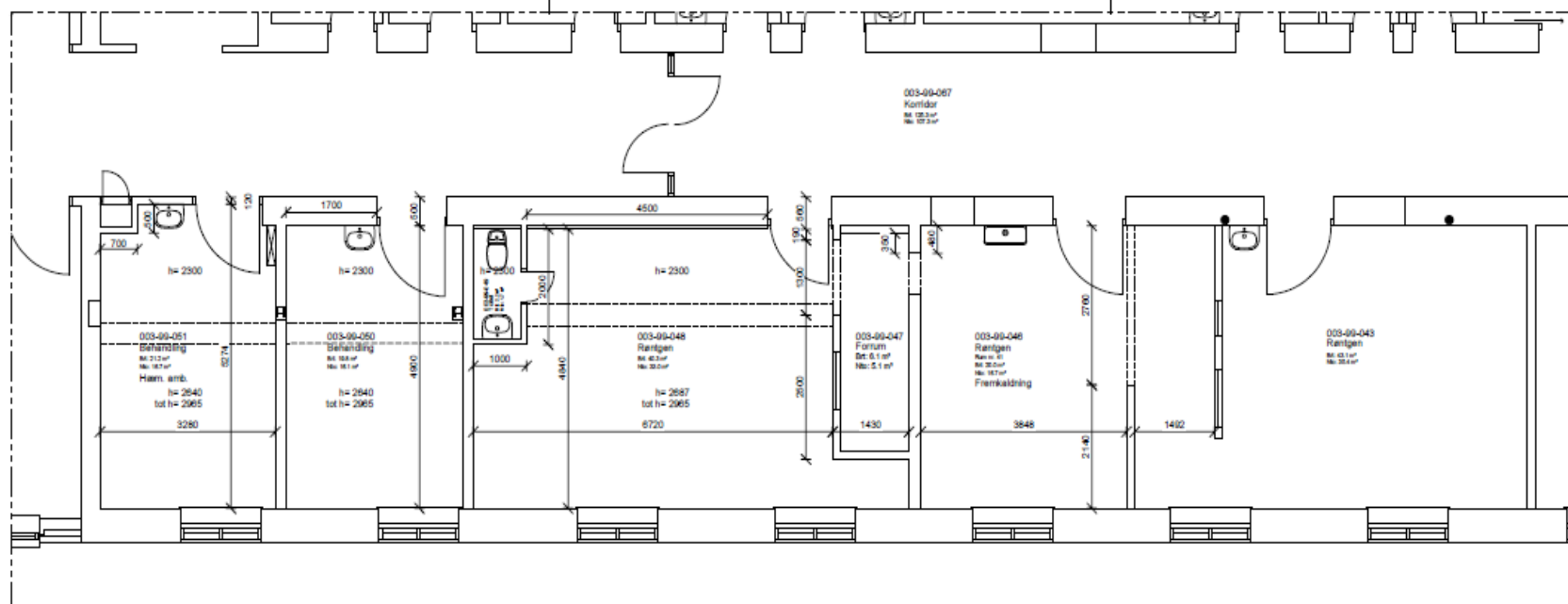


## Time Plan

Establishment af building site	90 days <b>Thu 28-02-13</b> Fri 12-07-13
Udv. Pipework (sewerage /cooling)	6 days Fri 08-03-13 Fri 15-03-13
Establishment af courtyard	83 days Thu 07-03-13 Wed 10-07-13
Façade 75 days 27 Indgangshul.	Tue 02-04-13 Fri 19-07-13
Access to building for bringing in scanner	3 days Tue 02-04-13 Thu 04-04-13
Establishment rårum for MR scanner	6 days Mon 20-05-13 Mon 27-05-13
Establishment af Forberedelserum	76,5 days
Establishment af teknikrum	13 days Tue 28-05-13 Mon 17-06-13
Levering / indbringning af MR magnet	Tue 02-07-13 Tue 02-07-13
Installation af MR scanner	10 days Tue 02-07-13 Mon 15-07-13
<b>Applications start / Idriftsætning commissioning af scanner</b>	<b>5 days Mon 15-07-13 Fri 19-07-13</b>



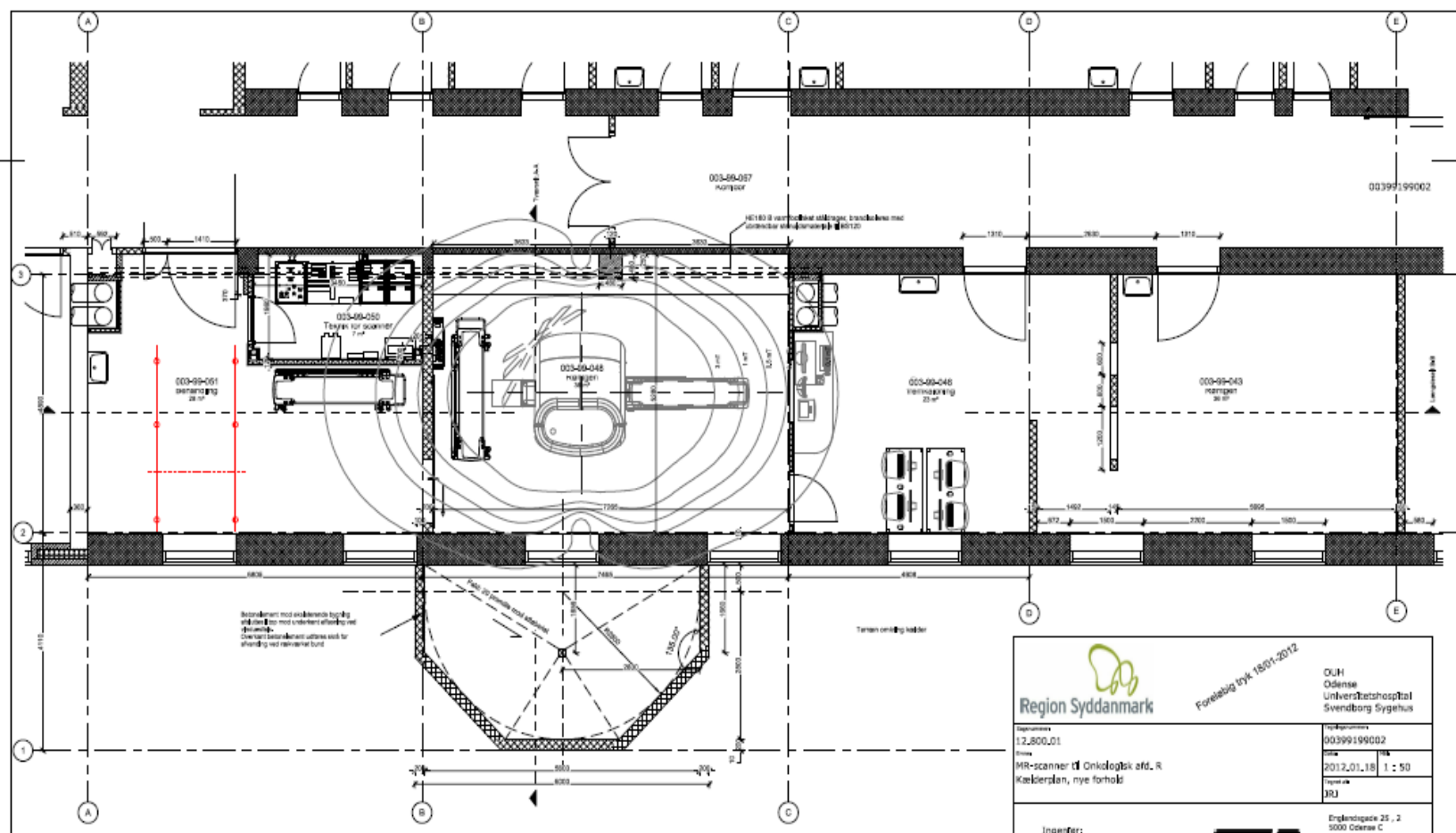






UDSNIT AF REGION SYDDANMARKS KJELDERPLAN  
TEGNING NUMMER 00399129 (OUH)

KAMPEL

Engledegade 25	DK-6100 Odense C	TEL. +45 65 42 96 00
Projekto:	11420214	MA 1:50
Projekt	Ny MR Scanner	
Dato	yyyy-mm-dd	Rev. dato
Emne	OUH tegning 00399129 tilpasset færdigste forhod	
Konst./Tegn.	MJS	Skriv nr. 0039999101



 <b>Region Syddanmark</b>		Forebygg byk 18/01/2012		OUH Odense Universitetshospital Svendborg Sygehus	
Dokumentnr 12.800.01		00399199002		12.800.01	
MR-scanner (d) Onkologisk afd. R Kækklerplan, nye forholds		2012.01.18		1:50	
Ingenfor		RBL		12.800.01	
<input type="checkbox"/> Rambøll Danmark A/S		<b>RAMBØLL</b>		Englekedgade 25, 2 5000 Odense C Telefon: 66 42 22 00 Telefax: 66 42 29 99	
<input checked="" type="checkbox"/> Ariktekt Credo Arkitekt A/S		 CRED ARKITEKTER		Buchsengade 35 2. et 5000 Odense C Telefon: 66 11 50 11 Telefax: 66 11 50 11	
12.800.01		12.800.01		12.800.01	









## Summer 2013

















## **Patient catagory for MR-simulation**

Curative prostata cancer

Curative head and neck cancer

Curative head (Stereotactic treatment)

Curative rectum cancer

Curative pancreas cancer

Curative liver cancer (Stereotactic treatment)

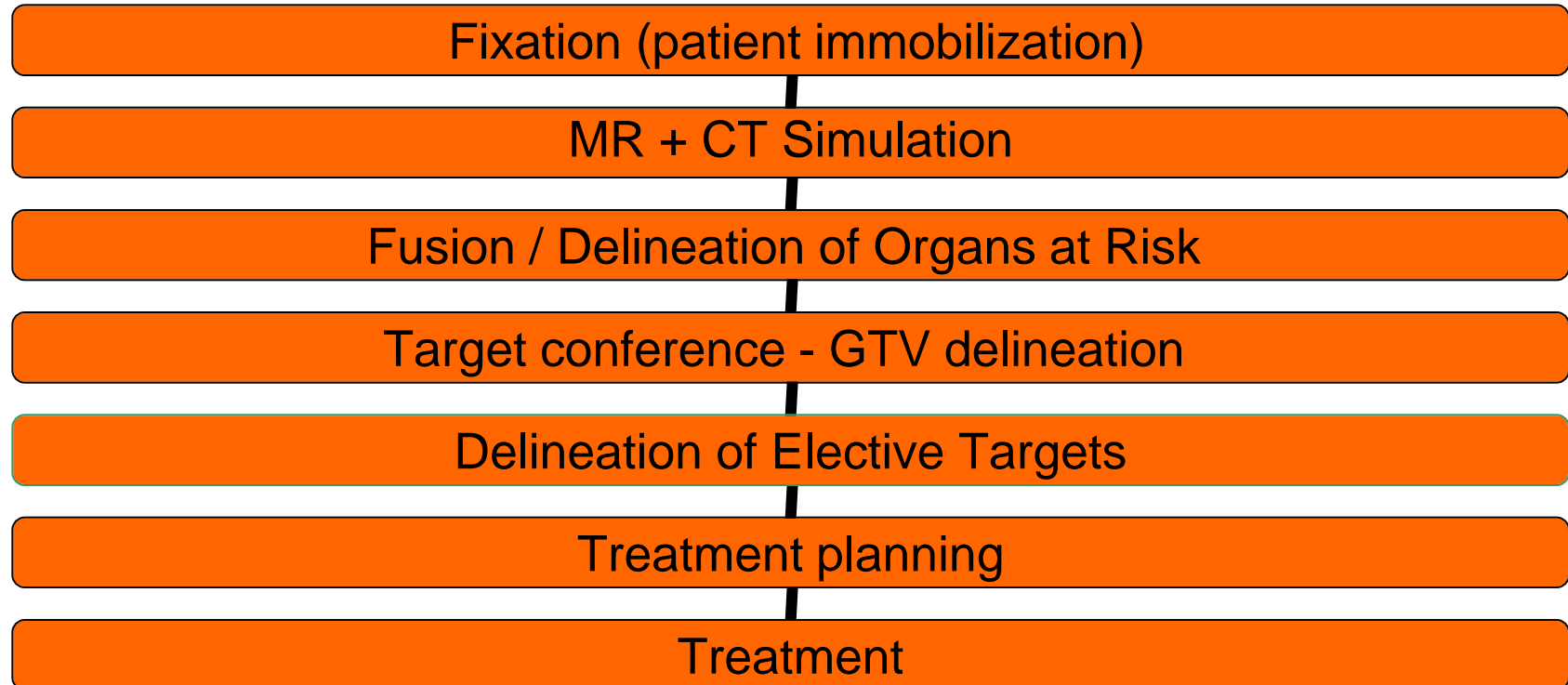
Curative Vesicae cancer

Curative gynaecological cancer (internal and external treatment)

Palliative bone metastaser (Stereotactic treatment)



## MR-RT Work flow





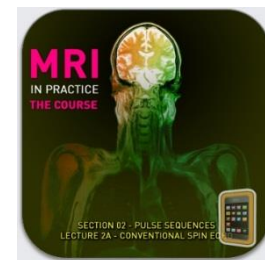
## Staffing and training

1 Department technician ,2 Physicists + 2 Radiographers responsible for the scanner.

Patient scanning with one Radiographer from Radiotherapy and one from the Diagnostic department.

On site MR-RT training for Radiographers with Philips technical specialist (included with the purchase of the scanner)

MRI in Practice Course 2013 for Radiographers and Physicists



Off site training/courses for departments Technician





## Booking

Radiotherapy departments secretaries (**MOSAIQ®**) working in conjunction with Department of Radiology's booking secretaries (**RIS PACS**)



Radiotherapy sends all referrals to Radiology secretaries for booking  
Every month extract a list from Mosaiq with Social Security numbers of our patients

Also a list for those who have received contrast and those who have not



## Problems with booking

First patient 07.45am, secretaries not at the desk

Head and neck treatment / treatment start guarantee (5 days)

3-4 patients daily /some days none

Brachytherapy (PDR) never on time



## **Obstacles when scanning**

No time allowed for unseen problems

Reffrrels not correct

Patients not informed

Placing an intravenous needle in the patient

Blood test results

Patient performance status not known

Pacemaker

Claustrophobic patients

Immobilization techniques

Unnecessary scans (c recti)

**Not possible to delay or move the time of scanning**

**Always under pressure to be finished 10:30 am**



## **Protocols/Sequences, what to use?**

Initial protocols set up with help of Phillips application specialist and Department of Radiology

Inexperienced staff

Protocols/ always new sequences and need for optimizing  
(eg Prstate, Neck + Gd)

Feedback from doctors /Radiotherapy and Radiology

Doctors inexperienced with MRI



## Scan Time Restrictions

Poor performance status/elderly

Immobilization methods can be very uncomfortable.

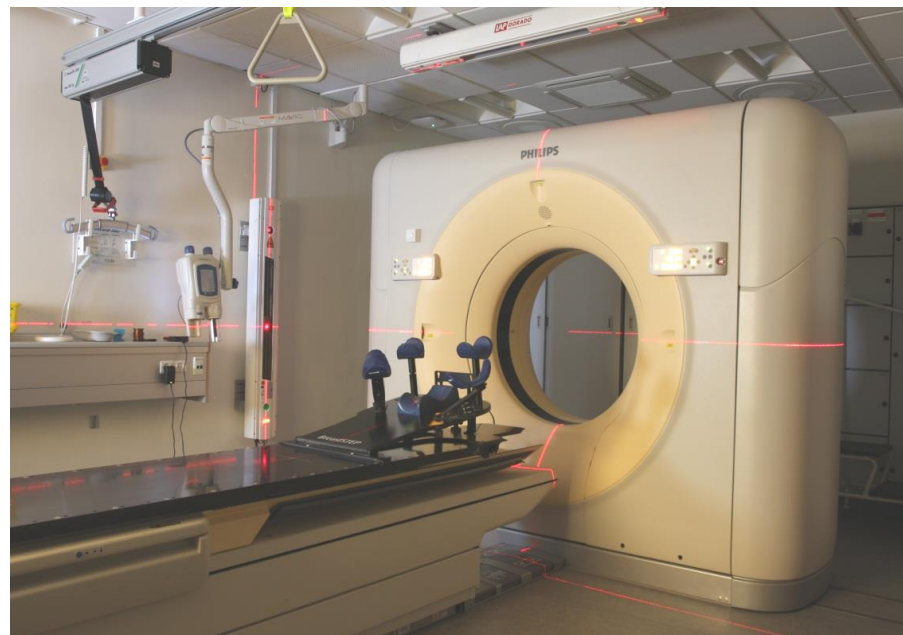
Limit scanning time (less than 20 min)

Limited scan slots



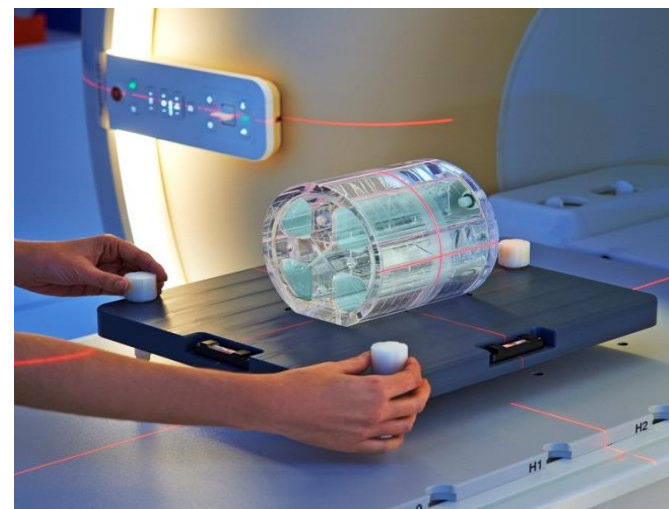


# MT + CT Simulation



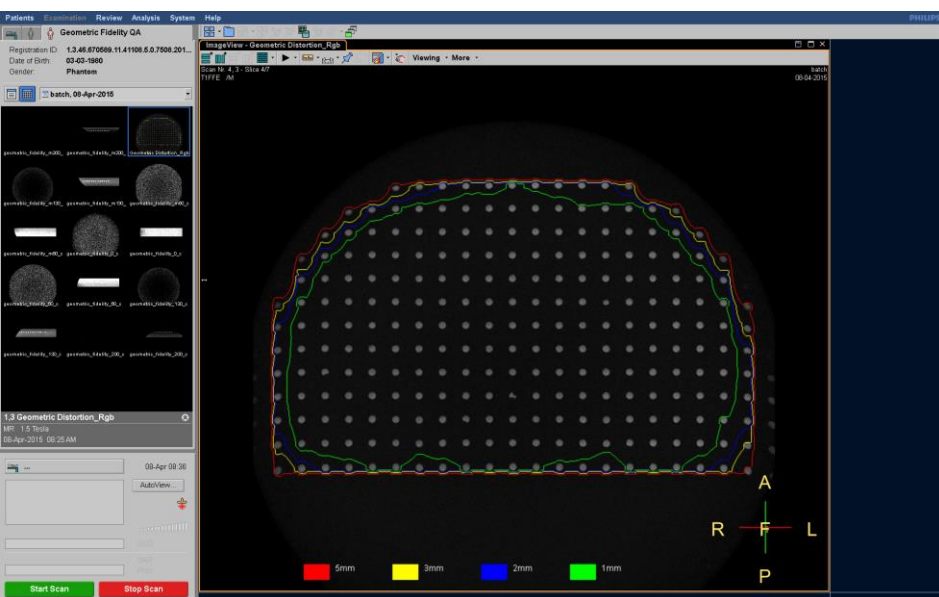


Extra trolley for transport of Brachyterapi





## Geometric QA test







## Dedicated coils

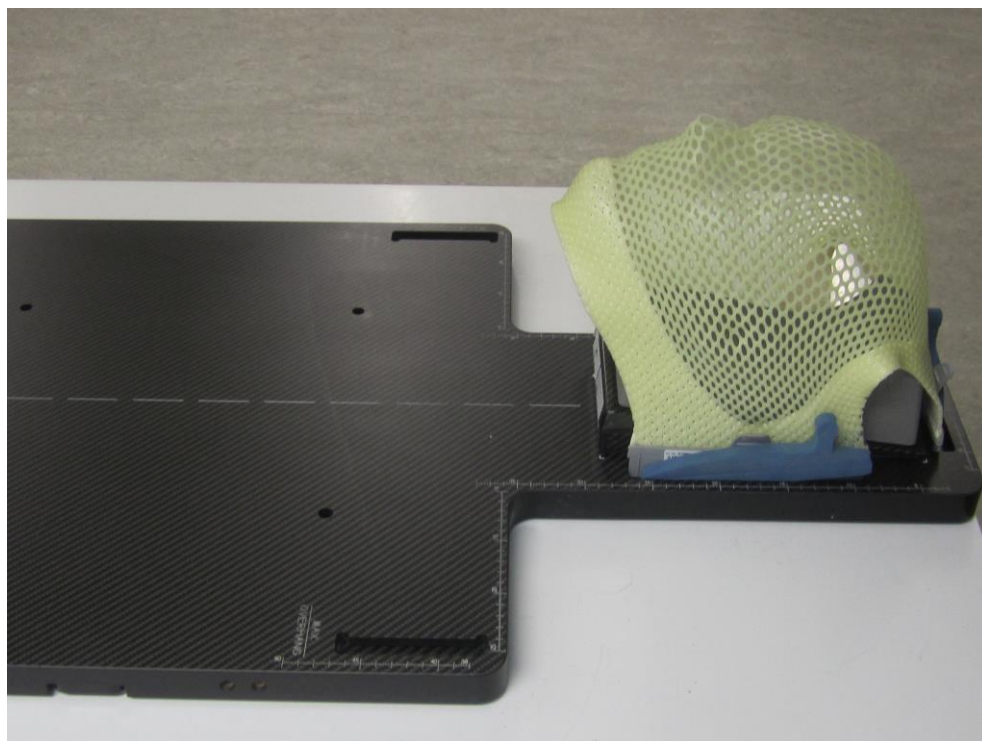


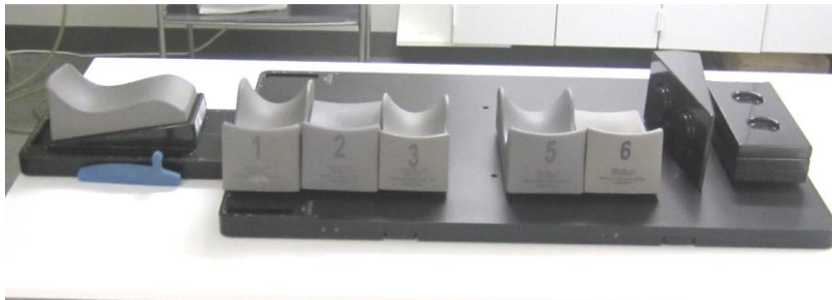
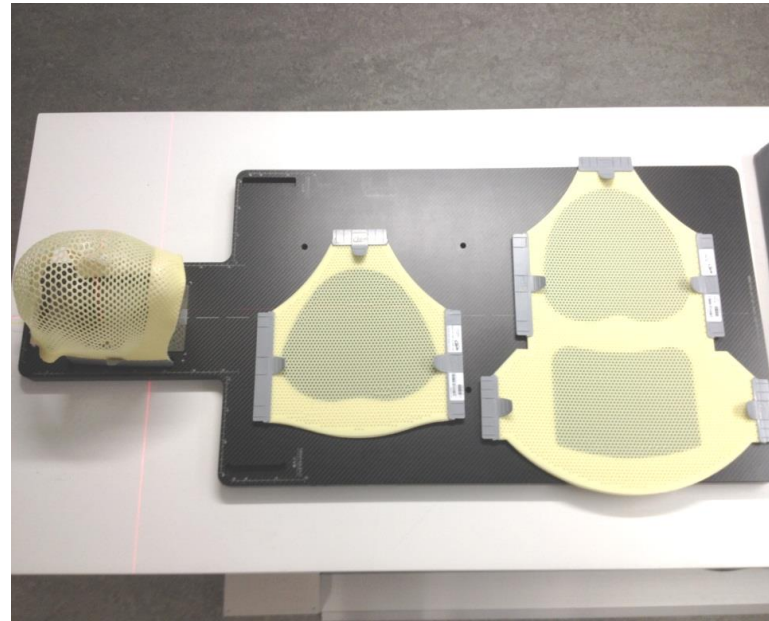
Coils making up the Integrated Coil Solutions:

- 1-Head top coil,
- 2-Posterior coil (built-in coil in patient support),
- 3 -2 x Anterior coil, 4 -Base coil, 5 -HeadNeck top coil, 6 -Flex coil in 3 sizes.



## Head & HeadNeck





Flat table top/ support blocks increase distance to table coil



**Ct and Treatment 3cm**

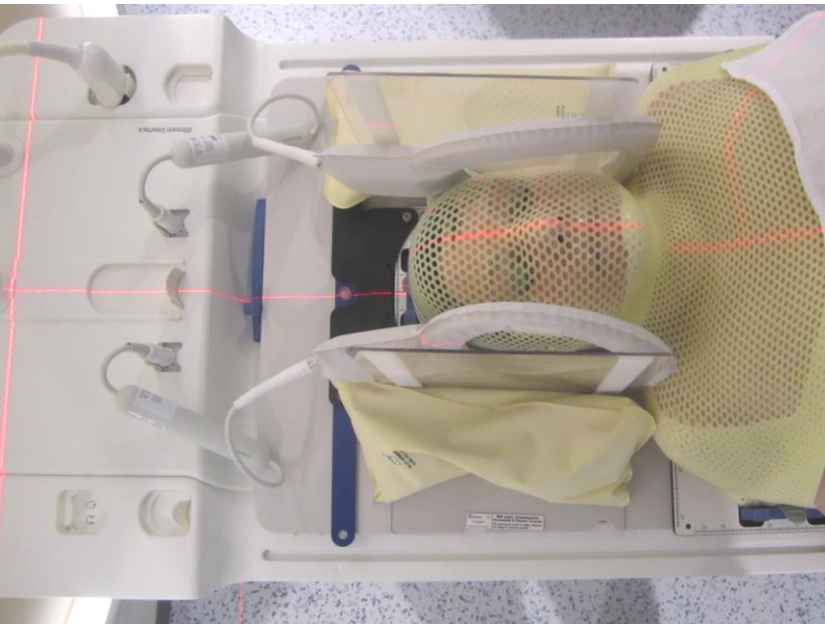


**MR simulation 1.3 cm**









Scanning below the shoulders without stopping the scan and repositioning the coils









## Scanning of the Pelvis / Abdomen







Long scanning times when scanning upper abdomen, eg. Curative liver cancer (movement of the diaphragm)

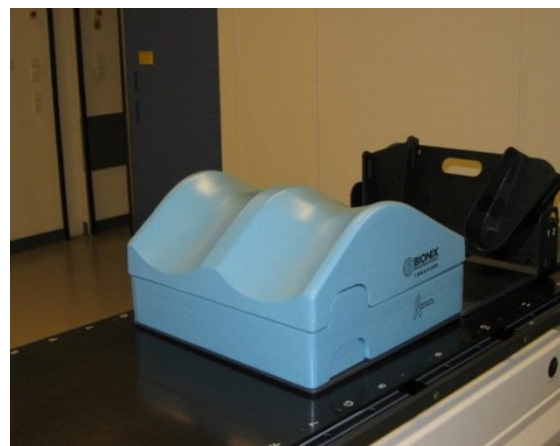
Use of the anterior coil support bridge increases distance from the subject being scanned.

Alternative, placing coil directly on the subject (possibly with use of straps) could cause deformation/ compression of organs. (to be tested)





## RT Immobilization Equipment

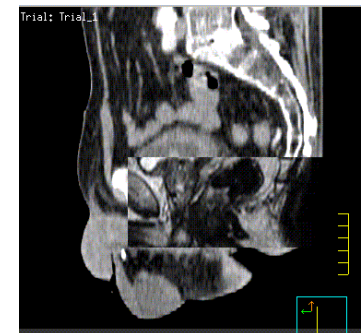
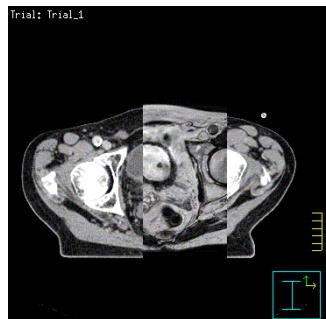




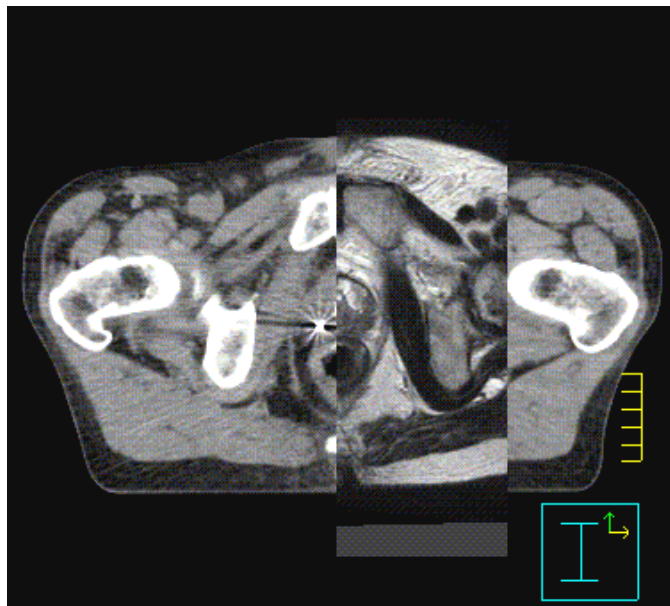
## MRI fusion med CT, Then and Now

Only c. prostata, liver and pancreas patients were MR scanned by the diagnostic department using our immobilization techniques

Head, neck and lung fusioned with PET





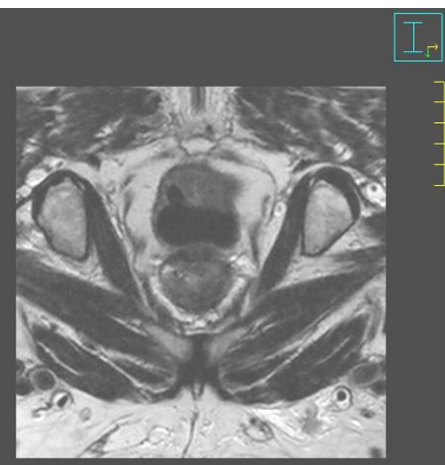
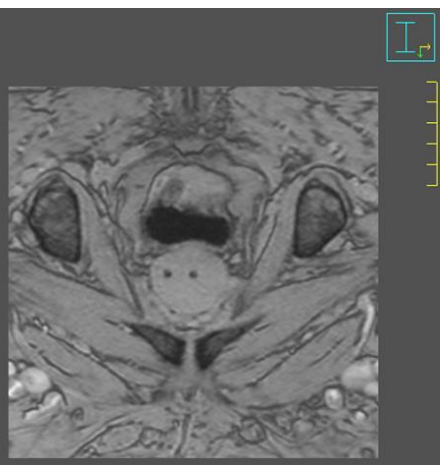
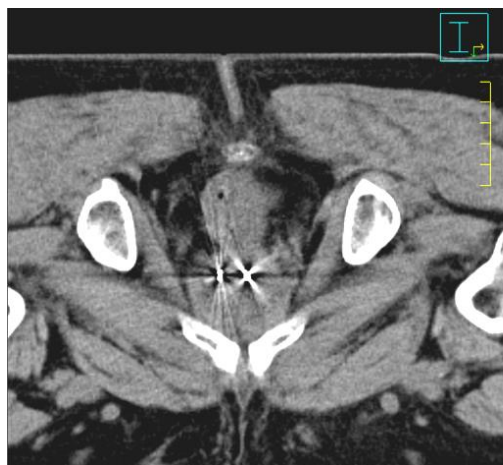


Matching with the help of markers

Prostate

Liver

Pancreas







# Deliniation

CT/T2



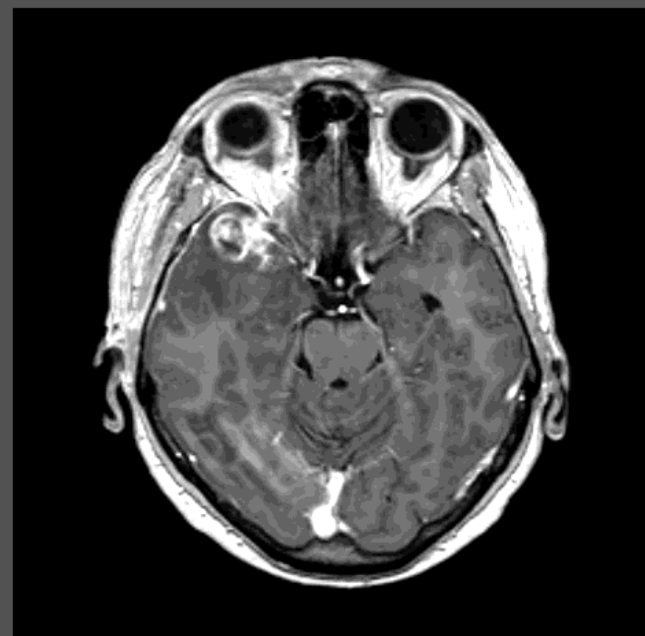




**CT**

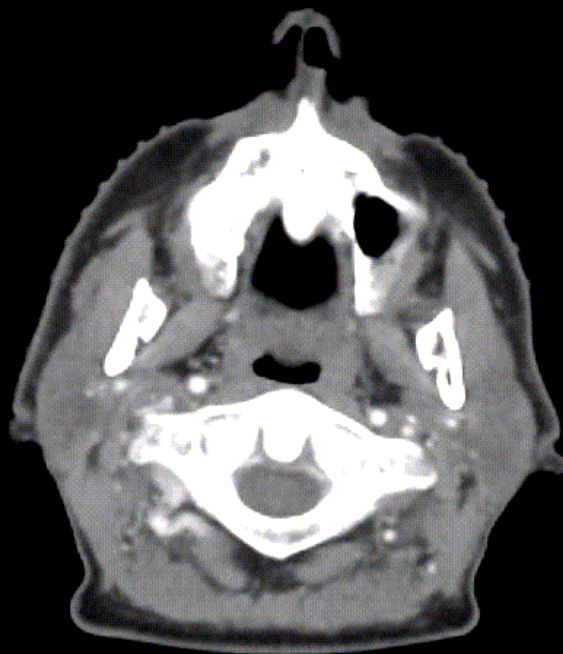


**T1**

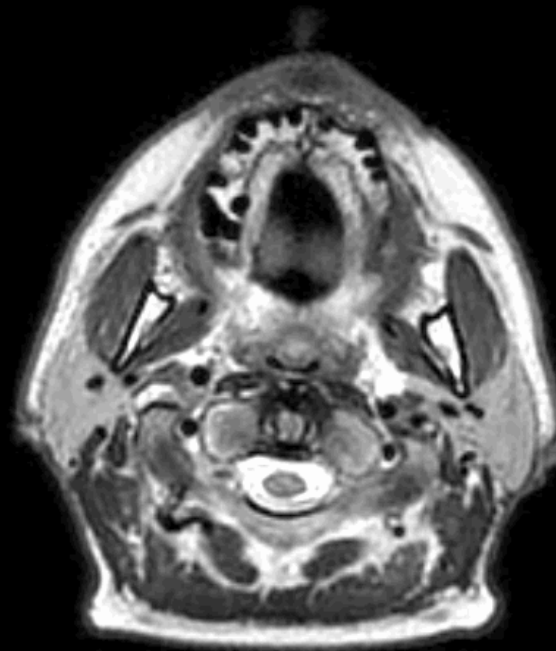




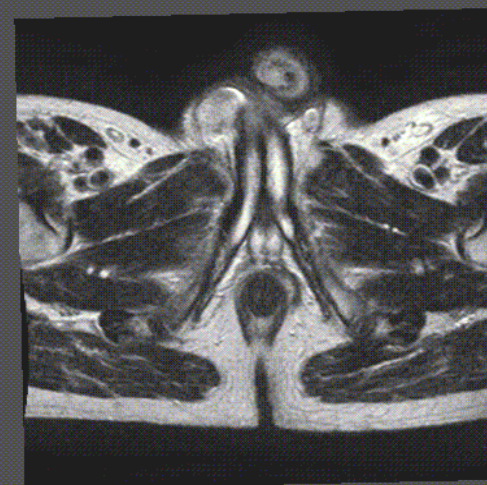
CT

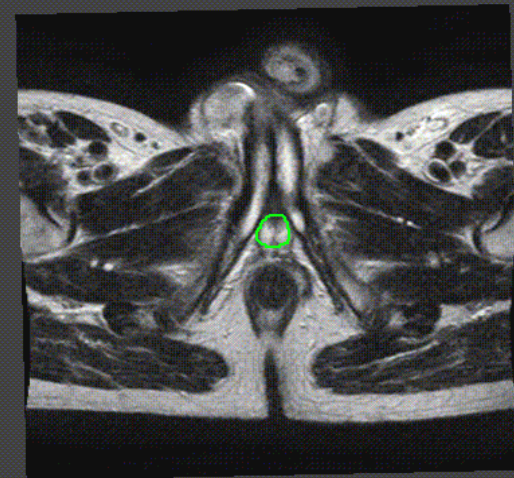
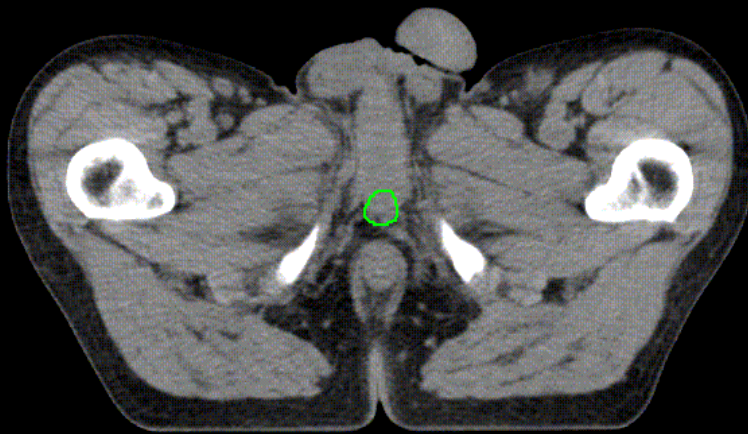


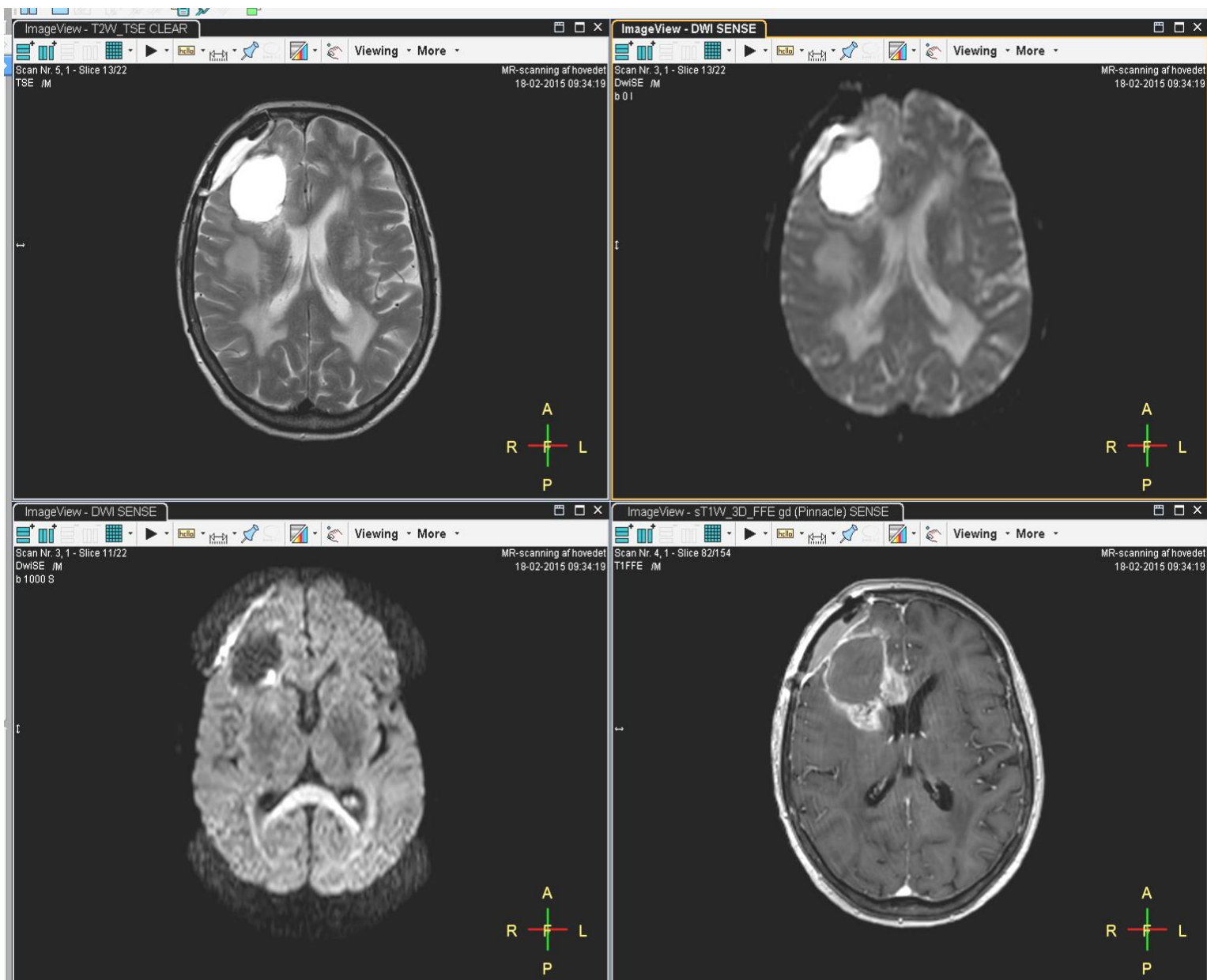
T2



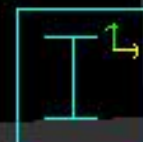
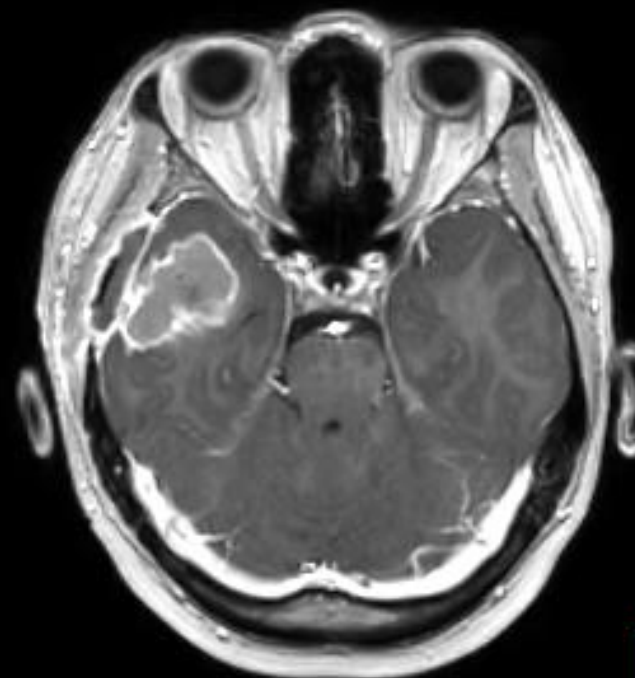








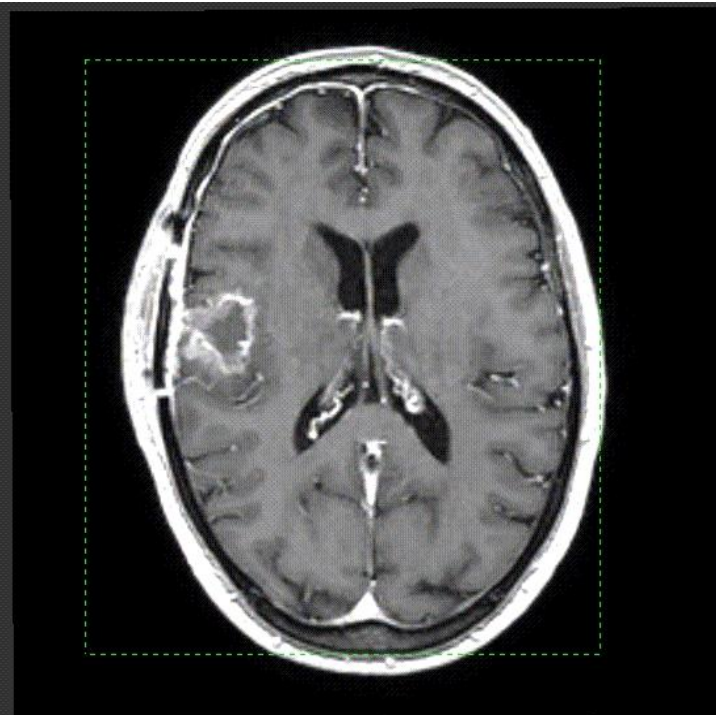


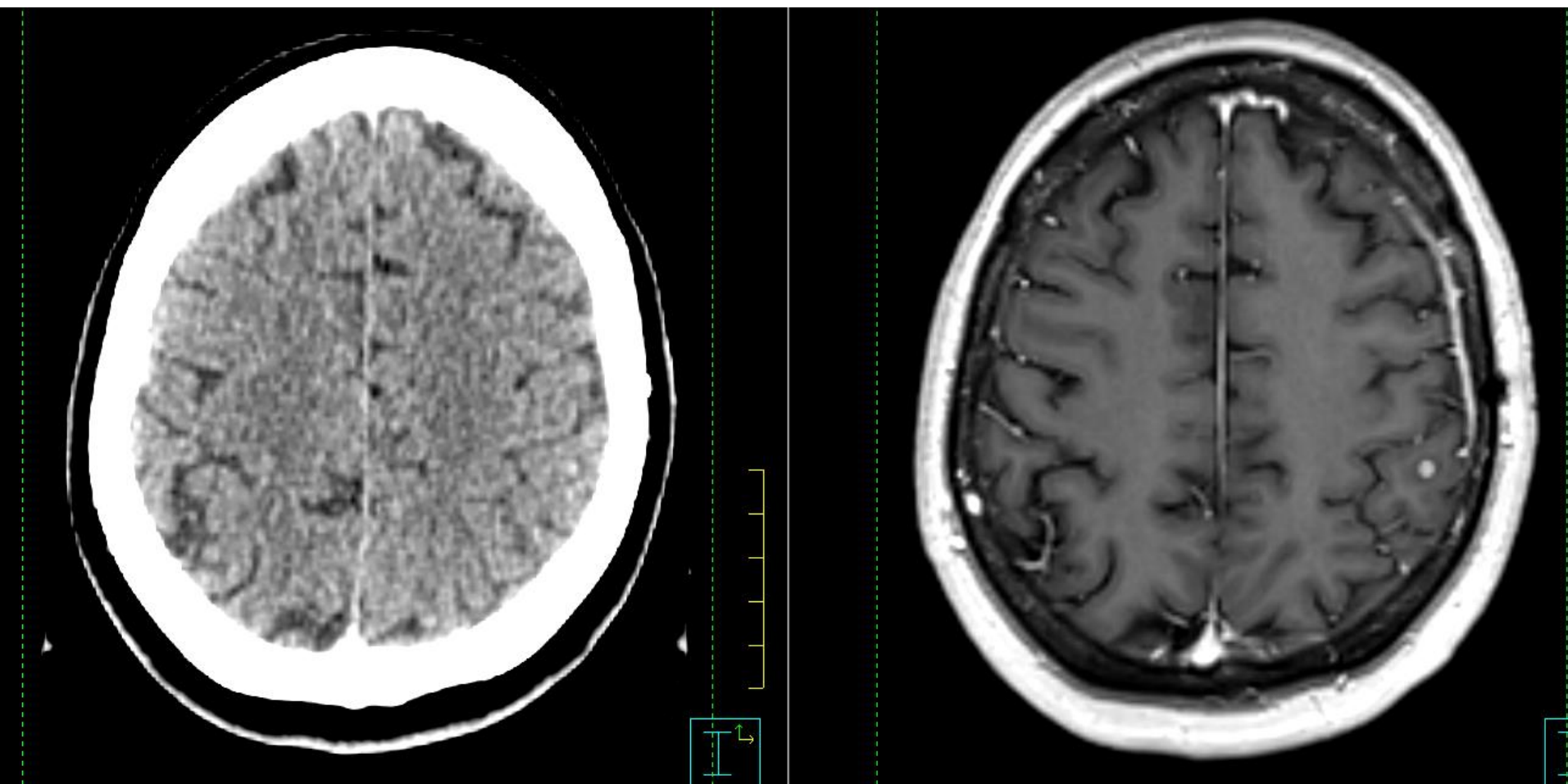


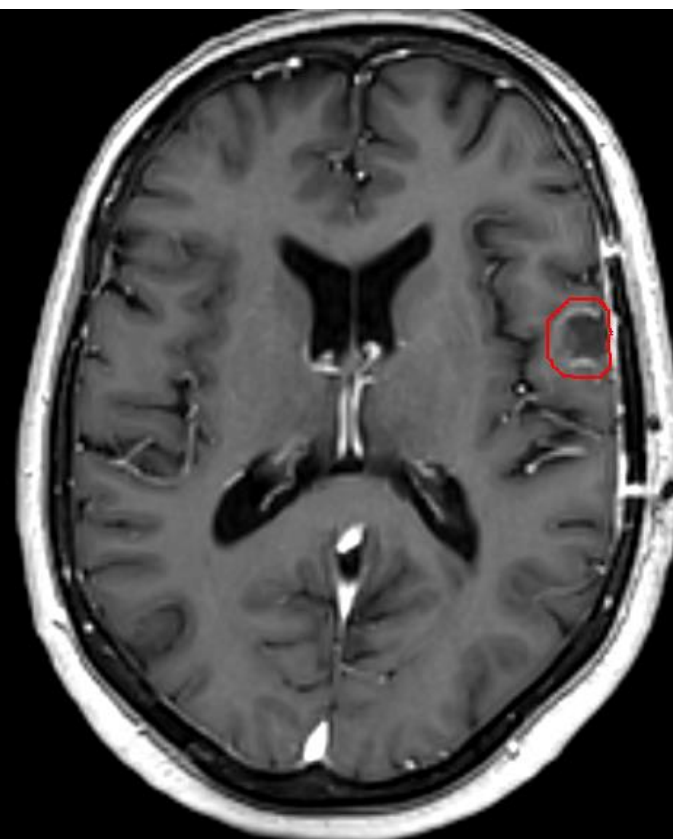
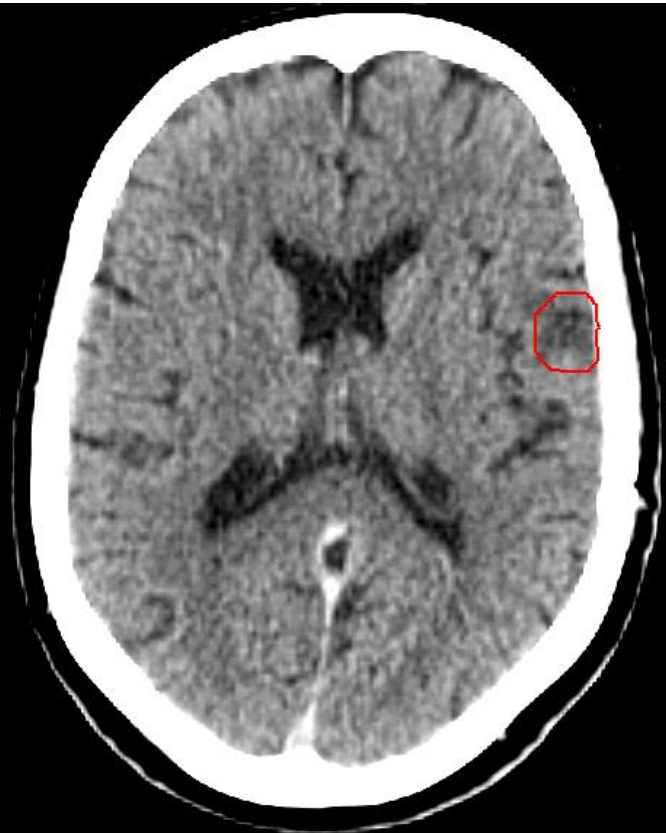




Trial: Final\_vmat













**CT**

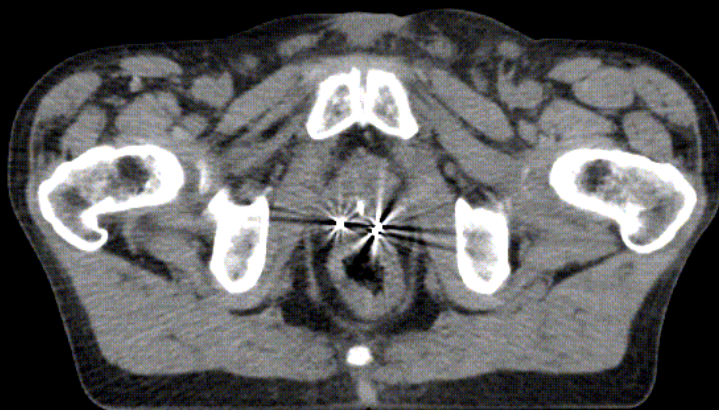
**T1**





CT

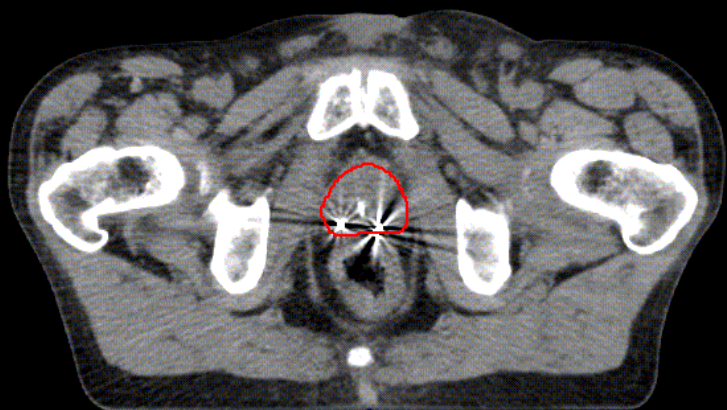
T2



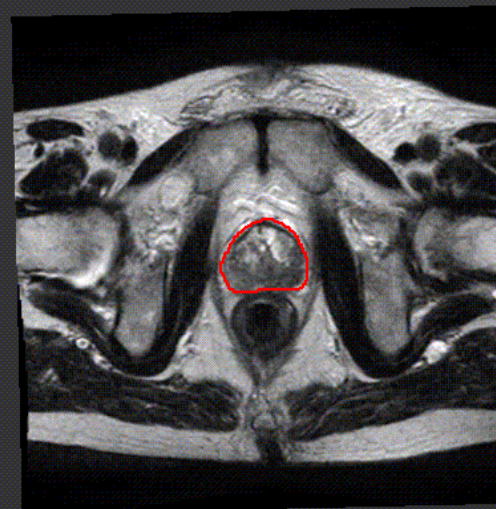




CT

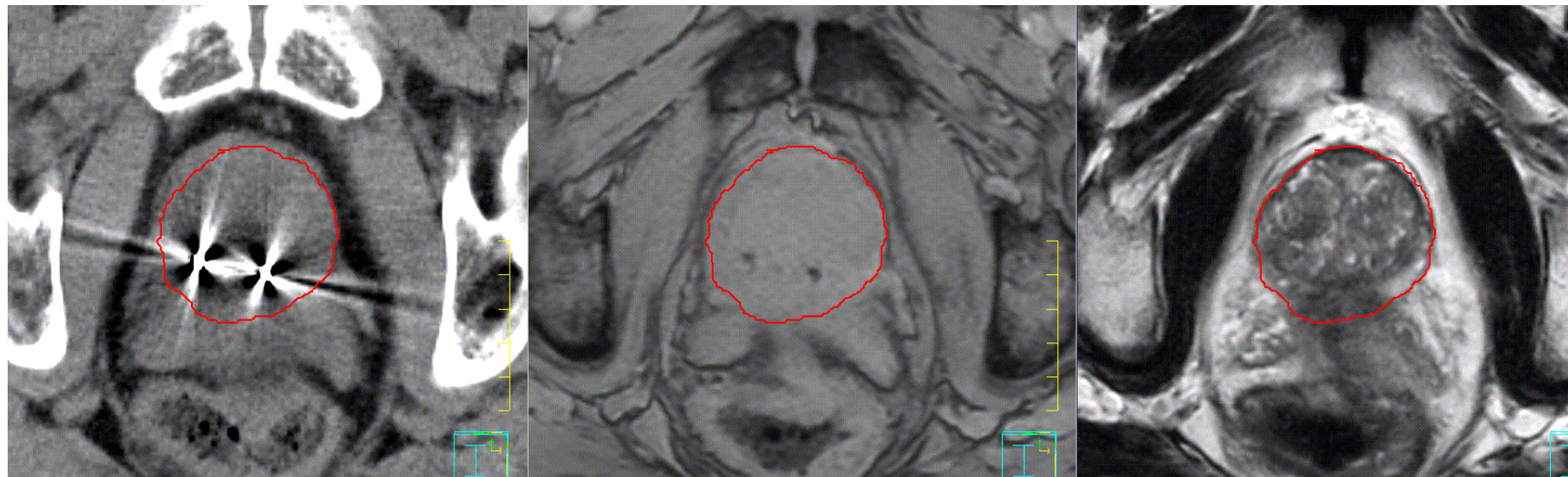


T2





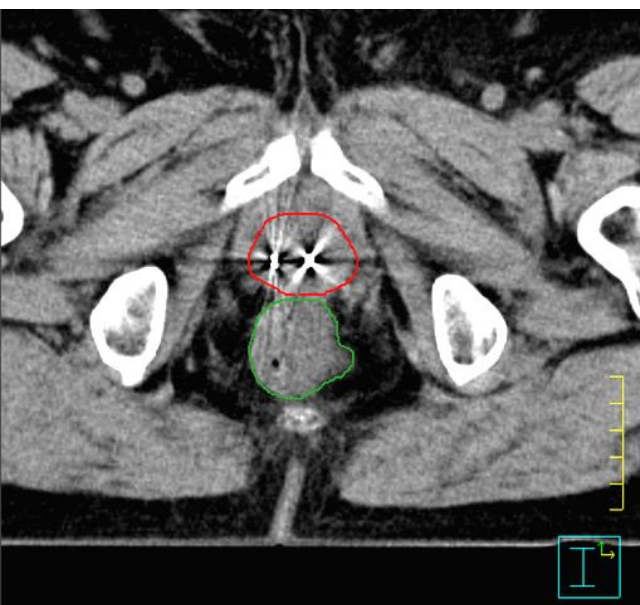
## Problems with Deliniation



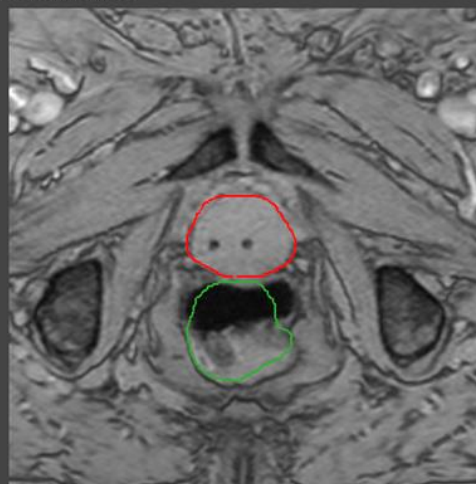




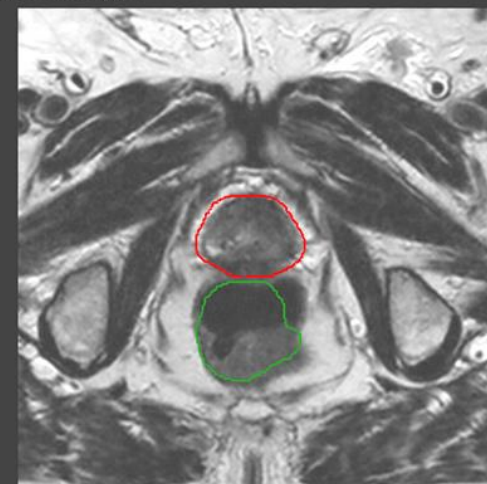
CT



T2\*



T2





Head and Neck

All Cancer Prostata

Palliative Patients

Protocols/ new sequences and optimizing

Reaserch

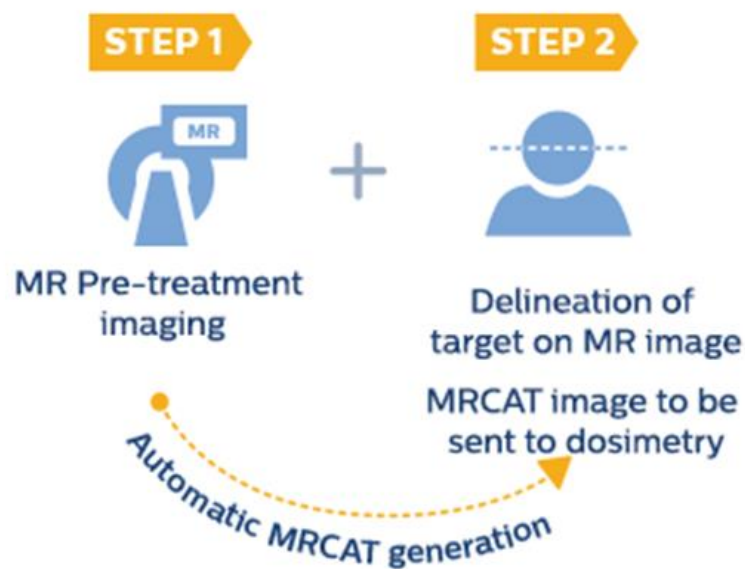
MRCAT (MR for Calculating Attenuation)



## PHILIPS

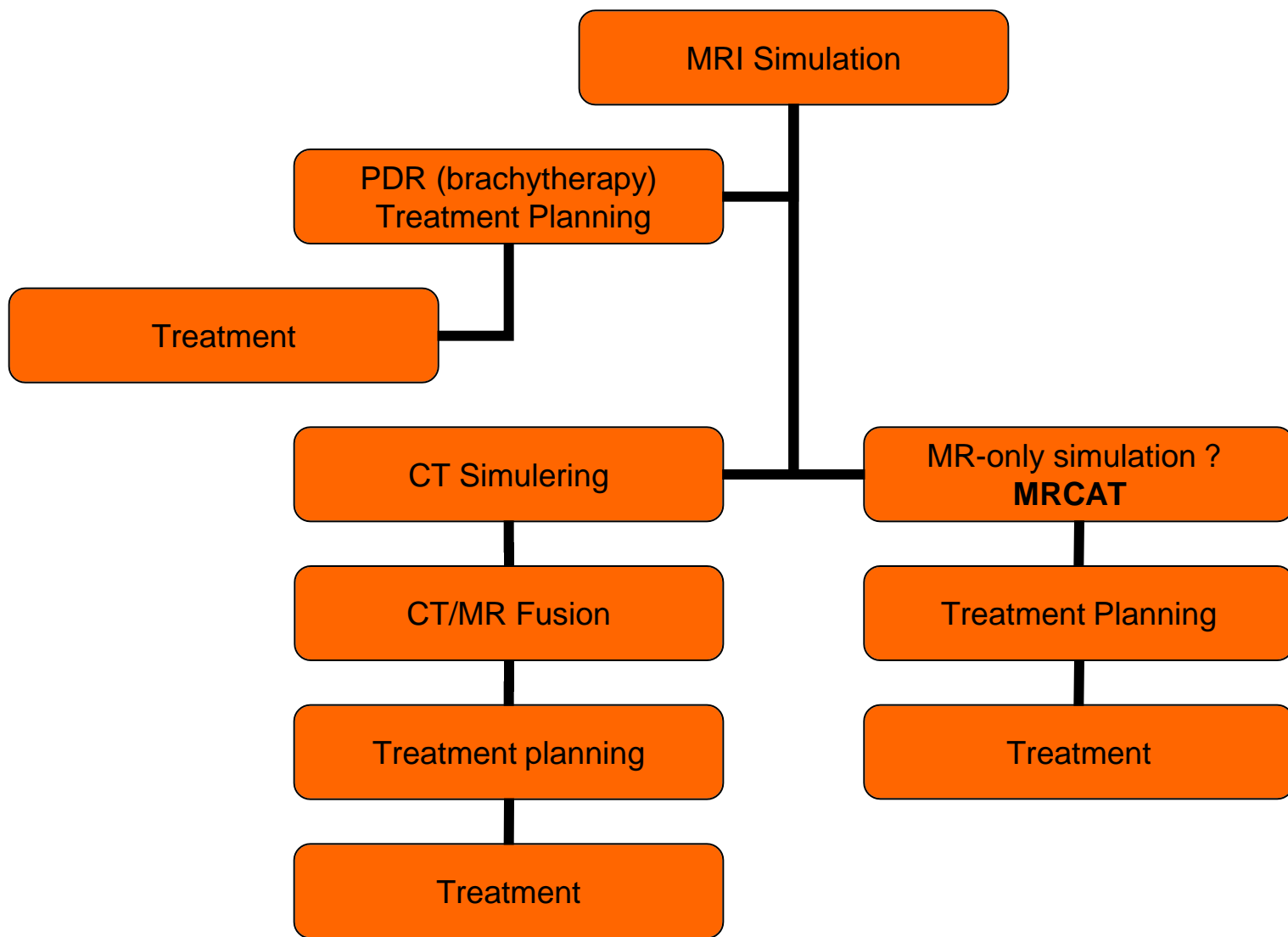
### Solution with MR-only simulation for a simplified workflow

---



*Figure 1 shows the current CT & MR workflow for RT treatment planning*

*Figure 2 shows the workflow with MR-only simulation for RT treatment planning*







# Production numbers

## from 01-01-2014 to 31-12-2014

Skanninger		Jan	Feb	Mar	Apr	Maj	Jun	Jul	Aug	Sep	Okt	Nov	Dec	Total
CT	CT Normalsim	108	91	111	93	91	97	100	120	109	105	96	96	1.217
	CT Røntgensin	85	79	92	85	80	110	110	91	101	91	81	101	1.106
	Resimuleringer	3	6	2	1	5	5	3	7	5	7	6	2	52
	PET simulering	0	0	0	0	0	1	0	0	0	0	0	0	1
	<b>Total</b>	196	176	205	179	176	213	213	218	215	203	183	199	2.376
MR	MR	12	26	24	36	21	35	26	26	35	28	28	20	317
	MR +kontrast	22	14	20	16	14	16	20	13	15	21	12	27	210
	<b>Total</b>	34	40	44	52	35	51	46	39	50	49	40	47	527
PET	PET simulering	3	3	4	5	5	4	0	0	3	2	0	4	33
	<b>Total</b>	3	3	4	5	5	4	0	0	3	2	0	4	33



**We want the scanner to ourselves!**

