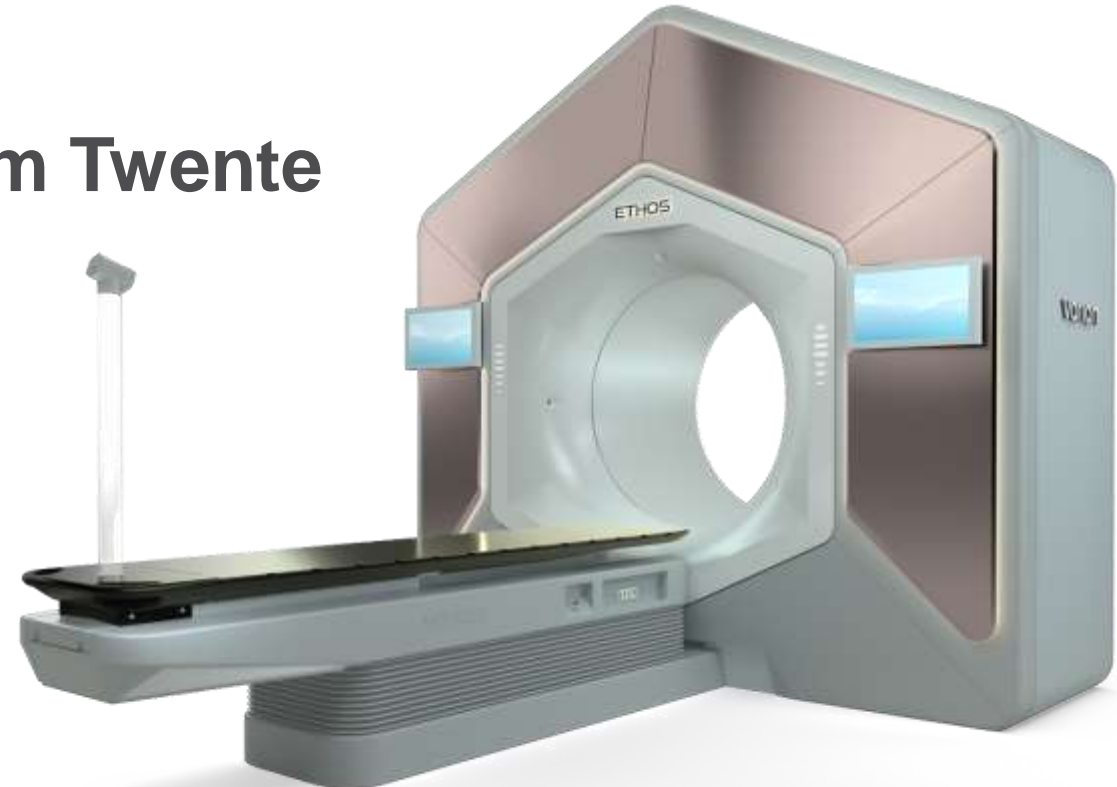


Ethos in Medisch Spectrum Twente

Liselotte ten Asbroek
Radiotherapy MST Enschede

September 2th 2022



1

CBCT guided online adaptive radiotherapy

Workflow

2

Our inhouse training program and processes

Training

3

2½ years treating patients using Varian's Ethos™

Results



Daily
plan



Effective
treatment



Spare
OAR's



Best possible
quality of life



Radiotherapy in MST – The Netherlands



2500 patients per year



3 Linacs



1 Ethos



75 Employees



Evolution of radiotherapy

Past

2022

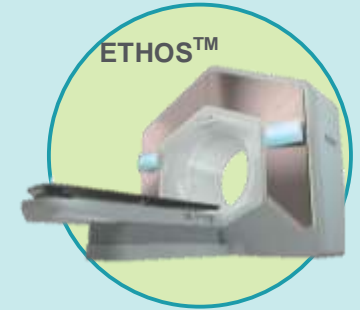
MV cassette

Linac with MV

Online imaging

CBCT imaging

Adaptive RT



MRI based

Unity Elekta

Mridian Viewray



~ one patient per hour

CBCT based

Ethos Varian



four patients per hour

Adaptive radiotherapy

Goals



**Better
target coverage**

**Reduce dose
to OAR's**

**Potentially improve
overall outcomes**

Ethos



**Integrated
workflow**

**Targeted
information**

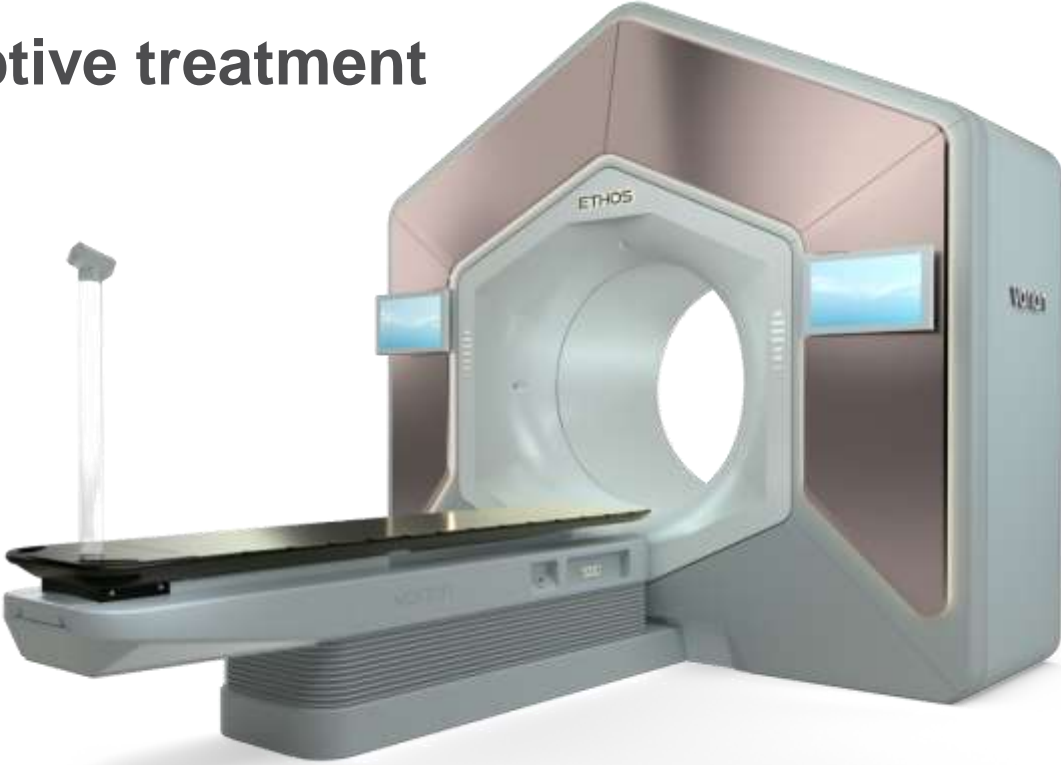
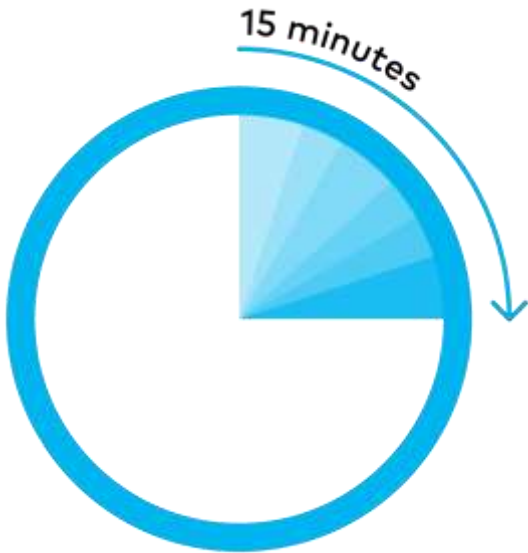
**Artificial
Intelligence**

1

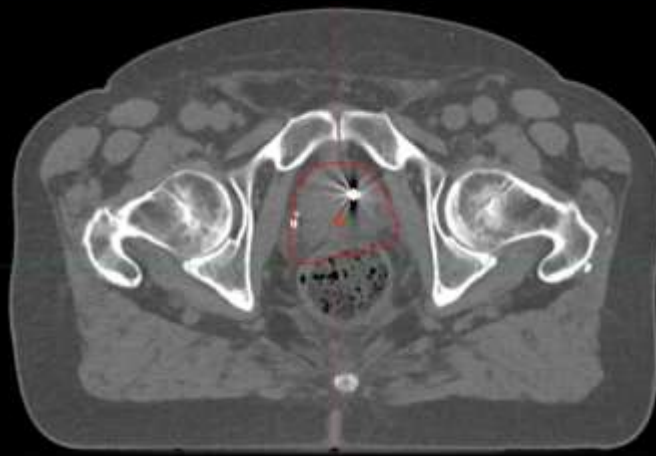
CBCT guided online adaptive radiotherapy

[Workflow](#)

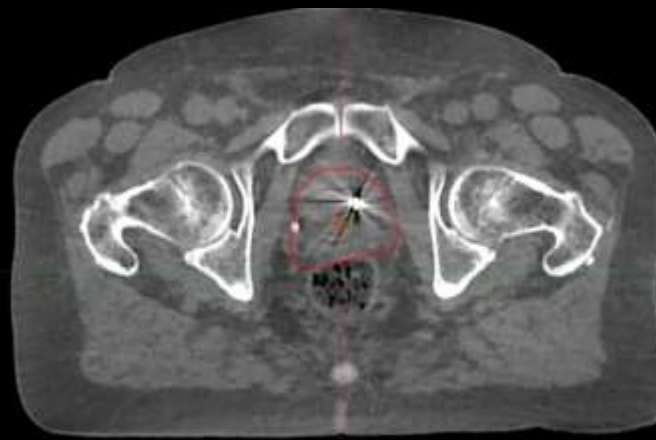
Daily online adaptive treatment



 Treatment
Planning-CT

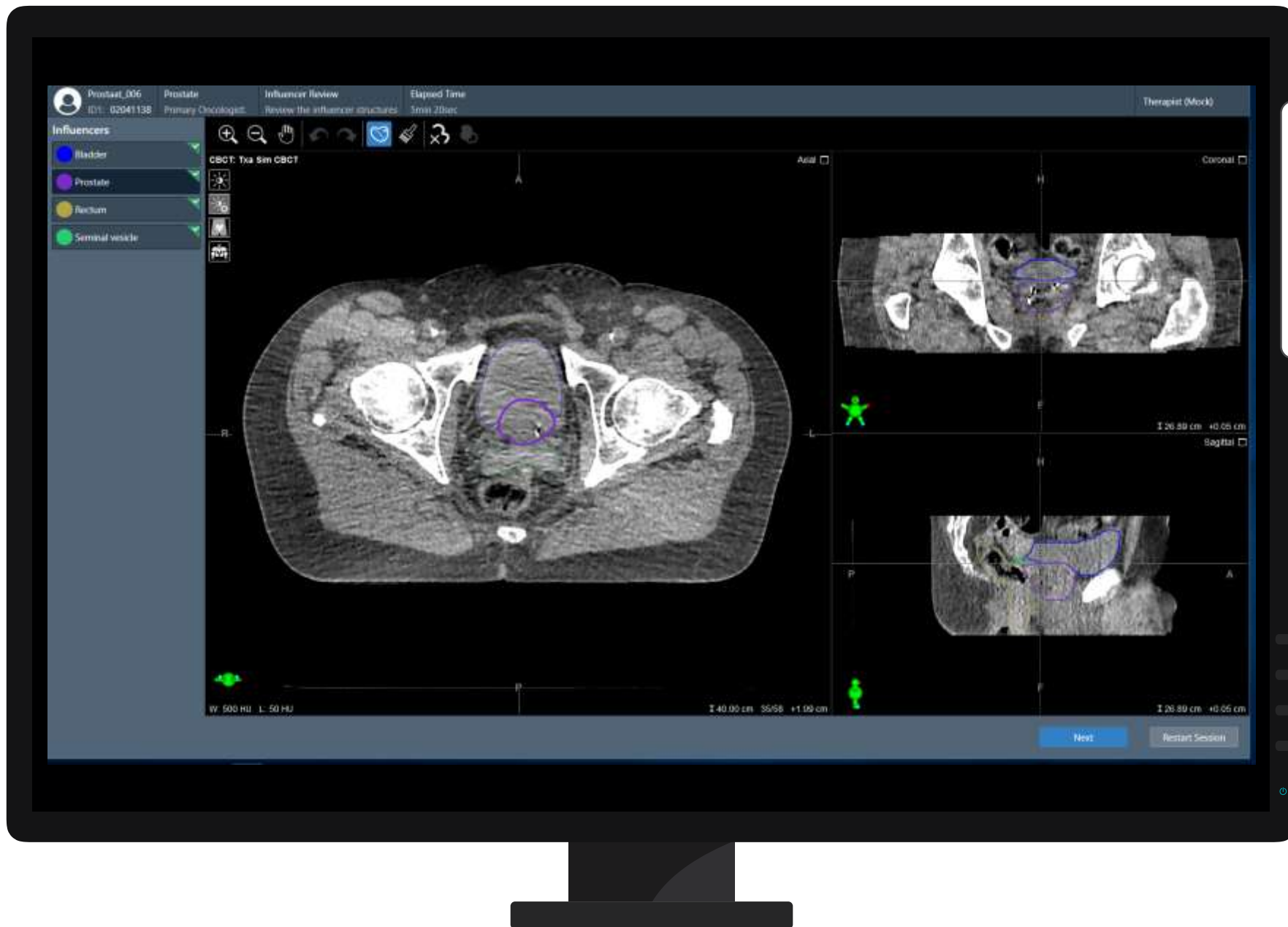


 CBCT



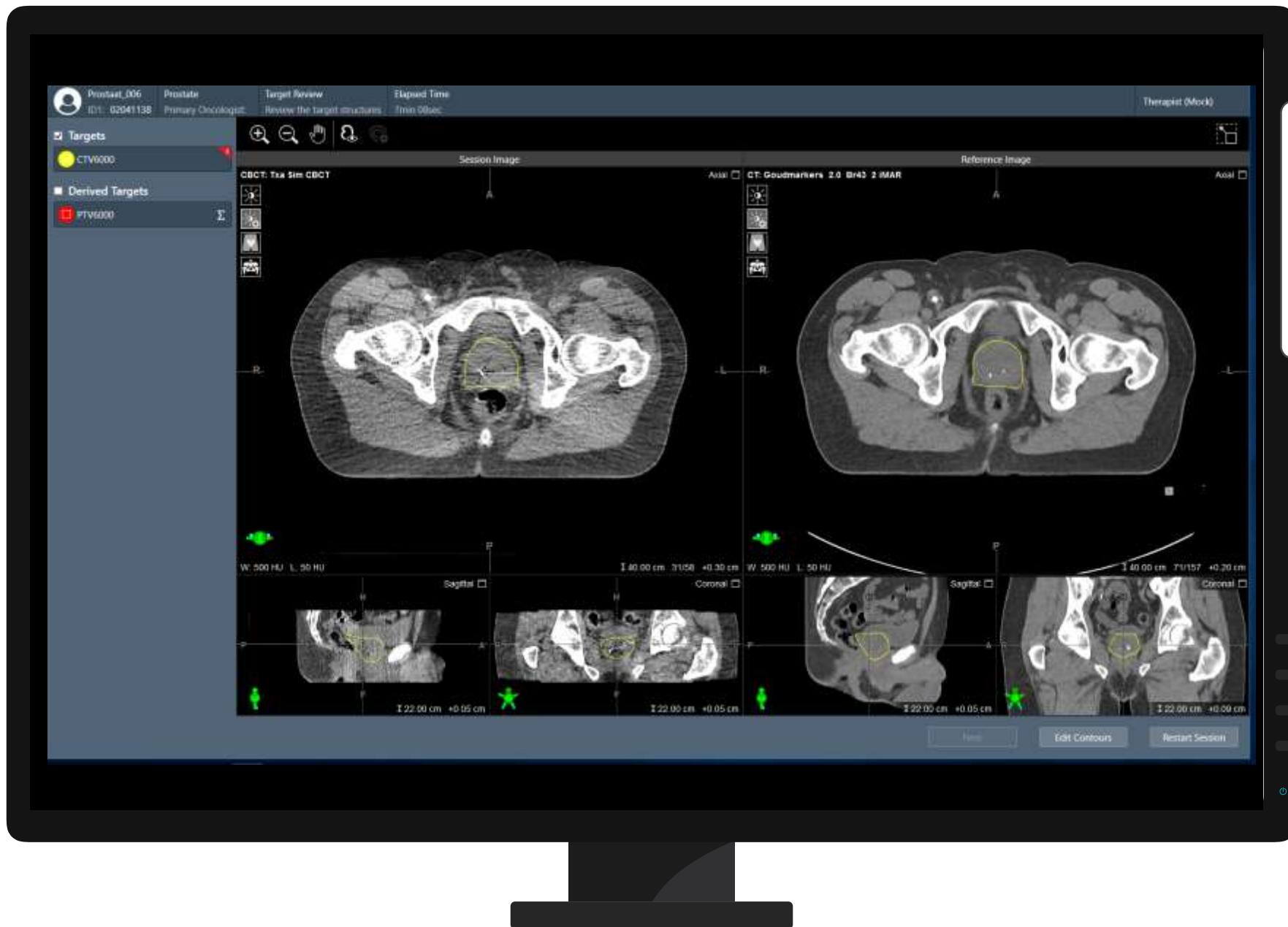
Patient set-up &
CBCT acquisition

0-3 min



**AI
Segmentation**

3-5 min



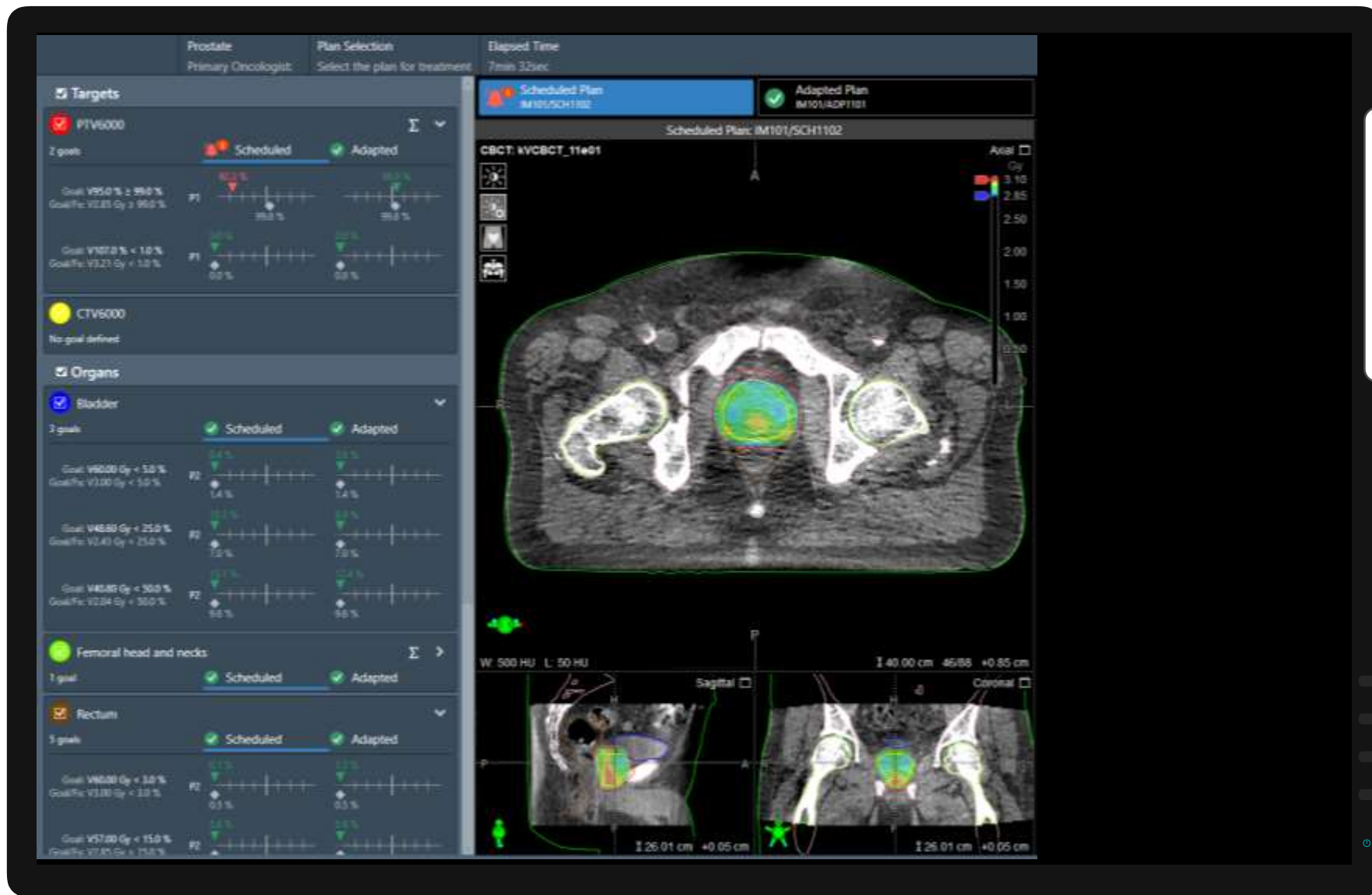
**Contour
evaluation**

5-8 min

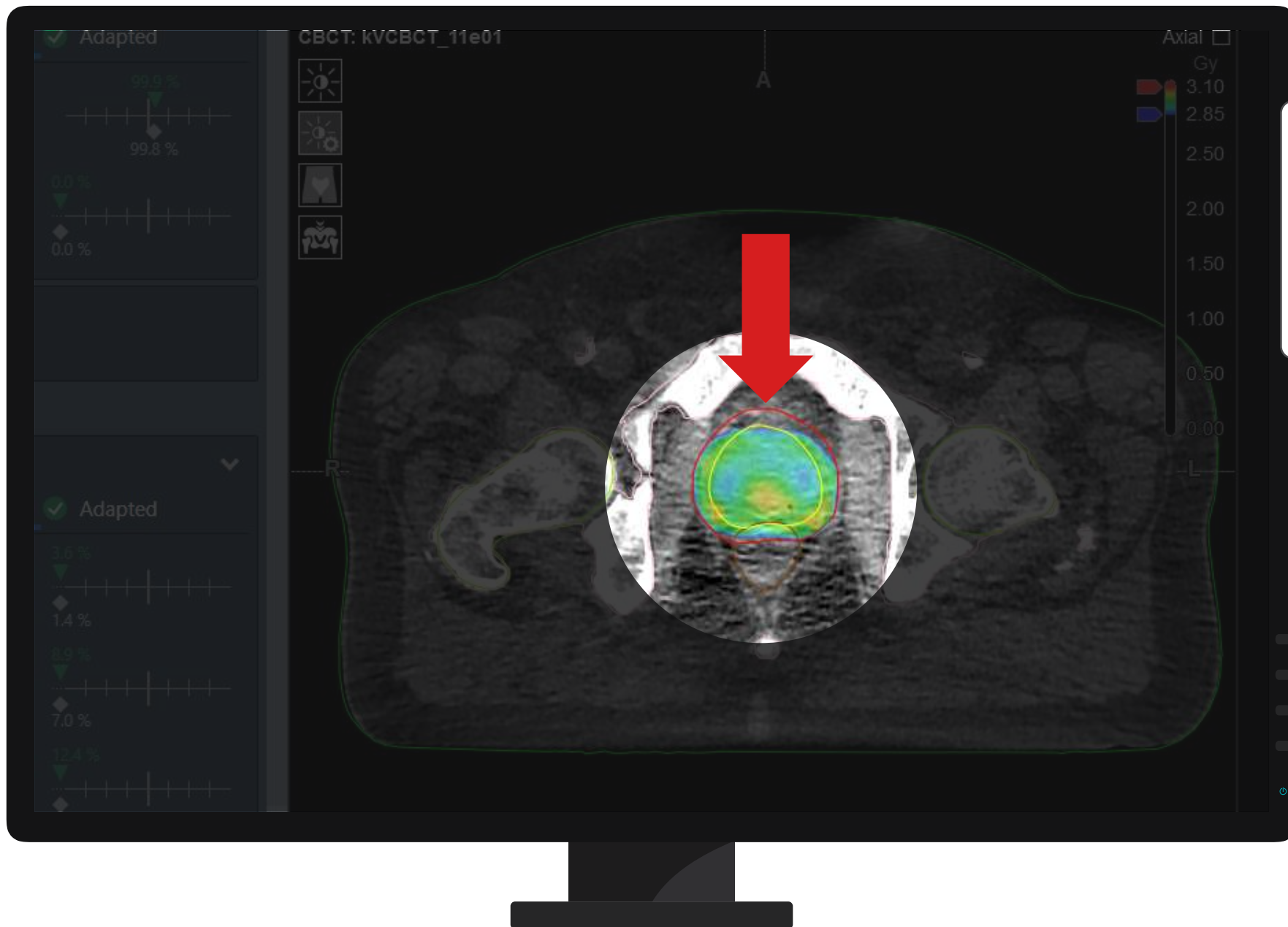


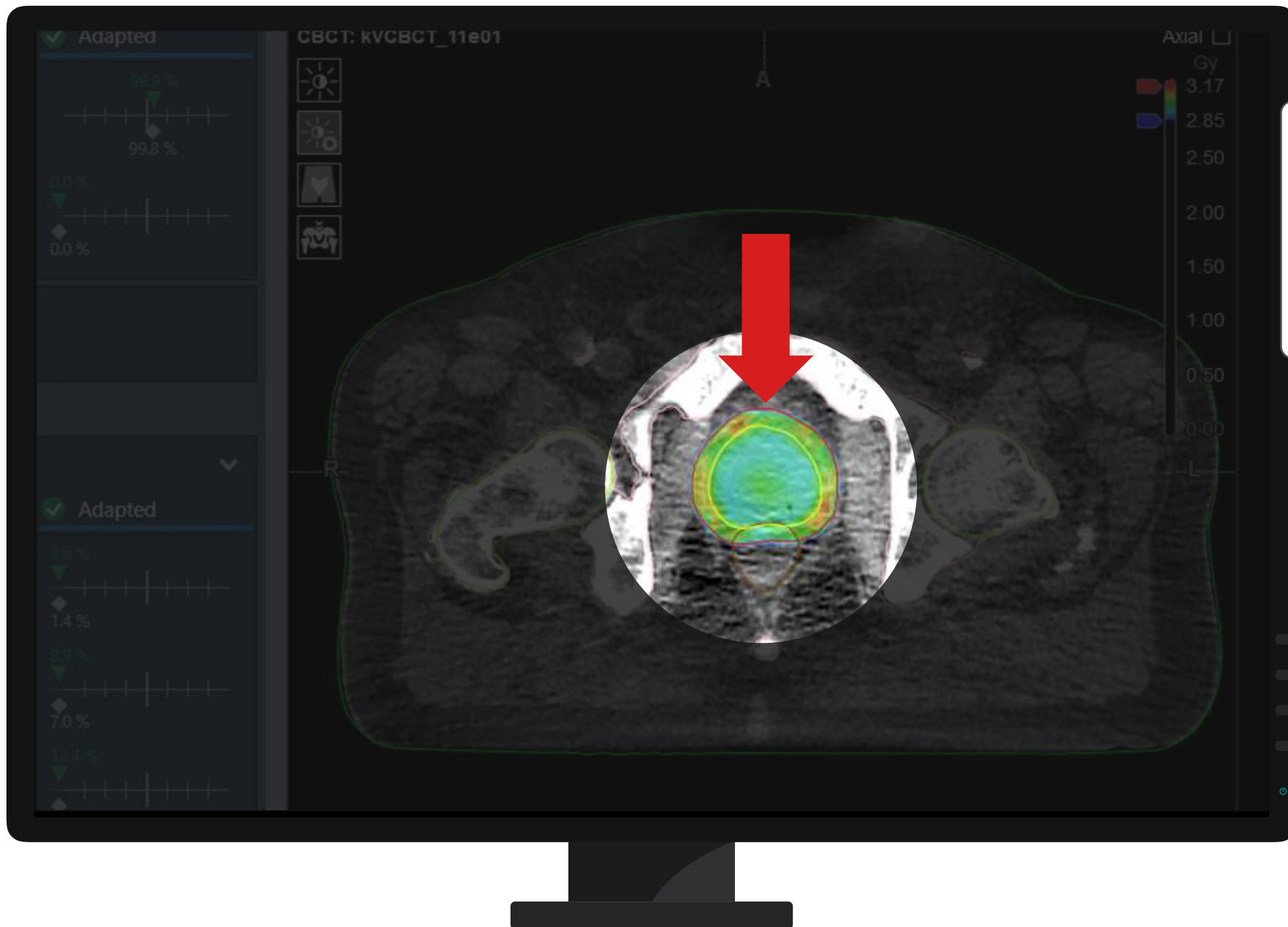
Contour evaluation

5-8 min



Plan generation
8-10 min





Plan generation

8-10 min

MobiusAdapt Patient Session

Machine Name: VARIAC

Scheduled

| Time | Plan Name | Target Coverage | DVH Limits | 3D Gamma | |
|------------------------|---|-----------------|------------|----------|---|
| 9:53 AM 4 hours ago | IMRT Prostate RT Intent Revision 3, IM116/SCH0102 | ✓ | ? | ✓ | ☰ |

DVH Limits

| TPS Name | Volume | Dose | TPS | M3D |
|----------|--------|------|-----|-----|
|----------|--------|------|-----|-----|

Adapted

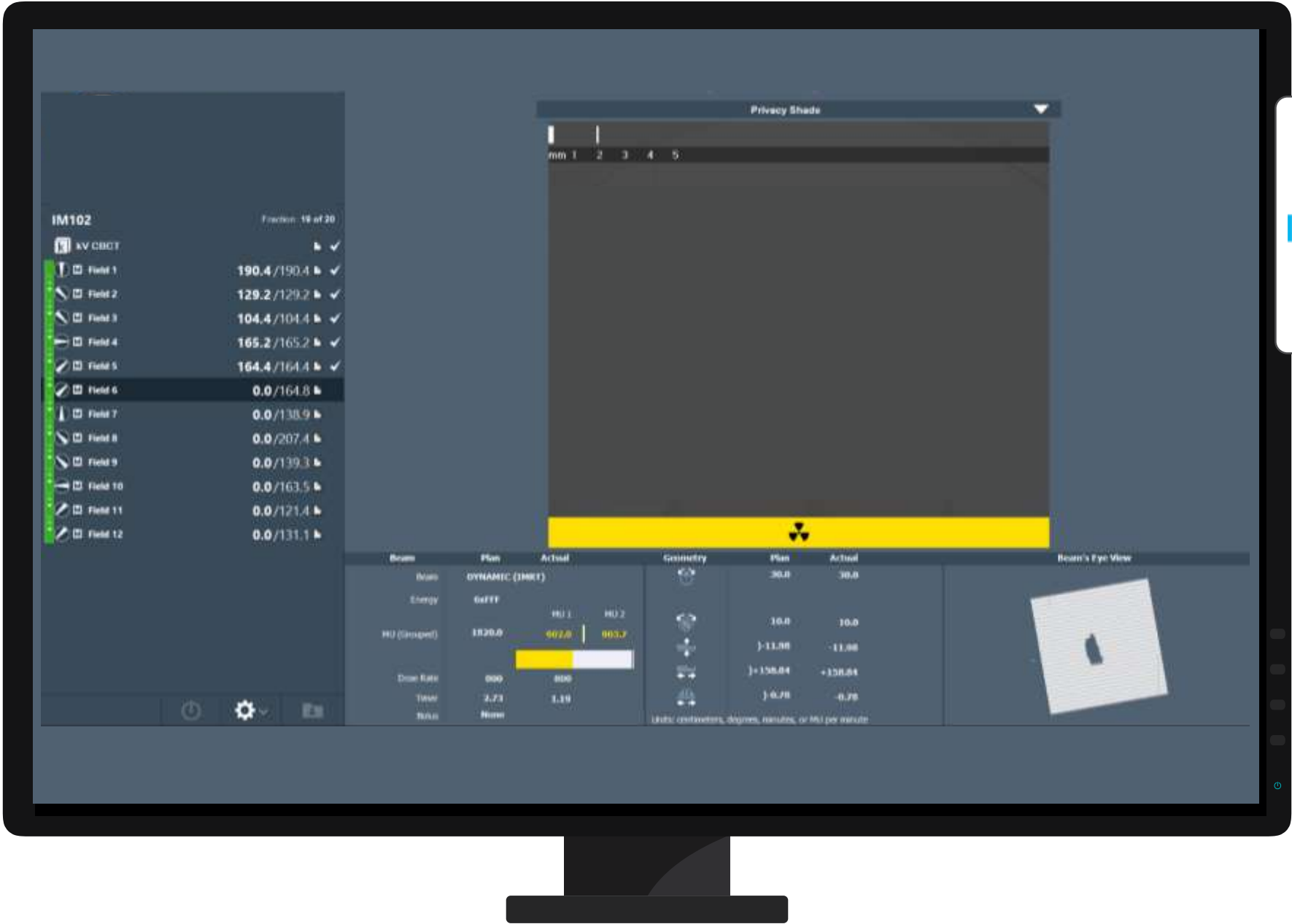
| Time | Plan Name | Target Coverage | DVH Limits | 3D Gamma | |
|------------------------|---|-----------------|------------|----------|---|
| 9:52 AM 4 hours ago | IMRT Prostate RT Intent Revision 3, IM116/ADP0101 | ✓ | ? | ✓ | ☰ |

DVH Limits

| TPS Name | Volume | Dose | TPS | M3D |
|----------|--------|------|-----|-----|
|----------|--------|------|-----|-----|

QA
Calculation

10-12 min



Treatment Delivery

12-15 min

IM102 Fraction: 19 of 20

| Field | Dose |
|----------|---------------|
| xv CBCT | |
| Field 1 | 190.4 / 190.4 |
| Field 2 | 129.2 / 129.2 |
| Field 3 | 104.4 / 104.4 |
| Field 4 | 165.2 / 165.2 |
| Field 5 | 164.4 / 164.4 |
| Field 6 | 0.0 / 164.8 |
| Field 7 | 0.0 / 138.9 |
| Field 8 | 0.0 / 207.4 |
| Field 9 | 0.0 / 139.3 |
| Field 10 | 0.0 / 163.5 |
| Field 11 | 0.0 / 121.4 |
| Field 12 | 0.0 / 131.1 |

Privacy Shade

mm 1 2 3 4 5

Beam's Eye View

| Beam | Plan | Actual | Geometry | Plan | Actual |
|-------------|----------------|---------------|----------|---------|---------|
| Name | DYNAMIC (IMRT) | | | 30.0 | 30.0 |
| Energy | 6FFF | | | | |
| HD (Shaped) | 1820.0 | 907.0 903.7 | | 10.0 | 10.0 |
| Dose Rate | 600 | 600 | | -11.98 | -11.98 |
| TWD | 2.73 | 1.19 | | +158.84 | +158.84 |
| WU | None | | | -0.78 | -0.78 |

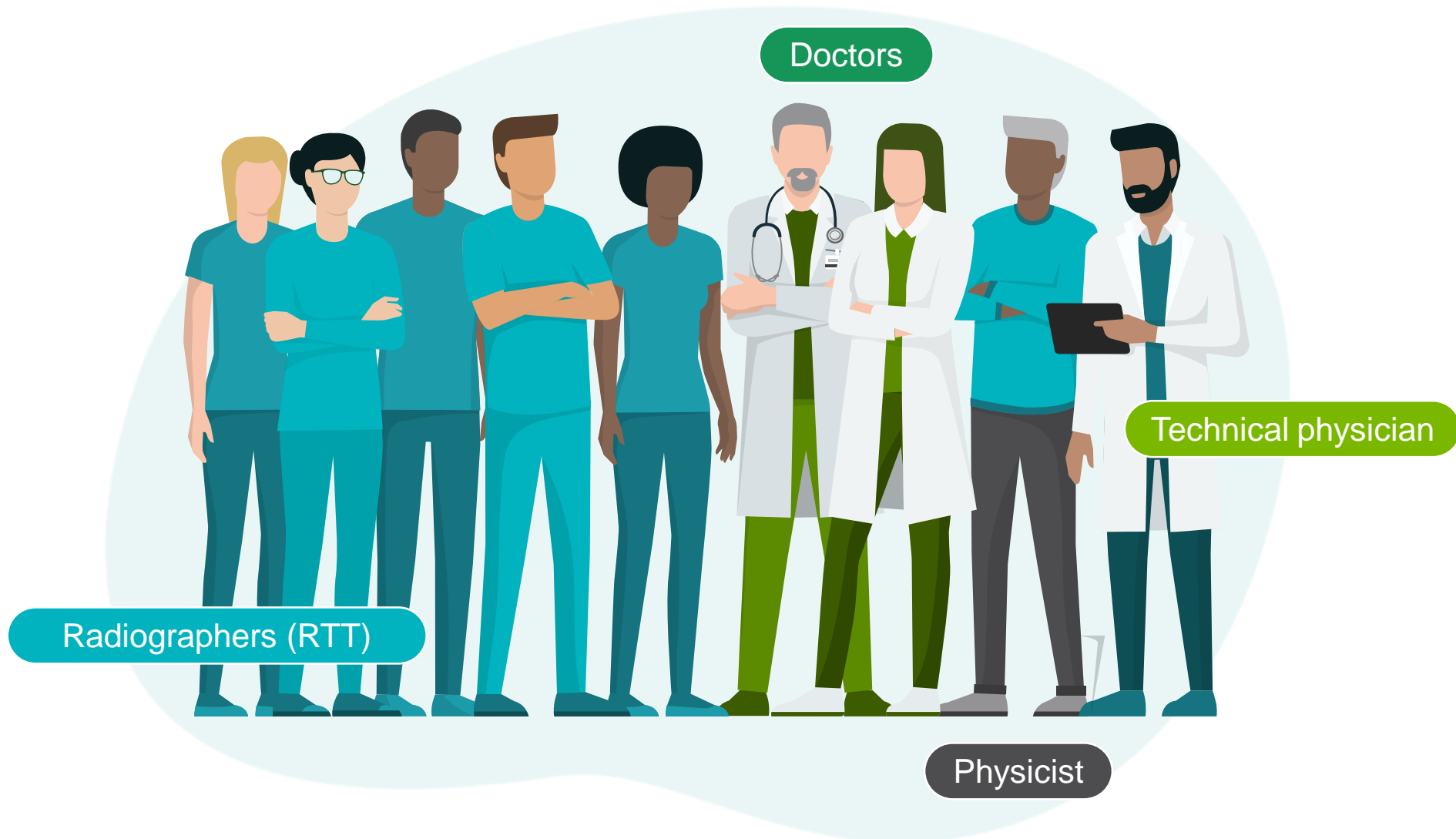
Units: centimeters, degrees, minutes, or MU per minute

2

Our inhouse training program and processes

Training

Start with a small and dedicated team





Prostate



Start adaptive treatments

- 3 patients / day
- Full team present
- Focus on workflow
- Assign the tasks
- Define the responsibilities
- Build experience



Situation

February – June 2020

Total team

Radiographers (RTT)



Doctors



Physicist



Technical physicians



Daily team



1h

3 Patients

Adaptive treatment

Training and education

Training phases

Clinical lessons anatomy

🕒 4h

Treatment planning

🕒 2h

Application training

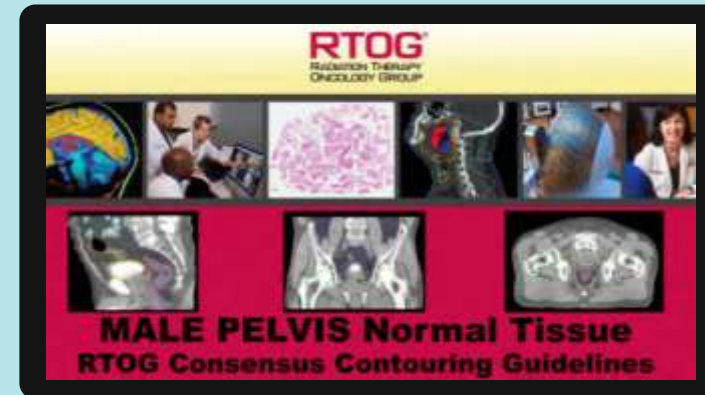
🕒 4h

Emulator training

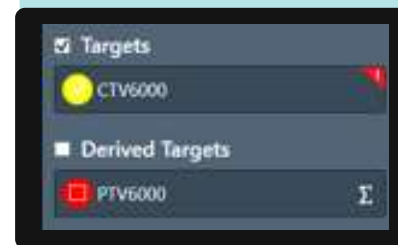
🕒 8h

Learning on-the-job

🕒 ~ 4 wks



TIPS & TRICKS



Training and education

Training phases

Clinical lessons
anatomy

🕒 4h

Treatment
planning

🕒 2h

Application
training

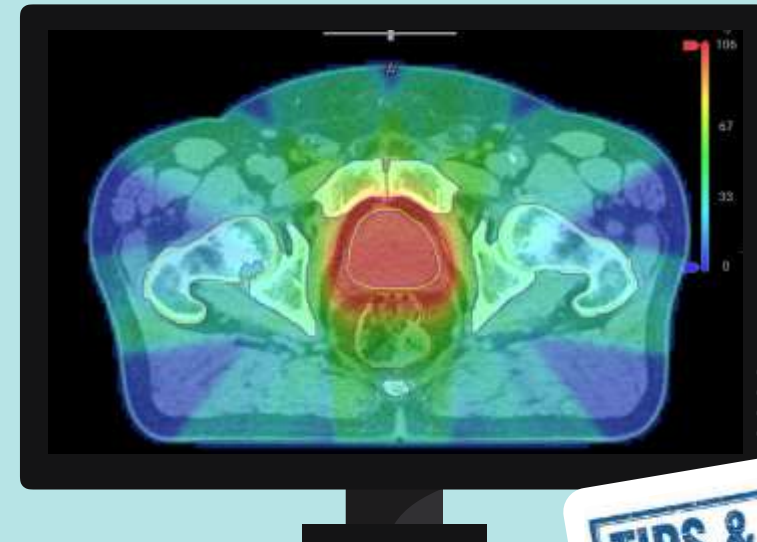
🕒 4h

Emulator
training

🕒 8h

Learning
on-the-job

🕒 ~ 4 wks



TIPS & TRICKS

Training and education

Training phases

Clinical lessons
anatomy

🕒 4h

Treatment
planning

🕒 2h

Application
training

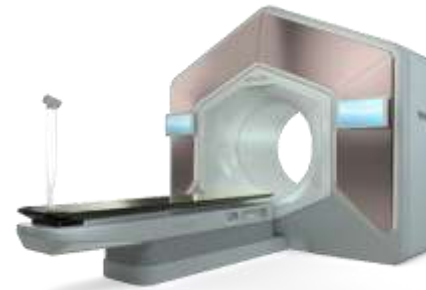
🕒 4h

Emulator
training

🕒 8h

Learning
on-the-job

🕒 ~ 4 wks



Patient set-up &
CBCT acquisition

0-3 min

AI
Segmentation

3-5 min

Contour
evaluation

5-8 min

Plan
generation

8-10 min

QA
Calculation

10-12 min

Treatment
Delivery

12-15 min

Training and education

Training phases

Clinical lessons
anatomy

🕒 4h

Treatment
planning

🕒 2h

Application
training

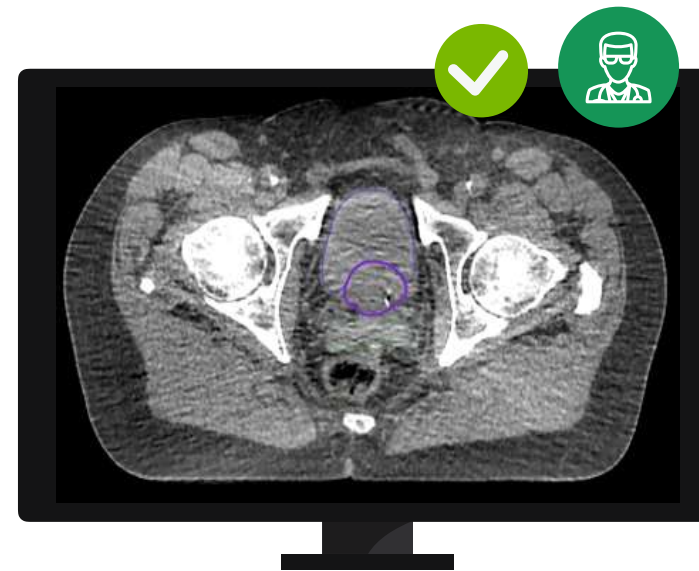
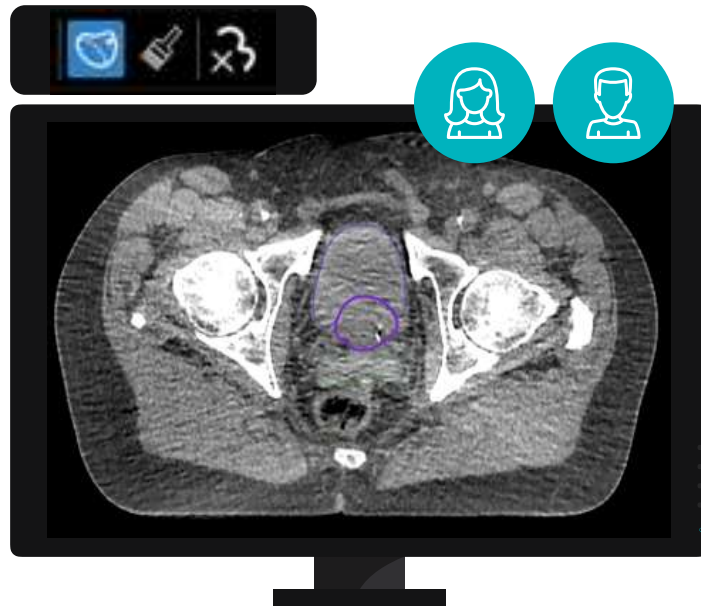
🕒 4h

Emulator
training

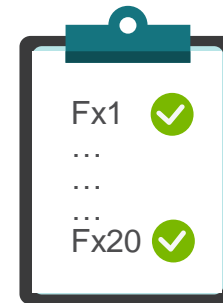
🕒 8h

Learning
on-the-job

🕒 ~ 4 wks



Training and education



Training and Education

Clinical lessons



Treatment planning



Application training



Emulator training



Learning on-the-job



Practical exam



Advanced
adapter



Quality control advanced adapters





Situation

Since July 2020

Total team

Radiographers (RTT)



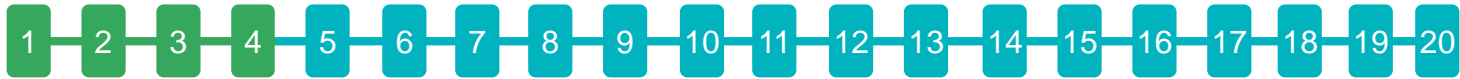
Doctors



Physicist



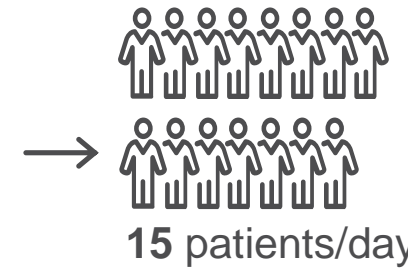
Technical physicians



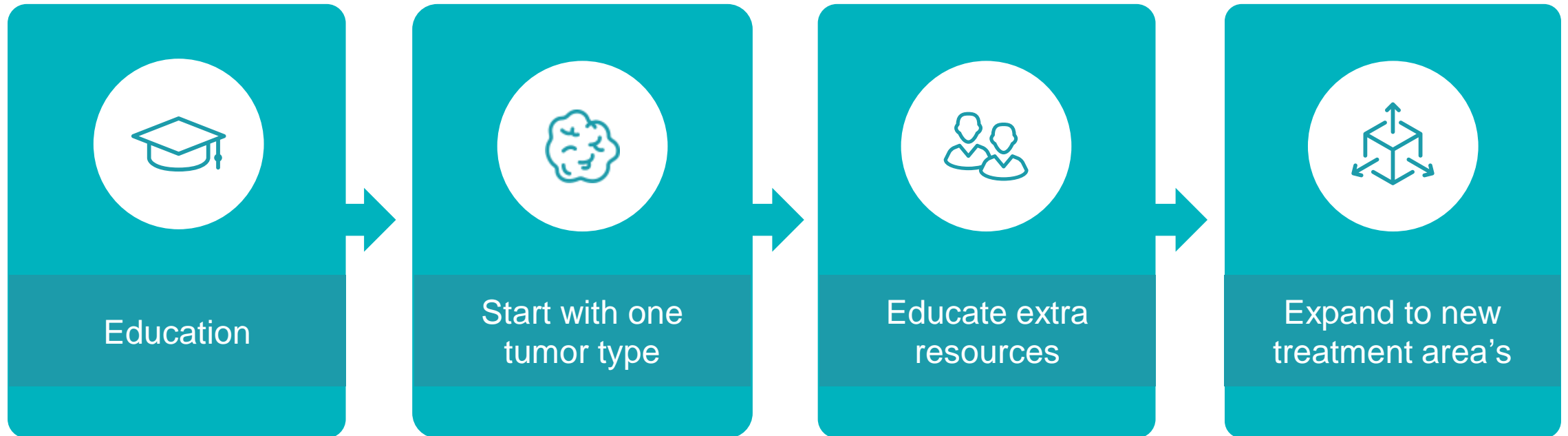
New patients (1st four fractions)



Daily team



Our growth model of the department for adaptive treatment



3

2½ years treating patients using Varian's Ethos™

Results

Clinical experiences



Prostate

 254



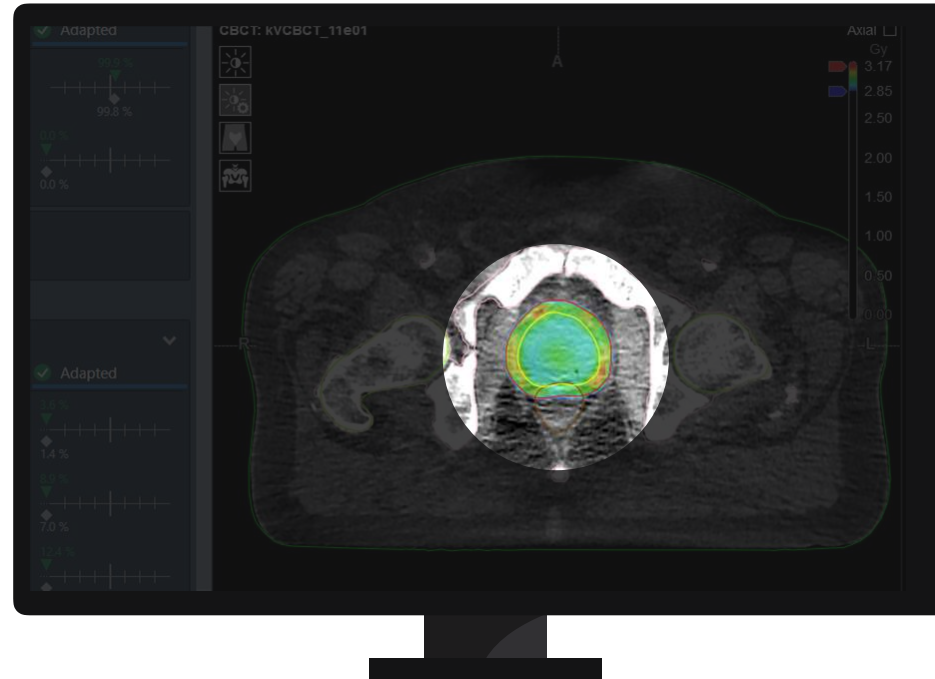
Added value of adaptive radiotherapy for prostate cancer





200 patients



3967 fractions

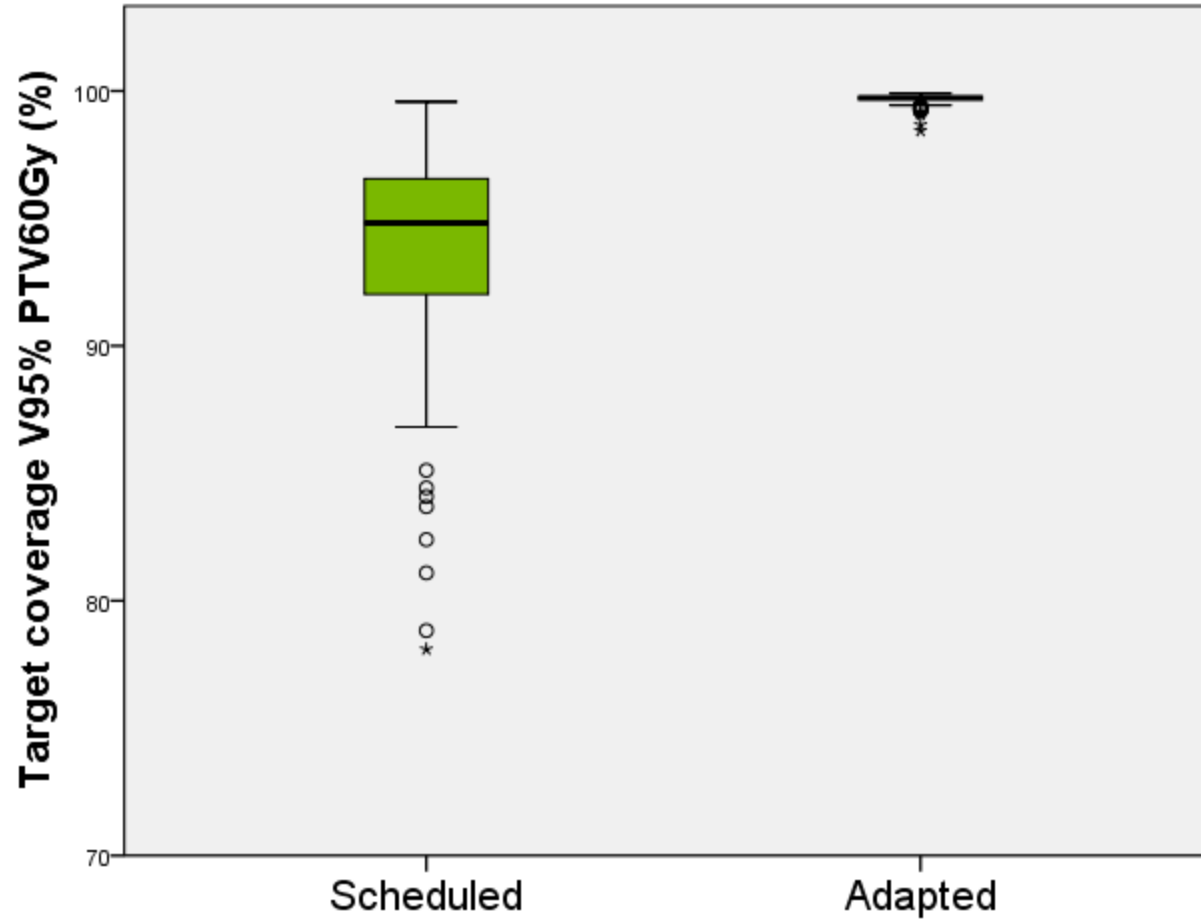


 Adapted plan (98,9%)
 Scheduled plan (1,1%)



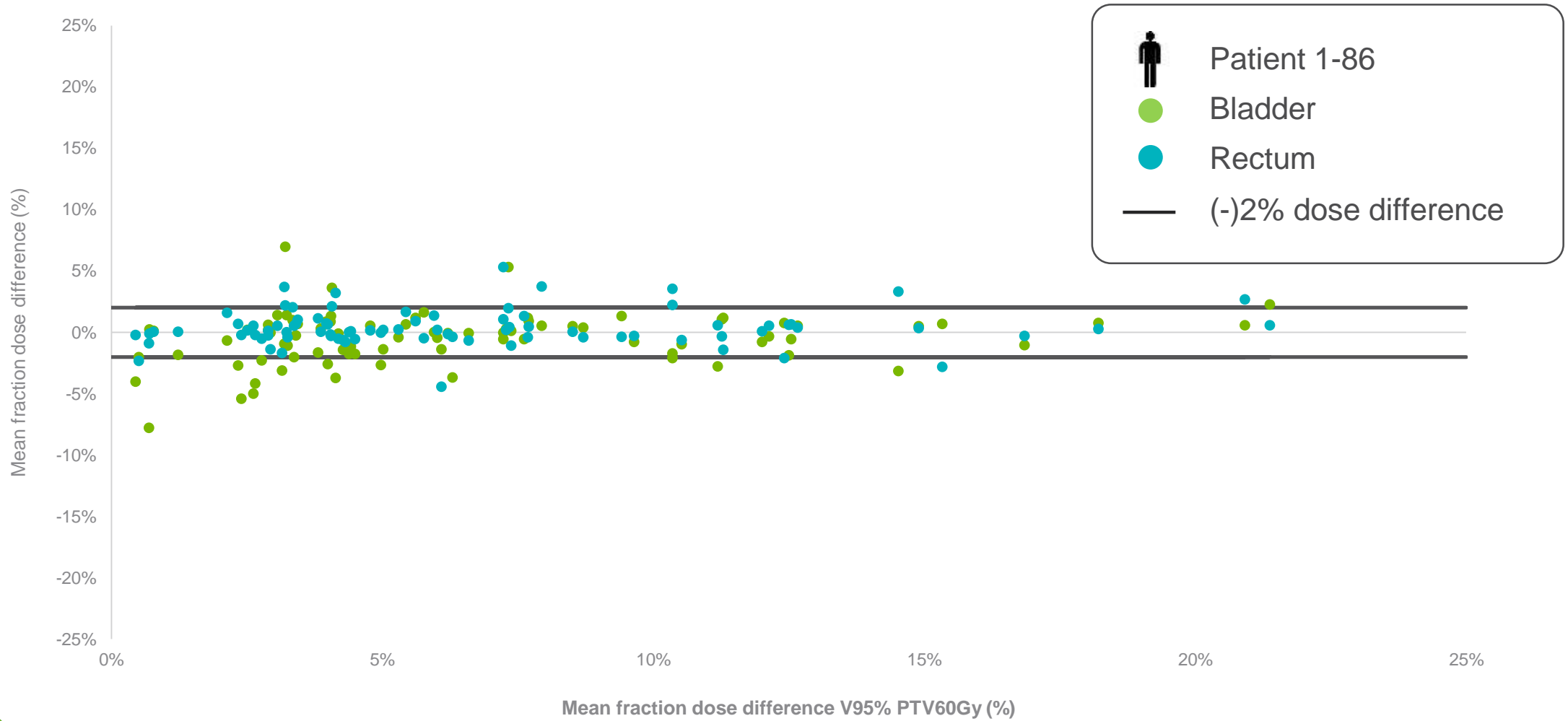


Added value of adaptive radiotherapy for prostate cancer



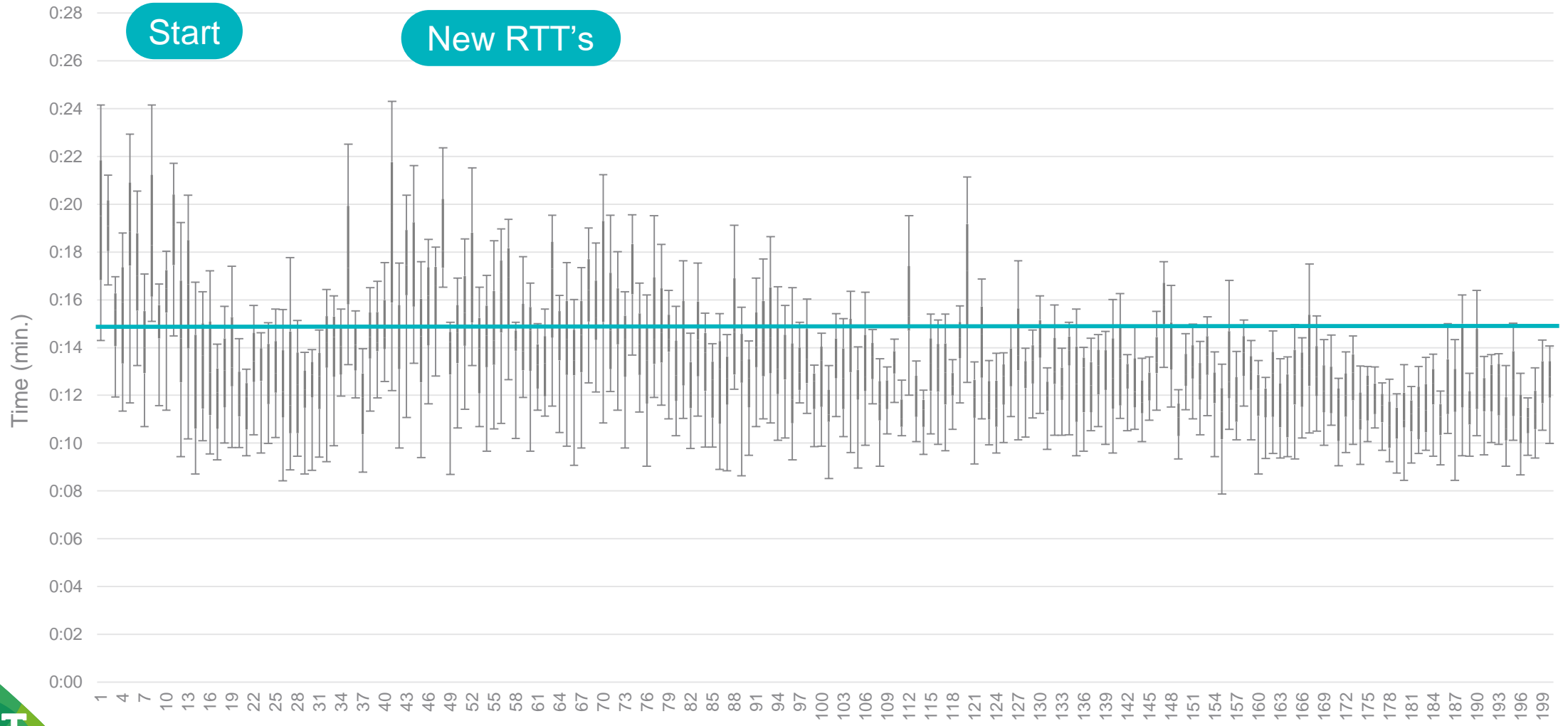


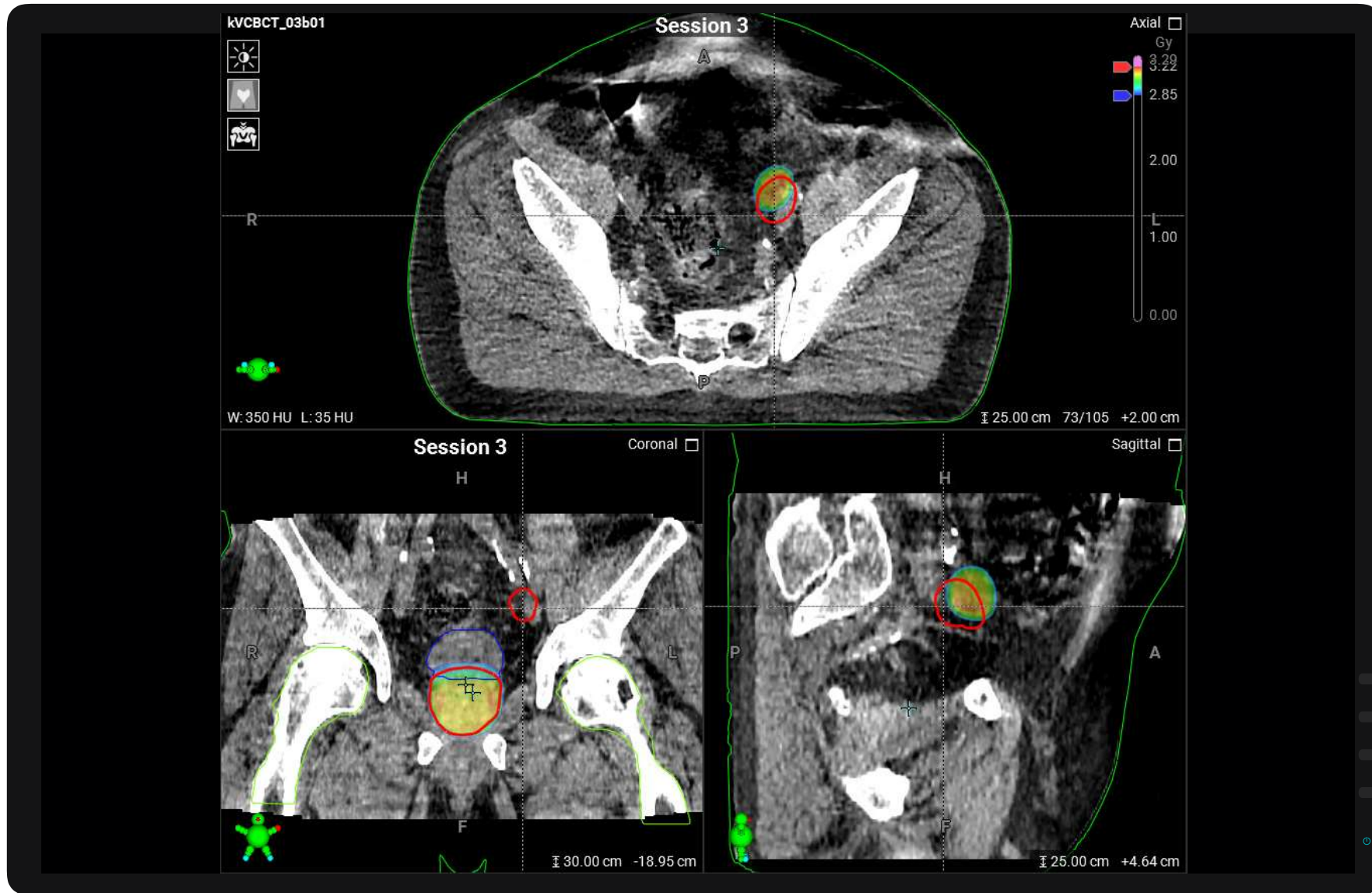
Added value of adaptive radiotherapy for prostate cancer



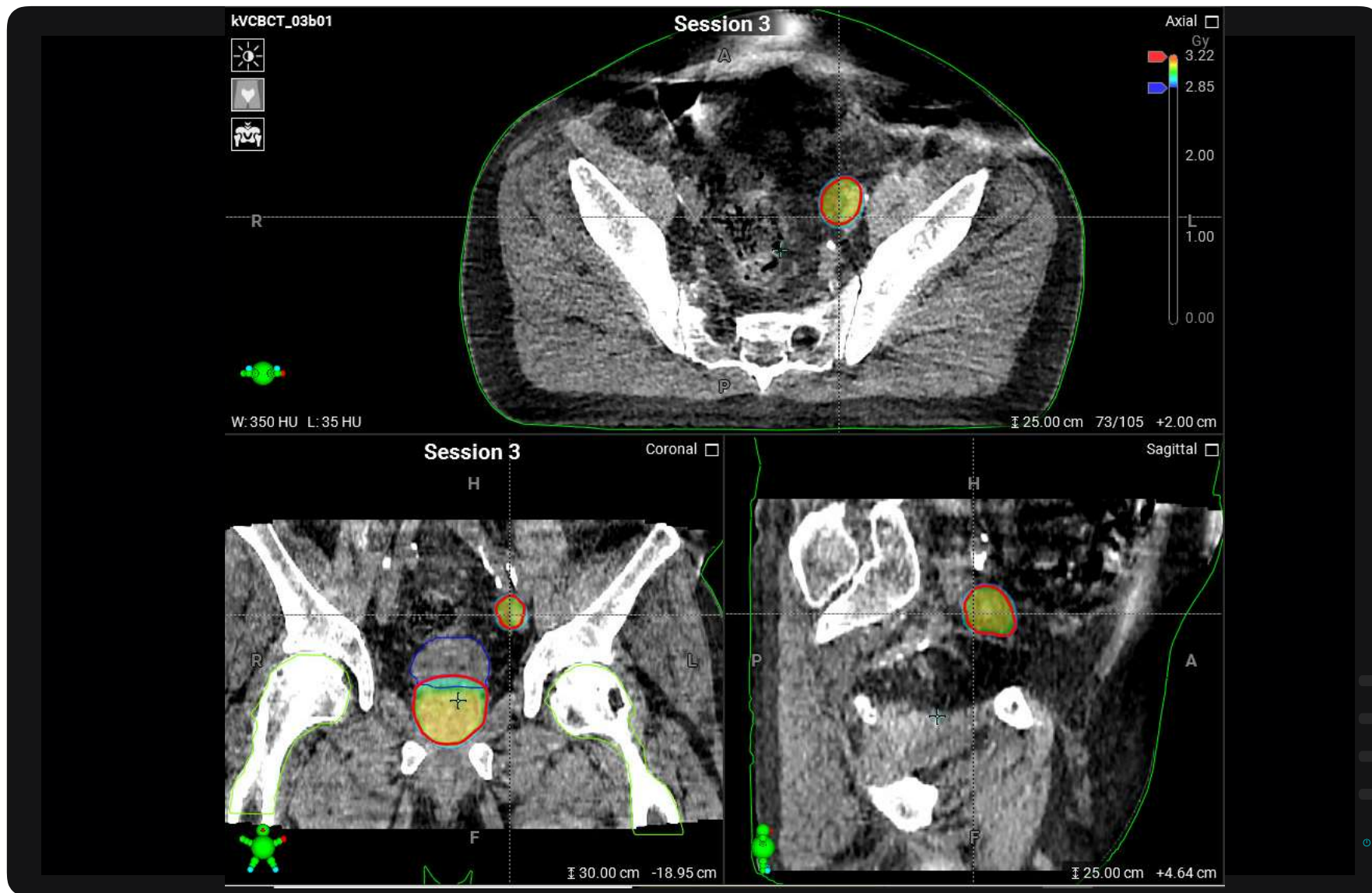


Treatment time of adaptive prostate cancer patients

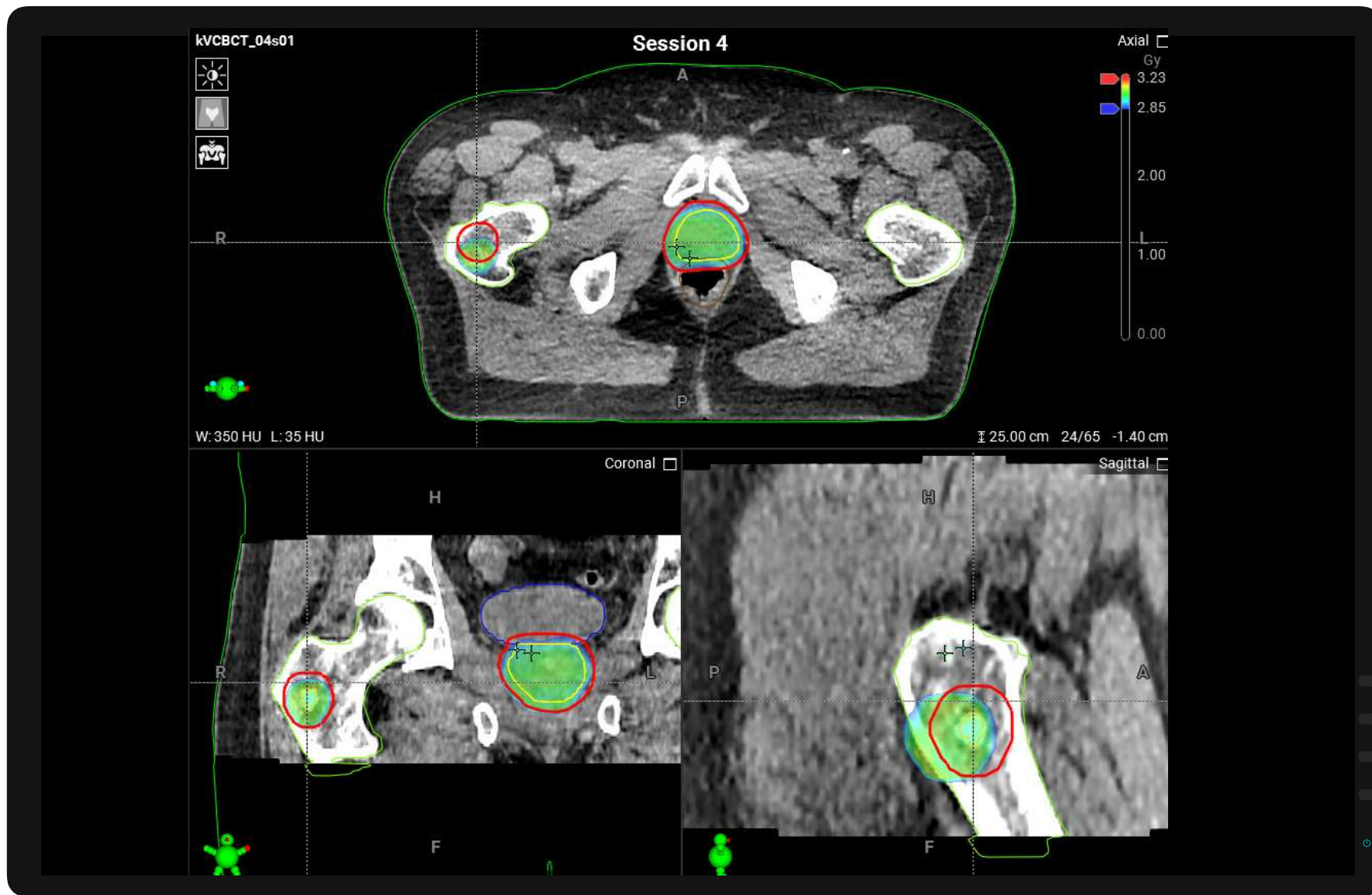




Scheduled plan



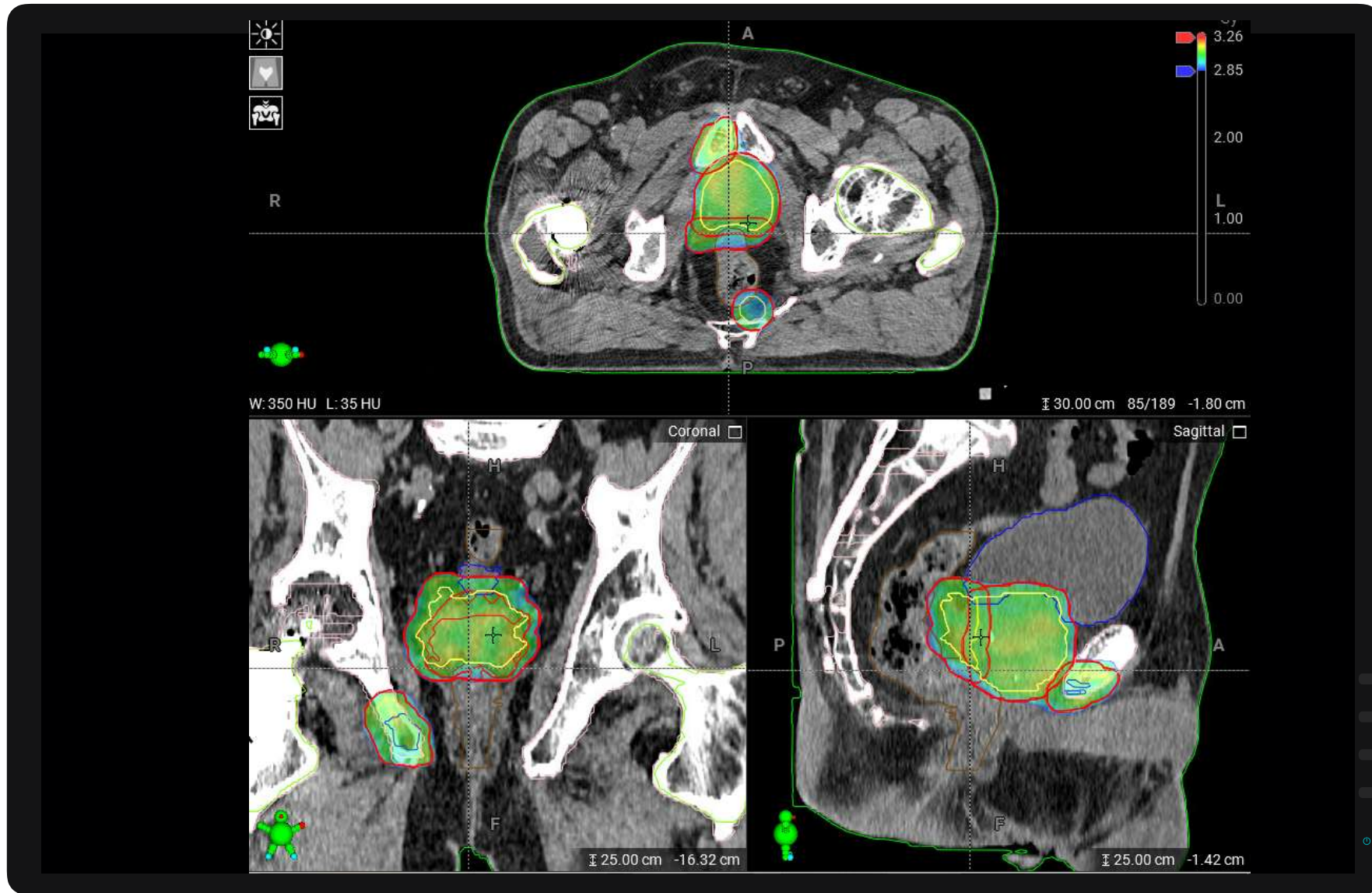
Adapted plan



Scheduled plan



Adapted plan



Plan CT

Clinical experiences

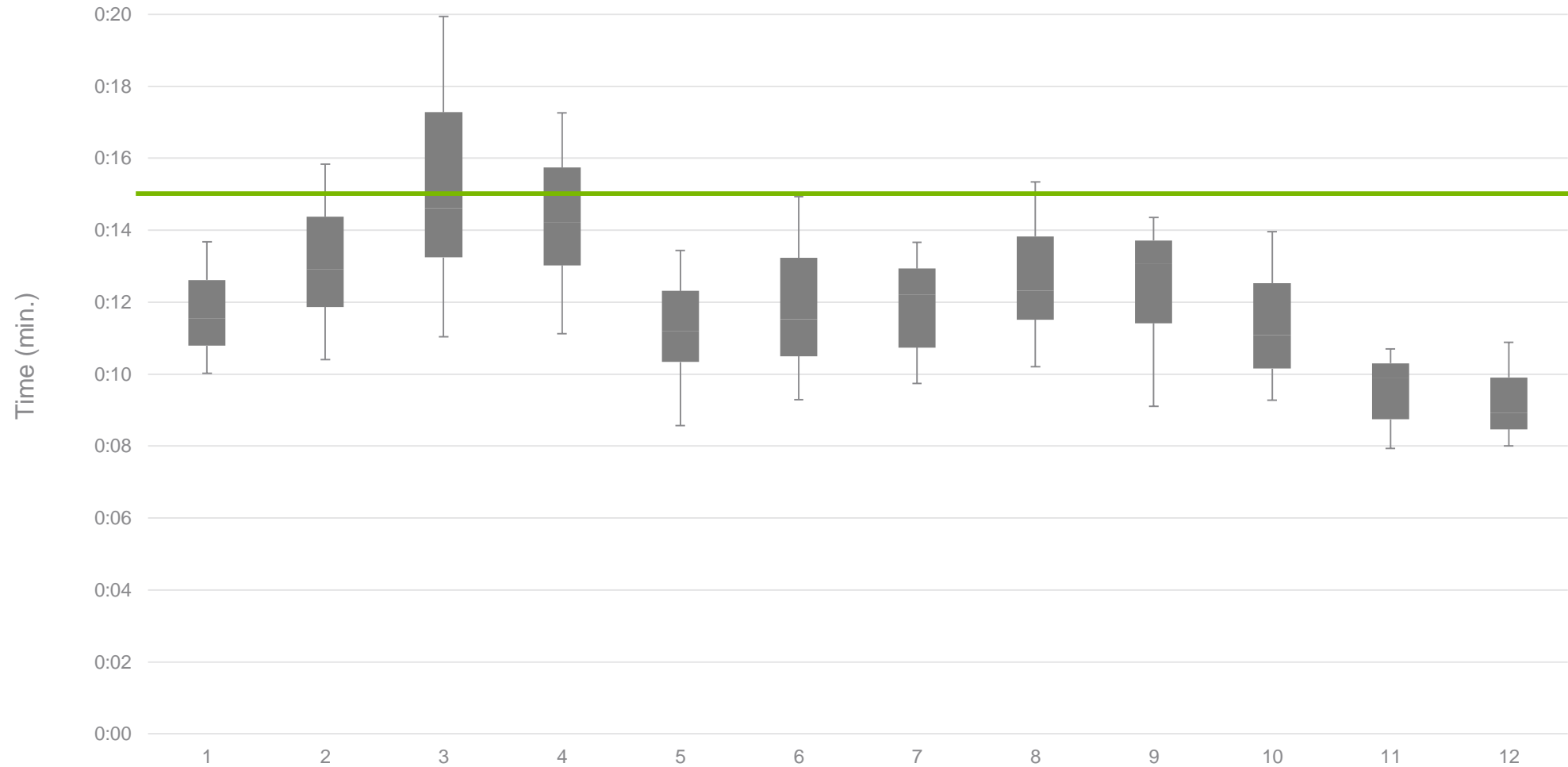


Bladder



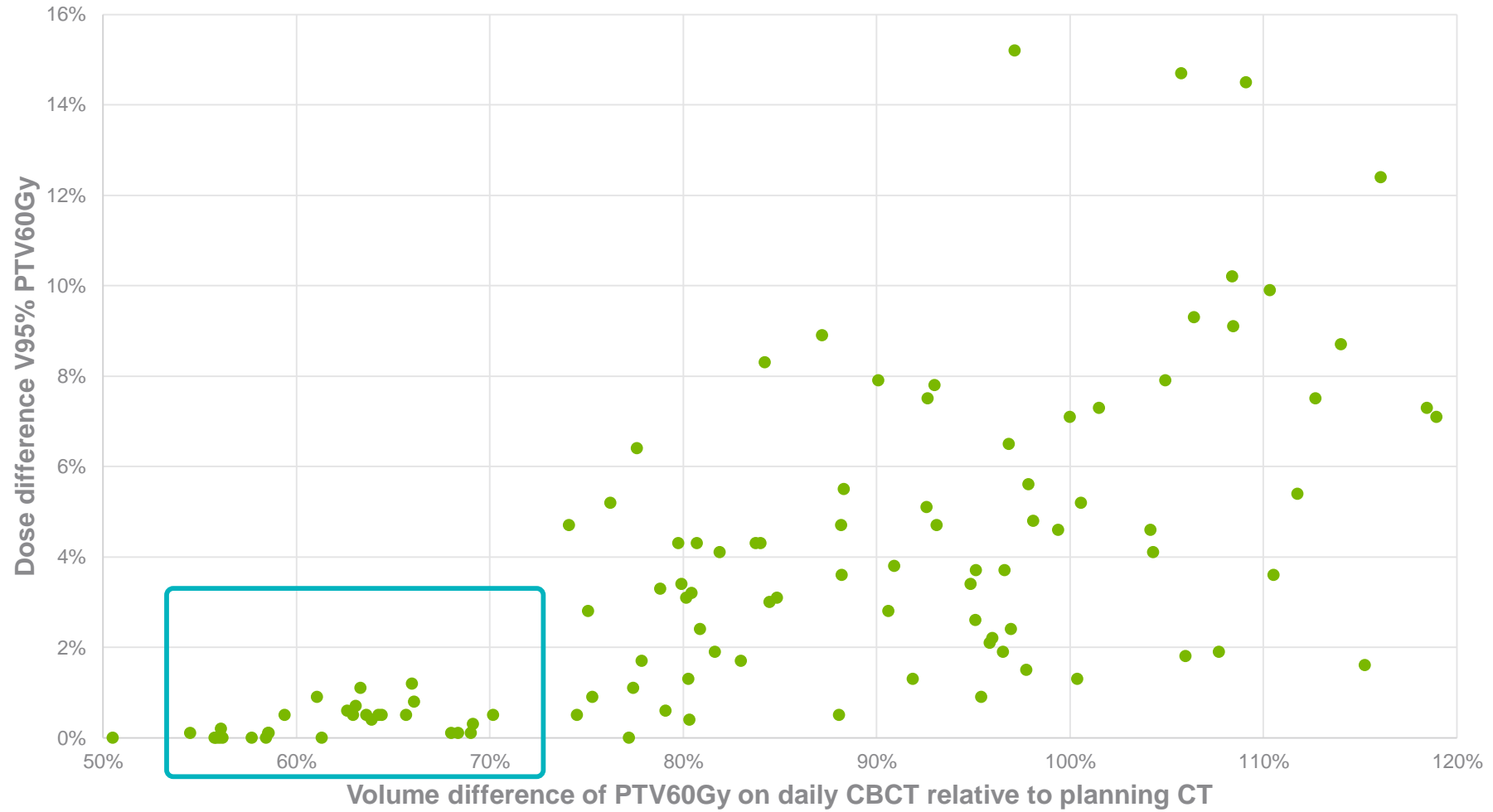


Treatment time of adaptive bladder cancer patients



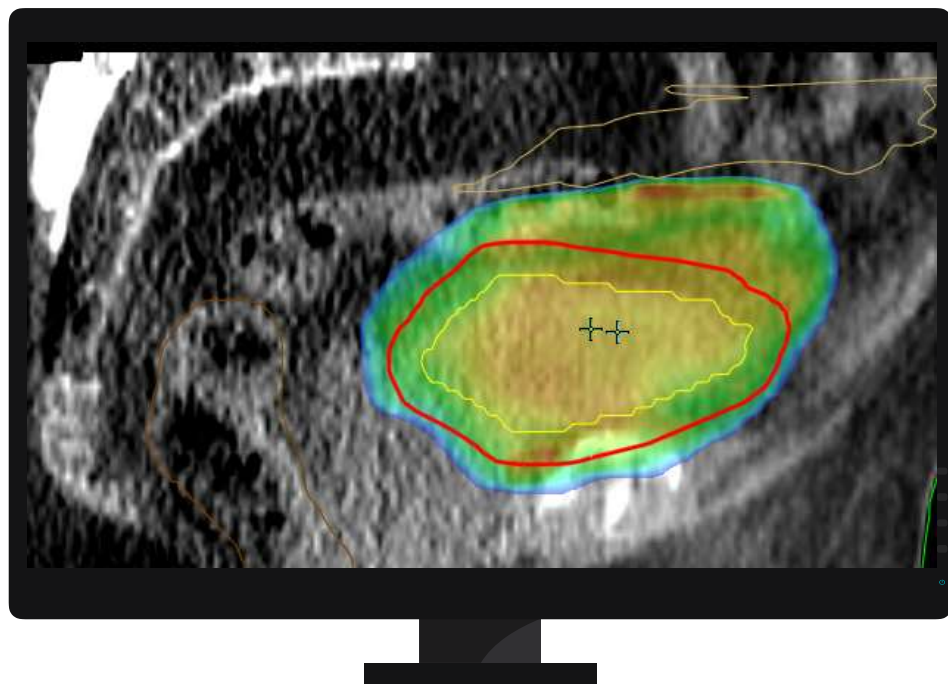


Bladder volume differences vs dose differences

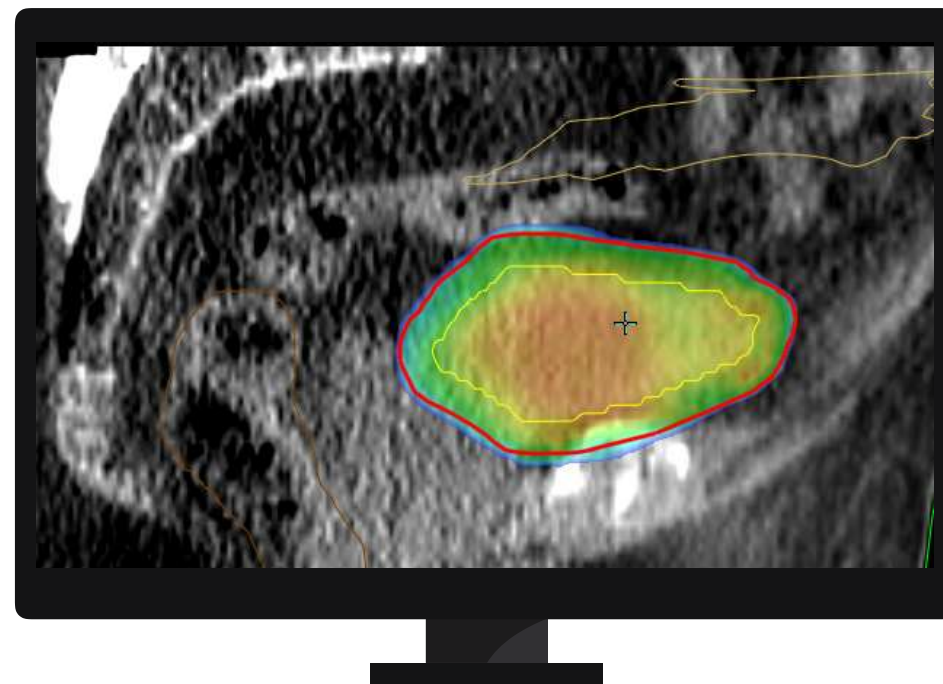




Added value of adaptive radiotherapy for bladder cancer



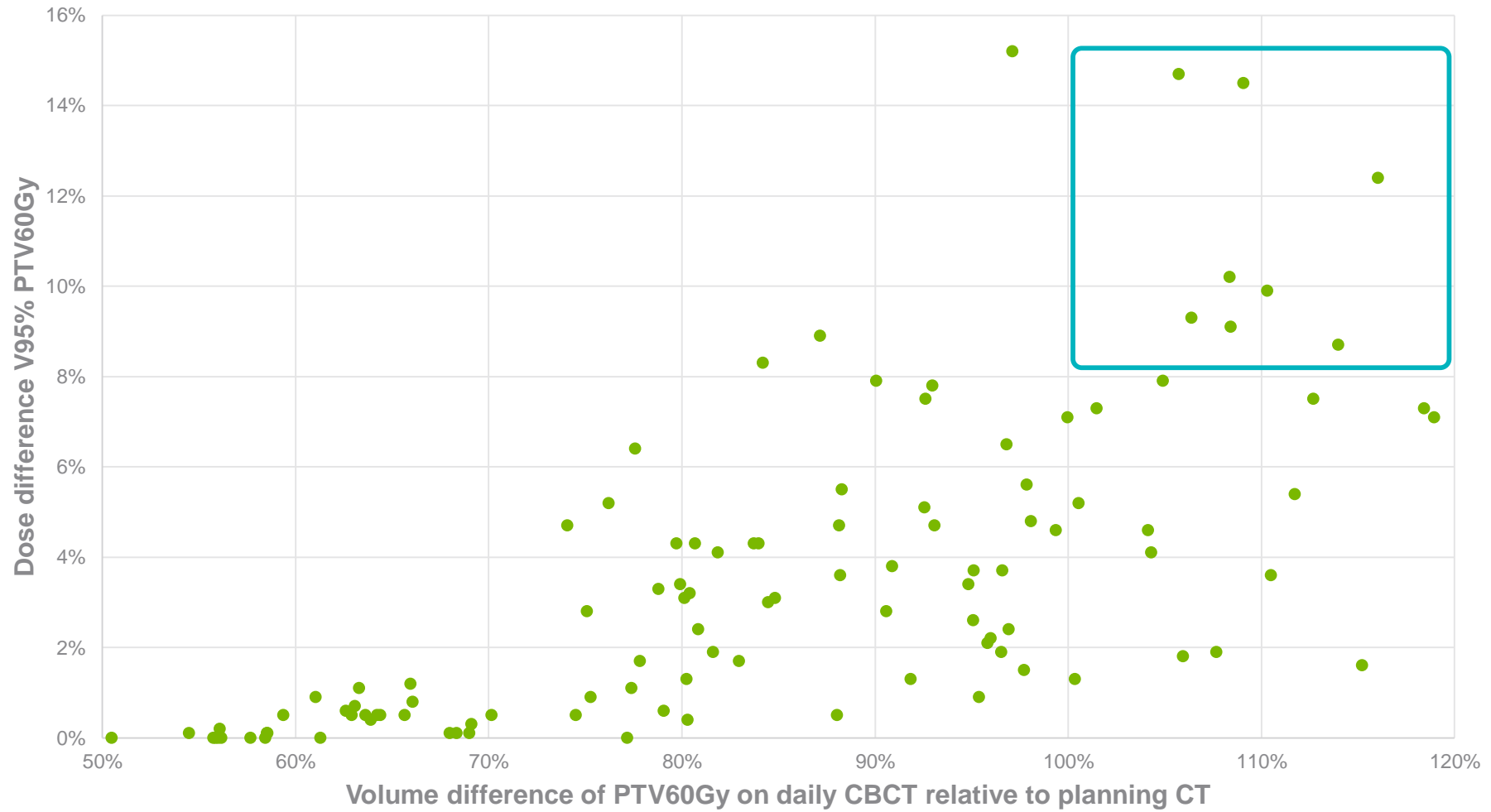
Scheduled plan



Adapted plan

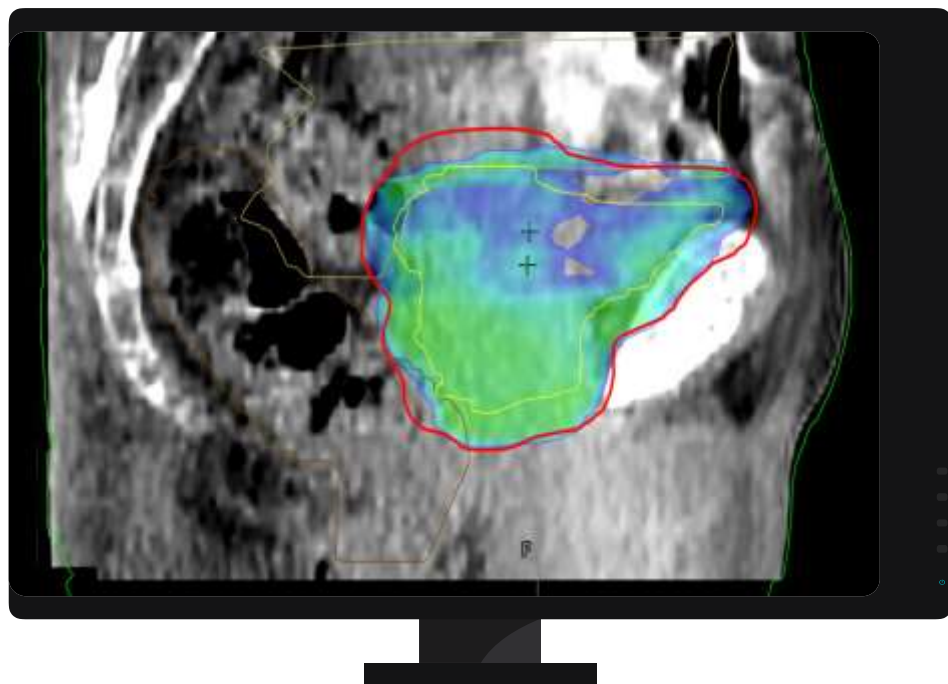


Bladder volume differences vs dose differences

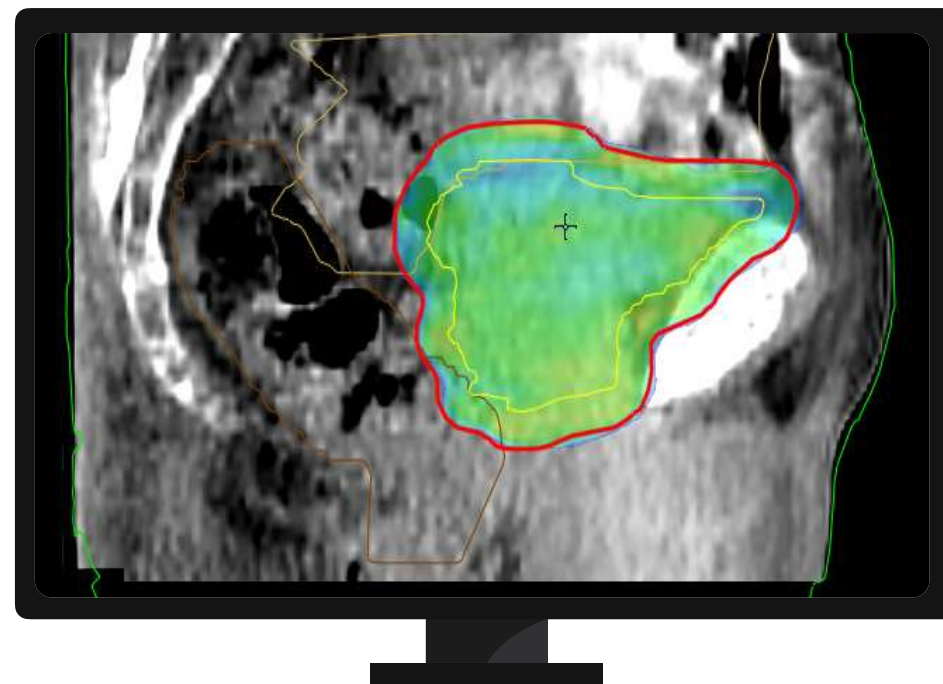




Added value of adaptive radiotherapy for bladder cancer



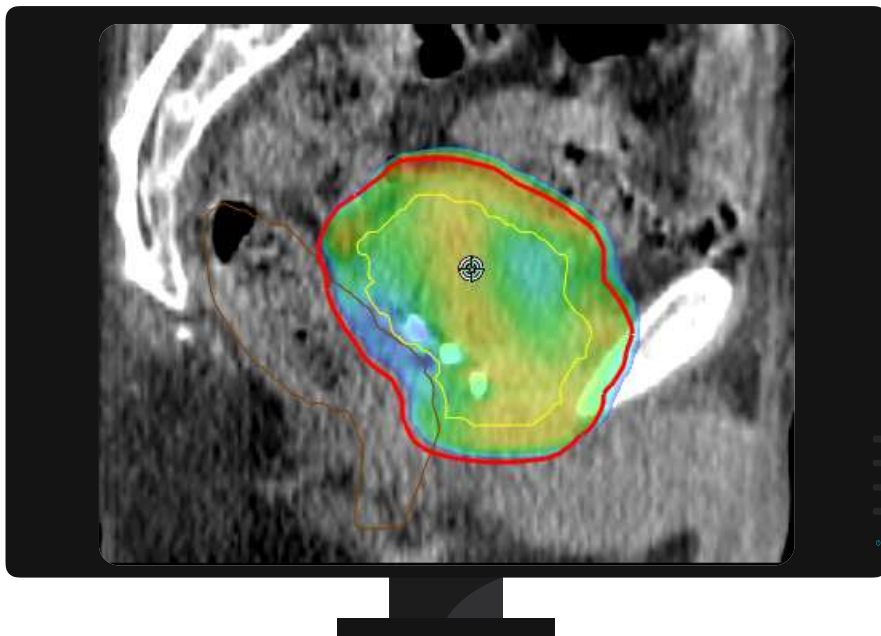
Scheduled plan



Adapted plan

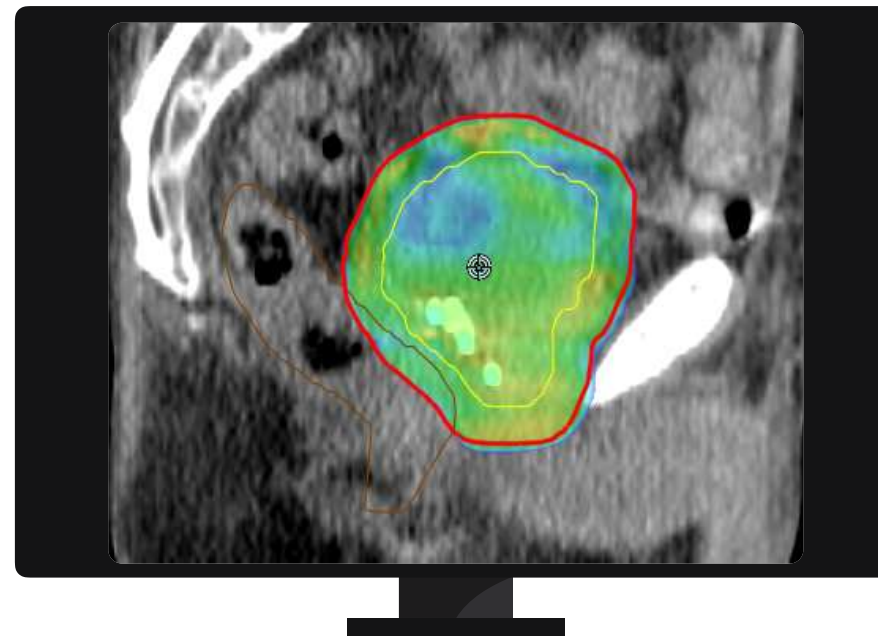


Added value of adaptive radiotherapy for bladder cancer



Adapted plan fx 3

Volume PTV: 74% of pCT



Adapted plan fx 16

Volume PTV: 74% of pCT

Clinical experiences



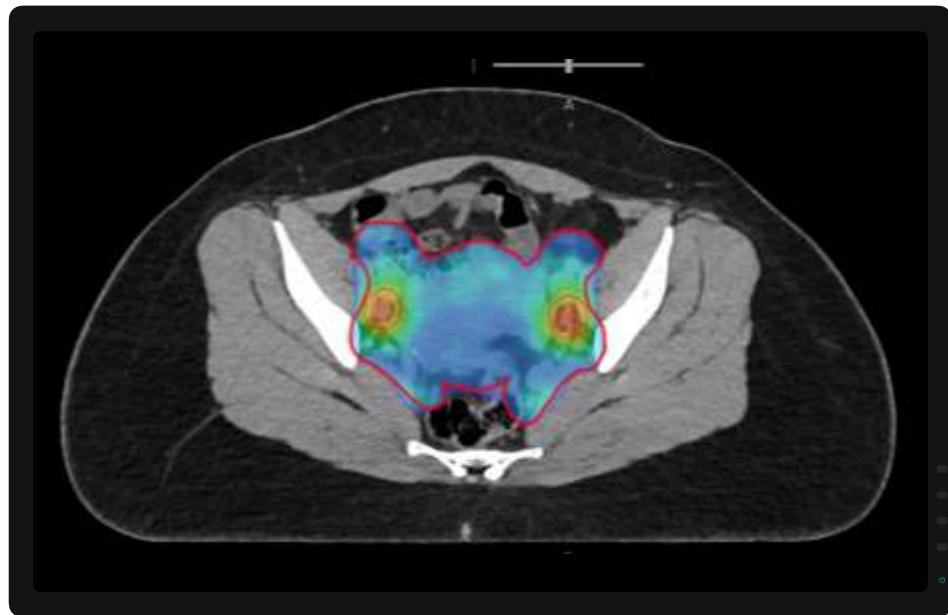
Cervix



2



Cervix



Plan CT

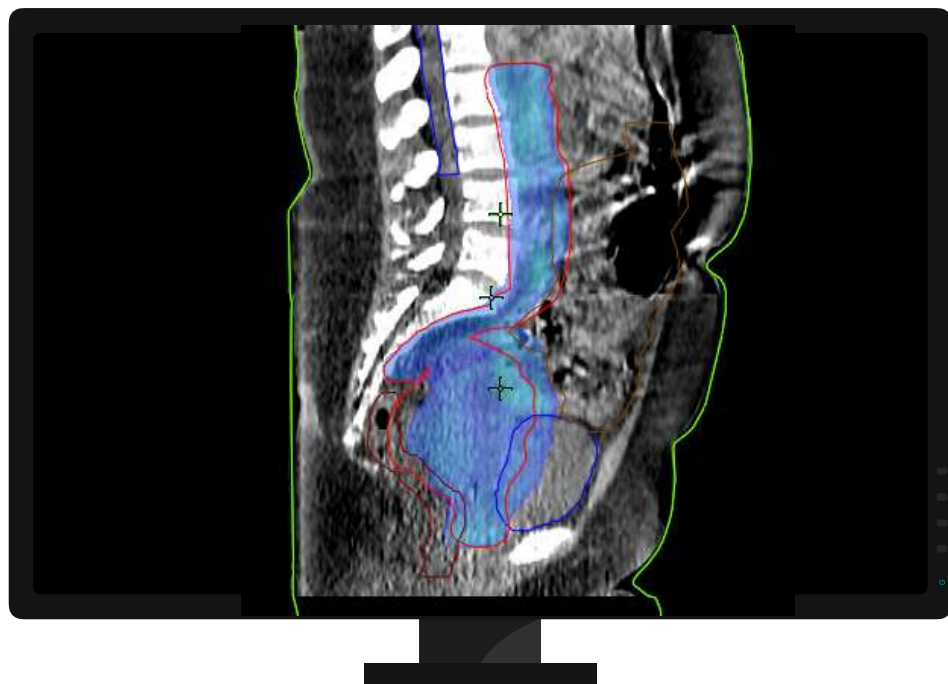


Plan CT

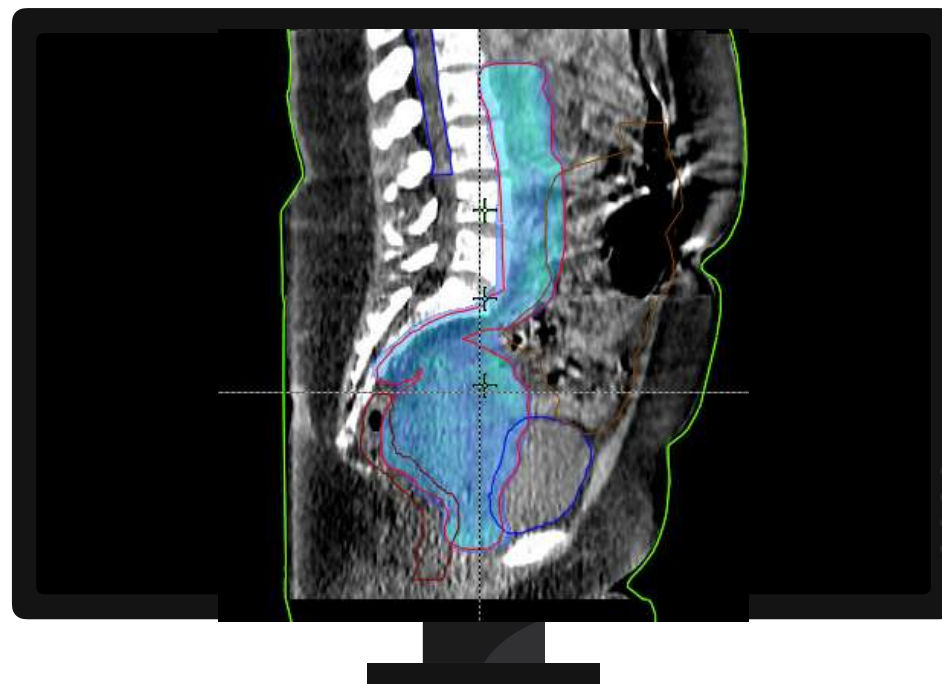




Fx 1



Scheduled plan

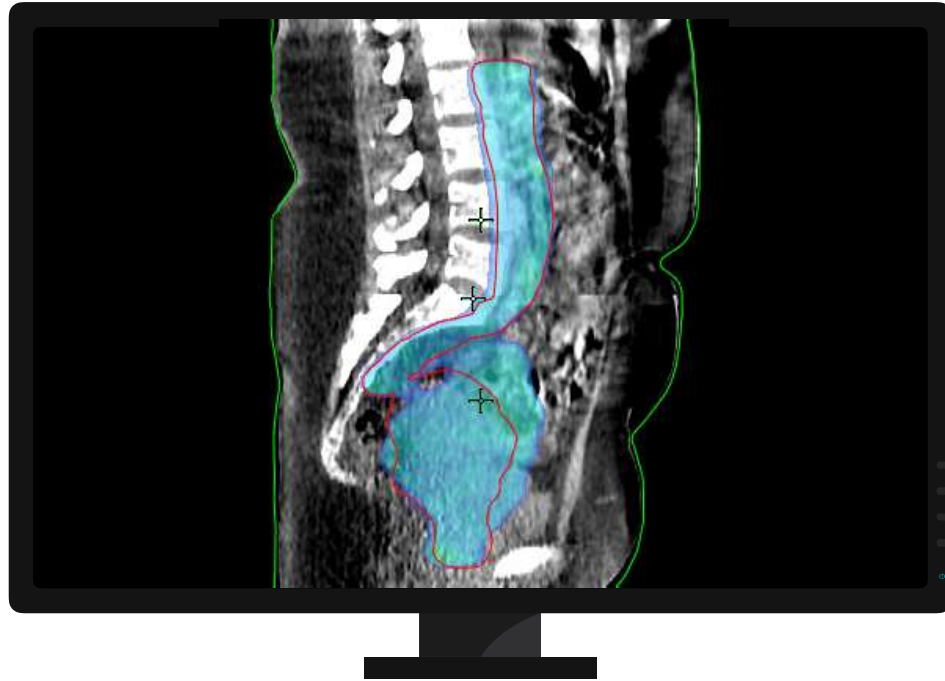


Adapted plan

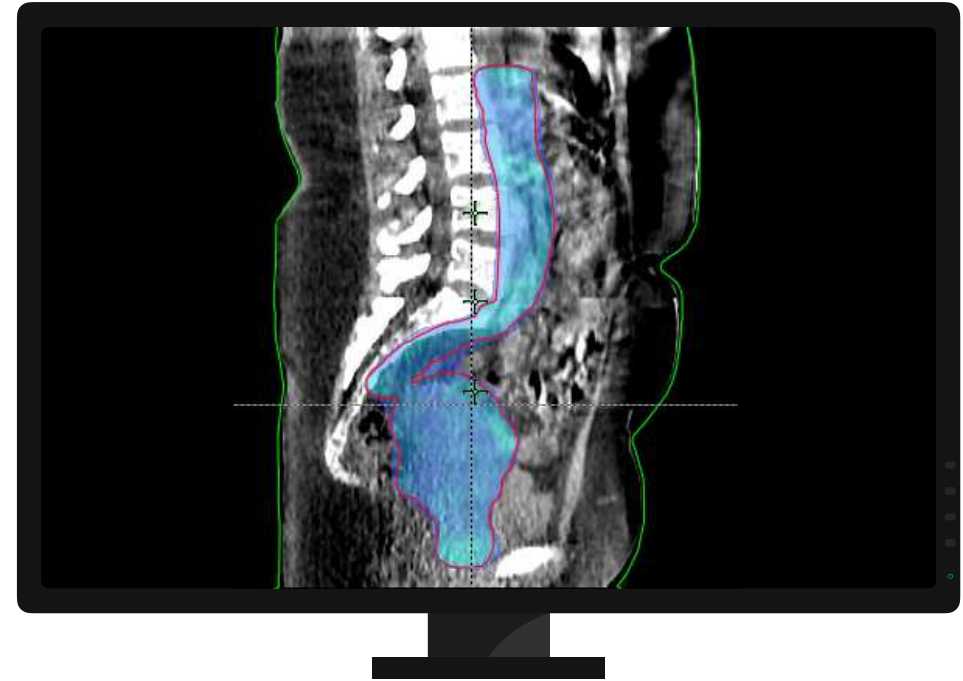




Fx 14



Scheduled plan



Adapted plan





Fx 24



Scheduled plan



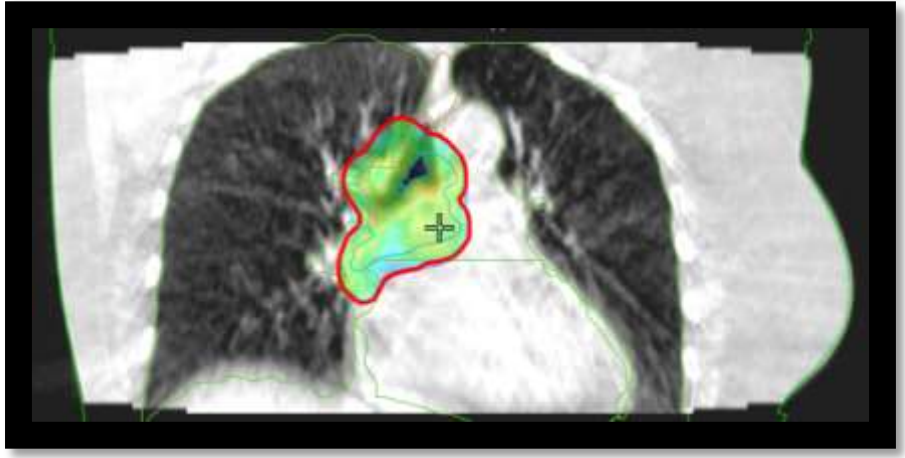
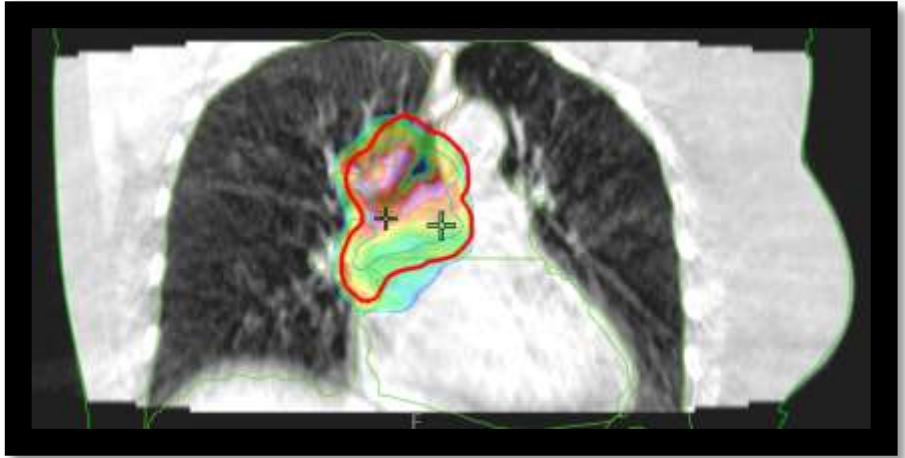
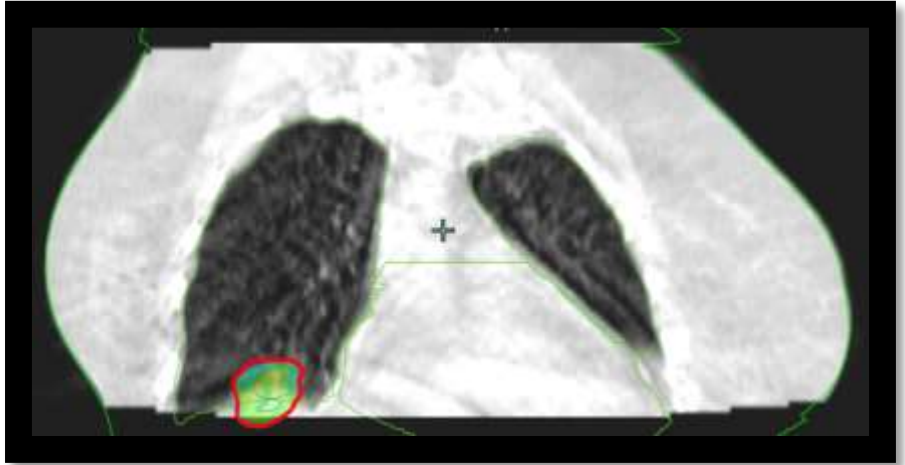
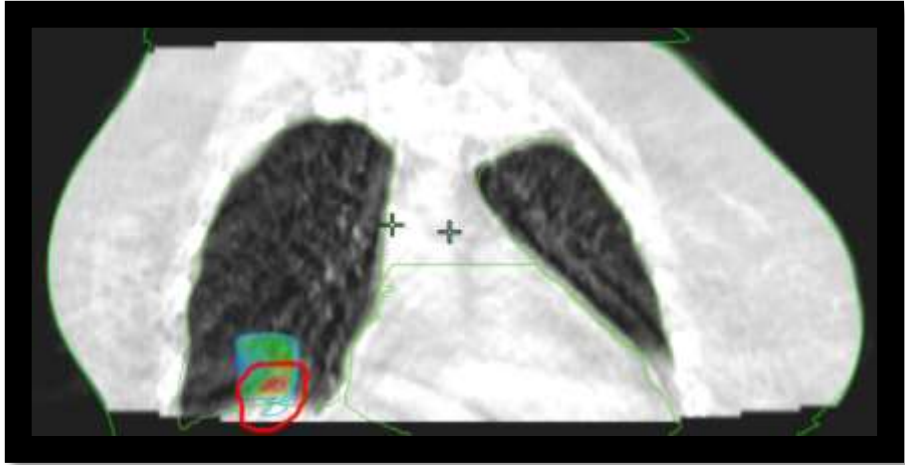
Adapted plan



Adaptive intelligence consortium



Lung



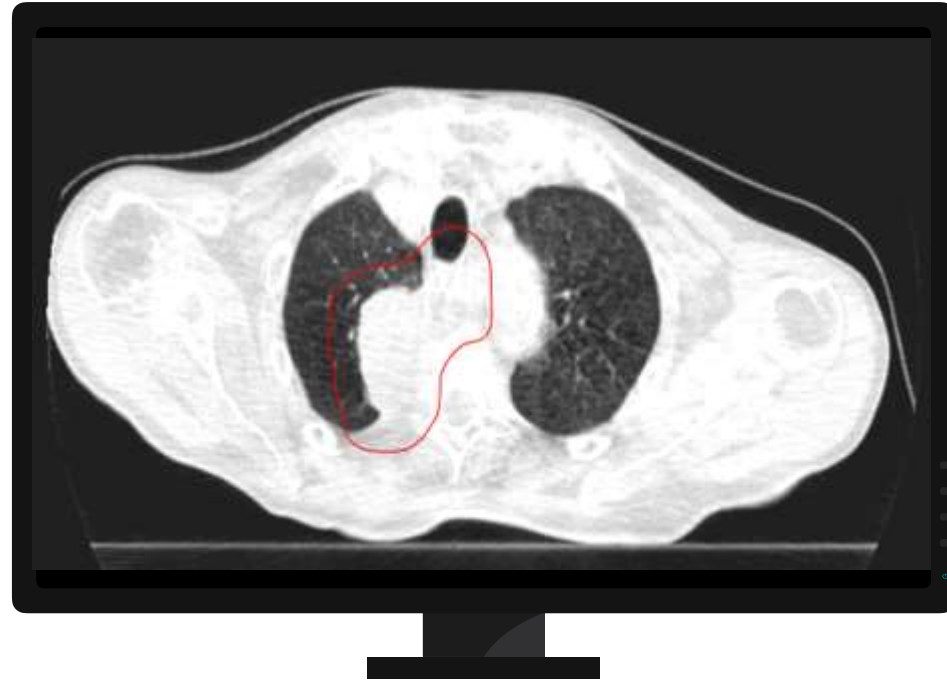
Scheduled plan

Adapted plan





Plan CT

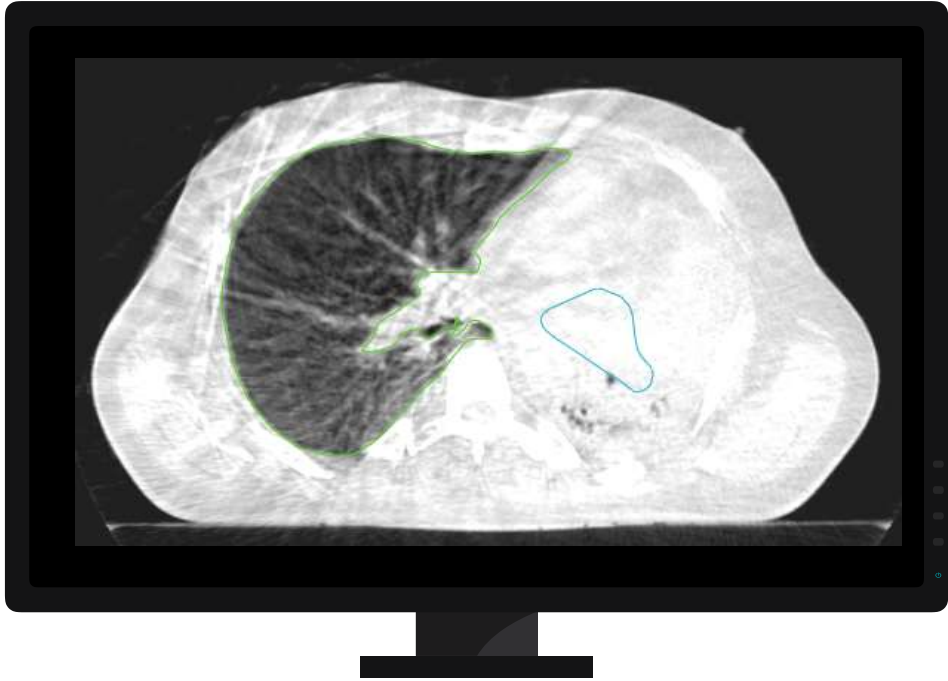


CBCT Fx 30





Plan CT



CBCT Fx 7





**Adaptive treatment
is the future**



Acknowledgements

Radiation Oncologists

- Anand Bhawanie
- Judith Dasselaar
- Ellen Hendriksen
- Francisca Ong
- Elisabeth de Wit
- Dankert Woutersen

Clinical Physicists

- Erik van Dieren
- Siete Koch

Radiographers (RTTs)

- Liselotte ten Asbroek
- Dennis Daal
- Laura Haverkate
- Marleen Heinemann
- Rob Sommer
- Ina te Veluwe

Technical physician

- Lianne Zwart



Engineer

- Maarten Smit

Manager

- André Doldersum

