TREATMENT WORKFLOW – HOSPITAL EXPERT PERSPECTIVE

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EBG MedAustron

TOPICS

1. **Introduction**
   a. Historical overview of MedAustron
   b. Medical staff groups

2. **Patient referral**

3. **Comparison of photon and ion beam radiotherapy**
   a. Beamgeneration and -application
   b. Immobilization/simulation and imaging
   c. Treatment planning
   d. Irradiation

4. **Challenges in (ion beam) radiotherapy**

5. **Ramp-up and improvements**

6. **Further development**

1. INTRODUCTION
a. Historical overview of MedAustron

History

End of 1980s
1st drafts and proposals – exclusively designed for research

2005
Decision to realize the project with a modified objective:
“therapy & research”

2012
Building completion

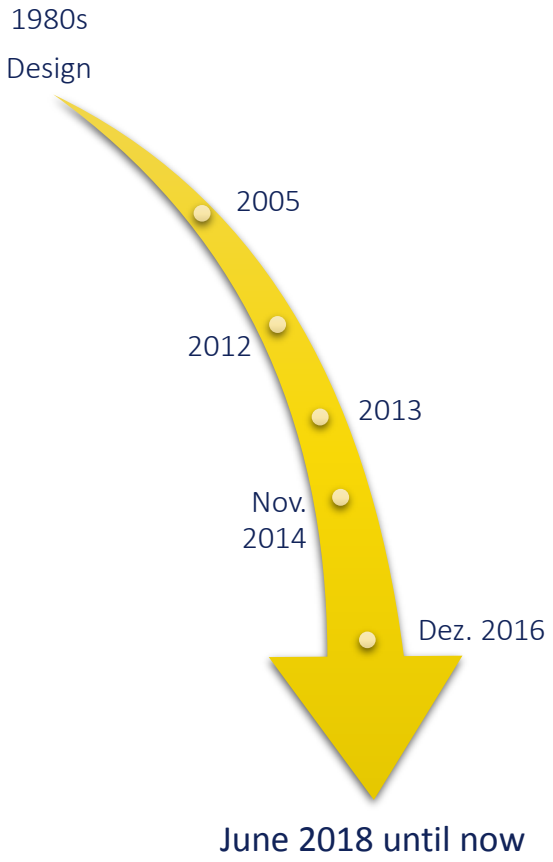
2013
Start of the accelerator installation

November 2014
The 1st proton beam is measured in a treatment room

December 2016
Start of patient treatment in 1 room

August 2017
Start of the 2nd room (horizontal only)

June 2018
Activation of vertical beam line in the 2nd room



1. INTRODUCTION
b. Medical staff groups at MedAustron

Radiation Oncologist

- Case preparation, evaluation of eligibility for ion beam radiotherapy, evaluation and considerations of prior treatments
- Patient education
- Definition of target volumes
- Evaluation of treatment plan and approval
- Physical examinations during therapy and follow-up
- Contact person for referring physicians

Patient administration (Reception, Intake)

- Administration of patient data, creation of medical record, import and export of imaging data
- Point of contact for patients during their treatment session
- Communication of appointments
- Communication and exchange of data between MedAustron and referring institutions

1. INTRODUCTION
b. Medical staff groups at MedAustron

Clinical Studies

- Every patient (who agrees) is included in a study protocol
- Initial Check to acquire baseline data for comparison + interviews during and at end of therapy
- Creation of valuable data for the assessment of ion beam treatment outcome

Patient care – Nurses

- Patient education about skin care, nutritional support
- Treatment of therapy related side effects
- Blood sampling
- Drug administration (e.g. anxiolytics)
- Coordination of external anesthesia team

Patient care - Patient Care Coordinator

- Supports patients prior to and during therapy (accommodation, transport, recreational activities, general counseling)

1. INTRODUCTION
b. Medical staff groups at MedAustron

Radiotherapy Technologists (radiographer, radiology technologist, ...)

- Patient education
- Creation of immobilization using positioning devices
- Imaging (CT, MR, PET-CT)

- Registration/Fusion of imaging data
- Organ at risk delineation
- Treatment planning together with MPE

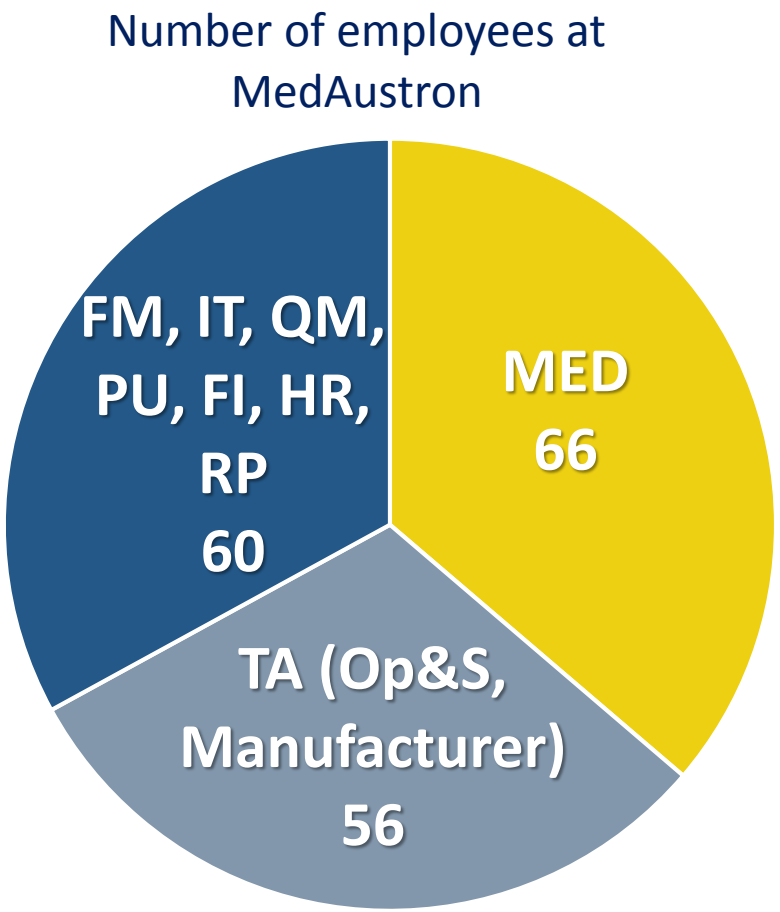
- Preparation of treatment sequence (Treatment Operation)
- DryRuns in the treatment room together with MPE

- Scheduling
- Patient-positioning and radiological positioning-verification
- Patient and treatment surveillance during treatment

- Support of the patient

1. INTRODUCTION
b. Medical staff groups at MedAustron

Medical staff professions	No. of employees
Radiation Oncologists (incl. Medical- and Clinical Directors)	9
Radiologist	1
Medical Physicists	22
Medical Technicians	3
Radiotherapy Technologists	17
Patient Care	3
Clinical Studies	4
Patient Administration	7
Sum	**66**



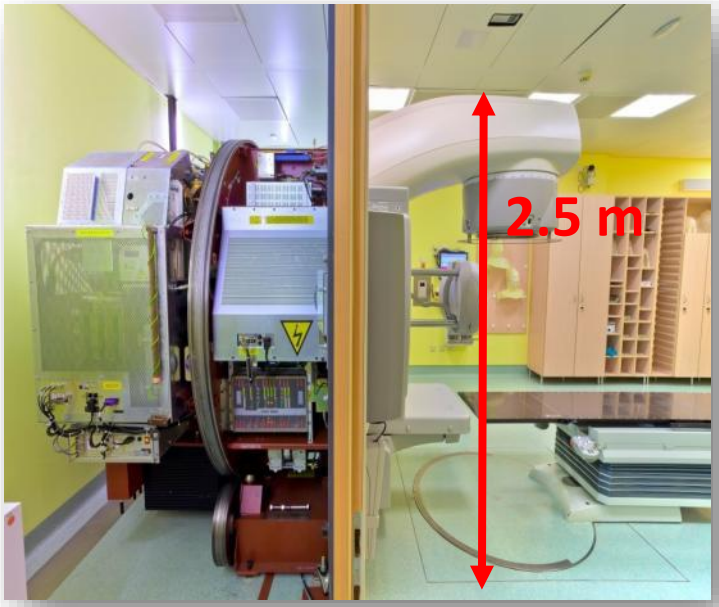
2. REFERRAL PROCEDURE

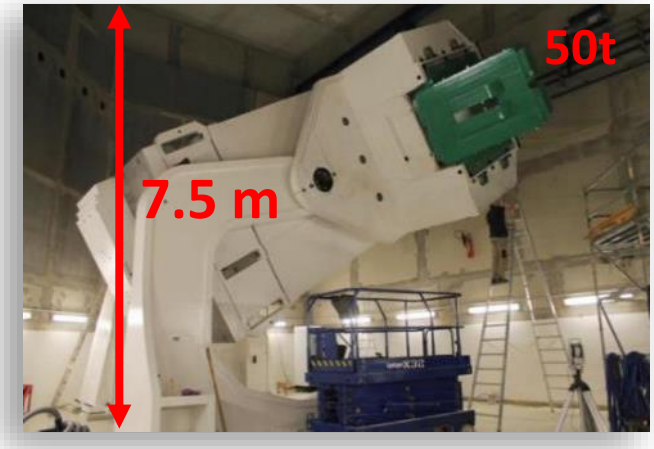
- Catalog with indications that are accepted by the main association of Austrian social insurances
- Costs are covered if a Tumorboard recommendationis available (Tumorboard = committee of oncological specialists of the referring hospital)
- If a case is not included in the catalog – Insurance may cover the costs
- Administrative workflow of filing the case at the insurance is done by MedAustron
- Contracts with some international health insurances are in place
- Alternatively, patients may cover the treatment costs by themselves

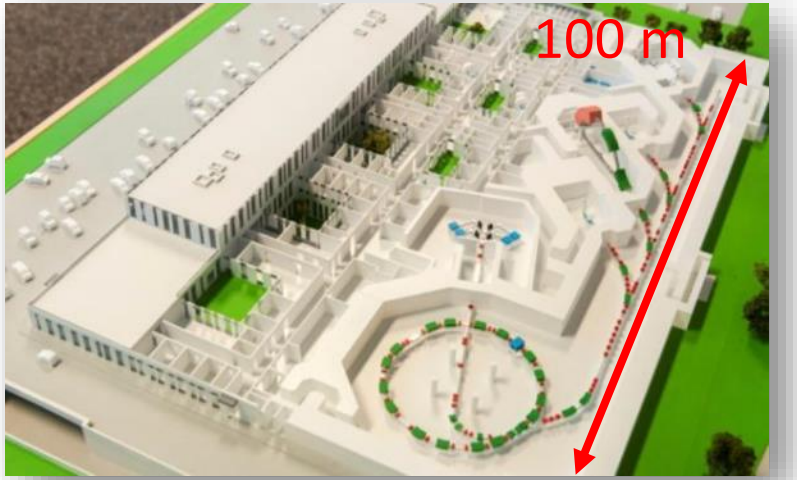
3. COMPARISON PHOTON AND ION BEAM RADIOTHERAPY

a. Beamgeneration and -application

Electron/photon-LINAC **vs.** **p, C Synchrotron**





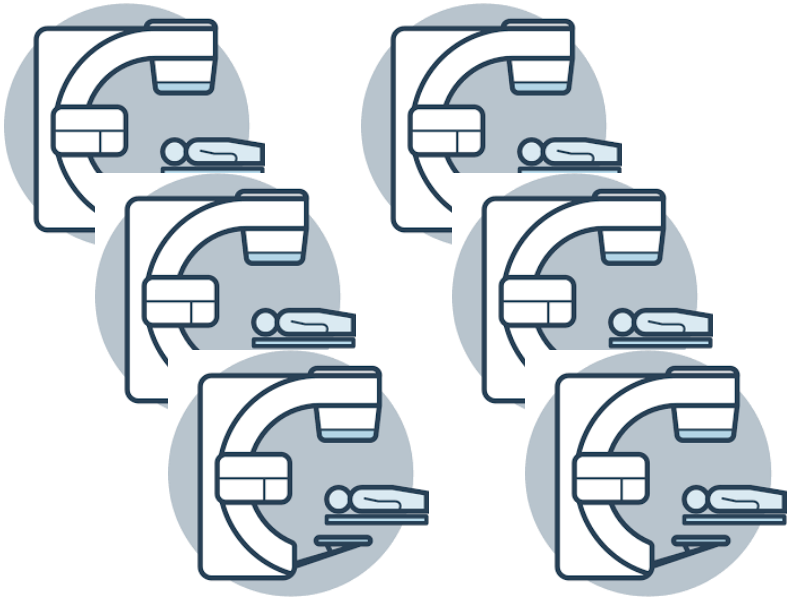


3. COMPARISON PHOTON AND ION BEAM RADIOTHERAPY

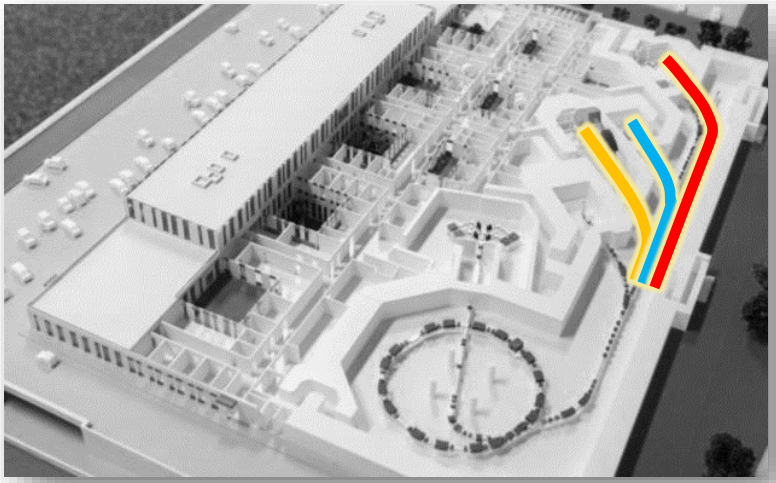
a. Beamgeneration and -application

Electron / photon-LINAC **vs.** **p, C Synchrotron**

- Simultaneous operation of all available devices



- Treatment rooms share the beam
- Simultaneous beam delivery is <u>not</u> possible
- Sequential and overlapping operation



3. COMPARISON PHOTON AND ION BEAM RADIOTHERAPY

a. Beamgeneration and -application

Unit consisting of
- Positioning device/couch
- X-ray imaging
- Radiation source

→ Designed for isocentric treatment
→ Very short couch movement during treatment

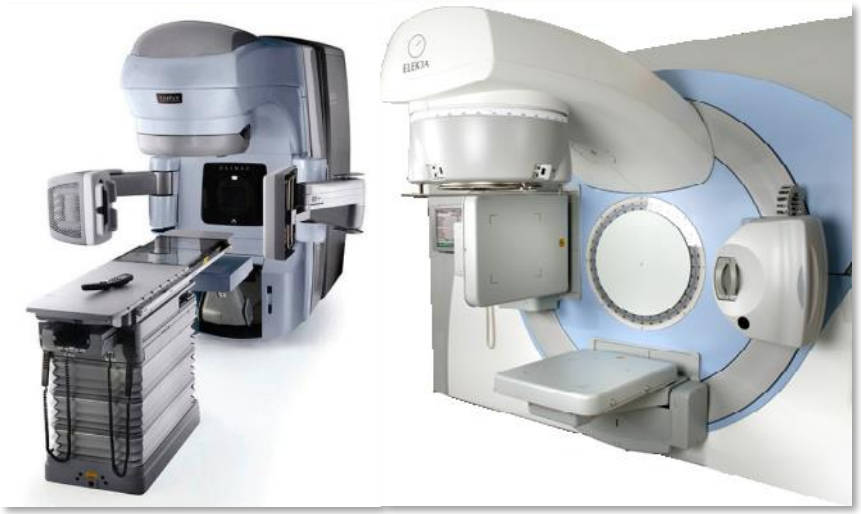
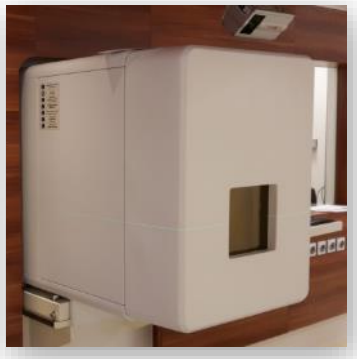


Image courtesy: Varian Medical Systems, Elekta Instrument AB

1. Patientpositioning and –verification system (Imaging Ring)
2. Beam outlet (nozzle)

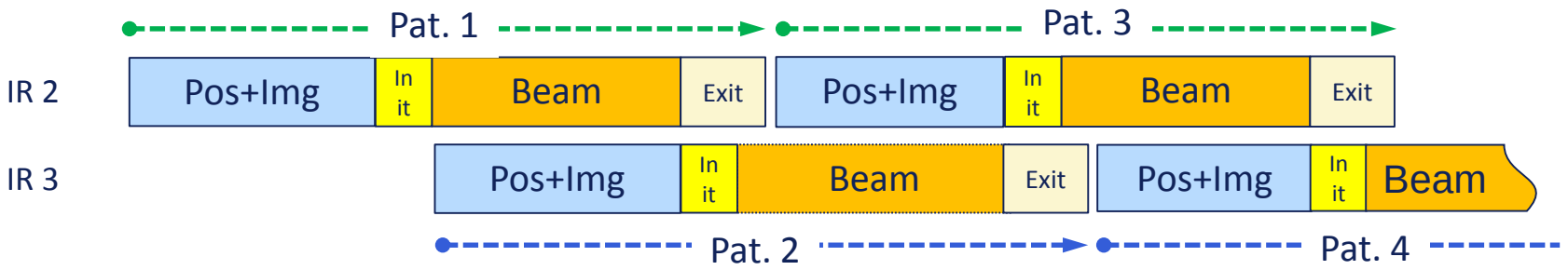
→ Designed for non-isocentric treatment
→ Several time consuming couch movements during treatment



3. Comparison photon and ion beam radiotherapy

a. Beamgeneration and -application

- Ideal case

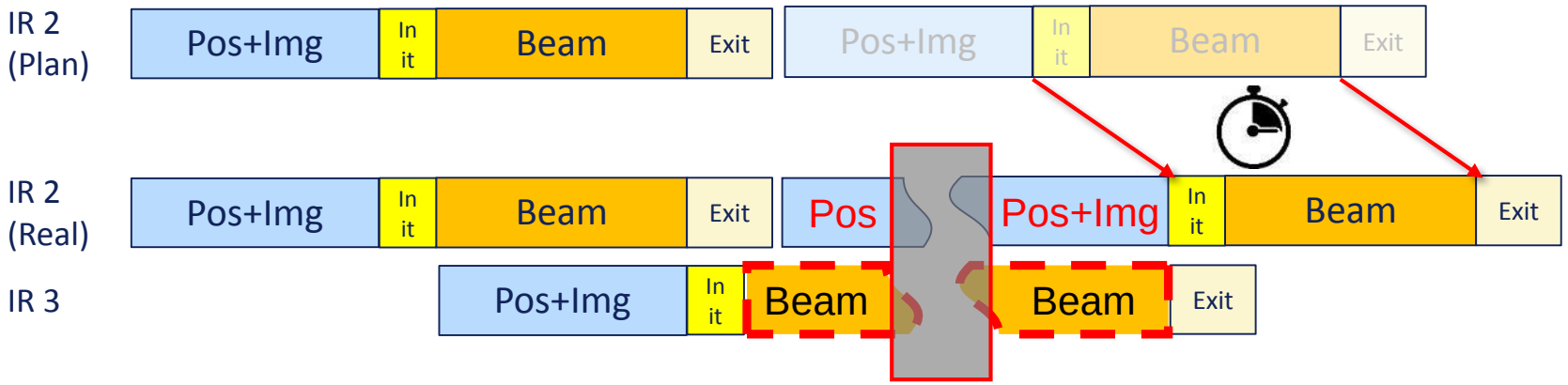


Pos+Img	Patient-Enter, Positioning, X-Ray Imaging (planar or ConeBeamCT), Verification/Image Registratin Includes several Robot- und ImagingRing Movements : 9 – 14 min
Init	Beam-release room1, beam-occupation room2, initialization of the accelerator: 2 -3 min
Beam	Mainly 2 beams from different directions. Includes robot movements between the beams and initialization of the accelerator : 12 – 15min, pure beam-on time 10 – 13 min (range of 5-50minutes)
Exit	Optional exit-imaging for the assessment of intrafractional patient- or organ motion. Robotmovement to the step on/off position. Release, mobilize the patient. Patient leaves the room.

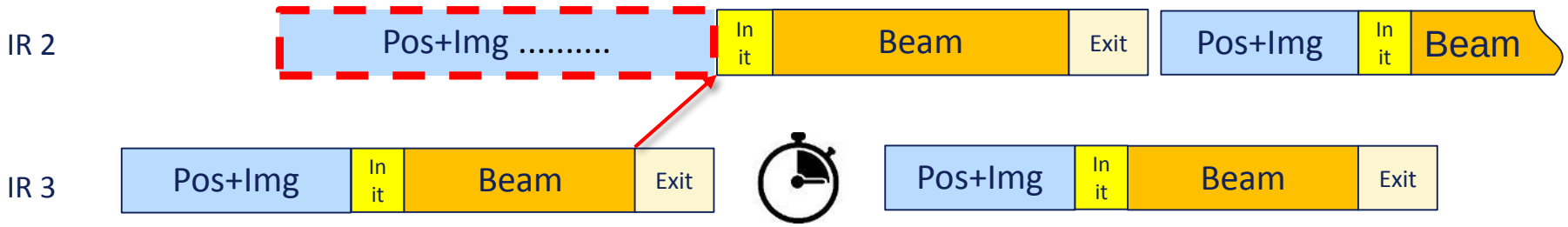
3. Comparison photon and ion beam radiotherapy

a. Beamgeneration and -application

- Technical problems during beam application affect ALL rooms



- Problems during patient setup, patient movement, etc.: waiting time in the other room(s)

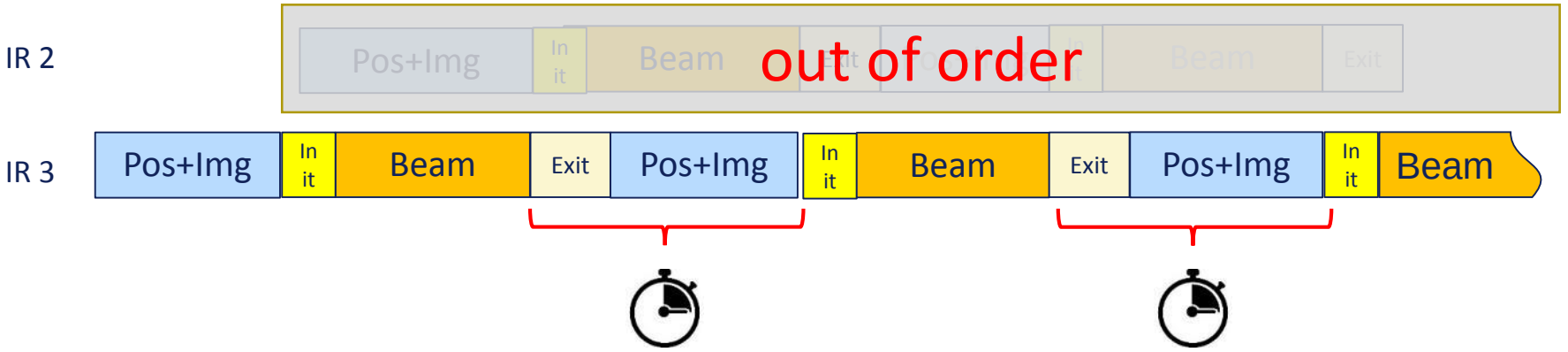


3. Comparison photon and ion beam radiotherapy

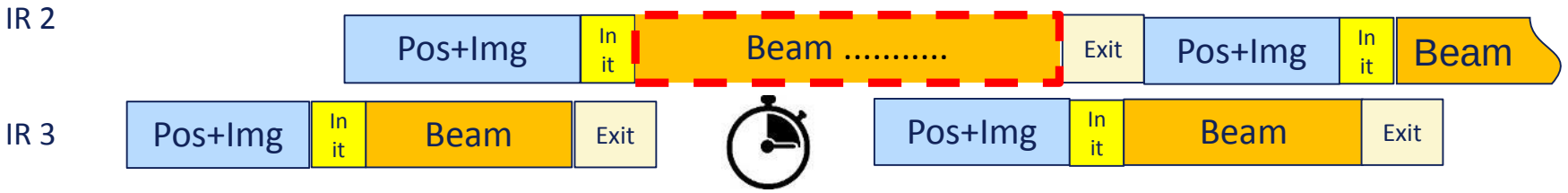
a. Beamgeneration and -application

- Downtime of one treatment room, e.g ImagingRing or Robot:

→ Inefficient beam utilization



- Long beam-time at big target volumes: waiting time in other room(s)



3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

b. Immobilization/Simulation and Imaging

- Basic requirements are the same for photons and ions
  - reproducible
  - minimize patient motion
  - reduce organ motion
  - comfortable
  - stable
  - unobstructed beam path

- Consideration of
  - treatment duration (25-60min)
  - No material in the beam entrance region unless it cannot be avoided (mask) or on purpose (bolus, flab)

- Immob.systems which allow for a minimal Air-Gap
  - Majority of the systems are standard (photon devices)
  - some specialized, ion-specific products

- Exclusively indexed positioning

3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

b. Immobilization/Simulation and Imaging

- Immobilization devices











3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

b. Immobilization/Simulation and Imaging

- **BoS (Base of Skull Overlay)**

  - Treatment in the head & neck region

  - Minimal distance (=air gap) between patient and nozzle

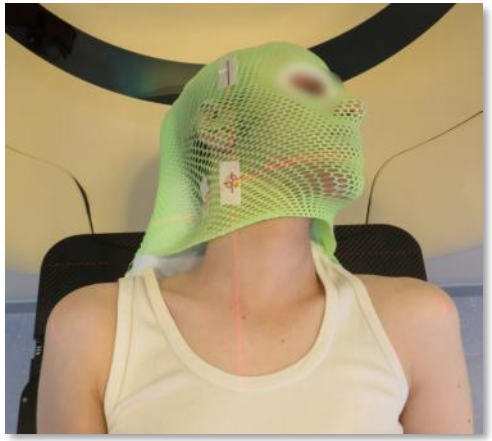
    → Improvement of beam geometry

3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

b. Immobilization/Simulation and Imaging

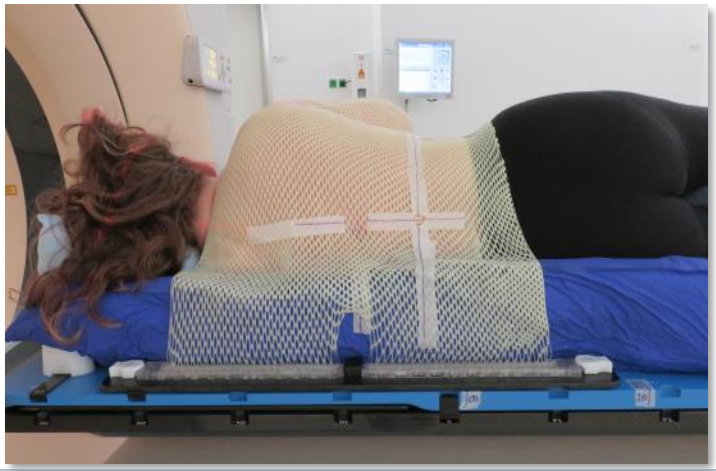
„Alternative" positions to compensate for limited beam entrance angles

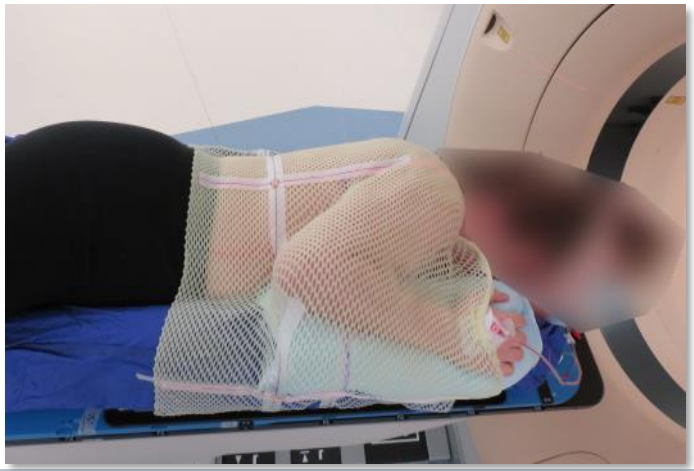
Tilting and rotation of the head



Decubitus position

- *Problematic, but can be done with training and experience*
- *requires creativity*
- *dependant on patient´s disease and physical condition*
- *no standards available; have to be established*

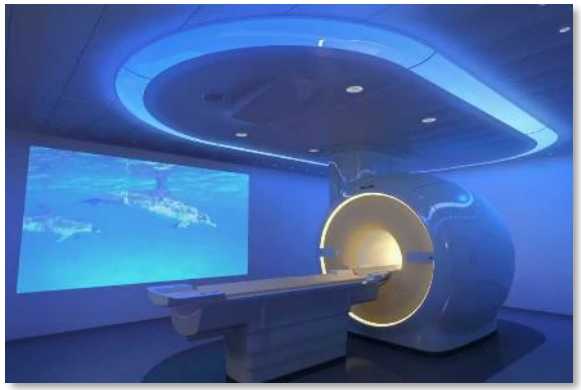




3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

b. Immobilization/Simulation and Imaging

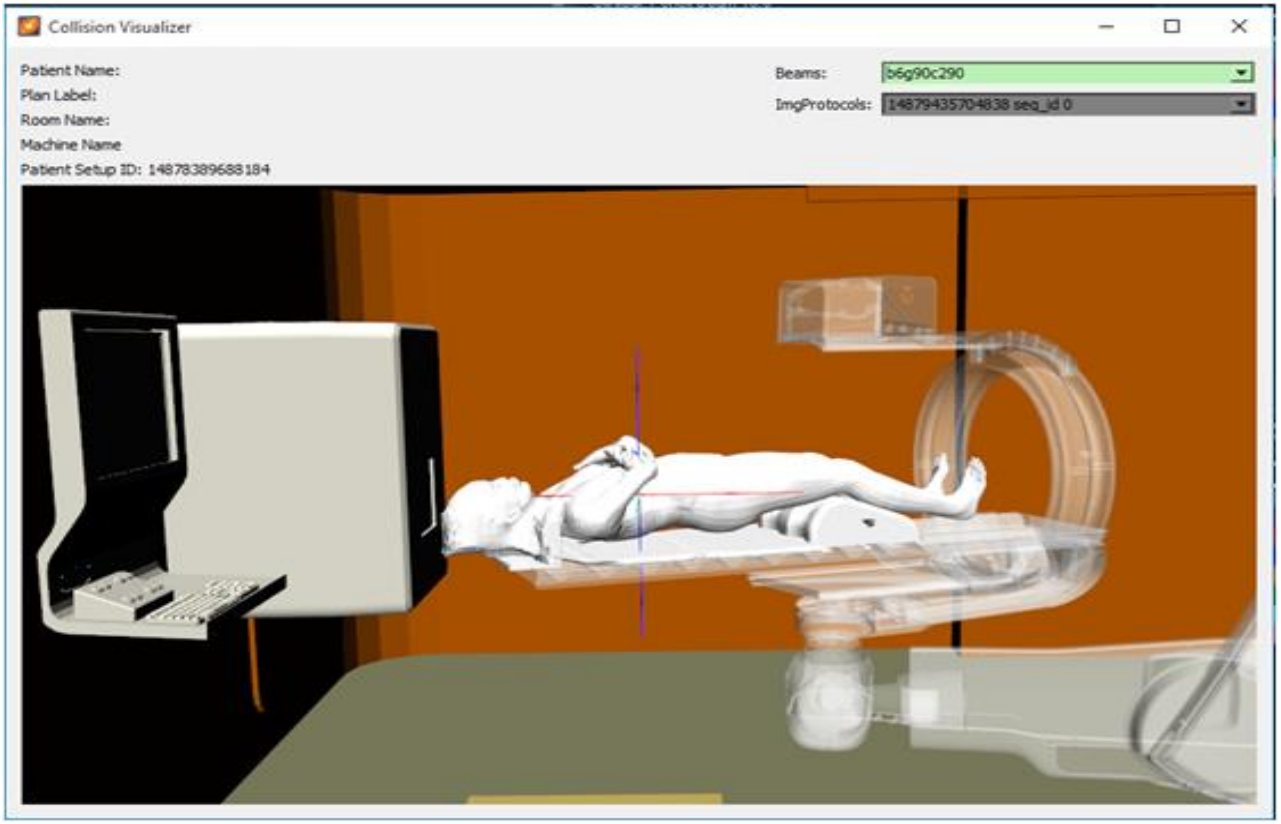
- Planning-CT with predefined protocols (X-ray and geometric parameters)
- MR in immobilized position (if possible) - incl. positioning devices
- CT mostly w/o contrast. MR always with contrast, unless there is a contraindication (renal function, known allergy or intolerance)
- Immobilization and imaging are pre-discussed with medical physicist and the radiation oncologist.



3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

b. Immobilization/Simulation and Imaging

- **Definition and 3D simulation of the patientensetup → Collision avoidance**



3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

c. Treatment planning

Involved staff: Medical physicists, RTTs and Radiation Oncologists

1. Import of Planning-CT and MR imaging to the treatment planning system
2. Import of external images
3. Registration/Fusion of images
4. Contouring/segmentation of OARs
5. Dose-prescription and contouring of the target volumes by the radiation oncologist
6. Planning

3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

c. Treatment planning

7. Preparation of QA plans

8. Plan approval by the responsible RO and the board of ROs

9. Creation of the Treatment Operation (= predefined sequence of actions)

10. Physical plan verification by MP

11. Dry run (w/o patient) in the treatment room

12. Final plan approval

3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

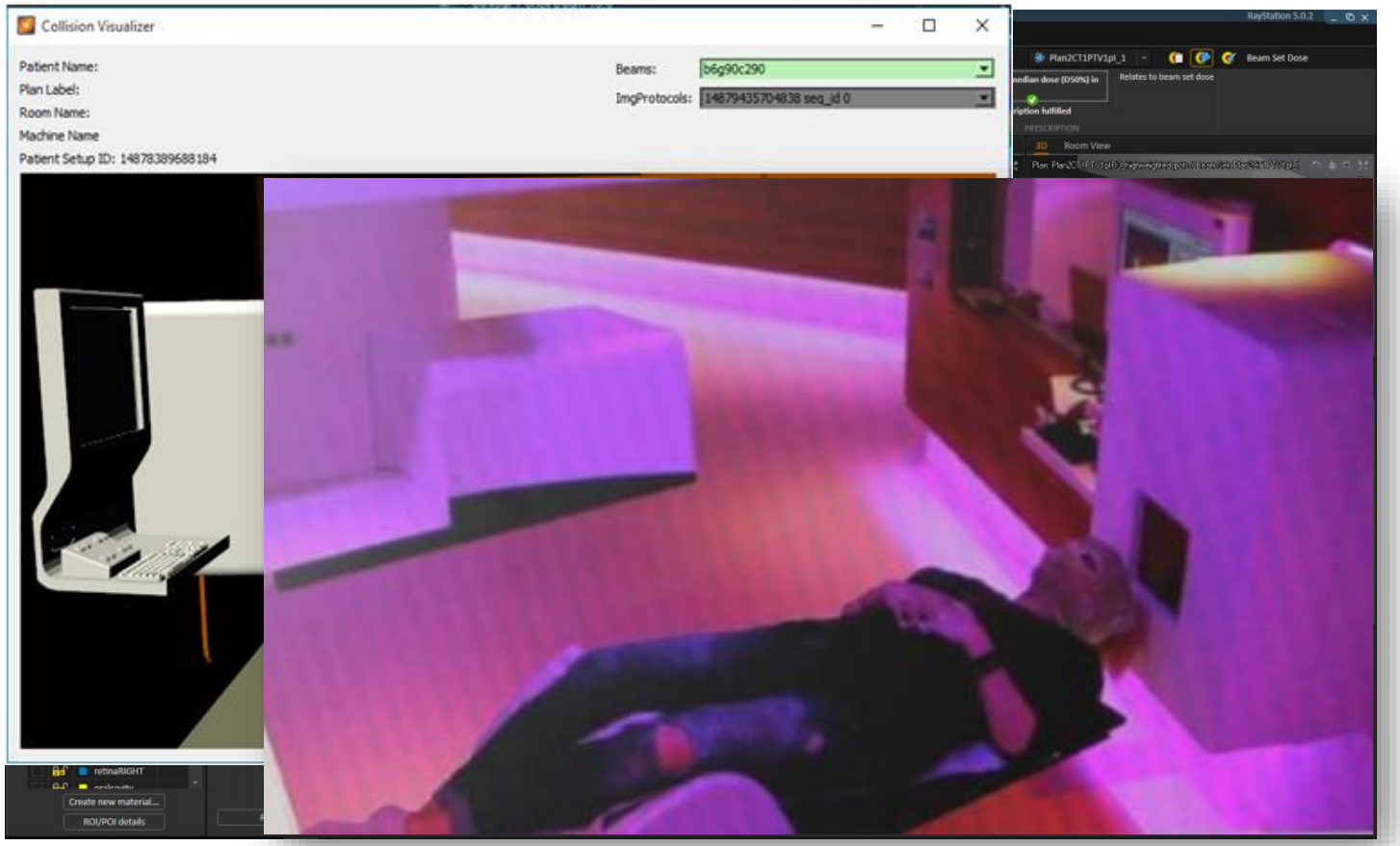
d. Irradiation

	Conventional Linac	MedAustron - fixed beam Particle therapy
Positioning and verification	Imaging in treatment position	Imaging in defined positions to avoid interference with dose monitors
Different beam angles	Gantry rotation	Positioning robot, fixed beam angles
Treatment time	7-10min	25 – 60min
Beam-On time (avg.)	Independant of treatment volume 1min – 5min	Depending on treatment volume 5 – 45min
Fieldsize	Up to 40x40 cm	20x20 / 17x14 cm

3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

d. Irradiation

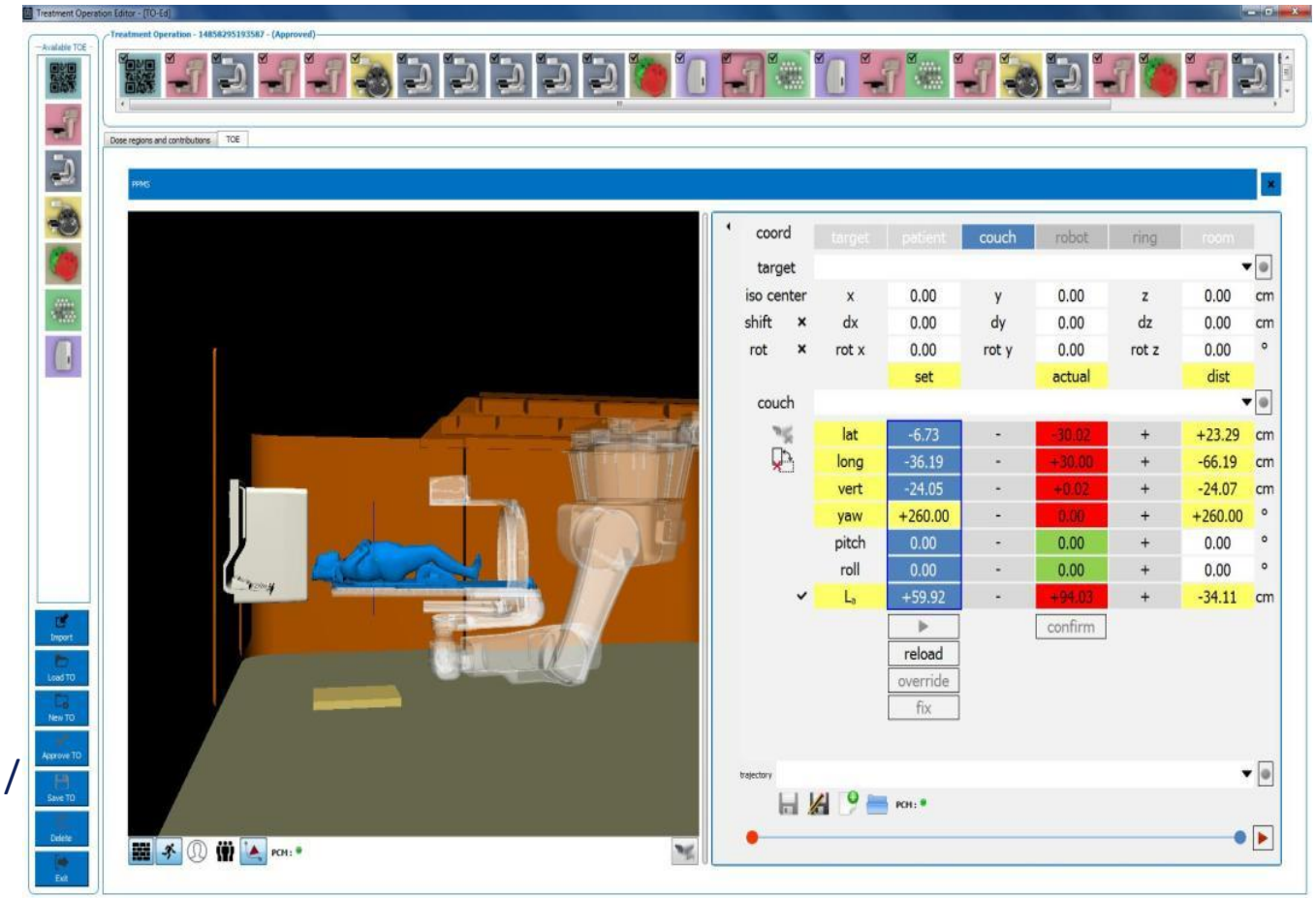
- Workflow is supported by a TPS based modelling of: Room-, robot- and patient geometry



3. COMPARISON OF PHOTON AND ION BEAM RADIOTHERAPY

d. Irradiation

- Softwarebased
- No manual control of the positioning table (exception: emergency)
- Pre-definition of:
  - Robot movements
  - Imaging geometry and -parameters
  - Registrationparameters
  - Sequence of the beams / portals



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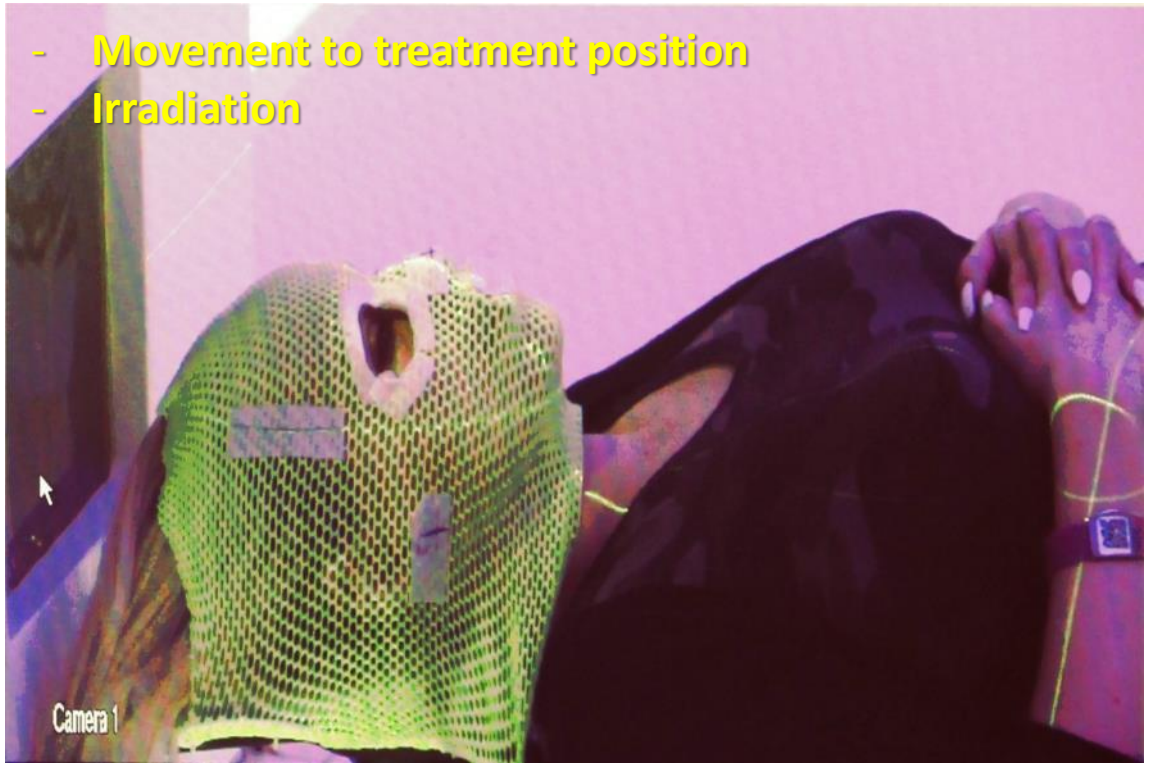
d. Irradiation



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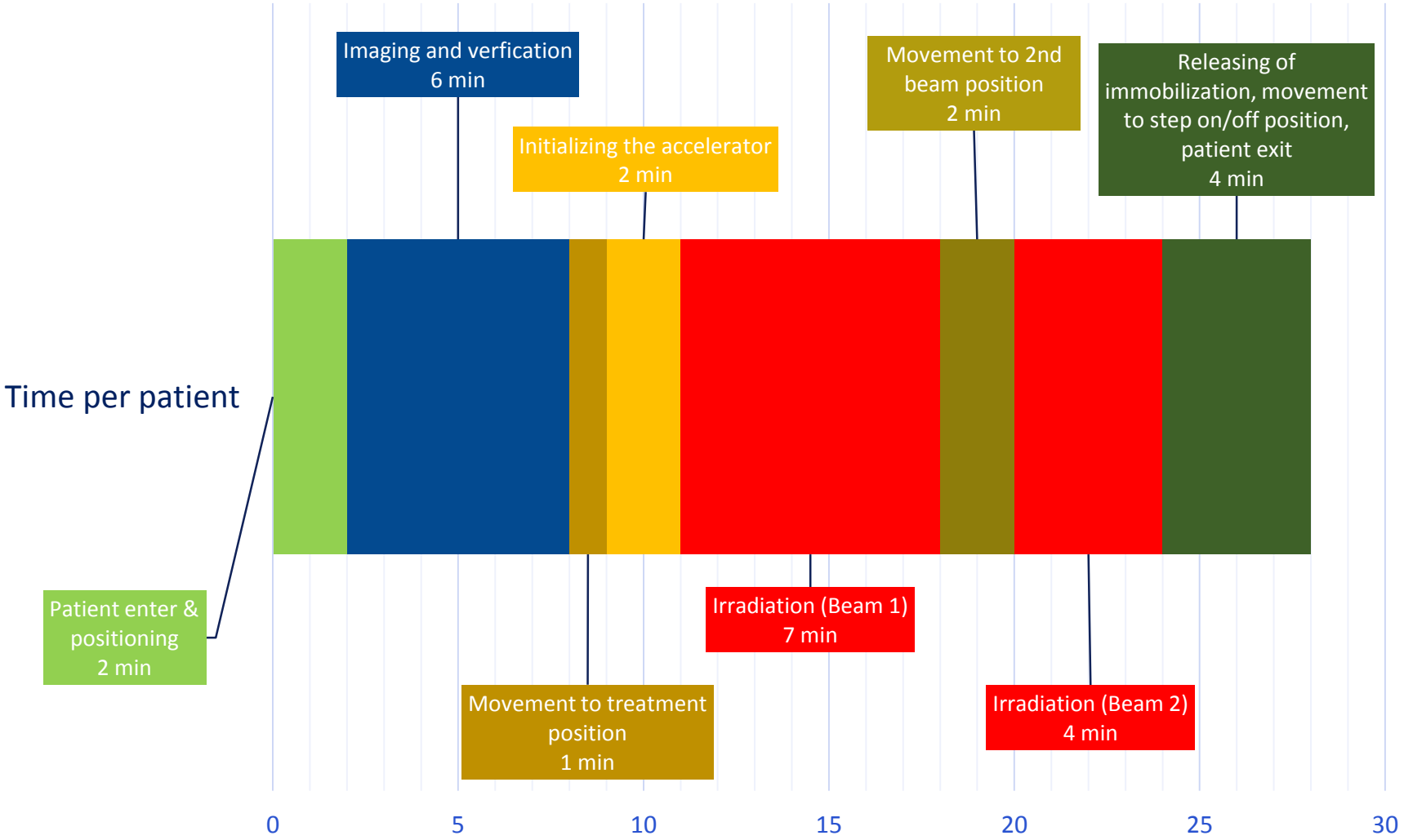
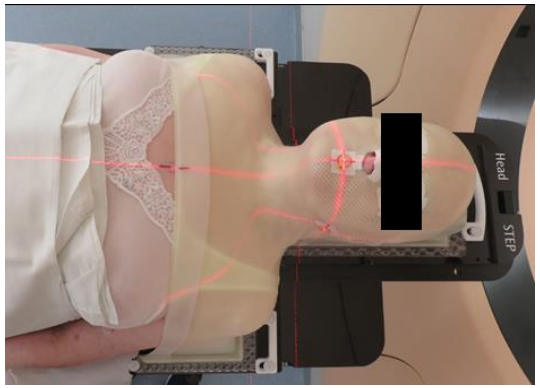
d. Irradiation

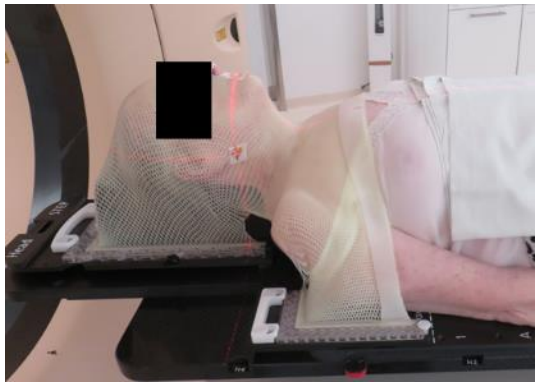


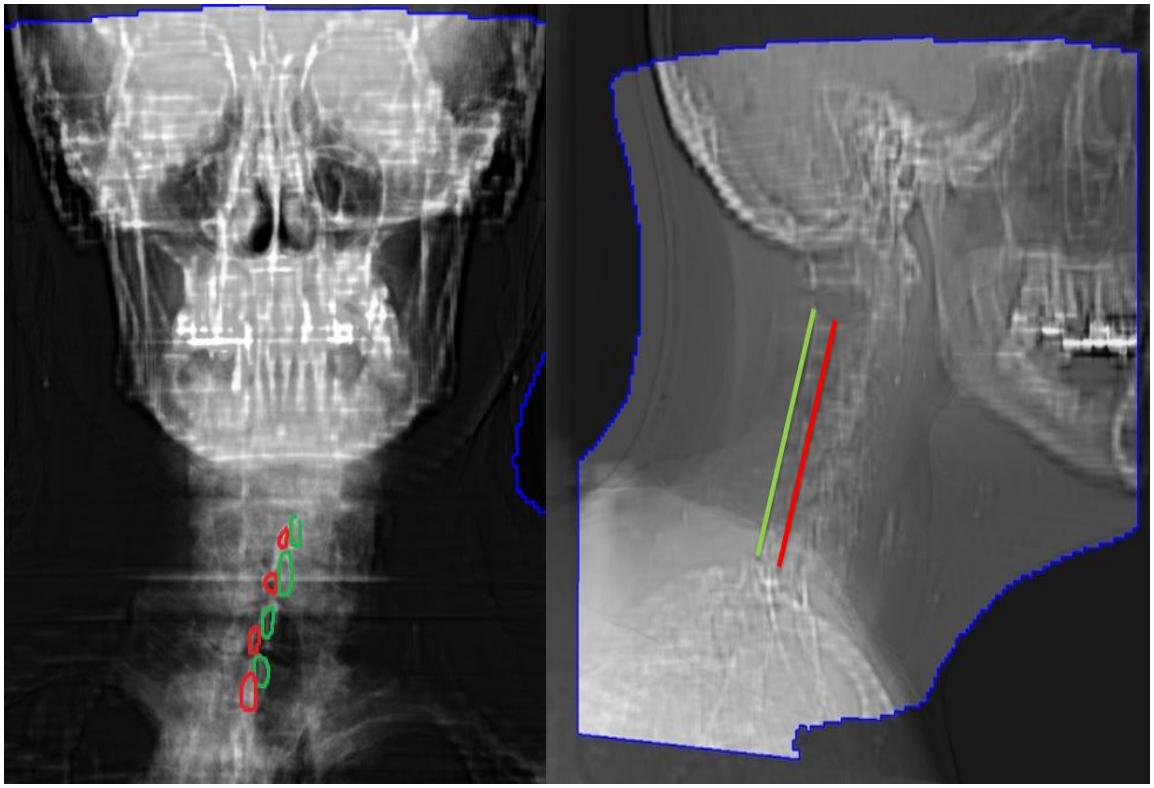
4. CHALLENGES IN (IB)RT

- **Reproducibility of positioning**

  The accuracy of the positioning is crucial to ensure correct dose delivery.
  ... *which can be challenging ...*







4. CHALLENGES IN (IB)RT

Claustrophobia

MR imaging
Although the oncology MRI has a relatively wide opening („big-bore“) it is still a narrow tube

Irradiation
Patients are immobilized with tight and rigid masks which restrict any movement of the region of interest

Long treatment time

Depending on the size of the treatment volume, the procedure takes between 25-60 minutes

- discomfort
- pain due to position, pressure marks (gets worse over time !!!)

- Coughing and sneazing causes interruptions and repetition of workflow steps → further increase of treatment time

4. CHALLENGES IN (IB)RT

Interruptions

Due to the complexity of the accelerator and the MedAustron specific use of prototype medical devices (Robot, ImagingRing, Software) downtimes are usually longer than in conventional RT.

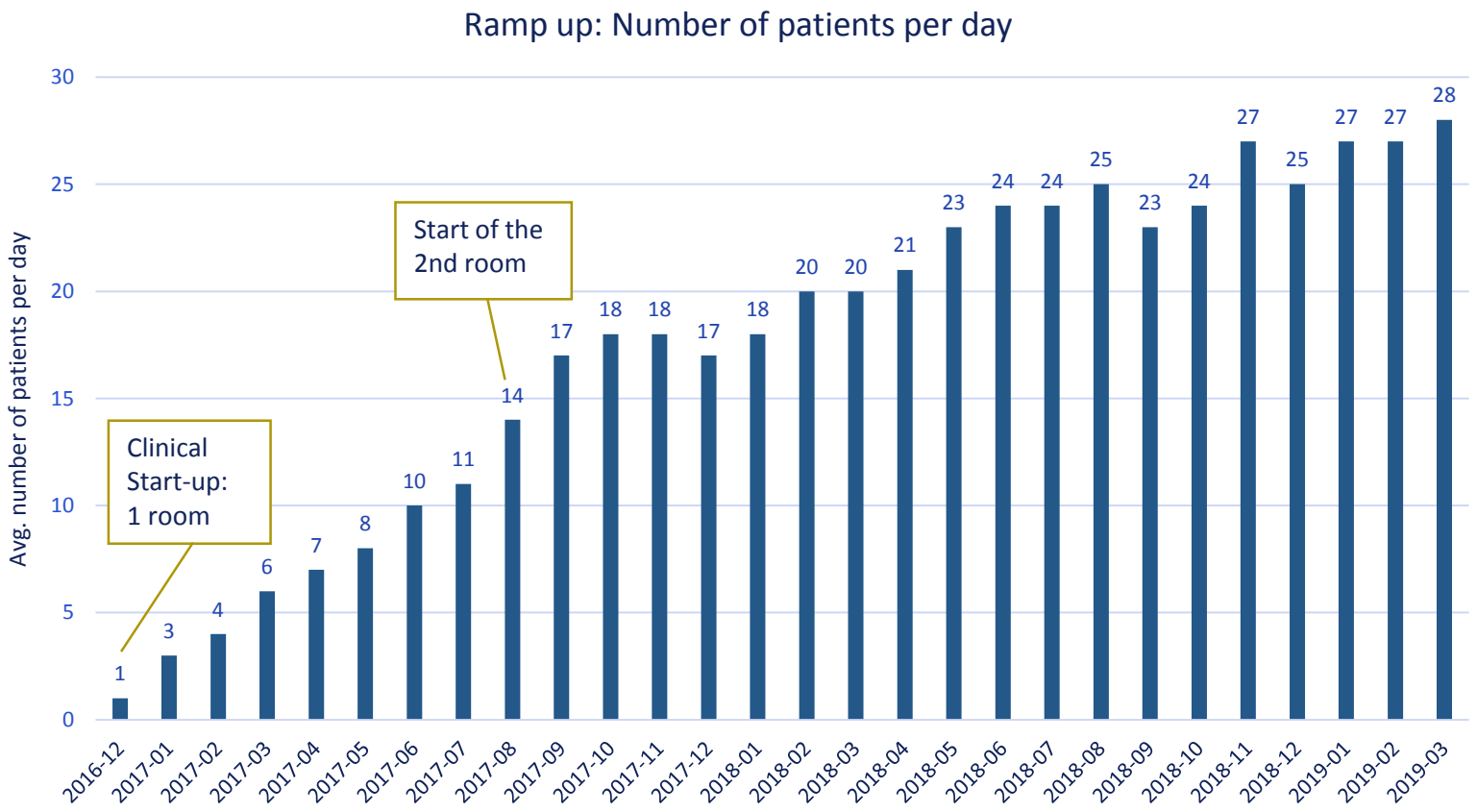
- Increased complexity in the anesthesia workflow for pediatric patients
  → patients must not eat and drink prior to sedation
  → duration of sedation is limited

- Difficult timing of patient-specific routines
  - drinking protocoll for defined bladder filling
  - enema for emptying the rectum
  - medication

- Competing patient appointments
  - concomitant external therapy, rehab, examinations

5. RAMP UP AND IMPROVEMENTS

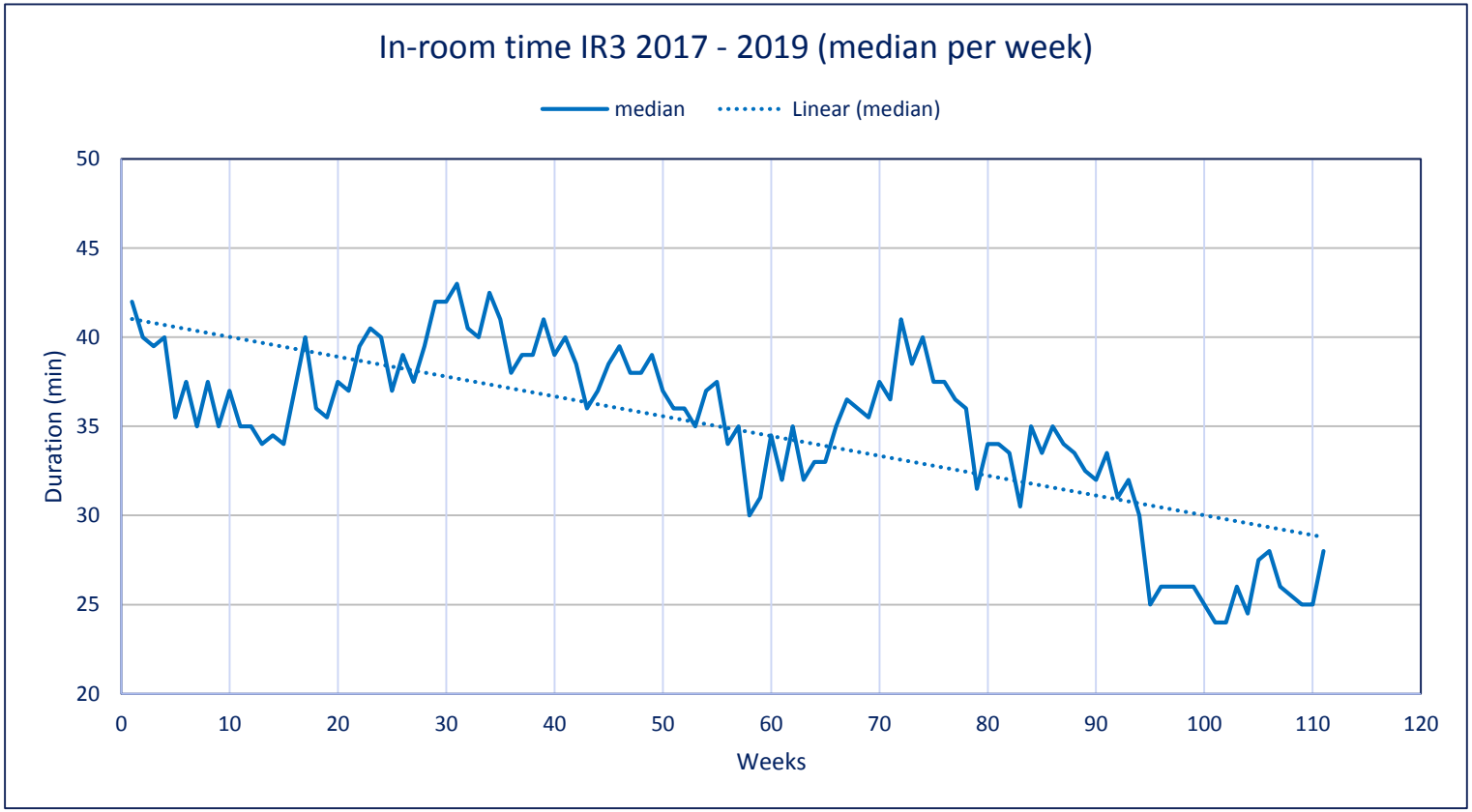
Number of patients per day



5. RAMP UP AND IMPROVEMENTS

Increase of efficiency

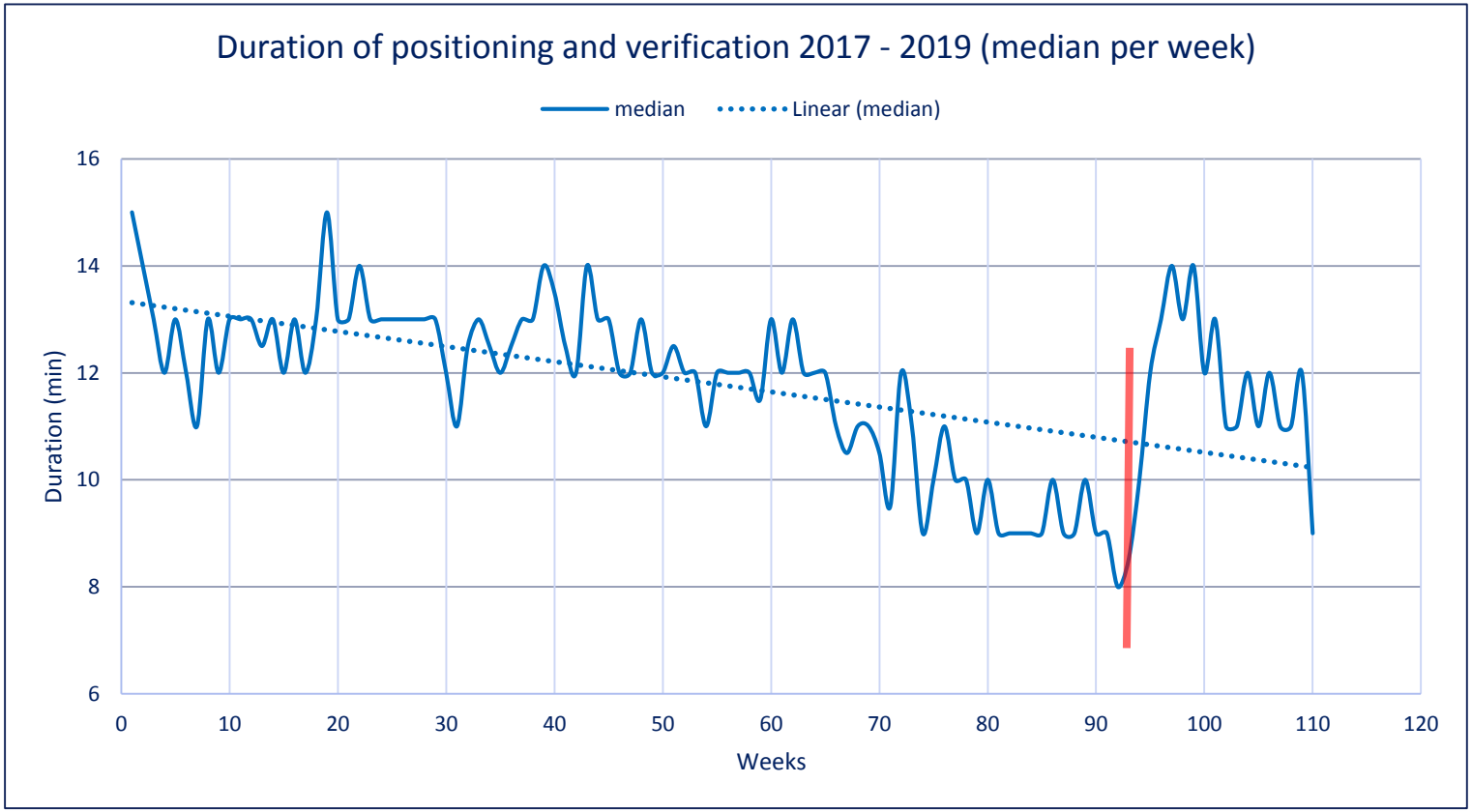
In-room time: Patient-enter to Patient-exit



5. RAMP UP AND IMPROVEMENTS

Increase of efficiency

Positioning and verification: Patient-enter to start 1st beam



5. RAMP UP AND IMPROVEMENTS

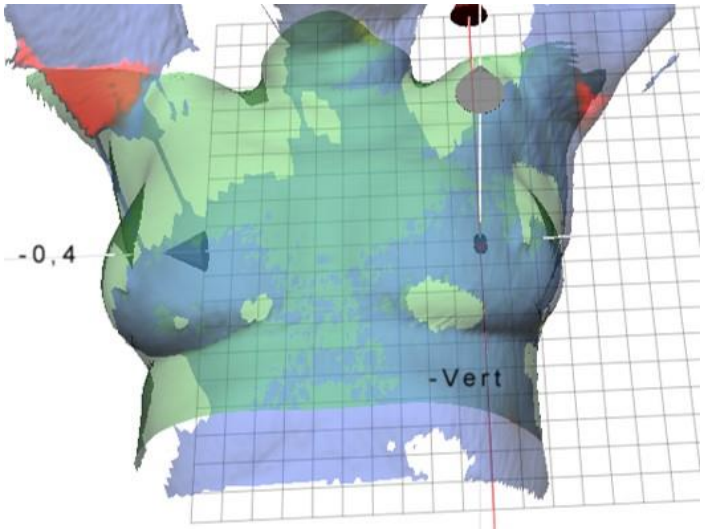
Increase of efficiency

- Reduce number of beams per treatment (split treatment plan into „beamsets“ which are treated in an alternating sequence
- Increase of robot speed
- Reduce robot travel distances by definition of optimized step-on and imaging positions
- Reduction of beam-time by stepwise implementation of accelerator performance increase projects
- RTT workflow improvements
- More effective and quicker troubleshooting

6. FURTHER DEVELOPMENT

Surface scanner installation: C-RAD Catalyst / Sentinel

- Patient setup
- Surveilance (intrafraction motion)
- 4D CT
- Gating



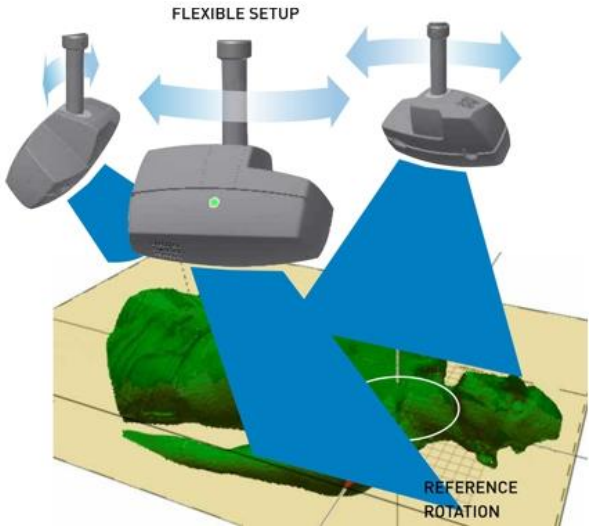


Image courtesy: C-RAD

6. FURTHER DEVELOPMENT

Surface scanner installation: C-RAD Catalyst / Sentinel

- Hardware installation is finished
- Next steps:
  - → Gradual installation of SW packages
  - → Acceptance
  - → Training (MP, RTT, MedTec)
  - → 4D CT - clinical use
  - → Assisted setup - clinical use
  - → Intrafraction motion surveillance
  - → Future goal = gated irradiation

6. FURTHER DEVELOPMENT

- Carbon ions 07/2019
- Proton-Gantry 12/2021
- Numbers of treated patients

  2018: ~200 patients (avg. 26/d)
  Goal for 2019: 270 patients (avg. 30/d)

- Treatment times

  Mo-Fr, including holidays
  Currently → 8:10 – 18:00 (in fact until treatments are finished)
  07/2019 → 8:10 – 19:00

CLOSING REMARK

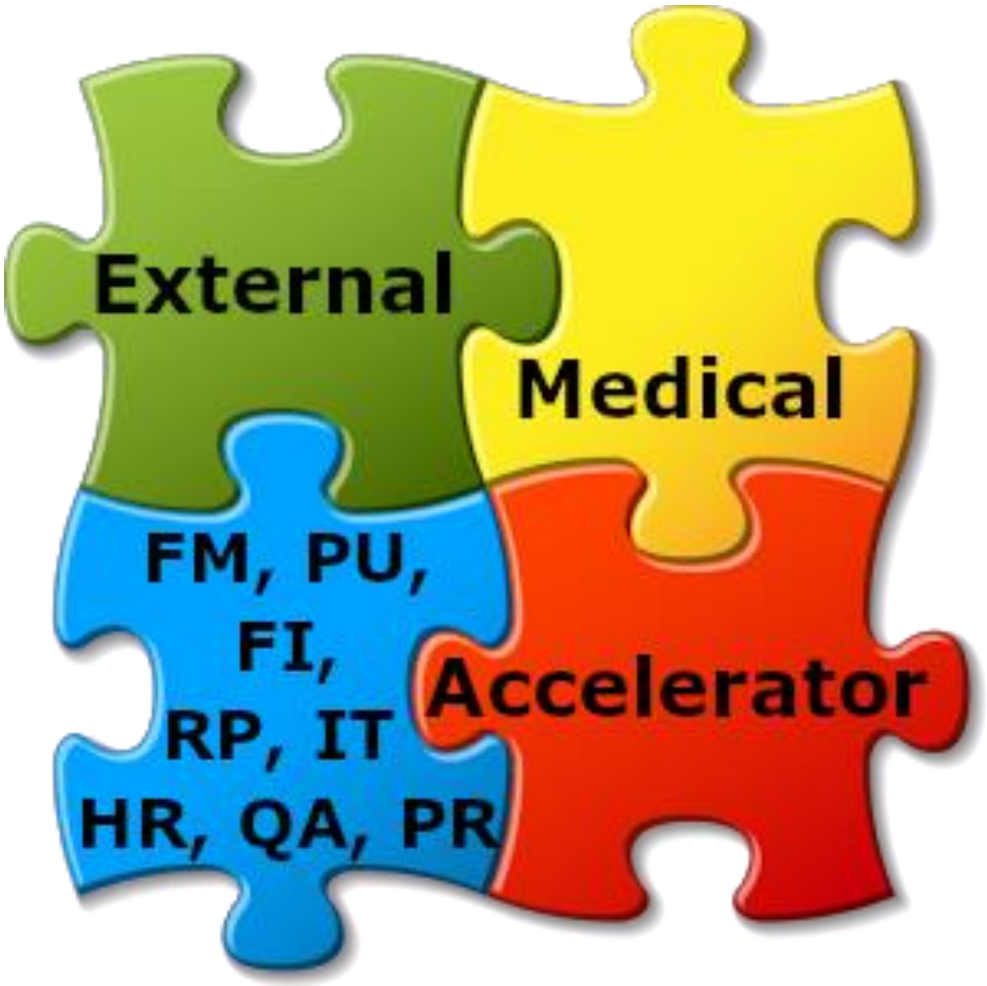
Interdisciplinary cooperation of teams is the precondition for

- treatment optimization

- cost-efficiency

- effectiveness

- safety



THANK YOU

QUESTIONS ?