

The role of ~~control system~~ software in novel Hadrontherapy workflows

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ON BEHALF OF DOMINIK PERUŠKO



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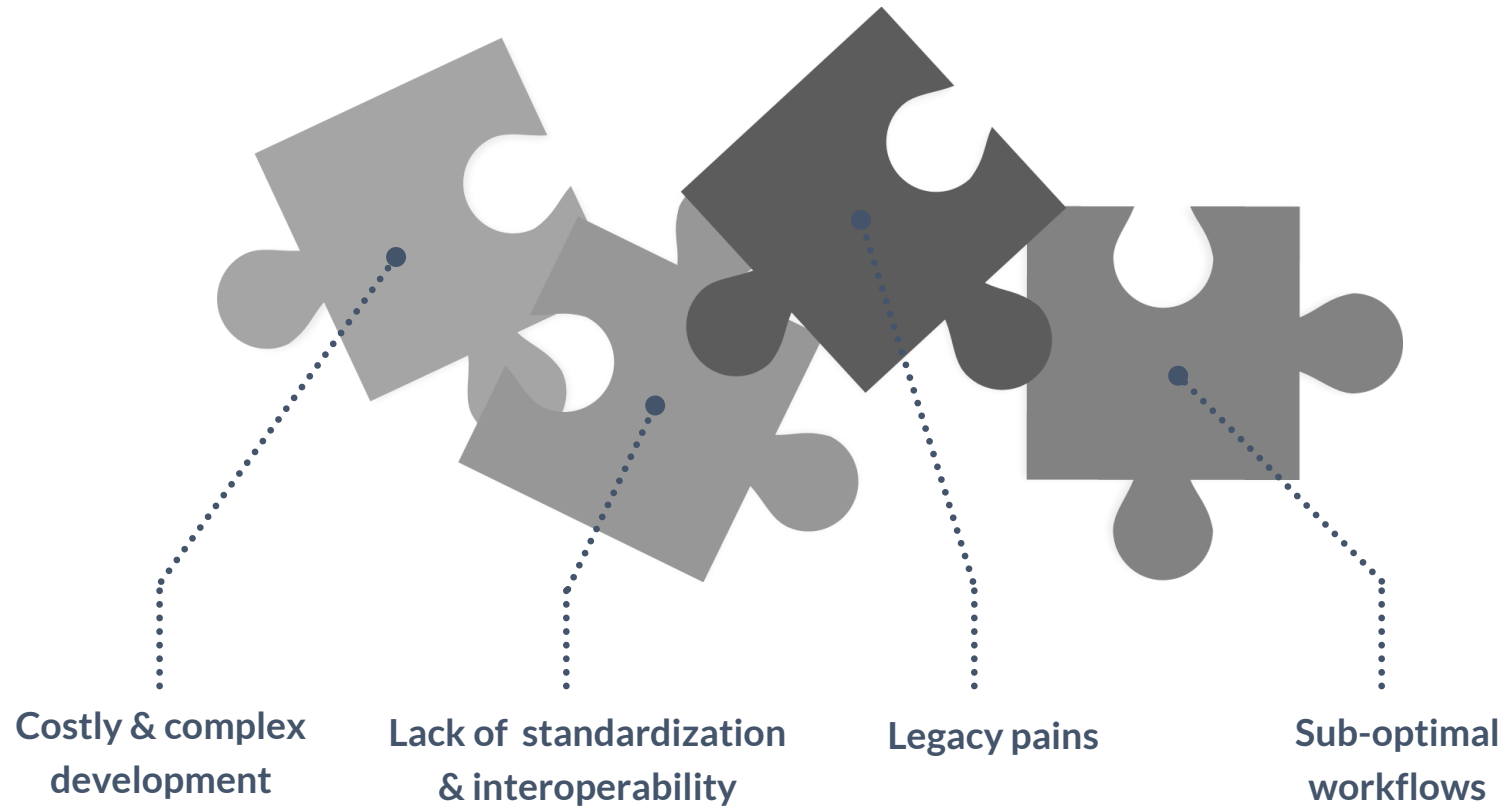
HITRIplus Work Package 11 - Controls and Safety



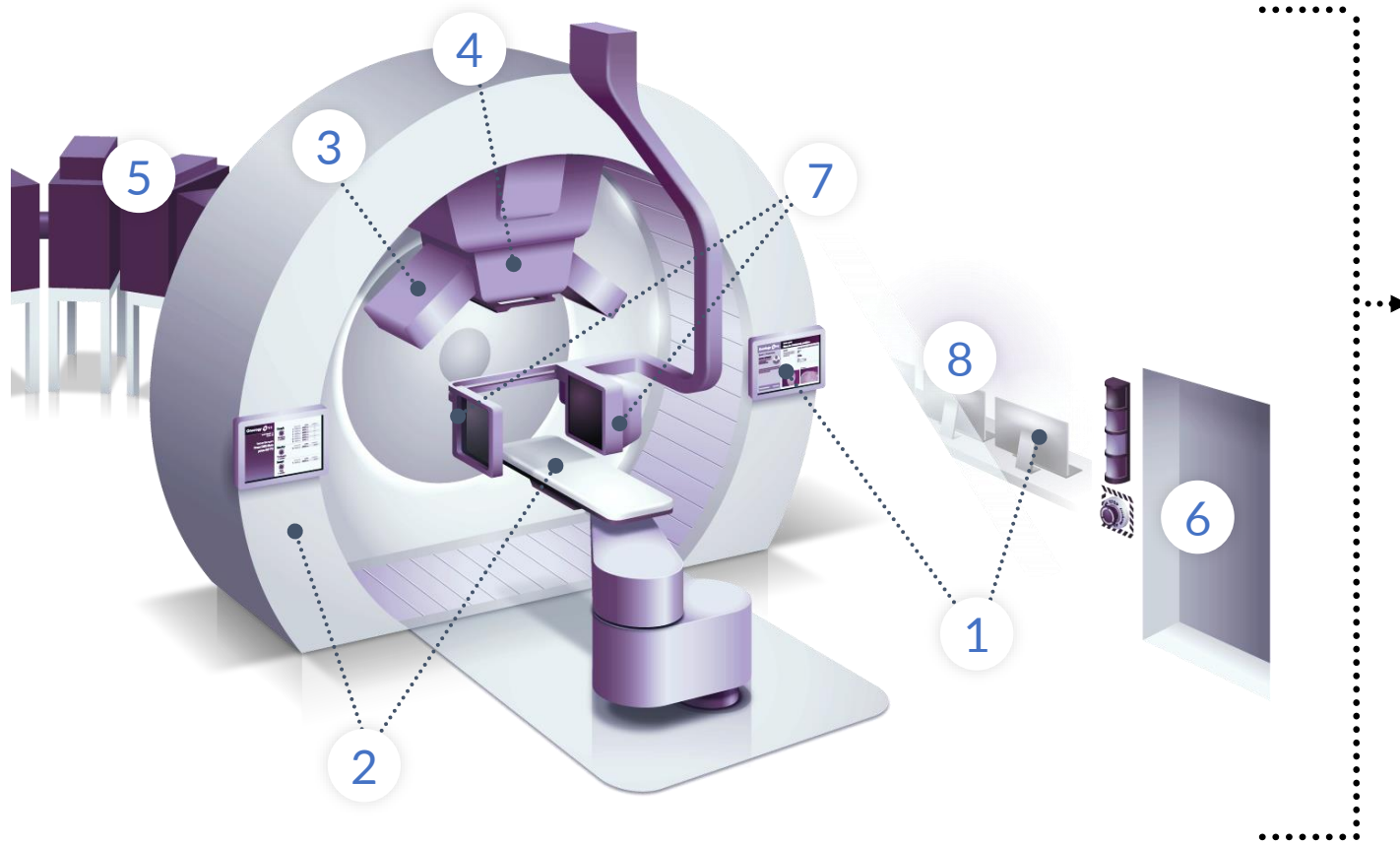
- MS11 Intermediate report on the state-of-the-art treatment room, accelerator control systems, and patient safety systems.
- D11.1 Design study on novel treatment room control systems
- D11.2 Design study on novel accelerator control systems
- D11.3 Design study on novel patient safety systems

Together we are tackling a lot of the challenges, presented today!

Current status of Hadrontherapy



Software is in every part of the machine



1. Treatment Control System
2. Patient Positioning and Motion Management
3. Image Guidance and Patient Position Verification
4. Dose Delivery
5. Accelerator Control System
6. Safety System
7. Proton Imaging
8. Workflow management

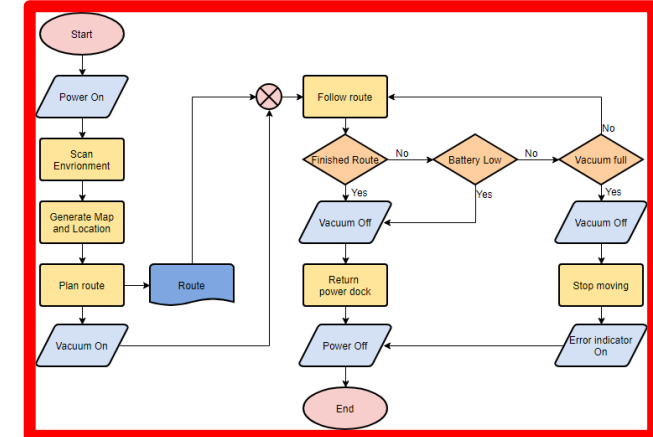
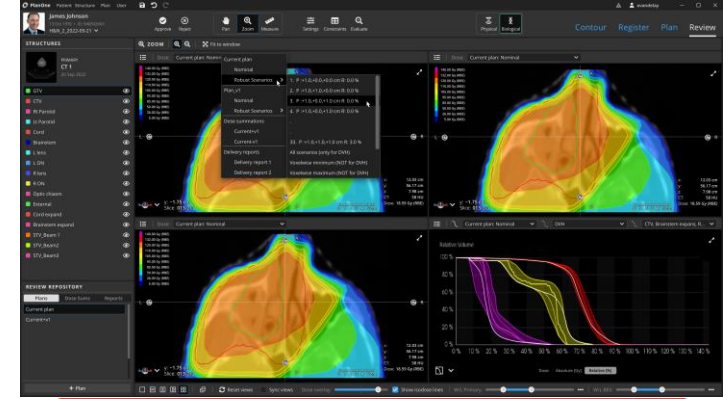
Software is in every part of the oncology workflow



Software plays a crucial role every step of the way!

Dilemma: How to show software?

- Colourful meaningless screenshots?
- Professional incomprehensible flowcharts?
- Impressive illegible lines of code?

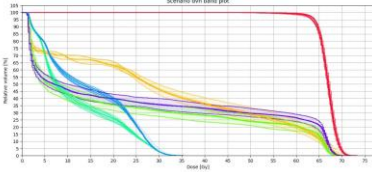


Just name the individual packages?



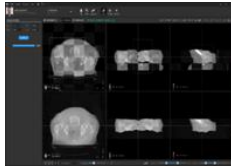
Information Systems

Treatment prescription, scheduling and follow-up



Treatment Planning System

Patient specific treatment plan



Imaging Software

Diagnosis, Planning and Image Guidance



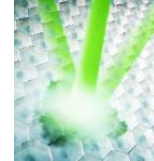
Treatment Control System

Execution of a Treatment Session



Accelerator Control System

Beam production



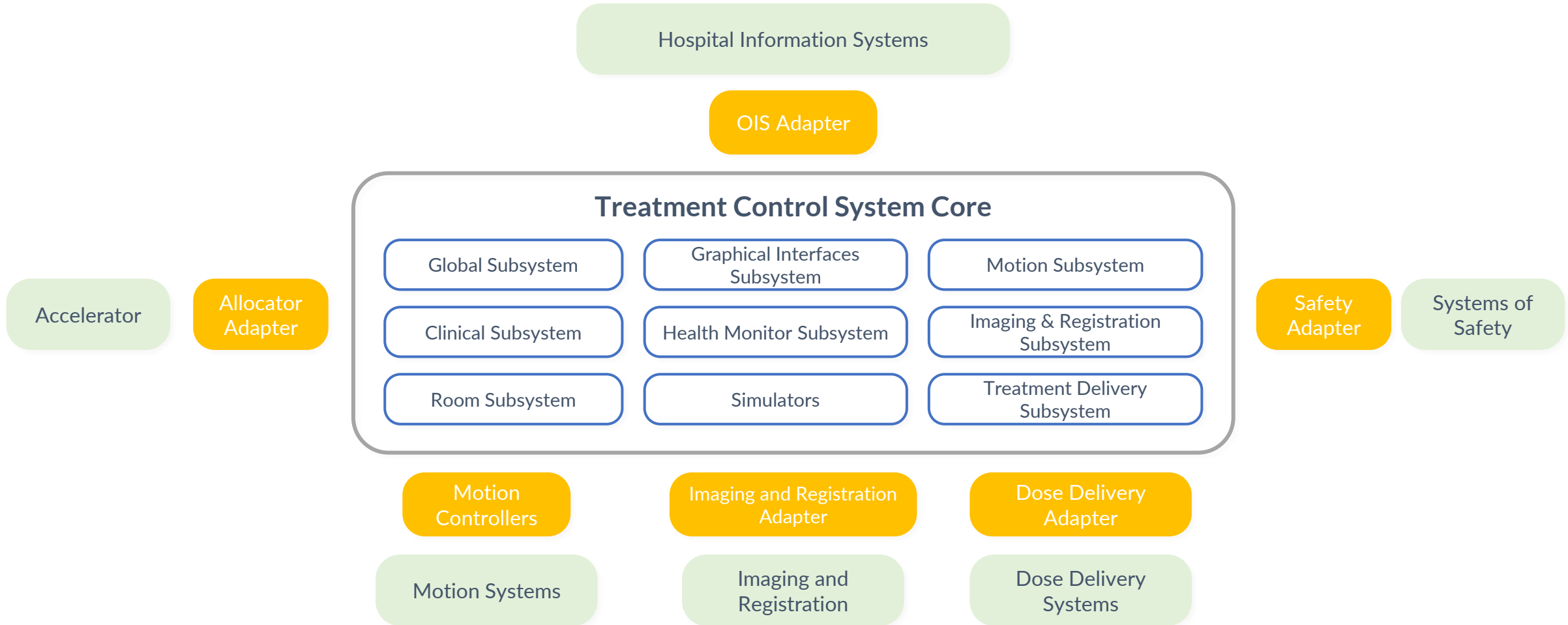
Dose Delivery

Pencil beam scanning

.. and more:

- Safety Systems (personnel, patient and machine safety)
- Patient Positioning (robot/chair control, optical tracking)
- ID Verification (personnel, patient, equipment)

Discuss expert software architecture?

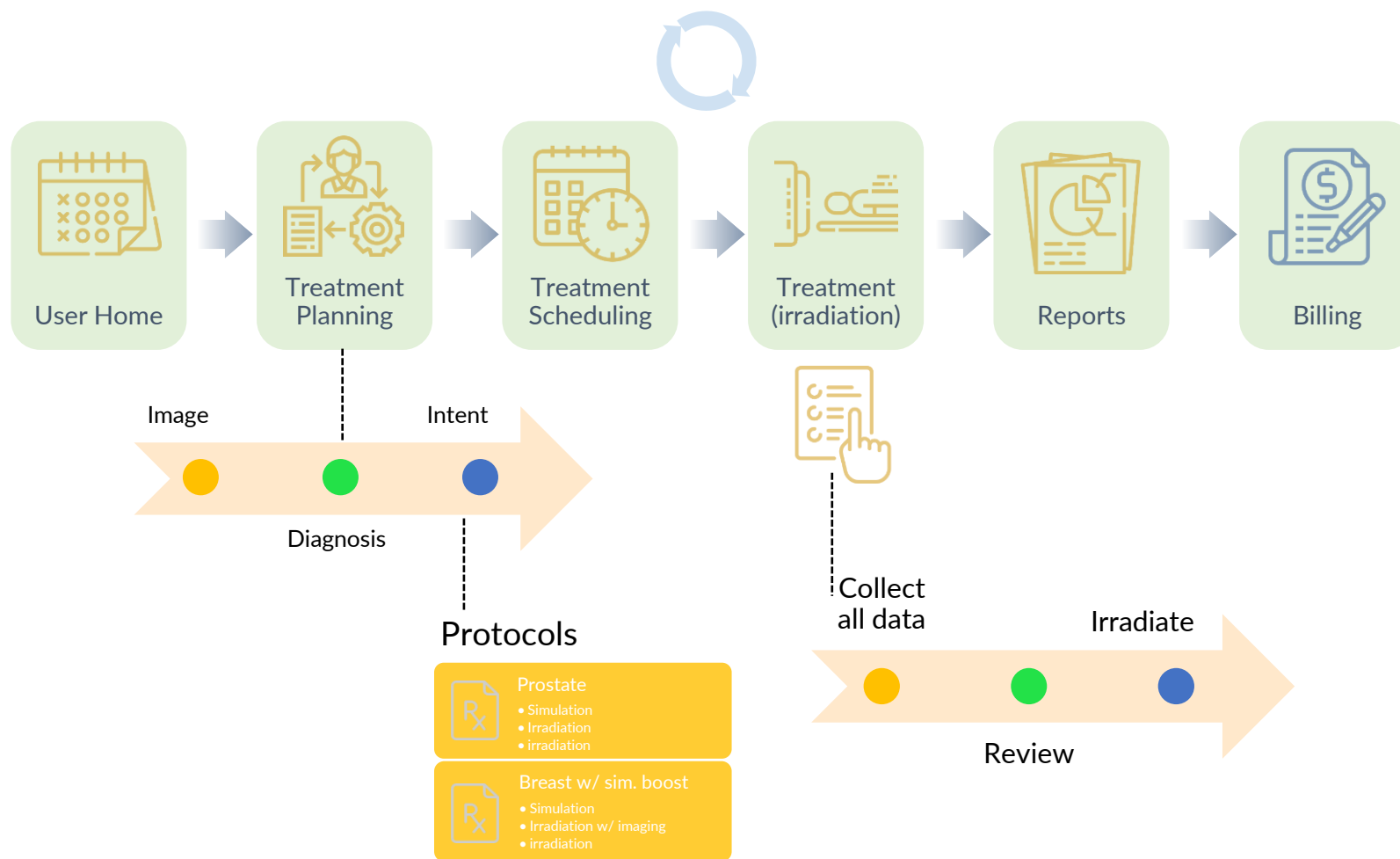
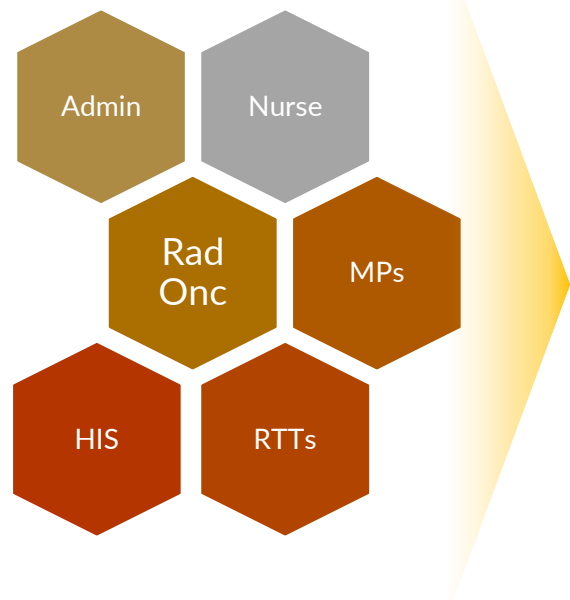


List the thousands of (buzzword compliant) features?

Create the most effective treatment plan for the patient:

- Usage of multi-modality imaging (CT, MRI, PET, **proton**) – Deformable Image Registration!
- AI Contouring
- Biological optimization (Carbon, FLASH)
- Robust optimization
- Multi-modality planning (comparison, boosts, fallback)
- GPU-powered Monte Carlo dose calculation
- Fast and automatic replanning, based on image of the day – Deformable Image Registration
- Automated Plan QA (machine-file based)
- Real-time tumor tracking – gating, adaptive beam delivery
- ...

Whatever, just focus on the patient journey



A few words on „Software Development“

- Software cannot be developed in isolation – it's connected to everything!!!
 - Design top-down, with clinical requirements in mind.
 - Standardization of SW interfaces and interoperability is crucial.
 - Tight integration with wider hospital software is needed (EHR, hospital information systems).
- Hadrontherapy devices are complex and extremely expensive
 - It needs to operate and be upgraded for 30+ years – modular and customizable SW design.
 - Try to avoid custom software development for each machine separately.

Hadrontherapy software is, or is part of, a Medical Device

Medical device regulations (FDA, MDR, NMPA)

Quality management systems (QMS)

- ISO 9001:2015
- ISO 13485:2016

Software development

- IEC 62304:2006+A1:2015

Usability

- IEC 62366-1:2015+CORR1

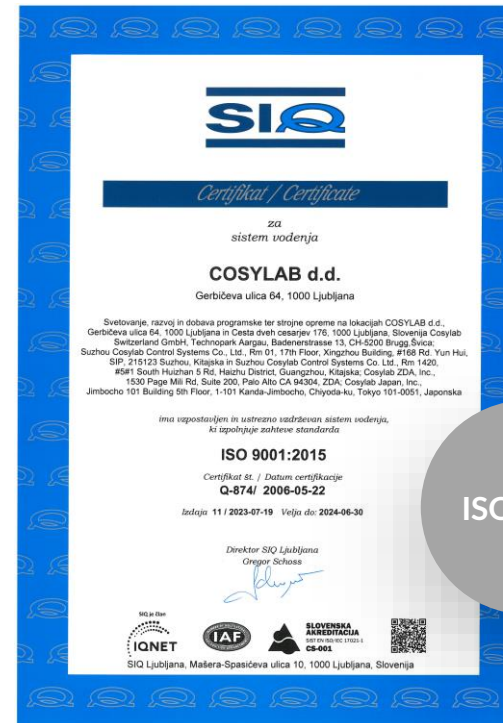
Risk management

- ISO 14971:2019

Technical standards (e.g. IEC 60601 family)

Cybersecurity

- ISO 27001:2022
- IEC 81001-5-1:2021

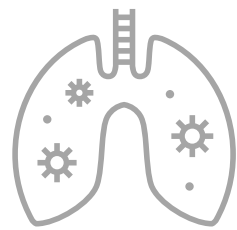


ISO 9001

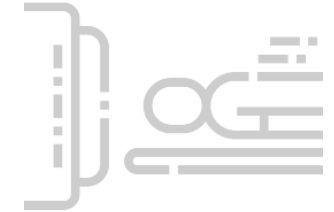
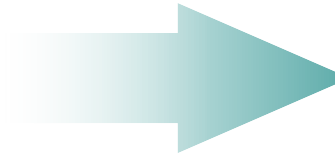
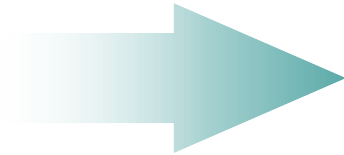


ISO 13485

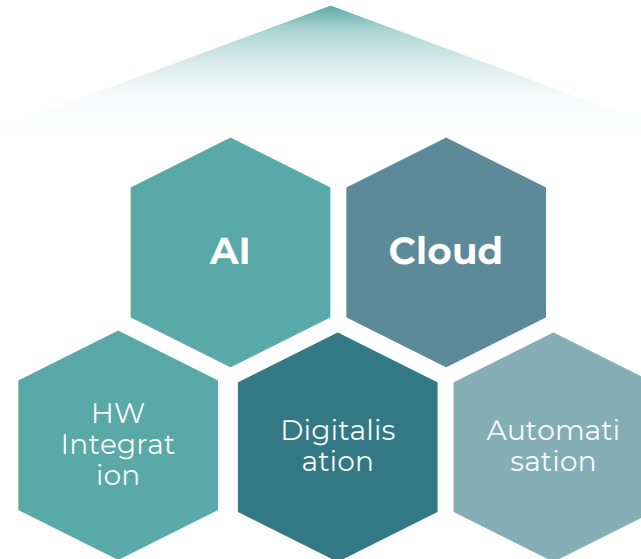
Vision: Contribute To Fully Automated Cancer Treatment



CT Scan



Patient Treatment



THANK YOU

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