

OncoRay – National Center for
Radiation Research in Oncology, Dresden

Partial adaptation for online-adaptive proton therapy triggered by prompt gamma imaging

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TECHNISCHE
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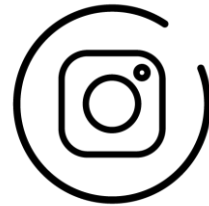
Universitätsklinikum
Carl Gustav Carus



Within the ProtOnART consortium OncoRay, PARTICLE, Raysearch and IBA collaborate in the field of online-adaptive proton therapy (OAPT).

A. Fredriksson is employed at RaySearch Laboratories AB, Stockholm, Sweden.

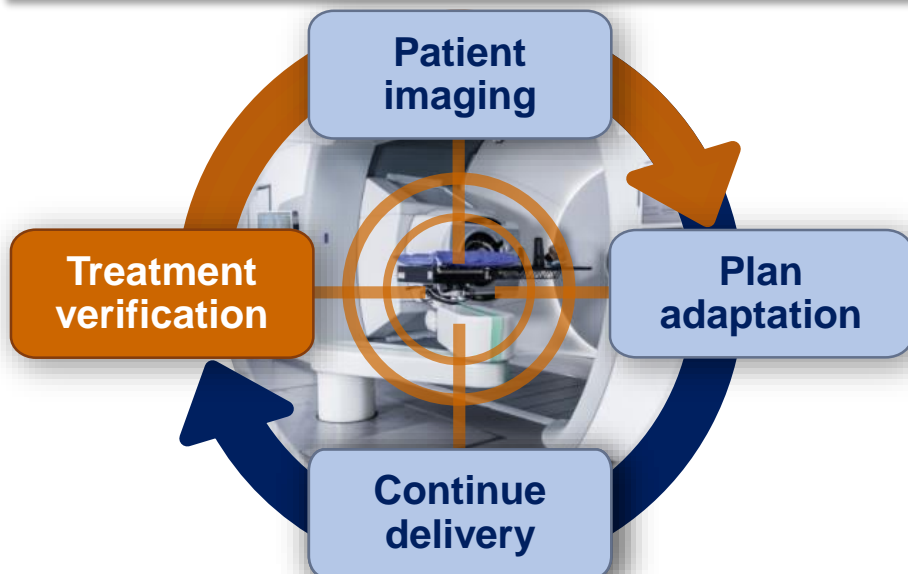
Please feel free to photograph and share these slides on social media.



Treatment verification in OAPT

Online treatment verification

Detect treatment deviations during delivery



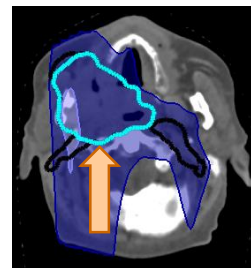
Triggered online adaptation
after portion of plan (e.g. 1 field) delivered

How to adapt remaining portion of plan after online-detected treatment deviation?

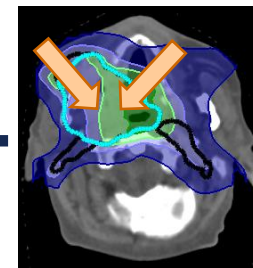
Partial adaptation

Introduced to save time with upfront OAPT
→ Feasibility proven on 3-field HNC treatments

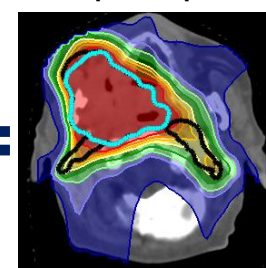
First delivered field



Adapted fields



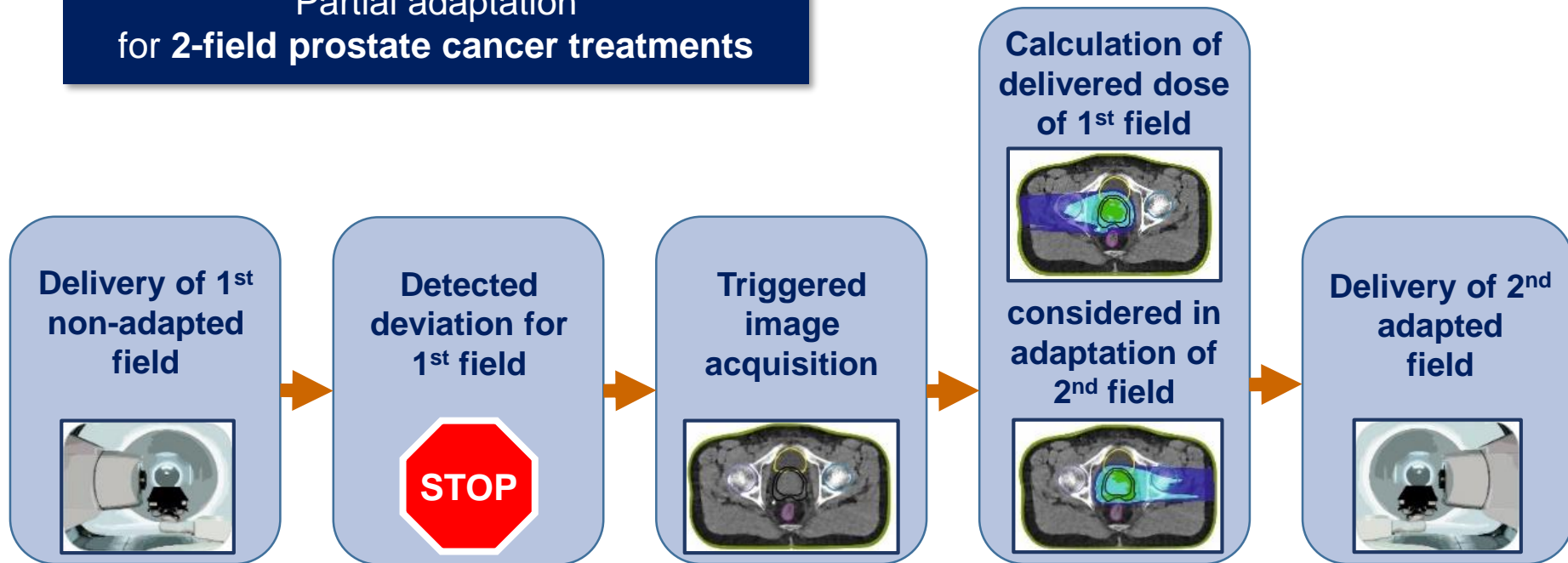
Partially adapted plan



V. Gambetta et al., Med Phys (accepted)

Workflow for verification-triggered OAPT

Partial adaptation for 2-field prostate cancer treatments



Is compensation of the suboptimal dose feasible by adapting one remaining field?

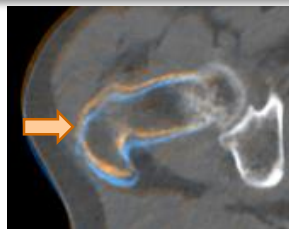
Online treatment verification with PGI

PGI-detected anatomical changes for prostate cancer

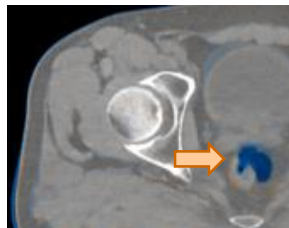


First systematic PGI observational clinical study

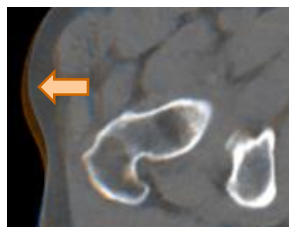
- PGI acquisition
- In-room control CT (cCT)





Rotation of femoral head



Rectum filling change



Subcutaneous fat tissue change

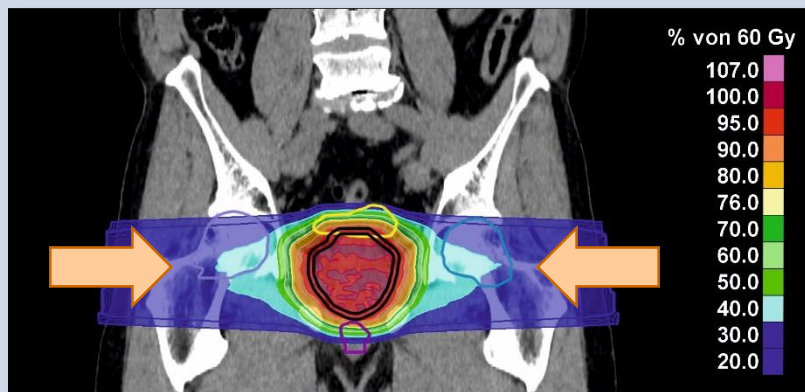
 planning CT
 control CT

J. Berthold et al., IJROBP, 2023

Study design

PGI-monitored patients

Prostate cancer cohort



- 10 fractions **with PGI-detected deviations** retrospectively confirmed on the cCTs
- **Clinical, robust SIB plans** (60 Gy / 48 Gy) with horizontal **opposing fields**

Dosimetric evaluation

Comparison of 4 plans

On the **planning CT**:

1. **Initial**

On the **cCTs**:

2. **Non-adapted**

3. **Fully adapted**

4. **Partially adapted**

- Target coverage and hotspots
- Organs-at-risk (OAR) sparing

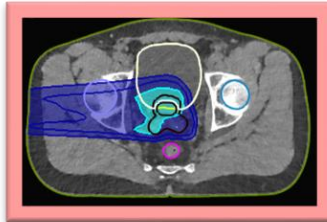
Adaptive strategy

1st field

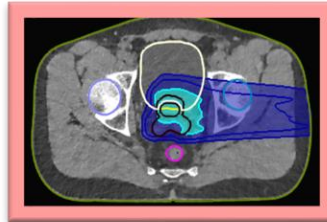
2nd field

Total dose

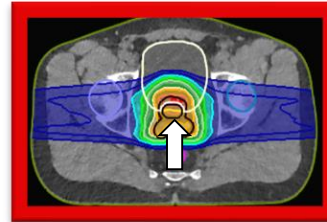
Non-adapted



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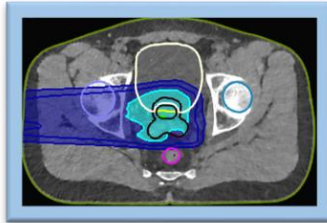


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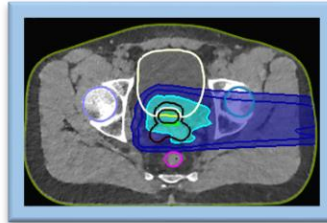


Initial plan
recalculated
on cCT

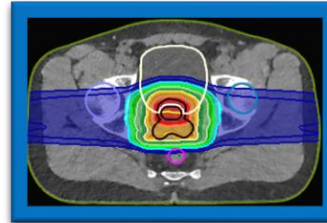
Fully adapted



+

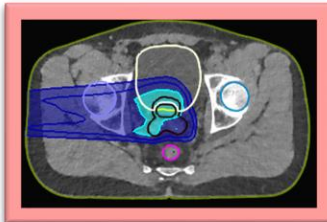


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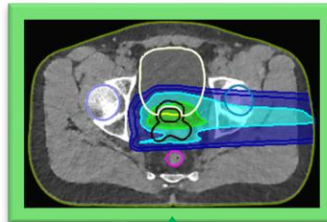


Initial plan
re-optimized
on cCT

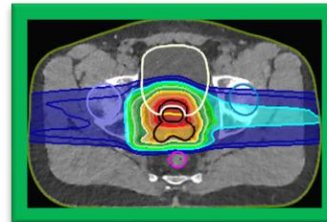
Partially adapted



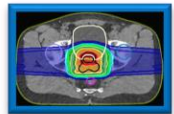
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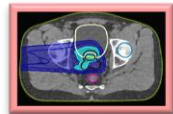
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Robust
dose
mimicking

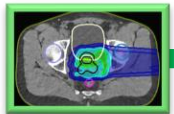


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Reference dose

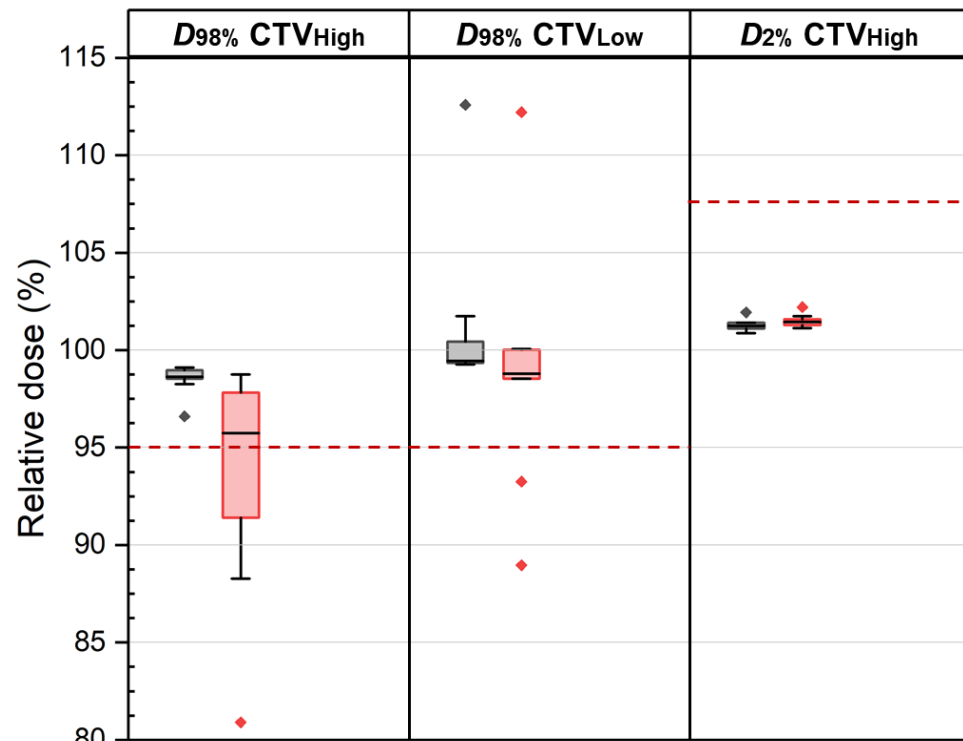
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Mimicking



Results: Target coverage and hotspots



No adaptation

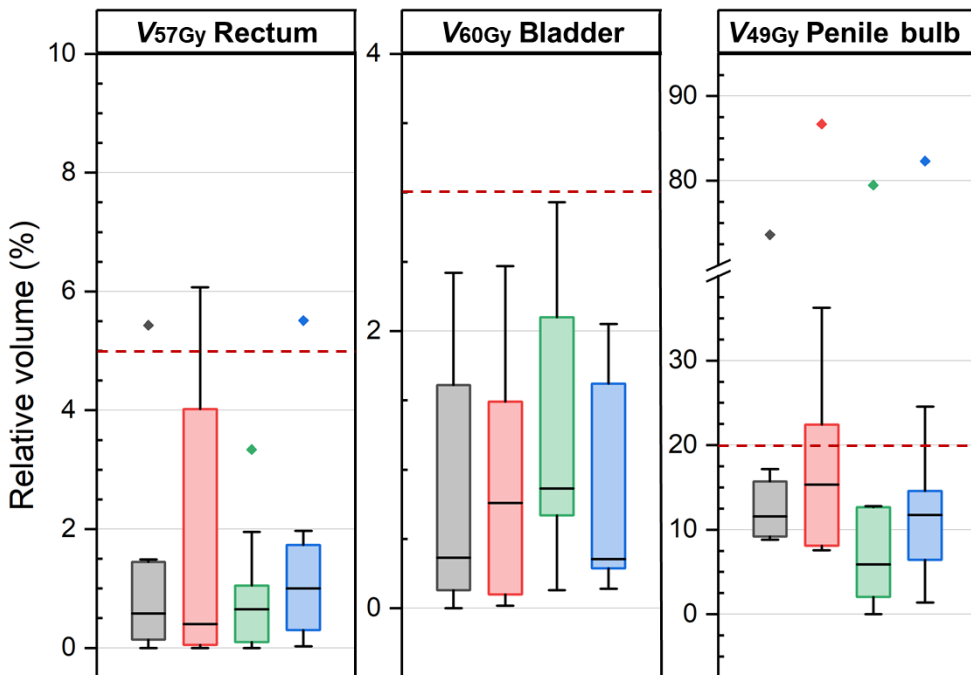
Clear loss in target coverage

Partial adaptation

- All clinical constraints met
- Comparable with **full adaptation**
- ... also under range/setup errors



Results: OAR sparing



OAR dose changes **case dependent**

Partial adaptation

- **Superior OAR sparing** apart from $V_{60\text{Gy}}$ (Bladder)



First feasibility study of PGI-triggered partial adaptation for OAPT

- **Partial adaptation** is a promising planning strategy for online-adaptive PT triggered by treatment verification
- Partial adaptation **dosimetrically effective** and comparable with full adaptation for **2-field** prostate cancer plans
- Significant step towards **near real-time OAPT**

Future steps

- Upcoming **interventional trial** (DEPICT) with **PGI-based online decision for control CT imaging** for prostate cancer patients