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# Adaptive Therapy: Effects on Data Transfer for Clinical Trials

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# What is Adaptive Therapy?

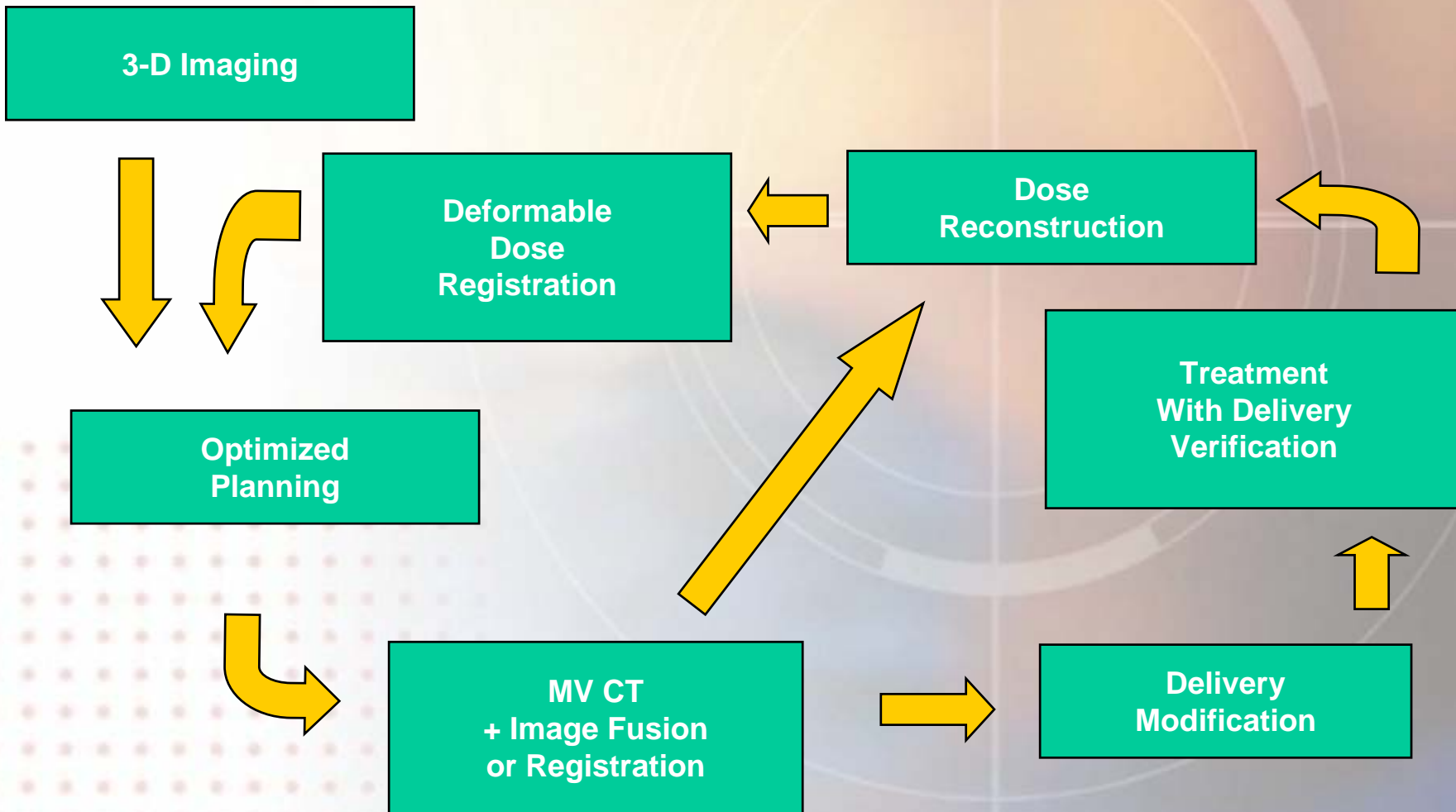
From Rock Mackie:

"The setup offsets of the patient can be determined on a daily basis by fusing (or registering) the verification CT acquired at the time of treatment with the planning CT. Post-processing the detector signal during treatment reconstructs the dose delivered with respect to the patient's CT scan acquired at the time of treatment. Deformable registration is a way of mapping the dose distribution back to the planning representation so that the success of therapy can be monitored and possibly corrected. Collectively we term this set of processes adaptive radiotherapy because it may be used to ensure that the whole course of radiotherapy is proceeding according to plan."



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# Adaptive Therapy





# 1. Verification CT Image Acquisition

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## 2. Per-Fraction Dose

- Currently use point dose measurements, midline dose computation, calculation based on adjusted planning CT.
- Dose reconstruction techniques generate “realistic” 3D dose distributions.





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# Dose Reconstruction

- Full 3D dose computed on per-fraction basis
- Requires:
  - Image of patient at time of treatment (3D verification image)
  - Delivered energy fluence distribution
- Generates dose distribution information relative to Targets and RARs

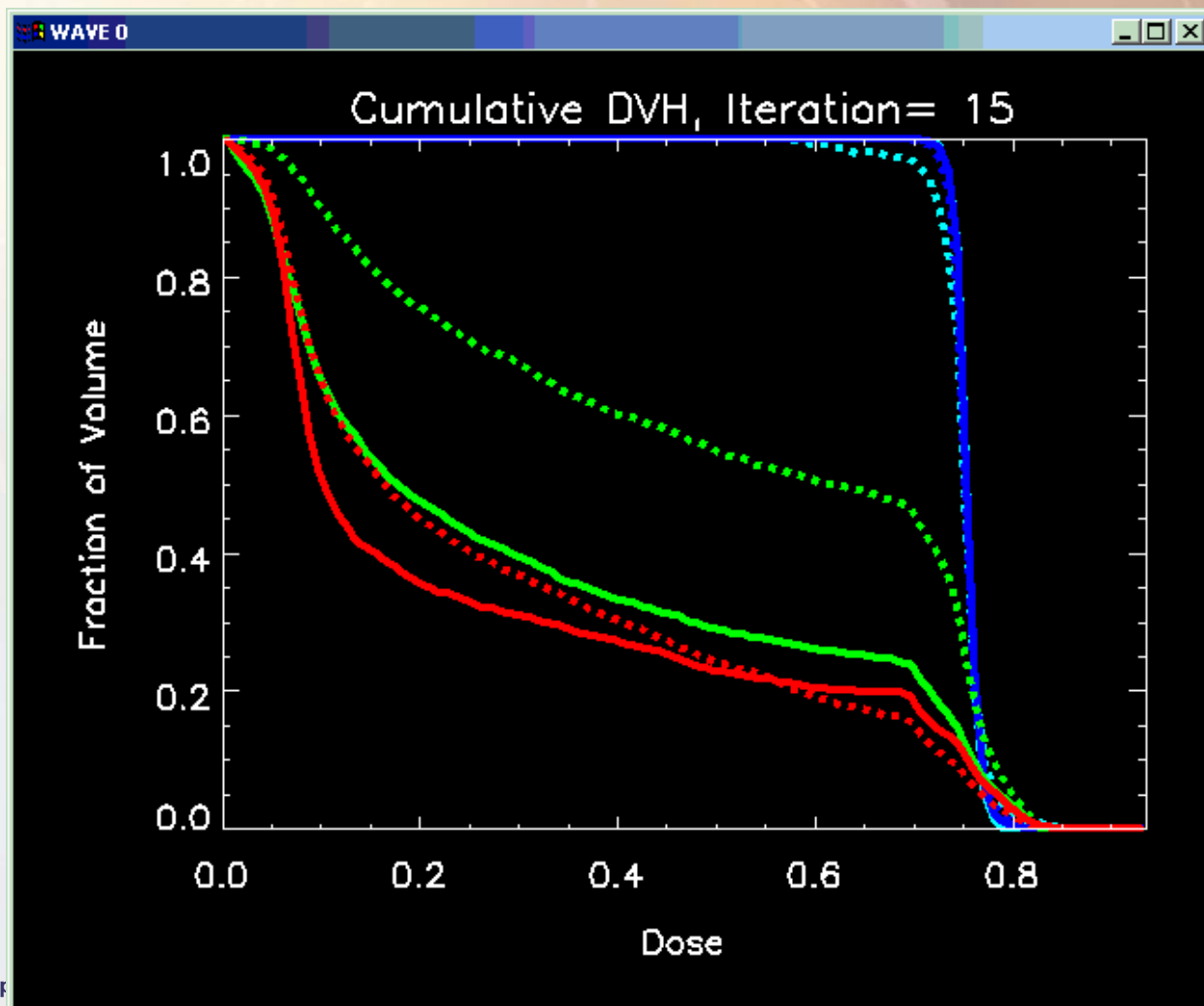


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# Why: Multi-day DVHs for daily CTVs

Overview

- Prostate day 1
- ⋯ Prostate day n
- Sem. Ves. day 1
- ⋯ Sem. Ves. day n
- Rectum day 1
- ⋯ Rectum day n
- Bladder day 1
- ⋯ Bladder day n





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### 3. Deformable Dose Registration

- Allows dose delivered over multiple fractions to be summed correctly (from a “cancer cell” view).
- Allows true biologically-based correction of cumulative dose distributions.
- Facilitates meaningful outcome analysis for different IMRT delivery techniques.



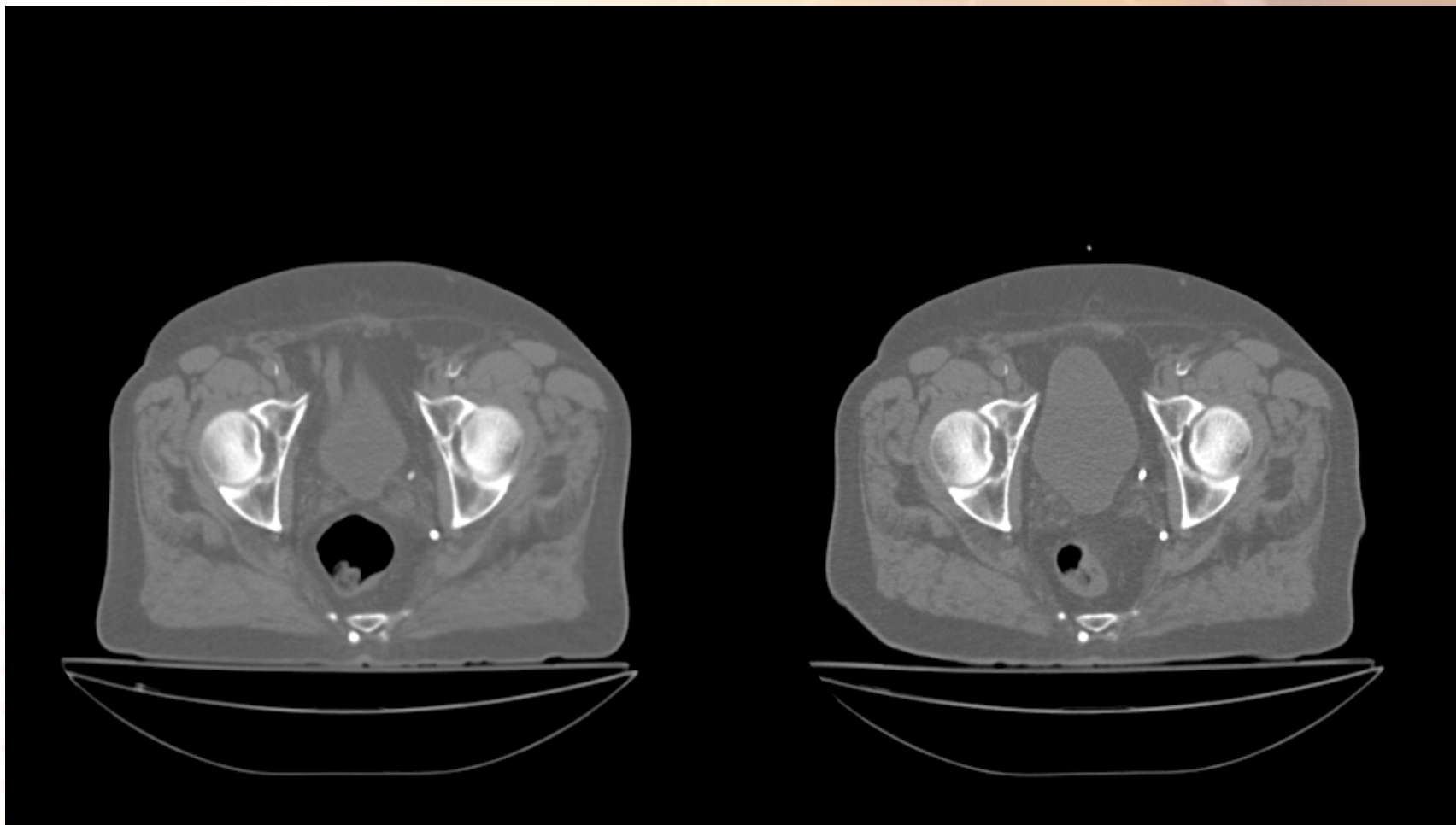


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# Deformable Dose Registration

Fraction 1

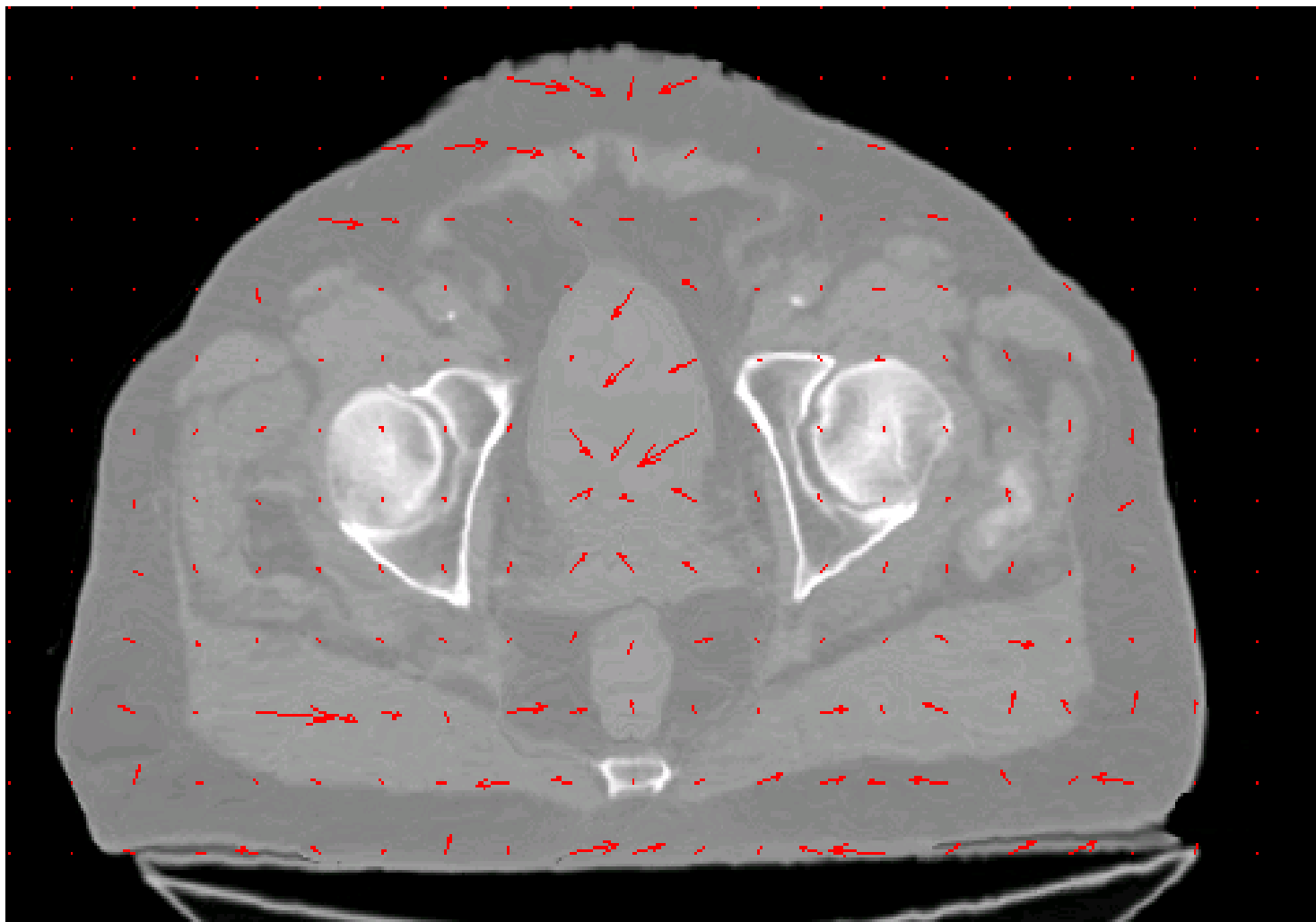
Fraction x





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# Deformation Map





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## ...Leading to Dose Summation

- Application of deformation map to reconstructed dose distribution can give “true” dose to each cancer tissue region.



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# Impact on Data Generated

- Daily 3D CT image sets (moderate resolution, depending on technology)
- Daily 3D dose distributions (if dose reconstruction available)
- Deformable registration will lead to progressive information on deposited dose
- Additional dose information will lead to mid-treatment adjustments (could be daily, semi-automated)
- Iterative replanning process will generate sets of evolving plans for one treatment



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# Conclusions

- Data volume will increase rapidly, and that data will be critical to understand outcomes.
- Multi-plan paradigm may break some data models in existing radiotherapy equipment.
- Linking related entities (DICOM or otherwise) will be crucial.