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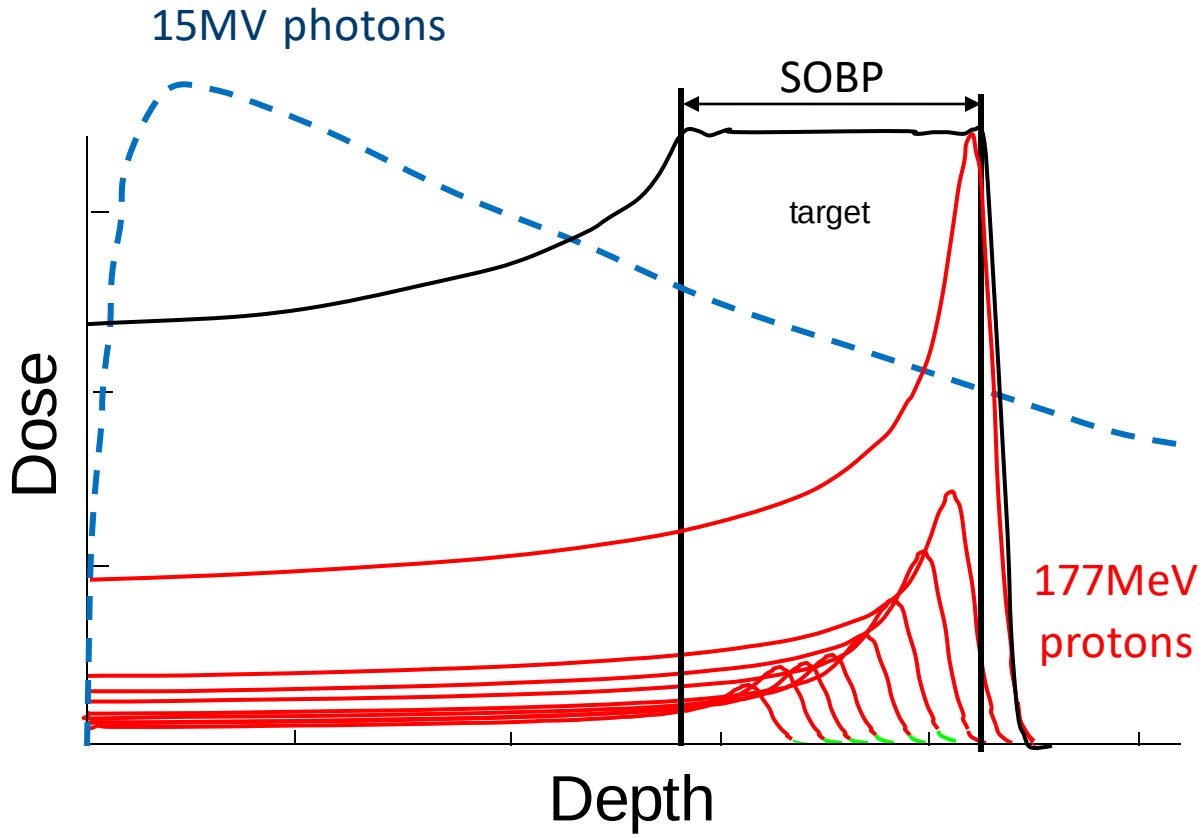
PSI

Tony Lomax :: Head of Medical Physics :: Paul Scherrer Institute
Department of Physics :: ETH-Zurich

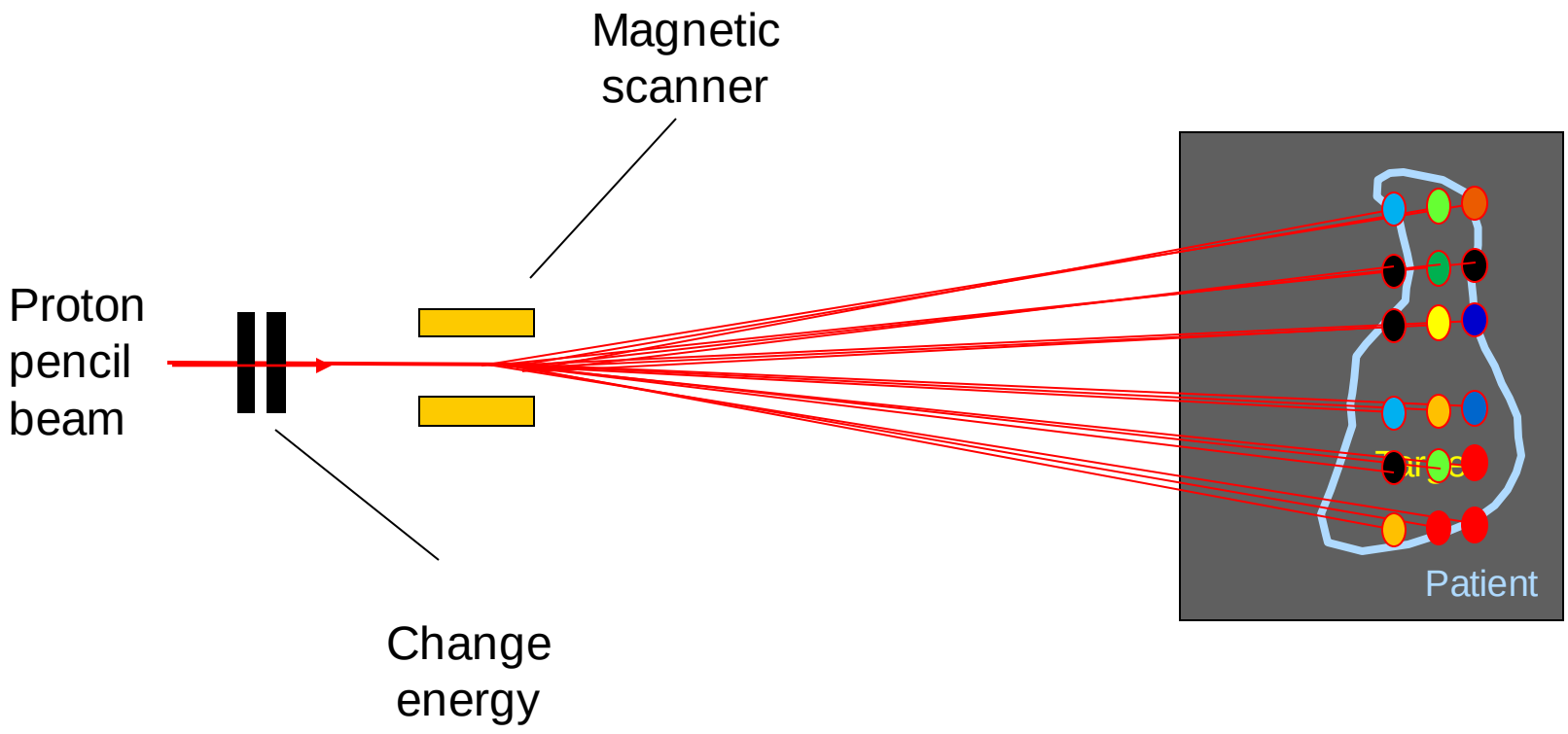
Proton therapy at PSI

Nuclear Engineering students introduction day, 17th May 2021

Radiation therapy with photons and protons



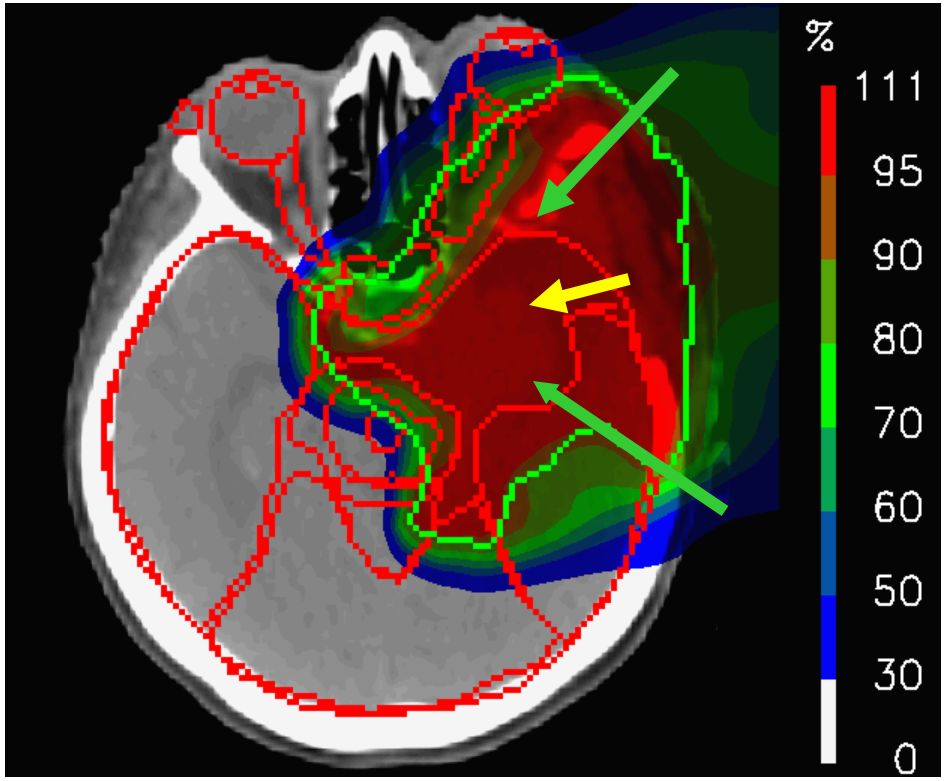
Pencil beam scanning with protons*



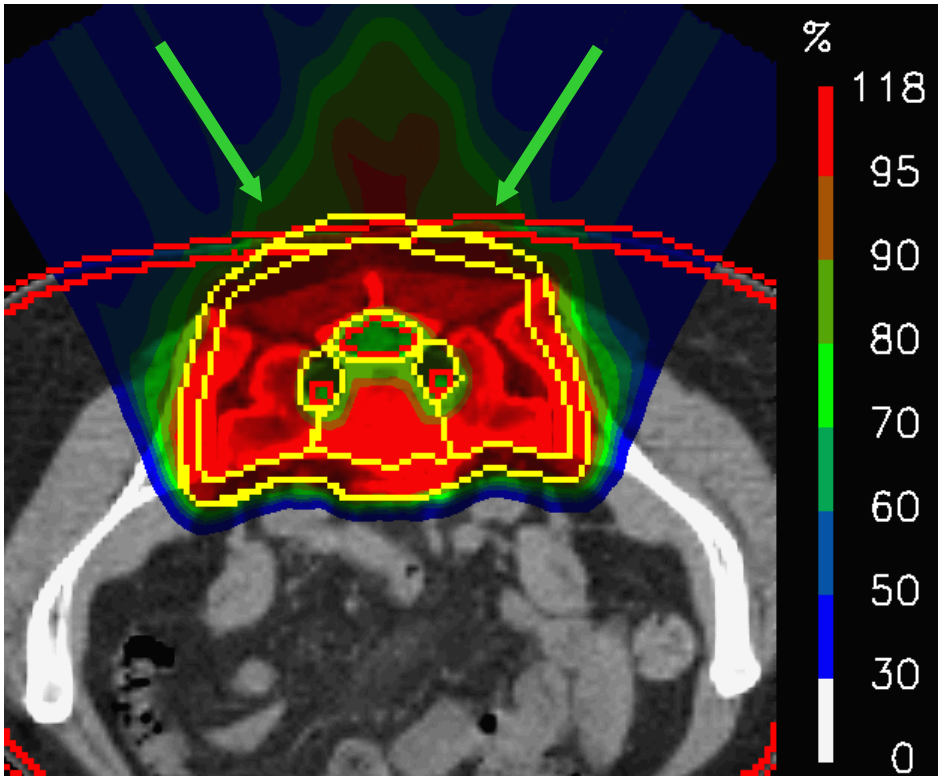
*Pedroni et al 1995, Med. Phys. 22:37-53.

PBS proton therapy – example cases

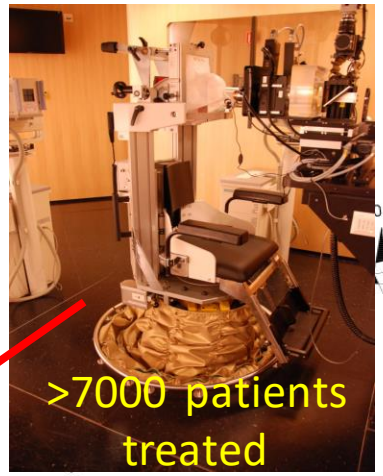
Meningioma (3 fields)



Sacral Chordoma (2 fields)



Proton therapy at PSI



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Current research topics at PSI

1. Non-invasive ocular treatments
2. FLASH irradiations
3. (Daily) adaptive therapy
4. Motion modeling and mitigation

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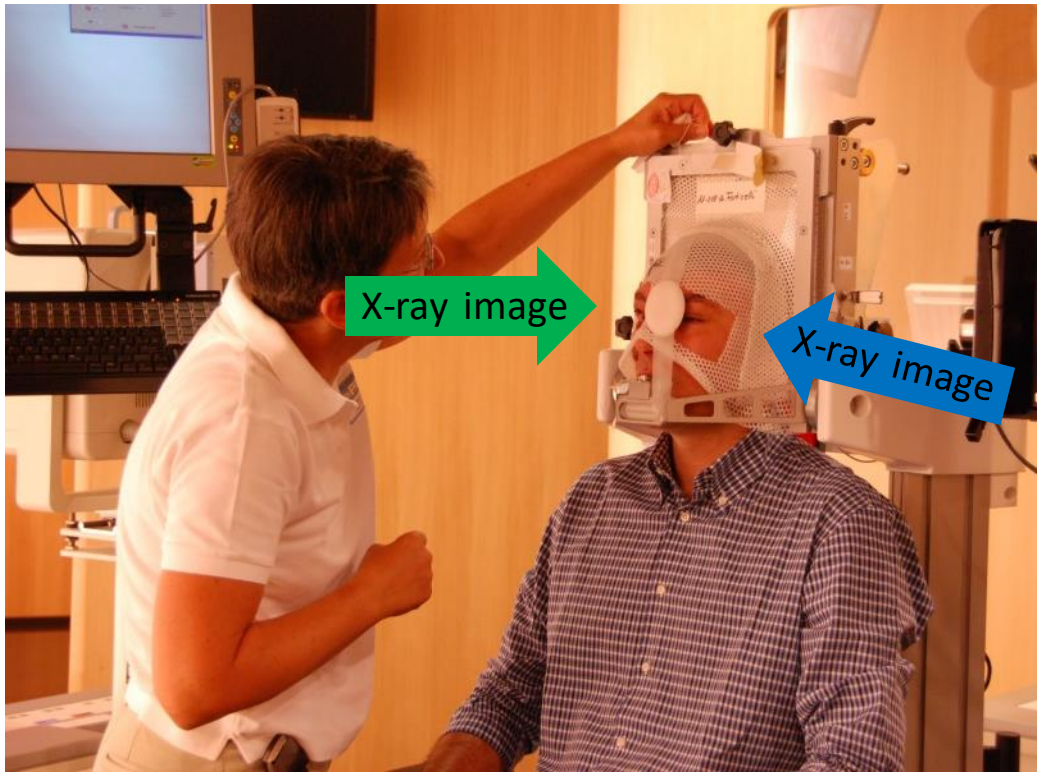
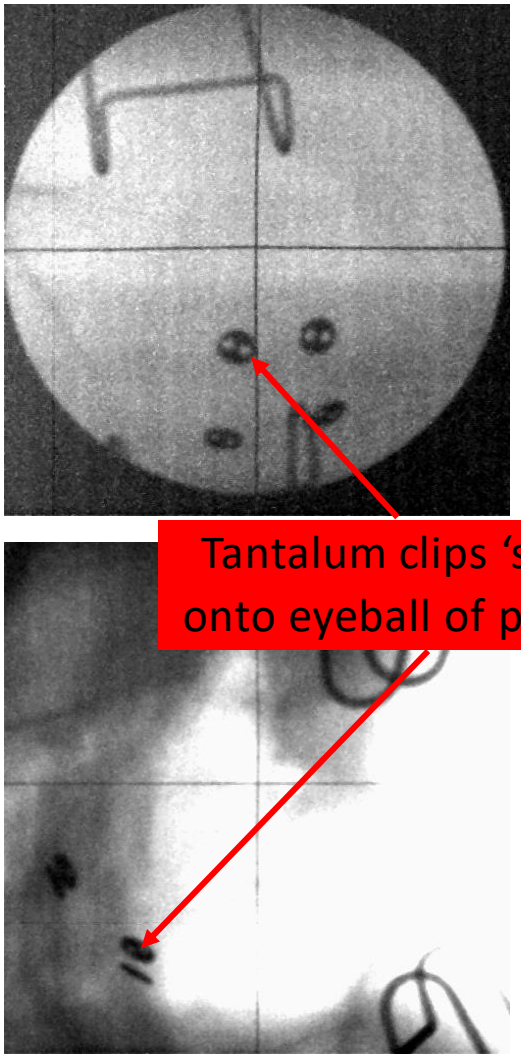
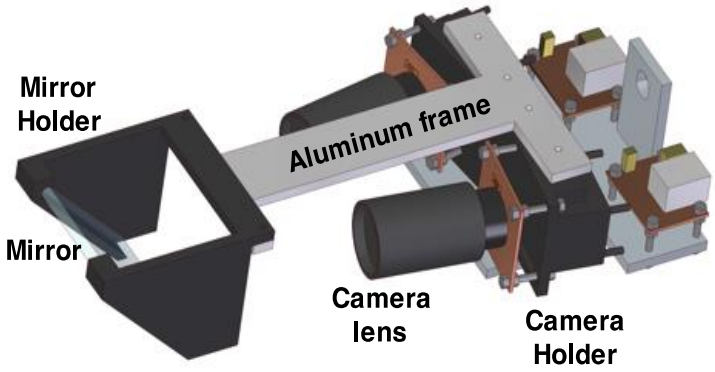
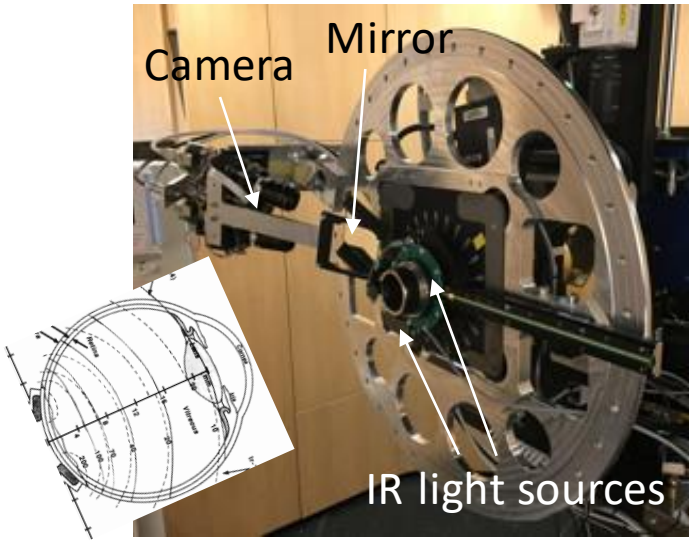
The use of ‘clips’ in ocular therapy

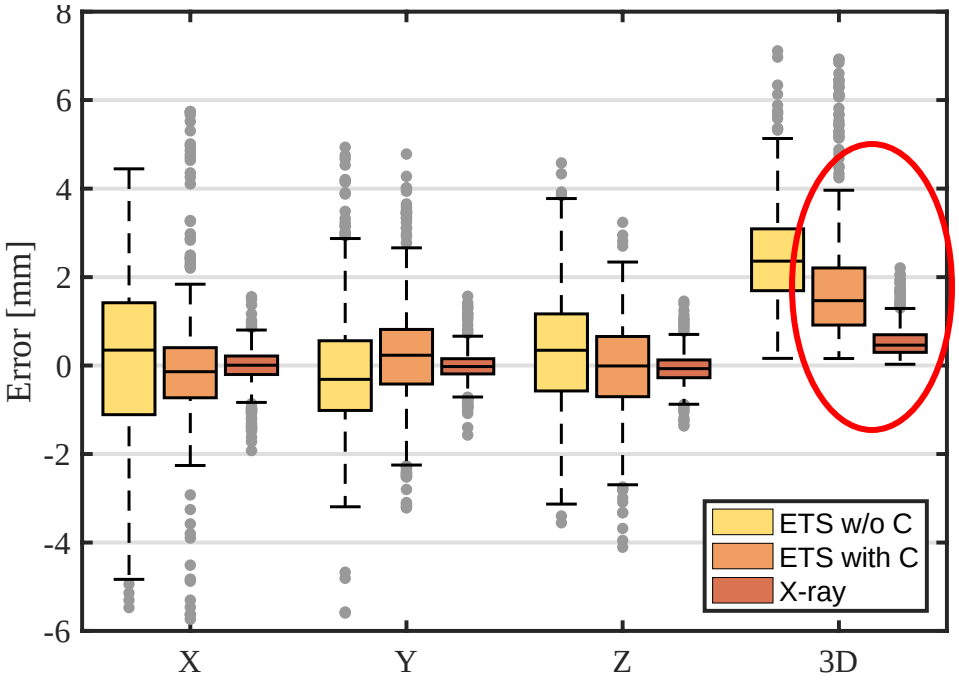




Eye localization using optical tracking







Via et al 2018, Med. Phys. 42:2194-2202

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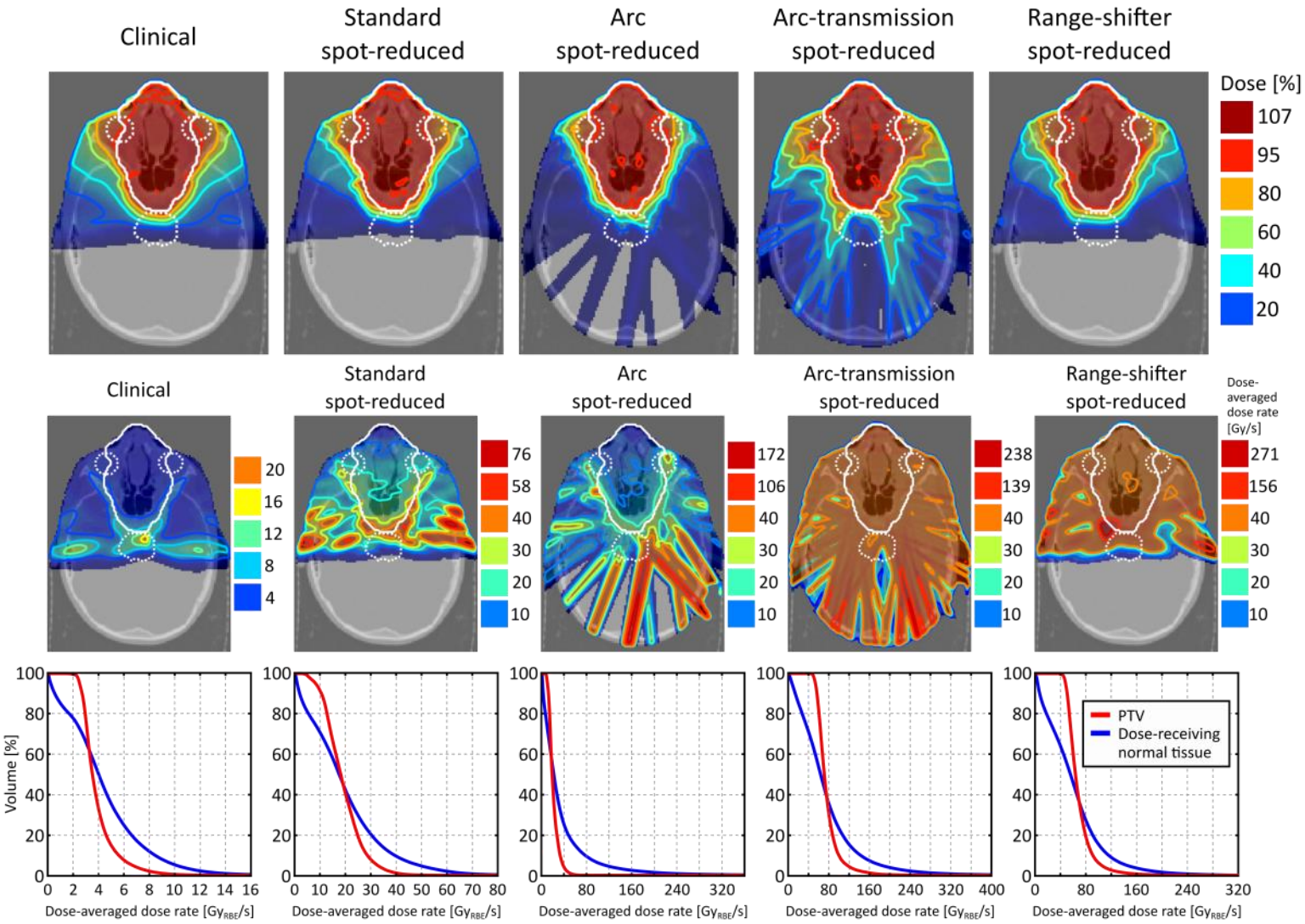
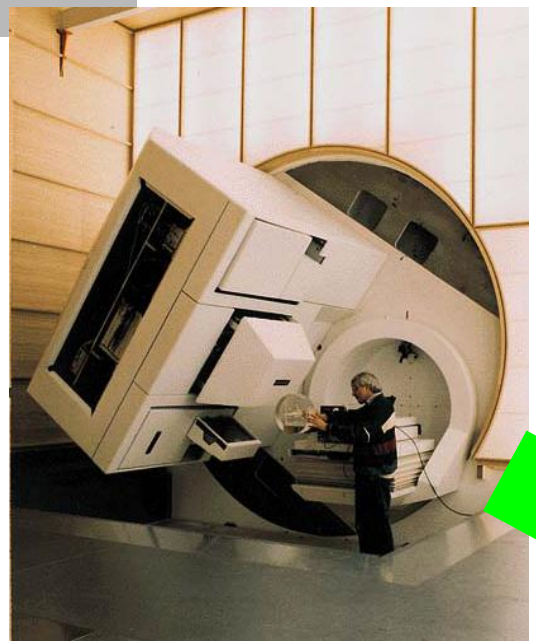
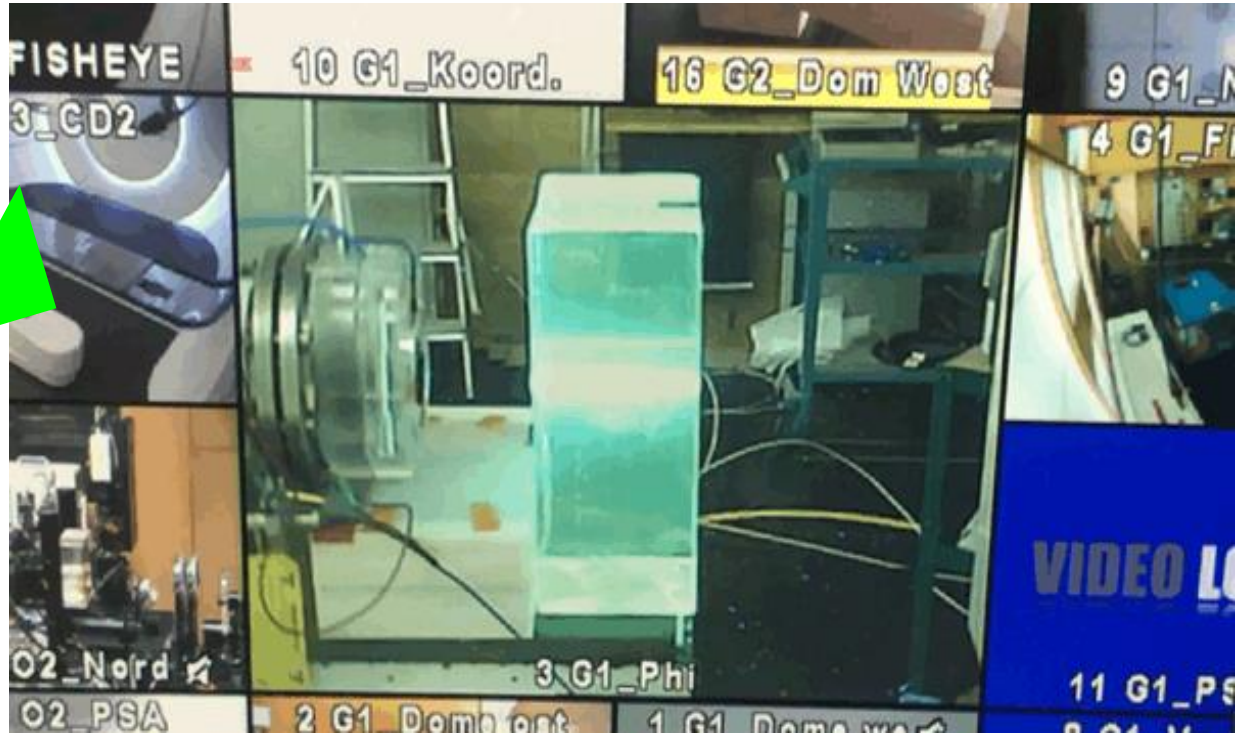
Simulations of FLASH scenarios



Development of pre-clinical FLASH irradiations on Gantry 1



Live image from a video camera of a 3000Gy/s beam traversing a scintillating block. The length of the pulse was 10 ms to deliver 30Gy.



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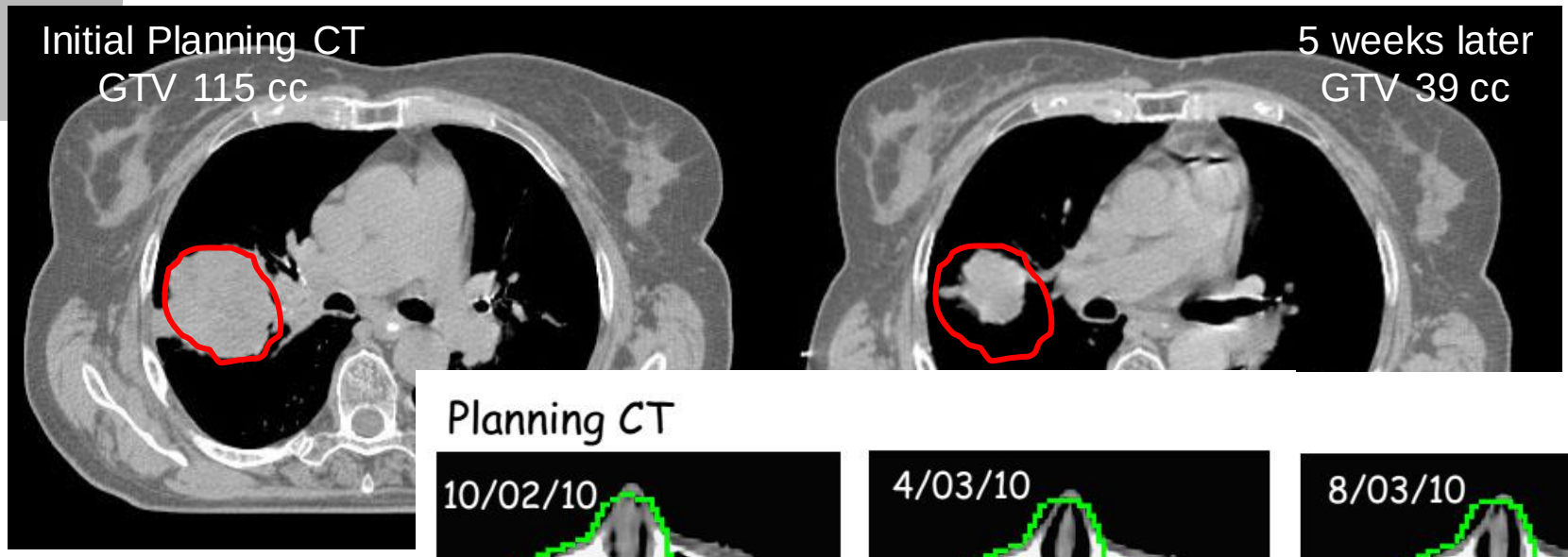
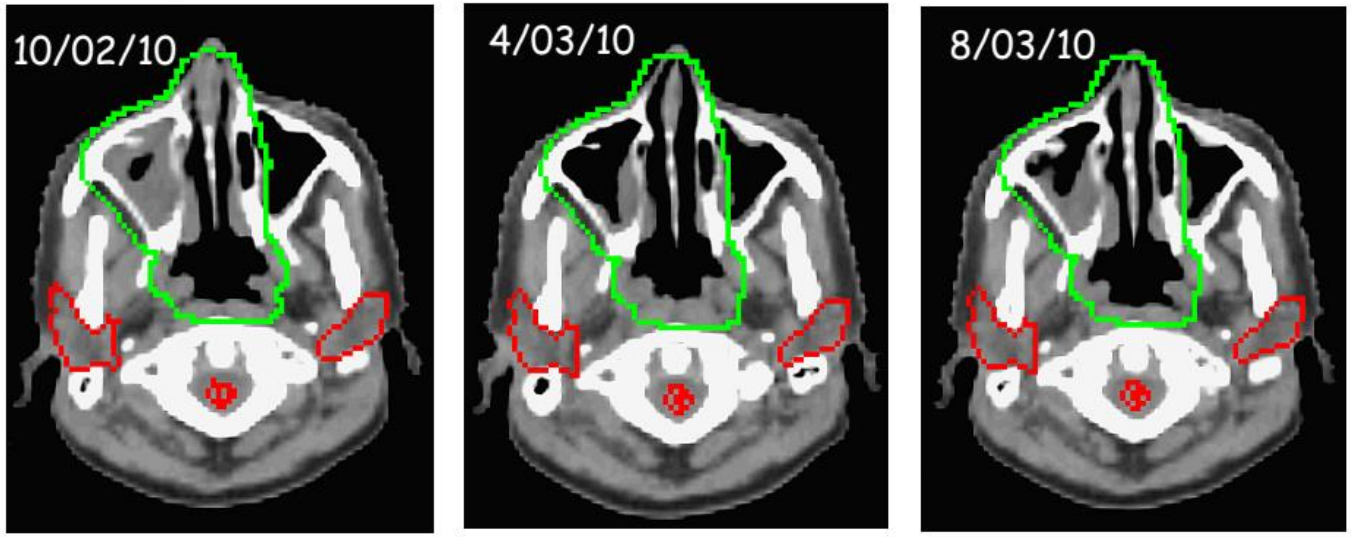
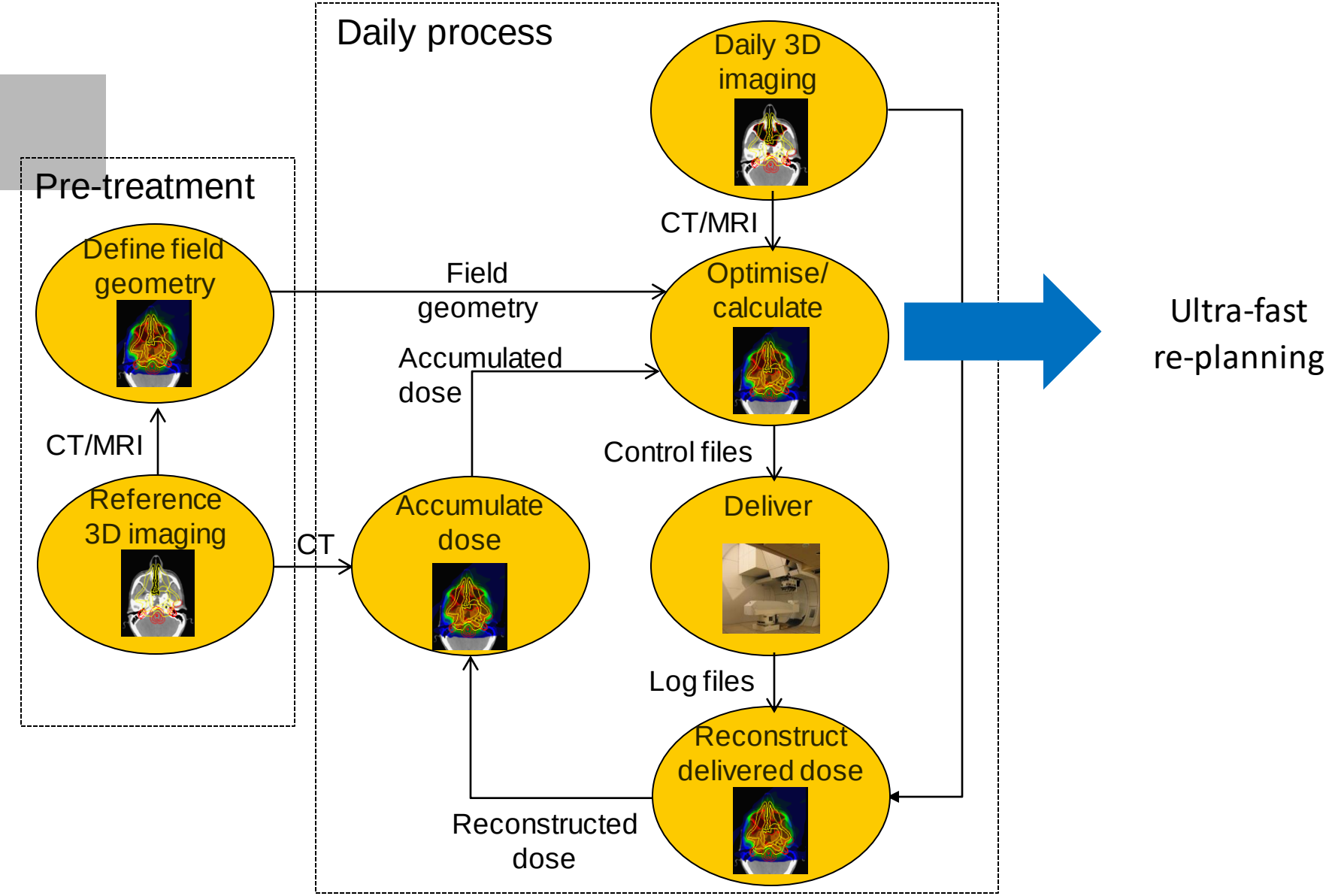
The problem of anatomical changes



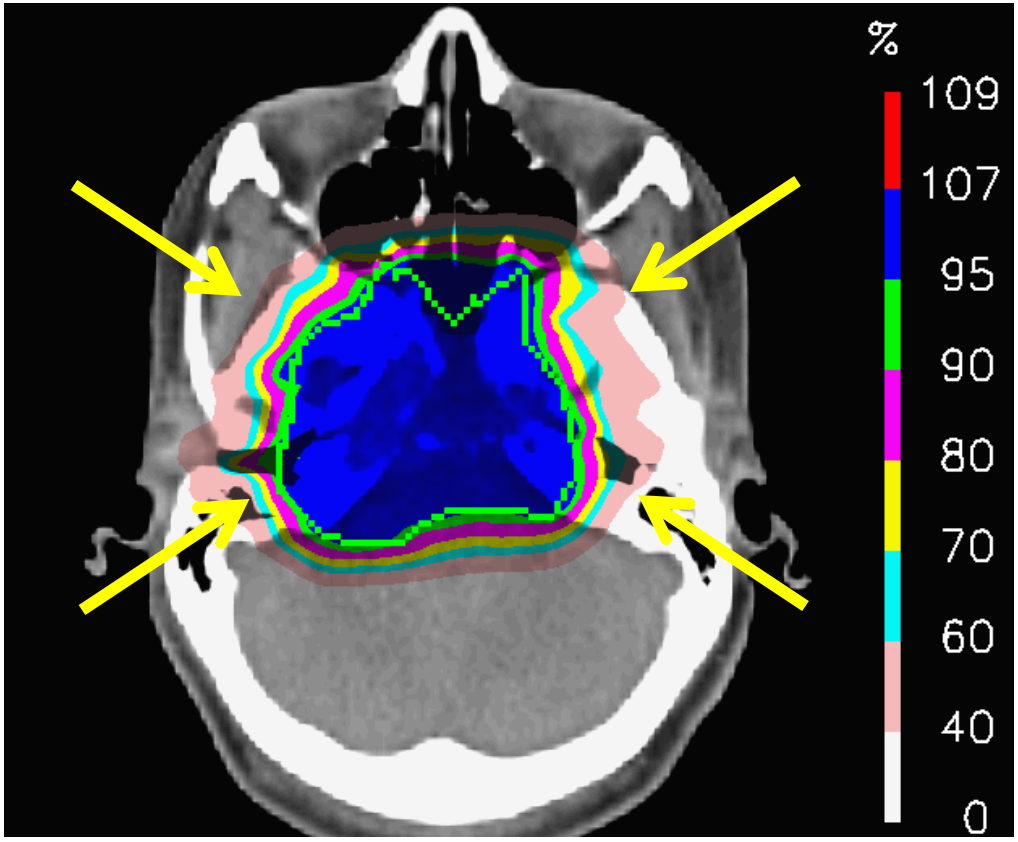


(Daily) adaptive therapy



GPU based treatment planning

A PBS proton plan to a skull base chordoma



- 4 field plan
- >20000 'Points' (~5000 per field)
- 5s for *complete re-*definition and re-optimisation of plan

Matter et al 2019, Accepted for publication in Acta Oncologica

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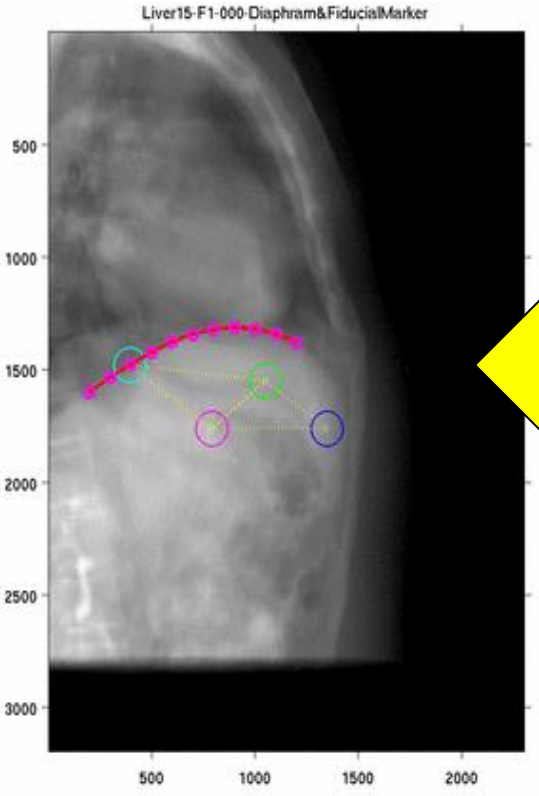
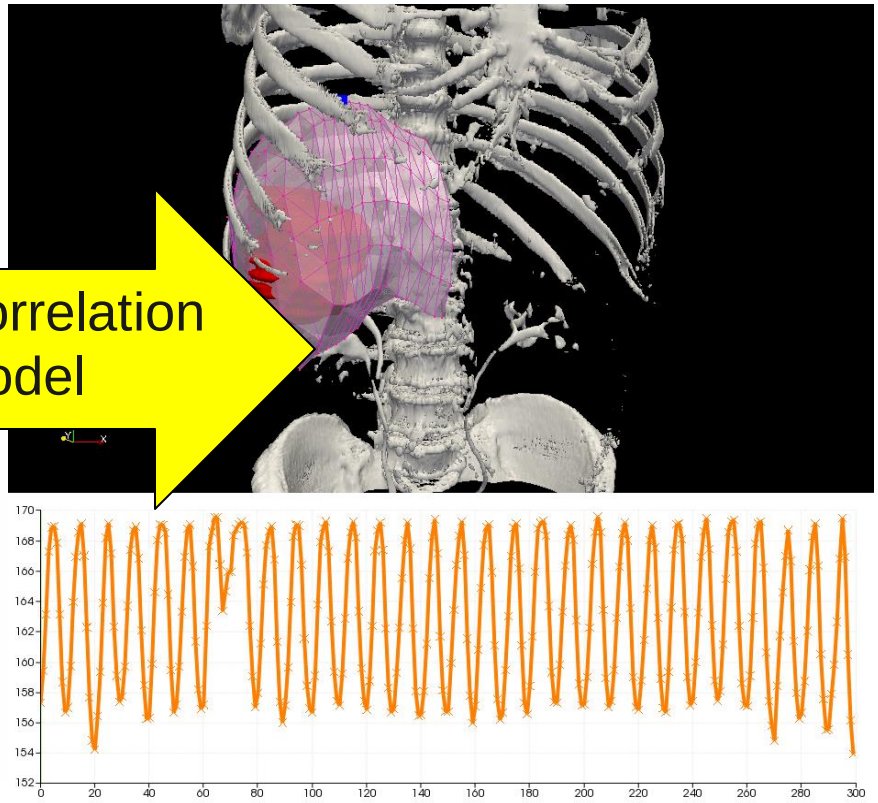
Knowing where the tumour is - motion prediction

2D fiducial/diaphragm motion



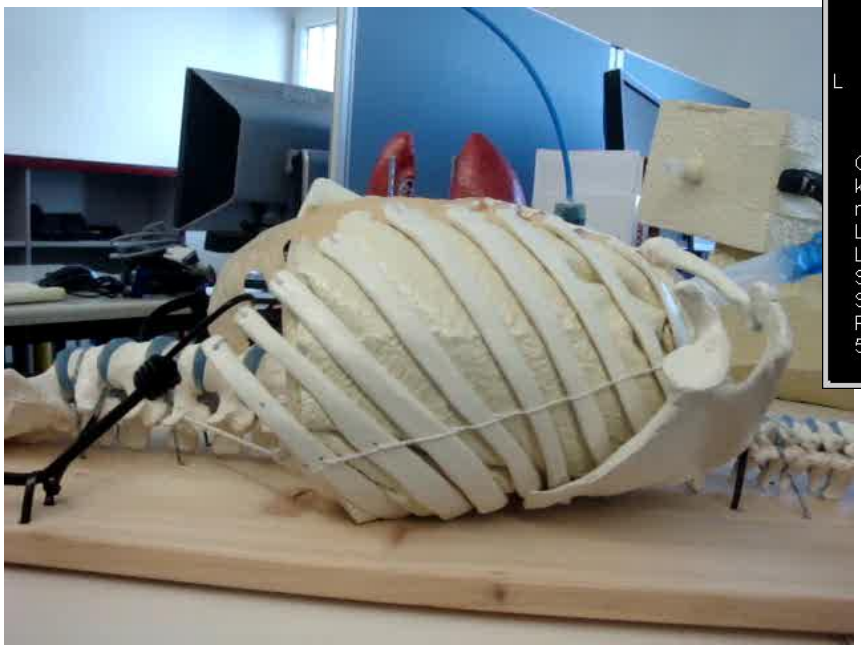
PCA Correlation model

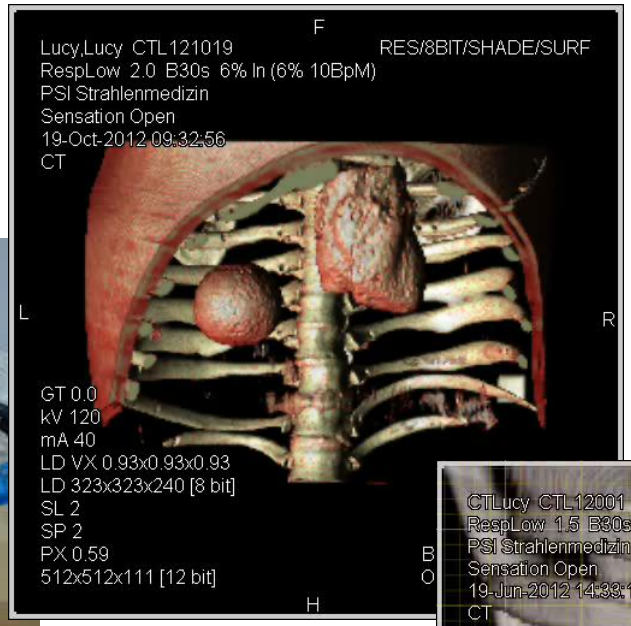
Motion extracted from 4DMRI

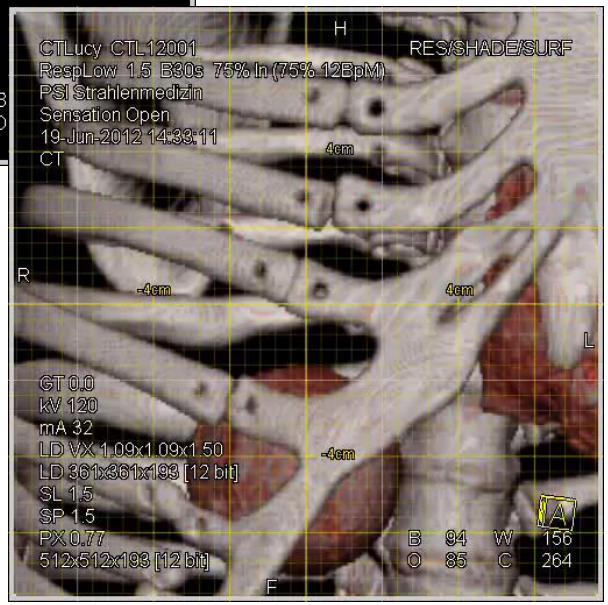


Zhang et al 2013, PMB, 58:8621, Zhang et al 2014,PMB, 59:7793

4D phantoms for motion validation







Colvill et al 2019, Submitted to Phys. Med. Biol.

To summarise

- Proton therapy has a long history at PSI
- By 2020, > 9000 patients have been treated at PSI with excellent clinical results
- Physics applied to medicine played, and still plays, a crucial role in these developments
- Current research concentrates on image guidance, high dose rate delivery, adaptive therapy and motion mitigation
- To get the best from proton therapy, there's still a lot of developments to do…

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For Master/Semester projects in proton therapy, please contact:

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Dr Serena Psoroulas (serena.Psoroulas@psi.ch)