Some elements of discussion about proton imaging

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Proton CT R&D meeting of the MI2B GdR – Nice, April 25, 2013

Main goal of proton radiography and pCT

Reduce range uncertainties in proton therapy

pCT for improved treatment planning
- IMPT not very useful with high range uncertainties
- OARs could be placed behind the Bragg peak!
- Planning directly with pCT images or use pCT to improve stoichiometric calibration of xCT

Proton radiography or pencil beam proton probe for QA
- Give a green light just before the treatment
- Clinical use less obvious than with pCT
- Use for tumour alignment?

Requirements

- Range uncertainties below 2%, 1 mm precision desired
- Spatial resolution less critical (several mm)
- Acquisition + reconstruction in 1 or 2 min
- Cost in the order of 300 k€ (selling price is 3 or 4× as much)
- Dose not higher than with xCT

How does pCT compare to xCT?

Does it beat x-rays? $\rightarrow$ Compare to CT / spectral CT / CBCT

Some comparison criteria:

- range precision
- spatial resolution
- contrast
- dose

Is the technology available? What kind of research is needed?

- Various hardware solutions exist, with components commercially available, but still unclear if robust and good enough
- Some reconstruction tools available
- Share experience:
  - Make data acquired with different systems available to the community, so that they can be reconstructed using different algorithms
  - Use a standard phantom
- Ultimate limits of pCT (and performance comparison with xCT) require further investigation (simulation)
- Clinical research needed

Why pR/pCT still not used in the clinic?

- Not really demonstrated yet
- No dedicated community, lack of specific workshops
- No clear claim from the medical community
- Cost vs expected benefit

Clinical trials could be close enough ($\sim$ 2 years) with a company involved

H&N would be a good application for pCT because of high range uncertainties and anatomical changes. Very tough treatment because of high toxicity $\rightarrow$ high benefit could be obtained.