Conclusions: We have developed and validated exact reconstruction algorithms for the central slice of a CBCT system with independent rotations of the source and the detector.

Materials and Methods: The Phase-II pCT scanner consists of two silicon-strip telescopes that track individual protons before and after the phantom or patient, and a multistage scintillation detector that measures a combination of the residual energy and range of the proton, from which one can derive the water equivalent path length (WEPL) of the protons in the phantom in this preclinical version. The WEPL values and associated paths of protons passing through the object over a full or partial circular scan are processed by an iterative, parallelizable reconstruction algorithm that runs on modern GP-GPU hardware. In order to assess the performance of this scanner, we have conducted extensive beam tests with 200 MeV protons from the synchrotron of the Loma Linda University Medical Center. The first objective of these tests was to demonstrate that the system can produce images of adequate image quality with scanning times under 10 minutes. The second objective was to perform a series of CT scans on a series of QA phantoms and a head phantom. Additional scans are planned to test the range accuracy that can be achieved with pCT of an anthropomorphic phantom head (CIRS, Model HH715).

Results: First tests demonstrated a high sustained rate of data acquisition, exceeding one million protons per second, allowing a full 360° scan to be completed in less than 10 minutes. Reconstruction of the CATPHAN 404 sensometry module verified that accurate reconstruction of the proton relative stopping power in a variety of materials is possible. Systematic reconstruction artifacts due to high-density parts of scanned objects, such as teeth in the head phantom, were absent. All experimental results were accurately predicted by Monte Carlo simulations with Geant4.

Conclusions: Proton CT images accurately reproduce the stopping power of different materials. Furthermore pCT images are free of artifacts from high-density objects.
Subsequently, repeated ARI datasets were acquired for all volunteers wearing their masks (m=10) thus simulating setup for multiple fractions. The total number of datasets was (n x m = 80). Using automatic image-to-image registration displacements of the head relative to the first dataset were calculated.

Results: The process of producing masks from image data proved to be simple and practical. Mask model computation was performed automatically with very little manual intervention. All masks fitted tightly on the volunteers' faces leaving only minimal space for moving and were subjectively assessed comfortable. Displacement calculations resulted in mean overall displacement vector lengths of 1.20 mm (0.53 mm SD).

Figure: Image-based mask model (left); volunteer with printed mask and headrest (right)

Conclusions: By integrating radiological imaging and 3D printing techniques with a dedicated algorithmic data processing we propose a completely new approach to produce individual immobilization devices. Its main advantage is that the mask is produced in a completely contact-free way using radiological image data already acquired for planning. It hence improves patient comfort and reduces psychological stress considerably.

Our analysis of positioning accuracy revealed very good values that are equal or even better than those published for conventional fixation devices. Further research will include careful analysis of interfracti onal setup accuracy in a real clinical scenario. However, in the near future our approach may replace the last manual segment in the modern radiotherapy workflow by an almost fully automated production line.

OC-0413
An international survey of immobilisation of limb extremity soft tissue sarcomas
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Purpose/Objective: Radiation therapy for patients with limb extremity soft tissue sarcoma (STS) requires accurate and reproducible dose delivery. However, patient positioning of limb extremities can be challenging and limited literature or guidance exists for STS immobilisation or imaging. Therefore, we conducted a survey to assess STS current practice, protocols and immobilisation techniques.

Materials and Methods: 82 UK and 20 international radiotherapy centres were invited to complete a questionnaire on STS treatment. Immobilisation issues and imaging protocols for adjuvant and palliative settings were investigated.

Results: 100% UK and 75% international centres completed the survey. Of 74 (90%) UK centres that treat STS, 12%, 41%, 30%, 12% and 5% use 1, 2, 3, 4 and 5 types of immobilisation device for lower limb sarcomas. Vacuum bag plus either foot or ankle support was the most common combination 42/74 (55%). 7%, 27%, 80% and 8% use 0, 1, 2, 3 or 4 types of immobilisation device for upper limb sarcomas, thermoplastic and vacuum bags being the most common devices used. These two devices were also the most commonly used in international centres for both upper and lower limb STS (Table 1). The most common UK set-up tolerance was 5 mm for both radical (45/74, 61%) and palliative (30/74, 41%) treatment, whereas 3 mm for radical (5/15, 33%) and 5 mm for palliative (5/15, 33%) was most common internationally. 21/74 (28%) and 13/74 (18%) UK centres have written protocols for lower and upper limb STS immobilisation; internationally 7/15 (47%) have treatment protocols for both. Surgical clips are currently used by 19/74 (26%) UK centres although 81% reported a preference for future use. 9/15 (60%) of international centres use clips. In the UK, IMRT (32 centres, 26 centres), RapidArc (6, 6), VMAT (13, 12) are used for (lower, upper) STS limb treatment. Internationally, IMRT (10 centres, 9 centres), RapidArc (3, 3), VMAT (4, 4) are used for (lower, upper) limb treatment. In the UK, 27/74 (36%); 25/74 (34%); 12/74 (16%) use kV planar; MV planar; CBCT imaging for the first 3 fractions and then weekly for both upper and lower limb STS. For international, daily imaging was more prevalent with 4/15 (27%); 1/15 (7%); 7/15 (47%) using kV planar; MV planar; CBCT imaging daily. Setup reproducibility was reported as a common problem by 73/74 (99%) and 12/15 (80%) of UK and international centres.

Conclusions: Within both the UK and international centres surveyed, there was no common STS immobilisation technique or imaging protocol. A wide variety of immobilisation devices and configurations are utilised, and the frequency and modality of imaging is similarly diverse. The lack of universal guidance on STS immobilisation and imaging protocols is reflected in the large spread of techniques that are currently implemented. There is scope to develop treatment guidelines for extremity STS to establish site specific best practice.

OC-0414
Evaluating the role of a micro-enema to reduce rectal volume variation and gas during radiotherapy for bladder cancer
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Purpose/Objective: To evaluate the role of an enema in reducing inter-fraction rectal volume variation and gas in bladder cancer patients during RT. The use of laxatives and