effect. The compensators being close to the patient and interfering with the beam is a source of concern as it may be the source for secondary cancers in the patient. The use of scanned proton beams however avoids this problem. We have recently introduced a magnetic scanning option to the SUMO proton system. The current abstract covers the description of this system and reports the first measurements.

Materials and Methods: A set of scanning magnets, positioned downstream of the bending magnet, scans the beam in the x- and y-direction. The system is capable of several techniques for scanning the beam, i.e. spot scanning, line scanning as well as variable scanning. A maximum field size of 30x40 cm can be generated with a dedicated nozzle. The characteristics of the scanning system have been verified in a clinical setting using line scanning with a pencil beam having dimensions of σx=3.6 mm and σy=4.0 mm.

Results: The maximum range in water is 32 g/cm² and the dose rate is limited to 1 Gy/min/litre irradiated volume, regardless of depth. For a simple field the dose uniformity is 2.5 % inside 80 % of the field size using the line scanning delivery mode. The lateral penumbra is 8.5 mm at 230 MeV.

Conclusions: The proton scanning system is capable of replacing the scattered beam delivery mode effectively. High dose rate and fast layer switching is used for optimal conformity. The full field can be delivered with many re-paintings at all layers, even under one breath-hold. To utilize the full extent of the scanning beam system a treatment planning system should be used for the purpose of optimizing the dose distribution using the various parameters that can be optimized.

PO-0888
Patient positioning in a heavy ion gantry
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Purpose/Objective: To develop the HIT heavy ion beam therapy system for patient treatment. The gantry allows rotation of the beam line in 360°, offering the same beam directions available in conventional radiotherapy gantries. First patients were treated with the gantry on November 19th. The gantry carries the complete beam line for high energy ions (large bending magnets, vacuum, imaging, IT and cooling systems) and has a total mass of 670t. Furthermore, the treatment room is built into the gantry structure and rotates during therapy. This leads to structural deformations at different gantry angles, which affect all devices related to patient position. To achieve the precise positioning required for ion-beam therapy, position motion had to be assessed and an overall concept for patient positioning that have to be developed and verified.

Materials and Methods: To determine the range and reproducibility of position deviations, the motion of treatment table, lasers and imaging systems was measured at different gantry angles. Using a tracking laser interferometer, positions of the respective devices were measured in a fixed coordinate system unaffected by gantry motion. Cross checks were done with a three axis translation stage. Based on these measurements, appropriate corrections were introduced to the patient positioning and ion-beam adjustment. Their correct implementation in our treatment planning system and accurately commissioning was described to the simplified workflow when electron field irradiation of both breasts and a boost in the tumour bed with 10 MeV electrons. The Monte Carlo treatment plans were calculated by using Oncentra Masterplan (Version 3.3.1.3).

Results: For both ad-hoc patients, six electron fields were shaped inside the treatment room shortly before irradiation, keeping the overall treatment time below one hour. The dose prescription for these irregular fields was verified after the first fraction with Gafchromic Films and the maximum discrepancy between expected and measured dose was approximately 5%. In the case of breast irradiation, the applicators and the EMLC generate comparable PTV dose coverage, although the mean dose produced with the EMLC is about 4% lower. The EMLC mean dose to the lungs is about 20% higher than the one with the applicator. Also in the case of the rib metastasis, the dose conformance obtained with the EMLC was comparable to the one generated by the common applicator. In both plans, due to a larger penumbra, the margins for defining the applicator field with the EMLC were about 3 mm broader than those used for conventional cut-outs.

Conclusions: We conclude that the simplified workflow in the clinical routine and the satisfactory tumour coverage encourage the use of the EMLC for fixed-beam electron therapy. These results represent a first step towards the clinical implementation of electron IMRT.
determine the amplitude of organ/target motion, prior to each SBRT fraction, a 4D MR technique, relying on retrospective image analysis of fast cine MR data, was developed. 4D image studies were generated by sorting and binning image data as a function of anatomical structures’ motion phase/amplitude. To test and validate the technique, patient and volunteer data was acquired on a 3T Siemens Verio MR scanner using a TurboFLASH sequence with an in-plane and temporal resolution of 1x1 mm² and 4 frames/sec, respectively. Regarding patient treatment planning, VMAT plans were generated using our CT model for comparison. To perform dose computations for the MR-based plans, bulk electron density values were assigned to organ structures (i.e. soft-tissue, lung).

**Results:** The 4D MR method was successfully benchmarked against 4D CT/CBCT and cine MR using liver clinical data from patients treated with abdominal compression and free breathing. The system-related (i.e. B0 inhomogeneities, gradient non-linearities) and the patient-induced (i.e. susceptibility) distortions were fully quantified using phantom measurements and numerical simulations, respectively. MR-only plans were found to be in good agreement with the corresponding CT-based plans. The comparison was performed using a TCP-based plan ranking tool.

**Conclusions:** An MRI-guided SBRT procedure was investigated for liver patients. The study included the development of a) an MR-based treatment planning process and b) a 4D MR method for daily patient setup verification. The MR-SBRT workflow is expected to be integrated on the linac-MR on rails platform.

**PO-0891**

Monte Carlo investigation into feasibility and dosimetry of Flat Flattening Filter Free (F4) beams

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**Purpose/Objective:** Flattening filter free (FFF) beams became commercially available recently and generated considerable interest in radiotherapy due to their high dose rate and unique dosimetric characteristics. However, due to their non-uniformity, FFF beams are sub-optimal for larger field sizes. The purpose of this study was to consider potential modifications to the incident electron beam parameters (and linac head components) that would produce Flat FFF (F4) radiotherapy beams without the use of flattening filter.

**Materials and Methods:** Monte Carlo (MC) simulations with BEAMnrc/DOSXYZnrc codes have been performed to evaluate the feasibility of this approach. The dose distributions in water for open 6MV beams were simulated using our model of a Varian 21EX linac head. This model will be called Flattening Filter (FF) model further in the text. Flattening filter has then been removed from FF model, while other components remained intact. MC simulations were performed using (1) 6 MeV electrons incident on the target with the same parameters as used in FF model, (2) 6 MeV electron beam with electron angular distribution optimized to provide flat dose profile. Configuration (1) represents FFF beam while configuration (2) produced a Flat FFF (F4) beam.

**Results:** Figure 1 shows diagonal profiles modeled for each of the beams at the depth of maximum dose (dmax) and normalized at the beam central axis. Profiles demonstrate that F4 beam greatly improved flatness of the FFF beam. For example, at 15 cm off-axis the dose increased from 62% for FFF to 96% for F4 beam. At 20 cm off-axis the dose increased from 52% to 92%. Also, importantly, compared to FF the out-of-field dose was reduced by about a factor of two for F4 beam, similar to that for FFF beam. Profiles of F4 beams did not change significantly with depth, unlike profiles of conventional FF beams. This is expected, as very little off-axis photon spectral variation exists in these beams, and was previously shown for FFF beams. Percentage depth doses (PDDs) were also calculated for these beams demonstrating that PDDs for F4 beams are similar to those of FFF beam, but slightly more penetrating. All FFF beams show less penetration compared to conventional 6MV FF beam.

**Conclusions:** Up to field sizes of 35x35 cm² profiles achieved for F4 beam at dmax are actually slightly flatter than profiles of conventional FF beam (though the dose off - axis is reduced rather than increased). F4 beam also demonstrated very little change of profile shape with depth. Therefore on average, through phantom depths, flatness of these beams can be considerable compared. Compared to FF, F4 beam considerably reduced out-of-field dose.

**Figure 1.** Diagonal dose profiles in water measured at dmax for Varian21EX linac and also calculated using our MC 21EX model for: open 40x40 cm² 6MV beam, open 40x40 cm² 6MV FFF beam, open 40x40 cm² 6MV F4 beam with optimized angular distribution incident of electrons (F4).

**PO-0892**

CancerData.org: open source biomedical data sharing to facilitate oncological research

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**Purpose/Objective:** The human genome project has demonstrated that the concept of open data tremendously stimulates research and additionally increases citation of the concerned paper. Therefore, we decided to build a platform to allow downloading and sharing of (pre-)clinical imaging and other biomedical datasets. Our immediate aim is to demonstrate the proof of concept with various (pre)clinical types of radiotherapy-related data.

**Materials and Methods:** Using free and open source software only, we have set up a DICOM image archive and data storage for metadata among others. The platform is built using the CaBIG software developed by the NCI, which offers a grid-enabled DICOM store. Data collections can be offered publicly or kept in a private collection if needed. To upload DICOM datasets, remote centres are using the RSNA Clinical Trial Processor (CTP) so that data is being sent over the internet in a de-identified manner. CTP configuration files have been defined to facilitate centre and collection specific de-identification, together with unique coding to guarantee that the uploaded images are stored in the proper collections. Windows and Linux based virtual machines have been created that use default web protocols to make sure the institutions firewalls do not block the transfer. Data can be collected in a shop-style basket and downloaded using an operating system independent download manager. Presentation of collection metadata and download of non-DICOM datasets is offered by integrating the site in a Drupal content management system with additional data handling modules.

**Results:** We have set up the CancerData.org site and integrated it into the CaBIG-enabled grid of Biomedical Imaging Archives. Private