were found to be enough to ensure a local gamma (3%,3mm) delivered dose. In our case three different (DLG,TF) couples can lead to significantly different from typical values. Because of this within the same district can arise when target volumes are H&N ones. Despite this rough classification, some differences (DLG,TF) needed to ensure the acceptance of all plans.

Conclusion: Our work shows that a single optimal couple (DLG,TF) can not be found for all possible clinical plans, but three MLC configurations can be enough to ensure the accuracy of delivered dose. A method to identify the group of MLC configurations is proposed together with indications about how to identify the appropriate couple to be used for any plan.

PO-0832 Preliminary scanning water phantom data for beam characterisation of a hybrid MRI-Linac
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Material and Methods: An Elekta MR-Linac (MRL) prototype has been installed at the author’s institute, combining 1.5 T magnetic resonance imaging (Philips) with linear accelerator treatment (Elekta). A novel method for alignment and use of a scanning water phantom has been established. The first data of sufficient precision and quantity to characterize the beam has been acquired in a 1.5 T magnetic field for the purposes of beam modelling and/or beam verification.

Material and Methods: The isocentre is located at 143.5 cm from the linac target and is within an enclosed MRI-like bore which affects the use of a water phantom. A prototype MR-compatible water phantom (PTW) was used to acquire percentage depth doses, inline and crossline scans, relative output factors and collimator scatter factors with a C404 ion chamber (IBA) and a micro-diamond detector (PTW). An exit PDD showing the electron return effect was also acquired. Position and orientation of the phantom was established using radio-opaque markers and a gantry-mounted electronic portal imaging device. Linac-specific parameters such as gantry tilt, EPID rotation and isocentre location were independently checked using the water phantom.

Results: The beam energy is consistent with a nominal 7.3 MV photon beam (TRF 0.702), however the depth of maximum dose is 13 mm, closer to the surface than in a standard field due to the 1.5 T magnetic field. Inplane profiles are generally consistent with those of a standard flattening-filter-free beam, however the crossline profiles are clearly distinct with an off-axis shift and asymmetric penumbra shoulders and feet due to the Lorentz force of the magnetic field on the secondary electrons. Small field data were acquired taking into account the dose-shift due to the magnetic field.

The relative output factors are consistent with those from a standard FFF beam, with no evidence of abnormal variation for small fields. Final results will be presented.

Conclusion: Practical use of a scanning water tank has been established in an MRL. The data presented here comprises the first substantial collection of MRL data that can be used for beam characterisation. The dataset is suitable for calculating relative doses and testing planning system model performance in a 1.5 T magnetic field.

PO-0833 Measured neutron spectra & dose: craniospinal irradiation on single-room passively scattered proton
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Purpose or Objective: Secondary neutron dose is of particular concern in proton craniospinal irradiation (CSI) as this treatment is primarily used to treat children and adolescents, who are at significant risk of developing radiation-related late effects. While Monte Carlo techniques have been used to calculate such data for proton CSI, doses that are based on spectra measurements are lacking in the literature. Furthermore, the existing data are only reported for one of the proton beamline manufacturers. Given that doses from externally generated neutrons are highly dependent on the design of the proton therapy machine itself and treatment-specific devices within the beamline, there is a need to report doses for all beamlines used to treat proton CSI. Single-room compact proton systems are particularly noteworthy as many units are currently operational and more are being commissioned and installed. Therefore, the objectives of the present study, for a typical passively scattered proton CSI treatment, were to measure the secondary neutron spectra and calculate dose equivalents for neutrons delivered via a single-room compact system.

Material and Methods: Secondary neutron spectra were measured using extended-range Bonner spheres for three different clinical CSI proton fields, including their respective brass apertures: whole brain, upper spine, and lower spine. For each field, measurements were repeated with an active scintillator and 18 different moderating. Measurements were performed with a water phantom at isocenter and the detector located at 50 cm from the isocenter along the patient plane. For each set of measurements, neutron spectra were determined by mathematical deconvolution of detector count rates. Ambient dose equivalents [H*(10)] were calculated using ICRP-74 conversion coefficients to the fluence spectra.

Results: The measured neutron spectral fluence and H*(10) for each field are shown in Figure 1a and 1b, respectively. The energy distributions for each of the fluence spectra were similar, with a high-energy direct neutron peak, an evaporation peak, a thermal peak, and an intermediate continuum between the evaporation and thermal peaks. Neutrons in the evaporation peak made the largest contribution to the dose equivalent. The, H*(10) in mSv per proton Gy to isocenter were 3.94, 2.79, and 2.71 respectively, for the brain, upper spine, and lower spine fields. Neutron fluence and H*(10) were approximately 1.6 times higher for the brain field than for the spine fields, which is attributed to the greater range and modulation for the brain field than for the spine fields.
Conclusion: We measured neutron spectra and calculated neutron dose equivalents for a clinical treatment for a single gantry proton system, whose use and planned installations have recently increased. Data reported here are consistent with dose equivalents reported for CSI carried out with other proton therapy beamlines.

PO-0834
Calibrating absolute malignant induction probabilities into life-time attributable risk
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Purpose or Objective: More than half of cancer patients receive radiotherapy for radical or palliative purposes. Increasing survival rates in cancer patients make it important to study late side-effects, including secondary radiation-induced cancers. Although a number of predictive models exist, the absolute accuracy of these models in the radiotherapy dose range is limited partly due to scarcity of data and partly by extrapolation beyond historical data bounds. The aim of this work is to investigate conversion of malignant induction probabilities, which provide useful relative risk estimates, into absolute life time attributable risk estimates (LAR) and excess absolute risk (EAR) by calibrating and benchmarking our models using published outcome data.

Material and Methods: An in-house modelling tool, which calculates voxelwise risk estimates from patient-specific 3D dose distributions, was modified to generate linear-no-threshold (LNT) model-based risk estimates for the whole body and per organ using organ-equivalent dose. Second cancer risk was calculated for uniform whole-body exposure of 0.1 Gy for comparison with tabulated BEIR VII data. Model parameters initially used were taken from existing published reports for the relevant models. The calculated LAR was then compared to the BEIR VII result and the linear coefficient, λ, was adjusted to make the model prediction better match the BEIR VII result. A similar calibration of parameters was then performed for the linear quadratic (LQ) and linear model (LIN) malignant induction coefficients. EAR was calculated for a dose range to compare results with published data.

Results: After calibration, calculations of LAR for single uniform exposure of 0.1 Gy produced a value of 837 cases per 100,000 for an exposure at age of 40, in comparison to 824 according to BEIR VII report. Averaging over ages at exposure of 20 to 80 produced a value within 5% of the BEIR VII report. Calculations of EAR for a dose range relevant to RT of 1-6 Gy using the LIN model were always within the range of uncertainty due to differences in RBE neutron value in the independent published Hodgkin Lymphoma data (Schneider et al, 2008).

Conclusion: These results show that our models can produce absolute LAR estimates for secondary cancer which are consistent with the values reported in the BEIR VII report for uniform irradiation to 0.1Gy. The comparison of our results of EAR using LIN model to published data showed agreement with independent published data of HL.

PO-0835
A system for measuring and calculating neutron doses in paediatric proton patients
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Purpose or Objective: There is increased use of proton therapy in pediatric cancer patients. In treatment planning, neutrons produced in the treatment delivery system and the patient are usually ignored and not documented. The goal of this ongoing project is to develop and establish a system for measuring and simulating 3D neutron and gamma radiation fields of passively scattered and actively scanned proton beams using representative clinical proton fields impinging on tissue-equivalent phantom materials. Eventually this should lead to a standardized approach for calculating organ neutron doses in paediatric proton patients.

Material and Methods: The neutron dosimetry consists of neutron and gamma fluence measurements with an array of three organic scintillators positioned 70-80 cm lateral to blocks of tissue equivalent materials (soft tissue and compact...