136(68%) and residual abnormality either clinical or radiological were seen in 64(32%). Immediate salvage surgery was carried out in 38(60%) patients with progressive residual disease who were fit. Eight (21%) had no pathological residual disease (ypT0). Surgery was withheld in further 8 (4%) out of 64 without progression of residual abnormality. Those with cCR 116(85%) maintained complete response. Sixteen (11.7%) developed local relapse after cCR. Early staged tumors respond better with less local and total relapse. At median follow up of 2.49 months following completion of treatment; complete remission was achieved in 160 (80%) patients , 12(6%) had asymptomatic static disease and 28 (14%) had progressive residual disease but not fit for salvage surgery due to age or medical co-morbidity. The main toxicity was bleeding occurring in 30% of cases and 10% needed argon beam. Organ preservation for the whole group was achieved in 158 (79%). Overall Survival (94% vs. 76%) [p=0.02] was better for responders (cCR +SD) at 2 years.

Conclusion: CBX (Papillon) boost reduced local recurrence to 11.7% after achieving cCR compared to 30-40% in those who had EBCRT alone. Organ preservation of 79% for the whole group is much higher than any ‘watch and wait’ studies with 40% published so far. A randomised trial OPERA has been set up to evaluate this further. Papillon has acceptable toxicity and is now recommended by NICE for patients not suitable for surgery. Papillon should be consider as a treatment option for elderly patients with early rectal cancer.

OC-0284
PD-L1 inhibition improves response of pancreatic cancer to radiotherapy
A. Azad1, Z. D’Costa1, S.Y. Lim1, O. Sansom2, W.G. McKenna1, R. Muschel1, E. Fokas1
1CRUK/MRC Institute for Radiation Oncology University of Oxford, Department of Oncology, Oxford, United Kingdom
1Cancer Research UK Beatson Institute-, Glasgow- Institute of Cancer Sciences- University of Glasgow, Glasgow, United Kingdom

Purpose or Objective: The programmed death ligand 1 (PD-L1) plays a key role in tumour progression and metastasis of pancreatic ductal adenocarcinoma (PDAC). Although recent preclinical studies have explored the radiosensitising potential of PD-1/PD-L1 inhibitors, the effect of PD-L1 blockade on the response of PDAC to radiotherapy remains unexplored.

Material and Methods: Herein, we investigated the influence of an anti-PD-L1 mAb on the tumour response to single dose and fractionated radiotherapy, and chemotherapy with gemcitabine and capecitabine.

Results: In-vitro, radiation and chemotherapy resulted in PD-L1 upregulation in both human (PSN-1) and murine (KPC-derived, Pan02) PDAC cells, although variability was observed. Exposure to conditioned media from pre-treated cells did not alter PD-L1 expression. In-vivo, PD-L1 was also upregulated in the tumour microenvironment after radiation and chemotherapy in the KPC-derived and Pan02 syngeneic mouse models. Similarly, chemotherapy induced PD-L1 upregulation in the KPC (Pdx1Cre, KRASG12D/+), P53R172Hv/+), a genetically-engineered mouse model of pancreatic cancer. In-vitro, PD-L1 blockade failed to radio- or chemosensitise PDAC cells. The anti-PD-L1 mAb significantly improved tumour response after irradiation in the KPC and Pan02 syngeneic mouse models. This effect was mediated by a cytotoxic T cell-dependent mechanism, whereas blockade of CD8+ cells attenuated the radiosensitising potential of anti-PD-L1. The effect of scheduling of anti-PD-L1 mAb with radiotherapy (concomitant vs sequential) was also investigated. Finally, we assessed the intratumoural and systemic expression of several immune markers (CD45: CD8, CD4, CD19, NK1.1, CD11b Gr1, Ly6G, CXCR2, FOXP3, IFN-γ) after the different treatments.

Conclusion: Altogether, our findings support PD-L1 inhibition in combination with radiation as a promising approach in the treatment of PDAC.

OC-0285
Experimental benchmarking of a probe-format calorimeter for use as an absolute clinical dosimeter
J. Renaud1, A. Sarlehnia1, J. Seuntjens1
1McGill University, Medical Physics Unit, Montreal, Canada

Purpose or Objective: In this work, the design, fabrication, and operation of a small-scale graphite calorimeter probe (GPC) developed for use as a practical clinical dosimeter, is described. Similar in size and shape to a Farmer-type cylindrical ionization chamber, the GPC represents the first translation of calorimetry from the primary standards dosimetry laboratory to the radiotherapy clinic. Providing a measure of absolute dose, its purpose is to help meet the clinical need for accurate reference dosimetry in non-standard fields without the need for calibration.

Material and Methods: Based on a numerically-optimized design obtained in previous work, a functioning prototype capable of two independent modes of operation (constant-power & constant-temperature) was constructed in-house. In constant-power mode, the radiation-induced temperature rise, \( \Delta T \), is measured in the sensitive volume (i.e. the core) while the outermost portion of the device is thermally stabilized by a software-based temperature controller. In constant-temperature mode, the entire device is subject to active thermal control and the quantity of interest is the electrical power, \( \Delta P \), necessary to maintain a stable temperature while irradiated. Absorbed dose to water measurements were performed in a water phantom, under standard conditions, using both GPC operation modes in a 6 MV photon beam and subsequently compared to dose to water measurements derived using a reference-class ionization chamber (Exradin A12). Linearity, dose rate, and field size dependence were evaluated by varying the irradiation period, the linac repetition rate, and primary collimating jaw settings, respectively.

Results: Compared to the chamber-derived dose to water of 0.765 cGy/MU, the average GPC-measured doses were 0.765 ± 0.005 (n = 25) and 0.767 ± 0.005 (n = 32) cGy/MU for the constant-power and constant-temperature modes, respectively. The linearity of the detector response was characterized by an adjusted R² value of 0.9996 (n = 40), and no statistically-significant dose rate dependence for rates greater than 1.8 Gy/min was observed. For lower dose rates, an over response of 1.7 % was attributed to the resolution of
the current-driven temperature controller. No field size dependence was observed down to 2 x 2 cm².

### Table I. Estimated uncertainty budget for the GPC’s constant power and constant temperature modes of operation in high-energy photon absolute dose to water measurements.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Constant power mode</th>
<th>Constant temperature mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type A (%)</td>
<td>Type B (%)</td>
</tr>
<tr>
<td>Heat transfer</td>
<td>–</td>
<td>0.3</td>
</tr>
<tr>
<td>Reproducibility</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Bridge calibration</td>
<td>–</td>
<td>0.1</td>
</tr>
<tr>
<td>Thermistor calibration</td>
<td>–</td>
<td>0.2</td>
</tr>
<tr>
<td>Electrical power</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Specific heat capacity</td>
<td>–</td>
<td>0.8</td>
</tr>
<tr>
<td>Mass</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Positioning</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Perturbation-dose conversion</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Other not considered</td>
<td>–</td>
<td>0.3</td>
</tr>
<tr>
<td>Quadratic summation</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Combined uncertainty</td>
<td>1.2</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Conclusion:** This work demonstrates the feasibility of using an ion chamber-sized calorimeter as a practical means of measuring absolute dose to water in the radiotherapy clinic. The potential introduction of calorimetry into the clinical setting is significant as this fundamental technique has formed the basis of absorbed dose standards in many countries for decades. Considered as the most direct means of measuring dose, a “calorimeter for the people” could play an important role in solving the major challenges of contemporary dosimetry. In particular, investigations into the use of the GPC for MR-linac dosimetry are currently underway.

**OC-0286**

**From pixel to print: clinical implementation of 3D-printing in electron beam therapy for skin cancer**

R. Canters¹, I. Lips¹, M. Van Zeeland¹, M. Kusters¹, M. Wendling¹, R. Gerritsen¹, P. Poortmans¹, C. Verhoef¹
¹Radboud University Medical Center, Radiation oncology, Nijmegen, The Netherlands
²Radboud University Medical Center, Dermatology, Nijmegen, The Netherlands

**Purpose or Objective:** Build-up material is commonly used in electron beam radiation therapy to overcome the skin sparing effect and to homogenise the dose distribution in case of irregular skin surfaces. Often, an individualised bolus is necessary. This process is complex and highly labour-intensive, while adaptation of the bolus is time consuming. We implemented a new clinical workflow in which the bolus is designed on the CT scan in the treatment planning system (TPS). Subsequently a cast with the bolus shape is 3D-printed and filled with silicone rubber to create the bolus itself [1].

**Material and Methods:** In the new workflow (figure 1), a patient-specific bolus is designed in the TPS. A 2 mm expansion is used to create a cast around the bolus. Subsequently, this cast is smoothed to remove CT scan resolution effects. After conversion to a stereolithography file, the cast is printed in polylactic acid (PLA) with a filament printer and filled with silicone rubber. After removal of the PLA cast, the bolus is ready for clinical use.

Before clinical implementation we performed a planning study with 11 patients to evaluate the difference in tumour coverage with a 3D-print bolus in comparison to the clinically delivered plan with a manually created bolus. During clinical implementation of the 3D-print workflow, for 7 patients a second CT-scan with the 3D-print bolus in position was made to assess its geometrical accuracy and the resulting dose distribution.

**Results:** The planning study showed at least equal coverage of GTV and CTV: V95% of the GTV was on average 97% (3D-print) vs 84% (conventional). V85% of the CTV was on average 97% (3D-print) vs 88% (conventional). Geometric comparison of the 3D-print bolus to the originally contoured bolus showed a high similarity (mean dice similarity coefficient of 0.87 (range 0.81 to 0.95)).

Comparison of the dose distributions at the planning CT scan to dose distributions at the second CT scan with the 3D print bolus in position showed only small differences (median difference in V95% GTV and V85% CTV of 0% (interquartile range: -12% to 0%) and -1.6% (interquartile range: -3.8 to 0.5%), respectively).

Time efficiency of the 3D-print workflow is likely to increase in comparison to the conventional workflow, with one less patient visit, and up to 3 hours less mould room time.

**Conclusion:** The implemented workflow is feasible, patient friendly, safe, and results in high quality dose distributions. This new technique increases time efficiency and logistically aligns electron with photon external beam treatments.

**Figure 1:** Illustration of the clinically implemented 3D-print workflow with designed bolus(A) and cast around the bolus(B) at the planning CT scan, smoothed cast (C), 3D model of the cast (D), printed cast (E) and silicone rubber final bolus (F).

**SP-0287**

**How to finish your residency / PhD project with a job offer**

S. Rivera

Institut Gustave Roussy, Villejuif, France

Radiation oncology is a rapidly evolving profession requiring continuous learning on the top of all routine activities. Residency is a unique period in a professional life where the main objective is to learn. Residency is full of research and educational opportunities for young radiation oncologists to gain know-how and expertise in clinical practice, patient care, fundamental, translational and/or clinical research and innovative technologies in the various aspects of our specialty. Through local, national and international programs, trainees gain valuable clinical and research experience and skills during and rapidly get the opportunity to disseminate information and update colleagues in their home institution. Playing a proactive role in the training will not only give access to the best training opportunities but will motivate as well supervisors in supporting trainee’s career development.

In a competitive world with limited resources, building up a good curriculum vitae with a number of publications and presentations is a major advantage that should be...