Purpose or Objective
MR simulation can facilitate target volume delineation for prostate irradiation. Registration of this MR to the planning CT is hampered by variations in endorectal balloon (ERB) positioning. In this study, the ERB position on MR was compared to planning CT and CBCT.

Material and Methods
ERB positioning was evaluated for 21 patients that underwent primary prostate irradiation in 28 fractions. Treatment simulation was done using CT and 3T MR imaging. The ERB was filled with 100 cc air during CT and treatment, and 100 cc water on MR. The MR protocol contained a 3D T1 VIBE sequence to visualize gold markers. For 20 patients, this scan was matched to the planning CT using a rigid marker match in Mirada Medical (Oxford, UK). For the remaining patient, this was impossible due to a missing marker. Most patients underwent online EPID during treatment. However, 5 patients underwent online CBCT. For these patients, the first CBCT of every week was collected, assembling a total of 35 CBCT sets.

The target volume and organs at risk (including ERB) were manually delineated on the planning CT by a radiation oncologist. For this study, the ERB was also delineated on MR (manually) and CBCT images (region growing). All images were registered to the planning CT using the clinical match (rigid marker match for MR, bone plus mask match in XVI for CBCT). The center-of-mass of each ERB was determined and compared to the treatment isocenter.

Results
On MR, the mean deviations in ERB position with respect to CT were -0.3 ± 2.1 mm in left-right (LR), 0.0 ± 3.5 mm in anteroposterior (AP), and 8.9 ± 7.4 mm in superoinferior (SI) direction. For CBCT, the mean deviations were 0.1 ± 1.9, 0.1 ± 2.7, and -1.7 ± 5.3 mm, respectively. Box plots are shown in Figure 1.
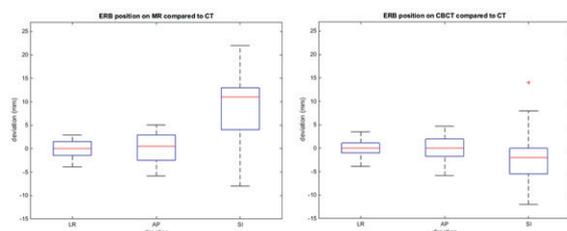

Figure 1: Box plots showing median deviations and interquartile ranges for the ERB position.

Figure 2 shows MR and CT images for the patient with the largest deviation (22 mm) in balloon insertion depth (SI direction). Prostate, bladder and rectal wall were delineated on the matched MR as well. As can be seen from the dose overlay on CT, the prostate (CTV) was still covered with the ERB positioned as on MR. Minimum, mean and max dose for prostate were identical on CT and MR, as was the max bladder dose. Rectal max dose was 0.2 Gy higher for the MR delineation.
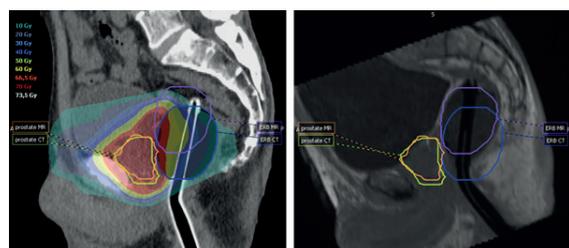

Figure 2: CT and MR images with dose overlay and delineations for worst-case deviation in ERB insertion depth.

Conclusion
ERB position on MR as compared to CT was consistent in LR and AP direction. Balloon insertion depth (deviation in SI direction) was less reproducible. These deviations were mitigated on CBCT imaging, indicating that dosimetric influence is small. The elaborated worst-case scenario showed this as well. However, in order to fully benefit from delineation on MR, the discrepancies found should be investigated further. These could be due to anatomical variations such as bladder and rectum filling, but also to differences in image registration, ERB filling, or scan/treatment time, for example.

Poster: RTT track: Treatment planning and dose calculation / QC and QA

PO-1068 ADSCAN: Feasibility of implementing adequate technology for a 'pick the winner' trial in lung cancer
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Purpose or Objective
ADSCaN (Accelerated, Dose-escalated, Sequential Chemo-Radiotherapy in Non-small cell lung Cancer (NSCLC); ISRCTN47674500) is a randomised phase II study comparing four radiotherapy (RT) regimes for NSCLC (CHART-ED ISRCTN 45918260, IDEAL ISRCTN 12155469, I-START ISRCTN 74841904 and ISOTOXIC IMRT NCT01836692) to standard of 55 Gy in 20 fractions. ADSCaN will use a 'pick the winner' approach to select one of the regimes for phase III testing. Each regime was developed through a separate early phase clinical trials with different imaging and planning requirements which were carried forward into the ADSCaN study. Centres can choose which investigational arm they are willing to participate in and it is essential to ensure that all centres meet protocol criteria. We report the planning and imaging techniques used for ADSCaN and evaluate the feasibility of centre compliance with ADSCaN technology requirements.

Material and Methods
A facility questionnaire (FQ) was sent to 40 ADSCaN centres investigating planning and imaging techniques as part of the radiotherapy quality assurance (RTQA) programme. The results of the FQ showing the available planning and imaging techniques were compared to

minimum requirements for each investigational arm. 4DCT and 3DCBCT are mandated. IMRT is encouraged throughout all of the arms, except for Isotoxic IMRT, where it is mandated. A minimum of imaging on fractions 1-3 and then weekly is required. Isotoxic IMRT arm mandates per fraction imaging. Gating techniques are optional.

Results
Between January and May 2016, 32 FQ were returned (80%). The results are shown in table 1. 28 centres will use 4DCT and 3 centres are commissioning it. Only 1 centre will need to implement 4DCT. IMRT and VMAT are used for lung patients in 17/32 centres. 7 centres will implement IMRT. The majority (27/32) uses 3DCBCT and 6/27 centres , have implemented 4D-CBCT for a selection of patients. 2 centres will implement 3DCBCT to join the trial. Participation in ADSCaN will require the implementation of per-fraction imaging in 13 centres. This represents only a change in the frequency of treatment imaging in all centres, which are already performing imaging as part of local protocols, and was therefore considered a minor change in clinical practice. Overall 7 centres out of 32 will implement new techniques to participate in ADSCaN.

Table 1: Frequencies (n) of centres - Facility questionnaire results								
4DCT		**Treatment technique**		**CBCT**		**CBCT frequency**		**Gating techniques**
Not commissioned	1	3D-CRT	13	Not used	2	1st 3# then weekly	19	
In the process of commissioning	3	Step and Shoot IMRT	16	3D-CBCT for a subset of patients	1			Yes 6
Used for a selection of patients	16	Sliding window IMRT	9	3D-CBCT for all radical patients	27	Daily	9	
Used for all patients	12	VMAT	13	4D-CBCT for a subset of patients	8			No 26
				4D-CBCT for all radical patients	0	Other	4	
Total	32	Total	51	Total	38	Total	28	Total 6

Conclusion
The FQ is an essential component of the ADSCaN QA programme. It allows the availability of the planning and imaging requirements for the different arms to be determined across the centres. Although the plan ning and imaging techniques differ across centres, the FQ res ults have shown that the majority will not have to substantially change their current practice to join ADSCaN. Measures are in place to ensure that centres participating in more than one arm provide identical levels of planning and imaging techniques for all arms, reducing the risk of bias. Future developments to the FQ will allow for streamlining of QA across other lung trials.

PO-1069 VMAT-SIB treatment Auto-Planning for breast with locoregional lymph nodes in breathhold.
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Purpose or Objective
Adjuvant locoregional radiotherapy (RT) has shown to decrease the risk of locoregional recurrence and breast cancer mortality in node positive patients. Unfortunately, it has side effects, such as fibrosis, cardiac and pulmonary toxicity, impaired shoulder function and the induction of secondary malignancies. The introduction of the ESTRO guidelines for delineation displayed that target volumes, with the conventional technique, were not adequately covered. Besides, that technique was not compatible with respiratory control. Our purpose was to develop a volumetric modulated arc therapy (VMAT)

treatment technique for locoregional irradiation of the breast including a simultaneous integrated boost (SIB) to the tumourbed, that creates conformal and homogeneous treatment plans, with adequate coverage of the target volume and low doses to the organs at risk (OARs). This technique should be compatible with respiratory control and should take into account changes in the shape of the breast during treatment.

Material and Methods
Ten left-sided breast cancer patients with an indication for locoregional RT and a boost to the tumourbed, underwent a CT-scan (3 mm slice thickness) with voluntary deep inspiration breathhold. The treatment plans were created in the Pinnacle[3] treatment planning system, (v. 9.10 with the Auto-Planning (A-P) module) using 6 and/or 10 MV VMAT-arcs. Treatment was delivered on an Elekta linac with Agility collimator. For each patient the CTV encompassed the breast and lymph node regions I-IV. Delineation was done according to the ESTRO guidelines. A margin of 7 mm was used to generate the planning target volume (PTV). The following OARs were contoured: lungs, heart, contra lateral breast, thyroid and esophagus. Prescription dose was 45.57/55.86 Gy in 21 fractions, 5 times a week. A butterfly-VMAT technique was used, combined with 2 extra arcs that only contributed to the boost. Table 1 shows the settings used for A-P. To ascertain a beam aperture width sufficient to account for swelling of the breast, for example increasing seroma or edema, a virtual contour exterior of the breast is created for treatment planning.

Auto-Planning settings					
Max Iterations			50		
Engine type			Biological		
Tuning Balance			0%		
Dose Fall Off Margin			2.6cm		
Hot-Spot Maximum Goal			107%		
Use Cold-Spot ROIs			No		
Target Optimization Goals					
PTV_Local			45.57 Gy		
PTV_4557 – PTV_Local			45.57 Gy		
PTV_5586			55.86 Gy		
OAR Optimization Goals					
ROI	Type	Dose (Gy)	Volume (%)	Priority	Compromise
Lung (Ipsilat) - PTV	Max Dose	10		Low	√
Lung (Ipsilat) - PTV	Max DVH	20	20	Low	√
Lung (Ipsilat) - PTV	Mean Dose	7		Low	√
Lung (contra lateral)	Max Dose	2		Low	√
Lung (contra lateral)	Mean Dose	1		Low	√
Heart	Max Dose	2		Medium	√
Heart	Mean Dose	1		Medium	√
Body-(PTV4557+15mm)	Max Dose	44		Low	√
Body-(PTV4557+15mm)	Max DVH	40	5	Low	√
LungHelp	Max Dose	40		Low	√
Contra lateral breast	Max Dose	1		Low	√
Esophagus	Max Dose	40		Low	√
Thyroid	Mean Dose	18		Low	√

Table 1: Auto-Planning settings.
The structure called "LungHelp" is a contour inside the lung, surrounding the PTV boost, created to further reduces the dose in the lungs.

The quality of the plans was evaluated by the target coverage, conformation index (CI) and the homogeneity index (HI) of the PTVs and clinical dose of the OARs.

Results
All A-P plans needed a warm restart to fulfill the clinical dose criteria of OARs and PTV coverage. Adding an objective was mostly sufficient, though sometimes it was necessary to restart A-P with a higher priority for a ROI. Table 2 shows the average dose results for 10 patients.