




Australian Government
**Australian Radiation Protection
and Nuclear Safety Agency**



ACDS in Review

January 2019 – June 2020



This report is compiled as part of ARPANSA's work to promote patient safety in radiotherapy and diagnostic radiology as outlined in the 2019-20 Health Portfolio Budget Statements.

This review is a summary of activity from 1 January 2019 to 30 June 2020 as we transition to financial year reporting. Information in this publication is current as of 30 June 2020.

Welcome to the latest edition of the *ACDS in Review*; a publication of the Australian Clinical Dosimetry Service.

This review marks the first of our New Zealand audits, and our national dosimetry audit program now provides data for benchmarking across both Australia and New Zealand, with the National dataset now referred to as the Australia and New Zealand dataset (ANZ dataset). On 9 November 2020 we acknowledge 10 years since the inception of ARPANSA's ACDS.

Development of the SABR, SRS, online adaptive radiotherapy and MR-Linac end-to-end testing has been the focus of the past 2 years, as we actively work towards developing audits that keep up with the pace of developments in Radiation Therapy. Working with the technical support of the Clinical Advisory Group (CAG) and the oversight of the ACDS Oversight Committee (AOC), we look towards moving these audits out of field trial. As always, we are grateful to the radiotherapy departments who actively engage in the field trial process as we strive to support safe innovation in patient treatment.

Of course, in the midst of this, in 2020, we were challenged by the global impact of COVID-19. The significance of working with border closures and lockdown will not be lost on our readers. We continued to share our work through conference presentations and engaging with the TEAP program.

We said goodbye to Jessica Lye in June 2020 as she stepped away from the role of ACDS Director to take up a clinical position at the Olivia Newton-John Cancer Wellness and Research Centre. Jess has been a key member of the ACDS team since its inception in 2011. Rhonda Brown was appointed the new ACDS Acting Director and warmly welcomed by the team (Rhonda has since been confirmed in the substantive role as ACDS Director from December 2020).

It is the role and responsibility of the ACDS to continue to share our findings with the radiation oncology community in order to support patient safety and accuracy of treatment delivery in radiation therapy. We hope in these pages that you find information that supports best practice and is useful to potential practice change where necessary, as we collectively work to improve the exceptional care that is offered to our patients.



Carl-Magnus Larsson
CEO of ARPANSA



Jessica Lye
ACDS Director (Outgoing)



Contents

Our people	6
Clinical trial credentialing	8
Our governance	10
Clinical Advisory Group	10
ACDS Oversight Committee	12
COVID-19	14
Audit developments	16
Online adaptive audits	17
Specialised units	17
Stereotactic radiosurgery (SRS)	18
Stereotactic ablative body radiotherapy (SABR)	19
Kilovoltage therapy	20
Key findings	24
Setup, positioning, plan choice and image matching	24
Multileaf collimator (MLC) modelling and plan complexity	26
Organ at risk (OAR) dose modelling	28
Case studies	30
Education and training	34
Publications and presentations	38
Benchmarking	40
Feedback	42

The goal of the ACDS is to deliver a service that provides confidence and assurance to patients undergoing cancer treatment with radiation. It offers confidence to radiation therapy departments and their staff, that the radiation exposure of the patient is accurate and delivered as prescribed, in order to achieve the desired clinical outcome.



Rhonda Brown



Maddison Shaw



Andrew Alves



Andrew Cole



Sabeena Beveridge



Fayz Kadeer



Jessica Lye



Katherine Collins



Cate Davey



Jeremy Supple



Daniela D'Antonio



Julie Giblett

We work towards providing our subscribers with an invaluable resource that supports safe implementation and delivery of advanced treatment techniques to their patient community by providing a comprehensive suite of audits covering common and emerging clinical practices.

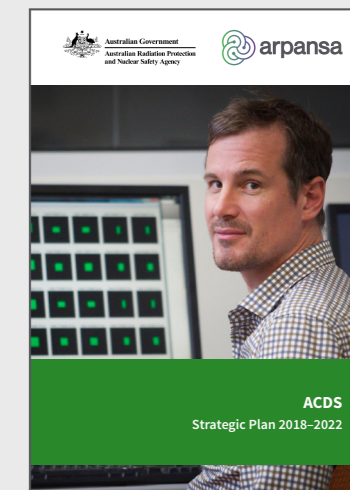
Our vision for the ACDS continues to be a world leading dosimetry audit service providing comprehensive, high accuracy audits, ensuring quality and patient safety in radiation therapy. This supports the ARPANSA vision for a safe radiation environment for the Australian community, with the team of physicists, radiation therapists and support staff working closely with one another to refine existing audits and proactively develop the necessary audits for emerging technologies. To support decision making, we work with our advisory groups to ensure that we have input from the wider radiation oncology professional bodies.

Our mission

To guide, support and improve patient safety and radiotherapy service delivery by:

- providing a comprehensive suite of audit modalities covering all common clinical practices
- improving national dosimetry capabilities in clinical treatment delivery
- offering services to Australian and overseas radiotherapy centres on a fee-for-service basis.

In this, we are fully aligned with ARPANSA's objective to promote the safe and effective use of radiation in medicine.



You can view the ACDS [Strategic Plan 2018-2022](#) on our website.

Associates and external auditors of the ACDS



Ivan Williams
Chief Medical Radiation
Scientist, ARPANSA



Joerg Lehmann
ROMP External Auditor



Johnny Laban
External Auditor



John Kenny
ROMP Consultant



Francis Gibbons
ROMP External Auditor



Leon Dunn
ROMP External Auditor



Stephanie Keehan
ROMP External Auditor



Clinical trial credentialing

The ACDS and TROG Cancer Research continue to maintain ongoing engagement with each other, ensuring each group is aware of the other's development roadmap. TROG representation on the Clinical Advisory Group (CAG) ensures audit development continues to be in line with current research and supports clinical trial credentialing. The ACDS participated in the stereotactic radiosurgery (SRS) working group technical subcommittee.

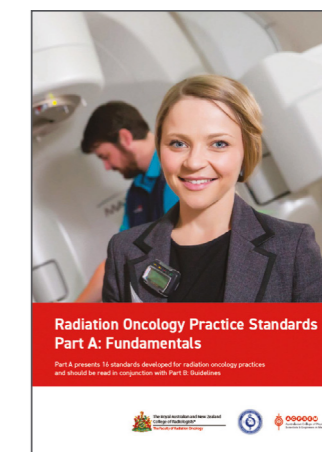
For ACDS subscribers, routine audits will frequently meet credentialing requirements.



Level II/III		
3DCRT/IMRT/VMAT	SABR	SRS
ANZ 1601/BIG 16-02 EXPERT	CTC 0245/AGITG AG0118PS/TROG 18.04 MASTERPLAN	TROG 17.02 OUTRUN
AGITG AG0407GR/TROG 08.08 TOPGEAR	TROG 15.03 FASTTRACK II	TROG 16.02 LOCAL HER-O
R2810-ONC-1788/TROG 17.11 C-POST	TROG 18.01 NINJA	EORTC 1308/TROG 15.02 ROAM
	PMC 17/013/TROG 17.05 AZTEC	
	TROG 17.03 LARK	
	VCCC/TROG 20.03 AVATAR	



Both ACDS and the ARPANSA Primary Standards Dosimetry Laboratory (PSDL) maintain accreditation with the National Association of Testing Authorities (NATA). Accreditations go beyond certification in compliance with systems and standards. It also assesses technical competence.



ACDS audit services are recognised as meeting the Radiation Oncology Alliance, Radiation Oncology Practice Standards (ROPS) criteria for independent dosimetric comparison/audit.

Horizon scanning

Looking ahead to ensure audit development meets emerging technologies.

- **Motion Management:** A new Level III audit is under development for motion management and adaptive strategies within the clinic. Design of the audit will be based on feedback received from a motion survey, to be released in December 2020.
- **MR-only planning:** The ACDS is working on a new Level III audit which will include MR-only planning.
- **Particle therapy:** The ACDS is preparing to conduct Level Ib and III dosimetry audits at the SAHMRI Proton Centre in Adelaide when it opens ~2023. As a part of the scoping work, the ACDS is participating in GHG Harmonisation of Proton vs Photon QA to ensure that developed procedures are in line with international best practice.



The ACDS is an active participant in the Global Quality Assurance of Radiation Therapy Clinical Trials Harmonisation Group (GHG).

The GHG aims to harmonise and improve the quality assurance of radiation therapy worldwide in support of multi-institutional cooperative clinical trials.



Clinical Advisory Group

The Clinical Advisory Group (CAG) is an independent expert team nominated by the professional colleges to advise the ACDS.

The CAG continues to provide invaluable, independent expert advice on clinical practice, meeting quarterly to support development of audits, advice on phantom and measurement techniques, and audit results. Extraordinary meetings have supported discussion and interpretation of specific audit results and provided clinical insight into any change of practice, warranted due to audit outcomes. They continue to support our role and responsibility in reporting any outcomes that can lead to a more robust planning to treatment pathway.

We thank our outgoing Chair Madhavi Chilkuri (RO) and outgoing members, Caroline Knipe (RT) and Neal Molloy (ROMP) for their involvement. Caroline has served as the Radiation Therapy (RT) representative since its beginning in 2011. Allan Fowler (RO) is welcomed as the new chair. Kate Francis, Radiation Therapy Manager for Austin Health and Chief RT at the Olivia Newton-John Cancer and Wellness Centre, steps in as the RT representative. Kate is a member of the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) and a part of the Advanced Practice Advisory Panel. We also welcome Albert Tiong, a Radiation Oncologist at the Peter MacCallum Cancer Centre, as the new Royal Australian and New Zealand College of Radiologists (RANZCR) representative.

CAG membership has expanded to include New Zealand representation and we welcome Andy Cousins, ROMP and Radiation Oncology Physics Team Leader for Christchurch Hospital. Andy represents two-thirds of New Zealand South Island ROMPs on the Radiation Oncology Working Group, which advises the Ministry of Health on radiotherapy matters.

Committee members



Allan Fowler (Chair)
Radiation Oncologist



Nick Hardcastle
Medical Physicist



John Shakeshaft
Medical Physicist



Albert Tiong
Radiation Oncologist



Kate Francis
Radiation Therapy Manager



Tomas Kron
Medical Physicist



Andrew Cousins
Radiation Oncologist





ACDS Oversight Committee

The ACDS Oversight Committee (AOC) is an independent government-appointed committee.

This oversight body, created via the Australian Health Ministers' Advisory Council (AHMAC), has seen the ACDS transition effectively from a Commonwealth-funded organisation, providing the radiation oncology sector with essential dosimetry audit requirements at no charge, to a sustainable cost-recovery service via a subscription-based model.

AOC advice on strategy and business management is provided through membership that includes Australian and jurisdictional government representation and business and professional expertise, as noted in the terms of reference.

Michael Penniment (SA) and Gillian Shaw (DoH) have retired from the AOC, with their positions filled by Angela Rezo (ACT) and Lara Purdy (DoH). As the transition to a cost-recovered service has now been successfully completed, the AOC will end in December 2020.

Committee members



Colin Hornby (Chair)



Lara Purdy



Sean Geoghegan



Simon Critchley



Megan Lavendar



Geoff Barbaro



Martin Naef



Angela Rezo





ACDS response to the COVID-19 challenge

The role of the ACDS in promoting the safe and effective use of radiation in medicine, while mitigating risk to the patient community, is no less important during a pandemic than at other times of the year.

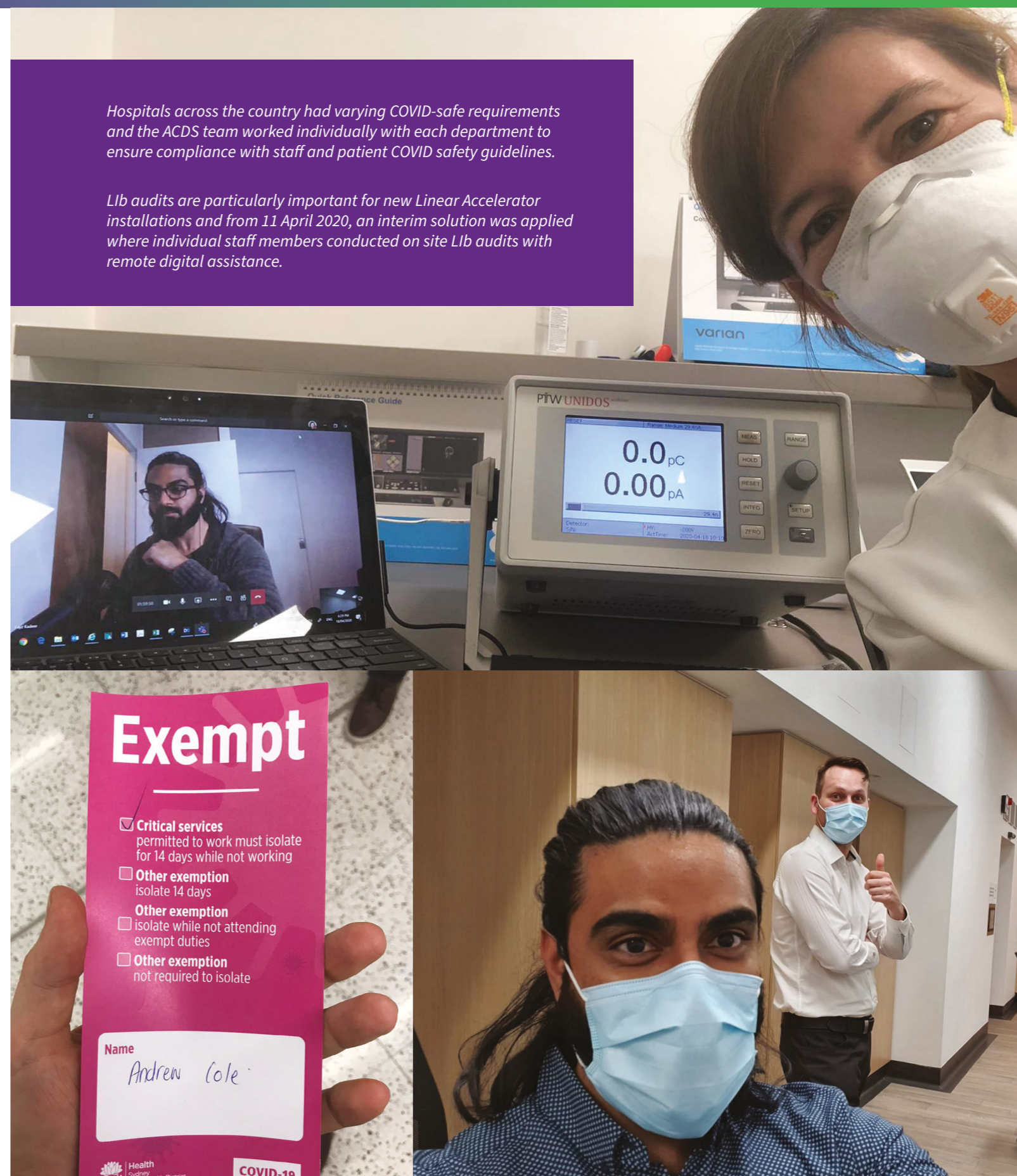
This year presented many challenges for the ACDS in maintaining the service to their subscribing facilities and the patients whom they treat. Despite the national shutdown, with a few modifications and a lot of perseverance, commitment, trouble shooting and hard work, the service continued to perform onsite and remote audits.

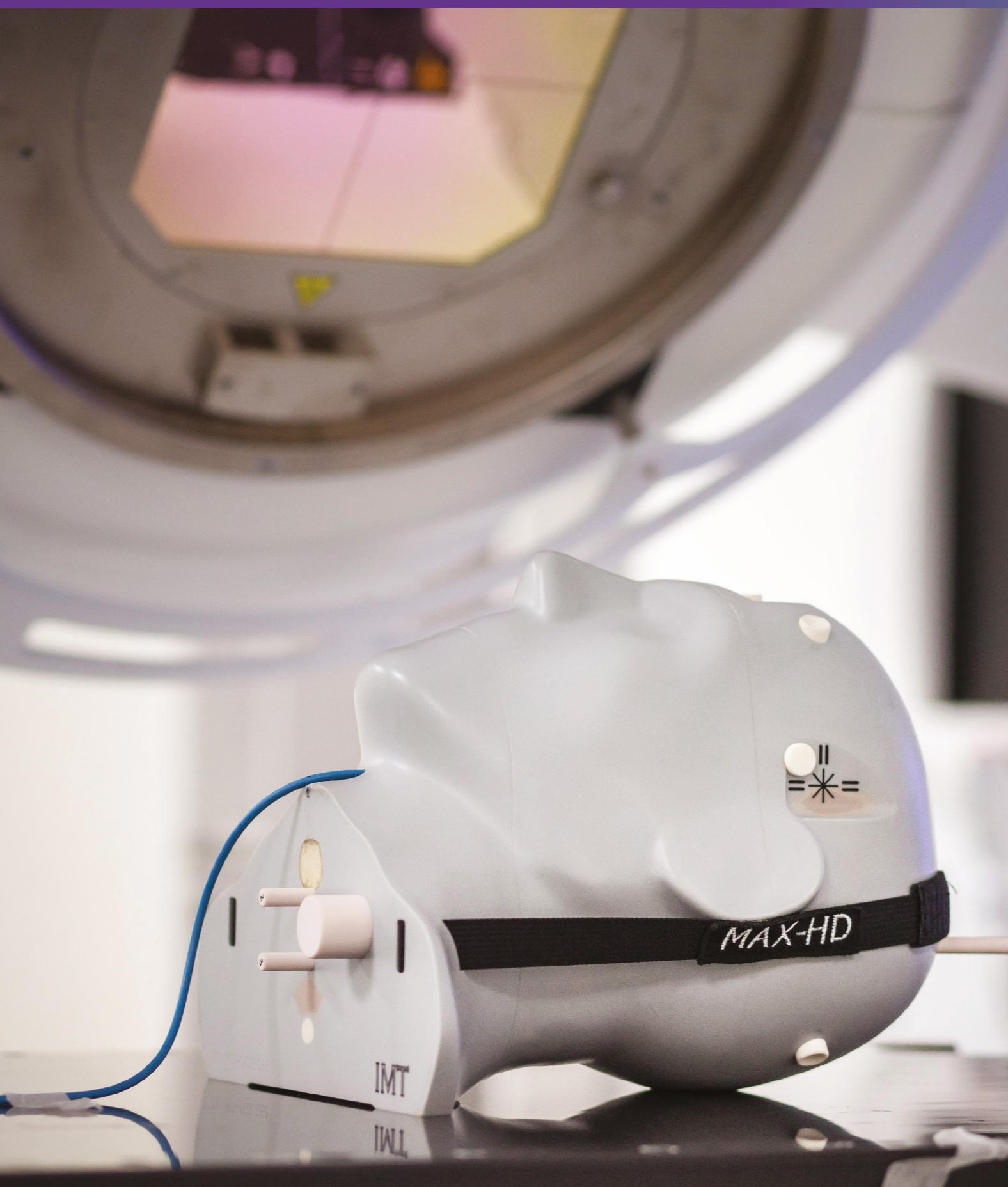
On 22 March 2020, with auditors in Canberra, the ACDS was grounded and all audits paused. On 2 April 2020, while multiple home work stations were being set up, ARPANSA and the ACDS met with state and territory regulators to resolve complexities and enable staff to cross jurisdictional boundaries in Australia and perform audits onsite in hospitals. Permission to enter jurisdictions was required, albeit for one staff member. When borders re-opened mid-May, the ACDS performed 19 onsite audits in just 7 weeks. COVID safety was a priority and ACDS staff worked closely with the departments to follow COVID-safe protocols, specific to each facility. Continuing to provide audits in New Zealand has proved particularly challenging due to ongoing travel restrictions.

With 60 audits scheduled for Q3 and Q4 in 2020, as well as report writing and checking; audit development; results analysis; and EPSM and ESTRO conference presentations to write and deliver, the second wave of COVID arrived. A number of jurisdictions closed their borders to Victorian travellers; however, ARPANSA and ACDS were able to develop a strategy for travelling and auditing interstate as ACDS is recognised as an essential service for the Australian and New Zealand radiation oncology profession.

Hospitals across the country had varying COVID-safe requirements and the ACDS team worked individually with each department to ensure compliance with staff and patient COVID safety guidelines.

Lib audits are particularly important for new Linear Accelerator installations and from 11 April 2020, an interim solution was applied where individual staff members conducted on site Lib audits with remote digital assistance.





Online adaptive audits

The ACDS has expanded its audit program to include end-to-end testing for online adaptive radiotherapy (ART) systems. The first Australian field trial audits for ART systems have been successfully completed using a common phantom for both MR and kV-based imaging.

Since 2019, two commercial ART systems, Elekta Unity (MR-guided RT) and Varian Ethos™ (AI-driven kV-based adaption), have become available for clinical treatment in Australia. Developing new audit cases that integrate into the existing ACDS audit structure and are consistent across both systems' imaging modalities and adaptive pathways, introduced a number of challenges for phantom design.

New audit cases and phantom materials were implemented in the first audits performed on the Elekta Unity MR-Linacs at Townsville Cancer Centre and Genesis Care Darlinghurst; and on Royal North Shore Hospital Radiation Oncology's Varian Ethos™. Building on our existing end-to-end (Level III) audits, the 3DCRT, IMRT and SABR cases were modified and new cases were added to test

the adaptive workflows. Designed for CT planning and kV imaging, the ACDS thorax audit phantom is opaque in MRI scans. The central solid water IMRT insert for the ACDS thorax phantom was replaced with a water-filled replica for MR image matching and dose measurement. Three new adaptive cases were trialled using a liquid soft plastic to create tissue-equivalent CT/MR-visible tumours for online imaging and also using virtual targets provided in the RT Structure set. Both Unity and Ethos™ could incorporate virtual targets into their adaptive workflows.

Preliminary results indicate that, on both systems, the dose delivered to a concave target from a standard IMRT plan agrees with that delivered using an adaptive approach to within 1%.

Specialised units

Field trial audits continue to be conducted on TomoTherapy®, CyberKnife®, Halcyon™ and kilovoltage therapy systems. Gamma Knife® systems have now entered stereotactic radiosurgery (SRS) field trial audits.



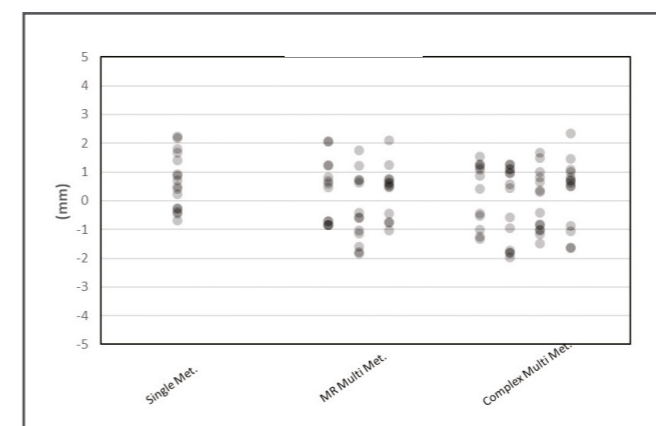
Stereotactic radiosurgery (SRS)

The SRS audit currently in field trial supports clinical trial credentialing for TROG OUTFIT and LOCAL HER-O SRS brain metastases trials. It consists of 5 audit cases ranging from simple output measurements, a single SRS target, and multi-metastases treatments. A 4-lesion multi-met case tests the geometric accuracy of targets visible on MRI only. A 5-lesion multi-met case tests the performance of the SRS delivery system in very complex deliveries and is based on the TROG ASM 2017 competition dataset.

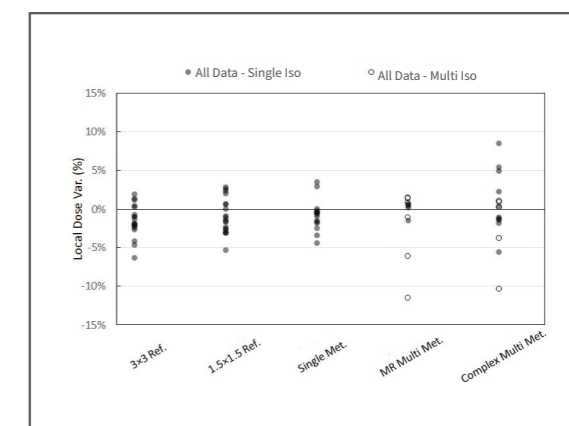
The customised IMT MAX-HD™ Phantom allows for optional detectors, film placement inserts and MR visible material. It is compatible with Linac, HyperArc, Gamma Knife®, CyberKnife®, Halcyon™ and TomoTherapy® systems. The detectors used are Gafchromic™ XD and EBT3 Film and PTW 60019 microDiamond.

Over 110 plans have been measured over 10 centres with a geometric accuracy metric for MR-defined workflow in progress.

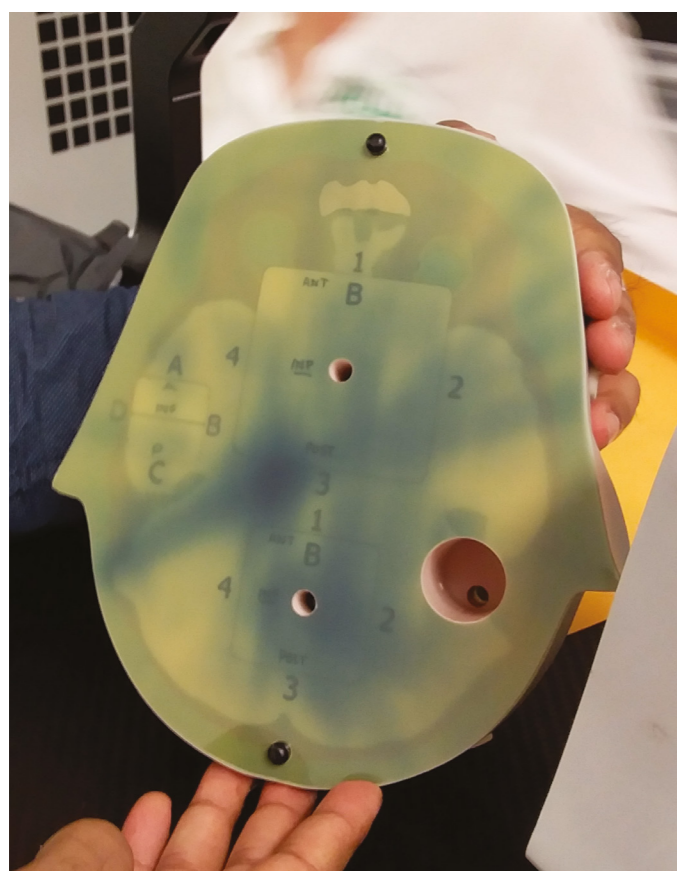
Results: Distance to agreement and microDiamond benchmarking dataset



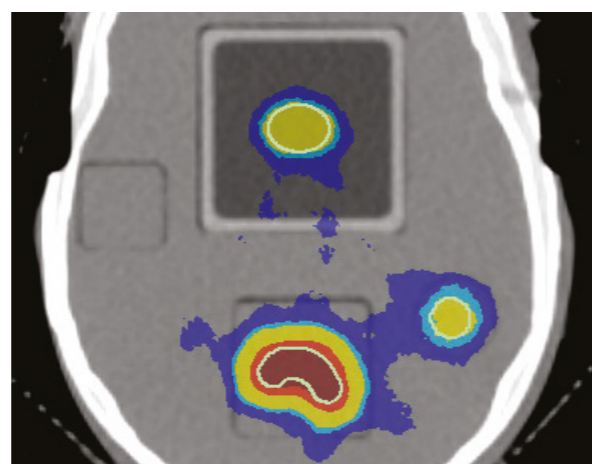
Australia and New Zealand (ANZ) dataset. Film - 1D DTA.



Australia and New Zealand (ANZ) dataset. SRS microDiamond.



Multi-metastases - complex.



Stereotactic ablative body radiotherapy (SABR)

After measuring SABR for over 2 years, the ACDS now has a significant dataset and is working with the CAG to assign Pass/Out of Tolerance outcomes.

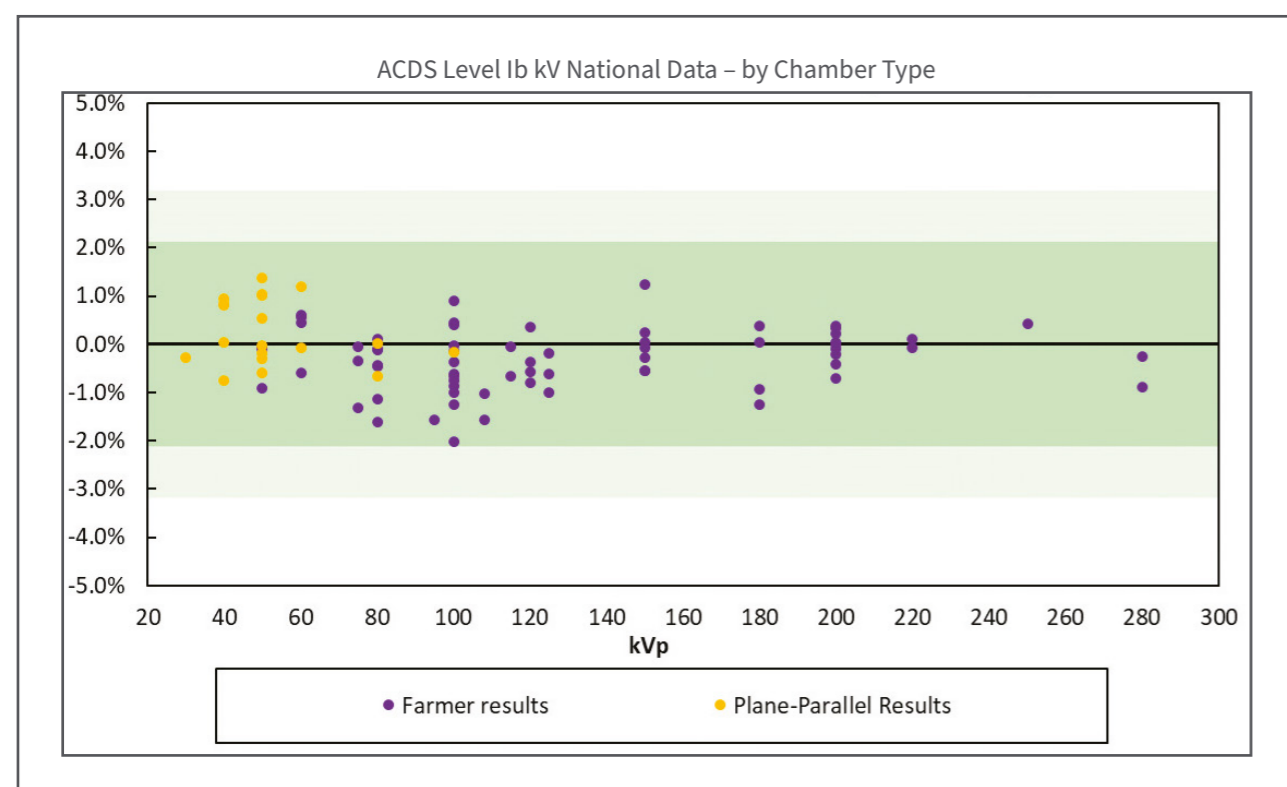
With approximately 300 plans measured to date, the SABR field trial is now a mature field trial. Corrections for dose to bone are being developed for incorporation into the data analysis code. The CAG and the ACDS are working to consider Red Flag protocol limits and this field trial is planned to go live in 2021.



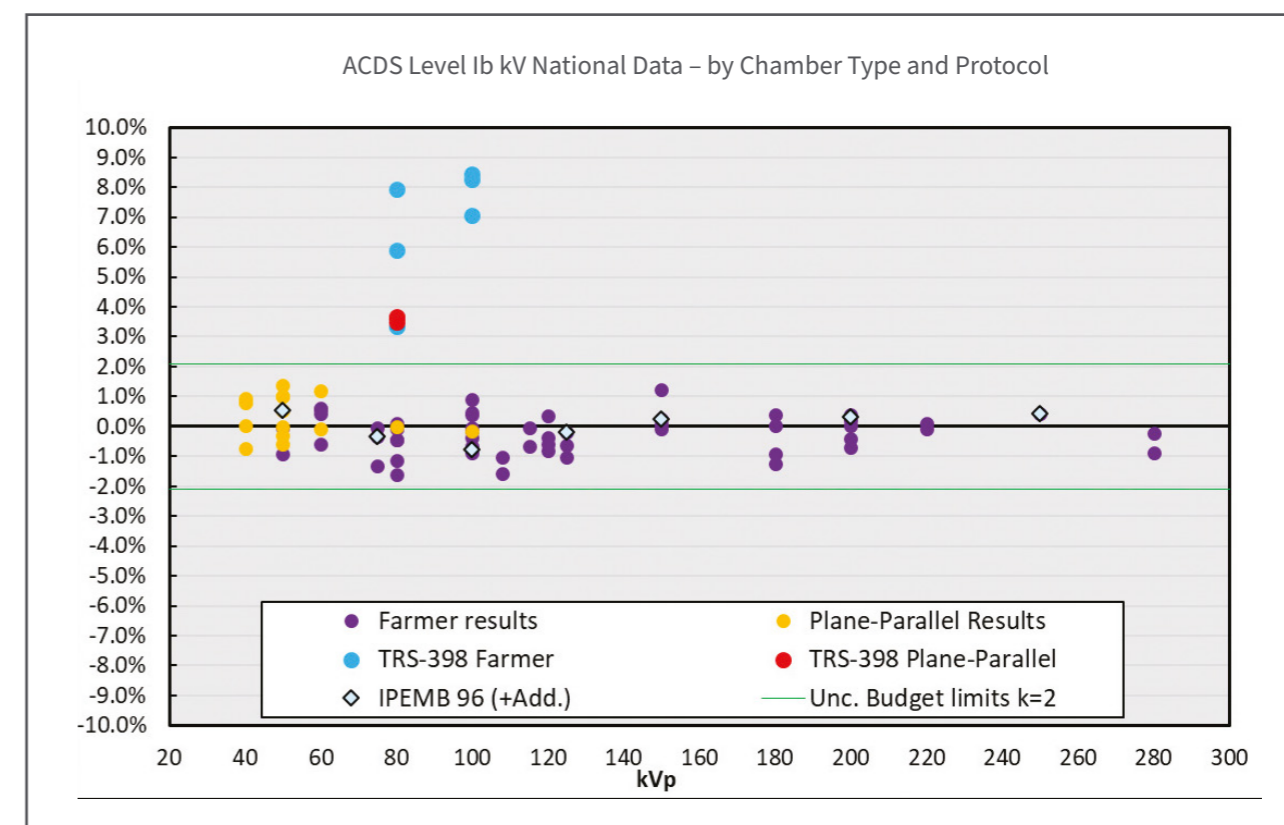
Kilovoltage therapy

The ACDS is progressing towards improved consistency of kV treatment beam dosimetry, as we collate audit data to build the ANZ dataset, allowing facilities to benchmark beam output calibration. Measurements from 77 beams with 20 different cones over 10 facilities is now included in this data. This benchmarking, along with the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) recommendations for kV quality assurance¹, will contribute to the standardisation of dosimetry practices.

For the current L1b audit protocol, the ACDS use the AAPM TG-61 protocol for onsite chamber measurements for 30–300 kVp (superficial and orthovoltage) radiotherapy beams, with In-air kerma measurements converted to dose-to-water at the surface ($D_{w,z=0}$). Reference dosimetry is performed using secondary standard PTW 30013 (Farmer-type) and PTW 23344 (Plane Parallel) chambers for up to 3 different cones/applicators. While onsite, the outputs are also measured using OSLDs and a measurement of HVL is offered for one or more beams. Currently, with the exception of one facility using the IAEA TRS-398 protocol, all measurements are within an estimated uncertainty budget of 2.1% ($\sigma=2$).



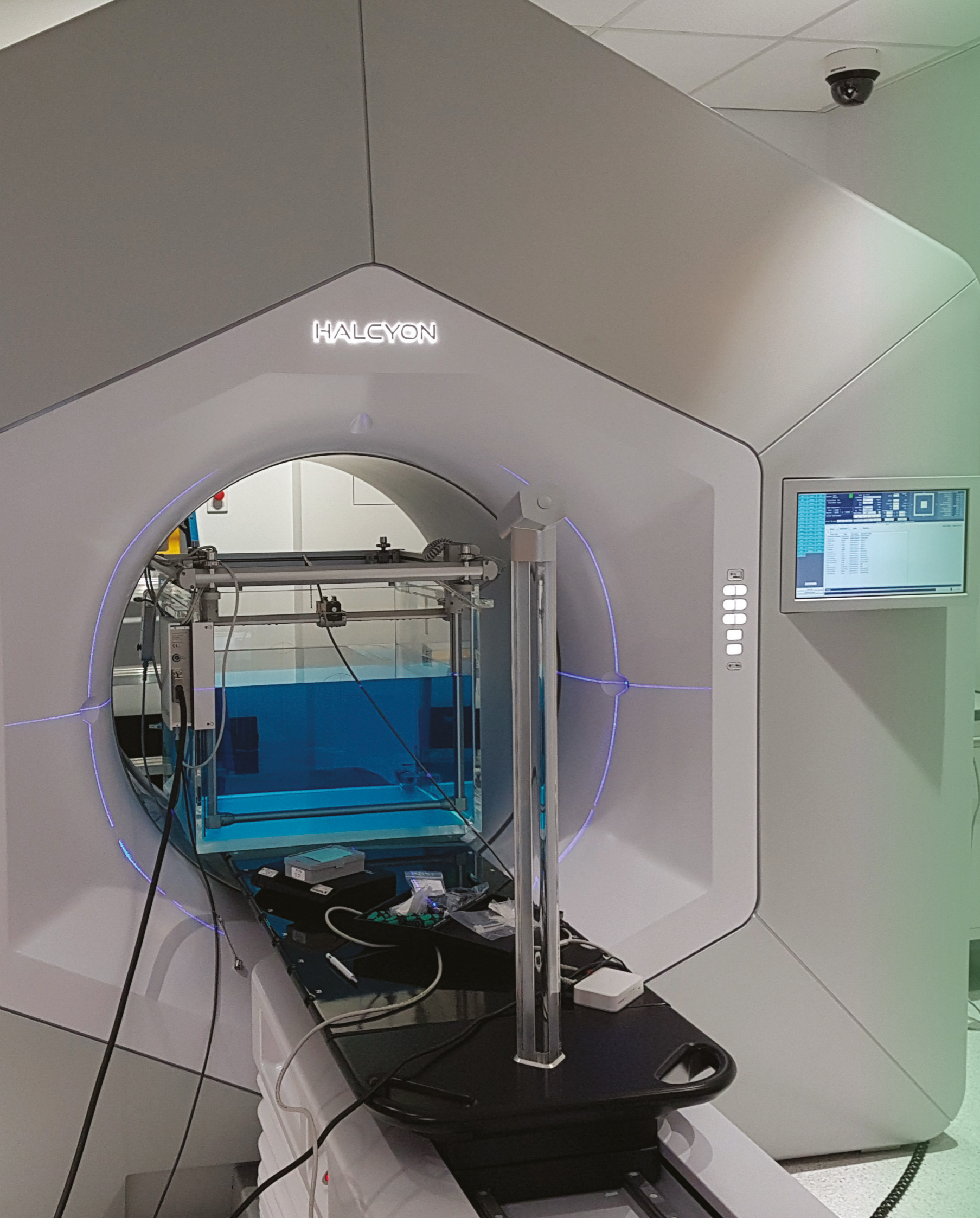
Case study: Kilovoltage dosimetry protocol comparison



Main differences between protocols:

- TG-61 and IPEMB both use Monte Carlo-modelled backscatter factors applied to air kerma measurements.
- TRS-398 Facility followed the recommendations for physical backscatter.

¹ Hill R, Healy B, Butler D, Odgers D, Gill S, Lye J, Gorjiara T, Pope D, Hill B, 2018. Australasian recommendations for quality assurance in kilovoltage radiation therapy from the Kilovoltage Dosimetry Working Group of the Australasian College of Physical Scientists and Engineers in Medicine. *Australasian Physical & Engineering Sciences in Medicine*, 41(4):781-808. <https://link.springer.com/article/10.1007/s13246-018-0692-1>





Key findings

Key themes continue to emerge from the ACDS dosimetry audit findings, with errors often resolvable immediately or after quick follow up. Not all of these are errors as such, but factors that can introduce uncertainties into the final dosimetry. When accumulated, they can result in an out of tolerance (OT) or pass-action level (A) result.

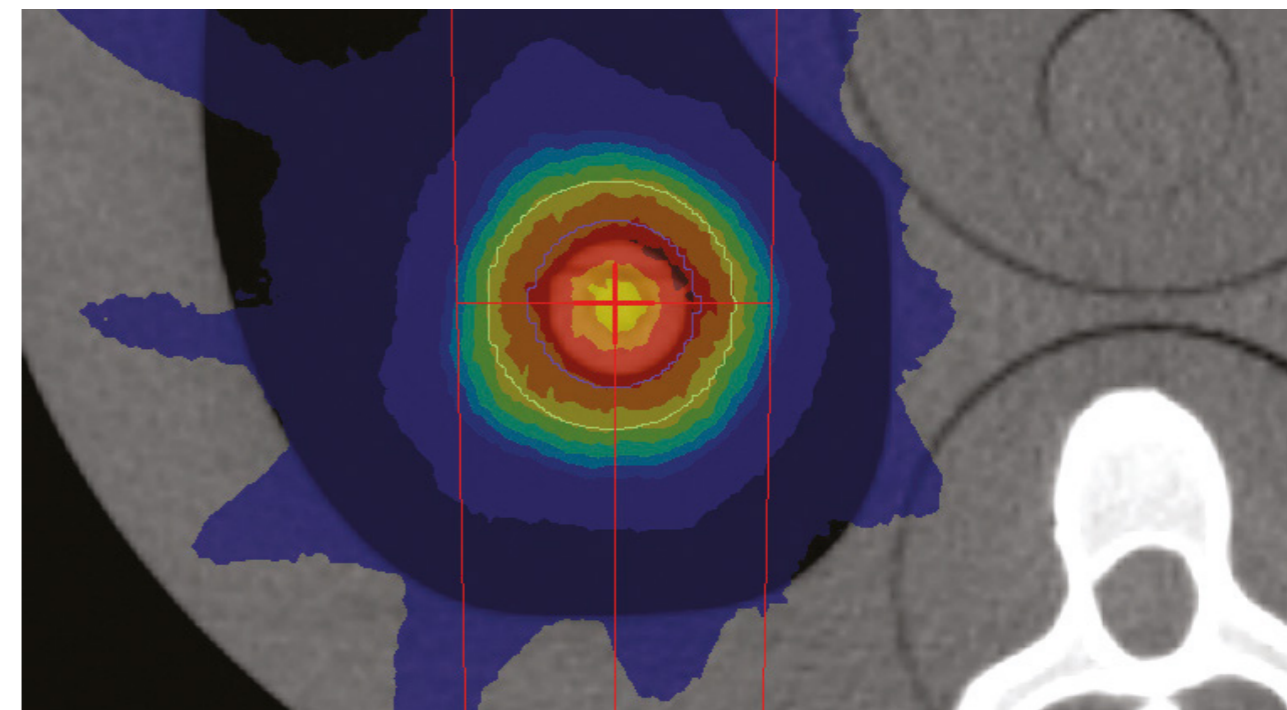
All audit findings provide valuable learning opportunities and insight into the most accurate way to optimise the planning and treatment pathway to improve the safety of radiation therapy delivery for our patients.

Setup, positioning, plan choice and image matching

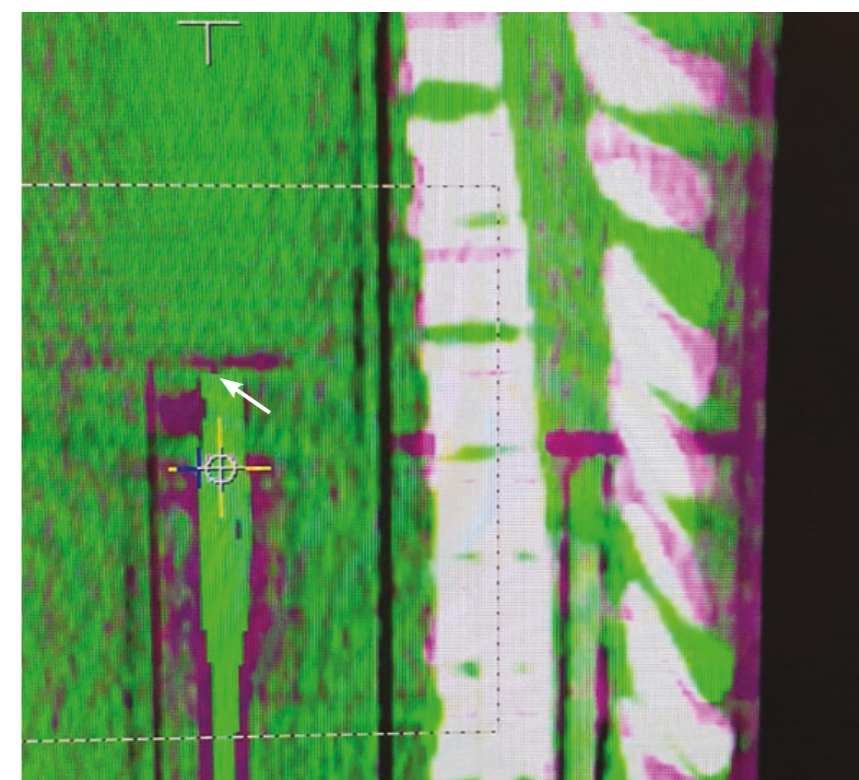
The role of the ACDS on the day of the audit is to measure treatment delivery dose as performed and delivered by the staff onsite. The expectation is that the phantom will be treated as a true patient and planning techniques, phantom set up and Image-Guided Radiation Therapy (IGRT) will be performed as per departmental protocol.

OT results have been returned as a result of planning techniques used and IGRT discrepancies at set up. While steep dose gradients are an advantage of modern modulated deliveries, it also means that any inaccuracies in set up and treatment delivery make these plans very susceptible to inaccuracies in dose delivery.

An example of an IGRT mismatch was evident in an audit of the SABR spine case, where one plan returned a Pass (Optimal Level) result, while another plan was Out of Tolerance (OT). Comparison of the film results showed an approximate 2mm shift in the L-R direction for the OT plan. A repeat measurement was conducted and the L-R shift did not appear in the redelivery. The 5%/2mm gamma passing ratio improved from 74.0% to 97.4%, resolving the plan to a Pass (Optimal Level) outcome.



An example where the plan choice had an impact on results was evident in an audit of the SABR lung case. The film results for the audited case returned a Pass (Optimal Level) result, with a 5%/2mm gamma passing ratio of 95.9%. The microDiamond point dose, however, returned a 9% dose discrepancy. It was identified that this large discrepancy was due to large dose gradients created from a cold spot in the centre of the target volume. The cold spot at the centre of the target would not be accepted clinically, however, departmental checking procedures did not identify this issue prior to delivery of the audit.



Another example of an IGRT mismatch was seen during a Level III audit, where the auto match function on CBCT was used during image verification. The auto match had incorrectly placed the phantom at the wrong vertebral level, which led to a complete geographic miss of the audit plan. This type of error is relevant in the clinic and highlights the importance of adequate review of automated processes.



Multileaf collimator (MLC) modelling and plan complexity

Complex Intensity Modulated Radiotherapy (IMRT) and Volumetric Modulated Arc Therapy (VMAT) plans require a high degree of control and understanding of MLC calibration and modelling limitations. Multiple audits have identified a dosimetry bias in IMRT/VMAT cases even with optimal 3D conformal dose delivery. The patient specific QA processes, depending on the device used and implementation at a centre, do not always have the sensitivity to detect the dosimetry bias.

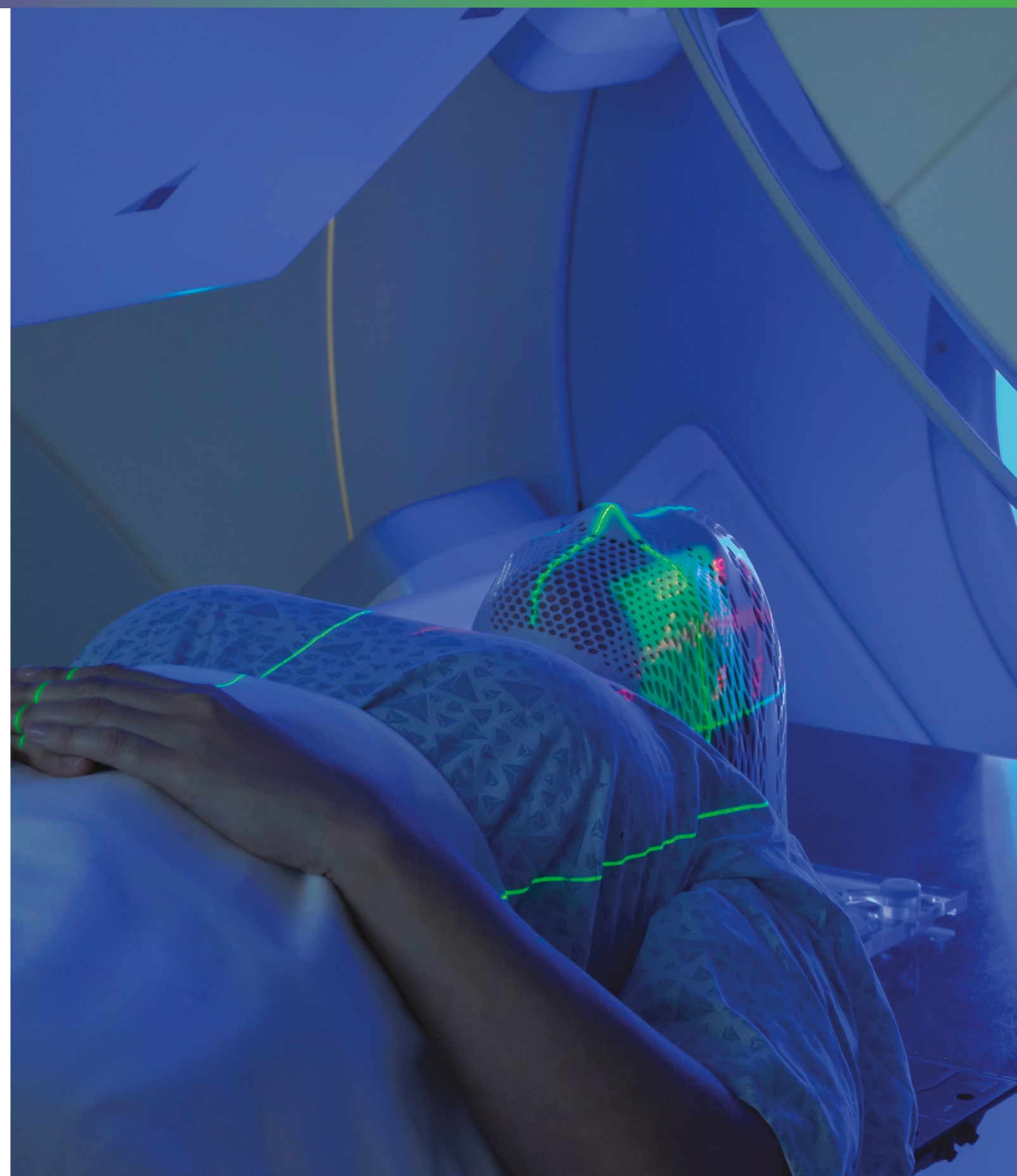
In several audit cases, sub-optimal results have occurred where the plan was identified to have a higher than usual level of complexity, as defined by the Modulation Factor (MU/cGy). In one specific instance a VMAT plan had a measured 2D gamma pass rate of 86.6% at 3%/3mm. The modulation factor was 10. After re-planning, the modulation factor dropped to 4 and the pass rate increased to 97%.

Significant Out of Tolerance (OT) results have been measured when an incorrect Dynamic Leaf Gap (DLG) setting has been used. In one instance, the DLG had been correctly determined then 'optimised' based on an additional measurement approach using small field profiles to 'tune' the DLG and focal spot size in the TPS. A Level III audit

conducted prior to the Linac entering clinical use for the first time detected Action and (OT) results for 6MV VMAT, prompting additional investigation.

It was determined that the DLG for 6MV was less than half the typical (and ultimately used) value. Additionally, the plans had omitted inclusion of the standard couch structures, which in this case counteracted the impact of DLG, lessening the measured difference. The facility tested a range of DLG in closer agreement to the measured value to fine tune VMAT results. This raises the issue of:

- only auditing a sub modality, e.g. VMAT but not IMRT
- only auditing selected energies, e.g. if only 10X VMAT was audited, the error would have been missed.



Organ at risk (OAR) dose modelling

ACDS Audit data suggests evidence for variability in the accuracy of different algorithms to predict organ at risk (OAR) dosimetry, with the electron cut-off energy (ECUT) effect on penumbra modelling being identified as one potential source of this discrepancy. The TG-119 'C-shape' is used across IMRT and VMAT LII and LIII audits, and comprises a target wrapping around a central OAR. Planned OAR dosimetry constraints ensure sufficient TPS stress-testing.

Separating OAR local dose variations across the ACDS national audit data by algorithm,

in Figure 1, suggests variability in accuracy between algorithms at predicting OAR dosimetry. The EGSnrc Monte Carlo simulation user code models radiation transport (National Research Council Canada). Deliveries to a target similar in nature to the 'C-shape' were simulated in water. The Electron Cut off Energy (ECUT) parameter was varied and the effect on penumbra and OAR dose was investigated.

ECUT effects to an OAR with a wrap-around target were modelled in DOSXYZnrc/BEAMnrc. The transverse plane comparisons are presented in Figure 1.

Electrons deposit and lose energy as they travel through a medium. Once their energy is below the predetermined Treatment Planning System (TPS) Electron Cut-off (ECUT) threshold, the TPS ceases transportation modelling and deposits the dose in the current voxel. If the ECUT parameter is set too high, low energy electrons with kinetic energies high enough to cross one or more voxels could have their dose deposited prematurely. The ECUT parameter exists as a compromise between computational efficiency and low energy electron dose-deposition modelling.

Stereotactic and other small-field treatments will have larger penumbra-to-field ratios, and thus the penumbra modelling effects on OARs may be significantly more pronounced. Clinical implications may be minimal for large-field treatments, such as for prostates.

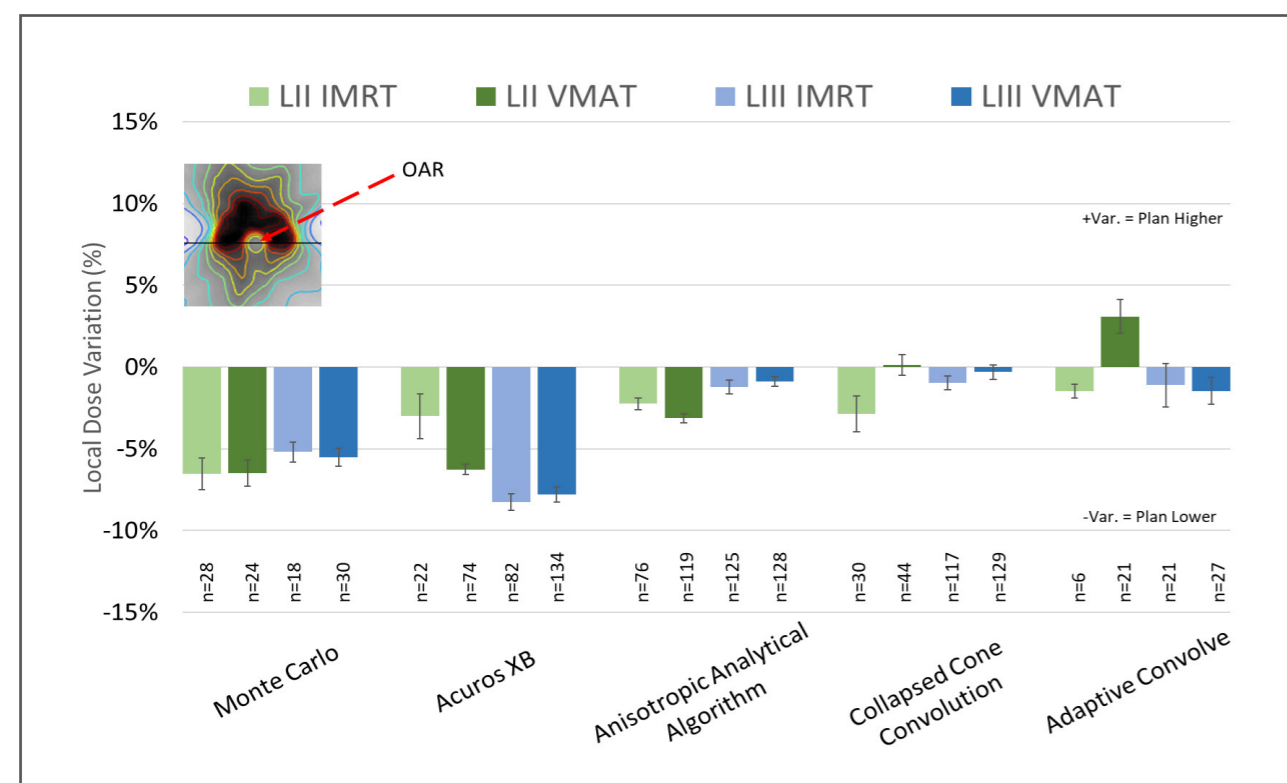
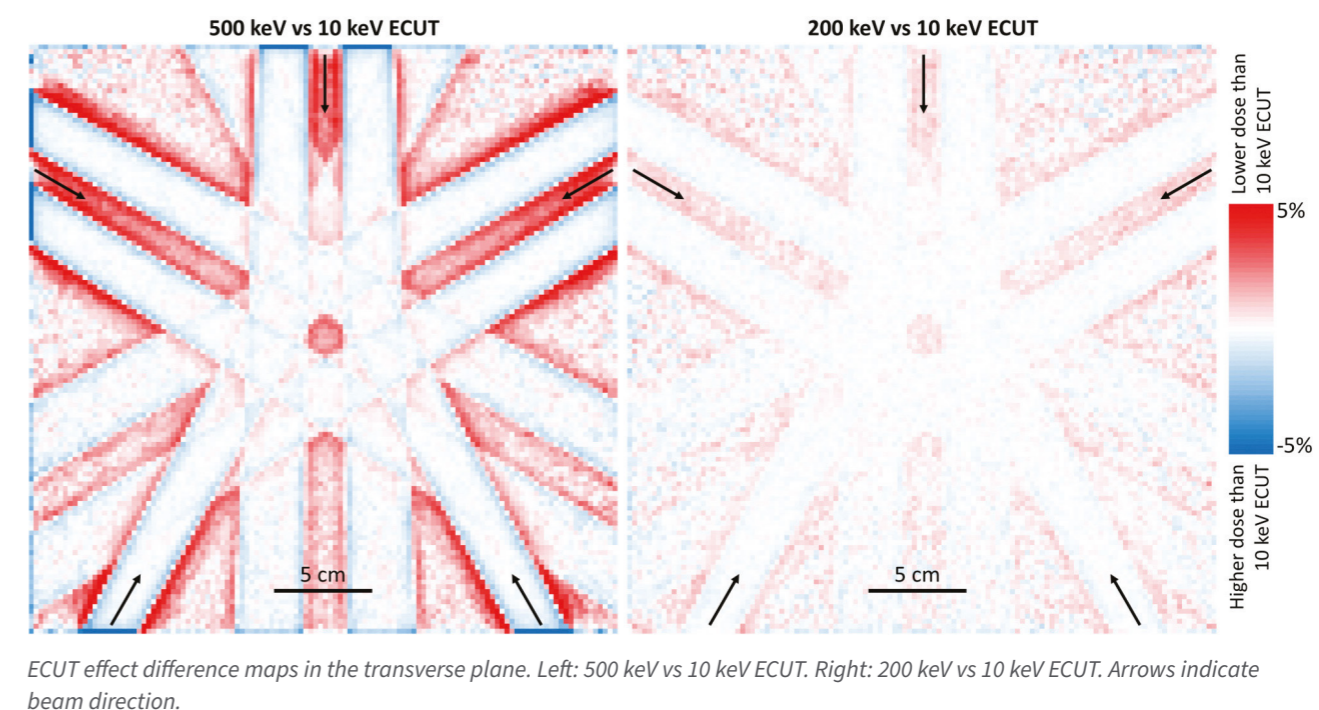


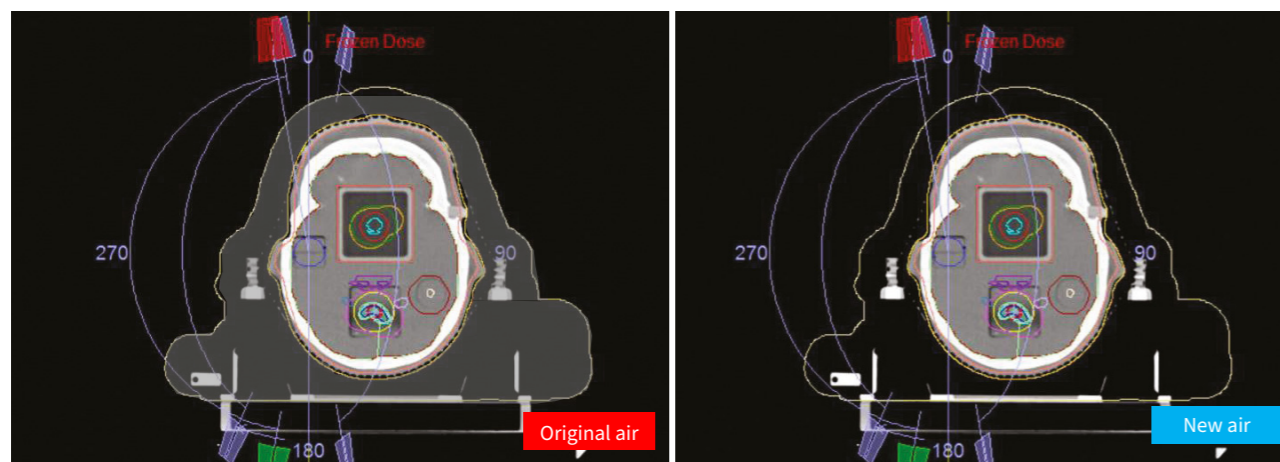
Figure 1: Local dose variations in the OAR measured by ACDS audits, with standard error bars.



All action level, out of tolerance and red flag results are opportunities for improvement, and as such are reported accordingly. Importantly, the following case studies resulted in changes to practice, improving accuracy and safety of treatment delivery.

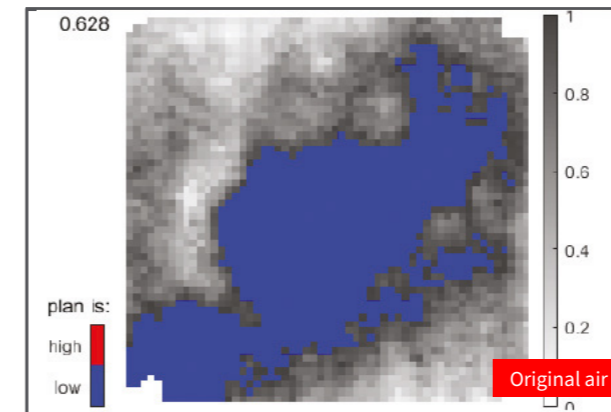
SRS – CT-ED conversion table

During a field trial of the cranial SRS audit, results indicated that the measured doses were higher than predicted in the planning system. Despite formal out of tolerance criteria not yet being established, the point doses appeared unusual compared with other field trials. Further investigation on the day of the audit revealed that air had not been included in the CT-ED calibration curve and air had been assigned the density of lungs. Audit plans showed an average overdose of 4.1%. The range was between 3.2–5.3% with the size of the error depending on the angle of the beam and the size of the air gap. The error was related to the contouring of the patient and the stabilisation equipment. This was an error not likely to be identified during patient specific QA or another audit as the external contour for these QA activities is typically the surface of the phantom rather than the stabilisation equipment. For the ACDS audit, the stabilisation mask is the external contour, replicating a more accurate clinical simulation and therefore providing more opportunity to identify potential errors in the planning to treatment pathway. The facility estimated that approximately 110 patients (122 plans) had been planned and treated with the incorrect model. All affected patient plans were recalculated with the correct CT-ED table which confirmed that there were associated increases in Organ at Risk (OAR) doses. Relevant radiation oncologists and affected patients were informed.

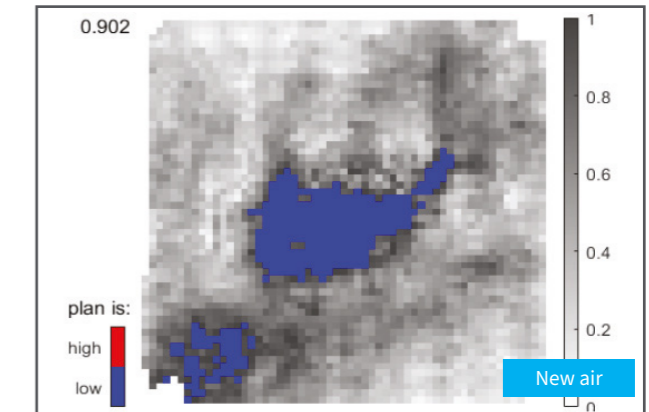


Original CT calibration curve (left) and new CT calibration curve (right).

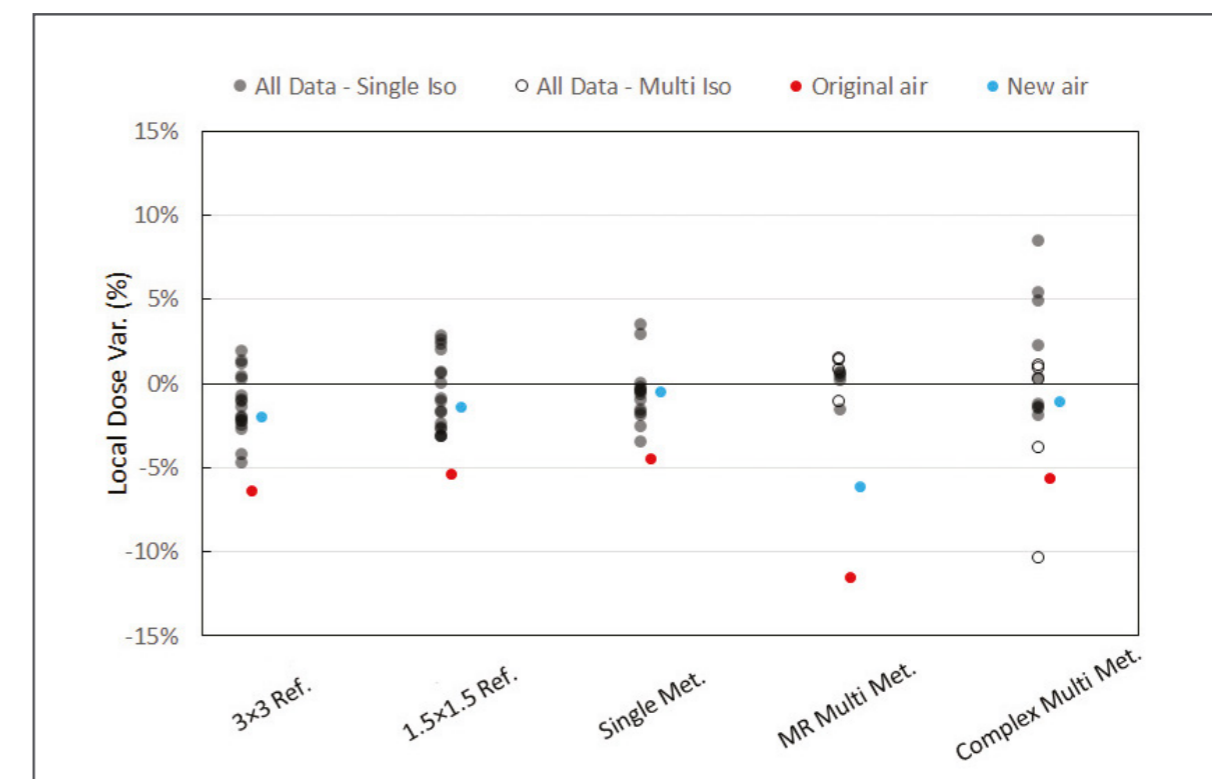
Original CT calibration curve, $\gamma = 62.8\%$



New CT calibration curve, $\gamma = 90.2\%$



Gamma pass rates and microDiamond measurements for number 5 SRS field trial case.

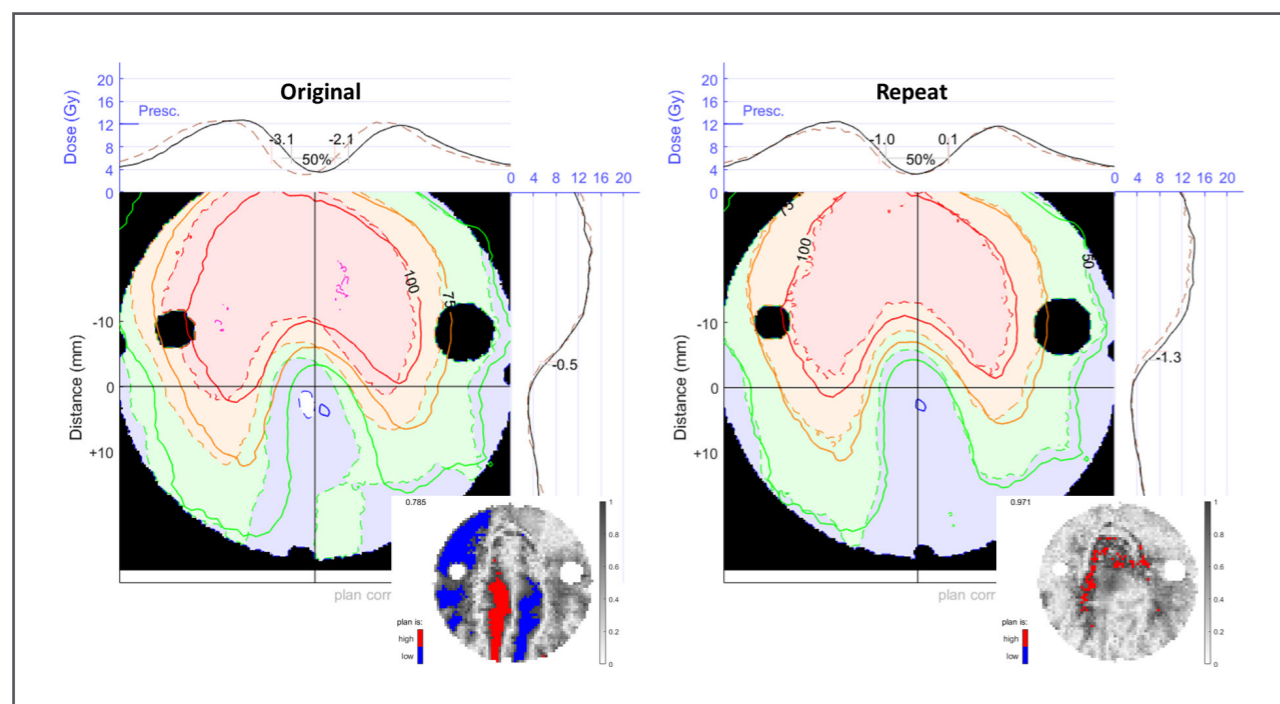


Australia and New Zealand (ANZ) Dataset. SR microDiamond, microDiamond benchmarking data.

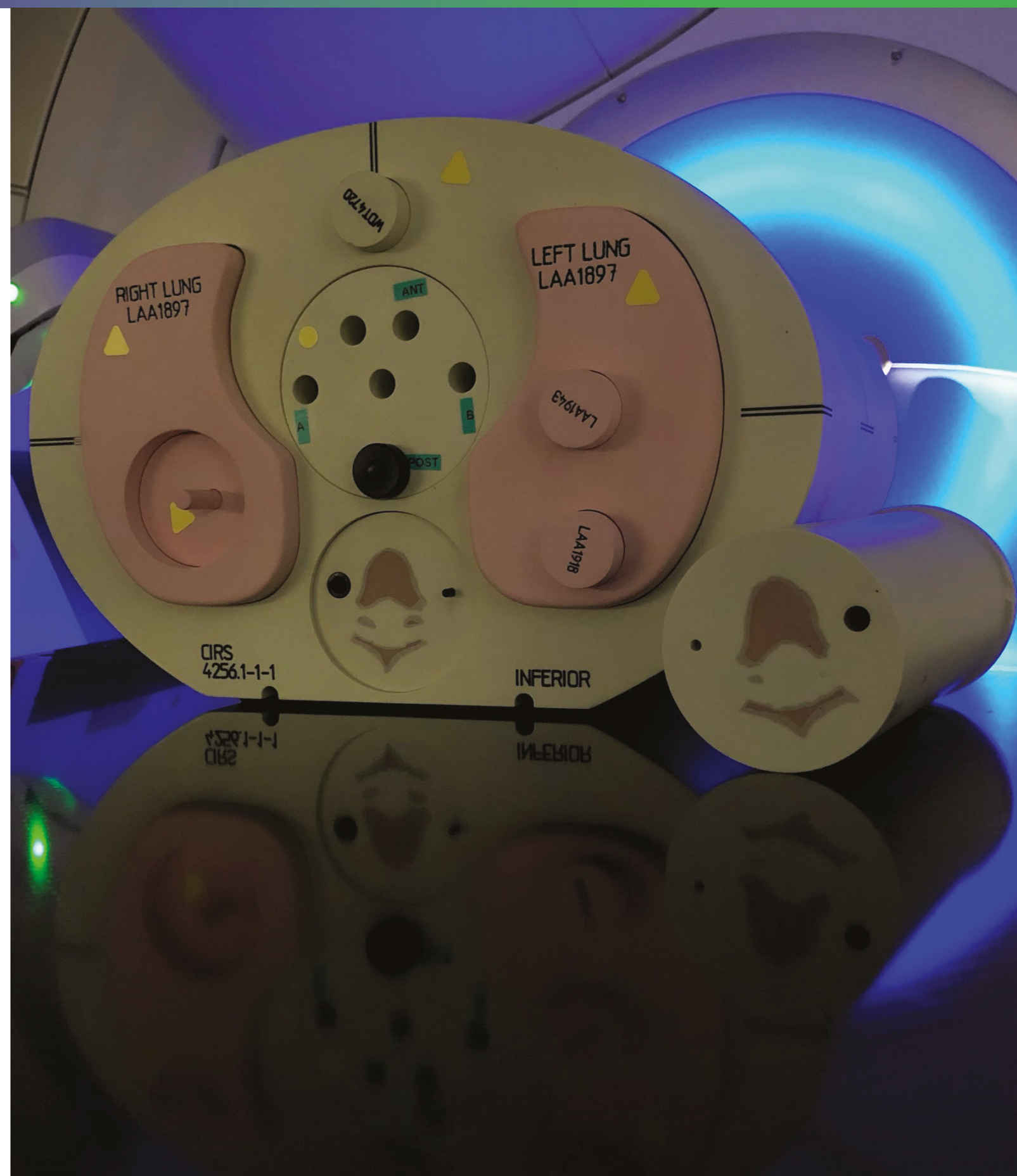
The newly introduced Treatment Planning System (TPS) at the organisation was initially for cranial SRS treatments only, with the intention to roll out to include other treatment areas. The outcomes from the ACDS audit and the collaboration of the department with the post-audit follow up has prevented this error from reaching further patients who are yet to be treated with the new TPS. This has contributed to a significant learning opportunity for the radiation oncology community and demonstrated a collective interest and investment in patient safety and treatment outcomes.

SABR – spine

An Out of Tolerance (OT) result was observed for a SABR spine case with a gamma passing rate of 78.5%. A lateral shift of approximately 2–3mm was identified as the contributing factor. Facility investigation determined that the FFF beam isocentres were misaligned, which was particularly for posterior beam angles. The plan pictured is IMRT 6FFF, heavily weighted posteriorly. Soft tissue and lung plan delivery for the same audit returned Pass outcomes, however, were delivered with VMAT and DCAT weighted evenly around the phantom. The facility corrected the isocentre misalignment and the audit was repeated, which saw the results improve to Pass (Optimal Level), with a gamma passing rate of 97.1%.



Distance to agreement and 5%/2mm gamma maps.





TEAP training

Training Education and Assessment Program (TEAP) continues to provide invaluable clinical experience, support for professional engagement and opportunities to contribute to research and development. Previous TEAP registrars, now working as ROMPs, have the knowledge to feed their clinical experience back into the ACDS, and contribute to supporting and strengthening the audit development and review process.



Steph Keehan

I feel very fortunate to have had the opportunity to do a six-month training placement at ARPANSA during my TEAP candidacy.

It was an invaluable experience for increasing the depth and breadth of my medical physics knowledge and for my overall professional development. It provided me the opportunity to grow and strengthen my professional network, participate in dosimetry audits and assist in research and development.

I was heavily involved in the commissioning of ARPANSA's new linear accelerator, installed just prior to my commencement. I would not otherwise have had access to a new linac installation and I gained instrumental real-world practical experience.

I was also involved in developing the beam models for the new linac to the high level of scientific rigour required at ARPANSA. I assisted with the design and commissioning of a new custom stereotactic phantom and commissioning of microDiamond detectors for use in measuring stereotactic plans for implementation of the ACDS SRS audit.

I was also the lead author of a peer-reviewed publication in collaboration between the Alfred Hospital and ARPANSA, utilising the clinical and primary standards expertise available in both organisations.



Jeremy Hughes

Working at ACDS for 12 months was an invaluable experience in my TEAP journey.

Not only did I gain the opportunity to work on multiple projects that bolstered sections of my knowledge that needed bolstering but I also gained access to the wealth of knowledge and experience within the staff at ACDS.

During my time there I helped to commission an Elekta Linac (after coming from a primarily Varian centre), analysed the national dataset to showcase differences between beam models, and performed audits around the country amongst many, many, other things. Being able to focus solely on projects and TEAP was much appreciated.

Without the clinical workload bearing down on my consciousness, I was able to make great headway in completing the training program. I would still probably be trying to complete it to this day without my stint at ACDS.

Overall I would highly recommend ACDS as a place for the budding TEAP physicist. The wide variety of knowledge and work available was lovely. The responsibility of completing projects was freeing. The access to a linac during daylight hours was like Christmas every single day. I loved my time spent there. Everyone was lovely and I learnt a lot.



Education and training



Claudiu Porumb

The involvement of ACDS in TEAP has been an excellent and invaluable opportunity in my training to become a qualified medical physicist.

During my six-month rotation at ACDS, I had the pleasure of working with experienced, knowledgeable & lovely people whom were very welcoming and approachable.

I was able to learn about the national auditing process, the types of audits, the equipment used, and I was able to contribute to some of the ongoing projects at both ACDS as well as PSDL. This opportunity allowed me to make substantial progress towards Level II and Level III sign-offs in the Radiation Protection and Dosimetry modules of TEAP.

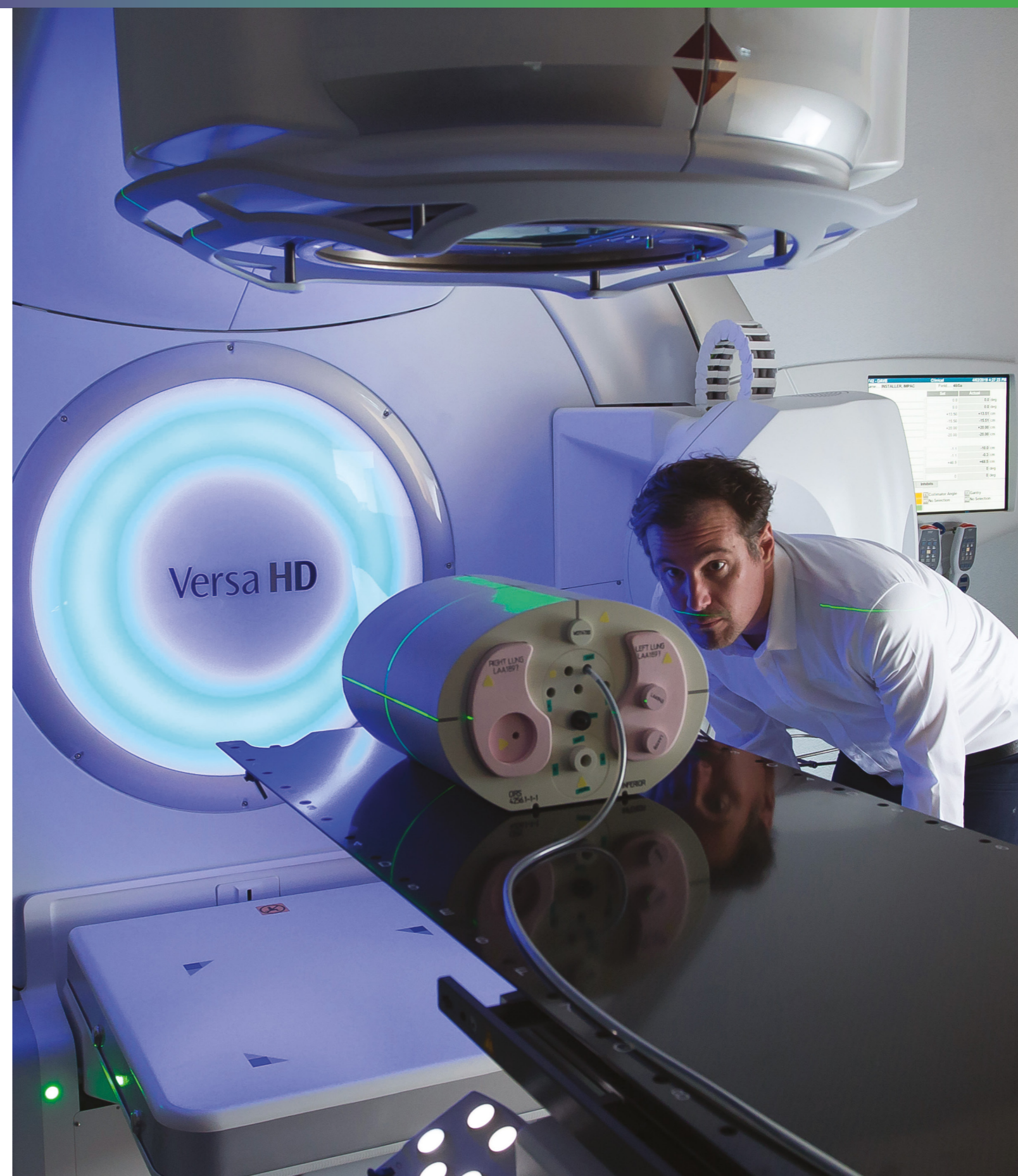
The ACDS also offer attendance to national audits. I was unfortunately unable to attend due to coronavirus lockdowns, however, I certainly believe it would have been an equally invaluable experience.

Overall, I am very glad that I had the rare opportunity to have been part of the ACDS during my TEAP training and I would certainly recommend the rotation to any registrar.



ASMIRT appellation

In recognition of the learning and development that comes from participation in a LII or LIII ACDS audit, this is now an established ASMIRT CPD activity for radiation therapists. ASMIRT CPD credits are claimable at a rate of 9.375 per audit for both planning and treatment RTs.





Publications and presentations



Development of an audit, conducting field trials, interrogating results and working towards best evidence-based practice is part of the ongoing work of the ACDS.

Sharing their results, new developments and collaborating with stakeholders is an important part of this work.

• ASMIRT & AACRT

- Can data accumulated from the Australian Clinical Dosimetry Service (ACDS) dosimetry audits inform IMRT and VMAT treatment planning in clinical practice?
- *Cate Davey*

• NZ Incident Workshop

- The provision of independent dosimetry audits for external beam radiotherapy centres in New Zealand
- *Johnny Laban*

• RANZCR

- The Australian Clinical Dosimetry Service: Development and deployment program of audits
- *Ivan Williams*
- The Australian Clinical Dosimetry Service: Outcomes, Findings and Futures
- *Ivan Williams*

• ESTRO ♡ Milan

- End-to-end dosimetry audits of Stereotactic Body Radiotherapy (SBRT)
- *Maddison Shaw*
- Dosimetry measurement in microbeam therapy
- *Jessica Lye*
- The ACDS approach to measuring dose to bone and comparing to TPS reported dose to water and medium
- *Jessica Lye*

• IDOS ♡ Vienna

- Developing a dosimetry audit for MRI-linacs
- *Rhonda Brown*

• EPSM & AOCMP

- National audit data reveals discrepancy in OAR dose for Monte Carlo algorithms
- *Andrew Alves*
- Results of the ACDS SABR dosimetry audit
- *Maddison Shaw*
- Design and commissioning of a protocol for absolute film dosimetry in ACDS audits
- *Jeremy Supple*
- Measuring the Dose in Bone
- *Jessica Lye*
- A multi-detector comparison for MRI-Linac dosimetry
- *Rhonda Brown*
- Design and initial commissioning of a cranial SRS phantom for dosimetry audits of complex treatments of multiple brain metastases
- *John Kenny*
- ACDS kV small field dosimetry audit
- *Fayz Kadeer*
- How the Australian Clinical Dosimetry Service responded to COVID-19
- *Ivan Williams*

• AAPM

- ♡ San Antonio
- Implementing a national SBRT dosimetry audit
- *John Kenny*

• Annual Australian MRI in Radiotherapy meeting

- Audit development for MRI Linacs
- *Rhonda Brown*



Publications

Lye et. al. 'A comparison of IROC and ACDS on-site audits of reference and non-reference dosimetry' *Medical Physics* (2019)

View on our website via our [ACDS publications section](#).

• ESTRO meets ASIA ♡ Singapore

- Results of the ACDS end-to-end dosimetry audit of spine and lung SBRT
- *Maddison Shaw, Andrew Cole*
- National Audit Service Demonstrates Increased Precision in Reference Dosimetry
- *Andrew Alves*

• Elekta Australasian User Meeting

- Early experience with dosimetry audits for Elekta Unity MRI-Linacs
- *Rhonda Brown*

• ANZ Acuros UGM

- Dose to medium vs dose to water
- *Andrew Alves*



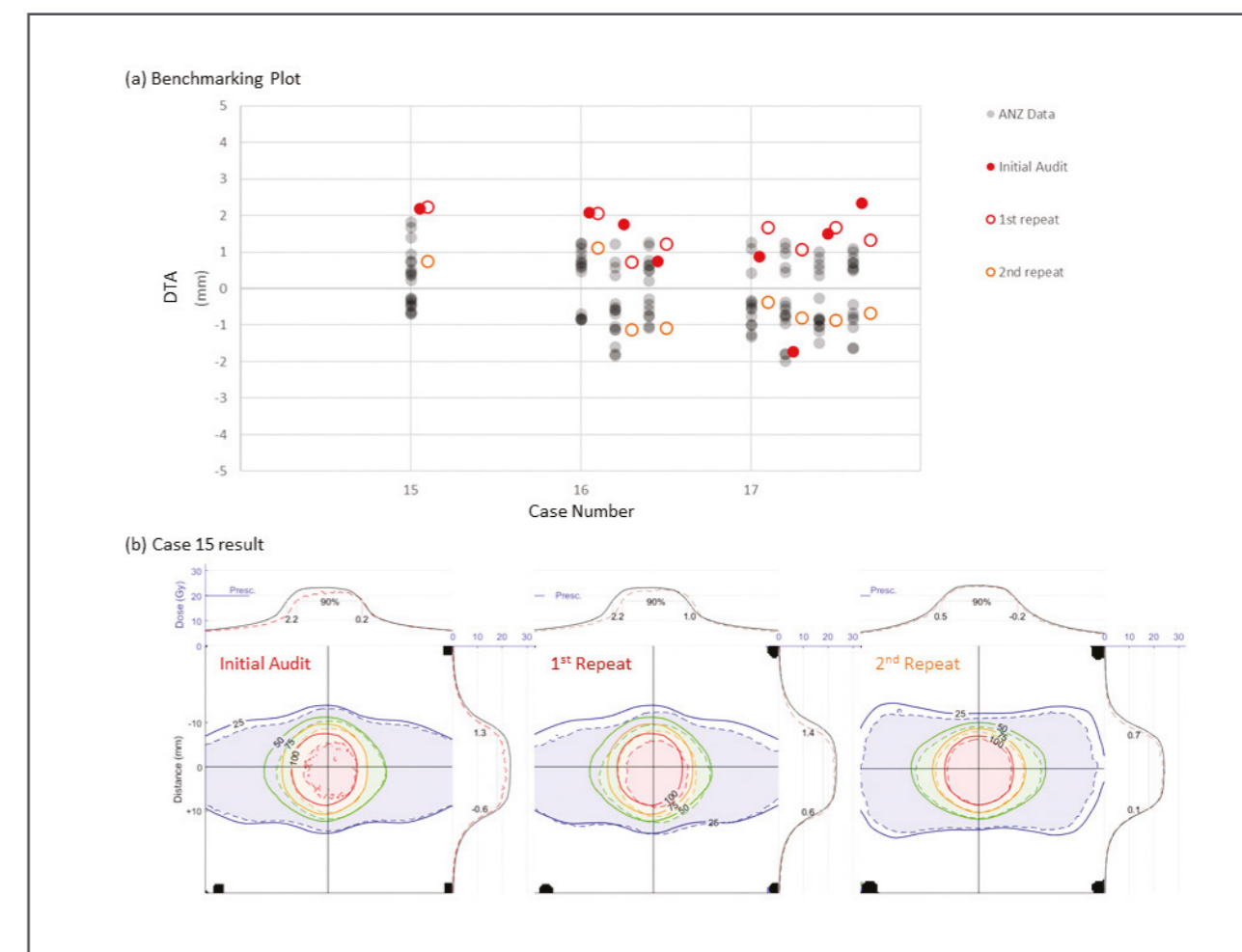
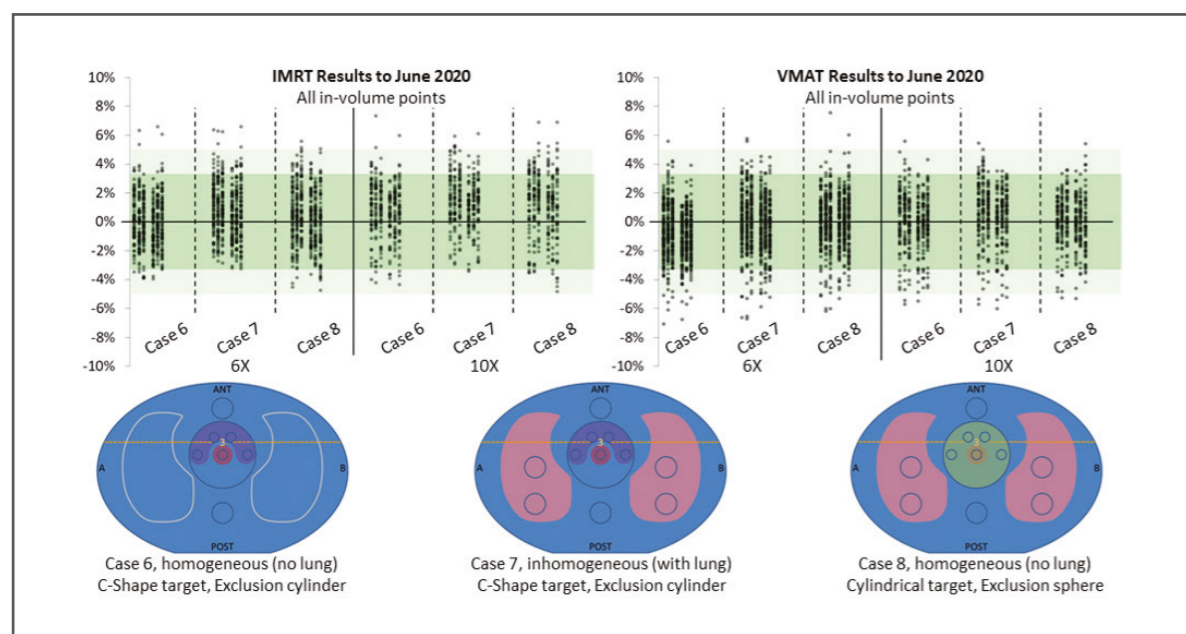
= poster presentation

The ACDS Australia and New Zealand Data Set (ANZ Dataset) comprises information collected while developing, executing and analysing ACDS audits. The data includes all metrics from the suite of audit results across all modalities and is used to benchmark a facility's dosimetry performance against other radiotherapy departments, especially against facilities with the same equipment and systems, thereby eliminating equipment bias.

Audit reports include charts of metrics such as dose variation as measured in detectors, distance to agreement, and gamma score from either film or array measurements, to provide the context needed to interpret a facility's individual results.

All audit results, from development to active deployment and any iterative improvement, are critically reviewed on a regular basis by the ACDS. This informs the relevance and effectiveness of particular audit case designs and the suitability of tolerances used. The ANZ Dataset is mined to provide insights into the root causes behind audit outcomes and dosimetry errors with the long-term aim of informing clinical practices and contributing to improvements in patient safety.

A detailed summary of the ANZ data for each audit level is publicly available on our website by searching 'ACDS Australia and New Zealand datasets' or visiting arpana.gov.au/acds-datasets.



(a) The metric being benchmarked is the distance-to-agreement (DTA) for SRS treatments. (b) For example in case 15 horizontal and vertical profiles are taken through a film measurement and compared to the plan dose. The metric returned and displayed on the benchmarking plot is the worst of 4 DTAs from the two profiles. In this instance the measurement was performed 3 times and the performance of the metric can be seen in the context of other SRS cases and all other audits.

Stakeholder feedback supports development of ACDS audits and contributes to the safety of radiotherapy patients. As such it is welcomed and encouraged.

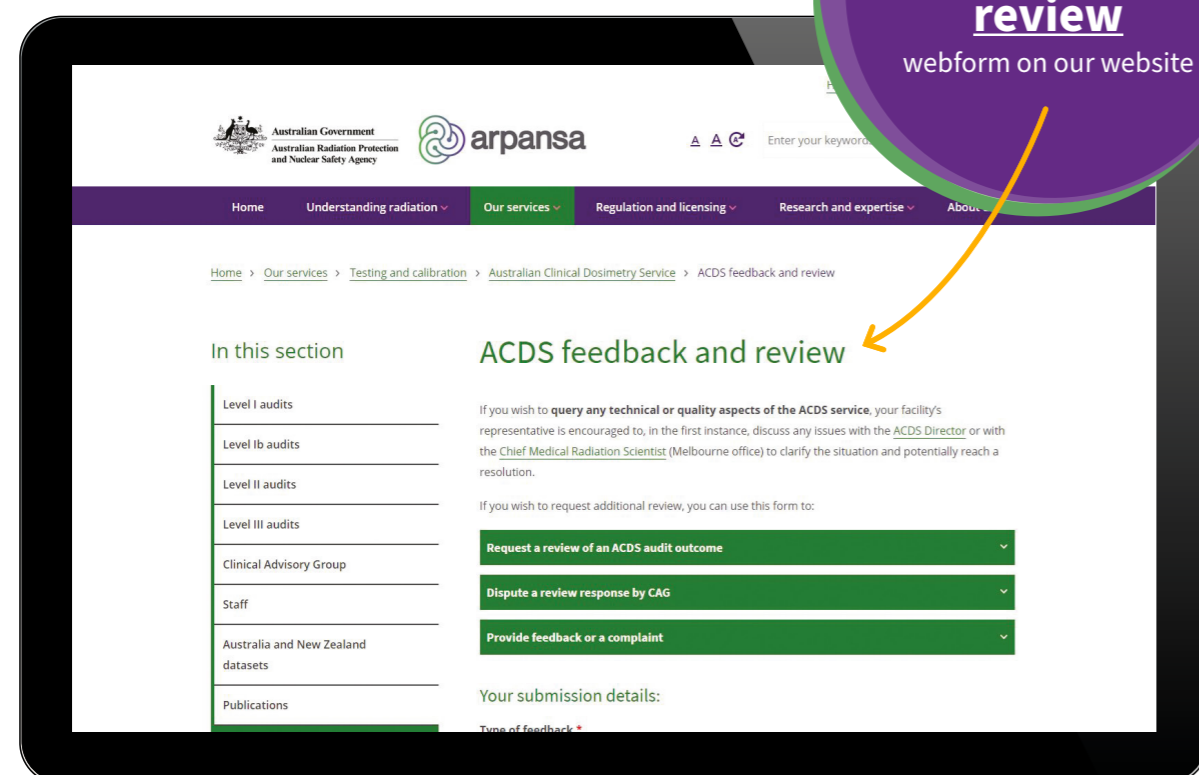
Feedback from subscribers and stakeholders is essential to the cycle of audit review and development and the ACDS continues to actively seek feedback on both their products and their service delivery.

With the assistance of the Clinical Advisory Group (CAG), the ACDS has developed a formal review process. In addition to the informal feedback and formal post audit surveys, there is now a request for review process, accessible via the ARPANSA website.

In the first instance, the facility representative is encouraged to discuss any issues or concerns with the director of the ACDS or the chief medical radiation scientist with the aim of a resolution. Alternatively, or in addition to this, there is the opportunity to either:

- request a further audit review
- dispute a review response by CAG
- provide feedback or a complaint.

Visit the
feedback and review
webform on our website



Australian Clinical Dosimetry Service

Australian Radiation Protection and Nuclear Safety Agency

619 Lower Plenty Road, Yallambie VIC 3085 AUSTRALIA

+61 3 9433 2211

acds@arpansa.gov.au

arpansa.gov.au/acds