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His first degree was a BA in Mathematics from Oxford, UK completing in 1993. He then studied for MSc and PhD in Computer Science at UCL, completing in 1997. After a post-doc at the University of Pennsylvania, USA, he returned to UCL as a lecturer in 2000 and has been Professor of Imaging Science since 2009.

Dear readers and colleagues,

How exciting is it to be gathering in person as a community again this year for ISMRM in London??? For many of us, the first major gathering of minds for almost three years. I can't wait! My schedule for the week is already delightfully overbooked. And I can feel the buzz building from students attending their first real-life conference (despite being in year 3 of their PhD already!), through to professors who have lost count of how many ISMRMs they have attended ... ahem, mentioning no names ...

I am always fascinated by how developments at the cutting edge of a technology can ultimately define the mainstream. Even when new techniques seem limited to use in only the most highly specialised centres, they are so often essential steps towards advances that ultimately transform research and practice. This year's ISMRM issue of MAGNETOM Flash brings these thoughts to mind through its juxtaposition of cutting-edge advances on high end platforms, e.g. 7T, with realisation of clinical capability on lighter platforms designed for accessibility, e.g. the MAGNETOM Free.Max 0.55T system.

MAGNETOM Flash's focus this time on advanced neuroimaging highlights, as always, advances at the forefront of MRI development and application. Applications in the brain using the latest hardware and software technologies so often drive forward innovations in MRI that propagate to other platforms and applications. We hear about the latest in deep-learning-based EPI for ultra-fast imaging and distortion-free diffusion-weighted imaging from Siemens Healthcare (Clifford et al; Zhou and Liu, respectively). Then three external articles focus on applications in multiple sclerosis. First, how the latest in diffusion MRI can underpin emerging models of disease (Schiavi and Inglese) aiming ultimately to inspire new and effective treatments and interventions. Second, an update on FLAIR Fusion (Bartsch et al.) and how the latest workflow enables robust longitudinal analysis in multiple sclerosis and beyond. Third, thoughts (from Kitzler et al.) on the pathways for translation of computer-assisted MRI assessments in multiple sclerosis to widespread usage in the clinic; thoughts which of course extend to much wider application areas. Attention then switches to epilepsy (Obusez et al.), one of the key demonstrators of how 7T can provide clinical benefit over 3T – blazing the trail for, we hope, a coming of age of 7T over the next decade as a widespread clinical tool. A key element of that maturity of course will be parallel transmit and (Massire, Boulant et al.) provide a welcome breakdown of the latest anatomical sequences available that exploit pTx on the MAGNETOM Terra[1].

Articles by Breit et al. and Sauernheimer in this issue focus on capability of the MAGNETOM Free.Max, highlighting the MR community's recent pursuit of increased accessibility. The former showcases musculoskeletal imaging on this platform, which opens availability to a broader subject base including for example patients with obesity, tattoos, implants, etc. who may find MRI exams unavailable to them on higher field, smaller bore systems. Finally, this issue offers snapshot updates from abdominal imaging, specifically elastography in the liver (Kolipaka et al.), cardiovascular imaging obtaining motion-corrected PET via a PET-MR platform (Munoz, Prieto, et al.), and prospects for sustainability of MR for future generations (von Grätz).

The theme of accessible MRI – devices and analysis techniques that can be deployed to and utilised effectively in low-resource settings and/or are open to wider groups of participants – has come strongly to the fore over the last two pandemic years. Viable portable technology has been a long-standing challenge for the MR community. The convergence of advances in MR hardware and in AI-driven optimised acquisition and reconstruction algorithms have made this a reality. The launch of the Hyperfine Swoop system on the open market is a clear landmark in development. Other systems are close on its heels. Portable systems typically use < 0.1T magnets largely through necessity. However, low-field (< 1T) non-portable systems also offer appeal. They have lower cost of both manufacture and installation, smaller footprint, can accommodate

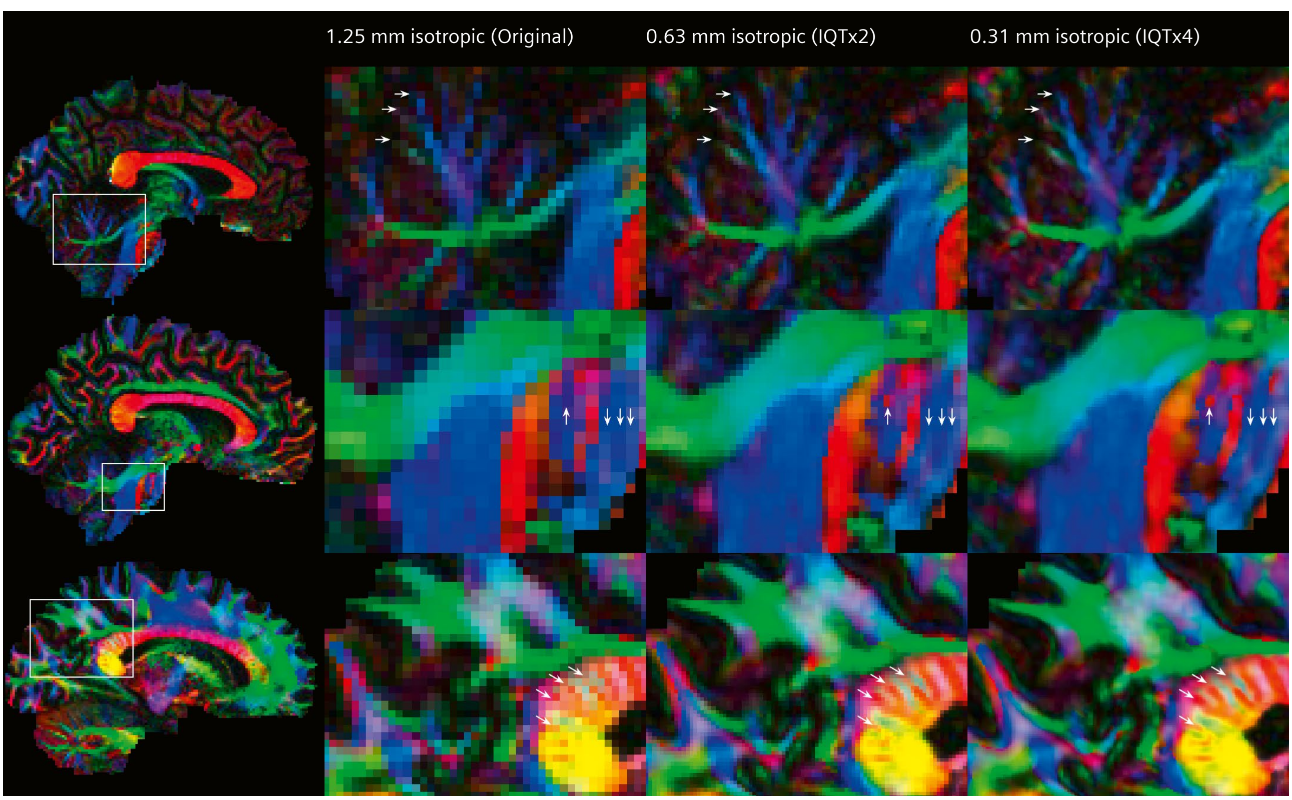
[1]For MAGNETOM Terra, pTx technology is included in Research mode (as part of the optional Dual mode) and is not intended for clinical use. Research operation may require observation of national regulations.

patient groups that cannot be imaged at higher field as mentioned above, can image body parts (e.g. the lungs and other areas with abundant air/tissue interfaces) more effectively than at higher field, and potentially offer different contrasts to higher fields by accessing different relaxation regimes. The launch in 2021 of the MAGNETOM Free. Max is another significant recent landmark, showing the return of mainstream MR manufacturers to these lower field strengths.

So existance proofs show these technologies are viable, and clearly scenarios exist where they offer an advantage. But questions and challenges remain. In what set of clinical scenarios do they offer enough advantage over competing technologies to support an emerging market? Can they compete with, say, ultrasound or X-ray in low-resource settings? Do they offer enough unique capability compared to higher field systems in high resource settings? There is also no doubt that such devices open up compelling research questions. What minimal set of measurements is sufficient to reconstruct a clinically useful image? Will the challenges in sparse image reconstruction drive new frontiers in machine learning? In general, how can advances at the forefront of MRI technology genuinely add value in low-resource settings?

Answers to the last question in particular may come from surprising places. My own experience of working to repurpose state-of-the-art technologies designed for application in high-income countries (HICs) for benefit in lower-and-middle-income countries (LMICs) have been challenging but inspiring, always surprising, sometimes shocking. I have long had a vision of democratising high end imaging tools through machine learning. That vision inspired my work on image quality transfer (IQT); see figures 1 and 2. In 2013 a consortium of UK researchers, led by Derek Jones in Cardiff, UK, obtained funding to work with Siemens Healthineers to install the Connectom[2] scanner in Cardiff. Being part of that team gave me the impetus to develop the first IQT implementation aiming to estimate, given an image from a standard hospital scanner, the image we would have got by transporting the patient to the super-scanner in Cardiff (Fig. 1). Soon afterwards,

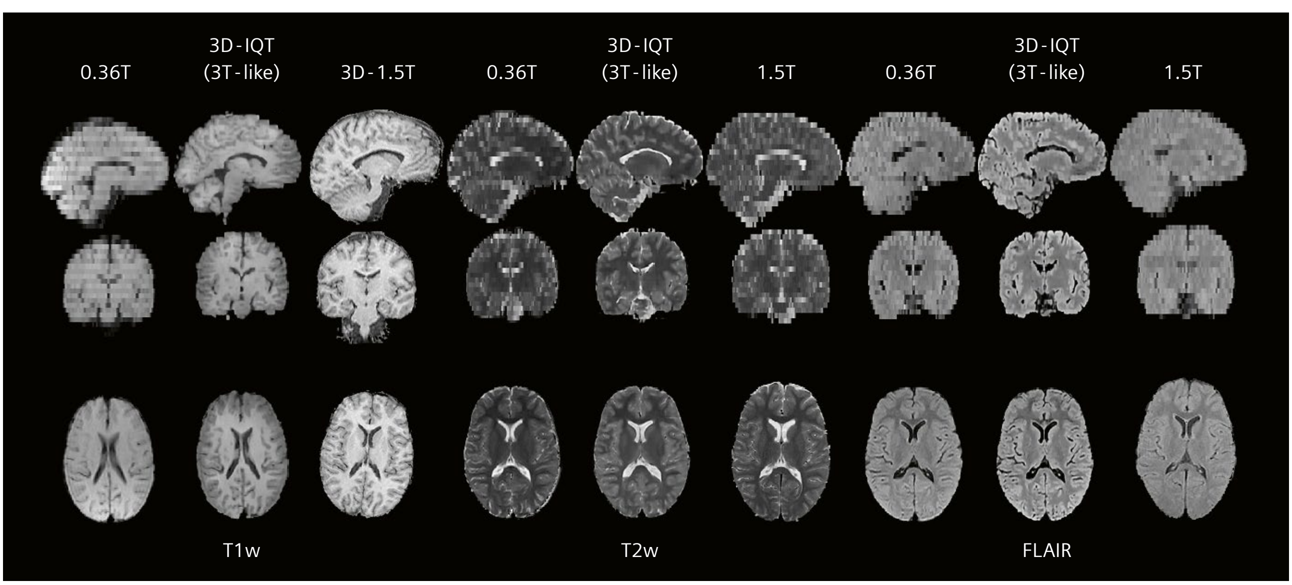
[2] *MAGNETOM Connectom is ongoing research. Siemens Healthcare does not intend to commercialize the system.*



1 Enhanced resolution and contrast from Image Quality Transfer (figure from Alexander et al. Neuroimage 2017). The original implementation (Alexander et al. MICCAI 2014; Neuroimage 2017) used a simple patch-regression approach via random-forest machine-learning. Later implementations, e.g. (Tanno et al. Neuroimage 2021; Iglesias et al. Neuroimage 2021), use deep learning, which improves performance substantially. This initial demonstration aims to estimate specialized diffusion MR images from high gradient systems (MAGNETOM Prisma / Connectom) given an input image from a more standard hospital scanner. It reveals hidden detail and can enhance tractography of small pathways.

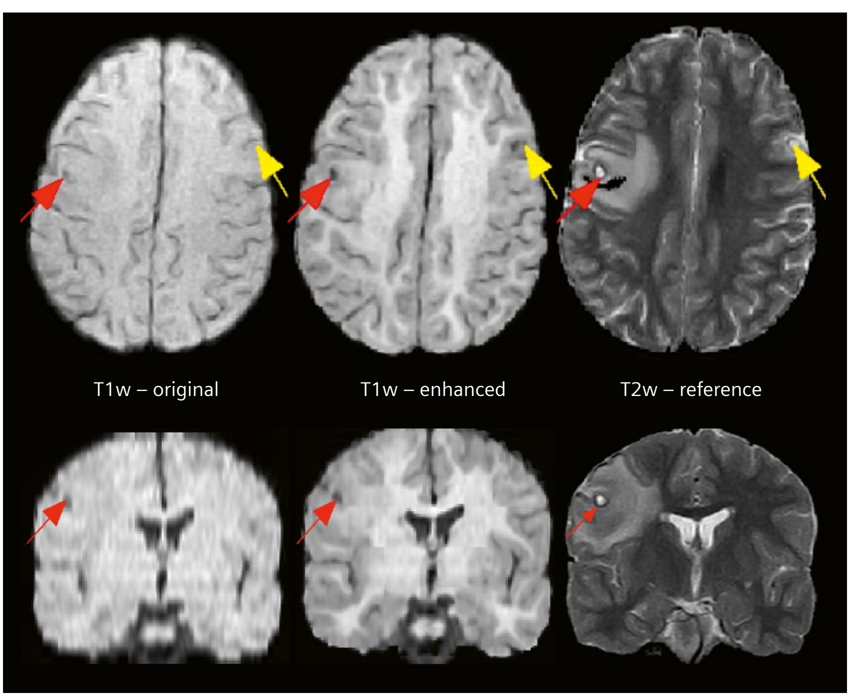
I established a collaboration with the University College Hospital in Ibadan, Nigeria with the aim of repurposing the IQT technology to enhance images from low-field MRI scanners, specifically their workhorse 0.36T open permanent-magnet system (Fig. 3), to estimate the image we would have obtained by flying a patient to London and imaging them with a modern 1.5T or 3T machine (Fig. 2 and 4). Their system is typical of LMIC scenarios; the choice is driven by low cost, availability of machine and maintenance, ease of installation, and robustness to frequent failures of power infrastructure. But of course, images from such systems lack the resolution and contrast of standard HIC systems, and that can prevent their usage for clinical decisions such as treatment planning for epilepsy; see figure 4.

Sounds like a great idea? It is! And quite rightly in 2017 the UK government's Global Challenges Research Fund awarded a team of us from UCL and Ibadan funding to develop the idea. But ... I'll leave the detail of the project itself for drinks at ISMRM evening events, and just give a few thoughts on the experience. First, I cannot emphasise enough the absolute necessity of local partners who believe in the project. Basic logistical challenges are impossible without them: recruiting patient cohorts, implementing scanning protocols compatible with local clinical workflows, navigating hospital administration, negotiating transportation, scan time, insurance, etc. etc. etc. But the partnership must run deeper. The idea of parachuting in with a cool machine-learning technology from London and revolutionising local radiology overnight is fantasy. Key application areas to demonstrate the potential and the adaptation of the underlying technology accordingly must be co-created to have a hope of gaining traction as a research initiative let alone translation as a clinical tool. Second, we must strive to understand the context. On first arriving at the hospital in Ibadan to discuss my "cool machine-learning technology from London" I was immediately struck by what a luxury item it is. Can we justify spending time and money on this when the hospital lacks basic capability like modern computers and internet? Those basic capabilities do need addressing, but nevertheless advanced "luxury" projects can help. They inspire forward thinkers to expedite change well beyond what the project envisioned. The most immediate impacts of our IQT-Nigeria project were not directly scientific, but more educational and cultural. They arose for example from getting radiologists in Nigeria and London together to exchange ideas and expertise on image assessment in different scenarios – both sides benefit hugely. We also used our visits to Ibadan to initiate training opportunities for computer science students and staff bringing new computational challenges to an immense pool of local talent and enabling sharing of experiences and ideas between UK and Nigerian computer scientists. The project itself also



2 Image quality transfer adapted to enhance structural images from a 0.36T scanner in Ibadan, Nigeria, to approximate the image that would have obtained by imaging the same subject at high field. The operation substantially enhances through-plane resolution and in-plane contrast (Images from Lin et al. MICCAI-MLMIR 2019).

3 The MRI suite and team at University College Hospital Ibadan, Nigeria, including my primary collaborators and friends in Ibadan, Ike Lagunju and Godwin Ogbole, and my wonderful colleague Delmiro Fernandez-Reyes at UCL.



4 A particular case study from the project applying IQT to low-field images from Ibadan. This patient has lesions that are barely visible in the low-field T1-weighted image, but IQT substantially enhances conspicuity (from Lin et al. MICCAI-MLMIR 2019).

dedicate time to engage fully with diverse often unfamiliar stakeholders. However, at least in my experience, the rewards are manifold and unexpected. My small IQT-Nigeria project has been one of my favourites over the years. I fully intend to continue the work it started and encourage others to explore similar opportunities.

I hope this issue of MAGNETOM Flash and this year's ISMRM inspire more work at both the cutting edge on high end platforms and in pushing forward accessible MRI, and perhaps most importantly how the two endeavours can inform one another. Looking forward to seeing everyone in London soon!

We appreciate your comments.
Please contact us at magnetomworld.team@siemens-healthineers.com