Abstracts

Method A design collaboration including a specialist MRI small-medium enterprise, clinicians, physicists and national metrology institutes was formed. A T2 mapping phantom (figure 1 i) was designed to cover clinically relevant T1 and T2 times in native and post-contrast myocardium across field-strengths (figure 1 ii,iii,iv). Two earlier prototypes had been manufactured and tested, with the third and final one being reported here.

Results The T2 mapping phantom which can be used at both 1.5 and 3 Tesla is an agarose gel-based phantom using nickel chloride as the paramagnetic relaxation modifier. It contains nine differently-doped agarose gel tubes embedded in a gel/beads matrix.

The phantom was free of air bubbles and susceptibility artifacts at both field strengths (figure 1 ii) and T2 maps were free from off-resonance artifacts (figure 1 iv). The incorporation of high-density polyethylene beads in the main gel fill was effective at flattening the B0 and B1 fields (figure 2 i,ii). T1 and T2 times measured in the phantom showed coefficients of variation of ≤1% between repeat scans indicating good short-term reproducibility. Temperature dependency experiments conducted at the national metrology institutes (figure 2 iii) confirmed that the range 13–40°C the short-T1/2 tubes were more stable with temperature than the long-T1/2 tubes.

Conclusion The program has developed a T2 mapping phantom for CMR replicating clinically relevant T1/T2 times across myocardial health and disease. The device will be shortly listed under the Food and Drug Administration (FDA) database and Conformité Européenne (CE) marking. Reproducible mass manufacture of this phantom may now commence to support the use of T2 mapping in longitudinal cohort studies, multicentre research or inflammation imaging.

Abstract 11 Figure 2 (i) B0 field homogeneity across the nine phantom compartments as a measure of off-resonance in hertz at 1.5T (red) and 3T (blue). These are extremely small shifts in frequency (e.g., 10 Hz = 0.08 ppm at 3T) and should not be regarded as significantly different between the tube compartments. (ii) T2 phantom field map at 3T showing B0 homogeneity across the device cross-section. (iii) Temperature tests carried out at PTB–German Physikalisch-Technische Bundesanstalt (Left) –using a 3T Siemens Magnetom Verio system (VB17) and a 12-channel head coil and at NIST–US National Institute of Standards and Technology (Right) –using Agilent 3T small bore scanner. T1 was measured by IRSE (TR [s] = 10, T1 [ms] = 50, 75, 100, 125, 150, 250, 500, 1000, 1500, 2000, 3000, 6000) and T2 by SE (TR [s] =10, TE [ms] =14, 28, 56, 112, 224); resolution: 0.5×0.5 mm; slice thickness: 2 mm. (iv) Comparison of reference T1/T2 times (by IRSE/SE respectively) to those obtained by MOLF (53(3)) and T2 mapping (SSFp) at 1.5T (Siemens Aera operating VE1C) and 3T (Siemens Prisma operating VE1C). TE=echo time; TR=repetition time. Other abbreviations as in figure 1.
prolongation (respectively \( \beta = 0.3 \) ms [95% confidence interval 0.01–0.64] \( p = 0.048 \); \( \beta = 6.0 \) ms [1.85–10.05] \( p = 0.006 \); \( \beta = 4.9 \) ms [0.22–9.60] \( p = 0.041 \)) and, \( T_2 \) and ECV with ARI prolongation (\( \beta = 5.9 \) ms [1.88–9.92] \( p = 0.005 \); \( \beta = 4.8 \) ms [0.40–0.12] \( p = 0.033 \)). All associations persisted after adjusting for LVEF.

**Conclusion**
The normal electrophysiological sequence of activation and repolarisation in the human heart changes markedly with ageing and may be explained by CMR-detected myocardial substrate changes consisting of low-grade inflammation and diffuse fibrosis. Our high-throughput and reusable CMR-ECGI solution has the ability to provide unprecedented insights into the pathophysiology of arrhythmogenesis beyond conventional measures of cardiac structure and function.

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**Intervention**
Changes in left atrial (LA) phasic function – defined as reservoir function (filling), conduit function (passive emptying), booster function (active emptying) (figure 1A) – are thought to precede structural changes (dilatation) of the