# Efficient Generation of Cardiac Digital Twins for Personalized Atrial Fibrillation Treatment Using Non-Invasive ECGI Data

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**Introduction.** Atrial Fibrillation (AF) is a prevalent cardiac arrhythmia. AF poses significant challenges to patient well-being and longevity as current treatments are not effective and personalized as desired. While cardiac modelling has advanced considerably, the translation of these models into personalized therapies remains challenging. This paper proposes a framework leveraging Digital Twins (DTs) based on non-invasive electrocardiographic imaging (ECGI) to enhance the planning and efficacy of ablation procedures.

**Methods.** The performance of the framework is tested against AF benchmark simulations. ECGs are obtained by situating benchmark simulations within a torso, solving the forward problem, and adding Gaussian noise with a 10 dB singal-to-noise ratio. After the ECGI calculation, DTs are personalized using ECGI-derived metrics, as Dominant Frequency (DF) maps, to modify tissue properties (diffusion coefficients and Action Potential Duration restitution curves) and simulate arrhythmia dynamics.

**Results.** The DF comparison between benchmark simulations and DTs shows have a mean CC of 0.68 (+/- 0.12), a mean MAE of 1.15 (+/-0.23) Hz and a mean RMSE of 1.41 (+/-0.21) Hz. The mean CC of the High-DFs areas was 0.67 (+/- 0.06) and the mean distance between high rotational areas was 1.92 (+/- 0.53) cm. Additionally, the ablation strategy effective in stopping arrhythmia in benchmark simulations also works in DTs.

**Conclusions.** The framework efficiently generates DTs that replicate benchmark dynamics using non-invasive data, with DF maps playing a crucial role in DT personalization. With its reliance on non-invasive data and efficient computational methods, the framework shows potential for real-time clinical use, assisting personalized AF ablation strategies.