**Introduction**: Substrate maps (SMs) are often acquired during ablation of complex arrhythmias. An important limitation of SM is that recorded voltages are affected by orientation of the electrode bipole with respect to activation wavefront direction, so SMs may not truly reflect voltage properties of the underlying substrate. Recently, a multi-electrode catheter utilizing a grid design was introduced; this was designed for use in conjunction with a software algorithm where each electrode is part of ≥2 bipolar configurations, and the annotated voltage for that electrode would be the highest recorded value for all configured bipoles. In theory, this should reduce dependence of SM voltage on wavefront direction. In this study, we explore the effect of different bipole configurations on recorded SM.

**Methods**: We retrospectively analysed SM acquired using the Abbott HD Grid / ESI Precision mapping system. Each map was re-processed using 4 different Grid configurations through the ESI Turbomap feature – (i) horizontal 12 electrogram (EGM) “H12” (ii) vertical 12 EGM “V12” (iii) manufacturer-recommended ‘HD Wave’ 18 EGM “HD18” and (iv) a custom 48 EGM configuration “HD48”. Peak-to-peak voltage data for each was then exported from the mapping system. Percentage of EGMs falling into conventional scar/border zone/healthy tissue thresholds were calculated (0.1-0.5V for atrial and 0.5-1.5V for ventricular cases).

**Result**: SM of 55 tachycardias from 36 patients were analysed (473625 atrial, 161630 ventricular mapping points). Mapped chambers were RA (18), LA (24), LV (7), RV (3), epicardium (3). Mapped rhythms were AF (8), AFLU (26), sinus (10), atrial pacing (5), ventricular pacing (6). Mean voltage of each atrial point was not different between H12 and V12 (0.73V for both). However, both HD18 and particularly HD48 configurations showed increased voltages – 0.83V and 1.01V respectively, corresponding to a 13.7% and 38.4% increase over H12. Mean voltage of the HD48 configuration was 21.7% higher than for HD18. Mean voltage for each ventricular point steadily increased from 2.12V (H12), 2.42V (V12, 14% increase over H12), 2.63V (HD18, 24.1% increase over H12) to 3.29V (HD48, 55.2% increase over H12). Mean voltage of the HD48 configuration was 25.1% higher than for HD18.
Conclusion: We confirm that directionality is an important effect when acquiring SM. We show this effect is reduced when using a grid-design catheter coupled with a novel software algorithm. We also show that a custom HD48 configuration is able to record even higher voltages than the manufacturer-recommended HD18 configuration. The increase in voltage is significant (21.7% for atrial and 25.1% for ventricular SM) and can affect clinical interpretation of SM. We conclude that use of HD48 for SM may be preferable compared to HD18 and deserves further study.