**Target.** Hyperpolarized 13C and multiband imaging researchers.

**Purpose.** DNP-dissolution MRI is a novel method for imaging in vivo metabolism in real-time [1], with increasing clinical relevance following completion of the “first in-man” clinical trial [2]. Spectral-spatial excitation can be used to image single spectral lines using rapid single-shot imaging readouts [3], and full 3D volumes can be imaged in a multi-slice mode by cycling through each resonance and slice position. For substrates with many downstream metabolites (e.g. following infusion of pre-polarized [2-13C] or [1,2-13C] pyruvate, or multiple polarized substrates), excitation of metabolic resonances one at a time is challenging due to limited available scan time. Simultaneous multi-slice (SMS) imaging can reduce imaging time with limited g-factor penalty [4]. Here, we investigate the feasibility of combining SMS acceleration with spectral-spatial excitation.

**Methods.** Pulse sequence. A SMS excitation pulse (Fig. 1) was constructed by summing phase-modulated spectral-spatial RF pulses [5] exciting single slices (duration 23 ms, passband 113 Hz, stopband 1600 Hz). The resulting spectral-spatial profile was found to be linear for flip angles between 0 and 90°. A single-shot EPI sequence was modified to include multiband excitation and CAIPIRINHA blips (Siemens 3T Trio, 7 slices, slice thk 6 mm, gap 20 mm, 96x48, FOV 250x125 mm², TR 1s, TE 30 ms, FA 90°, B1,max = 0.0019 mT/slice). Controlled aliasing was used to introduce a FOV/3 inter-slice shift to reduce g-factor noise amplification. In-plane compartment phantom containing tubes with varying proportions of water and acetone (v/v 0%, 25%, 50%, 75%, 100%; relative 1H chemical shift 250 Hz) was scanned using a 32 channel head coil. 13C data acquisition. Dynamic 13C single-shot spiral images from SPF pigs were acquired [6] using a 5-channel 13C cardiac array [7] and retrospectively regridded to a 36x18 matrix (2 slices, TR 2.5 s, FOV 360x180 mm², in-plane resolution 10x10 mm², slice thk 10 mm, gap 22 mm). A FOV/2 inter-slice shift was simulated and used to construct aliased data. Image reconstruction. Split slice-GRAPPA [8] (kernel: 1H: 5x5, 13C: 3x3 points, 1H reference: water images, 13C reference: 4° pyruvate frame) was used to unalias the multiband images.

**Results.** Figure 2 shows images of the water/acetone phantom obtained using SMS excitation. The multi-slice spectral-spatial pulse selectively excites water and acetone, and the aliased data was successfully separated using the split slice-GRAPPA method. Figure 3 shows a 20-fold scaled difference image. Figure 4 shows retrospectively reconstructed images of pyruvate and bicarbonate in the porcine heart using SMS reconstruction.

**Discussion.** The water/acetone phantom used in this study has a similar chemical shift to the 3T 13C chemical shift between [1-13C] pyruvate and [1-13C] lactate or 13C-bicarbonate, suggesting that our results are, in principle, directly translatable to the corresponding hyperpolarized experiment. We demonstrate that the water image can be used to encode the coil sensitivity for image reconstruction (7-fold acceleration). We also demonstrate that retrospectively aliased 13C cardiac images obtained with a 5-channel array can be reconstructed using this method (2-fold acceleration). This strategy is similar to using the abundant pre-polarized [1,2-13C] pyruvate signal to encode and measure imaging parameters such as transmit B1 using the Bloch-Siegert effect [9]. The development of multi-nuclear receiver coil arrays for 13C imaging [10] will facilitate rapid translation of this method. While the duty cycle for the HP 13C experiment is inherently low due to the need to preserve polarization, we anticipate that scan time reduction using SMS excitation will enable new applications. In particular, scan time is freed up to obtain additional information, including proton navigators (motion compensation), proton B0 maps, B1+ maps, as well as enabling spectral-spatial excitation when many metabolites are present (e.g. [1,2-13C] pyruvate or multiple polarized substrates).

**Conclusions.** We demonstrate the feasibility of using SMS spectral-spatial excitation to selectively image multiple metabolites, and that images of one metabolite can be used for GRAPPA reconstruction of images of another metabolite. We anticipate that the scan time reduction provided will enable new applications in hyperpolarized 13C MRI.