Areal Density Comparison between Conventional, Shingled and Interlaced Heat Assisted Magnetic Recording with Multiple Sensor Magnetic Recording

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I. INTRODUCTION

Heat Assisted Magnetic Recording (HAMR) is the next generation hard disk drive technology which enables continued and significant areal density growth [1]. There are currently three write architectures for the layout of tracks in hard disk drives: Conventional Magnetic Recording (CMR) Shingled Magnetic Recording (SMR) and Interlaced Magnetic Recording (IMR). In CMR, any track can be written at any time and neighboring tracks do not intentionally overlap. In SMR, the tracks are written sequentially in bands with the tracks intentionally overlap like shingles on a roof [2]. In IMR, the tracks are written in an interlaced order with different linear densities [3-4]. The system performance penalty for IMR is similar or less than SMR and will depends on the architecture and workload of the drive [5]. The read-back architecture Multi-Sensor Magnetic Recording (MSMR) can be combined with the three different write architectures to increase areal density [6-7] by using two or more readers to read-back the same track. In this paper, we compare the areal density capability (ADC) of HAMR CMR, HAMR SMR and HIMR combined with read-back with one reader, MSMR with 2 readers (MSMR-2R) and MSMR with 3 readers (MSMR-3R).

II. EXPERIMENTAL DETAILS

We investigated the ADC for HAMR CMR, HAMR SMR and HIMR combined with MSMR-2R and MSMR-3R on a spinstand using the ASTC areal density metric [8]. Ten HAMR heads were used. The heads and media were similar to those used in previous studies [4, 7]. Spinstand measurements were with writer current 55mA, active reader and writer clearance of 1 nm, radius of 23 mm, skew 0° and 4200 rpm with linear velocity of 10.2 m/s. Channel areal density (Tflux/in^2) was measured. The MSMR gain with 2-3 readers was calculated with multi-spin captured waveforms from the spinstand with the native HAMR reader processed by a MSMR 2 and 3 reader software channel. A code rate of 0.88 was used to calculate user areal density (Tbit/in^2).

II. RESULTS

The ADC of the ten HAMR heads yielded an average HAMR CMR ADC of 1.34 Tbit/in^2 with 1 reader, 1.40 Tbit/in^2 with MSMR-2R and 1.43 Tbit/in^2 with MSMR-3R. HAMR SMR observed ADC of 1.68 Tbit/in^2 with 1 reader, 1.74 Tbit/in^2 with MSMR-2R and 1.77 Tbit/in^2 with MSMR-3R. HIMR observed ADC of 1.83 Tbit/in^2 with 1 reader and 1.88 Tbit/in^2 with MSMR-2R and 1.91 Tbit/in^2 with MSMR-3R. The best head with HIMR + MSMR-3R achieved 1.94 Tbit/in^2 which is very close to the previous record 2.0 Tbit/in^2 with HAMR SMR + MSMR-3R.

II. CONCLUSION

The interlaced track layout architecture enables further increases in HAMR areal density capability which is favorable for the hard disk drive markets with a system performance penalty less than shingled magnetic recording. HIMR and HAMR SMR when combined with MSMR can achieve very similar areal density.

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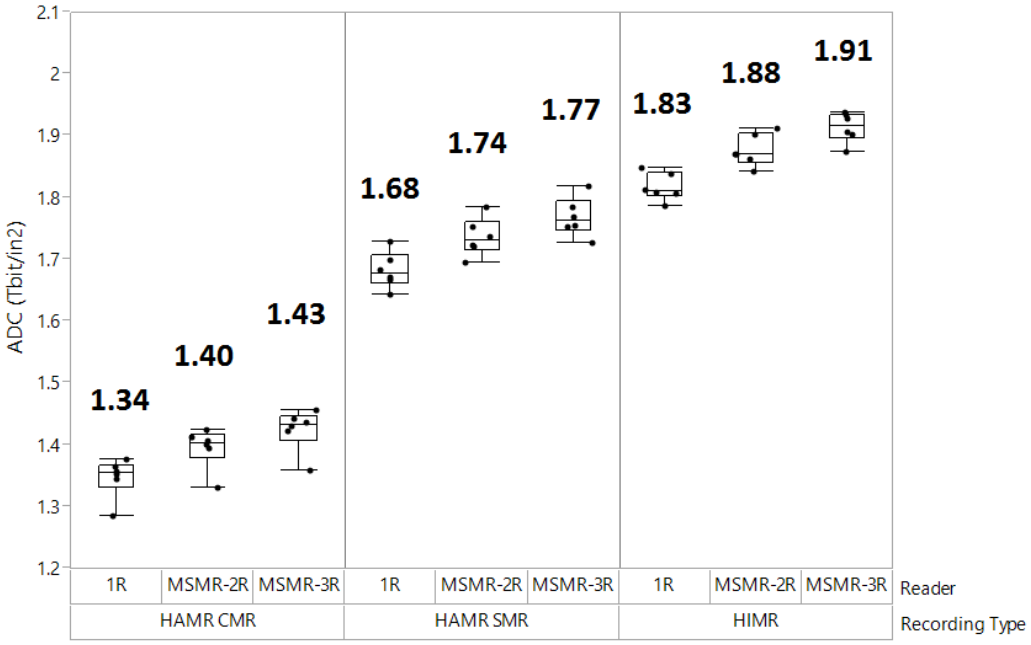

Figure 1: Areal Density Comparison between Conventional, Shingled and Interlaced Heat Assisted Magnetic Recording with Multiple Sensor Magnetic Recording

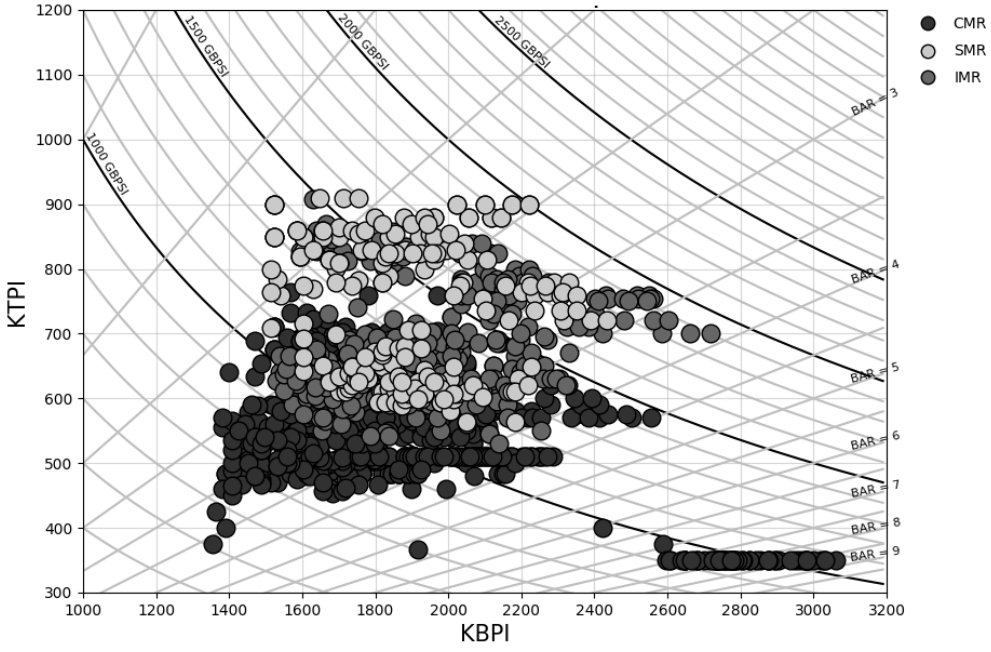

Figure 2: HAMR CMR, HAMR SMR and HIMR: ASTC Areal Density