INTERFERENCE FROM ADJACENT TRACKS IN HAMR RECORDING SYSTEMS: SIDE-READING AND ENCROACHMENT

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I. INTRODUCTION

The linear density capability of a head-media combination in a drive environment will deviate necessarily from its intrinsic capability due to factors such as readback interference from adjacent tracks, the existence of pre-existing data on the medium, and encroachment from subsequently written tracks. Due to the differences in head structure, media composition and structure, and recording physics of heat-assisted magnetic recording (HAMR), the influences of these various factors on recording performance differ substantially compared to conventional or shingled perpendicular magnetic recording (PMR).

II. RESULTS

In this study, the effects of pre-existing data (“background tracks”) and subsequently written data (“foreground tracks”) are examined separately to understand the relative contributions due to encroachment and side-reading. The effects of side-reading are measured by comparing the bit-error-rate (BER) of a data track written on a high-frequency AC background (band erased), which presumably has a minimal amount of readback interference, with data tracks written on a pair of background tracks at various distances off-track from where the main data track is then written. The difference in BER is attributed to background interference effects, which are due to side-reading and any written-in interference [1]. The effects of encroachment are measured by comparing BER of a track before and after the writing of two foreground tracks written at a full track width to either side of the data track. The foreground tracks themselves will also cause interference during readback due to side-reading, much as the background tracks.

Figure 1 shows the average data from 20 heads measured at seven different datarates ranging from approximately 65% to 100% of the nominal datarate for the head design. In all cases, the BER after the foreground tracks are written is the same, regardless of the background condition, indicating that the background condition does not significantly affect the write process for HAMR recording. The data labelled “Full BG” have the background tracks written at the same location as the later foreground tracks. Since the two conditions (before and after writing of the foreground tracks) should have similar degrees of side-reading, the difference between them can be attributed primarily to encroachment.

For the HAMR system, the data indicate that encroachment and side-reading result in a similar amount of on-track performance degradation compared to the intrinsic BER of the track. Similar measurements on a PMR system show a lower effect due to side-reading. The effects of both decrease at higher datarates, due in part to the higher bit density of the tracks, which results in lower and more localized stray fields from the media, but also due to the higher base error rate, which makes the channel detector less sensitive to additional noise sources.

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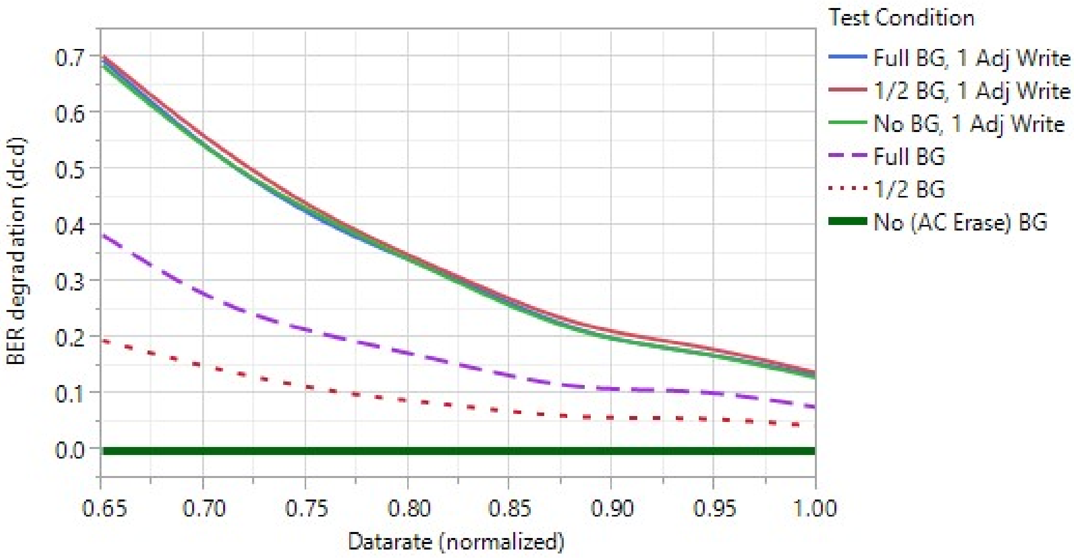

Fig. 1. Performance degradation due to background data and adjacent tracks in a HAMR recording system. "Full BG" indicates the background data is at a full track spacing from the center position where the main data track is written. "1/2 BG" indicates the background data was written at approximately 40% track spacing from the center position. Foreground tracks (labelled with "1 Adj Write") are always written at a full track spacing offset. For conditions with foreground tracks, all three lines overlap, indicating the background condition has no effect in these cases but the foreground tracks data have the same side-reading effect as the background data.

A micromagnetic model of a read sensor of similar structure as the one used in the experiment is also constructed to better understand the empirical data. Various different recording and media properties are varied, such as head-media spacing (which is larger in present HAMR systems due to thicker head and media overcoats), storage layer geometry, and the placement/existence of a soft underlayer in the media. It was shown that differences in these factors between HAMR and PMR recording systems can account for the large side-reading effect in HAMR.

REFERENCES

1) J. Fernandez-de-Castro, et al., "Measuring and understanding write width and off-track as a function of linear density in perpendicular recording", *J. App. Phys.,* 111, 07B702 (2012).