

Bit Patterned Recording Media: Progress and Remaining Challenges

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Granular media versus bit patterned media approach

write assist: ECC, HAMR, MAMR

Media SNR, Media Writeability, Thermal Stability & ATI

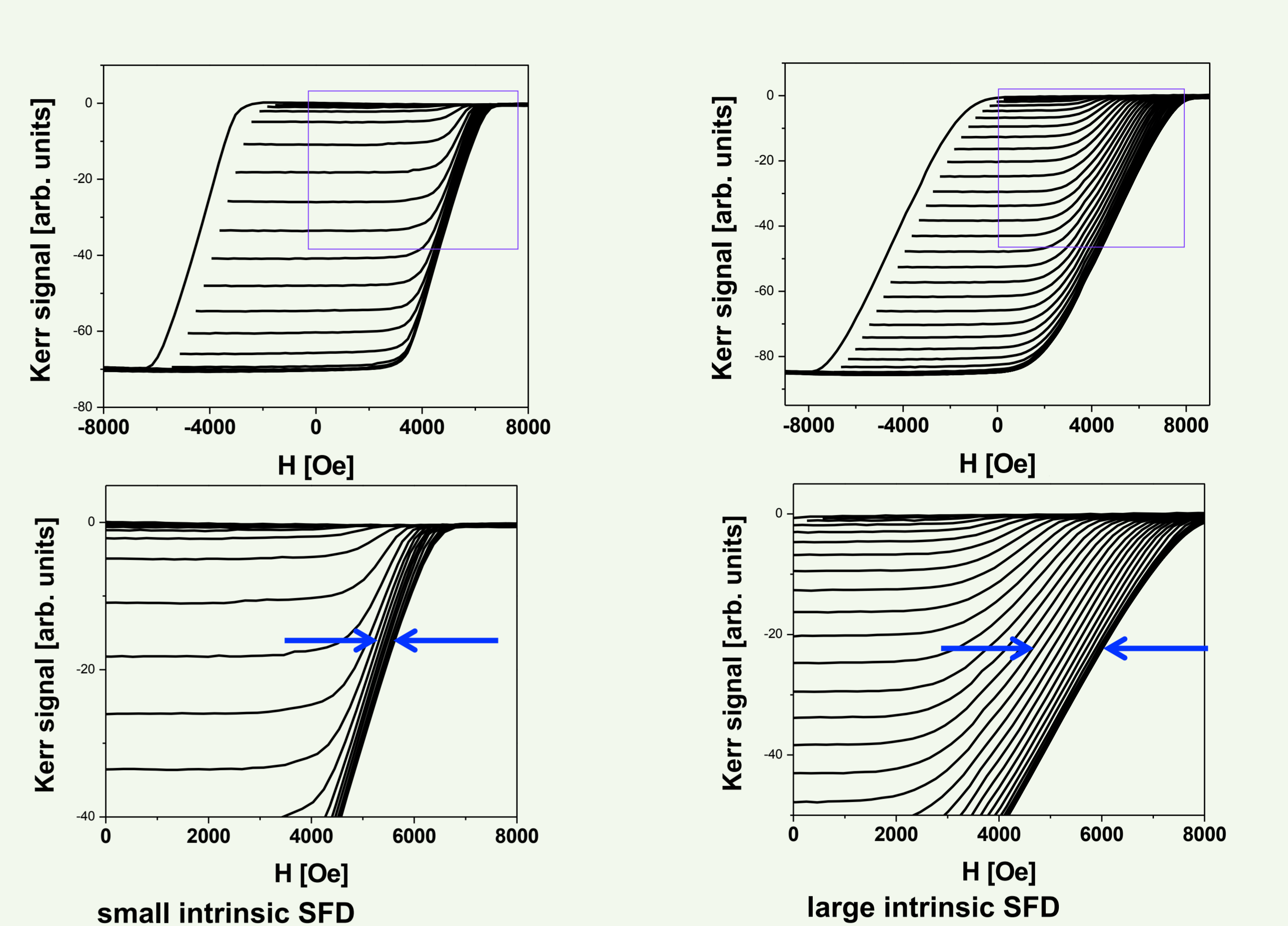
smaller grains

Conventional granular media vs Bit patterned media

100 nm scale bars

- granular media: simplistic "trilemma" reasoning doesn't tell the whole story
- SNR gains with grain scaling are difficult to achieve (even in HAMR)
- BPR is different: It does not rely on engineering statistical grain properties
- instead a narrow magn. SFD is needed
- suitable magnetic materials exist!
- good SNR, therm. stab. and writeability → extendible to higher areal density
- island mass fabrication and drive integration are the major challenges

Example minor loop data for small and large iSFD



Dipolar interactions and intrinsic SFD in BPM

field reversal

first island reversal field is lowered by dipolar fields of neighbors

last island reversal field is increased by dipolar fields of neighbors

MFM: 50 nm islands on 100 nm pitch

MFM: 38 nm pitch 500 Gb/in²

dipolar vs intrinsic

Crystal size distribution, Crystal boundary, Etch damage, oxidation, Interface mixing, Discontinuous interfaces, Strain variation, c-axis distribution, Substrate

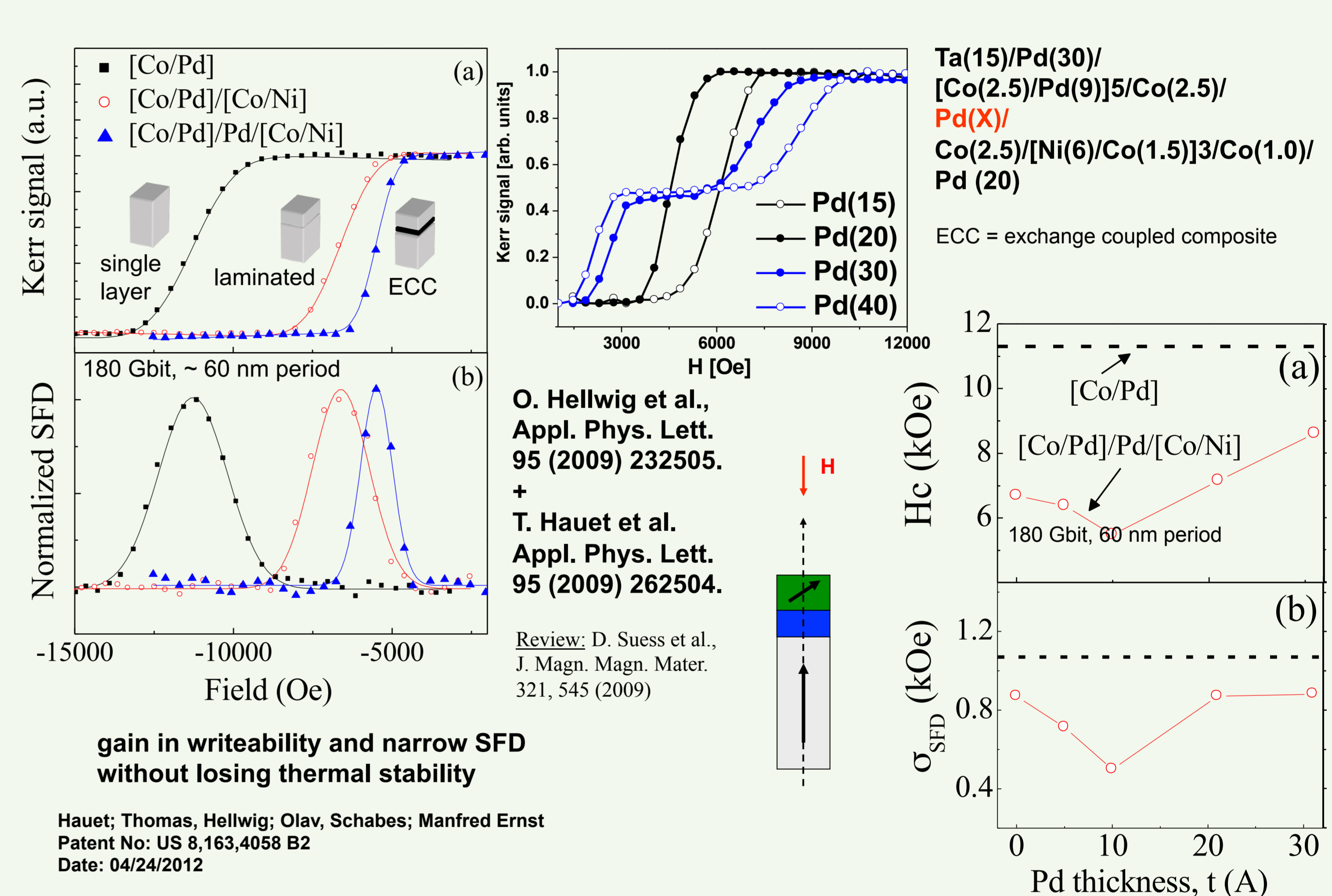
Co map

320 Gb/in²

How can we measure relative contributions of dipolar and intrinsic part?

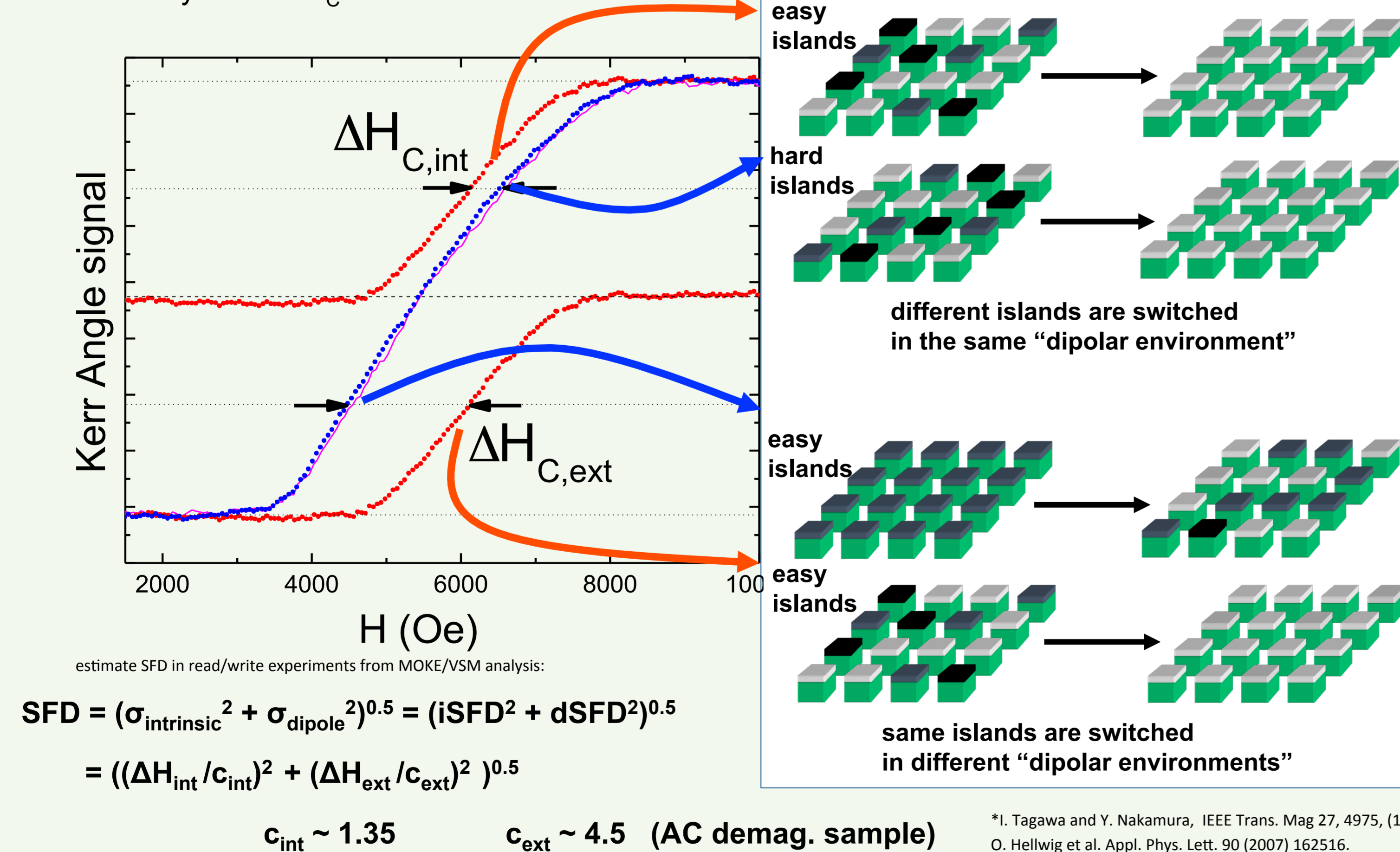
Engineering the reversal mechanism

→ de-couple hard and soft ML parts (create ECC type of media)



Experimental technique for extracting the intrinsic SFD

SFD analysis via ΔH_c method*



HGST: Evolution of BPM fabrication techniques

- blanket deposition onto pre-patterned substrates
- ion beam irradiation (resolution issues)
- post-etching into initially full continuous films
- templated (epitaxial) media growth
- long-range order for BPM
- short-range order for conv. rec.

10 nm scale bars

Mag, Ru, PR

Template generated from parallel lamella lines (pitch ~ 27 nm)

GS Bales, A Zangwill PRL 63 (1989)