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CMRR Report

Center for Magnetic Recording Research

Number 24 Summer 2005

Research Highlight

CMRR partners with US government to evaluate the ability of various prototype and commercial instruments to securely erase modern high coercivity magnetic media

Contents:

Professors Wolf and Bertram Receive Awards

Jack Keil Wolf

Jack Keil Wolf, the Stephen O. Rice Professor of Electrical and Computer Engineering at UCSD and CMRR Endowed Chair, has been elected by the **American Academy of Arts and Sciences** as a Fellow in the class of 2005. According to Academy President Patricia Meyer Spacks, "Fellows are selected through a highly competitive process that recognizes individuals who have made preeminent contributions to their disciplines and to society at large." The Academy will welcome this year's new Fellows and Foreign Honorary Members at its annual induction ceremony on October 8, 2005 at the Academy's headquarters in Cambridge, Massachusetts.

The AAAS Fellow is Professor Wolf's fourth major award in the last six years. In 2004 he was selected by the IEEE to receive the Richard W. Hamming Medal for his "fundamental contributions to the theory and practice of information transmission and storage." He was the recipient of the Koji Kobayashi Computer and Communication Award, and the IEEE Information Theory Society's Claude E. Shannon Award in 2001. Professor Wolf is also a Fellow of the IEEE and a member of the National Academy of Engineering. He earned his Ph.D. in 1960 from Princeton University, and later taught at New York University, Polytechnic Institute of Brooklyn, and the University of Massachusetts at Amherst. Jack joined the UCSD faculty in 1984 and was the first chaired professor at CMRR.

H. Neal Bertram

Neal Bertram and CMRR graduate student **Kai-Zhong Gao** were jointly presented the **2004 INSIC Technical Achievement Award** "for their pioneering work in the exploration of tilted magnetic recording and the resulting insights contributed to the INSIC EHDR Research Program for advanced hard disk storage technology." The **INSIC Technical Achievement Award** recognizes "the contributor(s) of a specific technical achievement in an

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2005 Sheldon Schultz Prize for Excellence

The Schultz Prize is intended to recognize CMRR graduate students who have distinguished themselves through the creativity of their research and the impact of their publications

On May 11, 2005, the Sheldon Schultz Prize for Excellence in Graduate Student Research was awarded to Joseph B. Soriaga, a graduate student of Professor Paul Siegel. Joseph received his Ph.D. at the 2005 UCSD Graduate Studies Commencement with a dissertation entitled "On Near-Capacity Code Design for Partial-Response Channels." External letters of endorsement from industry and academia praised Joseph's fundamental contributions in several areas: the calculation of information-theoretic limits on the capacity of partial-response models for recording channels; the development of a channel architecture that uses spectral-shaping inner codes, interleaved low-density parity-check codes, and multi-stage decoding to approach the channel capacity; and the design of coding and detection methods for two-dimensional optical holographic recording.

Joseph Soriaga and CMRR Director Paul Siegel

Joseph is now a member of the technical staff at Qualcomm Corporate Research and Development in San Diego.

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INSIC Research Program, for a contribution judged to provide a significant advancement toward the Program's stated goals." This was Neal's second INSIC Technical Achievement Award. In 2000, he received the award jointly with Roy Gustafson (Seagate Corporation, retired) for "modeling and system simulations that supplied the insights needed to develop specifications for a realizable 100Gb/sq. in. hard disk drive system."

In 2003, Neal was awarded the prestigious IEEE Reynold B. Johnson Information Storage Award. Neal earned his Ph.D. in Physics from Harvard University in 1968. From then until 1984, he worked for Ampex Corporation. He joined CMRR as the second endowed chaired professor in 1985. Neal is the author of a highly regarded textbook entitled "Theory of Magnetic Recording" (Cambridge University Press, 1994).

From the Director

As the news items in this issue of CMRR Report illustrate, CMRR offers its sponsors access to outstanding faculty and researchers – as well as their students, post-docs, and visiting scholars – whose activities span the full spectrum of topics that are vital to continued advances in data storage technology. But CMRR is much more than the sum of these individual parts. As a multi-disciplinary center, CMRR fosters interactions and collaborations among these investigators and sponsor organizations that enable technical progress that would not otherwise be possible. Let me mention just three examples.

1. **Dr. Fred Spada's** investigation of secure bulk erasure of disk and tape media, featured in this issue's Research Highlight, uses state-of-the-art scanning microscopy tools as well as specially formatted drives that have been donated by sponsor organizations. This project returns valuable knowledge not only to the U.S. government agency funding the work, but also to the sponsor companies who manufacture both the drives and the bulk degaussing equipment used in the experimental studies.

2. Collaboration between **Professor Neal Bertram** and **Dr. Panu Chaichanavong**, a post-doctoral researcher in my group, resulted in a novel methodology for exploring the space of head/media parameters and coding/detection schemes for high-density, high-performance perpendicular recording. This work, supported by sponsor funds and by INSIC, relies heavily upon CMRR's broad expertise in recording physics, channel modeling, and signal processing.

3. A CMRR-wide effort in nano-patterned media recording is being launched, having grown out of technical discussions with sponsor organizations. This exciting initiative will address a range of technical challenges that must be overcome in order for this technology to succeed, such as: nanofabrication of media, design of write and read transducers, precise servo and write-timing control, air bearing design, realistic channel signal and noise modeling, and coding and detection techniques that can recover from synchronization errors and adjacent track interference.

To pursue projects such as these-which demand unique technical strengths, cross-disciplinary collaboration, and the active involvement of storage industry leaders-requires a special sort of research organization.
It takes a Center. It takes a place like CMRR.

Lake Arrowhead Conference 2004

The 24th CMRR Lake Arrowhead Interactive Workshop on Data Storage was held December 5-8, 2004. Nineteen technologists discussed topics of contemporary interest in magnetic recording and information storage in an open, interactive workshop setting. The workshop motto is "Let no foil go unchallenged."

Peter Baumgart from HGST gave a tutorial entitled "Flying Below 7nm Magnetic Spacing - A Discussion on the Smallest Achievable Spacing and the Necessary Developments in Metrology, Sealed Drives, Ultra-low-Mass Sliders, Vapor Phase Lubricants, and Contact Recording."

The first workshop session was on "High Density Recording: Perpendicular Recording Issues"; the second session on "Alternative High Density Recording"; the third session on "Spin Torque Magnetic Switching"; and the final session covered "Particulate Recording."

For further details, contact the Workshop chair; Gordon Hughes, at gfhughes@ucsd.edu

Research Highlight

Secure Bulk Erasure of High Coercivity Magnetic Media

by F. Spada and P. Shchupak

Introduction

Recorded magnetic patterns will remain on magnetic media surfaces until the original patterns are rendered unrecognizable via exposure to a sufficiently strong magnetic field. Bulk erasure methods, which expose entire disk drives or removable media cartridges to strong AC or DC magnetic fields, are often preferred and sometimes essential when erasure must be performed quickly. Media containing extremely sensitive data must be *secure erased*, which is defined as erasure so that the magnetic patterns cannot be recovered or reconstructed by any known means. Bulk erasure methods satisfy this criterion when the original patterns have been erased to the noise level of the magnetic medium.

As part of a program funded by the U.S. government, we have been evaluating the ability of various prototype and commercial instruments to securely erase modern high coercivity magnetic media. These studies require unique approaches for different magnetic media formats. For example, hard disk drives do not function properly even after inefficient bulk erasure operations because the factory-written magnetic servo patterns, drive motor, recording head, and head actuator mechanism are all affected by the erasure fields. The original drive assembly therefore cannot be used to recover and analyze remnant patterns on the disk surfaces. Spin stands are impractical for playback of the partially erased patterns because mechanical tolerances prevent precise alignment of the spin stand axis with the geometric center of tracks having submicron widths. However, the Scanning Magnetoresistance Microscope[1] (SMRM), also known as a “dragtester,” can readily accommodate media removed from drive bodies, either as entire platters or disk fragments, and has proven to be a very useful tool in our secure erasure studies of hard disk media. We describe its use in this report.

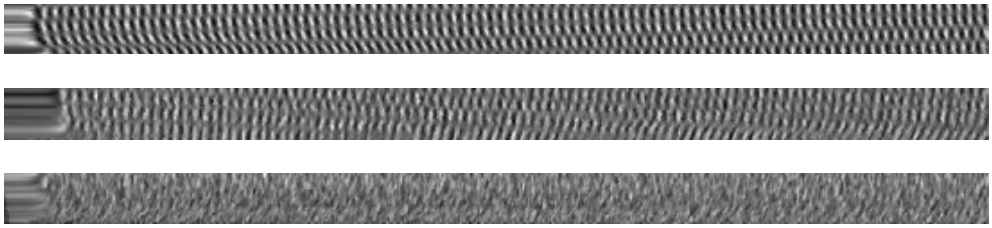
Experimental Details and Results

CMRR sponsor companies provided both the sliders and the drives for our SMRM experiments. GMR sensors were 0.14 μm wide, and the drives contained disks having a factory-written constant frequency pattern on all tracks. The special patterns permitted Fast Fourier Transform (FFT) techniques to be used for analyzing the degraded magnetic signal after erasure. Sliders were placed in contact with disk surfaces and held stationary as the disk specimens were translated stepwise along two orthogonal directions within the plane of the disk, and the GMR voltage response was recorded after each step. All SMRM scans shown here cover 24 μm x 1.25 μm areas, and were obtained with 30nm down-track and 50 nm cross-track step sizes. Playback amplitudes were monitored before and after various erasure protocols.

Figs. 1a-c show some SMRM grayscale images obtained with 4200 Oe longitudinal media before and after exposure to erasure fields. A remnant of the original pattern is clearly visible after partial erasure with an inefficient protocol using field intensity about 20% above the medium coercivity (Fig. 1b). One problem encountered when working with the pre-written pattern shown in Fig. 1 is that proper alignment of the GMR sensor with the down-track direction becomes more difficult when the degraded magnetic pattern approaches medium noise levels. This problem can be avoided by using a pattern created by stitching together a constant frequency pattern recorded coherently on adjacent tracks, as shown in Fig. 2a for 5000 Oe longitudinal media. GMR sensor alignment is now a less critical issue and erasure to medium noise levels can be readily followed. For both types of recorded patterns, the GMR responses along lines in the down-track direction are analyzed using FFT methods. The FFT amplitudes of the line scans are used to evaluate whether the pattern has been erased to medium noise levels, as shown in Figs. 2-4.

[1] S.Y. Yamamoto and S. Schultz, *Applied Physics Letters*, **69**(21), 3263, (1996).

For more information, contact Fred Spada, fspada@ucsd.edu - Ph: 858-534-8675.



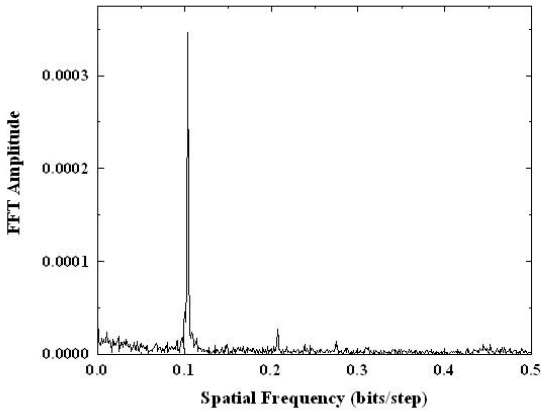
(a)

(b)

(c)

Fig.1. SMRM images of 4200 Oe hard disk media. (a) original 72.5 MHz pattern; (b) after partial erasure; (c) after complete erasure.

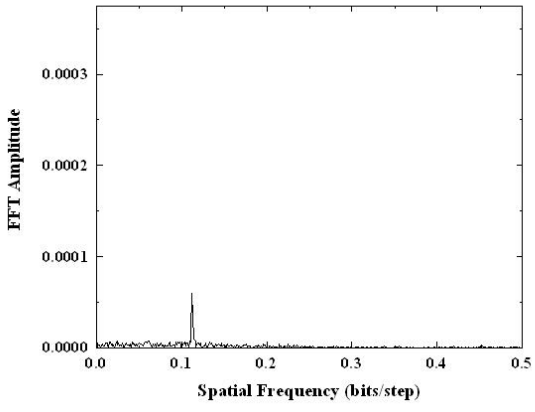
(a)



(b)

Fig. 2. Original “stitched” track 65 MHz pattern on 5000 Oe hard disk medium. (a) SMRM image; (b) corresponding FFT of a line scan along the “down-track” direction.

(a)



(b)

Fig. 3. “Stitched” track 65 MNz pattern on 5000 Oe hard disk medium after partial erasure. (a) SMRM image; (b) corresponding FFT of a line scan along the “down-track” direction.

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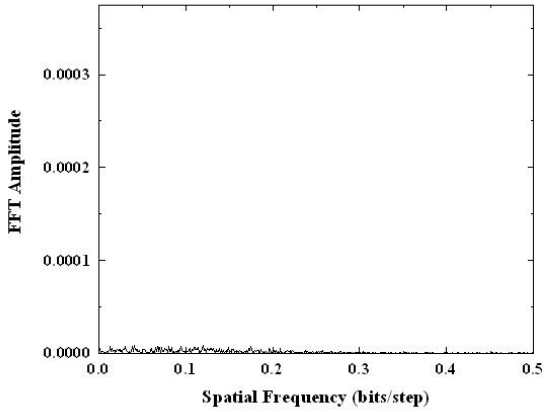
(a)



(b)

Fig. 4. "Stitched" track 65 MHz pattern on 5000 Oe hard disk medium after complete erasure. (a) SMRM image; (b) corresponding FFT of a line scan along the "down-track" direction.

Invited Talks and Papers

Dr. Gordon Hughes

"Emerging Information Storage Technology – A Technologist's Viewpoint," IEEE Mass Storage Conference, Monterey, California, April 2005.

Professor Sungho Jin

"Materials Research at CMRR – New Projects," Hitachi GST, San Jose, California, October 2004.

"Manipulation of Nanostructures for Ultra-High Density Magnetic Recording," Seagate Technologies, Fremont, California, February 2005.

"Controlled Geometry of Carbon Nanotubes," TMS Annual Meeting, San Francisco, California, February 2005.

Professor Paul Siegel

"Capacity of Noiseless and Noisy Two-Dimensional Channels," Los Alamos Workshop on Applications of Statistical Physics to Coding Theory, Santa Fe, New Mexico, January 2005.

"Constrained Coding Techniques for Advanced Data Storage Devices," Distinguished Speaker Seminar Series, Department of Electrical and Computer Engineering, University of Arizona, February 2005.

"Applications of the Viterbi Algorithm in Data Storage Technology," Viterbi Conference, University of Southern California, March 2005.

"Constrained Coding Techniques for Advanced Data Storage Devices" and "MTR-Constrained Tensor Product Parity Coding System," University of Electro-Communications, Tokyo, Japan, April 2005.

P. H. Siegel visited Toshiba and Fujitsu in April 2005. He presented an overview of CMRR technical programs and also gave a presentation on recent work in signal processing and coding.

Professor Frank Talke

F. E. Talke visited Hitachi, Toshiba, and Sony in November 2004. He gave presentations on research in the head/disk and head/tape interface area.

Professor Jack Wolf

"Updating Information and LDPC Codes," Department of Electronics Engineering, ISIK University, Istanbul, Turkey, January 2005.

CMRR RESEARCH REVIEW HIGHLIGHTS

CMRR hosted fifty people from the CMRR Industrial Sponsor companies and other invited guests at the **Fall 2004 Research Review and Advisory Council Meeting** on October 20-21, 2004. The two-day review highlighted the work of CMRR faculty, researchers, and graduate students. Professor Deli Wang, Affiliated Faculty at CMRR and Assistant Professor in the ECE Department at the University of California, San Diego, gave a Special Session presentation entitled "Semiconductor Nanostructures for Information Storage."

The **Spring 2005 Research Review and Advisory Council Meeting** was held on May 11-12, 2005. Over fifty representatives of CMRR sponsor organizations and guests participated in the meeting, including several who participated via teleconference.

In addition to the sessions devoted to technical presentations of CMRR research results, the Review featured a special sponsors-only Interactive Session on Patterned Media. The Interactive Session, part of the recently launched "Patterned Media Initiative" at CMRR, provided the opportunity for sponsor representatives and CMRR researchers to discuss the technical challenges that must be addressed in realizing the promise of patterned media recording.

CMRR Sponsor company employees may access the abstracts and viewgraphs of all Research Review presentations on the CMRR website in the Sponsor Resources section at http://cmrr.ucsd.edu/sponsors/subpgset.htm Contact Jan Neumann with any questions regarding Sponsor Resources at jneumann@ucsd.edu .

The Fall 2005 Research Review and Advisory Council Meeting will be held on October 26-27, 2005. For further information on the Fall Review, please contact Betty Manoulian at 858-534-6707 or bmanoulian@ucsd.edu .

Shannon Memorial Lecture

On April 29, 2005, CMRR hosted the third annual memorial lecture to honor Claude Shannon's accomplishments as a mathematician and pioneer of the digital information age. **Robert J. McEliece**, the Allen E. Puckett Professor and Professor of Electrical Engineering at the California Institute of Technology (Caltech) in Pasadena, gave a talk entitled "Are there Turbo-Codes on Mars?" McEliece surveyed the progress in interplanetary telecommunications technology made possible by Shannon's genius from 1963 to the present, and then speculated on the future. McEliece has been a consultant in the Communications Research Section of Caltech's Jet Propulsion Laboratory since 1978. His research interests include deep-space communication, communication networks, coding theory, and probabilistic inference. McEliece received his B.S. and Ph.D. degrees in mathematics from Caltech in 1964 and 1967, respectively. From 1963 to 1978, he was with the Communications Research Section of the Jet Propulsion Laboratory. From 1978 to 1982, he was Professor of Mathematics and Research Professor at the Coordinated Science Laboratory, University of Illinois, Urbana-Champaign. Since 1982, he has been on the faculty at Caltech.

McEliece's presentation is available for on-demand viewing in streaming video at the Calit2 Multimedia website:

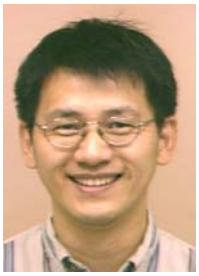
http://www.calit2.net/multimedia/ .

Graduate Degrees Awarded

Jiangxin Chen, a member of Professor Paul Siegel's group since September 2000, received his Ph.D. in June 2005. His dissertation, entitled "Information Rates for Two-Dimensional Recording Channels," examined the information-theoretic limits on two-dimensional recording technologies. His research interests are in coding and information theory, with applications to digital data storage and communications. While pursuing his Ph.D., he was a systems engineer at Qualcomm, Inc. in San Diego.

Joseph Binamira Soriaga was a member of Professor Paul Siegel's research group since the summer of 2000, and received his Ph.D. in June 2005. His thesis was entitled "On Near-Capacity Code Design for Partial-Response Channels." Joseph was also the recipient of the 2005 Schultz Prize for Excellence in Graduate Student Research. His research was concerned with determining the information-theoretic limits of simple one- and two-dimensional partial-response channels, and developing coding schemes that achieve these limits using iterative and multistage decoding structures. Some of this work resulted from fruitful collaborations with Dr. Henry Pfister (who graduated from the Siegel Group in Winter 2003) and Dr. Marcus Marrow (who graduated from the Wolf Group in Spring 2004). Joseph is currently with the Corporate Research and Development Division of Qualcomm, Inc. in San Diego.

Peter Shchupak recently received his Master's degree from the ECE Department and is now employed at SPAWAR in San Diego. Peter spent two years as an active participant in the NSA program under the supervision of Dr. Fred Spada. Some of his contributions are described in the Research Highlights section on page 4.



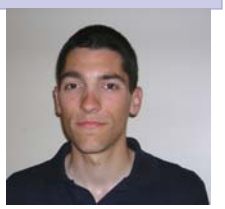
Jayson Wang, a member of Professor Frank Talke's group, received his Ph.D. in June 2005. His dissertation was entitled "Investigation of Tape Edge Wear of Magnetic Recording Tapes." Before joining the Center, Jason worked in the semiconductor industry for ten years. His work at CMRR concentrated on tape edge wear. He is currently with Titan Corporation in San Diego.

Jiadong (David) Zhang joined Professor Talke's group in Spring 2000 after receiving his B.S. and Master's degree from Tsinghua University, China. He has recently completed his Ph.D. thesis entitled "Design, Simulation, and Optimization of Air Bearing Sliders Flying at Ultra-low Spacing." David is currently with Komag in San Jose.

Graduate Students & Researchers Near Completion

Student	Level	Advisor	Dept	Research Interest	Completion
Ryan Taylor	Ph.D.	Talke	MAE	An investigation of lateral tape motion	Summer 2005
Sharon Aviran	Ph.D.	Siegel/Wolf	ECE	One-dimensional and two-dimensional constrained codes, iterative decoding and detection	Spring 2006

CMRR WELCOMES NEW RESEARCHERS



Bart Raeymaekers has joined CMRR as a graduate student in Professor Talke's lab. His research interest is high frequency lateral tape motion in tape drives. Bart studied industrial engineering option electro-mechanics (ing.) at KaHo St. Lieven in Ghent, Belgium, where he graduated in 2002. During the 2001-2002 academic years, he was a member of the international Siemens student program and completed an internship at the Siemens "Automation & Drives" research center in Erlangen, Germany. In 2004, Bart received his master's degree in mechanical engineering at Vrije Universiteit Brussels through a two year condensed program for industrial engineers. For the 2004-2005 academic years, he is sponsored by a fellowship of the Belgian American Educational Foundation and the Francqui Foundation. Outside of school Bart is a competitive cyclist.

Seyhan Karakulak, from Istanbul, Turkey, is a new graduate student of Professor Paul Siegel's. Her current research interest is algebraic decoding techniques. Before coming to UCSD, she received her B.S. degrees from Istanbul Technical University, Istanbul, Turkey in Electronics & Communication Engineering and Mathematics. She enjoys tennis, swimming, dancing, reading about cultures, and traveling.

POSTDOCS

Eirik Rosnes returns to CMRR as a postdoc in Professor Siegels' group. He was a visiting scholar in 2002. In 2003, he received his Dr. scient. from the University of Bergen, Norway. He is currently working on two different topics. The first topic is the finite-length analysis of turbo decoding over the binary erasure channel (BEC). The second topic is coded modulation using LDPC codes and nonequiprobable signaling.

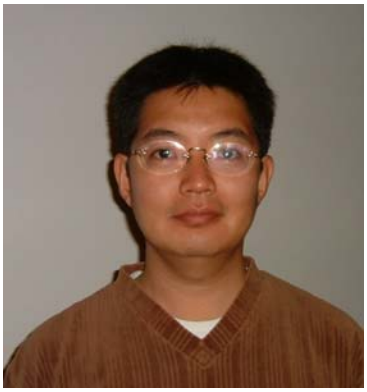
Moshe Schwartz is a Fulbright post-doctoral scholar who came to UCSD to work under the supervision of Professors Paul Siegel and Alexander Vardy. He received the B.A., M.Sc., and Ph.D. degrees from the Technion - Israel Institute of Technology, Haifa, Israel, in 1997, 1998, and 2004, respectively, all from the Computer Science Department. He has worked for the past year on probabilistic analysis methods for iterative decoders and constrained systems. His research interests include algebraic coding, combinatorial structures, and digital sequences. In his free time he likes to solve fun mathematical puzzles, play the piano, swim, and read science fiction.

VISITORS

Daisuke Kawase, an exchange student from Japan, joined Professor Talke's lab during the academic year 2004-2005. He is from Sendai Japan and currently attends Tohoku University as a Masters student in Professor Kato's group. His research at the Talke lab focused on nano-hardness testing with ultrasonic excitation. Outside of the lab Daisuke enjoys sports and enjoyed the different water sports during his stay in San Diego. Daisuke has returned to Japan to complete his Masters degree.

Phillip Schuricht joined Professor Talke's lab as a visiting scholar in January 2005. His research project is "Independent Calibration of Third Harmonic Spacing Measurement Method." He is currently a graduate student in electrical engineering at the University of Technology, Dresden Germany, where he began his studies in 2000. In 2002, he received his pre-diploma specializing in the field of precise engineering/mechatronics. Parallel to his studies he gained practical experience within the Fraunhofor Institute for Transportation and Infrastructure Systems. When Phillip is not in the lab, he enjoys volleyball and surfing.

Visiting Scholar Akihiko Takeo



Akihiko Takeo was a visiting scholar from Toshiba for about one and a half years at CMRR working primarily in the research group of Professor Neal Bertram. During that period "Tak" interacted with students in virtually all the CMRR groups, provided many stimulating ideas and generated an enormous amount of original work, both experimental and theoretical. Tak is not only exceptionally bright, but he is so pleasant, generous with his time and wonderful to work with that we are very sorry that his visit has come to an end!

Some of the projects to which Tak made major contributions include an ongoing project with the Bertram group in the analysis of medium transition noise. The group developed techniques to determine the transition parameter and cross track correlation width from analysis of experimental data. They realized that after a determination of the transition parameter one could use signal spectral data to determine the head-medium spacing. Tak performed most of the experimental and theoretical analysis. His primary contribution was to realize that the transition parameter is a function of density. He suggested using noise power versus density to estimate the density variation of the transition parameter. This knowledge gives an accurate determination from the signal spectra of both the transition parameter and the shield-to-shield spacing in the GMR head.

Tak also studied media development for high density perpendicular recording, where both tilted (perpendicular) grains and composite media are being considered. He performed detailed analysis of minimal grain size, including the effect of film demagnetizing fields, comparing these two approaches.

Another significant CMRR project which Tak helped to coordinate was in the area of patterned media recording. Tak wrote a paper on optimal read/write design for efficient signal processing in patterned media and gave a CMRR lecture on the subject. He also had many meetings with Professor Sungho Jin to discuss media design, and worked with Professors Paul Siegel and Jack Wolf on signal processing issues.

In June, Tak returned to Toshiba, but we look forward to many more collaborations with him as part of Toshiba's continued sponsorship of CMRR.

Secure Erase License SPAWAR

CMRR has licensed SPAWAR, the U.S. Navy information technology unit, to use the CMRR disk drive Secure Erase source code for Federal Government purposes. This Secure Erase utility erases all user data from hard disk drives, providing higher security and twice the speed compared to block write software utilities. The CMRR freeware utility may be downloaded from http://cmrr.ucsd.edu/hughes.

Recent Gifts, Grants, Awards, and Internships

Research Professor Ami Berkowitz was granted a research contract from **Raytheon** under the DARPA/RIPE Program to support his research work on "Development of Fe /Insulator Nanocomposite Materials Using the Spark Erosion Process."

Professor Frank Talke received funding under the **INSIC/EHDR** Program to support his research work on the tribological evaluation of sterically hindered polyester lubricants for near contact recording applications. This research is involved with the study of improved lubricants for near contact recording situations. Polyester lubricants have very good thermal properties but their tribological properties are not known. He also received funding from the **Office of Naval Research** to support a research project on "Brush Wear of Homopolar Motor." The goal of the investigation is to study the dynamic characteristic of the brush/rotor interface of a DC motor using acoustic emission transducers to establish whether the higher wear rates of positive brushes are due to the dynamics of the brushes as a consequence of the current polarity or due to other presently unknown non-mechanical effects.

Dr. Frederick Spada received continued funding from **INSIC/ Tape** Program on his research work "Contribution of Electrochemical Processes to Increased Head-Media Spacing in Tape Drives." The goal of the project is to determine if electrochemical processes contribute to pole tip recession (PTR) and whether bias potentials applied to the head structure can influence the rate of PTR.

Professor Paul Siegel's research work on "Signal Processing and Coding for Perpendicular Recording Channels with Jitter Noise" was funded under the **INSIC/EHDR** Program. This work involves application of a tensor-product parity coding scheme to the perpendicular magnetic recording channel with jitter noise.

A new 3-year **NSF** grant was awarded to **Professors Paul Siegel** and **Jack Wolf** to support their work on "Capacity-Approaching Coding and Detection for Page - Oriented Digital Recording Channels." This project studies theoretical limits on the storage capacity of page-oriented data storage technologies, as well as the signal processing and coding algorithms needed to achieve those limits in practice. Of particular interest are technologies based upon nanoscale patterned media recording, multi-beam two-dimensional optical recording, and optical holographic recording.

James Lemke, an adjunct professor in ECE and co-founder of the Center for Magnetic Recording Research at the University of California San Diego, has been elected a Fellow of the **American Association for the Advancement of Science**. The citation is for his "fundamental contributions to the development of magnetic information recording devices and materials, including computer disc drives, tape drives, and signal processing electronics."

Professor Frank Talke received an honorary doctorate degree (Dr.-Ing. E.h.) from the Technical University of Munich, Germany, in July 2005.

Several students of Professor Talke's are spending this summer working as interns in industry. **John (Jienfeng) Xu** is working at Seagate Corporation with Yiao-Tee Hsia. **Maik Duwensee** is working at Western Digital. **Ralf Brunner** is working at Hysitrone, and **Andrea (Yu-Chen) Wu** and **Paul Yoon** are working at Samsung.

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Dawn Talbot Retires

Dawn Talbot, the CMRR Librarian, has retired from the University. She began her career at the Center in 1984, before it was housed on campus. She created the CMRR Information Center. Over the last 20 years Dawn was instrumental in collecting and building an extensive core collection of books, serials, reference works, theses, and standards on magnetic recording. During her tenure she created many important services to meet our sponsors' needs, including the CMRR web page. She began a highly successful Japanese translation service and in 1991 wrote a book entitled "Japan's High Technology: an Annotated Guide to English-Language Information Sources."

CMRR staff left to right: Iris Villanueva, **Dawn Talbot**, Betty Manoulian, Jan Neumann.

Dawn also worked at the main campus library. Most recently, she served as the Senior Associate for Digital Library Development at the UCSD Libraries. According to Brian Schottlaender, the University Librarian, "she has been instrumental in putting UCSD on the 'digital library map' locally, regionally, and nationally. From standards development, through infrastructure specification, to content deployment Dawn has worked tirelessly …. to advance our objective of making digital resources available to meet our users' rising expectations."

Dawn has enthusiastically leaped into retirement. She has recently returned from a trip to Switzerland where she went parasailing in the Alps. We at CMRR will miss Dawn and wish her the best as she and husband Rich, develop their plans to relocate to Sydney, Australia.

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