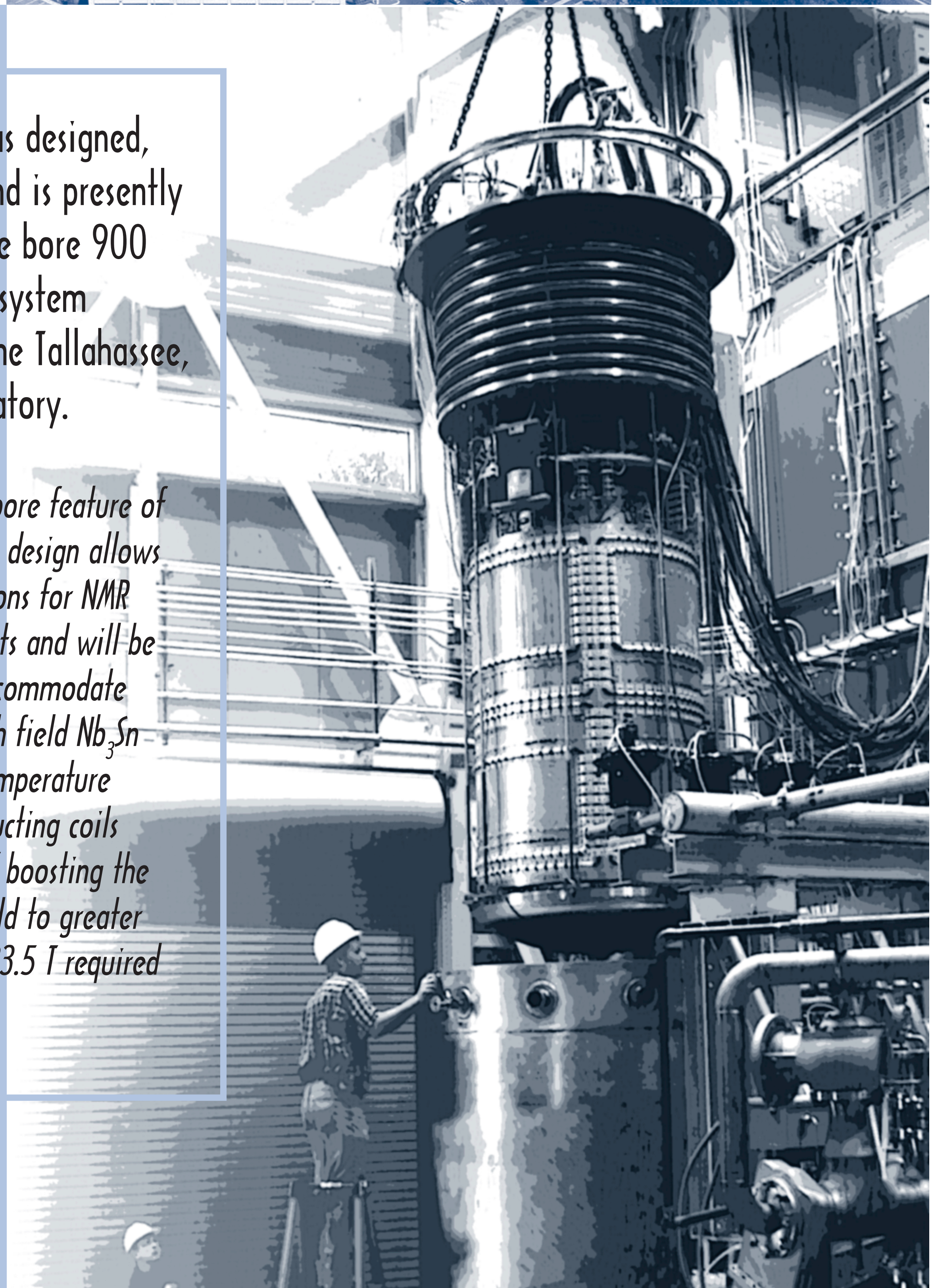
NATIONAL HIGH MAGNETIC FIELD LABORATORY

REPORTS



The NHMFL has designed, fabricated, and is presently testing a wide bore 900 MHz magnet system installed at the Tallahassee, Florida laboratory.

The wide bore feature of the NHMFL design allows more options for NMR experiments and will be able to accommodate future high field Nb_3Sn or high temperature superconducting coils capable of boosting the central field to greater than the 23.5 T required for 1 GHz.

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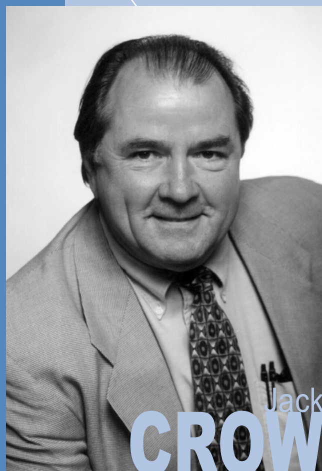
Cover designed by W.W. Thorner



from the Director's Desk

As Nobel laureate and NHMFL Chief Scientist Bob Schrieffer said in the *2001 NHMFL Annual Research Review*, the science productivity of the laboratory continues to grow in strength and size. In fact, the number of user and faculty research reports was up by 10 percent in 2001 and the investigations are increasingly interdisciplinary and collaborative. The laboratory's publication efforts also surged upward: the number of peer-reviewed journal articles increased by 21 percent, with over 50 papers appearing in major scientific journals.

During 2001, we also saw the world's highest continuous field magnet system—the NHMFL 45 T Hybrid—operated routinely for users. Demand was high, so time is governed by a very competitive proposal process. The science on the Hybrid has been rich, and there has been an explosion of interest by the NMR community. In addition, the laboratory continues development testing of the 21.1 T (900 MHz), high-resolution, NMR magnet, i.e., a homogeneity ~1 ppb and a warm bore of 100 mm. This system will be one of the world's highest field, largest bore, high-resolution NMR systems.

It is against this outstanding backdrop that I announce, with mixed emotions, that I will step down as director of the laboratory at the end of the year. The accomplishments of the last year, and in fact the last decade, are due to the incredible staff and scientists who I have had the honor and pleasure of working with. The success of the lab is really to their credit…from the people in Magnet Science and Technology who have built the best magnets in the world, to the people—both faculty and visiting users—who have driven the best high field science in the world.

Florida State University, in consultation with the University of Florida, Los Alamos National Laboratory, the NHMFL Users' Committee, and the National Science Foundation, is beginning an international search for a new director. The search committee has been identified (see next page), and NHMFL users and members of the science community are encouraged to contribute their input to the co-chairs, Drs. Zachary Fisk and Alan Marshall. On a personal note, I will be staying at FSU, working with Vice President for Research Ray Bye in building new multidisciplinary programs, focusing more intently on my research program, and perhaps even teaching a class or two.

continued page 4...

I would also like to announce two additional staff changes that should enhance lab efficiency and service to users, and provide an even greater focus on technology development and transfer. Mr. Brian Fairhurst has been appointed Interim Deputy Director of Management and Administration. Brian has been serving as MS&T Deputy Director since spring 2001, and brings to the laboratory over 25 years of professional management experience in the private sector. Brian will continue to provide services in MS&T but will also be the focal point for implementation of our budget and management control system. Dr. Hans Schneider-Muntau, current Deputy Director, will assume new duties and the title of Chief Technology Officer for the NHMFL. In this new position, Hans will report to the Director and continue to advise and consult with us on magnetic development projects and be a resource in our efforts to develop new opportunities both nationally and internationally.

On a different note: As this newsletter is being produced, the laboratory is busy preparing for the National Science Foundation External Site Review to be held on May 13-15. The committee has been selected, and I would like to thank them for their service: Dr. Miles Klein (University of Illinois, Urbana-Champaign), Meigan Aronson (University of Michigan), Paul Chaikin (Princeton University), Paul Ellis (Pacific Northwest National Laboratory), Clare Grey (State University of New York–Stony Brook), Michael J. Lamm (Fermi National Accelerator Laboratory), David Larbalestier (University of Wisconsin), and Ron Scanlan (Lawrence Berkeley National Laboratory). Their review is critical to the laboratory's future and to the position of the United States as the international leader in magnet research and technology.

Jack Crow

SEARCH COMMITTEE - NEW NHMFL DIRECTOR

Co-Chairs

Zachary Fisk (FSU Department of Physics and NHMFL)

Alan Marshall (FSU Department of Chemistry, NHMFL, and Co-Principal Investigator on the NHMFL grant from NSF)

Committee

Neil Sullivan (UF Department of Physics, UF Dean of Arts & Sciences, and Co-Principal Investigator on the NHMFL grant)

William Press (former Harvard Professor of Astronomy & Physics and currently Deputy Laboratory Director for Science, Technology, and Programs at Los Alamos National Laboratory)

Horst Störmer (Professor of Physics and Applied Physics at Columbia University, Nobel Laureate, and an NHMFL user)

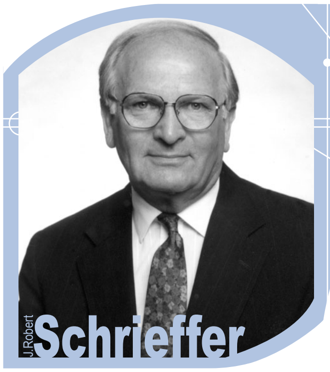
Alex Pines (Department of Chemistry and Seaborg Professor at University of California-Berkeley, and an NHMFL user)

Erich Bloch (former Director of the National Science Foundation and National Medal of Technology awardee)

Ex officio Members

Robert Schrieffer (FSU Eminent Scholar and Professor of Physics, Nobel Laureate, National Medal of Science awardee, and NHMFL Chief Scientist)

Hans Schneider-Muntau (Chief Technology Officer at the NHMFL)



from the Chief Scientist's Desk

The role of strong Coulomb interactions and randomness has been a long standing problem in condensed matter physics. The Coulomb potential tends to localize electrons into a so called Wigner lattice while randomness tends to pin electrons in regions of low potential. Dr. Popović has made forefront discoveries showing that electrons in two dimensions show glassy behavior between Wigner and random behavior. The noise spectrum of this system is particularly interesting.

Glass Transition in a Two-Dimensional Electron System in Silicon

S. Bogdanovich,* NHMFL
J. Jaroszyński,** NHMFL
D. Popović, NHMFL
T.M. Klapwijk, Delft University of Technology, Netherlands

The possibility of a metal-insulator transition (MIT) in two dimensions (2D) has been a subject of intensive research in recent years[1] but the physics behind this phenomenon is still not understood. Since the apparent MIT occurs in the regime where both electron-electron interactions and disorder are strong, it has been suggested that the 2D system undergoes glassy ordering in the vicinity of the MIT. The proposals include freezing into a Coulomb,[2,3] Wigner,[4] or spin glass.[5] It is clear that understanding the nature of the insulator represents one of the crucial issues in this field. Here, we report the first observation and study of glassy behavior in a 2D system in semiconductor heterostructures. The glass transition is manifested by a very abrupt onset of a specific type of random-looking slow dynamics, together with other signs of cooperativity. Our results strongly suggest that the

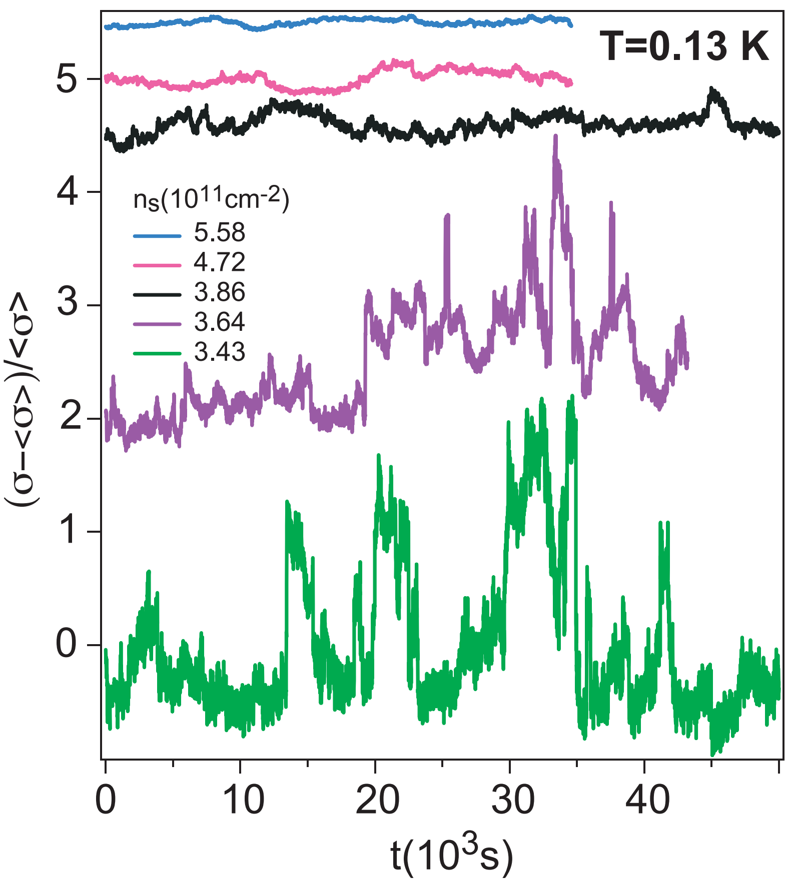


Figure 1. Relative fluctuations of σ *vs.* time for several n_s at T=0.13 K. Different traces have been shifted for clarity, starting with the lowest n_s at bottom and the highest at top.

glass transition occurs in the metallic phase as a precursor to the MIT, in agreement with recent theory.[6] Studies of both low- and high-mobility samples demonstrate that the glassy freezing of a 2D electron system in the vicinity of the MIT is a universal phenomenon in Si inversion layers.

Measurements of the conductivity σ of a 2D electron system in Si metal-oxide-semiconductor field-effect transistors (MOSFETs) were carried out as a function of time over a wide range of electron densities n_s and temperatures T. Such resistance noise studies have proven to be a powerful and, perhaps, the most important tool in unraveling the nature of glassy ordering and dynamics in metallic spin glasses.[7] Fig. 1 shows the relative fluctuations of σ (where $\langle\ldots\rangle$ denotes averaging over time) for a few selected n_s at T=0.13 K. The data were obtained[8] on a highly disordered sample, with a peak mobility of only 0.06 m^2/Vs at 4.2 K. It is quite striking that, for the lowest n_s, the fluctuations are of the order of 100%. In addition to rapid, high-frequency fluctuations, both abrupt jumps and slow changes over periods of several hours are also evident. The noise decreases with increasing either n_s or T, as described in more detail below. The analysis of the time-averaged conductivity $\langle\sigma\rangle$ as a function of T for different n_s (Fig. 2) shows that its overall behavior is similar to that of high-mobility Si MOSFETs. For example, a metallic-like behavior with $d\langle\sigma\rangle/dT<0$ is observed at the highest n_s, and $d\langle\sigma\rangle/dT$ changes sign when $\langle\sigma(n_s^*)\rangle\approx 0.5\ e^2/h$. A detailed analysis of $\langle\sigma(n_s,T)\rangle$ in the insulating and quantum critical regimes shows[8] that the MIT occurs at $n_c=(5.0\pm0.3)\times10^{11}cm^{-2}$. However, while $\delta\sigma/\langle\sigma\rangle$ ($\delta\sigma=\langle(\sigma-\langle\sigma\rangle)^2\rangle^{1/2}$) does not

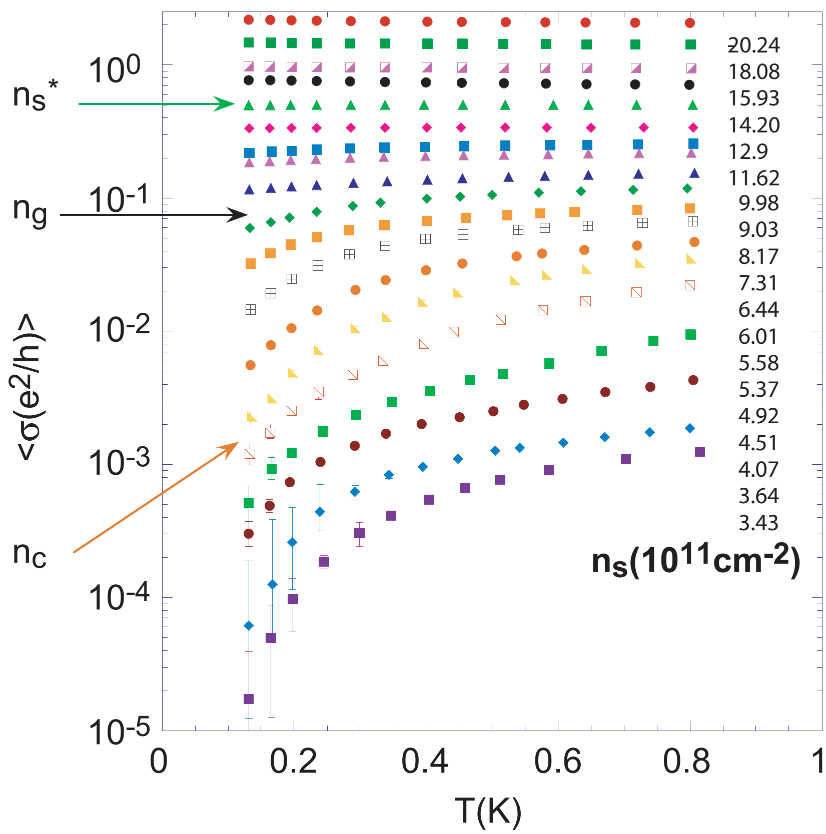


Figure 2. $\langle\sigma\rangle$ *vs.* T for different n_s. The data for many other n_s have been omitted for clarity. The error bars show the size of the fluctuations. n_s^*, n_g and n_c are marked by arrows. They were determined as explained in the main text.

depend on n_s at high densities, an exponentially large increase of noise is observed when n_s is decreased below $n_g=(7.5\pm0.3)\times10^{11}\text{cm}^{-2}$ [Fig. 3(a)]. This effect becomes more pronounced as T is lowered.

In order to understand the origin of this surprising increase in noise, we have carried out a detailed spectral analysis[8] of the fluctuations $(\sigma-\langle\sigma\rangle)/\langle\sigma\rangle$. The normalized power spectra $S_I(f)=S(I,f)/I^2$ (f-frequency, I-current) were obtained in the $f=(10^{-4}\text{-}10^{-1})$ Hz bandwidth, where they follow the well-known empirical law $S_I\propto1/f^{\alpha}$. We find that, while $S_I(f)$ does not depend on n_s at high densities, it increases enormously, by up to six orders of magnitude at low f, as n_s is reduced below n_g. It is clear that the observed giant increase of $\delta\sigma/\langle\sigma\rangle$ for $n_s<n_g$ [Fig. 3(a)] reflects a *sudden and dramatic slowing down of the electron dynamics.* This is attributed to the freezing of the electron glass. Perhaps even more remarkable is a sharp jump of the exponent α at $n_s\approx n_g$ [Fig. 3(b)]. While $\alpha\approx1$ for $n_s>n_g$, $\alpha\approx1.8$ below n_g, reflecting a sudden shift of the spectral weight towards lower frequencies. In general, such noise with spectra closer to $1/f^{\,2}$ than to $1/f$ is typical of a system far from equilibrium, in which a step does not lead to a probable return step. Indeed, we also have the analysis of higher order statistics[9] (non-Gaussianity or second spectra[7]) of the noise, showing an abrupt change to the sort of statistics characteristic of complicated multistate systems just at the density n_g at which α jumps. In particular, the results demonstrate that, while $1/f$ noise

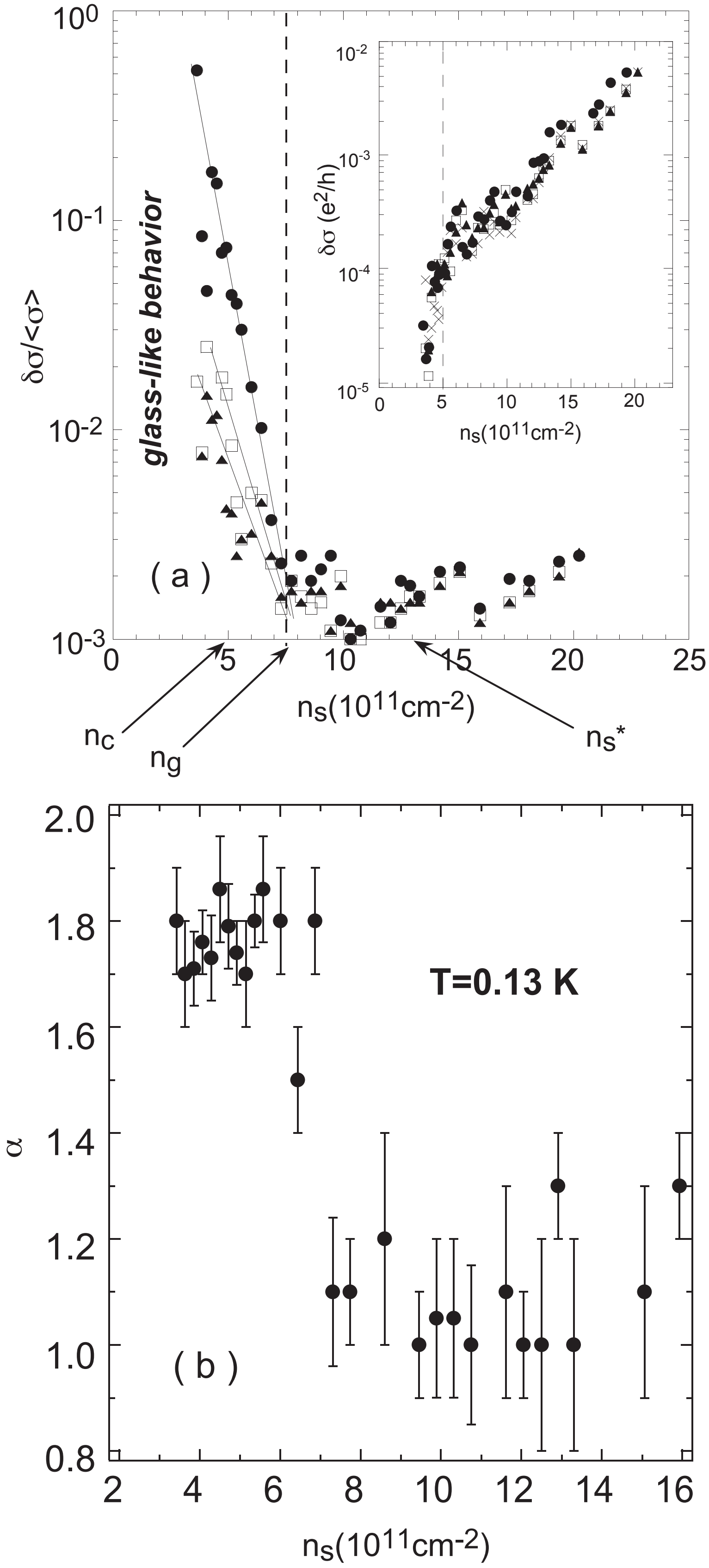


Figure 3. (a) $\delta\sigma/\langle\sigma\rangle$ (main) and $\delta\sigma$ (inset) *vs.* n_s at different T (•: 0.130 K, x: 0.196 K, □: 0.455 K, ▲: 0.805 K). Main: n_s^*, n_g, and n_c are marked by arrows. The vertical dashed line shows the region of densities $n_s<n_g$ where various glassy properties have been observed. Inset: The vertical dashed line shows the location of the critical density n_c for the MIT, where a sudden and dramatic change in the $\delta\sigma(n_s)$ occurs. (b) The exponent α, which characterizes the frequency dependence of the noise power spectrum $S_I\propto1/f^{\,\alpha}$, *vs.* frequency for several n_s. The jump in α occurs when $n_s=n_g$.

at $n_s>n_g$ is produced by uncorrelated fluctuators, in the glassy phase ($n_s<n_g$) the system wanders collectively between many metastable states related by a kinetic hierarchy. Metastable states correspond to the local minima or "valleys" in the free energy landscape, separated by barriers with a wide, hierarchical distribution of heights and, thus, relaxation times. Intervalley transitions, which are reconfigurations of a large number of electrons, thus lead to the observed strong, correlated, $1/f$-type noise, remarkably similar to what was observed in spin glasses with a long-range correlation of spin configuration.[7] We also note that other manifestations of glassiness, such as long relaxation times and history dependent behavior, have been observed for $n_s<n_g$. Glassy freezing occurs in the regime of very low $\langle\sigma\rangle$, apparently as a precursor to the MIT. The existence of such an intermediate ($n_c<n_s<n_g$) metallic glass phase is consistent with theoretical predictions.[6]

Measurements of transport and noise have been carried out[9] also on a 2D electron system in Si in the opposite limit of very low disorder, in samples with a peak mobility of 2.5 m^2/Vs at 4.2 K. We find that, similar to the case of low-mobility samples, the behavior of several spectral characteristics of noise indicates a sudden and dramatic slowing down of the electron dynamics at a well-defined electron density n_g, corresponding to the transition to a glassy phase with long-range correlations between fluctuators, in agreement with the hierarchical picture of glassy dynamics. Since the two sets of devices differ considerably by their peak mobility, which is a rough measure of the disorder, as well as by their geometry, size, and many fabrication details, we conclude that the observed glass transition is a universal phenomenon in Si inversion layers. The experiments, however, have also revealed an important difference between low- and high-mobility samples. In low-mobility devices, $n_g \approx 1.5 n_c > n_c$, whereas in high-mobility structures the onset of glassy dynamics seems almost to coincide with the MIT, *i.e.* $n_g \approx n_c$ ($\approx n_s^*$). In other words, the size of the intermediate glass phase, which separates the ordinary 2D metal and the (glassy) insulator, depends strongly on disorder, becoming extremely small in high-mobility samples. This is consistent with recent predictions of the model of interacting electrons near a disorder-driven MIT.[6]

In summary, studies of low-frequency resistance noise have demonstrated that the 2D electron system in silicon undergoes glassy freezing in the vicinity of the metal-insulator transition. The properties of the glass phase are consistent with the hierarchical picture of glassy dynamics, similar to spin glasses with long-range correlations. These results have great relevance for the development of a theory for the 2D MIT, and for disordered, strongly correlated systems in general. Future noise experiments in parallel magnetic fields should provide important information about the role of the spin degrees of freedom in these phenomena.

Acknowledgements: This work was supported by NSF grant DMR-0071668 and by an NHMFL In-House Research Program grant. We are grateful to the Silicon Facility at IBM, Yorktown Heights for the fabrication of low-mobility samples, and to V. Dobrosavljević for useful discussions.

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Attention Users

Alex H. Lacerda
Director, NHMFL-Los Alamos User Program

When investigating the low-energy excitations in strongly correlated materials (from heavy fermions to fractional quantum Hall systems to high T_c superconductors), it is of paramount importance to probe the collective dynamics at energies commensurate with the intrinsic energy scales of the material—and in particular to study these dynamics at both low temperatures and high magnetic fields. To this end, it is my pleasure to introduce to the users community a new experimental technique at the NHMFL-Los Alamos facility. The recent development of ultrafast coherent THz spectroscopy, for measurement of high frequency complex conductivity in the range between 100 GHz to 2000 GHz, is described in the following article by Scott A. Crooker (NHMFL-LANL). This technique will certainly open new horizons in low-energy spectroscopy measurements at extreme conditions.

Ultrafast Coherent Terahertz Spectroscopy in High Magnetic Fields

S.A. Crooker,
NHMFL–Los Alamos
A.J. Taylor, MST-10,
Los Alamos

Time-domain terahertz spectroscopy is an established technique for the measurement of high frequency conductivity, typically in the range between 100 GHz and ~3000 GHz. Pioneered in the late 1980s,[1] "table-top" terahertz spectrometers employing photoconductive antennas gated by ultrafast optical pulses have been used to study a wide range of material systems, including semiconductors and dielectrics, normal and high-T_c superconductors, liquids, flames, and gases.[2] This THz frequency range lies between that which is readily accessible by microwave cavity techniques (on the low frequency side), and Fourier-transform infrared spectroscopies (on the high frequency side). Further, these frequencies correspond to energies between 0.4 meV and ~12 meV, or alternatively, temperatures between 4 K and 140 K and magnetic fields between 4 T and 100 T.

This is precisely the energy, temperature, and in particular the magnetic field scale relevant to many novel correlated-electron systems of interest today, including high-T_c superconductors (where the upper critical field H_{c2} may be tens or even hundreds of T), heavy fermion and Kondo-insulating materials (where, *e.g.*, the Kondo spin/charge gap in $Ce_3Bi_4Pt_3$ may be closed above 30 T), colossal magnetoresistive manganites (melting of charge/orbital order at high fields), 2D electron gases (composite fermion dynamics in the high field fractional quantum Hall regime), and organic metals (novel field-*induced* superconductivity above 17 T). Thus, it is of keen interest to perform measurements of the complex THz conductivity not only in the regime of low temperatures, but also at high magnetic fields. The conventional "table-top" transmission terahertz spectrometer, however, is a rather involved and physically large setup, typically utilizing several micropositioning stages to align the THz antennas with respect to the free-space laser beams, and off-axis parabolic optics to collimate and focus the terahertz pulses over short distances. These traditional methods work extremely well but are not compatible with high field magnets (10 to 60 T), which are generally solenoids with narrow, cryogenic bores accessible primarily via meters-long experimental probes.

To this end, we have developed extremely sensitive, miniaturized, optical fiber-coupled THz emitters and receivers for remote use directly in the low-temperature bore of a high field (DC or pulsed) magnet.[3] These devices permit ultrafast, coherent, time-domain THz transmission spectroscopy of samples in the frequency range between 100 GHz and ~2000 GHz. Due to the coherent nature of the detection (both amplitude and phase of the THz electric field are measured), the complex conductivity may be directly evaluated without the need for Kramers-Kronig analyses. The gated nature of the detection permits high signal-to-noise data with minimal (~2 mW) optical power input and (where necessary), the ability to acquire complete spectra in tens of milliseconds. The primary challenges of this project include maintaining sub-micron alignment between fiber and antenna upon repeated thermal cycling, achieving ultrafast (<200 fs) optical pulses at the end of tens of meters of singlemode optical fiber, and obtaining complete time-domain scans with high signal:noise using only milliwatts of optical power, no lock-in detection, and (for pulsed magnets) only ~100 ms of integration time.

Using photoconductive antennas, wide-bandwidth THz pulses may only be generated (and detected) by gating the antennas with ultrafast optical pulses, and for this reason it is necessary to compensate for the positive group-velocity-dispersion (GVD) of optical fibers so that fast optical pulses may be obtained at the ends of long fibers. Normal silica optical fiber exhibits a GVD of roughly 120 fs/m-nm at 800 nm, so that without compensation, a 100 fs input optical pulse with a bandwidth of 10 nm broadens, in the best case, to >20 picoseconds after a typical 20 meter length of fiber. Such a lengthy optical pulse is useless for generating or detecting THz radiation. Thus, it is necessary to precompensate and impose a negative chirp on the optical pulses before launching into the optical fibers, so that the optical pulses shorten in time as they travel through the fiber and achieve a minimum value at the THz devices.

The experimental schematic for THz transmission spectroscopy in high field magnets is shown in Fig. 1, along with a photo of the actual THz probe. Ultrafast optical pulses (100 fs, centered at 800 nm) from a Ti:sapphire laser are directed to a 2-grating pulse stretcher, which imparts a negative chirp (blue wavelengths leading red wavelengths) onto the pulses. The magnitude of the negative chirp, tuned via the separation between the two gratings G1 and G2, is

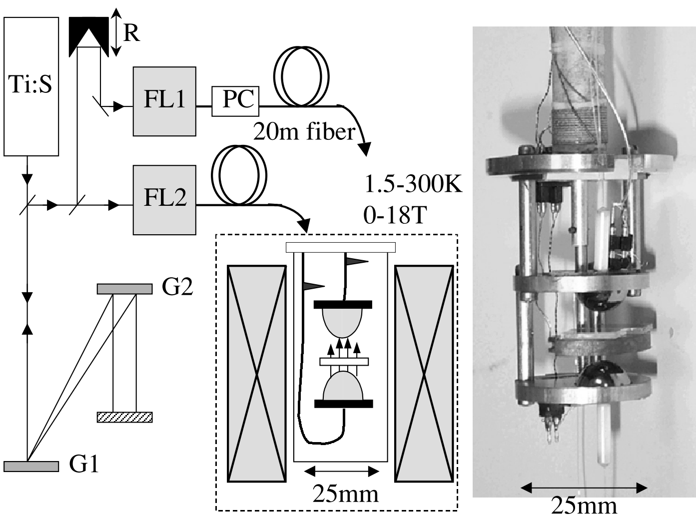


Figure 1. Experimental schematic. Ultrafast optical pulses are pre-chirped (stretched) by gratings G1 and G2, and coupled into fibers by fiber launchers FL1 and FL2. Pulses achieve minimum temporal width (and highest peak intensity) at the photoconductive THz emitter and receiver, which are located in the cryogenic bore of a high field magnet. On right, a photo of the THz probe.

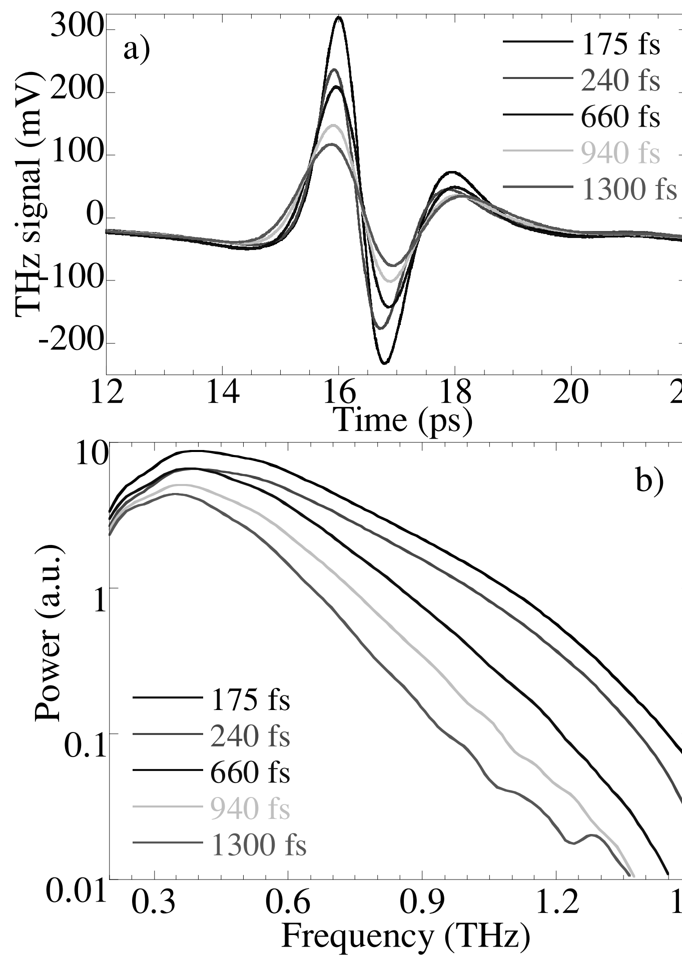


Figure 2. The measured ultrafast THz electric field (and corresponding power spectrum) from a fiber-coupled emitter/receiver pair as a function of the temporal width of the 800 nm optical gating pulses.

chosen to optimally compensate for the intrinsic positive GVD of optical fiber, and thus depends on the laser wavelength and the length of fiber used. For typical fiber lengths of 20 meters, the 100 fs, transform-limited pulses are stretched to approximately 24 picoseconds. After leaving the pulse stretcher, the negatively-chirped pulse train is equally split into an “emitter” and a “receiver” beam. The former is launched directly into a singlemode optical fiber, while the latter is delayed by a scanning retroreflector before being launched into another singlemode fiber of equal length. As the optical pulses travel from the laboratory to the low-temperature probe housing the THz antennas, their temporal width decreases due to the positive GVD of the fiber, achieving a minimum pulsewidth directly at the lithographically-defined photoconductive antennas. The minimum achievable pulsewidth depends critically on residual third-order (cubic) phase dispersion, and especially on pulse energy, such that only low-power optical pulses (<30 pJ/pulse) may be used to avoid the deleterious effects of nonlinear dispersion (self-phase modulation) in the fiber. The dependence of the generated THz radiation on the temporal width of the optical gating pulses is shown in Fig. 2—both amplitude and usable bandwidth of the THz radiation drops precipitously if the optical gating pulses are not ultrafast.

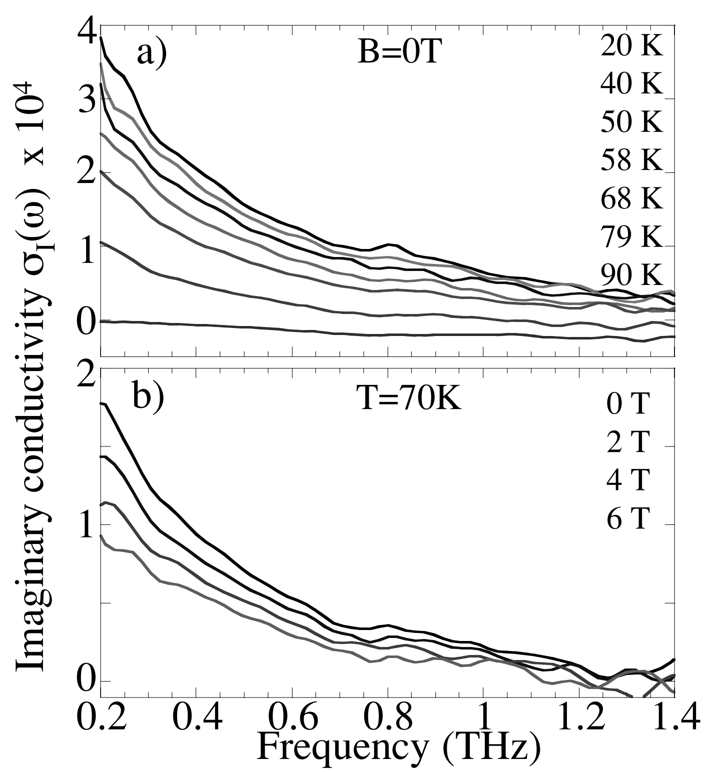


Figure 3. (a) The imaginary conductivity of a 50 nm thick YBCO film (T_c=85 K) as a function of temperature, showing suppression of phase-coherent superconductivity at high temperatures. (b) Same, except that here the superconductivity is suppressed by application of magnetic field at 70 K.

In an experiment, the sample is positioned between the THz emitter and receiver in the cryogenic bore of the magnet. An ultrafast optical pulse promotes mobile carriers in the biased (20 to 30 V) stripline emitter, and the subsequent current surge generates a burst of broadband THz radiation which is coupled into free space through a collimating silicon hyperhemispherical substrate lens. After passing through the sample, the THz pulse is focused onto the stripline receiver by another substrate lens, where the “instantaneous” THz electric field is gated by a second ultrafast optical pulse, generating a measurable current. The complete time-dependent THz electric field is mapped by rapidly scanning the time delay between the excitation and gating optical pulses, and the externally-amplified current signal is sent directly to a digitizing oscilloscope. The THz emitter and receiver are mounted facing one another with a gap of roughly 1 cm. A rotating copper sample stage enables the sample to be moved out of the THz beam path, so that a reference scan may be taken at each new temperature or field (crucial for quantitative interpretation of data, since the exact THz waveforms are field- and temperature- dependent). The entire probe is 25 mm in diameter. The THz stripline antennas themselves are based on 20 micron wide, 1 cm long, titanium-gold lines separated by 50 microns, which are deposited via photolithography onto ErAs/GaAs superlattices grown by MBE on GaAs substrates (courtesy of M. Hanson and A. Gossard, UCSB). The antennas also incorporate micron-scale features, matched to the mode-field diameter of the optical fiber, to maximize their efficiency and sensitivity.

The remaining figures show data from a few of the material systems to which this THz technique has been thus far applied. In Fig. 3, the experimental

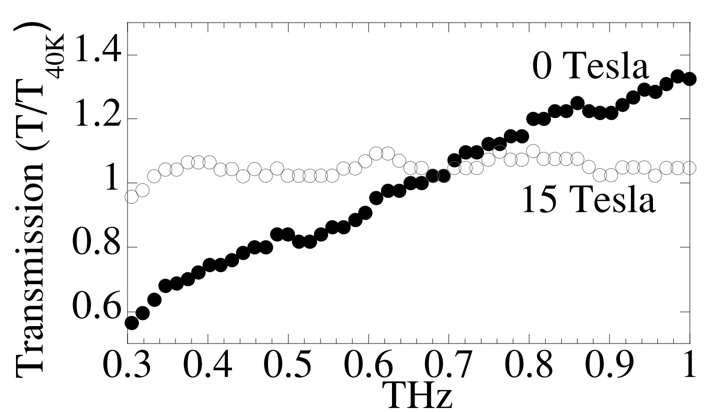


Figure 4. THz transmission $T(\omega)$ in an MgB_2 film at 15 K, at B=0 and B=15 T, normalized to $T(\omega)_{40K}$.

probe and a YBCO film (50 nm thick, T_c ~85 K) are loaded into a cryogenic vacuum can in the bore of a 7 T superconducting solenoid; the data show the imaginary part of the measured THz conductivity. At low temperatures, the 1/ω conductivity from the Drude-like response of superconducting particles with infinite scattering time is clearly observed. With increasing temperature above T_c, this conductivity falls rapidly, indicating the disappearance of phase coherent superconductivity, in agreement with previous works. Fig. 3b shows that similar behavior is observed as a function of magnetic field for temperatures below T_c, indicating again that superconductivity is being suppressed, but this time by the application of magnetic field rather than temperature. By using applied magnetic fields to suppress the superconducting state, these studies will permit investigation of the terahertz complex conductivity of the interesting *normal* state of high T_c superconductors at low temperatures *below* the zero-field T_c, where transport (zero frequency) measurements in pulsed fields have yielded a rich behavior. In a related experiment, Fig. 4 shows data from the recently-discovered superconductor MgB_2 (100 nm film, T_c~35 K), this time in the gas-flow insert of a 15/17 T superconducting magnet. In accordance with Mattis-Bardeen theory, the normalized transmission is reduced (enhanced) at low (high) frequencies when in the superconducting state at 15 K and zero field; however, at 15 T, the THz transmission is flat, indicating suppression of superconductivity in this thin sample by magnetic field.

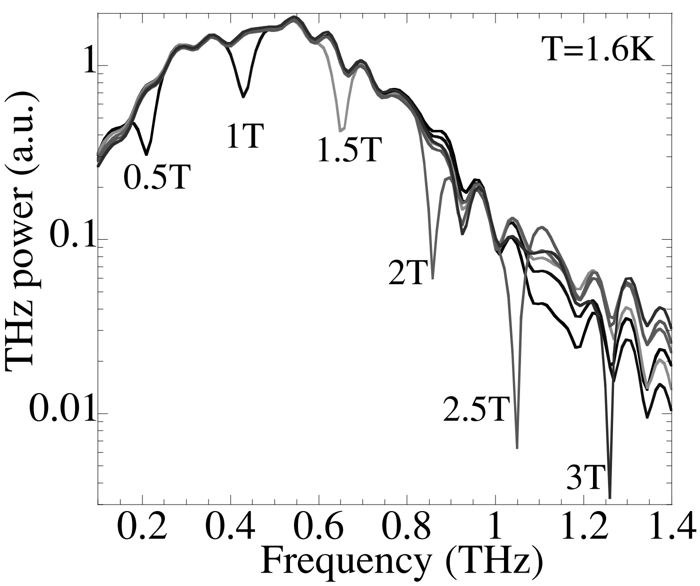


Figure 5. Low-field dependence of the power spectrum of the raw time-domain THz data upon passage through a high mobility 2D electron gas at 1.6 K. Absorption resonances correspond to cyclotron motion.

Lastly, Fig. 5 shows data on a very different system; namely, a very high mobility 2-dimensional electron gas (mobility 10^7 cm^2/V-s) formed at a GaAs/AlGaAs heterojunction, immersed in superfluid helium at 1.6 K. Here, the raw power spectrum of the transmitted THz pulse is shown in the low-field regime where the electron cyclotron energy falls within the THz detection bandwidth. Clear oscillations in the time-domain data (not shown) correspond to the observed cyclotron absorption resonance, which evolves with the expected behavior: $h\omega_c = eB/m^*c$ = 1.73 meV/T = 420 GHz/T (the additional ripples in the power spectrum are an artifact arising from a multiple reflection of the THz pulse which appears ~12 ps later in the time domain, and which may be avoided by stacking additional "dummy" wafers of GaAs onto the back of the 2DEG sample). Using THz spectroscopy, very sensitive density- and field-dependent studies of the THz conductivity of ultraclean 2D electron systems in the fractional quantum Hall regime may be performed, providing deeper insight into the dynamics and interactions of composite fermions.

This article is drawn largely from Ref. 3, wherein additional details can be found.

Acknowledgements: This work was supported by the NHMFL IHRP program.

[1] Smith, P.R., Auston, D.H., and Nuss, M.C., *IEEE J. Quant. Elect.*, **QE-24,** 255 (1988); Fattinger, C. and Grischkowsky, D., *Appl. Phys. Lett.,* **54**, 490 (1989).

[2] See, *e.g.*, papers by Nuss, M.C., and Grischkowsky, D.

[3] Crooker, S.A., *http://www.lanl.gov/abs/physics/0204016*, submitted.

SUMMER EDUCATION PROGRAMS

The NHMFL's Center for Integrating Research & Learning continues to be a local, state, and national resource for teachers, students, and the general public. Increasingly, individuals and organizations turn to the Center for assistance in creating educational programs, obtaining educational outreach, and enhancing science in the classroom and in the community. The Center has an ambitious program that touches students including pre-K through 12, undergraduates, and graduate students, teachers and pre-service teachers. Educators and scientists at the NHMFL work together to create programs and materials that translate the excitement of real-world science.

This summer the NHMFL will again be hosting undergraduates and teachers through the Research Experiences for Undergraduates Program and the Research Experiences for Teachers Program. Ten undergraduates will undertake internships at the NHMFL site in Tallahassee, with three students at Los Alamos and two at the University of Florida in Gainesville. The Center will also provide internship experiences for 18 elementary, middle, and high school teachers in a 6-week residential program that is unique among RET programs.

In addition to the residential programs administered by the Center, a four-day Summer Institute, "Changing Perspectives: What Is Science?" will be conducted for 40 area teachers. Because the State of Florida is instituting standardized testing in science in 2003, teachers are seeking ways to enhance their ability to weave science through the elementary curriculum. Magnets, magnetism, and related concepts, light and optics, and writing in science will be the focus of the workshop that will provide materials and practice for teachers anticipating that this combination will enable them to return to school and implement new activities and experiences for their students.

Outreach to elementary, middle, and high school students has increased significantly during this period. To date, CIRL has provided tours and outreach to 2,849 people representing 11,003 contact hours. In addition, the 2002 Annual Open House in March attracted over 2,000 people. Six NHMFL scientists mentored 14 middle school students during the Spring semester and 12 high school students worked with senior engineering students to create a re-designed maglev train model. The Robotics Club from a local high school was mentored by the Resistive Magnet group and 4 other high school students served in structured externship experiences.

The Center continues with its successful Ambassador Program that includes 103 teachers, administrators and community group participants representing 9 counties in north Florida and south Georgia, 56 public schools, 10 private schools, and 4 charter schools.

New partnerships were established since the last report. CIRL educators were invited to present at the North Carolina State University Science House conference on using technology to teach science, CIRL staff worked with Florida State University First Year Experience to support freshmen, and the NHMFL hosted the first High School/High Tech event in North Florida establishing strategies for handicapped students to attend colleges and universities in the area.

The Director of CIRL was invited to present and serve on a panel at the first annual Bringing Research Into Science Classrooms (BRISC) Conference in San Francisco. The invitation included a teacher from the RET program and a scientist/mentor from the laboratory. It was at this conference that the uniqueness of NHMFL educational programs was discussed and CIRL looked upon as a resource for other educational programs. The NHMFL and the Center are part of a statewide consortium to create partnerships between science institutions and science teachers and the Center has become an important leader with the Leon Association for Science Teaching, the Tallahassee Scientific Society, and the Community Classroom Consortium.

The Center has established new partnerships with groups at Florida Agricultural and Mechanical University through FAMU Day at the Capitol, FAMU Outreach Day that targets middle school girls to pursue courses in science, mathematics, and technology, and the Louis Stokes FGAMP Alliance. The Center has also become an active partner with the Girl Scouts of the United States providing "Girls in Science" workshops as well as workshops through which the young women earn science badges.

The Center for Integrating Research & Learning serves as the hub around which educational programs revolve. This unique infrastructure within the laboratory has enabled scientists, researchers, and educators to provide meaningful experiences that bring new understanding of science concepts to students, teachers, and the general public. Center educators are looking forward to developing new educational programs and products as well as conducting five additional trainings in Florida for the successful *Science, Tobacco & You* curriculum package that has now been adopted in 11 states.

For further information about the laboratory's education programs, contact Dr. Pat Dixon, program director, pdixon@magnet.fsu.edu, *850-644-4707.*

Successes and Challenges of Initial Testing of the Wide Bore 900 MHz Magnet

900 MHz MAGNET

Tom Painter, NHMFL

The NHMFL has designed, fabricated, and is presently performing initial testing of a wide bore 900 MHz magnet system to be installed at the Tallahassee, Florida laboratory. The wide bore feature of the NHMFL design allows more options for NMR experiments and will be able to accommodate future high field Nb_3Sn or high temperature superconducting coils capable of boosting the central field to greater than the 23.5 T required for 1 GHz.

The NHMFL wide bore 900 MHz NMR magnet system has successfully completed its first bucket test, which has provided valuable information about the performance of the magnet system as a whole. As described in last summer's *NHMFL Reports*, the bucket test is intended to characterize the maximum operating field, the persistence, and the field homogeneity as well as to qualify the operation of all the associated subsystems such as the quench detection and protection. The bucket test is designed to allow easy access to the magnet in the event that modifications are required before installing the magnet into the final cryostat, which is a completely welded, vacuum tight vessel.

Several successes and several challenges were encountered during the initial bucket test. The first major event of the test was a quench of the magnet at approximately 380 MHz (8.9 T), which began as our first challenge and resulted in a successful tuning of the quench detection system. Inspection of the data captured during the quench revealed that the quench protection system was triggered from a voltage spike on the coil. The recorded data showed that the voltage spike was decreasing in amplitude at the time the quench protection triggered the heaters in the superconducting coils, indicating that the voltage spike did not represent a true coil quench but was due to a non-quench inducing coil motion event. After a thorough study of the problem and subsequent redesign of the triggering electronics, the quench detection system was reconfigured to allow the occurrence of similar and slightly larger voltage spikes without triggering the quench protection system. Further 4.2 K testing yielded at least six more spikes of similar magnitude that would have triggered a quench, but due to the reconfigured detection system, no false quenches were activated. Success!

After reconfiguration of the quench detection electronics, the coil was charged to approximately 300 MHz and field maps were taken to verify the operation of the eight sets of superconducting shims and measure their strength in comparison to design values. The results of these tests confirmed that seven of eight shims worked as expected, and that the field strengths of all eight shims were as designed. Furthermore, the field maps also indicated that the superconducting shim strength—in combination with the room temperature shims—will be able to achieve the final homogeneity specification of less

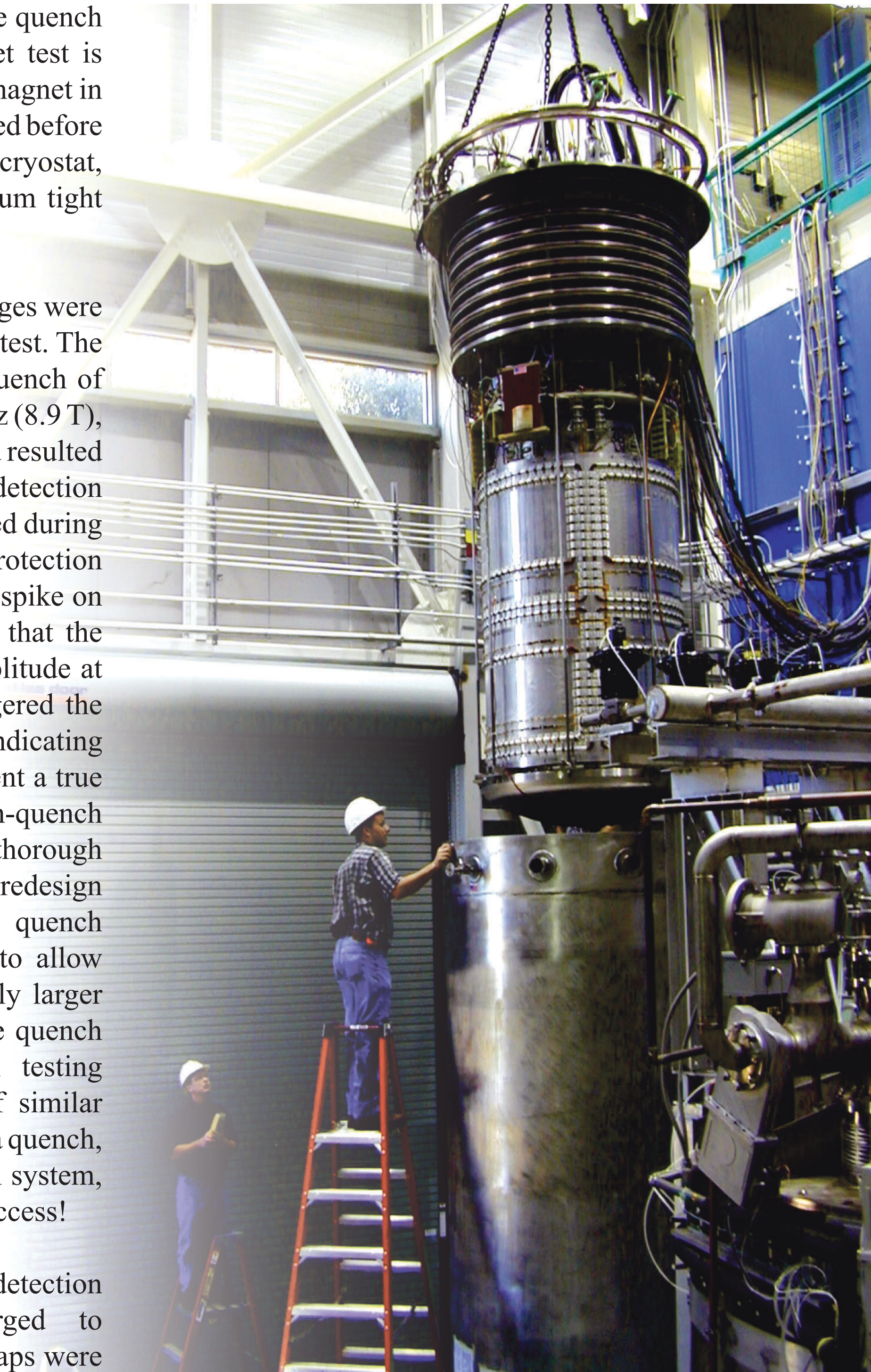


Figure 1. The magnet assembly is inserted in the bucket cryostat on October 26, 2001, in preparation for the initial bucket test.

than 1 ppb over a 4 cm DSV. Success! The superconducting shim that didn't work as expected still met its field strength requirement, but could not be charged as quickly as the others. Modifications made to the switch electronics after the magnet was warmed up are expected to correct the degraded charging capability of this shim.

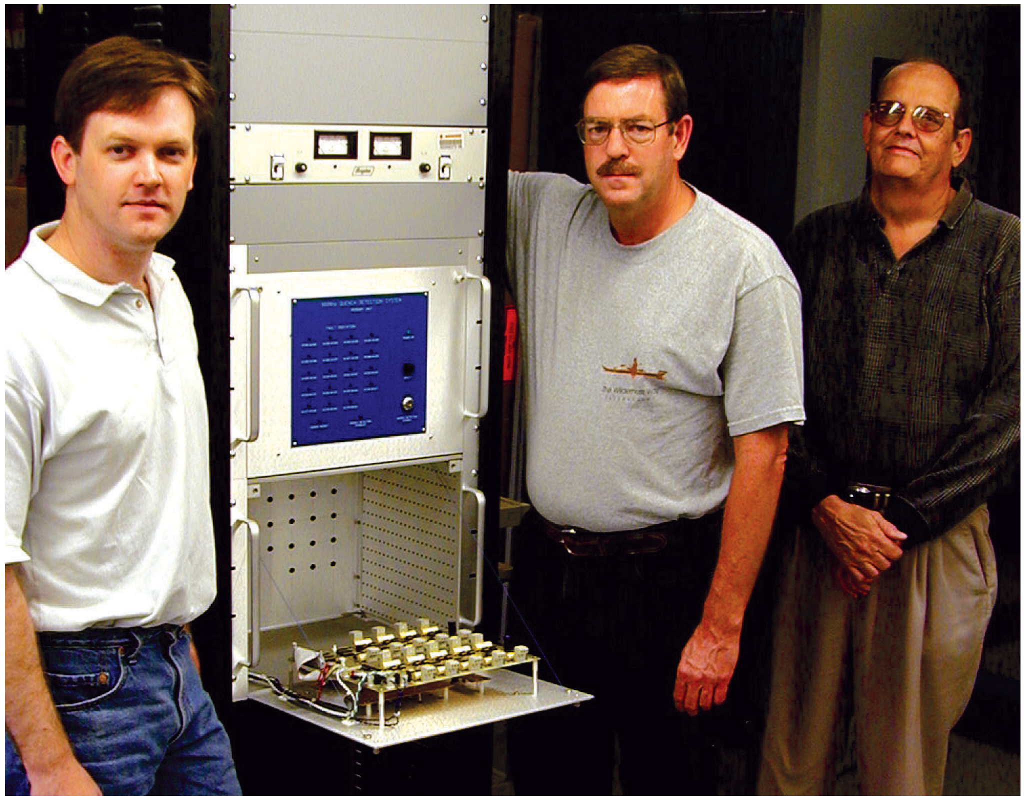


Figure 2. Nearly all the high voltage electronics, including the quench detection and protection system shown here were the responsibility of Andy Powell, Lee Bonninghausen, and Peter Murphy, standing from left to right.

Following the field mapping measurements, the magnet was charged to 722 MHz which is the highest field to which the magnet could be charged at 4.2 K while still allowing a safe superconducting temperature margin. This test showed that the magnet could be successfully charged to 722 MHz in one day without quench. The magnet was held at 722 MHz to measure the persistence, which revealed a higher than desirable decay rate and presented our greatest challenge. Options have been developed to correct for this decay, and one of these options will be investigated in the next bucket test.

Finally, the test plan requires 2.3 K testing to 900 MHz. During ramp down from 722 MHz, however, a prohibitive boiloff rate of liquid helium appeared due to a developed resistance in the current lead jumpers that connect the vapor cooled leads to the superconducting magnet. This resistance does not affect the performance of the final magnet system, but did prohibit bucket tests at 2.3 K until the current lead jumpers could be modified. At this point, no more information could be obtained from the initial bucket test until some hardware modifications were made, and the bucket test assembly was warmed up to room temperature.

In summary, the initial bucket test has provided the opportunity to successfully tune the quench detection system, confirm that the homogeneity performance of the system will successfully meet its specification of 1 ppb over a 4 cm DSV, confirm successful operation to 722 MHz, and reveal the challenge of correcting for a higher than desirable decay rate. The next bucket test, scheduled for early summer 2002, is expected to confirm successful operation to 900 MHz and to investigate a method for successfully correcting for a higher than desirable drift rate.

For further information, contact Tom Painter at 850-644-5752 or painter@magnet.fsu.edu.

fMRI and Glaucoma

X.S. Silver, UF AMRIS
B. Beck, UF AMRIS
J. Fitzsimmons, UF AMRIS
B.A. Berkowitz, Wayne State Univ.
W. Dawson, UF Opthamology

The major blinding, non-optical disease in the western world is glaucoma. Approximately 1.5 million Americans have glaucoma and suffer visual loss from it. The causes for retinal and optic nerve damage in patients are poorly understood, however, a major risk factor is thought to be metabolic instability in the optic nerve. Working in this area and making measurements has been very difficult in the past. But Bruce Berkowitz of Wayne State University, Detroit has teamed up with William Dawson of UF where a small colony of rhesus monkeys exhibit the abnormal pressures and visual losses experienced by human glaucoma patients. These rare monkeys are unique and apparently suffer from a genetically transmitted defect. Berkowitz has developed means for quantitatively analyzing tissue for free oxygen using functional MRI (fMRI) technology.

Recent experiments at UF's AMRIS facility have demonstrated that the consequences of systemic changes in circulating oxygen on the order of 30% can be

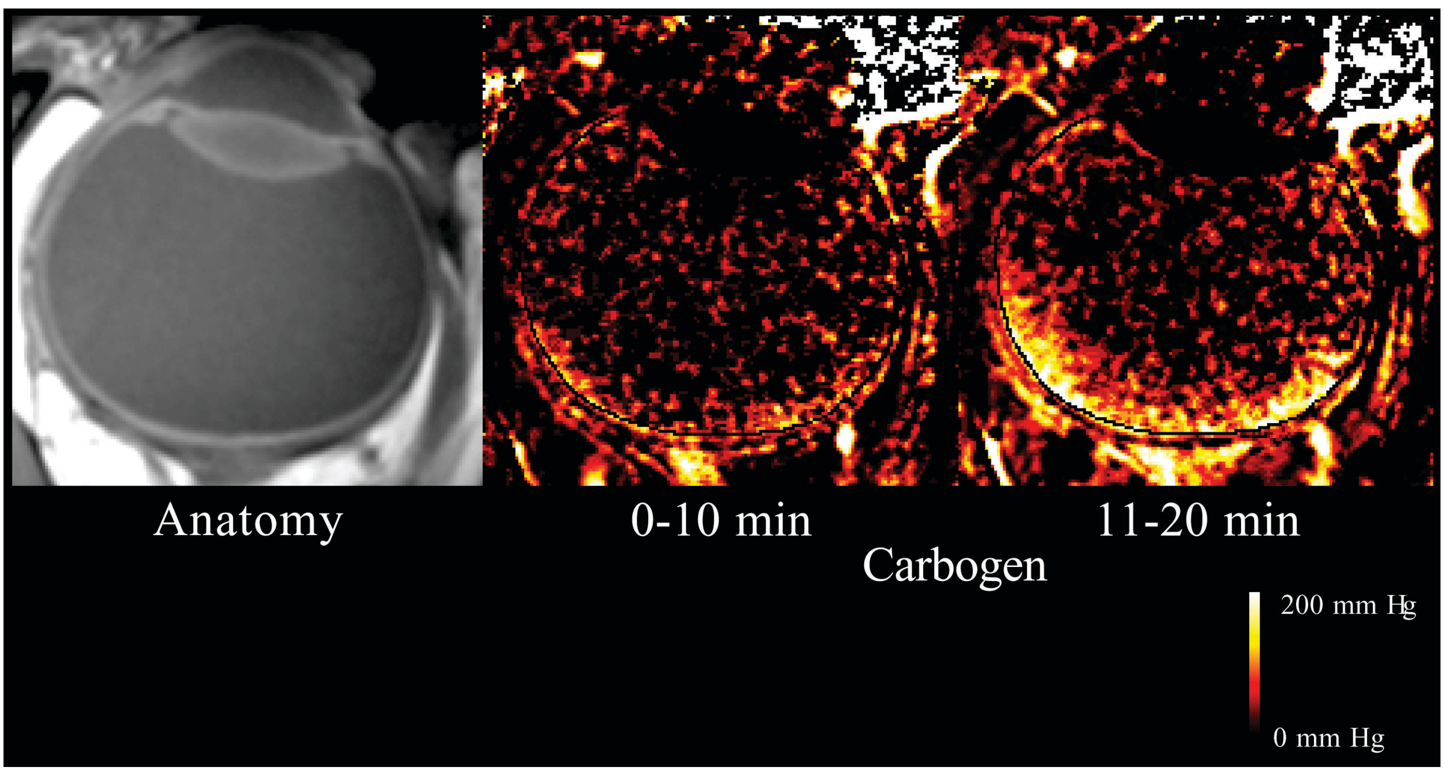


Figure 1. *In vivo* image of a rhesus monkey eye. The left image is an anatomic T_1-weighted image, and the center and right images are in pseudocolor where brightness is proportional to free oxygen in the vitreous body. Three of the anatomical images were collected to establish a baseline. Then, upon administration of Carbogen, four 5-minute images were collected. The first 2 Carbogen time points were averaged, and the baseline average image was subtracted from them to give the image in the center. The image on the right was similar but used the last 2 Carbogen time points.

detected easily at the optic nerve head in the eye by fMRI technology as a significant quantitative change in contrast. This enhancement is a result of a reduced T_1 due to the paramagnetic effect of an increase in the oxygen tension. The recent experiments act as a "proof of principle" and utilize control breathing of room air and then Carbogen (95% oxygen plus 5% carbon dioxide) to establish known levels of blood gas. The resulting images of the living monkey eye are presented in the figure in pseudocolor where brightness is proportional to free oxygen in the vitreous body. The oxygen diffusion into the vitreous body has major advantages since the measures are not confused by local changes of the intravascular circulation. This technology, coupled with the Florida glaucomatous rhesus colony, offers great promise in the search and eventual control for the risk factors controlling human glaucoma.

The unique animal model for this pathology presents challenges such as the need for a high field/large bore-size magnet system to accommodate a rhesus monkey, optimized RF coil geometry, special MR compatible monitoring apparatus for respiratory gas, blood gas, and pressure and ventilation. For these experiments, a Bruker 4.7 T AVANCE imaging spectrometer was used. With a bore size of 22 cm, a mature female subject could be accommodated. A one-turn linear surface coil was designed and built in-house which fit the anatomy of the zygomatic arch on the lateral aspect of the patient's head such that the B_1 field would be perpendicular to the optic nerve. A large animal cradle was used to support the body, and the head was stabilized using foam to reduce motion. All monitoring equipment was MR compatible and included a veterinary Pulse Oximeter for pulse and blood oxygen measures, a Microcapnograph for inhaled and exhaled gas analysis, leg cuff blood pressure measurement and flouroptic temperature detection, as well as a customized ventilator breathing circuit that allowed for the longer gas lines.

Following setup and calibration of all relevant equipment, the animal cradle was positioned in the magnet and three orthogonal pilot images were acquired using Gradient Echo pulse sequences. Once properly positioned, additional higher resolution pilot images were acquired using Spin-Echo imaging with RARE phase encoding to locate the optic nerve head and cup. From the pilot images, a slice geometry was selected which allowed visualization of the optic nerve and near perfect transaction of the eye. Images were collected using a single-slice spin-echo sequence with TR = 1 sec, TE = 10 ms 256 x 128 matrix with a 3.8 x 3.8 x 0.3 cm FOV resulting in 148 x 296 um in-plane resolution. Three baseline data sets were collected under room-air breathing conditions followed by four additional images collected immediately following Carbogen breathing. The data were collected continuously and all blood and respiratory parameter were recorded for data analysis.

These studies at 4.7 T have been important to demonstrate feasibility. Most of the monkeys, however, are too large to easily fit into the 33 cm (22 cm opening) 4.7 T magnet. Therefore, in the near future these studies will move to the 11 T, 40 cm magnet, which is at full field and should be ready for applications in June 2002. Going to the bigger magnet will not only significantly enhance S/N but will allow for the study to extend to large adult males, and thus allow complete longitudinal tracking of all the animals in the study.

LANL UPDATE

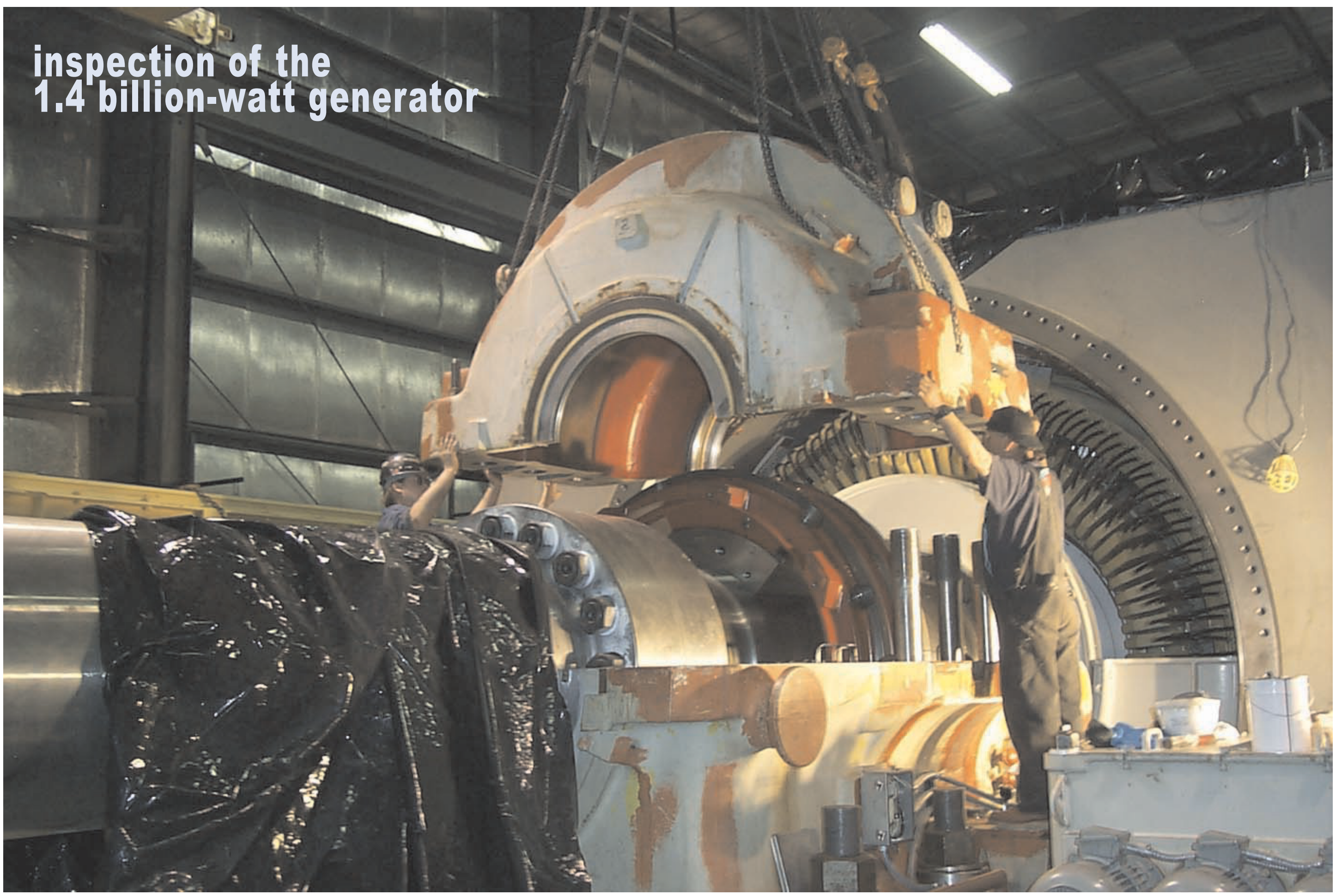
It is springtime in New Mexico. Birds are chirping, the sun is warming the earth and everyone is hoping for rain…

Although seemingly peaceful outdoors, the NHMFL Pulsed Field Facility has been anything but quiet this season as the lab has been bustling with activity.

Spring kicked off with the completion of the general inspection of the 1.4 billion-watt generator used to power the facility's largest magnets. Since the failure of the 60 T Long Pulse in the summer of 2000, the generator has been somewhat idle, providing a perfect opportunity to inspect the machine before the completion of the 60 T Rebuild and the new 100 T magnet. This inspection took about five months and no major problems were found.

"Going in we were unsure what we would find. If we had found anything major we might have had to pull out the rotor," said Joe Schillig, electrical engineer at NHMFL/LANL.

Workers from Western Power, Mannings USA, ABB/Alstom (France) and NHMFL/LANL were all involved in the inspection that included visual inspection, high voltage tests, and ultrasound tests. The generator was originally brought to Los Alamos in 1988 for a fusion experiment. It was inspected before purchase but had never actually been used. The generator had been built in Switzerland and shipped to a nuclear power plant in Tennessee that was never completed. The next inspection will depend on the usage of the generator—which will


inspection of the
1.4 billion-watt generator

be much more than in the past once the 60 T and 100 T magnets are up and running.

In research news, M.H. Jung and A.H. Lacerda, in collaboration with researchers from the University of Nevada at Las Vegas (A.L. Cornelius), the University of California at Irvine (J.L. Lawrence), LANL-MST-10, and Japan, have demonstrated that a magnetic field above 40 T can reveal, in addition to the Kondo temperature (TK~670 K), another low temperature T_c ~ 30 K to 40 K attributed to the onset of the Fermi Liquid coherence in $YbAl_3$. These results were recently published in *Physical Review Letters*: PRL **88** 1172001 (2002).

An ongoing collaboration between the NHMFL/LANL (A. Migliori, J. Betts, and G.S. Boebinger) and the University of Chicago (T.F. Rosenbaum's group) found that resistance displays a large (thousands of a percent), nearly linear increase, with applied field without saturation to 60 T. These results make silver chalcogenides attractive candidates as magnetic field sensors accurate to <0.005 T, which might be further applicable in >100 T pulsed magnets, where large fields have been produced but calibration better than 10% has proved elusive. These results appear in *Nature*: **417**, 421-424 (2002).

Throughout the month of April, NHMFL/LANL Center Leader Greg Boebinger participated in a Los Alamos National Laboratory-sponsored public lecture series in Northern New Mexico. The lecture series, entitled "Frontiers in Science" is an effort by the national lab to "inform neighboring communities about the broad range of scientific and engineering research that is being done at the lab." Boebinger's talk, "Levitation, Superconductivity and the World's Largest Magnets" was presented four times—in Santa Fe, Taos, Espanola, and Los Alamos.

"Greg did a great job," said Joe Ginocchio, chairman of the Frontiers in Science Lecture Series Committee. "At the one in Santa Fe, many young people showed up who were fascinated about it, and stayed around for the demos after [the talk]." Ginocchio also mentioned that a high school science teacher in the audience commented that Boebinger's talk was the "best one yet."

The consistent successes coming out of the magnet lab have prompted Los Alamos National Laboratory Director John Browne to include the NHMFL in his recent talks about current research in Los Alamos. Browne highlighted the NHMFL in his Annual State of the Lab address and in his presentation of "LANL Today" at the APS April Meeting.

In other efforts to publicize the importance of research at the NHMFL, the Pulsed Field Facility continues to host tours of the lab whenever possible. In February, the NHMFL/LANL welcomed U.S. DOE Under Secretary Robert G. Card, and in April for LANL Science Day, the NHMFL gave a tour to numerous state officials including tribal and county leaders and representatives from the offices of Senator Bingaman and Domenici and Representative Udall. On April 23, 2002, the lab hosted Professor J. Peterson, Interim Vice Chancellor for Research at the University of Colorado at Boulder.

Visits to the lab are not, however, reserved for users and politicians. On April 13, 2002, the NHMFL welcomed family members from all areas of the Los Alamos Lab to visit for the lab-wide Family Day. Staff members manned tables with magnet/conductor manipulatives and examples of some of the materials used in the lab's magnets, as well as the launcher and levitation train (thanks to Tallahassee!) and gave tours of the laboratory nearly every 20 minutes.

It was estimated that nearly 200 people showed up for the Family Day event, which was a great success since it was the first NHMFL Family Day to be publicized to the entire lab community. Next year, the Pulsed Field group hopes to continue the tradition and expand the audience as much as possible.

This article was contributed by Rebecca E. McIntosh at NHMFL/LANL, who may be contacted for further information, 505-667-7654 or mrebecca@lanl.gov.

8th Magnet Lab Open House Attracts More Than 2,000 Visitors

Heavy rains, blustery winds, and cold temperatures did not dampen either spirits or attendance at the 8th Open House of the NHMFL in Tallahassee. Over 2,000 visitors enjoyed a fun-filled and educational day at the lab, with some people traveling long distances to attend the event, like five science and engineering students from Jacksonville University, a teacher and his family from north of Valdosta, Georgia, and a community college group from Panama City, Florida.

At the Open House, visitors enjoyed a close-up look—and a layperson's understanding—of work underway at the Magnet Lab. Scientists and engineers explained their activities in simple terms or demonstrated a basic science or engineering principle. Highlights also included scavenger hunts for students, a rocket launch display, and a model maglev train. The demonstrations and hands-on activities were very well received, and once again, the only complaint was that we needed to stay open longer or have this event twice a year!

Everyone—faculty, staff, and visitors—was also impressed at the quality and big participation in the K-12 art and science contest. The theme this year was "Science in Our World," and we received 150 projects, including entries from a school in Connecticut and many from south Florida.

Thirty laboratory groups participated in the event, along with more than a dozen FSU and community science, environmental, and educational organizations. Many of the laboratory's Community Science and Education Partners participated with special events and activities, including: St. Marks Wildlife Refuge, the Tallahassee Museum of History and Natural Science, the Challenger Center, FSU's Museum of Fine Arts, Joe Budd Aquatic Center, Saturday at the Sea, FSU Physics Van, U.S. Geological Survey, Old Capitol organization, LeMoyne Art Center, City of Tallahassee, Department of Environmental Protection, Girl Scouts, and many others.

This year's new presentations included a demonstration of Newton's Law by dropping fruit from high above the Magnet Lab, a silent auction in support of local science and education organizations, and the FSU Meteorology Hurricane Hunter truck (when fully configured with Doppler radar and outriggers, meteorologists will drive this Mack semi into the path of a hurricane to take measurements).

Following the successful event, NHMFL Director Jack Crow thanked everyone who helped with the demonstrations and volunteered in other ways:

"In particular, I would like to thank our Governmental and Public Relations group and members of the Center for Integrating Research and Learning for their efforts in organizing this extremely important event. It is only one of the many activities and programs that we offer to increase public awareness and encourage science education, and we owe the success of these efforts to the broad participation across the laboratory. Thanks again for your dedication and commitment not only to scientific excellence but to our outreach programs as well. I am proud to be part of the NHMFL family."

PEOPLE IN THE NEWS

Thomas Baldwin, assistant professor of electrical engineering, along with Frank Renevick, received the 2001 Prize Paper Award for the IEEE Industrial Applications Power Systems Protection Committee for the paper, "Ground-Fault Locating in High-Resistance Grounded and Ungrounded Systems." Baldwin, who is affiliated with the FSU Center for Advanced Power Systems (CAPS), was presented this award in Savannah, Georgia at the 2002 I&CPS Technical Conference Awards luncheon in May. Baldwin's research centers around electric power systems (power quality, superconducting apparatus, power transformers, MV current limitiers, distribution network design, MV/LV protective relaying, energy storage systems, computational methods, distributed generation, and MV system stability).

Nicholas Bonesteel, associate professor of physics and member of the Condensed Matter Theory Group of the NHMFL, received a Developing Scholar Award from FSU. His research interests include condensed matter physics, correlated electrons, quantum hall effect, and quantum information theory. FSU's annual Faculty Awards Ceremony honors its most outstanding teachers, researchers, and advisers with awards that include certificates and cash stipends that recognize excellence in seven categories.

Jack E. Crow, director of the NHMFL, will step down from his leadership position at the end of the year. See "From the Director's Desk" on page 3 for further details. In announcing this news to faculty and staff and the media, FSU Vice President for Research Ray Bye said, "I know of no individual more responsible than Jack for bringing this laboratory from Cambridge to Tallahassee. No one else could have sold that vision to the chancellor, two university presidents, a governor, and the National Science Foundation. With the assistance of a marvelous staff, Jack has overseen the evolution of this laboratory into the preeminent facility of its kind in the world and provided outstanding leadership to the laboratroy, to Florida, and to the nation."

Casey Furman, a rising senior at Bayshore High School in Bradenton, Florida, has been named to the 2002 Lombardi Scholars class at the University of Florida. Casey conducted research on ceramic superconductors at the NHMFL at UF in Gainesville. Casey is his school's No. 1 ranked student and Manatee County's Sunshine State Scholar. Lombardi Scholars receive $4,500 each fall and spring semester for 8-10 semesters; $5,000 for each four summer programs; and $3,000 for essential computing or other academically-related supplies or equipments. This support is in addition to tuition, which is covered by Florida's Bright Futures Program. Eight Lombardi scholars are selected each year, as part of a new comprehensive and prestigious scholarship named after UF's ninth president, John V. Lombardi. The selected students exemplify Lombardi's commitment to excellence, community service, and public responsibility.

Timothy Logan, associate director of NMR and assistant professor of chemistry, has received an FSU Summer Research Award for the "Molecular Origin of Nonclassical Phi Values in Protein Folding Pathways." After a review of 48 faculty proposals for 2002 Summer Research Awards, the FSU Committee on Faculty Research Support (COFRS) and the Council on Research and Creativity (CRC) granted funding to 27. These awards provide faculty of all ranks with an opportunity to devote substantial time during the summer on a research or creative activity component of their academic careers.

Alan G. Marshall, FSU Kasha Professor of Chemistry and Biochemistry and director of the ICR Program at the NHMFL, has been granted the highest honor by the Society for Applied Spectroscopy—Honorary Member. This award recognizes individuals who have made outstanding contributions to the field of spectroscopy and consists of an engraved plaque and lifetime membership in the Society with all the privileges and rights of a regular member. Prior winners include Arnold Beckman, inventor of the pH meter, and G. Herzberg, Nobel winner. The only prior mass spectroscopist on the list is Al Nier, inventor of high resolution mass spectrometry.

Kyle Orth, safety coordinator of NHMFL Facilities, was awarded Mentor of the Year, out of 150 volunteer mentors, at the Leon County School's District School Volunteer Appreciation & Award Ceremony in May. As a mentor volunteer at Belle Vue Middle School, Orth contributed an extraordinary amount of time and dedication.

FSU Program Enhancement Grant Awards

Supported by the FSU Research Foundation's Cornerstone Program, Program Enhancement Grants or PEGs, are designed to provide seed money over two years for the support of research activities of long-term importance to FSU. This year, FSU had 32 letters of intent to file a full proposal for PEGs, with 14 selected for funding. Three members of the NHMFL family received awards.

Louis-Claude Brunel, EMR Program Director and scholar/scientist, received a PEG for "Quantum Computing with Biomolecules." Brunel's interests are in the development of electron magnetic resonance instruments and methodology, and their application to quantum computing using biomolecules that he wants to study in collaboration with N.E. Bonesteel, N.L. Greenbaum, and J. van Tol.

Jianming Cao, assistant professor of physics and member of NHMFL Condensed Matter/Experimental Group, received a PEG for the "Study of Nanomaterials and Strongly Correlated Systems with Femtosecond Spectroscopy and Electron Diffraction." Cao's research interests include ultrafast electronic and structural dynamics in solid materials, development of fs electron diffraction techniques, and his current research on metals and CMR materials.

Steven Van Sciver, director of Magnet Science and Technology at the NHMFL and professor of mechanical engineering, received a PEG for "Partical Image Studies of High Reynolds Number Liquid Helium Flows." Van Sciver's research interests include cryogenics, heat transfer and fluid dynamics of liquid helium; design and development of cryogenic systems; and application of high temperature superconductors.

PEOPLE

NMR Symposium of the 44th Rocky Mountain Conference on Analytical Chemistry

July 28-August 1, 2002
Denver, Colorado

Hotel Headquarters:
Hyatt Regency Hotel
http://www.milestoneshows.com/rmcac/RMCAC_NMR.htm

Partially sponsored by the NHMFL, this symposium focuses primarily on the development and applications of solid-state NMR and consists of poster and oral sessions. The oral sessions are Applications in Environmental Chemistry, New Detection Methods, Polymers and Dynamics, Glasses and Dynamics, New Methods and Modeling, and Biological Structures. A special tradition of the NMR Symposium is the Vaughan Lecture, and this year's Vaughn Memorial Lecturer is Professor Jeffrey Reimer of the University of California at Berkeley. Full details regarding the NMR Symposium can be found at the conference Web site.

Applied Superconductivity Conference (ASC04)

October 4-8, 2004
Jacksonville, Florida

Hotel Headquarters: Adam's Mark

This important international conference is held every two years and typically attracts approximately 1,800 participants. In September 2000, ASC00 was held in Virginia Beach, Virginia; in August 2002, ASC02 will be in Houston, Texas, and in October 2004, ASC04 comes to Jacksonville, Florida. For information, contact ASC04 Conference Chair Justin Schwartz in NHMFL's Magnet Science & Technology program, 850-644-0874, fax 850-644-0867; *schwartz@magnet.fsu.edu*

2002 SEMRC

32nd Southeast Magnetic Resonance Conference (SEMRC) and Symposium Honoring Edward O. Stejskal

October 24-27, 2002
Research Triangle Park, North Carolina

Hotel Headquarters:
Sheraton Imperial Hotel and Conference Center
http://www.ncsu.edu/chemistry/semrc/index.html

Abstract Deadline: August 1, 2002

The SEMRC provides an ideal opportunity for scientists in all areas of magnetic resonance to come together and share new applications and technique developments. This year's meeting will be particularly special in honor of the many significant contributions that Edward O. Stejskal has made to the science of magnetic resonance. Sponsors include the NHMFL, Advanced Chemistry Development, Bruker, GlaxoSmithKline, Eli Lilly, Magellan Laboratories, NC ACS, NC State University, and Varian, Inc. For registration information and further details, visit the conference Web site.

15th Conference of the International Society of Magnetic Resonance (ISMAR 2004)

October 24-29, 2004
Jacksonville, Florida

Hotel Headquarters: Sawgrass Resort

The scientific program of this major international program encompasses lectures and posters representing the various fields of magnetic resonance, showing its breadth and interdisciplinary nature. The program reflects the everlasting progress and exciting developments of new techniques, theory, and applications in chemistry, physics, biology, medicine, and material science.

The conference Chairman is Timothy A. Cross, NHMFL/FSU NMR Spectroscopy and Imaging Program Director/Professor. Complete conference information will be available in the near future.

ACTIVITIES

REPORTS

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Permit No. 55

Jim Brooks, Jerzy Krzystek, Isaac Rutel and Sergei Zvyagin get ready for testing in Cell 6.
Look for the full story in the next *NHMFL Reports*.