Report on the 2010 NHMFL User Advisory Committee meeting held in Los Alamos from Thursday, Sept. 30 – Saturday, Oct. 2, 2010.

Chair: Janice Musfeldt, Department of Chemistry, University of Tennessee.

DC/Pulsed/High B/T Vice-Chair: Roy Goodrich, Department of Physics, George Washington University

NMR/MRI/ICR/EMR Vice-Chair: Tatyana Polenova, Department of Chemistry, University of Delaware

Full list of user committee members: Sergey Bud'ko, Keith Earle, Nathaniel Fortune, Madalina Furis, Paul Goddard, Roy Goodrich, Kristina Hakansson, Vesna Mitrovic, Jan Musfeldt, Cy Opeil, Tatyana Polenova, Oliver Portugall, Scott Prosser, John Schlueter, Michael Sumption, Sergei Zvyagin

The committee thanks the staff of the NHMFL for their hospitality in Los Alamos, for organizing and presenting a day-long workshop on pulsed field science, and the scientific efforts of the NHMFL staff in supporting the user community. A summary of this workshop is included as an Appendix. We also thank the National Science Foundation, the State of Florida, Florida State University, the University of Florida, and Los Alamos National Laboratory for their generous, long-term support of the Lab.

Highlights and key recommendations:

- The user advisory committee as a whole voted to divide the committee into two subcommittees representing DC/Pulse/High B/T + NMR/MRI/S, ICR, and EMR. Vice-chairs will represent each subcommittee, and an overall chair will represent the committee as a whole. The bylaws were updated accordingly.
- Recommended new hires include a chief scientist for the chemistry/biology program, a high profile spectroscopist to take an active role in preparing for the big light program, and an infrared staff member to function in a user support capacity. Long-term plans should be developed to attract and retain the best high field scientists and engineers.
- We recommend broad pursuit of higher field dc magnets to drive discovery-class science. These include: extending the hybrid system to 47 T, putting the 40 T resistive systems on the floor, and developing the 30 T superconducting magnet. If successfully implemented into the NMR program, a 30 T superconducting magnet should be considered for the High B/T facility.
- We fully support the efforts of the High B/T facility to increase user throughput by opening Bay 1 in the next grant cycle.
- We strongly support the goal of piercing the 100 T barrier in pulsed fields and urge the pursuit of this goal after a full technical and operational risk analysis. We further support the implementation of 95 T fields for user experiments in tandem with the 100 T project. We also recommend that the single-turn coil magnet at LANL be folded into the NHMFL pulsed-field user program so it can remain as a resource for users for the foreseeable future and enable the kind of leadership-class science for which the Lab is known.
- Sustained infrastructure support is needed in the magnetic resonance area. This includes a plan for console upgrades in the NMR area, new further development of high resolution EPR capabilities for the Keck and Series Connected Hybrid magnets, and a 15 T test bed magnet for spectrometer development in support of ICR.
- The user committee regrets the delayed arrival of NSF funding for the magnet lab in both 2009 and 2010, which caused problems with instrumentation development and improvement programs. Steady, reliable support for the Lab is recommended.

General actions, remarks, remarks and recommendations:

Electing representatives: Jan Musfeldt was elected Chair of the User Advisory Committee by the entire committee. Roy Goodrich was elected vice-chair for DC/Pulse/High B/T Facilities. Tatyana Polenova was elected vice-chair for NMR/MRI/S, ICR, and EMR.

Hiring, retaining, and developing talent: One overarching theme in the presentations at the 2010 user meeting was the need to attract good scientific talent. This is a challenge for every organization, but it presents particular difficulties for a specialized organization like the NHMFL. We would like to see the Lab management give some attention to this problem in a general way, perhaps by developing a leadership training program within the Lab or by capitalizing on the NHMFL summer school to attract top talent.

User proposal and experiment portal: The Magnet Lab staff has invested a great deal of effort to standardize proposal and magnet time request submissions for all locations via the user portal. This process has streamlined the submission and review process significantly. While it seems to be working well at this time, the user committee would like to stay informed as to how the process is working and whether it is really changing the final magnet time allocation. We therefore request a report at the next user meeting on the results of the peer review process for magnet time proposals for all locations (TLH, LANL, GNV) and see no reason for a committee of visitors to be added to the proposal review process.

Evaluating user feedback: We applaud the NHMFL for their efforts to systematically evaluate user feedback with an eye to improving the user experience. In order to follow this effort more carefully, the committee requests a summary of this information in advance of the fall user meeting. This effort could be connected to the user portal.

Assessing the impact of the summer school: The User Committee strongly supports the summer program for advanced graduate students, postdocs, and beginning assistant professors. In principle, it should make users much more efficient and productive when they visit for experiments.

Participation-enhancing initiatives: The committee supports the dependent care travel grant program.

Funding delays: NHMFL funding: the user committee regrets the delayed arrival of NSF funding for the Lab in 2010, which delayed a variety of instrumentation development and improvement programs. An example of this impact is the procurement of instrumentation for the split bore magnet. Another example was the budget-shifting required to support the excellent magnet science and technology. A third example of broad impact was the delayed funding for the User Collaboration Grant Program, which supports collaboration of in-house researchers with users. We recognize that these delays are sometimes unavoidable, but we urge steady, reliable support for the Lab.

DC magnet facility:

Upgrades to maintain international competitiveness in dc magnet science: The committee strongly supports and encourages improvements to the high-field infrastructure in Tallahassee, particularly the continuation of the design and construction of the 40 T resistive magnets and the 30 T system. These systems should be deployed as soon as possible. If completed as proposed, the resistive magnets will give users multiple magnets to use to higher fields than are now available worldwide and at a reduced energy cost per Tesla. The 30 T superconducting system will not only be a technological milestone, having a notable impact on magnet technology in both R & D and industrial applications, but it will bring new avenues of research for NMR and other techniques requiring high homogeneity.

Optics in the split coil Helix magnet: The committee applauds the tremendous efforts made by the magnet design team to respond to all the needs of the optics community outlined in the last year User's Committee report. We especially value the efforts to ensure that spectroscopy experiments in Faraday geometry will be possible on a routine basis in the future, and strongly encourage the lab to consider the Faraday insert as an essential component for the Helix magnet. The recent technician hire is very important for building of experimental infrastructure around the magnet, especially in the context of an ambitious schedule for "first light" in the Helix.

Preparing for the free electron laser: The committee supports the large-scale project to install a free electron laser (FEL) in close proximity to the NHMFL in Tallahassee. The FEL has been under consideration, discussion, and design for many years, and the proposal will be submitted to NSF very soon. The committee would therefore appreciate a progress update. The committee feels that in preparation for the realization of the FEL, the Lab would do well to exhibit a world-leading proficiency in high-field optics. This aim will be accelerated by hiring new staff in the area of optical measurements, bringing the split Helix magnet online, and performing high-quality experiments with the currently available instrumentation and technologies.

Temperature control: The committee would like more specifics about the ongoing attempt to improve thermometry in Tallahassee. While not mentioned during the meeting, this also could be a problem in other continuous field measurements and should be examined. The committee has long maintained that this is an important issue to be solved. Therefore we recommend assignment of a full time technical person to work on solving this problem until a satisfactory solution is obtained.

Improving user-theory group interactions: On the subject of user – theorist interactions during the time the user is at the NHMFL for measurements, the committee would like to see this interaction facilitated by whatever means the group leaders think is most appropriate at their facility.

Infrared science investment: We urge the DC Lab to proceed with hiring a replacement infrared scientist as soon as possible. There is an active vibrational spectroscopy community that will benefit from such a hire.

Instrumentation needs: There remains a need to develop a system for low amplitude, < 100 gauss, and frequency < 20 Hz, magnetic field modulation in a dilution refrigerator for use in resistive magnets. High thermal conductivity materials could be used for this purpose. In addition such a system could easily be made for one of the 20 T superconducting magnets for use at dilution refrigerator temperatures.

High B/T facility:

Increased user throughput: The committee is very pleased that the High B/T facility at Gainsville has two bays (Bays 2 and 3) in full and simultaneous operation, and we are excited about the suggestion to open Bay 1 for users in the next grant cycle. This effort will allow an increased number of users to do experiments at ultra-low temperatures.

Opening the Annex: The user committee commends the High B/T facility for opening the Annex, which offers 10 mK + 10 T access and a 0.1 mK + 2T system for users who have special interests and for rapid turnaround experiments such as sample testing and low temperature electronics development.

Increasing the B/T ratio: We suggest that when the 30 T HTC superconducting magnet is operated successfully that one be built for the High B/T facility.

Noise reduction: In addition, new capabilities for measurement, such as ultra-sonics, have been developed with low temperature amplifiers that will increase signal to noise for the low powers used in this technique. A similar system could be employed in Tallahassee.

Pulsed field facility:

The race to 100 T: The committee strongly supports the ongoing efforts to produce a 100 T multiple shot pulsed field magnet at LANL. The risk assessment should be both technical and operational. For the near future we are pleased that the 95 T system is scheduled to be completed, tested, and put into operation for users as soon as Summer 2011. The committee also suggests that in addition to the current design for the 95 T magnet using a 10 mm bore the system should have the capability to replace the 10 mm bore inner coil with a 15 mm bore inner coil for use with more operational volume at fields up to 85 T, the operational field now in use.

Planning for the 100 T magnet: Because of the small bore magnets being produced for pulsed fields new probes, such as sample rotators, optical measurements, etc. need to be developed for users use in these magnets.

Bringing the single turn system into the user program: The single turn coil magnetic field generator at NHMFL pulsed field facility has become operational providing magnetic fields of up to 240 T with temperatures down to as low as 2.5 K with a pulse duration of roughly 6 microseconds. Robust and routine measurements are made in a 10 mm single turn coil to 175 T at 4 K. The coil size makes this system particularly user friendly. It is the user committees opinion that making this magnet available to the user program is a priority as this area of parameter space is not accessible with any other user magnet at the NHMFL. Optical, magnetization, and transport experiments have been demonstrated on materials such as heavy fermion systems, superconductors, semiconductors and dimensionally reduced systems such as carbon nanotubes as well as graphene. Therefore we strongly endorse its incorporation into NHMFL-LANL's user program.

Firing the magnets: The committee suggests that, as a matter of course, the pulsed field facility assign a secondary contact person to each user to fire magnets in case the primary user support person is unavailable.

Suggestions for the Renewal Proposal: DC/Pulsed/High B/T Facility

The user committee would also like to offer its guidance to the NHMFL leadership in an effort to better position the Lab for renewal. Below, please find our thoughts on how to extend the near and later term successes of the NHMFL as well as mitigate potential vulnerabilities, keeping in mind that the goal is to enable the Lab to pursue leadership-class science now and into the future.

Broad fielding of higher field dc magnets to enable new science: Specifically, we support upgrading the hybrid from 45 to 48 T, bringing the higher power 40 T resistive systems to the floor, and the development of the 30 T superconducting magnet.

Role of the Split-Helix magnet: The committee agrees with the EAC report's statement that science in the Split-Helix magnet is a top priority for the upcoming re-competition. However, expectations of having published results for the next renewal proposal must be tempered with the understanding that the tight magnet commissioning and cell renovation schedule will provide limited time for complex experiments. The committee believes that the highest probability of success in the short-term will come either from deep UV and/or polarization-resolved spectroscopes, both of which are severely handicapped at high magnetic fields by current fiber-based techniques. Ultrafast techniques in the Split-Helix also need to be aggressively pursued, but with the understanding that time-resolved and nonlinear techniques are considerably more difficult than corresponding continuous-wave spectroscopes and will need time and steady funding to grow. Efforts should be made to cultivate the user community in this regard.

Claiming the single turn system for user-based science: In the renewal proposal the user committee recommends that the single-turn coil magnet at LANL be folded into the NHMFL-LANL's existing pulsed-field user program so it can remain as a resource for users for the foreseeable future.

Piercing 100 T: Breaking the 100 T barrier will emphasize NHMFL technological leadership in a way that almost nothing else will. We recommend a thorough risk analysis and assault on this goal.

Driving discovery-class science, increasing user satisfaction, and improving efficiency – all at the same time: The ability to receive the currently existing flex-time for users when needed to complete an experiment at Tallahassee should receive continued funding in the renewal period. In addition, a continuation of the allotment of 250 liters of ^{4}He per week should be continued into the renewal period. The renovation of the He liquefiers and installation of a complete ^{4}He gas recovery system should continue into the renewal period if required.

Developing and deploying the series-connected hybrid: The development of the series hybrid should continue into the renewal period. Techniques for use in series hybrid other than NMR, such as STM should be proposed to be developed during the renewal period.

Strong scientific leadership: Recommended new hires during the renewal period include both a chief scientist for the chemistry-biology program a high profile spectroscopist to develop both science and capabilities in the run-up to the big light program.

NMR Magnet Facility and AMRIS Program:

Highlights from 2010

General

The Committee is very impressed with the advances in science and instrumentation made at the NHMFL in the past year. The program has established a balance between the three major areas of magnetic resonance, imaging, solution spectroscopy and solid-state spectroscopy. The Lab is building upon the unique capabilities and strengths of the facility that are not available elsewhere, and pursuing development of cutting-edge technologies. At the same time, NHMFL supports very well the needs of its wide user base from multiple institutions in the state of Florida, the United States and abroad, providing access to NMR resources to a diverse set of scientists at various levels. The NMR user Committee feels that the NMR program successfully balances the somewhat disparate tasks of driving cutting edge technology and serving the broad scientific user base.

Infrastructure

- Outstanding news on the successful NSF proposal for acquisition of NMR console for the SCH magnet
- The 900 MHz system remains an outstanding platform for science, with multiple high-profile publications in 2010.

Technology

- Successful NSF proposal for acquisition of NMR console for the SCH magnet
- Development of 3.2 mm triple resonance MAS probe surpassing the commercial probes in key characteristics (sensitivity, rf homogeneity, power handling)
- Development of 1.5 mm ^{13}C detect HTS probe (still in progress)
- Development of live mouse/rat probe for 750 MHz system (still in progress)
- Perfusion probe for live tissue microimaging
- MRI coil developments

Science

- fMRI of water diffusion in human and animal brain
- 900 MHz MRI program on materials and live rats
- Biosolids program- M2 structure, development of new methods
- Quadrupole tensor determination in complex materials

Prioritized List of Recommendations

While the users' committee is impressed with how the user programs are running, there are several suggestions from the committee members on how to improve the current operation of the facility. The synergy among the solution, solid-state and imaging aspects of the NMR program has been extremely important, especially in terms of cross-fertilization of ideas and mutually beneficial technological developments. Recognizing that resources are limited, we outline a priority list in five specific areas: general management, budget, technology development, user base and administrative issues, and scientific directions.

General management

- The user survey program needs to be tailored to the needs of the individual user base. The current survey did not take into account the existing NMR users, many of whom submit samples to NHMFL personnel for data acquisition and processing.
- It would be highly beneficial to the NMR/MRI programs that NHMFL demonstrates commitment for systematic infrastructure support, including maintenance and upgrades of existing equipment.
- It is essential for the most productive operation of NHMFL NMR program that the Laboratory supports development of both cutting-edge high-field magnet technology and maintenance of the existing intermediate frequency NMR instruments. These intermediate frequency spectrometers are essential for development of novel probe technology and testing of prototype probes operating at the high magnetic fields, as well as development of DNP (see below). Furthermore, the existing intermediate frequency instruments are essential for support of a diverse user base and a broad range of ongoing and future scientific projects in the Laboratory that yield multiple publications in high-quality peer-reviewed journals. It is necessary that appropriate balance is maintained between these two highly important aspects of NMR program.

Budget

- The current operational budget for the NMR facility needs to be increased to permit console upgrade and maintenance. It is proposed that \$250,000 per year is allocated to support the instrument upgrade and maintenance at the Tallahassee site.
- It is recommended that NHMFL seeks funds to perform renovation of the AMRIS facility to reconfigure the space so that additional NMR and MRI magnets can be installed.

- With the growth of the biosolids NMR program it is essential that full-time Ph.D. level engineer/manager is hired to work with the expanding biosolids user base.

Technology developments

- The news regarding successful NSF proposal for acquisition of NMR console for the 36 T SCH magnet is outstanding. It is recommended that the projected console is a hybrid solution/solids/imaging system with 4 channels, 2 receivers, amplifiers for solids, solution and imaging work. The most flexible configuration allowing for the broadest range of NMR/MRI experiments should be sought, possibly including capability for tunable frequency operation (^{1}H frequency between 1 and 1.6 GHz) to permit field dependent experiments.
- Begin development of probe technologies for the projected 30+ LTS/HTS NMR magnet. Secure funds to purchase NMR console for this system.
- Begin development of DNP technology for intermediate frequency systems in liquids and solids.
- Begin development of combined ^{13}C-detect HTS / DNP technology.
- With the advent of new magnet and probe technology, we recommend that greater partnerships be sought with commercial vendors to accelerate and catalyze development and opportunities for users
- High pressure NMR and the use of supercritical fluids are also examples of technology which the Magnet lab could develop and assist users in implementing such technologies

User base and administrative issues

- Build the user base with the focus on the unique capabilities of NHMFL in high field technology while reaching out to a broad and diverse range of scientists in the US and internationally
- There is a strong need to actively and aggressively recruit users of the high-field NMR facilities, and to make people aware of research initiatives and new instrumentation and infrastructure. We suggest examining the Canadian high-field facility site, http://nmr900.ca, and consider utilizing this as a model for building a website which better advertises ongoing research, facilities, probes, etc. Victor Terskikh, the facility manager, has managed to bring together a strong community of NMR users in Canada and around the world, via this website and quarterly newsletters, which describes publications, funding opportunities, employment opportunities and so forth.
- Continue supporting the broad range of users and diverse science
- It is strongly recommended that proposals be geared towards specific projects with clearly stated objectives, and not to broad, vaguely defined programs of study. Strong points in a proposal include the necessity for the high field NMR spectroscopy in relation to the research, new innovations in terms of technology and/or pulse sequence development, and novel applications to systems of fundamental importance and technological interest.

Scientific directions

- SCH: quadrupoles, microimaging, oriented sample (SLF) NMR, rapid data acquisition in liquid-state spectroscopy; explore additional directions
- Strengthen science in areas that could be unique to NHMFL: complex fluids, high-pressure and other extreme sample conditions.
- fMRI program on water diffusion in human and animal brains is an important and unique direction
- MRI coil development program is also a high-impact direction

EMR Facilities:

The EMR committee met via phone conference on 23 September, 2010. The purpose of the meeting was to obtain feedback from the EMR group on progress and accomplishments for the previous year. The committee was particularly gratified at the effort made to present reliable user statistics, as well as the context necessary for understanding them. In terms of instrumentation, the committee feels that acquisition of pulsed 95 GHz equipment is a useful complement to current laboratory strengths. Investment in laboratory infrastructure for EMR is clearly a priority of the NHMFL, and the committee hopes that this positive assessment and tangible support for the EMR continues in subsequent budget years. The notes from the phone conference indicate that the EMR program will continue to be funded at a high level, per agreement with the director. The committee is gratified by this increase in funding level, both in absolute terms and also as a percentage of NHMFL resources.

Keith Earle, EMR external user committee chair, attended general lab meeting at Los Alamos, as the EMR representative, and heard presentations on pulse field capabilities and got input from NHMFL personnel on a variety of Lab-related issues. This input from a Lab-wide perspective was important for placing the accomplishments and concerns of the EMR external users committee in a broader context. After the meeting, the following list of noteworthy accomplishments and concerns was compiled on the basis of the input received during the phone conference, at Los Alamos, in discussions with EMR personnel, and upon review of last year's report.

The EMR External User's Advisory Committee notes the following accomplishments since the last meeting in Tallahassee:

- We are pleased by the overall progress of the EMR program under its new director.
- We are gratified that many of the recommendations from last year's report have been implemented.
- The committee is also very pleased with the hire of Likai Song who will strengthen the biological EPR user's component.
- We are impressed by the number of publications, both in terms of total number and as a percentage of the NHMFL's total. In addition, we are gratified that such a high percentage of the publications are in significant journals.
- The committee supports formalizing the advisory committee member selection process.

The EMR External User's Advisory Committee also has some concerns:

- The committee feels that the EMR program should develop a prioritized list of strengths and evaluate user requests within the context of those priorities in order to prevent dilution of effort.
- User comments were generally favorable. One user has provided many useful suggestions for improving the high-resolution setup in the Keck magnet, both via the user feedback system and in private communications with the EMR director. We strongly encourage the EMR Scholar/Scientists to follow this advice. These issues include:
  - improving sensitivity (due to high insertion loss optics)
  - reducing spectral broadening (due to over-moding, source jitter, and sweep jitter)

– reducing *g* scale errors (due to magnet calibration)

- We also support the development of a probe with fiber optic access to enable photoinduced and light harvesting-related science.
- The committee is concerned that the 31 T, 50 mm magnet is being displaced to make room for the split coil magnet. As the 31 T magnet is the workhorse of the EPR user's program, some provision should be made to ensure that disruptions are minimized.

ICR Facilities:

Highlights from 2010

General

The ICR program has continued to maintain a world leading role in high field FT-ICR mass spectrometry and complex mixture analysis. The program is also making great strides towards improving diversity.

Infrastructure

- Outstanding news on the successful NSF proposal for acquisition of a first of its kind 21 Tesla ICR magnet and construction of a state-of the art spectrometer to be paired with this magnet.
- Commitment from FSU to construct a new building to house the 21 T instrument.
- Initiated Future Fuels Institute (with 5-6 major oil companies in a joint partnership, targeting high-profile problems of mutual interest)
- Exciting news is the hiring of Dr. Amy McKenna as Director for User Services.

Technology

- Mass accuracy improvements by an aggregate factor of 5 at a given magnetic field

Science

- Solved the puzzle of why much of heavy crude oil is insoluble (the individual molecules are small and soluble, but their aggregates are insoluble)
- 4 major external awards, plus the top-cited paper in the past decade for each of the two most-cited mass spectrometry journals

Targeted needs for the ICR Program

- 12-15 T test bed magnet for 21 T R&D
- Bioinformatics expert

Scientific directions

- Maintain and extend world leadership in FT-ICR MS instrumentation and capabilities: highest magnetic field, highest resolution and mass accuracy, new ionization methods, ion optics, automation, data reduction.

- Petroleomics becomes a predictive tool: quantitation, deposits, corrosion, flow assurance, emulsions, compartmentalization, etc.
- Future Fuels Institute: industrial partnerships to address "heavy ends", biofuels, oil spills, etc.
- Exploit full potential of FT-ICR MS for biochemistry/biology: human proteome, cell membrane lipids and glycolipids, protein complexes, metabolomics, drug design.

Appendix: Pulsed Field Science Workshop Agenda

08.30 Stefan Hansel Center for Research on Adaptive Nanostructures and Nanodevices. Trinity College, Dublin
Eddy currents and measurements in pulsed magnetic fields
Performing experiments in pulsed magnetic fields, eddy currents are the effect that you love to ignore whenever you don't attach wires to your reasonably well conducting sample. However, even optical investigations in pulsed field, especially the single turn coil, have been shown do be considerably affected by them. I am going to present a very basic theory for their quantification and show how to estimate their effects such as voltages, heating and internally applied pressure and thus understand experimental curves or even correct them into more reasonable ones. Moreover, I am going to show how lessons learned from the single turn coil enable us to develop measurement techniques based on eddy currents effects such as quantitative resonant circuits experiments simultaneously determining susceptibility and conductivity contactlessly.

09.05 Chuck Mielke NHMFL –PFF Los Alamos National laboratory
Extreme Perturbations: Beyond 100 T
Magnetic field generation in excess of 100 tesla currently requires a system that is in part destructive to the magnet itself.
At the NHMFL-PFF a system which employs the Single Turn technique is now mature and routinely delivering a research magnetic field of 170 tesla with successful tests to 240 tesla. Measurement techniques in this hostile environment with dB/dt rates in excess of 100 million tesla/second are extreme challenges in themselves. Optical techniques have produced some of the best achievable signal:noise and will be highlighted as applied to condensed matter systems. A significant effort towards realization of a resistivity technique in which inductive coupling to the metallic sample will be discussed along with preliminary results.

09.40 Oliver Portugal Laboratoire National des Champs Magnétiques Intenses CNRS, Toulouse, FRANCE
The Toulouse pulsed magnet facility - recent developments and future plans
The main part of this talk will be dedicated to a general overview over the experimental possibilities of the Toulouse pulsed magnet facility (generators, magnets, cryogenic equipment and experimental techniques) as well as selected scientific results. I will then discuss some of the ongoing technical developments and projects, in particular the construction of a 6 MJ mobile capacitor bank and the development of new experimental techniques to be used in connection with highly transient (< 10 us) Megagauss fields (> 100 T). The talk will also include a brief explanation of the current organization and future plans of the EuroMagNET consortium which comprises the four major high-field facilities in Europe.

10.30 Doug Tasker High Explosives Applications and Special Projects. Los Alamos National Laboratory
Isentropic compression studies using the NHMFL Single Turn
Magnetic isentropic compression experiments (ICE) provide the most accurate shock free compression data for materials at megabar pressures. Recent ICE experiments performed on the Sandia Z-machine and at the Los Alamos High Explosive Pulsed Power facility are providing our nation with data on material properties in extreme dynamic high pressure environments. The NHMFL can offer a less complex ICE experiment at modest pressures (up to 1 Mbar) with a high sample throughput and relatively low cost. We will discuss the physics of the NHMFL-ICE experiments and present data from the first proof-of-principle experiments.

11.05 Madalina Furis University of Vermont Burlington, VT
Challenges of Optical Spectroscopy in High Magnetic Fields
High magnetic fields play a crucial role in the investigation of spin-dependent phenomena in a large variety of materials ranging from semiconductors, ferroic materials, and superconductors to biomolecules and living tissues. Many of these phenomena leave their signature on the optical properties of these materials. Examples include the magnetization-induced circular birefringence (Faraday and Kerr effects) observed in ferromagnetic or paramagnetic systems, magnetic circular dichroism (MCD) of semiconductors or organic molecules, circularly-polarized radiative recombination of spin-polarized electrons in semiconductor nanostructures, luminescence from optically-forbidden states in carbon nanotubes and semiconductors nanocrystals, spin-flip Raman transitions. In this talk I will review the principles and challenges of high magnetic field optical spectroscopy experiments that investigate these phenomena, focusing on the successes as well as limitations of fiber-coupled optical techniques in pulsed magnetic fields. Examples of unique observations enabled by non-destructive pulsed B fields larger than 60T include a dark

exciton ground state and an Aharonov –Bohm phase in carbon nanotubes, or exciton g-factors in semiconductor nanocrystals. At the same time, the short duration of pulses (< 2 sec) and, in some cases, the lack of polarization control, limits severely limits studies of magnetic circular dichroism in thin films or ultrafast spin dynamics.

11.40 Philip Moll Laboratory for Solid State Physics, ETH Zurich, Switzerland
Ion Beam Sample Preparation for Pulsed Magnetic Fields: Application to Pnictides
The Focused Ion Beam (FIB) is a versatile high precision tool for material manipulation on the micro- and nanoscale. We present recently developed FIB based techniques giving precise control over the sample geometry and electrical behavior. This technique has in the past proven to be an ideal method to prepare sophisticated electronic transport samples out of microscopic crystals. These samples feature controllable absolute resistance, very low contact resistances, multiple measurements on one crystal, selection of crystal axes and extremely large Signal-to-Noise ratios, even in pulsed magnetic fields. We have very successfully applied this technique to study the anisotropy of the superconducting properties and critical currents in the pnictide superconductor SmFeAs(O,F) (T_c~55K) to assess the materials potential for application. The intragrain low temperature properties are promising: We found a combination of high (> 10^6 A/cm^2) and almost isotropic critical currents and only little influence of the current orientation in the crystal.

13.45 Zahirul Islam Advanced Photon Source, Argonne National Laboratory
Tools and techniques for precision x-ray studies of materials in pulsed magnetic fields
Pulsed magnets have emerged as a viable tool for studying materials using high-resolution structural probes at modern synchrotron facilities. A diversity of condensed-matter systems are being studied to determine field-induced structural and magnetic effects such as magneto-striction, Jahn-Teller distortions, and phase transitions using a number of x-ray diffraction and spectroscopic techniques. An overview of some representative x-ray studies is presented in this talk. At the APS efforts have been underway for advancing the use of three complementary 30 Tesla pulsed magnet systems. Two unique instruments have already been developed, which are compact, portable, and do not require special infrastructure. The first magnet is a split pair of mini-coils (pulse duration ~1ms) with applied field normal to the scattering plane [1], which has recently been used in the study of magneto-elastics of a spin-liquid system [2]. The second is a large-bore solenoid (pulse duration ~4ms) that allows fields to be in the scattering plane. The coils have been designed and built at Tohoku University. Finally, a conceptual design for a novel asymmetric “hour-glass” magnet has been developed in collaboration with NHMFL-PFF. This set of three pulsed-magnet instruments would allow a wide range of problems to be studied using various x-ray scattering and spectroscopic techniques.
[1] Zahirul Islam, Jacob P. C. Ruff, Hiroyuki Nojiri, Yasuhiro H. Matsuda, Kathryn A. Ross, Bruce D. Gaulin, Zhe Qu, Jonathan C. Lang, Rev. Sci. Instrum. **80**, 113902 (2009).
[2] J. P. C. Ruff, Z. Islam, J. P. Clancy, K. A. Ross, H. Nojiri, Y. H. Matsuda, K. A. Ross, H. A. Dabkowska, and B. D. Gaulin, Phys. Rev. Lett. **105**, 077203 (2010).
Use of the APS is supported by the U. S. Department of Energy, Office of Science, under Contract No. DE-AC02-06CH11357.

14.20 David Morris Director, Center for Integrated Nanotechnologies (CINT) Los Alamos
Research Opportunities at CINT: A DOE / BES Nanoscale Science Research Center
CINT, the Center for Integrated Nanotechnologies, is one of five Nanoscale Science Research Centers operated by the US Department of Energy Office of Science as a national user facility resource to promote and enable research in all aspects of nanoscience. CINT is differentiated from the other DOE NSRCs by its focus on nanoscience integration and by the fact that it is a joint venture of two DOE national laboratories; Los Alamos and Sandia National Laboratories. CINT also benefits from its colocation and historic strong collaborative interactions at Los Alamos with the National High Magnetic Field Lab and the Lujan Neutron Scattering Center. Together, these three national user facilities with operations at LANL comprise an enormous opportunity for discovery science that spans biology, chemistry, materials science, and physics. The focus of this talk will be on the structure of CINT and the extant capabilities for nanomaterials science research at both LANL Gateway and Sandia Core facilities, and details of our user facility operations including our user proposal process.

14.55 Alan Hurd Los Alamos Neutron Science Center (LANSCE)
Research opportunities and neutron scattering for complex materials
Human ingenuity continues to produce new materials that require a fresh look at how we solve materials physics problems with neutrons, which have a particular advantage in magnetically active materials. The trend in synthesis

is toward ever finer inhomogeneity of ever greater differences, which has been fruitful for pursuing ever higher performance density. Practitioners of neutron diffraction, inelastic scattering, and large-scale scattering techniques have sharpened their pencils significantly in the last decade, with higher flux sources and better detectors, to study exotic materials such as MAX phases, Laves phases, metal-oxide frameworks, archaeological speciments, and nanostructured materials to name just a few. Many new techniques have been developed, notably "total scattering" to obtain pair distribution functions (pdf) and dynamic pdfs. Perhaps the greatest progress has been in sample environments and auxiliary equipment: For example, it is now possible to apply over 200 kN to a sample in a neutron beam at temperatures from liquid nitrogen to 2200C. A dilution refrigerator is under commissioning as well. Through a call for Letters of Intent, users have grouped around fresh new instrumentation ideas as part of the Enhanced Lujan Program. Recent results taken mostly from LANSCE will be reviewed, highlighting cases where new techniques have encouraged the unearthing of complexity in behaviour.

15.30 Marcelo Jaime NHMFL –PFF Los Alamos National Laboratory
Modulation calorimetry in Pulsed magnetic fields
A new calorimeter for measurements of the heat capacity and magnetocaloric effect of small samples in pulsed magnetic fields is discussed for the exploration of thermal properties at temperatures down to 1 K. We tested the method in both DC and pulsed magnetic fields up to m_0H = 55 Tesla, but it could be extended to higher fields. Heat capacity and magnetocaloric effect for the spin-dimer compound $Sr_3Cr_2O_8$, the triangular lattice antiferromagnet $RbFe(MoO_4)_2$, the quantum magnet $Pb_2V_3O_9$ and the heavy fermion $CeIrIn_5$ will be discussed as illustration of the capability.