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LLNL Submissions to US ITER Project Office Request for Expression of Interest

D. L. Correll, Jr.

September 2, 2005

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LLNL Submissions to US ITER Project Office Request for Expression of Interest

Don Correll

August 31, 2005

US ITER PROJECT OFFICE

Request for Expressions of Interest (RFEI) to Perform Work
http://www.iter-us.org/page1.aspx

Input from Lawrence Livermore National Laboratory (LLNL)

***Indicates Required Field**

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ROLES IN WHICH YOUR ORGANIZATION HAS AN INTEREST	
Identify Organization Category*	**National Laboratory**
Primary Interest (Type of Service to be provided)*	**Hardware Design, Fabrication & Manufacture**
Technical and Administrative Systems *Check one or more boxes from the list of support functions*	[x] Engineering Analysis [x] Engineering Design [x] Engineering Design & Drafting [x] Research & Development [x] Manufacturing- Fabrication / Production [x] Manufacturing- Fabrication, Assembly & Testing [x] Manufacturing- Supply Commercial Components [x] Technical Contracts Manager [x] Administration Support
Select specific system area of interest	**Diagnostic Systems** *(4 RFEI's from FEP)* **Technical Systems** *(2 RFEI's from FEP)* **Management/Administration** *(1 RFEI from ENG)* *(one of the above will be chosen as appropriate to the RFEI)*

TECHNICAL CONTACT FOR USIPO POSITION:	
Title*	*Will vary with each RFEI (see list below)*
First Name*	*Will vary with each RFEI (see list below)*
Middle Initial	*Will vary with each RFEI (see list below)*
Last Name*	*Will vary with each RFEI (see list below)*
Employer*	*Will vary with each RFEI (see list below)*
Department*	*Will vary with each RFEI (see list below)*
Street Address*	*Will vary with each RFEI (see list below)*
Street Address	*Will vary with each RFEI (see list below)*
City*	*Will vary with each RFEI (see list below)*
State*	*Will vary with each RFEI (see list below)*
Zip Code*	*Will vary with each RFEI (see list below)*
Country*	*Will vary with each RFEI (see list below)*
Office Phone*	*Will vary with each RFEI (see list below)*
Fax*	*Will vary with each RFEI (see list below)*
Mobile Phone	*Will vary with each RFEI (see list below)*
e-mail*	*Will vary with each RFEI (see list below)*

BUSINESS CATEGORIES:	
Size of Business*	**US Domestic Other (Education/Non-Profit)**
List and describe the lead management [and technical support] role[s]s of interest to be performed by the individual[s] and their organization. (5000 characters maximum)*	
Will use text from the following 7 word documents: LLNL_ITER_RFEI_Diag_MSE.doc (Tech Contact: Jayakumar) LLNL_ITER_RFEI_Diag_EquatorialPorts.doc (Tech Contact: Casper) LLNL_ITER_RFEI_Diag_Cameras.doc (Tech Contact: Lasnier) LLNL_ITER_RFEI_Diag_UpperPorts.doc (Tech Contact: Hill) LLNL_ITER_RFEI_Tech_ShieldWall.doc (Tech Contact: Meier) LLNL_ITER_RFEI_Tech_ShieldShield.doc (Tech Contact: Meier) LLNL_ITER_RFEI_Manage_Admin.doc (Tech Contact: Karpenko)	
Describe previous work and relevant experience performed by the organization. (5000 characters maximum)*	
Will use text from the above 7 word documents	
List skills and experience of the key individual[s] in the organization identified to perform the ITER work. (5000 characters maximum)*	
Will use text from the above word 7 documents	

Motional Stark Effect

List and describe the lead management [and technical support] role[s] of interest to be performed by the individual[s] and their organization. (5000 characters maximum)*

LLNL's Fusion Energy Program (FEP) is committed to helping the US ITER Project Office (USIPO) succeed in providing the US contributions to ITER. FEP has identified four Diagnostics Systems – MSE, Equatorial Ports Design & Integration (D&I), Visible & IR Cameras, and Upper Ports D&I – that are of interest and that are consistent with the Lab's previous work and relevant experience. Although not explicitly listed as an EOI area, the US Port Test Facility is of particular interest to LLNL and is one of the drivers for our interest in port D&I efforts.

In close collaboration with General Atomics and the University of Wisconsin at Madison, LLNL is expressing interest in the design, procurement and integration of the MSE diagnostic. LLNL and GA would co-lead this effort with a strong participation from the University of Wisconsin. LLNL would be specifically responsible for the optical design (front end optics). The University of Wisconsin would design and fabricate the detecting system (polarization analyzer and detectors). GA would participate in the required R&D work for this diagnostic and plan to do the needed testing, including any prototyping, on existing facilities such as DIII-D. GA would assist in the efforts of integrating this system into the relevant port plugs and in the coordination with other ITER parties

Specifically, LLNL offers to undertake and/or lead the final design, fabrication and integration of the Motional Stark Effect (MSE) diagnostic for the ITER machine. The team would consist of diagnostic and tokamak physicists; neutron and optical materials experts; and design analysis and fabrication professionals. LLNL would team with General Atomics and University of Wisconsin in carrying out the work. LLNL would be the lead organization, and be responsible for the overall diagnostic performance, and be directly responsible for the design, the development, the procurement and testing of the front optics (optical train), from the blanket module to diagnostic room. LLNL would also be responsible for budget, schedule and configuration management. The documentation would be a collective responsibility with LLNL in the lead. University of Wisconsin would be responsible for the design, the development, the procurement and testing of the detection subsystem, including the polarization analyzer, filters, and detectors. General Atomics would be the lead for the analysis of system performance for supporting physics operations, simulations of various discharges scenarios, integration into equilibrium reconstruction and plasma control. In addition, General Atomics would be responsible for a suitable test of a representative prototype on DIII-D and evaluation of its performance. The MSE team leader would coordinate the effort with USIPO diagnostic team leader and with other ITER experts as appropriate and per USIPO procedures.

FEP has applied for internal LLNL-LDRD funding for R&D in optimizing MSE diagnostics for future MFE experiments, such as ITER. This activity would bring additional capability to ensure a successful MSE for ITER. Because of the location of MSE diagnostic, LLNL is also offering to undertake the Equatorial Ports D&I, again in collaboration with GA.

Describe previous work and relevant experience performed by the organization. (5000 characters maximum)*

LLNL's Research, Engineering, and Project experience in fusion spans its entire 50-year history including the Mirror Program, the Microwave Tokamak Experiment (MTX), the ITER CDA and EDA process, and current experimental work in MFE (SSPX, DIII-D collaboration, and other experimental research support e.g. NSTX, JET, and MAST). With respect to the MSE diagnostic, a 45 channel (3 array) system has been designed, fabricated, implemented, and maintained by the LLNL group on the DIII-D tokamak in San Diego, CA. This MSE diagnostic is one of the best MSE systems in the world, if not the best system, providing robust, accurate, reproducible and sensitive measurements.

The operation, plasma control and physics analysis on the DIII-D tokamak has become so dependent on this diagnostic that a majority of DIII-D experiments would be stopped if this MSE system were not available. The system is very similar to the system proposed for ITER and includes one array, which views the plasma with a mirror as in the ITER system. It consists of the photo-elastic Modulators with optical light collection optics with the desired spatial and time resolution and a set of detectors, analog as well as digital lock-ins for data extraction and data acquisition electronics.

The FEP team understands in detail, sources of systematic errors and methods to correct for such systematic errors and random errors. Recently, the team became the first in the world to develop a technique and measure the fast oscillating magnetic fields due to plasma MHD activity in a tokamak. A 20 channel (2 array) MSE system is now under fabrication for a counter-beam MSE system that would increase resolution and accuracy. The FEP team has developed the software for data analysis and for integrating into plasma equilibrium reconstruction program. Several original inventions and studies have been made in improving and optimizing the MSE system (e.g. half energy measurement, detailed study of beam in gas calibration, development of a method for calibration in presence of magnetic fields, noise analysis etc.). Through this thorough knowledge and experience, the FEP team members are also world experts in the difficult task of calibration, trouble shooting and optimization of the diagnostic.

The following are some of the pertinent experience and accomplishments of the LLNL team:

- Fabricated, installed and maintained the arguably the best MSE system in the world, on the DIII-D tokamak.
- Developed software for analyzing MSE data, generating equilibrium and calculating current and Er profiles.
- Developed sensitive calibration techniques for the multi array diagnostics including non-ideal effects.
- Carried out studies on beam-in-gas calibration techniques.
- Carried out collisional-radiative calculations for the D-Alpha spectrum under different plasma conditions.
- Carried out noise analysis on the MSE signal.
- Invented the technique for the measurement of oscillating magnetic fields associated with fast MHD activity.
- Simulated ITER plasma scenario with a pseudo MSE diagnostic in the code CORSICA, using the proposed MSE geometry.

The General Atomics (GA) team has considerable experience in engineering and integration of diagnostic instrumentation for fusion devices. Being at the forefront of

Advanced Tokamak experiments, the GA team is well versed in identifying plasma characteristics and plasma scenarios. GA also has developed state of art control methods for plasma profile and performance.

The University of Wisconsin Team has considerable experience in Beam Emission Spectroscopy (BES) and related diagnostic instrumentation on tokamaks. Since the BES views the same spectral line as the MSE and the DIII-D MSE and BES teams work together, the UW team has considerable knowledge in the optics and atomics physics related to MSE.

LLNL experts will be used to extend additional support in ITER-specific areas, which have not been encountered in DIII-D such as neutronics and first mirror (erosion and deposition). LLNL Neutronics physicists are already assisting in ITER and will work on any trade off studies that may be required and LLNL optical material experts will be consulted on the first-mirror issues. It may be noted that considerable expertise on optics and neutronics exists in LLNL due to experience in projects such as National Ignition Facility and through weapons stewardship programs.

The LLNL staff has many experienced engineers in the design and fabrication of plasma diagnostic equipment and in particular optical diagnostics through NIF, Spheromak, DIII-D and Mirror Plasma programs. The LLNL organization and the proposed team lead have considerable experience in project management. LLNL has established procedures and tools for budget, schedule and configuration management, and quality assurance and for meeting ES&H requirements.

List skills and experience of the key individual[s] in the organization identified to perform the ITER work. (5000 character maximum)*

The depth and breadth of the plasma physics and engineering staff at LLNL is known throughout the US and international fusion communities. At last count, over 130 scientists and engineers were in involved in fusion-relevant research. With respect to the MSE diagnostic system, the following individuals would be involved:

LAWRENCE LIVERMORE NATIONAL LAB:

Raghavan (Jay) Jayakumar (MSE Technical Contact),

Relevant Skills: Management and leadership of large and small technical projects and programs; interaction with international collaborators; experimental, theoretical and numerical abilities in fusion plasma research. Skilled in fabrication of variety of diagnostics and in atomic spectra calculations. One of the world experts on MSE diagnostics fabrication, calibration and operation.

Relevant Research experience: Physicist and Collaborator in DIII-D tokamak fusion research program, Deputy thrust leader for Hybrid tokamak scenario; Lead physicist for Motional Stark Effect diagnostics for the measurement of current profile, Lead physicist for discharge studies with unconventional current profiles

Michael A. Makowski,

Relevant Skills: Experimental plasma physics and plasma modeling; skilled in MSE optical modeling; one of the world experts, experienced in fabrication, calibration and operation of MSE diagnostics, Highly skilled in experimental and diagnostic data analysis, Skilled in software development for experimental data analysis.

Relevant Research experience: Physicist and LLNL Collaborator in the DIII-D tokamak fusion program. Lead Physicist for Motional Stark Effect Diagnostics for plasma Current Profile Measurement.

Chris Holcomb,
Relevant Skills: Experimental plasma physics, Skilled in MSE design and trade offs, Experienced in fabrication, calibration and operation of MSE diagnostics, and Highly skilled in experimental and diagnostic data analysis.
Relevant Research experience: Physicist and LLNL Collaborator in the DIII-D tokamak fusion program. Lead Physicist for the design and fabrication of a 20-channel counter-beam MSE system for the DIII-D tokamak. Physicist working on Motional Stark Effect Diagnostics for plasma Current Profile Measurement.
Jeffery F. Latkowski,
Relevant Skills: Nuclear and radiological engineering, neutronics from fusion sources, activation analysis, worker dose assessments for experimental facilities (e.g., NIF), and environmental impact assessments. Point of contact for work on automated CAD to Monte Carlo processing.
Relevant Research Experience: Nuclear Engineer, New Technologies Engineering Division. Deputy Associate Program Leader for Fusion Technology within FEP.
Lynn G. Seppala,
Relevant Skills: Optical engineering and optical design , Optical design of MSE system and ray tracing analysis, Experienced in choice of optical materials.
Relevant Professional Experience: Optical Engineer, Lawrence Livermore National Laboratory, LLNL, Optical Engineer, ITEK Corporation, Lexington, MA
GENERAL ATOMICS:
Dan M. Thomas, Scientist, Experimental Science Division, over 25 years experience in novel diagnostic systems for fusion experiments. Highly experienced on the development of precision edge magnetic measurements in DIII-D using atomic beam techniques and technical design of beam based diagnostics for ITER. Presently co-chair of the ITPA Specialist Working Group on beam-aided spectroscopy.
Keith H. Burrell, Program Manager, Experimental Science Division, General Atomics. Dr. Keith Burrell has 37 years of experience in theoretical and experimental plasma physics;; A pioneer in neutral beam-based diagnostic system ; Leader of the team which built the world class DIII-D CER system for measuring ion temperature, rotation speed profiles and electric field profiles.
Thomas N. Carlstrom, Chief Scientist, Sensors Group-Photonics Division, Highly experienced in the design, development, and operation of the CO2 interferometer, phase contrast interferometer and the Lithium beam edge current density diagnostic on DIII-D. Led the production of over 85 Thomson scattering Main contributor to the
Rejean L. Boivin, DIII-D Diagnostic Manager, Energy Group, Has developed many diagnostics for TFTR (PPPL) and Alcator C-Mod (MIT) e.g. particle analysis (neutrals, neutrons, fast ions), to line emission imaging, bolometry and RF physics..; led the diagnostic integration at Alcator C-Mod and at DIII-D tokamaks Currently the US deputy leader of the ITPA group on diagnostics.
UNIVERSITY OF WISCONSIN
George R. McKee, Associate Scientist with the University of Wisconsin-Madison. Played an integral role in the design, implementation, and operation of novel spectroscopic diagnostics at major fusion facilities. Worked in a collaborative program between UW and General Atomics; designed and implemented a major upgrade to the Beam Emission Spectroscopy density fluctuation diagnostic system at the DIII-D tokamak. Experienced in the development and application of unique fluctuation analysis techniques.

Equatorial Ports, E3/E9, Design & Integration

List and describe the lead management [and technical support] role[s] of interest to be performed by the individual[s] and their organization. (5000 characters maximum)

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LLNL and General Atomics (GA) express interest, as a team, to undertake the design, procurement and integration of the Equatorial Port diagnostic structures, as part of a national team of experts. In leading the D&I effort for the US equatorial ports (E3 and E9), we would assemble a combined management and technical team of knowledgeable physicists, engineers and technical staff who have a long history of development and operation of large and complex experiments in both the MFE and IFE programs. Both institutions will provide the coordination necessary to efficiently:

- Provide expertise to coordinate and execute the design, fabrication, assembly, testing, and installation of multiple diagnostic subsystems in the equatorial port plugs. LLNL and GA have the complementary experience and facilities and the support needed to accomplish these duties.
- Use our strong backgrounds in analysis, modeling and systems engineering to facilitate integration and testing of front-end subsystems delivered by the US and the other international parties. To support this effort, LLNL and GA can draw upon their internal expertise in design, fabrication, optics, materials, neutronics, instrumentation, remote handling and data systems.
- Provide the necessary research and development required to simplify and/or optimize diagnostic access and performance in these equatorial ports for the several instruments from both the US and international ITER parties.
- Establish detailed design requirements for the port plug and the accompanying diagnostics
- Manage budget, schedule, and progress reporting to the USIPO/Diagnostic Team Leader. Attend meetings at central locations and provide technical documentation as necessary and follow DOE standards for ES&H and quality control.
- Provide support for optimizing diagnostic geometries, e.g. mirror labyrinths, waveguides, mechanical/optical installations and electronic signals to optimize instrument performance while minimizing neutron flux to external locations.
- Host a US Port Test Facility for testing multiple diagnostic subsystem installations. This facility would provide for the testing of operating characteristics such as vacuum compatibility, bake out, noise immunity, calibration and data acquisition from the combined diagnostic port plug in preparation for installation at the ITER site.
- Provide the technical expertise and work force needed for the ultimate installation and commissioning of the US port plugs at the ITER site in Cadarache.

LLNL's primary interest is the management of port E3 due to our experience in with MSE instrumentation. GA has expressed primary interest in the details of port E9 due to their interests in electron cyclotron emission. We intend to optimize the use of complementary facilities, resources and expertise at our two sites to most efficiently manage and carry out these

tasks. Our intention is to foster collaboration within the US fusion program from disparate locations and groups including national labs, universities and industry for successful completion of the US diagnostic commitments to the ITER program. Our team leader will coordinate this activity with the US diagnostics team leader, with team leaders for the various diagnostic sub-systems from the US and the other ITER partners, and with the USIPO.

The LLNL Engineering Directorate, an integral part of our research efforts, is a large, diverse, and highly skilled work force closely involved in the design, construction, integration, commissioning, and operation of virtually every experimental device conceived at the Laboratory. We can draw on expertise from the mechanical and electronics engineering departments to help resolve issues associated with the diagnostics design and integration in the port plugs. Mechanical engineering has significant expertise in design, field engineering, structural, thermal, vacuum, cryogenics, fluid analysis, materials modeling and neutronics calculations. Significant experience is available for design of optical and x-ray diagnostics and tritium process systems. Electronics engineering expertise includes development of real-time data acquisition and processing, advanced radiography, antenna modeling and high-power RF systems, and nuclear and electromagnetic radiation effects. There is considerable expertise in communications, networking, information system vulnerability, and integrated control systems and signal processing.

Describe previous work and relevant experience performed by the organization. (5000 characters maximum)

LLNL's Research, Engineering, and Project experience in fusion spans its entire 50-year history that includes the Mirror Program, Microwave Tokamak Experiment (MTX), the ITER CDA and EDA process, and current experimental work in MFE; DIII-D collaboration, SSPX, and other experimental research support such as NSTX, JET, and ASDEX. With respect to design and integration for the US ITER equatorial port plugs, LLNL is unique qualified due to our extensive experience in experimental fusion science, engineering, and large project management.

LLNL has had substantial involvement in ITER. During the CDA (1988-1991) and at the start of the EDA (1992-1994), LLNL hosted the US ITER Home Team and produced its management plans. In our lead role for the US ITER CDA, we provided engineering support, worked with industry to develop viable hardware designs, developed physics simulation tools for machine design, developed operating scenarios, and provided data for the physics basis via ITER Expert Groups. LLNL scientists continued work on ITER in divertor physics, ECH, scenario development, and engineering support and project management for the superconducting central solenoid model coil with MIT and Japan. LLNL actively participates in International Tokamak Physics Activity (ITPA) groups researching ITER-relevant divertor, edge physics, advanced tokamak and diagnostic issues.

LLNL has a long history of collaborative research both nationally and internationally. In our 18-year collaboration at the DIII-D National Fusion Facility, we have held major experimental and managerial responsibilities in divertors, edge physics, diagnostics and advanced tokamak experiments. We provide contributions in physics, engineering, computations and technical expertise to the physics program and tokamak operations. We have led successful efforts to provide major hardware additions to DIII-D's diagnostic systems, e.g. a state-of-the-art MSE system, IR/visible cameras, and divertor Thomson scattering. We have participated in international experimental research on JET and ASDEX and contributed to the NSTX and NCSX experiments at PPPL. Our MTX experiment included a five-year collaboration with the JAERI JFT2M group to use LLNL's free electron laser to explore intense microwave interaction with

plasmas. LLNL pioneered development of the "Fusion Collaboratory" where we demonstrated the real possibility for remote operation of ITER by operating both DIII-D and Alcator C-mod from the Livermore site. We participated in several personnel and hardware exchanges with experimental programs on Gamma-10 in Japan and on the Ambal and GDT experiments at the Budker Institute in Russia. As a major collaborator with CEA, France, LLNL was responsible for the construction program of the Phebus laser.

LLNL's engineers, designers, technicians, and skilled crafts people relevant to diagnostic and technical systems are exemplified by accomplishments of the staff. They have designed and tested reliable, safe, secure nuclear weapons that included high-speed diagnostics. They have designed, built, and operated a series of increasingly powerful lasers, culminating with NIF, large linear induction accelerators, and a series of magnetic fusion experiments.

1. Significant experience working with industry and other scientific institutions is a result of LLNL's multidisciplinary nature. The EUV Lithography VNL is a consortium of laboratory and industrial partners from the semiconductor industry developing lithography techniques for mass production of integrated circuits. Development of PERIGRINE, a system to predict precise cancer radiation doses, involved a major collaboration among LLNL, UCSF, the National Cancer Institute and the NOMOS Corporation. LLNL provided physics and engineering expertise to the B-factory at SLAC where we also collaborated in the accelerator development with LBNL. LLNL participated in the BaBar Detector development, a multi-institutional, multi-national collaboration. Close industrial partnering in the joint development of large, optical quality glass with both Schott Glass Technologies and the Hoya Corporation was critical to the success of NIF. Adaptive optics, pulse-power and electro-optics systems capabilities were required for the success of NIF.

2.

List skills and experience of the key individual[s] in the organization identified to perform the ITER work. (5000 character maximum)*

The depth and breadth of the plasma physics and engineering staff at LLNL is known throughout the US fusion national and international communities. At last count, over 130 scientists and engineers were involved in fusion-relevant research. Many of the tasks related to the D&I of the upper ports will be common to the equatorial ports and specific ITER diagnostic systems. Some key individuals identified here are also identified on our other ITER expressions of interest. LLNL has more than 600 engineers with varying degrees of project experience and a wide range of technical skills. The individuals named here are "typical" of many others with similar experience and skills who could form our project team.

Thomas A. Casper (Equatorial Ports D&I Technical Contact)

Victor Karpenko – mechanical engineer, project management, mechanical systems integration

• Mechanical Engineer providing project management and leadership experience to unique high technology and international projects for over 25 years. Proven ability to deliver cost effective, innovative solutions on time and within budget.
• Currently the Project Leader for the Advanced Interceptor Technology Program at LLNL.
• Recent Project Manager of a joint, $150M laser project for United States Department of Energy and the British Ministry of Defense
• System Manager for the $75M NIF Target Experimental Systems supporting Stockpile Stewardship and the Inertial Confinement Fusion Programs; major subsystems include a 10-meter target chamber, optical support structures, environmental protection systems, auxiliary

systems, final optics assemblies, and target diagnostics. Developed and managed a multi-lab team with international participation.

F. Dean Lee – electronics engineer, diagnostics integration

• Several years managing technical groups in the area of diagnostics and working with multidisciplinary teams of electrical, mechanical and software personnel.
• Designed and developed diagnostic system in support of the experimental program for the National Ignition Facility and the Nuclear Test Program at LLNL.
• Experience in the design, development, and fielding of x-ray sensitive cameras, neutron pinhole cameras, streak cameras, micro channel plate components, high speed/high special resolution imaging systems, neutron-x-ray-gamma radiation detectors, and high-speed digitizers.
• Developed equipment to operate and survive in harsh radiation environments.

William Meyer – computational physicist

• 22 years in the MFE program in data acquisition, analysis and modeling and experience in multiple, parallel computing paradigms. Developer of program Beowulf compute clusters.
• Pioneered computational analysis of DIII-D tokamak visible light camera diagnostics using network-computing techniques.
• Developer of distributed plasma model and simulation interface in support of DIII-D tokamak plasma control system.
• Primary support for program collaboration and remote access technologies.
• Heterogeneous, distributed data acquisition developer/operator on the TMX-U tandem mirror and the MTX and DIII-D tokamak experiments. Development of an expert system for FEL control.

Jeffery F. Latkowski – nuclear engineer

• Experience in nuclear and radiological engineering analysis
• Experienced in neutronics from fusion sources and knowledgeable in environmental impact issues
• Deputy Associate Program Leader for Fusion Technology within the Physics and Advanced Technologies Directorate, New Technologies engineering Division at LLNL
• Prior experience on radiological issues for NIF.

Lynn G. Seppala – optical engineer

• Experience in optical design and materials
• Optical design of MSE system and ray tracing analysis
• Experienced in choice of optical materials.
• Prior industrial optical engineer experience at ITEK Corporation, Lexington, MA

Kevin Morris

• Mechanical design of experimental (vacuum, structural and optical) systems.
• Mechanical design of MSE system and laser diagnostics.

Upper IR/Visible Cameras

List and describe the lead management [and technical support] role[s] of interest to be performed by the individual[s] and their organization. (5000 characters maximum)*

LLNL's Fusion Energy Program (FEP) is committed to helping the US ITER Project Office (USIPO) succeed in providing the US contributions to ITER. FEP has identified four Diagnostics Systems – MSE, Equatorial Ports Design & Integration (D&I), Visible & IR Cameras, and Upper Ports D&I – that are of interest and that are consistent with the Lab's previous work and relevant experience. Although not explicitly listed as an EOI area, the US Port Test Facility is of particular interest to LLNL and is one of the drivers for our interest in port D&I efforts.

LLNL is interested in providing the design, fabrication, assembly, testing, experimental operations and data analysis of Visible & IR Camera diagnostic systems for ITER. This includes plasma facing mirrors, radiation and magnetic shielding as required, transport optics, windows, cameras, and data acquisition. Physics oversight, engineering, and technical support would be provided by LLNL. LLNL would team with General Atomics in carrying out the work. LLNL would be the lead organization, and be responsible for the overall diagnostic performance.

LLNL would also be directly responsible for the design, the development, the procurement and testing of the optics and cameras. LLNL would also be responsible for budget, schedule and configuration management. The documentation would be a collective responsibility with LLNL in the lead. General Atomics would be the lead for the analysis of disruption force analysis, magnetic shielding calculations, and effect of magnetic shielding materials on perturbations to the tokamak magnetic field. In addition, General Atomics would be responsible for a suitable test of a representative prototype on DIII-D and evaluation of its performance.

Because of the location of Visible and IR Cameras diagnostic systems, LLNL is also offering to undertake the Upper Ports D&I.

Describe previous work and relevant experience performed by the organization. (5000 characters maximum)*

LLNL's Research, Engineering, and Project experience in fusion spans its entire 50-year history including the Mirror Program, the Microwave Tokamak Experiment (MTX), the ITER CDA and EDA process, and current experimental work in MFE (SSPX, DIII-D collaboration, and other experimental research support e.g. NSTX, JET, and MAST).

With respect to the Visible &IR Cameras, the LLNL fusion energy group personnel listed under "key individuals" have approximately 90 man-years of experience with tokamak diagnostics. This includes design, fabrication, installation, operation, data acquisition, and analysis of multi-camera visible light systems with in-vessel mirrors protected by shutters. Our experience with these systems on DIII-D encompasses both visible light and infrared imaging using both analog and digital systems.

LLNL's Fusion Energy Program (FEP) staff has used these diagnostics to gain insight into divertor detachment, volume recombination, radiative divertors, ELM

morphology and symmetry, spatial distribution of radiating species under various plasma conditions, scaling of divertor plate heating with plasma parameters, and distribution of wall recombination. We have also monitored these diagnostics for first-wall protection. Over the many years of this work, we have developed state-of-the-art capability to invert tangential TV images for calculation of 2D poloidal profiles of emission for comparison with theory. We are sharing these techniques at the request of other laboratories by means of national and international collaborations including ongoing collaborations in these areas with JET and ASDEX-U.

In collaboration with FEP's theory group, we have a broad capability for modeling to aid in analysis and interpretation of results, using codes such as the UEDGE boundary layer and divertor modeling package, the CORSICA core equilibrium and transport package, the DEGAS neutrals code, and the BOUT Braginski fluid code for edge turbulence simulation.

LLNL has access to a deep reservoir of engineering and technical expertise accumulated by the engineering directorate during the course of numerous past fusion energy research projects. This experience has been accumulated from projects dating back to the beginning of controlled fusion research, as well as from numerous other engineering projects of every scale at LLNL.

List skills and experience of the key individual[s] in the organization identified to perform the ITER work. (5000 character maximum)*

The depth and breadth of the plasma physics and engineering staff at LLNL is known throughout the US and international fusion communities. At last count, over 130 scientists and engineers were involved in fusion-relevant research. The following individuals would be involved in the Visible & IR Cameras diagnostic system:

LLNL Fusion Energy Program –

Charles Lasnier (Visible & IR Cameras Technical Contact) - 12 Years in charge of infrared video cameras (IRTV) for DIII-D, including design, installation, maintenance, data acquisition systems, and analysis. Up to six simultaneous IR camera views of plasma facing components. Slow IR with wide coverage and fast IRTV for ELMs and disruptions. Coordinated installation of a fast visible camera for ELM physics. Created data acquisition systems that run the IRTV and visible cameras, with data storage to MDSPlus, with precision timestamps on data. Nine years in electron cyclotron emission measurements in mirror and tokamak confined plasma.

Max Fenstermacher - 12 Years in charge of spectroscopically filtered visible cameras at DIII-D, including tangential upper and lower divertor views. Supervised design and installation of cameras tangentially viewing the upper and lower divertors. Oversaw design, fabrication and installation of ultraviolet TV systems including in-vessel optics. Numerical modeling of plasma emission and comparison with measured emission profiles. Spectroscopic and spatial signatures of divertor detachment and plasma recombination derived from camera data. Physics of ELM propagation in the scrape-off layer.

Mathias Groth - 4 years in charge of spectroscopically filtered visible cameras at DIII-D. Design, installation, operation, and analysis of midplane tangential visible camera at DIII-D. Inversion of tangential visible camera images to obtain poloidal cross-sections of

radiated light. Capture and precision timing of ELM events and massive gas puffs using gated cameras. Study of transmission in optical fibers as a function of neutron dose. Impurity transport studies and plasma spectroscopy with Penning gauges at JET.
Vlad Soukhanovskii - 11 Years in charge of design, development, characterization, operation and maintenance of various fusion plasma spectroscopy diagnostics - soft X-ray (diode arrays, spectrometers, gratings, and multilayer mirrors), VUV and visible spectrometers, filtered cameras. Led laboratory characterization, modeling and plasma experiments to develop and optimize Supersonic Gas Jet fueling of NSTX plasmas. Diagnosed and analyzed plasma - liquid lithium surface interaction experiments in CDX-U.
Ronald Ellis- 18 years as LLNL diagnostic mechanical and optical technician. Expert in visible and infrared camera systems; motional Stark effect; Langmuir probes; plasma facing components; design, fabrication, and installation of shutter mechanisms and vacuum windows; vacuum and optical system mechanical design, construction, and maintenance.
William Meyer- 23 years experience in fusion data acquisition, processing, storage, and analysis. Expertise in development of efficient techniques for dealing with computationally intensive analysis problems, including inversion of camera images to poloidal cross-sections.
Jeffrey Moller- 25 years in fusion data acquisition, processing, storage, and analysis. Unix and PC-based data acquisition and timing systems.
LLNL Engineering –
F. Dean Lee -Designed and developed diagnostic systems in support of the Nuclear Test Program at LLNL. Designed and developed diagnostic system in support of the experimental program for the National Ignition Facility. Technology included x-ray sensitive cameras, neutron pinhole cameras, streak cameras, micro channel plate components, high speed/high special resolution imaging systems, neutron-x-ray-gamma radiation detectors, and high speed digitizers that will operate in and survive harsh radiation environments.
Victor Karpenko -System Manager for the $75M NIF Target Experimental Systems supporting Stockpile Stewardship and ICF Programs. Major subsystems include a 10-meter target chamber, optical support structures, environmental protection systems, auxiliary systems, final optics assemblies, and target diagnostics. Developed and managed a multi-lab team with international participation.
Doug Dobie -Vibration and shock testing, instrumentation design for explosive environments, shock sensor development, electro-optical sensor calibration, material characterization (mass, dimension, x-ray fluorescence, low energy, high resolution radiography). Hardware analysis using analytical or finite element and computational fluid dynamics software packages.
Fred Holdener -Design and fabrication of numerous diagnostic and hardware systems that include ultra-high vacuum, high and low temperature materials, water-cooled synchrotron-mirrors, laser systems, interferometers, small and large aperture mirrors.

Upper Ports, U5/U17, Design & Integration

List and describe the lead management [and technical support] role[s] of interest to be performed by the individual[s] and their organization. (5000 characters maximum)

LLNL's Fusion Energy Program (FEP) is committed to helping the US ITER Project Office (USIPO) succeed in providing the US contributions to ITER. FEP has identified four Diagnostics Systems – MSE, Equatorial Ports Design & Integration (D&I), Visible & IR Cameras, and Upper Ports D&I – that are of interest and that are consistent with the Lab's previous work and relevant experience. Although not explicitly listed as an EOI area, the US Port Test Facility is of particular interest to LLNL and is one of the drivers for our interest in port D&I efforts.

In leading the D&I for the US upper ports (U5 and U17), LLNL would assemble a combined management and technical team from our existing FEP staff plus knowledgeable engineers and technical staff who have a long history of development and operation of large and complex experiments in both the MFE and IFE programs to:

• Provide the expertise necessary for system integration and coordination of design, fabrication, assembly and testing of multiple components as required for installation of diagnostic subsystems in the port plugs. LLNL has the experience, facilities, and support needed to accomplish these duties.

• Use our strong background in systems engineering to facilitate the integration and testing of front-end subsystems delivered by US and the other parties. To support this effort, LLNL can draw upon its internal expertise in the areas of optics, materials, neutronics calculations, and instrumentation design, development and data systems.

• Provide the necessary research and development required to simplify and/or optimize diagnostic access and performance in these port plugs. This would include analysis and/or modeling needed to incorporate the several instruments from both the US and international ITER parties.

• Work with the USIPO and the International Team to establish detailed design requirements for the port plug and the accompanying diagnostic instrumentation.

• Manage budget, schedule, and progress reporting to the USIPO/Diagnostic Team Leader. Provide technical documentation as necessary and follow DOE standards for ES&H and quality control.

• Provide the technical expertise and work force needed for the ultimate installation and commissioning of the U5 and U17 port plugs at the ITER site in Cadarache.

LLNL's primary interest in the upper port integration stems for our long involvement in IR and visible camera measurements on the DIII-D tokamak and their association with our edge physics efforts. Our intention is to foster collaboration among the relevant providers within the US fusion program groups including other national labs, universities, and industry. Our team leader will coordinate this activity with the US diagnostics team leader, with team leaders for the other diagnostic sub-systems in these ports, and with the USIPO.

The LLNL Engineering Directorate will contribute key personnel to the team. The Directorate consists of a large, diverse, and highly skilled work force closely involved in the design, construction, integration, commissioning, and operation of virtually every experimental device conceived at the Laboratory. We can draw on expertise from the mechanical and electronics engineering departments to help resolve issues. Mechanical engineering has significant expertise in design, field engineering, structural, thermal, vacuum, cryogenics, fluid

analysis, materials modeling, and neutronics calculations. Significant experience is available for design of optical diagnostics. Electronics engineering expertise includes development of real-time data acquisition and processing, advanced radiography, antenna modeling and high-power RF systems, and nuclear and electromagnetic radiation effects. There is considerable expertise in communications and networking, information systems vulnerability, instrumentation and integrated control systems and signal processing.

Describe previous work and relevant experience performed by the organization. (5000 characters maximum)*

LLNL's Research, Engineering, and Project experience in fusion spans its entire 50-year history that includes the Mirror Program, Microwave Tokamak Experiment (MTX), the ITER CDA and EDA process, and current experimental work in MFE; DIII-D collaboration, SSPX, and other experimental research support e.g. NSTX, JET, and ASDEX. With respect to design and integration for the US ITER upper port plugs, LLNL is unique qualified due to our extensive experience in experimental fusion science, engineering, and large project management.

LLNL has had substantial involvement in ITER. During the CDA (1988-1991) and at the start of the EDA (1992-1994), LLNL hosted the US ITER Home Team and produced its management plans. In our lead role for the US ITER CDA, we provided engineering support, worked with industry to develop viable hardware designs, developed physics simulation tools for machine design, developed operating scenarios, and provided data for the physics basis via ITER Expert Groups. LLNL scientists continued work on ITER in divertor physics, ECH, scenario development, and engineering support and project management for the superconducting central solenoid model coil with MIT and Japan. LLNL actively participates in International Tokamak Physics Activity (ITPA) groups researching ITER-relevant divertor, edge physics, advanced tokamak and diagnostic issues. LLNL was a major partner in the TPX tokamak project, along with PPPL and other US fusion groups. LLNL was responsible for the TPX superconducting magnet design as well as divertor physics and divertor design.

LLNL has a long history of collaborative fusion energy research both nationally and internationally. In our 18-year collaboration at the DIII-D National Fusion Facility, we have held major experimental and managerial responsibilities in divertors, edge physics, diagnostics and advanced tokamak experiments. We provide contributions in physics, engineering, computations and technical expertise to the physics program and tokamak operations. We have led successful efforts to provide major hardware additions to DIII-D's diagnostic systems, e.g. a state-of-the-art MSE system, IR/visible cameras, and divertor Thomson scattering. We have participated in international experimental research on JET and ASDEX and contributed to the NSTX and NCSX experiments at PPPL. Our MTX experiment included a five-year collaboration with the JAERI JFT2M group to use LLNL's free electron laser to explore intense microwave interaction with plasmas. LLNL pioneered development of the "Fusion Collaboratory" where we demonstrated the real possibility for remote operation of ITER by operating both DIII-D and Alcator C-mod from the Livermore site. We participated in several personnel and hardware exchanges with experimental programs on Gamma-10 in Japan and on the Ambal and GDT experiments at the Budker Institute in Russia. As a major collaborator with CEA, France, LLNL was responsible for the construction program of the Phebus laser.

LLNL's engineers, designers, technicians, and skilled crafts people relevant to diagnostic and technical systems are exemplified by accomplishments of the staff. They have designed and tested reliable, safe, secure nuclear weapons that included high-speed diagnostics. They have designed, built, and operated a series of increasingly powerful lasers, culminating with NIF, large linear induction accelerators, and a series of magnetic fusion experiments.

Significant experience working with industry and other scientific institutions is a result of LLNL's multidisciplinary nature. The EUV Lithography VNL is a consortium of laboratory and industrial partners from the semiconductor industry developing lithography techniques for mass production of integrated circuits. Development of PERIGRINE, a system to predict precise cancer radiation doses, involved a major collaboration among LLNL, UCSF, the National Cancer Institute and the NOMOS Corporation. LLNL provided physics and engineering expertise to the B-factory at SLAC where we also collaborated in the accelerator development with LBNL. LLNL participated in the BaBar Detector development, a multi-institutional, multi-national collaboration. Close industrial partnering in the joint development of large, optical quality glass with both Schott Glass Technologies and the Hoya Corporation was critical to the success of NIF. Adaptive optics, pulse-power and electro-optics systems capabilities were required for the success of NIF.

List skills and experience of the key individual[s] in the organization identified to perform the ITER work. (5000 character maximum)*

The depth and breadth of the plasma physics and engineering staff at LLNL is known throughout the US fusion national and international communities. At last count, over 130 scientists and engineers were involved in fusion-relevant research. Many of the tasks related to the D&I of the upper ports will be common to the equatorial ports and specific ITER diagnostic systems. Some key individuals identified here are also identified on our other ITER expressions of interest. LLNL has more than 600 engineers with varying degrees of project experience and a wide range of technical skills. The individuals named here are "typical" of many others with similar experience and skills who could form our project team.

David N. Hill – (Upper Ports D&I Technical Contact)

Victor Karpenko – mechanical engineer, project management, mechanical systems integration

• Mechanical Engineer providing project management and leadership experience to unique high technology and international projects for over 25 years. Proven ability to deliver cost effective, innovative solutions on time and within budget.
• Currently the Project Leader for the Advanced Interceptor Technology Program at LLNL.
• Recent Project Manager of a joint, $150M laser project for United States Department of Energy and the British Ministry of Defense
• System Manager for the $75M NIF Target Experimental Systems supporting Stockpile Stewardship and the Inertial Confinement Fusion Programs; major subsystems include a 10-meter target chamber, optical support structures, environmental protection systems, auxiliary systems, final optics assemblies, and target diagnostics. Developed and managed a multi-lab team with international participation.

F. Dean Lee – electronics engineer, diagnostics integration

• Several years managing technical groups in the area of diagnostics and working with multidisciplinary teams of electrical, mechanical and software personnel.

• Designed and developed diagnostic system in support of the experimental program for the National Ignition Facility and the Nuclear Test Program at LLNL.

• Experience in the design, development, and fielding of x-ray sensitive cameras, neutron pinhole cameras, streak cameras, micro channel plate components, high speed/high special resolution imaging systems, neutron-x-ray-gamma radiation detectors, and high-speed digitizers.

• Developed equipment to operate and survive in harsh radiation environments.

William Meyer – computational physicist

• 22 years in the MFE program in data acquisition, analysis and modeling and experience in multiple, parallel computing paradigms. Developer of program Beowulf compute clusters.

• Pioneered computational analysis of DIII-D tokamak visible light camera diagnostics using network-computing techniques.

• Developer of distributed plasma model and simulation interface in support of DIII-D tokamak plasma control system.

• Primary support for program collaboration and remote access technologies.

• Heterogeneous, distributed data acquisition developer/operator on the TMX-U tandem mirror and the MTX and DIII-D tokamak experiments. Development of an expert system for FEL control.

Jeffery F. Latkowski – nuclear engineer

• Experience in nuclear and radiological engineering analysis

• Experienced in neutronics from fusion sources and knowledgeable in environmental impact issues

• Deputy Associate Program Leader for Fusion Technology within the Physics and Advanced Technologies Directorate, New Technologies engineering Division at LLNL

• Prior experience on radiological issues for NIF.

Lynn G. Seppala – optical engineer

• Experience in optical design and materials

• Optical design of MSE system and ray tracing analysis

• Experienced in choice of optical materials.

• Prior industrial optical engineer experience at ITEK Corporation, Lexington, MA

Kevin Morris

• Mechanical design of experimental (vacuum, structural and optical) systems.

• Mechanical design of MSE system and laser diagnostics.

Reginald D. Wood Jr. – physicist, operations and diagnostic development

• 25 years with the LLNL fusion program: mirror, tokamak, and spheromak research programs

• SSPX operation's manager, diagnostic development, spectroscopy, and wall conditioning

• Prior experience in divertor spectroscopy on DIII-D, diagnostic development on DIII-D, MTX, and TMX-U, and experiment operations on MTX and TMX-U

Harry S. McLean – physicist, physics and diagnostics integration

• 20 years LLNL’s fusion program: spheromak, tokamak, compact toroid plasma accelerators, pulsed power, high power/energy laser systems

• Physics leader on SSPX for MHD stability, energy confinement, transport analysis and modeling
• SSPX diagnostics manager; emphasis on Thomson scattering, laser interferometry, electronic noise reduction, grounding and cabling, data acquisition, instrumentation integration
• Compact toroid tokamak fueling and accelerator development

Blanket/Shield - 1st Wall
&
Blanket/Shield - Shield

(Identical input for both)

List and describe the lead management [and technical support] role[s] of interest to be performed by the individual[s] and their organization.

LLNL's Fusion Energy Program (FEP) is committed to helping the US ITER Project Office (USIPO) succeed in providing the US contributions to ITER. FEP has identified two Technical Systems (Blanket Shield–1st Wall and Blanket Shield–Shield) that are of interest and that are consistent with the Lab's previous work and relevant experience. Our interests span the entire range of possible roles, but with emphasis on engineering analysis, design and R&D. LLNL and SNL have agreed to explore teaming arrangements to bring their complementary resources together to ensure sufficient technical capability to carry out these technical systems tasks. The division of tasks and responsibilities between SNL and LLNL will be developed as part of our response to the RFP for this work. Although LLNL's RFEI Aug 31, 2005 input for the Blanket Shield–1st Wall and Blanket Shield–Shield is identical, there would most likely be changes in each of the two when LLNL responds to the RFP.

Describe previous work and relevant experience performed by the organization.

LLNL's Research, Engineering, and Project experience in fusion spans its entire 50-year history that includes the Mirror Program, the Microwave Tokamak Experiment (MTX), the ITER CDA and EDA process, and current fusion technology work in plasma facing components, plasma chamber systems & safety, and advanced materials modeling. With respect to the Blanket Shield systems (1st wall and shield) we note the following.

<u>ITER Specific Experience:</u>

In FY05, LLNL supported SNL with thermal and stress analyses for the first wall. This work was conducted as a collaborative effort with SNL providing input on the design, EM loads and heat deposition distributions and LLNL completing the analyses of thermal and mechanical response. LLNL and SNL have been working on various code interfaces needed to carryout the integrated analyses and have also recently completed code benchmarking to give confidence in the results. SNL has proposed to continue LLNL involvement in this work in FY06.

<u>Other Relevant Experience:</u>

The LLNL Engineering Directorate provides a large, diverse, and highly skilled workforce of nearly 2100 employees. Of the total staff, approximately 700 are engineers, and more than 620 possess advanced degrees. Engineering personnel comprise nearly one-third of the overall LLNL workforce and represent a significant resource upon which the US ITER Project Office can draw.

The Engineering Directorate's has been an integral part of the research effort at LLNL. The organization has had close involvement in the design, construction, integration, commissioning, and operation of virtually every experimental machine and apparatus conceived at the Laboratory. To support its mission, Engineering personnel have made technological breakthroughs in areas such as precision engineering, optics, advanced materials, nondestructive evaluation, and computational engineering codes. These breakthroughs have produced advances that often have had significant applications beyond the Laboratory's gates.

LLNL Engineering has a long history of collaborative research and design, both nationally and internationally, spanning several scientific disciplines. Engineering has played a major role in every fusion related program at LLNL. In the MFE Program, engineering has had a major role for over 18 years, including experimental and managerial responsibilities in tokamak experiments and mirror and tandem mirror research. LLNL was also deeply involved with the TPX design effort, providing the Program Director and engineering design teams for the $742M national project. This TPX activity was a direct outgrowth of LLNL efforts to design a steady-state tokamak, the preliminary design of which was selected by a US national panel and DOE. LLNL has already had a substantial historical involvement in the ITER CDA and EDA efforts:

- LLNL hosted the US ITER Home Team for the ITER CDA process (1988–1991)
- ITER EDA process (1992–1994).
- LLNL produced the US ITER Management Plan (1991) for the ITER EDA.

LLNL Engineering has experience and expertise in steady-state heat removal, first wall blankets, tritium process systems, vacuum, and materials development to support the ITER's Blanket/Shield First Wall technology effort, Mechanical Engineering has significant expertise in design; field engineering; structural, thermal, vacuum, and fluid systems development and analysis; multi-physics and materials modeling; and cryogenics. Significant experience is also available in the engineering of optical and x-ray diagnostic systems and tritium process systems.

LLNL Engineering possesses a long-standing, enviable record of accomplishment in undertaking projects with high technical risk and bringing them successfully to completion. For 50 years, Livermore's engineers, designers, technicians, and skilled crafts people have:

- Designed and tested reliable, safe, secure nuclear weapons that included high-speed diagnostics.
- Designed, built, and operated a series of increasingly powerful lasers, culminating with NIF.
- Designed, built, and operated large linear induction accelerators.
- Designed, built, and operated a series of magnetic fusion devices.

List skills and experience of the key individual[s] in the organization identified to perform the ITER work.

The depth and breadth of the plasma physics and engineering staff at LLNL is known throughout the US fusion national and international communities. At last count, over 130 scientists and engineers were involved in fusion-relevant research. With respect to the Blanket Shield systems (1st wall and shield), the following individuals would be involved.

Wayne Meier (Blanket/Shield 1st Wall and Blanket/Shield Shield Technical Contact)– BS Physics, MS Nuclear Engineering, PhD Nuclear Engineering/Fusion. Associate Program Leader for Fusion Technology, Fusion Energy Program (FEP). Responsible for FEP's work on magnetic and inertial fusion technologies.

Knowledgeable in nuclear and mechanical design aspects and issues for fusion chamber first walls, blankets and shields. As Technical Point of Contact for the FEP, Dr. Meier will provide oversight and management interface with SNL.

Douglas Dobie – BS Mechanical Engineering Technology, BS Mechanical Engineering. Project Engineer with over 21 years experience in project engineering, design and analysis. Doug has been a Project and Lead Mechanical Engineer for several 1 to 5 million dollar LLNL projects including; electro-optical sensors and pump propulsion systems for lightweight spacecrafts; the NIF; flight and ground test payloads; Nevada Test Site chemical release and munitions demolition. Recent relevant engineering experience includes DIIID MSE diagnostic and beam path hardware used on the National Ignition Facility. As the Engineering Point of Contact, Mr. Dobie will be responsible for identifying and supervising engineers and analysts assigned to the ITER Blanket/Shield tasks and will provide technical oversight for the work performed.

Fred Holdener – BS/MS Mechanical Engineering. He has worked as a professional mechanical design engineer for his entire 29-year career at LLNL. Fred has worked either as a project engineer, lead engineer or design engineer on a number of large research projects including: The Experimental Test Accelerator (ETA); The Advanced Test Accelerator (ATA); The Tritium Facility Upgrade (TFU); X-ray Calibration and Standards Facility (XCSF) of Stanford's SPEAR Facility; The BEAMLET Research Laser; B-Factory's High Energy Ring (HER) of the PEP-II Upgrade at Stanford Linear Accelerator Center (SLAC); and the National Ignition Facility (NIF) at LLNL.

Jeffery F. Latkowski – BS/MS/PhD Nuclear Engineering. Deputy Associate Program Leader for Fusion Technology in FEP. Jeff has extensive experience in nuclear and radiological engineering analysis for fusion experimental facilities and subsystems (e.g., work on radiological issues for the NIF). Currently serving as the point of contact for LLNL work with private industry on automated CAD to Monte Carlo modeling. Will lead or support neutronics work needed to define blanket/shield nuclear heating.

Management Administration

List and describe the lead management [and technical support] role[s] of interest to be performed by the individual[s] and their organization. (843 characters)

LLNL Engineering is interested in providing the following Technical and Administrative Systems support to the Technical and Diagnostic Systems:

- Engineering Analysis
- Engineering Design
- Engineering Design & Drafting
- Research & Development
- Manufacturing- Fabrication / Production
- Manufacturing- Fabrication, Assembly & Testing
- Manufacturing- Supply Commercial Components
- Technical Contracts Manager
- Administration Support

In addition, LLNL Engineering is interested in providing the following Management/Administration support to the US ITER Project Office:

- Quality Assurance
- System Engineering/Integration
- Safety & Environment
- Procurement
- Project Controls Manager
- Project Controls Scheduler
- Risk Management
- Information Systems
- Communications

Describe previous work and relevant experience performed by the organization. (4967 characters)

The LLNL Engineering Directorate provides a large, diverse, and highly skilled workforce of nearly 2100 employees. Of the total staff, approximately 700 are engineers, and more than 620 possess advanced degrees. Engineering personnel comprise nearly one-third of the overall LLNL workforce and represent a significant resource upon which the US ITER Project Office can draw.

With a defined mission to turn physics ideas into reality by integrating and extending technologies, often simultaneously, and pushing them to their extremes to solve tough technical problems. Engineering has been an integral part of the research effort at LLNL. The organization has had close involvement in the design, construction, integration, commissioning, and operation of virtually every experimental machine and apparatus conceived at the Laboratory. To support its mission, Engineering personnel have made technological breakthroughs in areas such as precision engineering, nondestructive evaluation, and computational engineering codes. These breakthroughs have produced advances that often have had significant applications beyond the Laboratory’s gates.

LLNL Engineering possesses a long-standing, enviable record of accomplishment in undertaking projects with high technical risk and bringing them successfully to

completion. For 50 years, Livermore's engineers, designers, technicians, and skilled crafts people have:

1. Designed and tested reliable, safe, secure nuclear weapons that included high-speed diagnostics.
2. Designed, built, and operated a series of increasingly powerful lasers, culminating with NIF.
3. Designed, built, and operated large linear induction accelerators.
4. Designed, built, and operated a series of magnetic fusion devices.

The considerable expertise in the seven Divisions within the Mechanical and Electronics Engineering Departments will enable us to resolve technical issues associated with the construction of ITER. For example, Mechanical Engineering has significant expertise in design; field engineering; structural, thermal, vacuum, and fluid systems development and analysis; multi-physics and materials modeling; and cryogenics. Significant experience is also available in the engineering of optical and x-ray diagnostic systems and tritium process systems.

Electronics Engineering expertise includes development of real-time data acquisition and processing, advanced radiography, antenna modeling and high-power RF systems, and nuclear and electromagnetic radiation effects. There is also considerable expertise in communications and networking, information systems vulnerability, instrumentation and integrated control systems, and signal processing applications. Lastly, we have developed adaptive optics, pulse-power, and electro-optics systems.

Project management is one of many core strengths of LLNL's Engineering Directorate. Engineering launched a Project Management and Systems Engineering Initiative to develop and facilitate the adoption of superior project-management and systems-engineering practices across Engineering and LLNL. Since its inception, the Initiative has:

5. Developed, standardized, and supported modern, integrated project-planning, tracking, and reporting tools, such as Primavera and Product Data Management systems.
6. Established comprehensive training, qualification, and certification of project managers.
7. Provided Web-accessible current policies, procedures, standards, and best practices for employees, including risk-based graded procedures for project management and systems engineering.
8. Developed and supported a suite of modern, integrated IT software tools to support project database generation, maintenance, and communications.

Livermore has designed, built, and operated a number of large-scale fusion experiments, ranging from the MTX tokamak to MFTF-B and from Nova to NIF. MTX incorporated the first microwave free-electron laser for plasma heating. In 1987, Livermore was selected to lead the US ITER CDA. In this role, LLNL provided engineering support, worked with industry to develop buildable hardware designs.

LLNL Engineering has numerous core competencies that are relevant to US ITER Project Office needs. These core competencies include:

9. Integrated management and engineering of large, complex, and applied physics projects with substantial technical risk
10. Computational modeling and simulation of complex systems
11. Multidisciplinary teams (electrical, electronic, mechanical, civil, nuclear, chemical, and optical) that can move quickly across organizational boundaries
12. System engineering for cost and risk reduction and configuration management
13. Large-scale economies and procurement experience

These technical capabilities will be available to the US ITER Project Office on an as-needed basis through the LLNL engineering matrix system. The matrix system allows our personnel to "live" within the technical programs during the growth of a new technology or fabrication of a new experiment or facility.

List skills and experience of the key individual[s] in the organization identified to perform the ITER work. (4733 character)

The following are representative of key individuals providing the design and analysis support to LLNL programs and projects. They are available to provide key engineering and project management support to ITER. The analysis groups have a total of 37 engineers of which 27 have PhD's.

Scott Perfect is the Group Leader for the Structural and Applied Mechanics Group. Scott received his Ph.D in Theoretical and Applied Mechanics from the University of Illinois. He has a strong technical background in large-scale nonlinear implicit and explicit structural and thermal finite element analysis. He has broad experience in directing design, analysis, fabrication, and testing of complex physics experiments. Extensive experience using the finite element codes NIKE3D, DYNA3D, TOPAZ3D, ALE3D, and LSDYNA. Programming experience using FORTRAN, C, and C++ under various operating systems.

Wayne Miller is the Group Leader of the Thermal Fluids group supporting computational engineering and analysis. Wayne received his Ph.D in Mechanical Engineering from Duke University in North Carolina in 1990. He has broad experience in heat transfer, fluid dynamics, stress analysis and project management. Prior to joining LLNL, Wayne designed utility scale wind turbines at Kenetech Windpower, and developed computational fluid dynamics software for helicopter aerodynamics at the NASA Ames Research Center

Mark Accatino is the Group Leader for the Integrated Engineering and Design Group where he is directly responsible for the administrative oversight, ES&H and technical Project Management associated with two large and unique engineering design groups. Mark has applied his Project Engineering and Project Management skills to a number of widely-varying LLNL projects over the span of his 25 year career, most recently LLNL's DHS-sponsored Cargo Container Neutron Interrogation Project, where he leads a team of engineers and designers responsible for the design, installation and testing of an experimental proof-of concept test bed. Previous to this assignment, Mark was a Manager/Project Lead for the National Ignition Facility Project. He was also responsible for the budget and schedule within these critical path NIF installations. Over the course of his career, Mark has led/supported the design, fabrication and installation of

mechanical hardware and gas systems associated with tritium research, high pressure systems, x-ray lasers and various LLNL weapons systems.

Tom Mccarville has twenty five years experience applying project management, system engineering, and engineering design methods to advanced technology programs. Proven ability to create and deploy practical engineering solutions to a wide variety of complex problems. Doctorate in fusion related studies, licensed mechanical engineer.

F. Dean Lee has designed and developed diagnostic systems in support of the Nuclear Test Program at LLNL. Designed and developed diagnostic system in support of the experimental program for the National Ignition Facility at LLNL. The technology included x-ray sensitive cameras, neutron pinhole cameras, streak cameras, micro channel plate components, high speed/high special resolution imaging systems, neutron-x-ray-gamma radiation detectors, and high speed digitizers that will operate in and survive harsh radiation environments.

Victor Karpenko is currently the Project Leader for the Advanced Interceptor Technology Program at the Lawrence Livermore National Laboratory. He is a Mechanical Engineer, providing project management and leadership experience to unique high technology and international projects for over 25 years. He was System Manager for the $75M NIF Target Experimental Systems supporting Stockpile Stewardship and the Inertial Confinement Fusion Programs. The major subsystems include a 10-meter target chamber, optical support structures, environmental protection systems, auxiliary systems, final optics assemblies, and target diagnostics. He developed and managed a multi-lab team with international participation.

Doug Dobie has experience with vibration and shock testing, instrumentation design for explosive environments, shock sensor development, electro-optical sensor calibration, material characterization (mass, dimension, x-ray fluorescence, low energy, high resolution radiography. He has good hardware analysis experience using analytical or finite element and computational fluid dynamics software packages.

Fred Holdener has been responsible for the design and fabrication of numerous diagnostic and hardware systems that include ultra-high vacuum, high and low temperature materials, water-cooled synchrotron-mirrors, laser systems, interferometers, small and large aperture mirrors.