

Mechanical Fabrication Department Strategic Plan (Draft 11/2005)

Why SLAC Should Maintain and Support Internal Fabrication Shops

- Maintenance of critical mass expertise required to keep the machine running. Continuity of corporate knowledge.

In order to operate a large and technologically complex facility like SLAC, a large and sophisticated operations infrastructure tailored to SLAC's needs is required to continuously maintain, repair, modify, upgrade and service all the varied technical facilities required to continue SLAC's scientific missions. The mechanical fabrication shops are a vital component of that infrastructure. These shops contain personnel resources with knowledge, skills, and techniques developed over many years to meet SLAC-specific technical challenges. The importance of maintaining the continuity of this "corporate knowledge" should not be underestimated. The shops are often the repository for, and a wellspring of, vital specific knowledge of lessons learned concerning UHV practices, efficient and reliable vacuum mechanical and vacuum electronic design practices, proven fabrication and chemical cleaning and plating methods, etc. Many individuals in the shops are known resources heavily used by designers and engineers to provide advice regarding design details of new experimental equipment and facilities. Many of these same individuals are key contributors to quickly and accurately troubleshooting machine operating problems. Without consistent strong support of these in-house tailored shops (as well as many other groups) SLAC could be in danger of losing its critical mass expertise required for successful operation.

- Response to peak demand load.

The Scientific R & D environment of SLAC is very different from a typical industrial environment where the manufacturing effort is usually more of less steady state. At SLAC, machine maintenance downs, new experimental installations, construction operations, and unexpected equipment failures all benefit from a diverse and highly trained staff that is available literally at a moments notice. During peak periods it is necessary is to move complex assemblies through machining, inspection, cleaning, brazing, welding and vacuum processing in a very short time. The shops provide an integrated, multi-disciplined approach to manufacturing that allows this to happen. The maintenance of a ready force of technicians intimately familiar with the SLAC operations and technical equipment would be very difficult, and at best inefficient, outside the context of a shop organization. Machinists, welders, magnet techs, as well as the precision assembly techs and vacuum techs, all can be deployed during peak installation or maintenance.

In order for these resources to be available during the maximum demand the shop capabilities must be supported in an ongoing basis. The continued use of the SLAC fabrication shops to manufacture hardware needed for new experiments, machine maintenance, etc allows for efficient use of the shops and personnel while maintaining a ready force for peak demands. Maintaining a centralized distribution of shop work allows for shifting of demand for the more routine shop work between inside and outside shops to balance shop loading yet provides resources for peak efforts. When individual groups make isolated decisions about where to place work it reduces the efficiency and effectiveness of the centralized shop.

- Quality.

Quality control can be of the utmost importance for many of the components used on the SLAC accelerator and experiments. The internal SLAC shops provide a venue where engineers and physicists can have total control over all aspects of fabrication quality including materials, design, cleaning, vacuum processing, etc. It can be difficult for a profit motivated shop to place the same emphasis on quality that can be imposed on a SLAC built component.

- Proximity to physicists and engineers results in better designs that reflect and emphasize performance requirements rather than profits.

Another important aspect of maintaining SLAC fabrication shops lies in the benefits of the close working relationship between the design engineering and manufacturing functions. Close communication between these groups can be vital to the success of a project. The engineer's and physicist's ability to work closely with a manufacturing organization experienced with design and construction of vacuum electronic accelerator components can make the difference between a cost effective design that meets performance expectations, and a design which fails to meet requirements. Working with distant shops, who are not experienced with SLAC specific fabrication processes can be problematic, especially when problems arise that may require a degree of flexibility made awkward by the subcontracting process. Often when a schedule requires the initiation of fabrication prior to the solution of all design issues, fabrication in SLAC shops is the only viable option.

- Schedule response. Cannot control priorities in outside shops.

Priorities in SLAC shops are completely under SLAC control. This may occasionally be frustrating to some whose jobs receive a lower priority, but is beneficial to SLAC overall. This is fundamentally not the case in an outside shop fabrication situation where priorities are affected by many factors beyond our control. A considered intelligent selection of the

specific jobs to be sent to outside shops versus jobs that should be best done at SLAC shops, further enhances our ability to respond to schedules and control priorities.

- Unique in-house physical facilities available under SLAC control

The SLAC mechanical fabrication shops house unique facilities and equipment which are a vital component of infrastructure required to support SLAC scientific mission. While it is true that many of individual capabilities can be duplicated in outside shops, the combination of facilities and equipment including chemical cleaning and plating, hydrogen atmosphere furnace brazing, complete machine shop services, full spectrum welding, electromagnet fabrication, and vacuum processing is unique. That these facilities, tailored to SLAC's needs, are readily available and under SLAC's control, is an enormous benefit facilitating SLAC operations and mission. Some of these facilities, such as the chemical cleaning and plating shop, the brazing facilities, and precision assembly capabilities simply do not have parallels available from outside services (not to mention the impracticality and inefficiency of using such services due to logistical and cleanliness reasons).

Core Functions and Distinctive Competencies

When Customers Say:

Mechanical Fabrication Department Responds:

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| We need it yesterday! —————→ | We provide quick turn around for urgently needed products |
| We need something sort of like this ———→ | We can manufacture with limited product definition |
| Can this even be done? —————→ | We develop processes as needed or if outside vendors say no we'll give it a try |
| Who else can do it? —————→ | We can handle toxic or radioactive materials |
| Take care of everything —————→ | We provide integrated service, taking your design from paper to installed product |
| Make it like last time —————→ | Our staff has years of experience and knows prior SLAC projects |
| We want process control —————→ | We are stakeholders in implementing your process for SLAC's success |
| We want to be involved —————→ | We provide a collaborative working environment with engineering, design and manufacturing |

Service Group	Core Functions (What We Do)	FTE's	M&S	Distinctive Competencies (Why Come To Us)	Shop Rate (per hour)	Outside Rate (per hour)
Machine Shop	Provides a broad range of machining operations including: <ul style="list-style-type: none"> • Conventional and computer numerically controlled (CNC) mill and lathe machining • CNC Wire and sinker electrical discharge machines (EDM) • Ceramic and surface grinding • Cutting and polishing plastics • Material cutting and handling • Support for staff machine shop • Machine shop safety training and testing 	16	\$120K	<ul style="list-style-type: none"> • Ability to work with informal drawing or sketches • Seamless integration of design models generated on SLAC's computer aided design (CAD) software to our computer-aided manufacturing (CAM) workstations then routed to CNC mills, lathes and EDM's. • Capable of "clean" machining of post-braze and other ultra high vacuum (UHV) components • Assembly repair and machining • Milling capacities up to a 100-inch by 60-inch by 25-inch machining envelope • Turning capacities up to 60 inches in diameter and 144 inches in length. • Precision machining to tolerances of .0002-inch to meet profile and surface 	\$89.60	Simple machining or production runs \$60-85 Complex machining or prototypes \$85-125

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				finish. <ul style="list-style-type: none"> Capable of machining a wide range of materials from plastics to exotic metals including low-level radioactive materials and hazardous materials such as lead Stock a wide variety of materials including aluminum, stainless steel, steel, titanium, tungsten, copper, plastic, phenolic, ceramic, brass, tool steel, aluminum to stainless transition material 		
Structural Fabrication	Provides sheet metal and welding services for ultra-high vacuum and structural assemblies. <ul style="list-style-type: none"> Electron Beam Welding Gas Tungsten-arc welding (GTAW) Gas metal arc welding (GMAW) Flux core arc welding (FCAW) Shielded metal arc welding (SMAW) Plasma arc welding (PAW) Oxy-fuel welding (OFW) Orbital welding Plasma arc cutting Oxy-fuel cutting and welding Torch brazing and soldering Sheet Metal including punching, forming, shearing, assembly, rolling, tube bending, breaking, sawing, nibbling 	5	\$38k	<ul style="list-style-type: none"> Provides welding and sheet metal engineering and design assistance Weld most metals and alloys from several inches thick to as thin as .005-inch Punch and form metals up to 1/8-inch on a 80-inch by 40-inch sheet Shear and bend metal up to 3/8 inch thick and up to 10 feet long Electron beam welder operates in a 10⁻⁴ Torr vacuum atmosphere and has a work envelop of 23 inches by 15 inches by 240 inches long Plasma cutting can trace intricate "as drawn" shapes and can handle steel aluminum and stainless steel 1-1/4 inch thick by 48 inches by 120 inches Oxy-fuel cutting up to 10 inches thick Computer-aided design and manufacturing (CAD/CAM) for sheet metal parts Stock variety of aluminum, steel, copper and stainless steel sheet 	\$76.00	Vacuum and structural welding \$65-75 Electron beam welding \$125-175 Sheet metal \$60-80
Precision Assembly	Provides mechanical assembly services. <ul style="list-style-type: none"> Hydrogen brazing Ultra high vacuum assemblies Helium leak detection Soldering and torch brazing Heat treatment 	10	\$77k	<ul style="list-style-type: none"> Provides brazing and magnet assembly engineering and design assistance Hydrogen furnaces thermally process components up to 1100°C with charted run history and documented process data. Ability to handle parts up to 34 inches in diameter, 126 inches in length 	\$76.00	Hydrogen brazing \$235-250 Assembly and Leak checking

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	<ul style="list-style-type: none"> • Coil Winding • Magnet Assembly • Perform hydrostatic testing • Tests insulation of electrical equipment by hi-pot testing 			<ul style="list-style-type: none"> and 700 lbs. • Provides hydrogen brazing services to other DOE laboratories such as Brookhaven, Fermi and Los Alamos • Work with specialized materials such as niobium, molybdenum, beryllium copper, titanium, ceramics, mu metal, glidcop, gold, and silver • Assemble delicate instrumentation • Capability of winding coil up to 24 feet in diameter • Epoxy impregnating coil facility 		\$50-125
Metal Finishing	<p>Provides chemical cleaning and electroplating services.</p> <ul style="list-style-type: none"> • Degreasing • Chemical cleaning of materials for ultra-high vacuum such as copper, stainless steel, aluminum, molybdenum, inconel, beryllium copper, delrin, ceramic-to-metal feedthroughs, welded bellows, copper-gold alloy, titanium, tantalum, Teflon, phosphorous bronze, niobium, ceramics, glass • Electroplating for brazing and vacuum applications including gold, silver, copper, indium, rhodium, electroless and sulfamate nickel, anodizing and chromate conversion for aluminum • Alumina and glass bead blasting 	9	\$126k	<ul style="list-style-type: none"> • Provides metal finishing recommendations and suggestions to engineers and designers before as well as during design and manufacturing of assemblies. • In house chemical laboratory which allows for stringent process control and testing resulting in consistent high quality results • Over 100 documented processes developed over 40 years specific to manufacturing of accelerator's assemblies • Specialized processes developed upon request • Pollution prevention and environmental quality award winning facility • Unique cyanide copper electroplating capabilities • Pioneering zero emission degreasing system • Uses analytical grade chemicals, alcohol and nitrogen to minimize accelerator's part contamination 	\$140.65 Minimum charge \$35 (15 mins.)	\$146-365 Minimum charge of \$75-365
Vacuum Assembly	<p>Provides assembly, processing and evaluation of ultra-high vacuum components.</p> <ul style="list-style-type: none"> • Clean room assembly and welding 	12	\$92k	<ul style="list-style-type: none"> • Provides engineering and design assistance for vacuum systems • Performs outgassing studies • Provides glow discharge cleaning 	\$76.00	Assembly and Leak checking \$50-\$125

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	<p>of simple to very complex vacuum components and instrumentation</p> <ul style="list-style-type: none"> • Performing outgassing measurements and residual gas analysis • Boroscope capabilities • Component testing (valves, pumps, gauges, etc) • Component fabrication consulting • Tests insulation of electrical equipment by hi-pot testing 			<p>services</p> <ul style="list-style-type: none"> • Capable of coating thin and thick films of kovar, titanium nitride, copper and gold • Two class 10,000 and one class 1000 cleanroom assembly areas • Helium leak check UHV subassemblies to a minimum sensitivity of 2×10^{-10} standard cc/sec per leak meter division, through the use of "dry" leak detectors using mass spectrometers or Residual Gas Analyzers • Capable of vacuum processing components with flanges from 1-1/3 to 16 inches in diameter, lengths up to 480 inches and computer thermal process control of temperatures up to 300°C. 		
Accelerator Operations Support	<ul style="list-style-type: none"> • Provides mechanical and vacuum installation, repair and maintenance of accelerator systems 	3*	\$23k	<ul style="list-style-type: none"> • Many years of experience and extensive knowledge working on accelerator vacuum and magnets systems • After hours on-call support • Trained radiation workers • Daily monitoring and analysis of vacuum instrumentation • Provides trouble shooting and diagnosis of mechanical and vacuum systems 	\$76.00	Assembly and Leak checking \$50-\$125
Machine Maintenance	<ul style="list-style-type: none"> • Maintains and repairs metal working machinery, manufacturing process systems and capital equipment for the department and other groups 	3	\$20k	<ul style="list-style-type: none"> • Readily available trained expertise on a wide range of equipment • Trained Electrical Equipment Inspector • Trained University Technical Representative (UTR) 	\$89.60	\$124-178
Production Control	<ul style="list-style-type: none"> • Plans and manages jobs within the department. Services include job input, routing, tracking, scheduling, cost estimation and summaries, material ordering, in process storage 	5	\$15k	<ul style="list-style-type: none"> • Manufacturability review and assistance available to improve quality and reduce cost • Engineering drawing review provided • Coordinates outside vendors services • Written travelers available for each job • Warehouse allows receipt of material in advance of work and holding finished goods. 	\$89.60	

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				<ul style="list-style-type: none"> Computerized scheduling, job and material tracking throughout all MFD and outside shops 		
Department Support	<ul style="list-style-type: none"> Provides department management, administrative, information/computer technology, vehicles and safety services to MFD and other groups 	4	\$177k	<ul style="list-style-type: none"> Developed model implementation strategies for new safety requirements Provides satellite ES&H computer based training Provides "competent person" resource in fall protection and confined space Provide electronic transfer of payroll 		
Totals		68	\$688			

*Vacuum and mechanical technician support for this group comes from Vacuum and Precision Assembly.