

Workforce development, and education and outreach

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1. *What are workforce development related challenges and best practices, e.g., recruitment, training, incentives, reward structures, etc.?*

- LIGO is embedded in Division of Physics, Mathematics and Astronomy (PMA) at Caltech and MIT Kavli Institute for Astrophysics and Space Research
 - Able to recruit outstanding students, postdoctoral scholars for R&D, data analysis, detector (interferometer) commissioning & improvements
 - World-class mentoring available
 - Excellent record of placing outgoing individuals into next steps of their careers
 - Faculty, postdoctoral appointments, positions in industry
 - Scientific, engineering and professional staff world class
 - Scientists and engineers have a low turnover rate
 - Non-scientific staff has a greater turnover
 - University environment provides limited means to reward performance
 - Salary scales rigidly enforced across the campuses
 - Salary scales typically lag/lower industry
 - Fixed escalations can cover only COL increases
 - Moderate bonuses are used to recognize outstanding performance, initiative taking
 - Part of the reward system includes conferences
- Filling key senior positions from outside the Laboratory has proven beneficial in introducing "new eyes," different experiences, best practices
 - Broad searches for applicants
 - Can lead to disappointment for long-time staff

2. How can we better facilitate awareness and sharing of solutions and best practices across different and disparate communities?

- LIGO IT leadership is engaged with other NSF supported efforts
 - Workflow & middleware implementation, utilization (Condor/Pegasus/OSG)
 - Identity management
 - Single-sign-on infrastructure
 - Code/pipeline optimization (XSEDE)
- LIGO Laboratory established a Program Advisory Committee (PAC) over 20 years ago, near the end of initial construction
 - Appointment of directors from other NSF Large Facilities and DOE facilities has proven useful to “compare notes”
 - DOE laboratories have a tradition of Directors’ meetings without agency participation to discuss, identify common issues candidly
 - This has not been our experience at LIGO (except for the PAC)
 - LIGO Directorate has discussed approaching peers at other NSF facilities to explore whether there is interest in establishing a venue similar to the DOE laboratories’ for discussion
 - DOE laboratories tend to have a more common set of missions than the spectrum of disciplines represented in NSF Large Facilities.

3. How can training and outreach become key mechanisms for concurrent improvement of workforce effectiveness and ability to adopt best tools and understand future needs?

- Peer review can provide a mechanism for improvements
 - Staff enabled to attend professional meetings
 - LIGO cybersecurity group has invited external peers to assist in internal audits, reviews – not done frequently enough
 - Safety: We have asked other (NSF, DOE) facility safety officers and consultants to participate in bi-annual safety inspections of the LIGO observatories
 - Received helpful advice, learned about best practices, reinforcement of our own protocols
 - External peer review of the LIGO Property Life-cycle Management Plan (PLMP)
 - Reviewers drawn from other (DOE, ESO, Smithsonian) facilities
 - Provided useful feedback on our plan

4. How similar or different are the training needs of our community with respect to industry? Can industry practices and resources be leveraged?

- IT/scientific/engineering staff encouraged to attend professional development & training workshops, etc.
 - Provides ability to interact with peers in industry
- Business practices can benefit—training of our administrative, business personal has proven beneficial