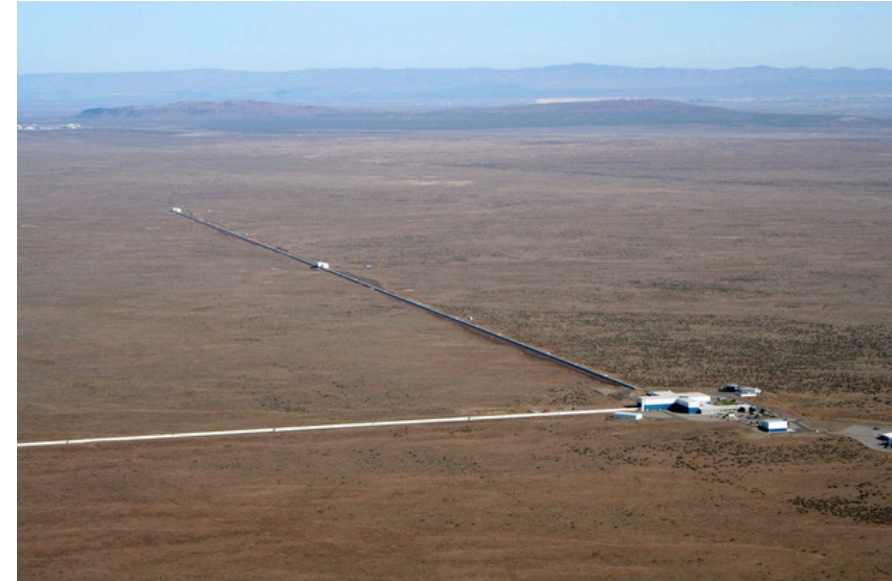


# LIGO facility operations in the COVID-19 era

Michael Landry  
head, LIGO Hanford (Caltech)

Joseph A. Giaime  
head, LIGO Livingston (Caltech)  
prof. of physics and astronomy (LSU)

- The LIGO Hanford Observatory (LHO) campus resides on the DOE Hanford Site in eastern Washington.
- LHO staff comprises fifty people, including scientists, engineers, operators, IT, EPO and facilities staff, and the LIGO business office.
- Currently we are in Phase 2 (triaged) Operations and Phase 3 (suspended) EPO.
- Approximately 15 staff members are on site on any given day.
- Currently we are in a commissioning phase. Having replaced one of the four test masses owing to point absorbers, we are resonating light and evaluating performance of the current setup.
- Next steps include construction: the creation of a new 300m filter-cavity beamtube and associated enclosure and building to house the endstation, plus ongoing construction of the LIGO Exploration Center (see right).



- Operated by Caltech and MIT for the NSF, the Louisiana site is in Livingston Parish, on 180 acres of land leased to the NSF by Louisiana State University, surrounded by privately-owned active forestry land.
- Collocated with the LIGO Science Education Center.
- Staffed by ~44 Caltech employees.
- Currently we are in Phase 2 (triaged) Operations and Phase 3 (suspended) EPO.
- Approximately 20–30 staff members are on site on any given day, plus contractor personnel and visitors.
- Currently we are in an installation/commissioning hybrid phase, to install new equipment for the A+ project and to characterize improvements installed earlier. We are also in the middle of waterproofing 8 km of beam tube enclosure.
- Coming up next is a major infrastructure build for A+, including the 300 m enclosure and building, as at Hanford.



- Washington State and Louisiana were among the first to experience disease spikes of COVID-19 in the United States.
- In March, 2020, LIGO realized that the pandemic would require us to alter our operational stance at the observatory sites.
  - Staff protection
  - Community protection
  - Observatory stewardship
- Like many other organizations, we sketched out an operational-phase system.
  - **Separate phases, one for maintenance & operation and one for education and public outreach.**
  - Numeric designations for each, roughly 0 = pre-pandemic practice, and 3 = shutdown. There are many numbered phase systems in use now; these are just LIGO's.

Phase	Description
0	Pre-pandemic norm
1	Enhanced Communication, training and cleaning; PPE; social distancing.
2	Triage: mission and priority adjustments to minimize risks.
3	Shutdown: mission reduced to site protection and maintenance.

- Main goal: Aggressively minimize opportunity for viral transmission among people on site.
- There are three main modes of SARS-CoV-2 transmission, close-contact (larger) respiratory droplets, airborne (small/ aerosol) particles, and via contact with surfaces.
- key transmission remediation approaches:
  - Social distancing, remote work
  - work permits
  - sanitary measures
  - PPE, analyzed task procedures
  - air filtering and space capacity controls
  - personnel and wastewater testing
  - travel control and approval
- Safety policies and procedures developed specifically for the pandemic response, drawing on:
  - Caltech policies
  - CDC and OSHA guidelines
  - Cleanroom experience in the Lab
  - Scientific literature
  - In-house calculations and measurements

COVID-19 Safety Documents	
LIGO COVID-19 Level 1 Staff Training	<a href="#">M2000139-v3</a>
LIGO Lab COVID-19 Level II Training	<a href="#">M2000194-v2</a>
LIGO Lab COVID-19 Level III Training	<a href="#">M2000289</a>
LIGO Laser Safety Eyewear Guidelines Working Under COVID-19	<a href="#">M2000171-v1</a>
LIGO COVID-19 Daily Wellness Check	<a href="#">M2000187-v2</a>
LIGO Observatories COVID-19 Cleaning Policy	<a href="#">M2000146-v1</a>
Time requirements and required PPE for differing work circumstances	<a href="#">M2000124-v3</a>
LIGO MIT COVID-19 Safety Protocol for Contractor Facility Access	<a href="#">M2000170-v1</a>
LIGO HANFORD COVID-19 Safety Protocol for Contractor Facility Access	<a href="#">M2000169-v1</a>
LIGO LIVINGSTON COVID-19 Safety Protocol for Contractor Observatory Access	<a href="#">M2000167-v1</a>
LIGO CIT COVID-19 Safety Protocol for Contractor Facility Access	<a href="#">M2000168-v1</a>
Occupying Vendor Facilities COVID-19 Safety Guidelines	<a href="#">M2000176-v1</a>
LIGO Facility COVID-19 Exposure Deep-Cleaning and Disinfection Protocol	<a href="#">M2100003-v1</a>
LIGO Air Travel During the COVID-19 Pandemic	<a href="#">M2000251-v1</a>
Coronavirus Airline Travel Hazard Evaluation	<a href="#">M2000254-v1</a>
Laser Eyewear Cleaning and Sanitation Methods	<a href="#">G2000476-v1</a>
UV-C Germicidal Lamp Standard Operating Procedure	<a href="#">M2000055-v1</a>
Form: Covid-19 Risk Assessment of Specific Procedures	<a href="#">F2000007-v3</a>
COVID-19 First Day Back to Work Safety Talk	<a href="#">L2000230-v1</a>
Proper Home Office Ergonomics Training	<a href="#">G2001025-v1</a>
COVID-19 Facilities Safety Signage	<a href="#">M2000133-v1</a>
COVID-19 Fall Protection Cleaning and Disinfectant Guidance	<a href="#">M2000262-v1</a>

# Work permit process

- Since COVID-19 is thought to spread mostly through virus-containing droplets that travel among people in close proximity, our main tool to prevent it is to keep people socially distanced and masked.
- The work permit system is critical in order plan and track activities in ways that respect this goal.
- Regular meetings are used to minimize staff overlap and optimize safety while enabling the phase-2 priority activities. Approved activities turn green.

**WORK PERMIT**

Work Permit Guidance: [M050194](#)

A work permit is needed for any (L)VEA work involving cranes, laser or optical reconfiguration, running > 50V wiring, manipulating anything connected to the main vacuum system, manipulating heavy weights, modifying wiring or instrumentation on the detector, or potentially hazardous or disruptive site work.  
Guidelines for work at a LIGO observatory: [M1100264](#)

Facility:   Work Location:

Task Leader:  Facility Liaison:

System/Subsystem:

**COVID-19 Special Considerations:**  Staff or contractor interactions to be inside the 6-foot social distancing guidelines.  Disinfect areas of known or suspected COVID-19 exposure.

**Level 0 permit:**  This work will be contained to the chosen subsystem and will not impact others.

Activity will be after hours / weekend:  Yes  No Buddy System Partner(s):

Description of activities to be performed:  
(Please be as detailed as you feel necessary)

Period of Work Activity:  
Begin:  End:

Tuesday maintenance:  Yes  No

Team Members:

## LIVINGSTON WORK PERMIT LISTING --- all regular open permits and those closed in the last day

[List](#) | [Today](#) | [Tuesday](#) | [Deferred](#) | [Opportunistic](#) | [Recently Closed](#) | Search by Date:

Permit / Submitted By	Task Leader / Facility Liaison / Team Members	Subsystem	Work Location	Description	Period of Work	Tuesday Maintenance	Submit Date	Closed Date	Closed By
<a href="#">6243</a> scott.mccormick	Scott McCormick Harry	Vacuum	VPW	Perform helium leak checks and visual inspections on 10%+ of the A+ vacuum feedthroughs prior to any clean and bake activity. FRS 14790 service request. <a href="https://services.ligo-la.caltech.edu/FRS/show_bug.cgi?id=14790">https://services.ligo-la.caltech.edu/FRS/show_bug.cgi?id=14790</a>	2020-07-22 through 2020-07-31 <input type="button" value="Save Date Changes"/>	<input type="radio"/> Yes <input checked="" type="radio"/> No <input type="radio"/> Deferred <input type="radio"/> Opportunistic	2020-06-19 16:00:44	<input type="checkbox"/> Work Completed <input type="checkbox"/> Discard Permit	
<a href="#">6330</a> william.parker	William Parker	PEM	Weather Stations (X, Y and Corner)	Perform Maintenance on Equipment. 98% of work will be done outside away from other personnel on-site. 2% - inside for parts clean up end Stations - Restroom area corner station - a. machine shop wash area or b. old shipping and receiving wash area <b>LIGO-G2100752-v1</b>	2020-07-23 through 2020-07-23 <input type="button" value="Save Date Changes"/>	<input type="radio"/> Yes <input checked="" type="radio"/> No <input type="radio"/> Deferred <input type="radio"/> Opportunistic	2020-07-15 14:42:23	<input type="checkbox"/> Work Completed <input type="checkbox"/> Discard Permit	
					2020-07-23	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Deferred <input type="radio"/> Opportunistic			

# Personal protection equipment

- Personal protective equipment (PPE) is a significant element in the arsenal of COVID-19 prevention, particularly when work packages require encroachment of 6' social distancing. Elements of PPE employed at LIGO observatories include:
  - Face coverings: surgical masks, N-95 masks, cloth coverings.
  - Touchless tools, copper or 3D-print, for door actuation.
  - UV lights for sterilization of some PPE e.g. masks.
  - 3D-printed face shields (e.g. worn by testing technicians).
  - Safety glasses.
  - Thermometers for daily attestation, both home and site use.
  - Antifog wipes for glasses used in combination with masks.
  - Modified back-band for ear and head relief from mask usage.
  - Air-purifying respirators (PAPRs).



PAPR  
example

# Aerosol reduction

- In order to allow staff to safely return to work at the observatory, LIGO established occupancy and time limits for given spaces. Each room at observatory and campus labs are evaluated and a person-hour limit is established to minimize transfer of COVID-19 between staff.
- Mathematical modeling for COVID-19 transmission and occupancy limits were based on *Avoiding COVID-19: Aerosol Guidelines*, by MIT professor and LIGO Lab member M. Evans, MIT (June 5, 2020). See:
  - doi: <https://doi.org/10.1101/2020.05.21.20108894>
- Aerosol calculations for occupancy/time include considerations such as
  - Room volume and measured air flow.
  - Assume surgical mask usage.
  - Mitigations include increased HVAC air flow, the addition of stand-alone HEPA air scrubbers, N-95 masks or PAPRs.

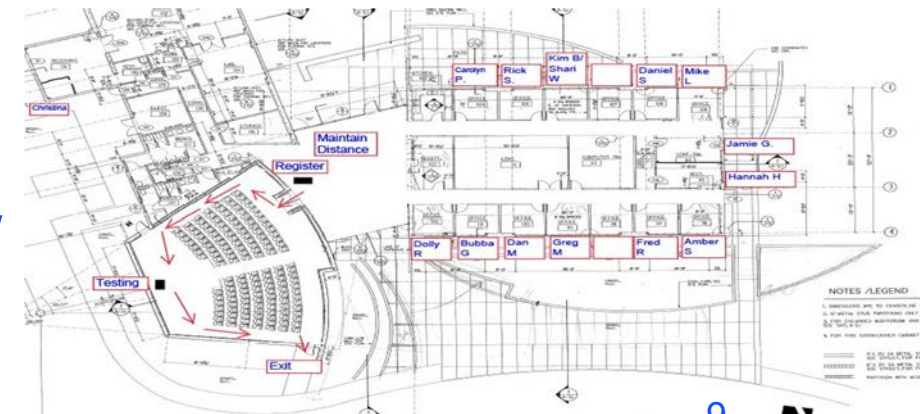


- Caltech has implemented survey testing for the presence of SARS-COV-2 in observatory staff.
- Surveys are made twice weekly at both observatories. Initial testing was made via nasal swab, with PCR evaluation by a commercial firm. More recently, Caltech has converted tests to saliva-based ones with evaluation via university partners.
- Testing requires
  - Dedicated observatory space with one-way traffic flow, signage, and six volunteer staff to act as test observers and technicians.
  - Hardware such as scanners and dedicated computers, PPE, logistical support, and cleaning.
  - Training and time of technicians and staff.
- We understand no cases of COVID-19 to have been transferred on-site at either observatory.

Testing at LHO



Foot traffic flow for LHO tests



# LIGO Wastewater testing

- In addition to personnel testing, we are using a complementary surveillance testing method at Livingston.
- LSU prof's John Pardue and Gus Kousoulas added LIGO to ongoing study at LSU & Baton Rouge.
- The sensitivity is sufficient to detect a single illness.
- Strong signals were seen just before and after the holiday break, in rough correspondence with community levels seen by other means.

