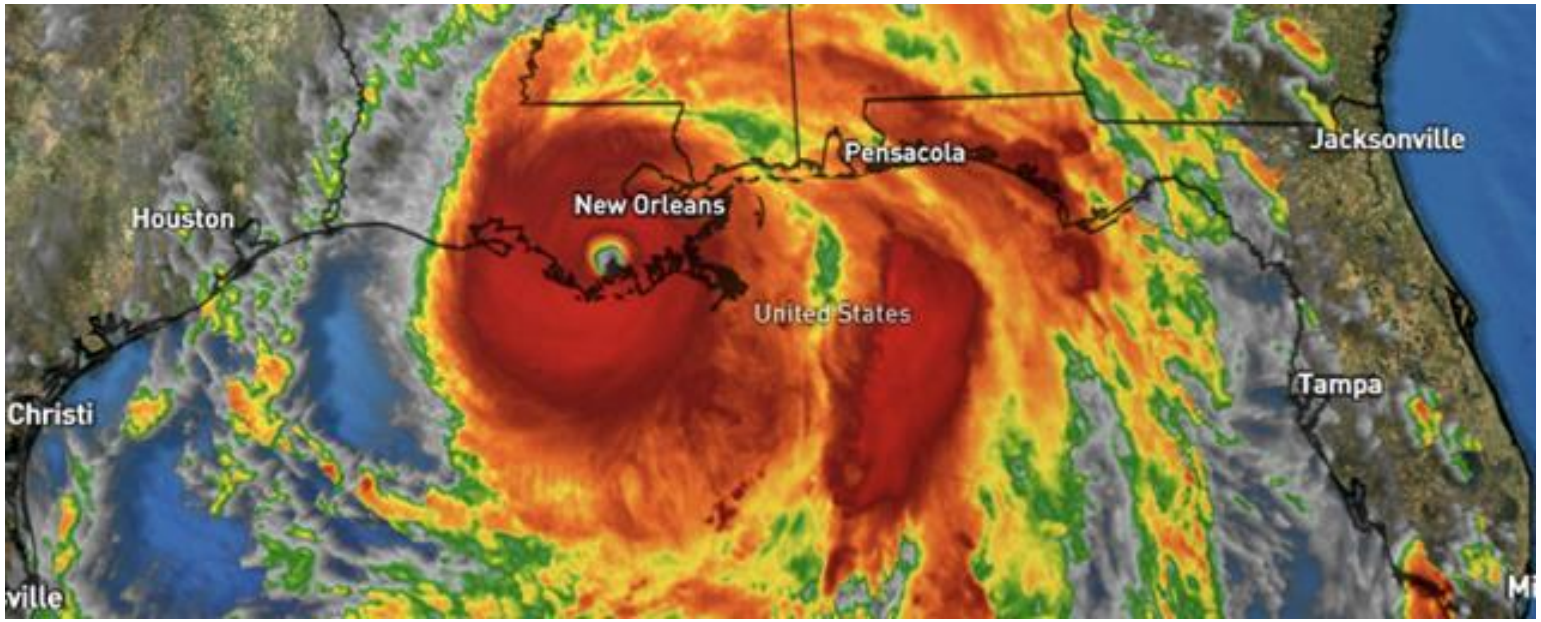
When extreme events are no longer rare

LIGO Lessons learned Hurricane Ida



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- On August 29, 2021, Hurricane Ida made landfall in south Louisiana as a category 4 storm with sustained maximum winds of 150 mph and higher gusts.
- Hurricane Ida was one of the strongest hurricanes ever to hit Louisiana, causing catastrophic wind and flood damage.
- Shortly after landfall, Ida turned north-northwestward, bringing the eye of the storm almost directly over the LIGO Livingston Observatory, downing nearly 31,000 utility poles, leaving more than 1 million residents without power.

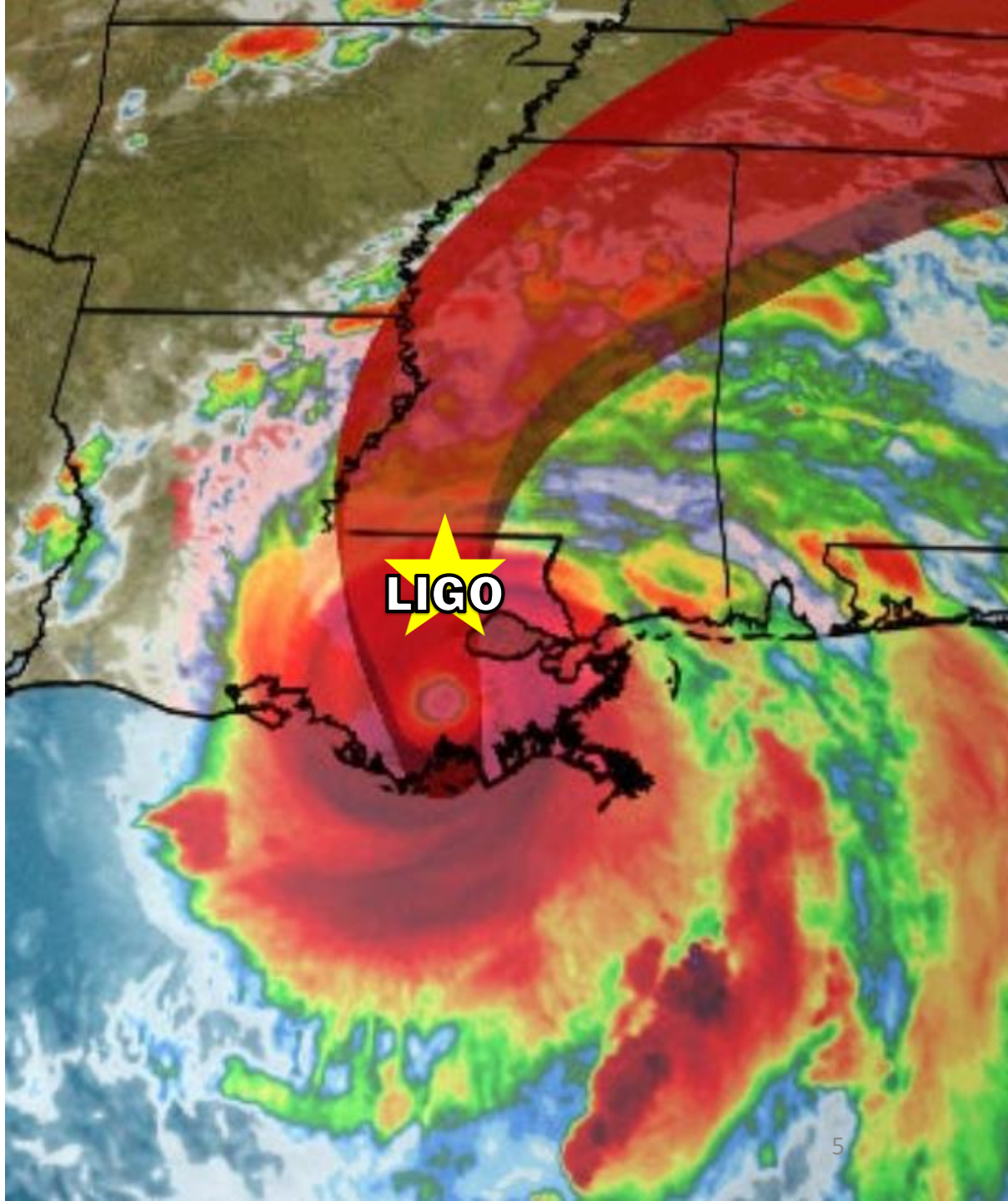
Preparing for Ida

- Two days before Ida's expected landfall, LIGO Livingston executed our standard emergency shutdown procedure.
  - Securing exterior items
  - Placing the detector's vacuum, laser, and electronic systems in the safest possible condition for the oncoming storm and expected power loss.
  - Stage portable electrical generators
  - Sending non-essential personnel home

Preparing for Ida

- Provide hurricane preparedness overview for LIGO staff and visitors prior to the storm's arrival
  - Community evacuation routes
  - Disaster supplies
  - Emergency contact information
  - Best practices for securing your home
  - Portable generator safety tips

- By the morning of August 29th, when Ida made landfall in south Louisiana, Ida had strengthened to a category 4 storm. Hurricane-force, ca. 75 mph, eyewall winds reached LIGO Livingston late that night.
- Despite record-breaking local damage, the direct hit from a hurricane caused very little damage to the site
- Site power was lost around 8 PM Sunday, Aug. 29.
- We were among DEMCO's first members to be restored in Livingston Parish, at approx. 6:36 PM on Sunday, September 5.



Site Damage

Exterior Siding Damage

Hundreds of downed trees and debris blocking the primary access road leading to the observatory

What worked, what didn't

Communications

- LIGO's emergency information system allowed broadcast messages to almost all site staff via SMS and email, except:
  - A few staff members were listing obsolete phone numbers and email account in their profile
- Most phone (mobile) and communication networks had difficulties or non-operational following the storm

What worked, what didn't

Transportation

- LIGO Livingston has one primary high-clearance 4WD vehicle, which since 2003 has played the role of the site's emergency response vehicle, transporting staff down LIGO's access road during flooding and debris removal after storms.
- However, during Ida, refueling gas-powered vehicles and equipment was nearly impossible due to power outages resulting in fuel delivery shortages

What worked, what didn’t

Electrical Power

- Ida's heavy winds impacted high voltage electrical transmission lines powering LLO's dedicated substation. This resulted in a five-day outage of the 13KV distribution powering the observatory.
- After three days without utilities, it became crucial for LIGO’s vacuum team to get confirmation of the current vacuum pressures within the beam tube arms.

Critical Systems Risk Assessment

Following the hurricane LIGO assembled a committee to perform an overall risk assessment to identify potential impact or loss to the detector. The risk assessment provided a severity and probability analysis to fully identify critical elements of LLO's vacuum system and detector operations to mitigate impact due to utility loss during an emergency.

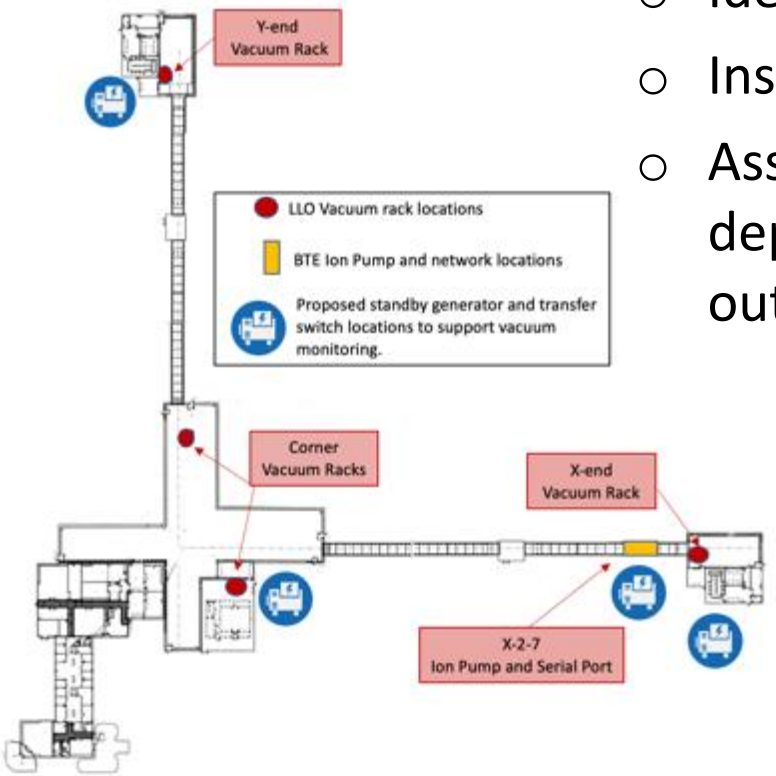
Risk assessment goals included:

- Formulate a preparedness duration goal (how long should we plan to mitigate impact)
- Compile a systems equipment criticality ranking (if the utility outage extends past our preparedness duration, there may be a need to triage specific systems).

Risk Assessment Findings and Outcomes

Electrical power

- Not having the ability to completely place the LLO vacuum system in a safe state, immediate focus will be placed on the following plan to improve vacuum system data visibility during power outages.
  - Identify critical vacuum readback equipment
  - Install transfer switches and permanent stand by generator systems
  - Assemble comprehensive procedures supported by trained staff to deploy generators and carry out transfers in the event of power outages.



Risk Assessment Findings and Outcomes

Updates to LIGO's Emergency Operations System

- Moving forward the lab has setup quarterly staff contact info update request.
- Replaced LIGO's aging emergency satellite phones.
- Pursuing satellite-based connection (i.e., Starlink) as an emergency network link to essential personnel.
- LIGO has installed a 1000-gallon diesel tank onsite and replaced the gas powered 4WD site truck with a ¾ ton 4WD diesel-powered vehicle to allow for onsite refueling.

Summary

- Early consideration should be taken to identify potential personnel, equipment and operational risks due to extreme weather events.
- Perform a facility and operations risk assessment for extreme weather events. Identify critical systems, duration goals, mitigations, and supporting personnel.
- Formulate an extreme weather emergency preparedness plan supported by annual reviews and drills.

Please share your thoughts or questions:

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