# NASA SGSLR Power and Lightning Protection System

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**Abstract:** The Space Geodesy Satellite Laser Ranging (SGSLR) Lightning Protection System will use a multi-tiered system to protect the station's sensitive electronic equipment and instrumentation. Without such protection, a ranging system can incur extensive electronic equipment damage and/or lengthy operational interruptions. As an example, on June 14, 2015, severe lightning occurred at the Goddard Space Flight Center (GSFC), location of the SGSLR Prototype, the Next Generation Satellite Laser Ranging system (NGSLR). When attempting to power on the various equipment of the NGSLR the following workday, it was realized that the system suffered significant damage to almost all major subsystems: meteorological, communications, timing, aircraft avoidance, optical bench, computer, security, and Heating Ventilation Air Conditioning (HVAC). The adjacent Mobile Laser Ranging System (MOBLAS) 7 station system incurred damage as well because of common signal paths between the systems. Another example of severe lightning damage occurred this year at the McDonald Laser Ranging System (MLRS) in Fort Davis, Texas, US. As a result of these incidents, a multi-tiered lightning protection system was designed and has been implemented for the GSFC Goddard Geophysical and Astronomical Observatory (GGAO) SGSLR and will be installed at all of the SGSLR sites. System power, station grounding, and data and communications have all been addressed to greatly minimize the effects of a lightning strike and/or associated power surges. This poster describes the resulting new lightning protection system as it is being installed at the SGSLR at the GGAO.

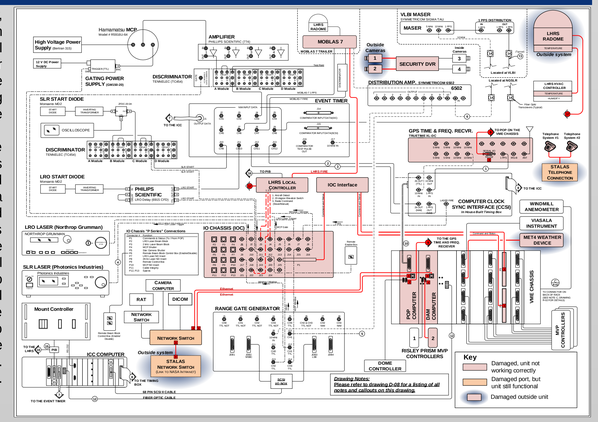
## The Lightning Strike at NGSLR


On June 14th, 2015, the NGSLR experienced a lightning strike. Outside security cameras recorded video of the storm as it passed over the system. The storm was short and intense with heavy rain and many lightning strikes. Though the security system was damaged, video was able to be extracted from the DVR. Heavy rains and lightning began at 21:18 local time. At 21:35 local time the NGSLR security cameras stopped functioning; it is believed this is when the damaged occurred. The image to the left is a frame from the security video showing a lightning strike at the GSFC GGAO in the background and the NGSLR in the foreground. Image to the right is of the NGSLR.

## NGSLR System Damage

The lightning storm damaged 6 of the 9 NGSLR subsystems: Computer, Meteorological, Time and Frequency, Safety, Shelter, and Optical Bench. Even though the NGSLR equipment was connected to UPS, many components were still damaged, and many beyond repair. These components were the Pseudo Operator (POP) and Device Access Manager (DAM) computers, the Paroscientific MET4, the TrueTime XL-DC time and frequency unit, the LHRS, the IO chassis, Heating Ventilation Air Conditioning HVAC unit 2, security system monitor/DVR/outside cameras, Risley prism controller, and telephones.

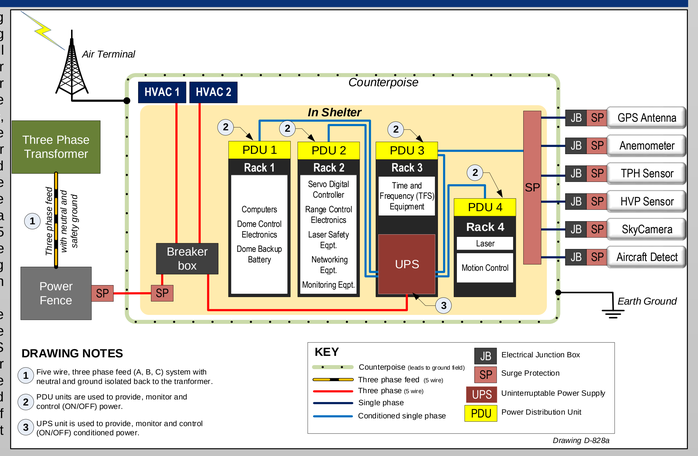
The lightning strike occurred near NGSLR causing a high voltage and current surge that entered the system through multiple paths. External copper communications lines for the telephones and internet are two likely paths as the associated equipment was damaged beyond repair. The internet line was connected to a Network Switch then to the VME Chassis and all were damaged. The VME based POP and DAM computers share various serial and parallel communications cards which connect to other equipment in NGSLR. The VME parallel interface were connected to the IO Chassis, which in turn, connects to the LHRS Local Control unit, both of which were damaged. The MOBLAS 7 LHRS, which was connected to the NGSLR Local Control unit, was also damaged. The LHRS temperature control unit located in the NGSLR shelter failed, as well as the temperature sensor for the controller, which is located outside. The security camera system was connected to two outdoor cameras and an HDTV monitor, all of which were damaged. The compressor for the HVAC unit 2 failed along with a controller board power supply. Equipment connected to the UPS systems did not receive damage. Communications and data interfaces to the outside world were the primary cause.



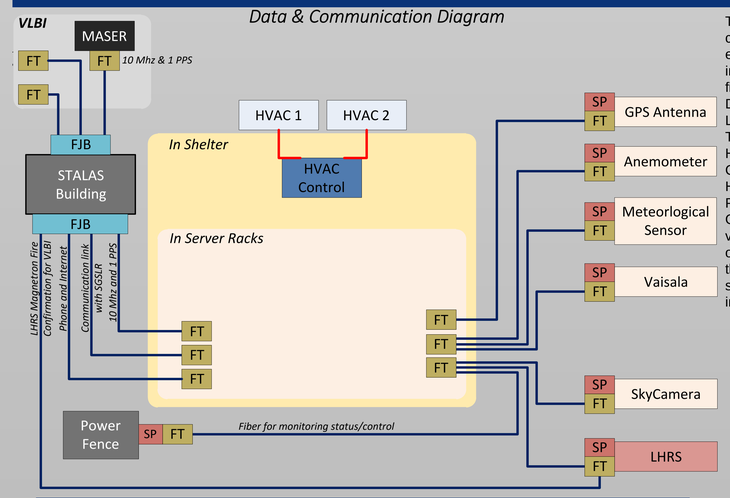

## SGSLR Power Distribution Protection

The SGSLR incoming power will be conditioned using multiple systems. A suppression filter system using thermally fused Metal Oxide Varistors (MOV) will significantly reduce power spikes from lightning or other equipment outside of the SGSLR. The suppression filter system has Ethernet connectivity to communicate time stamped events of magnitude and duration sags, surges, dropouts, frequency, etc. as well as health of the suppression system. The Uninterruptable Power System (UPS) will further filter the incoming power and compensate for power spikes, sags, surges, line frequency changes and interruptions protecting the equipment and instrumentation. The UPS has a computer interface allowing monitoring of each of the 5 power modules. Power Distributions Units (PDU) are used in each rack to prove power control and monitoring for each piece of equipment. Power consumption can be monitored to understand instrument health.

Equipment external to the SGSLR shelter such as the Laser Hazard Reduction System (LHRS) and the meteorological equipment will obtain power via the UPS and PDUs receiving protection from incoming power disturbances. MOV surge suppressors will be connected to the power lines at the shelter interface and the equipment interface to minimize the effects of lightning disturbances along the external equipment power line.

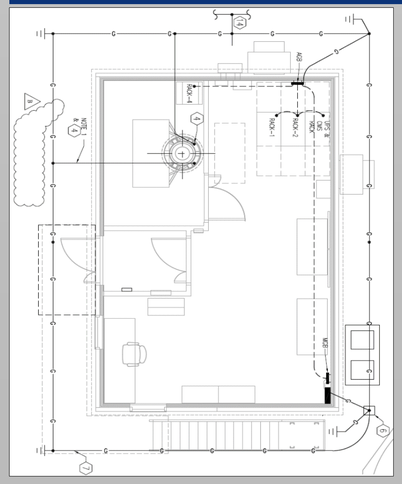



## Data & Communications External Interfaces

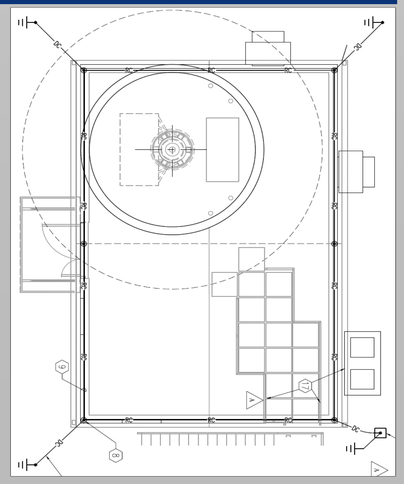



To minimize damage caused by lightning to external data and coms interfaces, SGSLR uses fiber optic transceivers. Data interfaces for the LHRS, Pressure and Temperature and Humidity, sensors, Sky Camera, Anemometer, Horizontal Visibility and Present Weather sensors, GPS antenna and internet/ voice comms are all optically coupled between the sensor outside the shelter and equipment inside the shelter.

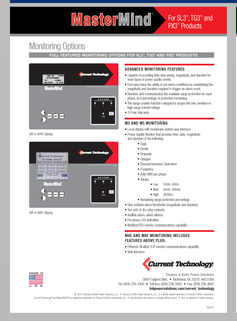
## Grounding, Counterpoise, and Air Terminals

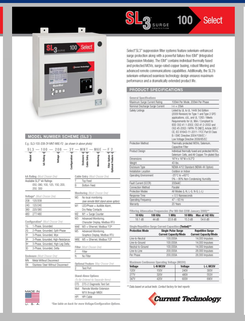


The SGSLR uses a counterpoise ground system. A heavy gauge copper cable encircles the perimeter of the Shelter and is buried beneath the ground surface. Ground rods were driven several feet into the earth and placed every 2 meters, then cad welded to heavy gauge copper cable. On the top of the Shelter, a heavy gauge braided copper cable was placed around the roof parameter then connected to the counterpoise. Air terminals were placed at the four corners of the roof and midway length wise of the building. The ground field was constructed to provide minimal earth ground resistance with a goal of no more than 5 ohms. Inside the building individual heavy gauge copper cables are connected directly to ground bus bar in each equipment rack then to a copper bus bar behind the racks. The bus bar behind the racks is then directly connected to the counterpoise.



## Lightning & Power Protection Equipment




Eaton 9PXM 12S 16K Uninterruptable Power Supply