HENEX Risk Mitigation Plan

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1. Purpose

The purpose of the HENEX Risk Mitigation Plan (RMP) is to (a) establish criteria for categorizing and ranking possible failure modes according to probability and consequences; (b) identify, categorize, and rank possible HENEX failure modes; (c) mitigate the probability and the consequences of failure based on the design of the instrument. Failure analysis and risk management are implemented and accomplished during the instrument design phase. The intent of this RMP is to help the project produce a reliable instrument within the constraints of cost and schedule. The HENEX design benefits from the knowledge gained by the design and deployment of the Hard X-Ray Spectrometer (HXS) at LLE.

2. Definitions

Component - The HENEX components, for the purpose of the RMP, are Nosecone, Spectrometer, Sensor, Battery, Electronics, and Cables (fiber optics).

Priority - The priority of the possible failure mode based on the probability of occurrence and the consequences of failure. The priority levels are 1=High, 2=Moderate, and 3=Low.

Probability - The estimated probability, in % units, of occurrence during the first year of instrument usage.

Event - Description of the failure event.

Effect - The consequences of failure.

Management - The steps taken during the instrument design phase to mitigate the failure probability and consequences.

Comment - Comment may be relevant to the assignment of the priority or probability, the design steps taken to mitigate the failure, or the experience with the HXS instrument.

Component	Priority 1=Highest	Probability % in 1st Year	Event	Effect	Management	Comment
Nosecone	3	20	Misalignment of the DIM to the source position.	Shift of the spectra on the sensors.	Implement attenuation filters and compute new energy scale using absorption edge positions.	Analytic expressions for the energy scales have been derived.
Nosecone	2	20	Entrance filter bursts.	Additional x-ray flux and visible light reach the sensor. Filter must be replaced.	The filter supports are designed for easy filter replacement.	Most likely for the thin filter on the lowest energy channel.
Spectrometer	3	10	Crystal breaks.	Crystal must be replaced.	Spectrometer is detached from the instrument, disassembled, and the new crystal and mount are inserted.	The crystal thickness is chosen to accommodate the bending radius.
Sensor	3	5	Sensor filter bursts.	Additional x-ray flux and visible light reach the sensor. Filter must be replaced.	Sensor/filter module is designed to be easily withdrawn, and the filter is replaced.	Unlikely because the sensor's filter is protected by the crystal and the entrance filter.
Sensor	3	10	Sensor fails because of EMI.	Destruction of the sensor.	EMI shielding is implemented. Sensor module is easily withdrawn, and the sensor can be replaced.	EMI shielding was successful for HXS.
Sensor	2	20	Sensors are overexposed.	Dynamic range is reduced.	Filters are designed to be easily withdrawn, and additional attenuation is added.	HXS saturation occurred on hohlraum shots.
Battery	1	<<1	Battery pressure vessel fails.	Dispersal of contaminants into the target chamber.	Engineering analysis indicates the battery pressure vessel is structurally over designed by at least a factor of 100.	Tiny probability, huge consequences.
Battery	2	5	Battery discharges before shot.	No data are recorded.	Voltages and temperatures are monitored in telemetry.	Fully charged battery lasts for >1 day.
Electronics	3	10	Electronics fails because of EMI.	Destruction of the electronics.	EMI shielding is implemented.	EMI shielding was successful for HXS.
Electronics	3	5	Electronics fails because of high temperature or voltage.	Destruction of the electronics.	Temperatures and voltages are monitored in telemetry.	Not an issue with HXS electronics.
Electronics	2	20	Download	Data are lost.	Discriminate valid facility trigger.	HXS data were lost

			interrupted by facility trigger.			because of facility trigger during image download.
Cables	2	30	Trigger failure because of signal loss in FO.	No data are recorded.	Trigger and data links are verified prior to the shot.	Trigger failure occurred during HXS operations.