Low Level Requirements for an International Lunar Network

Specified by:

ISSI Team: An International Reference for Seismological Data Sets and Internal Structural Models of the Moon

			WARNING: These requirements must be applicable to any instrument type (geophone, seismometer, VBB seismometer etc) and any mission type (hard or soft lander) from any agency (NASA, CNSA etc).	
Major Requirement #	Requirement #	Topic	Requirement	Comments
		OBJECTIVE		
	ILN-REQ-0	Interoperability of Stations for Network Analysis	Data from geophysical stations deployed on the Moon must allow an international community of researchers to locate events, perform waveform analysis and develop structural models.	These requirements cover seismic data. Additional requirements should be stated for sensors sensing ground temperature, gravity field, magnetic field, ground rotations, low frequency planetary scale rotations and deformations, and lunar laser ranging.
		SCIENTIFIC AIMS		This section outlines the reasons for the requirements in the following sections. In defining the requirements, we make the assumption that the internal structure is perfectly known.
ILN-REQ-0	ILN-REQ-0.1	Source Timing	The origin time of geophysical events detected by the seismic network must be recovered with an accuracy better than the sampling rate of the recording stations.	
ILN-REQ-0	ILN-REQ-0.2	Source Location	The source location of geophysical events detected by the network must be recovered with an accuracy better than a quarter of the wavelength of the signals used to locate the source.	
ILN-REQ-0	ILN-REQ-0.3	Source Energy	The energy of the source of geophysical events detected by the network must be recovered with an accuracy better than 20%.	
ILN-REQ-0	ILN-REQ-0.4	Source Radiation	The radiation pattern of the geophysical sources detected by the network must be recovered with an accuracy better than 10°.	
ILN-REQ-0	ILN-REQ-0.5	Data Access	Proper recording and archiving of all data and metadata is necessary to allow scientific analysis by an international community of researchers.	

		STATION REQUIREMENTS		We place the following limits on the back propagation of errors into new models of the Moon, which could arise from poor time synchronization or lack of station information etc.
ILN-REQ-0.1	ILN-REQ-1.1	Source timing: back propagated error level = X*dt	Time synchronization between stations must be provided with an accuracy that ensures that timing errors for the geophysical signals are smaller than the sampling rate of the sensor.	
ILN-REQ-0.2	ILN-REQ-1.2	Source location: back propagated error level = X * max wavelength	Station information must be provided with an accuracy that ensures that the errors on the location of the source of geophysical signals are smaller than a quarter of a wavelength of the signal used for finding the location.	
ILN-REQ-0.3	ILN-REQ-1.3	Source energy = X%	Characteristics of instruments deployed by the station must be provided with an accuracy ensuring that the errors on the estimate of the source energy are smaller than 20%.	
ILN-REQ-0.4	ILN-REQ-1.4	Source radiation = X°	The orientation of the instruments must be provided with a precision ensuring that the errors on the estimate of the source radiation are smaller than 10°.	
ILN-REQ-0.5	ILN-REQ-1.5	Data archiving and documentation	Data content, documentation, storage and archiving must ensure that an international community of researchers are able to understand these data and to implement research activities.	

		INSTRUMENT REQUIREMENTS		
ILN-REQ-1.1; ILN-REQ-1.2	ILN-REQ-2.1	Time Stamp/Time Accuracy and Precision	Accuracy on the dating of the samples must be better than one tenth of the average sampling rate of the data channel.	The aim is to use the data from various stations for network analysis.
ILN-REQ-1.1; ILN-REQ-1.2	ILN-REQ-2.2	Time Reference	Data samples must be provided in Coordinated Universal Time (UTC Time).	
ILN-REQ-1.5	ILN-REQ-2.3	Sampling Rate	For a given data channel, data acquisition should be designed to be performed at constant sampling rate in the time reference of the instrument.	
ILN-REQ-1.5	ILN-REQ-2.4	Format	Data and metadata must be provided in a format prescribed by the International Federation of Digital Seismograph Networks (FDSN) for the exchange of seismic data.	
ILN-REQ-1.6	ILN-REQ-2.5	Units	Data must be provided in units of the international reference system (SI units).	
ILN-REQ-1.3; ILN-REQ-1.5	ILN-REQ-2.6	Calibration Information	The amplitude of the instrument response must be provided with an accuracy better than 10% over the bandpass of the instrument during the entire lifetime of the instrument.	
ILN-REQ-1.3; ILN-REQ-1.5	ILN-REQ-2.7	Calibration Information	The phase of the instrument response must be provided with an accuracy better than 10° over the bandpass of the instrument during the entire lifetime of the instrument.	
ILN-REQ-1.5	ILN-REQ-2.8	Metadata and processing	Metadata must contain a description of all the processing steps from the physical unit to the digital (count) output of all data channels.	

		INSTRUMENT REQUIREMENTS continued		
ILN-REQ-1.3; ILN-REQ-1.5	ILN-REQ-2.9	Compression/ Decompression	If lossy compression is applied, it should allow signal reconstruction with an accuracy better than 10% of the signal energy.	
ILN-REQ-1.3; ILN-REQ-1.5	ILN-REQ-2.10	Aliasing	The instrument must be designed so that less than 0.1% of the signal above the Nyquist frequency is aliased in the bandpass of the instrument.	
ILN-REQ-1.5	ILN-REQ-2.11	Noise Estimates	Sensor and instrument noise must be estimated over the bandpass of the instrument and provided for each seismic channel in $m/s^2/\sqrt{(Hz)}$.	
ILN-REQ-1.5	ILN-REQ-2.12	Archiving	Data and metadata for all the instrument channels must be archived both in planetary databases and in geophysical sensor databases.	
ILN-REQ-1.5	ILN-REQ-2.13	Naming	A network code and a station code must be assigned to the geophysical station by the International Federation of Digital Seismograph Networks (FDSN).	
ILN-REQ-1.2; ILN-REQ-1.5	ILN-REQ-2.14	Station Location	The station location must be provided in a standard reference system defined by the International Astronomical Union (IAU).	
ILN-REQ-1.2	ILN-REQ-2.15	Station Location	The station location coordinates must be provided with an accuracy better than 25 m.	Half a wavelength, assuming highest frequency is 10 Hz and lowest S-wave velocity is 500 m/s.
ILN-REQ-1.4	ILN-REQ-2.16	Axis Orientation	The sensing direction of the instrument data channels must be provided with an accuracy better than 10°.	
ILN-REQ-1.5	ILN-REQ-2.17	Operations	Mission, platform and instrument operation activities impacting the signals above instrument noise level must be time-stamped, recorded and archived in the metadata for the instrument.	

ILN - International Lunar Network