EarthScope Primary Insturment Center (EPIC)

GENERATING STATION XML FROM MINISEED FILES USING NEXUS

For PASSCAL Platforms: Mac OSX & Linux
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This document was written and produced by the
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I. Introduction

Nexus is a EPIC-developed software tool for creating and modifying metadata in StationXML format for archiving SEED data at the IRIS DMC. Nexus was developed as part of an effort to make metadata creation user-friendly and lessen the amount of time needed to create complete, accurate metadata for EPIC experiments. Nexus has a graphical user interface (GUI) to make it easier for users to interact with their metadata.

Creation of accurate metadata is a fundamental part of archiving data from a EPIC experiment. The archiving of your data fulfills the principal investigator (PI) responsibilities defined in the EarthScope Data Delivery Policy:
https://epic.earthscope.org/content/general-information/policy/data-delivery-policy

Additional documentation can be found on our website:
https://epic.earthscope.org/content/passive-source-seed-archiving-documentation

Please take a moment to thoroughly review this guide before you start. If you have any questions please contact: epic.data.group@earthscope.org.

Within this document:

Headers, general scripts and commands are in bold.
GUI options and menus are highlighted gray
Fields that need to be filled out are highlighted yellow
Standard output is italicized. [example of response output in terminal]
URLs and email addresses are blue.

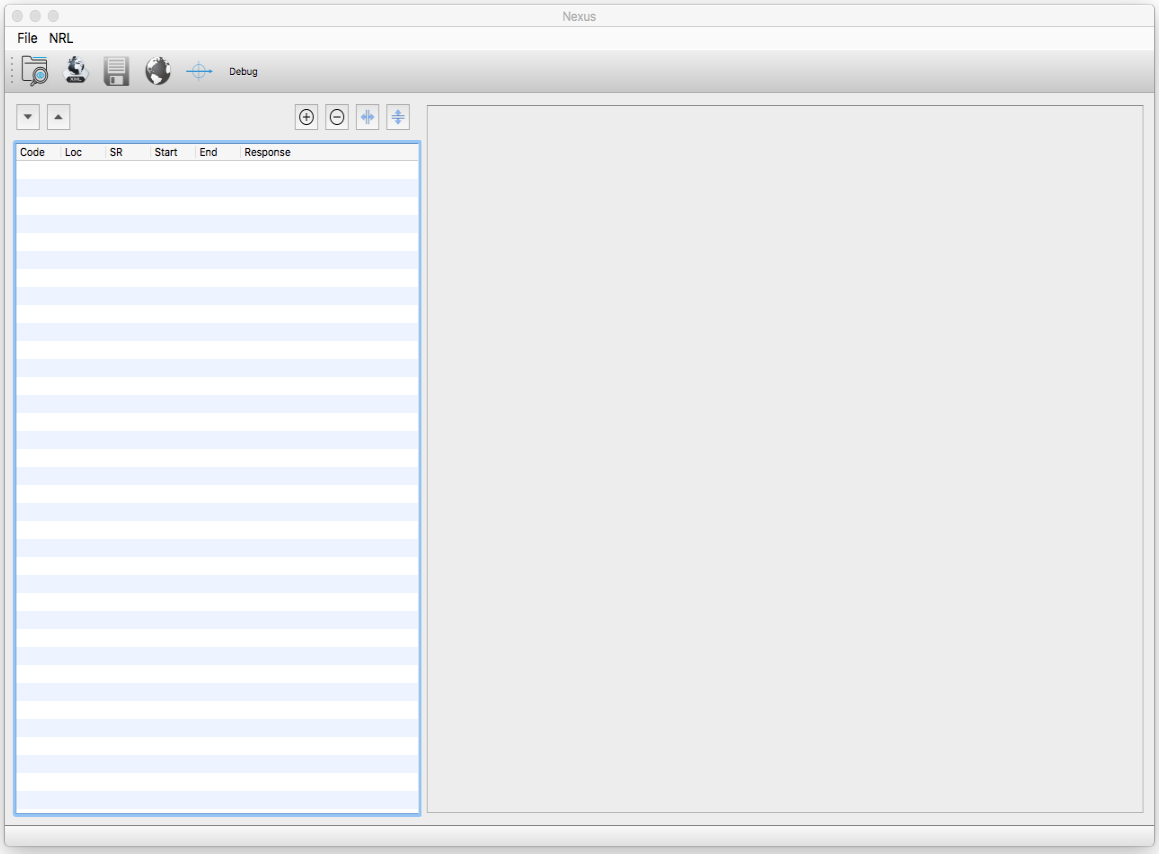
II. Installing Nexus

To install Nexus, please visit the Software Resources page on the EPIC website: https://epic.earthscope.org/content/software-resources

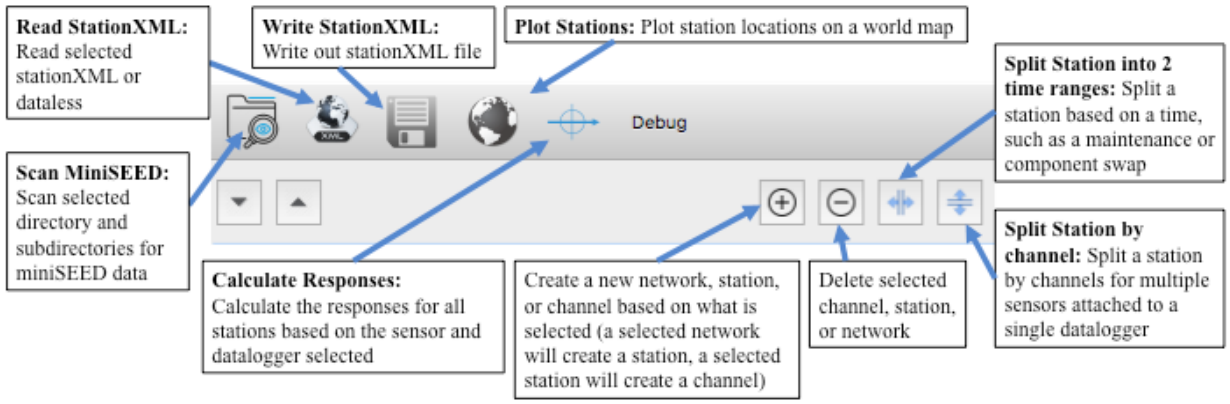
Nexus requires either Anaconda or Miniconda to be installed on your system. If you do not have a version of Conda installed, you can download and install Miniconda from the Conda website: https://conda.io/miniconda.html. Select your operating system and download the installer for the Python 3.7 version of Miniconda.

III. Introducing the Nexus GUI

After you have finished installation, you can start Nexus by typing **nexus** in a terminal window. This will bring up the Nexus GUI:



The main Nexus GUI has several buttons. Each button is duplicated in the File menu.



IV. Creating StationXML

The stationXML file is the history of your entire experiment. It records any and all of the changes, additions, and removals of dataloggers, sensors, channels, sample rates etc. for all the stations within the network and thus MUST include all of these changes, covering the entire duration of the experiment.

A. Scanning miniseed

To create a StationXML from already existing miniseed files, scan the miniseed files either by selecting the Scan MiniSEED button or going to File > Scan MiniSEED. Navigate to the directory your miniseed files are located and select Open. Nexus will scan the selected directory and all subdirectories and inventory all miniseed data files in those directories.

Nexus scans all the miniseed files header information and creates a preliminary list of network, station, channel, location, and sample rate with the corresponding start-end time on the left panel of the GUI.

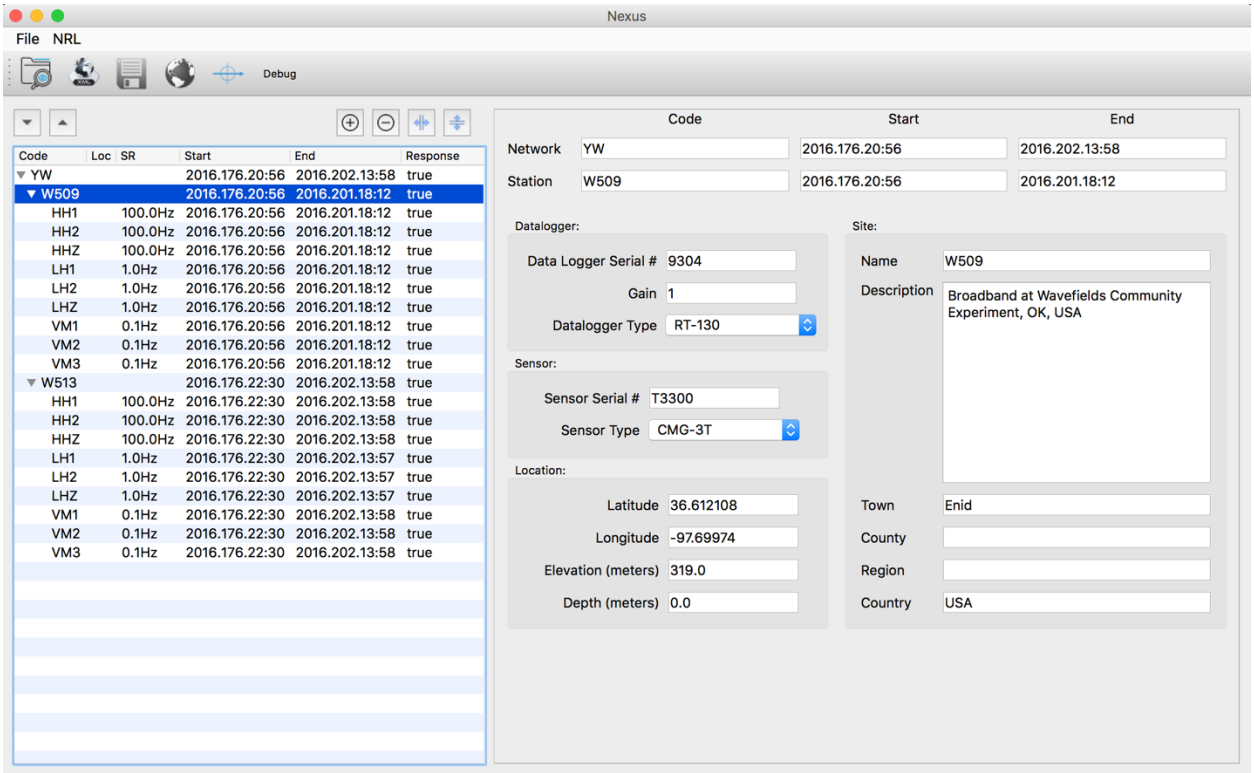
After scanning your miniseed, confirm that all stations listed are named correctly and have the correct channel names. Also, verify that the network code is the correct one for your network. If the network code, station or channel names are incorrect, you will need to fix them in the miniseed data before proceeding further. Please see the fixhdr doc on our website (see link above) for instructions on how to modify miniseed headers.

B. Adding station and equipment information

Miniseed files do not carry any information about location, instrument type or sensor orientations. This additional information is manually entered in the network, station and channel blocks.

Start by selecting the first station in your network from the list on the left panel of the GUI. Selecting a station will bring up the information for that station on the right panel. You will see that the network, station, and start and end time fields are already filled out. These fields are populated from the miniseed headers and do not need to be modified.

Using your field notes, fill out the empty information fields on the right panel of the GUI for your selected station. First, specify Datalogger Serial #, and Gain. Then use the dropdown menu to select Datalogger Type. Fill in the Sensor Serial # before using the dropdown menu to select Sensor Type.



Nexus is set up with default instrument types based on the EarthScope instrument pool. If you have equipment from the EarthScope pool, select the appropriate equipment from the Datalogger Type and Sensor Type dropdown menus. If you have non-EarthScope instrumentation, or if the equipment you are using is not listed in the dropdown, then select the ... field at the bottom of the dropdown menu. This will open an equipment selection GUI that will help you pick the appropriate equipment. To select the right response, you would need to have information about datalogger manufacturer, model, gain, its filter options and recording sample rate handy. Similarly you would need to know manufacturer, model, and sensitivity of your sensor.

Note: if you have non-standard orientations for your sensors see section VII.C.

Finally fill out the Location fields (Latitude, Longitude, Elevation, and Depth (in positive values) if the sensor is buried) and Site descriptions. In the Site section, only the Name field is required.

Repeat this process for all stations in your network.

V. Finalizing your StationXML file

A. Calculate responses

A stationXML is not complete and accepted without the sensor and datalogger responses. Select the Calculate responses button at the end of applying all changes to the station and network configuration, and after all fields are properly populated. After selecting Calculate Responses, all rows in the Response column on the left panel should indicate "true". If the response for a channel or station is not calculated column will indicate "false". Figure in section VII showes responses are calculated for station W509, but not completed for all dates of operation for station W513.

The calculate responses function in Nexus connects to Nominal Response Library (NRL) hosted at IRIS and grabs the response file. Thus, you need Internet access to complete this step.

B. Mapping stations

You can use the built-in mapping tool within nexus to plot your stations. This step adds another layer of visual checking to make sure all your stations are where you expect them to be. Go to File > Plot stations or select the Plot stations button on the main menu bar to bring up a map of the station locations.

C. Saving StationXML

After all values in the Response column are true and you have verified your station locations, go to File > Write StationXML or select the Write StationXML button to save your stationXML file. Name the stationXML file with the network code, experiment name, and today's Julian date. For example: PI.PasscalTestNetwork.2019143.xml

D. Sending your StationXML to EPIC

Email your stationXML to epic.data.group@earthscope.org , unless it is larger than 5Mb. For stationXML files that exceed 5Mb, please email epic.data.group@earthscope.org and you will receive instructions on how to transfer your stationXML.

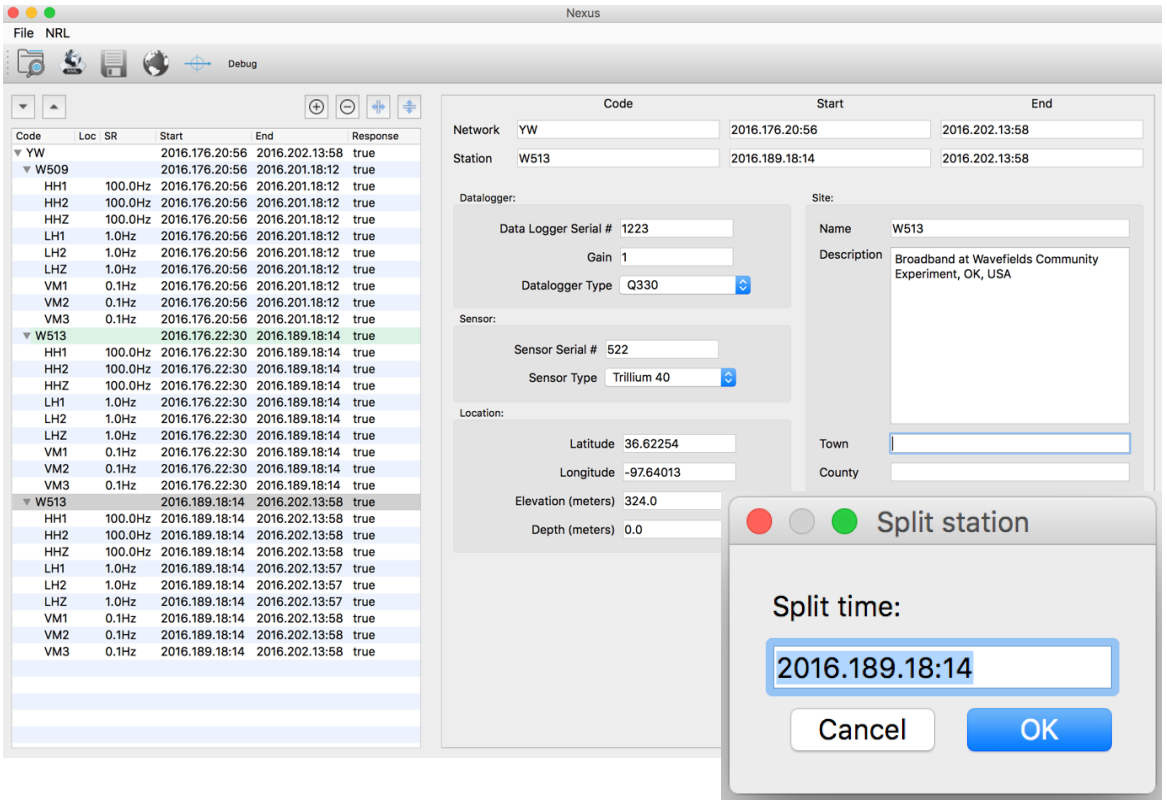
VI. Adding data from service runs:

A. Scanning new miniseed

You can update an already existing stationXML by scanning the miniseed data from a service run. Start Nexus by typing **nexus** in a terminal window. Select Read StationXML button or go to File > Read StationXML. Navigate to your existing stationXML and open it. Select Scan MiniSEED and then navigate to the miniseed files from the new service run. This will automatically append to the existing stations and update the stations end times based on the latest time tag on the newly scanned miniseed files. Save the changes to the updated XML file.

B. Creating new time epochs

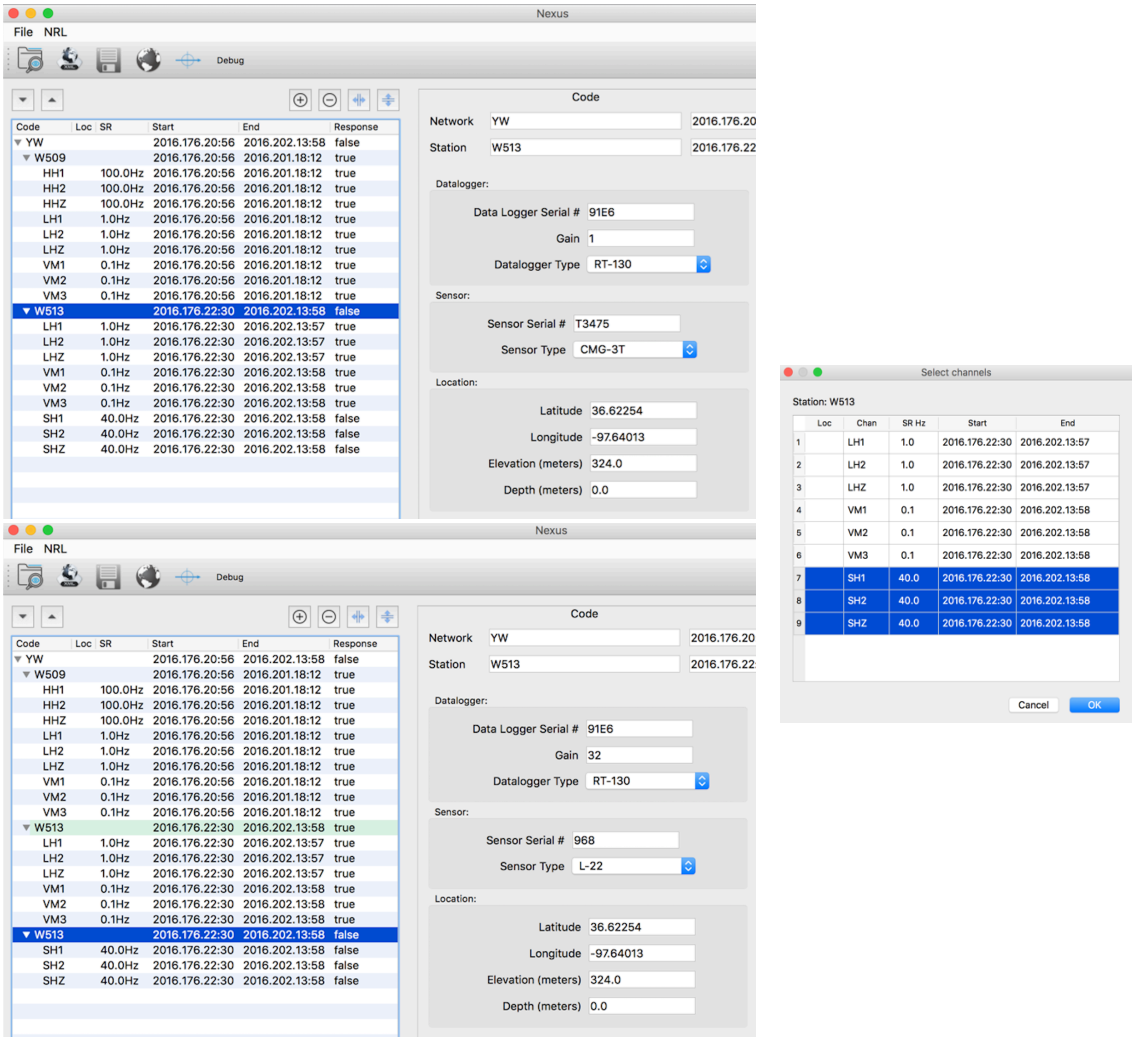
If a sensor or a datalogger was swapped or changed during a service run, you can create a new time epoch in the StationXML to reflect this change (change could be same type of sensor or datalogger with a different serial number, a completely different type of instrument, or a span of time in which sensors were mis-oriented). Select the Split Station into 2 time ranges button and specify the split time in the Split station window that pops up: the exact time the change happened, system came up and data was started to be collected. Fill out information for the new equipment and then select the Calculate Responses button. In the example below, station W513 was serviced on 2016.189.18:14 (split time) and both sensor and datalogger were replaced by a T40 and Q330.



VII. Additional cases

A. Dealing with multiple sensors at a station

When you scan miniseed data from a station with multiple sensors attached to a single datalogger, all channels appears under one station name. In order to properly associate the channels with their sensor, you need to split the station and assign the correct sensor to the corresponding channels. Use Split Station by channel button to reflect such changes. Select the station on the left panel where multiple sensors are installed, then select the Split Station by channel button. This will bring up a GUI window where you can select which channels are associated with the second sensor. After hitting OK, the station will be split into two segments, and the specified channels will be associated with the second instance of the station. Update sensor information on the right panel accordingly and save. If you have multiple sensors with similar band and instrument code, you should assign location code to channels to differentiate between the sensors.



B. Loading dataless and Converting from dataless to stationXML

If you already have your metadata information in a SEED dataless format Nexus has the capability to read that in and later save it as stationXML. Use the same Read StationXML button or select File > Read StationXML to open your dataless. Apply any changes to your dataless and then save your metadata in stationXML format by selecting the Write StationXML button.

The IRIS DMC has also developed a stationXML-SEED converter that will convert metadata files from stationXML to SEED and vice versa. It is available at their GitHub page: https://github.com/iris-edu/stationxml-seed-converter/

C. Why is your sensor pointing south? Non-standard sensor orientations and naming conventions

Azimuth and dip describe the direction of the sensitive axis of the instrument. Motion in the same direction of the axis is positive. Traditional conventions are:

Z: Dip -90, Azimuth 0 (reversed: Dip +90, Azimuth 0)
N [1]: Dip 0, Azimuth 0 (reversed: Dip 0, Azimuth 180)
E [2]: Dip 0, Azimuth 90 (reversed: Dip 0, Azimuth 270)

Most of the traditional broadband sensors follow the miniseed conventions of -90 for the vertical channel. Instruments that have been used and developed mostly for exploration industry such as the Sercel L22s have a dip of +90 on the Z channel.

On the horizontal channels, if the sensor was mis-oriented and not aligned properly to true north, you can compensate for it by adjusting the azimuth values on the two horizontal channels accordingly.

If your sensor is oriented beyond ±5 degree from N and E, you should use 1 and 2 as the orientation band in channel name. Since mis-orienting sensors is an unintended but frequent occurrence, we encourage all experiments to use 1 and 2 for horizontal channel names in place of N and E, respectively, to match current GSN convention. This also allows for updates to be made to the sensor orientations in case of incorrectly oriented sensors without requiring changing the channel names.

You can use Nexus to correct for azimuth and dip angles as well as sign change. On the left panel, select the channel you would want to apply changes, and on the right, enter correct values for Dip, Azimuth.

D. Creating StationXML without miniseed files

You can create a StationXML from scratch and without having to scan the miniseed files. Start Nexus by typing **nexus** in a terminal window. Create a new child object by selecting the Plus button on the top left menu. This creates a Network object. Select the Network object on the left panel and on the right panel edit Network code, Start and End fields.

After selecting the Network object on the left, create a new child object by clicking the Plus button to add a station object. Edit the station fields on the right panel. From the station object, follow the same procedure to create all the channels and fill out all the fields.