ISWI Instrument Data Management Plan

Instrument name: e-CALLISTO

Part 1: Instrument and personnel information

- Current PI and contact info: Christian Monstein, Istituto ricerche solari Aldo e Cele Daccò (IRSOL), Faculty of Informatics, Università della Svizzera italiana (USI), CH-6605 Locarno, Switzerland.
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- Other responsible personnel and contact info (e.g., instrument scientist/manager, if different from PI):
  - Prof. Dr. André Csillaghy, University of Applied Sciences, Bahnhofstrasse 6, CH-5210 Windisch, Switzerland, andre.csillaghy(at)fhnw.ch
  - Prof. Dr. Arnold Benz, Wolfgang-Pauli-Strasse 27, CH-8093 Zurich, Switzerland, benz(at)astro.phys.ethz.ch

- Instrument website: https://e-callisto.org/
  Alternate website to directly access data: http://soleil.i4ds.ch/solarradio/

- Instrument information
  - Science and measurement objectives: 24h/7d observation at different latitudes of solar radio bursts in the frequency range 45 MHz…. 870 MHz (wavelength 34.5 cm … 6.67 m) or any other frequency range by switching in a heterodyne up- or down-converter

  - Instrument descriptions
    - Software setup and user manual including specification (~5.2 MB): https://www.reeve.com/Documents/CALLISTO/CALLISTOSoftwareSetup.pdf

    - Hardware and construction manual (~8.2 MB): https://www.reeve.com/Documents/CALLISTO/CALLISTOConstruction.pdf

    - General information and articles: https://e-callisto.org/GeneralDocuments/Callisto-General.html

  - Instrument performance specifications: https://e-callisto.org/Qualification/applidocs.htm

  - Key/representative publications or references: https://arxiv.org/abs/astro-ph/0410437 https://link.springer.com/article/10.1007/s11207-005-5688-9

- Instrument locations (longitudes and latitudes) and local points of contact: https://e-callisto.org/Callisto_DataStatus_Vwww.pdf

- Station data availability intervals: Each location (which is operational) sends data in 15-minute interval between local sun-rise and sun-set. Current situation about availability of data here: https://e-callisto.org/daynight_mill.png This website is updated once every 15 minutes during 24h/7d.

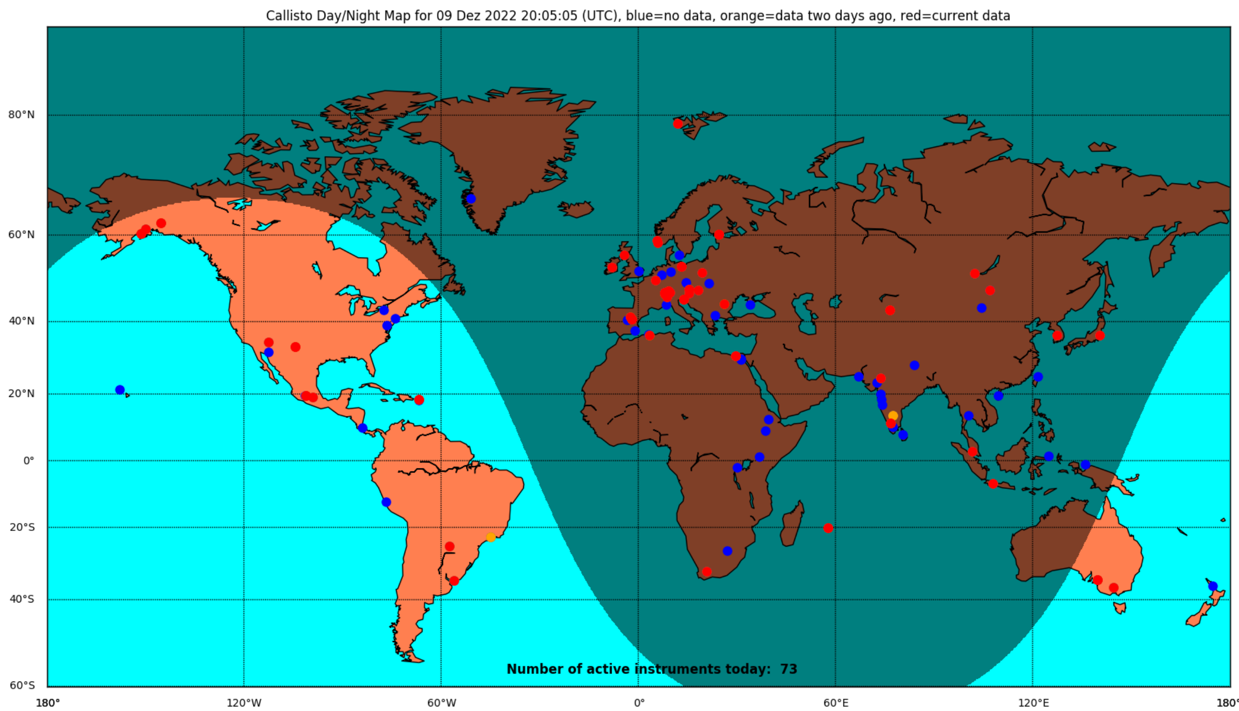

Fig. 1: Example of station availability on Friday, December 09, 2022. Plot is updated every 15 minute on the main website: https://e-callisto.org/

Part 2: Data and format

2.1 Measurements and data products

- Measured parameters and data products
  - How will the measured parameters be acquired or recorded?
    Data are acquired via a 10-bit ADC of an Atmel RISC processor ATmega16 inside the Callisto instrument. Data are then reduced to 8 bits to save memory space. Data are then transferred via RS-232 to a standard Windows PC and stored on a local disc or on a network-drive. A PERL or PYTHON script transfers the FIT-files every 15 minutes to the central server in Switzerland. The very latest details about how acquisition is performed can

be found in the firmware of Callisto here: https://e-callisto.org/Software/Callisto-Software.html

- Units? Temporal & spatial resolutions?
  In case of calibrated data the units are solar flux units (SFU) but the majority of the instruments is not calibrated in intensity, therefore the units are either 'nil' or 'digits'. Temporal resolution is programmable by the user as number of spectra per second (1....200), depending on the size of the spectrum (4…400 bins). Spatial resolution depends on the individual antenna type. The majority uses a logarithmic periodic dipole array (LPDA) with angular resolutions in the order of 70°…120°. Instruments based on long wavelength antennas (LWA) have a spatial resolution up to 180°. Images of the individual antennas can be found here: https://e-callisto.org/coverage/coverage.html

  

  Fig. 2: Typical example of a logarithmc periodic dipole array (LPDA) in Ahmedabad, India.

- How will physical parameters be derived from measured parameters?
  Physical parameters are usually derived by generating plots of the bursts, typically in IDL, SSW-IDL, MATLAB or PYTHON.
  - Units? Temporal & spatial resolutions?
    Most relevant are duration of the bursts in seconds, drift-rate in MHz

per second, bandwidth in MHz and structure of the burst which is a purely visual identification which requires some experience.

- Processing and calibration procedures
  Currently none of the instruments is able to make use of a calibration unit because such a device is extremely expensive compared to the instrument itself. Intensity calibration is anyway not required for burst-analysis and of second order interest. In case calibration is required then usually post-calibration is performed by comparing with other instruments which are able to calibrate (cross-calibration with Nançay, Humain (ROB) or Nobeyama)
- Coordinate systems, software, and models used?
  The instrument coordinate system is given by time (UTC), longitude, latitude and altitude. In most cases the antenna is pointing to zenith, therefore the declination is always equal to the latitude and the hour angle is equal to 0h because the antennas are mostly oriented in north-south direction. Only very few instruments allow to track the Sun. Software (firmware and PC-firmware as well data analysis tools in IDL and PYTHON) can be found here: https://e-callisto.org/Software/Callisto-Software.html
- Quality assurance & quality control measures
  Quality assurance is done by visual inspection of the data at least once a day by the PI. Control measures are performed every few years by collecting spectra which are fed into a dedicated Python tool. As long as the system noise is below ~1000 Kelvin the system is seen as functional. In case of bad sensitivity, the instrument owner is contacted by email to identify the problem. An overview about sensitivity and rfi of most of the stations can be found here: https://e-callisto.org/OVS/Spectral%20Overview.html
  Not all stations provide their spectral overview, possibly due to internal or political reasons.

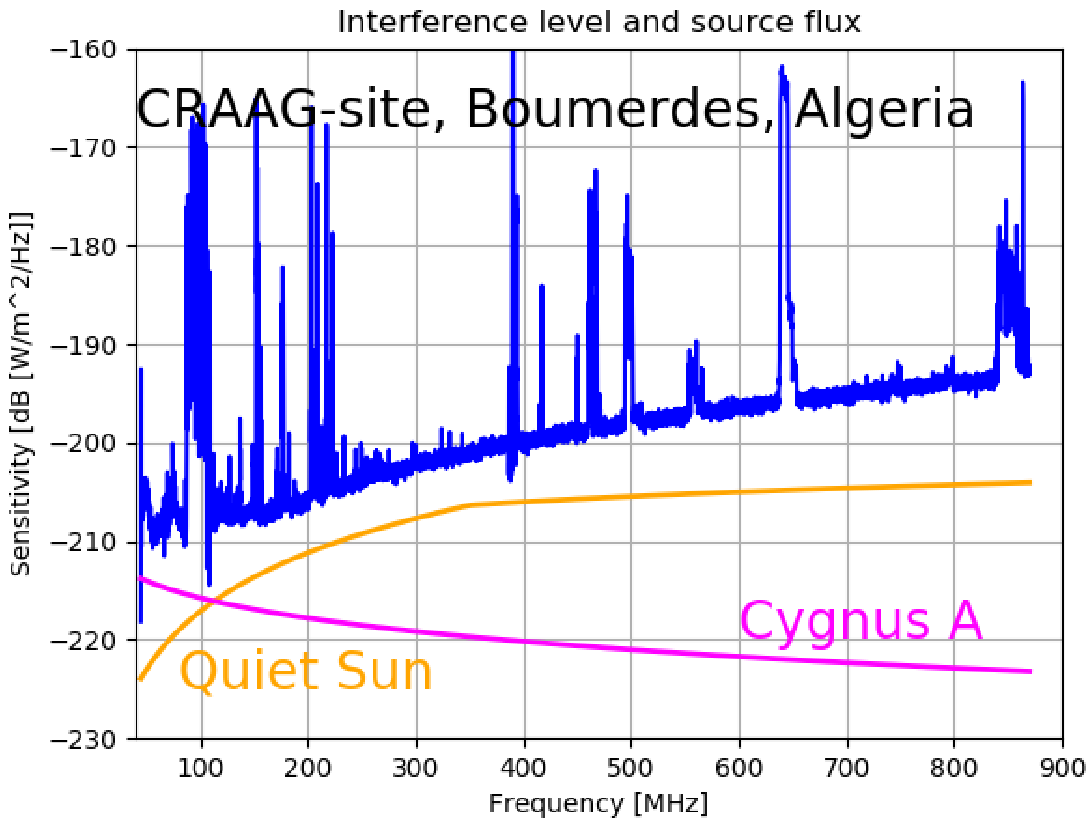

Fig.3: Typical example of a spectral overview (OVS), here from CRAAG, Algeria.

- Definitions and descriptions of higher-level instrument data products
  - Numerical: none
  - Graphical: We provide on the central archive quick-views (QV) for every 15 minute FIT-file here: [http://soleil.i4ds. ch/solarradio/callistoQuicklooks/](http://soleil.i4ds.ch/solarradio/callistoQuicklooks/)

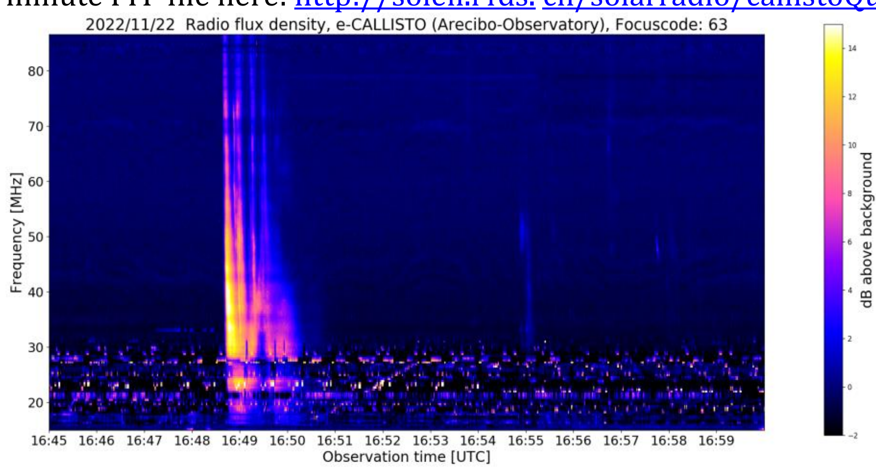

Fig. 4: Typical example for a quicklook or quickview, here a type III burst from Arecibo Observatory, Puerto Rico.

In addition we also provide a daily overview per location here:
http://soleil.i4ds.ch/solarradio/data/1998-2009_quickviews/
In addition, a daily light curve per station is available, presenting frequencies which are internationally protected by ITU here:
http://soleil.i4ds.ch/solarradio/data/Lightcurves/

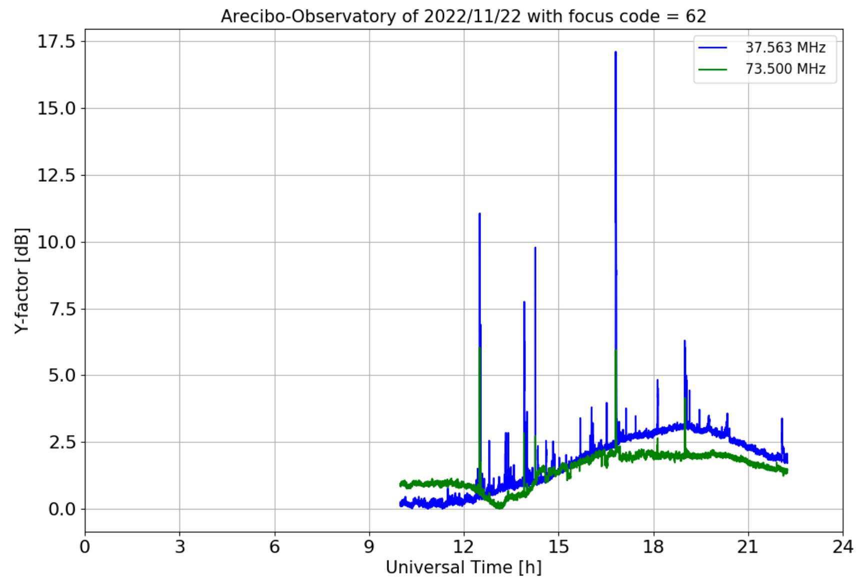

Fig. 5: Example of a daily light curve, here from Switzerland. We can see the burst as in figure 4 above at 16:49UT (blue peak).

- From January 2021 onwards we also provide daily maximum observation time of the Sun for instruments providing data the archive.

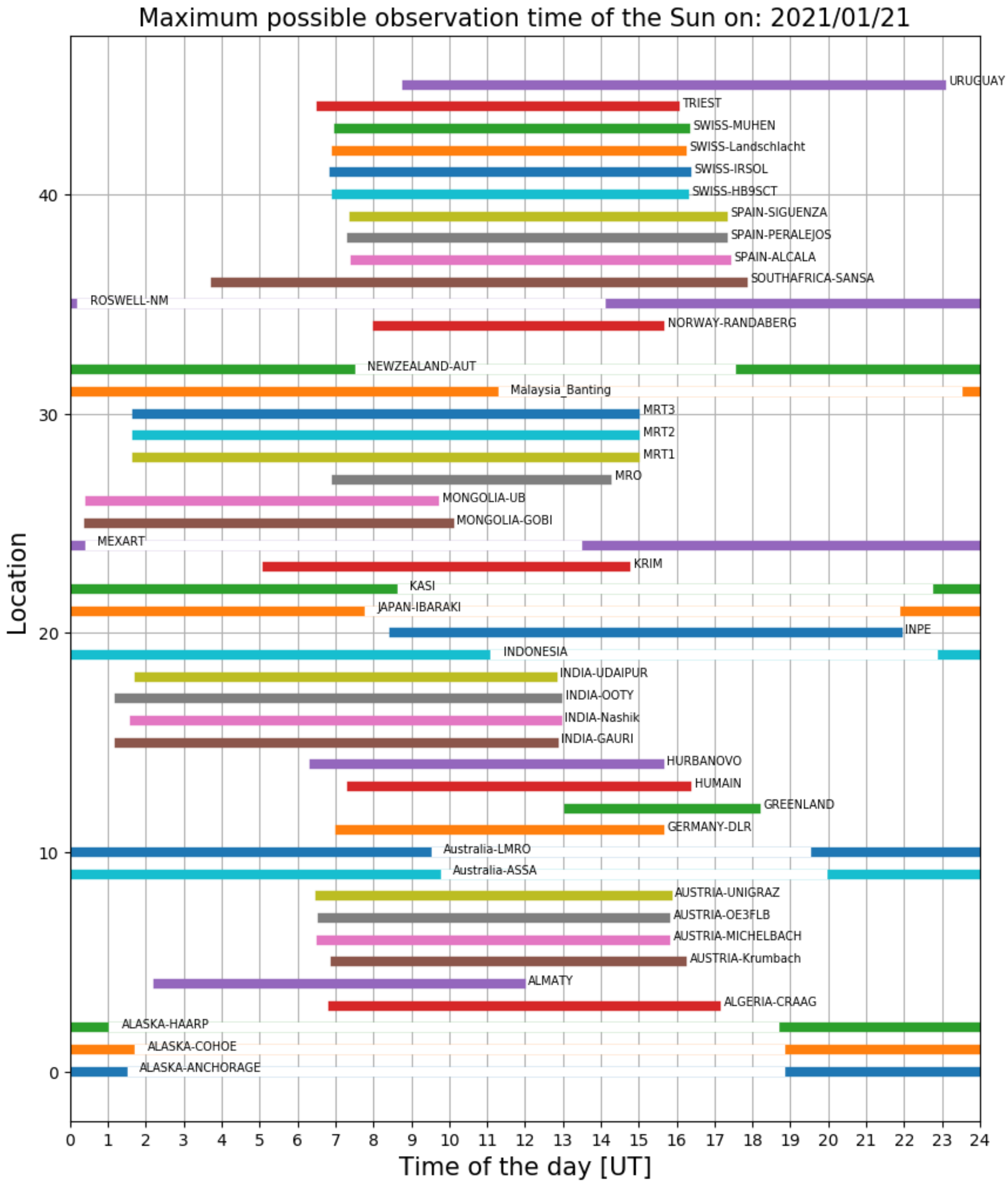

Fig. 6: Daily observation time for all hosts which provided data on January 21, 2021. It is updated every 24h around midnight CET.

- Real-time space weather data products
    - Product descriptions: We provide FIT-files covering 15minutes of observation to the central archive in Switzerland as described above. Due to internet speed of the instrument-hosts, the files may appear on the archive website up to 30 minutes later. Every instruments can also provide a set of light curves locally on the computer of the host in a faster cadence, every ~10 seconds. But these files are currently not available on the central server. But in addition we also provide a daily spectral overview per location with an

update every hour 24h/7d, see: http://soleil.i4ds.ch/solarradio/data/1998-2009_quickviews/

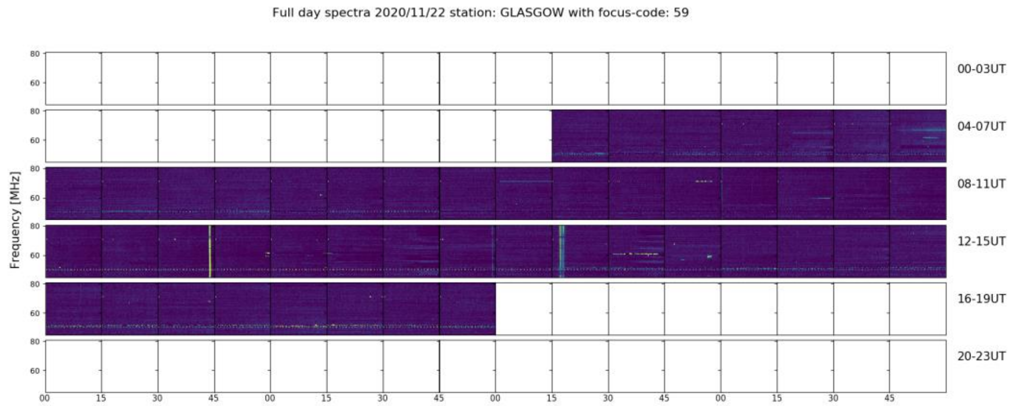

Fig. 5: Example of a daily spectral overview, here from University of Glasgow, UK. We can see the same burst as in figure 3 above at 12:44UT

- Method of acquisition and processing: See paragraph 2.1 above
- Data format: See paragraph 2.1 above
- Storage, distribution and access methods: See paragraph 2.1 above and paragraph 2.2 below.

- Data quality and caveats
Each instrument owner is responsible to provide best quality data possible and we cannot take over any responsibility to guarantee 100% perfect data quality. The scientist has to check if he/she can trust the data by comparing results with data from other, nearby locations. If at least two stations observe the same event, we can assume it's a solar burst. If only one station observes a dynamic structure, one has to be careful. A catalog with natural and man-made dynamic spectra to get acquainted with dynamic spectral structures can be found here: https://e-callisto.org/GeneralDocuments/BurstCatalog.pdf

2.2 Data file format and metadata

For each of the instrument data products defined above, please provide:

- Description of data file format (CDF, FITS, HDF, netCDF, ASCII, etc.)?
Main data output is stored as FIT-files and it's header is described in detail in appendix 'F' here: https://www.reeve.com/Documents/CALLISTO/CALLISTOSoftwareSetup.pdf
- Organization and range of data/parameters in data files?
Parameters of observation are stored individually in a configuration file named 'callisto.cfg'. It's content and ranges are described in detail in software setup manual here: https://www.reeve.com/Documents/CALLISTO/CALLISTOSoftwareSetup.pdf
- Information on how metadata will be provided with the data?
There are three types of metadata available:

- A log-file in real-time where all actions and errors of the instruments are stored. The file is simple text-file (ASCII) and a description can be found here: https://www.reeve.com/Documents/CALLISTO/CALLISTOSoftwareSetup.pdf
- An integrated light-curve file is also provided to produce real-time plots on a website. Details and tools available are described here: https://www.reeve.com/Documents/CALLISTO/CALLISTOSoftwareSetup.pdf
- A spectral overview file can be generated manually or automatically and it is described in detail here: https://www.reeve.com/Documents/CALLISTO/CALLISTOSoftwareSetup.pdf

- Metadata format. For example, SPASE <www.spase-group.org> is a metadata model that has been developed in recent years by the heliophysics research community for describing space-based and ground-based heliophysics data products.
  Not applicable in the current network system.

  All meta data can be downloaded from here: http://soleil.i4ds.ch/solarradio/
  See 'Ancillary data' for plots and raw-files.

Part 3: Archiving and distribution plans

3.1 Long-term data storage and management

- How and where will instrument data be stored and managed long-term?
  All data (FIT-files, log-files, weather-data and reports) are stored on our central server in a new server-room at campus Brugg-Windisch of University of Applied Sciences (FHNW). Storage device is a RAID6
- Data re-processing requirements and version control
  Data processing (quick views) is performed with scripts in combination with IDL, PERL and Python, while daily overviews are executed in Python on the central server in Python3.
- Data backup plan
  Every 3 hours an automatic backup is generated on a separate disc-system in the same server room. Every 1-2 week all data are copied onto a tape and stored in a separate building at FHNW campus.
- Once a month the PI copies all raw-files of previous month to an external USB-disc.
- Primary person responsible for the archived data and contact info (must be kept up-to-date in case there are requests for data or information about data)
  Server administrator is Mr. Bernhard Schindler:
  https://www.fhnw.ch/personen/bernhard-schindler
  Responsible group leader is Prof. Dr. André Csillaghy:
  https://www.fhnw.ch/people/andre-csillaghy/

3.2 Data distribution plan

How will instrument team support/enable instrument metadata and data access in accordance to the ISWI open data policy?

All data are freely available any time here:
http://soleil.i4ds.ch/solarradio/callistoQuicklooks/
Or, as an alternative way here: http://soleil.i4ds.ch/solarradio/
Logbooks about our own instruments here: http://soleil.i4ds.ch/solarradio/data/Journals/
Environmental data about our own instruments here:
http://soleil.i4ds.ch/solarradio/data/1998-20yy_EnvironmentalData/

We expect to be invited as co-author in case Callisto data are used for any publication. And we expect credit given to FHNW Brugg/Windisch, Switzerland.

In case Callisto data are used for any publications, the instrument PI expects to be invited to be a co-author of the paper. For this purpose, the paper must be sent to the PI at least two weeks prior to submission, so that he can review it, possibly give comments, and decide whether he chooses to be a co-author. Note that the explicit confirmation from the PI is needed for him to appear as a co-author on any such publication.

3.3 Policies for data access and sharing

All ISWI instrument teams and users of ISWI instrument data agree to abide by the ISWI open data policy. All instrument teams also agree to maintain their data management plans to ensure their accuracy and completeness.

Document Information

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0.1 (Draft major revisions, 05 Dec 2016)
0.2 (Final draft, 30 Sep 2017)
0.3 (Final, 14 Feb 2018)
0.4 (Lost affiliation, 14 Nov 2018)
0.5 (New affiliation, 01 Feb 2019)
0.6 (22.01.2021)
0.7 (Update affiliation, http->https, 09.12.2022)