

Callisto Software Setup Guide



~ Part of ~
e-CALLISTO
Solar Radio Spectrometer Network

CALLISTO-NA Software Setup Guide

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Additional information on the CALLISTO Receiver may be found here:

<http://www.reeve.com/Solar/e-CALLISTO/e-callisto.htm>

Additional information on e-CALLISTO, including a description of the e-CALLISTO Network, may be found here:

<http://www.e-callisto.org/>

e-CALLISTO logo on cover courtesy Christian Monstein

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Callisto Software Setup Guide

I. Description

I.1 Introduction

The CALLISTO Software Setup Guide describes the steps necessary to setup the software used with CALLISTO instruments. This guide supplements the *Callisto Installation Tool*, which is available at <http://e-callisto.org/Software/Callisto-Software.html> . The *Callisto Installation Tool* automates almost all of the setups described in this guide but does not replace this guide. It is recommended that the *Callisto Installation Tool* be used to install the Callisto software and then this guide be used to further customize the installation.

This guide is designed to be read and followed from beginning to end.

If you are unfamiliar with the CALLISTO instrument and accompanying software and you skip steps during initial setup, you do so at your own peril.

Be sure to read the operating notes and tips in section VI. Refer to the CALLISTO Construction Manual for receiver specifications, construction details and hardware and circuit descriptions.

Terminology: CALLISTO or Callisto refers to the radio spectrometer itself while e-Callisto denotes to the worldwide network. The associated software applications, for example, callisto.exe, usually are written lowercase. Variations exist for clarity.

I.2 Requirements:

To setup the CALLISTO and associated software, the following are required:

- ⚙ Windows desktop or laptop PC with the following: ≥ 1 GB hard drive, ≥ 1 GHz clock, one available serial port or USB port for each Callisto, and a network interface card (NIC) or equivalent. The software is compatible with Windows 2000, Vista, XP, 7, 10 and 11 (Pro versions) with firewall and anti-virus programs. Important note: The software supplied is not compatible with Linux operating systems. DO NOT use Windows emulators on LINUX systems; use native Windows installations to avoid strange system behavior. Recommended memory (RAM): ≥ 1 GB for XP, ≥ 2 GB for 2000, Vista and 7 and ≥ 16 GB for 10 and 11 . All service packs must be installed. XP is the preferred system. See par. I.7 for a list of known software incompatibilities.
- ⚙ Antenna and associated coaxial cable transmission line suitable for the frequency range to be observed. The CALLISTO RF input connector mates with a type N-Male coaxial connector.
- ⚙ DC power supply or ac adapter rated 9 to 15 Vdc and at least 300 mA for each Callisto. The power supply does not have to be regulated but its output must be well filtered. The CALLISTO dc power input jack mates with a 2.1 x 5.5 mm coaxial dc power plug. The Callisto is supplied with a suitable power plug. Wire it to the power source with center pin positive.

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- ⚙ Suitable EIA-232 (RS-232) cable. The cable should be shielded and must have a DB9-Female on one end and DB9-Male on the other with pins 2, 3 and 5 wired straight-through.
- ⚙ USB-serial adapter if the PC does not have a native serial port. Must be compatible with the Windows version used and have the latest drivers installed.
- ⚙ PC must be setup in the English language for remote support.
- ⚙ An internet connection is required for remote support.
- ⚙ A web-controlled power switch as well as a uninterruptible power supply (UPS) to cope with short power surges can be helpful in the case of a remote location.
- ⚙ It also recommended to use keyboard and mouse with cords to reduce potential radio frequency interference from wireless devices.

See CALLISTO Construction Manual for additional requirements.

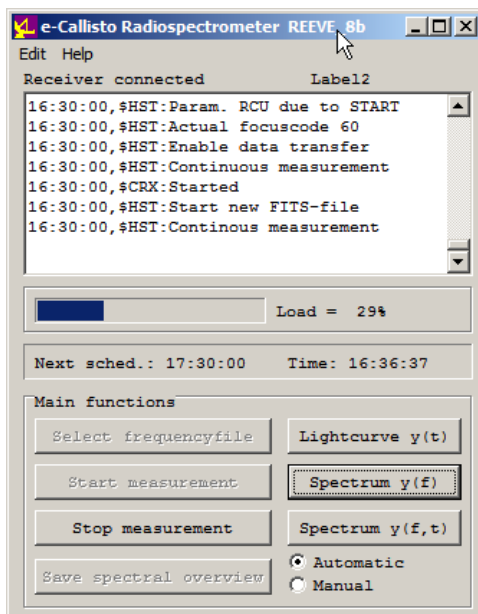
I.3 Data Time Stamps

The data collected by the CALLISTO Receiver and accompanying software applications are useless unless properly time and date stamped. All data are collected with respect to Coordinated Universal Time (UTC). Time stamps are determined by the software applications collecting data from the receiver. Most of these applications use the real-time clock in the PC running the applications, so it is very important that the real-time PC clock be as accurate as possible. This can be accomplished easily and cheaply using the Network Time Protocol (NTP). Setup using NTP is described in section V.

I.4 Software Applications and Tools

The primary software application program for the CALLISTO receiver is *Callisto*. Software tools are *Frequency Genie*, *Scheduler Genie*, *WWW Genie*, *Java FITS Viewer*, *PERL-FTP* and *FTP-WatchDog* and *M9703APlotter*. These are briefly described immediately following and in more

detail in later sections. All software applications and tools are supplied on the CD shipped with CALLISTO instruments and also are available here: <http://www.e-callisto.org/Software/Callisto-Software.html>



I.5 Callisto Application Program

Callisto (screenshot left) controls the basic operation of the CALLISTO Receiver and makes use of three configuration files listed below. All configuration files are ASCII text files (.cfg) and may be changed with any text editor

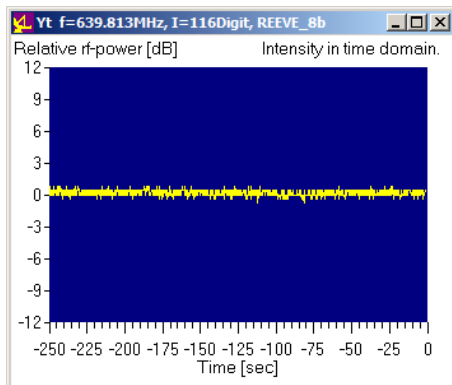
- ⚙ Receiver configuration: Specifies observatory identification details, receiver configuration details, data files locations, and COM port for communication with a PC

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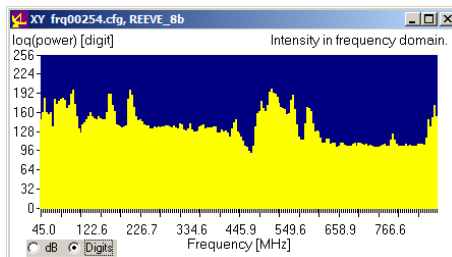
- ☀ **Scheduler:** The scheduler specifies the start and stop times for receiver observations and other actions that are needed throughout the observation period
- ☀ **Operating frequency and integration control:** The operating frequency and integration control file specifies the detailed frequency plan for the CALLISTO receiver (see specifications for frequency range, resolution and sweep rates). It also specifies the dwell frequencies and associated integration parameters

Callisto produces several output files. The most important are the data files, which use the Flexible Image Transport System (FITS) file format. The FITS files typically are produced at 15 minute intervals throughout the specified observation period but the interval may be changed in the Callisto configuration file.

Other data and information files produced by Callisto are lightcurve data files, spectral overview files and operating logs. Lightcurve files provide a chronological log of the receiver output, in which pre-selected frequencies have been integrated in time over the detected bandwidth.

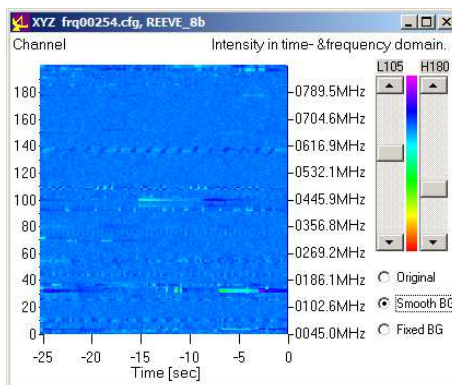


The spectral overview (OVS) files provide a tabular snapshot of the received spectrum at one or more times each day as determined by the Scheduler configuration file. The OVS file is used by the Frequency Genie tool (described later) to set the actual observation frequencies used in each frequency sweep. The OVS also may be used to manually customize the frequency sweep files. In addition to scheduled production of OVS files, Callisto allows an OVS file to be produced on demand.



Callisto has buttons on the lower-right side of the user interface for real-time viewing of (see screenshots left)

- ☀ Lightcurve for a selected frequency [y(t)]
- ☀ Amplitude versus frequency for the entire spectrum sweep [y(f)]
- ☀ Spectrograph showing the amplitude, frequency and time [y(f,t)]

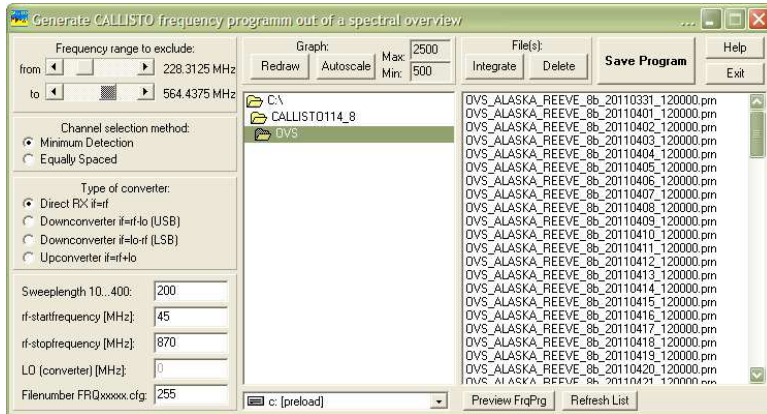


The functionality of the CALLISTO Receiver (for example, frequencies, sweep rate, gain setting and measurements, among others) is controlled by ASCII text commands generated within Callisto and sent to the receiver through the EIA-232 interface. The complete command list is given in Appendix A.

I.6 Software Tools

The CD includes several software tools that are used with the CALLISTO Receiver. These are listed below and along with other tools are described in greater detail in section V.

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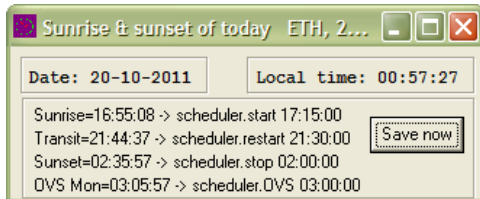


- ☀ Frequency Genie
- ☀ Scheduler Genie
- ☀ WWW Genie
- ☀ Java FITS Viewer
- ☀ FTP-WatchDog
- ☀ SymmTime
- ☀ M9703A Plotter

1.6.1 Frequency Genie Software Tool

Callisto uses a frequency file to sweep the receiver across the desired observation spectrum. This file can be setup to avoid interfering frequencies and to concentrate on one or more frequency bands. The frequency file typically has 200 channels and is somewhat tedious to

setup manually. The Frequency Genie tool reduces the tedium by using the spectral overview (OVS) files to find frequencies that have low background noise level. It also allows the user to ignore particular frequency bands.

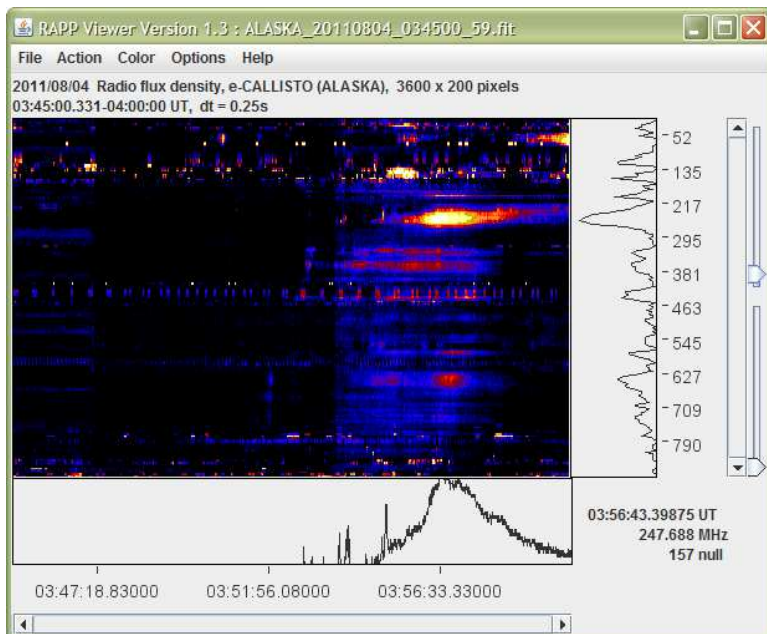


1.6.2 Scheduler Genie Software Tool



The Scheduler Genie tool determines sunrise and sunset times for a specified location. It then produces a Scheduler configuration file for the Callisto application program that schedules observations during daylight hours.

1.6.3 WWW Genie Software Tool



The WWW Genie produces lightcurve images that are suitable for viewing on the worldwide web. WWW Genie uses the lightcurve file produced by Callisto to produce a chart image showing the receiver output over time in each UTC 24-hour period. The chart image is updated at user selectable intervals and can be sent by FTP to a website for viewing in any browser.

1.6.4 Java FITS Viewer

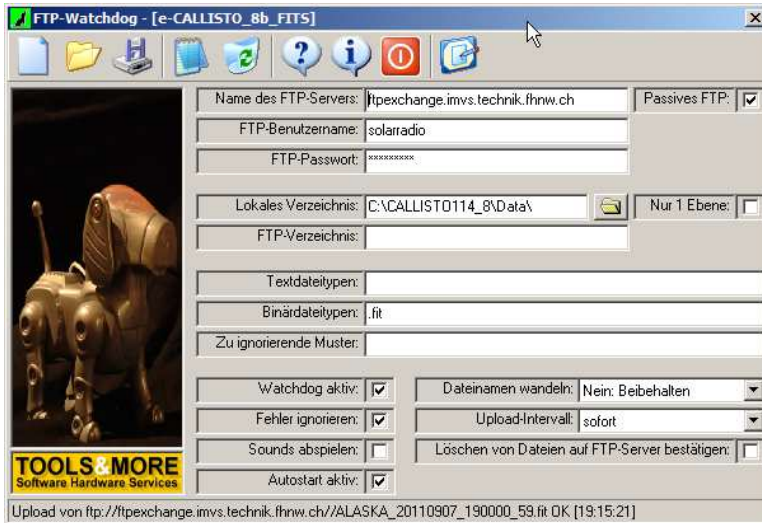
The Java FITS Viewer is used to

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view the FITS data produced by Callisto. The display is in the form of a spectrograph with frequency and time scales and colors to indicate intensity of each frequency/time pixel. It also allows zooming and customization of the displayed spectrograph.

I.6.5 FTP-WatchDog and PERL-FTP

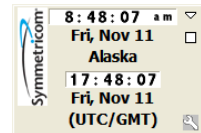
FTP-WatchDog and PERL-FTP are free programs that are used to upload files to an FTP server as they are produced. Their primary application with the Callisto software application is to provide a means to send the FITS files to the FHNW servers in Switzerland. They also can be



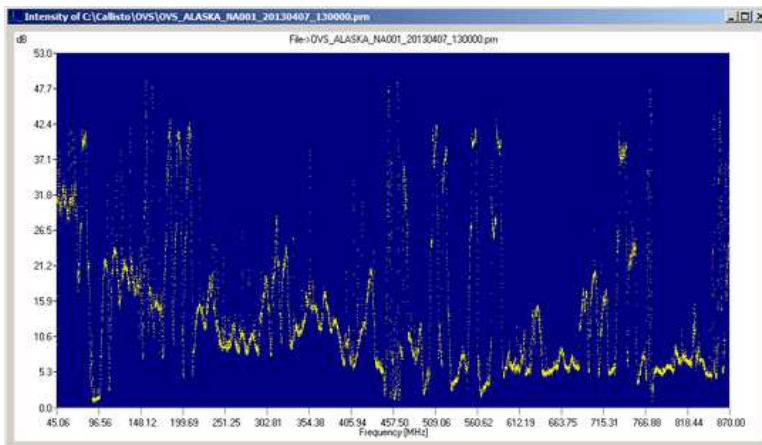
used to send lightcurve image files produced by WWW Genie to an FTP server for viewing in any web browser. Generally, either FTP-WatchDog or PERL-FTP is used in any given system.

I.6.6 SymmTime

SymmTime is a free program that is used to synchronize the Callisto PC real-time clock to Coordinated



Universal Time. It uses the Network Time Protocol (NTP) and is a reliable replacement for the Windows "Internet Time" capability built into some (but not all) versions of Windows. It is not compatible with 64-bit versions of Windows 7 or later versions. There are many free time keeping programs available for Windows 7 and later.



I.6.7 M9703APlotter

M9703APlotter provides a convenient way to view and produce images of spectral overview (OVS) files.

I.7 Known Software Incompatibilities

This paragraph provides a list of software known to cause problems with CALLISTO data collection. If any of this software is installed on the CALLISTO PC, it should be completely uninstalled.

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- ⌘ Sophos anti-virus scanner (excessive memory usage leading to PC stall and data loss). If you use Sophos, then you must Exclude *.FIT files from its anti-virus scan. Alternatively, replace Sophos with Microsoft Security Essentials (<http://windows.microsoft.com/en-US/windows/products/security-essentials>) or Avira (<http://www.avira.com/>)

I.8 Firmware

The CALLISTO Receiver uses a microprocessor for control. The microprocessor firmware and Callisto application software must be matched according to the following requirements:

1. Firmware v1.8 or higher is required in receivers with a 25.43 MHz quartz crystal resonator, Q1. All North American receivers with serial number NA0008 and higher have a 25.43 MHz crystal and have firmware v1.8 or higher.
 2. North American receiver serial number NA0007 and lower use a 27 MHz crystal and were shipped with firmware v1.7. These receivers may be upgraded by replacing the existing 27 MHz crystal with a 25.43 MHz crystal and loading v1.8 firmware (or later) on the microprocessor.
 3. If the receiver is equipped with a 25.43 MHz crystal, then Callisto software v116 or higher is required.
 4. Callisto v116 and higher automatically detects the firmware version. Callisto v116 or higher is backward compatible with all previous firmware versions including v1.7 and v1.8 and will work with either 27 or 25.43 MHz crystals.
-

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II. CALLISTO Setup Checklist

! PRINT THIS PAGE ! Use it to check your PC environment !	
Download, installation & settings	Check
Create System Restore point	
Set desktop to 'windows classic' and Display Properties – Appearance tab – Font size: Normal	
Set Microsoft indexing to OFF	
Disable Error Reporting in System Properties – Advanced tab – Error Reporting	
Set hard drive and peripherals to ON all the time, no sleep modes, no hibernation	
Allow Remote Desktop if fixed IP, else install TeamViewer, remember password and IP address	
Set PC clock to UTC, no daylight saving time	
Set time-date to automatically synchronize with an internet-time-server (see Software Tools)	
Disable automatic reboot after windows updates	
In My Computer – Tools – Folder Options – View – untick Hide extensions for known file types and click radio button Show hidden files and folders	
<u>Option 0:</u> Download & install AVIRA Antivirus or a similar, even better product If virus-scanner installed: set MS defender to OFF	
Install Firefox from web, set homepage to www.e-callisto.org	
Install Adobe Acrobat Reader or any other PDF reader from web	
Install Java run-time environment from: http://www.java.com/de/download/	
Download and install latest USB-Serial Adapter drivers	
Download Java Viewer from 1)	
Download Callisto software from 1) & edit callisto.cfg, scheduler.cfg	
Create Callisto shortcut on desktop and rename it to an appropriate name	
If Callisto does not work (task manager zombie), set compatibility mode to Win XP or 98 or 95 (try out)	
Kill possible zombies of <i>callisto.exe</i> with task manager (<i>taskmgr.exe</i>)	
Download FGeni software from 1) & edit *.cfg + create shortcut	
Download autoscheduler from 1) & edit *.cfg + create shortcut	
Download FTP-Watchdog from 2) & edit configuration & save configuration	
Configure Windows firewall to accept FTP-watchdog and Remote Desktop	
<u>Option 1:</u> Download PERL from: http://activeperl.softonic.de/	
<u>Option 1:</u> Download perl-script mover.pl and mover.bat from 1) and edit	
<u>Option 1:</u> Activate Windows scheduler to start mover.bat once a day	
<u>Option 2:</u> Download wwwgeni from 1) and edit wwwpar.cfg	
<u>Option 3:</u> (for scientists): install IDL and SSW (especially ETH radio spectrometer libraries)	
TweakUI for Autologin or delete password	
Optional: download & install WinScp from web	
Optional: download & install Putty from web	
Optional: download & install MS-Office (EXCEL) or Open Office from CD or web	
Optional: download & install IDL + SSW	
Save spectral overviews with reference (50 ohm termination) and with antenna	
Plot both spectral overviews separate and in dB (external noise)	
Create a frequency program with FGeni and save it under Callisto	
Configure and load new frequency program into Callisto	

1) <http://www.e-callisto.org/>

2) <http://toolsandmore.de/Central/Produkte/Software/Internet/Webmaster/FTP-Watchdog/>

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III. Callisto Application Software – Quick Start

A. Introduction

In the following paragraphs, you will quickly setup your PC to use the Callisto application software program. Callisto is provided with your system on the CD in the Software folder.

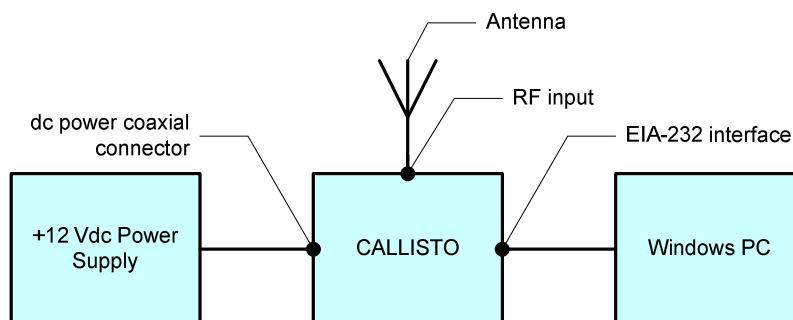
This quick start setup will allow you to run and become familiar with the CALLISTO Receiver and to record data, although the setup will not be optimized and the data may not be useful. Later sections will describe how to optimize your particular installation and obtain useful data.

B. Preparation

- B.1 Log-in with full Administrator privileges for all configurations. After configurations are completed, privileges can be reduced to Normal user
- B.2 Create a System Restore point and backup your computer
- B.3 If you are using a USB-Serial Adapter, download and install the latest driver for your operating system and adapter before going any further. This is especially important with Windows 7. DO NOT skip this step. Note: It has been found that some USB-Serial Adapters built prior to deployment of Windows 7 do not work reliably even though the manufacturer has Windows 7 drivers available. If your serial connection is unreliable, try another, more modern adapter. For additional information on USB port management, see this article:
http://www.reeve.com/Documents/Articles%20Papers/USBPortManagement_Reeve.pdf

C. Setup Receiver

Connect the CALLISTO Receiver to a power source, antenna and the serial port on your PC (through the USB-serial adapter if necessary). For testing purposes, you do not need an outdoor antenna but ultimately you will require an outdoor antenna suitable for the frequency range you wish to cover. After making all connections, turn on the CALLISTO Receiver power switch.



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D. Setup Folders for Callisto Application Software

- D.1 Make a new folder on your PC for the CALLISTO application program (for example, c:\Callisto\Software\). Note: If using Windows 7, DO NOT install or run Callisto software from the Users folder (c:\Users\) or any of its subfolders.
- D.2 Navigate to the Software folder on the CALLISTO CD. Locate and open the file *Callisto_vxxx.zip*. Extract the following eight files to the new folder you just setup on your PC:

<input type="checkbox"/> callisto.cfg	<input type="checkbox"/> callisto.exe	<input type="checkbox"/> cfitsio.dll	<input type="checkbox"/> cw3230.dll
<input type="checkbox"/> eCallistoManual.pdf	<input type="checkbox"/> frq99999.cfg (note)	<input type="checkbox"/> scheduler.cfg	<input type="checkbox"/> wsc32.dll

- D.3 The Zip file includes source code files and libraries, but these are not needed for normal operation. If you are upgrading from a previous version of the CALLISTO application program, it usually is necessary only to replace the old version callisto.exe file in your software folder with the new version.
- D.4 Setup a folder for Callisto data (example, c:\Callisto\Data\). DO NOT use the My Documents folder or any folder name that includes spaces in the path names.

E. Setup the Configuration File for Callisto

In the folder to which you unzipped the Callisto software files, open the Callisto configuration file *callisto.cfg* with NotePad or a text editor. It will look something like the text in the example file below. Each parameter is explained later in more detail. However, for now only a few parameters need to be changed and these are listed immediately below. Leave all other parameters at their default values for the time being. You can write down your values below.

[rxcomport]= _____ Serial port or USB-Serial Adapter port connected to your receiver

[datapath]= _____ Use the path you setup in Sect. D

[logpath]= _____ Use the path you setup in Sect. D

[lcpath]= _____ Use the path you setup in Sect. D

[ovspath]= _____ Use the path you setup in Sect. D

After changing the callisto.cfg file, click File – Save in your text editor to save your changes.

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```
// EXAMPLE CALLISTO.CFG FILE NO. 1
//
// RCU, receiver control unit
//
[rxcomport]=COM1           // COM1 .... COM24
[observatory]=12           // CALLISTO=12, fixed
[instrument]=MY_INST      // instrument code -> filename_
[titlecomment]=MY_RO     // Title of filename_ sub-prefix
[origin]=NA               // Place or area of world of instrument (NA=North America)
[longitude]=W,100.0       // default geographical longitude in decimal degree
[latitude]=N,50.0        // default geographical latitude in decimal degree
[height]=100.0           // default altitude in meters above sea level
[clocksource]=1          // RISC-level: 0=software, 1=internal, 2=external, default 1
[filetime]=900           // time periode for one single FIT-file (in seconds)
[frqfile]=frq99999.cfg   // default frequency file
[focuscode]=59          // default focuscode
[mmode]=3                // default continuous recording 2=calibrated, 3=raw data
[fitsenable]=1           // 0=no FITSfile, 1=FITS write On
[datapath]=c:\Callisto\Data\ // default datafile path
[logpath]=c:\Callisto\Data\ // default logfile path
[lcpath]=c:\Callisto\Data\ // default light curve path (LC*.txt)
[ovspath]=c:\Callisto\Data\ // default spectral overview path (OVS*.prn)
[chargepump]=1           // charge pump: 0=false=off, 1=true=on, default 1
[agclevel]=120           // PWM level for tuner AGC 50...255, default 120
[detector_sens]=25.4     // detector sensitivity mV/dB, default 25.4
[db_scale]=5             // dB per division in XY-plot, default 5
[autostart]=0            // autostart: 0=false, 1=true

// Modified by: W.D. Reeve, 12 Nov 2011 for Software Setup Guide

// Created by: Chr. Monstein 05.05.2003
// Updated by: Chr. Monstein 20.10.2006 e-Callisto
// Updated by: Chr. Monstein 20.11.2010 new autostart and new path (LC, OVS)

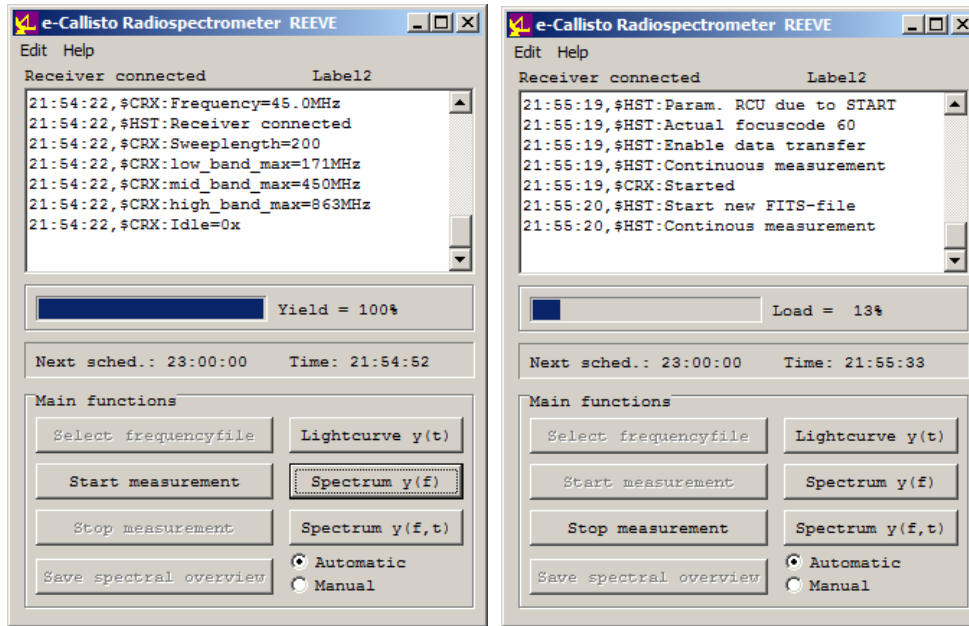
/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8092 Zuerich Switzerland */
/*-----*/
/* Programname: callisto.cfg */
/* */
/* Revision: V1.5      Date: 05.05.2003      Autor: Chr. Monstein */
/* */
/* Purpose: Configuration file Radiospectrometer CALLISTO */
/* */
/* Editor: Notepad or any other ASCII-Editor */
/*-----*/
```

F. Run Callisto

In the directory to which you unzipped the Callisto files, double-click the file *callisto.exe*. The program should open as shown below-left. The Yield bar will fill as the initial Frequency file is read into memory. If an error window pops up you probably used illegal characters in the Callisto Configuration file or did not setup the proper folders on your PC. Go back to section E and check your settings.

Look just above the status window to the left. You should see *Receiver Connected* and in the window itself there will be status information and time-stamps. At this point, Callisto is communicating properly with the receiver. Press the Start Measurement button. You should see some activity in the status window like that shown below-right. The Yield bar changes to a Load bar, and the value indicated there will vary.

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Congratulations! Your CALLISTO Receiver is now recording data. Look in the folder you setup for the data (example, c:\Callisto\Data\). After a few minutes you should see several files. The filenames will include a timestamp and other information. You will be able to customize your Callisto configuration and, thus, the data filenames in the section IV.

Meanwhile, become familiar with the buttons on the Callisto user interface – Lightcurve $y(t)$, Spectrum $y(f)$ and Spectrum $y(f,t)$ – and select Automatic and Manual modes. You will notice that some of the buttons in the Main Functions area are grayed out in Automatic mode but visible and usable in Manual mode.

You also can select the Edit menu at the top-left to open and edit the Configuration and Scheduler files. These files will be explained in great detail in section IV and for now you should not attempt to change them.

Now that your CALLISTO Receiver and associated software is running, you can customize it for your particular environment in section IV.

G. If You Have Problems

If you experience a problem running *callisto.exe*, in which it seems to start but the window does not open, do this: Open Windows Task Manager (Cntrl-Shft-Esc) and select the Processes tab. If one or more instances of *callisto.exe* are in the Processes list, right-click each one and select End Process from the menu. Restart *callisto.exe*.

If you still have problems, try running *callisto.exe* in Compatibility Mode. Go to the directory where the file is located, right-click *callisto.exe* and select Properties from the menu. Select the Compatibility tab and check the box *Run this program in compatibility mode for:* and then select

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one of the modes in the drop-down menu. Start with Windows 95 but, if necessary, also try Windows 98 and Windows 2000.

If you restarted your PC with CALLISTO Receiver connected to its serial port, cycle the CALLISTO power switch.

If you still have problems, it is possible the *callisto.exe* file is corrupted. Go to <http://www.e-callisto.org/Software/Callisto-Software.html>. Download the latest version and extract the files to overwrite the files in the folder you setup for the CALLISTO application programs. You should overwrite all files except *callisto.cfg*. If you overwrite *callisto.cfg*, you will have to edit it again with the settings for your environment.

The Callisto software application produces log files and places them in the folder specified in the [logpath] parameter of the Configuration File. The log file provides a chronological list of activities undertaken by the software and may be used as a troubleshooting aid. The log file may be opened in any text editor (for example, Notepad). An example log file is described in Appendix G.

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IV. Detailed Configuration for Your Environment

A. Introduction

In the previous section you setup a very basic configuration to run and become familiar with Callisto. In this section you will customize the configuration for your particular environment. Be sure to read the additional tips and notes in section VI. Be sure you are logged into Windows with full Administrator privileges for all configurations.

Before attempting to collect data, it is necessary to modify three ASCII text files for your environment: *callisto.cfg*, *frqxxxx.cfg* and *scheduler.cfg*. If you attempt to move forward without modifying these files, your efforts will surely fail. Therefore, read through this entire section before hitting the panic button.

B. Customize Your Callisto Data Folders

In the Quick Start section, you setup one folder for all files produced by Callisto. There are four data file types produced by Callisto – FITS data, logs, lightcurves and spectral overviews. Over time the number of files can get quite large. Data management is much easier and it is recommended to use a separate folder for each file type. Therefore, make new folders for each file type:

- ☀ Data (example, c:\Callisto\Data\)
- ☀ Logs (example, c:\Callisto\Logs\)
- ☀ Lightcurves (example, c:\Callisto\LC\)
- ☀ Spectral overviews (example, c:\Callisto\OVS\)

C. Customize the Configuration File for Callisto

C.1 Basic Setup

Re-open the Callisto configuration file *callisto.cfg* with NotePad or a text editor. There are 23 configuration parameters, and each one is explained in detail in par. C.2. However, for basic operation only a few more parameters need to be changed and these are listed immediately below. It is very important that you change the default values in *callisto.cfg* to reflect your specific environment. Leave all other parameters not listed immediately below at their default values for the time being. Use only alpha-numeric values with NO spaces in the parameter values. You can write down your values below.

```
[rxcomport]= _____ This parameter already should be setup
[instrument]= _____ Do not use default value
[titlecomment]= _____ Do not use default value
[origin]= _____ Do not use default value
[longitude]= _____ Do not use default value
[latitude]= _____ Do not use default value
```

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[height]= _____ Change as explained below, do not use default value

[datapath]= _____ Use the path you setup in Sect. B

[logpath]= _____ Use the path you setup in Sect. B

[lcpath]= _____ Use the path you setup in Sect. B

[ovspath]= _____ Use the path you setup in Sect. B

After changing *callisto.cfg* file to suit your environment, click File - Save in your text editor to save your changes. The Callisto configuration file also can be changed “on-the-fly” while Callisto is running. Callisto checks for a new file every 5 seconds and then updates its operation. However, see **Caution** note in the [agclevel] parameter in par. C.2 below.

```
// EXAMPLE CALLISTO.CFG FILE NO. 2
//
// RCU, receiver control unit
//
[rxcomport]=COM1           // COM1 .... COM24
[observatory]=12           // CALLISTO=12, fixed
[instrument]=MY_INST       // instrument code -> filename_
[titlecomment]=MY_RO      // Title of filename_ sub-prefix
[origin]=NA                // Place or area of world of instrument (NA=North America)
[longitude]=W,100.0        // default geographical longitude in decimal degree
[latitude]=N,50.0          // default geographical latitude in decimal degree
[height]=100.0             // default altitude in meters above sea level
[clocksource]=1           // RISC-level: 0=software, 1=internal, 2=external, default 1
[filetime]=900             // time periode for one single FIT-file (in seconds)
[frqfile]=frq99999.cfg    // default frequency file
[focuscode]=59           // default focuscode
[mmode]=3                  // default continuous recording 2=calibrated, 3=raw data
[fitsenable]=1            // 0=no FITSfile, 1=FITS write On
[datapath]=c:\Callisto\Data\ // default datafile path
[logpath]=c:\Callisto\Log\ // default logfile path
[lcpath]=c:\Callisto\LC\   // default light curve path (LC*.txt)
[ovspath]=c:\Callisto\OVS \ // default spectral overview path (OVS*.prn)
[chargepump]=1            // charge pump: 0=false=off, 1=true=on, default 1
[agclevel]=120            // PWM level for tuner AGC 50...255, default 120
[detector_sens]=25.4      // detector sensitivity mV/dB, default 25.4
[db_scale]=5              // dB per division in XY-plot, default 5
[autostart]=0             // autostart: 0=false, 1=true

// Modified by: W.D. Reeve, 12 Nov 2011 for Software Setup Guide

// Created by: Chr. Monstein 05.05.2003
// Updated by: Chr. Monstein 20.10.2006 e-Callisto
// Updated by: Chr. Monstein 20.11.2010 new autostart and new path (LC, OVS)

/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8092 Zuerich Switzerland */
/*-----*/
/* Programname: callisto.cfg */
/* */
/* Revision: V1.5      Date: 05.05.2003      Autor: Chr. Monstein */
/* */
/* Purpose: Configuration file Radiospectrometer CALLISTO */
/* */
/* Editor: Notepad or any other ASCII-Editor */
/*-----*/
```

C.2 Configuration File (callisto.cfg) Parameter Definitions

- (a) [rxcomport] – Specifies the serial port on your PC that is to be used for communication between Callisto and the CALLISTO Receiver. For example, if you use a USB-serial

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adapter on COM Port 2, then edit the line as follows: [rxcomport]=COM2 Maximum port number is limited to COM18 in version 118 and earlier and COM24 in version 119 and later. Most USB-Serial adapter drivers allow you set the port within this range

- (b) [observatory] – Specifies the type of observation. The default value is 12, which indicates a Fixed CALLISTO Receiver. It should be left unchanged unless a different value is specified by Christian Monstein at ETH Zurich
- (c) [instrument] – Specifies the prefix used in the FITS data filenames. For example, if the value is MY_INST (default value) then the FITS files will be named MY_INST_yyyymmdd_hhmmss.fit. Use a string that makes it easy to identify your data. The value could be the serial number of your receiver or abbreviation for your observatory name or location
- (d) [titlecomment] – Specifies a sub-prefix used with the [instrument] parameter for the lightcurve, spectral overview and log files. For example, if the [titlecomment]=MY_RO (default value) and [instrument]=MY_INST then the files will be named
 - ☀ LCyyyymmdd_ADU_MY_RO.txt (lightcurve files)
 - ☀ OVS_MY_INST_MY_RO_yyyymmdd_hhmmss.prn (spectral overview files)
 - ☀ LOG_MY_INST_MY_RO_yyyymmdd_hhmmss.txt (log files)
- (e) [origin] – Specifies the location of the CALLISTO Receiver. The value is embedded in the data files and used to further identify the instrument location. Use ASCII-characters only, no special characters. For example, if the value is NA it indicates the area where data were produced (in this case, North America).
- (f) [longitude] – Specifies the longitude of the CALLISTO Receiver location in decimal degrees. Includes an E/W flag. For example, if the longitude is 100.0 deg. west of the Greenwich meridian, the value would be W,100.0. If the longitude is 149.996505 deg. east of the Greenwich meridian, the value would be E,149.996505
- (g) [latitude] – Specifies the latitude of the CALLISTO Receiver location in decimal degrees. Includes an N/S flag. For example, if the latitude is 50.0 deg. north of the equator, the value would be N,50.0. If the latitude is 61.199301 deg. south of the equator, the value would be S,61.199301
- (h) [height] – Specifies the elevation of the CALLISTO Receiver antenna in meters above mean sea level (AMSL). For example, if the antenna is 100.0 m AMSL, the value would be 100.0
- (i) [clocksource] – Specifies the CALLISTO Receiver clock source. Normally, the internal oscillator will be used, in which case the value is 1. If an external 10 MHz TTL clock is used, the value would be 2. The value 0 is reserved for future

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- (j) [filetime] – Specifies the time period for one FITS file in seconds. Typically, this is 900 seconds (15 minutes). Any change to this value should be coordinated with Christian Monstein at ETH Zurich
- (k) [frqfile] – Specifies the initial frequency file used by Callisto for the frequency sweeps and integration. This file must be located in the same folder as *callisto.exe* and is described in more detail in section D. In the example file shown above, the initial file is *frq99999.cfg*. The parameter value is of the form *frqxxxxx.cfg*, where *xxxxx* is a numeric string from 00000 to 99999
- (l) [focuscode] – Specifies the type of focal plane unit control used with the CALLISTO Receiver, if any. This value appears in data filenames and the logic values also set the corresponding pins on the FPU connector. For basic CALLISTO applications, no FPU is used and the value normally is 59. However, other values can be used if coordinated with Christian Monstein at ETH Zurich. Allowed values are 00 ... 63. See Appendix E for a complete list of allowable focal plane unit focus codes
- (m) [mmode] – Specifies the data recording characteristic, or measurement mode. In basic CALLISTO applications, the value is 3 (default value) but in more advanced applications, where the receiver is calibrated, the value is 1. See Appendix B for a complete list of allowable codes
- (n) [fitsenable] – Specifies whether or not to enable FITS file recording. This provides an easy way to disable FITS file production during receiver setup and testing. To disable FITS recording set to 0. To enable FITS recording set to 1. Default value is 1
- (o) [datapath] – Specifies the file path for the FITS files. The full path must be specified and no spaces can be used. For example, if the FITS files are to be placed in *c:\Callisto\Data*, the value for this parameter would be *c:\Callisto\Data*. Be sure to place the backslash \ at the end of the path
- (p) [logpath] – Specifies the file path for the log files. See limitations in item (o). For example, if the log files are to be placed in *c:\Callisto\Logs*, the value for this parameter would be *c:\Callisto\Logs*. Be sure to place the backslash \ at the end of the path
- (q) [lcpath] – Specifies the file path for the lightcurve files. See limitations in item (o). For example, if the lightcurve files are to be placed in *c:\Callisto\LC*, the value for this parameter would be *c:\Callisto\LC*. Be sure to place the backslash \ at the end of the path
- (r) [ovspath] – Specifies the file path for the spectral overview files. See limitations in item (o). For example, if the OVS files are to be placed in *c:\Callisto\OVS*, the value for this parameter would be *c:\Callisto\OVS*. Be sure to place the backslash \ at the end of the path

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- (s) [chargepump] – Specifies whether the charge pump is on or off. This parameter is used for testing only and always should be set to On with a value of 1. For reference, the Off state value is 0
- (t) [agclevel] – Specifies the pulse width modulation (PWM) value for setting the receiver gain to a fixed value (in spite of its name, it is not an automatic gain control). The default value is 120 and normal operating range is around 100 to 150. You can experiment with this value later.

Caution: Changing the [agclevel] parameter value while Callisto is running has caused anomalous operation. Therefore, Callisto should be closed before editing this parameter. After the changes are saved, Callisto may be re-opened. Ordinarily, this parameter is set once and then left alone
- (u) [detector_sens] – Specifies the gradient (slope) setting in mV/dB used in calculations of the receiver output power. For the AD8307 log detector used in the CALLISTO Receiver, the nominal value is 25.4. If appropriate equipment is available a more precise value can be determined through experimental measurements
- (v) [db_scale] – Specifies the dB/division in the XY plots including the lightcurve charts and spectrum plots. The default value is 5 and for the y(f) spectrum plot results in 40 dB full scale.
- (w) [autostart] – Specifies whether or not Callisto starts in the measurement mode. For unattended operation, autostart generally would be set to On with a value of 1. Autostart can be disabled by using a value of 0.

D. Frequency Configuration File

D.1 Introduction

When you edited callisto.cfg in section C, you noticed a parameter called [frqfile] with a value of frqxxxx.cfg, where xxxx is a numeric string. This ASCII text file is a tabulation of frequencies and other parameters. A frequency file optimized for your location can be produced by the Frequency Genie tool (described in section V), or it may be setup manually (very tedious and not recommended).

It is very important that you prepare a customized frequency file for your specific location. If you use one of the frequency files supplied on the CD, your installation will not be optimum and may indicate excessive amounts of radio frequency interference.

Explore the CD provided with your CALLISTO. In the Frequency Files folder there are several files of the form frqxxxx.cfg. Four of the files provide a frequency list for four specific bands as follows:

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Filename	Frequency range	Channels	Channel spacing
frq45175.cfg	45-175 MHz	200	0.650 MHz
frq99450.cfg	175-450 MHz	200	1.375 MHz
frq99870.cfg	450-870 MHz	200	2.100 MHz
frq45870.cfg	45-870 MHz	200	4.125 MHz

These files were produced by the Frequency Genie tool (see section V) and are provided for convenience as a starting point. They may be edited for specific observation frequencies. Frequency files are usable only if they are in the same folder as callisto.exe.

Open any one of the frequency files with NotePad or a text editor to examine its contents. It will look something like the example file below. You can change the parameters and save the file under a new name (example, frq69696.cfg) but the name must be of the form frqxxxxx.cfg, where x are numeric values only. You can build as many Frequency files as desired but only one is used at a time.

```
// EXAMPLE FREQUENCY CONFIGURATION FILE FRQxxxxx.CFG NO. 1
//
[target]=CALLISTO

[on_line_testpoint_number]=146

[number_of_measurements_per_sweep]=200
[number_of_sweeps_per_second]=4

[external_lo]=0.000000

[0001]=0045.000,0
[0002]=0045.000,0
[0003]=0045.000,0
[0004]=0045.000,0
[0005]=0045.000,0
[0006]=0045.000,0
[0007]=0045.000,0
[0008]=0045.000,0
[0009]=0045.000,0
[0010]=0052.375,0
[0011]=0054.500,0
...      data not shown for brevity
...      data not shown for brevity
[0146]=0639.813,40
...      data not shown for brevity
...      data not shown for brevity
[0196]=0852.063,0
[0197]=0855.875,0
[0198]=0861.188,0
[0199]=0864.375,0
[0200]=0868.688,0

// Modified by: W.D. Reeve, 12 Nov 2011 for Software Setup Guide

/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8093 Zurich      */
/*-----*/
/* Programname: FRQ00255.cfg [minimum of a spectral overview]*/
/*-----*/
/* Revision: V2.2 Date: 6/25/2011 Autor: Chr. Monstein      */
/*-----*/
/* Purpose: Frequencyprogram for Callisto spectrometer      */
/* all entries may be edited manually using Notepad...      */
/*-----*/
```

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D.2 Frequency Configuration File (frqxxxxx.cfg) Parameter Definitions

- (a) [target] – Specifies the target instrument, in this case CALLISTO Receiver. Do not change this value
- (b) [on_line_testpoint_number] – Specifies the channel to be used by default in the lightcurve window displayed when you click the Lightcurve button on the Callisto user interface
- (c) [number_of_measurements_per_sweep] – Specifies the number of channel/frequency combinations in a single sweep. This value must equal the number of channel/frequency combinations listed in the file. This parameter is set to 200 in the example file above, and the tabulation below it has channel/frequencies 1 through 200
- (d) [number_of_sweeps_per_second] – Specifies the number of sweeps per second. In the example file above, the value of 4 indicates the receiver will be commanded to sweep from the beginning of the tabulated frequencies to the end 4 times per second. Useful values are: 1, 2, 4, 8, 10, and 20, where the product of [number_of_measurements_per_sweep] x [number_of_sweeps_per_second] must not exceed 800 channels per second. A common setup is 200 channel/frequencies and 4 sweeps per second. See Appendix C for possible rates
- (e) [external_lo] – Specifies the offset frequency in MHz. Default value is 0.000000, indicating no offset. An offset is used only when the CALLISTO Receiver is connected to an external up- or down-converter. See Appendix D for example setups for up- and down-converters.
- (f) [0001] through [xxxx] – Specifies the channel number corresponding to a frequency, as in [0001]=45.000, where 0001 is channel number 1 and 45.000 is the frequency in MHz. The channel numbers must be integers starting at 0001 with no gaps in the sequence. Maximum value is 0400.

Each channel/frequency combination is followed by a comma and an integer, for example, [0010]=0052.375,0 or [0146]=0639.813,40 as seen in the above example file. This integer indicates the number of samples to be averaged for that particular channel/frequency in the lightcurve file. A value of 0 indicates that the channel/frequency is not averaged and does not produce a light curve. A value of 40 indicates that 40 samples of the channel/frequency are averaged. For the example file above, the parameter [number_of_sweeps_per_second] is 4. Therefore, a value of 40 indicates that the lightcurve for that channel/frequency is averaged for 10 seconds (40 samples/4 samples/s).

No more than five lightcurve channels are possible. They can be set to any channel within the Frequency file. Fewer lightcurve channels may be setup if desired. For

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example, if you setup only two channel/frequency combinations for averaging, then the lightcurve image produced by WWW Genie will have only two traces, one corresponding to each of the two frequencies.

There is no upper limit on the averaging value but, as a practical matter, more than 1000 integrations would serve no useful purpose and the software has been tested only to 200. If a daily lightcurve is to be produced by the WWW Genie tool (described in section V), it is recommended that the number of integrations for each of the five frequencies be set to 40 or higher.

In the example frequency file above, you will notice that the first nine channels [0001] to [0009] are set to the same frequency, in this case 45.000 MHz. This is necessary to give the CALLISTO front-end tuner time to stabilize after a large frequency change. In the file example above the end of the sweep (channel 200) is 868.688 MHz and the beginning (channel 1) is 45.000 MHz. This is a large enough change that the tuner requires additional time to stabilize. If the frequency change is within one single receiver band (lo-, mid- or hi-band) then the number of stabilizing frequencies could be reduced or, if the frequency sweep range is less than 20 MHz, then no stabilizing channels are needed. The Frequency Genie automatically produces 8 stabilizing channels, corresponding to a dead-time of 10 ms. The number of 'dead' stabilizing channels is determined by the [nonlinchans] parameter in the Frequency Genie Configuration file params.cfg and is user adjustable (see section V).

With version 119 of callisto.exe, a change was made to how the first 8 channels in the frequency file are treated. The software changes do not affect the real-time viewers for lightcurve $y(t)$, spectrum $y(f)$, spectrum $y(f,t)$. Below is a brief description; see section V for additional details:

- ☀ If there are ≤ 8 channels in the frequency file, then all channels are stored in the FITS data files
- ☀ If there are > 8 channels in the frequency file, then the lowest 8 channels are replaced as follows and the remaining channels 9 ... N are stored in the FITS file:
 - Channels 1-6: column number modulo 255 (kind of color-table), so it's obviously no sky-signal and shall be ignored
 - Channel 7: contains PWM-value (gain control value which may change during a 900 s observation)
 - Channel 8: contains the average of channels 9...N, where N=maximum number of channels. Channel 8 may be used to observe weak radio sources, such as Milky Way and Cygnus A, in broadband mode

E. Scheduler Configuration File

E.1 Introduction

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Callisto can be setup to automatically make measurements and perform other activities at predetermined times. These times and activities are controlled by a file called *scheduler.cfg*. It must be in the same folder as *callisto.exe*. The Callisto CD includes three scheduler templates, one each for European longitudes, North American longitudes and Asian/Pacific longitudes. These are described later in this section.

Go to the folder on your PC where *callisto.exe* is located and find the file *scheduler.cfg*. Open the file with NotePad or a text editor to examine its contents. It will look something like this (your file may vary):

```
// EXAMPLE SCHEDULER.CFG FILE NO. 1
//
00:30:00,59,3 // restart
04:30:00,59,3 // restart
05:30:00,59,0 // stop
10:00:00,59,8 // spectral overview
14:30:00,59,3 // start
15:30:00,59,3 // restart
16:30:00,59,3 // restart
21:30:00,59,3 // restart
22:30:00,59,3 // restart

/* Each schedule-entry is composed of:
/* - Starttime hh:mm:ss (UT) + delimiter
/* - focuscodes decimal (00...63) to be applied + delimiter
/* - Planned measurement-mode (0, 2, 3 or 8)
/* - new local frequency-program to be loaded
/* - additional comment
/* each entry will be repeated automatically every day
/* empty lines are allowed to separate diffent tasks

// Modified by: W.D. Reeve, 12 Nov 2011 for Software Setup Guide

/* Created by: Chr. Monstein    29.10.2002  initial experiments
/* Updated by: Chr. Monstein    07.11.2002  reviewd version
/* Updated by: Chr. Monstein    03.02.2002  reviewd version
/* Updated by: Chr. Monstein    19.09.2003  some minor text changes & focuscode added
/* Updated by: Chr. Monstein    26.11.2004  integration deleted
/* Updated by: Chr. Monstein    30.12.2009  allow load frequency file

/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8092 Zuerich Switzerland */
/*-----*/
/* File: SCHEDULER.CFG      Revision: 04, 26.11.2004  Chr. Monstein */
/*-----*/
/* Time-scheduler describes what has when to be done on CALLISTO */
/*-----*/
```

E.2 Scheduler Configuration File (schedule.cfg) Parameter Descriptions

The example file above has a list of times and actions. Each line includes a time, focuscode and measurement mode in the form of hh:mm:ss,xx,y. Times (hh:mm:ss) always are in Coordinated Universal Time (UTC). Focuscodes are associated with focal plane units (FPU); for normal operation this code is the same as the focus code in the *callisto.cfg* file. The most common measurement mode values (y) are 0 (stop), 3 (start or restart) and 8 (spectral overview). Additional measurement modes are given in Appendix B.

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The times must be in chronological order with the earliest UTC time at the beginning of the list. In the file example above, the scheduler is setup to start data collection (mode 3) at 14:30:00 and stop (mode 0) at 05:30:00 UTC. However, notice that in this example, since 0530 is earlier than 1430, the stop time appears in the table before the start time.

When setting up the scheduler, you would first determine the sunrise and sunset times for your location. Depending on your latitude, these times may vary widely throughout the year and you may need to adjust them once per month or more often (there is no need to collect solar radio data at night). There are many online sources for sunrise/sunset times (for example, <http://www.timeanddate.com/worldclock/>).

Generally, you only want to collect data when the Sun is in view of your CALLISTO antenna; however, to capture over-the-horizon solar radio events, you can start data collection slightly before sunrise and continue slightly after sunset. For example, say the sunrise at your location is 1230 UTC and the sunset is 0030. You could set the start time 30 minutes before sunrise and stop time 30 minutes after sunset. Therefore, the start time would be 1200 and stop time would be 0100.

The Scheduler file can be generated automatically with the Scheduler Genie tool described in section V.

It is suggested to include actions to restart the measurements periodically throughout the day. These actions are shown in the file example above with measurement mode 3 and comment “restart”. Restarting data collection reduces the amount of lost data if the PC crashes or there is a power outage. Assuming Callisto is setup to automatically open when the PC starts and the [autostart] parameter in the Callisto configuration file is set to 1 (see section C), Callisto opens and waits for the next scheduled action. If you only have one start and stop time in your scheduler, and your PC crashes and then recovers right after the start time, Callisto will not actually collect data until the next start time (the next day) and you could lose an entire day’s data.

Another action in the file example above is mode 8 at 10:00:00. When Callisto encounters this mode, it takes a snapshot of the entire spectrum from 45 to 870 MHz with a resolution of 62.5 kHz. This is called a spectral overview, or OVS. The OVS data is placed in a file at the location specified in the Callisto configuration file (see section C). An important purpose of the OVS is to establish the background noise levels over the Callisto frequency range, so it usually is taken at night around 2 hours before sunrise when the ionosphere is quiet. The OVS file can be used for many other purposes such as choosing frequencies for the Frequency list with the least amount of radio frequency interference (RFI) and for RFI studies at different times of the day or night. The Frequency Genie tool uses the OVS file. Except for these types of studies, OVS normally are not scheduled during normal daylight observing hours.

The scheduler also can be setup to load different frequency files at different times. This allows customization of the measured spectrum based on time of day. For example, where a Sun tracking antenna encounters inband or intermodulation interference when pointed toward a

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broadcast station, one frequency file could be used when the antenna is pointed at the broadcast station and another when it is pointed in other directions.

When `callisto.exe` is opened, the scheduler loads the frequency file specified in the Callisto configuration (`callisto.cfg`); this is the initial frequency file. If `scheduler.cfg` specifies a new frequency file at a later time, the new file is loaded at that time and it is used until either

- ⚙ Another frequency file is specified later in `scheduler.cfg`, or
- ⚙ Callisto.exe is closed and then opened again

To automatically load different frequency files, `scheduler.cfg` is modified slightly to include the desired frequency files; for example:

```
01:00:00,59,3           // restart and continue using the last loaded frequency file
03:00:00,00,59,3       // restart and continue using the last loaded frequency file
15:30:00,59,3,frq00123.cfg // restart and load frq00123
16:30:00,59,3,frq00456.cfg // restart and load frq00456
21:30:00,59,3,frq00789.cfg // restart and load frq00789
22:30:00,59,3           // restart and continue using last loaded frequency file
```

In this example, frequency file `frq00123.cfg` is loaded at 1530. One hour later at 1630 file `frq00456.cfg` is loaded followed five hours later by `frq00789.cfg` at 2130. File `frq00789.cfg` is used until the scheduler encounters a command for a different file. In this example, that would occur the next day at 1530.

As previously mentioned, the Callisto CD includes scheduler templates. These are located in the Scheduler Files folder on the CD:

<code>scheduler_Europe.cfg:</code>	Start 0600, Stop 1800, OVS 2300
<code>scheduler_NorthAmerica.cfg:</code>	Start 1400, Stop 0200, OVS 0700
<code>scheduler_AsiaPacific.cfg:</code>	Start 2200, Stop 1000, OVS 1500

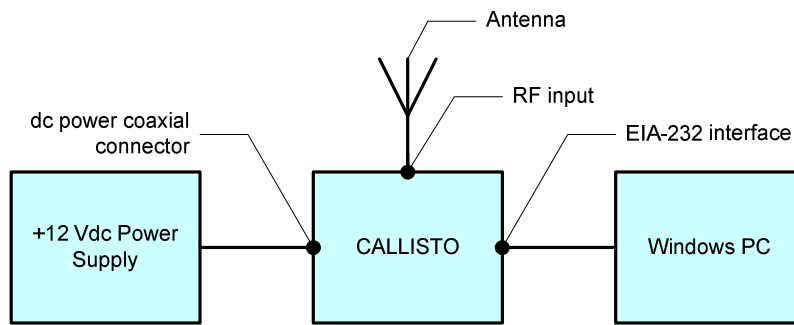
The scheduler templates provide approximate start and stop times for solar radio observing in three areas of the world as shown in their filename. Select the file that most closely matches your region. Using a text editor adjust the times for your observing schedule and, if necessary, change the focus codes for your specific setup. When done, save the changes and rename the file to `scheduler.cfg`. The `scheduler.cfg` file must be in the same folder as `callisto.exe`.

NOTE: Avoid event (start, stop, spectral overview) times at 00:00:00 ± 5 minutes. Windows PCs do a lot of housekeeping at that time and may interfere with the schedule.

F. Receiver Setup

The hardware setup is similar to that described in the Quick Start section except that you should connect the CALLISTO Receiver to an outdoor antenna suitable for your desired frequency range and pattern coverage. You also can connect a tower-mounted low noise amplifier if desired.

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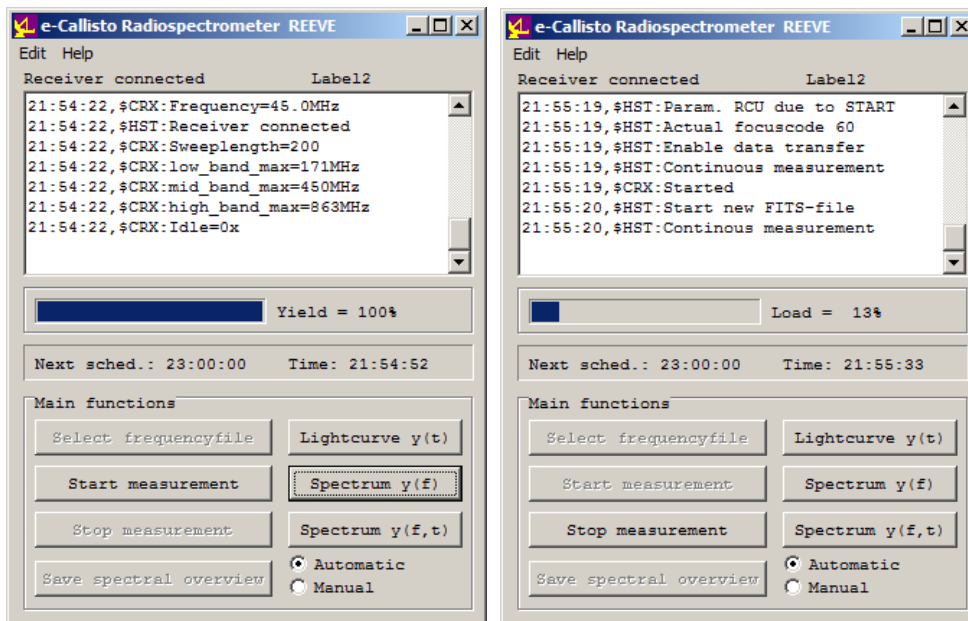


G. Run Callisto

G.1 Setup a Shortcut

In the directory to which you unzipped the Callisto files, right-click on the file *callisto.exe* and select Create Shortcut. Drag the shortcut to the desired location (for example, the Desktop).

Open Callisto from the shortcut. A window should open as shown below-left. The Yield bar will fill as the Frequency file is read into memory. If the program is running okay, you should see *Receiver Connected* just above the status window and in the window itself there will be status information and time-stamps. At this point, Callisto is communicating properly with the receiver. Press the Start Measurement button. You should see some activity in the status window like that shown below-right. The Yield bar changes to a Load bar, and the value indicated there will vary. If Callisto is in Automatic mode, the middle of the window will show the next scheduled activity (determined by the Scheduler file) and the current time. Callisto operating modes are described in more detail later.



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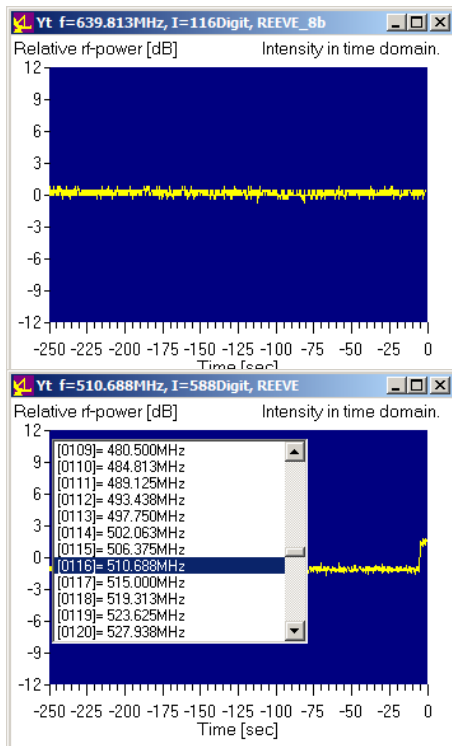
If an error window (or series of windows) pops up you probably used illegal characters in your configuration files or did not setup the file paths correctly. For example, you may see an error window indicating an access violation (in German text).

* Carefully check `callisto.cfg` and make sure the file paths are correct. The full paths must be specified, cannot have spaces and must end with `\`.

* If necessary change the paths in `callisto.cfg` or your PC configuration so both are consistent.

* Double-check for typing errors in your name for folders and files.

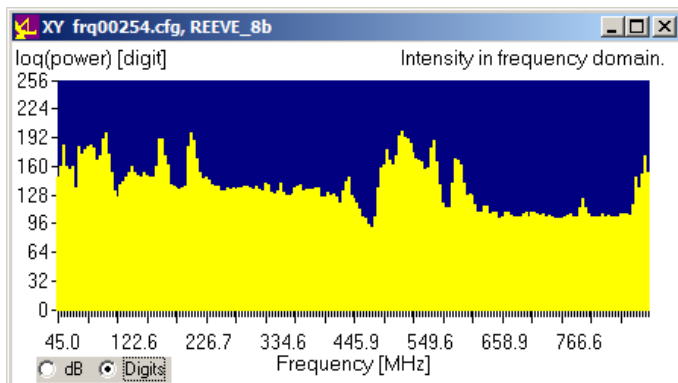
* Go back to section C and check your settings.



G.2 Real-Time Charts

Press the Lightcurve button on Callisto and the lightcurve window should pop up (left). The instantaneous output of the receiver is displayed as a yellow line that slowly scrolls from right-to-left. The lightcurve amplitude scales automatically. The default lightcurve displayed is for the channel/frequency specified in the `[on_line_testpoint_number]` parameter in the `frqxxxxx.cfg` file described previously.

Click anywhere in the window and a channel/frequency list should appear. This list corresponds to the list of channels and frequencies in the `frqxxxxx.cfg` file. You can select any channel/frequency from this list and the lightcurve displayed will correspond to that channel. The window can be resized by placing the mouse on the borders, left-clicking and dragging. Press the Lightcurve button on Callisto again and the lightcurve window should disappear.



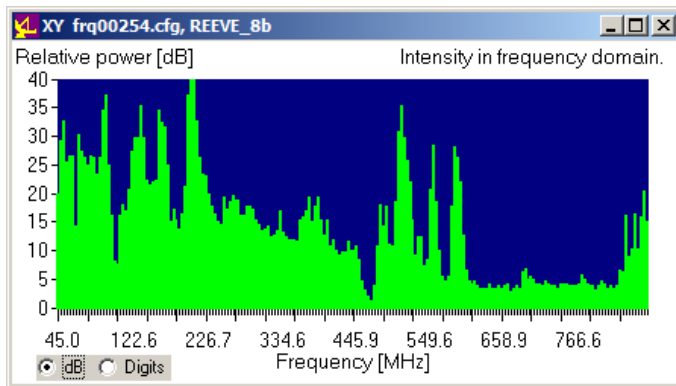
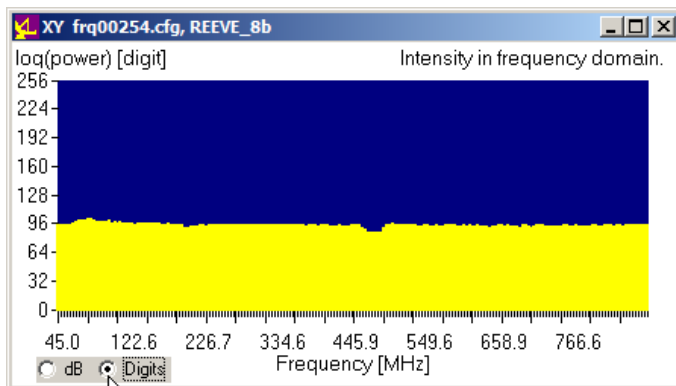
Press the Spectrum $y(f)$ button. A window should pop up that shows amplitude versus frequency. The default spectrum is displayed in terms of the digital output from the analog-digital converter (ADC) in the receiver. It is proportional to the logarithm of the IF power.

In the lower-left corner of the Spectrum $y(f)$ window are two radio buttons. The

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default setting is Digits as previously explained. The other button can be used in a pseudo-calibration of real-time spectrum display as follows:

- ☀ Click on the Digits radio button if it is not already selected
- ☀ Connect a 50 ohm termination to the RF Input jack of the CALLISTO Receiver or an external preamplifier associated with the receiver
- ☀ Measure for about 5 seconds.
- ☀ Click on the dB radio button to normalize the display (this subtracts the receiver noise level from subsequent spectra display)
- ☀ Replace the 50 ohm termination with the antenna.
- ☀ Now all spectra larger than the resistor noise are shown in dB above that noise



The two spectrum images (left) show this procedure. The first image shows the spectrum with the 50 ohm termination attached to the RF Input. This spectrum represents the receiver noise. The next image shows the display after clicking the dB radio button and reconnecting the antenna. (It is obvious the receiver in this example operates in a heavily polluted RF environment.) The spectrum trace color changes to green to indicate that it is a relative measurement.

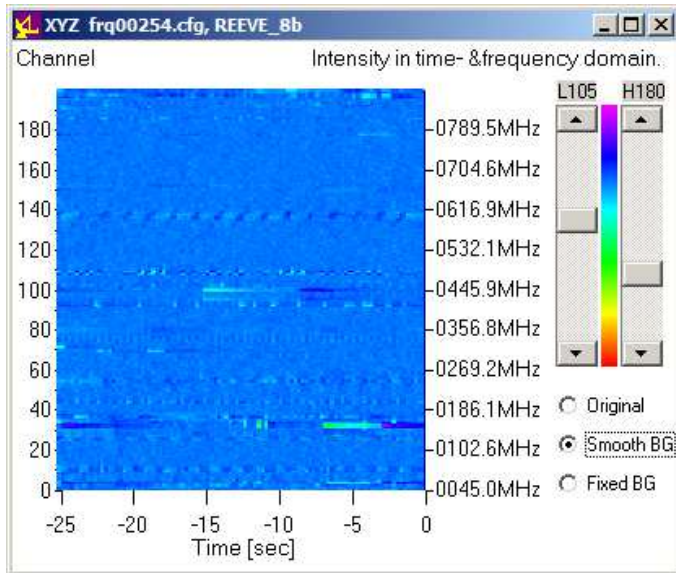
Note: The Spectrum $y(f)$ views shown here were taken with an 8-bit CALLISTO Receiver. Consequently, the vertical (amplitude) scale in Digits view has a maximum value of 256. All North American CALLISTO Receivers use a 10-bit ADC and the Digits vertical scale has a maximum value of 1024.

The Spectrum $y(f)$ view also can be used in a simple, low-resolution method to measure the receiver frequency response and minimum discernible signal (MDS). See Appendix D in the CALLISTO Construction Manual.

Now press the Spectrum $y(f,t)$ button on the Callisto Main window. This is a familiar spectrograph that shows frequency on the vertical scale and time on the horizontal scale (below-left). The colors correspond to the intensity of each frequency/time pixel. Slider bars are provided to adjust the color scheme.

Experiment with the slider bars. The two bars use a table with linear interpolation between a Low-value (left Slider 0 to 255) and High-value (right Slider 0 to 255). You can always return the Sliders to their default positions at the top of the slide or click the Original radio button in the

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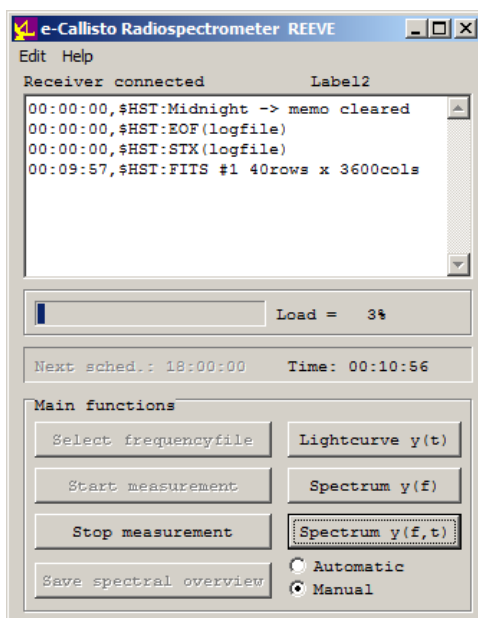


lower-right corner. The other radio buttons, Smooth BG and Fixed BG, subtract a smoothed or fixed background from the spectrum. One way to use the Fixed BG radio button is to run the instrument with its RF input connected to a 50 ohm termination until the Spectrum $y(f,t)$ screen fills with a constant color, then click the Fixed BG button. Now, reconnect the instrument RF input to the antenna. If desired, the Low and High sliders may be fine-tuned.

The difference between the Spectrum $y(f)$ and Spectrum $y(f, t)$ displays is that Spectrum $y(f)$ looks like a conventional spectrum analyzer and shows a real-time indication of the intensity of the spectrum at each frequency. Spectrum $y(f, t)$ adds a time parameter so that the display has some memory and you can see the spectrum changes over time.

Caution: Displaying the real-time Lightcurve, Spectrum $y(f)$ and Spectrum $y(f, t)$ requires considerable CPU resources. This normally is not a problem with modern PCs, especially if they are running only Callisto and no other applications, but older PCs and PCs running other applications may become overloaded.

Note: Previous to callisto software version 119, the Spectrum $y(f)$ and Spectrum $y(f, t)$ windows always show the default frequency file on the top window bar even though you may have manually loaded a different file. With version 119 and later, the top window bar shows the frequency file currently loaded, which may be different than the default.



G.3 Callisto Operating Modes

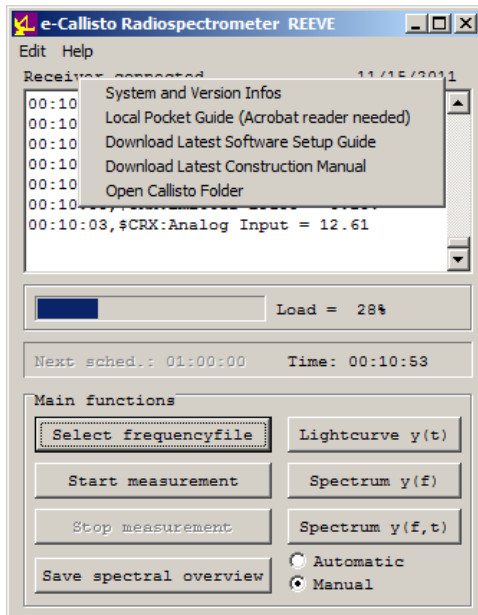
Callisto can be changed to Manual mode by selecting the radio button on the bottom-right of the main window (left). You must be in Manual mode and measurements stopped to load a Frequency file different than the default file specified in the Callisto Configuration file. You also can produce a Spectral Overview (OVS) file in Manual mode. When Callisto is in Manual mode, it does not follow the Scheduler configuration file.

If you press the Stop measurement button, Callisto will not collect any data. If you press the Start measurement button while in Manual mode, Callisto will collect data indefinitely or until Callisto is closed or the Stop measurement button is pressed.

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For most installations, Callisto will be setup to start in Automatic mode ([autostart]=1). In this case, Callisto will load the Frequency and Scheduler files and then collect data at the specified times. If Callisto is started in Automatic mode but then changed to Manual mode by the user, the schedule will not be followed and the “Next sched.” time details in the middle of the Callisto window will be grayed out. If Callisto was making measurements at the time, it will continue making measurements unless the user presses the Stop measurement button. If Callisto was not making measurements at the time, it will continue that way unless the user presses the Start measurement button.

The mode can be changed back to Automatic by selecting the Automatic radio button. At that time, Callisto will start following the specified schedule. Depending on how the Scheduler file is setup (see section E), Callisto may or may not be directed to make measurements during what remains of the current 24-hour period.



G.4 Callisto Help



On the Callisto main window, click the Help menu and select System and Version infos (left). A new window will open that shows the most important Callisto parameters. Another selection is Local Pocket Guide, which opens the eCallistoManual.pdf file in the home folder of the Callisto program. Testing has shown that this works only if the PC has Acrobat Reader and it is associated with file type PDF. Two additional selections on the Help menu allow the user to download the latest hardware and software manuals. Of course, internet access is required. If your default browser is Internet Explorer, clicking on these selections will open Internet Explorer and the download will proceed. If your default browser is FireFox, you will need to open it before using

these selections. The final selection is Open Callisto Folder. Clicking this selection simply opens an Explorer window for Callisto’s home folder.

G.5 Logs Closeout

At the end of each UTC day (2400 UTC, midnight), Callisto does some house-keeping and closes out the daily logs. This is done automatically and is indicated in the status window as “memo cleared”. If Callisto is making measurements, it continues doing so.

G.6 Closing Callisto

To close Callisto, first click on the Stop measurement button (if measurements are running), and then click the  in the upper-right corner. You also may close the program by simply clicking on the , at which time Callisto automatically stops measurements and closes.

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G.7 If You Have Problems

Refer to section III.

H. Automatically Load Callisto Software

To automatically open Callisto when the PC starts, place a shortcut to *callisto.exe* in the Windows Startup folder and set the [autostart] parameter in the Callisto Configuration file to 1.

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V. Callisto Software Tools

A. Introduction

The Callisto software tools were briefly described in section I. This section provides detailed setup and application information for Frequency Genie, Scheduler Genie, WWW Genie, FITS Viewer, PERL-FTP and FTP-WatchDog, SymmTime and M9703APlotter.

B. Frequency Genie Software Tool

B.1 Introduction

The Frequency Genie tool is used to produce the Frequency file. It uses the spectral overview (OVS) files generated by Callisto and produces a customized frequency file that has been optimized for your location. Frequency Genie looks in the OVS file for frequencies that produce the least receiver output, indicating low interference or noise level. Up to ten OVS files can be averaged. It is very important that you use an optimized frequency file; otherwise, your data files and spectrograms may indicate excessive amounts of radio frequency interference.

An OVS file can be produced any time when not observing by pressing the Save spectral overview button on the Callisto window. An OVS file also can be produced automatically by setting the measurement mode in the scheduler file to 8 (see par. C in this section). It is recommended that the scheduler be set up to regularly produce OVS files because RFI is a dynamic process that changes with time.

This section describes using Frequency Genie for Callisto without a heterodyne converter. See Appendix D for converter applications.

B.2 Frequency Genie Configuration File

Go to the Software folder on the CD and find the file *fgeni.zip*. Open and extract the files to a folder on your PC (example, c:\Callisto\Software\FGeni\). With NotePad or any ASCII text editor, open the file *param.cfg* (example below) to change the parameters for your environment. See the parameter definitions in the next paragraph and make changes to your file accordingly.

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```
// EXAMPLE FREQUENCY GENERATOR PARAM.CFG FILE NO. 1

/*Paths*/

[ovspath]=C:\CALLISTO\OVS\           // DO NOT use spaces in the path !
[outputpath]=C:\CALLISTO\FGENI\OUT\ //Default output directory for frequency file

/*Default Values*/

[nonlinchans]=8                       //non linear start of frequency file, default = 8 channels
[sweeplength]=200
[startfreq]=45.0
[stopfreq]=870.0
[localosc]=0.0
[filenumber]=255

// Modified by: W.D. Reeve for Software Setup Guide, 12 Nov 2011
```

B.3 Frequency Genie Configuration File (param.cfg) Parameter Definitions

The *param.cfg* parameter definitions are as follows:

[ovspath] – Specifies the default file path name of the spectral overview files (OVS). The path can be the same as the parameter [ovspath] in callisto.cfg or another location where you store the needed files. Be sure to include the backslash \ at the end of the path name. Be sure to make this directory before running Frequency Genie

[outputpath] – Specifies the file path name of the location where Frequency Genie places the Frequency File that it produces. Example, c:\Callisto\Software\FGeni\Out\. Be sure to include the backslash \ at the end of the path name. Be sure to make this directory before running Frequency Genie

[nonlinchans] – Specifies the number of duplicated frequencies at the beginning of the Frequency File to allow stabilization of the receiver front-end tuner during large frequency changes. The default value is 8. The purpose of this duplication is fully explained in section IV.D

[sweeplength] – Specifies the default number of channels, or sweep length. The sweep length can be changed in the Frequency Genie user interface. The default value is 200. Displays as **Sweeplength** in Frequency Genie user interface

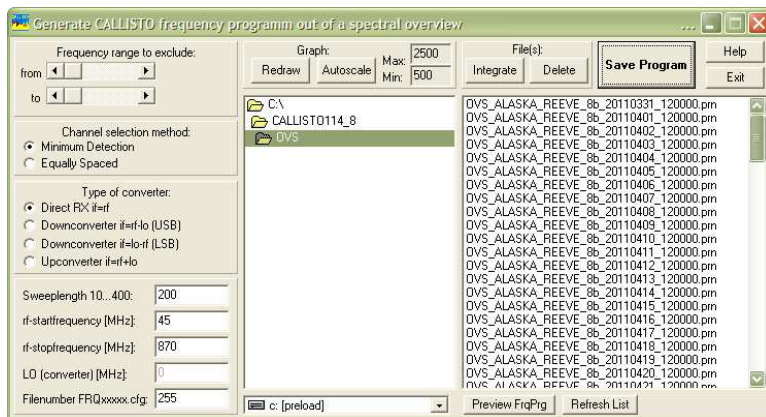
[startfreq] – Specifies the default start frequency in MHz. The start frequency can be changed in the Frequency Genie user interface. The default value is 45.0 MHz. Displays as **RF-StartFrequency** in Frequency Genie user interface

[stopfreq] – Specifies the default stop frequency in MHz. The stop frequency can be changed in the Frequency Genie user interface. The default value is 870.0 MHz. Displays as **RF-StopFrequency** in Frequency Genie user interface

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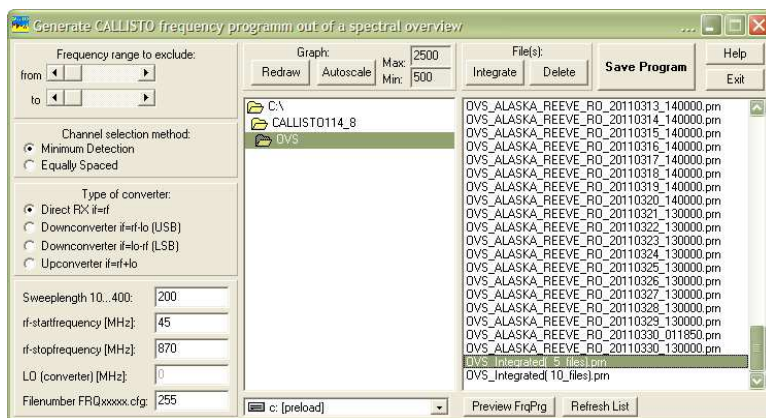
[localosc] – Specifies the default offset frequency in MHz for an up- or down-converter. The offset frequency can be changed in the Frequency Genie user interface. The default value is 0.0 MHz. Displays as **LO (Converter)** in Frequency Genie user interface

[filename] – Specifies the 3- to 5-digit number used in the Frequency File filename, frqxxxxx.cfg. It can be any number from 00000 to 99999. When Frequency Genie writes this file, it overwrites any existing file with the same filename. The string value can be changed in the Frequency Genie user interface. The default value is 255. Displays as **FileNumber** in Frequency Genie user interface



B.4 Run Frequency Genie

Navigate to the Frequency Genie folder, double-click the file *GenFrqPrg.exe*. A window opens similar to that shown left. In the middle frame you may need to navigate to the folder where your OVS files are located. This will be the location you specified in section IV (example, c:\Callisto\OVS\) or it could be an archive location.

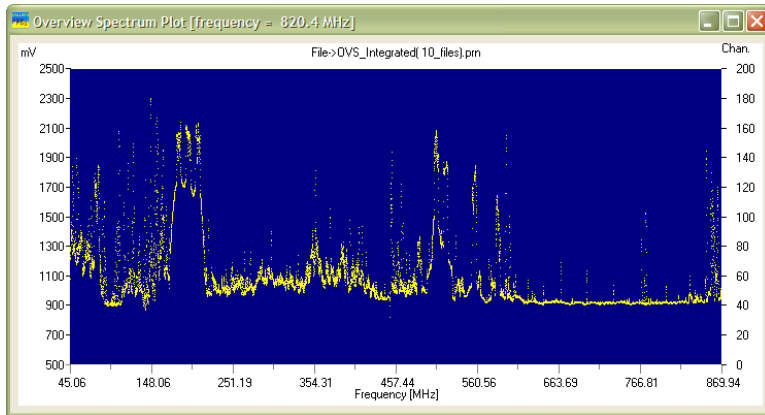


After you have navigated to the OVS files, they will appear in the right frame. You can select up to ten files for integration (averaging) using the normal file selection method (CTRL+Left-mouse or SHFT+Left-mouse).

After you select the files in the right main window frame, click on the Integrate button just above it. The outputs for each frequency in the spectral overview will be averaged and a new file will be saved automatically (lower-right corner in the screenshot to left). You can delete files from the frame by selecting the files and clicking the Delete button.

Above the middle main window frame are Graph buttons. Select one of the OVS files in the right frame and an associated spectrum image window should open (next page). If necessary, click the Redraw button. Use the Autoscale button to adjust the scaling so that the entire range of spectrum amplitudes is within view.

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By examining the spectrum you can get an idea of what bands to exclude from monitoring. Remember, this is a spectrum snapshot for one particular time. OVS files taken at other times and days may (and probably will) show variations in the displayed spectra.

In the upper part of the left main window frame, you can use the

horizontal Sliders to exclude a frequency range from the Frequency file. Vertical lines that correspond to the position of the sliders are shown on the spectrum chart. This is useful for excluding frequency bands that have heavy RFI such as the VHF-FM broadcast band between 88 and 108 MHz. You can exclude only one band within the sweep range using the Frequency Genie.

Just below the Sliders in the left frame are the Channel Selection Method radio buttons. The Minimum Detection radio button usually is selected for solar radio spectrometer work. This method automatically chooses the frequencies with the least detected output in the OVS. For RFI studies and other similar purposes, the Equally Spaced radio button can be selected. This method produces a frequency list at equally spaced intervals throughout the range.

The Type of Converter radio buttons in the middle of the left frame take into account the receiver configuration. For a standalone CALLISTO Receiver, the Direct RX radio button is selected. The other buttons are used when the CALLISTO Receiver is used with an up- or down-converter.

The five entry boxes at the bottom of the left frame allow further refinement of the frequency sweep. The values that appear when Frequency Genie is opened are the default values specified in the configuration file param.cfg, as described above. These are used as follows:

SweepLength	Specifies the number of channel/frequencies in the Frequency file
RF-StartFrequency	Specifies the start frequency in the Frequency file (MHz)
RF-StopFrequency	Specifies the stop frequency in the Frequency file (MHz)
LO (Converter)	Specifies the local oscillator frequency offset if an up- or down-converter is used (MHz)
FileNumber	Specifies the number used in the Frequency filename, a numeric value from 00000 to 99999. Leading zeros are not necessary (for example, if you want to use the filename frq00019.cfg, you would enter 19 into the box.

After all selections have been made, you can click the Save Program button above the right frame. The Frequency file will be saved in the form of frqxxxxx.cfg, where xxxxx is the number you used in the FileNumber entry box above.

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At this time you will be asked if you want to edit the file. If yes, then the Frequency file will open in your default ASCII text editor. You can check the file and adjust values if necessary. For example, if you want to use integration on selected frequencies (five maximum), you would scroll to those frequencies and change the integration value as desired. When finished, save the file in the normal way. To be usable by Callisto, the Frequency file must be in the same folder as *callisto.exe*. Depending on the path you specified in the *param.cfg* file, you may have to move or copy the file.

The Frequency file is now ready to use. The last step is to edit the Callisto Configuration file [frqfile] parameter to equal the filename you used above. Save the Configuration file. The new Frequency file does not take effect until loaded in Callisto. If Callisto is closed, it will load the specified Frequency file the next time it is opened.

If Callisto is running in measurement mode and you wish to load the new frequency file, you will need to press the Stop measurement button. The Select Frequencyfile button will become available and you can use it to load the new Frequency file. The new Frequency file is specified in the [frqfile] parameter in the Callisto Configuration file, and it will be automatically loaded whenever Callisto is opened.

You can produce as many Frequency files as you like but they must have a different number in the filename and, to be usable by Callisto, they must be located in the same folder as *callisto.exe*. In this way, you can customize your frequency sweeps for different purposes, for example, one for low-band solar radio monitoring, one for high-band, one for RFI studies, and so on.

C. Scheduler Genie Software Tool

C.1 Introduction

The Scheduler Genie tool is used to produce a *scheduler.cfg* file used by Callisto to schedule measurements. It determines sunrise, sunset and transit times for the user's location based on geographical coordinates and elevation above mean sea level. To allow reception of over-the-horizon solar radio events or to eliminate observation times blocked by mountains, the user may specify the Sun's angular position above or below the horizon.

C.2 Scheduler Genie Configuration File

Go to the Software folder on the CD and find the file *autosched.zip*. Extract the files to a folder on your PC (example, c:\Callisto\Software\AutoSched\). With NotePad or any ASCII text editor, open the file *autosched.cfg* (below) to change the parameters for your environment. See the parameter definitions in the next paragraph and make changes to your file accordingly.

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Note: Some versions of AutoSched have incorrect explanatory text in the ReadmeFirst.text file. Also, some earlier versions used different parameter definitions than described here. The application of the Scheduler configuration file is simple enough that any discrepancies are easy to reconcile.

```
// EXAMPLE SCHEDULER GENIE AUTOSCHED.CFG FILE NO. 1

[longitude]=100.0           // geographical longitude in degree, -=E
[latitude]=50.0            // geographical latitude in degree, -=S
[height]=100.0            // antenna elevation in meters above sea level
[horizon]=0.0             // Sun elevation in degrees from actual sunrise/set for start/stop
[focuscode]=59           // default focuscode
[cfqpath]=C:\CALLISTO\Software\CurVer\scheduler.cfg // configuration file path
[monitoring]=1            // Radio monitoring: create OVS once per day (1=on, 2=off)

// Revised by: W.D. Reeve, 12 Nov 2011 for Software Setup Guide

// Created by: Chr. Monstein 09.12.2008
// Updated by: Chr. Monstein 13.02.2009

/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8092 Zuerich Switzerland */
/*-----*/
/* Programname: autosched.cfg */
/* */
/* Revision: V1.5      Date: 09.12.1008      Autor: Chr. Monstein */
/* */
/* Purpose: Creates scheduler-file for Callisto and Phoenix */
/* */
/* */
/*-----*/
```

After making the changes, click File – Save in your text editor to save the Scheduler Genie Configuration file.

C.3 Scheduler Genie Configuration File (autosched.cfg) Parameter Definitions

The *autosched.cfg* parameter definitions are as follows:

[longitude] – Specifies the longitude of the CALLISTO Receiver location in decimal degrees. Longitudes east of the Greenwich meridian are negative (–). For example, if the longitude is 100.0 deg. west of the Greenwich meridian, the value would be 100.0. If the longitude is 149.9965 deg. east of the Greenwich meridian, the value would be –149.9965. This parameter is set the same as the [longitude] parameter in *callisto.cfg* (but note the different east/west flag)

[latitude] – Specifies the latitude of the CALLISTO Receiver location in decimal degrees. Latitudes south of the equator are negative (–). For example, if the latitude is 50.0 deg. north of the equator, the value would be 50.0. If the latitude is 61.199301 deg. south of the equator, the value would be –61.199301. This parameter is set the same as the [latitude] parameter in *callisto.cfg* (but note the different north/south flag)

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[height] – Specifies the elevation of the CALLISTO Receiver antenna in meters above mean sea level (AMSL). For example, if the antenna is 100.0 m AMSL, the value would be 100.0. This parameter is set the same as the [height] parameter in *callisto.cfg*

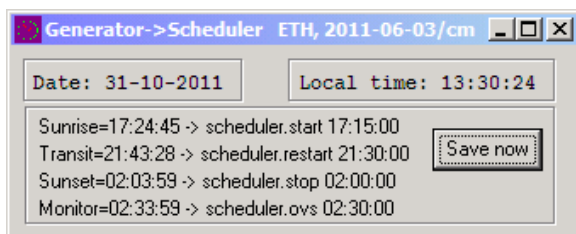
[horizon] – Specifies the Sun's elevation in degrees above or below the horizon when Scheduler starts and stops. The parameter is in decimal degrees and below-the-horizon values must be entered with the negative sign (-). For example, to start/stop when the Sun is 5.0 degrees below the horizon, the parameter would be -5.0 and, to start/stop 1.5 degrees above the horizon, the parameter would be 1.5

[focuscode] – Specifies the type of focal plane unit control used with the CALLISTO Receiver, if any. For basic CALLISTO applications, no FPU is used and the value normally is 59. Other values may be used but, if you upload data to FHNW, the value must be coordinated with Christian Monstein at ETH Zurich. Allowed values are 00 to 63. This parameter is set the same as the [focuscode] parameter in *callisto.cfg*

[measuremode] – Specifies the default measurement mode. Acceptable modes are Stop (0), Run Calibrated (2), Run Uncalibrated (3) and Monitor (8). For basic operation, use Run Uncalibrated (3). Run Calibrated mode (2) normally is used only in advanced operations. See Appendix B for a complete list of supported modes. This parameter is set the same as the [mmode] parameter in *callisto.cfg*

[cfgpath] – Specifies the file path name of the Callisto Configuration file *callisto.cfg*. Scheduler Genie places its output file at this location so Callisto can use it. The location will be the same as *callisto.exe*. Example, c:\Callisto\Software\. Be sure to include the backslash \ at the end of the path name, and be sure this path exists before running the Scheduler Genie

[monitoring] – Specifies whether or not the schedule includes a spectral overview (OVS). If the schedule is to include an OVS once per day, the value is 1 and, if not, the value 2



C.4 Run Scheduler Genie

While in the Scheduler Genie folder, double-click the file *SchedulerGeni.exe*. When opened it will look like the window to the left. The sunrise, transit and sunset times are automatically

calculated for the location specified in the Scheduler Configuration file on the current date. Click the Save now button and the *scheduler.cfg* file is produced and placed in the folder specified in the [cfgpath] parameter.

Go to that folder and open the *scheduler.cfg* file (example below). Note: Earlier versions of the Scheduler Genie incorrectly arranged the start and stop times for locations in North America. The correct order is for earlier times to be listed before later times.

C.5 Editing the Scheduler.cfg File

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NOTE: Avoid event times at 00:00:00 ± 5 minutes. Windows PCs do a lot of housekeeping at that time and may interfere with the schedule. If the Scheduler Genie tool sets an event time to 00:00:00, modify it to 23:55:00 or 00:05:00 or some other value outside of the avoided range.

As produced by Scheduler Genie, the configuration file scheduler.cfg includes one restart time. If desired the file can be edited to include additional restart times and frequency files as described in par. E of section IV. The example file below shows an edited version with additional restart times.

```
// EXAMPLE CALLISTO SCHEDULER.CFG FILE NO. 2 (EDITED)

/*-----*/
/ NOVEMBER 2011 SCHEDULE                               */
/ Sunrise 1727, Sunrise 0158 UTC                       */
/ Reeve Observatory, Anchorage, Alaska USA             */
/-----*/

00:30:00,60,3 // restart
01:30:00,60,3 // restart
02:30:00,60,0 // stop
15:00:00,60,8 // spectral overview
17:00:00,60,3 // start
18:30:00,60,3 // restart
19:30:00,60,3 // restart
20:30:00,60,3 // restart
21:30:00,60,3 // restart
22:30:00,60,3 // restart
23:30:00,60,3 // restart

/* Revised by: W.D. Reeve, 12 Nov 2011 for Software Setup Guide

/* Each schedule-entry is composed of:
/* - Starttime hh:mm:ss (UT) + comma delimiter
/* - focuscodes decimal (63...01) to be applied + comma delimiter
/* - Planned measurement-mode (0, 2, 3 or 8)
/* - new local frequency-program to be loaded
/* - additional comment
/* each entry will be repeated automatically every day
/* empty lines are allowed to separate different tasks

/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8092 Zuerich Switzerland */
/-----*/
/*
/* File: SCHEDULER.CFG      Revision: 04, 26.11.2004 Chr. Monstein    */
/*
/-----*/
/*
/* Time-scheduler describes what has when to be done on CALLISTO    */
/*
/-----*/
```

D. WWW Genie Software Tool

D.1 Introduction

The WWW Genie tool produces a regularly updated image of the lightcurve plot. The plot can have up to five traces, one for each of five frequencies. These five frequencies correspond to

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the frequencies selected for integration in the Frequency file (frqxxxxx.cfg) located in the Callisto folder and specified in the Callisto Configuration file. If no frequencies are selected for integration, the plot will have no traces. Refer to section IV for information on the frequency file.

D.2 WWW Genie Configuration File

Go to the Software folder on the CD and find the file *wwwgeni.zip*. Open and extract the files to a folder on your PC (example, c:\Callisto\Software\WWWGenie\). With NotePad or any ASCII text editor, open the file *wwwpar.cfg* and change the parameters for your environment. See the parameter definitions in the next paragraph and make changes to your file accordingly. After making the changes, click File – Save in your text editor to save the WWW Genie Configuration file.

```
// EXAMPLE WWWPAR.CFG FILE NO. 1

[configfile]=C:\CALLISTO\Software\CurVer\callisto.cfg           // Path to callisto.cfg
[imagedir]=C:\CALLISTO\LC\Plots\                               // Output path for storage of lightcurve image files
[timer]=30 //Seconds                                           // Lightcurve file update rate
[dayoffset]=0          // Plot data for today (0) or yesterday (1), DateOfFile = Today-dayoffset
[yscale]=30           // Y-axis limit in dB for uncalibrated lightcurves
[adcddivider]=4      // Divider for 8-bit (1) or 10-bit (4) receivers, all NA receivers are 10-bit
[width]=800          // Plot width in pixels
[height]=496         // Plot height in pixels, normally height = 0.62*width

/* Revised by: W.D. Reeve, 12 Nov 2011 for Software Setup Guide
```

D.3 WWW Genie Configuration File Parameter Definitions

The parameter definitions are as follows:

[configfile] – Specifies the path to the Callisto Configuration file. Edit the path as necessary so that it equals the path you used in section IV for the Callisto application program. This must be the full path including the filename (example, c:\Callisto\Software\callisto.cfg)

[imagedir] – Specifies the location where WWW Genie is to save the lightcurve image files (example, c:\Callisto\LC\Plots\). Before doing anything else, make the new folder at the specified path location

[timer] – Specifies the rate in seconds at which the lightcurve image file is updated. The default value of 30 seconds is suitable for most solar events considering the resolution of the lightcurve charts

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[dayoffset] – Specifies whether the plot is made for today (0) or yesterday (1). Generally, this should be left at the default value of 0

[yscale] – Specifies the y-axis limit. The default value is 30 dB and this should be left as-is for uncalibrated receivers

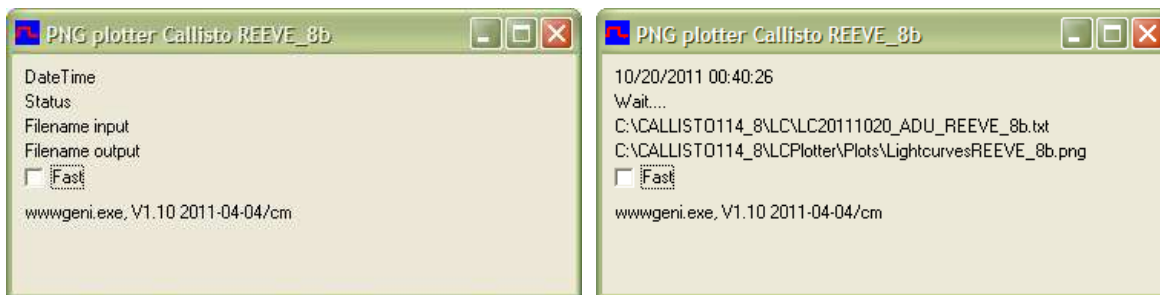
[adcddivider] – Specifies the scaling that WWW Genie uses in terms of the analog-digital converter (ADC) resolution, either 8-bit (1) or 10-bit (4). All North American CALLISTO Receivers (S/N NAxxx) are 10-bit, so the default is 4

[width] – Specifies the plot width in pixels. The default value is 800 and is suitable for viewing on most PC monitors

[height] – Specifies the plot height in pixels. This value should be 62% of the plot width. The default value is 496

D.4 Run WWW Genie

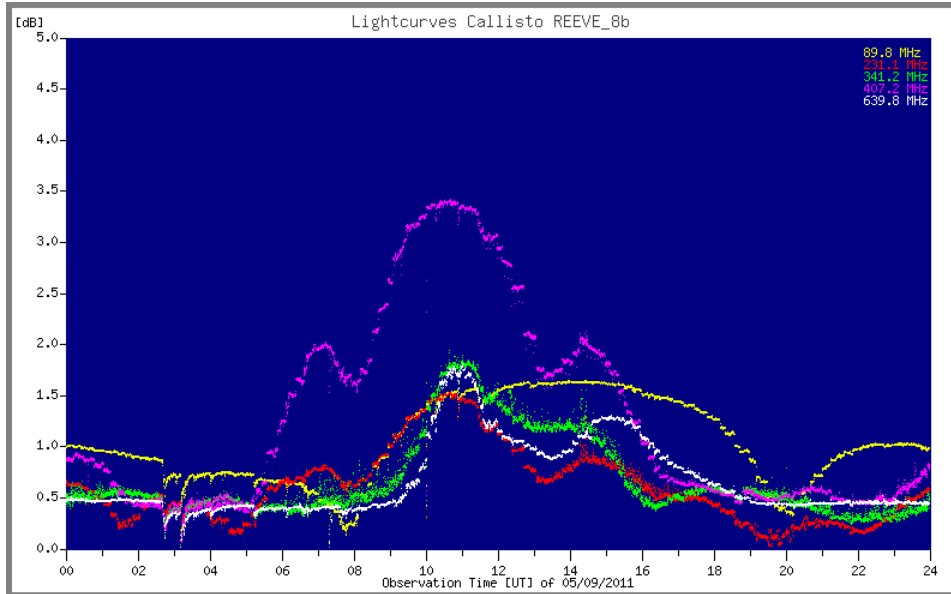
While in the WWW Genie folder, double-click the file *wwwgeni.exe*. When it first opens, the window will look like below-left. After a moment, the window will change slightly as shown below-right. Check the folder you specified for the plots and you should see an image file of the form *Lightcurvesxxxx_yyyymmdd.png*, where *xxxx* is the value you used for the [titlecomment] parameter in the Callisto Configuration file.



WWW Genie replaces the plot image file with an updated file at the interval specified in the [timer] parameter. As the UTC day progresses, the plot trace will move across the chart. You can upload the plots to a website for viewing in a browser. A new image file is started the next day, so the folder will hold daily files.

An example lightcurve image is shown below. This particular image was made with a Sun-tracking log periodic antenna arranged to track for 24 hours in a polluted RF environment. It shows very strong interference from a television broadcast station at around 400 MHz (purple trace). The peak occurs around 1000~1100 UTC when the antenna was pointed directly at the station and the Sun was below the horizon. In this case, the trace plots the antenna response at that frequency.

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E. RAPP Viewer ~ Java FITS Viewer

E.1 Introduction

The Java FITS Viewer is a free application that may be used to view the Callisto FITS data files. A description of the FITS file header can be found in Appendix F.

E.2 Install the Java FITS Viewer and Related Environment

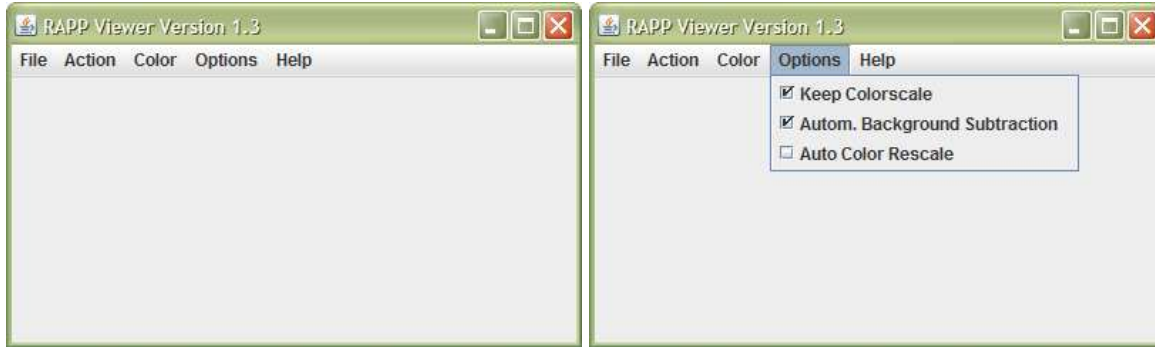
If the Java Runtime Environment is not already loaded on your PC, download and install it from here: <http://www.java.com/en/download/index.jsp>

Download the java FITS viewer application from here: <http://www.e-callisto.org/Software/Callisto-Software.html>. This viewer also is provided on the CD in the software folder.

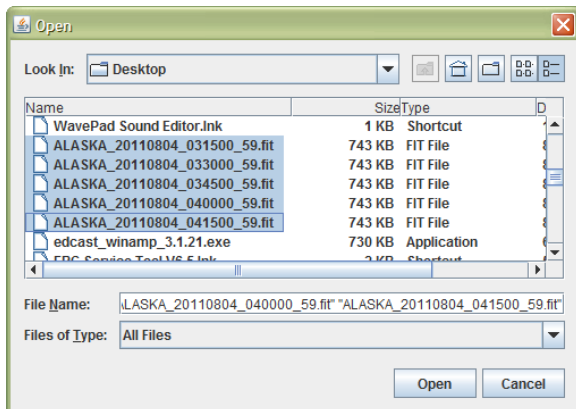
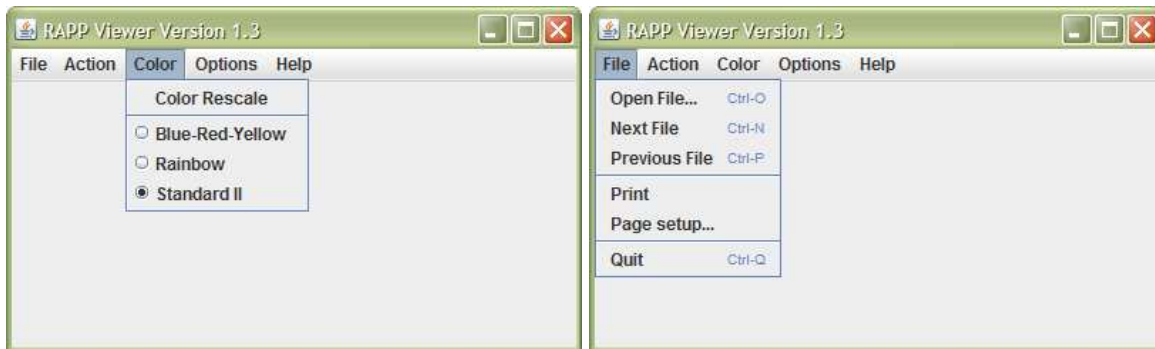
E.3 Setup the Viewer

Open the viewer (below-left). In the Options menu check the first two items – Keep Colorscale and Autom. Background Subtraction (below-right).

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In the Color menu, select the last item – Standard II (below-left). The Option and Color menu settings are not remembered by the program and need to be set each time the viewer is used. Under File menu, select Open Files (below-right).



E.4 Open FITS Files

Navigate to and select the FITS files you want to view. You can select more than one file with Shift and Ctrl + left-mouse button in the normal way.

Click Open, and the first file will open. The screen may be very dark and nothing may be visible on it.

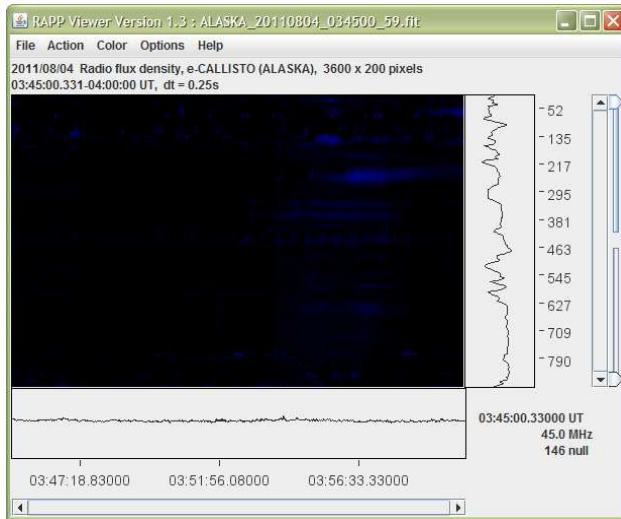
E.5 Adjust Image Color Contrast

Drag the Slider on the far upper-right almost all the way down until you can see the image. Adjust the Slider for best contrast. Leave the bottom-right Slider at its lowest position.

E.6 Step through Files

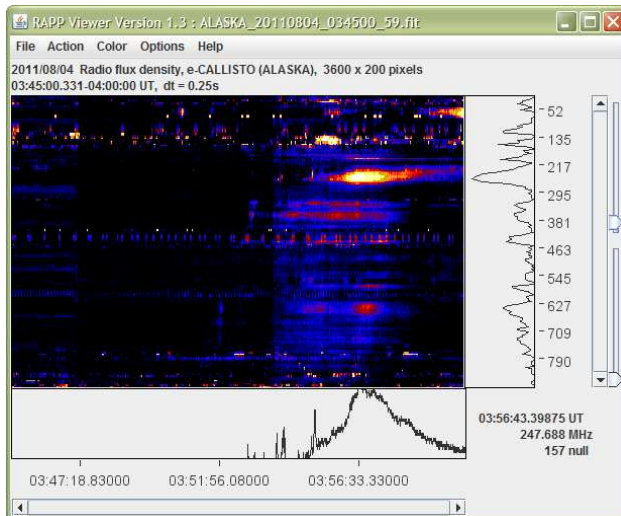
Use Ctrl-N and Ctrl-P to step forward and back through the selected files (N – Next, P – Previous).

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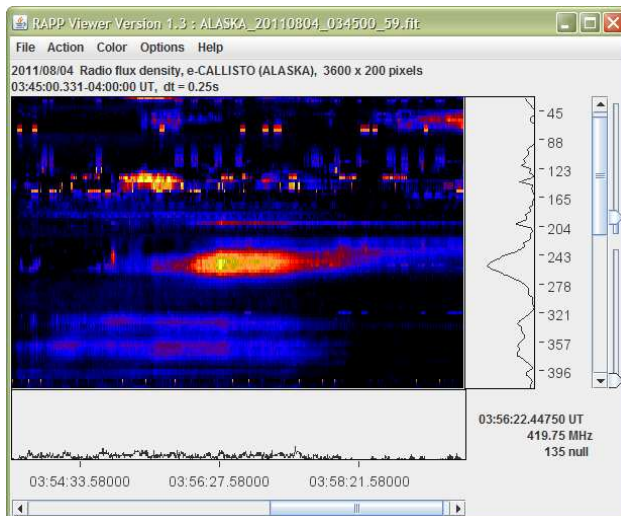
E7. Background Adjustments

When you set the Options to Automatic Background Subtraction, the viewer determines the average background noise level for the entire spectrum and subtracts it when the spectrum is displayed. You can adjust the background at any time by manually selecting a region. Click with the left-mouse button and drag to enclose an area having the noise level to be subtracted. Press Ctrl-B to subtract the background level of the marked area.

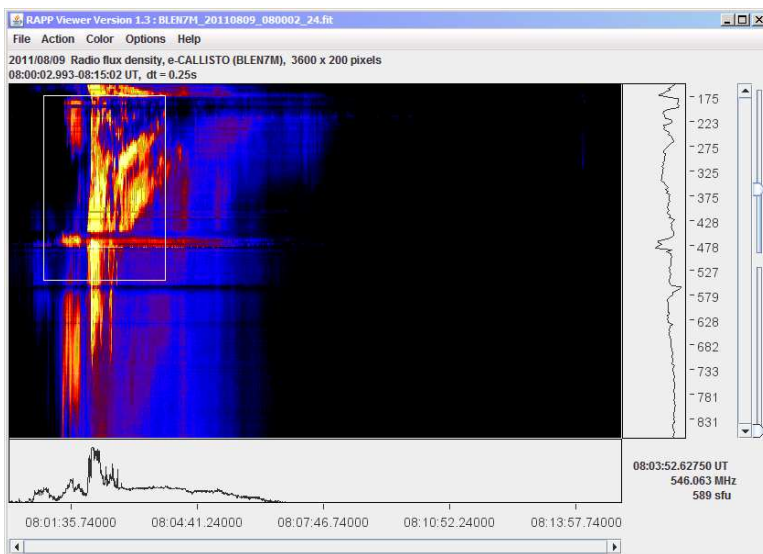
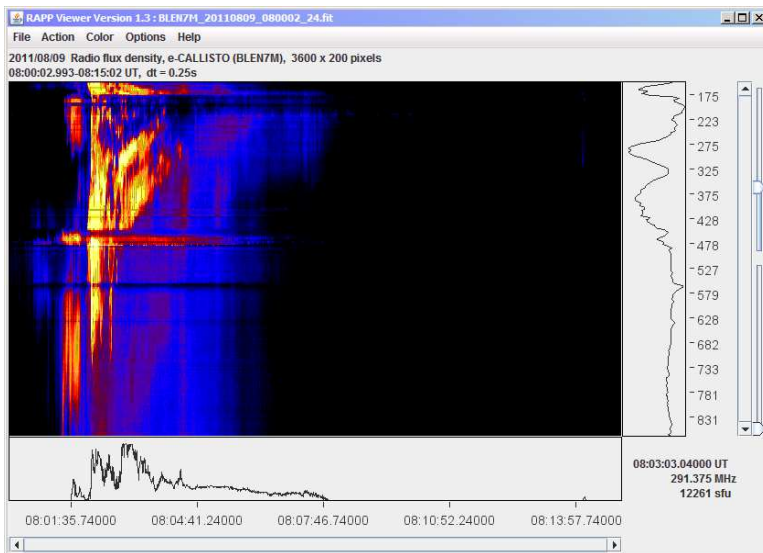
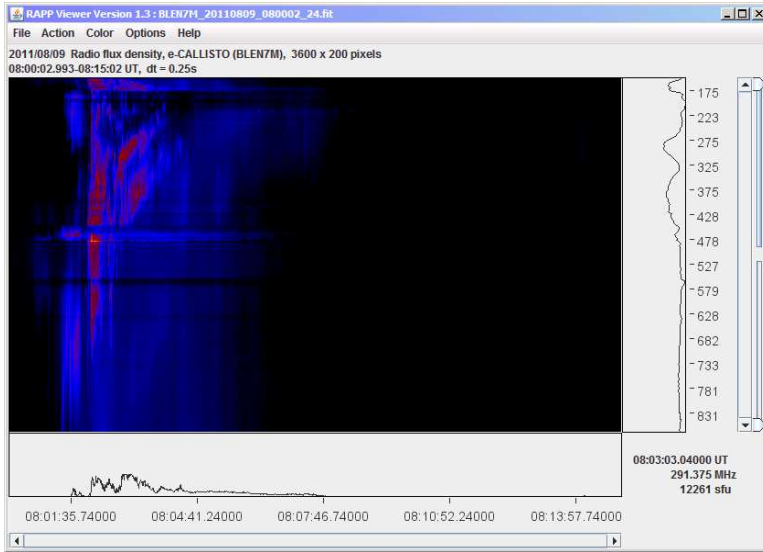


E.8 Zoom In and Out

Use the left mouse button to drag and select a portion of the image and then use Ctrl-Z and Ctrl-U to zoom in (images left) and out. After zooming in, scroll bars will appear so you can move the window horizontally and vertically to view different portions of the spectrogram.



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E.9 Additional Zoom Examples

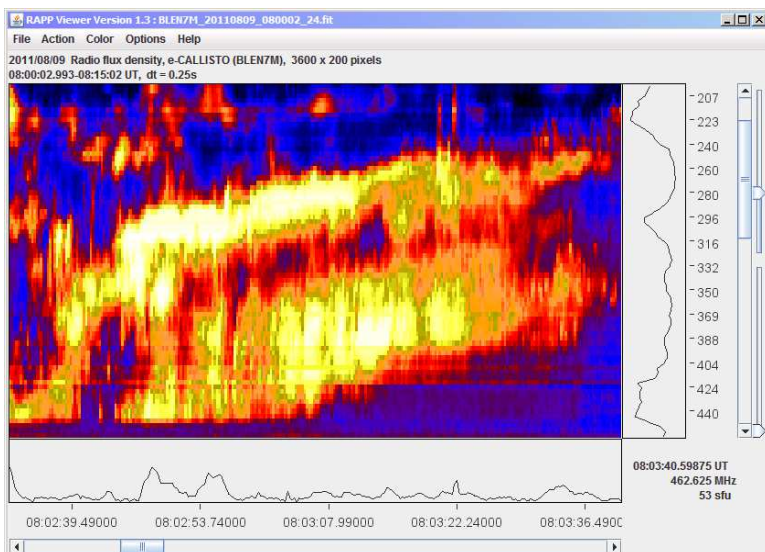
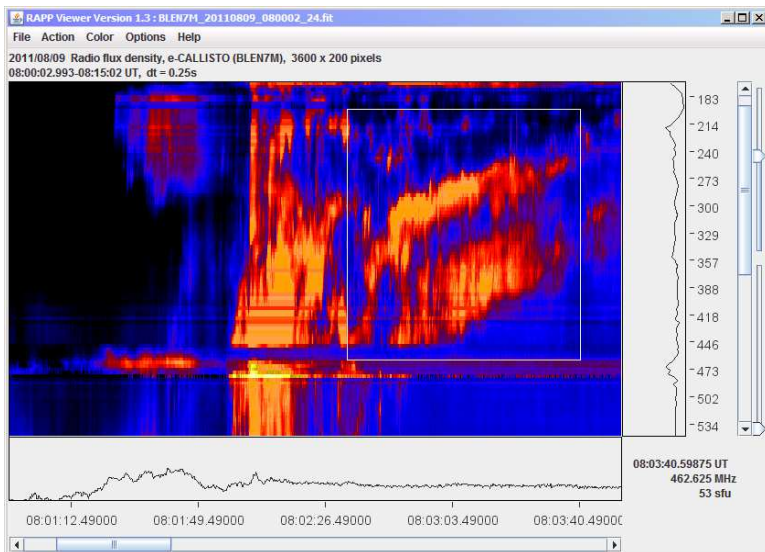
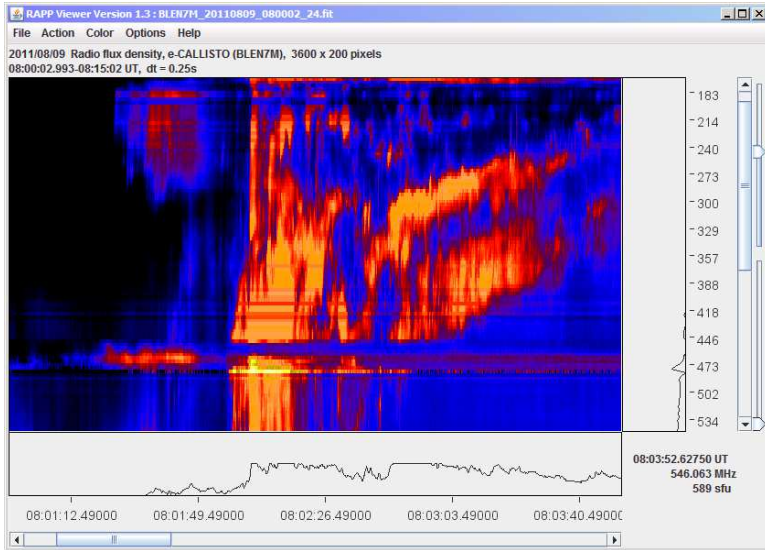
Views are provided on this and the next page of a different solar flare measured at a very quiet location.

The first image shows the spectrum when the file is first opened with no adjustments. The second shows color adjustments using the Slider on the upper-right. The next image (bottom of page) shows a white box in the upper-left, which was drawn by left-dragging the mouse. The area within the box is zoomed out with Ctrl-Z in the fourth image.

The view is further zoomed in by left-dragging the mouse and drawing a white box in the upper-right. The last image shows the view after clicking Ctrl-Z to zoom in again.

The following paragraphs describes additional uses of the Java FITS Viewer.

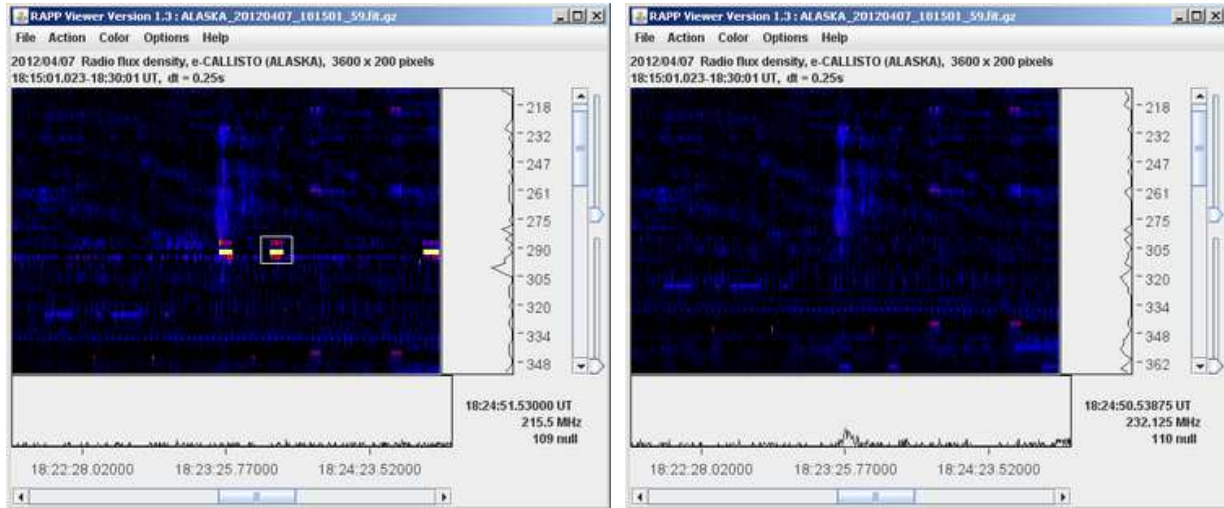
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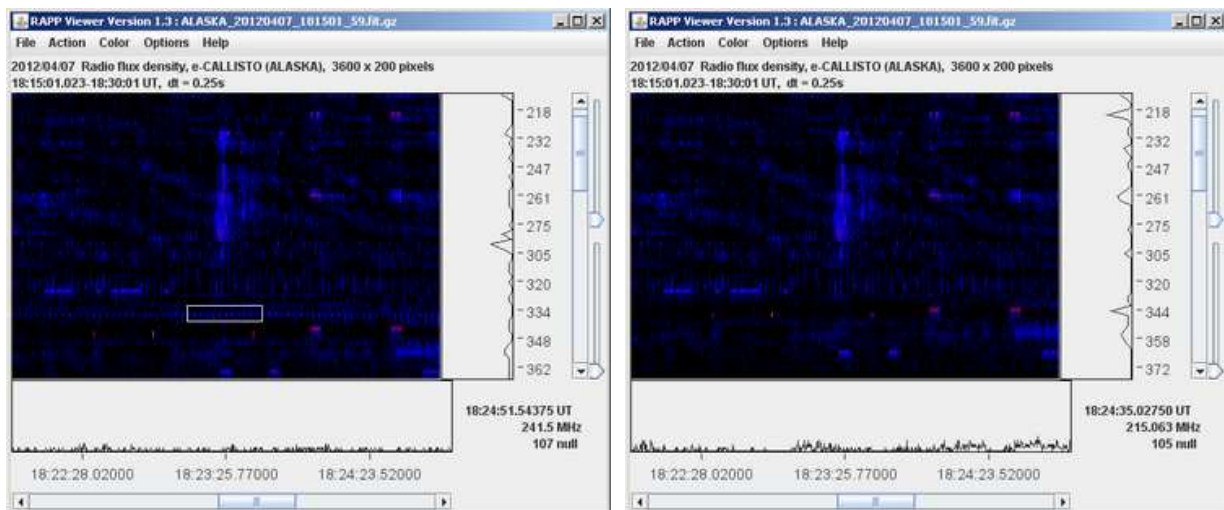
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E.10 Removing Interference from Java FITS Viewer Images

Mark the interference with the mouse by clicking and dragging (below-left). Press Ctrl-S and menu Action – Shift channel to shift the marked channel to an invisible area (below-right).



If there are additional interfered channels, mark them using the same procedure (below-left) and then click Ctrl-S again to shift them (below-right). Repeat as necessary.



E.11 Changes in callisto.exe v119 that affect how FITS files are viewed

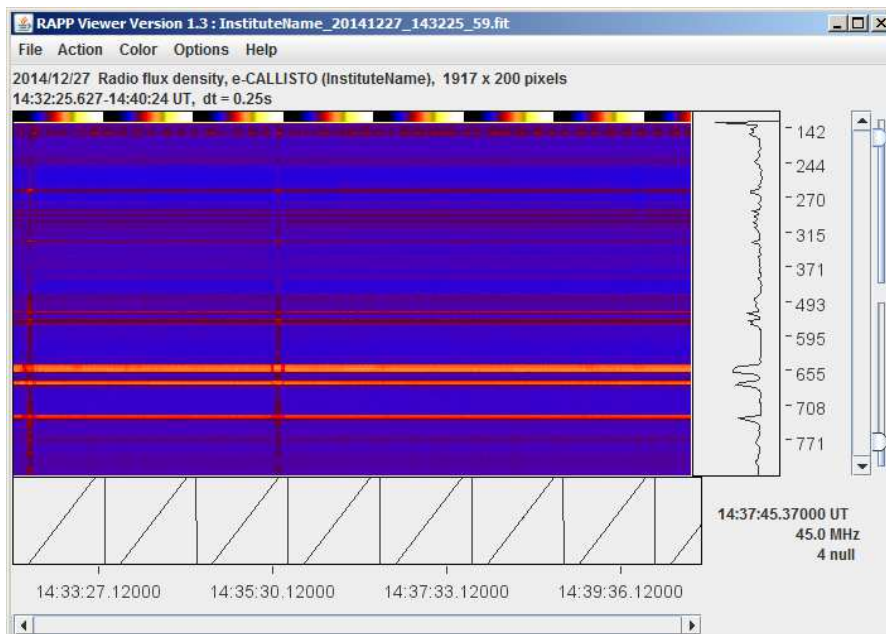
Callisto v119 changed how the first nine channels in a FITS file are populated. Refer also to images below.

If there are ≤ 8 channels in the frequency file, then all channels are stored in FITS-files and viewed normally with viewer.

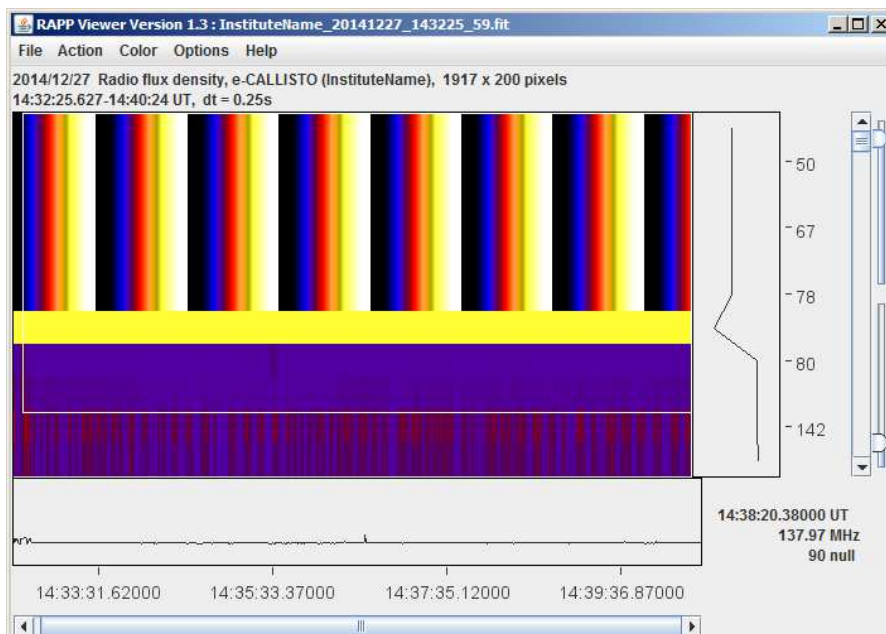
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If there are > 8 channels in the frequency file then the lowest 8 channels are ignored and replaced as follows and Channels 9 N are retained:

- ⚙ Channels 1-6: column number modulo 255 (in the form of a color-table). It is obviously not a sky-signal and is ignored
- ⚙ Channel 7: contains PWM-value (gain control value which may change during an observation)
- ⚙ Channel 8: contains the average intensity of channels 9...N, where N=maximum number of channels (this is used to observe weak radio sources in broadband mode)



FITS file with > 9 channels. RFI from high altitude flat in Swiss Alps with modified channels 1-8. No background subtraction. Note rainbows at top of spectrum window indicating the first 8 channels.



Zoom detail showing channels 1-8

where channels
1-6 = column%255
7 = PWM
8 = average of remaining channels

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To view channels 1-8 in the RAPP Viewer:

In the Options menu, check only Keep Colorscale (leave the others unchecked); in Color menu select Standard II radio button.

To view gain setting (PWM value) and average intensity of active channels, zoom into first 9 channels at top of the spectrum window (select area with mouse and then press CTRL-Z). Move mouse cursor to channel 7 just below the repeating rainbow to read the gain setting. The color in channel 7 corresponds to the setting, and the numeric value is shown in lower-right corner of main window. To view average relative power of all active channels 9 ... N, hoover the mouse cursor on channel 8. Again, the color corresponds to the average and a numeric value is shown in the lower-right corner of the main window.

E.12 Using the Java FITS Viewer to Estimate Y-Factor of the Sun

As you move the mouse around the spectrogram image, you will notice changing values in the lower-right of the window. These represent the time, frequency and power parameters associated with the pixel under the mouse cursor. With these values, the spectrograms can be used to estimate receiver and antenna performance.

The power value is given in terms of the 10-bit ADC output, which has been reduced to 8 bits by dividing it by four. For example, a value of 150 read on the image corresponds to an internal ADC digits value (in decimal) of $4 \times 150 = 600$. Since a fully loaded 10-bit ADC has a digit value of 1024, the power relative to full scale for this example is $600/1024 = 0.59$, or -2.32 dB_{FS} .



The zoomed example Viewer image below is from a FITS file taken in Crimea (an autonomous republic of Ukraine) using the 4x4 Yagi antenna array shown upper-left. For these measurements the antenna array was pointed at the Sun as indicated by the fairly uniform red area on the left and right sides of the image.

The antenna was then moved away from the Sun to the quiet sky for about 15 seconds as indicated by the vertical blue (dark) stripe in the middle of the spectrogram.

The Y-factor, or noise ratio, of the Sun can be estimated as follows:

1. Using the Zoom function, select the area of interest, such as the quiet sky area
2. Move the mouse cursor to an average position of the quiet sky (dark stripe area) and read the amplitude. In the upper example image, the value is indicated as "145 null" (the "null" indicates *Not Calibrated*). This represents the quiet, or cold, sky. Therefore, DigitCold = 145

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3. Move the mouse cursor to an average position of the Sun (red areas on the left and right in the example images) and read the amplitude. In the lower example image, the value is “158 null”. This represents the hot sky. Therefore, DigitHot = 158

4. Calculate the Y-factor from

$$Y(dB) = \frac{(DigitHot - DigitCold)}{DigitRange} \cdot \frac{VoltRange}{g}$$

where

DigitRange = 1024/4 = 256 digits, the ADC full-scale digits range for FITS files
 VoltRange = 2500 mV, the ADC full-scale voltage range
 g = 25.4 mV/dB, the log detector gradient (slope)

Alternatively,

Y(dB) = (DigitHot - DigitCold)/2.6 digit/dB and/or

Y(dB) = (DigitHot - DigitCold)*0.38 dB/digit

For the values from the example images above:

$$Y(dB) = \frac{(158 - 145)}{256} \cdot \frac{2500}{25.4} = 5 \text{ dB}$$

This method can be extended to calculate noise temperatures and solar flux.

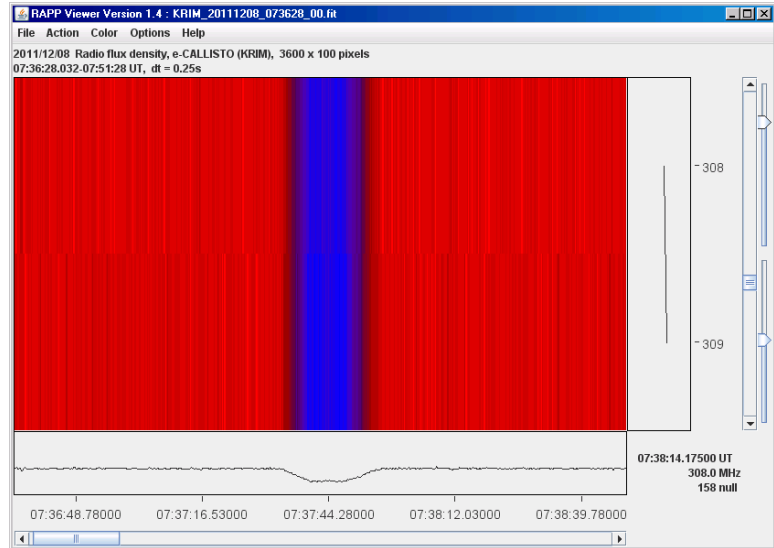
E.13 Using the Java FITS Viewer to Measure Solar Radio Bursts

The Space Weather Prediction

Center (SWPC) provides solar burst measurements in the daily *Solar and Geophysical Activity Summary* (SGAS) report. The reported solar flux at 245 MHz may be used in association with the CALLISTO Receiver.

An excerpt from the Solar and Geophysical Activity Summary report issued on 16 March 2011 for the previous day (15 March) is shown below.

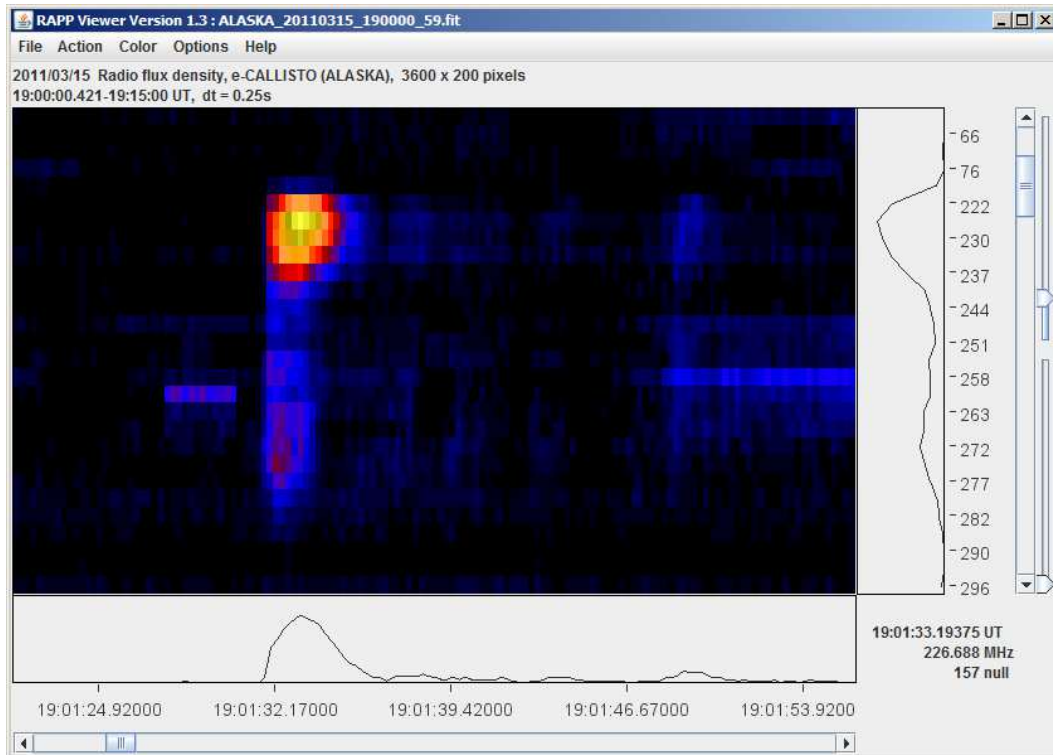
Begin	Max	End	Rgn	Loc	Xray	Op	245MHz	10cm	Sweep
0807	0811	0814	1172		B6.9		100		
0825	0825	0825					180		
0827	0827	0827					200		
1121	1125	1127	1169	N19W59	C1.1	Sf	170		
1448	1451	1451					670		



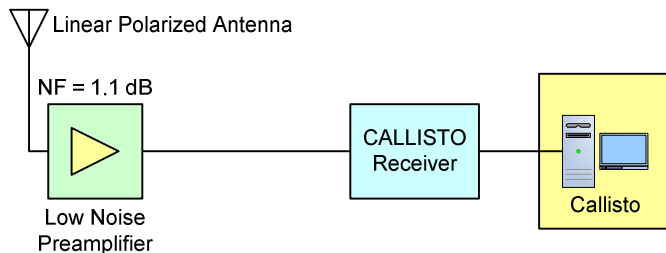
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1532	1532	1533			970
1858	1902	1904	1169	B5.6	3000
1958	1958	1958			350
2043	2044	2044			580
2046	2046	2046			100
2124	2124	2124			560

Of particular interest is the B5.6 flare, which peaked at 1902 UTC with a reported flux at 245 MHz of 3000 sfu. The value reported in the SGAS is total flux. It is assumed the bursts are randomly polarized. Therefore, a linear polarized antenna will receive only one-half of the total flux. Measurements made of this burst with a CALLISTO Receiver can be compared to SWPC measurements. Inaccuracies in the measurements, if any, are ignored in the analysis below. A zoomed-in image of this burst from the Java FITS Viewer is shown below.



In the following example, the CALLISTO Receiver has a low noise preamplifier located near a linear polarized antenna (see block diagram below).



First, convert the reported spectral flux density measurement in sfu to $W/m^2\text{-Hz}$. By definition, $1 \text{ sfu} = 10^{-22} \text{ W/m}^2\text{-Hz}$. Therefore, for the burst in question, the spectral flux density, S , is

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$$S = 3000 \cdot 10^{-22} \text{ W/m}^2\text{-Hz}$$

Next, calculate the effective area, $A_{\text{Effective}}$, of the CALLISTO Receiver antenna from

$$A_{\text{Effective}} = \frac{\lambda^2}{4 \cdot \pi} \cdot G \text{ m}^2$$

where λ is the wavelength in meters and G is the antenna gain as a linear ratio. To convert antenna gain in logarithmic units of dB to a linear ratio

$$G = 10^{\frac{G(\text{dB})}{10}}$$

For this example, assume the antenna gain is 6 dB or, as a linear ratio, $G = 4$ (rounded).

The measurements are at 245 MHz, which corresponds to a wavelength of

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{245 \cdot 10^6} = 1.22 \text{ m}$$

where c is the speed of light in m/s and f is frequency in Hz. Therefore, the antenna effective area is

$$A_{\text{Effective}} = \frac{\lambda^2}{4 \cdot \pi} \cdot G = \frac{1.22^2}{4 \cdot \pi} \cdot 4 = 0.48 \text{ m}^2$$

Now, calculate the power flux density (PFD) of the burst in W/Hz from

$$PFD_{\text{Burst}} = \frac{S \cdot A_{\text{Effective}}}{2} = \frac{3000 \cdot 10^{-22} \cdot 0.48}{2} = 7.2 \cdot 10^{-20} \text{ W/Hz}$$

where S and $A_{\text{Effective}}$ were defined above. The divisor 2 takes into account that a linear polarized antenna receives only 1/2 of the total flux. It generally is easier to work in dB, in which case the power flux density in dBm/Hz is

$$PFD_{\text{Burst}} (\text{dBm / Hz}) = 10 \cdot \log \left(\frac{PFD_{\text{Burst}}}{PFD_{\text{Ref}}} \right)$$

where $PFD_{\text{Ref}} = 1 \text{ mW/Hz}$ (0.001 W/Hz). Therefore,

$$PFD_{\text{Burst}} (\text{dBm / Hz}) = 10 \cdot \log \left(\frac{PFD_{\text{Burst}}}{PFD_{\text{Ref}}} \right) = 10 \cdot \log \left(\frac{7.2 \cdot 10^{-20}}{1 \cdot 10^{-3}} \right) = -161.4 \text{ dBm/Hz}$$

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To calculate the ratio of received solar flux to the receiver noise floor (conceptually similar to signal-to-noise ratio), first calculate the system noise temperature, T_{Sys} . The system noise temperature is the sum of the sky temperature and the receiver noise temperature in kelvin (K), or

$$T_{Sys} = T_{Sky} + T_{Rx}$$

T_{sky} is estimated to be 300 K at VHF. The receiver noise temperature, T_{Rx} , is

$$T_{Rx} = T_0 \cdot \left(10^{\frac{NF}{10}} - 1 \right)$$

where $T_0 = 290$ K, the reference temperature, and NF is the receiver preamplifier noise figure in dB. From the block diagram, the preamplifier noise figure is 1.1 dB. Therefore,

$$T_{Rx} = T_0 \cdot \left(10^{\frac{NF}{10}} - 1 \right) = 290 \cdot \left(10^{\frac{1.1}{10}} - 1 \right) = 83.6 \text{ K}$$

and

$$T_{Sys} = T_{Sky} + T_{Rx} = 300 + 84 = 384 \text{ K (rounded)}$$

The power flux density due to system noise temperature is

$$PFD_{Sys} = k \cdot T_{Sys}$$

where k is the Boltzmann constant, $1.38 \cdot 10^{-23}$ W/Hz-K. Based on the system noise temperature determined above, the power flux density at the system noise floor is

$$PFD_{Sys} = k \cdot T_{Sys} = 1.38 \cdot 10^{-23} \cdot 384 = 5.3 \cdot 10^{-21} \text{ W/Hz}$$

It follows that the system noise power flux density in dBm/Hz is

$$PFD_{Sys} \text{ (dBm / Hz)} = 10 \cdot \log \left(\frac{PFD_{Sys}}{PFD_{Ref}} \right) = 10 \cdot \log \left(\frac{5.3 \cdot 10^{-21}}{1 \cdot 10^{-3}} \right) = -172.8 \text{ dBm/Hz}$$

The difference between the received solar flux (-161.4 dBm/Hz) and system noise (-172.8 dBm/Hz) indicates the power level that the solar burst is above the receiver system noise. In this example,

$$PFD_{Burst} \text{ (dBm / Hz)} - PFD_{Sys} \text{ (dBm / Hz)} = -161.4 - (-172.8) = 10.4 \text{ dB.}$$

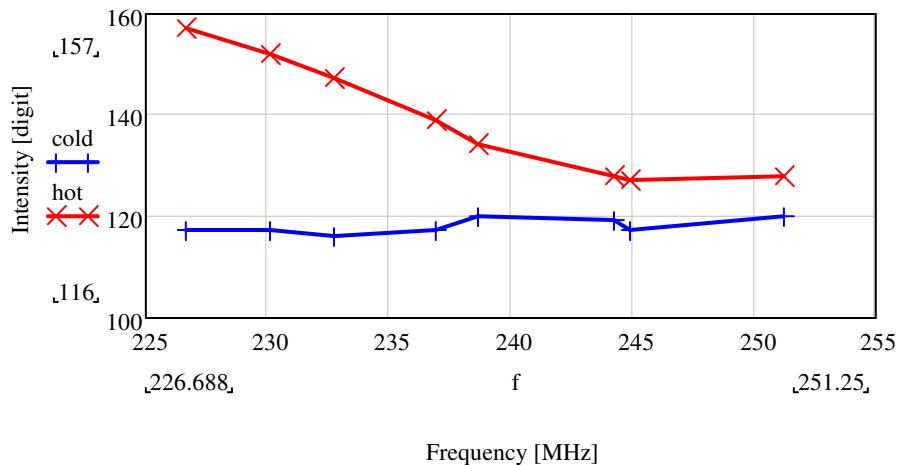
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The Java FITS Viewer can provide an estimate of this ratio based on the measured Y-factor of the burst. First, build a 3-column array [column (1) frequency, (2) hot power and (3) cold power values] from the burst using the measurement techniques described above. Several frequencies should be measured for comparison, and they should be near the frequency reported by SWPC (245 MHz).

Now, measure the *hot* power in digits - place the cursor over the burst peak and record the reading. Next, move the cursor to a cold region outside the burst at the same frequency and measure the *cold* power. Repeat for several different frequencies. See the example array below, which was made from the burst image.

Freq	Hot	Cold
226.688	157	117
230.125	152	117
232.750	147	116
236.938	139	117
238.688	134	120
244.313	128	119
244.938	127	117
251.250	128	120

These values may be plotted as shown below.



Now, calculate the Y-factor in dB.

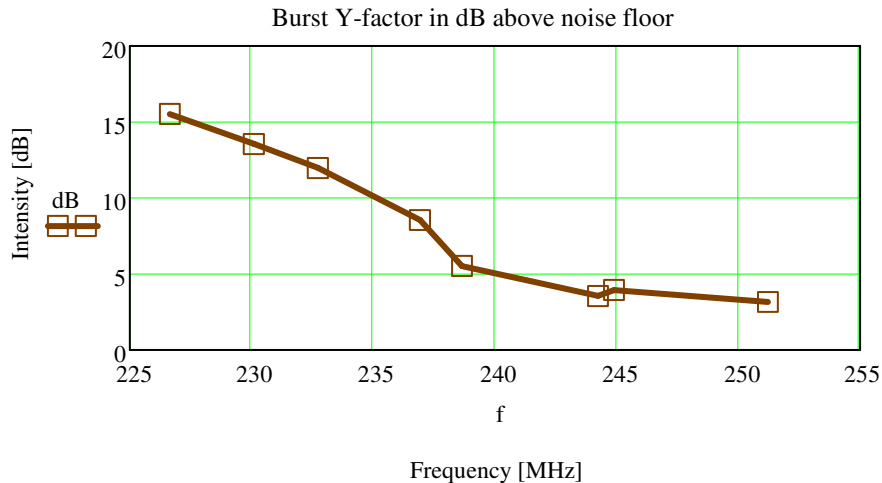
$$Y(\text{dB}) = \frac{\text{DigitHot} - \text{DigitCold}}{\text{DigitRange}} \cdot \frac{\text{VoltRange}}{g} \text{ dB}$$

As an example, the calculation for the measurement point at 244.938 MHz is

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$$Y(\text{dB}) = \frac{\text{DigitHot} - \text{DigitCold}}{\text{DigitRange}} \cdot \frac{\text{VoltRange}}{g} = \frac{127 - 117}{256} \cdot \frac{2500}{25.4} = 3.8 \text{ dB}$$

Similar calculations for each frequency can be made and then plotted as shown below.



Many factors affect the results. Differences can be expected between the calculations based on principles and those based on measurements.

F. Sending Data to FHNW with File Transfer Protocol

F.1 Introduction

This section describes three methods to send Callisto data file to the FHNW server in Switzerland: FTP-WatchDog software, PERL-FTP software and Windows native FTP tools. PERL-FTP is the recommended method for Windows 7 and later. FTP-WatchDog is the recommended method for Windows XP and earlier because as of early 2019 current versions of PERL are incompatible with those operating systems.

FTP-WatchDog still can be used but later versions are no longer available from the developer. Also, it has been found that if FITS files are allowed to accumulate in the Callisto data folder, FTP-WatchDog fails when the file count reaches a certain but unknown size (this problem can be easily solved by periodically moving files from the data folder, say, every month).

A new PERL script called Perl-FTP (version 1) was developed in mid-2014 to replace FTP-WatchDog. Perl-FTP (version 1) was replaced by a more robust Perl-FTP-Upload (version 2) in early 2017. Perl-FTP Upload currently is version 3. Perl-FTP-Upload provides direct access to the server, handles sending of the FITS files to the server and also moves the FIT-files into an archive folder on the Callisto PC.

F.2 Perl-FTP-Upload (version 3)

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Perl-FTP-Upload does the following:

- ⚙ Check the Callisto data directory for FITS files;
- ⚙ If a new FITS file is available, copy it to the FTP-server at FHNW using File Transfer Protocol;
- ⚙ Move the new FITS file to a predetermined location for backup such as another Windows folder, another drive on the same PC, a mapped drive, USB-stick, or USB-disk;
- ⚙ Wait 15 minutes and repeat the whole process under control of the System Scheduler application.

Perl-FTP-Upload and a short manual are available here: <http://www.e-callisto.org/Software/Callisto-Software.html>. Search this webpage for 'PERL script'. This software tool and document also is provided on the document/software CD provided with all Callisto-NA orders after 1 February 2017.

F.3 FTP-WatchDog

FTP-WatchDog is a reliable application program that can be used to send files using the File Transfer Protocol. FTP-WatchDog typically is used with software applications that regularly produce an image, data or text file. FTP-WatchDog automatically detects the new file and sends it to an FTP server on a website. FTP-WatchDog is used to send FITS data files to the FHNW server. FTP-WatchDog is provided on the CD but it may not be the latest available version. The latest version may downloaded here:

<http://toolsandmore.de/Central/Produkte/Software/Internet/Webmaster/FTP-Watchdog/> or <https://www.heise.de/download/product/ftp-watchdog-47183>

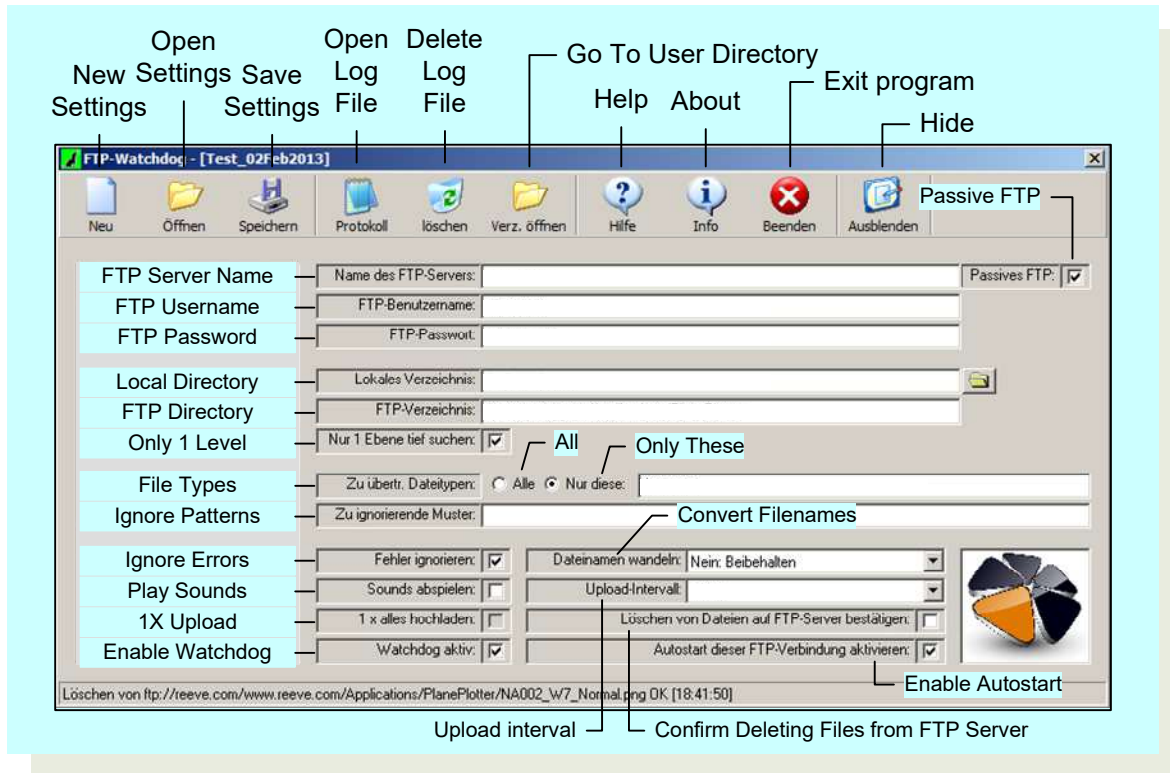
Previous issues of this manual had detailed setup instructions in this section for the e-CALLISTO application of FTP-WatchDog. The instructions are now a standalone document located here: http://www.reeve.com/Documents/CALLISTO/FTP-WatchDog_v3Setup.pdf. Users should download this document now and use it to setup FTP-WatchDog. As of early 2019, FTP-WatchDog is the recommended FTP program for use with Windows XP and earlier.

A method for manually sending data files is described at the end of this section.

F.3.1 FTP-WatchDog Reference

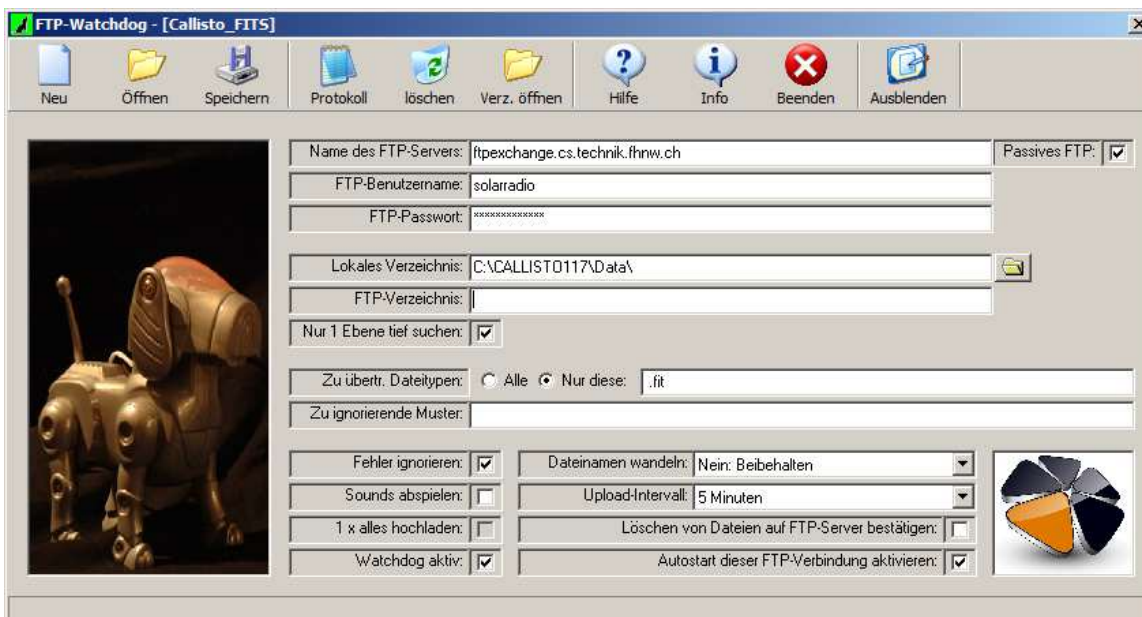
The FTP-WatchDog user interface is in German language. The screenshot below provides translation of the various fields and parameters to English. More detailed information is provided in the document mentioned above, and the next section shows Settings used with e-CALLISTO.

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F.3.2 FTP-WatchDog Configurations

The user interface Settings screenshots below shows specific setup information for sending the FITS files to FHNW server. The Local Directory setting will need to be changed for your specific setup. The FTP Password is obtained by email inquiry to Christian Monstein at ETH Zurich, monstein@astro.phys.ethz.ch.

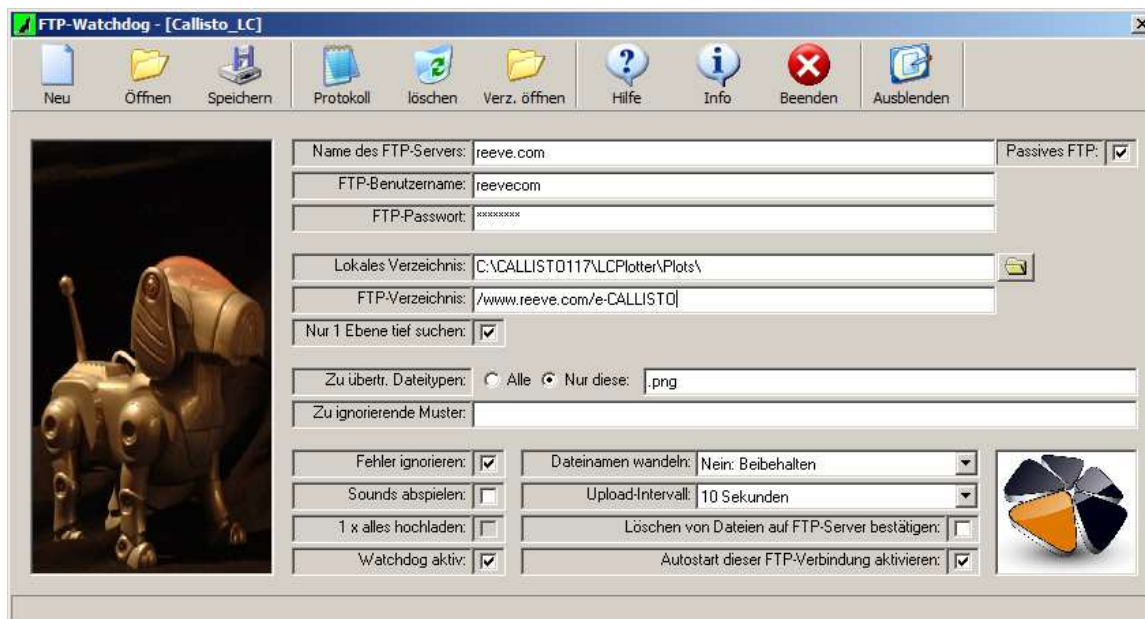


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An FTP-WatchDog Settings file is provided on the CD for sending FITS files to FHNW but, as above, the Local Directory setting will need to be changed. It is necessary to obtain a password as discussed above and insert it in the FTP-Password field. Put the Settings files in the same folder as the FTP-WatchDog application software. Load the Settings file into FTP-WatchDog and then make the necessary adjustment.

Note: It is not necessary to setup a shortcut in the Windows Startup folder to automatically run FTP-WatchDog when the PC reboots. FTP-WatchDog's built-in Autostart function is the preferred method (Autostart Enabled is checked). If Autostart Enabled is checked, DO NOT put a shortcut to FTP-WatchDog in the Windows Startup folder.

FTP-WatchDog also can be used to send lightcurve image files to a web server. An example setup is shown below. The settings shown are not the ones you will use, they are only an example. Note: At this time PERL-FTP cannot be used to send lightcurve image files to a web server.



F.4 Alternate Data Transfer Methods

PERL-FTP and FTP-WatchDog provide automatic methods for transferring data files. It may be necessary to manually transfer files for some reason (for example, if the server is temporarily out of service). In this case, the Windows built-in FTP client application or a standalone application program may be used. To use the Windows FTP client function:

1. Click Start – Run....
2. Type cmd – OK to obtain a DOS Command Prompt window
2. Change to your local directory containing FITS data files (for example, "cd c:\callisto\data")

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3. Start the Windows FTP client and send data as follows. Press Enter at end of each line below:

```
ftp -i ftpexchange.imvs.technik.fhnw.ch
user=solararadio
password=***** (replace ***** with password obtained as specified above)
binary
mput *.fit
bye
exit
```

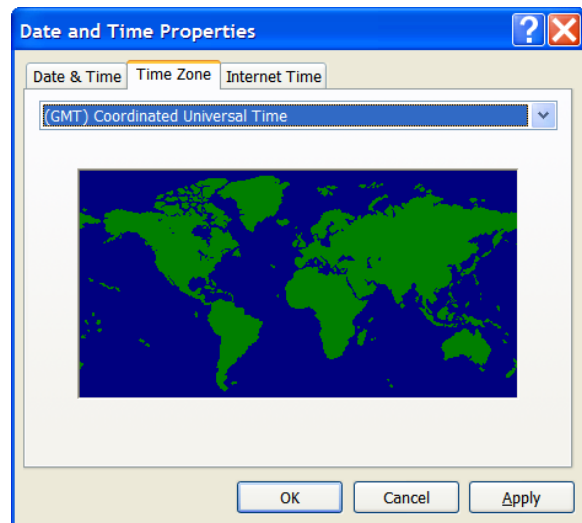
If you use the FireFox web browser, you can install a free FTP client Extension called FireFTP (<http://fireftp.mozdev.org/>), in which case you do not need to use the DOS commands described above. Another free FTP client application program is WinSCP (<http://winscp.net/eng/index.php>).

G. PC Real-Time Clock Synchronization

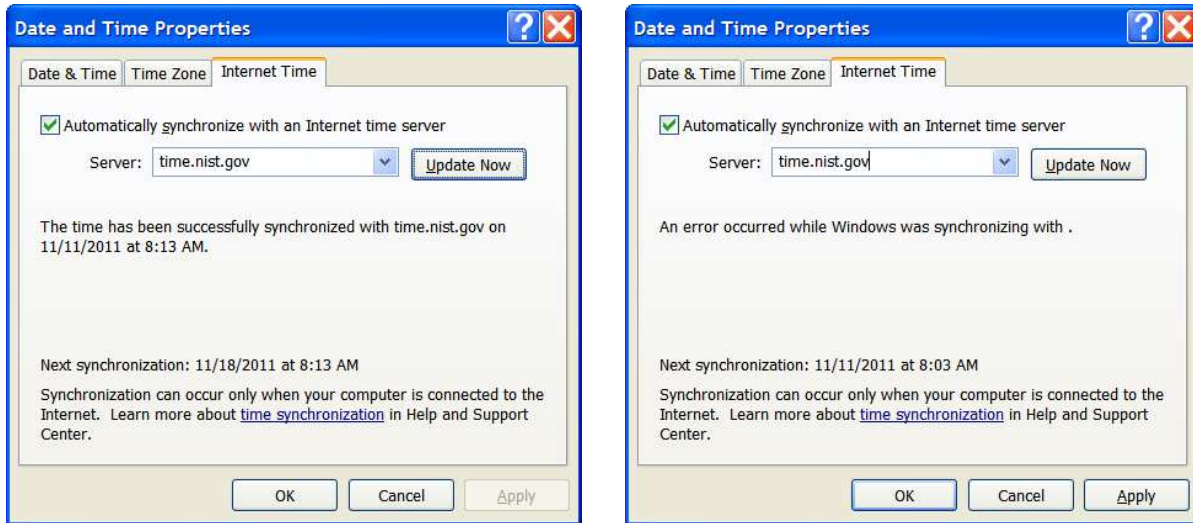
G.1 Introduction

Callisto uses the host PC's real-time clock for time-keeping purposes. The clock should be set to Coordinated Universal Time (UTC). Do this now: Click on Start – Control Panel – Date and Time. Select the Time Zone tab and from the drop-down list select *(GMT) Coordinated Universal Time* (below-right).

It is very important that the PC clock is accurate at all times, especially during data collection. As mentioned above Windows has built-in *Internet Time* synchronization capability but it may not be turned on. First, make sure your PC is connected to the internet, and then determine if your system has Internet Time synchronization capability, then click Start – Control Panel – Date and Time. Select the Internet Time tab, if it exists, and then check the box *Automatically synchronize with an Internet time server*. If available, select *time.nist.gov* server and then *Update Now*. Wait a moment. If the update is successful you will see a screen similar to below-left. If not, you will see an error similar to below-right. In case of failure, try another server. By default Windows has only two time servers available in the drop-down list but more can be added as discussed below. The update could fail for any number of reasons, one of which could be the time server is too busy. You could either troubleshoot or install an alternative software tool as described in the next section.



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If you decide to use the Windows Time service to update your PC clock, you should beware of its default settings. The default update interval is 604800 seconds, or 7 days. This is not nearly frequent enough for most PCs and useless for data collection. The default update interval can be changed through a Registry edit as follows:

- ☼ Start – Run...
- ☼ Type Regedit – OK
- ☼ Select: `HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Services\W32Time\TimeProviders\NtpClient`
- ☼ Right-click *SpecialPollInterval* and select *Modify*
- ☼ Select the *Decimal* radio button in Base
- ☼ Change the default decimal value from 604800 seconds to some other value. The value to be used depends on the drift rate of the PC clock. Typically, you would set it to update the clock at 10 to 60 minute intervals (example, for 15 minutes update rate, set the value to 900)
- ☼ Click OK

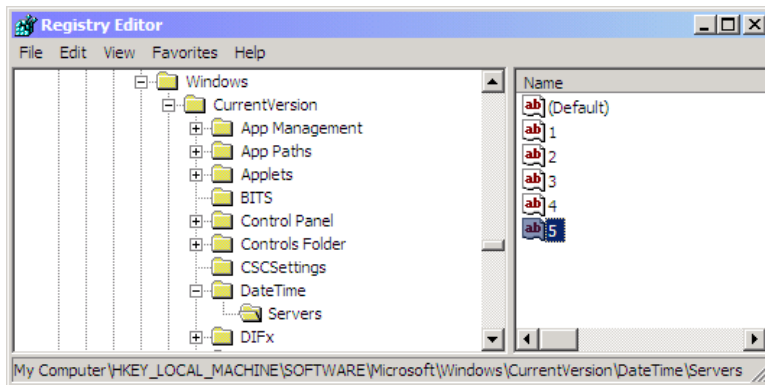
In addition to setting the update interval, you should add time servers to the drop-down list on the Internet Time tab. This requires another registry edit as follows:

- ☼ Go to the NIST website that lists NIST Internet time servers and shows their status: <http://tf.nist.gov/tf-cgi/servers.cgi> (Note: This website lists only NIST time servers; there are many other time servers throughout the world). Pick a time server that is geographically close to your location and is shown as “All services available”. Do not pick servers marked “... not recommended”
- ☼ On the PC, Start – Run...
- ☼ Type Regedit – OK
- ☼ Select:
`HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\DateTime\Servers`
- ☼ Right-click the right-hand panel and select *New – String Value*. Name it the next number in sequence (usually 3 in XP and 6 in Windows 7).

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- ☀ Right-click the new string and select *Modify*. Type in the *Value data* field the hostname or IP address of the time server you selected above
- ☀ Click OK
- ☀ Repeat the above steps to add two more servers. The screenshot below shows that a total of 5 servers are listed
- ☀ You can change the default server by setting the value of *(Default)* to the entry number of the desired time server. For example, if you want '3' as the default time server, right-click the *(Default)* string, select *Modify* and enter 3 in the *Value data* field

After you have added servers, go back to the Internet Time tab and check that the new servers are available on the Server: drop-down list. You may select one and click Update to test it.



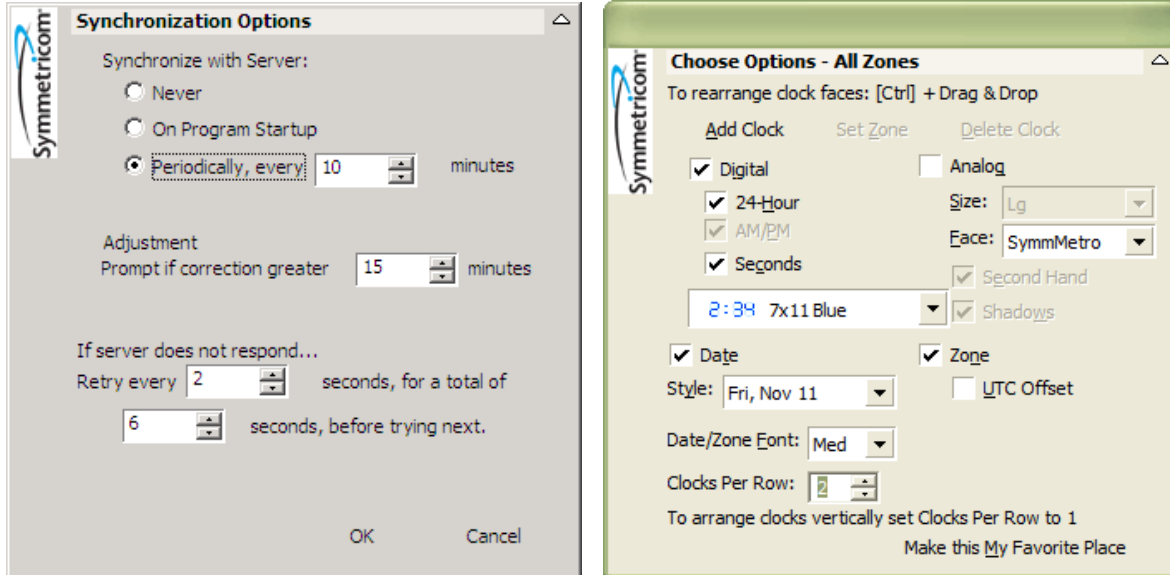
G.2 SymmTime Application

Your version of Windows may not have the *Internet Time* tab described above or it may not be reliable or you may not want to use it, in which case SymmTime by Symmetricom is a good alternative. If you choose not to use the Windows Time service, you should uncheck *Automatically synchronize with an internet time server* in Windows Date and Time properties. You still should set your PC's clock to GMT/UTC as previously described regardless of the application that handles time synchronization. You can configure SymmTime to display both UTC and local time.

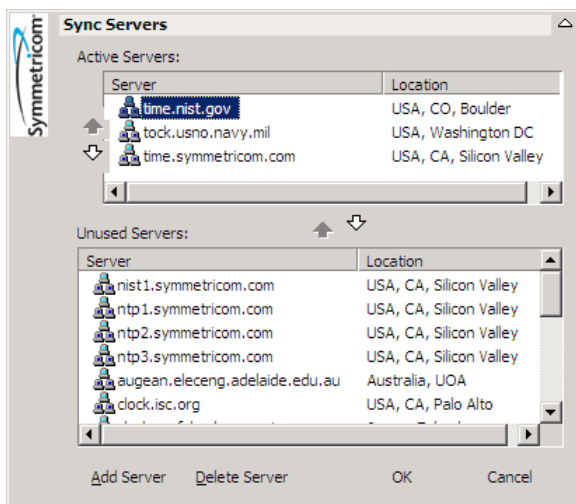
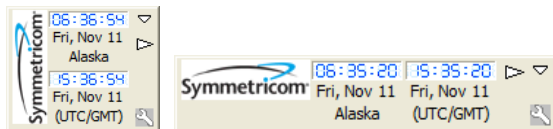
Note: Symmetricom discontinued support for SymmTime in mid-2012, presumably because it is incompatible with Windows 7 (64-bit) and 8. However, it still is available on the internet (the last version is 4.10) and it works fine with Windows 2000, XP and 7 (32-bit).

After downloading and installing the SymmTime application, it should start and run. You should see a small round clock icon on the Windows taskbar. Right-click the SymmTime window and select *Sync Options...* Under the *Synchronize with Server* setting select the radio button *Periodically, every xx minutes*, where xx is your desired update interval, typically 10 to 60 minutes (below-left). Click OK when done.

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Right-click the SymmTime window again and select *View Options...* (above-right). Setting up various time zone displays is self-explanatory (or you can use the *Help...* function), but you should setup two time displays, one to show UTC/GMT and another to show your local time. Note that the time zone displays are simply that – displays. The PC TOD clock itself is governed according to the settings previously described. You can setup the two time displays in a horizontal or vertical format (below-left and -right).

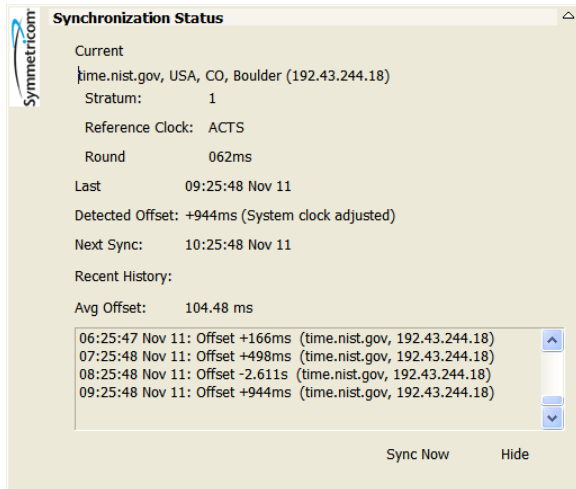


SymmTime can access any public time server. The default time server settings should be fine but you can change them. Right-click the SymmTime window and select *Sync Servers....* You will see a scroll-list of *Unused Servers* in the bottom frame (left). You can customize the list by using the *Add Server* and *Delete Server* selections at the bottom. You also can add or delete servers to the *Active Servers* in the top frame by selecting a server and then clicking on the arrows between the two frames. The individual servers are quite reliable but you can place several in the *Active Server* list. This way, if SymmTime is unable to contact the first one on the list, it will attempt to

contact the next one, and so on. It has been my experience that, if SymmTime cannot contact one of the listed public servers, the problem lies in the PC or its access to the internet and all other time servers are similarly inaccessible. When SymmTime is unable to contact the servers the clock icon in the Windows taskbar will flash red.

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The last step is to place SymmTime in the Windows Startup folder. This will ensure that SymmTime starts automatically when the PC is rebooted. One way of doing this is to go to the Program Files folder where SymmTime is installed (typically c:\Program Files\Symmetricom\Symmtime\). Right-click and drag the file GetTime.exe to Start – All Programs – Startup. That places a shortcut in the Startup folder, and it will automatically run whenever the PC reboots or is started.



G.3 Periodic Checks

After SymmTime setup is completed, you can check the amount of correction made when SymmTime queries the time server. You should let SymmTime run at least 24 hours before making this check. Right-click on the SymmTime window and select *Sync Status...* The window that opens shows some statistics including the average clock offset and recent history (left). Just below the *Avg Offset* value is a *Recent History* frame. It shows the correction made during each time query. It also will indicate if the time server

is unreachable for any reason. If you find that the update rate is too frequent or too infrequent, adjust the *Synchronize with Server* setting in *Sync Options...* as previously described.

If the PC is runs only during observations, daylight or during certain hours, it is necessary to resynchronize the PC TOD clock each time the PC is started. If you use SymmTime and set it up as described above, it will automatically resynchronize the clock within the interval specified in *Sync Options...* – *Periodically, every xx minutes*. Therefore, if your setting (xx) is 10 minutes, the program will resynchronize the PC clock within 10 minutes after SymmTime is loaded.

H. M9703A Plotter

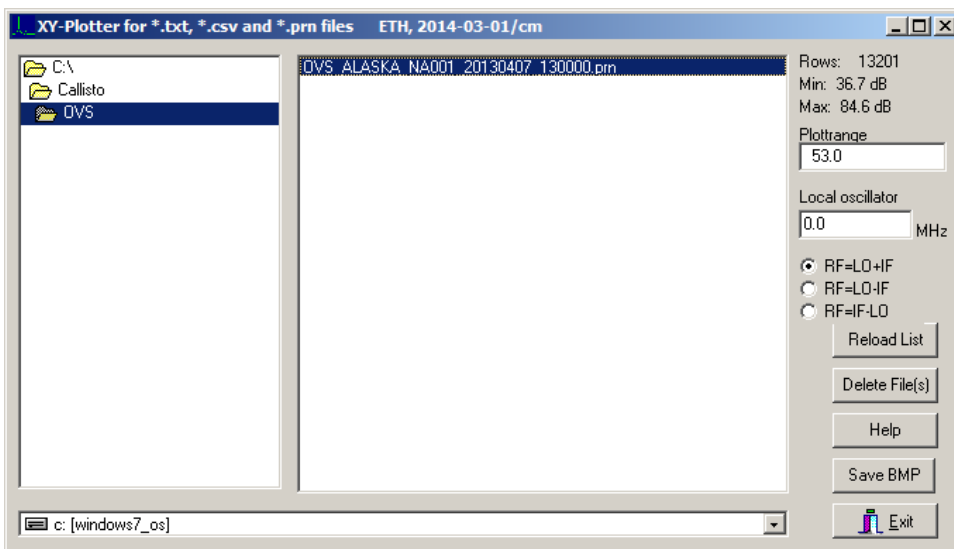
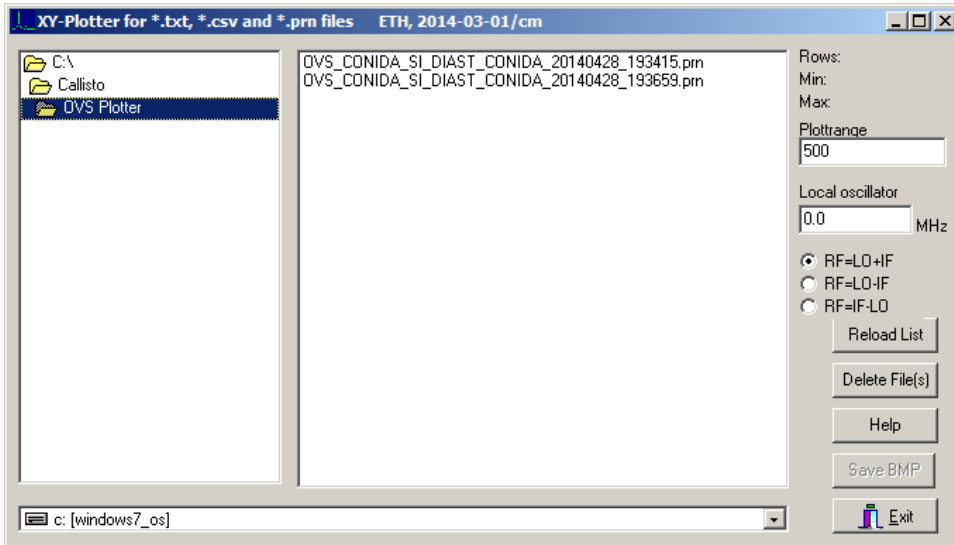
H.1 Introduction

The M9703APlotter tool provides a convenient way to quickly plot the spectral overview (OVS) files (or other files with .prn or .csv extension). To install the tool, find *M9703APlotter.zip* on the software CD and unzip the following files to a folder such as C:\Callisto\OVS Plotter:

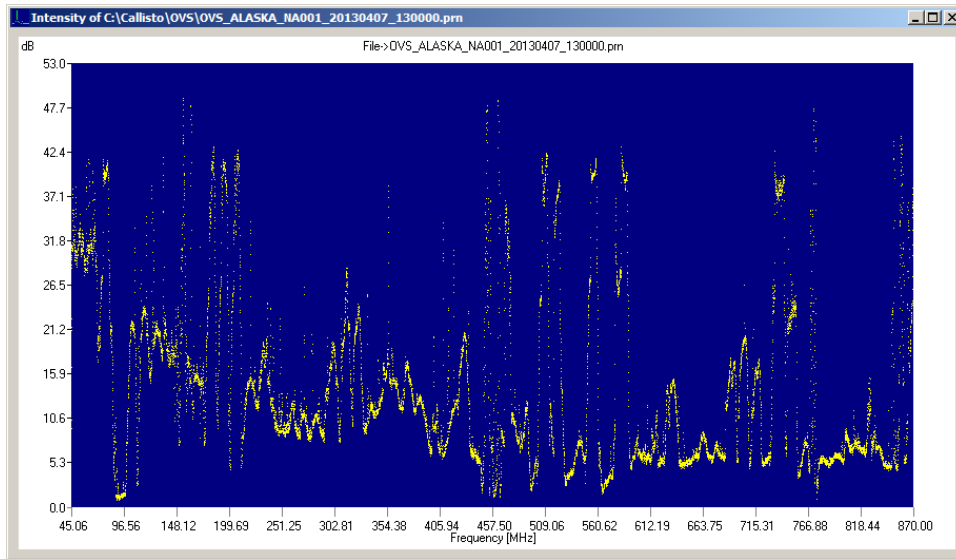
M9703APlotter.exe, M9703APlotter.bpr, M9703APlotter.cgl, M9703APlotter.cpp

When M9703A.exe is opened, two windows appear, a blank plot and folder navigation (see screenshots below). The folder navigation window defaults to the folder that holds the M9703APlotter.exe file. The mouse is used to navigate to the folder that holds the OVS files to be viewed, or the OVS files may be copied to the default plotter folder. If additional OVS files are placed in the default folder after the plotter is opened, it is necessary to click Reload List.

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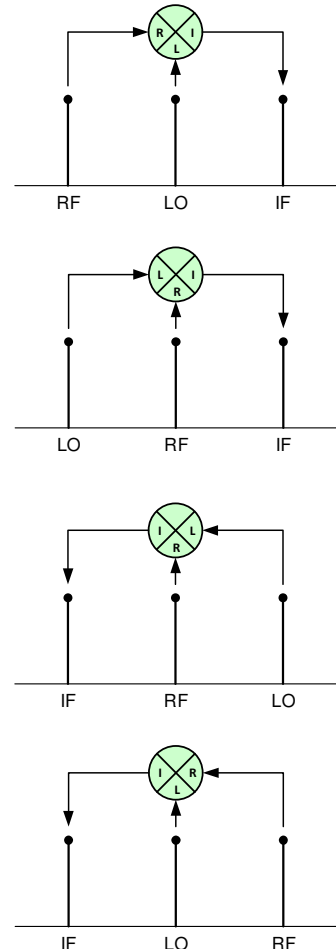
A plot of the file appears in the plot window immediately when a file is selected. Selected files may be deleted by clicking Delete File(s) and a displayed file may be saved as a bit-map image by clicking Save BMP. Exit the program by clicking Exit.

The plot vertical scale is in dB with 0 dB denoting the minimum value in the OVS file. The vertical scale range is automatically calculated for each OVS file as it is plotted, but the scale may be manually adjusted by entering a value into the Plorange field. Above this field are the number of rows in the OVS file (same as number of frequency channels) and the minimum and maximum with respect to loading of the Callisto analog-digital converter (ADC).

The folder navigation window includes three radio buttons, RF=LO+IF, RF=LO-IF and RF=IF-LO, and a local oscillator field. For standalone Callisto observations (no external up- or down-converter), the local oscillator value is 0.0 MHz and either RF=IF-LO or RF=LO+IF radio button may be selected (RF=LO+IF is default).

Where an external heterodyne converter is used with the CALLISTO instrument, the IF refers to the converter output frequency (Callisto input frequency after up- or down-conversion, which must be in the range 45 to 870 MHz) and RF refers to the converter input frequency. The radio button and local oscillator settings depend on the configuration (see also illustration right):

- ⚙ Up-converter with high-side local oscillator:
 $RF < LO < IF$
 Radio button setting RF=IF-LO, local oscillator = LO



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- ⚙ Up-converter with low-side local oscillator:
 $LO < RF < IF$
Radio button setting $RF=IF-LO$, local oscillator = LO
- ⚙ Down-converter with high-side local oscillator:
 $IF < RF < LO$
Radio button setting $RF=LO-IF$, local oscillator = LO
- ⚙ Down-converter with low-side local oscillator:
 $IF < LO < RF$
Radio button setting $RF=LO+IF$, local oscillator = LO

The example of the UPC-1 up-converter is shown below. The UPC-1 uses a high-side local oscillator with $RF = 20$ to 90 MHz, $LO = 200$ MHz and $IF = 220$ to 290 MHz. Therefore, the setting is $RF=IF-LO$ and local oscillator = 200.0 . Because the plot is based on the full frequency range of the Callisto instrument, it shows the correct image of the up-converter bandpass but also shows images due to LO harmonics (figure a). In the case of the UPC-1, the correct image frequencies are seen between 20 and 90 MHz, as expected, but additional image frequencies are seen at negative frequencies and at frequencies above 90 MHz. When the same OVS file is plotted with local oscillator = 0.0 MHz, the plot is identical except for the x-axis frequency range is Callisto's native frequency range (figure b).

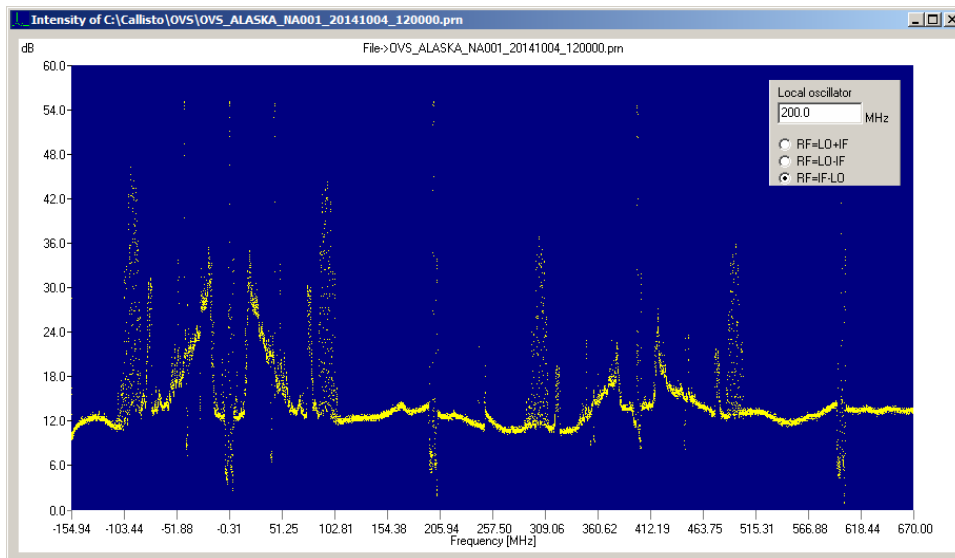


Figure a ~ Plot of Callisto spectrum when used with a UPC-1 up-converter with inset from the navigation window showing the 200 MHz local oscillator and radio button setting. The x-axis frequency scale is shifted by the 200 MHz local oscillator setting.

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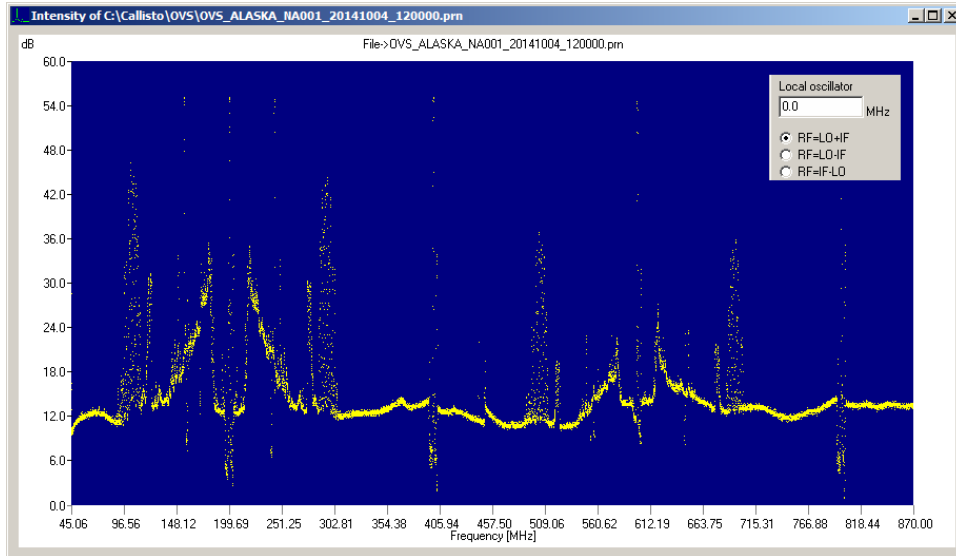


Figure b ~ Plot of Callisto spectrum when used with a UPC-1 up-converter with inset from the navigation window showing the 0.0 MHz local oscillator and radio button setting. This plot shows the native frequency range on the x-axis. The IF output from the up-converter covers the range 220 to 290 MHz, and image frequencies can be seen above and below that range..

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VI. Additional Operating Notes and Tips

- ☀ Do not leave an audio cable connected to the CALLISTO Receiver Video jack (it affects the integration time of the log detector)
- ☀ Use high-quality coaxial cable and RF connectors for all antenna connections
- ☀ Put the CALLISTO Receiver into a separate metal box (for example, 19" cabinet) to reduce RFI
- ☀ Run all cables from/to the CALLISTO Receiver through individual ferrite cores to reduce RFI
- ☀ Keep EIA-232 cable as short as possible and use a well shielded cable
- ☀ Configure every COM port on the PC only once at a given time
- ☀ If spectrum 'jumps', try disabling RX- and TX-FIFO in COM-port configuration
- ☀ Do not forget last backslash ('\') in path-description in configuration files
- ☀ Do not change format of parameter keywords in configuration files
- ☀ Frequency file keyword must have exactly 4 digits within brackets, [nnnn]=
- ☀ Use only lower-case letters in all keywords in the Frequency file
- ☀ Do not use a space character in configuration parameters, use underscore instead
- ☀ Keep the number of open applications on the PC as low as possible
- ☀ Configure all PC peripherals for Always On (no sleep activities or power down)
- ☀ Turn Off hibernation (Windows XP/2000/7/10/11 power management)
- ☀ Set time and date regional format on PC to 24 hours (no AM/PM) and time zone to UTC or GMT for compliance with Scheduler configuration file
- ☀ Periodically check PC time to ensure it is being synchronized to UTC
- ☀ Turn Off Windows indexing (Microsoft Office)
- ☀ If possible, exclude data- and log-folders used by Callisto from anti-virus scanner
- ☀ Before connecting an external clock to the CALLISTO Receiver, be sure to have frequency, amplitude and dc offset set to appropriate values: TTL-clock 0V/+5V at 1 MHz, duty cycle 50%, zero dc offset
- ☀ If Callisto is locked to an external 1 MHz clock and if Callisto freezes (non-responsive), remove the clock cable, switch CALLISTO Receiver off, reconnect clock, and switch Callisto on again
- ☀ In case of blockades (freeze) due to an overloaded PC, terminate the application or kill it using Task Manager, cycle power to CALLISTO Receiver and restart callisto.exe
- ☀ Change Windows 2000/XP/7 desktop appearance to 'windows classic' (like Windows 95); in Windows 10/11 use Classic Shell from classicshell.net
- ☀ Set System Properties to "Adjust for best performance" (System Properties – Advanced – Performance Settings)
- ☀ Set Display Properties – Appearance tab – font size to Normal
- ☀ If Callisto does not start, change compatibility mode to 'Win9x'
- ☀ Put a Shortcut to callisto.exe into the Windows Start menu
- ☀ In Automatic Updates control panel, set to *Notify me but don't automatically download or install them*
- ☀ Setup virus scanner and firewall to prevent automatic reboot after updates. Setup anti-virus scanner and firewall to run after sunset or when Callisto is not collecting data
- ☀ Use different focus code if you have two or more CALLISTO Receivers running on the same computer, for example, 59 for the 1st and 58 for the 2nd. Otherwise, it is not possible to store fits-data on the same drive
- ☀ Prepare separate log and data folders for each CALLISTO Receiver, one for 1st and another for the 2nd Callisto, and so on
- ☀ If Callisto freezes (non-responsive) after PC reboot, switch off CALLISTO Receiver and close Callisto software, switch on Receiver and open Callisto. As a matter of procedure it is best to switch off CALLISTO Receiver during PC reboot and then switch it back on after boot process is finished
- ☀ In Windows 7/10/11, do not run Callisto software from the Users folder (c:\Users\) or any of its subfolders
- ☀ In Windows 7/10/11, it may be necessary to turn off or reduce the FIFO buffers for the USB port
- ☀ In Windows 10/11, either disable updates or always install pending updates
- ☀ If Windows 11 refuses to install any of the applications needed for Callisto, simply select 'Install anyway'

Continued on Next Page ...

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- ☀ Disable disk drive caching as follows: Open *Device Manager*, click on > next to *Disk drives* to open the list of drives; right-click the drive that is used as the main system drive and select *Properties*, select the *Policies* tab, and uncheck *Enable write caching on the device*. Click OK.
-

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Appendix A: ASCII Commands for Receiver Control (courtesy Christian Monstein)

Important note: Always use ENTER key from number-keypad and not standard ENTER from main – keyboard unless the terminal emulator program (for example, HyperTerminal) is setup to send CR/LF! Otherwise Callisto will not understand commands (CR instead of CR/LF). All commands are upper-case.

A.1 Common commands

Command	Ex.	Description
Frequency-programming Receiver #0	F0x	Set main tuner (0) with frequency x, where x=frequency [MHz]
Store frequency entry in EEPROM	FEadr,db1,db2,cb,bb	adr = EEPROM-address or channel number for frequency table (1...500) db1 = [(frequency + IF2 + LO)/synthesizer_resolution]/256 db2 = [(frequency + IF2 + LO)/synthesizer_resolution]%256 cb = tuner control byte, see CD1316* datasheet bb = tuner band control byte, 1 of 3 bands, see CD1316* datasheet where frequency = observation frequency, 45.0 870 (MHz) IF2 = 10.7 (MHz) LO = 27.0 (MHz) for firmware ≤ 1.7, 25.43 (MHz) for firmware ≥ V1.8 synthesizer_resolution = 62.5 KHz
Read frequency number x and code	FRx	x=channel number, 0 ~ x < 500 result frequency and FPU-Code To get a response, set debug mode on <D1>
Set low band barrier of the tuner	FLx	x=frequency of the lowest switch barrier, see tuner specification somewhere near 175MHz
Set mid band barrier of the tuner	FMx	x=frequency of the middle switch barrier, see tuner specification somewhere near 450MHz
Set high band barrier of the tuner	FHx	x=frequency of the highest switch barrier, see tuner specification somewhere near 870MHz
Measuring delay	Mx	x measuring delay in msec or number of m-points per second [TBD]
Set repeat frequency of state machine using internal clock	GSx	Set frequency in asynchronous mode x=0-5 (choose 1.0Hz; 50Hz; 200Hz, 400Hz or 800Hz) For response, press <?>
Set repeat frequency of state machine using external clock	GAx	Set frequency in synchronous mode x=0-2 (choose 20Hz; 200Hz or 400Hz /stored in the internal EEPROM) For response, press <?>
Sweep length or number of channels	Lx	Number of channels to be measured in one sweep, 1<= x <=13'120

A.2 Measurement commands

Command	Ex.	Description
Stop data transfer of state machine	GD	Disable the data transfer between host and client of the state machine
Start data transfer of state machine	GE	Enable the data transfer between host and client of the state machine
Tuner gain	Oxxx	PWM voltage to tuner expressed in digits 0...255 For PWM-value, see sensitivity plot To check tuner AGC-voltage, press <U2>
Process stop	P0	Stop continuous recording to the end of actual sweep
Process continuous	P1	Start continuous recording with beginning of next sweep
Process single sweep real data	P2	Start one single sweep from F1 to F2
Process single step+	+	Next step in actual frequency program +62.5kHz

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Process single step-	-	One step back in actual frequency program -62.5kHz
Trigger via software	T0	Host controller starts a single measurement
Trigger via timer	T1	Local timer start measurements controlled by quartz crystal 11.0592MHz
Trigger extern	T2	Measurement is controlled by an external event such as a GPS, atomic clock or DCF77 (1 MHz, TTL source)
Start measuring process	S1	Start the parallel or the alternating measuring mode (state machine)
Stop measuring process	S0	Stop the parallel or the alternating measuring mode (state machine)

A.3 House keeping commands

Command	Ex.	Description
Charge pump off	C0	Low charge for low phase noise on both tuner but low frequency changing
Charge pump on	C1	High charge in PLL for high frequency changing
Measure AGC voltage	U2	Gain control tuner, set voltage by command <Oxxx>
spare	U3	spare
Measure emitter voltage	U4	Test voltage at emitter BF199
spare	U5	spare
Measure input voltage	U6	10/37 of input voltage after diode and fuse
spare	U7	spare

A.4 General single commands

Command	Ex.	Description
Clear bit	Cxy	Set any bit to 0 (0Volt) Port x=A,B,C,D, Bit y=0,1,2,3,4,5,6,7
Debugging off	D0	Don't send any additional info to the host controller
Debugging on	D1	Send all relevant info to the host controller
Get status	?	Dump all relevant system information back to host controller
Read Port x	Rx	Read any Port (A, B, C, D), answer 0...255
Read ADC channel x	Ax	Read any ADC, answer 10 bit reduced to 8 bit expressed in HEX 0 <= x <= 7
Set bit at Port x, Bit y	Sxy	Set any bit to 1 (5Volt), x=A,B,C,D; y=0,1,2,3,4,5,6,7
Set focus code. See Appendix E	fsxy	Switch rf-path (antenna, calibration unit and hybrids). Code x, y=00...63 decimal [use lowercase letters here!!!]
Set data format	%0	Decimal 10 bit
Set data format	%1	Decimal 8 bit
Set data format	%2	Decimal milli Volt
Set data format	%3	HEX 8 bit including carriage return between data elements
Set data format	%4	HEX 8 bit without carriage return in between (default binary format no header)
Set data format	%5	Send frequency and decimal 8bit

Example: Measuring a full channel overview using HyperTerminal

Choose Capture file on HyperTerminal menu and save it as filename.txt

D1 (enable debug)
 O120 (default gain)
 T0 (software trigger)
 M1 (select delay to 1msec or any other >= 1msec)
 F0045.0 (set start frequency)
 L13200 (measure 13200 points, 62.5 kHz step size, from 45 MHz to 870 MHz)
 %5 (send frequency and voltage in spreadsheet format)
 ? (get status to get all relevant parameters)

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P2 (start a single sweep)

... (now incoming data are stored on disk, wait a few seconds...)

Close actual capture file and start EXCEL or any other spreadsheet, load file.txt and make a XY-plot

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Appendix B: Scheduler Configuration File Measurement Modes

The highlighted modes are the most common.

Code	Measurement mode
0	Stop actual mode and go to idle. No data will be stored while in this mode. Scheduler waits for another entry
1	Spare code
2	Calibration mode. Save measured data, calibrated in SFU, to local disc. Storage is compressed as $45 * \log(S+10)$. Calibration parameter file needed!
3	Continuous recording mode. Uncalibrated sampled data at frequencies specified in the Frequency file are stored in raw format (digits) with 8-bit resolution at the location specified in Callisto Configuration file
4	Spare code
5	Spare code
6	Spare code
7	Terminate application program, go back to operating system (this mode is dangerous and is disabled within Callisto)
8	Automatic spectral overview OVS for periodic radio monitoring and other purposes (for example, CRAF)
9	Spare code

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Appendix C: Possible Data Rates (courtesy Christian Monstein)

Internal Clock Only		
Pixels/s (Note 1)	Mps (Note 2)	Sps (Note 3)
40	1	40
	2	20
	4	10
	5	8
100	10	10
	20	5
	50	2
400	10	40
	20	20
	50	8
	100	4
	200	2
	400	1
800	20	40
	40	20
	50	16
	100	8
	200	4
	400	2

External Clock Only (1 MHz TTL)		
Pixels/s (Note 1)	Mps (Note 2)	Sps (Note 3)
40	1	40
	2	20
	4	10
	5	8
100	10	10
	20	5
	50	2
400	10	40
	20	20
	50	8
	100	4
	200	2
	400	1
800	20	40
	40	20
	50	16
	100	8
	200	4
	400	2
1000	20	50
	100	10
	200	5
	250	4
	500	2

Notes:

1. Pixels/s = Mps x SPS
2. Mps = Measurements per sweep, $1 \leq Mps \leq 500$, integer value only
Same as [number_of_measurements_per_sweep] parameter in the Frequency file
3. Sps = Sweeps per second, integer > 0
Same as [number_of_sweeps_per_second] parameter in the Frequency file
4. Speeds above 800 Pixels/s are not recommended due to the finite response time of the synthesizer
5. Default value is 800 Pixels/s (200 Mps x 4 Sps)

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Appendix D: Up-Converter and Down-Converter Applications

For example, say an up-converter is used that covers 20 ~ 90 MHz and has a 200 MHz local oscillator, and the up-converter IF output to the CALLISTO Receiver is the sum in the range 220 ~ 290 MHz. To record data at the correct frequencies (20 ~ 90 MHz), the [external_lo] parameter would be set to 200.000000. Callisto subtracts this offset from the actual CALLISTO Receiver frequencies and displays the correct range of 20 ~ 90 MHz.

Before attempting to setup the Converter, refer to the detailed instructions for the Frequency Genie software tool. Setup the Converter according to the steps below, while referring to the screenshots immediately following.

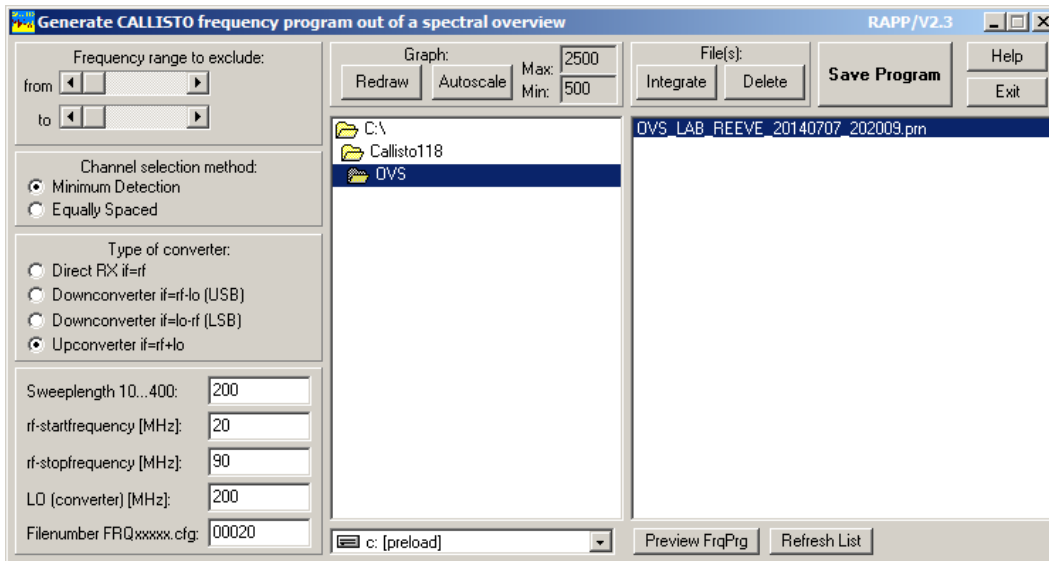
1. Connect all equipment including the antenna; double-check all RF and power connections and power supply voltages
2. Apply power to Converter, Callisto and preamplifiers (TMA)
3. Open callisto.exe and obtain a spectral overview (OVS) of the sky. This records the sky noise power at each frequency within Callisto's frequency range 45 to 870 MHz with 62.5 kHz resolution. This range includes frequencies within the up-converter IF output range. When finished with this step close callisto.exe
4. Open the Frequency Genie software tool and load the spectral overview from step 3
5. For the UPC-1 up-converter, setup Frequency Genie as follows.
Channel selection method: Minimum detection (see note)
Type of converter: Upconverter (IF=RF+LO)
Sweeplength: 200
RF Startfrequency (MHz): 20
RF Stopfrequency (MHz): 90
LO (converter)(MHz): 200
Filename FRQxxxxx.cfg: 00000 to 99999 (example, 00020)

Note: To prepare a frequency list based only on equal spacing of the channels, select Equally Spaced; however, strong radio frequency interference (RFI) may exist on some channels and the frequency list with equal spacing may require manual editing.

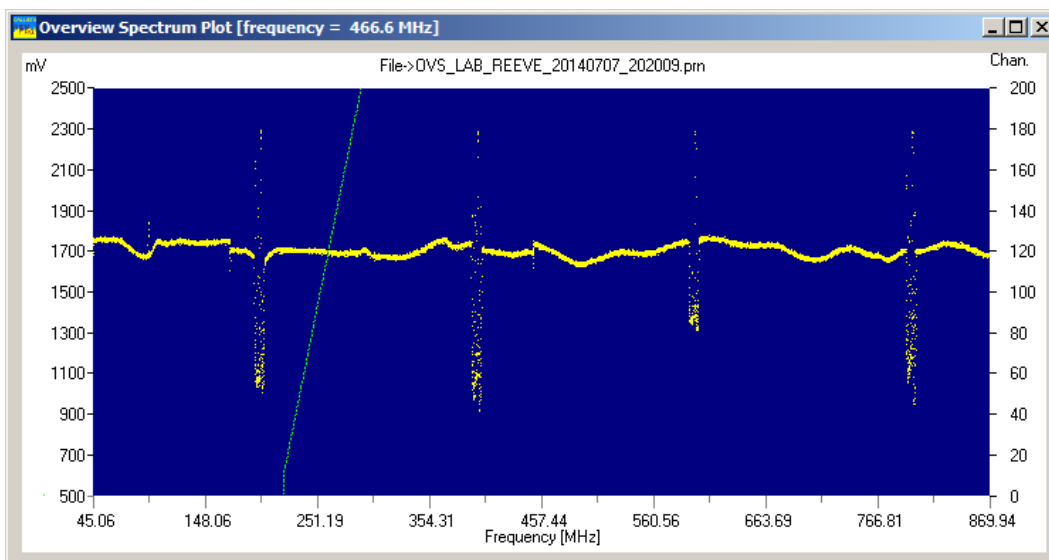
6. To view the frequency range on the Spectral Overview, click the Preview FrqPrg button on lower-right of the Frequency Genie main window. The programmed frequency range will be shown as a green slanted line
7. Click the Save Program button on the upper-right of the main window to generate the frequency list
8. Move or copy the frequency list file to the same folder as callisto.exe
9. Edit callisto.cfg parameter [frqfile] to use the frequency file from step 7. It may be necessary to reduce the Callisto gain parameter [agclevel] due to the gain of the up-converter. A new setting will have to be found experimentally and will depend on whether or not a preamplifier is used. Finally, change the focus code parameter [focuscode]; suggested code is 58.
10. Edit scheduler.cfg for the desired observing schedule

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11. Open callisto.exe. It will automatically load the new frequency file
12. If callisto.cfg is not setup for automatic execution, manually start the new observation. When the Automatic radio button is selected, Callisto will observe according to the scheduler.cfg file setup in step 10
13. On the callisto.exe main window, click on Spectrum $y(f)$ to view the spectrum of the programmed frequency range

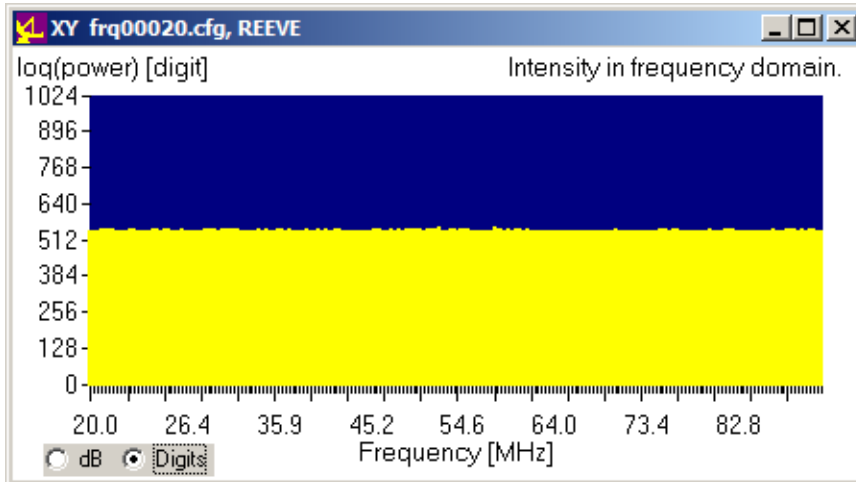


Frequency Genie main window showing setup for an up-converter with 200 MHz LO and 20 to 90 MHz RF input



Spectrum plot from Frequency Genie showing spectrum for the OVS. The upward slanted green line is the programmed frequency range. The spikes are LO leakage outside the programmed frequency range.

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Spectrum Y(f) plot from callisto.exe showing the frequency range 20 to 90 MHz for the UPC-1 up-converter with no signal input

```
frq00020.cfg - Notepad
File Edit Format View Help
-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8093 Zurich */
/* */
/* Programname: FRQ00020.cfg [minimum of a spectral overview]*/
/* */
/* Revision: v2.2 Date: 7/7/2014 Autor: Chr. Monstein */
/* */
/* Purpose: Frequencyprogram for Callisto spectrometer */
/* all entries may be edited manually using Notepad... */
/* -----*/

[target]=CALLISTO

[on_line_testpoint_number]=100
[number_of_measurements_per_sweep]=200
[number_of_sweeps_per_second]=4

[external_lo]=-200.000000

[0001]=0020.000,0
[0002]=0020.000,0
[0003]=0020.000,0
[0004]=0020.000,0
[0005]=0020.000,0
[0006]=0020.000,0
[0007]=0020.000,0
[0008]=0020.000,0
[0009]=0020.250,0
[0010]=0020.375,0
[0011]=0021.063,0
[0012]=0021.125,0
[0013]=0021.500,0
[0014]=0021.938,0
[0015]=0022.438,0
[0016]=0022.625,0
```

Part of an example frequency list generated by Frequency Genie with 200 channels/sweep between 20 and 90 MHz and local oscillator of 200 MHz

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Additional examples courtesy of Christian Monstein

Another example: The LO is 100 MHz, the Up-Converter RF input is 8 ~ 74MHz and the IF output is 108 ~ 174MHz. To observe 20 ~ 43MHz:

```
[target]=CALLISTO

[on_line_testpoint_number]=100

[number_of_measurements_per_sweep]=200
[number_of_sweeps_per_second]=4

[external_lo]=-100.000000

[0001]=0020.000,0
[0002]=0020.000,0
[0003]=0020.000,0
[0004]=0020.000,0
[0005]=0020.000,0
....
[0195]=0043.313,0
[0196]=0043.438,0
[0197]=0043.500,0
[0198]=0043.625,0
[0199]=0043.750,0
[0200]=0043.875,0

/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8093 Zurich      */
/*-----*/
/* Programname: FRQ00999.cfg [minimum of a spectral overview]*/
/*-----*/
/* Revision: V2.2 Date: 24.09.2011 Autor: Chr. Monstein      */
/*-----*/
/* Purpose: Frequencyprogram for Callisto spectrometer        */
/* all entries may be edited manually using Notepad...        */
/*-----*/
```

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Example for an S-band down-converter:

```
[target]=CALLISTO

[on_line_testpoint_number]=77

[number_of_measurements_per_sweep]=100
[number_of_sweeps_per_second]=8

[external_lo]=2280.000000

[0001]=2380.000,0
[0002]=2380.000,0
[0003]=2380.000,0
[0004]=2380.000,0
[0005]=2380.000,0
[0006]=2380.000,0
[0007]=2380.000,0
[0008]=2380.000,0
[0009]=2380.375,0
[0010]=2384.188,0
[0011]=2386.375,0
[0012]=2391.375,0
...
[0028]=2495.875,0
[0029]=2500.000,160
[0030]=2502.375,0
...
[0044]=2549.750,0
[0045]=2550.000,160
[0046]=2555.375,0
...
[0060]=2598.625,0
[0061]=2600.000,160
[0062]=2605.375,0
...
[0075]=2645.688,0
[0076]=2650.000,160
[0077]=2654.000,0
...
[0091]=2698.313,0
[0092]=2700.000,160
[0093]=2705.625,0
[0094]=2709.063,0
[0095]=2712.313,0
[0096]=2715.188,0
[0097]=2718.688,0
[0098]=2721.563,0
[0099]=2724.438,0
[0100]=2726.250,0

/*-----*/
/* (C) Copyright Institute of Astronomy ETHZ 8093 Zurich */
/*-----*/
/* Programname: FRQ00255.cfg [minimum of a spectral overview]*/
/* */
/* Revision: V2.2 Date: 18.09.2011 Autor: Chr. Monstein */
/* */
/* Purpose: Frequencyprogram for Callisto spectrometer */
/* all entries may be edited manually using Notepad... */
/*-----*/
```

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Appendix E: Focal Plane Unit Focus Codes (courtesy Christian Monstein)

CALLISTO Receiver focal plane unit antenna and calibration configurations (Note)

Code	Function
63	Left circular polarization, LHCP
62	Right circular polarization, RHCP
61	Spare
60	Spare
59	Linear polarization, dipoles oriented horizontally (most common situation)
58	Linear polarization, dipoles oriented vertically
57	Linear polarization, dipoles oriented north/south
56	Linear polarization, dipoles oriented east/west
55...54	Linear polarization rotating with hour angle on a polar mount (e.g. Siberia)
53...40	Spare
39	Hot noise source 20...30 dB ENR
38	Warm noise source 10...20 dB ENR
37	Cold noise source (50 ohm resistor) at ambient temperature
36...30	Rather cold noise source at temperatures of a Peltier element down to about 200 K
29...20	Very cold noise source at temperatures of liquid gases (nitrogen, helium etc.) < 77 K
19...10	Spare
09...00	Special configurations, e.g. frequency range

Note: Focuscodes are based on 6 bits logic, giving a range of 2^6 possible values (00...63). When these values are used in the Scheduler Configuration file (scheduler.cfg), the corresponding pins on the receiver focal plane unit connector are asserted high (TTL levels) during the time intervals specified. This allows control of an external focal plane unit through the FPU connector on the receiver. Control of a focal plane unit in this manner allows automatic application of a complete series of antenna or calibration configurations. These configurations can then be used for an automated calibration post-process.

The six control leads in the FPU connector are pins 16 (LSB), 17, 18, 19, 20 and 21 (MSB) of the FPU connector. See the CALLISTO Construction Manual for more detailed pin-out information and logic table.

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Appendix F: Description of FITS file header (courtesy Christian Monstein)

The following header information is stored in every FITS file. The FITS file is composed of four parts: (1) Header as printed below; (2) Binary spectrum; and (3), (4) Two BIN tables. One BIN table is for the time axis the other for the frequency axis.

```
SIMPLE      = T                / file does conform to FITS standard
BITPIX     = 16               / number of bits per data pixel
NAXIS      = 2                / number of data axes
NAXIS1     = 631              / length of data axis 1
NAXIS2     = 200              / length of data axis 2
EXTEND     = T                / FITS dataset may contain extensions
COMMENT    = 'Warning: the value of CDELT1 may be rounded!'
COMMENT    = 'Warning: the frequency axis may not be regular!'
COMMENT    = 'Warning: the value of CDELT2 may be rounded!'
COMMENT    = ' '                / empty comment
DATE       = '2004-12-06'     / Time of observation
CONTENT    = '2004/12/06 Radio flux density (BLENSM)' / Title of image
ORIGIN     = 'ETH Zurich Switzerland' / Organization name
TELESCOP   = 'Radio Spectrometer' / Type of instrument
INSTRUME   = 'LAB '          / Name of the spectrometer
OBJECT     = 'Sun'            / object description
DATE-OBS   = '2004/12/06'     / Date observation starts
TIME-OBS   = '12:45:23.382'   / Time observation starts
DATE-END   = '2004/12/06'     / date observation ends
TIME-END   = '12:50:38'       / time observation ends
BZERO     = 0.                / scaling offset
BSCALE     = 1.                / scaling factor
BUNIT      = 'digits '        / z-axis title
DATAMIN    = 0                 / minimum element in image
DATAMAX    = 255               / maximum element in image
CRVAL1     = 45923.            / value on axis 1 at reference pixel [sec]
CRPIX1     = 0                 / reference pixel of axis 1
CTYPE1     = 'Time [UT] '      / title of axis 1
CDELT1     = 0.5               / step between first and second element in x-axis
CRVAL2     = 200.              / value on axis 2 at the reference pixel
CRPIX2     = 0                 / reference pixel of axis 2
CTYPE2     = 'Frequency [MHz] ' / title of axis 2
CDELT2     = -1.               / step between first and second element in axis
HISTORY    = ' '
OBS_LAT    = 47.3412284851074 / observatory latitude in degrees
OBS_LAC    = 'N '              / observatory latitude code {N,S}
OBS_LON    = 8.11221504211426 / observatory longitude in degrees
OBS_LOC    = 'E '              / observatory longitude code {E,W}
OBS_ALT    = 416.5             / observatory altitude in meter asl
FRQFILE    = FRQ00021.CFG      / name of the frequency file
PWM_VAL    = 120               / pwm-value to control tuner gain voltage
END
```

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Appendix G: Example of Logfile (courtesy Christian Monstein)

Date of event	Time of event	Signal source	Event description
23.01.2004,	15:11:09,	\$HST:	Configurationfile callisto.cfg read
23.01.2004,	15:11:09,	\$HST:	Switched to automatic
23.01.2004,	15:11:09,	\$HST:	Frequencyfile frq00100.cfg
23.01.2004,	15:11:10,	\$HST:	Measurement idle
23.01.2004,	15:11:10,	\$HST:	File scheduler.cfg successful read
23.01.2004,	15:11:10,	\$HST:	Measurement enable
23.01.2004,	15:11:10,	\$CRX:	U2 (+12V)=10.13V
23.01.2004,	15:11:11,	\$HST:	Frequencyfile c:\TEMP\callisto\frequency\frq00100.cfg read
23.01.2004,	15:11:11,	\$HST:	Plot buffer erased...
23.01.2004,	15:11:11,	\$HST:	Parametrisation RCU due to new frequencyfile
23.01.2004,	15:11:12,	\$HST:	Yt plot selected
23.01.2004,	15:11:13,	\$HST:	Switched to manual
23.01.2004,	15:11:18,	\$HST:	manual frequencyfile selection
23.01.2004,	15:11:19,	\$HST:	Frequencyfile c:\temp\callisto\frequency\frq00020.cfg read
23.01.2004,	15:11:19,	\$HST:	Plot buffer erased...
23.01.2004,	15:11:19,	\$HST:	Parametrisation RCU due to new frequencyfile
23.01.2004,	15:11:20,	\$HST:	Parametrisation RCU due to START
23.01.2004,	15:11:20,	\$HST:	Actual focuscode 59,58
23.01.2004,	15:11:20,	\$HST:	Enable data transfer
23.01.2004,	15:11:48,	\$HST:	Create new RAW-file
23.01.2004,	15:11:48,	\$HST:	Continous measurement
23.01.2004,	15:11:56,	\$HST:	Measurement stop
23.01.2004,	15:11:56,	\$HST:	Measurement wait...
23.01.2004,	15:11:56,	\$HST:	EOT detected, end of HEX-data
23.01.2004,	15:11:56,	\$HST:	Measurement halted
23.01.2004,	15:11:56,	\$HST:	Measurement idle
23.01.2004,	15:11:56,	\$CRX:	Stopped
23.01.2004,	15:11:56,	\$HST:	Measurement enable
23.01.2004,	15:11:56,	\$CRX:	U2 (+12V)=10.13V
23.01.2004,	15:11:57,	\$HST:	All threads terminated
23.01.2004,	15:11:57,	\$HST:	This application closed

Note:

\$HST = Host

\$CRX = CALLISTO Receiver

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Appendix H: Archive FITS Files Locally (courtesy Christian Monstein)

Note: This script is no longer supported. You can manually archive your individual files or you can create a script to automate the process. The PERL-script shown below can help to archive FIT-files from a local directory to any other directory on the network.

```
#!/usr/bin/perl
# red text needs to be edited
#use strict;
#use warnings; use
File::Path; use
File::Copy;

@tt = localtime(time());
$today = sprintf("%04i%02i%02i", $tt[5]+1900, $tt[4]+1, $tt[3]);

$DIR="/home/www-data/www.myobservatory.ch/documentroot/callisto"; # example $DIR="E:/Data";
# another example

# Choose the correct folder
opendir(HU, $DIR) || die("Couldn't find directory"); my
@hu=readdir(HU);
closedir(HU);

foreach my $hu(sort @hu) {
    my $filename = $hu;
    if ($filename =~ /^BLEN7M_(\d\d\d\d)(\d\d)(\d\d)_.*\.fit?$/)
    {
        my ($year, $mon, $day) = ($1, $2, $3);
        if ( ! -d "$DIR/$year/$mon/$day")
        {
            mkpath("$DIR/$year/$mon/$day");
        }
        if ("$year$mon$day" ne $today)
        {
            my $old="$DIR/$hu";
            my $new="$DIR/$year/$mon/$day";
            move($old,$new);
        }
    }
}
```

This BATCH-file should be included into automatic scheduler of windows, e.g. after midnight. `perl -w mover-callisto.pl`

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Appendix I: ATmega RISC Processor I/O Manual (courtesy Christian Monstein)

Analog inputs from periphery			
Signal name	Port	Alias	Remarks
Video	PA0	ADC0	Detector voltage main receiver
0V	PA1	ADC1	
AGC	PA2	ADC2	Tuner control voltage
0V	PA3	ADC3	
Emitter BF199	PA4	ADC4	IF transistor
0V	PA5	ADC5	
Input voltage	PA6	ADC6	Via divider 10/37
0V	PA7	ADC7	

Digital input/output from/to EEPROM			
Signal name	Port	Alias	Remarks
	PB0	TO	Timer/Counter0 external counter input
Clock 1MHz	PB1	T1	Timer/Counter1 external counter input
	PB2	AIN0	
	PB3	AIN1	
EEPROM_~CS	PB4	~SS	SPI-EEPROM 25LC320 (32Kbyte) select
EEPROM_SI	PB5	MOSI	SPI-EEPROM 25LC320 (32Kbyte) input
EEPROM_SO	PB6	MISO	SPI-EEPROM 25LC320 (32Kbyte) output
EEPROM_SCK	PB7	SCK	SPI-EEPROM 25LC320 (32Kbyte) clock

Digital outputs to focal plane unit			
Signal name	Port	Alias	Remarks
FOPA_0	PC0	PC0	Focuscode to FPU which there will be decoded by either a RISC-processor or a GAL to: L, R, hot, cold, hot-10dB, DICKE, Hybrid-select, etc. etc
FOPA_1	PC1	PC1	
FOPA_2	PC2	PC2	
FOPA_3	PC3	PC3	
FOPA_4	PC4	PC4	
FOPA_5	PC5	PC5	
Do not use...	PC6	TOSC1	Timer oscillator Pin 1
Do not use...	PC7	TOSC2	Timer oscillator Pin 2

Digital input/output to periphery			
Signalname	Port	Alias	Remarks
RS232-TX	PD0	RXD	RS232 transmission to host PC
RS232-RX	PD1	TXD	RS232 transmission from host PC
	PD2	INT0	
	PD3	INT1	
SCL	PD4	OC1B	I2C-Clock to tuner
SDA	PD5	OC1A	I2C-Data to tuner
	PD6	ICP	
AGC	PD7	OC2	AGC-control via PWM

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Document History

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	3.1 (Added Windows 11 and additional requirements in sect. 1.2, 02 Feb 2026)

Note: Some images and portions of this manual were provided by Christian Monstein and are used with his permission.

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