HIPSR Observations User Tutorial

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1. Introduction

This a guide on the essential steps to setup up an observation with HIPSR in spectral line mode. It covers:

- Backend start up,
- normal observations,
- calibration observations,
- quick look GUI start up,
- scripts to check the calibration observation,
- calibrate and convert data to sdfits data format
- check input signal levels

It is intended to be a tutorial to guide on how to make an observation with HIPSR and does not intend to give a comprehensive description of the backend and its software or on how to conduct an observation with the Parkes Telescope, for which the user should refer to the HIPSR User Guide (http://telegraphic.github.io/hipsr/index.html)
and the Parkes Telescope User Guide – PTUG (http://www.parkes.atnf.csiro.au/observing/documentation/user_guide/pks_ug.html).

2. Backend start up

Check that the HIPSR backend is not used in BPSR mode (pulsar mode).

On a web browser (you must be on the CASS network or have setup an ssh-tunnel to joffrey, see PTUG) go to the HIPSR web page:
http://hipsr-srv0.atnf.csiro.au/bpsr/

click “Controls” (see Fig 1)

A new window appears.
Click “Stop” (see Fig 2)

It can take up to 30 sec to stop all.

When LEDs “Master Control” in both “Server Demons” and “Client Demons” have turned **RED** you are ready to proceed further.

Figure 1: BPSR main page

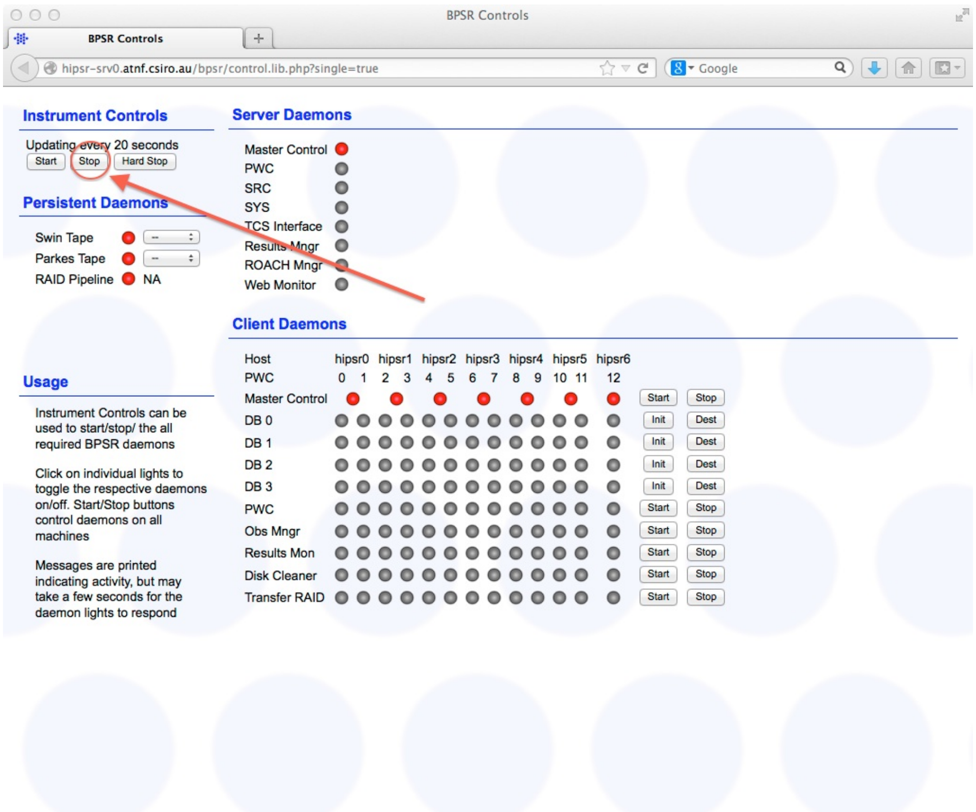

Figure 2: BPSR "Controls" page

Start HISPR.

On the VNC #2, start an HIPSR terminal (menu "backend tools" on the dock)

If not available:

- open a joffrey terminal,
- then ssh to hipsr-srv0:
  ssh corr@hipsr-srv0 (no passwd needed from joffrey)

For 400 MHz observations:
- Start the command "hipsr-server"

For 200 MHz observations:
- Start the command "hipsr-server –f hipsr_200_16384"

It can take some time to initialise all.

When "starting data capture" appears the server has started successfully.

Start HIPSR quick look GUI

On the VNC #2, start an HIPSR terminal (menu "backend tools" on the dock)

Start the command "hipsr-gui"

The main GUI will appear, showing the power spectra of all beams (See Fig 3)

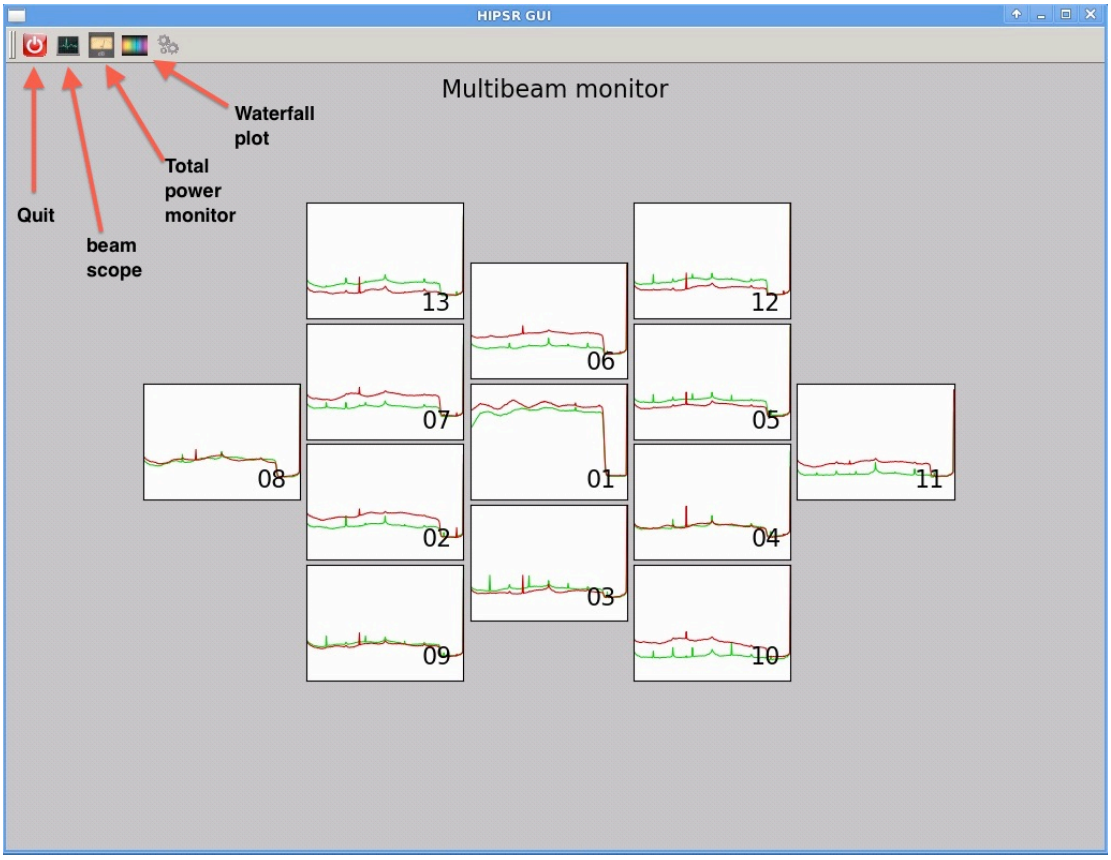

Figure 3: Main window of the quick look GUI

The buttons at the top-left corner open other monitor windows:

- beam scope: zoom in to individual beam spectra;
- total power monitor: plot of the average power versus time – all beams;
- Waterfall plot: scrolling 2D image of the spectra versus time (frequency – time plot of the power intensity).

They are opened embedded into the main window, but they can be dragged out and managed as separate windows.

Some examples are reported in Fig. 4-6

Figure 4: Individual beam spectra window embedded in the main GUI.

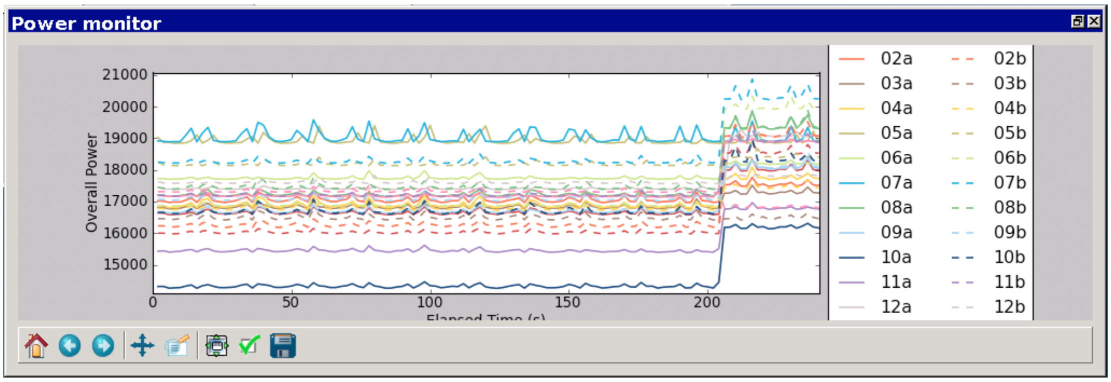

Figure 5: Total power monitor window.

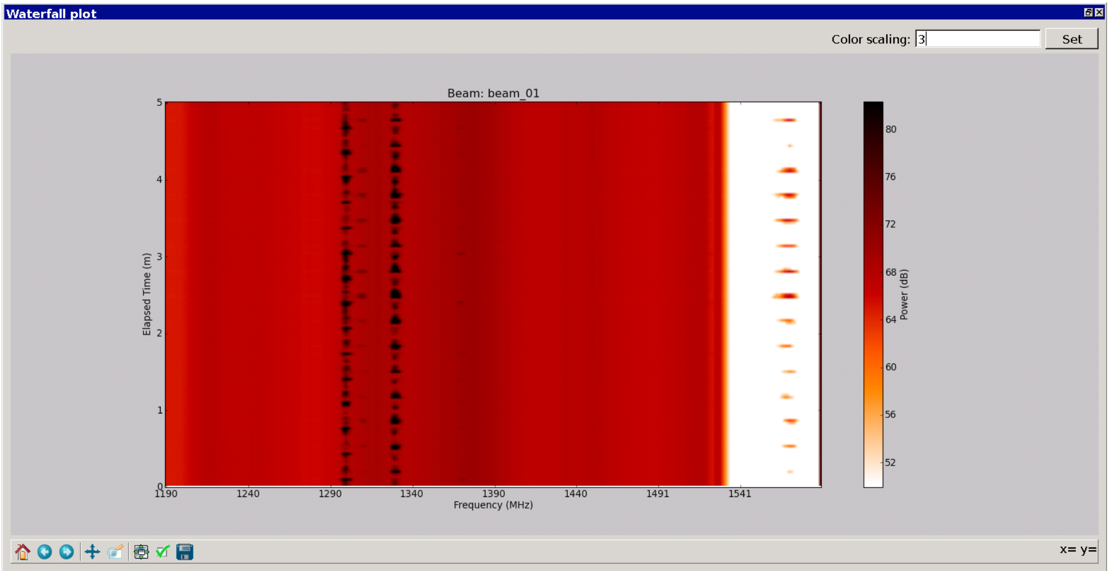

Figure 6: Waterfall plot of the power intensity vs time and frequency for an individual beam.

3. System start up

Set up the MB Cable Equaliser:

- on PKMC (see Telescope User Guide)
- select the Cable Equaliser (click on "Show")
- select "HIPSR 400" (also for 200 MHz observations)
- set the attenuations as follows (these values are valid at 19 March 2014)

Beam	1	2	3	4	5	6	7	8	9	10	11	12	13
Pol A	0	7	8	9	7	8	6	8	8	0	0	8	A
Pol B	1	9	9	8	8	9	9	9	9	8	7	0	0

N.B.: See below on how to check that the HIPSR input levels are correct. If not, adjust the attenuations of the relevant beam(s) to bring the levels within the correct range (where possible).

4. TCS start up

On the VNC session #1, start a joffrey terminal.

Start the command "tcs".

On the window that appears, select:

- HIPSR
- Expert Mode
- project ID and observation name (if saved previously)

Click “Start”

The main TCS GUI will appear.

Set it up manually or load your observation schedule file to set it up correctly. Specific to HIPSR is:

- no need to enable Correlator.
- No need to set up the calibration signal parameters, online T_{sys} calibration is always on and the parameters are hard coded and set to: frequency 128 Hz, duty cycle 50%, phase 0.
- TCS will set the Cal Control Unit for you, to ensure that HIPSR drives the noise calibration signal injection (at the start of the observation). Use the CCU GUI on PKMC to check that HIPSR is actually connected to your receiver (MULTI).
- Two correlator configurations are available to date:
    - hipsr_400_8192 (400 MHz, 8192 Channels)
    - hipsr_200_16384 (200 MHz, 16384 Channels)

Follow the PTUG to start an observation (like, e.g., to enable antenna, enable focus, and start a schedule file) and to prepare a schedule file (see online schedule generators for the 20cm Multibeam receiver http://www.parkes.atnf.csiro.au/observing/utilities/utilities.html).

5. Data location

Data files are in HDF5 format, extension “.hdf”.

Data are in:

/data/hipsr/data

Data files are organised in subdirectories with name the date of observation:
YYYY-MM-DD

6. Flux Calibration Observation

Flux calibration needs an MXCAL observation of a know source. An MXCAL observation is constituted by the source being observed by all beams in turn.

Currently we have calibrated the following sources across the entire band of the Multibeam 20 cm system:

- 1934-638
- 0407-658
- Hydra A

They are well spaced in RA and one of them should be visible in at least part of the scheduled observations.

An MXCAL observation schedule file can be prepared with our online schedule generators (see link above).

Example schedules to observe these calibrators are on *joffrey* under the directory:
/nfs/online/local/tcs/sched/hipsr

with names:
mxcal_0407_hipsronly_400.sch
mxcal_1934_hipsronly_400.sch
mxcal_hydA_hipsronly_400.sch

To check the calibration is ok, open a new terminal on hipsr-srv0 and run the command:

hipsr-mbcal <filename>

where <filename> is the mxcal observation file. Full path is required.

The program will return 4 plots with the estimated Tsys and calibrated intensity of the noise diode. Two dashed lines show the range where they are expected to be for most of the range when observing cold sky (e.g. far from the Galactic plane). The tail of the band (below ~1250 MHz and above 1500 MHz) are expected to be out of the range.

If the calibration is not ok, two are the possible reasons:
- presence of strong RFIs during the calibration => calibration to be repeated
- input signals too high => to increase the attenuation of the corresponding channel in the Cable Equaliser. (see next section).

A .mbcal file is also saved with the noise diode calibrated values.

7. Input Signal level check

Check input signal rms.

Stop the hipsr-server (ctrl-C on the terminal the server is running)

On a hipsr-srv0 terminal, run the command
hipsr-check-rms

The rms values are returned.
The rms values should be in the range 4 to 7.

If not, on PKMC, where possible adjust the Cable Equaliser attenuation of the relevant channels (beam, polarisation) to bring them within the valid range, or as close as possible.

8. Flux Calibration and Conversion to sdfits format

To calibrate your data you must have:
- the set of files to calibrate in one directory
- a calibrator observation

On a hipsr-srv0 terminal run the command

hipsr-converter

The following GUI is supposed to appear:

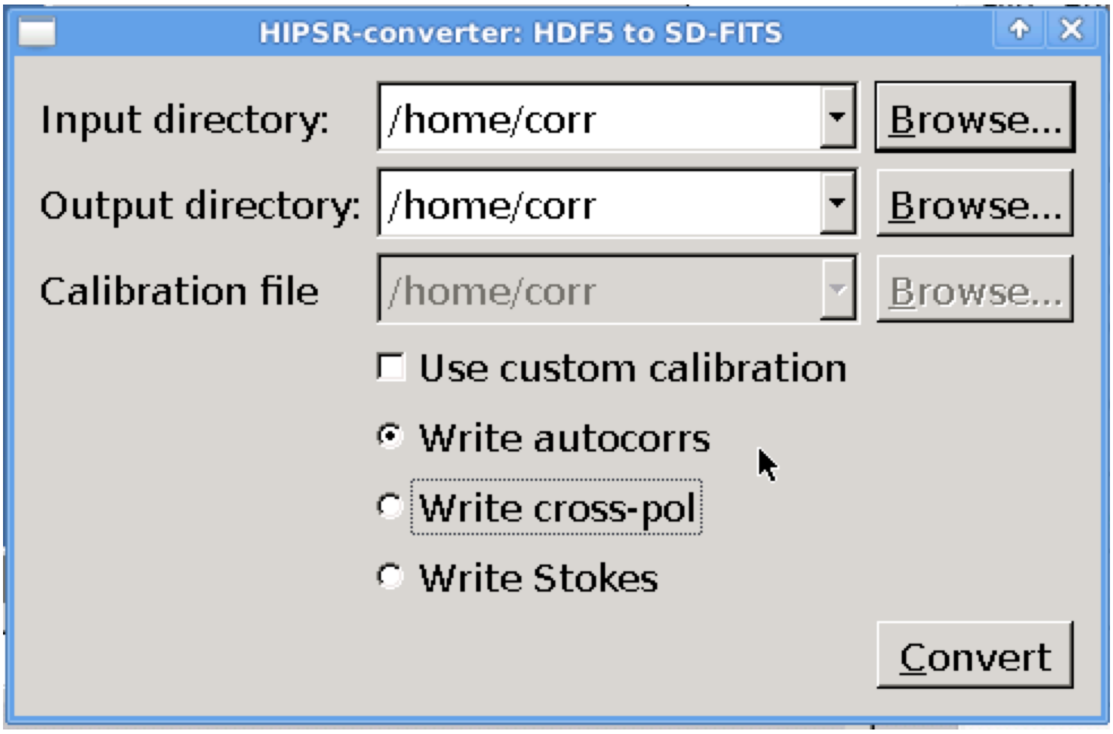

Figure 7: HDF5 to SDFITS converter GUI.

Select:
- the directory containing the hdf files to calibrate/convert (N.B.: **ALL** hdf files in the directory will be converted).
- The directory where the output files will be saved.
- "Use custom calibration".
- the Calibration file to use (i.e. the calibrator MXCAL observation file).
- Stokes products you like are flux calibrated and saved in the sdfits files, either:

- Autocorrelations only (Write autocorrs)
- Cross-products only (Write cross-pols)
- All Stokes (Write both autocorrs and cross-pols)

For the Tsys calibration, the noise diodes are sampled with a coarse resolution spectrum of 16 channels, 25 MHz each. The MXCAL observation of a know calibrator calibrates the noise diode in each of these sub-bands and interpolates to each channel of the fine resolution spectrum of the normal observation data.

During conversion, the calibration/converter software uses the coarse noise diode data in the calibrator file and the observation to: 1) calibrate the noise diode, 2) calibrate the observations using the calibrated noise diode.

If no calibration file is given (deselect "Use custom calibration") the calibration is performed assuming default values for the noise diode amplitudes.

The assumed values are those stored in:
/home/corr/hipsr_reduction/lib/

as
diode_jy_x.cal
diode_jy_y.cal.

They can be read in python with

```
import numpy as np
xcal = np.fromfile('diode_jy_x.cal')
```

This gives the option to use one diode calibration for all the observations to calibrate for the entire run, if one prefers to do so.

Other option is to produce many noise calibrations, average them and generate a custom .mbcal file and calibrate all data with it.

Calibration strategy is left to the user choice.

9. Data Converter Software on your own computer.

The entire hipsr_reduction can be downloaded from github at:
https://github.com/telegraphic/hipsr_reduction