Requirements for the GBT Interim Automated Reduction and Display System (IARDS)

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Version 1.1 - First non-draft version.

Contents

1 Preface

This document initially referred to the "Interim Real Time Display". I have changed to title to ephasize that the requirement is for a package which can operate automatically (driven by the arrival of new data), and which can do the requisite preliminary data processing as well as display the results.

After discussion at a number of aips++/gbt meetings, it has been agreed that there is NO requirement for the IARDS to process data or perform any sort of display on an integration by integration basis. This will of course be a requirement of the final system.

2 Introduction

By "automated reduction and display system", we mean a package that will automatically process and display the astronomical data obtained by the telescope within a short period of time (seconds) after new data is available. This should certainly be at the end of each scan, and in most cases at the end of each integration. The data should be displayed in a manner which is most meaningful to the observer; for example for spectral line observations the display might show the average, calibrated, normalised spectrum with rest frame frequency as the x-axis, and T^*_A as the y-axis. To achieve this implies that the data is actually processed in near real time; the long-term plan for the GBT is to implement this via a "data reduction pipeline".

At present, the data reduction pipeline does not exist. Also, there is no automatic display of any results, apart from the pointing and focus observations processed by the GOpoint procedure. Since the development of the data reduction pipeline will take some time, and since we would ideally have some form of automatic display available prior to the start of regular observing (nominally June) we have proposed development of an "interim" automated reduction and display system (henceforth IARDS).

A key requirement of the IARDS is therefore that it should be implemented quickly, and with comparatively little effort. If this requirement cannot be met, then most of the purpose of the IARDS will be lost. At the same time, the IARDS must have sufficient functionality to make it useful - otherwise we might as well simply require the observer to reduce their data interactively in order to get the display.

This document will not discuss implementation details in any depth. However, the assumption is that the IARDS will largely be implemented using the aips++ facilities which already exist or are under development (e.g. the online MS filler, DISH, etc). The intention of this document is to provide requirements and priorities for which parts of those facilities should be completed first, and how they should be combined to provide a useful facility for observers.

The data processing requirements for the GBT Spectrometer are described in detail in the memo: "GBT Spectrometer Software Data Processing" by Langston, Balser, Maddalena and Prestage. This is not yet released, but a draft version is available at:

http://www.gb.nrao.edu/GBT/MC/gbt/devices/backends/spectrometer/docs/specSoft.ps

Continuum data processing requirements are described in two memos by Ron Maddalena, available at:

http://www.gb.nrao.edu/ rmaddale/GBT/PointFocusScenario.htm

and http://www.gb.nrao.edu/ dblaser/memos/oss/ (see DCR section).

The purpose of the IARDS is not to produce publication-quality plots, but rather to provide a quick, and reasonably accurate assessment of the quality of each scan as it is acquired. It should therefore be capable of generating plots/summaries which provide the following kinds of information:

- Whether expected system temperatures are being achieved.
- Whether observations are being affected by RFI.

- Whether detectable lines of known strength are being detected with the correct strength and at the correct frequency.
- Whether pointing/focus results are acceptable.

The specific items required to achieve this are described in more detail below.

3 Requirements / Priorities

In the following sections, each "requirement" is labelled for ease of subsequent reference. In some cases, these requirements are simply statements of principle, or identify items which are specifically *not* required by the IARDS. These have no priority assigned to them. Items which require specific implementation have a priority assigned to them. These may take one of the following four values:

Value	Meaning
0	Essential Feature - required by June 30, 2001
1	Highly Desirable - required by August 30, 2001
2	Desirable - should be implemented if straightforward
3	Non Essential - implement only if it requires trivial effort

In general, all Priority 0 and 1 requirements should be met before priority 2 and 3 requirements are tackled. We should reassess progress at the end of May, and if necessary reassign priorities.

4 Scope of the IARDS

R1. The prime purpose of the IARDS is to automatically display astronomical data as it is acquired. In general, it should therefore not require significant interaction from the observer or operator to function correctly. However it is acceptable to require some initialisation/configuration, and for example some further interaction when switching between projects.

R2. The IARDS should be considered a tool for the Observer (or operator acting in that capacity) performing "standard" astronomical observations. The assumption is that observations will have been commanded through the GO user interface, the Glish FITS files will be available, and so on.

R3. There is no requirement for the IARDS to be able to support "engineering observations" that have not been commanded from GO (e.g. data produced by a backend with either the Scan Coordinator or backend itself being directly commanded through CLEO)

R4. the IARDS should be launched either as part of the GO startup procedure, or in a similar manner. It is acceptable for some reasonable amount of configuration information (e.g. project id, observer's name, etc) to either be obtained from the GO session if possible, or to be required from the user.

R5. If it simplifies implementation, we should consider having the IARDS driven by commands issued from the GO observing procedures. If this approach is adopted, such commands should be well isolated, so that they may be easily removed/modified at a later date.

R6. It is acceptable for the IARDS to have to be reconfigured if, for example, the project id is changed, the IARDS application is stopped and restarted, etc (i.e. the IARDS does not need to maintain context between invocations).

R7. In general, it should be possible for the IARDS to run unattended once configured. In some situations (e.g. designation of an OFF scan to use with a given set of ONs) it is permissable to require explicit user intervention. The IARDS should default to some sensible mode of operation (e.g. display total power only) if this information is not provided.

R8. It is acceptable for some features of the IARDS (e.g. Y axis scaling) to require some user intervention (e.g. effort should not be devoted to developing advanced auto-scaling mechanisms).

R9. No accepted "Early Science" proposals call for continuum science observations. Therefore there is no strong requirement for the IARDS to process and display these types of observation. The only continuum observing modes to be supported initially are therefore pointing and focus measurements. These may be incorprated into the IARDS, or left in the current "GOpoint" procedures - see requirement 13 below. Further continuum observing modes may be incorporated at a later date if this proves straightforward; the requirements for these are not discussed here.

R10. Very few accepted "Early Science" proposals call for any form of mapping observation. All aspects of mapping have therefore been placed at Priority 2; i.e. should be implemented only if straightforward, and after Priority 0 and 1 items are complete.

5 General Requirements

R11. The IARDS should be substantially complete by end June 2001. If this target cannot be met, we should reassess plans.

Priority: 0

R12. The IARDS should be capable of displaying data from:

The GBT Spectrometer	*Priority: 0*
The Spectral Processor	*Priority: 1*
The DCR	*Priority: 2*
Other GBT Backends	*Priority: 3*

The assumption is that visitor backends (including pulsar backends) will perform their own data processing, and hence provide their own display. In what follows, the GBT Spectrometer and Spectral Processor can be considered largely identical (the Spectrometer has some additional data processing steps).

R13. Some proposed features of the IARDS, specifically automated reduction and display of pointing observations, are currently handled by the GOpoint procedure. These should be incorporated into the IARDS if possible (preferred option), or else the remaining continuum modes (i.e. focus) should be incorporated into GOpoint. However, if GOpoint is retained as a separate package, the IARDS and GOpoint must be able to co-exist in a reasonable fashion.

Priority: 2

R14. The IARDS should be capable of displaying data acquired in the standard spectral line and continuum observing modes (as described in further detail below) only. Support for pulsar modes of the Spectral Processor and Spectrometer are not required. (The "Early Science" pulsar proposals all request visitor backends, which perform their own data processing and display.) The only continuum modes to be supported are those used to optimise the antenna pointing/focus.

Priorities for specific observing modes given in Section 6.

R15. The IARDS display should update shortly (within 5 seconds) after the end of each scan. There is no requirement for the IARDS to handle data on an integration by integration basis.

Priority: 0

R16. The IARDS should not impose any appreciable overhead (i.e. not greater than one second per scan) on data taking. The IARDS should have the option of "display every Nth scan", so that it does not fall behind for scans whose durations are shorter than the processing and display time. It is acceptable for the user to have to determine N by trial and error for their specific observing configuration.

Priority: 1

R17. It should be possible to have multiple invocations of the IARDS running simultaneously.

Priority: 2

R18. In cases where data is being acquired simultaneously with more than one backend, it should be possible for one invocation of the IARDS to display data from one, and the second from the other. There is no requirement for these to be controlled as a single unit (i.e. it is acceptable if each has to be configured separately).

Priority: 2

R19. There is no requirement for the IARDS to run independently of the current observing session (e.g. reprocessing earlier observations, or running off-line).

R20. The IARDS must be able to display successive scans in a sequence (described in further detail below) without requiring operator/observer interaction, although some optional modes of interaction (e.g. rescaling the display) may be provided.

Priority: 1

6 Observing Modes/Switching schemes

R21. The IARDS must be able to handle data from various observing modes, which are defined by the GO observing procedures which are used to command them:

Spectral line:

Track	*Priority: 0*
OffOnOff	*Priority: 1*
OnOff (see Note 1)	*Priority: 1*
Mapping Modes (see Note 2	*Priority: 2*

Note 1: There is currently no GO procedure which performs position switching by taking a series of ONs and OFFs as successive scans. There is a request to add this mode to the list of observing procedures, and support for this is a requirement for the IARDS.

Note 2: The IARDS should support mapping modes with one row per scan; there is no requirement to support the mapping modes where the entire map is a single scan.

Continuum: The modes required for pointing and focussing.

Priority: 2

As noted, these should be transferred from GOpoint to the IARDS if it is straightforward to do so.

R22. The IARDS should ignore data acquired from any non-supported observing mode, but should be able to function correctly if supported and non-supported modes are interspersed in the same observing session.

Priority: 1

R23. The IARDS must be able to handle data taken using the following switching schemes:

Spectral line: All those implemented by the GO glish procedures, including discrete ONs and OFFs.

Priority: 1

Continuum: Those required for pointing/focus measurements.

Priority: 2

7 Data Processing

R24. Essentially all GBT data needs to be processed before a meaningful display can be made. For example, Spectrometer data must be transformed from lags to spectra, different phases of a scan must be combined, and so on. As far as possible the IARDS should make use of existing facilities (e.g. the the MS fillers, DISH) to provide the required processing stages. If any stages do not exist, they will have to be implemented as required; these should be cleanly isolated so they may be replaced at a later date.

Priority: 1

R25. The data processing requirements for pointing/focus observations are described in the memos referenced in Section 1.

R26. For Spectral Line observations, the processing stages are as described in the memos referenced in Section 1. Processing for the Spectral Processor is identical to that for the GBT Spectrometer, apart from the fact that the initial stages (i.e. Van Vleck correction, FFT) are not required. The IARDS should be capable of processing and displaying data in “uncalibrated” or “calibrated” form (see below), or both, according to user configuration.

R27. For “uncalibrated” data, the IARDS should perform the Van Vleck, Weighting and Fourier Transform stages for the Spectrometer), and then for both the Spectrometer and Spectral Processor display bandpass spectra as data units versus channel number for all phases in the scan.

Priority: 0

For “calibrated” data, the IARDS should continue the data processing to apply the calibration and reference subtraction stages. The IARDS should then display the normalised spectrum as T_A^* versus rest frame frequency for the latest scan. In the case that both SIG and REF phases are not obtained within the scan (i.e. for ONs and OFFs in separate scans) the IARDS should use the last appropriate OFF (designated as such by the GO observing procedure) for the reference subtraction.

Priority: 1

R28. it must be possible for the user to switch the IARDS between the two above modes during operation, but there is no requirement for the IARDS to be able to re-process and display earlier data after a mode change.

Priority: 2

R29. There is no requirement that the processed data displayed by the IARDS be made available for later use, or saved in any way.

8 Sequences of Scans

R30. The IARDS must understand the “scan n of m” information provided by the GO observing procedures. Thus for example it should recognise the four scans which together comprise a cross observations, or the k scans which together comprise an RALongMap. Such sequences of scans should be handled as a coherent group.

Priority: 1

For any observing mode in which the telescope is tracking a single position (perhaps performing position switching) the IARDS must be capable of recognising and handling a group of scans taken on the same source with the same configuration, so that the ON-OFF/OFF processing can be performed. Some modification of the GO observing procedures (and content of the Glish FITS files) may be required to support this.

Priority: 1

9 The Display

R31. As well as the data, the IARDS should display standard header information in a convenient form; this includes Project id, scan number, source name, commanded position, system temperature (if derivable).

Priority: 1

R32. The IARDS should display one spectrum for each "spectral window" acquired by the backend.

Priority: 1

Spectral Line non-mapping modes:

R33. For pointed observations, the IARDS should display the various phases of the last scan, or the normalised spectrum, as described above. The should be as a simple line plot.

Priority: 0

R34. It should be possible to zoom in/out, reset and change scales on the display to isolate regions of interest. If the scale has been changed manually, this should be retained for subsquent plots. By default, the display should autoscale to min/max value, and repeat this autoscaling as successive plots are made.

Priority: 2

R35. Under user configuration, in addition to the above, show with x-axis = frequency, y-axis = time and color/greyscale = intensity each successive scan as it arrives.

Priority: 2

Spectral Line mapping modes:

R36. For discrete (PointMap) observations, the IARDS should process the scan taken at each map point as described above. For "calibrated data", with no switching within the scan, use (under user configuration) a designated (existing) OFF scan.

Priority: 2

R37. For raster observations (RALongMap, DecLatMap) done with each row as a separate scan, the behaviour depends on the switching scheme/processing mode chosen. For "uncalibrated data" mode, show the bandpass spectrum for each phase for the first, middle and last point in each row.

Priority: 2

R38. For "calibrated data" with SIG/REF switching within the scan, show the normalised spectrum for the first, middle and last point in each row.

Priority: 2

R39. For "calibrated data" with no switching within the scan, use (under user configuration) a designated (existing) OFF scan, and show the normalised spectrum for the first, middle and last point in each row, or, use the average of the first and last point as the OFF, and display the normalised spectrum of the middle point in the row.

Priority: 2

R40. There is no requirement for the IARDS to support RALongOTF or DecLatOTF (entire map done as a single scan).

R41. There is no requirement for the IARDS to provide any form of display of the coverage of a mapping observation, or any sort of integrated intensities, channel maps, or cubes.

Continuum modes:

R42. The IARDS for continuum observations should match that currently provided by the GOpoint procedure, with similar capabilities added for focus measurements.

Priority: 2