Future Development of the PTI

R.P.Norris

25th February 1988

This note is a result of last weeks astrophysics group meeting, and is an attempt to summarise the current shortcomings of the PTI, and the steps that may be taken to rectify them.

1) Introduction

A recent group meeting of the Astrophysics Group considered the operation and future of the Parkes-Tidbinbilla Interferometer (PTI). It was considered at that meeting that the PTI would continue to be used at least for the next couple of years, and quite possibly into the era of AT LBA operations. Furthermore, an increasing number of people both from within Radiophysics and without are now proposing to use it.

Probably the greatest criticism that can be made of the PTI at present is that, despite substantial efforts, the PTI is still not considered to be sufficiently user-friendly. The on-line help files and manuals appear to be sufficient for most routine observations, but fail when there are problems or when the observations are non-standard. This problem of user-surliness can therefore be attacked on two fronts: increase the level and quality of help and make the system less prone to problems.

Most problems that have occurred have been due to finger-trouble rather than failures of software or hardware, and so a key aim must be to reduce the opportunity for finger-trouble, by reducing the complexity of the cabling. Much of this complexity stems from an original goal of the PTI: to produce a working interferometer using the minimum of expense and new equipment. The design has now been proven, and the performance assessed, and so it now seems justifiable to spend some resources on improvements to the PTI. The aim of this document is to consider ways in which the PTI might be improved, and estimate the cost of these improvements.

There are also a number of additional minor improvements that have been suggested, and these are also included in this note.

2) A Catalogue of Problems

2.1) Parkes Hardware (in no particular order)

i) The hardware connections in the control room are so complex that mistakes are often made.

ii) There is no way of checking the coherence of the system as a whole without complex ad hoc set-ups

iii) The synthesiser levels are too critical, resulting in LO breakthrough when not adjusted optimally.

iv) We do not at present have adequate synthesisers at Parkes for 1st LO's

for X band and above.

v) Producing autocorrelation spectra is difficult and involves complex re-cabling

vi) Connections for observing systems at some frequencies differ substantially from those in the Users Guide.

vii) An obscure hardware fault in the IEEE bus occasionally produces 'Rockland errors', which are disastrous for pulsar observations and inconvenient for other observations.

viii) There are some unexplained anomalies in the behaviour of the VAX clock and the correlator timing.

ix) There are spurious correlations, apparently in the correlator receiver, which seem to be getting worse (or is it just that we're getting more ambitious?). These spurious correlations sometimes render band 2 almost unusable for all but the strongest sources.

x) The amplitude stability of the microwave link, as monitored through the correlator A/D's, seems poor, so that it is not possible to monitor the Tid pointing.

xi) The Tid IF up-converter in the Parkes control room suffers from breakthrough of the local oscillators - better filters are needed.

xi) The facilities for Isr corrections, etc are inadequate.

xii) It is not yet possible to observe at two widely-spaced frequencies (e.g. S and X) simultaneously, largely because only one Rockland phase rotator is currently driven although two are available.

xiii) LO breakthrough occurs in the Tid IF up-converter unit.

2.2) Tidbinbilla hardware

i) The ability to feed coordinates directly to the control computers is an important requirement, both in order to reduce the load on the observers at Tidbinbilla and also to permit faster source changes.

ii) The ability to feed the current position (Az/El) of the Tidbinbilla antenna back into the communications software (COMMS) and thence to PTI is essential for rapid diagnosis of pointing problems at Tidbinbilla.

2.3) On-line Software

i) Producing autocorrelation spectra is difficult and involves obscure commands. (see 2.1.v above)

ii) The software should be able to take advantage of the Binary Atomic Time (BAT) which is now available to the VAX, rather than the current complex system of event generators and interrupts.

iii) Single-dish calibration data and error logging is currently stored separately from the visibility data, so that observers don't always know where to find it.

2.4) Off-line Software

i) Some commands are obscure and not well explained in the on-line help.

ii) The handling of files is tedious - files often need to be re-read (e.g. after a SUMMARY command)

iii) Comment records on processed data generally tend to be inadequate.

iv) Because of inadequate computer communications between Parkes and Epping (it's easier to send software from Epping to the UK than to Parkes!) , (a) it's difficult to ensure that the same version of software exists at both sites, and (b) it's difficult to monitor and debug PTI problems from Epping.

2.5) Documentation

i) The Users Guide and on-line help both need updating

ii) There is inadequate documentation for running the Tidbinbilla end.

3) A Catalogue of Solutions

3.1) A new PTI IF converter unit

Most of the hardware problems would be solved by the construction of the IF converter unit (for which I thank John Murray for his help) shown in Fig. 1. This has the following advantages:

i) The quantity and complexity of cabling is very much reduced

ii) Two completely independent bands can be observed simultaneously

iii) Autocorrelations would be made much easier by the use of software-driven switches .

iv) LO breakthrough will be reduced because of a different LO path made possible by the use of two Rockland synthesisers

v) Long term phase noise will be reduced because of the lower operating frequency of the Rocklands.

vi)The setup for different observing frequencies will be done automatically using the software-driven switches.

John Murray has given a guesstimate for the construction of this unit costing of order $1000 and requiring about 2 man-months.

3.2) Front-end tone injection

Tracing coherence problems would be greatly eased if a tone injection before the Parkes front end were possible. The best way of doing this would be to radiate a comb of frequencies, at 10 MHz steps, from the vertex. The cost of this has not yet been established.

3.3) Other Parkes hardware

The 1st LO problem could be solved either (a) by the purchase of a new synthesiser such as a Rohde & Schwarz similar to that owned by the AT LO group, or else (b) (probably) by the construction of a 105 MHz multiplier as

designed for the AT.

The VAX timing problem would be eliminated by the use of BAT.

The source of the IEEE bus problem should be traced as a matter of priority (this also causes problems to other programs such as SPECTRA).

The spurious breakthrough in the correlator receivers should also be fixed. Again, this also affects SPECTRA.

The link amplitude problem should be investigated.

An adequate computer communications system needs to be set up between Parkes and Epping, so that a DECNET connection can be established. This is obviously of general importance to the AT, and is currently being investigated by John Deane.

3.4) Tidbinbilla Hardware

John Reynolds has kindly undertaken to write a program for a PC which will replace the current terminal at Tidbinbilla, and which will pass coordinates to and from the Tidbinbilla computers.

3.5) On-line software

In addition to the items above, a major revision to the PTI software is also required by the need to use the new FITS format chosen for the AT. Thus it is proposed that a new version of PTI be written with the following features:

i) Use of FITS rather than RPFITS. Error logs and calibration files will be appended to the data as tables. This will involve some complex cross-checking so that in the event of a computer crash or a CTRL_Y abort, the files are tidied up and the correct tables appended. (This is a fundamental disadvantage of FITS, but one which is considered to be outweighed by other factors).

ii) Two observing bands will be permitted at arbitrary frequencies, rather than the close spacing required at present.

iii) Autocorrelations will be handled in a tidy way (in a similar way to the present CAL command), and will be entirely software-driven. This will require a somewhat different correlator configuration.

iv) Time throughout the program will be derived from BAT, rather than from VAX time + COORD interrupts as at present.

v) Synthesisers will be computer-driven rather than manually-driven.

It is estimated that this will take approximately four man-weeks, excluding the writing of the AT FITS routines.

3.6) Off-line Software

At the same time as the changes to PTI discussed above, a change will be made to the off-line software (PTILOOK) at the same time. During the changeover period, the old software will be running on the VAXes and the new software will run on the Convex. Eventually, when the new software is debugged, it will completely replace the old.

The new PTILOOK will have the following features:

i) Data will be stored as indexed files to permit faster reading and writing and avoid the need for re-reading data.

ii) RPFITS will be replaced by FITS, and more attention paid to writing COMMENT and HISTORY cards on processed data.

iii) Several switches will be moved from the menu to prompted questions.

It is estimated that this software will take about 4 man-weeks (i.e. about 8 real weeks).

3.7) Documentation and help

I will update all the documentation and on-line help as part of the software changes described above. However, additional help from someone who is not so familiar with the PTI (and who would therefore have a different view) would be useful in the following areas:

i) review and edit the updated documentation, re-writing where necessary

(ii) write a cook-book for the off-line software (based on the on-line help and in the style of the AIPS cookbook).

I estimate that this will require about 2 man-weeks (i.e. 4 weeks of someone's research time).

It would also be of considerable help to observers if a Parkes 'friend of PTI' could be appointed. This person (presumably one of the OA's) would have to be given sufficient time to develop a real familiarity with PTI software, hardware, and observing techniques. Such expertise would also constitute a real asset in the future, both for the individual and the AT.

4) Conclusion

The task to be tackled has three aims:

i) Fix existing shortcomings of the PTI

ii) Make the PTI more user-friendly

iii) Enhance the PTI to (i) make off-line software run on the Convex (ii) make the PTI more flexible (e.g. allow simultaneous use of two separate frequency bands.

To accomplish this task will incur the following identifiable costs:

i) IF Converter: ~ $1000 + 2 months of JDM time

ii) On-line software: 4 weeks of RPN time

iii) Off-line software: 4 weeks of RPN time

iv) Documentation and on-line help: 2 weeks of XXX time

v) Front-end tone injection: Pks staff - cost not known

vi) Fix faulty IEEE bus: Pks staff - cost not known

vii) Fix breakthrough in correlator IF's: Pks staff - cost not known

viii) Establish adequate computer communications between Parkes and Epping. Cost currently being investigated by John Deane.

ix) Provide communications with control computers at Tidbinbilla - being undertaken by John Reynolds (MSSSO) at no cost to the AT.

This list excludes the purchase of a high quality synthesiser for use as a first LO, as it appears that this will go ahead anyway for VLBI/AT use. Similarly, much of the work listed above needs to be done anyway either for the AT or for other Parkes programs. The work that needs to be done for the PTI alone is entirely contained within the items above with identified costs (although these still contain work needed for other programs).

Table 1 : filter specifications

Each filter will be used only for rejection of the image at 60MHz away, and so need not posses very steep edges or high rejection. All frequencies are in MHz.

Filter #	centre freq	min. bandwidth	used for observing bands:
1	125	30	1665, 12178
2	185	12	1612
3	315	30	8400, 22235
4	390	12	2290

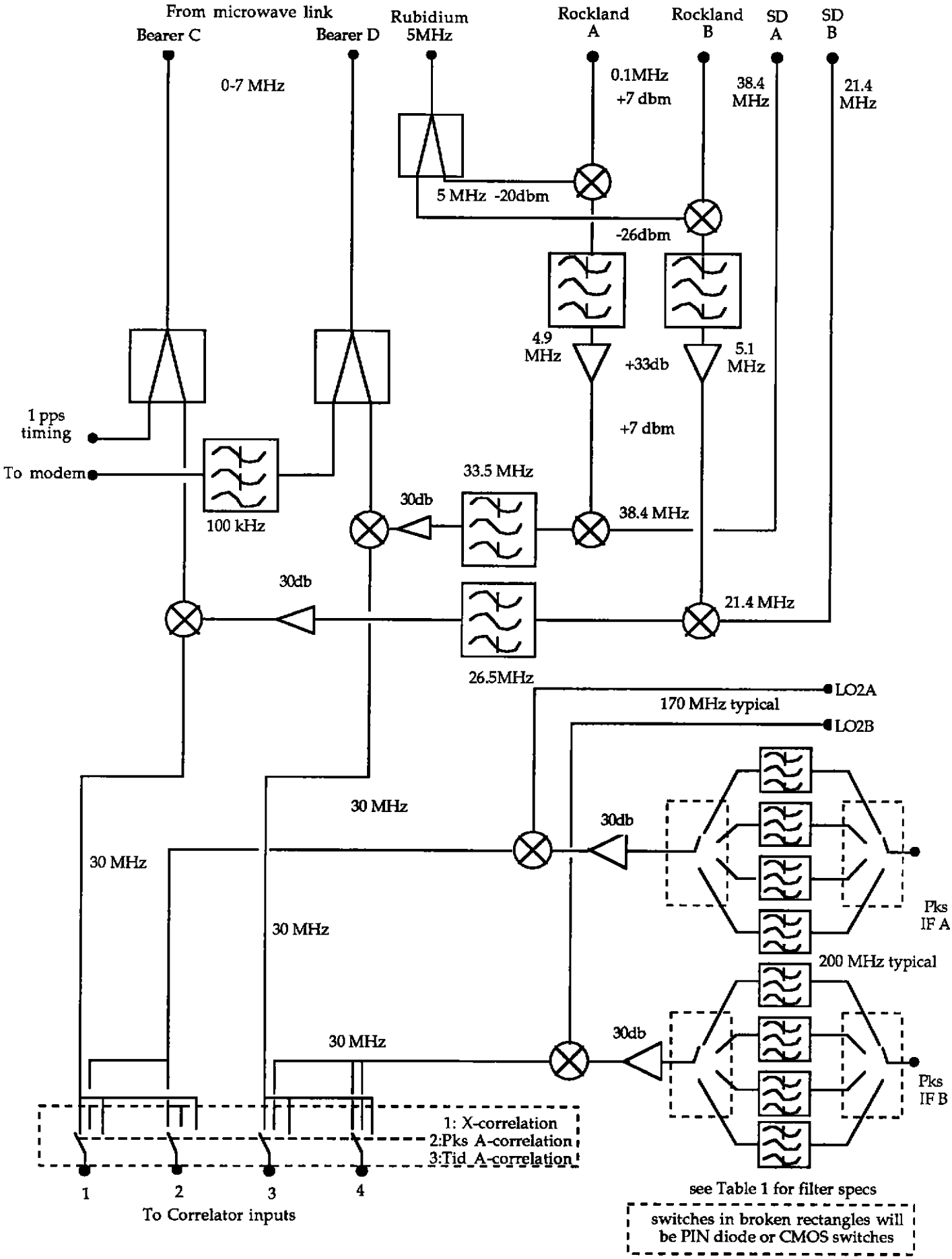

Figure 1: proposed PTI IF converter unit