News from the Plateau de Bure Interferometer

Weather conditions and observing

Following the successful installation and commissioning of the New Generation Receivers (NGRs) for the 3 mm and 1.3 mm atmospheric windows last autumn, regular observing was resumed on January 18th, 2007 when the array in its D configuration. We switched to the A array on January 28 and moved to a configuration intermediate between A and B (keeping the three longest baselines) on March 7. The B configuration was scheduled from March 18 until March 30 only, because of very poor weather conditions. The C configuration was then available until April 24, when the interferometer was brought back into its D configuration. Many projects requesting the C configuration, notably at 1mm, could not be finished yet and will be deferred to the end of the summer/beginning of the upcoming winter semester. Since May 22nd the array is observing with 5 antennas in D configuration. The current antenna maintenance period is foreseen to end in October.

All in all, the observing conditions were quite mediocre due to the unusually warm winter and humid spring in Europe.

As far as A-rated projects are concerned, we look forward to bring many of these to completion before the end of the current summer semester. B-rated projects are likely to be observed only if they fall in a favorable LST range. We remind users of the Plateau de Bure interferometer that B-rated proposals which are not started before the upcoming proposal deadline have to be resubmitted. In any case, **all** projects will be kept on the schedule until the end of the summer semester (i.e. until November 30). Investigators, who wish to check the status of their project, may consult the interferometer schedule on the Web at ../PDBI/ongoing.html. The page is updated daily.

The global VLBI session, which includes the array in the 3 mm phased-array mode, started on time on May 10. The interferometer, equipped with a new maser and the new receiving system successfully participated for two nights.

Installation of the 2 mm band

It is foreseen to equip all 6 antennas with 2 mm mixers still in the current summer period. The 2 mm band will be offered to the community in the following Call for Proposals on a shared-risk basis only, since delays in the installation cannot be excluded and the overall performance of the receivers is not known yet.

Call for Observing Proposals for the Plateau de Bure Interferometer

Conditions for the next winter session

Based on our experience in carrying out configuration changes in winter conditions with limited access to the observatory, we plan to schedule four configuration changes next winter. We therefore ask investigators to submit proposals for any of the 4 primary configurations of the six antenna array.

A preliminary configuration schedule for the winter period is outlined below. Adjustments to the provisional configuration planning will be made according to proposal pressure, weather conditions, installation of the 2 mm receiver band and other contingencies. Due to the installation of the new generation receivers last fall, the C configuration was not available in December, and this spring not all of the projects requesting the C configuration could be worked off. These projects are now postponed for the C configuration to be scheduled at the end of the summer semester and at the beginning of the upcoming winter. We therefore may again have less time available in C configuration this winter than in regular previous years. The configuration schedule given below should be taken as a guideline, in particular when the requested astronomical targets cannot be observed during the entire winter period (sun avoidance circle of radius 45°.).

Conf	Scheduling Priority Winter 2007/2008
C	December
A	December – January
B	February – March
C	March – April
D	April – May

We strongly encourage observers to submit proposals for the new set of AB configurations that include 730 and 760 meter baselines. For these proposals we ask to focus on bright compact sources, possibly at high declination.

We invite proposers to submit proposals also for observations at 3 mm. When the atmospheric conditions are not good enough at 1.3 mm, 3 mm projects will be observed: in a typical winter, 20-30% of the time used for observations is found to be poor at 1.3 mm, but still excellent at 3 mm.

Proposals requesting the 2 mm band should be submitted on a shared-risk basis only.

All applications under this call for proposals will have to take into account that the new receivers cannot be operated simultaneously at more than one frequency band. Investigators will therefore have to make it clear whether a request is made for one (e.g., 3 mm) or more (e.g., 3 mm and 1 mm) frequency bands.

Proposal category

Proposals should be submitted for one of the five following categories:

1.3 MM: Proposals that ask for 1.3 mm data. 3 mm receivers can be used for pointing and calibration purposes, but cannot provide any science data.

2 MM: Proposals that ask for 2 mm data. These proposals will be observed on a shared risk basis as "science verification" projects to inaugurate the new receiver band should it become available for the winter semester.

3 MM: Proposals that ask for 3 mm data.

TIME FILLER: Proposals that have to be considered as backup projects to fill in periods where the atmospheric conditions do not allow mapping, to fill in gaps in the scheduling, or even to cover periods when only a subset of the standard 6-antenna configurations will be available. These proposals will be carried out on a "best effort" basis only.

SPECIAL: Exploratory proposals: proposals whose scientific interest justifies the attempt to use the PdB array beyond its guaranteed capabilities. This category includes for example non-standard frequencies for which the tuning cannot be guaranteed, non-standard configurations and more generally all non-standard observations. These proposals will be carried out on a "best effort" basis only.

The proposal category will have to be specified on the proposal cover sheet and should be carefully considered by proposers.

Configurations of the six-antenna array

The six-element array can be arranged in the following configurations:

Conf	Stations					
A	W27	E68	N46	E24	E04	N29
B	W12	W27	N46	E23	E12	N20
C	W12	E10	N17	N11	E04	W09
D	W08	E03	N07	N11	N02	W05

The general properties of these configurations are:

- `A` alone is well suited for mapping or size measurements of very compact, strong sources. It provides a resolution of $0.8''$ at 100 GHz, $\sim 0.35''$ at 230 GHz.
- `B` alone yields $\sim 1.2''$ at 100 GHz and, in combination with A provides an angular resolution of $\sim 1.0''$ at 100 GHz. It is mainly used for relatively strong sources.
- `C` provides a fairly complete coverage of the uv-plane (low sidelobe level) and is well adapted to combine with D for low angular resolution studies ($\sim 3.5''$ at 100 GHz, $\sim 1.5''$ at 230 GHz) and with B for higher resolution ($\sim 1.7''$ at 100 GHz, $\sim 0.7''$ at 230 GHz). C alone is also well suited for snapshot and size measurement experiments.
- `D` alone is best suited for deep integration and coarse mapping experiments (resolution $\sim 5''$ at 100 GHz). This configuration provides both the highest sensitivity and the lowest atmospheric phase noise.

The four configurations can be used in different combinations to achieve complementary sampling of the uv-plane, and to improve on angular resolution and sensitivity. Mosaicing is usually done with D or CD, but the combination BCD can also be requested for high resolution mosaics. Check the ANY bullet in the proposal form if the scientific goals can be reached with any of the four configurations or their subsets.

Please consult the documentation on the Plateau de Bure configurations and the IRAM Newsletter No. 63 (August 4th., 2005, accessible on the web at `../IRAMFR/ARN/aug05/aug05.html`) for further details.

Receivers

Since December 2006, all antennas are equipped with a new generation of dual polarization receivers for the 3 mm and 1.3 mm atmospheric windows. The frequency range is 81 GHz to 116 GHz for the 3 mm band, and 201 GHz to 256 GHz for the 1.3 mm band. For the upcoming winter semester, the 2 mm band may additionally become available, covering the frequency range 129 GHz to 168 GHz.

Each band of the new receivers is dual-polarization with the two RF channels observing at the same frequency. The mixers are single-sideband, with a typical image rejection of 10 dB. Only one frequency band (dual polarization) can be connected to the IF transmission lines at any time. Because of this reason and due to pointing offsets between different frequency bands, only one band can be observed at any time. The other band is in stand-by (power on and local oscillator phase-locked) and is available, e.g., for pointing and focusing. Time-shared observations between two frequency bands cannot be offered for the winter (this mode is currently being tested).

The two IF-channels (one per polarization), each 4 GHz wide, are transmitted by optical fibers to the central building. At present, the 4 GHz bandwidth can be processed only partially by the existing correlator, through a dedicated IF processor that converts selected 1 GHz wide slices of the 4-8 GHz first IFs down to 0.1-1.1 GHz, the input range of the existing correlator. Further details are given in the section describing the correlator setup and the IF processor.

PdBI Receiver Specifications

	Band 1	*Band 2**	Band 3
RF coverage	81–116	*129–168*	201–256
T_{rec} LSB	40–55	*40–60*	40–60
T_{rec} USB	”	”	50–70
G_{im}	-10 dB		-12 -8 dB
RF range LSB	81–104		201–244
RF range USB	104–116		244–256

*: preliminary values

Signal to Noise

The rms noise can be computed from

$$\sigma = \frac{J_{\rm pK} T_{\rm sys}}{\eta\sqrt{N_{\rm a}(N_{\rm a}-1)N_{\rm c}T_{\rm ON}B}} \frac{1}{\sqrt{N_{\rm pol}}} \qquad (1)$$

where

- $J_{\rm pK}$ is the conversion factor from Kelvin to Jansky (22 Jy/K at 3 mm, 35 Jy/K at 1.3 mm, *29 Jy/K at 2 mm*)
- $T_{\rm sys}$ is the system temperature ($T_{\rm sys}$ = 100 K below 110 GHz, 170 K at 115 GHz, *130 K at 150 GHz*, 200 K at 230 GHz for sources at $\delta \geq 20°$ and for typical winter conditions.)
- η is an efficiency factor due to atmospheric phase noise (0.9 at 3 mm, *0.85 at 2 mm*, 0.8 at 1.3 mm).
- $N_{\rm a}$ is the number of antennas (6), and $N_{\rm c}$ is the number of configurations: 1 for D, 2 for CD, and so on.
- $T_{\rm ON}$ is the on-source integration time per configuration in seconds (2 to 8 hours, depending on source declination). Because of various calibration observations the total observing time is typically 1.4 $T_{\rm ON}$.
- B is the spectral bandwidth in Hz (up to 2 GHz for continuum, 40 kHz to 2.5 MHz for spectral line, according to the spectral correlator setup)
- $N_{\rm pol}$ is the number of polarizations: 1 for single polarization and 2 for dual polarization (see section *Correlator* for details).

Investigators have to specify the one sigma noise level which is necessary to achieve each individual goal of a proposal, and particularly for projects aiming at deep integrations.

Coordinates and Velocities

The interferometer operates in the J2000.0 coordinate system. For best positioning accuracy, source coordinates must be in the J2000.0 system; position errors up to 0.3″ may occur otherwise.

Please do not forget to specify `LSR` velocities for the sources. For pure continuum projects, the "special" velocity `NULL` (no Doppler tracking) can be used.

Coordinates and velocities in the proposal `MUST BE CORRECT`. A coordinate error is a potential cause for proposal rejection.

Correlator

IF processor

At any given time, only one frequency band is used, but with the two polarizations available. Each polarization delivers a 4 GHz bandwidth (from IF=4 to 8 GHz). The current correlator accepts as input two signals of 1 GHz bandwidth, that must be selected within the 4 GHz delivered by the receiver. In practice, the new IF processor splits the two input 4–8 GHz bands in four 1 GHz "quarters", labeled *Q1…Q4*. The system allows the following choices:

- first correlator entry can only be Q1 HOR, or Q2 HOR, or Q3 VER, or Q4 VER

– second correlator entry can only be Q1 VER, or Q2 VER, or Q3 HOR, or Q4 HOR

where HOR and VER refers to the two polarizations:

Quarter IF1 [GHz]	Q1 4.2 - 5.2	Q2 5 - 6	Q3 6 - 7	Q4 6.8 - 7.8
input 1	H	H	V	V
input 2	V	V	H	H

How to observe two polarizations? To observe simultaneously two polarizations at the same sky frequency, one must select the same quarter (Q1 or Q2 or Q3 or Q4) for the two correlator entries. This will necessarily result in each entry seeing a different polarization. The system thus gives access to 1 GHz $\times$ 2 polarizations.

How to use the full 2 GHz bandwidth? If two different quarters are selected (any combination is possible), a bandwidth of 2 GHz can be analyzed by the correlator. But only one polarization per quarter is available in that case; this may or may not be the same polarization for the two chunks of 1 GHz.

Is there any overlap between the four quarters? In fact, the four available quarters are 1 GHz wide each, but with a small overlap between some of them: Q1 is 4.2 to 5.2 GHz, Q2 is 5 to 6 GHz, Q3 is 6 to 7 GHz, and Q4 is 6.8 to 7.8 GHz. This results from the combination of filters and LOs used in the IF processor.

Is the 2 GHz bandwidth necessarily contiguous? No: any combination of two quarters can be selected. Adjacent quarters will result in a continuous 2 GHz band. Non-adjacent quarters will result in two independent 1 GHz bands. Note that in any case, the two correlator inputs are analyzed independently.

Where is the selected sky frequency in the IF band? It would be natural to tune the receivers so that the selected sky frequency corresponds to the middle of the IF bandwidth, i.e. 6.0 GHz. However, this corresponds to the limit between Q2 and Q3. It is therefore highly recommended to center a line at the center of a quarter (see Section "ASTRO" below). At 3 mm, the receivers offer best performance in terms of receiver noise and sideband rejection in Q3 (i.e. the line should be centered at an IF1 frequency of 6500 MHz) whereas at 1 mm best performance is obtained in Q2 (i.e. the line should be centered at 5500 MHz).

Spectral units of the correlator

The correlator has 8 independent units, which can be placed anywhere in the 100–1100 MHz band (1 GHz bandwidth). 7 different modes of configuration are available, characterized in the following by couples of total bandwidth/number of channels. In the 3 DSB modes (320MHz/128, 160MHz/256, 80MHz/512 – see Table) the two central channels may be perturbed by the Gibbs phenomenon if the observed source has a strong continuum. When using these modes, it is recommended to avoid centering the most important part of the lines in the middle of the band of the correlator unit. In the remaining SSB modes (160MHz/128, 80MHz/256, 40MHz/512, 20MHz/512) the two central channels are not affected by the Gibbs phenomenon and, therefore, these modes may be preferable for some spectroscopic studies.

Spacing (MHz)	Channels	Bandwidth (MHz)	Mode
0.039	1 × 512	20	SSB
0.078	1 × 512	40	SSB
0.156	2 × 256	80	DSB
0.312	1 × 256	80	SSB
0.625	2 × 128	160	DSB
1.250	1 × 128	160	SSB
2.500	2 × 64	320	DSB

Note that 5% of the passband is lost at both ends of each subband. The 8 units can be independently connected to the first or the second correlator entry, as selected by the IF processor (see above). Please note that the center frequency is expressed – as in the old system – in the frequency range seen by the correlator, i.e. 100 to 1100 MHz. The correspondence to the sky frequency depends on the parts of the 4 GHz bandwidth which have been selected as correlator inputs.

ASTRO

The software `ASTRO` has been updated to reflect these new receiver/correlator setup possibilities. Astronomers are urged to download the most recent version (**February 2007 or later**) of GILDAS at `../IRAMFR/GILDAS/` to prepare their proposals.

The old `LINE` command has been replaced by several new commands (see internal help):

– `NGR_LINE`: receiver tuning

- `NARROW`: selection of the narrow-band correlator inputs
- `SPECTRAL`: spectral correlator unit tuning
- `PLOT`: control of the plot parameters.

A typical session would be:

```
! choice of receiver tuning
ngr_line xyz 230 lsb

! choice of the correlator windows
narrow Q1 Q3

! correlator unit #1, on entry 1
spectral 1  20 520 /narrow 1

! correlator unit #2, on entry 1
spectral 2 320 260 /narrow 1

! correlator unit #3, on entry 2
spectral 3  40 666 /narrow 2
...
```

Sun Avoidance

For safety reasons, a sun avoidance limit is set at 45 degrees sun distance. Please take this into account for your target sources AND for the calibrators. We are currently working toward a reduction of the sun avoidance limit.

Mosaics

The PdBI has mosaicing capabilities, but the pointing accuracy may be a limiting factor at the highest frequencies. Please contact the Science Operations Group (sog@iram.fr) in case of doubts.

Data reduction

Proposers should be aware of constraints for data reduction:

- In view of the new receiver system, **data have to be reduced in Grenoble**. Proposers will not come for the observations, but will have to come for the reduction. For the time being, remote data reduction will not be offered for projects observed with the NGR system.
- We keep the data reduction schedule very flexible, but wish to avoid the presence of more than 2 groups at the same time in Grenoble. Data reduction will be carried out on dedicated computers at IRAM. Please contact us in advance.
- In certain cases, proposers may have a look at the uv-tables as the observations progress. If necessary, and upon request, more information can be provided. Please contact your local contact or the Science Operations Group (sog@iram.fr) if you are interested in this.
- CLIC evolves to cope with upgrades of the PdBI array. The newer versions are downward compatible with the previous releases. Observers who wish to finish NGR data reduction at their home institute should obtain the most recent version of CLIC. Because differences between CLIC versions may potentially result in imaging errors if new data are reduced with an old package, we advise observers having a copy of CLIC to take special care in maintaining it up-to-date. The upgrade of CLIC to handle the NGR data implied many modifications for which backward compatibility with old PdBI receiver data has not yet been fully checked. To calibrate data obtained with the "old" receiver system, we thus urge you to use the January 2007 version of CLIC.

Local Contact

A local contact will be assigned to every A or B rated proposal which does not involve an in-house collaborator. He/she will assist you in the preparation of the observing procedures and provide help to reduce the data. Assistance is also provided before a deadline to help newcomers in the preparation of a proposal. Depending upon the program complexity and on the help requested by the PI, IRAM may require an in-house collaborator instead of the normal local contact.

Technical pre-screening

All proposals will be reviewed for technical feasibility in parallel to being sent to the members of the program committee. Please help in this task by submitting technically precise proposals. Note that your proposal must be complete and exact: the source position and velocity, as well as the requested frequency setup must be correctly given.

Non-standard observations

If you plan to execute a non-standard program, please contact the Interferometer Science Operations Group (sog@iram.fr) to discuss the feasibility.

Documentation

The documentation for the IRAM Plateau de Bure Interferometer includes documents of general interest to potential users, and more specialized documents intended for observers on the site (IRAM onduty astronomers, operators, or observers with nonstandard programs). All documents can be retrieved on the Internet at `../IRAMFR/PDB/docu.html`
Note however, that the documentation on the web has not yet been updated with respect to the new generation receivers. All information currently available on the new generation receiver system is given in this call for proposals.

> Finally, we would like to stress again the importance of the quality of the observing proposal. The IRAM interferometer is a powerful, but complex instrument, and proposal preparation requires special care. Information is available in this call and at `../IRAMFR/PDB/docu.html`. The IRAM staff can help in case of doubts if contacted well before the deadline. Note that the proposal should not only justify the scientific interest, but also the need for the Plateau de Bure Interferometer.

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