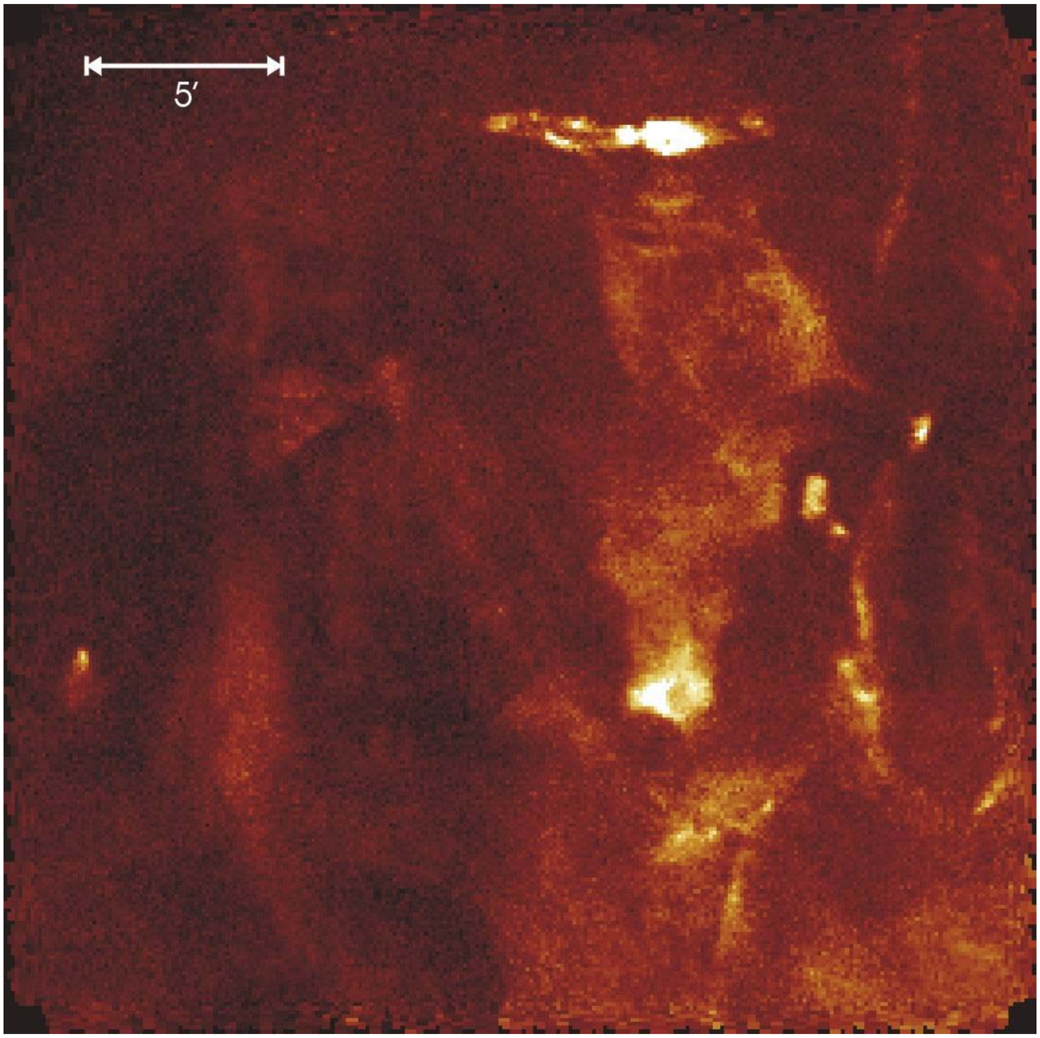
IRAM 2003



ANNUAL REPORT

Front Cover : Field A of the CO(2-1) survey in the TMC-1 cloud as observed with the multibeam system HERA at the IRAM 30m telescope. The map covers 0.5 x 0.5 square degrees with 11" resolution and shows emission in a 0.5 km/s wide velocity channel which is offset by +2 km/s from the main cloud velocity. A large number of molecular flows are visible, some of them from yet unidentified sources.

ANNUAL REPORT

2003

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1. INTRODUCTION

In 2003, a number of decisions were taken that will significantly influence IRAM's midterm and longterm future. The most significant of these was the decision by the IRAM Executive Council to call upon a Visiting Committee to evaluate IRAM's current achievements, its midterm development plan and its future role during the ALMA era. As a preparatory step towards this analysis, IRAM has organised in December 2003 a workshop with about 70 members from the scientific community, in which all scientific topics to which the IRAM telescopes have contributed were reviewed and the scientific drivers for future technical developments were discussed. IRAM has started to prepare a White Paper on its future role, taking into account the inputs received during the workshop, and identifying future technical development options that would allow IRAM to remain one of the leading institutes in millimetre wavelengths radioastronomy during the next decade. The Visiting Committee will base its evalution on this and other documents and will give its advice to the IRAM Council in the course of 2004.

A second major event in 2003 was the trial in connection with the Plateau de Bure cable car accident in 1999. The trial took place in the second half of November 2003, in Gap, and resulted in a judgement that was delivered in February 2004. IRAM, as a legal entity, was involved as the operator of the system, and two former IRAM employees were involved because of their role in 1985/86 when the system underwent a major technical modification. Unfortunately, several parties saw reason to contest the judgement and consequently put in an appeal. The matter will therefore be taken up again at higher Court level in 2005.

Very fortunately, the scientific activities at the two IRAM observatories were not affected by the preparation of these events, and they continued to produce fascinating scientific results at a very high rate. This is true for both the 30m-telescope and the 6-element Plateau de Bure Interferometer. Scientific highlights that resulted from the observations are described in Chapter 2 of this report, and we only mention here as examples the detection of CO molecules and dust in a source at redshift > 6, and the first successful VLBI experiment that produced fringes on a transatlantic baseline (PV- HHT) at a wavelength of 1mm, setting a new world record in angular resolution.

IRAM has always been striving to further enhance the observing efficiency at its observatories, and some significant progress has been made in 2003. At the 30m-telescope the "pool observing mode" has been further developed and has improved the success rate of observing projects that crucially depend on best weather conditions. On the Plateau de Bure, the largest ever number of projects has been completed, and we expect further improvements thanks to the installation of 22 GHz water vapor monitors that should allow a more systematic correction of atmospheric phase fluctuations.

The efforts to re-establish a safe, reliable and efficient operation of the Plateau de Bure observatory have continued and will continue. As an important step towards this goal, the old cable car system has been modified into a transport system for materials by the CNRS-INSU, and the system was returned to IRAM for exploitation in the summer of 2003. IRAM decided to subcontract both the technical supervision of the system and its operation to an outside company, C2EI, which assumed this responsibility in August 2003. Some further improvements of the system are still necessary, especially in order to increase the safety during maintenance operations, but the fact that loads of up to 5 tons can now (again) safely be carried up to the Plateau de Bure is already a great help.

In order to advance the new access solution for the personnel, for which a combination of a 300m long horizontal tunnel at an altitude of about 2300m, and a vertical elevator of 200m height from there to the Plateau has been baselined, a test drilling was made during the summer of 2003. The aim was to verify that in the location chosen for the new access the structure of the mountain holds no surprises. The result was very encouraging, and normally the actual ground work should start during the summer of 2004.

IRAM has continued in 2003 its series of Summer Schools by organising a school on ”Millimeter Observing Techniques and Applications” in October in Pradollano. It was attended by young astronomers from 15 different countries, despite the fact that only very limited financial support could be provided. IRAM intends to continue this activity as part of the schools and workshops in radioastronomy that are planned at European level and that will, at least in part, be funded by the European Commission.

Together with the other European radioastronomical institutes, IRAM has actively participated in the preparation of a proposal to the European Commission in response to the call for proposals for the EU-FP6 funding programme. One of the elements in the “RadioNet” proposal that has been submitted to the EU is the support of transnational access to existing observing facilities. Obviously, the IRAM observatories could play an important role in preparing European astronomers for the ALMA era, not only to acquaint a larger number of astronomers with millimetre interferometry, but also to perform preparatory and complementary scientific projects before and during the time when ALMA is operational.

2. HIGHLIGHTS OF RESEARCH WITH THE IRAM TELESCOPES IN 2003

2.1 SUMMARY

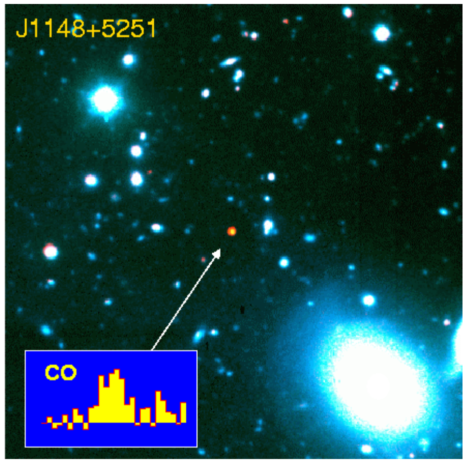
Among projects at the IRAM telescopes done or published in 2003, a few highlights were :

- **Redshift 6 gas and dust**: CO lines and dust in the highest-redshift quasar known ($z = 6.4$);
- **Neutral carbon at high z**: the redshifted 809-micron line detected in the Cloverleaf quasar.
- **High-redshift sources:** New detections of CO in SCUBA sources at z = 2.4 to 3.4.
- **Circumnuclear starbursts:** Circumnuclear gas dynamics and star formation in NGC 7469.
- **Star formation:** Triggered star formation around the expanding H II region Sharpless 104.
- **Disks around young stars:** High resolution studies of gas and dust in disks around the young stars DM Tauri, BP Tauri, and HD 34282.
- **Interstellar Molecules:** Detection of interstellar SiN in absorption toward Sgr B2, deuterated ammonia in 11 protostellar cores, and triply-deuterated methanol in the low-mass protostar IRAS 16293-2422.
- **Protoplanetary Nebulae:** Detection of an orbiting gas disk in the Red Rectangle.

2.2 EXTRAGALACTIC RESEARCH

CO lines and dust in the highest-redshift quasar known

Some of the most exciting millimeter results of 2003 were the detections of continuum emission from dust and of several CO lines in the host galaxy of the quasar J1148+5251, at a redshift of 6.419. This object, discovered in the Sloan Digital Sky Survey by Fan et al., is the most distant *quasar* currently known (at the end of 2003). The dust continuum was detected with the MAMBO bolometer array at the IRAM 30 m telescope, with a 1.2 mm flux of 5 mJy (Bertoldi et al. 2003, A&A, 406, L55). The CO(3-2) line was detected at the VLA, and was quickly followed up by detections of the CO(6-5) and (7-6) lines with the IRAM Interferometer (**Fig. 2.1**; Walter et al. 2003, Nature, 424, 406). Analysis of the millimeter data (Bertoldi et al. 2003, A&A, 409, L47) indicates a molecular gas mass of 2 x 10^{10} Msun, uncorrected for gravitational lensing. The true value may be somewhat lower, because the optical spectrum shows absorption from an intervening galaxy at $z = 4.9$, which may indeed gravitationally amplify the quasar's flux, thereby improving the probability of detection in the millimeter range. The idea of lensing is supported by the relatively small H II region created by the quasar's ionizing radiation, which indicates the quasar may be less luminous than its apparent brightness would indicate (White, Becker, Fan, & Strauss 2003, AJ, 126, 1). With or without lensing, it is remarkable that stellar nucleosynthesis produced such a large quantity of metal-enriched material (CO and dust) by a time only 870 million years after the Big Bang as indicated by the redshift z = 6.4.



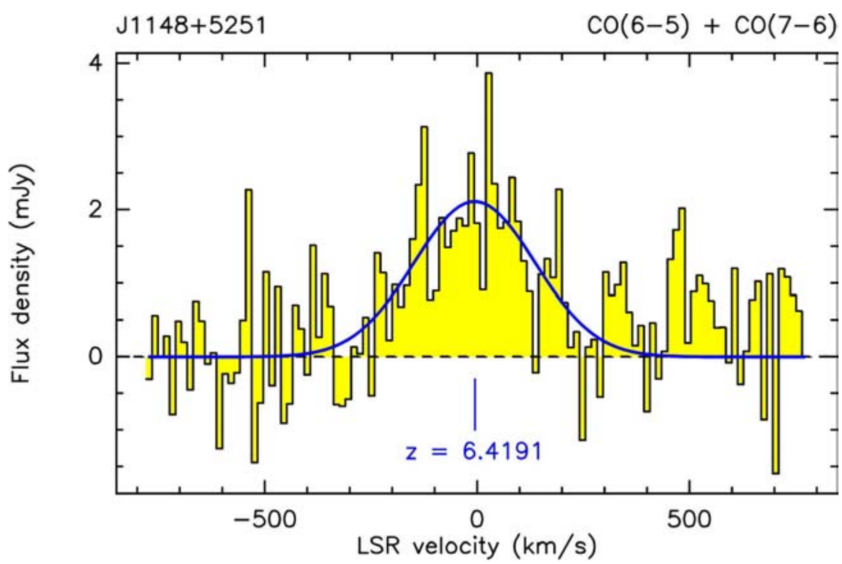


Fig. 2.1: IRAM CO detection toward the z=6.4 quasar J1148+5251. *Upper:* Keck telescope optical image of a 2 x 2 arcmin field around the quasar J1148+5251. The quasar is the red object at the center of the field; all the other objects are galaxies closer to us (Keck image due to S.G. Djorgovski et al.) The inset is the IRAM CO spectrum, shown in greater detail below. *Lower:* Composite CO spectrum from the IRAM interferometer. Because of the weakness of the signal in individual lines, the CO(6-5) data at 93 GHz were added to the CO(7-6) data at 109 GHz. These two CO lines have about the same flux, and the figure shows their average profile (Walter et al. 2003, Nature, 424, 406 ; Bertoldi et al. 2003, A&A, 409, L47).

Neutral carbon line from the Cloverleaf quasar at z = 2.56

The upper fine structure line of neutral carbon, CI($^3P_2$ — $^3P_1$), normally at an emitted frequency of 809 GHz, has been detected with the IRAM interferometer, redshifted to 227 GHz, in the Cloverleaf quasar at z = 2.56 (**Fig. 2.2**).

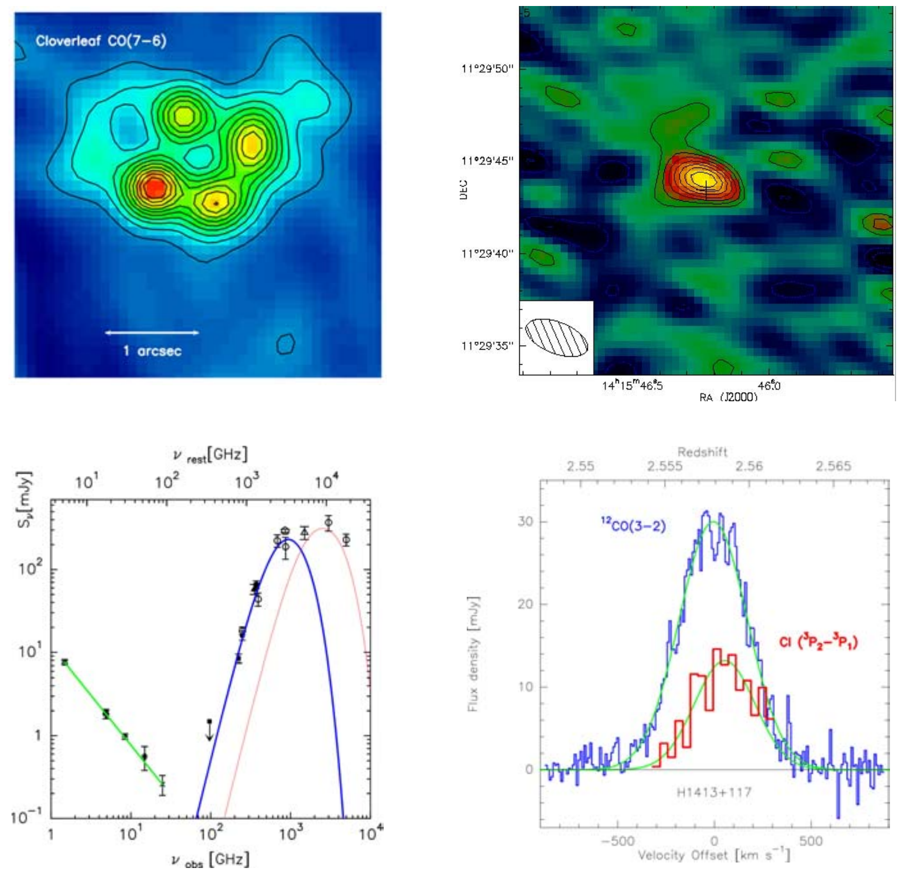


Fig. 2.2: IRAM Interferometer detections of CO and neutral carbon in the Cloverleaf quasar at z=2.56. *Upper left:* An earlier CO(7-6) map with a 0.6" beam shows the four Cloverleaf images produced by the gravitational lens. This CO(7-6) line at 226.7 GHz has a flux of 50 Jy km/s. *Upper right:* New detection of the neutral carbon CI($^3P_2$--$^3P_1$) line at 227.4 GHz with a 3.5″x1.7″ beam. At the position of the quasar, the carbon-line flux is 5 Jy km/s, while away from the quasar, the noise in the field is 0.5 Jy km/s. *Lower left:* Radio-to-far-infrared continuum spectrum of the Cloverleaf. Flux densities are from the IRAM telescopes (mm range), the VLA (cm range), JCMT and CSO (sub-mm), and IRAS and ISO (far-IR, near-IR). The lines show the synchrotron cm-radio emission (in green), the outer, cool ``starburst'' dust at 50 K (in blue) and the inner, hotter quasar-heated dust at 115 K (in red). *Lower right:* CO(3-2) line at 97 GHz and CI($^3P_2$--$^3P_1$) line at 227 GHz, both detected with the IRAM interferometer. The CO line ratios and the carbon-line ratios indicate that the CO and the neutral carbon lines are emitted in the outer, cooler starburst disk around the quasar, not in the inner, hotter AGN torus (Upper left diagram from Kneib et al. 1998; all other diagrams from Weiss et al. 2003, A&A, 409, L41).

With this detection, the Cloverleaf is now only the second extragalactic source, after M82, where *both* carbon fine structure lines have been convincingly detected. Combining this new detection with that of the lower fine structure line, seen earlier at the 30m telescope (Barvainis et al. 1997), allows one to estimate an excitation temperature of ~30 K for the carbon atoms, so the line obviously comes from a relatively cool region several hundred parsecs away from the quasar itself. The flux of this carbon line at 227.4 GHz is ten times lower than that of the CO(7-6) line at the nearby frequency of 226.7 GHz. This weakness relative to CO accounts for the difficulty in detecting the CI line in high-redshift objects until now (Weiss et al. 2003, A&A, 409, L41).

CO in submm galaxies with optical redshifts measured at the Keck telescope

A significant breakthrough in the studies of high-redshift dust sources discovered at 850 microns with the SCUBA bolometer array on the JCMT telescope has been the measurement of their optical redshifts at the Keck telescopes. Knowledge of these optical redshifts for a large sample of SCUBA galaxies has now made possible CO detections in these sources with the IRAM Interferometer.

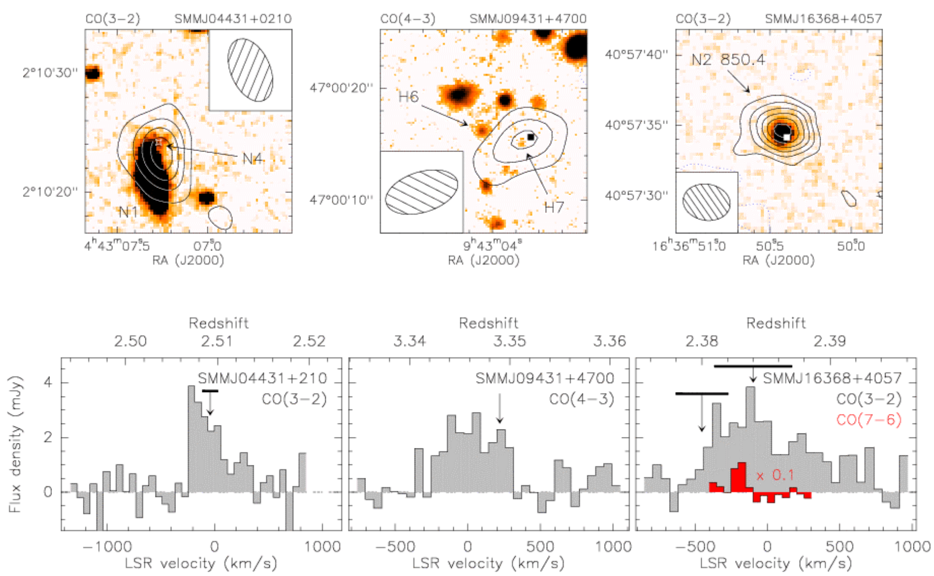


Fig. 2.3: Detection of CO in three Submillimeter Galaxies at z = 2.4, 2.5, and 3.4.
The upper panels show maps of the integrated CO emission (in 2-sigma contour steps, typically 0.3 Jy km/s). These CO contours are superposed on near-infrared images. The lower panels show the CO spectra, with the velocity scale centered on the CO redshift. The arrows show the previous determination of the redshifts from optical spectroscopy. The peak-to-peak noise in the spectra is typically 3 mJy in 20 MHz channels. For the source 16358+4057, a spectrum is also shown at the frequency of the CO(7-6) line, with its true intensity divided by 10 (Neri et al. 2003, ApJ, 597, L113).

The first three CO detections in this new sample have been published, with redshifted CO lines at about the 2 mJy level, among the weakest of the high-z CO sources detected so far. Two of the new sources, at redshifts 2.4 to 3.4, are weakly gravitationally lensed, but even after downward correction for lensing, the line fluxes correspond to large gas masses, typically 10^{10} Msun. All of this indicates that a large fraction of the stars in galaxies formed in the epoch z = 2 to 3 (Neri et al. 2003, ApJ, 597, L113).

Nuclear gas dynamics and star formation in NGC 7469

The Seyfert galaxy NGC 7469 is a luminous infrared source at a distance of 66 Mpc. More than half of the infrared luminosity comes from recent star formation in a circumnuclear ring. To study this ring, data from the IRAM Interferometer in CO(2-1) and HCN(1-0), with beams of 0.7" and 2", have been combined with Keck Telescope adaptive optics spectroscopy in the 2.2-micron band of the innermost few arcsec around the nucleus. The CO(2-1) map (**Fig. 2.4**) shows a ring of molecular clouds at a radius of 740 pc, mostly outside of the ring of the infrared-bright knots. The interferometer map also shows an extended gas peak at the nucleus, and a gas bar or pair of gaseous spiral arms between the nucleus and the 740-pc ring.

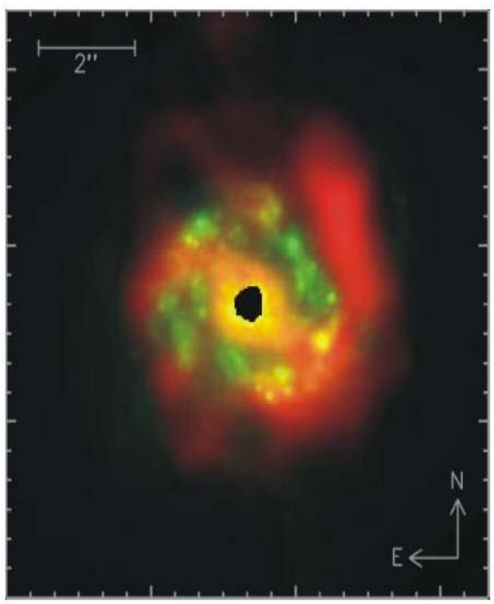


Fig. 2.4: Molecular gas and recently-formed stars around the nucleus of NGC 7469. This overlay shows the interferometer map of the CO(2-1) emission (in red), superposed on a Hubble Space Telescope image of the stellar light at a wavelength of 1.2 microns (in green). Regions with both gas and starlight appear yellow. The ring of star-forming knots lies mostly inside the ring of gas clouds. The intense light at the nucleus has been masked out to improve the contrast. The 2 arcsec scale indicator at the top left corresponds to a length of 640 parsecs. (Davies et al. 2004, ApJ, 602, 148 ; HST image from A. Evans).

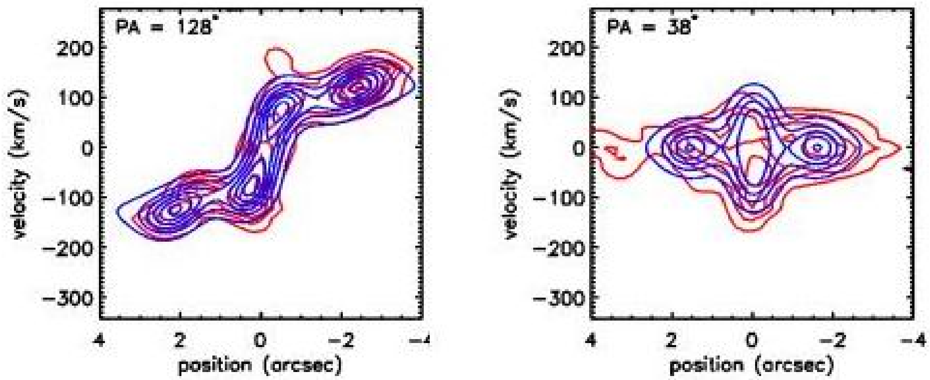


Fig. 2.5: Molecular gas dynamics around the nucleus of NGC 7469. The plots show CO(2-1) position-velocity diagrams in the nuclear region, along the kinematic major axis (left) and along the minor axis (right). The red contours show the interferometer measurements. The blue contours show a computed model for a 3-component nuclear disk. (Davies et al. 2004).

The CO data indicate that within a radius of 4" (1300 pc) of the nucleus, more than half of the total mass of 4 x 10^9 Msun is in the gas, but within a radius of 0.1" (30 pc), most of the mass (3 x 10^7 Msun) is in stars. It is remarkable that the same rotating-disk model (**Fig. 2.5**) is able to fit well the motions derived from both tracers: the millimeter lines of CO and the infrared lines of H_2. There is no kinematic signature of gas motion along a bar, or of movement toward the nucleus (Davies et al. 2004, ApJ, 602, 148).

2.3 STAR FORMATION IN OUR GALAXY

Triggered Star Formation at the Border of an Expanding H II Region.

It has long been known that stars form in gas contracting under its own gravity, but this is only part of the story. An important ingredient must be the role of shocks in starting and keeping the process going. An example is the expansion of an H II region ionized by a massive star. The HII region expands supersonically, sweeping up dense neutral gas between the outward-moving shock and the ionization front that follows it. The dense, swept-up shocked gas then breaks into fragments that contract to form more stars. A real example where this may be happening is the shell around the H II region Sharpless 104, a low-density H II region at a distance of 4 kpc from the Sun. The mass of gas ionized by the central O6 star is substantial, ~450 solar masses. There is also an unresolved *thermal* radio source at its eastern border, at the site of a second ionizing star. This Sharpless 104 H II region has recently been observed in molecular lines with the 30m telescope.

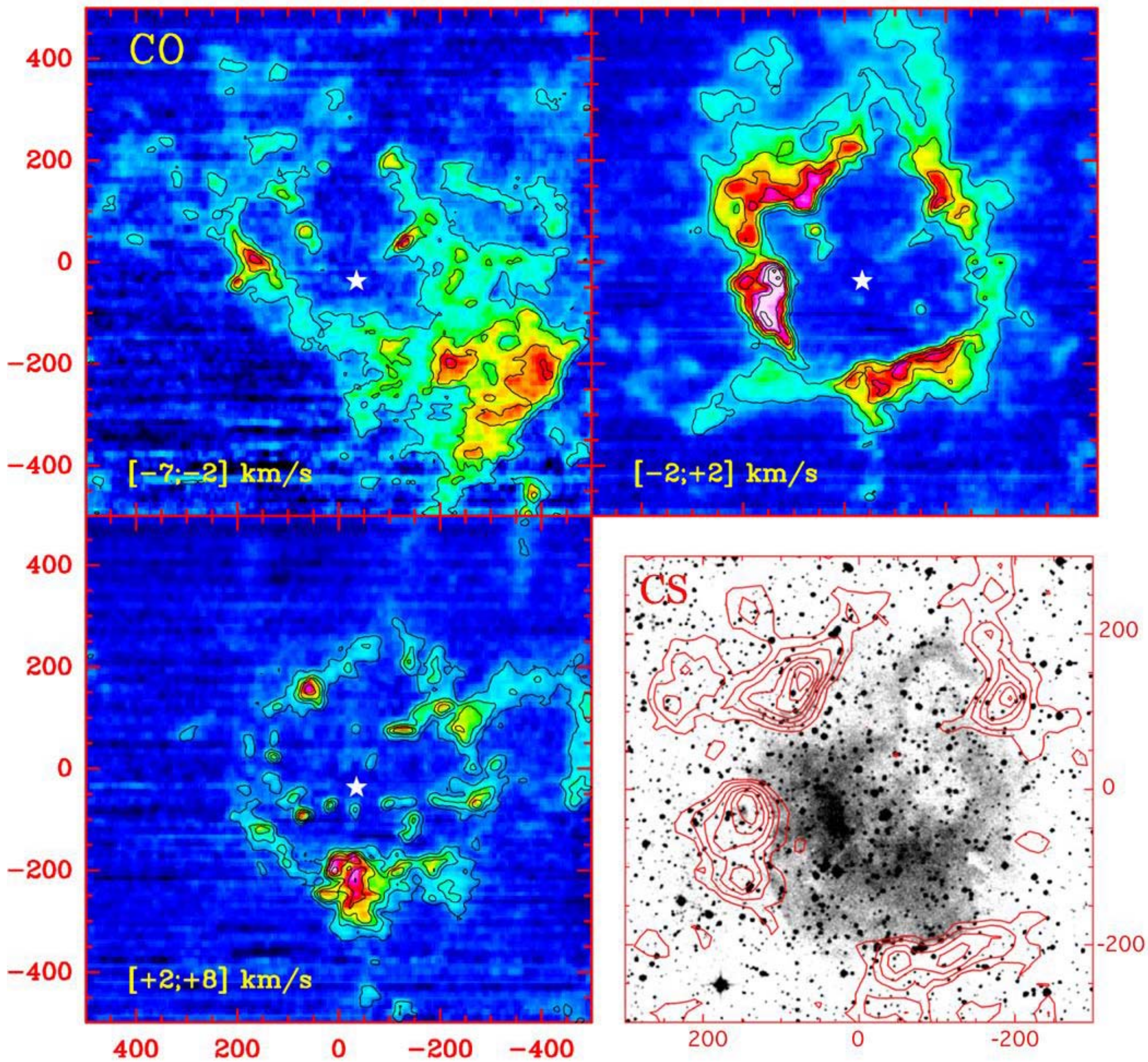


Fig. 2.6: Triggered Star formation around an expanding H II region. *First 3 panels:* Maps made with the HERA multibeam array on IRAM 30 m telescope, of a 15′ x 15′ field, showing CO(2-1) emission in an expanding ring around the H II region Sharpless 104. Labels on each panel indicate the velocity range. Coordinates are offsets in arcsec from the field center. The star symbol marks the position of the exciting star. *Lower right panel:* Map of CS(2-1), a dense gas tracer, superposed on the optical (red) image of the region. CS contour steps are 0.3 K km/s. The four main CS clumps contain several massive cores of molecular gas, an embedded infrared cluster of young stars, and at least one massive star ionizing an ultra-compact H II region (Deharveng et al. 2003, A&A, 408, L25).

The CO(2-1) maps, made with the HERA multibeam array, show that just outside the H II region, there is a ring of molecular gas, expanding with a velocity of 7 km/s. In this ring, there are four large condensations of molecular gas. The brightest of these fragments has a size of 3 x 1.5 pc, a mean hydrogen density of 3100 cm^{-3}, a gas temperature of 30 K, and a mass of 670 Msun. This bright gas condensation contains a cluster of young stars seen in near-infrared images. All around the ring, the total mass of molecular gas is 6000 Msun. Observations of $C^{18}O$ and CS(3-2) show that this large mass breaks up into condensed cores with H_2 densities of 10^4 /cm^3, sizes of 0.4 to 0.6 pc, and masses of 70 to 100 Msun. These cores are likely sites of future new stars (Deharveng et al. 2003, A&A, 408, L25).

2.4 DISKS AROUND YOUNG STARS

New Studies of Disks around pre-Main-Sequence Stars

New interferometer observations have been made of the disks around the stars DM Tauri and HD 34282, and new 30m-telescope observations have been made of the disk around the star BP Tau. The disk of DM Tau was observed with 1" resolution in the 2-1 lines of ^{12}CO, ^{13}CO, and $C^{18}O$ to probe the vertical temperature distribution in the disk (**Fig. 2.7**). The different opacities of these lines mean that ^{12}CO samples the gas at 2 to 4 scale heights, while the ^{13}CO(2-1) probes the 1-scale height level, and ^{13}CO(1-0) reaches into the middle of the disk plane. At the radius of 50 AU to which the IRAM observations are sensitive, the data indicate that the temperature increases from 20 K in the disk mid-plane, to 30 K at 2 scale heights, as expected for flared disks that are heated by radiation from the central T-Tauri type star. The disk also appears to be truncated at smaller radii in ^{13}CO and $C^{18}O$ than in ^{12}CO, as expected from their relative sensitivity to photodissociation (Dartois et al. 2003, A&A, 399, 773).

The Herbig Ae star HD 34282 was observed in CO(2-1) and in the dust continuum at 1.3 mm. These observations showed a large Keplerian disk around the star. Modeling the results indicates the Hipparcos distance to this star is underestimated; the true distance is about 400 pc. The disk around this stars is more massive and somewhat hotter than the disks observed so far around the less massive T Tauri stars, but it otherwise appears to share their same, passively-rotating disk behavior (Piétu et al. 2003, A&A, 398, 565).

The new 30m observations of BP Tauri, together with an improved analysis of earlier interferometer data on this star, have yielded more details about the circumstellar disk. The disk has a relatively small outer radius of 120 AU, and is just marginally opaque in the

$^{12}CO(2\text{-}1)$ line. It's gas temperature is 50 K at 100 AU. The mm continuum flux from dust in the disk varies with frequency as $\nu^{2.7}$ and indicates a disk mass of 1.2×10^{-3} Msun. The dust radiation is strong, but the CO is weak, so CO may be depleted by a factor of 150 relative to H_2 or else there is either an anomalously low gas-to-dust ratio or the dust properties are unusual. This suggests that BP Tau may be in the phase of clearing its disk, a period thought to be relatively short in T-Tauri stars (Dutrey et al. 2003, A&A, 402, 1003).

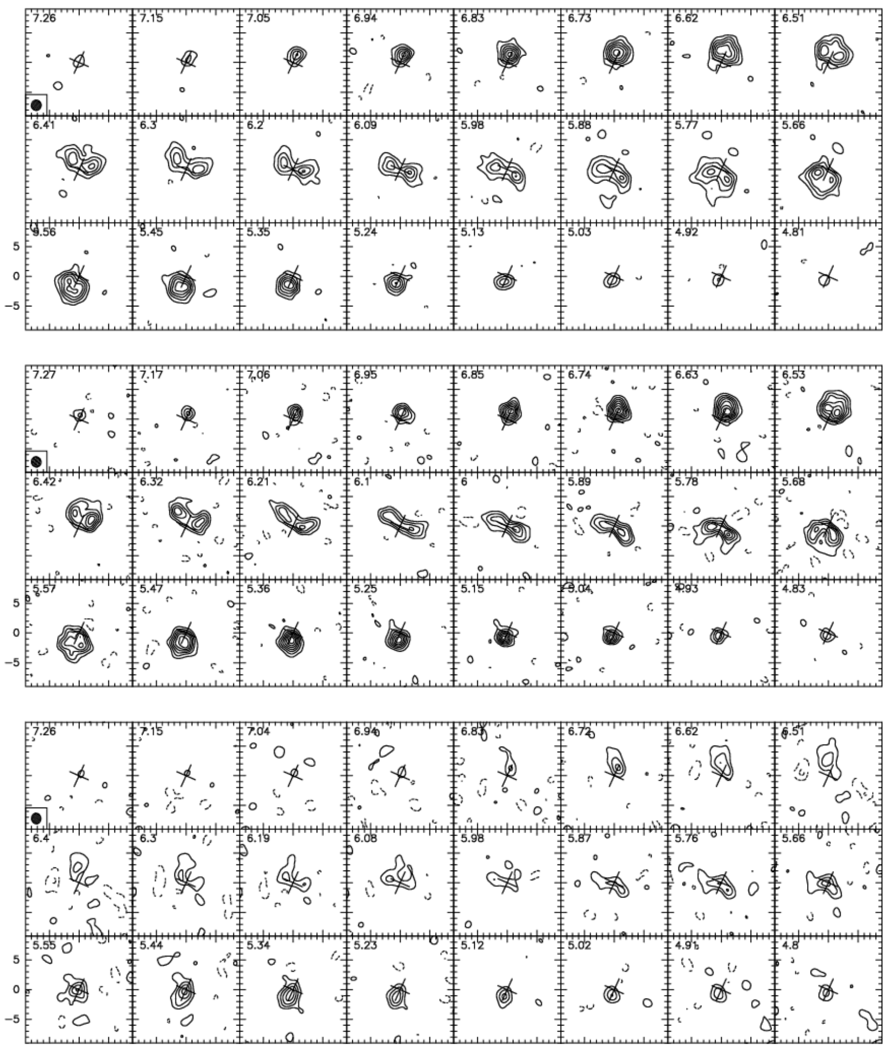


Fig. 2.7: CO in the disk around the star DM Tauri. Channel maps, spaced every ~0.1 km/s, of $^{13}CO(1\text{-}0)$ *(upper panels)* with contours every 1 K, $^{13}CO(2\text{-}1)$ *(middle panels)* also with 1 K contours, and $C^{18}O(2\text{-}1)$ *(lower panels)* with contours of 0.5 K. The half-power beamwidths in all maps are the same (1.7" x 1.6"). The cross in each map indicates the centroid of the disk and its major and minor axes (Dartois et al. 2003, A&A, 399, 773).

2.5 INTERSTELLAR MOLECULES

Interstellar SiN

The 30m telescope has been used to detect silicon nitride (SiN), in its N=2-1, J=5/2-3/2 transition, in a molecular cloud absorbing the strong continuum from the Sgr B2(M) H II region (**Fig. 2.8**). Although this line had previously been observed in a circumstellar envelope, this is the first time this molecule has been seen in the interstellar gas. This observation is significant because it is extremely rare to find molecules containing refractory elements in the diffuse gas --- most are condensed out onto dust grains. The 30m observations yield a SiN column density of (1 to 2) x 10^{13} cm^{-2}, which is 20 to 50 times lower than that of silicon monoxide (SiO) toward the same source. Like silicon monoxide and iron oxide (FeO), the SiN molecule is probably created in the gas phase, after dust grains are destroyed by shocks or UV radiation, thereby releasing refractory elements like silicon (Schilke et al. 2003, A&A, 412, L15).

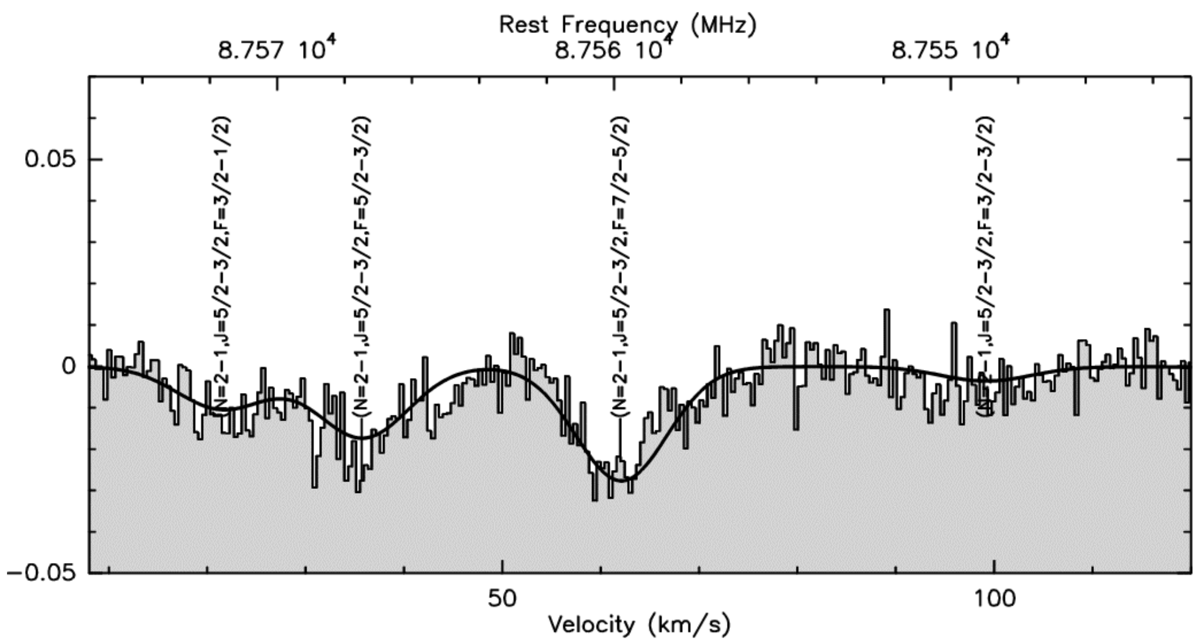


Fig. 2.8: Interstellar Silicon Nitride in absorption against Sgr B2. This spectrum, taken at the 30m telescope, shows the absorption of the Sgr B2 continuum by the hyperfine components of the SiN molecule in the frequency range 87.5 to 87.6 GHz. The quantum numbers are listed at the locations of the hyperfine lines. The solid line shows a fit to the hyperfine components, assumed to be optically thin (Schilke et al. 2003, A&A, 412, L15).

Large fractions of deuterated ammonia in protostellar cores

In spite of the low abundance of deuterium in the universe ([D/H] = 1.5×10^{-5}), an exciting discovery in the past few years has been the high abundance of deuterated molecules in the surroundings of protostars. Observations at the 30m telescope toward 11 protostellar objects in Perseus, Taurus, and Orion have resulted in detections of deuterated ammonia (NH_2D) in its 85.93 GHz 1(1,1)-1(0,1) transitions (6 hyperfine lines). Comparison with Effelsberg observations of normal ammonia (NH_3) indicates that these sources have the highest [NH_2D/NH_3] ratios yet measured, of 4 to 33 percent. These D/H ratios are higher than those measured on larger scales, showing that deuterium fractionation increases toward protostellar cores. As in cold clouds, such high ratios can be produced by gas-phase ion-molecule chemistry, where depletion of CO onto dust grains results in an increase of [H_2D^+/H_3^+] in the gas phase (Hatchell, 2003, A&A, 403, L25).

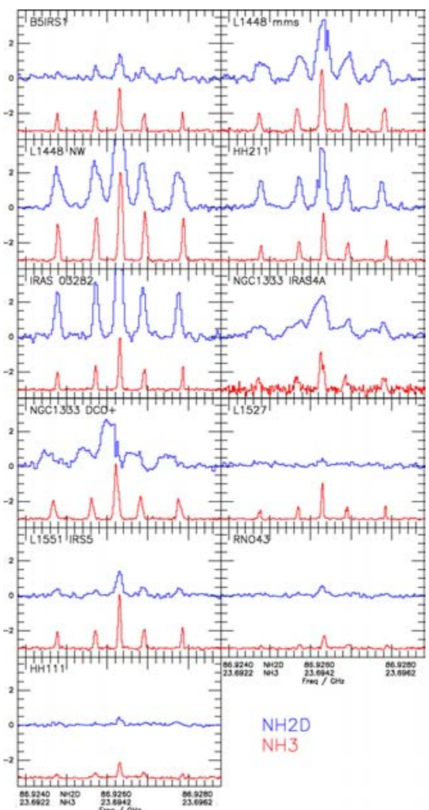


Fig. 2.9: Deuterated and undeuterated ammonia from protostellar cores. The NH_2D spectra *(in blue)* are from the 30m telescope, operating at 3mm, while the NH_3 spectra *(in red)* are from the Effelsberg 100m telescope, operating at 1.2cm. Both species show the hyperfine structure characteristic of ammonia. The spectra are plotted vs. frequency, so the NH_2D lines appear wider, because of the factor of 3.6 difference in line frequency. In velocity units, both species have nearly the same linewidths.

Triply-deuterated methanol

The 30m telescope has been used to make the first detection of triply-deuterated methanol, in 12 spectral lines, observed near 156 and 161 GHz. All these lines were observed toward the low-mass protostar IRAS 16293-2422, where singly- and doubly deuterated methanol had previously been detected at the 30m telescope (see our Annual Report 2002). The abundance ratio of CD_3OH to CH_3OH in this source is 1.4 percent. The results on deuterated methanol suggest that the ratio of deuterium to hydrogen in some molecules and molecular ions in the gas accreting to the protostar may be as high as 10 to 30 percent. This high pre-existing D/H ratio in various molecules and molecular ions in the gas phase may then set the stage for the later formation, on grain surfaces, of highly-deuterated methanol. These molecules, stored in the ices of the grains, may be liberated into the gas phase when the newly-formed protostar starts to heat its envelope and evaporates the ices on the grains (Parise et al. 2004, A&A, 416, 159).

2.6 PROTOPLANETARY NEBULAE

Detection of an orbiting gas disk in the Red Rectangle

Gas disks are often suspected to be orbiting around post-AGB stars, possibly in association with a companion star or maybe a planet. These suspicions are motivated by optical images showing bi-conical outflows from stars in this phase of their evolution. These outflows produce a protoplanetary nebula, whose shape may be preserved later on, when the star becomes much hotter, and ionizes its surroundings to form a planetary nebula. The outflows must be channelled or focused by something, and this something is probably a disk. Evidence for such a gas disk has now been obtained with the IRAM Interferometer in the Red Rectangle, a well-known, nearby (380 pc) protoplanetary nebula, surrounding an A1 star. The IRAM observations of CO(2-1) show that most of the molecular gas is not in the bipolar flow seen in visible light, but perpendicular to it, in a disk 2000 AU across and less than 500 AU thick. The mass of gas in the disk is ~0.04 Msun, and the velocity pattern follows that expected for a rotating disk dominated by the mass of the central star **(Fig. 2.10).** At a radius of 10^{16} cm from the star, the disk's gas temperature is 40 K, the molecular hydrogen number density is 10^{6} cm^{-3}, and the rotation velocity is 1 km/s. These observations provide the first evidence for an orbiting molecular disk around a post-AGB star (Bujarrabal et al. 2003, A&A, 409, 573).

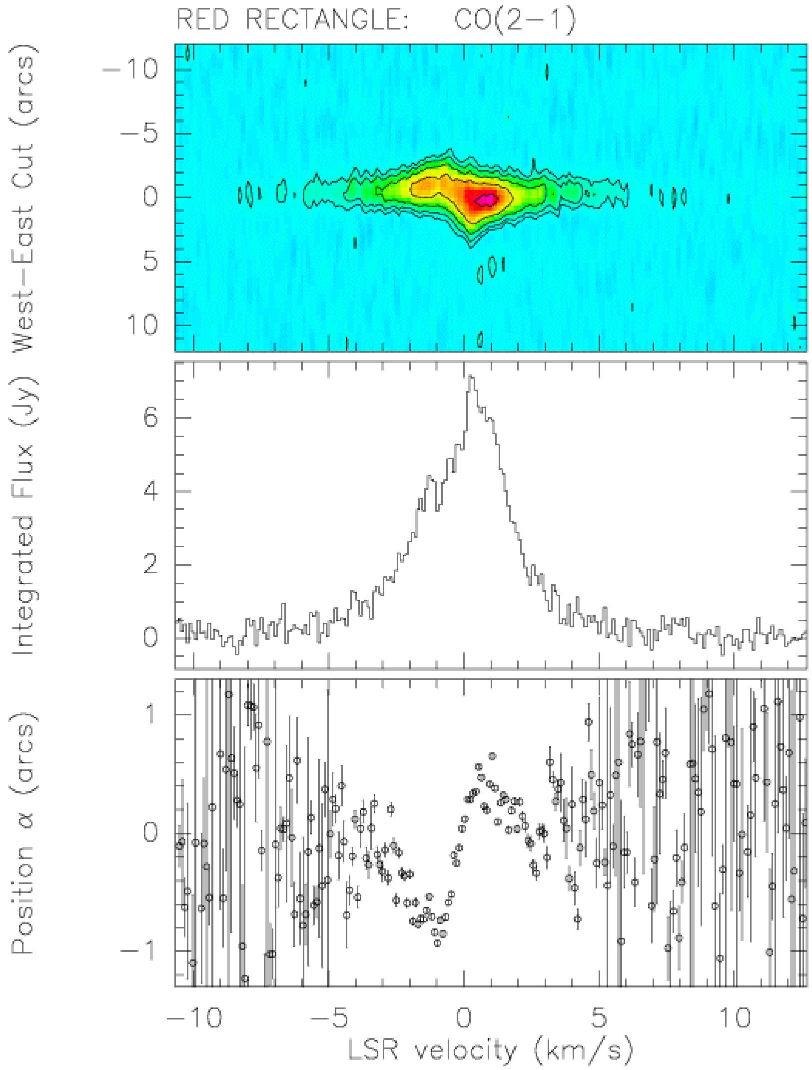


Fig. 2.10: Evidence for a Rotating Disk in the Red Rectangle. *Top Panel:* Position-velocity diagram, in the east-west direction, of the CO(2-1) emission. *Middle Panel:* integrated CO line profile from the disk. *Lower Panel:* Position (in R.A.) of the centroid of the CO emission, as a function of velocity, showing the characteristic profile of a rotating disk. The interferometer maps were made with a 3.6″ x 1.6″ beam. (Bujarrabal et al. 2003, A&A, 409, 573).

3. Pico Veleta Observatory

3.1. Staff changes

Enrique Lobato followed as a telescope operator Teresa Gallego who left IRAM. Manuela "Manolita" Aguila who has been the chief cook for many years retired; Maria Lara took over her responsibilities and a new cook, Carmen Ruiz, was hired. Miguel Ángel Torres Pérez joined IRAM as Ramón y Cajal fellow. Núria Marcelino started her thesis work as a predoctoral fellow. Jean-François Desmurs was hired in the astronomy group.

3.2 Telescope operations

Operation in 2002 was generally smooth. As shown in Fig. 3.1, 62% of the total time could be used for observations. Fig. 3.2 shows the distribution of the telescope observing, maintenance and down times for each month.

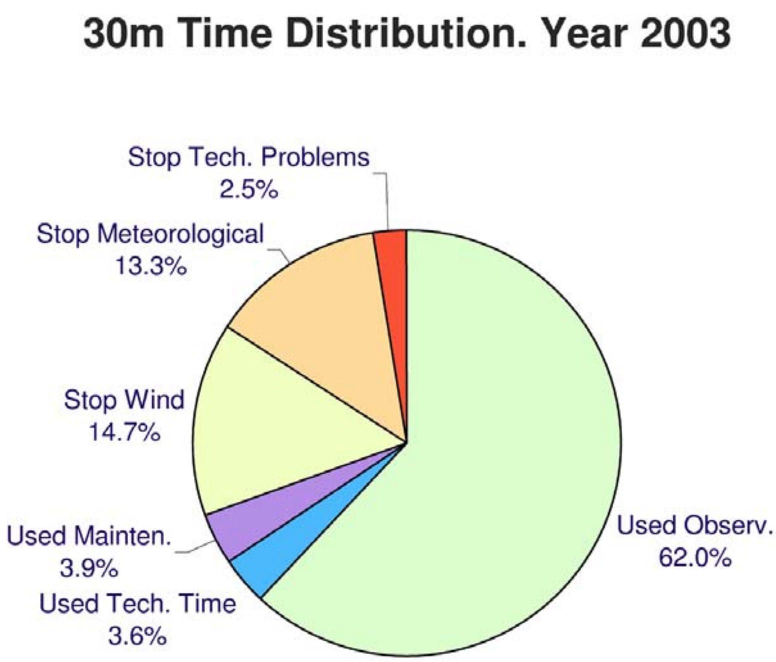


Fig. 3.1: Distribution of the total telescope time for the year 2003.

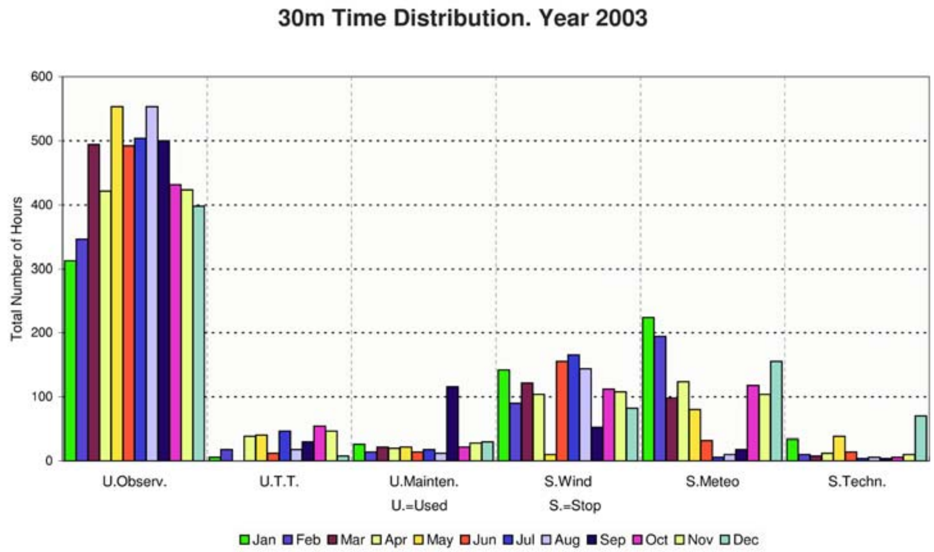


Fig. 3.2: Monthly distribution of the telescope time in hours.

Many of the project proposals that have the potential of creating a big scientific impact, require excellent weather conditions. In order to optimize the chances that such projects can successfully be carried out despite the often quickly changing weather conditions, IRAM offers the pool observing mode at the 30m telescope. In this mode all bolometer and some crucially weather dependent spectroscopy programs share the allocated observing time together with some less weather demanding spectroscopy programs.

They are executed in a sequence that takes into account the actual weather conditions, the ranking given by the program committee, and the source visibility. This observing mode has drastically increased the average success rate of A ranked projects that require good or excellent weather conditions. The statistics for the winter period 2002/2003 are shown in Figure 3.3.

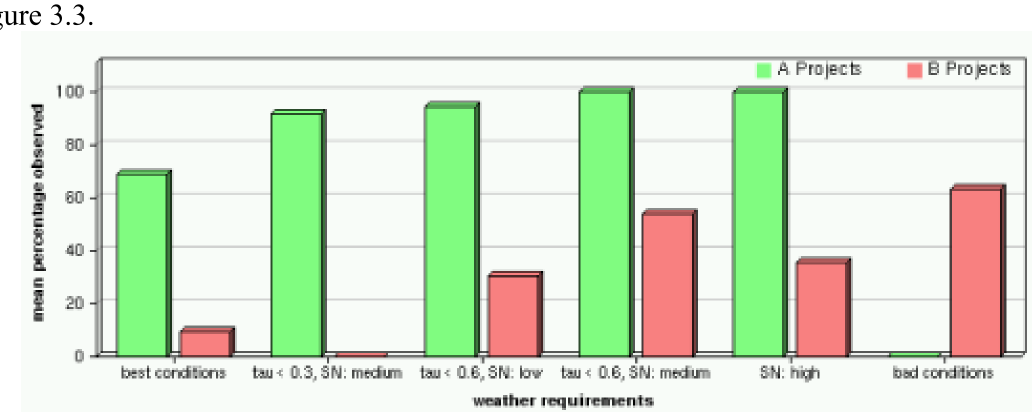


Fig. 3.3: Completion rate of A and B rated proposals participating in the winter pool 2002/2003 in relation to their weather requirements. Note: SN=sky noise.

The pool observations are conducted mostly by the astronomers whose programs are included in the pool. Support is provided by the IRAM astronomers and telescope operators. There are typically three guest astronomers, one IRAM astronomer, and the telescope operators at the telescope. Given the flexible use of different instruments and the large variety of scientific programs, students are sometimes invited to participate in the pool observations for training purposes.

Pool observations were first tested at the IRAM 30m telescope during the winter 2000/2001, and have now expanded to 12 weeks during the winter semester, and about 4 weeks during the summer. The winter 2003/4 pool includes almost 50 different programs with more than 500 different targets. To manage such a pool requires an efficient organizational structure, so that at any time the status of a program, target priorities and weather/technical requirements can be assessed. This motivated the development of a special tool, the observation database system (ODS).

The IRAM pool observation database system (ODS) is based on PHP scripts executed from an apache web-server, which accesses a MySQL database. The database contains detailed information on all projects including technical and meteorological requirements. Observational information is read from the fits data headers of each scan. This observation information is easily associated with observing projects, and thereby allows book keeping, planning, data quality control, and in connection with an external data reduction software, an automated pipeline data reduction. The system also permits data archiving and the easy access/download of data for the users. The users interactively enter and modify their target lists, observation instructions, and they are able to check the state of the project and the data quality.

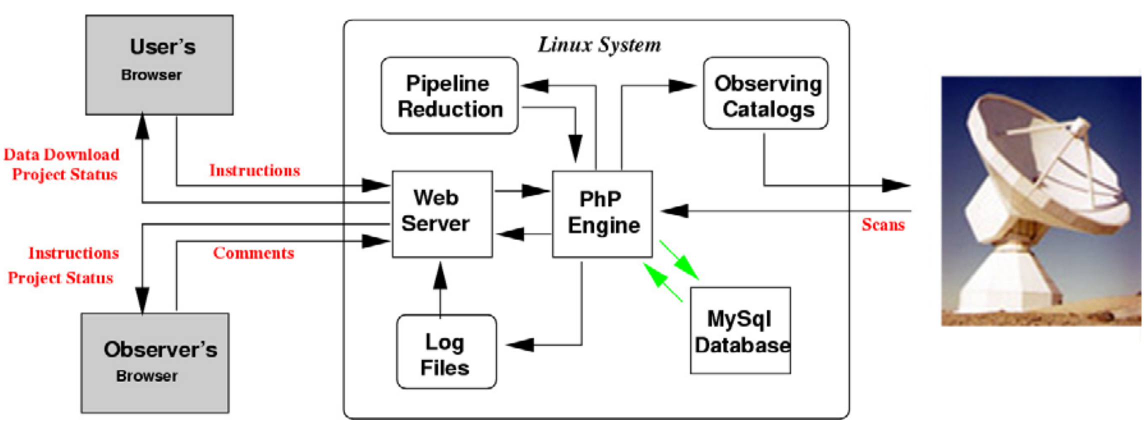


Fig. 3.4: Block diagram of the pool observing database used at the Pico Veleta Observatory

To assure high data quality, it is mandatory to trace constantly the weather conditions and the calibration results. The ODS provides the observers with functions to monitor the corresponding parameters: all skydips are automatically reduced by ODS using the pipeline MOPSIC reduction scripts. The results are subsequently used for the reduction of all other scans. Similarly the skynoise is automatically determined by ODS from each scan. A graphical display of both parameters allows to monitor the transmission and the stability of the atmosphere during the observations.

The observers can use the pipeline reduction to determine the quality of the accumulated observations and to determine the resulting rms. ODS automatically determines the rms and makes an entry in the source field of the corresponding project. In this way all observers (and the PIs) can easily check if the required S/N ratio of a given observation has been reached or if further integration is required. Once the observations for a source have been finished, the observers set the source priority within a project to "done". The source will than show up in red on the project page, and it will no longer show up in the LST plot or other selection functions, nor on the Xephem display. The PIs can still modify the source priority, and thereby enter it again into the active part of the pool, if they decide that further integration time is needed.

To ensure a fast feedback from the PIs, ODS provides all project accounts with an unlimited online access to the project and calibration data. On login to ODS, the PI gets a message if new data have been taken for her/his project. Upon request ODS generates a tar-file which contains all target observations and all pointing, focus and calibration scans done within 1h before and after a target observation. In addition the PIs will get the latest measurements of the receiver parameters of the bolometer array suitable for her/his observations. The tar file also contains all log files which cover the observations and a detailed summary of all scans taken for the project. The PIs can themselves run the pipeline reduction for bolometer observations to have a quick look at the observations, and judge their quality independently from the observer.

3.3 Antenna

The quality of the *antenna pointing* was good during the year, the pointing model parameters being more stable than in previous years. Only six pointing sessions had to be run and implemented during the year. The main reasons for this improvement over previous years are:

a) the continuous updating of the pointing parameters P4 and P5 using the inclinometers. P4 reflects the tilt N-S and P5 the tilt W-E of the antenna azimuth axis. Fig. 3.5. shows the evolution during the whole year with a total of 2093 measurements.
b) The new antenna temperature regulation that also controls now the temperature of the counter-weight. This has significantly reduced the thermal deformations in the entire antenna structure, including the servos and the receiver steel structures.

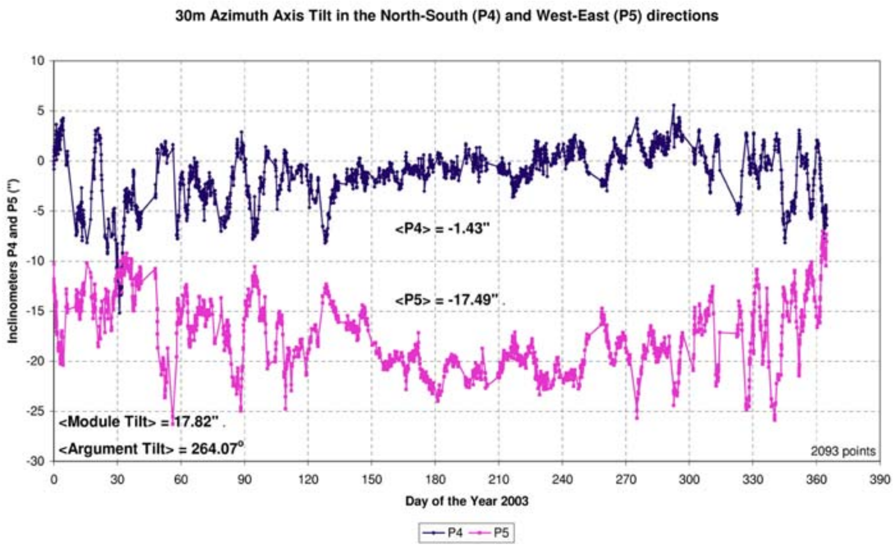


Fig. 3.5: Determinations of the pointing parameters P4 and P5 with the inclinometer in the course of one year.

Other tasks aimed at improving the antenna pointing were the following:
- The tilts of the support of the mirrors M3 and M4 were measured versus the antenna elevation. The M4 column tilts by up to 12” over the 90° elevation range. Considering that M4 rotates by 180° when switching between heterodyne receivers and the bolometers, two different pointing models have been considered, and the offsets determined.
- Six new temperature sensors have been installed around the wall of the servo cabin, close to the roof, to identify thermal gradients which could deform the servos-receiver steel.
- Inclinometer sensors have been installed in the base of the antenna tower for test purposes. The goal is to check the long-term stability of the inclinometer measurements.
- The actual pointing subroutine has been modelled identifying all the contributions for pointing corrections as: pointing model, homology, refraction, subreflector movement, etc, to be used with the new control system.

The *program to control the subreflector* spindles has been developed in VME under Linux as part of the tasks for the NCS. The new servo control program in Linux has similar characteristics as the old program in CAMAC, but includes some additional features. The reading of the spindle encoders for the positioning of the subreflector is done with a resolution

of 4 μm (with CAMAC this was limited to 30 μm). The higher resolution allows a better positioning of the subreflector, avoiding standing waves ripples. The reading of each one of the six subreflector spindles is done by averaging two independent encoders, The individual malfunction of any of the encoders is immediately detected and notified. This application is ready to be implemented.
A bug was identified in the *program of the Servos Programmable Controller* (Krupp MAN design) that was potentially risky for the antenna as described below. When a failure happened in the movement of an antenna axis, for instance elevation, everything was triggered to STOP the movement of that axis, and as soon as the velocity was close to 0 (below 7%) the brakes were applied. But should it be the case that the reason for the failure, for instance a servoamplifier failure, did not permit to move that axis to velocity 0 and in that case the brakes were never applied while the antenna continued moving and accelerating in elevation (falling down) due to the wind or its unbalanced weight until the operator forced the emergency STOP (in the history of the 30m that problem seems to have happened a few times, but the reason was not identified because of the intermittent nature of the problem). With the modification carried out in the program of the Servos Programmable Controller, in case of failure in any antenna axis or in case the velocity of that axis exceeds by any reason 70% of its maximum velocity (in normal operation never moves at velocities higher than 50%) the command to STOP in a smooth way is activated giving a timing of two seconds to STOP. If after that timing of two seconds the related axis of the antenna is still not stopped the power is automatically forced to OFF and brakes are immediately ON.

The old *weather station* from Lambrecht had problems to be maintained, several sensors and electronic interface cards were neither any more produced nor maintained, and to guarantee a good calibration of the readings became a difficult task. With the new weather station we are using sensors from different suppliers with the only requirement that they deliver standard outputs that can easily be read by VME modules. The connection to the VME had priority with respect to CAMAC (but the reading with CAMAC is still possible). With the new weather station the wind is recorded every second in a VME system (previously this was done with a dedicated PC). The weather data are also delivered every minute for the graphic display on the IRAM web page.

The *vertex blades* that the operator controls remotely, opening them for making observations, and closing them during bad weather, have been equipped with limit switches that give status information about the actual position of the blades. Before, only the commanded status was indicated without any feedback of the real status.

The deicing system for the subreflector has been repaired and modified to give more reliability and now, after a winter storm, the subreflector surface can be de-iced faster than before. The backstructure has been painted, and the four legs.

The Instituto Geográfico Nacional (IGN) has included the Pico Veleta observatory in the Spanish network of stations where gravity is monitored with high precision. IRAM has provided the necessary facilities.

3.4 Receivers

The activities in this area during 2003 focused on the preparations for the installation of additional 9 channels in the multibeam receiver (HERA), improvements in the operation of the tau-meter receiver, and work for the ALMA project.

The arrival of the second group of 9 channels for the multibeam system required the fabrication of a second 9 channels (+1 spare) down converter box and the installation of a new set of cables for transporting the IF signals. In anticipation of future wideband receivers that are likely to come in a few years time, the installed coaxial cables are specified for up to 8 GHz.

The tau-meter receiver has become the standard tool at the telescope for assessing the quality of the atmosphere in the high frequency bands. Actual information of the atmospheric transmission as well as some accumulated statistics can already be accessed on the IRAM web page.

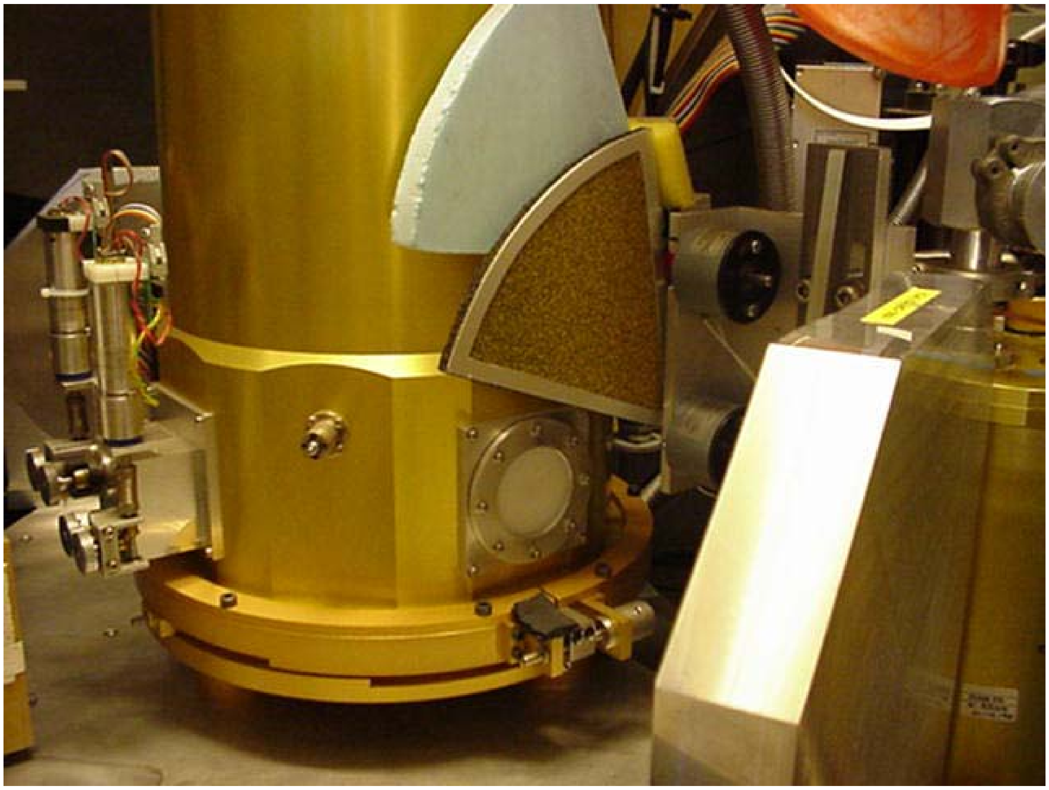


Fig. 3.6: First test of the semi-transparent vane calibration scheme for ALMA.

The work for the ALMA project included the design and assembly of a new version of the infrared filters for all ALMA bands. For bands 3 and 4 the design is completely new, and for all bands improvements have been made that should reduce reflections and standing wave problems.

The other topic on which work was done during 2003 concerns the proposed idea of using a semi-transparent vane to calibrate the ALMA receivers with high precision. The concept was tested and demonstrated to work to a good precision. A first attempt with the absorbing material just in front of the receiver gave strong reflections and unstable results while a second set-up, with the vane located far away from the cryostat, provided repeatable and consistent data. An alternative scheme, using the existing Martin-Pupplet filters, already located in front of the receivers, was also tested with even better results. These calibration systems, independently of their possible use for the ALMA receivers, could be an interesting alternative to the currently used calibration system at the 30 meter telescope. The topic will be studied further.

During the past year we also had the opportunity to host and participate in several experiments with new devices that might one day become facility instruments at the 30m-telescope or elsewhere. Examples are the new bolometer polarimeter (POLKA) from the MPIfR in Bonn, and the rotating half wave plate polarimeter (ROVER) from the UK Astronomy Technology Centre in Edinburgh.

3.5 VLBI

In April 2003 a new world record in angular resolution was set. Fringes at 1mm were obtained between the 30m-telescope on Pico Veleta and the Heinrich-Hertz-Telescope in Arizona.
3C 454.3 was detected with a signal-to-noise ratio of 7-8 in three scans. Fringes at 1mm were also detected between the two IRAM observatories on PV and the PdB. Successful observations were also carried out at 2mm which confirmed results obtained in the year before. In addition, a final 3mm session coordinated by the CMVA was successfully carried out. In the future, IRAM will participate in global 3mm-VLBI experiments under a new agreement that has been signed recently between several institutes in Europe and in the US.

During the April session, a new recording-formatting MARK-5 system has been tested. It uses packs of eight hard disks instead of tapes. Recording at 1Gbit/s will become routine with this new system, thereby increasing the continuum sensitivity. IRAM will buy two such units and install them at PV and on the PdB.

3.6 Backends

The program for data acquisition with VESPA has been modified permitting to record a total number of 18432 channels at a rate of up to 32 Hz. The new facilities of fast sampling with VESPA were used for the data acquisition with the guest polarimeter ROVER. The hardware interface to synchronize the polarimeter position with the time stamp had to be developed.

The racks in the backend room have been redistributed to accommodate new hardware and to obtain free space for future new spectrometers (Fig. 3.7).

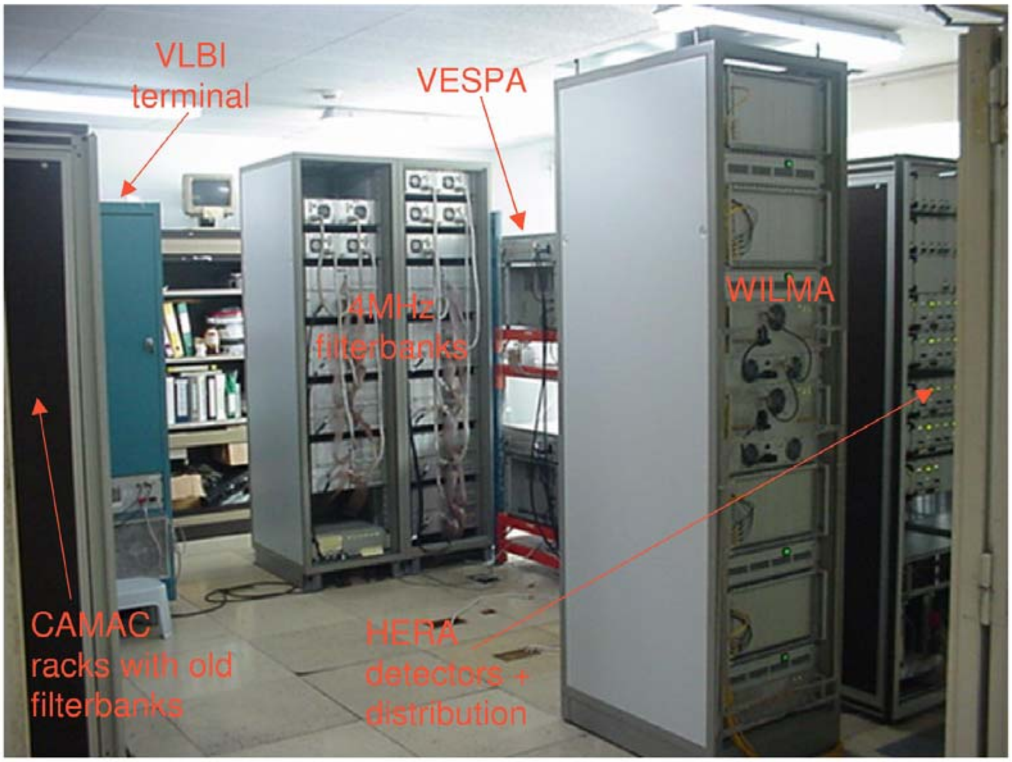


Fig. 3.7: New distribution of backends in the backend room at Pico Veleta.

The second set of nine detectors and selector modules for HERA have been installed. All 18 detectors are now working.

The growing number of IF´s and spectrometers require a new device that allows cross-switching between them. The new distribution accepts 18 inputs from the Multibeam Receiver and makes 72 outputs: 36 for VESPA, 18 for WILMA, 9 for the 4MHz filterbanks, and 9 remain as spares. One can select in blocks of 9 the HERA polarization to which the spectrometer is connected. This selection will soon be done remotely. In addition, the inputs to the first 4 pixels of the 4MHz filterbanks can be selected between normal IF´s (A,B,C,D) or HERA pixels. Fig. 3.8 shows an individual IF splitter-selector module designed at IRAM with two inputs and eight outputs.

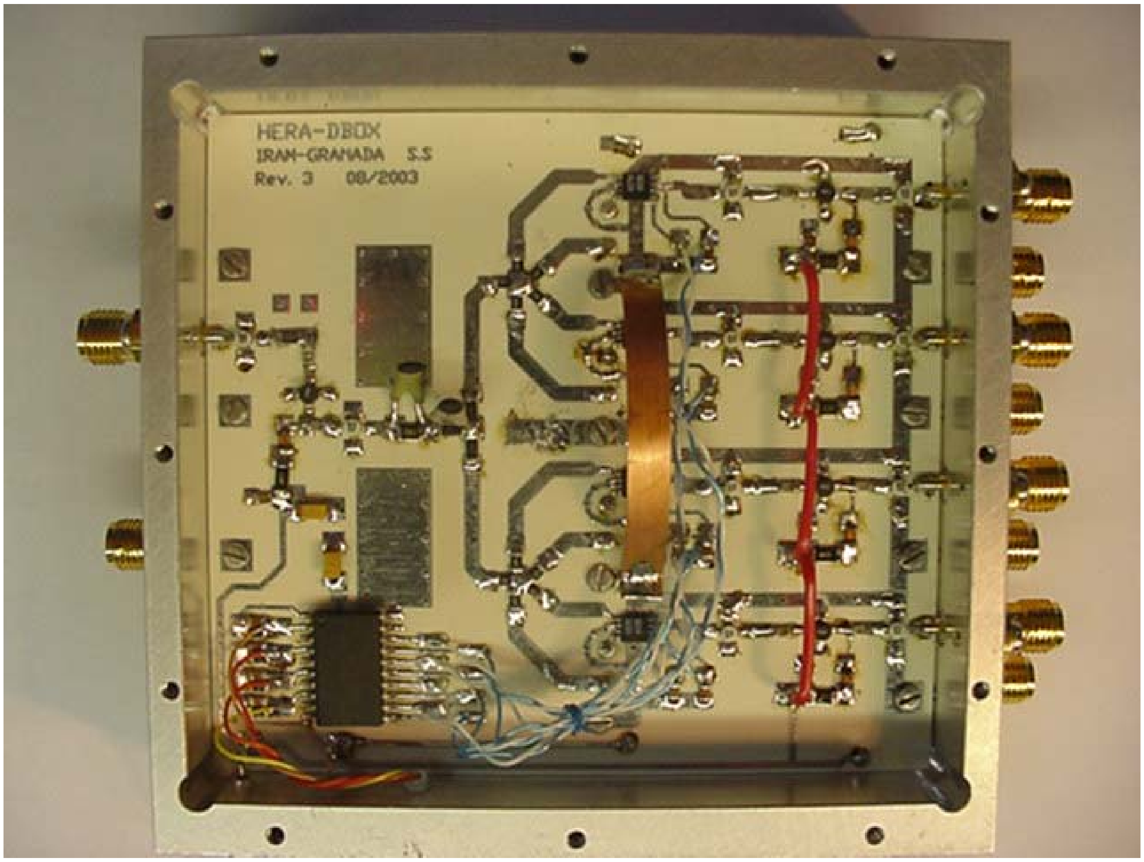


Fig. 3.8: An individual IF selector modul with two inputs and eight outputs.

The Wideband Line Multiple Autocorrelator (WILMA) hardware was installed. 18 spectrometers of 1 GHz bandwith each are housed in a single rack. Hardware tests and the software installation are ongoing.

The antenna/backend group has participated in the preparation of pulsar observations at 86 and 130 GHz, a project headed by R. Wielebinski from the MPIfR,Bonn. A system for data acquisition able to record in real time four receiver channels with 16 bit resolution at a rate of 2000 samples per second, including the time stamp in UTC, was prepared.

3.7 Computers and Software

Development of software was continued for several subsystems of the *New Control System* (NCS) for the 30m telescope. Software for the control loops of the main axes was successfully completed and tested with the new hardware. Many higher level functions for the main-axis control to support different observing modes, i.e., antenna movements on the sky, were developed and tests are ongoing. A prototype of the software to acquire trace data from the main axis control system, i.e., a fast record of the telescope's position, was written and tested.

The lower level part of the software for the control of the secondary mirror was developed and tested with the new hardware. A prototype of the software to handle messages between the subsystems was developed and is about to be tested. Complete information about observing blocks, scans, subscans, and results needs to be exchanged between the NCS subsystems: for this purpose we defined an XML format based on the VOTable format and developed prototype tools to handle these XML files.

A prototype of the observer's user interface to the NCS, called PAKO, and the scan analyzer subsystem is available for tests and comments by users. It can run offline, independently from the rest of the NCS, and it now supports most of the observing modes, source and line catalogs, as well as setup of switching modes, receivers, and backends. It includes extensive error checking, on-line help, and a graphical preview for the more complex observing modes like on-the-fly (OTF) maps.

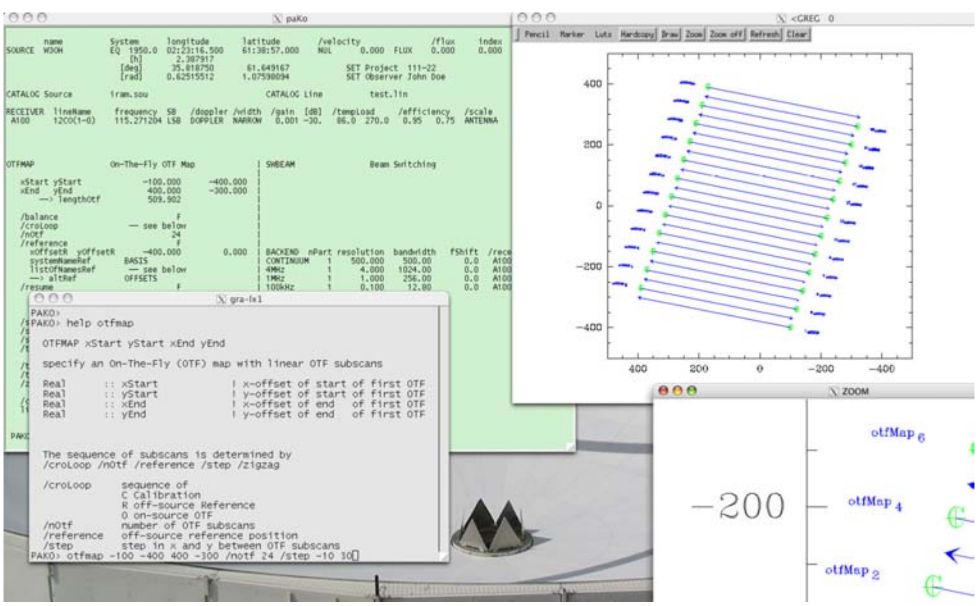


Fig. 3.9: Screenshot of the user interface PAKO in the new control system

Visitors can now take their data back home on DVD, CD, DAT tape, or just sent it via Internet. The link between Granada and the telescope runs at 2MBit and from Granada we have a 10 MBit link to the University of Granada that connects us with the Internet.

Early in the year, the radiolink equipment at the telescope failed. Although only five years old, it could not be repaired by its provider. Material that had been outphased by the Instituto de Astrofisica de Andalucia in Granada allowed us to set up a new radiolink. However, the provider does not maintain this equipment anymore, and we are testing now devices that are used for standard wireless networks. Hoping that a new system will become operational in 2004, we plan to raise on that occasion the communication speed to 10 Mbit/s.

3.8 Infrastructure and Safety

A system for *lightning warning* has been installed in the control room. The system measures the atmospheric electrical field and triggers an alarm if this exceeds a predefined threshold. The electric field is recorded in a file together with the weather data. Two *safety life-lines* have been installed in the lifting platform to access the prime focus. They improve the safety and facilitate the movement on the platform during the work.

3.9 IRAM Observing School on "mm Observing Techniques and Applications"

In October 2003, the second IRAM Observing school in Spain was held in Pradollano. Young astronomers from 15 countries attended the lectures and a lab course. Observing time at the 30m telescope was granted in order to gain practical observing experience. Several participants were invited to participate in pool observations during the winter semester 2003/2004 to get additional experience. The lecturers offered assistance to the participants in writing observing time proposals for the IRAM telescopes. A small computer center was setup for the summer school. Besides some twelve computers, two printers, a scanner, and most important of all a fast (ADSL) link to Internet was offered at the hotel where the summer school was held. Students could practice with the standard data processing software used at the 30m telescope.

4. PLATEAU DE BURE OBSERVATORY

4.1 Staff Changes

In October, Lilian Masnada joined the operations group as a telescope operator. He will support the astronomical and technical activities at the Observatory.

Marie Minière and Éliane Bargagin from the Bure kitchen staff retired at the end of June and August, respectively. This left only one person from the original staff, Nadine Durand, who left IRAM at the beginning of October 2003, after it had been decided to completely subcontract the cooking and the cleaning to an external company (EUREST).

4.2 Observations

General Observing

The 6-element interferometer was performing well with almost no downtime due to equipment failure during scheduled observations. The same can be said about the receivers which all worked well throughout the year without significant problems. The weather conditions on the site were excellent in January, February and March, conditions were relatively good from spring to fall, and rather poor in November and December. The percentage of total telescope time scheduled for observing programs was lowest in the summer with an average of 30 percent of the total time, and about 40 percent in the winter months. About 10 to 15 percent of the time went into test measurements, antenna maintenance, and the remaining time was lost due to bad weather conditions.

The year 2003 saw the highest ever achieved scientific return of the interferometer. More than 140 different observing projects coming from 95 different proposals were scheduled at the Observatory in 2003. Almost equal amounts of time went into galactic and extragalactic projects. Appendix 7.2 details all the proposals to which time was granted in the course of the year. The second week in April was reserved to a first intercontinental 1mm VLBI test run including the 6-element array and the 30m telescope, and the last week in April was entirely devoted to coordinated 3mm VLBI continuum observations together with a number of other observatories in Europe and in the United States.

Despite the limited total number of people working at the Observatory, and the constraint that this puts on our ability to carry out configuration changes, an effort was made to schedule all four (ABCD) configurations during wintertime. More than 3 years after the cable car accidents, the scheduling of the A configuration has been very beneficial for many projects and for the scientific return of the interferometer. As in the last two years, a large amount of observing time was invested in the D configuration between spring and fall in order to detect the line-emission from carbon-monoxide in high-redshift galaxies.

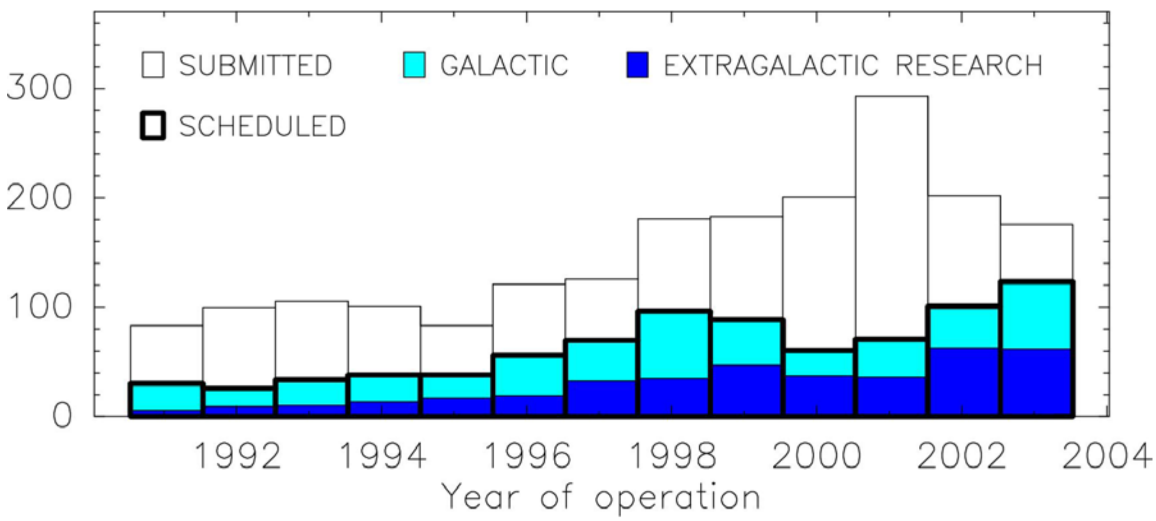


Fig. 4.1: Ten years of science operations at the Plateau de Bure Interferometer. The vertical axis shows the number of projects requested and scheduled. For the latter the division into galactic and extragalactic topics is shown. The pressure factor has been varying but was generally higher than two. Note the steadily increasing interest for extragalactic observations.

VLBI observations

In early April 2003 both IRAM instruments participated in a transatlantic experiment at 230 GHz, together with Kitt Peak and the HHT. This experiment was recorded with Mark5A equipment, which was lent for this occasion by the MPIfR, Bonn. For the first time, transatlantic fringes were found (on the baseline PV-HHT), establishing with 20 micro-arcsec angular resolution a new world record. Fringes were also found between Plateau de Bure and Pico Veleta, although weaker than originally expected due to a phase noise problem on Bure, which becomes dominant at high frequencies. This problem is still under study, and several modifications have been implemented in the LO chain to eliminate error sources.

In late April 2003, Plateau de Bure and Pico Veleta participated successfully in the Global 3mm VLBI session. For both observing campaigns IRAM received valuable support from staff of the MPIfR Bonn. The contribution of the Plateau de Bure to the obtained results can be illustrated with a map of the innermost portion of the jet of 3C274 (=M87).

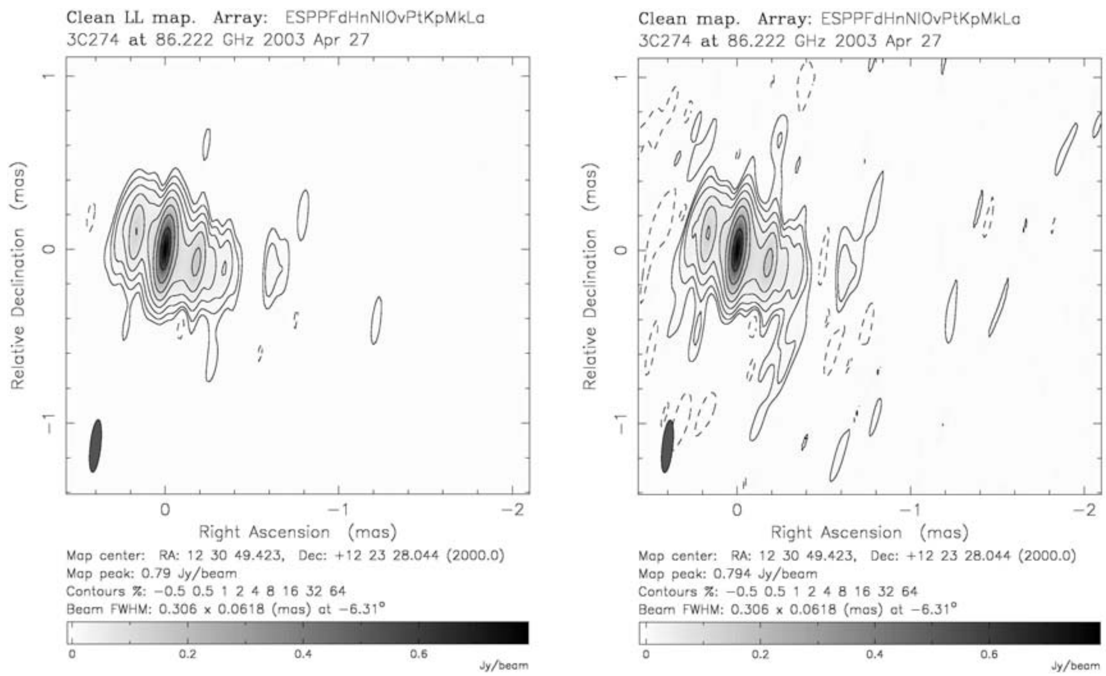


Fig. 4.2: two preliminary 86 GHz VLBI maps of 3C274 as obtained during the Global 3mm VLBI session in April 2003. The global fringe fitting was done using the nearby quasar 3C273 as fringe tracer. For comparison, we show on the right an image made without using Plateau de Bure data. Note that without the Bure array the global fringe fitting process would have led to the loss of detection sensitivity, which was not taken into account when producing this figure (Credit: MPIFR Bonn).

In August 2003, the first Call for proposals for the Global 3mm VLBI Array has been published. This array is the successor to the former Coordinated Millimeter VLBI Array (CMVA) and offers 3-4 times more sensitivity than the VLBA at 3mm wavelengths. The Global 3mm VLBI Array consists of 8 VLBA antennas equipped with 3mm receivers, plus the IRAM 30-m telescope on Pico Veleta (Spain), the IRAM phased 6-element interferometer on Plateau de Bure (France), the 20-m radio telescope in Onsala (Sweden), the 14-m telescope in Metsahovi (Finland) and the MPIfR 100-m radio telescope in Effelsberg (Germany). Other telescopes may join later.

In December 2003, IRAM has ordered its own Mark 5A VLBI terminals which can register data rates of up to 1 Gigabit/s. This will double the maximum data rate (and thus the bandwidth) compared to Mark 4, i.e. weaker astronomical sources can be detected within a given coherence time. These terminals will be available in 2004.

The 22GHz radiometric phase-correction system

By the end of May 2003 all antennas had been equipped with 22 GHz three-channel radiometers. The receivers are used to correct for wavefront distortions caused by moving cells of atmospheric water vapour. The radiometers have a three-channel discriminating system to detect emission from water vapour while rejecting spurious emission from cloudlets and water droplets. Work carried in December 2003 with the aim to stabilize the temperatures in the receiver cabins with a new ventilator-heater system has been essential. The improved system stability now allows to correct for phase decorrelation.

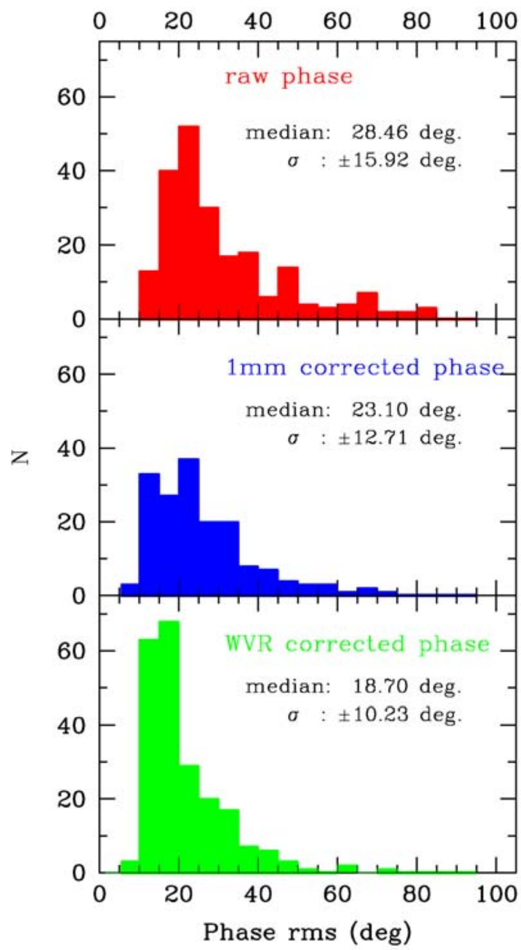


Fig. 4.3: The histograms show the distribution of the phase noise on time intervals of 10 min measured on Plateau de Bure between June and December 2003 on a representative number of projects. The upper panel displays the atmospheric phase noise at 3 mm wavelength, the central diagram shows the residual phase noise after the correction derived from the 1 mm continuum detectors is applied, and the lower panel gives the residual phase noise after the 22 GHz radiometric phase correction is applied. No correction was made here for cloudlets and water droplets. The ordinate N refers to single baselines.

Data Calibration

Efforts have been continued to improve the calibration pipeline by optimising the flux density calibration strategy to increase the quality of the flux calibrator database, and work was started to provide an automatic assessment of data quality. At the end of 2003 work was under way to define a set of stable flux calibrators to be observed regularly and in a coordinated manner at the 30m telescope and the Plateau de Bure array.

Data archive

Work to provide a Web-based access to the entire Plateau de Bure Archive was completed in the fall. The Archive contains the years from 1990 to 2002. The database, which is a collaborative effort with the Centre de Données Stellaires in Strasbourg (CDS), is planned to go online in 2004.

4.3 Technical Maintenance Work

Organisational Matters

As in previous years, the maintenance of the interferometer was carried out during the summer. The “Cellule Bure”, the Observatory’s logistical services group located at the Grenoble headquarters, coordinated activities related to the maintenance, organized the training and working schedule for personnel recruited on fixed-term contracts, scheduled transports by helicopter and on ground, provided assistance to the Observatory staff when needed and coordinated technical activities. The group also helped to establish technical procedures that have resulted in a more efficient overhaul schedule, and to purchase critical spare parts and materials to support antennas and instruments. Despite the many technical activities and a first and careful inspection of the mechanics and of the painted surface panels of antenna 6 after a first winter of continuous operation, the maintenance time could be optimised and reduced to five months.

As last year, to keep the number of people at the Observatory as small as possible, regular scientific observations were carried out with an astronomer on duty providing remote support from Grenoble for most of the time in the period from May to November. During the wintertime, an astronomer on site provided support to optimise the scheduling of astronomical observations, and thereby the scientific return of the instrument.

In order to improve the maintenance of the interferometer and the buildings of the observatory, a GMAO system *(Computer Assisted Maintenance Management)* is being installed. Throughout the year, the Bure staff gathered relevant information that could be implemented in the GMAO data base (spare references, suppliers, addresses, prices, etc…). The next step for 2004 is to finish the data “gathering” phase and to install the complete data base on a server. The last phase will be to train the Bure staff to the use of the GMAO software “Optimaint”.

Antennas

Work has continued to improve the tracking control system of the antennas. At the end of the antenna maintenance, the tracking rms of each antenna was found to correspond to the expectations. It is in all cases better than 0.3 arcsec.

In October 2004, the aluminium subreflector of antenna 3 had to be replaced. Holographic measurements had revealed a deformation on the bottom surface that was significant enough to justify its replacement. We used one of the first generation Hostaflon covered carbon fiber subreflectors as a spare. The replacement was completed on October 30 and extensive tests were made in the weeks that followed.

As in previous years, all antennas that still have Hostaflon covered carbon fiber panels have carefully been inspected for new pinholes. A few thousand stickers had to be glued on a large part of the surfaces of Antennas 1, 2 and 4 to stop the degradation of the Hostaflon layer, and a few panels had to be painted with a reflective layer of silver emulsion paint (covered with a white protective film) when the reflectivity losses were already too important or if there was a risk of delamination of the underlying carbon fibre layers. The surface of all antennas was readjusted in the fall and verified with holographic measurements. According to the final analysis, the surface accuracy of all six antennas was found to be in the 50 to 60 micron range on the inner four rings, and 10 to 30 micron higher on the outer two rings.

4.4 New Technical Installations

Fiber optic cables

Work has continued during the summer to replace the LO cable signal transport system with wide-band fiber-optic cables. The major goal for 2003 was to equip every station of the ABCD configurations with fiber optic connections, and to test the installation of the prototype electronic system in two antennas. By June 2003, most of the stations of the northern, western and eastern arms had already been equipped. Work on the remaining stations will be completed during the summer of 2004. Tests of the prototype electronics were progressing well by the end of 2003.

The new optic fiber system is also used to communicate with the antennas via an Ethernet protocol, replacing the old coaxial cables. This change eliminated the problems related to lightning which could damage the old communication system.

Computer resources

Throughout 2003, work has continued to increase operational reliability and to improve the system performance. The computer division installed a file server with a 2.5 TB capacity that provides quasi-instantaneous access to the raw data of every project observed with the Plateau de Bure Interferometer since 1990, and a mirror server in Grenoble.

The installation of the new hardware was carried out in poor weather conditions in order to minimize the downtime for astronomical observations, and extensively tested since then.

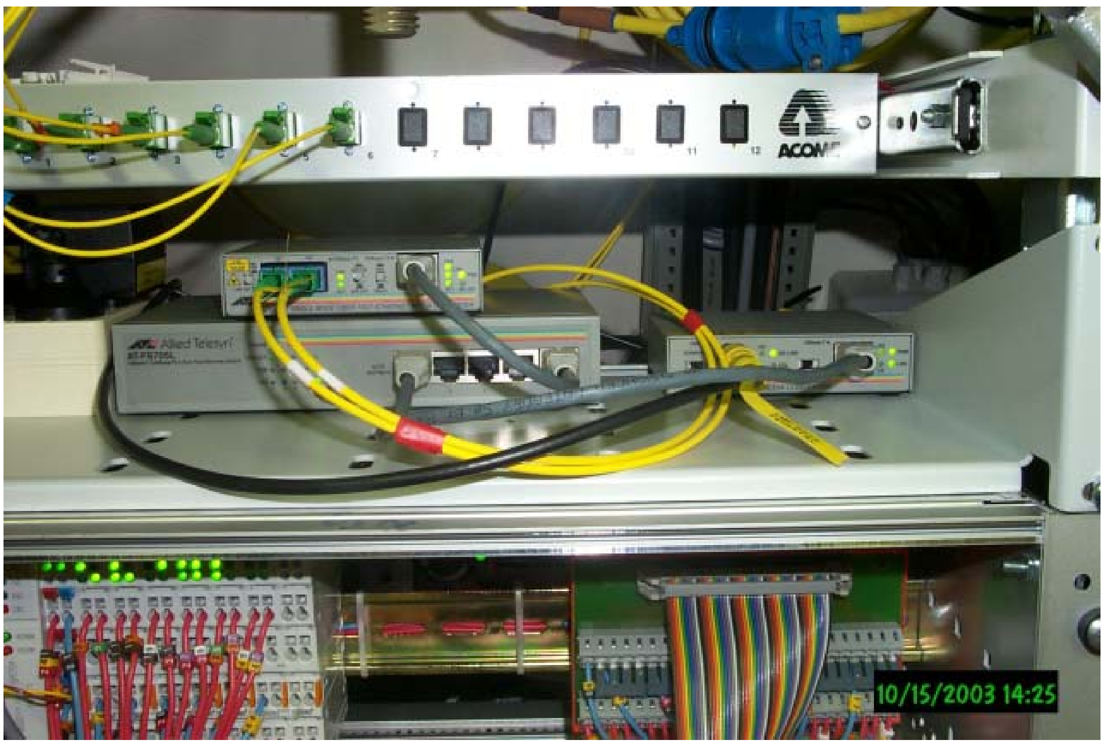


Fig. 4.4: Optical fibre system in an antenna

4.5 Infrastructure Improvements

Buildings

In order to accommodate the additional staff that will work on the northern track extension and start the work on the eastern track, the number of beds in the POM2 building has been increased to 8, distributed in four different rooms.

The renewal of the structure that connects the arrival station of the cable car with the hangar is now finished. The walkway in the gallery has been completed during the spring with a galvanized steal ground supported by a new metallic structure. This gallery is used frequently by the technical staff to carry material that arrives on the Plateau with the “blondin” into the hall.

Blondin

The transformation of the old cable car system into a material transport system, a “blondin”, has been finished, and the necessary certifications obtained. In July, the CNRS/INSU delivered the system to IRAM. Accessories such as a fuel and a water tank, a light carrying rack, a tipping wagon for gravel and a maintenance skiff, have been added by IRAM to transport the different materials needed at the observatory.

IRAM has decided to subcontract the technical supervision as well as the operation and maintenance of the system. The contract was given to C2EI, a newly founded company that specialises on such tasks.

Fig. 4.5: View of the tipping wagon

Extension of the Northern track

As soon as the blondin became available it was possible to complete the earthwork for the extension of the Northern track. QUEYRAS TP, the company which had been working on this already in 1999 resumed the work which should, in principle, be finished by the end of the summer of 2004.

New access test drilling

During the summer period, FORACO, a company specialised in geotechnical studies, made a 200m deep test drilling in the area selected by SCETAUROUTE as possibly the best location for building an elevator as part of the new access solution for the observatory. IRAM supported this activity by accommodating the FORACO staff and providing the necessary water and fuel. This would not have been possible without the blondin. The drilling took 2.5 months with 3 people. It was a success, i.e. it confirmed that the rock in the chosen area is well behaved with only minor exceptions. The construction of the new elevator should begin during the summer of 2004 and be completed by the end of 2005/early 2006.

Fig. 4.5: View of the drilling machine on the Plateau de Bure

Safety

In order to improve the safety of the operators who have to disconnect manually the high voltage electrical power, each time a storm is announced on the Plateau de Bure, a new high voltage cell has been put in place in the transformer room. This new device is electrically controlled and allows the operator to disconnect the power from a remote place where there is no potential danger.

As last year, electrical and mechanical safety of the Plateau de Bure (stations, antennas and buildings) have been checked by a certified firm and all recommended improvements have been put in place

5. GRENOBLE HEADQUARTERS

5.1 SIS GROUP ACTIVITIES

During 2003 work on device development and fabrication has been focussed on 350 GHz junctions for ALMA (Band 7) as well as on junctions for the four bands of the new generation PdB receivers (100, 150 and 230 GHz).

The year has been marked by the installation of two important pieces of equipment: the new ICP etching machine and the new motor stage for the electron beam writing system. Process parameter optimisation with a multi variant analysis and experiment design software has been performed for the ICP system. The etching machine is now successfully integrated into the IRAM standard process.

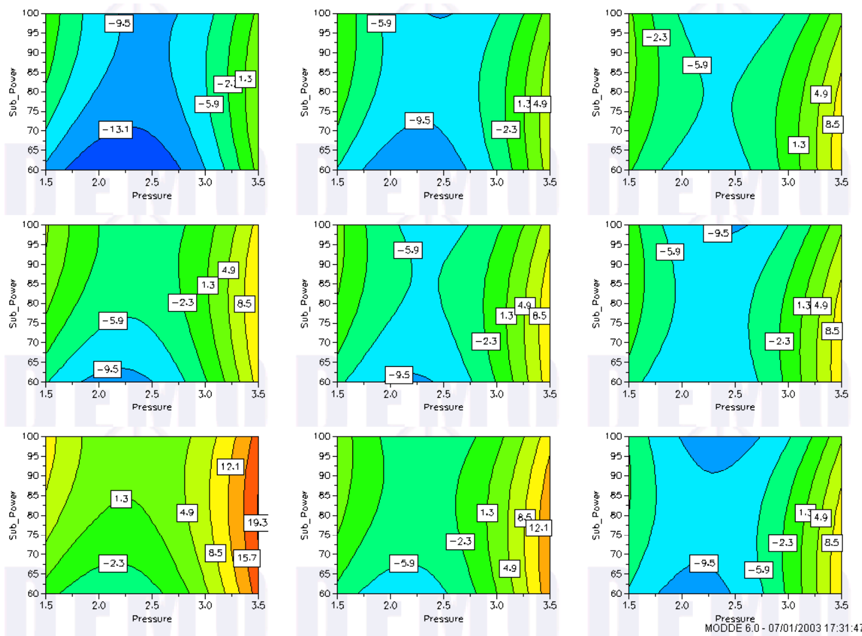


Fig. 5.1: Anisotropy (inclination of etch profile in degrees) for Nb etching as a function of process parameters.

The new interferometric XY motor stage for the E-beam lithography system allows to expose about 300 devices within 1hour and an alignment precision of better than 0.5 µm. With these developments the mayor part of the preparation for production of ALMA devices has been achieved.

New superconducting mixer designs are now exploring the intrinsic limits of the SIS technology. To approach these limits, fabrication has to improve the tolerances of the SIS junctions to previously unachieved levels. Some of the most important parameters are area and normal resistance of the junctions. For the purpose of a tighter control of these parameters the SIS group improved the scheme of junction area determination. Junction size is evaluated systematically by E-beam measurements after the etching step and by electrical means (comparison with test junctions of variable sizes). Both methods give coherent results with precisions below 2% for 1 μm^2 squared junctions. The results show that the common hypothesis of a uniform tunnel barrier transparency is valid at least for our 2-inch substrates.

As for the new wide band designs the critical current of the SIS junctions is above 9 kA/cm and the control of oxidation parameters is a considerable challenge. A refined model for the oxidation parameters has been developed for our equipment including additional parameters such as background pressure before tri-layer processing.

To improve step edge coverage of the dielectric SiO_2 films bias sputtering has been successfully explored. The corresponding equipment has been upgraded for improved reproducibility.

The automatic DC measurement system has been upgraded for lower noise operation and to provide data formats which can be directly incorporated into an online database.

The space qualification program for junctions which where produced in the framework of the HERSCHEL HIFI Channel 1 collaboration has been completed. An automatic thermal cycling set-up has been developed and the SIS junctions show no changes after 20 cycles between room temperature and 4.2 Kelvin. The performance of the produced junctions complies with the project goal, and the junctions are currently integrated into the flight mixer block.

5.2 RECEIVER GROUP ACTIVITIES

5.2.1 IRAM receivers

HERA (1.3mm Multibeam)

The second nine-pixel matrix for the second polarization is almost ready for the installation scheduled to take place in March 2004. Mixer characterization is 50% complete as of end 2003. The final characterization of the LO box for the second polarization was completed.

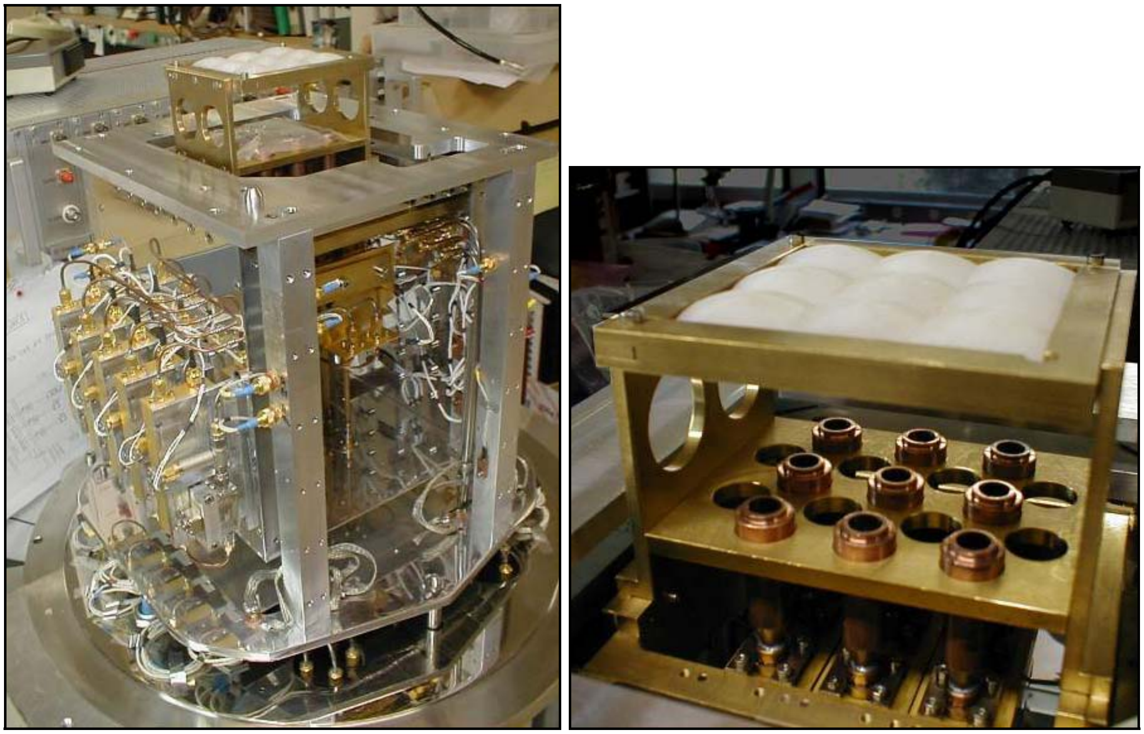


Fig. 5.2: The nine-pixel RF module for the second polarization of HERA. *Left:* general view. *Right:* close-up on the array of scalar horns and the fly's eye array of lenses.

22GHz water vapor radiometers for PdBI

Two radiometers that were waiting in the laboratory (due to high pressure for observing time) have been installed on the Plateau de Bure, reaching the goal of having all six antennas equipped with water vapor radiometers. The astronomers have pursued the development of data processing techniques to improve the phase correction. The #7 receiver (spare) is also on the Plateau de Bure site to allow for rapid exchange in case of a failure. A few minor repairs were performed on the receivers in operation.

PdBI new generation receivers

The design of the cryostat has been completed, and the prototype dewar delivered by a sub-contractor. The prototype dual-polarization optical modules for Bands 1 and 3 (3mm and 1.3mm) have been characterized, and the measurement results (beam patterns) comply with the design goals.

The new layout of the PdB receiver cabin has been designed, including mechanical supports for the cryostat, the associated electronics, and the 22-GHz WVR. That new layout has a space provision for the possible installation, in the more distant future, of a second cryostat — possibly a multibeam receiver — in the PdB receiver cabin.

A test cryostat was designed and built, and was used for acceptance testing of the first two Sumitomo cryocoolers (out of seven ordered) that were delivered in September 2003. Apart from one minor incident that was rectified promptly by the supplier, these cryocoolers proved to perform satisfactorily within contractual specifications.

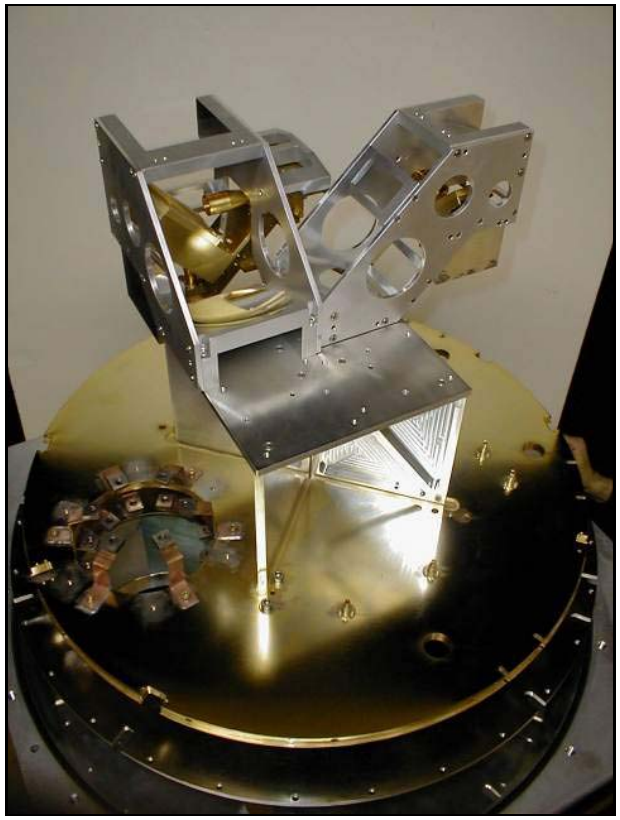


Fig. 5.3: Two optical modules (3mm and 1.3mm) out of the total of four foreseen, mounted on top of the pedestal on the 15K stage of the dewar. On the left, the thermal links to the cold head can be seen.

A mixer chip design for PdB Band 1 (3mm band) was completed and given to the SIS group for mask drawing and junction fabrication. As the other designs for PdB, it uses a moving backshort for SSB tuning.

The mechanical design of the mixer blocks for PdB bands 1, 2, and 3 has been completed, and they were released for fabrication in limited quantities, subject to validation by testing.

Bias and control modules are in various stages of elaboration: vacuum monitoring, all built; junction bias, all built; temperature measurement, prototype tested; coil supply, design complete.

Modules for selection and distribution of the 1.875 GHz first LO reference have been designed, prototyped, and tested (isolation, phase versus temperature stability). The series construction has been started. Modules for the selection (2 out of 8) of the 4-8 GHz IF, have also been developed and tested.

Maintenance

During the summer 2003, the LO boxes of the PdBI interferometer were brought into the lab (following the antenna maintenance schedule) for preventive maintenance and refurbishment.
The spare HDV10 cryostat for the PdBI, following a leak in the He reservoir, had to be sent twice to the manufacturer until a proper repair was made; following this, the RF equipment was re-mounted and characterized.

In Pico Veleta, a problem appeared in September 2003 in the 100GHz channel of the B100/230 cryostat. When the spare receiver was installed, it appeared to have a leak in the He reservoir, that was small enough that the receiver could be operated with permanent pumping. Meanwhile, the dis-mounted B100/230 cryostat was sent back to Grenoble and the 100GHz channel was repaired; that cryostat was sent back to Spain in Nov-2003.

A number of "minor" repairs concerning multipliers, harmonic mixers, Gunn oscillators, etc, were performed.

5.2.2 ALMA work

Band 7 cartridge

First junctions of the low capacitance design have been delivered by the SIS group. Although these junctions were not yet fulfilling the given specifications with respect to the properties of the dielectrics, promising results could be obtained. The sideband separating mixer with the new mixer chips meets the ALMA specifications for the intermediate frequency range of 4 to 8 GHz and the image rejection of at least 10 dB. The obtained noise temperatures are well below the ALMA limit for 80% of the RF range. A new bias scheme allows the suppression of the bias tee, and substantially improves the flatness across the IF band of both the noise temperature and power density.

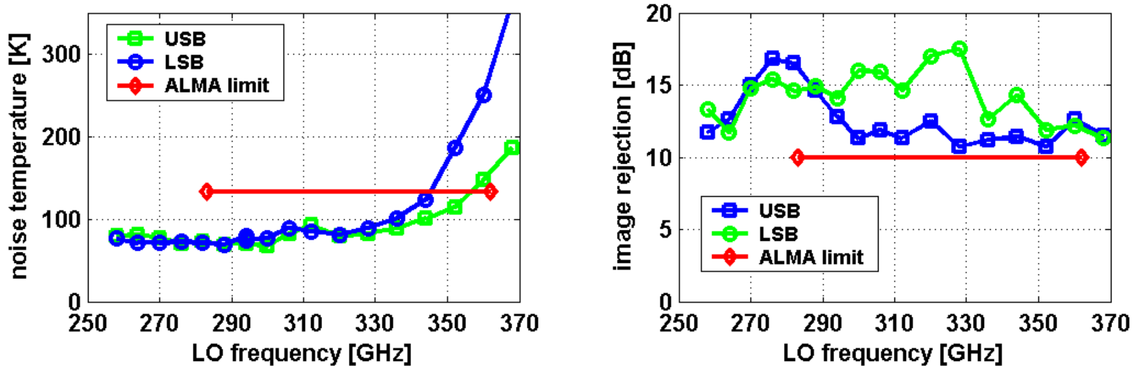


Fig. 5.4: Results of the sideband separating mixer for ALMA band 7 for 4 to 8 GHz IF obtained with the new low capacitance mixer chip. *Left:* Noise temperature of the two sidebands. *Right:* Image band rejection.

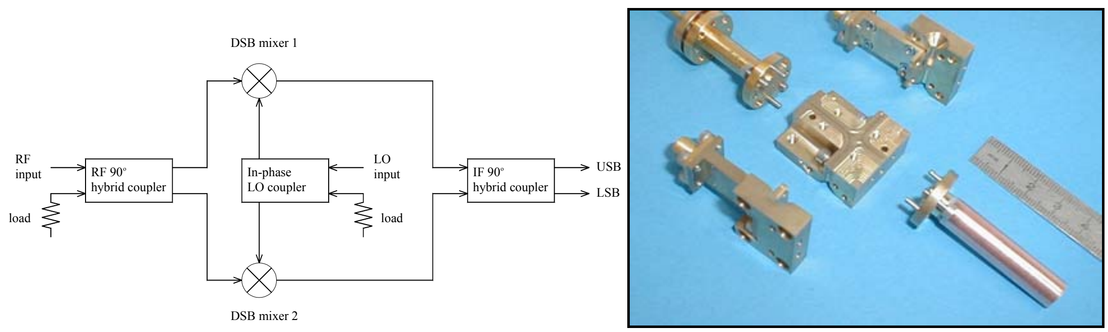


Fig. 5.5: *Left:* block diagram of a sideband separating mixer (2SB). *Right:* The same in real life, including the signal horn, but without the IF hybrid, which is a commercial component. The center part comprises the RF 3dB 90°hybrid, the LO in-phase divider, and the two 17dB LO injection couplers.

A test setup for the measurement of the image response of the sideband-separating mixers (also applicable to PdB SSB mixers) has been developed.

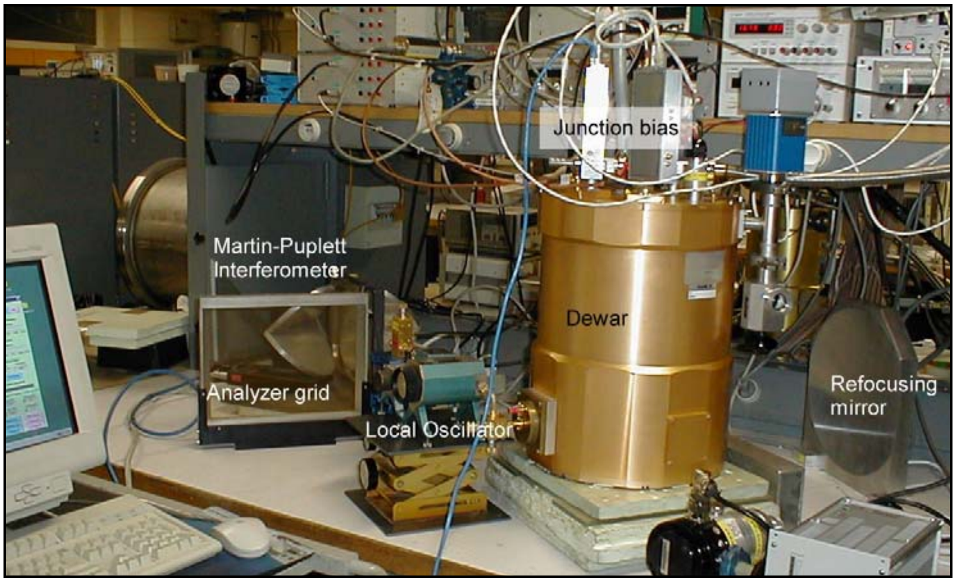


Fig. 5.6: Test setup for the measurement of sideband response, based on a Martin-Puplett interferometer.

The detailed design of the Band 7 cartridge has been completed: placement of components, wiring, LO distribution, thermal and mechanical analysis, including eigenmodes. A new design for the 4K assembly of mechanical supports and optical mirrors, with a much reduced parts count to reduce tolerance build-up, was completed and fabricated. The assembly of the prototype cartridge — dual polarization, each dual sideband 4–8 GHz — is in progress.

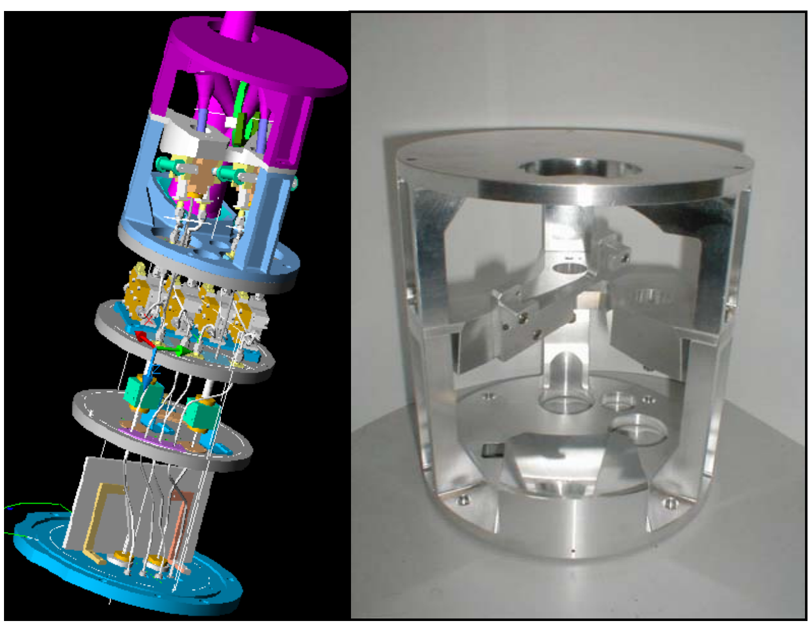


Fig. 5.7: *Left:* CAD model of the cartridge assembly, from the 300K baseplate at the bottom, to the 4K supports and optics assembly at the top. *Right:* prototype 4K supports and optics assembly, CNC machined from just three aluminium blocks.

ALMA optics

The Optics work package, coordinated by IRAM, with a number of tasks performed in other participating groups, was brought close to completion. The optical design for all bands is finalized. Measurements of prototype optics for bands 6, 7, and 9 have been performed on IRAM's antenna range. An improved design for band 3, featuring a phase-corrected horn, has been made and tested.

Windows and infrared filters for all bands have been designed and prototyped.

A calibration scheme involving semi-transparent vanes has been designed and tested.

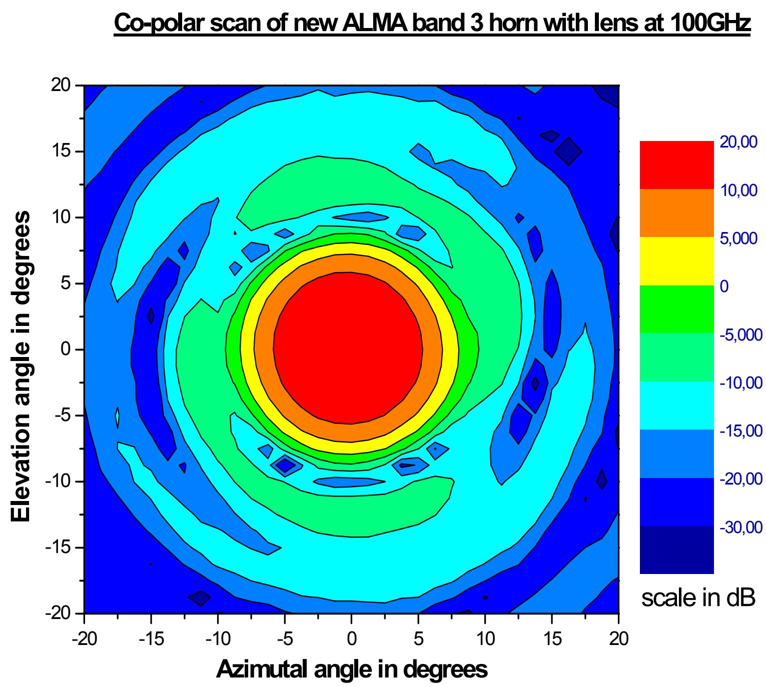


Fig. 5.8: Measurement with the IRAM antenna range of a phase-corrected horn for ALMA Band 3. Note the >50 dB dynamic range of the antenna range. Concerning the horn itself, deviations from circular symmetry appear only below –25dB from bore sight response.

5.2.3 Development activities

New couplers were designed, fabricated, and characterized for the mm-wave Vector Network Analyzer (VNA). They allow measurements in the band 260-370 GHz, as required for the measurement of components of the ALMA Band 7 cartridge and of the PdBI Band 4 receiving channel.

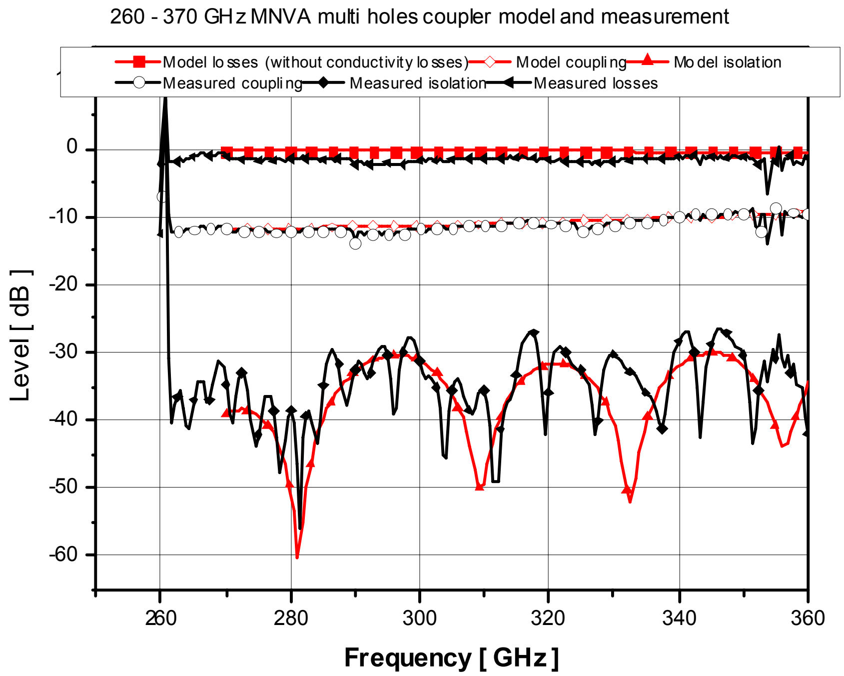


Fig. 5.9: Model and measurement results for a 260-370 GHz coupler designed and built for IRAM's mm-wave network analyzer. *Red*: model; *black:* measurement. *Top to bottom*: direct port; coupled port; isolated port.

New couplers were made for the band 210-320 GHz, previously the highest frequency band of the IRAM VNA. A new harmonic mixer with integrated diplexer was also made for that same 210-320 GHz band, allowing the subharmonic LO to span the range 13–40GHz, with a correspondingly low harmonic number and good conversion losses.

Work has continued on the fully electronic LO based on a YIG oscillator and a chain of active and passive multipliers.

A first version of software (LabView) and associated hardware for automated mixer testing has been developed and is being used for testing PdB and ALMA mixers. More functionalities are being developed.

5.3 BACKEND DEVELOPMENTS

5.3.1 Delivery of the WILMA spectrometer to Pico Veleta

The wideband correlator for the 2-polarization multibeam receiver has been rolled out and transported to PV, for integration at the observatory. This included both the hardware and the software. The correlator can process 18 bands of 1 GHz, at the fixed resolution of 2 MHz/channel.

5.3.2 Design and prototyping of the ALMA digitizer clock

The clock that accurately defines the time at which the samples are taken and digitized has been designed. It uses a new frequency synthesis scheme that involves I/Q modulators followed by PLL filtering to improve linearity. It delivers 4 GHz and 250 MHz signals that can be delayed by 15.6 picosecond steps. Two prototypes have been built, and a special software written for them. Measurements on both units have demonstrated that the clock can be set to better than 0.5 picoseconds.

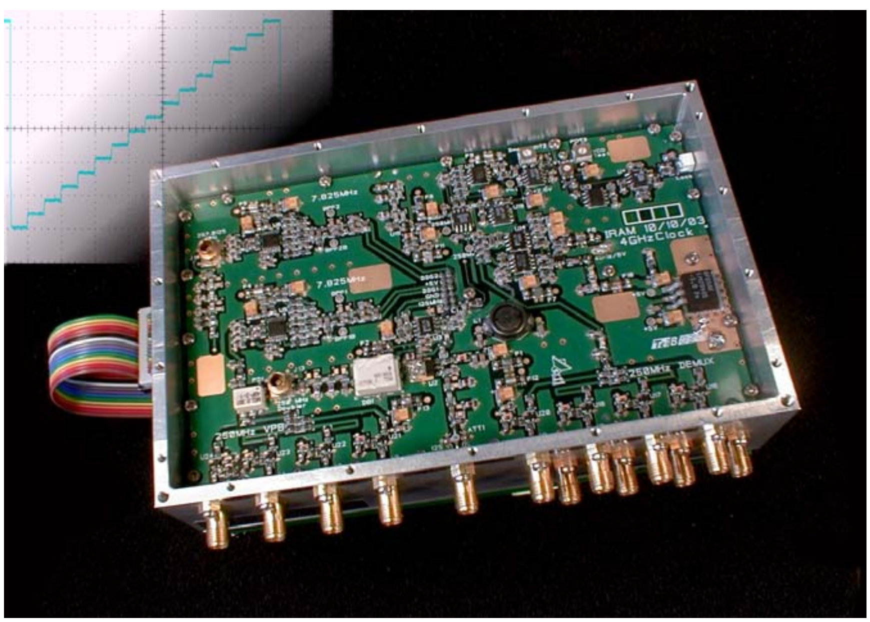


Fig. 5.10: the clock module, and its 16 steps of 15.6 picoseconds

5.3.3 IF transport and processing design for Plateau de Bure

The IF of the future PdB receivers will be 4-8 GHz. It will be transported to the central building via an analog optic fiber transmission system. Two prototype links have been installed as a testbed for gathering linearity and endurance data. They currently transport the IF1, which is 1.5 GHz.

In order to fit the present and future receiver and correlator ranges, a new frequency plan that offers added flexibility has been proposed. In a first step it will allow to make full use of the existing correlator capacity.

5.4 COMPUTER GROUPS

This section covers both the work of the *hardware, system and real-time software group*, and the work of the *scientific software group*.

5.4.1 General Software Support

Efforts have been made to customize the security and the easiness of the installation of Linux workstations on the PCs, a solution which many of the astronomers favor. The general trend is to use Linux for the servers and the control and monitoring processors, Linux or MS Windows on the PC workstations, and to accept customized and fast OS for our NAS file servers.

Besides Office 2000 installed on all MS Windows PCs, Office XP is the supported solution for all people involved in ALMA, on MS Windows of course but also on Linux through CrossOver. This support is driven by compatibility reasons requested by the ALMA Management.

Substantial efforts have been made to improve the functionality and security of the local network in Grenoble. The most important ones are the installation of a new Apache web server, with its search engine, the webmail facility which allows staff members to access and answer to their mails from elsewhere, and the installation of spam and virus filters.

As far as scientific software is concerned, the scientific software group has completely updated the GILDAS package in 2003: the code has been cleaned up, re-organized, and put under CVS. A new reconstruction and distribution mechanism has also been developed. Altogether, these changes will make the installation and use of GILDAS much easier, while allowing an easier and therefore more efficient development process.

5.4.2 PdBI Data Acquisition and Archiving

Now all data collected on the Plateau de Bure are available on-line, for quick look on site and for further analysis in Grenoble. A solution with 2 file servers has been set up, one on Plateau de Bure and the second in Grenoble with a daily synchronization of the data to Grenoble via a rented telephone line. This solution increases the security and optimizes the use of the network link. Each system has a capacity of 2.5Tbytes, sufficient to keep on-line all the interferometry data collected since the beginning of the observations at the observatory. Nevertheless, all data are still also archived on DVDs and are stored in a safe place in Grenoble.

5.4.3 Real-Time Software Developments

There are also many developments in control and monitoring software. A major step has been reached in the New Control System for the 30m-telescope with the completion of the main axis servo control software under Linux, running on a VME Single Board Computer.

The control software for the multibeam receiver at the 30m-telescope has been updated to cover the second polarization and to integrate new tools which can be used to optimize the tuning parameters.

On Plateau de Bure, the network connections between the VME controllers and the computer room use now the newly installed optical fibers. They are clocked at 100Mbits/s.

To prepare the control of the next generation receivers for the Plateau de Bure interferometer, a prototype of a mini DC motor connected with its controller on a CAN bus has been developed and tested. It is already evaluated in the front-end lab.

5.4.4 ALMA Related Activities

A feasibility study on the use of a variant of real time Linux for controlling the ALMA prototype antennas has successfully been completed. The proposed solution has been tested at the ALMA Test Facility.

The scientific software group has worked on the development of the real-time Calibration Pipeline, and participated in the work of the ALMA Scientific Software Requirements group, which is in charge of defining the requirements and testing of the ALMA software.

5.5 TECHNICAL GROUP

5.5.1 Mechanical Workshop

The staff in the workshop has dealt with a total of 167 requests for mechanical components, of which 94 were handled internally (drawings and fabrication), and 73 were subcontracted to outside companies (preparation and follow up of the projects).

The workshop produced a large number of microwave components, mixers, couplers, horns and lenses for the frequencies 100/150/230/320 GHz for the next generation PdB receivers, and for the ALMA project.

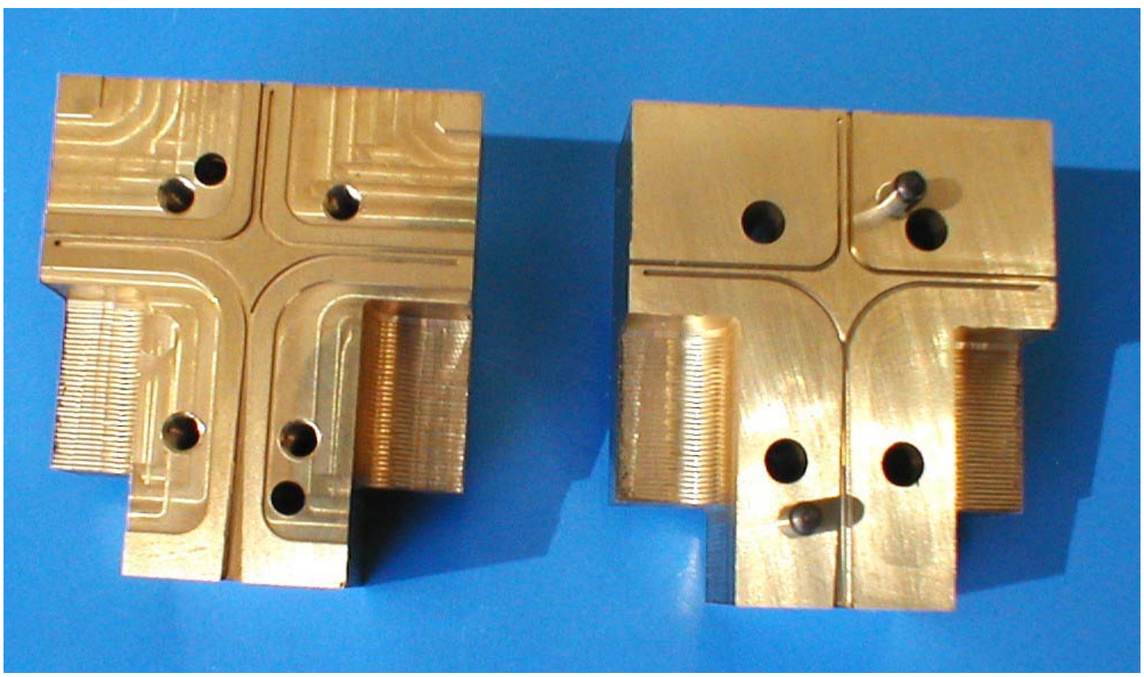


Fig. 5.11: Mixer block for the ALMA band 7

In order to further improve the quality and reproducibility of microwave components, a new numerically controlled machine has been installed in the workshop.

Fig. 5.12: The new cnc controlled lathe "TAKAMAZ" for lenses and horns

5.5.2 Electro-forming

The installation for electro-forming has been running almost continuously throughout the year for the production of the horns needed for the different projects under development.

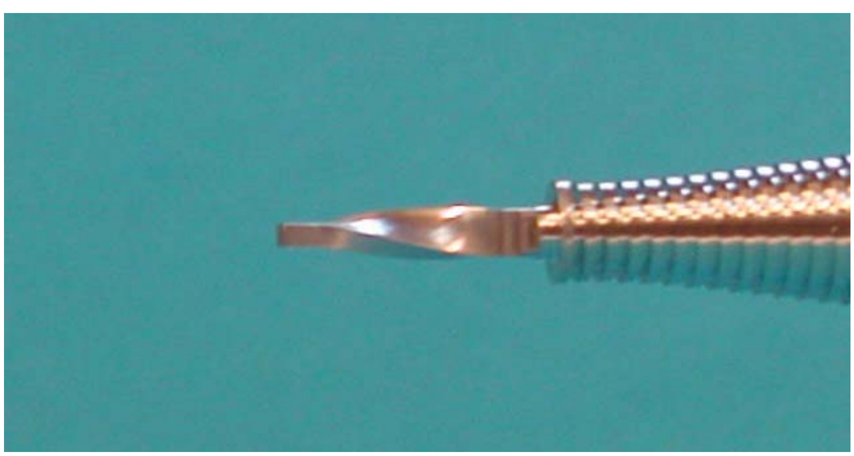


Fig. 5.13: A "twisted" horn design for the next generation of Plateau de Bure receivers.

5.5.3 Drawing office

The drawing office worked on numerous mechanical designs, in close collaboration with the other groups. This concerned :

- the design of all new micowave components for the next generation PdB receivers and the ALMA band 7 receiver,
- the study for the new support structure for the next generation PdB receivers that will be installed in the cabines of the PdB antennas,
- design work for the multi-beam receiver and for the SIS group.

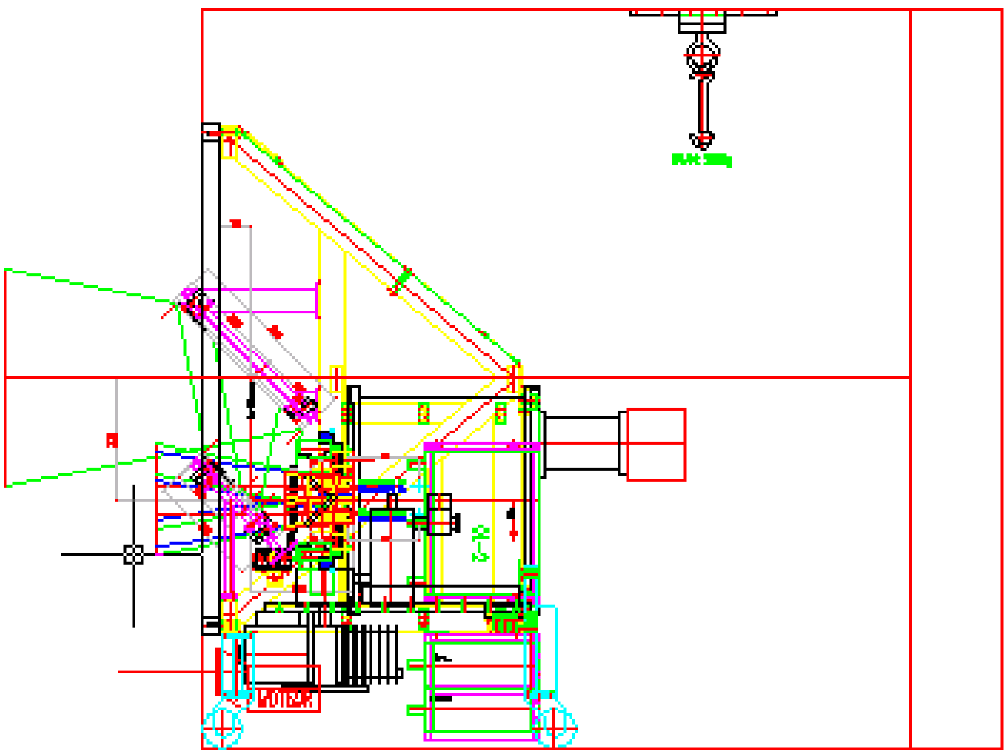


Fig. 5.12: study of the new support structure for the next generation PdB receivers

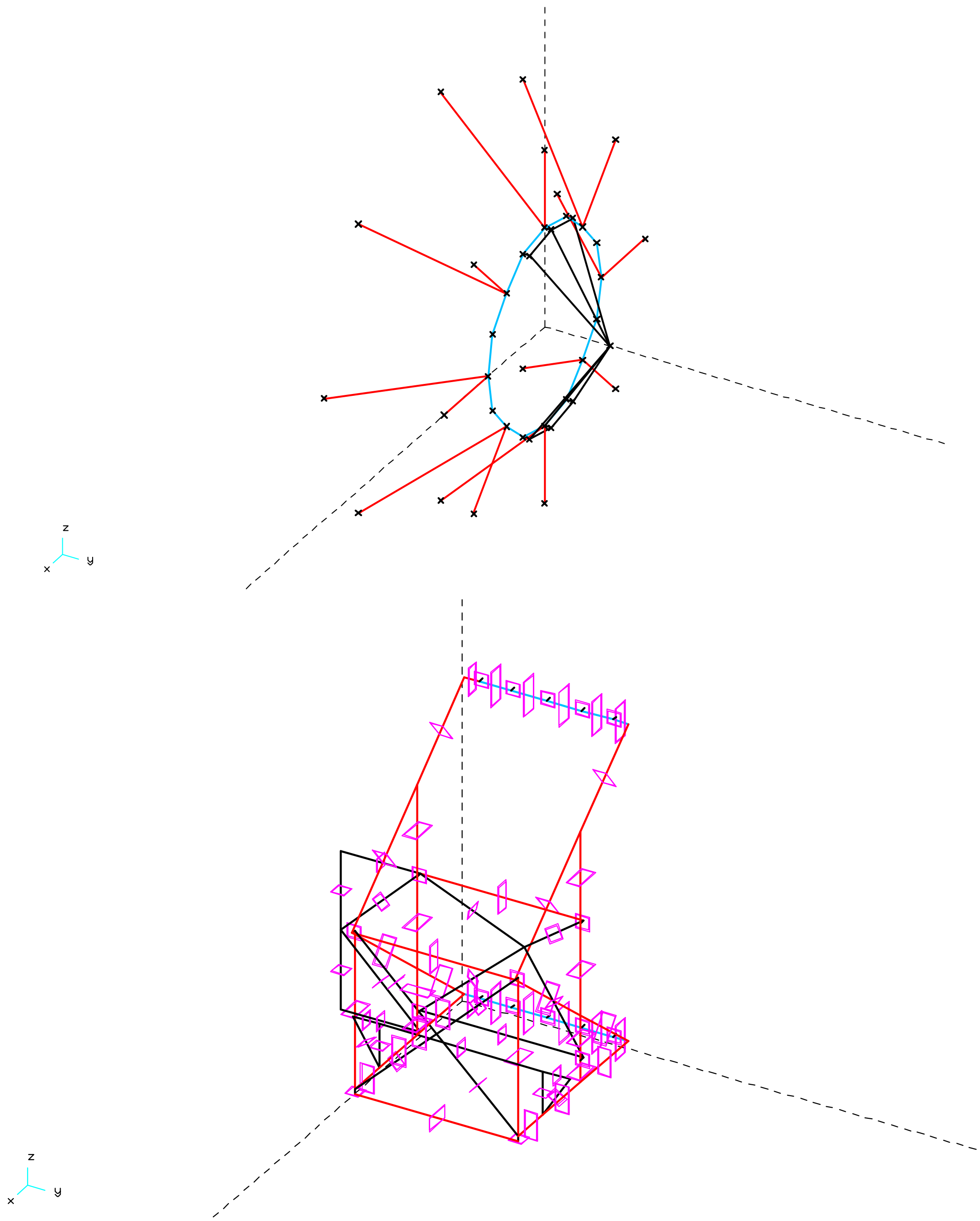


Fig. 5.13: Models for developing the attachments of the central hub and the support for the next generation Plateau de Bure receivers.

5.5.4 Technical support for the Plateau de Bure

The group supported the local mechanical team on the Plateau de Bure during the maintenance work on the six antennas of the interferometer during the summer of 2003.

6. PERSONNEL AND FINANCES

6.1 Personnel

The personnel plan for the year 2003 allowed for 104,6 positions. *De facto* only 97.1 positions were filled with staff on longer-term or unlimited contracts. In addition, the equivalent of 16 positions was used for shorter-term contracts (see below). Of the staff positions, 69.3 are based in France and 27.8 in Spain. The MPI für Festkörperforschung (Stuttgart) financed one secretary position in Grenoble throughout 2003.

Furthermore, 3 post-docs (3 FR), and 3 thesis students (2 FR, 1 ES), plus 2 persons delegated by DEMIRM/Paris in the framework of the HERSCHEL project and the ALMA project, worked at IRAM.

Extra workloads during certain periods of the year made it necessary to issue a large number of limited-term contracts, and to call on staff from a manpower company. This corresponded to:

- 5.8 man-years on Bure, including Interim workers, to complete the 3 teams for maintenance and for logistical and medical support,
- 10.2 man-years in Grenoble, for replacements and additional work in the Administration and in the technical groups.

6.2 Finances

IRAM's financial situation in 2003 is summarised in the attached tables. These contain also the budget provisions for 2004.

2003 - Operating budget

The total income and the actual expenses very closely matched. The total level was slightly lower than expected, both on the income side and for the expenses.

The largest variations on the income side came from the request of the IRAM partner organisations that IRAM should execute the budget in such a way that the funding contributions would not fully be needed. This has been possible by making use of provisions that had been built up in 2000, 2001, and 2002 in connection with the cable car accident, by higher than expected bank interests, and by an increase in “other income” which is basically project money.

The savings made in the staff budget costs by not occupying all positions were largely offset by the large amount of subcontracting to manpower companies, in part because of the greater flexibility that this scheme offers and that is needed. Manpower shortages both on the Plateau de Bure and in particular also in Grenoble necessitated a much larger than before number of short-term contracts.

Substantial new provisions were made especially in connection with the cable car accident from 1999 because the legal procedure will continue at a higher Court in 2005 after the State Prosecutor as well as several other parties have made an appeal following the first judgement in February 2004.

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2003 - Investment budget

a) Expenditure concerned mainly :

- continuing investment into the next generation of PdB receivers
- purchase of further components for the IF transmission through optical fibres on the PdB
- investment into molds and tools for the fabrication of Ni panels for PdB by Media Lario
- investment into the extension of the N-S track on the PdB (continuation of the work started in 1999)
- instrumentation and accessories for the backend, receiver and SIS laboratories

b) Income

The income was basically as predicted if one takes into account that IRAM has been asked to execute the investment budget in such a way that funds are only called up when actually needed. Because of some delays in some of the investment projects due to circumstances that were mostly outside the control of IRAM, not all the money that had been authorised for 2003 was spent, though a large fraction of the remaining money was committed..

BUDGET 2003

(in EUROS)

2003 – EXPENDITURE

Budget heading	Approved	Actual
Operation / Personnel	6,994.796	6,857,042
Operation / other items	3,052,000	3,095,205
TOTAL OPERATION	**10,046,796**	**9,952,247**
TOTAL INVESTMENT	**2,976,127**	**1,787,283**
TOTAL EXPENDITURE	***13,022,923***	***11,739,530***
VAT (19,6%)	823,392	823,392
TOTAL EXPENDITURE incl. VAT	***13,846,315***	***12,562,922***

2003 – INCOME

Budget heading	Approved	Actual
CNRS contributions	4,936,119	4,936,119
MPG contributions	4,936,119	4,936,119
IGN contributions	630,142	630,142
TOTAL CONTRIBUTIONS	**10,502,382**	**10,502,382**
IRAM's own income not less than	886,766	796,212
Carry forward from 2001/2002	1,633,775	1,633,755
TOTAL INCOME excl. VAT	***13,022,923***	***12,932,369***
CNRS contribution for VAT (19,6)	823,392	823,392
TOTAL INCOME incl. VAT	***13,846,315***	***13,755,761***

BUDGET PROVISIONS 2004

(in EUROS)

2004 – EXPENDITURE

Budget heading	Approved
Operation / Personnel	6,911,000
Operation / other items	3,187,000
TOTAL OPERATION	**10,098,000**
TOTAL INVESTMENT	**2,154,127**
TOTAL EXPENDITURE	***12,252,127***
VAT (19,6%)	842,992
TOTAL EXPENDITURE incl. VAT	***13,095,119***

2004 – INCOME

Budget heading	Approved
CNRS contributions	5,036,120
MPG contributions	5,036,120
IGN contributions	642,908
TOTAL CONTRIBUTIONS	**10,715,148**
Own income	946,979
Carry forward from 2002 investment budget	590,000
TOTAL INCOME excl. VAT	***12,252,127***
CNRS contribution for VAT (19,6)	842,992
TOTAL INCOME incl. VAT	***13,095,119***

7. ANNEX I : TELESCOPE SCHEDULES / 7.1. IRAM 30m Telescope

DECEMBER 31 – JANUARY 14

Ident.	Title	Freq. (GHz)	Authors
111.02	Complex molecules as tracers of starburst evolution in the ULIRG Arp 220	87-263	Mauersberger, Huettemeister, Bergman
135.02	Methanol as interstellar temperature and density tracer	96-241	Leurini, Menten, Schilke, Wyrowski, van der Tak, Walmsley, Moscadelli, Flower
174.02	Very diverse environments within the post-starburst galaxy NGC 1569	HERA	Muehle, Klein, Huettemeister, Frits
162.02	Temporal and latitudinal dispersal of trace species HCN, CO and CS in Jupiter's stratosphere	88-265	Marten, Moreno, Matthews
110.02	PAHs as precursors of small hydrocarbons : spanning wider PDR conditions	81-244	Teyssier, Abergel, Cernicharo, Gerin, Joblin, Pety, Roueff
204.02	OBSERVING POOL	MAMBO	

JANUARY 14 – JANUARY 28

Ident.	Title	Freq. (GHz)	Authors
205.02	OBSERVING POOL	MAMBO	
206.02	OBSERVING POOL	MAMBO	

JANUARY 28 – FEBRUARY 11

Ident.	Title	Freq. (GHz)	Authors
207.02	OBSERVING POOL	MAMBO	
208.02	OBSERVING POOL	MAMBO	

FEBRUARY 11 – FEBRUARY 25

Ident.	Title	Freq. (GHz)	Authors
103.02	The composition of Io's volcanic gases	104-265	Lellouch, Paubert, Moses, Schneider, Strobel
181.02	Origin of high velocity gas in the galactic center	HERA	Thum, Schuster, Downes
122.02	Calibrating molecular gas masses in starburst galaxies	HERA	Weiss, Mauersberger, Walter, Henkel
159.02	HERA mapping of extremely high velocity outflows	HERA	Van der Tak, Beuther, Lebron

FEBRUARY 25 – MARCH 11

Ident.	Title	Freq. (GHz)	Authors
209.02	OBSERVING POOL	MAMBO	
210.02	OBSERVING POOL	MAMBO	

MARCH 11 – MARCH 25

Ident.	Title	Freq. (GHz)	Authors
211.02	OBSERVING POOL	MAMBO	
212.02	OBSERVING POOL	MAMBO	
110.02	PAHs as precursors of small hydrocarbons : spanning wider PDR conditions	81-244	Teyssier, Abergel, Cernicharo, Gerin, Joblin, Pety, Roueff
178.02	SiO maser emission monitoring in the protoplanetary nebula OH231.8+4.2	86-215	Sanchez-Contreras, Bujarrabal, Alcolea, Soria, Desmurs, Colomer

MARCH 25 – APRIL 08

Ident.	Title	Freq. (GHz)	Authors
088.02	Search for molecular gas towards infrared quasars	82-280	Andreani, Tacconi, Cristiani, Grazian
102.02	The molecular gaz reservoir in nearby powerful radio galaxies	112-228	Lim, Combes, van Trung, Leon
114.02	Collimated massive outflows – necessary short spacings	230	Beuther, Gueth, Schilke
120.02	What drives the bipolar outflow in HH 80-81?	HERA	Lebron, Anglada, Osorio, Rodriguez, Mauersberger
160.02	The evolution of molecular gas in distant cooling flows	110-222	Edge, Ebelling
172.02	Observation of desorbed grain mantle organic molecules	84-276	Nuevo, Dartois, d'Hendecourt, Pineau des Forets
213.02	OBSERVING POOL	MAMBO	

APRIL 08 – APRIL 22

Ident.	Title	Freq. (GHz)	Authors
	VLBI OBSERVATIONS		
142.02	A CO survey of early-type galaxies from the SAURON sample	115-226	Combes, Bureau, Young, van Gorkom
131.02	Water abundance in cold clouds	HERA	Ceccarelli, Plume, Caux, Bergin
145.02	Jets and molecular outflows from Orion protostars	HERA	Stanke, McCaughrean, Menten, Smith, Zinnecker, Nuernberger, Schilke
126.02	Multiple deuteration of methanol in IRAS 16293-2422	83-272	Parise, Ceccarelli, Caux, Castets, Tielens
129.02	Sulphur chemistry in low mass protostars	96-261	Wakelam, Ceccarelli, Castets, Caselli, Maret, Caux
173.02	A search for the CaC radical in the late-type star IRC+10213	144,165	Ziurys, Halfen

APRIL 22 – MAY 06

Ident.	Title	Freq. (GHz)	Authors
126.02	Multiple deuteration of methanol in IRAS 16293-2422	83-272	Parise, Ceccarelli, Caux, Castets, Tielens
175.02	Searches for metal nitrides in the circumstellar shell of IRC+10216 : FeN and CrN	106-271	Ziurys, Halfen, Savage
188.02	The search for interstellar NiCN : more metal Cyanides ?	99-203	Savage, Ziurys, Guelin
	VLBI OBSERVATIONS		
128.02	CO depletion and deuteration in a HD-112mic absorbing cloud	85-276	Caux, Pagani, Ceccarelli, Castets, Caselli
087.02	A mm study of the embedded driving source of the HH 92 jet	110	Castets, Reipurth
123.02	Is methanol via grain-chemistry in pre-stellar cores ?	96-207	Bacmann, Ceccarelli, Tielens, Lefloch, Parise, Castets, Steinacker
102.02	The molecular gas reservoir in radio galaxies	112-228	Lim, Combes, van Trung, Leon

MAY 06 – MAY 20

Ident.	Title	Freq. (GHz)	Authors
136.02	CO in outer disk…fuel for tidal dwarfs ? Dark matter ?	115,230	Braine, Vallejo, Cuillandre
163.02	Magnetic field in Miras	115	Greaves, Thum, Wiesemeyer, Hollang

MAY 20 – JUNE 03

Ident.	Title	Freq. (GHz)	Authors
030.03	Water in regions of high-mass star formation	203,225	Van der Tak, Walmsley, Viti, Ceccarelli, Herpin
099.03	A 3-mm line survey of the simplest star forming regions	90-101	Mauersberger, Marcelino, Martin-Pintado, Thum, Tafalla, Paubert, Cernicharo, Fonfria, Roueff, Gerin
018.03	Dense molecular gas and the role of starburst activity in local PG QSOs	81-164	Evans, Downes, Solomon, Tacconi, Vavilkin
022.03	Interaction of the SNRs W28 and W44 with surrounding molecular clouds	220-223	Reuen, Wyrowski, Philipp, Guesten, Menten
061.03	IC63 : a critical template to understand photodissociation regions	220,230	Polehampton, Guesten, Wyrowski, Philipp, Muders
042.03	Excitation studies of PDR & SNR interaction layers of molecular clouds – HERA CO(2-1) observations to complement CHAMP CO (4-3) & (CI) data	203,220	Philipp, Guesten, Ungerechts

JUNE 03 – JUNE 17

Ident.	Title	Freq. (GHz)	Authors
151.02	A square degree search for the most luminous mm galaxies	Bolometer	Bertoldi, Voss, Menten, Kreysa, Carilli, Owen, Genzel, Lutz, Ivison
097.03	Infall, rotation and outflow properties of bolometer protostellar condensations	85-267	André, Onishi, Belloche, Motte
034.03	The polarization signature of the galactic center black hole (II)	80-270	Wiesemeyer, Thum, Downes
040.03	Origin of ionised gas near the galactic center (II)	231,256	Thum, Schuster, Downes
077.03	The hot cores of sun-like protostars	90-257	Ceccarelli, Bottinelli, Castets, Caux, Cazaux, Tielens, Williams
088.03	SiO maser emission monitoring in the protoplanetary nebula OH231.8+4.2	86	Sanchez-Contreras, Alcolea, Bujarrabal, Soria, Desmurs, Colomer

JUNE 17 – JULY 01

Ident.	Title	Freq. (GHz)	Authors
040.03	Origin of ionised gas near the galactic center (II)	231,256	Thum, Schuster, Downes
077.03	The hot cores of sun-like protostars	90-257	Ceccarelli, Bottinelli, Castets, Caux, Cazaux, Tielens, Williams
033.03	A search for CO in the elliptical component of a sample of E + S pairs	114	Cullen, Alexander, de Grijis, Anders
108.03	Search for methyl carbamate in hot cores	81-265	Demyk, Wlodarczak, Dartois
055.03	The extended source of CO in comet 29P/Schwassmann-Wachmann 1	230	Bockelée-Morvan, Gunnarsson, Biver, Festou, Rickman
109.03	Probing simple hydrocarbon chemistry in low-mass cores with CCH and CCD	87,144,216,262	Shirley, Hogerheijde
014.03	Complex molecules in hot corinos	98,161,205	Schilke, Beuther, Comito, Leurini, Wyrowski

JULY 01 – JULY 15

Ident.	Title	Freq. (GHz)	Authors
014.03	Complex molecules in hot corinos	98,161,205	Schilke, Beuther, Comito, Leurini, Wyrowski
037.03	Searching for evidence of triggered massive-star formation	97,146,219,244	Zavagno, Deharveng, Lefloch, Brand, Massi
024.03	A search for pure rotational emission from TiO toward red giant stars	95-253	Menten, Schilke, Alcolea
089.03	A search for CN2 radicals towards circumstellar envelopes	110-271	Fuchs, Bruenken, Puetz, Winnewisser, Stutzki, Wyrowski, Schilke
065.03	Looking for pre-stellar massive cores with N_2D^+/N_2H^+ observations	93-279	Crapsi, Fontani, Caselli, Cesaroni, Walmsley
069.03	The evolution of outflows in young massive (proto)stars	230,219	Fontani, Beltran, Brand, Cesaroni, Molinari, Testi, Walmsley, Zhang

JULY 15 – JULY 29

Ident.	Title	Freq. (GHz)	Authors
052.03	Jet-like molecular outflows in massive young stars : Fill short spacings	86	Zhang, Beuther, Wyrowski, Schilke, Chen
102.03	Search for interstellar CD_3 OD	110-273	Van der Tak, Schilke, Mueller, Thorwirth, Li-Hong Xu
092.03	Sgr D: a key to understand the galactic center	110,220,97,244	Rodriguez-Fernandez, Combes, Martin-Pintado, Martin
015.03	Complete HERA imaging of IC5146 : studies of depletion and cloud structure	219	Richer, Kramer, Bell, Hills, Lada
025.03	A CO line survey of an unbiased sample of hyperluminous infrared galaxies	84-146	Verma, Baker, Rigopoulou, Serjeant, Farrah, Efstathiou, Rowan-Robinson
013.03	Comprehensive chemical and dynamical studies of molecular cores	93,96,109	Bergin, Lada, Alves, Huard
094.03	Gas content of synchrotron-deficient galaxies : candidate nascent starbursts	115-230	Roussel, Bosma, Helou
036.03	Molecular gas in radio galaxies with recent re-startes nuclear activity	115	Mack, Saripalli, Subrahmanyan, Staveley-Smith
088.03	SiO maser emission monitoring in the protoplanetary nebula OH231.8+4.2	86	Sanchez-Contreras, Alcolea, Bujarrabal, Soria, Desmurs, Colomer

JULY 29 – AUGUST 12

Ident.	Title	Freq. (GHz)	Authors
027.03	Deuteration and depletion toward massive pre/protocluster candidates	85,110,219,231	Wyrowski , Gibb, Thompson, Hatchell, Pillai
106.03	Molecular gas in Abell 262 cluster galaxies	115,230	Krips, Bertram, Eckart
035.03	Astronomical search for the Si_3 trimer, a key to the Silicon chemistry	86,92,98	Guélin, McCarthy, Thaddeus
045.03	Tracing the diverse molecular gas properties in NGC 1569	115	Muehle, Klein, Huettemeister, Fritz
023.03	The 2mm line survey of selected position in the nucleus of the Milky Way	129-171	Martin, Mauersberger, Martin-Pintado
046.03	Molecular gas in tidal dwarf galaxies : Beyond detection	110-230	Braine, Duc, Lisenfeld, Leon, Brinks, Charmandaris
099.03	A 3-mm line survey of the simplest star forming regions	90-101	Mauersberger, Marcelino, Martin-Pintado, Thum, Tafalla, Paubert, Cernicharo, Fonfria, Roueff, Gerin

AUGUST 12 – AUGUST 26

Ident.	Title	Freq. (GHz)	Authors
023.03	The 2mm line survey of selected position in the nucleus of the Milky Way	129-171	Martin, Mauersberger, Martin-Pintado
096.03	A deep search for CO emission in the lowest-metallicity galaxy I Zw 18	115	De Paz, Madore, Sanchez-Contreras, Zamorano
078.03	The evolution of molecular outflows : completion of a deep investigation of H_2S and SO_2 through observations of the ^{34}S isotopomers	167,213,102	Codella, Bachiller, Caselli
087.03	The effects of X-rays on molecular clouds	86-267	Caselli, Randich
057.03	Chemistry around young stars and protostars of intermediate mass		Fuente, Bachiller, Caselli, Rizzo
081.03	PPNe : CO emitters and not	115,230	Bujarrabal, Alcolea, Castro-Carrizo

AUGUST 26 – SEPTEMBER 09

Ident.	Title	Freq. (GHz)	Authors
056.03	Pulsar observations at 86 and 130 GHz	86,130	Wielebinski, Klein, Loehmer, Kramer
090.03	Jet/Outflow/Shock-interactions in IRAS 19410+2336 (short spacing observations)	86	Beuther, Schilke
004.03	Molecular deuteration in protoplanetary disks	83-276	Ceccarelli, Dominik, Caux, Caselli
060.03	Mars' atmosphere at perihelion : dynamics and CO variations	115,230	Lellouch, Moreno, Paubert, Encrenaz, Forget
003.03	Study of the chemistry of the L379 star-forming region	93-242	Kalenskii, Promyslov, Alakoz, Larionov
070.03	HDCO and CHD_2OH in low-mass protostars	83-256	Parise, Castets, Caux, Ceccarelli, Tielens
010.03	Line observations of an unbiased sample of massive protostars	86-265	Bontemps, Schneider, Motte
064.03	Gas-phase versus solid-phase deuteration of Class I low-mass protostars		Parise, Castets, Caux, Ceccarelli, Simon, Tielens

SEPTEMBER 09 – SEPTEMBER 23

Ident.	Title	Freq. (GHz)	Authors
	HEAVY MAINTENANCE		
001.03	Molecular gas in early-type galaxies		Xilouris, Charmandaris, Leon, Lim, Madden
018.03	Dense molecular gas and the rôle of starburst activity in local PG QSOs	81-164	Evans, Downes, Solomon, Tacconi, Vavilkin
031.03	MAMBO observations of luminous Lyman alpha emitters at z = 4.5	250	Baker, Lehnert, Lutz, Malhotra, Rhoads
075.03	Searching for the youngest dense cores	93-219	Tafalla, Santiago
090.03	Jet/outflow/shock-interactions in IRAS 19410+2336 (short spacing observations)	86	Beuther, Schilke

SEPTEMBER 23 – OCTOBER 07

Ident.	Title	Freq. (GHz)	Authors
	HEAVY MAINTENANCE		
075.03	Searching for the youngest dense cores	93-219	Tafalla, Santiago
082.03	Searching for heavy water in outflows from low-mass protostars	80,241	Santiago, Tafalla, Codella, Bachiller
093.03	Where is the molecular gas in NGC 4700 ?	114,229	Dahlem, Lisenfeld, Walter
009.03	Infall structure of infalling starless cores	93,216,144,2 67	Lee, Sohn, Myers, Bourke, Tafalla, Caselli
042.03	Excitation studies of PDR & SNR interaction layers of molecular clouds – HERA CO(2-1) observations to complement CHAMP CO (4-3) & (CI) data	203,220	Philipp, Guesten, Ungerechts
022.03	Interaction of the SNRs W28 and W44 with surrounding molecular clouds	220-223	Reuen, Wyrowski, Philipp, Guesten, Menten
301.03	OBSERVING POOL	MAMBO	

OCTOBER 07 – OCTOBER 21

Ident.	Title	Freq. (GHz)	Authors
302.03	OBSERVING POOL	MAMBO	
074.03	Probing deuterium chemistry of hydrogen sulfide in dense cores and star forming regions	91-257	Roueff, Gerin, Coudert
084.03	A search for $O^{18}O$ and $OC^{18}O$ in Mars and Venus atmospheres	110-233	Cernicharo, Pardo, Lara, Rodrigo
086.03	A search for deuterated small hydrocarbons in dark clouds	135,232,237	Cernicharo, Pardo, Roueff, Gerin

OCTOBER 21 – NOVEMBER 04

Ident.	Title	Freq. (GHz)	Authors
303.03	OBSERVING POOL	MAMBO	
304.03	OBSERVING POOL	MAMBO	

NOVEMBER 04 – NOVEMBER 18

Ident.	Title	Freq. (GHz)	Authors
105.03	Search for infall towards massive protostars detected by ISO	93-267	Krause, Henning, Vavrek, Lemke
088.03	SiO maser emission monitoring in the protoplanetary nebula OH231.8+4.2	86	Sanchez-Contreras, Alcolea, Bujarrabal, Soria, Desmurs, Colomer
020.03	Cold dust and gas in the ISO-bright ellipticals	115	Haas, Bertoldi, Klaas, Krause, Rueger, Stickel
022.03	Interaction of the SNRs W28 and W44 with surrounding molecular clouds	220,230	Reuen, Wyrowski, Philipp, Guesten, Menten
042.03	Excitation studies of PDR & SNR interaction layers of molecular clouds – HERA CO(2-1) observations to complement CHAMP CO (4-3) & (CI) data	203,220	Philipp, Guesten, Ungerechts
159.03	Rapid variability and inverse Compton catastrophes in 0716+714 and 0836+710	86,142,228	Krichbaum, Grewing, Ungerechts, Wagner, Britzen, Fuhrmann, Agudo, Witzel, Zensus

NOVEMBER 18 – DECEMBER 02

Ident.	Title	Freq. (GHz)	Authors
230.03	Molecular gas in tidal dwarf galaxies : Beyond detection	110-230	Braine, Duc, Lisenfeld, Leon, Brinks, Charmandaris
134.03	SiO maser emission monitoring in the protoplanetary nebula OH231.8+4.2	86	Sanchez-Contreras, Alcolea, Soria, Desmurs, Colomer
132.03	Search for interstellar CD_3OH and CD_3OD	110-273	Van der Tak, Schilke, Mueller, Xu, Thorwirth
154.03	CO in outer disks – fuel for tidal dwarfs ? Dark Matter ?	115,230	Braine, Cuillandre, Brouillet
170.03	Composition and outgassing of comet 2P/Encke	88-265	Biver, Bockelée-Morvan, Colom, Crovisier, Gunnarsson, Lecacheux, Lis, Moreno, Paubert
146.03	N_2H^+ excitation, deuteration and depletion in L183/L134N	93-231	Pagani, Daniel, Dubernet, Apponi, Bacmann
169.03	Jet and molecular outflows from Orion protostars	115,230	Stanke, McCaughrean, Menten, Nuernberger, Schilke, Smith, Zinnecker

DECEMBER 02 – DECEMBER 16

Ident.	Title	Freq. (GHz)	Authors
401.03	OBSERVING POOL		
402.03	OBSERVING POOL		

DECEMBER 16 – DECEMBER 30

Ident.	Title	Freq. (GHz)	Authors
403.03	OBSERVING POOL		
161.03	Part II – Gas content of synchrotron-deficient galaxies : nascent starbursts	115-230	Roussel, Bosma, Helou
099.03	A 3-mm line survey of the simplest star forming regions	90-101	Mauersberger, Marcelino, Martin-Pintado, Thum, Tafalla, Paubert, Cernicharo, Fonfria, Roueff, Gerin
119.03	The fraction of dense gas in warm starburst mergers	84-219	Huettemeister, Aalto, Boone
134.03	SiO maser emission monitoring in the protoplanetary nebula OH231.8+4.2	86	Sanchez-Contreras, Alcolea, Soria, Desmurs, Colomer

7. ANNEX I: TELESCOPE

SCHEDULES 7.2 PdB Interferometer

Ident.	Title	Line	Authors
L036	High-resolution CO observations of yellow hypergiants	$^{12}CO(1-0)$ $^{12}CO(2-1)$	A.Castro-Carrizo V.Bujarrabal J.Alcolea R.Neri R.Lucas
L038	Extragalactic chemistry of starbursts: NGC 253	SO(3-2) $CH_3OH(5-4)$	S.García-Burillo A.Fuente J. .Martín-Pintado
M002*	Chemistry of the DM Tau disk	C_2H H_2CO	V.Piétu A.Dutrey S.Guilloteau
M00S	Late-Stage Galaxy Mergers and the Fundamental Plane	$^{12}CO(1-0)$ $^{12}CO(2-1)$	L.Tacconi R.Genzel A. Baker R.Hönle M.Tecza C.Iserlohe
M00B	Probing the nucleosynthesis in the young Universe (II)	HCO^+ $H^{13}CO+$ DCO^+ HCN $H^{13}CN$ HNC $HN^{13}C$	S.Muller M.Dumke M.Guélin R.Lucas F. Combes M.Gerin T.Wiklind
M00C	Discovery of a huge SiO chimney in the halo of M82	SiO $H^{13}CO^+$	S.García-Burillo A. Usero J.Martín-Pintado A.Fuente R.Neri
M00D	mm-wave absorption towards NGC 1052	HCO+ $^{12}CO(1-0)$	H.Liszt R.Lucas
M015	Massive young stars, protest ars, and outflows in Onsala 1	SiO $H^{13}CO+$ $^{12}CO(2-1)$	R.Bachiller M.Kumar M.Tafalla
M01B	Molecular Gas in the 3C48 QSO Merger Host Galaxy	$^{12}CO(1-0)$ $^{12}CO(3-2)$	A.Eckart D.Downes R.Neri M.Krips J.Zuther J.Scharwächter
M— 2	Extending Onsala 1 to the South	SiO(2-l) $^{12}CO(2-1)$	R.Bachiller M.S.N.Kumar M.Tafalla
M022*	The Formation of Cometary Globules in Planetary Nebulae	$^{12}CO(1-0)$ $^{12}CO(2-1)$	R.Bachiller P.Huggins P. Cox T.Forveille E.Josselin
M026	A quest for rotating circumstellar disks in high-mass YSOs	$CH_3CN(5-4)$ $CH_3CN(12-11)$	R.Cesaroni M.Beltran C.Codella R.Furuya R.Neri L.Olmi L.Testi
M027	Millimeter observations of GRB afterglows (TOO)	Cont3mm Cont1mm	A.Castro-Tirado M.Bremer R.Sagar S.Thrushkin
M029	The fine-scale structure of unusual clumpuscules	$^{12}CO(1-0)$ $^{12}CO(2-1)$	A.Heithausen
M02A	High spatial resolution study of the core region of AFGL 2688	SiS $^{13}CO(2-1)$	P. Cox R.Lucas S.Guilloteau P.Huggins T.Forveille R.Bachiller J.-P.Maillard A.Omont
M02C	The shock-induced chemistry in the bipolar PPN OH231.8+4.2	HNC CO^+ SiO ^{13}CO	J.Alcolea V.Bujarrabal R.Soria R.Neri C.Sánchez-Contreras
M02D	PdBI observation of the "Flying Saucer" edge-on circumstellar disk	HCO^+ $^{12}CO(2-1)$	N.Grosso A.Dutrey T.Montmerle J.Alves
M02E	The most luminous source in the Orion KL hot core	HC_3N $^{12}CO(1-0)$ HCN_3N	P.DeVicente J.Martín-Pintado R.Neri
M030	NUclei of GAlaxies (NUGA): IV	$^{12}CO(1-0)$ $^{12}CO(2-1)$	S.García-Burillo F. Combes A.Eckart L.Tacconi L.Hunt S.Leon A. Baker P.Englmaier F.Boone E.Schinnerer R.Neri

Ident.	Title	Line	Authors
M032	The Feeding Mechanism of the Nuclear Starbursts in NGC 6946	$^{12}CO(1-0)$ $^{12}CO(2-1)$	T.Böker E.Schinnerer U.Lisenfeld
M034	The Compact Component of the Dust Emission in Protostar B335	Cont3mm CS(5-4)	D.Harvey D.Wilner
M038	High resolution observations of the disk of HK Tau B	^{13}CO $^{12}CO(2-1)$	F.Ménard G.Duchêne G.Duvert K.Stapelfeldt
M039	Identification of mm sources without radio counterpart: The highest redshifts?	Cont3mm Cont1mm	D.Lutz F.Bertoldi K.Menten H.Dannerbauer M.Lehnert L.Tacconi R.Genzel C.Carilli
M03E	Are PAHs precursors of small hydrocarbons? The Horsehead case	C_2H $^{12}C^{18}O$	J.Pety A.Abergel M.Gerin E.Habart E.RouefT D.Teyssier
M03F	Circumstellar disks around MWC 1080, MWC 137 and R Mon	Cont3mm Cont1mm	A.Fuente J.Martín-Pintado R.Bachiller A.Natta L.Testi A.Rodriguez-Franco
M040	Imaging the Molecular Gas Disk in the FR I Radio Galaxy 3C31	$^{12}CO(1-0)$ $^{12}CO(2-1)$	J.Lim F. Combes S.Leon Vqan-Trung Dinh
M041	Mapping the molecular gas in the multiple starburst ULIRG IRAS 12112+0305	$^{12}CO(1-0)$ $^{12}CO(2-1)$	P.Planesas L.Colina L.Lara A.Alberdi
M042*	A bright submm source possibly associated with a gravitationally lensed arc	Cont3mm Cont1mm	C.Borys D.Lutz L.Tacconi D.Scott P.Newbury G.Fahlman
M043	Gas and dust in the Lyman break galaxy Westphal-MMDll	$^{12}CO(3-2)$ Cont1mm	A. Baker L.Tacconi R.Genzel M.Lehnert D.Lutz
M044	High-resolution study of the intermediate-mass Class 0 protostar NGC7129-FIRS2	$CH_3CN(5-4)$ RN_2D	A.Fuente R.Bachiller R.Neri A.Rodriguez-Franco
M046	The quest for disks in high-mass protostellar objects	CN(1-0) CN(2-1)	H.Beuther P.Schilke F.Wyrowski
M047	A massive protocluster - complementary D-configuration	CS(2-1) CN(5-4)	H.Beuther P.Schilke J.Kerp
M04C	Zooming on the kinematics of a molecular spiral arm at z = 0.9	HCO^+	S.Muller M.Guélin
M04D	500 AU structures in the ^{12}CO and continuum emission of a high latitude cloud	$^{12}CO(1-0)$	E.Falgarone F.Levrier J.Pety
M04F	TITAN: Study of the HC_3N and CH_3CN spatial distributions	HCN(1-0) CH_3CN HC_3CN	R.Moreno A. Marten T.Hidayat G.Paubert
M050	Physico-Chemistry of Protoplanetary Disks	N_2H^+ C_2H HCN DCO+ CS CN	V.Piétu A.Dutrey C.Kahane F.Gueth S.Guilloteau P.Hily-Blant E.Roueff E.Dartois G.Pineau des Forets
M051	Morphology and Excitation of the Molecular Gas in the z = 2.56 QSO J 1409+5628	$^{12}CO(3-2)$ $^{12}CO(7-6)$	A.Beelen F.Bertoldi C.Carilli P.Cox A.Omont J.Pety P.Petitjean
M055	Detection of the C_1 ($^3P_2 \rightarrow ^3P_1$) fine structure line at redshift z = 2.5	$^{12}CO(3-2)$ C_1 ($^3P_2 \rightarrow ^3P_1$)	A.Weiss C.Henkel D.Downes
M056	Molecular Gas in the Center of NGC1068	$^{13}CO(1-0)$ $^{12}CO(2-1)$	M.Krips A.Eckart L.Tacconi A. Baker E.Schinnerer
M058	Methanol in Class 0 YSOs disks	$CH_3OH(2-1)$ $CH_3OH(5-4)$	F.Gueth S.Guilloteau
M05C	The barred host galaxy of the QSO HE1029-1831	HCN(1-0) $^{12}CO(2-1)$	M.Krips A.Eckart T.Bertram Ch.Straubmeier J.Staguhn
M05D	CO identification of submillimetre galaxies	$^{12}CO(3-2)$ $^{12}CO(4-3)$ Contlmm	R.Ivison R.Genzel F.Bertoldi R.Neri A.Omont P.Cox T.Greve S. Chapman A.Blain I.Smail

Ident.	Title	Line	Authors
M05F	Chemical properties of high-mass protostellar disks	HCN CN HDO $H_2^{18}0$	C.Comito P.Schilke E.Bergin D.Neufeld
M060	Probing the structure of the high-redshift lensed AGN MG0751+2716	^{12} CO (4-3) ^{12}CO(8-7)	J.-P.Kneib D.Alloin M.Bremer
M061	High-resolution observations of SMM J14011+0252	^{12}CO(3-2) ^{12}CO(7-6)	D.Downes P.Solomon
M062	The lensed quasar Q0957+561: Is the ^{12}CO line profile real?	^{12}CO(2-1)	M.Krips R.Neri A.Eckart P.Planesas L.Colina J.Martín-Pintado
M063	Molecular Gas in the Counter-rotating Disk of NGC4138	^{12}CO(1-0) ^{12}CO(2-1)	R.Hönle A.Baker L.Tacconi R.Genzel
M064	CO "microflows" : a direct probe of wide-angle winds in young stars ?	^{13}CO $C^{18}0$ ^{12}CO(2-1)	N.Pesenti C.Dougados S.Cabrit
M068	Temperature and density maps of massive protostars	CH_3OH CH_3OH H_2CO	S.Leurini K.Menten P.Schilke F.Wyrowski H.Beuther F.VanDerTak C.Wamsley D. Flower
M069	HCN in Ultraluminous Galaxies	HCN ^{12}CO(2-1)	P.Solomon D.Downes
M06C	High resolution observations of CO in the HD 141569 circumstellar disk	^{13}CO(1-0) ^{12}CO(2-1)	J.-C.Augereau A.Dutrey A.-M.Lagrange T.Forveille D.Mouillet
M-14	High resolution PDBI follow-up of a high-z submillimeter source in C- or B-configuration	^{12}CO(3-2)	R.Genzel R.Ivison F.Bertoldi A.Blain S. Chapman P. Cox T.Greve R.Neri A.Omont I.Smail
M-15	High resolution PDBI follow-up of a high-z submillimeter source in C- or B-configuration	^{12}CO(4-3)	R.Genzel R.Ivison F.Bertoldi A.Blain S. Chapman P. Cox T.Greve R.Neri A.Omont I.Smail
M-16	Search for CO emission from the dark ages	^{12}CO(6-5) Contlmm	F.Bertoldi K.Menten C.Carilli X.Fan M.Strauss P.Cox A.Beelen A.Omont
M-17	Redshifted CO(6-5) near the z=6.28 QSO	^{12}CO(6-5)	A.Bolatto L.Blitz M.Wright L.Tacconi
M-18	^{13} CO and ^{12}CO observations of a YSO in M17	^{13}CO ^{12}CO	R.Chini
VLBI	Imaging Cygnus A with 75 milli-pc resolution	Cont3mm	U.Bach T.P.Krichbaum W.Alef E.Middleberg D.Graham A.Witzel J.A.Zensus A.Greve M.Bremer M.Grewing R.Booth J.Conway
VLBI	The Interior Structure of Relativistic Jets at 86 GHz	Cont3mm	T.P.Krichbaum D.Graham A.Lobanov A.Witzel J.A.Zensus A.Greve M.Bremer M.Grewing R.Booth J.Conway J.L.Gomez A.Alberdi
VLBI	Looking through the obscuring torus of NGC 1052	Cont3mm	M.Kadler E.Ros T.P.Krichbaum A.Kraus J.A.Zensus D.Graham A.Lobanov A.Greve M.Bremer M.Grewing R.Booth J.Conway
N001*	Grain growth around an intermediate mass class I source	$C^{18}O$ $C^{17}O$	E.Dartois L.d'Hendecourt
N003	Millimeter observations of GRB afterglows (TOO)	Cont3mm Cont1mm	A.Castro-Tirado M.Bremer R.Sagar S.Thrushkin

Ident.	Title	Line	Authors
N004	NUclei of GAlaxies (NUGA)	$^{12}CO(1-0)$ $^{12}CO(2-1)$	S.García-Burillo F. Combes A.Eckart L.Tacconi L.Hunt S.Leon A. Baker P.Englmaier F.Boone E.Schinnerer R.Neri
N005	Episodic mass loss on the AGB: the detached CO shell around S Set	$^{12}CO(1-0)$	H.Olofsson R.Lucas P.Bergman J.Bieging K.Eriksson B.Gustafsson
N006*	The temperature of high-mass protostellar cores	$CH_3C_2H(5-4)$ $CH_3C_2H(13-12)$	F.Fontani M.T.Beltrán R.Cesaroni L.Testi C.M.Walmsley J. Brand S.Molinari F.Palla
N00A	Mars' middle atmosphere dynamics at perihelion	$^{12}CO(1-0)$ $^{12}CO(2-1)$	E.Lellouch R.Moreno S.Guilloteau T.Encrenaz F.Forget
N00B	Jet/Outflow/Shock-interactions in IRAS 19410+2336	SiO(2-l) SiO(5-4)	H.Beuther P.Schilke T.Stanke
N00C	Jet-like molecular outflows in massive young stars	SiO(2-l) SiO(5-4)	Q.Zhang H.Beuther F.Wyrowski P.Schilke Y.Chen
N00D*	Molecular Gas in Massive low surface brightness galaxies	$^{12}CO(1-0)$ $^{12}CO(2-1)$	K.O'Neil E.Schinnerer
N011	C0(4 -3) in the z = 3.8 radio galaxy 4C41.17	$^{12}CO(4-3)$	C.DeBreuck A.Omont R.Neri D.Downes M.Reuland W.VanBreugel H.Röttgering
N012	Molecular clouds and star formation in IC 10	$^{12}CO(1-0)$	E.Bayet M.Gerin A.Contursi M.Guélin J.Pety
N013	Search of [CI] in the z = 4.12 QSO PSS2322+1944	[CI]	P.Cox A.Beelen J.Pety F.Bertoldi C.Carilli G.Djorgovski A.Omont
N015	Molecular gas (and dust) in the Lyman break galaxy Westphal-MMDll	$^{12}CO(4-3)$	A. Baker L.Tacconi R.Genzel M.Lehnert D.Lutz
N017	Mapping cold molecular gas in cooling flows	$^{12}CO(1-0)$	P.Salome F. Combes
N019	A search for CO in the submillimetre-loud, radio quiet z=2.618 +/— 0.0016 quasar LBQS B0018-0220	$^{12}CO(3-2)$	K.Isaak R.McMahon R.Priddley A.Omont N.Nagar P.Hirst
N01A	An Extremely Young Massive Stellar Object near IRAS 07029-1215	CS(2-1)	Th.Henning K.Schreyer J.Forbrich
N01C*	The role of clumping in the Wind Momentum-Luminosity Relationship for Olf Supergiants	Cont3mm Cont1mm	F.Najarro A.Herrero J.Martín-Pintado
N01E	A massive disk around the intermediate-mass young star AFGL 490?	$C^{34}S(2-1)$	K.Schreyer R.Klein J.Forbrich
N021*	Mass-loss variations in AGB stars: Detached shells in their making?	$^{12}CO(1-0)$ $^{12}CO(2-1)$	T.LeBertre J.M.Winters J.Pety R.Neri
N026	Spectral variations during coronal actvity of a T Tauri star	Cont3mm	M.Massi K.Menten J.Neidhöfer S.Leurini
N028	CO identification of submillimetre galaxies. II	$^{12}CO(3-2)$ $^{12}CO(4-3)$	R.Genzel R.Ivison F.Bertoldi R.Neri P.Cox A.Omont T.Greve S. Chapman LSmail
N--1	Search for C^+, CI, HCN and H_20 emission	C+ [CI] HCN H_2O	F.Bertoldi R.Neri P.Cox A.Omont K.Menten A.Beelen F.Walter C.Carilli X.Fan M.Strauss

Ident.	Title	Line	Authors
N--3	Search for CO emission from the most distant QSOs	$^{12}CO(6\text{-}5)$ Contlmm	F.Bertoldi C.Carilli P.Cox A.Beelen G.Djorgovski M.Bogosavljevic A.Mahabal X.Fan A.Omont M.Strauss R.Neri
N--4	CO emission in the J04135 at z=2.8	$^{12}CO(3\text{-}2)$	D.Downes A.Weiss
N032	Water in regions of high-mass star formation	HDO $1_{10}\text{-}1_{11}$ $H_2{}^{18}O$	F.van der Tak F.Herpin S.Viti M.Walmsley C.Ceccarelli
N033	Structure in the Debris Disk around a Nearby G Star	$^{12}CO(2\text{-}1)$ Contlmm	D.Wilner J.Williams
N034	A massive disk around the intermediate-mass young star AFGL 490?	$C^{34}S$ $C^{17}O$	K.Schreyer J.Forbrich T.Henning
N038*	High Resolution mm-Interferometry of Submm Galaxies: Testing High-z Mass Assembly	$^{12}CO(3\text{-}2)$ $^{12}CO(4\text{-}3)$ Cont1mm	R.Neri R.Genzel R.Ivison F.Bertoldi A.Blain S.Chapman P.Cox T.Greve A.Omont I.Smail L.Tacconi
N03A*	NUclei of GAlaxies (NUGA)	$^{12}CO(1\text{-}0)$ $^{12}CO(2\text{-}1)$	S.García-Burillo F. Combes A.Eckart L.Tacconi L.K.Hunt S.Leon A. Baker P.Englmaier F.Boone E.Schinnerer R.Neri
N04A	A Search for Pure Rotational Emission from TiO toward the Peculiar Red Supergiant VY Canis Majoris - Second Attempt	SiO(2-l) TiO (7-6)	K.Menten P.Schilke S.Leurini J.Alcolea
N04B	Resolving a Strong Dynamical Interaction at the Center of the NGC2264C Protocluster	N_2H^+ $C^{18}O$	N.Peretto P.André A.Belloche F.Motte P.Hennebelle
N053*	Search for Glycine and Precursors	SiO(2-l) Glycin-1MM	F. Combes D.Despois G.Wlodarczak A.Wootten M.Guélin N.Brouillet
N05B	CO-Dynamics of Bright Sub-mm Galaxies in Abell 2218	$^{12}CO(3\text{-}2)$ $^{12}CO(7\text{-}6)$	J.Kneib R.Neri I.Smail K.Kraiberg P. Van der Werf A.Blain K.Sheth
NOSE*	Properties of the dense gas in the redshift 6.42 quasar J1148+5251	$^{12}CO(7\text{-}6)$ [CI] H_2O Cont1mm	F.Bertoldi P.Cox R.Neri C.L.Carilli F.Walter A.Omont J. Black A.Beelen X.Fan M.A.Strauss K.M.Menten
N070*	Properties of the high-mass accretion disk in Cepheus-A	SiO(2-l) CS(2-1) CS(5-4) CH_3CN	C.Comito P.Schilke
N079*	The circumstellar disk around the massive star R Mon	$^{13}CO(1\text{-}0)$ $^{13}CO(2\text{-}1)$	A.Fuente A.Natta L.Testi R.Neri R.Bachiller
N07B*	Hot molecular spots in the circumstellar disk around the radiojet Cep A HW2	SiO(2-l) CH_3CN	I.Jimenez J.Martín-Pintado A.Rodriguez S.Martin C.Thum

* Projects close to completion on December 31, 2003.

8. ANNEX II: PUBLICATIONS/ 8.1 PUBLICATIONS WITH IRAM STAFF MEMBERS AS (CO-)AUTHORS

970. STRUCTURE OF THE DM TAU OUTER DISK: PROBING THE VERTICAL KINETIC TEMPERATURE GRADIENT
E. Dartois, A. Dutrey, S. Guilloteau
2003, A&A 399, 773

971. DUST EMISSION FROM YOUNG OUTFLOWS: THE CASE OF L1157
F. Gueth, R. Bachiller, M. Tafalla 2003, A&A 401,L5

972. CO EMISSION AND ASSOCIATED ffl ABSORPTION FROM A MASSIVE GAS RESERVOIR SURROUNDING THE $z = 3$ RADIO GALAXY B3 J2330+3927
C. de Breuck, R. Neri et al.
2003, A&A 401, 911

973. OPTICAL AND RADIO BEHAVIOUR OF THE BL LACERTAI OBJECT 0716+714
C.M. Raieteri, H. Ungerechts, U. Lisenfeld et al.
2003, A&A 402, 151

974. PRODUCTION AND KINEMATICS OF CO IN COMET C/1995 01 (HALE-BOPP) AT LARGE POST-PERIHELION DISTANCES
M. Gunnarsson, D. Bockelée-Morvan, R. Moreno, G. Paubert et al.
2003, A&A 402, 383

975. THE BP TAU DISK: A MISSING LINK BETWEEN CLASS II AND III OBJECTS?
A. Dutrey, S. Guilloteau, M. Simon 2003, A&A 402, 1003

976. DENSE GAS IN NEARBY GALAXIES
XV. Hot Ammonia in NGC 253, Maffei 2 and IC342
R. Mauersberger, C. Henkel, A. Weiss, A.B. Peck, Y. Hagiwara
2003, A&A 403, 561

977. A STUDY OF X BOOTIS TYPE STARS IN THE WAVELENGTH REGION BEYOND 7000 Å
E. Paunzen, I. Kamp, W.W. Weiss, H. Wiesemeyer
2003, A&A 404, 579

978. A MULTIWAVELENGTH STUDY OF THE S106 REGION
II. Characteristics of the photon dominated region
N. Schneider, R. Simon, C. Kramer, K. Kraemer, J. Stutzki, B. Mookerjea 2003, A&A 406, 915

979. DUST EMISSION FROM THE MOST DISTANT QUASARS
F. Bertoldi, C.L. Carilli,, P. Cox, X. Fan, M.A. Strauss, A. Beelen, A. Omont, R. Zylka
2003, A&A 406, L55

980. SELF-CONSISTENT MODELING OF THE OUTFLOW FROM THE O-RICH MIRA IRC-20197
K.S. Jeong, J.M. Winters, T. Le Bertre, E. Sedlmayr
2003, A&A 407, 191

981. MOLECULAR GAS IN **NU**CLEI OF **GA**LAXIES (NUGA) I. The counter-rotating LINER NGC 4826
S. García-Burillo, F. Combes, L.K. Hunt, F. Boone, A.J. Baker, L.I Tacconi, A. Eckart, R. Neri, S. Leon, E. Schinnerer, P. Englmaier
2003, A&A 407, 485

982. THE LINE –OF -SIGHT DISTRIBUTION OF THE GAS IN THE INNER 60 PC OF THE GALAXY
B. Vollmer, R. Zylka, WJ. Duschl 2003, A&A 407, 515

983. TRIGGERED MASSIVE-STAR FORMATION AT THE BORDER OF THE HII REGION SH 104
L. Deharveng, B. Lefloch, A. Zavagno, J. Caplan, A.P. Whitworth, D. Nadeau, S. Martin
2003, A&A 408, L25

984. SIMBA OBSERVATIONS OF THE R CORONA AUSTRALIS MOLECULAR CLOUD
R. Chini, K. Kämpgen, B. Reipurth, M. Albrecht E. Kreysa, R. Lemke, M. Nielbock, L.A. Reichertz, A. Sievers, R. Zylka
2003, A&A 409, 235

985. GAS AND DUST IN THE CLOVERLEAF QUASAR AT REDSHIFT 2.5
A. Weiss, C. Henkel, D, Downes,F. Walter
2003, A&A 409, L41

986. HIGH-EXCITATION CO IN A QUASAR HOST GALAXY AT z = 6.42
F. Bertoldi, P. Cox, R. Neri, C.L. Carilli, F. Walter, A. Omont, A. Beelen, C. Henkel, X. Fan, M.A. Strauss, K.M. Menten
2003, A&A 409, L47

987. DETECTION OF AN ORBITING GAS DISK IN THE RED RECTANGLE
V. Bujarrabal, R. Neri, I. Alcolea, C. Kahane
2003, A&A 409, 573

988. FIRST DETECTIONS OF EXTRAGALACTIC SO_2, NS AND NO
S. Martin, R. Mauersberger, J. Martín-Pintado, S. García-Burillo, C. Henkel
2003, A&A 411, L465

989. NON-GAUSSIAN VELOCITY SHEARS IN THE ENVIRONMENT OF LOW MASS DENSE CORES
J. Pety, E. Falgarone
2003, A&A 412, 417

990. MOLECULAR GAS AND DUST AT z=2.6 IN SMM J14011+0252: A STRONGLY LENSED ULTRALUMINOUS GALAXY, NOT A HUGE MASSIVE DISK
D. Downes, P.M. Solomon
2003, ApJ 582, 37

991. SPATIALLY RESOLVED MILLIMETER INTERFEROMETRY OF SMM J02399-0136: A VERY MASSIVE GALAXY AT z=2.8
R. Genzel, A. J. Baker, L. J. Tacconi, D. Lutz, P. Cox, S. Guilloteau, A. Omont
2003, ApJ 584, 633

992. INTERFEROMETRIC OBSERVATIONS OF POWERFUL CO EMISSION FROM THREE SUBMILLIMETER GALAXIES AT z=2.39, 2.51, AND 3.35
R Neri, R. Genzel, E, J. Ivison, F. Bertoldi, A.W. Blain, S.C. Chapman, P. Cox, TR. Greve, A. Omont, D.T. Prayer
2003, ApJ 597, L113

993. FIRST EVIDENCE OF DUSTY DISKS AROUND HERBIG BE STARS
A. Fuente, A. Rodríguez-Franco, L. Testi, A. Natta, R. Bachiller, R. Neri
2003, ApJ 598, L39

994. THE OPACITY OF NEARBY GALAXIES FROM COUNTS OF BACKGROUND GALAXIES. II. LIMITS OF THE SYNTHETIC FIELD METHOD
R.A. González, L. Loinard, R.J. Alien, S. Muller
2003, ApJ 125, 1182

995. MOLECULAR GAS IN THE HOST GALAXY OF A QUASAR AT REDSHIFT z=6.42
F. Walter, F. Bertoldi, C. Carilli, P. Cox, K.Y. Lo, R. Neri, X. Fan, A. Omont, M. Strauss, K.M. Menten
2003, Nature 424, 406

996. THE ESSENTIAL SIGNATURE OF A MASSIVE STARBURST IN A DISTANT GALAXY
P. Solomon, P. VandenBout, C. Carilli, M. Guélin
2003, Nature 426, 636

997. A HIGH-FREQUENCY AND MULTI-EPOCH VLBI STUDY OF 3C273
T.P. Krichbaum, D.A. Graham, A. Witzel, J.A. Zensus, A. Greve, M. Grewing, A. Marscher, A.I. Beasley
2003, *in Particles and Fields in Radio Galaxies,* San Francisco: eds. R.A. Laing, K.M. Blundell ASP Conf. Series 250, 184

998. EXTRAGALACTIC AMMONIA
C. Henkel K.M. Menten, J. Braatz, R. Mauersberger, A. Weiss, M, Lebron, A. Tarchi, A.B. Peck, C.L. Carilli, D.A. Lubowich
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999. PROBING THE NUCLEOSYNTHESIS OF THE YOUNG UNIVERSE: C, N, O AND S ISOTOPIC RATIOS AT REDSHIFT z = 0.9
S. Muller, M. Guélin
2003, in *CNO in the Universe* eds. C. Charbonnel, D, Schaerer, G. Meynet ASP Conf. Series 304, 252

1000. STANDING WAVES FOR ALMA: SIMULATIONS OF VARIOUS TANGENT CONES ON THE SUBREFLECTOR A. Bacmann, S. Guilloteau
2003, ALMA Memo 457, NRAO, Socorro
http://www.Alma.nrao.edu/memos/html-memos/alma457/memo457. pdf

1001. THE AMPLITUDE CALIBRATION SYSTEM REVISITED
S. Guilloteau, A. Bacmann
2003, ALMA Memo 461, NRAO Socorro
http://www.alma.nrao.edu/memos/html-memos/alma461/memo461.pdf

1002. COMPLEMENTARITY OF THE AIPS++, GILDAS AND MIRIAD PACKAGES AS SEEN FROM EVALUATIONS FOR ALMA OFF-LINE DATA PROCESSING
J. Pety, F. Guetli, S. Guilloteau, P. Teuben, M. Wright 2003, ALMA Memo 464, NRAO, Socorro
http://www.alma.nrao.edu/memos/html-memos/alma464/memo464.pdf

1003. CASE FOR INTEROPERABILITY AS AN ALMA OFF-LINE MODEL
J. Pety, F. Gueth, S. Guilloteau, P. Teuben, M. Wright
2003, ALMA Memo 465, NRAO, Socorro
http://www.Alma.nrao.edu/memos/html-memos/alma465/memo465.pdf

1004. SITE PROPERTIES AND STRINGENCY
N. Evans, R. Lucas et al.
2003, ALMA Memo 471, NRAO, Socorro
http://www.Alma.nrao.edu/memos/html-memos/alma471/memo471.pdf

1005. AIPS++ REUSE ANALYSIS TEST: Report on Phase I
A.Kemball, K. Golap, G. Moellenbrock, R. Lucas, D. Broguière
http://www.Alma.nrao.edu/memos/html-memos/alma472/memo472.pdf

1006. AIPS++ REUSE ANALYSIS TEST: Report on Phase II
J. Pety, A. Baker, A. Coulais, F. Gueth, D. Shepherd, L. Testi, C. Wilson
http://www.alma.nrao.edu/memos/html-memos/alma473/memo473.pdf

1007. IRAM/AIPS++ TEST: Phase III
R. Lucas, D, Broguière, K. Golap, I. McMullin, R. Rusk
http://www.alma.nrao.edu/memos/html-memos/alma474/memo474.pdf

1008. CARACTERISATION DE LA MATIERE INTERSTELLAIRE EXTRAGALACTIQUE
Propriétés physiques, masse de poussière et masse de gaz moléculaire S. Muller
2003, Thèse, Univ. Joseph Fourier, Grenoble I

1009. INVESTIGATING THE CHEMICAL DIVERSITY OF COMETS FROM RADIO OBSERVATIONS
P. Colom, N. Biver, D. Bockelée-Morvan, I. Crovisier, F. Henry, R. Moreno, G. Paubert, D. Despois, D.C.Lis
2003, in *SF2A Scientific Highlights 2003* eds. F. Combes, D. Barret, T. Contini, L. Pagani EDP Sciences, Les Ulis, 140

1010. MOLECULES AND DUST IN EXTERNAL GALAXIES: RECENT RESULTS OBTAINED WITH THE IRAM TELESCOPES
M. Guélin
2003, in *SF2A Scientific Highlights 2003* eds. F. Combes, D. Barret, T. Contini, L. Pagani EDP Sciences, Les Ulis, 260

1011. DISTRIBUTION AND PROPERTIES OF MOLECULAR COMPLEXES IN THE ANDROMEDA GALAXY
S. Muller, M. Guélin
2003, in *SF2A Scientific Highlights 2003* eds. F. Combes, D. Barret, T. Contini, L. Pagani EDP Sciences, Les Ulis, 260

1012. SiO MASER POLARIZATION IN EVOLVED STARS: MAGNETIC FIELD
F. Herpin, A. Baudry, C. Thum, D. Morris, H. Wiesemeyer
2003, in *SF2A Scientific Highlights 2003* eds. F. Combes, D. Barret, T. Contini,L. Pagani
EDP Sciences, Les Ulis, 524

8. ANNEX II: PUBLICATIONS/ 8.2 PUBLICATIONS WITH RESULTS FROM USERS' IRAM OBSERVATIONS

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III. The first-ranked HII region complex Hubble V
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