cedented distances, promising real progress in clarifying the extragalactic distance scale. As an example we note that Planetary Nebulae should be observable with FORS not only in the Virgo and Centaurus clusters but also at the distance of the "Great Attractor" region of enhanced galaxy densities.

The FORSes will also be excellent instruments for spectroscopic surveys of (field) galaxies down to B-magnitudes fainter than 24^m. They will serve to constrain the basic cosmological parameters and the scenarios for the evolution of galaxies as well as to investigate the clustering of galaxies in redshift.

With their superb imaging capabilities the FORSes will be particularly valuable for investigating the galaxy environment of QSOs, for probing the large-scale structure of the distant universe in selected fields and, perhaps, for finding very young or still forming galaxies.

Finally we note that in astronomy new and more powerful instruments almost always resulted in the discovery of new and often completely unexpected types of objects. Not the least for this reason are we looking forward with great excitement to the year 1996 when, if everything goes well, FORS I will see its first light at the VLT on Paranal.

Delay Lines of the VLT Interferometer: Current Status

M. FAUCHERRE and B. KOEHLER, ESO

The four 8-m telescopes of the VLT, located at fixed positions, as well as the movable auxiliary telescopes, need delay lines between them to cancel out the optical path difference (OPD) due to sidereal motion. The ESO design comprises 60 metre delay lines using cat's eye optics of 80 cm diameter to transmit an 8 arcsec field-of-view.

An exceptionally high dimensional stability is required both for longitudinal and lateral positioning. A feasibility study was performed by MBB (Ottobrunn) between October 1990 and September 1991 to find solutions for both requirements. The goal was to reach the requirements with a straightforward single-stage approach based on state-of-the-art air bearings (passive solution) or magnetic suspension (active solution).

Six commercially available air bearings were found to be inadequate due to excessive acoustic noise exciting cat's eye eigenmodes. The magnetic suspension option is an elegant solution to actively control vibrations. However, to eliminate uncertainty with regard to stability performance, a prototype is needed to assess the performance at the unusual manometer level.

Following this, tests were performed by ESO and OCA in September 1991 in Limoges (Ateliers Maître, Microcontrôle) and in October 1991 at the TU München on air bearings using different technologies. The test carried out at the TU München on sintered bronze air pads, patented by Prof. Heinzl's group, revealed a level of acoustic noise more than an order of magnitude lower than air bearings previously measured. This shows that air bearings exist which meet our OPD requirement, and that air bearings are still potential candidates for VLTI delay lines.

In conclusion, the main driver to select a solution for VLTI delay lines remains the cost for the design, manufacturing and installation on the site.

References

Jörck, H., Maurer, R., Käse, J., Faucherre, M., Beckers, J.M., Kühn, G. and Hupe, H., "The design of delay lines for the VLT Interferometer", Proc. ESO Conf. on "High Resolution Imaging by Interferometry", Garching, March 1992.

Faucherre, M. and Maurer, R., "On metrology systems for delay lines", Proc. ESO Conf. on "High Resolution Imaging by Interferometry", Garching, March 1992.

Bourlon, P., Faucherre, M. and Koehler, B., "Report on experimental vibration measurements on air bearing pads at Technische Universität München", internal document, issue December 1991.

IRAC 2 – ESO's New Large Format Infrared Array Camera

IRAC 2 has been developed to exploit the new generation of large array detectors for broad and narrow band infrared imaging and to gain experience with these devices of relevance for the VLT. It is equipped with a Rockwell 256×256 pixel Hg:Cd:Te NICMOS 3 array; broad and narrow band filters between 1 and 2.5 μm; a scanning Fabry Perot etalon covering the range ~ 2–2.5 μm at R ~1000 and five selectable objectives providing for image scales from 0.15 to 1.1 arcsec/pixel (at the 2.2-m telescope). At present IRAC 2 is in the integration and test phase in Garching with installation and tests on the ESO/MPIA 2.2-m telescope scheduled for May 1992. An HP workstation will be used for instrument control, with MIDAS available on-line for image display/handling, in line with the current ESO policy of phasing out the HP 1000 computers on La Silla. The final user interface and control software as well as new VME based motor controllers are being developed on La Silla and are planned to be installed in October 1992. In the meantime, the instrument will be used with software developed in Garching for laboratory testing. The accompanying photographs show the instrument mounted on the telescope simulator in Garching and the cryogenically cooled optical assembly.

Observational Capabilities

IRAC 2 will be installed initially at the 2.2-m telescope where it will be mounted on the F/35 infrared adapter. Its main characteristics are summarized in Table 1. It should be noted that the five objectives have been provided not only to allow optimization of the image scale for particular scientific programmes and seeing conditions but also to foresee use of this camera with different array detectors and possibly at the 3.6-m telescope in future. For most applications and average seeing conditions it is expected that the 0.53 and 0.28″/pixel scales will be the most ap-

Figure 1: *IRAC 2 mounted on the telescope simulator during testing in Garching.*

Table 1: *IRAC 2 Characteristics*

Image Scales and Fields		
Objective	arcsec/pix	arcsec
A	0.15	38×38
B	0.28	72×72
C	0.53	136×136
D	0.74	Φ = 180
E	1.1	Φ = 180
Filters		
Name	λ (μm)	Δλ (μm)
J	1.25	0.3
H	1.65	0.3
K'	2.1	0.34
K	2.2	0.4
NB1 ([FeII])	1.262	0.04
NB2 ([FeII])	1.645	0.04
NB3 (HeI)	2.058	0.036
NB4	2.105	0.037
NB5 (H_2)	2.121	0.039
NB6	2.136	0.038
NB7	2.148	0.037
NB8 (Brγ)	2.164	0.037
NB9	2.177	0.038
NB10	2.216	0.075
NB11 (CO)	2.365	0.088
Fabry Perot	~ 2–2.5	λ/Δλ~1000
Array Detector		
Type	Rockwell NICMOS 3 (Hg:CD:Te)	
Format/pitch	256×256	40 μm
Bad pixels	416 (0.6 %)	

propriate. The higher magnifications yield a somewhat larger but circular field limited to 3′ by the cryostat window which also acts as the field lens. The K' filter has been kindly supplied by Dr. R. Wainscoat at the University of Hawaii. It is slightly narrower and shifted to shorter wavelengths compared with the standard K filter in order to reduce the telescope/sky thermal background in this band. The narrow band filters are intended for imaging in prominent spectral features. In the K band they provide almost complete coverage from 2.04 μm to 2.4 μm (allowing for e.g. observations of He I, H_2 and Brγ in low redshift galaxies) and can be used alone or as order isolating filters for the Fabry Perot.

Performance

The NICMOS 3 engineering array measured in our test cryostat has a quantum efficiency increasing from ~ 0.4 in the J band to ~ 0.6 at K; a read noise of ~ 40e/s and a dark current of ~ 15e/s (although most of this may be radiation from the on-chip amplifier). Its sister science grade array appears to exhibit comparable quantum efficiency and read noise but is of far superior cosmetic quality with a relatively small number of unuseable pixels (~0.6 %) for devices of this type. Due to time pressure, this array was installed directly in the camera for system testing including measurements of the optical quality, so has not yet been characterized as well as the engineering array. With regard to its astronomical performance, however, its exact read noise and dark current values are not particularly relevant at the sky background levels expected with IRAC 2.

Sky backgrounds measured with IRAC 1 at the 2.2-m telescope are J ~ 14.5, H ~ 13.8 and K ~ 12.1 mag/arcsec^2 and the overall system efficiency with IRAC 2 is expected to be ~ 30%.

Under these conditions, the background limited performance (3σ in 1 minute) should correspond to J~ 20.2, H~19.3, K~18.2 and K'~18.7 mag/arcsec^2. Corresponding values (3σ in 1 minute) for photometry in a 5″ software aperture are J ~ 18.4, H ~ 17.7, K ~ 16.7 and K′ ~ 17.2. Based on the experience gained with other infrared cameras it is expected that the ultimate deep imaging limits achievable with longer measurement times will be flat field limited at ~ 10 mag. below the sky.

Availability to Visiting Astronomers

As it is expected that IRAC 2 will offer a performance which is competitive or superior to other infrared cameras existing elsewhere, we would like visiting astronomers to have access to it as soon as possible. Proposals are therefore invited for the use of IRAC 2 at the 2.2-m telescope in period 50 (October 1992–March 1993) by the usual deadline of April 15, 1992.

Unfortunately, as this deadline falls before the first telescope test, proposers will obviously have to accept some shared risk. As the results of this test will be known before the OPC meeting in June, however, it will be possible to take both these and the overall instrument/software status into account before the final time allocations and schedule are made. It is recommended that Proposers (i) place as few restrictions as possible on the required observing dates and (ii) also state in the section "Special Remarks" whether or not their programme is also feasible using the 64×64 IRAC 1 camera already installed at the 2.2-m.

A. MOORWOOD and G. FINGER
ESO-Garching, Feb. 1992

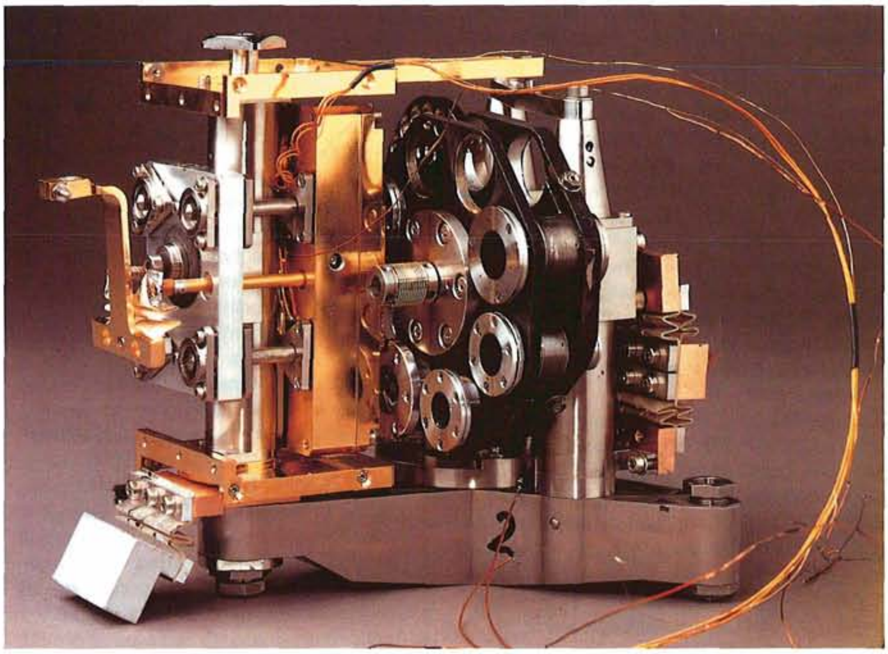

Figure 2: *The cryogenically cooled optical assembly showing the array detector mount (gold), objective wheel and, just visible behind the latter, the 24-position filter wheel.*

Visiting Astronomers

(April 1 – October 1, 1992)

Observing time has now been allocated for Period 49 (April 1 – October 1, 1992). The demand for telescope time was again much greater than the time actually available.

The following list gives the names of the visiting astronomers, by telescope and in chronological order. The complete list, with dates, equipment and programme titles, is available from ESO-Garching.

3.6-m Telescope

April 1992: Reimers/Köster, Shaver/Böhringer/Ebeling, Miley et al. (2-001-43K), François, Pallavicini/Pasquini/Randich, Hensberge et al. (5-005-45K), De Graauw et al. (9-003-49K), Zamorani/Vettolani/Bardelli/Zucca/Scaramella/MacGillivray/Collins, Jørgensen/Rasmussen/Franx, Van Drom/Hutsemékers.

May 1992: Van Drom/Hutsemékers, Turatto et al. (4-004-45K), Cacciari/Clementini, Danzinger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, Van der Hucht/Thé/Williams, Weitzel/Leinert, Mirabel/Duc/Dottori, Böhringer et al. (1-023-49K), Amram/Balkowski/Le Coarer/Marcelin/Sullivan/Cayatte.

June 1992: Corradi/Schwarz/Boulesteix, Bandiera/Corradi/Boulesteix, Mathys, Da Silva/de la Reza, Pasquini/Spite M./Spite E./Lindgren H., Lagrange-Henri/Loinard/Bouvier/Gomez/Bertout, Baade/Crane, Ferlet/Lemoine/Vidal-Madjar/Dennefeld, Vladilo/Centurion/Molaro/Monai, Schmid/Schild.

July 1992: Duerbeck/Leibowitz/Shara, Turatto et al. (4-004-45K), Duerbeck/Leibowitz/Shara, Moehler/de Boer/Heber, Jockers/Boehnhardt/Thomas/Kiselev, test of TIMMI (Moorwood), reserved – "WAD", Caulet/Hook/Pirenne/Brown/Waller/Woodgate, Danziger/Gilmozzi/Zimmermann/Hasinger/MacGillivray.

August 1992: Danziger/Gilmozzi/Zimmermann/Hasinger/MacGillivray, Ruiz/Leggett/Bergeron, P., Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, Courvoisier/Bouchet/Blecha/Orr/Valtaoja, Macchetto/Sparks, Macchetto/Sparks, Barbon/Marziani/Notni/Radovich/Rafanelli/Schulz, Freudling.

September 1992: Turatto et al. (4-004-45K), Reimers et al. (2-009-45K), Courvoisier/Bouchet/Blecha/Orr/Valtaoja, Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, Vettolani et al. (1-019-47K), Mazure/Rhee et al. (1-014/005-43K), Danziger et al. (6-003-45K).

3.5-m NTT

April 1992: Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, West/Hainaut/Marsden/Smette, Bender et al. (1-004-43K), Turatto et al. (4-004-45K), De Graauw et al. (9-003-49K), Boisson/Joly/Kotilainen/Ward/Moorwood/Oliva, Cox/Baluteau/Emery/Gry, Meylan/Djorgovski/Thompson, Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, Thomsen/Hjorth/Grundahl Jensen/Sodemann.

May 1992: Surdej et al. (2-003-43K), Miley et al. (2-001-43K), Webb/Shaver/Carswell/Barcons/Rauch, Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, Le Bertre/Lequeux, Krautter/Evans/Weight/Rawlings, Fosbury/Morganti/Robinson/Hook/Tsvetanov, Zinnecker/Reipurth/Brandner, Bandiera, Fosbury/Morganti/Robinson/Hook/Tsvetanov, Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, West/Hainaut/Marsden/Smette, Zeilinger/Bertola/Bertin/Danziger/Dejonghe/Pizella/Sadler/Saglia/Stiavelli/de Zeeuw.

June 1992: Zeilinger/Bertola/Bertin/Danziger/Dejonghe/Pizella/Sadler/Saglia/Stiavelli/de Zeeuw, Buonanno/Matteucci/Fusi/Pecci/Danziger, Cimatti/di Serego Alighieri, Rampazzo/Bland-Hawthorn/Hernquist/Blandford, Lutz/Genzel/Drapatz/Krabbe/Harris/Hillier/Kudritzki, Richtler/Wagner/Held/Capaccioli, Surdej et al. (2-003-43K).

July 1992: Augusteijn/van der Klis/van Kerkwijk/van Paradijs, Capaccioli/Piotto/Zaggia/Stiavelli, Piotto/Cacciari/Ferraro/Fusi Pecci/Djorgovski, Carollo/Danziger, Danziger/Carollo, Capaccioli/Böhm/Lorenz/Richter, Falomo/Tanzi.

August 1992: Falomo/Tanzi, Walsh/Meaburn, Alcaino/Liller/Wenderoth, Eckart/Genzel/Hofmann/Drapatz/Sams, Stecklum/Eckart/Hofmann/Henning, Hofmann/Eckart/Drapatz/Genzel/Sams, Redfern/Pedersen/Cullum/Charles/Callanan/Shearer, Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, Christensen/Sommer-Larsen/Hawkins/Flynn, Bowen/Lanzetta, Cetty-Véron.

September 1992: Lagerkvist/Williams/Magnusson/Fitzimmons/Dahlgren, Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, Moorwood/Origlia/Oliva, Danziger/Bouchet/Gouiffes/Lucy/Fransson/Mazzali/Della Valle, De Lapparent et al. (1-003-43K), Surdej et al. (2-003-43K), Peterson/D'Odorico/Tarenghi/Wampler/Yoshii/Silk.

2.2-m Telescope

April 1992: Miley et al. (2-001-43K), Bender et al. (1-004-43K), Pagel/Terlevich/Diaz/Vil-