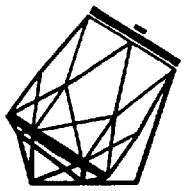

Southern African Large Telescope

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Dr V. S. Dhillon
Dept. of Physics and Astronomy
University of Sheffield
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March 1, 1999

Dear Vik,
I was most interested to read your proposal for ULTRACAM, which promises to be a very versatile instrument in studying rapid time variability in a variety of astrophysical objects. As you are aware, SAAO has been involved in time-resolved observational programs for sometime. More recently Darragh O'Donoghue (formerly of the University of Cape Town) has developed the *UCT CCD Camera*, which utilises a Wright Instruments Camera with a frame-transfer CCD (the active area is only 380 × 260 pixels). This modest sized device has been revolutionary at SAAO for studies of various time-varying phenomena, including such diverse objects as non-radially oscillating stars and accreting binaries with either white dwarf or black hole primaries. The instrument has been used on the SAAO 1.9-m, 1.0-m and 0.75-m telescopes and is becoming increasingly over-subscribed, particularly from external proposers.

ULTRACAM offers a major advance over any (of the few) existing *high-speed* CCD instruments. The CCD has demonstrated superior DQE in the blue and is much larger, while the dichroics provide for simultaneous multi-waveband observations. These characteristics, combined with the high frame rates, will ensure new and unique science opportunities. The possibility of using ULTRACAM at SAAO is very appealing, and I for one would be very keen in any collaborations using such an instrument. I know that many of my colleagues would also be interested. I am also sure that any external, scientifically worthy, proposal to use ULTRACAM would be fully supported at SAAO. Indeed SAAO has had various user-provided instruments allocated from time to time (the Durham Polarimeter being a recent example).

Furthermore, I see no potential logistical problems mounting ULTRACAM on the SAAO telescopes. In the case of the 1.9 and 1.0-m telescopes, the instrument would be mounted directly onto the standard acquisition/guider box, which has its own off-set guide CCD camera. In the case of the 1.9-m it might also be an advantage to mount ULTRACAM at the Newtonian focus, where the plate-scale is more suited to CCD photometry.

I would also like to mention to possibilities of ULTRACAM's use on SALT. Although primarily a spectroscopic telescope, there will likely be some interest in imaging (a Fabry-Perot imager is planned) and high-speed photometry. The Hobby Eberly Telescope, (SALT's prototype) is commissioning a Low Resolution Spectrograph, which also has an imaging capability. We expect that SALT will have a similar instrument, perhaps with a rapid read-out CCD similar to ULTRACAM. Although the telescope has severe restrictions in terms of it's 'viewing window', it nevertheless offers some unique opportunities for un-precedented high-time resolution studies of QPO phenomena, eclipses, milli- and micro-second

variability, all with a 9.2-m diameter pupil! I am particularly interested in exploring whether ULTRACAM could be an instrument mounted as an alternative to the currently planned standard acquisition camera for SALT. Such an instrument would not likely become a work-horse facility instrument, being rather specialised, but would be offered for specific time-critical observations from time to time. It might be the case that the instrument would spend most of its time on SAAO's smaller telescopes and be available on SALT only at certain times.

In conclusion I can see ULTRACAM having a high level of support in the SAAO community, either as a 'visiting' instrument and/or as the basis of a similar instrument acquired for SAAO at sometime in the future. I wish you all success in making ULTRACAM a reality and I hope that the proposal's reviewers grasp the importance such an instrument will have in the study of time-varying phenomena, a subject currently undergoing a renaissance of sorts!

Yours sincerely,

Dr David A.H. Buckley
SALT Project Scientist

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March 2, 1999

Dr Y Dhillon
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FAX NO: 0944 114 2728079

Dear Dr Dhillon

Regarding your proposed high-speed CCD camera, ULTRACAM, we are very interested in the possibilities of its use at SAAO. As you are aware, we make extensive use of a high-speed Wright Instruments camera, developed by Dr Darragh O'Donoghue. ULTRACAM promises a major advance in high time resolutions studies, and I know that a number of astronomers at SAAO would be interested in collaborating with you in using it.

In addition, SAAO hosts a number of visitor instruments from time to time (e.g. the Durham polarimeter) from external applicants whose proposals are accepted. ULTRACAM could certainly be allocated time at SAAO in similar circumstances when external time is awarded on the usual basis of scientific ranking of the particular proposal.

Yours sincerely

Robert S. Stobie

R S Stobie (Dr)
Director

c.c. Dr David Buckley

Isaac Newton Group of Telescopes

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Dr. V. S. Dhillon
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Date: 1 March 1999

Dear Vik,

In response to your note regarding the possible future deployment of UltraCam on the ING telescopes I can confirm that ING will support access of this instrument to our telescopes under the usual guidelines for *Visitor Instruments*.

Both the William Herschel Telescope and the Isaac Newton Telescope currently allow access of visitor instruments. From the documentation you sent I understand that UltraCam is largely a stand-alone system, and that you wish to deploy this system first of all at the GHRIL Nasmyth focus of the WHT. Once the instrument development is funded, I can advise you to establish contact with our engineers and astronomers well before coming out to La Palma. Engineering and safety aspects can then be addressed. You may wish to take advantage of our generic engineering instrument design document, which can be found on the WWW.

ING will offer the usual engineering and astronomy support during the future commissioning and observing runs. Observing time will have to be applied for through the usual peer review process. Timing of access to the telescope will depend on scheduling constraints.

I believe that UltraCam fills an important niche in the capability of common-user instruments at ING. I hope you will be successful in its development and look forward to seeing your instrument come to La Palma.

With kind regards,

René Rutten

Director, ING

Liverpool John Moores University
School of Electrical Engineering, Electronics and Physics
Astrophysics Group

New Generation Astronomical Telescopes

Dr. V.S. Dhillon,
Department of Physics,
University of Sheffield,
Sheffield S3 7RH.

Dear Vik,

We would welcome your proposed Ultracam imaging CCD instrument as a visitor instrument on the Liverpool Telescope, for a period which we could agree, starting some time after the completion of our astronomical commissioning/shared risks observing period, i.e. no earlier than March 2001. Scheduling of Ultracam time within this period would be subject to time allocation and scheduling constraints, and we would expect the majority of the time allocated on the instrument to be allocated by PATT. Ultracam could go at the Cassegrain focus of the LT, where the restriction on the weight is that it must weigh no more than 400 kg, and if it is this heavy its centre of mass must be no more than 60 cm below the mounting plane. The out of balance moment perpendicular to the optical axis must be no more than 25 kg m. The space envelope available to visitor instruments is a cylinder extending 90 cm along the optical axis below the mounting plane, and 120 cm in diameter. The diameter of the mounting flange on the A&G box is 85cm. The nominal focal plane is 75 mm below the mounting plane. In addition to this, a small amount of electronics weighing no more than 15 kg can be attached to one of the faces of the octagonal A&G box.

Cabling available to visitor instruments will be: mains power (230 Volts, capacity 10 amps), 10baseT Ethernet connection (control LAN), and a number of optical fibres.

Your group would have to support all use of Ultracam, or arrange it with ING, and to finance all costs additional to the normal running costs of the LT (for example the cost of installation on and removal from the telescope, and call out costs associated with the instrument).

Yours sincerely,

David Carter

Project Scientist: Dr D Carter MA PhD
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Royal Greenwich Observatory

Supported by the European Regional Development Fund under the Objective One Programme for Merseyside

NATIONAL MUSEUMS & GALLERIES ON MERSEYSIDE NMGM

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23 April 1999

Vik Dhillon
Department of Physics & Astronomy
University of Sheffield
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Dear Vik,

I have read your grant proposal for ULTRACAM.

ULTRACAM is clearly a timely and innovative instrument which promises to open up an important new area of observational parameter space, namely that of high time resolution.

The UK is particularly strong in precisely the areas of science which ULTRACAM is targeting, and I would be very keen to see such an instrument used at the AAT.

The design of ULTRACAM as a stand-alone, compact and lightweight instrument makes it striaghtforward to support as a private instrument on the AAT at Cassegrain Focus.

Yours sincerely

Brian Boyle

Dr R.W. Wilson
Cavendish Astrophysics

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UNIVERSITY OF CAMBRIDGE

Astrophysics Group
Cavendish Laboratory

27 April 1999

Dear Dr Dhillon

Application of Ultracam to NRM Imaging.

We write to express our very great interest in your proposal for the Ultracam triple-beam CCD camera. Equipped with suitable fore-optics, Ultracam would provide an excellent camera for our non-redundant mask (NRM) interferometric imaging observations.

NRM is a proven method which permits high angular resolution imaging of stellar surface features and other compact sources at optical wavelengths. The method routinely allows the diffraction limit of the telescope to be achieved, a capability that is beyond the range of even the most advanced adaptive optical systems currently available at large optical telescopes.

The NRM technique relies upon the use of detectors with high time resolution and the best possible quantum efficiency and noise performance, as well as high data acquisition rates. Ultracam represents state-of-the-art technology in these respects, and would be a significant improvement over the detectors that have been available to us previously.

The ability to record in three colours simultaneously would be another important advantage. Since most science programmes for NRM require observations in a range of colours, for example to measure stellar diameters as a function of wavelength, the efficiency of our observations would be improved by a factor of three. Furthermore, simultaneous multi-wavelength observations will allow a more complete solution for the atmospheric phase errors in the NRM data reduction, thus improving the SNR and dynamic range of the resulting maps.

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The rapid data processing capability afforded by Ultracam would further increase our observing efficiency via rapid reduction and interpretation of results during the observations (eg. allowing us to quickly assess which targets had interesting surface structure and were worthy of further investigation).

For observations at the WHT GHRIL focal station, the fore-optics required to allow Ultracam to be used for NRM imaging would be relatively simple and inexpensive. Many science projects would be possible, including investigations of pulsation and mass loss from evolved stars, and the nature of surface features on supergiants. Interferometric observations with monolithic telescopes are also required to compliment data from dedicated interferometers such as COAST or LOA, by providing 'compact array' observations of (relatively) large scale structure, and for source selection.

The portability of Ultracam is one of its most important features since it presents the possibility of applying the optical NRM technique to an 8m telescope for the first time. Deployed on the GEMINI telescopes in NRM mode, Ultracam would permit the resolution of structures at the 10 milli-arcsecond level. Significant new insights will inevitably result from the ability to resolve much greater detail on those objects already studied with 4-m telescopes, and to resolve many new targets of smaller angular size.

Observations with GEMINI would require a more robust fore-optics unit for use at the Cassegrain focus, which would need to be the subject of a separate grant application.

In summary, the use of Ultracam for NRM imaging represents an exciting and timely opportunity to pursue astrophysical programmes which will exploit the full diffraction limited resolution of both four and eight meter class telescopes.

Yours sincerely,

R. W. Wilson

C. Haniff

Dr. Richard Wilson
Dr. Chris Haniff