some checking of the validity of the users' co-ordinates was recommended and could save wasted observations. There was discussion about selection of filters for VST when it replaces WFI. Although Sloan bands are broader than Johnson ones they are not much used in globular cluster photometry. A few users asked if Stromgren filters could be provided for VST but generally the Johnson set was preferred. If Sloan filters are used, then good standards must be provided to allow transformation to the standard system.

At the end of the two days of the Workshop, the conclusion was that there are many exciting observing programmes waiting to be done with FLAMES and that the user community is waiting with anticipation for the data avalanche. The Workshop was informal in the sense that no published proceedings are foreseen. However, many speakers contributed printed versions of their presentations and a bound copy is available on request from jwalsh@eso.org.

# The Great Observatories Origins Deep Survey (GOODS)

*R. FOSBURY and the GOODS Co-Is at ESO/ST-ECF*
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## What is GOODS?

In the tradition of the Hubble Deep Fields (HDF-N and HDF-S), the Great Observatories Origins Deep Survey (GOODS) is designed to push the performance of major modern observational facilities to their sensitivity limits. GOODS unites the deepest observations from ground- and space-based facilities at many wavelengths, and was selected in late 2000 as one of six Legacy programs for the Space Infrared Telescope Facility (SIRTF: the fourth of NASA's Great Observatories after Hubble, Chandra and Compton). The Legacy program is meant to "...maximise the scientific utility of SIRTF by yielding an early and long-lasting scientific heritage… producing data that will enter the public domain immediately". Under the leadership of the PI, Mark Dickinson at ST ScI, the programme will map two fields with SIRTF, one Northern one Southern, exceeding a total of 300 square arcmin. GOODS will produce the deepest observations with the SIRTF IRAC instrument at 3.6–8 microns, and at 24 microns with the MIPS instrument pending on-orbit demonstration of instrument performance relative to SIRTF Guaranteed Time observations, which will also survey these same fields at 70 and 160 microns. The depth will be such that ordinary L* galaxies will be detected in their rest-frame near-infrared light out to a redshift of 4 or beyond. Luminous starburst galaxies and AGN – even the obscured 'type 2' objects – will be seen beyond the current record redshift of ~ 6 if any lie in the fields. At the longest wavelength (24 microns), the mid-IR emission from starburst galaxies will be seen to a redshift ~ 2.5 (see Fig. 1).

The two fields selected are already amongst the most intensively studied areas of the deep 'extragalactic' sky: HDF-N (around 12.6 hr RA and +62 deg Dec) and the southern Chandra Deep Field (CDF-S: around 3.5 hr RA and –28 deg Dec). Both areas have already been imaged with the Chandra X-ray satellite with an exposure time of one million seconds, the deepest X-ray observations ever. CDF-S has been extensively observed by ESO telescopes: fairly deep optical and near-infrared imaging (SUSI2, SOFI, WFI) has been secured as part of the EIS project and further observations are planned, while several VLT programmes targeting this field have been executed (FORS deep imaging and multi-object spectroscopy and ISAAC deep imaging and spectroscopy). All these ESO data are already public or will soon be so.

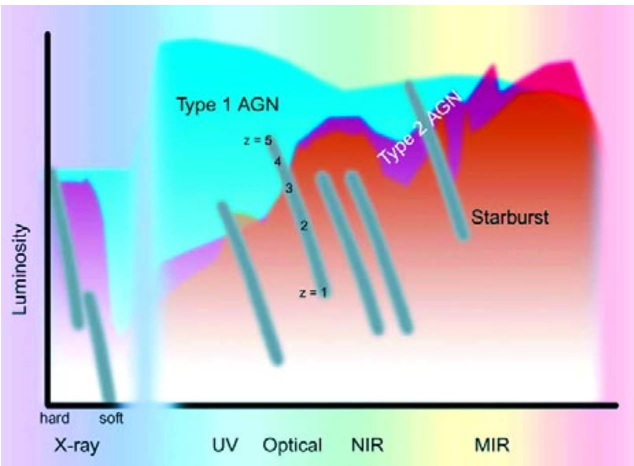


*Figure 1: A schematic SED for Type 1 and Type 2 AGN and starburst galaxies showing the expected sensitivity limits as a function of redshift in a selection of GOODS bands.*

In support of the SIRTF/GOODS programme, a wide range of other observations are being planned or have already been carried out which will, over the next four years, provide a public data-set covering the entire electromagnetic spectrum from X-ray to radio wavelengths at unprecedented depth. Ground-based telescopes, notably the VLT, Gemini-S and the CTIO 4-m for CDF-S, will be used to produce complementary imaging both at optical and near-infrared wavelengths. The principal role of the large telescopes, however, will be to provide follow-up spectroscopy with their new multi-object spectrographs. Time has already been allocated by ESO to begin a long-term programme using ISAAC for JHKs imaging of CDF-S. This requires some 32 pointings in each of the three filters (see Fig. 2). Some HST data are already available in these fields (most notably the HDF-N WFPC2 and NICMOS observations themselves), and new observations will be proposed for the new Advanced Camera for Surveys, scheduled to become available on HST early in 2002, for deep imaging in several filters to study galaxy morphology at a depth comparable to the HDF but over a much larger area.

To probe even higher energies than Chandra, XMM-Newton is currently being used to map the fields with its large effective collecting area and excellent spectral capabilities. The favourable K-correction and the superior high energy sensitivity of the new X-ray telescopes enables them to see most of the X-ray background as discrete sources. The combination of the spatial resolution of Chandra and the sensitivity and spectral response of XMM-Newton makes an extremely powerful diagnostic tool, even in the presence of heavy obscu-

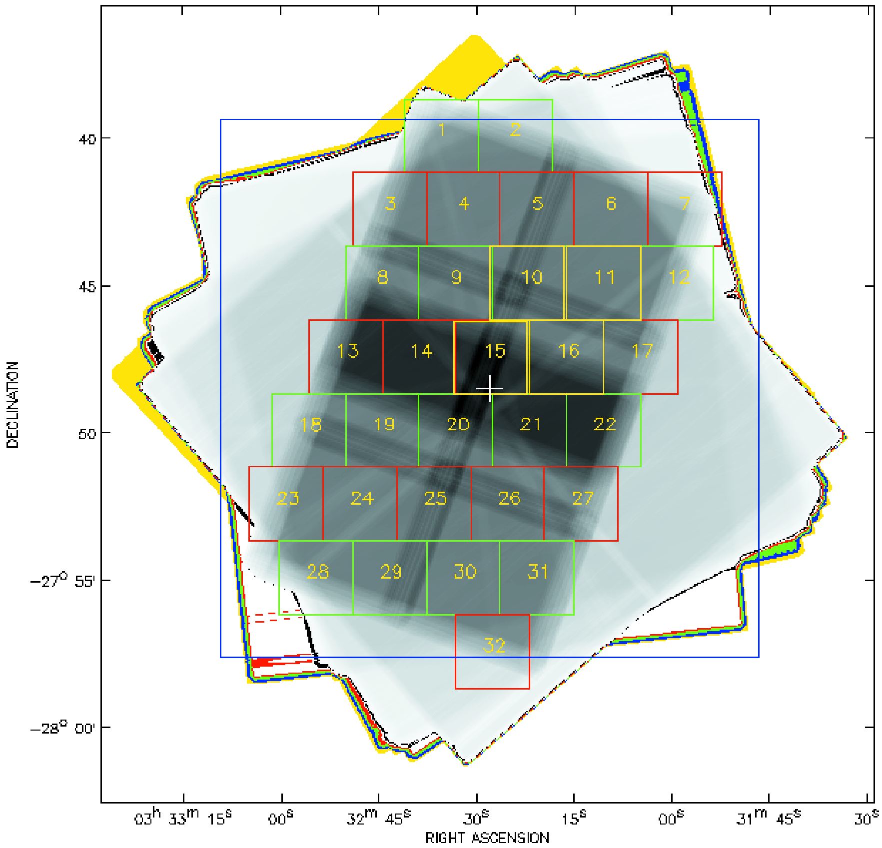


*Figure 2: CDF-S showing Chandra and SIRTF (IRAC) exposure maps (greyscale; outer rotated squares and inner rectangular area respectively), the EIS SOFI field (blue) and the proposed ISAAC JHKs pointings (red and green tiles). The four fields marked in yellow have already been observed with ISAAC (PI E. Giallongo) in J (~ 12 kiloseconds) and Ks (~ 30 kiloseconds) in ESO programmes 64.O-0643, 66.A-0572 and 68.A-0544.*

ration. At longer wavelengths, the fields will be mapped with bolometer arrays in the mm- and sub-mm bands. Deep radio surveys already exist and it is very likely that these will be pushed to even fainter limits over the next few years. In the future, it is clear that these fields will become prime targets for study with FIRST-Herschel, NGST and ALMA.

## What are the Scientific Goals?

The essential purpose of GOODS is to provide the most sensitive census of the distant Universe, making it possible to follow the mass assembly history of galaxies and the nature and distribution of their energetic output – from both stars and black holes – over a broad span of cosmic history. With SIRTF in the mid-infrared, the rest-frame near-IR light from evolved stars (which trace the baryonic mass) can be followed to high redshifts. The combination of mid-infrared and hard X-ray observations allows the use of their intrinsically isotropic radiation in these bands to find and identify essentially all of both the type 1 (unobscured) and type 2 AGN which fall in the GOODS fields (see Fig. 3). The GOODS database will be used to:

- Make reliable estimates of the stellar and dynamical mass of bright galaxies all the way to redshift ~ 5
- Measure the star-formation rates in complete samples of galaxies selected at all explored redshifts.
- Obtain detailed morphological information for all such galaxies, hence mapping the emergence of the Hubble sequence.
- Measure the relative role of stars and black-hole-powered AGN in the global energetics of the universe.
- Measure the contribution of individual sources to the extragalactic background radiation at all wavelengths.

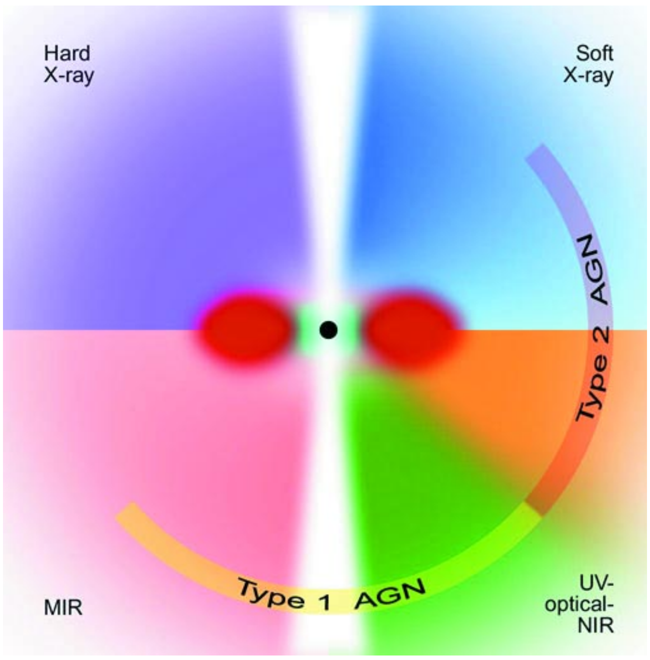


*Figure 3: A cartoon illustrating the radiation anisotropies of AGN in different wavebands produced by the obscuring torus and the Doppler-boosted jets.*

## Europe's Role

Approximately a quarter of the SIRTF/GOODS Co-Is are from European institutes, the largest participation in any SIRTF Legacy program. Their specific roles include the XMM-Newton observations, a significant involvement with planning, proposing and processing the HST observations and, especially, the planning, processing and prompt public distribution of the ESO observations. In addition to the planning and execution of the observations and the archiving of the data, it is clear that major efforts will go into data processing and scientific exploitation. All data will be in the public domain and it is clear that the scientific return will go to those teams that are organised to react quickly and efficiently to their availability. In order to give young European researchers the opportunity to benefit from this uniquely large and rich dataset, a proposal has been made to the European Commission by 15 institutions in 7 countries to set up a dedicated Research Training Network which, if funded, could support up to 336 person-months of (mostly) postdoctoral appointments of young people over the next four years.

### *Useful websites*

http://www.STScI.edu/science/goods/
http://sirtf.caltech.edu/
http://www.eso.org/goods/
http://www.eso.org/science/eis/eis_proj/deep/pointings.html
http://chandra.harvard.edu/photo/cycle1/cdfs/index.html
http://sci.esa.int/home/xmm-newton/