SIRTF Overview

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The Observatory

• **SIRTF:**
  - Background Limited Performance
    3 -- 180 \( \mu \)m
  - 85 cm f/12 Beryllium Telescope,
    T < 5.5K
  - 6.5 \( \mu \)m Diffraction Limit
  - New Generation Detector Arrays
  - Instrumental Capabilities
    - Imaging/Photometry, 3-180 \( \mu \)m
    - Spectroscopy, 5-40 \( \mu \)m
    - Spectrophotometry, 50-100 \( \mu \)m
  - Planetary Tracking, 1 arcsec/sec
  - >75% of observing time for the
    General Scientific Community
  - 2.5 yr Lifetime/5 yr Goal
  - Launch in Jan 2003
  - Solar Orbit

• Novel design allows for twice the lifetime with approx. 15-20% liquid Helium of ISO.
- SIRTF will eventually become a satellite of the Sun, trailing Earth. After 5 years SIRTF will be a considerable distance from Earth.
Pointing Constraints

- **Contiguous Viewing for 7 months+ per year**
- **Operational Pointing Zone (≈35%)**
- **Power Constrained Zone (25%)**
- **Sun Avoidance Zone (≈40%)**
• SIRTF instruments are VERY SENSITIVE!
LIMITING FLUX $F_\nu$ (mJy) vs. $\lambda$ (\(\mu\)m)

- SIRTF IMAGING
- SIRTF SPECTROSCOPY (R = 50)
- SIRTF SED MODE
- FUTURE GROUND, AIR (IMAGING)
- IRAS
- ISO
- 10 yr, 5MJ BROWN DWARF AT 10 pc
- DISK AROUND BETA PICTORIS x 10
- ULTRALUMINOUS GALAXY, Z = 7
- L* GALAXY, Z = 5

ALL FLUX LIMITS 1 $\sigma$ - 1 HR
(HIGH LATITUDE CONFUSION INCLUDED)

MWW (2/20/98)

APM -- Observer Support
• Only one instrument is in use at moment in time.
• Instruments are on for periods of 4-10 days (campaigns). Typically in the order IRAC-MIPS-IRS.
• Data is collected and downlinked to the ground every 12 hours. At the same time the spacecraft receives updated schedule information.
• During data taking periods the spacecraft is working autonomously for periods close to 12 hours (Periods of Autonomous Observations -- PAOs).
• With pointing reconstruction, images are expected to have a positional accuracy of approx. 1.4”.
• Each instrument has a set of Astronomical Observation Templates (AOTs) which have set modes of instrument use, including frame times (or scan rate in the case of MIPS SCAN).
• A particular requested use of an AOT is an Astronomical Observation Request (AOR). These are what is defined using the SPOT software -- includes information on target as well as AOT to use.
Basic Instrument Capabilities:
IRAC

- IRAC:
  - Allows imaging at 3.6, 4.5, 5.8 and 8µm over 5.’12 fields. Arrays 3.6/5.8µm and 4.5/8µm look at separate areas of the sky simultaneously (6.’5 apart).
  - Few discrete frame times available (2s to 200s).
  - Shorter frames available by using **High Dynamic Range** mode or **subarray** mode.
  - Resolution: approx. 2” (FWHM at 3.6µm).
  - *Sample point source sensitivity* -- 5µJy (1σ) in 200s at 5.8µm.
  - *Saturation*: max. unsaturated point source in 2s frame -- 0.2Jy at 3.6/4.5µm and 0.5Jy at 5.6/8µm.
IRAC Flight Unit

PICKOFF MIRROR

MIC ALIGNMENT PLATE

SHUTTER

TRANSMISSION CALIBRATOR

OPTICAL HOUSING

FPA1  FPA3
Basic Instrument Capabilities: IRS

- IRS
  - Capable of low- to moderate-resolution mid-infrared spectroscopy between.
  - Low-res 5.3-40µm spectroscopy (2 modules SL and LL).
    - R=62-124.
    - Sensitivity: 1σ of approx. 0.1mJy at 6-16µm and 0.4mJy from 14-40µm in 512 seconds of integration.
    - Slits 54.6”x3.6” at 6-14µm and 151.3”x9.7” at 14-40µm.
  - High-res 10.0-37.0µm spectroscopy (2 modules SH and LH).
    - R=600.
    - Sensitivity: approx. 8 times worse than for low-res modules.
    - Slits 11.8”x5.3” at 10-19.5µm and 22.4”x11.1” at 19.3-37.0µm.
  - Mapping mode available -- step along and parallel to the slits.
  - Discrete time frames available.
  - Peak-up facility available to allow accurate positioning of objects on a slit.
IRS on the MIC baseplate
Basic Instrument Capabilities: MIPS

- MIPS
  - Imaging [MIPS PHOT -- at 24, 70, and 160 µm]
    - Wide field imaging - 5x5 arcmin at 24,70 µm; 0.5x5 arcmin at 160 µm
    - Nyquist sampling achievable in all three bands [with 2.5x2.5 field at 70 µm]
  - Internal scan mirror allows mapping in all three bands simultaneously [MIPS SCAN]
  - Total power mode [MIPS TP -- deferred, not available in CP1].
  - Spectral Energy Distribution [MIPS SED] modes
    - SED mode provides resolving power ~15 from ~50-100µm
    - PSF ~ 20” at 70 µm and 45” at 160 µm.
MIPS Instrument Layout

Fig. 4 MIPS Optical Layout
Focal Plane Apertures

Field Radius = 16 arcmin

PCRS central array
- IRAC array
  - 3.6 & 5.8 μm
- IRS Hires slit
  - 10-20 μm
- IRS peakup
- IRS slit 5-15 μm
- IRS Hires slit
  - 20-40 μm
- IRAC 4.5 & 8.0 μm
- IRS slit
  - 15-40 μm
- PCRS roll array

MIPS 160 μm
MIPS 24 μm
MIPS 70 μm WF
MIPS 70 μm NF
MIPS slit 50-100 μm
MIPS slit 15-40 μm

APM -- Observer Support
First Year of SIRTF

Launch

- In-Orbit Checkout (60d)
- Science Verification (30d)
- First-Look Survey (100h)

EROs

- Guaranteed Time Observations (GTOs)
- Legacy Science Program

6 mo

- General Observer (GO) Investigations + DDT

12 mo
First Look Surveys

- Approx. 100 hours of time in 3 components -- extragalactic, galactic and ecliptic. Will take place at end of IOC/SV period. Meant to
  - Characterize the mid-IR sky as seen by SIRTF roughly 100 times deeper than previously seen.
  - Rapidly process data and make publicly available (available for archival research in Cycle 1).

- See [http://sirtf.caltech.edu/SSC/fls/](http://sirtf.caltech.edu/SSC/fls/)

- **Extragalactic** -- 5 square degrees with IRAC/MIPS imaging (1 minute/pixel). A smaller 0.25 square degree verification survey with 10 times the integration time/pixel also to take place. Area covered is low cirrus portion of the CVZ.

- **Galactic** -- IRAC/MIPS observations of two strips at different galactic longitudes (l=67.5 and l=285 degrees), latitudes -30 to 0. Plus long strip through the Chameleon II molecular cloud.

- **Ecliptic** -- IRAC/MIPS (24 microns) strips 5’ x 2 degrees between -5 and +5 ecliptic latitude. IRAC imaging done several times with time intervals that allow the detection of moving objects. Simultaneous ground-based optical data are also being planned.
Extragalactic FLS Survey Area
(overlayed on IRAS)
Galactic FLS

IRAC (left) and MIPS (right) First Look Survey Scans at l=272 degrees.
Ecliptic FLS

MIPS scan (red) and IRAC mapping (blue) for the Ecliptic plane
First Look Survey
EXTRAGALACTIC

• Mark Dickinson (STScI) & 40 Co-Investigators @ 13 institutions
  “GOODS: Great Observatories Origins Deep Survey”
  647 hours (IRAC, MIPS)

• Carol Lonsdale (IPAC/Caltech) & 21 Co-Is @ 9 institutions
  “SWIRE: SIRTF Wide-area Infrared Extragalactic Survey”
  851 hours (IRAC, MIPS)

• Robert Kennicutt (U. Arizona) & 14 Co-Is @ 7 institutions
  “SINGS: SIRTF Nearby Galaxies Survey”
  512 hours (IRAC, MIPS, IRS)

GALACTIC

• Ed Churchwell (U. Wisconsin) & 20 Co-Is @ 7 institutions
  “GLIMPSE: Galactic Legacy Infrared Mid-Plane Survey Extraordinaire”
  400 hours (IRAC)

• Neal Evans (U. Texas) & 10 Co-Is @ 8 institutions
  “From Molecular Cores to Planet-Forming Disks”
  400 hours (IRAC, MIPS, IRS)

• Michael Meyer (U. Arizona) & 18 Co-Is @ 12 institutions
  “FEPS: The Formation and Evolution of Planetary Systems”
  350 hours (IRAC, MIPS, IRS)
• Provide diagnostic templates for interpreting observations of objects in the distant universe
GTO/Legacy Extragalactic Surveys

The Journey Through Cosmic Time

- Dickinson
- Kennicutt
- Lonsdale

Distance (redshift)

Survey Area

APM -- Observer Support
• Origin and evolution of the Hubble Sequence (SIRTF + HST + spectroscopy)
• Evolution of the “red envelope”
  • Early-type galaxies at high redshift
  • Old stellar content of $z > 2$ galaxies
  • Discrimination between old vs. dusty EROs via mid-IR
• Identification and SEDs of objects at $z >> 5$
• [ ?????? ]

“J-dropout” object HDFN-JD1

... 3.6 to 24 μm ?
GLIMPSE Survey

Supernova Remnants Interacting with the ISM

New Globular Clusters

Embedded Regions of Massive Star Formation

APM -- Observer Support
Molecular Clouds (Legacy and GTOs)
From Active Accretion to Planetary Debris Disks

- Few My
- 10 My
- 100 My
- 5 Gy
Comparison of the spectrum of the young star HD100546 and that of comet Hale-Bopp in the mid-IR. The similarity in features indicates a possible bombardment of comets in the early stages of the disk forming around HD100546.

Crystalline forsterite

(Malfait et al 1998)
The first GO Call will be for 3700 hours of observing time on SIRTF.

GO requests are expected to enter the pool for scheduling at Launch + 9 months.

Observation planning and proposal submission are to be done using the SIRTF Planning Observation Tool (SPOT), extensively used later in the workshop.

To assist in observation planning please also see the following documents:
- Call for Proposals for GO-1 (released Nov. 8 2002)
- SIRTF Observer’s Manual v3.0 (released Nov. 8 2002)
- SIRTF Cookbook v1.0 (released on web only, Nov. 8 2002)

Proposal Submission: This is via the proposal submission tool available under SPOT. All elements of a proposal are submitted electronically via this tool to a SSC database.

It is a one step submission process -- this allows for quick turnaround and placement in our Science Operations Database (SODB) after program selection.

Observations to be performed are based precisely on the Astronomical Observation Requests (AORs) you provide with your submission.
Tracking Observations

- Tracking of observations can be done through the SSC website at
  
  http://sirtf.caltech.edu/SSC/approvedprog/

- The **Baseline Instrument Campaign** (what instruments are working on the observatory on any given date) will be provided on the web.
- Observer Support will also provide web pages with links to each week’s full schedule.
- The schedule is done dynamically and is typically completed 3 weeks in advance of observing date. The process is described more fully by Deborah Levine in the following presentation.
- Approved schedules are posted to the SSC website.
Final Products and Post-Pipeline Software

- The SSC will produce calibrated FITS files of data produced with all modes of operation of the science instruments using a set of dedicated pipelines that use the results of calibration observations made throughout an instrument campaign (4-10 days).

- Observers can expect to receive (at least) the following for each AOR (see instrument presentations):
  - raw frames
  - basic calibrated data frames (BCD frames)
  - image mask frames
  - quality analysis table
  - ensemble images (coaddition/mosaic of frames)

- Post-BCD software:
  - Point source extractor
  - Mosaicker/coadder
  - Bandmerger