EXIST IRT Camera and Spectrometer

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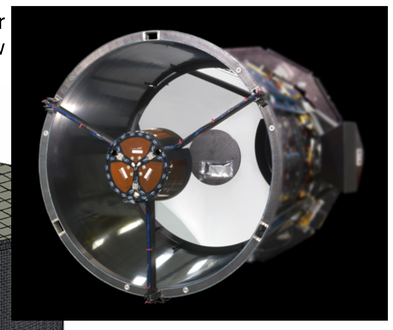
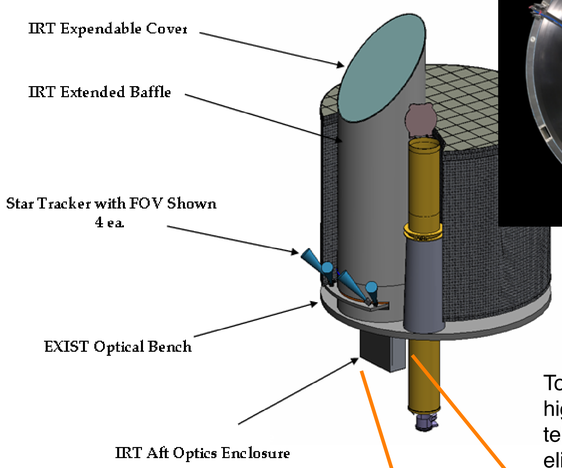
The EXIST mission includes a 1.1m infrared and visible telescope which provides the capability to locate, identify, and obtain spectra of GRB afterglows at redshifts up to z~20. To allow rapid identification and spectroscopic follow up, the instruments will provide wide band imaging, covering the full error circle of the Gamma Ray Telescope (GRT), low spectral resolution slitless spectroscopy, and high resolution spectrometer. The high resolution long slit spectrometer will allow to obtain single object high resolution spectrum with spatial resolution along the slit. The instrumentation capabilities will allow this telescope quickly identify the afterglow, measure its brightness curves, redshift, measure spectral characteristics of the GRBs and measure absorption spectra of the intervening intergalactic medium. With this instrument, high redshift GRBs become important tools for observing the processes through which the universe is ionized.

IR telescope - part of EXIST observatory

IRT - Infra-Red Telescope has both imaging a spectroscopic capabilities that cover a broad spectral range from 0.3 um to 2.2 um. The instrument has four channels that allow it to do simultaneous broad band photometry. Low resolution objective prism mode is used for GRB afterglow identification and highest possible redshift measurements. High res mode is for brighter aftrerglow, chemical evolution study and other transient objects that require measurements of narrow spectral lines.

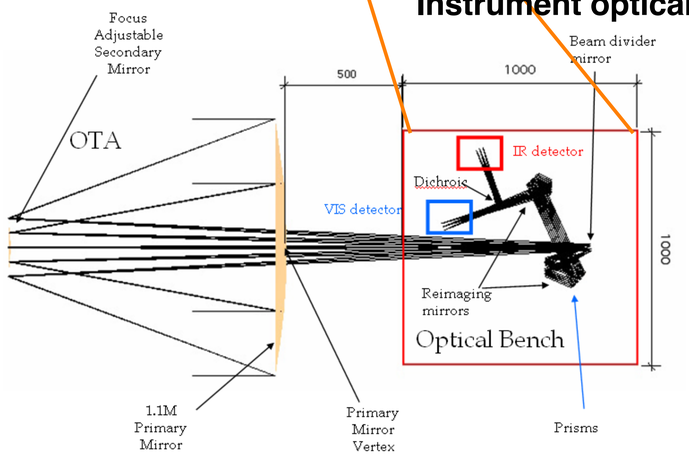




Baffle

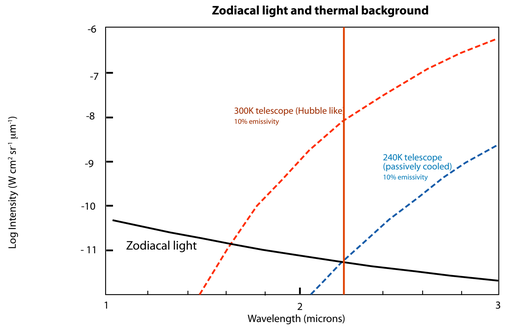
To expand the viewing area with the highest possible sensitivity the telescope baffle is designed to eliminate or greatly reduce the scattered light from the sun and earth limb.

Instrument optical layout



Thermal background

The telescope operating temperature is defined by the thermal background produced by the mirrors emission. To achieve the required background (zodiacal light) limited performance of the instrument the telescope needs to be cooled down to ~240K.



IRT instrument: imager-spectrometer

- spectral coverage: 0.3 um to 2.2 um
- cryo-cooled
- four channels: 2 VIS (0.3 to 0.9 um) and 2 IR (0.9 um to 2.2 um)

Each channel has:
- imaging FOV 3.75' x 4.25'
- low resolution objective prism spectroscopy 0.75' x 3.75'
- high resolution (R~3000) single slit spectrometer

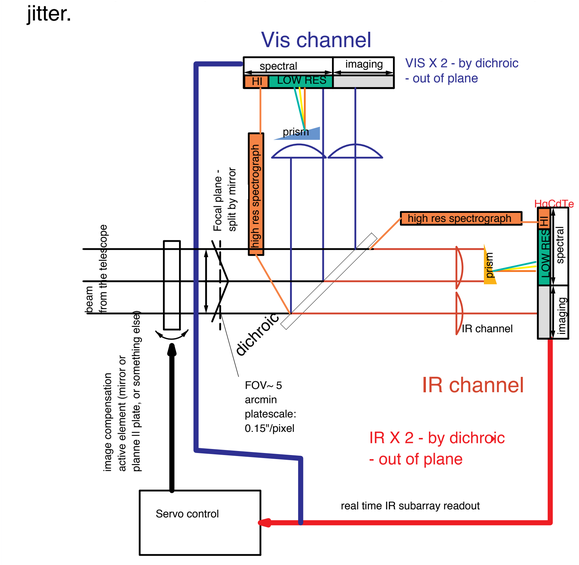
Detectors:
- IR - two HIIRG detectors, VIS: two HyVisi detectors

Plate scale: 0.15" pix

Bands: 0.41 um (0.3 - 0.52), 0.71 um (0.52-0.9), 1.14 um (0.9-1.38) and 1.71 um (1.38 -2.2).

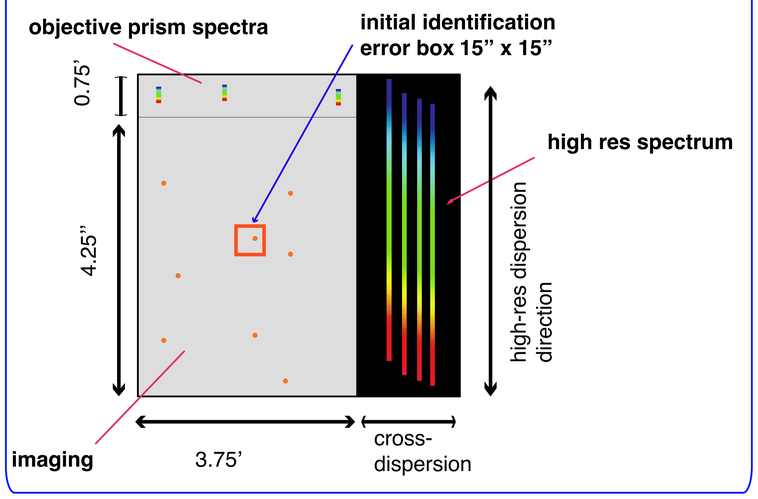
IRT instrument block diagram.

There are 4 channels in the instrument: 2 visible and 2 infrared. These four photometric/spectral channels cover spectral range from 0.3 um to 2.2 um. The telescope field of view is divided between the imaging and spectral channels. Depending on the operation mode, the object can be placed in the imaging part for rapid photometry or in the low resolution part of the field for spectrophotometric measurements or in the high resolution (single slit) spectrometer. The diagram below shows the overall instrument layout. The same detectors, that are used for scientific data acquisition are used for fast guiding to compensate for the residual instabilities and jitter in the observatory pointing. A fast (5 Hz) servo loop with a tip-tilt mirror allows to compensate up to 6″ drift and jitter.



IRT instrument field of view

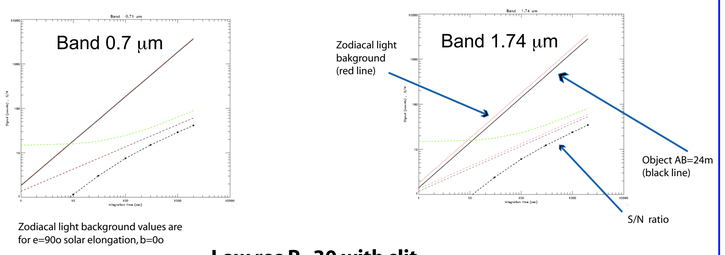
Each of the 4 instrument channels is split in three subfields: 1- imaging, 2 - objective prism spectra, 3 - high resolution spectroscopy. Imaging area occupies most of the field of view. It is used for initial identification of transient events and for the follow-up photometry. Four instrument photometric channels will allow crude estimate of the redshift and to identify the dropouts by this initial photometry. The field of view is divided in three regions: imaging area that covers most of the detector, low resolution slitless spectroscopy area and single slit high resolution (R=3000) area that occupies approximately a quarter of the detector.



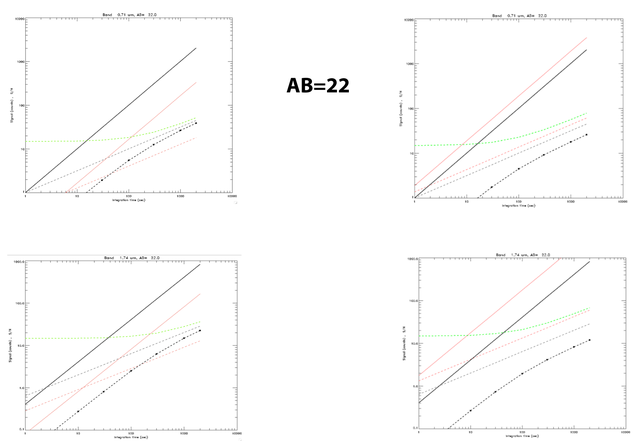
Goals of IR/Vis Imager-Spectrometer

- Accurate redshift of GRBs
- Maximum sensitivity
- Adequate spectral resolution for z determination
- spectral resolution R~30 for slitless spectroscopy
- Localization of the event for follow up
- Robust process/design for rapid event ID
- High res spectroscopy for bright object follow up, ancillary GRB, AGN, other science
- R ~ 3000 single slit cross - dispersed spectrometer
- Imaging photometry for deep light curves

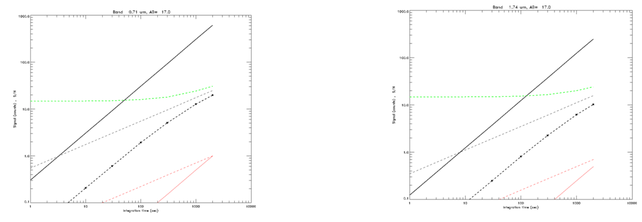
Imaging S/N AB=24



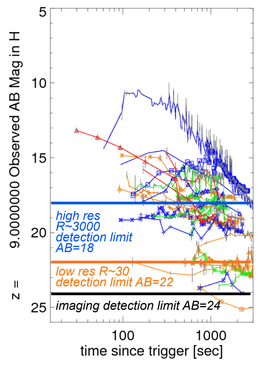
Low res R=30 with slit



High-res spectroscopy R=6000 AB=17



Expected GRBs lightcurve at z=9



The afterglow from virtually all of the observed GRBs in H and K bands when redshifted to z=9 will be detected. Low res spectroscopy will allow to measure redshifts for the entire sample.
High resolution spectroscopy on the brightest half of the sample will enable measurement of damped L-alpha to constrain patchy reionization.