The GTC photometric calibration programme

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GTC Project

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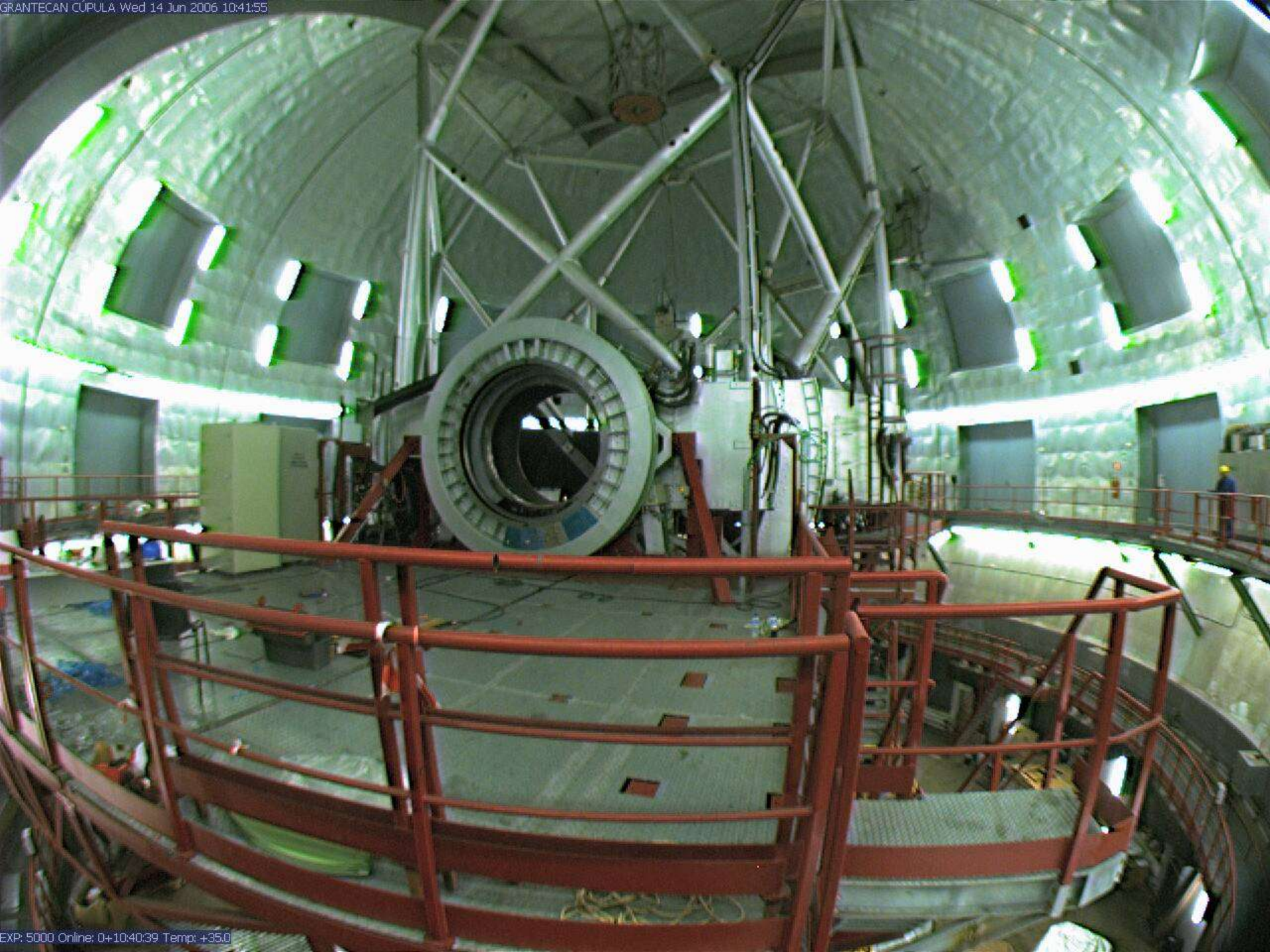
Summary

- Why is calibration important for 10m Class telescopes
- What are the problems with the current standards
- What are we doing for the GTC

Panoramic views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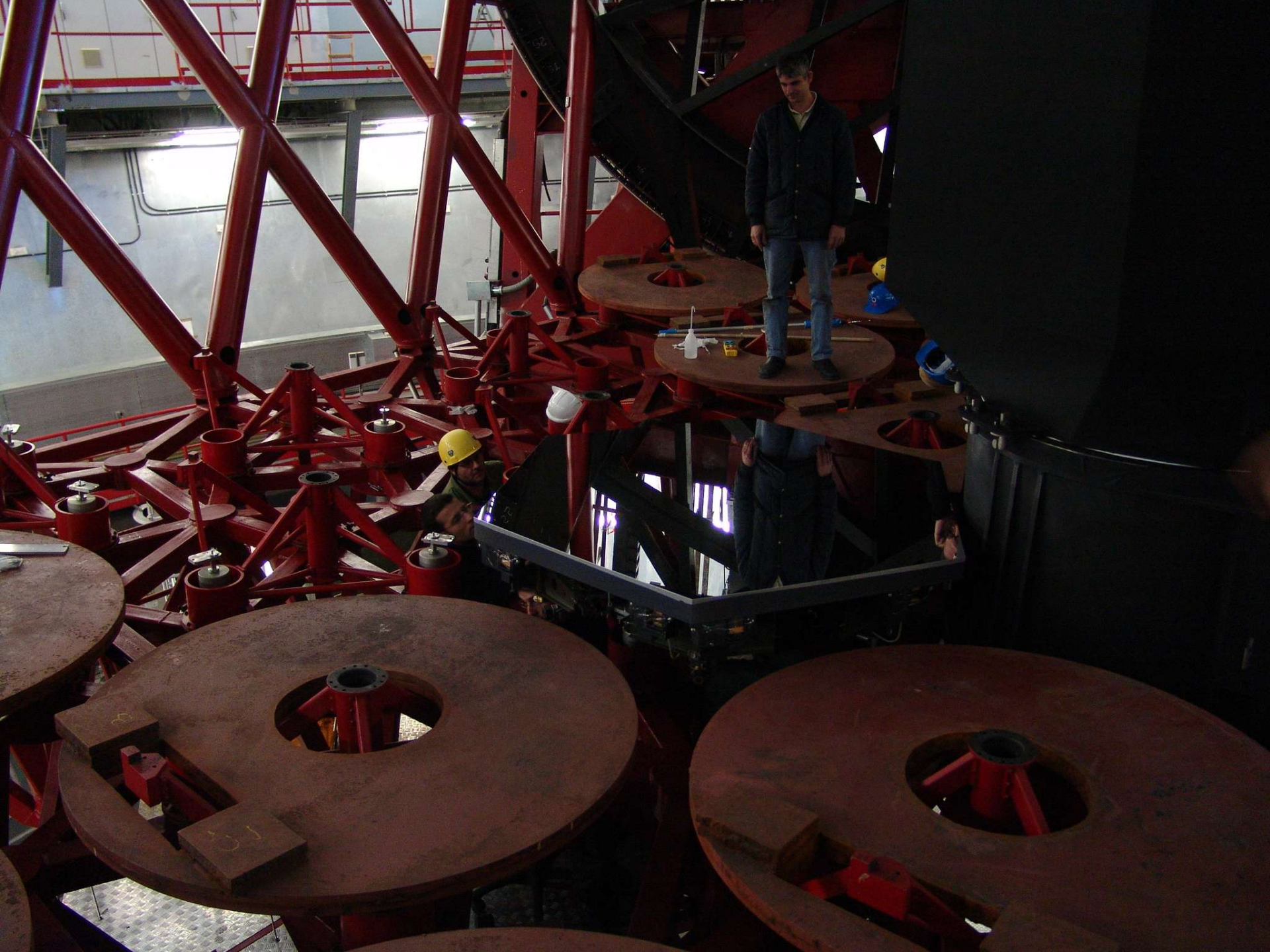
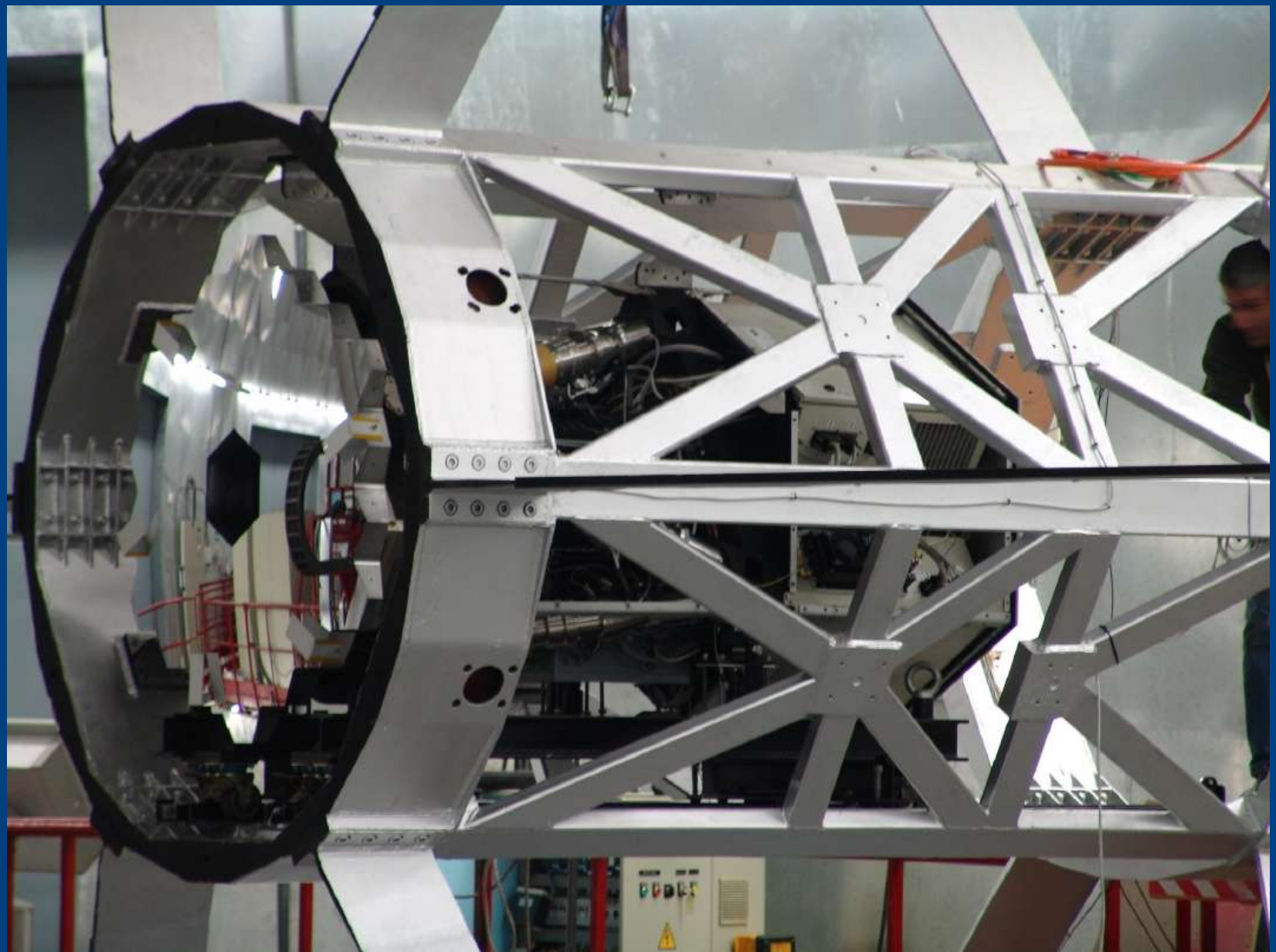


M2 in its socket



Why is a good calibration important for large telescopes?

- Comparing results with other telescopes/surveys
- It is important that also large telescopes, like the GTC, provide accurate calibrations
- The increased importance of Archives requires that the data can be properly referred to bona fide standards

Fundamental problems when Calibrating large Telescopes

- Most common standards are on the equator.
- Current standards were adequate for 4m class telescopes, i.e., too bright for large telescopes
  - Saturation: 12th mag. in 1 second (400nm to 2.5 microns)
- Instruments on large telescopes carry a wide range of filters to be calibrated, from the optical to the mid IR, including tuneable filters
- Cost of observing time.

GTC Science Instruments

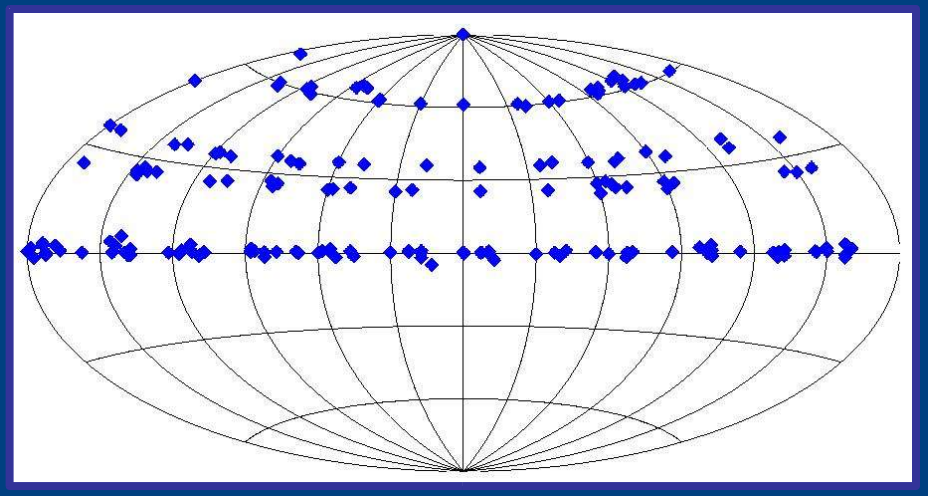
- First Light facility instruments
  - OSIRIS: Wide FoV Tuneable filter imaging & low-resolution MOS
  - CANARICAM: Imaging, Spectroscopy, Coronagraphy and Polarimetry in the thermal IR
  - ELMER, a high throughput optical imager/spectrograph
- Second Generation Science Instruments
  - EMIR: Wide field cryogenic Multi-Object near IR spectrograph
  - FRIDA: AO IFU imager/spectrometer
- Visiting Instruments
  - CIRCE: Versatile near IR camera with spectroscopic & polarimetric capabilities

The GTC Calibration Approach for the visible & near IR

- The requirements:
  - Calibration Fields, not single objects
  - Zero Points accuracy 0.01 mag in all filters
  - Zero Points changes from field to field less than 0.005 mag for all filters
  - Linearity errors under 0.01 mag for up to magnitudes in excess of mag 20
  - Colour errors less than 0.015 mag

The Calibration fields

- About 30 Fields (from 180 pre-selected) from the equator to the North pole
- Each field about 10x10 arc minutes
- Stars in the range 12 to 17 magnitude
- Obtain the SEDs of several stars in each field



Data obtained

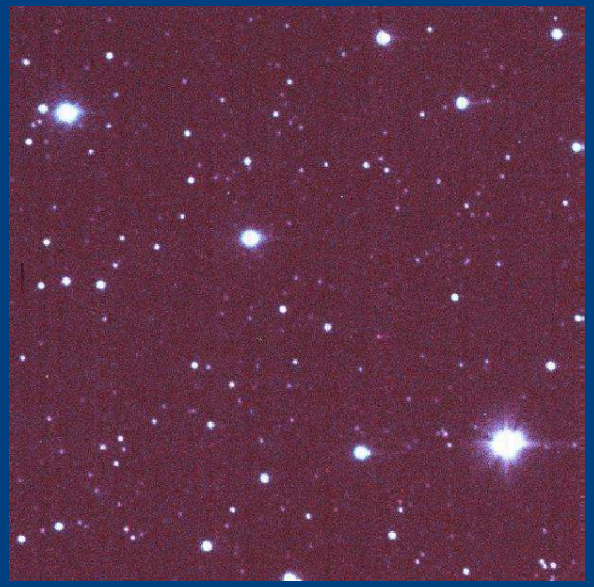
B V R I J H K CCD & NIR multi-epoch photometry

- Over 3 years of visible & IR photometry so far
- Determination of Landolt apparent magnitudes as well as the rest of the stars in the fields
- Automatic rejection of variable stars

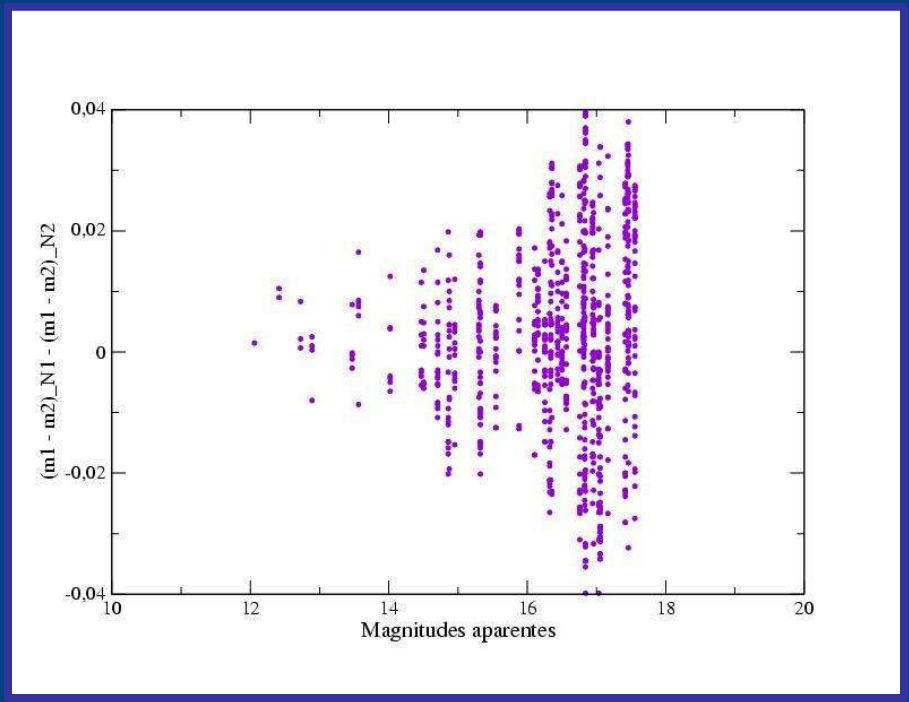
$$\left(m_1 - m_2\right)_{NI} - \left(m_1 - m_2\right)_{Ni} = Err_i$$

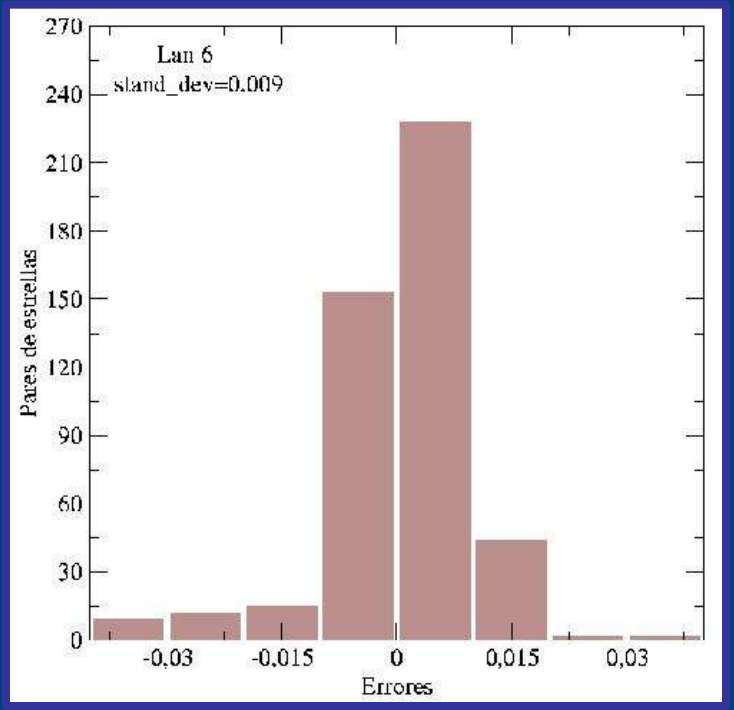
Relative error for each of the stars in a given field i

Lan6



Some results





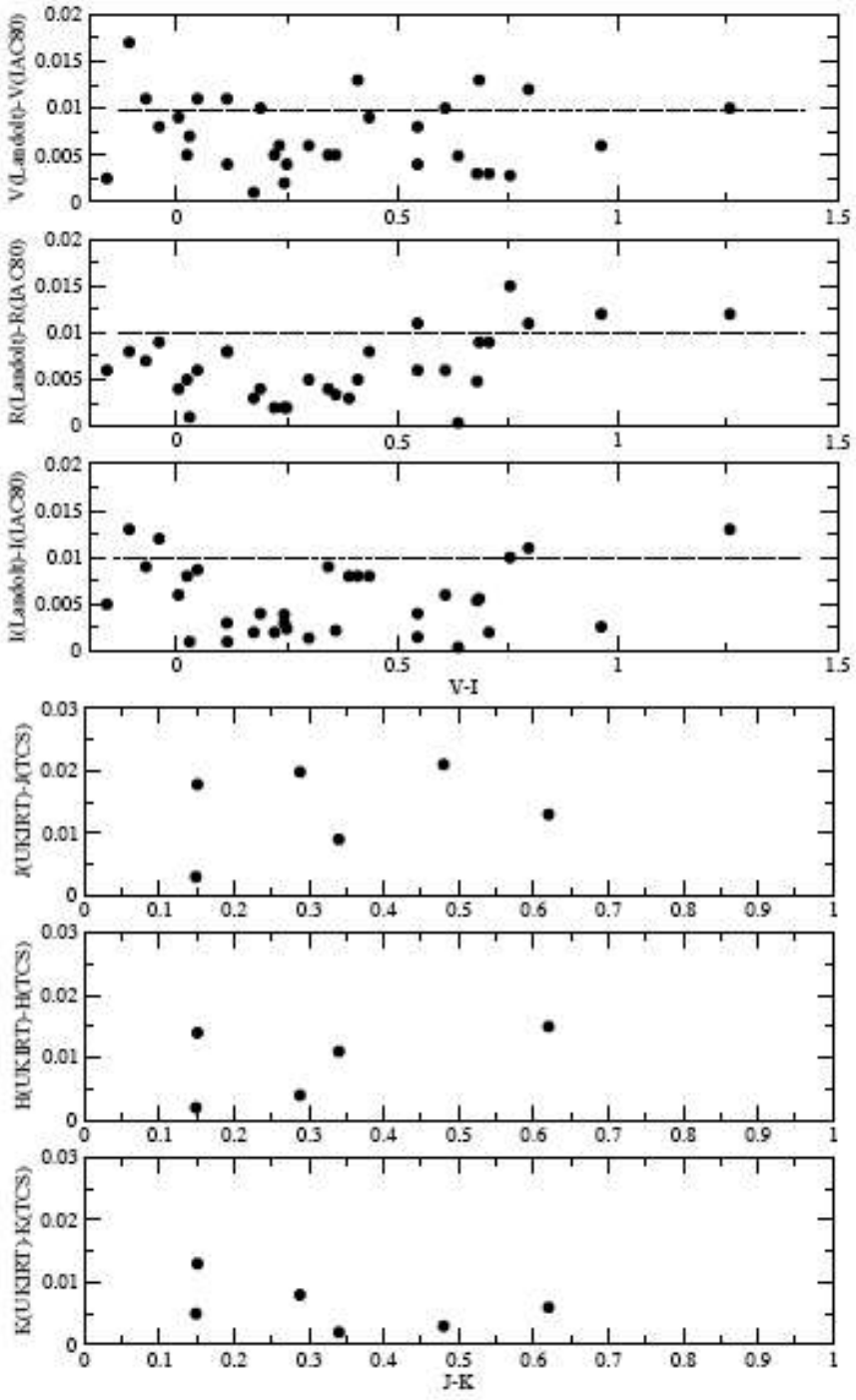
For 465 pairs of stars

σ: 0.009mag

Typical photometric errors

- Errors for four typical fields in the visible
- These can still be improved as more data are gathered

Field	RA	DEC	Err(V)	Err(R)	Err(I)
Field 1	20:40:13	+60:39:36	0.013	0.010	0.016
Field 2	16:59:38	+36:37:14	0.012	0.015	0.017
Field 3	14:31:44	+60:43:19	0.011	0.010	0.009
Field 4	22:30:24	+25:32:12	0.017	0.014	0.011



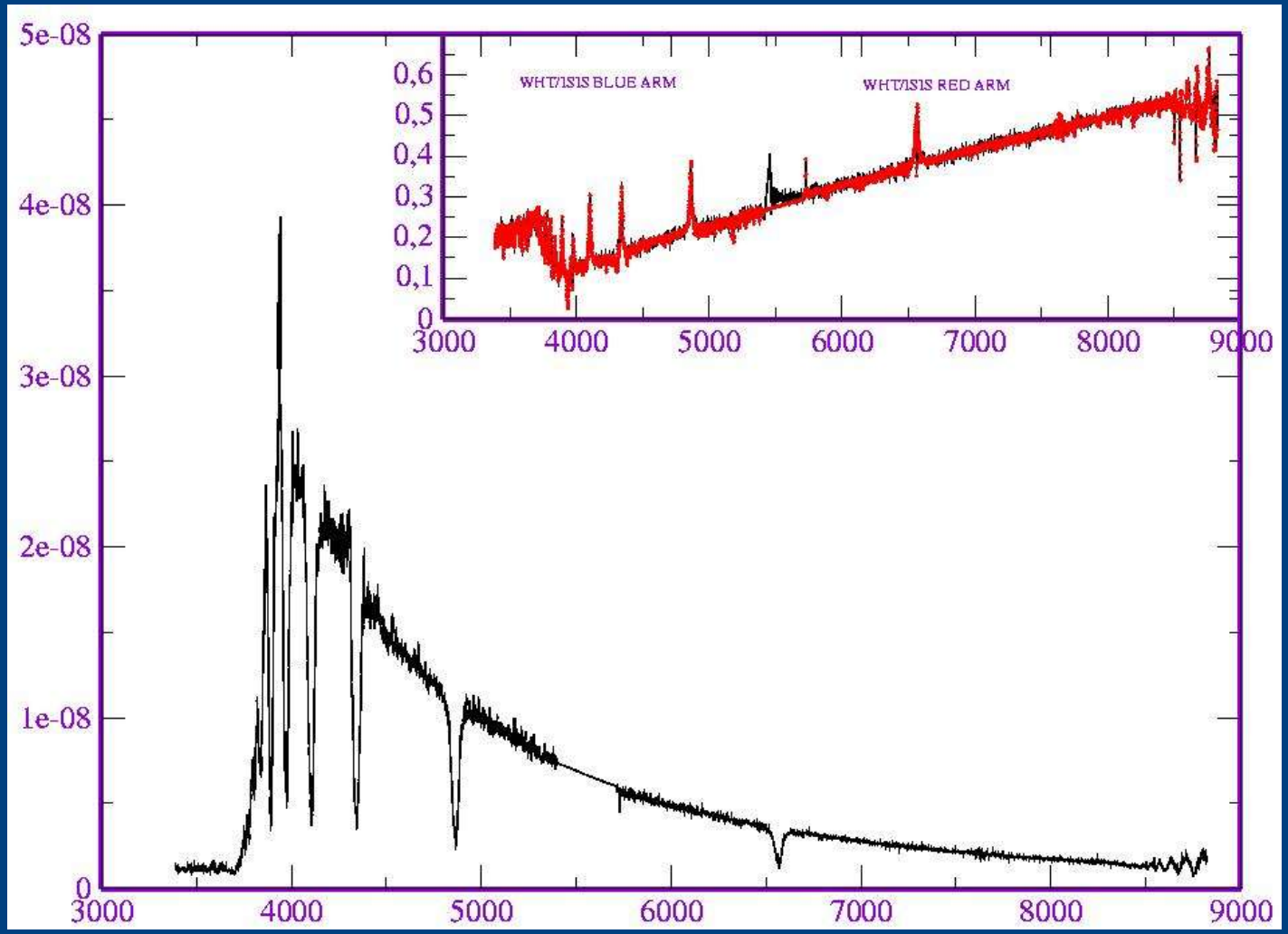
Photometric cross check

Landolt & UKIRT in relation to our IAC photometry

Spectral data

- Visible spectra of selected sources from the photometric fields
- Develop SEDs for the stellar shapes + photometry
- Look in detail at
  - Zero points
  - Non linearity effects
  - Other systematic effects
- Near IR spectra (still pending)
- A similar programme has been undertaken for the Mid IR by F. Martín Luis (Ph. D. Thesis)

Spectral shape from an ISIS spectra



The method

- Very much following the approach taken by Cohen & Hamersley to calibrate the ISO data (Hammersley et al. A&A 1998)
- Spectral templates are built, assuming that the spectral SEDs are determined from the spectral type and luminosity class, then the flux density level is set by the actual photometry
- The spectral templates are then multiplied by the total instrument transmission for each filter, thus obtaining in band absolute flux calibrated magnitudes

Summary

- A Catalogue of optical and NIR Standard star fields is being produced for the GTC
  - Special attention is paid to ZP accuracies and other systematic errors
- Together, the photometry plus the spectral templates yield an absolute calibration for any of the various filters of the GTC instruments
- We expect to have a usable calibration data base by first light