T0007 : The Final CFHTLS Release

Patrick Hudelot, Yuliana Goranova, Yannick Mellier,
Henry Joy McCracken, Frédéric Magnard,
Mathias Monnerville, Gregory Sémah
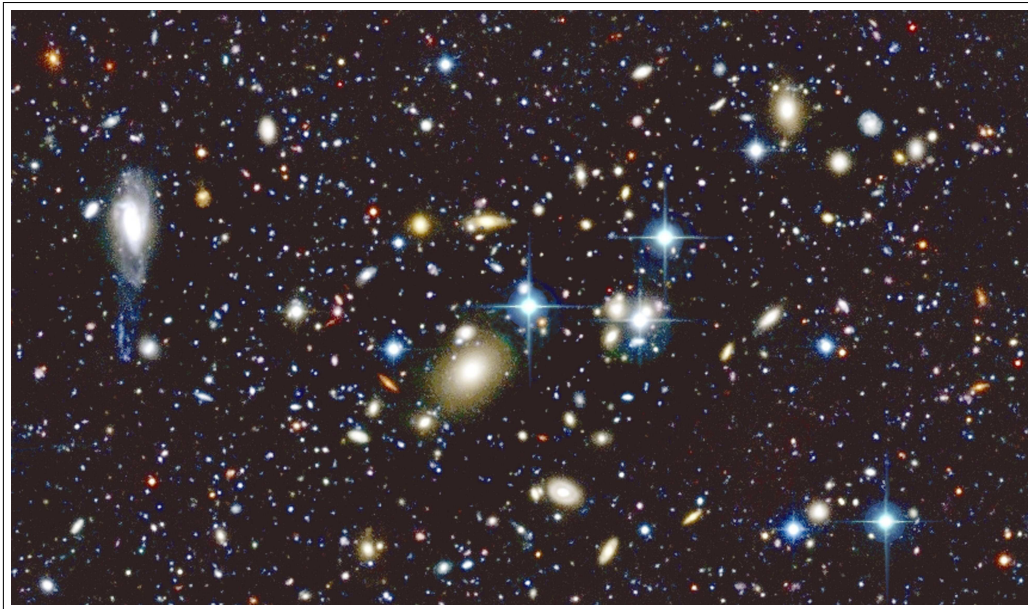**Terapix / Institut d'Astrophysique de Paris**

Jean-Charles Cuillandre, Kanoa Withington
Canada-France-Hawaii Telescope Corporation

Nicolas Regnault, Marc Betoule
LPNHE, CNRS-IN2P3 and Universités Paris 6 & 7

Mathias Schultheis
Observatoire de Besançon

Hervé Aussel
AIM CEA CNRS, Saclay

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1 CFHTLS-T0007 Executive Summary

This document describes T0007, the 7th and final release of the Canada-France-Hawaii Telescope Legacy Survey CFHTLS[1], produced by Terapix[2] based on a data set collected with MegaCam[3] on the CFHT. CFHTLS-T0007 is a deep sub-arcsecond (0.8″) wide-field (157 deg^2 total) optical survey (u^*, g, r, i, z bands) providing a high quality and homogeneous data set precisely calibrated photometrically (1.0%) and astrometrically (0.028″). This final release is directly public, open to the worldwide community.

CFHTLS-T0007 has two components: 1) the "CFHTLS Deep", four independent 1 deg^2 MegaCam ultra deep pointings, reaching a 80% completeness limit in AB of u^*=26.3, g=26.0, r=25.6, i=25.4, z=25.0 for point sources, and 2) the "CFHTLS Wide" made of 171 MegaCam deep pointings which, due to overlaps between adjacent fields consists of a total of ∼ 155 deg^2 in four independent contiguous patches, reaching a 80% completeness limit in AB of u^*=25.2, g=25.5, r=25.0, i=24.8, z=23.9 for point sources. The sky location of these fields is shown in Figure 1. This final release of the CFHTLS greatly benefits from vastly improved flat-fielding and photometric calibration techniques developed by the Supernova Legacy Survey (SNLS) team in collaboration with the CFHT. These new recipes significantly improve the precision of our photometric calibration compared to previous releases.

T0007 is derived from a parent sample comprising all validated images taken during the survey between May 26, 2003 and Feb. 02, 2009 and delivered by the CFHT pre-processing pipeline Elixir[4]. In addition, this release contains DDT (CFHT Director's Discretionary Time) observations targeted to fill missing half-CCDs caused by malfunctioning detectors over the course of five months in 2003. All science stacks have been visually inspected; quality control information is available for each of them.

Observations were made in u^*, g, r, z and either i or y filters (y is the Terapix designation for the replacement i-band filter, also known as $i2$ at CFHT). Stacks are provided as MegaCam-size FITS images each covering 1 deg^2 with 0.186″pixels. Each tile is located at each pre-defined center position listed in Table 31 for the Wide survey and Table 17 for the Deep survey. In addition, the Deep survey contains two sets of stacks, those comprising the 85% best-seeing images (D85) and those comprising the 25% best seeing images (D25). In total there are 48 Deep stacks corresponding to u^*, g, r, i, y and z bands, 12 for each field. There are 855 Wide stacks, in u^*, g, r, i, y and z bands or 360, 125, 245, 125 for W1−4. Over the 171 fields of the Wide, 141 are covered in i-band and 30 in y-band. The total volume of the T0007 release (stacks and catalogs) amounts to nearly 9 terabytes.

The internal astrometric errors of the stacks are between 1/15 and 1/3 of pixel, in x and y. The external astrometric errors are between 0.20″ and 0.27″ and are limited by the reference catalogue accuracy. The astrometric offsets between the CFHTLS and the astrometric reference catalogue are negligible. They are smaller than ±1/10 of pixel in both axes and for all fields. Photometric errors have been estimated for all stacks using several independent methods. Based on external photometric comparisons with the SDSS, we find that our absolute photometric accuracy in the AB standard as well as the internal photometric homogeneity over the entire survey is at the 1.0% level or better in the g, r, i bands, 1.5% level in the z band, and 2% level in the u^* band.

Catalogues have been produced for each stack using a g-r-i selected "chi2" as a detection image and an associated mask. These data sets are complemented by a series of *merged catalogues* that combine information for each source in all filters into one file in addition to many different types of quality control data (tables, plots, figures). Merged catalogues for each of the four Deep fields and each of the four Wide

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[1] http://www.cfht.hawaii.edu/Science/CFHTLS/
[2] http://terapix.iap.fr/
[3] http://www.cfht.hawaii.edu/Instruments/Imaging/MegaPrime/
[4] http://www.cfht.hawaii.edu/Instruments/Elixir/

patches are provided. Sources from overlapping tiles have been dealt with correctly and the parent tile information is recorded for each source. Aperture magnitudes, total magnitudes, and variable-aperture magnitudes (based on the image quality for each tile) are provided for each source.

For a concise overview of the survey, the reader should consult Tables 6, 18 and 19. These tables provide all basic data on the survey coverage, seeing, exposure times, depth and completeness, astrometric and photometric errors. This release document is complemented by practical information at the Terapix T0007 release page and the T0007 "synoptic table"[5]. All data sets are available worldwide directly from both Terapix and the Canadian Astronomy Data Centre (CADC). In addition, searchable catalogues are made available at the Centre de Données astronomiques de Strasbourg (CDS) through VizieR while the entire survey can now be explored visually through the Aladin sky atlas in the HEALPix format.

For users who prefer to produce their own stacks using the individual Elixir images, which are available at CADC along with their new weight-map produced by Terapix, a complete set of T0007 configuration files are listed in the Appendix A.2. In addition, a list of all images used in each Wide stack is given in Table 32. Weight maps and astrometric solution files are also provided for each individual image.

All T0007 data products are immediately available worldwide along with the photometric redshifts which are released simultaneously (Ilbert et al. 2012).

For further information, the Terapix team can be contacted at `terapix@iap.fr`.

CFHT, with support from CEA, has provided outstanding MegaPrime/MegaCam support, ensuring the steady collection of data of uniform quality through CFHT's Queued Service Observing. CFHT provided data pre-processing and calibration (Elixir) and distribution (DADS). Overall survey integrity has been ensured by the CFHTLS Steering Group and oversight by the CFHT Science Advisory Committee. Data have been archived and distributed by CADC. It is important to acknowledge this collective effort in all works using the CFHTLS data. Following recommendations of the CFHT Executive Director and the CFHT Board of Directors, the following acknowledgement should be part of any publication using CFHTLS data:

"*Based on observations obtained with MegaPrime/MegaCam, a joint project of CFHT and CEA/DAPNIA, at the Canada-France-Hawaii Telescope (CFHT) which is operated by the National Research Council (NRC) of Canada, the Institut National des Sciences de l'Univers of the Centre National de la Recherche Scientifique (CNRS) of France, and the University of Hawaii. This work is based in part on data products produced at Terapix and the Canadian Astronomy Data Centre as part of the Canada-France-Hawaii Telescope Legacy Survey, a collaborative project of NRC and CNRS.*"[6]

2 Key new features in T0007

The main goal of the T0007 release versus the T0006 release was to improve the absolute and internal photometric calibration of the survey. This has been done by applying recipes adopted by the Supernova Legacy Survey (SNLS) for the SNLS/Deep fields to both the Deep and Wide fields of the CFHTLS. These recipes were used to generate a new set of photometric flat-fields (known as "Elixir B5/SNLS") which have been used to run a new pre-processing by Elixir at CFHT on the entire CFHTLS raw data set. Consequently, all individual weight-maps and object catalogues have been re-generated at Terapix for T0007.

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[5] `http://terapix.iap.fr/cplt/T0007/table_syn_T0007.html`
[6] `http://www.cfht.hawaii.edu/Science/CFHTLS/cfhtlspublitext.html`
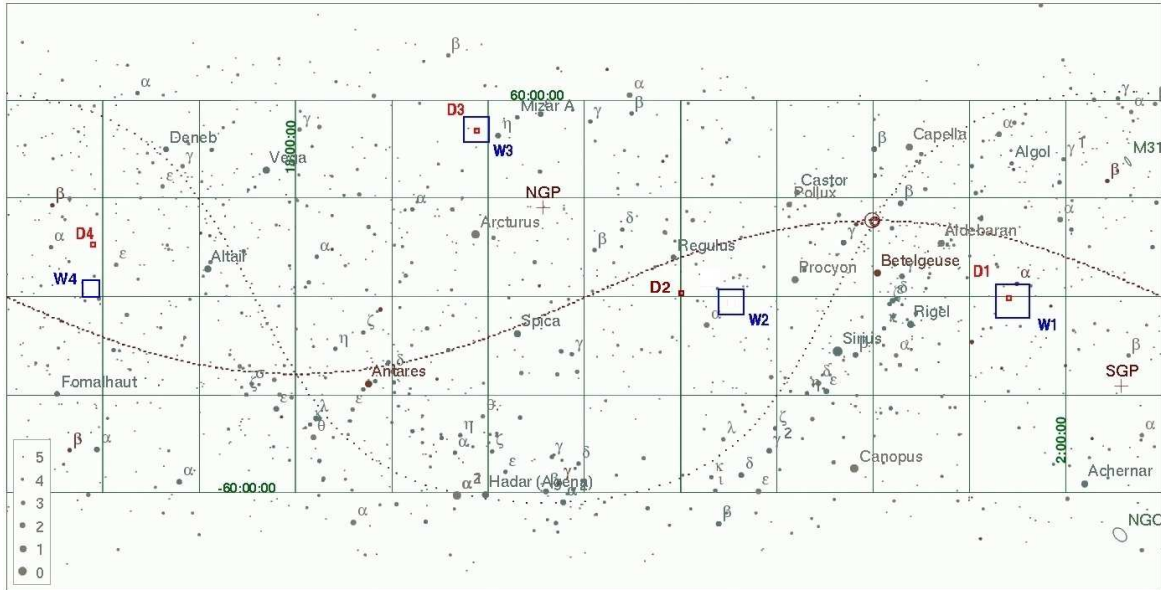
Figure 1: Location of the four Deep and four Wide CFHTLS fields on the sky.

A new series of shallow photometric calibration observations (a MegaCam program called "L99") were made in photometric conditions towards the end of the CFHTLS survey. These observations pave in each filter the whole of the CFHTLS Wide within a short time window and are bracketed by observations of the SNLS tertiary standards on the Deep survey fields. These observations allowed the SNLS tertiary standards to be transfered to both the Deep and Wide surveys. This brings the absolute and relative photometric calibration over the entire survey at the 1% level or better in the g, r, i bands, 1.5% in the z band, and at the 2% level in the u^* band.

Several other key aspects of the processing have been revised and improved for T0007:

- A robust system is now used to correctly flag saturated objects at all stages of the processing;

- For the Deep fields, two sets of stacks are now provided, one generated using a sigma-clipped combination algorithm (leading to a slightly higher signal-to-noise) and one using the standard median combination;

- In the merged catalogues, object flags have been revised to provide object classification (star/galaxy), saturation, and masking in all bands;

- An effective seeing-scaled aperture magnitude, `MAG_IQ20`, is introduced, although `MAG_AUTO` magnitudes remain the best estimate for extended sources, i.e. not seeing dominated profiles;

- For each of the four Wide patches, merged catalogues have been generated and contain unique sources (overlapping objects from adjacent tiles are correctly dealt with);

- The CFHTLS catalogue data products are made available for the first time at the Centre de Données astronomiques de Strasbourg (CDS) through VizieR, while the entire survey can now be explored visually through the Aladin sky atlas in the HEALPix format;

Taken together, these changes represent a significant improvement in the scientific potential of the world-wide release T0007 (2012) compared to the six previous Terapix releases (2004-2009).