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DOCUMENT

Astrometry correction for observations affected by a thermoelastic drift

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Table of Contents

1 INTRODUCTION

This document presents the analysis of observations performed in the so-called 'warm' attitude range, which introduces a degradation of the pointing performance, and the script created to correct for that effect.

2 DESCRIPTION

2.1 Rationale

Observations performed at the end of the Solar Aspect Angle (SAA) range (the so-called 'warm' attitude range, with SAA in the 110° to 119°.2 interval) can present a degradation of the pointing performance due to thermoelastic effects. These include a larger APE and a pointing drift. From the definition of the spacecraft reference axes, these pointing drifts are expected to be mainly detected in the spacecraft Z-axis (see Sánchez-Portal et al. 2014). One of the problems is that the thermoelastic-induced offsets do not respond immediately to the variations of SAA, but present some delay due to the heating-cooling times of the Service Module (SVM) and structures connecting it to the Payload Module (PLM).

Therefore, we would expect that the pointing offsets do not correlate directly with the SAA, but instead with the temperature of the SVM. In order to test this hypothesis, we have performed a study on this effect by calculating the Z-axis offset for a set of pointing calibration observations (we chose these observations since the targets are true point sources with very accurate astrometry) as a function of the temperature of a passive component of the SVM. Since the backup star tracker (STR2) was switched-off for the whole mission with the exception of a few Operational Days, the temperature sensors mounted in its structure (baseplate and baffles) measure a mostly passive element. In fact, the time variation of the temperature recorded by these sensors responds to the variations of SAA, with clear and uniform delay ramps that were precisely what we wanted to find. When plotting the pointing offsets vs. temperature, we found that while for STR2 temperatures below -15C the median offset presents a certain scatter around zero, for higher temperatures the behaviour of the Z-axis offset diverges. We have derived a linear correlation between the STR2 temperature and the Z-axis that aims at correcting the effect of such a thermoelastic drift.

We have developed a script aimed at correcting the astrometry offset produced by the thermoelastic effect. This should be applied to improve the pointing for observations performed at the 'warm' attitude range (STR2 temperature >-15C). As a test, we have applied the script to a set of calibration observations and checked that the general pointing is improved. The left panel on plot below shows the linear correlation between the STR2 temperature and the Z-axis used to correct this effect. The right panel presents the Z offset distribution before (green) and after (purple) applying the correction, the latter showing an improvement of the APE+ with respect to the original.

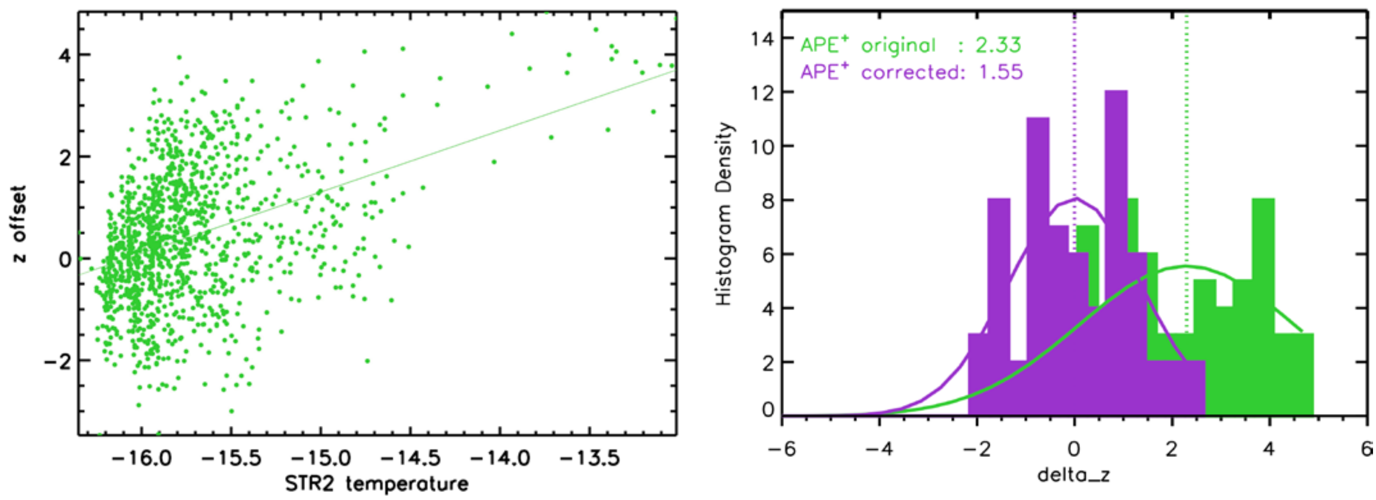

Fig.1. Left panel: STR2 temperature vs Z-axis offset distribution and its linear correlation. Right panel: Z offset distribution before (green) and after (purple) applying the correction.

2.2 Script usage

The "Astrometry Thermoelastic Drift Correction" script can be found in HIPE under the "Scripts" menu, in the "General Useful scripts" section. Any Herschel observation can be processed, although for observations performed in STR switch-over periods, those indicated in http://herschel.esac.esa.int/twiki/bin/view/Public/StrSwitchOversAndSvvResets, an informative output message is only returned. The script inputs that should be provided by the user (lines 260-263) are the following:

- **workdir:** working directory
- **obsId:** observation id
- **instrument:** instrument used to perform the observation
- **changeWCS:** boolean to define output (see next section)

2.3 Output

The user can select between two possible outputs using the changeWCS input parameter:

- **changeWCS = True**
  New Level 2 products are created in which the offsets in RA y DEC have been used to adjust the WCS and the resulting products saved to the working directory. These maps incorporate the thermoelastic correction and are ready to be used for scientific purposes. Please note that this is only applicable to photometry.

- **changeWCS = False**
  A new pointing product is created that takes into account the updated rotation matrix/quaternion and corrects the filtered attitude. This product is then saved to the working directory. To correct for the thermoelastic effect, the user should re-process the observation with the new pointing product. Please note that for spectroscopic observations, changeWCS is automatically set to False.