

TES re-calibration software description.

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The re-calibration of MGS TES data is performed in 2 steps. The 1st step is called setup. During setup instrument response functions (IRF), instrument radiances (Ri) and temperatures (Ti) are calculated. The 2nd step is recalibration, when raw data are read and calibration functions are applied to obtain calibrated radiances. Therefore the software to recalibrate MGS TES data is also split into two collections.

1. SETUP.

Extract raw space and reference surface observations spectra from TES data using vanilla code. Run **select_aux_data.bat** to extract aux, ref and space data (for some data volumes). This will create files **aux_vol_suf.dat**, **ref_vol_suf.dat** in \ref directory and **space_vol_suf.dat** in \space directory. Here vol is mgst_xxxx data volume number and suf is 'ss' or 'ds' for single and double scans, respectively.

run_tes_calibration_setup.pro – runs the main setup program (**tes_calibration_setup_v3.pro**), reads **vol_seq.txt** to get ranges of data volumes to process.

tes_calibration_setup_v3.pro – main recalibration setup program, calculates calibration functions (IRFs, Ri) for data in the given range of data volumes [vol1, vol2].

read_tes_wavenumbers.pro – reads wavenumbers spectral channels for each of the 6 TES detectors from files **wavnumss.tab** (single scan data) **wavnumds.tab** (double scan data).

read_space_correction.pro – reads space radiance correction for 6 detectors for observations starting from ock =12585 and for mirror pointing angle +74° – from files **s74corss.tab** and **s74cords.tab**.

calculate_sr_irfs_v2.pro – calculates IRF, Ri and Ti from SR-pair data for the [vol1,vol2] range of MGS TES data volumes.

read_aux_file.pro, **read_aux_file.pro**, **read_space_file.pro** – read raw spectra from observations of reference surface, temperatures of the reference black body and raw spectra from space observations.

find_sr_pairs.pro, **find_groups.pro** – find space, reference and aux data that are part of the same SR-pair observation.

calculate_sr_irfs.pro – calculate IRFs and Ri from space and ref data for one TES data volume.

add_irf_struct.pro, **add_space_struct.pro** – combine IRF and Ri data from single volumes into one structure.

calculate_s_irfs.pro – Calculate IRF, Ri and Ti for each S observation in [vol1,vol2] interval by interpolation between SR-pairs.

determine_limits.pro – determine ranges of ocks within the considered range of data volumes [vol1,vol2] that do not contain times of 'breaks' in IRF behavior, listed in **thm_sclk_table.txt**.

read_thm_sclk_table.pro – read external file listing the times of IRF ‘breaks’ in **thm_sclk_table.txt**.

read_ock_sclk_table.pro – read external file **ock_sclk_table.txt** linking data volumes to ocks and sclks in TES data. **ock_sclk_table.txt** was created using data from **cumindex.tab** file provided in TES data PDS archive.

calculate_irf_fit_v3.pro – calculate IRF fit to T_i , and ‘effective emissivity’ of the instrument R_{eps} for an interval [ock1, ock2] provided by **determine_limits.pro**.

check_Ri_quality.pro – check that R_i is consistent with instrument radiance – occasionally the data are corrupted or observing not instrument. Excluded problematic R_i and corresponding T_i from fit calculation.

calculate_vs_fit_v3.pro – calculate V_s fit to T_i using the now known IRF(T_i) fit.

calculate_ti_s_v4.pro – Calculate T_i , IRF and R_i in S observations for [ock1,ock2] interval.

debug_setup_plots_v2.pro – create plots to debug the setup process.

write_output_files.pro – write output files **irf_xx_vol1_vol2.dat**, **ri_xx_vol1_vol2.dat**, **ti2_xx_vol1_vol2.dat**, where xx is ‘ss’ or ‘ds’, – and create more plots with calibration data.

List of SETUP files:

1. run_tes_calibration_setup.pro
 - a. vol_seq.txt
2. tes_calibration_setup_v3.pro
3. read_tes_wavenumbers.pro
 - a. wavnumss.tab
 - b. wavnumds.tab
4. read_space_correction.pro
 - a. s74corss.tab
 - b. s74cords.tab
5. calculate_sr_irfs_v2.pro
 - a. read_ref_file.pro
 - b. read_aux_file.pro
 - c. read_space_file.pro
 - d. find_sr_pairs.pro
 - i. find_groups.pro
 - e. calculate_sr_irfs.pro
 - f. add_irf_struct.pro
 - g. add_space_struct.pro
6. calculate_s_irfs.pro
7. determine_limits.pro
 - a. read_thm_sclk_table.pro
 - b. thm_sclk_table.txt
 - c. read_ock_sclk_table.pro

- d. ock_sclk_table.txt
- 8. calculate_irf_fit_v3.pro
 - a. check_Ri_quality.pro
- 9. calculate_vs_fit_v3.pro
- 10. calculate_ti_s_v4.pro
- 11. debug_setup_plots_v2.pro
- 12. write_output_files.pro

2. RECALIBRATION.

tes_recalibration_v2.pro – main re-calibration code: run recalibration of TES raw radiances in interval [ock1, ock2].

find_mgst_vol.pro – find TES data volumes corresponding to ocks in the interval [ock1,ock2] using external file **mgsvol_index.dat**.

read_tes_wavenumbers.pro – reads wavenumbers spectral channels for each of the 6 TES detectors from files **wavnumss.tab** (single scan data) **wavnumds.tab** (double scan data).

get_toc.pro – get the list of files containing IRF, Ri and Ti calibration data.

extract_raw_rad.pro – extract raw radiance spectra from TES binary data and write to disk as ASCII files.

read_raw_rad.pro – read raw radiances for a single ock.

read_cal_func.pro – read calibration functions IRF and Ri corresponding to this ock.

interpolate_irf.pro, interpolate_ri.pro – interpolate IRF and Ri data from times of SR and S observations to times of all observations.

apply_masks.pro – apply spectral and detector masks to interpolated IRF and Ri functions.

calibrate.pro – calibrate data for this ock: $R_p = V_p / IRF + Ri$

write_calibrated_rad.pro – write output file **calrad_xx_ock.dat** with calibrated radiances, where xx is 'ss' or 'ds', and ock is an ock from [ock1,ock2] interval.

List of RECALIBRATION files:

- 1. tes_recalibration_v2.pro
- 2. find_mgst_vol.pro
 - a. mgsvol_index.dat
- 3. read_tes_wavenumbers.pro
- 4. get_toc.pro
- 5. extract_raw_rad.pro
- 6. read_raw_rad.pro

7. read_cal_func.pro
8. interpolate_irf.pro
9. interpolate_ri.pro
10. apply_masks.pro
11. calibrate.pro
12. write_calibrated_rad.pro