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0.1	August 28th, 2008	All	First draft issue of document	0.1
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Contents

Abstract

In this report we show the results of the two Warm Functional Tests (WFT) performed before and after the Planck Cryogenic Test campaign held in the laboratories of the Centre Spatial du Liége (Belgium) during Summer 2008.

1 Introduction

1.1 Purpose and Scope

This document presents the analysis of the two Warm Functional Tests (WFT) performed in the Centre Spatial du Liége before and after the cryogenic test campaign held in summer 2008. The procedure followed during the WFT is reported in [RD1]. Refer also to [AD1] for finer details.

1.2 Test Configuration

The test configuration used for the REBA calibration is the following:

- SCOS2K HPCCS Version ?.?.?
- LFI Gateway Version ?.?.?
- TQL ?.?.?
- LIFE OM version 3.0.9 (2008/08/29).

The LFI personnel involved during the test is listed in the following table:

Role	Name	Institute	E-mail
AIV Manager	A. Gregorio	UniTS	anna.gregorio@ts.infn.it
Calibration S.	A. Mennella	UniMI	daniele.mennella@fisica.unimi.it
Instrument S.	M. Bersanelli	UniMI	marco.bersanelli@fisica.unimi.it
IOT	M. Tomasi (remote)	UniMI	maurizio.tomasi@unimi.it
Industry	P. Battaglia	Alcatel	battaglia.p@thalesaleniaspace.com
...			

2 Applicable and Reference Documents

Reference Documents

[RD1] L. Stringhetti. LFI Warm Functional Test Procedure (WFT). Technical Report PL-LFI-PST-PR-017, INAF/IASF Bologna, September 2007.

Applicable Documents

[AD1] A. Gregorio, M. Miccolis, L. Stringhetti, and A. Zacchei. Planck LFI User Manual. Technical Report PL-LFI-PST-MA-001, University of Trieste, June 2007.

3 Pre-cooling Warm Functional Test

3.1 Overview

The WFT was performed on June, 6th 2008 before the start of the Planck cryogenic test campaign. The procedure followed in the test is a simple iterative sequence where each Front End Module (FEM) is set up to the nominal warm biases (V_1^g, V_2^g, V_d, I_1 and I_2), the phase switches are enabled and the response of the radiometer is recorded.

3.2 Procedure

The procedure used to set up LFI and to acquire the data required for the WFT is described in [RD1]. Four TMH sessions have been saved:

AMB_0183	#18, #26, #19, #20, #28 (M1)
AMB_0184	#28 (S1, S2)
AMB_0185	#21, #22, #24, #27
AMB_0186	#23, #25.

Session AMB_0183 was closed because of a failure in the TMH software. During the time needed to restart it the phase switch of #28 M2 was turned on and off, and therefore we lost the data needed to test this channel.

3.3 Data Analysis

The biases applied during the test are reported in table 1. With the exception of the arm M2 in RCA #28 (where we have lost the data relevant for the analysis), all the channels responded to the stimuli as expected, with the following exceptions:

1. Channels #18 S2, #22 S1, #23 M1 and S2, #27 M2 and S2 have a sky/reference separation less than 1%.

2. Channels #24 S1 and S2 have a negligible voltage output (a few mV). It is therefore difficult to detect any separation after the 4 kHz phase switches are turned on.

Figure 1 shows the temperatures measured by the four sensors mounted on the BEU.

RCA	Arm	V_1^g	V_2^g	V_d	I_1	I_2
18	S2	130	84	255	255	255
	S1	87	132	255	255	255
	M1	108	99	255	255	255
	M2	118	82	255	255	255
26	M2	229	228	255	205	205
	M1	229	228	255	205	205
	S2	229	228	255	205	205
	S1	229	228	255	205	205
19	S2	69	75	255	255	255
	S1	117	108	255	255	255
	M1	132	135	255	255	255
	M2	75	129	255	255	255
20	S2	112	88	255	255	255
	S1	72	132	255	255	255
	M1	87	114	255	255	255
	M2	105	132	255	255	255
28	M1	234	114	200	206	205
	M2	234	115	240	205	206
	S1	233	115	200	205	206
	S2	234	115	200	206	205
21	S2	173	134	255	255	255
	S1	122	119	255	255	255
	M1	156	135	255	255	255
	M2	153	120	255	255	255
22	S2	120	126	255	255	255
	S1	96	78	255	255	255
	M1	108	78	255	255	255
	M2	96	76	255	255	255
24	M2	229	229	255	205	205
	M1	229	229	255	205	205
	S2	230	230	255	205	205
	S1	230	230	255	205	205
27	M1	234	114	180	205	205
	M2	234	114	180	205	205
	S1	234	115	200	205	205
	S2	234	114	200	205	205
23	S2	114	81	255	255	255
	S1	99	78	255	255	255
	M1	94	84	255	255	255
	M2	135	130	255	255	255
25	M1	229	228	255	205	205
	M2	228	228	255	205	205
	S1	229	229	255	205	205
	S2	230	229	255	205	205

Table 1: Table of the biases used during the Warm Functional Tests.

RCA	Arm	I_d	Sky_0	Ref_0	Sky_1	Ref_0	Δ_0	Δ_1
18	S2	24.8	0.412	0.409	0.403	0.404	0.7	0.2
	S1	23.2	0.381	0.400	0.424	0.403	4.9	5.1
	M1	22.0	0.474	0.446	0.584	0.620	6.1	6.0
	M2	23.3	0.712	0.693	0.993	1.021	2.7	2.8
26	M2	32.8	0.038	0.040	0.052	0.051	5.1	1.9
	M1	32.4	0.069	0.073	0.087	0.082	5.6	5.9
	S2	32.6	0.061	0.065	0.069	0.065	6.3	6.0
	S1	32.3	0.090	0.094	0.110	0.104	4.3	5.6
19	S2	23.5	0.300	0.284	0.266	0.277	5.5	4.1
	S1	23.9	0.383	0.369	0.385	0.396	3.7	2.8
	M1	23.8	0.308	0.286	0.303	0.324	7.4	6.7
	M2	24.0	0.208	0.202	0.213	0.218	2.9	2.3
20	S2	24.1	0.438	0.411	0.452	0.483	6.4	6.6
	S1	23.8	0.378	0.367	0.400	0.412	3.0	3.0
	M1	23.5	0.339	0.317	0.295	0.317	6.7	7.2
	M2	23.8	0.376	0.359	0.330	0.346	4.6	4.7
28	M1	22.5	1.555	1.578	2.118	2.096	1.5	1.0
	M2	—	0.000	0.000	0.000	0.000	0.0	0.0
	S1	22.5	1.474	1.498	1.361	1.342	1.6	1.4
	S2	21.9	1.633	1.653	1.466	1.450	1.2	1.1
21	S2	24.2	0.271	0.258	0.239	0.249	4.9	4.1
	S1	24.2	0.162	0.157	0.143	0.147	3.1	2.8
	M1	24.2	0.100	0.093	0.090	0.097	7.3	7.5
	M2	25.1	0.073	0.069	0.064	0.068	5.6	6.1
22	S2	24.1	0.346	0.318	0.399	0.432	8.4	7.9
	S1	23.8	0.305	0.292	0.352	0.364	4.4	3.4
	M1	23.4	0.325	0.304	0.368	0.394	6.7	6.8
	M2	23.6	0.288	0.279	0.328	0.340	3.2	3.6
24	M2	35.1	0.013	0.014	0.015	0.014	7.4	6.9
	M1	34.5	0.022	0.023	0.021	0.020	4.4	4.9
	S2	36.4	0.007	0.007	0.009	0.009	0.0	0.0
	S1	36.0	0.005	0.006	0.008	0.007	18.2	13.3 3
27	M1	19.3	1.640	1.657	1.861	1.843	1.0	1.0
	M2	19.0	2.011	2.028	2.013	1.996	0.8	0.8
	S1	21.3	2.379	2.424	2.015	1.980	1.9	1.8
	S2	20.8	2.228	2.247	1.836	1.829	0.8	0.4
23	S2	23.1	1.174	1.184	0.593	0.589	0.8	0.7
	S1	24.7	0.994	1.023	0.540	0.525	2.9	2.8
	M1	23.6	0.541	0.535	0.645	0.647	1.1	0.3
	M2	23.6	0.865	0.896	1.198	1.155	3.5	3.7
25	M1	32.6	0.106	0.112	0.113	0.108	5.5	4.5
	M2	32.1	0.161	0.171	0.164	0.153	6.0	6.9
	S1	33.6	0.035	0.037	0.031	0.029	5.6	6.7
	S2	34.1	0.033	0.034	0.034	0.033	3.0	3.0

Table 2: Values of the drain currents (I_d[mA]), voltage outputs ([V]) and unbalance (percentage) during the pre-cooling WFT. Note: data for #28 M2 were lost.

4 Post-cooling Warm Functional Test

4.1 Overview

The Warm Functional Tests were repeated at the end of the Planck cryogenic test campaign on June, 21st 2008.

4.2 Procedure

According to the documentation (see [RD1]) the procedure should have been exactly the same followed in the pre-cooling tests. However, for unknown reasons we discovered that there were an important difference:

1. In the pre-cooling test, after having tested each power group the operator turned it off;
2. In the post-cooling test the four power groups were never turned off.

This difference can be seen in figure 1, where the temperature of the BEU is plotted against time.

4.3 Data Analysis

The results of the test are reported in table 3. Bar charts comparing these numbers with the one obtained during the pre-cooling WFT (see table 2) are shown in figures 2 and 3.

There were no issues in the execution of the post-cryogenic WFT. However, we detected the following peculiarities when comparing the sky/reference separation with the pre-cooling WFT:

1. The following channels show a *reduction* in the sky/reference separation so that in the post-cooling WFT the separation was hardly detectable:

Channel	Detector 0	Detector 1
#18 S2	1.0%→0.2%	0.5%→0.0%
#23 M1	1.3%→0.6%	0.7%→0.0%

2. The following channel shows instead a considerable *increase* in the separation:

Channel	Detector 0	Detector 1
#22 S1	0.3%→4.0%	0.2%→3.6%

RCA	Arm	I_d	Sky_0	Ref_0	Sky_1	Ref_0	Δ_0	Δ_1
18	S2	24.8	0.427	0.426	0.424	0.423	0.2	0.2
	S1	23.2	0.380	0.400	0.426	0.405	5.1	5.1
	M1	22.0	0.471	0.448	0.583	0.613	5.0	5.0
	M2	23.3	0.723	0.705	1.006	1.030	2.5	2.4
26	M2	32.4	0.037	0.038	0.049	0.048	2.7	2.1
	M1	32.4	0.066	0.070	0.082	0.077	5.9	6.3
	S2	32.6	0.053	0.057	0.063	0.059	7.3	6.6
	S1	32.4	0.078	0.081	0.098	0.093	3.8	5.2
19	S2	23.5	0.311	0.295	0.274	0.286	5.3	4.3
	S1	23.9	0.384	0.369	0.392	0.403	4.0	2.8
	M1	23.9	0.325	0.303	0.321	0.342	7.0	6.3
	M2	24.0	0.215	0.209	0.220	0.226	2.8	2.7
20	S2	24.1	0.454	0.427	0.468	0.499	6.1	6.4
	S1	23.8	0.399	0.386	0.421	0.435	3.3	3.3
	M1	23.5	0.346	0.324	0.306	0.327	6.6	6.6
	M2	23.8	0.384	0.366	0.338	0.355	4.8	4.9
28	M1	22.5	1.594	1.617	2.168	2.145	1.4	1.1
	M2	25.2	2.076	2.129	2.497	2.447	2.5	2.0
	S1	22.5	1.503	1.529	1.386	1.366	1.7	1.5
	S2	21.9	1.667	1.687	1.495	1.478	1.2	1.1
21	S2	24.2	0.280	0.268	0.248	0.258	4.4	4.0
	S1	24.2	0.162	0.157	0.141	0.145	3.1	2.8
	M1	24.3	0.102	0.095	0.093	0.100	7.1	7.3
	M2	25.1	0.076	0.072	0.067	0.071	5.4	5.8
22	S2	24.1	0.353	0.325	0.412	0.445	8.3	7.7
	S1	23.8	0.307	0.295	0.358	0.371	4.0	3.6
	M1	23.4	0.327	0.307	0.372	0.398	6.3	6.8
	M2	23.6	0.286	0.277	0.325	0.336	3.2	3.3
24	M2	35.2	0.010	0.011	0.013	0.012	9.5	8.0
	M1	34.6	0.017	0.018	0.018	0.017	5.7	5.7
	S2	36.5	0.006	0.006	0.008	0.007	0.0	13.3
	S1	36.1	0.004	0.005	0.006	0.006	22.2	0.0
27	M1	19.3	1.687	1.704	1.906	1.888	1.0	0.9
	M2	19.0	2.060	2.074	2.050	2.036	0.7	0.7
	S1	21.3	2.404	2.453	2.028	1.990	2.0	1.9
	S2	20.8	2.266	2.285	1.862	1.855	0.8	0.4
23	S2	23.1	1.213	1.230	0.619	0.612	1.4	1.1
	S1	24.7	1.029	1.060	0.561	0.544	3.0	3.1
	M1	23.6	0.591	0.588	0.706	0.705	0.5	0.1
	M2	23.7	0.911	0.944	1.248	1.205	3.6	3.5
25	M1	32.7	0.094	0.098	0.097	0.092	4.2	5.3
	M2	32.2	0.142	0.151	0.139	0.129	6.1	7.5
	S1	33.7	0.028	0.030	0.024	0.022	6.9	8.7
	S2	34.1	0.027	0.029	0.027	0.026	7.1	3.8

Table 3: Values of the drain currents (I_d[mA]), voltage outputs ([V]) and unbalance (percentage) during the post-cooling WFT.

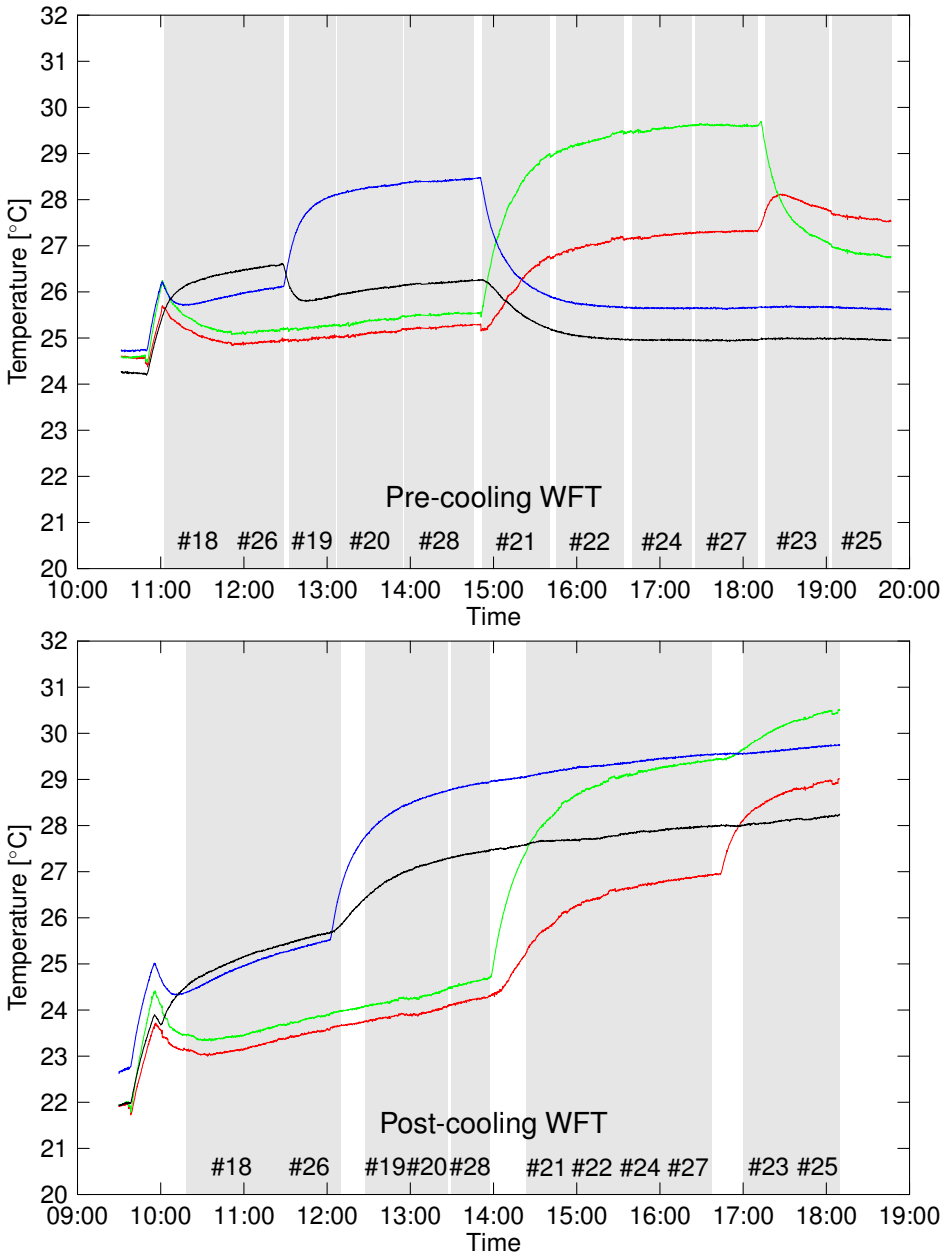

Figure 1: Temperatures of the four BEU sensors L-BEM1 (red), L-BEM2 (green), R-BEM1 (blue), R-BEM2 (black) during the pre-cooling WFT (above) and the post-cooling WFT (below). The gray bands indicate where each RCA was exercised during the test.

Figure 2: Comparison between the drain currents measured during the pre-cooling WFT (light bars) and the post-cooling WFT (dark bars). Data for #28 M2 was lost due to a TMH failure.

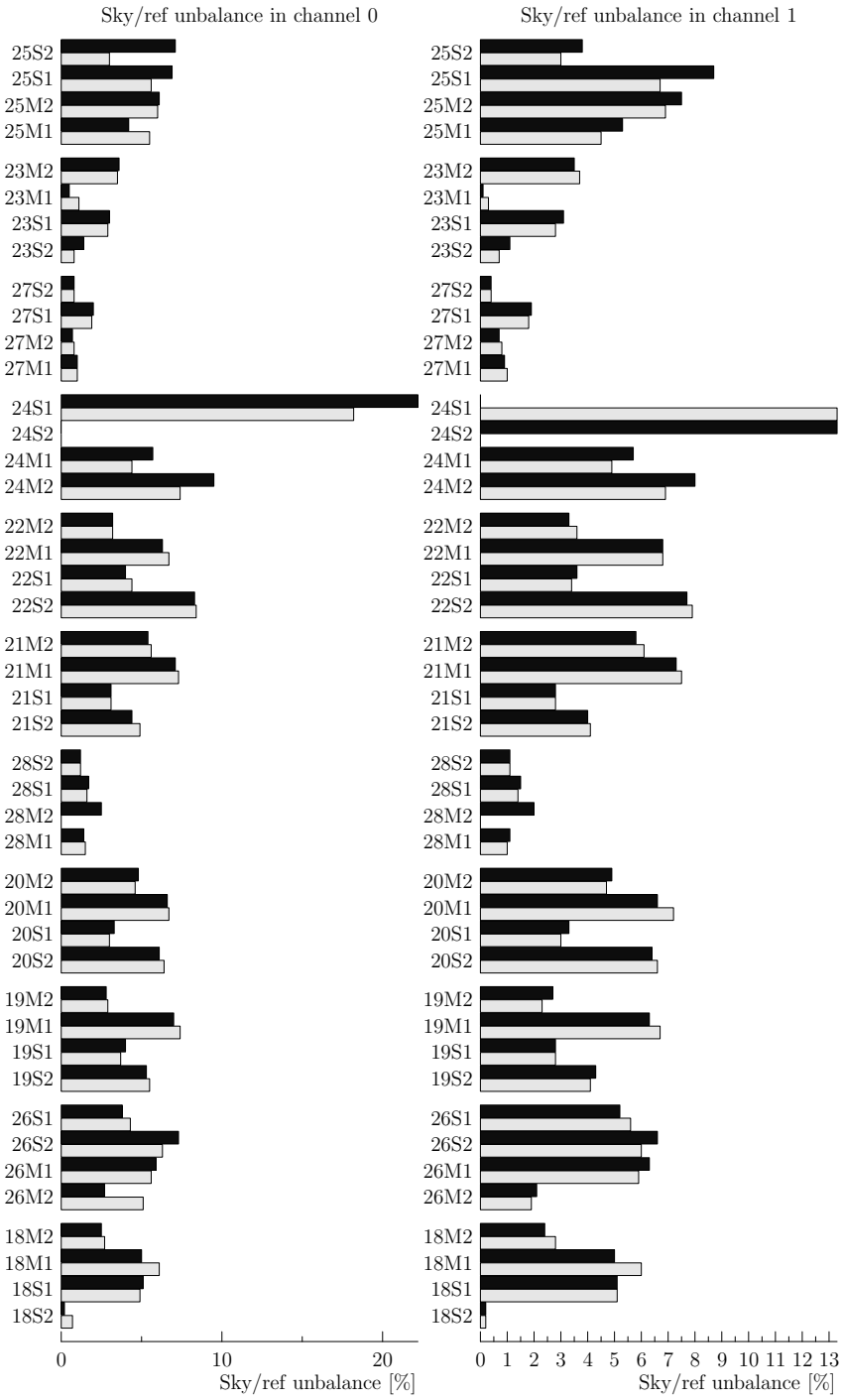

Figure 3: Comparison between the sky/reference voltage unbalance (for both the BEM channels connected to the same FEM channel) in the pre-cooling WFT (light bars) and the post-cooling WFT (dark bars). Data for #28 M2 was lost due to a TMH failure.

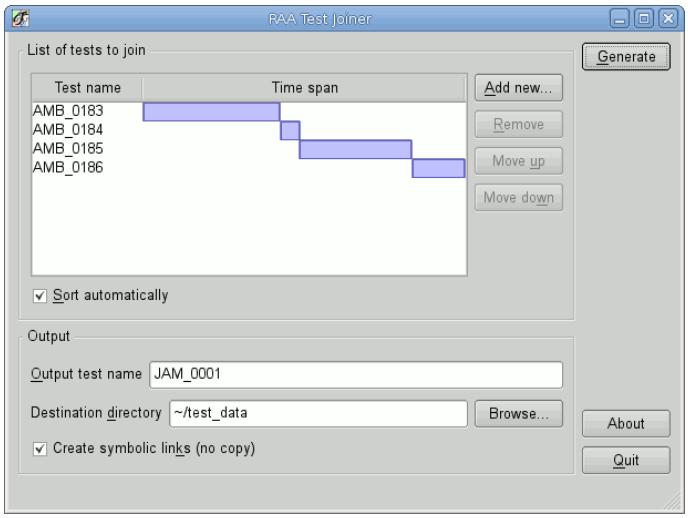

Figure 4: Usage of the Lama Join utility to create the dummy test session `JAM_0001` for the analysis of the pre-cooling WFT.

A Data Analysis

The two WFT tests were acquired using different policies: while the pre-cooling test was splitted into four tests (`AMB_0183`, `AMB_0184`, `AMB_0185` and `AMB_0186`), the post-cooling one was recorded into a single TQL session (`AMB_0193`).

In order to analyze the tests in the most similar way, we decided to use the Lama Join tool (available within LIFE since July, 15th 2008) to join the four tests of the pre-cooling WFT into one file, which we named `JAM_0001`. Under Unix one can create test JAM_0001 by starting Lama Join from the LIFE base directory with the following shell commands:

```
cd lama/lama_join
qmake && make
./lama_join ~/test_data/AMB_018[3456]
```

in the hypothesis that the tests reside in the `/test_data` directory. Then, the user must write the name `JAM_0001` under "Output test name" and press the "Generate" button. This will generate test `JAM_0001` (see figure 4).

We have implemented a simple function that analyzes the bias changes of the RCAs in a test, `analyze_wft_test.pro`. This function relies on the LIFE BScope module and is reported here:

```
pro analyze_wft_test, test_name, tab
   for i = 0, n_elements (tab[0,*]) - 1 do begin
      result = $
        lama_bscope (tab[0, i], $
                     [date_to_tql_time (tab[1, i], tab[2, i], tab[3, i], $
                                        tab[4, i], tab[5, i], tab[6, i]), $
                      date_to_tql_time (tab[7, i], tab[8, i], tab[9, i], $
                                        tab[10,i], tab[11,i], tab[12,i])], $
                     test = test_name, time_format = 'local', /report)
   end
```

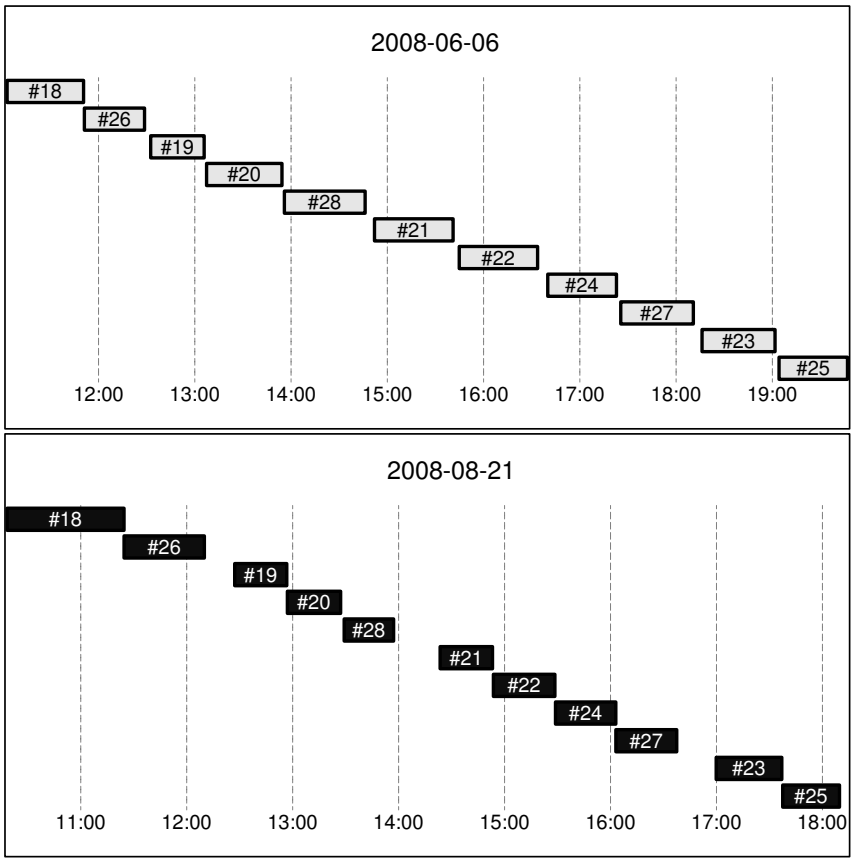

Figure 5: Time table of the two WFT tests. The boxes represent the time windows considered by the Bscope module in its analysis. See section A for further details.

```
end
```

Then we wrote the following scripts to analyze the contents of the tests `JAM_0001` and `AMB_0193`:

```
;;; File: liege-wft-JAM_0001
;;;          FH  Year  MM Day  HH  MM  SS  Year  MM Day  HH  MM  SS
JAMtimes = [[18, 2008,  6,  6, 11, 03, 00, 2008,  6,  6, 11, 50, 40], $
            [26, 2008,  6,  6, 11, 51, 10, 2008,  6,  6, 12, 28, 40], $
            [19, 2008,  6,  6, 12, 32, 30, 2008,  6,  6, 13, 05, 50], $
            [20, 2008,  6,  6, 13, 07, 20, 2008,  6,  6, 13, 54, 20], $
            [28, 2008,  6,  6, 13, 55, 50, 2008,  6,  6, 14, 46, 10], $
            [21, 2008,  6,  6, 14, 52, 00, 2008,  6,  6, 15, 41, 00], $
            [22, 2008,  6,  6, 15, 44, 50, 2008,  6,  6, 16, 33, 40], $
            [24, 2008,  6,  6, 16, 40, 00, 2008,  6,  6, 17, 22, 50], $
            [27, 2008,  6,  6, 17, 25, 30, 2008,  6,  6, 18, 10, 45], $
            [23, 2008,  6,  6, 18, 16, 10, 2008,  6,  6, 19, 01, 40], $
            [25, 2008,  6,  6, 19, 04, 10, 2008,  6,  6, 19, 46, 50]]
```

```
analyze_wft_test, 'JAM_0001', JAMtimes

;;; File: liege-wft-AMB_0193
;;          FH  Year  M Day  HH  MM  SS  Year MM Day  HH  MM  SS
AMBtimes = [[18, 2008, 8, 21, 10, 18, 17, 2008, 8, 21, 11, 24, 30], $
            [26, 2008, 8, 21, 11, 24, 31, 2008, 8, 21, 12, 10, 00], $
            [19, 2008, 8, 21, 12, 27, 10, 2008, 8, 21, 12, 56, 40], $
            [20, 2008, 8, 21, 12, 57, 00, 2008, 8, 21, 13, 27, 10], $
            [28, 2008, 8, 21, 13, 29, 10, 2008, 8, 21, 13, 57, 10], $
            [21, 2008, 8, 21, 14, 23, 30, 2008, 8, 21, 14, 53, 10], $
            [22, 2008, 8, 21, 14, 53, 40, 2008, 8, 21, 15, 28, 30], $
            [24, 2008, 8, 21, 15, 28, 50, 2008, 8, 21, 16, 03, 00], $
            [27, 2008, 8, 21, 16, 03, 01, 2008, 8, 21, 16, 37, 30], $
            [23, 2008, 8, 21, 16, 59, 50, 2008, 8, 21, 17, 37, 00], $
            [25, 2008, 8, 21, 17, 37, 30, 2008, 8, 21, 18, 09, 40]]

analyze_wft_test, 'AMB_0193', AMBtimes
```

The times used in the two scripts are shown in figure 5.