Solar Orbiter Mission Operations Report #13

Period [18 May 20 - 26 May 20]

Prepared by	**Sylvain Lodiot**
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APPROVAL

Title Solar Orbiter Mission Operations Report #13	
Issue Number 13	Revision Number 0
Author Sylvain Lodiot	Date 26/05/2020
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Sylvain Lodiot, SolO SOM	

CHANGE LOG

Reason for change	Issue Nr.	Revision Number	Date
Updated with reporting for new time period	13	0	**26/05/2020**

CHANGE RECORD

Issue Number 13		Revision Number 0	
Reason for change	Date	Pages	Paragraph(s)
New issue	26/05/2020	All	all

Note: no change record is kept for this document since every new issue corresponds to a new reporting period.

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1 SUMMARY OF ACTIVITIES

The weekend issues are finally recovered with a cold restart of the SSMM performed this morning, the patch to the instrument "cascade switch off" effect applied, and a restart of the NECP timeline v5.9 with a gradual switch on of the instruments planned in the next days. Several activities need re-planning, including the IM-IIC campaign (which was initially planned on 24/05 but could not take place).

All instrument teams are kindly requested to carefully read the "events" section and the constraints which apply to instrument TM data generation in order to avoid any further SpW overload. A SpW overload on Thursday evening triggered the switch off of all instruments (EUI staying powered on only).

DoY	Date	Activity
139	18/05/2020	***STP 13 start (PL NECP week 12)*** IX-4 STR-B alignment update in RAM STR-B defective pixel detection WOL
140	19/05/2020	IX-4 IP-FDT (pointing SOL-SGS-TN-0019 0.4)
141	20/05/2020	IU-10_4 IU-10_5-10 STR B Foto Dump WOL
142	21/05/2020	IU-10_5-10 IP-HRT Activities interrupted by SpW overload
143	22/05/2020	IU-10_5-10, activity interrupted by SpW overload CPS Purging WOL
144	23/05/2020	IX-Crab Nebula (preserved)
145	24/05/2020	Did not take place: IU-10_5-10 IM-IIC_MAG_RPW_EPD_SWA
146	25/05/2020	***STP 14 start (PL NECP week 13)*** SSMM router configuration dump and analysis EUI switch off

DoY	Date	Activity
		STR-B alignment update in SGM WOL
147	26/05/2020	SSMM cold restart "Instrument Cascade switch-off" patch installation EUI switch ON STIX switch ON SPICE recovery MAG switch ON

The table above only reports interactive activities. Many non-interactive activities run throughout the week for multiple instruments.

At the end of the reporting period (DoY 147, 26/05) Solar Orbiter was at:

- 81.3 million km from the Earth (0.54 AU); the one-way signal travel time was 4 min 31 sec (271 sec).

- 86.5 million km from the Sun (0.57 AU).

2 SATELLITE STATUS

2.1 Platform

2.1.1 *AOCS / propulsion*

The AOCS configuration at the end of the reporting period is:

- AOCS in NCM mode
  - with attitude control based on Wheels (all 4 Wheels)
  - using the gyro stellar estimator (GSE) on STEADY gains
  - with inertial reference attitude guidance

- AOCS Sensors
  - IMU A (all 4 Channels) ON and IN-USE
  - IMU B (all 4 Channels) OFF and all 4 Channels PRESELECTED

  - ACC (all 4 Channels) OFF

  - FSS A (XP and ZM) ON and IN-USE, with FSS A XP having SUN Presence
  - FSS B (XP and ZM) OFF

  - STR A ON (NEAT mode) and IN-USE
  - STR B OFF

STR defective pixels check started with STRB complete. All STRB tables before and after the autonomous defective pixel detection activity show 0 defective pixels. Also, no event indicating defective pixels detection was received. STRB activities are complete. STRA defective pixel checks are pending.

Lost in space acquisition tests open behaviors are further being iterated after initial feedback from ADS.

A new FOTO dump took place on 20/05. The brightest star has a pixel of 2004 DU. No indication of a defective pixel or a strangely shaped artefact as in the dump from February could be found. However, there is a very bright "blob" located around pixel (278,838) with 16 saturated pixels (4095 DU). Perhaps a charged particle? See attachments section for more information.

STR-B alignment update in RAM on 18/05 was successful. STR-B alignment in SGM was performed on 25/05.

The gyro bias and null space calibration was updated in SGM on DoY 135.

AOCS Actuators

- RW 1-4 ON and IN-USE used for Attitude Control since DoY 042 and LEOP day 1
- RW Momentum Target Levels @ 18/-18/-18/18 Nms

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- CPS B OFF and PRESELECTED, CPS A OFF

  o AOCS Flags
    - Sun Distance set to NEAR since 16/03/2020 (DoY 76)
    - Flyby set to NO FLYBY since launch

  o AOCS HK and TM mode configuration: Default since DoY 052 (21/02/2020)

  o Propulsion system
    - Valves in default configuration (all TLVs + LFLV closed, except for LFLV 3+4)
    - The propulsion system is configured in regulated mode since launch
    - The pressure relief function is activated when needed
    - Pressure levels
      - NTO tank pressure @ 16.5 bar
      - MMH tank pressure @ 16.45 bar
      - HE tank pressure @ 150 bar
    - Pressure relief function period updated to 40 days on 17/04 (DoY 108) in RAM only; duration unchanged and at 8 cycles. SGM RAM values unchanged (18 days/8 cycles). The new RAM period applies following the pressure relief from 27/04.

2.1.2 *Mechanisms*

  o SADE
    - SADE A ON and IN-USE
    - SADE B OFF
    - SA @ 60 degrees since 127.19.52. The next scheduled rotation is on 152.20.30 to 70 degrees.

  o HGA APME
    - HGA Deployment Status = TRUE
    - HGA selected as PRIME Antenna (PM and SGM RAM)
    - APME A OFF and PRESELECTED
    - APME B OFF

  o MGA APME
    - MGA Deployment Status = TRUE
    - MGA is selected as PRIME Antenna (SGM RAM) since DoY 058
    - APME A OFF and PRESELECTED
    - APME B OFF

The Fdyn attitude colleagues calibrated the MGA and the HGA. The MGA is fine, but for the HGA a 3dB half cone angle of 0.64 deg was estimated. The HGA pattern calibration will be

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repeated in flight on 01/06. The activity is being defined with ADS and project. ADS reports that with the latest ground station processed data, the 3dB beamwidth looks ok at +-1deg, but that there is a boresight misalignment. The test on 01/06 will allow to get more data points to get a more accurate plot but the antenna looks fine in general.

2.1.3 *TT&C*

The performance of the subsystem is nominal

- TRSP-1 X-band up and down via HGA, 4 kbps uplink, downlink bit rate is selected according to the used ground station

- TWTA-1 is in use, RF power nominal (from Helix Current telemetry reading)

- TRSP-2 back-up uplink is configured for X-band reception at 7.8 bps via LGA-2 since DoY 044 13/02/2020

- TWTA-2 is OFF and in cold redundancy

- MGA is selected as safe mode antenna since DoY 058.

- PN ranging is fully validated and used by default since DoY 057 (26/02). This allows to currently be on the max TM bit rate.

2.1.4 *Thermal*

TL97 (MAG OBS) latest setting is a regulation (in RAM only) of -90 to -88 degC.

Thermal configuration is configured for the op range for some instruments (decontamination heaters were not touched).

In orbit thermal characterisation data acquired on 15/03 is being analysed offline.

2.1.5 *Power*

The subsystem is in its nominal configuration and performing nominally.

- PCDU A OFF
- PCDU B ON and in use

PCDU A and B EEPROM table updates have been tested and reviewed on ground and are pending upload to the spacecraft. The update in flight is scheduled for 28/05.

2.1.6 *Data handling*

The subsystem is in its nominal hardware and software configuration.

The SSMM is ON and fully configured in 3 MM Configuration.

SSMM ASW 02.07.00 was uploaded on DoY 052 in both ASW images and both supervisors.

The SSMM router configuration reports on 25/05 highlighted router configuration issues needing a cold restart of the SSMM. This cold restart was performed on 26/05. The issues to switch on MAG on 23/05 may also be related to SSMM issues too, despite a priori a clean MAG SSMM router configuration.

AR to be raised. The SSMM behaviour is to be fully understood. A cold restart of the SSMM beyond NECP would be a significant issue.

The TC Link Monitor is configured back to a time-out of 3 days since 31/03 (DoY 091). Configuration for cruise is now set as follows (TC link TH1/TC link TH1 increase/TC link TH2):
PM RAM: 72h/24h/142h
SGM RAM: 72h/12h/106h
This configuration will soon need updating with the ground station pass reduction in June (and no longer daily passes).

The TM generation mode is configured to NOMINAL.

The ADS patch (3.0.3p5) for SOL_SC-06 ([LEOP] OMM packet stores cannot be dumped) has been applied on board on DoY 098 (07/04).
Patch CSW V3.0.3p6 for the instrument "cascade switch-off effect" was applied on 26/05 .

OBCPs: an issue with timing in the METIS OBCP was identified and is being addressed.

The current DMS configuration is:

Item	A	B
OBC PM	Active	Off
OBC CSW Image Select	0	0
OBC CSW Version	3.0.3p1	3.0.3p1
OBC CSW RAM version	3.0.3p6	
OBC EEPROM Segs	1 : Code 2: Data 3-8 : Profiles	1 : Code 2: Data 3-8 : Profiles
RM PAP Prog. Set	1 (PM-A Nominal)	1 (PM-A Nominal)
RM	Enabled	Enabled
SSMM SV	Active	Off
SSMM ASW Image	1	1
SSMM ASW Version	02.07.00	02.07.00
RIU	Active	Off
OMM	On and in use (slave)	On and in use (Master)

2.2   Instruments

EPD
Nothing to report.

EUI
EUI triggered the SpW overload on 22/05. With a consequent switch off of all instruments. AR to be raised.
EUI was switched off on 25/05 following several ARBs and the analysis of EUI CEB temperature predictions. EUI off meant all instruments off, allowing for a clean SSMM cold restart and cascade patch installation.
EUI CEB temperature fell rapidly from -4 deg to below -10 deg which is an allowed range for switch on which took place on 26/05. EUI verbosity was then updated to acceptable levels.

MAG
It is currently not understood why MAG did not switch on properly on 23/05.
AR to be raised.
It was initially thought this may be a MAG issue. But with the confirmation of SSMM router configuration issues, attempts to switch MAG on were made on 26/05.
MAG switch on nominally albeit in its high power mode. 3 further power cycles were attempted to address this without success.

METIS
Nothing to report.

PHI
Nothing to report.

RPW
Nothing to report.

SWA
Nothing to report.

SoloHi
Nothing to report.

SPICE
SPICE was recovered on 26/05.

STIX
The crab nebula activity was preserved over the weekend.
STIX NECP IX-4 Interactive activity on 18/05 was successful with the uplink of the new ASW to both units (Main and Redundant).
STIX was recovered on 26/05 with first part of IX-5 run.

Decontamination heater status
Current status:
- SPICE OU   = ON
- SPICE CE   = ON
- METIS   = OFF since DoY 113 (22/04)
- EUI OU   = OFF since DoY 106 (15/04)

Heat shield door status

The doors were touched during the weekend to protect some instruments.
Current status:
- Door 1 (SPICE)   = CLOSED (since 21/04 DoY 112)
- Door 2 (EUI-FSI)   = CLOSED (since 22/05, DoY 143)
- Door 3 (EUI-HRI) = CLOSED (since 22/05, DoY 143)
- Door 4 (METIS)   = CLOSED
- Door 5 (PHI-FDT) = OPEN
- Door 6 (PHI-HRT) = OPEN (since 07/04, DoY 098)

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3 GROUND FACILITIES

3.1   Ground Stations

During the reporting period mission operations have been conducted with the CEB ESA station. CEB EoT was extended on 25/05 and this will likely continue the rest of this week to allow for some more station time. Ground station negotiation is on-going with other missions to allow for some extra station time and fully apply NECP timeline v5.9.

3.2   Control Centre

SolO MCS SW versionD3.15.10 is used on all operational machines since week 16/2020. This version uses:
- GFTS SW version 3.1.6
- EDDS SW version 2.3.0
- NIS SW version 5.2.0
- FARC SW version 3.2.1

Version 3.15.12 was installed on devlan on 18/05 for FCT testing. Testing is postponed to early next week due to the SC issues and NECP replanning.
Version 3.18 is under preparation.

MATIS (our automation tool) is used since 14/02 (DoY 045) to manage all links to the ground stations. Since 20/04 (DoY 111) MATIS is also used for some start of pass commanding. MATIS should take over full start of pass commanding activities in the coming weeks. This needs MCS version 3.18 to address all open MATIS issues.

A strange behavior was observed on 15/05 with many OOLs due to a toggling bit rate. An MCS SPR was raised.
Investigations continue on recent strange behaviors mainly affecting the commanding chain (verifier, signed integer TC par management), as well as file transfer issues from devlan to opslan). The commanding chain issues need urgent addressing/understanding and fixing if needed.

4 SPECIAL EVENTS

(A)   TM generation date rate constraints to be respected

(1) The first constraint to respect is the 50 bps to the OMM.
When events and acknowledgments are in the hundred-per-day range their contribution is negligible so one can only count HK, as it is simpler. Strictly speaking though the 50bps applies to all PL TM to the OBC, other than the IIC packet.

(2) Input from ADS:

Document TMTC Traffic Scenario Spec (SOL.S.ASTR.TN.00183) sets an assumption of just 1 event/instrument/sec (assumption references TM-5 and SP-4). This assumption is built into the overall 'Traffic from SSMM to OBC' budget, which derives a peak rate of 98 TM/sec.

The FDIR limit of 135 packets in a second to the OBC total, including the SSMM itself should not be thought of as an arbitrary limit that can simply be adjusted. This limit is an integral part of the overall CPU Loading management strategy.

The FDIR limit includes the SSMM itself. The SSMM sends 3 different HK usually which may fall within the same second.
Each payload is allowed 5 HKTM to the OBC, an extra 50 total, this includes their IIC packet. One also needs to account for the TC acknowledgment packets generated for each instrument TC.
All this contributes to the number of packets per second to the OBC from SSMM and instruments.

MOC and ADS therefore do not recommend anything above 1 event / second and ask the instrument teams to respect this constraint. Please get back to us in case of questions.

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(B)   Glitches on AGC and SPE out of pass

On a totally different topic, glitches in AGC and SPE out of pass have been observed, while testing the new MOC simulator and comparing against real SC TM.

7 occurrences with strong peaks were looked into.
One idea is an early warning radar somewhere north Pacific, with the s/c always visible at low elevations from there. That is where most powerful radars scan from as well, searching for missiles rising above horizon.

This has been raised with the Frequency Management office too, to see if they can help.

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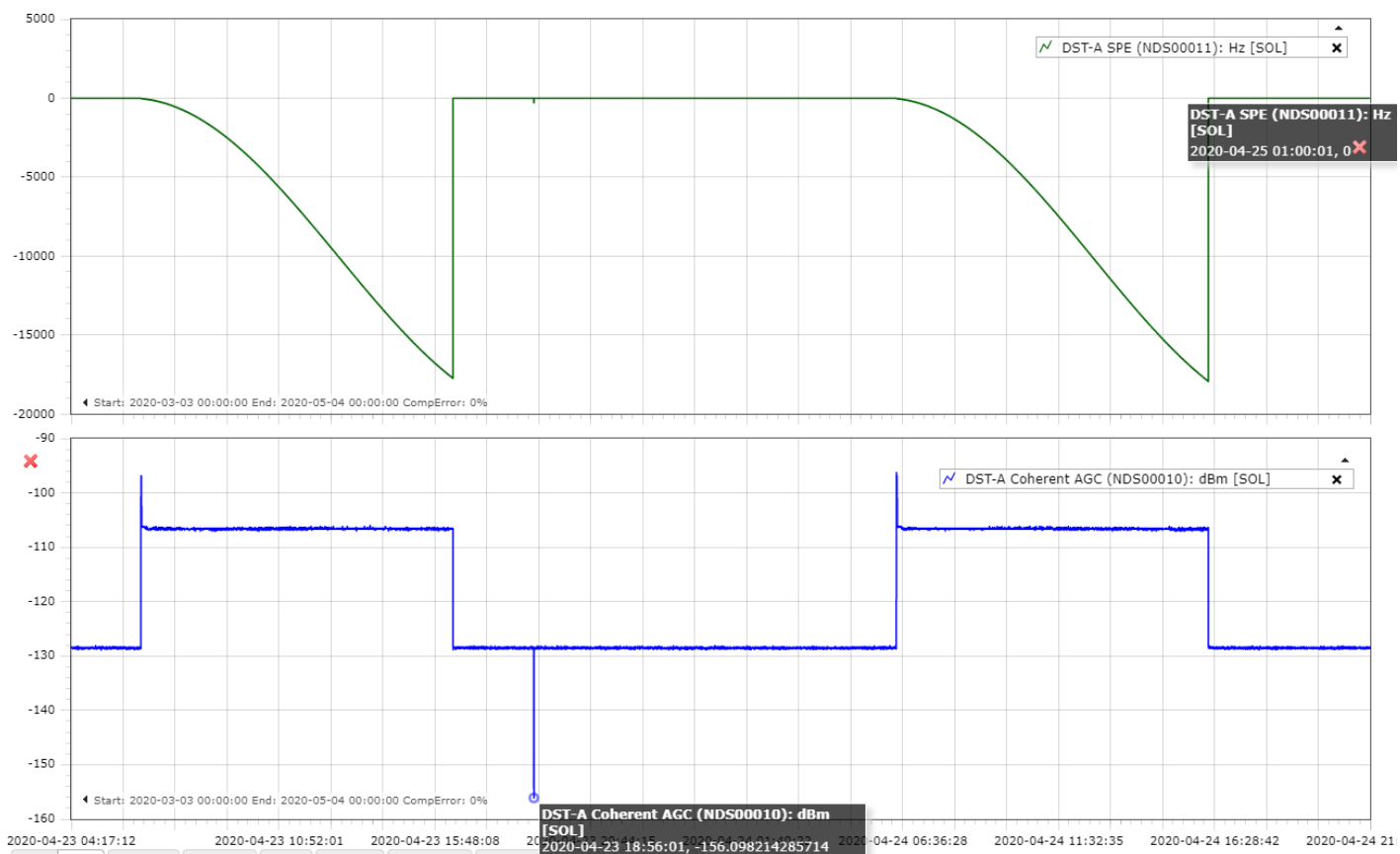
5 ANOMALIES

The following Anomaly Reports were raised in the reporting period:

Spacecraft

TbW	[NECP] SSMM router configuration issues post SpW overload
TbW	[NECP] EUI triggering SpW overload
TbW	[NECP] MAG issues at switch on on 23/05

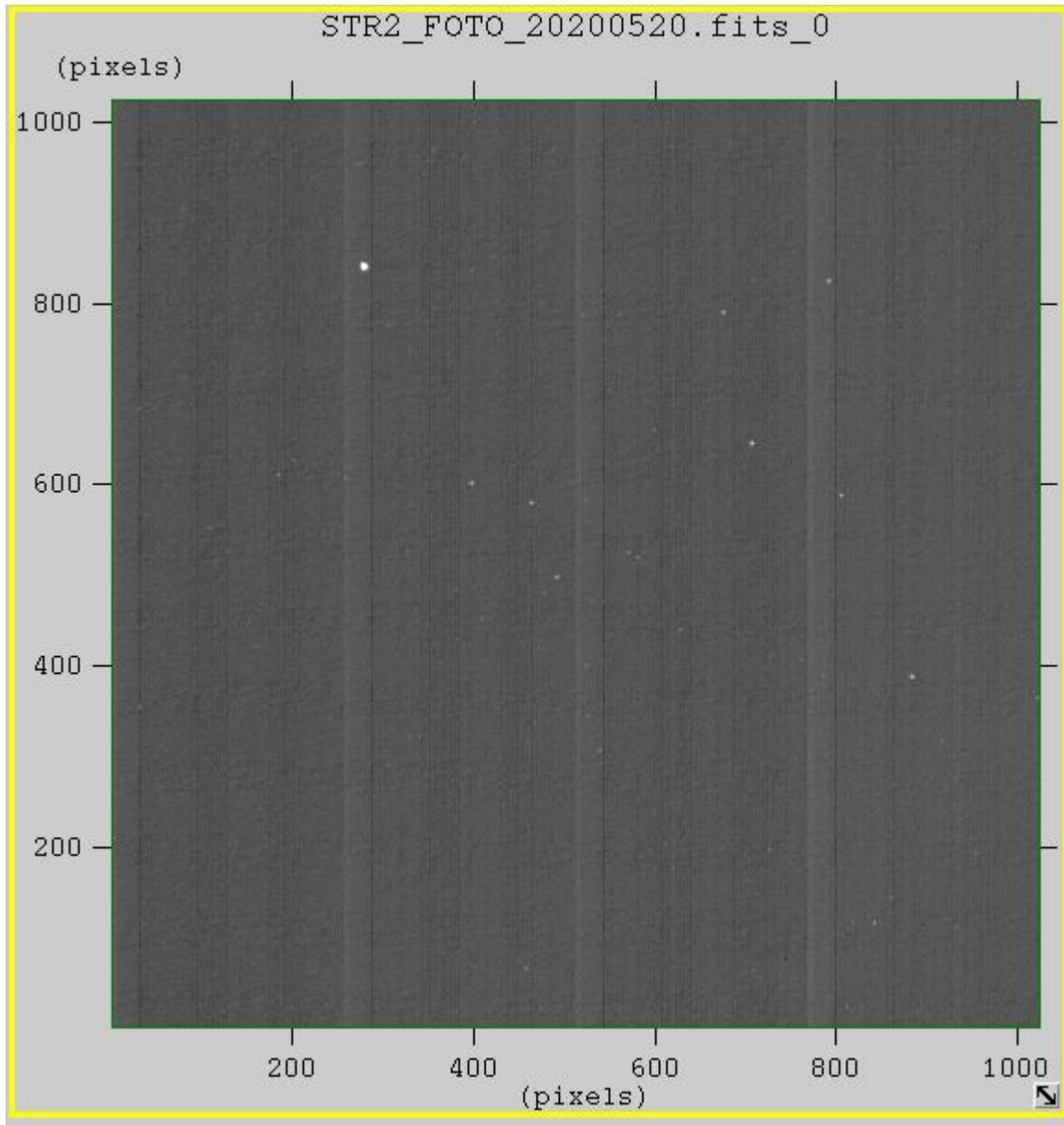## Ground Segment
None

Non Conformance Reports
None

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6 FUTURE MILESTONES

This is the timeline of future milestones:

Milestone	Date	Comment
Start of PL NECP week 13 (STP 14)		
	DoY 148, 27/05/20	STIX IX 5 & 6 PHI IP-9 WOL
	DoY 149, 28/05/20	EUI IU-11 pre-IC-RSC-00 IC-RSC campaign PCDU B EEPROM patch SPICE CE Decont to OFF
	DoY 150 29/05/20	IC-RSC campaign completion IT-5 IC-IIC campaign IU-12 (and missing IU-10)
	DoY 151, 30/05/20	SWA comet EPD ON
	DoY 152, 31/05/20	SA steering
	DoY 153, 01/06/20	HGA calibration test, public holiday
Beyond		
NECP plan available till LTP1 start		
LTP1 start on 15/06	DoY 167, 15/06/20	
LTP2 start on 29/06	DoY 181, 29/06/20	

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7   ANNEX 1, STR FOTO DUMP FROM 20/05/2020

For explanations, refer to the relevant section above.

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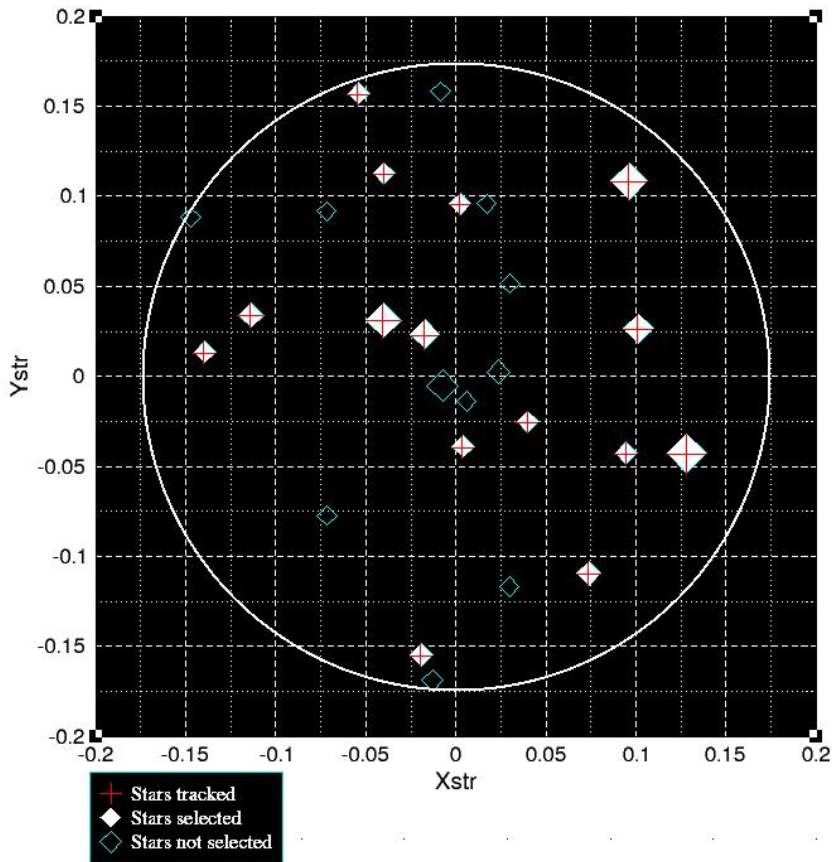
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STR 2: NEAT   [cycle: 00005120]

2020-05-20T18:53:17.685Z / 2020-05-20T18:42:37.685Z

Stars in FoV : 26
Stars Tracked: 15

	ID	CATmag	STRmag
Valid :	0927	2.592	2.640
	0832	2.842	2.860
	1040	2.990	3.030
	0894	3.474	3.600
	1018	3.540	3.610
	1113	4.095	4.070
	1054	4.405	4.340
	1184	4.564	4.840
	0963	4.743	4.820
	1055	4.753	4.760
	1161	4.755	4.690
	1009	4.773	4.860
	0933	4.880	4.910
	0943	4.882	4.900
	0967	4.957	5.070

	ID	CATmag	
Not Valid :			
Not Selected :	1036	3.216	
	0996	4.387	
	1192	4.907	
	0895	5.175	
	1016	5.218	
	0944	5.275	
	1170	5.291	
	1103	5.302	
	0918	5.334	
	1026	5.342	
	1096	5.379	