



**esoc**

European Space Operations Centre  
Robert-Bosch-Strasse 5  
D-64293 Darmstadt  
Germany  
T +49 (0)6151 900  
F +49 (0)6151 90495  
[www.esa.int](http://www.esa.int)

# Solar Orbiter Mission Operations Report #6

## Period [23 March 20 - 05 April 20]

<b>Prepared by</b>	<b>Sylvain Lodirot</b>
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# APPROVAL

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Sylvain Lodiot, Solo SOM	

# CHANGELOG

Reason for change	Issue Nr.	Revision Number	Date
Updated with reporting of new period of time	6	0	06/04/2020

# CHANGE RECORD

Issue Number	Revision Number		
Reason for change	Date	Pages	Paragraph(s)
New issue	06/04/2020	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

After a week interruption, due to Coronavirus, payload commissioning has resumed. A four week plan has been redefined. The rest of NECP and beyond will be planned after Easter. More in the special events section.

DoY	Date	Activity
83	23/03/2020	<b>STP 5 start</b> WOL from 19:21 to 22:21
84	24/03/2020	Unmanned GS pass, no dumps
85	25/03/2020	Unmanned GS pass, no dumps WOL from 21:55 till 00:55
86	26/03/2020	Uplink of 8 weeks of planning products
87	27/03/2020	Unmanned GS pass, no dumps MAG ON for weekend rolls WOL from 21:59 till 00:58
88	28/03/2020	GS pass released WOL from 07:13 to 09:58 WOL from 18:53 to 21:53 Rolls from 21:53 to 11:09
89	29/03/2020	GS pass released
90	30/03/2020	<b>STP 6 start</b> WOL from 22:00 to 31/03/2020 01:00 RPW ON as of 00:00
91	31/03/2020	SA steering 11:17 to 11:32 (going to 30 deg) TC link monitor update Close EUI HS Doors IU-6_4-7 Interactive SPICE SWON Interactive MAG power cycle

<b>DoY</b>	<b>Date</b>	<b>Activity</b>
92	01/04/2020	WOL from 22:00 to 02/04/2020 01:00 EPD SWON Interactive IC-SOU-42_46 Interactive. SPICE Decont. Heater threshold to OP values
93	02/04/2020	ID-51 interactive EPD IA-5 Interactive SWA
94	03/04/2020	WOL from 22:00 to 04/04/2020 01:00 IC-SOU-50 Interactive SPICE ID-52 Interactive EPD
95	04/04/2020	
96	05/04/2020	

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 096, 05/04) Solar Orbiter was at:

- 23.6 million km from the Earth (0.158 AU); the one-way signal travel time was 1 min 19 sec (79 sec).
- 131.6 million km from the Sun (0.879 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 discussion is on-going.

Lost in space acquisition tests open behaviors are further being investigated with ADS.

The STR triangular shaped object (artefact) is further being discussed with ADS.

#### 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
- CPS B OFF and PRESELECTED, CPS A OFF
- **Impact of instruments being off is clearly visible on wheel friction and bearing temperatures. See attached plots in annex.**
- AOCS Flags
  - Sun Distance set to NEAR since 16/03/2020 (DoY 76)
  - Flyby set to NO FLYBY since launch
- AOCS HK and TM mode configuration: Default since DoY 052 (21/02/2020)

- 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

### 2.1.2 *Mechanisms*

- SADE
  - SADE A ON and IN-USE
  - SADE B OFF
  - On 091.11.17.17 (31/03) a scheduled solar array rotation took place from 0 to 30 degrees (offset set to 0 degrees), as per the nominal profile LUT. The next scheduled rotation is on 120.00.47.14 to 56 degrees.
  
- HGA APME
  - HGA Deployment Status = TRUE
  - HGA selected as PRIME Antenna (PM and SGM RAM)
  - APME A OFF and PRESELECTED
  - APME B OFF
  
- MGA APME
  - MGA Deployment Status = TRUE
  - MGA will be selected as PRIME Antenna (SGM RAM) on 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 is estimated, while the nominal value in the FDDB is 1.0 deg. This finding is still to be further analysed, validated and confirmed internally. However, for the next 8 weeks (commands already on board) HGA re-positioning commands are based on a 3 dB half cone angle of 0.60 deg to be on the safe side. Ground station signal strength data is being analysed too.



### 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 EEPROM tables are pending final clean up.

### 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.

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

The TM generation mode is configured to NOMINAL.

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

SOL\_SC-28 AR investigations continued ([NECP] Unknown packet during dump of OMM PS REPORTS) with further specific OMM\_A dumps performed upon ADS request.

The ADS patch for SOL\_SC-06 ([LEOP] OMM packet stores cannot be dumped) has been extensively tested in ESOC and will be applied on board week 15.

The current DMS configuration is:

<b>Item</b>	<b>A</b>	<b>B</b>
OBC PM	Active	Off
OBC CSW Image Select	0	0
OBC CSW Version	3.0.3p1	3.0.3p1
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

All EPD activities completed successfully. Status at end of activities:  
EPD in Operational Mode, STEP ON, SIS ON (Science Mode), IRIS A OPEN, IRIS B OPEN, EPT-HET 1 and 2 ON.

### EUI

On 31/03, Heat Shield Doors were closed. The launch locks were fired and all three EUI Camera doors were opened.

The movement allowed flag for these two doors has been set to FALSE. EUI will remain in this configuration until April 14th for decontamination purposes. Opening the EUI HS doors could cause damage to the EUI cameras.

2 unknown SPID packets were received from EUI. These are being investigated.

### MAG

MAG is on since 27/03, on time for the MAG rolls which took place on 28/03. A SC AR on MAG is to be raised. MAG is consuming slightly more power than before the power down on 21/03 (a so called "high power mode" which had been observed on ground too). A MAG power cycle on 01/04 did not help.

### METIS

Nothing to report, METIS is OFF.

### PHI

Nothing to report, METIS is OFF.

### RPW

RPW was commanded back on on 30/03.

### SWA

SWA Activity IA-5 Day 1 was re-arranged to focus on both EAS1 & 2 sensors, deferring the MCP high voltage commissioning to next week. Activities completed successfully.

### SoloHi

Nothing to report. SoloHI is OFF.

### SPICE

The SPICE activity IC-SOU-42\_46 on DOY092 was successfully executed.

This activity consisted on switching OFF the SPICE CE decontamination heater and waiting for CE to cool down up to the operational range, acquisition of detector science images, high voltage ramp up, commissioning on the detectors and FEE.

At the end of the activity SPICE is in standby mode with the SPICE CE decontamination heater ON.

The SPICE activity IC-SOU-50 on DOY094 was successfully executed.



The purpose of this activity was to activate the particle deflector system and open for the first time the SPICE Door and the SPICE Heatshield door. At the end of the activity both doors remained opened and the particle deflector remained ON with SPICE in Standby mode.

## **STIX**

Nothing to report. Not switched on yet.

## **Decontamination heater status**

Current status:

- SPICE OU = ON
- SPICE CE = ON
- METIS = ON
- EUI OU = ON

## **Heat shield door status**

Current status:

- Door 1 (SPICE) = OPEN (since 04/04, DoY 094), flag movement allowed = false
- Door 2 (EUI-FSI) = CLOSED (since 31/03, DoY 091), flag movement allowed = false
- Door 3 (EUI-HRI) = CLOSED (since 31/03, DoY 091)
- Door 4 (METIS) = CLOSED
- Door 5 (PHI-FDT) = OPEN
- Door 6 (PHI-HRT) = CLOSED



## 3 GROUND FACILITIES

### 3.1 Ground Stations

During the reporting period mission operations have been conducted with the CEB ESA station.

### 3.2 Control Centre

Solo MCS SW version D3.15.9 is used on all operational machines since week 08/2020. 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

MCS SW version D3.15.10 is installed on devlan and going through testing.

MATIS (our automation tool) is used since 14/02 (DoY 045) to manage all links to the ground stations.

MCS issues related to SC file transfer, OOL management of the offline datastream and data gap issues (including EDDS) are further being investigated.

DARC has been updated to run consolidation based on reception time.

A patch will be installed next week on EDDS to fix management of TC packet reports in play back TM.

Gap issues are now understood and are being fixed:

- 1) TC history not reflecting the same status as MCS (missing handling of Status for PB confirmations): 3 systems need to be updated (EDDS (see patch above), ARES and WebMUST).
- 2) Consolidations not working consistently and FindGaps not always repopulating all gaps: This can be addressed by configuration changes or adjusting operational processes.
- 3) (some) Live data marked as INVALID and not calibrated (meaning eng. value 0). SPR on Scos (S2K-9318) is currently under investigation (after extensive investigation done on DARC)

Many commands remain unverified in TC History with execution times between 091.12.27.46.004 and 091.15.53.43.592. These were commands released during the pass for the various activities via FT and had a source "onboard".



The TM(1,1) and TM(1,7) packets had been properly received but not registered by the MCS. The problem occurred during the MCS restart and it seems that the TC Verifier confused TCs with same SSC and APID.

## 4 SPECIAL EVENTS

NECP has resumed, with replanning done for 4 weeks till early May. The rest of NECP will be replanned after Easter.

The updated plan allows max 2 interactive activities in parallel, to limit the number of people in the control room at any given time.

SC planning has been done for 8 weeks till end May. For this, a fixed WOL pattern has been applied, 3 times a week (Mon/Wed/Fri 22:00). CPS purging and SA relubrication activities have been descoped. A fixed roll angle (0 deg) is applied throughout the phase.

HGA is repositioned when needed (allowing permanent ground contact in case of need).

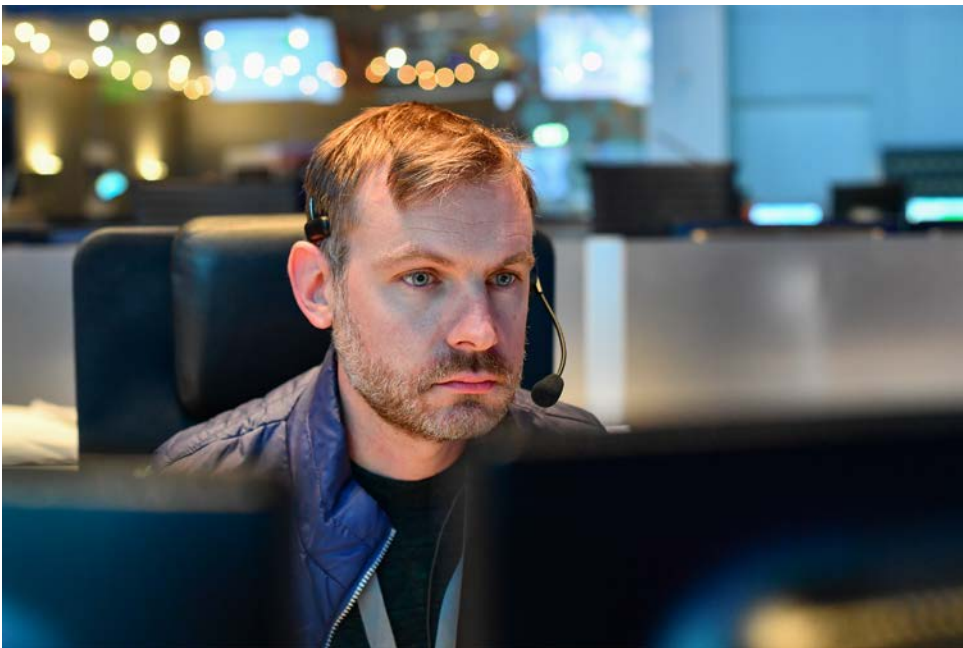
NECP activities requiring specific rolls are postponed to TBD date.

NECP end will be postponed. In particular, it is already clear that the multi-instrument activities (EMC/IIC/pointing calibration) can't be completed on time.

LTP 1 (and 2) discussions, planning and preparation are under way.

Pending platform activities (mainly AOCS related) are on hold.

And... Matthias's last day in the FCT was on Monday 30/03... Thanks for all Matthias, it's been a long and amazing ride since Rosetta and 2014! Good luck for your future challenges! Bon vent !



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## 5 ANOMALIES

The following Anomaly Reports were raised in the reporting period:

### Spacecraft

SOL\_SC-XX *TbWMAG* consuming slightly more power than before the power down on 21/03 (so called “high power mode” observed on ground too)

### Ground Segment

None

### Non Conformance Reports

None



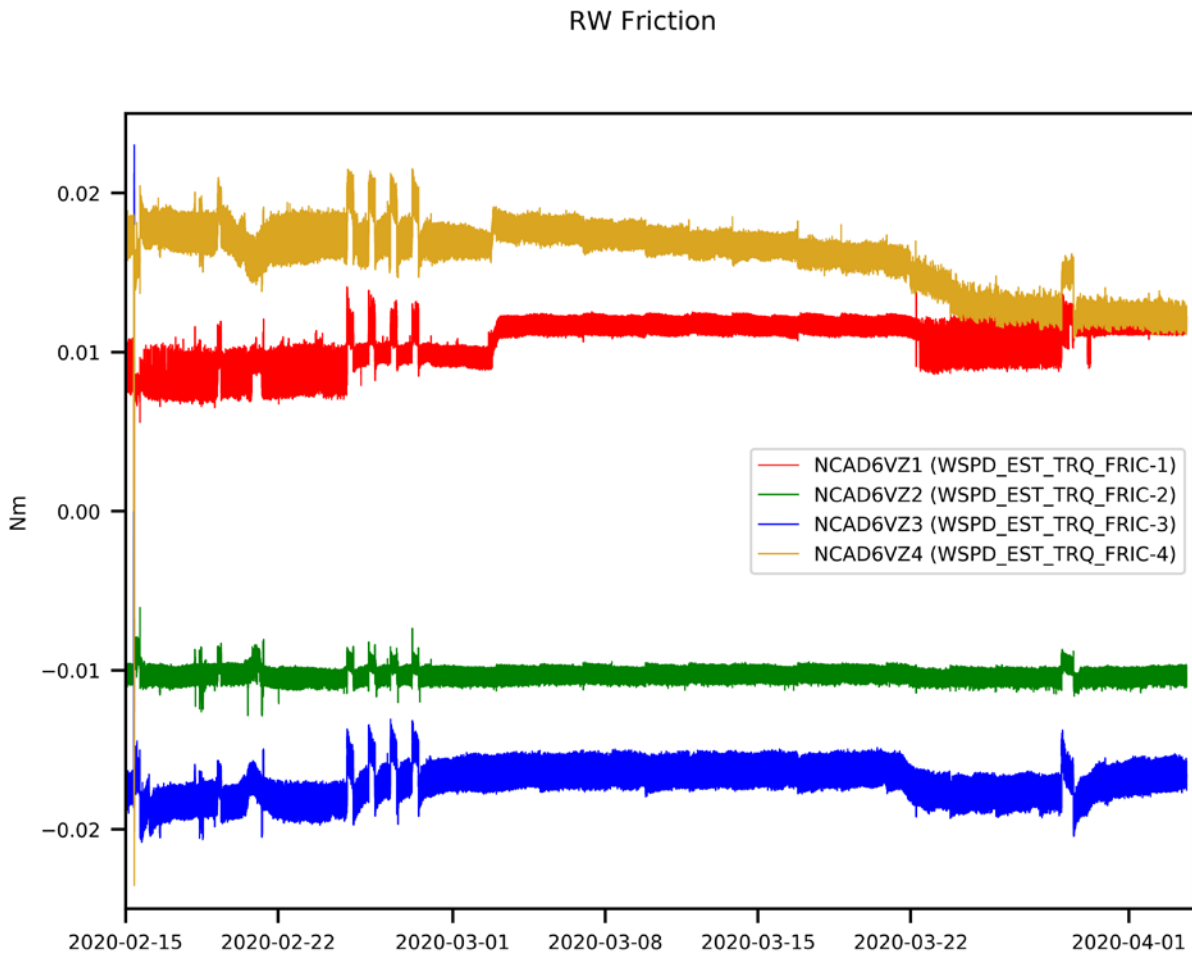
## 6 FUTURE MILESTONES

This is the timeline of future milestones:

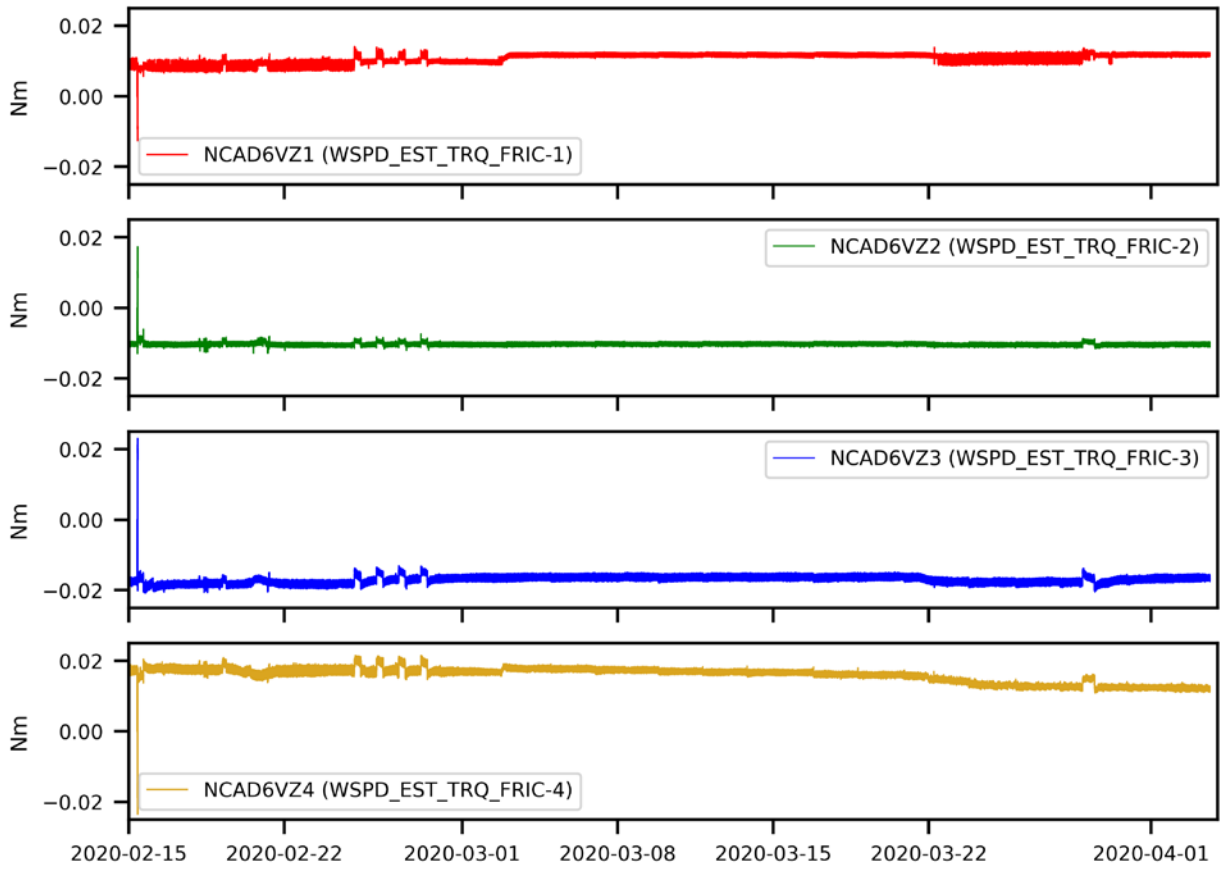
<b>Milestone</b>	<b>Date</b>	<b>Comment</b>
<b>Start of PL NECP week 6 (STP 7)</b>		For PL, only interactive activities are reported
	DoY 097, 06/04/20	WOL from 22:00 to 07/04/2020 @ 01:00 IT-4_1 Interactive METIS IA-5 Interactive SWA
	DoY 098, 07/04/20	IP-4 Interactive PHI IA-5 Interactive SWA
	DoY 099, 08/04/20	WOL from 22:00 to 09/04/2020 @ 01:00 IC-SOU-50 Interactive SPICE IT-4_2-11 Interactive METIS IP-4 Interactive PHI
	DoY 100, 09/04/20	No pass (BepiColombo flyby)
	DoY 101, 10/04/20	WOL from 22:00 to 11/04/2020 @ 01:00 Easter Friday, and ESOC public holiday
	DoY 102, 11/04/20	
	DoY 103, 12/04/20	
<b>Beyond</b>		
NECP Plan currently goes till 03/05. Beyond that will be (re)defined after Easter.		

## 7 ANNEXES

RW friction and bearing temperatures since 15/02 (when all instruments were off) till now.

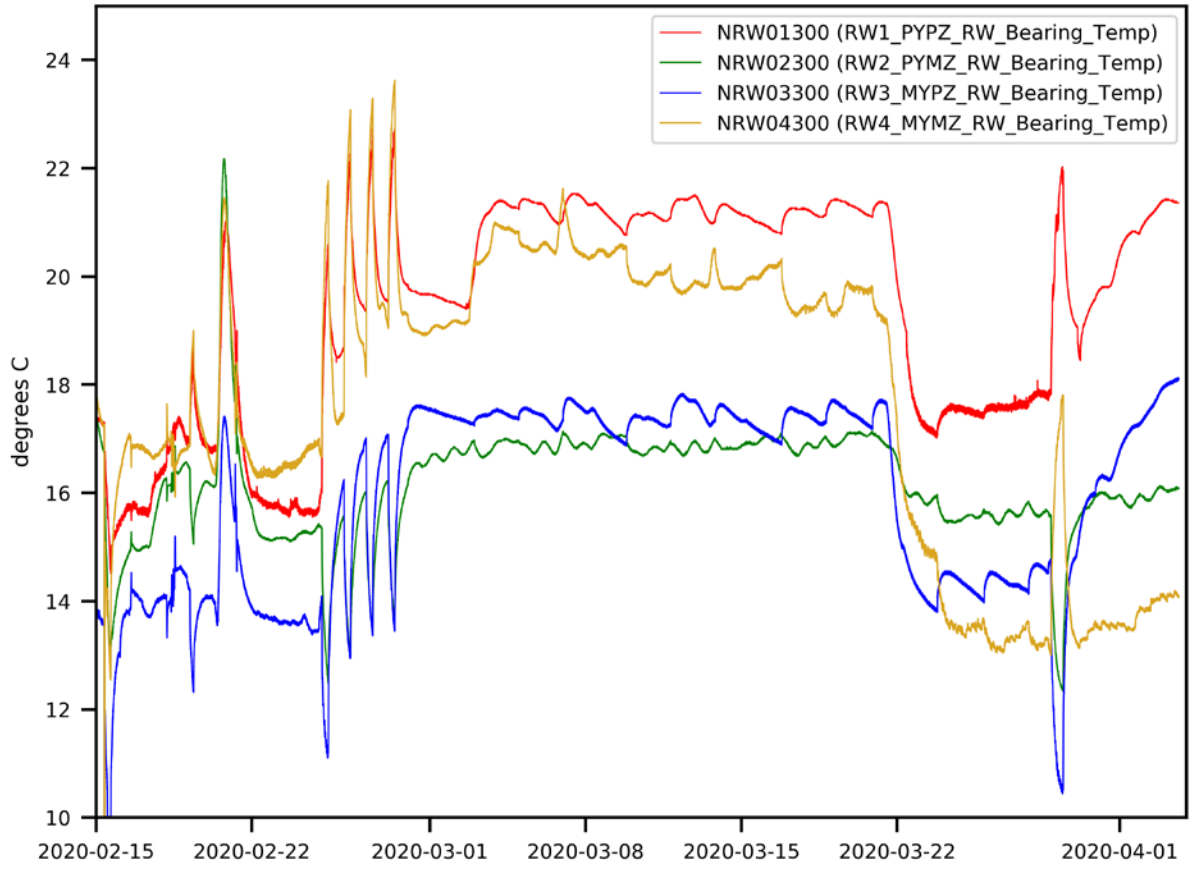


### RW Friction





### RW Bearing Temp





### RW Bearing Temp

