# Low latency improvement

**D.** Berghmans

SOWG, Tuesday 2023 01 17

		Instrument	Type of data product [use case(s)]	Cadence	Total data vol./day
	Gesa	MAG	Magnetic field vector primary (outboard) sensor [1,2]	8s	75 kB <sup>2</sup>
	esac	EPD	SIS science data, all species, low cadence [1,2] Subset of HET, EPT, STEP science data [1,2]	30 min 1s to 1h	4200 kB3 average max 4371 kB
	European Space Astronomy Centre (ESAC) P.O. Box, 78 28691 Villanueva de la Cañada, Madrid, Spain Te (34) 91 8131100 Fax (34) 91 8131139	RPW	TNR Radio flux at frequency close to 1 MHz [1,2]	1s to 15s	Varying: max 400 kB4
<b>DOCUMENT</b> Solar Orbiter Low-Latency Data:	www.es.olu	SWA	PAS moments (counts, density, velocity, pressure) [1-3] HIS charge state ratios & rate spectra [1,3] EAS single energy distribution [1,3]	4s 300s 100s (or 400s)	450 kB 43 kB⁵ 470 kB (or 117 kB)
concept and implementation		Total			max 5.8 MB (TBC)
		Instr.	Type of data product [use case(s)]	Cadence	Total data vol./da
		EUI	<u>Beacon data</u> : low-resolution FSI images (174/304Å) [2,3] <u>Synoptic data</u> : low-cadence, high-quality FSI images [1] If applicable: Sample <u>HRI data</u> (EUV+Ly-a) [1,3]	30 min 1 set/day 1 set/day	~1.5 MB/day <sup>6</sup>
		РНІ	<i>LL data only when change in mode (or pointing)</i> <u>QL: full-disk continuum &amp; magnetogram thumbnail [all*</u> <u>Precursor: continuum &amp; magnetogram 1Kx1Kx8bit [1,3]</u> <u>Calibration:</u> snapshot of calibration products [1]	Not daily ] Few per RSW 1 before RSW start/end RSV	<b>Max 1MB/day</b> 34 kB / QL set <sup>7</sup> 220 kB/precursor W
		SPICE	Each science study is preceded by LL version with same scientific performance. [1]	Varying	<b>Varying:</b> ≤0.1 MB/LL study Max 1 MB/day
Prepared by  Anik De Groof, with input from Solar Orbiter is    Reference  SOL-SGS-TN-0003    Issue  1    Revision  2    Date of Issue  10 Sep 2017    Status  Draft    Document Type  Technical Note    Distribution  SOWG mailing list	nstrument teams	SoloHI	Regular set of horizontal strips to build "J-maps" [3] Compressed sample of detectors or regions of interest [1]	TBD	Max 1 MB/day
		Metis	2 VL image for tB + 1 UV image (all rebinned) [1] 8 light curves for each VL sector	1 set/day 4*DIT <sup>8</sup>	~900 kB/day
	European Space Agency Agence spatiale europeenne	STIX	Light curves per energy band [all*] Flare information data [all*] Energy calibration spectra [1]	45 8s	800 kB/day
		Total			~6.2 MB (TBC)

- It allows crude checks of instrument performance and science data quality (i.e. avoids up to 6 month delay in "seeing" what the instrument did).
  It allows making the selective decision for some instruments that use selective data.
- 3. It allows improvement of pointing profile and/or re-targeting when tracking solar features.

Instrument    Type of data product (use case(s))    Cadence    Total data wol/day      MAG    Magnetic field vector primary (outband) sensor [1,2]    8s    75 kB+      DOCUMENT    Silve construction and sensor [1,2]    90 min    420 kB+      Solar Orbiter Low-Latency Data: Concept and Implementation    SWA    PAS moments (counts, density, velocity, pressure) [1-3]    4s    450 kB      SWA    PAS moments (counts, density, velocity, pressure) [1-3]    4s    450 kB    430 kB      Total    Instr.    Type of data product (use case(s))    Cadence    Total data wol/day      Instr.    Type of data product (use case(s))    Cadence    Total data wol/day      Instr.    Type of data product (use case(s))    Cadence    Total data wol/day      Instr.    Type of data product (use case(s))    Cadence    Total data wol/day      Instr.    Type of data product (use case(s))    Cadence    Total data wol/day      Instr.    Type of data product (use case(s))    Cadence    Total data wol/day      Instr.    Type of data product (use case(s))    Cadence    Total data wol/day      Instr.    Type of data product (use case(s))    Cadence    Total data wol/day <th></th> <th></th> <th></th> <th></th> <th></th> <th>-</th> <th></th>						-	
MAG    Magnetic field vector primary (outboard) sensor [1,2]    8s    75, kB <sup>3</sup> MAG    Magnetic field vector primary (outboard) sensor [1,2]    8s    75, kB <sup>3</sup> DOCUMENT    Subsect of HET, ETP, STEP science data [1,2]    30 min    #200 kB <sup>3</sup> average      Solar Orbiter Low-Latency Data:    Solar Orbiter Low-Latency Data:    SWA    PAS moments (counts, density, velocity, pressure) [1,3]    4s    450 kB      SWA    PAS moments (counts, density, velocity, pressure) [1,3]    4s    450 kB    450 kB      WAG    Magnetic field vector primary (outboard) sensor [1,3]    3soos    450 kB      SWA    PAS moments (counts, density, velocity, pressure) [1,3]    4s    450 kB      SWA    PAS moments (counts, density, velocity, pressure) [1,3]    4s    450 kB      Concept and Implementation    max 5.8 MB (TEC)    Total    max 5.8 MB (TEC)      Total    max 5.8 MB (TEC)    Single energy distribution [1,3]    3o min    -1.5 MB/day      Life data only uber change in mode (or pointing)    30 min    -1.5 MB/day    2so kB /precursor      Life data only uber change in made (or pointing)    30 min    -1.5 MB/day    2so kB /precursor      Life data only uber change in mode (or pointing)<				Instrumen	t Type of data product [use case(s)]	Cadence	Total data vol./day
EPD    SUS science data all species, low cadence [1,2]    30 min    420 MB sverage      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Warying:      Mark 400 kB    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Subsci of HET, EPT, STEP science data [1,2]    is to 1s    Subsci of HET, EPT, STEP science data [1,2]    Subsci of HET, EPT, STEP science data [1,2]    Subsci of HET, EPT, STEP science data [1,2]    Subsci of HET, EPT,			Gesa	MAG	Magnetic field vector primary (outboard) sensor [1,2]	8s	75 kB <sup>2</sup>
Normal Market			esac	EPD	SIS science data, all species, low cadence [1,2] Subset of HET, EPT, STEP science data [1,2]	30 min 1s to 1h	4200 kB3 average max 4371 kB
SWA    PAS moments (counts, density, velocity, pressure) [1-3]    4s    45b kB      SWA    PAS moments (counts, density, velocity, pressure) [1-3]    4s    45b kB      Total    max 5.8 MB (TBC)      Total    max 5.8 MB (TBC)      Instr.    Type of data product [use case(9]]    Cadence    Total data velot      Instr.    Type of data product [use case(9]]    Cadence    Total data velot      Instr.    Type of data product [use case(9]]    Cadence    Total data velot      Instr.    Type of data product [use case(9]]    Cadence    Total data velot      PHI    LL data only when change in mode (or pointing)    1 set/day    1 set/day      PHI    LL data only when change in mode (or pointing)    Not daily    3 at Me/day      Self CE    Each science study is preceded by LL version with    Self at x1/end RSW    2 ot MB/LL stud      Max 1 MB/day    Self energy alimation space for H + 1UV image (all relinmed) [1]    1 set/day			European Space Astronomy (centre IESAL) P.O. Box, 78 28691 Villanueva de la Cafada, Madrid, Spain Tea (24) 91 8131100 Fax (34) 91 8131139 www.ex.int	RPW	TNR Radio flux at frequency close to 1 MHz [1,2]	1s to 15s	<b>Varying:</b> max 400 kB4
Total    max 5.8 MB (TBC)      Instr.    Type of data product [use case(s)]    Cadence    Total data vol./d      Imstr.    Type of data product [use case(s)]    Cadence    Total data vol./d      EUI    Beaceon data-low-resolution FSI images (174/9041) [Lag]    30 min    -1.5 MB/day <sup>6</sup> Synoptic data: low-cadence, high-quality FSI images [1]    1 set/day    1 set/day    -1.5 MB/day <sup>6</sup> PHI    LL data only when change in mode (or pointing)    Not daily    Max 1MB/day      QL: fail-disk continuum & magnetogram IKxIK&Bbit [1,3]    Not daily    Yee wer 8SW    stat/edm RSW      Calibration: snapshot of calibration products [1]    Not daily    Yee wer 8SW    stat/HB/day      SPICE    Each science study is preceded by LL version with same scientific performance. [1]    Varying    Varying:      SoloHII    Regular set of horizontal strips to build "J-maps" [3]    TBD    Max 1 MB/day      SoloHII    Regular set of horizontal strips to build "J-maps" [3]    -900 kB/day      Metis    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    -900 kB/day      Bisht curves for each VL sectors or regions of interest [1]    Metis    SoloHII    SoloHII    SoloHII    SolokB/dai	Solar Orbiter Low-Latency Data:		SWA	PAS moments (counts, density, velocity, pressure) [1-3] HIS charge state ratios & rate spectra [1,3] EAS single energy distribution [1,3]	45 3005 100s (or 400s)	450 kB 43 kB⁵ 470 kB (or 117 kB)	
Instr.    Type of data product [use case(s)]    Cadence    Total data vol./d      EUI    Beasen data: low-resolution FSI images (174/504Å) [a.g]. Synoptic data: low-cadence, high-quality FSI images (174/504Å) [a.g]. Set data vol./d    Son in 1 set/day    -1.5 MB/day <sup>6</sup> PHI    LL data only when change in mode (or pointing) QL: full-disk continuum & magnetogram thumbnail [all <sup>11</sup> ] Few per RSW Calibration: snapshot of calibration products [1]    Not daily Few per RSW 1 before RSW 20 kB/precursor continuum & magnetogram thumbnail [all <sup>21</sup> ] Few per RSW 20 kB/precursor continuum & magnetogram thumbnail [all <sup>21</sup> ] Few per RSW 20 kB/precursor continuum & magnetogram thumbnail [all <sup>21</sup> ] Few per RSW 20 kB/precursor continuum & magnetogram thumbnail [all <sup>21</sup> ] Few per RSW 20 kB/precursor continuum & magnetogram thumbnail [all <sup>21</sup> ] Few per RSW 20 kB/precursor continuum & magnetogram thumbnail [all <sup>21</sup> ] Sol HII    Not daily Regular set of horizontal strips to build "J-maps" [3] Compressed sample of detectors or regions of interest [1]    Max 1 MB/day Max 1 MB/day 20 kB/day 4*DIT*      Present with spea few base transmitteres Register with set of the state of the state of the context register Bierheiter Bier		concept and implementation		Total			max 5.8 MB (TBC)
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Instr.    Type of data product [use case(s)]    Cadence    Total data vol./d      EUI    Beasen data: low-cadence, high-quality FSI images (174/304Å) [E,G] Synoptic data: low-cadence, high-quality FSI images (11)    iset/day iset/day    -1.5 MB/day <sup>6</sup> PHI    LL data only when change in mode (or pointing) QL: full-disk continuum & magnetogram thumbnail [all*] Precursor: continuum & magnetogram thumbnail [all*] Precursor: continuum & magnetogram thumbnail [all*]    Not daily Few per RSW 34 kB / QL set?    Max 1MB/day 20 kB/precursor      SPICE    Each science study is preceded by LL version with same scientific performance. [1]    TBD    Max 1MB/day Max 1 MB/day      SoloHI    Regular set of horizontal strips to build "J-maps" [3] Compressed sample of detectors or regions of interest[1] Decentory with and for solar Other intrament teams where interest int							
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SPICE    Each science study is preceded by LL version with same scientific performance. [1]    Varying    Varying: sol. MB/LL stud Max 1 MB/day      SoloHI    Regular set of horizontal strips to build "J-maps" [3]    TBD    Max 1 MB/day      SoloHI    Compressed sample of detectors or regions of interest [1]    Max 1 MB/day      Netis    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Bight curves for each VL sector    4*DIT8    ~900 kB/day      STIX    Light curves per energy band [all*]    4s    8oo kB/day      Flare information data [all*]    8s    *00 kB/day    *00 kB/day      Total    Total    *00 kB/CTE    *00 kB/CTE				РНІ	<i>LL data only when change in mode (or pointing)</i> <u>QL</u> : full-disk continuum & magnetogram thumbnail [all: <u>Precursor</u> : continuum & magnetogram 1Kx1Kx8bit [1,3] <u>Calibration</u> : snapshot of calibration products [1]	Not daily *] Few per RSW 1 before RSW start/end RS	<b>Max 1MB/day</b> 34 kB / QL set <sup>7</sup> 220 kB/precursor W
Prepared by Reference    Anik De Groof, with input from Solar Orbiter instrument teams Reference    SoloHI    Regular set of horizontal strips to build "J-maps" [3]    TBD    Max 1 MB/day      Name    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Revision    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Netis    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Bight curves for each VL sector    4*DIT8    800 kB/day      Bight curves per energy band [all*]    4s    800 kB/day      Flare information data [all*]    8s    800 kB/day      Flare information spectra [1]    5    76.2 MB (TBC)				SPICE	Each science study is preceded by LL version with same scientific performance. [1]	Varying	<b>Varying:</b> ≤0.1 MB/LL study Max 1 MB/day
Reference    SOL-SOS-TN-0003      Issue    1      Issue    1      Revision    2      Netis    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Netis    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Netis    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Status    Does    Technical Note    2 VL image for tB + 1 UV image (all rebinned) [1]    1 set/day    ~900 kB/day      Does    Tenhical Note    SWG mailing list    SWG mailing list    STIX    Light curves per energy band [all*]    4s    800 kB/day      Flare information data [all*]    8s    Energy calibration spectra [1]    *6.2 MB (TBC)	Prepared by  Anik De Groof, with inpu    Reference  SOL-SGS-TN-0003    Issue  1    Revision  2    Date of Issue  19 Sep 2017    Status  Draft    Document Type  Technical Note    Distribution  SOWG mailing list	Prepared by Anik De Groof, with input from Solar Orbiter	e Groof, with input from Solar Orbiter instrument teams S-TN-0003 2017	SoloHI	Regular set of horizontal strips to build "J-maps" [3] Compressed sample of detectors or regions of interest [1	TBD ]	Max 1 MB/day
Status  Technical Note    Distribution  Technical Note    Distribution  SWG mailing list    European Space Agency  Agence spatial european    Agence spatial european  STIX    Light curves per energy band [all*]  4s    Book B/day    Flare information data [all*]  8s    Energy calibration spectra [1]  -6.2 MB (TBC)		Reference      SOL-SGS-TN-0003        Issue      1        Revision      2        Date of Issue      19 Sep 2017        Status      Deep 2017		Metis	2 VL image for tB + 1 UV image (all rebinned) [1] 8 light curves for each VL sector	1 set/day 4*DIT <sup>8</sup>	~900 kB/day
<b>Total</b> ~6.2 MB (TBC)		Dorument Type Technical Note Distribution SOWG mailing list	European Space Agency Agence spatiale européenne	STIX	Light curves per energy band [all*] Flare information data [all*] Energy calibration spectra [1]	45 85	800 kB/day
			I	Total			~6.2 MB (TBC)

Currently in LTP10, SPICE has 'given' its 1 MB/day to EUI

- It allows crude checks of instrument performance and science data quality (i.e. avoids up to 6 month delay in "seeing" what the instrument did).
  It allows making the selective decision for some instruments that use selective data.
  It allows improvement of pointing profile and/or re-targeting when tracking solar features.

## 3. Pointing

- 1. It allows crude checks of instrument performance and science data quality (i.e. avoids up to 6 month delay in "seeing" what the instrument did).
- 2. It allows making the selective decision for some instruments that use selective data.
- 3. It allows improvement of pointing profile and/or re-targeting when tracking solar features.

- The "last day of FSI datas" are available at <u>https://www.sidc.be/EUI/data/lastDayFSI/</u> This is typically 1 FSI174/304 image pair of 'yesterday' that was brought down per LL.
- At the Pointing Decision Meetings (PDM), these data are loaded in jHelioviewer and combined with MADAWG.
- EUI/FSI is the only source that provides the on-disc configuration in near real time, as seen from Solar Orbiter. This is particular important in the autumn perihelia and in the later phase of the spring perihelia.



#### Ideal/hypothetical situation



- 1 FSI image pair per day is systematically send into Low Latency just before the pass before the PDM, which are typically in the afternoon.
- in principle, the PDM could have a LL data that is ~ 2 -3 hours old.
  In practice it is nearly always >24 hours old

#### More realistically



- 1. The LL data have to queue when an EUI data flush is ongoing. This can take many hours.
- 2. The EDDS data connection to ROB is not entirely stable. Sometimes FSI data are available at ESAC that are not available yet at ROB.
- 3. The as-flown SPICE kernels are not available until after the end of the pass, making the data pointing metadata initially inaccurate.

EUI PDM support would be more consistent/timely if a second LL pair could be taken at the end of the (previous) pass.

### 2. Selective downlink

- 1. It allows crude checks of instrument performance and science data quality (i.e. avoids up to 6 month delay in "seeing" what the instrument did).
- 2. It allows making the selective decision for some instruments that use selective data.
- 3. It allows improvement of pointing profile and/or re-targeting when tracking solar features.
- EUI can, in its internal memory, disregard uninteresting data. This functionality allows to e.g. prioritise flare data.
- To be able to do that we have to get quickly to the ground an inventory of what is currently in memory. These "filesystem list reports" can be 0.3 MiB, often much smaller.
- These reports are currently already generated but not send through Low Latency.



### **Conclusion/ EUI wish list**

- 1. It allows crude checks of instrument performance and science data quality (i.e. avoids up to 6 month delay in "seeing" what the instrument did). 2. It allows making the selective decision for some instruments that use selective data.
- 3. It allows improvement of pointing profile and/or re-targeting when tracking solar features.

LL function	out RSW	in RSW	
1. crude check instrument performance	1 image pair/day: ~1.2 MiB	covered already	
2. selective decision data	1 filesystem list per day: 0.3 MiB	1 filesystem list per day: 0.3 MiB	
3. pointing decision support	NA	2 image pairs/day: ~2.4 MiB	
Total	1.5 MiB (current allocation)	2.7 MiB	