

# Currently Implemented in SPICE MAPPS/EPS Model

SPICE consists of 1 telescope/optical path which includes several mechanisms: SPICE Heatshield Door (state is important), SPICE Door Mechanism, Slit Change Mechanism, Scan Focus Mechanism, and ends in 2 detectors (which work as one). The EPS model of SPICE contains several modules, corresponding to those things which are generally switched on independently of each other, according to the flight procedures and User Manual.

In particular, instead of modelling all SPICE units and subunits (detectors, heaters, mechanisms etc.) separately, we chose to model the SPICE Electronics Box and SPICE Optical Unit each as a module, with different states depending on which subunits are switches ON/OFF (approximately 1 module state per operations mode): (see *sol\_spice\_model.edf*).

Power, unless stated otherwise, is taken from SPICE-RAL-TN-0040 (FM Power Budget Updates) Issue 1.0 (2017/06/19),

## Modes

SPICE has 4 meaningful modes for operations, OFF, STANDBY, ENGINEERING and OPERATE, with submodes defined for the last three.

Power for each submodule (when on) is shown in brackets.

* basic mode for MOC state model.	Command to get there		SPI_SEB (Contains terms in italics on the right)	<i>SPI_SEB: SEB proper</i>	<i>SPI_SEB: Detector Assembly Heater</i>		SPI_SFM	SPI_DOOR	SPI_SCM	SPI_SOU	<i>SPI_SOU: Front End Electronics</i>	<i>SPI_SOU: Particle Deflector System</i>	
OFF*	SPI_OFF		SEB_OFF	SEB_OFF	DA_OFF		SFM_OFF	SDM_CLOSED	SCM_OFF	SOU_OFF	FEE_OFF	PDS_OFF	
STANDBY (Passive)	SPI_SBY_PAS SIVE or SPI_READY_T O_PASSIVE	Results directly from SEB switch-on. Used during CMS contamination measurements with CMS (Ready) state.	SEB_PASSIVE	SEB_ON (14.6)	DA_OFF		SFM_OFF	SDM_CLOSED	SCM_OFF	SOU_OFF	FEE_OFF	PDS_OFF	
STANDBY (Ready/Stable)	SPI_PASSIVE_T O_READY	DA heaters on, PDS on, usually with door open.	SEB_STANDBY	SEB_ON (14.6)	DA_HTR_STBL (2.4) after 1 hours (modelled) of DA_HTR_WUP (3.2)		SFM_OFF	SDM_OPEN	SCM_OFF	SOU_PDS	FEE_OFF	PDS_ON (0.2)	
ENGINEERING (HV Off)	SPI_SBY_TO_ENGOFF or SPI_OPOFF_T O_ENGOFF SPI_OPON_TO_ENGOFF	During preparation for dark calibration	SEB_READY	SEB_ON (14.6)	DA_HTR_STBL (2.4)		SFM_OFF	SDM_OPEN	SCM_OFF	SOU_OPENG	FEE_ON (4.2)	PDS_ON (0.2)	
ENGINEERING (HV On)	SPI_HV_ON_ENGOFF or SPI_SBY_TO_ENGOFF	During preparation for normal science / calibration	SEB_READY	SEB_ON (14.6)	DA_HTR_STBL (2.4)		SFM_OFF	SDM_OPEN	SCM_OFF	SOU_OPENG	FEE_ON (4.2)	PDS_ON (0.2)	
OPERATE (HV Off)	SPI_HV_OFF_OP	Ready for dark acquisitions, no study active	SEB_READY	SEB_ON (14.6)	DA_HTR_STBL (2.4)		SFM_OFF	SDM_OPEN	SCM_OFF	SOU_IDLE	FEE_IDLE (4.5)	PDS_ON (0.2)	
OPERATE (HV On)	SPI_HV_ON_OP	Ready for normal acquisition, no study active	SEB_READY	SEB_ON (14.6)	DA_HTR_STBL (2.4)		SFM_OFF	SDM_OPEN	SCM_OFF	SOU_IDLE	FEE_IDLE (4.5)	PDS_ON (0.2)	

OPERATE (Ready)	SPI_READY_OP	Ready for normal acquisition with scan mechanism	SEB_READY	SEB_ON (14.6)	DA_HTR_STBL (2.4)		SFM_INIT (3.1)	SDM_OPEN	SCM_OFF	SOU_IDLE	FEE_IDLE (4.5)	PDS_ON (0.2)		I
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## Modules

### SPI\_SEB: SPICE electronics box

This has 4 components:

- SEB itself (SEB)
- Detector Assembly (DA)
- ASIC Heater
- Mirror Heater

but they can be modelled as one.

For Science Operations, the SEB has the following module states:

- SEB\_OFF
- SEB\_PASSIVE (DA not warmed up)
- SEB\_STANDBY (DA heaters on)
- SEB\_READY (Ready to take data)

### SPI\_SFM: Scan/focus mechanism

### SPI\_DOOR: Telescope front door

### SPI\_SCM: Slit change mechanism

### SPI\_SOU: SPICE optical unit

### SPI\_DHV: Detector high voltage

## Modes

The following power modes/system states are modelled as SPICE 'modes', and linked to their associated modules (see *sol\_spice\_modes.edf* and *sol\_spice.edf*). Each of the 'mode' switches are modelled as EPS 'actions' with a 1 to 1 correspondence to EPS 'activities' (see *sol\_spice\_activities.edf*).

- **OFF**: All modules OFF, SDM\_CLOSED
- **STANDBY**: SEB\_STANDBY, SOU\_OFF, LL\_OFF
- **ENGINEERING**: SEB\_ENG, SOU\_OFF, LL\_OFF
- **OPERATE**: SEB\_ENG, SOU\_OPERATE, LL\_ON
- **(BOOT mode is currently not modelled)**

Extra EPS activities/actions are written for: (see *sol\_spice\_activities.def* and *sol\_spice.edf*)

- **SPI\_DOOR\_OPEN/CLOSE**: SPICE door (SDM) opening and closing
- **SETSPIDR**: SPICE data rate calculation. *Currently the datarate is just set in the timeline and passed on to the parameter SPI\_DR but this can be updated to automatically calculate based on parameters.*
- **START\_SPI\_STUDY**: this action starts the following timeline of SPICE model actions:
  - switch SEB and SOU in FOCUS state (1min),
  - switch SEB and SOU in SLIT state (1min),
  - calculate SPICE datarate (or pass on datarate parameter)
  - switch SEB and SOU in ACQ state
- **STOP\_SPI\_STUDY**: this action switches all modules back to normal OPERATE mode: SEB\_ENG, SOU\_OPERATE
- (spice flush command: placeholder to be used for LL data flushes - 0.1MB per science study that is run)

The science observing modes are modelled as SPICE 'observations' that all run in OPERATE mode: (see *sol\_spice\_observations.def*)

Currently, datarates are specified when calling the study. However, [in next version of the model we can calculate them based on parameters like nb\\_x\\_positions, repeat, ...](#)

- SPICE\_SPECTRATLAS (DATARATE=28260.0)
- SPICE\_COMPOSITION (DATARATE=420.0 )
- SPICE\_DYNAMICS (DATARATE=17790.0 )
- SPICE\_LIMB (DATARATE=17790.0 )
- SPICE\_CMEWATCH (DATARATE=17790.0 )
- SPICE\_MOVIE30 (DATARATE=34440.0)
- SPICE\_MOVIE90 (DATARATE=11440.0)
- SPICE\_WAVES (DATARATE=75150.0)
- SPICE\_TWOEXPOS (DATARATE=2660.0)

All observations and activities can be called from the observations timeline, see example below and the test timelines in [Tests run on SPICE model](#).

```
#POWER MODE CYCLE
11-JAN-2022_00:00:00 SPI ACTIVITY SPI_OFF
11-JAN-2022_04:00:00 SPI ACTIVITY SPI_STANDBY
11-JAN-2022_08:00:00 SPI ACTIVITY SPICE_DOOR_OPEN
12-JAN-2022_00:00:00 SPI ACTIVITY SPI_ENGINEERING
13-JAN-2022_00:00:00 SPI ACTIVITY SPI_OPERATE
14-JAN-2022_00:00:00 SPI ACTIVITY SPI_STANDBY
14-JAN-2022_08:00:00 SPI ACTIVITY SPICE_DOOR_CLOSE
15-JAN-2022_00:00:00 SPI ACTIVITY SPI_OFF

#SPICE SCIENCE WINDOW - CYCLING THROUGH ALL SCIENCE MODES

RS_WINDOW_START -01:00:00 SPI ACTIVITY SPI_STANDBY
RS_WINDOW_START -00:30:00 SPI ACTIVITY SPI_DOOR_OPEN

RS_WINDOW_START 000_00:00:00 SPI OBS_START SPICE_SPECTRATLAS (DATARATE=28260.0)
RS_WINDOW_START 001_00:00:00 SPI OBS_END SPICE_SPECTRATLAS
RS_WINDOW_START 001_00:00:10 SPI OBS_START SPICE_COMPOSITION (DATARATE=420.0 )
RS_WINDOW_START 002_00:00:00 SPI OBS_END SPICE_COMPOSITION
...
RS_WINDOW_START 008_00:00:10 SPI OBS_START SPICE_TWOEXPOS (DATARATE=2660.0)
RS_WINDOW_END -00:10:00 SPI OBS_END SPICE_TWOEXPOS

RS_WINDOW_END -00:05:00 SPI ACTIVITY SPI_DOOR_CLOSE
RS_WINDOW_END 00:00:00 SPI ACTIVITY SPI_OFF
```

### SPICE science activities with corresponding resource usage

## Power modes / system states as documented in UM Iss7.0 and Detailed Budget Report 3.0 Annex A

EPS Activity (- mode)	EPS Observation	HK Datarate (bps)	LL Datarate (bps)	Science Datarate (bps)	Total documented Datarate (bps)	Total modelled Datarate (bps)	Power documented (Watts)	Power modelled (Watts)
SPI_OFF	/	0	0	0	0	0	0	0
SPI_BOOT <i>not modelled</i>	/	50	0	0	0	/	17.06	/
SPI_STANDBY	/	50	0	0	50	50	14.30	14.30
SPI_ENGINEERING	/	500	0	0	500	500	15.2 (max)	15.2
SPI_OPERATE	IDLE - SPICE only thermally stable	500	0	0	500	593 (incl. 93bps LL)	20.53 (max)	20.53
	SPECTRATLAS	500	variable (0.1MB /study)	28260	28760	28853 (incl. 93bps LL)	max 30.08 W (during 10s to 60s) max 31.25 W (during 20s to 60s) max 24.68 W (during acquisition)	max 30.08 W (during 10s to 60s) max 31.25 W (during 20s to 60s) max 24.68 W (during acquisition)
	COMPOSITION	500	0.1MB /study	420	920	1013 (incl. 93bps LL)		
	DYNAMICS	500	0.1MB /study	17790	18290	18383 (incl. 93bps LL)		
	LIMB	500	0.1MB /study	2690	3190	3283 (incl. 93bps LL)		
	CMEWATCH	500	0.1MB /study	4120	4620	4713 (incl. 93bps LL)		

	MOVIE30	500	0.1MB /study	34440	34940	35033 (incl. 93bps LL)		
	MOVIE90	500	0.1MB /study	11440	11940	12033 (incl. 93bps LL)		
	WAVES	500	0.1MB /study	75150	75650	75743 (incl. 93bps LL)		
	TWOEXPOS	500	0.1MB /study	2660	3160	3253 (incl. 93bps LL)		
SPL_DOOR_OPEN	/	depending on current mode	depending on current mode	depending on current mode	depending on current mode	depending on current mode	power of current mode +8.83 W	power of current mode +8.83 W
SPL_DOOR_CLOSE								

### Link to source documents

- [SPICE detailed budget report Iss3.0](#) - Sect. 4.3 & Annex A : power consumption
- [SPICE User Manual Iss 7.0 DRAFT](#) (extract chapters 1&2 only) : data rates

### Tests run on SPICE model