



# CRaTER Flight and Mission Operations

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CRaTER CDR

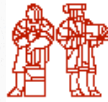


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## Flight Ops

- CRaTER has no flight software
- Any changes in, e.g., discriminator settings, thresholds, etc. would go through the SOC.
  - Do not anticipate changing the parameters often.
- SOC will quickly validate data and request resend from MOC as needed.



## Real-time monitoring

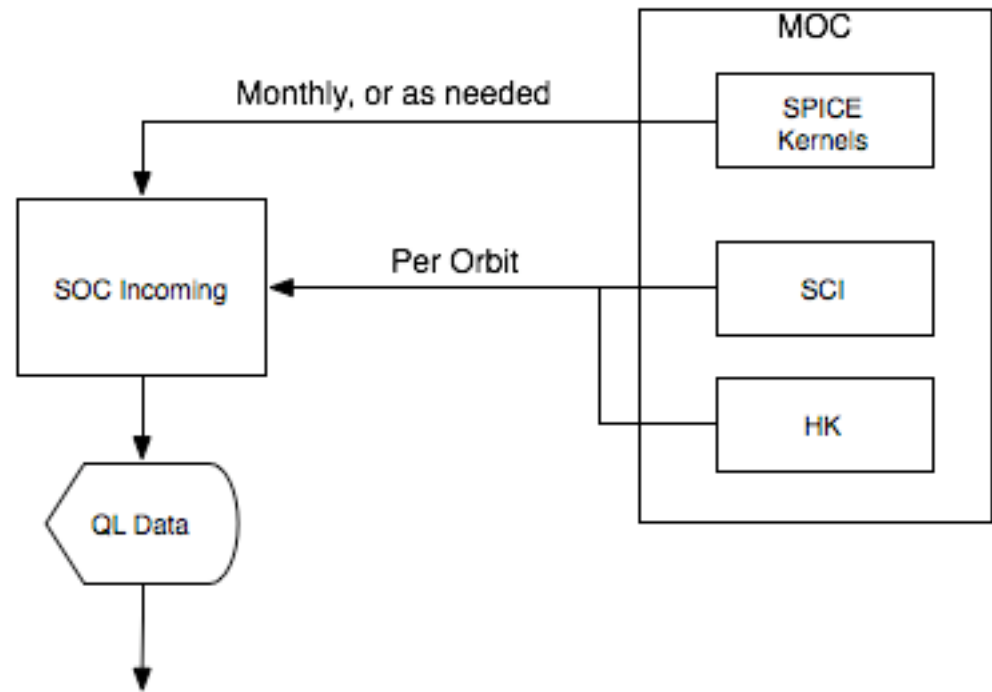
- Housekeeping data are acquired in real-time as available
  - SOC monitors health of instrument (voltage, temperature, etc.) and notifies team if anomalies arise.
  - Would also like singles rates, contained in primary science data stream. Awaiting discussion with MOC regarding ICD contents.
- SEC/SRAG real-time desires are minimal and non-binding.
  - Integrated count-rate once per orbit, tens of minutes after orbit completion.
  - Integrated energy deposited in D1 and D2, per orbit.
  - the temporally resolved (~once per minute) count rate, dumped once per orbit, for at least the D1 and D2 detectors (Level 1)
  - temporally resolved (~once per minute) deposited energy (ie, dose), dumped once per orbit, for at least the D1 and D2 detectors (Level 2)

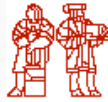
## Mission Ops

- Data are pulled/pushed from the LRO MOC on a per-orbit basis.
- These files are:
  - Instrument Level 0 science data (contains primary and secondary science)
  - Instrument housekeeping data
  - Real-time files
- Spice kernels downloaded monthly, or as needed based on updates.
  - CRaTER data are not mapped to the lunar surface, so kernels are not required to create CRaTER standard data products.

# SOC Processing (1)

- Data are pushed/pulled per orbit to the SOC
- QL plots are immediately generated
- Once validated, data are
  - Staged for write to CD/DVD (constitutes L0 archive)
  - Staged for conversion to L1





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## SOC Processing (2)

- The SOC produces three Level 1 files (ascii)
  - Amplitude in each detector for processed events, 1-s resolution
  - Secondary science, 1-s resolution
  - Housekeeping data, 16-s resolution
- Samples to follow

# CRaTER L1 Science

sclk	01-01-2006T01:01:00.000	1	det1	det2	det3	det4	det5	det6
sclk	01-01-2006T01:01:00.000	2	det1	det2	det3	det4	det5	det6
sclk	01-01-2006T01:01:00.000	3	det1	det2	det3	det4	det5	det6
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
sclk	01-01-2006T01:01:00.000	308	det1	det2	det3	det4	det5	det6
sclk	01-01-2006T01:01:01.000	1	det1	det2	det3	det4	det5	det6
sclk	01-01-2006T01:01:01.000	2	det1	det2	det3	det4	det5	det6
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
sclk	01-01-2006T01:01:01.000	947	det1	det2	det3	det4	det5	det6
sclk	01-01-2006T01:01:02.000	1	det1	det2	det3	det4	det5	det6
sclk	01-01-2006T01:01:02.000	2	det1	det2	det3	det4	det5	det6

At maximum data rate (1200 events/second), ~400 MB/orbit; rate typically well below (factor of 10-100) this.



# CRaTER L1 Secondary Science

sclk	01-01-2006T01:01:00.000	s1, s2, s3, s4, s5, s6, discarded events, etc.
sclk	01-01-2006T01:02:00.000	s1, s2, s3, s4, s5, s6, discarded events, etc.
sclk	01-01-2006T01:03:00.000	s1, s2, s3, s4, s5, s6, discarded events, etc.
sclk	01-01-2006T01:04:00.000	s1, s2, s3, s4, s5, s6, discarded events, etc.

Primarily interested in singles rates





# CRaTER L1 Housekeeping

```
sclk, 01-01-2006T01:01:00.000, bc1, bc2, bc3, bc4, bc5, bc6, thin V, thick V, T, ...  
sclk, 01-01-2006T01:17:00.000, bc1, bc2, bc3, bc4, bc5, bc6, thin V, thick V, T, ...  
sclk, 01-01-2006T01:33:00.000, bc1, bc2, bc3, bc4, bc5, bc6, thin V, thick V, T, ...  
sclk, 01-01-2006T01:49:00.000, bc1, bc2, bc3, bc4, bc5, bc6, thin V, thick V, T, ...  
sclk, 01-01-2006T02:03:00.000, bc1, bc2, bc3, bc4, bc5, bc6, thin V, thick V, T, ...
```



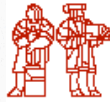
## SOC Processing (3)

- Level1 data are validated and staged for writing to CD/DVD
- Level 1 Data are immediately staged for processing to Level 2 data
  - Require only calibration files for processing to Level 2.

# SOC Processing (4)

- Level 2 data are similar to Level 1 primary science data, with event amplitude converted to energy and addition of Si LET

sclk	01-01-2006T01:01:00.000	1	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
sclk	01-01-2006T01:01:00.000	2	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
sclk	01-01-2006T01:01:00.000	3	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
sclk	01-01-2006T01:01:00.000	308	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
sclk	01-01-2006T01:01:01.000	1	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
sclk	01-01-2006T01:01:01.000	2	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
sclk	01-01-2006T01:01:01.000	947	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
sclk	01-01-2006T01:01:02.000	1	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.
sclk	01-01-2006T01:01:02.000	2	det1	det2	det3	det4	det5	det6	LET1	LET2	etc.



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## SOC Processing (5)

- Processing through Level 2 will begin immediately as data are received - requires no additional information.
- Data are delivered to PDS every 3 months (still being negotiated in LDWG).



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# SOC timeline

Table 2 SOC Data Management Schedule

Activity or Document	2006												2007												2008												
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
<SOC Milestone 1>																																					
SOC Requirements doc				1		2																															
ICD: SOC-PDS Discipline						1		2																													
SOC DM&AP								1		2																											
<SOC Milestone 2>																																					
<SOC Milestone 3>																																					
<SOC Milestone 4>																																					
SOC Test Plan										1		2																									
SOC IT Security Plan																		1		2																	
SOC S/W Release 1																																					
SOC S/W Release 2																																					
I/F Tests: SOC internal																																					
ETE Tests: SOC internal																																					
SOC->PDS: Data Prod SIS																		1		2																	
Review of DP SIS & doc mod																			X	X																	
SOC->PDS: Archive Vol SIS																		1		2																	
I/F Tests: SOC-PDS Node																				X	X	X															
I/F Tests: LOLA SOC-SOCs																				X	X	X															
I/F Tests: MOC-SOC																					X	X	X														
Tests: Ground System																					X	X	X	X													
Tests: Operations																					X	X	X	X													
SOC->PDS: INST.CAT, DATASET.CAT, PERSON.CAT, REF.CAT																																			X		
SOC->PDS: DP method&algorithm																																			X		
SOC Operations																																			X	X	X

Notes: 1) Document versions- 1= draft, 2 = final; 2) Ground System & Operations Testing- actual dates, types of tests, and goals are as agreed between LRO Project Ground System Test Lead & SOC; 3) Items shown as '<SOC milestone>' or items without dates are determined by SOC Manager (e.g., SOC Peer SRR, Peer PDR, Peer CDR, SOC Design Document, etc.); 4) ETE is End-to\_End Data Flow; 5) PDS holds Peer Review of Data Product SIS. SOC changes document as appropriate.



## SOC near-term Activities

- Finalize SOC requirement document
  - Draft submitted to Stan Scott (LDWG)
- Draft SOC-PDS ICD due end of July
- Draft DM&AP due end of August
- Internal peer review October, +/-
  
- Prepare for engineering model data
  - Requires L0->L1 and L1->L2 processing code, and archiving capability
  - Will enable us to test SOC internal processing dataflow well before formal SOC testing.



# Backup slides

*Cosmic RAY Telescope for the Effects of Radiation*



# CRaTER Data Products

	Description
Level 0	Unprocessed instrument data (pulse height at each detector), secondary science (singles), housekeeping.
Level 1	Science data depacketed, 1-s resolution. Ancillary data pulled in (spacecraft attitude, calibration files, etc)
Level 2	Pulse heights converted into energy deposited in each detector. Calculation of Si LET spectra.
Level 3	
Level 4	Calculation of TEP LET, incident energies and particle flux. Pull in GCR data from other spacecraft (e.g. ACE).