Virtual SPICE Training Class
BepiColombo

Marc Costa Sitja

ESA SPICE Service
by RHEA Group

22nd July 2020, Webex

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Agenda (updated)

Tuesday (21st July)

- 09:30 – 10:00 Introduction to SPICE (00)
- 10:00 – 11:00 SPICE fundamentals (01-02)
- 11:15 – 13:00 SPICE fundamentals (03-13)
- 13:00 - 14:00 Lunch Break
- 14:00 - 15:20 SPICE fundamentals (14, 15, 17)
- 15:40 – 16:30 Setting up SPICE
- 13:00 - 17:30 Hands-on SPICE (I): Remote Sensing Observation Tutorial

Wednesday (22nd July)

- 09:30 - 10:00 SPICE fundamentals (18, 16)
- 10:00 - 11:00 Hands-on SPICE (II): Remote Sensing Observation Tutorial
- 11:15 - 12:15 WebGeocalc and SPICE-enhanced Cosmographia (19)
- 12:15 - 13:00 SPICE for BepiColombo
- 13:00 - 14:00 Lunch Break
- 14:00 – 16:15 Hands-on SPICE (III): Venus first swingby
- 16:30 – 17:30 Wrap-up: Open Discussion, Q/A, AOBs

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SPICE for BepiColombo

A look at particulars and to the SKD

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SPICE Kernel Dataset

- A SKD consists on a complete set of SPICE Kernels that cover the whole mission lifespan including long term predicted trajectory and orientation. Kernels in a SKD can be classified in two main types:
  - **Setup kernels (STK)** [FK, IK, PCK, LSK] are developed by the ESA SPICE Service (ESS) and are reviewed and iterated with the SGS and with the Instrument Teams when need be during the whole duration of the mission.
  - **Time-varying kernels (TVK)** [SPK, CK, SCLK, MK] are generated by ESS with an operational pipeline and the source data is provided by the Flight Dynamics or the given SGS Downlink group in terms of OEMs, AEMs and Housekeeping TM data.

- The distribution of the SKDs is done via:

An operational FTP with all the kernels that were ever produced: **ftp://spiftp.esac.esa.int/data/**SPICE

Peer-reviewed kernels are published as PDS3/4 Bundles in the PSA FTP

A permanent link to a ZIP file that contains the the latest operational subset of the SPICE Kernels

A BitBucket Git repository with a given subset of the SPICE Kernels (operational, planning, archived etc.). **Https://repos.cosmos.esa.int/socci/projects/SPICE_KERNELS**

SPICE Kernel Dataset

- The main purpose is to provide a complete, consistent, high-quality, validated and up-to-date SPICE Kernel Dataset (SKD)

[bc_ops_]**v210_20191015_001**[.tm]

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v210_20191015_001

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v210_20191015_001

- ESS has focused efforts on systematically providing meta-kernels (**MK**) to users.
  - The **operational subset** (implemented by the meta-kernel *bc_ops.tm*) includes all the data, and the predicted attitude is superseded by the measured one from the HK TM.
  - The **planning subset** (implemented by the meta-kernel *bc_plan.tm*) only includes predicted from FDy.

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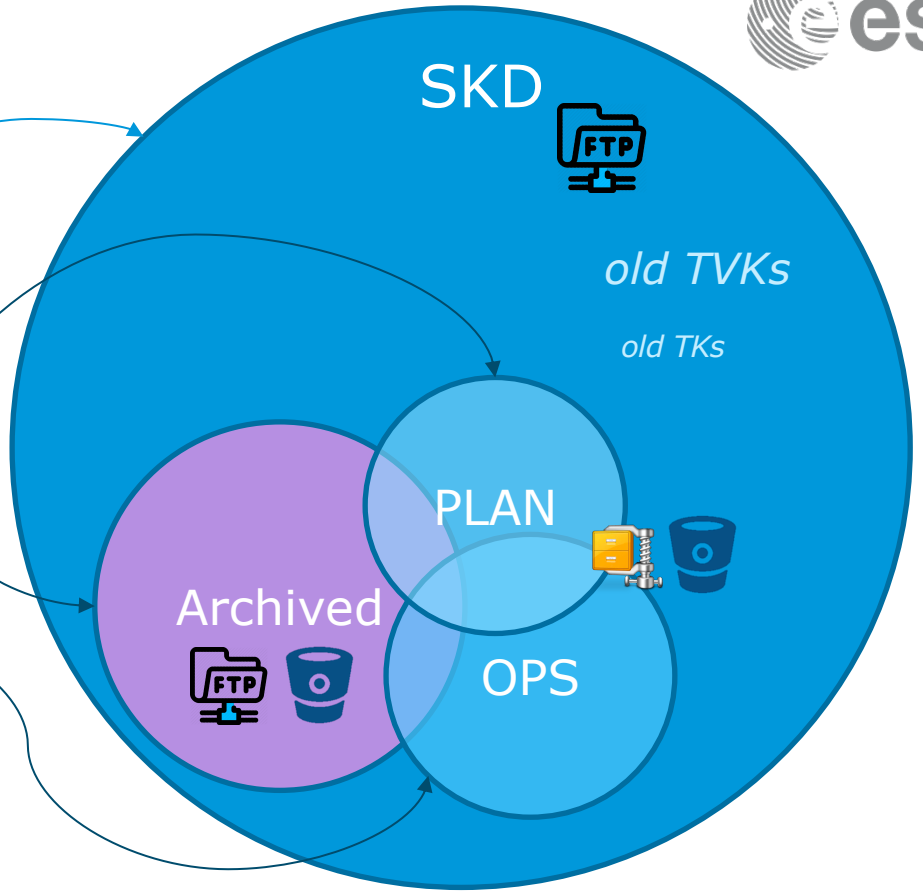
SPICE Kernel Dataset

SKD: Evergrowing, contains all the SPICE kernels ever produced for the mission

ARCHIVED (PSA): Contains a snapshot of the OPS with peer-reviewed kernels that are fed back into OPS and SLK

OPS: New STKs and TVKs are added and old ones are removed but are still part of SKD

PLAN: New TVKs are added and old ones are removed but are still part of SKD



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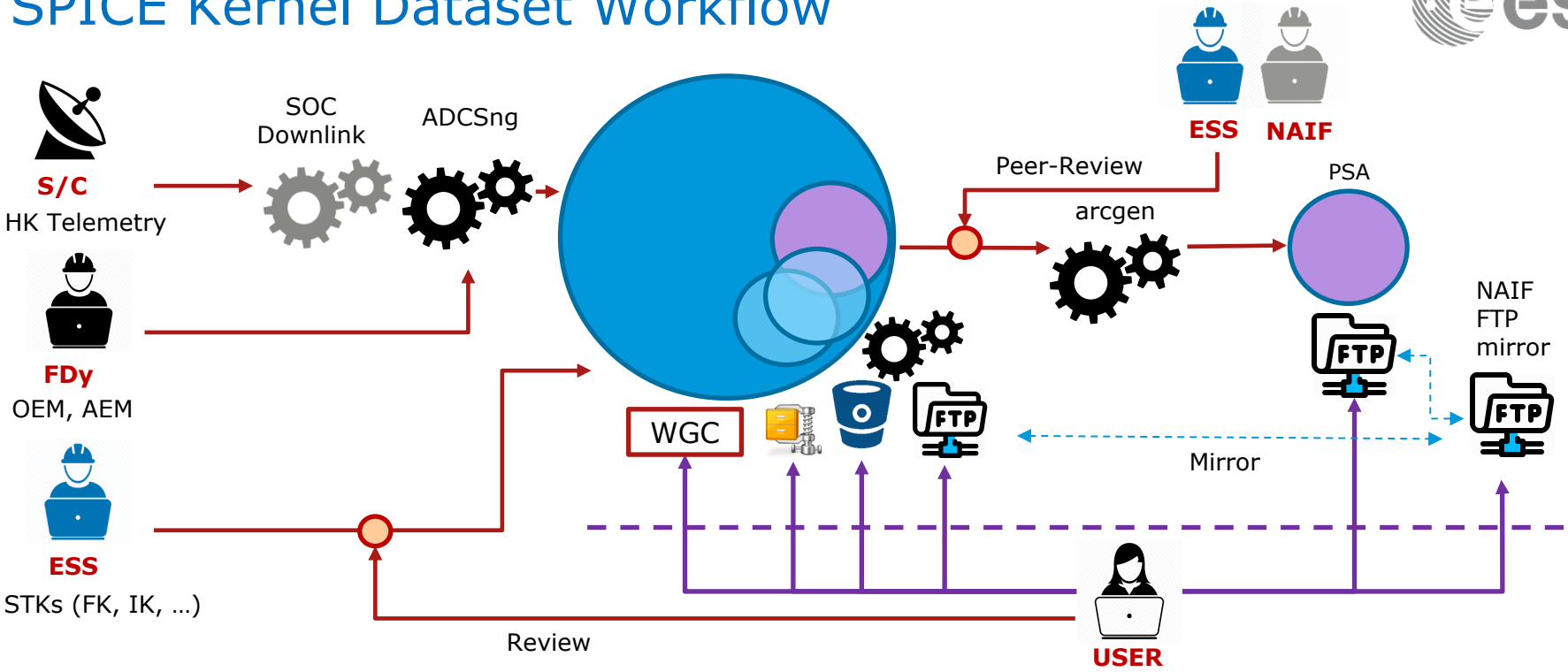
SPICE Kernel Dataset Workflow



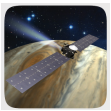
- The Auxiliary Data Conversion System next-generation (ADCSng) generates the time-varying kernels when the mission is in operations and provides up-to-date time correlation, trajectory and orientation information to users.

Some comments on SKDs, WGC and COSMO

- The **META-KERNEL** is the centralizing item

- The BitBucket SKD includes a subset based on the contents of the OPS and the PLAN meta-kernel
- Each run of the ADCSng pipeline is a new Git tag **v210_20191015_001**
- This ensures inter-operability in between internal and external users and with WGC

- Permanent link with the latest version of the SKD, can be downloaded any time:
  ftp://spiftp.esac.esa.int/data/SPICE/BEPICOLOMBO/misc/skd/BEPICOLOMBO.zip

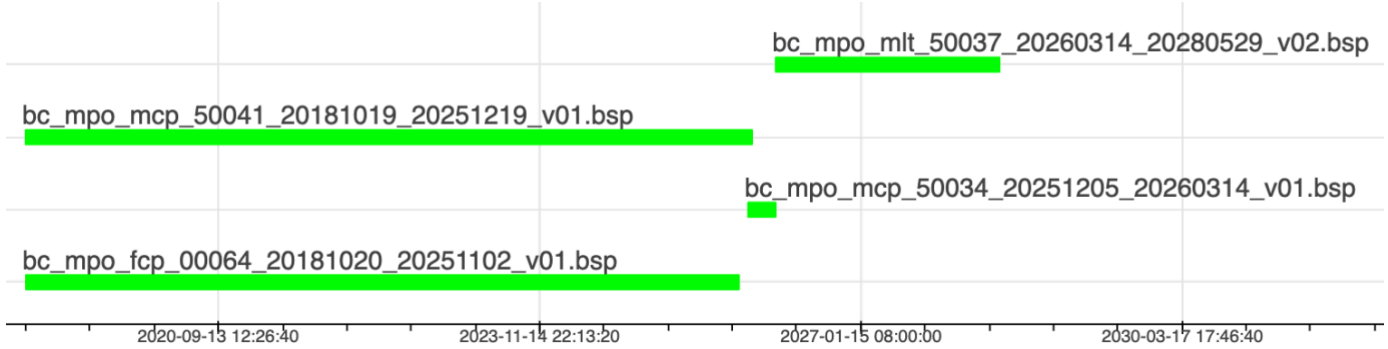


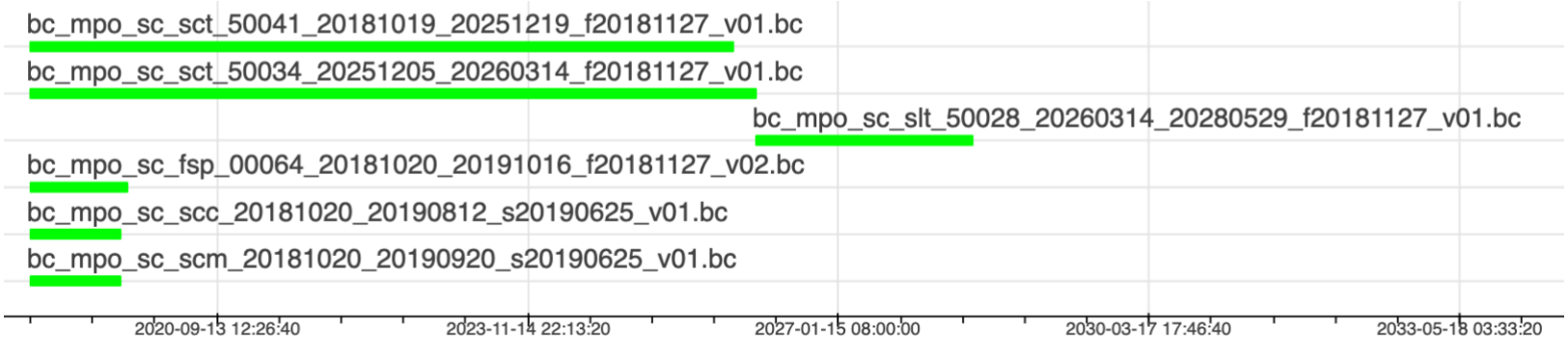
- Cosmo configuration is available in the misc directory of the SPICE Kernels Dataset
- Sensor model is available for each instrument (if not, let us know)

WebGeocalc
Version 2.1.0 (4386 N66 11-FEB-2019)

- WGC has now available a RESTful interface: http://spice.esac.esa.int/webgeocalc/documents/api-info.html
- There is a Python package forked at the ESS Github: https://github.com/esaSPICEservice/python-webgeocalc

Coverage and applicability of SPKs and CKs





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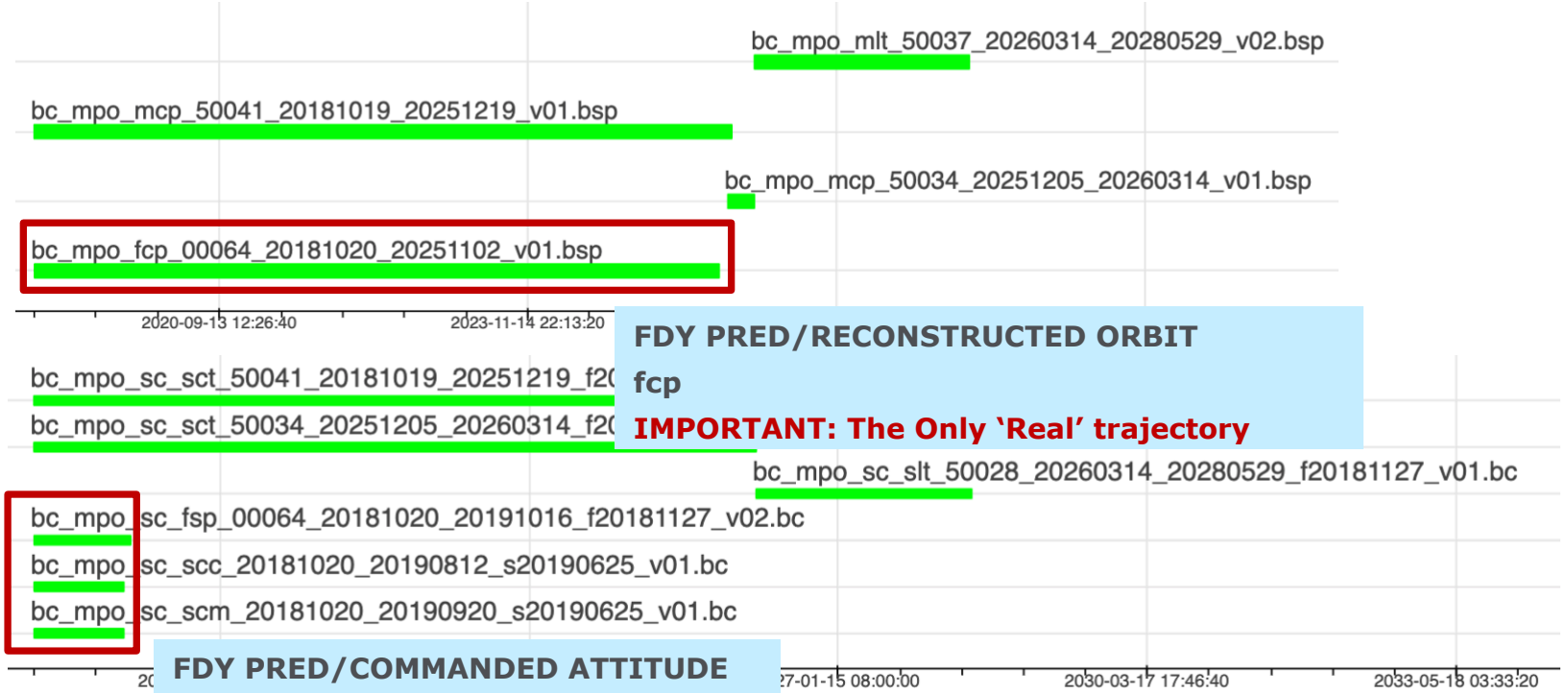
Coverage and applicability of SPKs and CKs



FDY PRED/RECONSTRUCTED ORBIT

fcp

IMPORTANT: The Only 'Real' trajectory

FDY PRED/COMMANDED ATTITUDE

fcp, scc, scm

IMPORTANT: The Only 'Real' attitude

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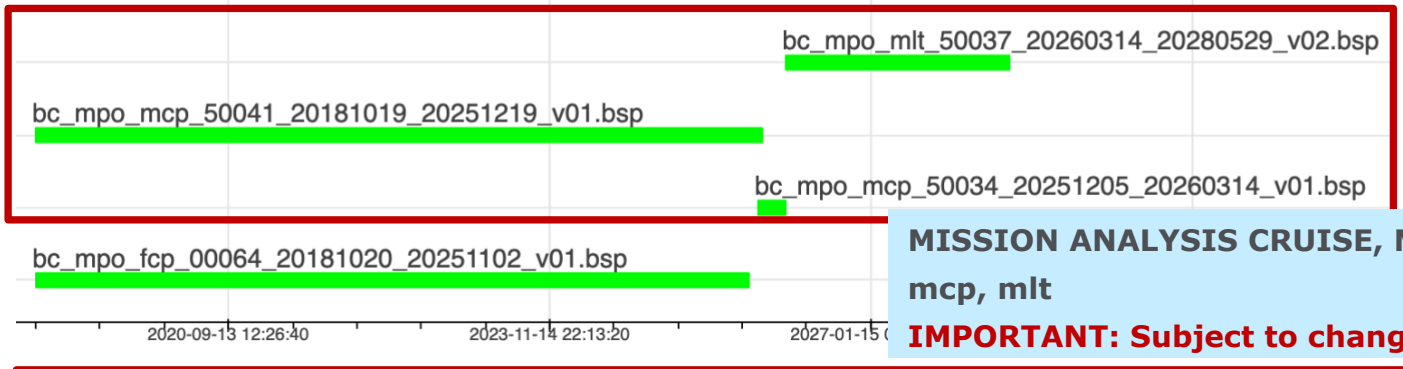
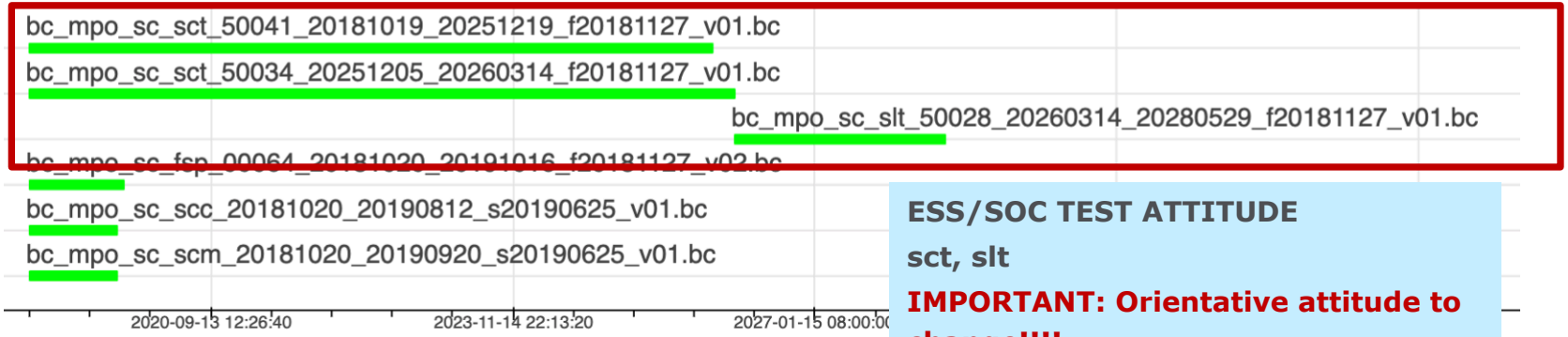
Coverage and applicability of SPKs and CKs



MISSION ANALYSIS CRUISE, MOI, SCIENCE

mcp, mlt

IMPORTANT: Subject to change



ESS/SOC TEST ATTITUDE

sct, slt

IMPORTANT: Orientative attitude to change!!!!

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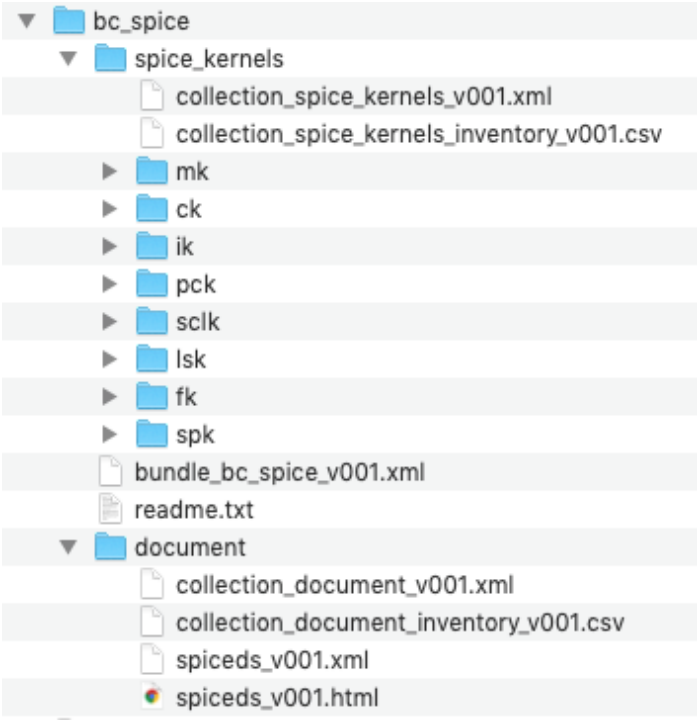
BepiColombo PDS4 Bundle

- ESA—NASA MOU is now activated for SPCE
  - We can now receive direct support from NAIF/JPL
  - For the time being we would ask/recommend not to ask questions to them, they are still not familiar/peer reviewed the kernels.
- This means that we can perform peer-reviews of the kernels and therefore we are GO for releasing the PDS4 Bundle
- Schedule for the release:
  - April 2020: Internal iterations to fine tune PDS4 issues
  - July 2020: Generation of PDS4 Bundle with data up to ~July 2020
  - August 2020: Provision of SKD to NAIF for peer-review
  - September 2020: Publication of the first PDS4 Bundle
  - After 09/2020 and every 6 months: Increment of the PDS4 Bundle.
- Details of the PDS4 Bundle can be found in the PDS4 Archiving Guide of the PSA and/or you can check the em16_spice PDS4 Bundle which is already public.



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Citing SPICE data

- We have incorporated DOIs for the SPICE Kernels Datasets (Operational and Archived).
- Please use them to cite your work.

ESA SPICE Service, BepiColombo Operational SPICE Kernel Dataset, https://doi.org/10.5270/esa-dwuc9bs

- DOI is indicated in the SPICE collection label of the PDS4 Bundle.
- We will also implement version control of the DOIs but a new DOI will not be issued per version
- And please do the same with the other ESA SPICE Kernel Datasets that you use.

- In addition please keep citing the 'SPICE' paper
- DOI: 10.1016/0032-0633(95)00107-7

Acton, C. H. 1996, Planet. Space Sci., 44, 65

bepicolombo

Operational SPICE Kernel Dataset
DOI: 10.5270/esa-dwuc9bs

Operational SPICE Kernel Dataset Information

IDENTIFIER	BEPICOLOMBO
NAME	BepiColombo SPICE Kernel Dataset
TYPE	Operational Dataset
VERSION	Click for latest version
DESCRIPTION	The BepiColombo SPICE kernel dataset (SKD) contains the operational observation geometry and other ancillary data in the form of SPICE System kernel files for the MPO, MMO and MTM spacecrafts and its instruments and targets.
SEARCH/ACCESS DATA	BepiColombo SPICE Kernel Dataset (FTP) BepiColombo SPICE Kernel Dataset Subset (Git) BepiColombo SPICE Kernel Dataset Subset (ZIP)
Citation	
AUTHOR LIST	ESA SPICE Service
DOI	10.5270/esa-dwuc9bs
GUIDELINE	ESA SPICE Service, BepiColombo Operational SPICE Kernel Dataset, https://doi.org/10.5270/esa-dwuc9bs
Context	
START DATE TIME	2015-01-01T00:00:00.000Z
STOP DATE TIME	2050-01-01T00:00:00.000Z
INVESTIGATION	BepiColombo
OBSERVING SYSTEM	MPO, MMO, MTM
TARGET	MERCURY
Contact Points	
Prime	ESA SPICE Service
Backup	Marc Costa Sitjà
Related Datasets	
PDS4 Bundle	
Ancillary Data Collection	urn:esa:psa:bc:miscellaneous
Operational Ancillary Data Dataset	BEPICOLOMBO