SESAME

in a nutshell

M. Knapmeyer, v3.2, 29.10.2014

Introduction

The purpose of this document is to provide a condensed, visual compilation of the whereabouts of SESAME components for quick reference. The document is designed for printing on A3 paper, such that it may be mounted on office doors or walls near the user‘s desk. Graphical representations are believed to be self-explanatory. It is, however, assumed that the user is familiar with the SESAME experiment and only needs reminders for some details.

The document consists of three parts:

1. „SESAME in a nutshell“ shows a top view of the Philae lander, with positions of all SESAME components marked and tables containing numerical position data.
2. „Rosetta Orbital Calendar“ visualizes the motion of comet 67P/Churyumov-Gerasimenko throughout the solar system, highlighting the places and times of key events
3. This introduction, containing explanations of the previous pages and giving the references on which the former rely.

The document uses three colours to signify different types of content:

1. Coordinate frames and the respective scale bars are drawn in a light gray.
2. Objects like instruments, but also celestial body orbits are drawn in black.
3. Designations of objects and events are drawn in red.

The support by F. Finke (DLR MUSC, LCC) in producing technical drawings and determining coordinates is gratefully acknowledged.

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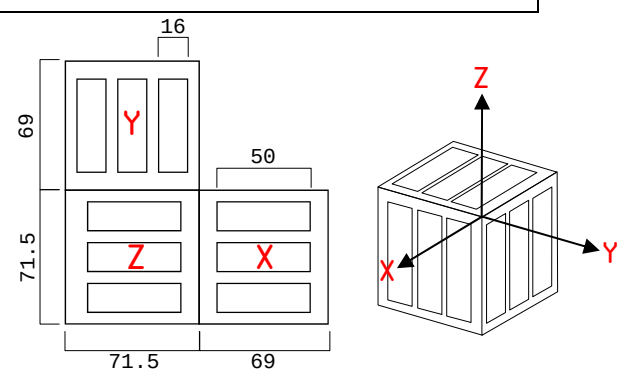
Locations in R_{LDR} and R_{LGF} [mm, deg]				
	Frame	X	Y	Z
DIM APXS MUPUS SD2	R_{LDR}	198.8	375.5	679.0
	R_{LGF}, ζ=θ=ρ=0	-197.7	375.5	868.0
	R_{LDR}	75.0	-200.0	0.0
	R_{LGF}, ζ=θ=ρ=0	-321.5	-200.0	189.0
	R_{LDR}	34.0	-200.0	0
	R_{LGF}, ζ=θ=ρ=0	-362.5	-200.0	189.0
	R_{LDR}	76.1	258.5	0
	R_{LGF}, ζ=θ=ρ=0	-32.04	258.5	199.0

Locations and Orientations in R_{LGF} [mm, deg]				
		X	Y	Orientation
ACC TRM	+X	+1416.98	+75.02	+Z: 90
	+Y	-796.00	+1245.02	+Z: 210
	-Y	-651.11	-1283.85	+Z: 330
	+X	+1416.98	-75.02	0
	+Y	-651.11	+1283.85	120
	-Y	-796.00	-1245.02	240

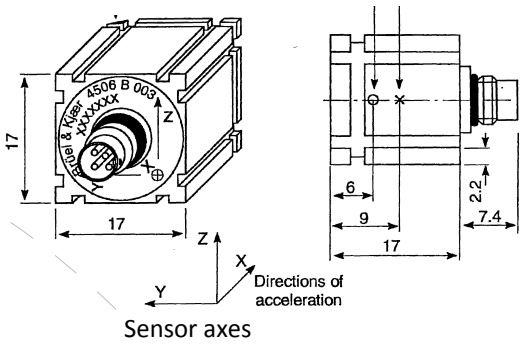
Mutual Distances [mm]			
	+X TRM	+Y TRM	-Y TRM
+X ACC	150	2395.47	2576.76
+Y ACC	2576.76	150	2490.08
-Y ACC	2395.47	2567.72	150



Seismic mass barycenter

ACC barycenter

Sensor area = 3 x 24 cm² = 72 cm²



Sensor axes

DLR

SESAME in a Nutshell

The SESAME experiment consists of the three instruments CASSE, DIM, and PP. Two of these, CASSE and PP, are not housed in a single box, but consist of several parts distributed over the entire lander.

The main part of the „SESAME in a Nutshell“ page is a top view technical drawing of the Philae lander, placed in a simplified polar coordinate system.

The overview figure shown on the right highlights the following groups of sub-figures:

A. Table of locations of DIM, APXS (center of hole in balcony floor), MUPUS (tip of PEN), and SD2 (Borehole in balcony bottom) in the lander body coordinate frame, R_{LDR}, as well as in the Landing Gear coordinate Frame, R_{LGF}. The coordinates of APXS, MUPUS, and the SD2 tip will change after deployment, and the R_{LGF} coordinates of all three instruments will change if the lander body is rotated (angle θ), lifted, or tilted (angles ρ and ζ). In cruise configuration, all rotation and tilt angles are zero.

B. The coordinates of CASSE transmitters and accelerometers, as well as the distances between them.

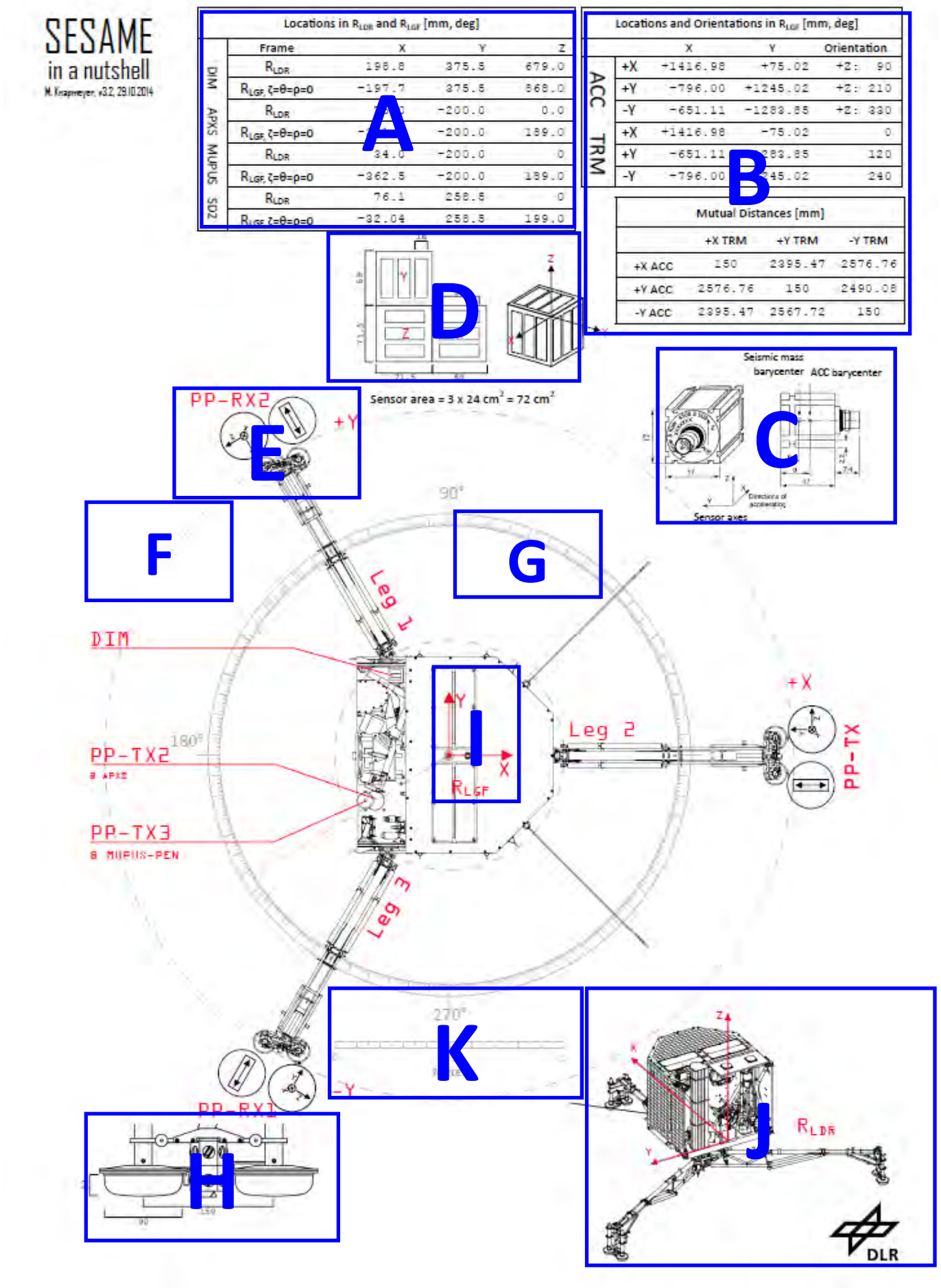
C. A technical drawing of a CASSE accelerometer (taken from B&K documentation), visualizing the dimensions and axis orientations with respect to the accelerometer cubicle. When printed on A3 paper, this drawing will have almost the actual size. Note that the X, Y, Z axes of the accelerometer do not correspond to the X, Y, Z axes of the reference frames R_{LDR} and R_{LGF}, please refer to item E, too.

D. Unfolded and perspective view of the DIM sensor cube, with face designations and size and area of sensor facets. The origin of the XYZ coordinate system is drawn at the DIM coordinate reference point given in A.

E. At each foot of the lander, the foot and PP electrode designations are applied. Two circular sketches show the orientation of CASSE transmitters and accelerometers. Take care not to confuse the accelerometer axes with those of the landing gear or lander reference frame.

F. Dashed circles with radii of 0.5 and 1.5 meters show distances from the origin of R_{LGF}.

G. At a radius of 1 m, an angular scale with degree resolution is drawn to facilitate direction measurements.



H. Detail side view of a foot, with measures of soles and sole distance.

I. Origin and orientation of the landing gear reference frame R_{LGF}.

J. Perspective view of the Philae, showing origin and orientation of the lander body reference frame R_{LDR}.

K. Scale bar with a length of 1 m and tick marks every 5 cm (short) and every 10 cm (long).

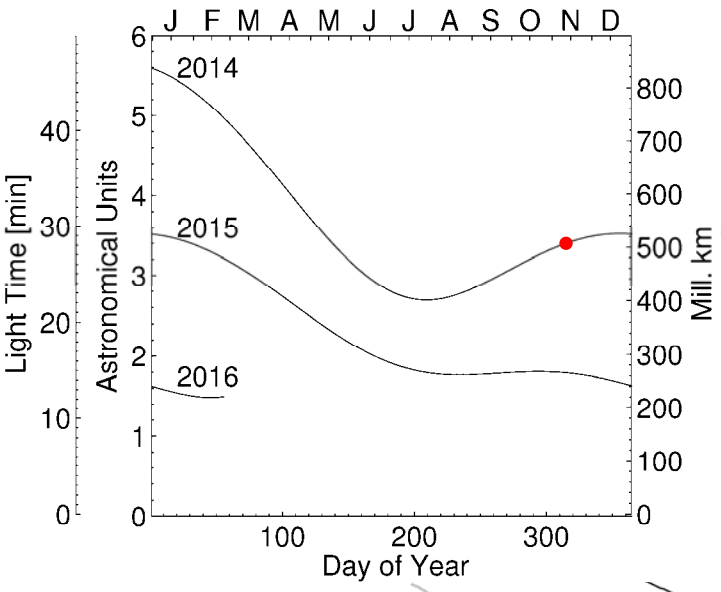
ROSETTA

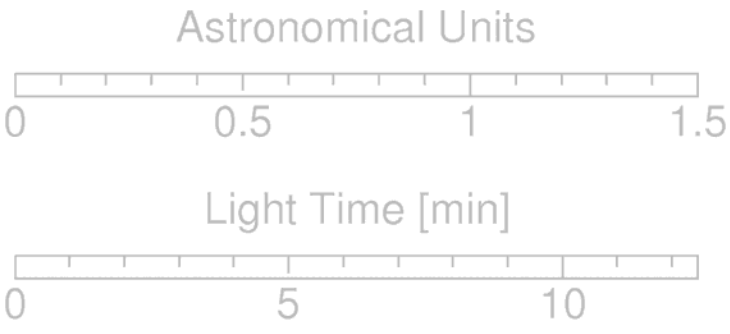
Orbital Calendar

M. Knapmeyer, v3.2, 29.10.2014

Perihelion
13.08.2015 @ 1.25 AU

Perigee
15.02.2016 @ 1.49 AU





Landing
12.11.2014

Begin Lander delivery
26.10.2014

Begin Global Mapping
10.09.2014

1st Rendezvous Burn
21.05.2014

Lander Wake-Up
28.03.2014

Orbiter Wake-Up
20.01.2014

Start 1st Medium Term Planning cycle
07.05.2014

Orbit Insert
06.08.2014 @100 km

ESS
Escort @ 30 km
10 km
20 km
30 km
50 km

Landing Preparation Time Line		
Day	Date	Item
L-110	24.07.2014	300 m shape model available
L-92	11.08.2014	10% accurate comet mass
L-90	13.08.2014	16 m shape model available
L-80	23.08.2014	5 landing site candidates defined
L-30	12.10.2014	preferred landing site selected
L-0	12.11.2014	nominal landing date

DLR

Rosetta Orbital Calendar

The orbital calendar is an orbit-shaped calendar, i.e. the positions of both Earth and 67P/Churyumov-Gerasimenko are drawn with high resolution and markers for daily positions throughout 2014 and early 2015. Orbits were computed via the JPL Horizons webpage, see there for details.

Orbits are drawn for selected bodies only. Mercury and Venus were omitted to use the space inside the Earth‘s orbit as explained in items C and E below. Ceres is the largest body outside Mars‘ orbit that falls within the plot area. Jupiter‘s orbit is entirely outside.

As the Earth‘s orbit has a shorter period than the comet, the Earth‘s positions are drawn only for 2014. The positions for a given date in 2014 and the same date in 2015 are not far apart such that this inaccuracy was accepted for increased clarity of the plot.

The calendar consists of the following main parts:

A. Orbits of Earth and 67P/C-G are drawn in a „barbed wire“ style with circular symbols for each day and tick marks every other day. The circular markers are open for weekdays and filled in light gray for saturdays and sundays. Two sets of tick marks are applied: at the inner side of the orbit, the day of year (DOY) is marked with short marks for every even day number, long marks for every tenth day, and numbers 1, 100, 200, and 300 at the ticks for the respective DOYs. At the outer side of the orbit, calendar dates are marked with short ticks for even dates, long ticks for the tenth, twentieth and thirtieth of the month. At the first day of each month, an abbreviated month name is applied. Along the comet‘s orbit, the first of January is also marked by the year. See also item L.

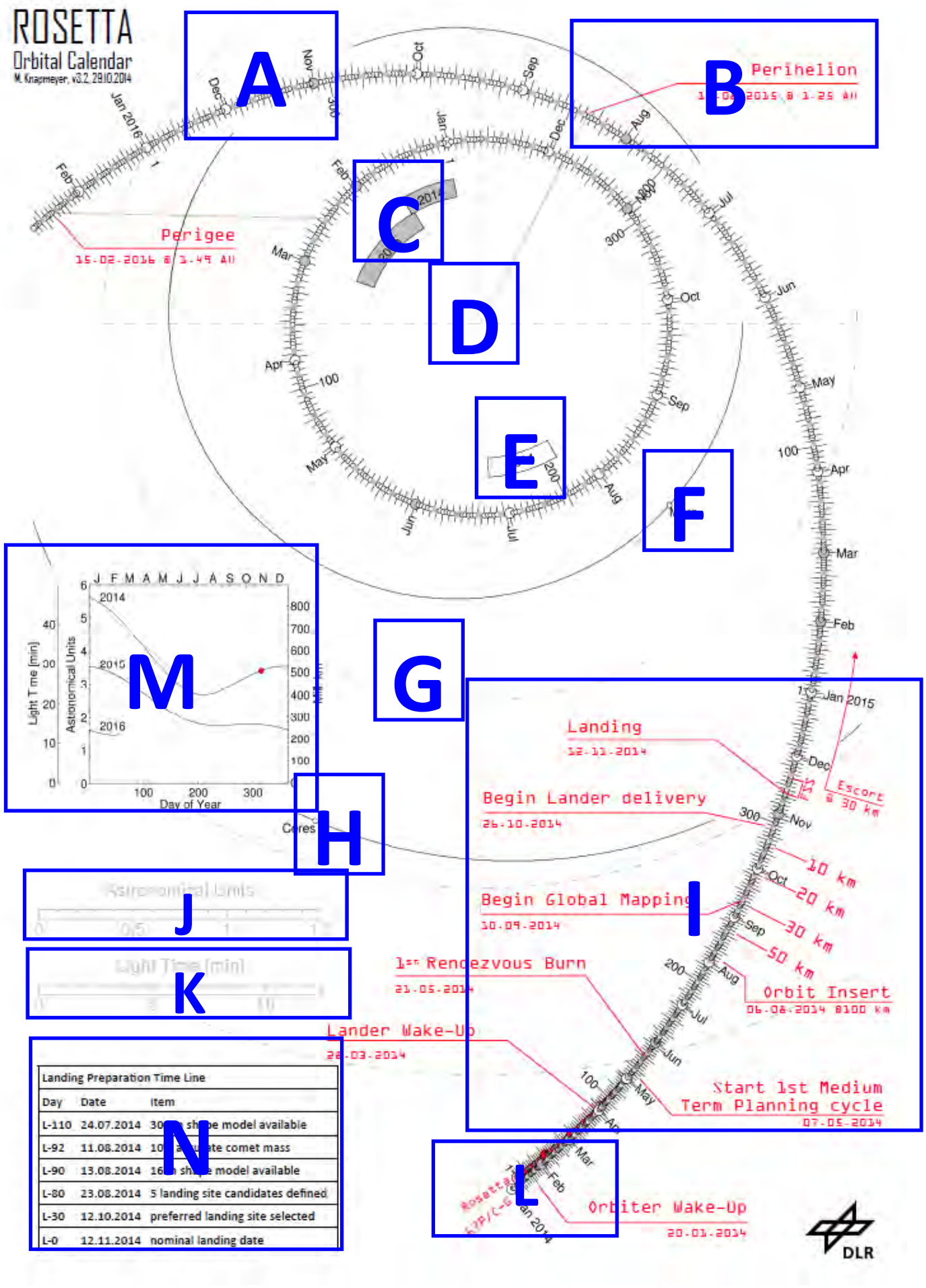
B. The perihelion of the comet‘s orbit is labeled with date and distance from the Sun. A radius line is also drawn from the Sun to the position of the comet at perihelion. The perigee is marked in the same way.

C. Conjunctions are marked by gray circle segments inside the Earth‘s orbit, with the year of the conjunction given inside the segment. The Mission calendar defines conjunctions and oppositions as times when the angle sun-spacecraft-Earth is smaller than 5°. See also item E.

D. The coordinate origin of this figure is at the solar system barycenter.

E. Oppositions are marked by white circle segments inside the Earth‘s orbit, with the year of the opposition given inside the segment. See also item C.

F. The orbit of Mars is drawn without time ticks. The position of Mars for 11. Nov. 2014 (the planned landing date at the time of the first issue of this document) is marked by a small circle and a name label.



Landing Preparation Time Line		
Day	Date	Item
L-110	24.07.2014	30[illegible] shape model available
L-92	11.08.2014	10[illegible]ate comet mass
L-90	13.08.2014	16[illegible] shape model available
L-80	23.08.2014	5 landing site candidates defined
L-30	12.10.2014	preferred landing site selected
L-0	12.11.2014	nominal landing date

G. Distance circles with radii of 2, 3, 4 astronomical units are drawn for scale.

H. The orbit of Ceres is drawn without time ticks. The position of Ceres for 11. November 2012 is marked by a small circle and a name label.

I. A selection of mission key events as well as distances between orbiter and comet are marked.

J. Length scale labeled in Astronomical Units, with ticks at every 0.1 AU and labels every 0.5 AU.

K. Length scale in units of light travel time, with ticks every minute and a label ever 5 minutes. Note that 1 AU corresponds to 8 m 19 s light time, and 1 minute light time corresponds to 0.12 AU or about 18 million km.

L. In early 2014, the distance between Rosetta and 67P/C-G is large enough to be visible on the scale of the calendar. The orbit of the spacecraft is also drawn in „barbed wire“ style from 01. Jan. 2014 to 30. Apr. 2014, but using red symbols. In this time range, the DOY scale is applied to the spacecraft trajectory only, while the date scale is applied to the comet orbit only.

M. Distance between 67P/C-G and Earth, with different time and distance scales. for the three years for which the orbit is drawn. The nominal landing day is marked by a red dot. The light time scale denotes the light travel time for a single way.

N. A table of dates relative to the landing day, listing important dates for the preparation of the landing. These dates are not attached to the orbit curve for clarity. Version 3.1: dates prior to release date were not updated.

References

Brüel & Kjaer 4506B003 Calibration Chart

CASSE Scientific Interpretation RO-LSE-UG-3121, v. 0.38, 23.11.2013

Drawing „PHILAE_Legs unfolded“ by F. Finke, DLR, 21.11.2013

Drawing „PHILAE LG TOP-View“ by F. Finke, DLR, 11.12.2013

Drawing „Philae_SD2_borehole“ by F. Finke, DLR, 24.10.2014

Drawing „Sesame Sender-Sohle“ by Kosciels-ki, MPAE, RO-LLG_DW_3508053-BC, rev. 01, 28.11.2000

Drawing „Rosetta Lander unfolded configura-tion“ by B. Chares, MPAE, RO-LLG-DW-35006 -BC, 30.05.2001

Ephemerides from JPL Horizons web site http://ssd.jpl.nasa.gov/horizons.cgi#top

Flandes, A., et al. (2013) Dust Impact monitor (DIM) onboard Rosetta/Philae: Comparison of experimental results and the theory be-hind the experiment, Planet. Sp. Sci., vol. 84, 122-130

Rosetta lander configuration Summary RO-DSS-TN-1179m, iss. 1, 27.01.2003

Rosetta Lander User Manual 5.1 RO-LAN-UM -3100_DLR, iss. 5, rev. 1, 07.09.2012

Rosetta Mission Calendar, RO-ESC-PL-5026, Issue 3.1, 20. Nov. 2013

Seidensticker, K.J., et al. (2007) SESAME – An experiment of the rosetta lander philae: ob-jectives and general design, Sp. Sci. Rev., vol. 128, 301-337

Tech. Note Reference Frames, Models and Conventions for Rosetta Lander Ground Seg-ment RLGS-NT-TECH-9179_CNES, iss. 1, rev. 6, 28.06.2013