www.cdpp.eu

Planetary data distribution by the French Plasma Physics Data Centre (CDPP): - the example of Rosetta Plasma Consortium in the perspective of Solar Orbiter, Bepi-Colombo and JUICE

Vincent Génot (1), Nicolas Dufourg (2), Myriam Bouchemit (1), Elena Budnik (3), Nicolas André (1), Baptiste Cecconi (4), Michel Gangloff (1), Joelle Durand (2), Frédéric Pitout (1), Christian Jacquey (1), Alexis Rouillard (1), Nathanaël Jourdane (1), Dominique Heulet (2), Benoit Lavraud (1), Ronan Modolo (5), Philippe Garnier (1), Philippe Louarn (1), Pierre Henri (6), Marina Galand (7), Arnaud Beth (7), and Anthony Allen (7)

(1) IRAP/CNRS/UPS, Toulouse, France (vincent.genot@irap.omp.eu), (2) CNES, France, (3) Noveltis, France, (4) LESIA, Observatoire de Paris, France, (5) LATMOS, France, (6) LPC2E, CNRS, France, (7) Department of Physics, Imperial College London, London, UK

The CDPP

- Is established in 1998 in Toulouse by CNRS and CNES to archive plasma physics data for space mission with French participation
- Is a gathering of both scientists and engineers who participate voluntarily or as part of their duty
- Widens its scope since 2006 when AMDA is open and simplifies data access, visualization and analysis
  - In particular those from NASA/PDS (*see session OPS3 tomorrow*)
- Participated and participates in several Virtual Observatory projects whose aim is also to simplify data access, visualization and analysis
- Is part of the data distribution pipeline for Solar Orbiter (SWA) and JUICE (RPWI)
- Distributed data from the Rosetta Plasma Consortium (RPC) during the proprietary period

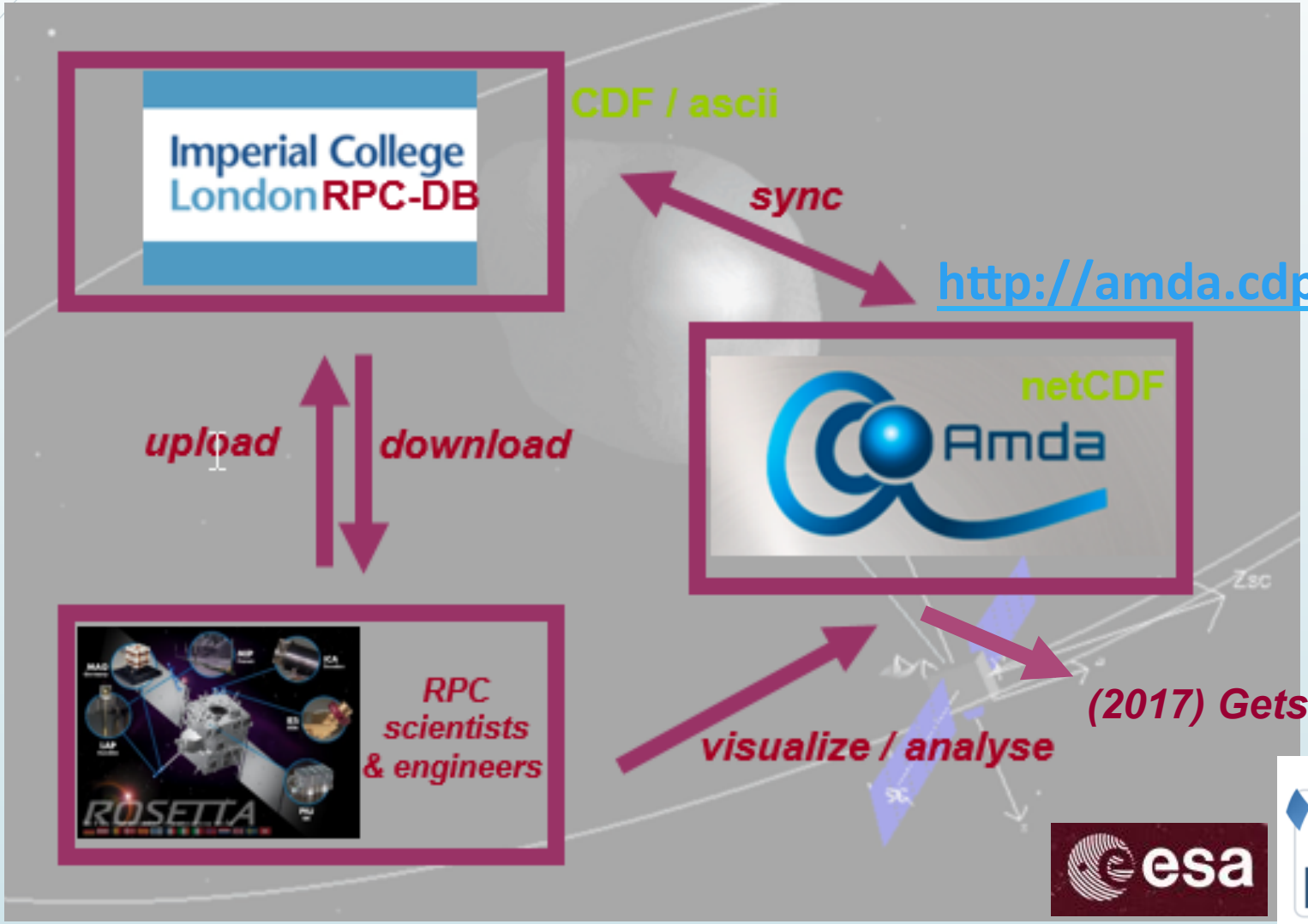
CDPP role in RPC data distribution and valorization

- Initial RPC pipeline: all teams sent their data to Imperial College London where they were transformed in CDF. No visualization is provided at the time
- *Spring 2014*: RPC leads ask CDPP to provide a quick-look system such that the team at large (including post-docs, PhD, …) can browse data, select events, …
- *Fall 2014*: CDPP proposes a customized version of AMDA where data from all instruments can be visualized. This environment is only accessed by the RPC team. RPC leads must give their approval before a new RPC user is registered.
  - http://amda.cdpp.eu/
- *October 2016*: end of operation

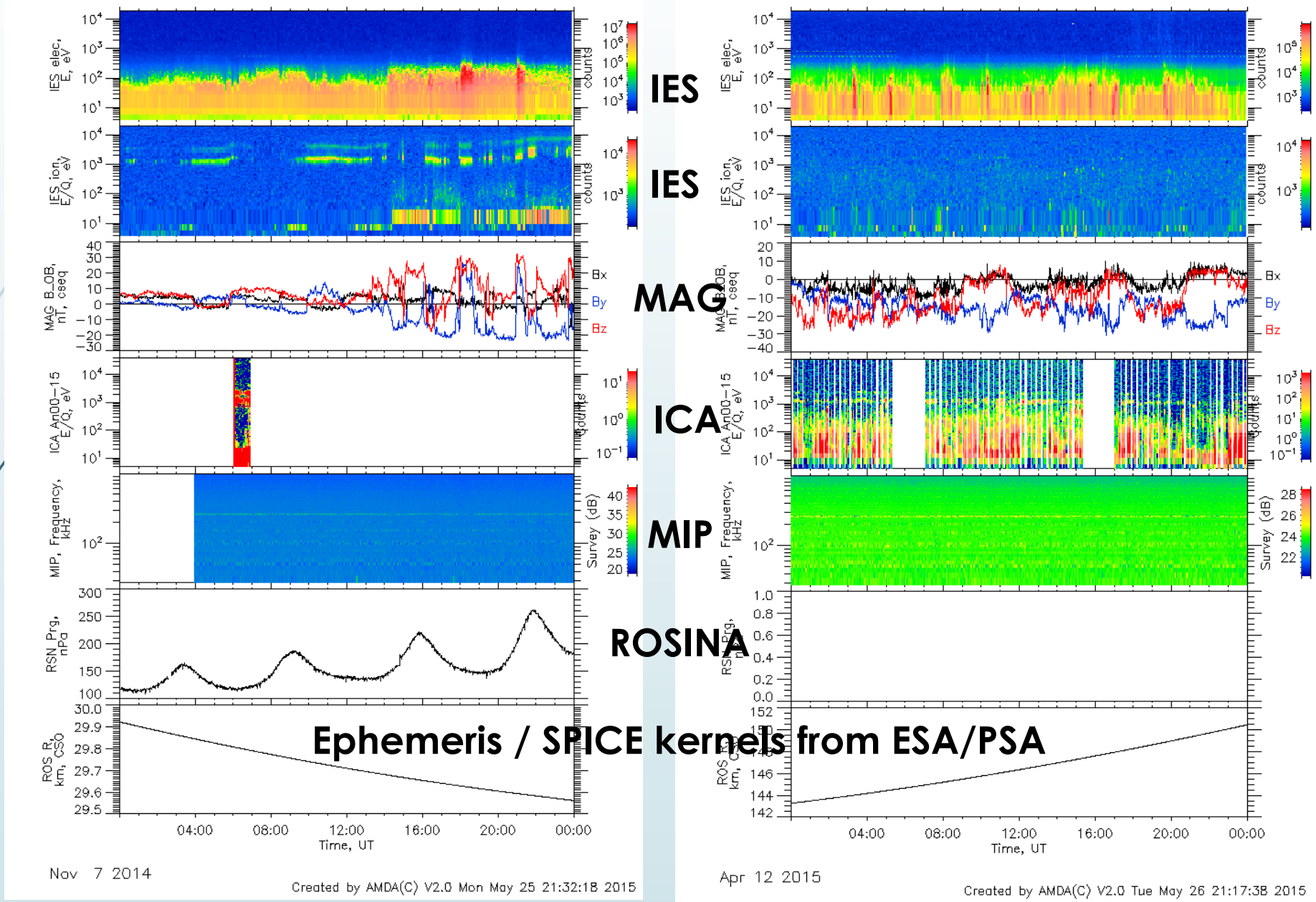
CDPP role in RPC data distribution and valorization

- Data are in different levels of calibration
- Limitations were applied by the AMDA system at the request of PIs on download, data mining, and parameter combination capabilities due to the above reason
- From beginning of 2017 data are progressively replaced by those available at PSA if different from those in AMDA. They're now public without access or manipulation restriction.
- For some instruments the data in AMDA and those delivered at PSA are the same

Data distribution of RPC data during the proprietary phase



RPC data in AMDA



CDPP role in RPC data distribution and valorization

- An hands-on session (via Webex) was organized early in the project to have RPC scientists accustomed to the tool
- RPC data were available in AMDA but also in 3Dview (also only to RPC members)
  - http://3dview.cdpp.eu/
- Complementary data were made available to the scientists in AMDA:
  - Giotto and ICE data
  - model data : Solar Wind conditions propagated at 67P (1D MHD, *Tao et al.*, 2005)

See session MG2 Tuesday afternoon
Goutenoir et al.

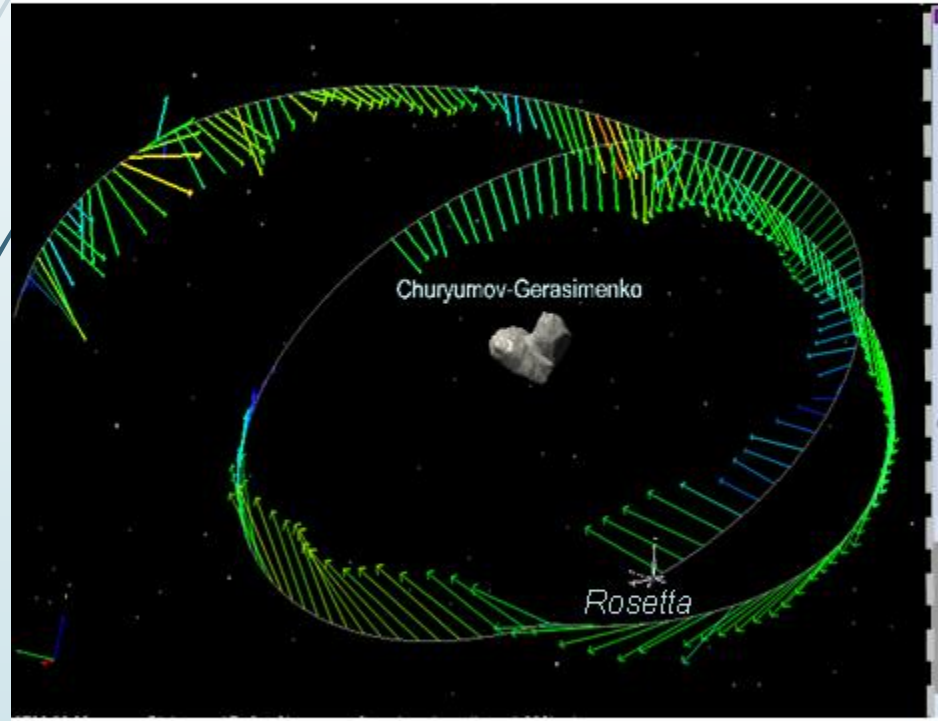
Use of AMDA + 3DView in the Rosetta context

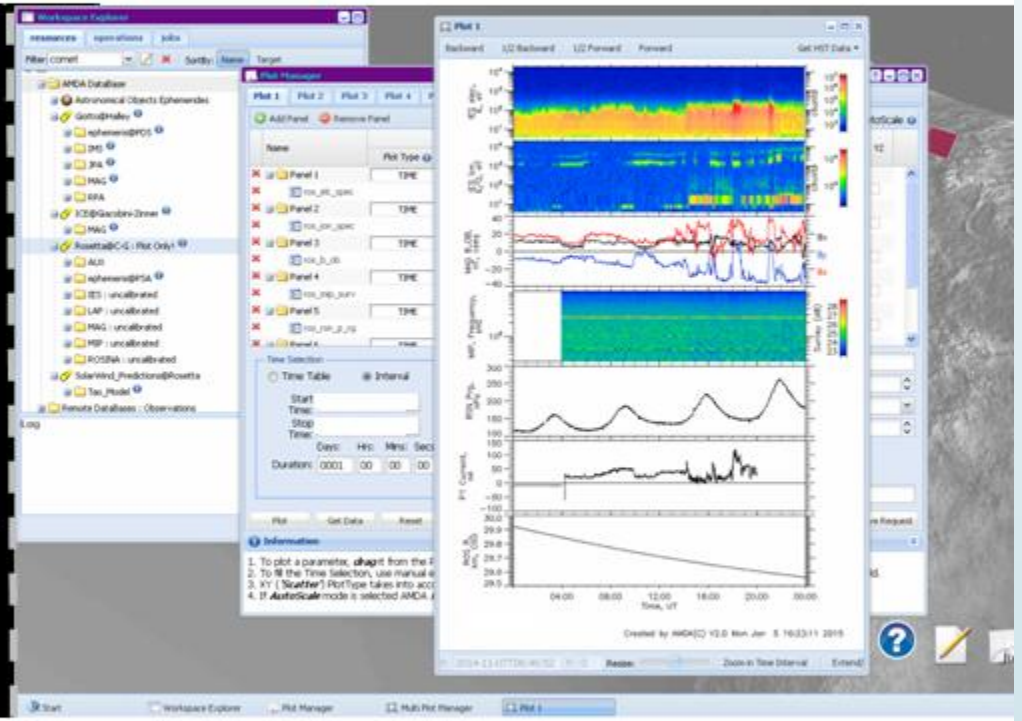
in-situ and model data
in 3D interactive scenes
3dview.cdpp.eu

3DView

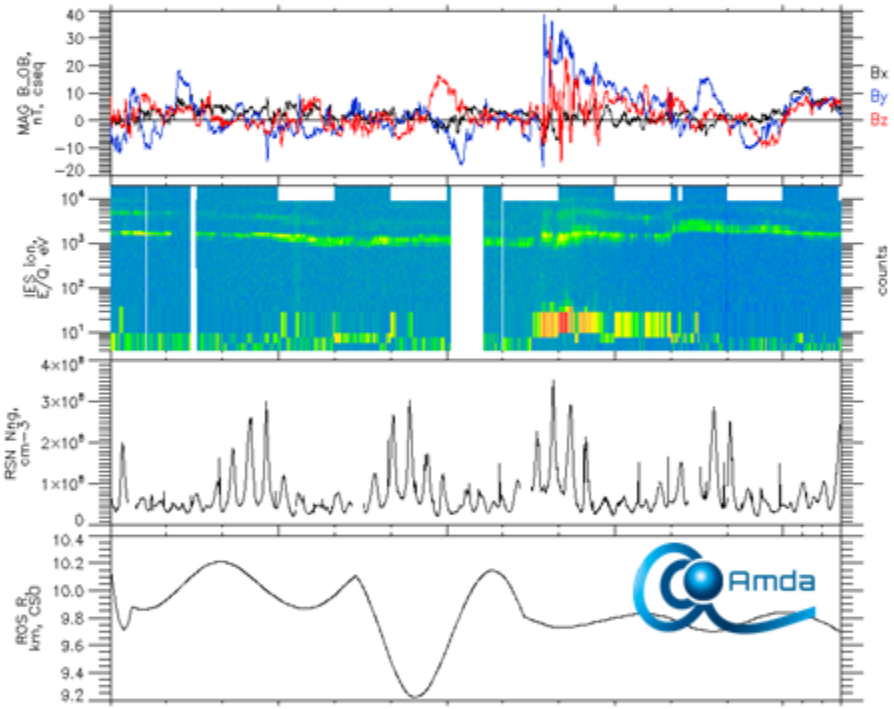
Amda

database and analysis tool
amda.cdpp.eu

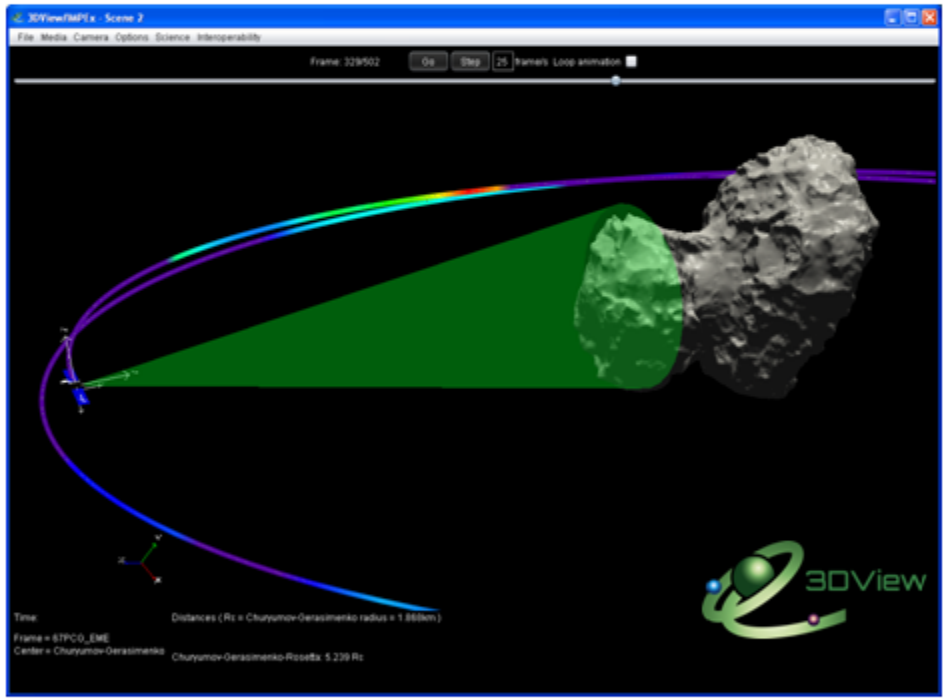




Use of AMDA + 3DView in the Rosetta context

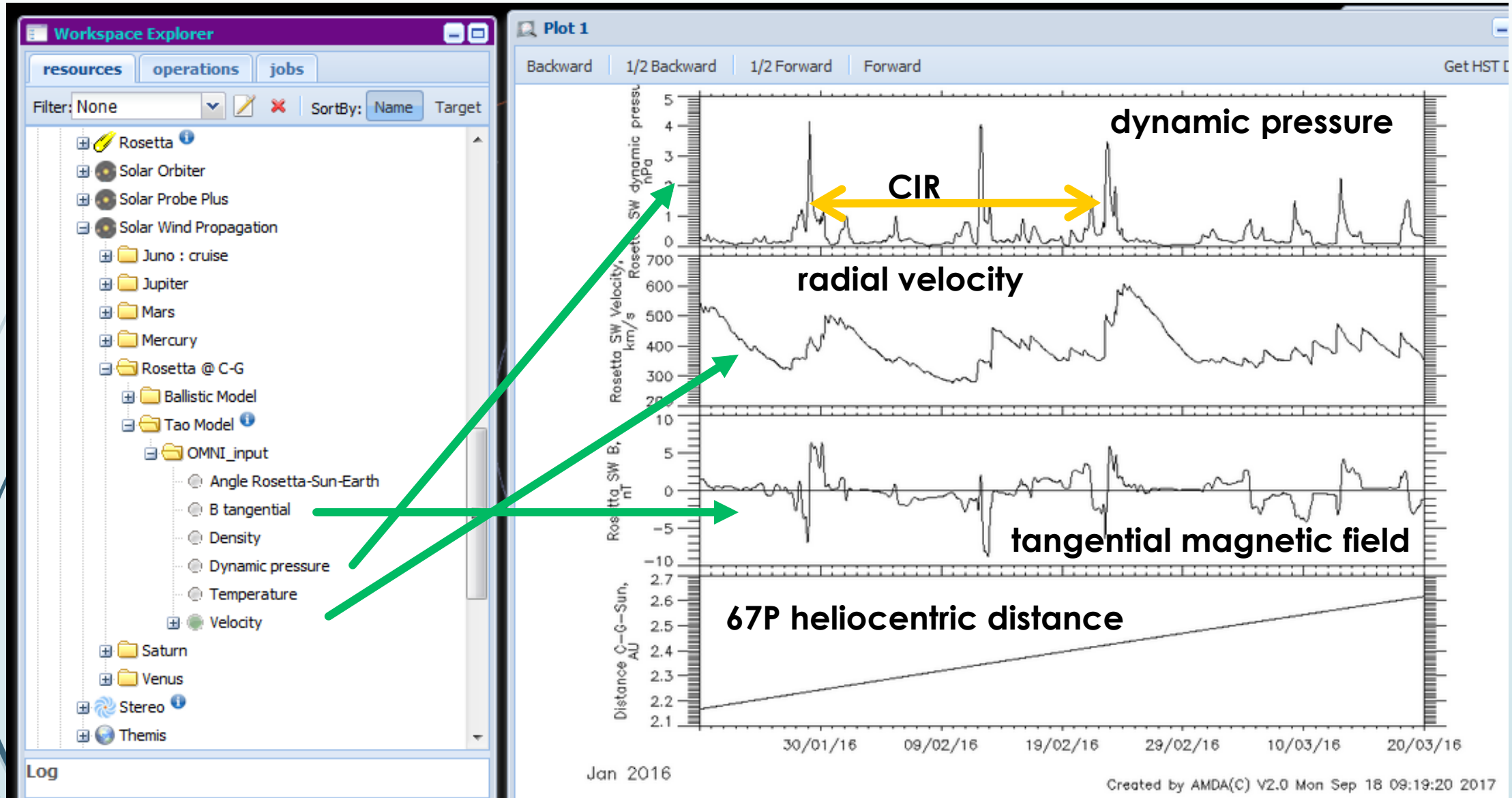


database and analysis tool
amda.cdpp.eu



in-situ and model data
in 3D interactive scenes
3dview.cdpp.eu

Solar wind conditions propagated at Rosetta / 67P (1D MHD model, *Tao et al.*)



CDPP role in RPC data distribution and valorization

- The RPC team activity on AMDA accounted for 25% of traffic in 2015-2016
- Publications acknowledging AMDA were issued (*very important !*)
- The RPC team members regularly expressed their satisfaction on the system in place

RPC publications acknowledging CDPP in 2016

- **Observations of high-plasma density region in the inner coma of 67P/Churyumov–Gerasimenko during early activity**, Yang et al., Mon Not R Astron Soc (2016) 462 (Suppl_1): S33-S44, doi:10.1093/mnras/stw2046, 2016
- **Structure and evolution of the diamagnetic cavity at comet 67P/Churyumov–Gerasimenko**, Goetz et al., Mon Not R Astron Soc (2016) 462 (Suppl_1): S459-S467, doi:10.1093/mnras/stw3148, 2016
- **CME impact on comet 67P/Churyumov-Gerasimenko**, Edberg et al., Mon Not R Astron Soc (2016) 462 (Suppl_1): S45-S56, doi:10.1093/mnras/stw2112, 2016
- **Statistical analysis of suprathermal electron drivers at 67P/Churyumov–Gerasimenko**, Broiles et al., Mon Not R Astron Soc (2016) 462 (Suppl_1): S312-S322, doi:10.1093/mnras/stw2942, 2016
- **Ionospheric plasma of comet 67P probed by Rosetta at 3 au from the Sun**, Galand et al., Mon Not R Astron Soc (2016) 462 (Suppl_1): S331-S35, doi:10.1093/mnras/stw2891, 2016
- **Charged particle signatures of the diamagnetic cavity of comet 67P/Churyumov–Gerasimenko**, Nemeth et al., Mon Not R Astron Soc (2016) 462 (Suppl_1): S415-S421, doi:10.1093/mnras/stw3028, 2016

RPC publications acknowledging CDPP in 2016

- **First in situ detection of the cometary ammonium ion NH4+ (protonated ammonia NH3) in the coma of 67P/C-G near perihelion**, Beth et al., Mon Not R Astron Soc (2016) 462 (Suppl_1): S562-S572, doi:10.1093/mnras/stw3070, 2016
- **First detection of a diamagnetic cavity at comet 67P/Churyumov-Gerasimenko**, C. Goetz, et al., A&A, Volume 588, April 2016
- **Solar wind interaction with comet 67P: impacts of corotating interaction regions**, N.J.T. Edberg et al., J. Geophys. Res., 02/2016, DOI : 10.1002/2015JA022147
- **Mass loading at 67P/churyumov-Gerasimenko: a case study**, E. Behar, et al., Geophys. Res. Lett., doi:10.1002/2015GL067436, 2016
- **Mass-loading, pile-up, and mirror-mode waves at comet 67P/Churyumov-Gerasimenko**, M. Volwerk, et al., Annales Geophysicae, doi:10.5194/angeo-34-1-2016
- **RPC observation of the development and evolution of plasma interaction boundaries at 67P/Churyumov-Gerasimenko**, Mandt et al., MNRAS, Vol. 462, Suppl. 1, 2016

Comet-related publications acknowledging CDPP in 2014-2015

- **Evolution of the plasma environment of comet 67P from spacecraft potential measurements by the Rosetta Langmuir probe instrument**, E. Odelstad, A. I. Eriksson, N. J. T. Edberg, F. Johansson, E. Vigren, M. André, C.-Y. Tzou, C. Carr and E. Cupido, JGR, 2015
- **Evolution of the ion environment of comet 67P/Churyumov-Gerasimenko. Observations between 3.6 and 2.0 AU**, H. Nilsson et al., Astronomy & Astrophysics, doi: 10.1051/0004-6361/201526142, 2015
- **Spatial distribution of plasma around comet 67P from Rosetta measurements**, N. J. T. Edberg, A. I. Eriksson, E. Odelstad, P. Henri, J.-P. Lebreton, S. Gasc, M. Rubin, M. André, R. Gill, E. P. G. Johansson, F. Johansson, E. Vigren, J. E. Wahlund, C. M. Carr, E. Cupido, K.-H. Glassmeier, R. Goldstein, C. Koenders, K. Mandt, Z. Nemeth, H. Nilsson, I. Richter, G. Stenberg Wieser, K. Szego, M. Volwerk, GRL, doi:10.1002/2015GL064233, 2015
- **Mirror mode structures near Venus and Comet P/Halley**, Schmid, D.; Volwerk, M.; Plaschke, F.; Vörös, Z.; Zhang, T. L.; Baumjohann, W.; Narita, Y., Annales Geophysicae, Volume 32, Issue 6, 2014, pp.651-657, DOI:10.5194/angeo-32-651-2014

Publications

Evolution of the plasma environment of comet 67P from spacecraft potential measurements by the Rosetta Langmuir probe instrument, *E. Odelstad et al., GRL 2015*

$$\frac{n_{e2}}{n_{e1}} = \frac{I_{ph,2}}{I_{ph,1}} \exp\left\{-\frac{e\Delta V_{S/C}}{k_B T_e}\right\}$$

A study of the evolution of the plasma environment of comet 67P using measurements of the spacecraft potential (3.5 to 2.1 AU) obtained by the Langmuir probe (RPC-LAP) instrument.

→ a cometary plasma with a strong radial dependence and the highest densities (i.e. the most negative spacecraft potentials) observed in the northern (summer) hemisphere above the neck region of the comet nucleus

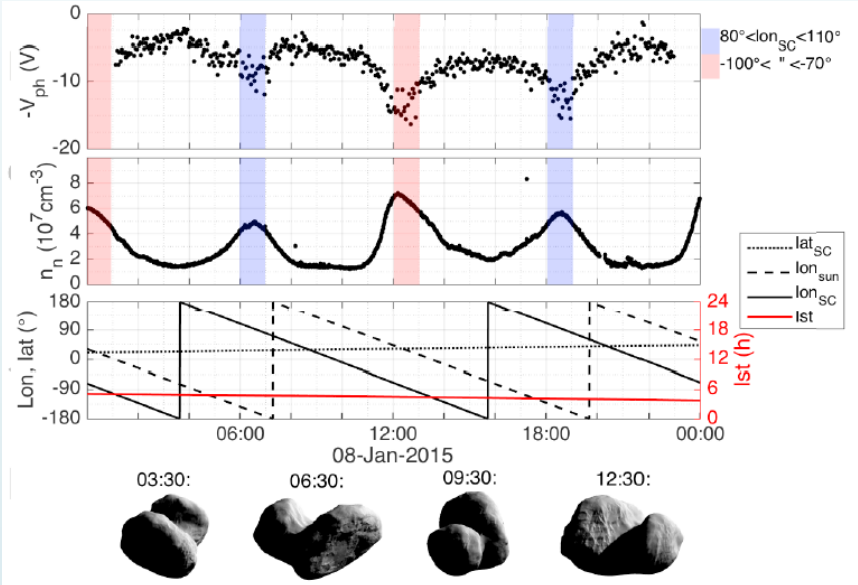


Figure 1. RPC-LAP spacecraft potential (

density (

red colored

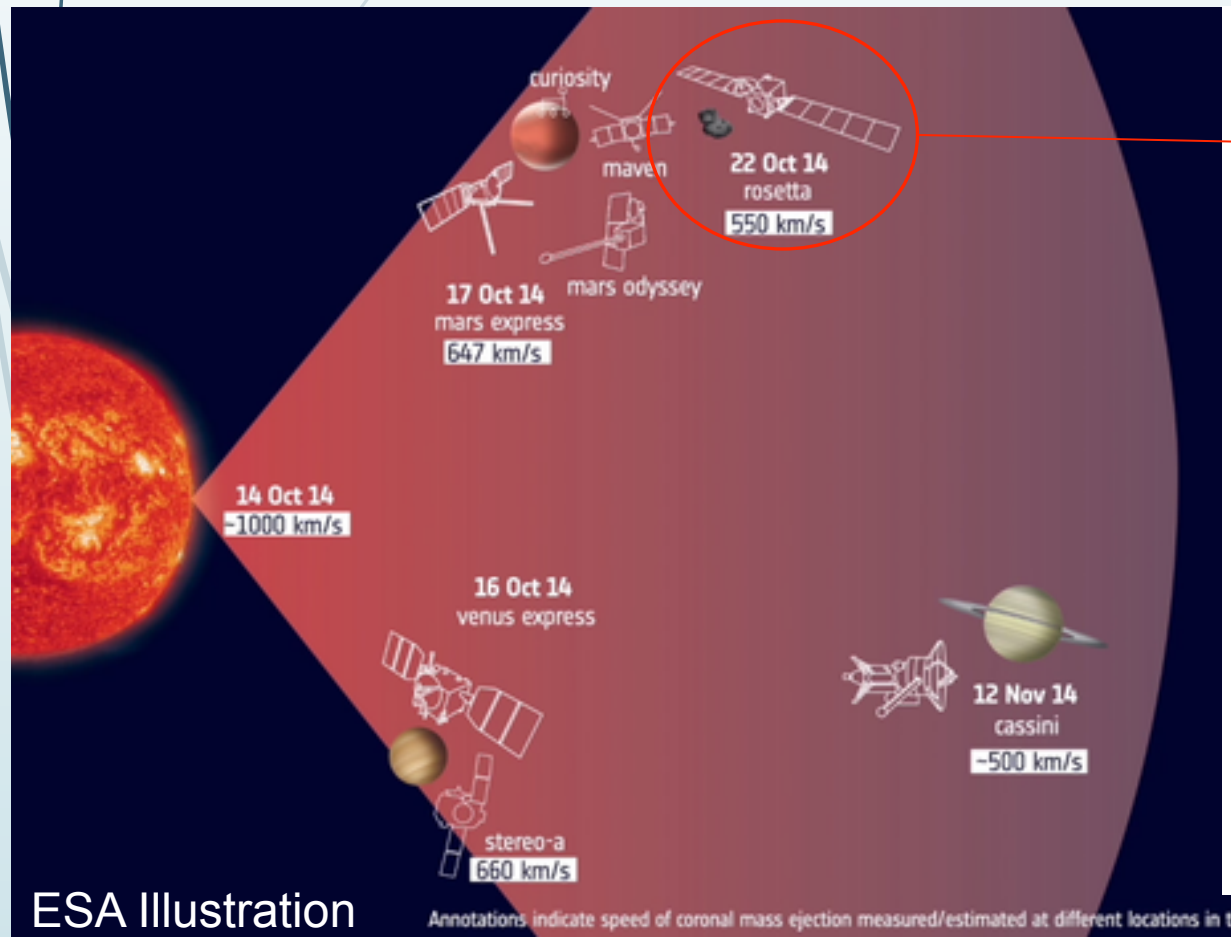
the spacecraft was between 80° and 110° and -100°

respectively. Spacecraft perspectives of the partially illuminated nucleus are shown for four different times below the bottom panel.

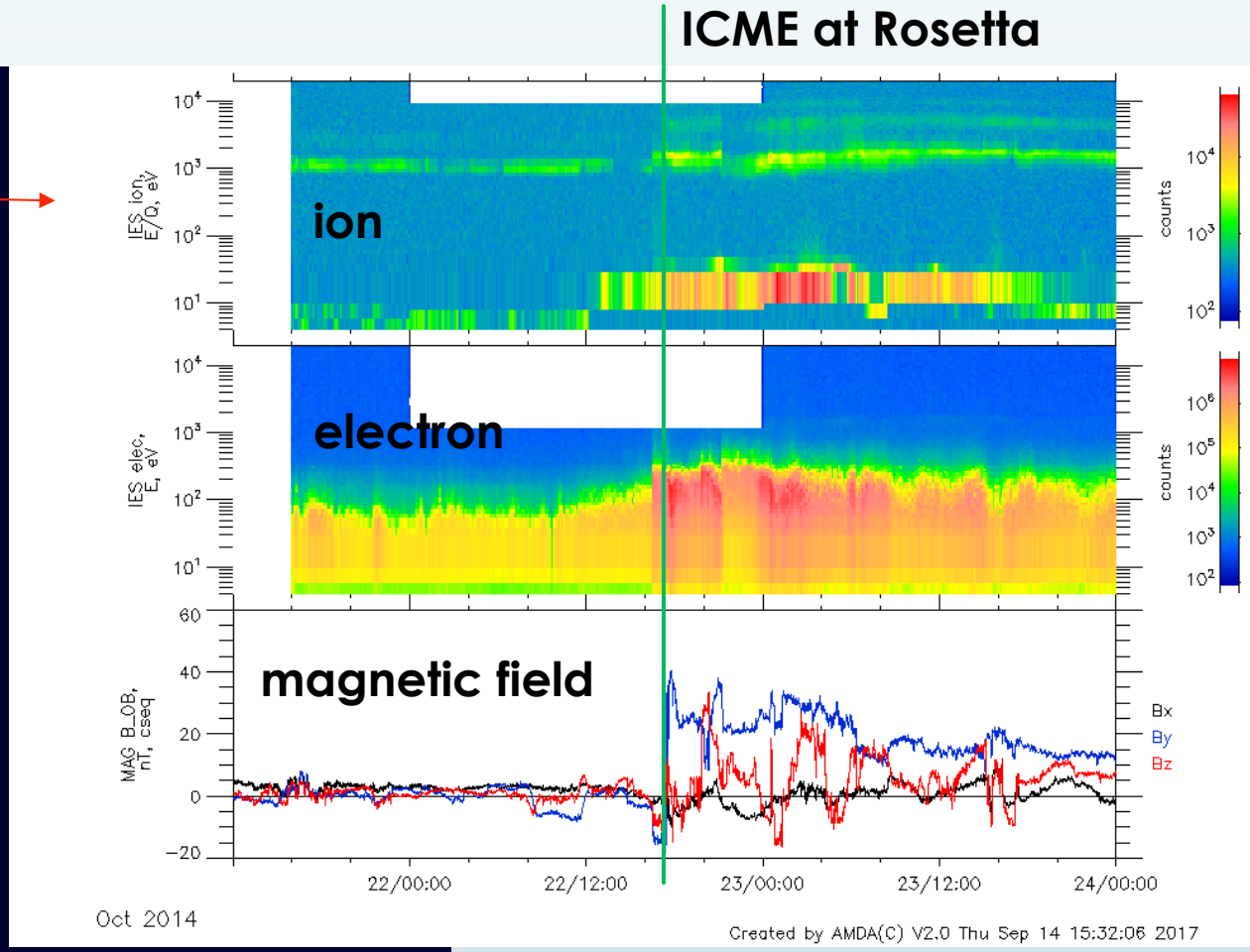
AMDA was used to visualize data from several instruments while in the early phase of the mission

Publications

Interplanetary coronal mass ejection observed at STEREO-A, Mars, comet 67P/Churyumov-Gerasimenko, Saturn, and New Horizons en-route to Pluto. Comparison of its Forbush decreases at 1.4, 3.1 and 9.9 AU, *Witasse et al.*, JGR 2017

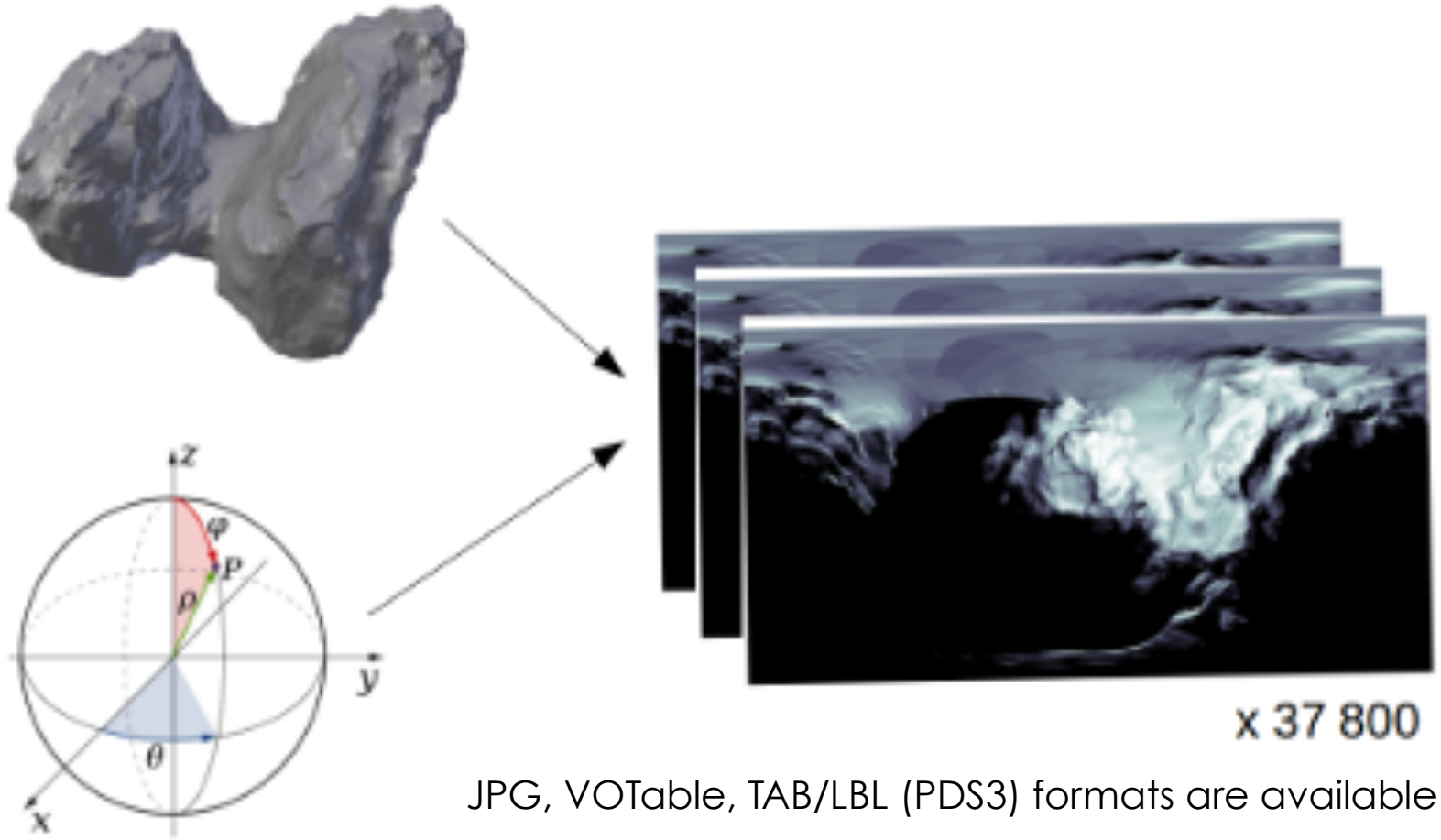


ESA Illustration



Illumination maps of comet 67P

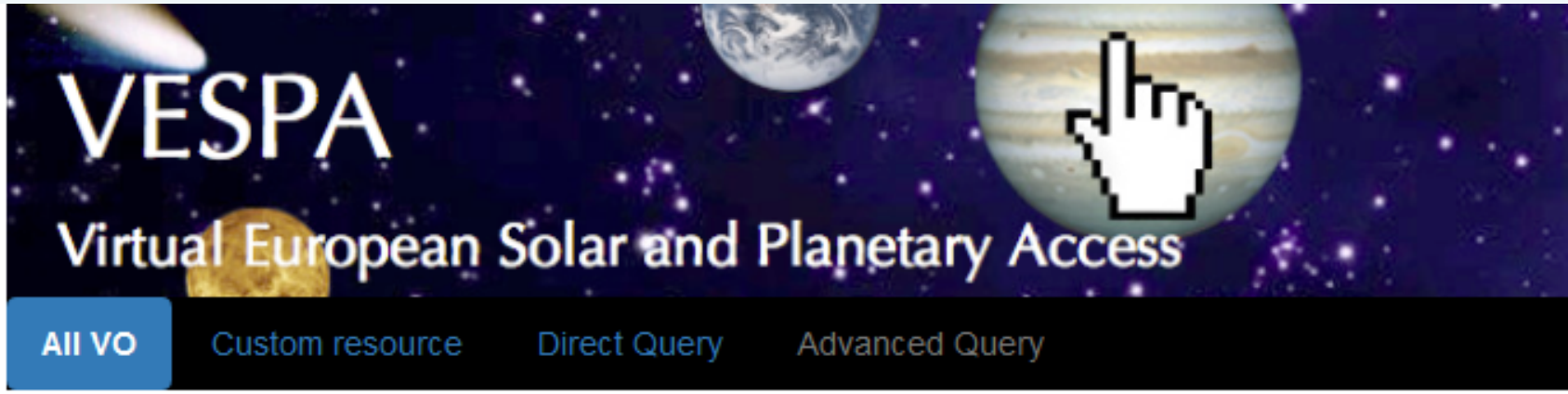
- Collaboration with Imperial College London (A. Beth, M. Galand)
- Deliverable for ESAC
- VESPA service



JPG, VOTable, TAB/LBL (PDS3) formats are available

Availability as VESPA services

- On VESPA portal or other EPN-TAP clients
- "Target Class = Comet"



EPN Resources

AMDA - Planetary and heliophysics plasma data at CDPP/AMDA 6631 results

BASECOM - The Nançay Cometary Database 15611 results

IKS - IR spectroscopy of comet Halley 206 results

ILLU67P - Illumination maps of 67P 189000 results

CDPP role in data distribution and valorization

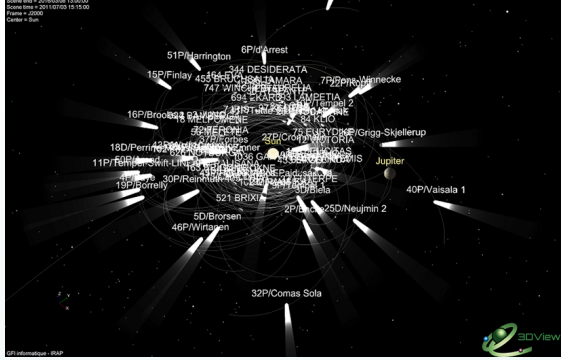
- The AMDA tool was used to distribute RPC data
- The CDPP offered a wide environment of tools and complementary data
- This collaboration was a success from both RPC and CDPP points of view
- The CDPP aims at providing similar facilities for the next European Solar and Planetary missions

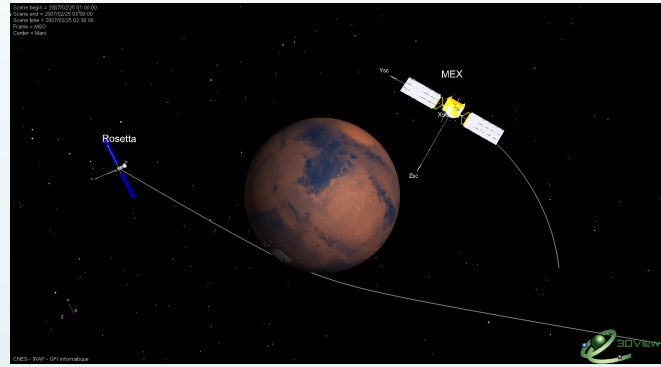
News about AMDA

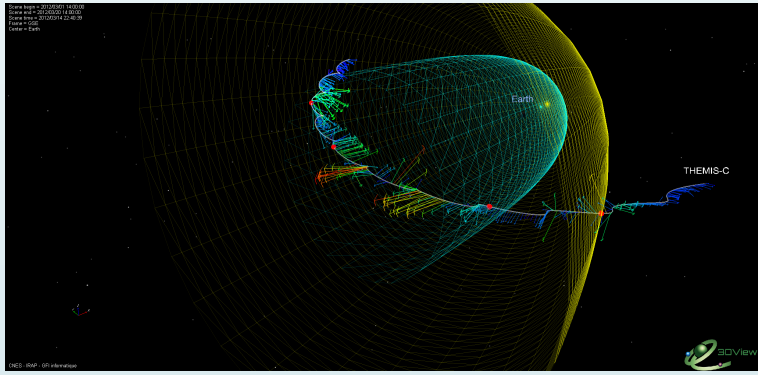
- New version is planned for early next year
  - Better plotting capabilities
  - Better download capabilities (header)
  - Includes an EPN-TAP client
  - On the code itself : lots of hidden things that will make our life easier for evolution
- Data
  - Juno from PDS
  - EISCAT radars
  - DSCOVR data for RT solar wind

3DView

- Orbitography (SPICE kernels)
- Data (from AMDA, CDAWeb, uploaded, APIS)
- Simulations (MHD, hybrid)
- Models
  - Boundaries
  - Magnetic fields







BS/MP model in 3DView

Planet	Bow shock	Magnetopause or magnetic pile-up boundary
Mercury	Kallio and Janhunen, 2003	Kallio and Janhunen, 2003
	Slavin et al., 2009	Slavin et al., 2009
	Moldovan et al., 2011	Moldovan et al., 2011
Venus	Smirnov et al., 1980	*none*
Earth	Sibeck et al., 1991	Shue et al., 1997
Mars	Trotignon et al., 2006	Edberg et al., 2008
	Edberg et al., 2008	Dubinin et al., 2006
Jupiter	Slavin et al., 1985	Slavin et al., 1985
Saturn	Slavin et al., 1985	Slavin et al., 1985
	Masters et al., 2008	Kanani et al., 2010

Comet trajectories (JPL catalogue) added in 3DView