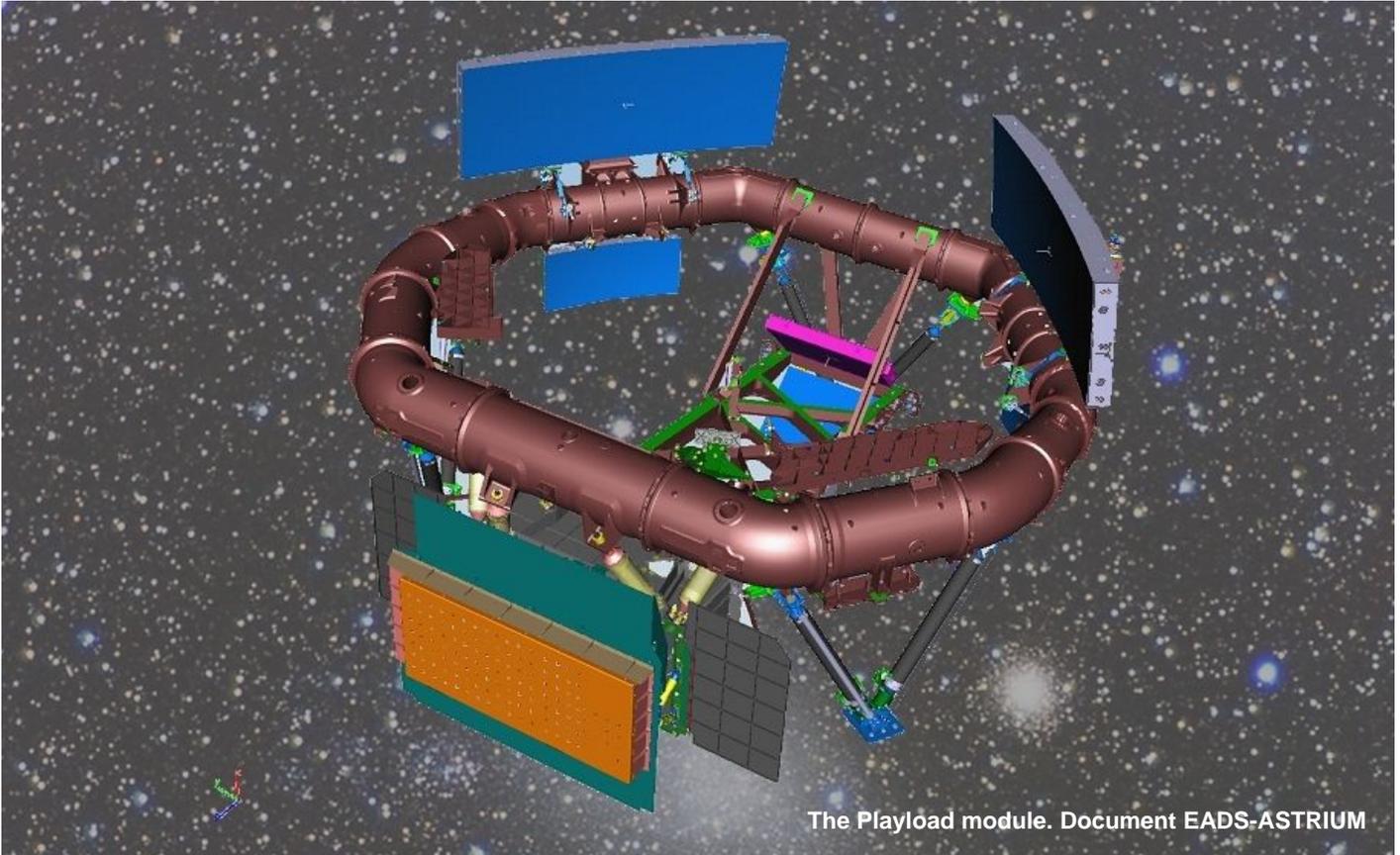


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The Payload module. Document EADS-ASTRIUM

## Editorial by DPAC chair, François Mignard

The January issue of the DPAC NewsLetter is a good opportunity to present the Gaia community at large our **Best Wishes for 2009**.

A major event for the DPAC at the dawn of the year is the formal start of the Project Office on January 15 at ESAC with Emmanuel Mercier as project coordinator and Gonzalo Gracia as project scheduler. Both are now fully installed at ESAC and will soon have contact with the CU managers. Obviously a transition phase is needed for them to catch up with the documentation and the DPAC issues. R. Drimmel, the CU1 group at ESAC and myself are trying to make their life easier during this phase. An interface engineer will join the Office in a few months.

Early January was also the end of the open definition phase for the DPAC Interface Control Document which is now under configuration control and will serve as a

basis for the content and the design of the Main Data Base. In this issue J. Hernandez summarises the status of this important step and gives us an idea of the number and variety of parameters that would be produced, consumed and stored during the actual processing.

A very important review (Critical Design Review) will take place for the DPAC this spring and formally mark the end of the detailed definition. The main objective is to review the design and testing specifications to ensure the design test documents reflect the science requirements and to identify and correct possible deviations. As for the previous system review, this goes with a substantial data pack to be prepared for the Review Panel. The review itself and its report will extend until mid-July this year and will draw significantly on the DPAC management.

The Gaia Project / DPAC Interface Control Document by Jos de Bruijne



DPAC is responsible for the design, implementation, validation, and testing of the software system for the processing of Gaia data. DPAC will also operate the Gaia data reduction and calibration. In order to accomplish these tasks, DPAC requires detailed knowledge of the spacecraft and instrument characteristics. The "Gaia Project / DPAC Interface Control Document" - or DPAC ICD - defines a list of items required by DPAC and to be provided by ESA. The DPAC ICD, jointly prepared by ESA and DPAC management, is currently in an advanced stage of preparation. The document covers the optical configuration, the detectors/electronics and focal plane assembly, the spacecraft attitude, the payload data handling unit, video processing unit, and telemetry, the basic angle monitoring and wave front sensor devices, and the atomic clock.

The current DPAC needs derive from the simulation and calibration of instrumental effects. The data reduction algorithms are being developed based on instrument models and will be validated through simulated data. The instrument models need to be as realistic as possible, not only with respect to the nominal case but also with respect to expected variations. Information is needed on the initial values of the models to be used in

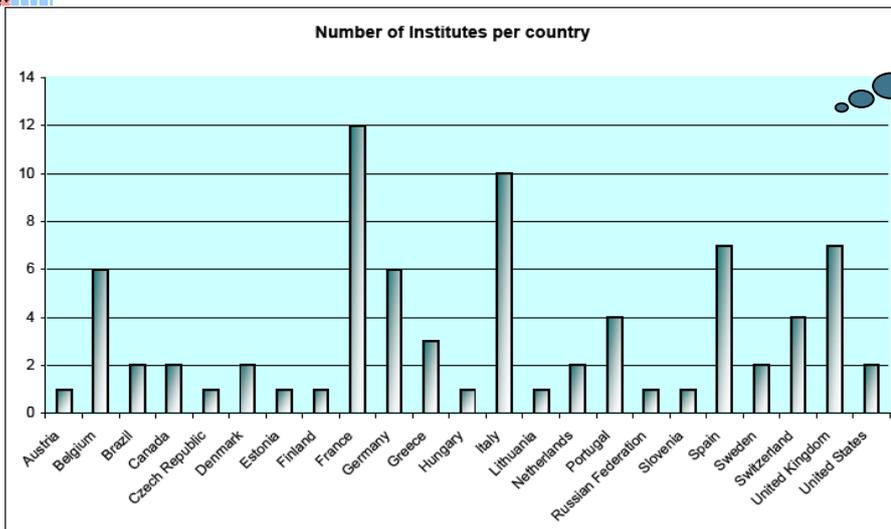
the calibration procedure. Those values will come from various industrial test, calibration, and commissioning campaigns.

DPAC follows 6-month development cycles, with the complexity of the simulation, data reduction, and calibration software increasing over the 5 years of pre-launch development. The level of detail required for the instrument models follows these cycles. In early cycles, information on the nominal configuration suffices. In later cycles, more detailed information on the spacecraft and payload will become available, which is also needed by DPAC at that time to increase the level of realism of the calibration models. Several delivery dates of DPAC ICD items are thus foreseen ("early design", "final design", and "as built").

The first DPAC ICD deliveries have already taken place and have been incorporated in GaiaTools and the Gaia Parameter Database. As soon as the first official version of the document is signed by all parties, it will be made available (restricted access to DPAC members) through Livelink under code GAIA-EST-ICD-05489. For more information, please contact the DPAC Project Office.

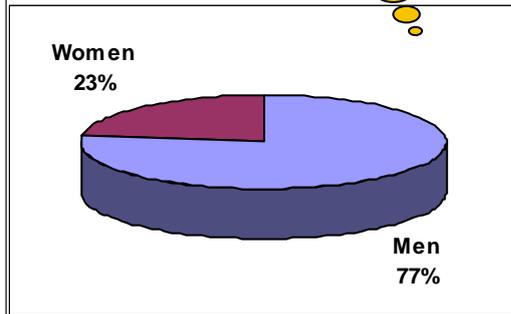


Consortium main figures by Sophie Rousset



79 institutes among 23 countries \*

Gender distribution within DPAC



\*Note: you can find details on DPAC public webpages at [http://www.rssd.esa.int/index.php?project=GAIA&page=DPAC\\_Membership](http://www.rssd.esa.int/index.php?project=GAIA&page=DPAC_Membership)

**The IvS @ K.U.Leuven by J. De Ridder**

The Instituut voor Sterrenkunde (<http://www.ster.kuleuven.be>) is the astronomical research group of the largest university of Belgium, the K.U.Leuven.

The institute has around 40 active researchers, and owns the 1.2m Mercator telescope at La Palma Observatory. It focuses primarily on asteroseismology, late stages of stellar evolution, and astronomical instrumentation. The IvS has a strong implication in the technical and/or scientific preparation of space missions like ISO, Herschel, Eddington, CoRoT, Gaia, and the Plato proposal submitted to Cosmic Vision.

Regarding Gaia, the asteroseismology team of the IvS, led by C. Aerts, is involved the analysis of stellar variability within CU7.

The daily coordination of Gaia activities is done by J. De Ridder (post-doc). He and J. Blomme (PhD student) are funded through Prodex. The team is responsible for the optimal modelling of Gaia time series of periodically variable stars given the frequencies of their proper oscillations. This involves statistical model comparison and selection.

Another area is with the automated and supervised statistical classification of variable stars detected by Gaia. Our group develops a software to automatically assign to every variable star a variability class ("Cepheid", "RR Lyrae", ...), given the attributes of the time series and the atmospheric parameters provided by CU8. The algorithm is able to learn how to distinguish between the different variability classes through training sets of variable stars with known class labels.

We also work on the processing of time series of non-radially pulsating main-sequence stars. Here, the observed amplitude ratios and phase differences are confronted to theoretical models to constrain the oscillation degree.

The team builds upon its long-standing experience of time series analysis of pulsating main-sequence stars, its successful classification of B stars observed by Hipparcos, and that of the variable stars found in the exo-planet fields of CoRoT.



[The Mercator telescope](#)

**Astronomical Observatory of Bologna by C. Cacciari**

The Astronomical Observatory of Bologna (OABO, <http://www.bo.astro.it/>) is one of 19 research institutes of the Istituto Nazionale di Astrofisica (INAF <http://www.inaf.it/>) and hosts about 80 among scientists, PhD students, technicians and support personnel. The main research areas are stars and stellar populations, extragalactic astronomy and cosmology, and hydrodynamics. We also have an instrumentation program contributing instruments to the TNG, LBT and ELT.

The OABO hosts a Gaia group of 12 people (and 1 PhD student based at the TNG in La Palma) involved in CU5 DU13 and DU14, and in CU7. The main activity develops around the absolute calibration of the photometric system.

DU13, managed by E. Pancino, has the responsibility of providing the grid of spectrophotometric standard stars (SPSS) by collecting homogeneous and accurate spectral energy distributions (SEDs) in absolute flux units. A large observing campaign is being carried on to this purpose, in collaboration with several people from the Astronomy Department of the University of Barcelona and with S. Trager from Groningen.

DU14, managed by C. Cacciari, has the responsibility of providing the calibration model for the G, BP and RP integrated photometry and the BP/RP spectra.

The CU7 group led by G. Clementini deals with the treatment of special objects, in particular RR Lyrae and Cepheid variables, in collaboration with several other institutions. The Gaia program is funded by INAF for the salaries of staff people, and by the Italian Space Agency (ASI <http://www.asi.it/>) supporting temporary appointments and other expenses.

**The OABO Gaia team**

**Back:** Michele Bellazzini Emanuel Rossetti Carla Cacciari – Angela Bragaglia – Elena Pancino – Gisella Clementini – Paolo Montegriffo

**Front:** Giuseppe Altavilla – Luciana Federici – Silvia Ragaini – Flavio Fusi Pecci

## Gaia Satellite by Xavier Moisson (EADS ASTRIUM)

The Gaia spacecraft is designed and developed by EADS Astrium (<http://www.astrium.eads.net/fr>) for ESA. EADS Astrium is leading the industrial team composed of more than fifty companies spread around Europe, including several Astrium sites. The Core team activities are split over the different EADS Astrium sites :

- Toulouse (FR), for the Spacecraft Prime contractor activities, responsible for spacecraft design, operation definition and AIV (Assembly, Integration and Verification), Payload Module (PLM) and Central on board software (CSW)
- Friedrichshafen (DE), for the Mechanical Service Module (MSVM) and system support to the Prime in the fields of mechanical and thermal analyses,
- Stevenage (UK), for the Electrical Service Module (ESVM) and system support to the Prime in the field of electric, avionics and attitude control engineering, including the Avionic Model AIV campaign.

The complete Core team activities represent more than 1 000 000 working hours over the whole programme, involving up to 250 people in the EADS Astrium national entities.

In addition to the system activities, EADS Astrium is also responsible of hardware and software development:

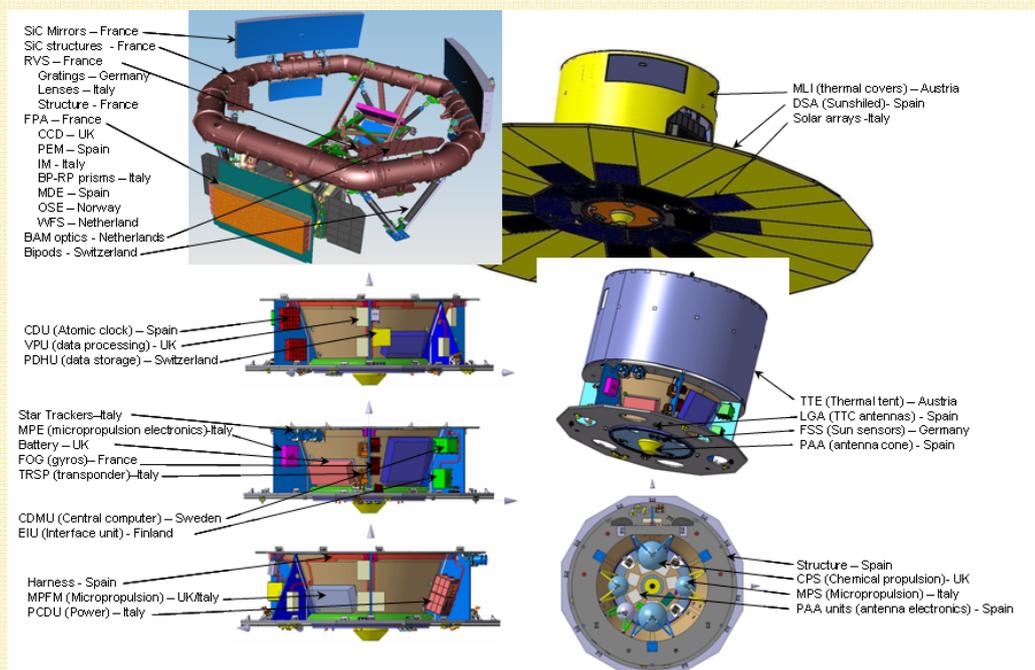
- The French part provides the high accuracy Fibre Optics Gyroscopes, the power conditioning unit (EPIC) of the active Phased Array Antenna used for science telemetry downlink, develops and validates the first versions of the spacecraft central computer software and the highly complex science algorithms for the Video Processing Units. For the PLM, Astrium SAS

performs the complete engineering (design, mechanical analyses, definition, validation) of all silicon carbide (SiC) elements – i.e. all mirrors and PLM structural pieces with unprecedented stability and accuracy performances to meet the ultimate Gaia accuracy - manufactured by Boostec in France, and delivers also major subassemblies like the one Gigapixel Focal Plane Assembly and the high resolution Radial Velocity Spectrometer.

- The British part develops and delivers the seven Video Processing Units with their full software, designs and integrates on the structure the Chemical Propulsion System for orbit and coarse attitude control and the Feed Module of the cold gas micropropulsion system used for fine attitude control.
- The German part manufactures and delivers propulsion items for the propulsion systems.
- The Spanish part develops the structure and the harness of the service module and the phased array antenna for science data downlink to Earth.

2009 will see the first integration activities on both spacecraft and payload modules. The validation has started in 2008 using engineering models of the equipments, with the objective to provide confirmation of the design and authorise release of flight model of the units.

Overall, EADS Astrium provides a major contribution to Gaia, being directly in charge of the most critical elements required to meet key performance requirements, with the aim to deliver a product able to fulfil all the objectives of the utmost challenging astrometric mission.



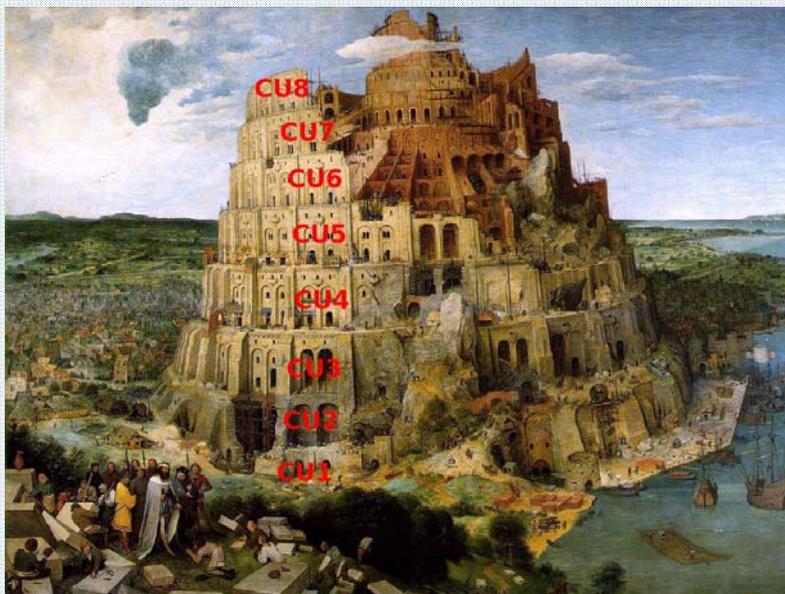
Also check Picture on the front page.

## Building the Gaia Main Database *by José Hernandez*

According to the biblical account, Babel was a city that united humanity, all speaking a single language, their pretentious citizens decided to build a tower reaching up into the heavens. God, seeing what the people were doing, gave each person a different language to confuse them and scattered the people throughout the earth. The Data Processing of Gaia has some parallelisms with Babel's story; it is being developed in a distributed manner by many individuals and centers.

The Main Database will be the place where all the different data processing results will be gathered together and then resent to the Data Processing centers. A bit like Babel's tower where the same language will be spoken (and we will succeed this time).

At the heart of the MDB design lays the MDB Dictionary Tool, the first version was out in early 2007 and 13 versions have seen the light since then. The tool allows the different CUs to describe the structure and meaning of the data they are going to produce. It also allows the DPCs to select the MDB data that the CU subsystems executed at their premises will need in order to perform their task.



It has been agreed that from 2009 onwards changes done in the MDB will have to be documented through mantis and approved by a CCB. This just means that we need to ensure a smooth evolution and that there is adequate information flow between the CUs so that the changes can be discussed, agreed and their impact on the consumers evaluated beforehand. Other important decisions adopted recently was the need for all of us to use internally within our subsystems the data model as defined in the Dictionary Tool.

Along these lines from cycle 6 onwards GOG simulated data will only come in the MDB format; we also have now a number of subsystems (IDT, AGIS, etc.) producing data as defined in the MDB. Current estimations of the MDB data volume at the end of the mission are still uncertain to some degree; it seems that we will

be in the order of 300 to 400 TB, however more than the volume of the data the greater challenge will be to manage efficiently the huge number of records ( $10^9$  Sources,  $10^{11}$  FOV Transits,  $10^{12}$  CCD transits). A number of tests, benchmarks and data arrangement strategies will be performed prior to launch on the Databases and Extraction/Ingestion tasks in order to achieve a solution which scales and gives us the required performance.

*Current contents of the MDB Dictionary and number of contributors per CU:*

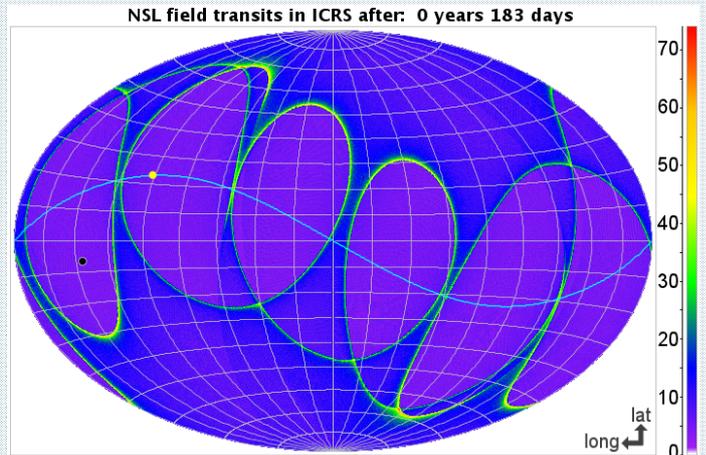
		CU1	CU2	CU3	CU4	CU5	CU6	CU7	CU8	Total
<b>MBD</b>	Objects	28	35	74	25	8	16	10	16	<b>212</b>
	Parameters	170	197	658	354	46	77	118	184	<b>1804</b>
	Contributors	10	6	26	13	4	2	2	10	<b>73</b>
<b>DPC</b>	Objects	5	3	82	35	42	24	4	36	<b>231</b>
	Parameters	23	3	538	435	480	174	35	579	<b>2267</b>
	Contributors	2	1	19	12	5	3	2	10	<b>54</b>



Focus on ELSA programme: Berry Holl, Lund University, Sweden

Berry Holl is a PhD student at Lund University in Sweden and is working on “Characterisation and analysis of the astrometric errors in the global astrometric solution for Gaia”. Berry’s work is directly related to the CU3 Astrometric Global Iterative Solution (AGIS). Since September 2007 he is working in Lund with Lenart Lindegren and David Hobbs. Until now he has mainly worked on AGISLab, a software package that allows to investigate the properties of AGIS in great detail. At first sight one might question the need for such a separate package since at ESAC they are already successfully running AGIS for datasets of millions of sources. AGISLab however runs scaled down solutions with only  $10^4$  to  $10^6$  sources in a very short time (hours). This permits to do many (Monte Carlo like) experiments, which can be used to study error propagation in AGIS in great detail. Recently Berry has made a movie of the Gaia Nominal Scanning Law (see image). Should you be interested in how the 6 hour spin period and the 63 day spin axis pre-

cession period make Gaia scan the full sky, have a look at the movie on SVN: /DPAC/docs/slides-and-talks/images-and-movies/scanning-laws/ (restricted access to DPAC).



Movie frame: Equatorial Hammer-Aitoff projection of the number of field transits after 0.5 year. Light blue line is the ecliptic plane, yellow dot is the sun and black dot is the Gaia spin axis.

DPAC public webpages by S. Rousset

**New** DPAC has now public webpages at <http://www.rssd.esa.int/gaia/dpac> easily accessible from ESA Gaia website .

The main target of these pages is to give a better visibility of the Consortium to a wider community. Basic information such as Organization, list of members (per Institutes), technical objectives, DPAC Newsletter etc...have been identified as relevant items to be presented. However, pages content is still under construction, so suggestions are more than welcome!

Special thanks to Carmen Blasco and the team at ESA for their support in this action!

The screenshot shows the DPAC website interface. At the top, it says "Gaia Data Processing and Analysis Consortium" and "DPAC: International consortium in charge of Gaia data processing". Below this, there is a list of bullet points describing the consortium's goals and structure. At the bottom, there is an organizational chart showing the relationship between ESA, National Agencies, ESA Project Scientist, DPAC, Gaia Science Team, and the Scientific Community.

This newsletter is published by DPAC Chair

To publish news or articles please contact: [sophie.rousset@oca.eu](mailto:sophie.rousset@oca.eu)



Calendar of next DPAC related meetings

Date	Place	Who	Type	Resp.
09-10 Feb	ESAC	All	DB WS	De Teodoro
25-27 Feb	ESTEC	Joint GST/DPACE	DPACE-GST	Prusti
5 - 6 March 09	ESAC	CU1	System Architecture #8	O'Mullane
20-21 April	Torino	CU3	Core Processing #4	Lattanzi/Bastian
22-23 April	Torino	CU2	Cycle 7 kick-off meeting	Luri

More information on calendar of Gaia : [http://www.rssd.esa.int/index.php?project=Gaia&page=Calendar\\_of\\_meetings](http://www.rssd.esa.int/index.php?project=Gaia&page=Calendar_of_meetings)