Gaia DPAC Newsletter 12

N° 12 - April 29, 2011

Artist's impression of a Soyuz launch from the new European Spaceport under test, near Kourou in French Guiana. The launch-pad is in the foreground with the moveable protecting gantry slightly behind. Then one sees the Soyuz Integration building connected to the launch zone by a railway track and in the background the Control Centre, where launches are operated.

More details on page 5.

Editorial *by DPAC chair, François Mignard*

In early April the members of the Gaia Science Team had the chance to see the advancement of the integration of Gaia in the Astrium premises in Toulouse. A wonderful opportunity to see real pieces of hardware being assembled in the Service Module or the Payload (the latter, secured in its hightech cleanroom, only spotted in the distance). A very impressive and moving visit for all the participants who have noticed the professionalism of the Astrium team, their care for quality and safety, and, above all, realised the extreme complexity of this phase of the project. A spectacular happening is awaited with the full deployment of the Deployable Sunshield in the assembly hall, later this year or in 2012. Schedule remains very tight, although the sub-systems procurement and the assembly are proceeding nominally.

In this issue you will learn that the new Soyuz dedicated launch site in Kourou is nearing readiness and local staff are actively preparing for the first launch later this year. Gaia allocated Soyuz rocket is in the making and will be ready for launch on-time.

On the DPAC side, you will get to know in this issue of a new couple of DPAC participating institutes in Edinburgh and Lund and learn important things about the current performances of the CU8 object classifiers or the independent sphere reconstruction currently developed by the Torino group in the framework of the astrometric verification unit.

DPAC news

The first campaign of the DPAC wide integration testing (see DPAC NewsLetter #6) is completed and has been declared successful by the Review Board. The objectives of the testing at this stage is to demonstrate the DPAC system ability to fulfil its tasks, focusing on the interface and data transfer capacity and reliability on one hand, and the functional performance of some of the early processing. Only minor issues have been raised, but the data volumes and performances required at the DPCs remain a true challenge. The second testing campaign is now being initiated.

DPAC has begun the preparation of the Implementation Review to be conducted by ESA. The review will start with the overall presentation by DPAC on September 13 at ESTEC and will continue until the end of October with the DPAC/SOC Review Board meeting. Numerous documents will be made available to the review panel early September and are being prepared, the whole organisation being oversighted by the Project Office and the SOC manager.

Following the Mission CDR and the discussions with the GST, the science-performance pages have been updated by J. de Bruijne and should be used by DPAC members as a consistent source of communication for this sensitive data. These are now actual expected performances instead of requirements, used up to now. The final information will be available in the coming weeks at http://www.rssd.esa.int/index.php?project=GAIA&page=Science_Performance.

GREAT NEWS !

GREAT: Gaia Research for European Astronomy Training - The Initial Training Network Begins

By Nicholas Walton (naw@ast.cam.ac.uk), Timo Prusti, Francois Mignard (GREAT co-chairs)

GREAT is an initiative from the Gaia ESA Project, the Gaia ESA Science Team and the Gaia DPAC aiming to enable, through focused networking interactions on a European scale, the fullest scientific exploitation of the Gaia mission. GREAT is currently funded through two major European programmes.

The ESF funded GREAT Research Network Programme (http://www.great-esf.eu) is a five year networking activity (2010-2015) which provides funding for community proposed activities such as conferences, workshops, training schools and exchange visits. Through its first three calls it has and is already supporting two major conferences, ten workshops and a training school - covering a wide range of topics across the breadth of the Gaia science remit. The full list of these activities can be found at http://great.ast.cam.ac.uk/Greatwiki/GaiaScienceMeetings. Meetings of interest are open to all interested, and the aforementioned website provides link to the registration pages of each of those meetings. Further, there is a currently open funding call - see http://www.great-esf.eu) - with a deadline of 3 June 2011 - for proposals for further workshops and exchange visits.

Recently, the EU FP7 Marie Curie GREAT Initial Training Network (http://www.great-itn.eu) commenced, the network running for four years 2011-2015. This involves 13 full institutes from Europe (with one in China) and 19 associate institutes and organisations from academia and industry (including ESA) and will involve the training of a cohort of young researchers in the scientific exploitation of the Gaia data. The training encompasses four major themes in Galactic Astrophysics: unravelling the origin and history of the Milky Way; tracing the birth place and understanding the astrophysical properties of the stellar constituents of our galaxy; deepening the understanding of planetary systems by linking the study of extrasolar planets with research into the origins of the solar system; take up the grand challenges offered by Gaia in the domains of the distance scale of the universe and the exploration of the transient sky. The kickoff meeting of the GREAT-ITN has just taken place at the Institute of Astronomy, University of Cambridge, UK - see http://www.great-itn.eu/gitn-kickoff-meeting.

Finally, the next GREAT Plenary, bringing together the entire GREAT community including the GREAT working groups (http://great.ast.cam.ac.uk/Greatwiki/CategoryWorkgroups), will take place in Brussels (21-23 June 2011) - see the meeting page at http://www.great-esf.eu/events/Brussels-Jun11/. This meeting will highlight the current planning for the release of Gaia data to the community, and will be your chance to feed into the discussion underpinning the shape and timeline for data releases.

The IfA Gaia team at Edinburgh University, UK, *by Nigel Hambly*

The University of Edinburgh's Institute for Astronomy (IfA at http://www.roe.ac.uk/ifa/) within the School of Physics and Astronomy hosts a small team of scientists and Java developers contributing to the Gaia DPAC. The team is part of the IfA's Wide Field Astronomy Unit (WFAU).

Our group is contained within Development Unit 10 of Coordination Unit 5 and we, along with our colleagues at the University of Leicester, commonly refer to ourselves as CU5DU10, while our main contributions to DPAC are to the core processing developments within CU3. Current staff (pictured at the Royal Observatory Edinburgh, which houses the IfA) consist of survey data flow astronomers Michael Davidson, Nigel Hambly and Nicholas Cross, and Java developers Ross Collins, Alexandros Ouzounis and Albert Heyrovsky. While Michael, Alex and Albert are full-time on the project, the fractions of Ross, Nigel and Nick vary as funding and other WFAU projects demand; presently, we are contributing 4.7 full-time equivalent staff to the Gaia DPAC workforce.

Our main areas of work are in the design and implementation of radiation damage mitigation techniques, along with associated calibration processes, in Sky Mapper and Astrometric CCDs (and latterly with corresponding developments in BP/RP with other CU5 colleagues). We play a significant role in process developments under the auspices of the Radiation Task Force, the Calibration Working Group and the Offset Instability Task force. We contribute to the burgeoning DPAC Java code base in the IDT, FL, IDU and Calibration Tools projects. In common with all the other DPAC DUs, we are responsible for writing and maintaining a detailed set of formal documents, technical notes and reports describing our software and processing developments. Funding for the Edinburgh group is currently provided by the UK Science and Technology Facilities Council, and will continue from mid 2012 via a grant from the newly formed UK Space Agency.

The Edinburgh's Institute for Astronomy team: top left to right: Nigel Hambly, Ross Collins, Nick Cross; bottom left to right: Michael Davidson, Alex Ouzounis, Albert Heyrovsky

The Gaia team at Lund Observatory, Sweden, *by Lennart Lindegren*

Lund Observatory (http://www.astro.lu.se) is the astronomy department of Lund University, located in the south of Sweden. Since 2010 it is part of the Department of astronomy and theoretical physics, with a total staff of about 75 persons, including some 25 PhD students. The theoretical physics division, making up 60% of the staff, do research on theoretical high energy physics and computational biology. The astronomy division, i.e. Lund Observatory proper, is mainly focused on Galactic research including Gaia-related activities and the formation and evolution of exoplanetary systems. Other research groups work on laboratory measurements of fundamental atomic data and optomechanical design of telescopes.

Lund Observatory has a long involvement in space astrometry, going back to 1976 when Lennart Lindegren joined the ESA study team for what later became Hipparcos. During 1981-1997, the group including Staffan Söderhjelm (retired) worked on the construction of the Hipparcos Catalogue and analysis of double stars. The present team having a direct involvement in DPAC consists of Lindegren together with Dr. David Hobbs and PhD student Berry Holl. Our main contributions concern the development of algorithms and software for the Astrometric Global Iterative Solution (AGIS), which will be run at ESAC (Madrid). As part of this, we have developed a small-scale simulation/solution setup, AGISLab, which has become an indispensible tool for experimenting with different solution methods (for example the currently used Conjugate Gradients algorithm was developed on AGISLab and later implemented in AGIS) and many other tests (e.g. for the velocity correction in collaboration with the team in Dresden). In addition, PhD student Daniel Michalik works on implementing an AGIS-like solution for the Japanese Nano-JASMINE satellite, scheduled for launch in August this year.

The Gaia team in Lund is supported by the Swedish National Space Board.

Astronomy building in Lund (Photo: Berry Holl)

Classification with Apsis *by Kester Smith and Chao Liu (CU8, MPIA)*

The Gaia catalogue will contain the classification and main parameters of each detected source. Obtaining this information is the responsibility of DPAC CU8 - Astrophysical Parameters. The CU8 software, called Apsis, will use two main classification packages, one supervised and one unsupervised, to sort the Gaia sources by astrophysical class. Further packages will then obtain astrophysical parameters.

Supervised classification is performed by the Discrete Source Classifier (DSC). This package is modularized to deal separately with three types of data; photometry, astrometry and position and magnitude. The main module is the photometric classifier, which processes the BP/RP low-resolution spectra. All the subclassifiers return a vector of probabilities for the different possible source types. These probabilities are then combined.

The photometric classifier is based on a machine learning algorithm called a Support Vector Machine (SVM). This algorithm uses training data to identify an optimally-separating plane between two classes, which is defined in terms of particular exemplars in the training data called Support Vectors. Multiclass classification is treated as a series of one-against-one classification problems. The probabilities are obtained by modelling the density of training points either side of the separating plane. The photometric classifier also contains an SVM classifier that checks consistency with the training data and identifies outliers. A separate outlier analysis package will analyse these objects.

The main stellar parameterizers are called GSP-Phot, standing for General Stellar parameterizer - photometry and similarly GSP-Spec for spectroscopy. GSP-Phot estimates stellar astrophysical parameters for normal stars using several algorithms. The basic one is the SVM, as used in DSC, but configured for regression. It estimates the effective temperature, extinction, metallicity and surface gravity from the BP/RP data of Gaia.

Alternative algorithms include ILIUM, an iterative method based on a forward model, and q-method, a probabilistic framework combining photometric data, parallax and prior knowledge of the Hertzprung-Russell diagram. The latter two methods not only estimate the most possible parameter values but also the uncertainties and the likelihood map in parameter space. Examples are shown in Figure 2.

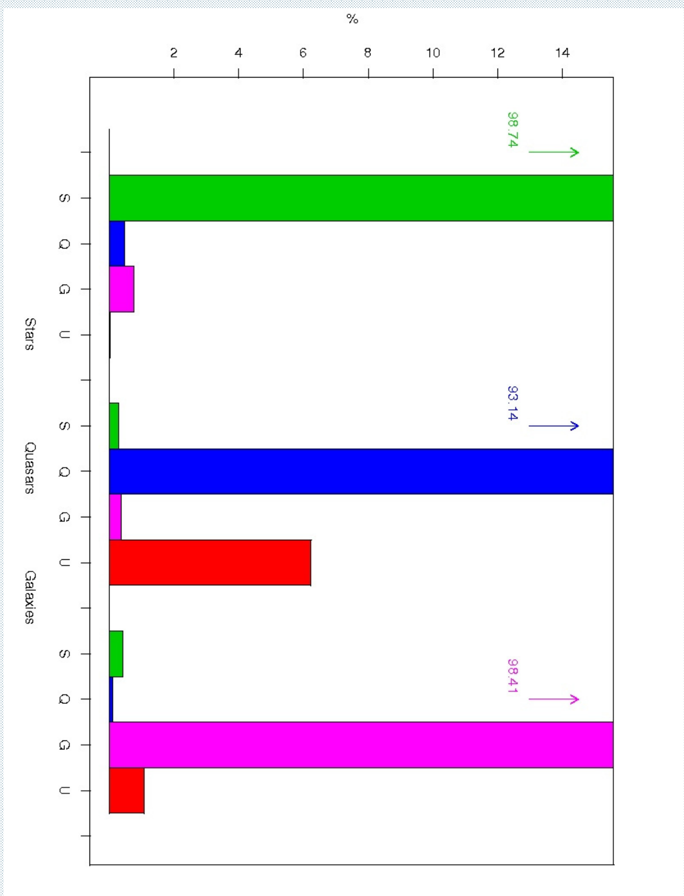


Figure 1. Classification performance. For each test data set (stars, quasars and galaxies) the output classification is shown (green=star, blue=quasar, violet=galaxy, red=unknown) as a percentage of the test set size. The percentage axis is cut at 15%.

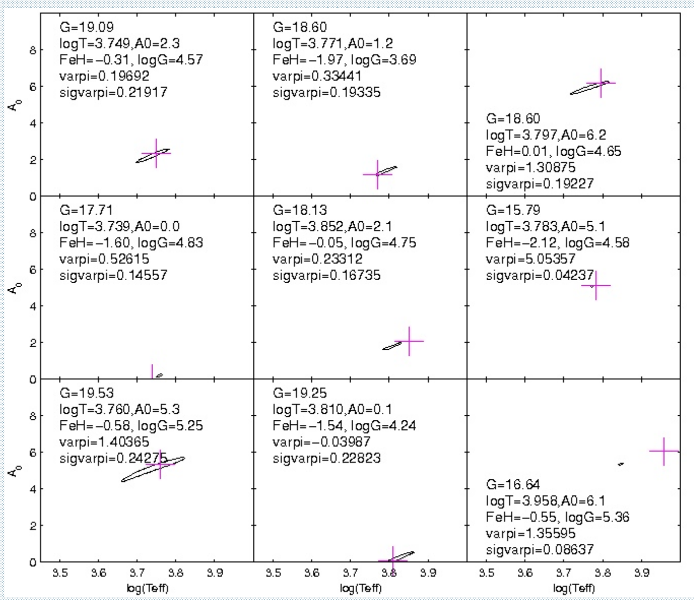
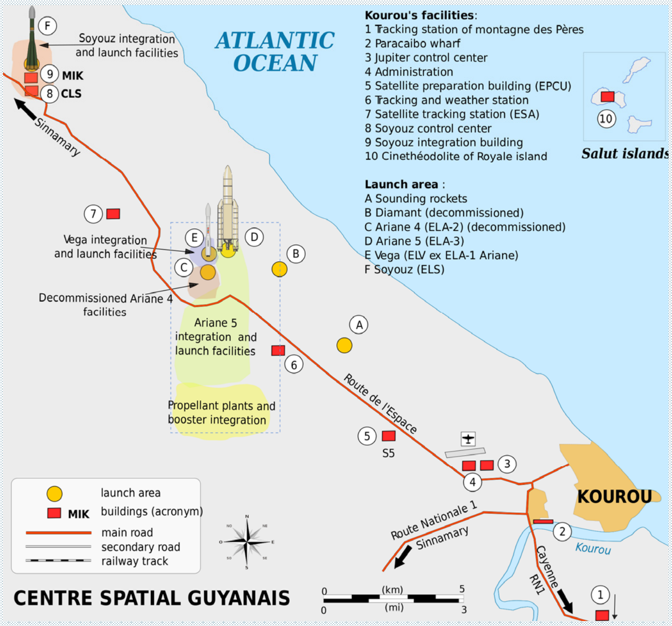


Figure 2. GSP-Phot output for T_{eff} - A0, which are degenerate. T_{eff} is star effective temperature and A0 is the first parameter of the extinction curve. The contour bounds the 90% likelihood interval and the cross marks the true values of T_{eff} and A0.

Soyuz launchpad in Kourou *by François Mignard*

Earlier this month, the new Spaceport in French Guiana designed for Soyuz launches has passed its acceptance review. It was formally handed over by CNES (the prime contractor for the development phase and its construction) to ESA and few days later by ESA to Arianespace. This is the provisional conclusion of an undertaking which has started in 2003 when the Russian and French governments formally agreed to bring Soyuz to Kourou. This was later formalised in 2005 with an agreement between ESA and CNES for the implementation of a program to allow launch of Soyuz rocket from this new Spaceport. The project during its different stages, is funded by ESA, France, Arianespace, Russia and the European community.



The Soyuz launch site, is located 13 km northwest of the Ariane launch site (see the map). It consists of three main zones: the launch platform where the launcher will be erected for liftoff; the preparation area where the three stages will be horizontally assembled and controlled; and the launch control centre.

When Soyuz is launched from Baikonur, the full integrations of the rocket and the satellite are done horizontally, and the launcher and its payload are set upright on the launchpad. For ESA, the rockets will be assembled horizontally as well, then erected on the pad and protected by a 45m-tall gantry that moves into place. The payload is then integrated on top of the rocket.

Moving from Baikonur to Kourou near the equator, nearly doubles the capability of a Soyuz launcher, increasing the payload mass into geostationary orbit from 1.7 to 2.8 tonnes.

Using the restartable (up to 20 times!) Fregat upper-stage, allows complex orbit choices and also to place heavy spacecrafts on escape-orbit.

Arianespace has now begun the necessary procedures to qualify the launch operations. A simulated launch is being set up to ensure that the Soyuz, which underwent significant adaptations to fit the new site and European safety regulations, and the new facilities fit together. The Soyuz launch vehicle that will be used at Europe's Spaceport is the Soyuz-2 version called Soyuz-ST. This includes the Fregat upper stage and the ST fairing. This simulated launch campaign will include the vehicle's transfer to the launch zone, its erection into the vertical position, its installation on the pad, and the testing of ground and launcher interfaces.

The current target date for the first launch of a Soyuz from Kourou is the third quarter of 2011 and should consist of two satellites of the Galileo constellation. Gaia will be launched sometime in 2013 from the new spaceport.

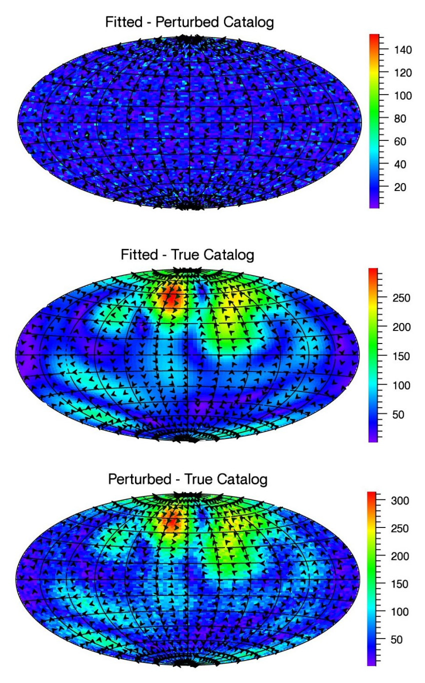
There has been so far (as of 5 April 2011) 1768 launches of the different versions of Soyuz and very few failures. Soyuz launchers to be flown from the Spaceport are evolved versions that include an updated digital flight control system, an increased-performance third stage and a larger payload fairing. The first two Soyuz launchers arrived from Russia by sea in November 2009 to be assembled in the new preparation and integration building. Through Starsem, an European-Russian subsidiary of Arianespace, Europe has already marketed and operated launches of several satellites with Soyuz, and particularly relevant for astronomer, the CoRoT satellite was a Starsem operated launch of Soyuz. Jean-Yves Le Gall, chairman & CEO of Arianespace, holds the same position at Starsem.

When Soyuz flights begin from Kourou, ESA, through Arianespace, will have two of the most reliable rockets in the world at its disposal.

Soyuz launchpad in construction in early 2010. (credit ESA/CNES)

ELSA: Ummi Abbas *(Turin Astronomical Observatory, Italy)*

Ummi Abbas is a postdoctoral researcher at the Turin Astronomical Observatory and member of CU3 within DPAC. She is actively involved in the development and integration of the Global Sphere Reconstruction (GSR). Gaia, like HIPPARCOS, will perform absolute astrometry. Inherent to such a process is the difficulty in identifying possible errors in the measurements or produced by the data reduction. Within DPAC, the Astrometric Verification Unit (AVU) has been established in order to verify crucial steps independently of the baseline data processing chain. One of the AVU components is GSR, hosted by the Italian Data Processing Centre at Torino (DPCT), that generates the global sphere solution on a smaller scale for comparison with the baseline AGIS solution. GSR uses a subset of up to 10 million stars chosen from the AGIS dataset and will provide the results of the comparison as part of a 5-step modular process involving: 1) obtaining the system of linearized observation equations from the observation data, 2) solving the system to generate the GSR solution, 3) assessing the quality of the solution, 4) converting the solution to an AGIS compatible format, and finally, 5) comparing the two solutions.



Example showing the comparison of two catalogs with 100,000 stars using vector spherical harmonics. The plots show the positional residuals (in muas) for a catalog with injected systematic distortions plus a gaussian error of 50 muas before (lower plot) and after (middle plot) obtaining the fits to the perturbed catalog. The upper plot shows that the fitted systematics leads to the correctly recovered random errors. (datasets courtesy B. Bucciarelli, refs. LL-BB-001, LL-UA-001).

Calendar of next DPAC related meetings				
04-06/05	Lund	CU3	Plenary	U. Bastian / L. Lindegren
04-05/05	Liege	CU8	Plenary	C. Bailer-Jones / J. Surdej
11-13/05	Budapest	CU7	Plenary	L. Eyer / L. Szabados
16-20/05	Frascati	CU5	Plenary	F. van Leeuwen / P. Marrese
17-19/05	Strasbourg	CU4	Plenary	D. Pourbaix / JL. Halbwachs
26-27/05	Chamonix	CU3	AGIS#15	U. Lammers
14-16/06	MSSL	CU6	Plenary	D. Katz / M. Cropper
16-17/06	ESTEC		GST #35	T. Prusti
06-07/07	Brussels		DPACE #13	F.Mignard / D. Pourbaix

Gaia and related science meetings			
03-06/05	Naples	WS Cosmic Distance Scale	http://www.oacn.inaf.it/ESFdistance/
04-06/05	Pisa	WS Solar System Science	http://www.oca.eu/workshop/Pise/
23-27/05	Granada	Stellar Clusters & associations WS	http://sca.iaa.es/
30/05-03/06	Canary Islands	JWS & summer school: astrostatistics and data mining in large astronomical databases	http://iwinac.org/Astrostatistics/
06-09/06	Porto	WS QSO, Reference frame	http://www.fc.up.pt/great-ws-porto/
21-23/06	ULB, Brussels	GREAT, Plenary	http://www.ast.cam.ac.uk/ioa/GREAT/
23-24/06	Brussels	WS Stellar Atmospheres in the Gaia Era	http://great-esf.oma.be
29/06-01/07	Cambridge	WS Science Alerts	http://www.ast.cam.ac.uk/ioa/research/
11-14/07	Leiden	WS Interstellar medium	http://www-thphys.physics.ox.ac.uk/

More information on calendar of Gaia : http://www.rssd.esa.int/index.php?project=Gaia&page=Calendar_of_meetings

This newsletter is published by DPAC Chair. To publish news or articles please contact: sophie.roussel@oca.eu