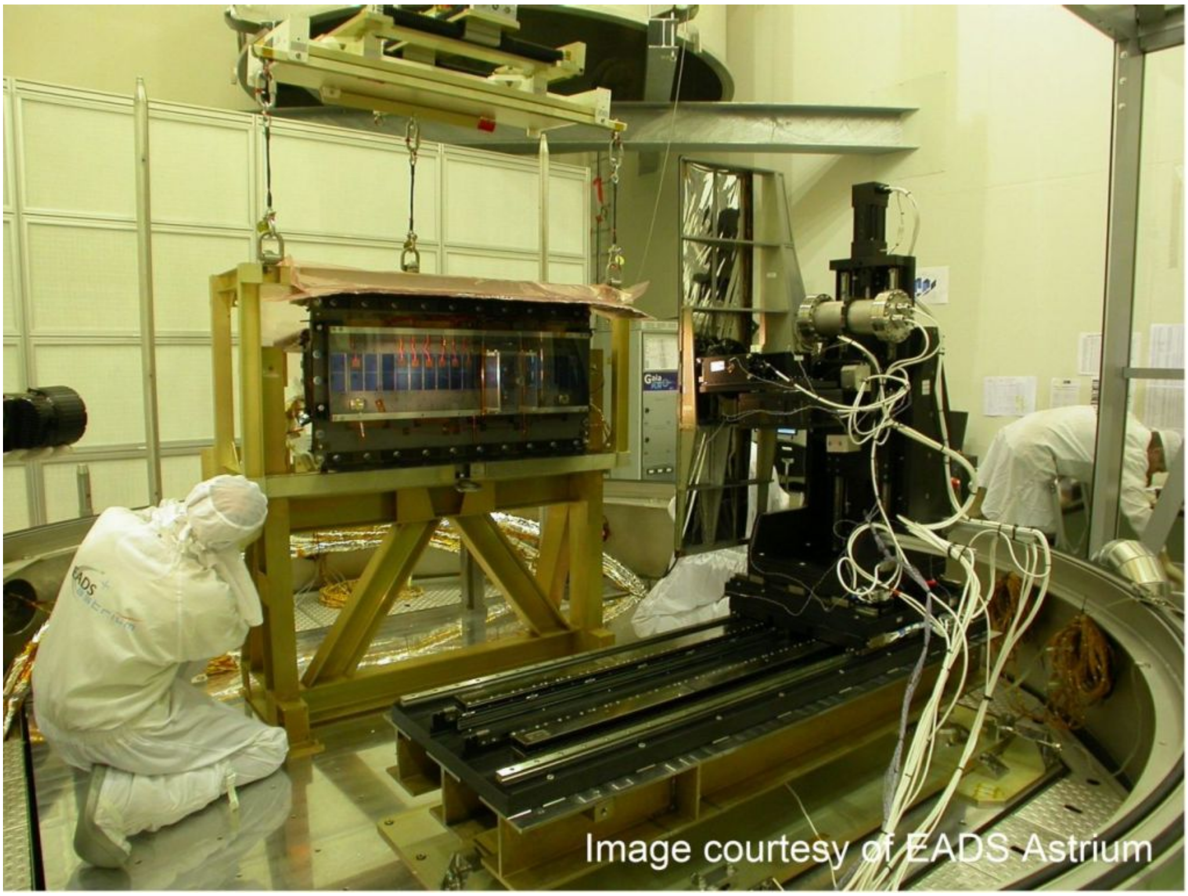
Gaia DPAC Newsletter 7

N° 7 - JANUARY 28, 2010



Engineering model of the Gaia Focal Plane Assembly in its dedicated chamber in Toulouse. There are two rows of CCDs, including one WFS (Wave-Front sensor) CCD, mounted with their related electronics. The optical system movable on the rails in the foreground simulates illumination by star-like point sources observed on Time Delay Integration mode. The system is used to test the proper functioning and performances of the detection chain and its proximity electronics, the window allocation software and the centroiding algorithms. First light shows compliance to expected performances and a Line Spread Function (LSF) very close to the Gaia typical LSF.

Editorial *by DPAC chair, François Mignard*

With this late January issue of the NewsLetter, this is the last opportunity to present the Gaia community and all the addressees of the letter the Best Wishes for 2010 from the NL editorial board.

Several key deliveries for the mission took place with Astrium over the recent months and, hopefully, this will continue in 2010. One milestone of particular significance was the signature in December of a contract with Arianespace for the procurement of a Soyouz launch vehicle to put Gaia on its Lissajous orbit around L2. Therefore we have a rocket in construction to lift off Gaia from the dedicated launchpad near Kuru in French Guiana.

You will see in this issue new facets of the DPAC organisation, with the presentation of our Project Office located at ESAC and now operational. This is an important management structure for the DPAC in charge, among others, of monitoring the schedule(s) and managing the numerous internal and external interfaces. The Data Processing cannot go without a significant volume of auxiliary data to be obtained from the ground before launch. This is coordinated at the level the DPAC by a dedicated Working Group whose activities are outlined by C. Soubiran, the chair of this group. As you will see the topics covered are very broad and several of the on-going observing programs make valuable contributions to astronomy, even without the perspective of Gaia. Also, something even less known, is the effort within the DPAC devoted to improve the velocity determination of the spacecraft, either from astrometric observations as already reported in a previous issue, or from the data itself as explained here by A. Butkevich and S. Klioner.

DPAC Project Office *by Emmanuel Mercier (DPAC project coordinator)*

In 2007, the DPACE, (DPAC executive committee), decided to create the DPAC Project Office. The goal of this structure was ambitious: the day-to-day management of the overall DPAC development and operations activities.

To reach this objective, the Project Office has to monitor some complementary management fields like system engineering, scheduling, interfaces, resources, risks, the technical progress and the configuration and quality assurance.

Started in late 2008, the Project Office today comprises six people, three of them are full time equivalent and one more FTEs should start in February 2010. The PO people are all well experienced and their profiles are mixed: PhDs, MBA, astronomer, developer and include ESA staff members as well as national civil servants.

One must say that the start of the PO was late compared to the development phase of DPAC, although it has been successful already in providing efficient management information thanks to the remarkable work previously set up by CU1 in terms of methodology (ECSS) and collaborative architecture (subversion, wiki, Mantis, scripts).

To date, the main achievements have been the set up of the master schedule baseline, the implementation of the milestones collection process, the monitoring of the design review, the actions management, the critical items monitoring and reporting, the start of an efficient internal and external interface management and the provision of support to integration tests. Some management fields are not yet fully covered and 2010 should see the completion of the technical progress management through the monitoring of the requirements in a PO database (Information Management Tool) and the follow-up of the entire DPAC resources (who does what, when).

Finally, as a support office, the PO would like to emphasize its openness and availability to all DPAC members for any management matters.

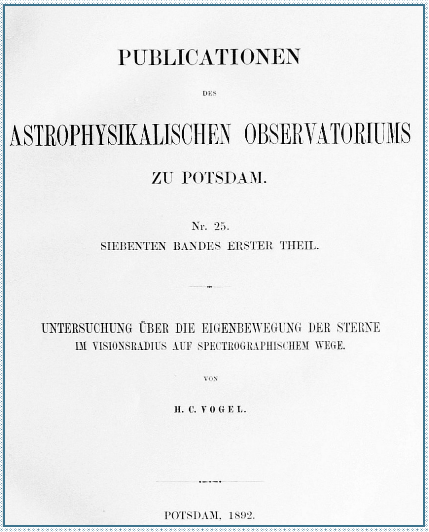
The Project Office members from left to right: Gabriele Comoretto, Gonzalo Gracia, Emmanuel Mercier, Sebastien Els, Tim Lock; (not shown: William O'Mullane).

***More information** at (restr. Access):* http://www.rssd.esa.int/wikiSI/index.php?title=Project_Office&instance=Gaia

Words of Gaia

Radial Velocity:

The Austrian physicist H.C.Doppler had suggested in 1840 that, similarly to the alteration of a sound with the source motion, the colour of a star would change according as it recedes from us or comes toward us. The insight was correct, but Doppler was blatantly wrong in his application to the colour of the stars. The breakthrough came with the French H.L. Fizeau few years later when he realised that dark absorption lines in the star's spectrum would change position due to the component of the star motion in the radial direction. The reality of the phenomenon and its value for investigating motion in astronomy triggered a long controversy which ended up with the first undisputable measurement of radial velocities, nearly 50 years later.



PUBLICATIONEN

DES

ASTROPHYSIKALISCHEN OBSERVATORIUMS

ZU POTSDAM.

Nr. 25.

SIEBENTEN BANDES ERSTER THEIL.

UNTERSUCHUNG ÜBER DIE EIGENBEWEGUNG DER STERNE IM VISIONSRADIUS AUF SPECTROGRAPHISCHEM WEGE.

VON

H. C. VOGEL.

POTSDAM, 1892.

Sir W. Huggins claimed in 1866 to have seen the displacement of the Balmer lines by judging the spectral shifts by the eye alone. But the accuracy was too poor to bring convincing evidence of a radial velocity and the first successful measurements were carried out in 1890 by H.C. Vogel, the then director of the newly erected Potsdam Astrophysical Observatory. Visual observations were replaced by photographic plates, allowing higher resolution spectroscopy and velocities were ascertained for Sirius, Procyon, Rigel and Arcturus to few km/s. On his way to improve the technique, Vogel made his most spectacular discovery, the spectroscopic binary stars, by showing the close relationship between the velocity of Algol along the line of sight and its photometric change, proving the existence of a companion periodically eclipsing the star. Adding that Vogel was also a forerunner in stellar classification from their spectra, he pioneered three fields that Gaia will cover with the accuracy and sensitivity permitted with modern technology.

Title page of Vogel's paper of 1892, in which the radial velocity of stars were first cautiously recorded spectrograhically from their Doppler-Fizeau shifts.

Focus on partners

Department of Astronomy at the University of Vienna, Austria *by Thomas Lebzelter*

The Department of Astronomy at the University of Vienna is the largest research institution for astronomy in Austria and has a long tradition in stellar astrophysics. Scientists of this institute are working on two major topics within the coordination units stellar variability (CU7) and astrometry (CU4). The team, supported by the Austrian Science Fund FWF, consists of three postdocs (K. Kolenberg, T. Lebzelter, S. Sacuto) and one PhD student (D. Lorenz).

The Austrian contribution focuses on the pulsating variable stars like RR Lyrae.

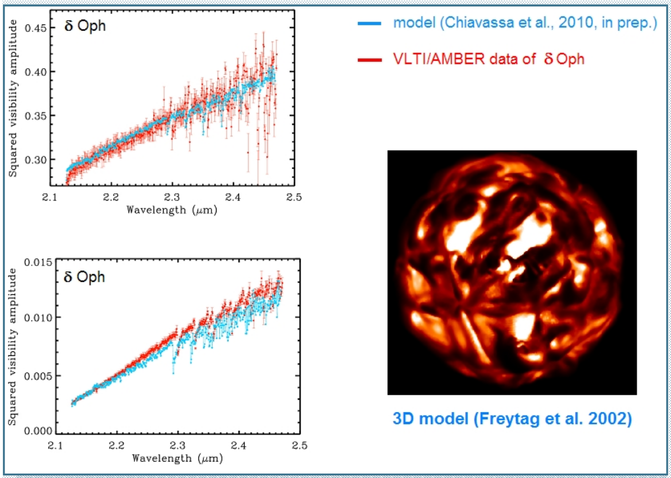
These stars play an important role as distance indicators and as tracers of galactic evolution. From the Gaia light curves various fundamental quantities of RR Lyrae stars can be estimated.

More specifically, we investigate the mysterious Blazhko effect, a periodic modulation of the amplitude and/or the phase of the main pulsation. Gaia will provide more accurate occurrence rates of this effect, which, if undetected, could bias the average magnitude of such stars.

Variables in a later evolutionary stage are studied by a second group. Vienna is leading the Specific Object Studies work package on long period variables (LPVs) within CU7. We aim to provide an automatic classification according to the various period-luminosity (P-L) sequences found in the Magellanic Clouds. The Gaia dataset will be important for the study of the P-L-sequences in our Milky Way and for understanding the variability of these stars in general.

This project is part of a wider study on the properties of P-L-relations for LPVs.

Web-addresses: www.univie.ac.at/astro and www.univie.ac.at/lebzelter/gaiafwf

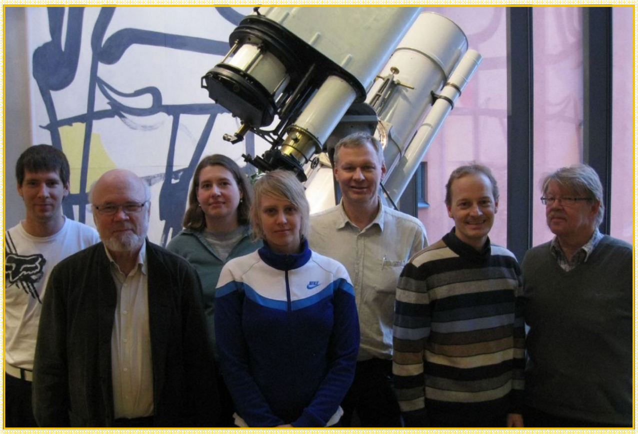


Upper and lower left panels show interferometric measurements of delta Oph (2 baselines). The right panel corresponds to the synthetic image of the corresponding RSG simulation.

Division of Astronomy & Space Physics at Uppsala University, Sweden, *by Andreas Korn*

Due to Uppsala's long and productive history in stellar-atmosphere modelling, researchers at the Division of Astronomy & Space Physics at Uppsala University found their DPAC home in CU8 "Astrophysical Parameters". Within the WP "Training Data", we coordinate the Europe-wide computation of synthetic stellar observables that are used to produce Gaia-simulated data for testing diverse algorithms in various CUs. Uppsala is a natural choice for this task, as we provide stellar observables covering stars with effective temperatures between 2500 K and 16000 K, i.e. the range of T_{eff} values in which more than 95% of all Gaia targets will fall. Two different codes are maintained for that purpose: MARCS models for stars cooler than 8000 K and LLmodels (Line by Line stellar atmosphere model in 1-D) for hotter stars. Both are codes for solving the stellar-atmosphere problem using classical assumptions (one-dimensional geometry, hydrostatic equilibrium, local thermodynamic equilibrium, local convection model), but they are sophisticated in treating arbitrary elemental mixtures and, in the case of LLmodels, magnetic fields and vertical element stratification. Researchers in Göttingen, Nice, Montpellier and Vienna contribute to this effort.

It is our ambition to systematically explore the limits of such classical models. We do this mainly in two ways: we collect and analyse high-quality data of stars whose parameters are known from independent measurements. Such efforts are coordinated within the cross-CU GBOG team (cf. the GBOG article in this issue). Uppsala coordinates the GBOG efforts related to CU8. We also try to develop atmosphere modelling and physics (e.g. line-broadening theory) further to achieve a higher degree of self-consistency. This means relaxing the above-mentioned classical assumptions one by one and quantifying the impact this has on derived quantities like stellar parameters, abundance, ages etc. The Uppsala DPAC efforts are supported by the Swedish National Space Board.



From left to right: Vitaly Makaganiuk, Bengt Gustafsson, Ulrike Heiter, Anna Önehag, Bengt Edvardsson, Andreas Korn, Kjell Eriksson (not shown: Paul Barklem and Oleg Kochukhov).

Astrometric velocity determination *by Alexey Butkevich & Sergei Klioner (Lohrmann-Observatorium, Dresden)*

It is well known that Gaia velocity v relative to the barycentre of the solar system must be known with an accuracy of a few mm/s. The reason for this is that the Newtonian aberration $\propto v/c$ must be computed with an accuracy of a few microarcseconds, similar to the final astrometric accuracy for the best stars. The error budget of Gaia orbit determination analysed by ESOC experts shows that the standard orbit determination techniques cannot ascertain the Gaia velocity with this accuracy. Our group works on one of the possible solutions of this problem: the determination of Gaia velocity from its own astrometric data as a part of the global astrometric solution. Since the velocity of Gaia influences the observed directions, a correction to the given ephemeris velocity can be determined by assuming that most of the sources have nearly constant velocity in space and thus behave according to the standard astrometric model that includes five source parameters: two components of the position, two for the proper motion and the parallax. The idea seems to be straightforward, but there are a number of tricky obstacles on this way.

First, three particular signatures in the velocity are degenerated with source parameters:

- a constant velocity produces a systematic shift of positions;

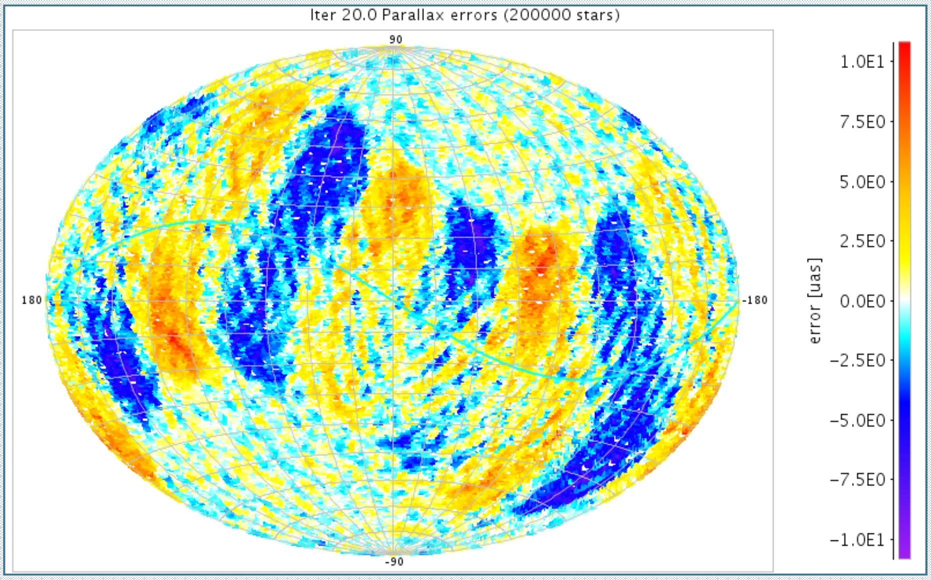
- a velocity linearly varying with time (constant acceleration) produces a systematic shift of proper motions;

- a velocity proportional to the barycentric position of the satellite produces a systematic shift of parallaxes.

These three kinds of signals in the velocity cannot be determined from astrometric observations. The whole idea of fitting a correction to the velocity remains useful only if one can be sure that these signals are not present, at the relevant level, in the real error of the ephemeris velocity. Fortunately, this can be demonstrated for Gaia.

Now, the peculiarities of the Gaia design come into play. Another difficulty originates from the fact that, for Gaia, some components of the velocity highly correlate with the attitude. The fields of view of Gaia are small enough for the differential aberration due to a small velocity correction (at most 10 mm/s) to be negligible. As a result, e.g., a small velocity variation directed along the spin axis, shifts all stellar images in almost exactly the same way as a corresponding small change in the attitude. The existence of such sort of correlations means that a simultaneous fit of both attitude and velocity is very close to degeneracy and cannot be done reliably. Nevertheless, if an effect of velocity is absorbed by the attitude it is fully acceptable for Gaia. Of course, the resulting attitude will not describe the real attitude of Gaia satellite, but we are only interested in getting correct source parameters. Detailed analysis shows that the only component of the velocity we have to worry about is the component directed along the axis rotating with the satellite and going exactly midway between the two fields of view (X-axis of the so-called Scanning Reference System).

Using AGISLab, an elegant Gaia simulation tool developed in Lund, we are now investigating the problem of fitting this component of the velocity in detail. Our goal is to find a version of the velocity determination, which is sufficient for Gaia and, simultaneously, acceptable from the computational point of view.



Example of errors in final parallaxes caused by a wrong velocity of Gaia.

The shift in the velocity has been taken as a quasi-periodic signal with an amplitude of about 20 mm/s. The error distribution results from an intricate interaction between the velocity error and the scanning law of Gaia.

Ground-Based Observations for Gaia *by Caroline Soubiran*

(Laboratoire d'Astrophysique de Bordeaux, France) and the GBOG Working Group

Although Gaia is usually labelled as a self-calibrating instrument, some auxiliary data are needed to improve, test, calibrate or validate several pieces of the data processing pipeline. In general this means new observations from the ground because no pre-existing dataset fulfils the Gaia requirements in terms of homogeneity, precision, sky coverage, magnitude range, spectral interval and variety of astronomical objects. Several observing programmes are in full swing in order to have the auxiliary data ready by 2012, at the start of the data processing. Some observations will even continue during the mission. National and international facilities are involved in this preparatory work which requires a substantial amount of telescope time.

Gaia is a complex instrument designed to gather billions of measurements with technologies that have never been experimented before, for a variety of astronomical objects that are far from being well understood. The success of the photometry and spectroscopy relies on our ability to connect these measurements to a standard system. The BP/RP flux calibration (CU5) and the definition of the zero point of RVS radial velocities (CU6) are obvious tasks that must be performed in a very accurate way, otherwise Gaia's photometric and spectroscopic data will be meaningless. Some 200 spectrophotometric standard stars are currently being intensively observed with several instruments in Italy, Spain, Mexico and at ESO. Furthermore, a list of more than 1400 stars is being followed-up with three echelle spectrographs, in France and Chile, to validate them as radial velocity standards.

Important programmes are also conducted within CU3. The daily ground-based optical tracking of the satellite is being prepared by making tests with astrometric observations of WMAP, located at L2 and with a magnitude similar to Gaia's. Negotiations have begun to build the network of small telescopes that will perform the tracking over the five years of the mission. Several telescopes are also used to create astrometric, photometric and spectroscopic reference fields at both Ecliptic Poles, two regions that will be intensively observed during the commissioning phase.

The alignment of the ICRF2 and the future Gaia reference frame is also being prepared by observing weak extragalactic radio sources with VLBI, involving the European EVN and the American VLBA networks.

Other observing programmes are on-going in CU4 related to the taxonomic training for asteroids, and in CU8 for the stellar parametrisation training. CU7 is building the network of small and medium size telescopes that will complement the variable star pipeline. Finally the flux alert detection and classification will be assessed during a short, but intensive, period of ground based observations, one cycle after launch.

The GBOG Working Group was created in 2006 as a pan-CU structure in order to coordinate the observing programmes required to support Gaia. It started with a census of all ground based observations necessary for the data processing. It was mandatory to first identify overlaps among needs, targets and facilities in the various observing programmes, to organise the coordination of the proposals, the cooperation of teams and to frame the current long term observing plan. Now that all programmes are on a good track, the WG is dealing with several issues such as the availability of facilities until 2017, the release of auxiliary data within the Gaia catalogue and the storage of all GBOG observations. It is worthwhile noting that most of the auxiliary data acquired for Gaia will also be useful for other projects.

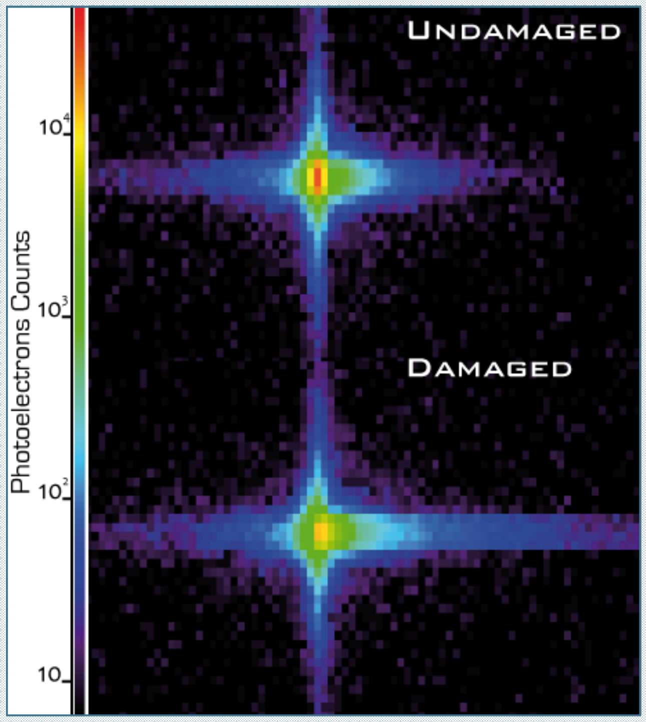
T1.93m at Observatoire de Haute-Provence is one of the telescopes involved in the GBOG observing programmes. Its instrument, the echelle spectrograph SOPHIE, is used 10 nights per year for the qualification of radial velocity standards.

More information at (restr. Access): http://www.rssd.esa.int/wikiSI/index.php?title=GBOG&instance=Gaia

Focus on ELSA programme: Thibaut Prod'homme, *Leiden Observatory*

Thibaut Prod'homme works at Leiden Observatory as a PhD Student under the supervision of Anthony Brown. His research is dedicated to the modelling of radiation damage effects on astronomical CCDs with a particular focus on Gaia's CCDs. Thibaut is closely interacting with the DPAC Radiation Task Force, which consists of representatives from all CUs aiming to develop and implement a radiation damage mitigation scheme.

During the 5-year mission lifetime, solar protons will collide with the satellite's focal plane and create photoelectron traps in its 106 CCDs. This will lead to a degraded precision for all Gaia's measurements. The DPAC mitigation scheme relies on a better understanding of radiation damage physics and the development of a fast charge distortion model (CDM) to simulate radiation damage effects. Thibaut's work is involved at every level of this scheme. He is developing detailed Monte-Carlo simulations at the CCD pixel level, analyzing the experimental tests carried out by Astrium, and contributes to the CDM validation studies.



Outcome of a pixel level Monte-Carlo model simulating unaffected and radiation affected transits of a 14th magnitude star over a Gaia-like CCD. The damaged has been artificially increased to clearly bring out the photo-centre shift. According to experimental tests, for the astrometric data the PSF distortion will lead to biases in the image location measurement of up to 10 milli - arcseconds for a 15th magnitude star. More about this work at: *www.strw.leidenuniv.nl/~prodhomme*.

New on wiki DPAC *by Sophie Rousset*

An open page has been created on the wiki DPAC (restricted access) to welcome your suggestions of articles and various comments.

Feel free to initiate a discussion on the last edition of the DPAC Newsletter or share ideas about themes you would like to be developed in our bulletin.

Should you be willing to write an article yourself, please do not hesitate to mention it on this page.

For non-DPAC members, you can also contact directly the editorial board at sophie.rousset@oca.eu.

Calendar of next DPAC related meetings

Date	Place	Who	Type	Resp.
18/02	Strasbourg	GREAT	ESF Kick-Off	N. Walton
16-17/03	ESAC	CU1	Plenary	W. O'Mullane
16/03	Dresden	CU3	Velocity thinkshop	S. Klioner
15-16/04	ESTEC	GST#30		T. Prusti
21-22/04	ESAC	CU3	Plenary	U. Bastian

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
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