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|  | ***INAF – Osservatorio Astrofisico di Torino******Missione Gaia – Fase Operativa*****RA2 PROGRESS REPORT** |   |

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| **RA2 Progress Report****Missione Gaia – Partecipazione Italiana al DPAC****Fase Operativa** |

SIGNATURE AND APPROVALS ON ORIGINAL

|  |  |
| --- | --- |
| **Authors:** | **M.G. Lattanzi, R. Drimmel, M. Sarasso with contributions from D. Busonero, C. Cacciari, A. Cellino, M. Crosta, A. Dell’Oro, A. Lanzafame, R. Morbidelli, L. Pulone, V. Ripepi, A. Riva, Sozzetti, A. Spagna, A. Vallenari, A. Vecchiato** |
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APPROVALS:

|  |  |
| --- | --- |
| PI (Resp. Sci.): Mario G. Lattanzi  |  |
| PROGRAM MANAGER: R. Drimmel |  |

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# INTRODUCTION

## **SCOPE**

This document is the progress report for the *Italian participation in Gaia DPAC*, financed under ASI contract 2014-025-R.0, prepared for the second *“Riunione di Avanzamento”* (RA2) to be held within 14 months of the KO meeting of Jun 9, 2014.

The activities reported are with respect to the **reporting period Dec 16, 2014 – Jul 15, 2015.**

## **DEFINITIONS AND ACRONYMS**

| ***Acronym*** | ***Definition*** |
| --- | --- |
| **A&A** | Astronomy and Astrophysics |
| **ACS** | Oracle Advanced Customer Support |
| **AGIS** | Astrometric Global Interactive Solution |
| **AIM** | Astrometric Instrument Model |
| **ALTEC** | Advanced Logistic Technology Engineering Center |
| **AO** | Announcement of Opportunity |
| **AP** | Astrophysical Parameter |
| **APACHE** | A PAthway toward the Characterization of Habitable Earths |
| **ASC** | Attitude Star Catalog |
| **ASDC** | ASI Science Data Center |
| **ASI** | Agenzia Spaziale Italiana |
| **ASM** | Oracle Automatic Storage Management |
| **AVU** | Astrometric Verification (development) Unit |
| **BA** | Basic Angle |
| **BAM** | Basic Angle Monitoring |
| **BAV** | Basic Angle Variation |
| **CCB** | Configuration Control Board |
| **CCD** | Charge-Coupled Device |
| **CDR** | Critical Design Review |
| **CINECA** | Consorzio Interuniversitario dell’Italia Nord-Est per il Calcolo Automatico |
| **CNES** | Centre National d'Etudes Spatiales (France) |
| **CTI** | Charge Transfer Inefficiency |
| **CU** | Coordination Unit (in DPAC) |
| **DB** | Data Base |
| **DBMS** | Data Base Management System |
| **DE-MCMC** | Differential Evolution – Markov Chain Monte Carlo |
| **DPAC** | Data Processing and Analysis Consortium |
| **DPACE** | DPAC Executive |
| **DPC** | Data Processing Center |
| **DPCB** | DPC Barcelona (Spain) |
| **DPCC** | DPC CNES (Toulouse, France) |
| **DPCE** | DPC ESAC (Madrid, Spain) |
| **DPCG** | DPC Geneva (ObsGE/ISDC, Switzerland) |
| **DPCI** | DPC Institute of Astronomy (Cambridge, UK) |
| **DPCT** | DPC Torino (Italy) |
| **DU** | Development Unit |
| **EC** | European Community |
| **ECSS** | European Cooperation for Space Standardization |
| **EPC** | Ecliptic Pole Catalogue |
| **EPSL** | Ecliptic Pole Scanning Law |
| **ESA** | European Space Agency |
| **ESAC** | European Space Astronomy Centre |
| **ESO** | European Southern Observatory |
| **ESF** | European Science Foundation |
| **ESP** | Extended Stellar Parametrizer |
| **ESR** | Early Stage Researcher |
| **EWASS** | European Week of Astronomy and Space Science |
| **E2E** | End-to-End tests of scientific Ground System |
| **E2ESn** | End-to-End Stage n |
| **FLAMES** | Fiber Large Array Multi-Element Spectrograph (VLT) |
| **FP7** | Seventh Framework Programme |
| **FTE** | Full Time Equivalent |
| **GAME** | Gravitation Astrometric Measurement Experiment |
| **GAP** | Gaia Archive Preparation |
| **GAPS** | Global Architecture of Planetary Systems |
| **GAREQ** | GAia Relativistic Experiment (on) Quadrupole |
| **GAREX** | GAia Relativistic EXperiment |
| **GASS** | GAia System-level Simulator |
| **GENIUS** | Gaia European Network for Improved User Services |
| **GES** | Gaia ESO Survey |
| **GBOG** | Ground Based Observations for Gaia |
| **GBOT** | Ground Based Optical Tracking |
| **GIBIS** | Gaia Instrument and Basic Image Simulator |
| **GOG** | Gaia Object Generator |
| **GREAT** | Gaia Research for European Astronomy Training |
| **GREM** | Gaia RElativity Model |
| **GSA** | Gaia Science Alerts |
| **GSP** | General Stellar Parametriser |
| **GSR** | Gaia Sphere Reconstruction |
| **GST** | Gaia Science Team |
| **GTC** | GREAT Training Committee |
| **GTS** | Gaia Transfer System |
| **GWP** | Gaia Work Package |
| **HARPS-N** | High Accuracy Radial velocity Planet Searcher – North  |
| **HQ** | Head Quarter |
| **HW** | Hardware (also denoted H/W) |
| **ICG** | Italian Coordination Group |
| **IDL** | Interactive Data Language |
| **IDT** | Initial Data Treatment |
| **IDU** | Intermediate Data Update |
| **IGSL** | Initial Gaia Source List |
| **IM** | Instrument Model |
| **INAF** | Istituto Nazionale di Astrofisica |
| **IOCR** | In-Orbit Commissioning Review |
| **IPD** | Image Parameter Determination |
| **ITN** | Initial Training Network |
| **IWP** | Italian Work Package |
| **JUREX** | JUpiter Relativity EXperiment |
| **KO** | Kick-Off |
| **LoI** | Letter of Intent |
| **LSF** | Line Spread Function |
| **MDB** | Main Data Base |
| **MIAPP** | Munich Institute for Astro- and Particle Physics |
| **MLA** | Multilateral Agreement |
| **MNRAS** | Monthly Notices of the Royal Astronomical Society |
| **MPI** | Message Passing Interface |
| **NSL** | Nominal Scanning Law |
| **NSS** | Non-Single Star |
| **O11Gdbms** | Oracle 11 Grid Database Management System |
| **O12Cdbms** | Oracle 12 Cloud Database Management System |
| **OABo** | Osservatorio Astronomico di Bologna |
| **OACt** | Osservatorio Astronomico di Catania |
| **OANa** | Osservatorio Astronomico di Napoli |
| **OAPd** | Osservatorio Astronomico di Padova |
| **OARm** | Osservatorio Astronomico di Roma |
| **OATe** | Osservatorio Astronomico di Teramo |
| **OATo** | Osservatorio Astronomico di Torino |
| **OGLE** | Optical Gravitational Lensing Experiment |
| **ODA** | Oracle Database Appliance |
| **OM** | Object Model |
| **OR** | Operations Rehearsal |
| **PCA** | Principal Component Analysis |
| **PCDP** | Personal Career Development Plans |
| **PI** | Principle Investigator |
| **PIO** | PI Office |
| **PIP** | Project Implementation Plan |
| **PM** | Progress Meeting or Project Manager |
| **PMS** | Pre-Main Sequence |
| **PO** | (DPAC) Project Office |
| **POP** | Physical Optical Propagation |
| **PR** | Progress Report |
| **PSF** | Point Spread Function |
| **RA** | Research Astronomer (Astronomical Observatory) or Riunione di Avanzamento |
| **RAC** | Oracle Real Application Cluster |
| **RAMOD** | Relativistic Astrometric MODel |
| **REMAT** | RElativistic Model And Tests |
| **RF** | Riunione Finale |
| **RfQ** | Request for Quotation (same as the Italian RdO) |
| **RID** | Review Item Discrepancy |
| **RRL** | RR Lyrae |
| **RTF** | Radiation (Damage) Task Force |
| **RVS** | Radial Velocity Spectrometer |
| **SC** | Steering Committee of the MLA |
| **SDD** | Software Design Document |
| **SDP** | Software Development Plan |
| **SED** | Spectral Energy Distribution |
| **SEP** | South Ecliptic Pole |
| **SGI** | Silicon Graphic Inc. |
| **SGS** | Science Ground Segment |
| **SMP** | Science Management Plan |
| **SOC** | Science Operation Center or Scientific Organizing Committee |
| **SPC** | Science Program Committee |
| **SPSS** | Selection Spectrophotometric Standard Stars |
| **SRN** | Software Release Note |
| **SRS** | Software Requirements Specification |
| **SSO** | Solar-System Object |
| **SSS** | Software System Specifications |
| **STS** | Software Test Specifications  |
| **STR** | Software Test Report |
| **SVD** | Special Variability Detection |
| **SVN** | SubVersioN |
| **SW** | Software (also denoted S/W) |
| **TD** | Tempo Determinato (Astronomical Observatory) |
| **TGE** | Total Galactic Extinction |
| **TNG** | Telescopio Nazionale Galileo |
| **UniCt** | Università di Catania |
| **UniPd** | Università di Padova |
| **UVES** | UV-Visual Echelle Spectrograph (VLT) |
| **VMC** | VISTA Magellanic Cloud |
| **VO** | Virtual Observatory |
| **WBS** | Work Breakdown Structure |
| **WFS** | WaveFront Sensor |
| **WISE** | WIde-field Survey Explorer |
| **WP** | Work Package |
| **WPD** | Work Package Description |
| **XM** | Cross Matching |

## **REFERENCES**

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| --- | --- |
| [AD 1] | “Accordo (attuativo della convenzione quadro) N. 2014-025-R.0, CUP F82I14000830005 per *Missione Gaia – Partecipazione Italiana al DPAC – fase operativa”* |
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| [AD 5] | O’Mullane W., Drimmel R., Mignard F. et al., “*Project Implementation Plan for Gaia Data Processing Analysis Consortium”*, GAIA-CD-PL-ESAC-WOM-**017-2**, Issue 2, Rev. 0., 31 pgs, Apr 2013 |

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| [RD 2] | Mignard F. & Drimmel R. eds., “*DPAC Proposal for the Gaia Data Processing. Response to ESA’s Announcement of Opportunity”*, GAIA-CD-SP-DPAC-FM-030-2, 711 pgs, Apr 2007 |
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| [RD 9] | Bailer-Jones C., Janotto A.-M. et al., “*CU8 Software Development Plan”,* GAIA-C8-PL-MPIA-CBJ-031-10, May 2011 |
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| [RD11] | ASI contract to ALTEC S.p.A. “Gaia – DPC Italiano (DPCT)”, ASI N. 2013/030/I.0, May 2013 |
| [RD12] | Accordo Quadro INAF-Oracle IT-OMA-1606 (Lic\_OMA\_General\_Terms\_v101912\_IT\_ITA) |

# EXECUTIVE summary

This Progress Report is the consequence of the new agreement successfully negotiated on June 25 by ASI-EOS and the Italian Gaia Project Office (PO) based at INAF-OATo. The agreement went into effect as of June 29, following the digital signature of the contract by both ASI and INAF Management.

This new contract was established in the form of an Addendum to contract ASI 2014-025-R.0 deployed in June of 2014 thereby extending its validity for three years. Therefore, in this framework, this is Progress Report No. 2 (RA2) following PR1 that was held last January.

It must be emphasized here that with this new ASI-INAF agreement a full 3-year funding cycle has finally been re-established, securing, under the new the MLA, the Italian participation in Gaia’s DPAC to July 2018.

This represents three more years of the Gaia scientific operational life; actually the **first, most critical, three years** of the satellite scientific life when most of the actual scientific performances of the satellite will finally be measured…. And Italy will have the opportunity of a leading role in such activities given that, thanks to the systems we have built and to the DPCT, we are in the unique position to independently tell to what extent Gaia’s astrometry, and part of the photometry, are fulfilling expectations!

In the seven months since RA1 the AVU systems running at DPCT continued to be absorbed by OR#5, Cycle 0 and the beginning of Cycle 1 activities to a level that has far surpassed planned for expectations.

Also, support through the AVU Payload Experts has continued toward the monitoring and understanding of the stability/contamination problems uncovered on the satellite with dedicated attention to the astrometric payload and BAM device. Likely DPAC, and AVU in particular, will have to cope with these problems throughout the entire mission.

This has required extensive work on the pipeline tested during the OR’s, therefore maintaining the needs for continuous Java development. Therefore, we confirm that, as anticipated earlier, i.e., during early operation, that at least one more year into Nominal Operations (that began on Sep 25, 2014) is required before the AVU systems AIM and BAM can be transited to ‘maintenance’ (more details in the ‘PM assessment’ section below).

Supporting the ALTEC Team in coping with the issues of increased processing power and storage needs for the extension the G=20.7 (V=21) as the new magnitude limit of the Gaia survey (to recover from some of the losses due to the payload non-compliances) has been a major activity throughout this reporting period and a source of major concerns. The HW situation (storage and servers) reached a critical level at the beginning of May (which would have compromised the DPCT operability) and called for immediate and direct intervention that resulted in a letter to the President of ASI sent by the PI on May 12 on the risks for the Italian participation in Gaia. The events that followed testify of the abnegation of and the hard work from all of the parties involved that led, in less than two months, to the requisition (based on detailed planes that had been prepared in anticipation of these problems) of all the necessary HW and SW licenses. Installation and integration of the most critical HW (storage) over the last three weeks. At the time of this writing we can say the major criticalities, e.g. the daily operability of the Main Repository DB (an ORACLE 11c-based DBMS), have been resolved and the situation is expected to normalize at the beginning of September.

Despite the many changes imposed by the post-commissioning payload and the resulting system limitations, the daily AVU pipelines, AIM and BAM, continues to be in full swing at the DPCT. Since Dec 2014, AIM has successfully completed 203 daily runs and issued the relative reports (a total of 406), while BAM AVU has done the same for 193 runs, for an equivalent number of reports, and 5 ‘weekly’ reports (each of these covering about 1-month of BAM measurements for a medium term assessment of the BAV behavior).

To put the operation activities in numbers the following table is the impressive summary of what accomplished by the AVU systems at the DPCT (as of July 15, 2015), despite the difficulties encountered:

* 61,736 workflows executed and 5,795,699 job processed
* 30-40 GB of telemetry download from Gaia every day (SOC)
* 40-50 GB of files received every day at DPCT
* about 35.000.000.000 Astro Observation received
* 516 AVU/BAM processing completed
* 524 AVU/AIM processing completed
* About 72.2 TB in the database repository
* About 17 TB in the operation’s database
* 5,341 Mission Log entries

This is has also been the time of the deployment of the data reduction systems of the other, off-line, CUs (CU4, CU7, and CU8), starting from the new Operational Rehearsal Campaign No. 5 (started in Sep 2014 and will take most of 2015 to complete) and which sees many Italian contributions at all levels. Noticeable is also the supporting ground based initiatives, especially those for the Gaia Science Alert (GSA) system, that continue to see the significant (and visible) involvement of personnel of this proposal.

The management activities of the Italian Project Office were many and intense during this reporting period and they are detailed, as usual, in the section of the PR devoted to the updates for the work package IWP-M-100. It is worth mentioning here the critical work done to prepare and finalize the negotiation meeting that led to the new 3-years agreement in the form of an Addendum to the current contract, as mentioned at the beginning of this Executive Summary. Among other things, this has allowed us to continue to keep the CU9 activities of the INAF staff a part of the Italian effort in Gaia as per the new Gaia-MLA. In this context the continuous support from INAF, both in kind and with additional funds (PHD fellowships, GES support, Post Docs,…) must be acknowledged.

Finally, there are no pending action items since the KO event.

## **PROGRAM MANAGER ASSESSMENT**

Overall the project is on schedule. Gaia has completed one year of science operations, and the DPAC Initialization phase (Cycle00) is formally ending this month.

The DPAC Operations Rehearsal OR5 test campaign is proceeding, though with the completion of OR5 Stage2, the DPCT/AVU participation has been completed.

While it is evident that the transition from development to maintenance for AIM and BAM will need to come later than originally planned, this will not have an effect on the overall Gaia Science Ground Segment schedule. This delay in the AIM and BAM schedules is primarily due to the unexpected satellite issues that came to light during Commissioning. (See AB-052) These include:

1. High straylight levels with solar origin, most likely caused by diffraction off the edge of the solar shield.
2. Large periodic (6hour) Basic Angle (BA) variations whose cause is unknown.
3. Telescope throughput loss likely due to contamination on the mirrors requiring periodic decontamination (i.e. heating) campaigns.

Handling these issues has required major adaptation in some parts of the processing. Furthermore it has become clear that the BA variations potentially may compromise the astrometry. Indeed, it has become critical that the BAM signal is calibrated so that it can be used in the astrometric processing. DPAC and ESA has also formed a dedicated working group with Airbus to investigate the cause of the BA variations. In any case, the importance of the BAM processing, and the difficulty of the interpretation, analysis and calibration of the BAM data has highlighted the **urgent need** to dedicate further resources to this task. **Given the criticality of the BAM system for the astrometric processing, and the unexpected complications that have been manifested by the in-flight instrument, the PM recommends the provision of an additional contract dedicated to this system to support calibration and data analysis.**

In this reporting period CU3/AVU AIM and BAM have each made major SW deliveries to DPCT, including multiple follow up patches. AIM and BAM WP managers and the AVU deputy (myself) continue to contribute to DPAC’s Gaia Payload Experts group, which held regular biweekly telecons during this reporting period.

GSR has completed the test campaign of a major release of the GSR system that includes the new functionality of including the adjustment of the attitude parameters. Associated documents associated with the release (SRN and STR) are pending. In parallel with the test campaign has been the implementation of an instrument calibration model, necessary for the treatment of real Gaia data. GSR also participated in the OR5 test campaign. While the results of these tests were not of scientific value, they proved very useful for preparing and validating that GSR will be able to treat actual Gaia data.

AVU activities and deliveries are detailed in section 5.2.2 under GWP-340.

In CU5 (Photometry), development and testing continued for the handling of crowded fields, and the observational campaign for the CU5 standard stars was concluded, though significant data reduction remains to be completed. The post-launch publication of the Gaia photometric standards is currently scheduled for March 2016 (see EP-014). This schedule is quite tight, given current FTE levels. Testing and optimization of SW dedicated to the absolute photometric calibration was carried out based on OR5 results. Contributions were made to the follow up of Gaia Photometric Science Alerts. Details of CU5 contributions can be found in section 5.2.3.

The Italian participation in CU4 has delivered updated SW modules. For CU7 several revised versions of SW modules were delivered to DPCG, after the OR5 stage2 test campaign which used real Gaia data. In addition the CU7 network of small/medium size telescopes continues to contribute to the validation of the Gaia Science Alerts (GSA) system and observations made at the Bologna Astronomical Observatory in Loiano have contributed to the analysis of Gaia14aae, a very rare cataclysmic variable in an eclipsing binary system (see the paragraphs dedicated to the WP **GWP-T-513-00000 in sec. 5.2 below).**

Simulated datasets for galactic fields from CU2, based on a request from Cycle 11, are still pending. A TGE SW delivery was made for the OR5 test campaign.

For a complete list of main deliverables see section 4.4.3.

## **KEY ISSUES LIST**

1. Additional support for AVU/BAM is recommended. See section 2.1 for details.
2. The modification of the limiting magnitude of Gaia (now to G=20.7, approximately V=21) has led to the rapid decrease in available disk space at DPCT. Additional storage HW has been acquired and is currently being installed to assure the nominal functionality of DPCT.

# contractual and financial STATUS

With the new 3-year agreement now in place, the ASI funding support is not of any concern anymore. Although not at the level needed, the funding level established with the new contract fully complies with the minimum funding requirements agreed between the ASI representatives and the INAF PO during the months that preceded the negotiation meeting. The Italian participation is therefore on solid ground though July 2018, and it is up to the PO and Coordination Group (GC) to use the funding appropriately and wisely, taking into account the evolution of the mission.

# Program ManageMENT status

## **ACTIONS**

* + Actions related to activities of the Italian Project Office:
* as per the minutes of the RA1 there are no open actions.

## **RISKS**

Main risks are:

* Until a calibration procedure is defined, implemented and tested, there is some risk that calibrated BA variations will not be available for the astrometric processing in time for the first data release. This will compromise the Gaia astrometry.
* CU5 delivery schedule may be compromised due to lack of sufficient FTE. In particular, shortage of manpower will delay the delivery of the SpectroPhotometric Standard Stars (SPSS) with respect to the schedule planned and agreed with DPAC, and/or degrade the quality of the delivered product.
* DPCT resources dedicated to testing and development support may not be sufficient to support necessary *development* needed for GSR during early Operations.
* Computing resources at DPCT may not be sufficient to support AIM and GSR co-processing. Currently AIM is out of specification for its performance. HW originally planned to be dedicated to GSR processing has been purchased in anticipation to mitigate this persistent performance issue with the AIM system, but additional computing resources might still be needed if this performance issue is not resolved, or AIM will need to de-scope its processing, for instance reducing the number of observations to be reduced.

## **PROJECT TEAM**

A complete list of the individuals involved in activities covered by the contract, and their level of involvement (FTE) is maintained by the Italian PO for use within the DPAC consortium and is available for consultation upon request.

## **SCHEDULE, DELIVERABLE STATUS AND MEETINGS**

### **Project Schedule**

Figure 1 shows the current main DPAC and ESA milestones up until mid 2018, with the first Gaia Intermediate Data Releases also indicated.

|  |
| --- |
|  |

Figure 1. DPAC master schedule showing end dates of development cycles and ESA reviews.

The launch of Gaia took place on December 19, 2013 and the IOCR (In-Orbit Commissioning Review), took place the 18 July, marking the start of the Nominal Science Operations for Gaia. The test campaign OR5 has started, but is about a month behind schedule with respect to the baseline schedule defined in AV-011-5. Also, ESA has announced that the planned data release schedule has slipped by about 8 months with respect to the pre-launch expectations, in part due to the long-than-expected Commissioning phase (7 months rather than 4) and the additional work necessary to deal with the unexpected non-compliances of the Gaia instrument.

### **Major Release Schedule**

This reporting period covers all of Development Cycle 17 and start of Cycle 18. SW releases and deliverables, noted in the following section, are thus mostly associated with cycles 16 and 17.

### **Main Deliverables**

The following deliverables from the Italian Participation were made for this reporting period (Dec 16, 2014 – Jul 15, 2015).

| **WP** | **Milestone** | **Deliverables** | **Client** | **Status** |
| --- | --- | --- | --- | --- |
| IWP-M-100 | RA2 | Progress Report (this document) | ASI | Issued |
| IWP-M-100 | RA2 | Financial Report  | ASI | Issued |
| GWP-M-340 | Cycle 18 | AIM SW release 18.0 | DPCT | Delivered |
| GWP-M-340 | Cycle 19 | BAM SW release 18.0 | DPCT | Delivered |
| GWP-M-437 | Cycle 18 | DU437 SW release 18.0 | CU4 | Delivered |
| GWP-M-437 | Cycle 18 | DU437 SW release 18.1 | CU4 | Delivered |
| GWP-M-453 | Cycle 18 | DU453 SW release 18.0 | CU4 | Delivered |
| GWP-M-453 | Cycle 18 | DU453 SW release 18.1 | CU4 | Delivered |
| GWP-M-458 | Cycle 18 | DU458 SW release 18.0 | CU4 | Delivered |
| GWP-M-511 | Cycle 18 | SW module: Crowding evaluation algorithm revised and tested | CU5 | Delivered |
| GWP-M-710 | Cycle18 | VariSpecialDetection Version 17.2.0 | DPCG | Delivered  |
| GWP-S-710-05000 | Cycle18 | SW for Solar-like Activity Detection | DPCG | Delivered  |
| GWP-S-720-03000 | Cycle 18 | SW for characterizing Cepheid and RR Lyrae variables | DPCG | Delivered  |
| GWP-S-720-07000 | Cycle 18 | SW for treating Pre-Main-Sequence Oscillators | DPCG | Delivered  |
| GWP-S-720-08000 | Cycle 18 | SW for Rotational Modulation Variables | DPCG | Delivered  |
| GWP-S-720-09000 | Cycle 18 |  SW for Flaring Stars | DPCG | Delivered  |

### **Document List**

The following documents were produced during the reporting period (Dec 16, 2014 – Jul 15, 2015).

***DPAC Technical Notes, Minutes and ECSS documentation***

| **DPACE / CU /** **DPCT** | **Authors and Title** | **Document Code** | **Date / Issue / Rev.** | **Status** |
| --- | --- | --- | --- | --- |
| **DPACE** | VALLENARI et al., **OR# 5 Planning. Exercising the DPAC cyclic processing, and a test plan for CU4/7/8** | *GAIA-CD-PL-OAPD-AV-***011-6**, 59 pgs | Jan 22, Issue 6, Rev. 0 | **issued** |
| **DPACE** | Brown, VALLENARI et al., **DPAC and Gaia Collaboration Publication Plan** | *GAIA-CD-PL-LEI-AB-***041-1**, 8 pgs | Mar 30, Issue 1, Rev. 1 | **issued** |
| **CU3** | AIM and DPCT Team**, Automated AIM RDP/MON Daily Report** | 208 reports | From Dec 16 to Jun 30 | **Not in LL** |
| **CU3** | AIM and DPCT Team, **Automated AIM Calibration Daily Report** | 208 reports | From Dec 16 to Jun 30 | **Not in LL** |
| **CU3** | RUSSO, BUZZI, **AVU/BAM Software Design Description** | *GAIA-C3-SP-INAF-DG-***010-02**, 60 pgs | Jan 12, Issue **2**, Rev. 0 | **issued** |
| **CU3** | VECCHIATO et al., **AVU-GSR 16.0.0 Software Test Report** | *GAIA-C3-TR-INAF-AVE-***023** |  |  |
| **CU3** | RIVA, BUZZI, PECORARO, LATTANZI, DRIMMEL, **AVU/BAM 17.0 Software Test Report** | *GAIA-C3-SP-INAF-RA-***014-02 to 05**, 25 pgs | Apr 22, Issue **1 to 5**, Rev. 0 | **issued** |
| **CU3** | RIVA, LATTANZI, GAI, BUSONERO, **DPCT AVU/BAM Weekly Report** | *DPCT-AVUBAM-***W000018-01** until**W000022-01** | Jun 30, Issue 1, Rev. 0 | **Not in LL** |
| **CU3** | RIVA, LATTANZI, PIGOZZI, **DPCT AVU/BAM Daily Report** | *DPCT-AVUBAM-***000324-01** until **000494-01** | From Dec 16 to Jun 30 | **Not in LL** |
| **CU3** | RIVA, BUZZI, PECORARO, LATTANZI, DRIMMEL, **AVU/BAM 18.0 Software Test Report** | *GAIA-C3-SP-INAF-RA-***016-01**, 25 pgs | Jun 12, Issue 1, Rev. 0 | **issued** |
| **CU5** | van Leeuwen, Busso, CACCIARI, ……, PANCINO et al., **CU5 Internal Report 2015.06** | *GAIA-C5-PR-IOA-FVL*-143, 75 pgs | Jul 1, Issue 1, Rev. 0 | **issued** |
| **CU5** | van Leeuwen, Busso, CACCIARI, ……, PANCINO et al., **CU5 Internal Report 2015.05** | *GAIA-C5-PR-IOA-FVL-*142, 62 pgs | Jun 1, Issue 1, Rev. 0 | **issued** |
| **CU5** | van Leeuwen, Busso, CACCIARI, ……, PANCINO et al., **CU5 Internal Report 2015.04** | *GAIA-C5-PR-IOA-FVL-*141, 65 pgs | May 1, Issue 1, Rev. 0 | **issued** |
| **CU5** | van Leeuwen, Busso, CACCIARI, ……, PANCINO et al., **CU5 Internal Report 2015.03** | *GAIA-C5-PR-IOA-FVL-*139, 76 pgs | Apr 1, Issue 1, Rev. 0 | **issued** |

| **DPACE / CU /** **DPCT** | **Authors and Title** | **Document Code** | **Date / Issue / Rev.** | **Status** |
| --- | --- | --- | --- | --- |
| **CU5** | van Leeuwen, Busso, CACCIARI, ……, PANCINO et al., **CU5 Internal Report 2015.02** | *GAIA-C5-PR-IOA-FVL-*138, 64 pgs | Mar 1, Issue 1, Rev. 0 | **issued** |
| **CU5** | van Leeuwen, Busso, CACCIARI, ……, PANCINO et al., **CU5 Internal Report 2015.01** | *GAIA-C5-PR-IOA-FVL-*137, 74 pgs | Feb 1, Issue 1, Rev. 0 | **issued** |
| **CU7** | CU7 team , **CU7 Variability Processing Software Test Report OR5 Stage 2 (EPSL)**  | *GAIA-C7-TR-GEN-ILT*-**050-1**, 256 pgs | May 26, Issue 1, Rev. 0 | **issued** |
| **CU7** | Lecoeur, LANZAFAME, ....., LECCIA, .....,DISTEFANO et al., **CU7 Variability Processing Software Test Specification** | *GAIA-C7-SP-GEN-ILT-***003**,374 pgs | May 26, Issue 11, Rev. 0 | **issued** |
| **CU7** | CLEMENTINI, RIPEPI, LECCIA, MARCONI, MUSELLA et al., **Cepheids and RR Lyrae stars – Software Requirement Specification (GWP-S-720-03000)** | *GAIA-C7-SP-OABO-GC-***001-6**,116 pgs | May 1, Issue 6, Rev. 0 | **issued** |
| **CU7** | Eyer, LANZAFAME, ….., CLEMENTINI, RIPEPI et al., **CU7 Internal Report (2014-07-16 to 2014-10-31)** | *GAIA-C7-PR-GEN-LE*-**040-1**, 38 pgs | Jun 7, Issue 1, Rev. 0 | **Issued** |
| **CU9** | VALLENARI, BRAGAGLIA, SPAGNA et al., **GWP-947 Cluster selection requirements for the first Gaia data release** | *GAIA-C9-SP-OAPD-AV-***014-0**, 16 pgs | Jun 5, Issue 1, Rev. 0 | **issued** |
| **CU9** | PANCINO, **Census of DPAC auxiliary data products** | *GAIA-C9-TN-OABO-EP-***013-1**, 41 pgs | Jun 23, Issue 1, Rev. 1 | **issued** |
| **PO** | Els, VALLENARI, **Release Critical Items and DPC status check-point #2** | *GAIA-PO-TN-ESAC-SE*-**061-1**, 432 pgs | Jun 25, Issue 1, Rev. 0 | **issued** |
| **DPCT** | Messineo, …., VECCHIATO et al., **DPCT OR#5 Stage 2 Report** | *GAIA-DT-RP-ALT-RM-***041-01**, 26 pag | May 6, Issue 01, Rev. 00 | **issued** |

|  |
| --- |
| ***Software Release Notes*** |
| **DPACE / CU /** **DPCT** | **Authors and Title** | **Document Code** | **Date / Issue / Rev.** | **Status** |
| **CU3** | BUZZI, PECORARO, RIVA, **AVU/BAM 17.0 Software Release Note** | *GAIA-C3-SP-INAF-RBU-***003-02 until 05**, 21 pgs | Apr 22, Issue 5, Rev. 0 | **issued** |
| **CU3** | BUZZI, PECORARO, RIVA, **AVU/BAM 18.0 Software Release Note** | *GAIA-C3-SP-INAF-RBU-***004-01**, 21 pgs | Jun 12, Issue 1, Rev. 0 | **issued** |
| **CU4** | SOZZETTI, **DU437 Module 18.0 Software Release Note** | *GAIA-C4-SP-OATO-ASO-***017-001**, 10 pgs | Mar 16, Issue 1, Rev. 0 | **issued** |
| **CU4** | SOZZETTI, **DU437 Module 18.1 Software Release Note** | *GAIA-C4-SP-OATO-ASO-***018-001**, 11 pgs | Jun 14, Issue 1, Rev. 0 | **issued** |
| **CU4** | DELL'ORO, **DU453 Module 18.0 Software Release Note** | *GAIA-C4-SP-OAFI-ADO-***012-01**, 10 pgs | Apr 30, issue 1, Rev. 0 | **issued** |
| **CU4** | DELL'ORO, **DU453 Module 18.1 Software Release Note** | *GAIA-C4-SP-OAFI-ADO-***013-01**, 10 pgs | May 4, issue 1, Rev. 0 | **issued** |
| **CU4** | CELLINO et al.,  **DU458 Module 18.0 Software Release Note** | *GAIA-C4-SP-OATO-AC-***015-01**, 10 pgs | Jun 15, Issue 1, Rev. 0 | **Issued**  |

| ***Documents related to the ASI Contract*** |
| --- |
| **Authors and Title** | **Document Code** | **Date / Issue / Rev.** | **Status** |
| Lattanzi, Drimmel, Sarasso et al., **RA2 Progress Report**(this document) | GAIA–PR–OATo–**0014**, 59 pgs | Jul 29, Issue 1, Rev. 0 | ***Issued*** |
| Sarasso, Lattanzi, **Financial Report for RA2** | GAIA-FR-OATo-**0010** | Jul 30, Issue 1,Rev. 0 | ***Issued*** |

| ***Observing proposals at ground-based or space-borne facilities in support of the Gaia mission***  |
| --- |
| **Authors and Title** | **Telescope/****Instrument** | **Date**  | **Status** | **Comments** |
| Altavilla, Pancino, Bellazzini, Bragaglia, Cocozza, Federici, Galleti, Marinoni, Ragaini, Silvotti, Valentini **– *Ground-based observations for Gaia's calibrations: establishing the Grid of Spectro-Photometric Standard Stars*** | *1.5m G.D.Cassini BFOSC* |  |  *Executed* | 11 nights |
| Clementini, Altavilla et al. **– *The Transient Sky with Gaia*** | *1.52m telescope in Loiano+BFOSC* | 15-20 Dec 17-24 Jan | *Executed* |  |
| Clementini, Altavilla et al. – ***The Transient Sky with Gaia*** | *1.52m telescope in Loiano+BFOSC* | 19-24 Feb 14-18 Mar 17-22 April 15-19 May 8-11 June | *Executed* |  |
| Clementini, Altavilla et al. – ***The Transient Sky with Gaia*** | *1.52m telescope in Loiano+BFOSC* | 17-20 Aug 3-12 Sept 12-20 Oct 9-12 Nov | *Assigned* |  |

### **Meetings Held**

The following meetings were attended during the reporting period (Dec 16, 2014 – Jul 15, 2015).

| **Meeting** | **Date** | **Location** | **Participants** | **Comments** |
| --- | --- | --- | --- | --- |
| Rome-Teramo DU11 meeting | 12 Jan | ASDC,Rome | De Luise, Piersimoni, Castellani, Giuffrida, Pulone  |  |
| Workshop *Chemical and dynamical evolution of the Milky Way and Local Group* | 19-24 Jan | Bolzano | Spagna | On other funds |
| CU5 Meeting #14 | 27-29Jan  | Barcelona (E) | Cacciari, De Luise, Giuffrida, Montegriffo, Piersimoni | Giuffrida on other funds |
| DPACE Meeting #21 joint with GST #47 | 11-13 Feb | ESTEC (NL) | Vallenari |  |
| ODA in INAF  | 24-27 Feb | Trieste | Morbidelli | On other funds |
| CU9 Validation Workshop | 2-4 Mar | Meudon (F) | Cantat, Vallenari |  |
| Working meeting | 22-28March | Geneve (CH) | Distefano | Test pipeline on EPSL data  |
| PO visit to CNES | 24 Mar | Toulouse (F) | Vallenari |  |
| DPC/CU1/PO Meeting | 25-27 Mar | CNESToulouse (F) | Vallenari |  |
| MOS Certification Oracle course | 26 Mar | Milano | Morbidelli | On other funds |
| Working meeting | 19-24April | Geneve (CH) | Clementini, Leccia | Test pipeline on EPSL data  |
| PO visit to DPCB | 21-22 Apr | Barcelona (E) | Vallenari |  |
| MIAPP Workshop, *The new Milky Way: Impact of Large Spectroscopic Surveys on our Understanding of the Milky Way in the Gaia-era* | 4-29 May | Garching | Bragaglia, Pancino |  |
| Upgrade, Migrate & Consolidate Oracle DB 12c Workshop | 6 May | Milano | Busonero, Morbidelli |  |
| IAU Symp. 314, *Young Stars and Planets Near the Sun* | 11-15May | Atlanta (GA, USA) | Sozzetti |  |
| LIX Congresso SAIt | 18-22 May | Catania | Bellazzini, Lanza, Lanzafame, Messina, Pagano | On other funds |
| PO visit to DPCT | 19-20 May | Torino | Vallenari |  |
| CU7 Meeting #20 | 20-22 May | Lisbon (PT) | Clementini, Distefano, Ripepi |  |
| CU4 Meeting #19 | 26-28 May | Besançon (F) | Cellino, Sozzetti |  |
| CU3 Plenary Meeting #10 | 10-12Jun | Edinburgh (UK) | Abbas, Bucciarelli, Busonero, Drimmel, Lattanzi, Riva, Smart, Spagna, Vecchiato |  |
| Gaia Ultracool Dwarfs Coll. | 15-28 Jun | Madrid | Smart |  |
| EWASS 2015 | 22-26 Jun | Tenerife (E) | Abbas, Drimmel, Pancino | Drimmel on other funds |
| ODA Product Development Workshop  | 25 Jun | Milano | Morbidelli | On other funds |
| Tavolo Negoziale ASI-Gaia, Addendum n. 1 Jun 2015 – Jun 2018 | 25 Jun | ASI HQ, Roma | Lattanzi, Sarasso |  |
| DPACE Meeting #22 | 1-2 Jul | Pic du Midi | Vallenari |  |
| Meeting *Next Steps towards Future Space Astrometry Missions* | 6-8 Jul | Cambridge (UK) | Busonero, Gai, Vallenari |  |
| Marcel Grossman Meeting | 12-18 Jul | Roma | Crosta |  |

### **Procurement Status**

**HW procurement:**

All of the H/W required to run nominally has worked whiteout failures and with acceptable performance range during the period.

All of the major h/w problems that happened in the HP infrastructure and storage systems were solved by the support. This support be maintained by ALTEC, an important aspect that has proved quite effective.

Also, SGI support for the Altix 450 continue.It should be noted that the resource show important eligibility limits (7 years holdest)

The DPCT work on the Operational HW infrastructure right after launch. All of the operational DB instances are registered on the Oracle Customer Support Interface. Work to fine tune performances of the DBMS hosted on the DPCT hardware is continuing by utilizing the Oracle Advanced Customer Support (ACS).

For storage infrastructure, an important issue affect availability of disk space (high capability type) for the nominal activities of REPdb during and after galactic plan satellite scanning period. The fast disk segment reach the limits in space with some heavy limitation in global system management and resources availability The operational difficulties was maintained under control by handling strategies of data switch between storages, associate with data high compression (operations require Oracle ACS support). This contingency result in heavy burden of time and availability of the system as a whole.

New H/W (high capacity and high capability disks and 4 new servers) will be available at end of July and we are confident that daily data ingestion activities return to a nominal state soon in august.

Given the Gaia payload (lack of) performances established during commissioning, AIM has been issued with a much more sophisticated model of the telescope PSF to execute the basic astrometric measurements and monitor calibration at the appropriate level. We expect that the above-mentioned new server acquired accomplish (partially) this issue taking also in to account GSR new entry impact in autumn.

The tape library for backup has reached its operational capacity limits and to be increased. Full back up random fail and time required to do operations is impressive (about 1 week) and expected increasing. A mirror strategy for a secure and most efficient duplication using Oracle (es. Golden gate, multi-tenancy … ) strategies is under analysis. Consider technical feasibility, costs sustainability in next time like (required) evolution of mission.

**SW procurement:**

A Data Mining facility aimed to data retrieve from DB tables been implemented in DPCT environment and is under test by OATo users.

The IDL environment is confirmed as a tool for the realization of a first level, scientific oriented, off-line pipeline, and also as a tool for accessing the Gaia DB by the OATo scientists (as part of DAAS). A five-users INAF-provided IDL float license is available at DPCT since 2011 with associated (again through INAF) Technical Support for simultaneous data mining operations.

This special agreement with Exelis VIS is not a part of the current INAF IDL Campus agreement. For the time needed it will remain again a ‘trial’ long term gentlemen agreement now extended until March 2016. Contacts are maintained with Exelis VIS to modify, if required, this temporary gentlemen agreement in a definitive.

We recall that IDL licensing and technical support is provided annually by INAF, and is guaranteed, now, through March 31, 2016, and comes at no direct cost to this ASI contract.

The previous three years Campus Wide Oracle licensing (expired on 3/2014) successfully changed to a special form of perpetual licensing before the lunch of Gaia require annual support (CSI). Purchased contract for CSI give warranty for updates and basic support up to December 2015.

Therefore remark that the use of the Oracle DB is guaranteed for the duration of the Gaia mission (and beyond if needed); however, ordinary support to actual O11g was ended on 31/01/2015 and starting from next year a renegotiation of support or an O12c migration redefine the framework of contract and an additional cost will be need.

Negotiations are in place between INAF and ORACLE for a renewal scenarios conducted in the Gaia license Campus wide and its support for 2016. The dismissing of O11g and migration to O12c environment give evidence for exigence in a licenses packet integration. A predictable human effort for do migration without operational activities stop It is another sensitive issue.

A protocol to allow the request and extraction of data, from RepDB, by the scientific community with no impact on the daily processing been developed by DPCT and under testing. Usage rules will happen in the next Operation Plan.

#### **Critical / Open Points**

* DAAS (for medium and long term scientific analysis) operating environment is not consolidated yet, but, some step for do queries on Rep DB have been completed
* The beginning of GSR operations scheduled end autumn 2015 to be a possible risk factor for h/w pipe line processing resources
* H/W Resources not completely compliant with the complexity of the management of medium/long-term data analysis and affordable backup.

## **FORECAST**

See section 4.4.1.

# Technical status

This section provides the details of the activities performed during the reporting period, their current status, and, whenever appropriate, the activities planned for the immediate future.

## **INTRODUCTION**

The technical activities carried out in the period Dec 16, 2014 – Jul 15, 2015, are described in section 5.2 and its subsections, which have been arranged following the DPAC CU structure, that is, those CUs where the work of this Italian participation is implemented. It is worth recalling here that there is no Italian activity, under the current contract, in CU6 (analysis and reduction of spectroscopic data).

## **ACTIVITIES AND STATUS**

The activities are reported according to the WPs to which they belong. The WPs are those listed in the Technical Attachment to the ASI-INAF contract (AD [2]) .This should facilitate program monitoring and cross-referencing with sec. 4.4.3 above. It is useful to recall here that the WPs ending with five zeros are at the Development Unit (DU) level (RD [2]).

### **CU3**

**GWP-M-301-00000 (DU301): Management and Scientific Coordination of CU3** – Bastian; **Lattanzi**, Torra

Collaboration with the CU3 Chair has continued for the organization of the CU3 plenary held at SOC (Vilspa, Madrid) last June. MGL also chaired all of the sessions at the CU3 plenary.

**GWP-M-330-00000 (DU330): REMAT. Relativistic Models and Tests** – Klioner; **Crosta**, de Felice, **Vecchiato**

|  |  |
| --- | --- |
| **Sub WPs** | **GWP-M-330-30100: RAMOD Model** – Crosta |
|   | **GWP-M-330-30300: Theoretical comparisons** – Crosta  |
|   | **GWP-M-330-30400: Numerical comparisons** – Vecchiato  |
|   | **GWP-M-330-60100: Local deflection tests close to the giant planets** – Crosta  |

**GWP-M-330-30100: RAMOD Model** – Crosta

The paper “The Ray Tracing Analytical Solutions within the RAMOD framework. The case of a Gaia-like observer"  by Crosta, Vecchiato, de Felice and Lattanzi is in publication in CQG. The scope of this paper is to present analytical solutions for the light tracing problem consistently with the requirements of Gaia's astrometric mission (initially set to 0.1 micro-arcsec modeling accuracy) and within the RAMOD framework, which uses a measurement protocol according to General Relativity. In particular, the paper contains the fundamental analytical equations needed to construct the linearized full-accuracy model of observation equations for the transition from GSR2 to GSR3.

**GWP-M-330-30300: Theoretical comparisons** – Crosta

No activities for this reporting period.

**GWP-M-330-30400: Numerical comparisons** – Vecchiato

Nothing to report.

**GWP-M-330-60100: Local deflection tests close to the giant planets** – Crosta

No activities for this reporting period.

**GWP-M-335-00000 (DU335): Auxiliary data: definition and acquisition** – Bastian; **Smart**

|  |  |
| --- | --- |
| **Sub WPs** | **GWP-S-335-11000: Initial Gaia Source List** – Smart  |
|   | **GWP-S-335-12000: Attitude Star Catalogue** – Smart  |
|   | **GWP-M-335-43000: Ground Based Optical spacecraft Tracking** – Smart |

**GWP-S-335-11000: Initial Gaia Source List** – Smart

**GWP-S-335-12000: Attitude Star Catalogue** – Smart

The Initial Gaia Source List (IGSL) and the Attitude Star Catalog (ASC) are still being actively used
in the DPAC  reductions and Smart continues to support the activities though at a reduced level. During the
period   July to December Smart replied to one internal support request concerning the role of QSOs
in the catalog and one external request concerning access to the public version. In addition Smart
has made the ASC available to Chinese colleagues who are undertaking similar activities.

**GWP-M-335-43000: Ground Based Optical spacecraft Tracking** – Smart

The Ground Based observations of Gaia has continued to observe Gaia at regular intervals for the
whole of the second part of 2014. Smart has contributed to the monthly telecons and attended the
GBOT meeting in Edinburgh just before the CU3 plenary meeting. Minutes have been produced
and will soon be submitted to Livelink.

**GWP-M-340-00000 (DU340): Astrometric Verification Unit (AVU). BAM, AIM and GSR processing – Lattanzi, Drimmel**

|  |  |
| --- | --- |
| **Sub WPs** | **GWP-M-340-10000: Management and coordination** – Lattanzi; Drimmel, Sarasso |
|   | **GWP-M-340-20000: Verification of different IDT algorithms** – Busonero  |
|   | **GWP-M-340-30000: GSR development and maintenance** – Vecchiato; Bucciarelli |
|   | **GWP-M-340-40000: Design and maintenance of comparison tools** – Bucciarelli; Vecchiato |
|   | **GWP-S-340-50000: AIM development and maintenance** – Busonero  |
|   | **GWP-S-340-60000: BAM model and monitoring** – Riva |

**GWP-M-340-30000: GSR development and maintenance** – Vecchiato; Bucciarelli and

**GWP-M-340-40000: Design and maintenance of comparison tools** – Bucciarelli; Vecchiato

The main activities concerning the GSR development were:

* the continuation of the testing campaign of release 17.0.0 needed to explore the behavior of the Source+Attitude solutions with simulated data; these tests suggest the need of a different astrometric constraints to avoid convergence problems;
* the ending of the testing campaign for OR5, which put to evidence the robustness of the new Attitude Definition Chain (ADC), and at the same time suggest the possibility of including in the known terms some parameters from the CDB to improve the convergence when using real data;
* the continuation of the testing campaign on the comparison module(s) which allowed to establish that the results of the analytic VSH implementation gives identical results at the sub-microarcsec level with respect to those of the numerical fit, and to fix a lower bound limit (at lmax=140) to the order of the VSH development which allows the recovering of systematic errors at the 5-microarcsec level;
* the development of release 18.0.0, which included a more refined attitude statistics for the ADC and the first successful local tests of the Instrument (Calibration) parameters.
* Start development of the new subsystem ASTRA for the short-term/local (a few consecutive scans, number TBD) GSR-like solution for instrumental calibration including sky-calibrated BA variations (to be compared to calibrated BAV results from the AVU/BAM system).

**GWP-S-340-50000: Astrometric Instrument Model** – Busonero

[and **GWP-M-340-20000: Verification of different IDT algorithms**] – Busonero

The main activities for AIM in the reporting period are:

* AIM patches deliveries from v17.0.2 to v17.0.4 for solving issues related to the selection of the 2D observations used for AC profile reconstruction vs. AC motion and to producing results for all the case.
* with associated documentation (SRN and STR): see Mantis n. (Busonero, SW developer EURIX).
* AIM 17.0.x pre-integration and integration activity in ALTEC (Busonero, SW developer EURIX and ALTEC colleagues).
* Development of AIM 18.0 (Busonero, SW developer EURIX) for introducing high density region treatment and VPU sw version 2.8 changes. An extensive DPAC test campaign was carried on in March and April (Busonero, SW developer EURIX, ALTEC colleagues).
* Participation in the Gaia Segment 00 operations phase with DPCT (Nov-June 2014) (Busonero, SW developer EURIX).
* PE activity support for AF issues evaluation (Busonero).
* AIM 18.0.0 pre-integration and integration activity in ALTEC (Busonero, SW developer EURIX and ALTEC colleagues).
* AIM patches deliveries from v18.0.1 to v18.0.3 for solving issues related to with associated documentation (SRN and STR): see Mantis n. (Busonero, SW developer EURIX).

The AIM release 18.0 contains the high density region filter module and the sw changes due to RDP and daily calibration for dealing with the new VPU sw version 2.8. (Busonero, SW developer EURIX).

Payload Experts Activity (Busonero):

* Participation to the Payload Expert teleconferences held beweekly from December 2014 to June 2015.
* Production of 208 AIM RDP/MON Daily Reports and of 208 AIM Calibration Daily Reports.

Participation to the DPCT weekly briefings (Busonero).

**GWP-S-340-60000: BA monitoring and model** – Riva

The main activities for BAM, in the reporting period are:

* Participation at Operations activities with DPCT (Dec 2014-Jun2015).
* Tuning for fast tools for the Payload Experts activity.
* Periodicity signals study and treatment
* PE activity support for BAV-BAM evaluation
* Preliminary Calibration Module design and delivery
* Fringe Across Scan Motion introduction

The following activities were completed in this reporting period:

* delivery of AVU/BAM 17.0.1, 17.0.2, 17.0.3, 17.0.4, 17.0.5, and 18.0.0 with associated documentation (SRN and STR).

Ongoing activities include:

* Evaluation of the of the IDL and ZEMAX tools (e.g. Physical Optical Propagation (POP)) for addressing the possible degradation of the interferometric signal from the BAM device associated with the collimator defocusing.
* Calibration Strategy Study and first implementations.
* Code V files preliminary study

Payload Experts Activity

* Participation the 13 Payload Expert teleconferences
* Production of 170 AVU/BAM Daily Reports
* Production of 5 AVU/BAM Weekly Reports
* Production of 23 PE&FL Weekly Reports.

**GWP-S-345-00000: IDU – coordination, framework, modules and operations** – Torra, Castañeda

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| **Sub WPs** | **GWP-S-345-32000: Cross-Matching** (XM) – Spagna |

During the reporting period the following activities were conducted on the Cross Matching for IDU:

* IDU XM: revise the SkyRegionXm code in order (1) to address various Mantis issues and (2) to include the updated data model.
* Spagna attended to CU3 Plenary meeting in Edinburgh and presented a talk on the status of the IDU XM algorithm.

**GWP-M-350-00000 (DU350): IDT – Management, Implementation, Operations** – Torra, Portell

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| **Sub WPs** | **GWP-S-350-32000: Cross Matching algorithms** – Spagna  |
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**GWP-S-350-32000: Cross Matching algorithms** – Spagna

During the reporting period no activities were conducted on the Cross Matching for IDT.

**Presentations at Gaia working group meetings:**

CU3 Meeting #10, Edinburgh (UK), Jun 10-12:

* Abbas, *The differential astrometric capabilities of Gaia*
* Busonero, *AIM: experiences, status and development*
* Drimmel, *see Verification Test Spec (VTS) document*
* Vecchiato, *GSR: test & development status: operation plan*

### **CU4**

**GWP-M-437-00000 (DU437): Extrasolar Planets** – **Sozzetti**

During Cycle 17 and the beginning of Cycle 18 of software development, DU437 continued improving on the functionality and performance of WP100, WP200, and WP300.

The software module is in line with a full IRD compliance analysis using GinHets 13.2 (except for minor warnings on the use of non-final static variables), and tested via JUnit tests and a Cobertura coverage of 62% of the written code (this figure is subject to improvement).

DU437 activities focused in particular on the following items: a) the fine tuning of the external parameters in input to the Differential Evolution Markov Chain Monte Carlo (DE-MCMC, see Eastman et al. 2013, PASP) code of WP210 to provide estimates of running times necessary to achieve significant improvements in the

quality of the orbital solutions; b) the design of an initial set of verification and validation check-ups of the DU437 Module; c) the correction of a number of errors in the management of exceptions within the Module; d) a bug fix involving a mismatch between one parameterization in the properties files and its effecfive use within the Module; e) the implementation of the mechanism for identification of logs/exception messages to simplify bug analyses during scientific chain runs within SAGA; and f) the correction of several coding style errors (Array brackets at illegal position, construct must use ’fg’s, Should use uppercase ’L’, etc.) in WP100, WP210, and WP300, based on the checkstyle report produced by cu4metrics. Results were presented at the CU4 meeting in Besancon (May 2015).

Sozzetti has been invited to deliver an invited talk on ‘*Gaia: The Astrometry Revolution*' at IAU Symposium 314 *Young Stars and Planets Near the Sun*, held in Atlanta (GA), USA (May 2015). He also delivered an invited seminar on *“Gaia: The Astrometry Revolution'*” at the Royal Observatory Edinburgh, United Kingdom (June 2015).

**GWP-M-450-00000 (DU450): Management and Implementation of Solar System Object Processing** – Tanga; **Cellino**

The coordination of the activities of development, testing and delivery of the software for Gaia data processing of Solar System bodies continued in the temporal window of interest. The most recent meeting of the CU4 Steering Committee took place on May 26, 2015, during the CU4 meeting at the Besançon Observatory. The activity in the last semester was focused on setting up the Short Term Chain of data reduction for SSO and to the first preliminary analyses of real Gaia data. The chain is currently reducing the data of known asteroids, just to assess the efficiency of the identification algorithms and to implement the necessary tools to minimize the number of false detection. Once this is done, the Short-Term chain will start to process objects that are unknown at the epoch of detection, in order to issue to appropriate alarms.

**GWP-M-453-00000 (DU453): CCD processing** – **Dell’Oro**

In this cycle, some modifications of the DU453 software have been done in order to fit the CNES requirements concerning the new logging strategy. Moreover, the code has been modified in order to make it able to ingest and process data from IDT according to the new VPU 2.8 format.

**GWP-M-458-00000 (DU458): Physical Parameters** – **Cellino**, Galluccio (Deputy)

In addition to usual maintenance and futher “cleaning” of the software for photometric inversion of asteroid data, a new treatment of light scattering effects by planetary surfaces according to the Lommel-Seeliger approach has been implemented, but not yet tested. A new Boolean field has been added, in order to label the results of photometric inversion as reliable or uncertain, according to the RMS of the obtained solutions, in order to minimize the number of wrong inversion solutions, at the cost of removing also some uncertain solutions that can be correct. Some improvements of the software aimed at computing the reflectance spectra of asteroids based on BP/RP data have been also done, mainly for what concerns the computation of the wavelengths. Finally, the treatment of all Java Exceptions has been updated and debugged.

**Presentations at Gaia working group meetings:**

CU4 Plenary Meeting #19, Besançon (France), May 26-28, 2015:

* Cellino, *DU458 Status Report 1*

### **CU5**

**GWP-M-511-00000 (DU11): BP/RP flux extraction and initial data treatment –** Brown, Busso; **Pulone**, Marrese, Giuffrida, Castellani, De Luise, Piersimoni, Iannicola, van Elteren

Regular biweekly telecons are held among DU11 members.

**Sub WPs: DU11-N-11: PhotPipe: Crowding Evaluation**

The integration test to evaluate the whole crowding evaluation process has been completed and launched by De Luise (INAF-OATeramo). To do that, an ”ad hoc” (fake) scene containing ten objects in all possible relative position to a window has been created. The main goal to verify the ability of pipeline to disentangle the blending, contaminating and isolated has been achieved. Further, necessary modules to iterate over all the objects present in the above mentioned fake scene have been developed. Incoming steps are to integrate the iteration with the crowding evaluation integration modules, complete the test over all the scene. The improvement of the integration test has been also used as debugging of Crowding Evaluation packages (i.e. Du11CrowdingEvaluation, Du11TemplateLibrary, Du11Commons) as well as to optimize/improve/debug some of its parts. In addition, De Luise worked on the implementation of two separated modules: one verifying the iteration over a (fake) scene, checking that all the scene items are properly loaded and the rescaling of coordinates to the reference window (target object) is well performed; another module has been created and launched to verify the crowding evaluation process using a target window and a set of scene items as suitable blending or contaminating sources. These two modules have been completed and tested. Now it is possible to verify a fake scene (presently involving ten items) iterating over all items in it. The tests performed have shown the perfect working of crowding evaluation algorithm and code. Everything is available on Du11Sandbox. The whole set of LSFs and spectral templates, together with the correspondent Principal Components have been integrated to the procedure. Scene items have been improved as well, creating a more similar to real objects and a more complex scene. Together with Piersimoni (INAF-OATeramo), some problems related to the magnitude zero point in AF, BP and RP used in the pipeline have been investigated. At the present time, the fake scene used so far has been substituted with a real one. The new scene has been set up by Piersimoni starting by the dataset provided by Busso (commissioning phase data). The items have been selected by looking at their relative position and magnitude, in order to provide to the pipeline a distribution as variegate as possible. Other factors will be included little by little in future. The first results obtained have been very encouraging, with a good percentage of objects properly identified.

**Sub WPs: DU11-N-12: PhotPipe: Template Library for Crowding Evaluation**

The work on the capability to reproduce the observed AC profiles by means of principal components, derived from simulated 2D spectra, disclosed a not perfect compatibility. The sample of data (mainly bright stars in 2D windows) shows that the AC PSF has a lower FWHM both in BP and RP. Piersimoni found that the files containing the PCs were corrupted and recomputed the PCs. After the correction, a much better agreement with the data can be obtained with a small number of PC at least within the window. De Luise and Piersimoni have worked to identify in a set of observed data the brightest stars and their neighbours and, by means of a cross match with other catalogues, to derive a prediction on the relative positions. The goal is to estimate the contributions due to the extended wings of the bright stars. A small set of observed data containing possible contaminated windows, with the necessary input for a realistic crowding evaluation test has been prepared and used. In this experiment the template spectra for the AC expansion are the transit spectra themselves. The still missing step is computing the weights of the principal components for the expansion from a direct fit of the involved 2D windows.

**Sub WPs: DU11-N-14: PhotPipe: Non-Nominal Windows Flagging**

No activities for this reporting period.

**Sub WPs: DU11-D-02: PhotPipe: Per Transit Deblending**

Giuffrida (ASI-ASDC), Castellani, and Pulone (INAF- OARome) have exploited a GAIA Dataset sent by Busso finding 91 blended transits. Considering the lack of information about the sources parameters, the deblending module has been adapted adding a simple procedure which fits the position inside the window. The module was run on the whole dataset obtaining a valid solution for about 80% of the blended transits. It’s crystal clear from these tests that, with a better knowledge bout position coordinates, a much higher percentage of the dataset could be recovered . Some results and possible improvements of the procedure, have been presented by Giuffrida in Barcellona for CU5M14. Moreover, Castellani, Pulone and Giuffrida have investigated the better procedure of validation for the deblending. Extensive tests indicate that minimizing the residuals may not always adequate since they sometime lead to non physical solutions. A sort of shape functions are going to be included into the code, to gain a further grade of validation, besides residuals. A first implementation showed that the validation code can automatically discriminate between good and bad reconstruction of the spectra. However there are still problems with the spectra alignment, crucial for the shapes factors evaluation, and the work is going to be focussed on this problem. The use of these simplified shape factors in the optimization process is also currently under investigation. The validation criteria have been defined as the distance from a ”fiducial line” calculated on the basis of theoretical spectra.

**Sub WPs: DU11 Other Tasks and Issues**

**Related activities**

Coordination Telecons have been organized/attended by all team members every two weeks.

Piersimoni gave a seminar on February 19 at INAF-OATe about Gaia, in particular about the mission status, using the slides that Brown provided for this aim, and the recent updates of the tasks of the internal Gaia group (DU11 and DU13 in CU5). Giuffrida also published a small contribution about the development and status of the BR/RP deblending on the ASDC newsletter. This contribution was also adapted for the Image of the Week on the ESA-Gaia webpage.

Coordination Telecons and meeting among INAF-OAR, INAF-OATe and ASDC members are held as well, according development necessities.

**GWP-T-513-00000 (DU13): Instrument absolute response characterization, ground-based preparation** – **Pancino**, Altavilla, Bellazzini, Bragaglia, Cocozza, Federici, Galleti, Marinoni, Ragaini, Valentini, Tessicini

**Management.** All contracts expiring at the end of 2014 (Cocozza, Ragaini, Galleti, all at INAF-OABO) were renewed for one more year, until December 2015. Altavilla, whose contract definitely expired on January 2015, obtained a new position for 4 months, renewed for 40 days more, until July 31.

Cacciari handed over the management of Gaia-DPAC funds for OABO to Pancino.

Regular weekly meeting held between the DU13 members.

**Interfaces.** Altavilla participated to the joint observations performed at the Loiano telescope with polish observers within the Gaia science alerts verification programme. The first paper of the Gaia Alerts collaboration was recently published (Campbell et al. 2015 arXiv:1507.04663). G. Altavilla participated to the semestral GBOG teleconference held on Feb. 10, as new CU5 representative. S. Ragaini spent one week at ESO Garching working with Kerzendorf studying his program for automated spectra fitting. Pancino periodically went to ASDC (Feb 2-6, Apr 13-17, Jun 8-12) to work with Marinoni on the Gaia archive. Pancino had a telecon with Valentini and one with Tessicini to organize their work. Pancino had one telecon with Marinoni to organize the work on SPSS short-term light curves.

Pancino and Bragaglia attended the MIAPP Workshop, Garching, 4-29 May 2015: *“The new Milky Way: Impact of Large Spectroscopic Surveys on our Understanding of the Milky Way in the Gaia-era”.*

Bellazzini presented an invited talk on the “G*alactic archaeology* *perspective in the Gaia era”* at the LIX Congresso della Società Astronomica Italiana, Catania, 18-22 May 2015.

**Observations.** The observations at the Nordic Optical Telescope (NOT) in the Canary Islands (Mar 29) and the 11 nights at the Cassini 1.5m telescope (Loiano, Italy) spread along the last semester, concluded our ground based observing campaigns.

**Data reductions and analysis.** Efforts are now focused in finalizing the data reduction of last observing runs, in the advanced reduction steps and in the storage in the ASDC archive. New procedures for reducing fringing and for differential light loss correction are ready and used to improve already processed and new data. Ragaini extended the spectra of our first SPSS release to cover the full Gaia spectral coverage (330-1050nm) by means of observed and theoretical template. New procedures for the ingestion of the new data products (extracted spectra, fringing corrected spectra and spectra corrected for differential light loss) have been implemented in the ASDC archive, currently populated with these data.

A paper on high-order instrumental effects (based on GA-004, SMR-002, and GA-005) was submitted and accepted by Astron. Nachr. (Altavilla et al. 2015 arXiv:1505.00970). Technical Notes on the reduction strategies and techniques are in preparation, as well as another refereed paper by S. Marinoni on the *S*hort-term constancy monitoring. Galleti, finished measuring instrumental magnitudes for SPSS observed in photometric conditions, she is now working on the automated macro that applies the night solutions to derive absolute magnitudes for each measurement and on the calibration error determination. Future SPSS releases will increase both the number of available SPSS, the data quality of the flux tables and the data products available for each SPSS.

**GWP-T-514-00000 (DU14): Instrument absolute response characterization, definition and application** – **Cacciari**, Bellazzini, Montegriffo, Ragaini

The activity focused on debugging, optimising and testing the code in preparation for the test of the absolute calibration model using real data. The test was performed on OR5 data (23 days of EPSL transits) provided by DPCI, and preliminary results were presented by PMN and discussed at the CU5 plenary meeting 14 in Barcelona (27-29 Jan 2015). Work was done on Mantis issues. Adjustments were made to adequate the software to the 17.4.0 release requirements. A technical note on “*Basis functions for G/BP/RP filter definition*” (SR-004) is in progress and tests of the refactored calibration model using a set of NSL data are ready to start as they are made available by DPC.

Regular monthly meetings with the CU5 Management Team were held via teleconference by Cacciari, as well as working meetings with the collaborating teams at the University of Barcelona and Cambridge. Internal meetings were held regularly to discuss, plan, organize and coordinate all aspects of the work to be done.

**GWP-T-517-00000 (DU17): Science Alerts – Altavilla**

G. Altavilla collaborated with Monika Sitek and other polish students (Warsaw Observatory) to prepare and carry out observations with the 1.5m G.D.Cassini Telescope (Loiano Observatory - Italy) on 8-11 June 2015, within the *''Gaia Science Alerts programme*” (GSA) in a Bologna-Warsaw joint proposal. A similar joint proposal was submitted on Jun 18 for the next semester (proposal accepted, 25 nights awarded).

The first paper of the GSA collaboration has been recently published (Cambell et al. 2015 arXiv:1507.04663).

**Presentations at Gaia working group meetings:**

CU5 Plenary Meeting #14, Barcelona (Spain), Jan 27-29, 2015:

* Giuffrida, *Progress on BP/RP Deblending*
* Pancino, Cacciari, *Status of the ground-based program*
* Montegriffo, *Absolute calibration: implementation and testing*

### **CU7**

**GWP-M-710-00000 (DU10): Special Variability Detection – Lanzafame**

Activities in this period focused on the EPSL data OR, which resulted in significant improvements of the software.

The GVD code was significantly improved with 2 main changes. It is now possible to configure VariGeneralDetection to compute p-Values with empirical or analytical distributions (for each band). It is also now possible to run a Random Forest classifier to classify constant and variable sources: the main new taker created is called GvdClassification. Release 17.0.X were produced with the associated SRN (ILT-046).

GVD was run on OR5S2 data. Results are reported in OR5S2 EPSL test report GAIA-C7-TR-GEN-ILT-050.

Monitoring and validation plots were implemented for Planetary Transits. The Planetary Transits code was ran iteratively during the OR. Results were analysed and new functionalities were added where necessary. In particular, the time series were de-trended before running the Planetary Transits analysis. The runtime parameters were adjusted to obtain the best results. SVD 17.2.0 release contains several bugs fixes and time-series de-trending for Planetary Transits. OR test results are reported in the STR.

For Short time-scale the ”slope” and ”variogram” methods were improved during the OR5S2 exercise. The slope method was made more robust to outliers. The variogram method is now more configurable.

These 2 methods were run on OR5SE data. Results are reported in OR5S2 EPSL test report GAIA-C7-TR-GEN-ILT-050.

**Sub WP: GWP-S-710-05000: Solar-like Activity Detection** – Distefano

Monitoring and validation plots were implemented. The code has been ran iteratively during the OR. The results were analysed, bugs fixed and new functionalities added where necessary. Runtime parameters were adjusted for getting the best results from the data. The Solar-like validation catalogue based on ASAS and OGLE XM sources was assembled. The SVD 17.2.0 release contains several bugs fixes for Solar-like. The OR test results are reported in the STR.

**GWP-S-720-00000 (DU20): Specific Object Studies** (Mowlavi; **Clementini, Ripepi, Lanzafame, Pagano**)

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| **Sub WPs** | **GWP-S-720-03000: RR Lyrae/Cepheids** – Clementini  |
|  | **GWP-S-720-07000: Pre-Main-Sequence Oscillators** – Ripepi  |
|  | **GWP-S-720-08000: Solar-like and Rotation-induced Variables** – Lanzafame  |
|  | **GWP-S-720-09000: Flare Stars** – Pagano  |

**GWP-M-720-03000: RR Lyrae/Cepheids** – Clementini

We progressed in the following activities:

1. Documentation: the SRS document is being actively updated according to the new software design and to the new requirements from the Geneve group (new tables for Object Model and configuration parameters). We wrote our contributions to the general CU7 IR documents.

A report of the test of our pipeline on EPSL data (OR5S2) was included in the general CU7 Software Test Report (STR) document.

1. System update: the whole package was updated to the latest version of the Object Model.
2. Code implementation: The whole code was reviewed to help the future maintenance and readability. All the bugs found during the OR5S2 tests (on the EPSL data, see the following step), were fixed. The whole GWP-M-720-03000 package was delivered to Geneva and included in the latest C7 DPCG release.
3. Test of the implemented codes: All coded methods were tested by writing *JUnit Tests*. The new code was tested on the EPSL data (from February to April) and the analysis of the results of the tests produced two images of the week (IoW\_20150305 and IoW\_20150528) and an INAF news on 2 June 2015 (http://www.media.inaf.it/2015/06/02/le-stelle-variabili-di-gaia/).
4. Meetings and workshops, organization and participation:
* Clementini and Leccia visited the Geneve Team on 19-24 April, 2015, to analyze the results of the run of the GWP-M-720-03000 package on the Gaia EPSL data.
* Clementini and Ripepi attended the CU7-20 meeting held in Lisbon on May 20-22, 2015. Clementini presented a 30min talk on the status of the GWP-M-720-03000 RR Lyrae/Cepheids and on the results of running the pipeline on the EPSL RR Lyrae and Cepheid data.

**GWP-S-720-07000: Pre-Main-Sequence Oscillators** – Ripepi

1. Documentation: The SRS is under revision to include the planned analysis of the per-CCD photometry.
2. System update: The whole package was updated to the latest version of the Object Model.
3. Code development: the code was partially updated according to the new requirements.
4. Tests of the implemented code: All the methods coded were tested by writing *JUnit Tests.*

**GWP-S-720-08000: Solar-like and Rotation-induced Variables** – Lanzafame

Scientific tests on ASAS data show that differential rotation can also be revealed in Gaia data.

Rotational modulation variable candidates were found in the ASAS data for EPSL targets, useful for comparison with the Gaia EPSL data. The catalogue contains 144 stars at less than 2.5 degrees and 132 between 2.5 and 5 degrees from the South Pole.

An adaptive algorithm for the definition of the segment length for period search in rotational modulation variables has been defined in GAIA-C7-TN- OACT-EDS-002. This is tailored to the Gaia case. The segment length algorithm has been implemented in SVD.

The Solar-like rotational modulation simulation package has been revised to work in the current version of the Vari system and made user-friendly. Gaia simulated data for rotational modulation variable can now be produced at will.

**GWP-S-720-09000: Flare Stars** – Pagano

Flare-like light curves were added at random to the rotational modulation simulated data. The java code is available and ready for testing and further development.

Tests on EPSL data show that the java code was able to select flare candidates stars

**GWP-M-732-00000 (DU32): Supplementary Observations** **– Clementini**

As part of the Supplementary Observations and GBOG activities Leccia, Ripepi and Clementini proceeded in the characterization of the RR Lyrae stars (RRLs) and Cepheids (CCs) in the Gaia South Ecliptic Pole (SEP) based on visual data from EROS-2, OGLE III and near-infrared data from the VMC survey and derived Period-Luminosity and Period-Wesenheit relations in the Gaia bands for the SEP CCs and RRLs to be published shortly.

The CU7 network of small/medium size telescopes continues to contribute to the validation of the Gaia Science Alerts (GSA) system. In particular a total of 45 nights of observation with the 1.52m telescope of the Loiano Observatory were assigned in the period Dec. 2014 to July 2015 to the program “*The Transient Sky with Gaia*”, P.I. Clementini, to follow up Gaia alerts. Further 27 nights have been assigned to the program in the period August-November 2015. Data obtained with the Loiano telescope have contributed to the analysis of Gaia14aae, a very rare transient alerted by Gaia, formed by a cataclysmic variable of AM Canum Venaticorum (AM CVn) type in a binary system. Results on the analysis of Gaia14aae have been published in the paper: “*Total eclipse of the heart: The AM CVn Gaia14aae / ASSASN-14cn*”, Campbell et al. 2015, MNRAS 452, 1060, of which Altavilla and Clementini are co-authors and presented in an INAF News on 2 June 2015 (http://www.media.inaf.it/2015/06/02/le-stelle-variabili-di-gaia/).

**Presentations at Gaia working group meetings:**

CU7 Plenary Meeting #20, Lisbon (PT), May. 20-22:

* Clementini, *Cepheids & RR Lyrae: Results from EPSL OR5S2 data*
* Clementini et al., *Supplementary observations: example of the Gaia Science Alerts*
* Distefano, Lanzafame et al., *Special Variability Detection, Solar like variability and corresponding SOS WP*

### **CU8**

**C8 Management Team**: Bailer-Jones, Thevenin, Frémat, Janotto, Smith, Tsalmantza, **Vallenari**

CCB activities: management of MANTIS issues, document approval (STS, STR, SQR)

Lanzafame coordinated a major revision of the SDD of scientific algorithms.

CU8 management team: dismissed.

CCB activity: several document approved (Vallenari)

**GWP-S-811-00000 (DU11): Training data** – Thevenin; **Vallenari**

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| **Sub WPs** | **GWP-S-811-10020: Expert Panel on Stellar Physics** |
|   | **GWP-S-811-10030: Expert Panel on Sub-grid Boundaries** |
|   | **GWP-S-811-10600: Cool (Chromospherically-Active) Stars** – Lanzafame  |
|  | **GWP-S-811-20400: Search for relevant data in existing databases** – Vallenari  |
|   | **GWP-S-811-20500: Ground-based observations for GSP** – Vallenari  |
|  | **GWP-S-811-20700: Libraries of training spectra** – Vallenari |
|   | **GWP-S-811-30000: Assemble training data grids** – Vallenari, Sordo, Lanzafame  |

**Sub WP: GWP-S-811-20500: Ground-based observations for GSP** – Vallenari, Sordo, Cantat-Gaudin

A catalog of reference stars for Apsis validation was delivered, after careful data analysis involving different

methods. The Padova Post-Doc Cantat-Gaudin supported by an EU grant was involved in the project.

A TN (CS-014) was prepared.

**SUB WP: GWP-S-811-30000: Assemble training data grids** – Vallenari, Sordo, Lanzafame

Sordo and Vallenari supported the development of the CU8 simulator. Simulations of several fields were delivered to CU8. This involves an ad-hoc software preparation to select and assemble the corresponding GOG spectra, starting from UM simulations.

**GWP-S-812-00000 (DU12): Interstellar extinction** – **Drimmel**

A TGE SW delivery was completed in this reporting period. The associated documentation (SRN, STR) have been completed, but have not yet been uploaded into svn.

It should be noted that for testing the TGE SW it was necessary to reuse the old cycle 8 field simulations as the new galactic field simulations are still pending, A small representative test dataset of these new simulations was received in May, and the GSP-Phot processing results of these new data was just recently received and is under analysis. Potentially the GSP-Phot results should be much better with respect to the previous simulated data, as for the first time the same stellar libraries used to generate the simulated field data will have also been used to train GSP-Phot. Also, a long-standing problem in the simulation of unresolved binaries should be solved.

TGE is also participating in current OR5 test activities. Processing results are pending.

We provided feedback on GSP-Phot (stellar APs) and DSC (object classification) performance. We helped identify a problem in the simulation of RP/BP spectra of unresolved binary stars in the currently available field simulations provided by CU2, generated by the cycle 8 version of the GOG simulator. Hopefully this issue will be resolved in the new (and pending) field simulations.

**Sub WP: GWP-S-832-10000: Management** – Kontizas, Vallenari, Sordo

No activities for this reporting period.

**GWP-S-835-00000 (DU35): Extended Stellar Parametrizer** – Frémat; **Lanzafame**

**Sub WP: GWP-S-835-20000: Cool Stars** – Lanzafame

No activities for this reporting period.

### **The Italian DPC (DPCT): management and operations**

**GWP-O-T10-00000: Operations of the DPCT systems – Morbidelli**

Several planned and unanticipated operational activities, scientific aspects of the AVU systems, and the operational procedures implemented at DPCT, were followed during this reporting period (Dec 16, 2014 to Jul 15, 2015), of nominal operations.

No formal CCB took place in the period. The changes on the s/w infrastructure vas monitored continuously in some parts of the Scientific S/W by the scientific managers @ OATo led to the adoption of a more streamlined procedure for a fast implementation of the changes made in the Test and Development environment fast propagate to the Production environment. The risk of reduced PA and QA activities was mitigated by executing sw delivery and pre-integration was done directly on the test and development facilities at DPCT with scientific (OATo) and infrastructure (ALTEC) teams working together on the premises. Now Version 18 of the s/w (both scientific and infrastructure) is implemented. The scientific s/w concerning AVU-BAM and AVU-AIM follows the evolution of satellite operations.

The development of AVU–GSR modules and the migration to operational mode are planned for this Fall.

The previous limitation, emerged in September 2014, concerning the data processing power for AIM, is now solved through the acquisition of new servers (as per the options foreseen in the current ALTEC-ASI contract). However the solution remains partial because in some particular situations (galactic plane crossing) the available computational h/w still has limits in the daily activities, especially at times when the AVU-GSR module requires its resources. A high level of attention will be maintained concerning the adequate size of h/w resources.

This computational sufferance coming, essentially, from “a priori” unpredictable changes occurred, after launch, in the CCD satellite observing strategies and changes in magnitude limits, as already evidenced by ALTEC (GAIA-DT-MN-ALT-VIC-037). It’s important to remember that the increased needs were largely unexpected (worse data quality than anticipated discovered during Commissioning) and the h/w now available was originally meant for GSR. On the other hand, we continue to warmly suggest that DPCT maintain serious consideration concerning possibilities to pursue optimizations of the engineering s/w and h/w solutions adopted for their infrastructure.

In February, it was acquired by INAF Trieste an ODA, the resource is available (subject to schedule) to carry out tests aimed at study H/W alternative or complementary solutions to the actual Database operational strategies.

Consulting activities conducted by Oracle specialists on dedicated days continued as part of the “ad hoc” ALTEC annual contract to Oracle ACS expired and renewed in June 2015. The choice made by Altec to keep this type of support active, initially supported by OATo, and has greatly helped with the relatively smooth DB operations (ingestion, pipeline processing, DB maintenance, etc.) to maintain adoption of “best practices” recommended by Oracle in DBMS use.

No DBMS - related “incidents” occurred during the reporting period; the MDB data size met and exceeded 80 TB (Sum of LDB and RepDB) .

In parallel the systematic and adequate backup strategy of all data, daily and weekly conducted, demonstrate some significant time delay or errors especially for huge amount of data coming from RepDB.

There was a training session held by the WP Managers to ALTEC operators personnel to provide some basic information’s regarding the data processing and eligibility of scientific data obtained from daily AVU segments. Stable and efficient remote connection allow monitoring of the operations by the OATo DPCT staff has been routinely used in support of monitoring of daily activities and weekly briefing.

Continue a WEB-DAAS interface construction on WEB access tool. An applet aimed to build queries on Rep DBMS and browse data for scientific purposes by off-line DB access it is in progress. The IDL INAF licensing, that comes at no direct cost to this ASI contract and is compliant with the Oracle DB, remain the (only) practicable smart way to solve off line scientific oriented DB access and analysis issues.

We recall here that the Oracle licenses [RD 12] used for Gaia are the property of INAF and part of a special agreement with the Oracle Corporation for Gaia mission only.

During the period, no new versions of the DPCT Procedure Handbook and DPCT Operations plan were issued. This will happen before the end of the current calendar year.

### **IWP-M-100: Management of the Italian Participation in DPAC**

This is the IWP-type work package under the responsibility of the Italian Project Office composed of Lattanzi (PI), Drimmel (PM) and Sarasso (Contract Manager).

The management activities of the Italian Project Office were many and intense during the reporting period Dec 16, 2014 – July 15, 2015. Major activities of this WP devoted to the management of the Italian participation in DPAC, are as follows:

* Preparations for the RA2.
* Letter to the ASI President on the HW criticalities for the DPCT.
* Successfully negotiated with the Chinese Academy of Sciences, Shanghai Astronomical Observatory, the support for a Chino-Italian PHD to work on the GSR activities. Mr. Shilong Liao of SHAO, CAS joined the GSR team at the end of June.
* Conduct coordination work with the ICG (Italian Coordination Group) through teleconferences and/or dedicated initiatives.
* Renewal of seven TD contracts for 6 months for CU3, CU5, CU7 and CU8.
* Support ASI in issues related to proper representation of our national contribution at DPACE and MLA SC levels (e.g. the ESA unilateral decision on extending the mag limit of Gaia to G=20.7).
* Preparation and finalization of the negotiation meeting that has led to the new 3-year ASI-INAF agreement.

**DPACE activity**. (from DPACE Deputy Chair A. Vallenari)

Vallenari as Deputy Chair has attended the monthly DPACE teleconference/meetings. In addition to the usual supervision activity of CU4, CU7, CU8, as part of the PO, she took part in the second review of the Release Critical Items, i.e. all the software modules and data centers involved in the first data release to assess their degree of readiness. A TN was prepared. In addition she visited and reviewed all the other data centers, Geneva DPC, Torino, CNES.

In her role of PO scientific interface, Vallenari attended the weekly DPC teleconf to organize and supervise the OR#5 preparation.

# Related activities

We report here on the “other” activities which, although not strictly related to the DPAC efforts, are intimately related to the scientific nature of the Italian involvement in the Gaia mission. These activities have to do for the most part with the several scientific initiatives that directly or indirectly relate to Gaia and offer the opportunity to present to the general scientific community worldwide the importance of the Italian effort for the Gaia mission. These activities are given high visibility in the ASI contract to the extent that they must not just be mentioned in the PR’s but meeting contributions and actual science articles constitute contract deliverables.

## **THE DPAC WG Ground-Based Observations for Gaia (GBOG)**

The main activities of GBOG are to coordinate ground-based activities in DPAC, to interact at a higher level with the observing institutions (for example ESO), to disseminate information between different CUs concerning observation and data analysis techniques. From Italy there are two CU representatives in GBOG (Altavilla for CU5 and Clementini for CU7), they both participated to the GBOG teleconference 15, held on February 10 2015, presenting the status of the corresponding CU. Altavilla also presented the report on Gaia Alerts by Wyrzykowski (CU5 representative that could not participate). Several groups are participating to this effort and helping CU3 to deliver radial velocities, astrophysical parameters, and abundance ratios for about 100 stars observed with UVES (R = 45000) and 1000 stars observed with GIRAFFE (R = 20000).

Vallenari, Sordo, and Pancino participated to the data reduction and analysis of UVES and GIRAFFE spectra of stars to be included in the South Ecliptic Pole Catalog, which are fundamental to test the instruments and software performances during commissioning. Sordo prepared a pipeline to correct the observed spectra for telluric lines. Pancino participated to the data reduction and preparation, to the radial velocity measurements, and to the abundance analysis with the classical EW technique.

## **THE DPAC CU9 (Catalog Access)**

**Project description.** ~~The Italian team led by ASDC is continuing the collaboration for the GAP (Gaia Archive Preparation) activities. The "~~*~~Announcement of Opportunity for the Gaia Data Processing Archive Access Coordination Unit~~*~~" was answered by GAP in January 2013, the answer was accepted after minor changes and CU9 was officially formed before the Summer~~. CU9 is the last DPAC coordination unit, in charge of the design and implementation of the Gaia archive. The SDP was completed in December 2013 (GAIA-C9-PL-ESAC-WOM-086) and is presently being revised internally before LiveLink publication. The Italian team is participating to the CU9 effort with Marrese, Giuffrida, Vallenari, and Pancino as task managers, with progress reports here below.

**WP 947 – Cluster Validation (Vallenari)**

The tests to validate Gaia data in cluster regions, and the provisions for the treatment of the relevant reference catalogues from the literature were collected into three documents (AV-012, AV-013, AV-014).

**WP 957 - Auxiliary data (Pancino)**

The auxiliary data team held three teleconferences in the reporting period, to define milestones, deliverables, and to organize the work, in particular to help define the SDP of CU9. Work started to complete the census of auxiliary data within DPAC, which is made of two parts: *“A census of potential GBOG auxiliary data products for GAP/CU9”* (GAIA-CD-TN-OABO-EP-009, issued) and a second document which was assembled in October and is presently being completed by all the DPAC involved teams *“A census of DPAC auxiliary data projects for CU9”* (GAIA-C9-TN-OABO-EP-013, in prep).

**CU9 activities** (Vallenari, Marrese, Spagna, Giuffrida, Marinoni, Cantat-Gaudin, Pancino, Smart).

Open clusters as tests for Gaia data. The algorithms for TGAS testing were developed. Tristan Cantat, supported by non-ASI funds was actively involved in the work. The algorithms involving tests on TGAS proper motions and parallaxes were integrated in the Gaia system and tested on simulated and real data from a preliminary TGAS solution. Auxiliary data for TGAS tests were collected from literature search. Two TN (TGC-01 and AV-016) describing the auxiliary data and the TGAS tests are on SVN.

Auxiliary data on globulars for the tests on the first data release positions were collected.

One borsa was begun in 2014 under the GENIUS FP7 program in collaboration with the Trieste Observatory to develop VO tools for access to the Gaia archive. The National Coordinator was Smart and the local Coordinator Molinaro (OATs).

## **THE PARTICIPATION IN THE “GREAT” INITIATIVE**

**Project description.** GREAT (Gaia Research for European Astronomy Training) is a pan European science driven research infrastructure which will facilitate, through focused interaction on a European scale, the fullest exploitation of the ESA Gaia 'cornerstone' astronomy mission, enabling the European astronomy community to provide answers to the key challenges in our understanding of the Galaxy and Universe. The GREAT ITN project ended on 28 February 2015.

On behalf of a team of Italian astronomers interested in galactic archaeology, on January 23 Drimmel submitted an Expression of Interest in participating in GREAT2Net (ESF Research Network COST action).

Steps toward submission of a new GREAT proposals (GREAT2Net) in September 2015 have been initiated by N. Walton and the Italian community is participating (in particular: interest has been expressed by Bragaglia, also on behalf of Altavilla, Bellazzini, Montegriffo, Pancino in Bologna and many more in other Institutes).

Clementini and Vallenari contributed to the preparation of the final scientific and financial balance of the project which was delivered in Spring 2015.

Pancino participated to the preparation of a new ITN fund request, in the Horizon 2020 framework and the Marie Curie Initial Training Network action, entitled *“Gaia – ITN”*, which foresees the participation of INAF as a main node, with two ESR in Padova and Bologna. The deadline for the presentation of the proposal to ERC is 13 January.

Smart  successfully proposed to the Gaia Research for European Astronomy Training (GREAT)
group for a short visit to the University of Madrid to study the follow-up of Brown Dwarf research
using Gaia with Luis Sarro.

**Participation to Conferences and Meetings**

* Spagna participated to the workshop “Chemical and dynamical evolution of the Milky Way and Local Group” (Jan 19-24, Sexten Center for Astrophysics, Sexten - BZ, Italy).
* Abbas, Drimmel, Pancino and Poggio participated to the final GREAT Plenary Meeting held in La Laguna (Spain) on 23-24 June 2015; see <http://great.ast.cam.ac.uk/Greatwiki/GreatMeet-PM8>).

**People: Fellowships and exchange visits**

* Tristan Cantat-Gaudin using external support from GREAT-ITN spent 3 weeks at Meudon Observatory to study and implement a prototype of TGAS test on parallaxes using open clusters.
* Eloisa Poggio started her PhD at the University on Torino (Dept. of Physics and Astrophysics). Her research project is *Kinematic of the disk stellar populations for the study of the Galactic warp based on the GAIA catalogue* (supervisor: Spagna, co-supervisor: Drimmel).

## **THE Gaia ESO Survey (GES)**

**Project description.** Among the GREAT projects, the Gaia-ESO Survey (GES) was designed during 2010, was accepted by ESO in 2011, and the actual observations started on 31 December 2011. ESO assigned 300 nights to GES in 5 years (at a rate of approximately 5 nights per month), to gather high- and medium resolution spectra with FLAMES of ~100,000 stars belonging to all Galactic components: halo, bulge, thin and think disc, and open clusters of all ages. GES data will complement Gaia by obtaining precise radial velocities of faint (V > 17 mag) stars in the same spectral region covered by Gaia RVS, in a blue spectral region useful for chemical analysis (and in other regions for the open clusters), and by providing astrophysical parameters and precise abundances of elements other than iron and the alpha-elements in various spectral ranges.

**GES Activities**. Randich is co-PI of the GES proposal. Micela and Vallenari are member of the GES steering committee, while Bragaglia, Pancino and Lanzafame are leading three key working groups, which are WG4 “*Cluster stars target selection*”, WG5 “*Calibrators and standards*”, WG12 “*Pre-Main Sequence spectrum analyses*”, respectively. Between December 2014 and June 2015 operations proceeded in routine mode and many scientific papers have been published on A&A.

Between January and June 2015, operations proceeded in routine mode, in terms of observations preparation and data analysis. Several new science verification papers have been drafted or submitted to A&A, and a few others were accepted.

The internal third data release GESiDR2iDR3 has been made available through the ESO and WFAU portals.

* Bragaglia, Randich, Sordo and Vallenari contributed to the activities of WG10 and WG11 (spectrum analysis of FGK stars, both in clusters and in the field) and, Lanzafame and Frasca to the WG12 activities. Using different methods tailored to the different kind of targets, the spectra of the first half of the survey have been analyzed. The reduced spectra of the first six months have been publicly released by ESO and the second complete data release has been sent to ESO. We are now working on DR4.
* Bragaglia, Lanzafame, Pancino, Randich, Sordo, Vallenari participated in the preparation of many of technical and scientific papers based on GES activity.
* Several telecon were organized/attended by all team members.

## **SUPPORTING “APACHE” AND “HARPS-NORTH” EXTRASOLAR PLANETS PROJECTS**

**APACHE** (<http://apacheproject.altervista.org/>). A fundamental element of support for the Gaia DPAC activities connected to the study of extrasolar planets, the APACHE ground-based photometric survey of thousands of nearby M dwarfs in search for transiting exoplanets (Sozzetti, Project Scientist, Lattanzi, Project Manager) from the Western Italian Alps is now well into his second year of nominal operations. Project meetings have been held to discuss in-depth the profound synergies between APACHE and Gaia. Particular attention has been devoted to preliminary studies of the potential for accurate astrometric orbit determination with Gaia of possibly transiting intermediate-separation planets around the APACHE target sample of bright M dwarfs, for which Gaia will be able to deliver very high-precision astrometry.

**HARPS-N** operations started officially at the TNG in August 2012, with the instrument offered in open time to the scientific community. Sozzetti is the PI of a large observational programme gathering a 70-strong team of Italian and foreign scientists under the name of GAPS (Global Architecture of Planetary Systems) that was awarded 36 nights during the AOT26 observing semester and was awarded and additional 40 nights during the AOT27 observing semester plus long-term status (ensuring the GAPS programme continues until the end of 2014). Recently GAPS was extended by INAF until the end of AOT31 (August 2015).

The radial-velocity survey of a sample of bright M dwarfs monitored by APACHE which are going to be observed very frequently by Gaia is one of the key GAPS programme elements. Data taking was hampered during AOT26 by the HARPS-N CCD failure but during subsequent semesters the programme has only suffered from time losses due to weather.

Planetary candidates orbiting this late-type stellar sample are already emerging from the HARPS-N data, some of which could greatly benefit from the Gaia astrometric data to come.

Two systems are in particular the objective of publications in preparation. Significant periodicities identified in the HARPS-N data for two other targets were identified as due to intrinsic stellar variability thanks to the fundamental support of the APACHE photometric data.

## **THE PARTICIPATION TO THE WEAVE PROJECT**

Participants: Vallenari, Randich, Lanzafame, Frasca, Bragaglia, Bellazzini, Smart, Lattanzi

Project description. WEAVE is a new wide-field spectroscopy facility proposed for the prime focus of the 4.2m William Herschel Telescope. The facility comprises a new 2 degree field of view prime focus corrector with a 1000-multiplex fibre positioner, a small number of individually deployable integral field units, and a large single integral field unit. The IFUs and the MOS fibres can be used to feed a dual-beam spectrograph that will provide full coverage of the majority of the visible spectrum in a single exposure at a spectral resolution of ~5000 or modest wavelength coverage in both arms at a resolution ~20000.

The instrument is expected to provide spectroscopic sampling of the fainter end of the Gaia astrometric catalogue, chemical labelling of stars to V~17, and dedicated follow up of substantial numbers of sources from the medium deep LOFAR surveys.

Project status. The instrument is expected to be on-sky by end 2017 early 2018. The project is now fully funded by the WEAVE Consortium, and fully on track.

Weave science case on open clusters was revised including Spanish contribution on the study of young associations.

Target clusters young, intermediate age and old were selected, their color-magnitude diagrams and data were collected to produce a survey plan document. In each field a preliminary and provisional target selection was operated. The list of targets was sent to the WEAVE Science Team. The configuration tool for fibre positioning was run to assess the degree of feasibility of the proposed targets, since positioning about 1000 fibres is an dense and centrally concentrated field is far from trivial.

Vallenari as Italian executive participate to the monthly teleconf of the WEAVE projects, coordinating the Italian participation. As member of the Science Team, she coordinates the open clusters survey.

## **PARTICIPATION IN GENERAL WORKSHOP AND CONFERENCES**

The table provided in sec. 6.3.1 below presents the complete collection of the contribution related to Gaia, in the sense of the activities covered by this ASI contract, presented at workshops and conferences different from the DPAC meetings reported in sec. 4 above and published in conference Proceedings.

### **Non-DPAC Conference presentations/contributions**

| **Authors and Title** | **Document Code** | **Location/****Date** | **Status/****Date** |
| --- | --- | --- | --- |
| Eyer, ….., LANZAFAME, ….., CLEMENTINI et al., **The variability processing and analysis of the Gaia mission** | Proc.GREAT-ITN Conf. "*The Milky Way Unravelled by Gaia: GREAT Science from the Gaia Data Releases",* N. Walton, F. Figueras & C. Soubiran eds., EAS Publ. Ser. | Barcelona (E), Dec 1-5, 2014 | ***Feb 2015*** |
| SPAGNA, … DRIMMEL, LATTANZI et al., **On the connection between the Galactic disk and the Galactic bar** | Workshop on *Chemical and dynamical evolution of the Milky Way and Local Group* | Sexten (BZ, Italy)Jan 19-24 | **On the web** |
| PANCINO, **Connecting the field and the (open) stellar clusters - does it work?**  | MIAPP Workshop, *The new Milky Way: Impact of Large Spectroscopic Surveys on our Understanding of the Milky Way in the Gaia-era* | Garching May 4-29 |  |
| SOZZETTI, **Gaia: The Astrometry Revolution, *Invited talk*** | IAU Symposium 314 "Young Stars & Planets Near the Sun", held in Atlanta (Georgia), USA (May 2015) |  |  |
| BELLAZZINI, ***Invited talk***, **Archeologia galattica** | LIX Congresso SAIt | Catania,May 18-22 |  |
| LANZAFAME, ***Invited talk***, **L’età e la rotazione delle stelle** |
| CACCIARI, **Gaia’s contribution to reconstructing the history of the Milky Way** | Physikzentrum Bad Honnef - Germany-, *592. WE Heraeus Seminar: Reconstructing the Milky Way's History: Spectroscopic Surveys, Asteroseismology and Chemodynamical Models* | Jun 1-5 |  |
| Poggio, DRIMMEL, SMART, SPAGNA, LATTANZI, **Kinematics of the disk stellar populations for the study of the Galactic warp** | GREAT Plenary Meeting: PM8, EWASS 2015 | La Laguna (Spain)Jun 23-24 | **On the web** |

## **SCIENTIFIC PAPERS IN THE OPEN ASTRONOMICAL LITERATURE**

The table provided in sec. 6.4.1 below presents the complete collection of the science articles related to Gaia, in the sense of the activities covered by this ASI contract, sent to astronomical or physical journals.

### **Publications in astronomical journals**

|  |  |  |  |
| --- | --- | --- | --- |
| **Authors and Title** | **Document Code** | **Date / Issue / Rev.** | **Status** |
| Campante, …, SOZZETTI et al., **An Ancient Extrasolar System with Five Sub-Earth-size Planets**  | ApJ, 799, 170 | 2 | ***Issued*** |
| Vanderburg, …, SOZZETTI et al., **Characterizing K2 Planet Discoveries: A Super-Earth Transiting The Bright K-Dwarf HIP 116454** | APJ, 800, 59 | 2 | ***Issued*** |
| Dressing, …, SOZZETTI et al., **The Mass of Kepler-93b and The Composition of Terrestrial Planets** | ApJ, 800, 135 | 2 | ***Online first*** |
| SOZZETTI, **Exoplanets with Gaia: Synergies in the Making** | EAS Publ. Ser. | 2 | ***Issued*** |
| Damasso, …, SOZZETTI et al., **The GAPS programme with HARPS-N at TNG. V. A comprehensive analysis of the XO-2 stellar and planetary systems** | Astron. Astrophys., 575, A111 | 3 | ***Issued*** |
| CROSTA M., VECCHIATO A., DE FELICE F., LATTANZI M.G., **The Ray Tracing Analytical Solution within the RAMOD framework. The case of a Gaia-like observer** | Class. Quantum Grav. | 5 | ***In press*** |
| ALTAVILLA, ….., PANCINO, ….., RAGAINI, BELLAZZINI, COCOZZA, BRAGAGLIA, ….., FEDERICI, ….., VALENTINI et al., **The Gaia spectrophotometric standard stars survey -II. Instrumental effects of six ground-based observing campaigns** | Astron. Nachr. | 5 | ***In press*** |
| QI Z., YU Y., BUCCIARELLI B., ….., LATTANZI M.G.et al., **Absolute Proper motions Outside the Plane (APOP). A step towards the GSC2.4** | Astron. J. | 6 | ***In press*** |
| Jofré, ….., CANTAT-GAUDIN, ….., PANCINO, ….., SORDO, ….., VALLENARI, **Gaia FGK benchmark stars: abundances of alpha and iron-peak elements** | Astron. Astrophys. | 6 | ***In press*** |
| Borsa, …, SOZZETTI et al., **The GAPS programme with HARPS-N at TNG. VII. Putting exoplanets in the stellar context: magnetic activity and asteroseismology of Bootis A** | Astron. Astrophys., 578, A64 | 6 | ***Issued*** |
| Silvotti, …, SOZZETTI et al., **Detectability of Substellar Companions Around White Dwarfs with Gaia** | ASP Conf. Ser., 493, 455 | 6 | ***Issued*** |
| Campbell, ….., ALTAVILLA et al., **Total eclipse of the heart: The AM CVn Gaia14aae / ASSASN-14cn** | MNRAS | 7 | ***In press*** |