Objectives and Management of the Gaia-FUN-SSO Network

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Introduction

Ground-based observations in addition to observations by space missions can be a very efficient way to get complementary data, to go beyond the primitive objectives of this mission and actually to increase the scientific return of the mission. This strategy is used in the frame of several missions, for example when a ground-based network is required to get a large coverage of observation, for a fast verification of an event or its follow-up with instruments unavailable on board. For example, the Corot space observatory for asterosismology and detection and study of exoplanets, or the future Swom space mission for the detection and study of Gamma Ray Bursts, apply this strategy. The space-ground synergy is also an efficient strategy for the Gaia mission and in particular for the Solar System Object science (Thuillot et al., 2010). Several ground-based activities are being organized in the frame of the Gaia mission: the GBOT (Ground based Optical Tracking of Gaia, see Altmann et al. ibid) is a specific observing program of the probe itself; observing sites are also foreseen in a Science Alert Network for various science alerts mainly dedicated to astrophysical objects, photometry and spectroscopy; the Gaia-FUN-SSO program, presented here, is focused on an astrometric follow-up of specific Solar System objects.

1. The Gaia Follow-Up Network for Solar System Objects

1.1 Objectives

During its mission, Gaia will observe many Solar System objects and we can easily foresee that several interesting detections will be done during this five year mission. One of the important specificities of its observations is that they could be done at rather low solar elongation, 45 degrees, therefore detections of inner earth asteroids (IEAs, or Atens) could be performed. Detection of some new NEAs at bigger solar elongation could also be done. In these cases, due to the motion of the objects and perhaps to the limiting magnitude, the scanning law of Gaia will restrict the orbit determination to be founded on a very small number of astrometric measurements. In that case, only a ground-based network can avoid the loose of the asteroid and can permit to build an orbital modeling, based on enough astrometric measurements even at a lower accuracy than Gaia, in such a way that future observations remain possible. This is the primary objectives of the Gaia Follow-up Network for Solar System Objects.

In addition to the improvement of the astrometric data used for the orbital modeling of some specific objects, we can also think that some peculiar objects such as new comets, or even asteroids with cometary activity, could be detected. Due to the limiting factors of the Gaia observing method, ground-based networks can be very helpful in order to get fast more information upon the physical characteristics of these objects. Moreover, in particular during the first months of the mission, many unpredictable detections can arise, but the filtering parameters of the data processing will have to be tested and tuned and an important task will be to discriminate these detections, in particular for the detection of moving objects. Ground-based networks, such as the Gaia-FUN-SSO network, will be sollicitated for a contribution to this task.

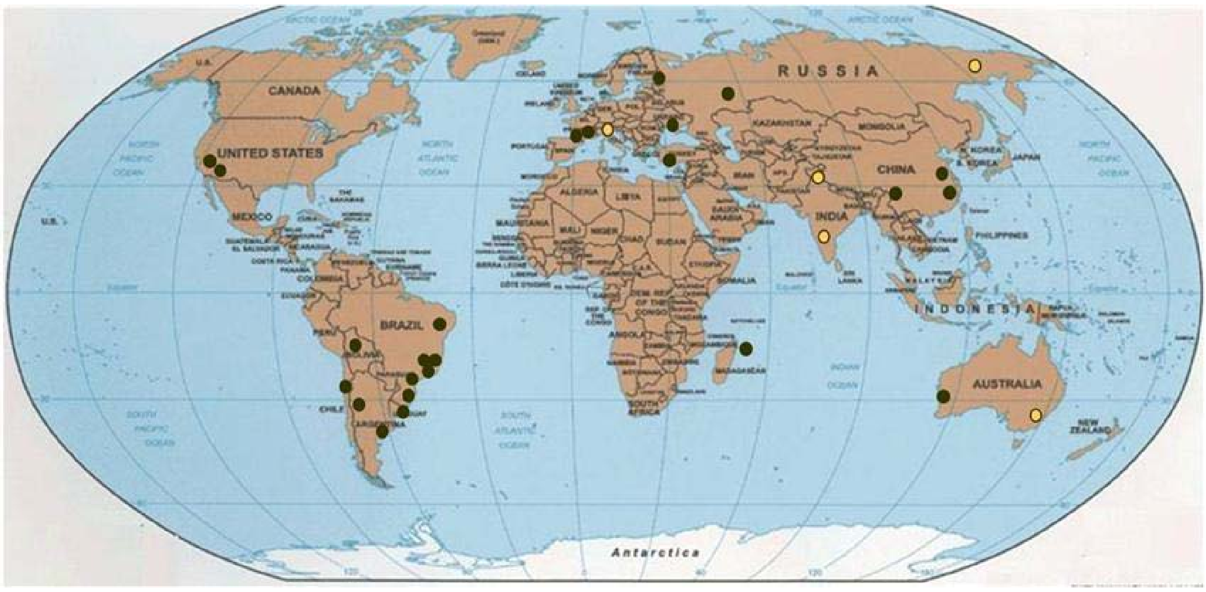

Fig. 1 – Geographical location of observing sites contacted to participate to Gaia-FUN-SSO

1.2 Observing sites and instruments

In order to be efficient in case of the trigger of an alert by the Gaia data processing system, the network must have a large geographical coverage. This is why several observing stations have been contacted for a participation to this project. Almost 25 observing sites are candidate to be members of the network (cf. figure 1). Alerts from the Gaia data processing system can be received between 24 and 48 hours after detection. Difficulties may arise for the observation of peculiar objects: fast moving objects, faint objects, NEAs close to Earth therefore with strong parallax effect…Thus, even if some small instruments (smaller than 0.6 m) can be useful in this network, some telescopes with larger diameters, large field of view and some with sensitive detectors must be included in it. Furthermore, robotic telescopes could be very efficient instruments for such observations on alert.

The figure 2 shows a histogram of the telescope diameters according to the preliminary information received from the candidate’s sites. Among these telescopes, 3 are Schmidt telescopes and 12 are robotic telescopes. Note that these observing sites and instruments will be subsequently much precisely determined thanks to a census organized at the time of this workshop.

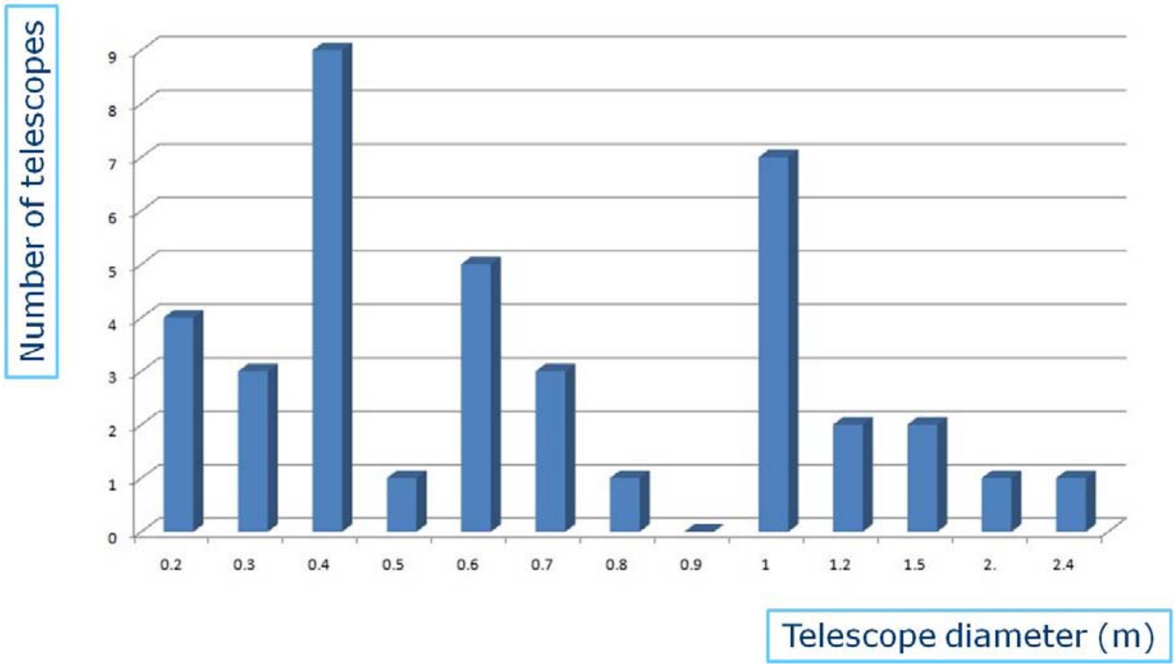

Fig. 2 – Histogram of the telescope diameters of the candidate sites of the network

1.2 Organization

As described in figure 3, the Gaia-FUN-SO network will be composed with a Central Node (CN) and several Observing Sites (OS). The role of the CN will be the coordination of the network, the preparation of ephemerides and the dissemination of the data and results. The alerts related to the Solar System Objects will be received about 24 to 48 hours after the detection by Gaia. The rough format of the data, issued from the Gaia data processing system, will have to be transformed in ephemerides or in celestial coordinates of zone of interest for ground-based detection (depending on the ability to build ephemerides). Once a detection is done in an OS, astrometric measurements must be done and send to the CN. Improved ephemerides can then be done by the CN and disseminated in the network.

At the end of the observing process by the Gaia-FUN-SSO network, the observed coordinates of a newly detected SSO, or improved astrometric data for known objects, will be sent to the Minor planet Center. This will be the only way to inject new SSO data issued from the network in the auxiliary database used by the Gaia data processing for subsequent identification of SSO objects. A possible channel can also be used, to send these data to the ESA Space Situational Awareness programme when the SSO will be Near-Earth Objects.

2. How to be ready for the observations

For the next months we can foresee several important actions in order to have the Gaia-FUN-SSO in a good shape for the observations on alert as soon as the Gaia probe will be operating after the launch in spring 2013:

- For the Central Node:

- some new observing sites could be get in touch in order to complete the geographical coverage of the network.

- more information are necessary for a better definition of the data format of the inputs/outputs and prepare the data useful for observing
- a wiki will be set up to facilitate the exchange of information and tools
- guidelines and recommendations will be posted on the wiki
- an online agreement document will define the reciprocal commitments
- tests and simulation of alerts will be organized

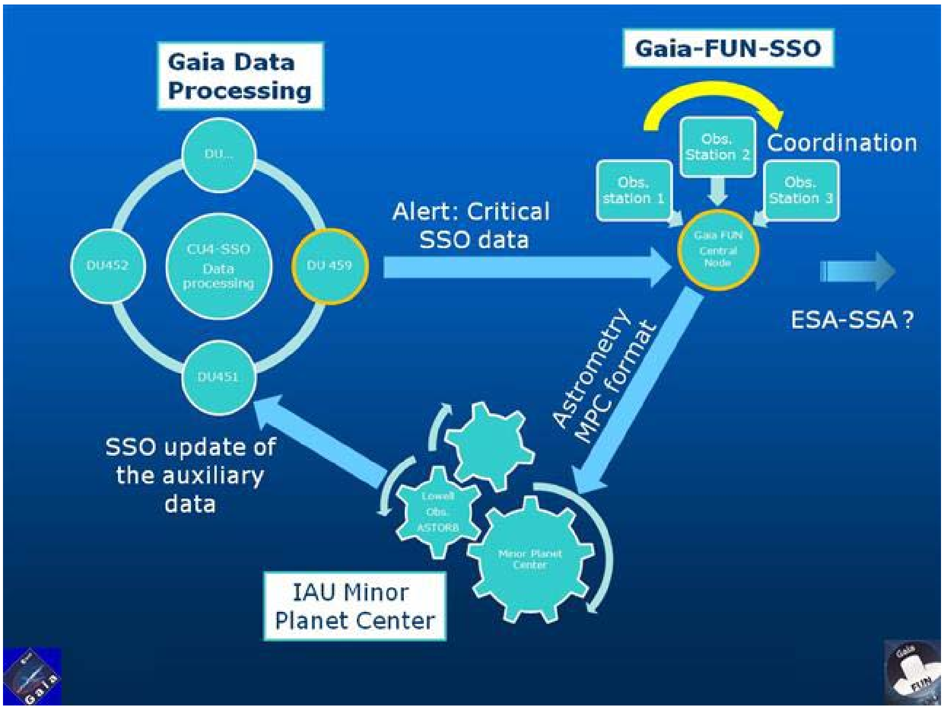

Fig. 3 – Scheme of processing of alerts on Solar System Objects

- For the Observing Sites:

- local organization must be set up for astrometric observations on alert (observers, accurate timescale in UT,…) and be ready to participate to observing tests almost one year before the launch
- OS will have to agree the reciprocal commitments and to register on the wiki in order to access the data
- OS will have to describe the site and instrument characteristics on the wiki

Conclusion

This will be probably the first time that coordinated ground-based measurement will improve, or even to secure, space astrometry measurements. In that sense, the Gaia-FUN-SSO network will be a fine opportunity to get benefit from the ground-space synergy and an important mean to improve the scientific return of the Gaia mission for the Solar System Objects science.

References

Thuillot , W., Hestroffer, D., Tanga, P.: .2011, Complementary ground-based observations for Solar System applications, EAS Publications Series 45, 2010, GAIA: At the Frontiers of Astrometry, 237-242.