EPSC Abstracts
Vol. 13, EPSC-DPS2019-1803-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

FRIPON first results : network efficiency and error estimation

François Colas (1), Simon Jeanne (1), Brigitte Zanda (2,1), Sylvain Bouley (3,1), Mirel Birlan (1), Pierre Vernazza (4), Jérémie Vaubaillon (1), Jérôme Gattacceca (5), Laurent Jorda (4), Jean-Louis Rault (7), Lucie Maquet (1), Cyrille Blanpain (8), Asma Steinhausser (2), Julien Lecubin (8), Adrien Malgoyre (8), Pierre Hewins (1)
(1) IMCCE, Observatoire de Paris, Paris, France (colas@imcce.fr), (2) IMPMC, Muséum National d'Histoire Naturelle, Paris, France, (3) GEOPS, Université Paris Sud, Orsay, France, (4) LAM, OSU Pytheas, Marseille, France, (5) CNRS, Aix Marseille Université, IRD, Coll France, INRA, CEREGE, Aix en Provence, France, (6) IAS, Université Paris Sud, Orsay, France, (7) International Meteor Organization, (8) OSU Pytheas, Marseille, France

Abstract

FRIPON (Fireball Recovery and interplanetary Observation Network) founded by ANR (Agence Nationale de la Recherche) aim is to connect meteoritical science with asteroidal and cometary sciences in order to better understand solar system formation and evolution. The main idea was to cover all French territory to collect meteorites with accurate orbits allowing us to pinpoint possible parent bodies. 100 all-sky cameras were installed since 2016 realizing a dense network with an average distance of 100km between stations. To maximize the accuracy of orbit determination, we mixed our optical data with radar data from GRAVES beacon received by 25 stations [1](Rault et al, 2015). As the network installation and the creation of research teams for meteorites need many persons, at least much more than our small team of professionals, we also developed a participative science network for amateurs called Vigie-Ciel [2](Zanda et al, 2015). It is possible to simply use our data, participate to research campaigns or even add cameras.

As the the network is working now for 3 years and is also extending to Europe vie e-FRIPON network, we have enough data to measure the efficiency of the network and the accuracy of the data.

The network efficiency

The original French network consists in 100 cameras, with the European extension (fig. 1) 160 cameras are now working, we hope 200 active cameras for 2020. The actual detection rate is of 1000 fireballs per year with a limiting magnitude of -1.

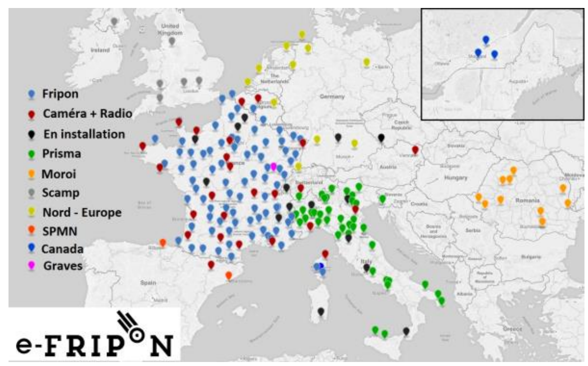

Figure 1 : *State of the e-FRIPON network (100 cameras installed, light blue) and extensions in Europe, PRISMA (Italy, green), MOROI (Romania, dark blue). Red dots are for radio stations using GRAVES radar*, black for station in installation, yellow for new European networks.

Measurements accuracy

All the observations of the FRIPON fireball network are made with the same hardware configuration [4] (Colas et al. 2015): both for the fish-eye lens (f=1.25mm) and for the detector (Sony ICX445). Fish-eye lenses are known to produce heavy distortion, and we were unable to obtain the optical design from the lens manufacturer. Furthermore we found a strong heterogeneity among the distortion figures in the same set of lenses, and among the positions of the chip inside the camera. Hence, we developed our own distortion model to be fitted on each camera, as we needed to compute calibrations with background stars . Our objective is to get a good calibration for elevations superior to 10◦. Indeed, with a characteristic distance between two cameras about 80 km, a meteor at 20 km of altitude will be seen with an elevation down to 10◦ by six or seven cameras; but only one or two cameras on average will see it at an elevation superior to 20◦. So a calibration from zenith to 10◦ allows us to observe the whole trajectory of a large majority of bolides. As we use a video acquisition frame rate of 30 fps, the limiting magnitude is only zero, so there are almost no stars visible on a single frame. In order to detect enough calibration stars, longer exposure frames are needed. Even a five second pause is not sufficient to efficiently sample the field of view, as only a few dozens of stars are measured. Hence, the measurement needs to be repeated and this is done every 10 minutes so that the acquisition is disturbed as little as possible. With such a strategy, for a clear night, a few thousand stars are measured per camera and they fill the whole field of view (Fig 2).

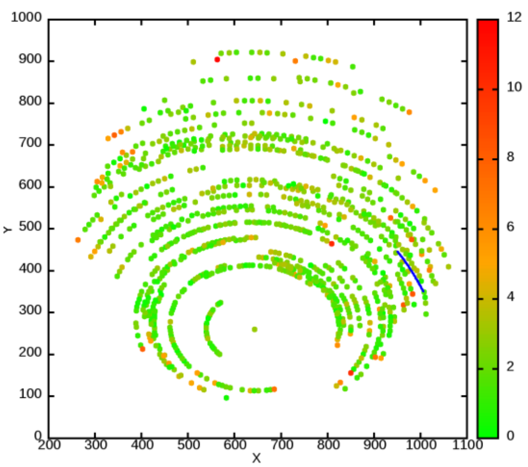

Figure 2 : *Calibration of a fish eye lens with all the long exposure (5 sec) frame of a night covering all the visible sky.*

As the camera mount is stable, this calibration can be used over several nights in the case of a partly cloudy sky. Photometric corrections (flatfield, bias and dark) are not used as such calibration images are not obtainable with remote fish-eye cameras. Instead, we compute the median of all the calibration images of the night, which automatically removes the stars as they move with the sky. This produces a map of the hot pixels and other static features related to the camera itself, which can in turn be

The average accuracy measurement is of 1/5 pixel so about 2 arcmin (fig 3)

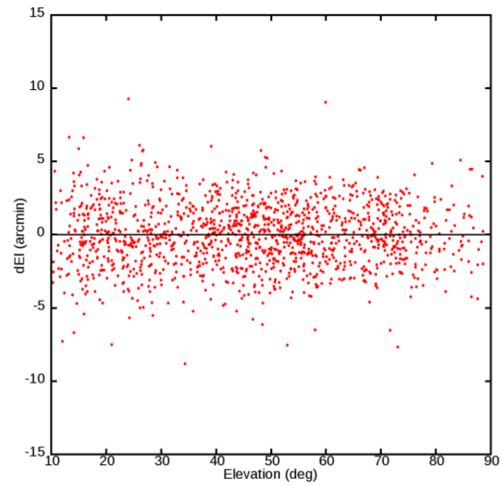

Figure 3 : *The residuals in elevation, using a nine degree odd polynomial function to model the distortion. The standard deviation is 2:12 arcmin. Toulouse fish-eye camera.*

Acknowledgements

The FRIPON project is funded by the French ANR (Agence Nationale de la Recherche: www.anr.fr).

References

[1] Rault, J.L., Colas, F. and Vaubaillon, J.: Radio set-up design for the FRIPON project, Proceedings of the 2014 International Meteor Conference pp 185-186, IMO, 2015.

[2] Zanda, B., Bouley, S., Colas, F., Marmo, C., Rotaru, M., Lewin, E., Rault, J.L., Maquet, L., Birlan, M., Audureau, Y., Kwon, M.K., Vernazza, P., gattacceca, J., Julien, J.F., Steanhauser, A., Linares, M., Birnbaum, C., Cochard, F.and Thizy, O.: Vigie-Ciel projetc, EPSC 2015.

[3] Jeanne, S., Colas, F., Zanda, B., Birlan, M., Vaubaillon, J., Bouley,S., Vernazza, P., Jorda, L., Gattacceca, J., Rault, J.L., Carbognani, A., Gardiol, D., Lamy, H., Baratoux, D., Blanpain, C., Malgoyre, A., Lecubin, J., Marmo, C., and Hewins, P. : Calibration of fish-eye lens and error estimation on fireball trajectories. Application to the FRIPON network, 2019 Accecpted (Astronomy and Astrophysic)

[4] Colas, F.; Zanda, B.; Bouley, S.; Vaubaillon, J.; Marmo, C.; Audureau, Y.; Kwon, M. K.; Rault, J. L.; Caminade, S.; Vernazza, P.; Gattacceca, J.; Birlan, M.; Maquet, L.; Egal, A.; Rotaru,, O. FRIPON, the French fireball network, 2015, EPSC 2015