Ten years of H.E.S.S. I extra galactic observations revisited

Abstract
In the past decade, the H.E.S.S. (High Energy Stereoscopic System) experiment has significantly contributed to the field of very-high energy gamma-ray astronomy. In particular, during the first phase of the experiment from 2004 to 2013, the extra galactic observation program led to the discovery of more than 20 sources of VHE gamma-rays. During the observation program, some regions of the sky were also observed without leading to a detection. About 6.5% of the sky was observed and it is now possible to re-analyse these data with the most up-to-date analysis techniques in an uniform way. This allows to update the source population studies, transient searches in the observed regions and robust comparison with the latest Fermi-LAT catalogs.

Variability search with the ON-OFF method
We can compute a set of maps for each observation. At any given position in the map and for each RunsCluster and each observation, we have the number of reconstructed gamma-like events together with an estimation of the detector’s acceptance.

Released maps
For each RunsCluster identified on the all-sky map below, the following maps are computed: Significance, Flux, Flux Upper Limits and ON-OFF variability test. As an example, the RunsCluster presented here is the one towards the source Mrk 501. We intend to release the maps for all the RunsClusters in FITS format.

Data selection and analysis procedure
All H.E.S.S. data taken between January 2004 and January 2013 are selected for this analysis. The observation runs are then grouped in RunsClusters using the DBCSCAN algorithm from the scikit-learn library [1]. After this step, some regions are removed from this study, such as the Galactic plane or the LMC. Each remaining RunsCluster defines a spatially independent region observed by H.E.S.S. The 123 selected RunsClusters are the results of ~1500 observation runs, corresponding to ~2700 hours of observation and covering ~6.5% of the sky.

The analysis of each RunsCluster is then performed using the Model Analysis [2] and a set of maps – significance, flux or upper limits – is derived. From these maps, values of interest can easily be retrieved. In this analysis, the flux-related products were derived assuming a Power-Law with a spectral index of 3. The results presented here have been cross-checked using an independent calibration and analysis chain.

Comparisons with Fermi-LAT catalogs
From this analysis it can be derived how many Fermi-LAT sources have been observed by H.E.S.S. In addition, the Flux UL maps are useful to constrain the extrapolation of the flux observed with Fermi in the H.E.S.S. energy range.

216 3FGL [5] sources have been observed in this dataset. For 196 sources, the VHE extrapolation is not constraining. For 20 sources, however, this extrapolation is constraining as in the two example SEDs given in the figure below:

References