Executive summary:
The H.E.S.S rapid Gravitational Waves follow-up program

Since the first direct detection of Gravitational Waves (GW), the astrophysical community has taken interest in the electromagnetic follow-up of these events in order to detect their counterparts. However, the poor localization of GW events, does not make that task easy. Dedicated follow-up strategies and algorithms have been developed by follow-up facilities in order to maximize the chances of counterpart detection. In this contribution, the strategies and techniques developed and used within the High Energy Stereoscopic System (H.E.S.S.) collaboration are presented along with the automation of the process and its output.

In order to schedule observations on GW events three ingredients are taken into consideration: the telescope observation constraints, which requires it to observe under low to moderate background light for example, the GW localization maps provided by the GW interferometer collaborations and possibly external information on the distribution of the matter in the Universe like galaxy catalogs.

These three ingredients are taken into consideration when developing follow-up strategies. In total five follow-up strategies are developed for H.E.S.S and presented in this contribution. In summary, the first two only consider the posterior probability of finding a GW event in the 2D sky (provided in the GW maps) and the remaining strategies take into consideration additionally the distribution of the matter in the Universe and 3D information on the GW localization (distance) in order to limit the search to few galaxies instead of entire regions in the sky. For a given observation window, the first strategy simply targets to hottest pixel in the sky. The second one integrates the probability inside the entire telescope field of view (FoV). The third one correlates the GW map with the galaxies in the GW region and targets the galaxy with the highest probability. The fourth and the fifth strategy consider the integration of the galaxy probabilities inside the FoV.

The H.E.S.S. response to GW events is automized. H.E.S.S. is capable of filtering out uninteresting GW events, either due to their terrestrial nature or to its inability to cover large portions of the GW uncertainty. H.E.S.S. chooses automatically the best strategy for the follow-up depending on the available information and the selection cuts depending on the nature of the GW event. It is also capable of scheduling prompt or delayed observations for the entire night depending on the time of the alert arrival without any human intervention. The H.E.S.S. automatic response to GW events is illustrated in the poster. The latency to the H.E.S.S. response for promising GW alerts is estimated to be less than 1 minute.

Finally, with the developed tools, H.E.S.S. observed six GW events so far. The observations are presented in the conclusion of the poster.