The Science Alert Generation system of the CherenkovTelescope Array Observatory

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The Cherenkov Telescope Array (CTA), with dozens of telescopes located in both the Northern and Southern Hemispheres, will be the largest ground-based gamma-ray observatory and will provide broad energy coverage from 20 GeV to 300 TeV. The large effective area and field-of-view, coupled with the fast slewing capability and unprecedented sensitivity, make CTA a crucial instrument for the future of ground-based gamma-ray astronomy.

To maximise the scientific return, the array will send alerts on transients and variable phenomena (e.g. gamma-ray burst, active galactic nuclei, gamma-ray binaries, serendipitous sources). Rapid and effective communication to the community requires a reliable and automated system to detect and issue candidate science alerts. This automation will be accomplished by the Science Alert Generation (SAG) pipeline, a key system of the CTA Observatory.

The SAG system is part of the Array Control and Data Acquisition (ACADA) system of CTA. SAG is the system that performs the first real-time scientific analysis during the data acquisition to perform data reconstruction, data quality monitoring, science monitoring and real-time candidate science alert issuing during observations to the Transients Handler functionality of ACADA.

The SAG is composed of three main pipelines that run in parallel: the Low-Level Reconstruction (**sag-reco**), the On-Line Data Quality (**sag-dq**), and the High-Level Reconstruction (**sag-sci**).

The Array Data Handler acquires the data streams from the telescopes at a rate of tens of kHz, and the **sag-reco** receives this data stream. This software component performs the reconstructions of raw data in several steps. The first reconstruction step (DL0 to DL1) is executed for each telescope data stream, while the following steps (DL1 to DL3) merge the data acquired by all telescopes in the sub-array and require the software array stereo trigger. The results are input for the next SAG Data Quality pipelines (**sag-dq**). The sag-dq performs several data quality checks on the different data level reconstructed by the sag-reco. Some of the data quality checks are performed on the single telescope data, while others are performed after the stereo trigger analysis. Finally, the data quality results of all sag-dq pipelines are aggregated, stored in a database, and used to check if the data quality level required to generate a candidate science alert are satisfied. The DL3 resulting from the sag-reco pipeline is also the input for the High-Level Reconstruction pipeline (**sag-sci**) that executes scientific analyses on the DL3 with several science tools. First, the DL3 data are collected in a database. Then, the Pipeline Manager, a component of sag-sci, executes the configured analyses in parallel to obtain the DL4 results (counts maps and analysis) stored in a database. During these analyses, the sag-sci can detect candidate science alerts and send them to the Transients Handler system within 20 s from acquired data to perform further investigations. The operator and the support astronomer can visualise the results of both the sag-dq and sag-sci pipelines using the Operator HMI, an ACADA system that shows the results stored in the databases.