

SAG-SCI: Real-time, High-level Analysis Software for ACADA system of the CTAO

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ABSTRACT

The **Science Alert Generation** (SAG) pipeline of the Array Control And Data Acquisition (ACADA) system of the CTAO is an automated pipeline for real-time analysis and generation of candidate science alerts. We present the **architecture** and **workflow** of **SAG-SCI**, the component responsible for high-level analyses: significance estimation, generation of sky maps and light curves, and blind source searches. We simulated the observations of a **steady source**, a gamma-ray **flare**, and a **serendipitous transient discovery**, demonstrating SAG's critical role in enabling CTAO to rapidly identify and respond to transient events.

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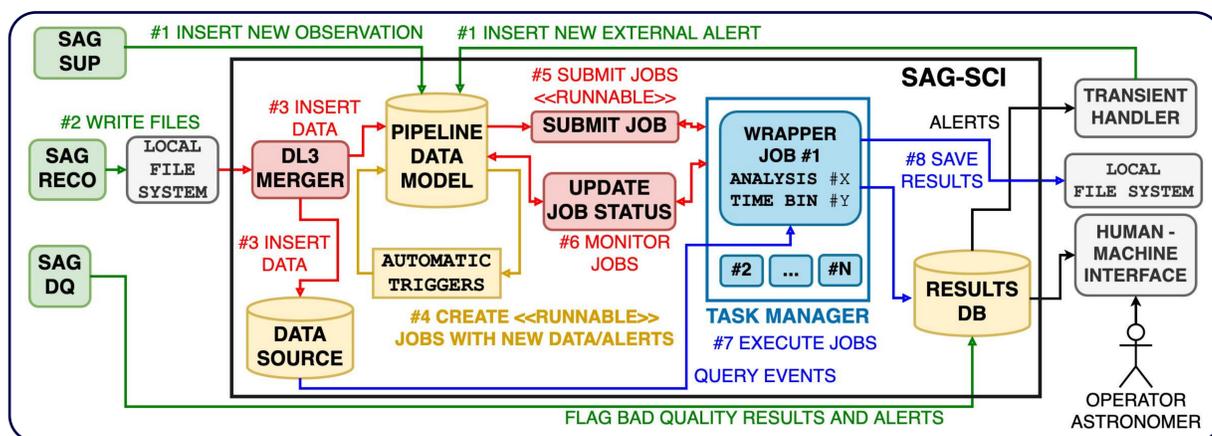


Fig. 1: Architecture and workflow of SAG-SCI.

4- BLIND SEARCH DISCOVERY

In parallel with light curve analysis, SAG-SCI computes a significance map and performs a blind search to detect transients. Fig.3 shows the detection of a **serendipitous transient** (cyan) during observations of a regular target (white). The transient's significance is 7σ , which prompts the generation of a candidate alert and light curve analysis on the new target. The blind search is also performed during follow-up observations of **poorly localised** transients, such as Gravitational Waves.

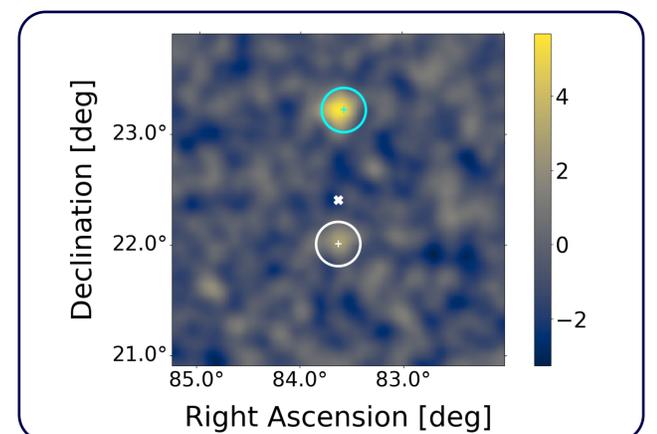


Fig. 3: Simulated Significance Map. SAG-SCI's blind search detects a transient source (cyan) in parallel to analysis of a regular target (white)

5- CONCLUSION

SAG is a key system for CTAO's **real-time** science. It performs **science monitoring** of the observed sources with sky maps, light curves and stacked results, and enables rapid response to transient events by **generating candidate science alerts**. SAG will reinforce CTAO as a leading observatory for **time-domain** astrophysics, supporting multi-wavelength and multi-messenger strategies to deepen our understanding of the Universe.

1- ARCHITECTURE, WORKFLOW

SAG-SCI architecture is shown in Fig.1. The **Pipeline Manager daemons** control the workflow: reading input, submitting analysis jobs and checking their status. Data, pipeline metadata and results are stored in **MySQL databases**, which also include automatic **triggers** that create jobs when new data arrive. Analysis jobs are submitted via the slurm task manager and executed by **wrappers on science tools** like gammapy.

2- STEADY SOURCE SIMULATION

To **test** SAG-SCI, we simulated a steady source and successfully recovered its flux using 1D likelihood analysis with the gammapy wrapper. The measured flux agreed with the simulated value within a **35% statistical error**. We estimated an additional **30% systematic uncertainty** to account for a possible 20% error in the assumed spectral index of likelihood fit.

ACKNOWLEDGEMENTS

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3- FLARING SOURCE SIMULATION

SAG-SCI analyses sources using a sliding-window approach to create binned **light curves**, that complements time-averaged, stacked results. The light curve of a **flaring source** is shown in Fig.2. The flux in the 5th bin is incompatible with quiescent values, prompting the **generation** of a candidate **science alert**. For one-time transients like Gamma-Ray Bursts and **follow-up observations** of external alerts, source detection alone may be sufficient to generate a candidate alert.

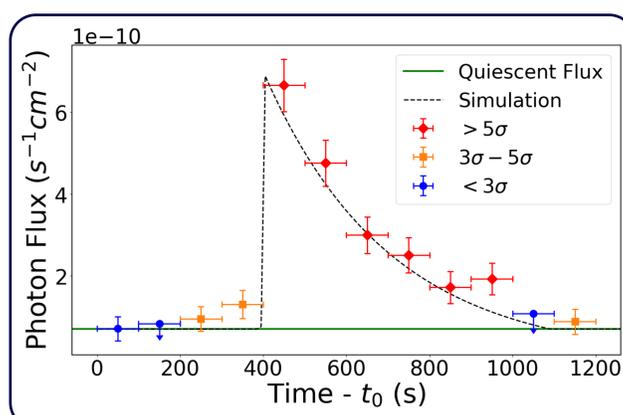


Fig. 2: SAG-SCI light curve of a flaring source, which will prompt a science alert. Points are color-coded by significance.