Celebrating two decades of SWIFT and H.E.S.S.: A joint history of Gamma-Ray Bursts follow-up

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for the **H.E.S.S. Collaboration**

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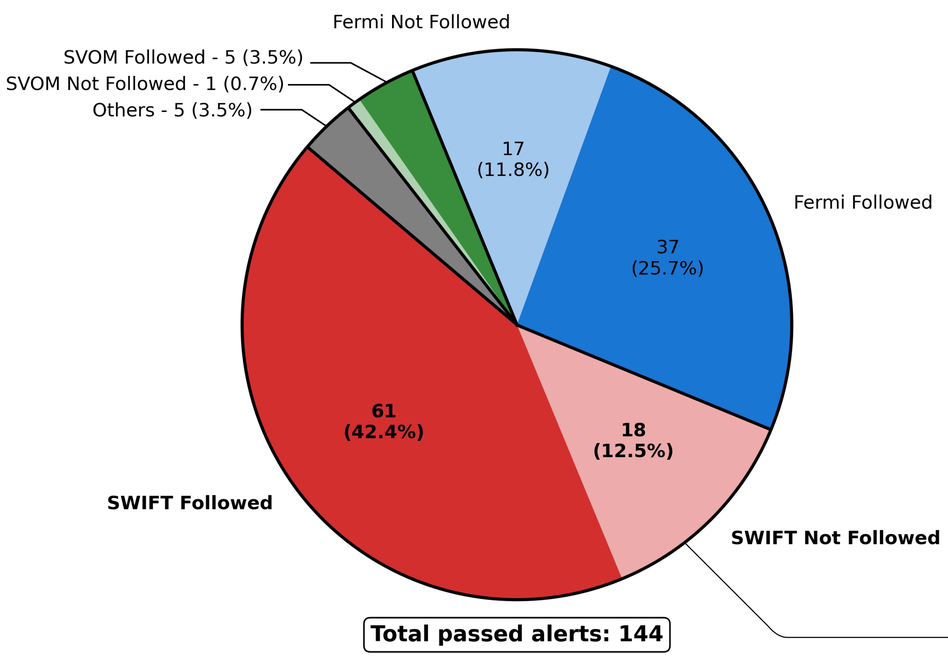
The H.E.S.S. public GRB follow-up information page

Since December 2019, the H.E.S.S. observatory has been documenting all GRB alerts that pass our observation criteria. The information is updated in real time to allow for efficient campaign planning. All performed and cancelled follow-ups are listed on a public GitHub page showing the following information:

grbhess.github.io

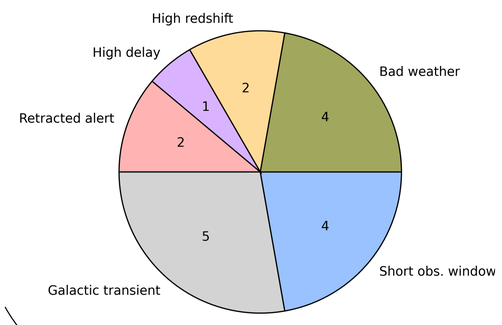
GRB ID	Triggering instrument	Alert time (T0)	GRB RA (J2000)	GRB Dec (J2000)	H.E.S.S. window start	H.E.S.S. window end	Obs mode	Reaction	Contact
GRB221009A	SWIFT-BAT	2022-10-09 13:16:59 UTC	288.2643 deg (19h13m3.43s)	19.7712 (+19h46'16.3'')	2022-10-11 18:04:00 UTC (T0 + 51.8h)	2022-10-17 19:10:11 UTC (T0 + 198.9h) (Multiple nights)	Pointed	Manual	Jean Damascene Mbarubucyeye

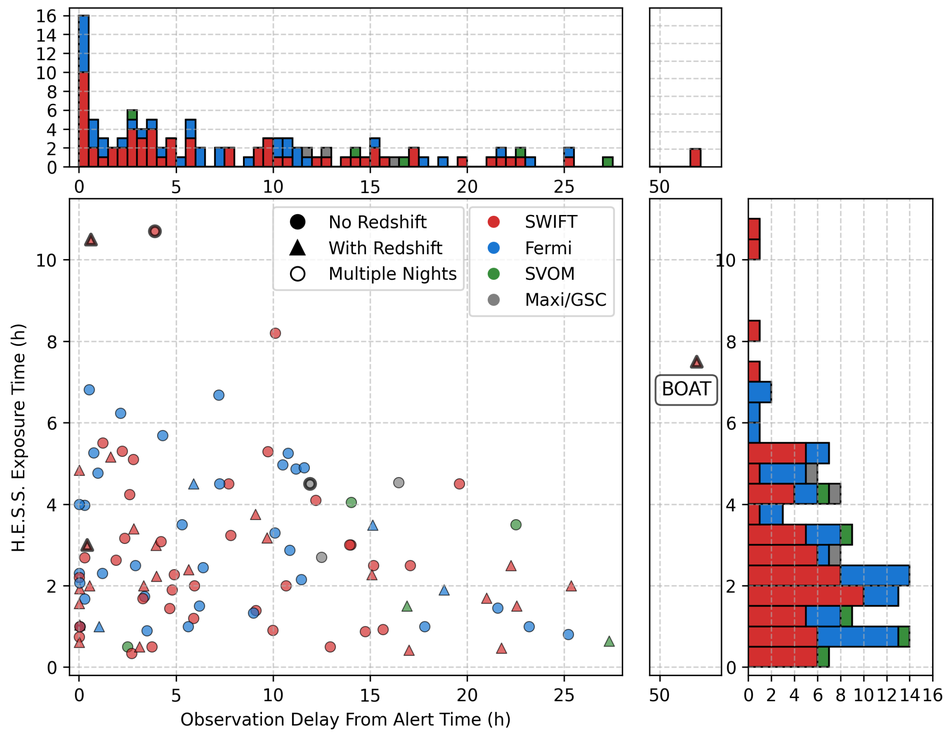
GRB follow-ups since 2020



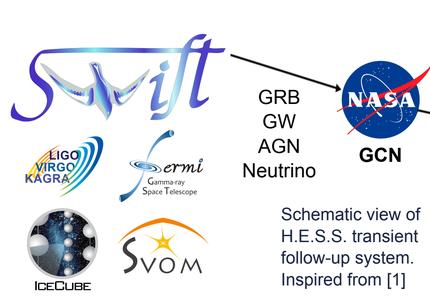
Some shared statistics with SWIFT:

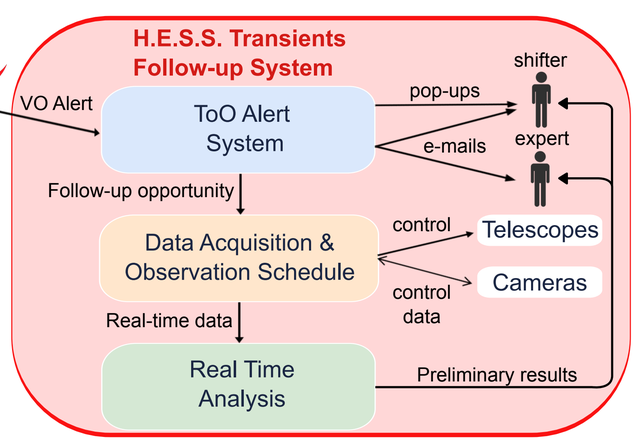
Total SWIFT alerts : 353
Passed alerts : 79 (~22.38%)
Followed alerts : 61 (~17.28%)
Events with a **redshift** : 25





The H.E.S.S. transients follow-up strategy

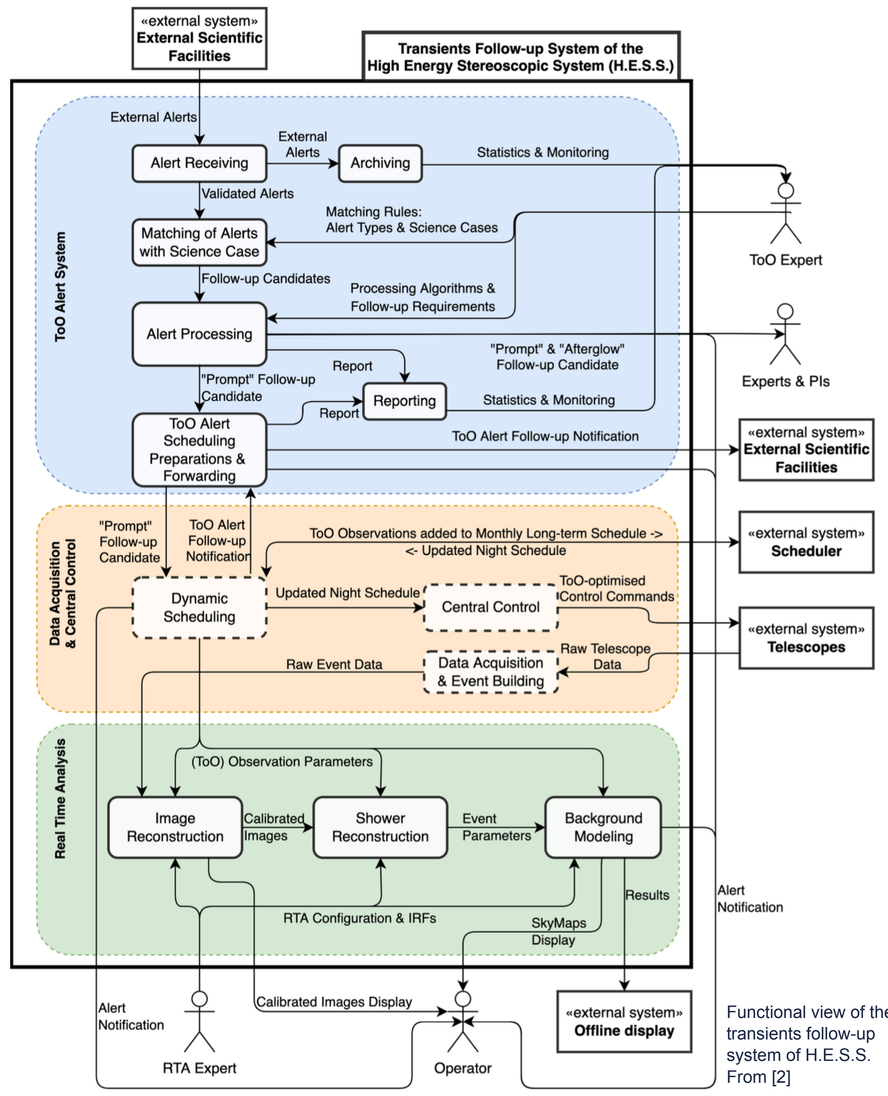




Public alerts distributed via GCN, TNS and other alert systems or brokers are filtered by the ToO alert system.
If an event meets our observation criteria, a notification is sent to the shifters and the members of the working group. If the event is observable at the time, an **automatic response** is triggered. If not, a later strategy will be discussed.

As observations are ongoing, an automatic **real-time analysis** is run to guide us through the campaign. If a hint is visible in the excess/ significance maps, multiple-night observations will be discussed.

Once observations are done, data is calibrated through two separate pipelines. Low-level checks on telescope performances during runs are then performed. A dedicated **unblinding** procedure is required before any high-level analysis to prevent bias.



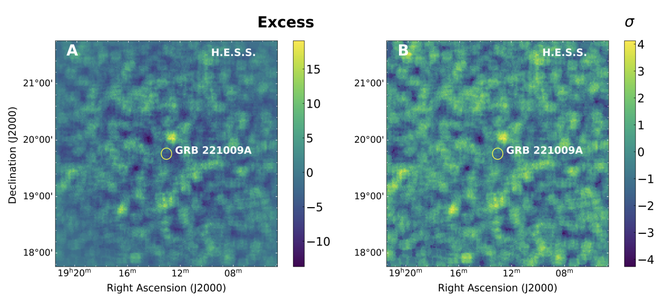
Functional view of the transients follow-up system of H.E.S.S. From [2]

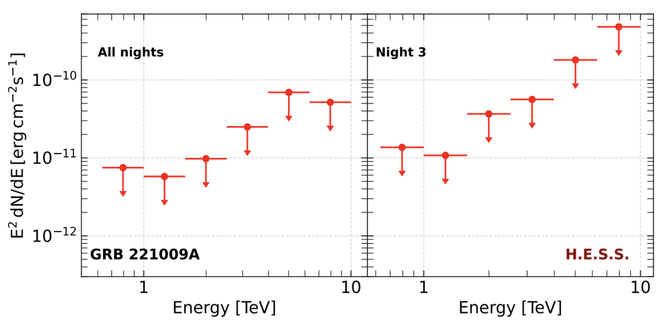
GRB 221009A: An analysis example

On October 9 2022, SWIFT-BAT triggered on the event later called "Brightest Of All Time". It was not visible by H.E.S.S. until the night of October 11th. Observations were then carried out for four nights under challenging conditions (moonlight, atmospheric disturbances), for a total exposure time of 7.5 hours.

Once calibrations were done and the unblinding was granted, analyses were carried out using the two distinct pipelines, followed by a cross-check of the results. Main results presented include excess and significance maps, and differential and integral flux upper limits. After applying atmospheric corrections, the combined observations yield an integral energy flux upper limit of
$\Phi_{UL}^{95\%} = 9.7 \times 10^{-12}$ erg cm^{-2}s^{-1} above $E_{thr} = 650$ GeV.

In-depth results and information are available in the dedicated paper [3].





Conclusions

This work highlights the key role of SWIFT in GRB follow-up campaigns, serving as the primary trigger instrument for H.E.S.S. The observations are later carried out through a well-defined, optimized, and semi-automatic follow-up strategy. No detections have been registered using real-time analysis during this period.

References

[1] Ashkar H. et al., The H.E.S.S. gravitational wave follow-up program, JCAP 03:045, 2021
[2] Hoischen C. et al., The H.E.S.S. transients follow-up system, A&A 666 A119, 2022
[3] Aharonian F. et al., H.E.S.S. Follow-up Observations of GRB 221009A, ApJL 946 L27, 2023

Acknowledgments :

Please see standard acknowledgments in H.E.S.S. papers, not reproduced here due to lack of space.