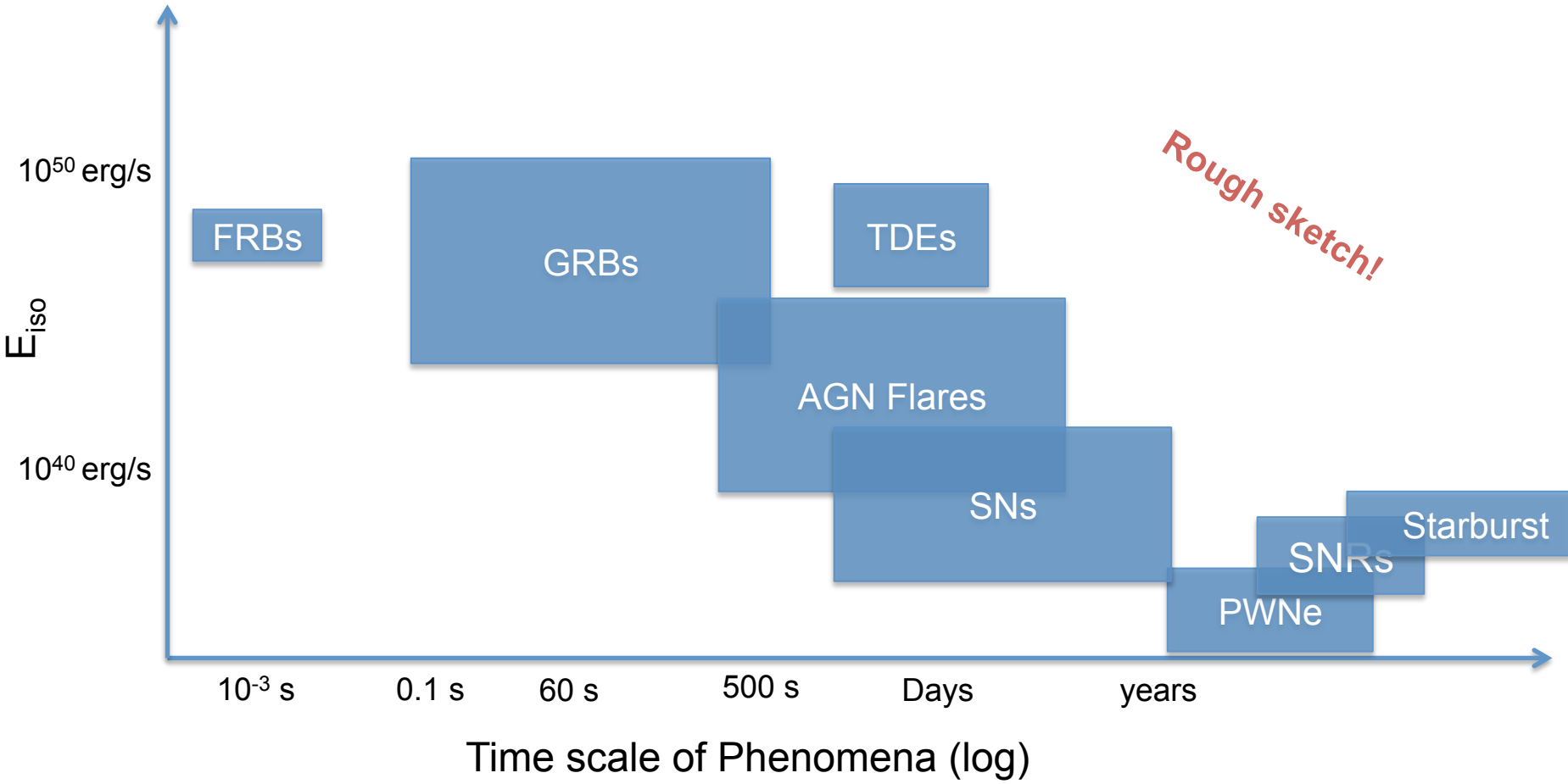
The H.E.S.S. prompt alert and follow-up system

Clemens Hoischen (Potsdam University),
Arnim Balzer (UvA), Matthias Füßling (DESY),
Stefan Ohm (DESY)

on behalf of the H.E.S.S. Collaboration

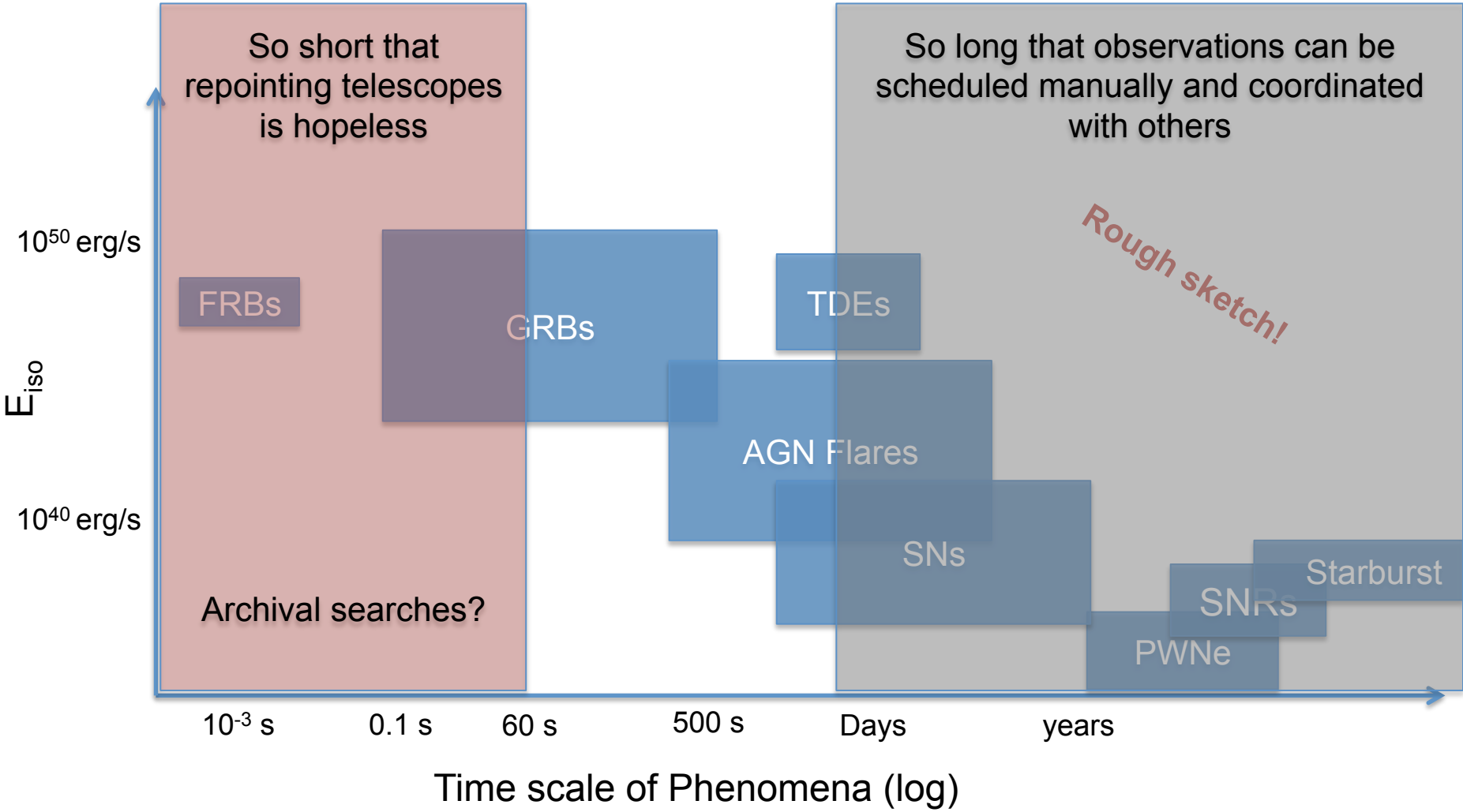
GEFÖRDERT VOM
Bundesministerium
für Bildung
und Forschung

Transient Astrophysical Phenomena in a Nutshell

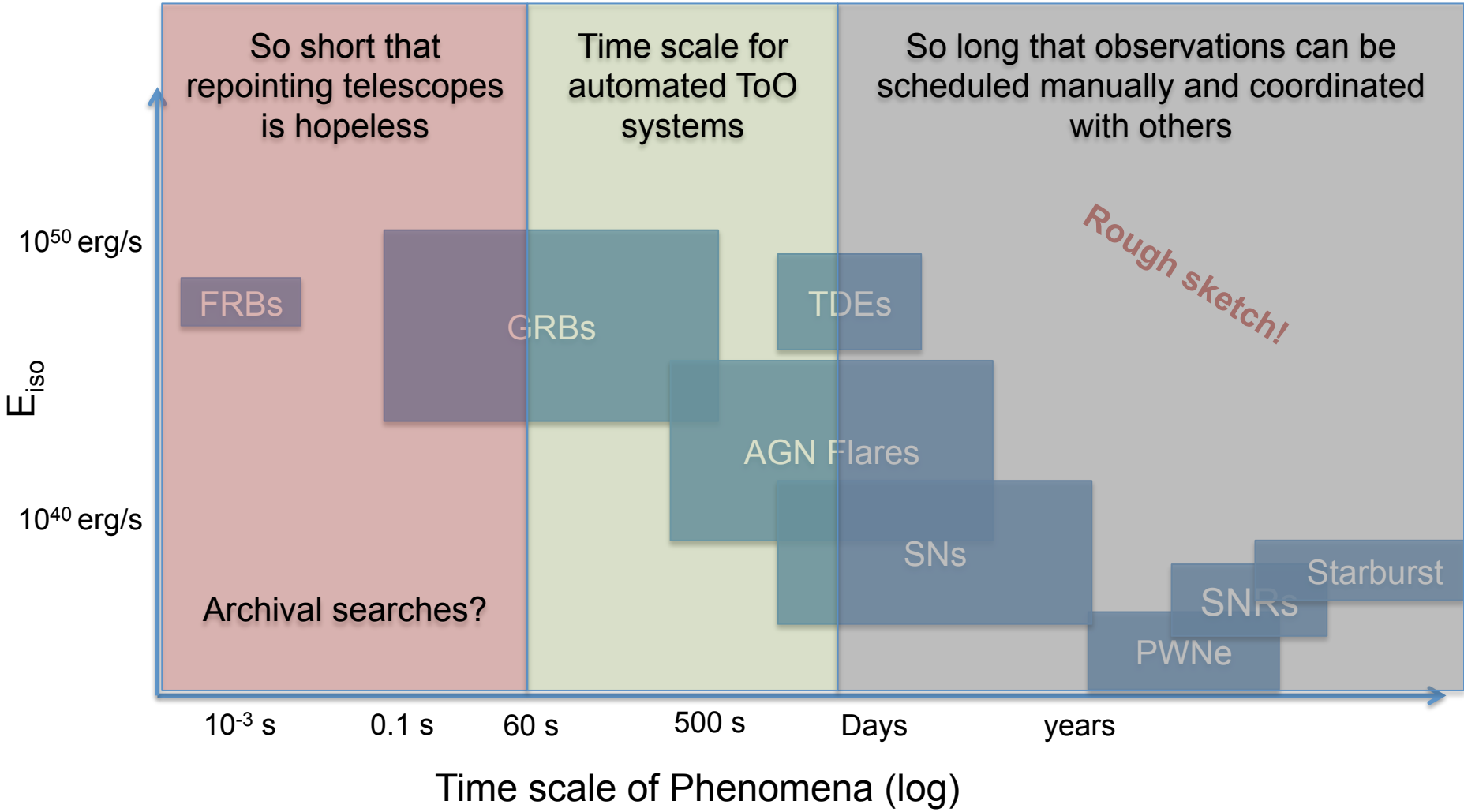


Transient Astrophysical Phenomena in a Nutshell

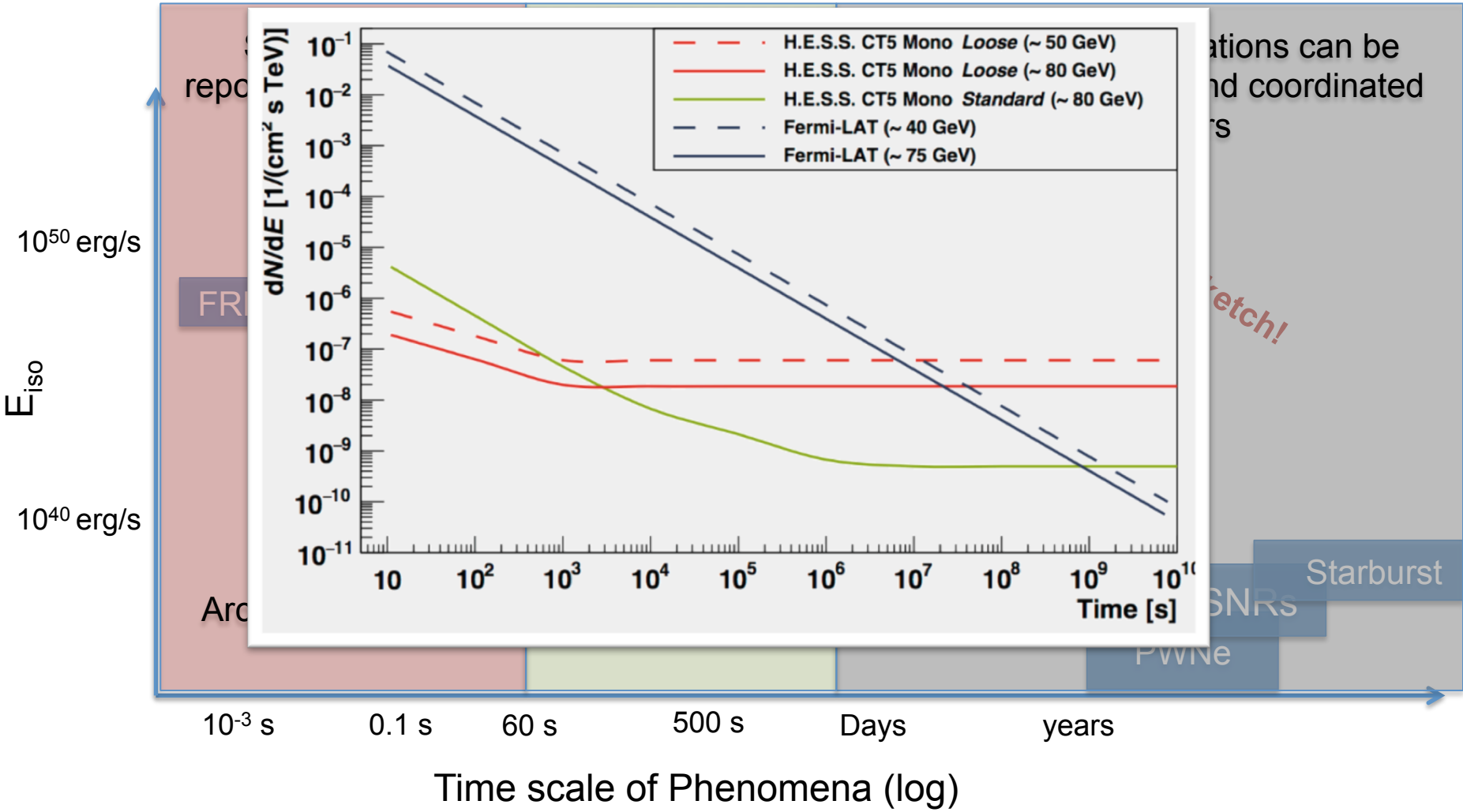
Why do we need a ToO System



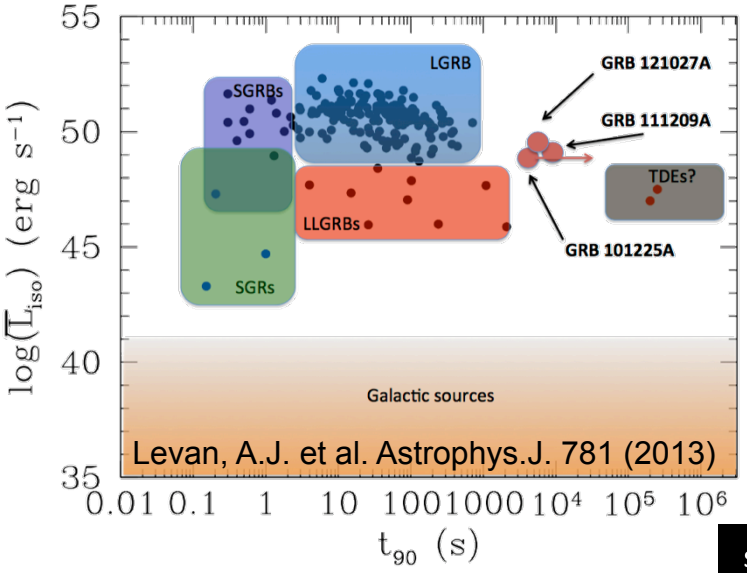
Transient Astrophysical Phenomena in a Nutshell



Transient Astrophysical Phenomena in a Nutshell

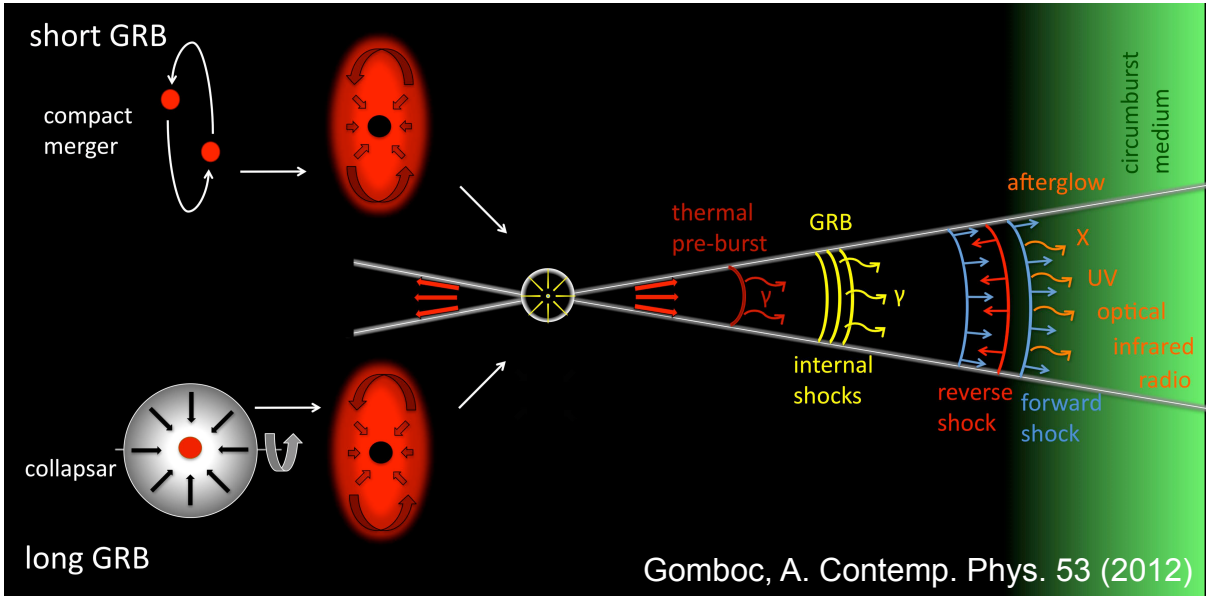


Reality is a bit more complicated.
GRBs have many different time scales



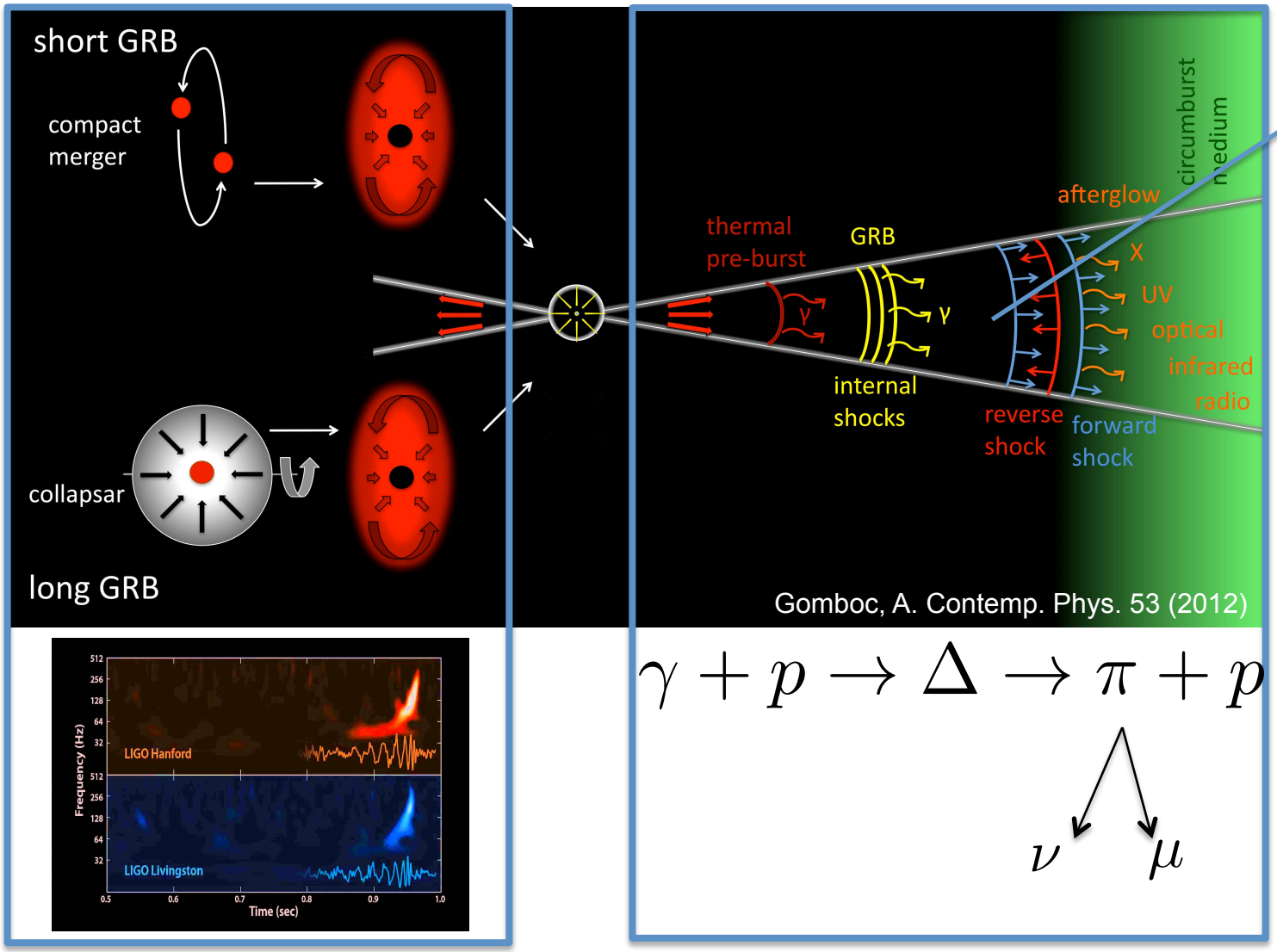
Phenomena can be subdivided in many different classes. Sub classes can even result from completely different progenitor systems

Each of these classes usually has several sub-aspects with individual time scales



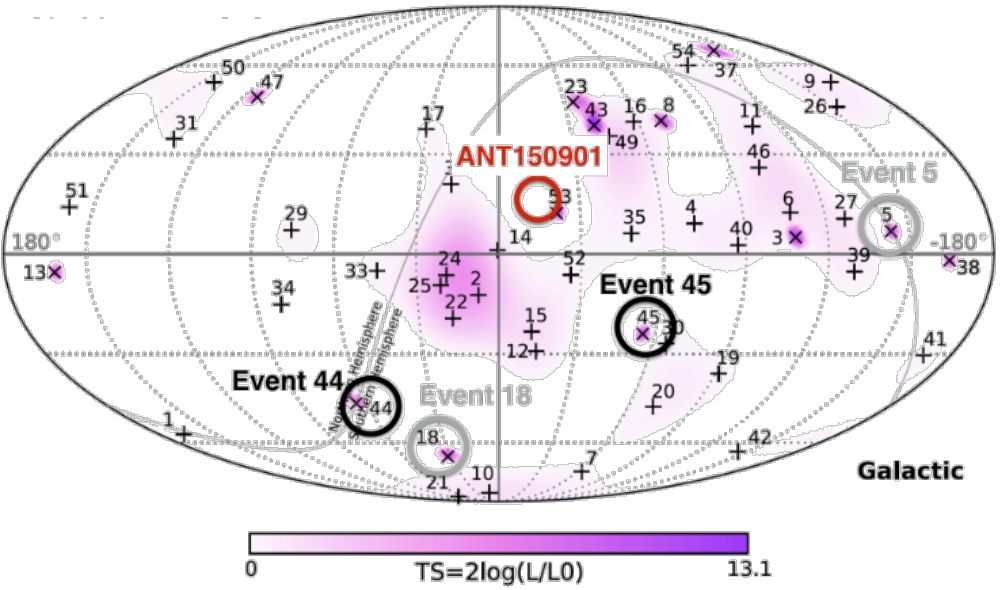
Many messengers are available

Why do we need a ToO System

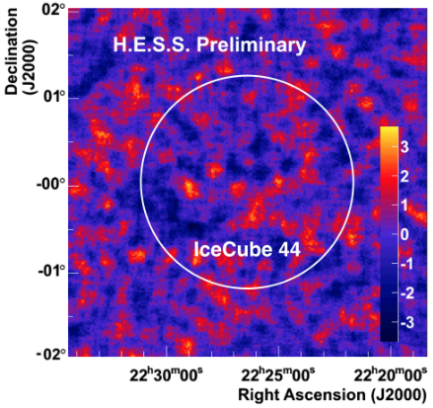


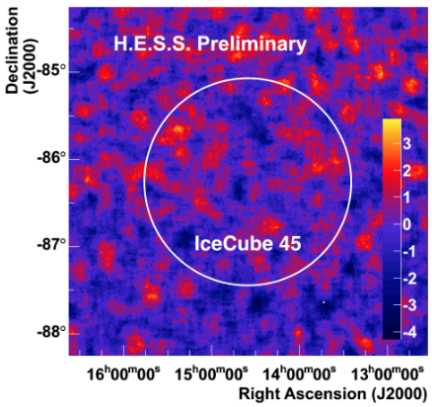
From H.E.S.S. Neutrino follow-up (Schüssler et. al. Gamma16)

Previous neutrino follow-up approach



Pick locations of Neutrino candidates
Check archival data or take new observations





Problems

Unclear what the sources of the neutrinos are

If they are time dependent this approach is useless

→ Alert systems and rapid follow-up

→ Upper Limits

E. Resconi, S. Coenders, P. Padovani, P. Giommi, L.Caccianiga:
“30% of IceCube Flux can be explained by BL Lacs”
(Three Messenger Conference 2016 & submitted)

→ BL Lac are variable!

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

① Triggered by any type of astrophysical messenger

② Clear criteria for each channel
→ Science cases

③ Fast repointing of Telescopes

④ Robust system that deals with corner cases

⑤ Fast feedback of the observations
→ continue observing?

⑥ Inform community about our results

① Triggered by any type of astrophysical messenger

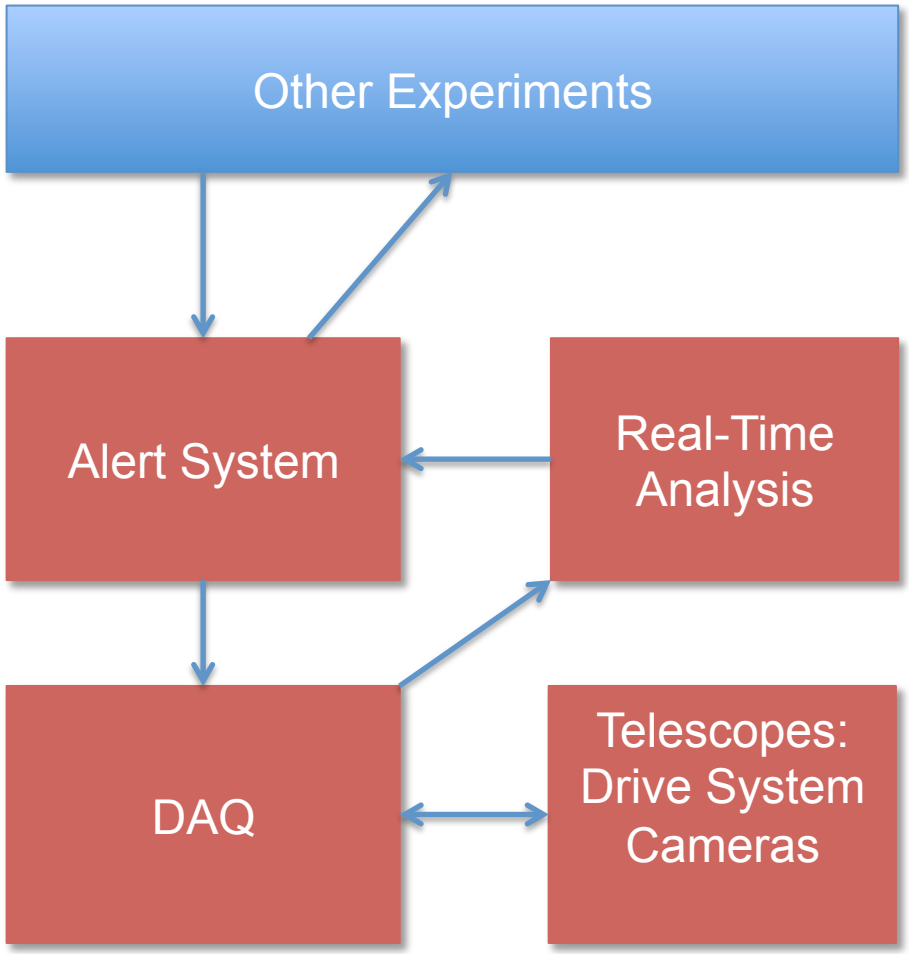
② Clear criteria for each channel
→ Science cases

③ Fast repointing of Telescopes

④ Robust system that deals with corner cases

⑤ Fast feedback of the observations
→ continue observing?

⑥ Inform community about our results



GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

① Triggered by any type of astrophysical messenger

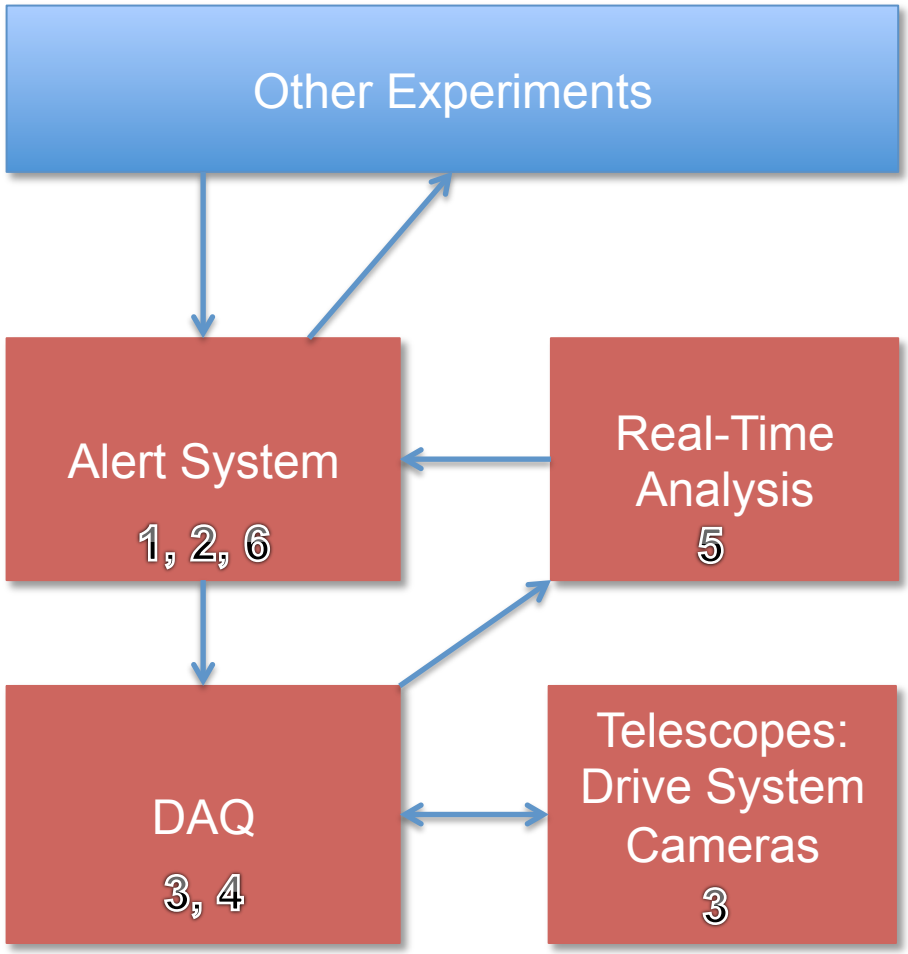
② Clear criteria for each channel
→ Science cases

③ Fast repointing of Telescopes

④ Robust system that deals with corner cases

⑤ Fast feedback of the observations
→ continue observing?

⑥ Inform community about our results



GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Where can we save time?

- DAQ software overhead
  →Negligible
- Drive system

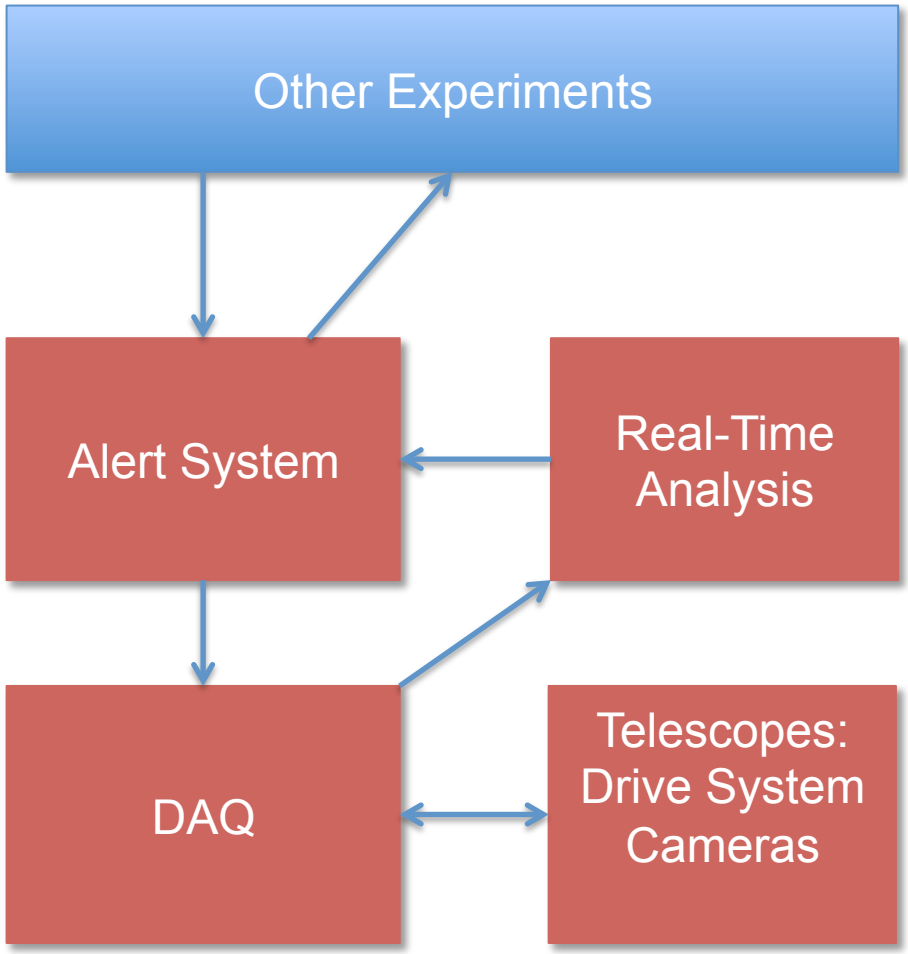
Who provides triggers?

- How much delay do they have?
- What are their uncertainties?

How do others provide their triggers?

- Can we incorporate their triggers into our system

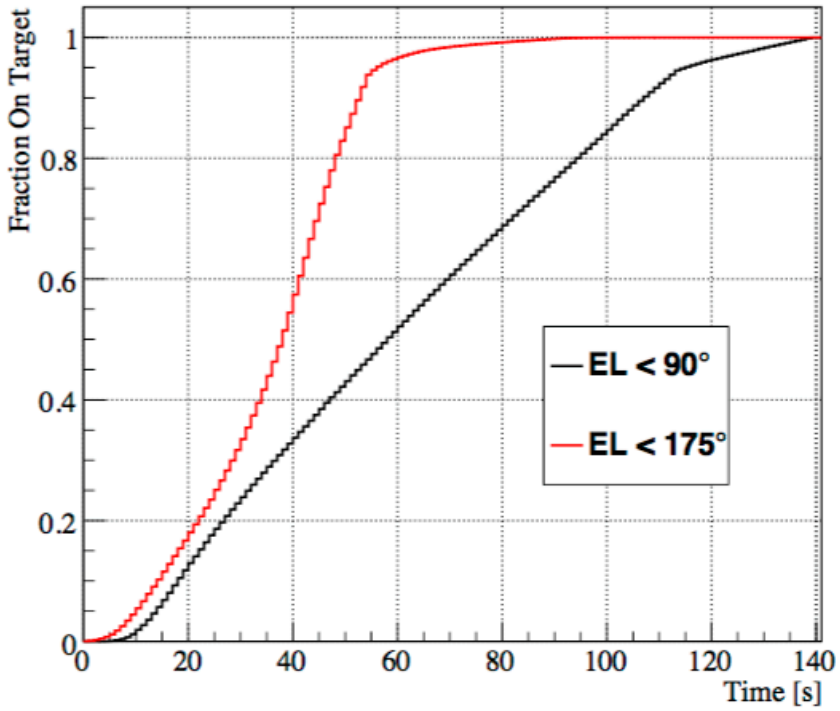
How do we report our findings?



H.E.S.S. CT5 drive system

CT1-4: Time needed to be on target for 90% of possible target locations: ~3 minutes.

→ CT5 drive system designed with fast repointing in mind

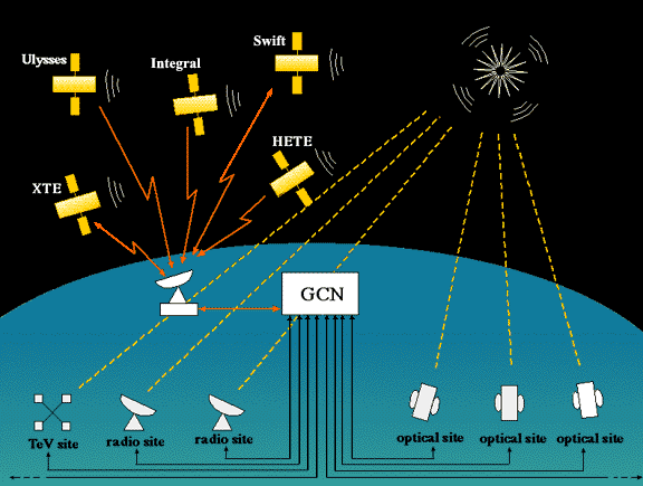


Configuration	Mean time [s]	90% on target [s]
EL < 90°	61	107
EL < 175°	36	52

From Hofverberg, P., et al. "Commissioning and initial performance of the HESS II drive system. *arXiv:1307.4550* (2013).

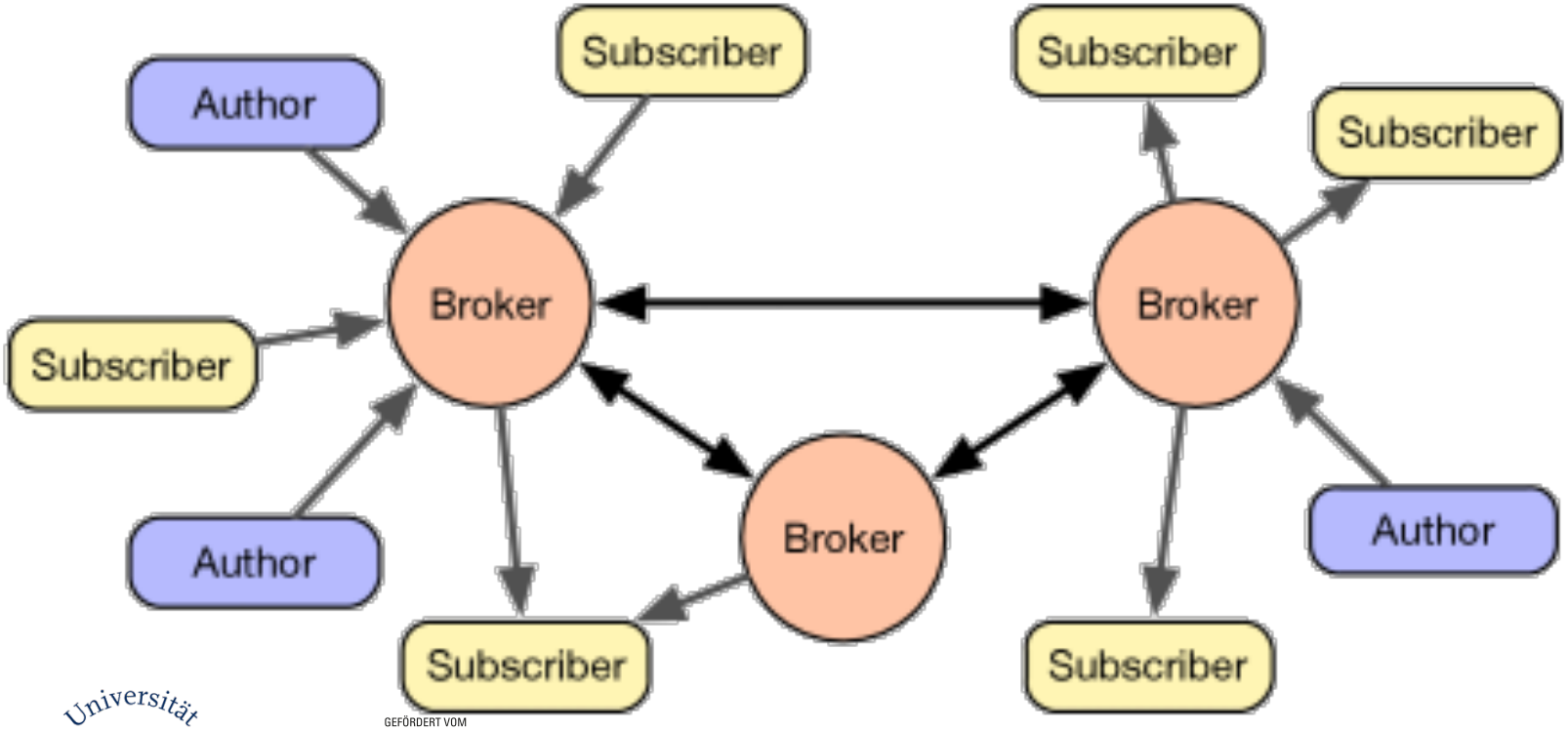
GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

©Matthias Lorentz



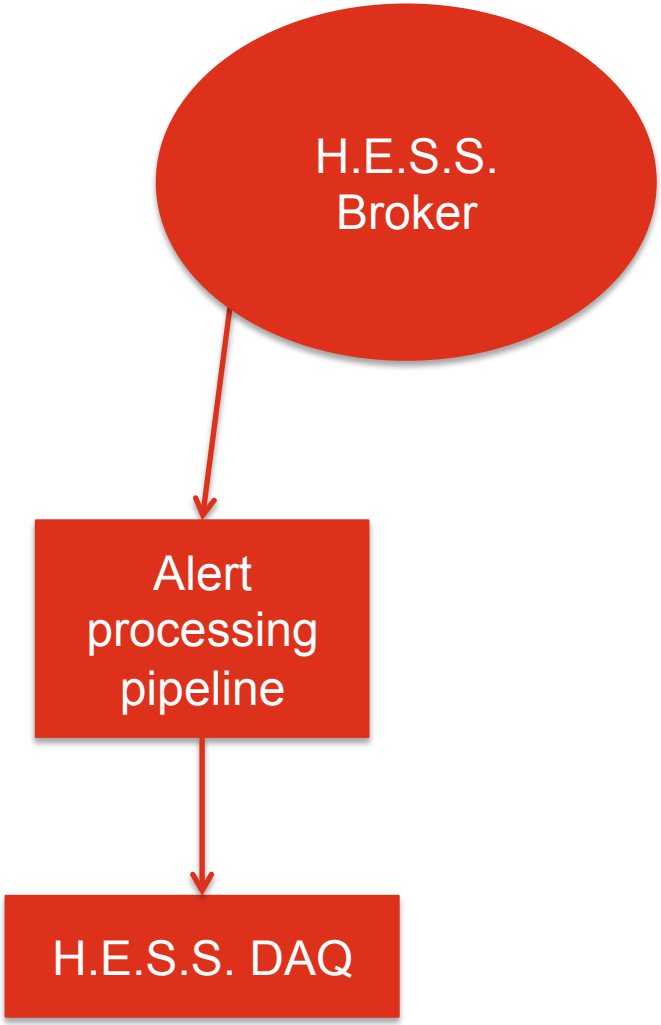
Several python packages available for simple usage:

- voevent-parse
- voeventdb
- comet

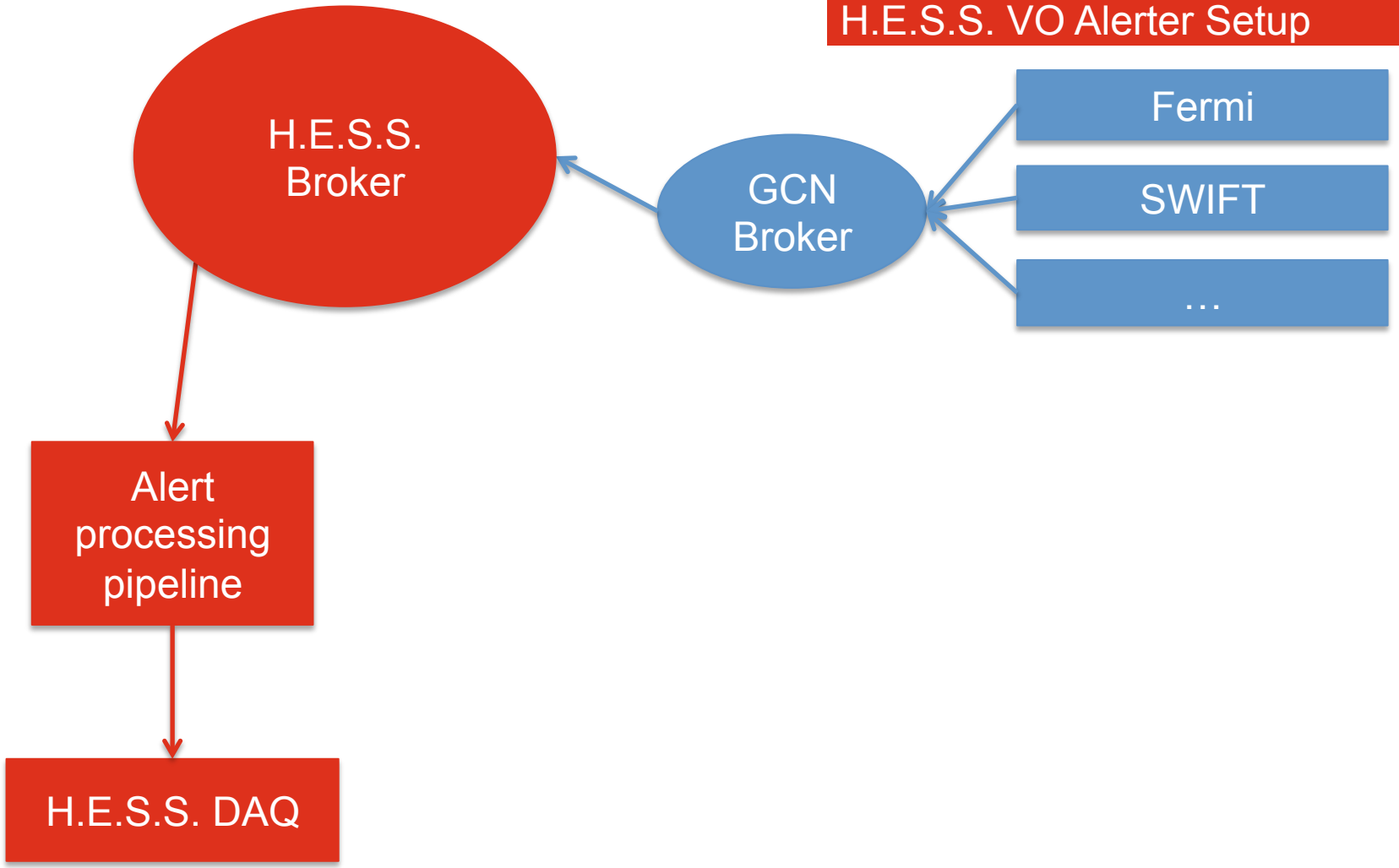


GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

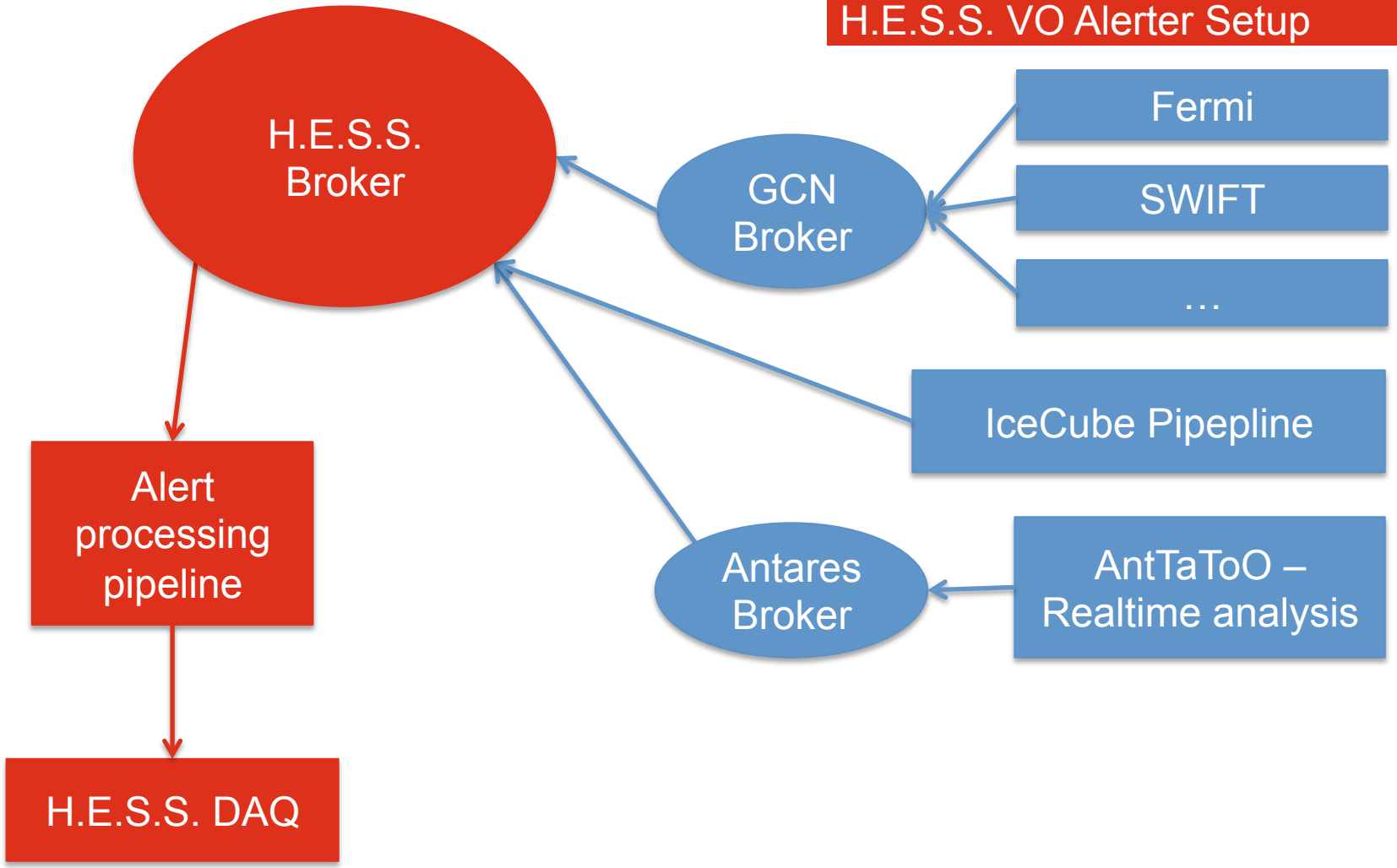
H.E.S.S. VO Alerter Setup



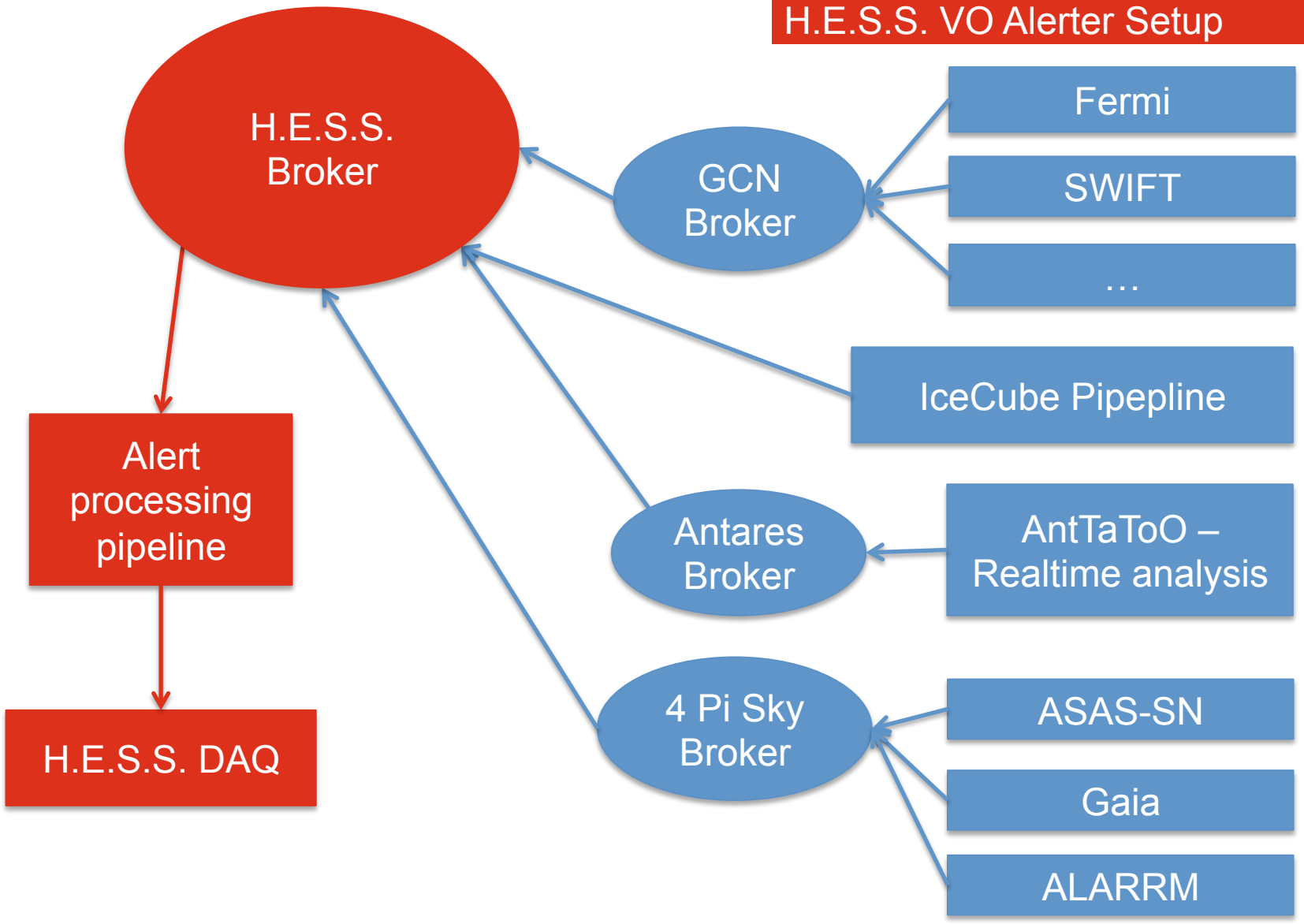
H.E.S.S. VO Alerter Setup



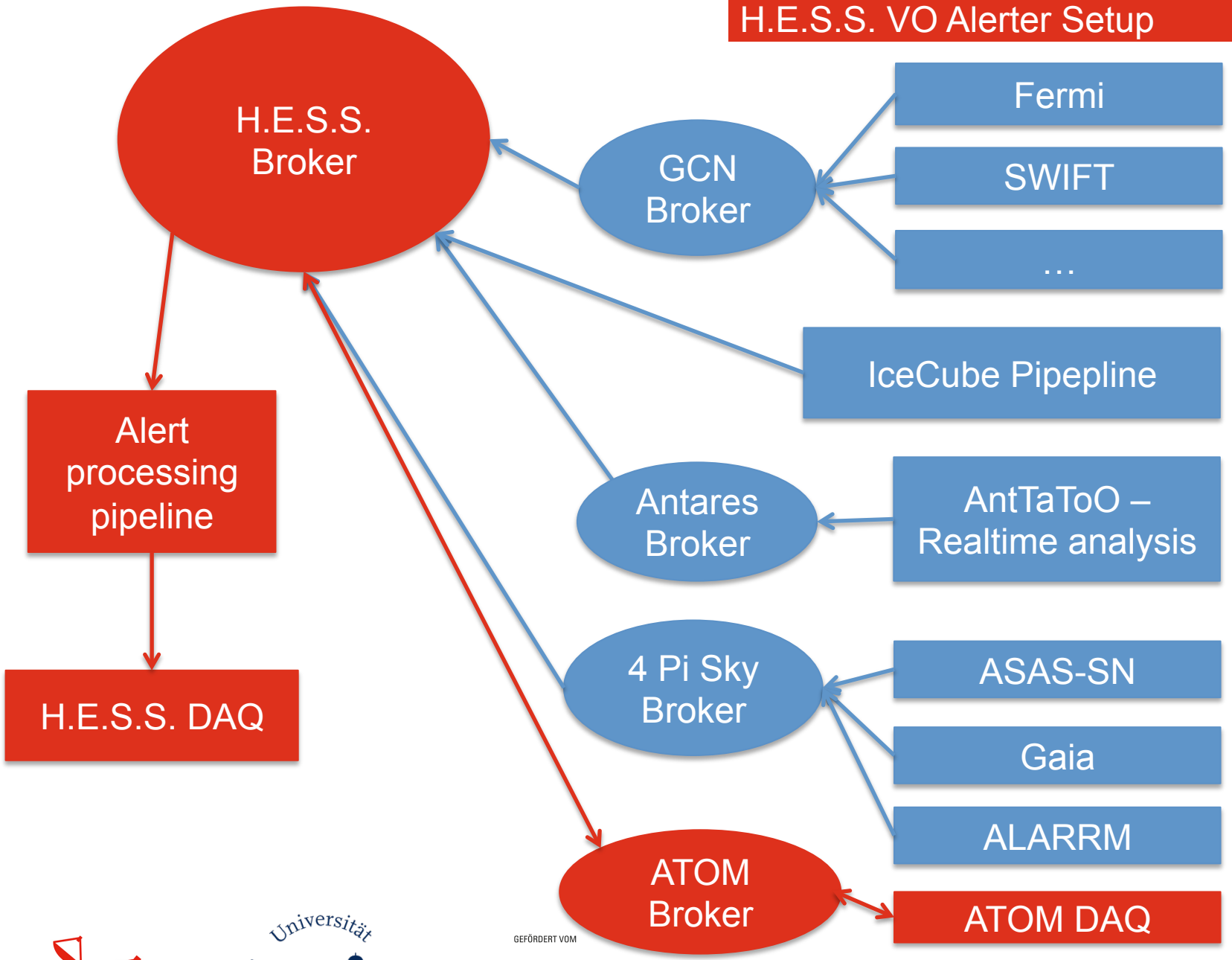
H.E.S.S. VO Alerter Setup



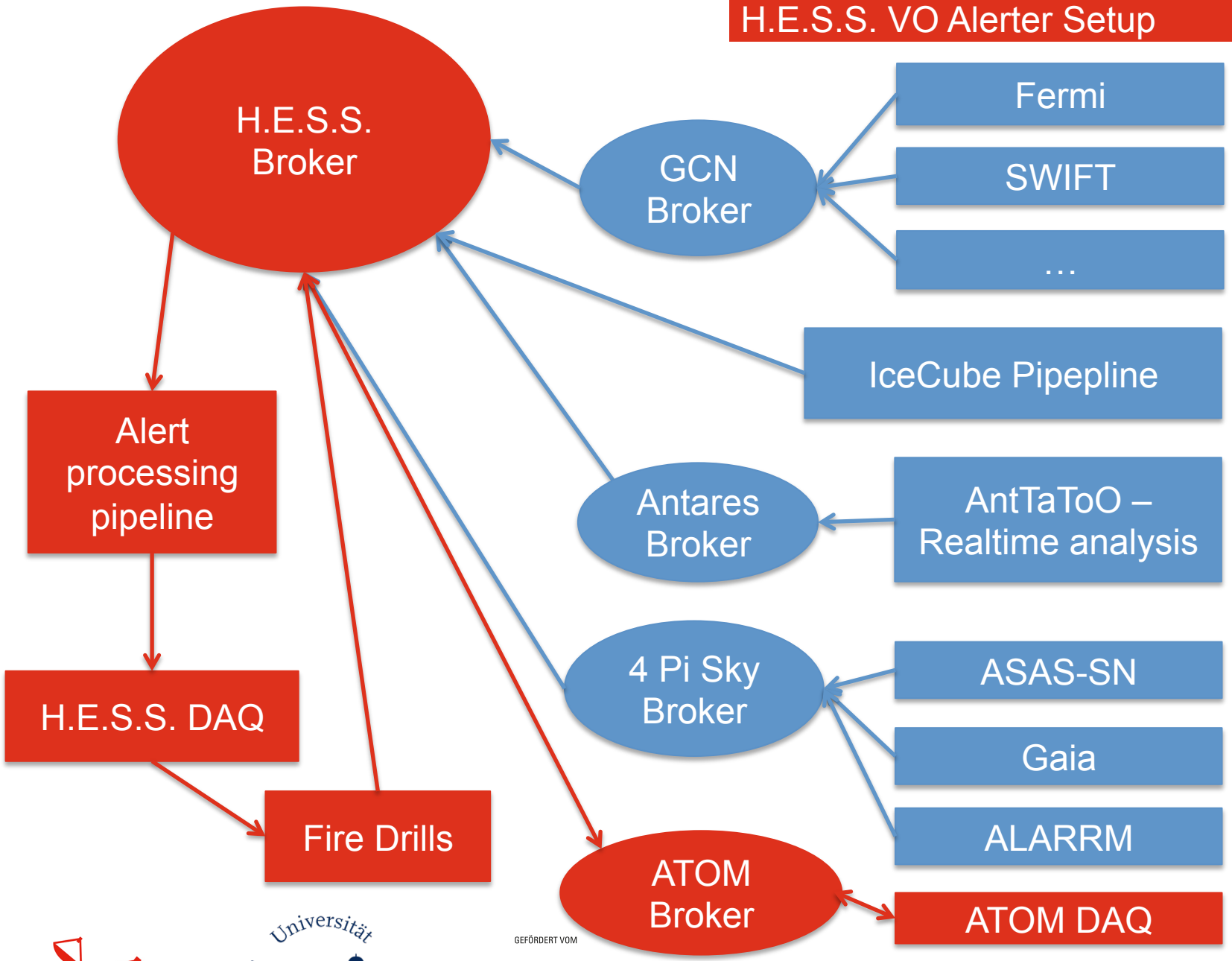
H.E.S.S. VO Alerter Setup



H.E.S.S. VO Alerter Setup



H.E.S.S. VO Alerter Setup



30% of dark time is reserved for target of opportunity observations

Science cases	Messenger	Automated follow-up
AGN Flares	GeV γ-rays, Optical, X-rays	✗
GRBs	X-rays, GeV γ-rays	✔
Neutrinos	ν	✔
SGR/AXP	X-rays	✔
FRBs	radio	(✔) planned
GWs	GWs	✔
HMXBs	X-rays	✗
Flaring stars	X-rays	✗
Near CC SNe	optical	✗

Interesting extension

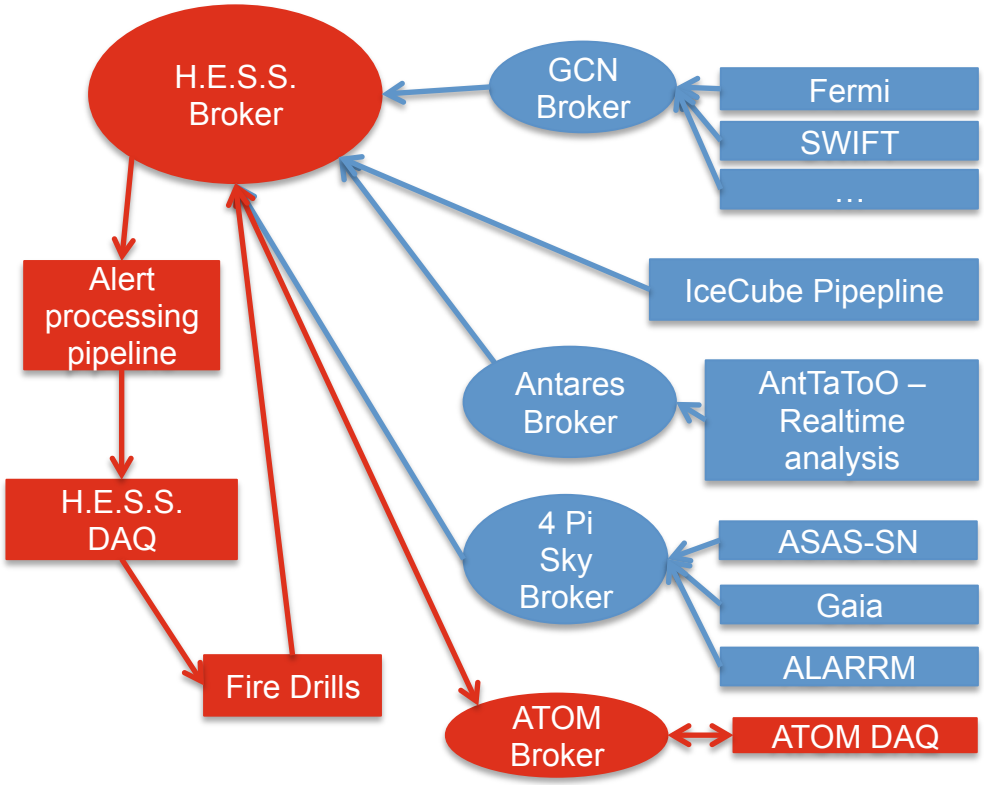
AMON: correlate different messengers with lower alert threshold

Common alert types

Prompt: Position is visible at the moment the alert is received

Afterglow: Position will become visible later

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung



9301 **H.E.S.S. follow-up of IceCube-160731A**

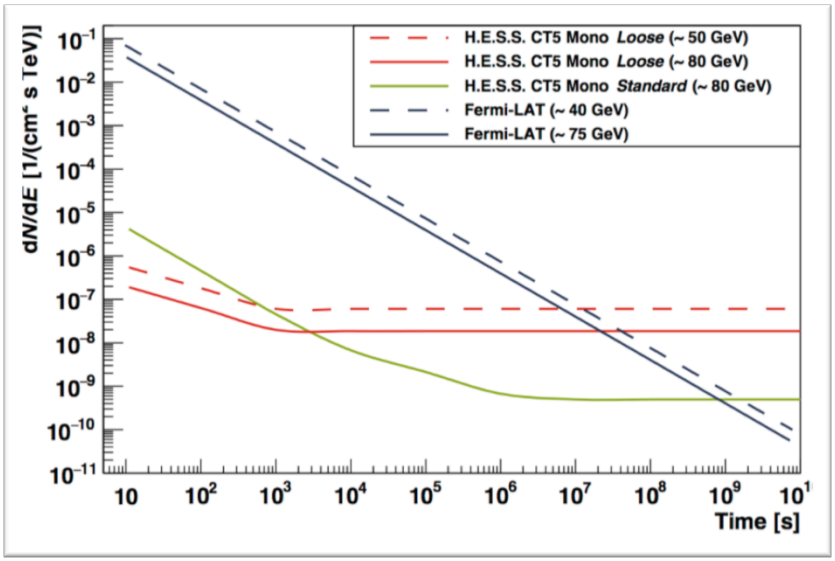
MATHIEU DE NAUROIS FOR THE H. E. S. S. COLLABORATION
2 AUG 2016; 15:57 UT

Expect results from rapid follow-up observations of transients from H.E.S.S. soon!

Summary

Automated systems are the only viable way to perform follow-up observations with spatial + temporal correlation to the astrophysical event.

Sensitivity of pointed observations is desperately needed to learn about the physics of short-lived transients



GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung