



The H.E.S.S. multi-messenger program

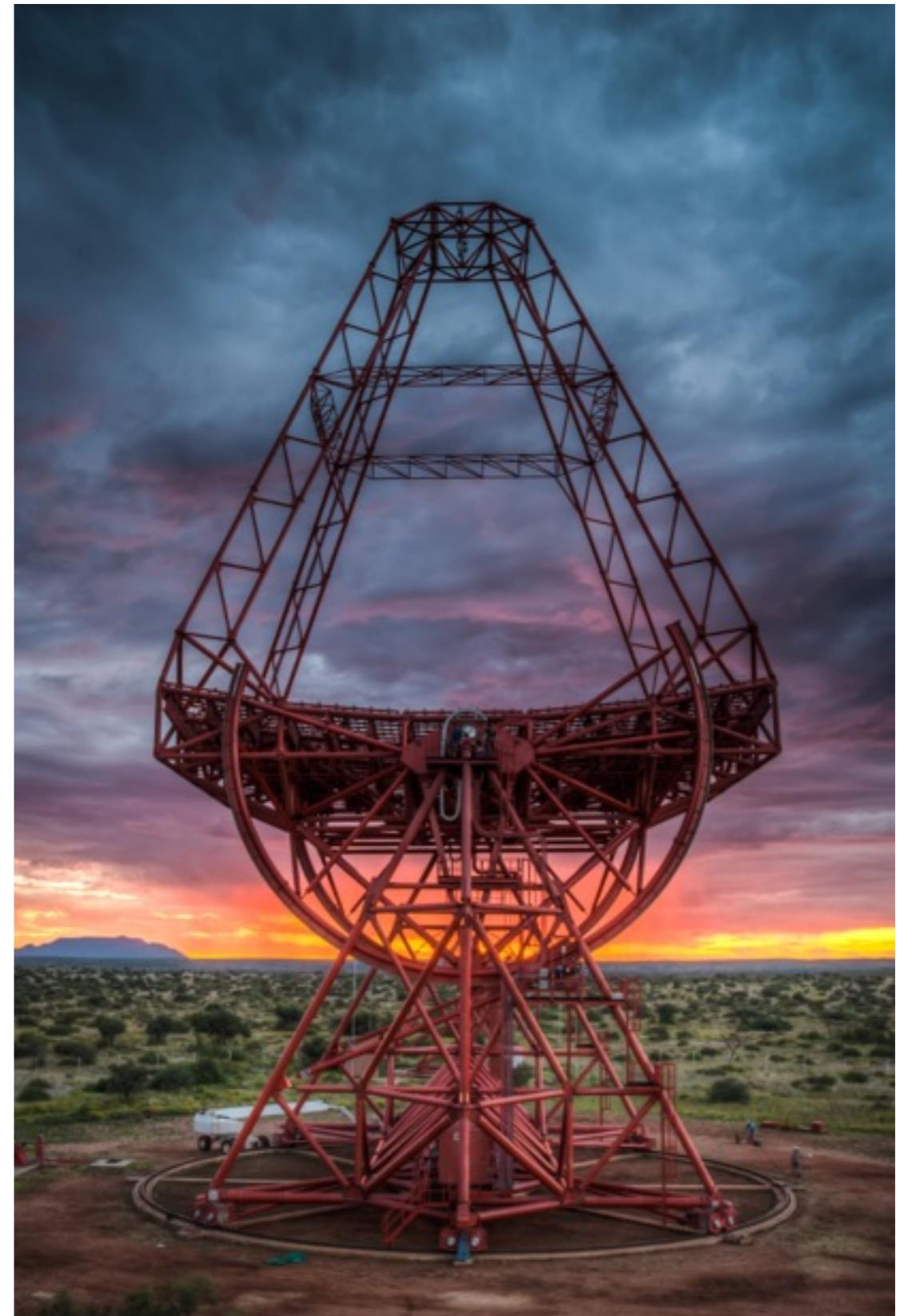


Fabian Schüssler (Irfu/CEA-Saclay)
H.E.S.S. multi-messenger contact

AMON-2014 (Desy-Zeuthen, 2014-12)

Overview

- The H.E.S.S. instrument
 - H.E.S.S.-II
 - ToO follow-up performance
- multi-wavelength program
 - dedicated campaigns
 - ToOs (e.g. GRBs)
- multi-messenger program
 - Neutrinos
 - IceCube HESE events
 - ToOs
 - Gravitational waves



The H.E.S.S. experiment



H.E.S.S. phase I

- four 12m telescopes
- FoV 5deg
- energy threshold ~100GeV
- angular resolution <0.1deg

H.E.S.S. phase II

- four 12m telescopes
- one 28m telescope (FoV 3.5deg)
- energy threshold ~30GeV
- angular resolution from 0.4 to less than 0.1deg

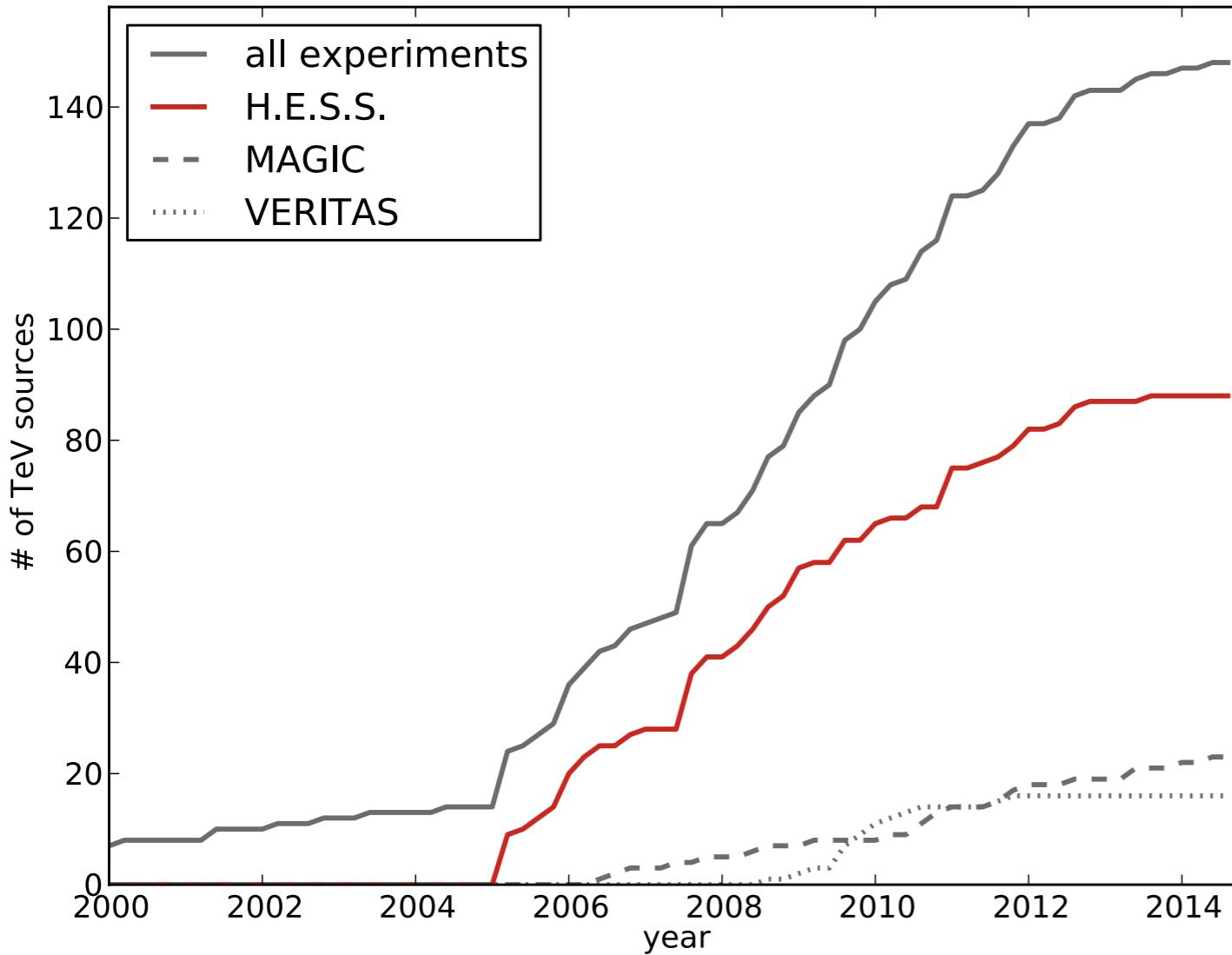
2012

H.E.S.S. phase I

H.E.S.S. phase II



The H.E.S.S. experiment

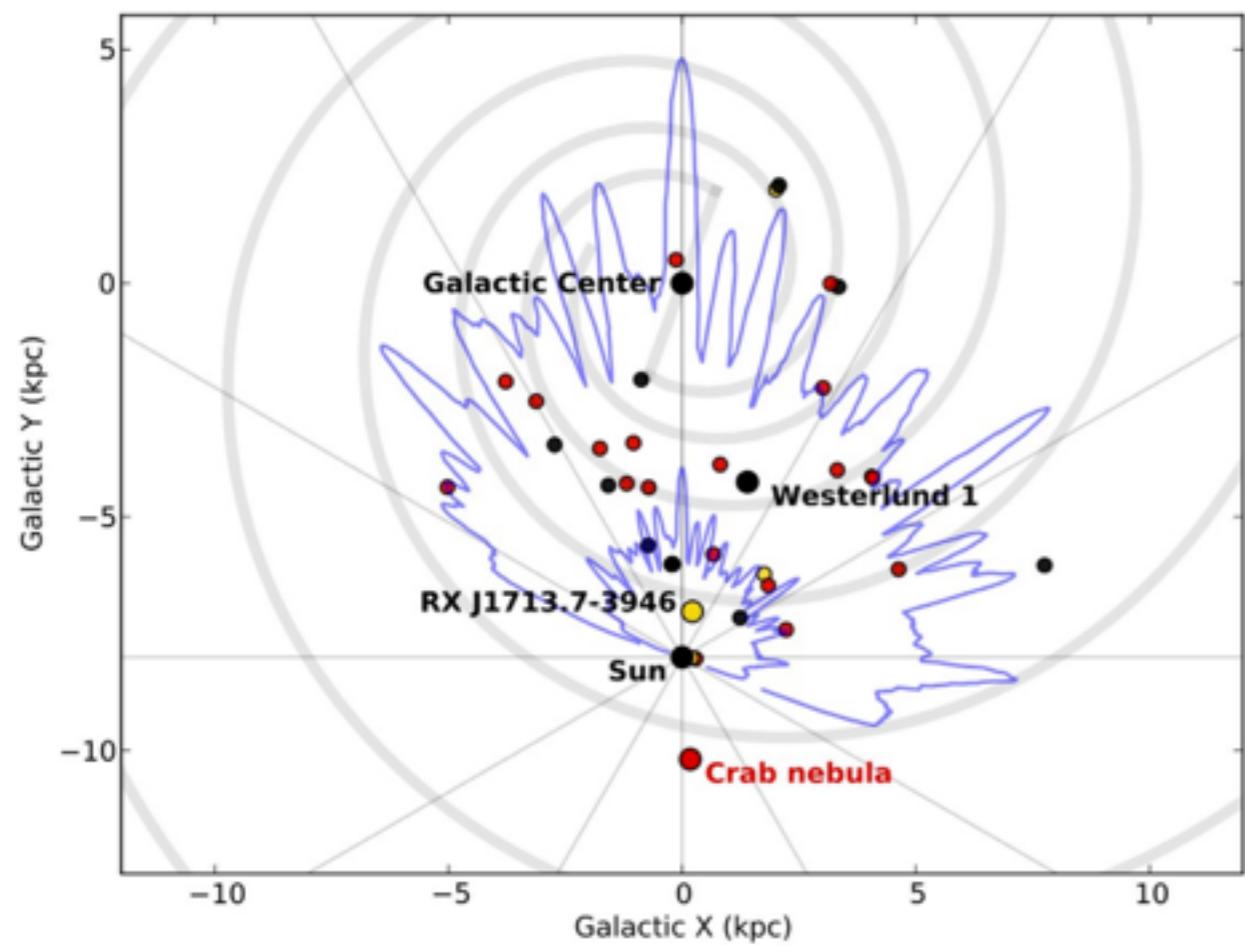


- **H.E.S.S. phase I**
 - more than 10.000 hours of data
 - discovered over 80 new VHE gamma ray sources
- **H.E.S.S. phase II**
 - lower energy threshold (e.g. overlap with Fermi-LAT)
 - rapid response to transients

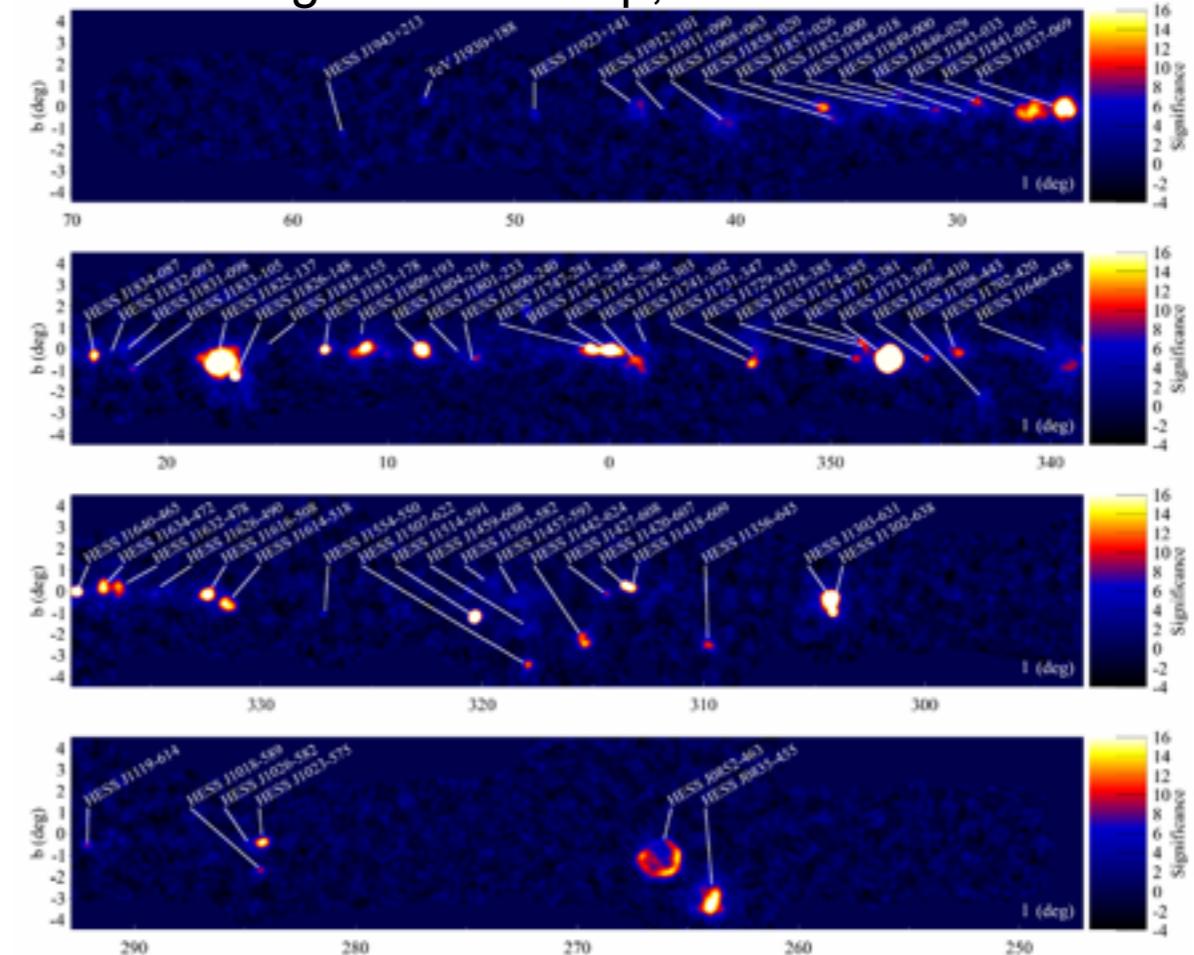
The H.E.S.S. Galactic Plane Survey

- H.E.S.S. phase I
- ~2800h of high-quality data

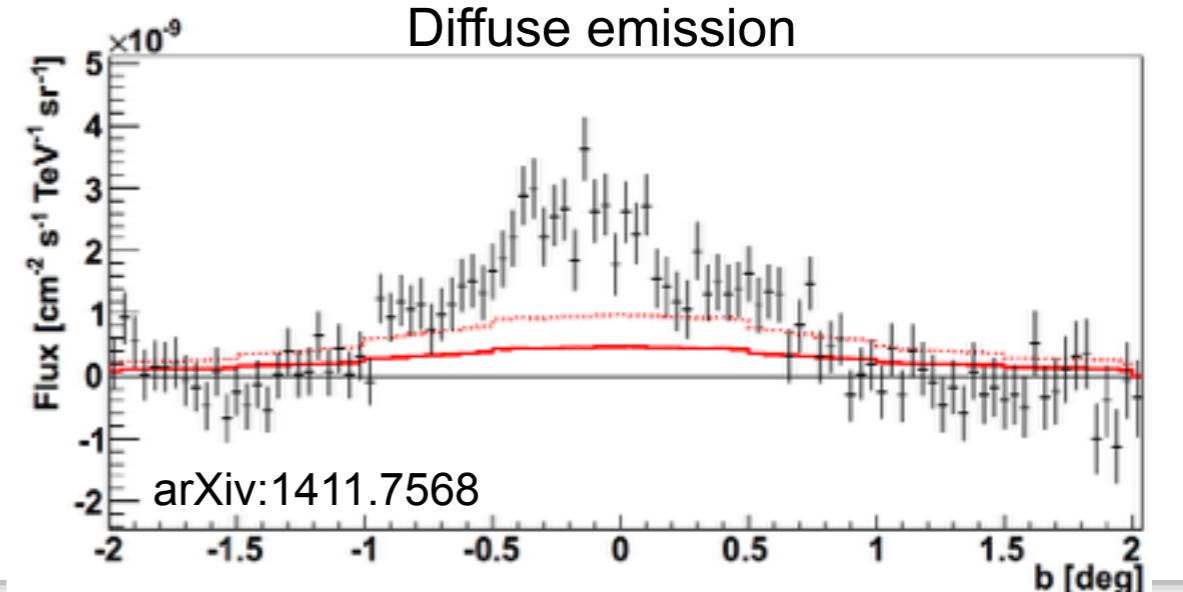
H.E.S.S. horizon for 1% and 10% Crab sources



Pre-trial significance map, correlation radius 0.1°

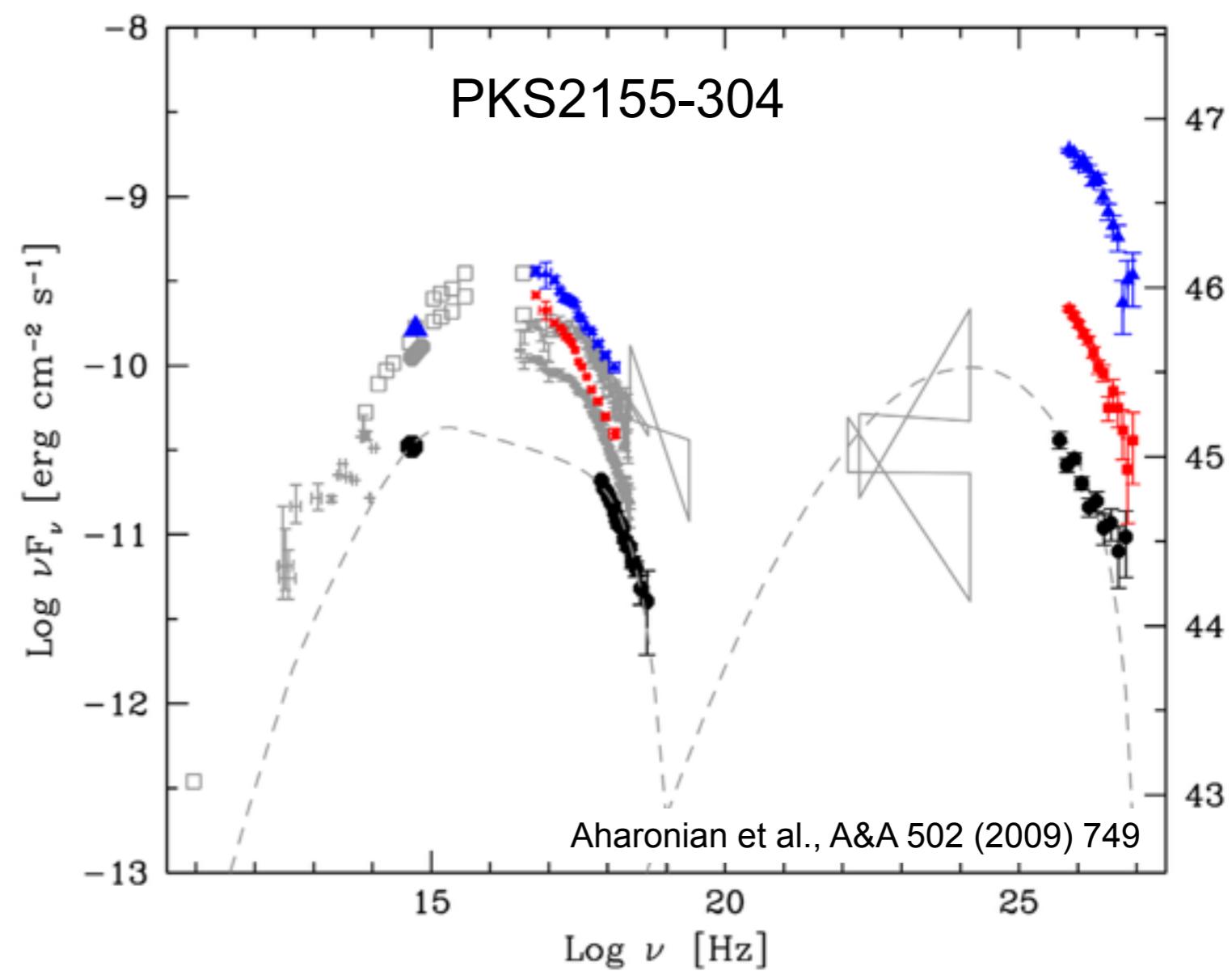


Diffuse emission



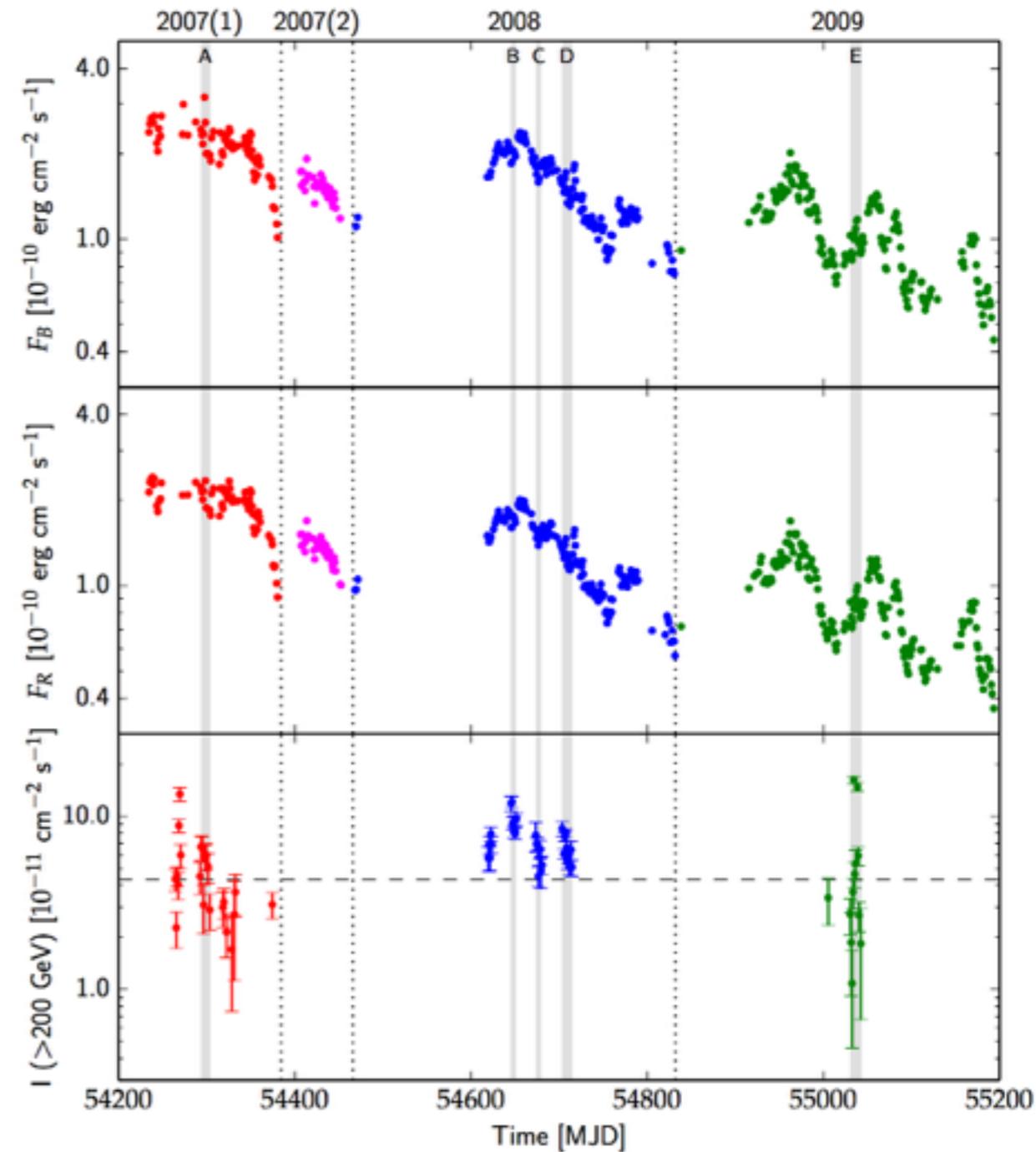
Multi-wavelength program

- (contemporaneous) multi-wavelength coverage essential for most physics analysis
- typical ways to get there
 - response to Call for Proposals
 - joint MWL campaigns
 - MoUs
 - external proposals to H.E.S.S.
- H.E.S.S.- MWL support group
 - contact: Gerd Pühlhofer
 - topical sub-conveners



Multi-wavelength program, a few examples (I)

- ATOM (Hauser et al. Astron. Nach. 325 (2004) 659)
 - 75cm optical, automatic telescope on the H.E.S.S. site
 - 4 bands: B (440 nm), V (550 nm), R (640 nm) and I (790 nm)
 - contemporaneous observations with H.E.S.S.
 - long-term monitoring program



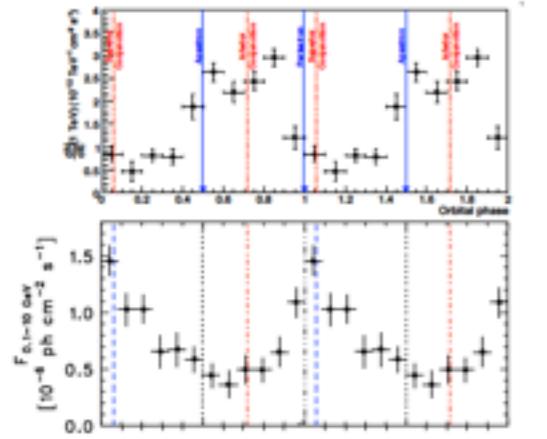
Abramowski et al., A&A 571, A39 (2014)



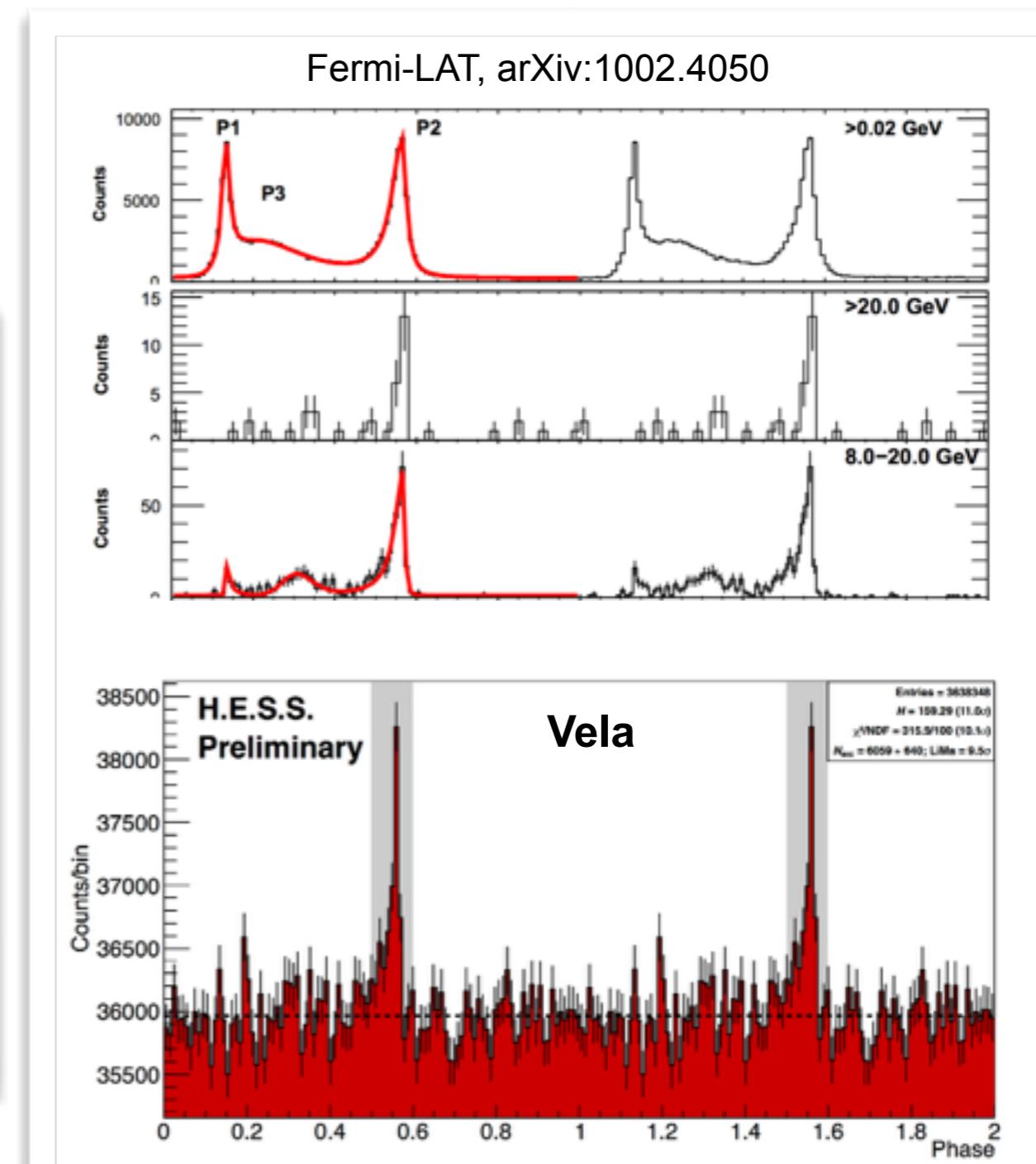
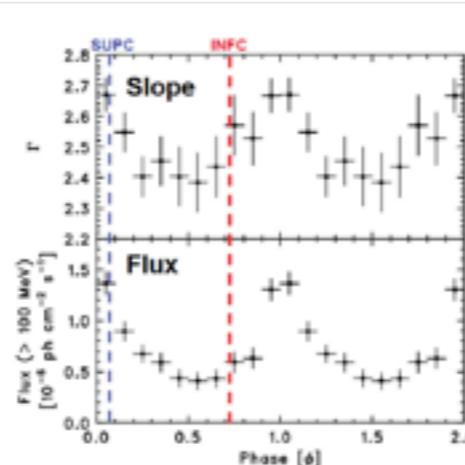
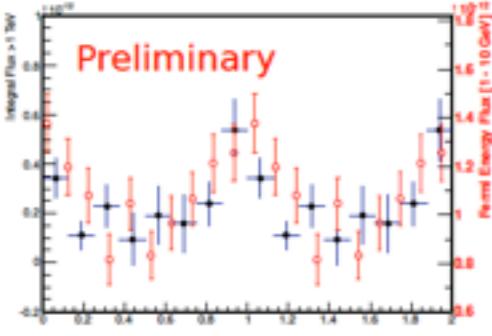
Multi-wavelength program, a few examples (II)

- GeV-TeV connection very important
 - e.g. variable systems

LS 5039

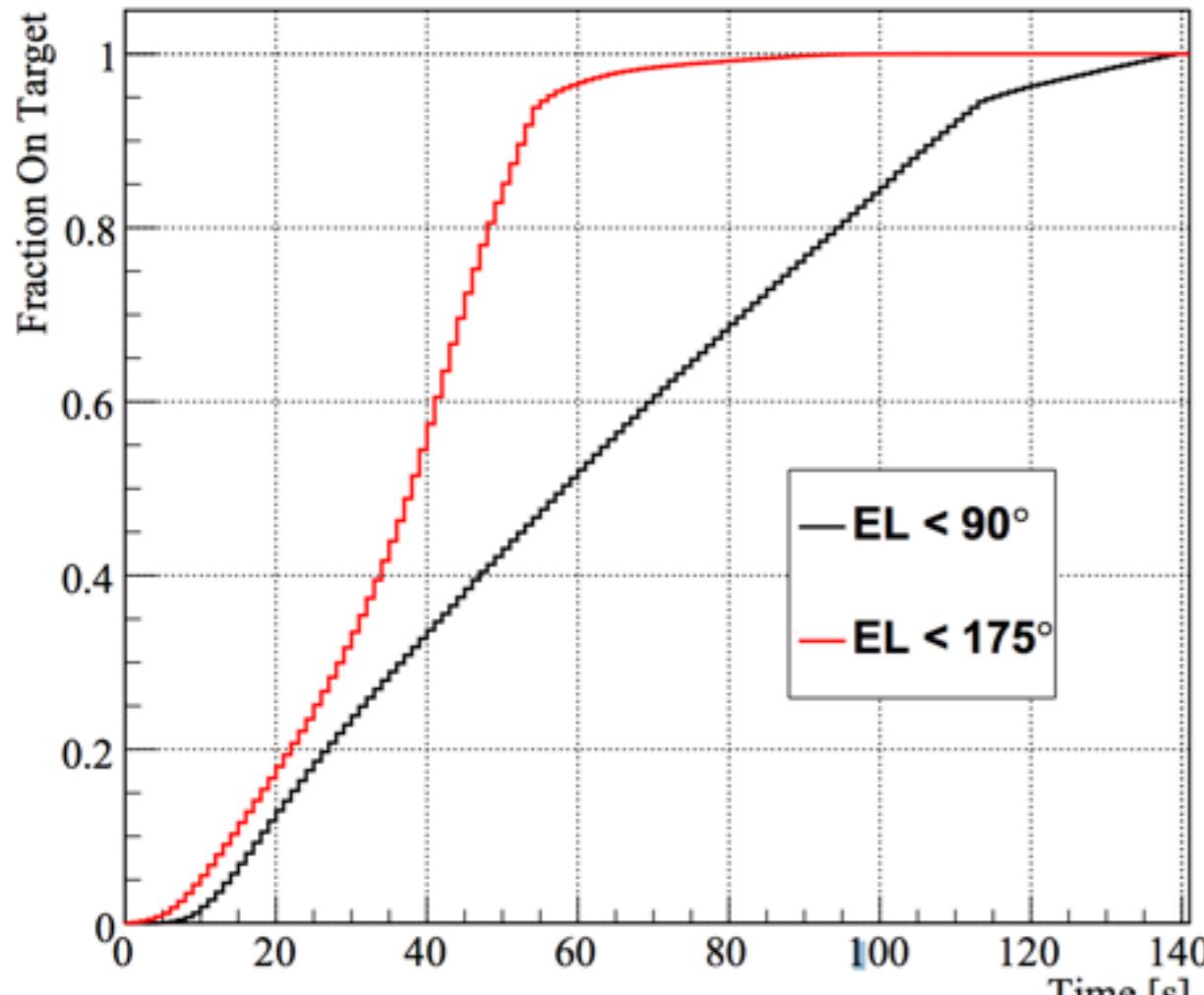


1FGL J1018



H.E.S.S. II: ToO follow-up performance

- main design principles of the H.E.S.S. 28m telescope
 - large photon collection area → 614 m² mirror area (largest IACT worldwide)
 - **rapid response time**

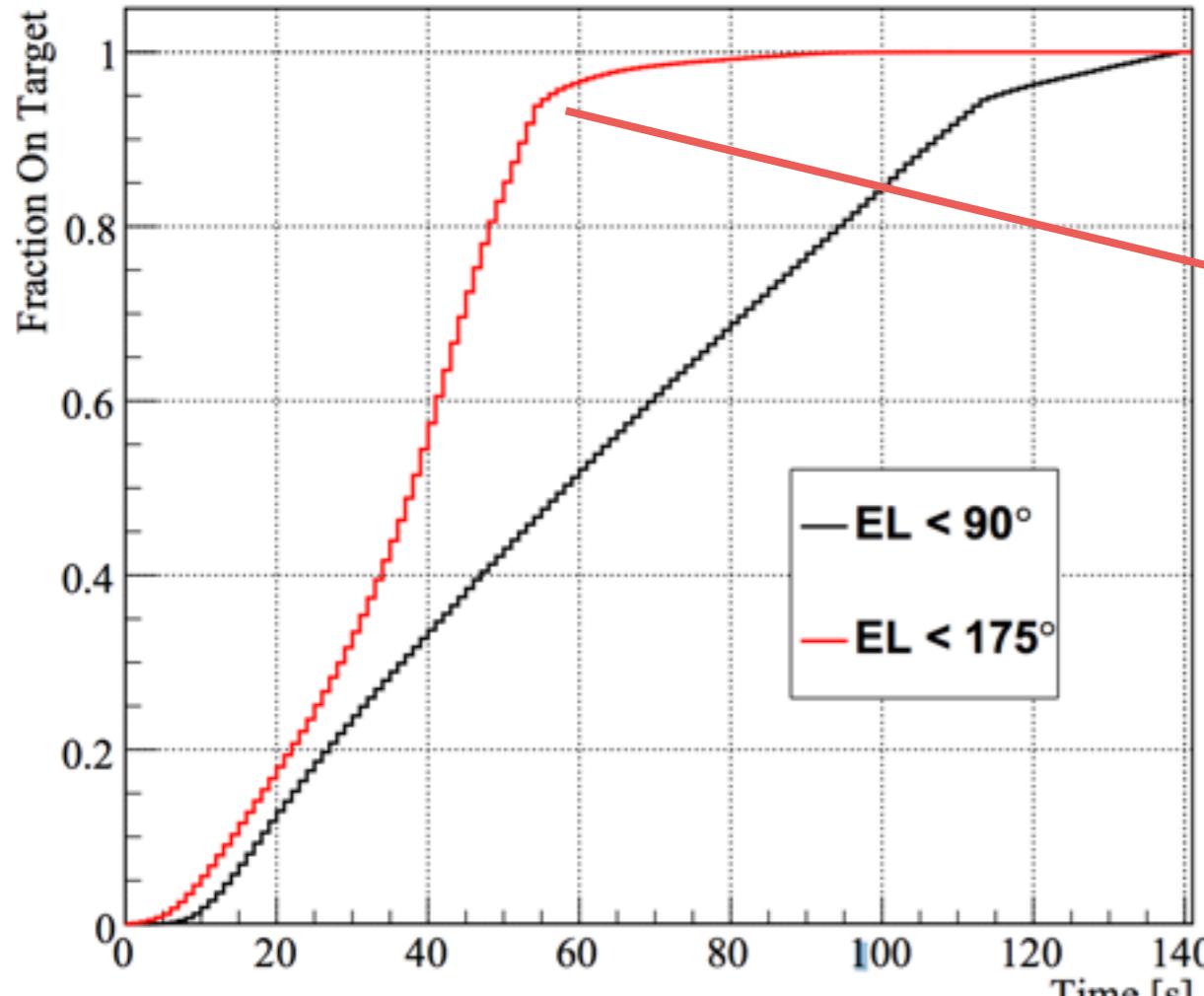


Hofverberg et al., ICRC 2013

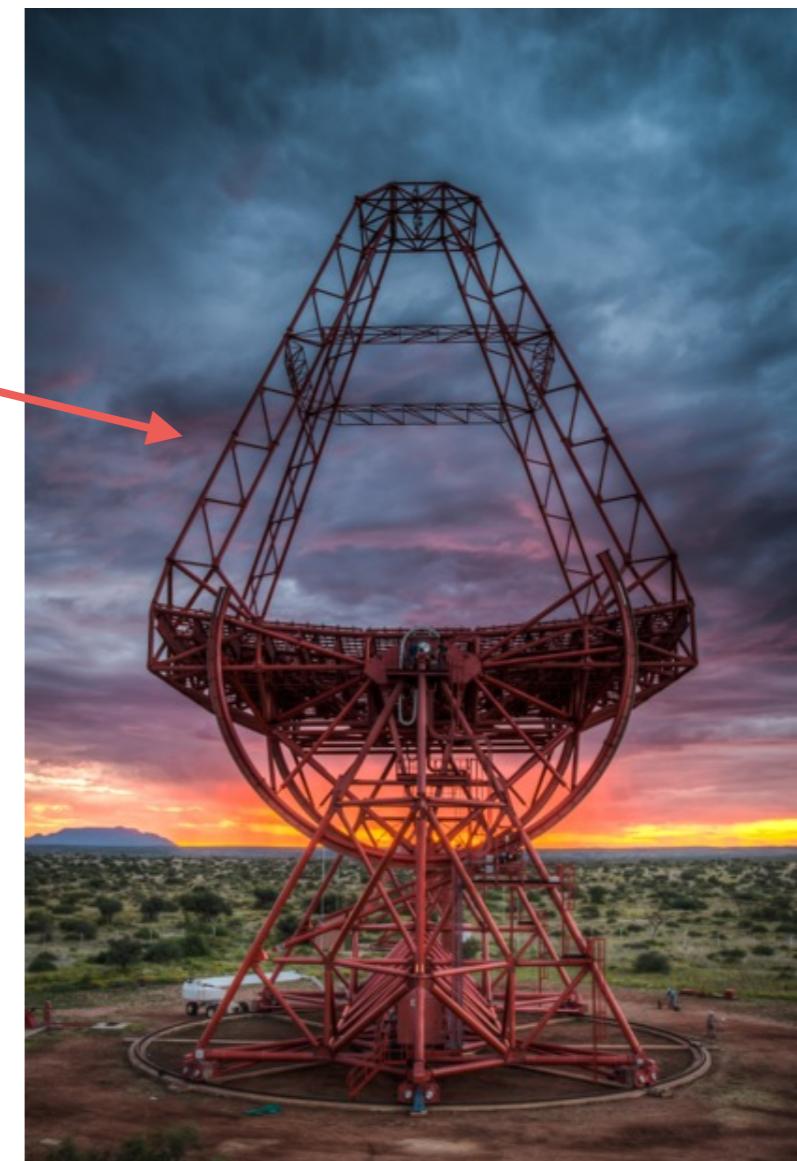


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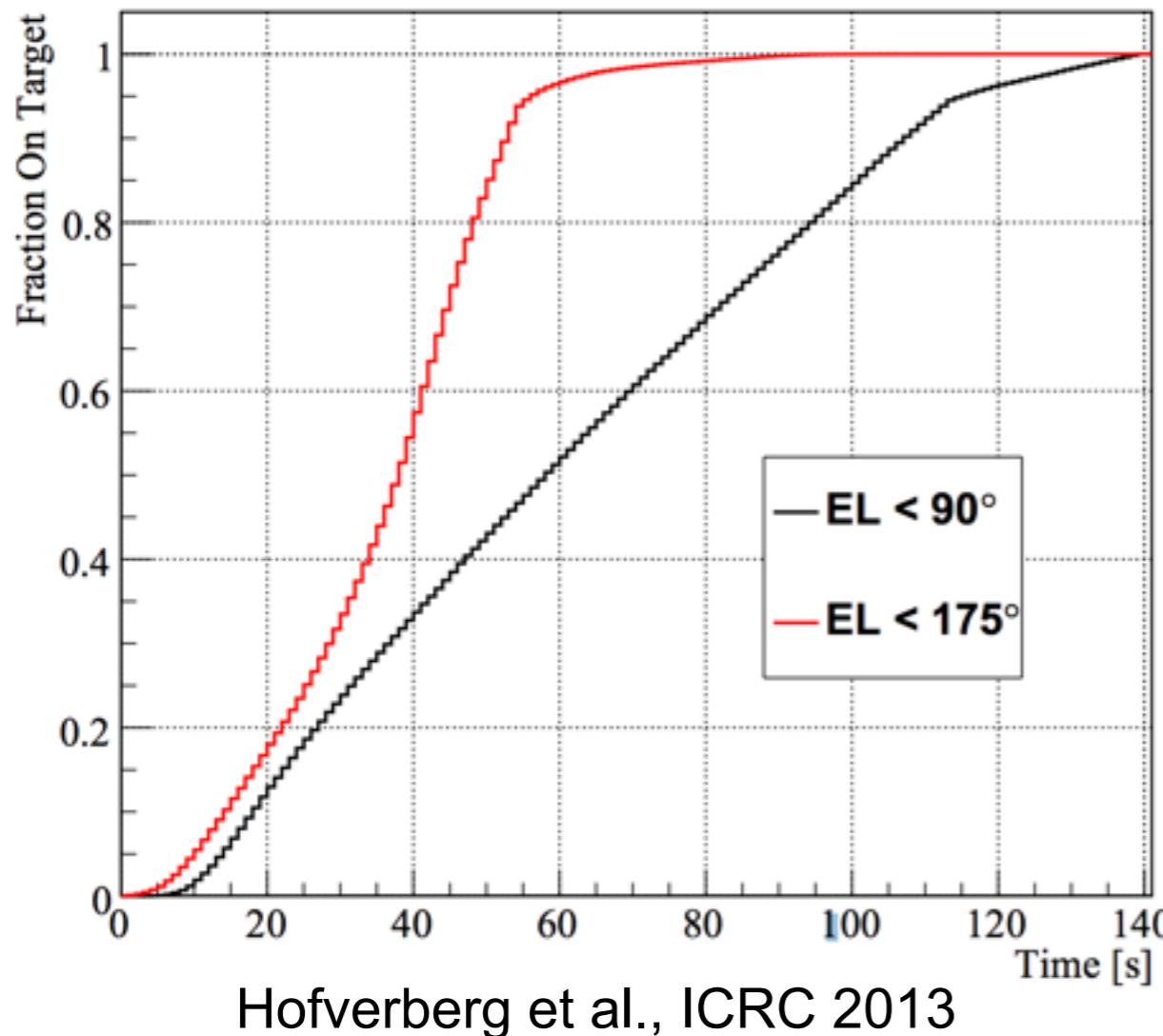


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Hofverberg et al., ICRC 2013

- ToO+DAQ re-organization in 2014
 - significant reducing overhead
 - software overhead now: O(s)
 - CTA requirement: <10s
- response time only limited by hardware
 - slewing: O(60s)
 - HV ramping: O(s)
 - Camera configuration: O(s)

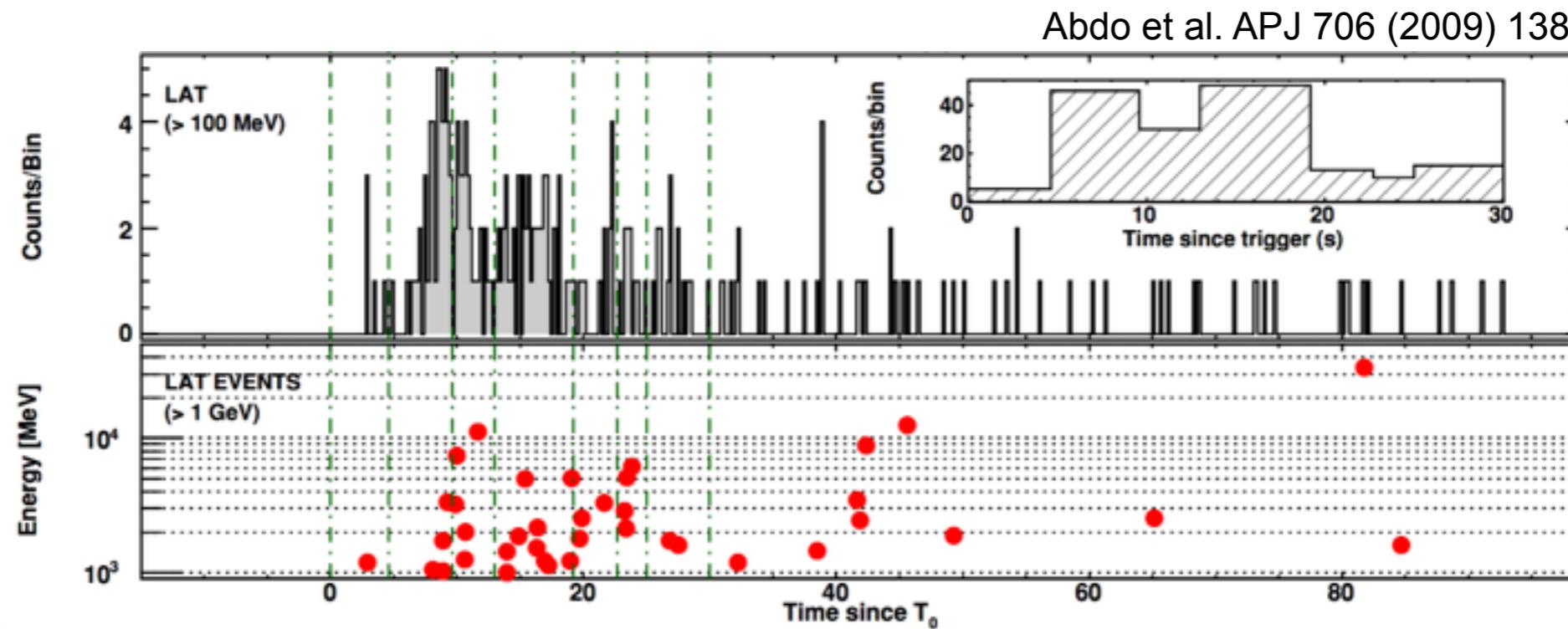
VoEvent alert system
commissioning in 2015



Multi-wavelength program, a few examples (III)

■ GRBs

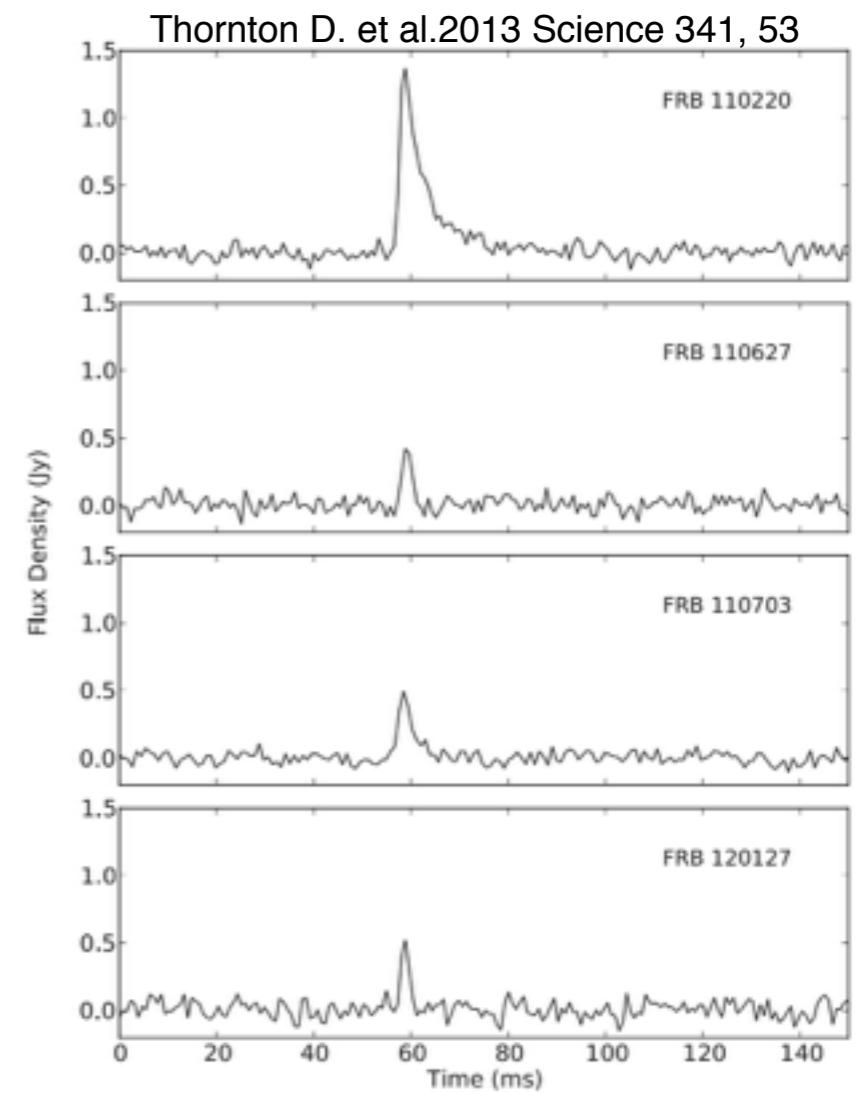
- extensive follow-up program during H.E.S.S. phase I (e.g. A&A 495, 505-512 (2009))
- follow-up rapidity increased with H.E.S.S. II
 - rapid slewing speed
 - re-organisation of the DAQ (e.g. data taking starts as soon as source enters the FoV)
 - fully automatic repositioning after the reception of a GCN alert
- GRBs have highest ToO priority (following all accessible alerts)
- dedicated data blinding scheme in place



Multi-wavelength program, a few examples (IV)

■ Fast radio burst (FRBs)

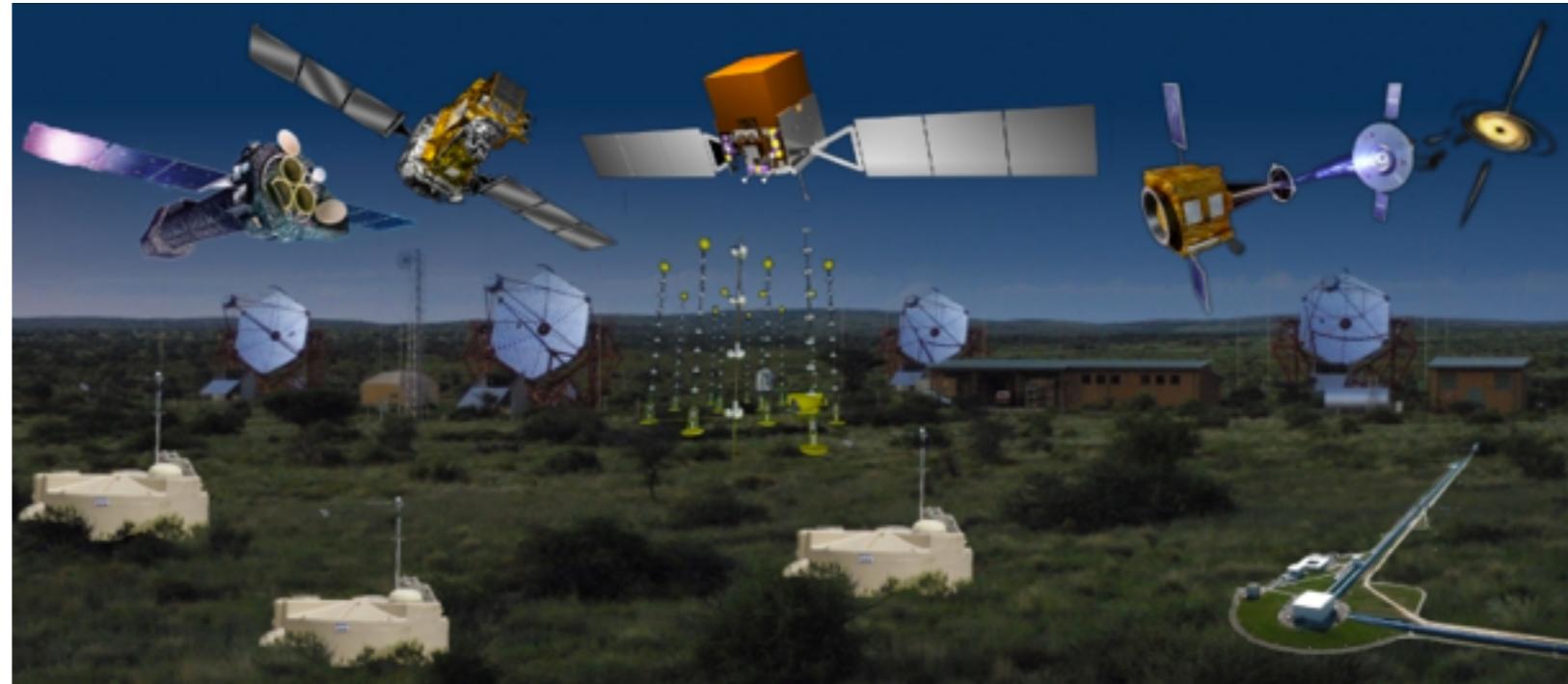
- extremely strong radio burst of possibly extragalactic origin
- H.E.S.S. takes part in the SUPERB project @ Parkes
- alert exchange currently via e-mail



Multi-messenger program

- Cosmic rays
 - raison d'être
 - no time correlation (except neutrons): waiting for a localized excess ;-)
- Gravitational waves
 - increasing interest (Advanced Virgo/Ligo)
 - H.E.S.S. signed the Virgo/Ligo EM follow-up MoU
 - follow-up difficult due to large pointing uncertainties
 - important input from additional EM detection
- Neutrinos
 - ROIs
 - neutrino hotspots
 - IceCube HESE events
 - ToOs
- AMON ?

VoEvent alert system
commissioning in 2015



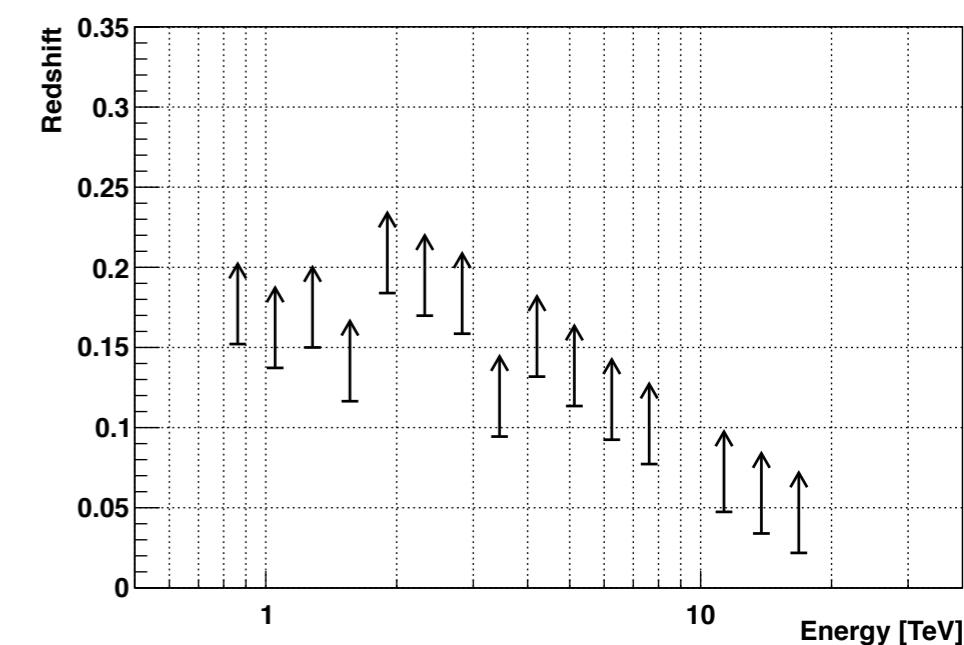
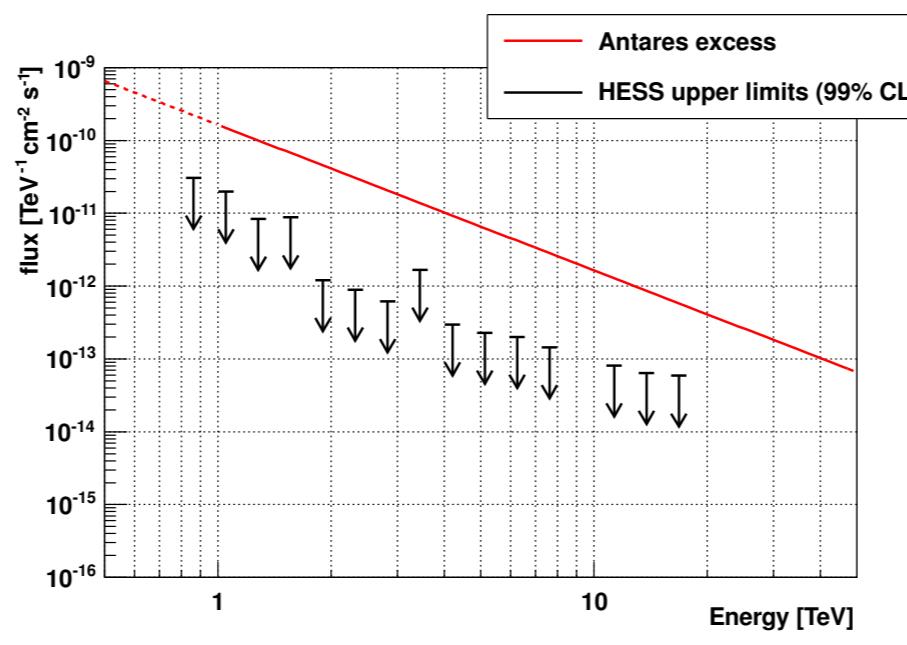
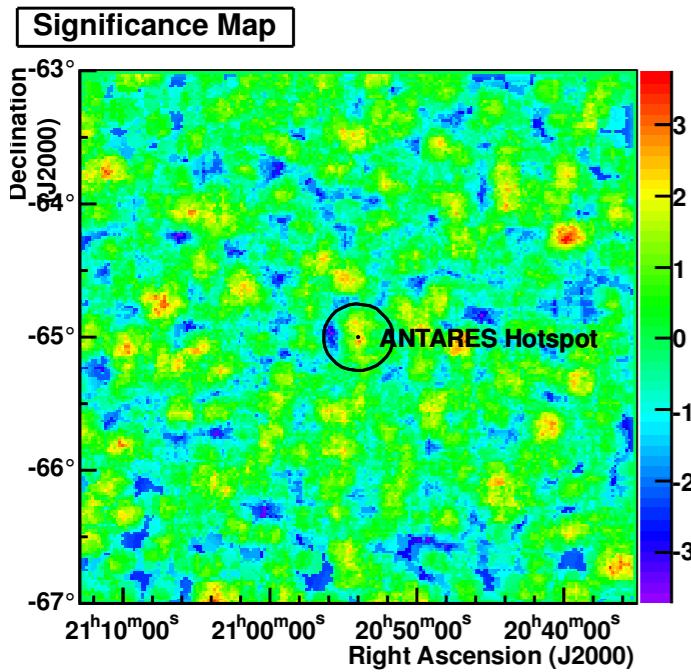
Multi-messenger program: Neutrino hotspots

■ IC-22 hotspot

- IC-22 analysis: 2.2σ excess (arXiv:0811.4110)
- H.E.S.S. observations (E. Resconi et al.) hampered by bad weather
- excess gone in IceCube follow-up analyses

■ Antares hotspot

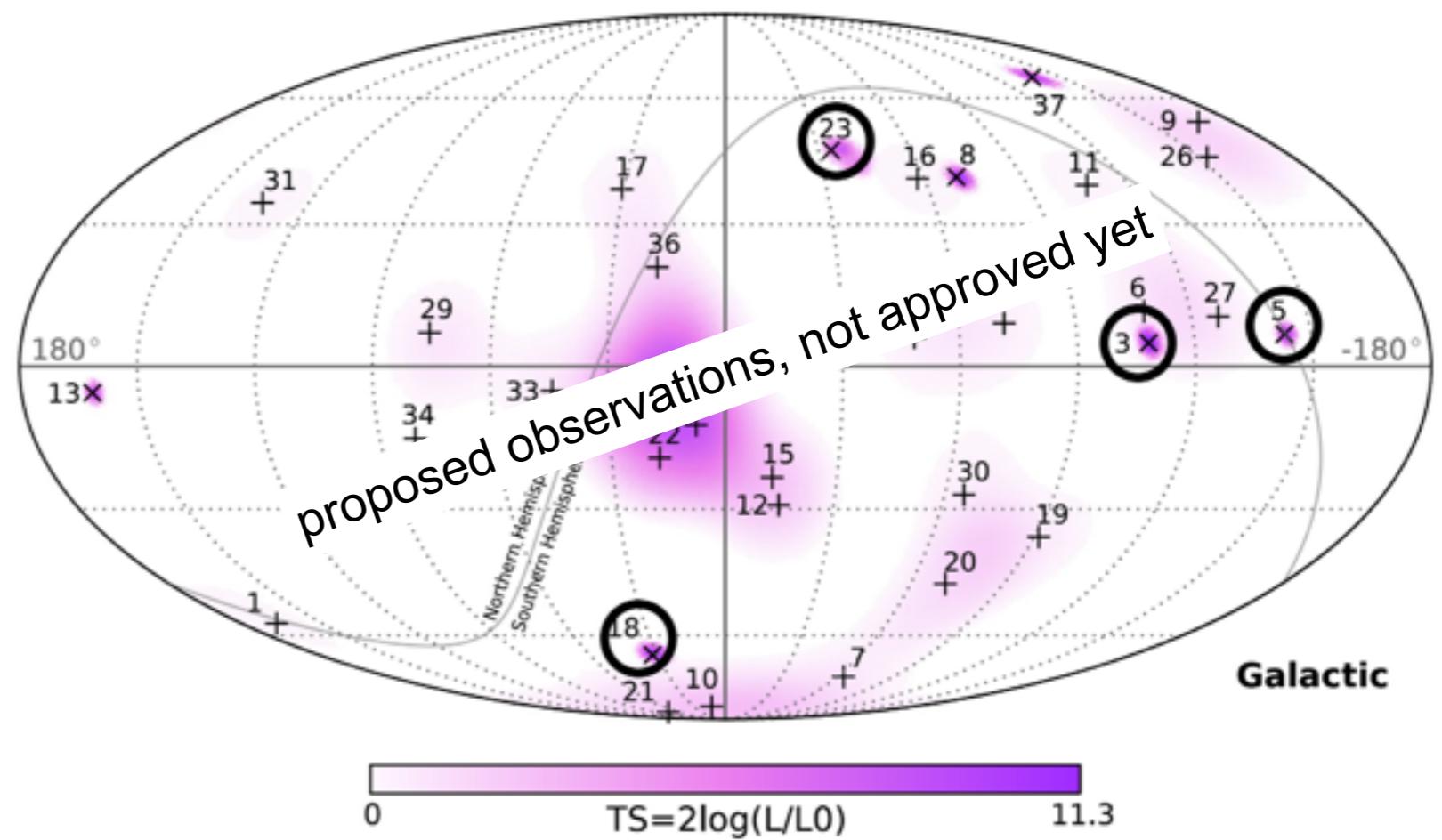
- 2.2σ excess (Adrian-Martinez et al., APJ 760 (2012) 53)
- 2h of H.E.S.S. observations in 2013 ruling out close-by source



FS, ICRC 2013, arXiv:1307.6074

Multi-messenger program: IceCube HESE tracks

- 2014
 - H.E.S.S. observations of 2 HESE events
 - analysis in progress
- 2015
 - joint IceCube-H.E.S.S. observation proposal
 - aim: start of a mid/long-term program on HE neutrino events



Multi-messenger program: Neutrino alerts

- IceCube

- similar to gamma-ray follow-up already in place with MAGIC/Veritas
 - Southern Sky
 - potentially without pre-defined source list
- final aim: real-time alerts on HE/HESE events
- in discussion/preparation

- ANTARES

- online reconstruction and rapid alert emission: TAToO (Ageron et al., APP 35 (2012) 530)
- using the upcoming VoEvent alert system: no human in the loop; expected delays <1min
- joint proposal to H.E.S.S.: first alerts in 2015



Summary

- Multi-wavelength context plays a fundamental role
 - follow-up for source identification (e.g. HESS J1713-347)
 - contemporaneous observations
- H.E.S.S. phase II: lower energy threshold and rapid response
 - overlap with Fermi-LAT (e.g. pulsars)
 - GRBs
 - FRBs
- Multi-messenger
 - currently focused on neutrinos
 - hotspots/HE/HESE source searches
 - ToOs programs starting
- AMON ?