

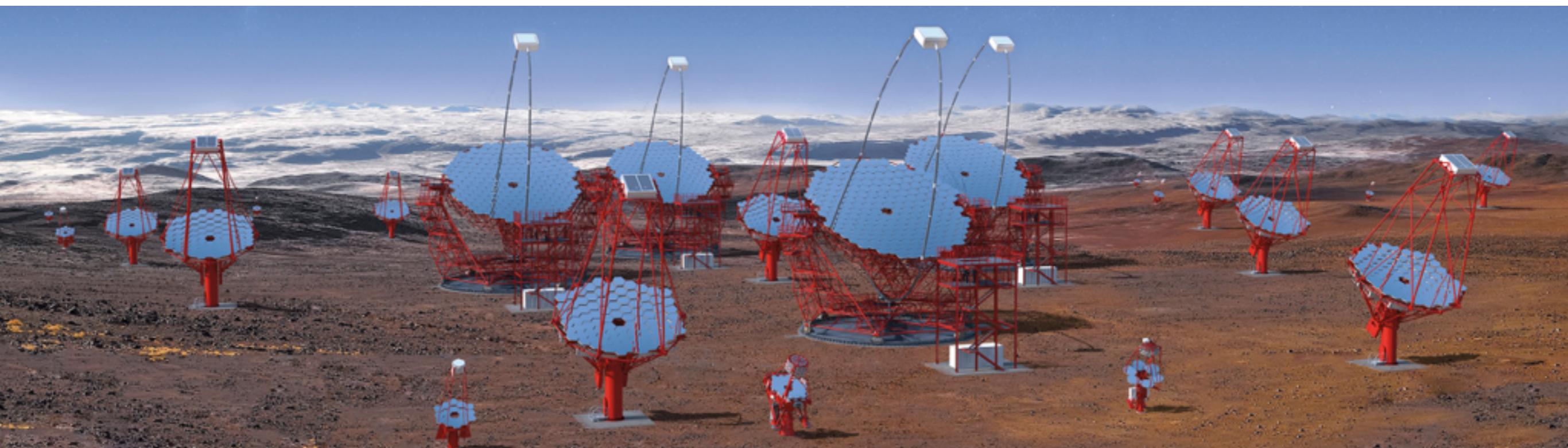


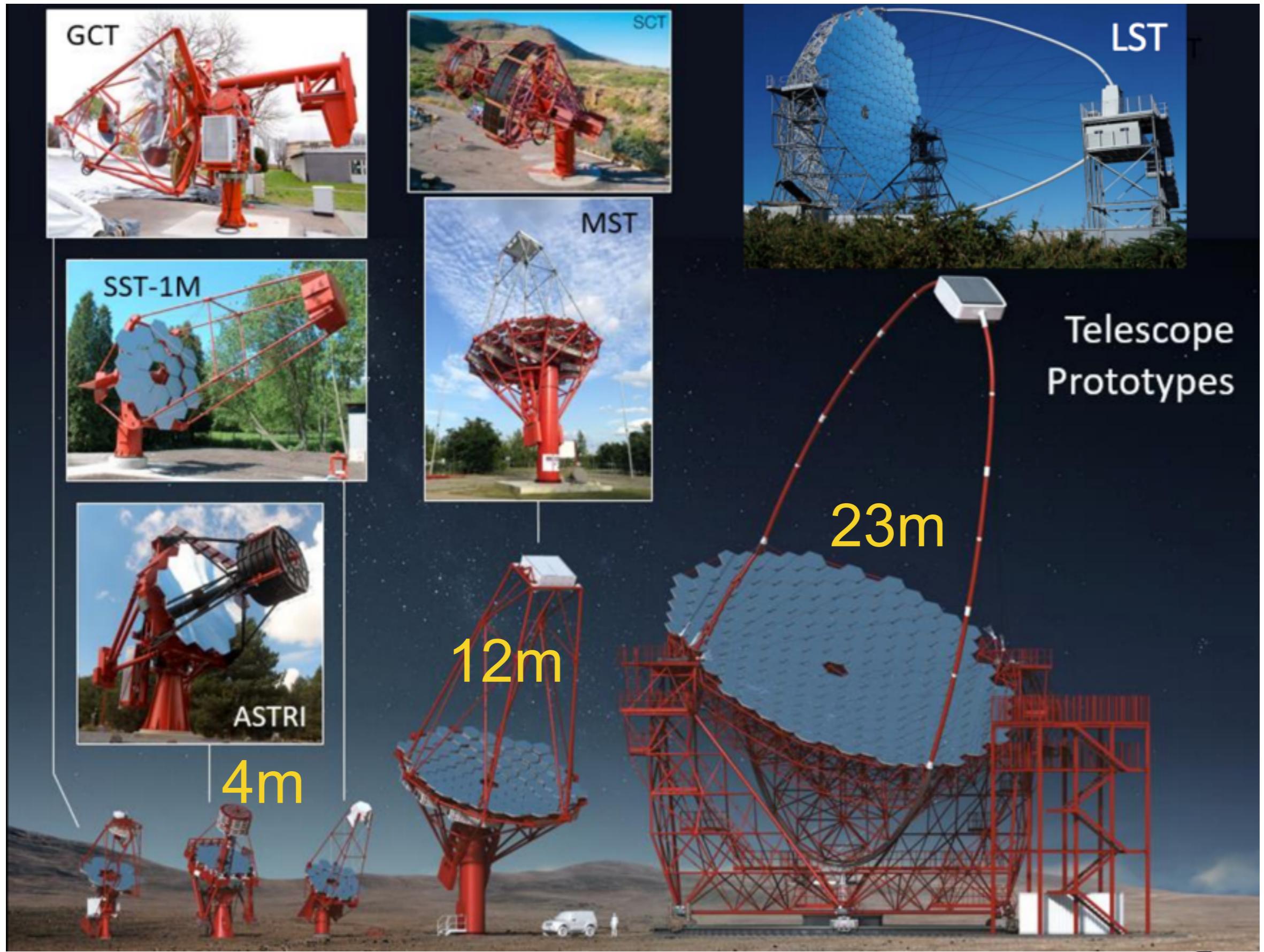
The Cherenkov Telescope Array

Synergies with THESEUS

Fabian Schüssler

IRFU / CEA Paris-Saclay



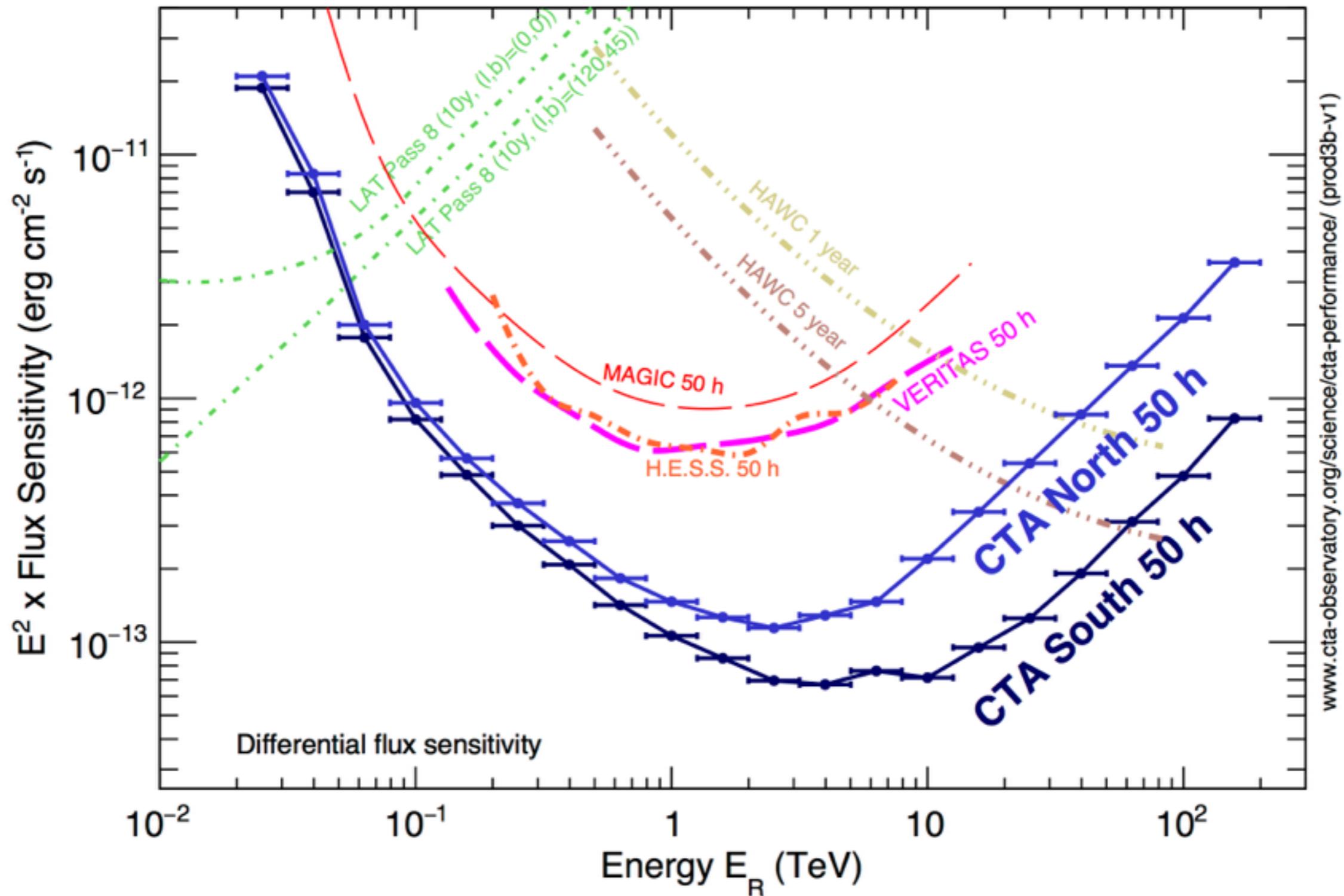


Cherenkov Telescope Array (CTA)

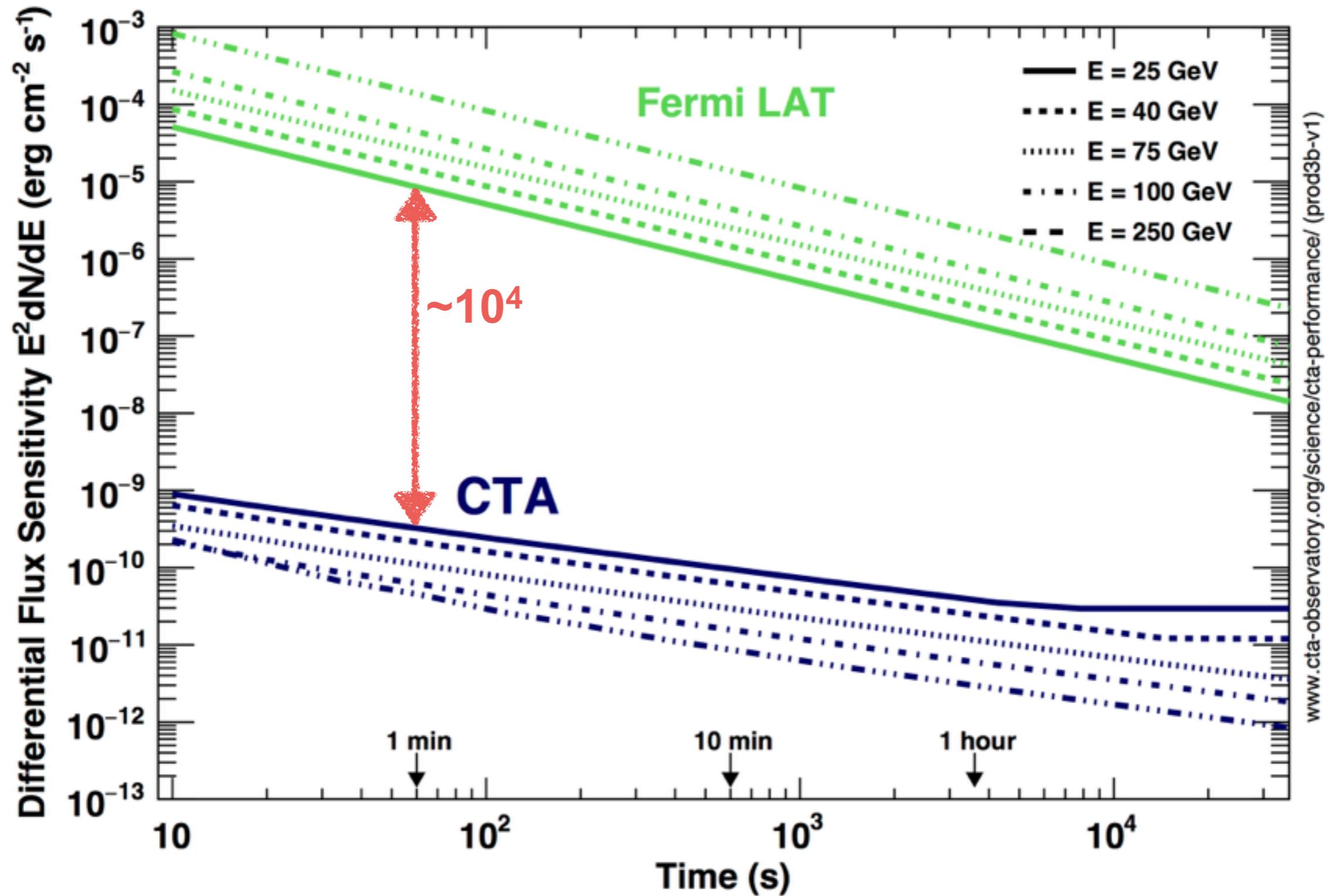
- A global project: one site on each hemisphere + headquarters + science data management center

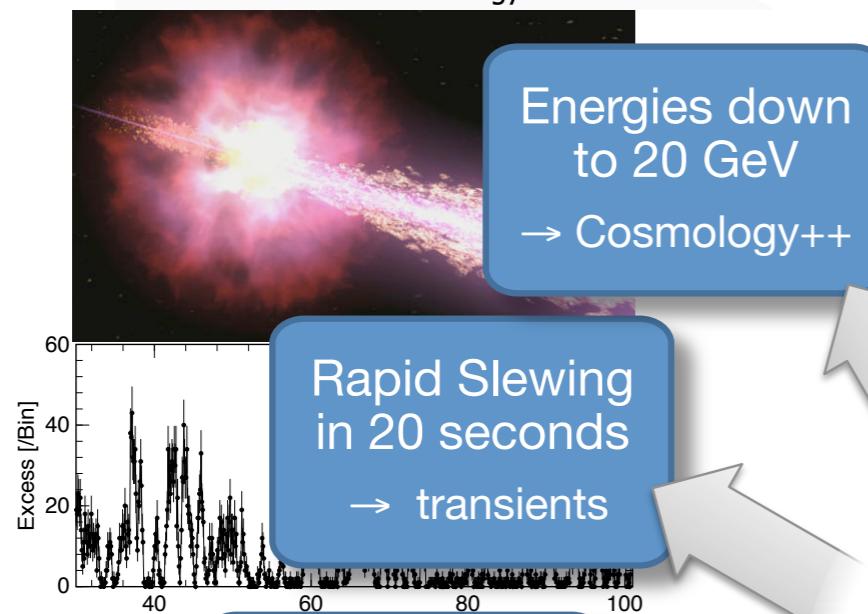
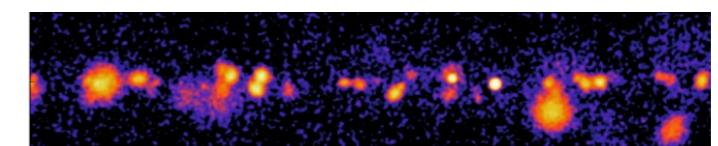
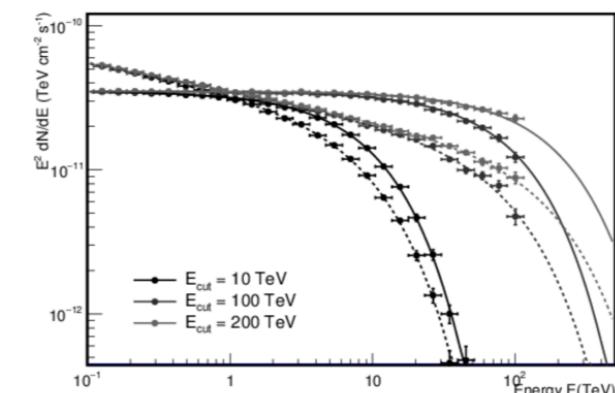
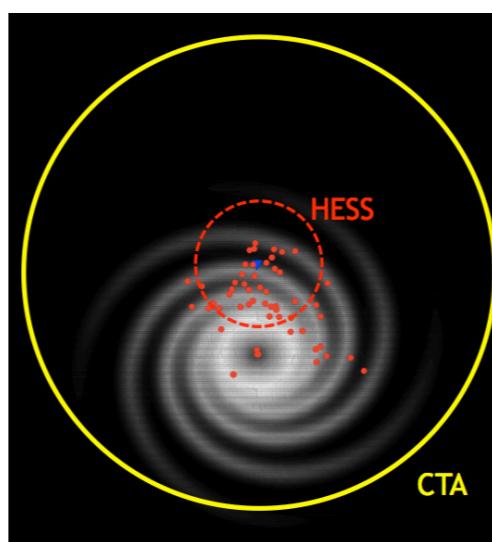
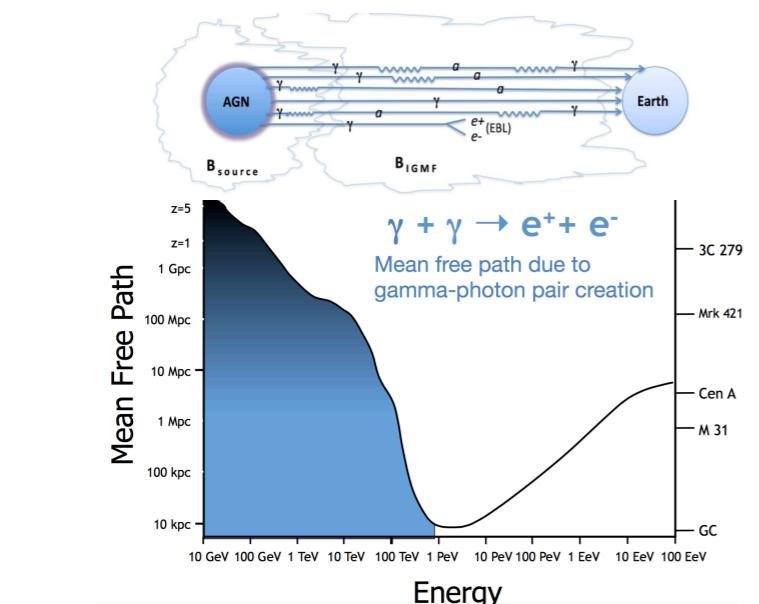


Sensitivity



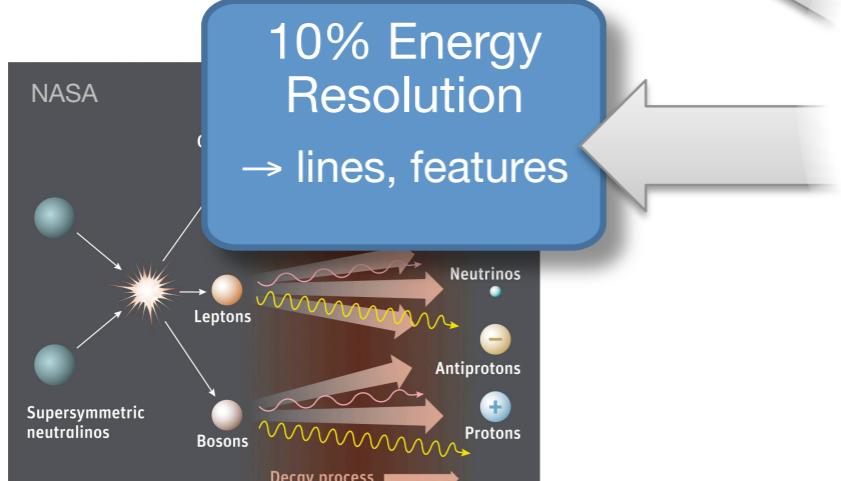
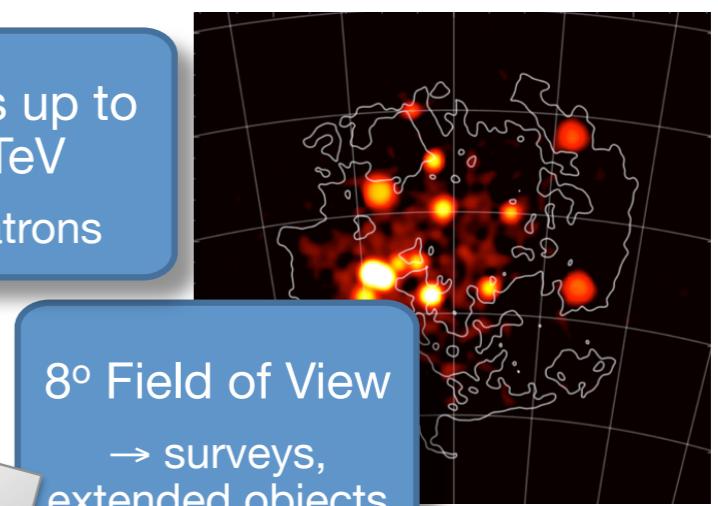
Sensitivity to transient emission



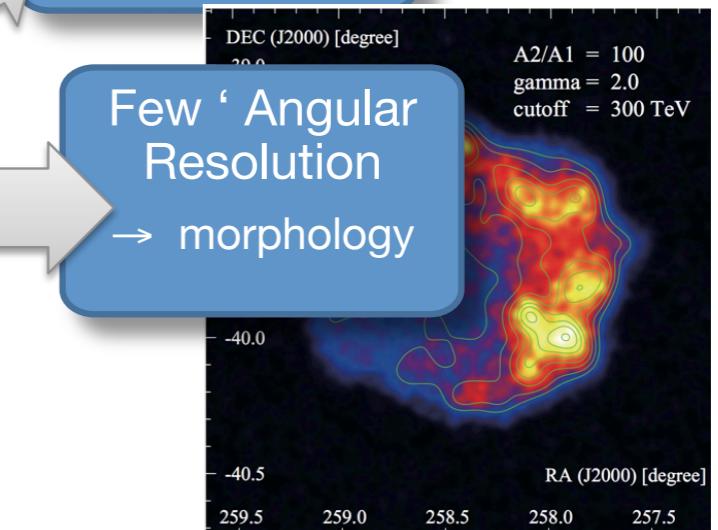


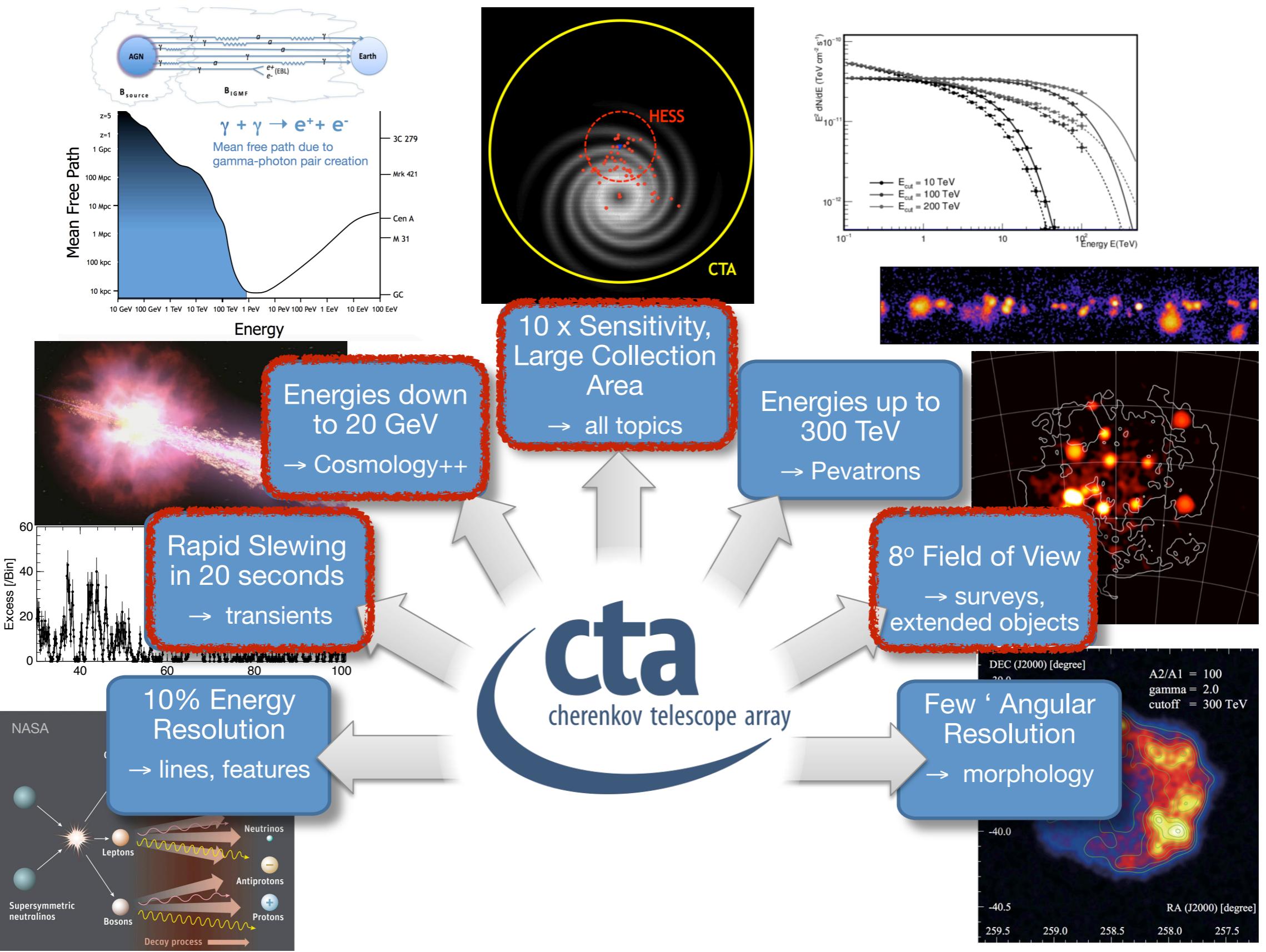
10 x Sensitivity,
Large Collection
Area
→ all topics

Energies up to
300 TeV
→ Pevatrons



cta
cherenkov telescope array



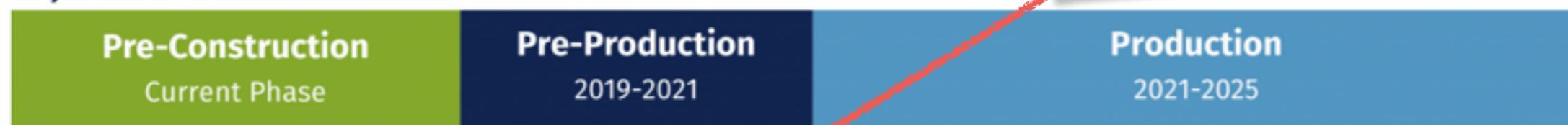


Status of CTA



Sarah A. Bonds, 2018

Project Phases



Status of CTA

Project Phases

Pre-Construction

Current Phase

Current Phase



CTA Offices Open in Bologna

Q1 2017

Q3 2017

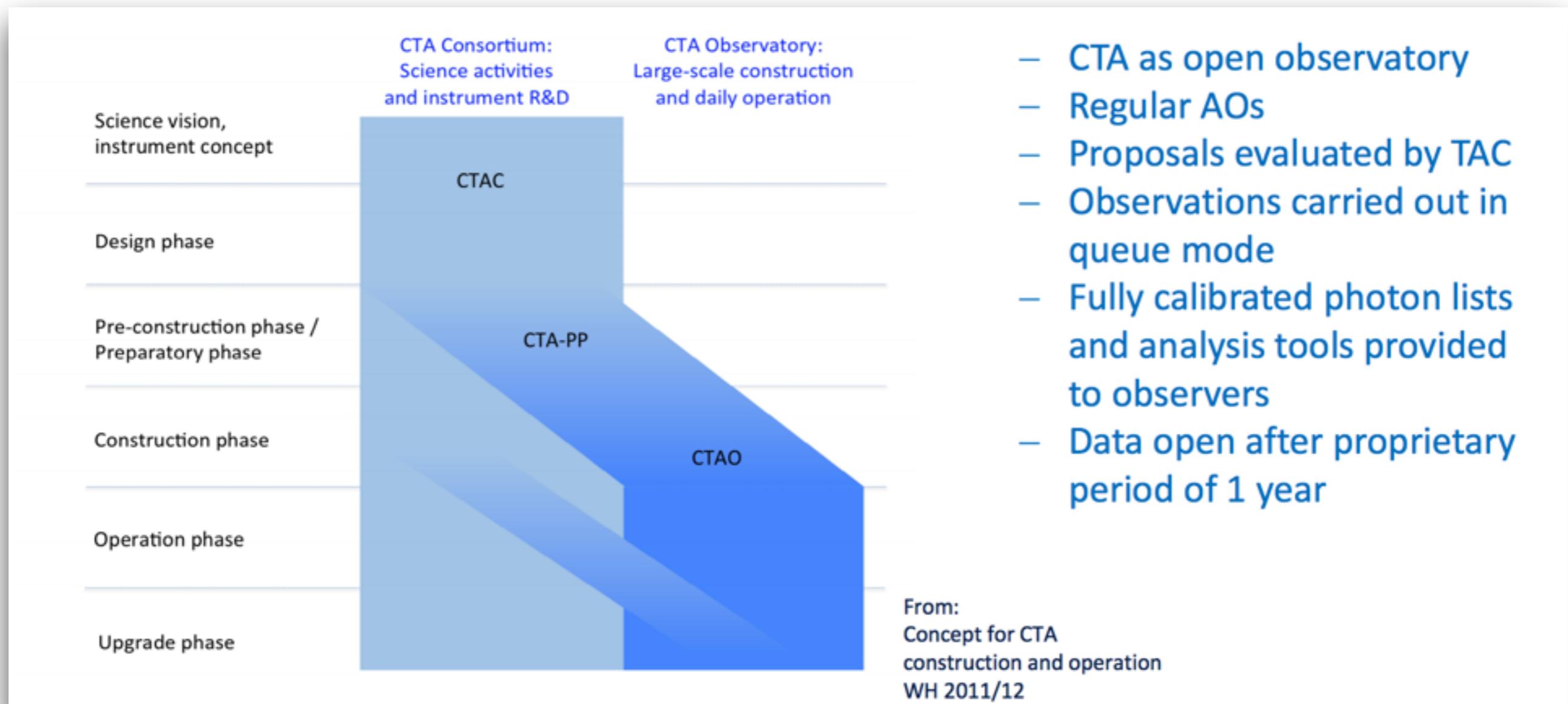
Q



Sarah A. Bonds, 2018

The CTA Observatory

- build and operated by the "CTA observatory" (CTAO, Bologna)
- in-kind contributions by the "CTA consortium" (CTAC)
- observation time allocated to the CTA consortium for Key Science projects

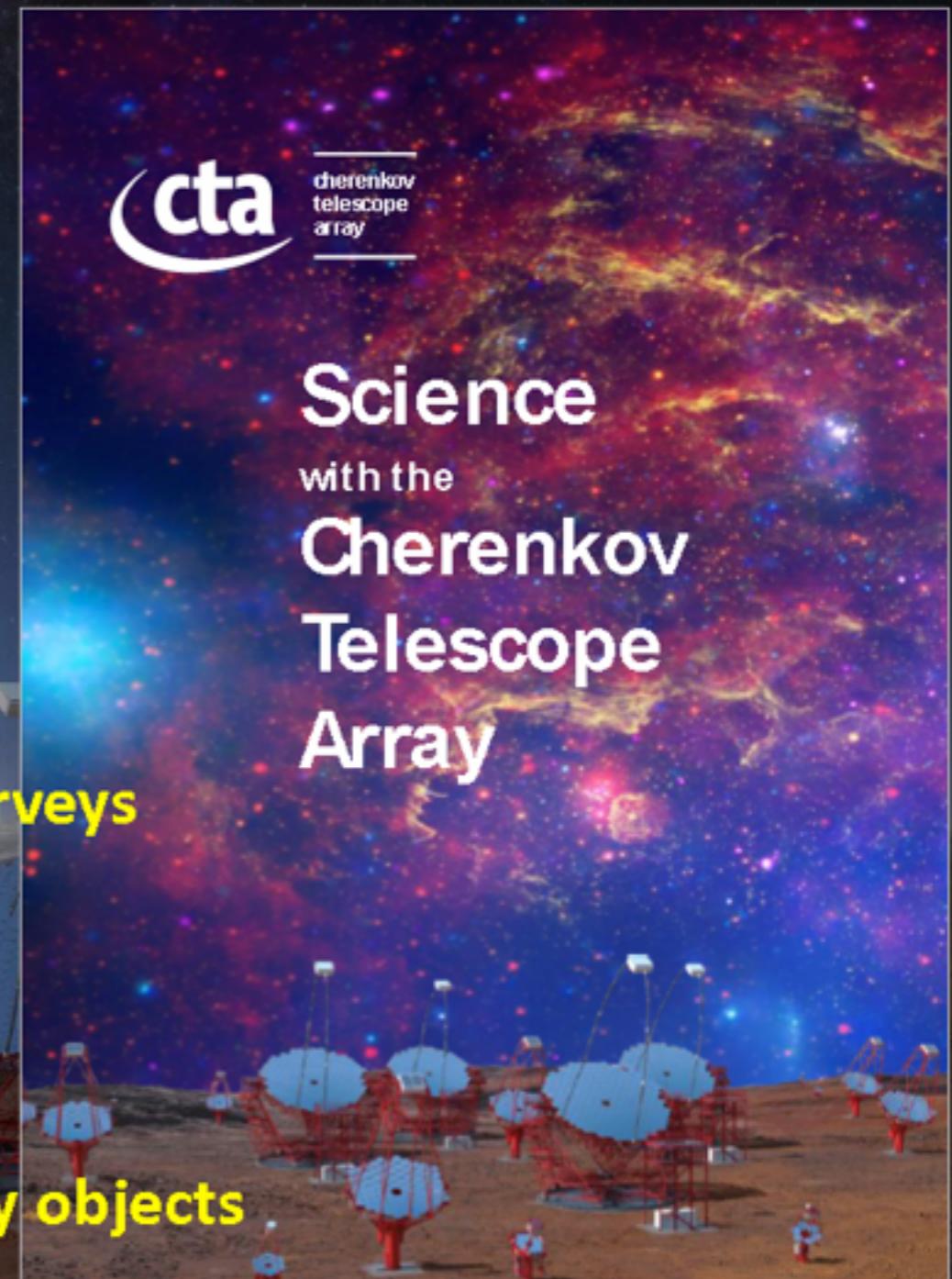
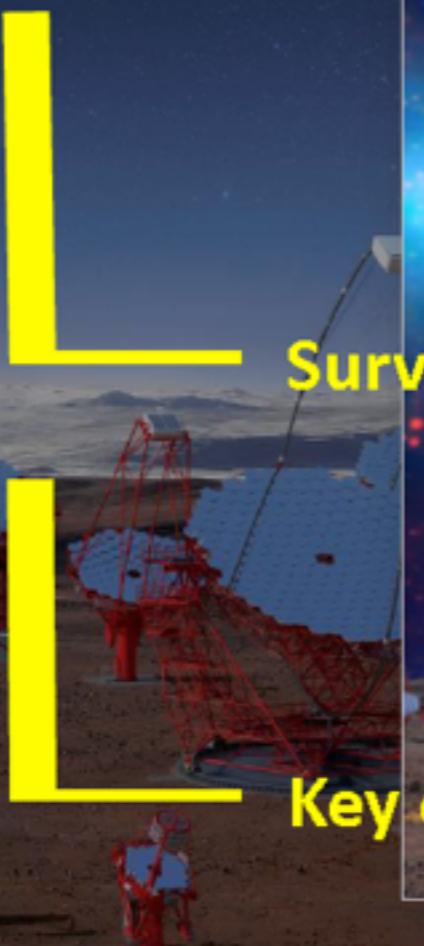


The CTA Key Science program

KEY SCIENCE PROJECTS

provide legacy data sets and data products

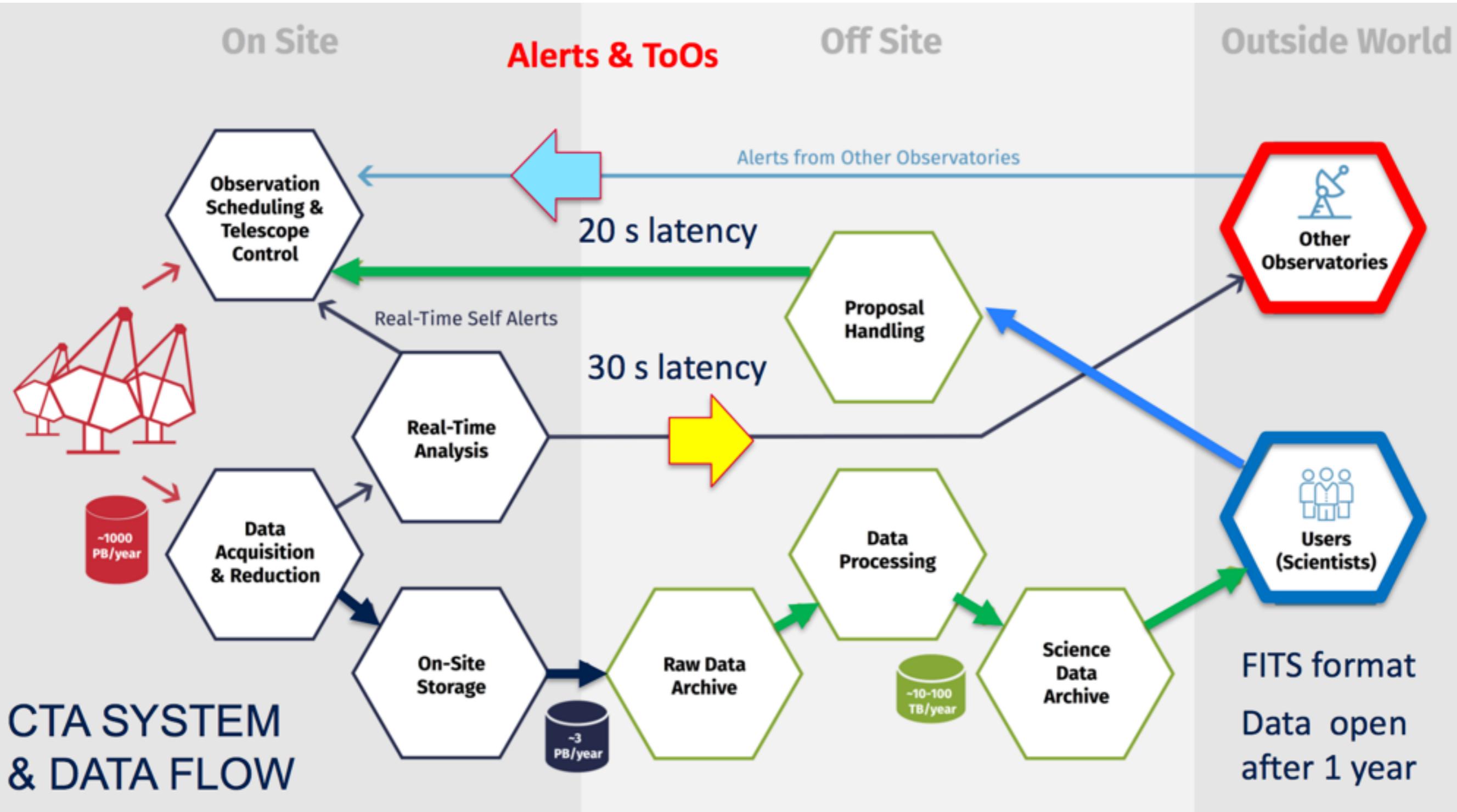
1. Dark Matter Programme
2. Galactic Centre
3. Galactic Plane Survey
4. Large Magellanic Cloud Survey
5. Extragalactic Survey
6. Transients
7. Cosmic-ray PeVatrons
8. Star-forming Systems
9. Active Galactic Nuclei
10. Cluster of Galaxies
11. Beyond Gamma Rays



The CTA Transient program

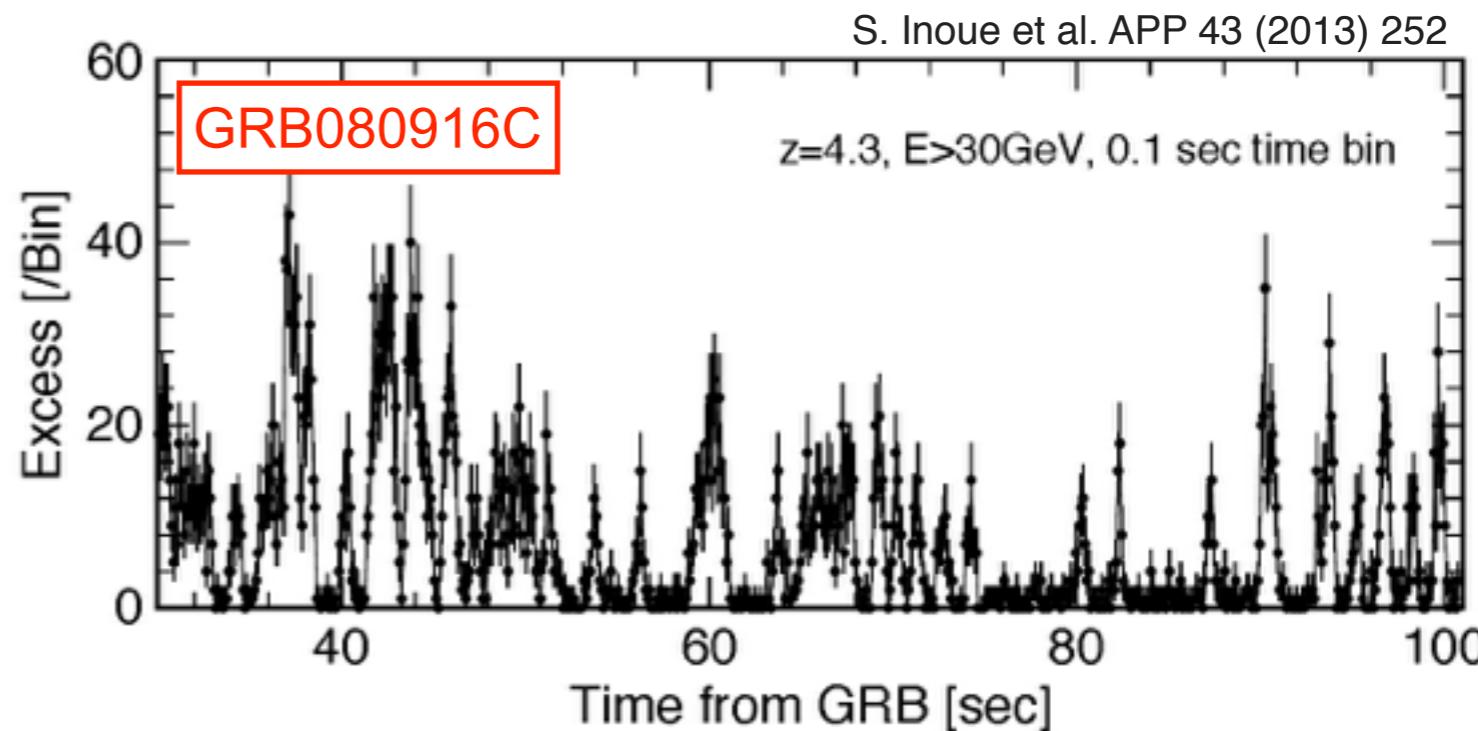


- Transients are integral part of the CTA "Key Science Projects"
- dedicated Science Working Group "Transients and MWL"
 - Preparation of the first observations (reaction to external ToOs, definition of observation program, preparation of science analysis, etc.)
 - Setup of multi-wavelength/messenger connections
 - Main topics: gamma-ray bursts, gravitational waves, high-energy neutrinos, FRBs, Galactic transients (e.g. microquasars, novae, magnetars, etc.)
- Also: AGN monitoring program + survey of the extragalactic sky + ...
- Note: at the THESEUS timescale most (all?) of the CTA observations will be driven by Guest Observer programs



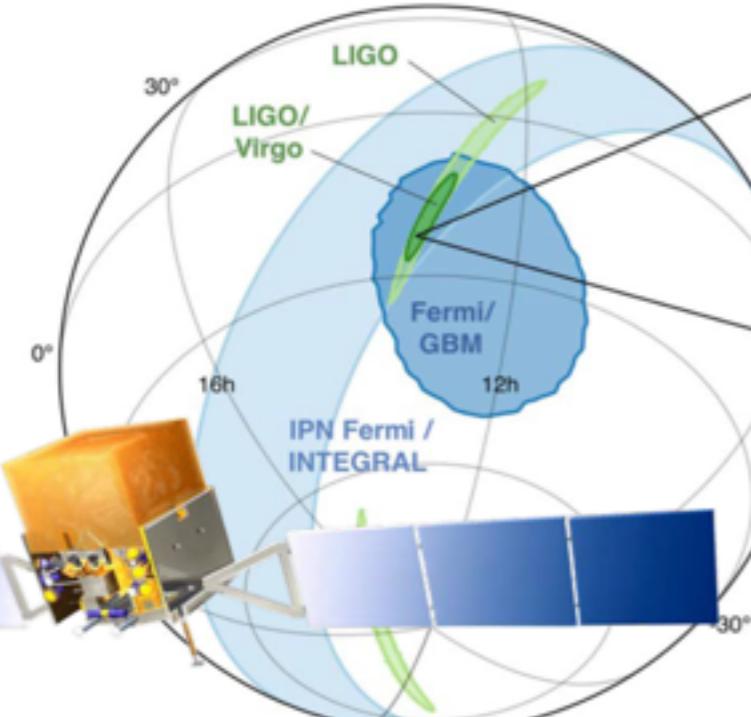
Gamma-ray burst observations

- Important program with strong links to most other topics (GW!, neutrinos?, etc.)

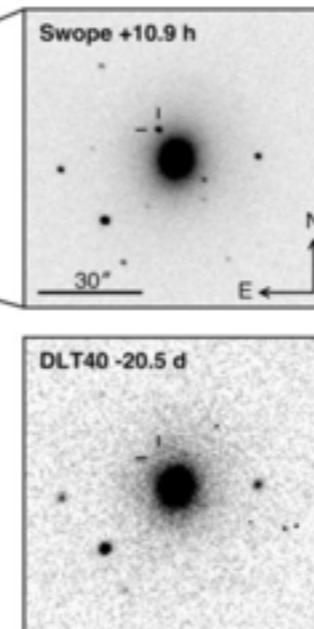


- Recent breakthroughs:
 - GRB190114C: >300GeV emission 50s after the burst (ATEL #12390)
 - GRB180720B: >100GeV emission 10h after the burst (E. Ruiz Velasco et al., CTA Symposium 2019)
 - GRB190829A: VHE detection after 4h (ATEL #13052)

Time-domain multi-messenger astronomy

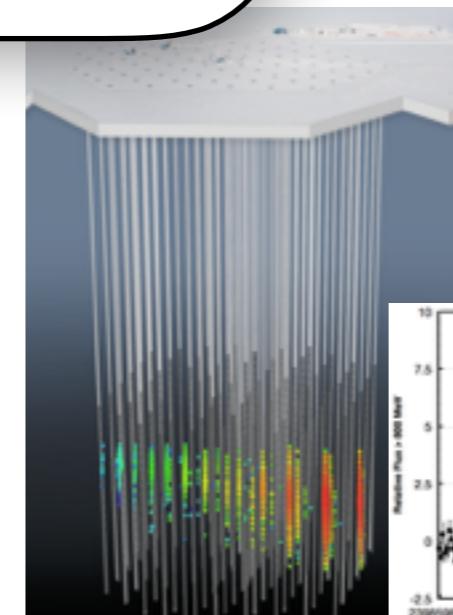


ApJL, 848:L12, 2017

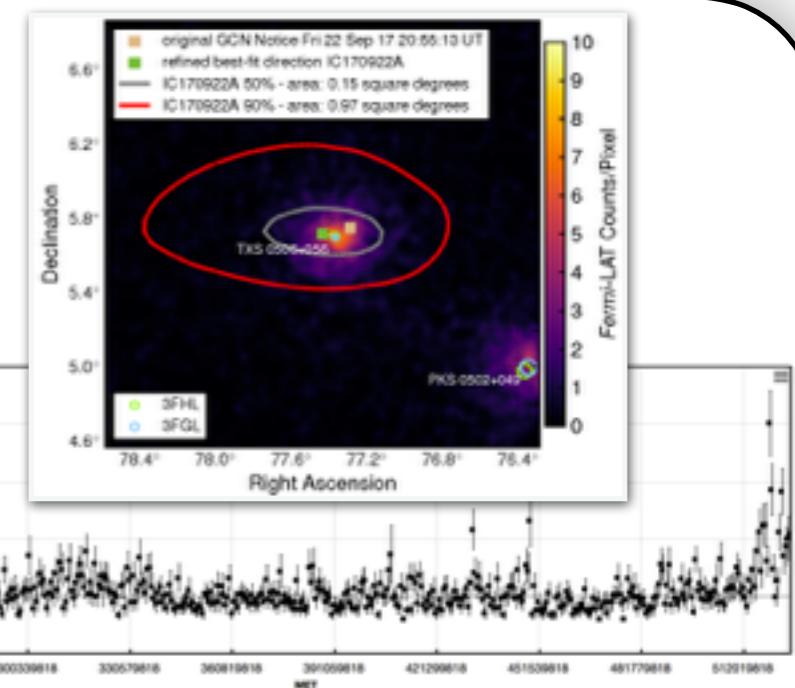


Gravitational waves

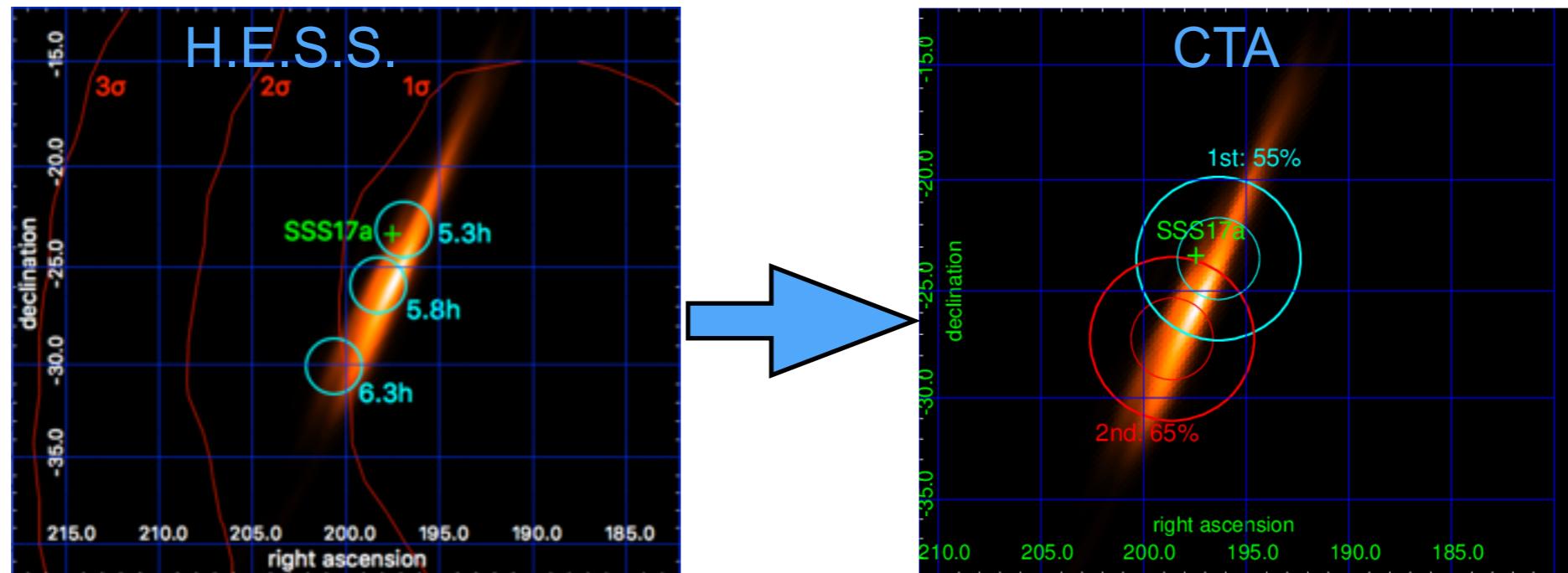
High-energy neutrinos



Science 361, eaat1378 (2018)



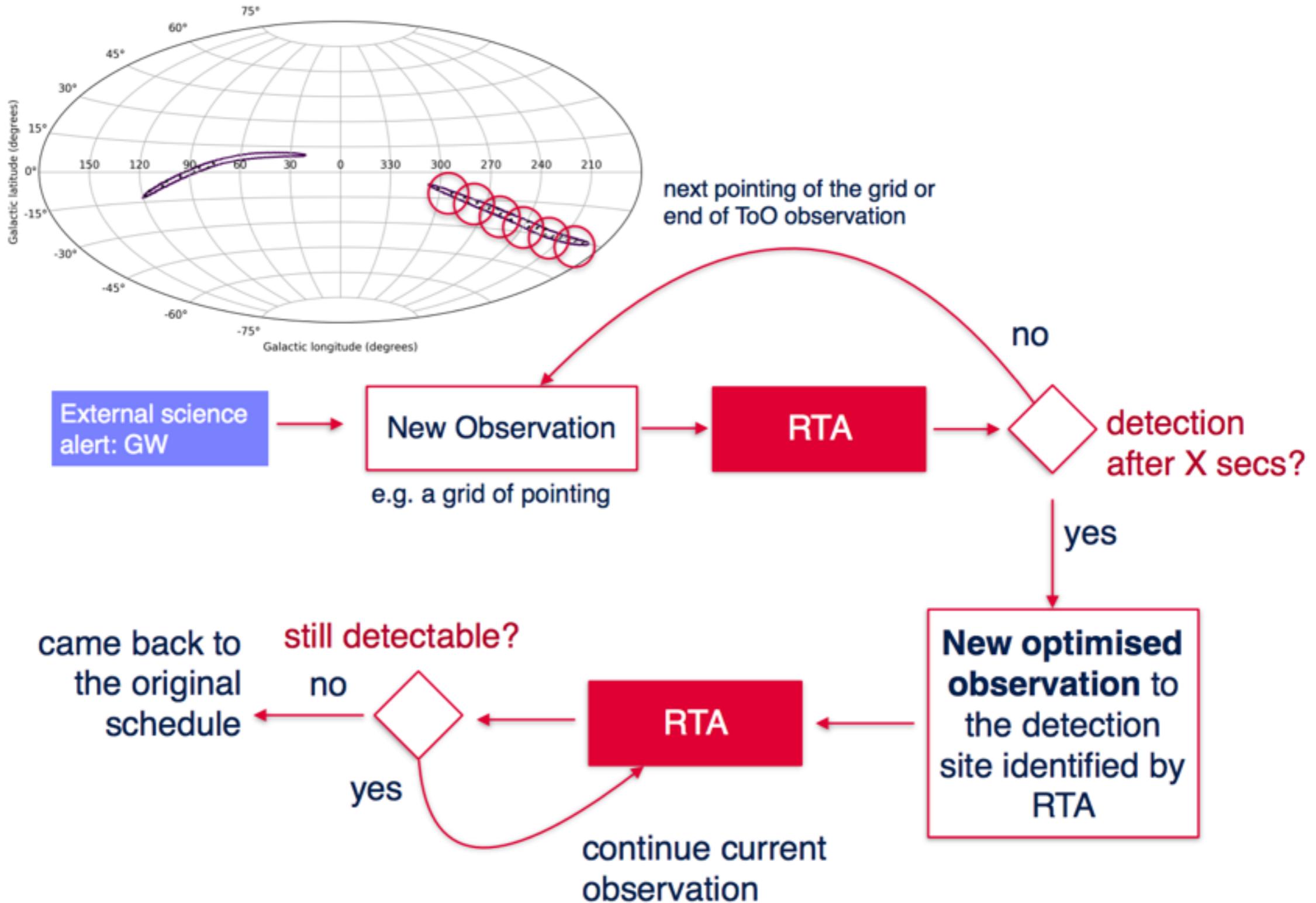
GW170817 @ Cherenkov Telescope Array



H. Abdalla et al. (H.E.S.S.), ApJL 855:L22 (2017)

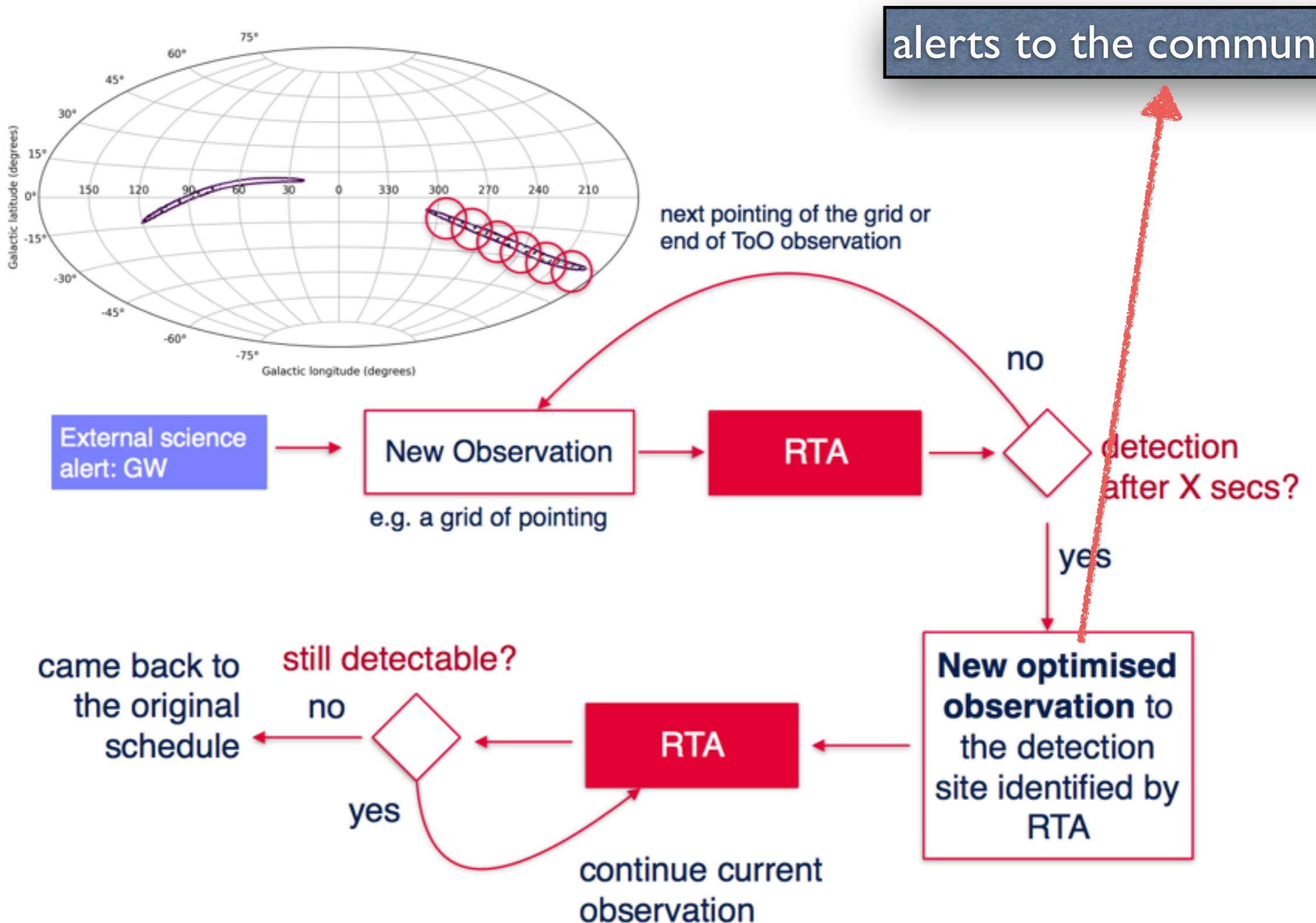
FS (CTA consortium), preliminary

The CTA Real-Time Analysis



A. Bulgarelli et al.

The CTA Real-Time Analysis

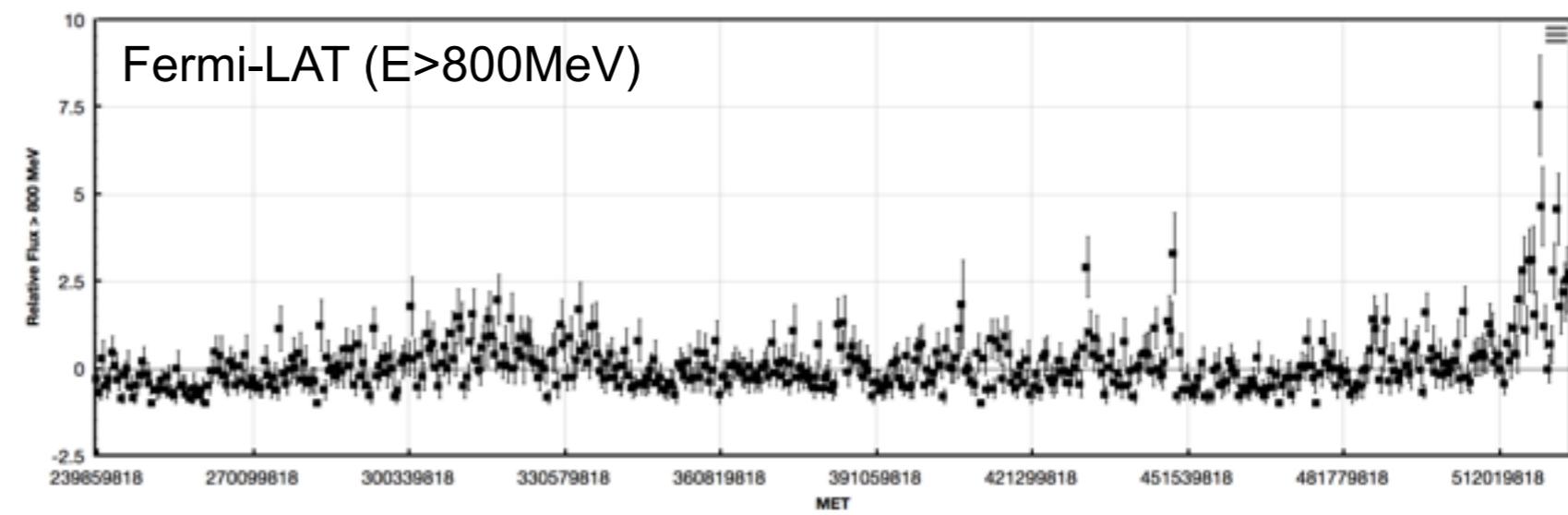
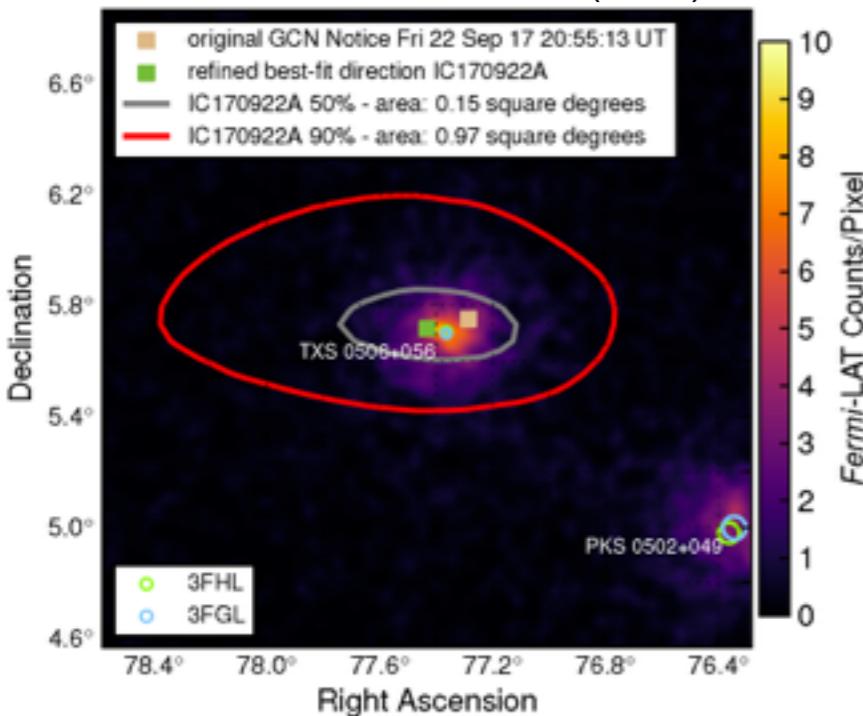


A. Bulgarelli et al.

Identifying the sources of high-energy neutrinos

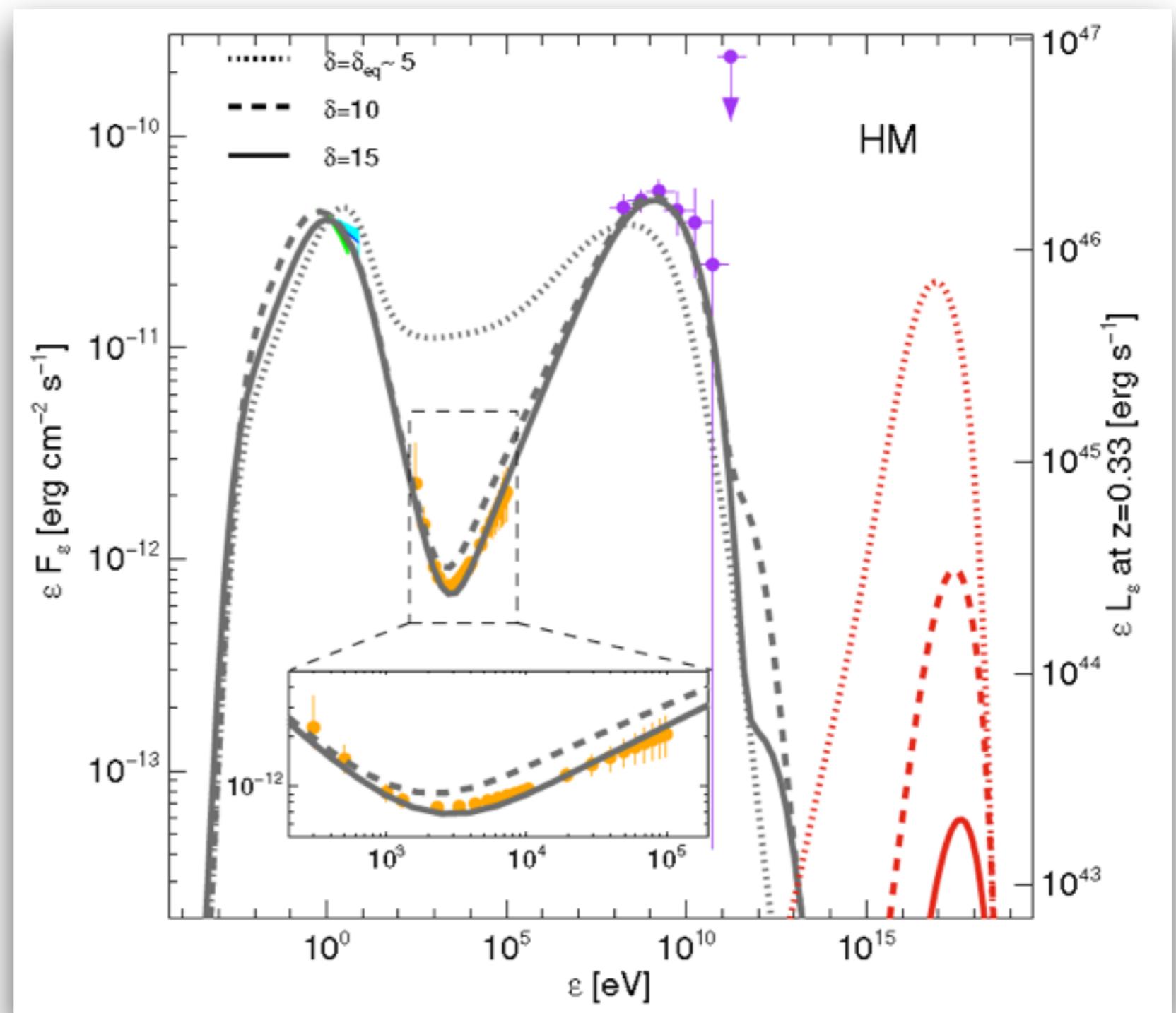
- Building on successful programs of all current IACTs
 - follow-up of individual high-energy neutrinos (e.g. IC-170922A)
 - neutrino "flares" (all-sky searches, pre-defined candidate sources, etc.)
- Links to CTA AGN program (e.g. duty-cycle of TeV flares) and wide FoV instruments (e.g. HAWC, LHAASO, SWGO)
- need for extensive MWL coverage

Science 361, eaat1378 (2018)



X-ray data crucial for interpretations

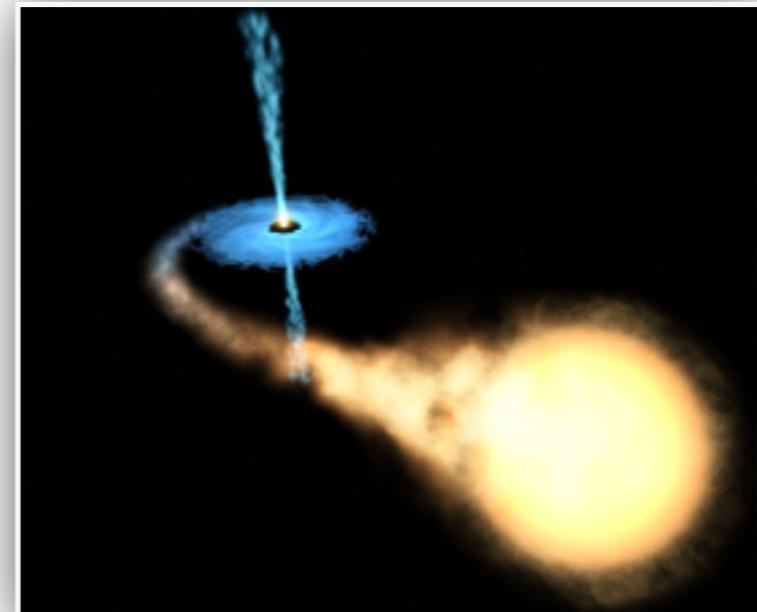
- e.g. TXS 0506+056



A. Keivani et al., ApJ 864 (2018)

Galactic transients

- large number of interesting sources
- e.g. gamma-ray binaries + many prospective possibilities, i.e. no GeV/TeV detections so far
 - microquasars, PWNe flares, Novae, etc.



A large zoo of MWL transients

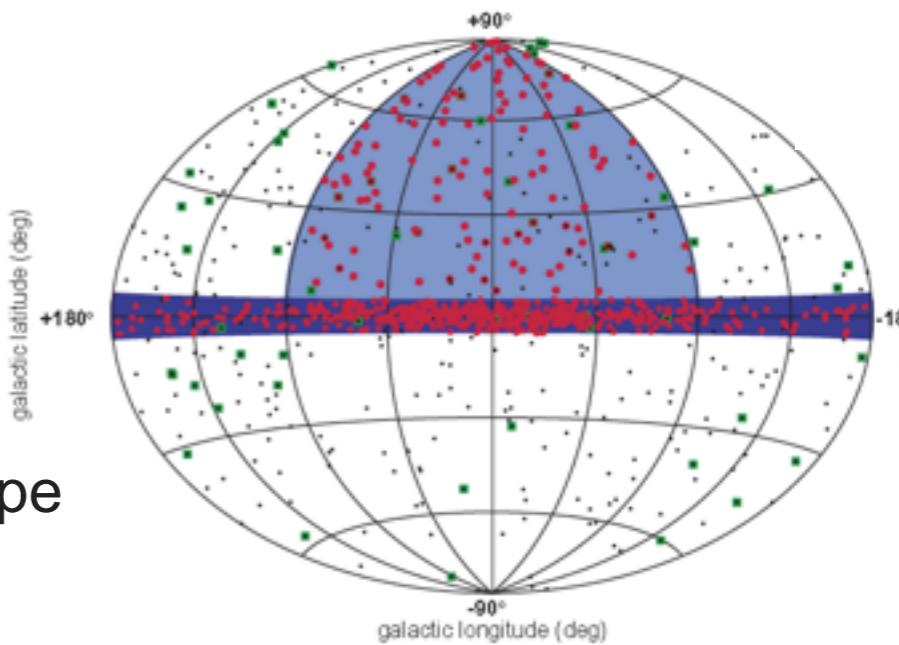
- taking advantage of the time-domain revolution
- optical transient factories (e.g. ZTF, LSST)
- Fast Radio Bursts
- ...



CTA surveys

- CTA will cover large portions of the sky
 - large telescope FoV: 4 - 10deg depending on telescope type
 - may be increased by divergent pointing
- important survey programs (Galactic + Extragalactic)

- input for the THESEUS observation program?
- deep MWL studies of interesting objects

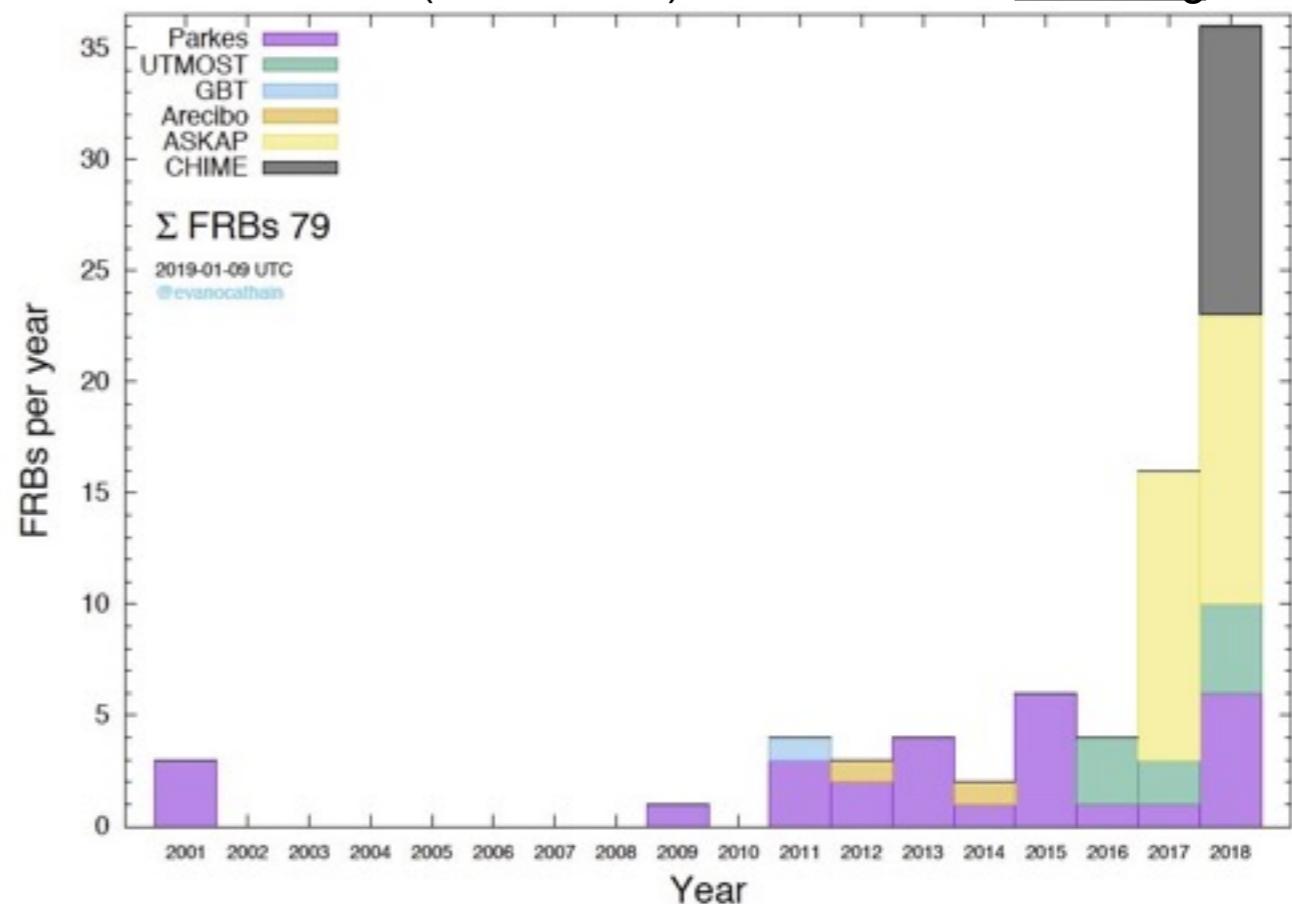


Links to multi-messenger and multi-wavelength community

- MWL/MM input necessary for most (all?) CTA science cases
 - X-ray domain crucial for interpretations/modelling
- Key Science Projects: significant dataset of the VHE sky (e.g. surveys)
 - useful to refine the THESEUS program(s) ?
- Transients
 - alerts to CTA on a large range of objects/sources (GRBs!!)
 - public alerts from CTA on transient emission from known and unknown sources
 - Real-time analysis => alert emission with O(30sec)
- CTA will be an observatory
 - A lot of opportunities for joint programs + ToOs
 - How to trigger CTA?
 - How to respond to CTA alerts?
 - ...

Fast Radio Bursts

- mysterious, millisecond long, strong bursts in the radio domain
- rapid increase in detections over the last years
- only three (irregularly) repeating bursts: different classes?



- first TeV follow-up programs (e.g. H.E.S.S: A&A 597, A115, 2017)
- repeating bursts: coordinated campaigns possible (e.g. MAGIC: MNRAS 481 (2018) 2479)
- FRBs as example of future detections of new transient phenomena