Synergies between *Fermi* and the Cherenkov Telescope Array

The CTA Consortium* represented by

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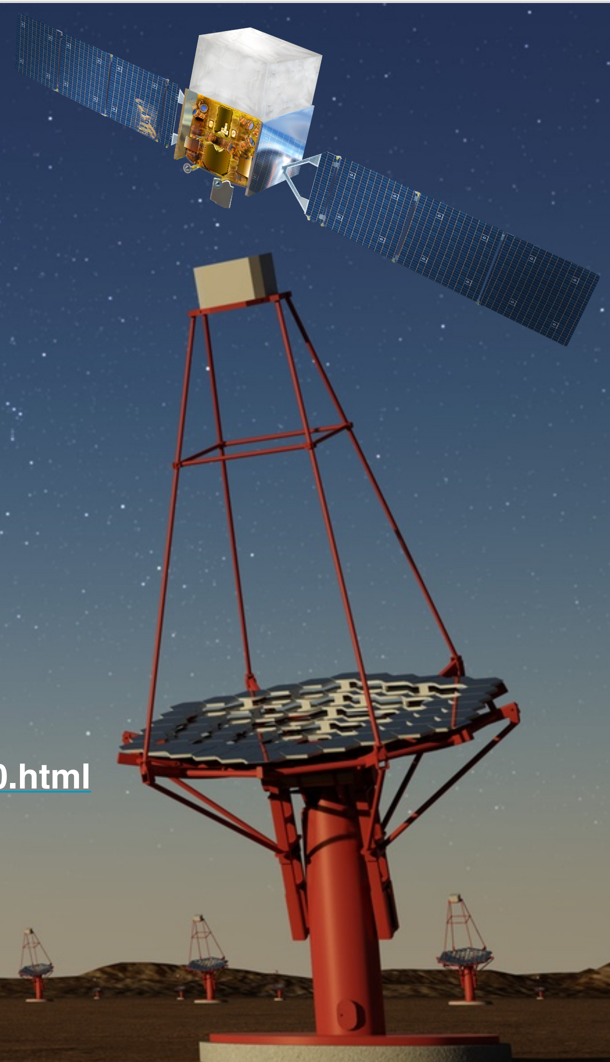
* see http://www.cta-observatory.org/consortium_authors/authors_2018_10.html for full author list



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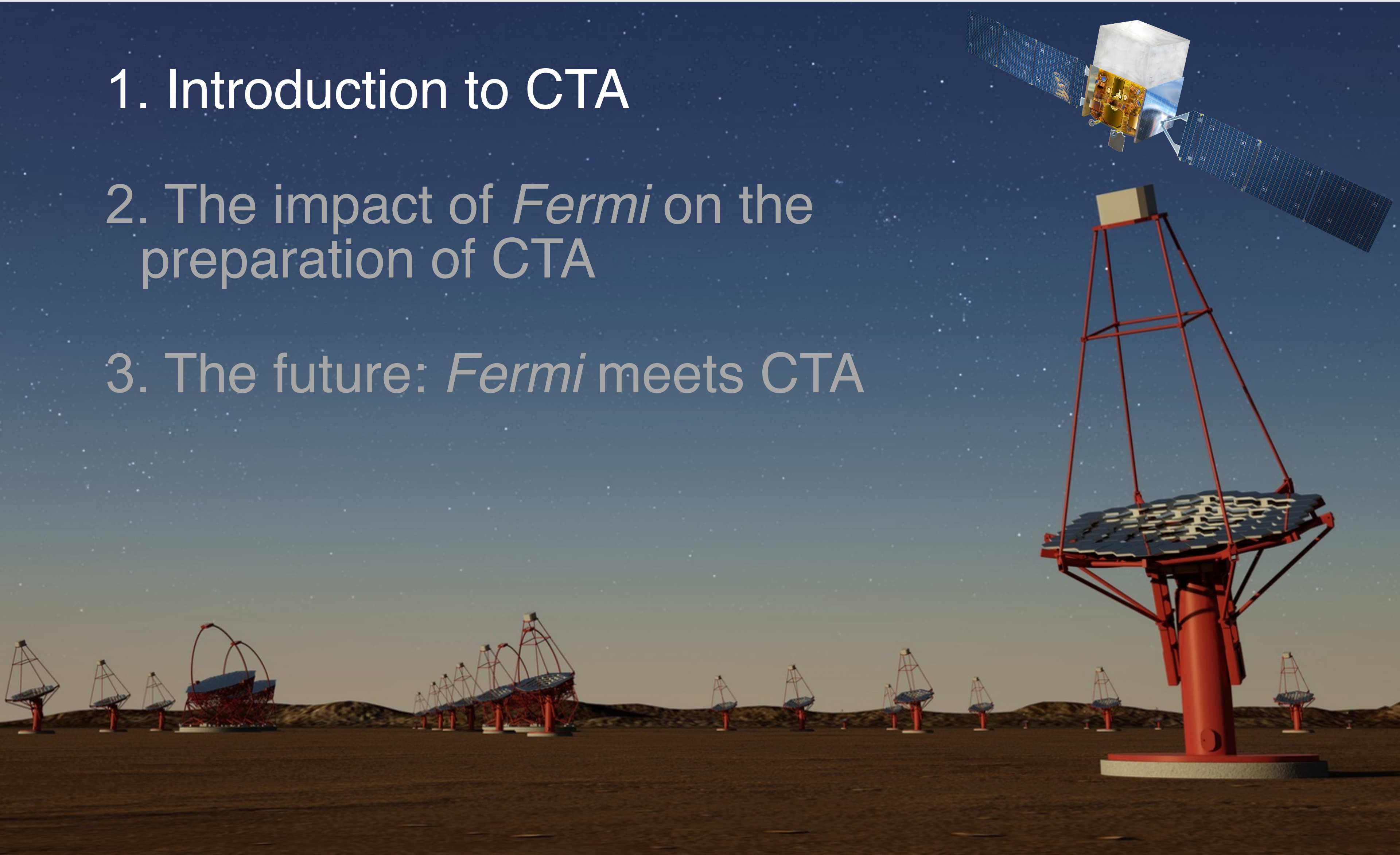
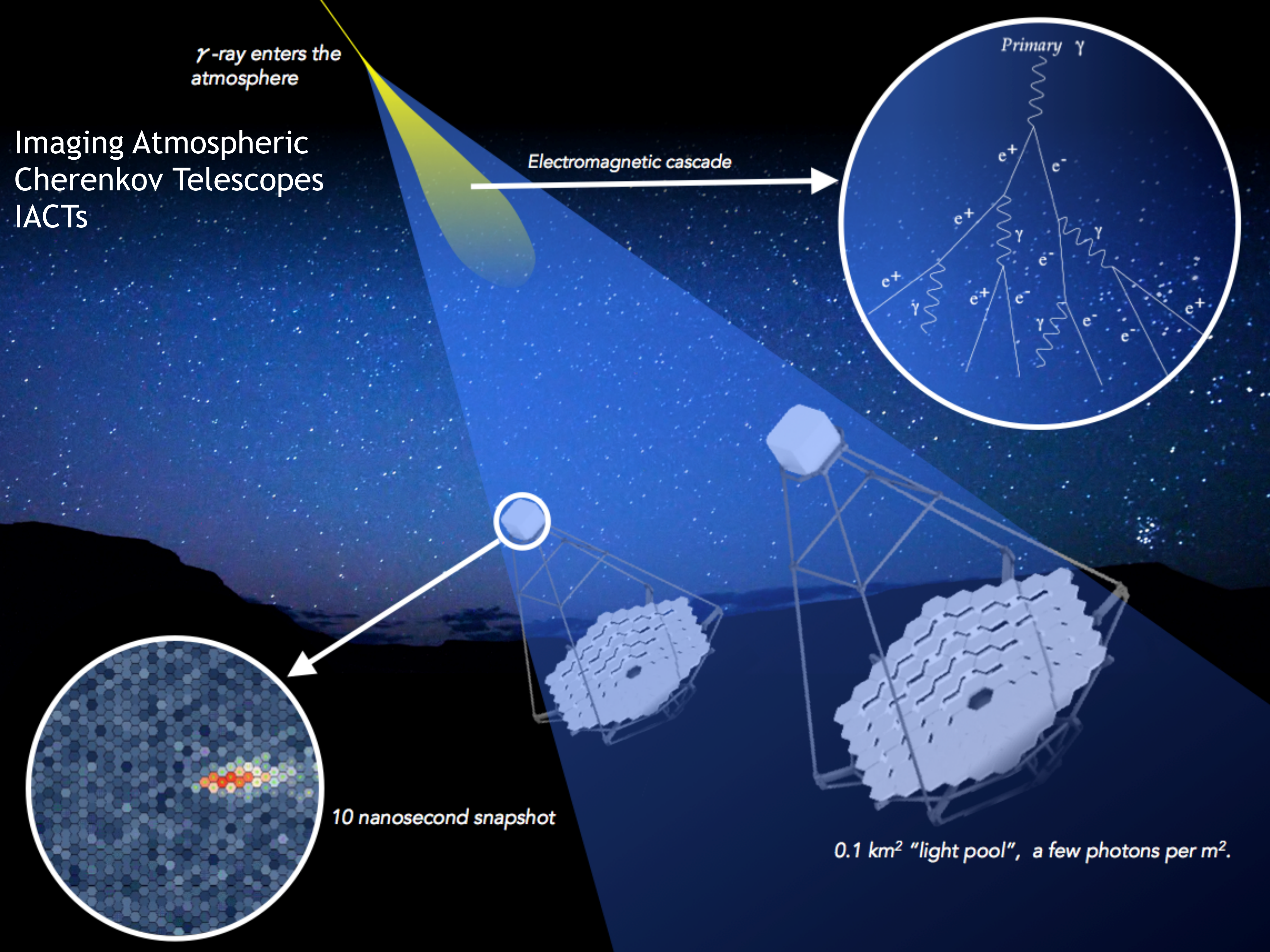
2. The impact of *Fermi* on the preparation of CTA

3. The future: *Fermi* meets CTA



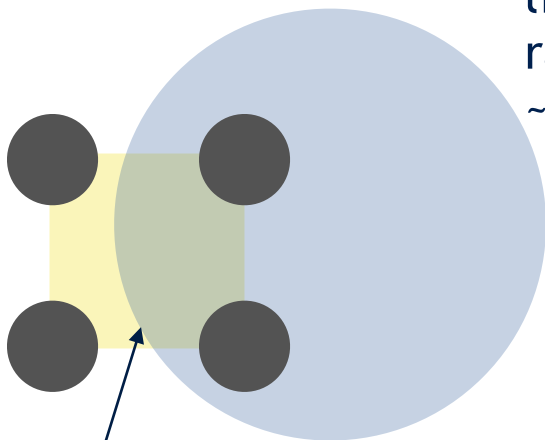


Imaging Atmospheric Cherenkov Telescopes IACTs
γ-ray enters the atmosphere
Electromagnetic cascade
Primary γ
e+
e-
γ
10 nanosecond snapshot
0.1 km² "light pool", a few photons per m².

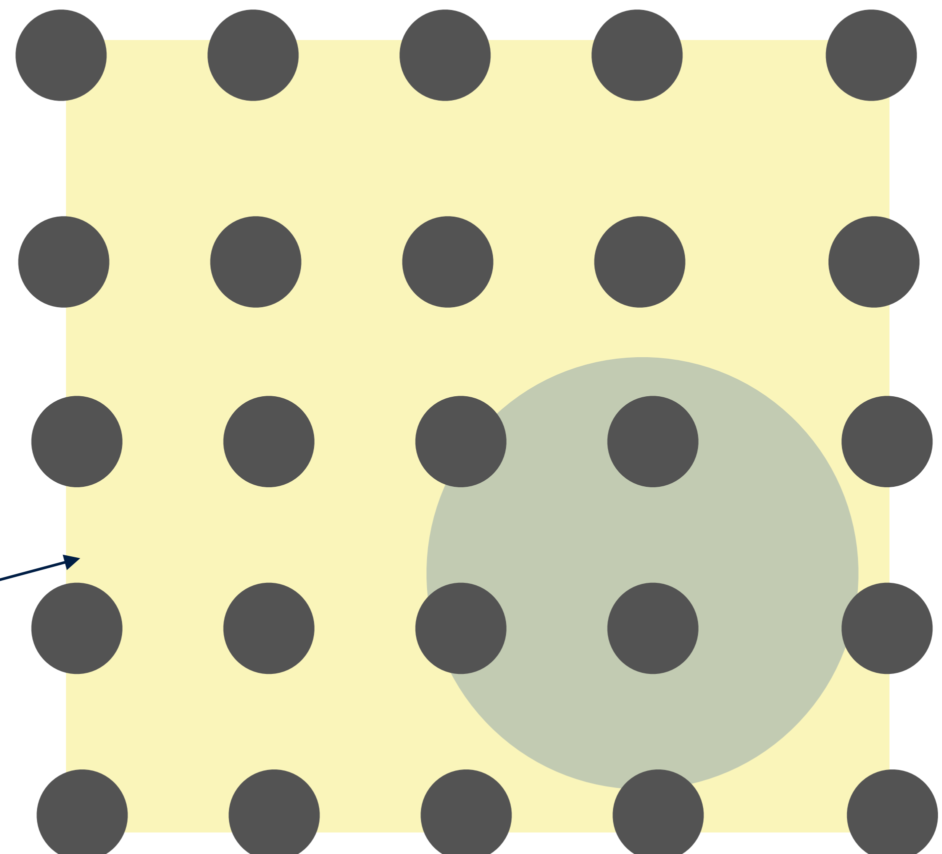
From current IACTs to CTA

Credit: Werner Hofmann

light-pool
radius 100-150 m
~ telescope spacing



sweet spot for trigger
and reconstruction:
most showers miss it

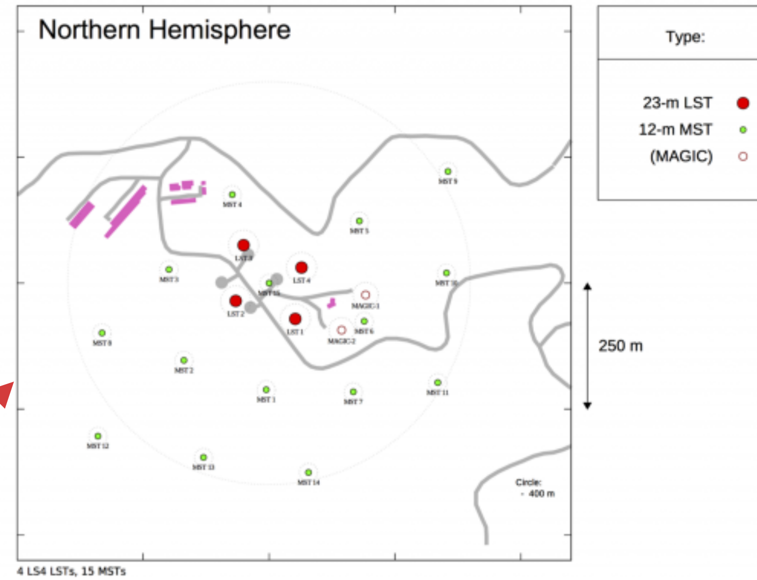


large detection area
more images per shower
lower trigger threshold

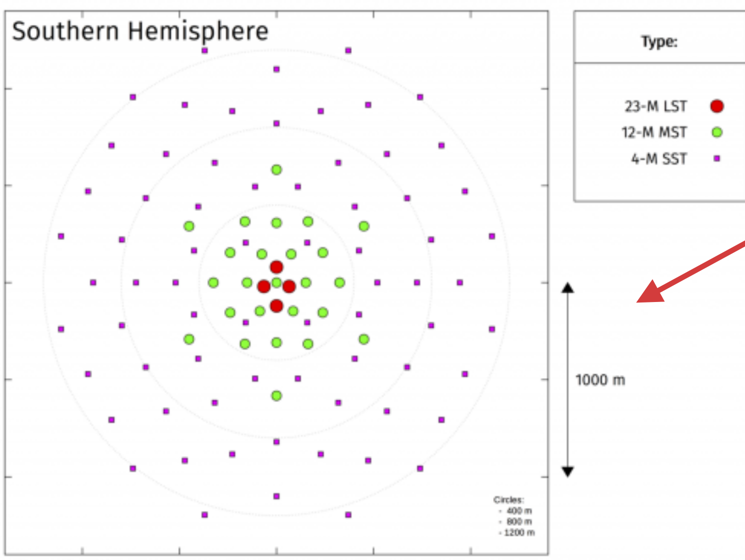
The Cherenkov Telescope Array

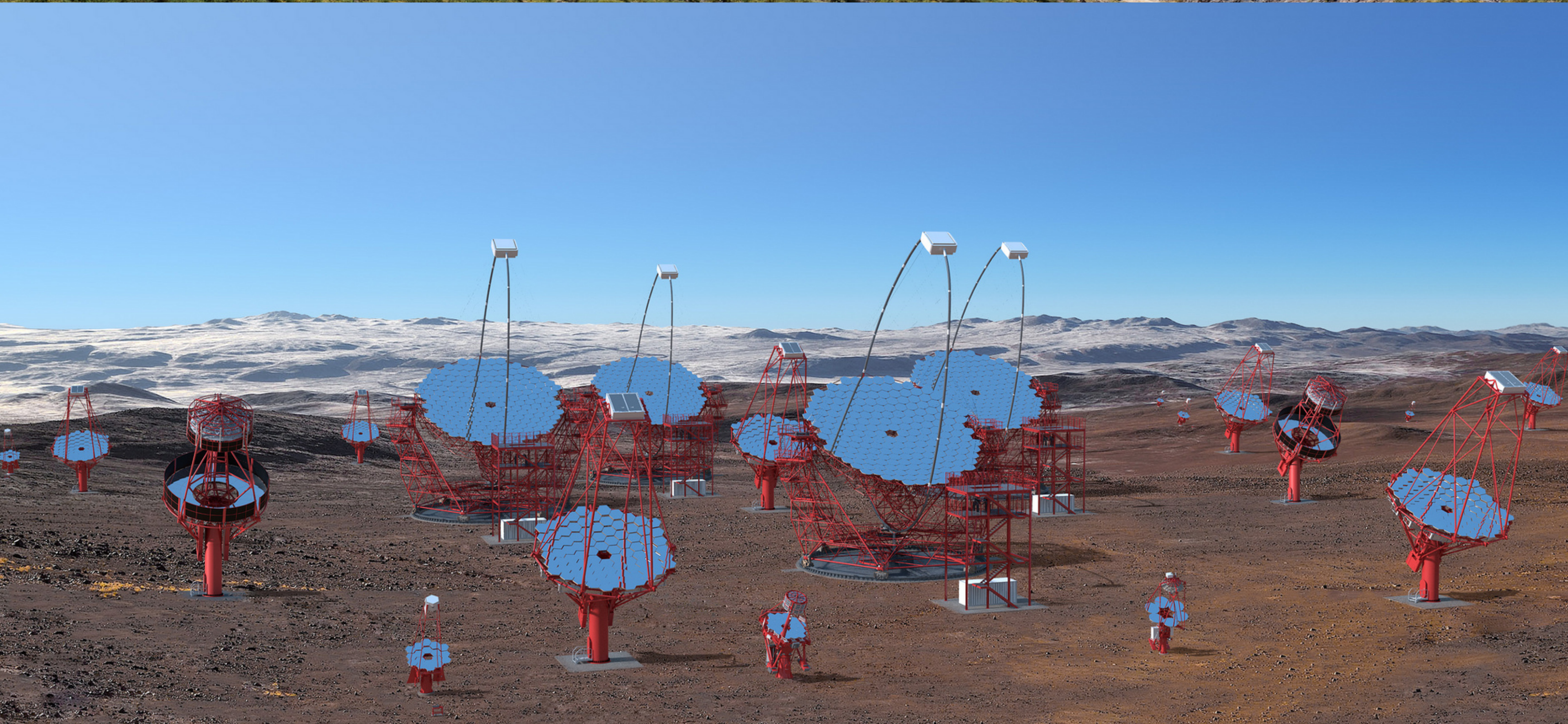
- two sites for full sky coverage
- > 100 telescopes of different sizes: optimal performance over wider energy range

La Palma, Canary Islands, Spain

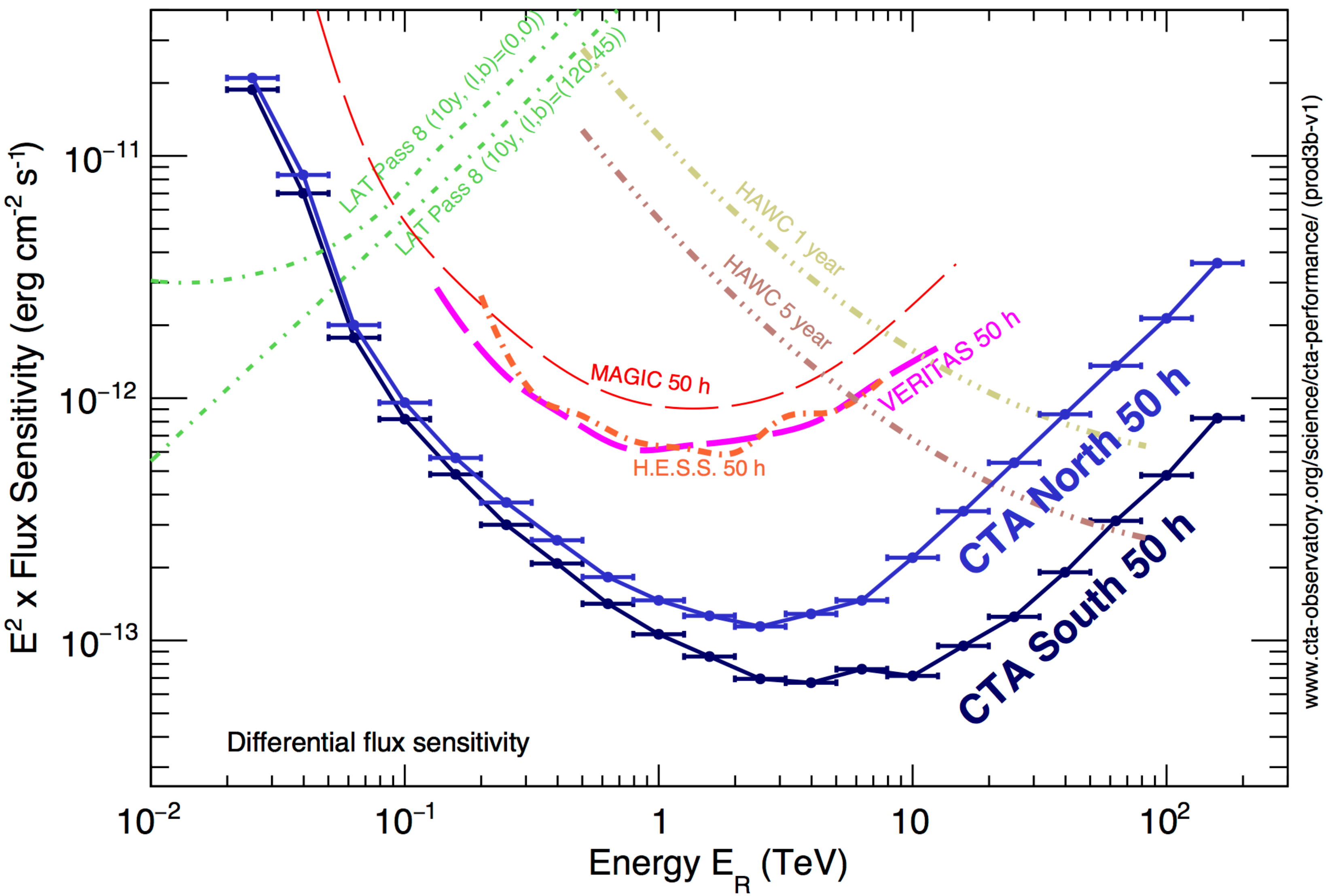


Paranal, Chile

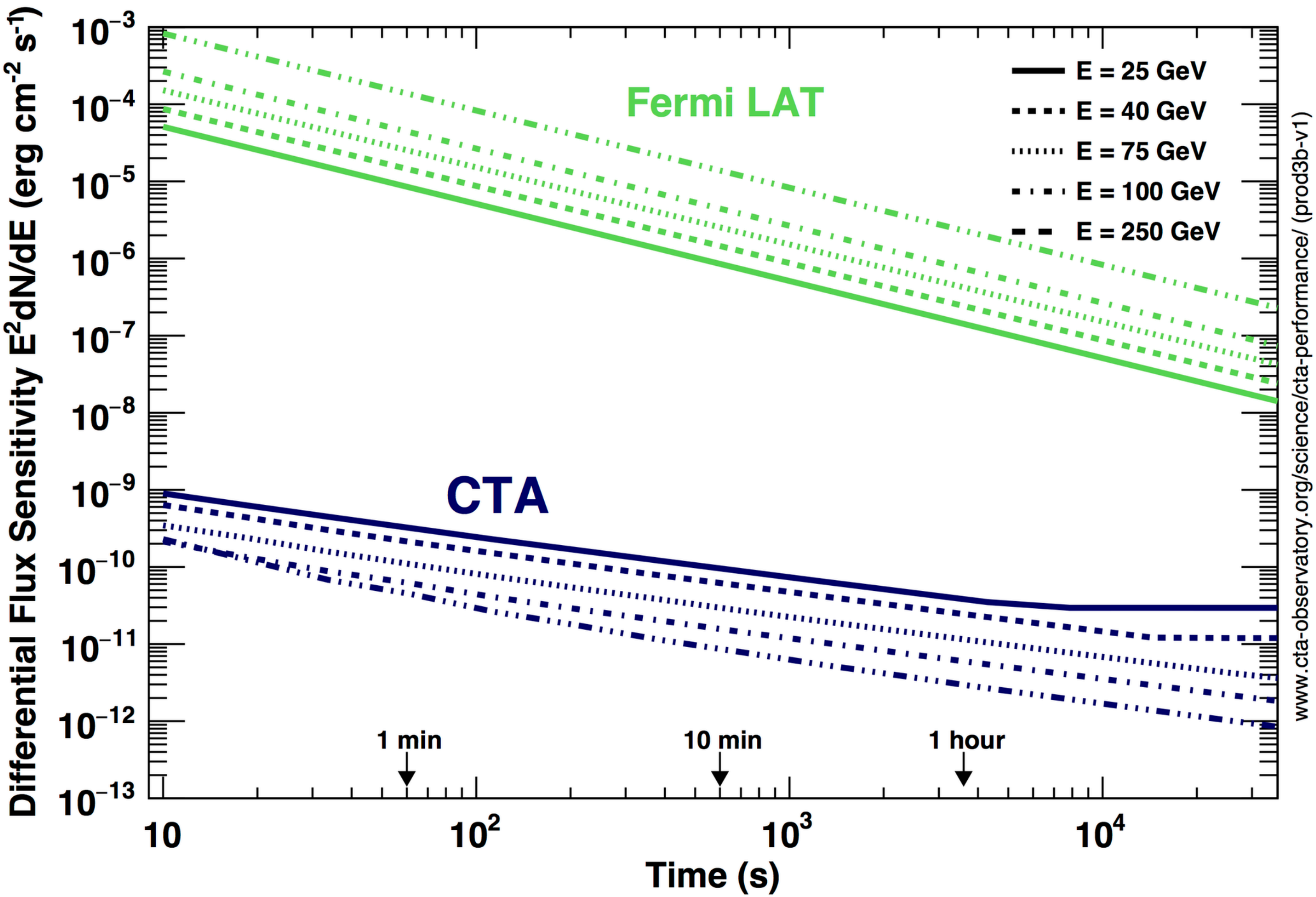


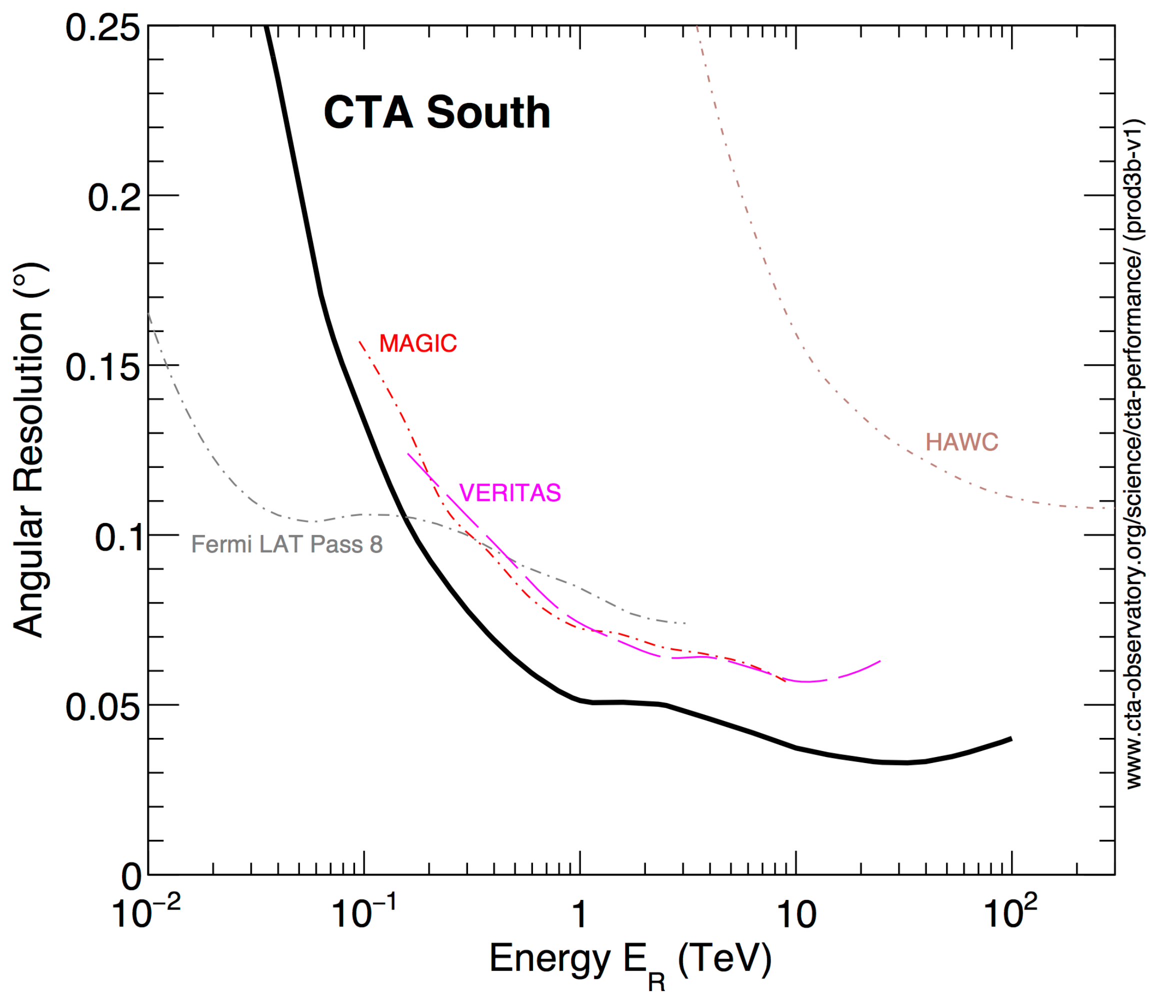
Sensitivity



Sensitivity vs observation time



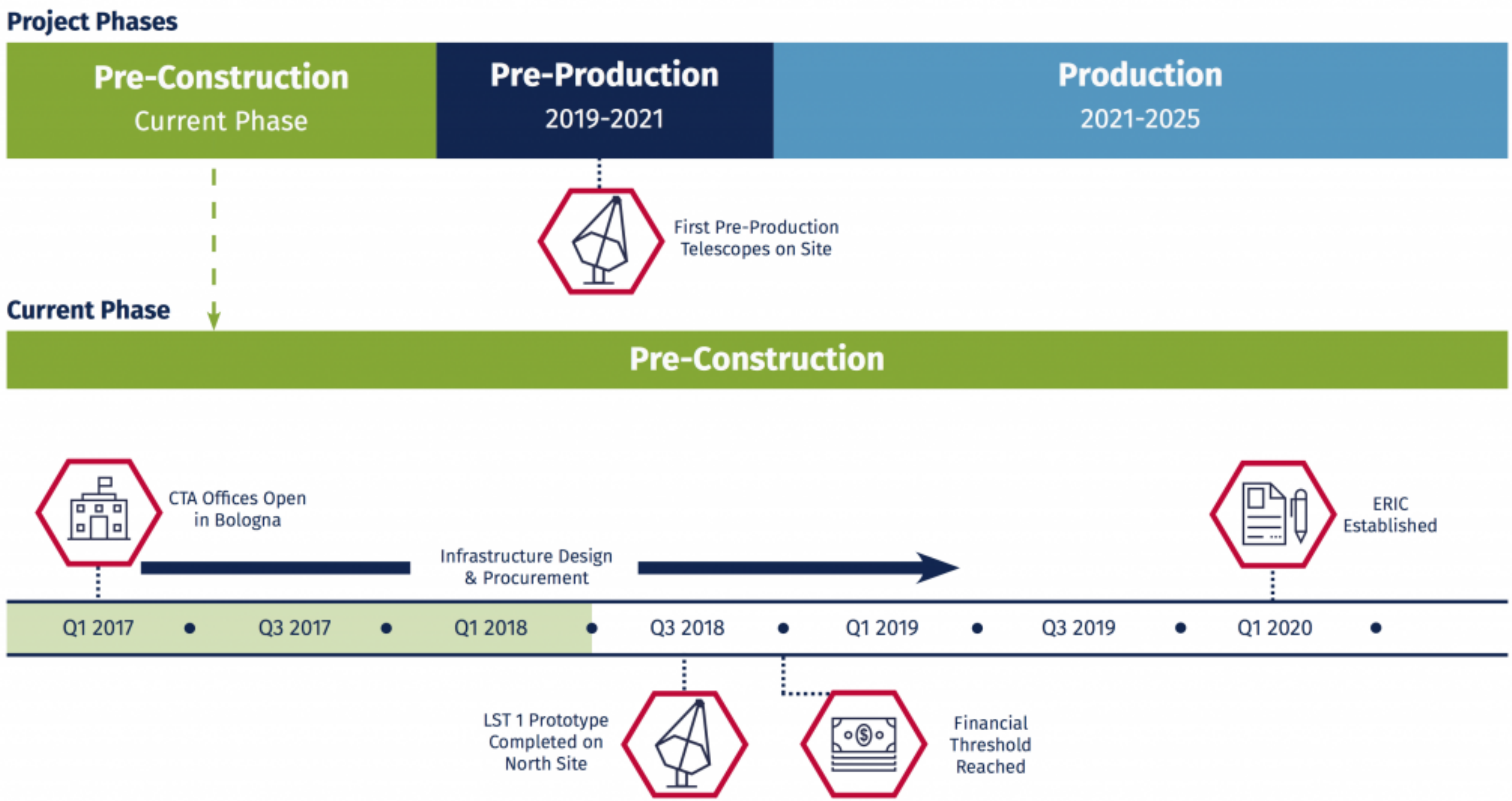
Angular resolution



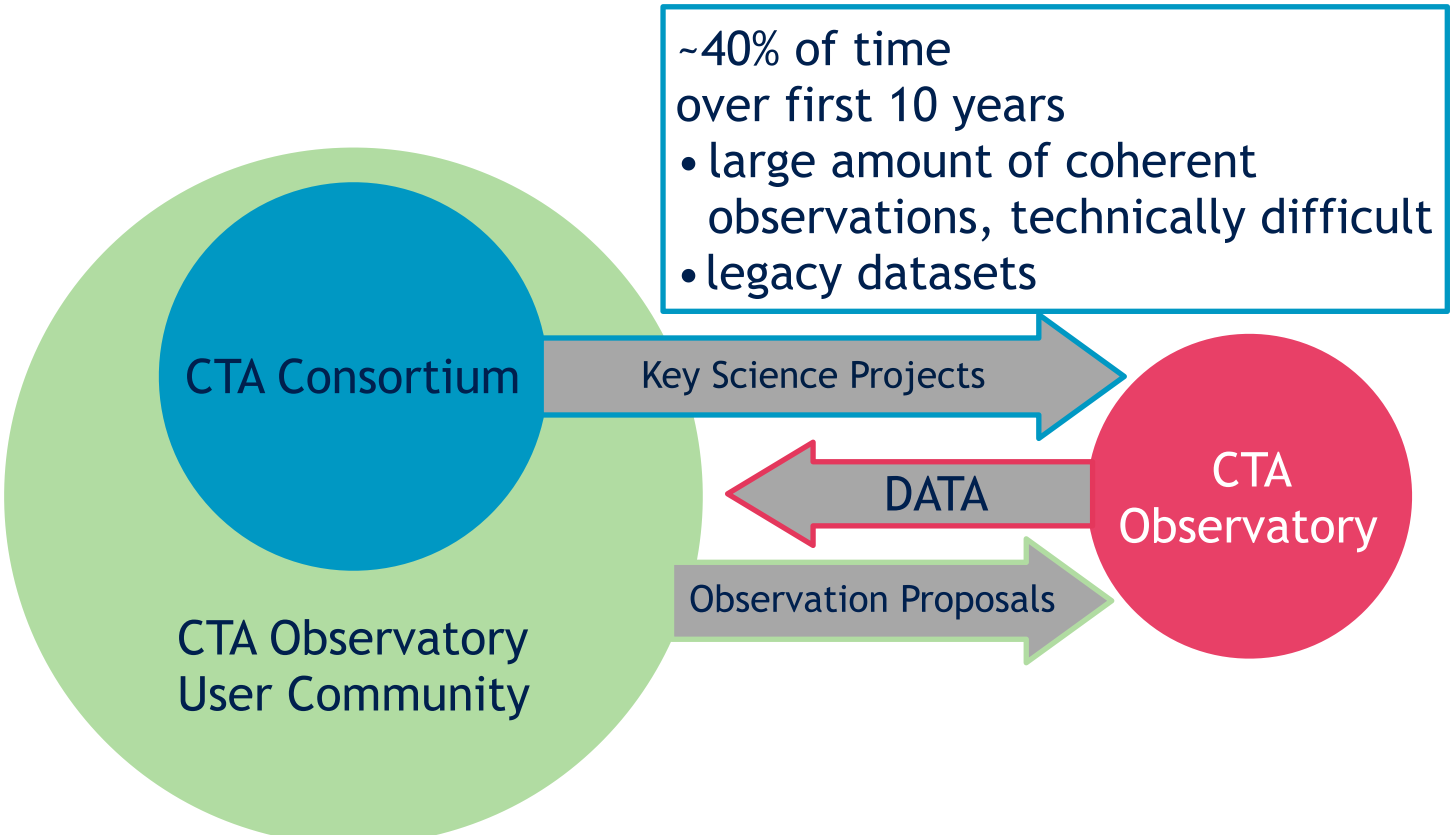
event analysis optimized for best sensivity,
angular resolution can be improved

First CTA telescope in La Palma

Status


Project Phases
Pre-Construction
Current Phase
Pre-Production
2019-2021
Production
2021-2025
First Pre-Production Telescopes on Site
Current Phase
Pre-Construction
CTA Offices Open in Bologna
Infrastructure Design & Procurement
ERIC Established
Q1 2017
Q3 2017
Q1 2018
Q3 2018
Q1 2019
Q3 2019
Q1 2020
LST 1 Prototype Completed on North Site
Financial Threshold Reached

Novel: Open Observatory



Science Book

- Science capabilities
- Dark matter program (see talk by G. Zaharijas)
- Key Science Projects
- Science beyond gamma rays
- Synergies

https://arxiv.org/abs/1709.07997
https://www.worldscientific.com/worldscibooks/10.1142/10986

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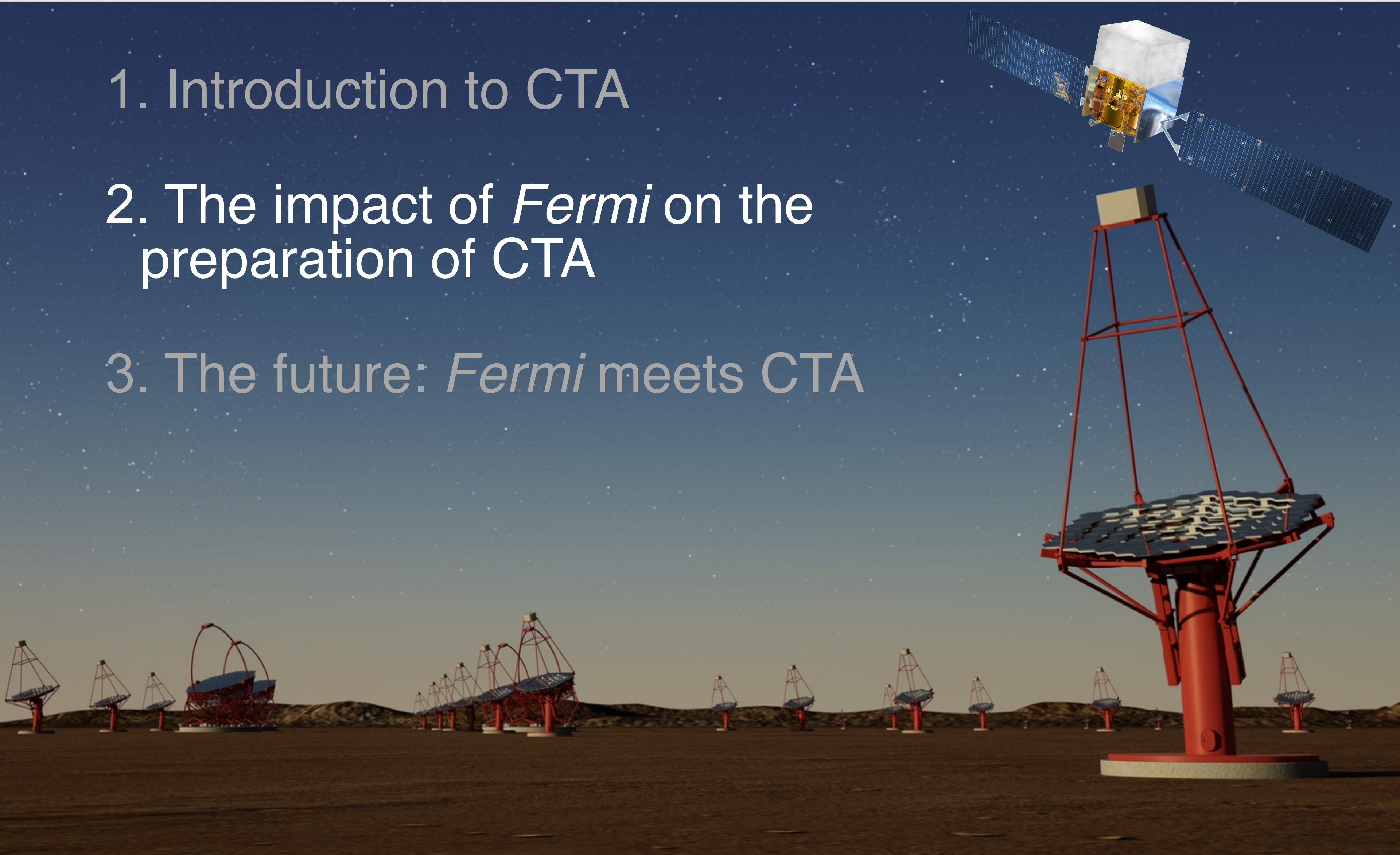
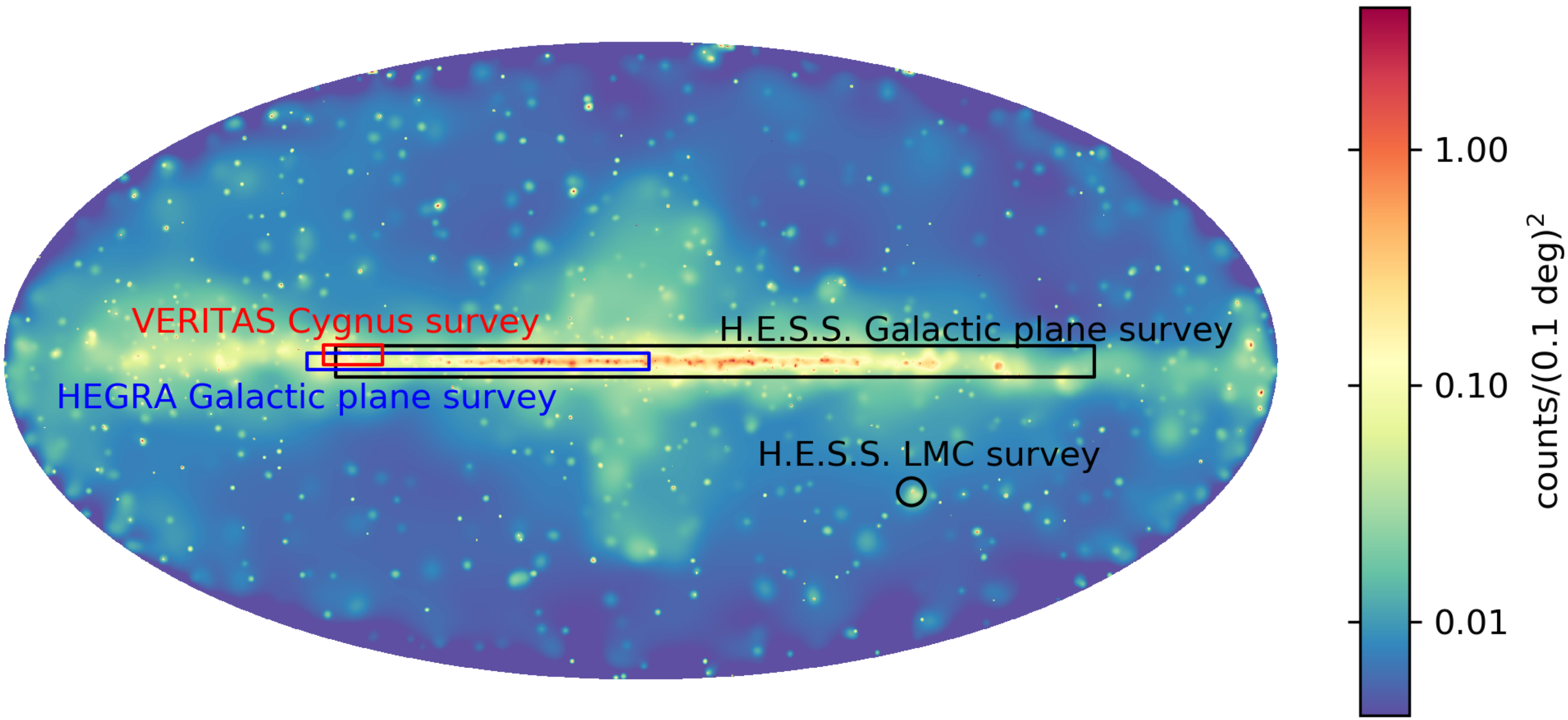


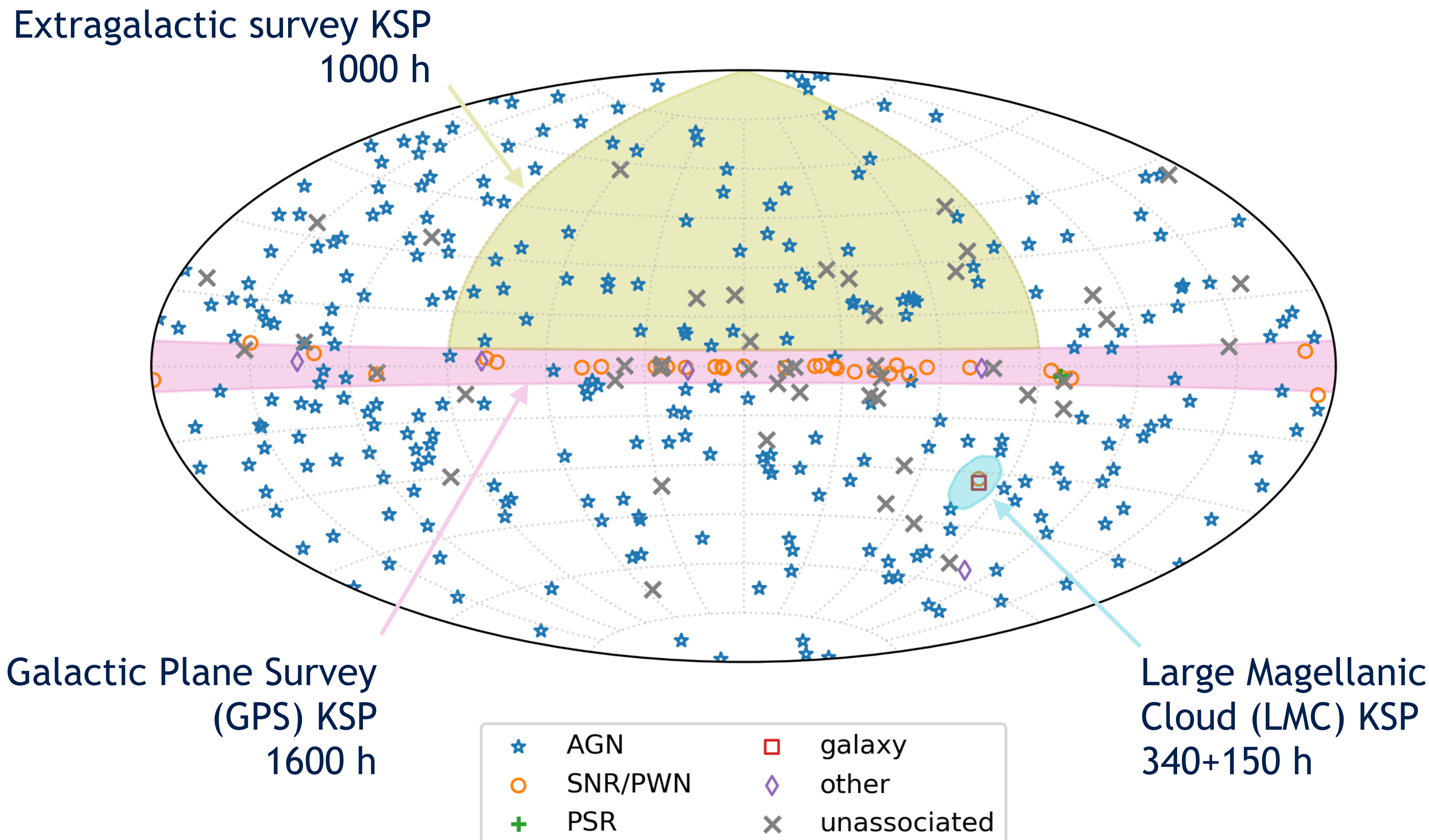
Fermi and the CTA core program

- CTA Science book mentions *Fermi* 108 times
- unique: *Fermi* surveys the whole sky and overlaps in energy with CTA



Fermi skymap > 50 GeV (2FHL)

Census of gamma-ray sources

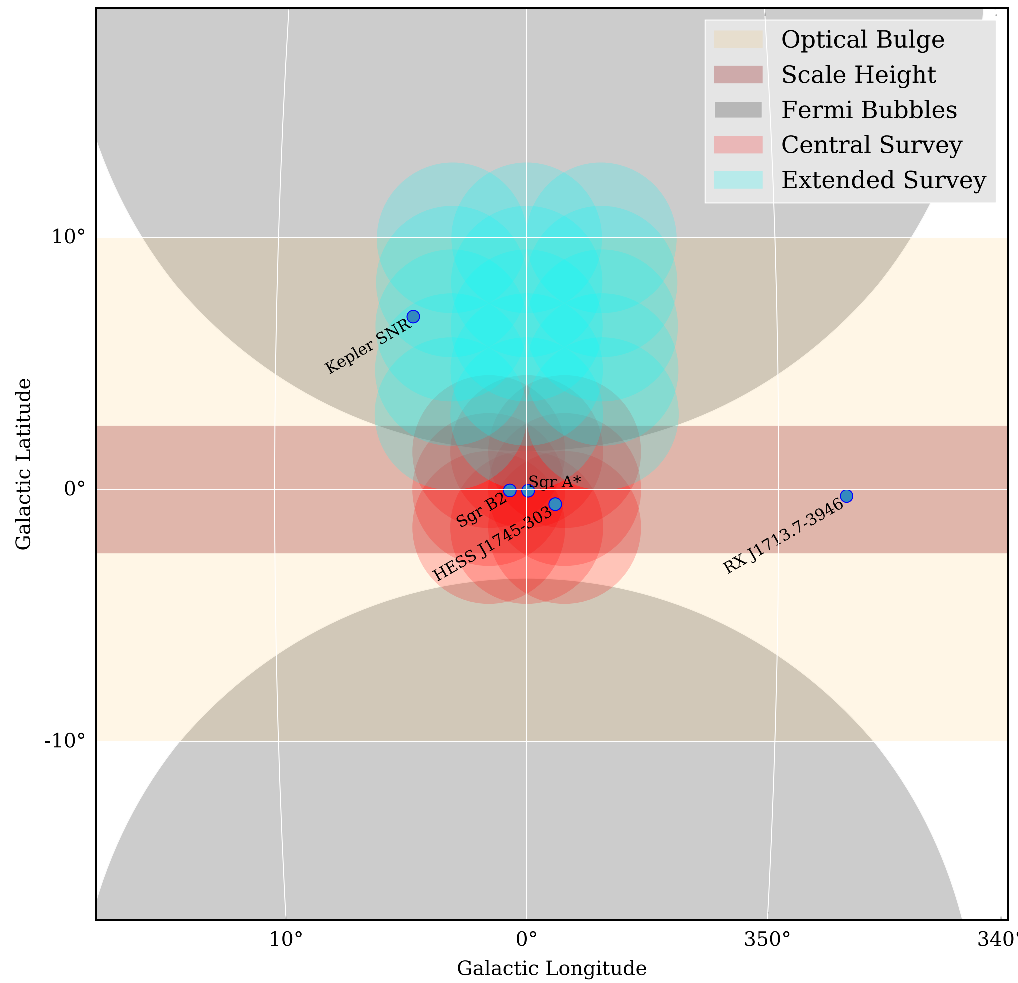


Fermi sources > 50 GeV (2FHL)

New sources

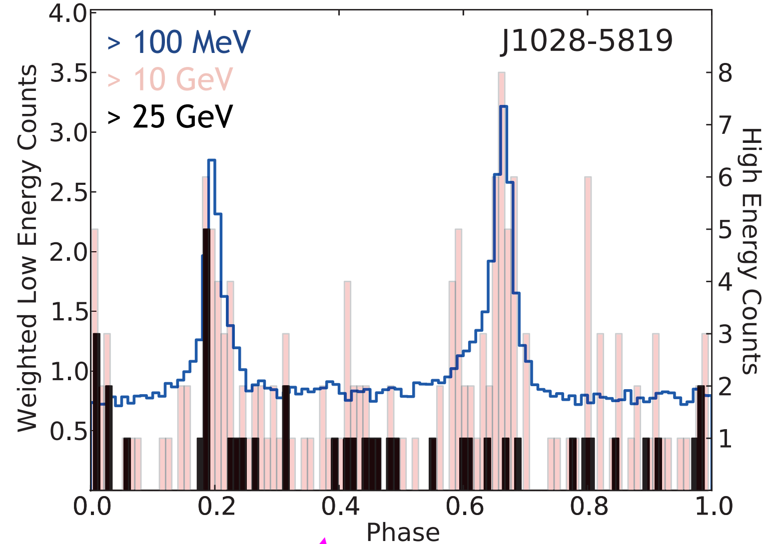
- *Fermi* bubbles, Cygnus cocoon, …
- observing strategy to sample sources comparable or larger than field of view

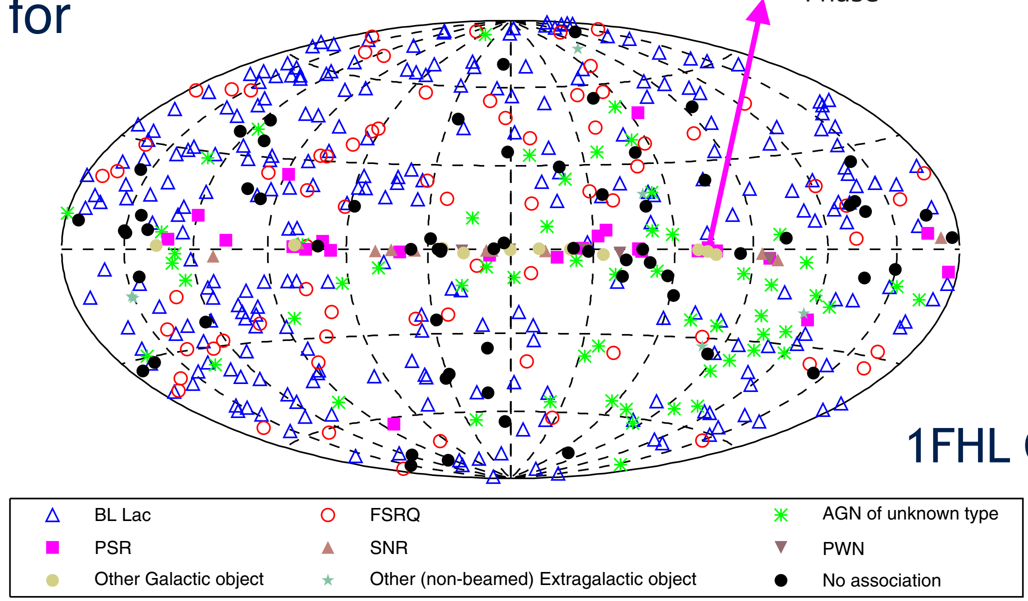
Galactic center survey KSP
800 h



Old sources, new very-high-energy emitters

- source classes newly observed to reach the CTA domain: pulsars, GRBs, …
- e.g., pulsars
  - three detected by current IACTs
  - *Fermi* found a dozen interesting as targets for CTA

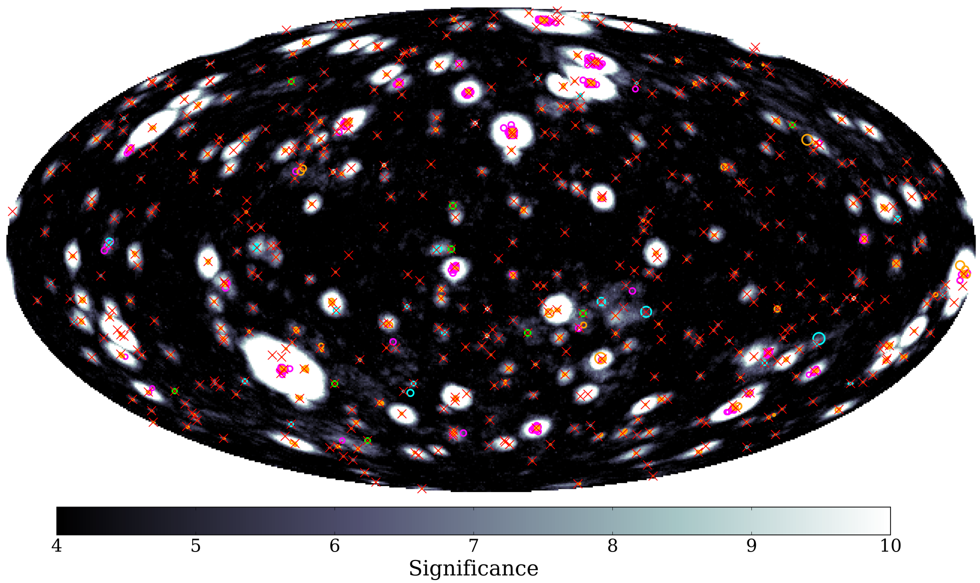




1FHL Catalog

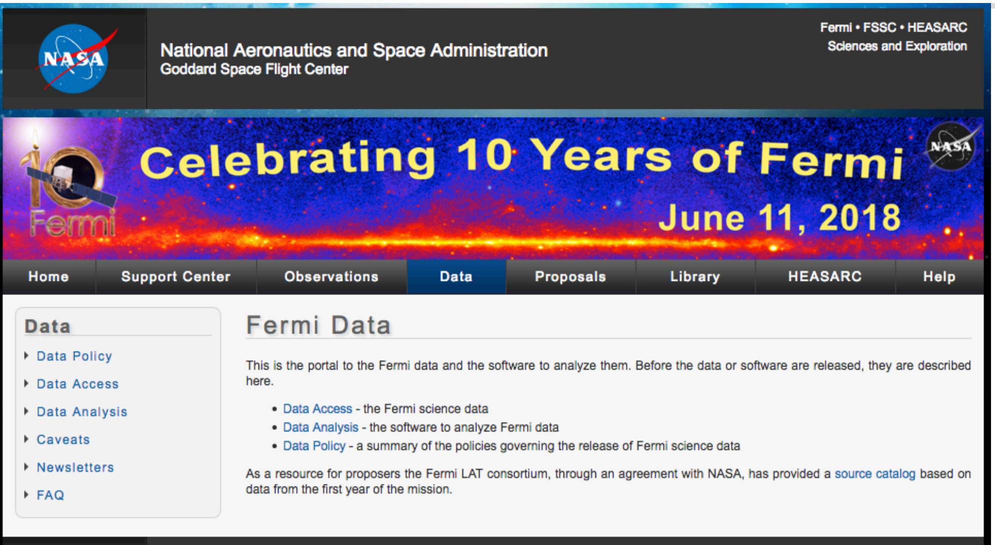
The flaring gamma-ray sky

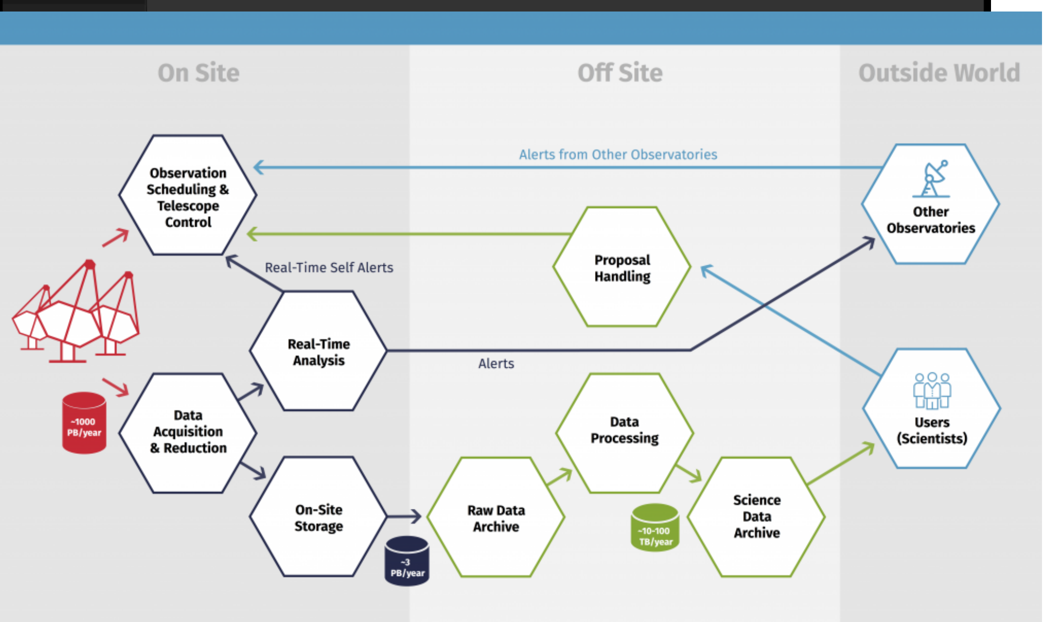
- widespread rapid gamma-ray variability
  - GRBs, AGNs, gamma-ray binaries
  - new classes: novae, PWNe (Crab)
- Transients KSP includes follow-up of *Fermi* flares and investigation of new transient classes discovered by *Fermi*



2FAV catalog of
flaring gamma-ray sources

Open Observatory legacy





- CTA is the first ever ground-based gamma-ray open observatory
- *Fermi* has been inspiring
  - data format and analysis tools
  - data access
  - interactions with other observatories
  - preparation of the team Science program

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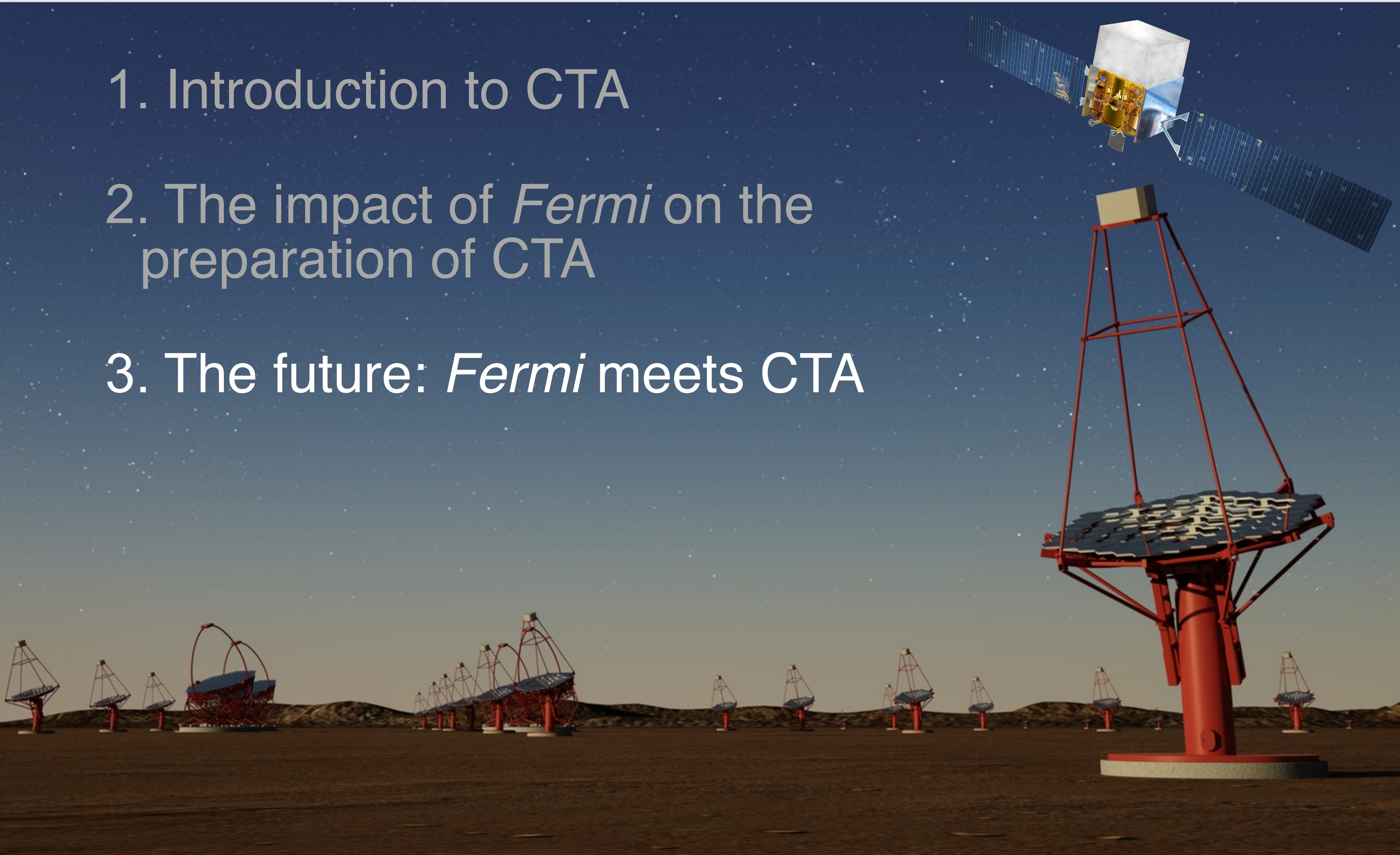
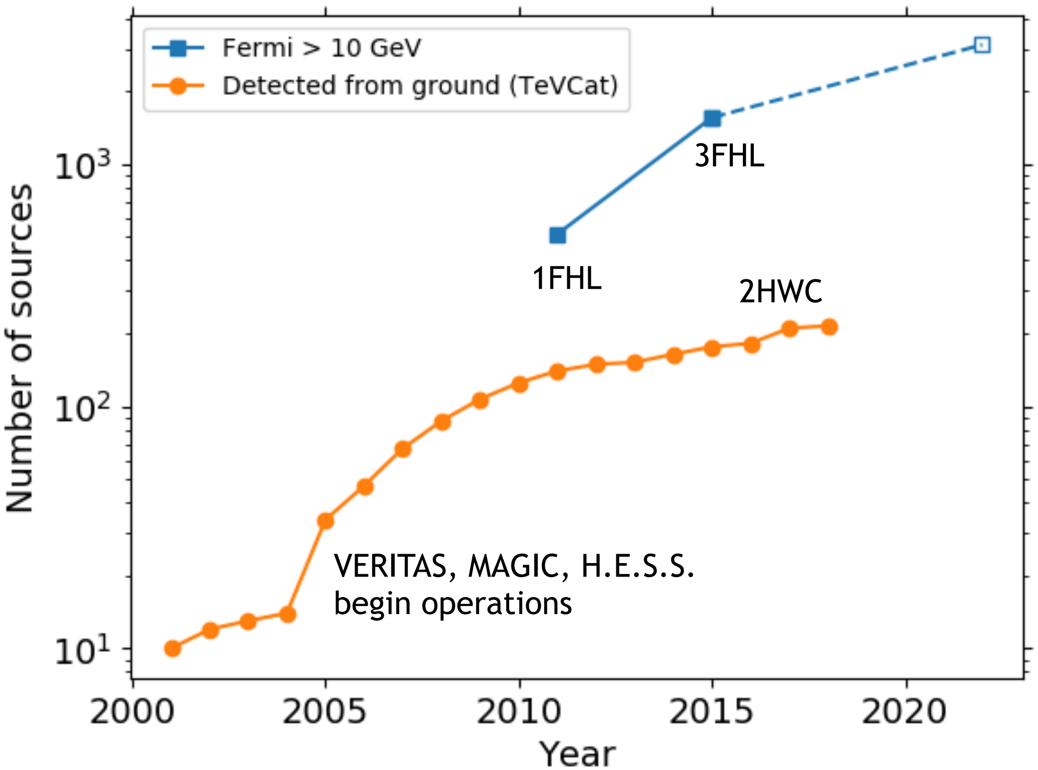
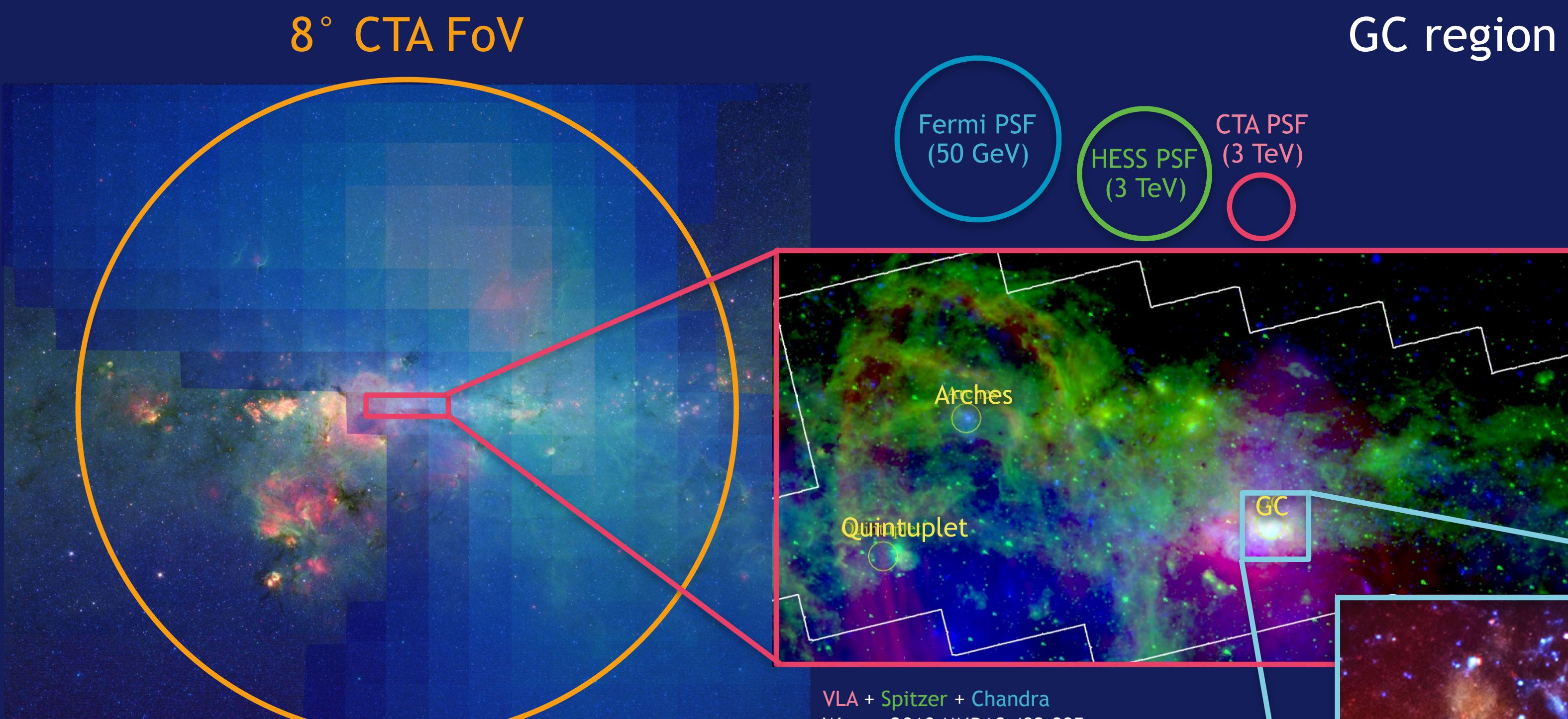


Targets for CTA

- 1556 sources in 3FHL
- count limited, number of sources increases linearly with time
- > 3000 sources at the beginning of CTA scientific operations

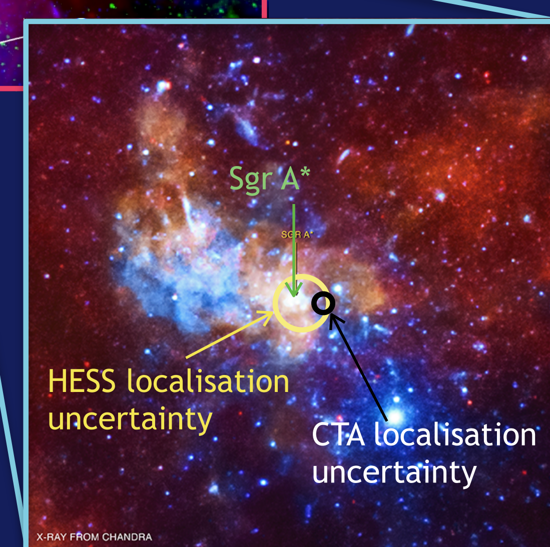


Complementary imaging capabilities



Spitzer
Credit: NASA/JPL Caltech
+ *Fermi* bubbles
Ackermann+ 2017 ApJ 840 43A

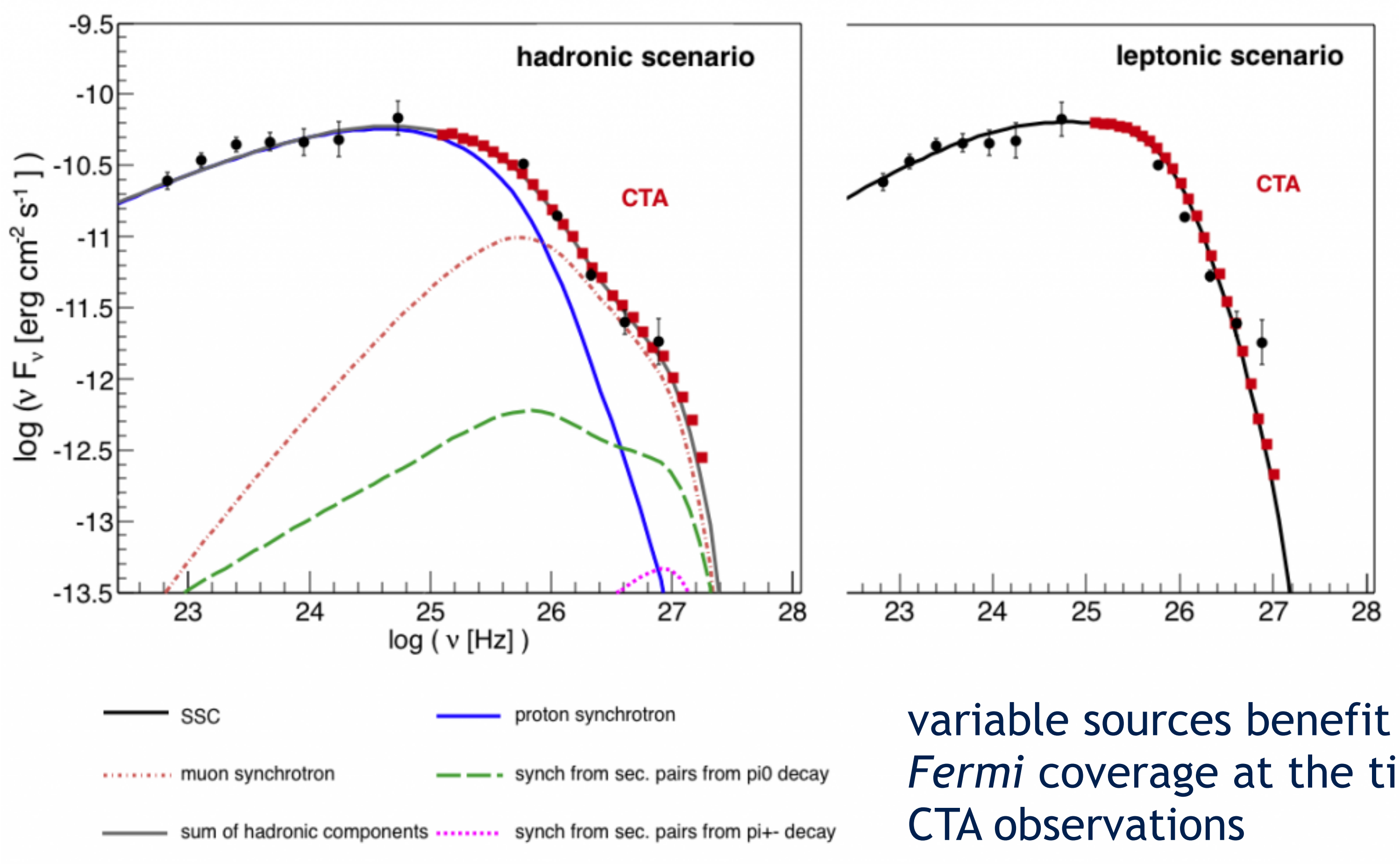
VLA + Spitzer + Chandra
Wang+ 2010 MNRAS 492 895



- *Fermi*: large field of view, low background
- CTA: high angular resolution, high statistics

Broadband spectral coverage

PKS 2155-304
AGN KSP

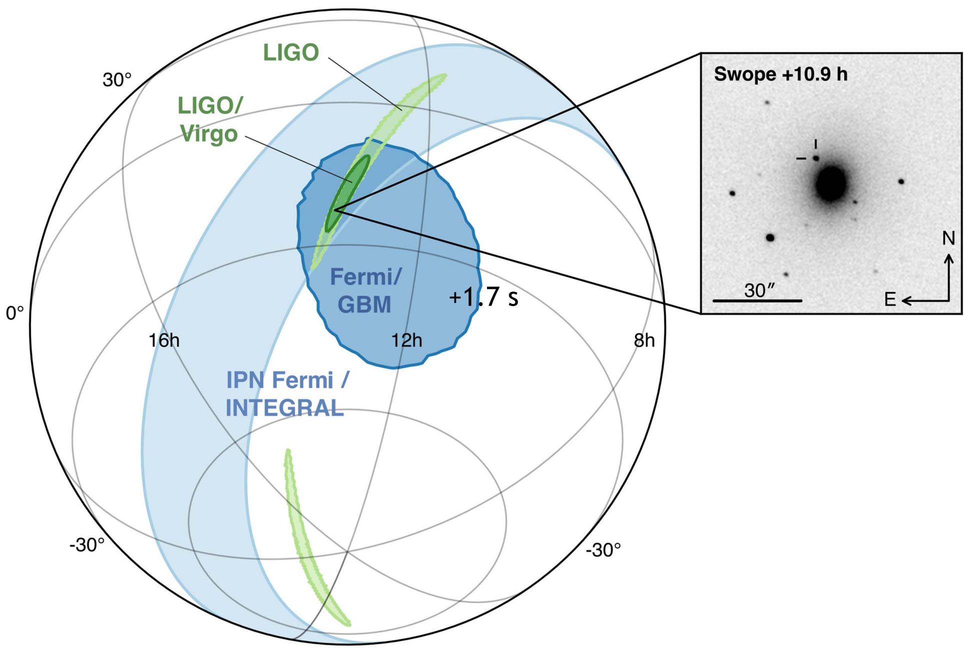


variable sources benefit from *Fermi* coverage at the time of CTA observations

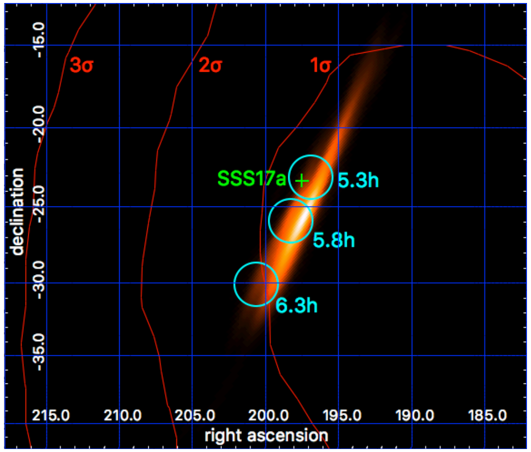
Transient triggers

GW170817

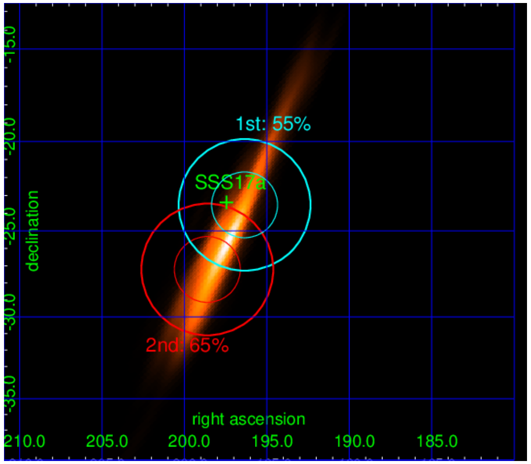
Abbot et al. (2017) ApJ 848L 12



H.E.S.S. follow up within 24 h
Abdalla et al. (2017) ApJ 850L 22A



simulated follow up with CTA
credit: Fabian Schüssler



CTA large telescopes will slew to any observable direction in < 50 s (goal 20 s)

Final remarks

- CTA making progress toward scientific operations
- *Fermi* helped defining and shaping CTA's Science program
- *Fermi* and CTA together: complementary imaging capabilities, broadband spectral coverage, time-domain astronomy