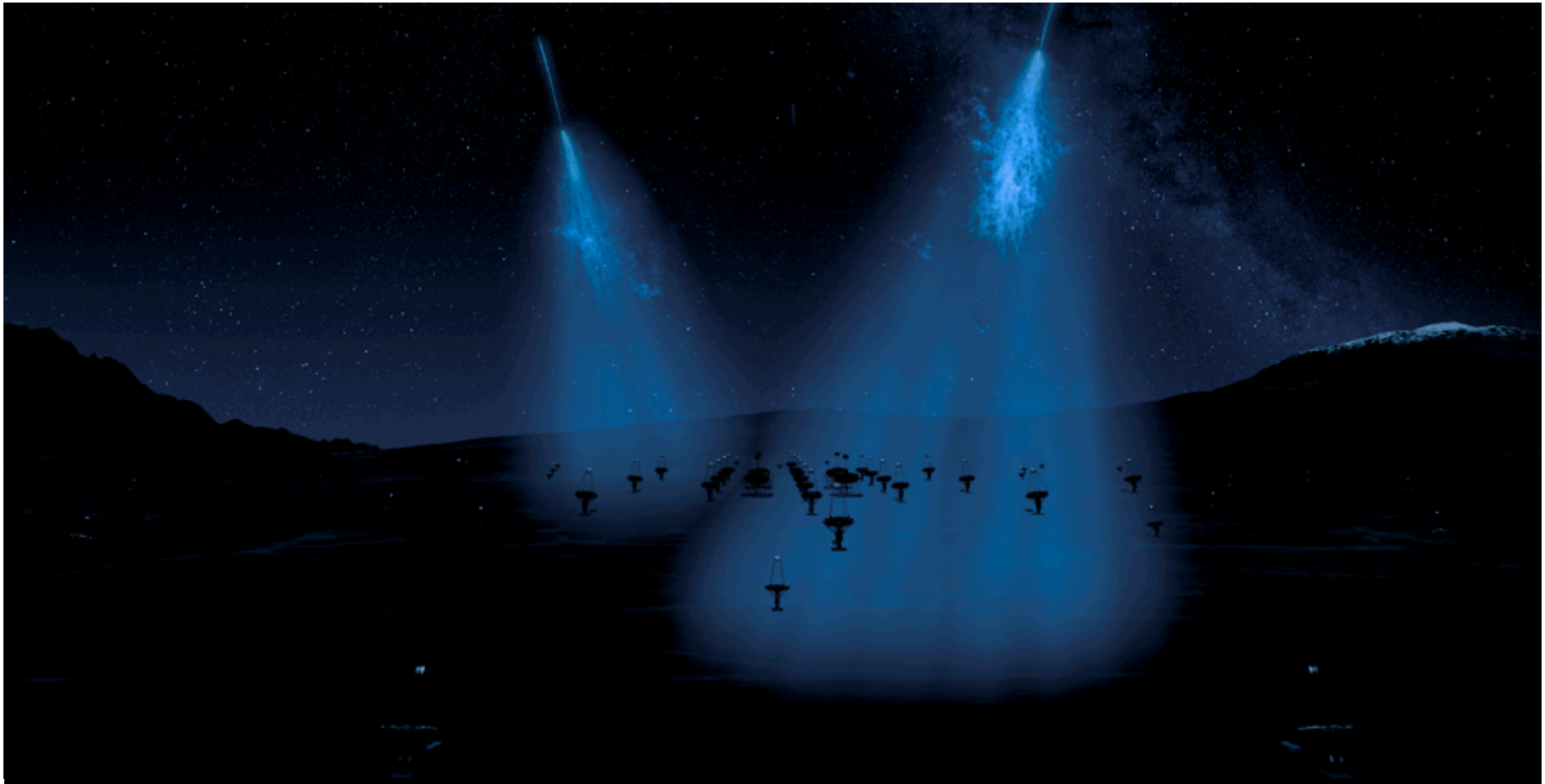
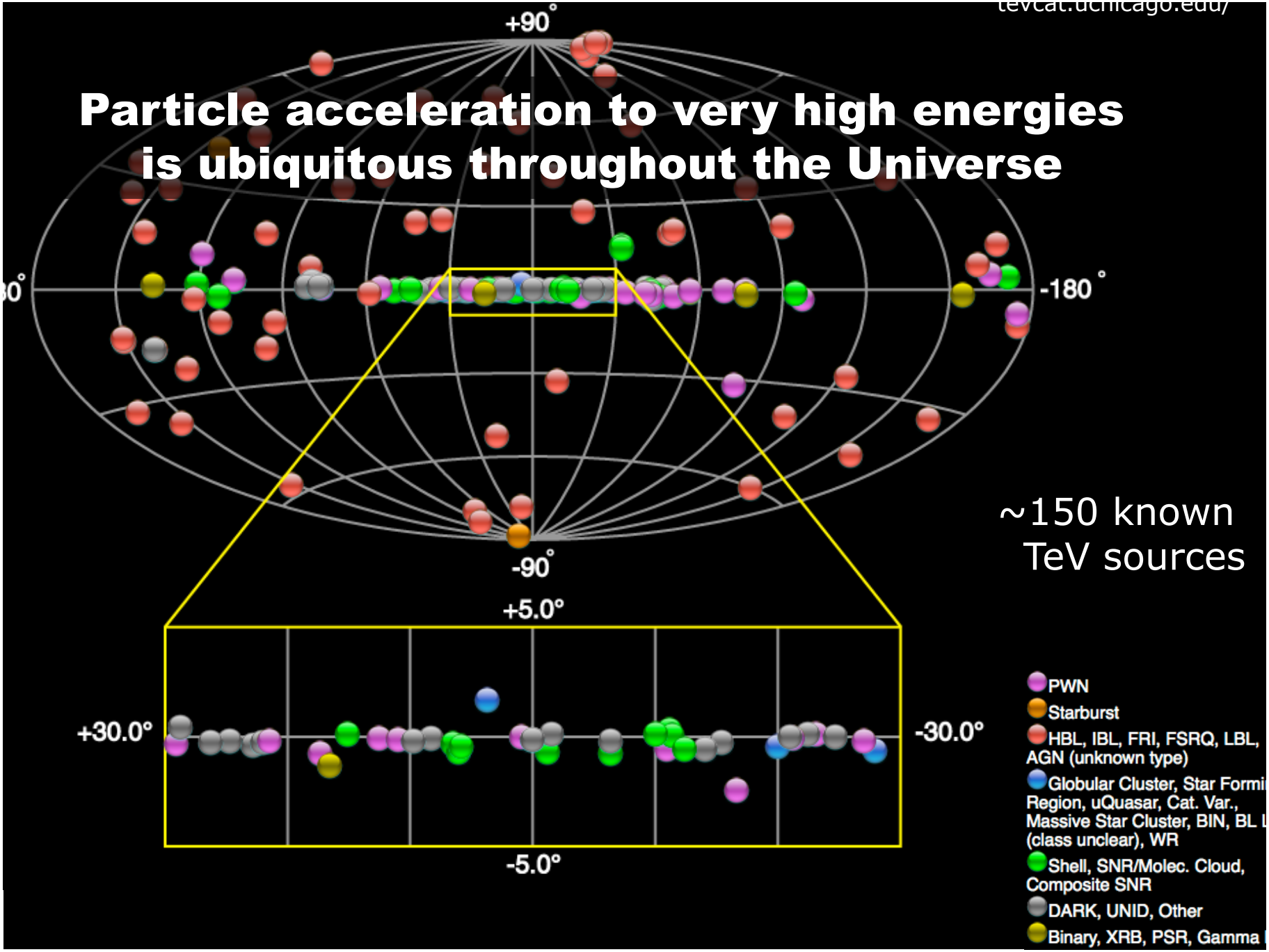
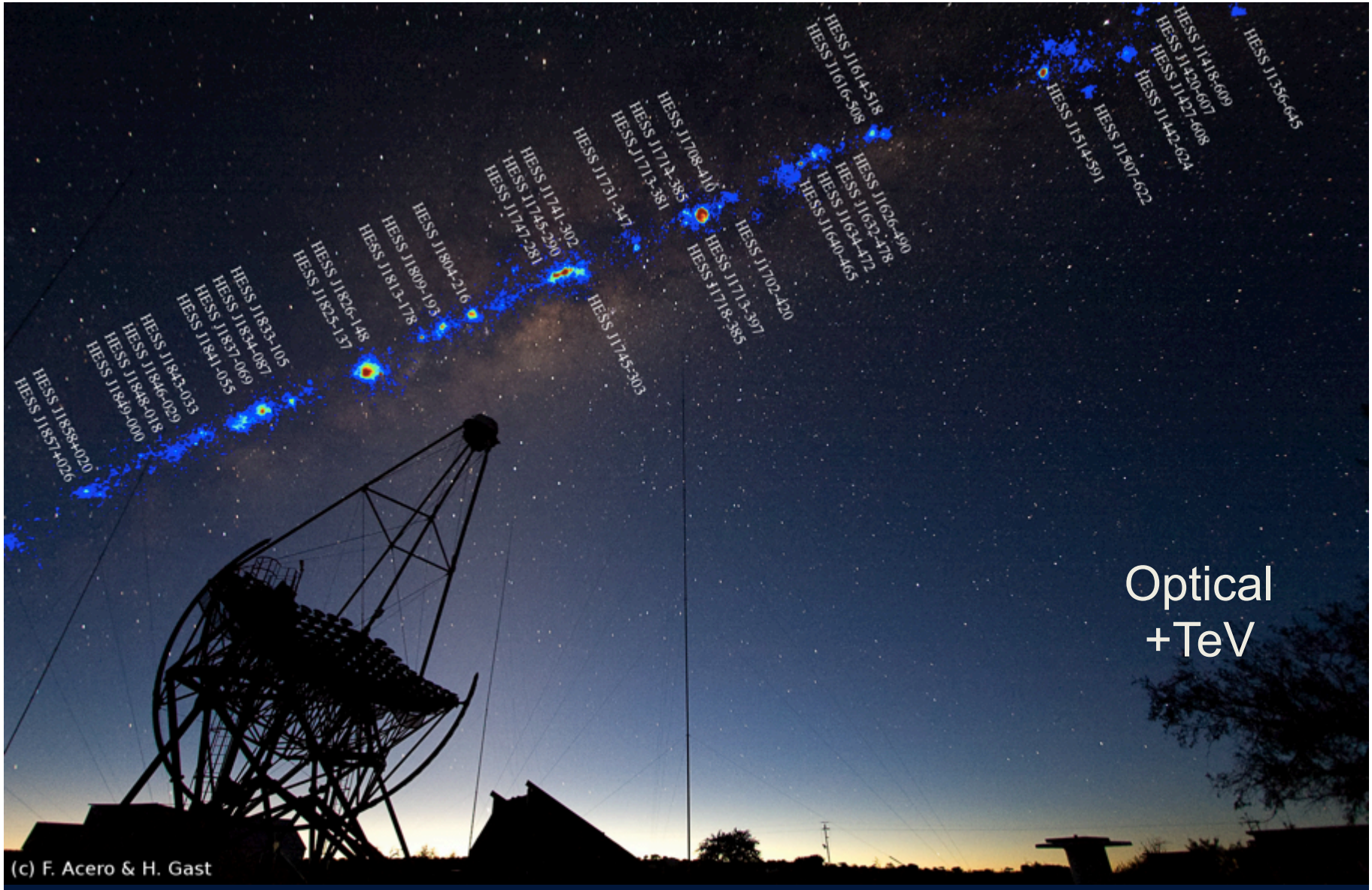


The Cherenkov Telescope Array

Garret Cotter, University of Oxford
for the CTA Consortium

SciNeGHE 2014

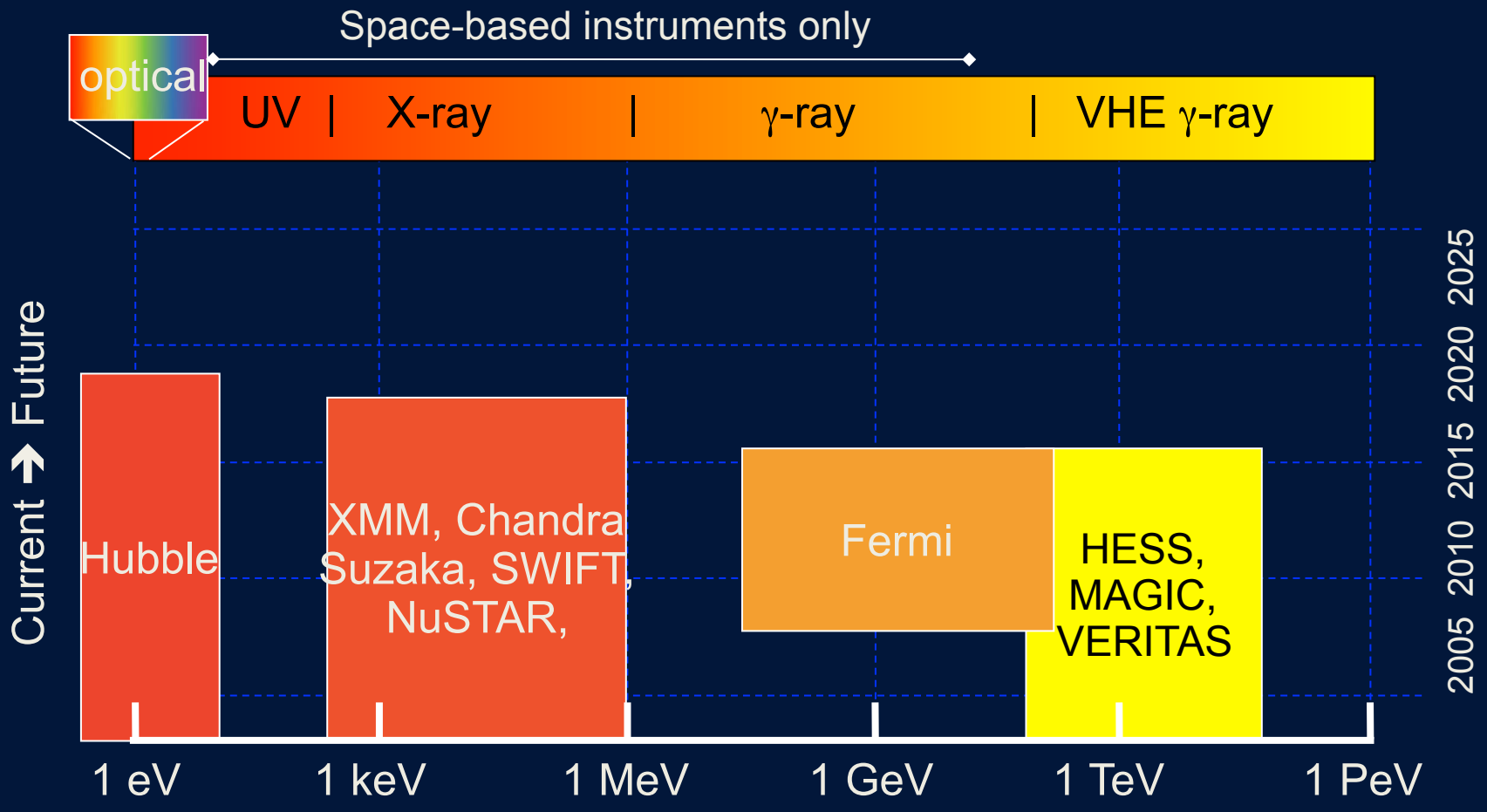

tevcat.uchicago.edu/
Particle acceleration to very high energies is ubiquitous throughout the Universe
+90°
-180°
-90°
+5.0°
+30.0°
-30.0°
-5.0°
~150 known TeV sources
PWN
Starburst
HBL, IBL, FRI, FSRQ, LBL, AGN (unknown type)
Globular Cluster, Star Formi Region, uQuasar, Cat. Var., Massive Star Cluster, BIN, BL L (class unclear), WR
Shell, SNR/Molec. Cloud, Composite SNR
DARK, UNID, Other
Binary, XRB, PSR, Gamma



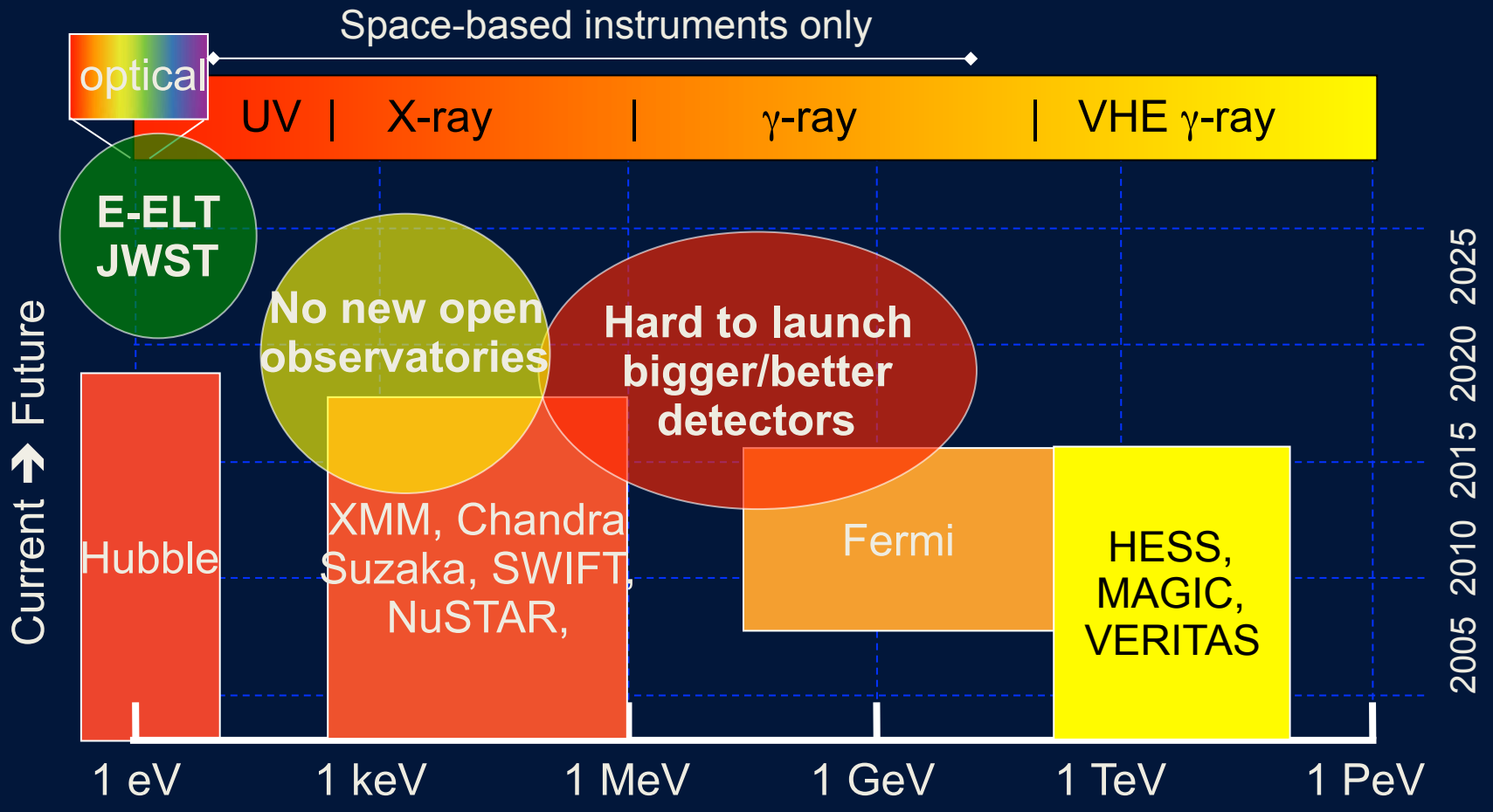
cta
cherenkov telescope array

Cherenkov Telescope Array SciNeGHE 2014

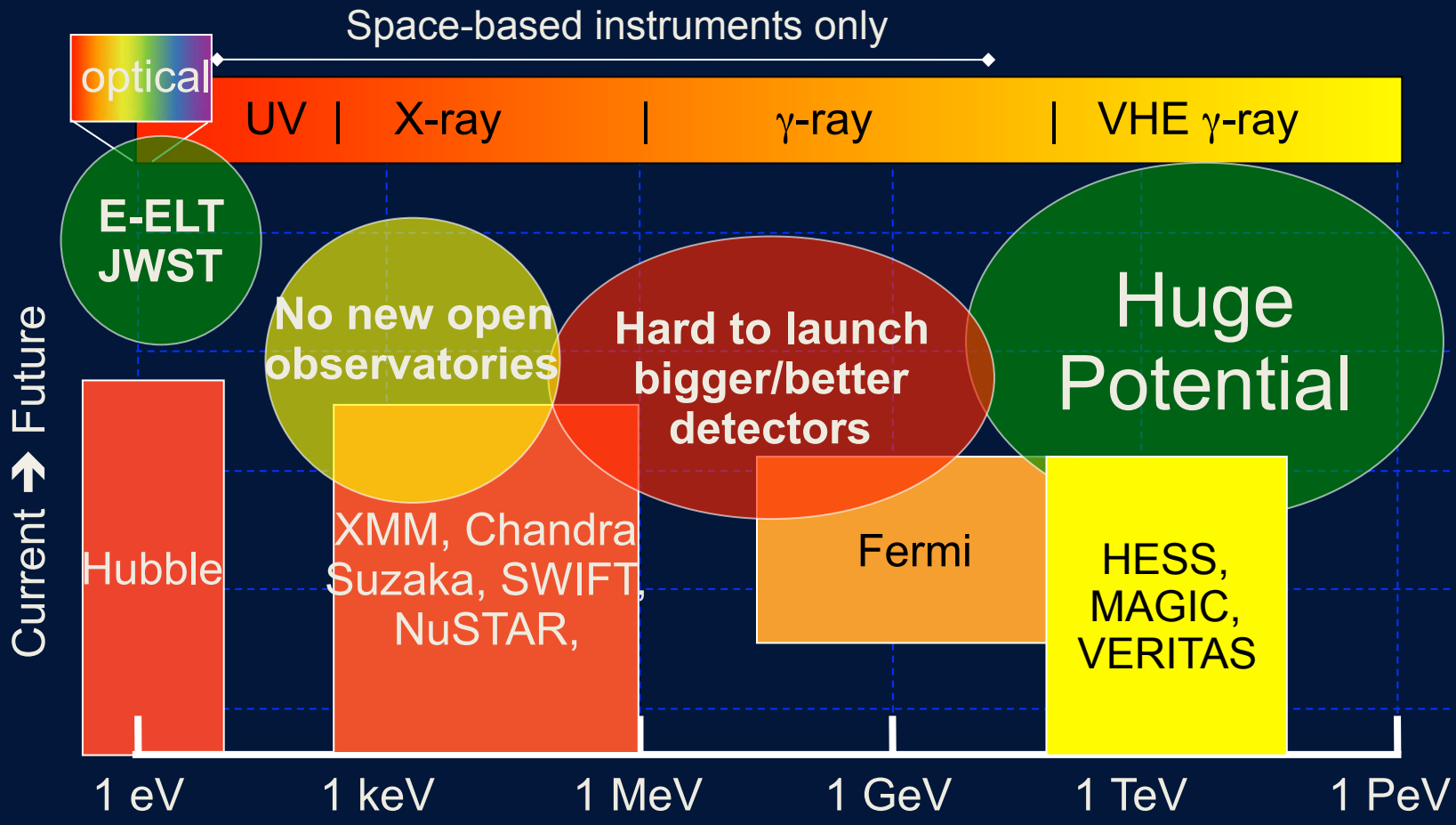
High Energy Astronomy



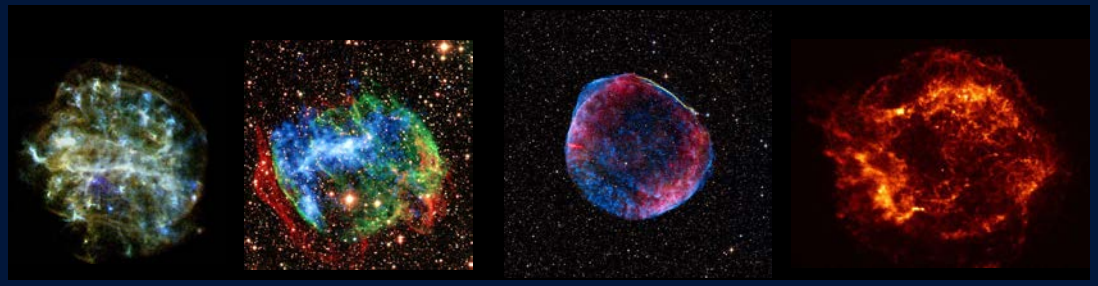
High Energy Future?

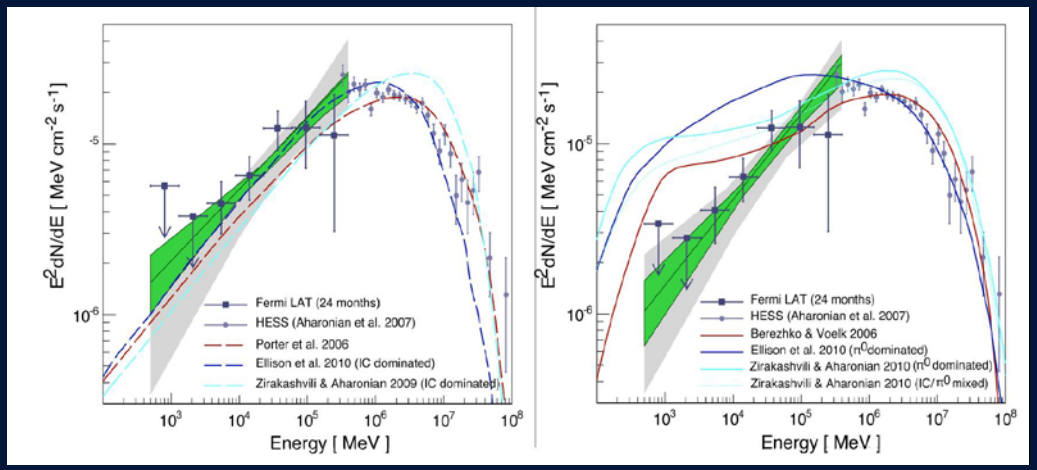


High Energy Future?

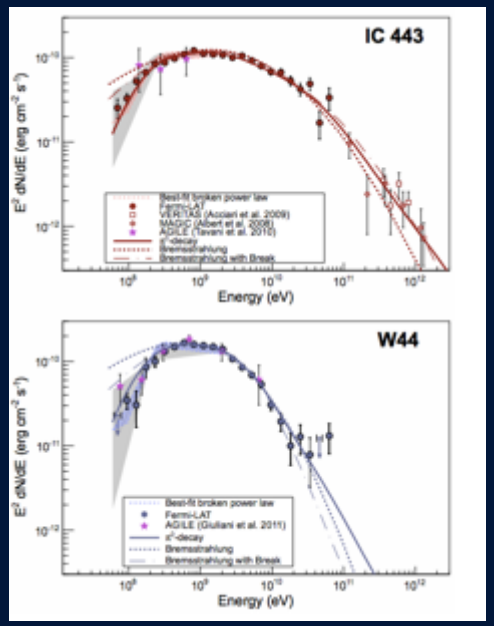


Galactic cosmic rays



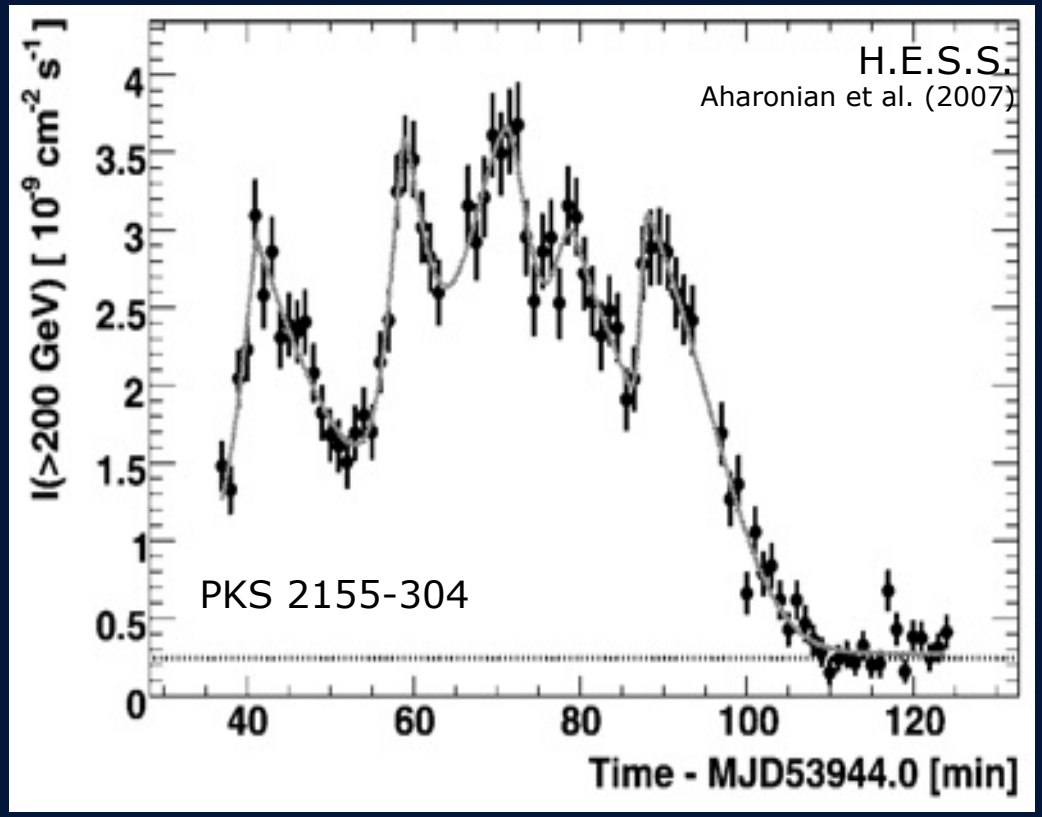


Funk, *AIP Conf. Proc. 1516*, 127 (2013)



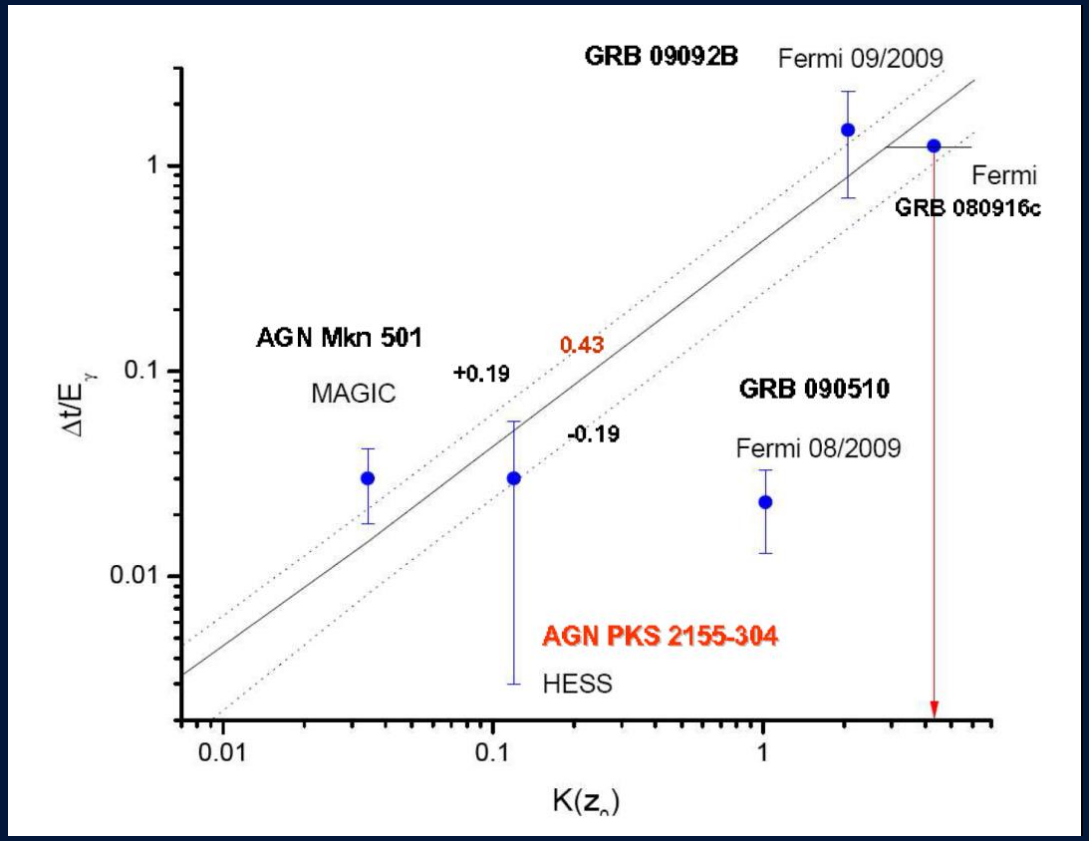
Ackermann et al. *Science*, **339**, 807 (2013)

Acceleration in AGN – Blazar variability



Jet physics
+
LIV

Lorentz Invariance Violation



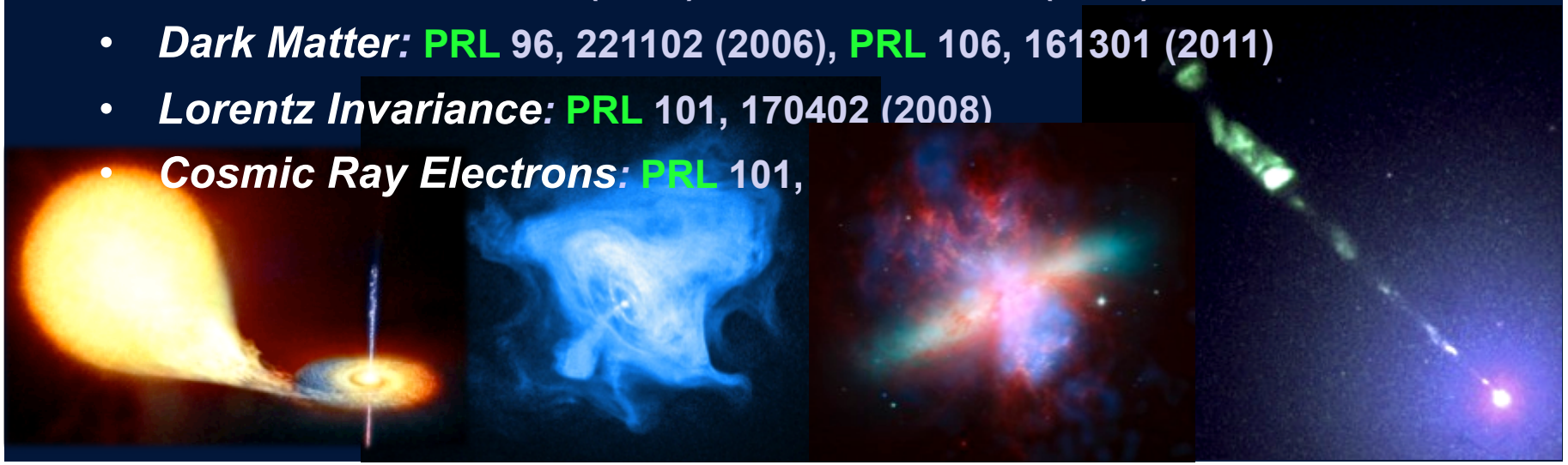
Best limit to date is via *Fermi* for a z=0.9 GRB

Ellis et al., *Int. J. Mod. Phys.*, A26 (2011)

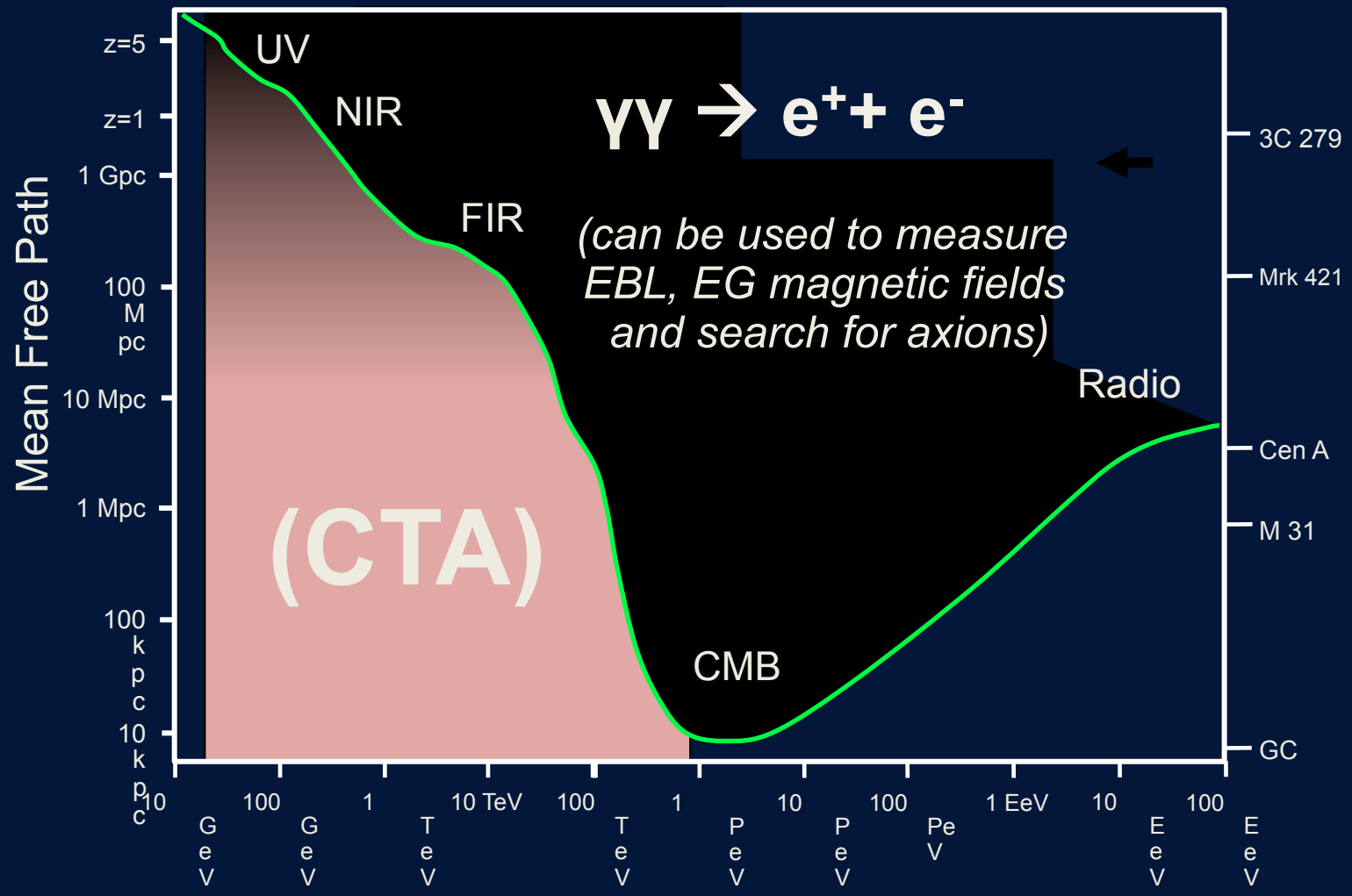
TeV Highlights

Results from **HESS, MAGIC** and **VERITAS**

- *Microquasars:* Science 309, 746 (2005), Science 312, 1771 (2006)
- *Pulsars:* Science 322, 1221 (2008), Science 334, 69 (2011)
- *Supernova Remnants:* Nature 432, 75 (2004)
- *The Galactic Centre:* Nature 439, 695 (2006)
- *Galactic Survey:* Science 307, 1839 (2005)
- *Starbursts:* Nature 462, 770 (2009), Science 326,1080 (2009)
- *AGN:* Science 314,1424 (2006), Science 325, 444 (2009)
- *EBL:* Nature 440, 1018 (2006), Science 320, 752 (2008)
- *Dark Matter:* PRL 96, 221102 (2006), PRL 106, 161301 (2011)
- *Lorentz Invariance:* PRL 101, 170402 (2008)
- *Cosmic Ray Electrons:* PRL 101,

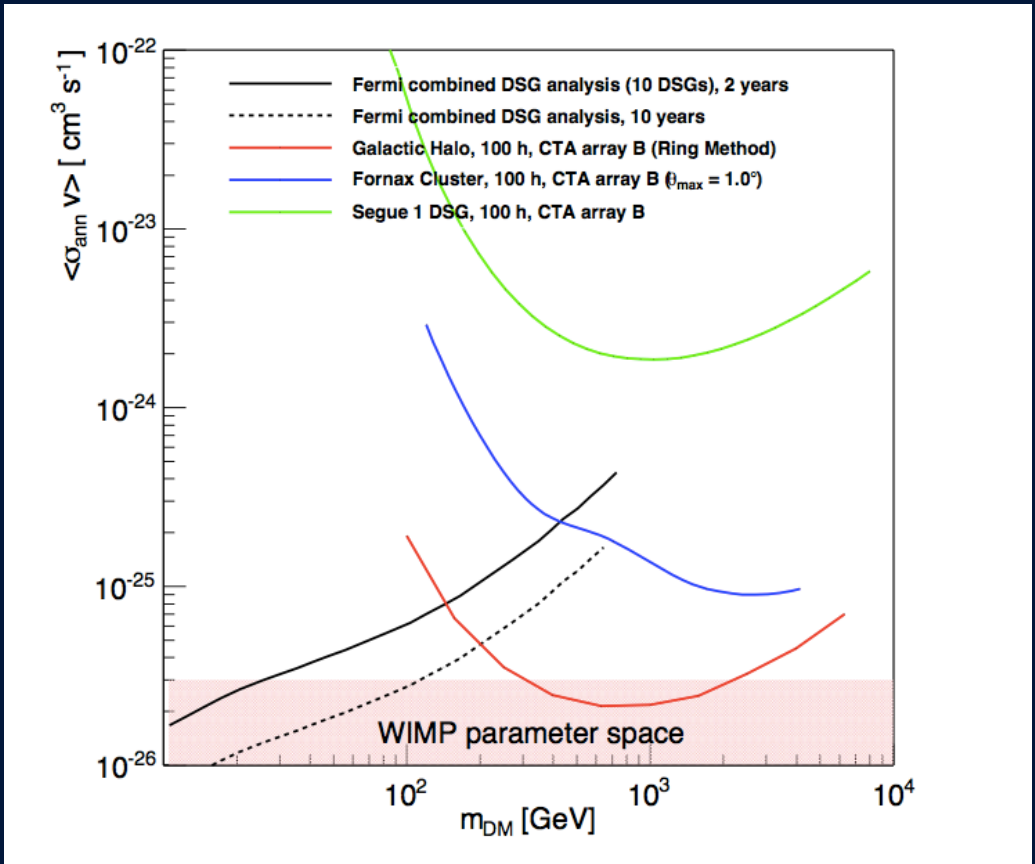


++ EBL, Axions…



cta cherenkov telescope array

Dark matter detection



Doro et al. APh 43, 198, 2013

The frontier of VHE gamma-ray astronomy

Key results that are still elusive:

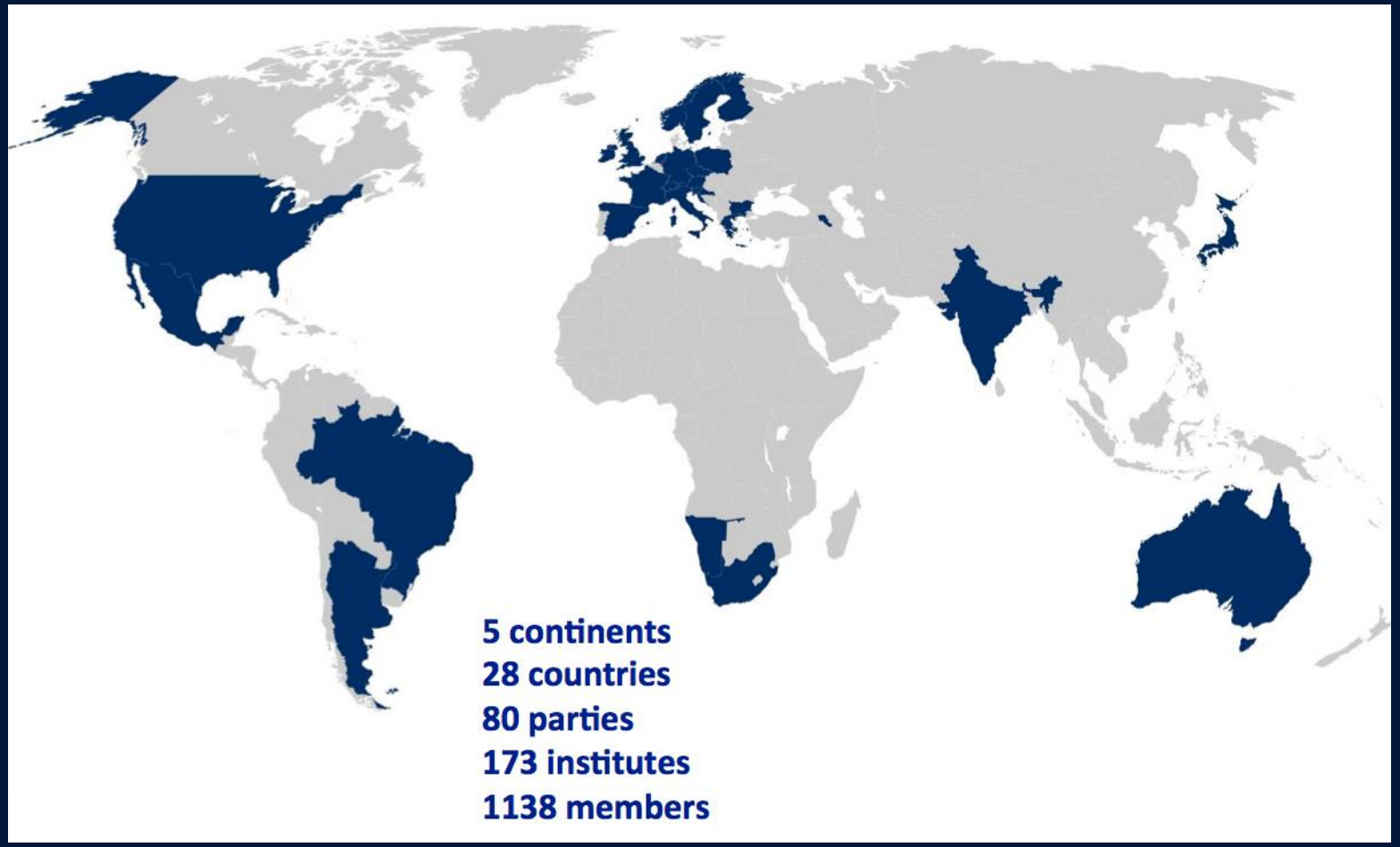
- **Galaxy clusters as cosmological stores of CRs**
- **No GRBs at VHE yet**
- **Dark matter annihilation signal**

Key questions that remain:

- **Are SNRs the primary source of Galactic CRs?**
- **What is the energy conversion mechanism in pulsars?**
- **What is the production mechanism in AGN?**

CTA: The Consortium

CTA Consortium 2014



The CTA Science Themes

Theme 1: Cosmic Particle Acceleration

- **How and where are particles accelerated?**
- **How do they propagate?**
- **What is their impact on the environment?**

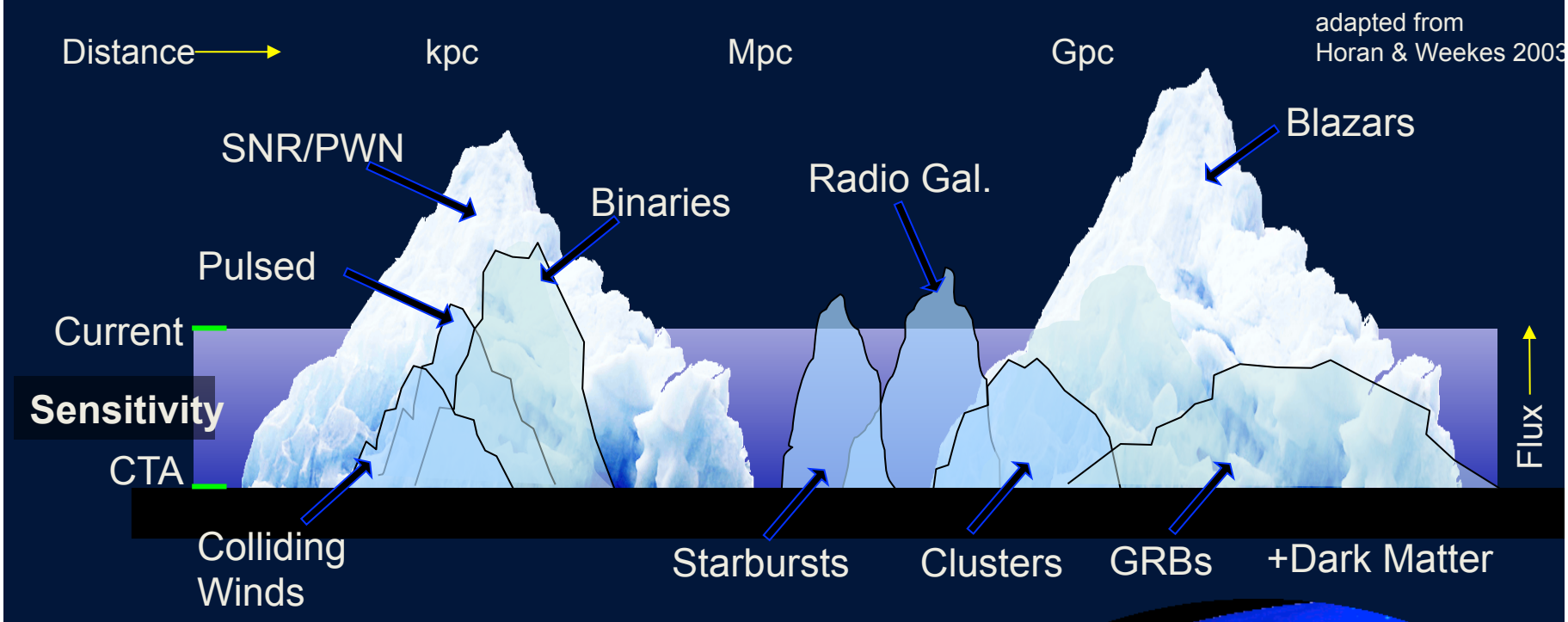
Theme 2: Probing Extreme Environments

- **Processes close to neutron stars and black holes**
- **Processes in relativistic jets, winds and explosions**
- **Exploring cosmic voids**

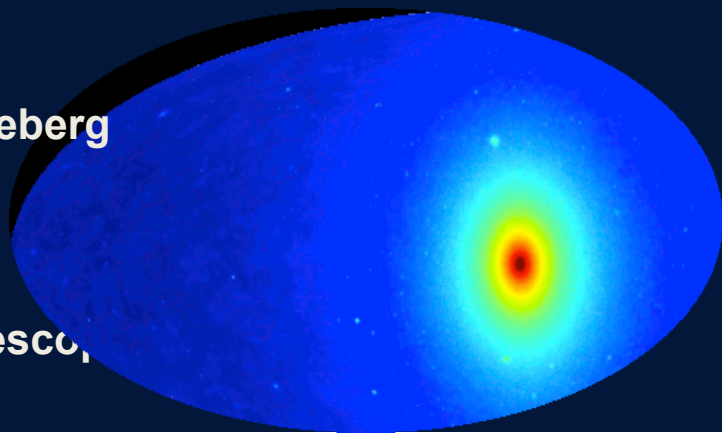
Theme 3: Physics Frontiers – beyond the SM

- **What is the nature of Dark Matter? How is it distributed?**
- **Is the speed of light a constant for high energy photons?**
- **Do axion-like particles exist?**

CTA Science Targets

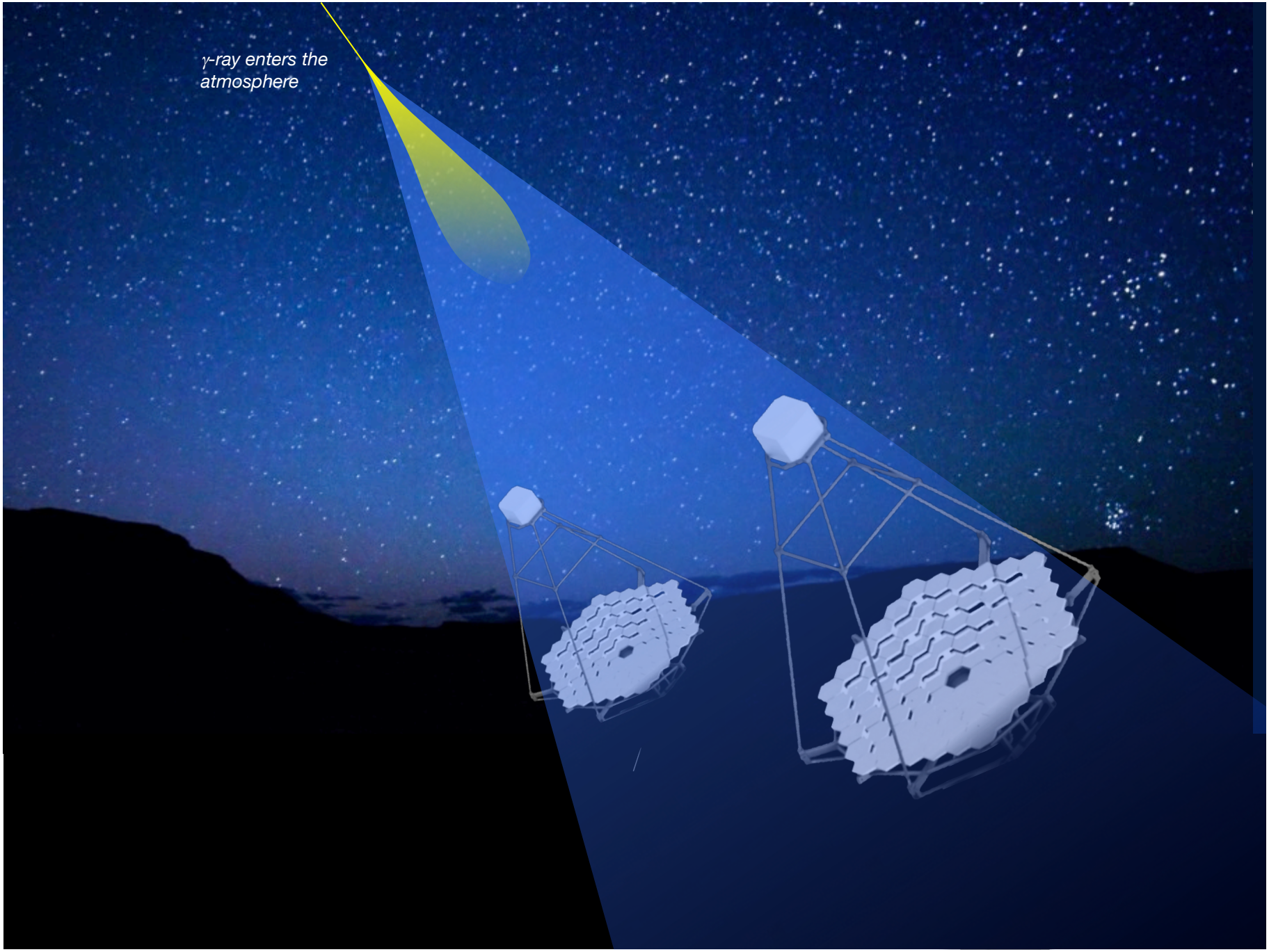


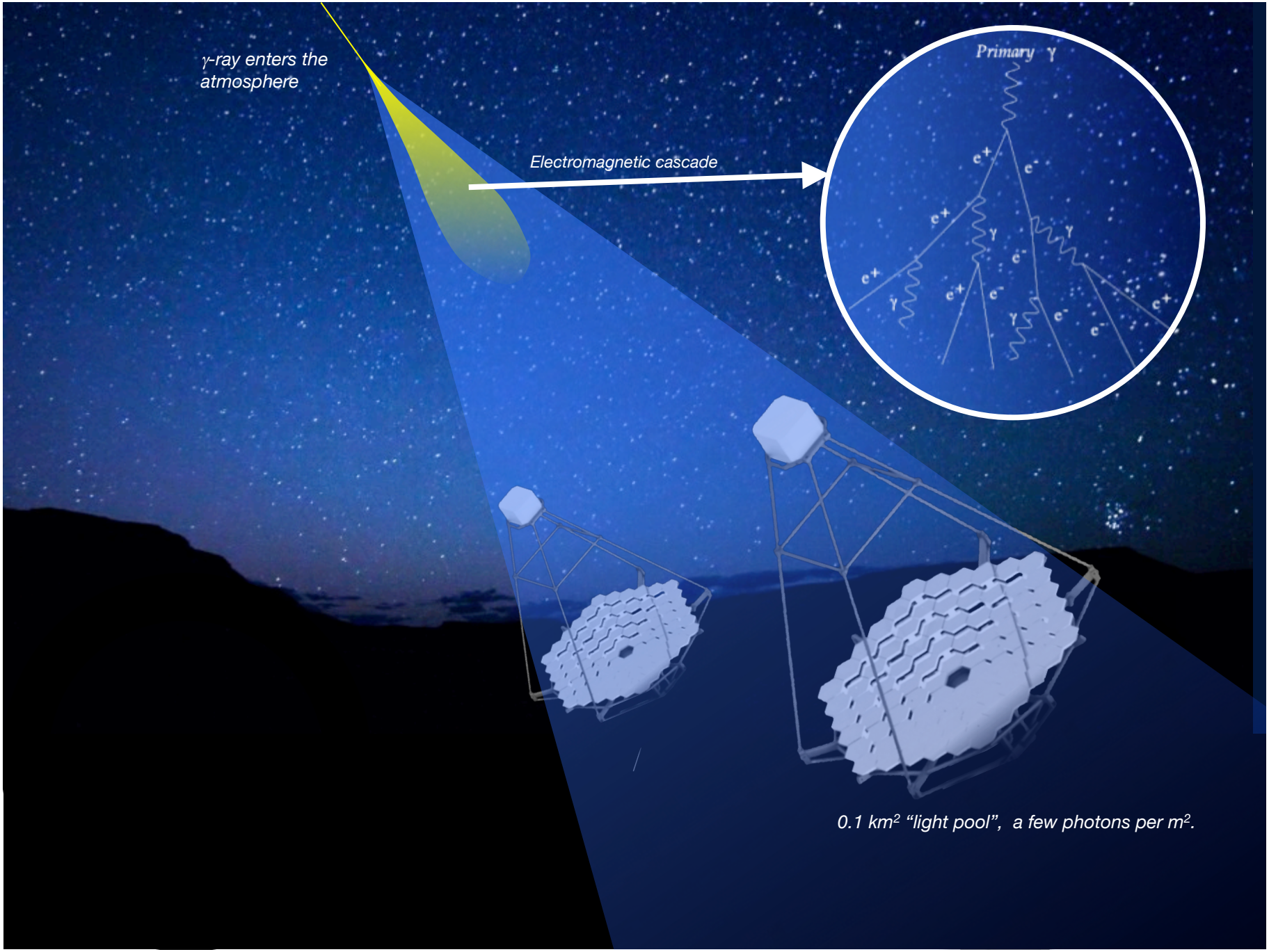
- **Guaranteed astrophysics**
  - **Current detections are the tip of the iceberg**
- **Major discovery potential**
  - **Including really fundamental physics**

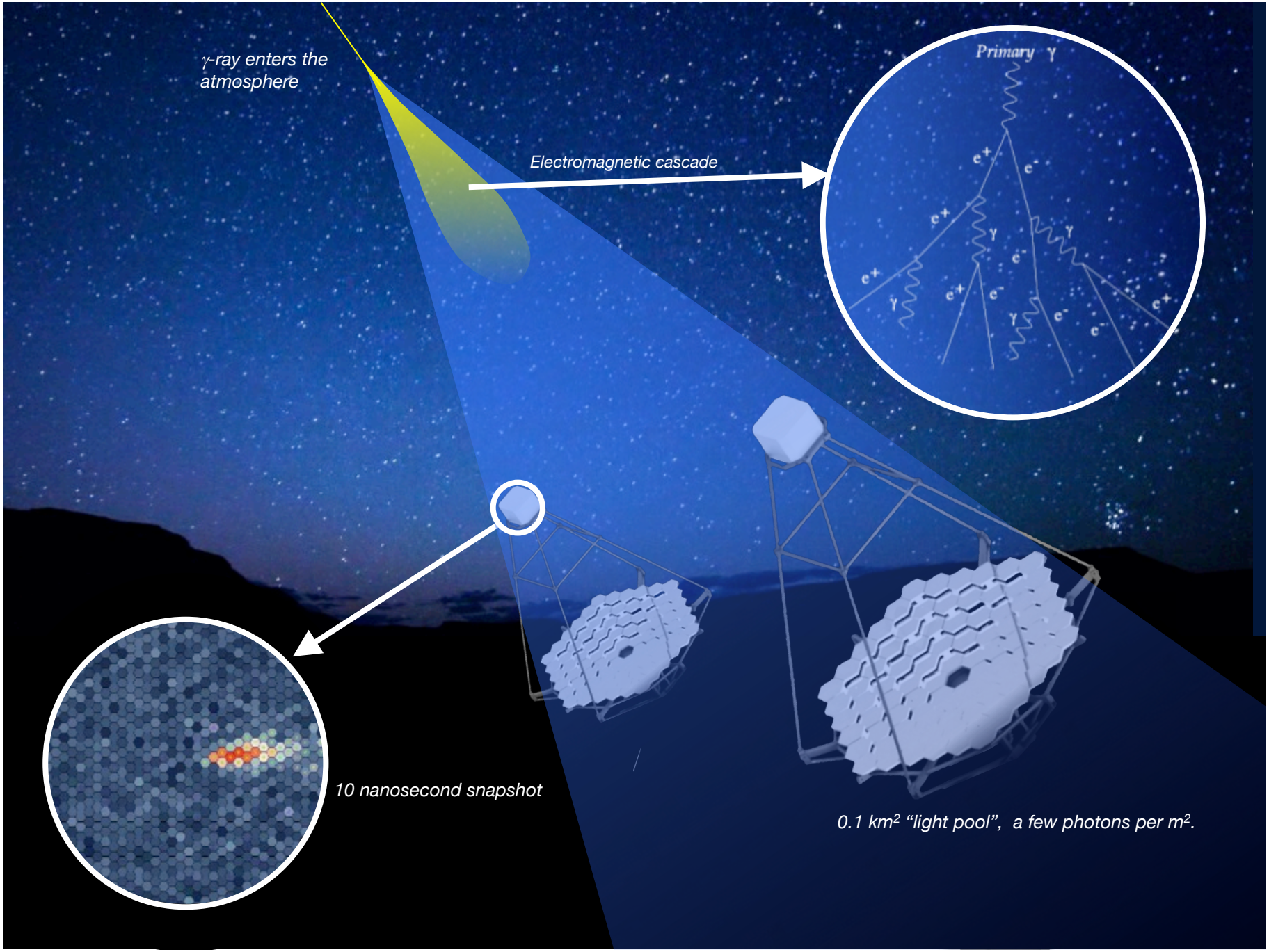


cta
cherenkov telescope array

Cherenkov Telesco


γ-ray enters the
atmosphere

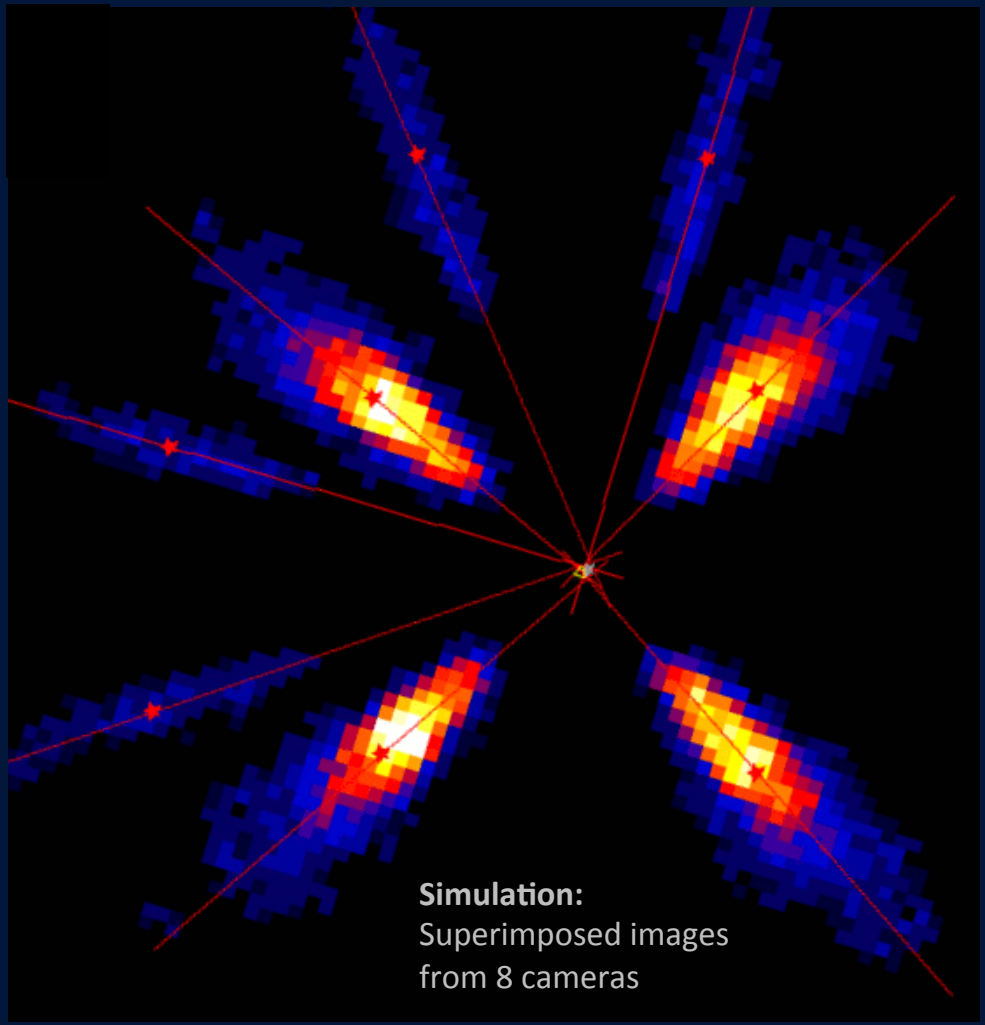

γ-ray enters the atmosphere
Electromagnetic cascade
Primary γ
0.1 km² "light pool", a few photons per m².


γ-ray enters the atmosphere
Electromagnetic cascade
Primary γ
10 nanosecond snapshot
0.1 km² "light pool", a few photons per m².

How to do better?

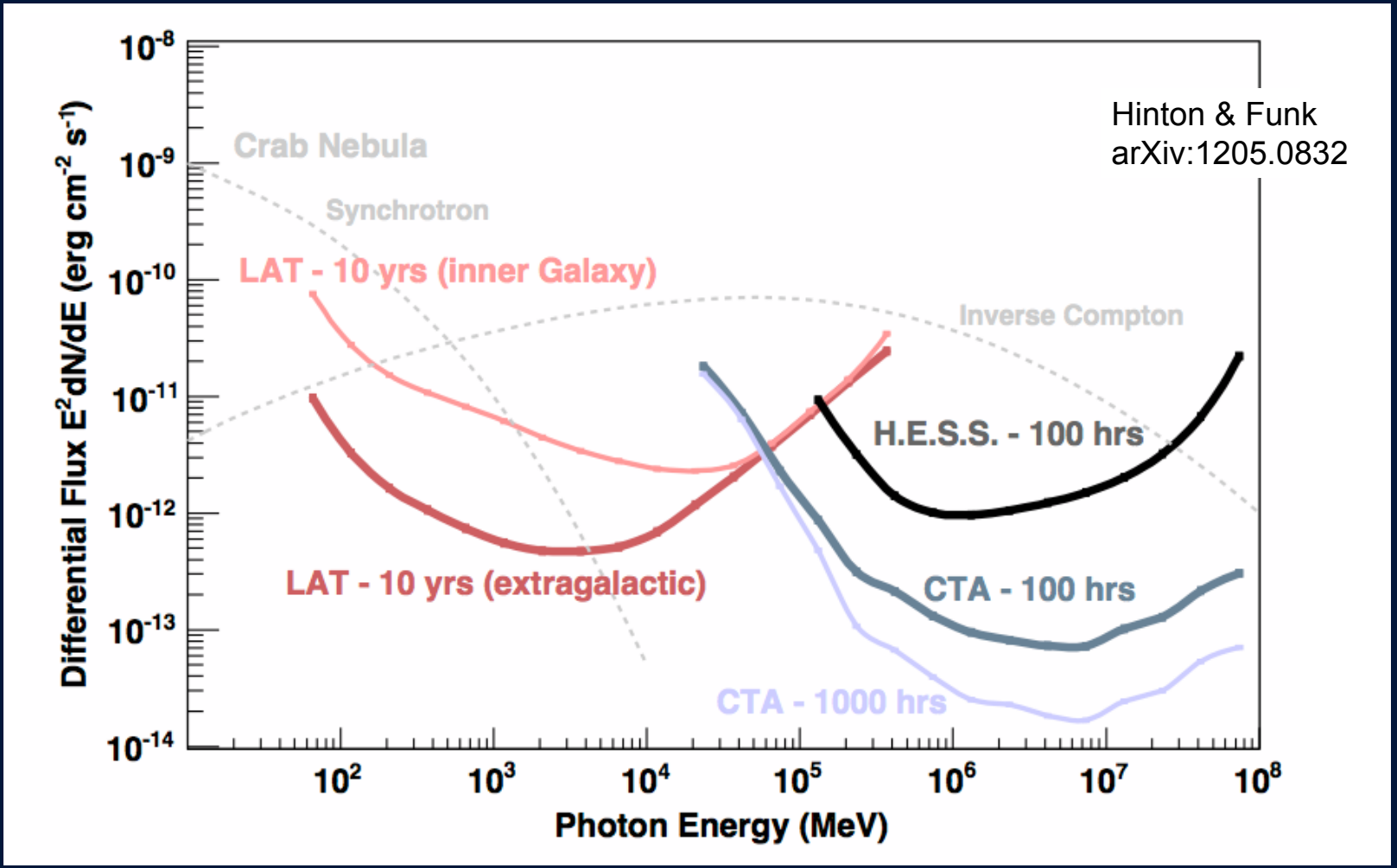
- More events
  - More photons = better spectra, images, fainter sources
    - Larger collection area for gamma-rays
- Better events
  - More precise measurements of atmospheric cascades and hence primary γ-rays
    - Improved angular resolution
    - Improved background rejection power

☞ More telescopes!

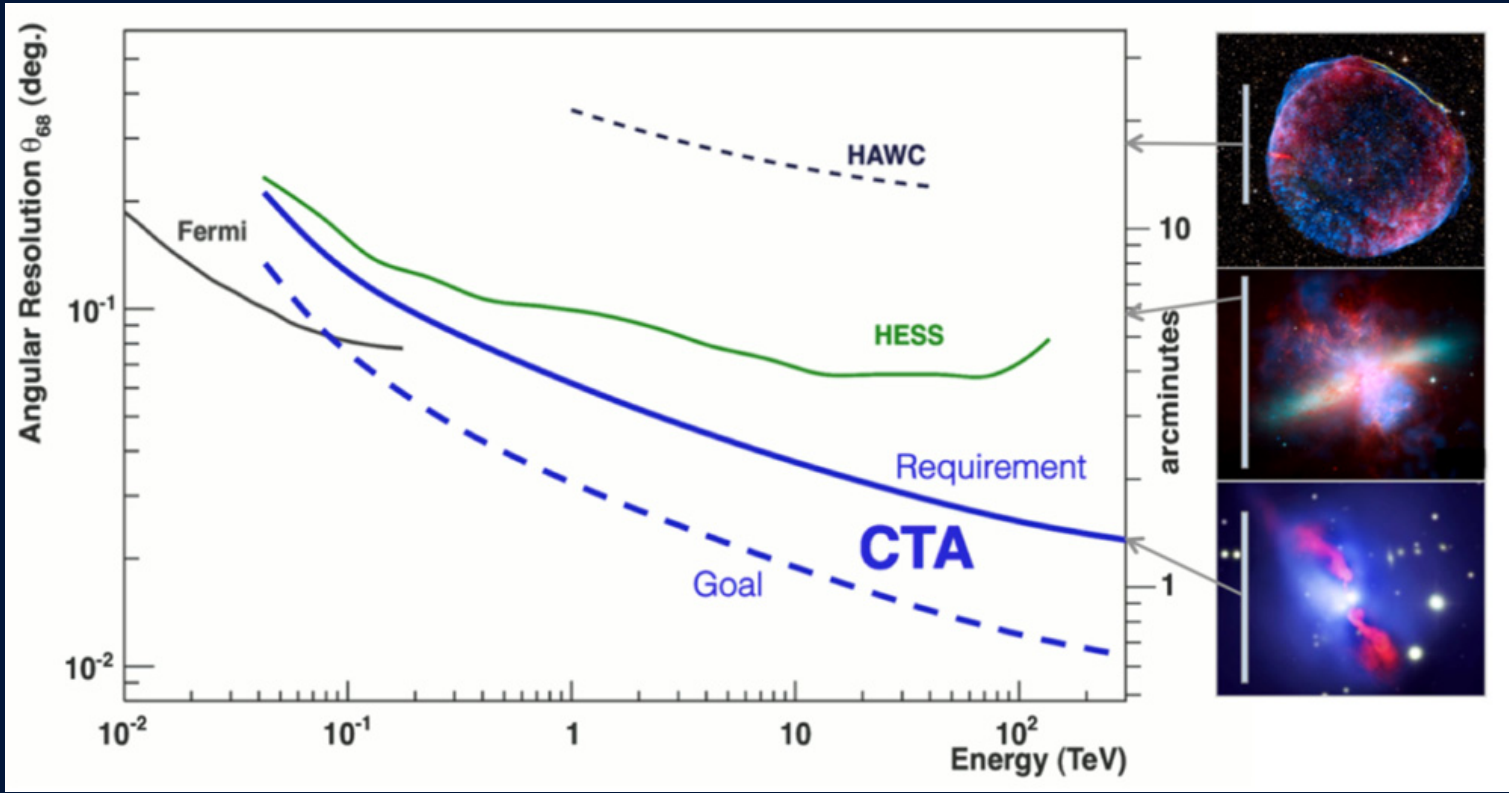


Simulation:
Superimposed images
from 8 cameras

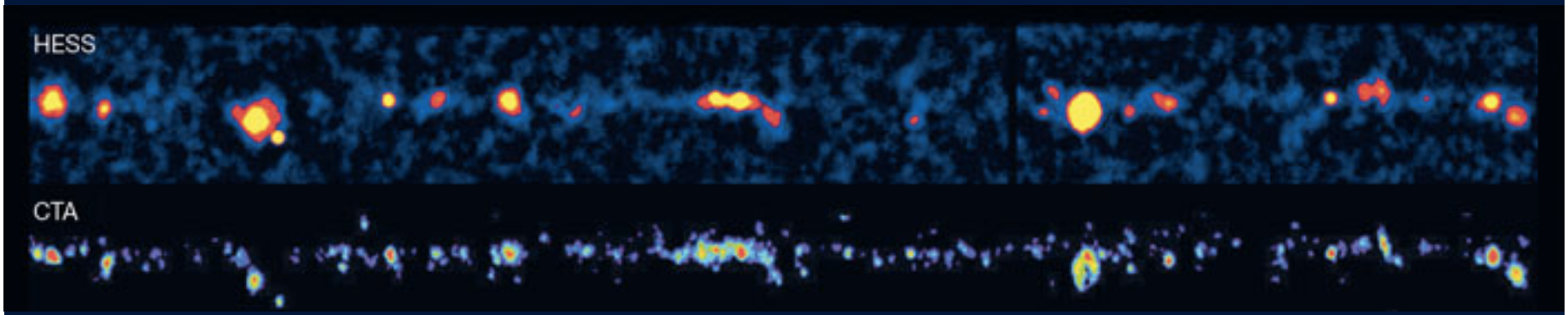
Flux Sensitivity



Angular resolution



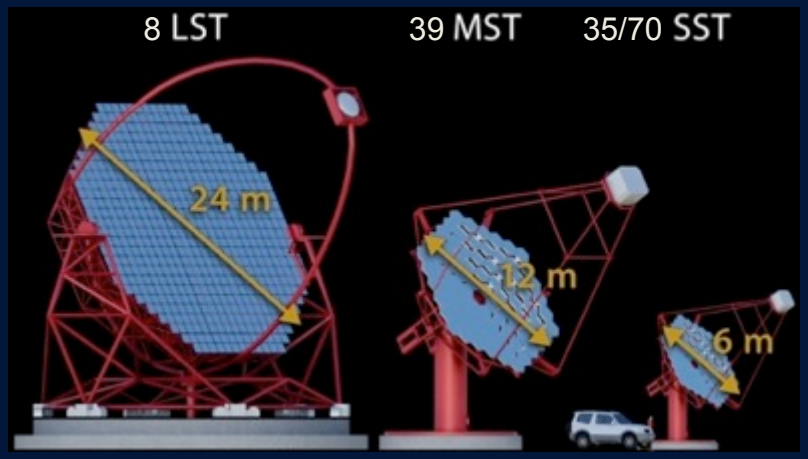
CTA galactic plane survey simulation

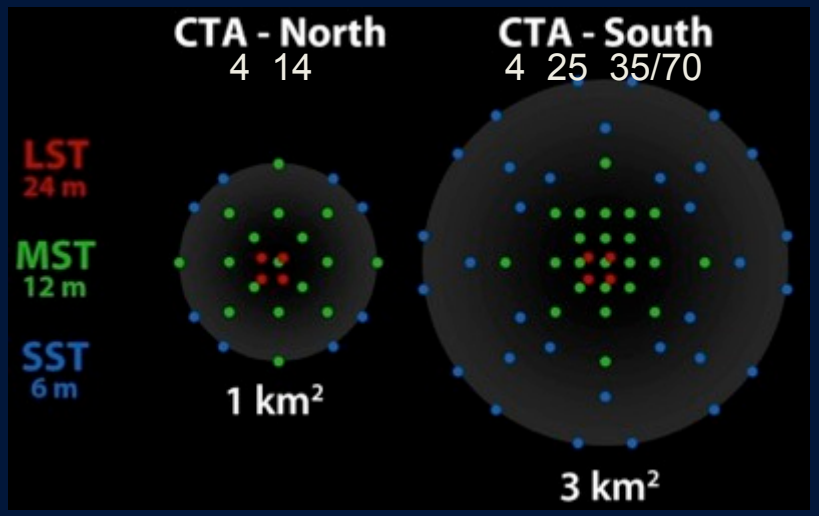


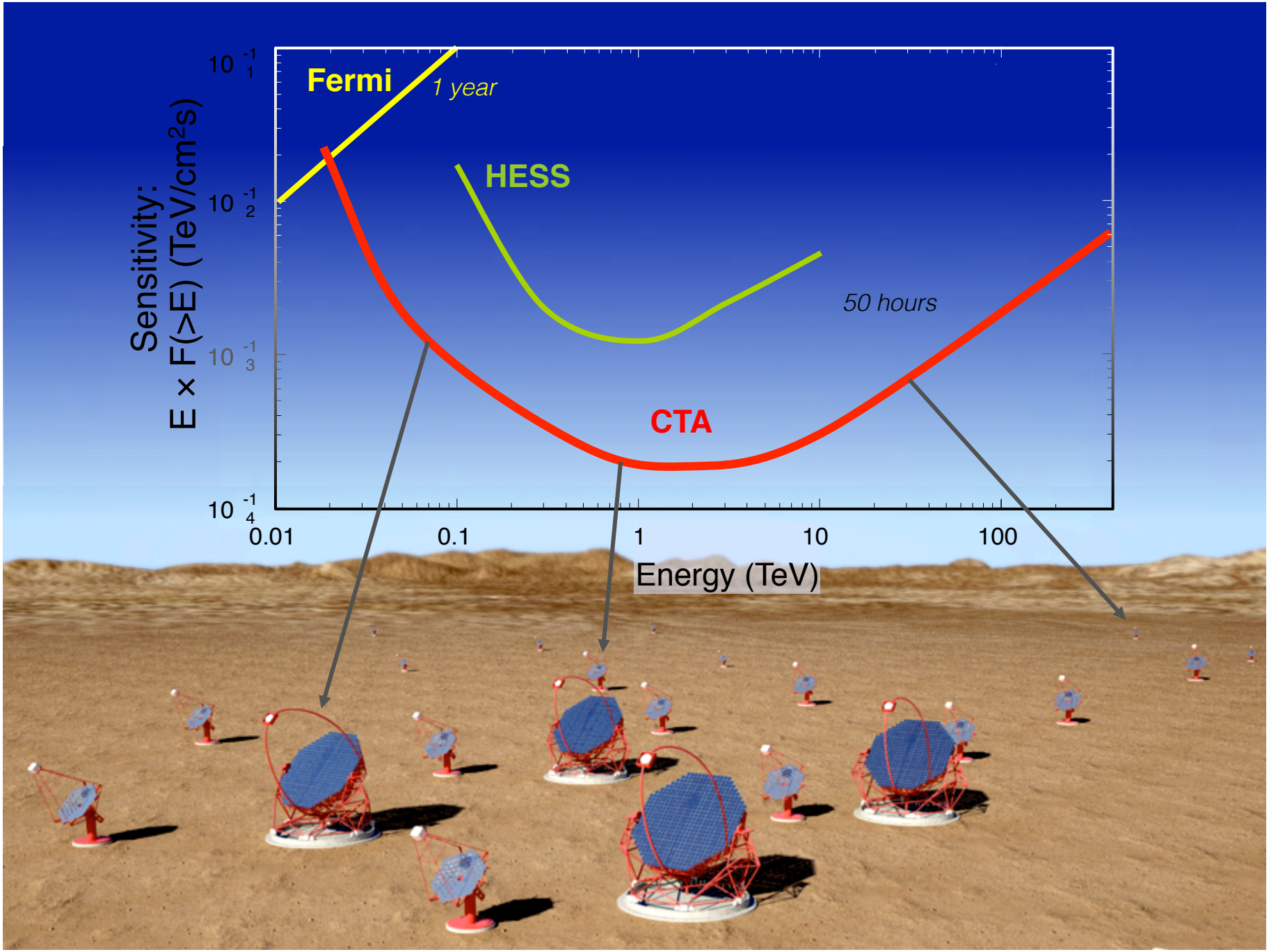
CTA: The Observatory

The CTA observatory

- ~100 Cherenkov telescopes at two sites (Northern and Southern Hemispheres)
- Three different classes of telescope to span energy range
- 10x flux sensitivity and spectral range
- 5x angular resolution
- For the first time an *Open Obervatory* with community access



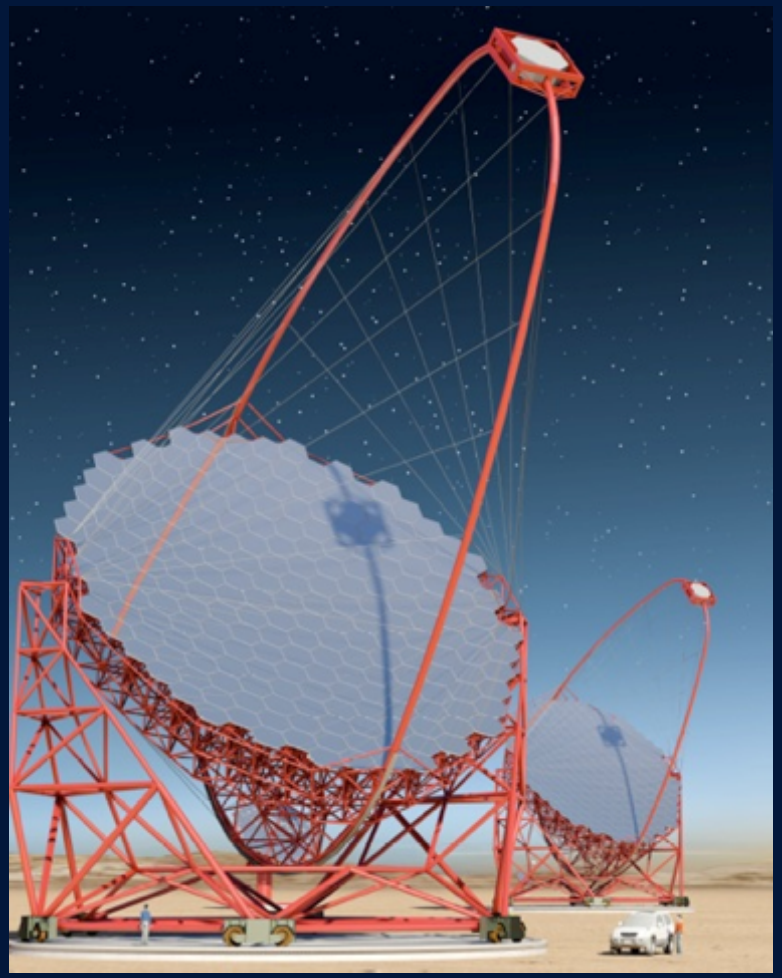



Fermi
1 year
HESS
50 hours
CTA
Sensitivity:
E x F(>E) (TeV/cm²s)
10 -1 1
10 -1 2
10 -1 3
10 -1 4
0.01
0.1
1
10
100
Energy (TeV)

Large Size Telescopes (LST)

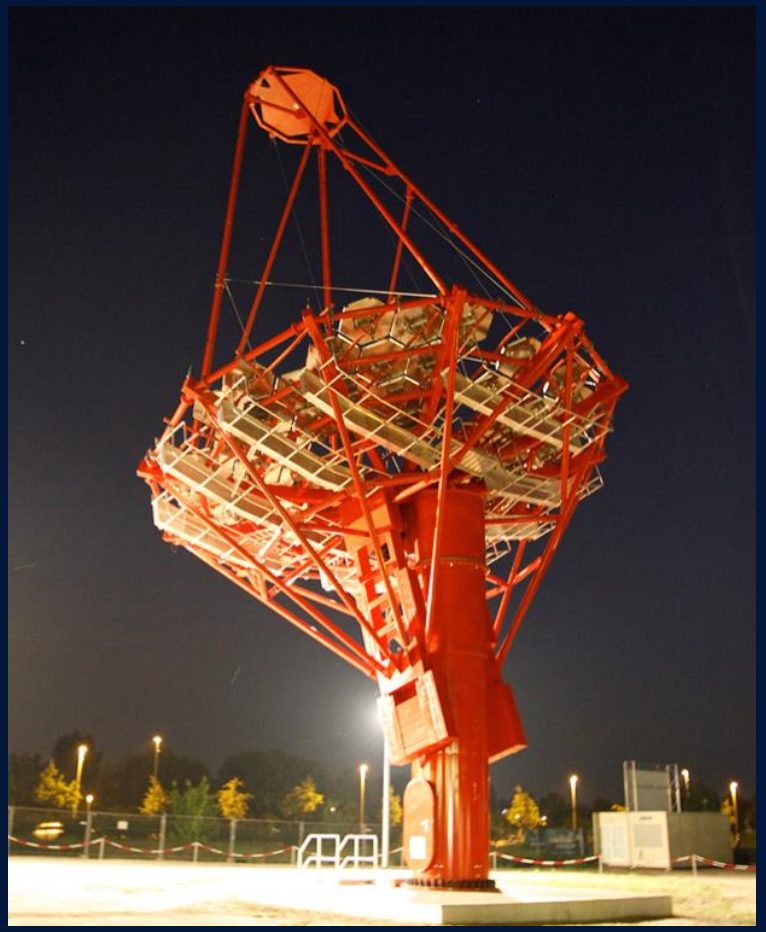
- 23 m diameter
- 389 m^2 dish area
- 28 m focal length
- 1.5 m mirror facets
- 4.5 deg field of view 0.1-deg pixels
- Camera diameter over 2 m
- Carbon-fibre structure
- Active mirror control

4 LSTs on South site
4 LSTs on North site
Prototype will be the 1st telescope



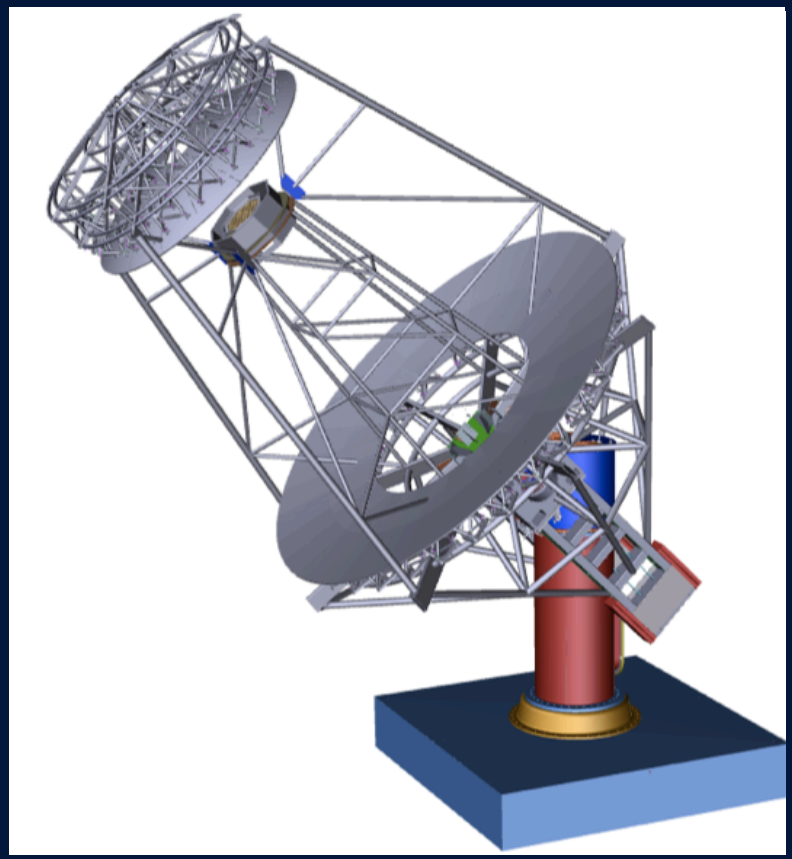
Medium-Sized Telescopes (MST)

- Optimised for ~100 GeV to ~10 TeV range.
- 100 m^2 dish area
- 16 m focal length
- 1.2 m mirror facets
- 8 deg field of view ~2000 x 0.18 deg pixels
- 25 MSTs on Southern site, 15 MSTs on Northern site



Schwarzschild-Couder MST Extension

- 9.6-m primary, 8 deg FOV
- Pixel scale allows SiPM camera
- Potentially could extend MST array from 25 to 49 telescopes

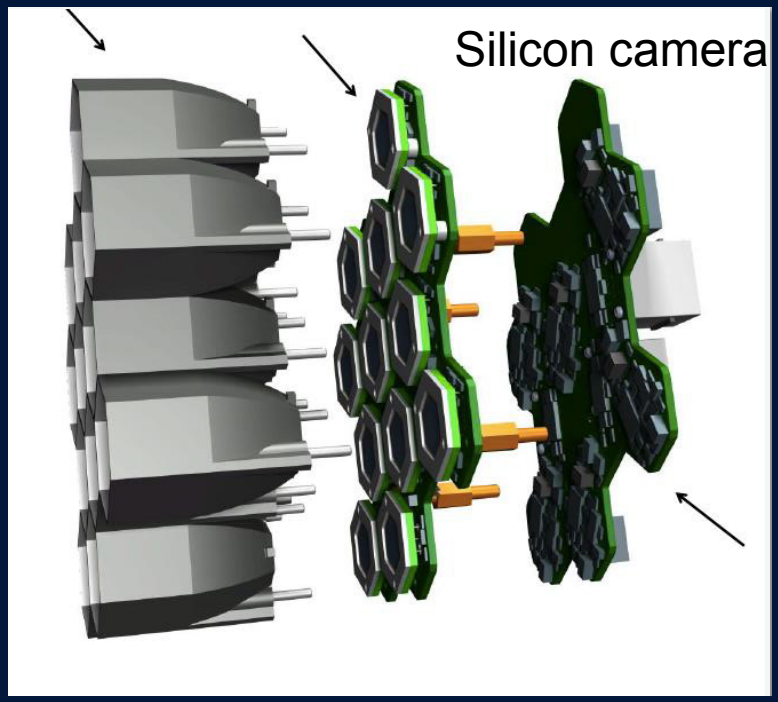


Rouselle et al. arXiv 1307.4072

Small-Sized Telescopes (SST)

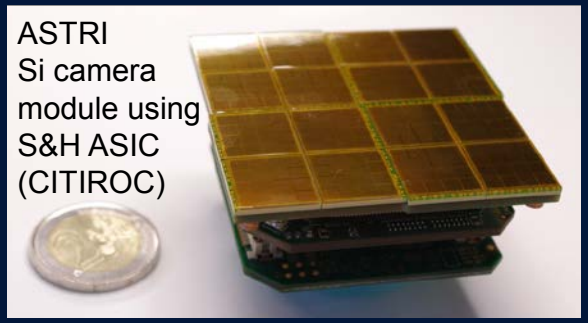
- Optimised for > 10 TeV
- Up to 70 SSTs on Southern site
- Three telescope designs and several camera options under study:
  - Conventional single mirror, PMT camera
  - Single mirror, silicon sensor camera
  - Dual mirror optics, silicon & MAPMT camera

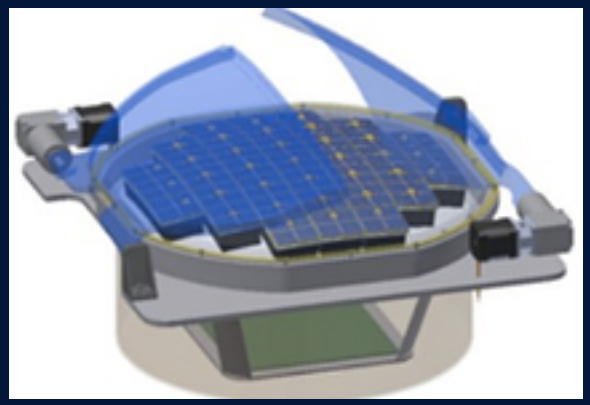
Single-mirror SST (SST-1M)

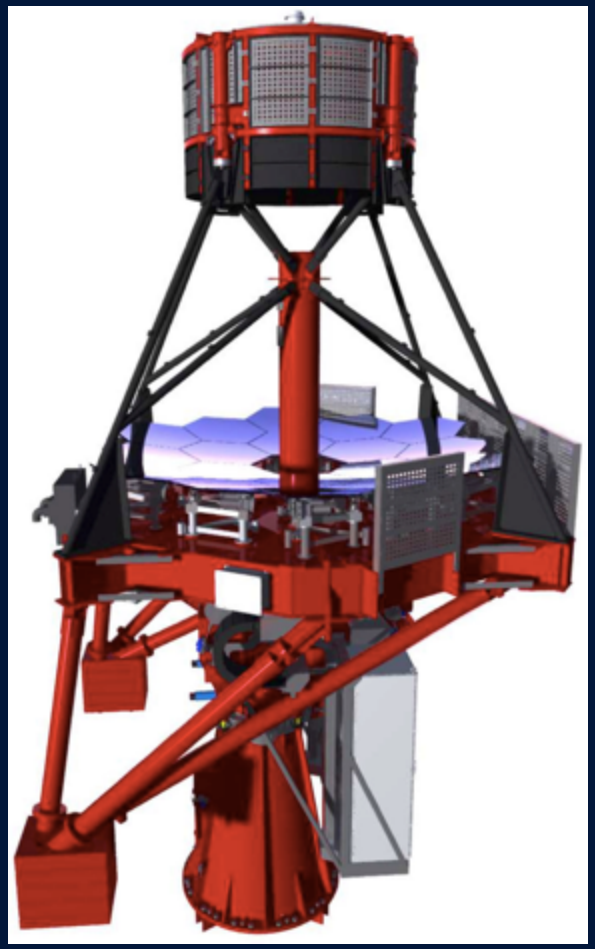


Dual-mirror SST (SST-2M)

ASTRI



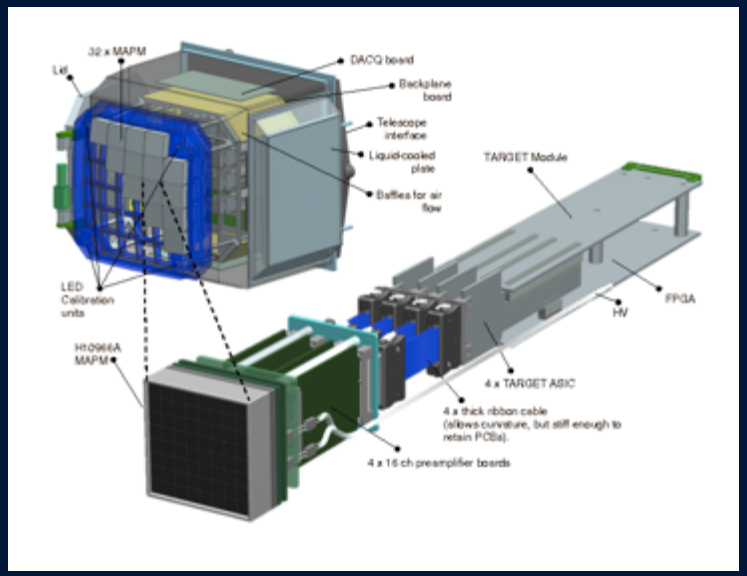




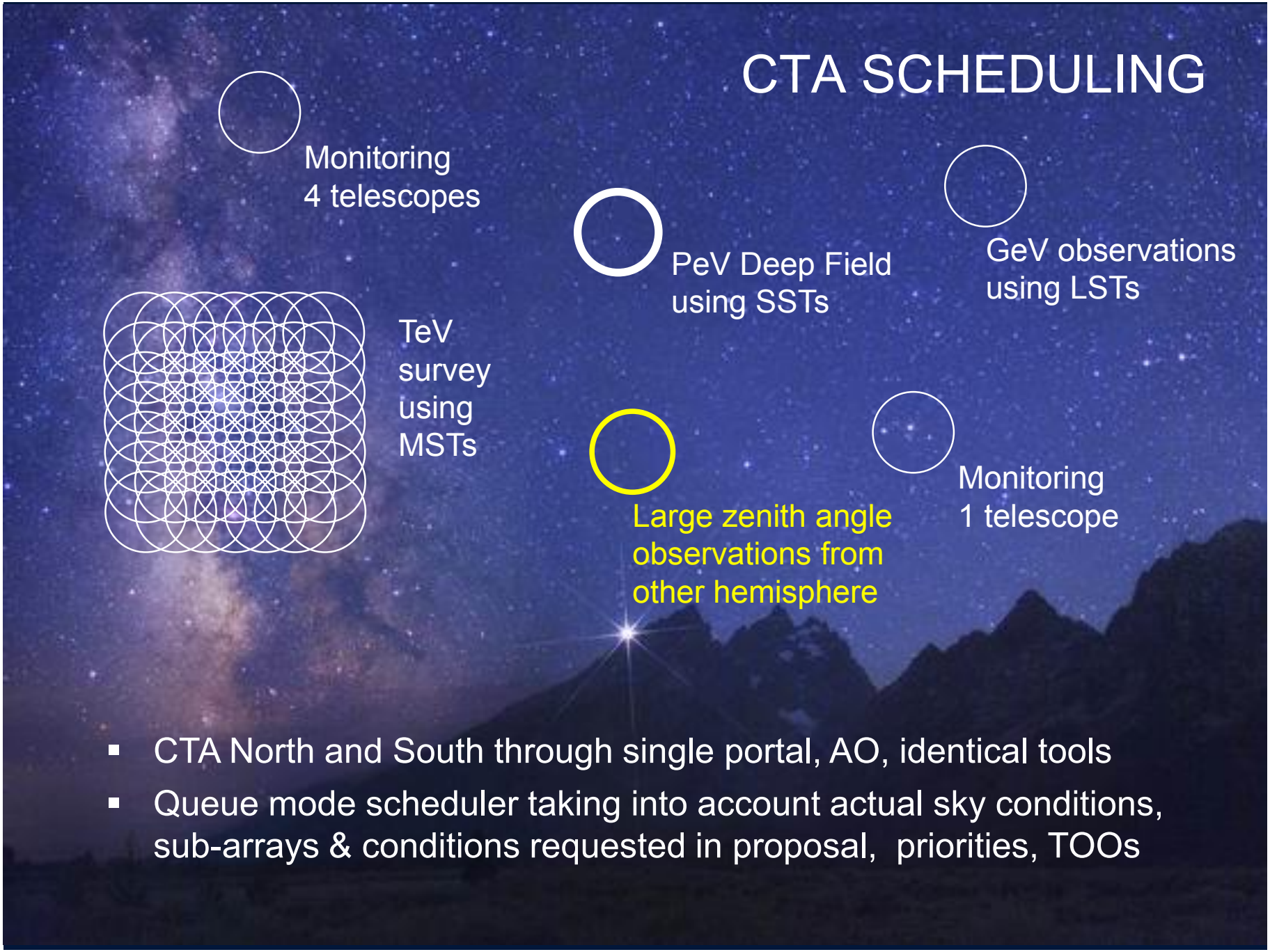
Dual-mirror SST (SST-2M)

GATE dual-mirror SST

CHEC protoype cameras MAPM & Silicon



CTA SCHEDULING

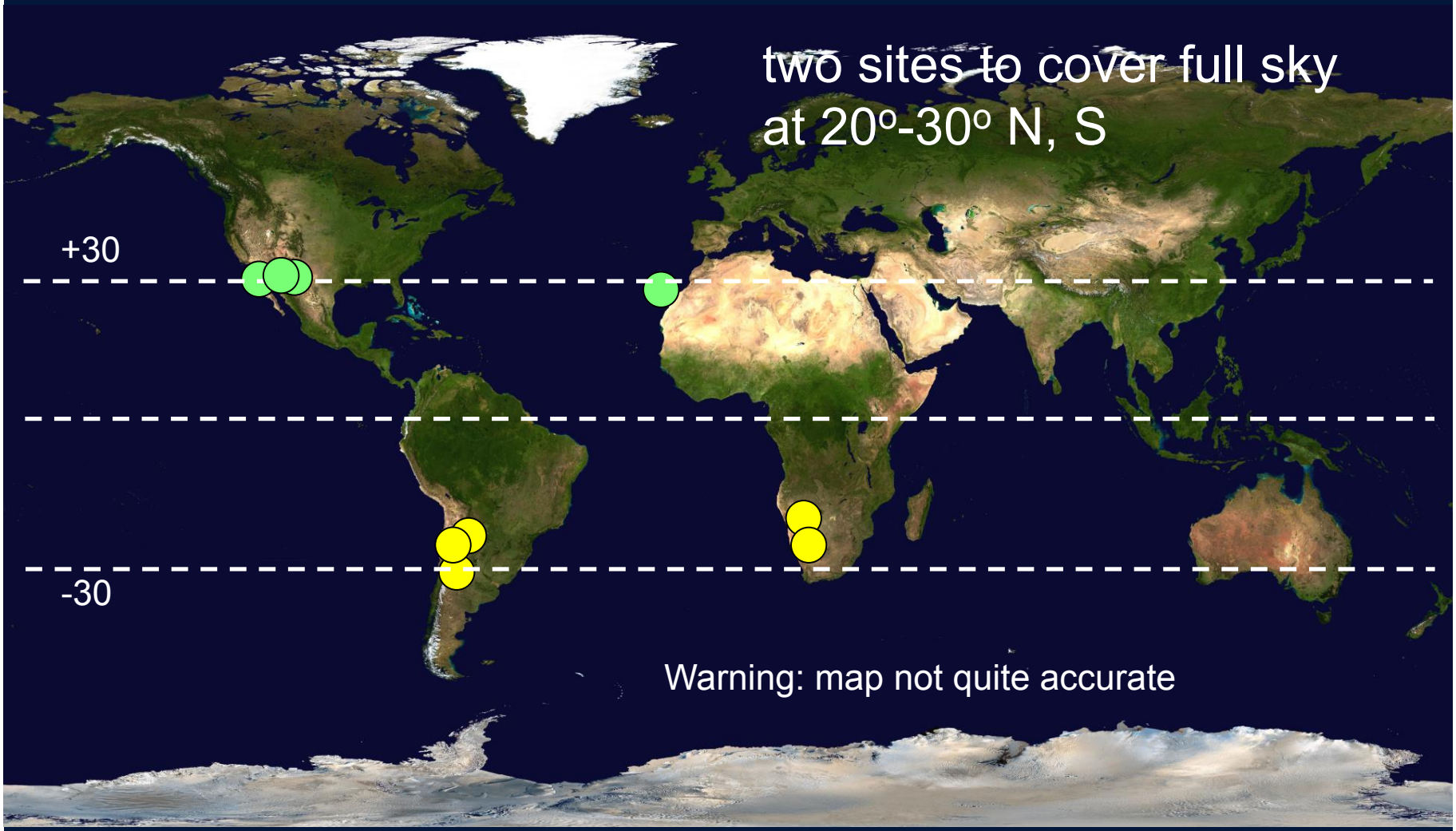


- CTA North and South through single portal, AO, identical tools
- Queue mode scheduler taking into account actual sky conditions, sub-arrays & conditions requested in proposal, priorities, TOOs

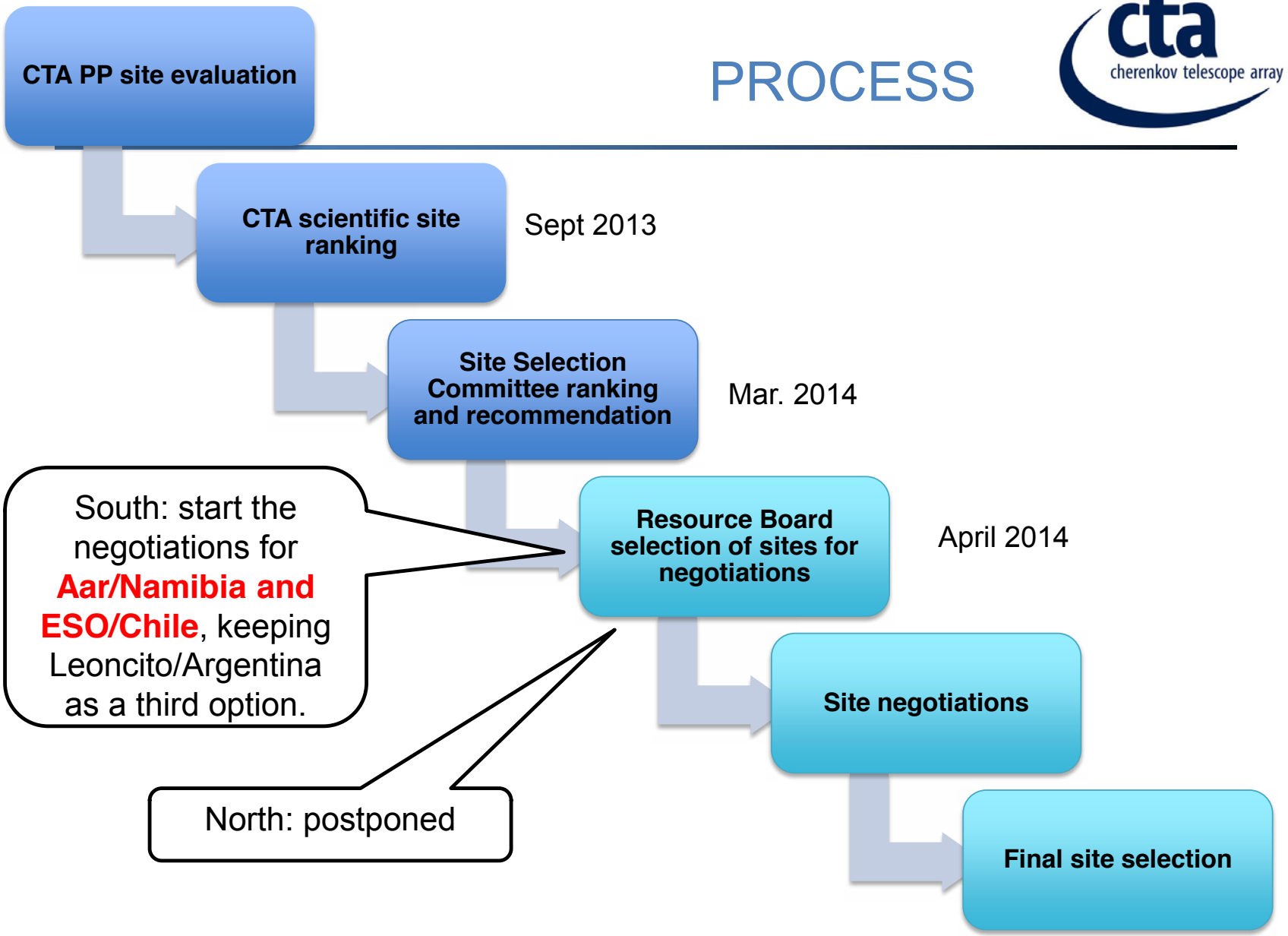
Timeline

- 2012 July “By signing this Declaration of Intent, the signatories – Ministries and Funding Agencies – wish to express their common interest in participating in the construction and operation of CTA.” signed by 13 countries.
- 2013 Nov PTDR
- 2014 Site selection proceeding – negotiations started
- 2014 Preparing for creation of interim CTA legal entity (GmbH)
- 2014 Q3 TDR
- 2016 Start construction
- 2020 CTA complete

Sites: Candidates



PROCESS


CTA PP site evaluation
CTA scientific site ranking
Sept 2013
Site Selection Committee ranking and recommendation
Mar. 2014
South: start the negotiations for Aar/Namibia and ESO/Chile, keeping Leoncito/Argentina as a third option.
Resource Board selection of sites for negotiations
April 2014
North: postponed
Site negotiations
Final site selection

Site Panoramas

Horizons 2020

COUNCIL OF
THE EUROPEAN UNION

EN

Conclusions on the implementation of the roadmap for the European Strategy Forum on Research Infrastructures

COMPETITIVENESS Council meeting
Brussels, 26 May 2014

The Council adopted the following conclusions:

"THE COUNCIL OF THE EUROPEAN UNION

RECALLING its Conclusions of 11 December 2012[1], endorsing the Com
on 'A reinforced European research area partnership for excellence and gr
the need for renewing and adapting the mandate of the European Strategy
Infrastructures (ESFRI) to adequately address the existing challenges and
up of implementation of already on-going ESFRI projects after a compreh
well as the prioritisation of the infrastructure projects listed in the ESFRI

2. **Implementation Support**

- ECCSEL: European Carbon dioxide Capture and Storage Laboratory Infrastructure
- EISCAT-3D: The next generation incoherent scatter radar system
- EMSO: European Multidisciplinary Seafloor & Water column Observatory
- BBMRI: Biobanking and Biomolecular Resources Research Infrastructure
- ELI: Extreme Light Infrastructure
- CTA: Cherenkov Telescope Array
- SKA: Square Kilometre Array
- CLARIN: Common Language Resources and Technology Infrastructure
- DARIAH: Digital Research Infrastructure for the Arts and Humanities

CTA Acknowledgments

We gratefully acknowledge financial support from the following agencies and organizations: Ministerio de Ciencia, Tecnología e Innovación Productiva (MinCyT), Comisión Nacional de Energía Atómica (CNEA), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina; State Committee of Science of Armenia, Armenia; Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ), Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), Brasil; Croatian Science Foundation, Croatia; Ministry of Education, Youth and Sports, MEYS LE13012, 7AMB12AR013, Czech Republic; Ministry of Higher Education and Research, CNRS-INSU and CNRS-IN2P3, CEA-Irfu, ANR, Regional Council Ile de France, Labex ENIGMASS, OSUG2020 and OCEVU, France; Max Planck Society, BMBF, DESY, Helmholtz Association, Germany; Department of Atomic Energy, Department of Science and Technology, India; Istituto Nazionale di Astrofisica (INAF), MIUR, Italy; ICRR, University of Tokyo, JSPS, Japan; Netherlands Research School for Astronomy (NOVA), Netherlands Organization for Scientific Research (NWO), Netherlands; The Bergen Research Foundation, Norway; Ministry of Science and Higher Education, the National Centre for Research and Development and the National Science Centre, Poland; MINECO support through the National R+D+I, CDTI funding plans and the CPAN and MultiDark Consolider-Ingenio 2010 programme, Spain; Swedish Research Council, Royal Swedish Academy of Sciences, Sweden; Swiss National Science Foundation (SNSF), Ernest Boninchi Foundation, Switzerland; Durham University, Leverhulme Trust, Liverpool University, University of Leicester, University of Oxford, Royal Society, Science and Technologies Facilities Council, UK; U.S. National Science Foundation, U.S. Department of Energy, Argonne National Laboratory, Barnard College, University of California, University of Chicago, Columbia University, Georgia Institute of Technology, Institute for Nuclear and Particle Astrophysics (INPAC-MRPI program), Iowa State University, Washington University McDonnell Center for the Space Sciences, USA.

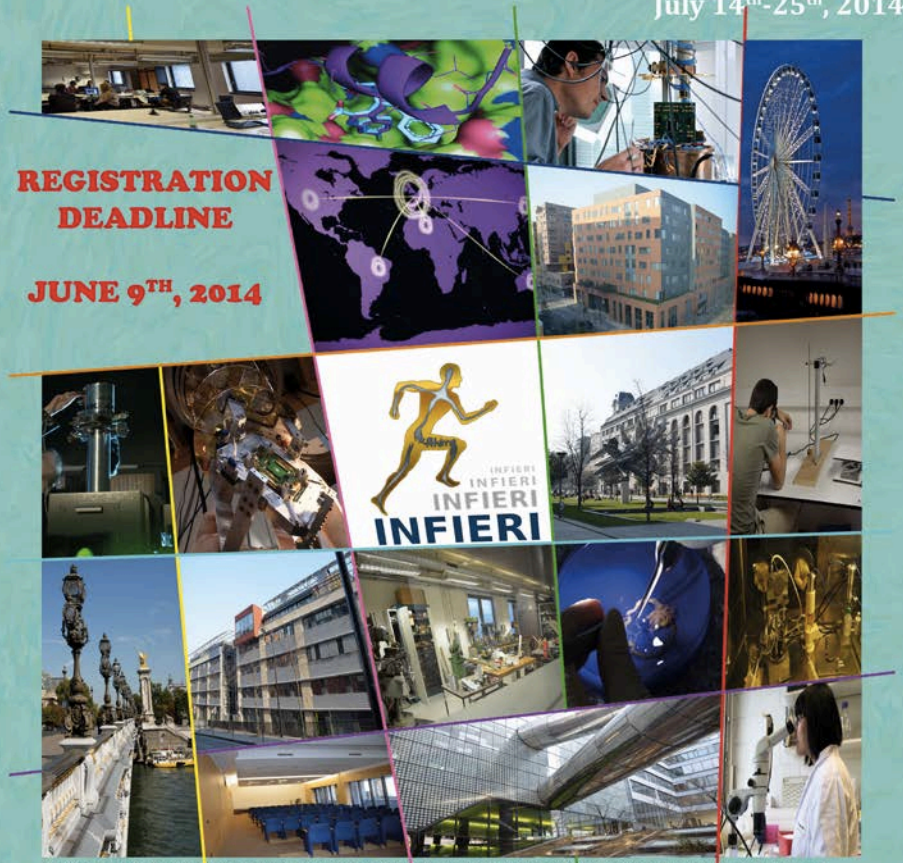
We have received funding from the European Union's Seventh Framework Programme ([FP7/2007-2013] [FP7/2007-2011]) under Grant Agreement 262053.


cta
cherenkov telescope array
2014 ++

2nd International Summer School on: INtelligent signal processing for FrontIEr Research and Industry

Astrophysics - Medical Physics - Particle Physics - Technologies

Paris Diderot University, PARIS
July 14th-25th, 2014



Photos by: Alain Monclin (Studio Vidéo Université Paris Diderot), Daniele Vadruccio (LIP Lisboa), Sarodia Vydelingum (APC Paris)

ALL the informations about the school in:

http://infieri2014summerschool.in2p3.fr