Novo doba visokoenergijske gama-astronomije

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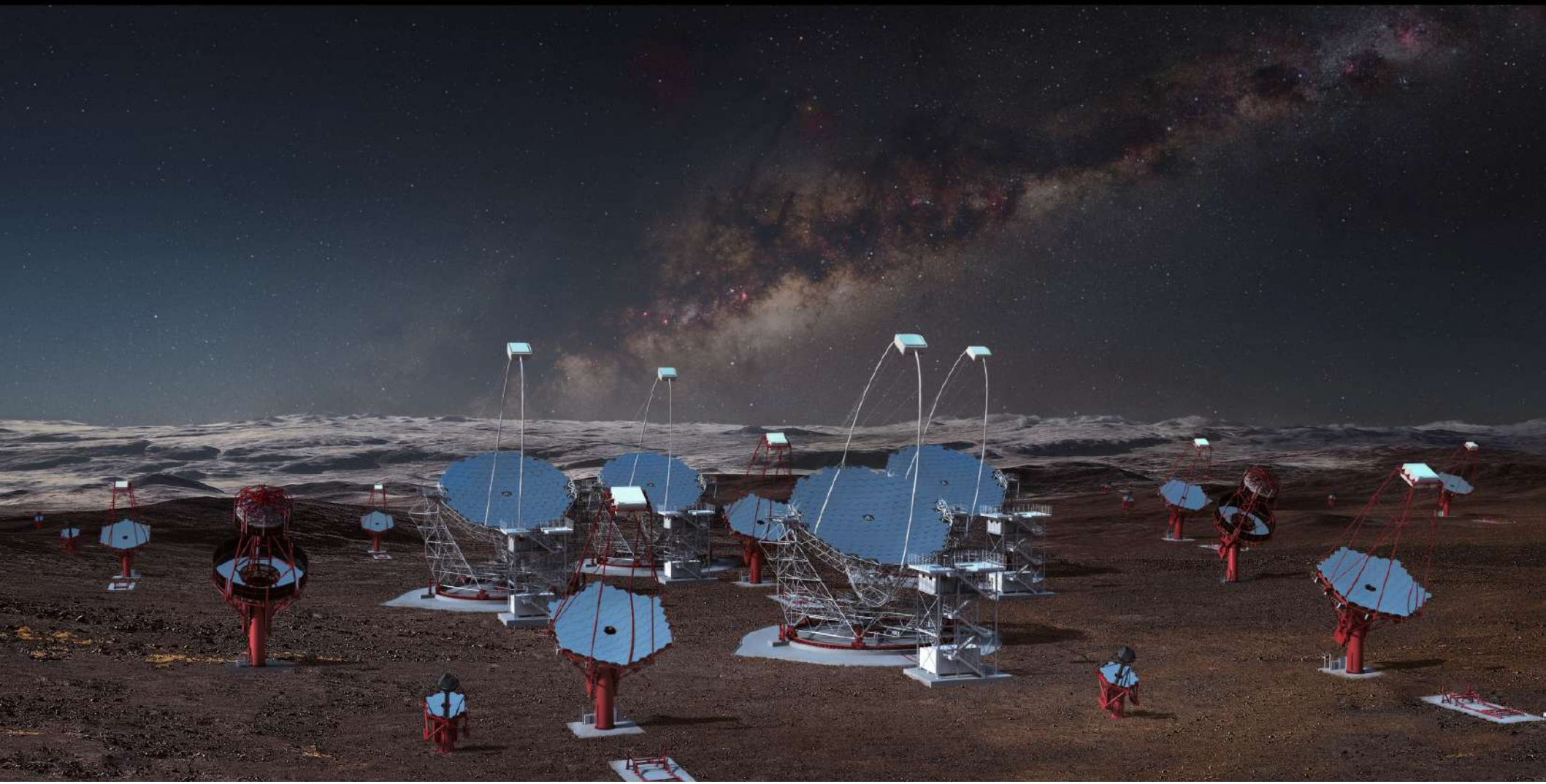
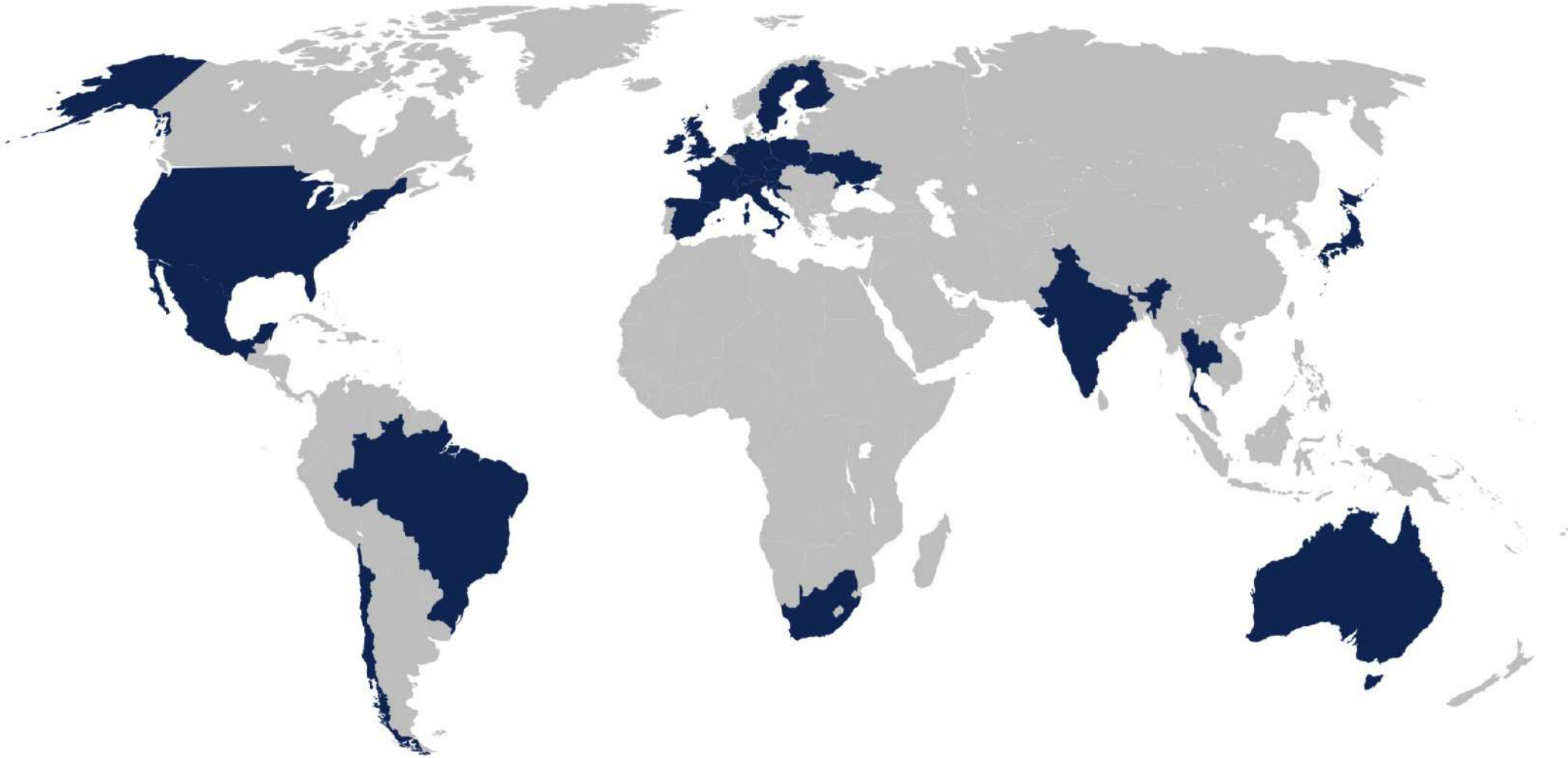
Državni stručni skup *Suvremena područja istraživanja u astronomiji*
Zvjezdarnica Zagreb, 23. veljače 2023.



✔ CTA (Cherenkov Telescope Array, Postav Čerenkovljevih teleskopa)

✔ iduća generacija zemaljskog opservatorija za VHE gama-astronomiju

✔ najveći i najosjetljiviji opservatorij za VHE gama-astronomiju

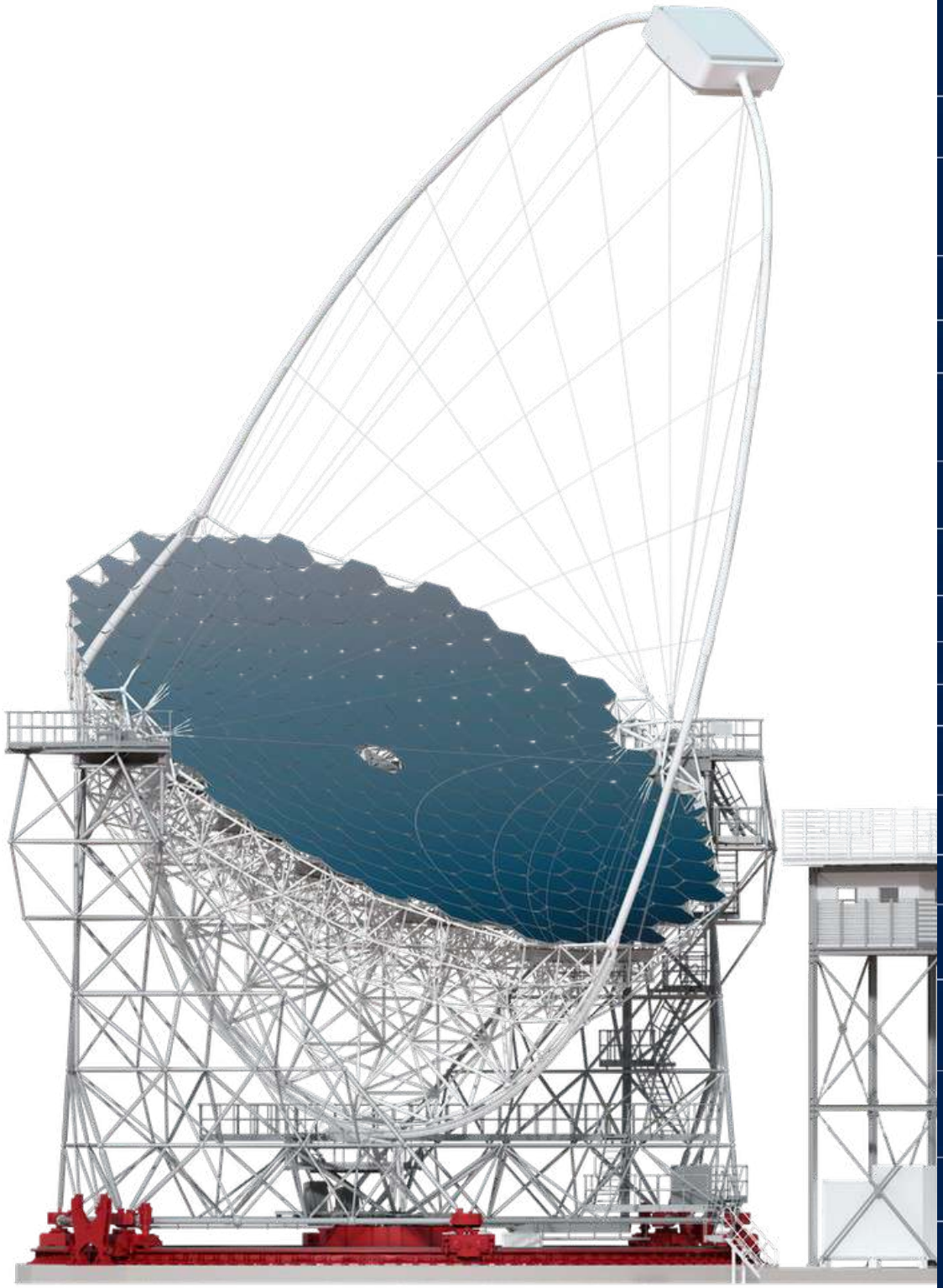


✔ 1500 znanstvenika i inženjera

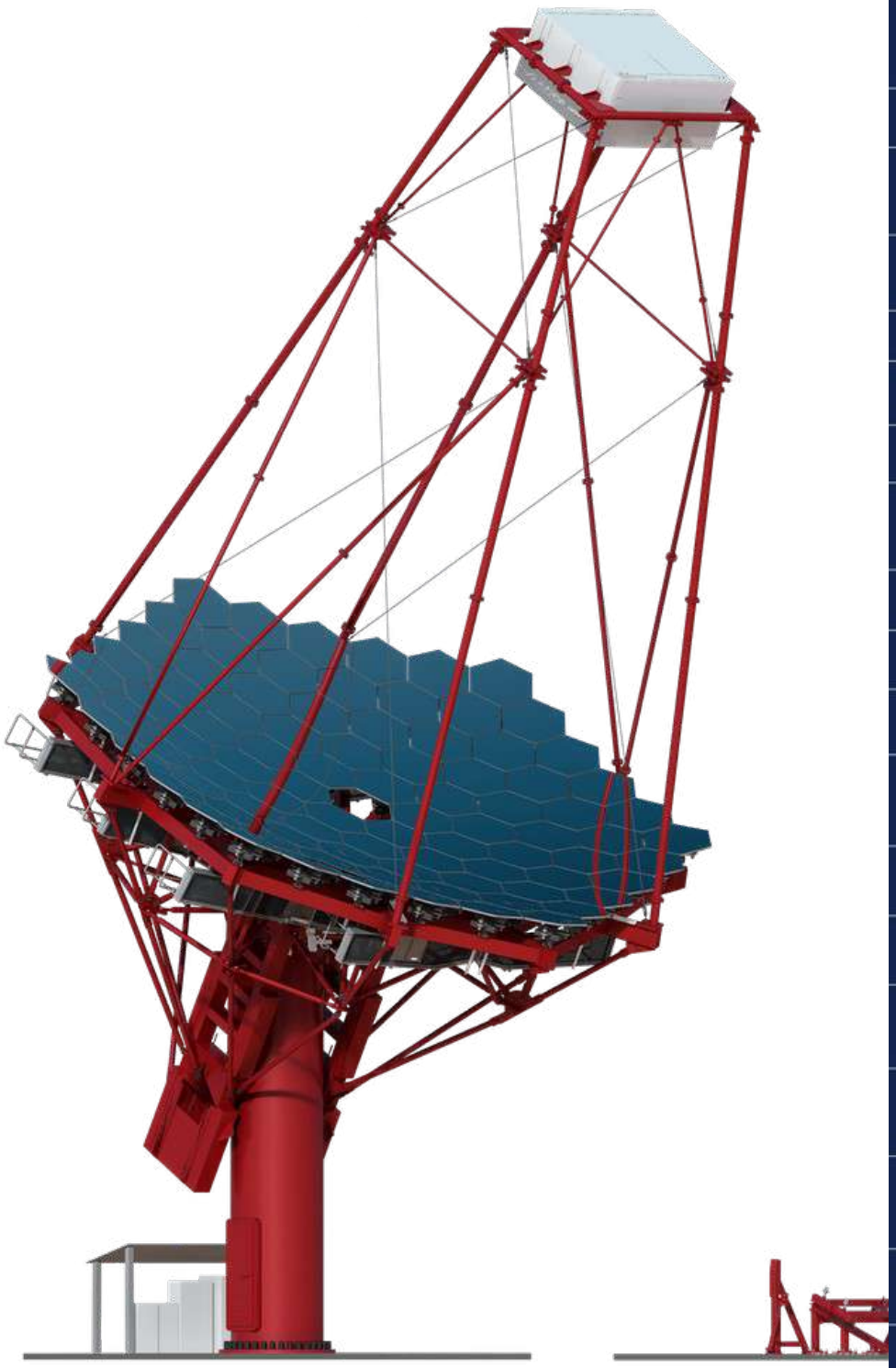
✔ 150 institucija

✔ 25 zemalja

✔ više od 100 teleskopa na sjevernoj i južnoj hemisferi



	Large-Sized Telescope (LST)
Required energy range	20 GeV – 3 TeV
Energy range (in which subsystem provides full system sensitivity)	20 GeV – 150 GeV
Number of telescopes	4 (South) 4 (North)
Optical design	Parabolic
Primary reflector diameter	23.0 m
Secondary reflector diameter	--
Effective mirror area (including shadowing)	370 m^2
Focal length	28 m
Total weight	103 t
Field of view	4.3 deg
Number of pixels in Cherenkov camera	1855
Pixel size (imaging)	0.1 deg
Photodetector type	PMT
Telescope readout event rate	>7.0 kHz (after LST array trigger)
Telescope data rates (readout of all pixels; before array trigger)	24 Gb/s
Positioning time to any point in the sky (>30° elevation)	30 s
Pointing precision	<14 arcseconds
Observable sky	Any astrophysical object with elevation > 24 degrees



	Medium-Sized Telescope (MST)	
	FlashCam	NectarCam
Required energy range	80 GeV – 50 TeV	
Energy range (in which subsystem provides full system sensitivity)	150 GeV – 5 TeV	
Number of MST/SCT telescopes	25 (South) 15 (North)	
Optical design	Modified Davies-Cotton	
Primary reflector diameter	11.5 m	
Secondary reflector diameter	--	
Effective mirror area (including shadowing)	88 m^2	
Focal length	16 m	
Total weight	82 t	
Field of view	7.5 deg	7.7 deg
Number of pixels in Cherenkov camera	1764	1855
Pixel size (imaging)	0.17 deg	0.17 deg
Photodetector type	PMT	PMT
Telescope readout event rate (before array trigger)	>6 kHz	>7.0 kHz
Telescope data rates (readout of all pixels; before array trigger)	12 Gb/s	
Positioning time to any point in the sky (>30° elevation)	90 s	
Pointing precision	<7 arcseconds	
Observable sky	Any astrophysical object with elevation > 24 degrees	

	Small-Sized Telescope (SST)
Required energy range	1 TeV – 300 TeV
Energy range (in which subsystem provides full system sensitivity)	5 TeV – 300 TeV
Number of telescopes	70 (South) 0 (North)
Optical design	Schwarzschild-Couder
Primary reflector diameter	4.3 m
Secondary reflector diameter	1.8 m
Effective mirror area (including shadowing)	8 m_2
Focal length	2.15 m
Total weight	19 t
Field of view	10.5 deg
Number of pixels in Cherenkov camera	2368
Pixel size (imaging)	0.19 deg
Photodetector type	SiPM
Telescope readout event rate (before array trigger)	>0.3 kHz
Telescope data rates (readout of all pixels; before array trigger)	2 Gb/s
Positioning time to any point in the sky (>30$_o$ elevation)	60 s
Pointing precision	<7 arcseconds
Observable sky	Any astrophysical object with elevation > 24 degrees

cherenkov telescope array

The Electromagnetic Spectrum

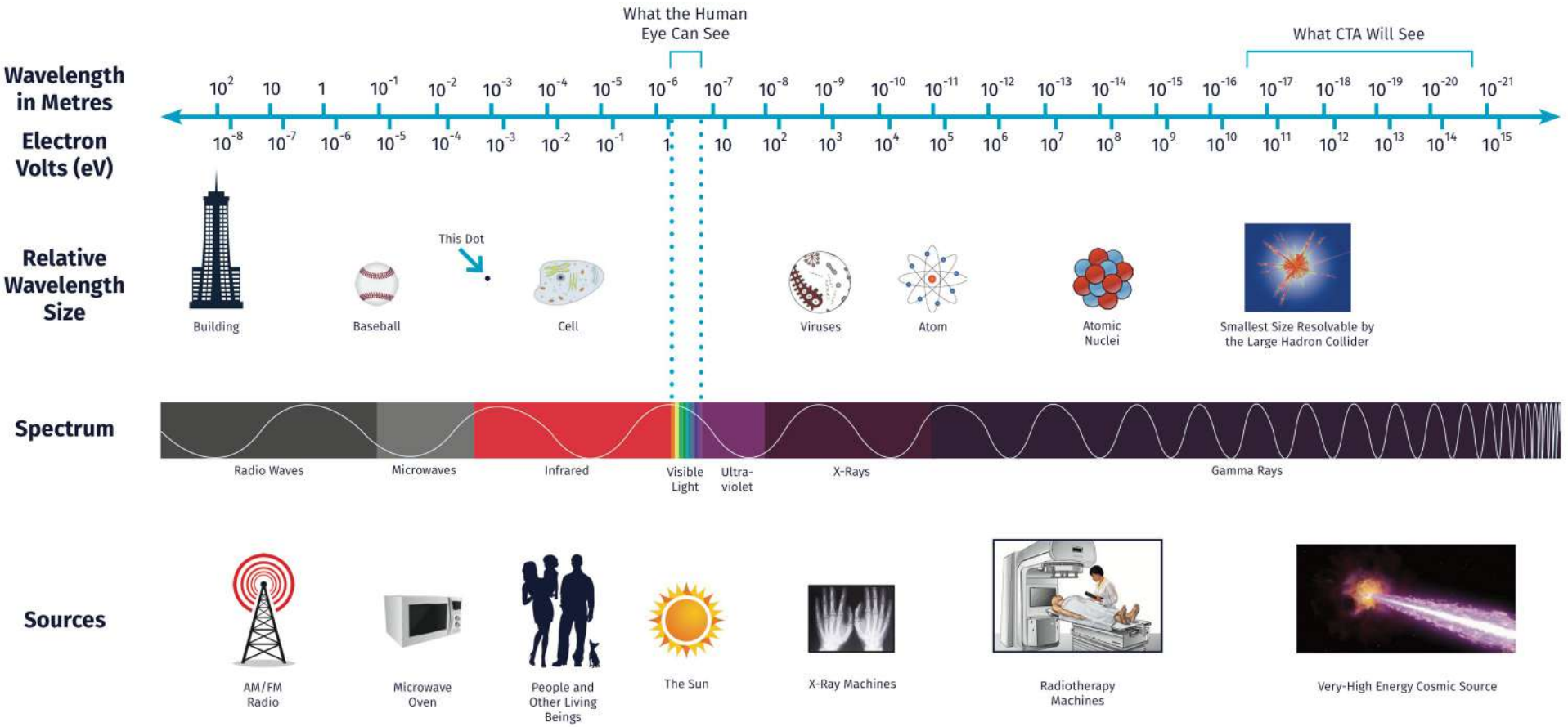
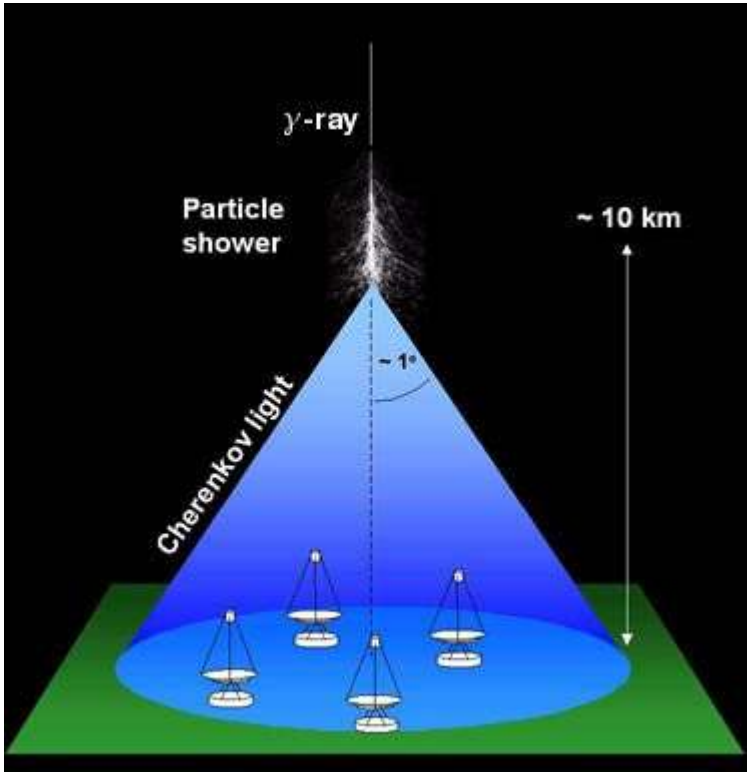
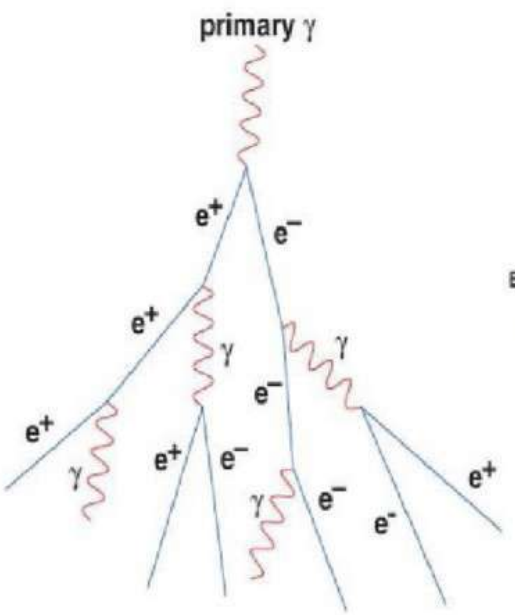
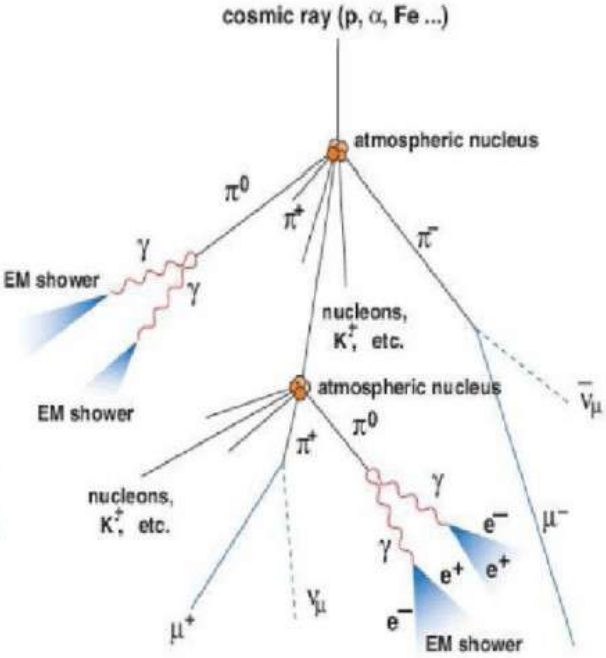
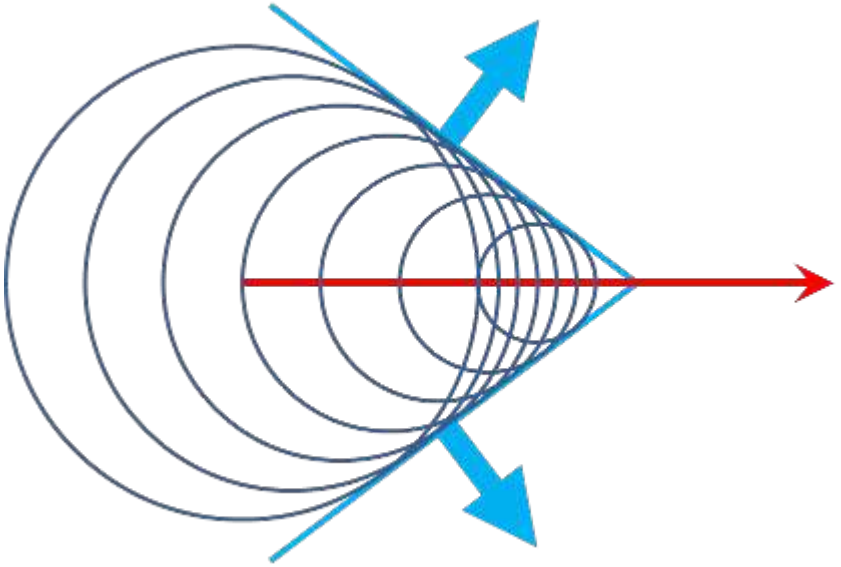


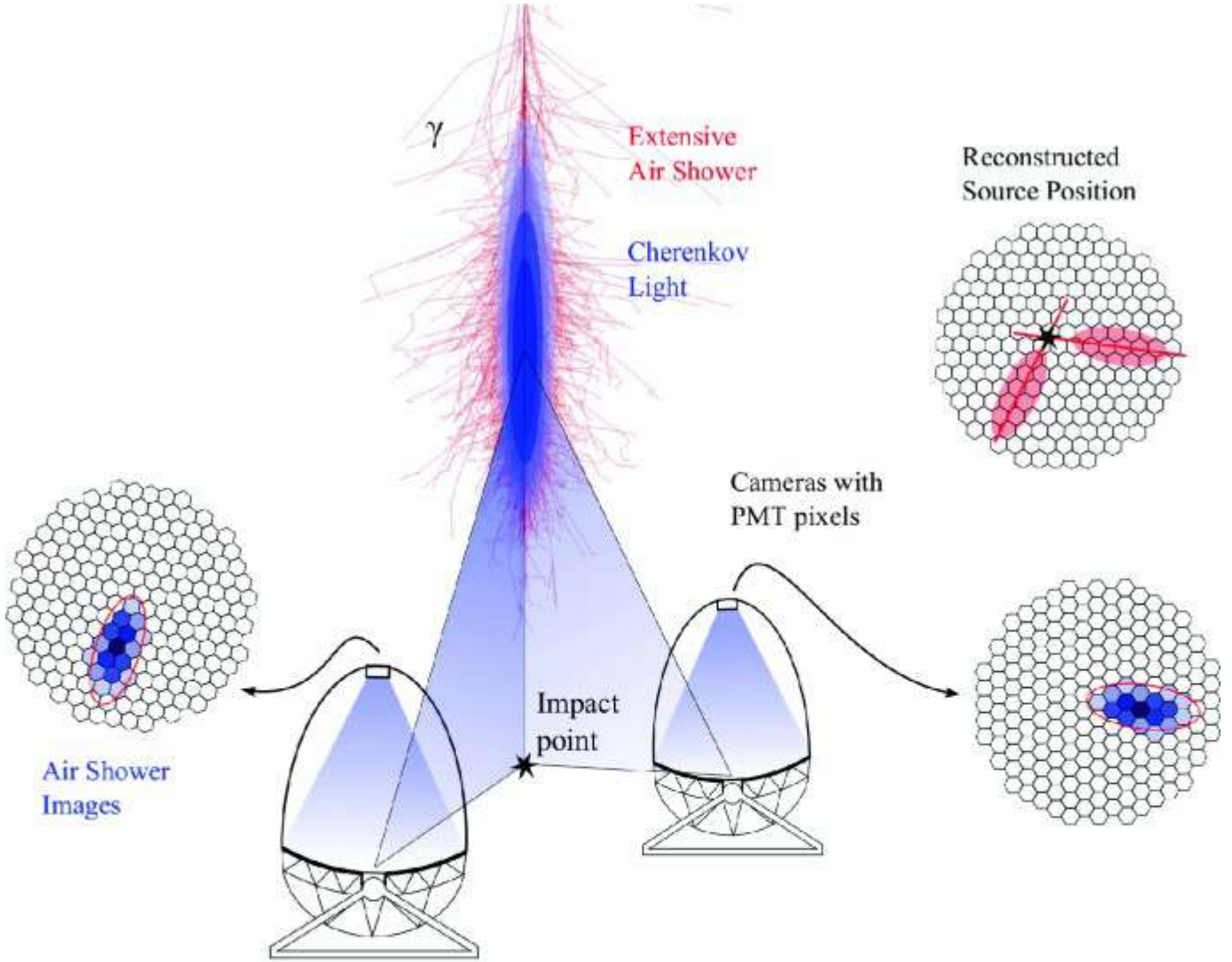
Image credits: Vecteezy.com, Dragonartz.net, NAOJ, NCI, CERN, NASA

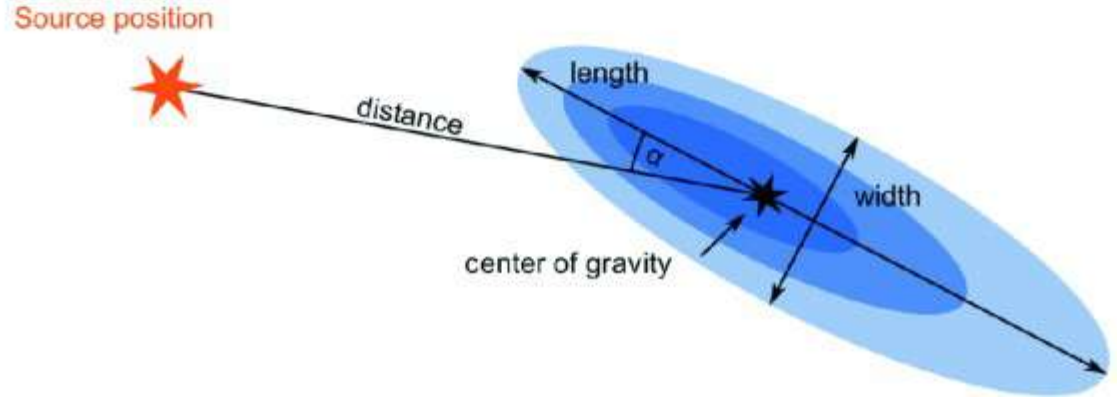

γ-ray
Particle shower
~ 10 km
~ 1°
Cherenkov light

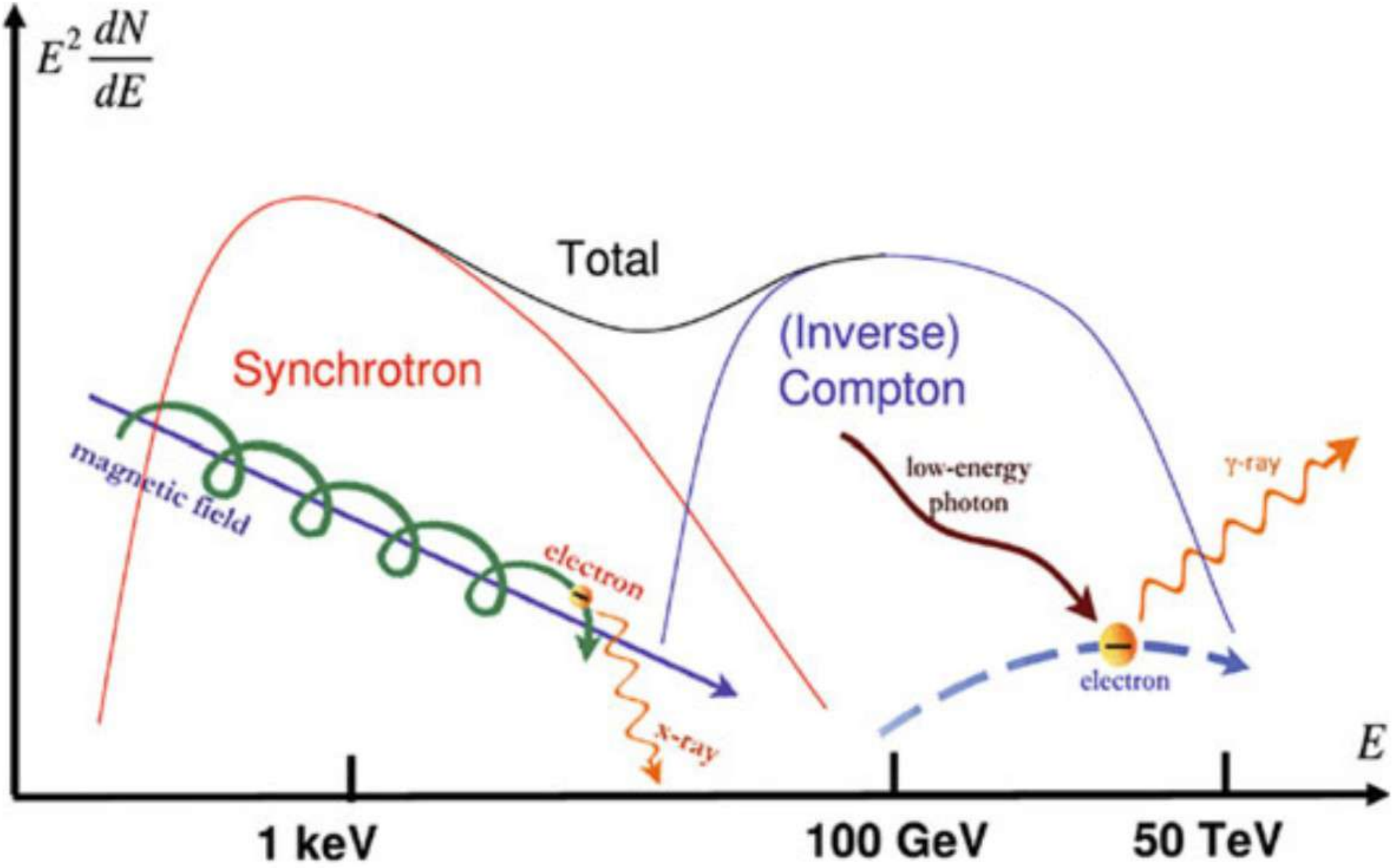

primary γ
e+
e−
γ


cosmic ray (p, α, Fe ...)
atmospheric nucleus
π0
π+
π−
γ
EM shower
nucleons, K±, etc.
atmospheric nucleus
EM shower
ν̄μ
π0
π+
nucleons, K±, etc.
γ
e−
μ−
e+
e+
νμ
μ+
e−
EM shower




γ
Extensive
Air Shower
Cherenkov
Light
Reconstructed
Source Position
Cameras with
PMT pixels
Impact
point
Air Shower
Images


Source position
distance
length
α
width
center of gravity


$E^2 \frac{dN}{dE}$
Total
Synchrotron
(Inverse)
Compton
magnetic field
electron
x-ray
low-energy
photon
γ-ray
electron
E
1 keV
100 GeV
50 TeV

Tema 1: Razumijevanje podrijetla i uloge VHE kozmičkih čestica

Gdje se u svemiru ubrzavaju visokoenergijske čestice?

Koji su mehanizmi ubrzavanja kozmičkih čestica?

Kakvu ulogu kozmičke čestice imaju u nastanku zvijezda i razvoju galaksija?

Tema 2: Propitivanje ekstremnih okruženja

Koji fizički procesi djeluju blizu neutronskih zvijezda i crnih rupa?

Koje su karakteristike relativističkih mlazova, vjetrova i eksplozija?

Kakva polja u kozmičkim voidovima i mijenjaju li se s vremenom?

Tema 3: Istraživanje granica fizike

Koja je priroda tamne tvari i kako je tamna tvar raspoređenja?

Postoje li kvantno-gravitacijski utjecaji na propagaciju fotona?

Postoje li čestice nalik aksionima?