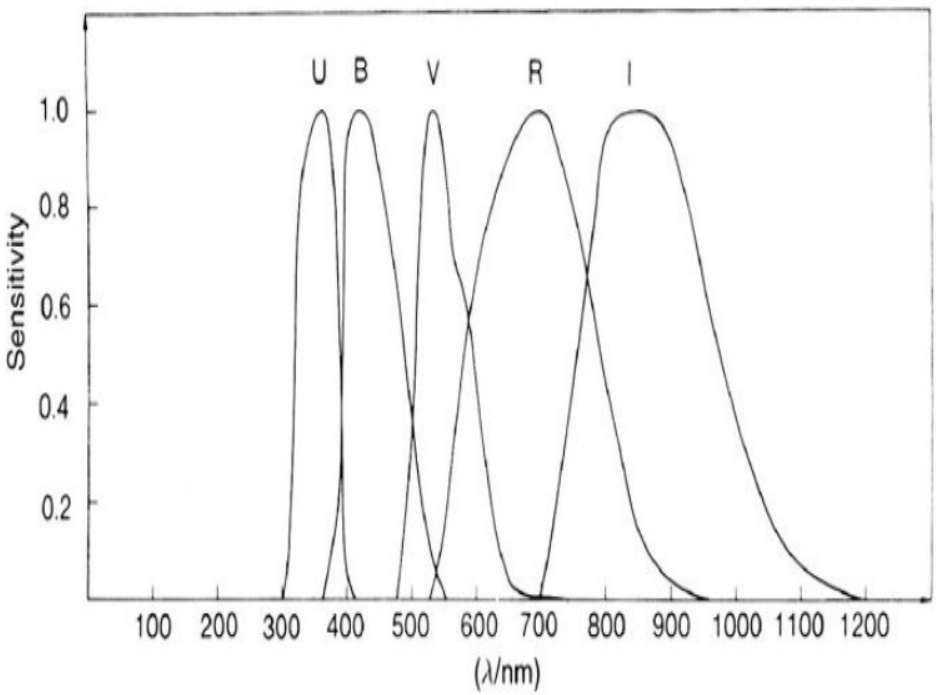
L'osservazione astronomica

Fluxes in the optical / infrared bands : Magnitudes

Apparent Magnitude :

$$m - m_0 = -2.5\ Log_{10}(F/F_0)$$



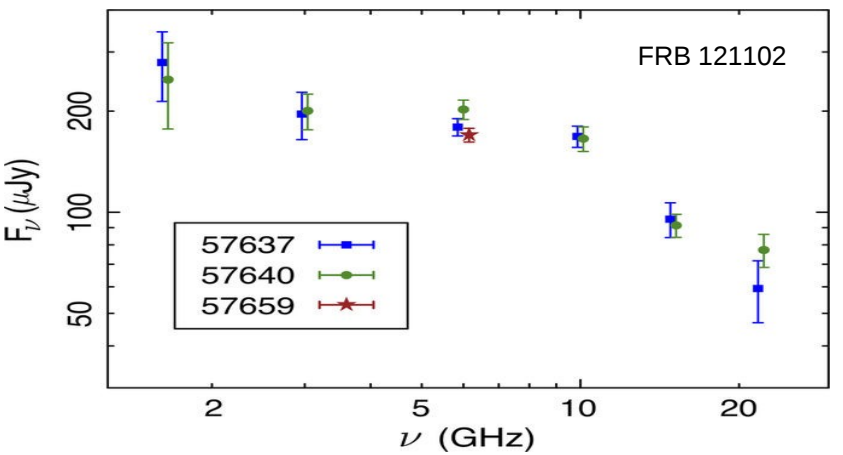
Absolute Magnitude :

$$M = m - 5\ Log\frac{D}{10\ pc}$$

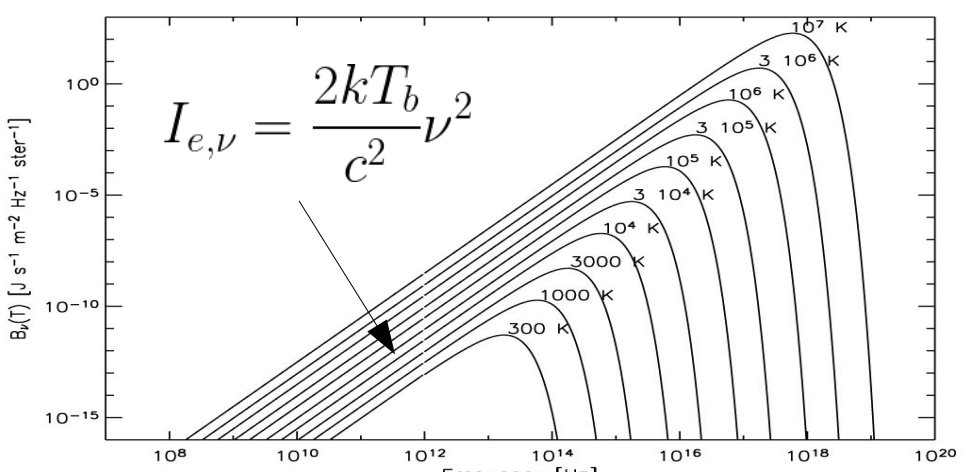
Fluxes in the Radio band

$$1\ Jy = 10^{-23}\ \mathrm{erg\ cm^{-2}s^{-1}Hz^{-1}}$$

Nature volume 541, pages 58–61 (2017)



$$I_{e,\nu} = I_\nu h\nu = \frac{2h\nu^3}{c^2}\frac{1}{e^{\frac{h\nu}{kT_b}} - 1} \quad \left[\frac{erg}{cm^2 s\ sr Hz}\right]$$



Special relativity

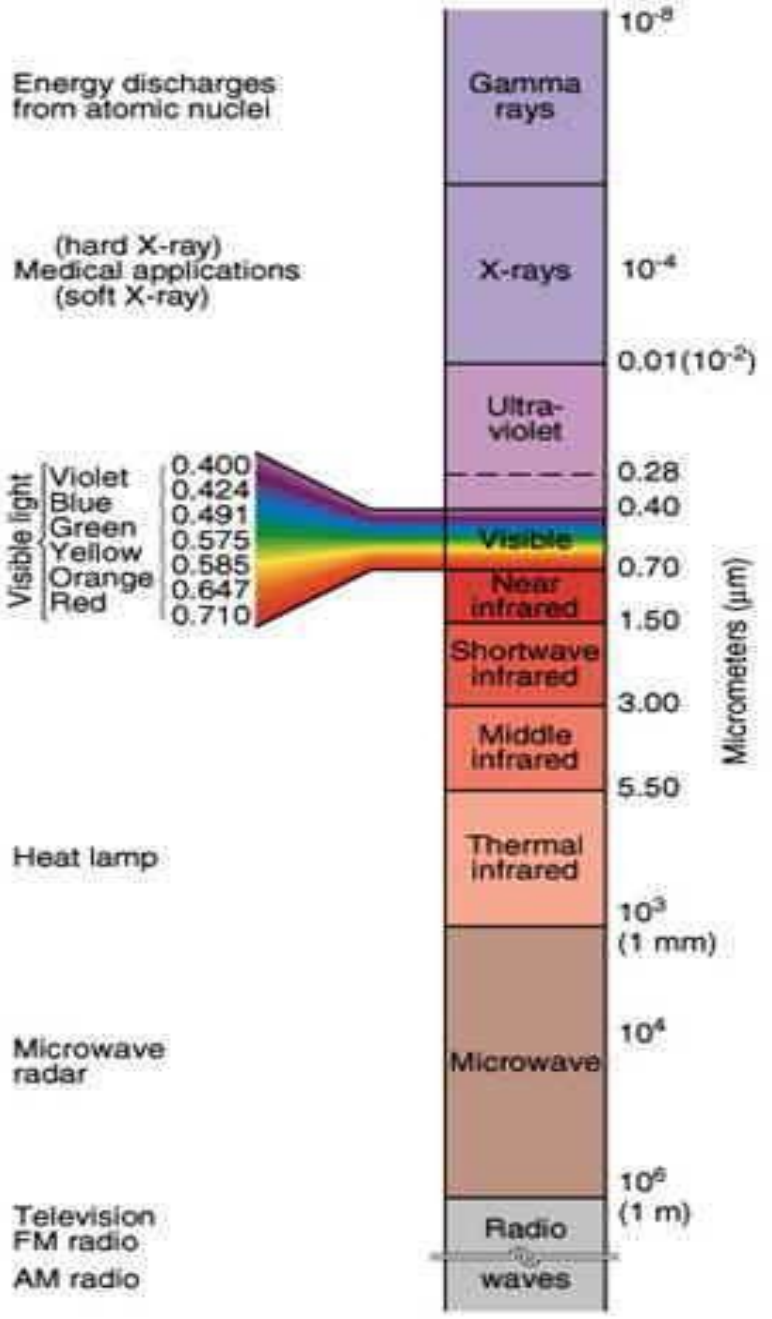
$$V = (x, y, z, ct)$$

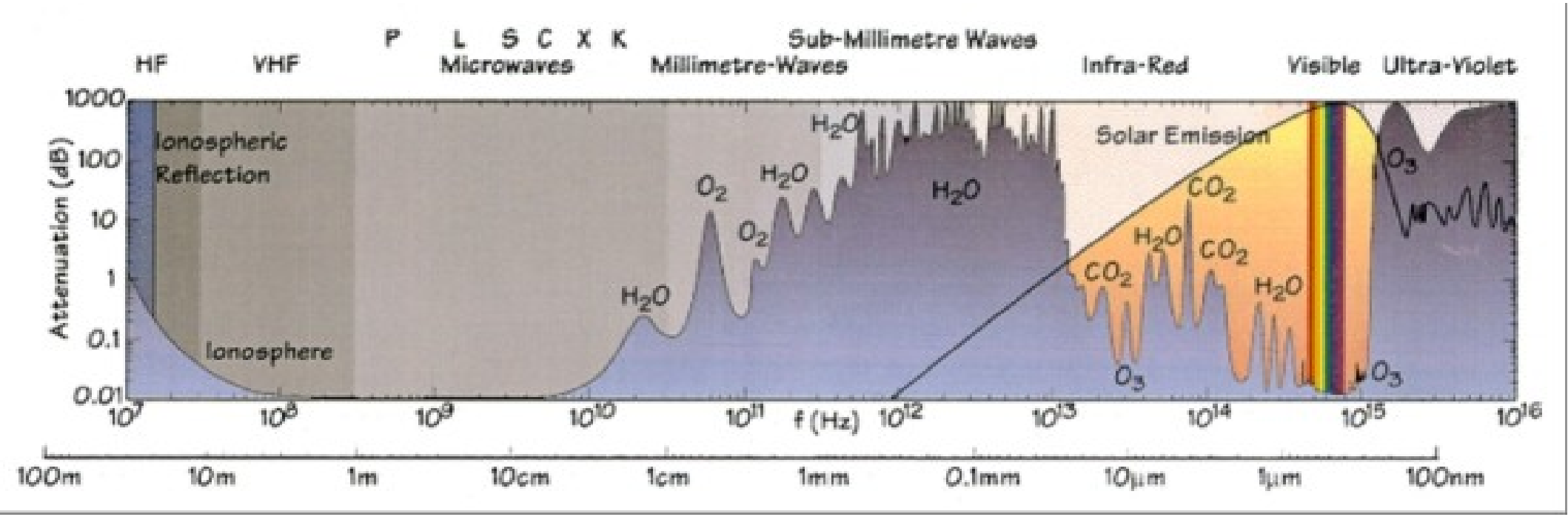
$$V^2 = V^T \eta V = x^2 + y^2 + z^2 - c^2 t^2 = r^2 - c^2 t^2$$

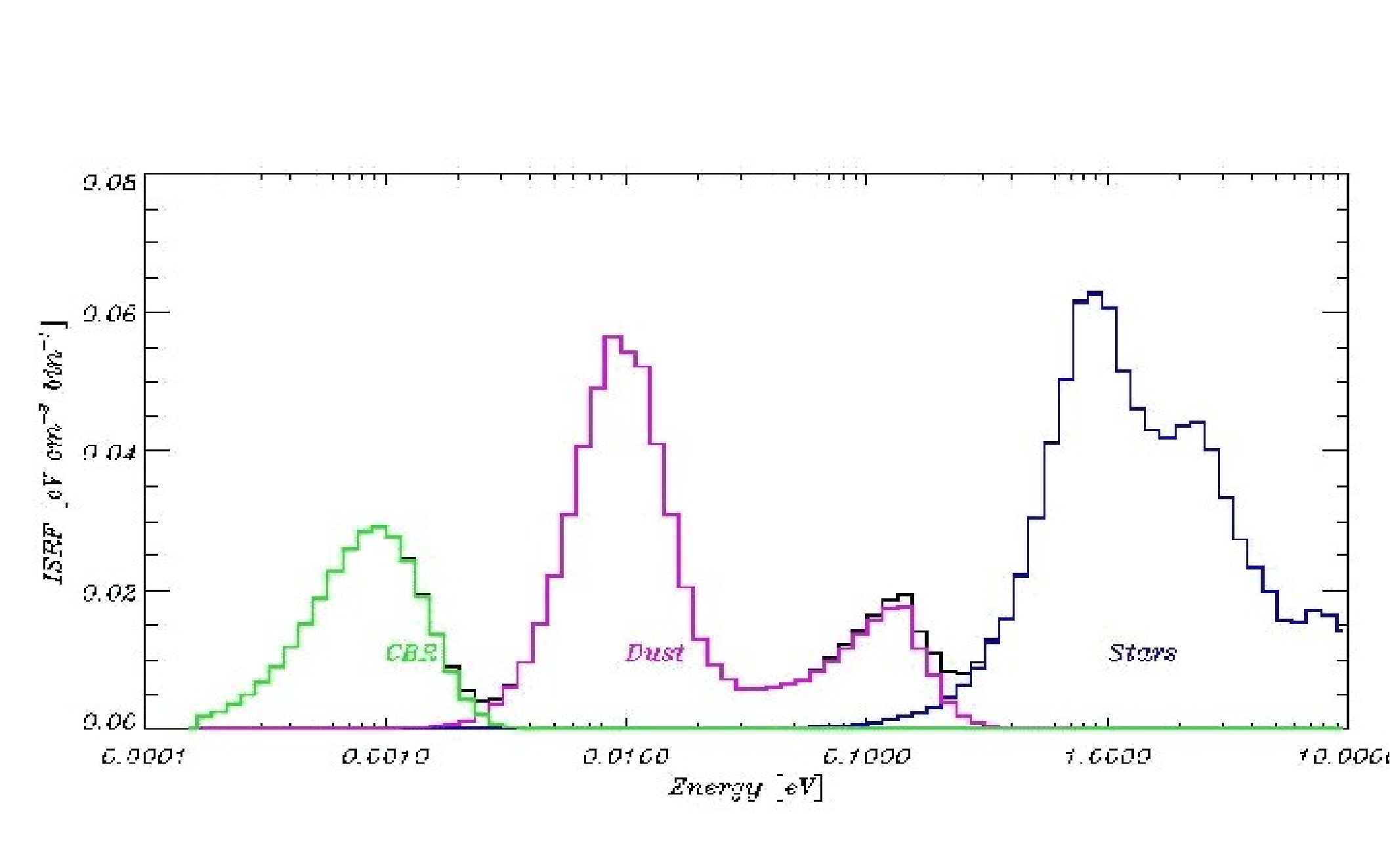
$$\eta = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$

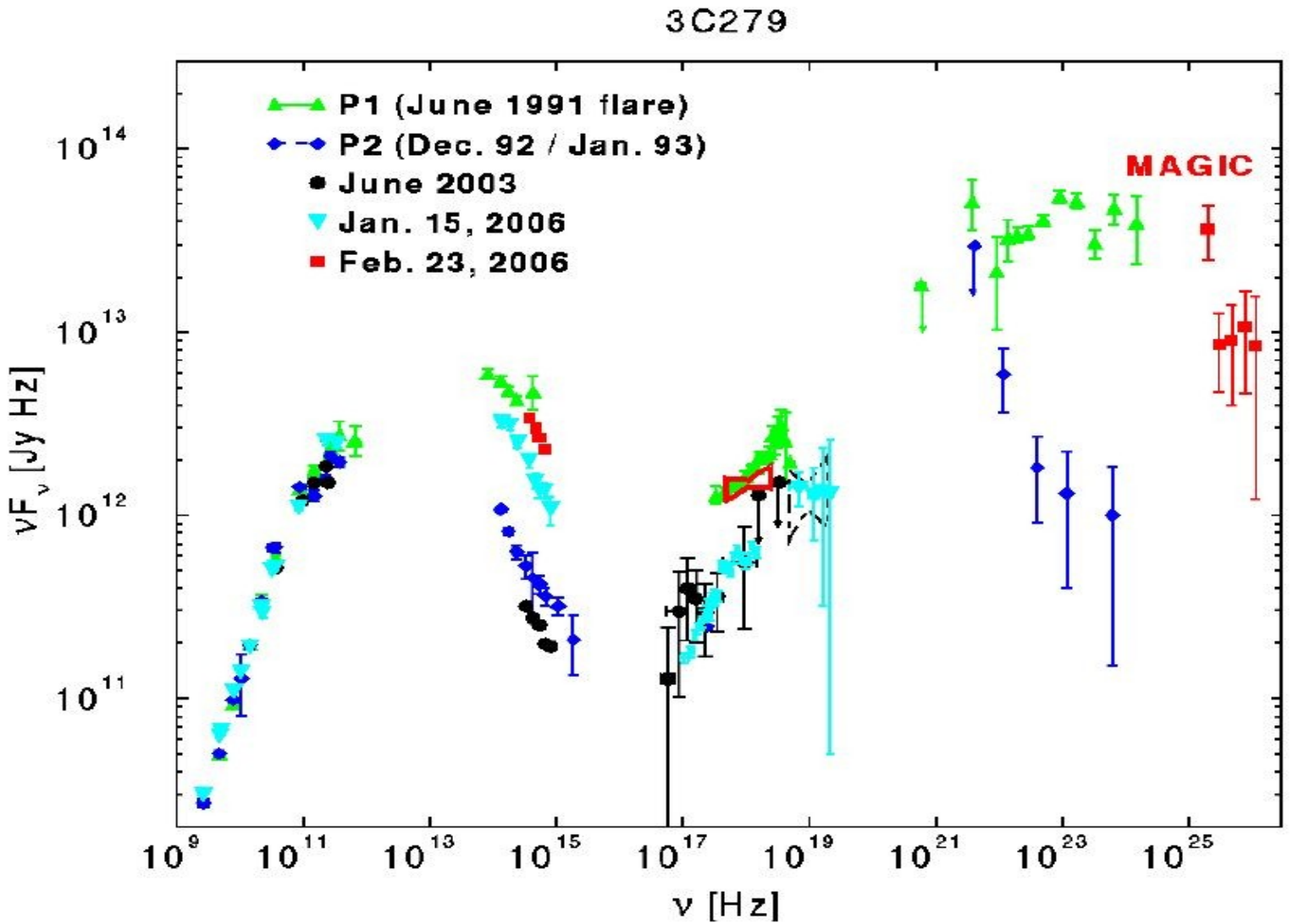
$$P = (p_x, p_y, p_z, \frac{E}{c})$$

$$P^2 = p_x^2 + p_y^2 + p_z^2 - \frac{E^2}{c^2} = p^2 - \frac{E^2}{c^2}$$

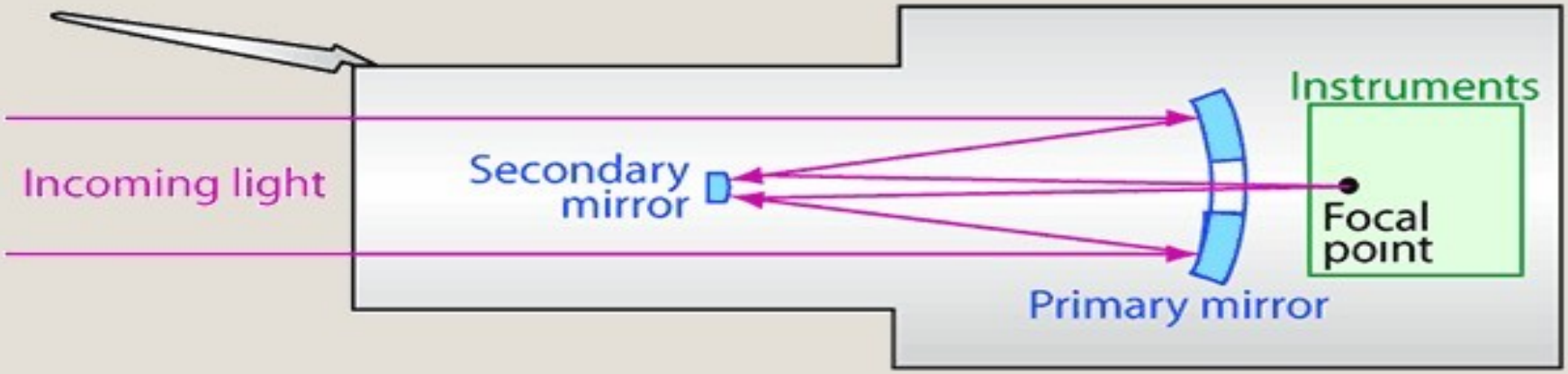

Energy discharges from atomic nuclei
Gamma rays
10^{-5}
(hard X-ray)
Medical applications
(soft X-ray)
X-rays
10^{-4}
0.01(10^{-2})
Ultra-violet
0.28
0.40
Visible light
Violet
Blue
Green
Yellow
Orange
Red
0.400
0.424
0.491
0.575
0.585
0.647
0.710
Visible
0.70
Near infrared
1.50
Shortwave infrared
3.00
Middle infrared
5.50
Micrometers (μm)
Heat lamp
Thermal infrared
10^{3}
(1 mm)
Microwave radar
Microwave
10^{4}
10^{5}
(1 m)
Television
FM radio
AM radio
Radio waves

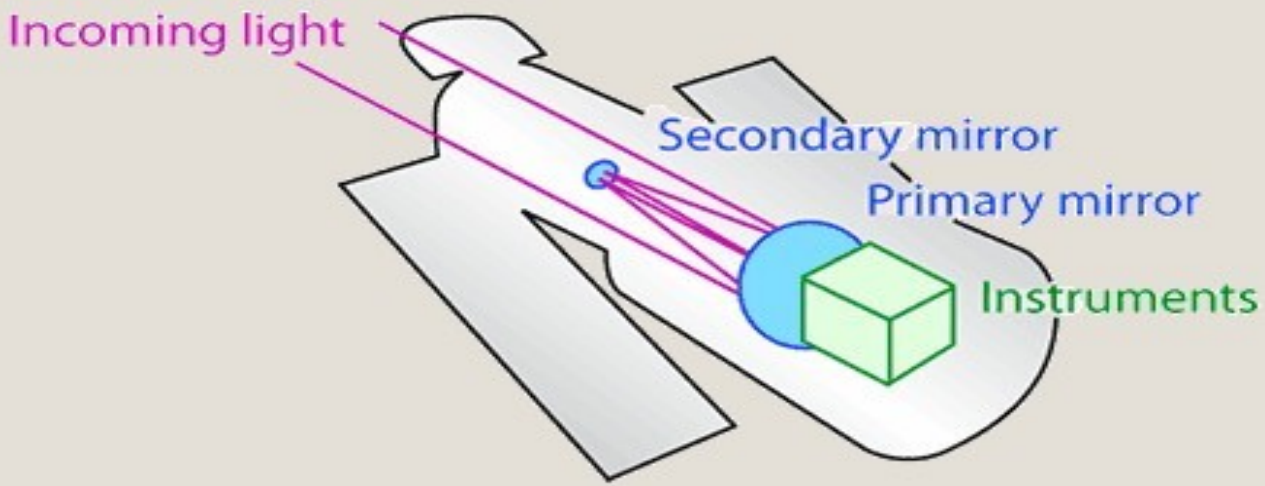

P L S C X K
Sub-Millimetre Waves
HF
VHF
Microwaves
Millimetre-Waves
Infra-Red
Visible
Ultra-Violet
Attenuation (dB)
1000
100
10
1
0.1
0.01
Ionospheric Reflection
Ionosphere
Solar Emission
H_2O
O_2
CO_2
O_3
10^7
10^8
10^9
10^{10}
10^{11}
f (Hz)
10^{12}
10^{13}
10^{14}
10^{15}
10^{16}
100m
10m
1m
10cm
1cm
1mm
0.1mm
10μm
1μm
100nm


0.08
0.06
0.04
0.02
0.00
ISRF [eV cm^{-3} bin^{-1}]
CBR
Dust
Stars
0.0001
0.0010
0.0100
0.1000
1.0000
10.0000
Energy [eV]

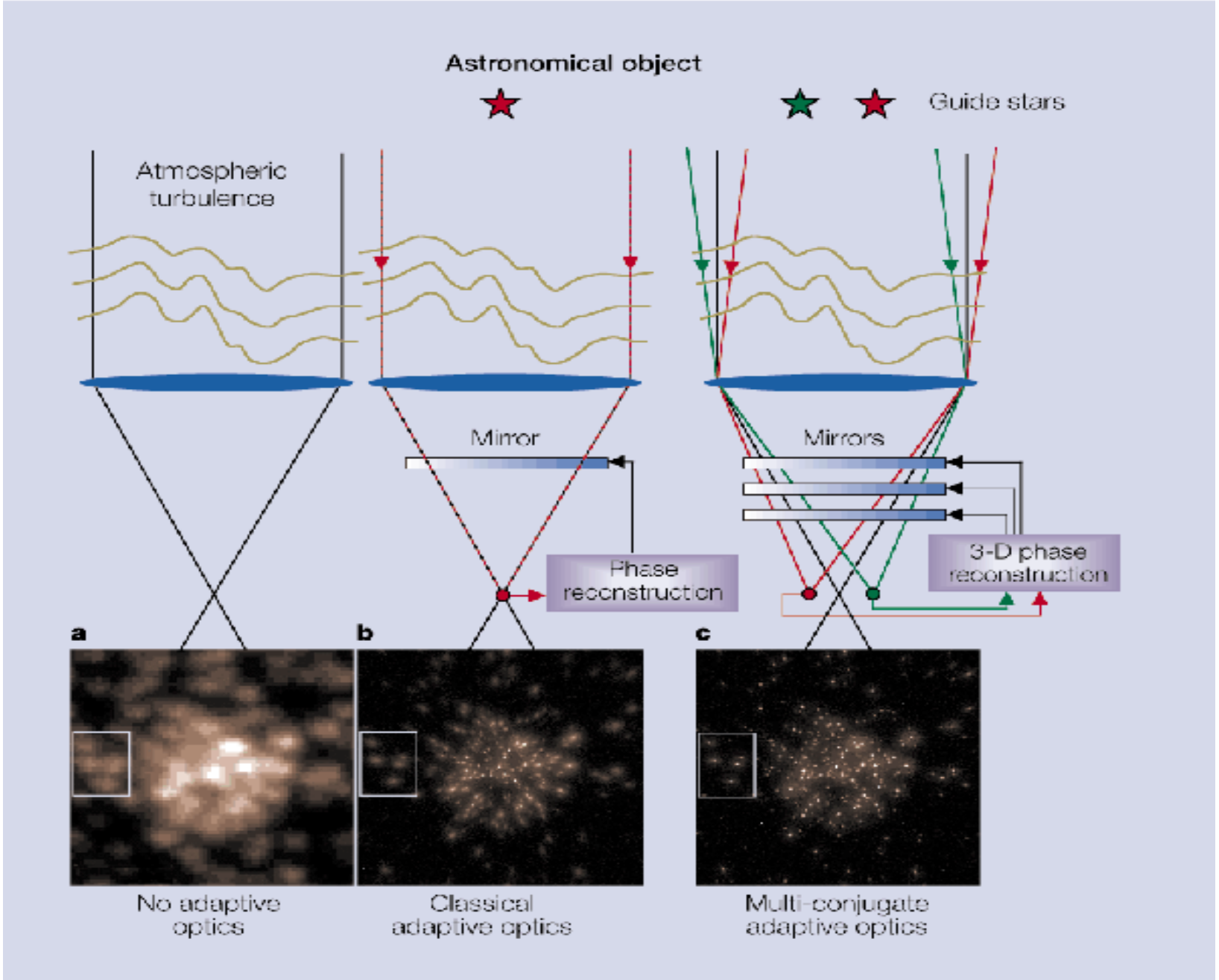

3C279
P1 (June 1991 flare)
P2 (Dec. 92 / Jan. 93)
June 2003
Jan. 15, 2006
Feb. 23, 2006
MAGIC
10^{14}
10^{13}
10^{12}
10^{11}
νF_ν [Jy Hz]
10^{9}
10^{11}
10^{13}
10^{15}
10^{17}
10^{19}
10^{21}
10^{23}
10^{25}
ν [Hz]

S109E5910

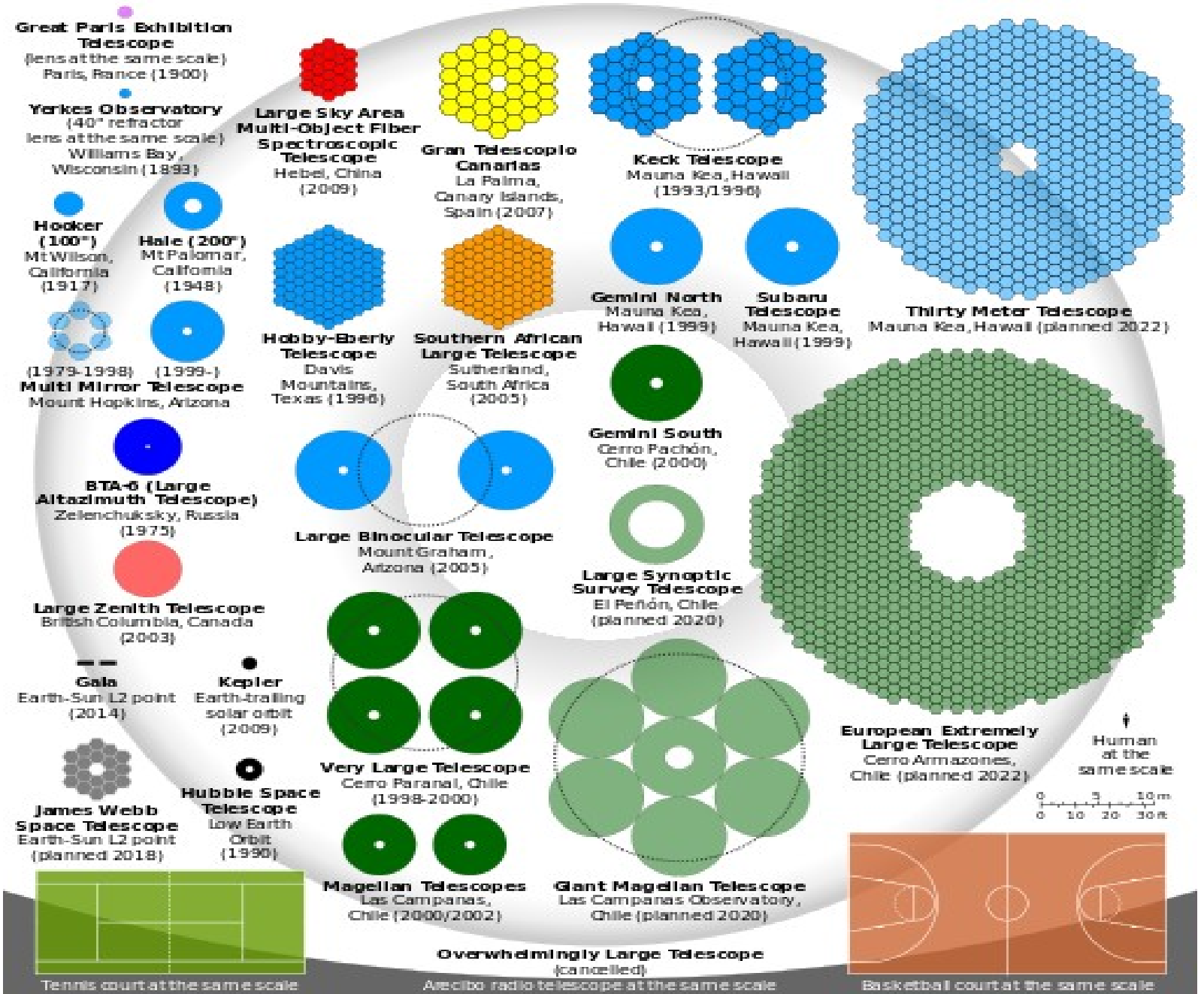


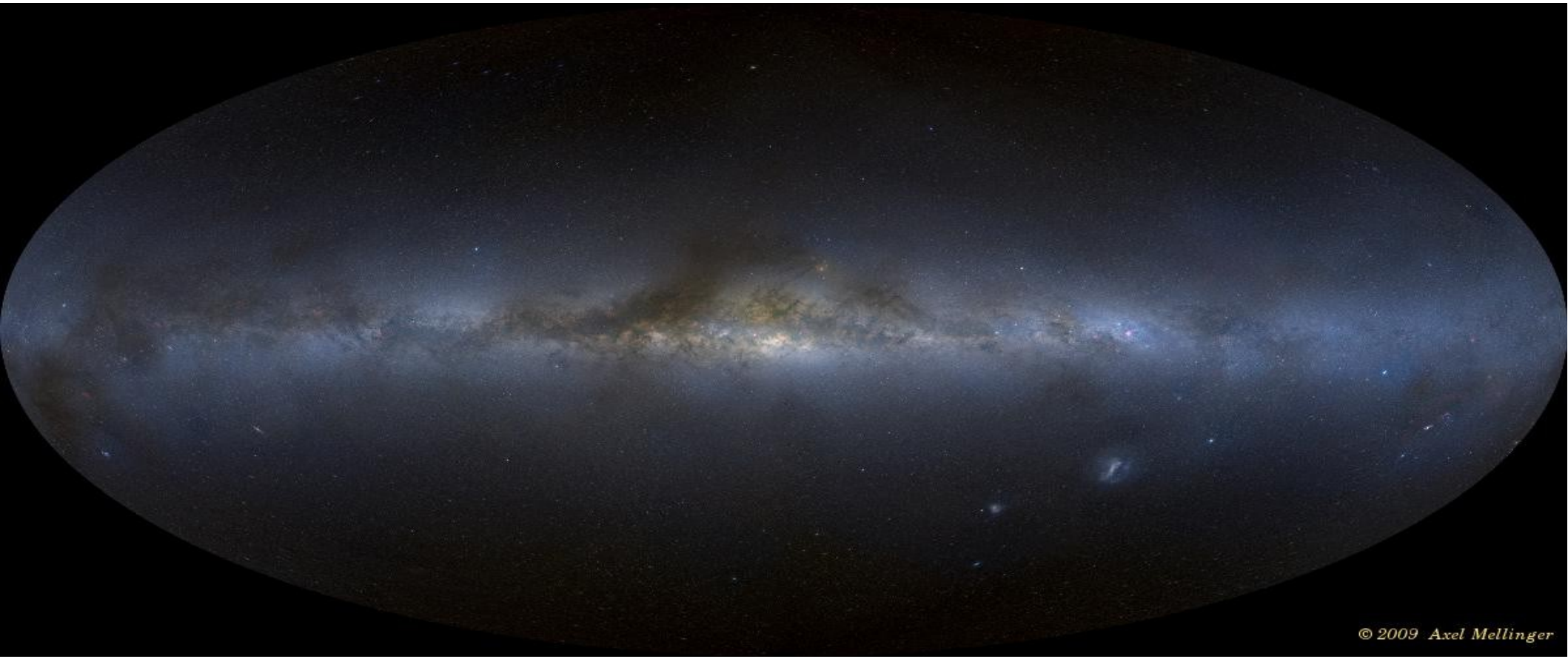


When light strikes the concave primary mirror of the Hubble Space Telescope, it is reflected to the convex secondary mirror, then back through a hole in the center of the primary mirror. There, the light comes to the focal point and passes to one of Hubble's instruments. Telescopes of this design are called Cassegrain telescopes, after the person who designed the first one.

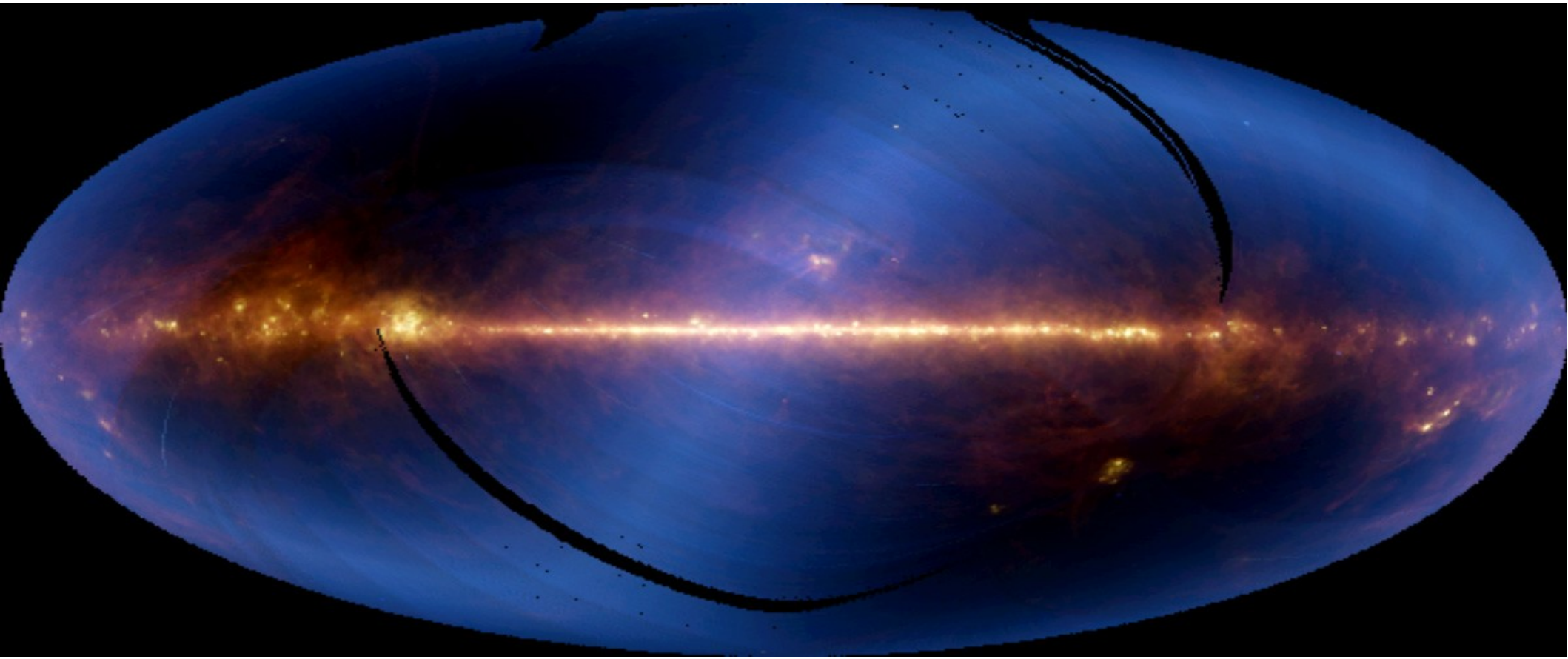

Astronomical object
Guide stars
Atmospheric turbulence
Mirror
Mirrors
Phase reconstruction
3-D phase reconstruction
a
b
c
No adaptive optics
Classical adaptive optics
Multi-conjugate adaptive optics

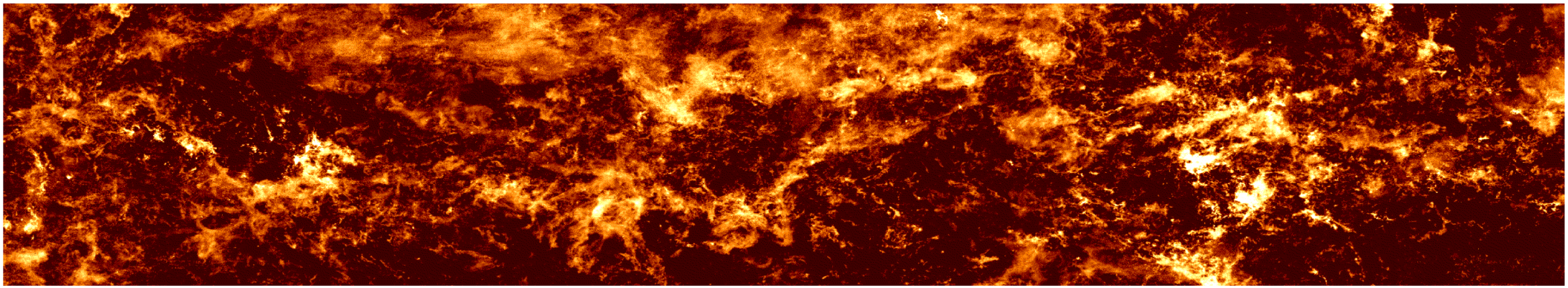

140 м
120 м
100 м
80 м
60 м
40 м
20 м

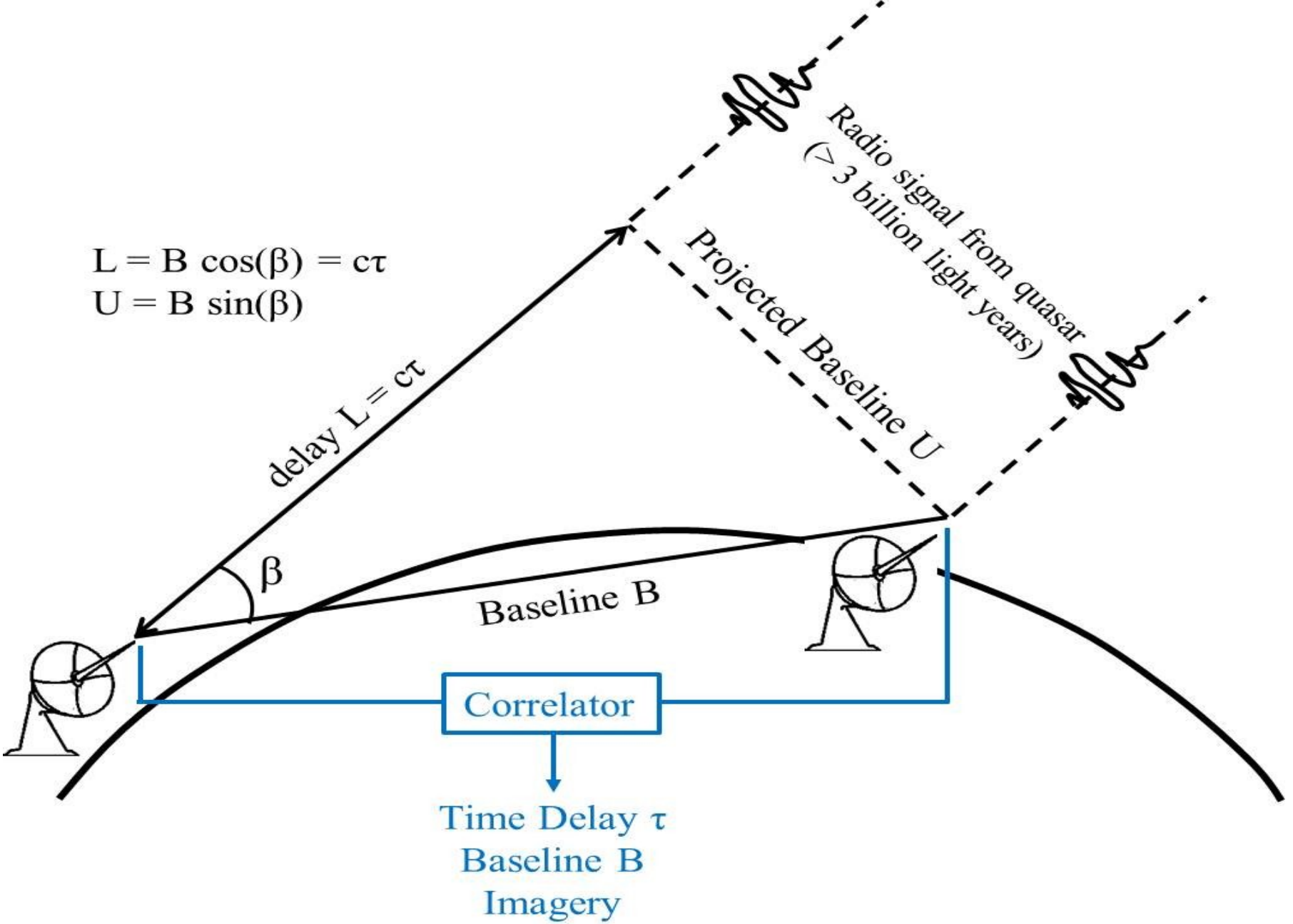

Great Paris Exhibition Telescope
(lens at the same scale)
Paris, France (1900)
Yerkes Observatory
(40" refractor
lens at the same scale)
Williams Bay,
Wisconsin (1893)
Hooker (100")
Mt Wilson,
California
(1917)
Hale (200")
Mt Palomar,
California
(1948)
(1979-1998)
(1999-)
Multi Mirror Telescope
Mount Hopkins, Arizona
BTA-6 (Large Altazimuth Telescope)
Zelenchuksky, Russia
(1975)
Large Zenith Telescope
British Columbia, Canada
(2003)
Gaia
Earth-Sun L2 point
(2014)
Kepler
Earth-trailing
solar orbit
(2009)
James Webb Space Telescope
Earth-Sun L2 point
(planned 2018)
Hubble Space Telescope
Low Earth
Orbit
(1990)
Large Sky Area Multi-Object Fiber Spectroscopic Telescope
Hebei, China
(2009)
Hobby-Eberly Telescope
Davis
Mountains,
Texas (1996)
Large Binocular Telescope
Mount Graham,
Arizona (2005)
Very Large Telescope
Cerro Paranal, Chile
(1998-2000)
Magellan Telescopes
Las Campanas,
Chile (2000/2002)
Gran Telescopio Canarias
La Palma,
Canary Islands,
Spain (2007)
Southern African Large Telescope
Sutherland,
South Africa
(2005)
Keck Telescope
Mauna Kea, Hawaii
(1993/1996)
Gemini North
Mauna Kea,
Hawaii (1999)
Subaru Telescope
Mauna Kea,
Hawaii (1999)
Gemini South
Cerro Pachón,
Chile (2000)
Large Synoptic Survey Telescope
El Peñón, Chile
(planned 2020)
Giant Magellan Telescope
Las Campanas Observatory,
Chile (planned 2020)
Thirty Meter Telescope
Mauna Kea, Hawaii (planned 2022)
European Extremely Large Telescope
Cerro Armazones,
Chile (planned 2022)
Human at the same scale
0 5 10 m
0 10 20 30 ft
Overwhelmingly Large Telescope
(cancelled)
Tennis court at the same scale
Arecibo radio telescope at the same scale
Basketball court at the same scale

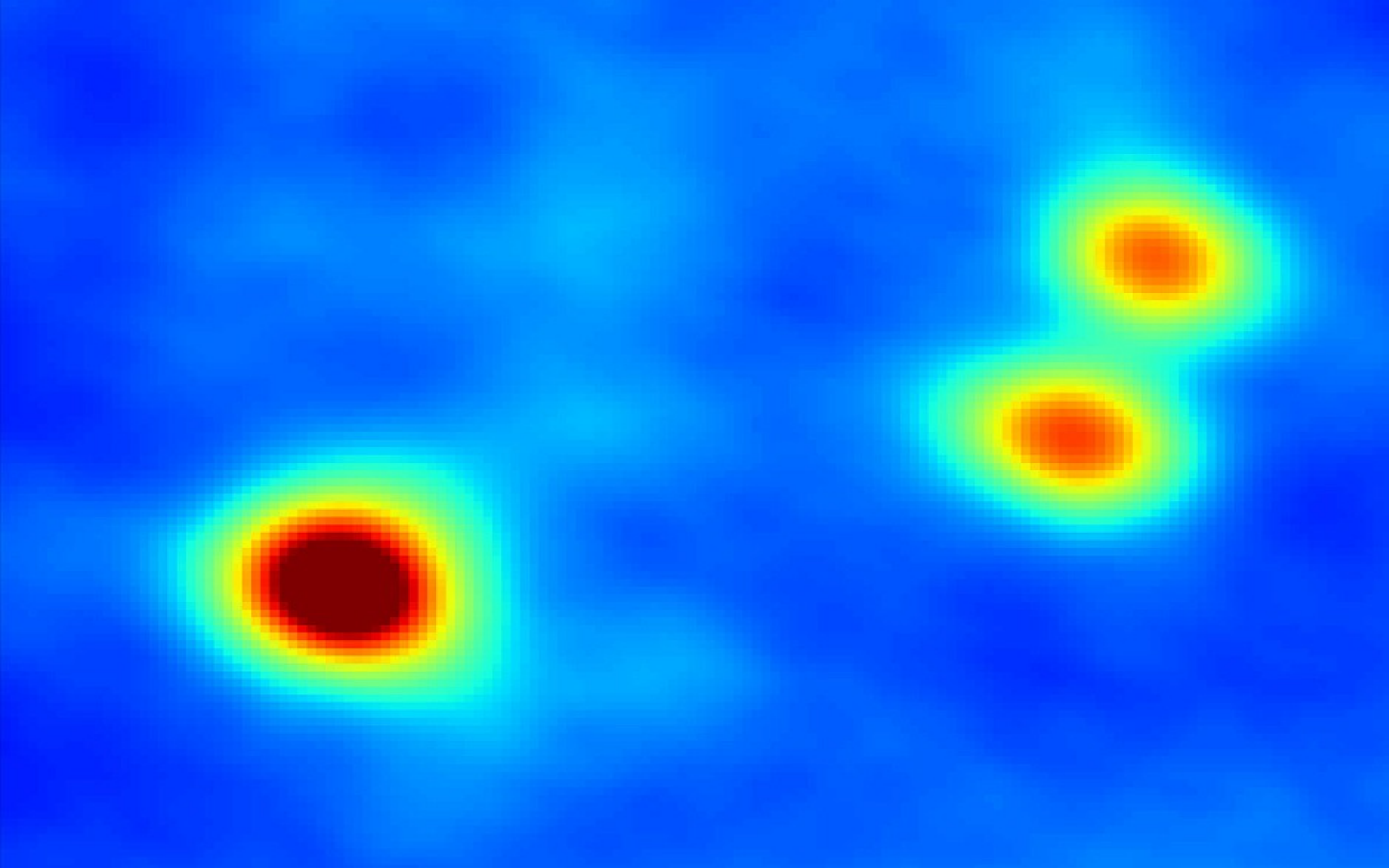

© 2009 Axel Mellinger

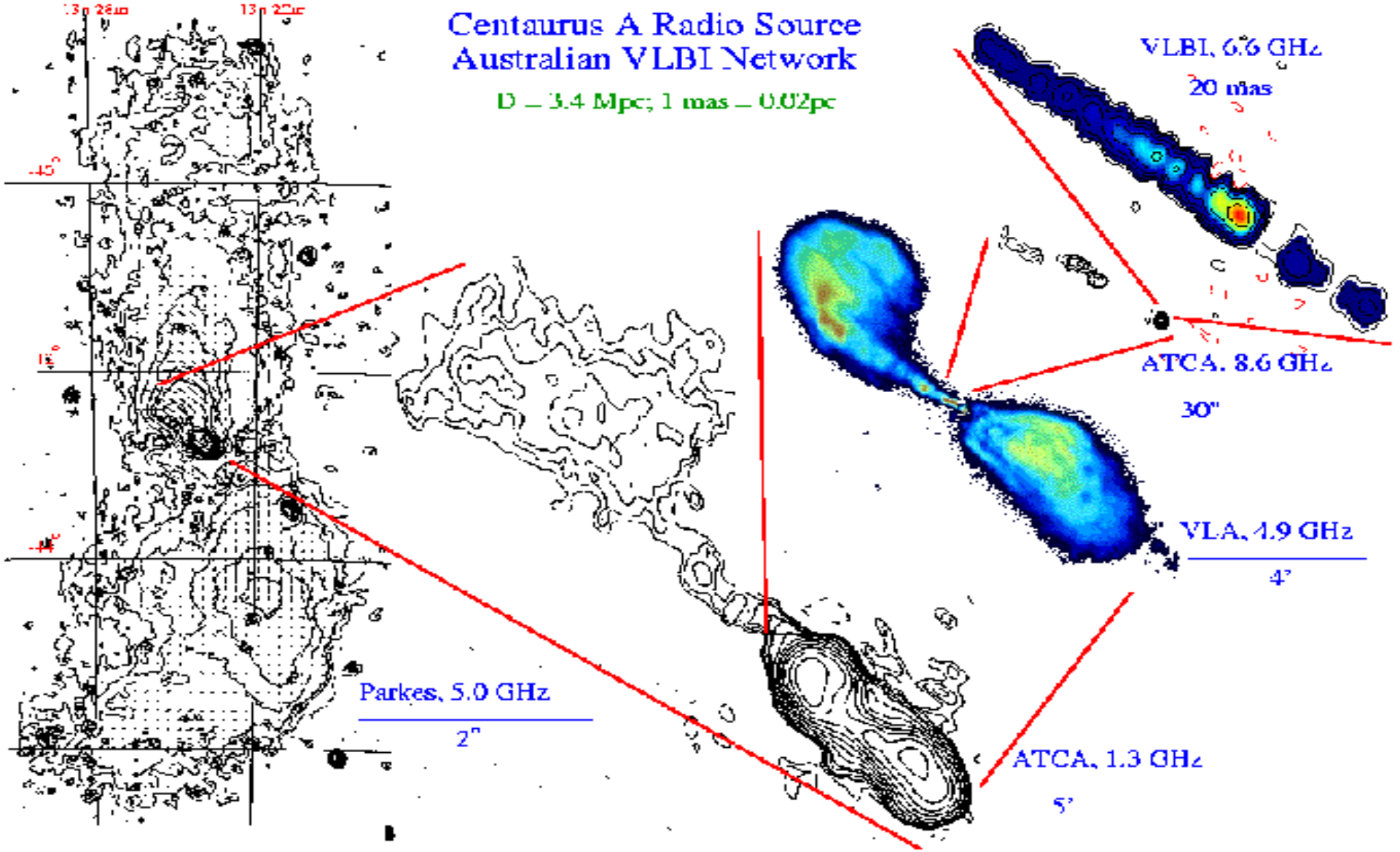

SOFIA
STRATOSPHERIC OBSERVATORY
FOR INFRARED ASTRONOMY
NASA
DLR
N747NA

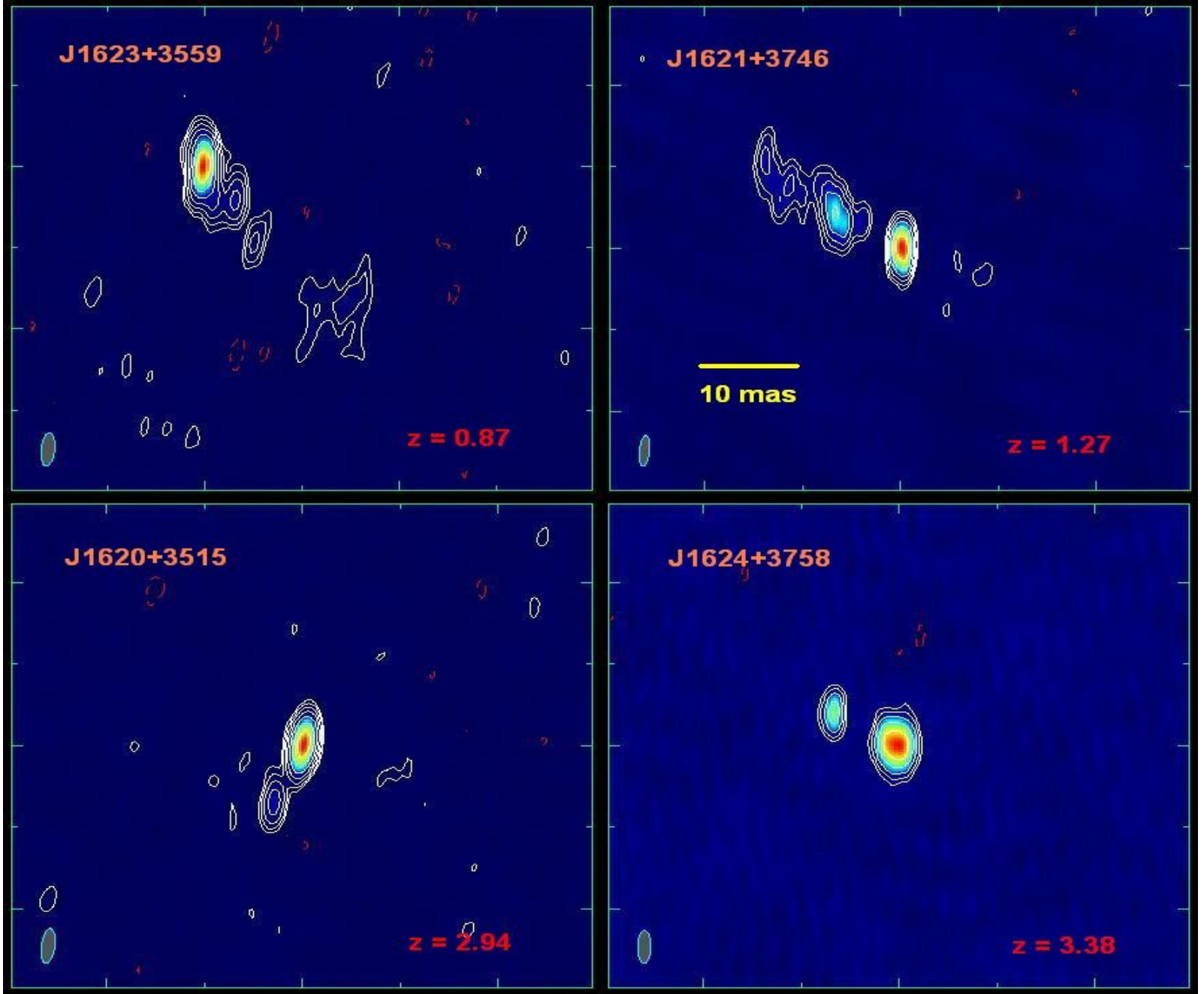


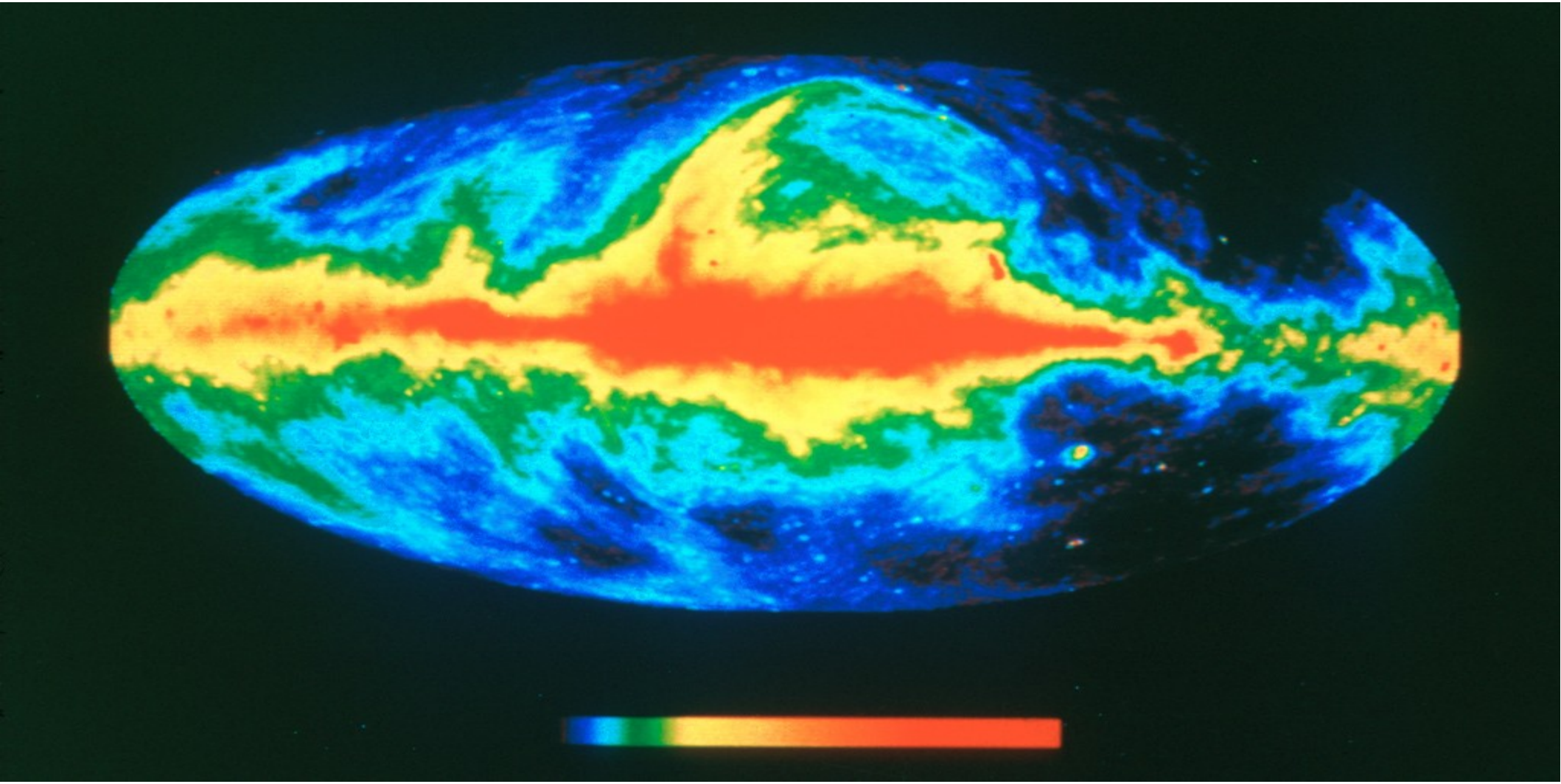


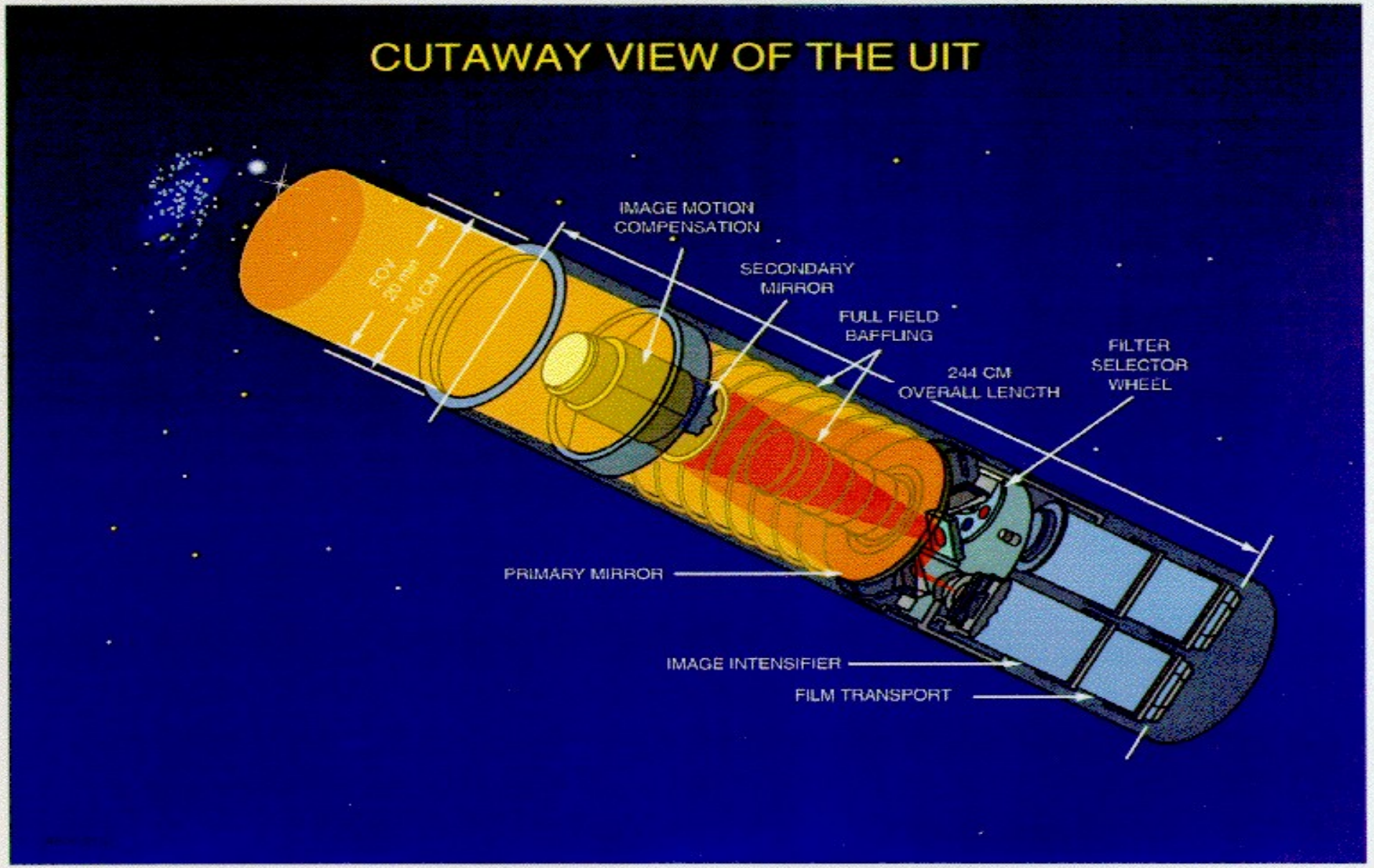

L = B cos(β) = cτ
U = B sin(β)
Radio signal from quasar
(> 3 billion light years)
Projected Baseline U
delay L = cτ
β
Baseline B
Correlator
Time Delay τ
Baseline B
Imagery

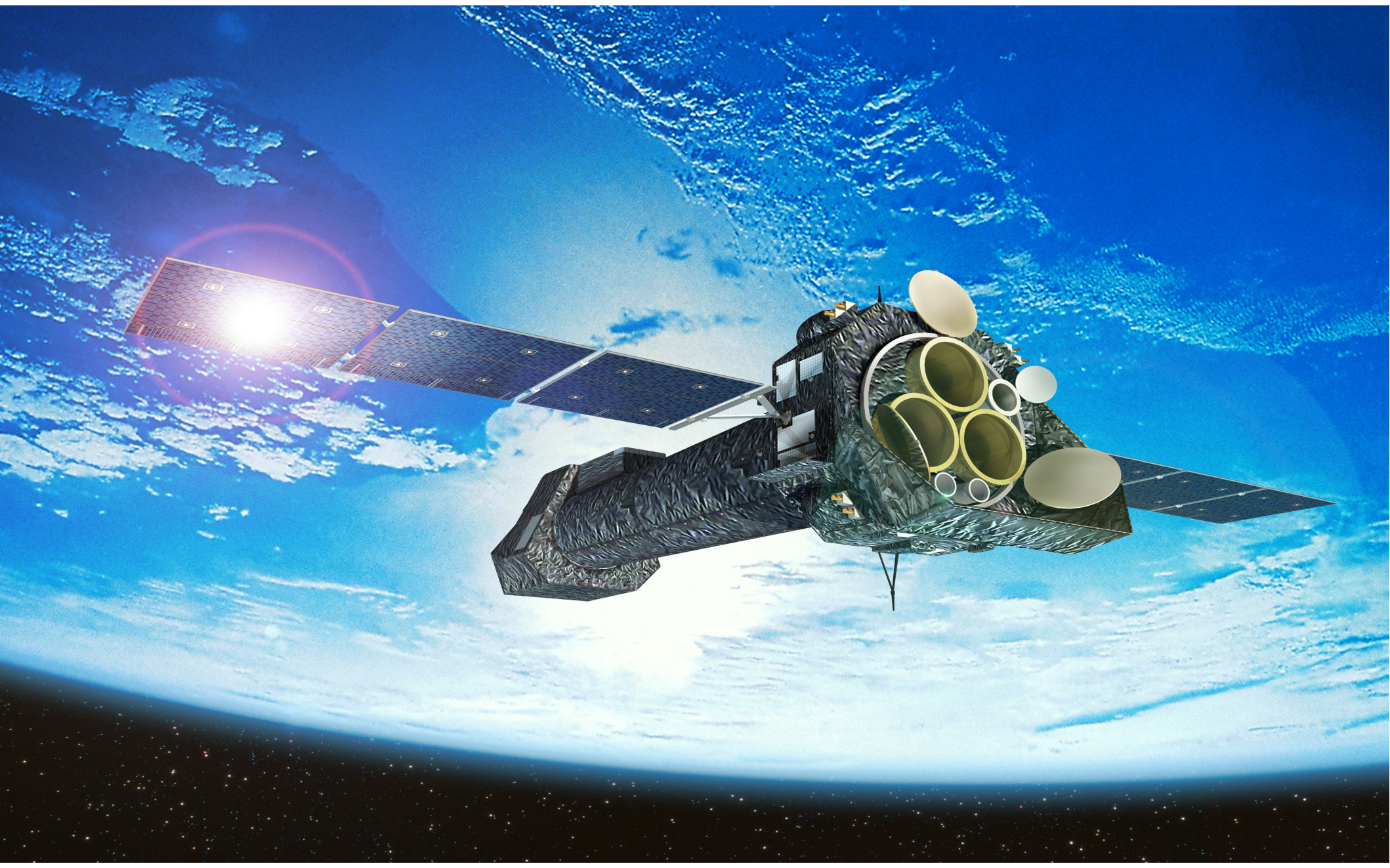


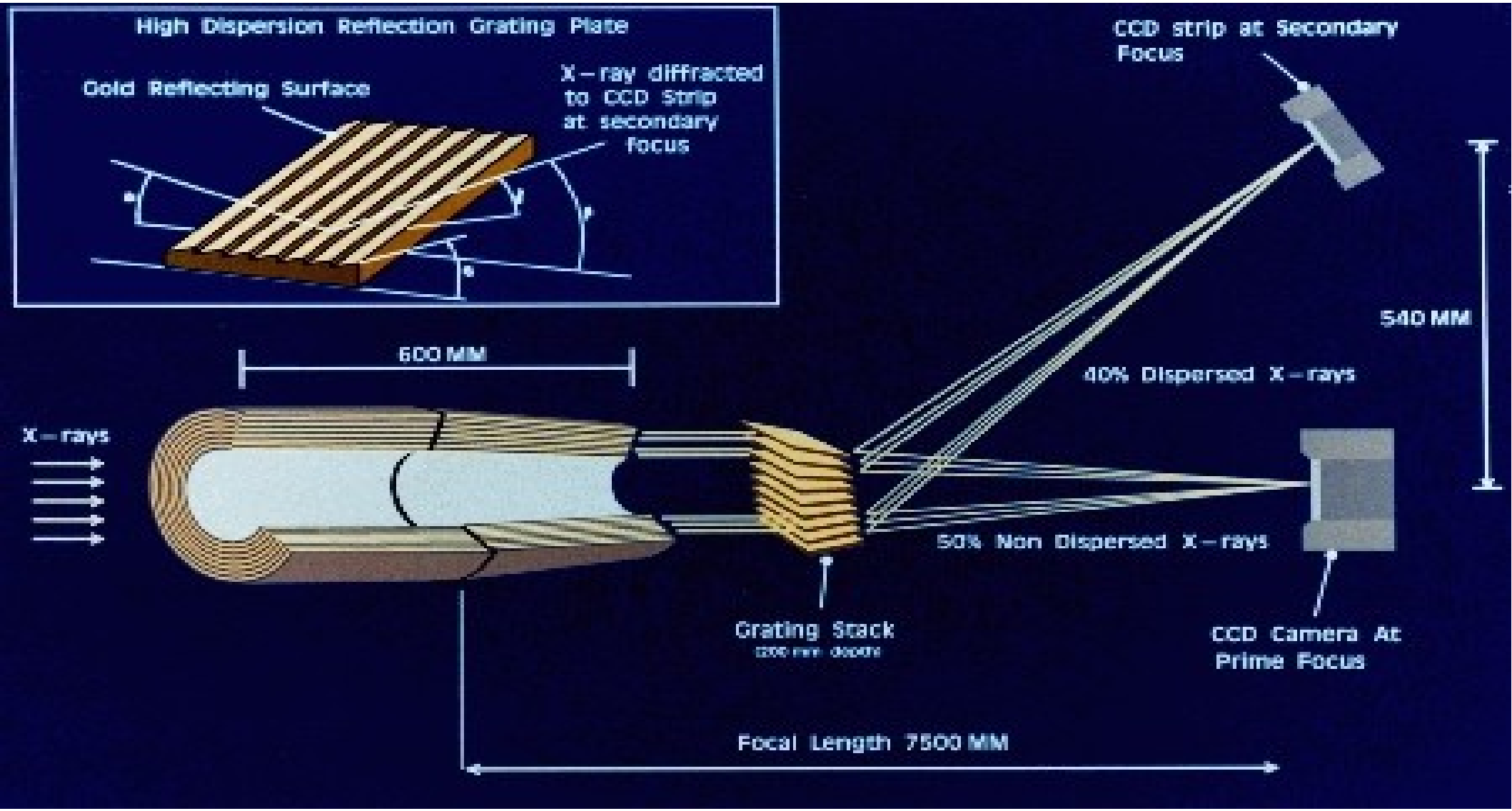

Centaurus A Radio Source
Australian VLBI Network
D = 3.4 Mpc; 1 mas = 0.02pc
VLBI, 6.6 GHz
20 mas
ATCA, 8.6 GHz
30"
VLA, 4.9 GHz
4'
Parkes, 5.0 GHz
2°
ATCA, 1.3 GHz
5'


J1623+3559
z = 0.87
J1621+3746
10 mas
z = 1.27
J1620+3515
z = 2.94
J1624+3758
z = 3.38



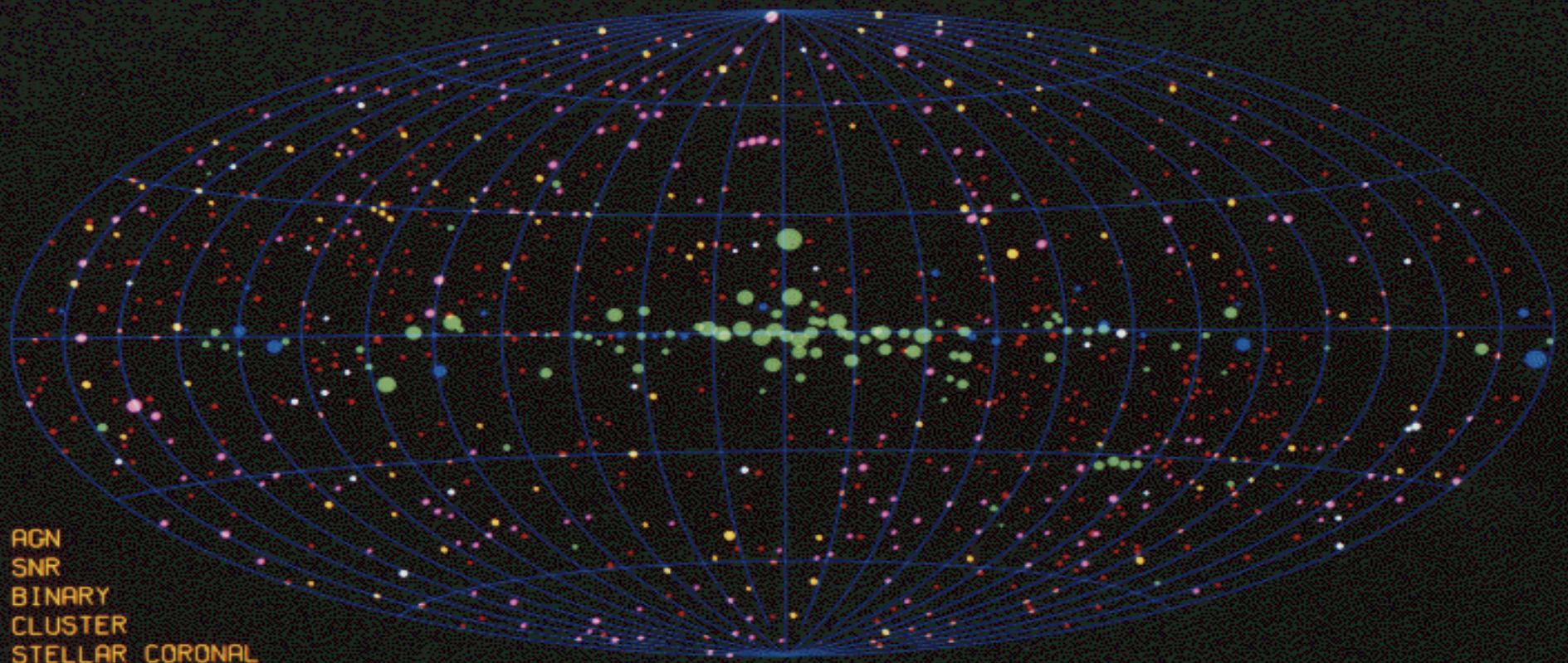

CUTAWAY VIEW OF THE UIT
IMAGE MOTION COMPENSATION
SECONDARY MIRROR
FULL FIELD BAFFLING
FILTER SELECTOR WHEEL
244 CM OVERALL LENGTH
PRIMARY MIRROR
IMAGE INTENSIFIER
FILM TRANSPORT

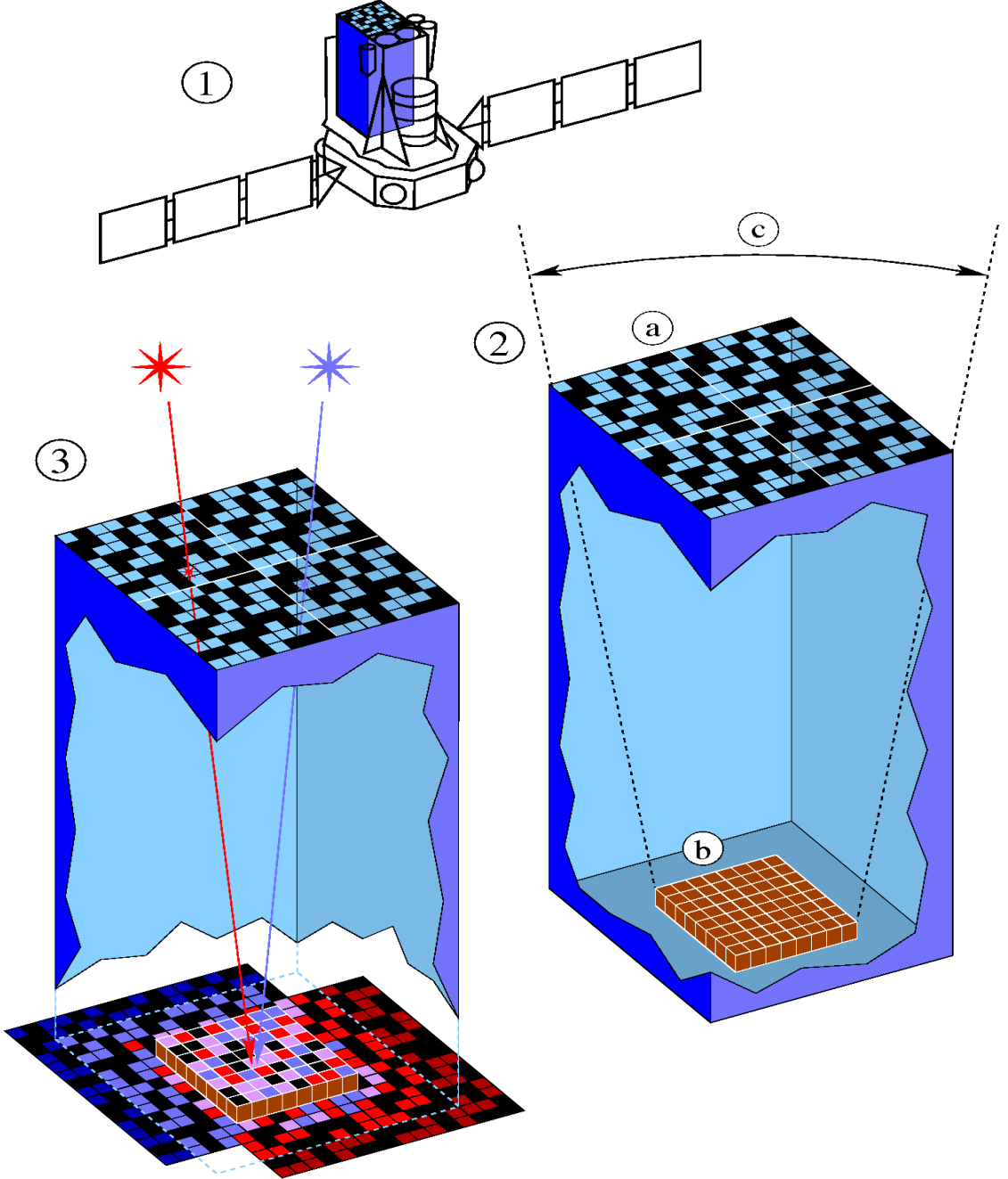


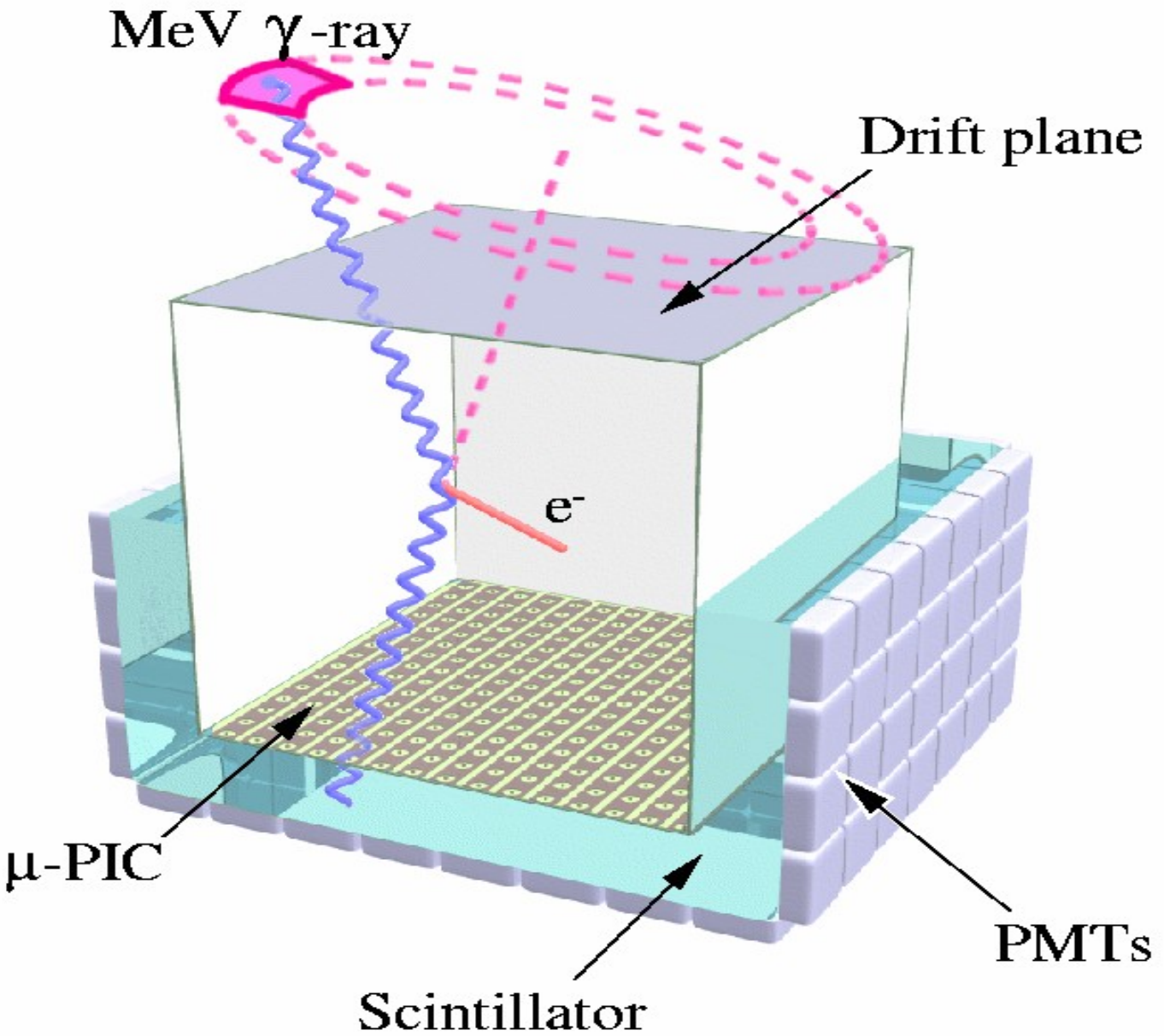

High Dispersion Reflection Grating Plate
Gold Reflecting Surface
X-ray diffracted to CCD Strip at secondary Focus
CCD strip at Secondary Focus
540 MM
600 MM
40% Dispersed X-rays
X-rays
50% Non Dispersed X-rays
Grating Stack
CCD Camera At Prime Focus
Focal Length 7500 MM

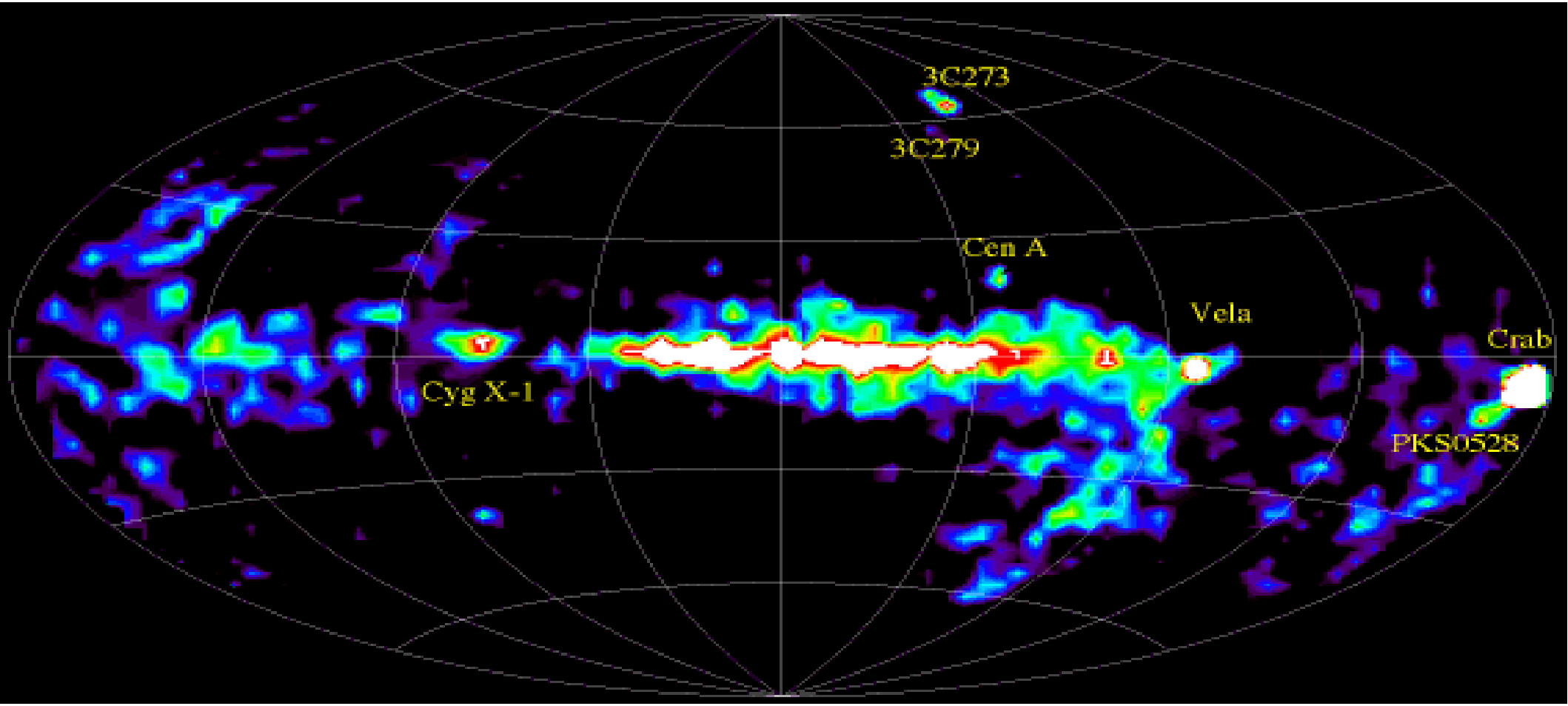
HEAO A-1 ALL-SKY X-RAY CATALOG

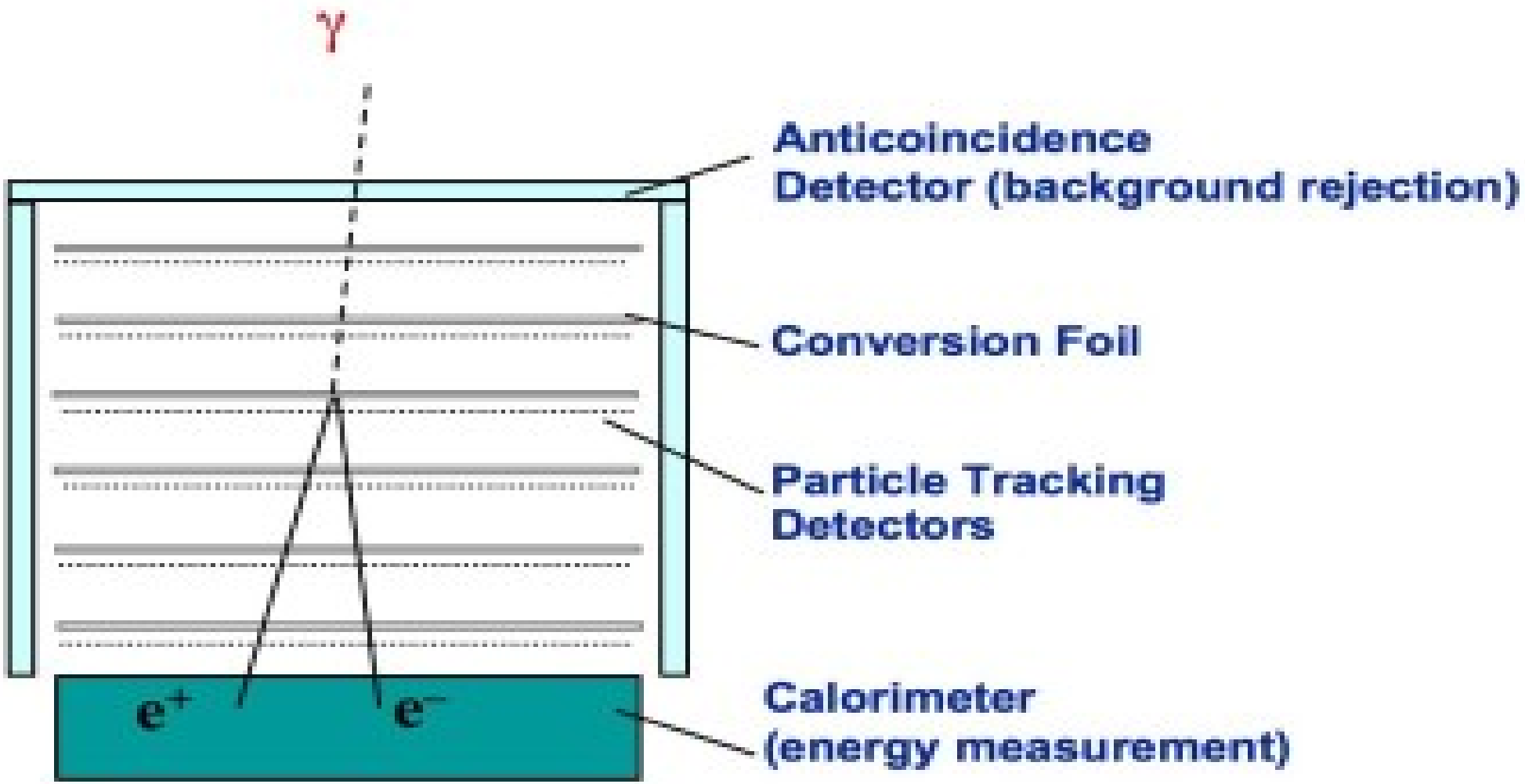
NAVAL RESEARCH LABORATORY

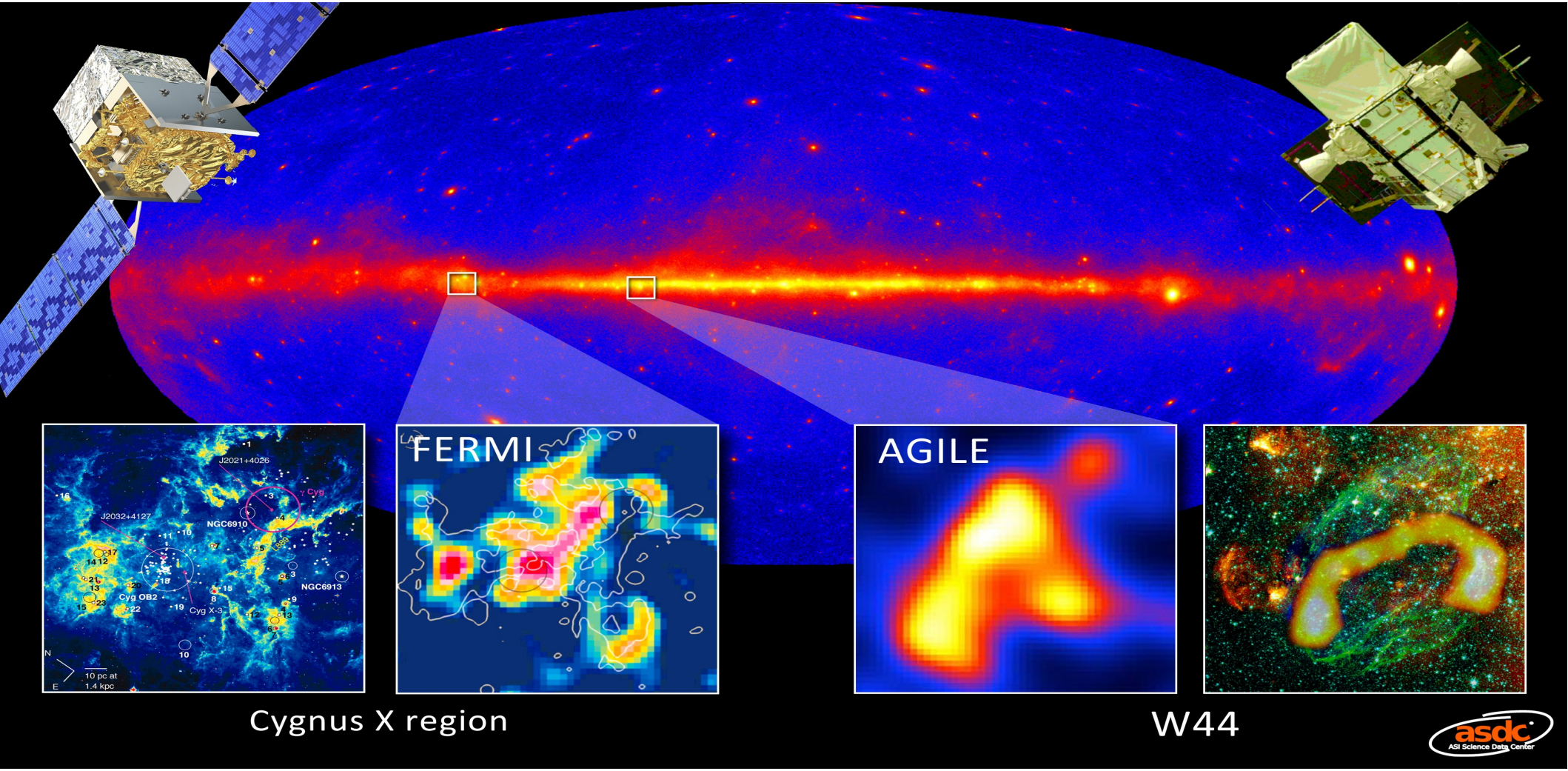



1
2
3
a
b
c


MeV γ-ray
Drift plane
e-
μ-PIC
Scintillator
PMTs


3C273
3C279
Cen A
Vela
Crab
Cyg X-1
PKS0528

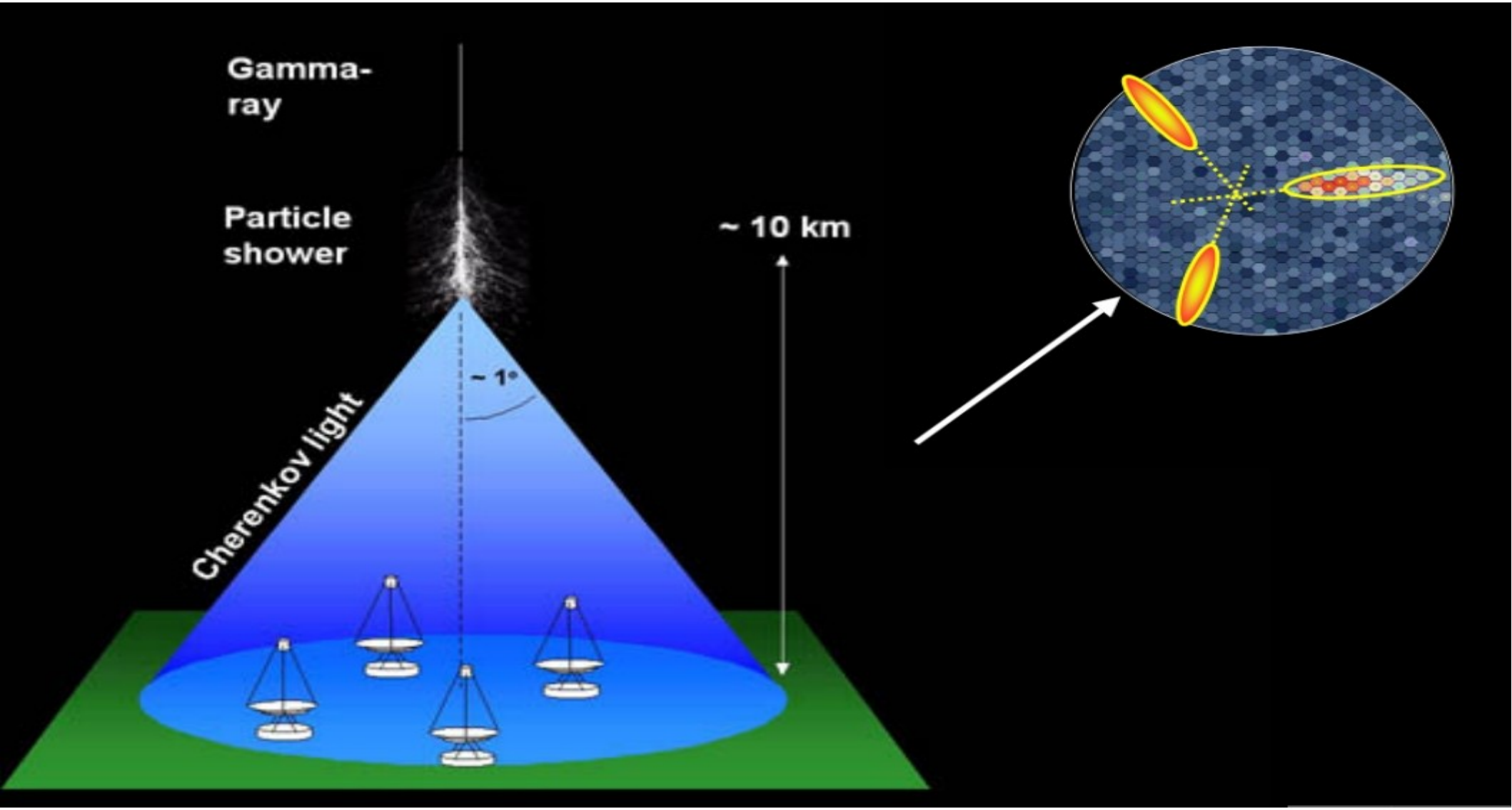

γ
Anticoincidence
Detector (background rejection)
Conversion Foil
Particle Tracking
Detectors
e+
e−
Calorimeter
(energy measurement)

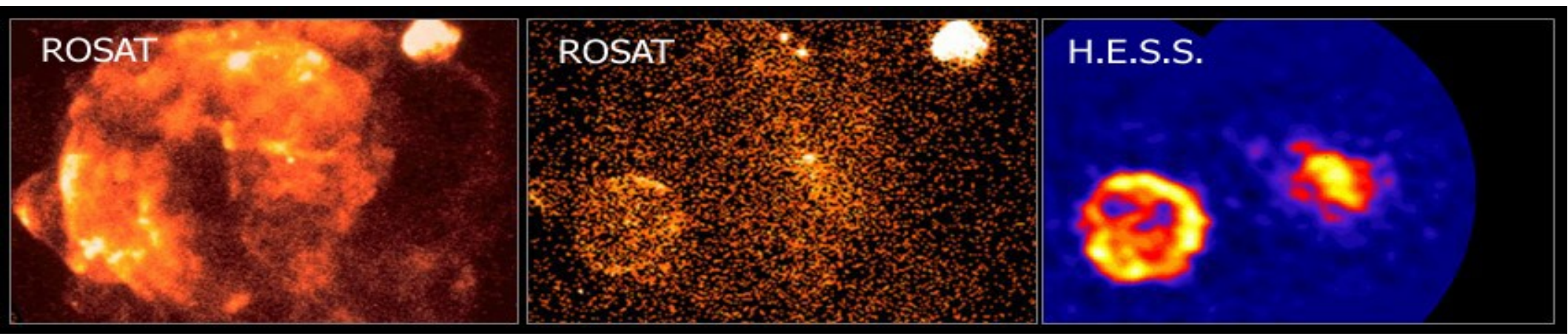


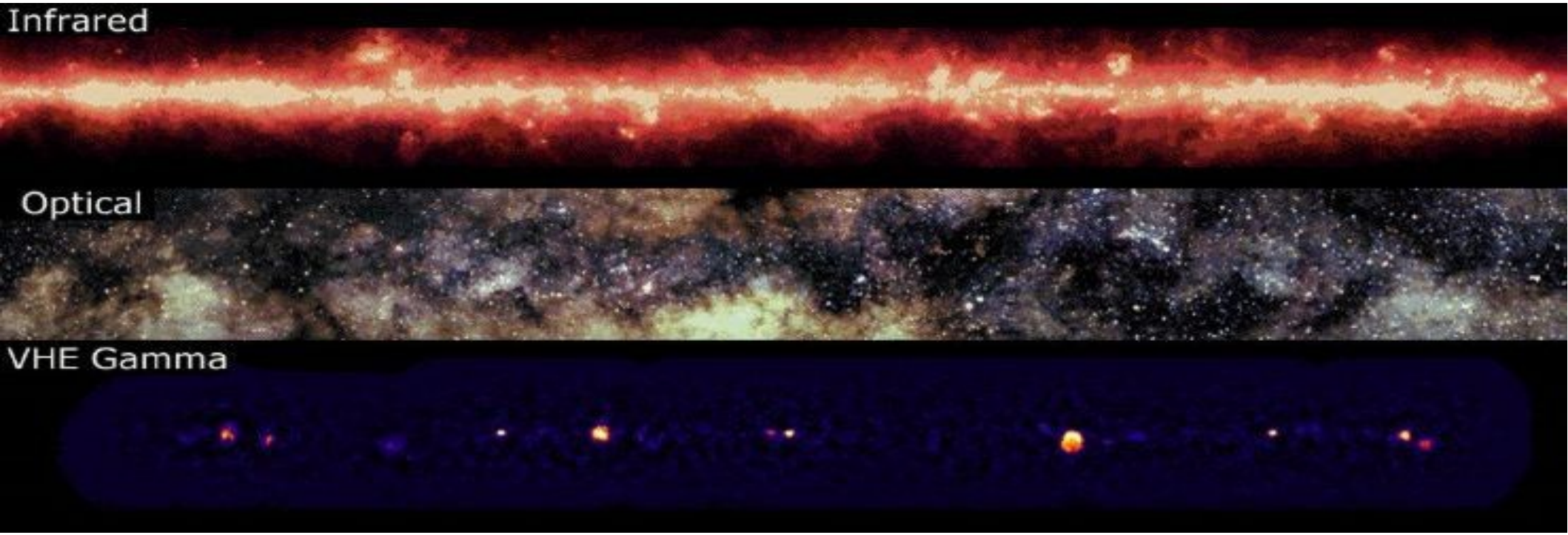
Cygnus X region

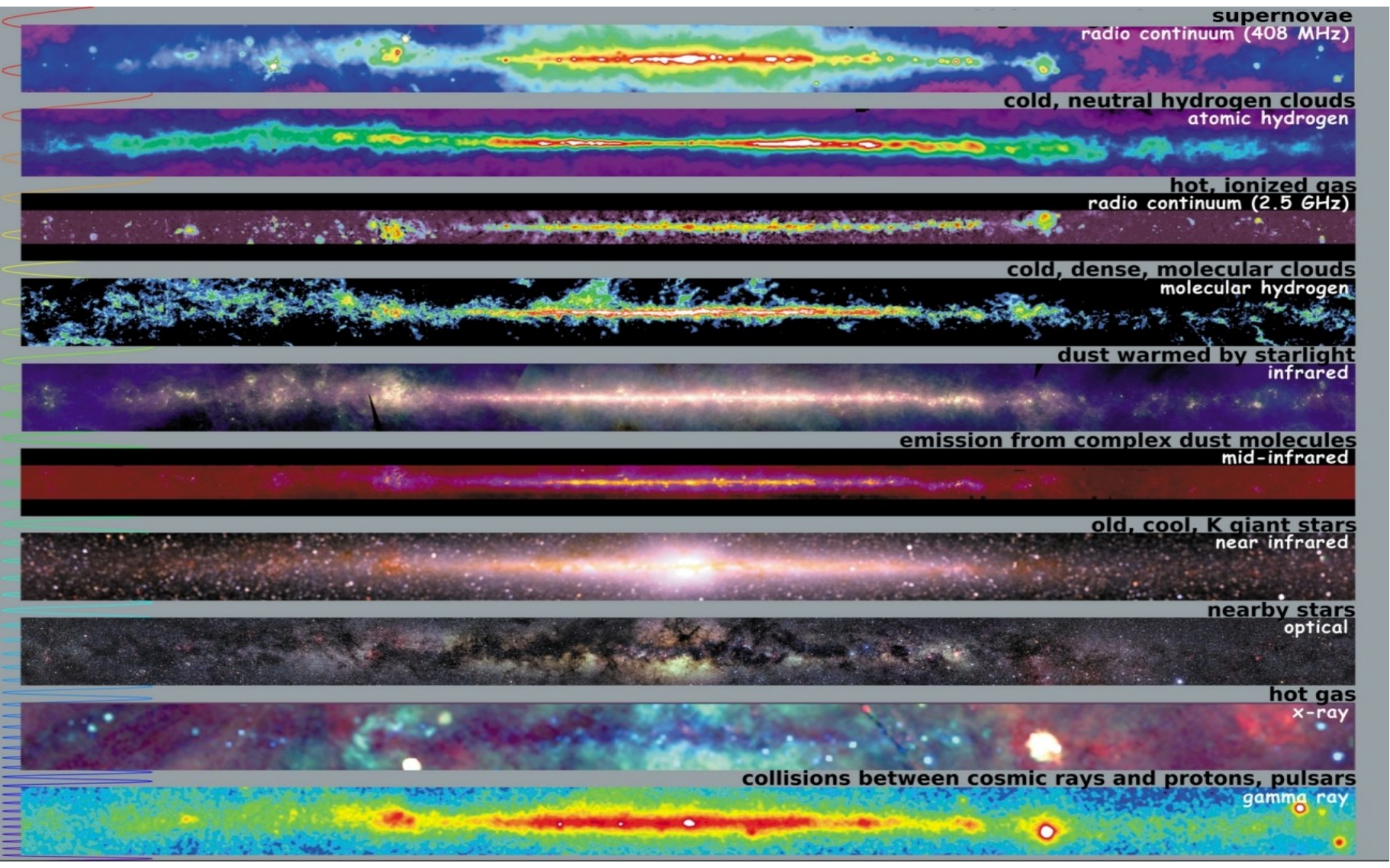
W44

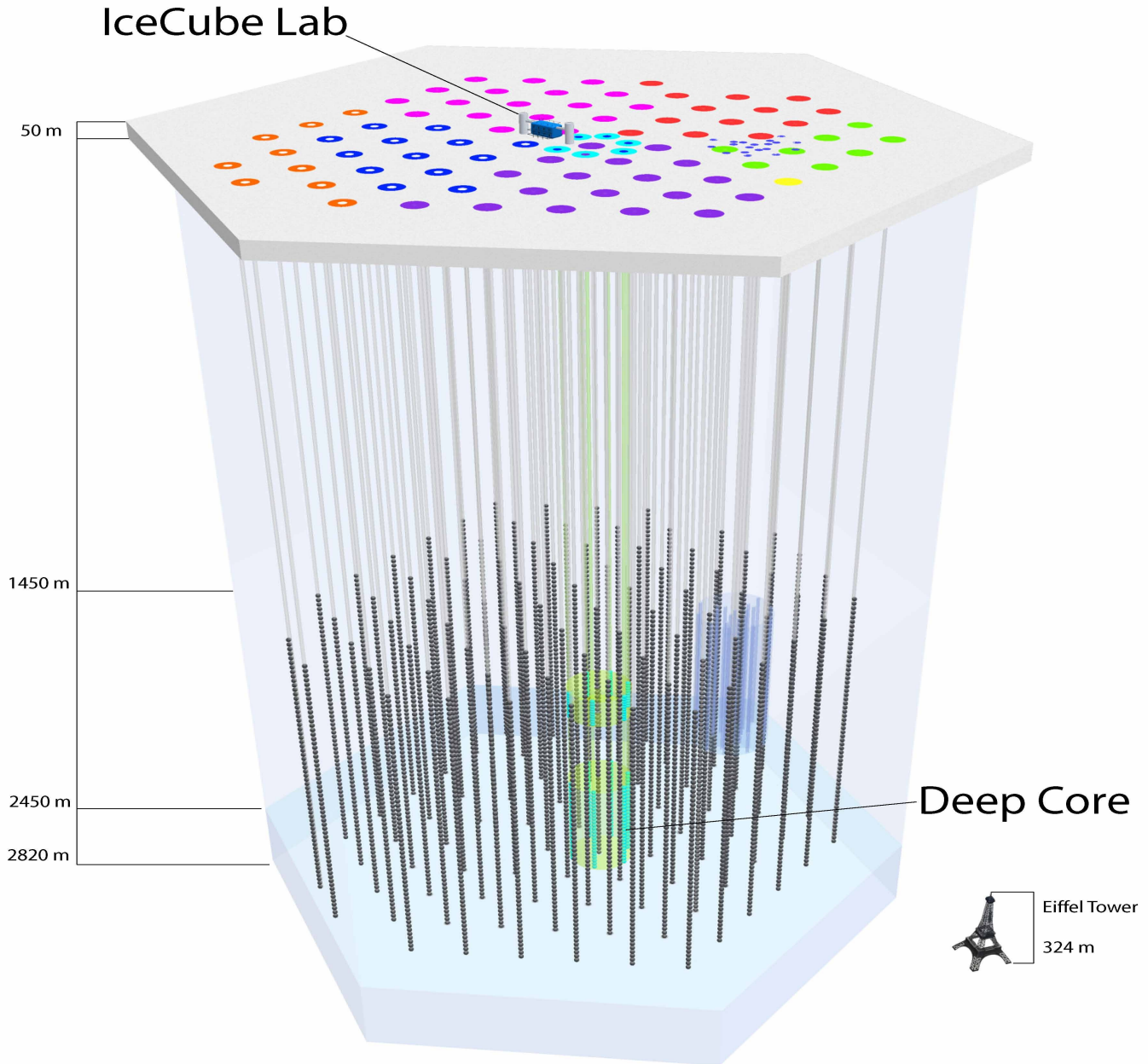
asdc
ASI Science Data Center

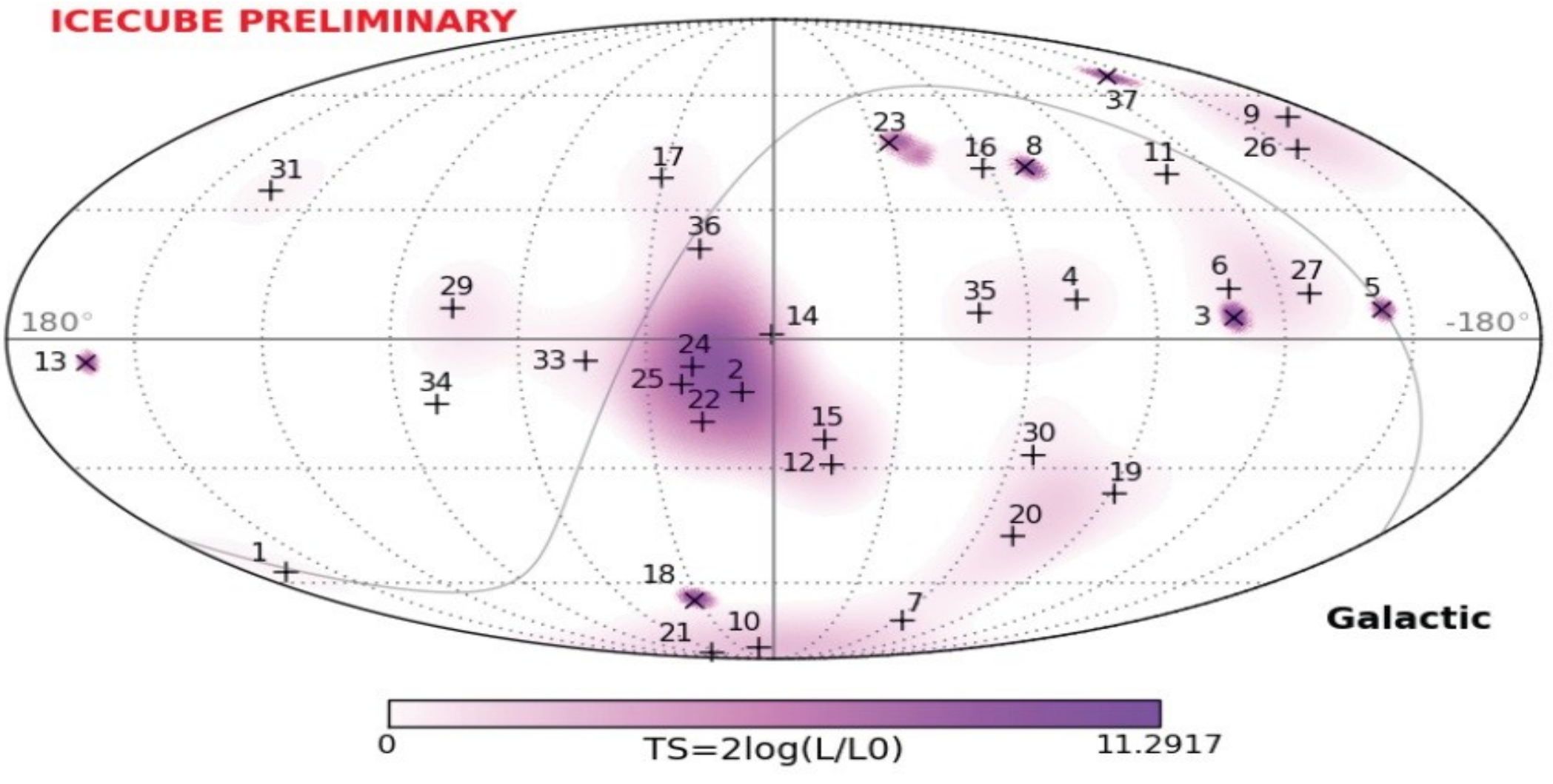

Gamma-ray
Particle shower
~ 10 km
~ 1°
Cherenkov light

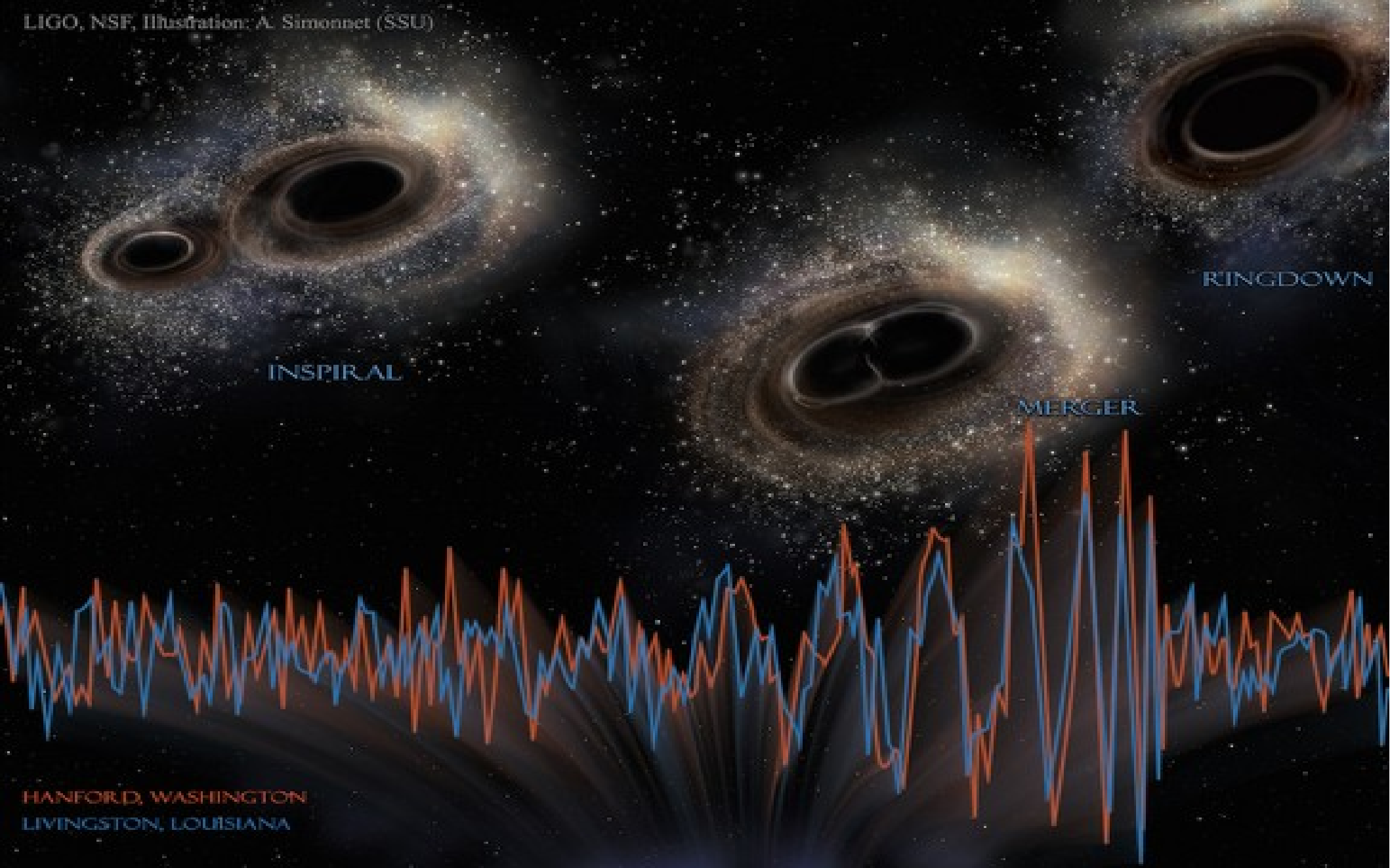

ROSAT
ROSAT
H.E.S.S.

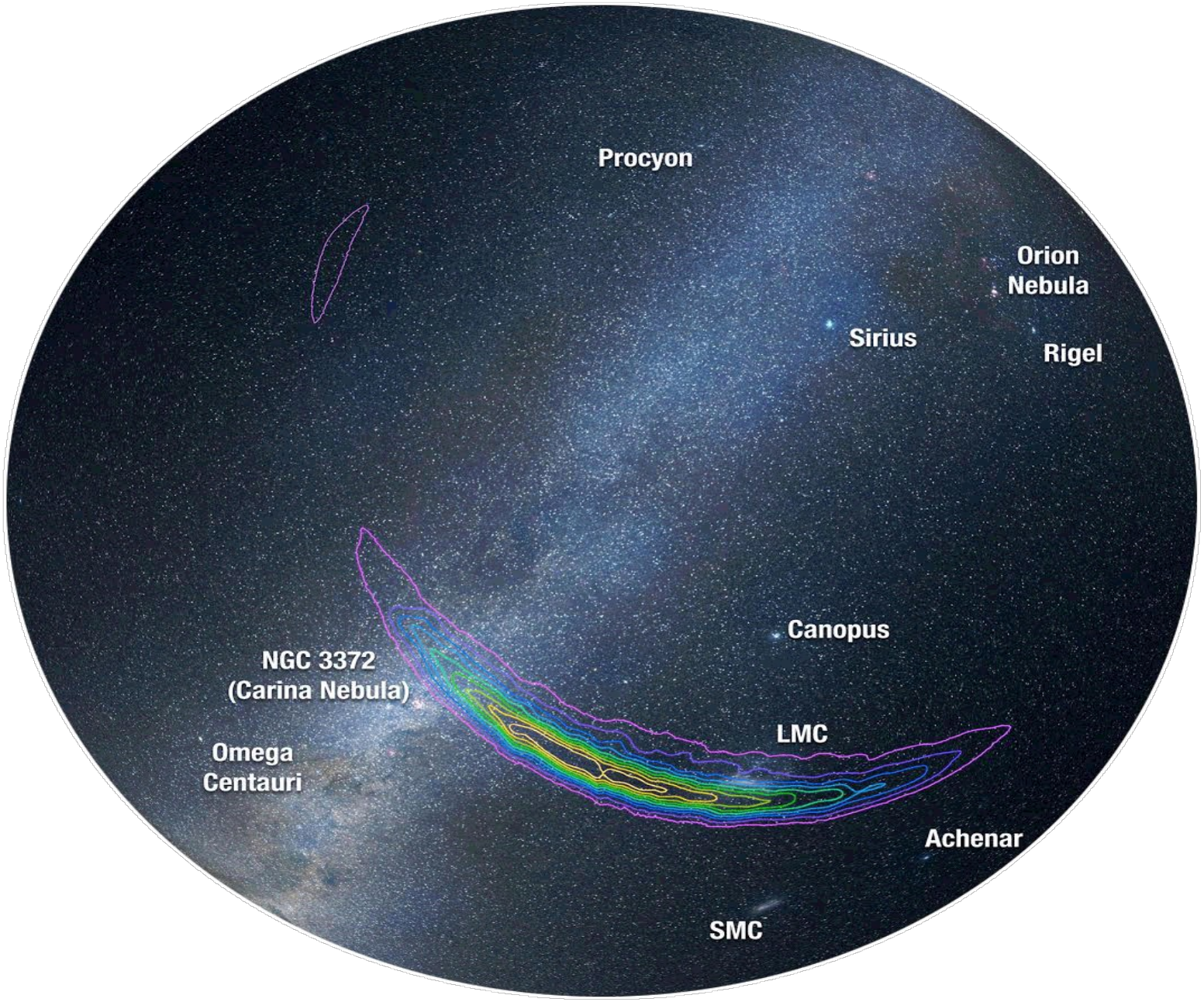

Infrared
Optical
VHE Gamma


supernovae
radio continuum (408 MHz)
cold, neutral hydrogen clouds
atomic hydrogen
hot, ionized gas
radio continuum (2.5 GHz)
cold, dense, molecular clouds
molecular hydrogen
dust warmed by starlight
infrared
emission from complex dust molecules
mid-infrared
old, cool, K giant stars
near infrared
nearby stars
optical
hot gas
x-ray
collisions between cosmic rays and protons, pulsars
gamma ray


IceCube Lab
50 m
1450 m
2450 m
2820 m
Deep Core
Eiffel Tower
324 m


ICECUBE PRELIMINARY
180°
-180°
Galactic
0
TS=2log(L/L0)
11.2917


LIGO, NSF, Illustration: A. Simonnet (SSU)
INSPIRAL
MERGER
RINGDOWN
HANFORD, WASHINGTON
LIVINGSTON, LOUISIANA


Procyon
Orion
Nebula
Sirius
Rigel
Canopus
NGC 3372
(Carina Nebula)
LMC
Omega
Centauri
Achenar
SMC