HIGH ENERGY COSMIC RAY EXPERIMENTS

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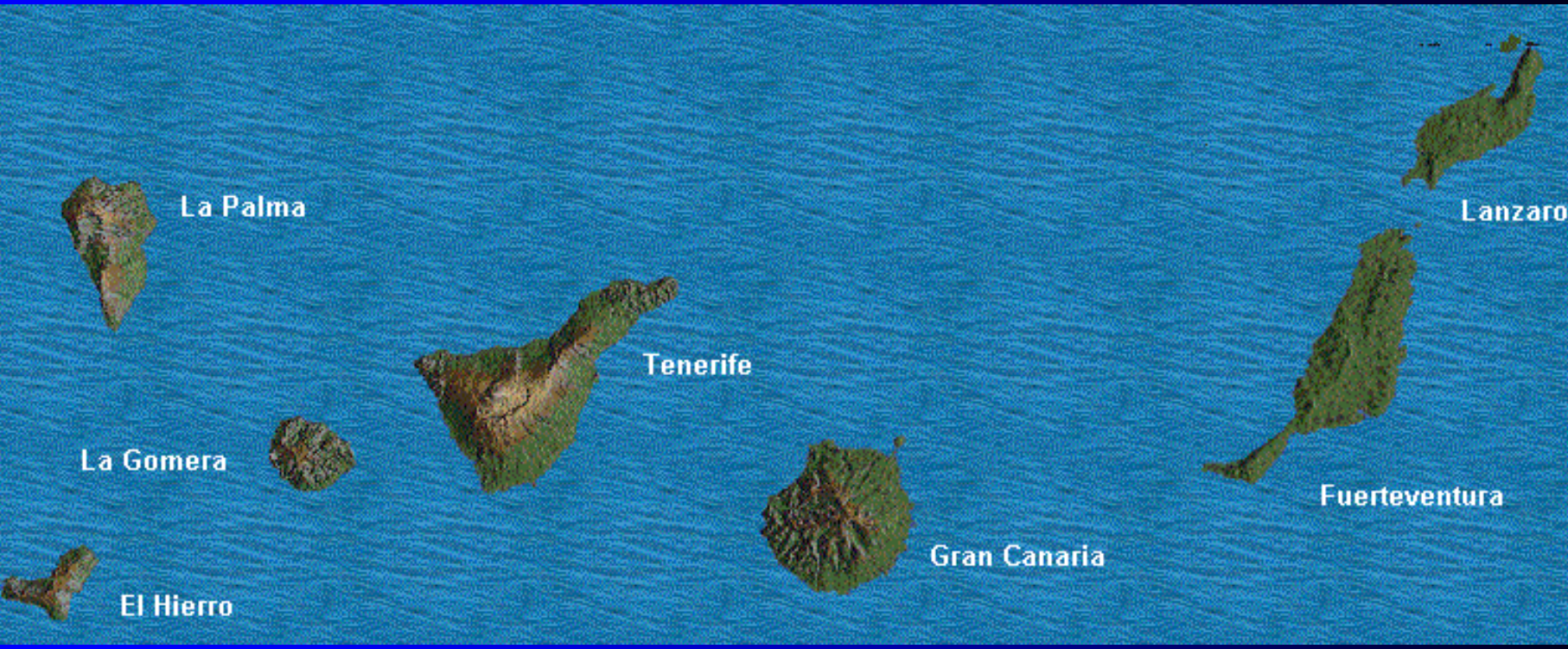


COSMIC RAYS & HIGH ENERGY ASTROPHYSICS

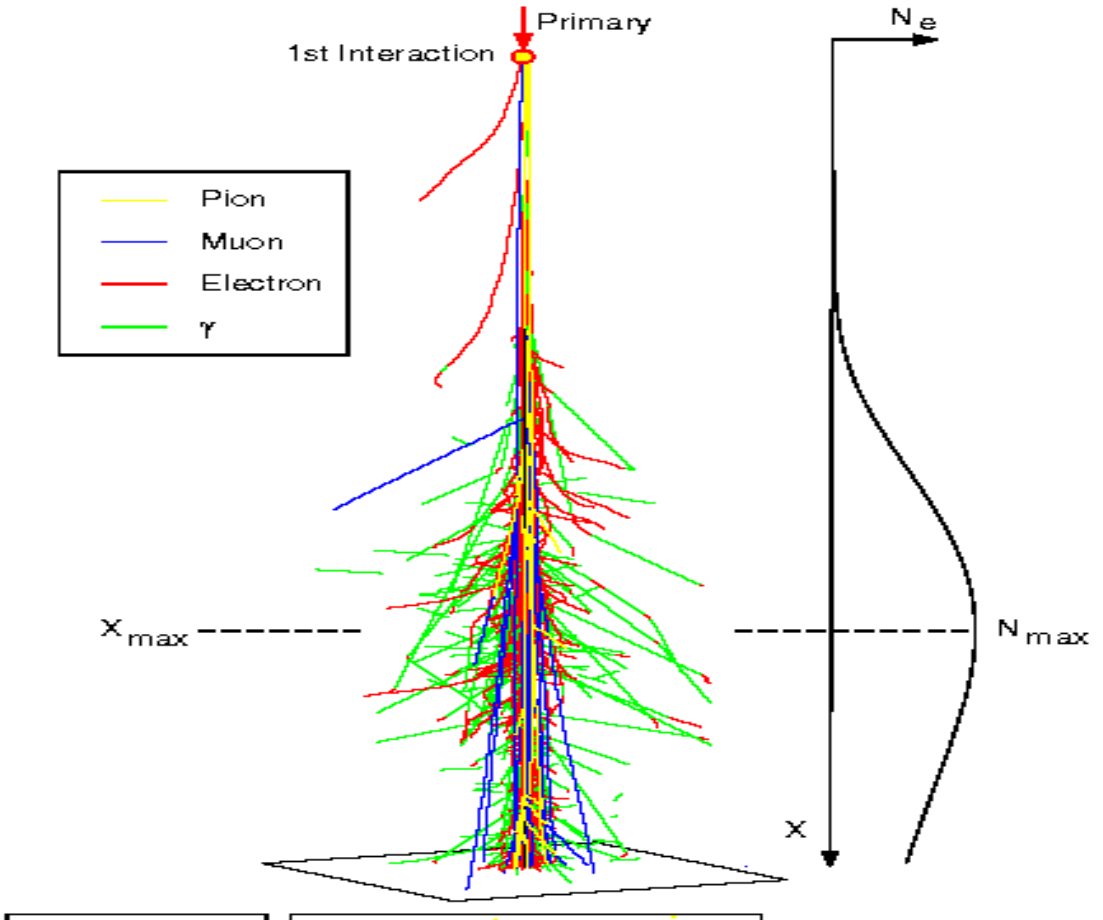
The HEGRA Experiment

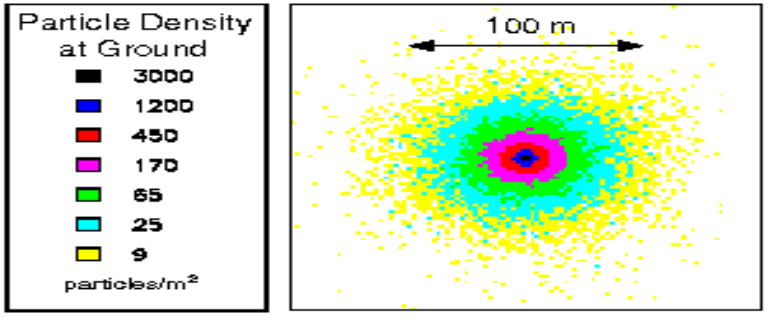
running period: 1987 - 2002

The MAGIC Telescope

Collaboration starts in 1998→2003

Air Shower


Primary
1st Interaction
Pion
Muon
Electron
γ
N_e
X_{max}
N_{max}
X


Particle Density at Ground
3000
1200
450
170
65
25
9
particles/m²
100 m

HEGRA: High Energy Gamma Ray Astrophysics

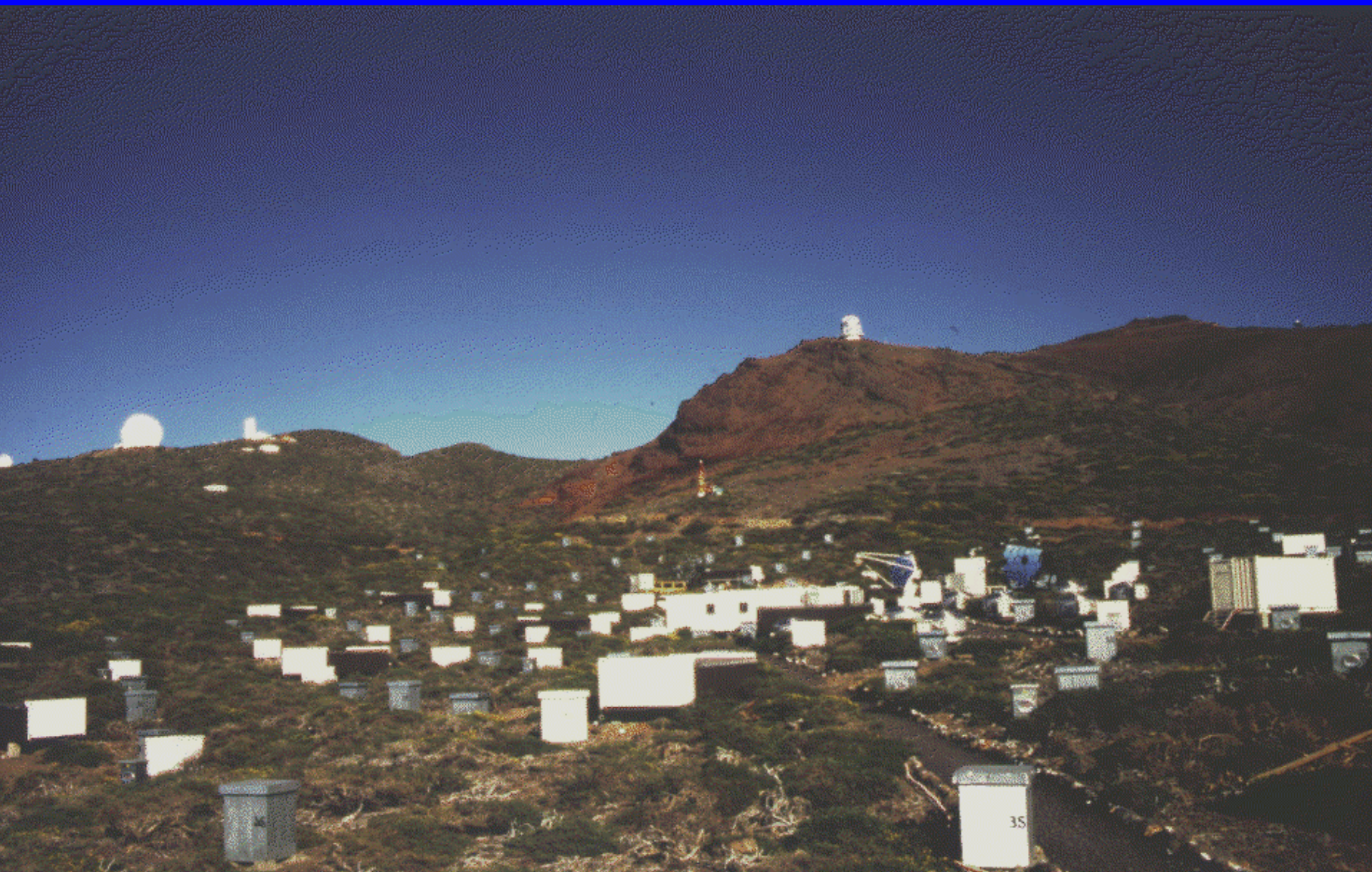
- Collaboration (about 50 members) :
  - Complutense University (6-8 members)
  - Hamburg University
  - Wuppertal University
  - Max-Planck Institute –Munich
  - Max-Planck Institute – Heidelberg
  - Yerevan Institute

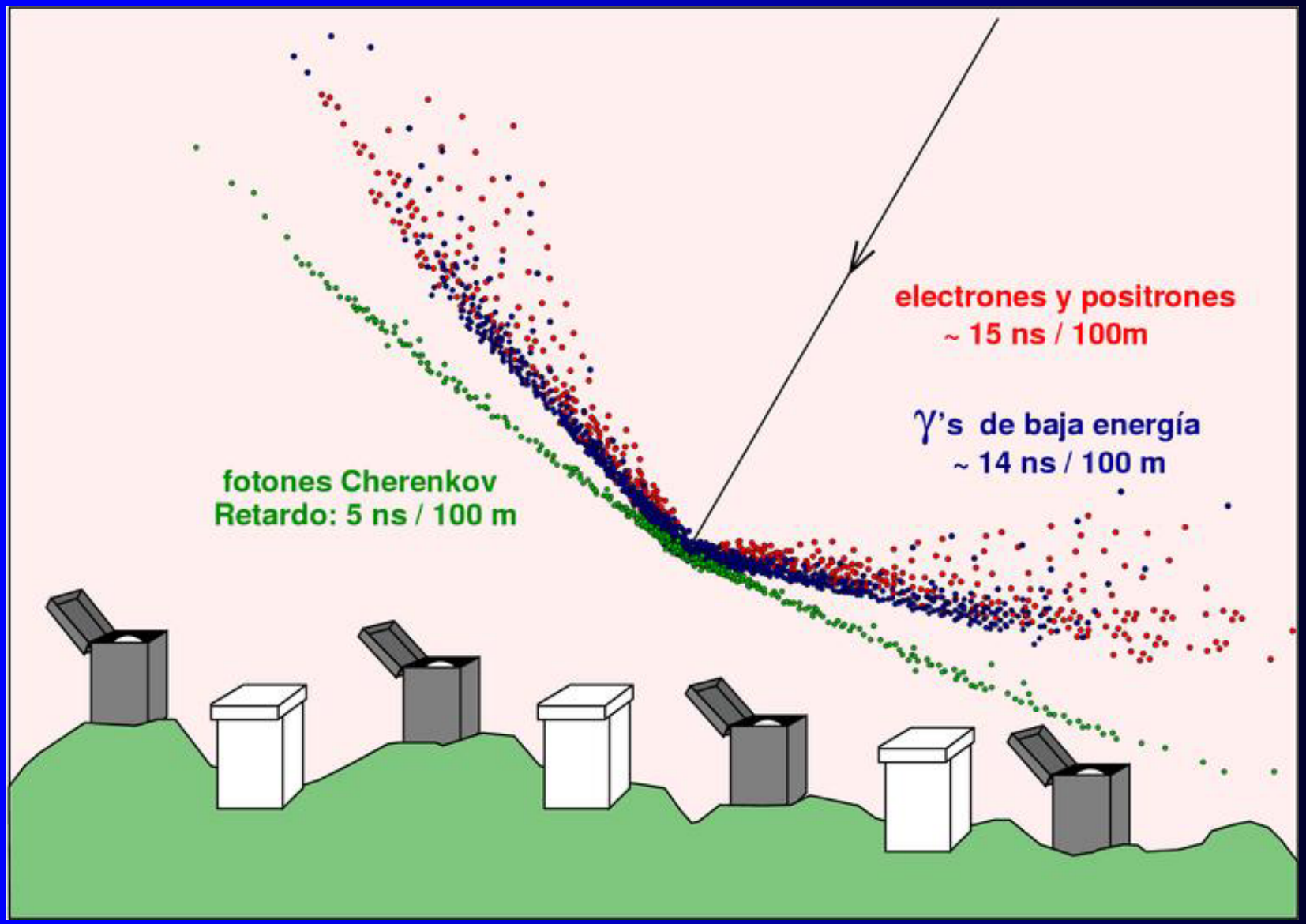
HEGRA

- ***1987-1997 running as an air shower array***
- ->237 scintillation counter
- ->100 wide angle air Cherenkov counters
- -> 17 muon towers
- *Energy range: 20 TeV-15000 TeV*

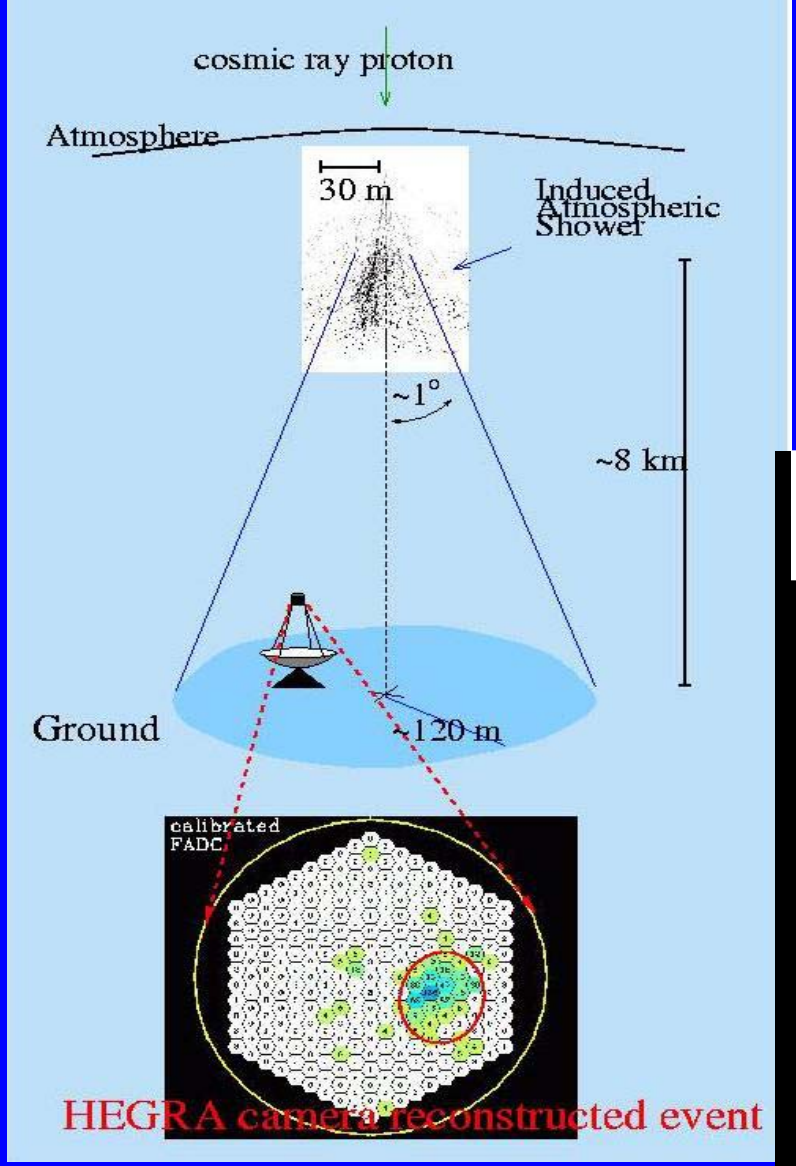
- **1997-2002 Cherenkov telescopes added**
- -> 5 telescopes running in coincidence
- ->1 telescope for prototype studies
- *Energy range: 500 GeV-20 TeV*

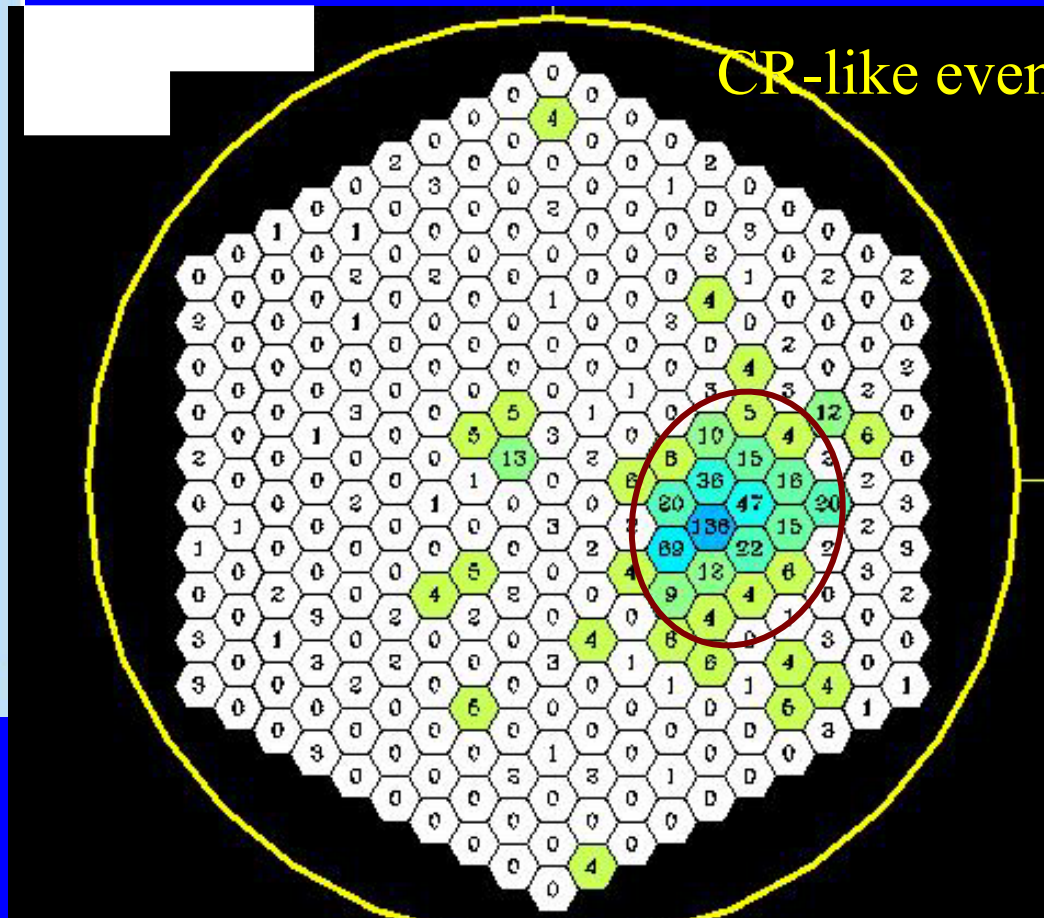
HEGRA-arrays




electrones y positrones
~ 15 ns / 100m
γ's de baja energía
~ 14 ns / 100 m
fotones Cherenkov
Retardo: 5 ns / 100 m

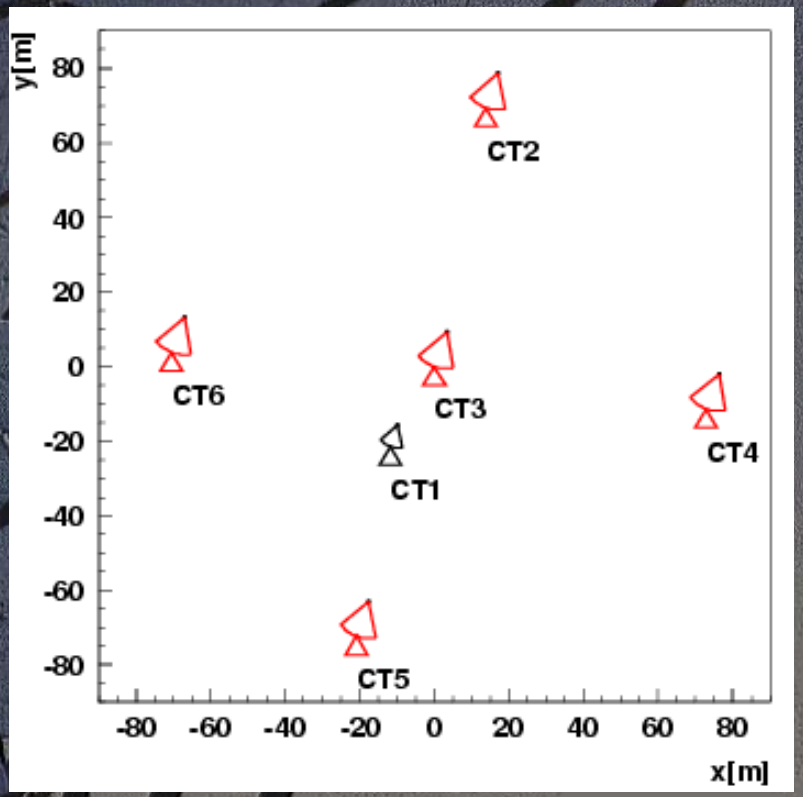
Cherenkov Front





The HEGRA IACT System

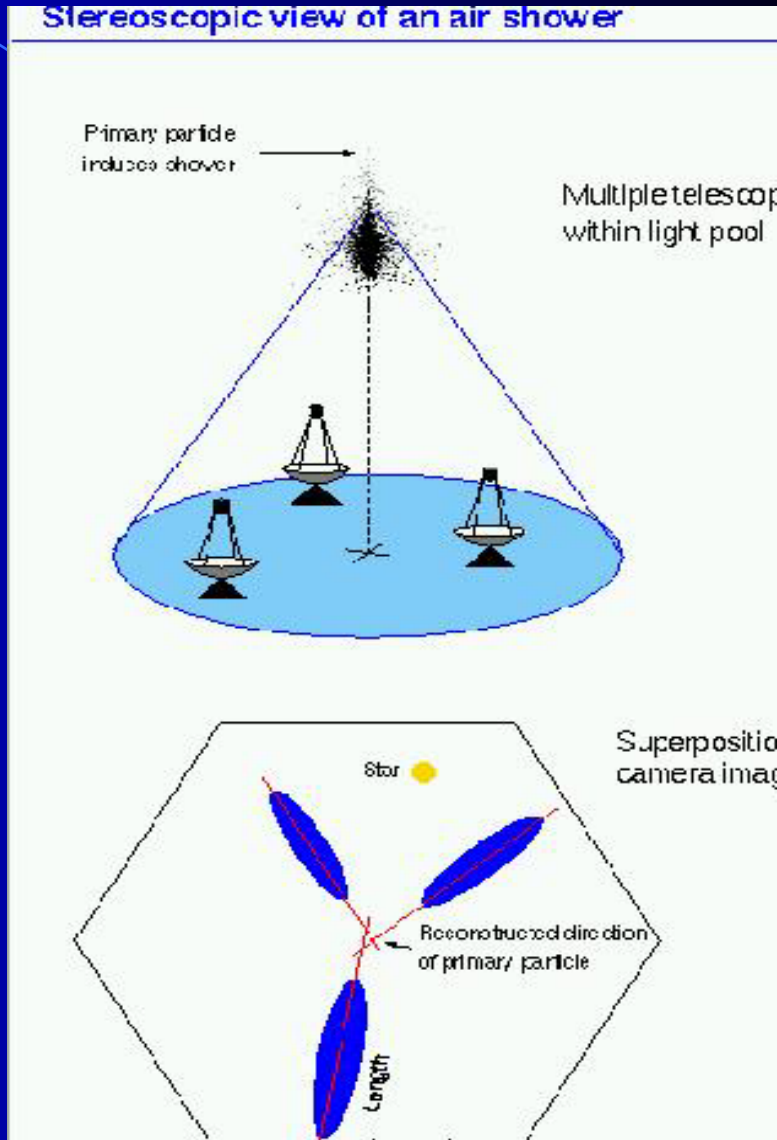
- Stereoscopic system of 5 IACTs located at the Roque de los Muchachos.
- Mirror area: 8.5 m² each
- 271 PMTs cameras – Field of view: 4.3°
- Angular resolution: 0.1°
- Trigger levels: 2/5 tel., 2NN/271 pix. > 8 ph.e.



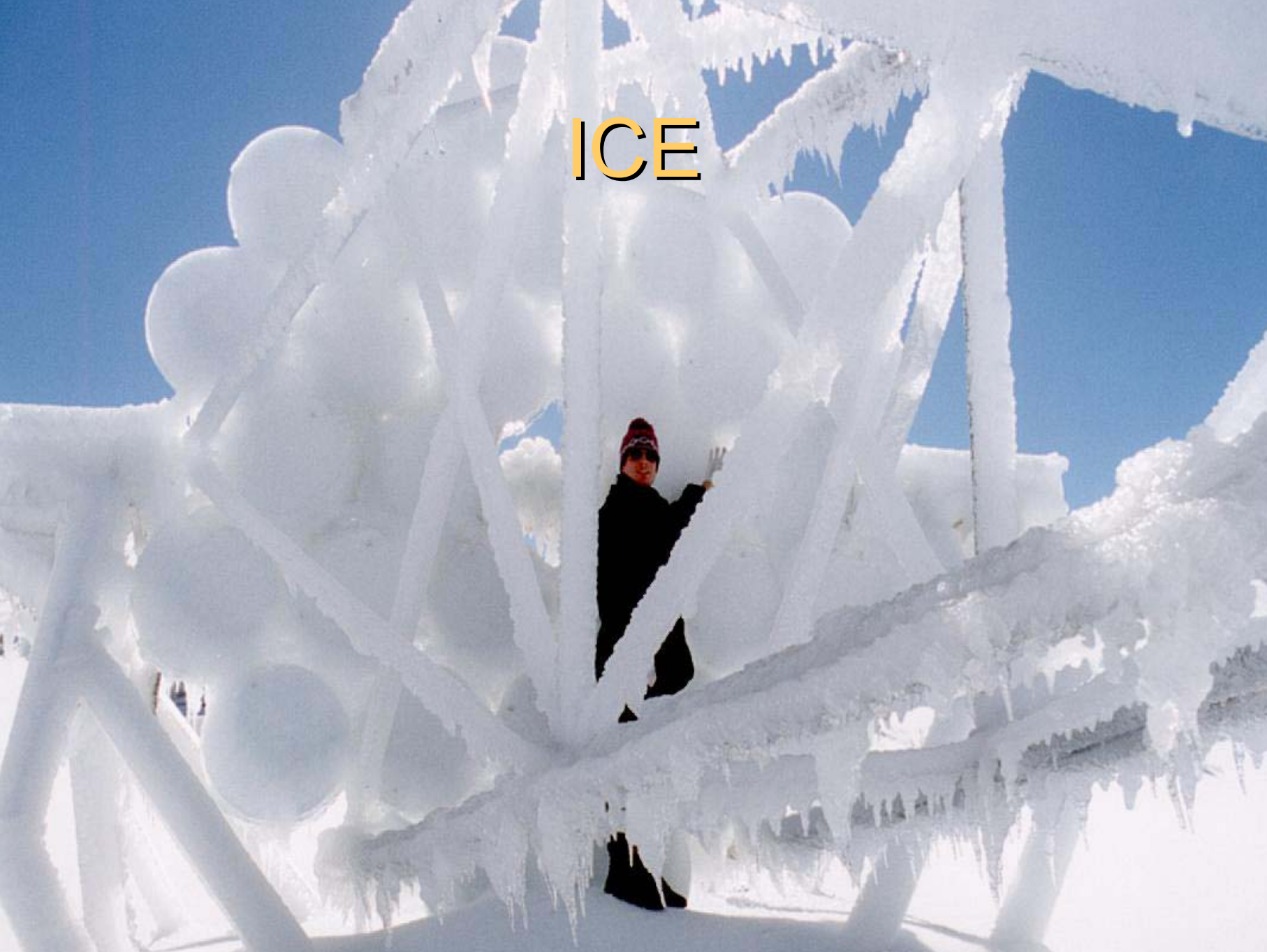
ENERGY RANGE: 500 GeV-20 TeV

The IAC Stereoscopic technique

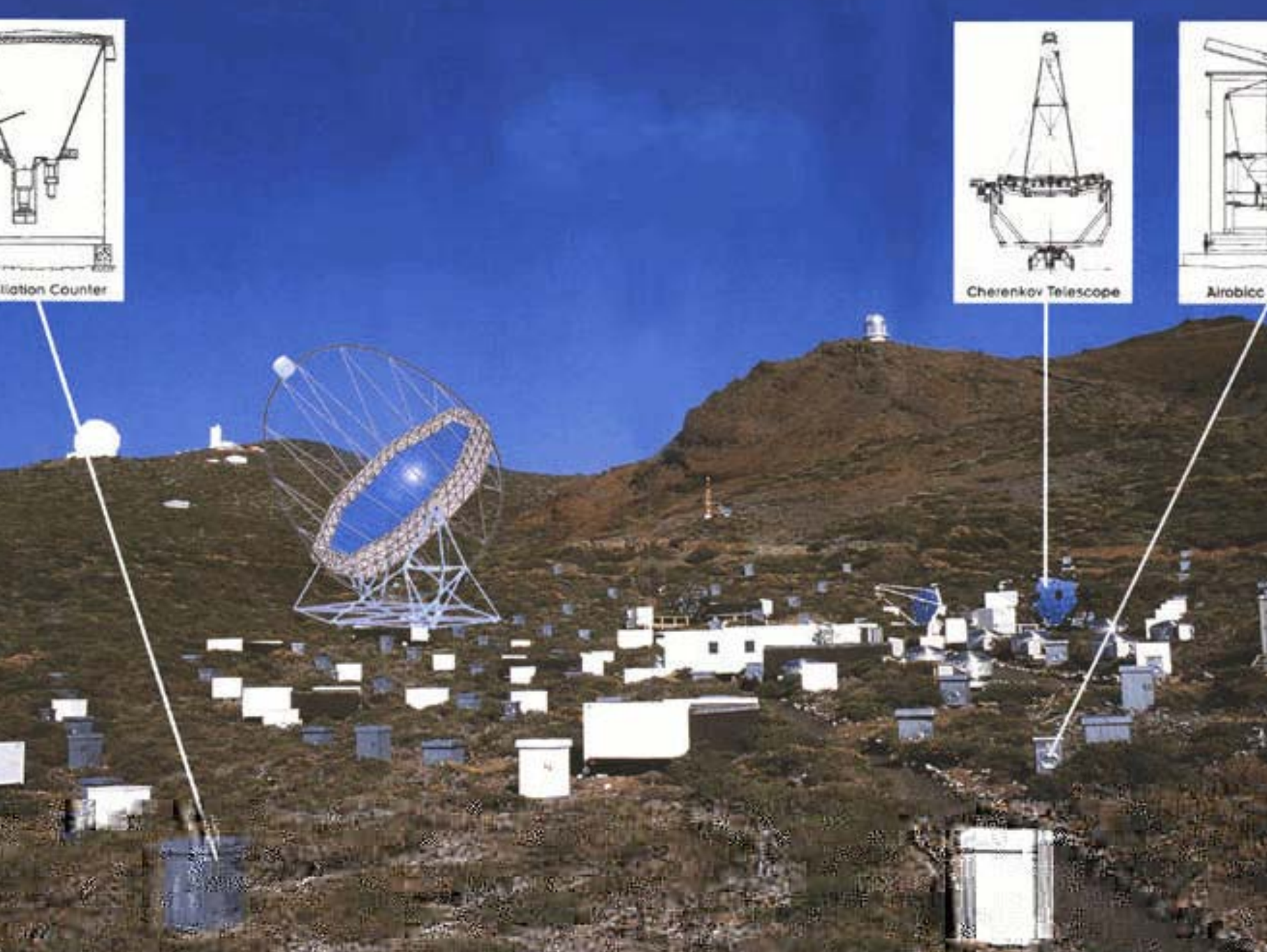
- View of the atmospheric shower from different angles (stereoscopic).
- Unambiguous reconstruction of the shower geometry (event-by-event reconstruction).
- Highly backgroung rejection.
- High energy resolution ($\Delta E/E \sim 20\ \%$ @ 1 TeV).




CT2


ICE


FIRE


iation Counter
Cherenkov Telescope
Airobicc

HEGRA RESULTS

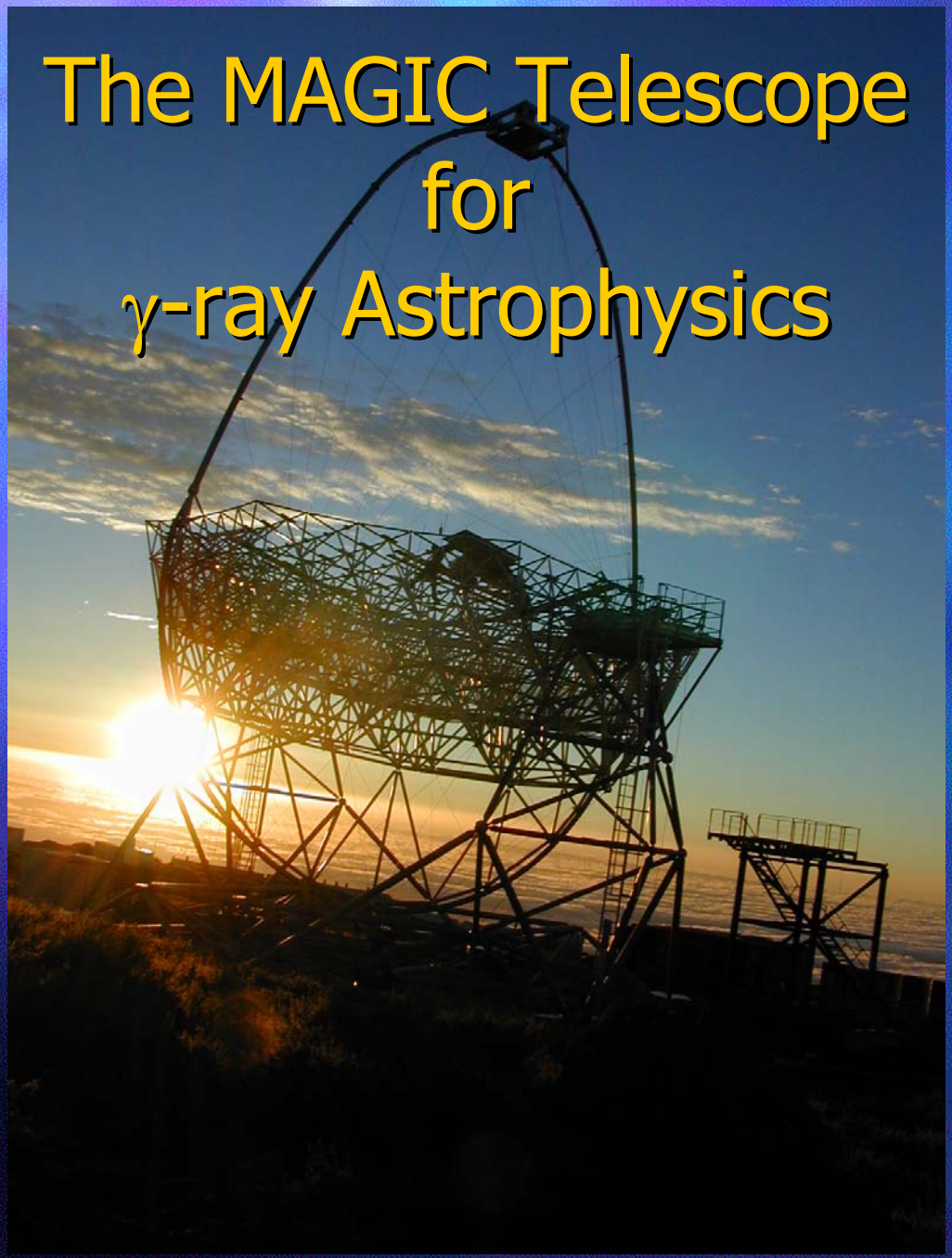
- Particle detector arrays had a low gamma/hadron separation. Source detection at the 3 sigma level.
- Cherenkov Telescopes very successful!!. Galactic and extragalactic sources detected: Mrk421, Mrk501, H1426+428, 1ES1959, Crab, Cas A, CygOB2, Monoceros.....

HEGRA RESULTS

HEGRA has been a prototype experiment to develop the techniques of the next generation of Cherenkov Telescopes:

- Large area telescopes: MAGIC
- Stereoscopic systems: HESS

The MAGIC Telescope for γ-ray Astrophysics



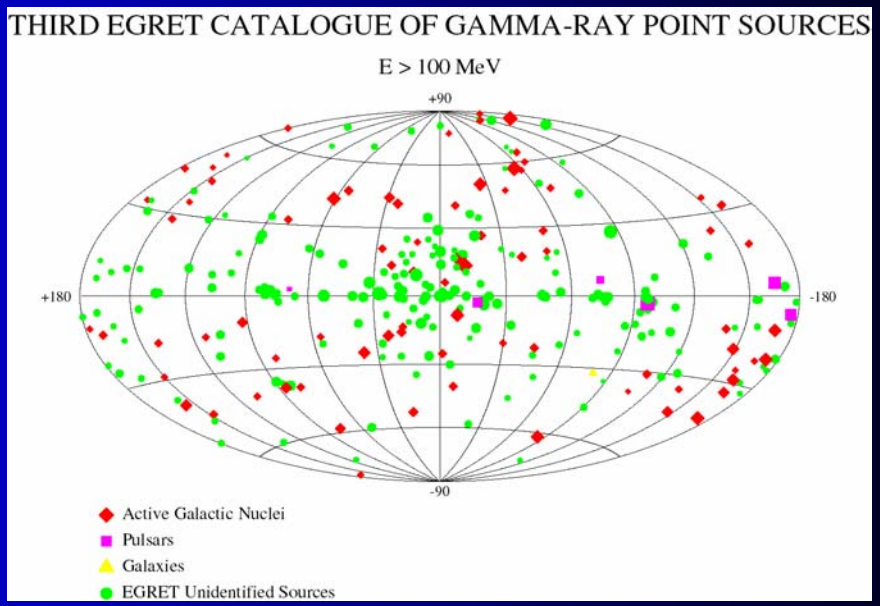
The MAGIC Collaboration

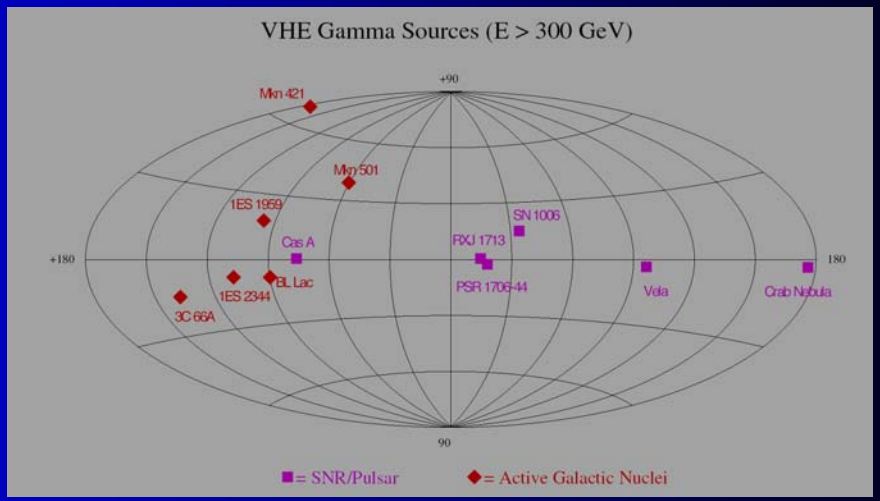
MPI Munich
→ IFAE Barcelona
INFN/U. Padua
U. Würzburg
→ UCM Madrid
U. Siegen
→ UAB Barcelona
Crimean Observatory
U.C. Davis
Sternwarte Goettingen
U. Lodz
INR Moscow
U. Siena
U. Potshefstroom
Tuorla Obeservatory, Finlad
Yerevan Phys. Institute

http://hegra1.mppmu.mpg.de/MAGICWeb/

The unexplored spectrum gap

- Satellites give a nice crowded picture of energies up to 10 GeV.
- ***MAGIC covers the gap (GeV range)***
- Ground-based experiments show very few sources with energies ≤ 300 GeV.





II. Technological Innovations

17 m diameter dish

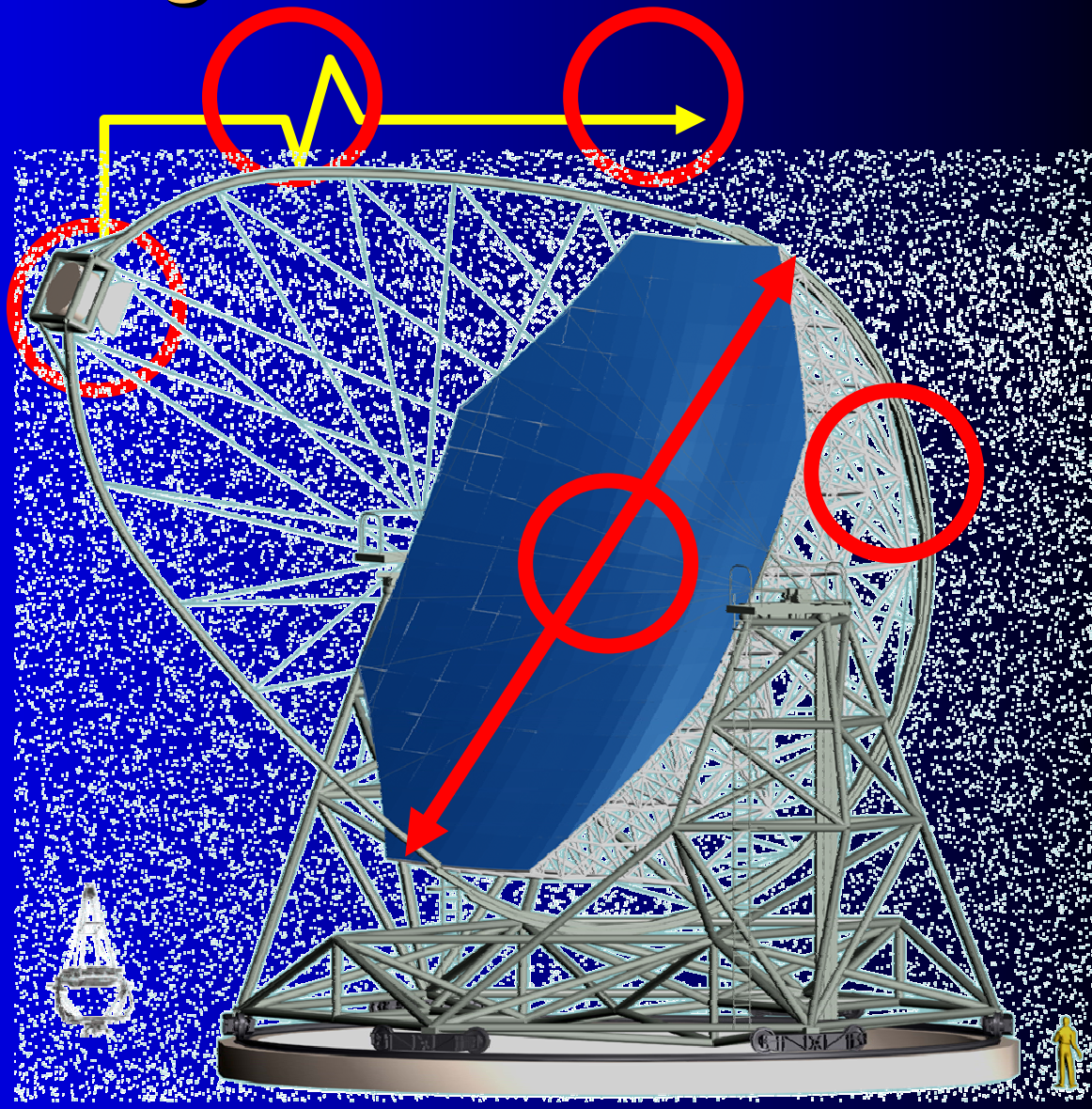
Ultra light carbon fibre frame

Active mirror control

577 pixels, 3.9 deg FOV camera

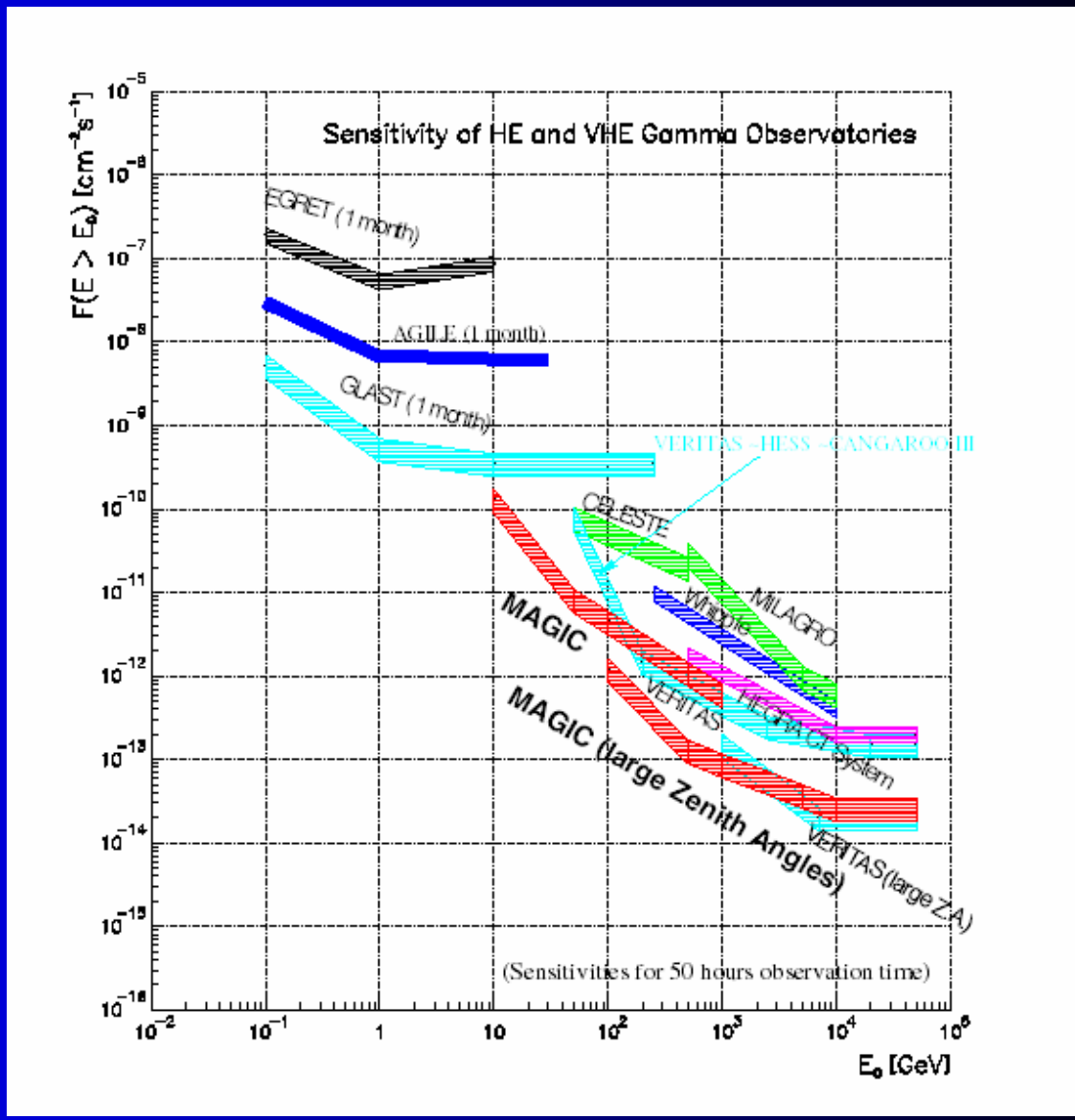
Optical signal transport

Fast pulse sampling: 300MHz-1GHz FADCs

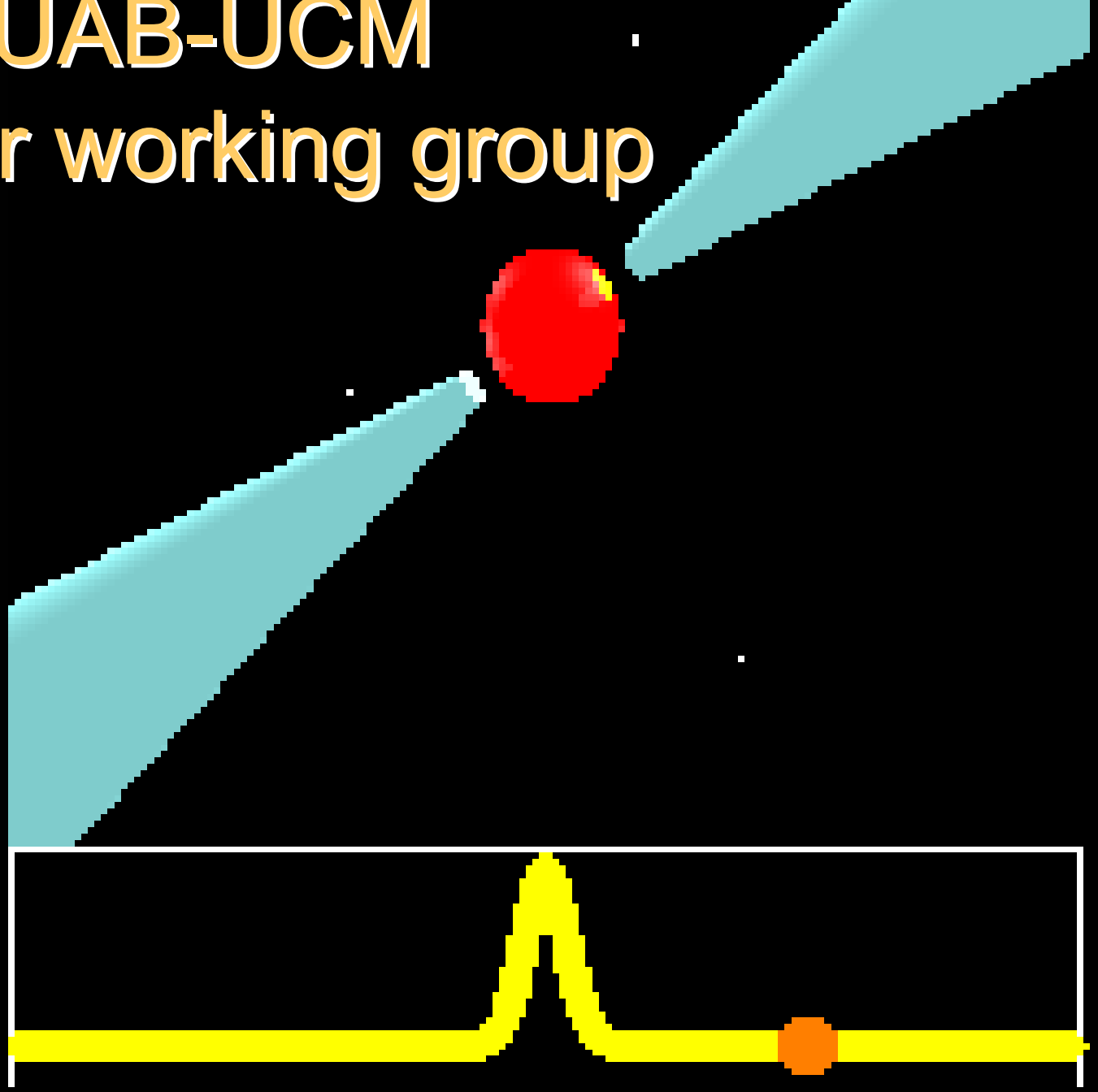


MAGIC Sensitivity

- With these innovations MAGIC will have a energy threshold of **30 GeV** (10 in Phase II).
- **This is a unique feature in present technology**
- Overlaps with EGRET/GLAST



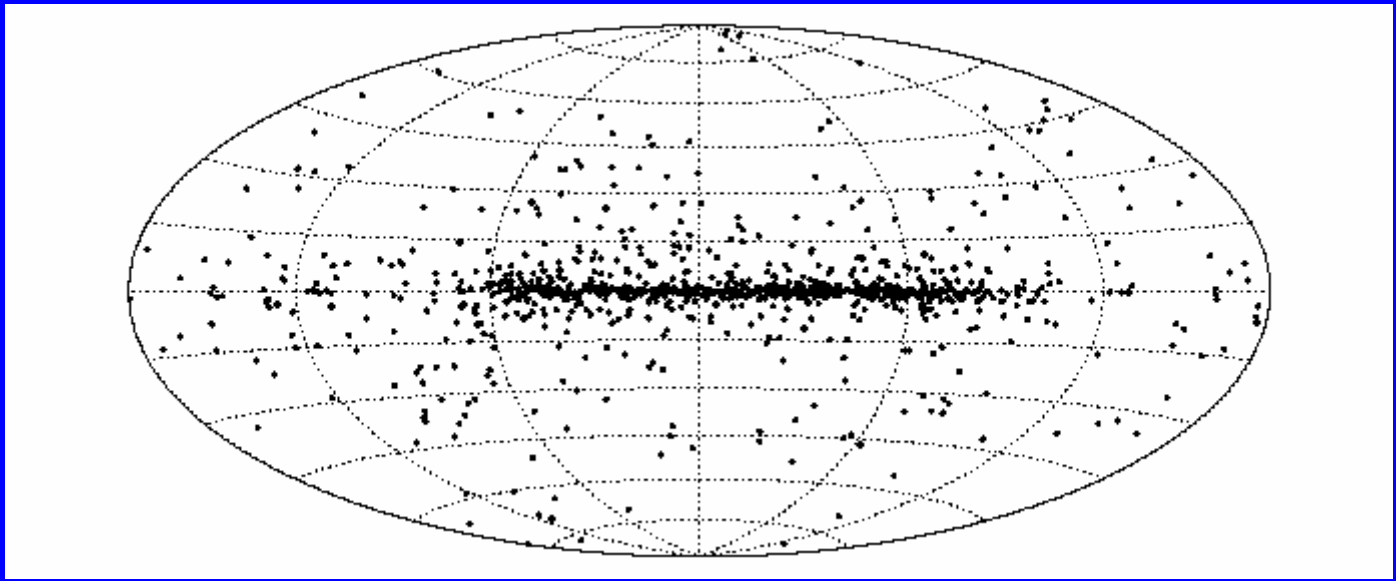
UAB-UCM
pulsar working group



UCM-UAB

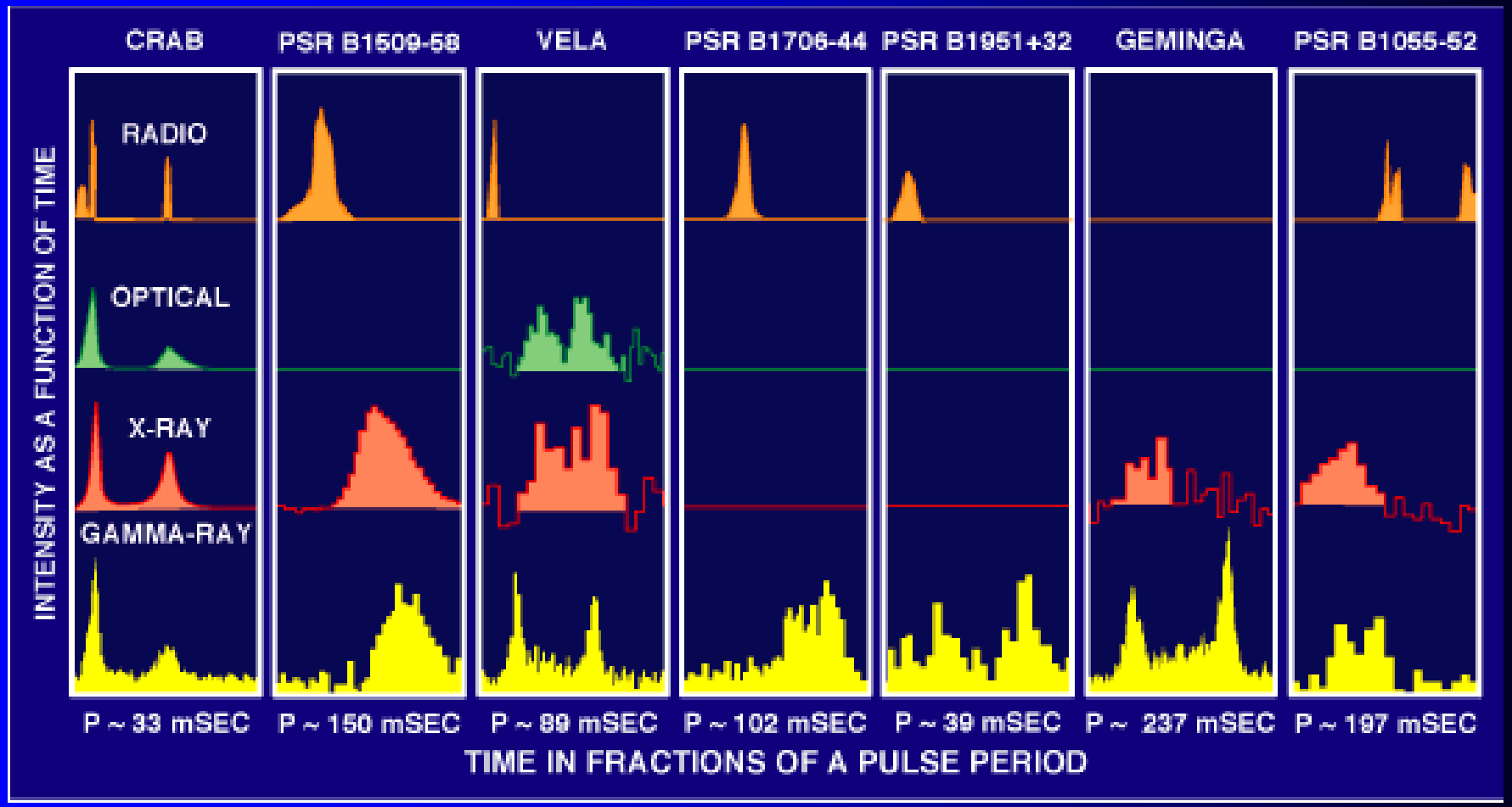
- Joint proposal since 1998 to study pulsed gamma radiation at MAGIC energy Threshold (30 GeV).
- Number of investigators: UCM (7) , UAB (7)
- Collaboration with pulsar groups on other wavelenghts.
- Optical studies using the central pixel of the MAGIC camera and optical telescopes.
- Atmospheric studies.
- Low noise amplifier development for light detectors.

More than 1500 pulsars known in radio



D.R.Lorimer, astro-ph/01043

Only 7 pulsars known 100 MeV-10 GeV



MAGIC STATUS

- The MAGIC telescope is getting operational
- First results are coming!!

FUTURE

Development of next generation IACT

- Large mirror areas
- Low noise photodetectors with red extended sensitivity
- Stereoscopic approach