ASTROPARTICLE PHYSICS AT DESY

THE CHERENKOV TELESCOPE ARRAY

Stefan Schlenstedt

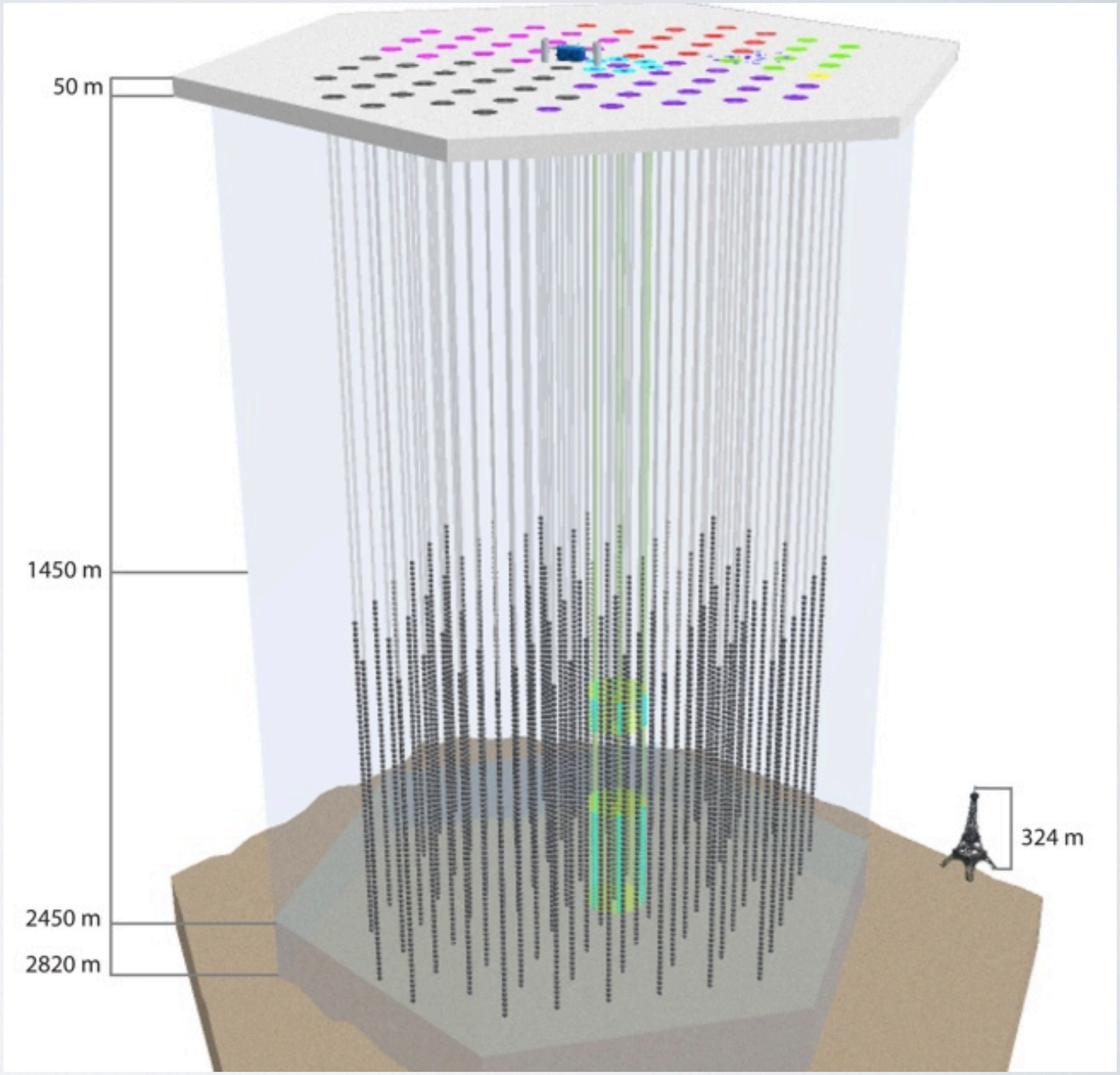
68th DESY PRC Meeting
Hamburg, November 5th, 2009

HELMHOLTZ ASSOCIATION

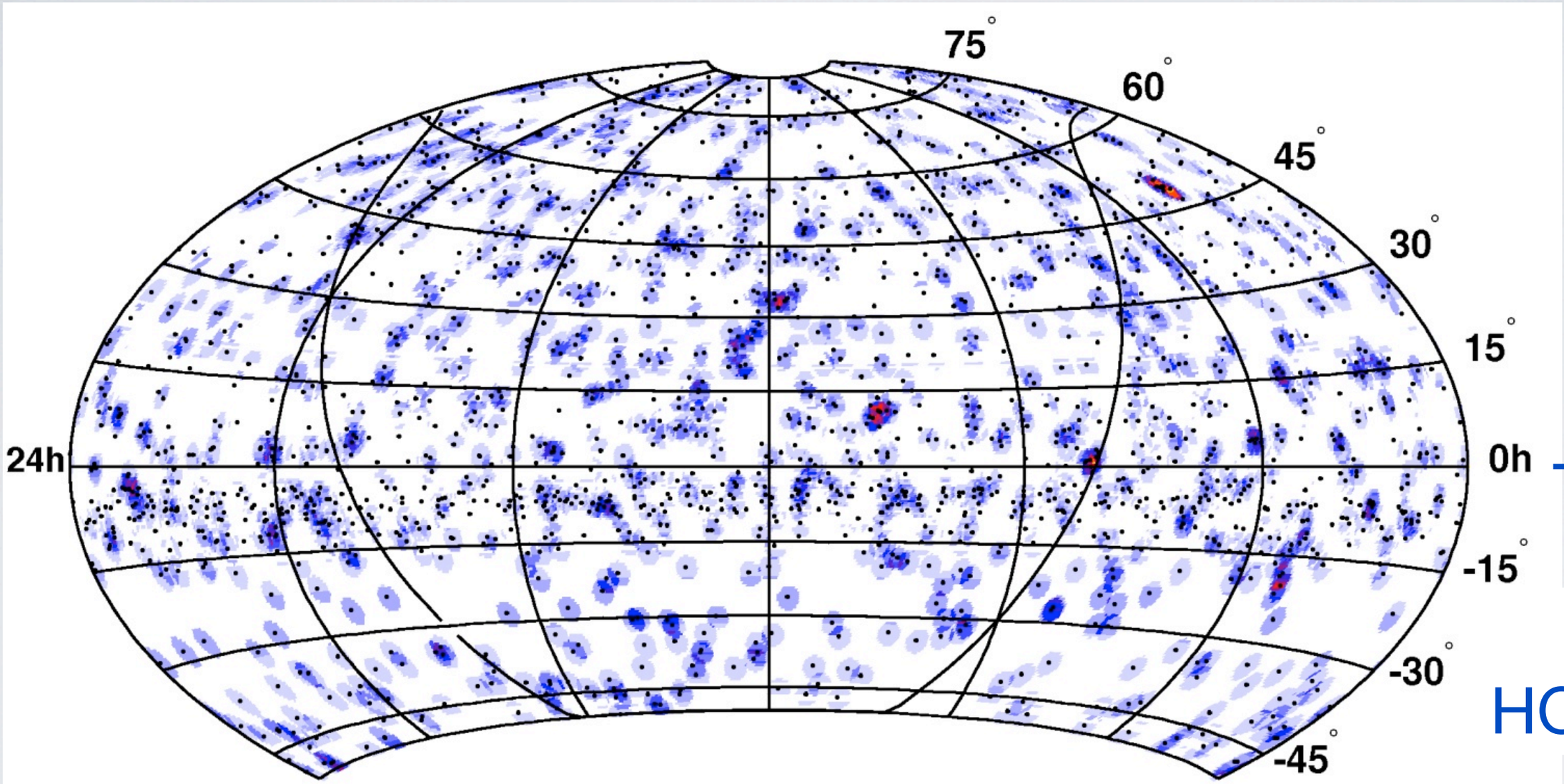
DESY

HIGH-ENERGY NEUTRINOS WITH ICECUBE

- ⅔ installed – completion 2011
- Data taking with high efficiency
- DESY Analyses:
  - transient point sources
  - Cosmic Ray flux
  - monopole filter
  - ν_e channel

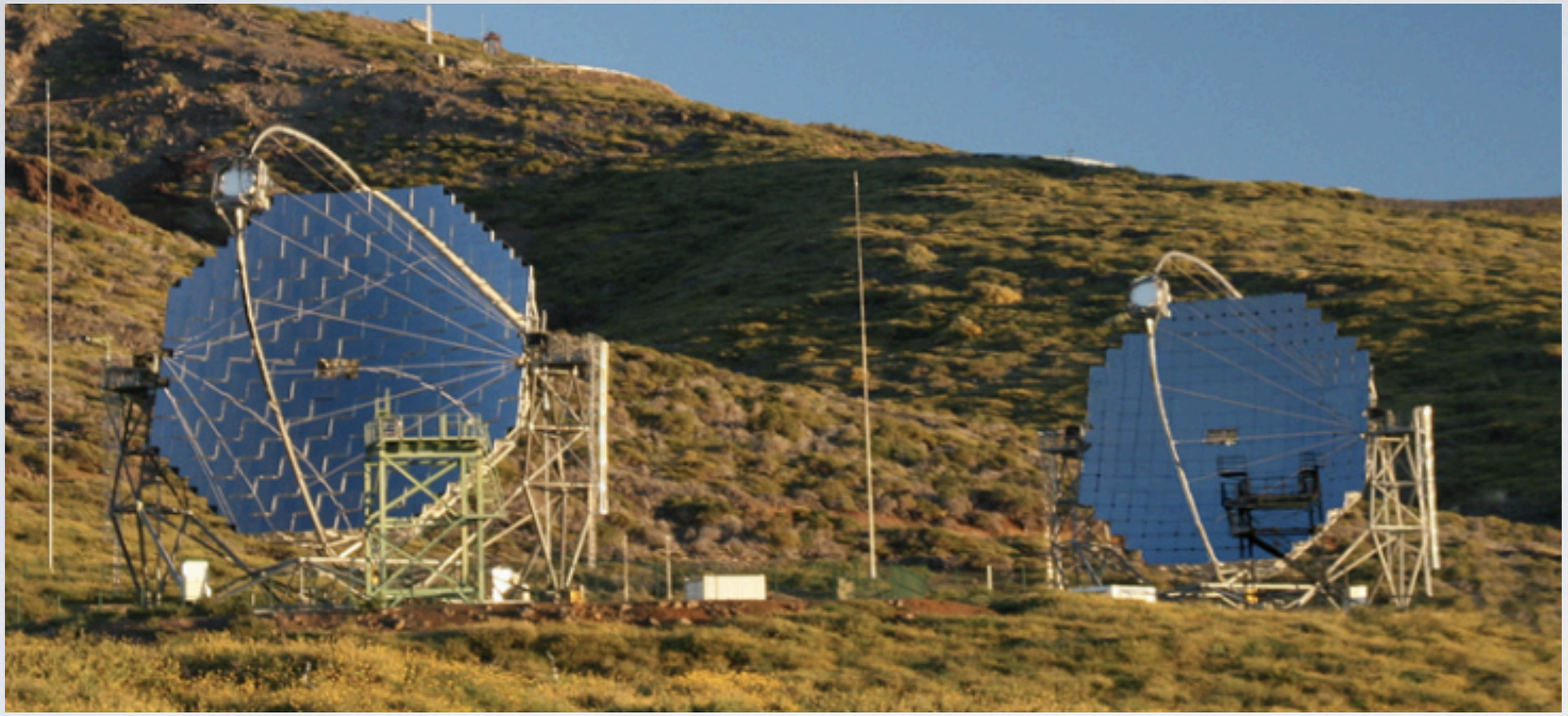


EXTENDING THE SEARCH FOR NEUTRINO POINT SOURCES WITH ICECUBE



- Apply energy-sensitive cuts to suppress background
- Cover point sources in the southern sky up to EeV energies

GAMMA-RAY ASTRONOMY WITH MAGIC



Young Investi-gator Group

- DESY Analyses:
  - Multi Messenger – IceCube multiplet trigger
  - New measurements of Active Galactic Nuclei
  - Multiwavelength campaign with X-ray and gamma-ray satellites

GAMMA-RAY ASTRONOMY WITH THE CHERENKOV TELESCOPE ARRAY AT DESY

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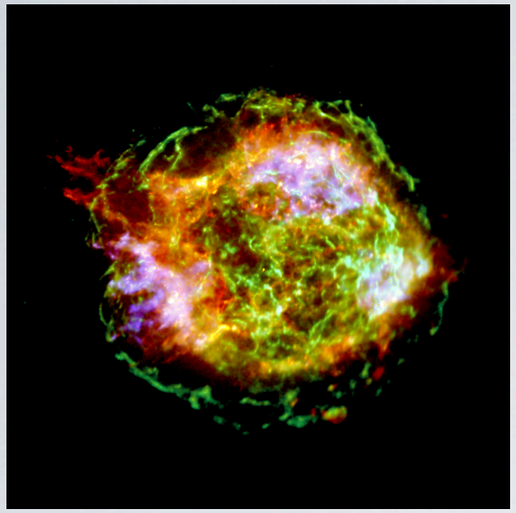
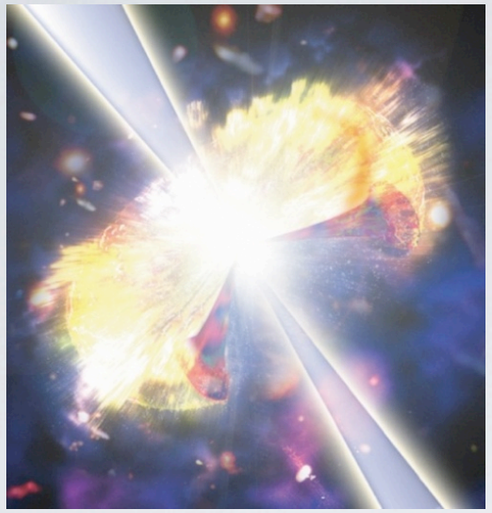
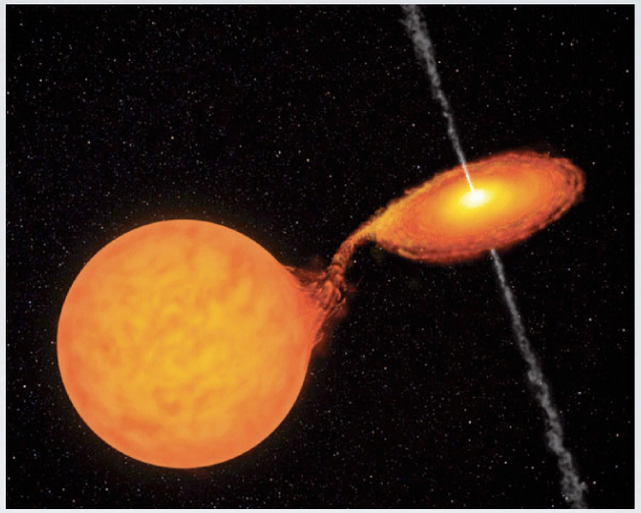
DESY



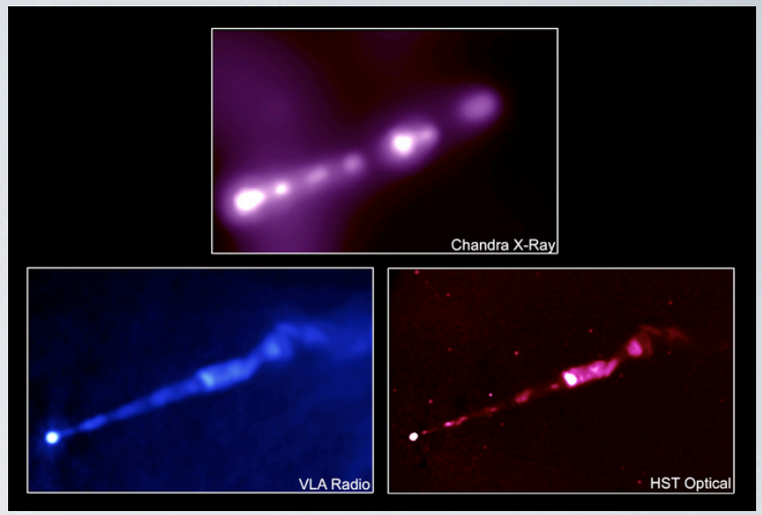
SNR



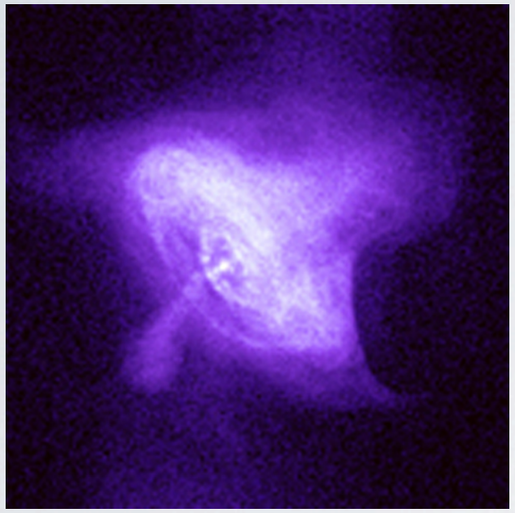
GRB



Micro quasars



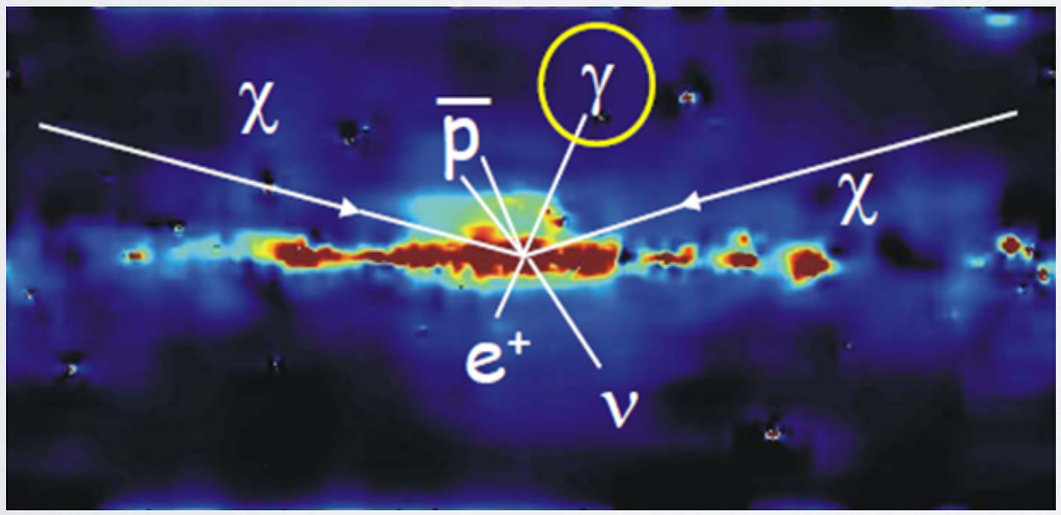
Active galactic nuclei



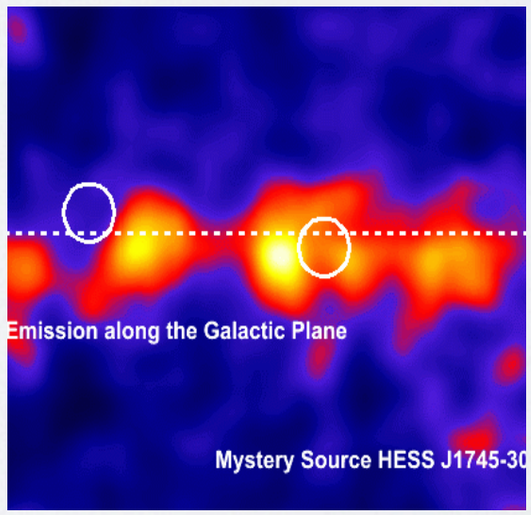
Pulsar, PWN

- Sources of cosmic rays
- Astrophysics of sources
- Acceleration and propagation

Starburst galaxies

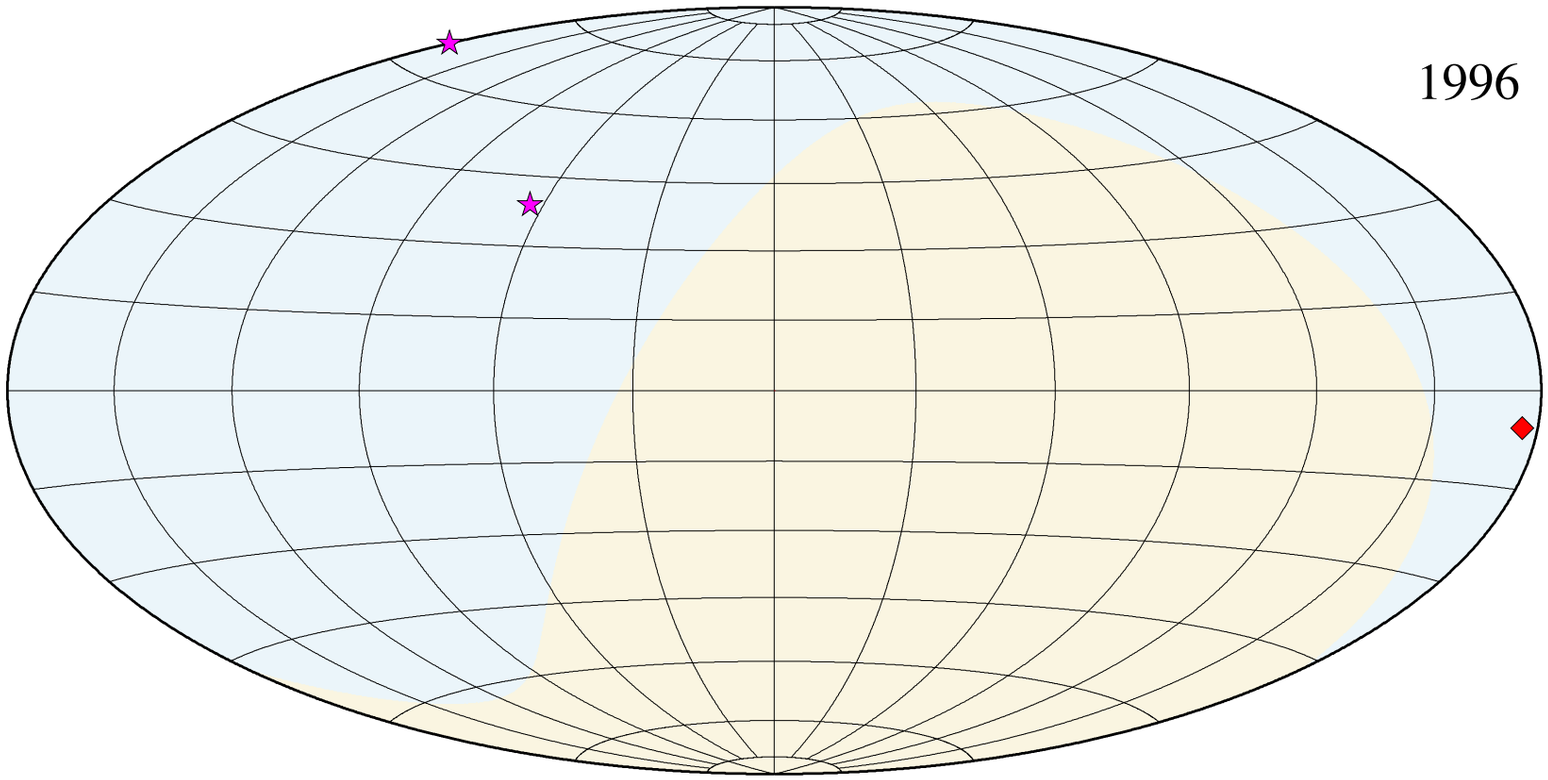


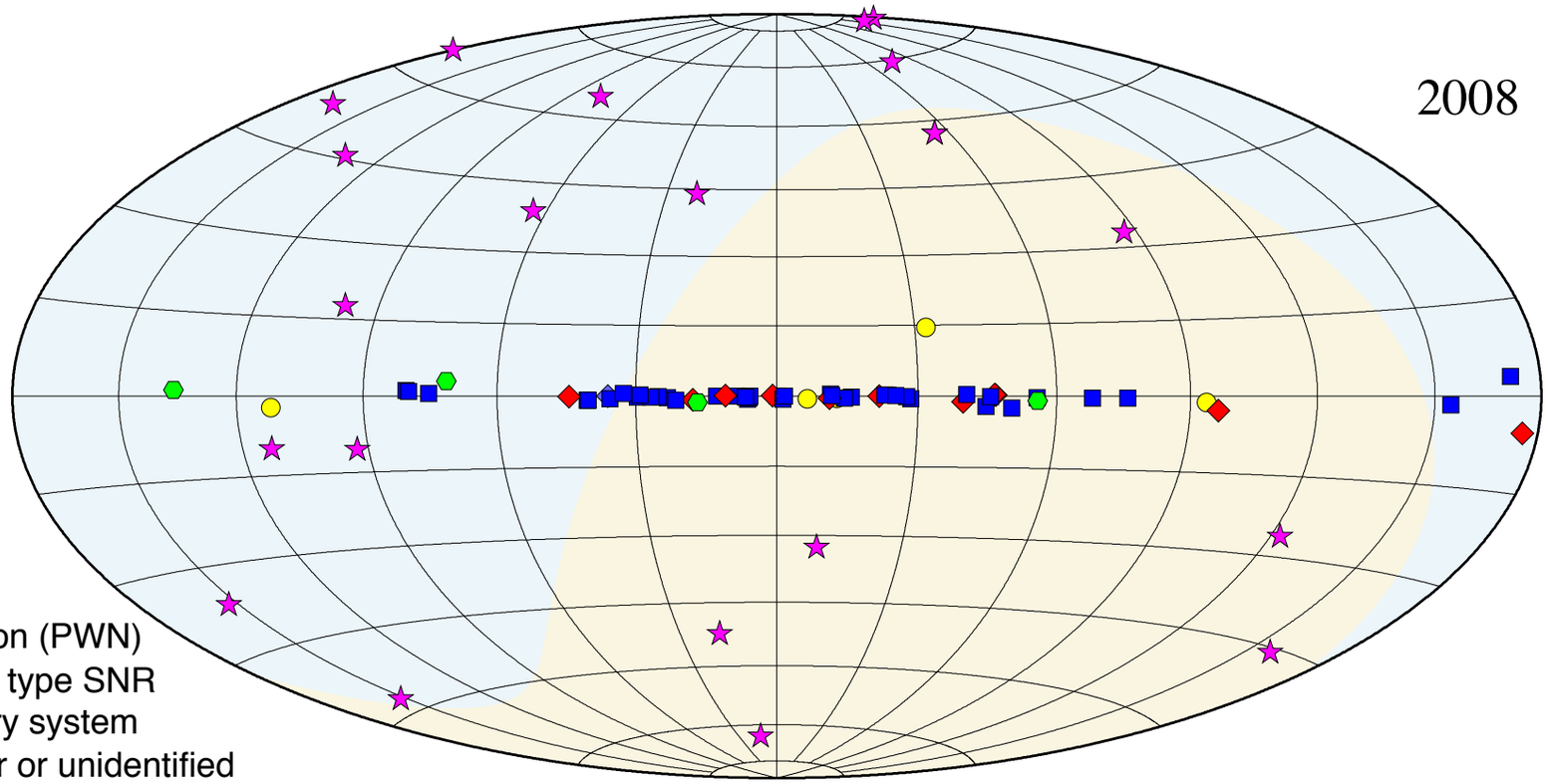
Dark matter



Unknown sources

HIGH-ENERGY GAMMA-RAY SKY





Background colours indicating northern / southern sky

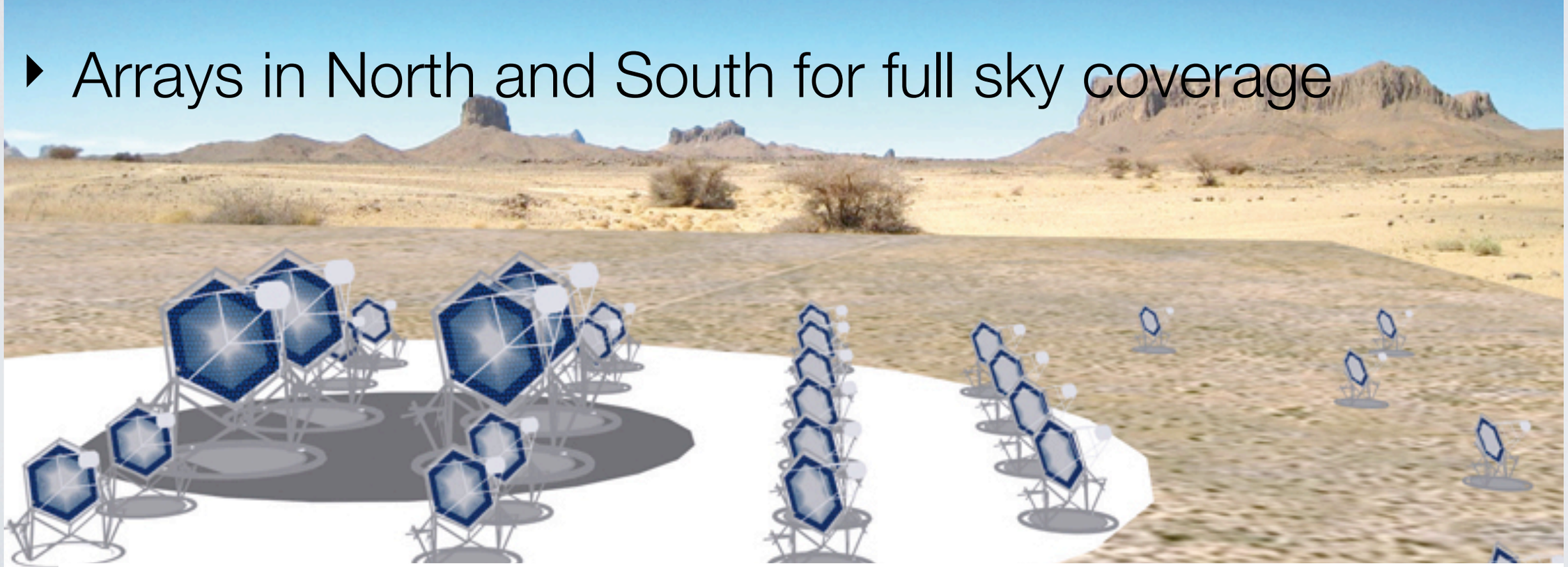
Graphics by Konrad Bernlöhr 2008

THE CHERENKOV TELESCOPE ARRAY

- Increase sensitivity
- Extend energy range
- Improve angular resolution

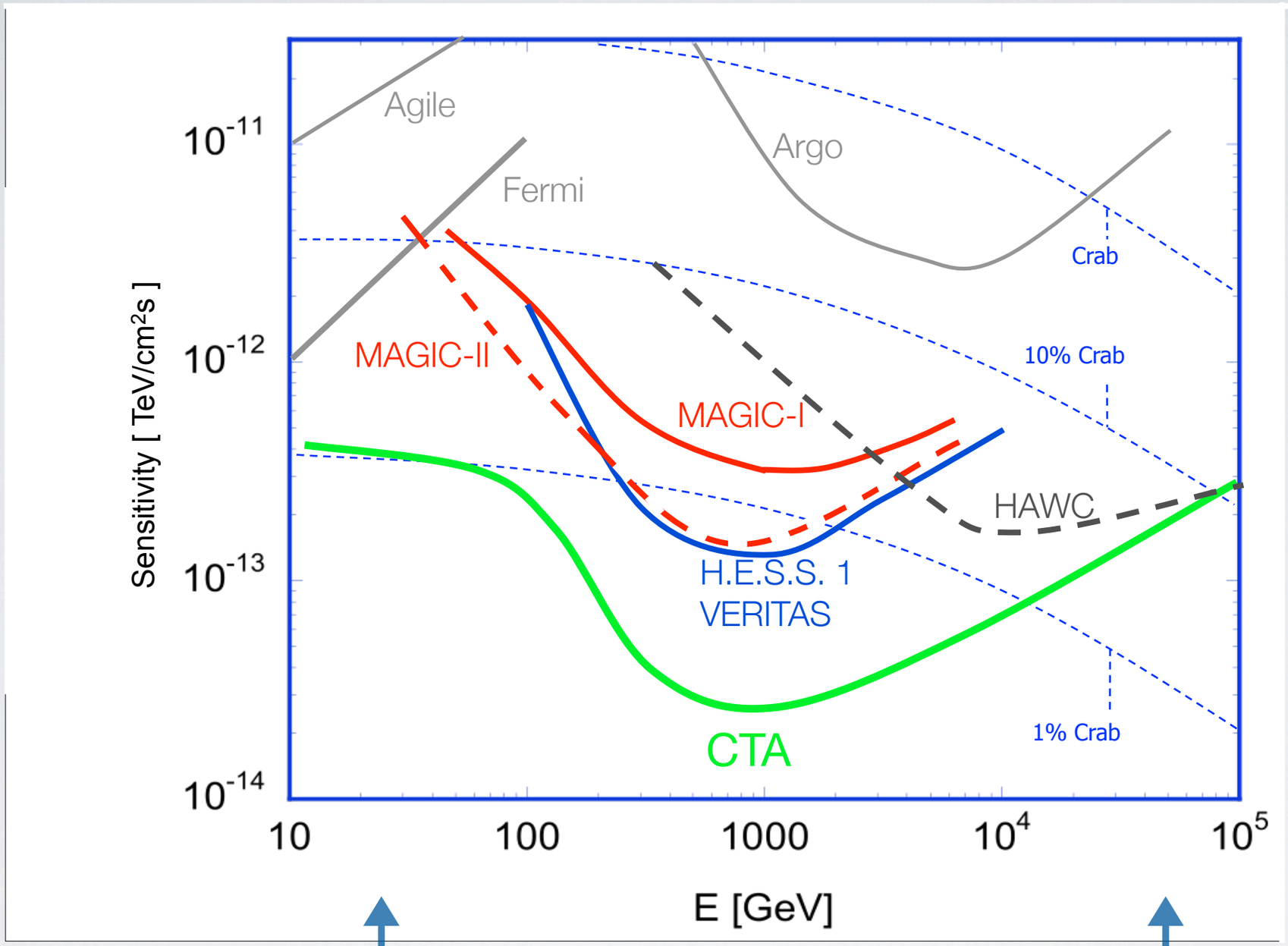
CTA: An advanced facility for ground-based γ-ray astronomy and astro-particle physics

- Observatory with flexible and robotic operation
- Arrays in North and South for full sky coverage



50 to 100 large, medium and small telescopes

SENSITIVITY

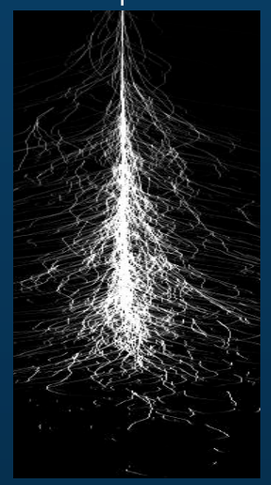


AGN pulsars GRB

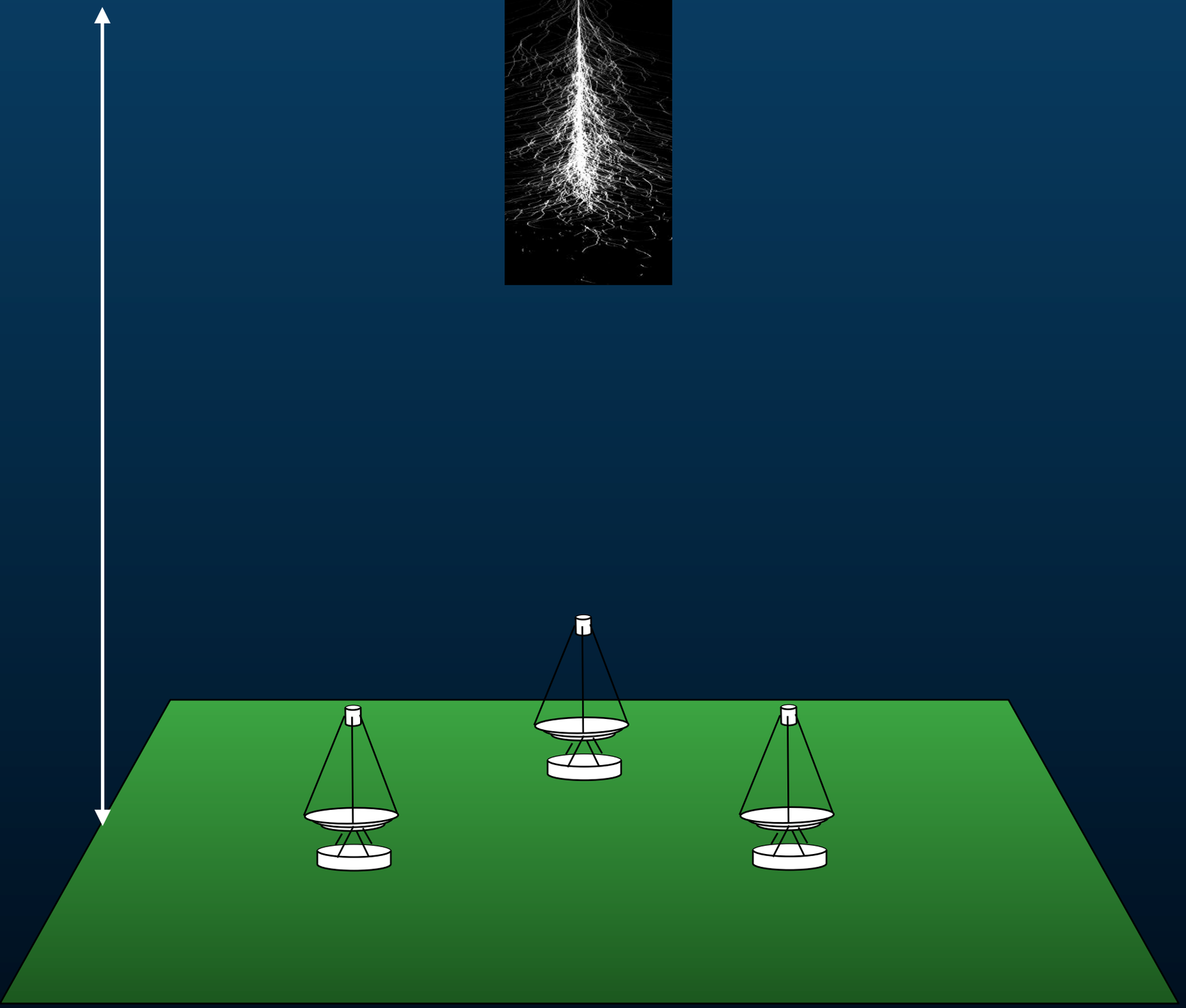
Deep look at the TeV sky

Galactic sources (knee)

gamma
ray



~15 km



gamma
ray

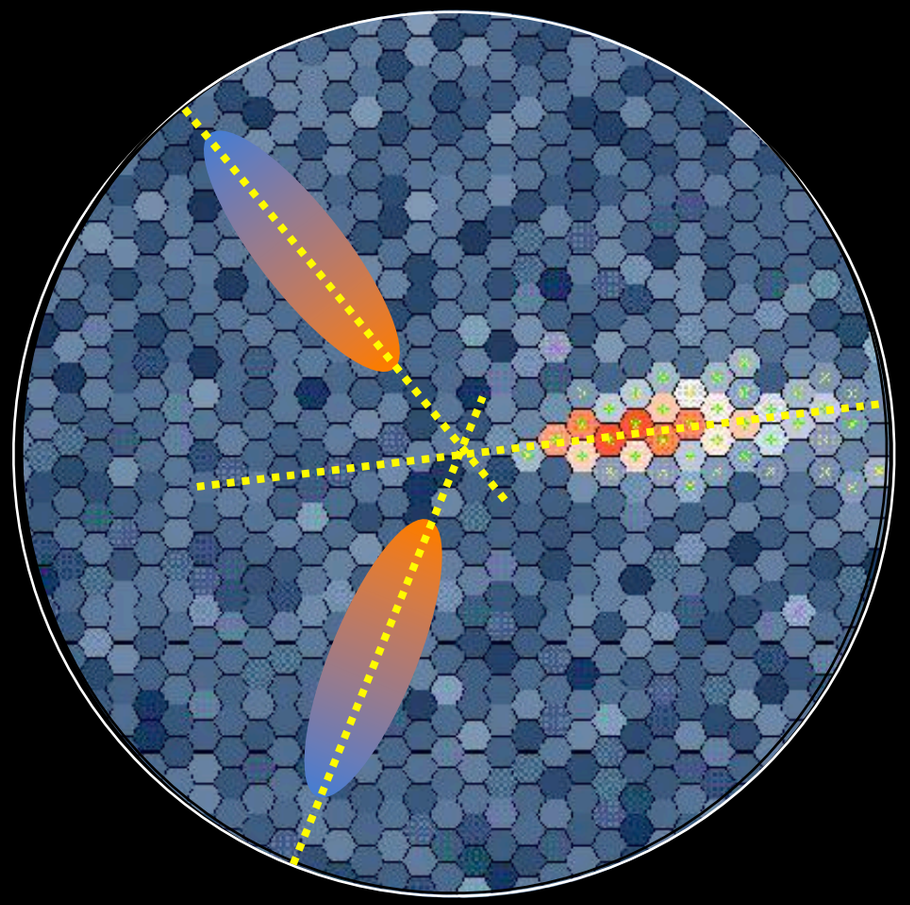
~15 km

Cherenkov light

gamma
ray

~15 km

Cherenkov light



intensity → energy
orientation → direction
shape → primary
stereo → source position

The CTA Project

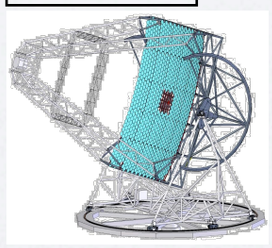
- Priority project by European funding agencies (ASPERA and ASTRONET)
- ESFRI (European Strategy Forum on Research Infrastructures) Roadmap 2008
- FP7 call for preparatory phase and eScience
- CTA consortium = extended H.E.S.S. + MAGIC community from 22 countries in Europe, also USA, Argentina and Japan
- Close collaboration with USA initiative AGIS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	★ Startup meeting											
		★ FP7 proposal										
		Array layout										
				★ Consortium								
Design and Prototype Phase			Components									
					Telescopes							
								Array construction				
									Science operation			

VERITAS

Fermi

H.E.S.S. II



MAGIC II

DESY EFFORTS IN CTA

- Physics program
- Monte Carlo studies for trigger optimization
- Telescope design
- Drive system
- Digital trigger concept
- Camera PMT high voltage
- Array Control Centre
- Monte Carlo event production

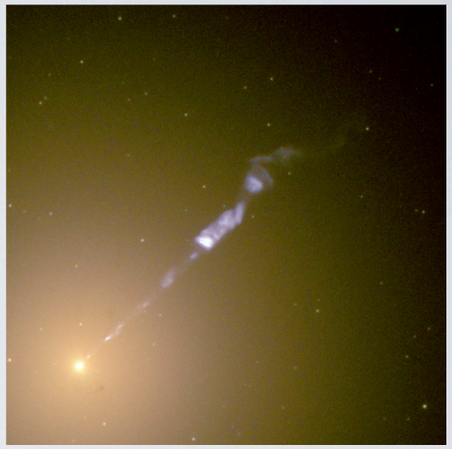
new Young Investigator Group

support from mechanics, electronics, and computing groups

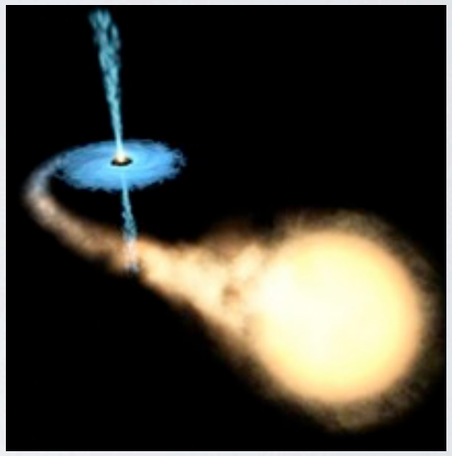
Collaboration with German groups and labs in the US

PARTICLE ACCELERATION IN JETS

- Powerful flows of matter and energy
  - form close to massive objects (black holes,...)
  - accelerate particles to high energies
- Jet formation
  - particle acceleration: how? where? what?
  - sources of ultra-high energy cosmic rays?

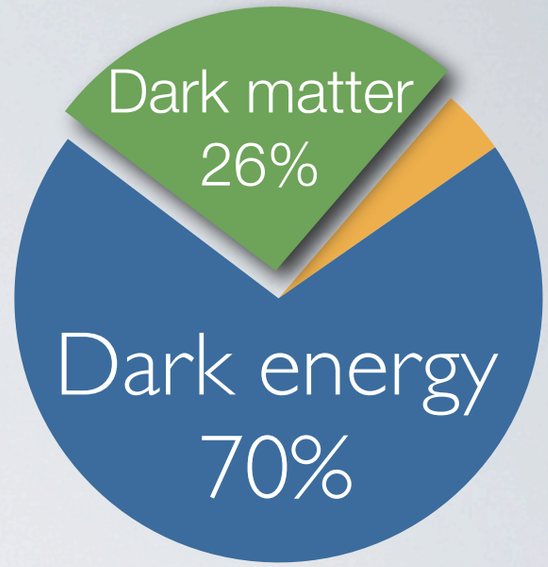


Active Galactic Nuclei

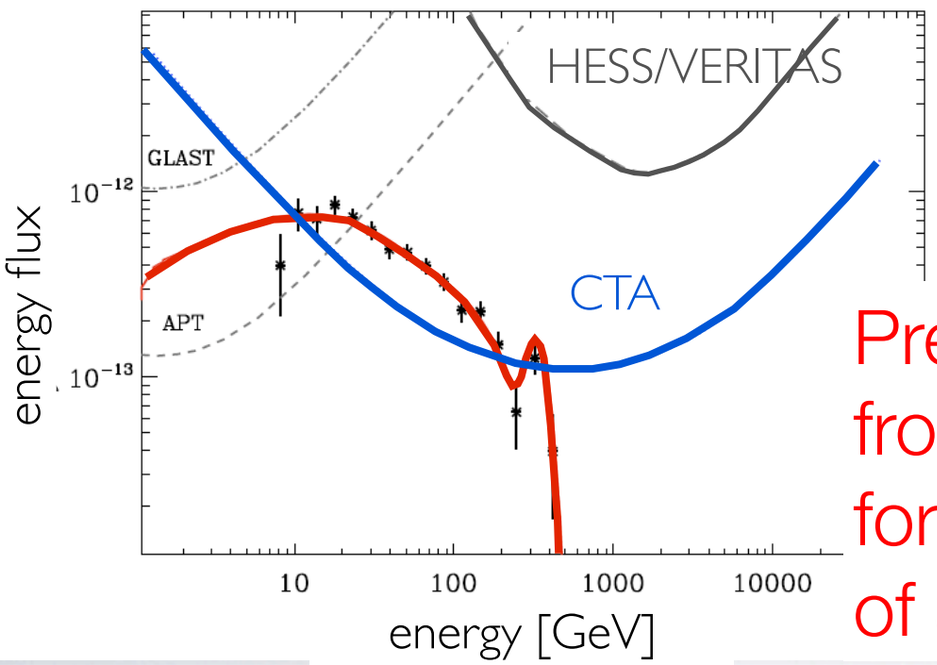


Microquasars

NATURE OF DARK MATTER PARTICLES?



- Presence inferred from gravitational effects on visible matter
- Search for annihilation signal of dark-matter particles
- Challenge: distinguish this signal from astrophysical gamma rays



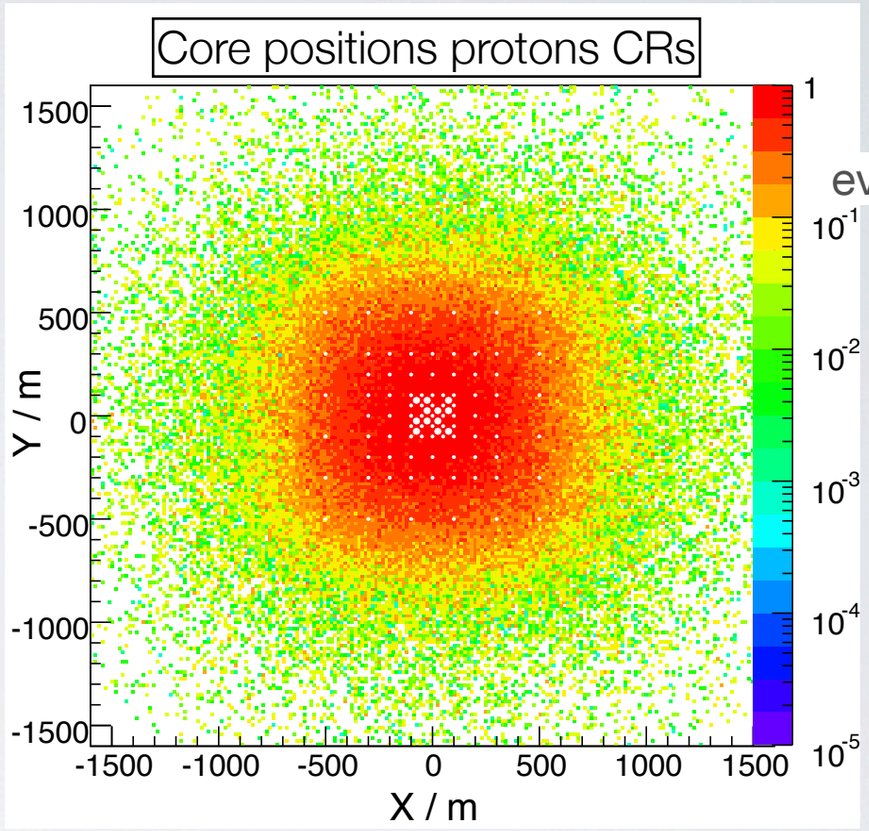
Predicted signal from a dwarf galaxy for neutralino mass of 330 GeV

Parallel with other searches (e.g. Edelweiss, IceCube) and production (LHC)

ARRAY LAYOUT

- Explore parameter space
  - telescope diameters and focal length
  - telescope distances
  - camera size and pixel size
  - array height

→ Performance in a given budget

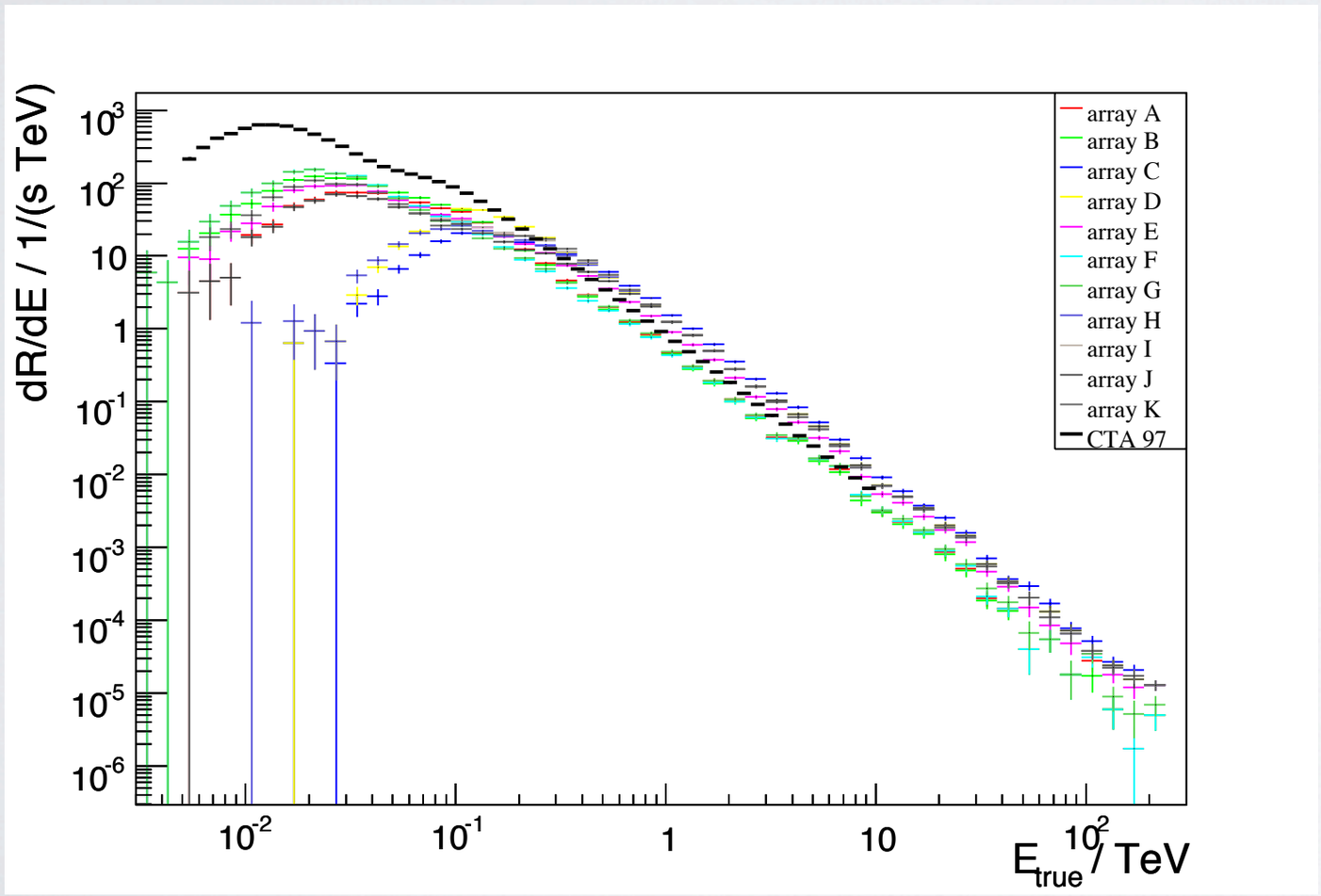


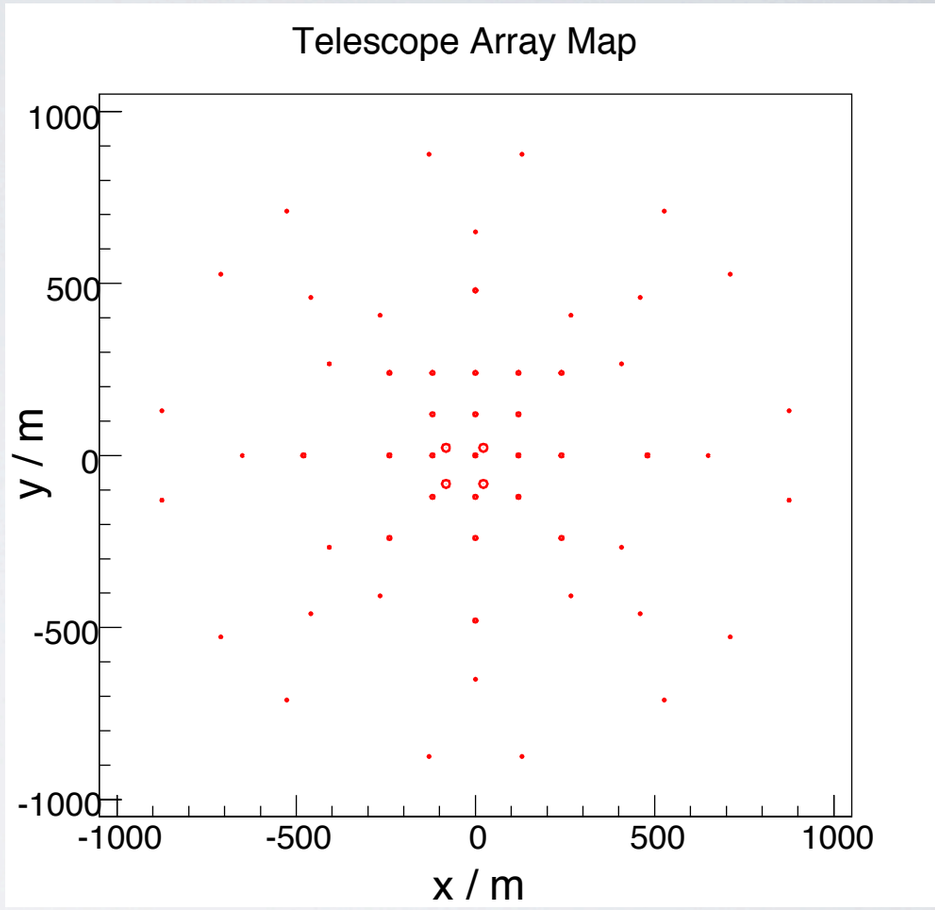
DESY works on

- timing studies for background suppression
- trigger optimization

CAMERA AND ARRAY TRIGGER RATES

- Investigate ~20 array configurations from a pool of 275 telescopes
- Differential trigger rates





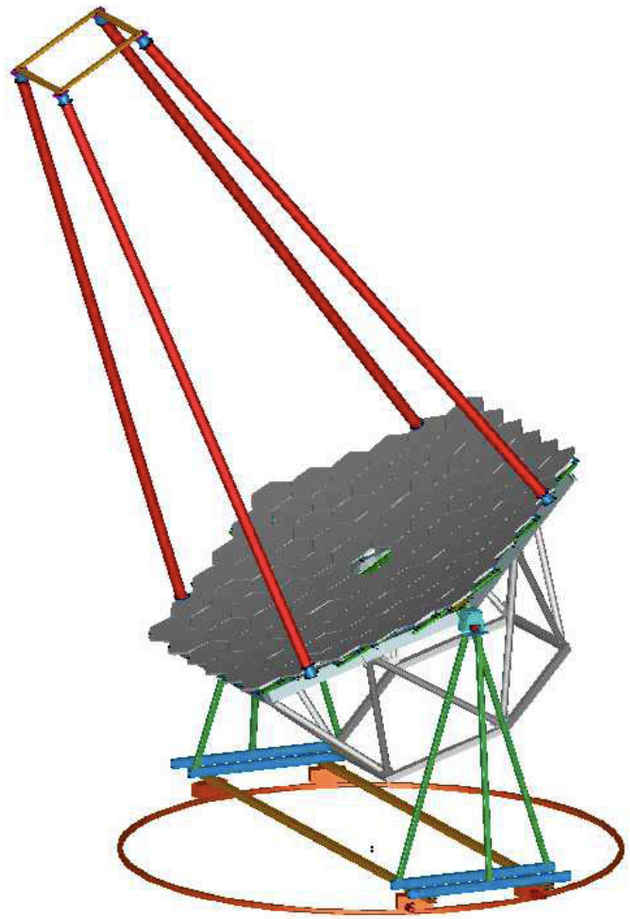
- Total trigger rate from protons 9...15 KHz

- Data rate 400 MB/s → 1.8 PB/ year → online trigger farm

TELESCOPE CONSTRUCTION

- Baseline designs for different
  - diameters
  - focal length
  - field of view
  - spherical or parabolic mirror
  - alternatives

→ Prediction of performance parameters and costs

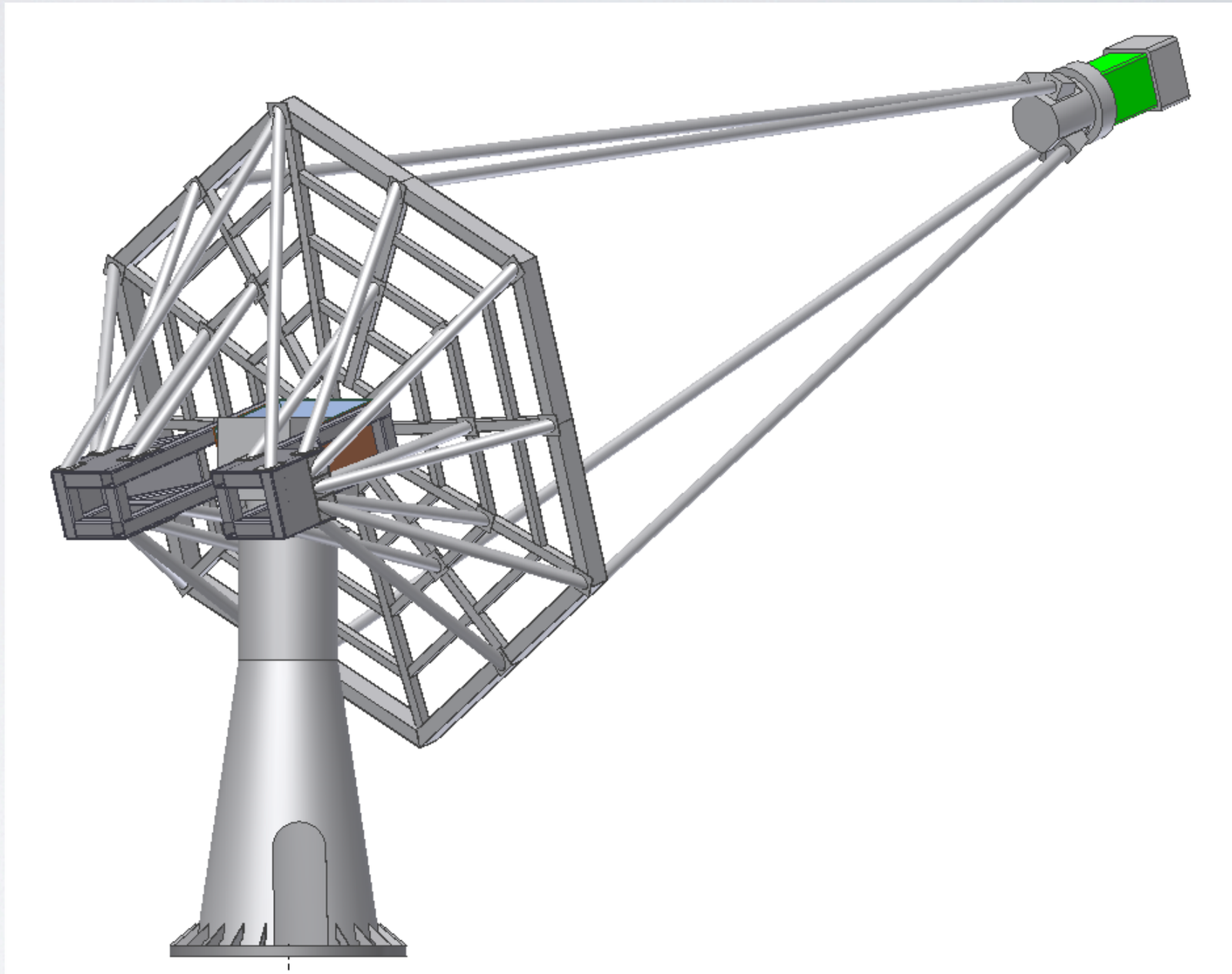


DESY works on

- design for medium-size telescope
- drive and control system

TOWARDS A TELESCOPE PROTOTYPE

- diameter 12 meters
- focal length 16 m
- 8° field of view
- price and ease of construction
- small deformations → small point spread function

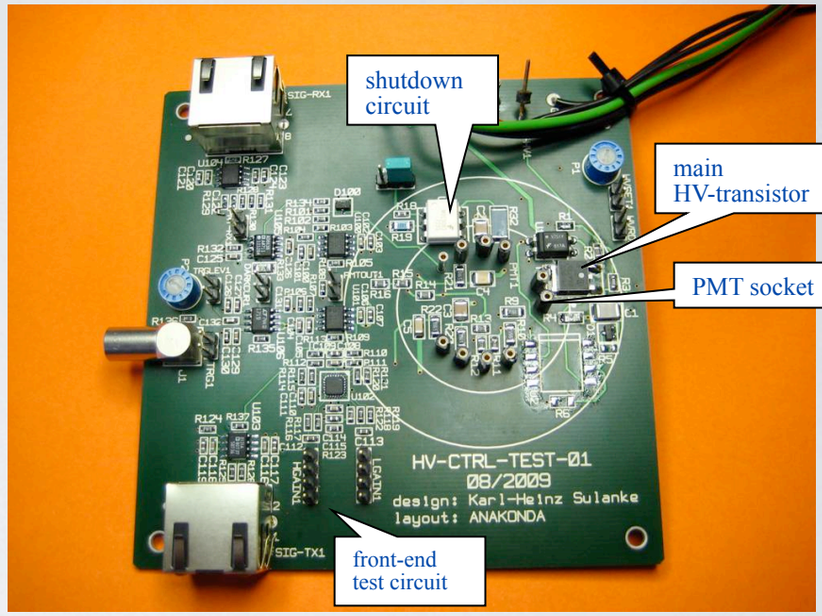


DRIVE AND SAFETY SYSTEM

- Motors
- Feedbacks
- Gears
- End switches
- Emergency system

ELECTRONICS FOR CTA

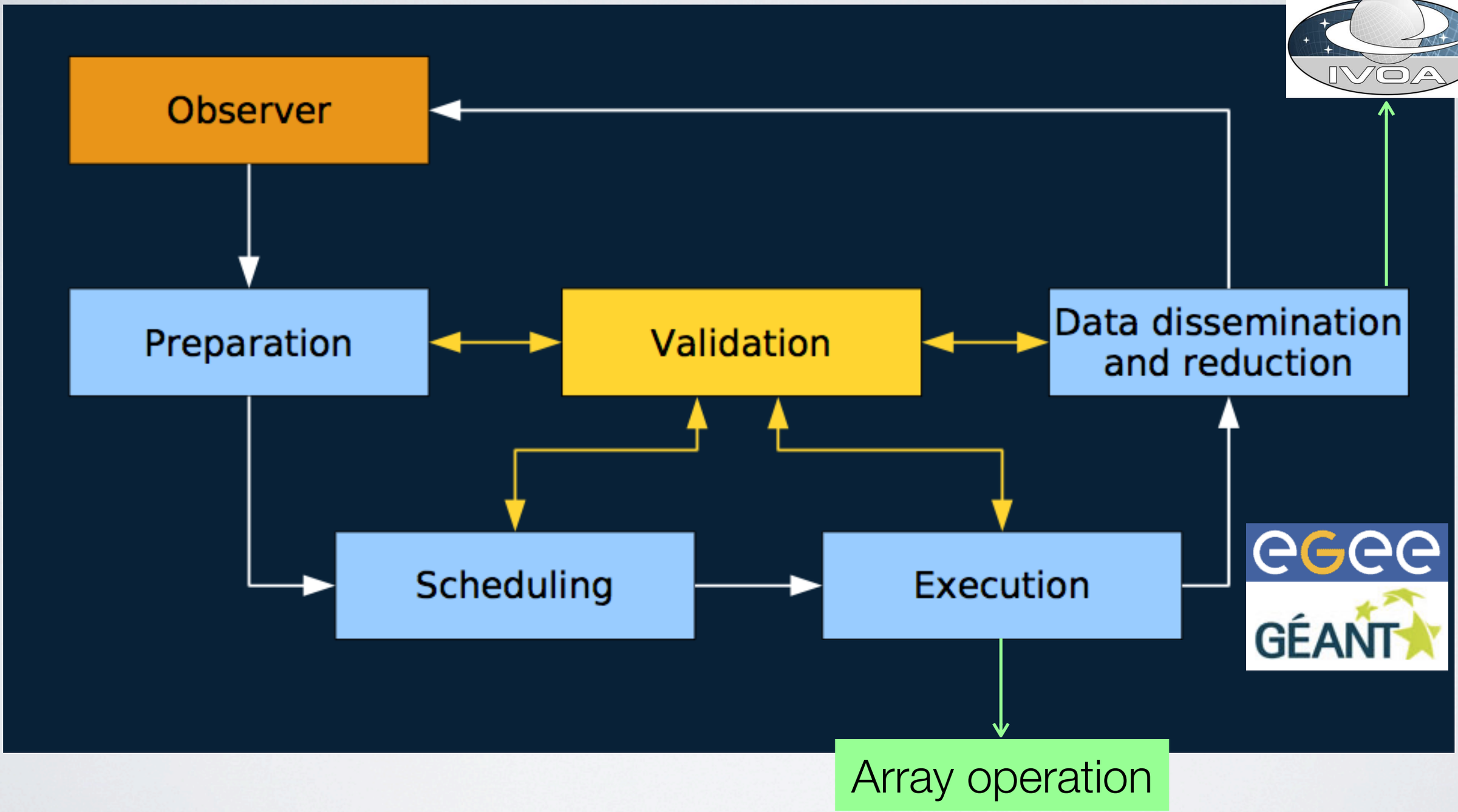
- High voltage system for camera PMTs
  - special features on control, safety, power dissipation
  - test board



- Studies for a FPGA based digital camera trigger in a three-stage trigger structure:
  - channel concentrator
  - trigger algorithm board
  - central trigger board

ARRAY OPERATION CENTER

ARRAY OPERATION CENTER



Prototype for telescope prototype operation

DESY WILL PLAY A STRONG ROLE IN CTA

- Medium-size telescopes
- Drive and safety systems
- Major electronics contributions
- Array control Centre
- Key group in
  - Data analysis and simulation
  - Physics of jets and dark matter search