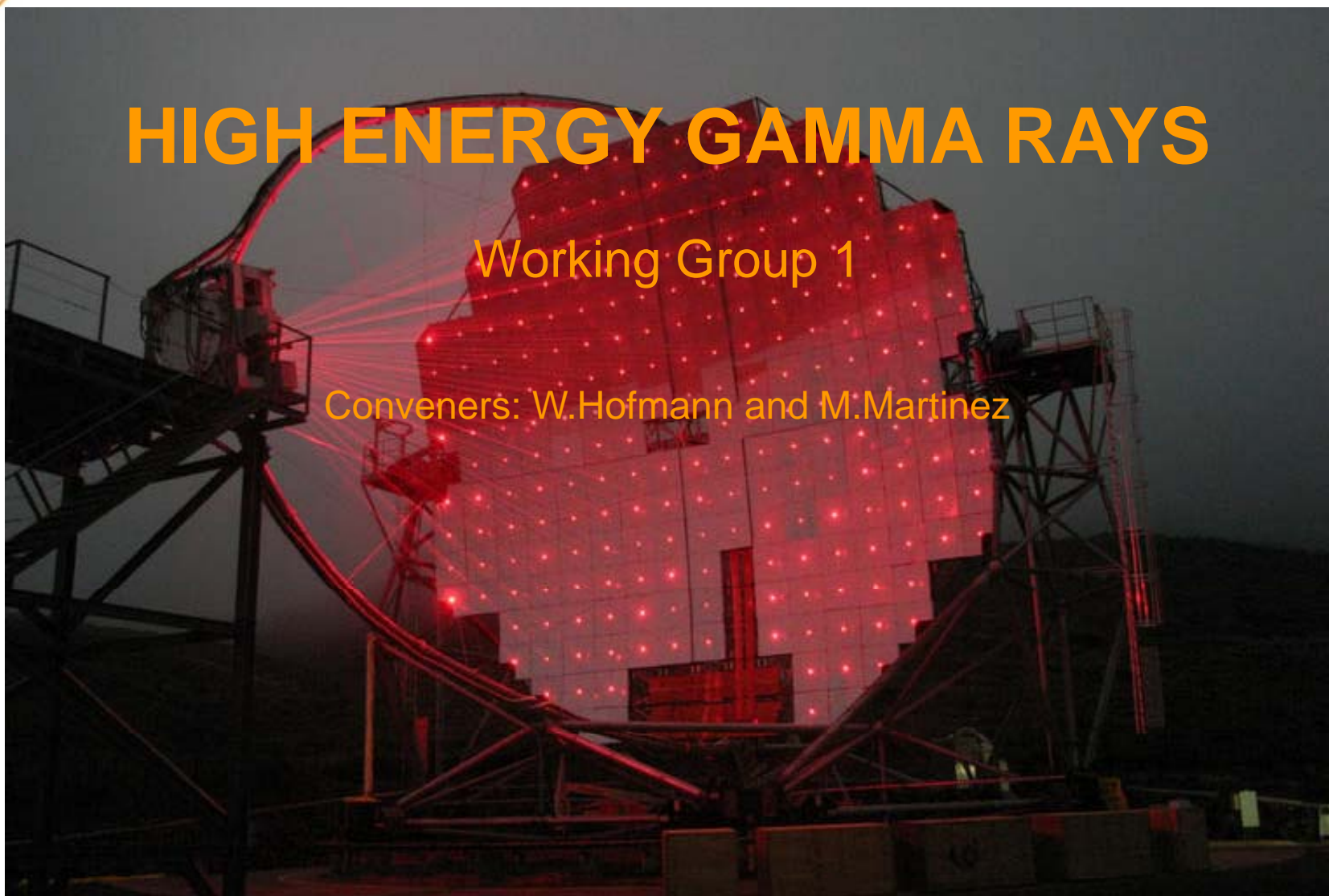


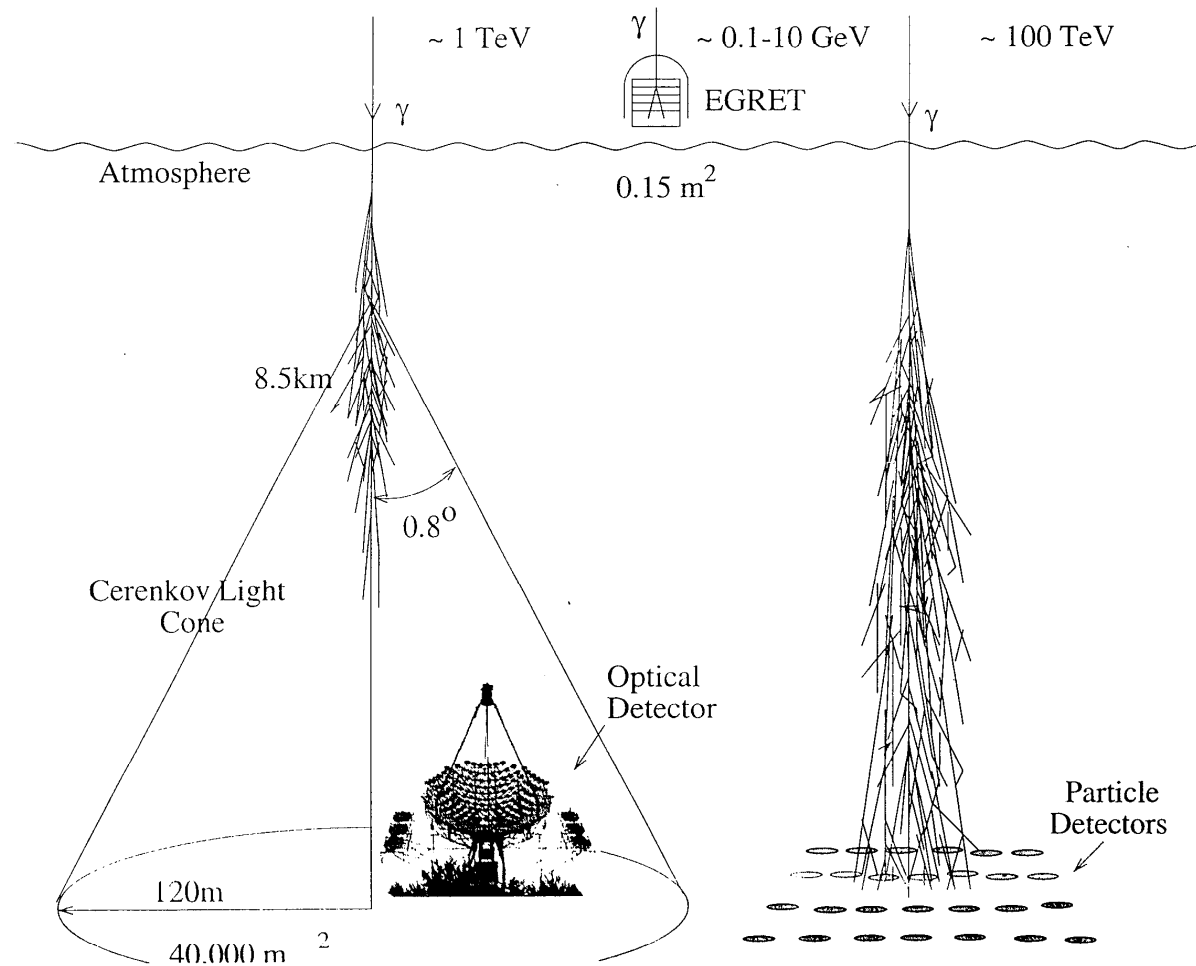
# HIGH ENERGY GAMMA RAYS

Working Group 1

Conveners: W.Hofmann and M.Martinez



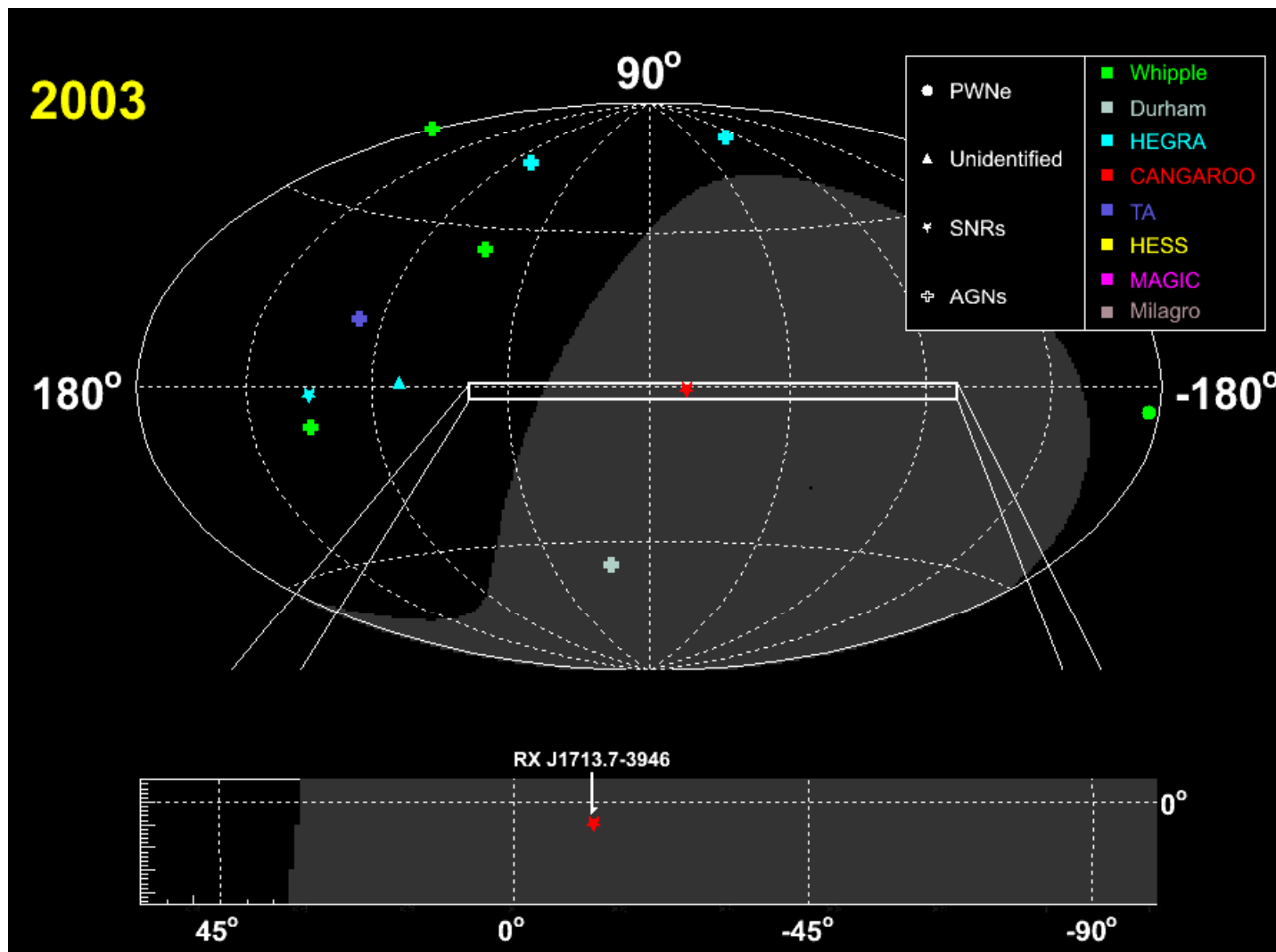
## Detection of VHE Cosmic Gamma Rays

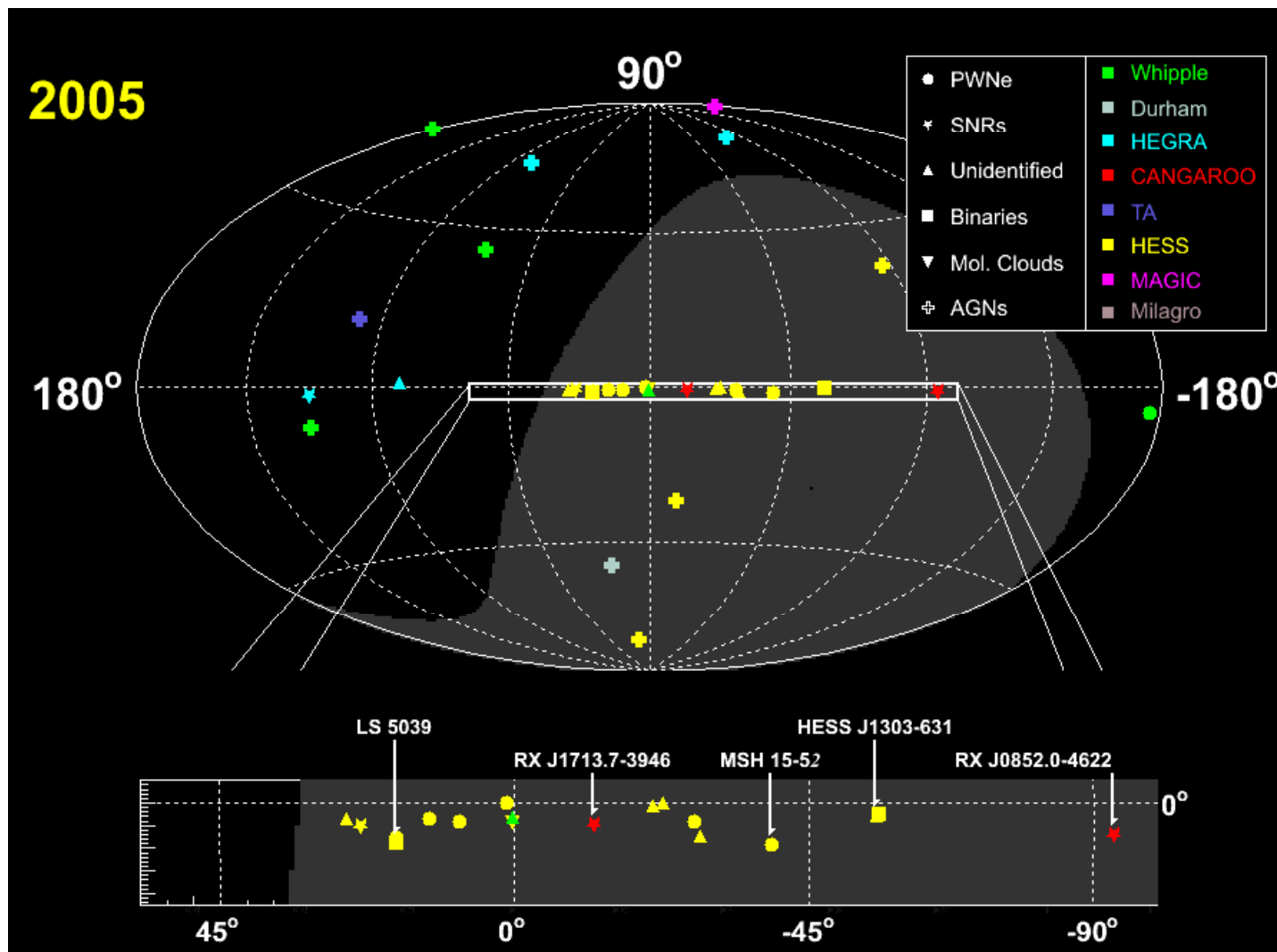


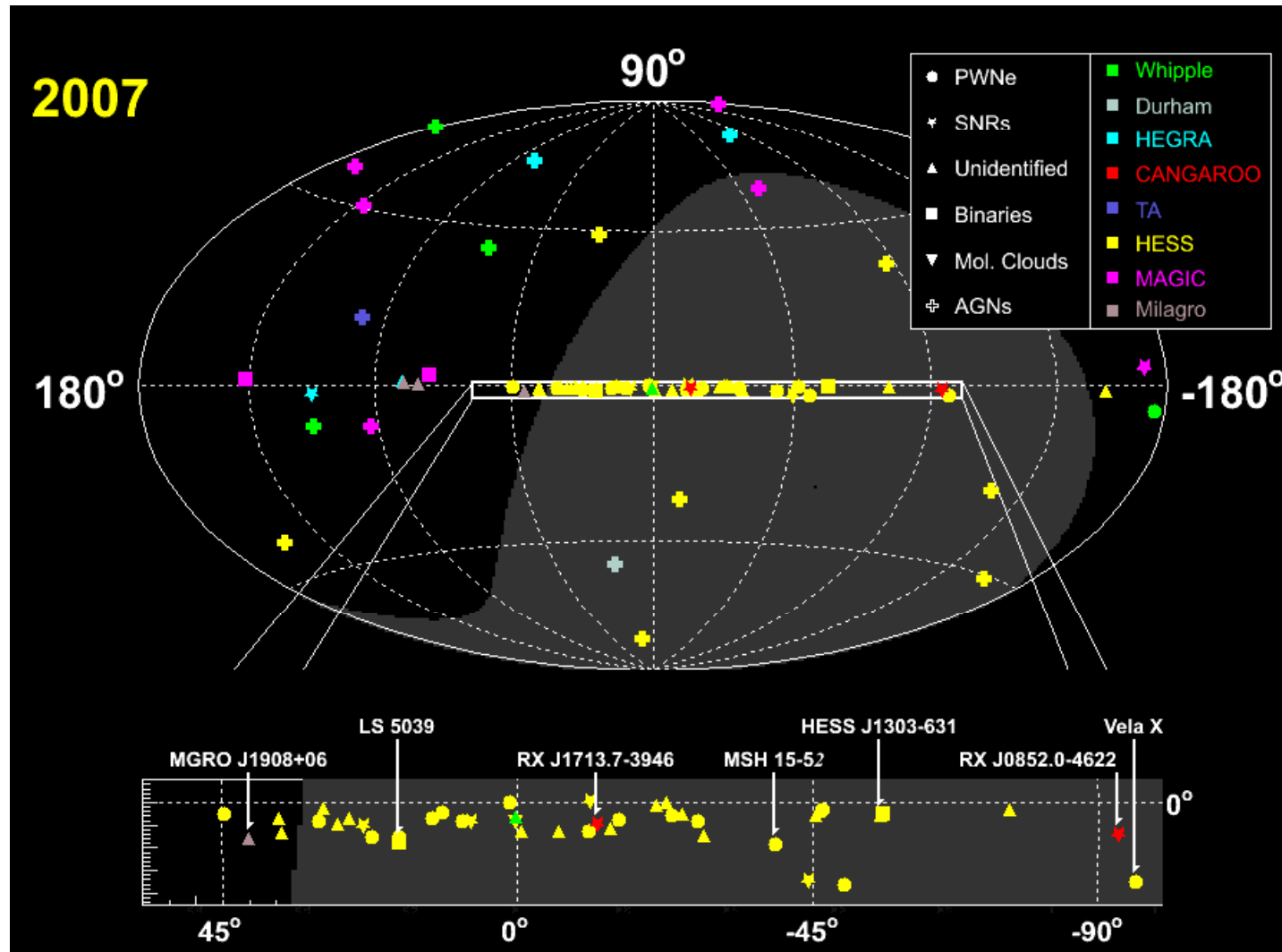
# State of the Art TeV Astrophysics ...



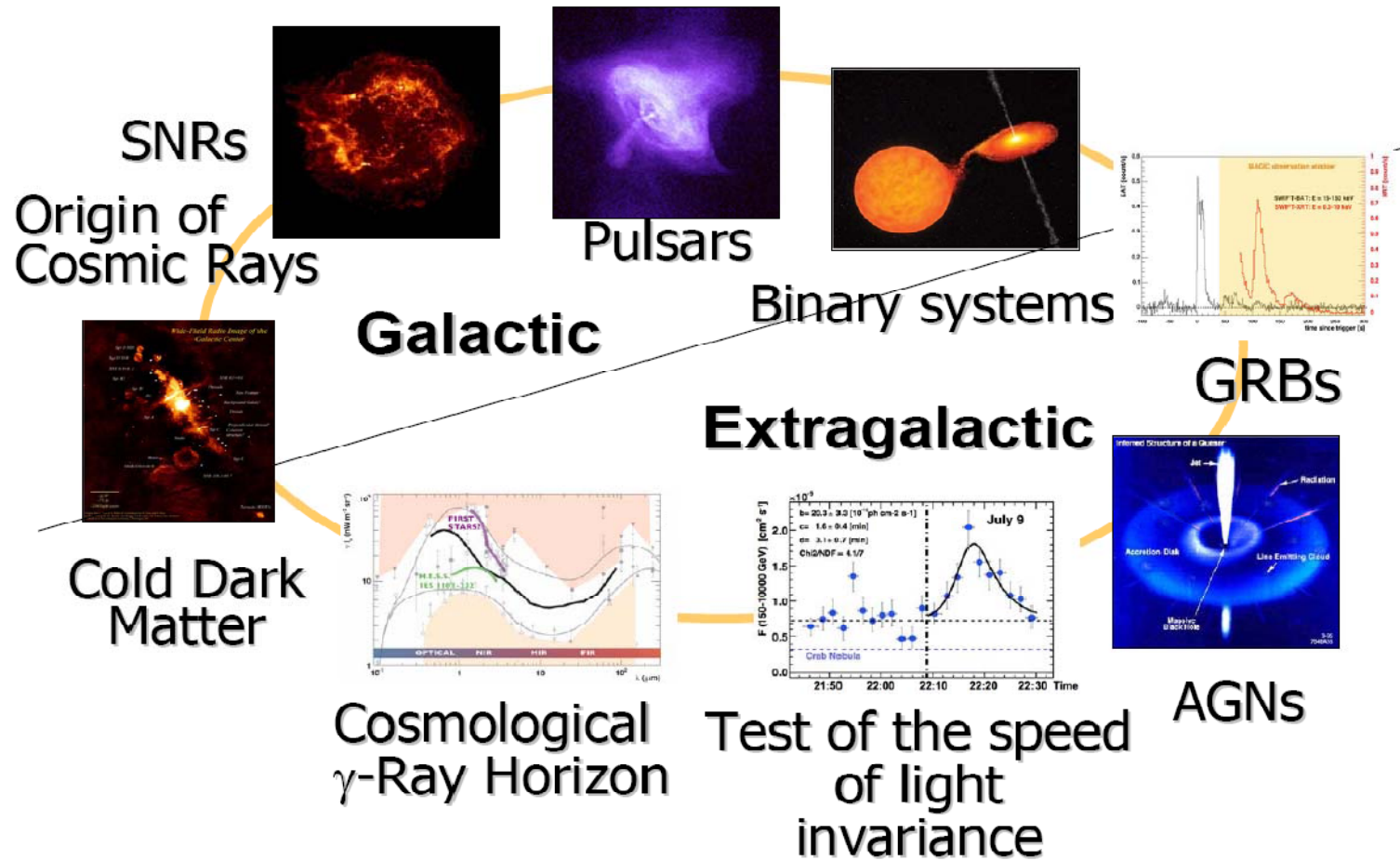
Europe  
world-wide  
leading in the field !







# The VHE $\gamma$ -ray Physics Program



## **SOME OPEN QUESTIONS:**

- What is the origin of cosmic rays ?
- How does particle acceleration by accretion into a massive black hole work ?
- Are there strong hadron accelerators which could be good targets for neutrino telescopes ?
- Do pulsars produce VHE gamma rays ?
- Does Dark Matter annihilate producing gamma rays ?
- Is the origin of EBL completely resolved ?



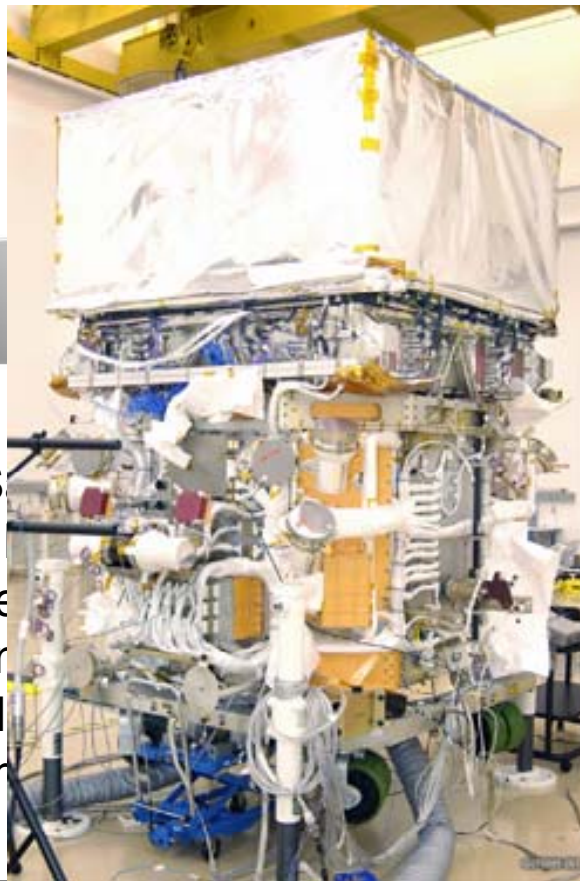
- What is the impact of the measurements on EBL absorption in the understanding of the history of structure formation ?
- Can the absorption pattern in the spectrum of distant Blazars be used to measure Dark Energy ?
- Can VHE gammas emitted by flaring AGNs or GRBs unveil the quantum structure of gravity ?
- Do GRB produce VHE gamma rays ?
- ...

# Gamma Ray Satellites

- INTEGRAL
- AGILE
- AMS
- **GLAST**

# GLAST

Gamma Large Area Space Telescope



- NASA S...ments:
- LAT: ...V
- En...v
- Ser...r
- GBM...d.
- Thousan...

# GLAST Status

- **Status:** ready. Thermal vacuum testing ongoing. To be launched on Spring 2008
- **Collaboration:**
  - USA, Japan, Sweden, France, Italy & Germany
  - 50 scientists; 50% European
- **Obstacles:**
  - None foreseen (provided no NASA launch delays)
- **R&D required:** none

# GLAST 2008-2018

- **Timetable:** Operation funded and warranted until 2013. Extension to 2018 very likely is everything goes well.

- **Risks**

- **Equipment reliability**

- **Resources**

Total Cost k€	FTE
198200	150.5

50 % European

- **ASPERA**

99.100 k€, 75 FTE

Compiled by: David A. Smith

# Surface Particle Detectors

- TIBET ARRAY
- MILAGRO -> HAWK
- **ARGO-YBJ**

# ARGO-YBJ



- 6500
- Loca
- Wid
- Pro

here).

ts.

# ARGO Status

- **Status:** detector completely mounted. Central 5800 sqm carpet taking data since July 2006. Lead mounting by summer 2008.
- **Collaboration:**
  - Exists: Italian-Chinese Collaboration
  - 80 scientists; 50 % European
- **Obstacles:** none
- **R&D required:** none



# ARGO FUTURE

- **Timetable:** Completion of the installation ongoing. Started conversations with MILAGRO/HAWK about future plans

- **Risks:** none

- **Resources**

Total Cost k€	FTE
4150	300

- **ASPERA**
  - 2500 k€ 150 FTE (Cost Sharing:60 % EU; Scientists: 50% EU)

---

Compiled by: M. Iacovacci

# Air Cherenkov Telescopes

## *NON-IMAGING:*

- STACEE
- CACTUS
- SOLAR-2

## *IMAGING:*

- TACTIC
- CANGAROO-III
- **VERITAS**
- **H.E.S.S.**
- **MAGIC**
- **CTA**
- AGIS

## *WIDE-FIELD:*

- **GAW**

# H.E.S.S.

## High Energy Stereoscopic System



- Array of 4 x 12 meter (100 sqm) Cherenkov Telescopes
- Located at the Khomas Highland Namibia (Southern Hemisphere)
- Fully operational since 2003
- Analysis  $E_{th}$  about 150 GeV and Crab-like detection in about 30 seconds
- Lots of discoveries and high impact results

# H.E.S.S. II

... a recent view of the H.E.S.S. site ...



# HESS Status

- **Status**
  - Phase I (4 Telescopes) operational
  - Phase II (5th 600 sqm telescope) under construction
- **Collaboration**
  - Phase I collaboration MoU; Phase II agreement under preparation
  - 150 scientists 95% EU
- **Obstacles: None**
- **R&D required: None**

# HESS 2008-2018

- **Timetable:** until 2015 seems certain; until 2018, depends on CTA progress
- **Risks for HESS II**
  - **Funding (some remaining funding gap, no contingency)**
  - **Schedule: commissioning may slip due to potential delays in several areas**

➤ **Resources:**

Total Cost k€	FTE
9.050	235

95% European

➤ **ASPERA**

- **8550 K€    220 FTE**

Compiled by: Werner Hofmann

# MAGIC

## Major Atmospheric Gamma Imaging Cherenkov



- Single 17 meter (250 sqm) Cherenkov Telescope with several new technological elements
- Located at the La Palma Canary island (Northern Hemisphere)
- Fully operational since 2004
- Analysis  $E_{th}$  about 60 GeV and Crab-like detection in about 2 minutes
- Many of discoveries and high impact results

# MAGIC 2



- Twin 17 meter Cherenkov Telescope with state-of-the-art technology
- Commissioning in fall 2008
- Three times better sensitivity and physics  $E_{th}$  below 50 GeV



# MAGIC Status

- **Status**
  - Phase 1: First telescope operational
  - Phase 2: Second Telescope under Construction
- **Collaboration**
  - Phase 1 and 2 MoU exists
  - 22 Institutions, 3 non-European
  - 155 scientists 90% EU
- **Obstacles: None**
- **R&D required:**
  - Larger mirrors, new active mirror control, new optical links, ultrafast digitizers: already done
  - Improved QE camera: on the way (2009 foreseen)

# MAGIC 2008-2015

- **Timetable:** until 2015 seems certain; until 2018, depends on CTA progress
  - Upgrade MAGIC 2 to HPD camera: 2008-2009
  - MAGIC 1 Camera Upgrade

- **Risks for MAGIC Phase 2:** funding for upgrades not yet secured

- **Resources:**

Total Cost k€	FTE
9.700	260

89 % EU: MPI, IFAE, INFN, INAF + 25 univ  
11% Non EU: ETH, UC Davis, Yerevan

- **ASPERA**
  - 8700 K€ and 234 FTE (2008-2015)

Compiled by: Mose Mariotti & Masahiro Teshima

# VERITAS

Very Energetic Radiation Imaging Telescope Array System



- Array of 4 x 12 meter (100 sqm) Cherenkov Telescopes
- Located at the Kitt Peak Observatory, Arizona (Northern Hemisphere)
- Started full operation spring 2007
- Several sources already observed

# VERITAS Status

- **Status:** full 4-telescope system inaugurated April 2007. Two-year program of Key Science Projects underway.
- **Collaboration**
  - Exists: institutes from US, Canada, Ireland and UK
  - 60 scientists, 15% EU
- **Obstacles:** none
- **R&D required:** none

# VERITAS 2008-2012

➤ **Timetable:** until 2012 seems certain; after that, depends on AGIS and CTA progress

➤ **Risks:** none

➤ **Resources**

Total Cost k€	FTE
11.050	115

15% European

➤ **ASPERA**

▪ **1.660 K€ 17 FTE**

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Compiled by: Joachim Rose

# GAW

GAMMA AIR WATCH



# GAW Status

- **Status**
  - Phase I approved: Installation of first telescope end of 2007
- **Collaboration**
  - Exists, Institutes from Italy, Portugal & Spain
  - 40 european scientists
- **Obstacles**
  - Funding for Phase II
- **R&D required:**
  - Prototype telescope phase I: Fresnel Lens and ASIC integrating front-end and readout electronics

# GAW 2008-2018

- **Timetable:** If prototype operation fulfills expectations, array completion during 2010-2013 and operation extending to 2018.

- **Risks**

- **Funding**

- **Resources**

Total Cost k€	FTE
985	103.5

100 % European

- **ASPERA**

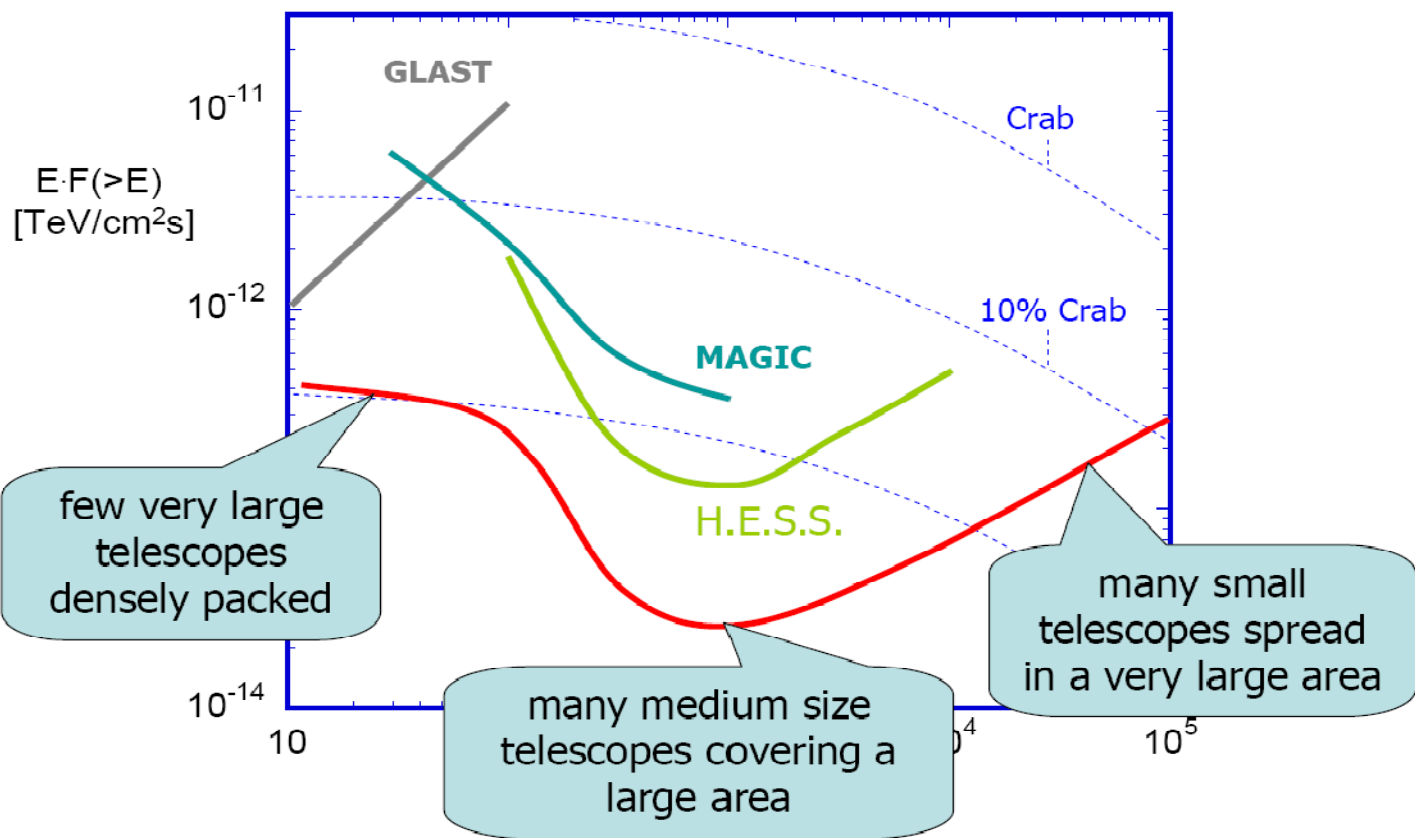
- **985 K€ 103.5 FTE**

Compiled by: Osvaldo Catalano



# CTA

## Cherenkov Telescope Array



# CTA Status

- **Status:** Conceptual. Applied for FP7 Design Study
- **Collaboration:**
  - Information
  - 34 institutions signed application for Design Study
  - 260 scientists; 96% European
- **Obstacles:**
  - Funding
- **R&D required:**
  - Layout: MC optimization
  - Components: Mainly cost-optimization for mass production

# CTA 2008-2018

- **Timetable:** Design Study until 2011. Construction 2011-2014. Commissioning 2015-2016. Aim for close collaboration/eventual merger with American competing initiative AGIS.
- **Risks**
  - Funding
  - Achievable cost per telescope to stay within 100 MEuro target for full-scale site.

- **Resources**

Total Cost k€	FTE
177500	990

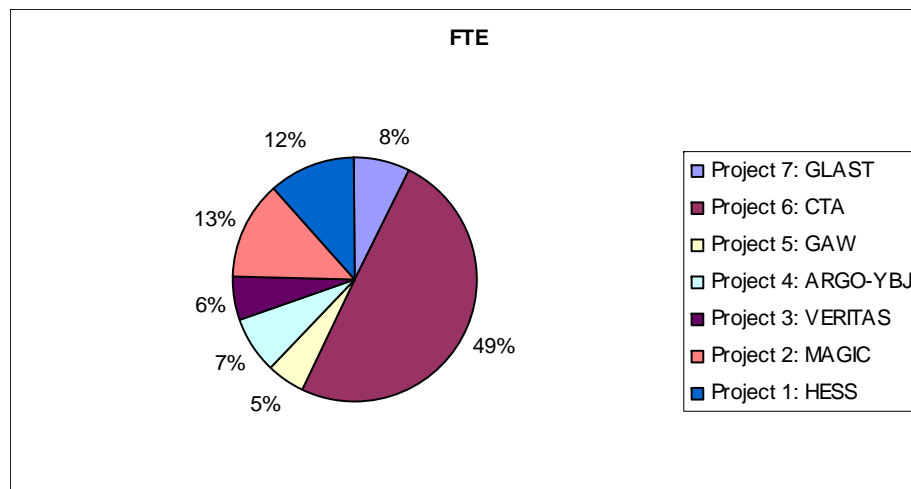
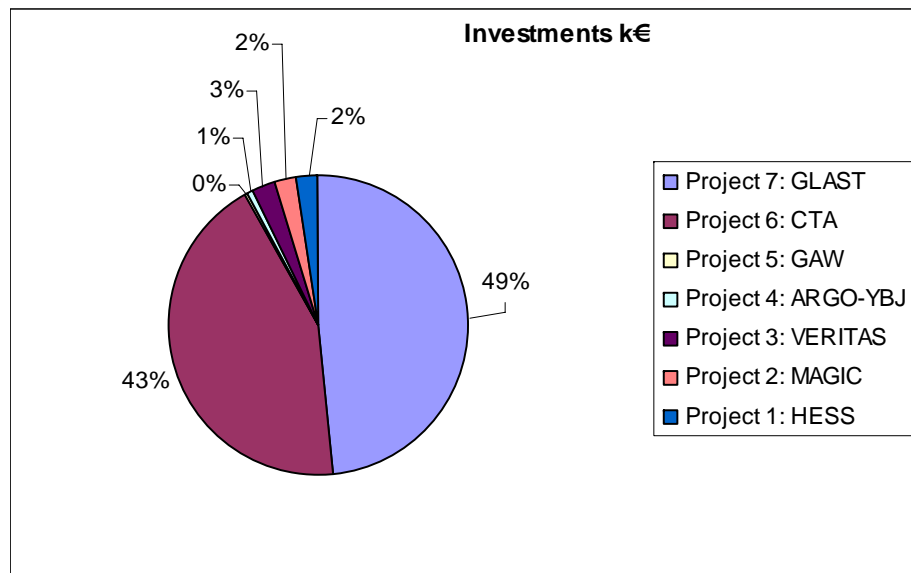
96 % European

- **ASPERA**

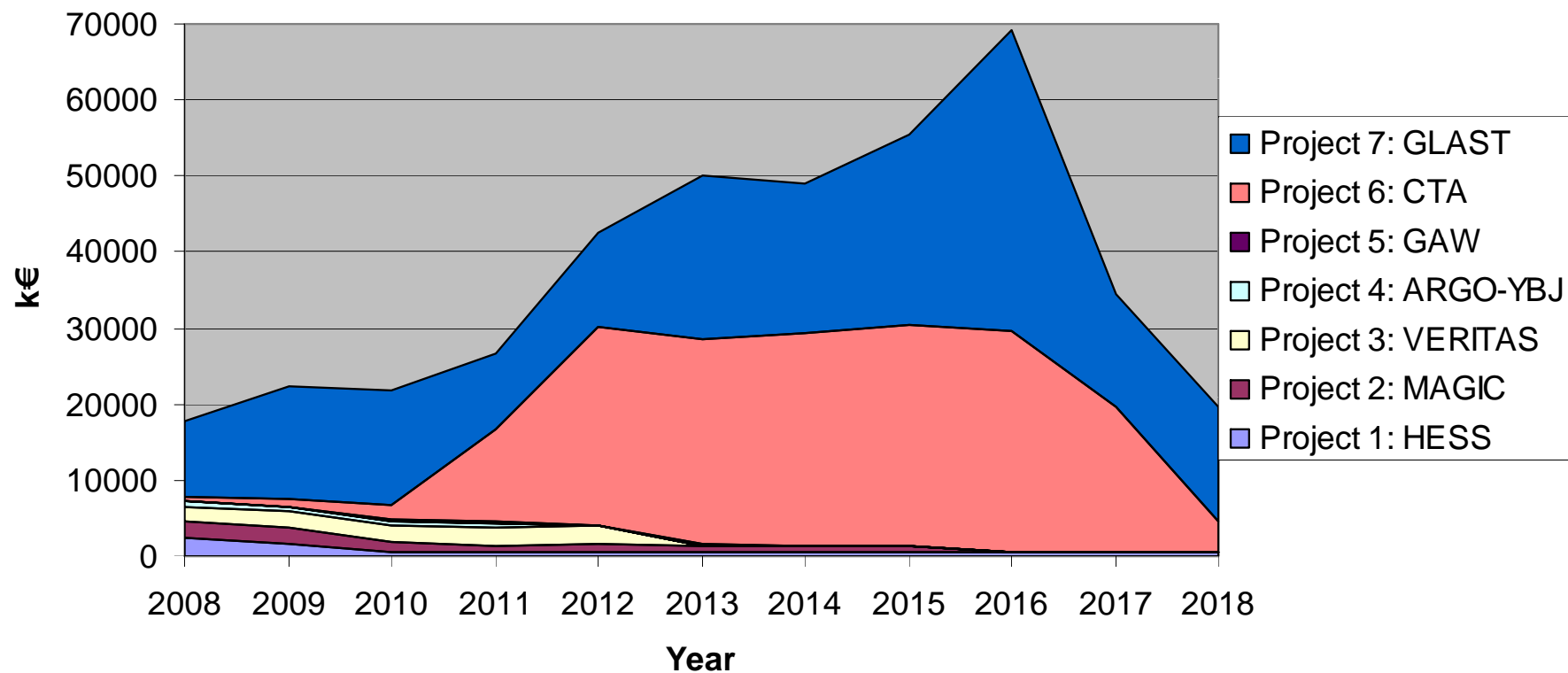
177500 K€ 990 FTE (~100% EU)

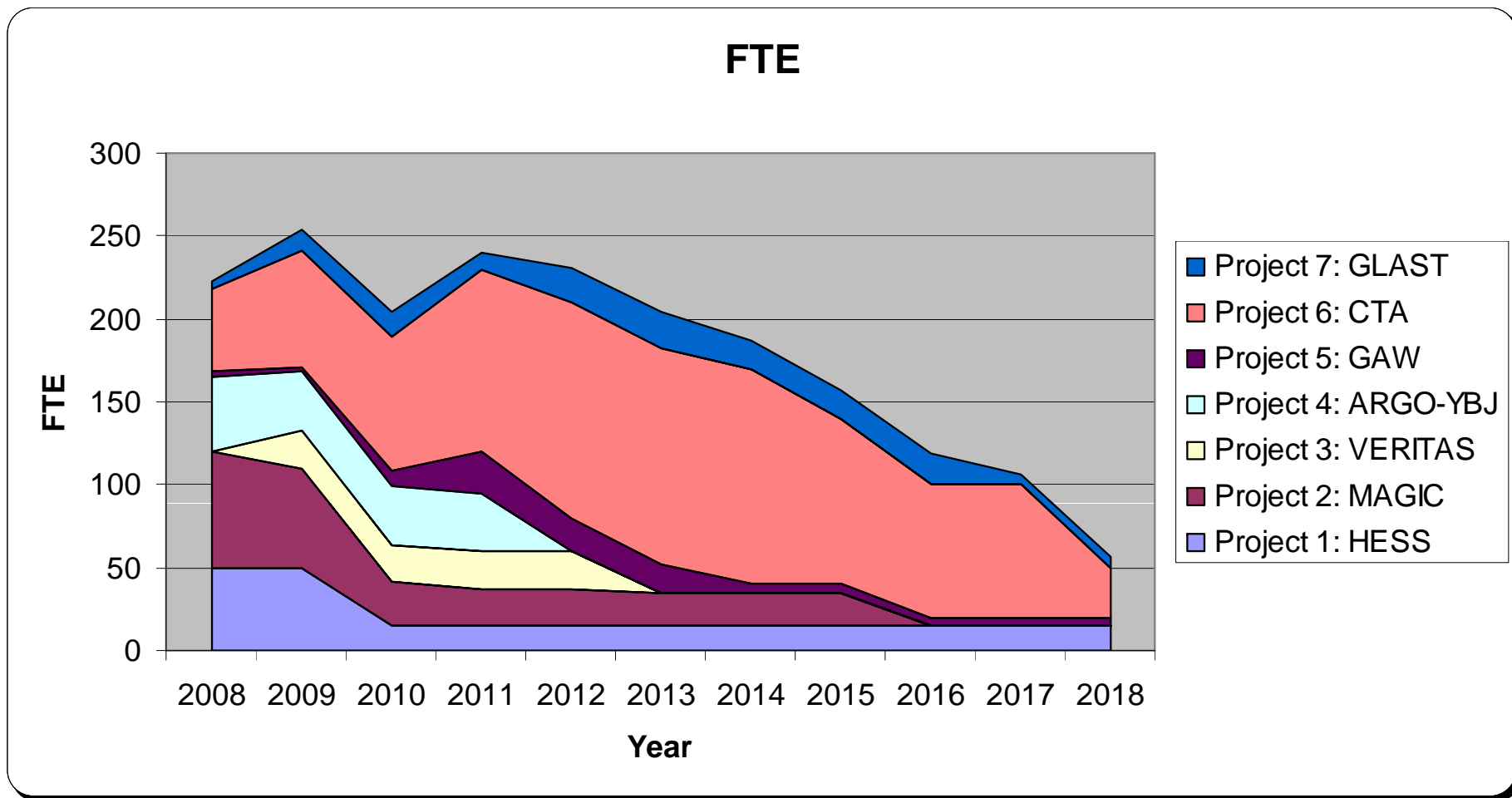
Compiled by: Werner Hofmann

Experiment	k€	FTE (additional 2008-18)
main source	milestones	
•H.E.S.S.:	9.050	235
Astrop.Phys.	HESS II commissioning in 2009	
•MAGIC:	9.700	260
Astrop.Phys.	MAGIC 2 commissioning in 2008	
•VERITAS:	11.051	115
Astrop.Phys.	Started full operation spring 2007.	
•ARGO-YBJ	2.500	150
Astrop.Phys.	Completion with lead layer in 2008	
•GAW:	985	103.5
Astrop.Phys.	First telescope by end 2007	
•CTA:	177.500	990
Astrop.Phys.	Design Study until 2011; Start construction 2011	
•GLAST	198.200	150.5
Space agencies	Launch in 2008; 5 years warranted operation	



### Investments





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