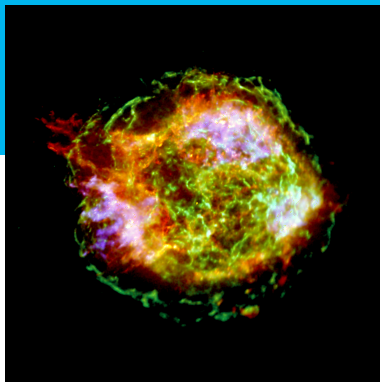


Gamma-Ray Astroparticle Physics: CTA and VERITAS

Stefan Schlenstedt, DESY

71st PRC, Open session

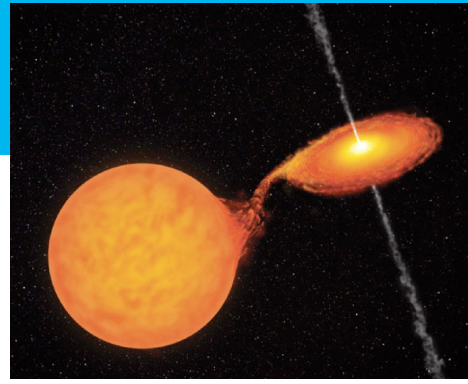
Hamburg, April 28, 2011



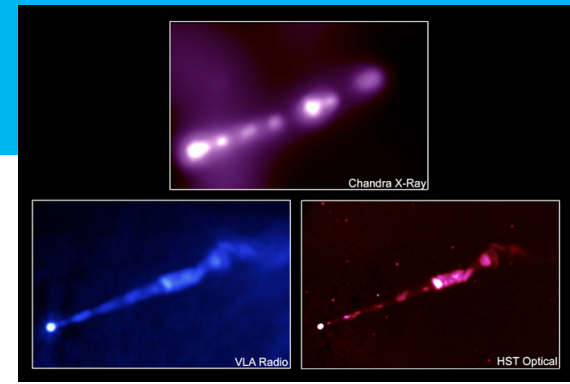
Super Novae R



Gamma Ray B

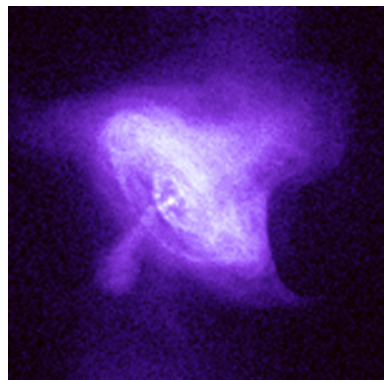


Micro quasars



Active galactic nuclei

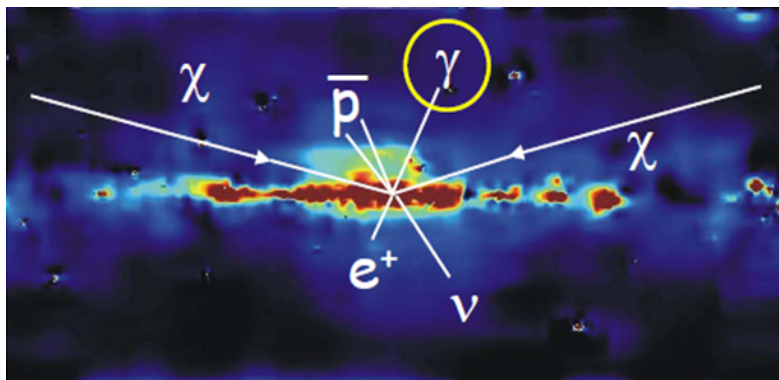
- > Sources of cosmic rays
- > Astrophysics of sources
- > Acceleration and propagation



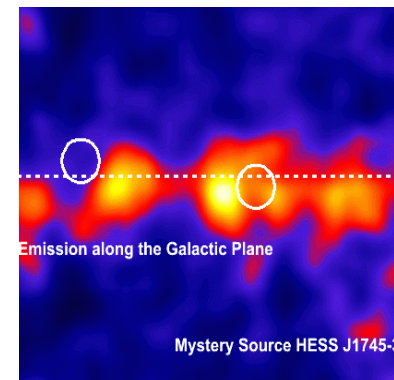
Pulsar (wind nebulae)



Starburst galaxies



Dark matter



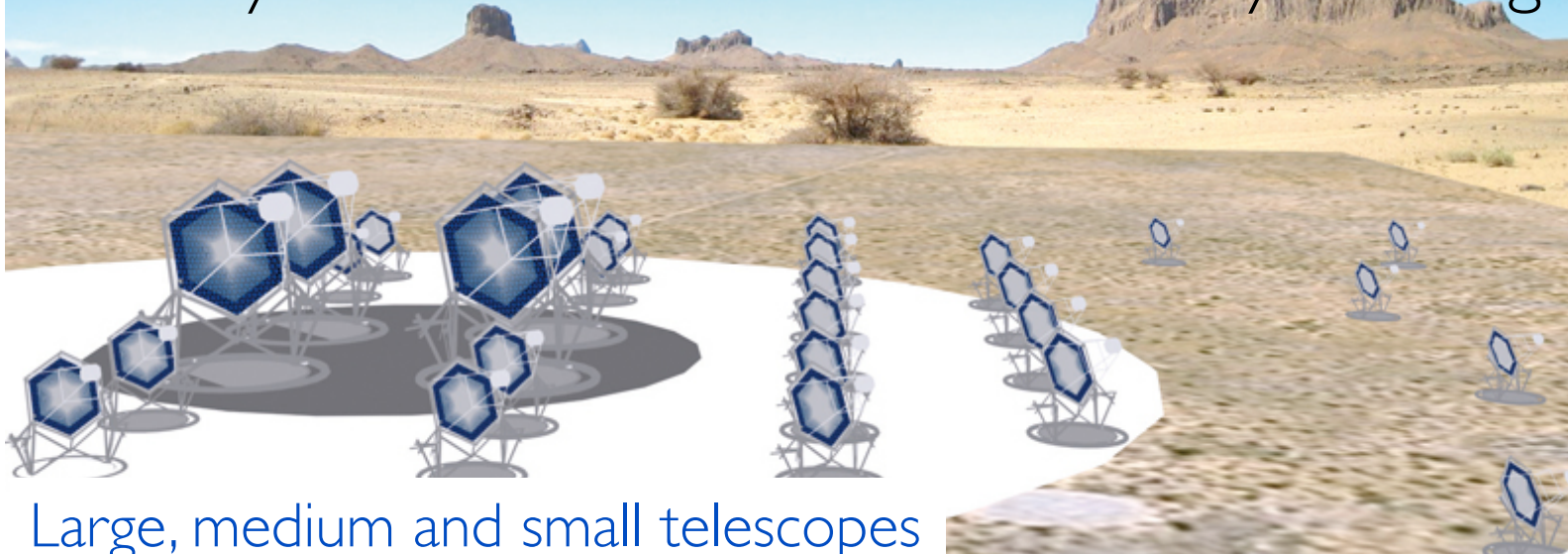
Unknown sources

The Cherenkov Telescope Array

- > Increase sensitivity
- > Extend energy range
- > Improve angular resolution

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

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



Large, medium and small telescopes

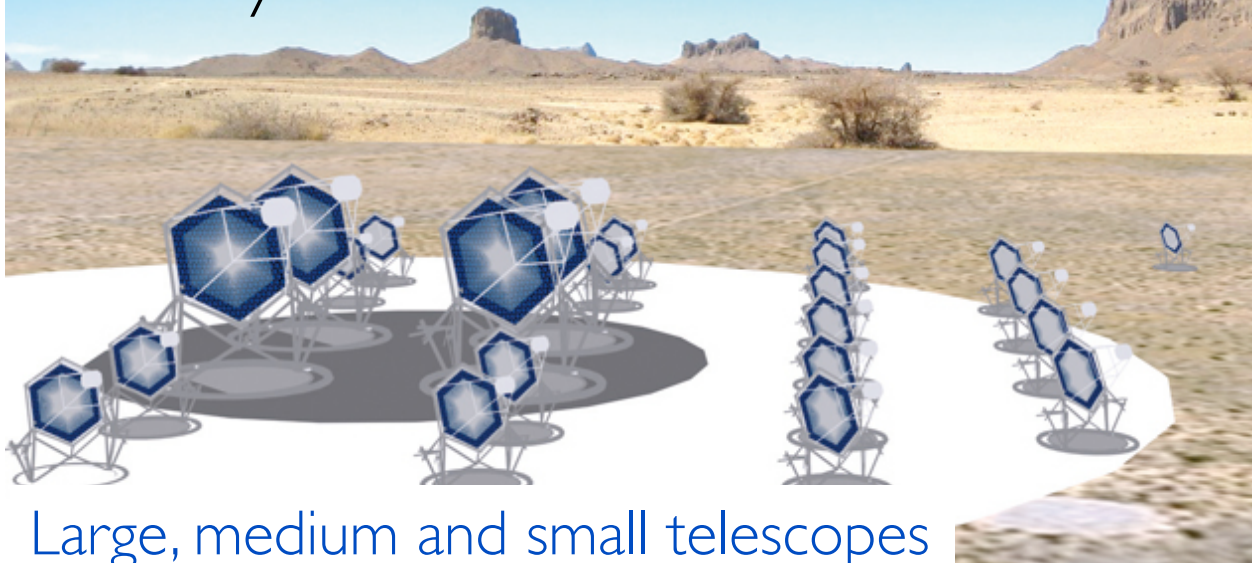
The Cherenkov Telescope Array



- > Increase sensitivity
- > Extend energy range
- > Improve angular resolution

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

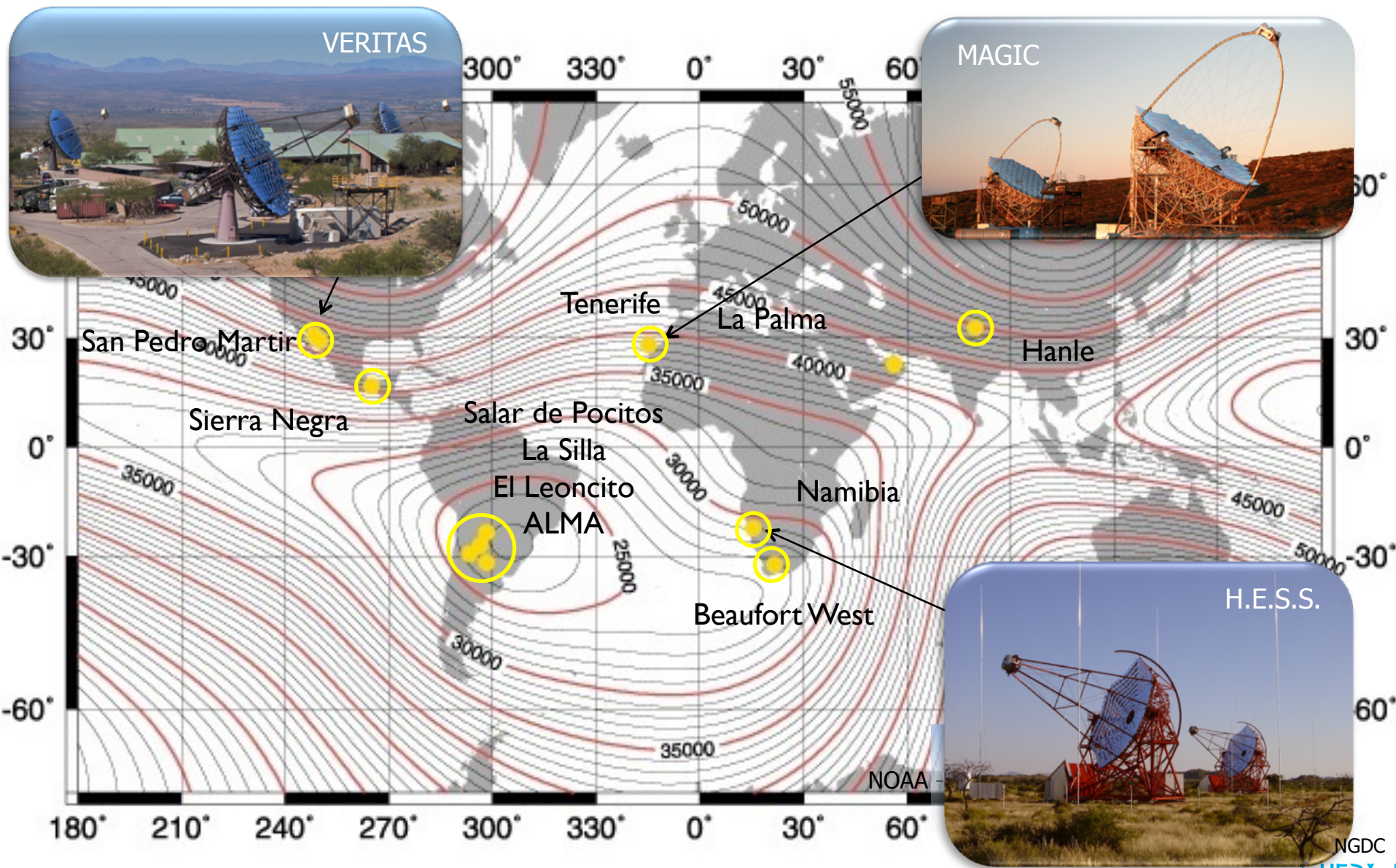
- > Observatory with flexible operation
- > Arrays in North and South for full sky



– 2013:
preparatory phase, prototypes, site decision

> 2013:
construction and partial science operation

CTA Site?



DESY Activities

> Hardware

- medium-size telescope
- electronics

> Array Control

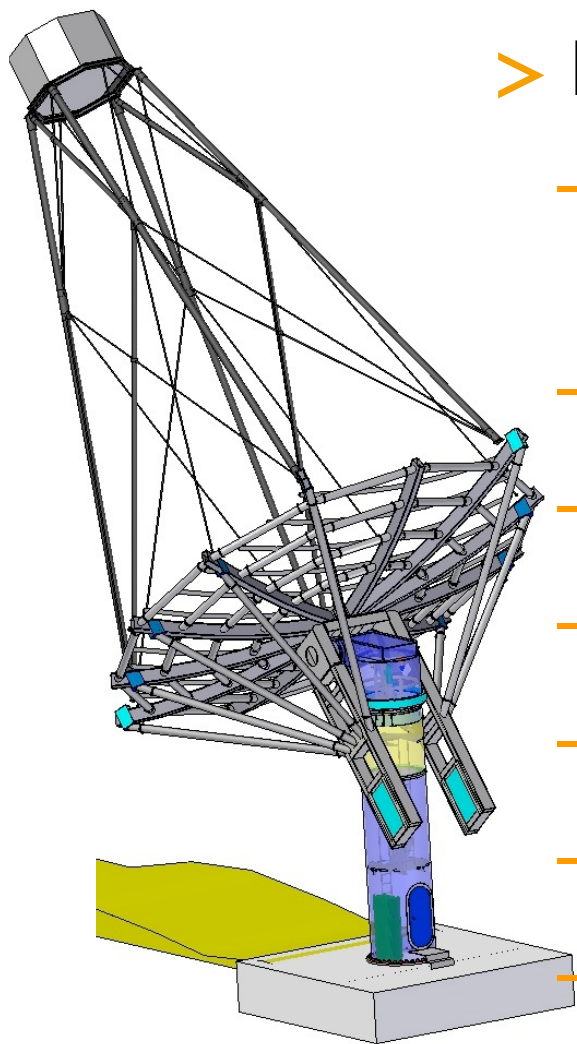
> Sensitivity and Reconstruction methods

> Analysis

> Computing

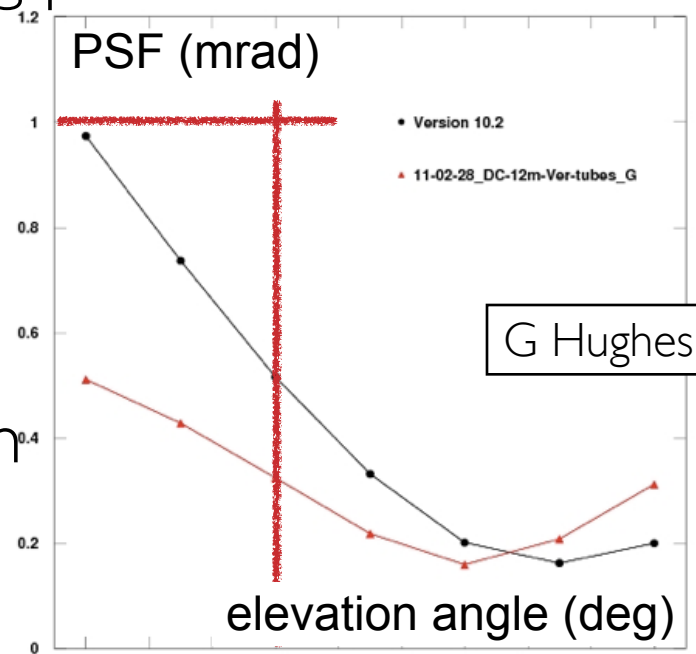


Medium Size Telescope



> Prototype 2011 in Berlin

- design: dish, camera structure, head, tower, foundation
- statics - building permit
- production
- measurements
- 'operation'
- instrumentation
- pointing

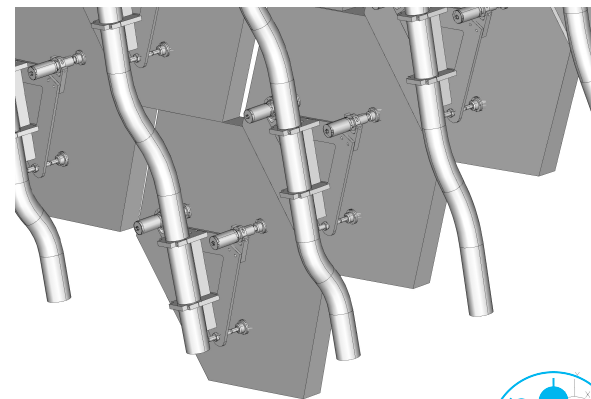
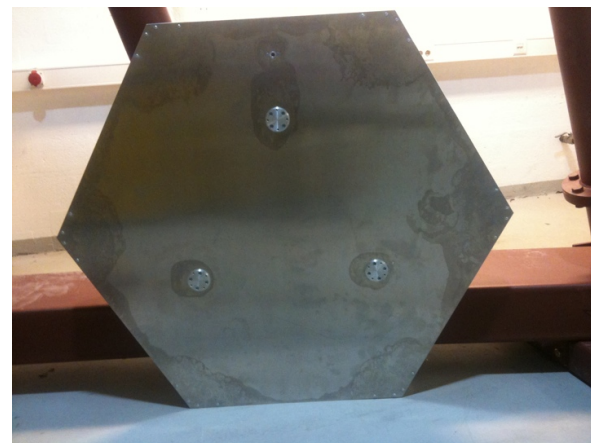


Medium Size Telescope

- > Pre-prototype = quarter-dish in Zeuthen
 - measure with photogrammetry and tachymetry
 - mirror mounting

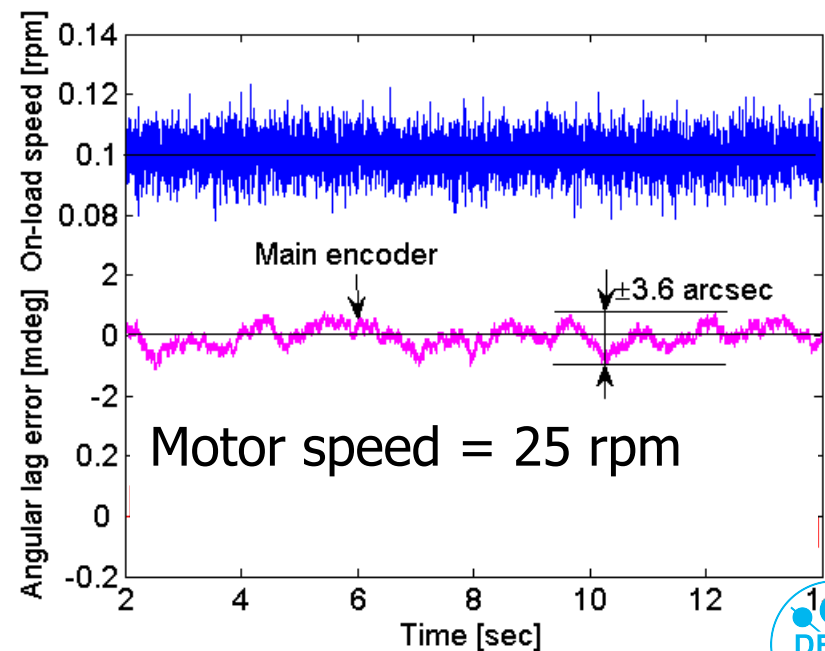
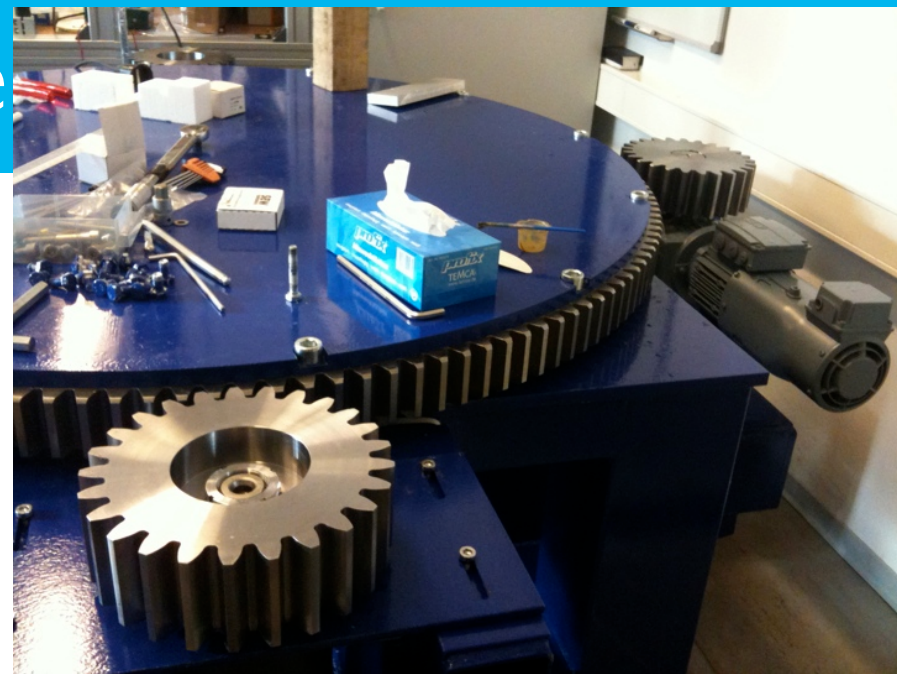


J Bähr



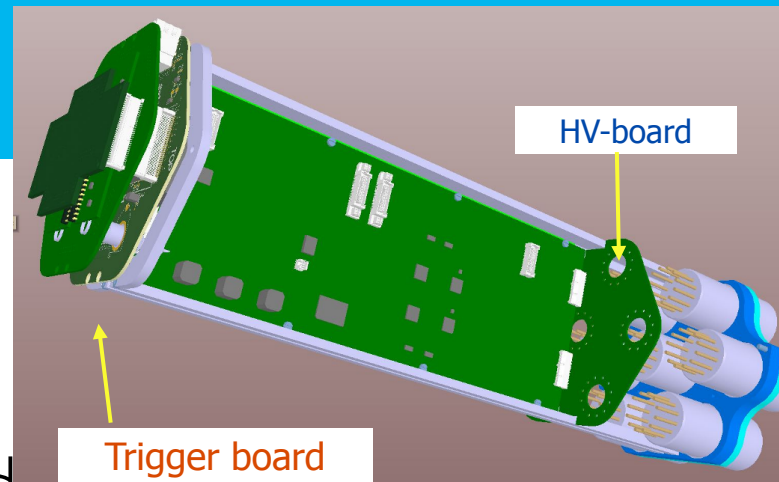
Medium Size Telescope

- > Drive system:
 - 2 azimuth and 4 elevation motors
 - speed range 1 ... 3600 rpm
 - high accuracy
- > Safety concept
 - active and passive
 - risk analysis
- > Energy management system

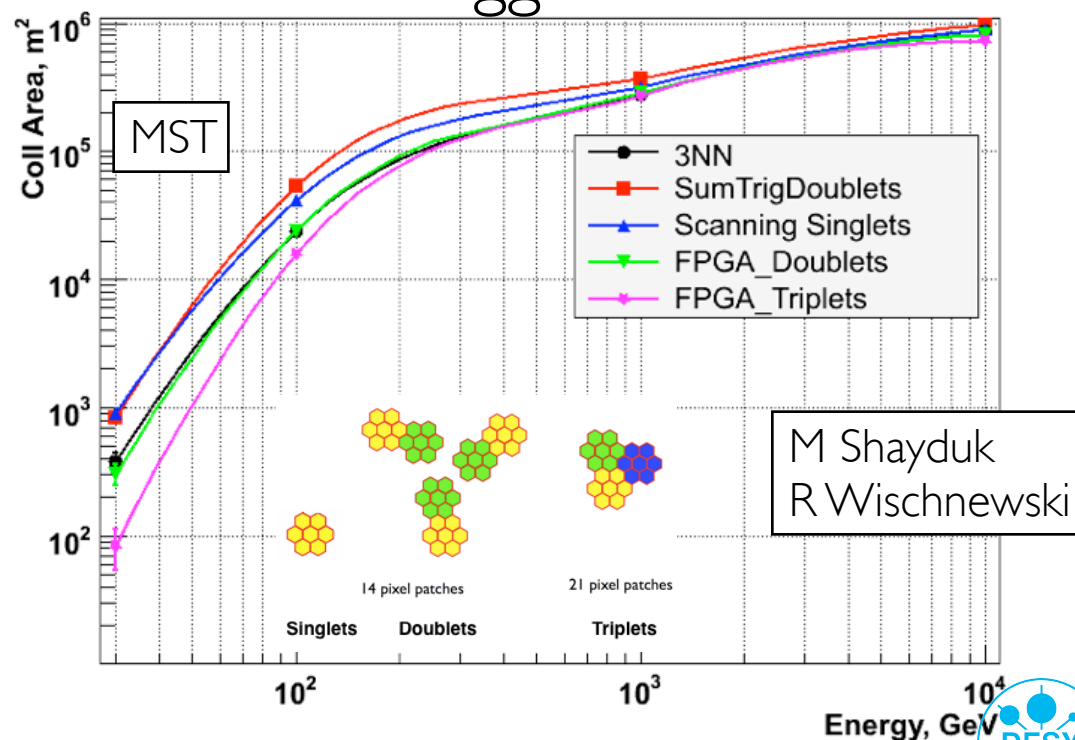
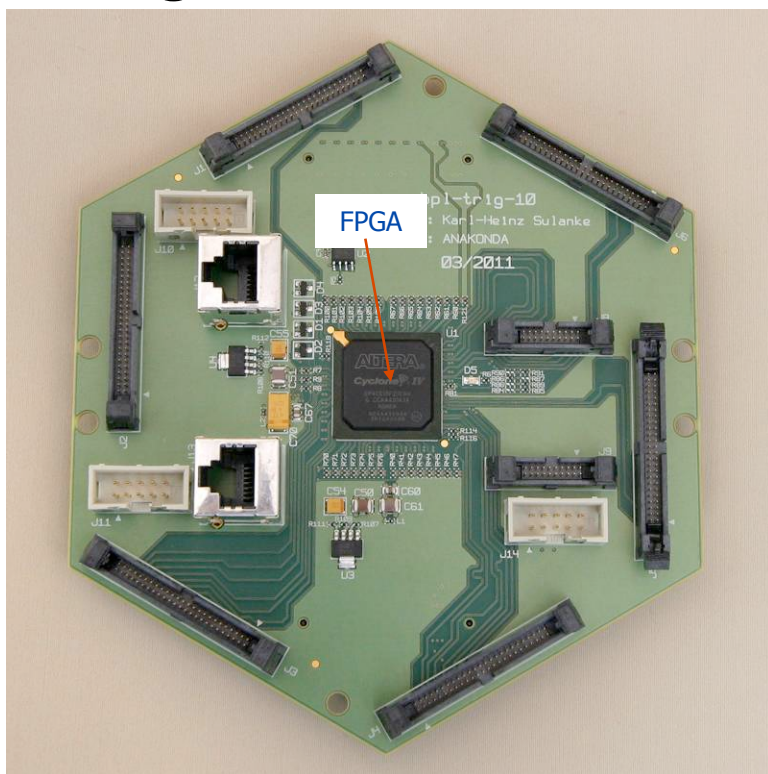


Electronics Development

- > Camera photo-tube HV board
- > Digital trigger electronics (1 Hz signal with 120 MHz background)



> Trigger simulation



DESY Activities

> Hardware

> Array Control

> Sensitivity and
Reconstruction
methods

> Analysis

> Computing



Array Control

- > Evaluate software frameworks (ACS: ESO supported software framework for the ALMA telescopes)
- > Implement a prototype for Array Control Centre
 - drive system
 - mirror control
 - weather station
 - alignment system
 - camera simulator

B Behera
P Kostka
T Schmidt

CTA operation

DESY topics:

- Science management
- Operation planning
- Telescope operation
- Data acquisition
- On-site analysis
- Data reduction

G Maier
S Schlenstedt
P Wegner

DESY Activities

> Hardware

> Array Control

> Sensitivity studies

> New reconstruction
methods

> Analysis

> Computing

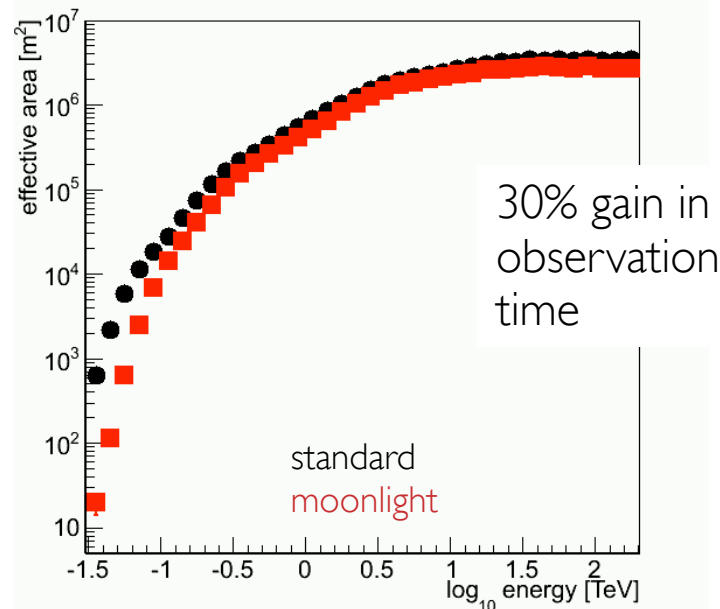
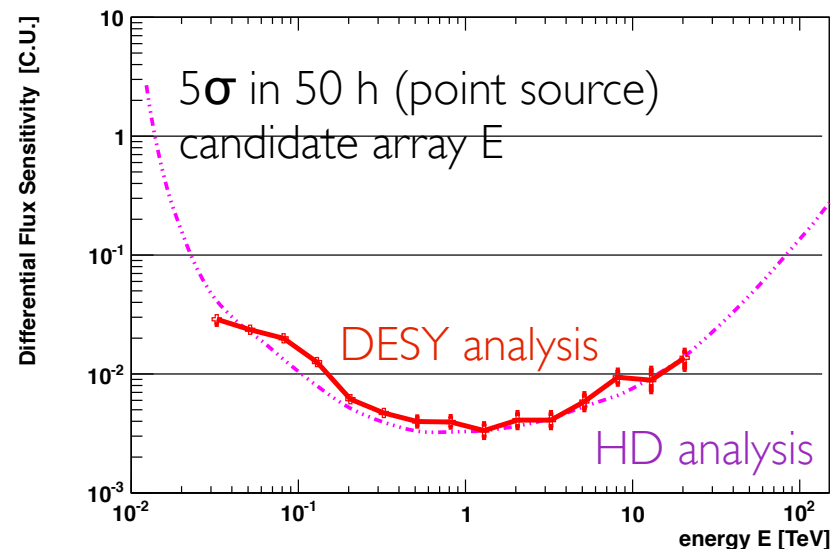


CTA Analysis Chain

- > Complete analysis chain for CTA
 - well tested and used for science publications in VERITAS
 - core developer team at DESY
 - interfaces to DESY trigger simulations and CTA-US simulation packages
 - very flexible in terms of detector geometry (used for VERITAS, AGIS, CTA, ...)
 - available to everybody in CTA
(in contrast to most of the tools in CTA)
- > Processing of and optimization with CTA MC simulations

CTA Sensitivity

- > Processing and optimization of CTA MC simulations
- > Study of different arrays; different observing (e.g., moonlight) and site conditions (e.g. height)

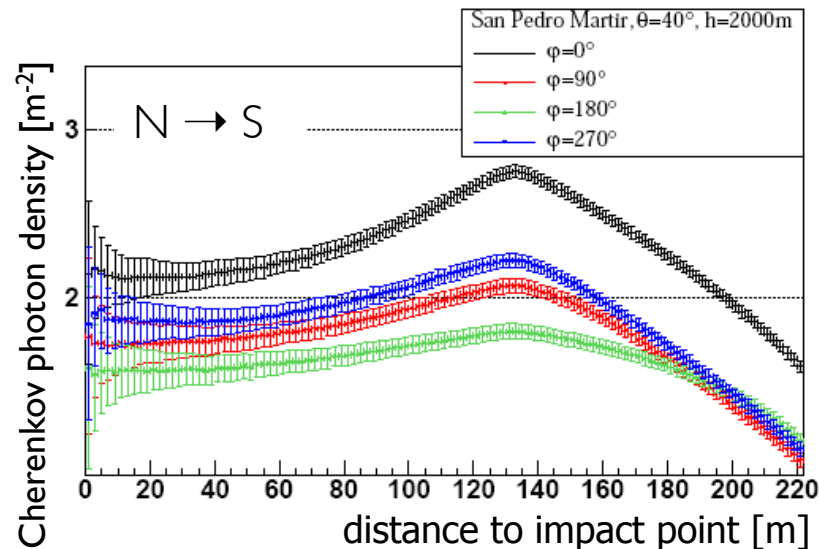
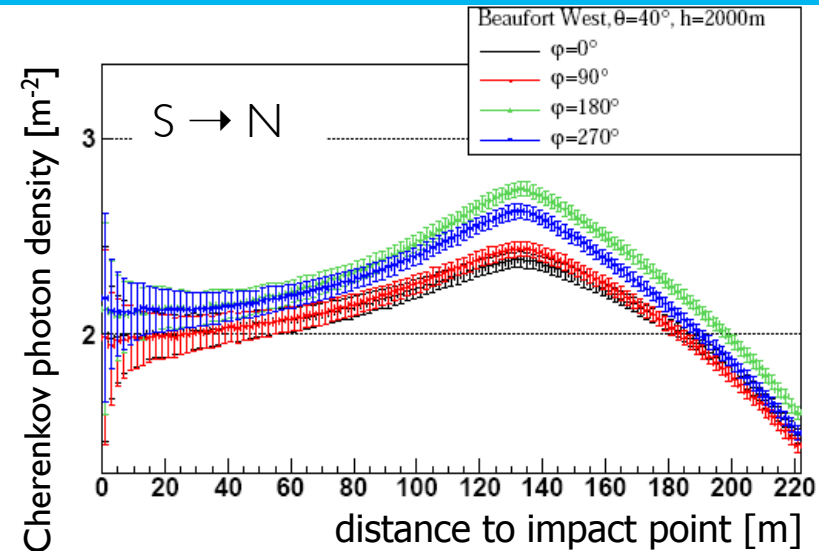


Geomagnetic Field (20,70) μ T

Beaufort West
H.E.S.S.
El Leoncito

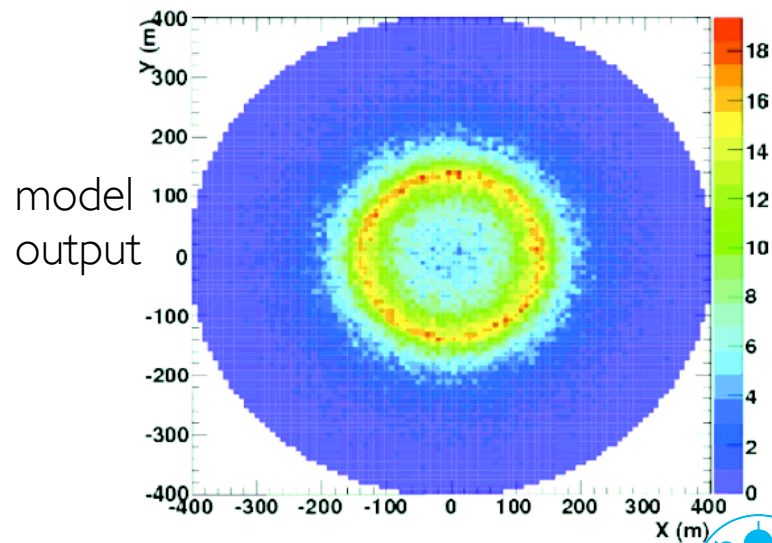
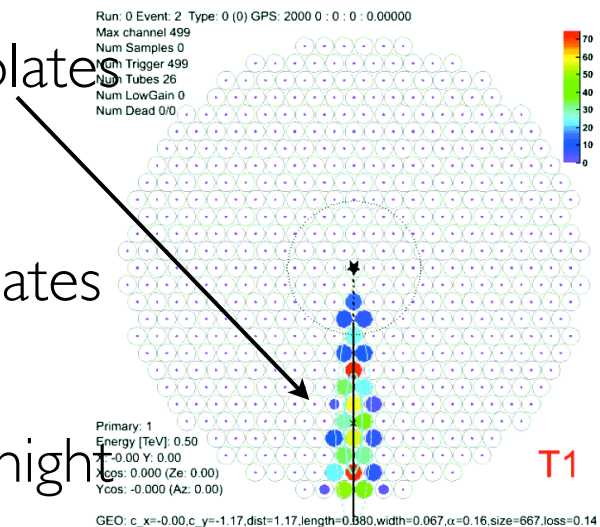
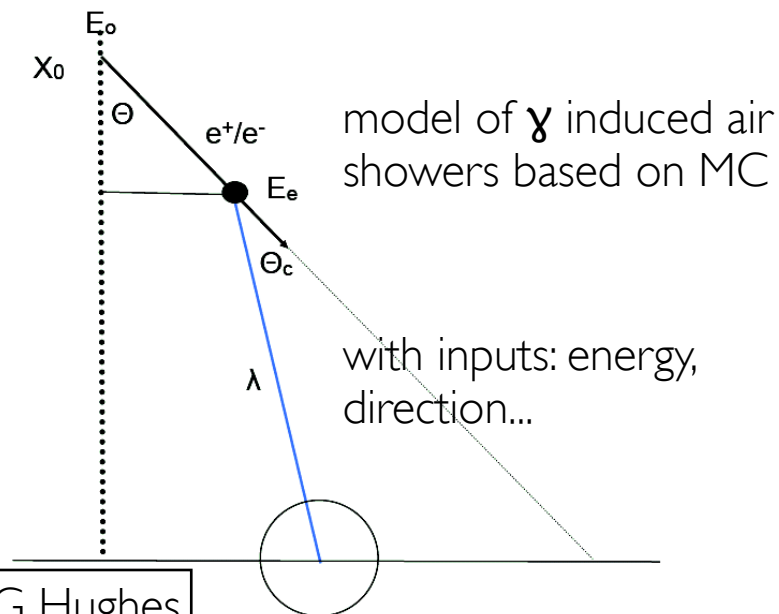
La Palma
San Pedro Martir

showers 50° above horizon



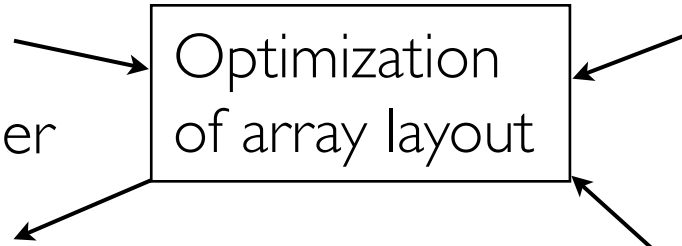
New Reconstruction Techniques

- > Reconstruct γ -ray showers using shower templates
- > Shown to improve sensitivity by 2x
- > Use a semi-analytical model to generate templates
 - large parameter space of showers
- > Compare templates to real data (and realistic night sky backgrounds and pedestals)



Site Optimization – Dual Mirror Telescopes

Baseline: Davies-Cotton
(H.E.S.S., MAGIC, VERITAS)
US-CTA: Schwarzschild-Couder



MC tools
(CORSIKA/
Simtelarray/
CARE)

Energy & angular resolution

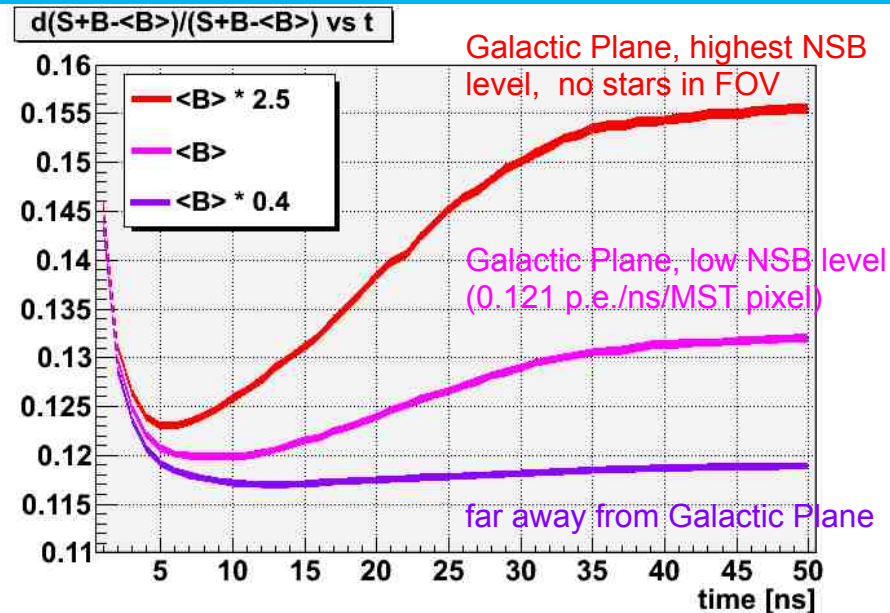
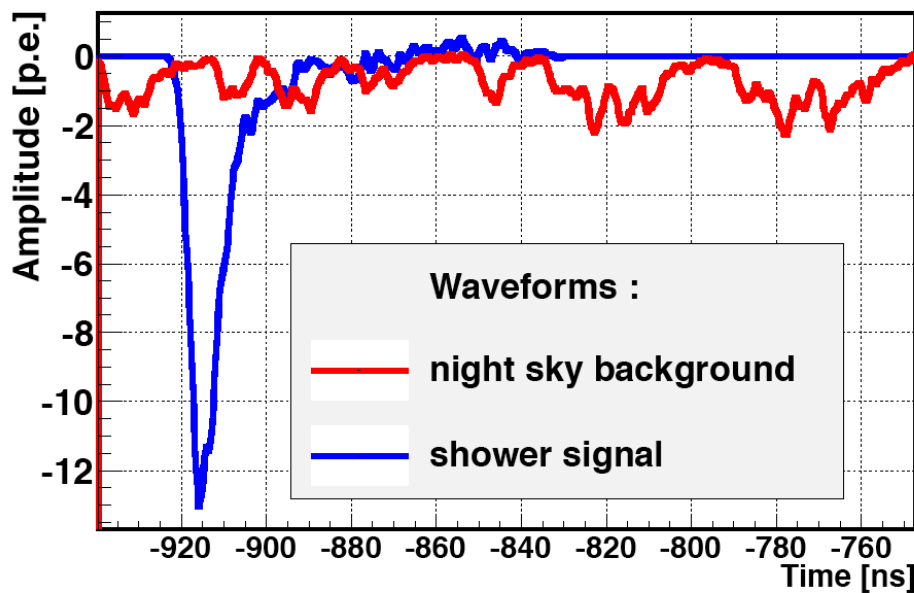
Cost



- > Gain using Schwarzschild-Couder telescopes?
- > How to integrate them?
- > How to arrange them – for a given budget?

G Decerprit

Optimization of Front-End Electronics



- > Analyze waveforms (shower+background) for various physical and instrumental parameters using real PMT signals
- > Optimal readout time (~ 5 -20 ns) is smaller at lower S/B ratios
- > Optimal analog bandwidth is related to trigger parameters ($\rightarrow$ input)
- > Optimize CTA performances (energy threshold, sensitivity, resolution) using readout+trigger+analysis

DESY Activities

> Hardware

> Array Control

> Sensitivity studies and
Reconstruction
methods

> Analysis of VERITAS
data

> Preparation of CTA
physics

> Computing







- > Non-affiliated members in VERITAS
- > Real-data and observing experience for postdoc and PhDs
- > Implementation of next-day analysis → fast analysis feedback for variable sources
- > MC development, validation and production
- > Lead authors in papers on observations of binaries

THE ASTROPHYSICAL JOURNAL, 732:1 (10pp), 2011 ???
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doi:10.1088/0004-637X/732/1/1

VERITAS Reports Increased Activity of HESS J0632+057 in Very High Energy Gamma Rays

ATel #3153; [Rene A. Ong, for the VERITAS Collaboration](#)
on 8 Feb 2011; 22:54 UT
Distributed as an Instant Email Notice Transients
Credential Certification: Rene Ong (rene@astro.ucla.edu)

Subjects: >GeV, TeV, VHE, Binary, Transient

Referred to by ATel #: [3161](#), [3180](#), [3209](#)

astro-ph/1103.3250

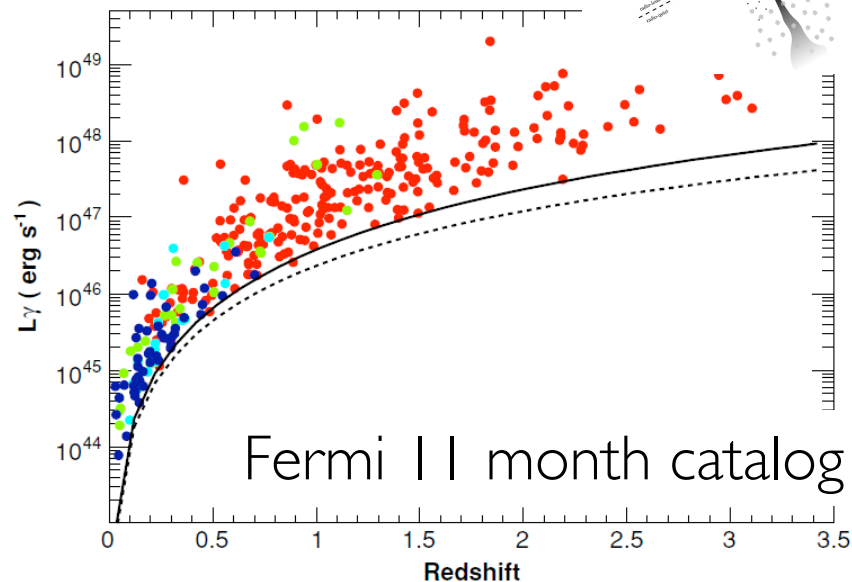
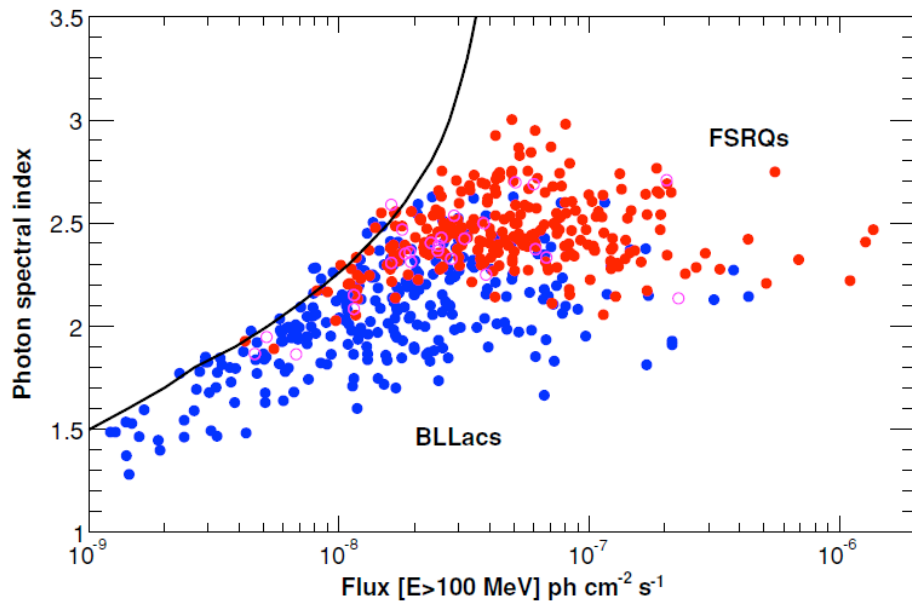
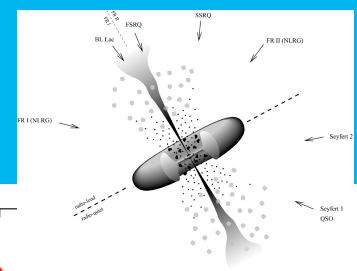
GAMMA-RAY OBSERVATIONS OF THE Be/PULSAR BINARY 1A 0535+262 DURING A GIANT X-RAY OUTBURST

V. A. ACCIARI¹, E. ALIU², M. ARAYA³, T. ARLEN⁴, T. AUNE⁵, M. BEILICKE⁶, W. BENBOW¹, S. M. BRADBURY⁷, J. H. BUCKLEY⁶, V. BUGAEV⁶, K. BYRUM⁸, A. CANNON⁹, A. CESARINI¹⁰, L. CIUPIK¹¹, E. COLLINS-HUGHES⁹, W. CUI^{3,26}, R. DICKHERBER⁶, C. DUKE¹², A. FALCONE¹³, J. P. FINLEY³, L. FORTSON¹¹, A. FURNISS⁵, N. GALANTE¹, D. GALL³, S. GODAMBE¹⁴, S. GRIFFIN¹⁵, R. GUENETTE¹⁵, G. GYUK¹¹, D. HANNA¹⁵, J. HOLDER¹⁶, G. HUGHES¹⁷, C. M. HUI¹⁴, T. B. HUMENSKY¹⁸, A. IMRAN¹⁹, P. KAARET²⁰, M. KERTZMAN²¹, H. KRAWCZYNSKI⁶, F. KRENNRICH¹⁹, A. S. MADHAVAN¹⁹, G. MAIER^{17,26}, P. MAJUMDAR⁴, S. MCARTHUR⁶, P. MORIARTY²², R. A. ONG⁴, A. N. OTTE⁵, D. PANDEL²⁰, N. PARK¹⁸, J. S. PERKINS¹, M. POHL²³, H. PROKOPH¹⁷, J. QUINN⁹, K. RAGAN¹⁵, L. C. REYES¹⁸, P. T. REYNOLDS²⁴, E. ROACHE¹, H. J. ROSE²⁷, D. B. SAXON¹⁶, G. H. SEMBROSKI³, G. DEMET SENTURK²⁵, A. W. SMITH⁸, G. TEŠIĆ¹⁵, M. THEILING¹, S. THIBADEAU⁶, A. VARLOTTA^{3,26}, S. VINCENT¹⁴, M. VIVIER¹⁶, S. P. WAKELY¹⁸, J. E. WARD⁹, T. C. WEEKES¹, A. WEINSTEIN⁴, T. WEISGARBER¹⁸, S. WENG³, D. A. WILLIAMS⁵, M. WOOD⁴, AND B. ZITZER³

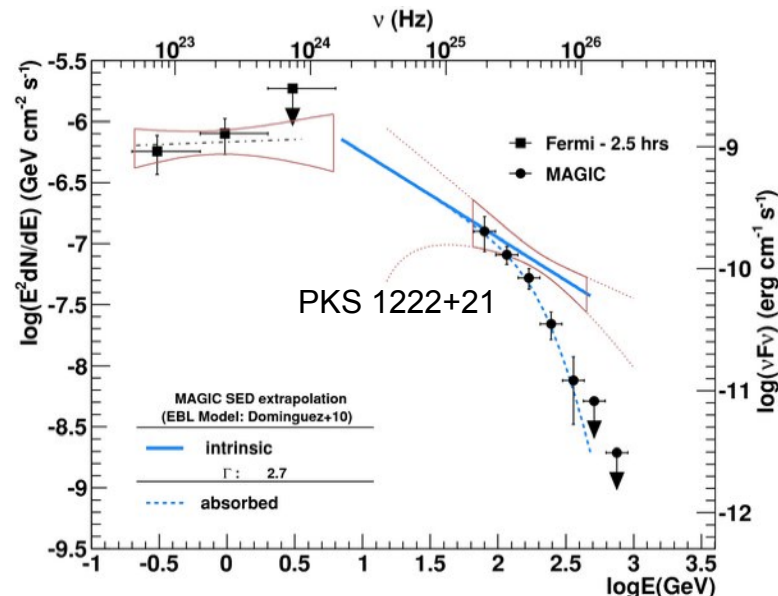
G Maier, G Hughes, H Prokoph, C Skole



Flat Spectrum Radio Quasars



- > Brighter and steeper spectrum blazars
- > Detected up to larger distances
- > Three quasars detected so far by HESS and MAGIC
- > Interesting for VERITAS, HESS II & CTA



DESY Activities

> Hardware

> Array Control

> Sensitivity and
Reconstruction
methods

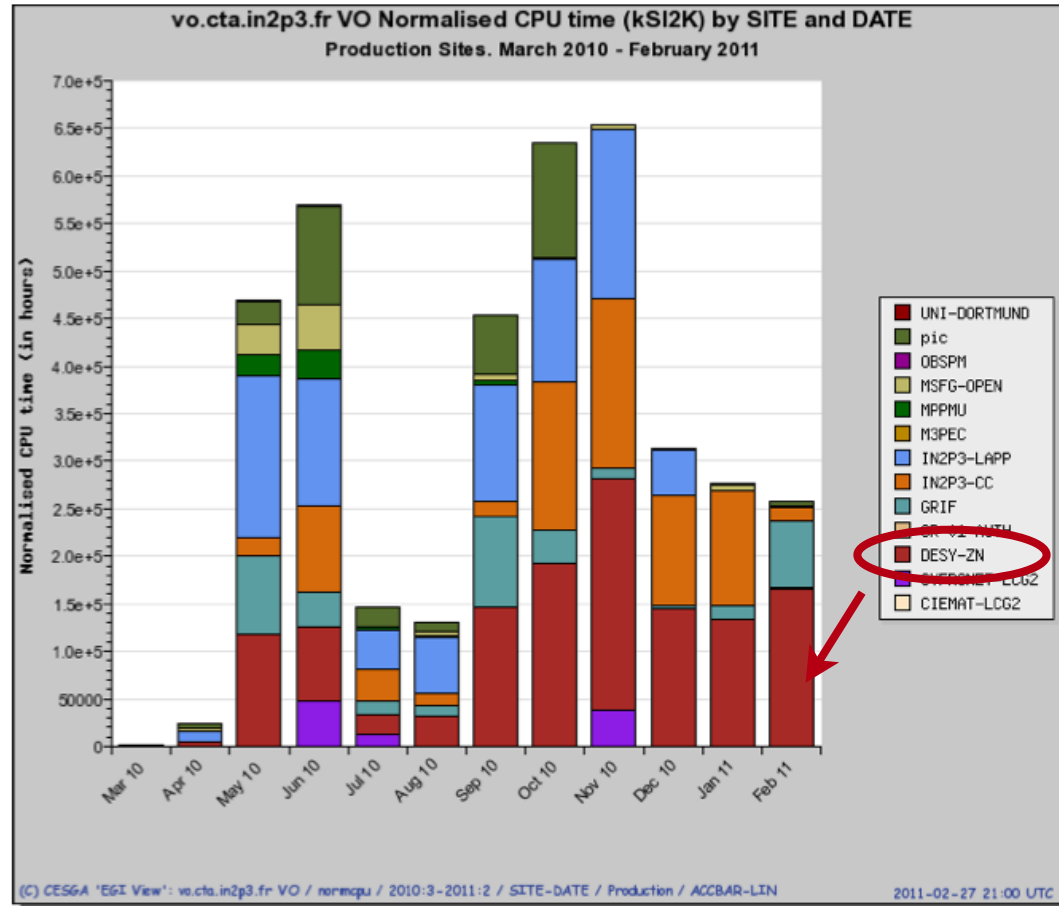
> Analysis

> Computing: massive, grid based computing element
and centre for MC production



Computing

- > Grid MC production of massive signal and background data-sets
- > Prepare CTA data processing and storage element
 - connected to Array Control Centre
 - analysis
 - storage currently: 100TB in dCache/Grid, 150 TB lustre



Summary

- > CTA in Preparatory Phase working towards final design
- > CTA will be the first VHE observatory open to the community
- > CTA will be unique and versatile tool for astronomy and astroparticle physics
- > DESY plays a key role in the preparation for CTA in key areas of design and planning
- > Rich VERITAS analysis
- > Prepare CTA physics using VERITAS experience

Young
Investigator
Group