



bmb+f - Förderschwerpunkt

Astroteilchenphysik

Großgeräte der physikalischen
Grundlagenforschung



Entdeckung von
VHE -Strahlung
aus dem Binärsystem
PSR B1259-63 / LS 2883
mit H.E.S.S.

Frank Breitling



Inhalt

1) Das H.E.S.S. Experiment im Überblick

- ▶ -Astronomie mit H.E.S.S.
- ▶ Kollaboration, Lage, Ausstattung (Hardware)
- ▶ Datennahme, Datenanalyse (Software)

2) Das Binärsystem PSR B1259-63 / LS 2883

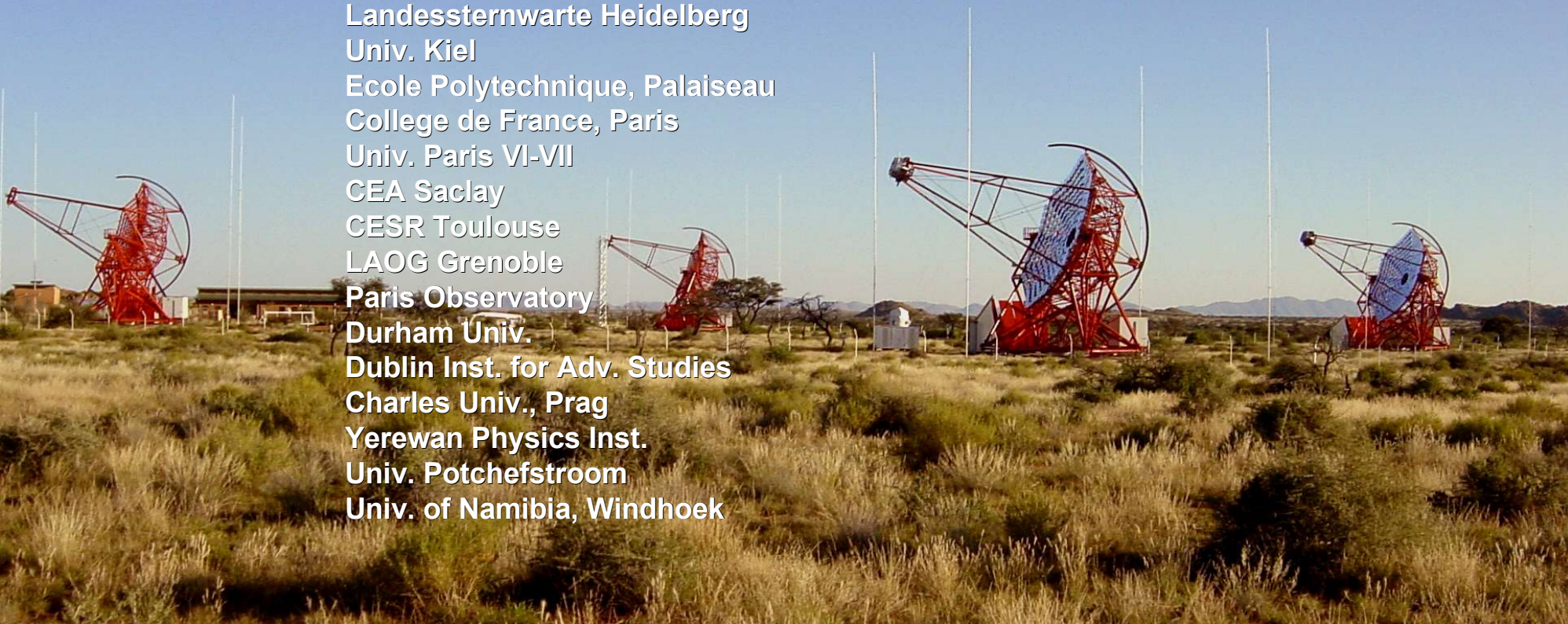
- ▶ Allgemeiner Überblick über das System
- ▶ Beobachtungen mit H.E.S.S.
- ▶ Erste Ergebnisse und ihre Bedeutung



High Energy Stereoscopic System

- Energiebereich 100 GeV – 20 TeV
- 4 atmosphärische Cherenkov Teleskope zur γ -Astronomie
- Kollaboration: 100 Physiker, 19 Institute

MPI Kernphysik, Heidelberg
Humboldt Univ. Berlin
Ruhr-Univ. Bochum
Univ. Hamburg
Landessternwarte Heidelberg
Univ. Kiel
Ecole Polytechnique, Palaiseau
College de France, Paris
Univ. Paris VI-VII
CEA Saclay
CESR Toulouse
LAOG Grenoble
Paris Observatory
Durham Univ.
Dublin Inst. for Adv. Studies
Charles Univ., Prag
Yerewan Physics Inst.
Univ. Potchefstroom
Univ. of Namibia, Windhoek



-Astronomie mit H.E.S.S.

Ursprung der kosmischen Strahlung

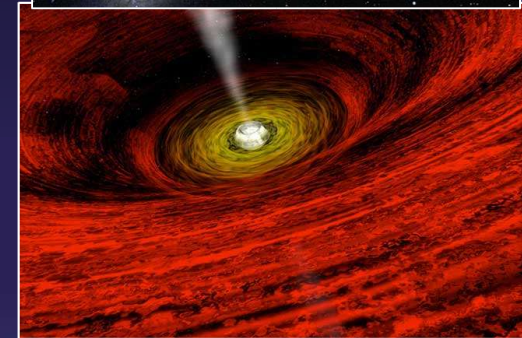
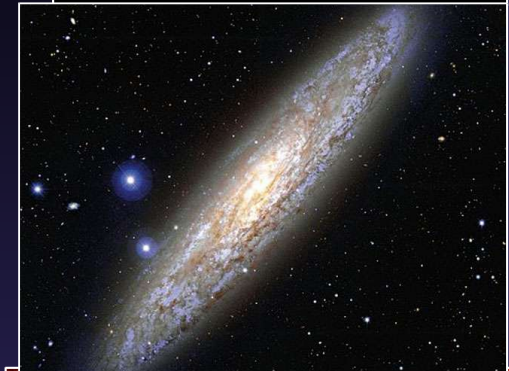
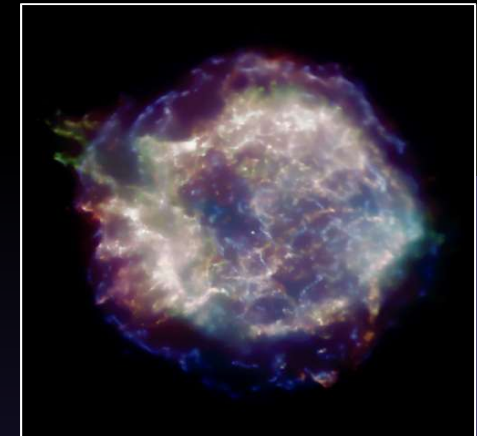
- Supernova Überreste
- Galaxien (Galaxienhaufen, Starburst Galaxien)
- Unidentifizierte galaktische Quellen

Astrophysik kompakter Objekte

- AGNs
- Pulsare, Micro-Quasare, Black holes
- Gamma ray bursts

Kosmologie

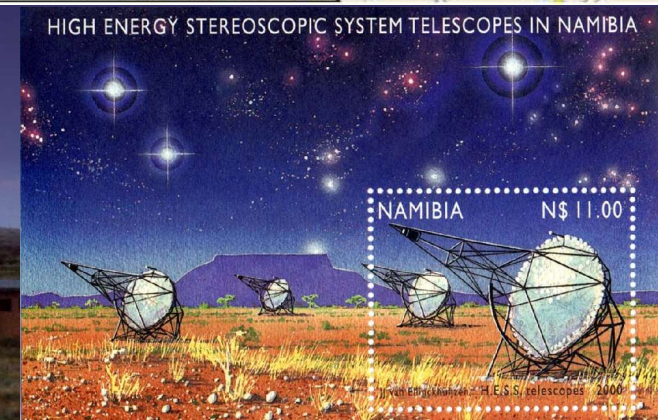
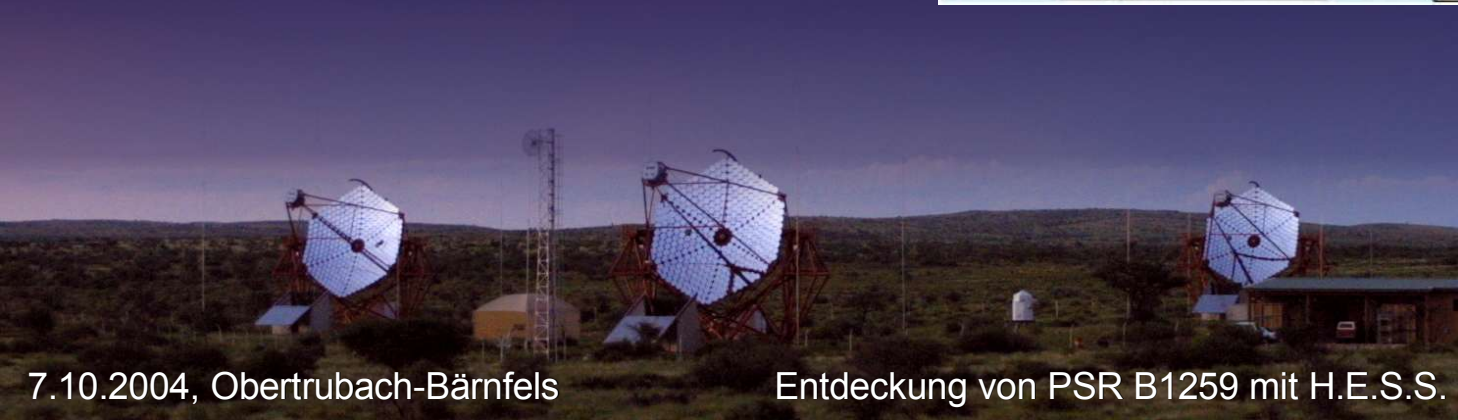
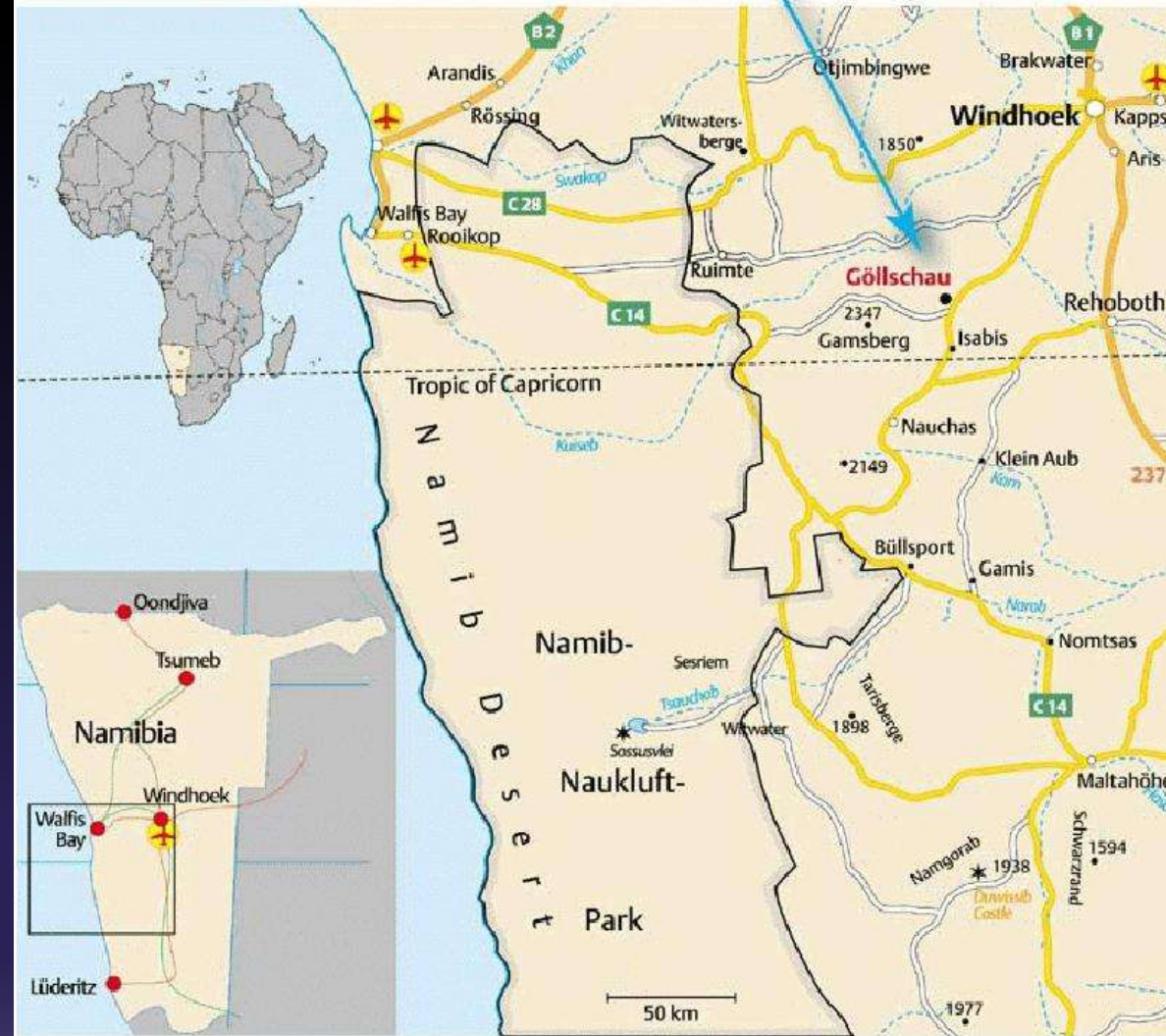
- Neutralinozerstrahlung in dunkler Materie Halos
- Diffuse extragalaktische Strahlungsfelder mittels AGN Spektren



Lage

- Khomas Hochland, Namibia
 - Höhe: 1800 m
 - Ideale Wetterbedingungen
 - Südhalbkugel
- => Beobachtungen des Südhimmels und des galaktischen Zentrums

Farm Göllschau, Khomas Hochland, 100 km südwestlich von Windhoek



7.10.2004, Obertrubach-Bärnfels

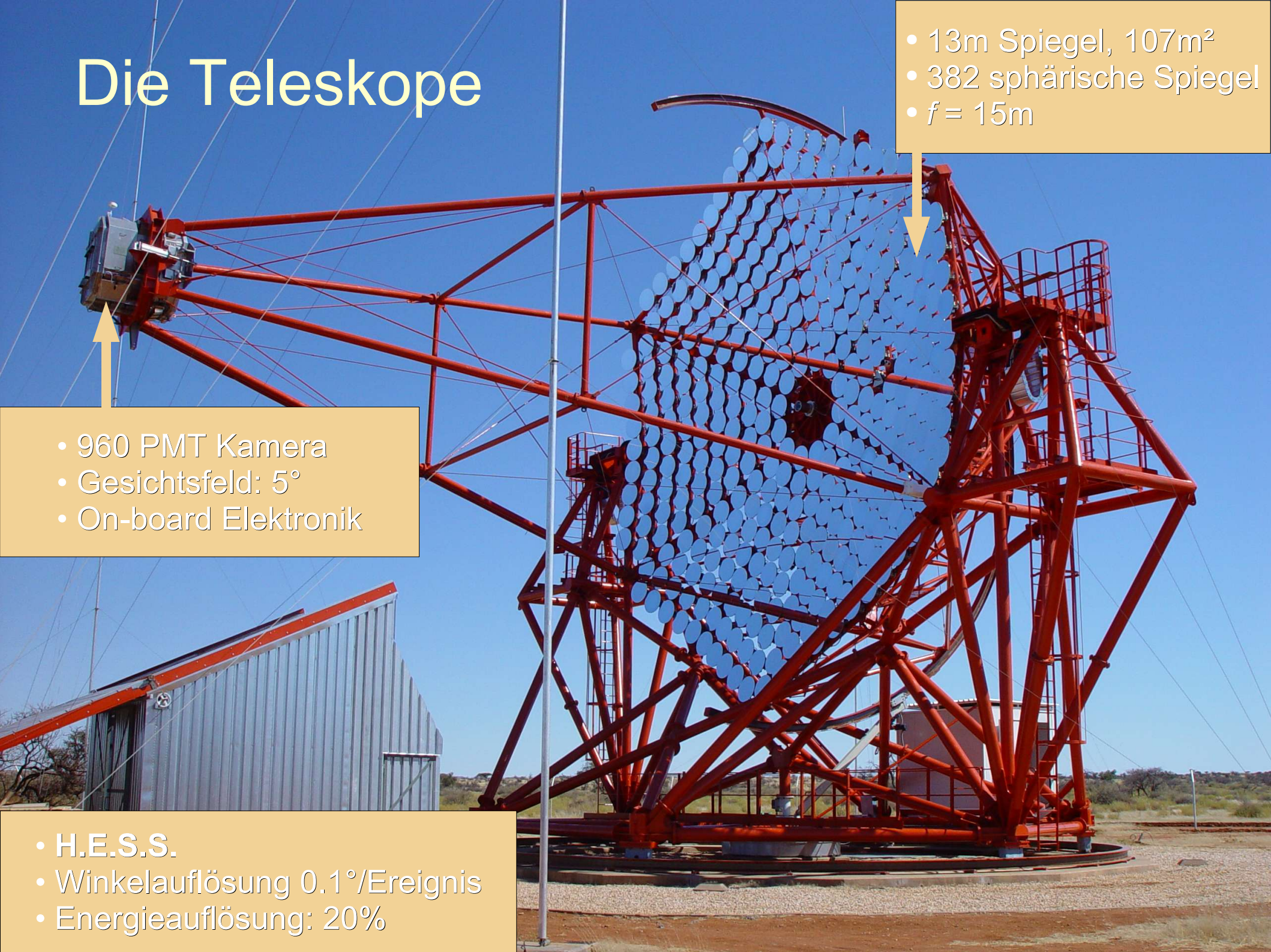
Entdeckung von PSR B1259 mit H.E.S.S.

Die Teleskope

- 13m Spiegel, 107m²
- 382 sphärische Spiegel
- $f = 15\text{m}$

- 960 PMT Kamera
- Gesichtsfeld: 5°
- On-board Elektronik

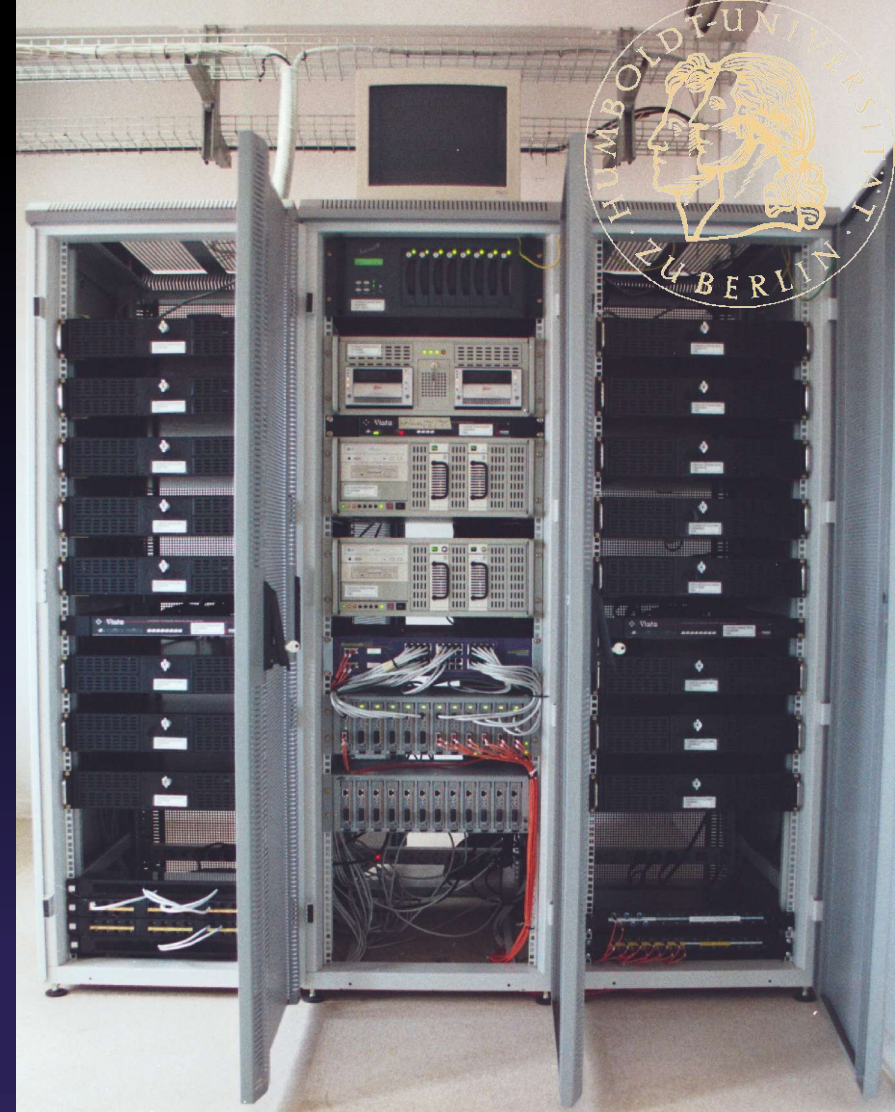
- H.E.S.S.
- Winkelauflösung 0.1°/Ereignis
- Energieauflösung: 20%



Datenverarbeitung

Computeranlage:

- 2 Doppelprozessor-Server (3 GHz)
- 16 Doppelprozessor-Clients (800MHz)
- 1GBit+100MBit Netzwerk
- 3 TB RAID System
- 2x ISDN Mikrowellen-Internetverbindung
- weitere Kontrollraum-PCs

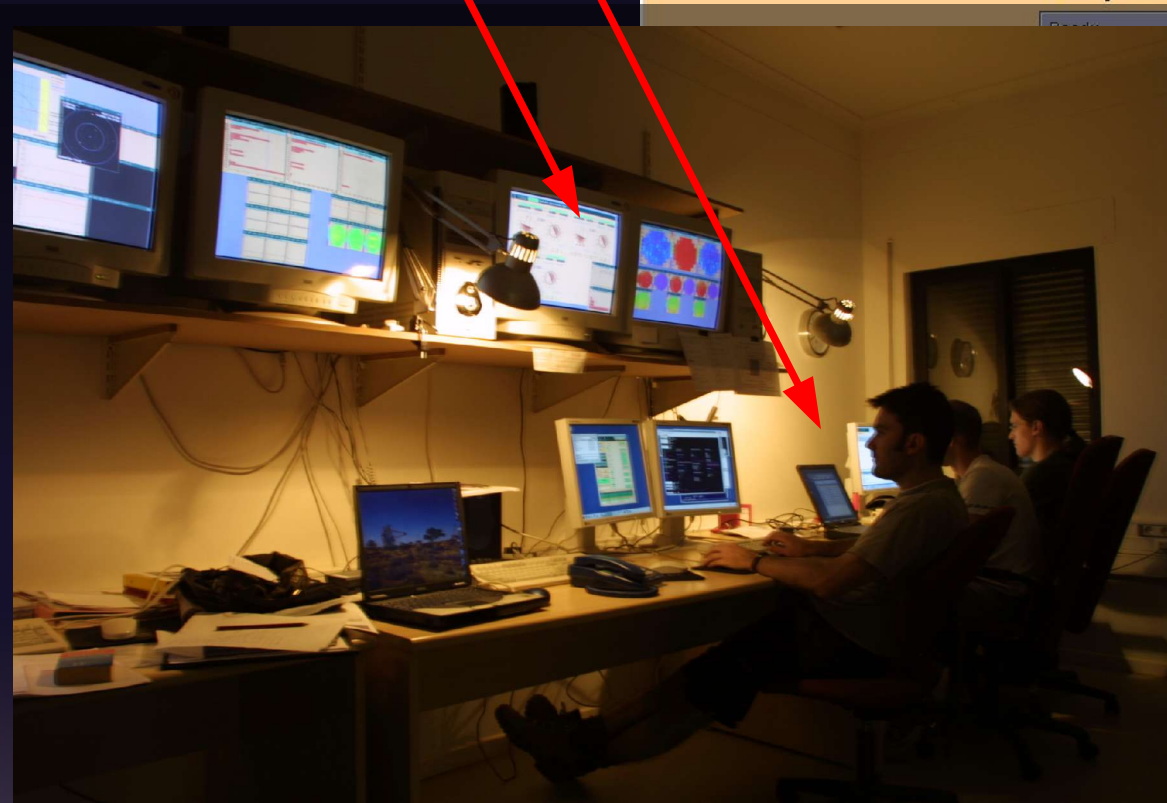


Datennahme

- DAQ Steuerung per GUI



- Physiker im Kontrollraum
- Kontrollmonitore



H.E.S.S. Array Control

Quit Launch Processes Schedule

ArrayManager

SubArray03

Control

Configure

Start

Stop

Goto Safe

Interrupt

Status

RunNumber: 12349

RunType: Tracking

DailyRunCount: 34

Telescopes: CT4

Nodes: 01

Running

275:37

Central

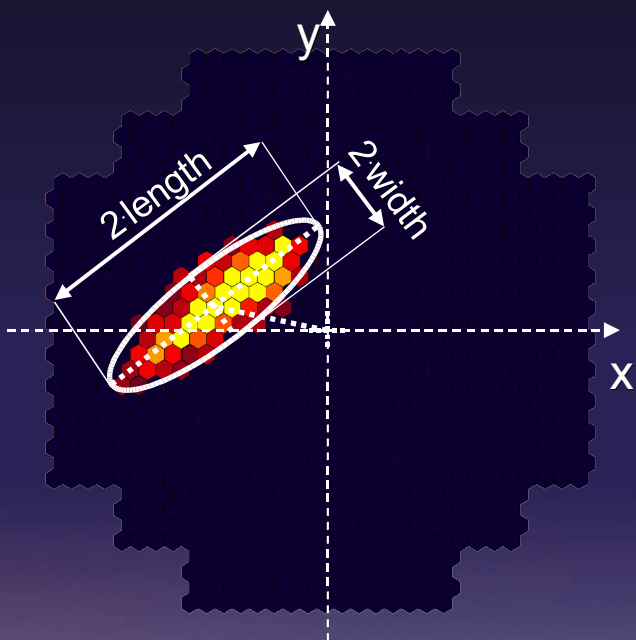
- SubArray01**
 - Receiver
 - Manager: Running
 - CameraRate: Running
 - CameraMonitor: Running
 - Trigger: Ready
 - Radiometer: Running
 - Tracking: Running
 - FlatField: Ready
 - Services
 - Displays
 - Manager: Running
 - CT3**
 - Manager: Running
 - StarController: Running
 - Radiometer: Running
 - Camera: Running
 - CameraLid: Running
 - CameraHV: Running
 - CameraTrigger: Running
 - CameraLED: Safe
 - Tracking: Running
 - FlatField: Ready
 - Node01**
 - Manager: Running
 - Receiver: Running



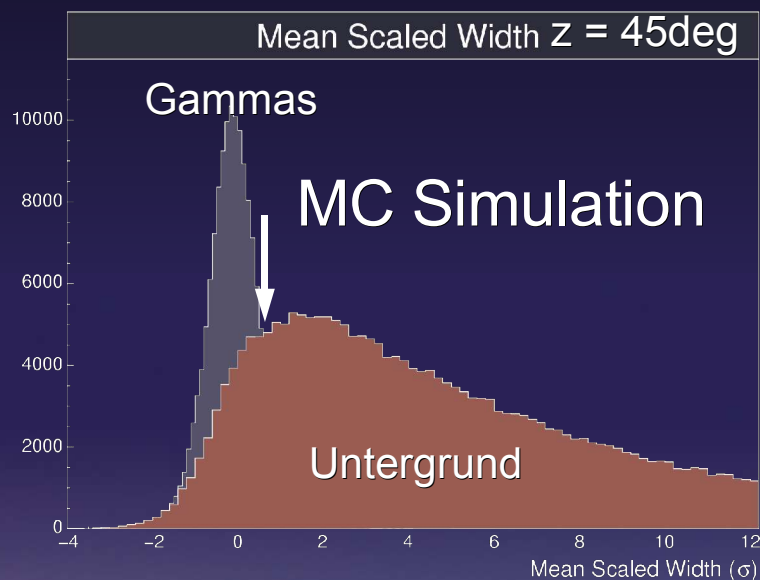
7.10.2004, Obertrubach-Bärnfels

Datenanalyse

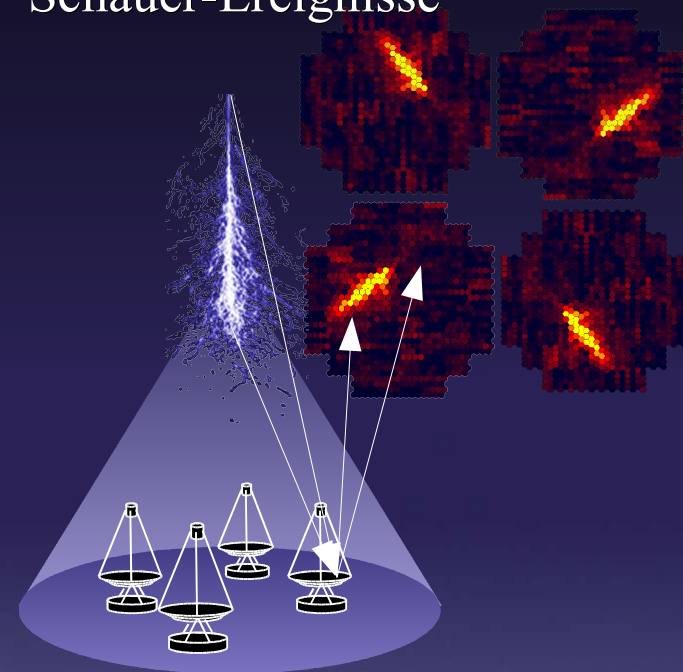
- Bildparametrisierung mit Hillas Parametern



- Optimierung der Parameterschnitte mittels MC

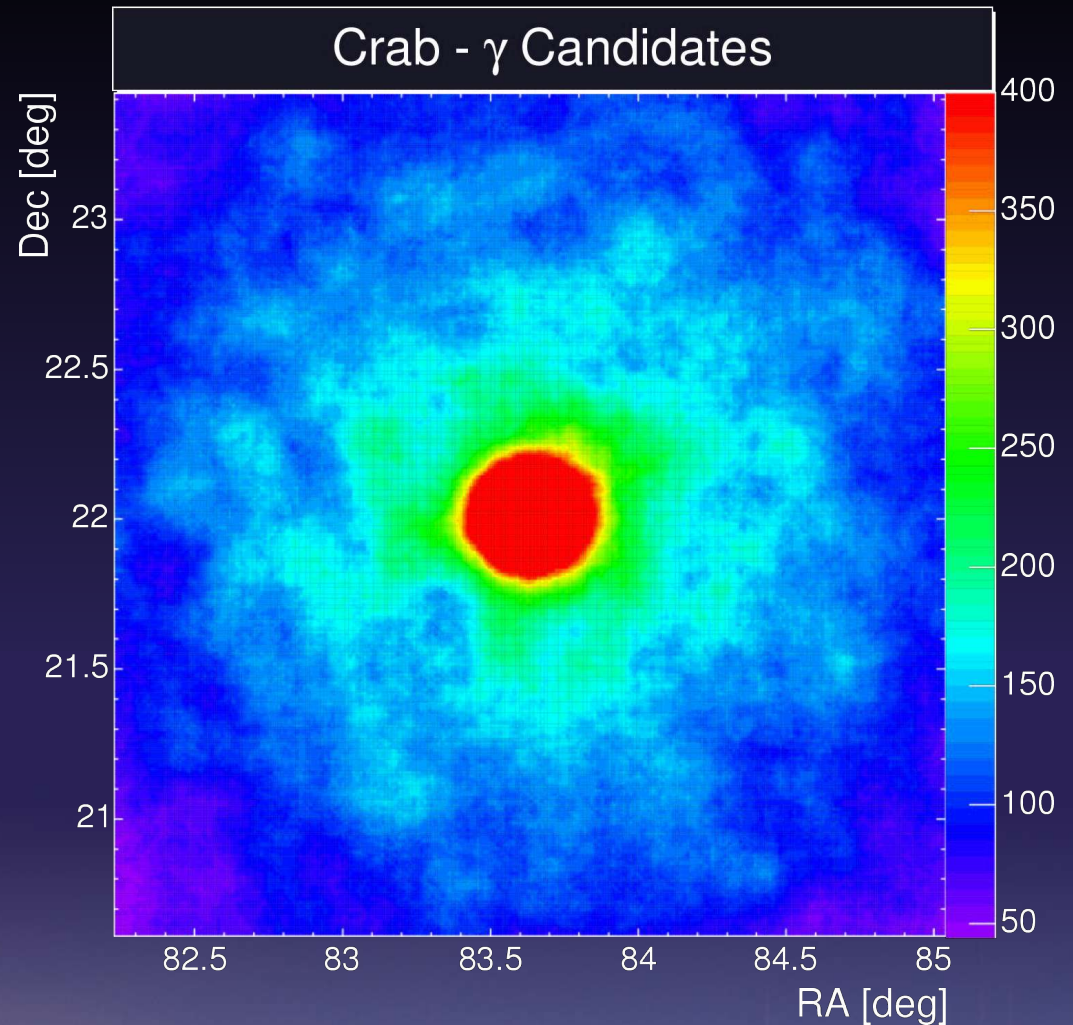


- Richtungs- und Energie-Rekonstruktion der Schauer-Ereignisse



Himmelskarten

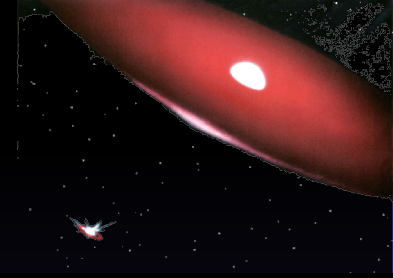
Mit der Richtungsinformation
kann man 2D Himmelskarten
der γ -Ereignisse erzeugen
und damit ein Bilder der γ -
Intensitäten der Quellen
gewinnen





Beobachtung des Binärsystems
PSR B1259-63 / LS 2883

PSR B1259-63 / LS 2883 System



LS 2883

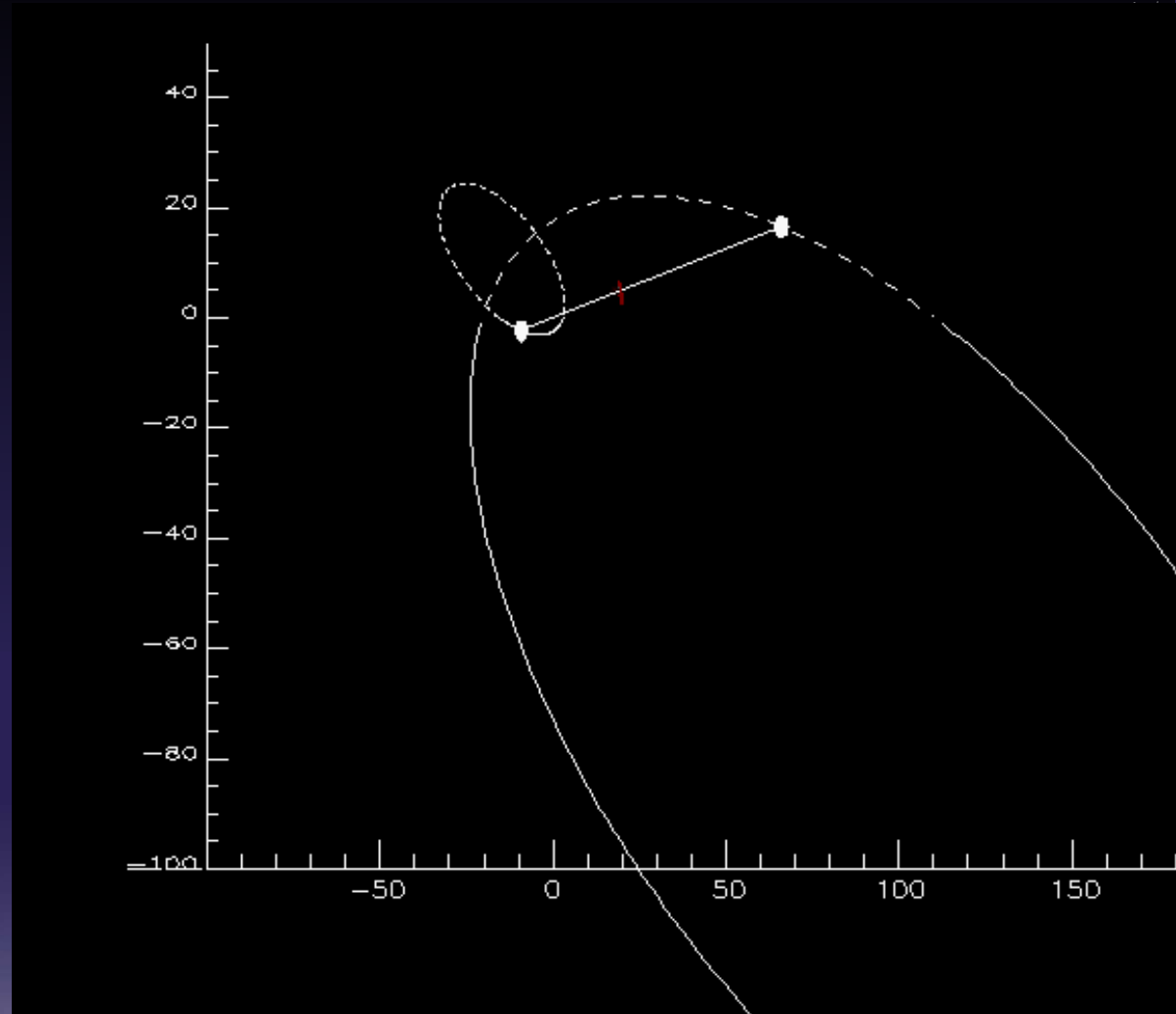
- Heller und massereicher Be-Star
 $L = 8.8 \cdot 10^3 L_{\odot}$, $M = 10 M_{\odot}$
- Akkretionsscheibe

PSR B1259-63

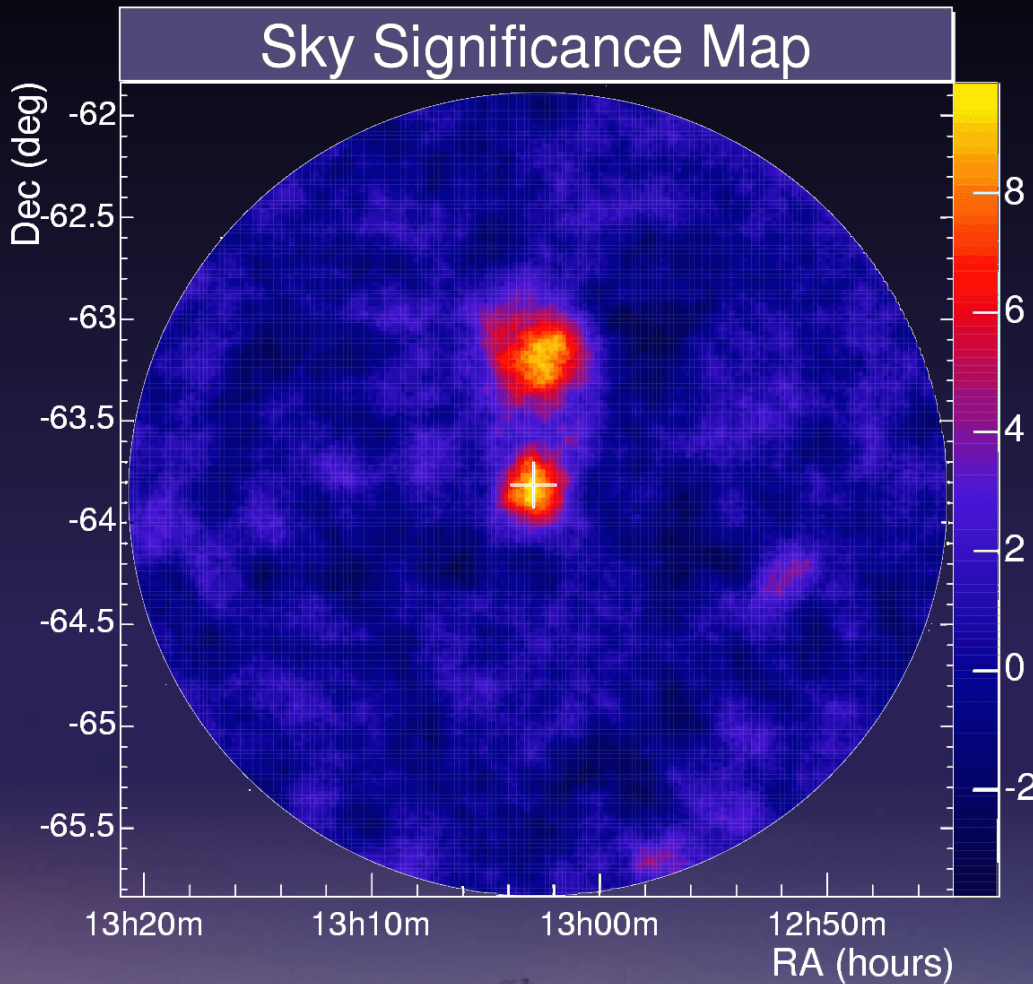
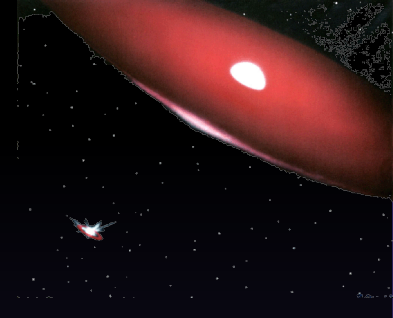
- Radio pulsar with
 $P = 48 \text{ ms}$, $B_{\text{surface}} = 3.3 \cdot 10^7 \text{ T}$

Umlaufbahn

- Umlaufzeit von 3.4 Jahren
- Entfernung 1.5 kpc
- Periastron: 7. März 2004



Entdeckung mit H.E.S.S.



IAU Telegram

The Astronomer's Telegram
for reporting and commenting on new astronomical observations

Discovery of PSR B1259-63 in VHE Gamma-Rays with H.E.S.S.

ATEL # 249; M. Beilicke, *Universitaet Hamburg*;
M. Ouchrif, *Laboratoire de Physique Nucleaire de Haute Energie, Universite Paris VI and VII*;
G. Rowell, *Max-Planck-Institut fuer Kernphysik*;
S. Schlenker, *Humboldt-Universitaet, Berlin*;
on behalf of the H.E.S.S. (High Energy Stereoscopic System) Collaboration
on 12 Mar 2004; 7:32 UT
Distributed as an Instant Email Notice (Request for Observations)
Password Certification: Michael Punch (punch@in2p3.fr)

Subjects: Gamma Ray, >GeV, Request for Observations, Binaries, Pulsars
Referred to by ATEL #: [250](#)

We report detection of very-high-energy gamma-ray emission from the binary millisecond pulsar PSR B1259-63 (1236.72-day orbit) by the H.E.S.S. experiment above a threshold of about 200 GeV (in the observed zenith-angle range, 40-45 $^\circ$) at the 5.9-sigma level, where previously upper limits were reported by the CANGAROO collaboration (Kawachi et al. 2004, Ap.J., in press). The source was observed for a total of 4.6 hr live-time between Feb. 26 and Mar. 5 with the full four-telescope Cherenkov array. Preliminary estimates yield a flux at about 10 percent of the level of the Crab nebula (0.4 photons/min gamma-ray excess detected after selection cuts). Periastron passage of the pulsar was expected on Mar. 7.43 UT.

Observations at other wavelengths are strongly encouraged, especially on Mar. 20-25, when the neutron star will cross the inclined Be disk for the second time. Observations with H.E.S.S. are scheduled to recommence on Mar. 14, after the bright-moon period. Particle acceleration associated with the pulsar wind is predicted to result in observable GeV/TeV emission also after periastron (Kirk et al. 1999, *Astroparticle Phys.* 10, 31).

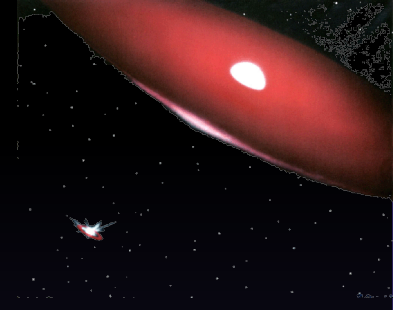
[H.E.S.S. experiment Homepage](#)

[[Telegram Index](#)]

R. E. Rutledge, Editor-in-Chief
Derek Fox, Editor

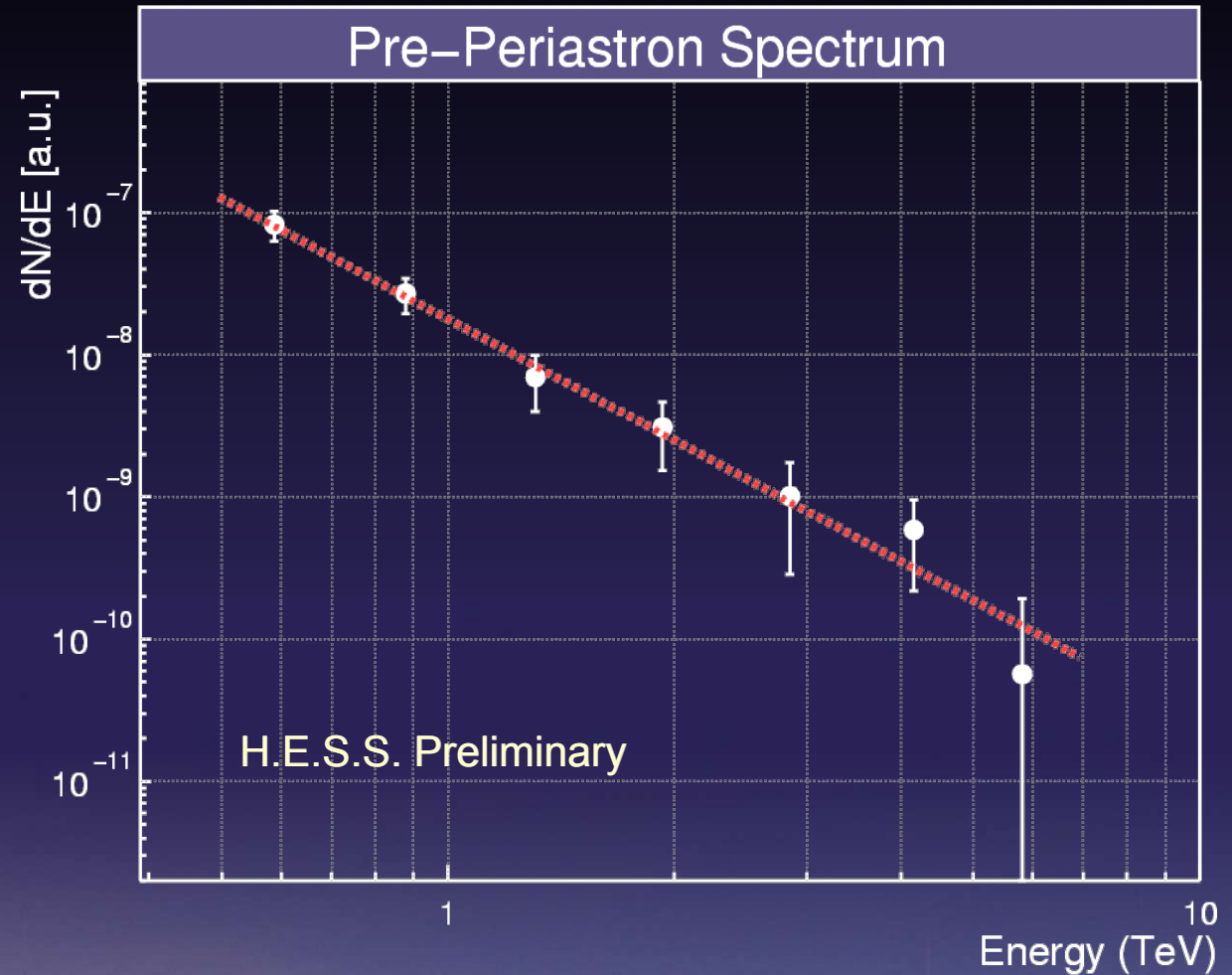


Vorläufiges Spektrum



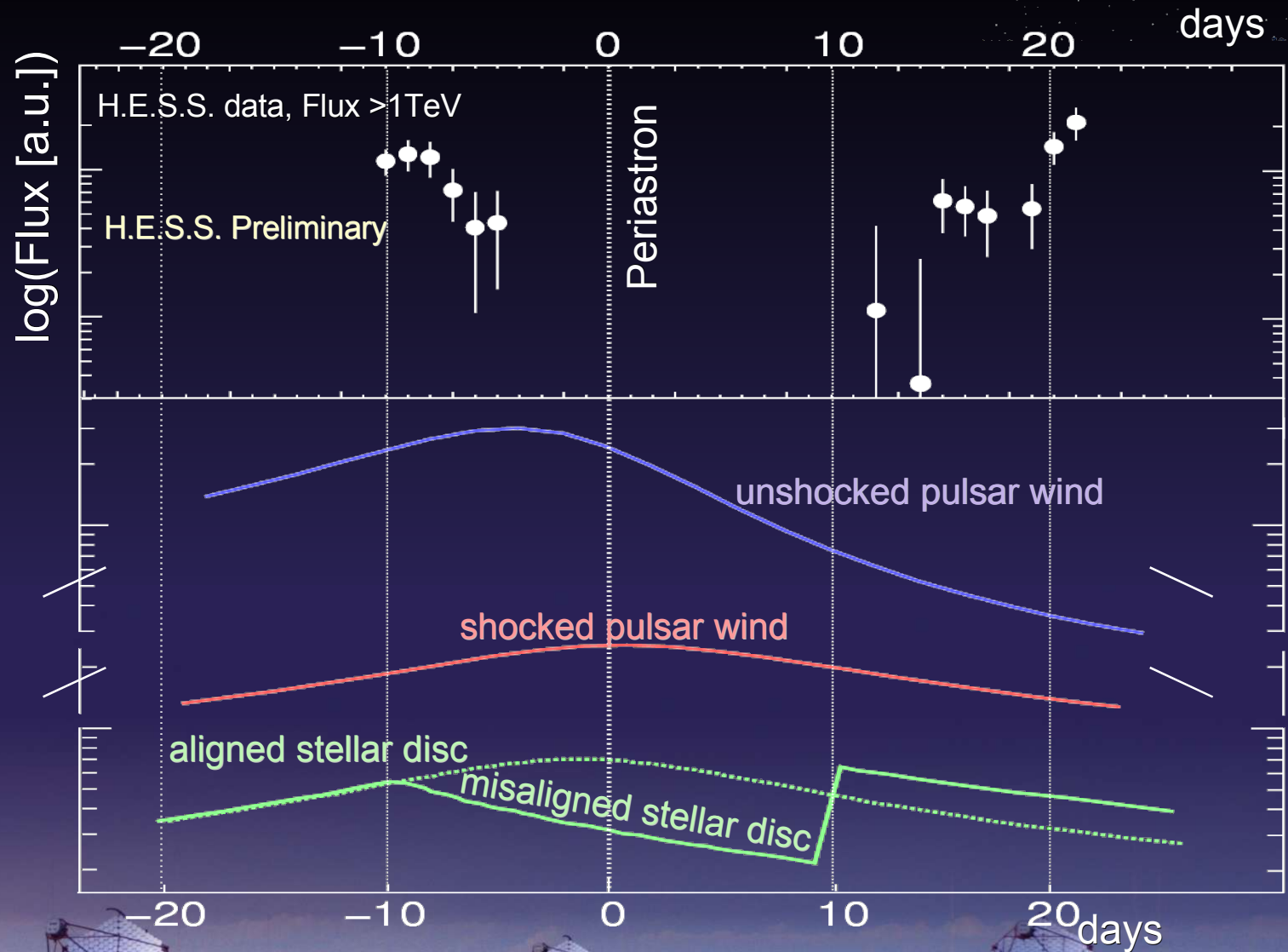
Spectrum Fit:

- ▶ Spectral index:
 2.8 ± 0.3 (stat)
- ▶ Integrierter Fluß:
5% des Krebsnebels
($2 \cdot 10^{-7} / \text{m}^2 \text{s}$; 2.5/s)



Lichtkurve und theoretische Modelle

Daten sprechen gegen Modelle mit kontinuierlicher Abnahme des Flusses nach dem Periastron



Zusammenfassung

**VHE γ -Strahlung aus dem
Binärsystem PSR B1259-63 / LS 2883
wurde entdeckt**

- Integrierter Fluß: 5% Krebsnebel Flusses
- Spectraler Index: 2.8
- Flußverlauf während Periastron bringt neue Erkenntnisse über die Entstehung von γ -Strahlung
- Weiter Beobachtungen sind geplant