Detection of the binary pulsar PSR B1259-63 at TeV energies with the H.E.S.S. Cherenkov telescopes

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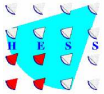

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- The H.E.S.S. Cherenkov telescopes
- The binary system PSR B1259-63
- Detection in the GeV/TeV energy regime

The H.E.S.S. Cherenkov Telescopes

- **H**igh **E**nergy **S**tereoscopic **S**ystem, Namibia, 1800 m above NN
- Mirror surface: $\sim 110\,\mathrm{m}^2$ (per telescope)
- PMT camera: 960 pixels (field of view: $\sim 5\,^\circ$, $0.16\,^\circ$ pixel size)
- Status: All 4 telescopes running in stereoscopic (coincident) mode since Dec.2003

▷ Angular resolution:
$< 0.1\,^\circ$ (per event)

▷ Energy:
$E_{\mathrm{thresh}} \sim 100\,\mathrm{GeV}$
$\Delta E/E \sim 15\,\%$

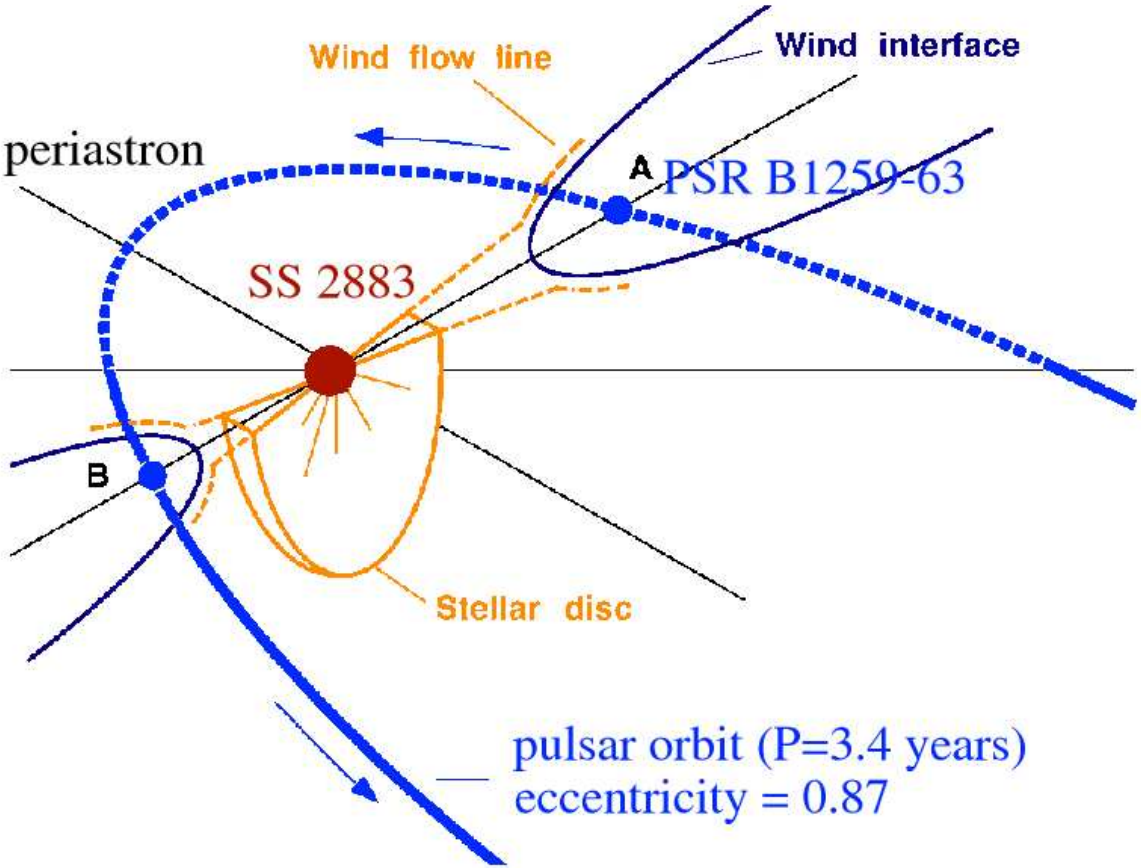
▷ Sensitivity: 1 Crab:
(at 45° zenith):
$5\,\sigma$ in $< 3\,\mathrm{min}$

The binary system PSR B1259-63 / SS 2883

Distance:
1.5 kpc

Pulsar:
PSR B1259-63:
$M_{\rm p} = 1.4\,M_\odot$
radio freq.:
47.75 ms

companion:
SS 2883:
$M_* = 10\,M_\odot$
$R_* = 6\,R_\odot$



⇒ Very exotic geometry of system

Model for GeV/TeV-γ-Emission

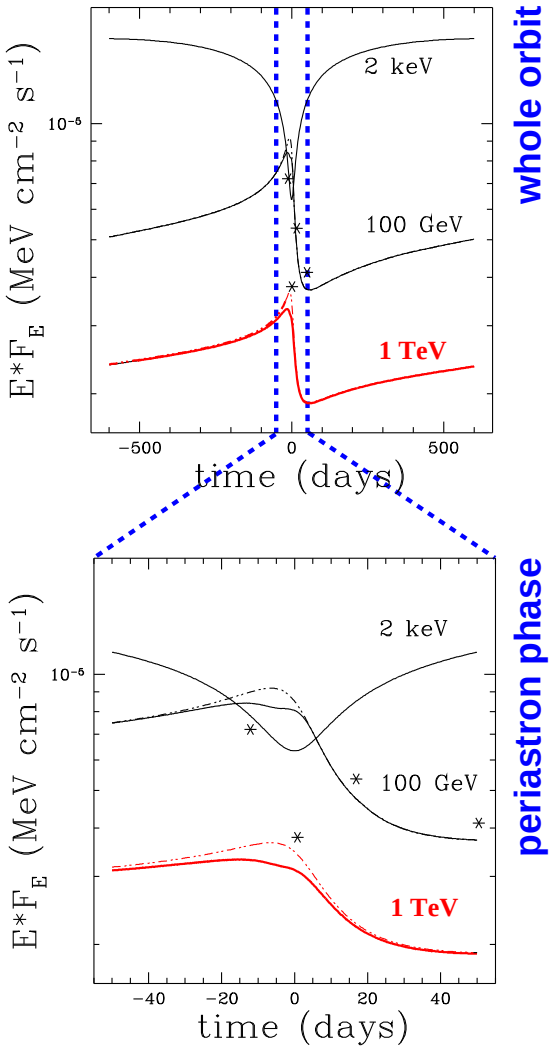
- *Kirk et al., Astrop.Phys. 10, 31 (1999)*
- e^+/e^- pulsar wind: termination schock close to the companion star
- Fermi acceleration of the e^+/e^- up to very high energies (VHE)

  $\Rightarrow$ Synchrotron radiation in $\vec{B}$-field

  $\Rightarrow$ Inverse Compton-Scattering in companion star photon field γ_*:

  $e^+/e^- + \gamma_* \rightarrow e^+/e^- + \gamma_{\mathrm{TeV}}$
- GeV/TeV-γ flux dependent on Φ_{orbital}

$\Rightarrow$ GeV/TeV observations near periastron very promising!



Previous GeV/TeV observations

- Observation with *CANGAROO-II*: (astro-ph/0402214)

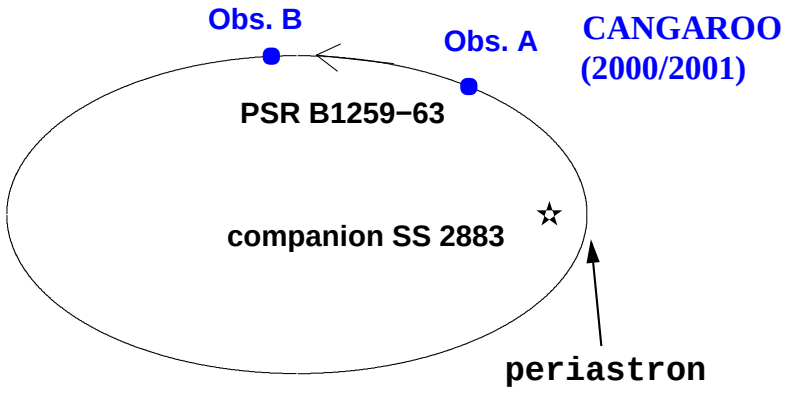
ID	time	$T - T_{\text{Periastron}}$	$E_{\text{threshold}}$
Obs. A	Dec. 2000	47 days	3.6 TeV
Obs. B	March 2001	157 days	0.78 TeV

CANGAROO results:

flux upper limits

$0.13\,\Phi_{\text{Crab}}$ (*Obs. A*)

$0.54\,\Phi_{\text{Crab}}$ (*Obs. B*)



⇒ no significant detection...

Previous GeV/TeV observations

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ID	time	$T - T_{\text{Periastron}}$	$E_{\text{threshold}}$
Obs. A	Dec. 2000	47 days	3.6 TeV
Obs. B	March 2001	157 days	0.78 TeV
H.E.S.S.	Feb/March 2004	~ -8 days	~ 0.2 TeV

CANGAROO results:

flux upper limits

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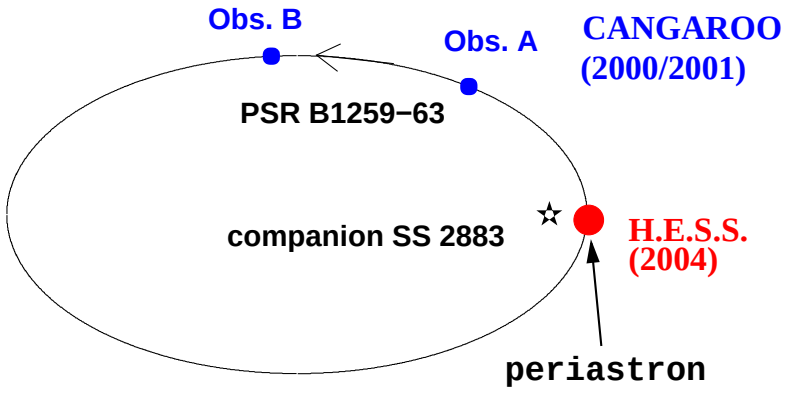
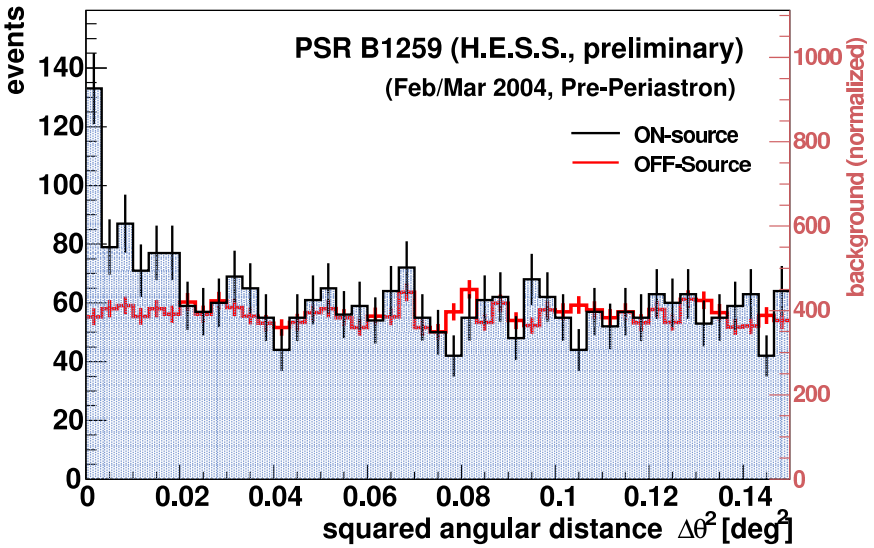
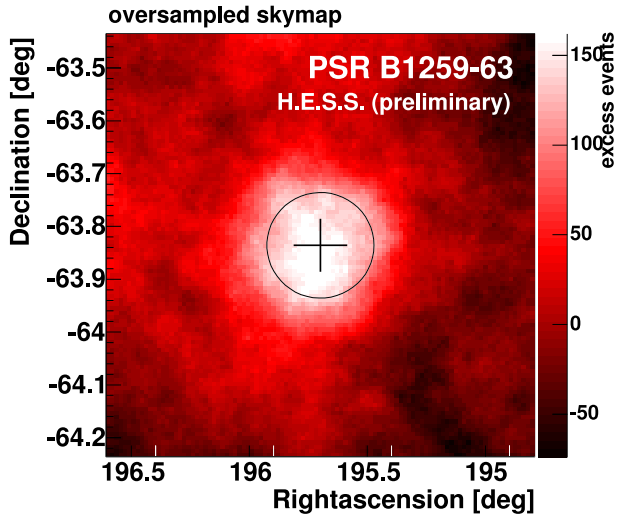


⇒ H.E.S.S.: more sensitive, observations closer to periastron

Detection with H.E.S.S.





- H.E.S.S. dataset: 26. Feb. - 5. March 2004 (6.0 h lifetime)
  periastron at: 7. March 2004
- *WOBBLE* observations (simultaneous background measurements)
- Energy threshold (zenith angle = $40 - 45°$): $E_{\mathrm{thr}} \sim 200\,\mathrm{GeV}$

▷ 167.7 ± 23.3 excess events: $8.2\,\sigma$, flux (preliminary): $\approx 5\%\ \Phi_{\mathrm{Crab}}$

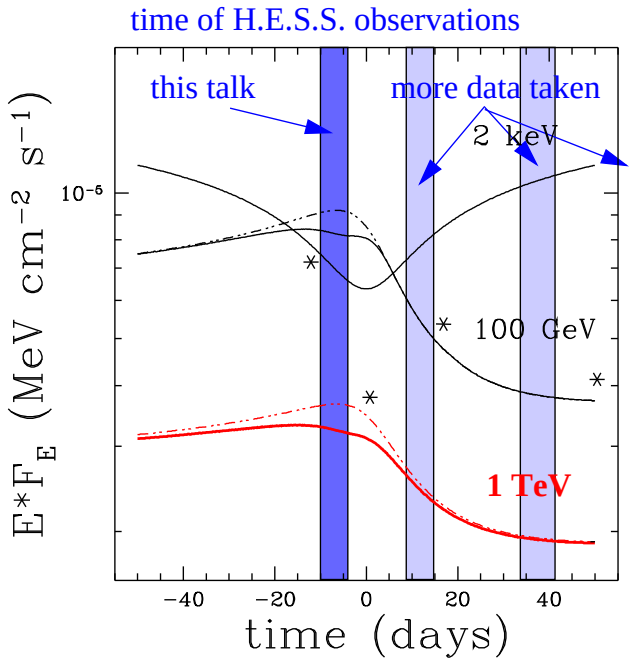
Outlook: Comparisons with model

work in progress:...

- Analysis of post-periastron data
- absolute flux and spectrum
- Post-periastron H.E.S.S. data:
  $\Rightarrow$ longterm lightcurve
- Post-periastron X-ray data:
  $\Rightarrow$ MWL studies

$\Rightarrow$ Comparison of H.E.S.S. and model lightcurves

$\Rightarrow$ Refinement of the model?
$\Rightarrow$ more detailed system geometry (matter disk, etc.)



detailed comparison
model $\leftrightarrow$ data possible

Summary

- Predictions of GeV/TeV emission from PSR B1259-63 before detection (*Kirk et al., Astrop.Phys. 10, 31 (1999)*)
- 2004 H.E.S.S. observations close to periastron (preliminary results):
  $\Rightarrow$ first detection, $8.2\,\sigma$ significance
  $\Rightarrow \sim 5$ % of the Crab nebula flux ($E_{\mathrm{thr}} \sim 200$ GeV)
- More data (H.E.S.S. and other wavelength) taken after periastron
- Work in progress:
  - energy spectrum & flux: TeV-γ production mechanisms?
  - lightcurve: possible flux variations?
  - MWL: flux correlations with other wavelengths

$\Rightarrow$ Comparison with theoretical models