TeV Flux modulation in PSR B1259−63/LS2883

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- The lightcurve
- IC model
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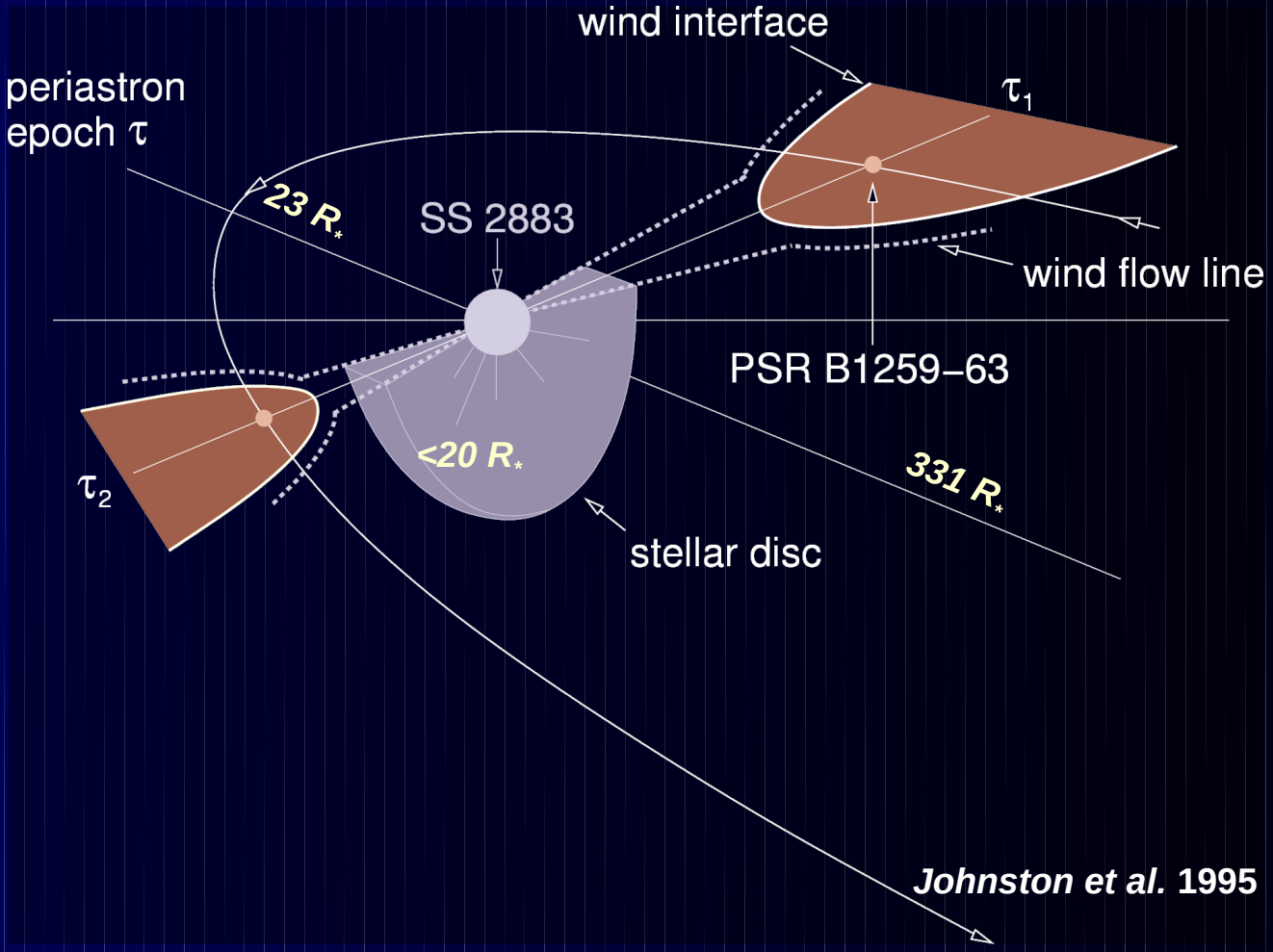
The System PSR B1259-63/SS2883



Orbit

- **Period** 3.4 years
- **Distance** 1.5 kpc ➲ point source
- **Last periastron** 27th of July 2007
- **Next periastron** 15th December 2010

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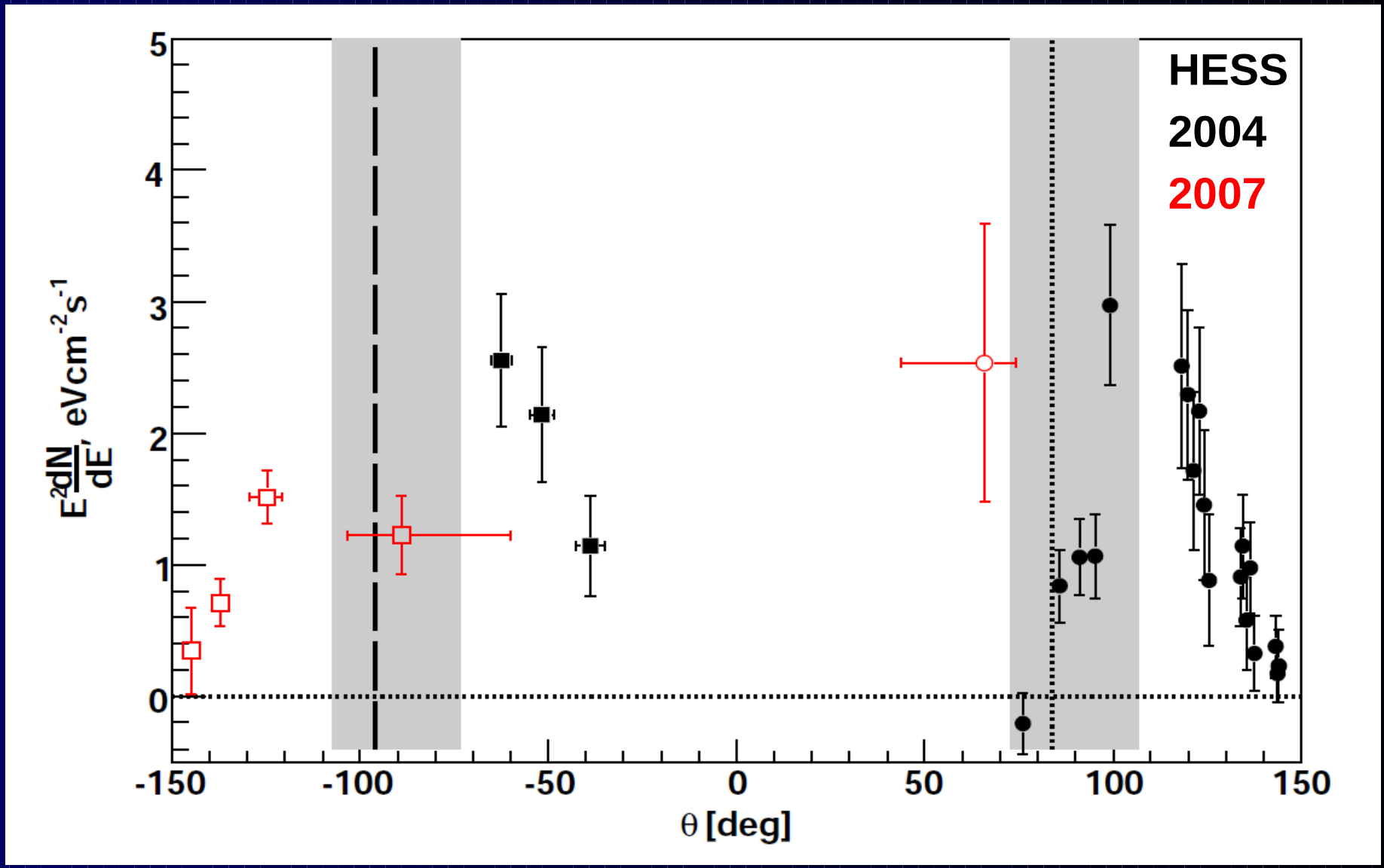
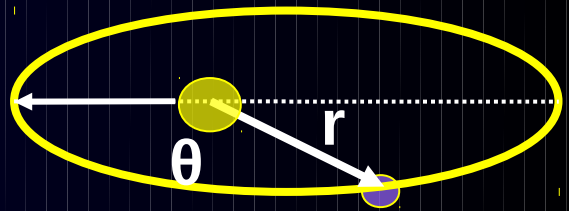
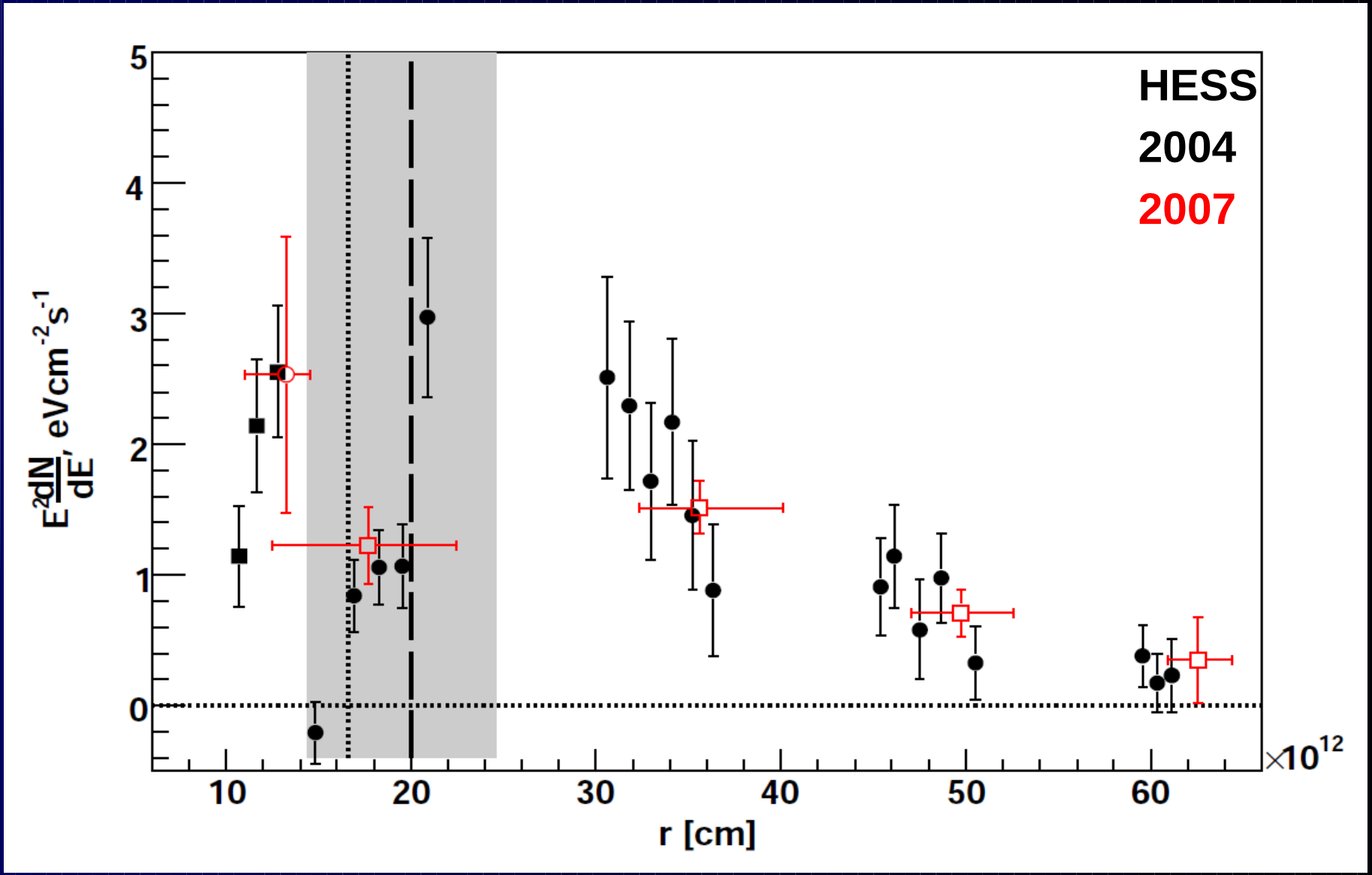
TeV Lightcurve

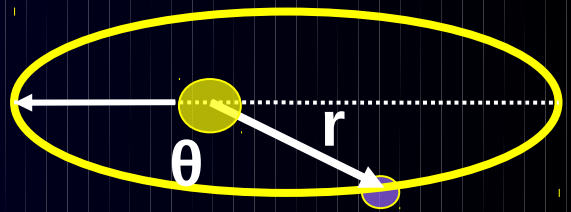




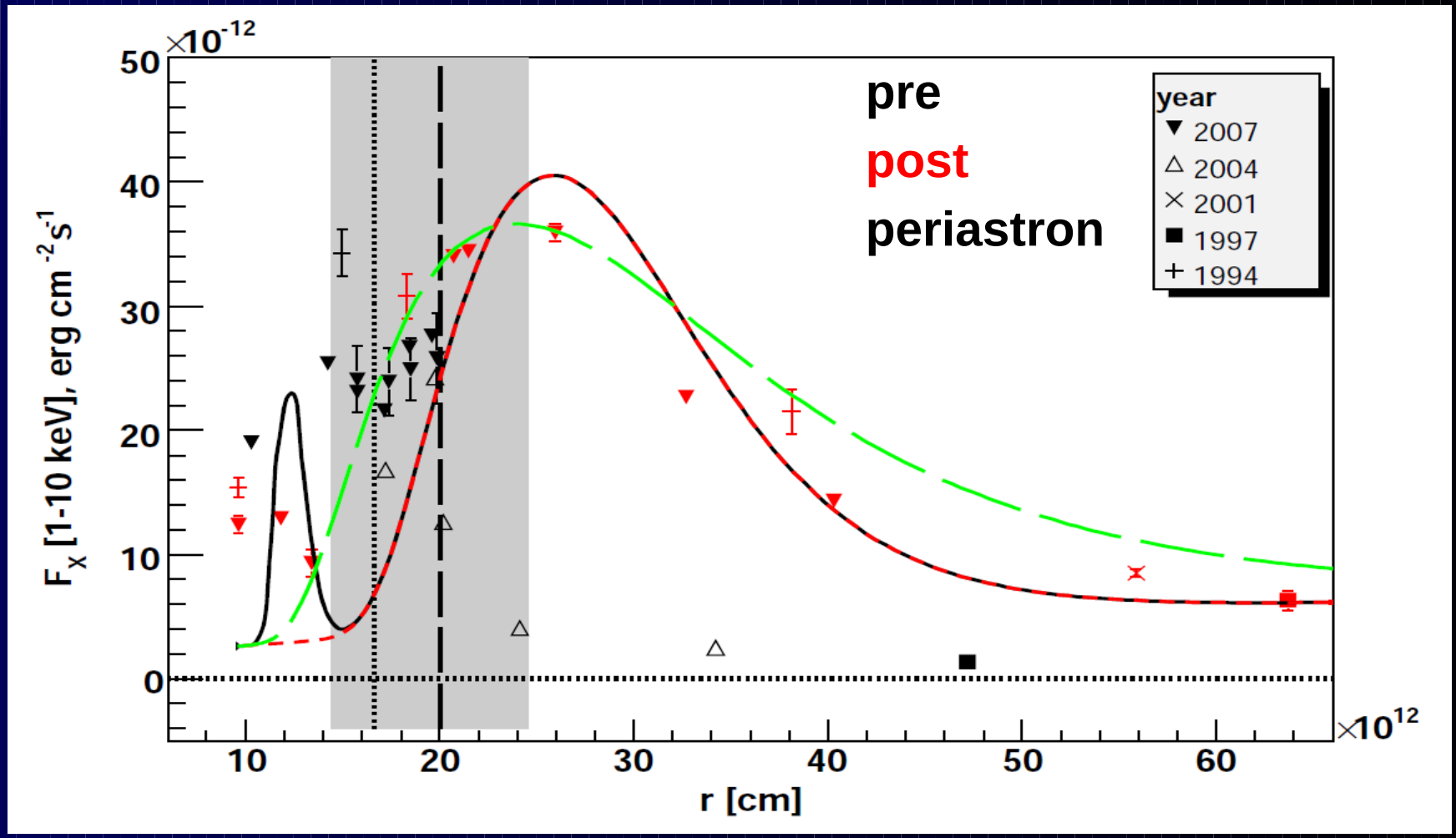
TeV Lightcurve Symmetry



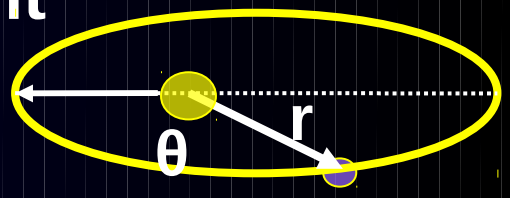
- TeV flux only a function of orbital separation *r* !?
- Hints that PSR B1259-63 is a periodical VHE emitter



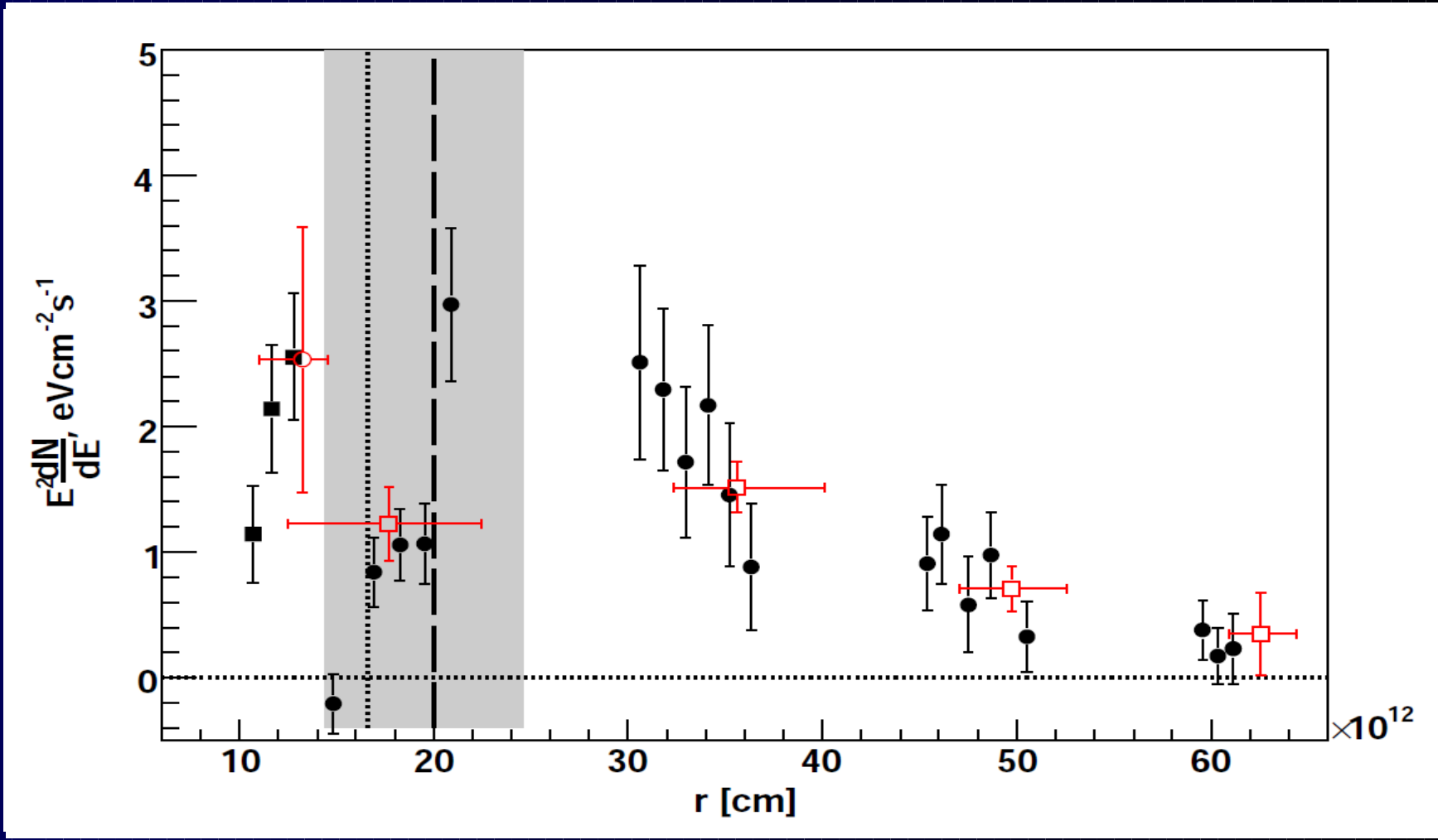
X-rays vs. γ-rays



- no symmetry w.r.t. periastron in X-rays
- decrease in γ-ray flux at r ≈ 2e12 cm coincident with increase in X-rays



X-rays vs. γ-rays



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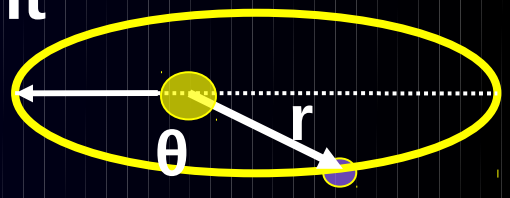

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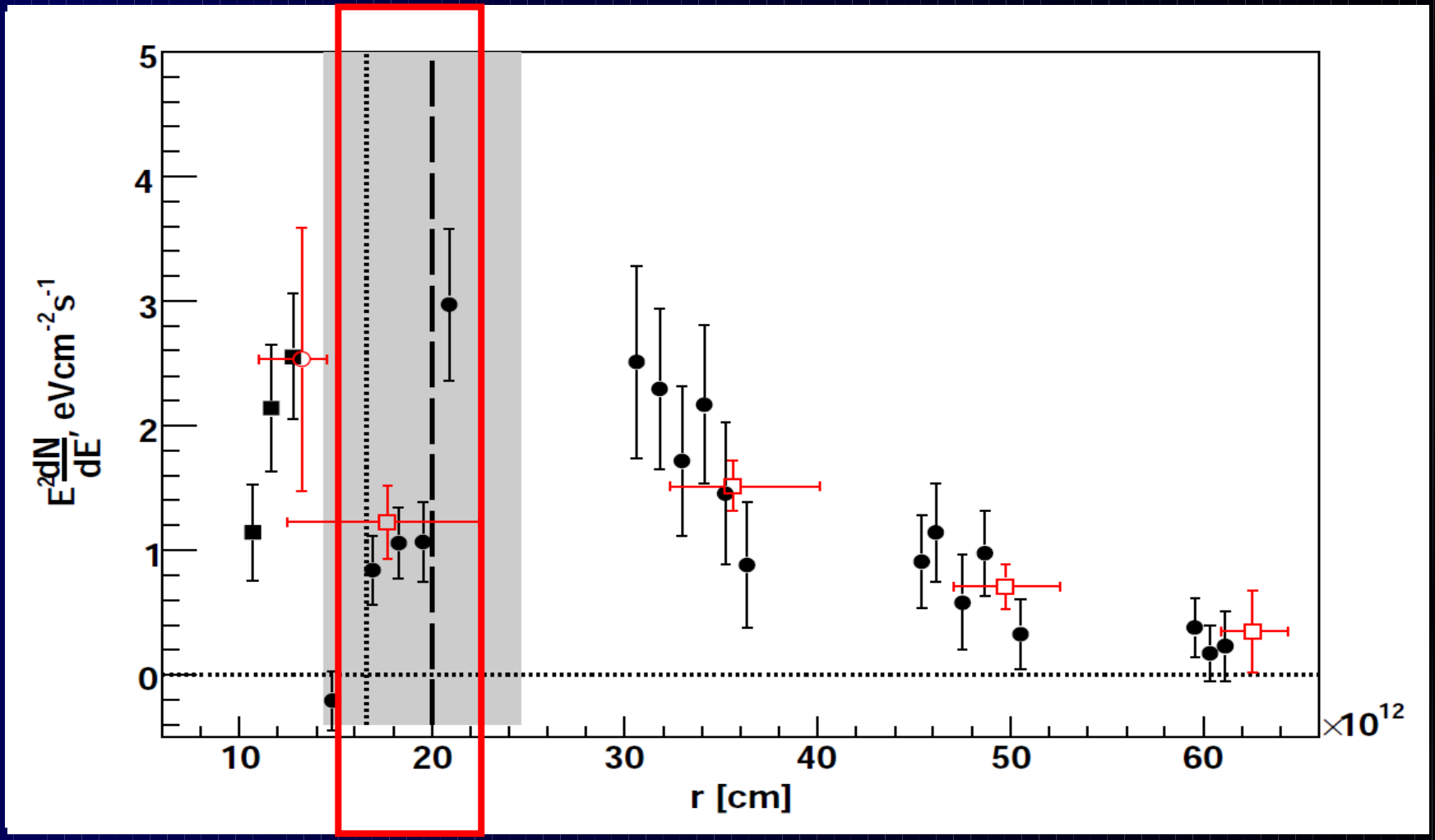

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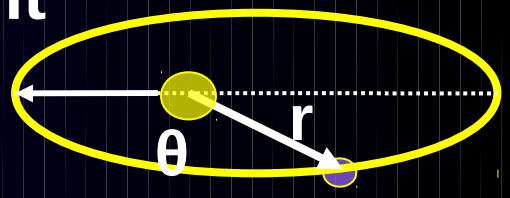

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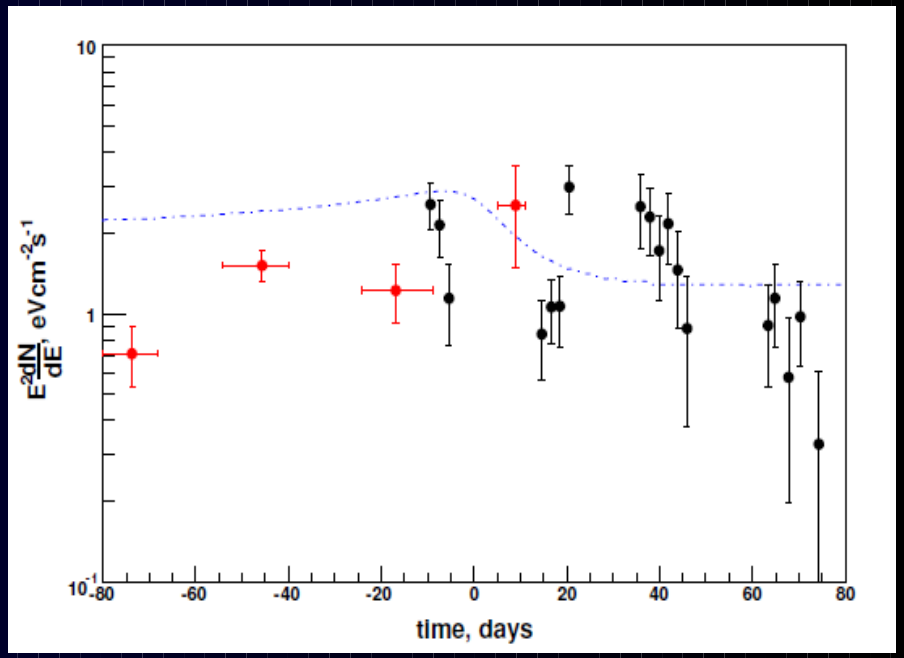
Inverse Compton (IC) Cooling including non-radiative losses

- Pure IC scenario does not describe the HESS data
- Adiabatic losses and particle escape could play a key role in PSR B1259-63
- Analytical calculation of adiabatic losses non-trivial
- Extract adiabatic cooling profile from data by comparing with prediction adopting electron injection without non-radiative losses (Khangulyan et al., 2007)



Electron distribution fkt EDF (Ginzburg & Syrovatskii 1964) :

$$n_e(t,\gamma) = \frac{1}{|\dot{\gamma}(\gamma,t)|}\int_{\gamma}^{\infty} Q(\gamma')\mathrm{d}\gamma'$$

$$Q(t,\gamma) = A\gamma^{-\alpha} e^{-\frac{\gamma mc^2}{E_{e,max}}}\theta(\gamma-\gamma_{\min})$$

$$\dot{\gamma} = \dot{\gamma}_{\mathrm{syn}} + \dot{\gamma}_{\mathrm{ic}} + \dot{\gamma}_{\mathrm{ad}}$$

$n_e(t,\gamma)$ ...EDF (per energy)

γ^{dot} ... losses

Q ... e^- injection spectrum

$E_{e\ max}$ ... e^- cutoff energy

A... norm; => fraction PW e^- to injection e^-

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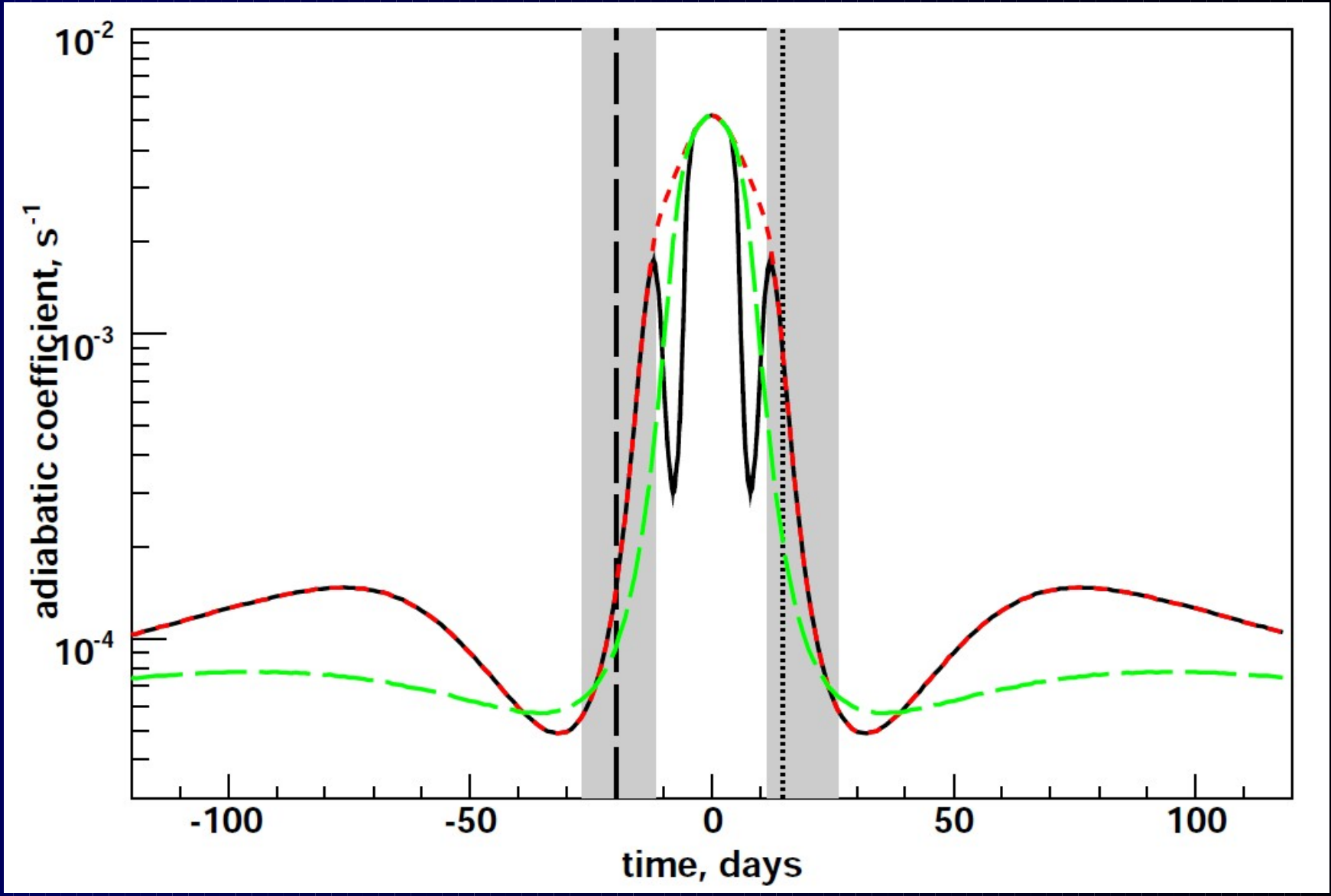
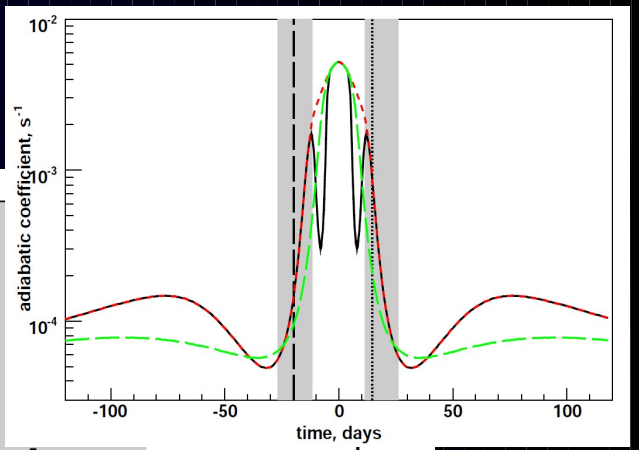
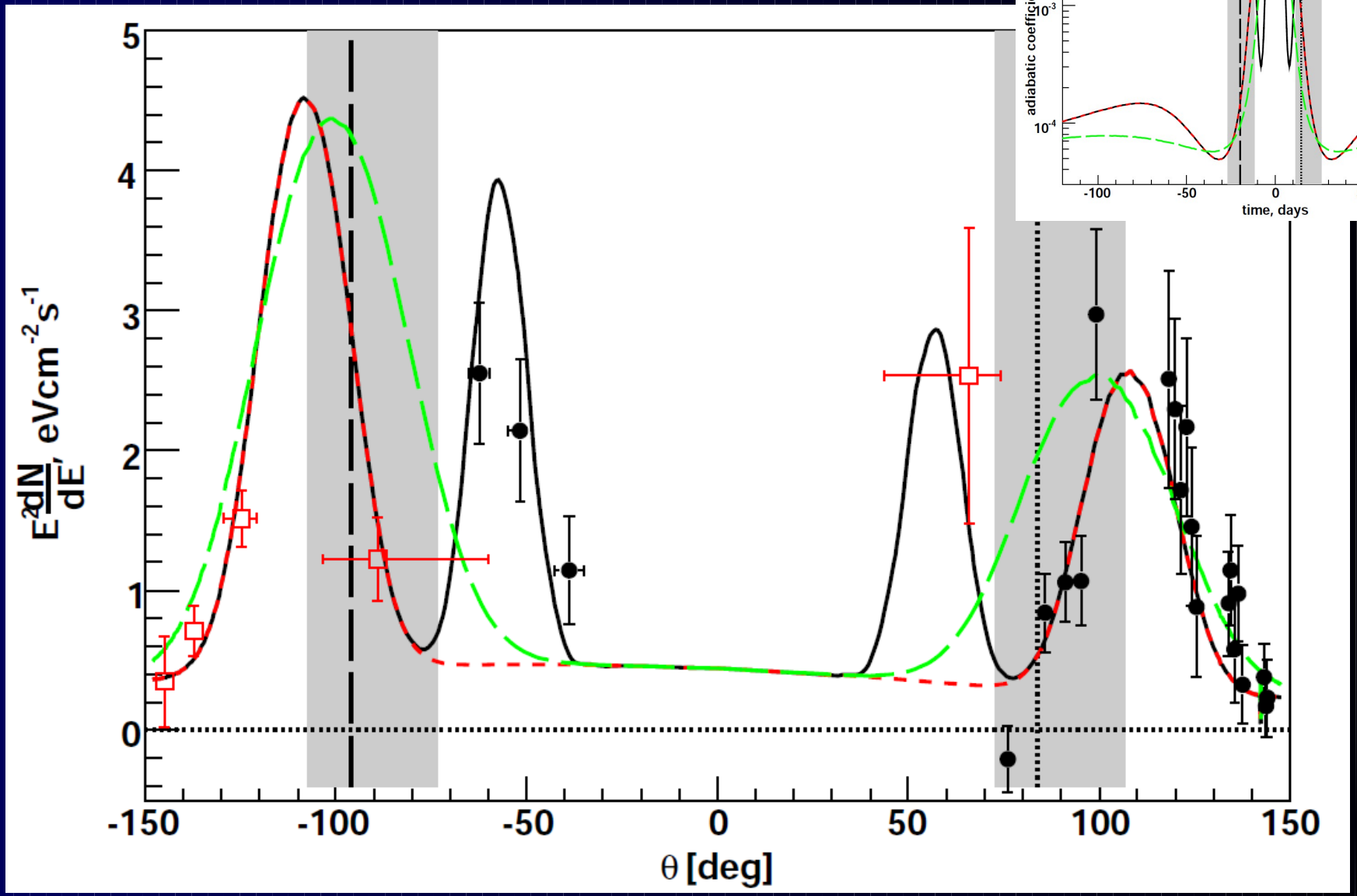
Cooling Profiles



Tested three different cooling profiles γ^{dot}_{ad} to account for HESS data

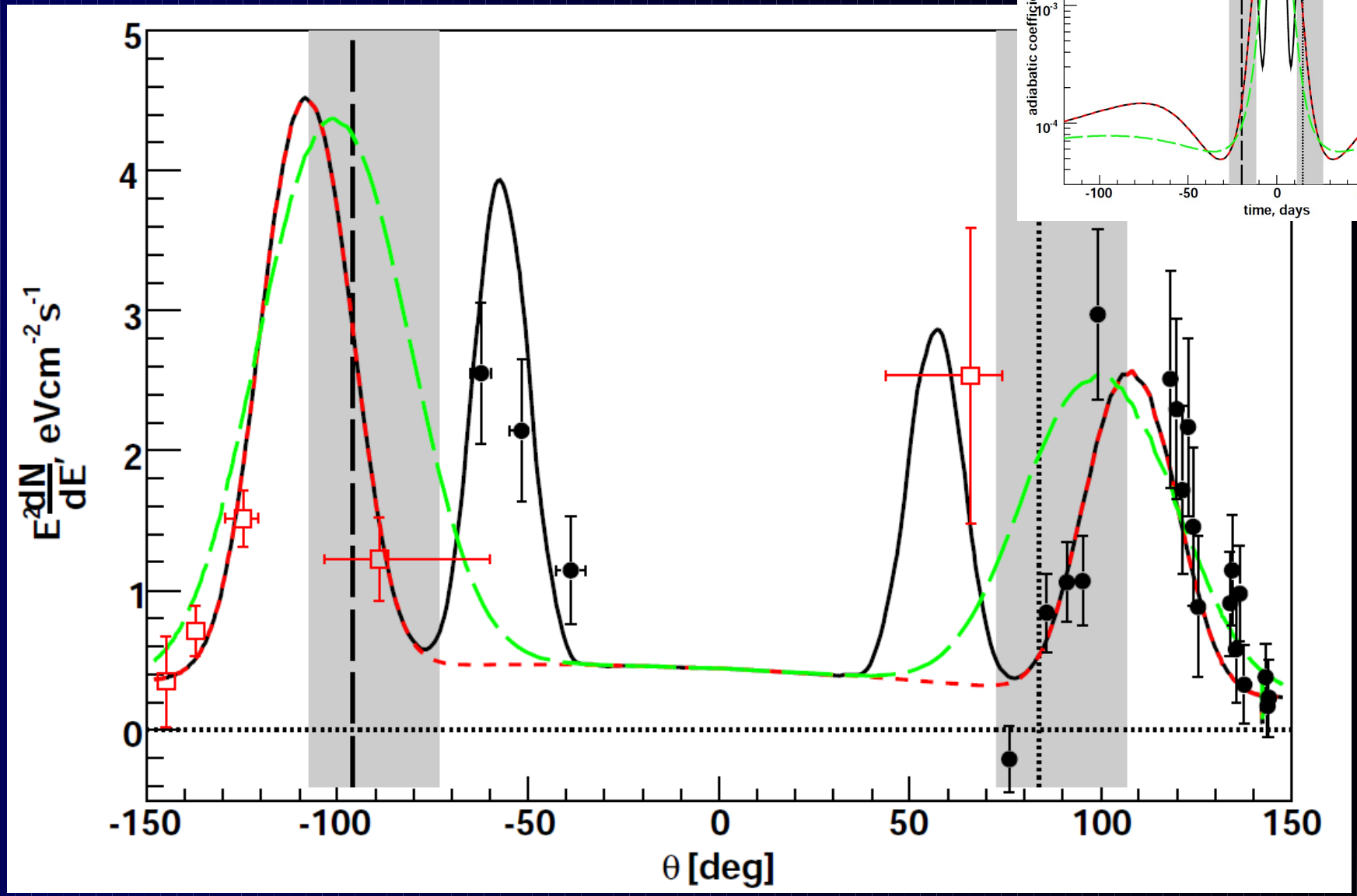
Predictions

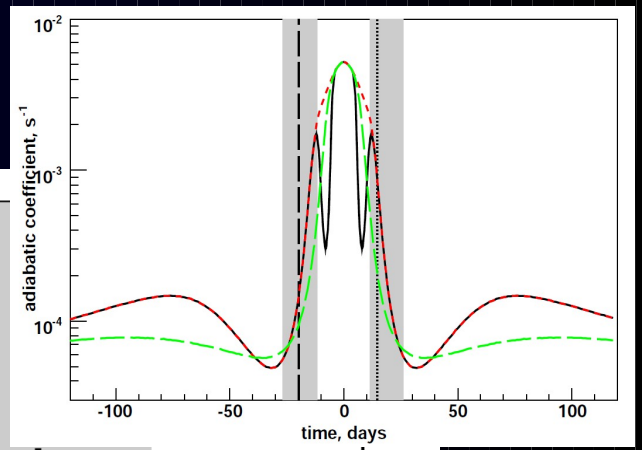




2004/07 data qualitatively compatible with IC model including (phenomenologically) non-radiative losses.

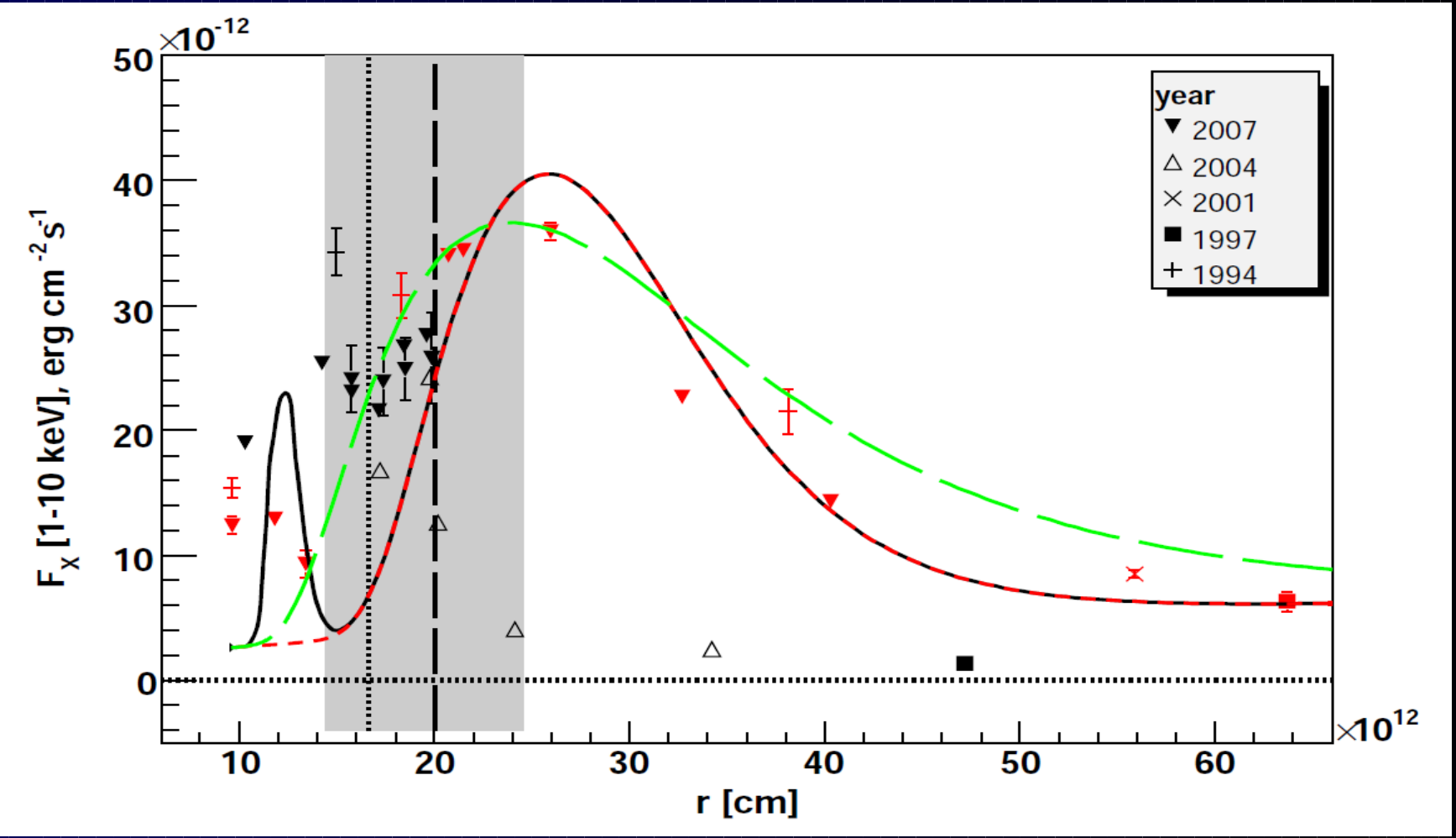
Predictions





Non monotonic cooling profile γ^{dot}_{ad} (black) results in two additional dips at θ ± 75° (coincident with disc!)

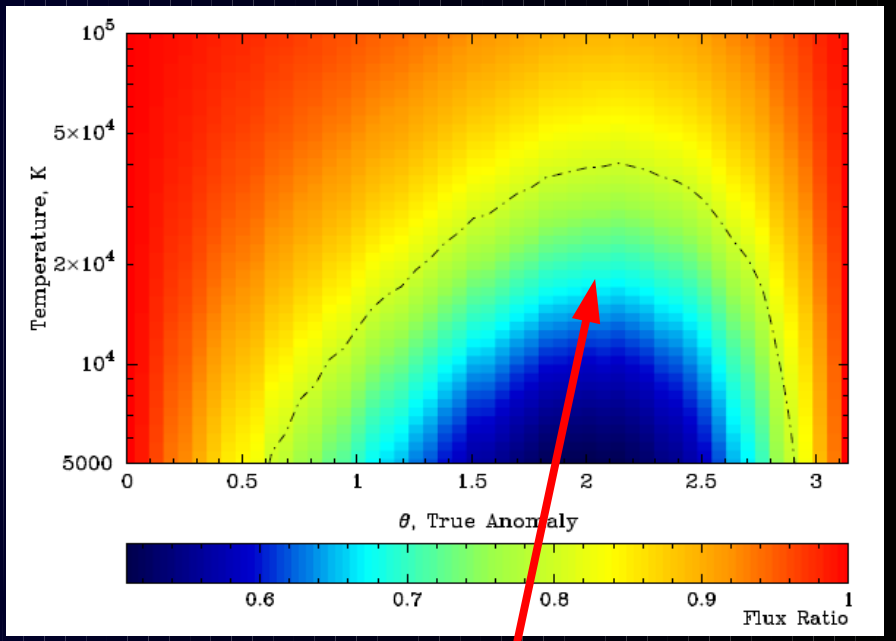
X-rays

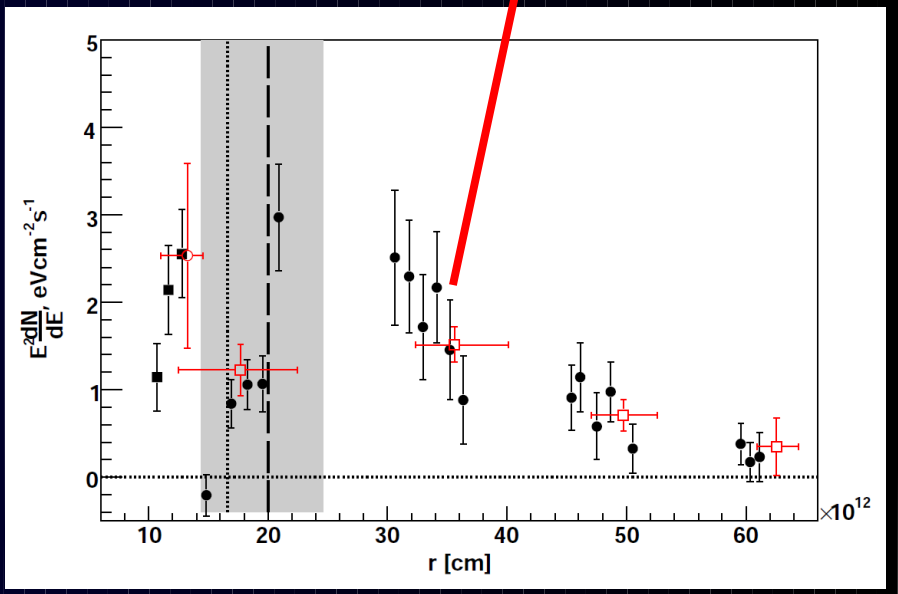


- No quantitative agreement for X-ray data and (synchrotron) model prediction
- Qualitative agreement for post-periastron (red) data
- Magnetic field more complicated than simple *B~1/r* dependence adopted in model

Interpretation

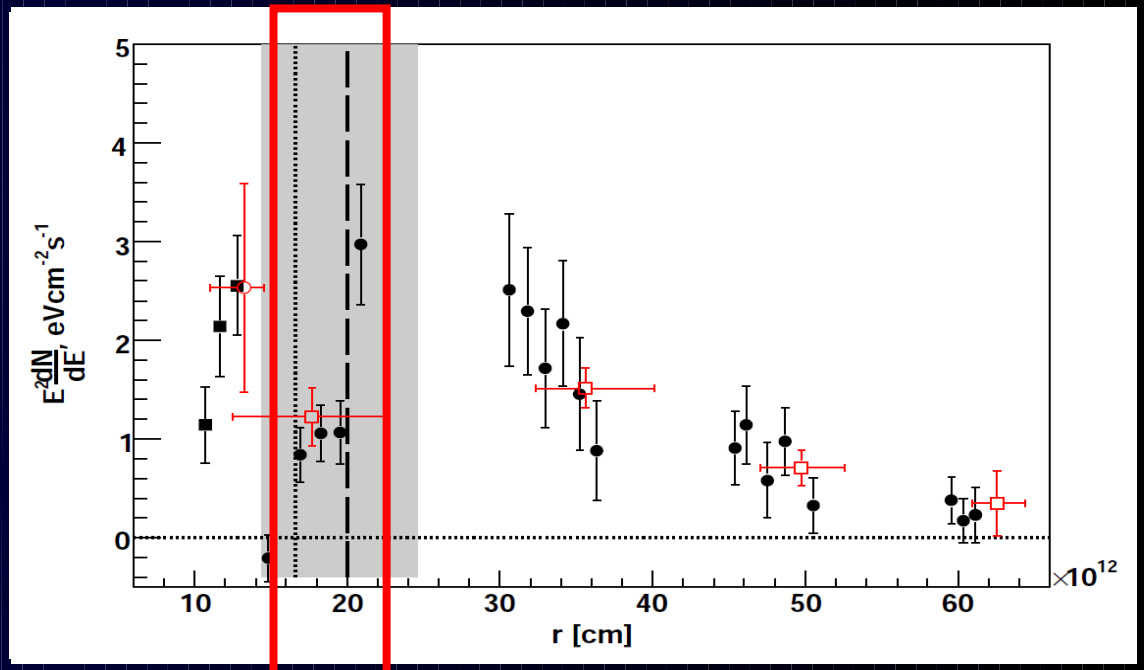
- If symmetry in TeV true → unexpected in leptonic scenario since IC is anisotropic
- However, depends on many factors: production region size, γ-ray energy band, slope of e^--spectrum, T_{star}, Doppler modulation etc.
- If $T'_{star} = 1.5 \times T_{star}$ → IC occurs deeper in Klein-Nishina → more isotropic
- Smoothing due to production region size?!
- Compensation of effects (Doppler, γ-γ absorption, anisotropic IC)?!

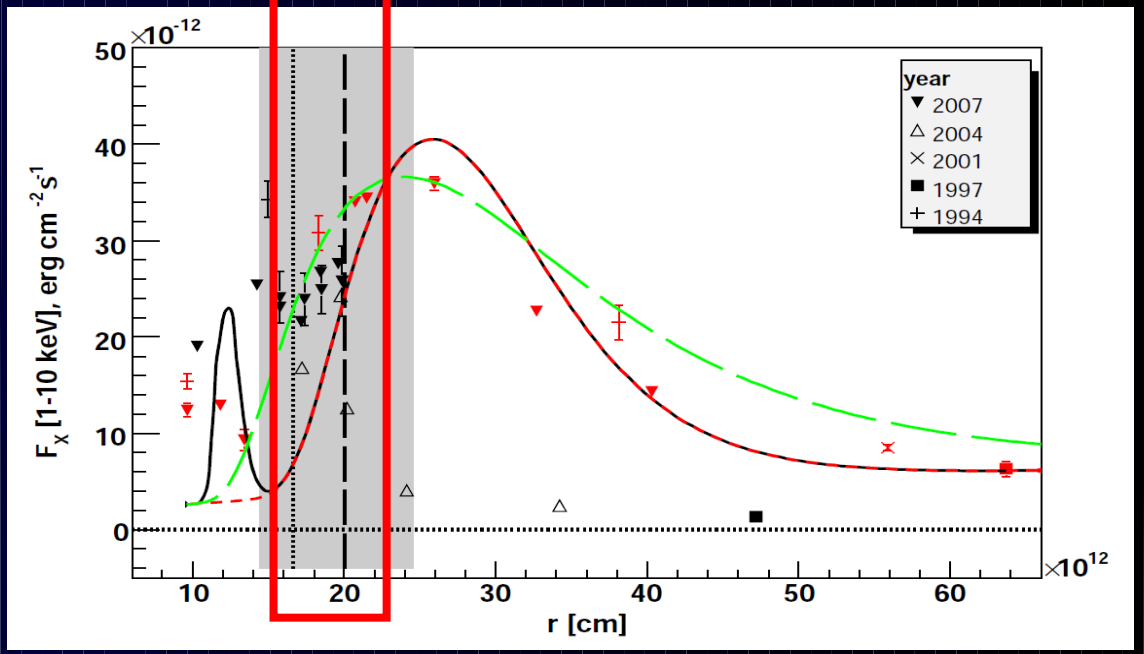




Interpretation II

- Decrease of TeV flux towards periastron around r~2e12 cm accompanied by increase in X-rays
- Pulsar crosses disc → increase ram pressure → PW termination shock closer to pulsar → B-field enhancement
- Behavior in X-rays not explained by this simple qualitative picture





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- TeV lightcurve of PSR B1259 possibly symmetric
- Can be described by leptonic IC scenario adopting non radiative losses.
- Peculiar dips in the cooling profile coincident with stellar disc position
- "TeV Flux modulation in PSRB1259−63/LS2883", A&A 525, A80 (2011) [arxiv.org/abs/1009.5307]

- Special thanks to: F. Aharonian, D. Khangulyan