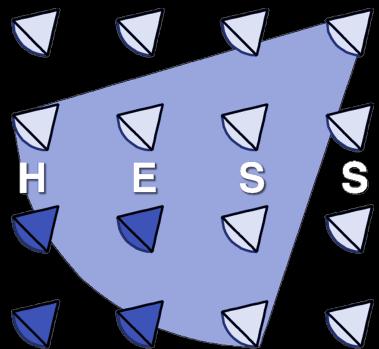


Establishing a connection between  
high-power pulsars  
and VHE  $\gamma$ -ray sources  
with **H.E.S.S.**



Svenja Carrigan, MPIK Heidelberg



# OUTLINE

- Motivation
- Approach
- Modeling
- Results
- Summary/Outlook

# MOTIVATION

- H.E.S.S.** - large field of view ( $5^\circ$ )  
- high sensitivity

→ ideal for **scans of the Galactic plane**  
in very-high-energy (VHE)  $\gamma$ -rays

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**pulsar wind nebulae (PWNe)**

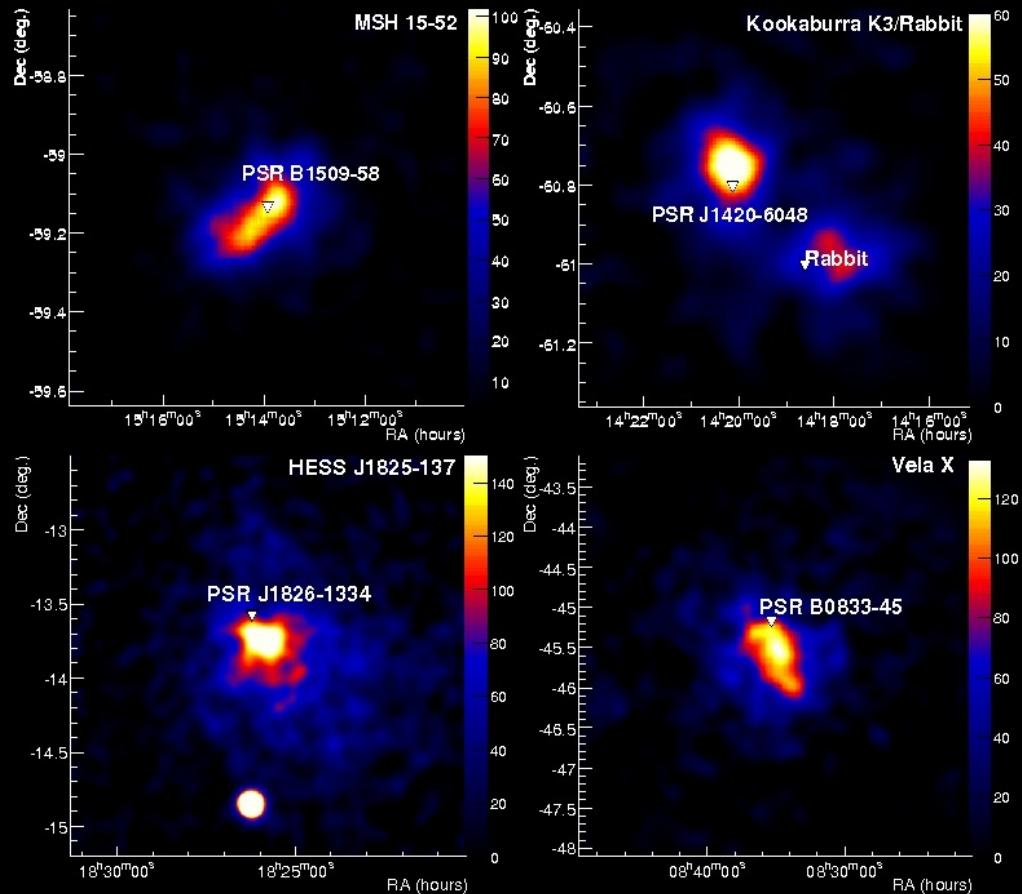
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(e.g. PWN in MSH 15-52, Kookaburra,  
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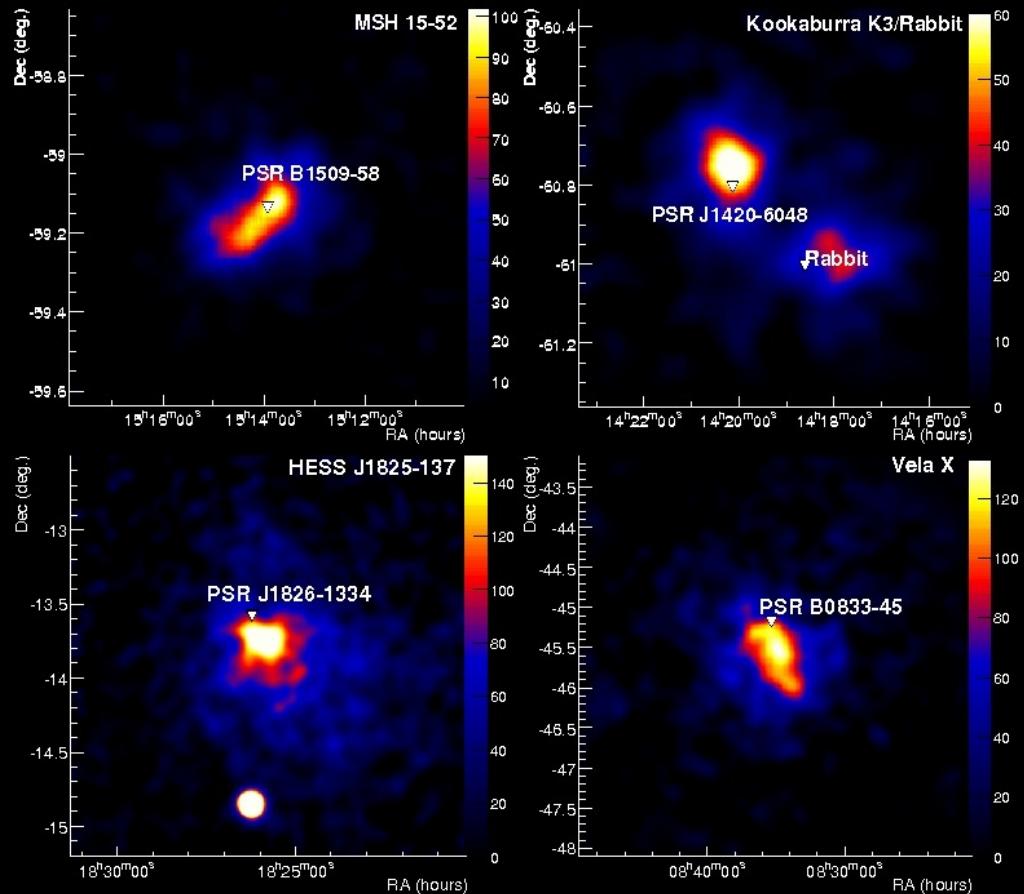
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## Motivation:

- details of energy conversion mechanisms in PWNe not well understood
- do all pulsars (PSRs) drive PWNe?
- try and understand connection between PSRs and VHE  $\gamma$ -ray sources

# APPROACH

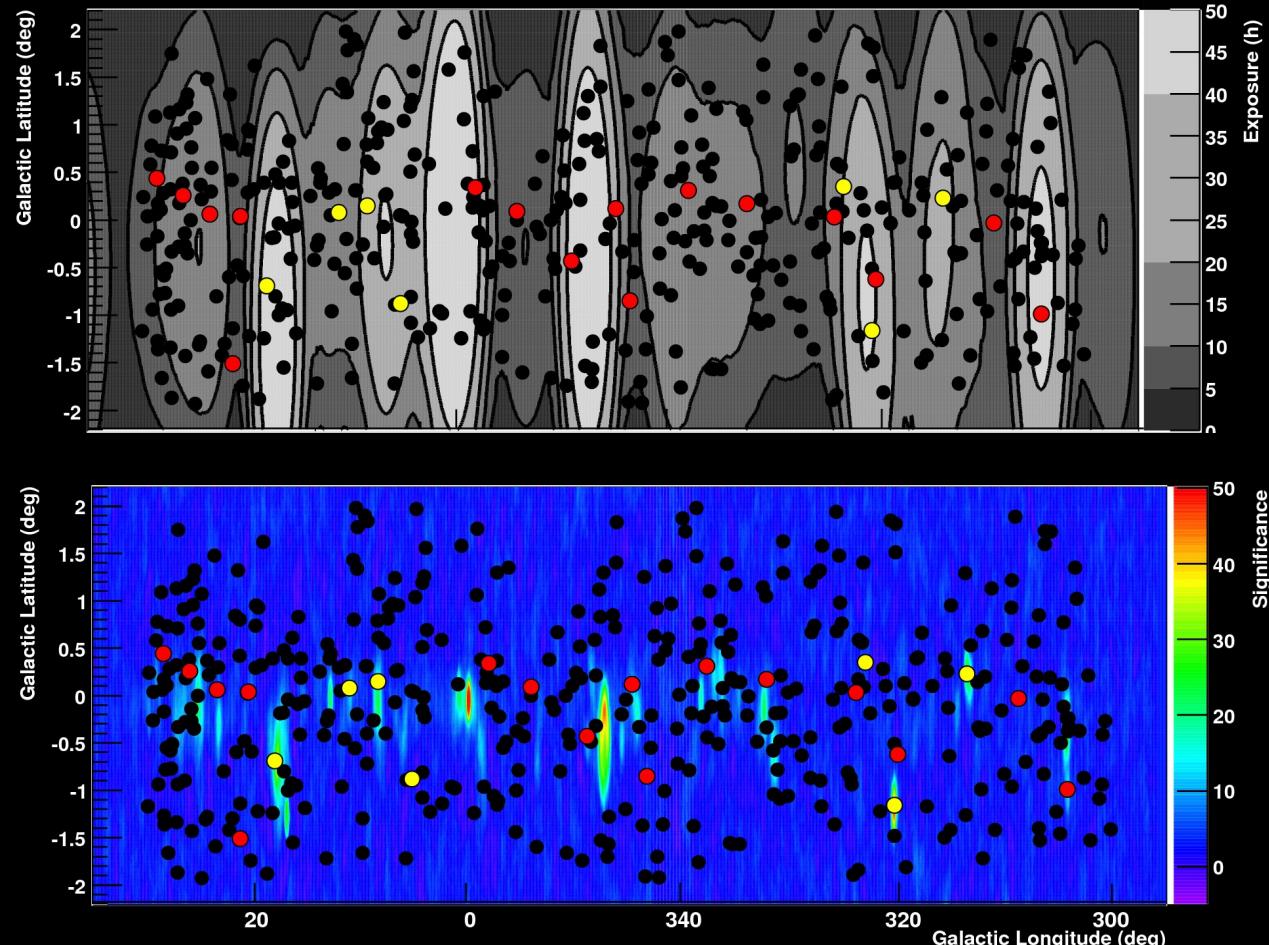
## Assumption:

the  **$\gamma$ -ray output** of a PWN correlates somehow with the power of the **PSR** feeding it

## Approach:

- systematic search for VHE  $\gamma$ -ray counterparts of energetic PSRs
- investigate how the probability to detect PWNe surrounding known PSRs varies with the spin-down energy flux  $\dot{E}/d^2$  of the PSR

# PARENT POPULATION

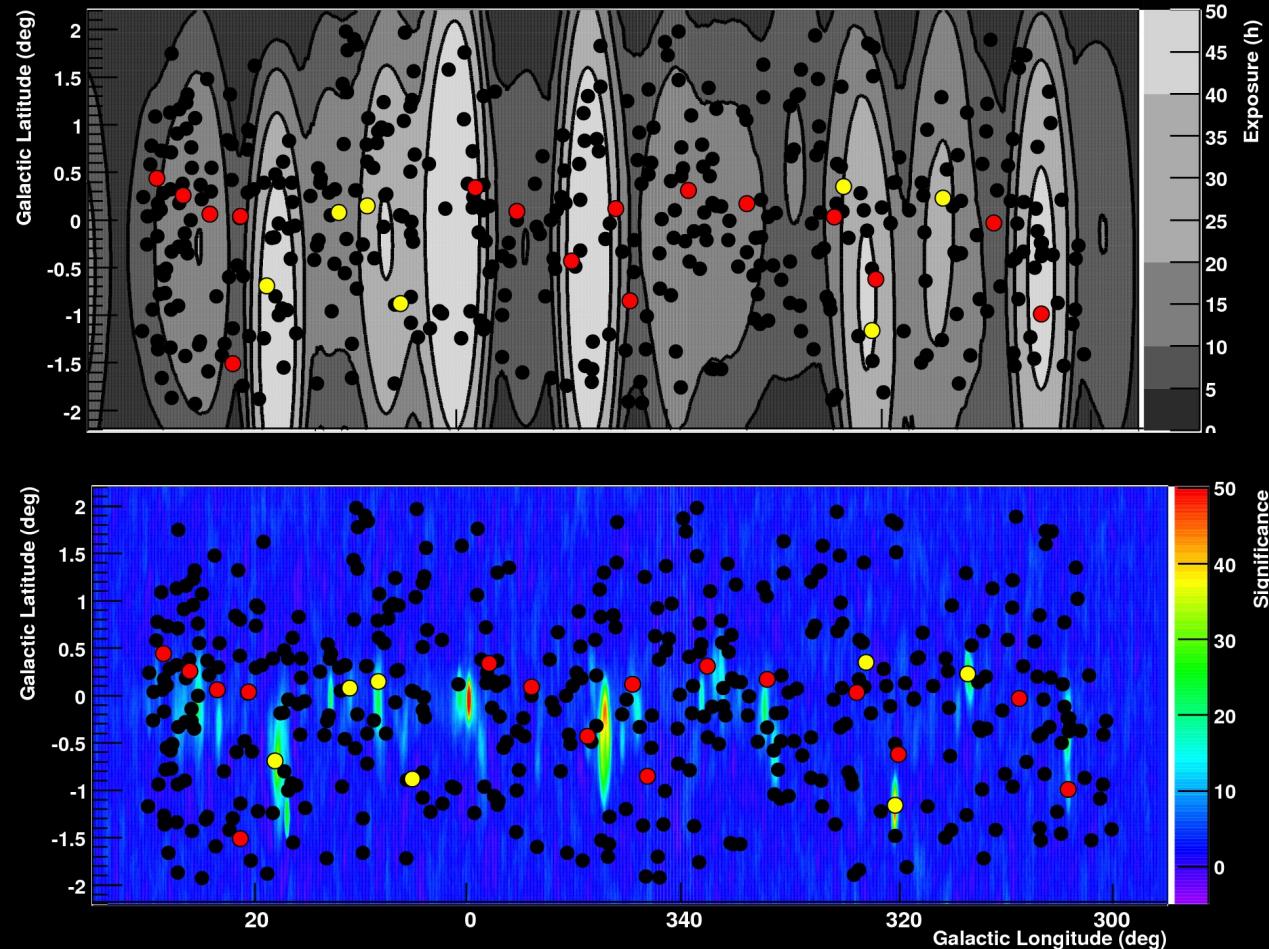


435 PSRs from the Parkes  
Multibeam Pulsar Survey  
(ATNF catalogue)

yellow:  $\dot{E}/d^2 > 10^{35}$  erg/s/kpc $^2$   
red:  $10^{34} - 10^{35}$  erg/s/kpc $^2$   
black:  $\dot{E}/d^2 < 10^{34}$  erg/s/kpc $^2$

→ check in sky map for  
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at PSR position (ext. search)

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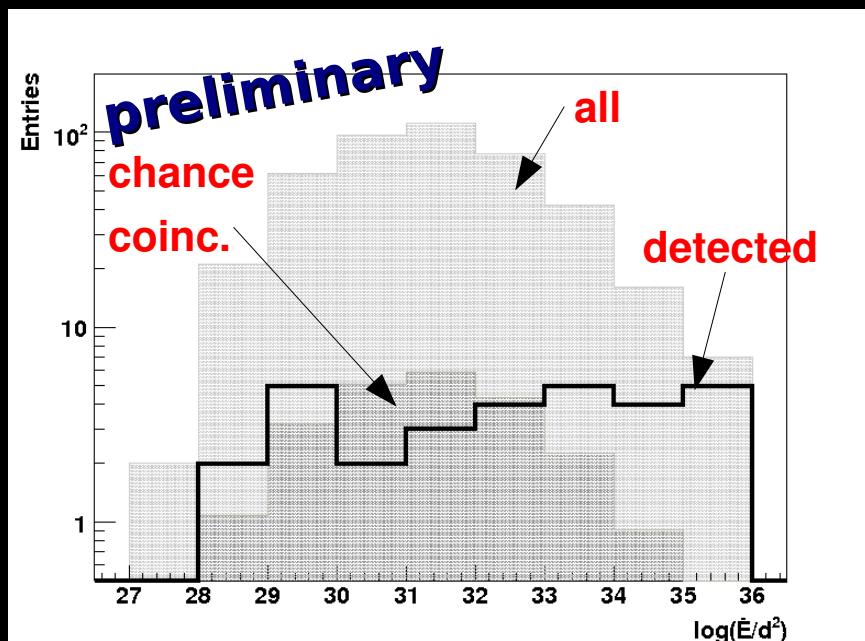
yellow:  $\dot{E}/d^2 > 10^{35}$  erg/s/kpc<sup>2</sup>  
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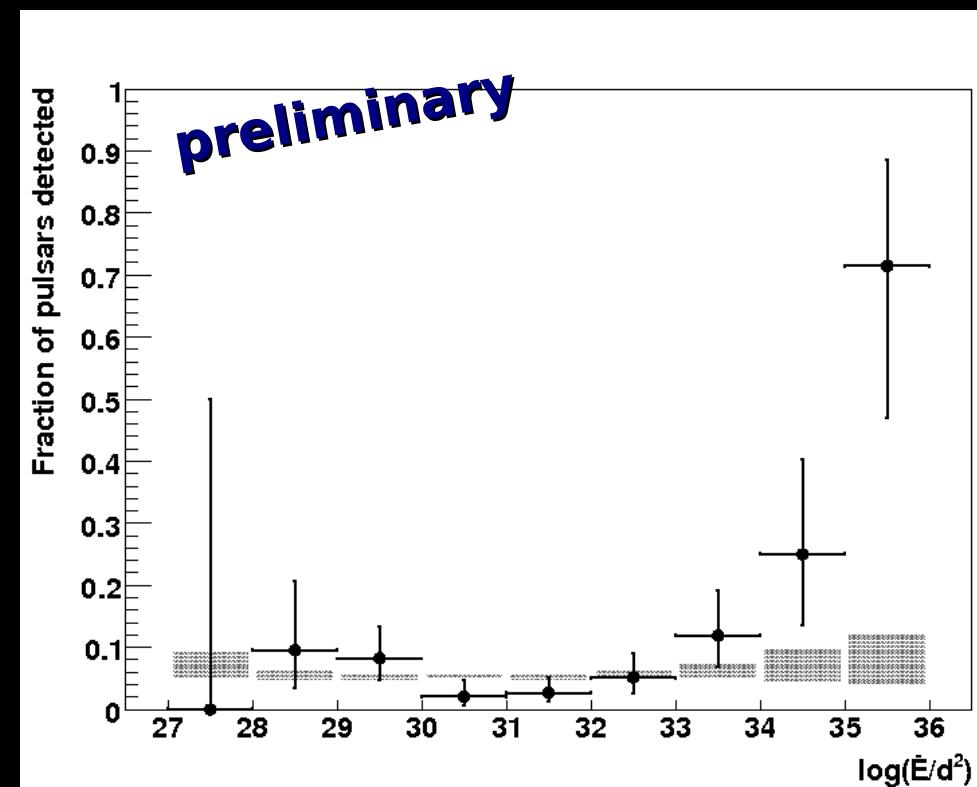
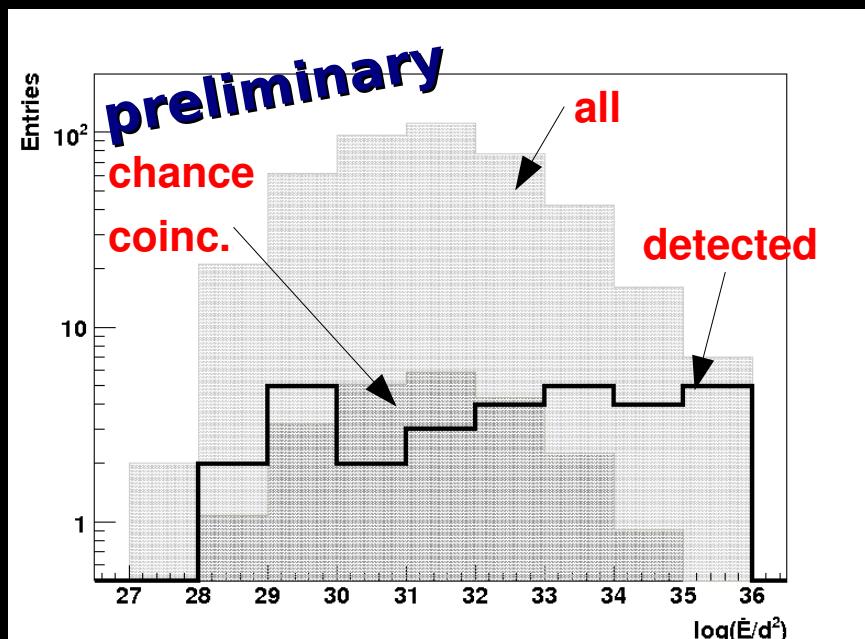
## Need to estimate the chance coincidences:

- model after this parent population: position ( $\lambda, \beta$ ) and power  $\dot{E}/d^2$  for each random test position → take into account narrowing of  $\beta$  with increasing  $\dot{E}/d^2$
- generate  $10^6$  random catalogues and check for emission at each position  
→ gives chance coincidences

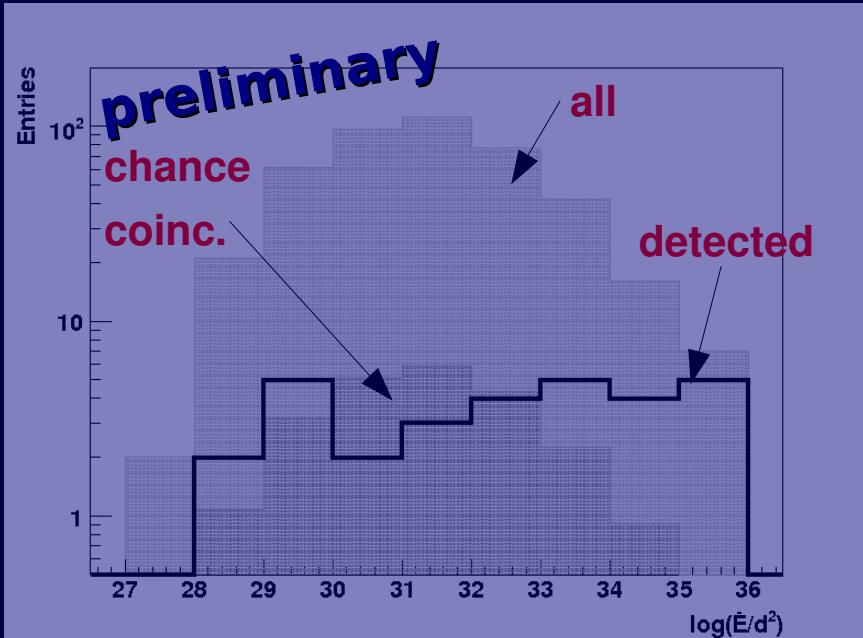
# RESULTS



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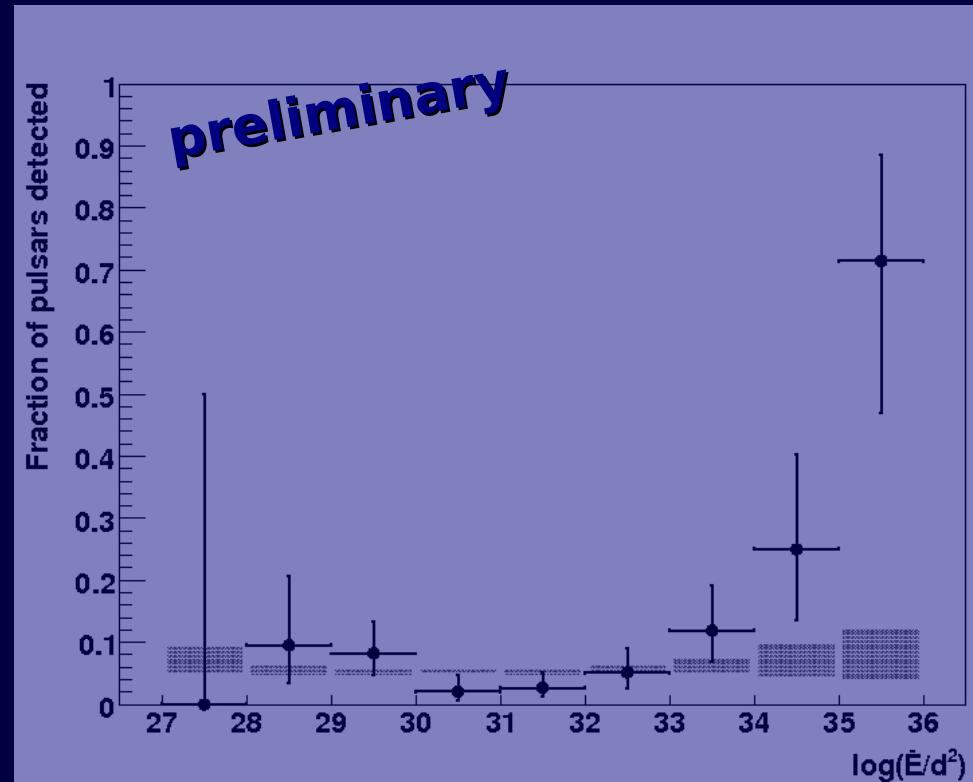
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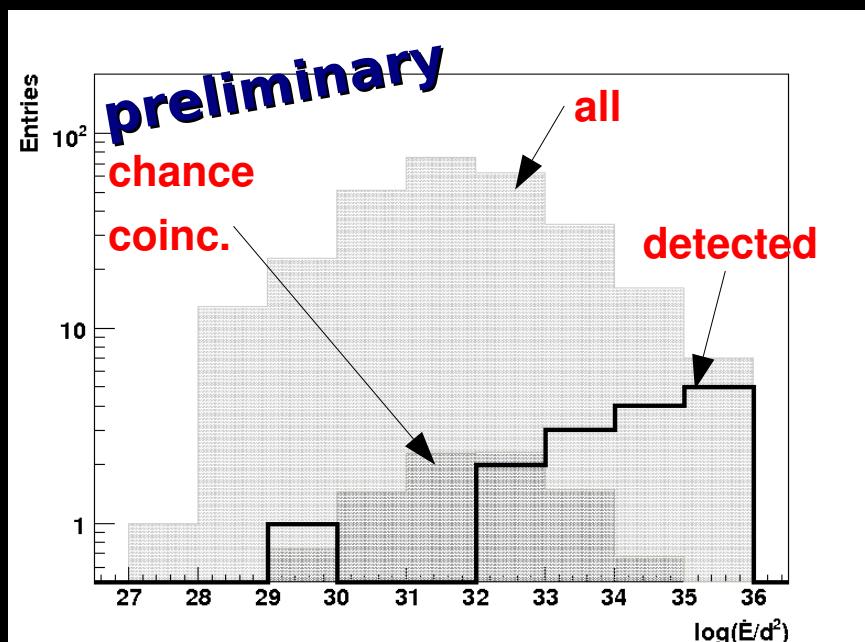
## STABILITY CHECK

High density of PSRs

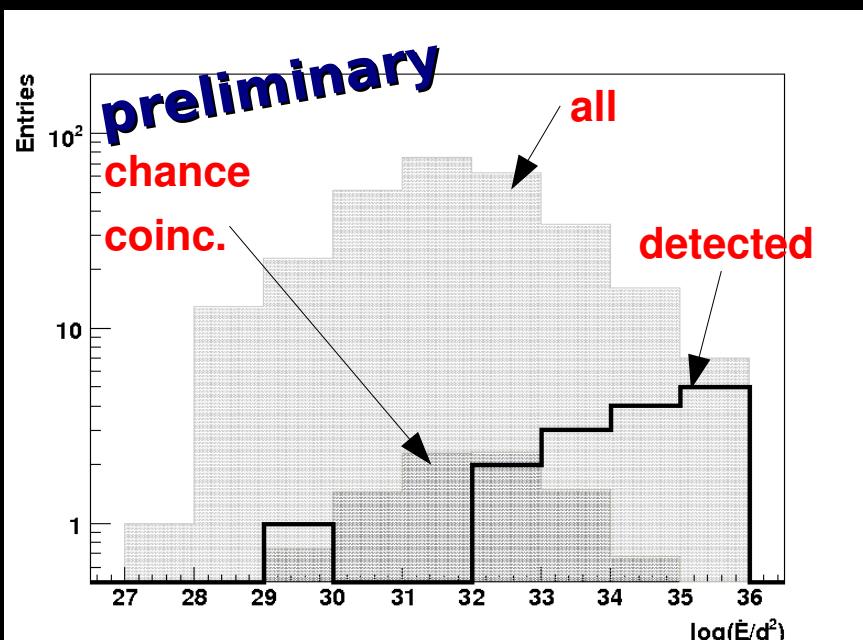
- single  $\gamma$ -ray source may coincide with more than one PSR
- remove double occurrences by an angular separation of PSRs (and exclude PSRs on known non-PSR  $\gamma$ -ray sources)



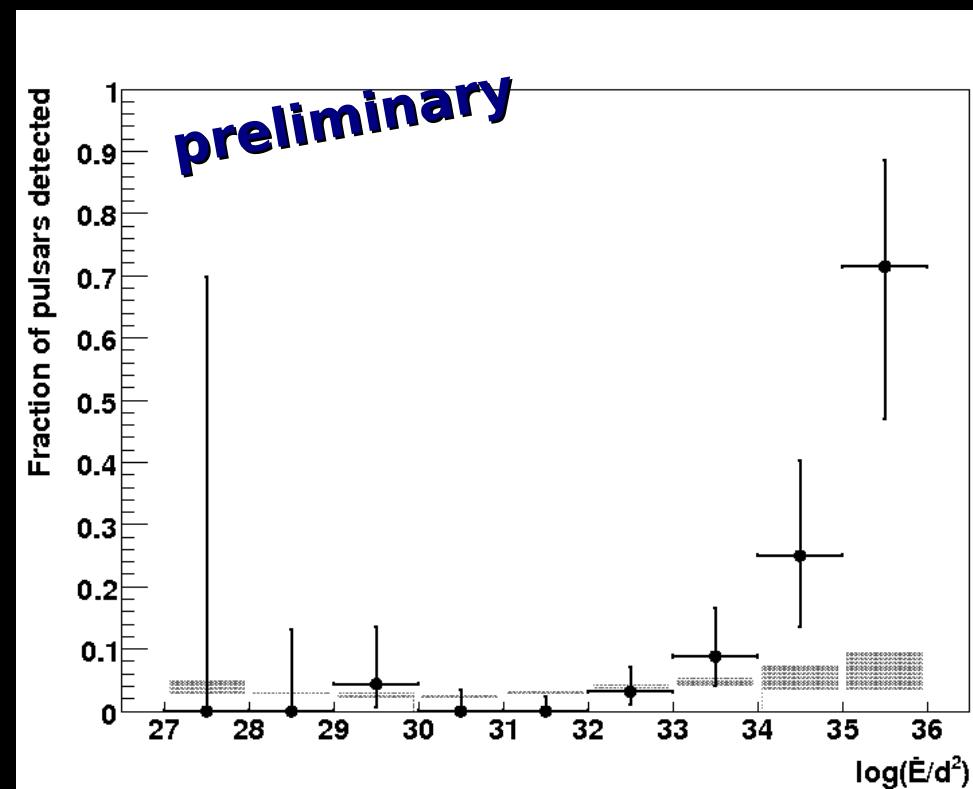
# RESULTS



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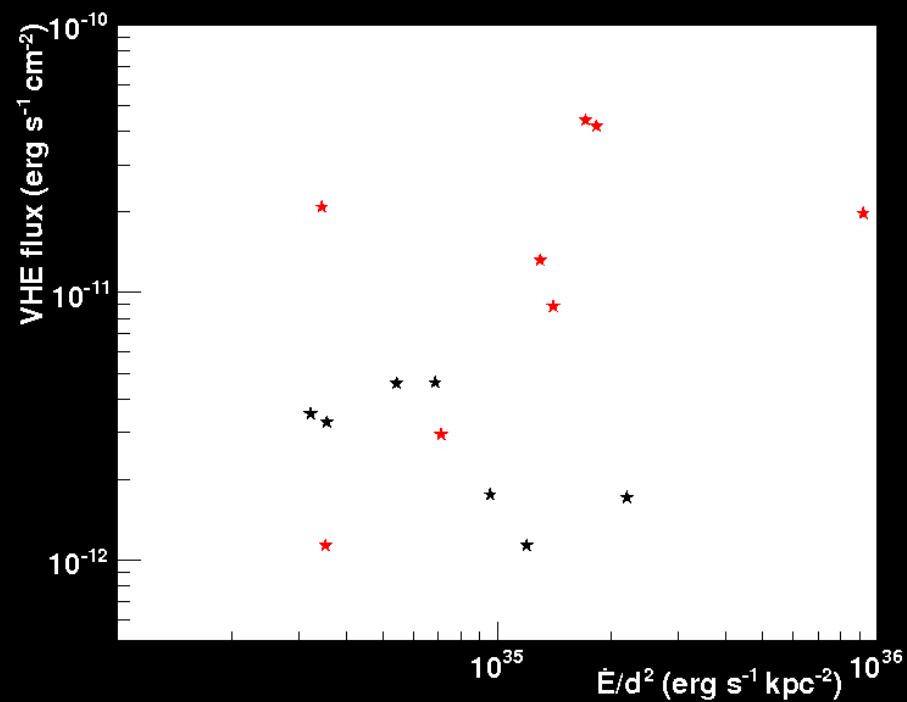
►► Result is stable



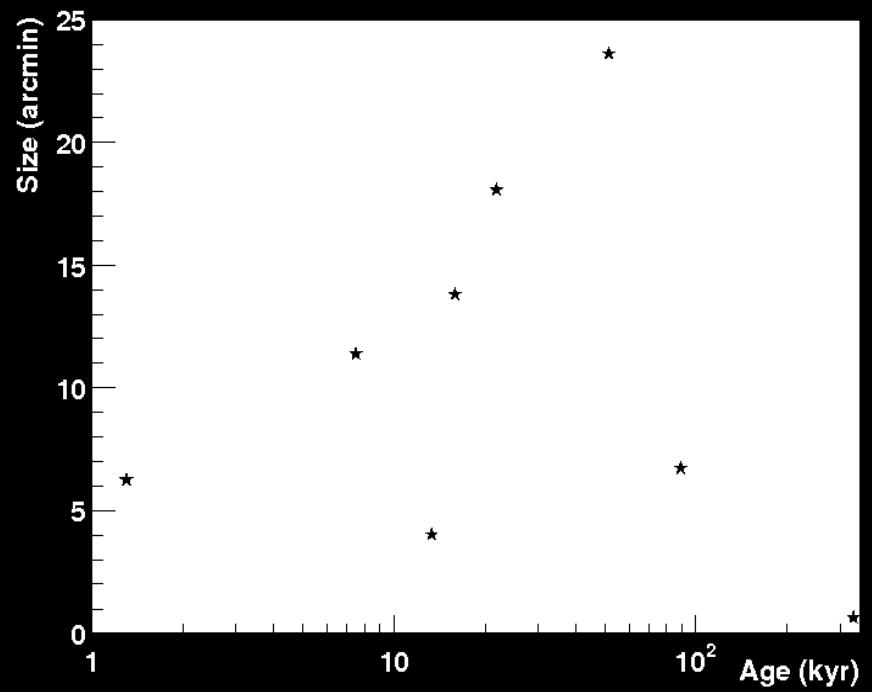
## SUMMARY/OUTLOOK

- Large fraction of high-power PSRs correlate with VHE  $\gamma$ -ray sources
- Probability that detecting ~70% of the PSRs with  $\dot{E}/d^2 > 10^{35}$  erg/s/kpc<sup>2</sup> is a fluctuation is  $\sim 10^{-4}$
- Future more sensitive  $\gamma$ -ray instruments will detect a rapidly increasing number of PWNe
- VHE  $\gamma$ -rays might prove to be a useful tool for discovering more PWNe

# BACKUP SLIDES

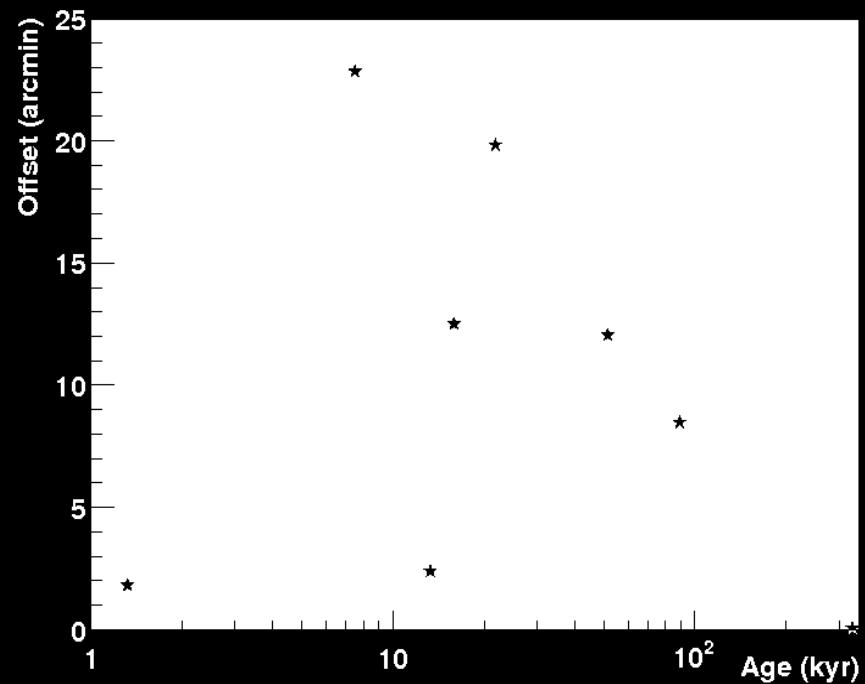


VHE flux versus  $\dot{E}/d^2$

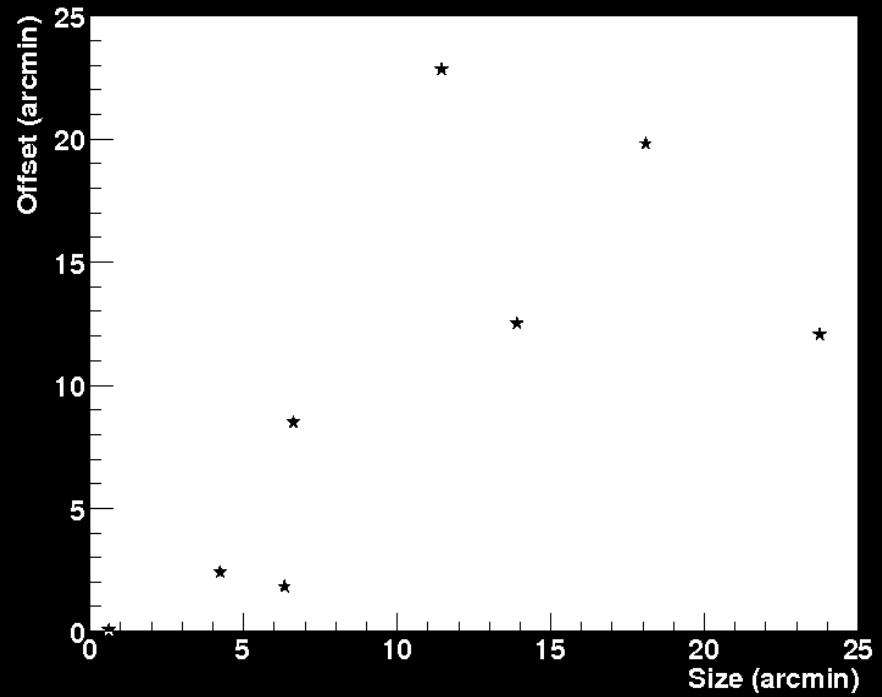


Size versus Age

# BACKUP SLIDES



Offset versus Age



Offset versus Size

# BACKUP SLIDES

