



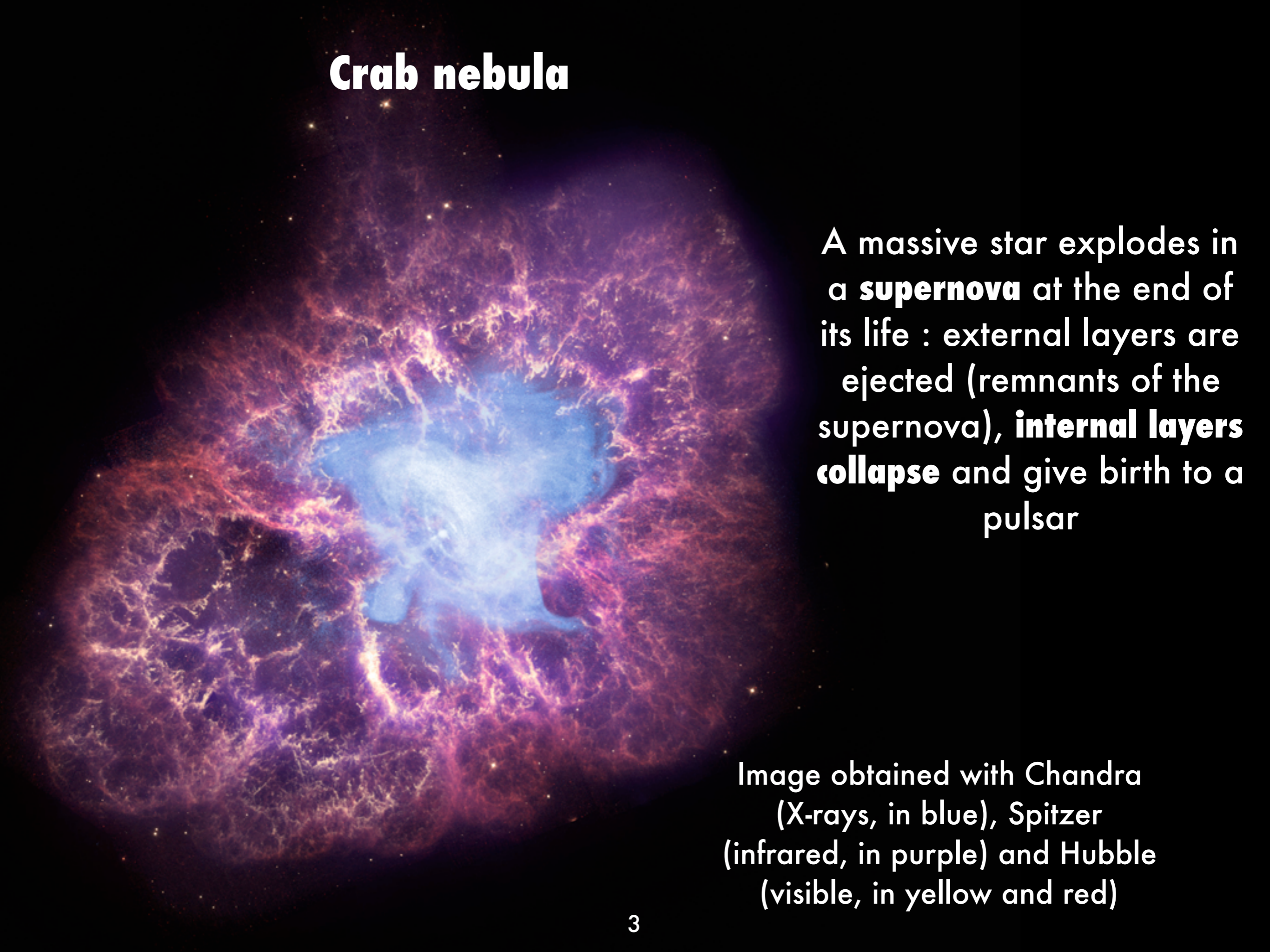
Pulsars at very high energy with the H.E.S.S. experiment

Marion Spir-Jacob, supervised by **Arache Djannati-Atai**

Contents

1. **Pulsars** : what are they ?
2. Presentation of the **H.E.S.S. experiment**
3. **My PhD** and statistical tests on periodicity

Crab nebula



A massive star explodes in a **supernova** at the end of its life : external layers are ejected (remnants of the supernova), **internal layers collapse** and give birth to a **pulsar**

Image obtained with Chandra (X-rays, in blue), Spitzer (infrared, in purple) and Hubble (visible, in yellow and red)

Extremely compact objects

▶ Solar mass in a ~ 10 km radius

▶ Compacity $\Xi = \frac{GM}{Rc^2} \sim 0.2$

▶ Neutron stars $\left\{ \begin{array}{l} n \rightarrow p^+ + e^- + \bar{\nu}_e \\ p^+ + e^- \rightarrow n + \nu_e \end{array} \right.$

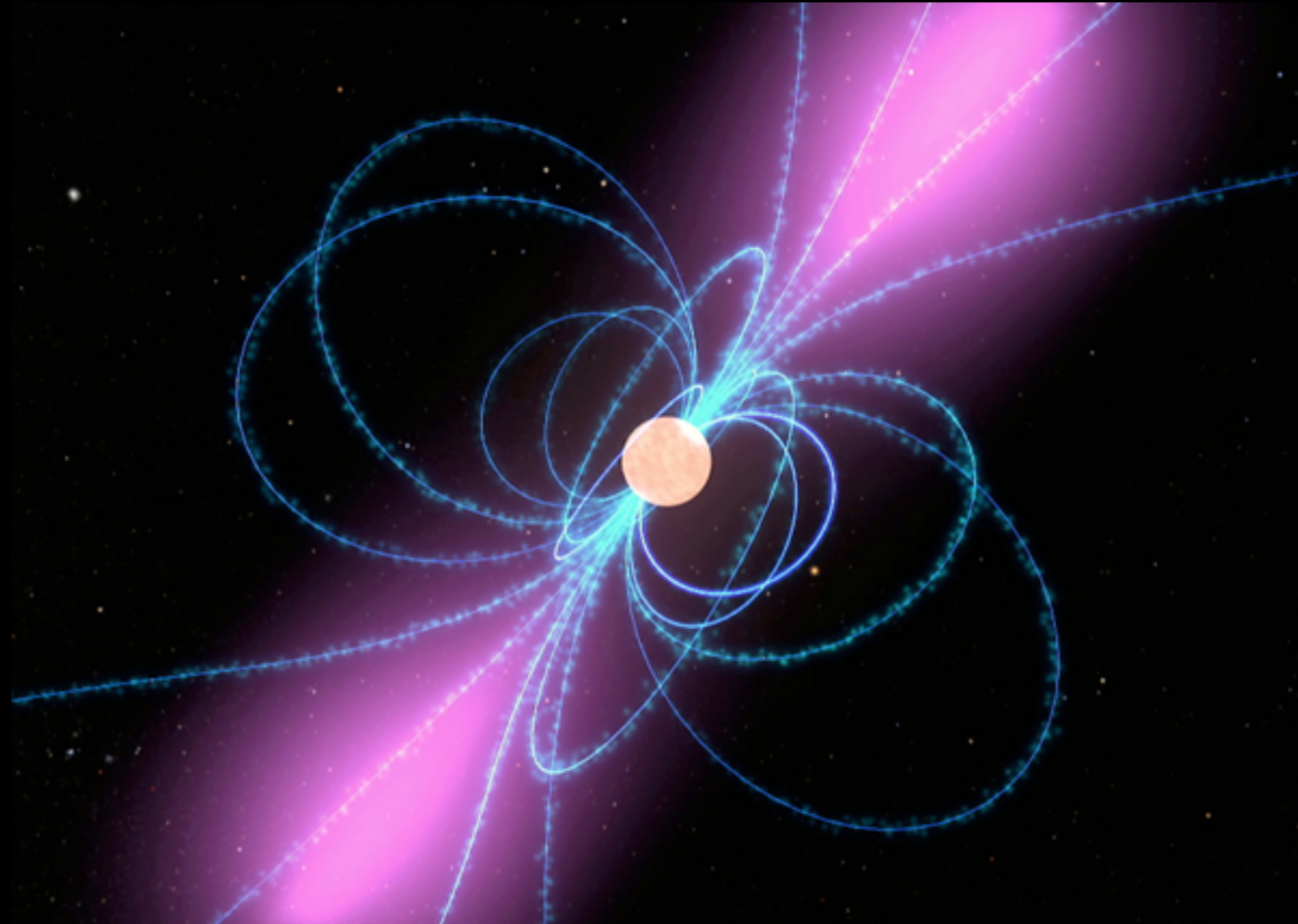
Equilibrium between the gravity and the strong force

▶ Difficult equation of state (implies quantum chromodynamics and general relativity)

Highly magnetized, fast-spinning neutron stars

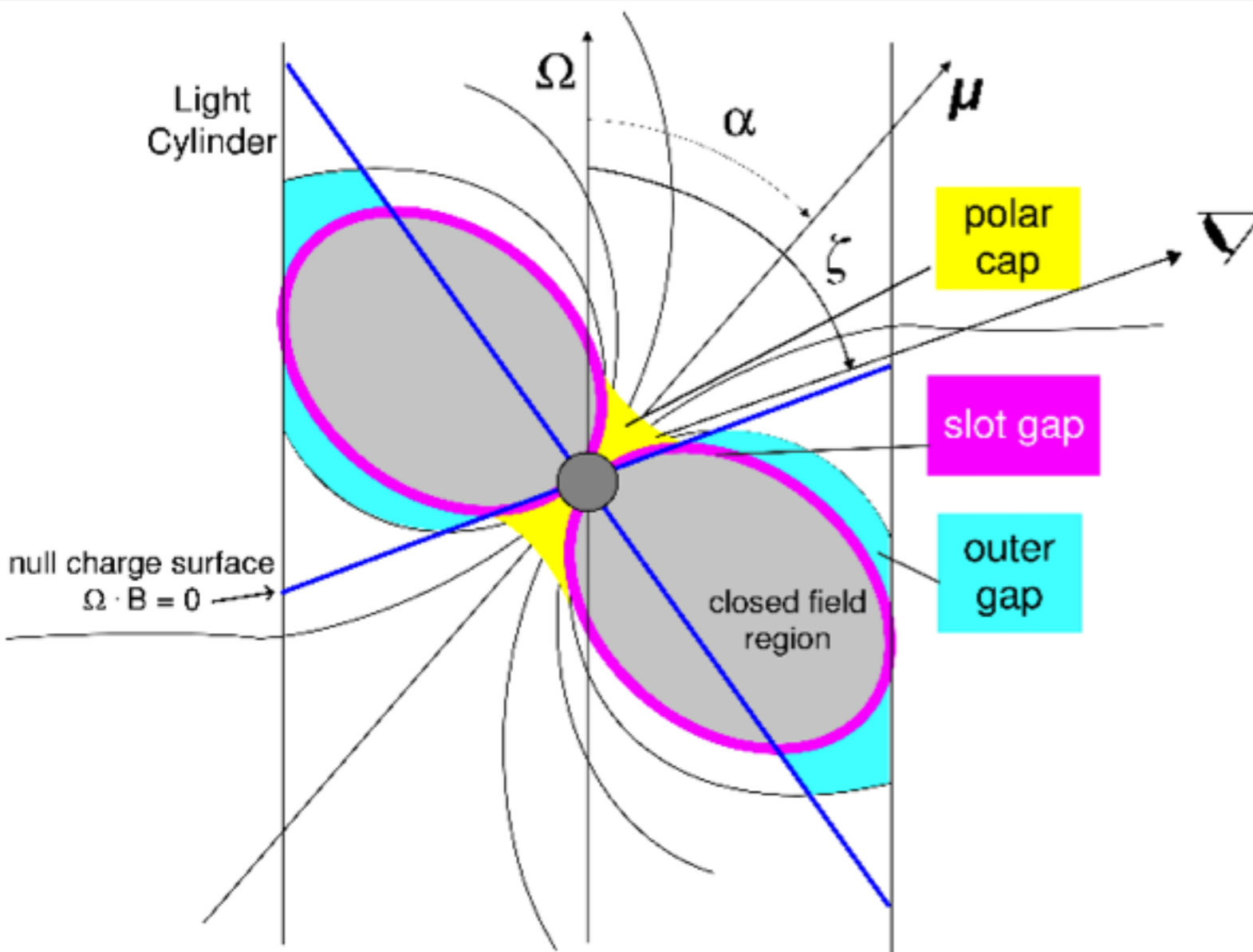
- ▶ Conservation of magnetic field flux
- ▶ Conservation of the angular momentum
- ▶ Radius diminishes drastically so the intensity of the magnetic field, as well as the speed of rotation, increases a lot

Simplified view of a pulsar

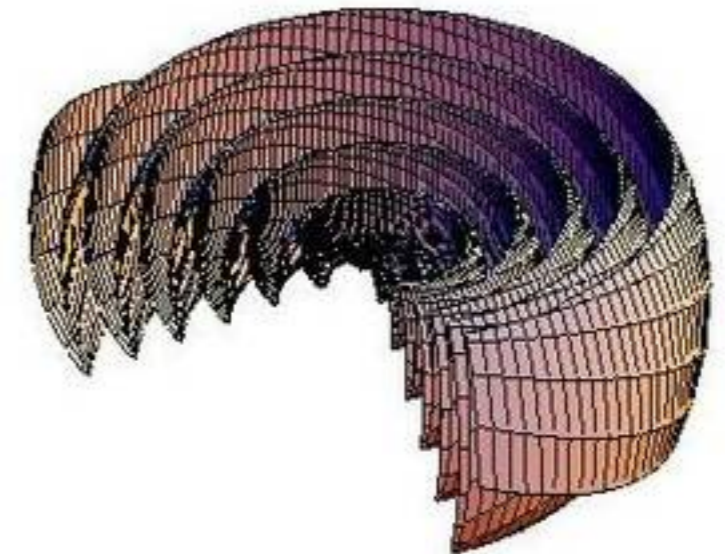


- ▶ More than 2000 detected in radio (since 1967)
- ▶ More than 200 detected in **gamma**

Different models for the pulsed emission



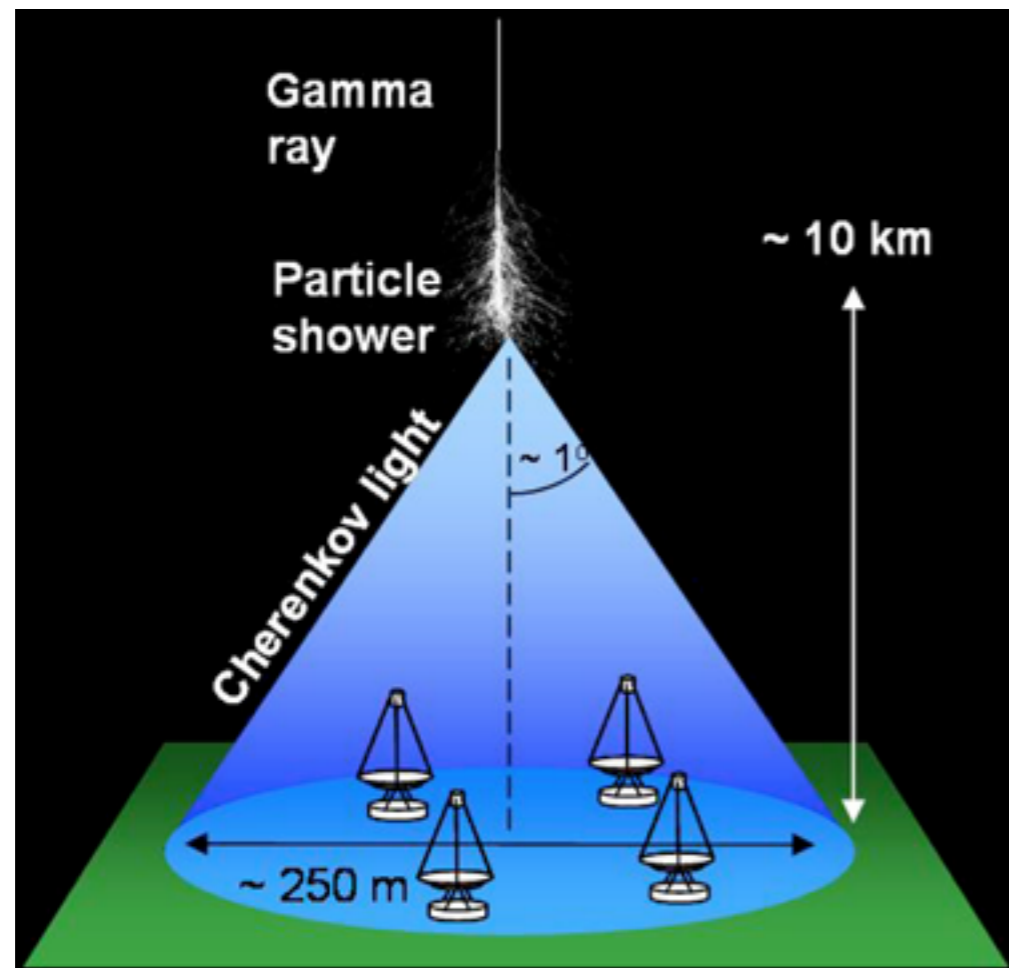
- ▶ Different models to explain **acceleration and emission** of these particles
- ▶ Different regions **inside and outside of the light cylinder**
- ▶ Different **processes** implicated



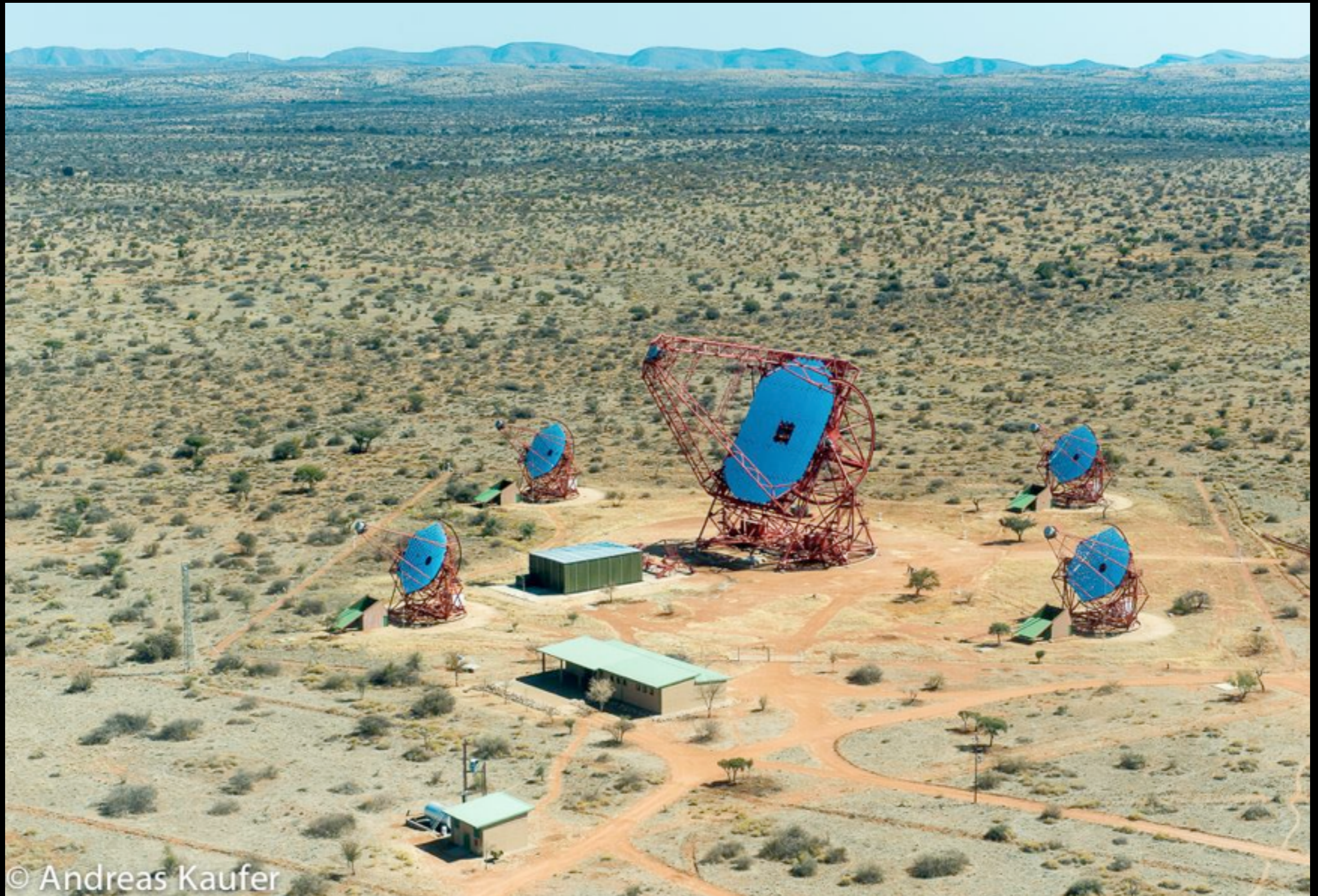
Gamma astronomy



- ▶ **Direct** detection : **Fermi** spatial telescope
- ▶ **Indirect** detection : Cherenkov telescope arrays (**VERITAS**, **MAGIC**, **H.E.S.S.**)



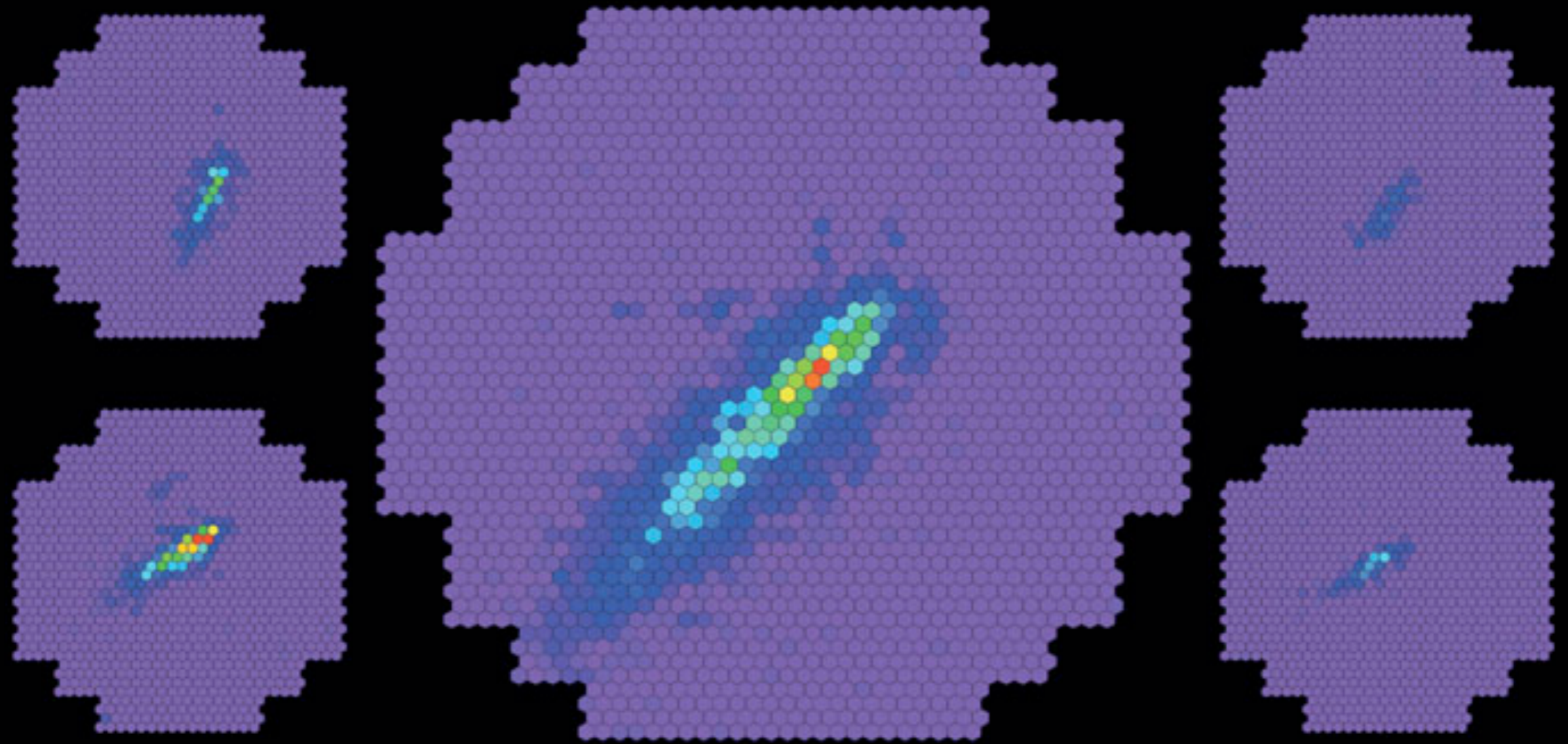
Array of Cherenkov telescopes H.E.S.S.



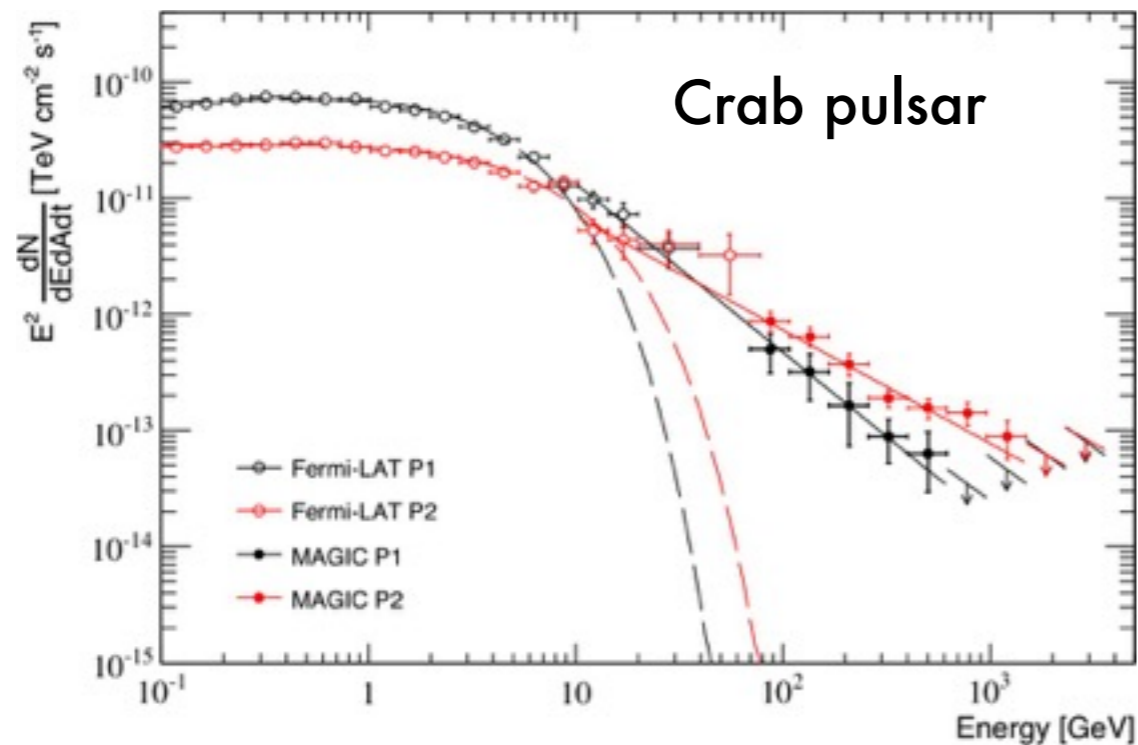
Located in Namibia where we do one-month-long shifts



The position is reconstructed by stereoscopy



Pulsars at very high energy

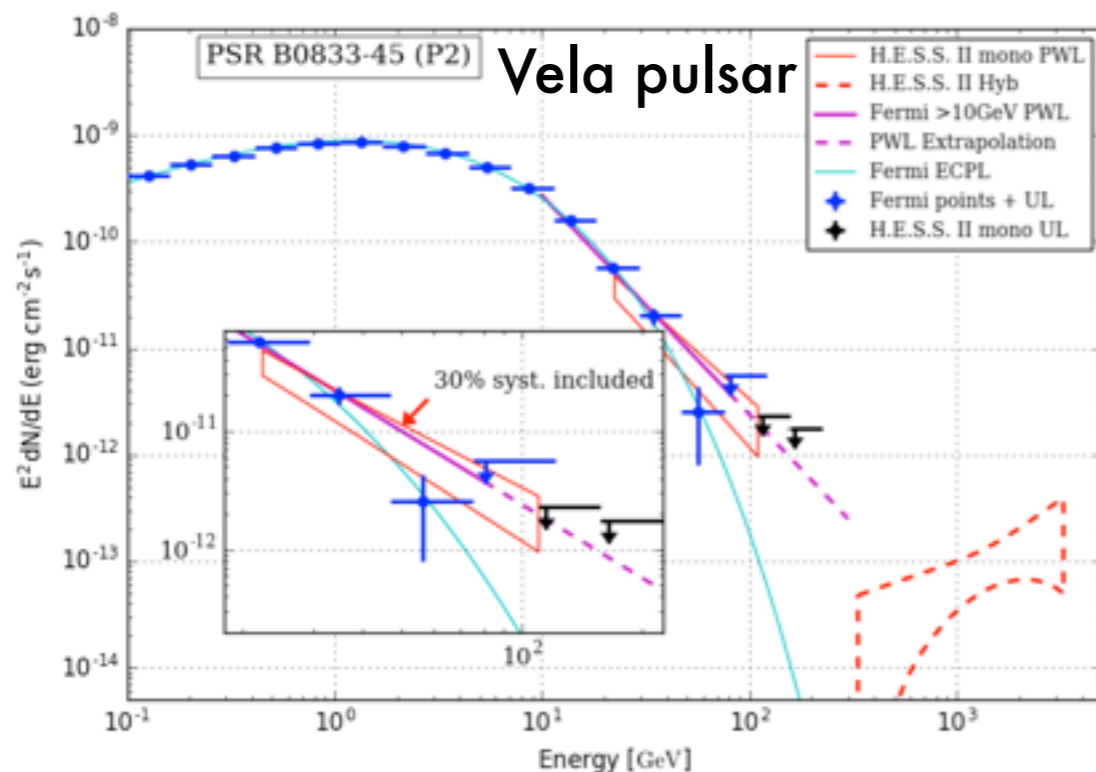


► Questioning exponential cutoff around the GeV

► Implications on pulsar models

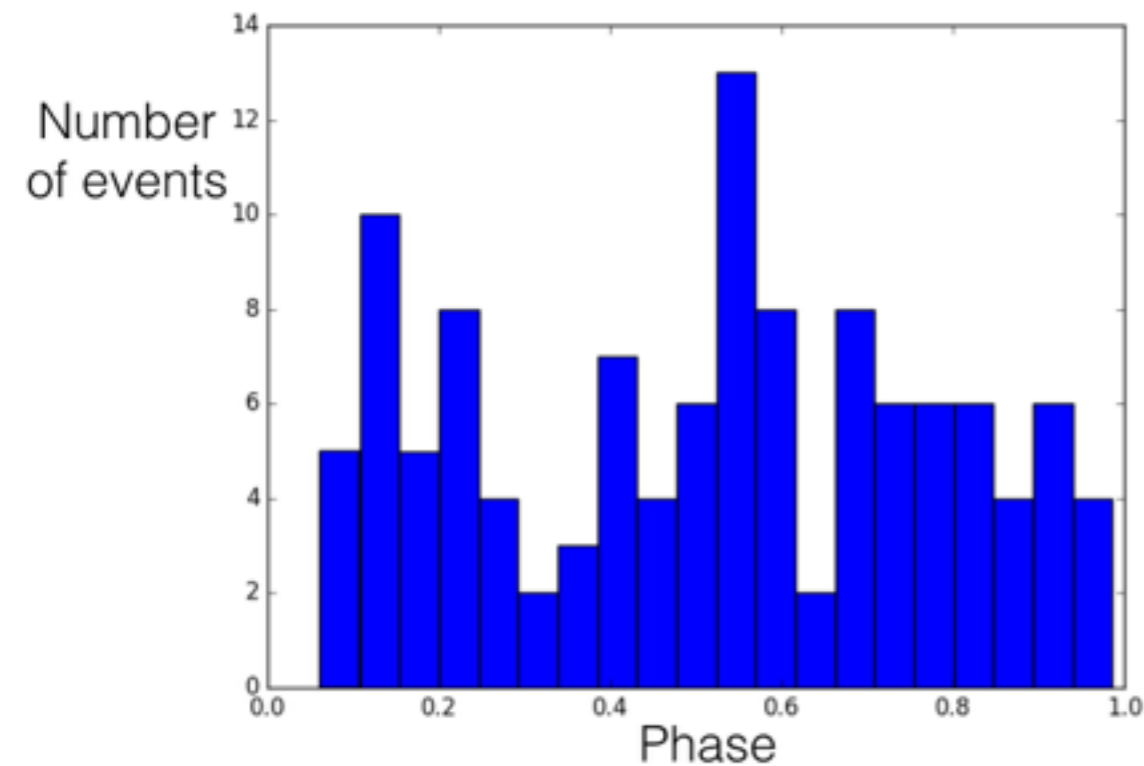
► Possible second component around the TeV

► Even more unexpected implications



My PhD

- ▶ Shifts in Namibia
- ▶ Data analysis
- ▶ Theoretical consequences of the very high energy pulsed signal
- ▶ Monte Carlo study on statistical tests on periodicity



Simulation of a typical histogram of phases

- ▶ **Few events and a lot are background:** how do we distinguish the pulsed signal from background fluctuations ?
- ▶ Need for statistical tests on periodicity
- ▶ Different tests based on different hypotheses
- ▶ Improving those tests using additional information (like the position)

Thank you for your attention ! Questions ?