



# New Extended GeV Sources in the Galactic Plane Found in a Search of the Pass 8 data from Fermi-LAT

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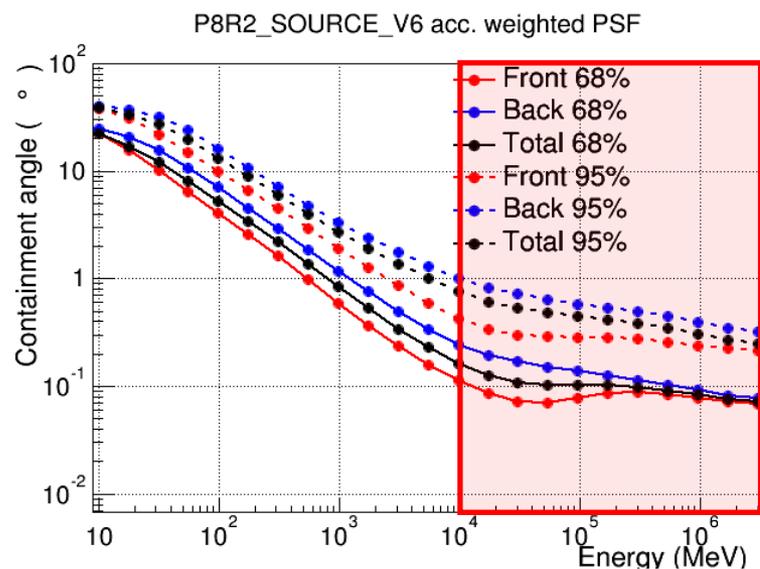
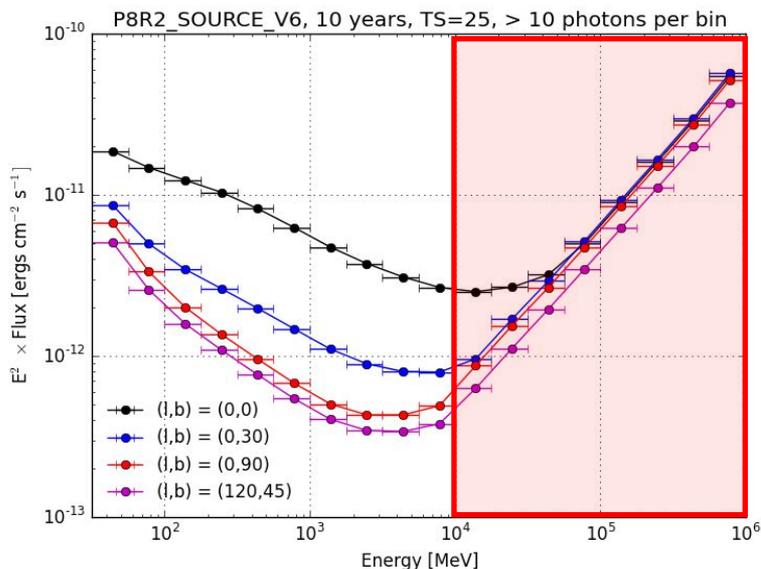
# Context & Motivation (II)

Going down from 50 GeV to 10 GeV :

- **Enhanced sensibility** => more statistics (650000 in the whole sky, **~10x more photons**)

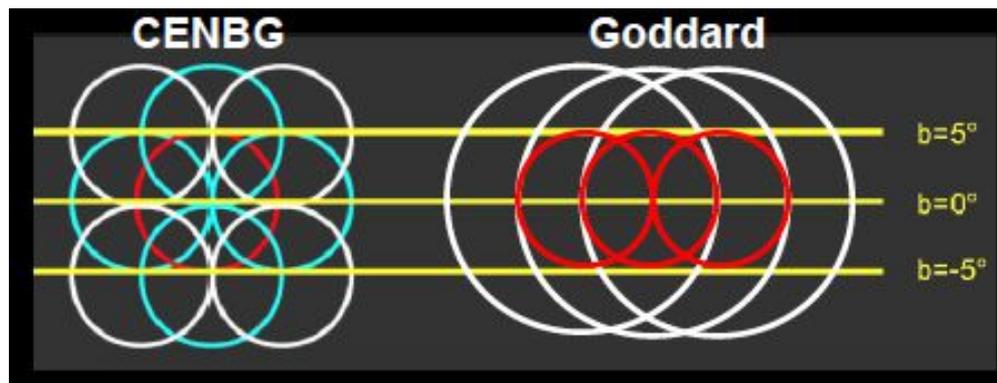
- **Still good angular resolution** ( $0.11^\circ$ , 68% containment angle)

=> **high capability to resolve and detect extended sources**



# Method

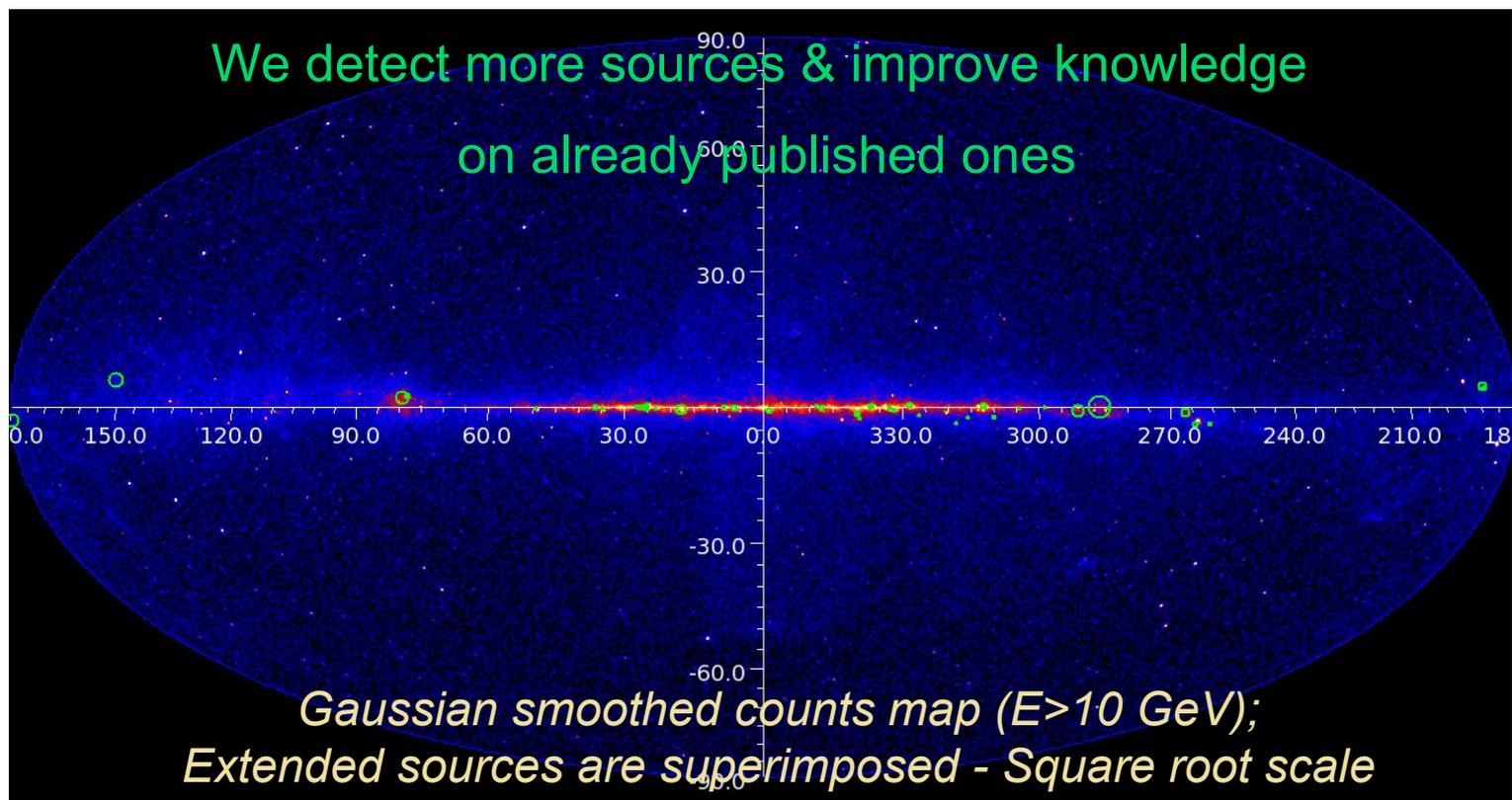
- 6 years of Pass 8 data (P8R2\_SOURCE\_V6)
- Energy : 10 GeV – 2 TeV
- Start from 3FGL source positions
- Scan the Galactic plane with overlapping regions covering **latitudes from  $-7^\circ$  to  $+7^\circ$  : two independant pipelines (CENBG vs GFSC)**



- Test candidates for position, extension, alternate hypotheses (2 pt. sources vs 1 ext. source) and curvature
- **Extended sources :  $TS > 25$  &  $TS_{\text{ext}} > 16$  &  $TS_{2\text{pts}} < TS_{\text{ext}}$**

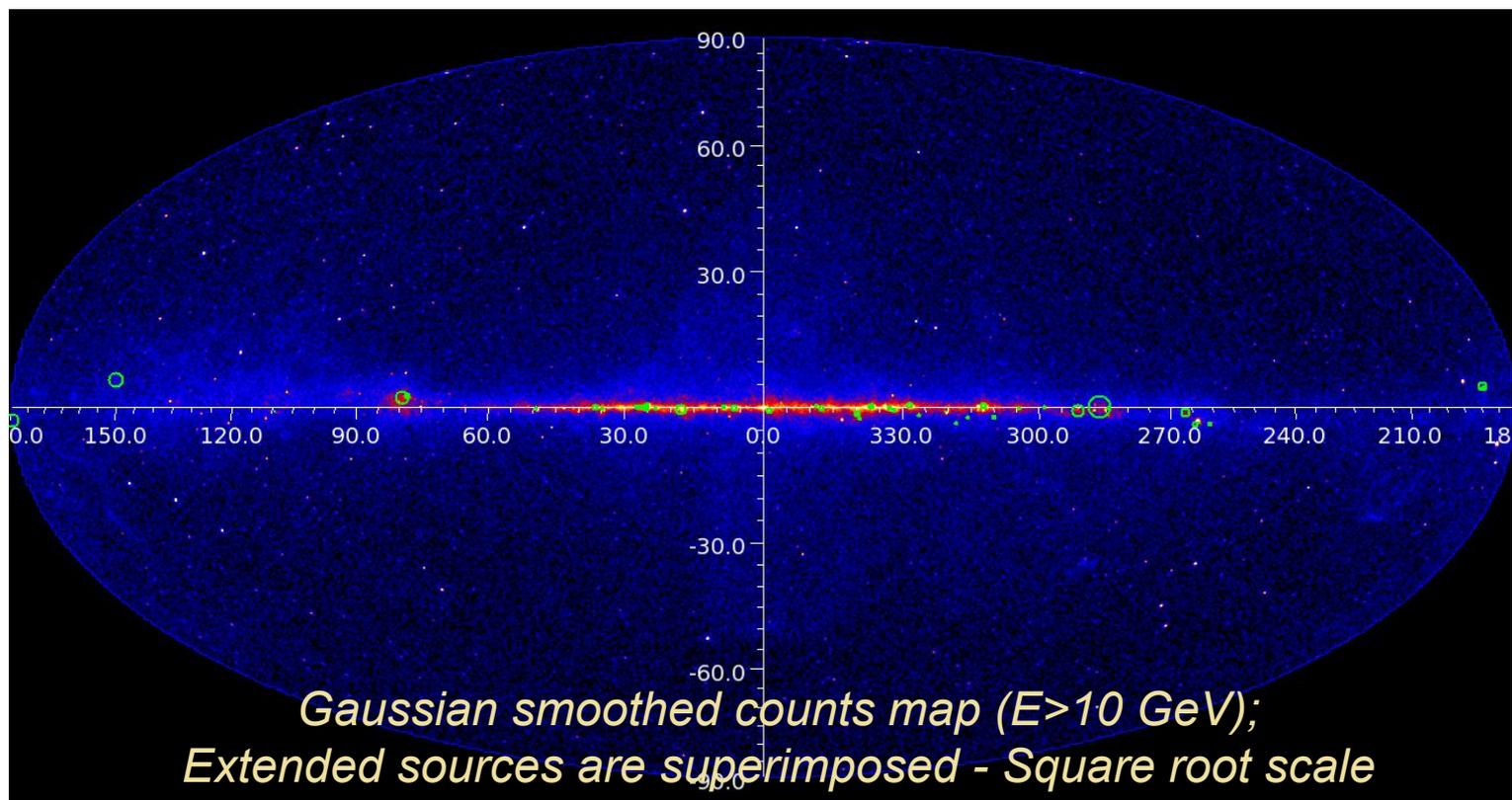
# Results

- More than 40 extended sources are detected
  - > 15 have different morphology than 3FGL
  - > 10 are new extended sources



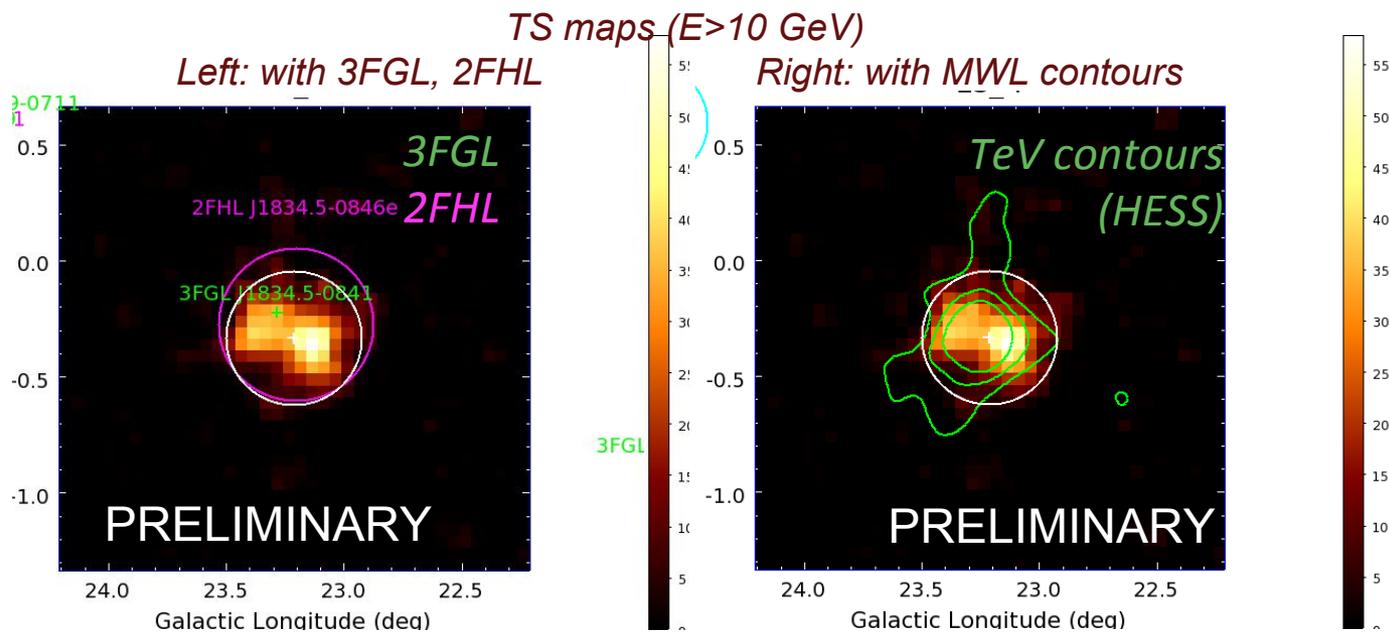
Cases can be distinguished in :

- A. Agreement
- B. Improvement
- C. New extended sources



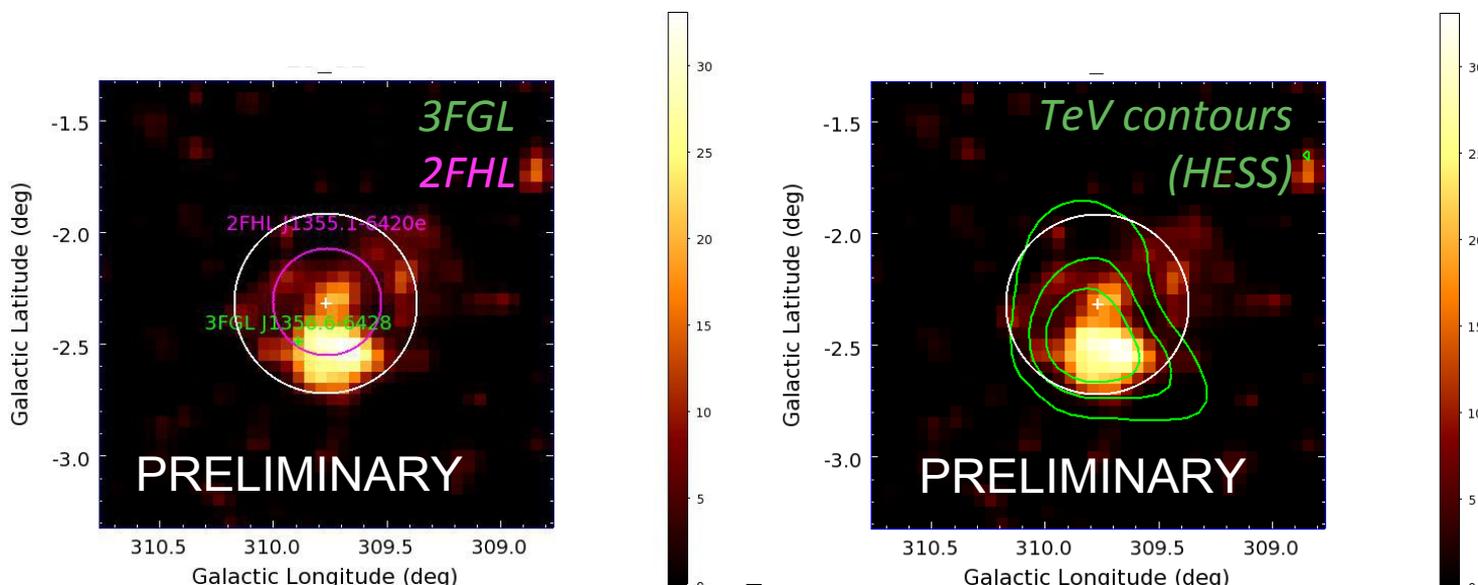
# A. Agreement

- **Example : HESS J1834-087 = SNR W41**
  - UNID detected by H.E.S.S.; origin related to SNR or PWN
  - Extension :  $0.29^\circ \pm 0.02^\circ_{\text{stat}}$  (SNR Cat :  $\text{ext} = 0.33^\circ \pm 0.04^\circ$ )
  - $TS = 133$ ,  $TS_{\text{ext}} = 76$
  - Position and extension compatible with HESS J1834-087
  - 10 GeV Spectrum nicely connects to the TeV results



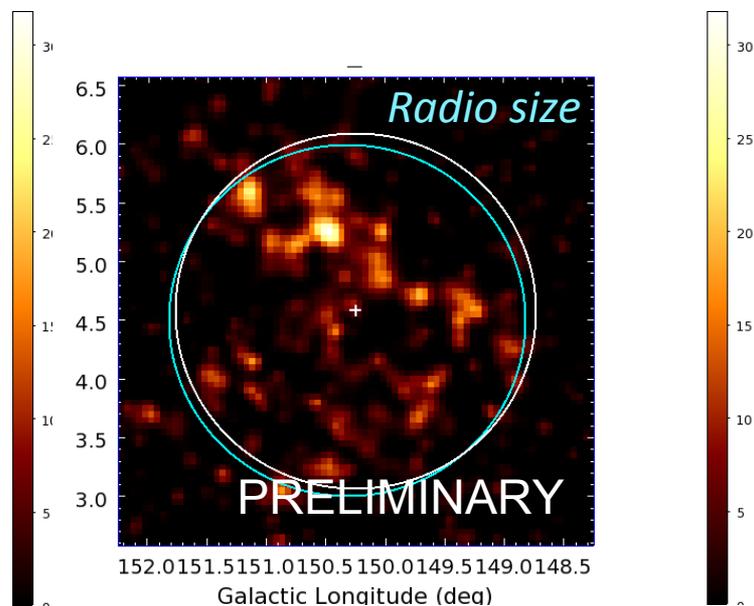
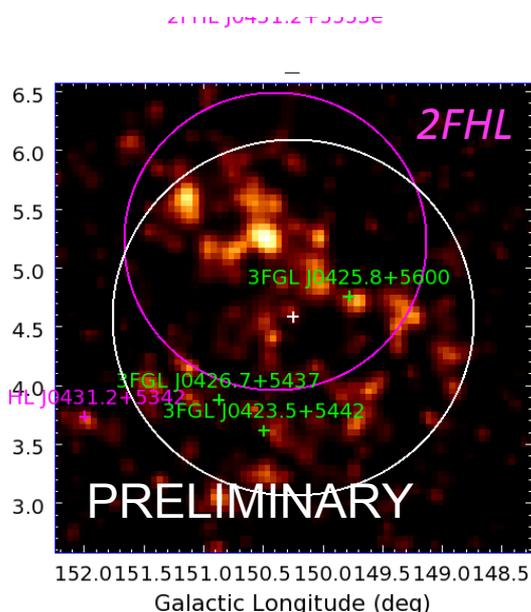
## B. Improvements

- **Example 1 : HESS J1356-645**
    - PWN powered by PSR J1357-6429
    - Detected at TeV by H.E.S.S.
    - 10 GeV Extension :  $0.40^\circ \pm 0.02^\circ_{\text{stat}}$  (2FHL : ext =  $0.24^\circ$ )
    - TS = 84, TS<sub>ext</sub> = 41
    - Position and extension compatible with HESS J1356-645
- Excellent morphological and spectral agreement with H.E.S.S.**



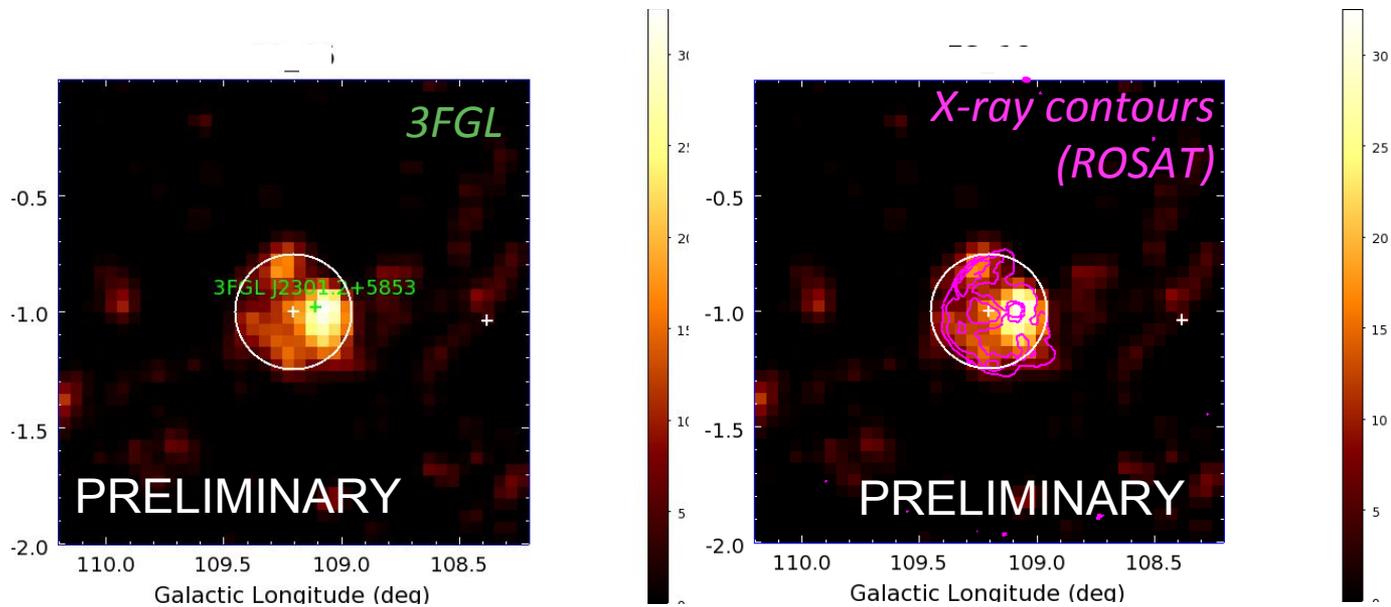
## B. Improvements

- **Example 2 : SNR G150.3+4.5**
  - Recently discovered radio remnant by Gao & Han (2014)
  - Identified as an extended gamma-ray source in 2FHL
  - **Above 10 GeV, the full shell is detected: excellent agreement with the radio size**
  - Large size seems to argue that the remnant is quite old or quite nearby but hard spectrum unusual for such SNRs



# C. New extended sources

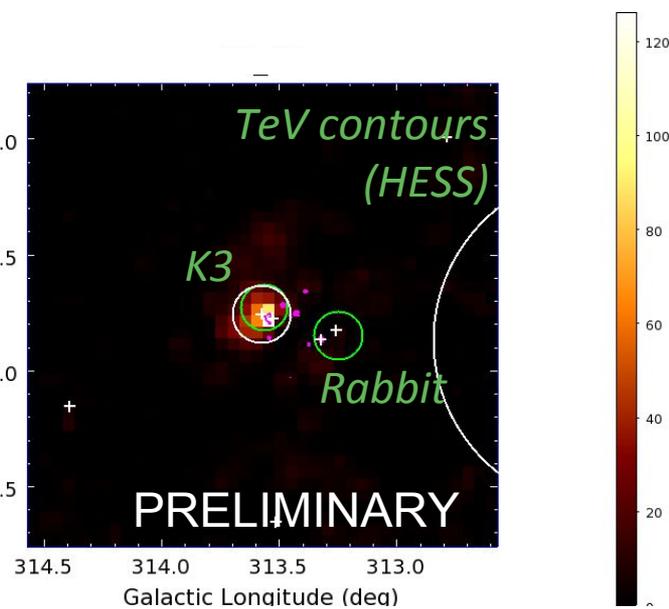
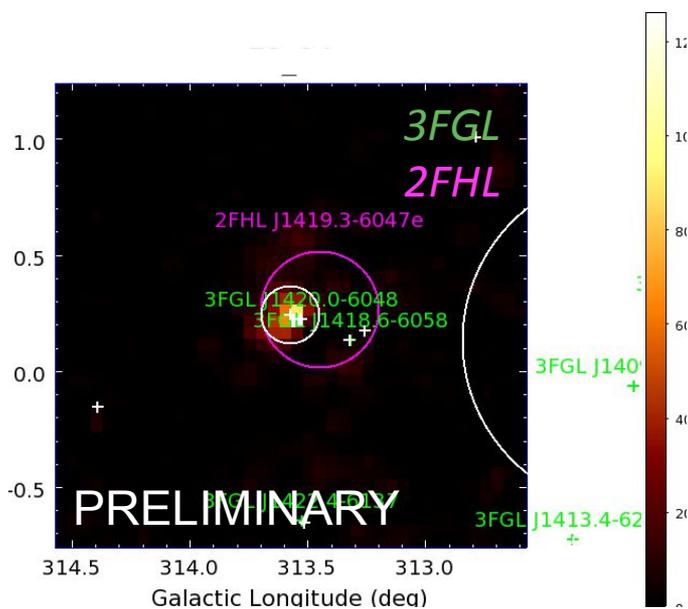
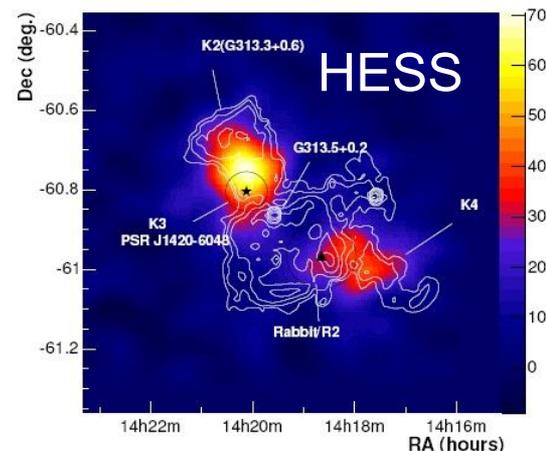
- **Example 1 : SNR CTB 109**
  - Age : 8800 – 14000 yrs
  - Contains a magnetar
  - Detected at radio and X-ray (shock + cloud)
  - Extension :  $0.25^\circ \pm 0.02^\circ_{\text{stat}}$
  - $TS = 54$ ,  $TS_{\text{ext}} = 26$
  - Position and extension compatible with the SNR seen in X-rays



# C. New extended sources

## • Example 2 : Kookaburra complex

- Complex contains 2 pulsars and 2 PWNe
- Both PWNe detected at TeV
- 2FHL detects the whole complex
- Extension :  $0.12^\circ \pm 0.01^\circ_{\text{stat}}$
- $TS = 77$ ,  $TS_{\text{ext}} = 32$
- Position and extension compatible with HESS J1420-607 (K3)



# Conclusions

- Paper by the Fermi collaboration to be submitted by summer
  - > 40 extended sources
  - > 10 new extended sources
  - Some statistics :
    - Average spectral index :  $\sim 2.1$
    - Average disk radius :  $\sim 0.5^\circ$
    - Dominant fraction of identified sources : SNRs
    - All PWNe detected in this work are coincident with TeV sources

This analysis has resolved sources that were previously unknown to be spatially extended or in some cases were confused at GeV energies, thus helping for the identification or the modeling.

# Perspectives

- Fermi's HE catalogs are extremely useful for the TeV community
  - LAT large FoV avoids biases with respect to usual observation programs
  - Large SNR (such as G150) are difficult to detect at TeV
- Aim of this work : perform a comparison with the TeV sources and see which sources are good candidates in the future for TeV instruments

**=> Going beyond HE catalogs is a good preparation for CTA science**

