Disentangling the hadronic from the leptonic emission in the composite SNR G326.3-1.8

6th Fermi symposium

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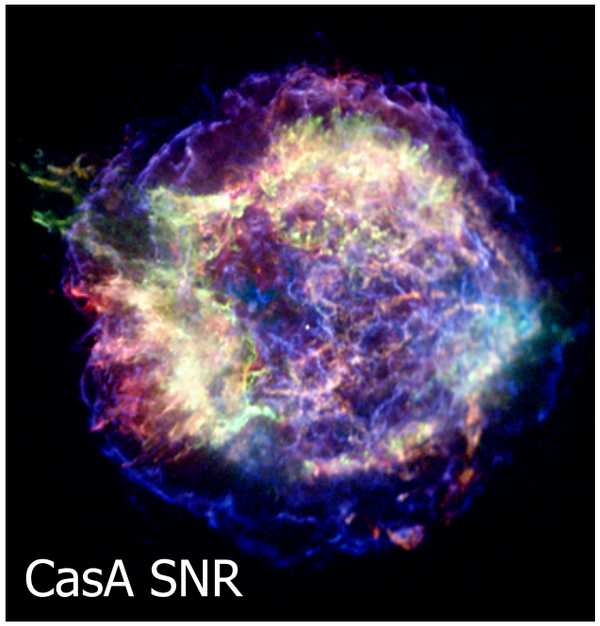
for the Fermi-LAT collaboration

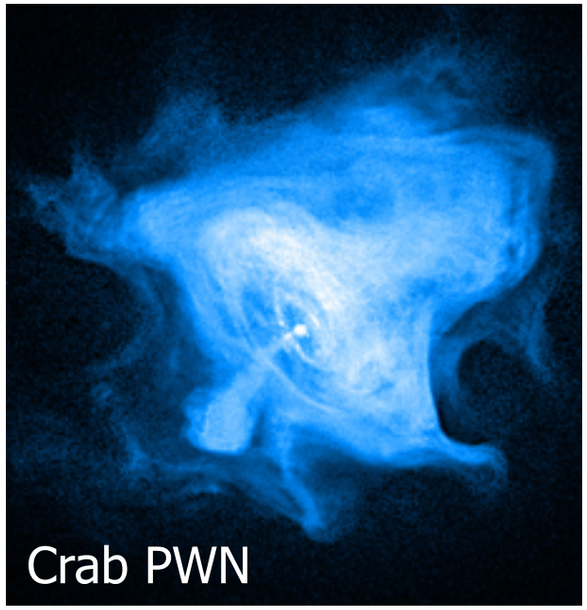
1) LUPM, Univ. Montpellier

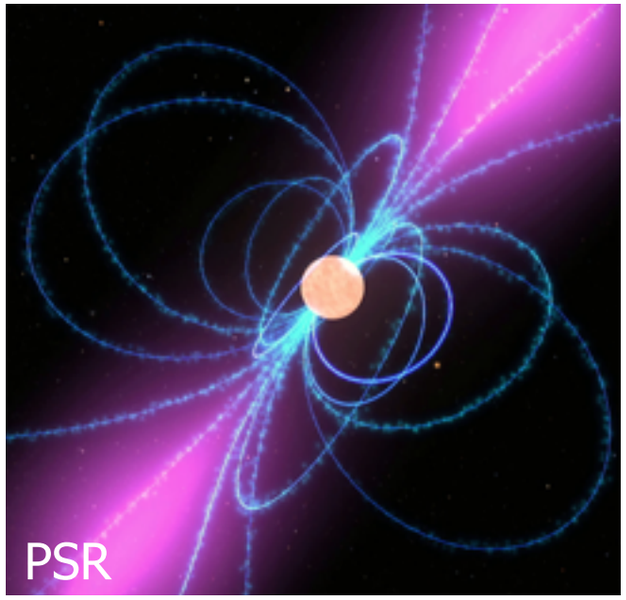
2) AIM, CEA-Saclay

Particle acceleration in the stellar graveyard

SNR, PWN, Pulsar







Acceleration at:

Forward shock

Relativistic shock

Polar cap, slot gap ?

Dedicated Fermi catalog:

SNRcat, Fermi collab+15

PWNcat, Rousseau+13

2PSRcat, Abdo+13

A core collapse supernova may produce all three

Composite SNR

G326.3-1.8

T = 16 kyrs

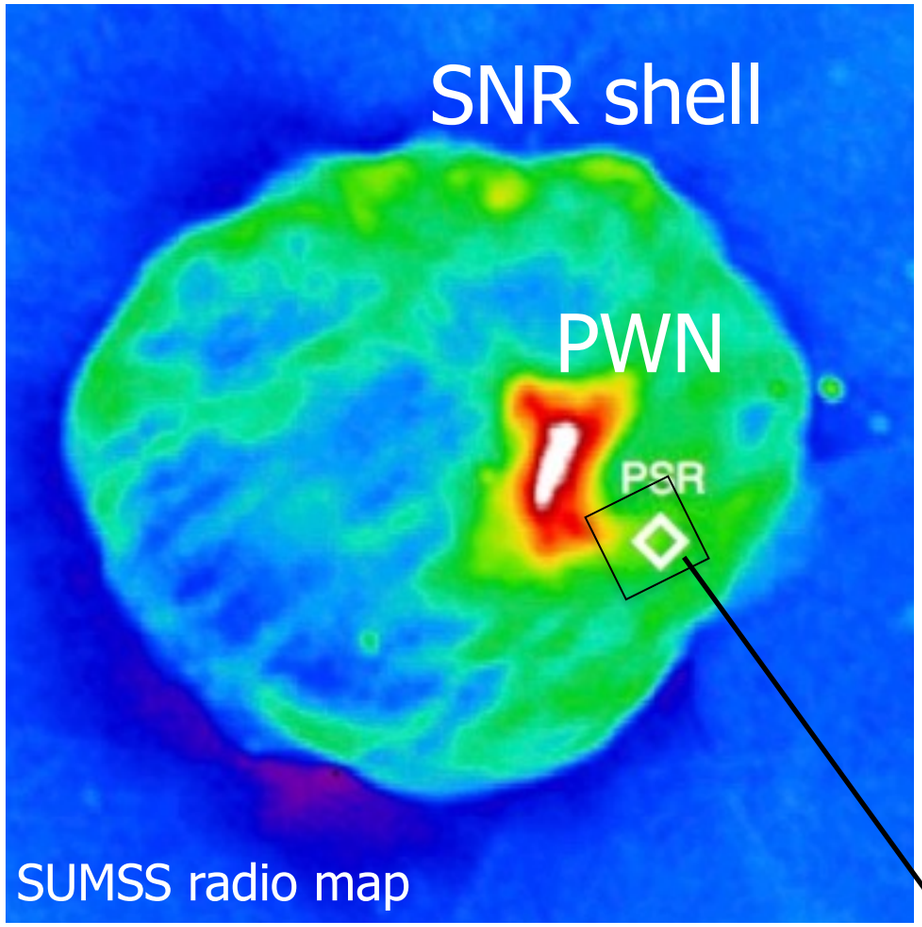
d = 4.1 kpc

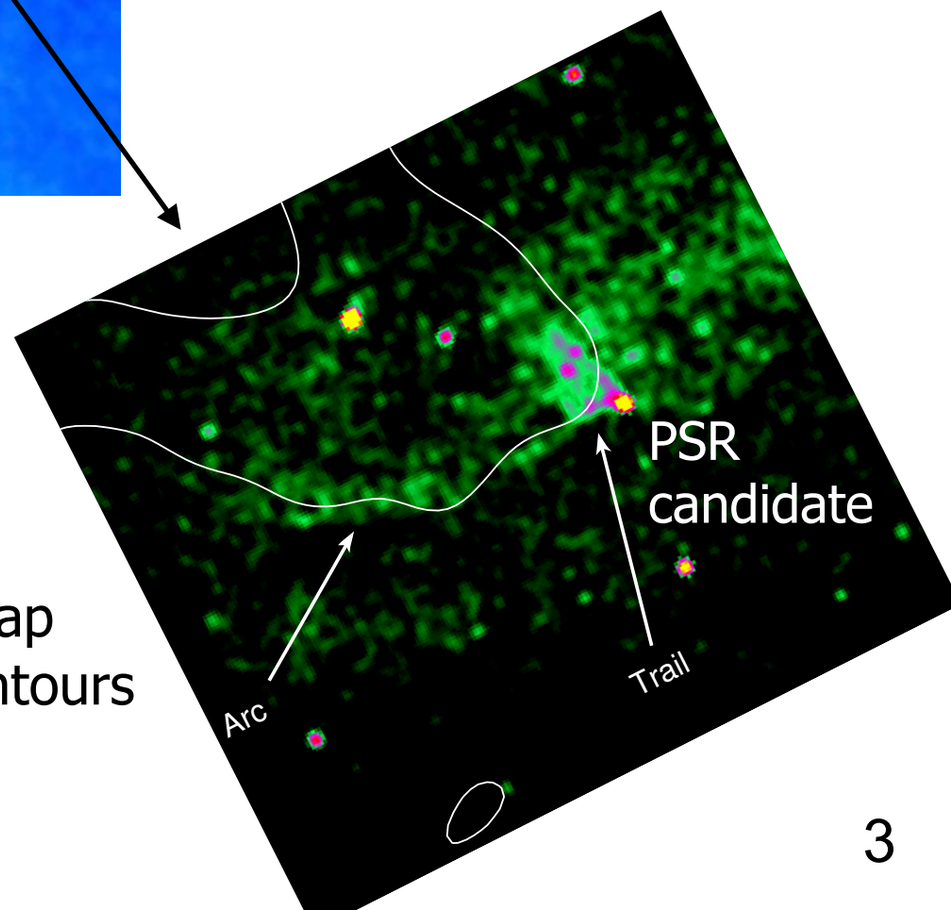
$\dot{E}$ = 4×10^{36} ergs/s*

R = 0.3°

*estimated from model. No timing.

Where are the γ-rays coming from ?

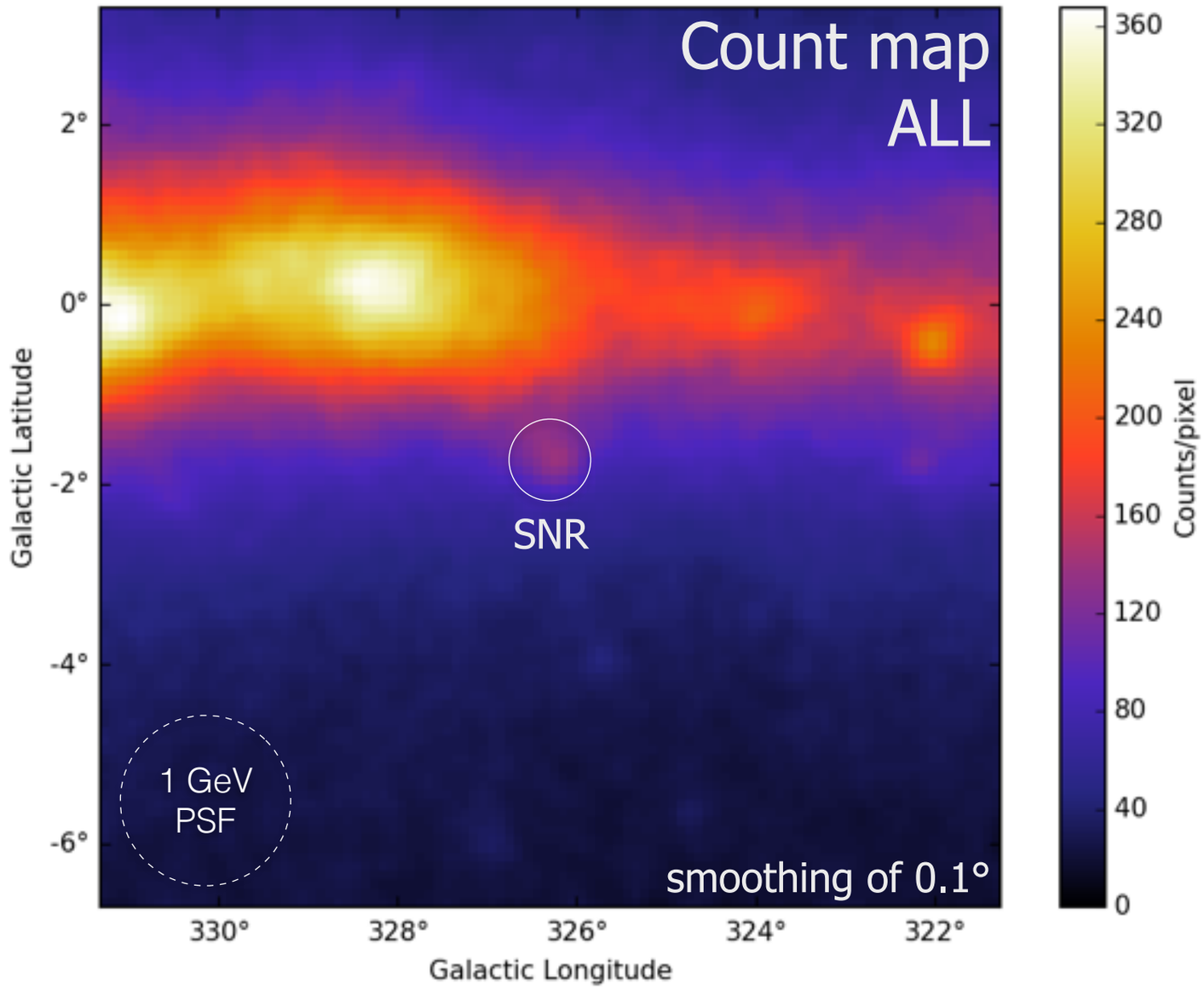




Chandra map
+ radio contours

Temim+13

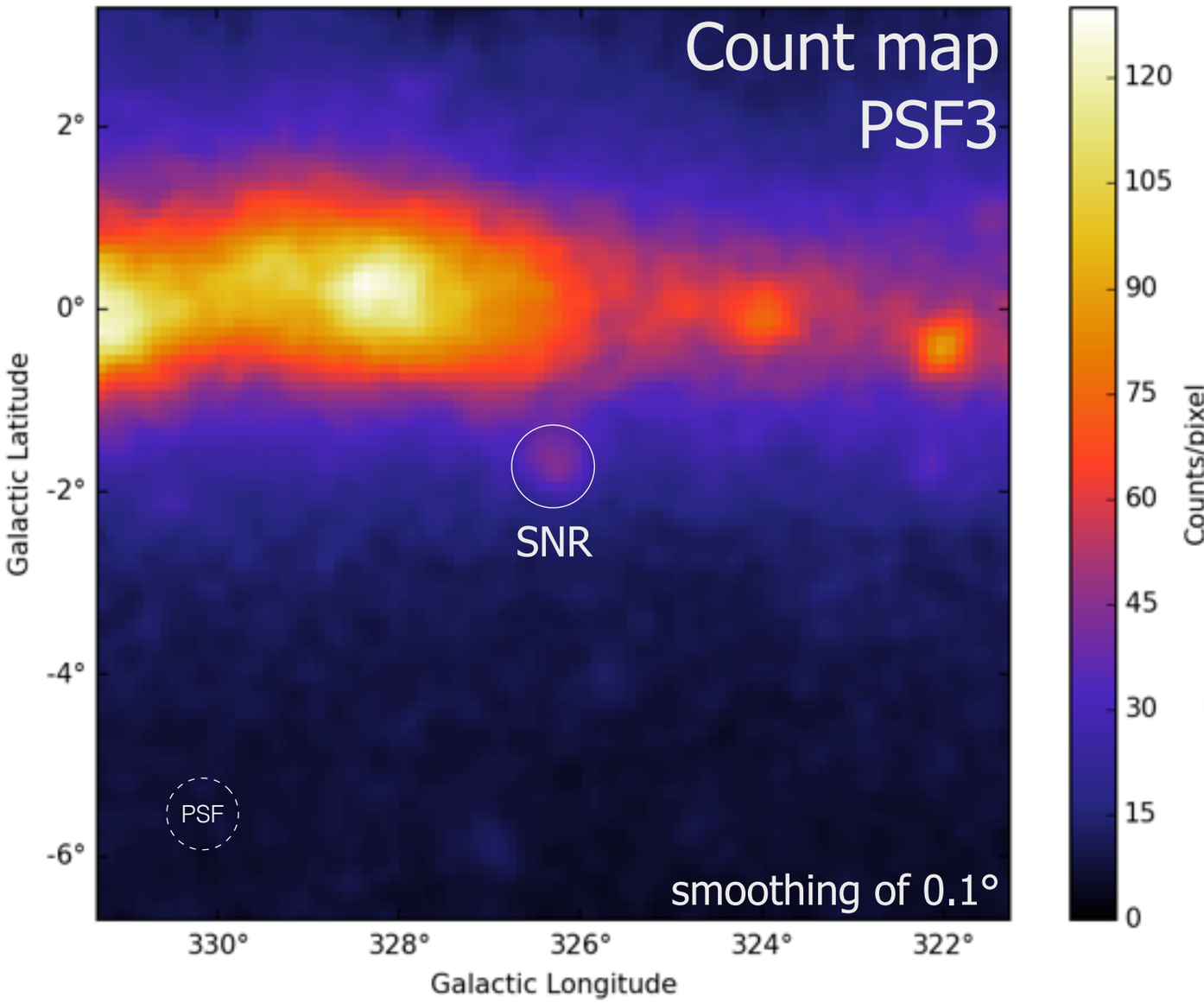
SNR G326 with 6.5yrs of P8 data



Bright SNR
TS~1400
for ALL events

- Analysis on 10°x10° ROI for 0.3-300 GeV
- 6.5 yrs of P8_SOURCE - **PSF3 only**
  (Temim+13: 4yrs of P7V6 data)
- Binned analysis
- Starting point : 3FGL

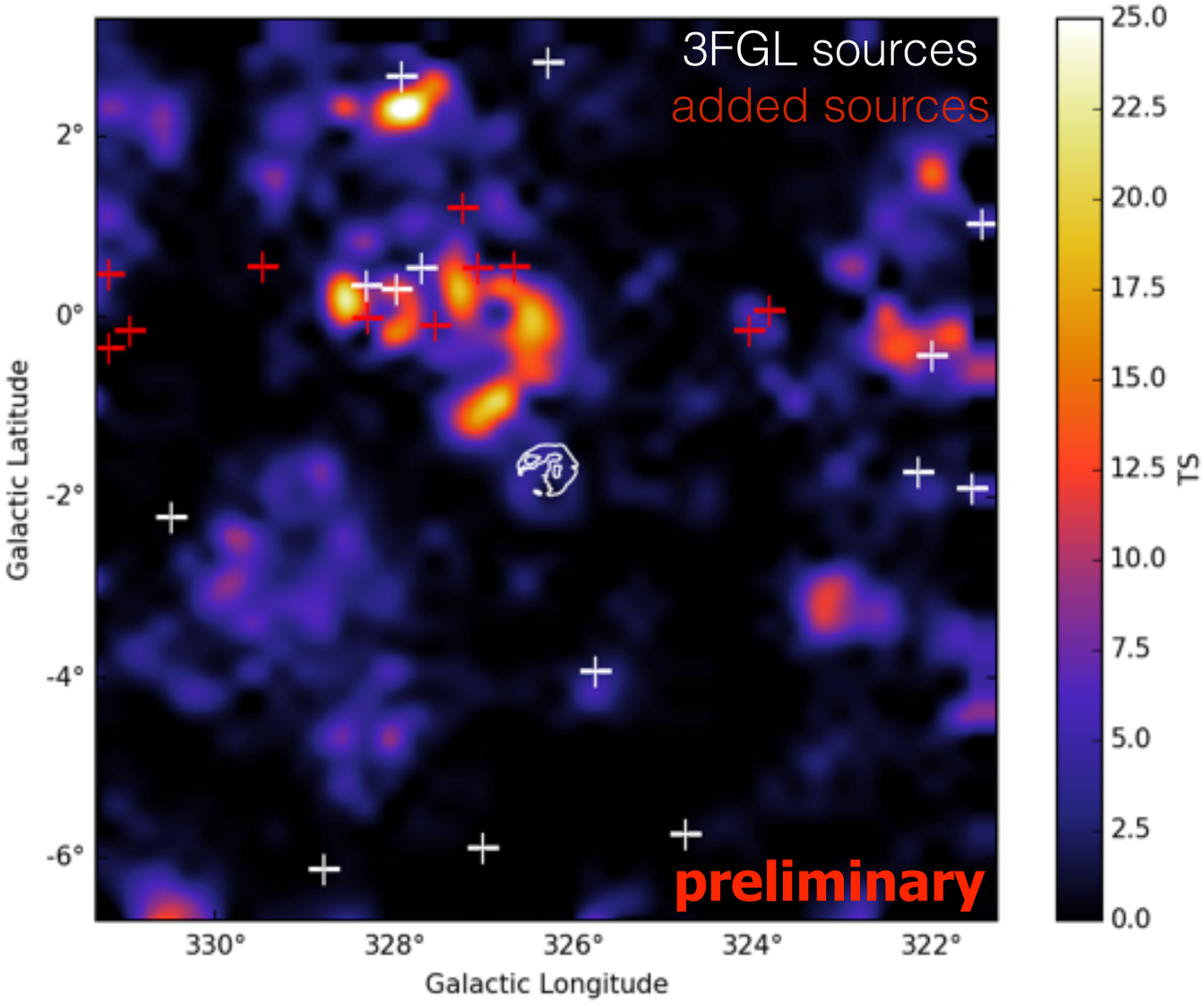
SNR G326 with 6.5yrs of P8 data



Still TS~700 for PSF3 events
+
Reduce spill-over from the galactic plane
+
Disentangle the contribution from different morphological components

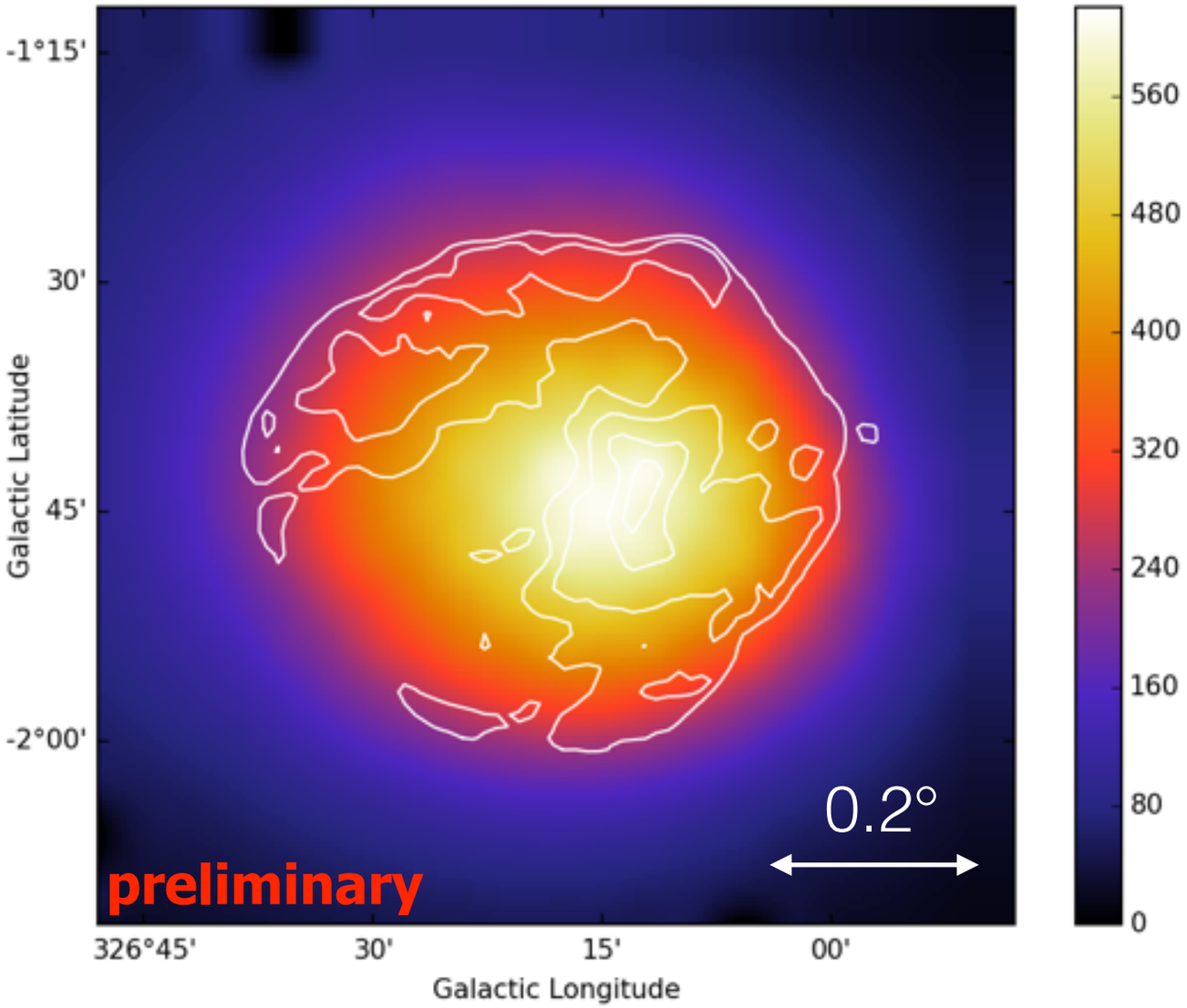
- Analysis on 10°x10° ROI for 0.3-300 GeV
- 6.5 yrs of P8_SOURCE - **PSF3 only**
  (Temim+13: 4yrs of P7V6 data)
- Binned analysis
- Starting point : 3FGL

Large scale residual TS maps



- **10°x10° ROI for 0.3-300 GeV**
- **6.5 yrs of P8_SOURCE**
- **PSF3 only**
- **Added few sources (mostly in plane)**
- **Closest source is 2.3° away**
- **Residual TS map. SNR is included**

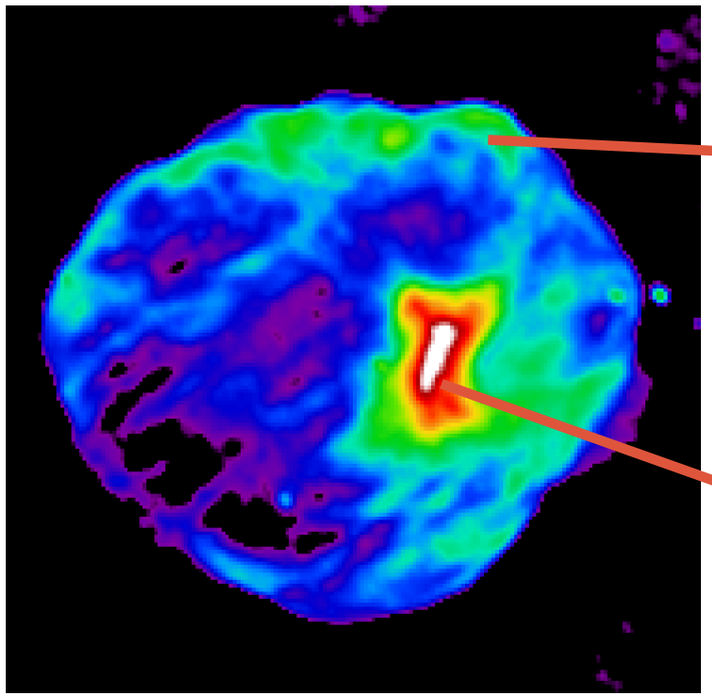
Zoom on the TS map



- **10°x10° ROI for 0.3-300 GeV**
- **6.5 yrs of P8_SOURCE**
- **PSF3 only**
- **Added few sources (mostly in plane)**
- **Closest source is 2.3° away**
- **Residual TS map. SNR is not included**

- **Can we disentangle the PWN/SNR components ?**

Testing PWN+SNR shell separately

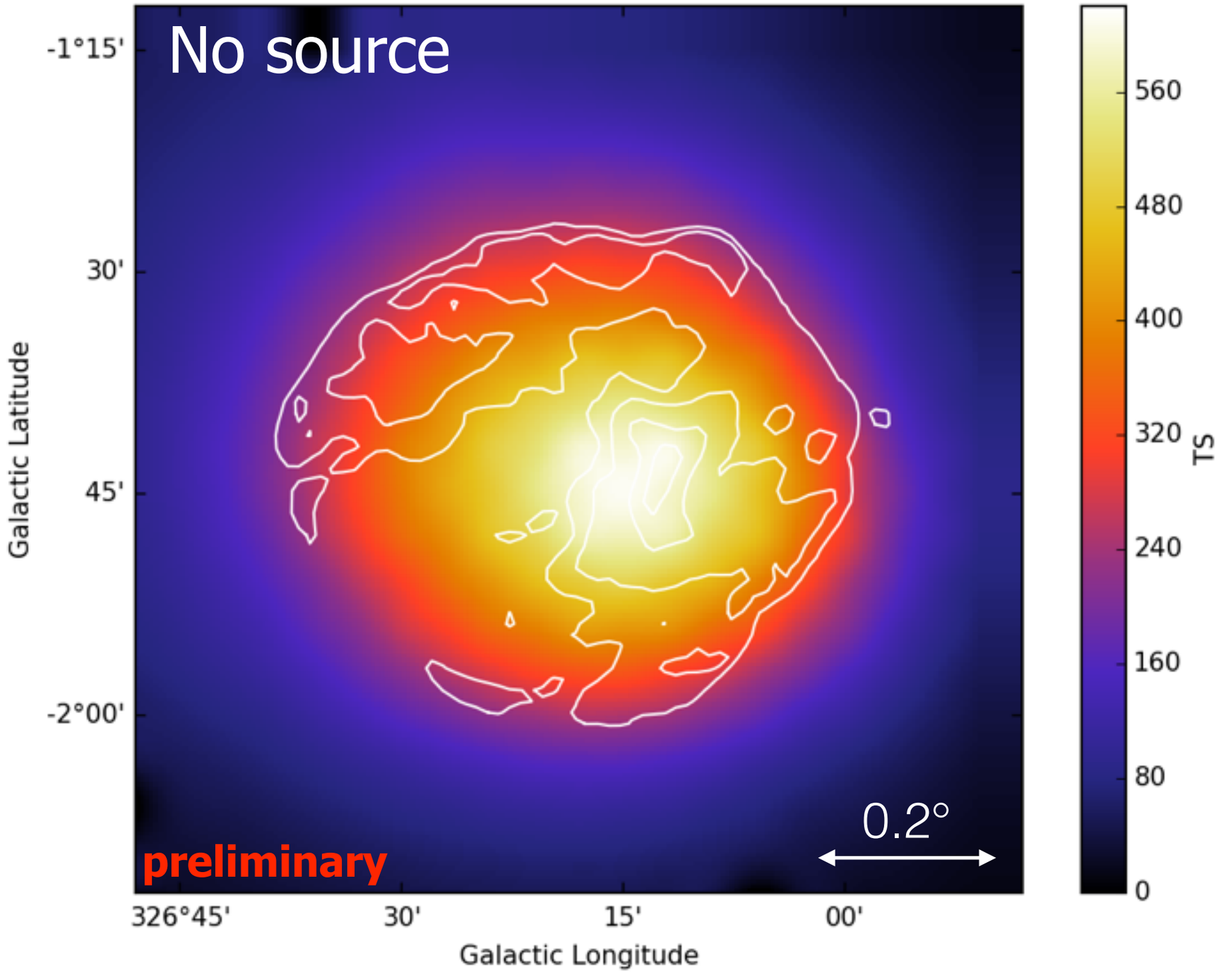


templates for analysis

- **Can we disentangle the PWN/SNR component ?**
  - **1) Morphological analysis using multi-wavelength templates**
  - **2) Spectral analysis of each component (spectral signature?)**
  - **3) Energy dependent morphological analysis**

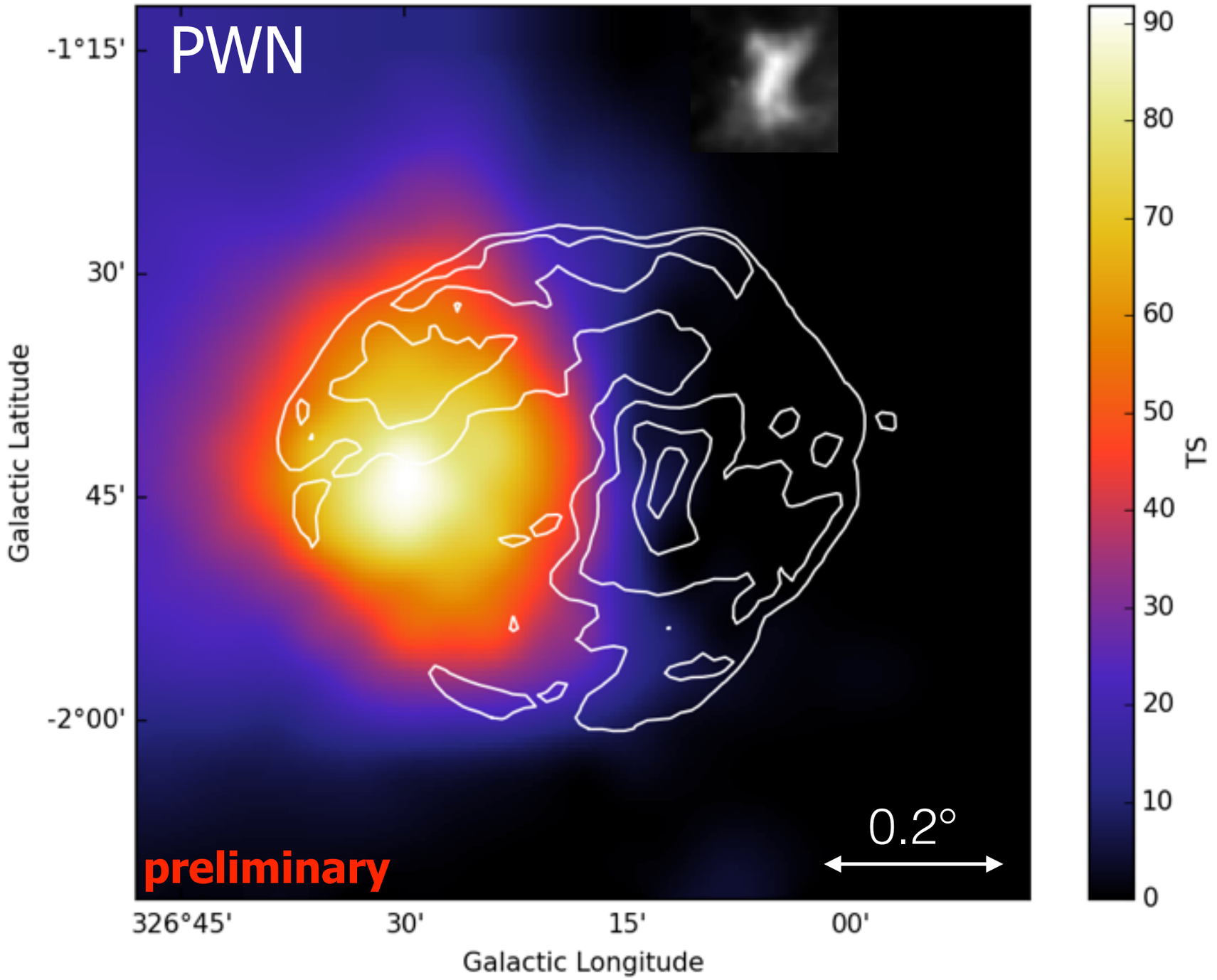
1) Morphological analysis with templates

TS maps



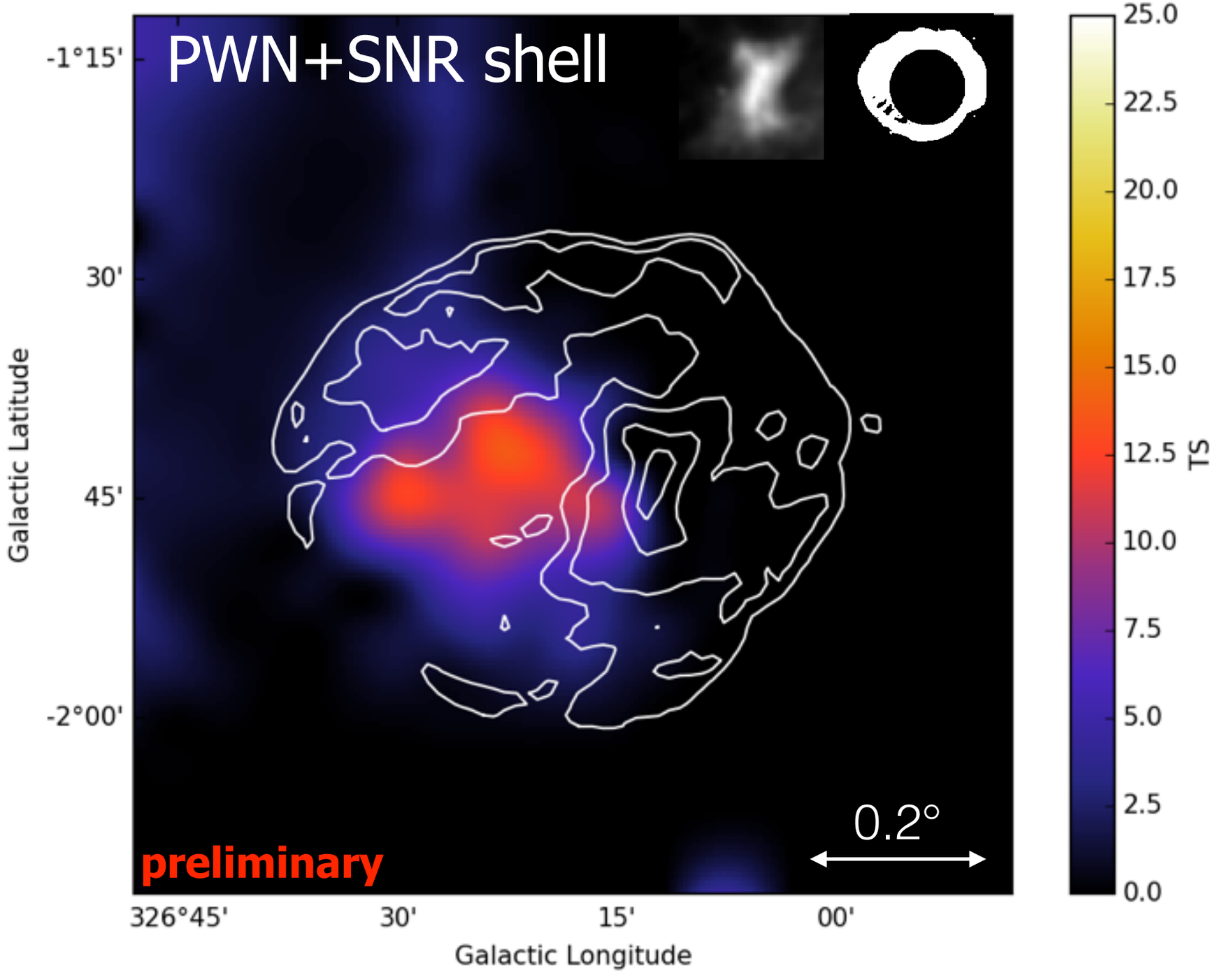
1) Morphological analysis with templates

TS maps

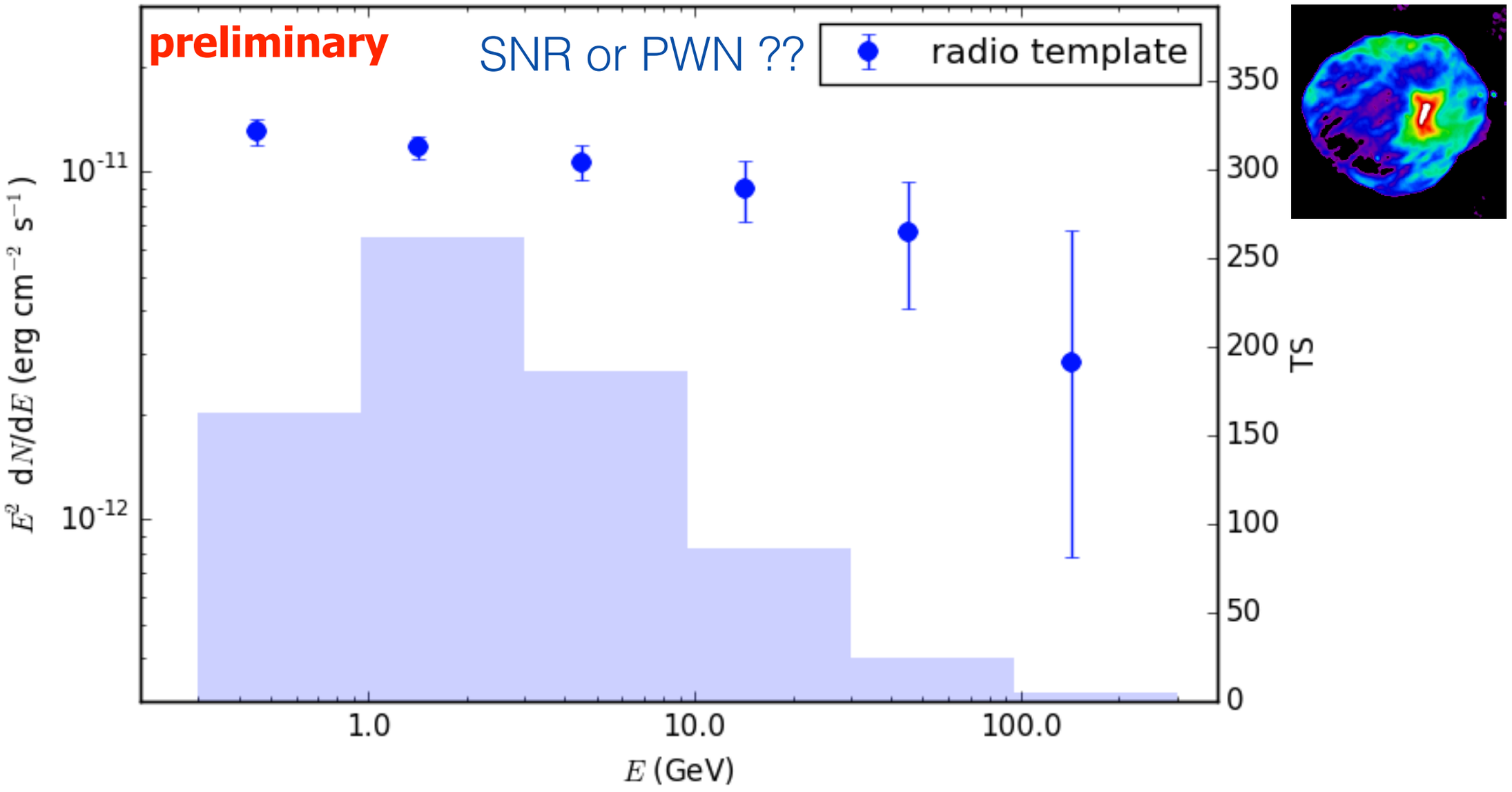


1) Morphological analysis with templates

TS maps



2) Spectral analysis of components



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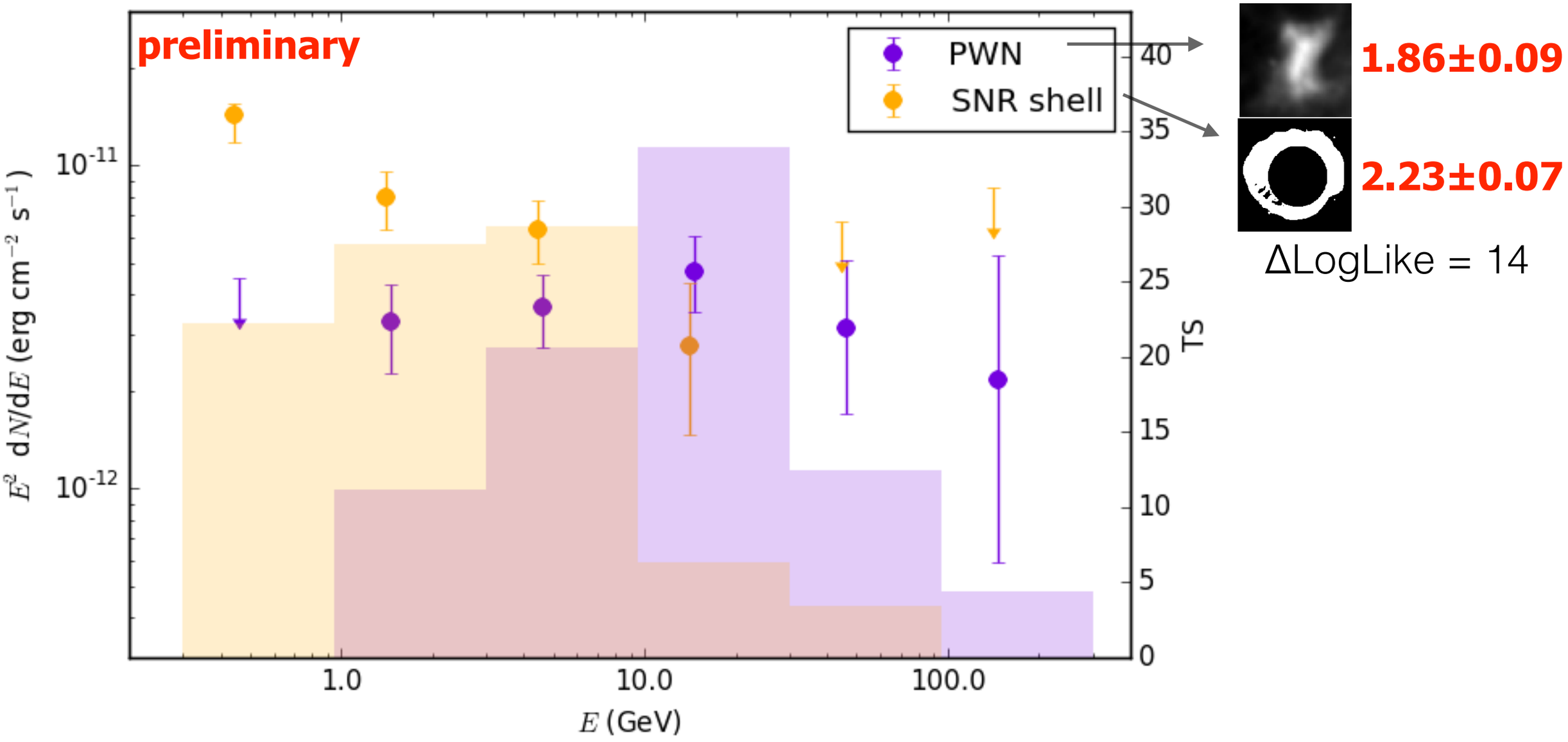
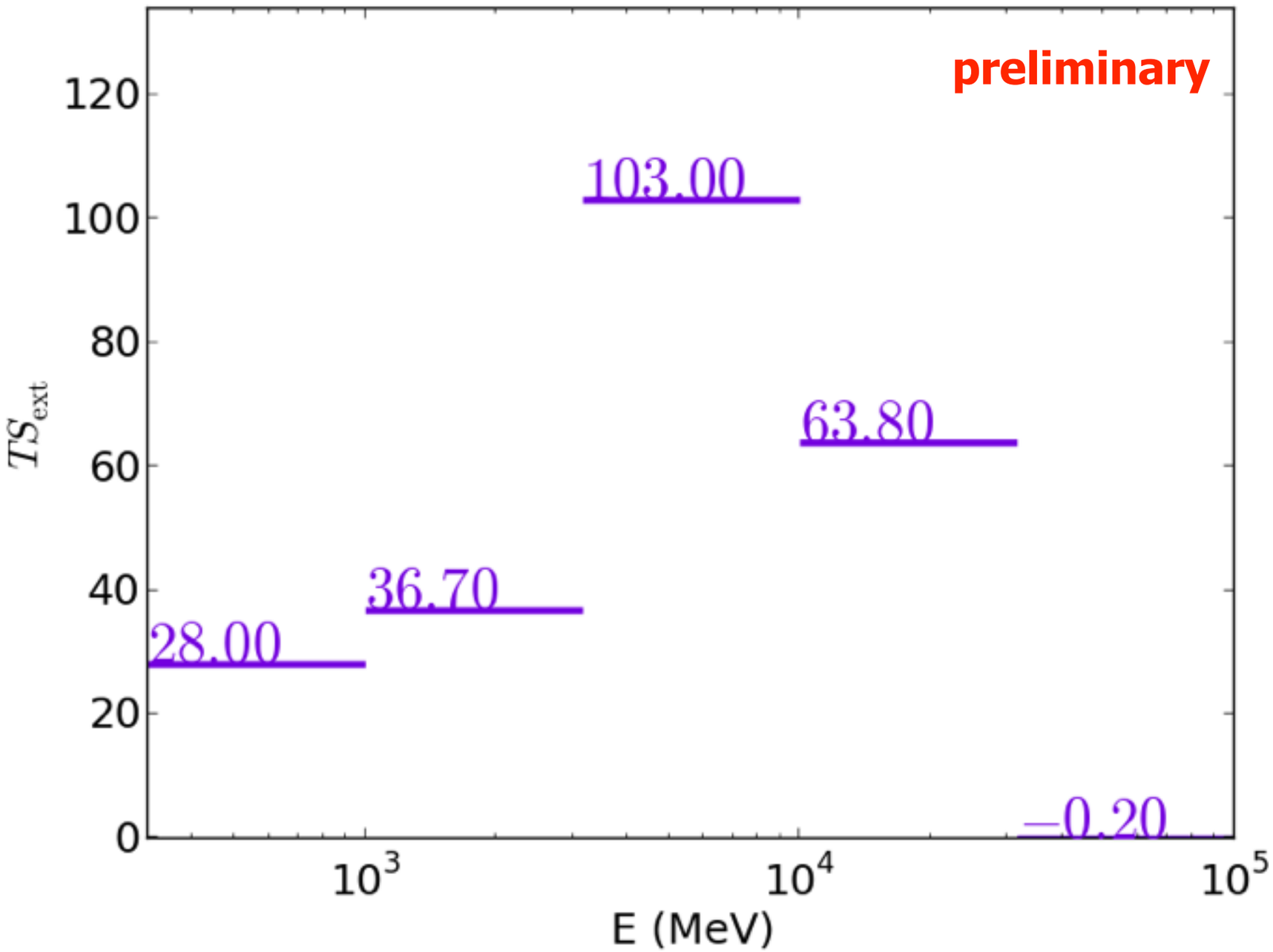


- **Different spectral signatures**
  - **Low E spectrum reminiscent of other hadronic GeV SNRs**
  - **Flat/harder spectral component associated with the PWN**

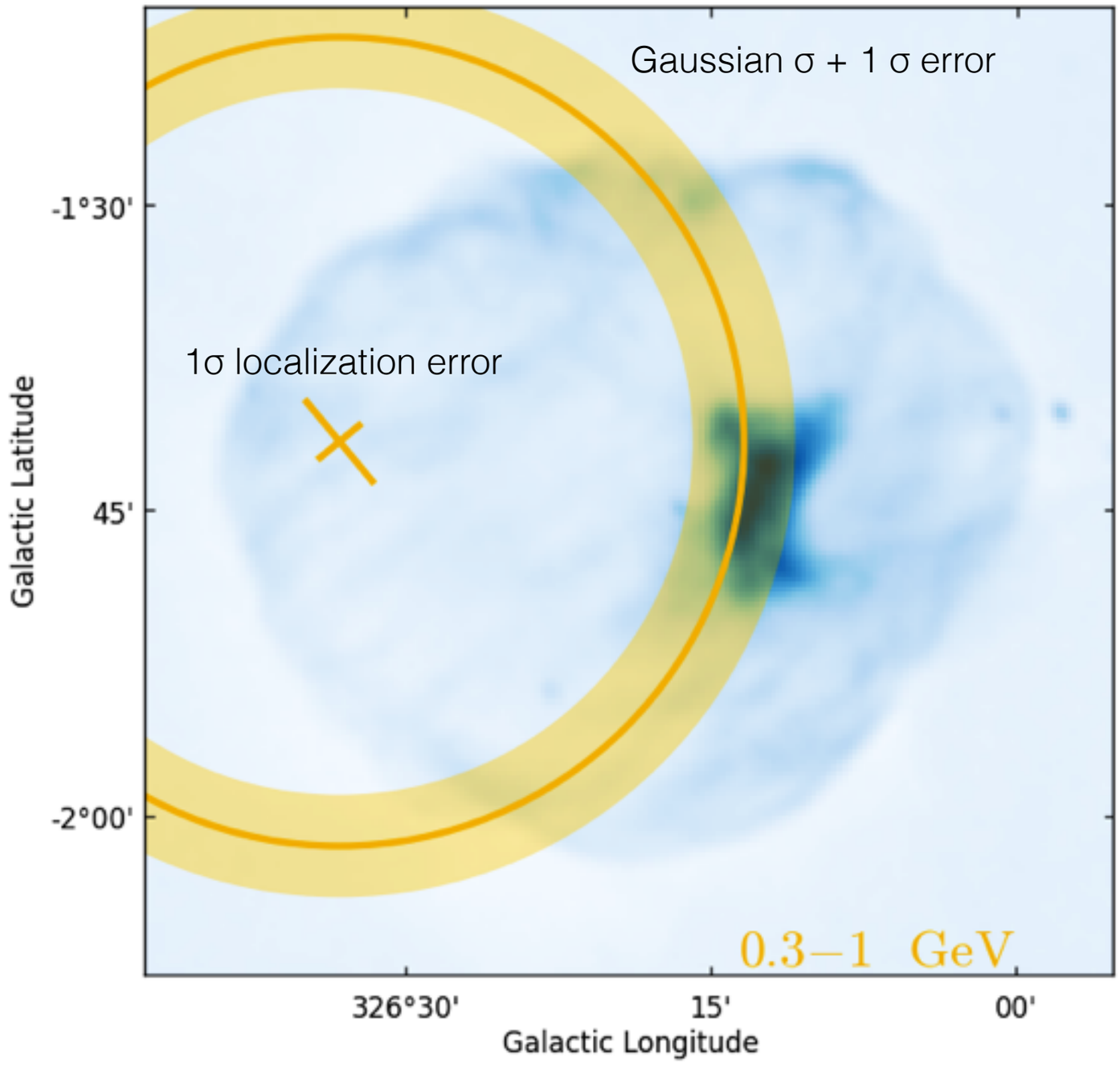
3) E-dependent morphology - source is extended



- **Source is significantly extended (Gaussian model) in the 0.3-30 GeV band**

3) E-dependent morphology - source is moving

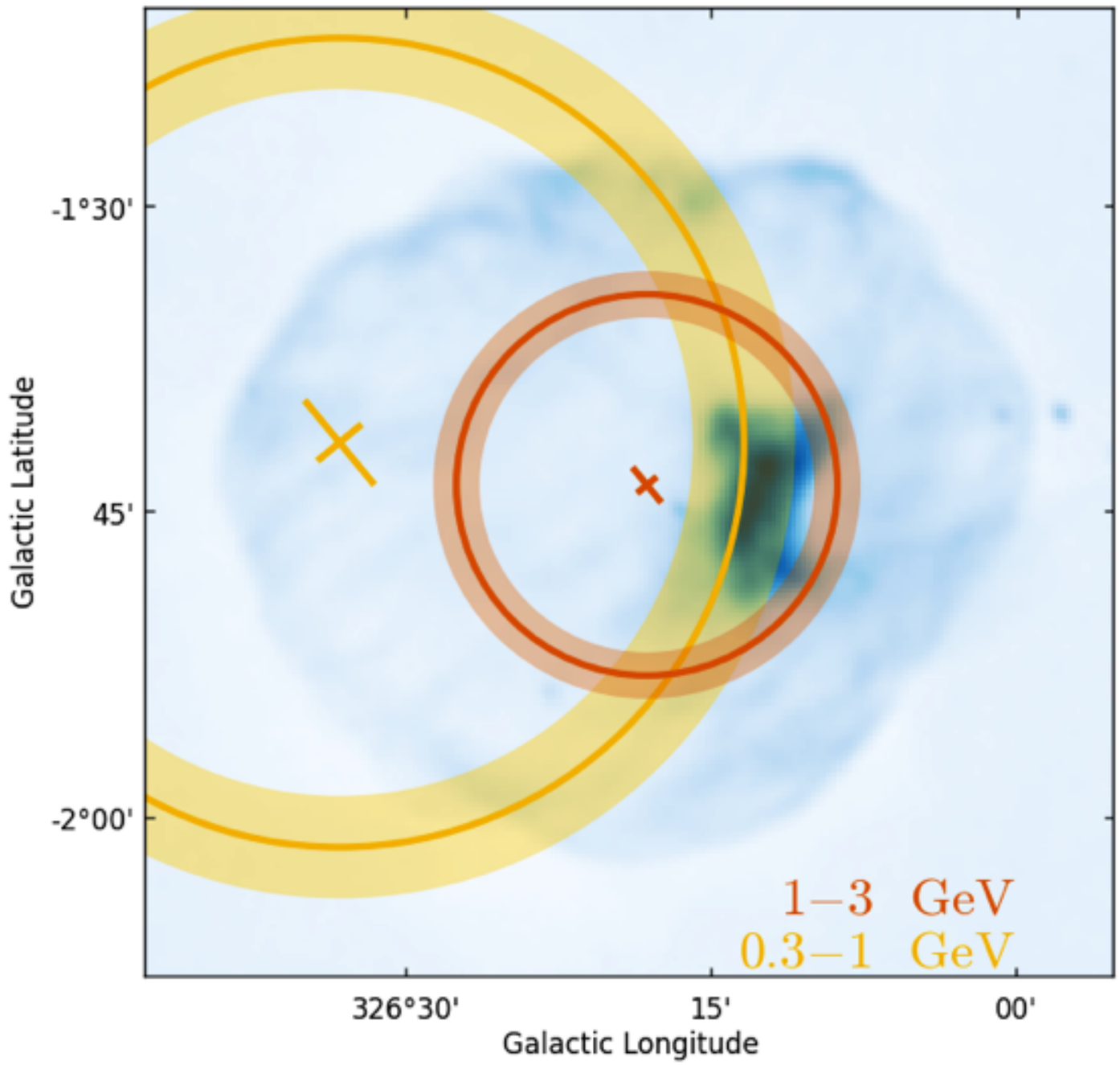
preliminary



- **Best-fitted Gaussian model as a function of energy**

3) E-dependent morphology - source is moving

preliminary



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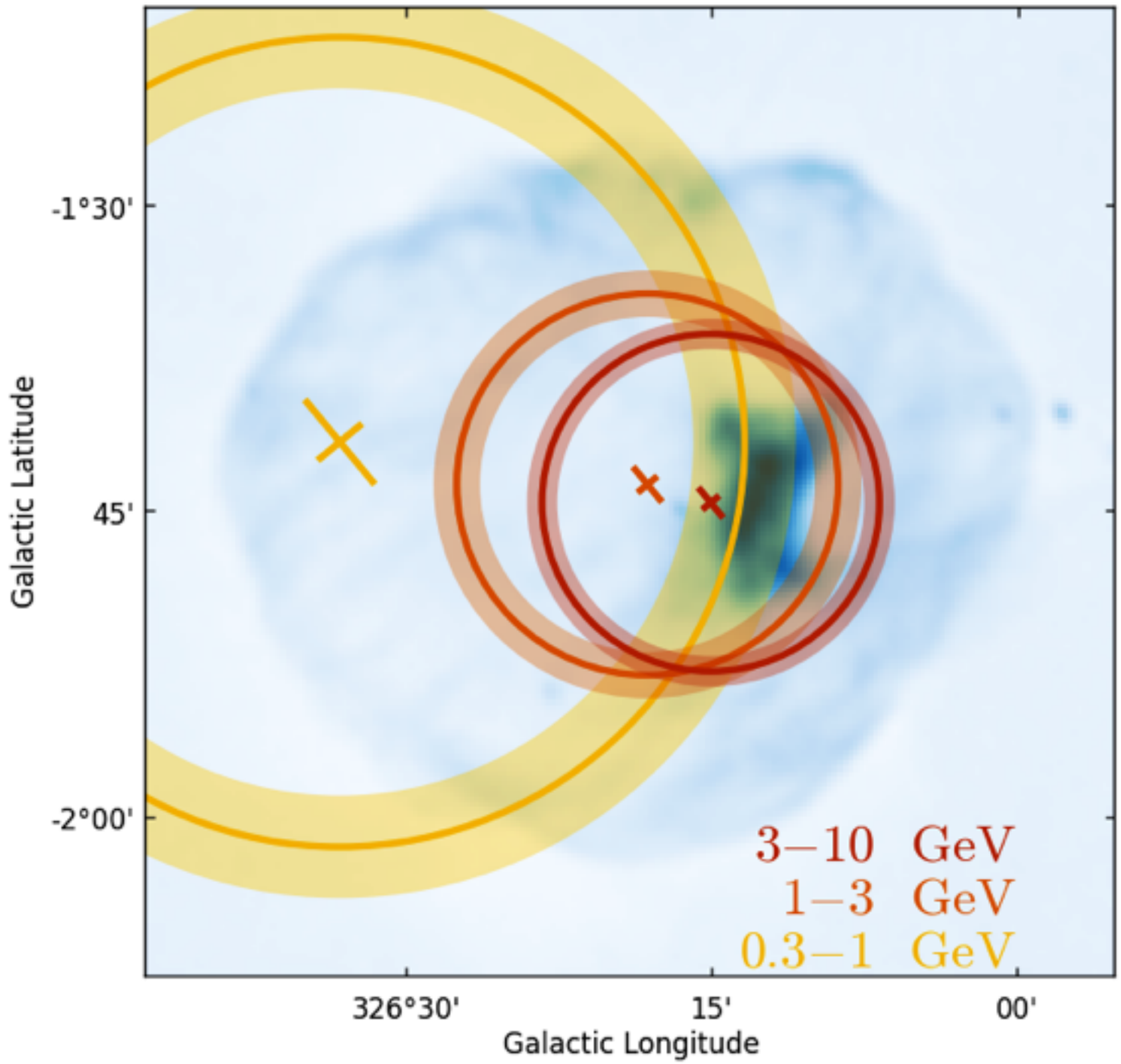

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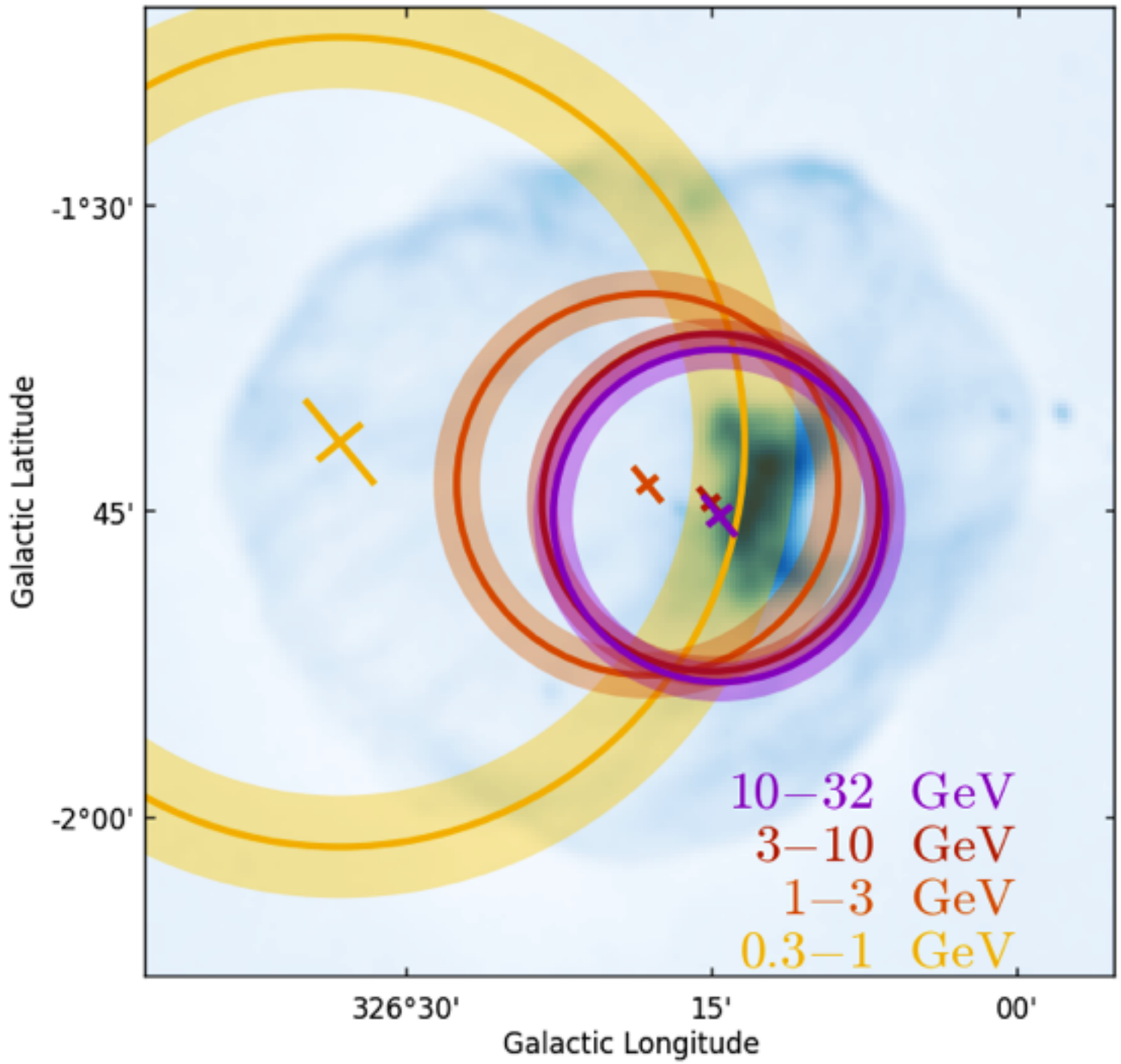
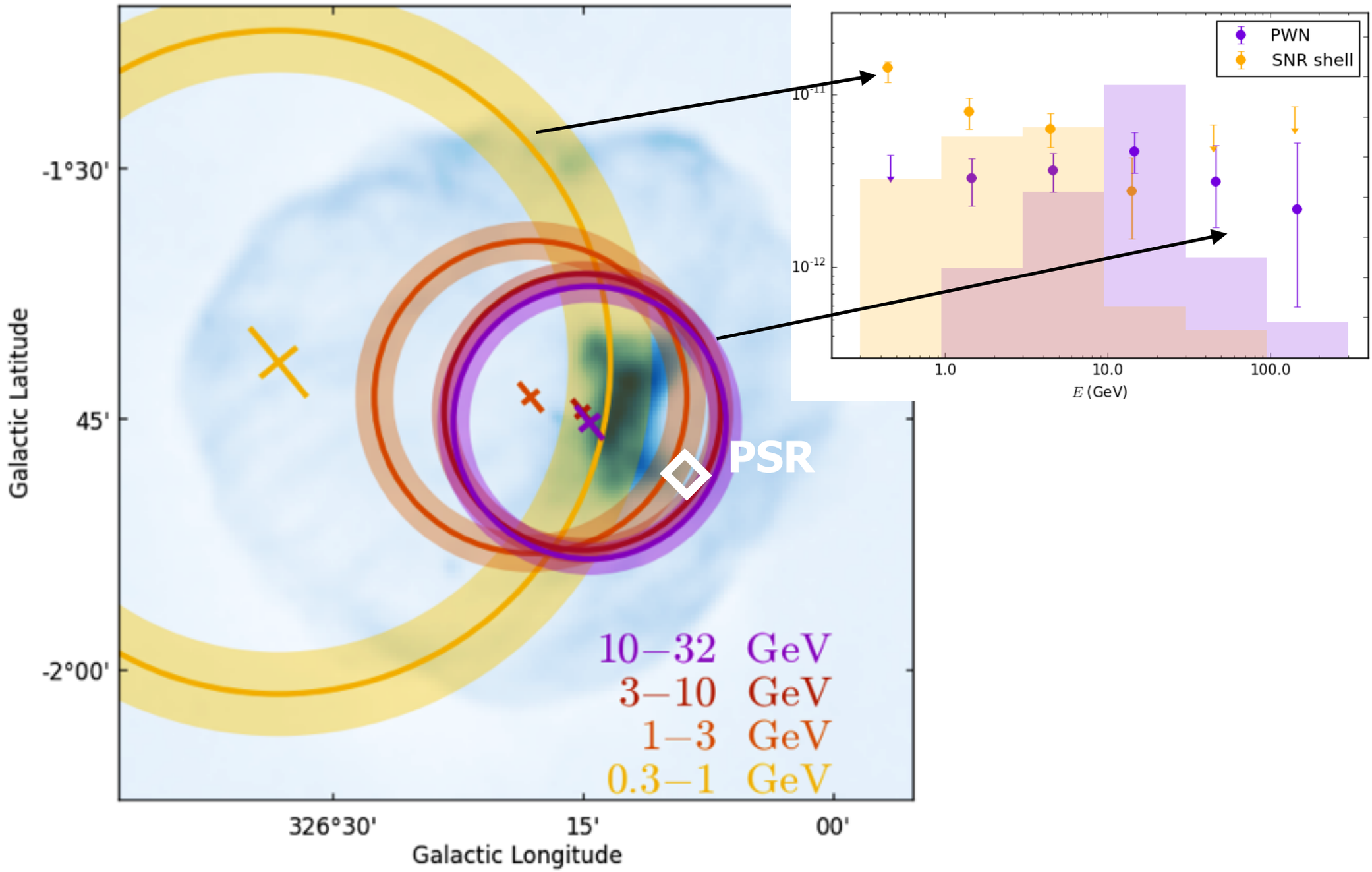


- **Best-fitted Gaussian model as a function of energy**

3) E-dependent morphology - source is moving



- **Best-fitted Gaussian model as a function of energy**
- **Emission is not centered on putative pulsar**
- **PSR emission is not dominant (if any)**

All-inclusive Galactic CR accelerator

- **Textbook Galactic accelerator ?**
  - **Acceleration of both nuclei (SNR), electrons and positrons (PWN)**
  - **PSR emission is not dominant (if any)**

- **1) Morphological Analysis: multiple components**
  - **Extended source can be explained by multiple components:**
    - **Residuals left when subtracting PWN coincident with the shell**
  - **E-dependent morphology:**
    - **Source is moving from SNR shell towards PWN**

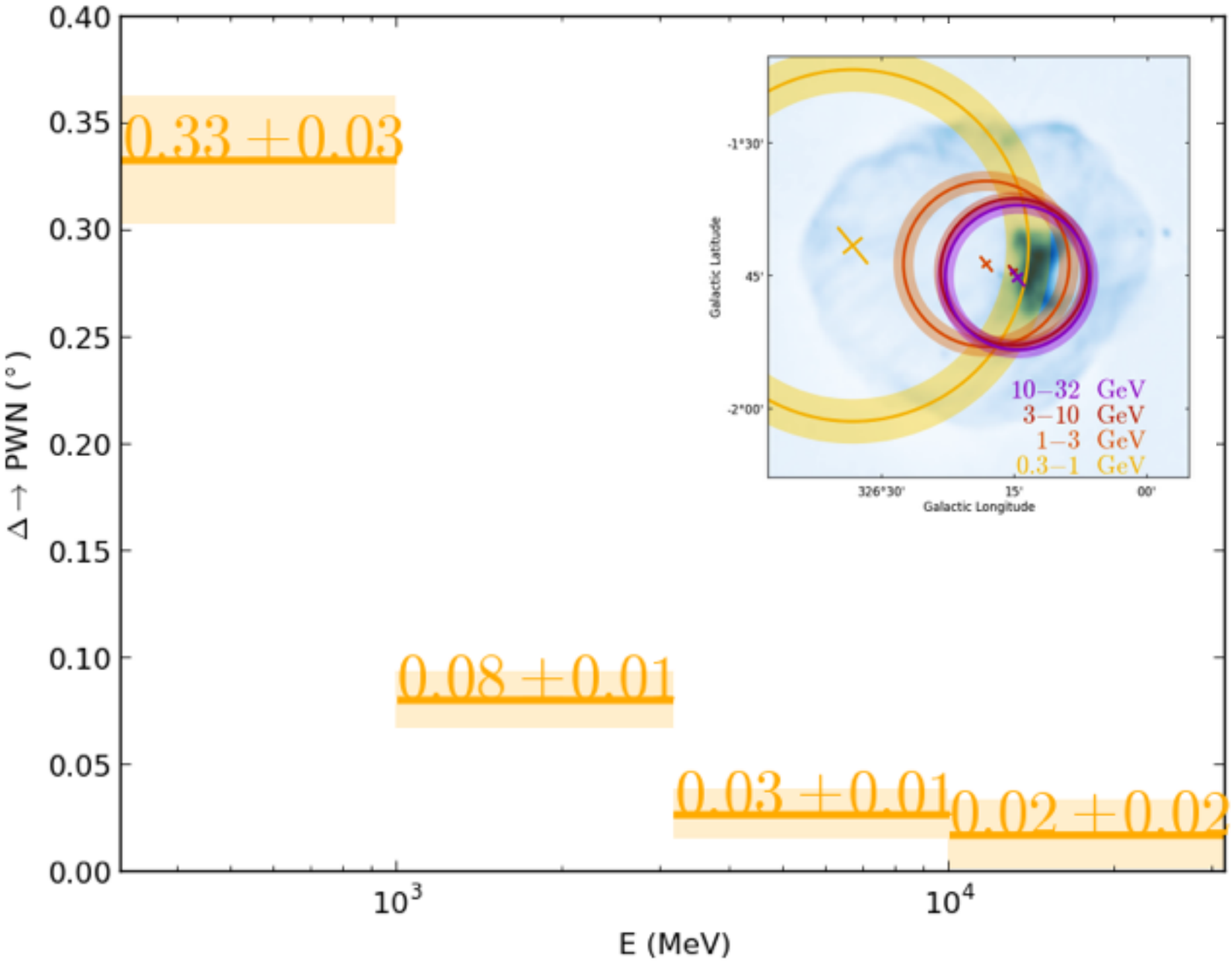
- **2) Different spectral signatures**
  - **SNR + PWN component with different spectral signatures**
    - **PWN: Hard high energy component (Γ=1.86±0.09)**
    - **SNR: Soft low energy component (Γ=2.23±0.07)**

- **Nice example of PSF types capabilities**
  - **Need PSF3 events to separate as much possible the components**

Backups

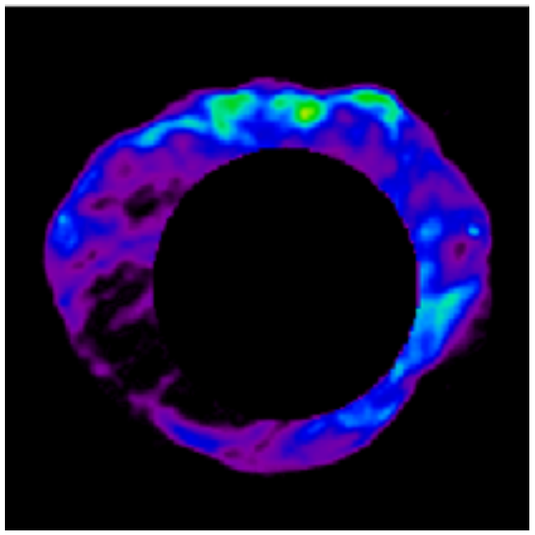
3) Source centroid is shifting towards the PWN

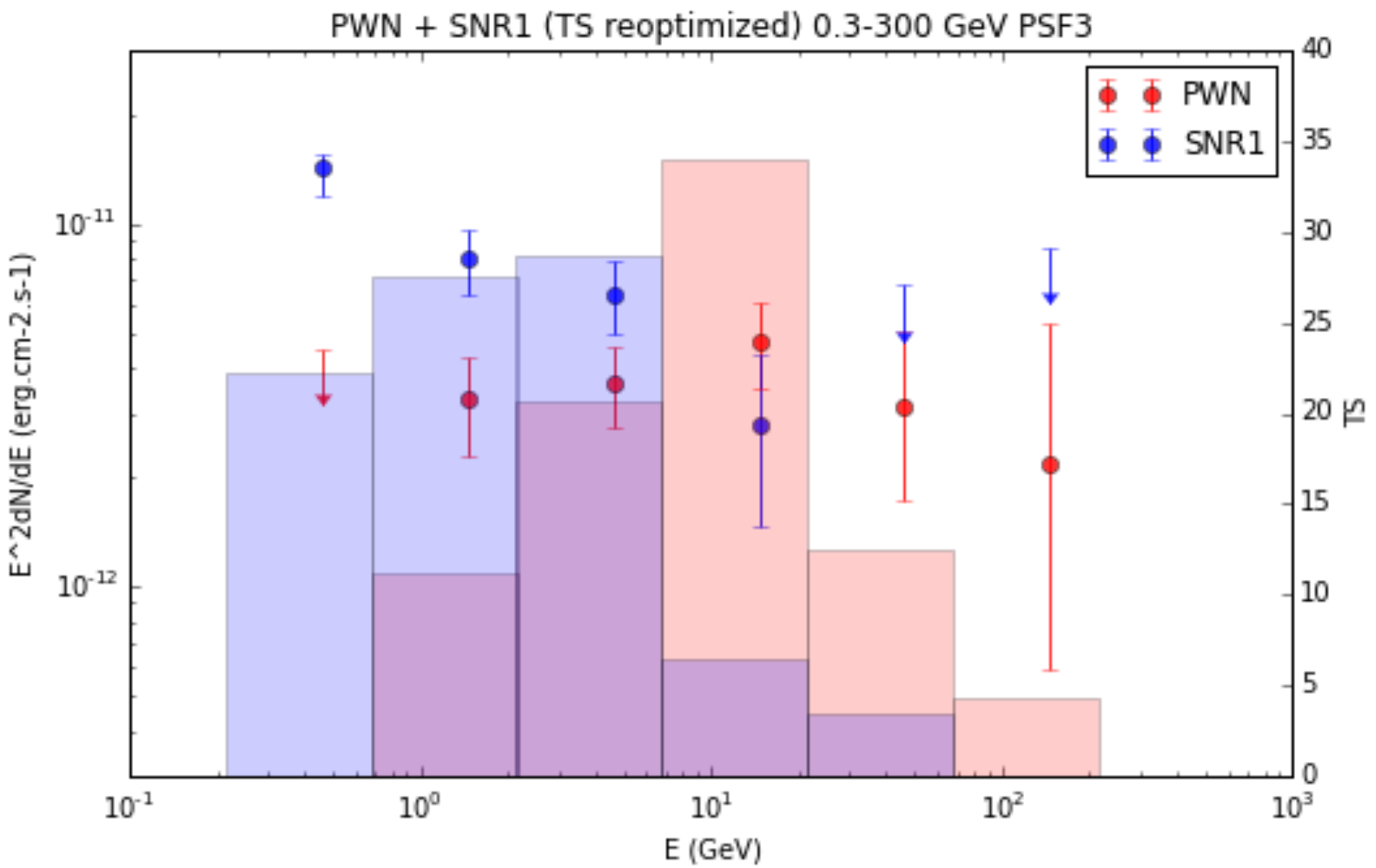
preliminary



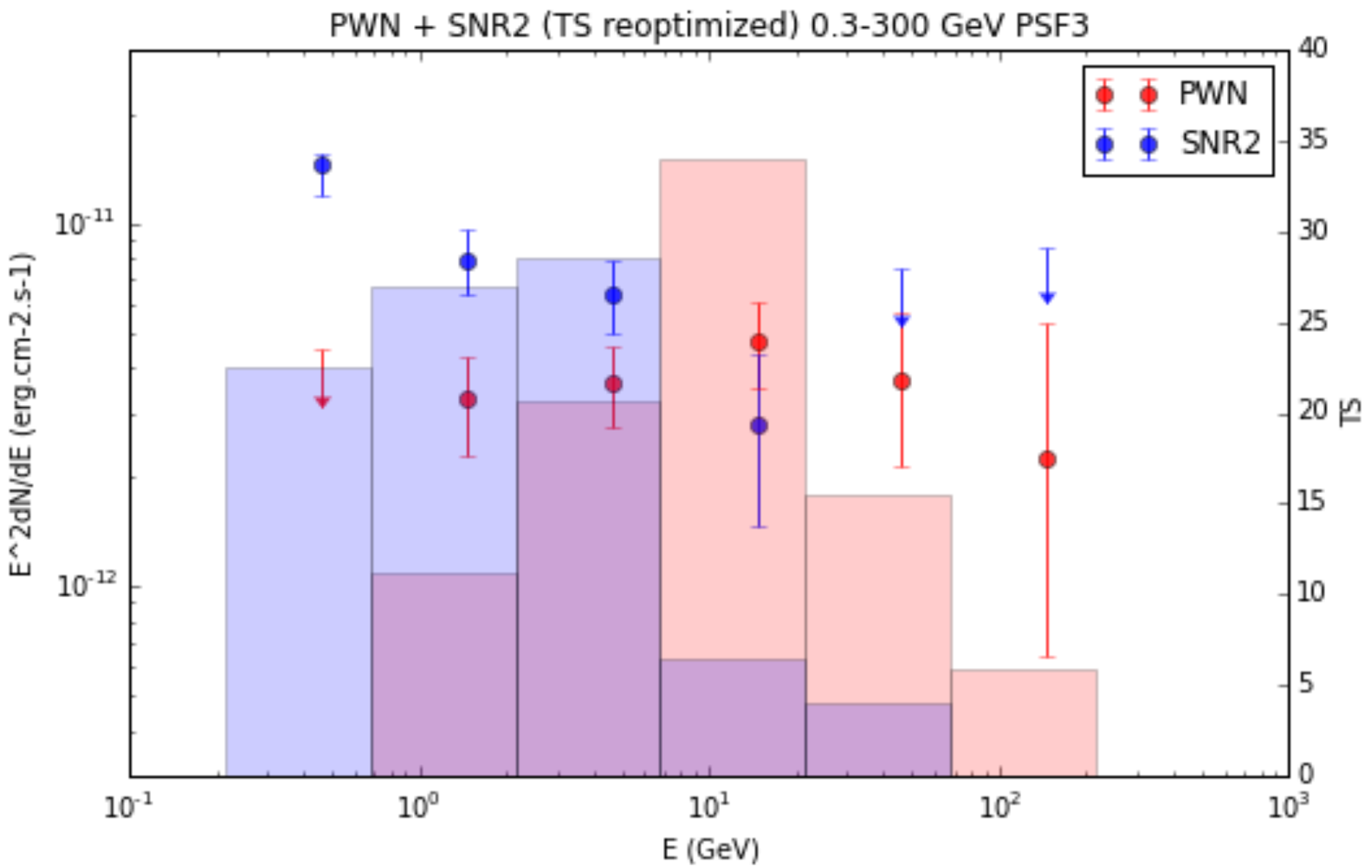
- **Centroid of the best-fitted Gaussian is moving towards the radio PWN peak**

SED for SNR templates

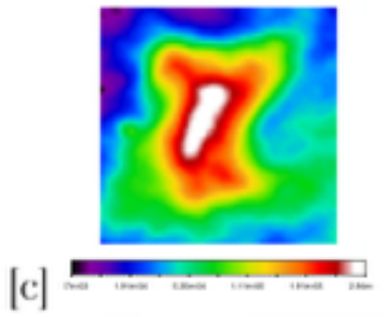




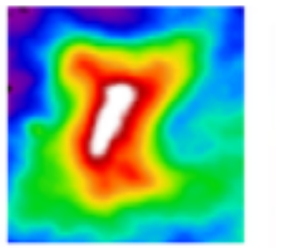
SED for SNR templates

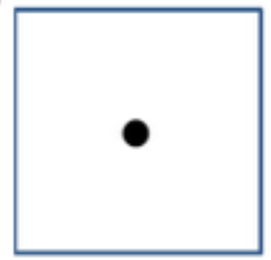


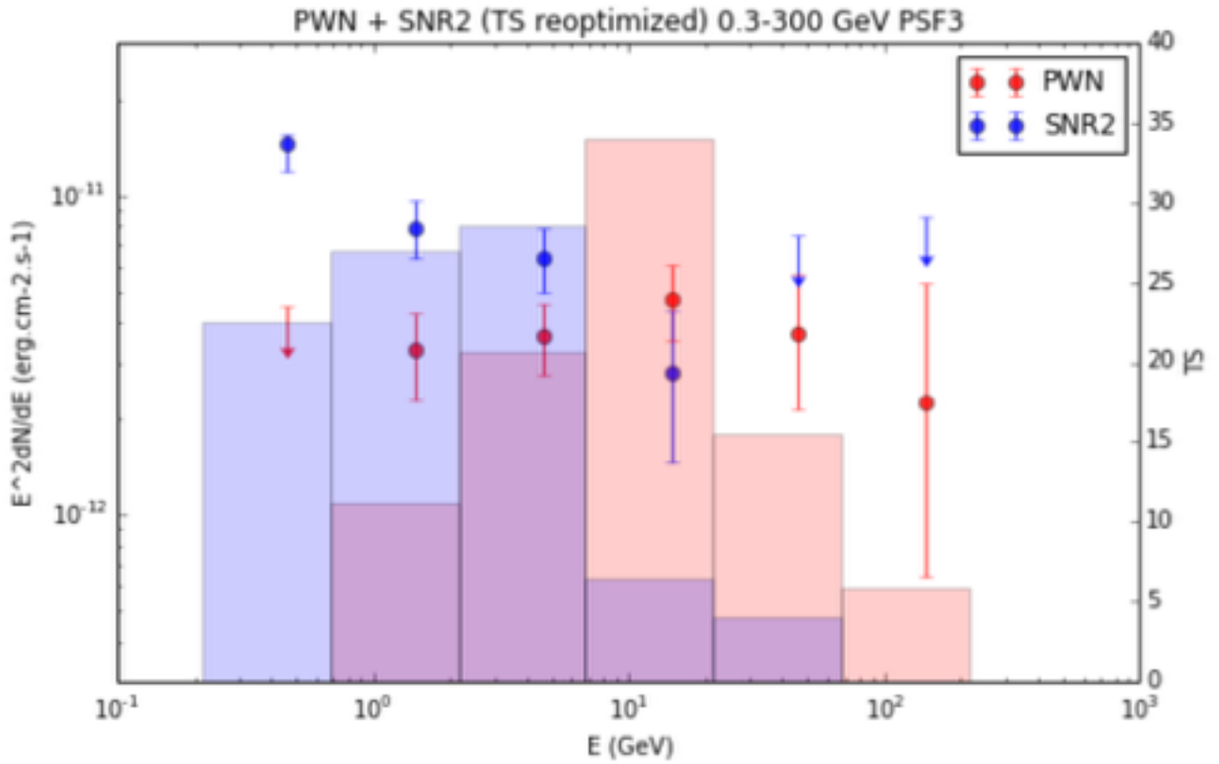
SEDs for different morphologies

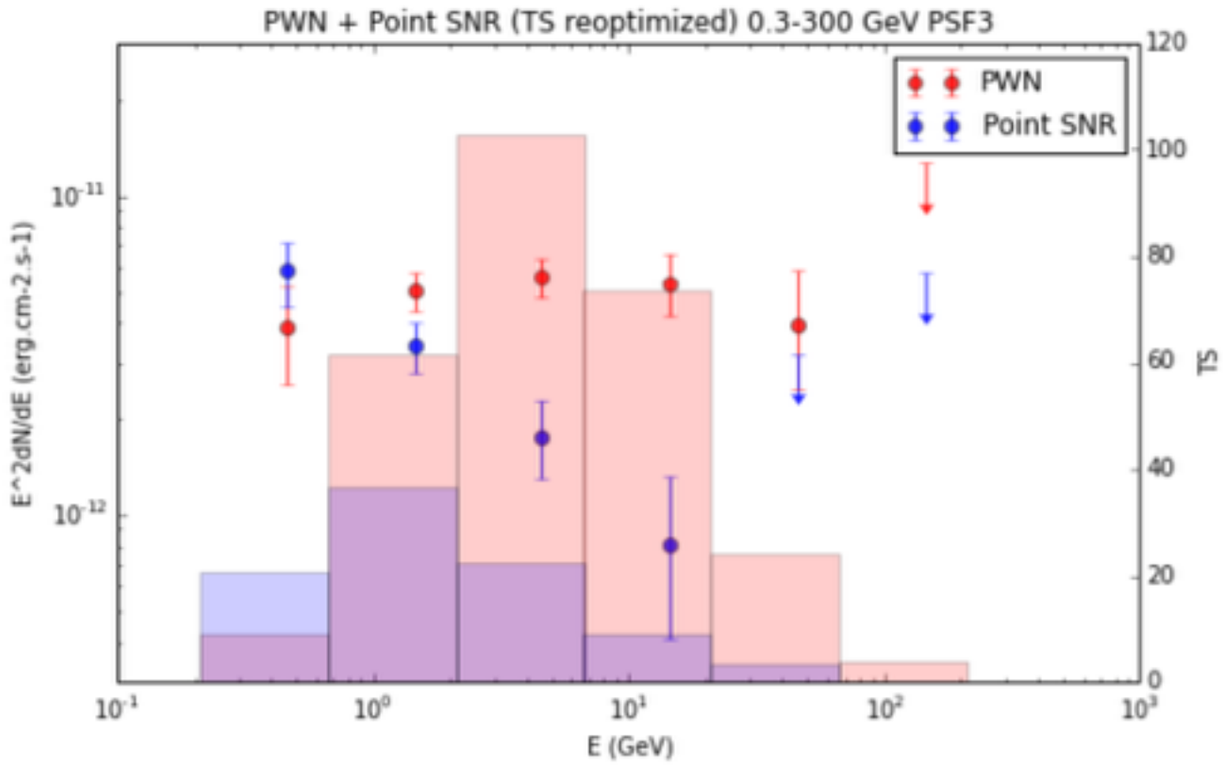


LL= 366 115.23

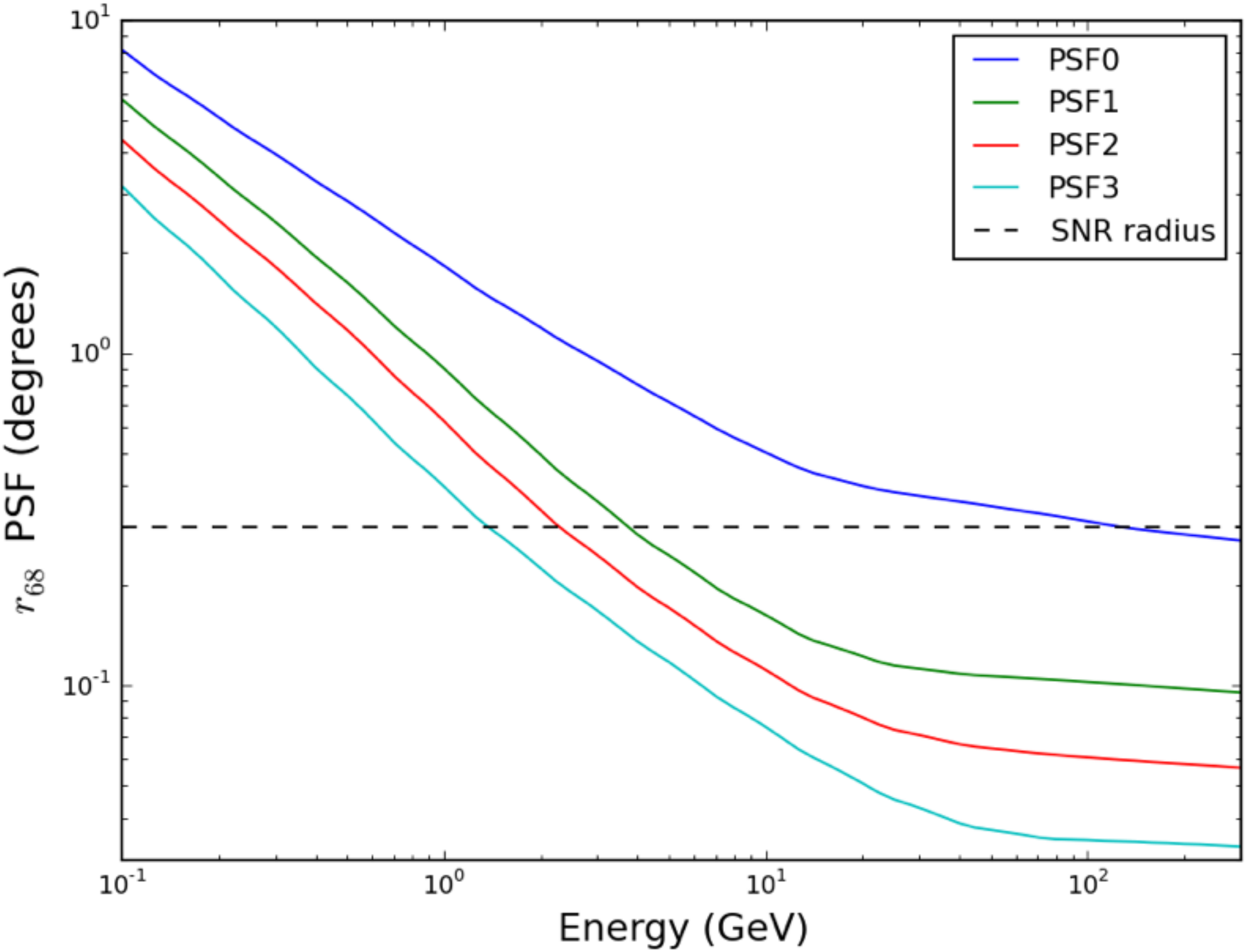




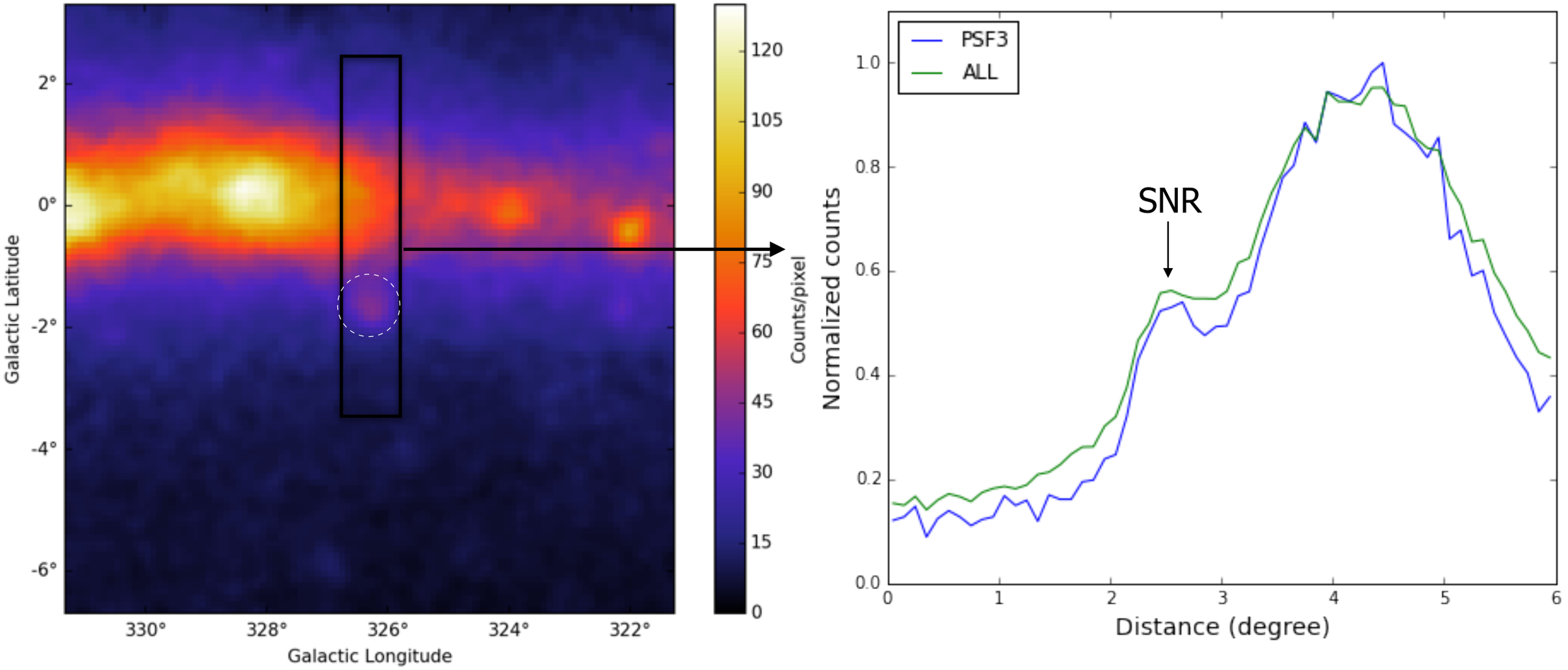




PSF event types



Using P8 PSF types



- **Better localization and extension measure**

  but also:

- **Reduce spill over from the Galactic plane (G326.3-1.8)**
- **Reduce cross-contamination in nested templates**
- **Disentangle the contribution from different morphological components**