# CTA Simulations of the Star-forming region: NGC 3603

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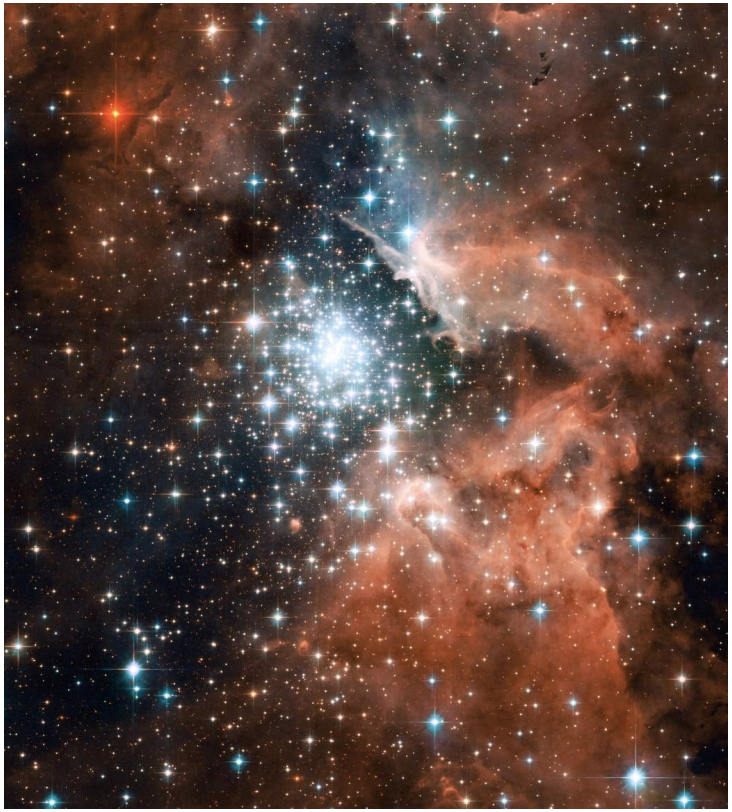
# The case of the NGC 3603

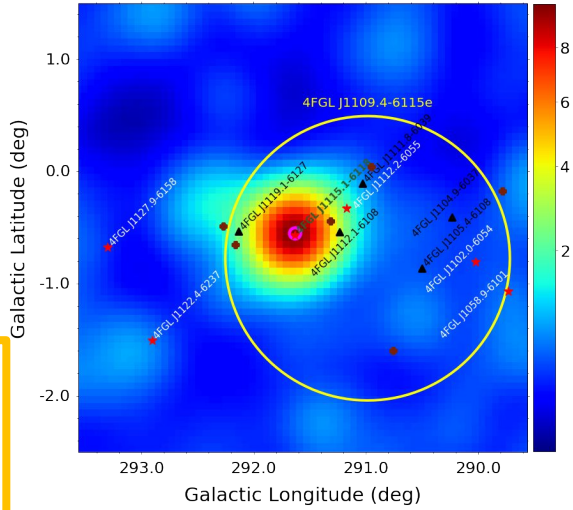
- The rich star forming region: NGC 3603
- This stellar "jewel box" is one of the most massive young star clusters in the Milky Way Galaxy
- NGC 3603 is a prominent star-forming region in the Carina spiral arm of the Milky Way, about 20,000 light-years away.
- This image shows a young star cluster surrounded by a vast region of dust and gas. The image reveals stages in the life cycle of stars. The nebula was first discovered by Sir John Herschel in 1834.



3.24 x 3.26 arcminutes

# Morphology of 4FGL J1115.1-6118 (NGC 3603)

**A Fermi-LAT source is positionally coincident with NGC 3603**




## Results of detailed morphological analysis data

Best-fit location and extension of **4FGL J1115.1-6118**

RA = 168.78 +/- 0.01, DEC=-61.29 +/- 0.02 (in deg)
Extension: **0.08 +/- 0.02** (in deg)
TS_ext = **7.7**

Energy range: **10 GeV to 1 TeV**

- **The source is not extended**
- **No diffuse emission**

**L. Saha, A. Dominguez, L. Tibaldo, S. Marchesi, M. Ajello, M. Lemoine-Goumard & M. Lopez, ApJ, 897, 2020**

# Spectral analysis of 4FGL J1115.1-6118

**Energy range: 300 MeV to 1 TeV**

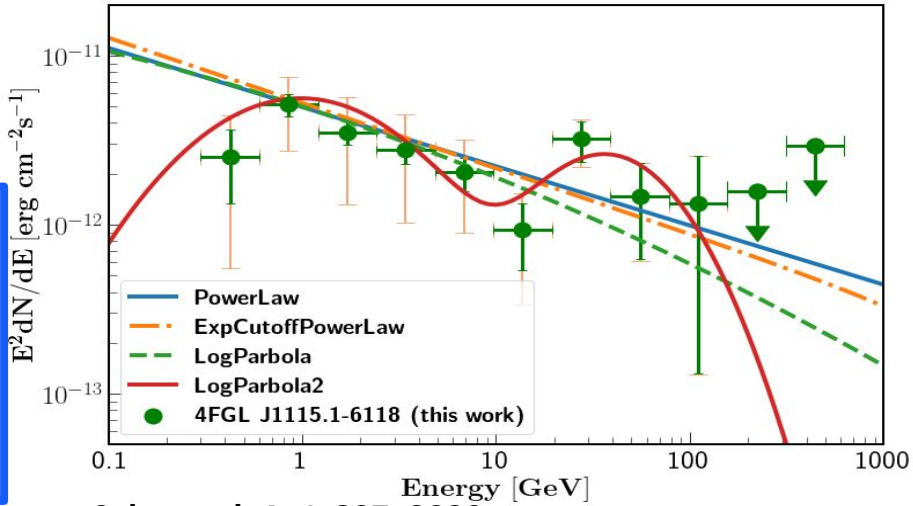
Spectral fit  with power-law spectral shape.

The SED may suggest that the **emission has two components**, one **below 10 GeV** and the other **above 10 GeV**.

To understand the significance of the spectral curvature, we fit the data with different spectral shapes:

- Power-law
- Exponential cutoff power-law
- Log parabola
- Sum of two Log parabola models

| Spectral model | $\Delta \log \mathcal{L}^a$ | d.o.f | $\Delta$ AIC$^a$ |
|---|---|---|---|
| Powerlaw | 0.0 | 22 | 0.0 |
| ExpCutoffPowerlaw | 0.6 | 23 | 0.8 |
| Logparabola | 1.0 | 23 | 0.0 |
| Logparabola2 | 7.1 | 26 | -6.2 |




**Saha et al, ApJ, 897, 2020**

# Simulations of NGC 3603 using Ctools (1.7.4)

## Source Models:

- Point sources detected
- Associated sources
- Unassociated sources
  **NGC 3603 as point source**
- An extended source

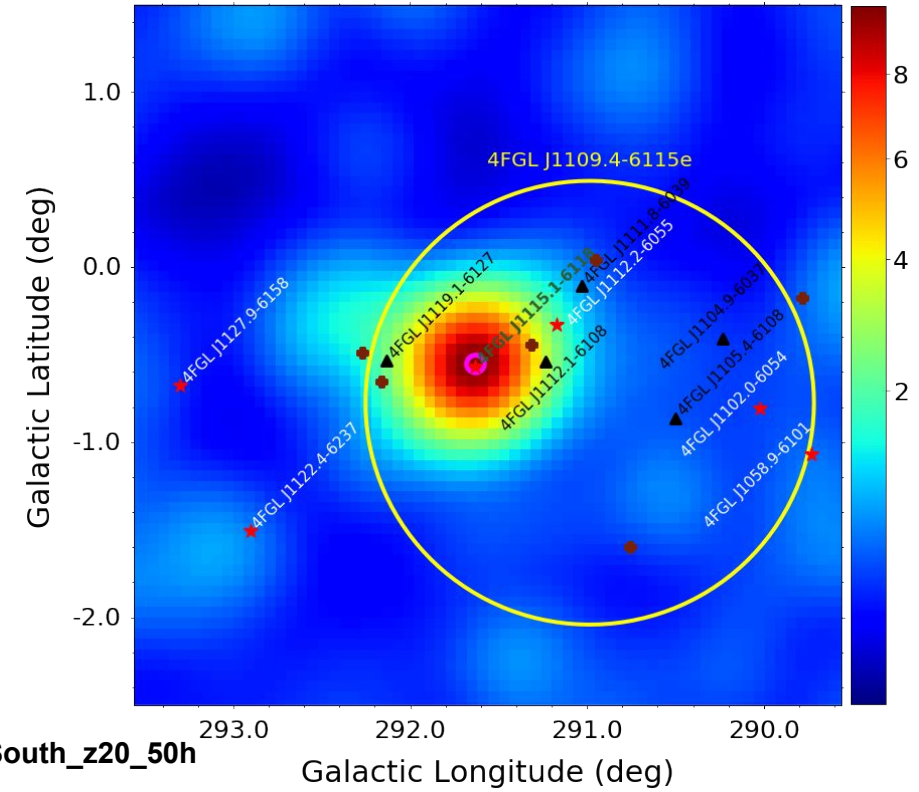
## Background Models:

CTABackgroundModel

Calibration database:

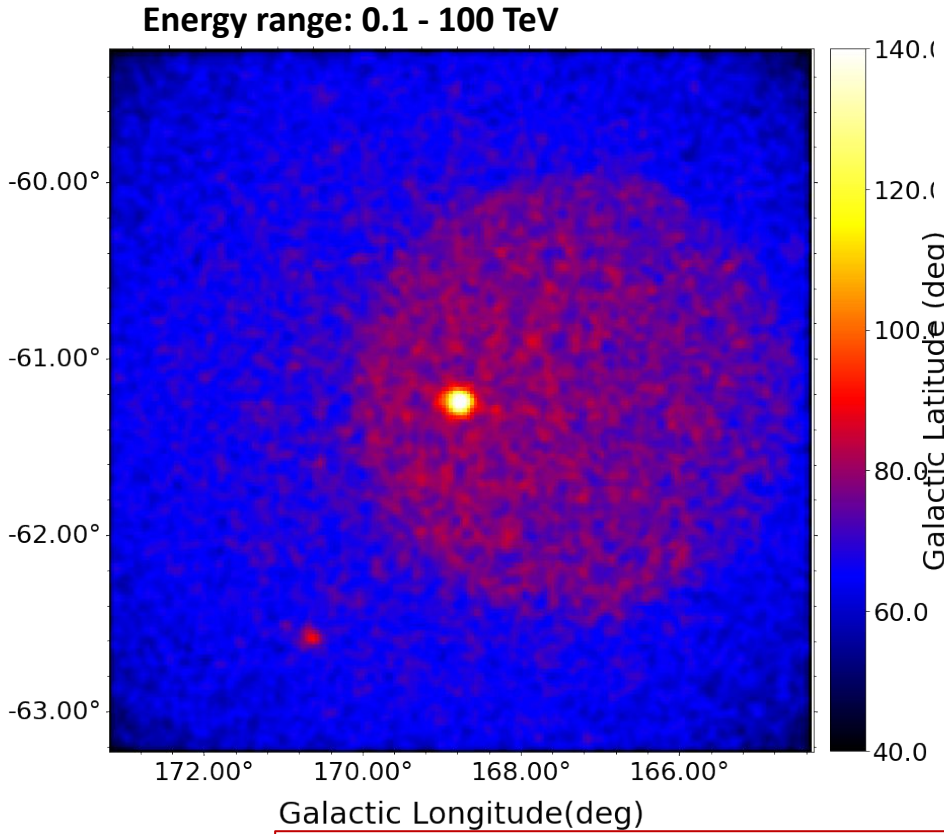
IRF

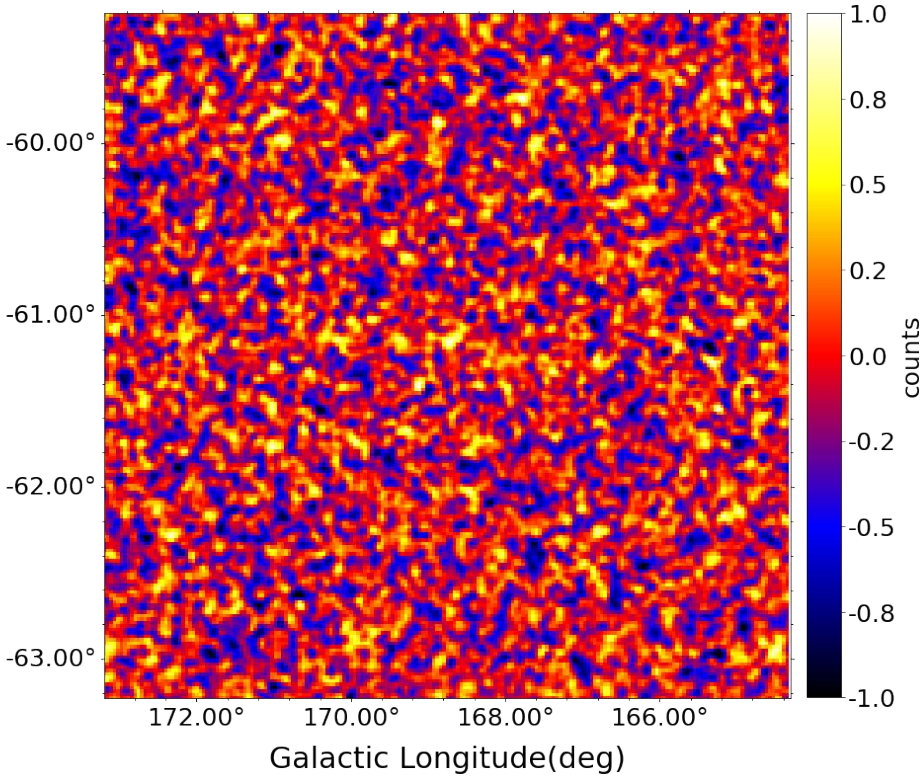
| | | | | |
|---|---|---|---|---|
| **Prod2** | **South_0.5h** | **South_5h** | **South_50h** | |
| **prod3b-v2** | **South_z40_5h** | **South_z20_0.5h** | **South_z20_5h** | **South_z20_50h** |
| **Prod5** | **South_z20_0.5h** | **South_z20_5h** | **South_z20_50h** | |




**Energy range -> 0.01 to 100 TeV**

# Simulations: Results-I




**No significant residuals, which indicates that the model fit was satisfactory.**

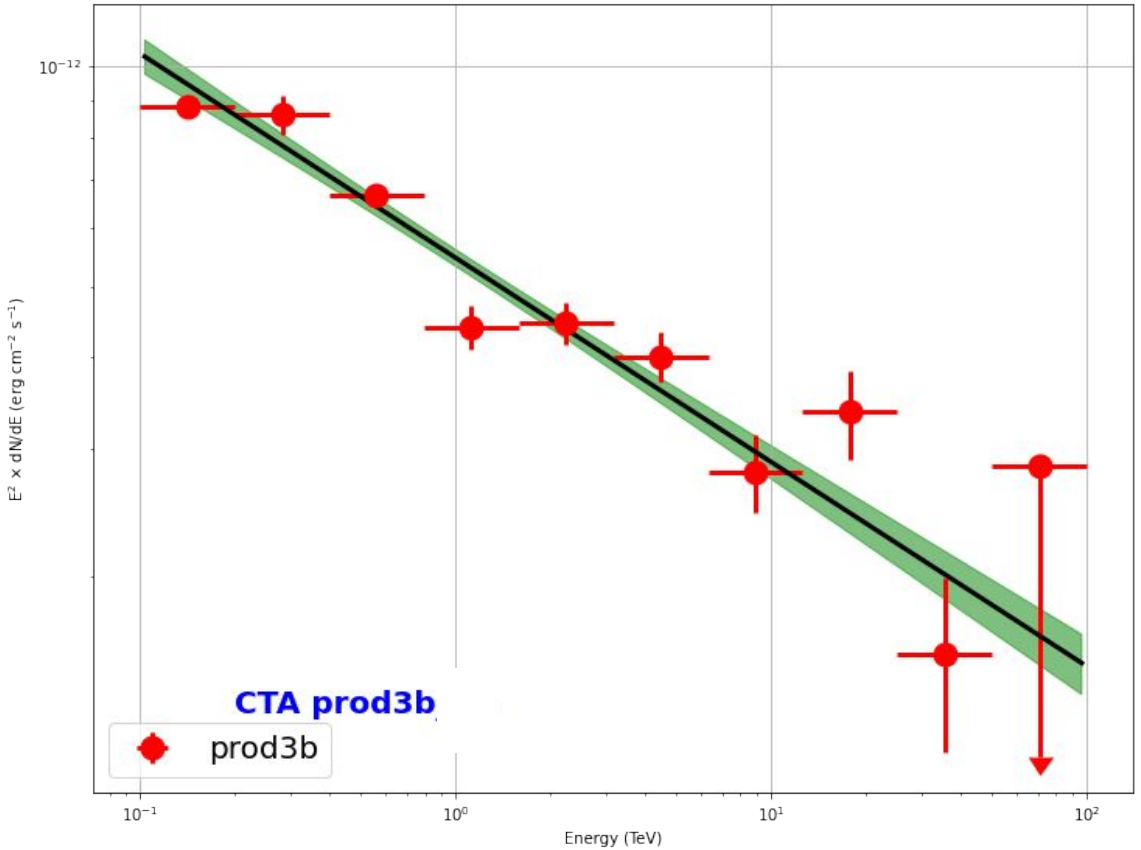
# Simulations: Results-II (NGC 3603)

Point source model
Exposure: 20 hours

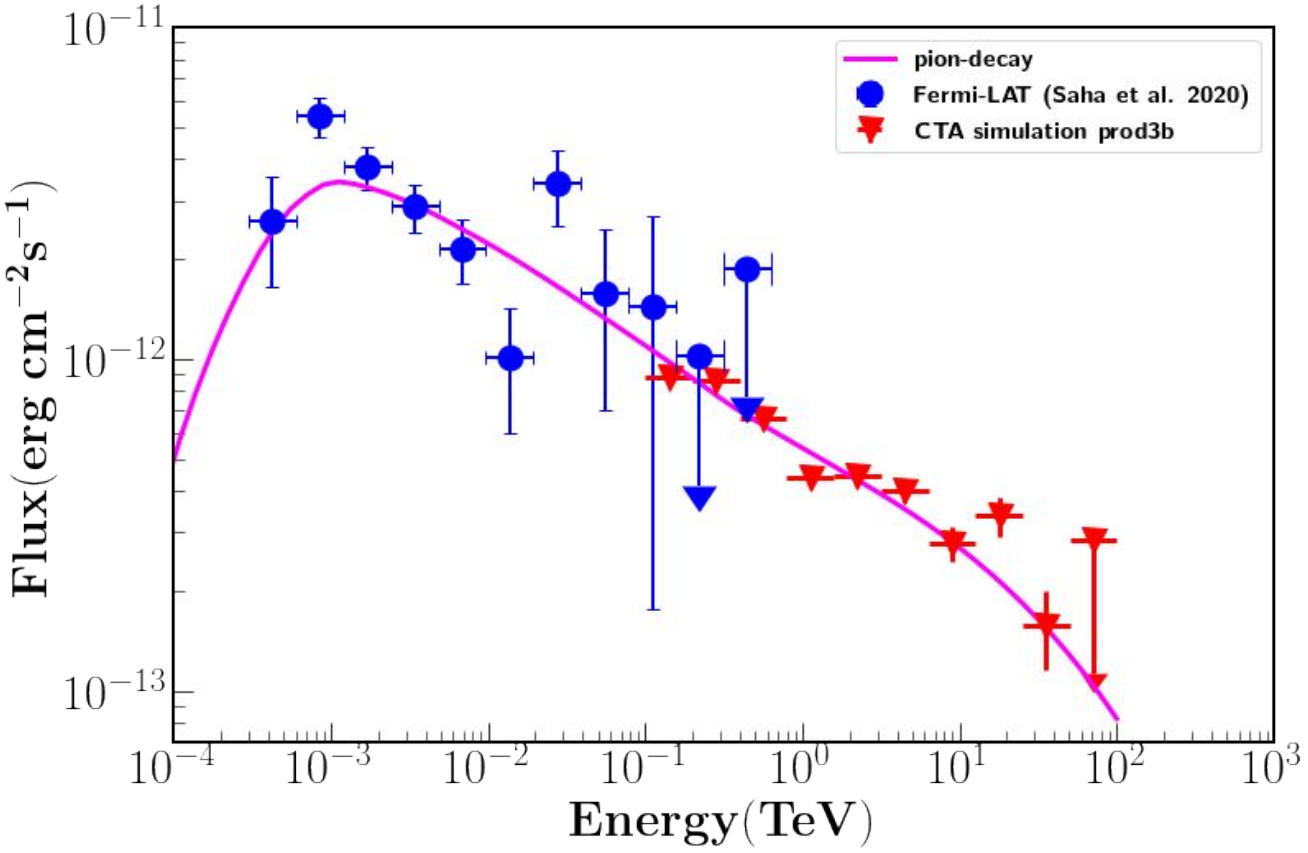
**Fitted parameters:**
Index = 2.28 ± 0.02
Prefactor = (1.6 ± 0.2) x $10^{-13}$ ph/MeV/cm$^2$/s

**Input spectral parameters:**
Index = 2.31
Prefactor = 2.07 x $10^{-13}$ ph/MeV/cm$^2$/s

TS = 3092



# Combined spectrum with modelling




alpha = 2.32
Distance = 7 kpc
Matter density = 10/cm^3
Emax = 1000 TeV

# Conclusions

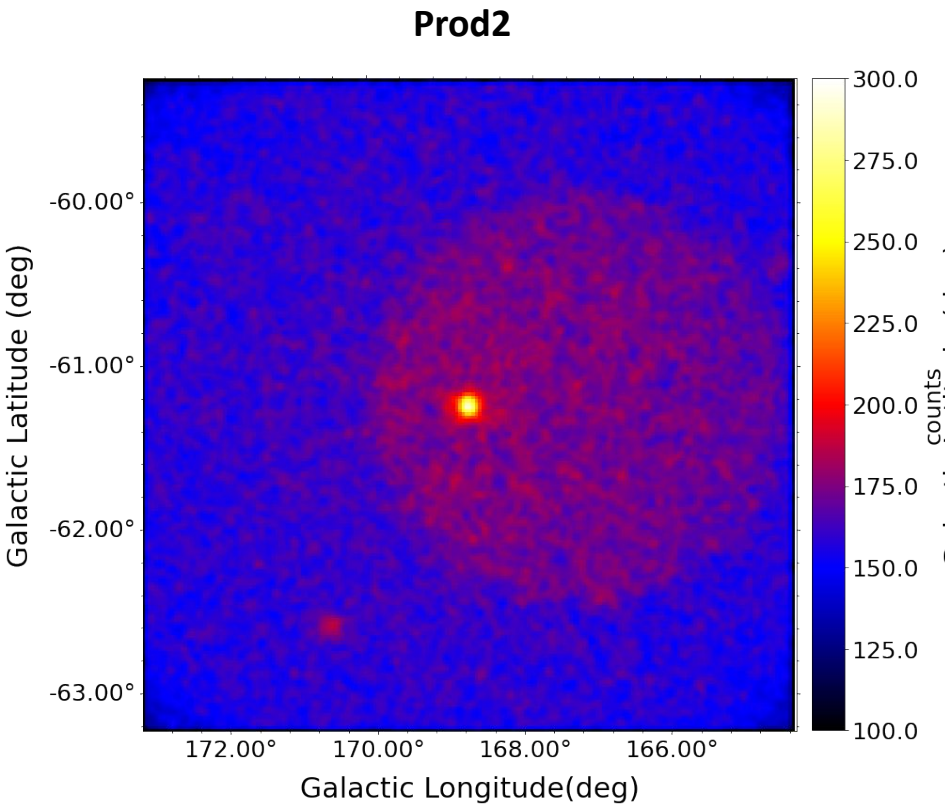
1. NGC 3603 can be considered as a potential gamma-ray source at TeV energies for observations with CTA.

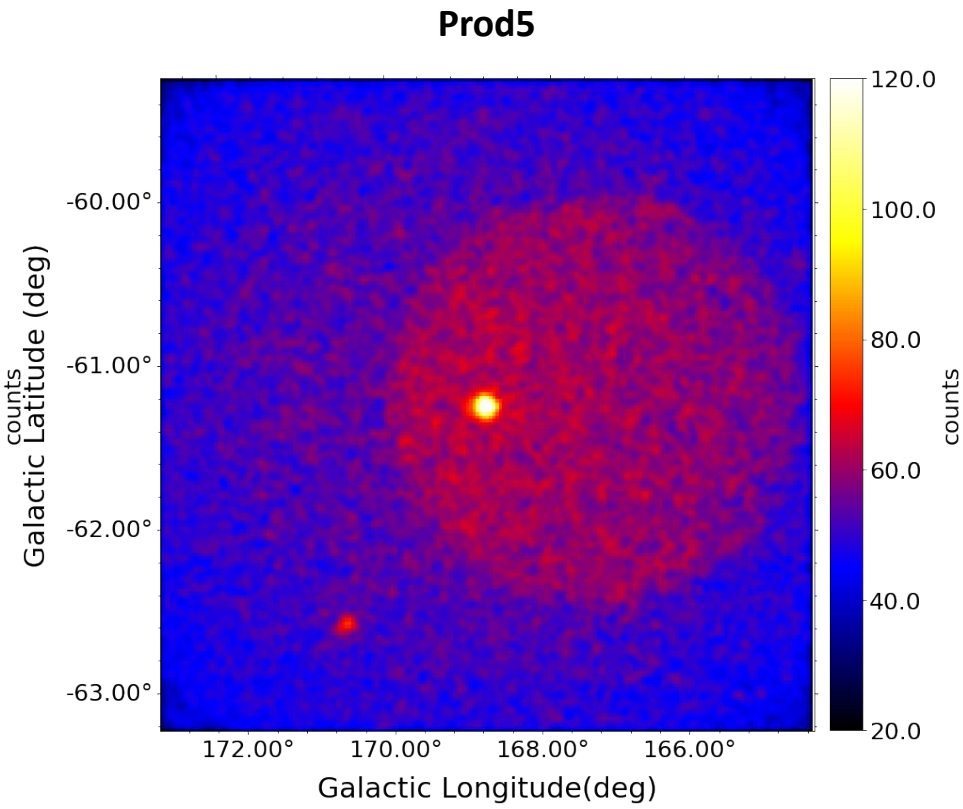
2. Residuals show that the source is modelled well.

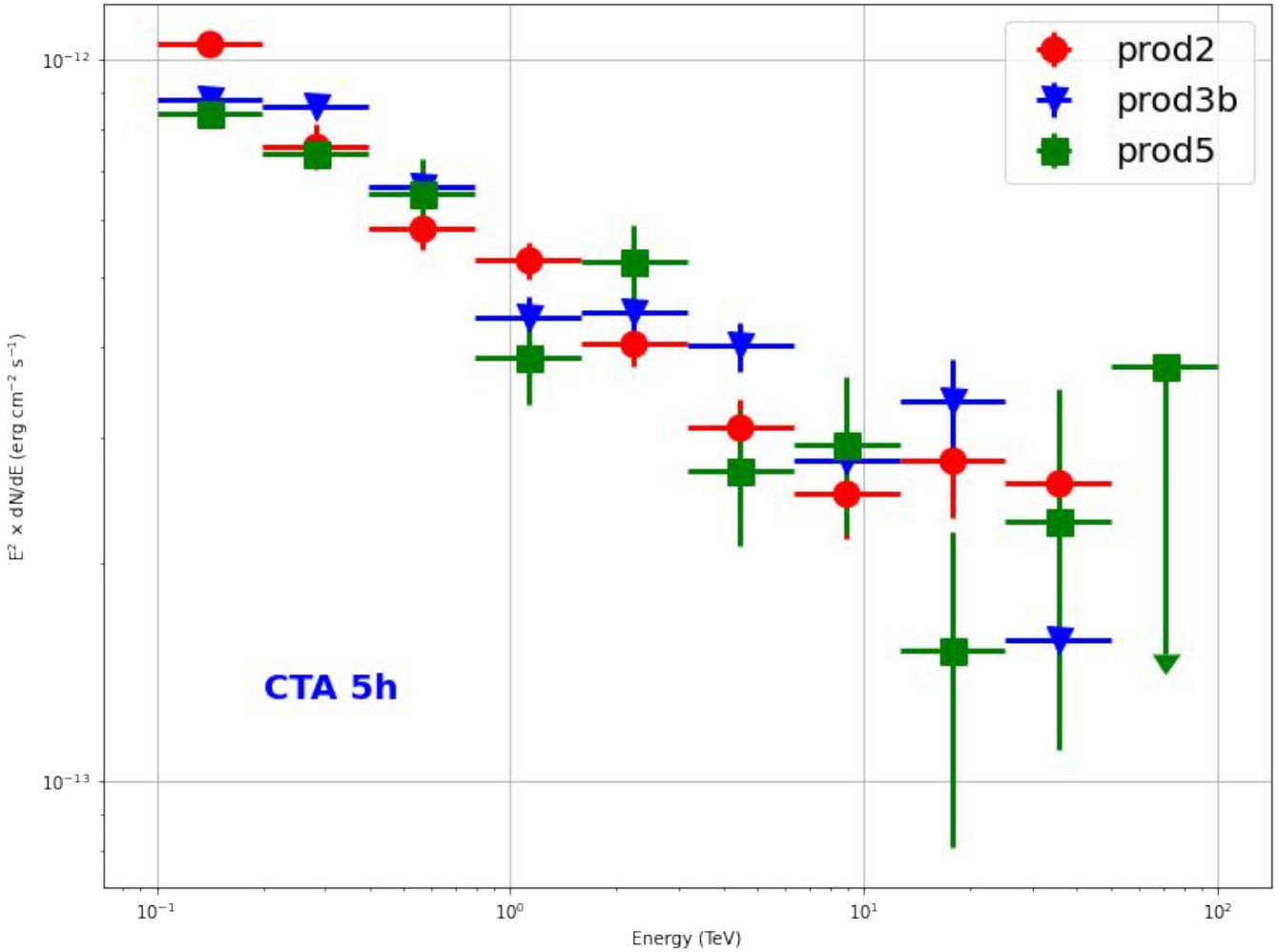
3. The simulations show that NGC 3603 can be detected well both spatially and spectrally with roughly 20 hours of CTA data.

# Thank You

# Backup slides

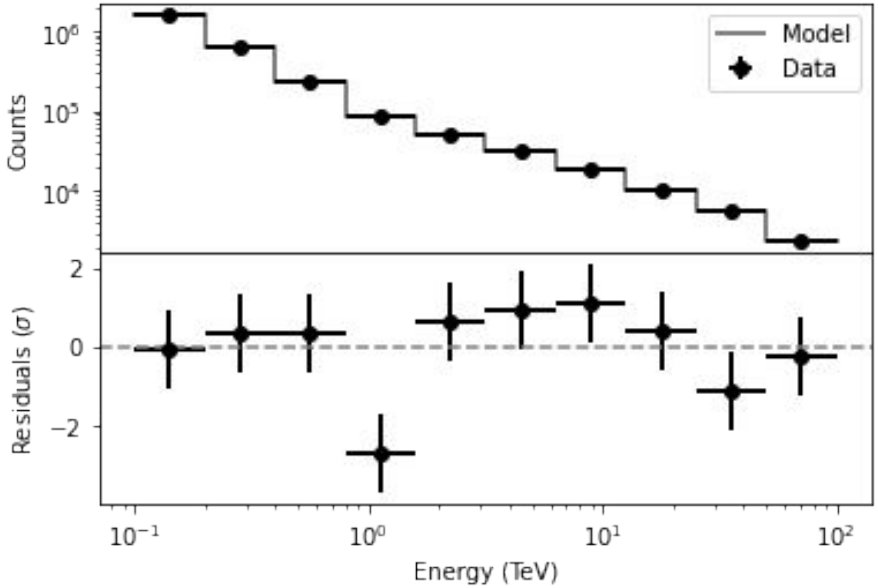

Prod2
-60.00°
-61.00°
-62.00°
-63.00°
Galactic Latitude (deg)
172.00°
170.00°
168.00°
166.00°
Galactic Longitude(deg)
300.0
275.0
250.0
225.0
200.0
175.0
150.0
125.0
100.0
counts

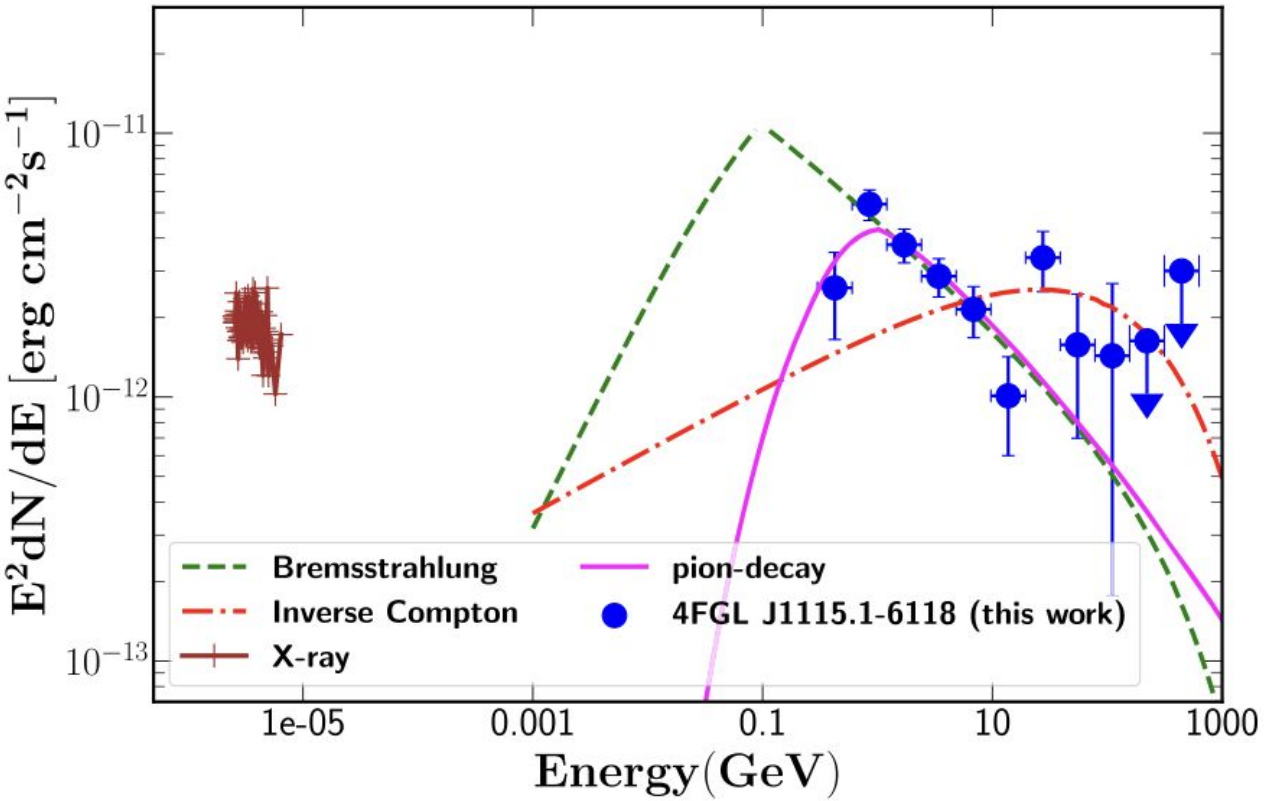

Prod5
-60.00°
-61.00°
-62.00°
-63.00°
Galactic Latitude (deg)
172.00°
170.00°
168.00°
166.00°
Galactic Longitude(deg)
120.0
100.0
80.0
60.0
40.0
20.0
counts


prod2
prod3b
prod5
CTA 5h
$10^{-12}$
$10^{-13}$
$E^2 \times dN/dE$ (erg cm$^{-2}$ s$^{-1}$)
$10^{-1}$
$10^{0}$
$10^{1}$
$10^{2}$
Energy (TeV)

# Simulations

spectral fit residuals






Saha et al, ApJ, 897, 2020