

An X- and gamma-ray view of the sky region around SNR G69.7+1.0

MICHELA RIGOSELLI^{1,2}

Silvia Crestan², Andrea Giuliani², Sandro Mereghetti², Alberto Bonollo^{2,3,4}, Iacopo Bartalucci²

1 INAF, OA Brera — 2 INAF, IASF Milano — 3 IUSS Pavia — 4 Università di Trento



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Outline

- J2002u+3244u one of unassociated LHAASO sources
- Radio and gamma-ray sources spatially coincident
- We asked for ~50 ks of XMM-Newton data to investigate the X-ray counterpart

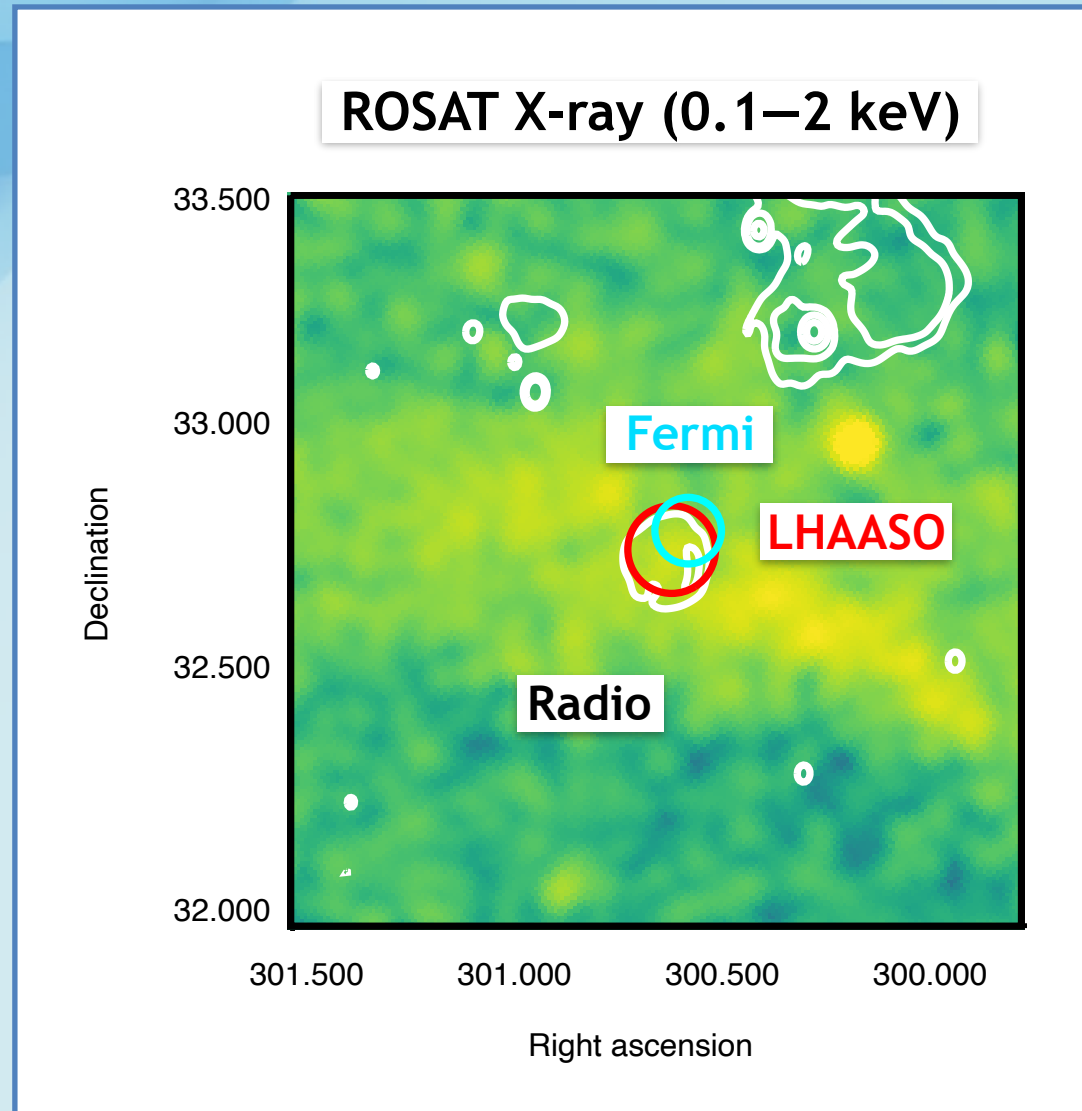
Outline

- J2002u+3244u one of unassociated LHAASO sources
- Radio and gamma-ray sources spatially coincident
- We asked for ~50 ks of XMM-Newton data to investigate the X-ray counterpart
- Reanalysis of Fermi-LAT data
- Preliminary results on half of XMM-Newton data

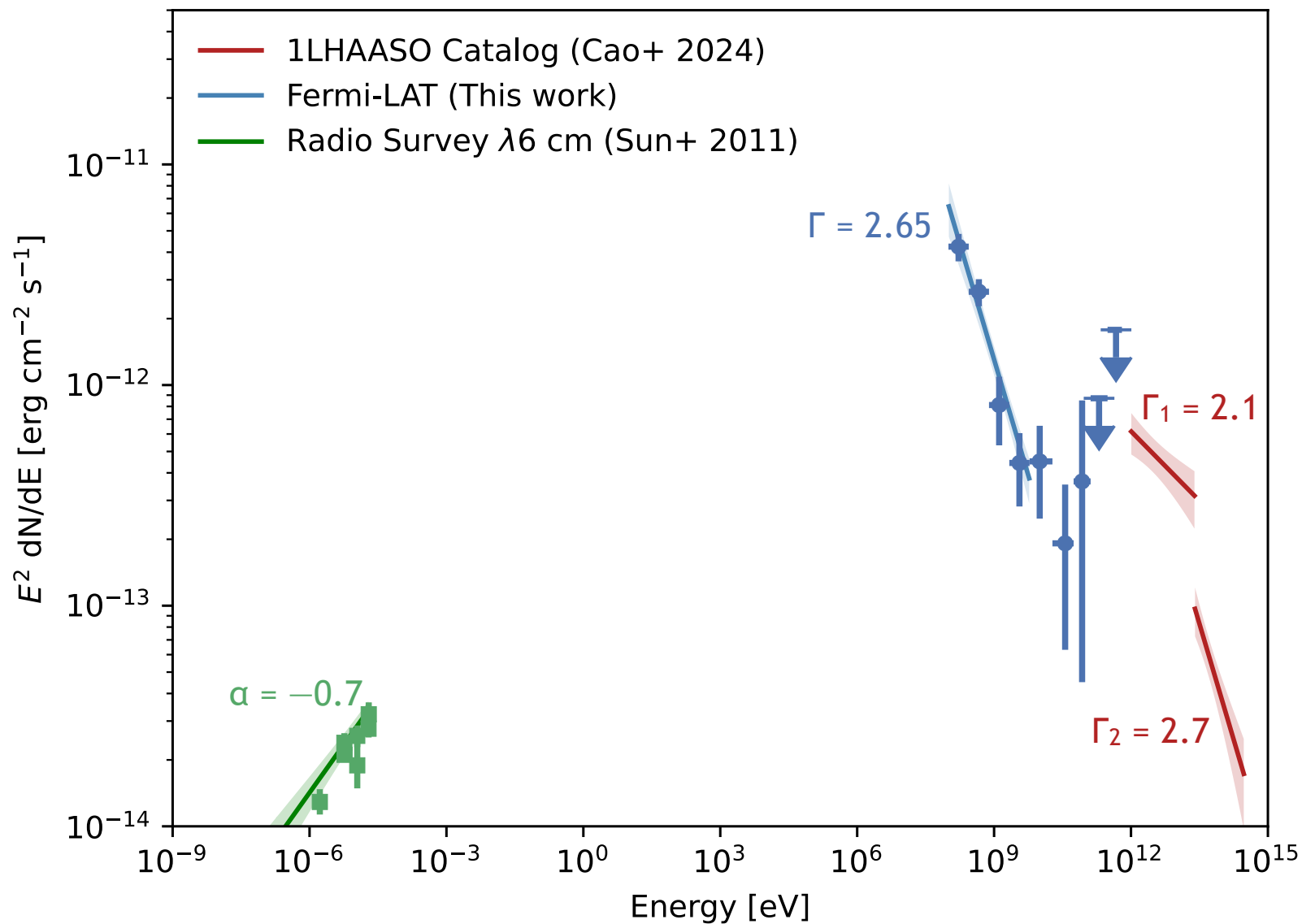


SNR G69.7+1.0 sky region

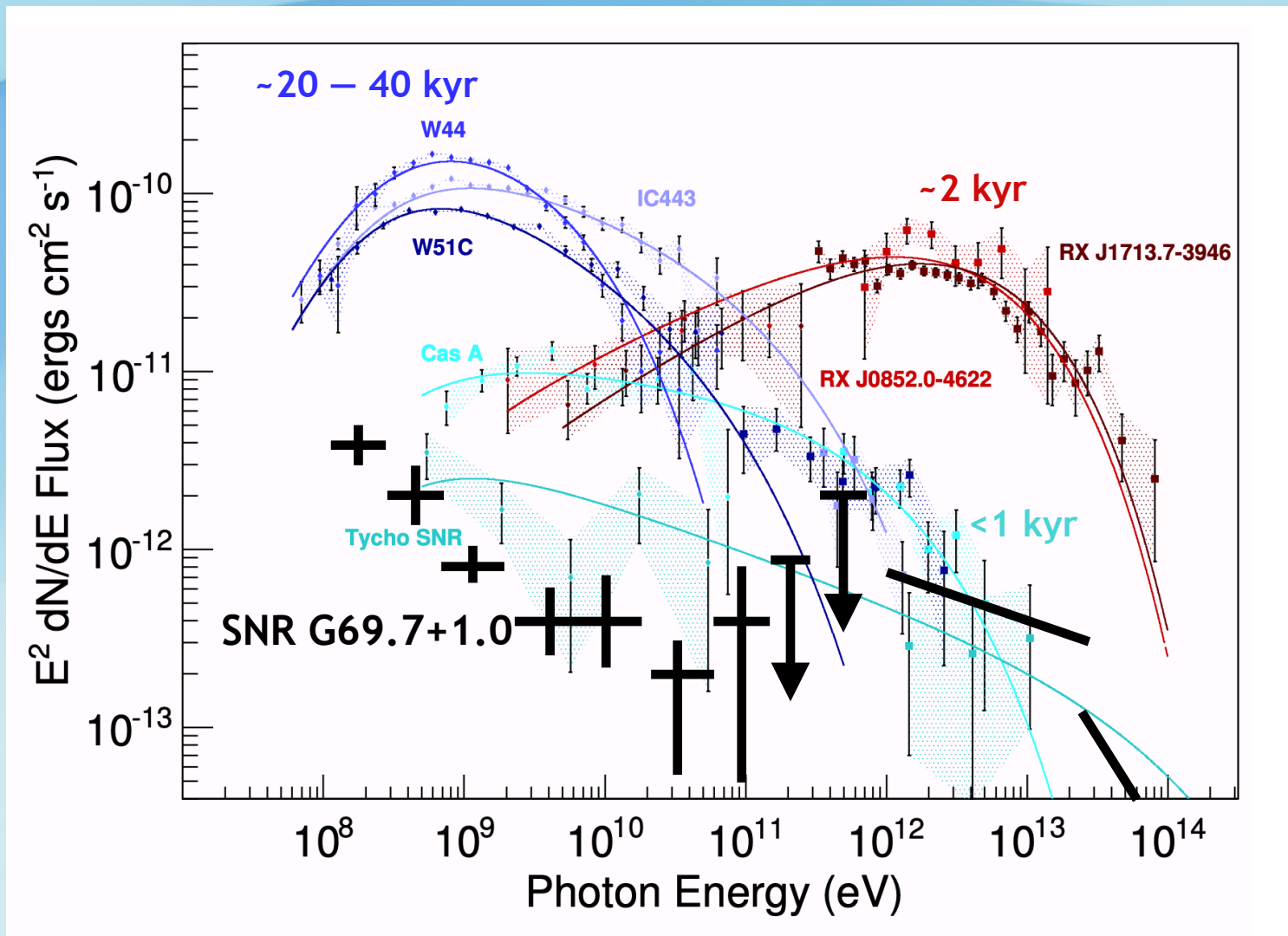
- Radio shell-like SNR
 - 16×14 arcmin
 - $d \approx 8 - 15$ kpc [Σ - d relation]
 - $\tau \approx 20 - 100$ kyr [Sedov]
- Unresolved Fermi-LAT source
 - Steep spectrum ($\Gamma \sim 2.6$)
- Unresolved LHAASO source
 - $TS_{100} = 28$
- ROSAT all-sky survey
 - Thermal emission extending for $\sim 1^\circ$
 - A foreground SNR?



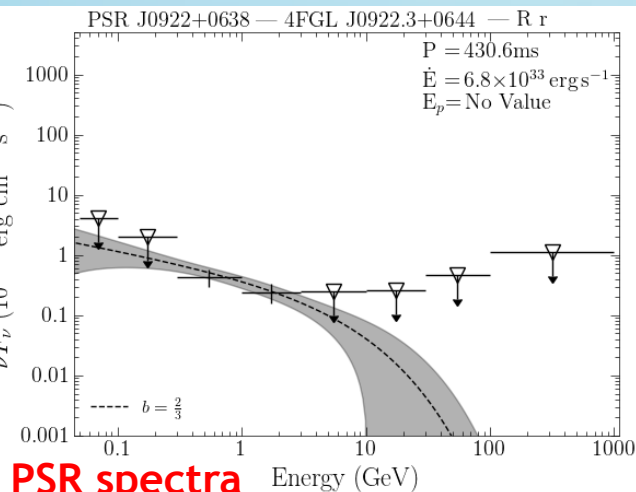
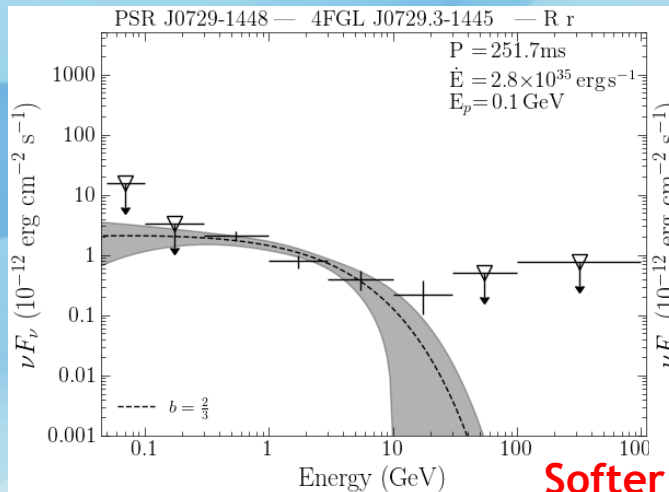
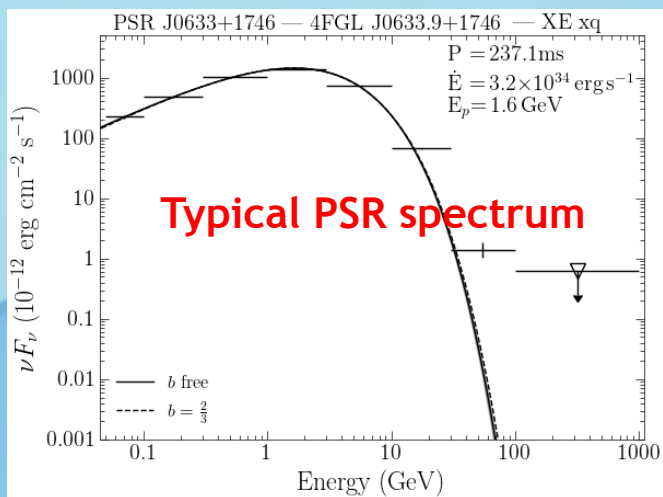
SNR G69.7+1.0 SED



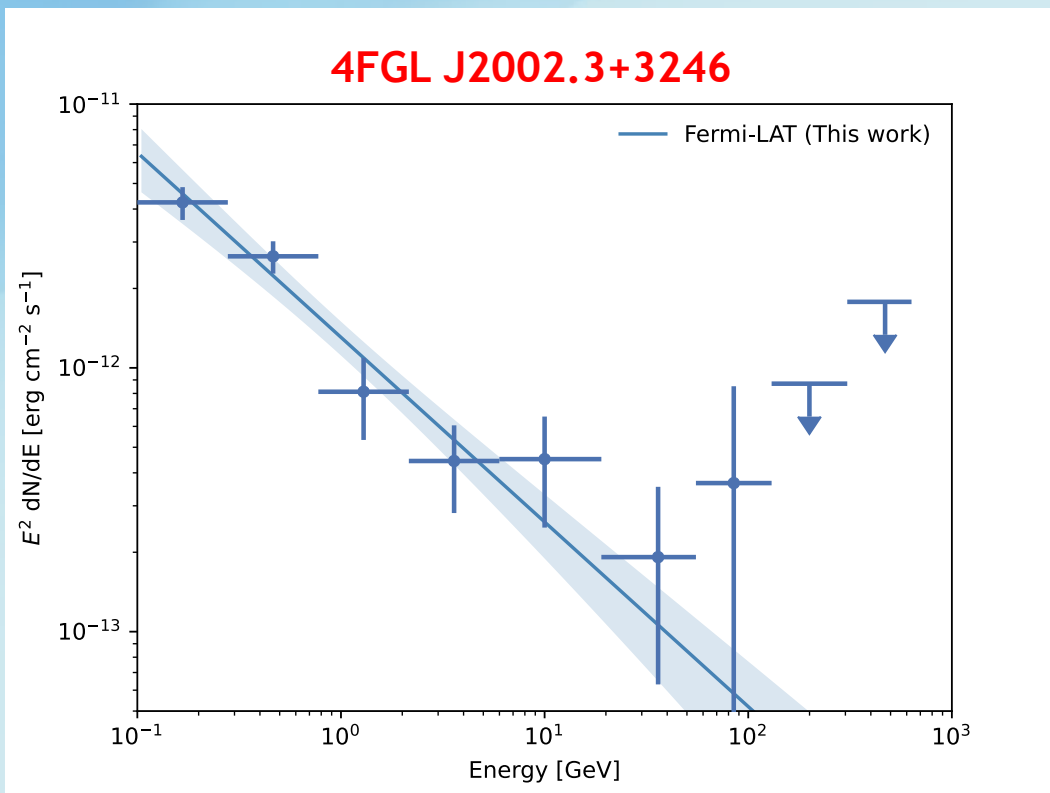
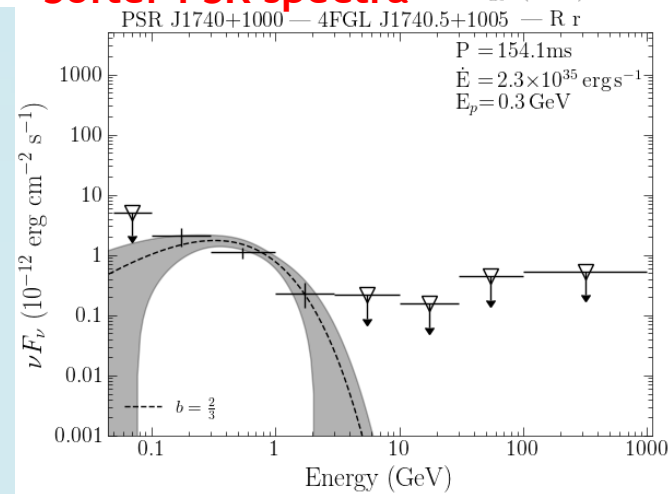
Comparison with other SNRs



Comparison with other PSRs

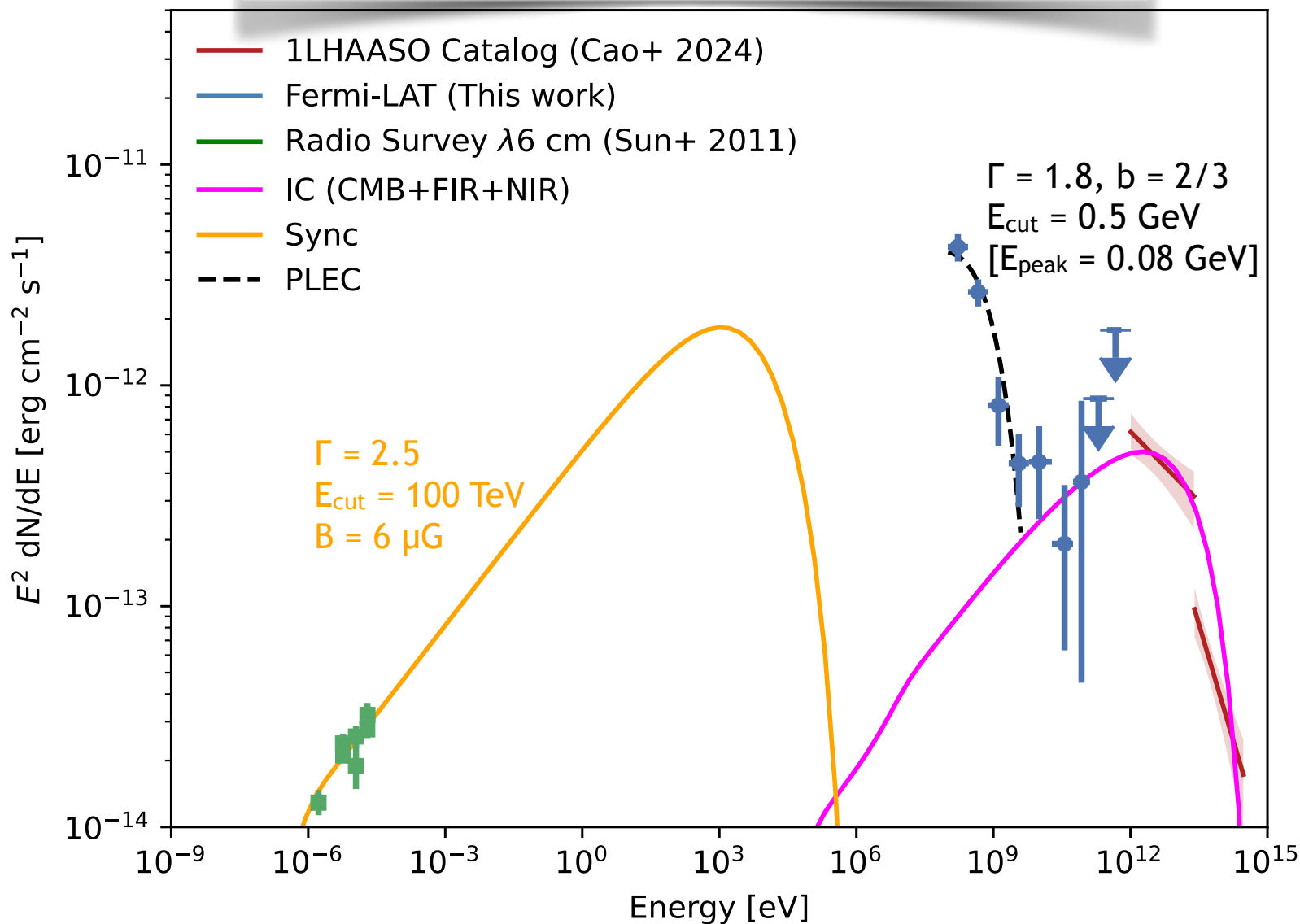


Softer PSR spectra



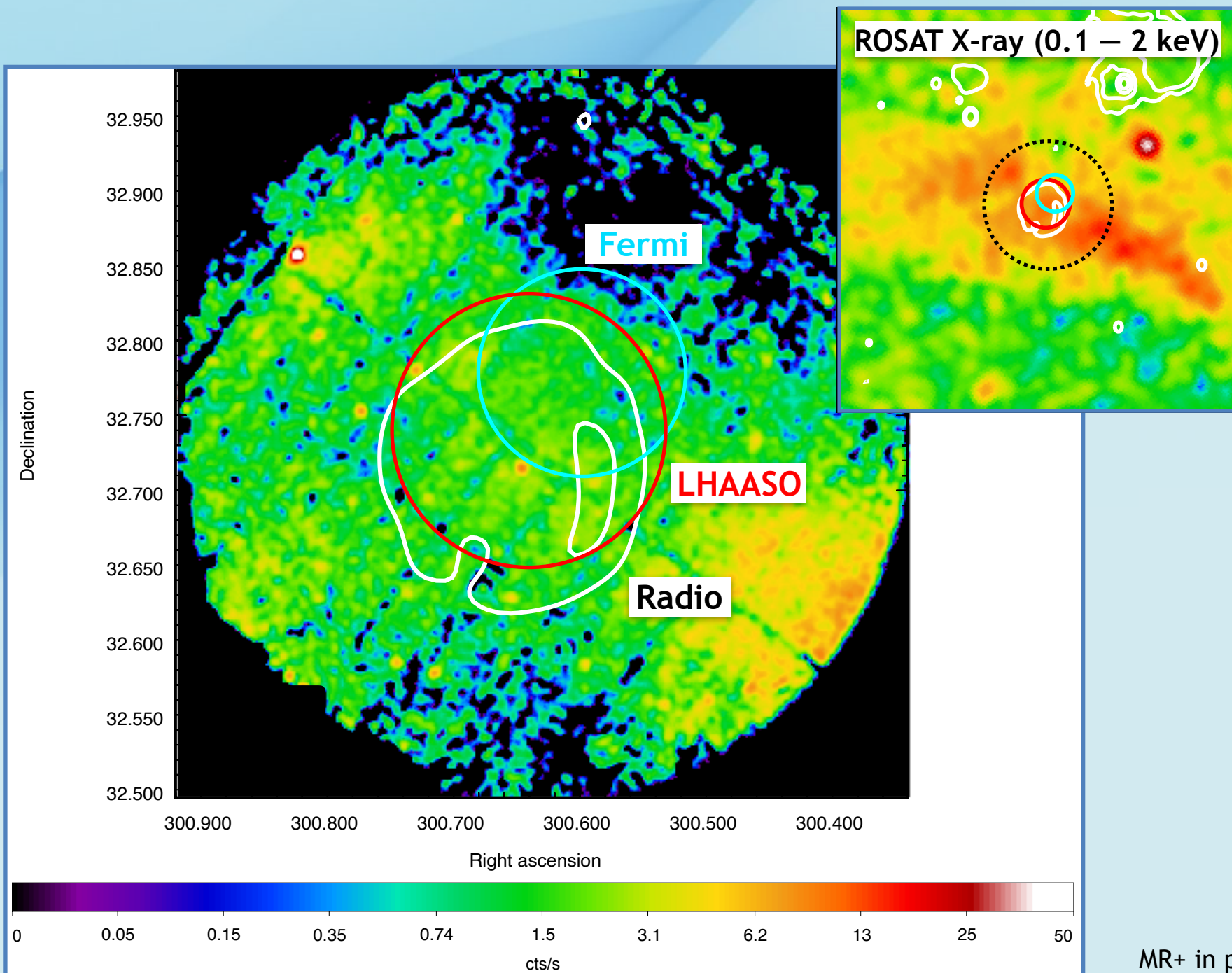
SNR G69.7+1.0 SED

One-zone leptonic model + Pulsar



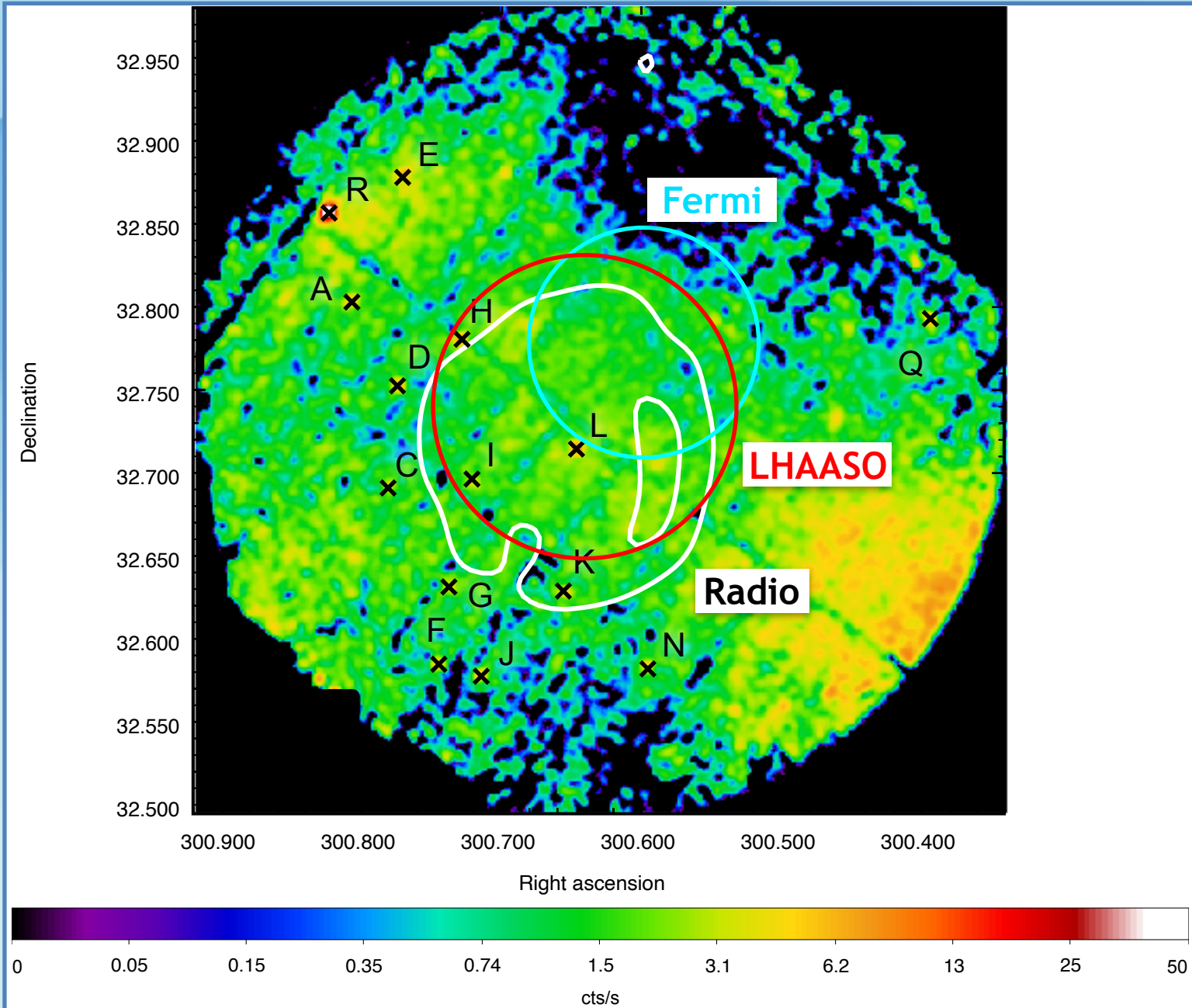


XMM-Newton 0.3 – 10 keV



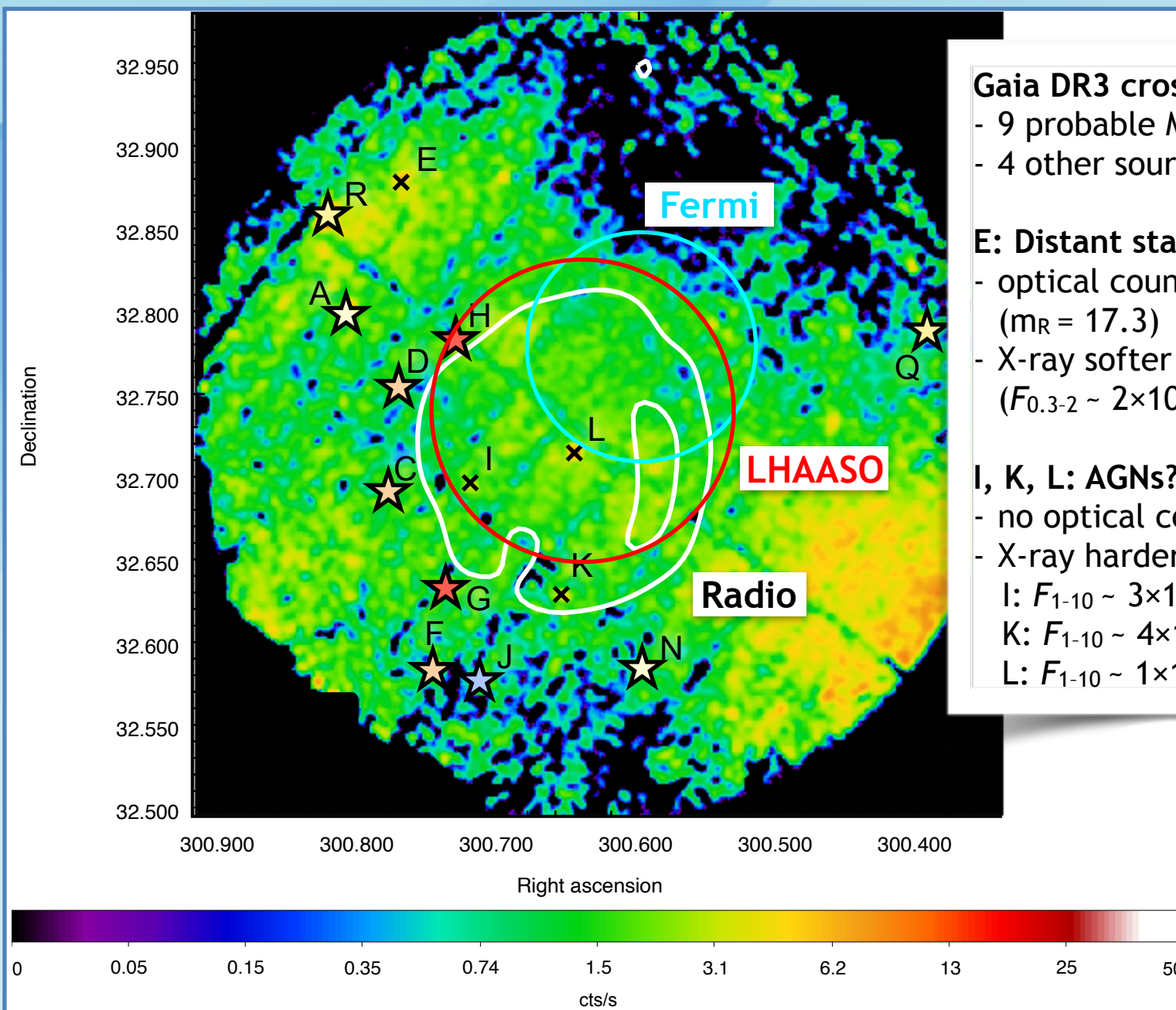


Point sources ($\sigma > 5$)





Point sources ($\sigma > 5$)



Gaia DR3 cross correlation

- 9 probable MS stars
- 4 other sources

E: Distant star?

- optical counterpart ($m_R = 17.3$)
- X-ray softer ($F_{0.3-2} \sim 2 \times 10^{-11}$ erg/cm²/s)

I, K, L: AGNs? Pulsars?

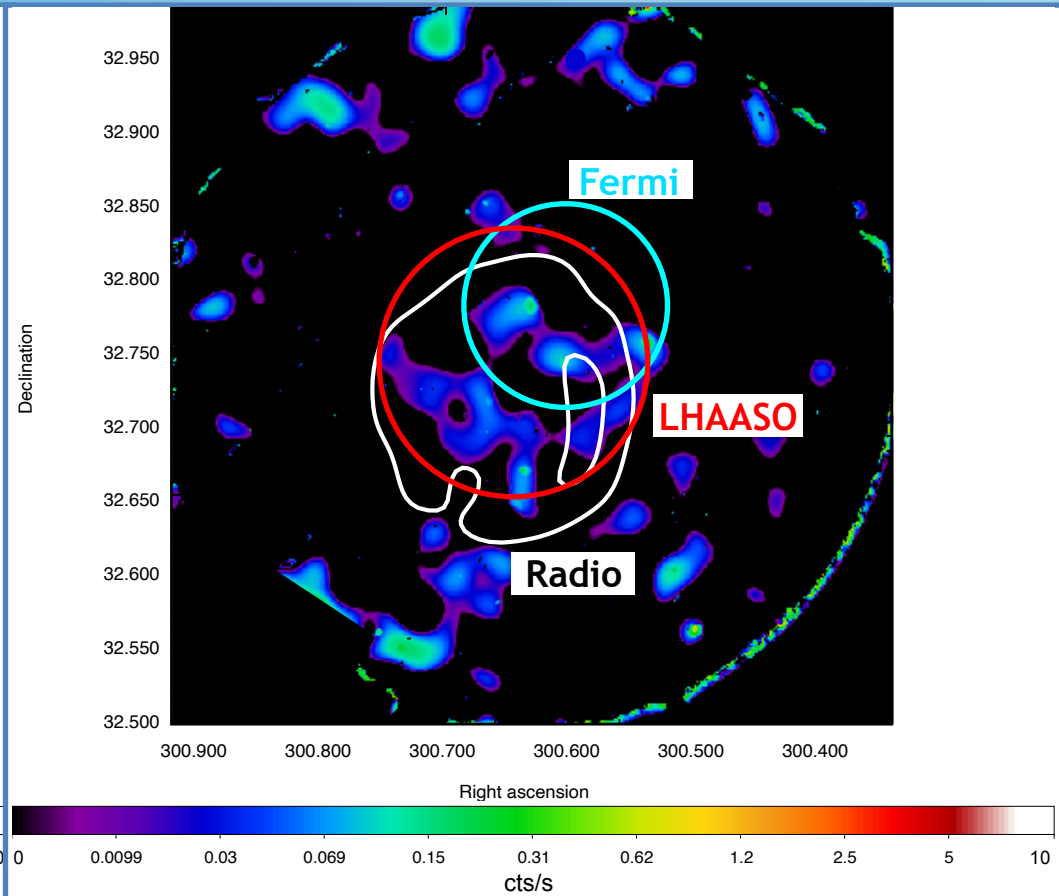
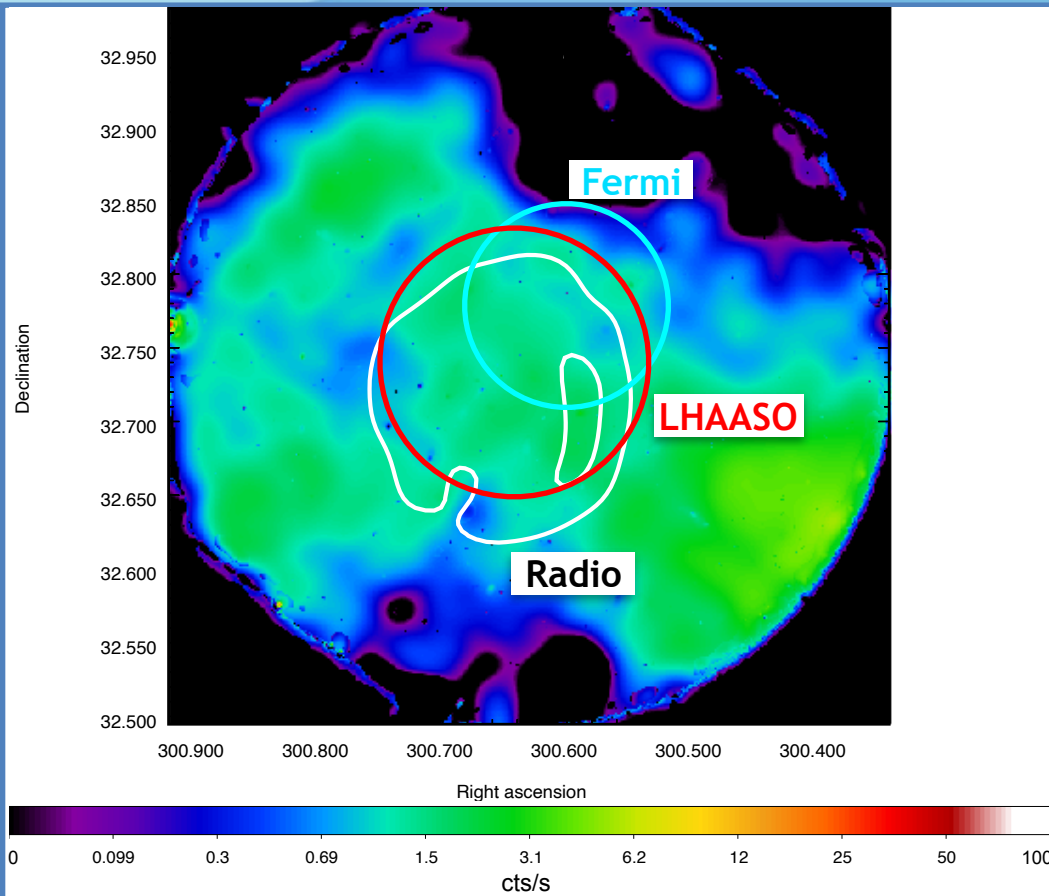
- no optical counterpart
- X-ray harder
- I: $F_{1-10} \sim 3 \times 10^{-14}$ erg/cm²/s
- K: $F_{1-10} \sim 4 \times 10^{-14}$ erg/cm²/s
- L: $F_{1-10} \sim 1 \times 10^{-13}$ erg/cm²/s



Extended sources

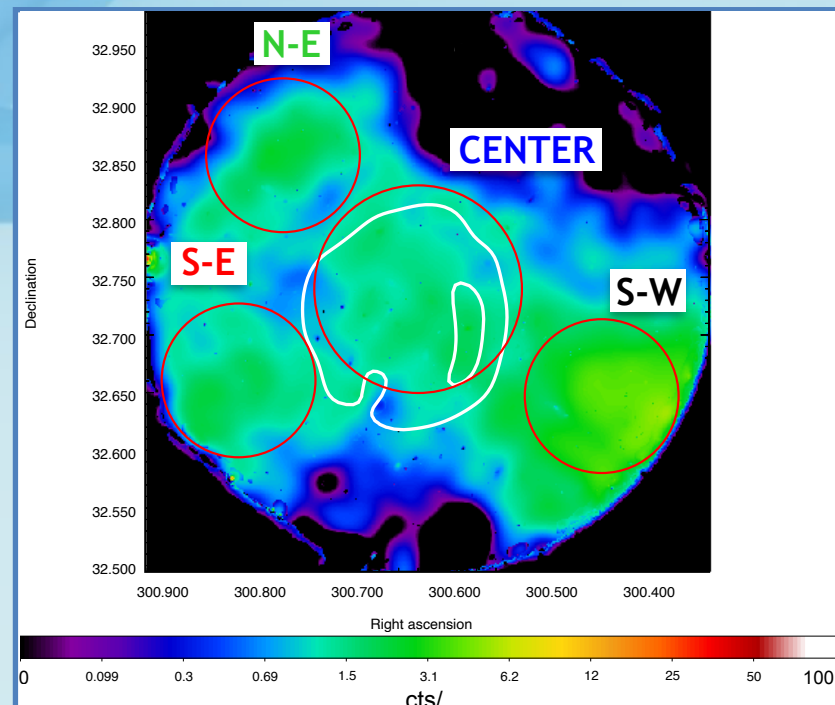
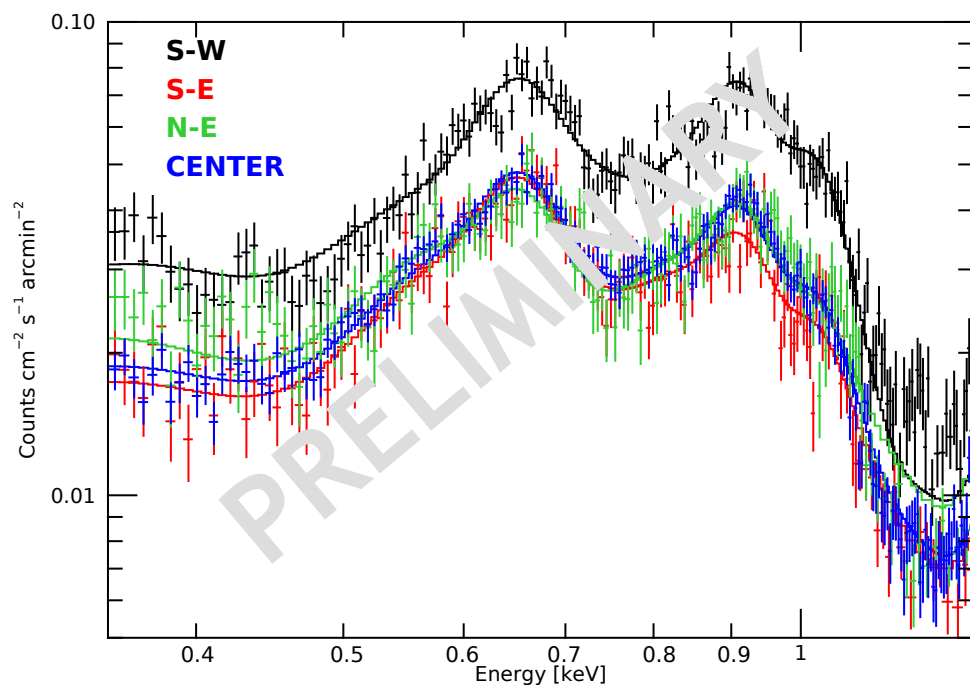
0.5 – 2.5 keV

2.5 – 10 keV





Spectra: soft component

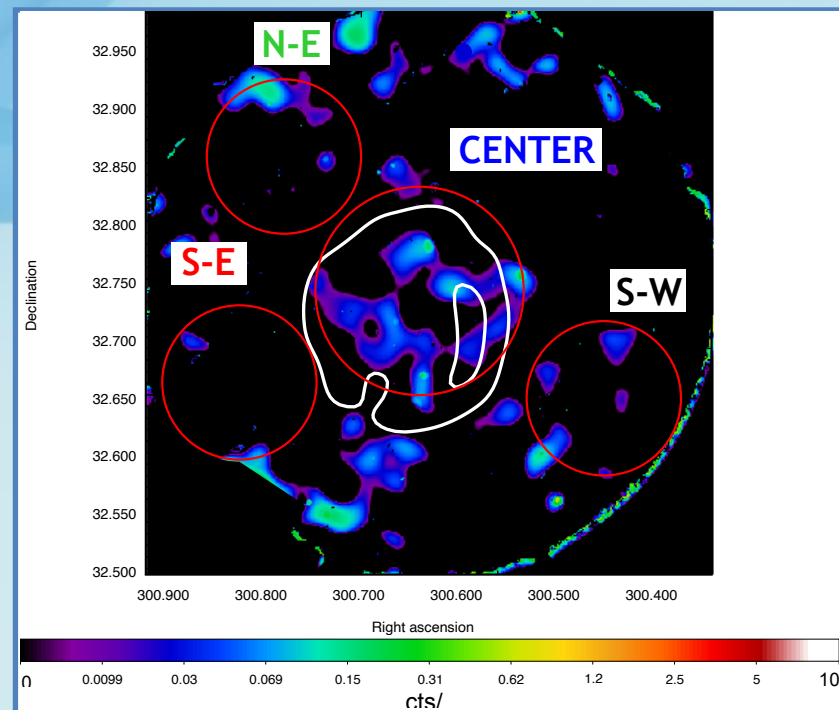
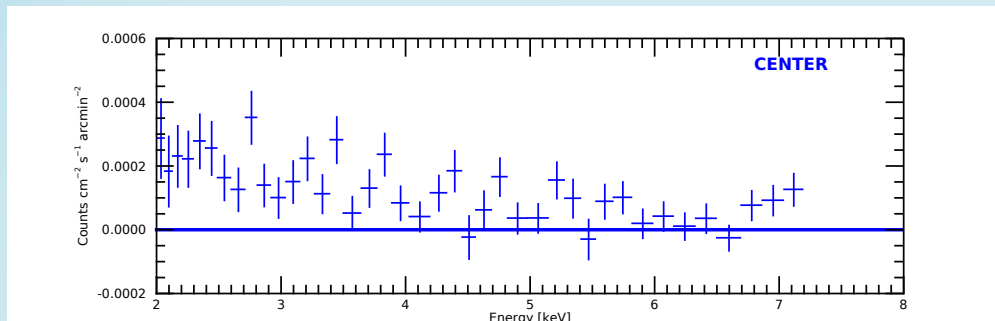
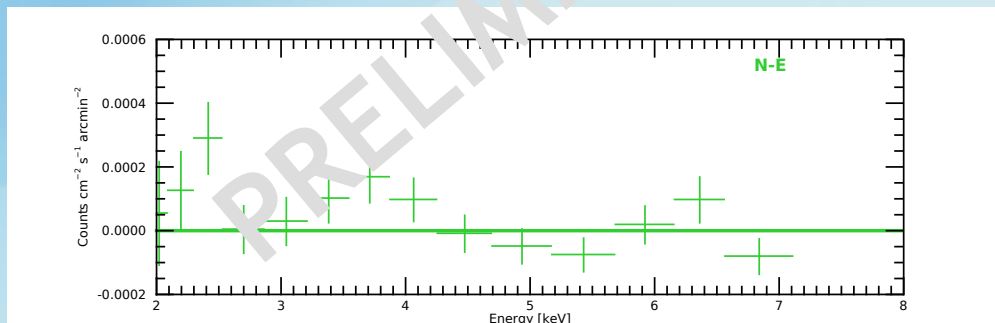
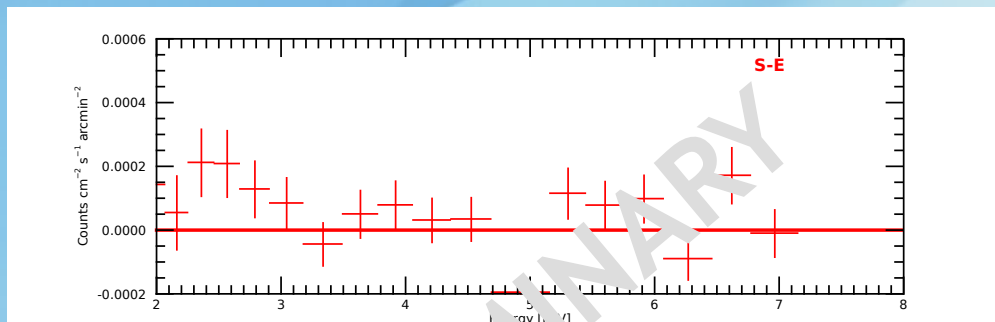
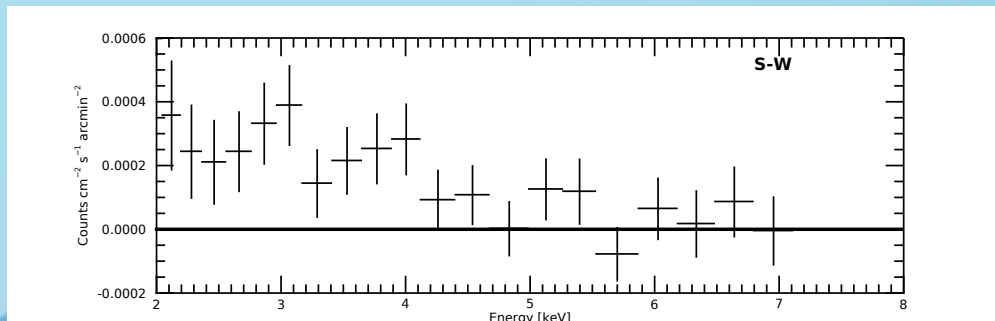


All regions fitted by hot diffuse gas with emission lines (vMekal)

- $N_{\text{H}} = 1.2 \times 10^{20} \text{ cm}^{-2}$
- $kT = 0.41 \text{ keV}$
- Slightly different abundances
- Surface brightness 0.3 – 2 keV
 - N-E: $1.6 \times 10^{-14} \text{ erg/cm}^2/\text{s/arcmin}^2$
 - S-E: $1.6 \times 10^{-14} \text{ erg/cm}^2/\text{s/arcmin}^2$
 - S-W: $4.0 \times 10^{-14} \text{ erg/cm}^2/\text{s/arcmin}^2$
 - CENTER: $1.6 \times 10^{-14} \text{ erg/cm}^2/\text{s/arcmin}^2$



Spectra: hard component

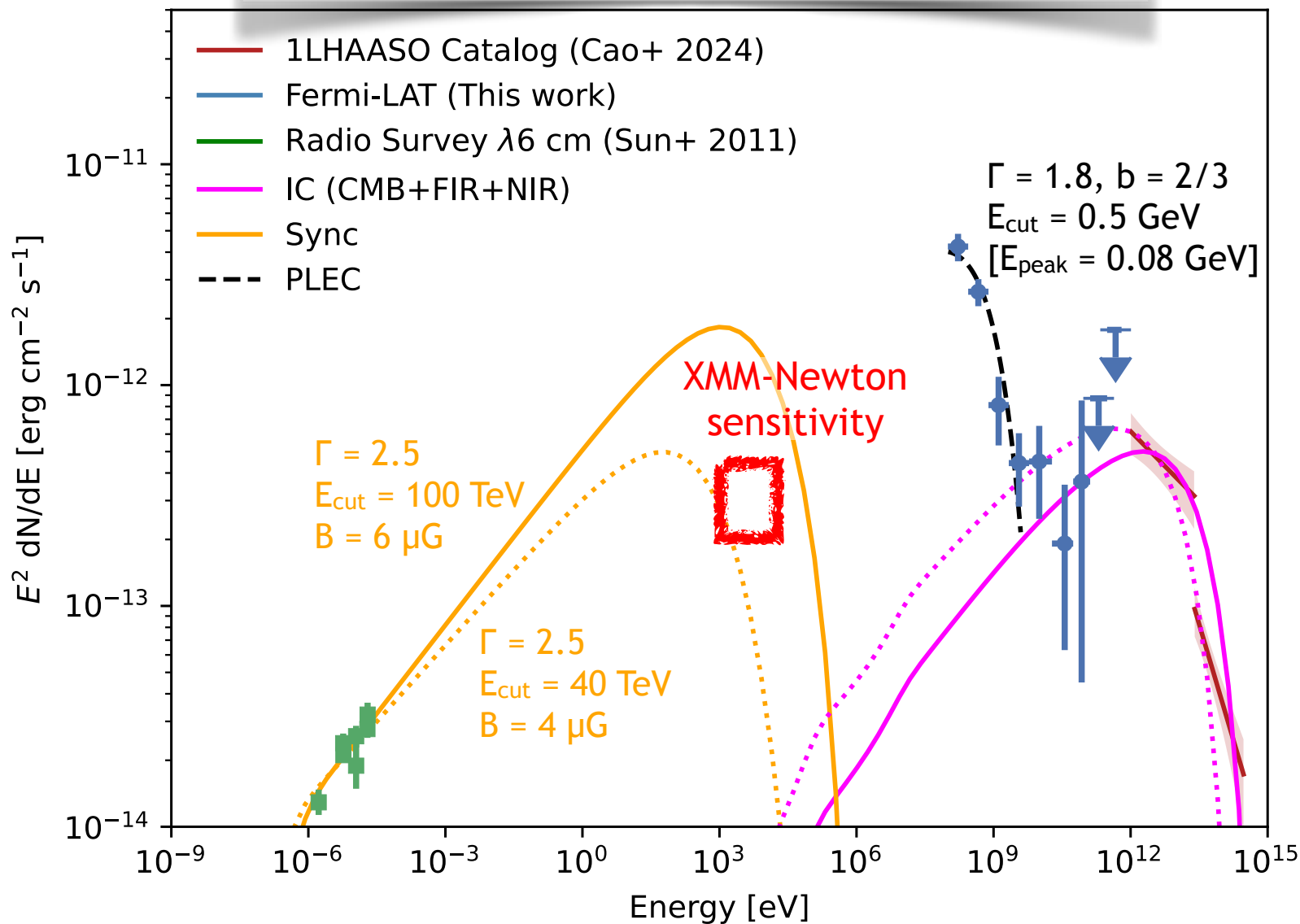


Hard excess

- $\Gamma \sim 2$
- Flux 2 – 10 keV
 - N-E: $6(4) \times 10^{-13}$ erg/cm²/s
 - S-E: $7(4) \times 10^{-13}$ erg/cm²/s
 - S-W: $2.2(5) \times 10^{-13}$ erg/cm²/s
 - CENTER: $2.5(5) \times 10^{-13}$ erg/cm²/s

SNR G69.7+1.0 SED

One-zone leptonic model + Pulsar



Conclusions and Future Prospects

X- and gamma-rays

- γ -ray source @10 kpc has $L_\gamma \sim 5 \times 10^{35}$ erg/s:
it could be a pulsar having $\dot{E} \sim 10^{36}$ erg/s and a possible X-ray counterpart
- Soft X-ray thermal emission has nothing to do with SNR G69.7+1.0
- Hard X-ray non-thermal emission could be associated to SNR G69.7+1.0

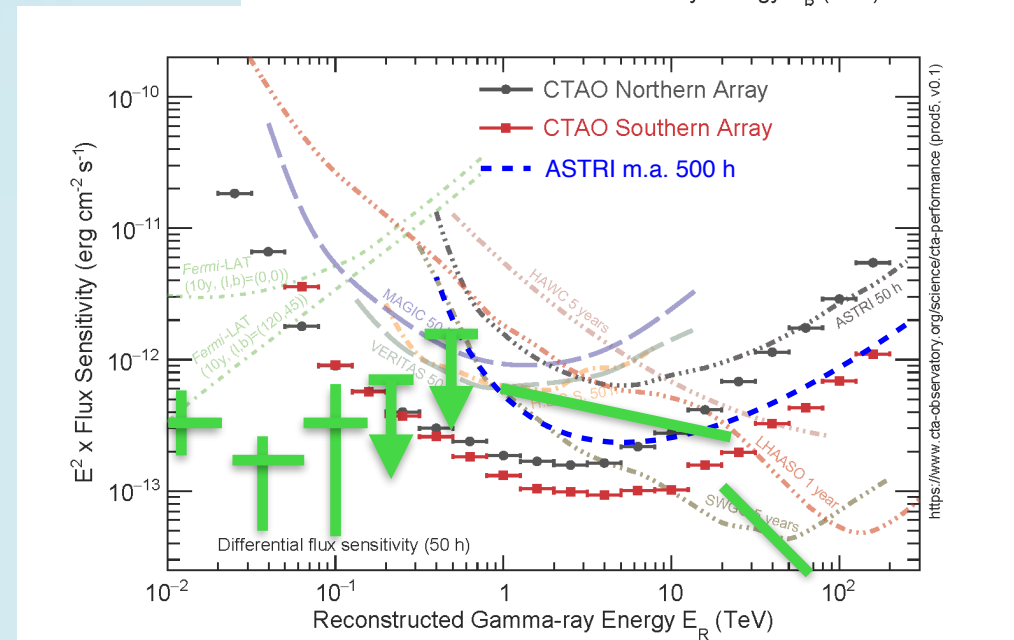
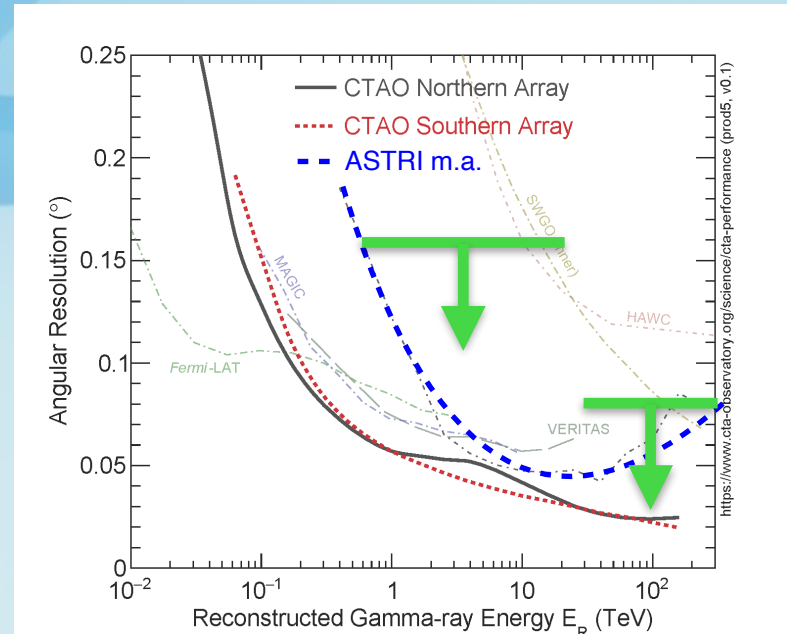
Conclusions and Future Prospects

X- and gamma-rays

- γ -ray source @10 kpc has $L_\gamma \sim 5 \times 10^{35}$ erg/s:
it could be a pulsar having $\dot{E} \sim 10^{36}$ erg/s and a possible X-ray counterpart
- Soft X-ray thermal emission has nothing to do with SNR G69.7+1.0
- Hard X-ray non-thermal emission could be associated to SNR G69.7+1.0

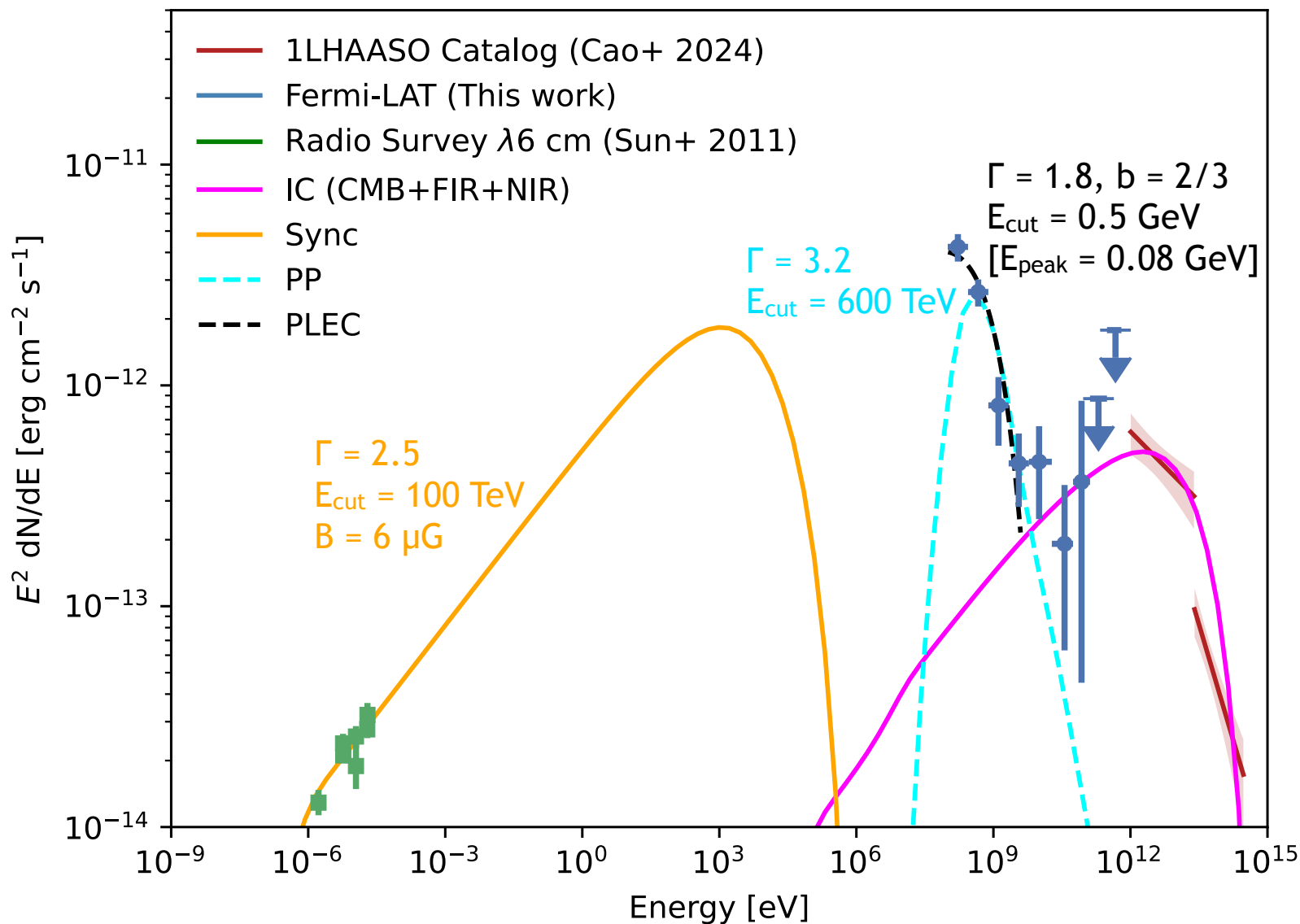
TeV [ASTRI & CTAO]

- Improved angular resolution to assess the associations
- Fill in the gap between 0.1 – 1 TeV to better characterize the bridge between the Fermi and the LHAASO components

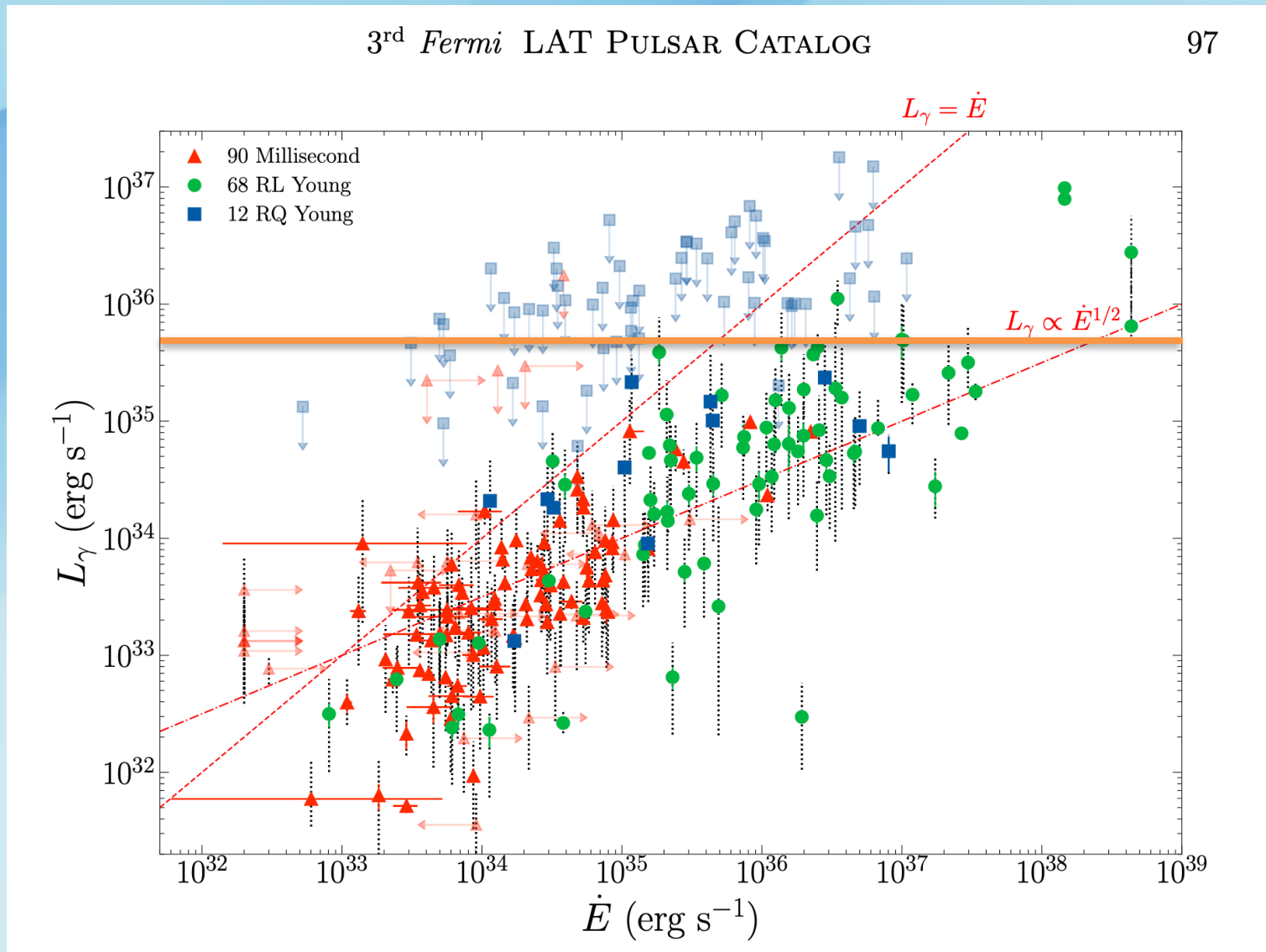


Thanks for the attention!

SNR G69.7+1.0 SED



Comparison with other PSRs



Comparison with other PSRs

