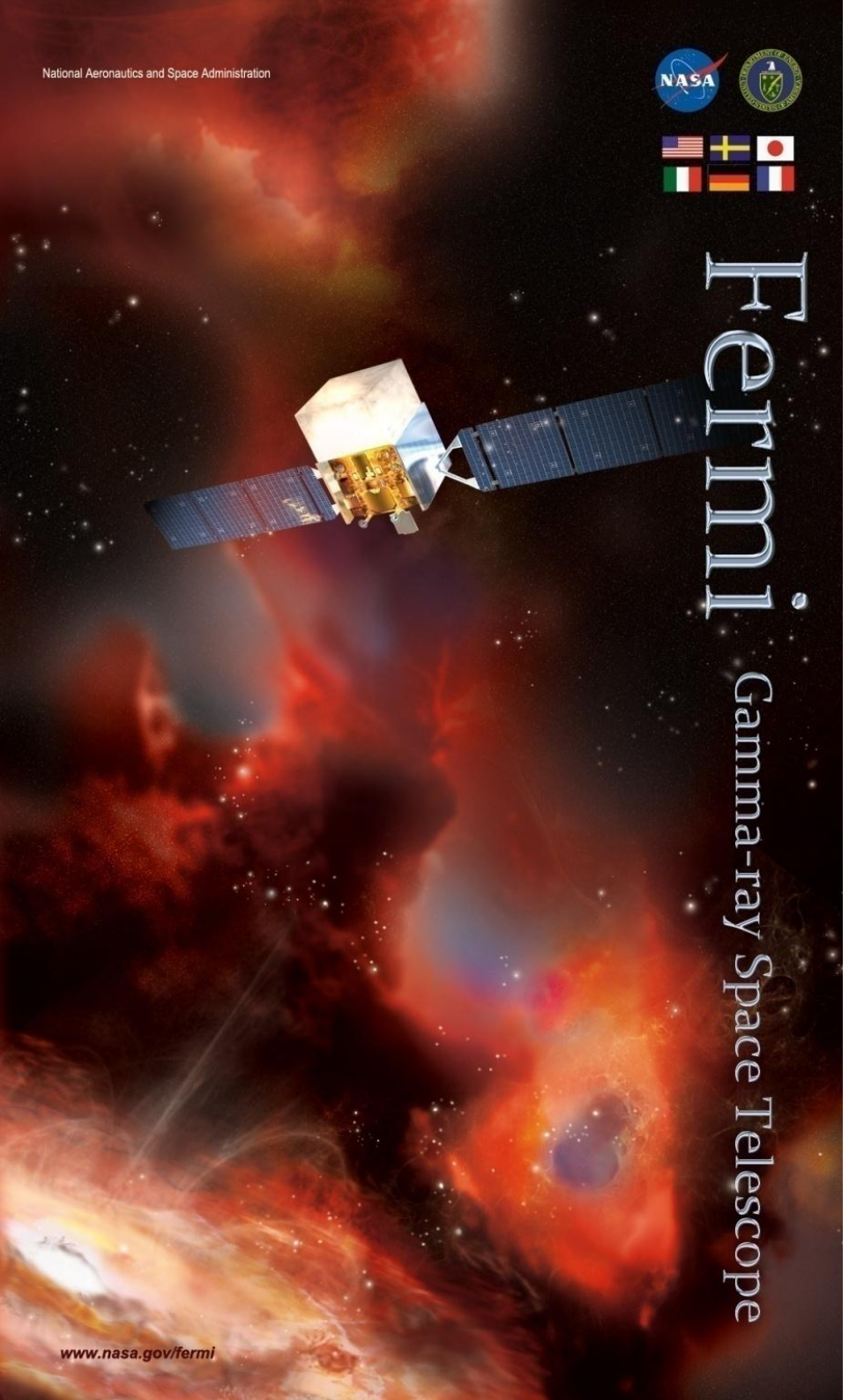

The First Fermi LAT Catalog of Supernova Remnants

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on behalf of the
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SNR catalog

The aim of the catalog is to better understand SNRs emission in a statistically significant manner within a multi wavelength context. This presentation will illustrate the pipeline analysis method under advanced development.

The main items of this work are:

- Characterize GeV emission in ROIs containing SNRs, with a uniform algorithm and dataset;
- Evaluate systematic errors, including diffuse models and variability;
- Examine multi wavelength correlation, including spectrum and morphology for radio, X-ray, TeV , and so on;
- Determine statistically significant SNR classification(s) and perform spectral modeling.

Pipeline description

Main characteristics of the analysis:

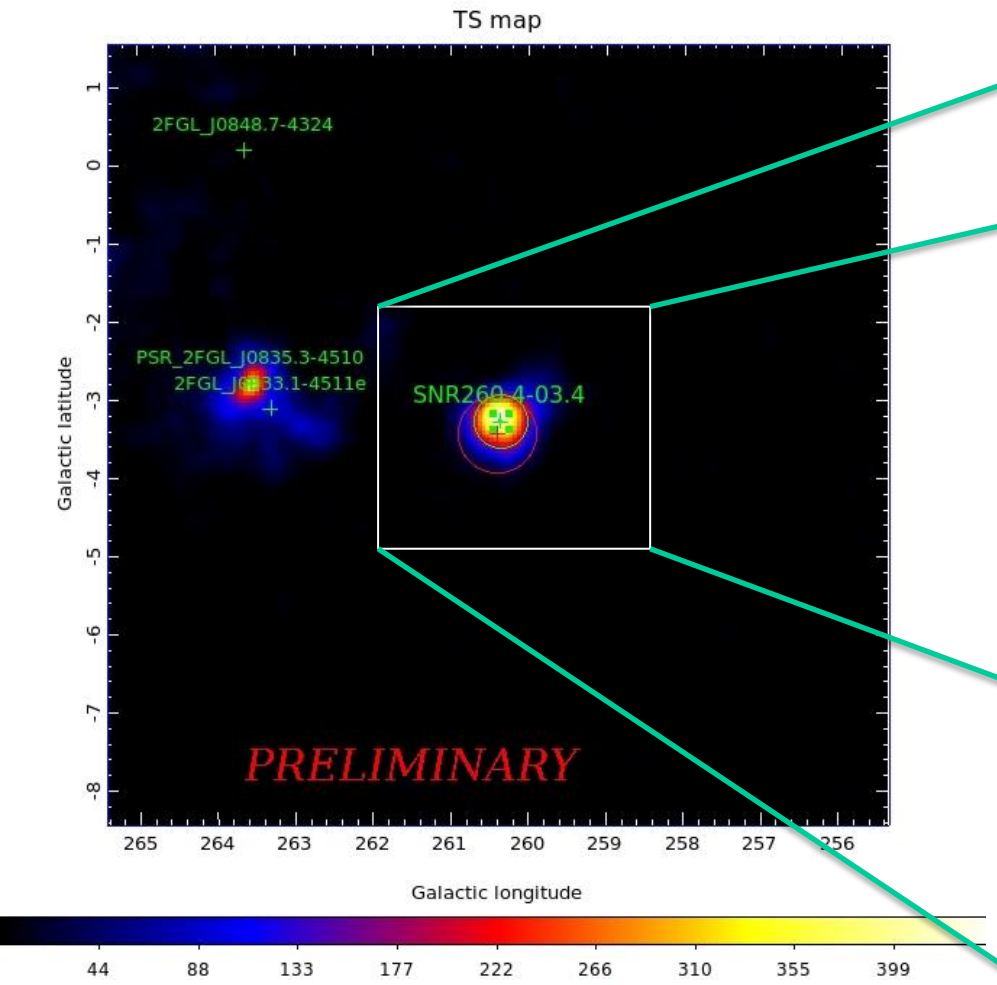
- Data set 3 years of P7SOURCE_V6, in the energy range 1 -100 GeV and with an ROI of 10° around each of the Green catalog SNR (278).
- The starting model is generated from the values in the 2FGL.
- Check for ovelapping sources (*distance between 2FGL source and radio centroid smaller than radio radius plus 2FGL source 95% localization error*):
  - None-> Add a new extended source in the radio position.
  - One source (not PSR) -> Replace with extended source.
  - More than one source -> Replace source closest to radio centroid with extended source. Delete all other sources (non PSR).
- Localize source and fit (disk) extension (extension seed = radio size)

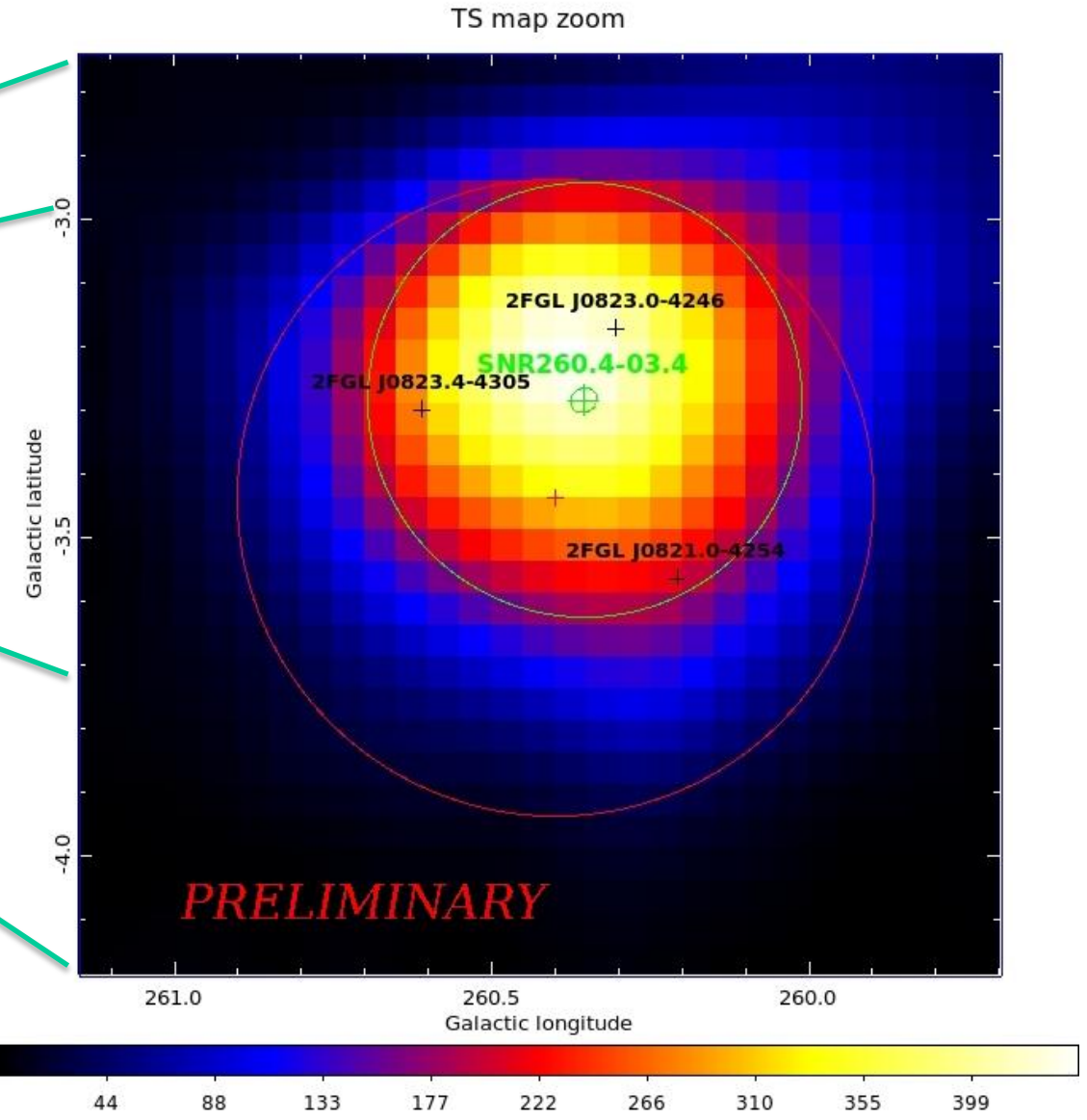
  (see *Lande et al.* 2012 submitted).
- The SNRs are modeled with a power-law spectral shape.
- The normalizations of all the sources in 5° and the normalization of the galactic diffuse are left free to vary during the minimization procedure.
- Cross-check with two independent spectral fitting procedures.

Output of the analysis

- Test statistic maps, residual test statistic maps, sigma maps and smoothed counts maps, for study of the spatial residuals;
- SEDs;
- Summary files are created to compare with the output results of the whole pipeline;
- Large number of diagnostic test and plots were produced and analyzed to test the consistency of the results.

Characterize GeV Emission: TS maps for Puppis A





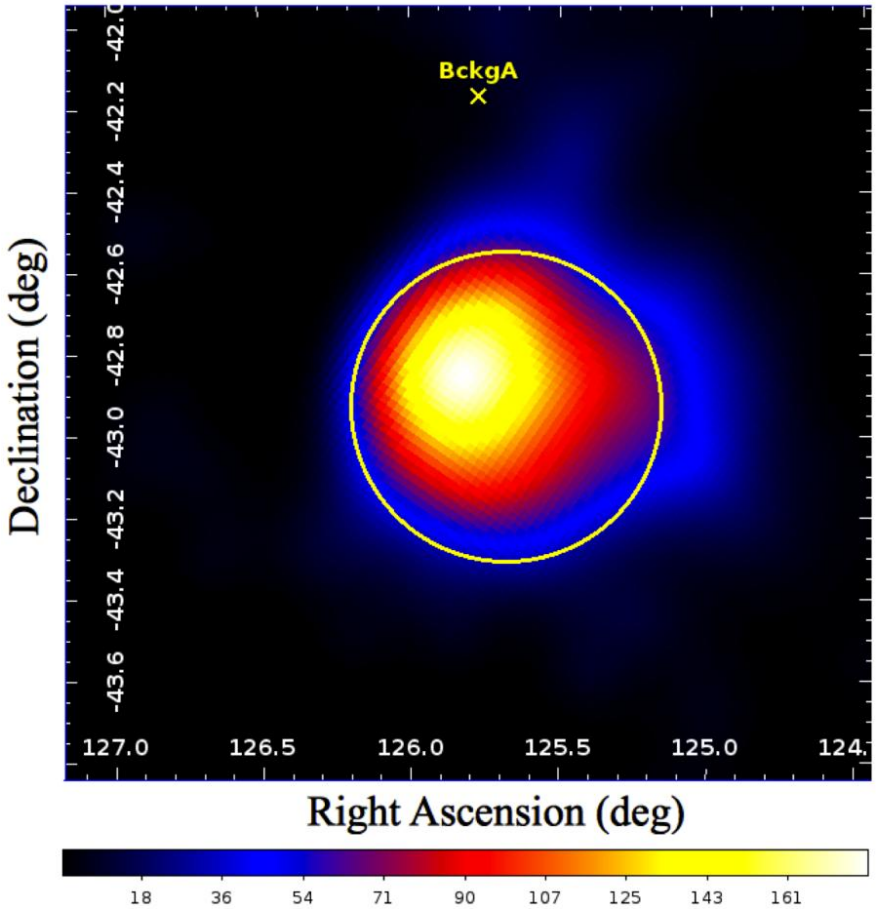
- Starting model from 2FGL results;
- 3 sources deleted and substituted with the extended source.

- No selection on Vela phase was applied.

Comparison with single paper results

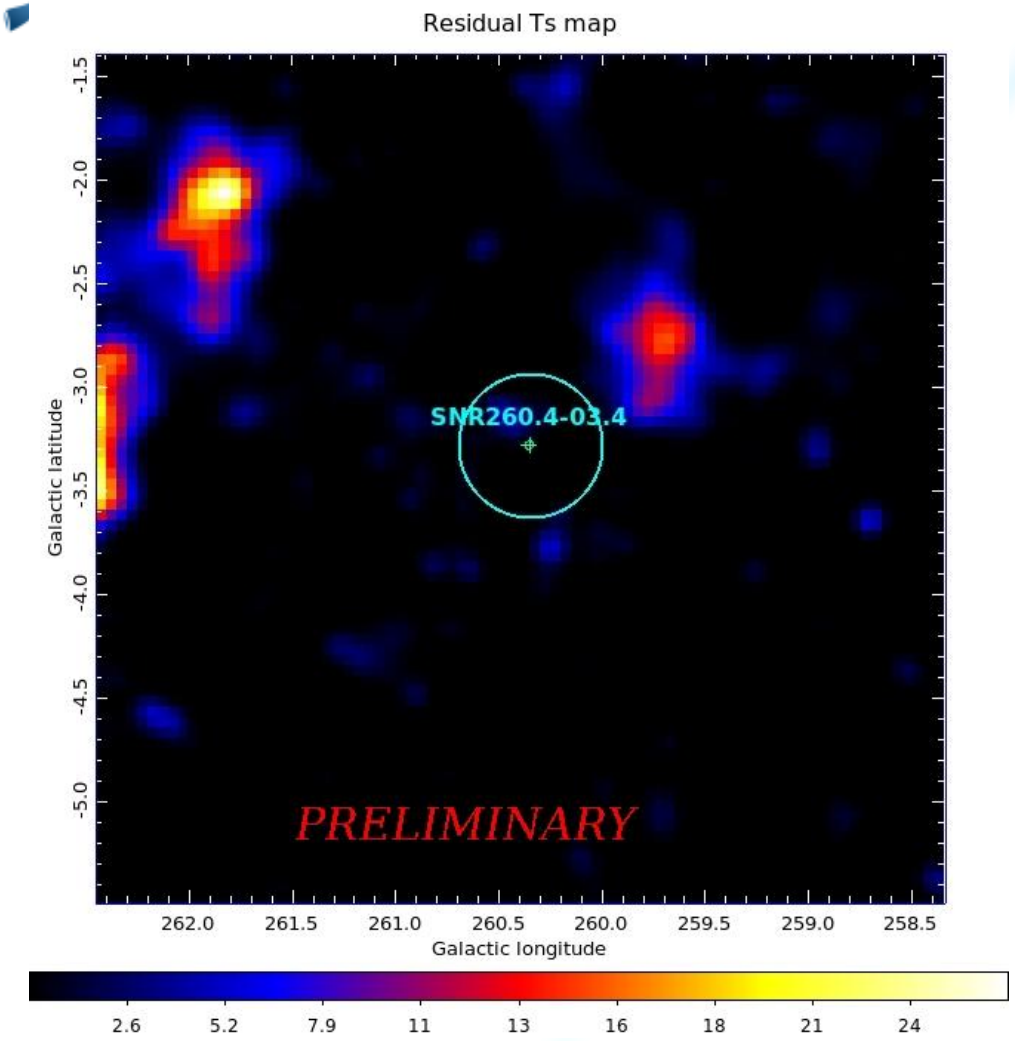
Despite remaining residuals, pipeline results reasonably match those for individual sources:

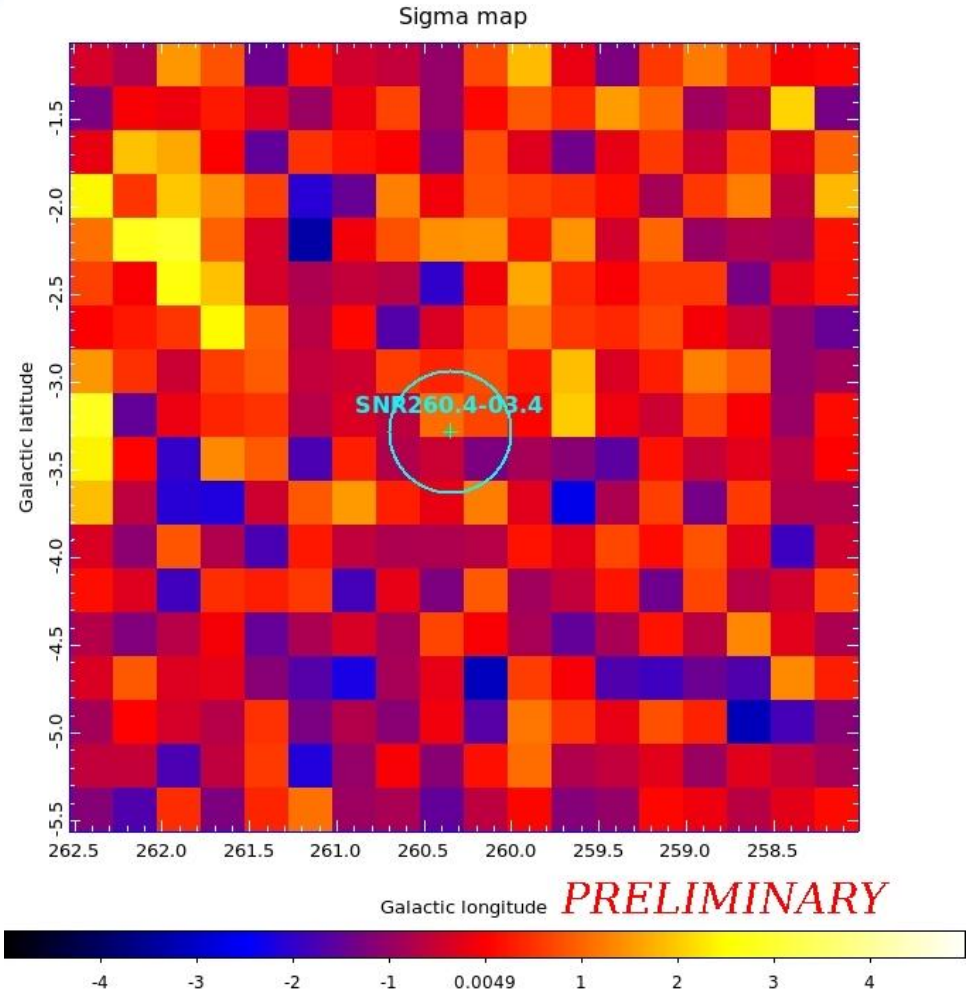
- Index:
  - Paper: 2.10 ± 0.07 ± 0.10
  - Pipeline: 2.22 ± 0.07
- Flux: Paper: ~ Pipeline ~10^{-11} erg/cm^2/s



From Puppis A paper
See the following, J. Hewitt talk

Fit residuals analysis





In the whole map
Max residual TS= 26
Inside the SNR
Max residual TS = 4

σ = (cts-model)/√(model)
Bin size = 0.25°
Average=-0.1
RMS=1.1

Some numbers

2FGL results

78 sources associated with SNRs
(with an estimated chance coincidence of ~45%)

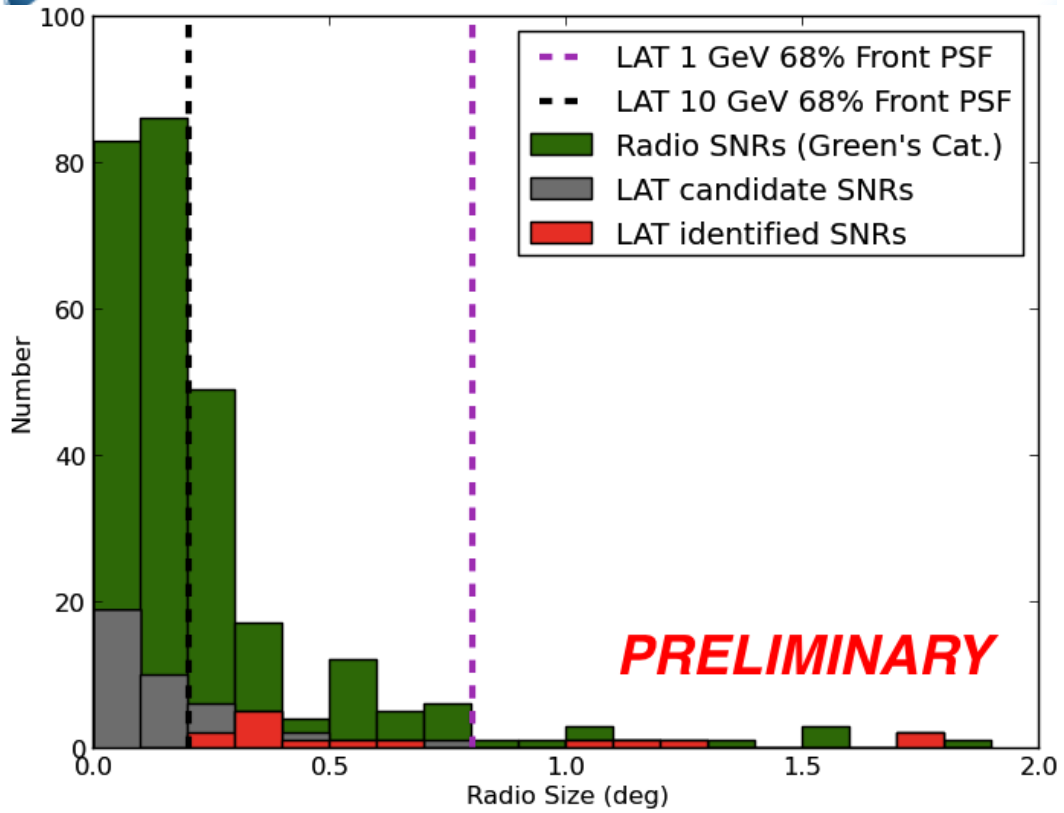
SNR catalog results:

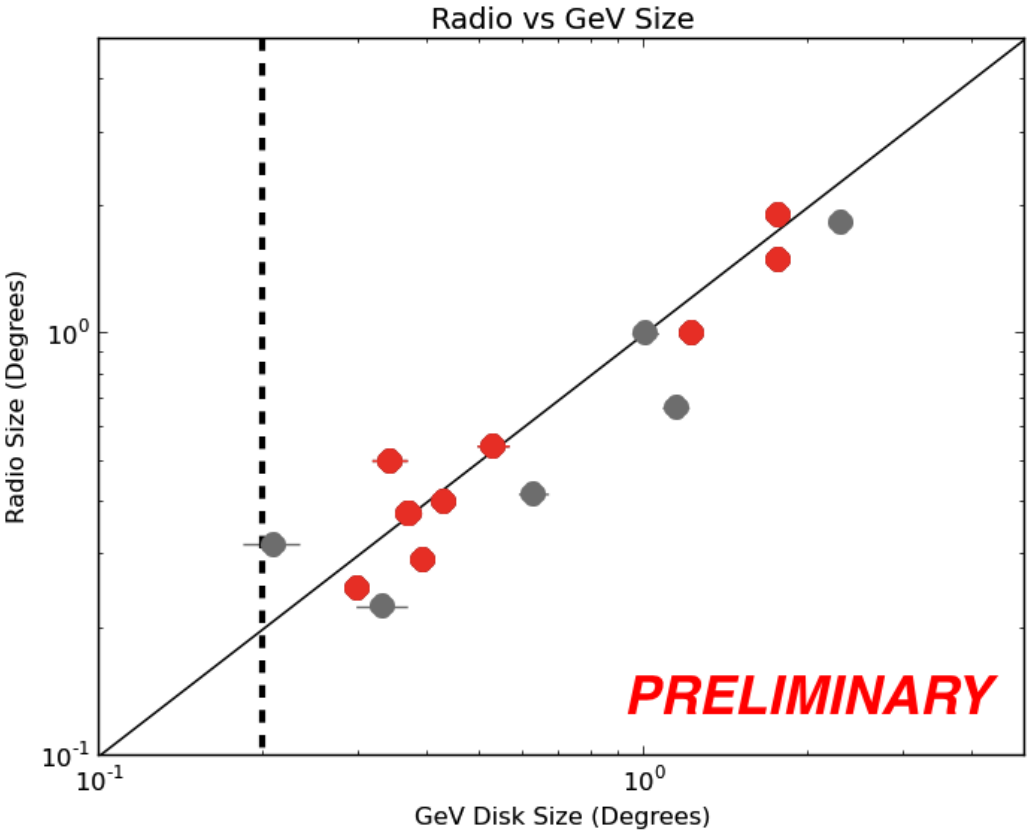
- 51 of 278 Radio SNRs detected

- 12 previously identified SNRs
- 8 are identified as **NOT** SNRs
  (PSR, PWN, HMB or AGN)

31 new candidate SNRs

Size of candidate SNRs





- **Previously identified SNRs**
- **Candidate SNR (significantly extended)**

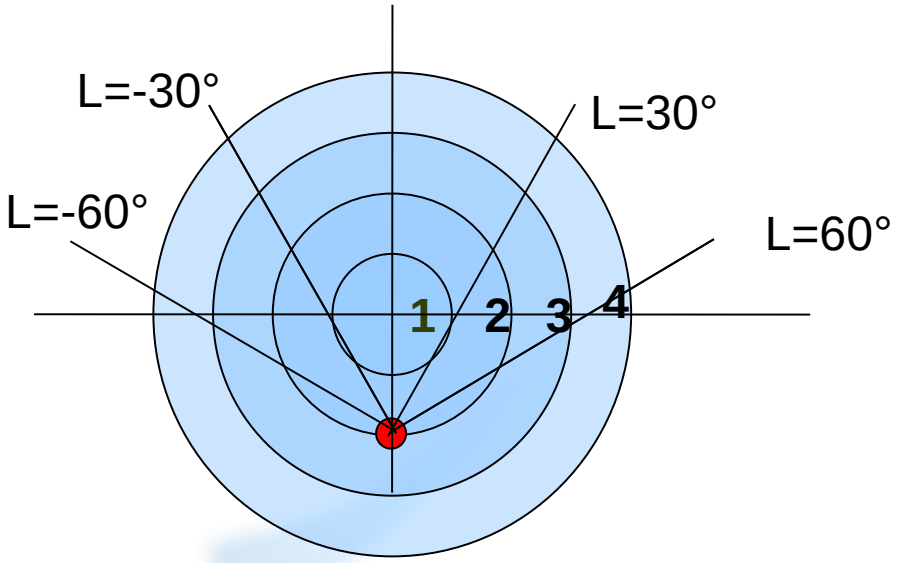
Several new detectable extended SNR with LAT PSF.

- Only statistical error is reported.
- Good correlation between radio and GeV size.

Interstellar models studies for systematic effects

Aim: evaluate the systematic errors induced by different and reasonably extreme interstellar emission models (but still a limited sample).

A grid of 8 models is used, varying the CR source distribution (SNR and Lorimer), CR propagation the halo size (4 kpc and 10 kpc) and the HI spin temperature (150k- optically thin) (see also Ackermann *et al.* 2012).



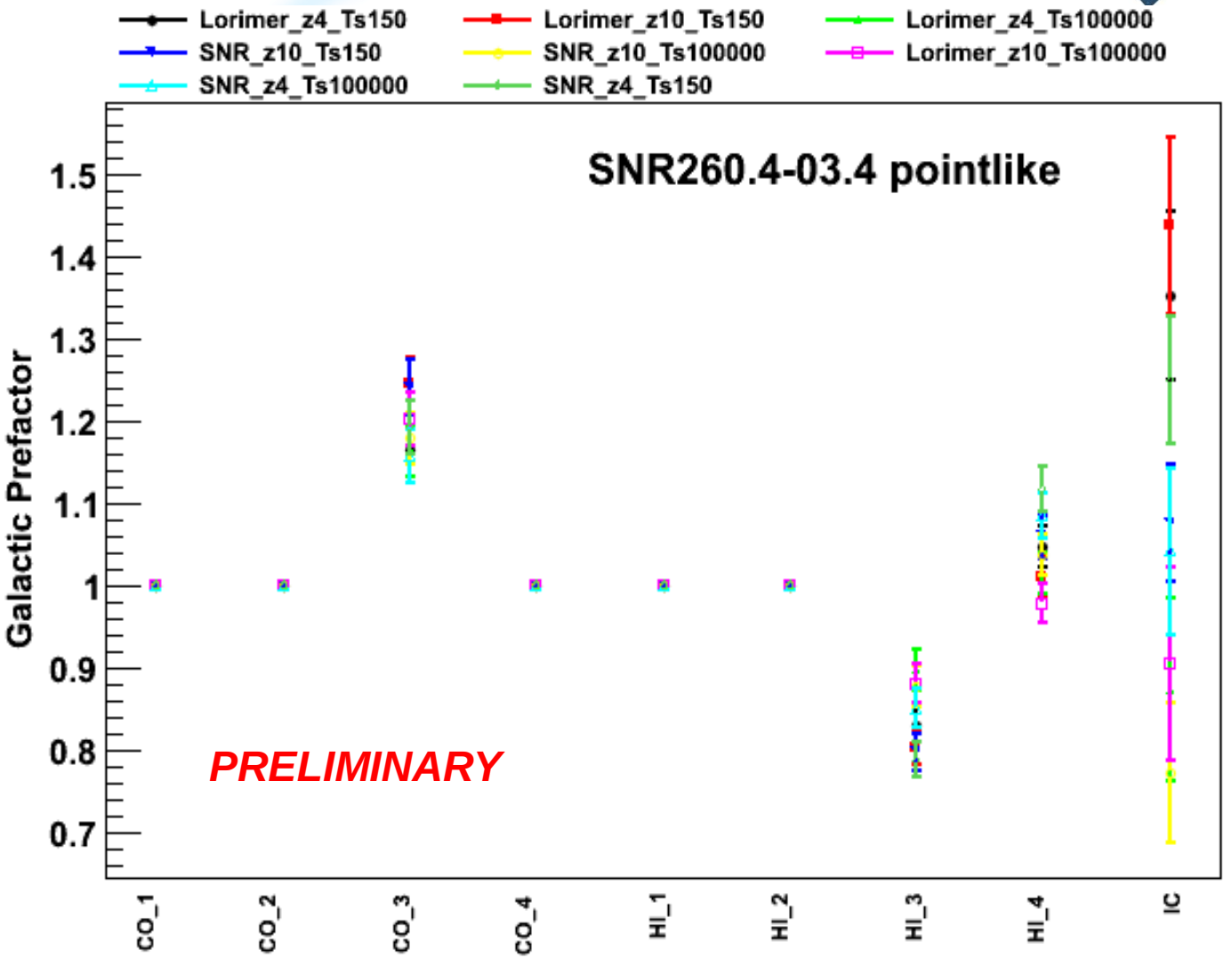
Each model was splitted into 4 annuli around the Galactic center for each gas component (HI and CO). There is also a scaling parameter for the IC component.

Differences with pipeline analysis:
- max 5 sources free in the ROI.
- if a background source is not anymore detected (TS<5) it is locked at the 2FGL value.

Interstellar models studies for systematic effects

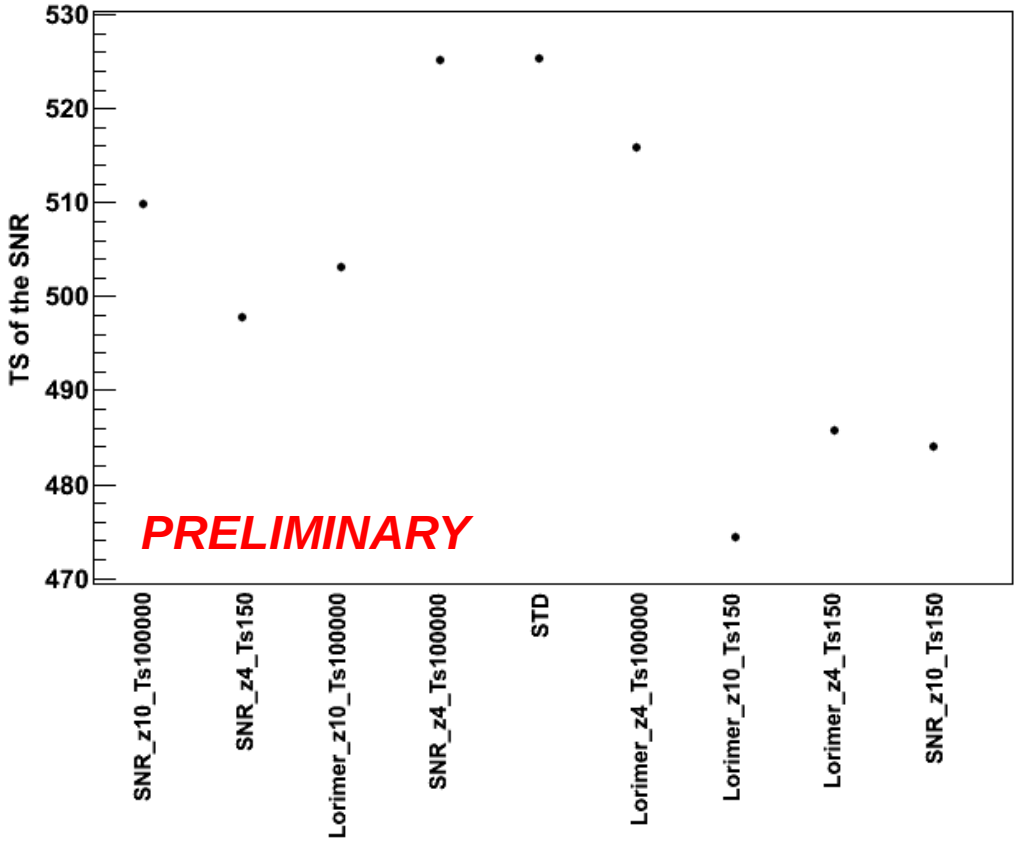
8 test sources in different part of the galaxy and different spectral characteristics:

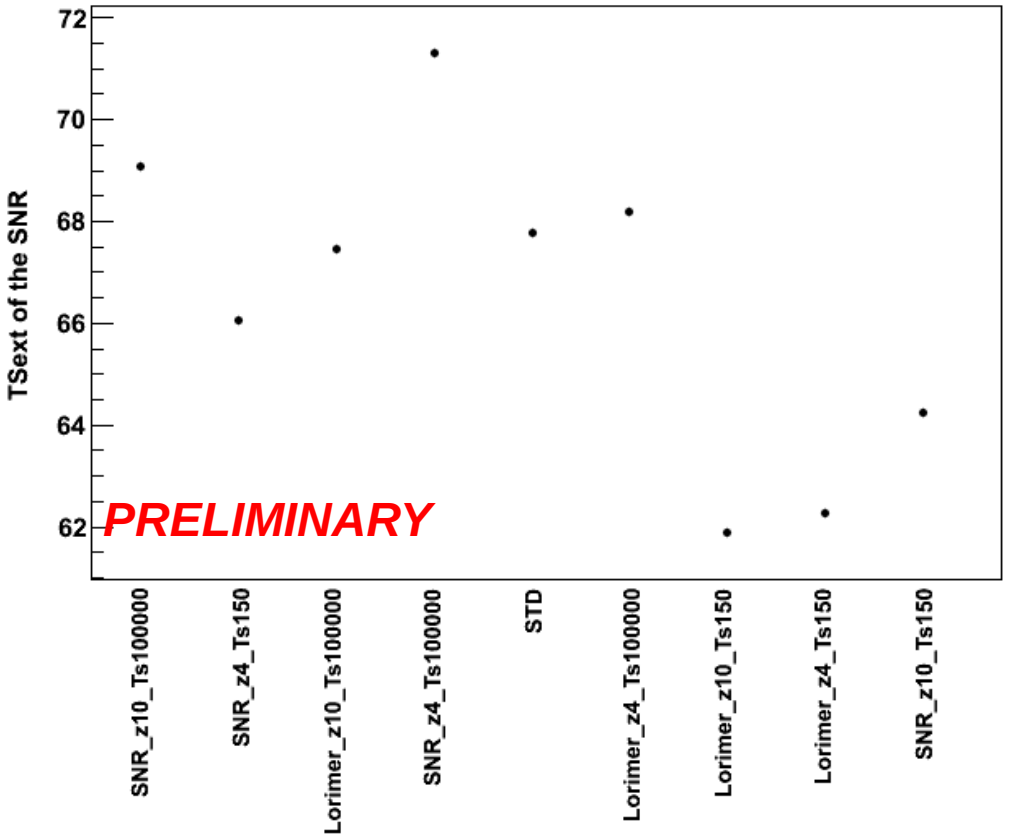
CTA1	W41
RXJ1713	HB21
Tycho	SNR213.3-0.4
Puppis A	S147



Puppis A is the one with the highest TS and it is less affected by the changes in the interstellar model.

Results for SNR260 with the different interstellar models

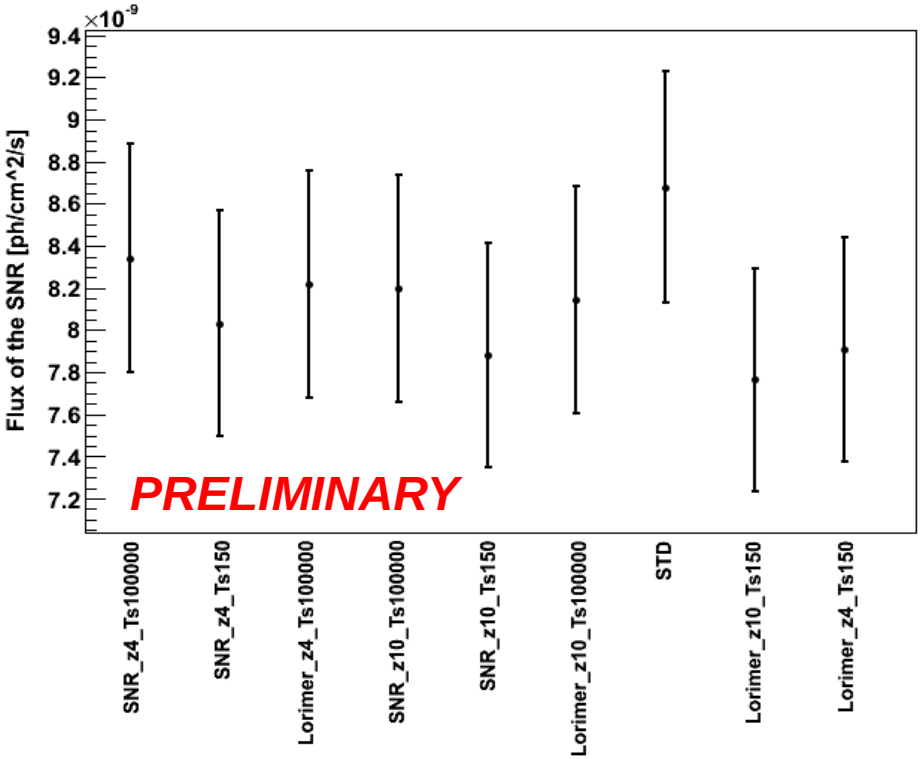


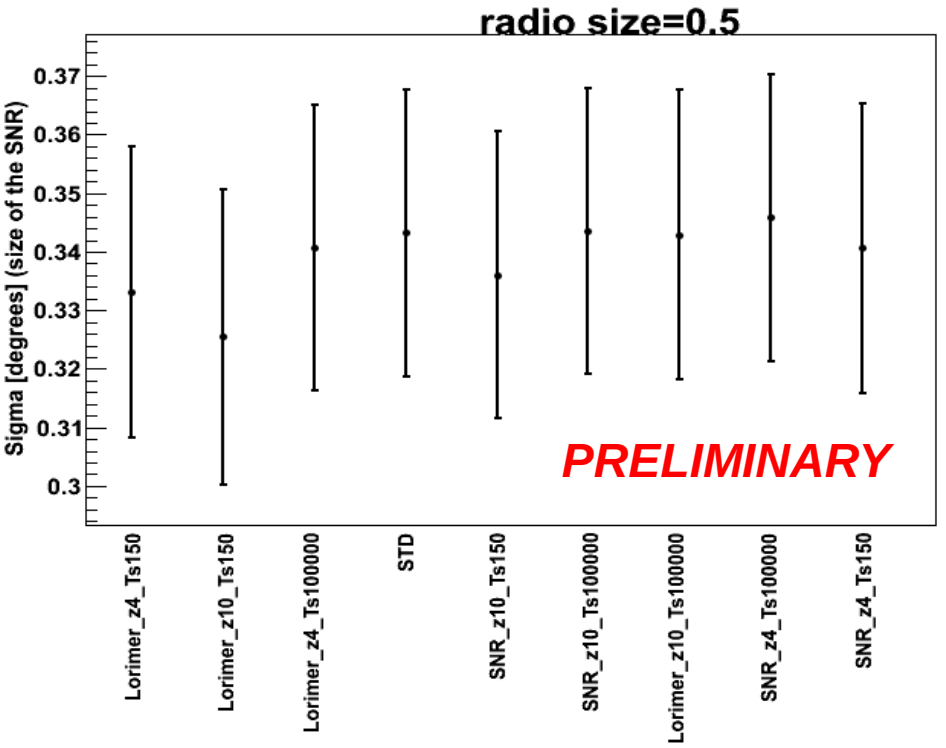


With all the diffuse models:

- TS > 25: source exists,
- TS_{ext} >16: source is extended,
- In both cases with a variation of around 10%.

Results for SNR260 with the different interstellar models





- SNR Flux and radius (sigma) are consistent;
- Index does not depend strongly on model;

- **We are investigating the effects for fainter sources or more complex region of the sky.**

Pipeline improvements

Improvements to the analysis under advanced test:

- Check residuals in 5°x5° region around extended source, If TS > 20-25:
  - if no 2FGL source near (<0.4°) the residual, add a new source otherwise, check if it extended or try a different spectral seed,
  - flag as near the extended source, near a 2FGL source, or far from either. Repeat localization and extension fit.

- Check TS of neighboring (2FGL) sources:
  - If TS < 9-12: discard source if nearby, repeat localization and extension fit.

- Analysis with different starting location (i.e. always the radio location) to test the robustness of our analysis.

Conclusion

- The pipeline analysis is working well and new features are still under advanced testing,
- Preliminary scientific results are already compatible with the ones obtained in dedicated studies and in the 2FGL,
- The study of different diffuse models will allow us to better evaluate the systematic errors for the various parameters,
- For the main preliminary scientific results see following talk.