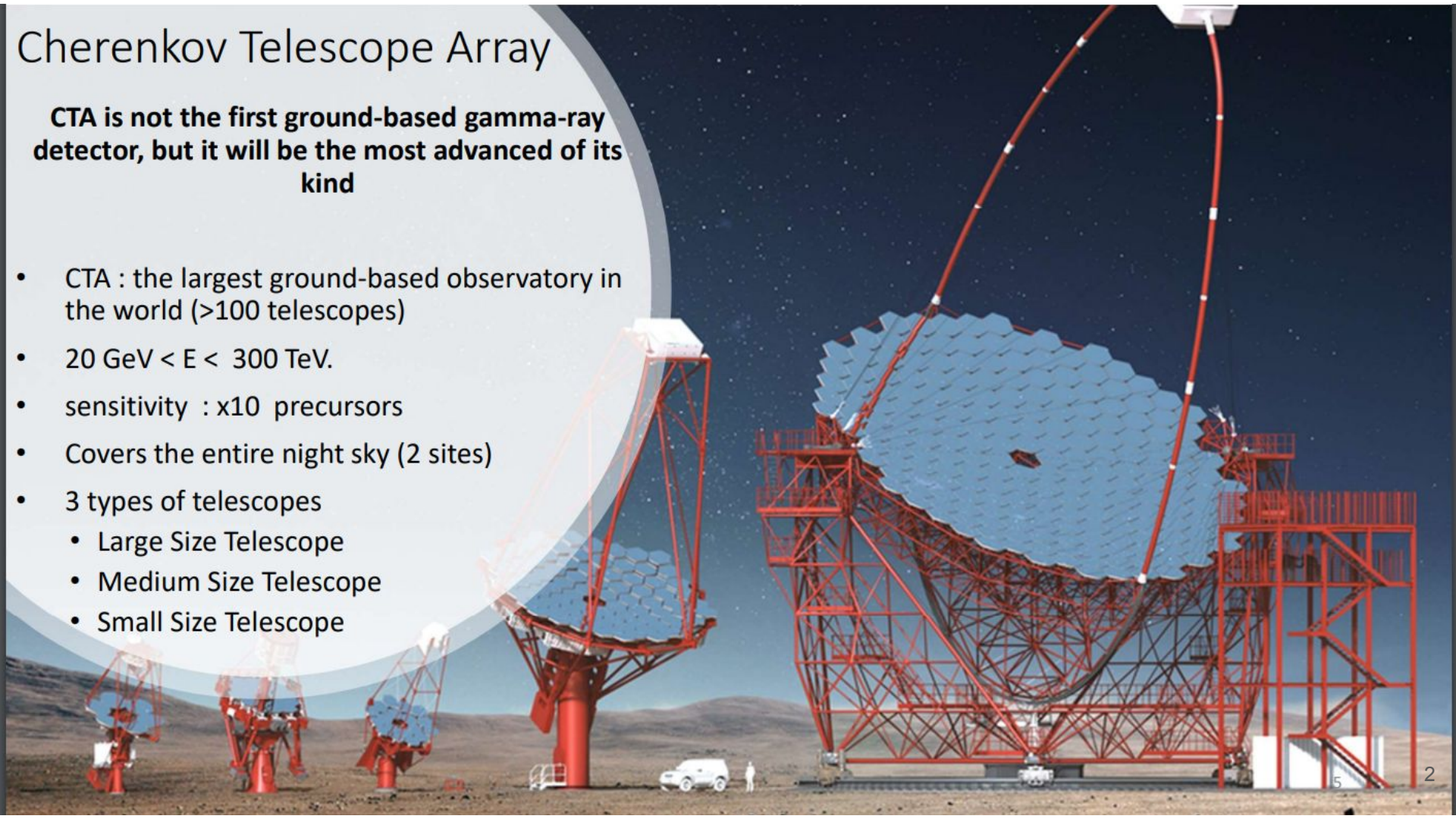
Comité d'Accompagnement des Thèses (CAT)

Pooja Sharma
Supervisor - Tiina suomijarvi
Co-supervisor - Giulia Hull

Cherenkov Telescope Array

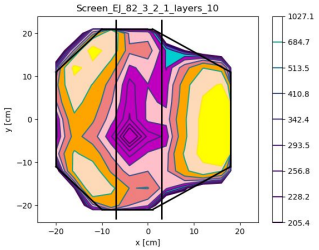
CTA is not the first ground-based gamma-ray detector, but it will be the most advanced of its kind

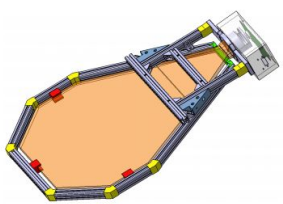
- CTA : the largest ground-based observatory in the world (>100 telescopes)
- 20 GeV < E < 300 TeV.
- sensitivity : x10 precursors
- Covers the entire night sky (2 sites)
- 3 types of telescopes
  - Large Size Telescope
  - Medium Size Telescope
  - Small Size Telescope

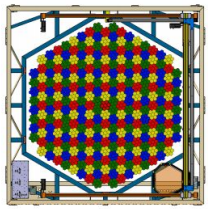


Thesis Work Plan

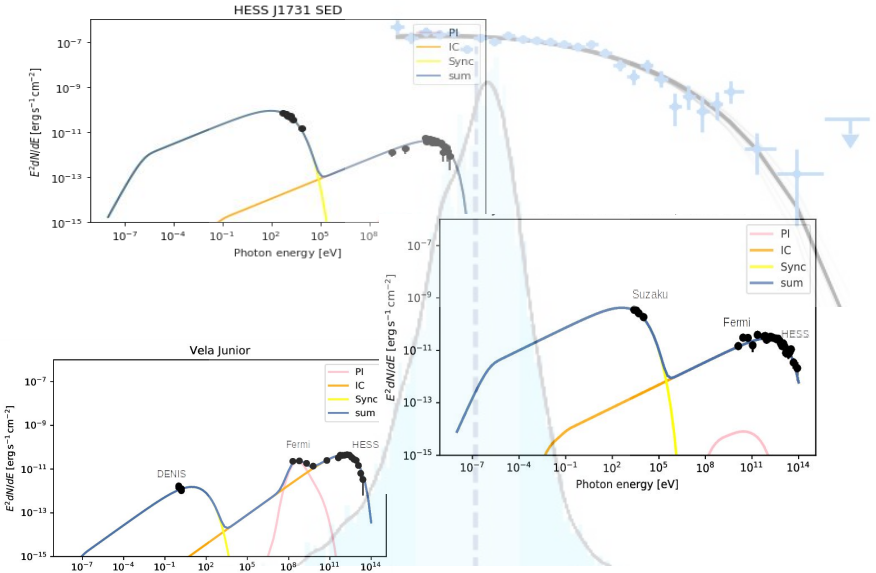
Calibration of NectarCAM
Camera of Medium-sized telescope of CTA







Study of Supernova Remnants
Analysing simulated data and fitting observations



Supernova Remnants

A supernova remnant (SNR) is the remains of a supernova explosion, which occurs due to the death of a massive star ($M > 8M_{\odot}$).

Two main types include:

- **Shell-Type SNR** - They are often observed as bright rings which form due to the radiation from a shell of shocked material. More hot gas is present in our line of sight at the edges than when we look through the middle.

- **Interacting SNR** - Massive stars have short lifespan and explode as SN within the molecular environments in which they were born. These SNRs interact with the dense molecular clouds surrounding the dead star.

E0102-72 is a shell-type supernova remnant in the Small Magellanic Cloud. Credit: NASA/CXC/SAO

NASA, ESA, G. Dubner (IAFE, CONICET-University of Buenos Aires) et al.; A. Loll et al.; T. Temim et al.; F. Seward et al.; VLA/NRAO/AUI/NSF; Chandra/CXC; Spitzer/JPL-Caltech; XMM-Newton/ESA; and Hubble/STScI

Why study Supernova Remnants?

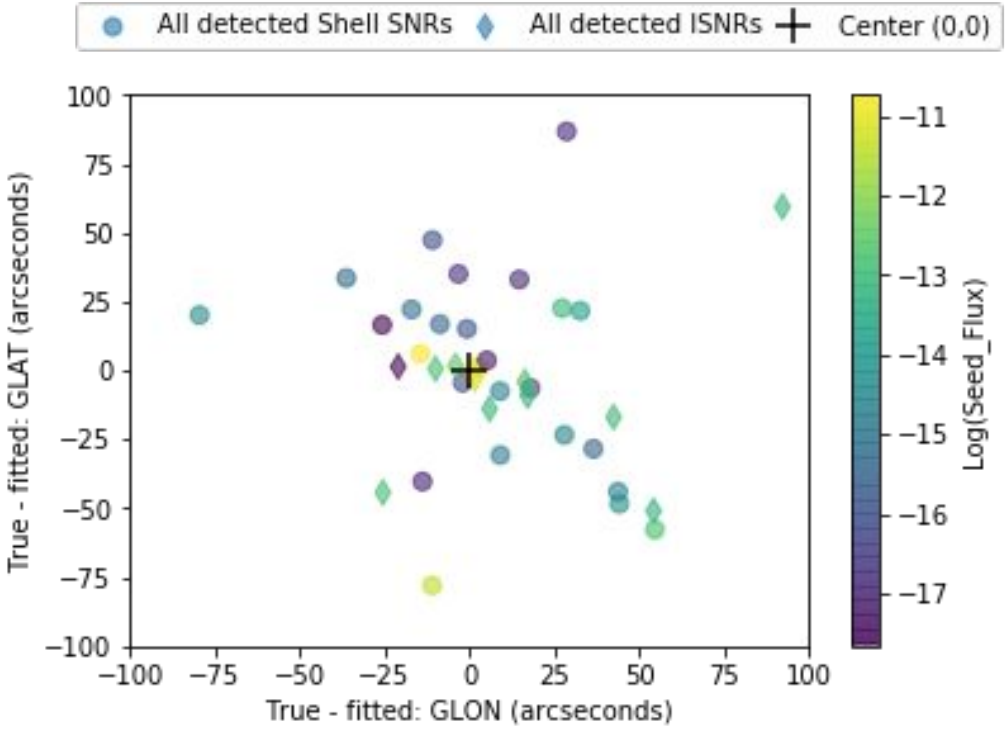
- We see an abundance of SNRs in our galaxy.
- 10% of the kinetic energy of a SNR is sufficient to accelerate CRs upto PeV energies.
- Knee of the CR spectrum may be a result of accelerated CRs due to SNRs.
- A good candidate for PeVatron, a source which accelerates particle up to 10^{15} eV.
- Fitting an SED can give us a wealth of information about the properties of SNR.

Summary of the SNRs in Catalogue

This analysis pertains to sources simulated for CTA in the Galactic Plane Survey

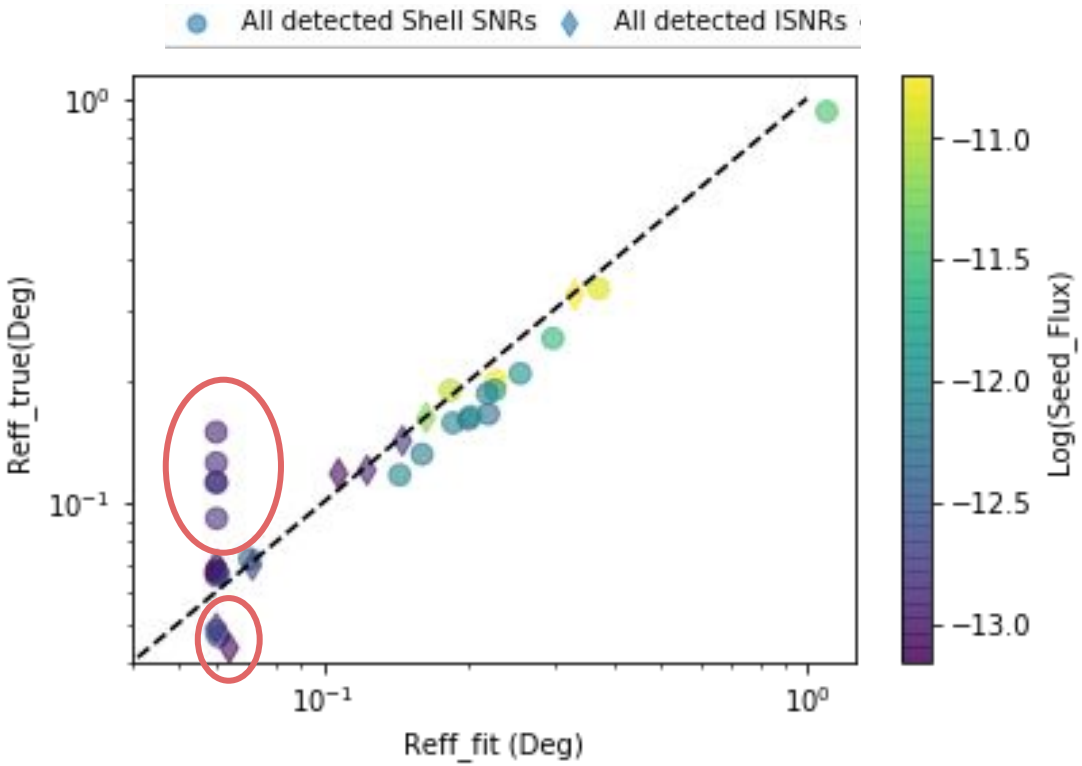
Total simulated Sources in GPS	1541
Simulated SNRs in GPS (TS_postTeV > 9)	77
Reconstructed SNRs (TS_postTeV > 25)	37
Reconstructed Shell SNRs	26
Reconstructed Interacting SNRs	11

Precision of the Position Coordinates



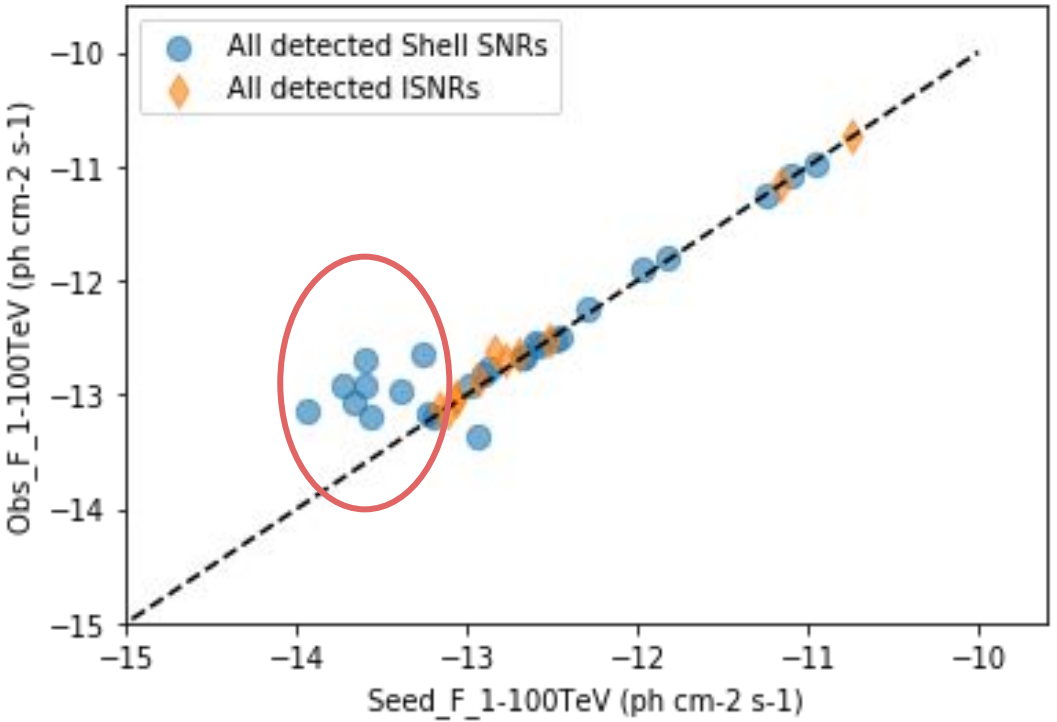
- Plot shows the difference between the True and Fitted Galactic Longitude (GLON) and Galactic Latitude (GLAT) of various SNR sources.
- All sources have been reconstructed with precision on location better than 0.01°.

Effective Radius between True and Fitted Sources



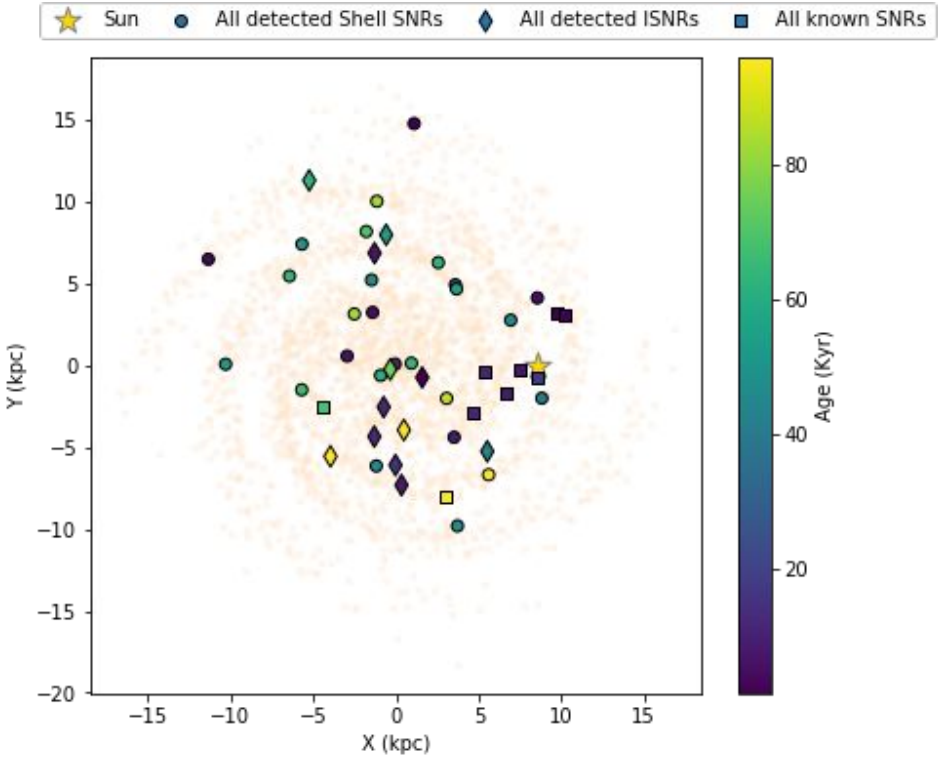
- Good reconstruction of size of the SNRs.
- Reconstructed effective radii are always smaller than the True effective radii - inability to account for the edges.
- 18 new extended sources detected.
- Outliers may correspond to too small or too faint sources which can be difficult to resolve.

Seed Flux vs Observed Flux



- Photon flux of various associated sources have been plotted.
- Good reconstruction of the source flux is observed.
- Discrepancy between seed and observed flux at very low flux values could be due to confusion effect.

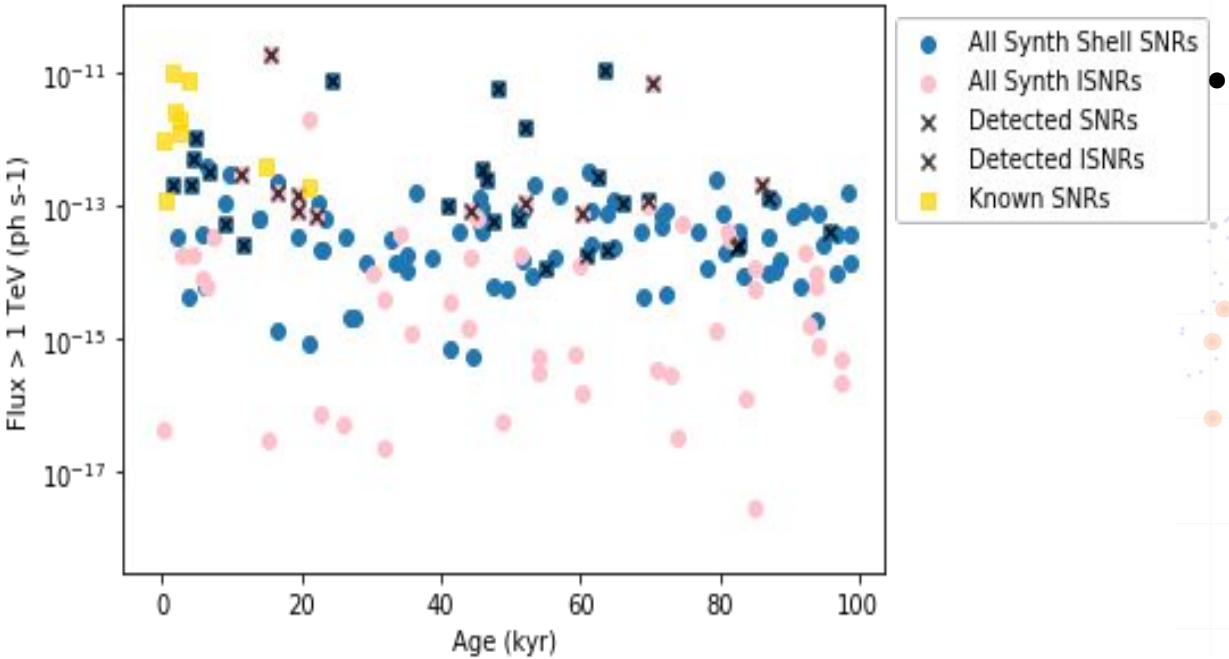
Distribution of SNR sources in our Galaxy



- Plot of the all the simulated sources in the Galaxy with:
  - Associated Shell type SNRs as dots
  - Associated ISNRs as diamonds
  - Known sources as squares
  - Sun as star
- Color scheme depicts the age of the SNRs.

With CTA we can detect new young SNRs up to the other side of the Galaxy!

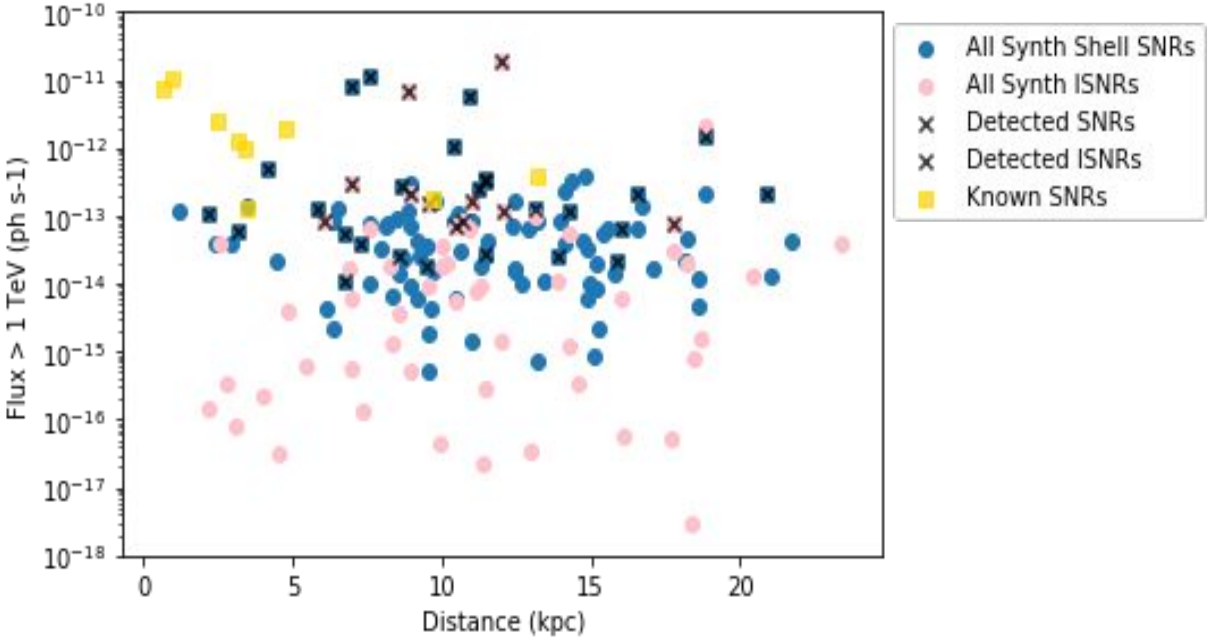
Flux vs Age



- Flux vs Distance plot of all the simulated sources with:
  - Simulated Shell SNR and ISNRs as blue, pink dots respectively.
  - Associated Shell SNR and ISNRs have crosses on them.
  - Known sources as Squares

We expect to find more SNRs at farther distance with CTA!

Flux vs Distance Plot



- Flux vs Radius plot of all the simulated sources with:
  - Simulated Shell SNR and ISNRs as blue, pink dots respectively.
  - Associated Shell SNR and ISNRs have crosses on them.
  - Known sources as Squares

Current Flux limit is 10^{-13}, New flux limit is 10^{-14} and detection horizon at 20 kpc !

Summary

We have analysed the simulated data for the Galactic Plane Survey of CTA

To review, we have been able to detect **37 new** SNRs:

- 26 - Shell Type SNRs
- 11 - Interacting SNRs

TeVCat lists:

- 16 - Shell Type SNRs
- 11 SNR/Molecular Cloud

We have been able to detect **18** extended sources.

CTA has a **significant increase in the number of new sources** even in such short observation time (10 h).

New young SNRs can be detected up to the **other side of the Galaxy**!

New **flux limit is 10 times lower** than current deep exposures!

Detection horizon at **20 kpc** !

Still work needs to done to explore the discrepancies we see in various plots.