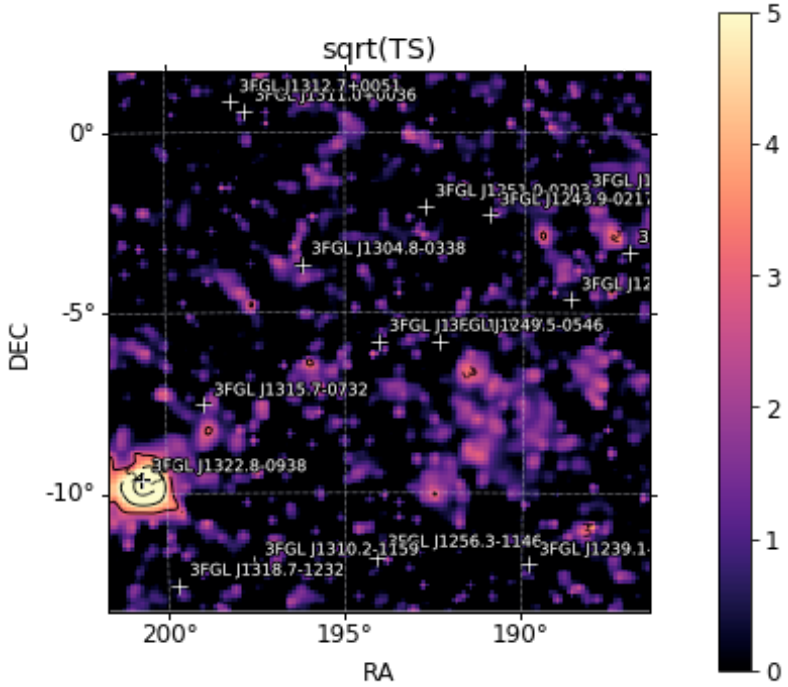
Checklist for basic LAT likelihood analysis

- ❑ LAT photon data file
  - ❑ Position and region size
  - ❑ Energy range
  - ❑ time interval
  - ❑ Event class
- ❑ LAT spacecraft data file
- ❑ Analysis choices, e.g. fermiPy configuration file
  - ❑ Data Selection (again)
    - ❑ event class, type/IRFs
    - ❑ zenith angle
    - ❑ Data region size (e.g. full width of square)
    - ❑ time interval
  - ❑ Region model (region size for modeled sources and catalogs)
  - ❑ Spectral model
  - ❑ Spatial and energy bin sizes for likelihood calculation

First steps

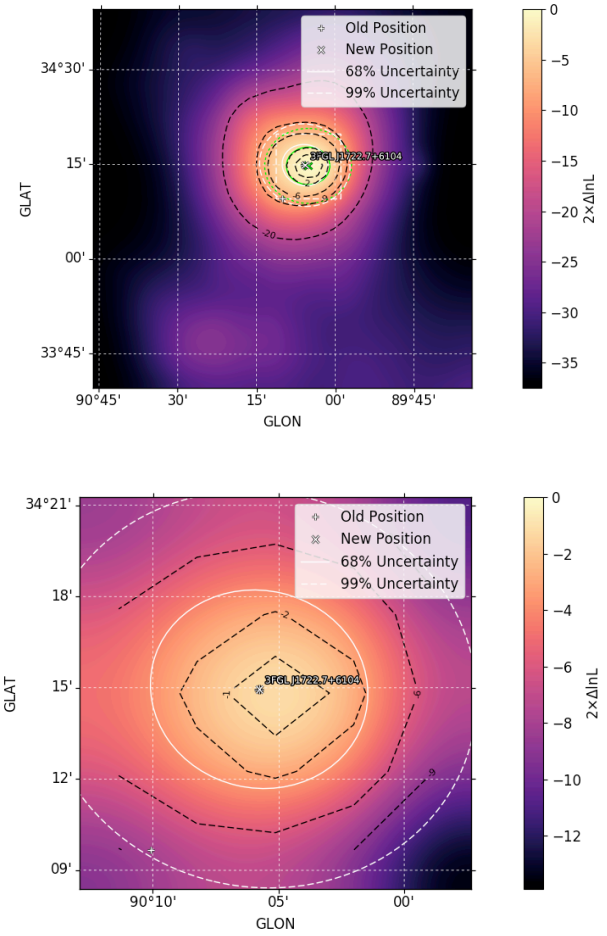
- **Source detection**

$$TS = 2(\ln \mathcal{L}_1 - \ln \mathcal{L}_0) \sim \chi^2(1)$$



First steps

- **Localization**
- E.g., fermiPy localize() method
  - Localization performed by scanning likelihood surface for source position in a local patch around nominal position.
  - **TS Map Scan**
    - Grid of likelihood results around nominal source position (all background parameters fixed)
  - **Likelihood Scan**
    - Refine by scanning likelihood surfac around best-fit location (full likelihood fit refitting all fre parameters at each location)
    - Can generate confidence contours



First steps

- Changing the ROI model, e.g. spectral shape
  - Source components of the model can be configured and modified in fermiPy in the config.yaml or by adding and deleting sources at run time.

```
model:

  src_radius: 5
  src_roiwidth: 15.0
  catalogs :
    - '3FGL'
    - 'my_extra_sources.xml'
  sources :
    - { name: 'SourceA', glon : 120.0, glat : -3.0,
        SpectrumType : 'PowerLaw', Index : 2.0, Scale : 1000,
        Prefactor : { value : 1.0, scale : !!float 1e-11, free :
'0' },
        SpatialModel: 'PointSource' }
```

If a source is defined in multiple catalogs,
the source definition from the last file in the catalogs list takes precedence.

Second steps

- Pulsars/Binaries
  - Spectral shape
  - Apply rotational or orbital phase information
  - Energy-dependent pulse profile
  - Phase-resolved spectra
  - Long-term lightcurves

Second steps

- AGN/blazars
  - Spectral shape
  - Long term lightcurves
  - Spectral evolution during flares
  - Timing features of flares and multiwavelength correlations

Second steps

- Pulsar Wind Nebula/Supernova Remnants/OB associations
  - Spatial extension/Morphology
  - Spectral features
  - Energy dependent morphology
  - Spatially resolved spectrum

Second steps

- Your favorite source…