Investigation on the sky-position reconstruction given two geometries of ET

Alexander Dietz
Benoit Mours

Outline

- Overview
- Technical details
- Preliminary results
- Outlook

Overview

- Investigate the ability of two different ET geometries to reconstruct the sky position
- **Using individual SNR values only!**
- Do not use time-delay information.
- Two ET geometries:
  - Two L-shaped instruments at Hanover and Cascina, the Hanover instrument 45deg rotated. L=7.5 km
  - Triangular instrument at Cascina only. L=10km

Technical I

- Using self-made code: pyET.py
  - Can choose noise curve (LIGO-I, advanced, ETB,ETC)
  - Can define any detector with any arm directions
  - Can create a 'network' of detectors
  - Calculates the SNR of a signal (VIR-027A-09)

$$\rho = 1.56 \times 10^{-19} \left(\frac{\mathcal{M}}{M_\odot}\right)^{5/6} \left(\frac{Mpc}{r}\right) f_{geo} \sqrt{\int_{f_{low}}^{f_{ISCO}} \frac{f^{-7/3}}{S_h(f)} df}$$

Technical II

- For now:
  - masses = 1.4/1.4 Solar masses
  - distance = 1 Mpc
- SNR value depends only on
  - low cutoff frequency (LIGO-I: 40, adv: 10, ET: 3 [Hz])
  - sky position
  - source orientation

Determine the sky area

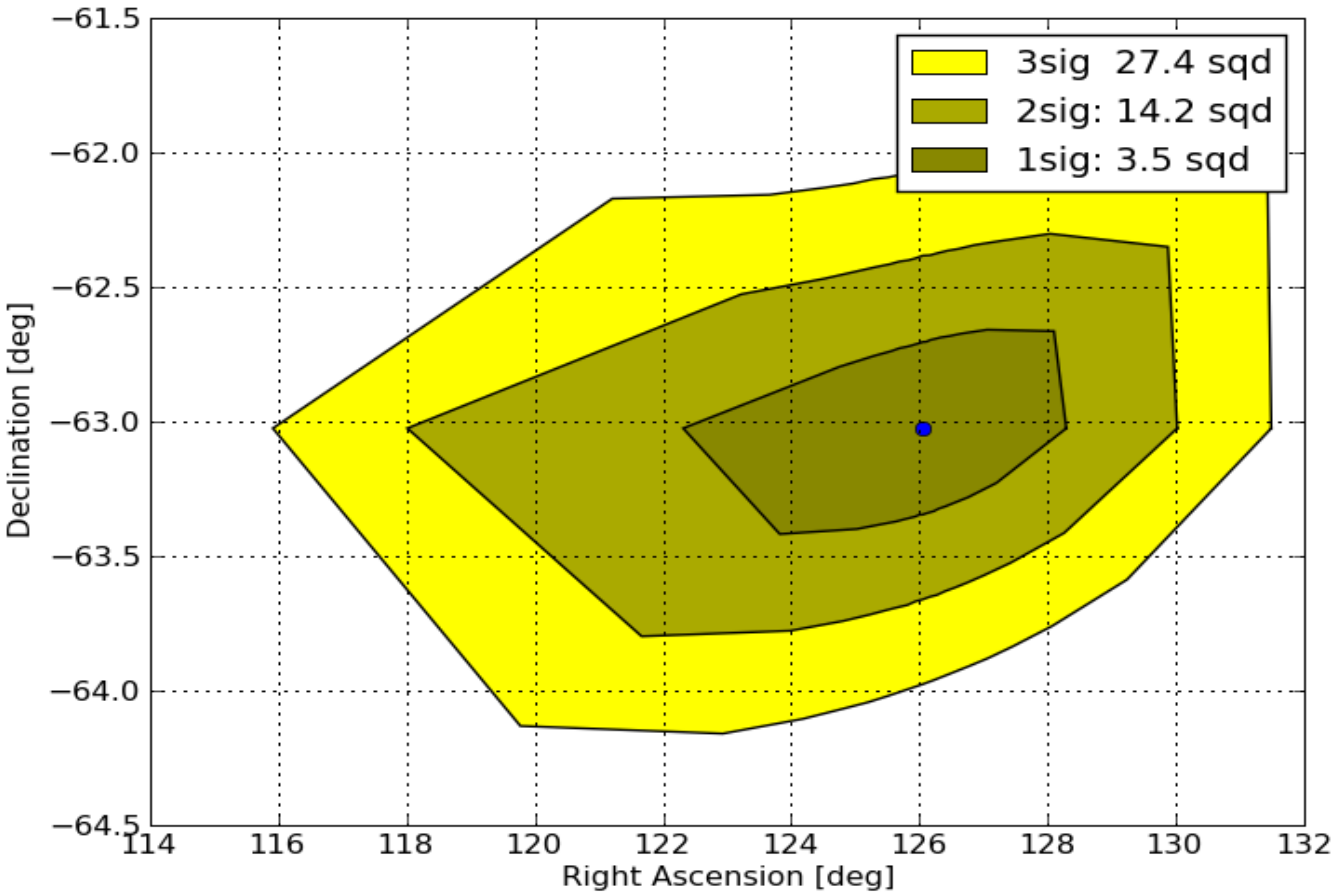
- To determine the 1-sigma sky area:
  - Use the known position of the source
  - Go from that source in small steps (Δφ) in some direction (α)
  - Determine when $\delta = \sqrt{\sum_{i=1}^{n} (\rho_i - \hat{\rho}_i)^2}$ is >1
  - Repeat procedure from same point in different direction.

Determining sky area

Example

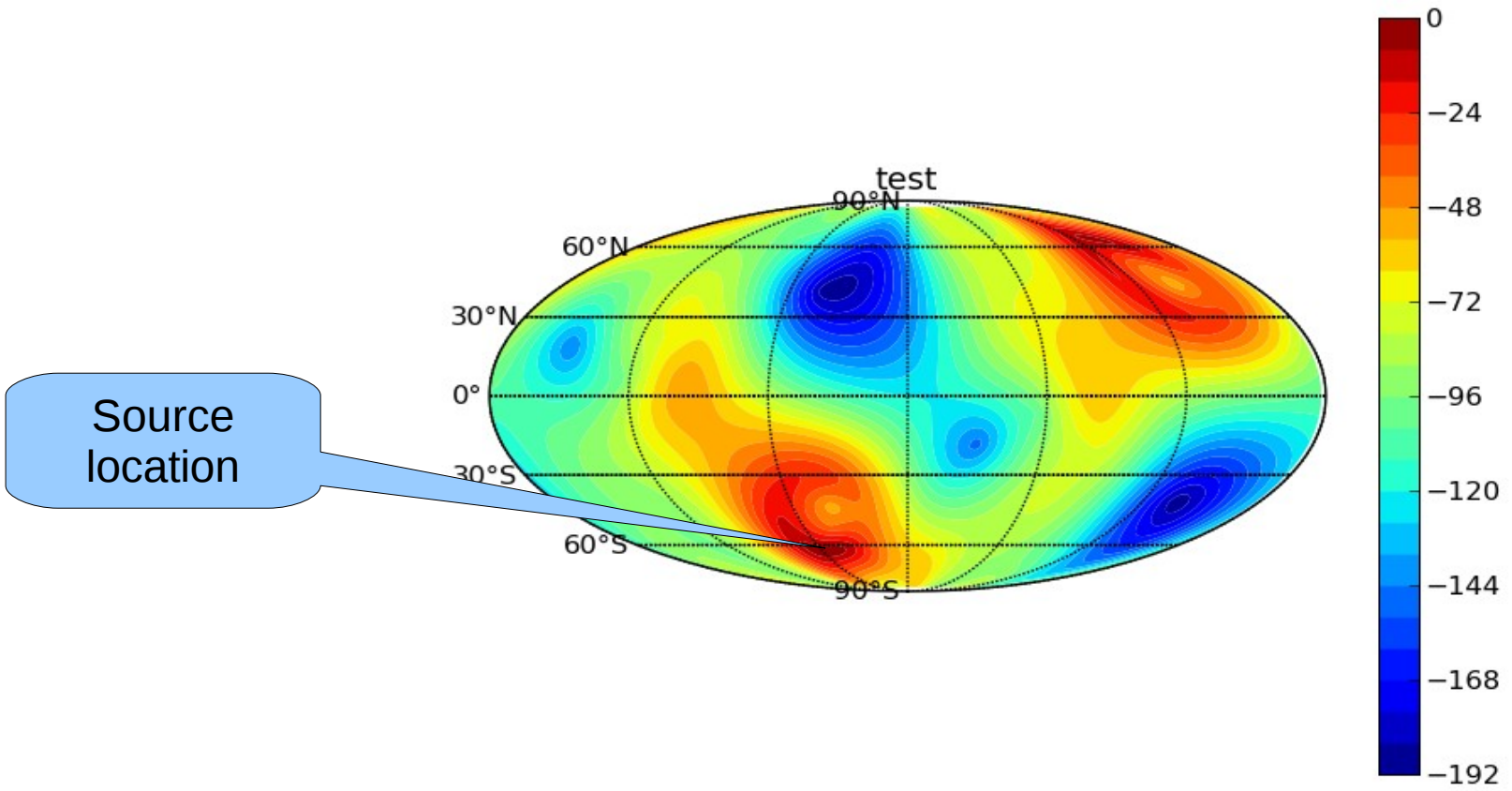
SNR:
•H1: 51
•L1: 30
•V1: 130

(SNR ET:
•20'000-30'000)



Example: δ over the sky

- Difference in SNR

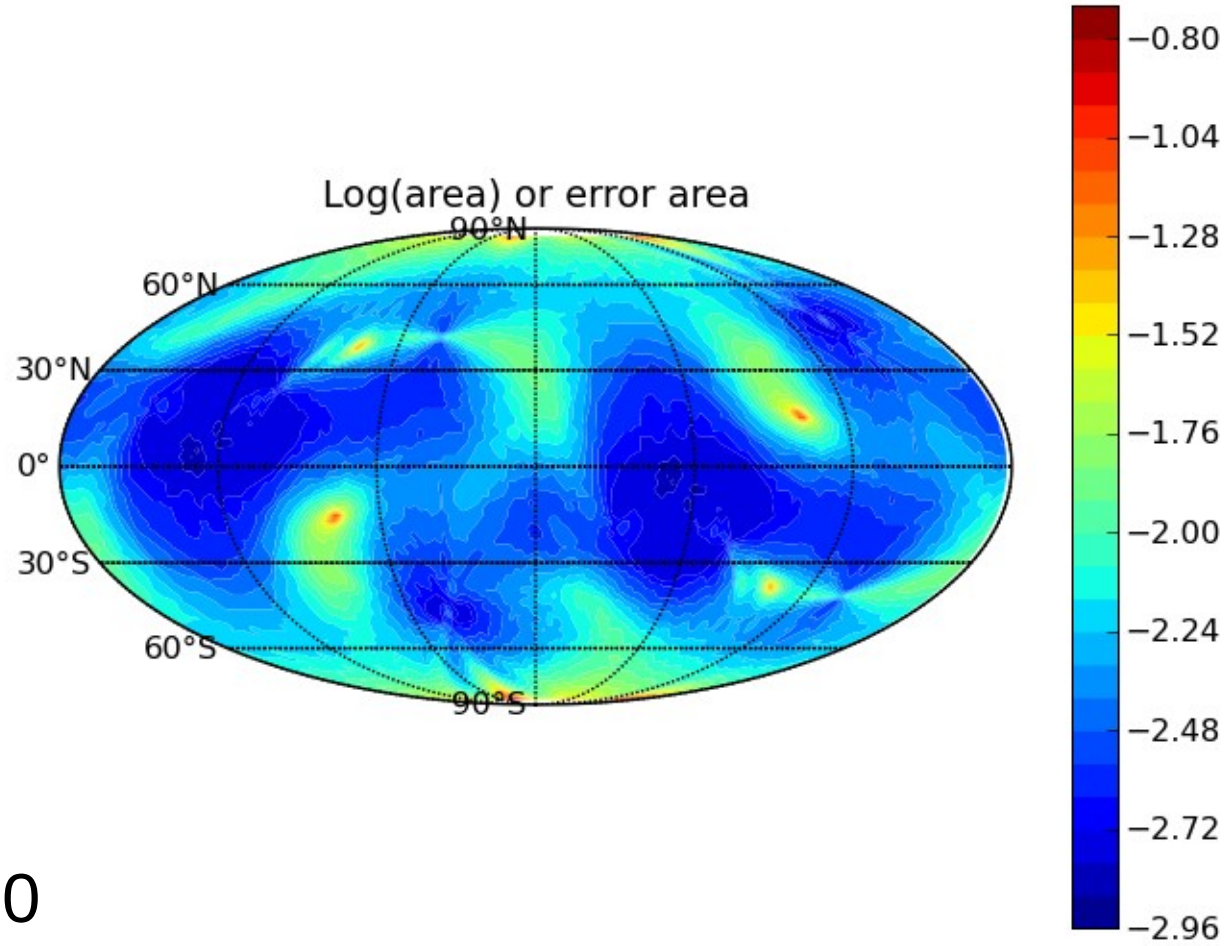


Prelim. results

- Choosing 5000 **random sky locations**
- **random source orientation**
- Masses = 1.4/1.4, Distance=1 Mpc
- 1-sigma areas in square-degree:

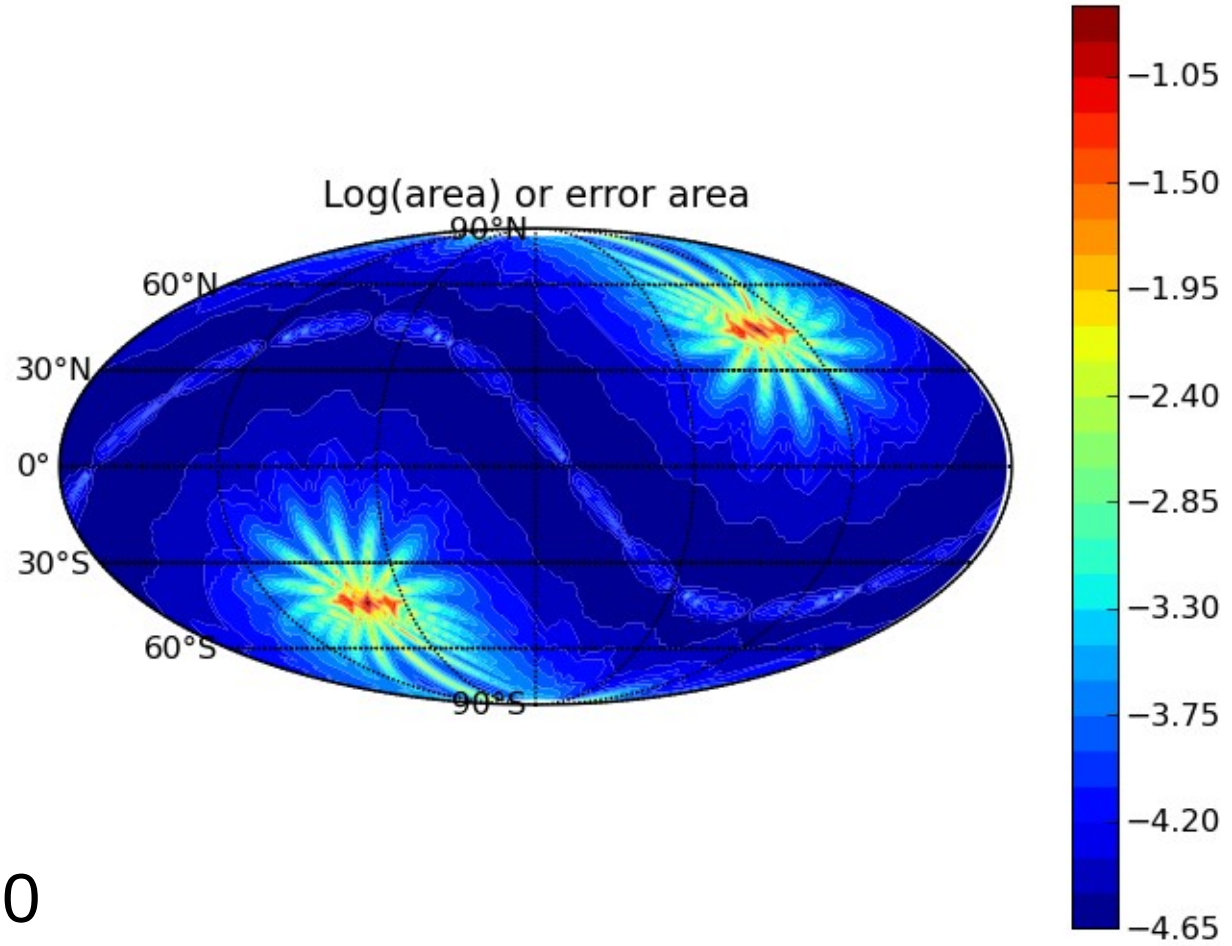
	min	max	median
Initial	4.12	57.1	4.12
Advanced	1.03	1.94	1.03
ET triple	3.00E-005	0.22	6.00E-005
ET double	1.00E-004	0.12	1.40E-004

Results: Advanced detectors



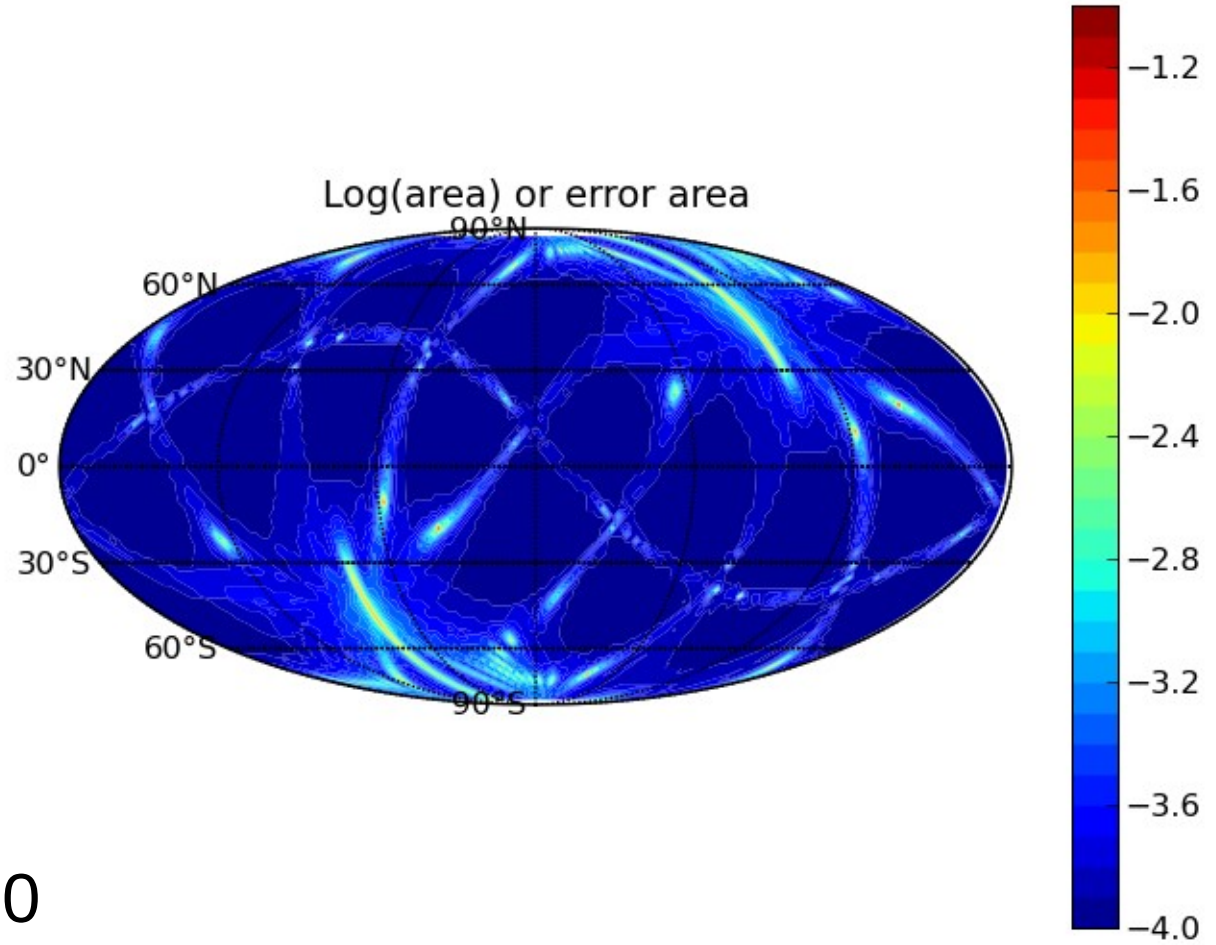
incl = pol = 0

ET: Triangle



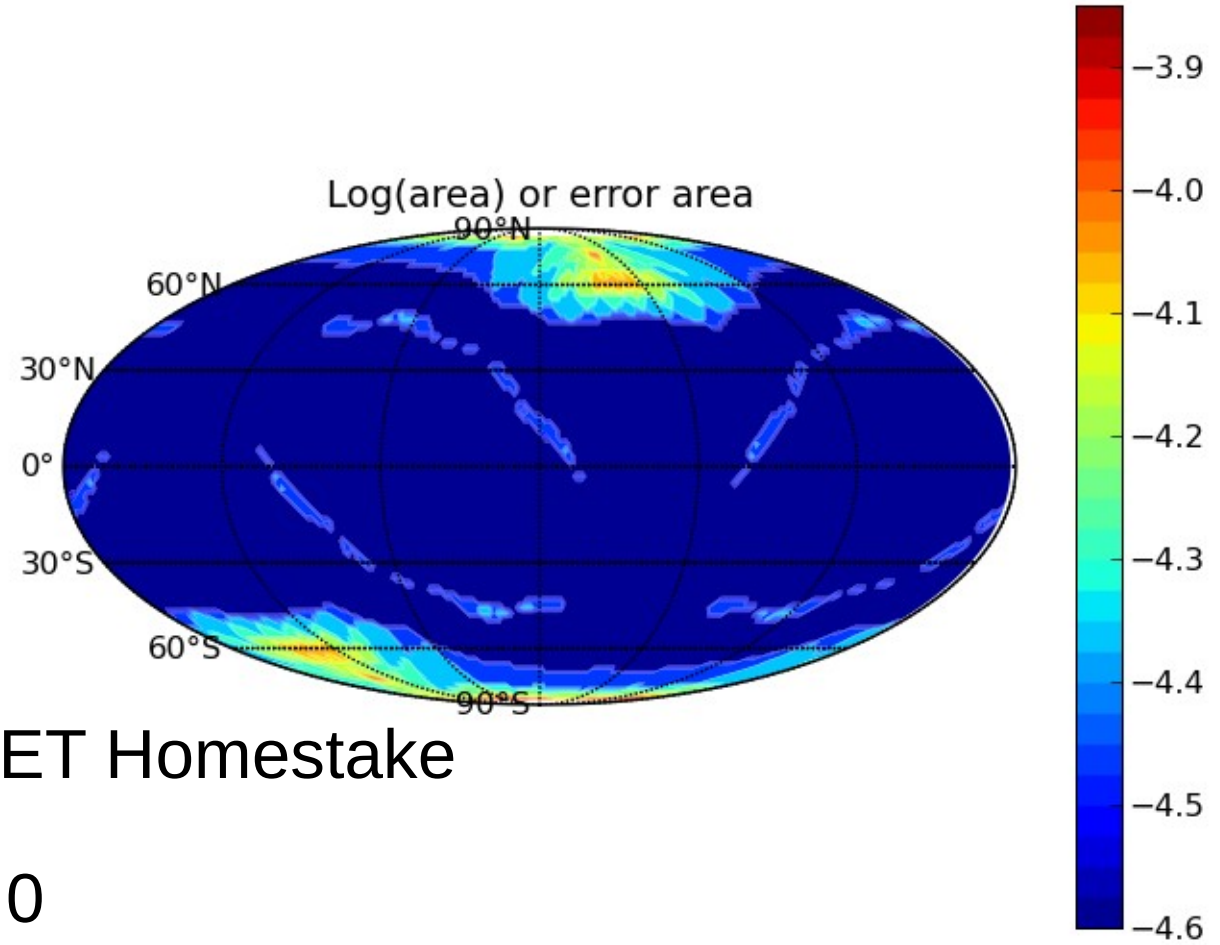
incl = pol = 0

ET: Two separate



incl = pol = 0

Double Triple



ET Cascina, ET Homestake

incl = pol = 0

Outlook

- Compare with **Time-of-Flight** estimations
- Look at double ET case (Europe/US)
- Use **realistic distances** (e.g. volume-sampling)
- Use **higher masses** *(cf. TOF)*
- *Verify the code*