

Performance study of the first low latency joint EM/GW search

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DCC # G1100006-v4

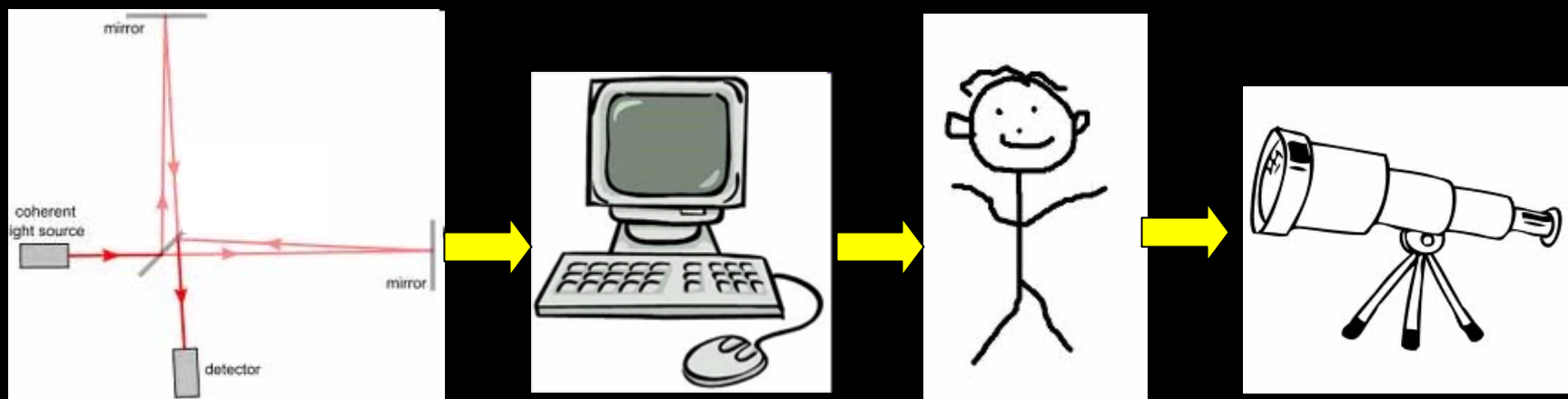


EM Follow-up program

Run data analysis in nearly real time

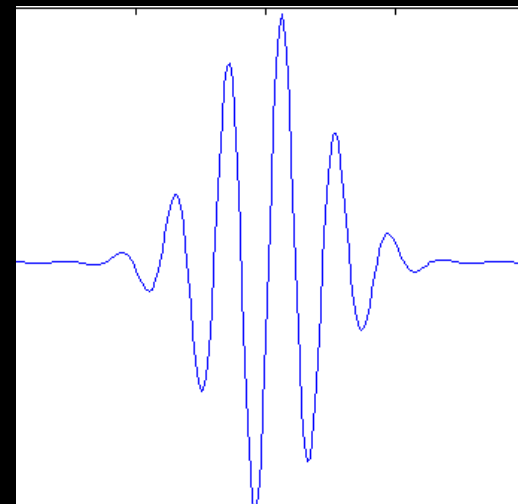
→ Share Triggers with Telescopes

→ Seek EM counterpart to GW event



Burst Source Monte Carlo

- Ad-hoc “Burst” Signals
- Galaxies within 50 Mpc
- Randomly choose galaxy
→ weight by mass
- Superimposed on data
Sept-Dec 2009
- ~70,000 injections
- Mix Linear and Random polarizations
- 70 to 2,000 Hz



33 Waveforms X
12 Amplitude Factors =
396 “Standard Candles”

Coherent Network Localization

Burst “all-sky” pipelines

Omega Pipeline

- Used in previous all-sky analyses
- Designed to detect unmodeled GW transients
- Explicit signal model (Sine-Gaussians)
- Seeks excess, consistent power in a network of detectors

Coherent WaveBurst

- Used in previous all-sky analyses
- Designed to detect unmodeled GW transients
- **No** explicit signal model
- Seeks excess, consistent power in a network of detectors

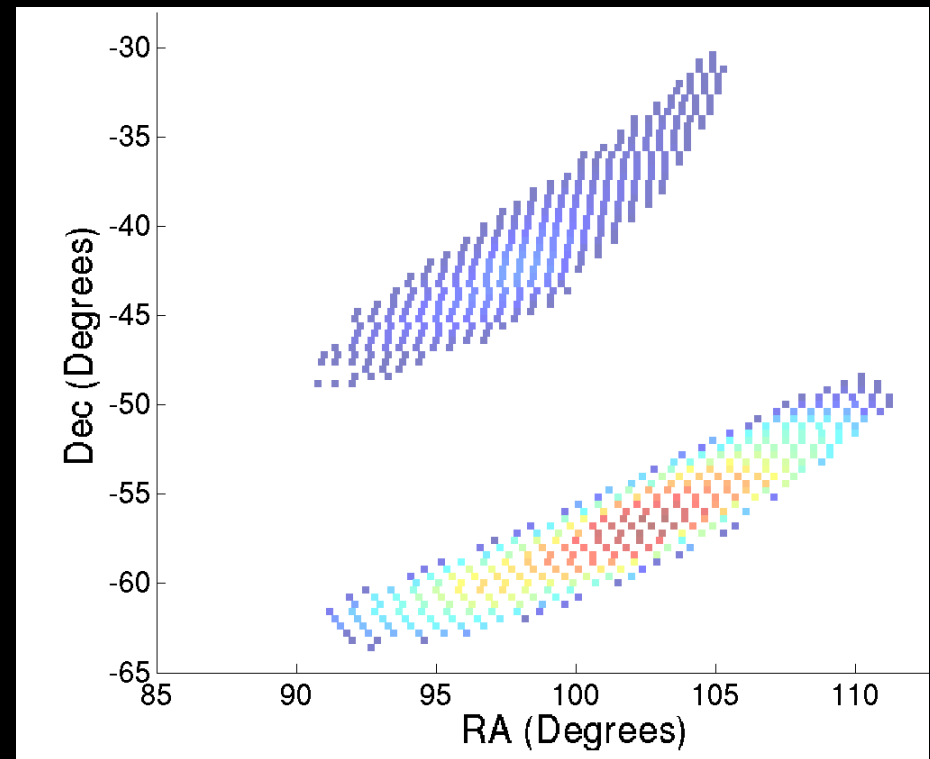
Coherent Network Localization: “Coherent Wave Burst” and “Omega”

Grid of trial positions over sky

Each Pixel $\sim 0.4^\circ$

Sky Position \longrightarrow Time Shift & Antenna patterns

Assuming each position:
Calculate statistic that reflects
amount of consistent signal
power



“Skymap” of likelihoods

Figure of Merit: “Searched Area” statistic

*Measure the uncertainty region from
the Coherent Network Localization*

- Irregularly shaped
- “Empirical”
- Area ranked above true location

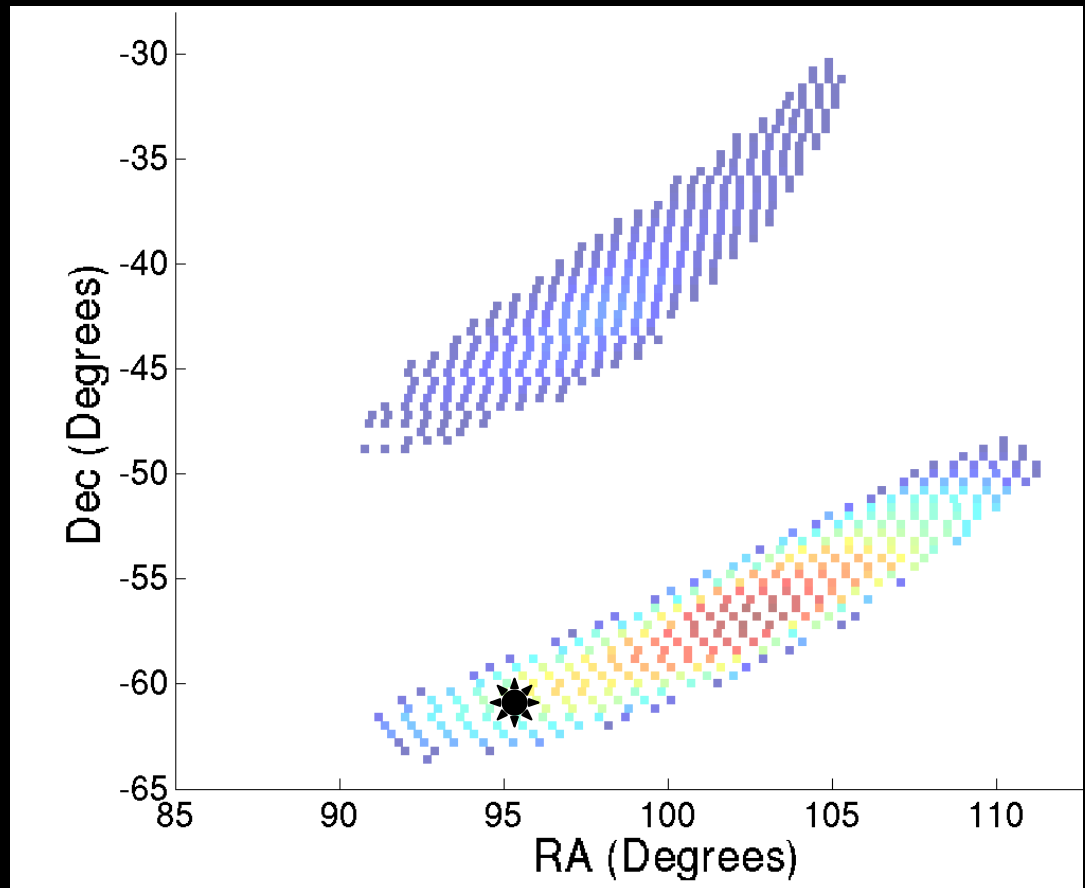
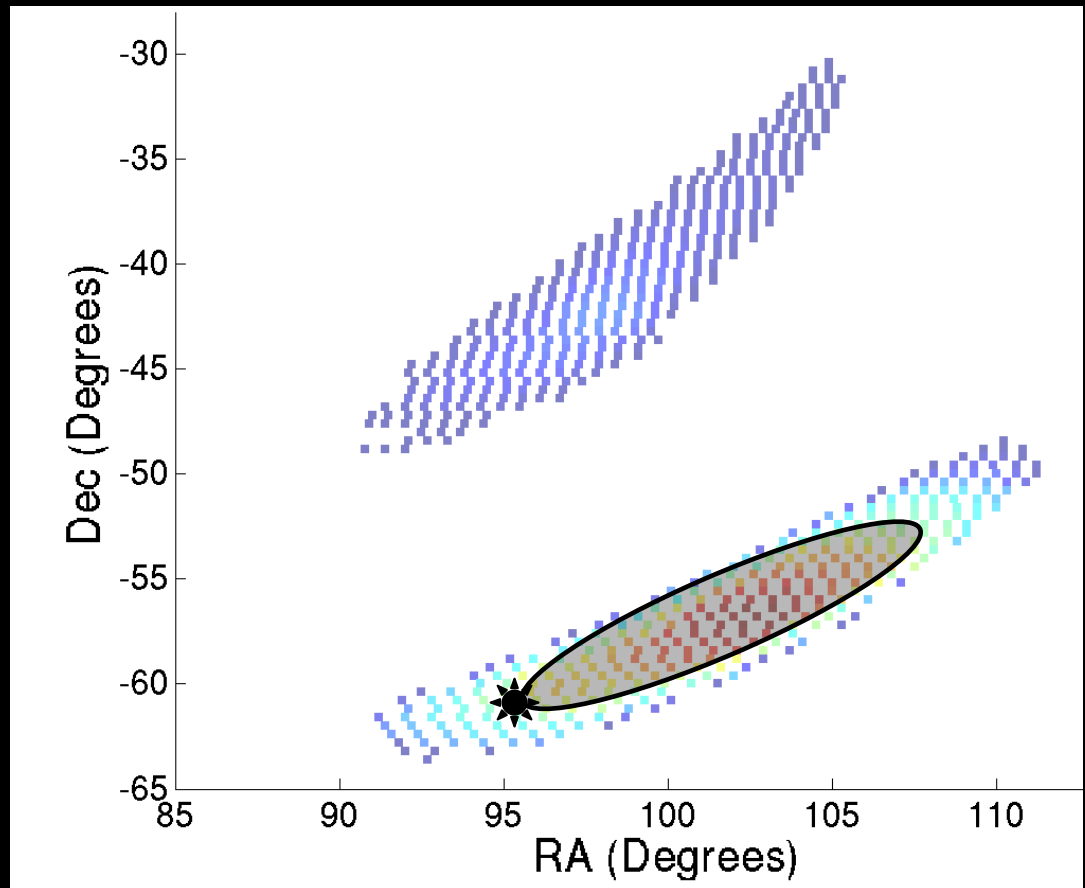


Figure of Merit: “Searched Area” statistic

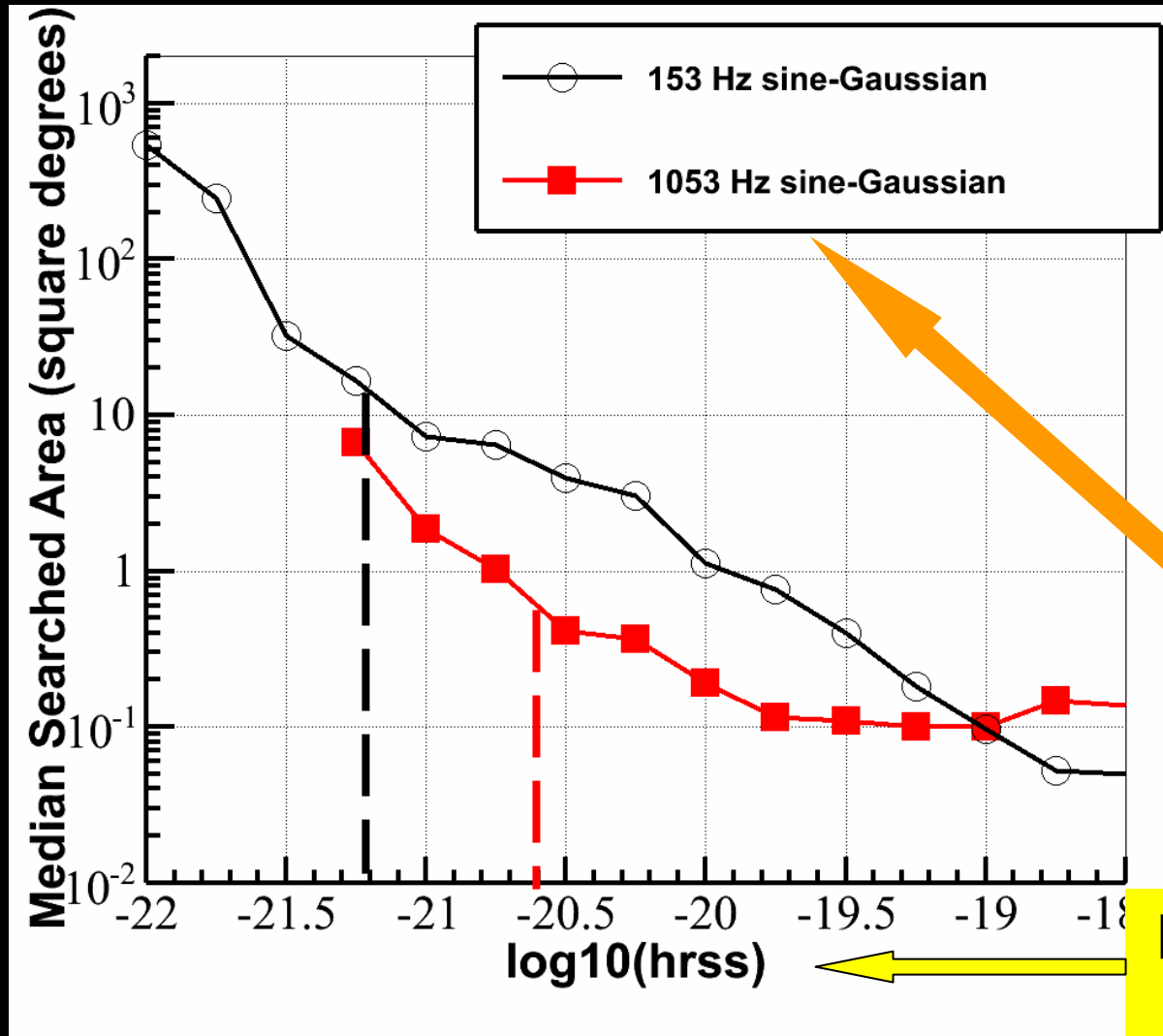
*Measure the uncertainty region from
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Searched Area: Omega

PRELIMINARY



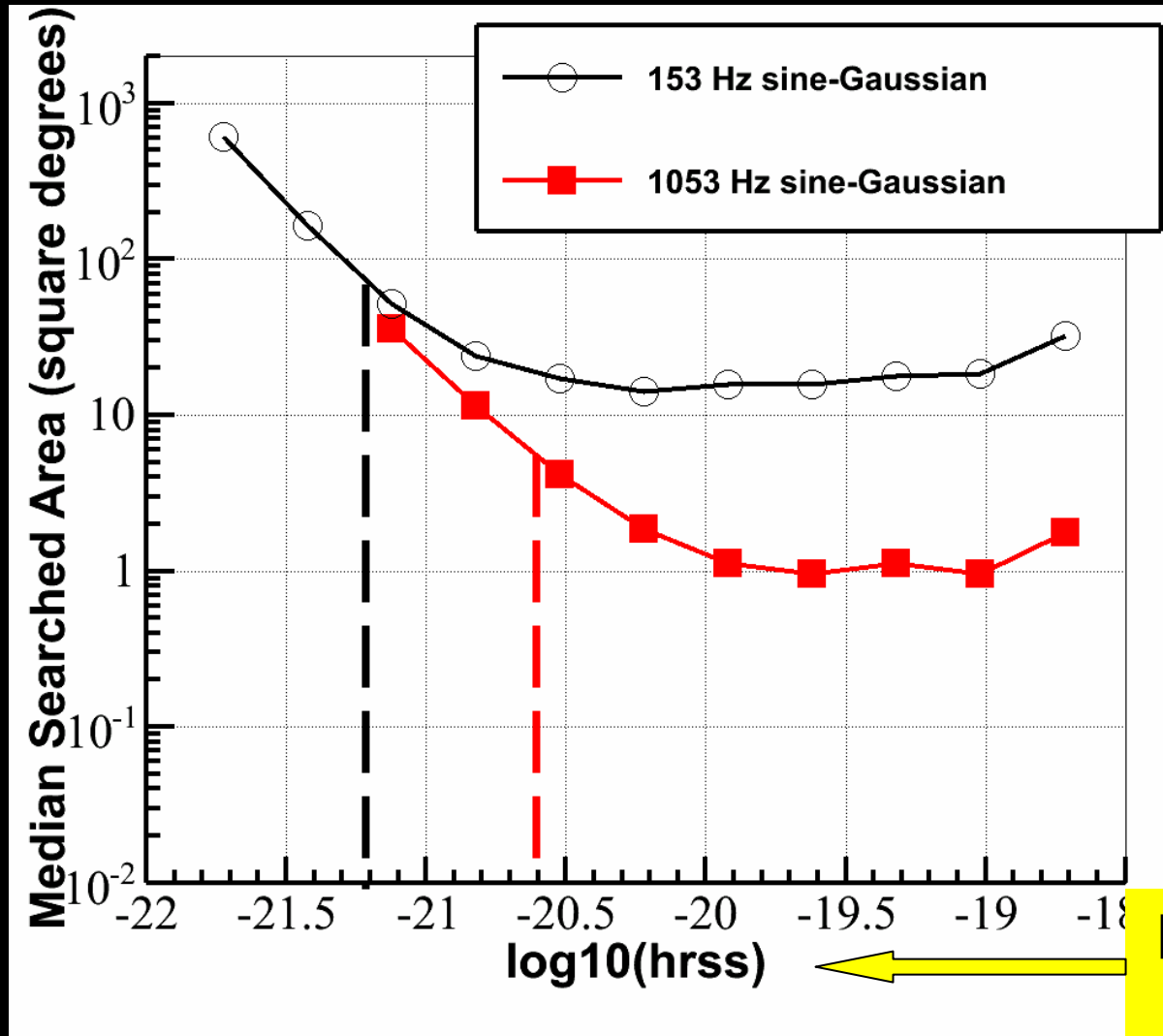
Dashed lines indicate hrss for cWB S5y2 50% detection efficiency

Omega Pipeline "tuned" to SG waveforms

hrss is a measure of signal amplitude at earth

Searched Area: cWB

PRELIMINARY



Dashed lines indicate hrss for cWB S5y2 50% detection efficiency

hrss is a measure of signal amplitude at earth

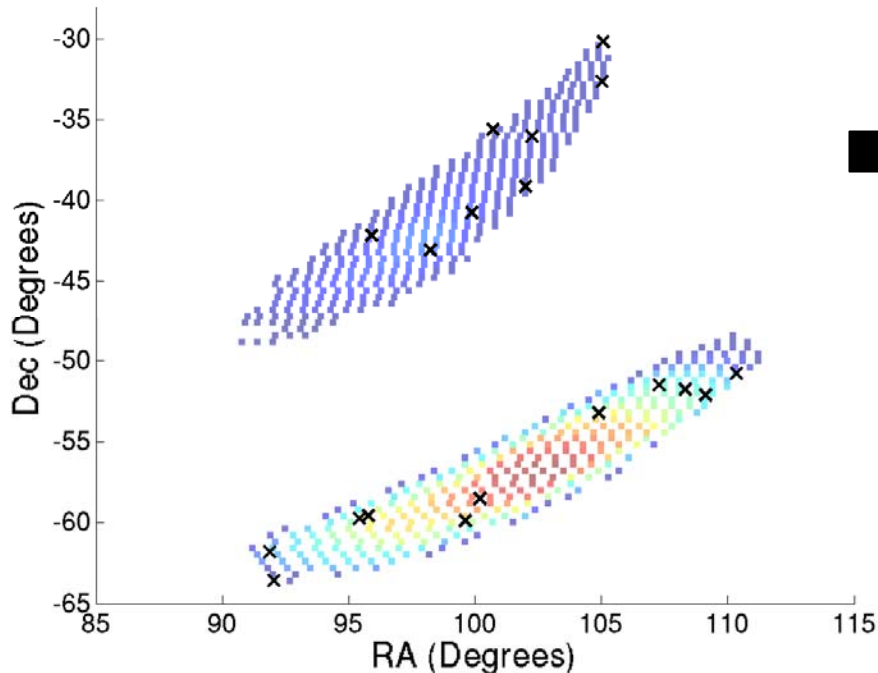
Galaxy Weighting & Tile Selection

Galaxy Weighting & Tile Selection: LUMIN & GEM

Catalog used to find locations
of nearby galaxies
 $D < 50$ Mpc
Marked in black

$$P = \frac{\text{Mass X Likelihood}}{\text{Distance}}$$

Skymap and Galaxy Positions



Pointings for Telescope Maximize P Statistic

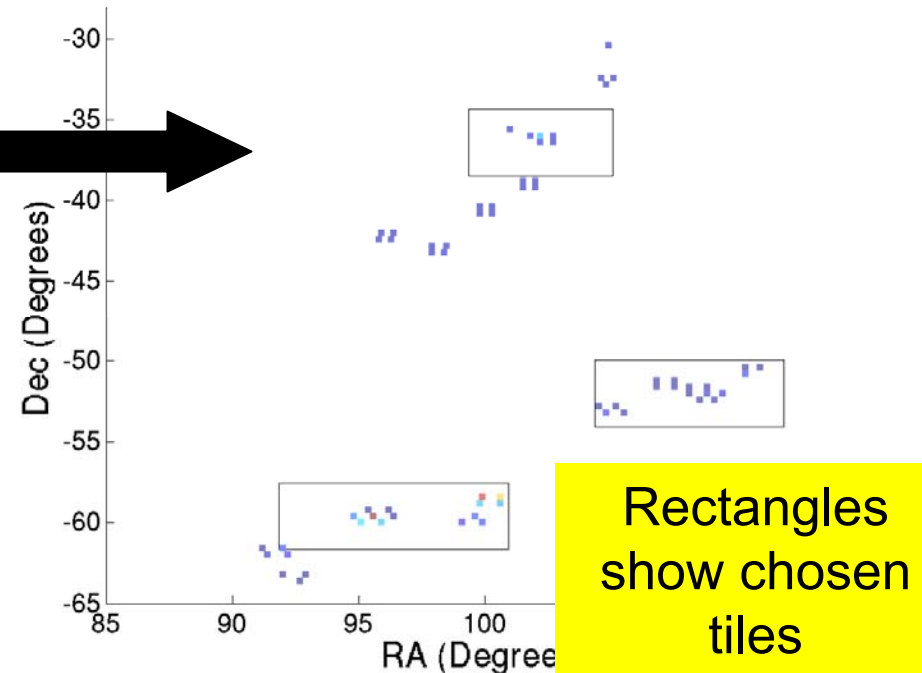


Figure of Merit: Fraction of events imaged

Measure the ability to recover the right sky location.

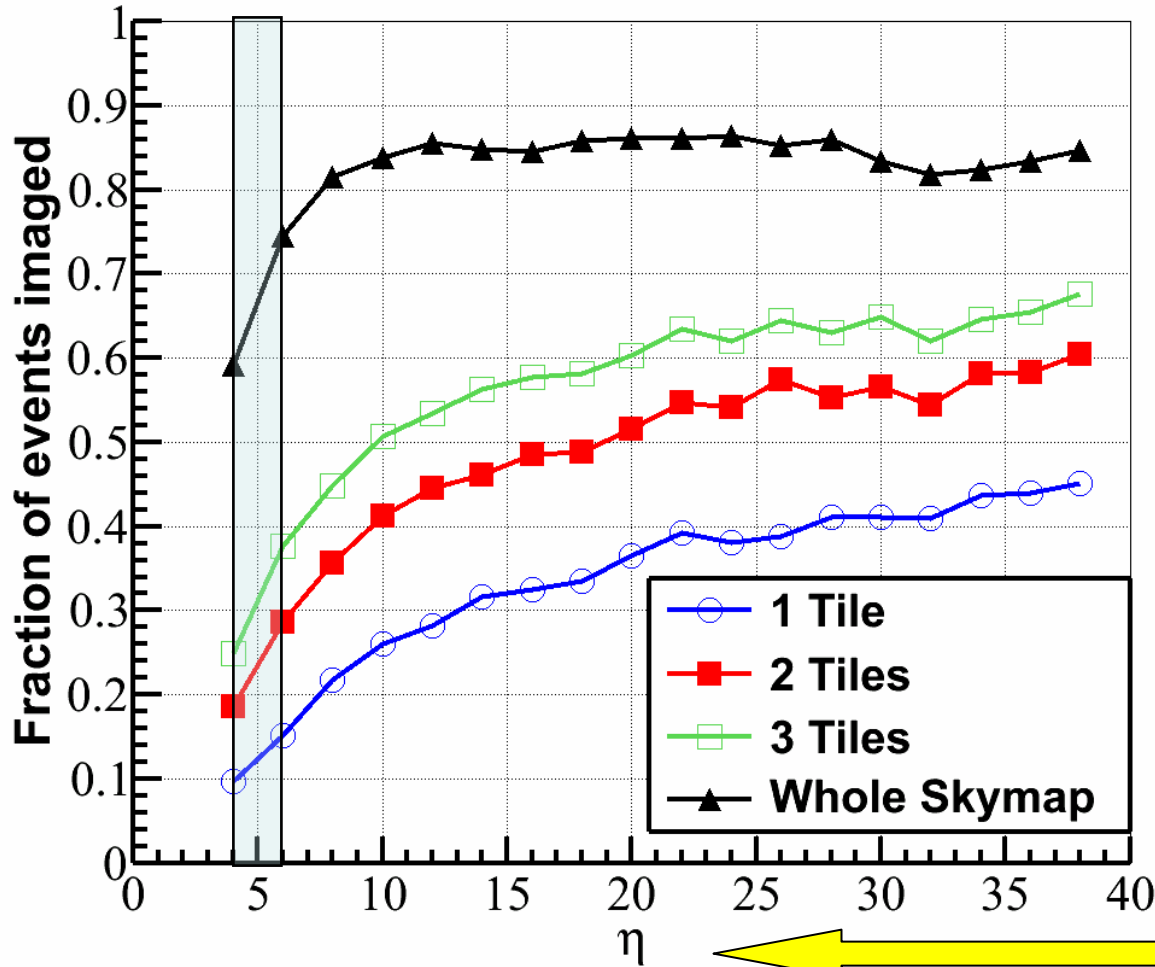
- ROTSE Size FOV
(1.8 x 1.8 Deg)
- Ignore geography
- Use Galaxy weighting



Image courtesy ROTSE collaboration

Tiling Success - cWB

PRELIMINARY

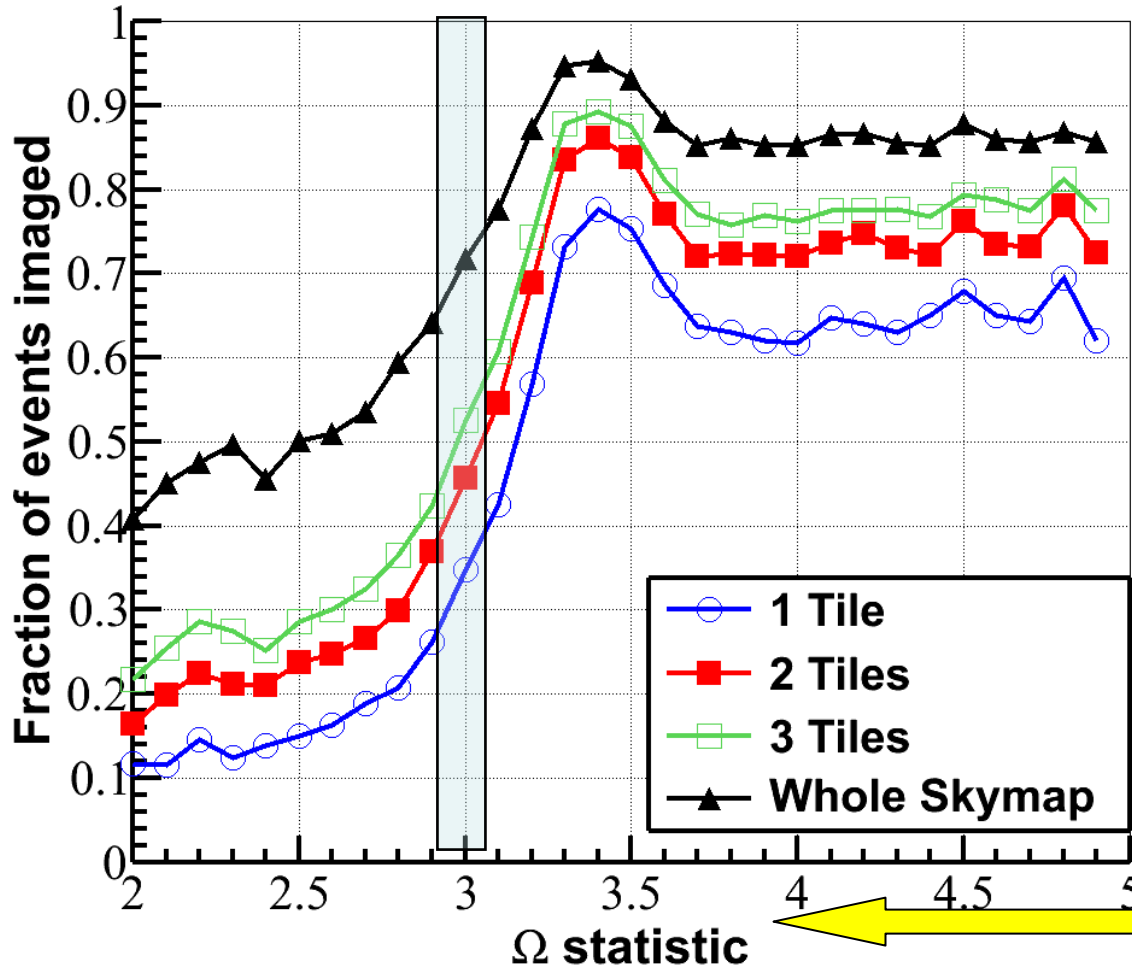


Shaded box shows range of nominal detection thresholds in S5y2

η is “coherent SNR” measured by cWB; scales with network SNR

Tiling Success - Omega

PRELIMINARY



Triggers at $\Omega = 3$ occur in background once every few days

“ Ω Stat” is the ranking statistic used by Omega Pipeline

Summary

- Performed the first low latency EM follow-ups to GW triggers
- Triggers and sky positions available in about 30 minutes
- Sky localization measured through simulations → tens of Deg² near detection threshold
- Source recovery of 10-50% with a few pointings near detection threshold

Thank you!