



# Position estimation from a network of interferometers

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# Position estimation

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- Electromagnetic counterpart searches
- Network-coherent burst detectors
- Targeted upper limits / burst searches

# EM counterpart to NS inspirals

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- Many mechanisms for NS inspirals to emit EM radiation
- For matched filtering, (error box area)  $\sim \text{SNR}^{-2}$
- Assuming a search area of  $3.4 \text{ deg}^2$ , the observation of EM counterparts is
  - » unlikely for Initial LIGO and Virgo (30 Mpc,  $0.002 \text{ yr}^{-1}$ )
  - » possible with Advanced LIGO and Virgo (60 Mpc,  $0.01 \text{ yr}^{-1}$ )
  - » likely with Advanced LIGO and “Advanced” Virgo (400 Mpc,  $7 \text{ yr}^{-1}$ )
- JS 2003, ApJ in press [astro-ph/0303512]

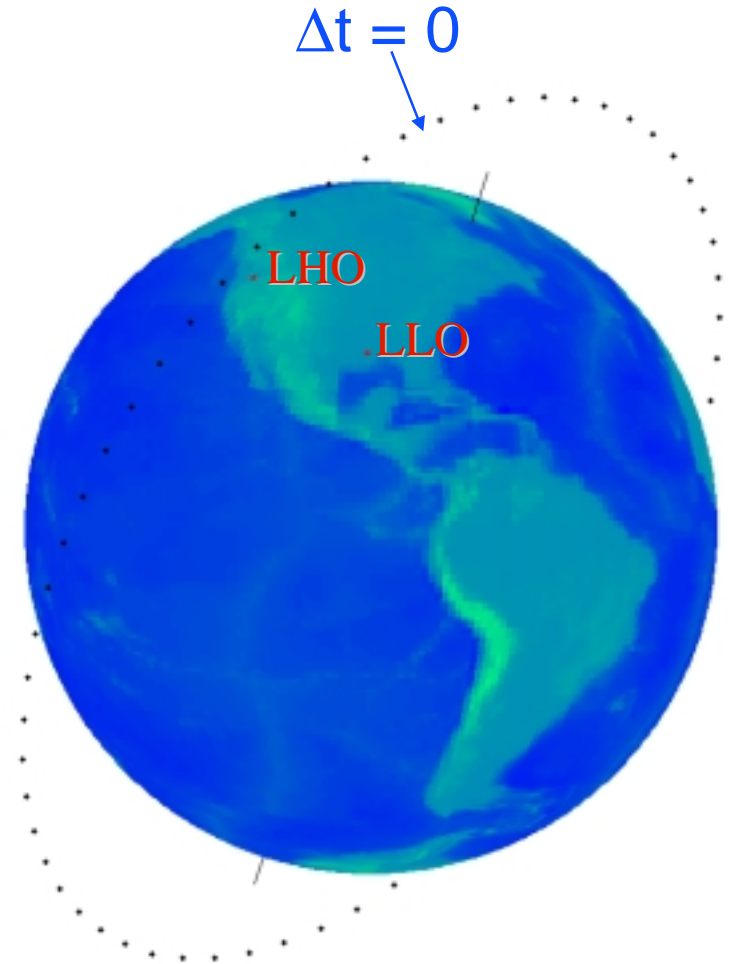
# Coherent Power Filter algorithm

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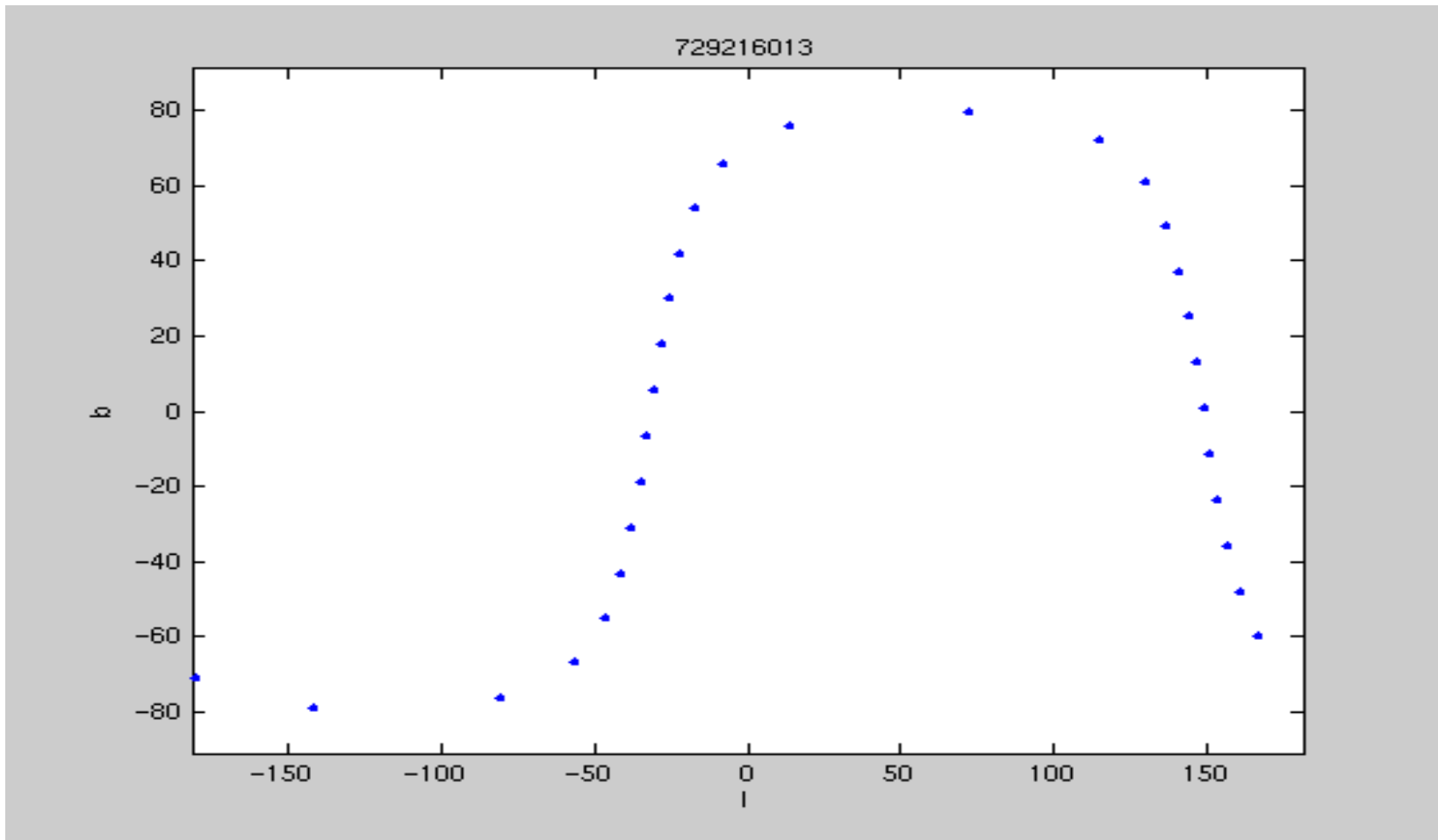
- Generalization of power detectors to optimally process network data
- 25-40% improvement in SNR over incoherent searches
- Supernova-like signal ( $E_{\text{GW}} \sim 10^{-7} M_{\text{sun}} c^2$ ): 25% of simulations have position errors smaller than 1 degree for sources within 70 kpc (Initial LIGO and Virgo)
- JS 2003, CQG in press [gr-qc/0304111], PRD under review

# Two-detector network

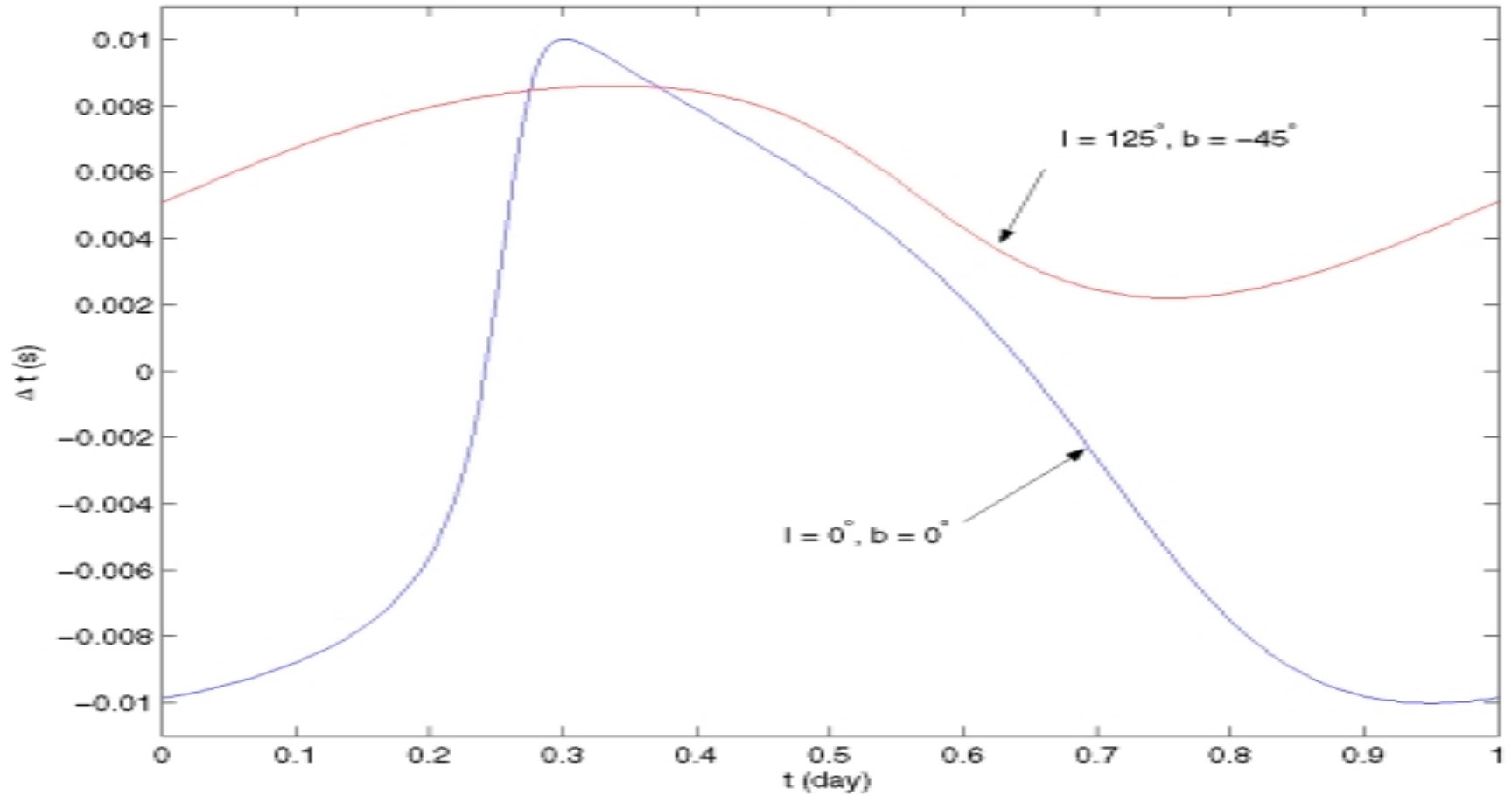
- The LIGO interferometers at Hanford and Livingston are optimally aligned
- This allows to use cross-correlation techniques (for instance) to get the difference in arrival time to a fraction of a ms
- $\Delta t = t_{\text{LHO}} - t_{\text{LLO}}$



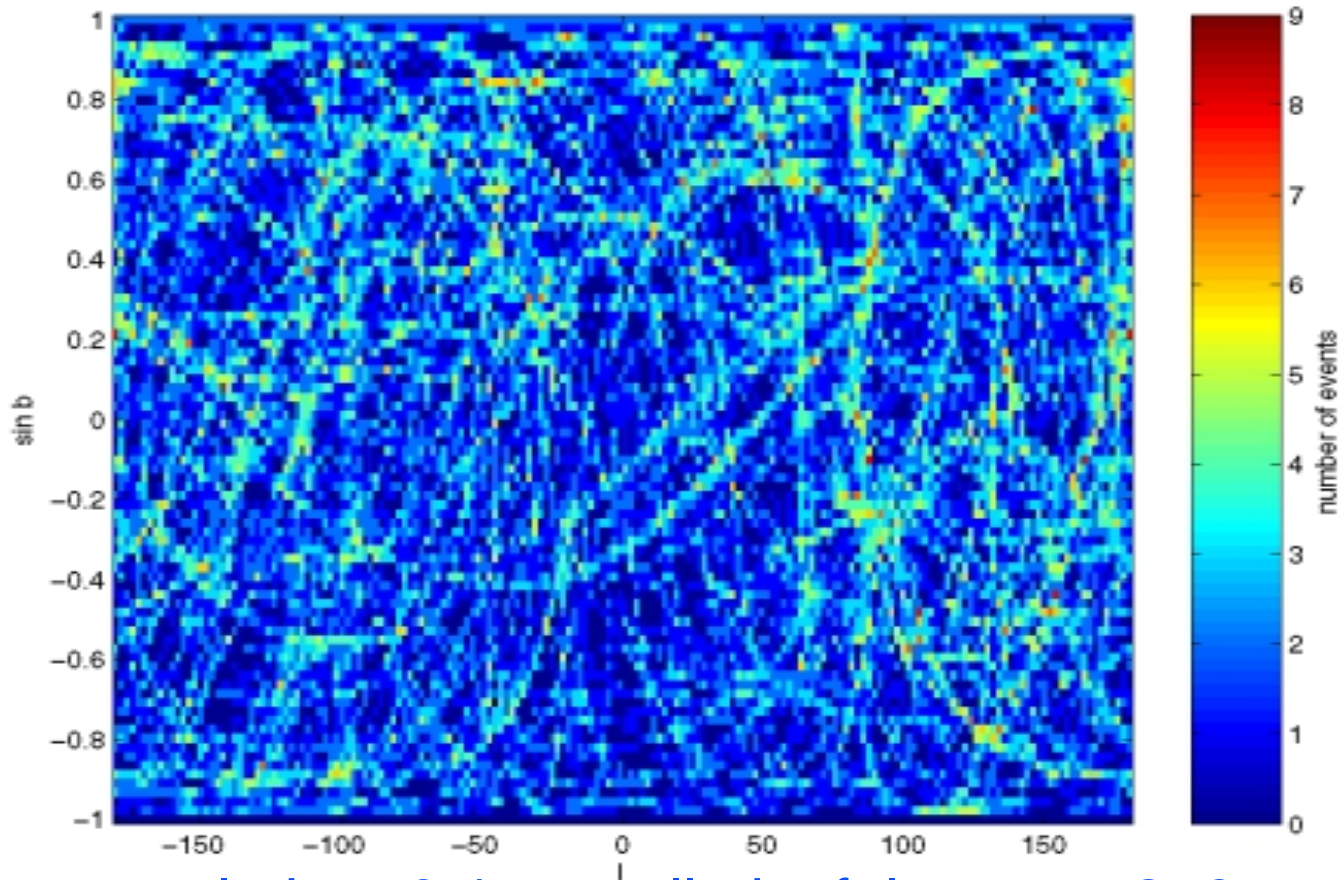
# $\Delta t = 0$ great circle in galactic coordinates



# $\Delta t$ vs. time



# Simulation for the S2 time period: background

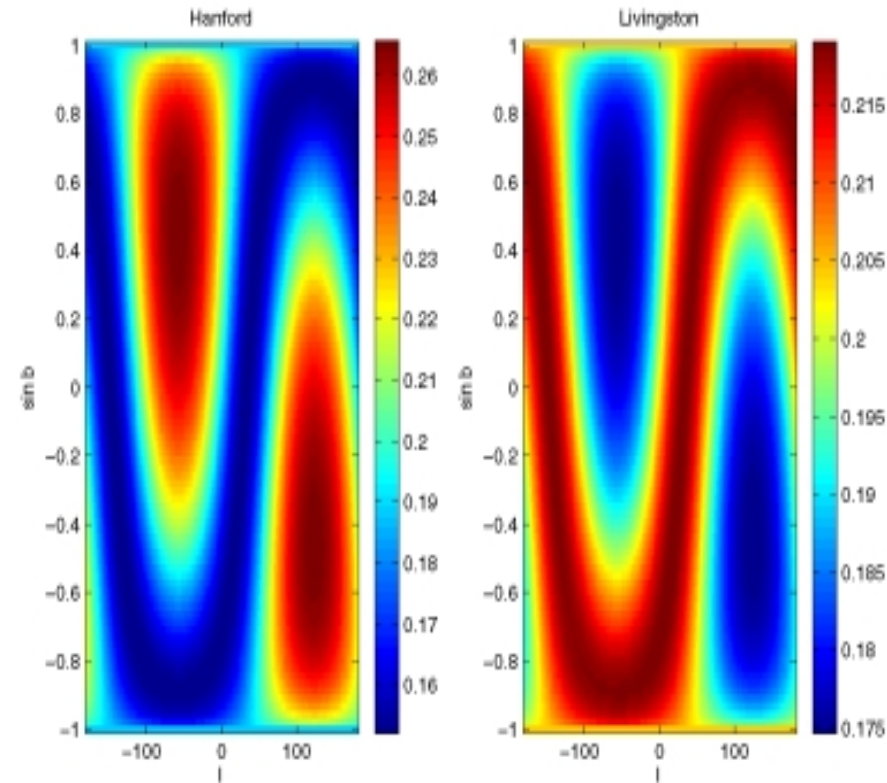


Time resolution: 0.1 ms, all-sky false rate: 259 events



# Targeted rate upper limits

- A time delay resolution  $w$  leads to a background reduction  $\sim 10 \text{ ms} / w$
- Sensitivity isn't significantly reduced by targeting
- Targeted rate upper limit is  $\sim 10$  times better than all-sky limit (for  $w \sim 0.1 \text{ ms}$ )



Time averaged response (S2)