Martin McHugh

IGEC

Event rates from the IGEC

Outline

- The IGEC
- Properties of the exchanged data
- Coincidence search
- Upper limits
- Upgrading the IGEC protocol
- Conclusion and summary

http:// igec.lnl.infn.it

IGEC

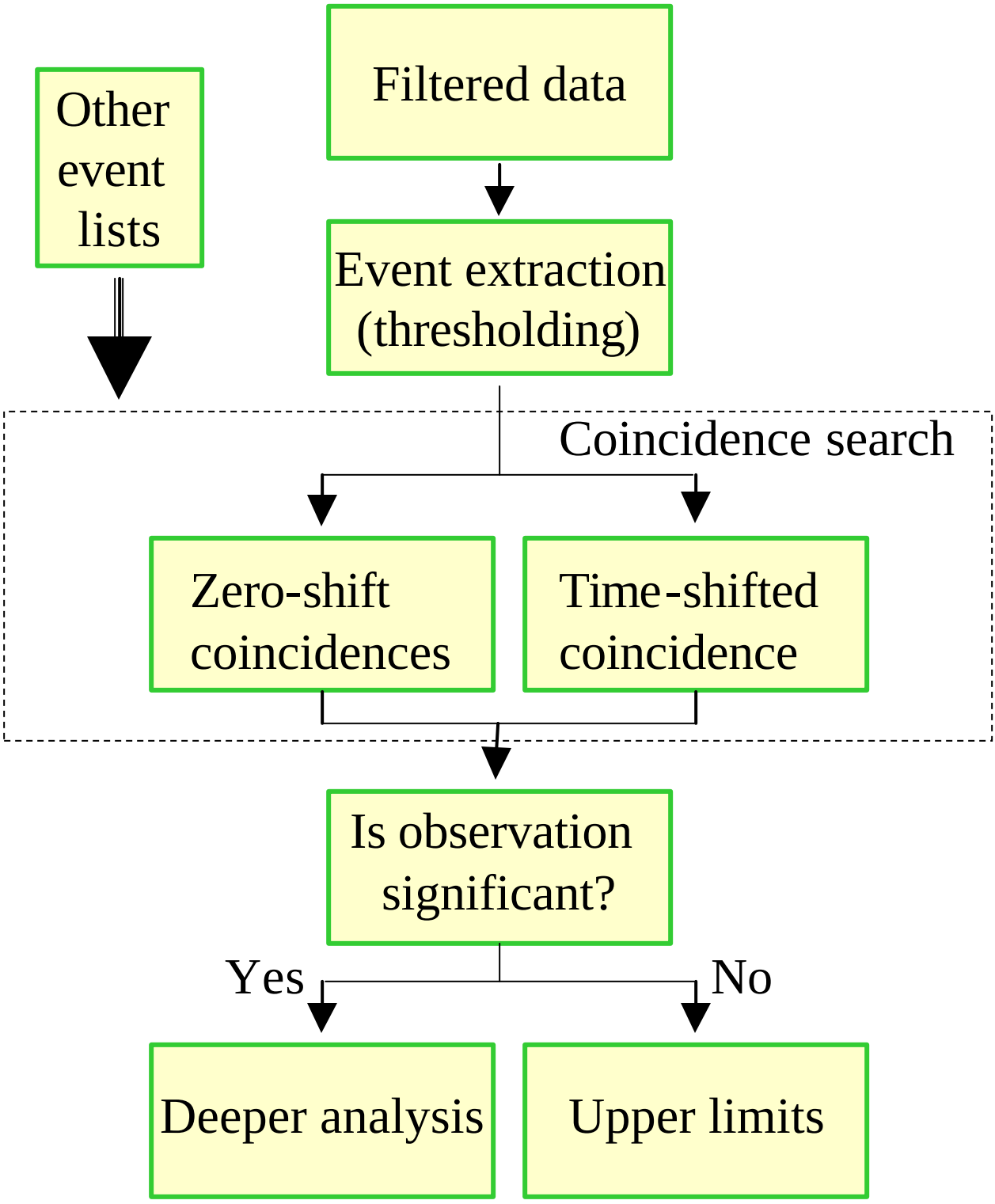
The IGEC

- Worldwide collaboration aimed at detecting short gravitational wave bursts

- Currently consists of the 5 cryogenic resonant-mass detectors:
  - ALLEGRO, Louisiana State University, Baton Rouge, USA
  - AURIGA, Laboratori Nazionali di Legnaro, Legnaro, Italy
  - EXPLORER, CERN, Geneva, Switzerland
  - NAUTILUS, Laboratori Nazionali di Frascati, Frascati, Italy
  - NIOBE, University of Western Australia, Perth, Australia

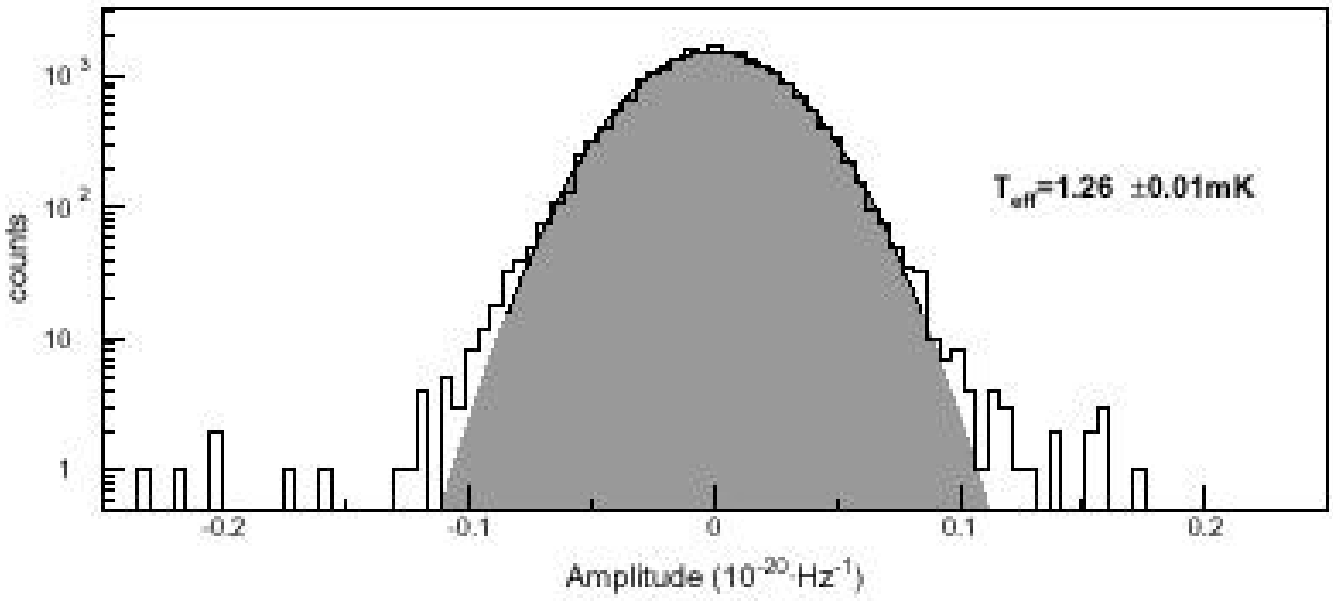
IGEC

Method of Analysis



Filtering & thresholding

- Each detector group:
  - implements their own version of the optimal filter
  - Applies a threshold to extract candidate gw events at ~100 events per day



G.A. Prodi et al., Proc. Of Third Edoardo Amaldi Conference on Gravitational Waves, pp. 344-345

Event rates, overlap

Exchanged data from 1997 and 1998

Detector	Observation time (days)	No. of events	Event rate (per day)
ALLEGRO	405.7	45805	113
AURIGA	153.0	26817	175
EXPLORER	137.5	20711	151
NAUTILUS	108.5	8764	81
NIOBE	189.5	2600	14

Common observation time

260 days	at least 2 detectors
90 days	at least 3 detectors
15 days	4 detectors

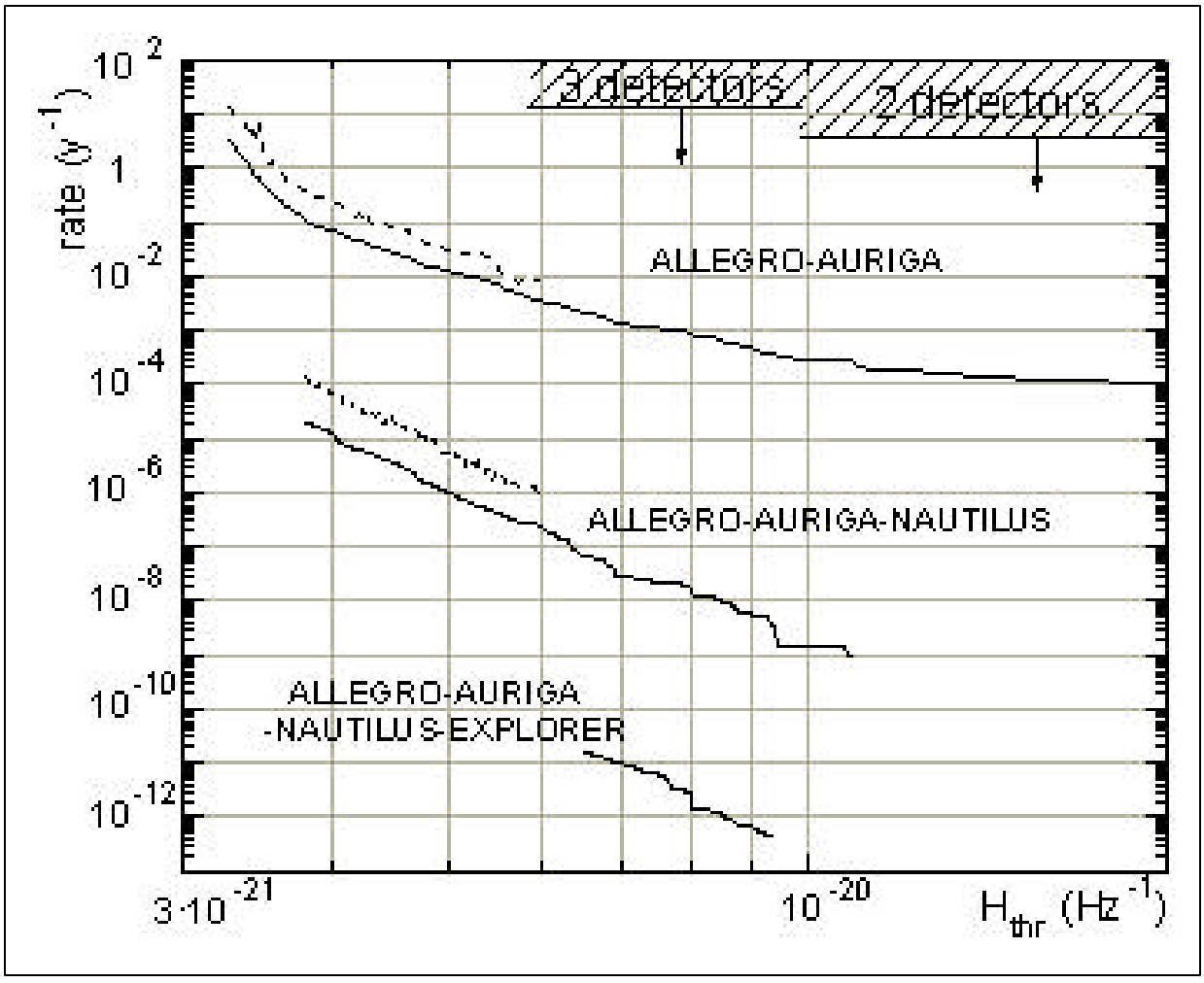
IGEC

Coincidence search

- No 3 or 4-fold coincidences were observed
- No excess 2-fold coincidences were observed

- Considering all possible pairs of detectors, we observed,
  - a total of 112 2-fold coincidences
- Of the 112 coincidences,
  - 47 were outside the observation of another detector
  - 12 were below the threshold of third detector

Upper limits on gw rates



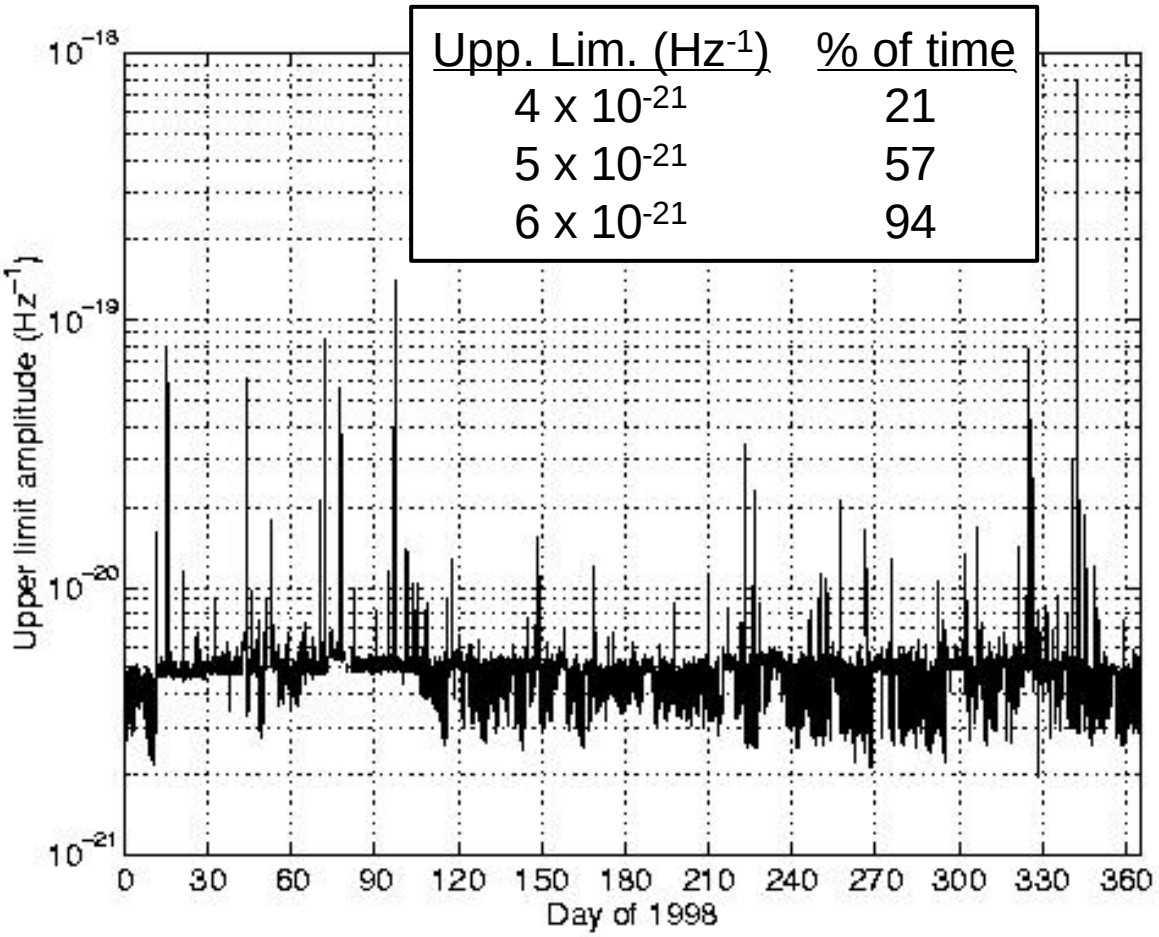
Upper limit procedure:

1) E. Amaldi et al., Astron. Astrophys., (216) 325, 1989

2) Astone et al., gr-qc/0001035

Upper limits on gw amplitude

- The detectors in IGEC could be asked by interested parties to set an upper limit on the amplitude of a burst gw associated with an astronomical trigger.



IGEC

Upgrade of protocol

- Current protocol asks for:
  - Time
  - Amplitude
  - SNR

- Proposed to:
  - Change event rate
- Looking to include:
  - Regular declaration of detector noise levels
  - Vetoed events
  - Amplitude uncertainty
  - Timing uncertainty

IGEC

Amplitude & timing uncertainty (1)

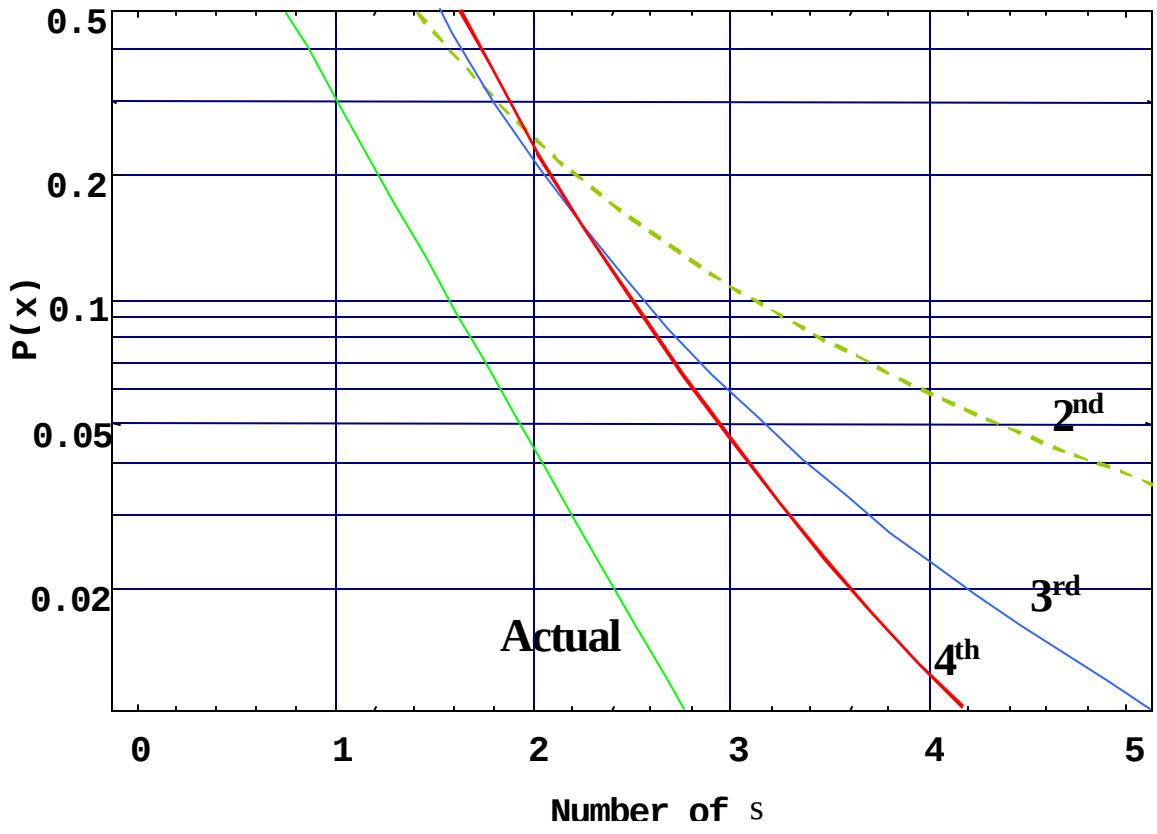
- Signal impinging on the detector interacts with noise
- Causes fluctuations in the amplitude of detected signal -> uncertainty in amplitude and time of arrival of actual signal
- Want to be able to make a statement about the confidence level of our amplitude upper limits
- Better calculation of the efficiency of detection
- Better calculation of false dismissal for a given coincidence time window

Amplitude & timing uncertainty (2)

- Exchange Moments of the distribution
- Estimate distribution using Bienaymè (generalised Tchebycheff) inequality

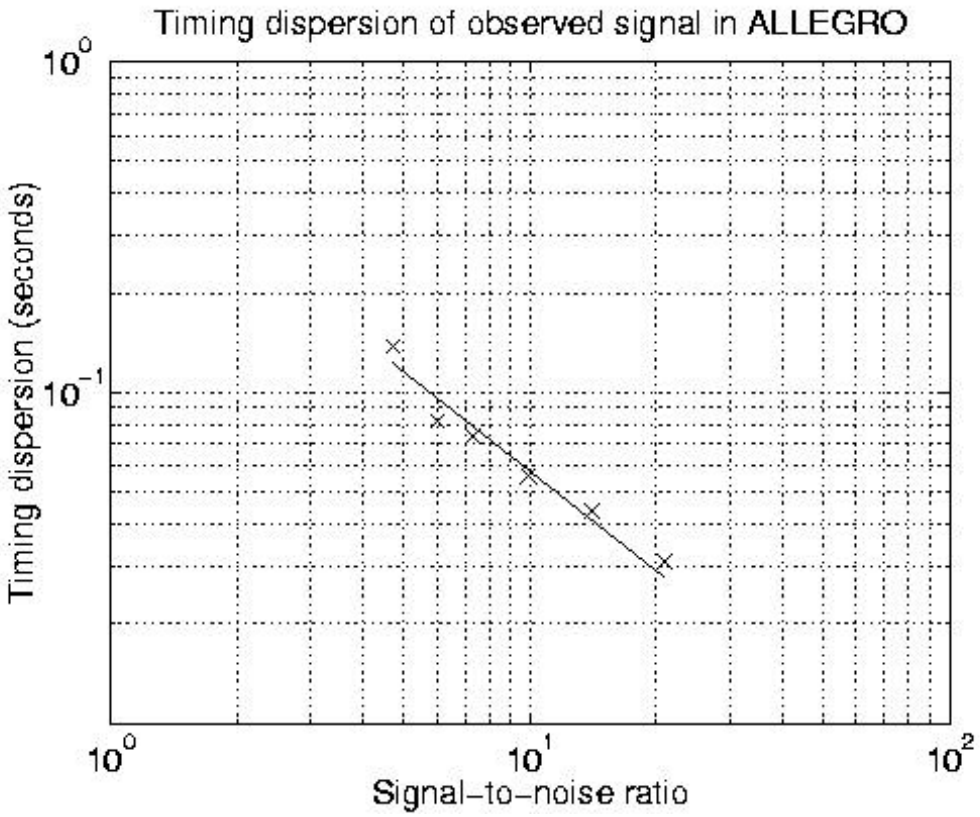
$$P\left(\left|x-m\right| \geq e\right) \leq \frac{E\left\{\left|x-m\right|^{n}\right\}}{e^{n}}$$

Where μ is the mean, ε is the number of standard deviations away from the mean, n is the moment



Amplitude & timing uncertainty (3)

- **When the noise is Gaussian -> behaviour is well-known**



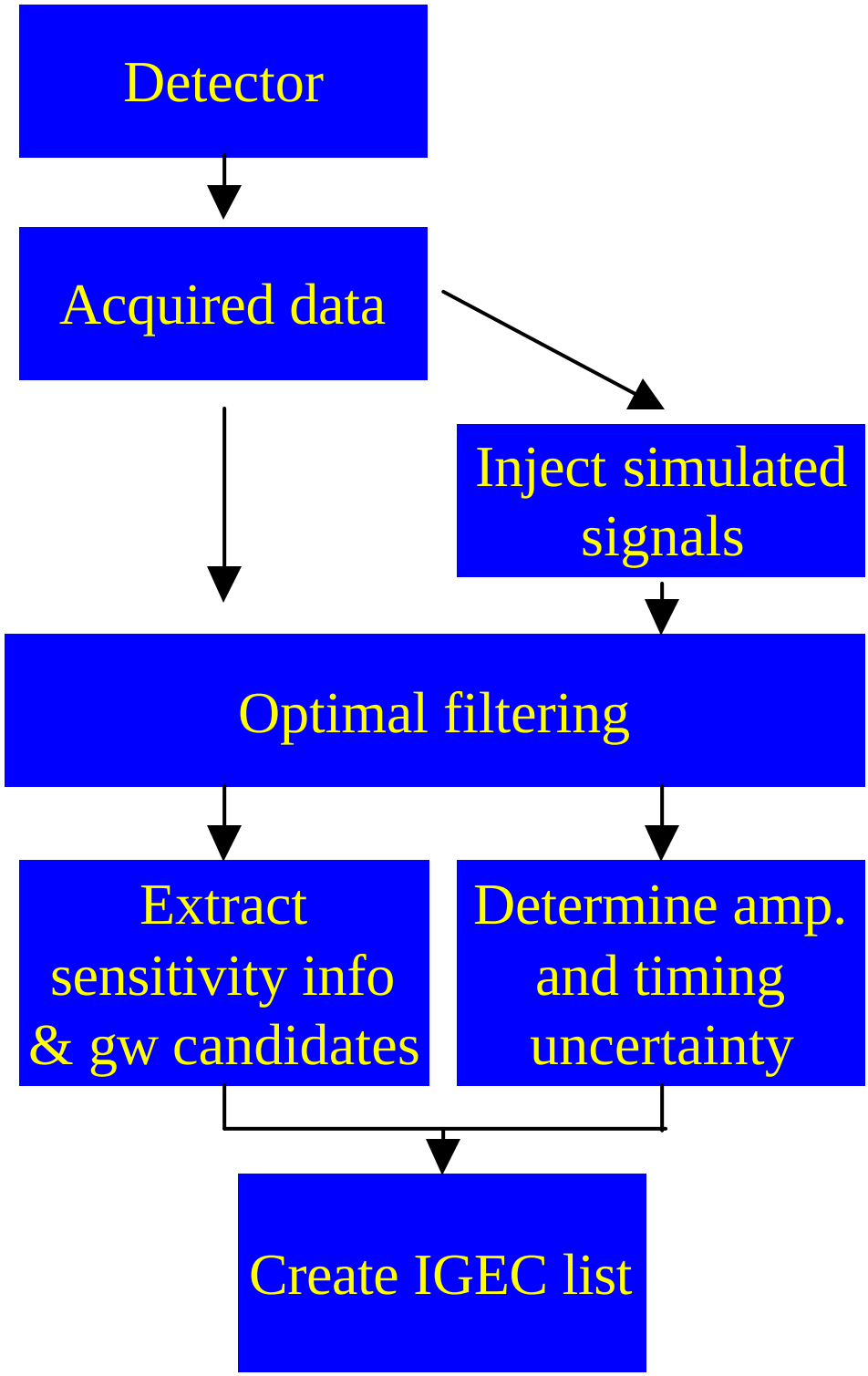
Also see: P. Astone, S.D'Antonio, G. Pizzella
Phys.Rev. D62 (2000) 042001 (also gr-qc/0001030)

V. Crivelli-Visconti et al., Phys. Rev. D57 (1998) 2045

- **When the noise is non-Gaussian -> ???**

IGEC

Determining the uncertainty



IGEC

Summary and conclusions

- Upper limits of:
  - ~4 per year for $H = 10^{-20}$ Hz^{-1} (2 detectors)
  - ~12 per year for $H = 6 \times 10^{-21}$ Hz^{-1} (3 detectors)

- The network of detectors set an hourly upper limit of 6×10^{-21} Hz^{-1}

- Changed the protocol to
  - Increase event rate
  - Include vetoed events
  - Set better detection efficiencies & confidence levels

- Propose continuous Monte Carlo to determine behaviour of signal in noise