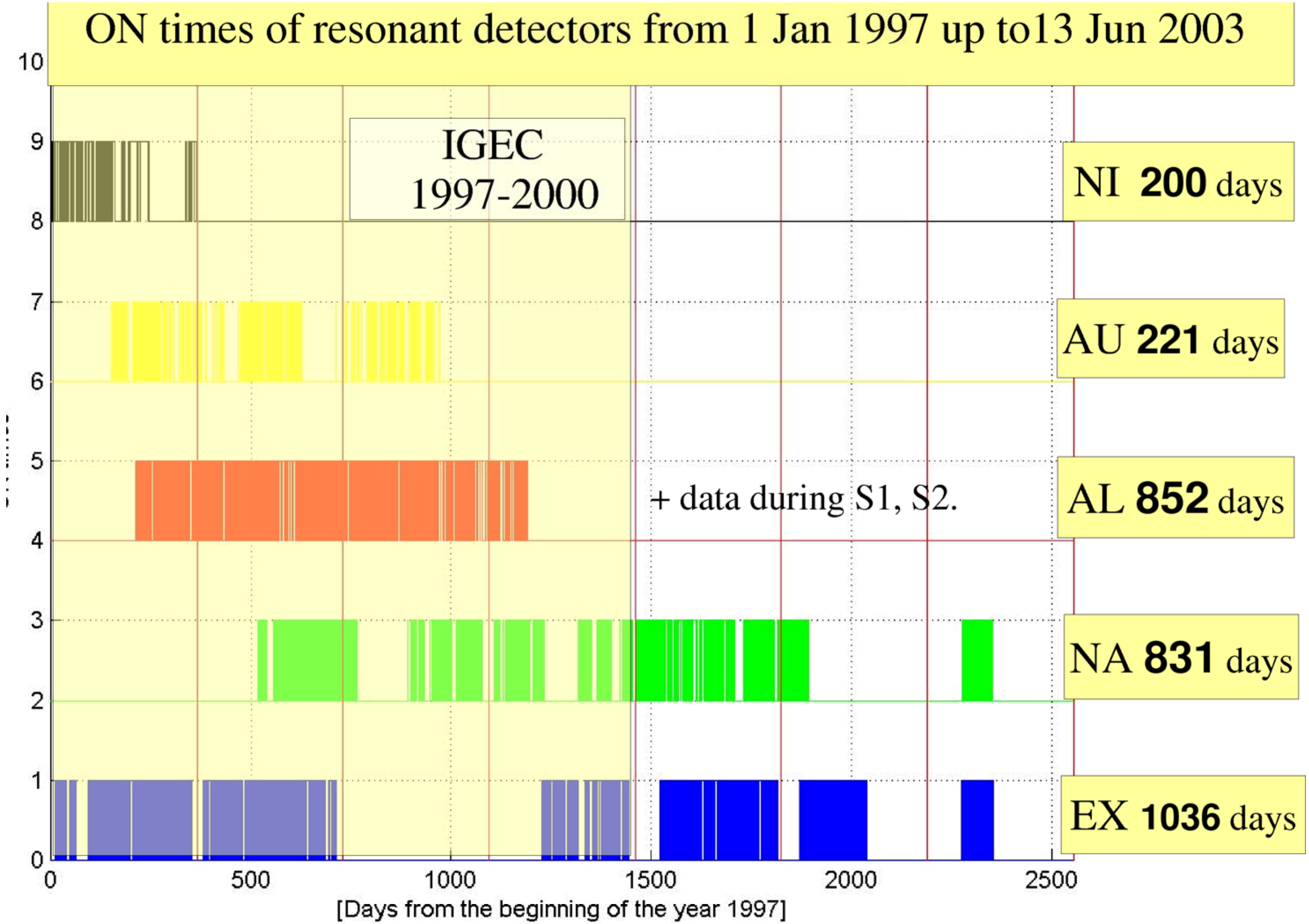
Seven years of data taking and analysis of the data of the Explorer and Nautilus g.w. detectors

Pia Astone
ROG collaboration

http://www.roma1.infn.it/rog

http://www.roma1.infn.it/rog/astone

GWDAW, Milwaukee
December 2003


ON times of resonant detectors from 1 Jan 1997 up to13 Jun 2003
IGEC
1997-2000
NI 200 days
AU 221 days
AL 852 days
+ data during S1, S2.
NA 831 days
EX 1036 days
[Days from the beginning of the year 1997]
0
500
1000
1500
2000
2500
0
1
2
3
4
5
6
7
8
9
10

AN EXAMPLE OF STRAIN SENSITIVITY of a resonant g.w. detector

Note that the bandwidth depends ONLY on the transducer and amplifier

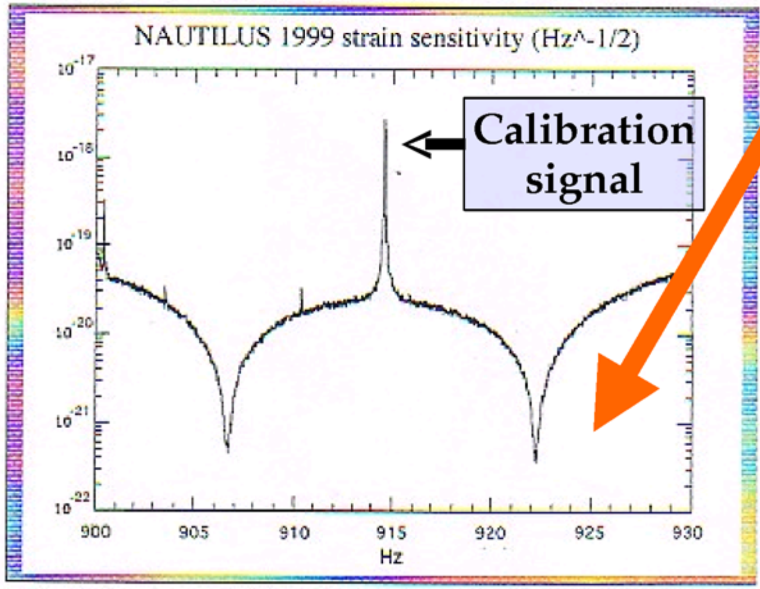
$$\Delta f \approx \left(\frac{\beta}{T_n}\right)^{1/2} \quad [Hz]$$

ß Capacitive transducer efficiency

T_n Electronic temperature noise

$\tilde{h}_{min} \approx 3 \cdot 10^{-22} 1/\sqrt{Hz}$

$\Delta f \approx 1 Hz$



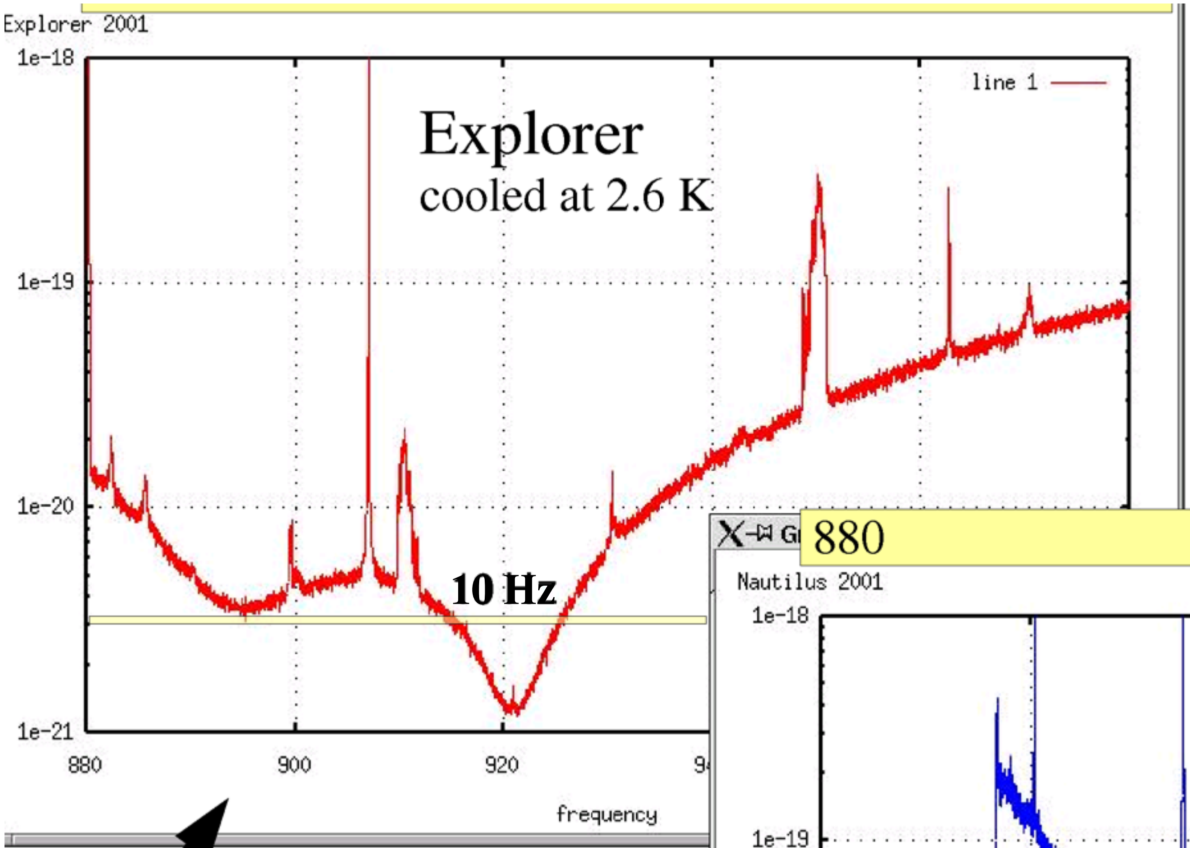
Sqrt(T/MQ)

cooled at 100 mK

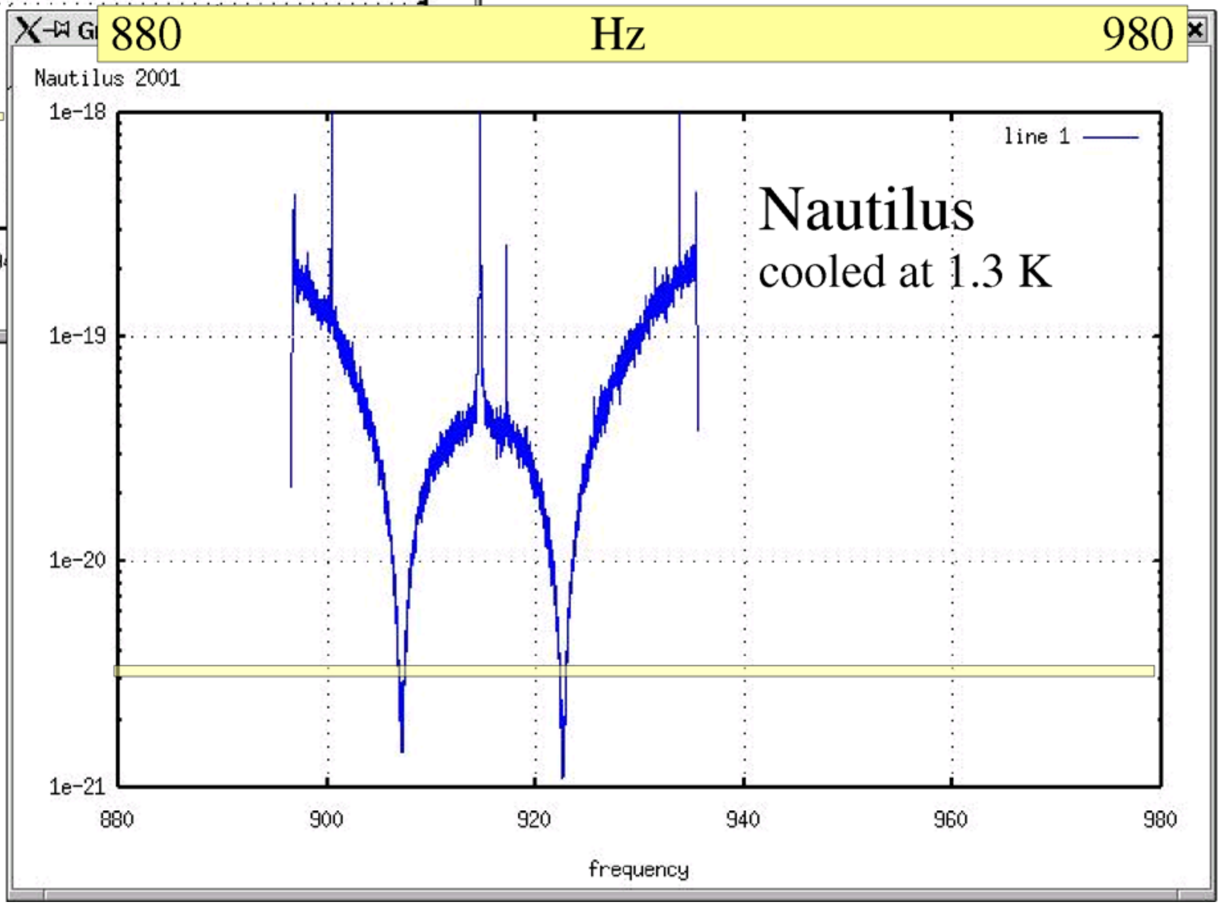
NAUTILUS 1999

The bandwidth of the antenna can be increased acting on the transducer-amplifier of the signals, by increasing ß and/or decreasing T_n

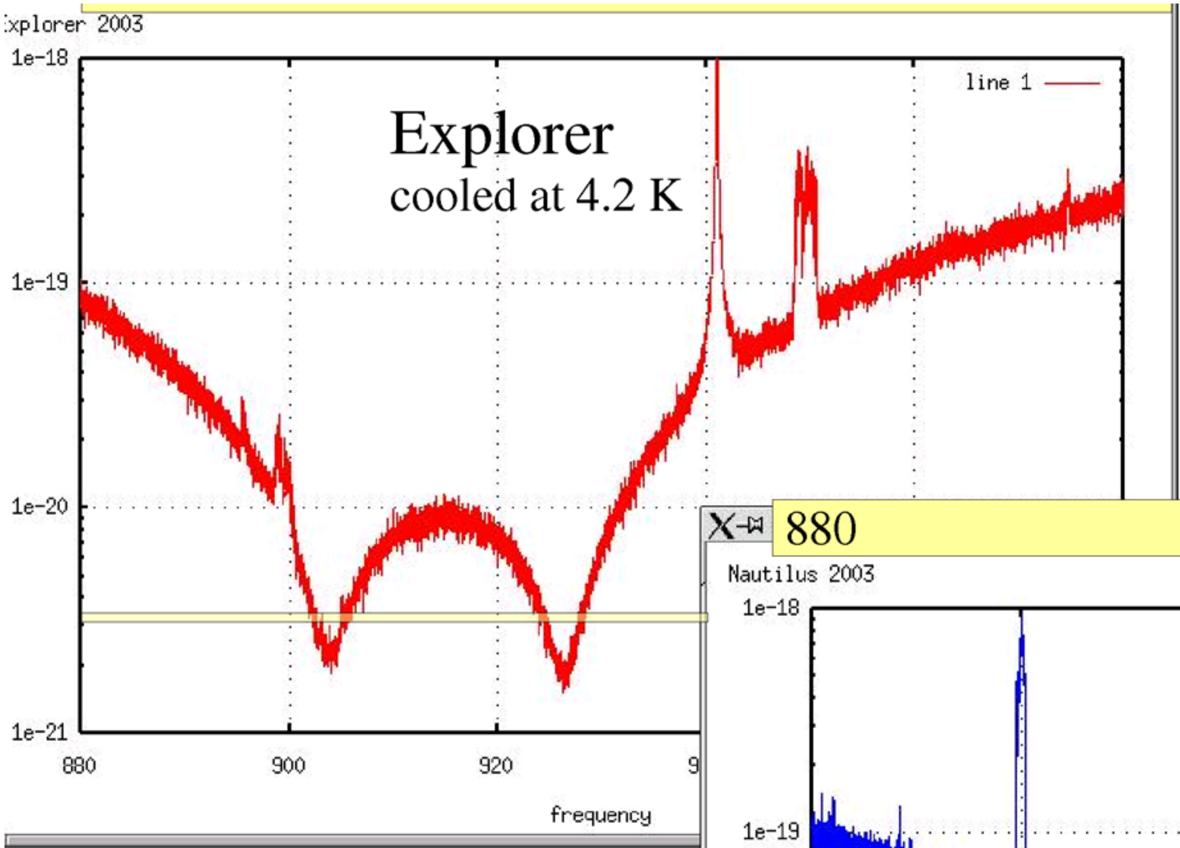
The year 2001

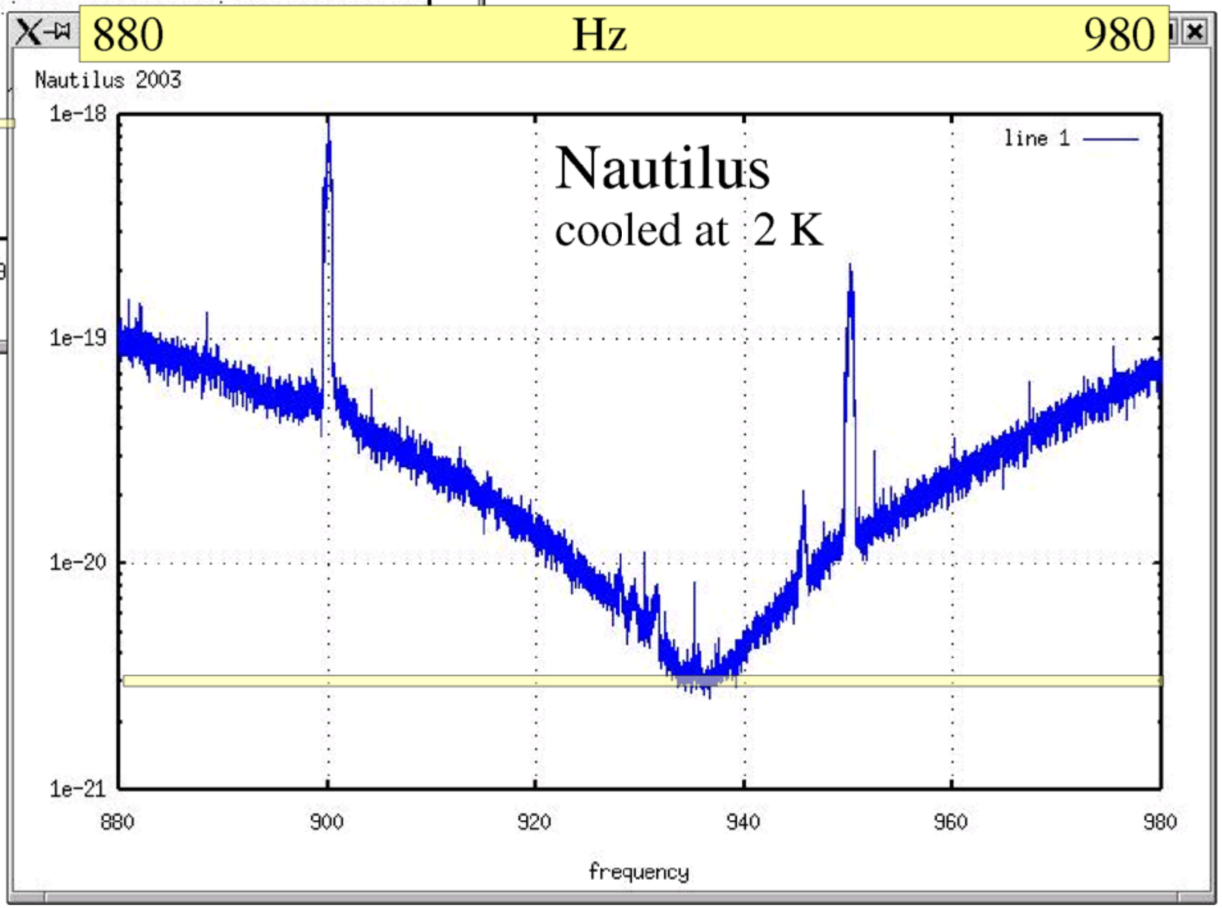


ys Rev Letters 91
111101 (2003)



The year 2003





The detection of bursts

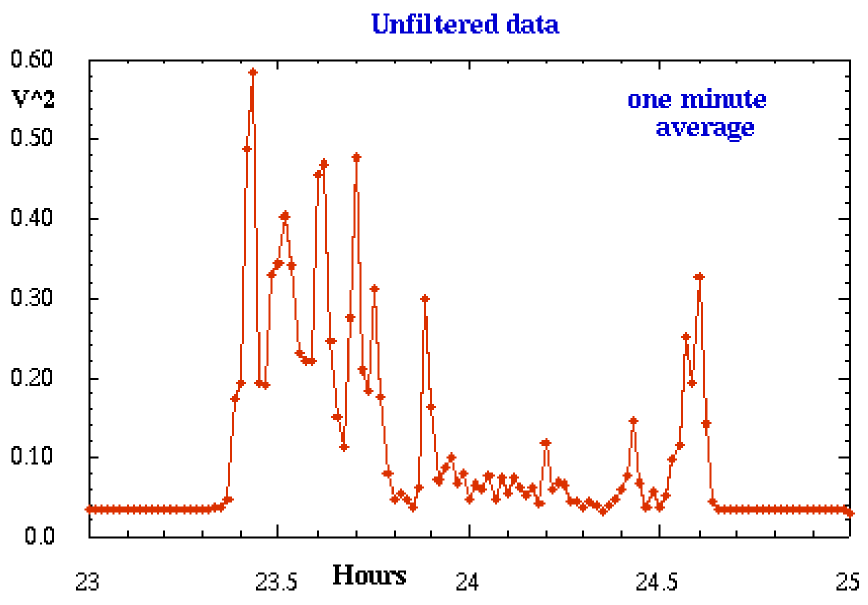
The DAGA2_HF noise estimators for matched filters on non-stationary noise

P.Astone, S.D'Antonio, S.Frasca, M.A. Papa

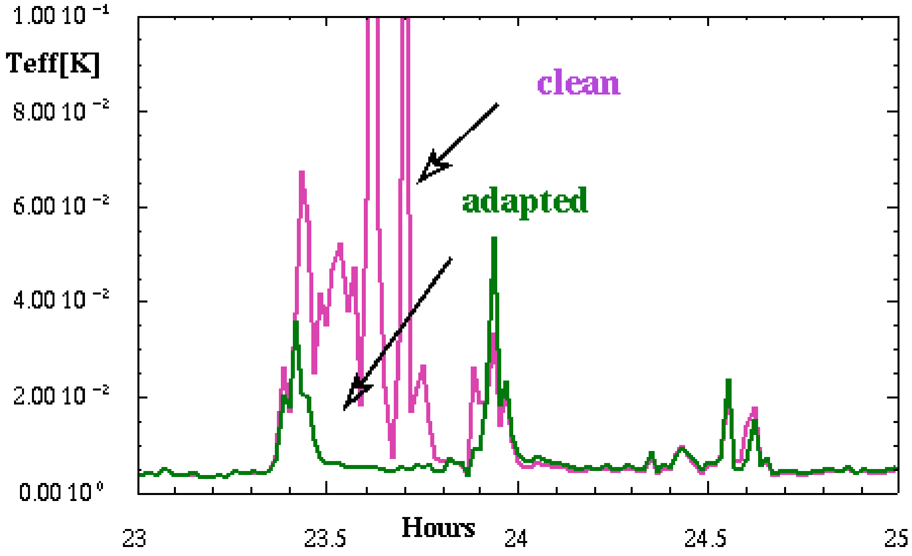
Three procedures are used for the estimation of the noise:

'whole' 'clean' 'varying memory (adapted)'

(presented by S. D' Antonio at the GWDAW2002 in Kioto)



Unfiltered data
one minute average
V^2
0.60
0.50
0.40
0.30
0.20
0.10
0.0
23
23.5
Hours
24
24.5
25



Teff[K]
clean
adapted
Hours
23
23.5
24
24.5
25

Burst signals for a bar detector:
we use to model them as 'delta' signals

- Is this reasonable, given the actual bandwidth ?

- Which sources are suitable to do coincidences within a network of bars and interferometers ?

2 approaches:

--> Analytical

-->Simulations, adding fake signals to the noise of the detectors

(P. Astone, S. D' Antonio, A. Pai with the help of V. Ferrari)

Burst signals for a bar detector:
we use to model them as 'delta' signals

- G. w. from the core collapse: Muller catalog
- G. w. from neutron stars at different evolutionary stages (Ferrari, Miniutti, Pons astro-ph/0210581 and CQG 20, S841 presented at GWDAW2002 in Kioto by V. Ferrari):

  hot joung stars: damped sinusoids with f(t) and τ(t)

  cooled stars: damped sinusoids with f and τ, for the QNMs

  (τ 'moderate' ; τ 'small' -->the spectrum becomes 'flat')
- G. w. from the Ringdown of BHs: damped sinusoids

  ($\tau \sim 10^{-5}$ s M/M_0 f ~ 12kHz/(M/M_0))

Practical problems of coincidence analysis:

The sensitivity of each detector varies with time

The sensitivities of the various detectors are different

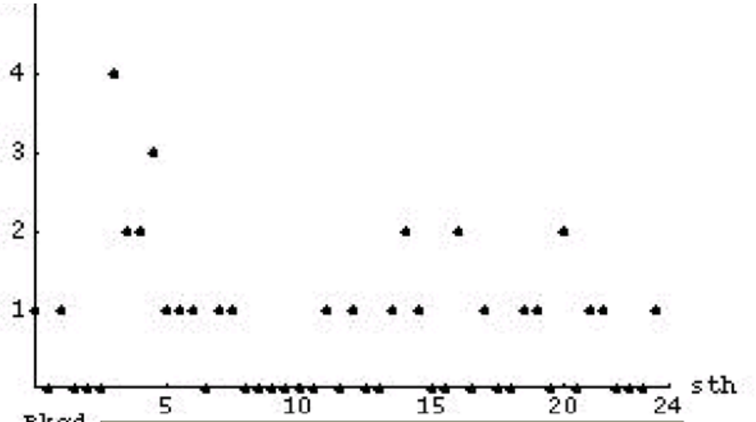
The same signal generates events with energies different for each detector

Use of Energy filters and Antenna pattern

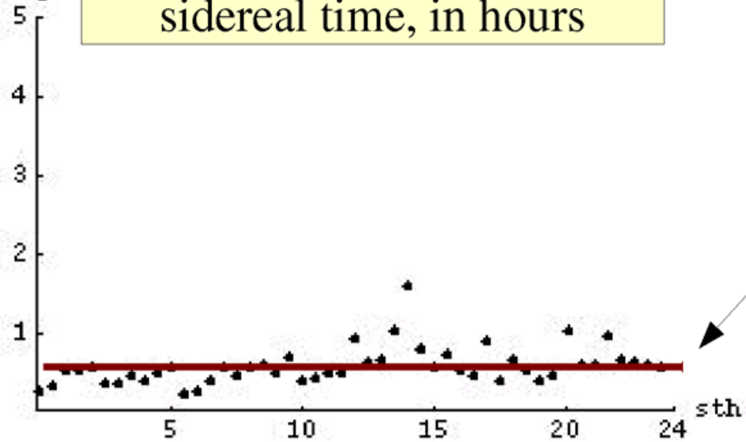
selection algorithm based on the event energies)

CQG, 18 (2001)

Explorer and Nautilus: coincidences in the year 2001
CQG 19, 5449 (2002)

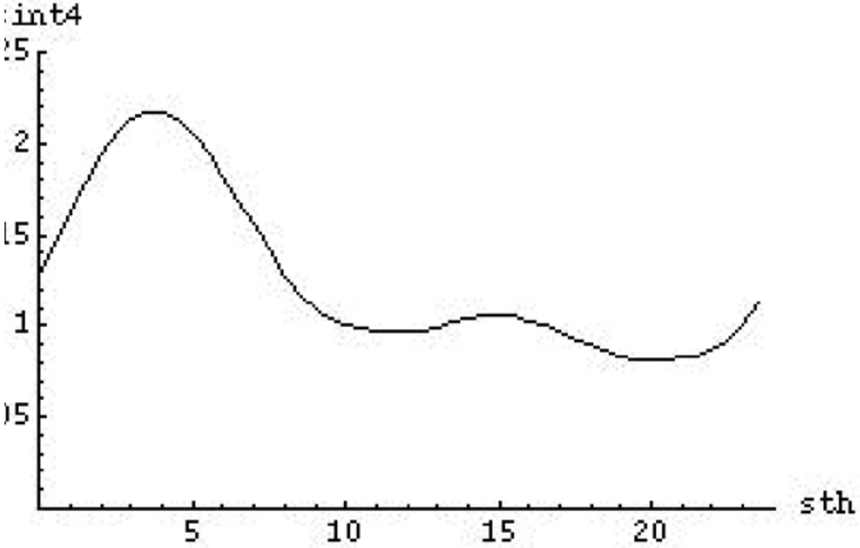


sidereal time, in hours

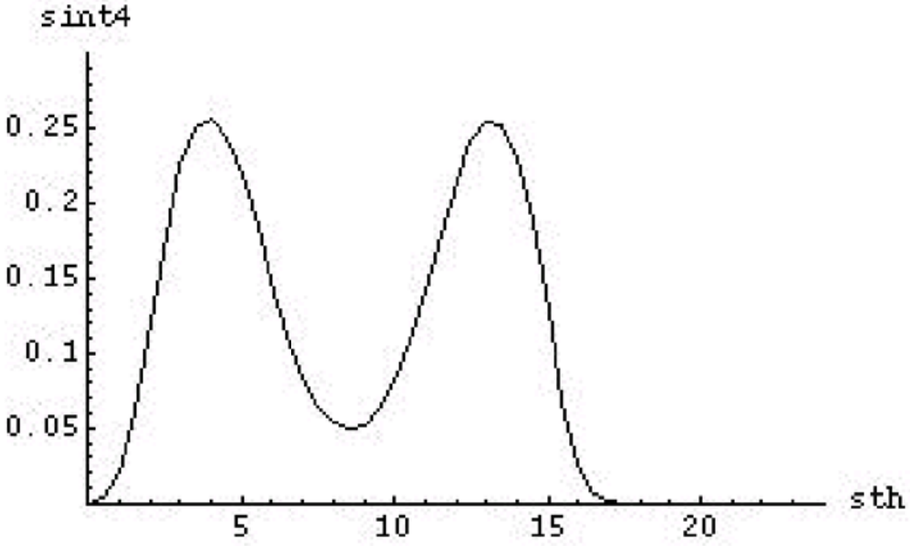


<b>=0.57

GD



GC



Review critically how our **beliefs** are modified by the actual observation.

-> Bayesian analysis

P. Astone,G. D'Agostini,S. D'Antonio ***CQG 20 (2003)***

Ingredients of the inference are:

-->the data;
-->the knowledge of the detectors;
-->hypotheses on the underlying physics;

-->the physical quantity with respect to which we are *uncertain* is the g.w. rate on Earth, r, and the model responsible for g.w. emission;
-->we are *rather sure* about b, but not about the number which will actually be observed;
-->what is *certain* is the number nc of coincidences;

Review criti... beliefs are
mo...

If new information -which has to be independent from our data- is avalaible, the hypotheses might change and it is easy within this inferential scheme to re-evaluate Bayes factors

Ingr...

-->the data;
-->the knowledge of the detectors;
-->hypotheses on the underlying physics;

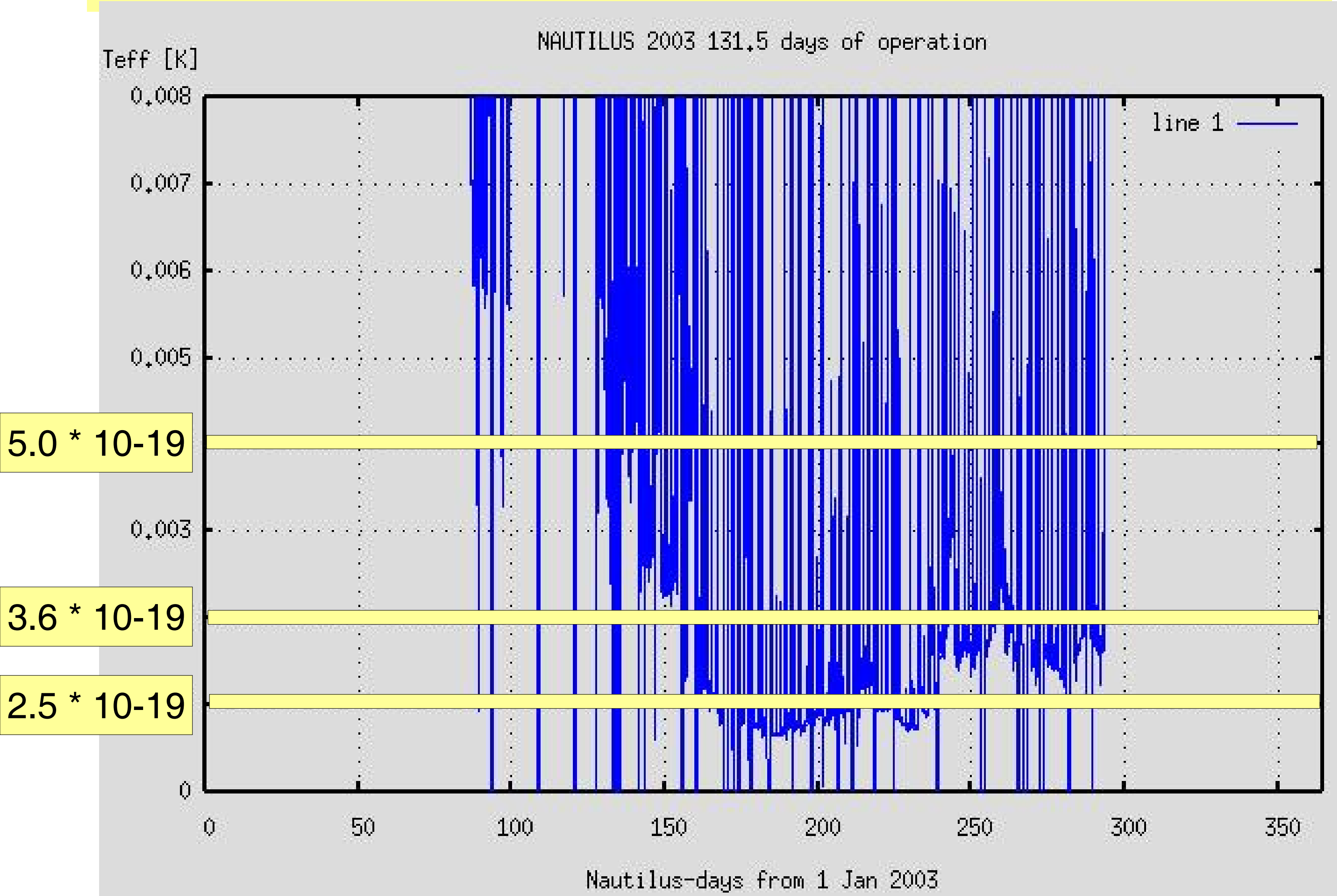
-->the physical quantity with respect to which we are *uncertain* is the g.w. rate on Earth, r, and the model responsible for g.w. emission;
-->we are *rather sure* about b, but not about the number which will actually be observed;
-->what is *certain* is the number nc of coincidences;

MOU TAMA300-ROG

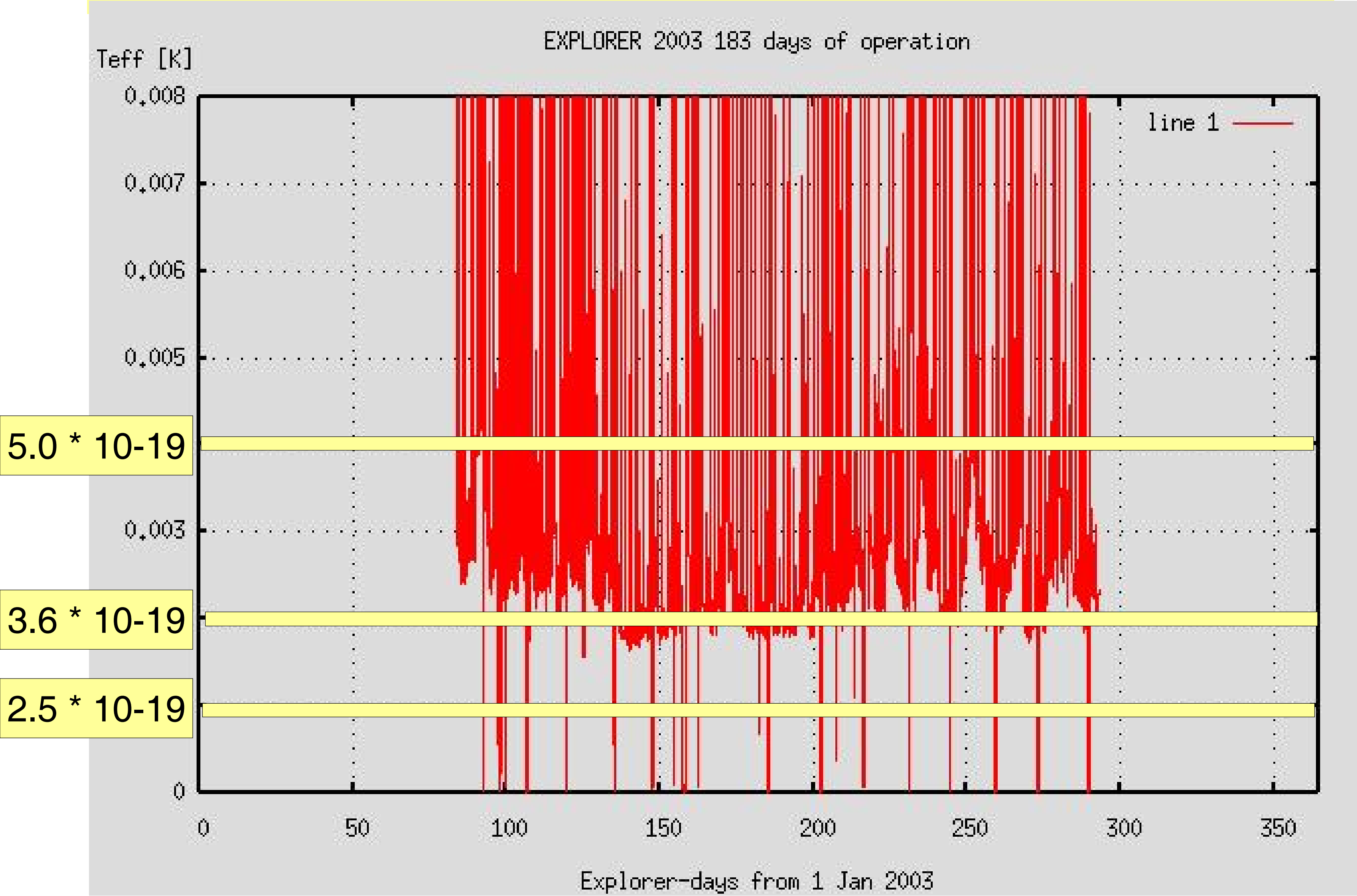
- The TAMA group and the ROG group share the joint goal of observing gravitational radiation as an astrophysical probe.
- This agreement is intended to establish and define the exchange of data collected by the TAMA interferometric detector and the bar detectors Explorer and Nautilus in the year 2001, when these detectors had simultaneous periods of observation.

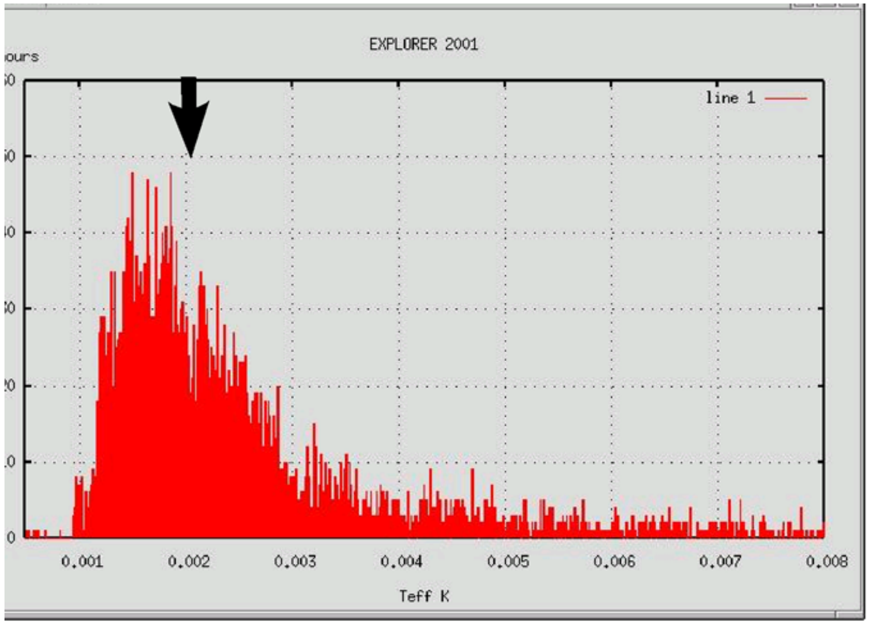
The data exchange covers the time period from August, 1st up to September, 20th

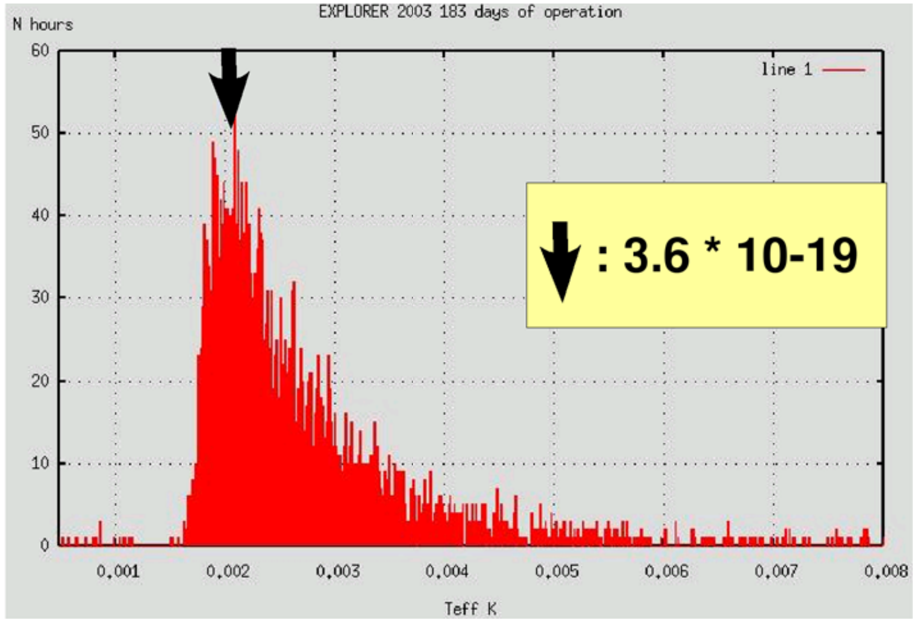
Nautilus 2003 data

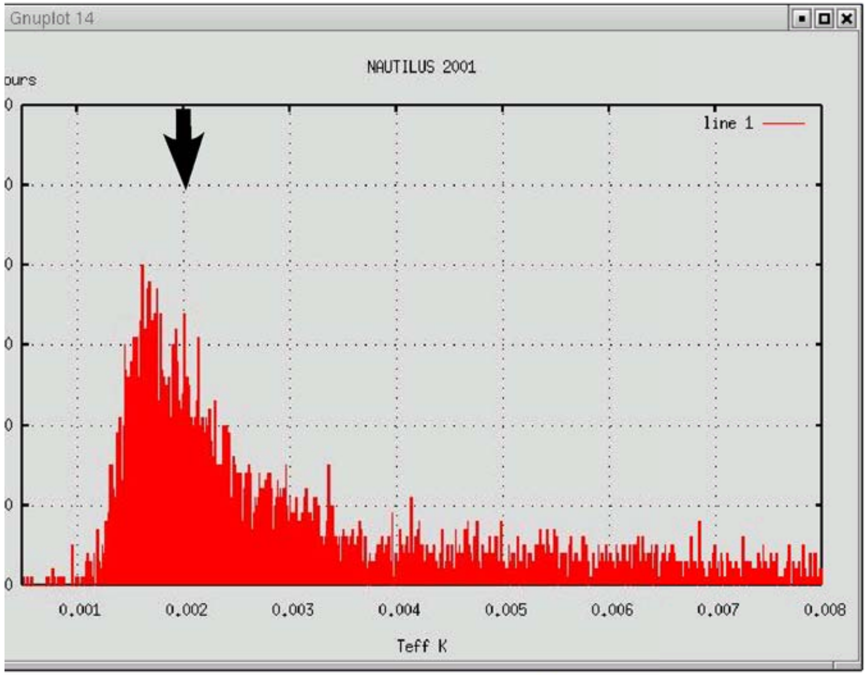


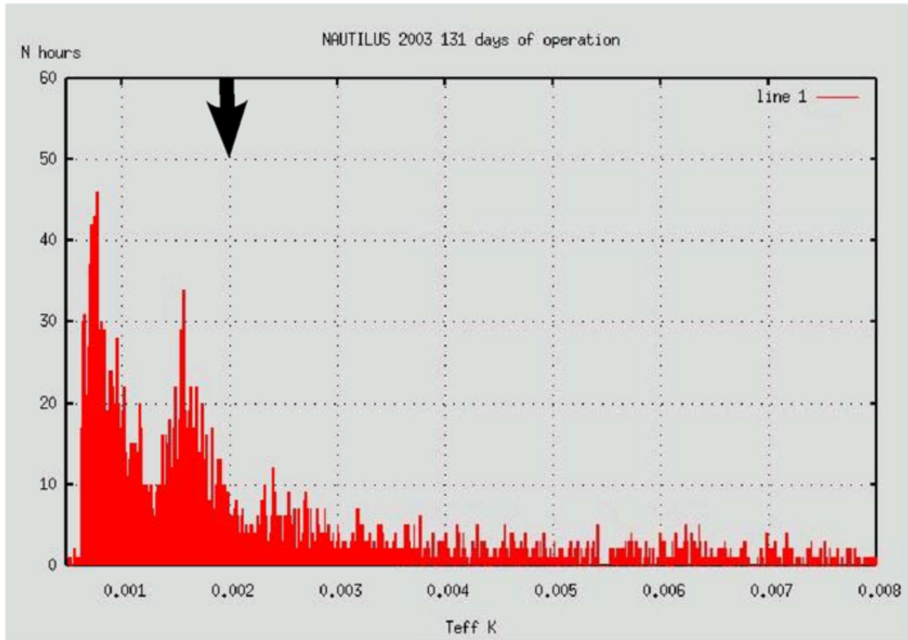
Explorer 2003 data




EXPLORER 2001
line 1
0,001 0,002 0,003 0,004 0,005 0,006 0,007 0,008
Teff K


EXPLORER 2003 183 days of operation
N hours
line 1
: 3.6 * 10-19
0,001 0,002 0,003 0,004 0,005 0,006 0,007 0,008
Teff K

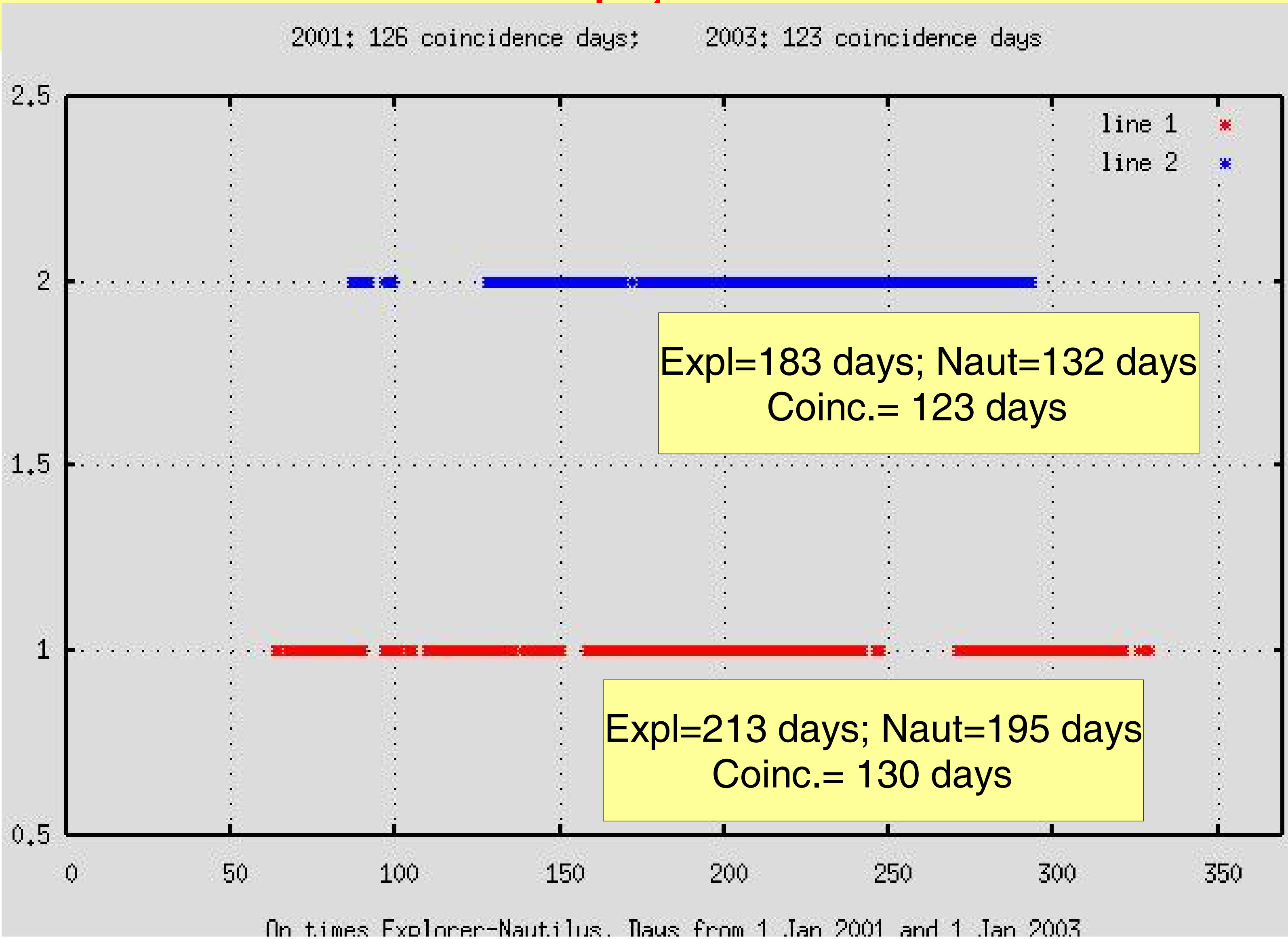

Gnuplot 14
NAUTILUS 2001
line 1
0,001 0,002 0,003 0,004 0,005 0,006 0,007 0,008
Teff K


NAUTILUS 2003 131 days of operation
N hours
line 1
0,001 0,002 0,003 0,004 0,005 0,006 0,007 0,008
Teff K

2001

2003

Explorer and Nautilus 2001-2003 run figure: up to Oct, 20 - we are taking



All-sky search for g.w. from neutron stars:

MOU Rog-A. Krolak and collaborators

Explorer, 2 days of Nov. 1991 strain*10^22/Sqrt(Hz)

921 Hz 921.8

All-sky upper limit for gravitational radiation from spinning neutron stars

P Astone†, D Babusci‡, M Bassan§, K M Borkowski#, E Coccia§, S D'Antonio§, V Fafone‡, G Giordano‡, P Jaranowski£, A Królak$*♯, A Marini‡, Y Minenkov§, I Modena§, G Modestino‡, A Moleti§, G V Pallottino‖, M Pietka£, G Pizzella¶, L Quintieri‡, A Rocchi§, F Ronga‡, R Terenzi[+] and M Visco[+]

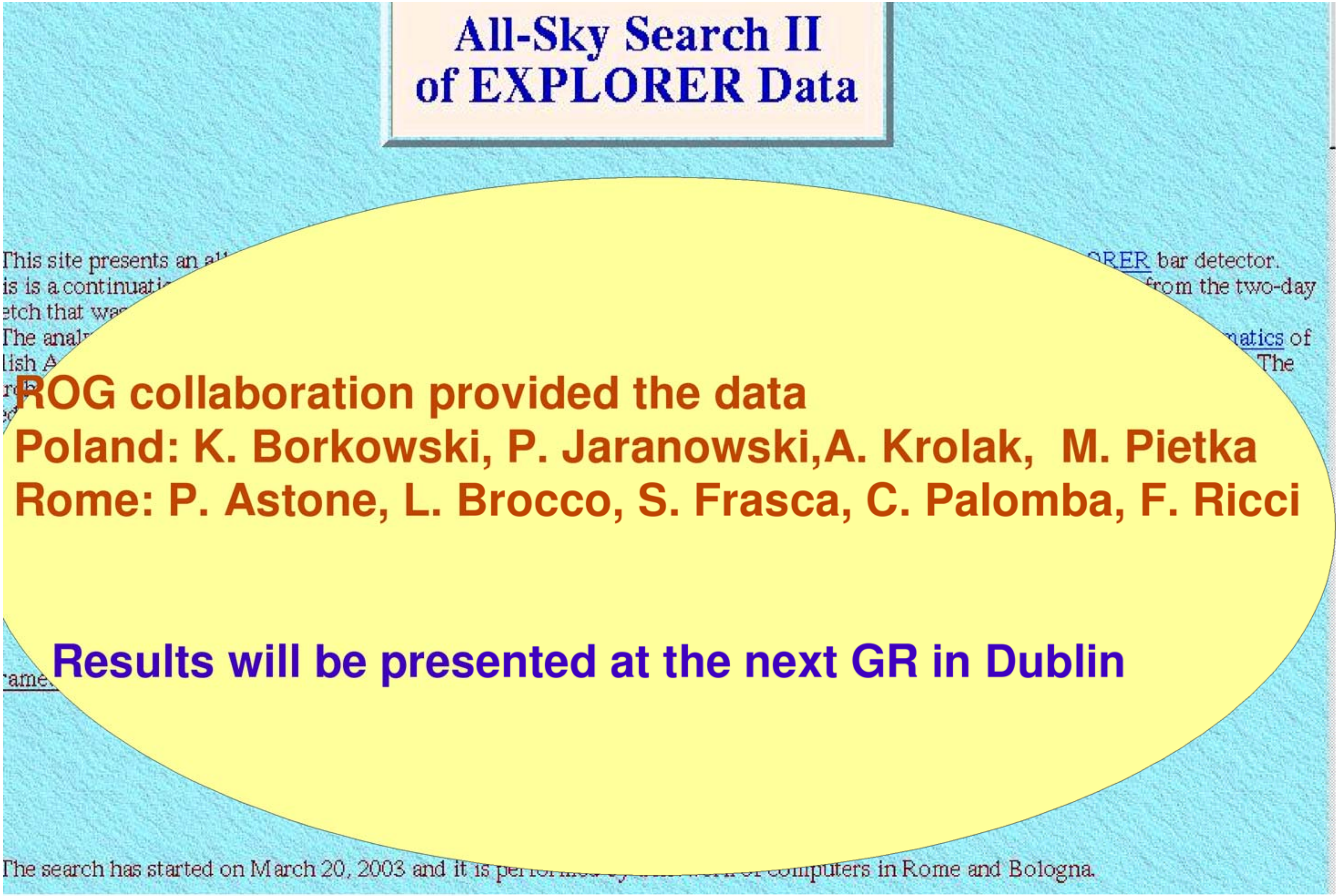
† Istituto Nazionale di Fisica Nucleare INFN, Rome, Italy
‡ Istituto Nazionale di Fisica Nucleare INFN, Frascati, Italy
§ University of Rome "Tor Vergata" and INFN, Rome II, Italy
‖ University of Rome "La Sapienza" and INFN, Rome, Italy
¶ University of Rome "Tor Vergata" and INFN, Frascati, Italy
[+] IFSI-CNR and INFN, Rome
Centre for Astronomy, Nicolaus Copernicus University, Toruń, Poland
£ Institute of Theoretical Physics, University of Białystok, Białystok, Poland
$ Jet Propulsion Laboratory, Pasadena, USA

Abstract. We present results of the all-sky search for gravitational-wave signals from spinning neutron stars in the data of the EXPLORER resonant bar detector. Our data analysis technique was based on the maximum likelihood detection method. We briefly describe the theoretical methods that we used in our search. The main result of our analysis is an upper limit of $\mathbf{2 \times 10^{-23}}$ for the dimensionless amplitude of the continuous gravitational-wave signals coming from any direction in the sky and in the narrow frequency band from 921.00 Hz to 921.76 Hz.

CQG, vol. 20, Sept 2003

All-sky search II and III using Explorer 1991 data

- Thanks to a very good team-work and coordination among different groups we have been able to repeat the overall-sky search over two different stretches of 2-days Explorer data-----> now we have three sets of candidates, which have to be analyzed looking for coincident candidates
- ---->WEB site:



ROG collaboration provided the data

Poland: K. Borkowski, P. Jaranowski, A. Krolak, M. Pietka

Rome: P. Astone, L. Brocco, S. Frasca, C. Palomba, F. Ricci

Results will be presented at the next GR in Dublin

http://www.astro.uni.torun.pl/~kb/AllSky/AllSkyII.html

MOU ROG-VIRGO Rome on the search for continuous signals

Talk by Sergio Frasca

The search method is based on a hierarchical method.

- Short FFT data base
- Construction of Time Frequency maps
- Hough Transform (inchoerent, no phase information is used)
- Candidate Selection
- Coherent search in the selected frequency ranges (Zooming, Doppler correction , FFT…..)
- New iteration

Web site: grwavsf.roma1.infn.it/pss

PSS_astro User Guide

Target of the search:

- All-sky blind searches, over long observation times, using the hierarchical procedure;
- Tests on the efficiencies and computer needs comparing the hierarchical procedure and a fully coherent search.

MOU between the Max Planck Institute for Gravitational Physics (AEI) and the Rome g.w. group (ROG+S. Frasca+A. Krolak):
The purpose of the MOU is to establish and define collaboration for the joint analysis of data taken by the ROG detectors, for the search of continuos g.w.

- The D.B. consists of 17191 Nautilus FFTs (header + data);
- Each FFT has a time duration of 27.96 minutes (number of samples=131072) and data are not interlaced;
- The frequency ranges from 896.45 – 935.5 Hz, and the best sensitivity is around the two resonances, at 907.08 Hz and 922.54 Hz;
- Vetoes: 9252 FFTs survided, which means an observation time of 179.66 days;
- We plan to do coherent analyses pointing at the Galactic Plane, and to Globular Clusters in Milky Way;

Tue, 25 Jun 2002 11:48:49 GMT (66kb)

ch for correlation between GRB's detected by BeppoSAX and gravitational wave detectors 'LORER and NAUTILUS

's: P. Astone, M. Bassan, P. Bonifazi, P. Carelli, G. Castellano, E. Coccia, C. Cosmelli, G. D'Agostini, S. D'Antonio, V. Fafone, G. Federici, F. Frontera, C. zi, A. Marini, Y. Minenkov, I. Modena, G. Modestino, A. Moleti, E. Montanari, G. V. Pallottino, G. Pizzella, L. Quintieri, A. Rocchi, F. Ronga, A. Rocchi, R. i, G. Torrioli, M. Visco

ents: 14 pages, 7 figures. Latex file, compiled with cernik.cls (provided in the package)

Data obtained during five months of 2001 with the gravitational wave (GW) detectors EXPLORER and NAUTILUS have been studied in correlation with the gamma ray burst data (GRB) obtained with the BeppoSAX satellite. During this period BeppoSAX was the only GRB satellite in operation, while EXPLORER and NAUTILUS were the only GW detectors in operation.
No correlation between the GW data and the GRB bursts has been found. The analysis, done over 47 GRB's, excludes the presence of signals of amplitude h >=1.2 * 10^{-18}, with 95 % probability, if we allow a time delay between GW bursts and GRB within +-400 s, and h >= 6.5 * 10^{-19}, if the time delay is within +- 5 s. The result is also provided in form of scaled likelihood for unbiased interpretation and easier use for further analysis.

-->Data analysis
-->statistical inference procedures

PRD 66 102002 (2002)


EXPLORER