Operation of 300m Fabry-Perot-Michelson Interferometer in TAMA

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LSC meeting March 3rd - 5th, 1999

LIGO-G990022-17-M

What's New

- We operated the 300m Fabry-Perot-Michelson interferometer over 5 hours without unlocking.

- The transmitted light through the 10m MC has been introduced into the Fabry-Perot-Michelson interferometer,

  and

  resonates with the arm cavities.

only optical connection

not yet servo connection

Contents

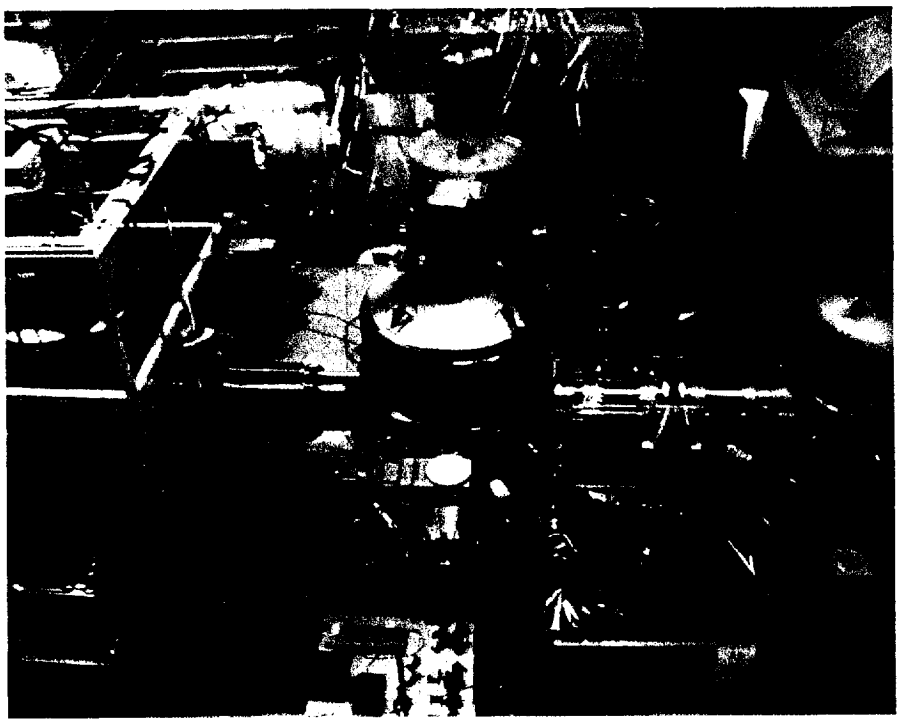
TAMA300 - Gravitational Wave Detector -

TAMA300 is an interferometeric gravitational wave detector with 300m baseline arm cavities

The site for TAMA300

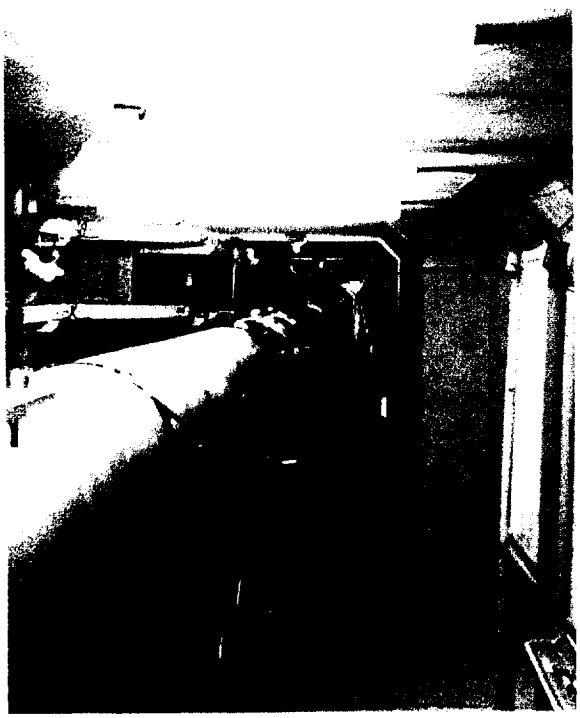
in the campus of
NAO,Mitaka, Tokyo

TAMA300 - Gravitational Wave Detector -

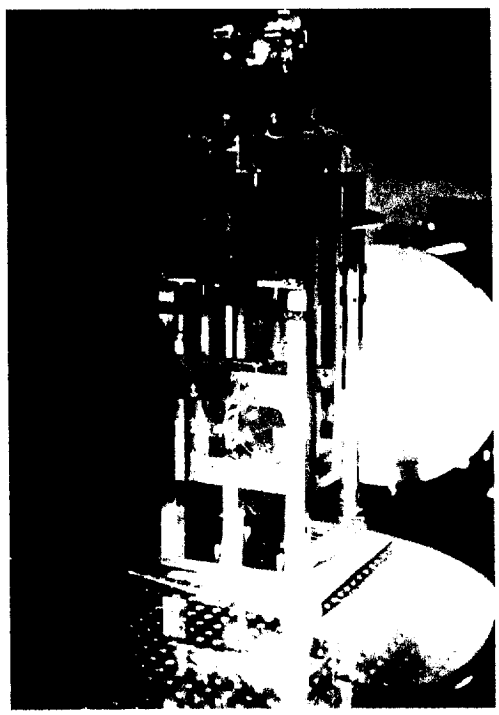


center room

300m beam pipe



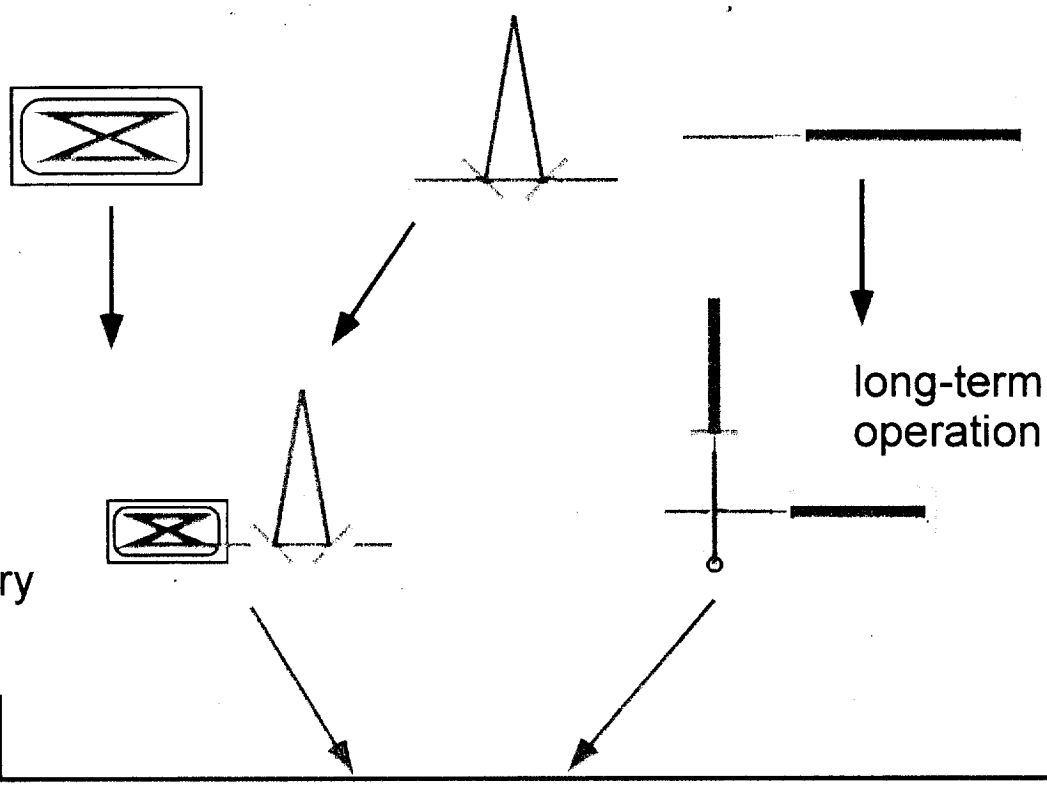
Suspension



double pendulumn

eddy-current damping

roadmap of TAMA300



long-term
operation

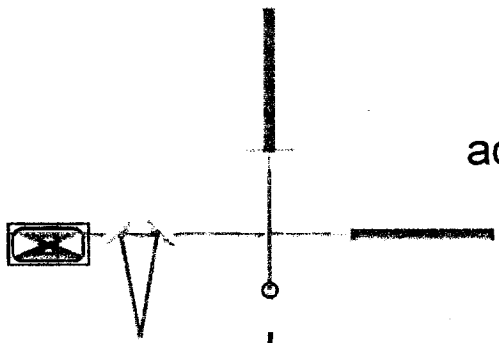
98 May
- '99 February

NOW !

'99 March
- '99 July

operation

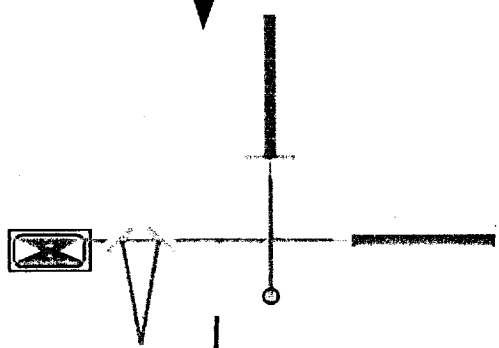
achieve design sensitivity
5×10^{-19} m/rtHz



'99 August

Data taking I

99 September -



'00 March

Data taking II

Overview of current status

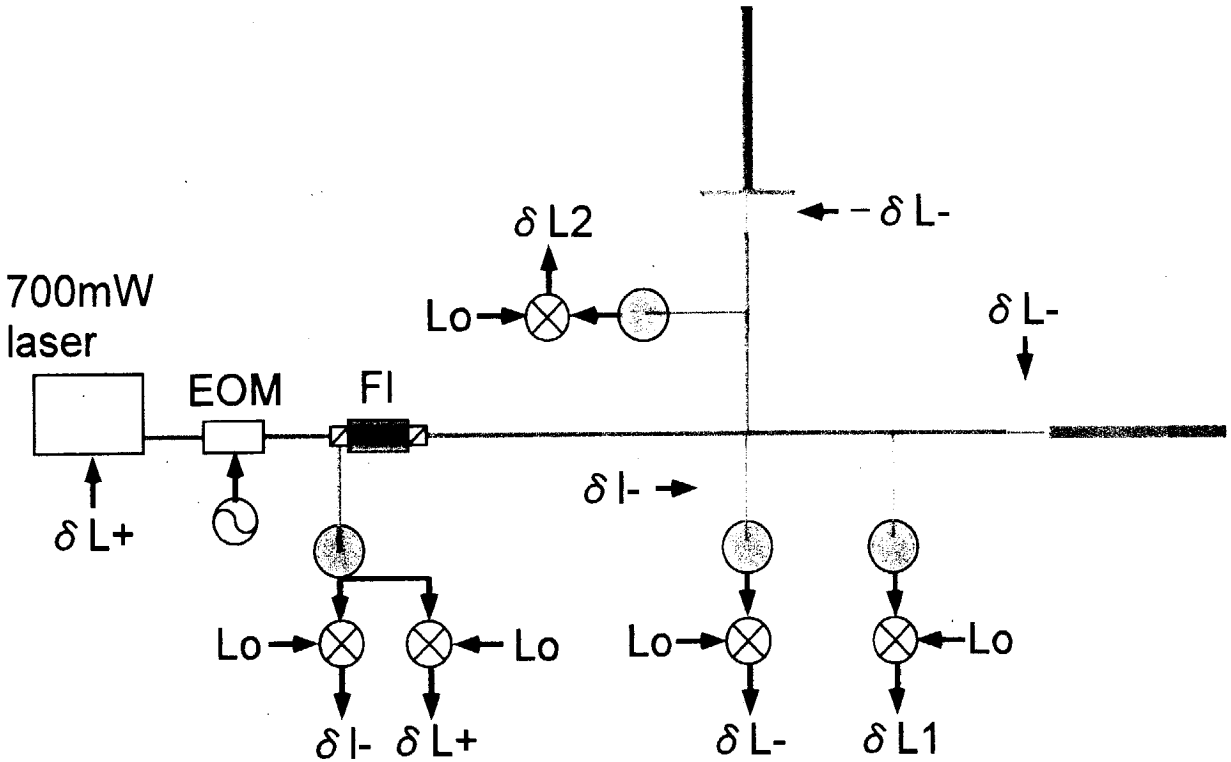
Fabry-Perot-Michelson interferometer

- FPMI : LSC and ASC locked
- long-term operation : over 5 hours without unlocking.
- the frequency noise and the noise caused by the alignment control system limit the sensitivity.

10W laser and 10m mode cleaner

- The transmitted light power : 3W
- The frequency noise : 2 X 10^{-4} Hz/rtHz

Operation of TAMA300 - length control -



δ L+ : DC − 50 kHz

δ L− : DC − 800 Hz

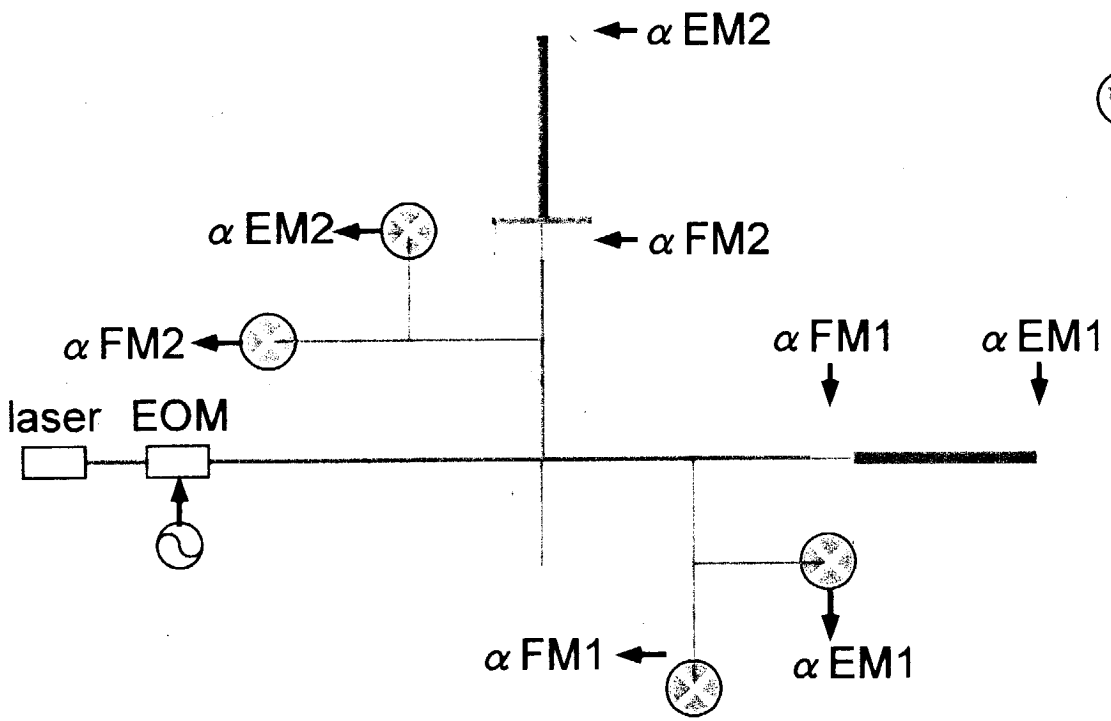
δ I− : DC − 20 Hz

light source : 700mW Nd:YAG laser

signal extraction: frontal modulation

δ L1, δ L2 are used for lock acquisition

Operation of TAMA300 - alignment control -



Wave front sensor

Guoy phase telescope

Two Fabry-Perot cavities are controled indipendently.

Lock aquisition (1)

For lock acuisition

δL1, δL2 at pick off ports → Electrically +/− → "electrical" δL+/ δL−

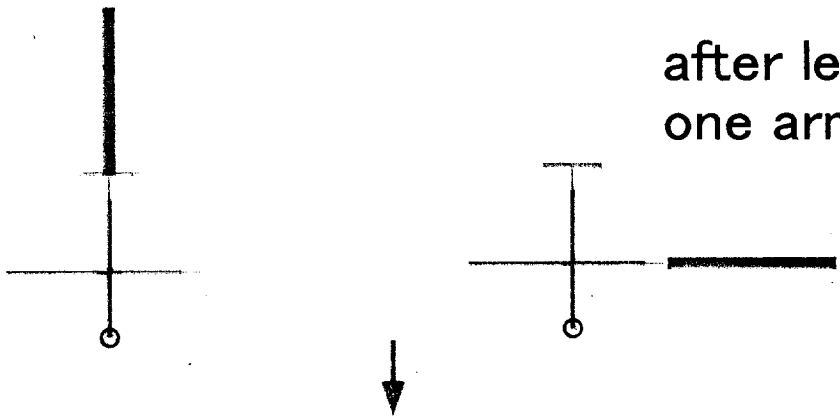
After locked

change to the "real" δL+/ δL− signal

extracted at symmetric/anti−symmetric port

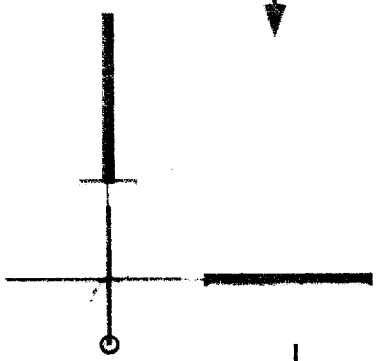
Lock aquisition (2)

"electrical" δ L−/ δ L+, δ I− are fed back



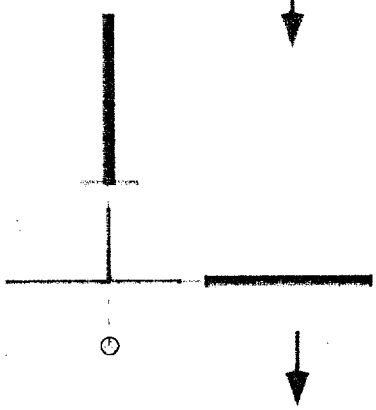
after less than 1 sec.
one arm locks

alignment control switch on (manually)



after several tens sec.
the other arm locks

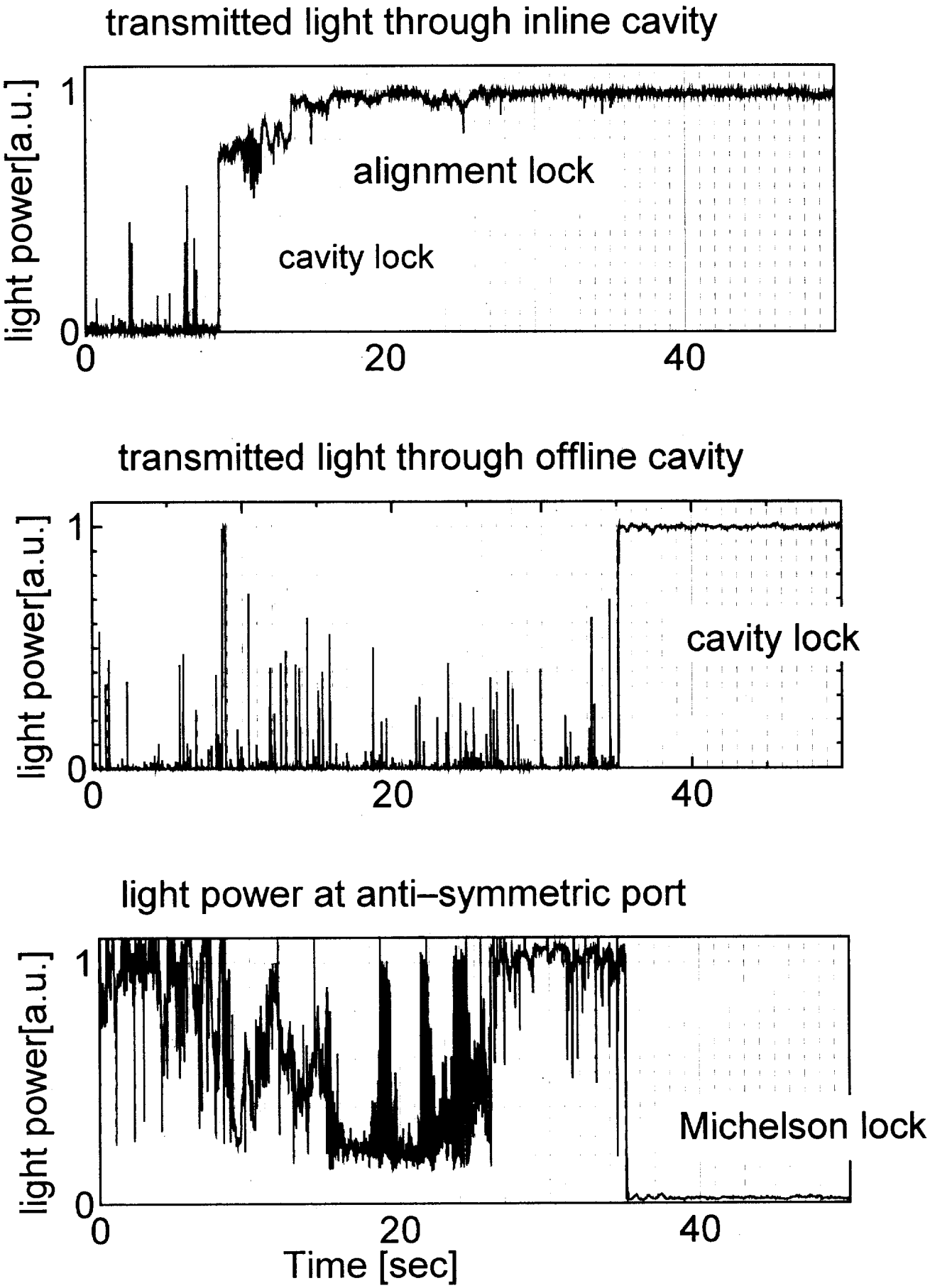
alignment control switch on (manually)



after less than 1 sec.
Michelson fringe locks

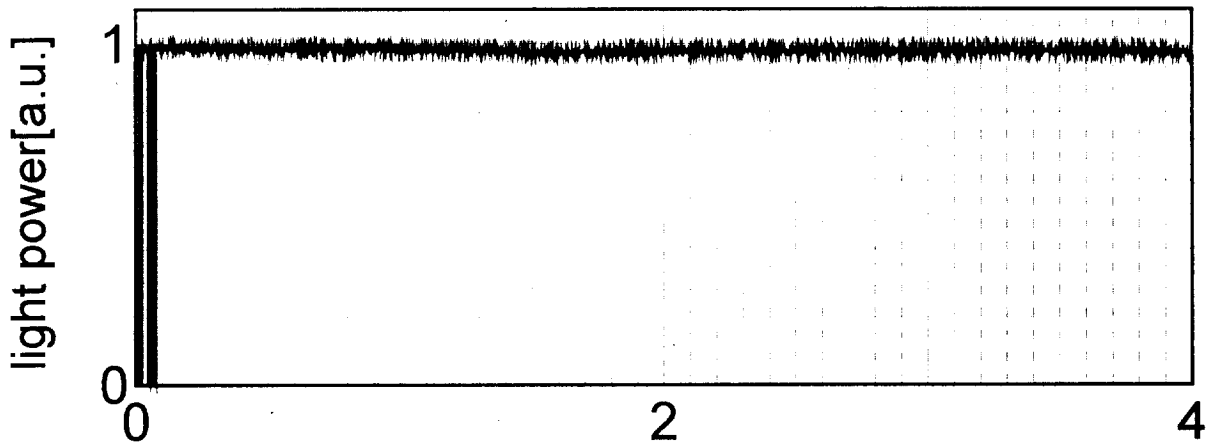
change to the "real" δ L−/ δ L+

lock–acquisition (3)

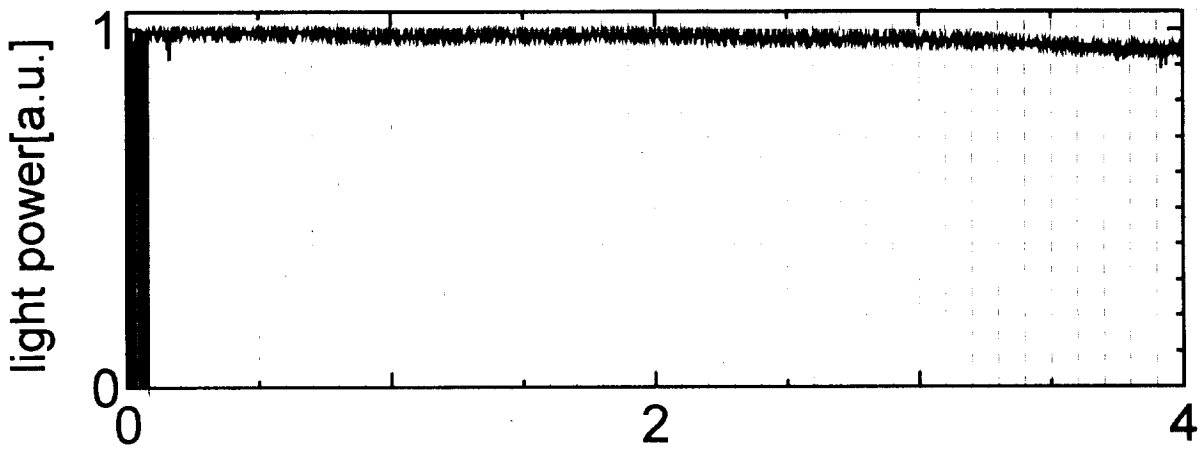


Long–term operation

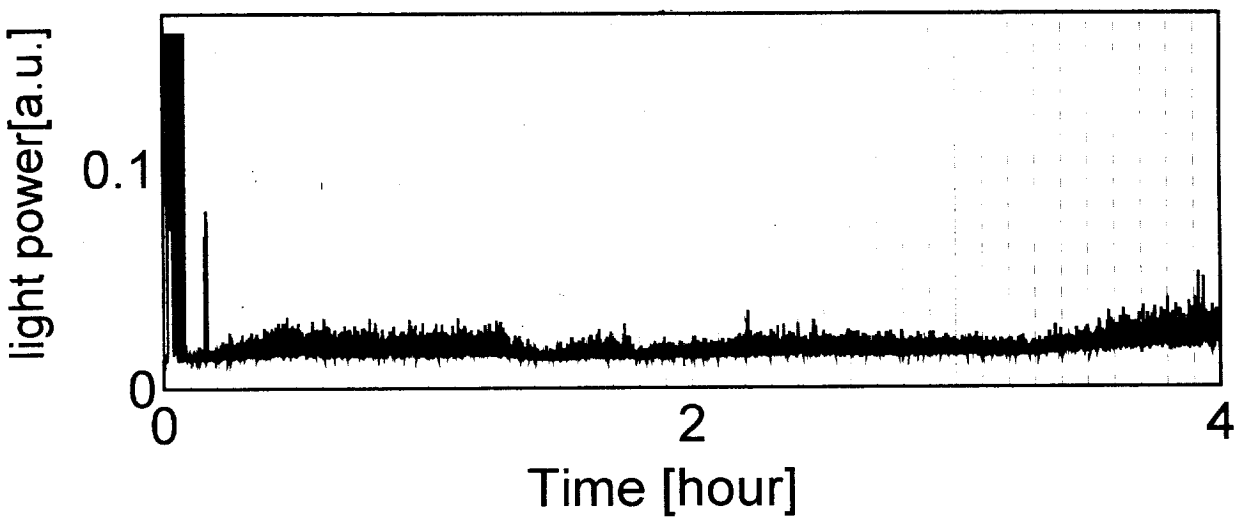
transmitted light power through the off line cavity



transmitted light power through the inline cavity



light power at anti–symmetric port

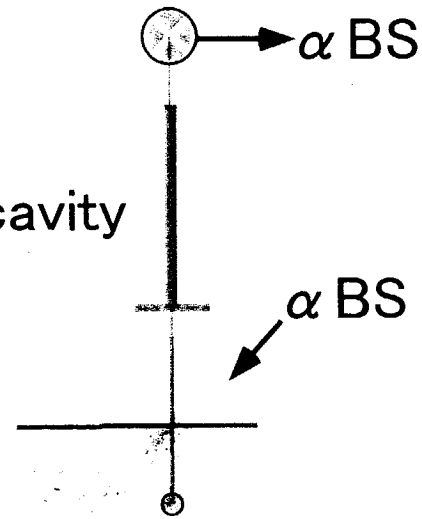


Long-term operation of TAMA300

first, 1 hour at best → Reseach →

Reasons for unlocking → Drifts are out of control range.

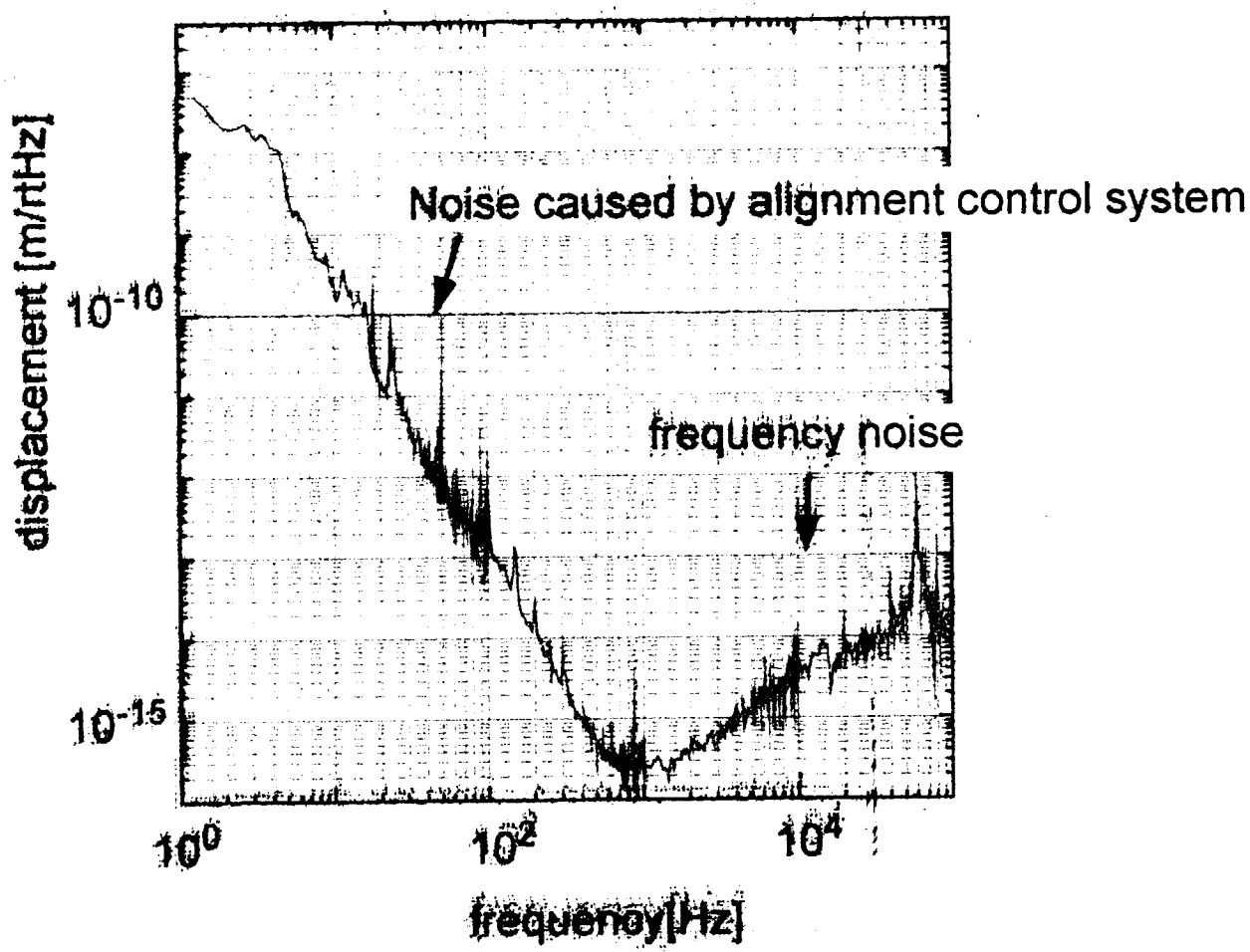
Drifts		Remedies
δ L+	→	feedback to the thermal control
BS's orientation	→	BS orientation control



With these remedies,
we operated over 5 hours (typically 3–5 hours).

Other drifts are still main reasons for unlocking.
Remedies against other drifts will be done,
then, we will operate the interferometer longer.

Current Sensitivity of TAMA300



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Next Steps

From March to July '99

- connect the FPMI to 10m MC and 10W laser
  in terms of servo system
- more stable operation (more than 1 day)
- achieve our design sensitivity : 5×10^{-19} m/rtHz
  We must reduce...
  - the noise caused by the alignment control system,
  - frequency noise,
  - and so on.

August '99

- Data taking