Report on the Observation Run of TAMA300 in the Spring of 2003

National Astronomical Observatory of Japan

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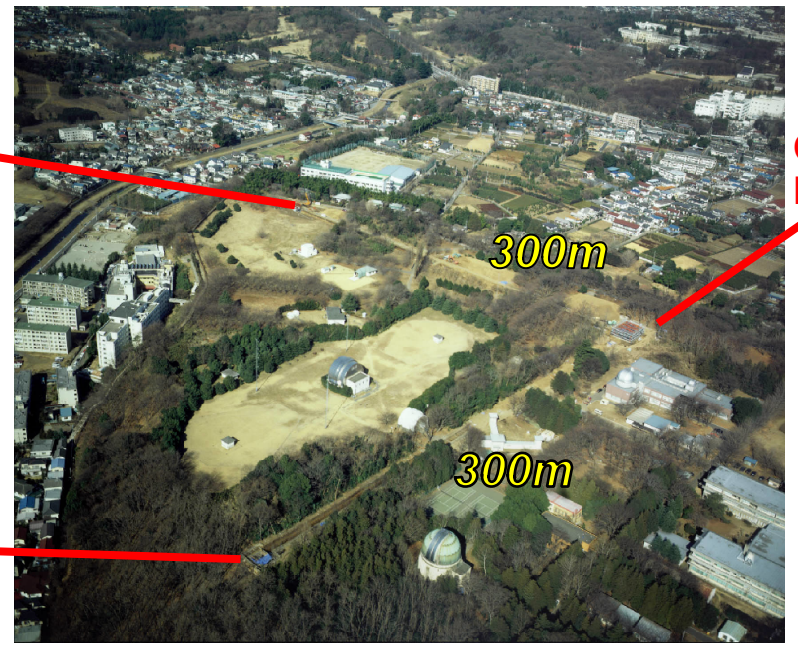
ICRC2003

TAMA300

- ***Laser interferometric GW detector***
  - ***with arm length of 300m***

Site: National Astronomical Observatory of Japan,
(Mitaka, Tokyo)



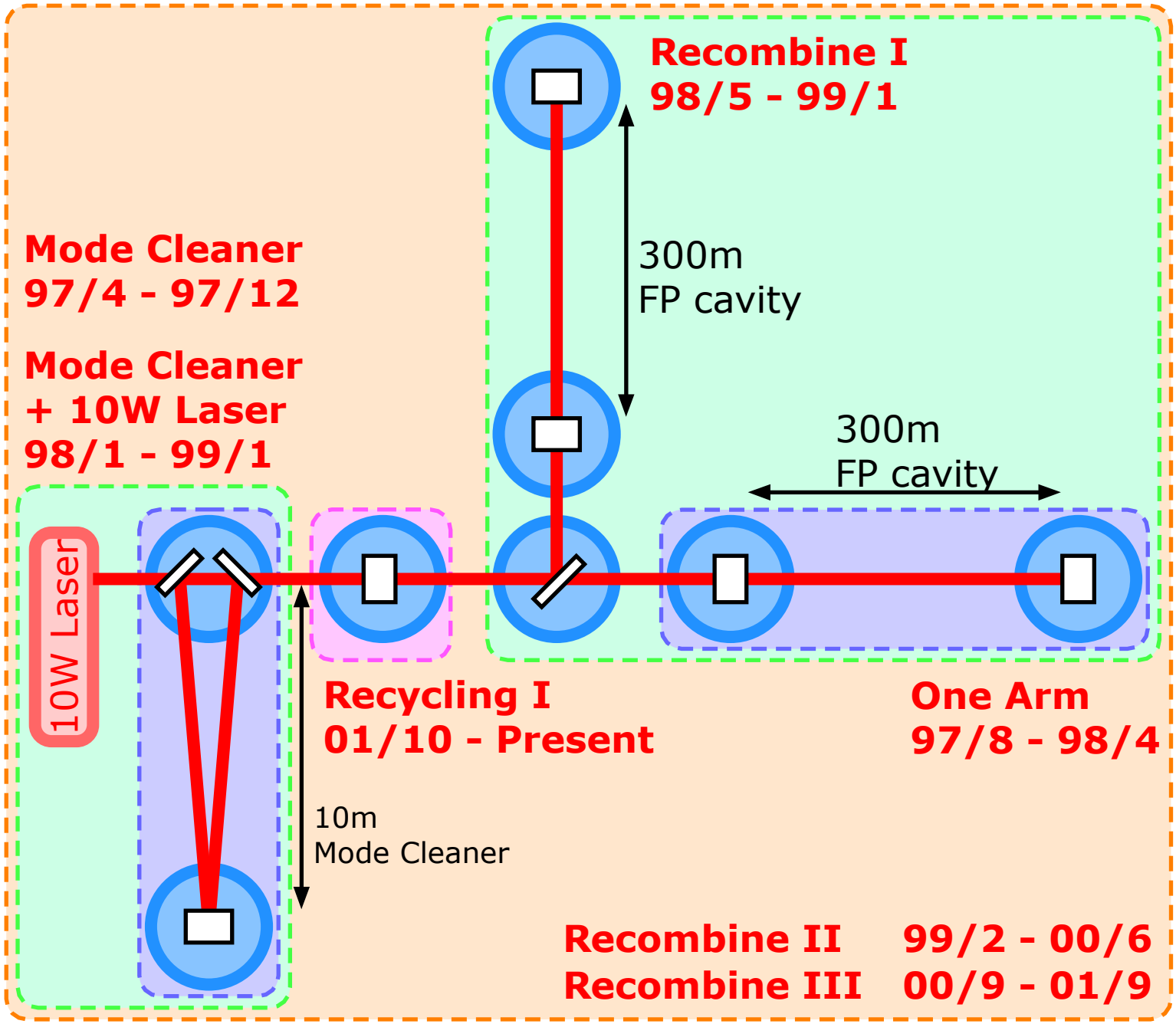
- ***Objects of the project***

To develop a detector capable
- to detect GW events
- in nearby galaxies.

To establish techniques
for a future km-class interferometer

Designed sensitivity ~ $h_{RMS} = 3 \times 10^{-21}$ @300Hz (BW300Hz)

History of TAMA development



1995	Project started	
1996	Facility construction completed	
1997	Vacuum system completed	
1999/8	Data Taking 1	11h
1999/9	Data Taking 2	31h
2000/4	Data Taking 3	13h
2000/8, 9	Data Taking 4	167h
2001/3	Data Taking 5	111h
2001/8,9	Data Taking 6	1038h
2001/10-	Recycling experiment	
2002/8-9	Data Taking 7	25h
2003/2-4	Data Taking 8	1158h

Data taking (DT) runs in past

6 observations without power recycling
2 observations with power recycling

[Without power recycling]

DT1	1999 Aug. 6~ 7	1 night	11 hours	
DT2	1999 Sep. 17~20	3 nights	31 hours	
DT3	2000 Apr. 20~23	3 nights	13 hours	
DT4	2000 Aug. 21~Sep. 4	13 nights	167 hours	
DT5	2001 Mar. 2~ 8	6 days	111 hours	***Coincidence***
DT6	2001 Aug. 1~Sep. 20	50 days	1038 hours	**LISM(20m)**

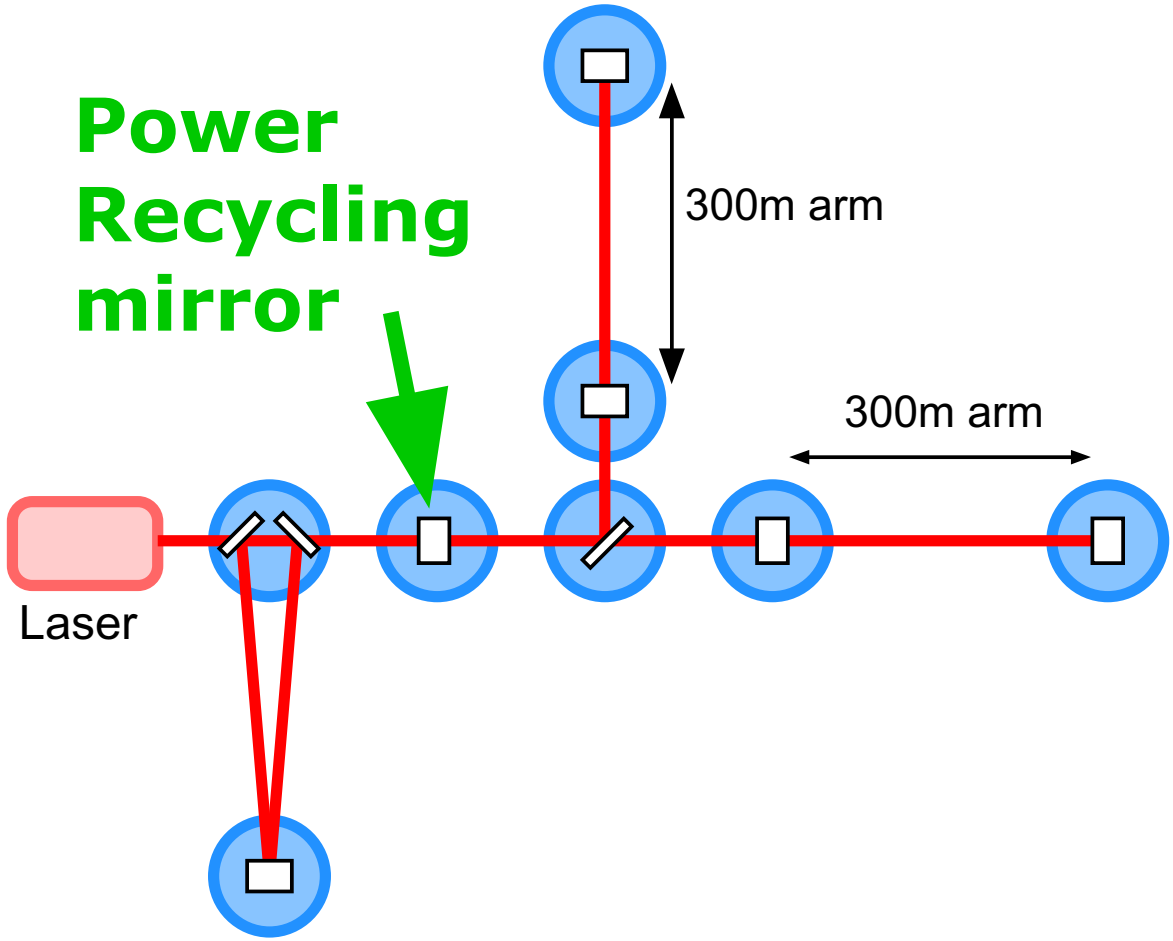
[With power recycling]

DT7	2002 Aug, 31~Sep. 2	1 day	25 hours	**LIGO & GEO**
DT8	2003 Feb. 14~Apr. 15	59 days	1158 hours	**LIGO**

Data Taking 8

- **DT8 ~ 2 months run (2003/2/14~4/15)**
  - First full-time joint observation with LIGO
  - ☐ (called S2 in LIGO)
  - First long-term observation with power recycling

Power recycling of TAMA300 (2001/10~Present)



Key points on the long-term obs.

- **The detector must operate:**
  - **~ as sensitive as possible** => Dr. Sato's talk
    - Improved sensitivity by power recycling
      - Power recycling gain of 4.5
      - Best sensitivity: 2.7×10^{-21} [/$Hz^{1/2}$] (@1.5kHz)
  - **~ as long as possible**
    - Improved stability from the previous run
      - Accumulated data: 1158 hours (segment longer than 10min)
      - Duty cycle: 81.3%
      - Longest lock: 20.5 hours
  - **~ as easy as possible**
    - Automatic lock acquisition system using a master controller
    - and digitally-switched analog circuits

Maintaining the stability

- **Seismic activity**

  The TAMA site is in the middle of a city area

  - roughtly 10 times worse than those of the other large IFOs
  - 100~1000 times worse than in Kamioka-mine

  => Test mass alignment control / Active vibration isolator

- **Drift compensation**

  Optical path length / mirror alignment drift

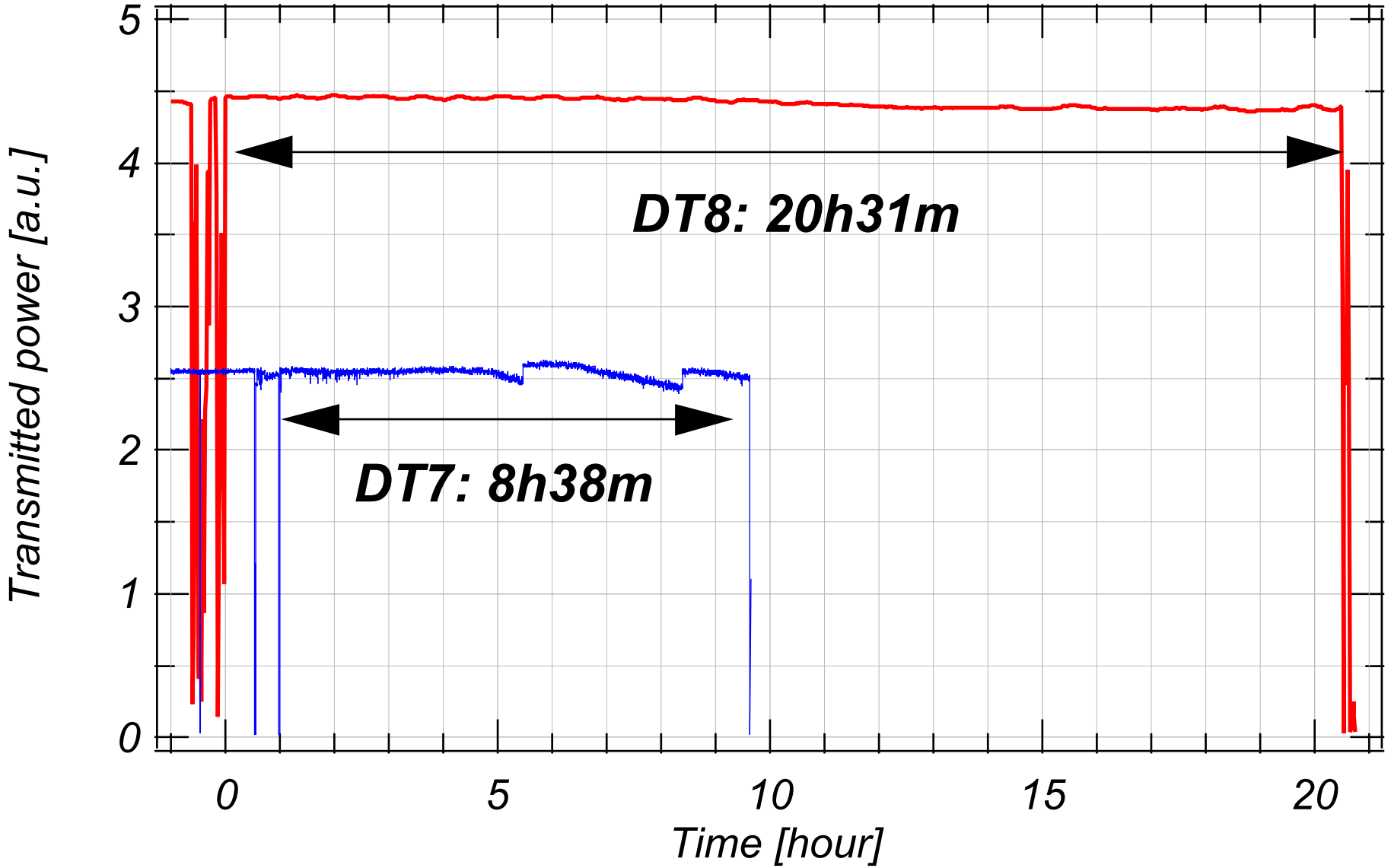
  - Temperature drift
  - Ground deformation by ground water pumping

  => Length drift compensation

  - **Recycling mirror alignment**
  - **Optical axis control**

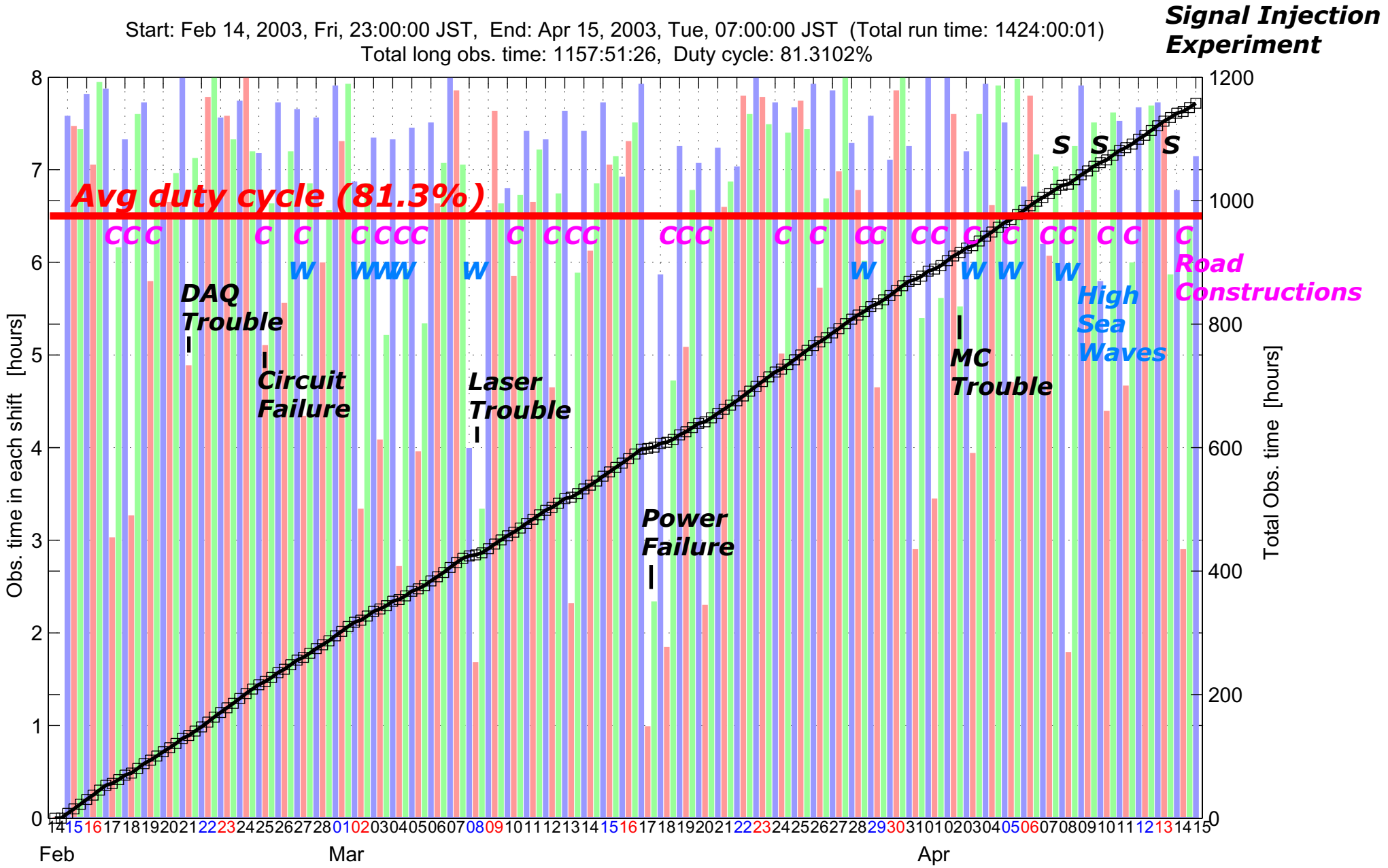
Improved long-term stability

Longest lock stretch in the observations



Duty cycle

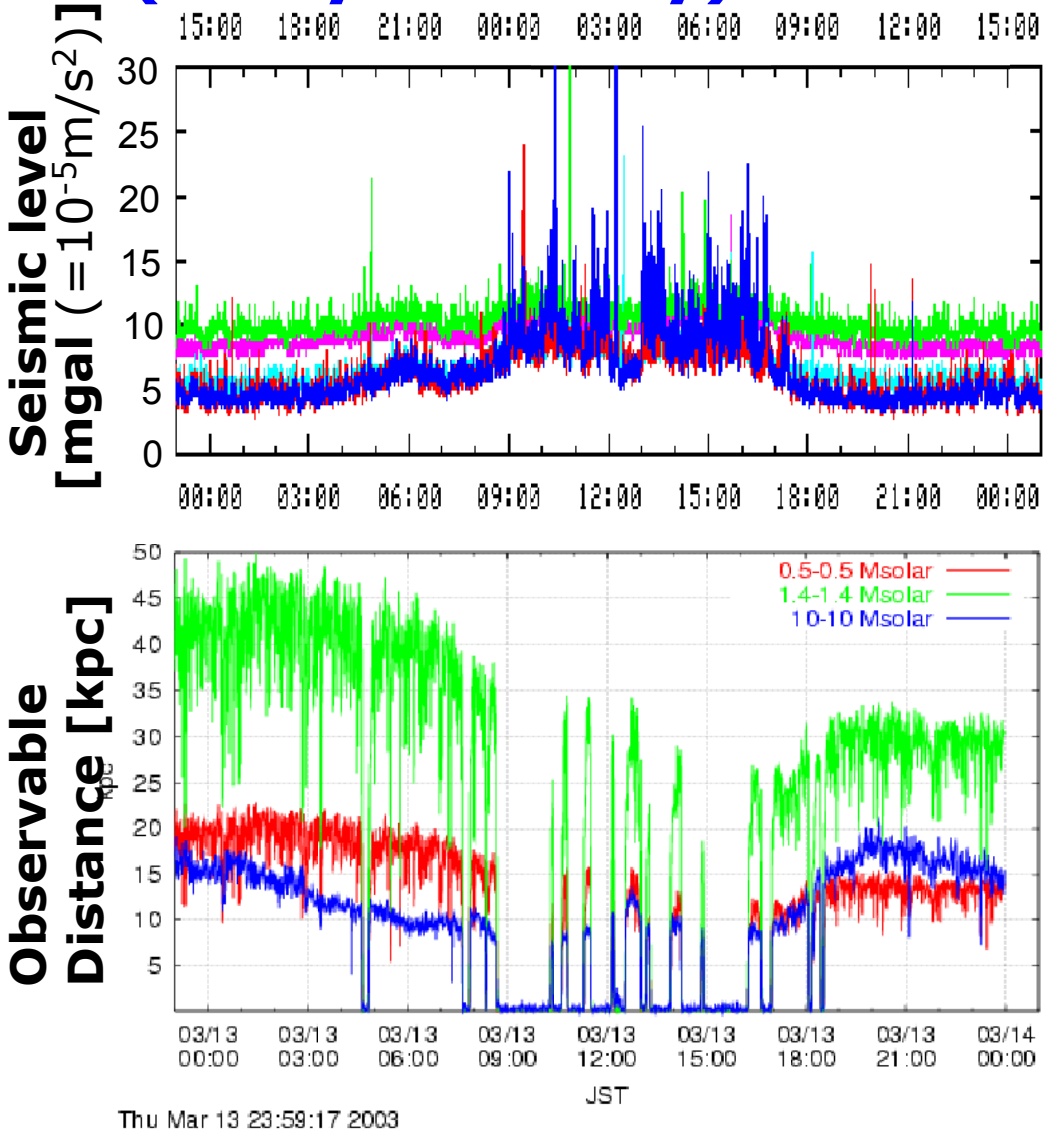
- **1157h51m (out of 1424 hours, duty cycle 81.3%)**



DT8 ~ Disturbance by construction

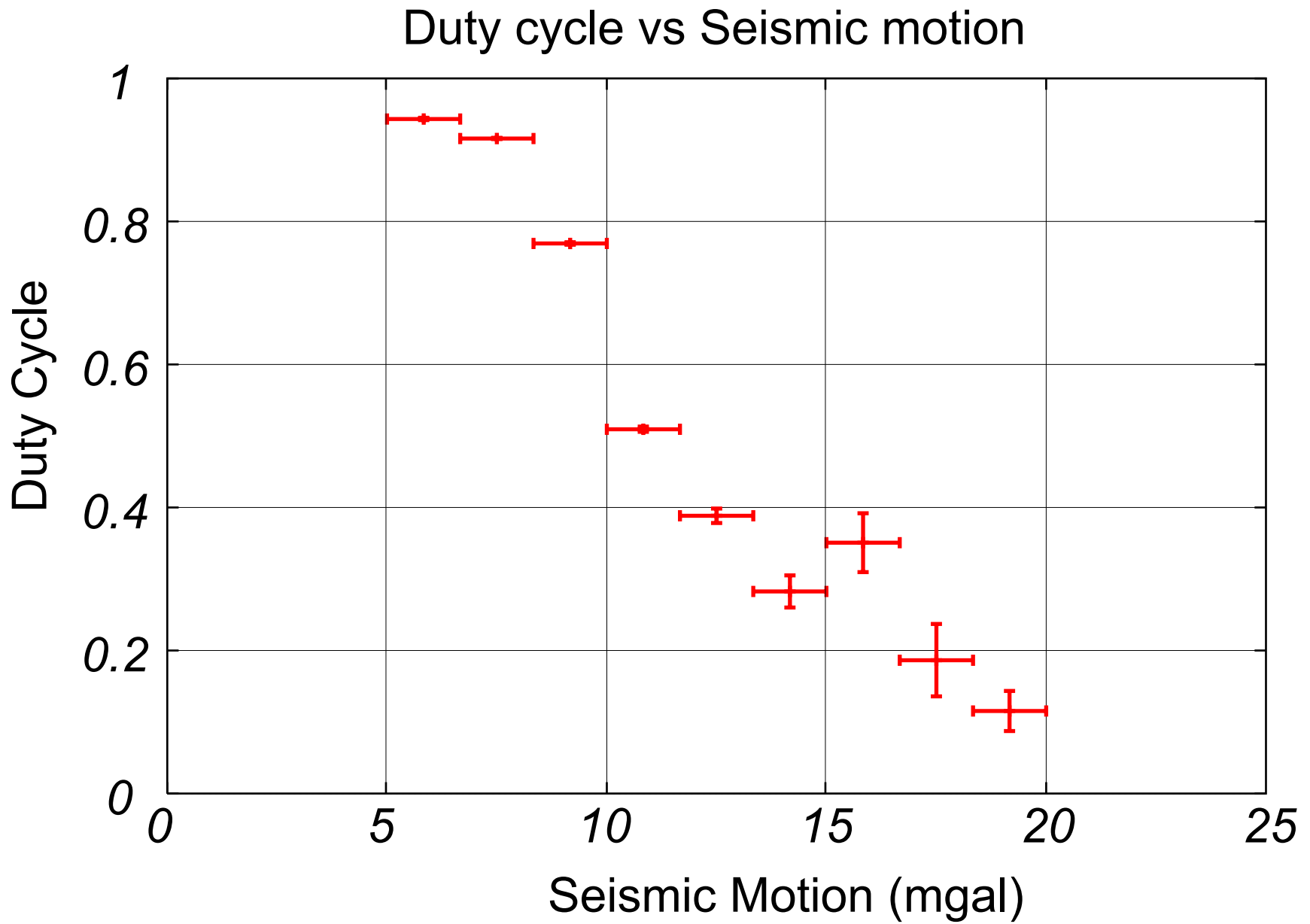
13rd May, 2003 (Thu)

(Noisy weekday)

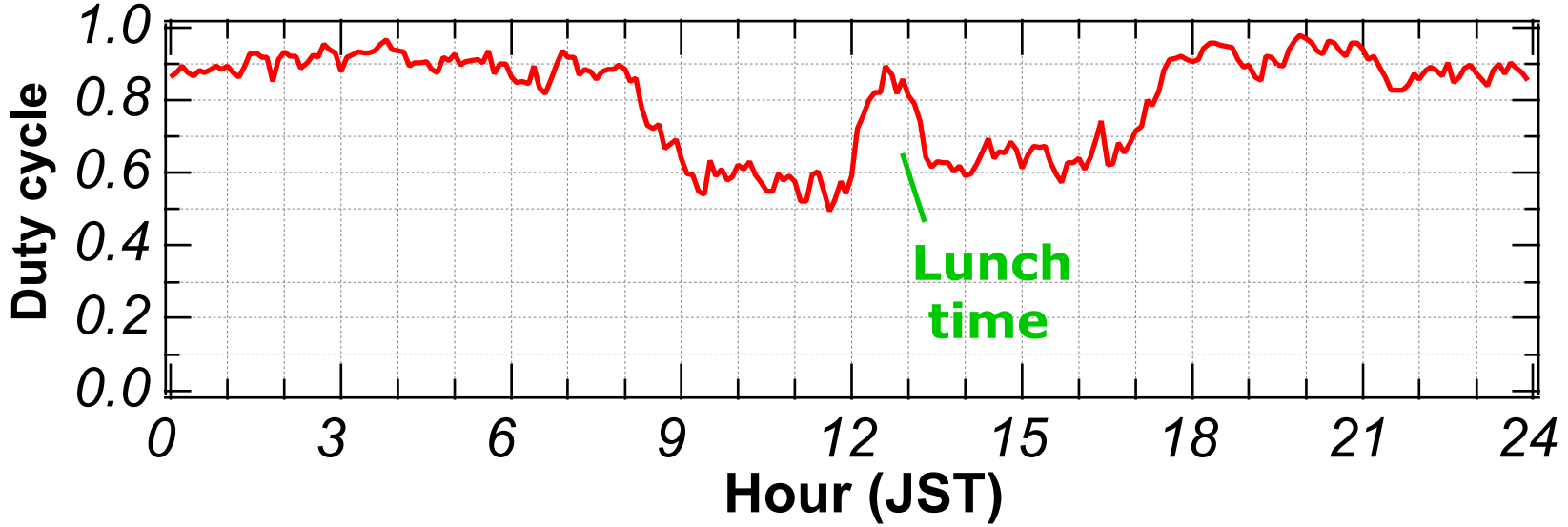


Construction works near the site

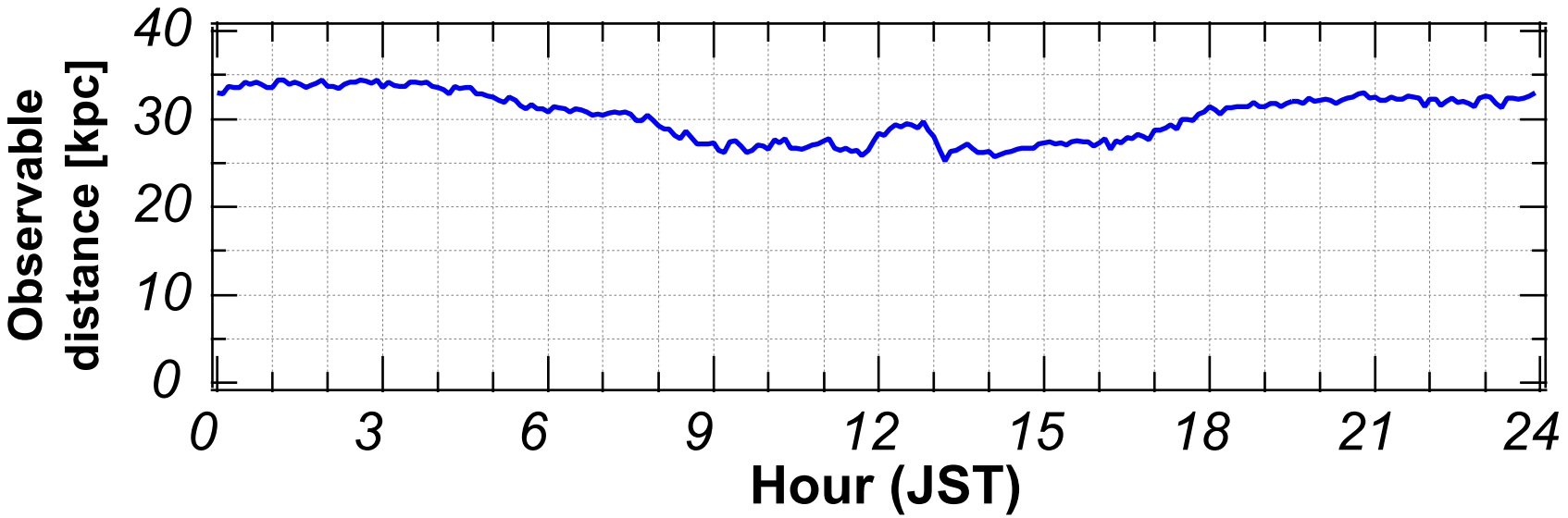
Seismic level vs Duty cycle



Daily trend of duty cycle/sensitivity



With construction ~ IFO didn't work => Duty cycle about 60%



Even without construction ~ sensitivity reduction of about 20%

Summary

- ***Gravitational wave detector TAMA300***

  A Michelson interferometer with 300-m cavity arms located at Mitaka in Tokyo, Japan.

- ***Data Taking 8***

  Full-time joint observation with LIGO

  First long-term operation with power recycling

  With improved sensitivity by power recycling

  $h = 2.7 \times 10^{-21}$ /sqrtHz @1.5kHz

  1158 hours of 1424 hours => duty cycle 81.3%

  Main cause of the dead time: construction works neaby

Future Plan

- ***Data Analysis of the DT8 data***

  In progress. Preliminary result for NS inspiral search

- ***Investigation on the noise issues***

- ***Further automation of the observation***

  To operate the interferometer

  with less operators

- ***Upgrade of the vibration isolation***

  Seismic attenuation system (SAS)

  Isolation from low frequency (~0.1Hz)

  R&D by Caltech, U-Tokyo and U of Pisa

  Installation in early 2005

- ***More power in the arms***

  High gain (G=10) recycling

SAS (Univ. of Tokyo)