S1G-GRP/cavity position measurement by WPM and Laser Displacement sensor

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0bjective and history of this study

- Objective: to understand the GRP/Cavity position movement due to the cooling in the present cryostat.

- History: From the early stage of the STF cryomodule development, we have tried the measurement of the GRP/cavity movement during the cool down by using WPM, however, we could not succeeded to obtain the reliable data.

  In 2009, we have performed the comparative measurement of GRP movement in a STF-cryomodule by three kinds of methods, using laser displacement sensor (LDS), optical telescope, and WPM.

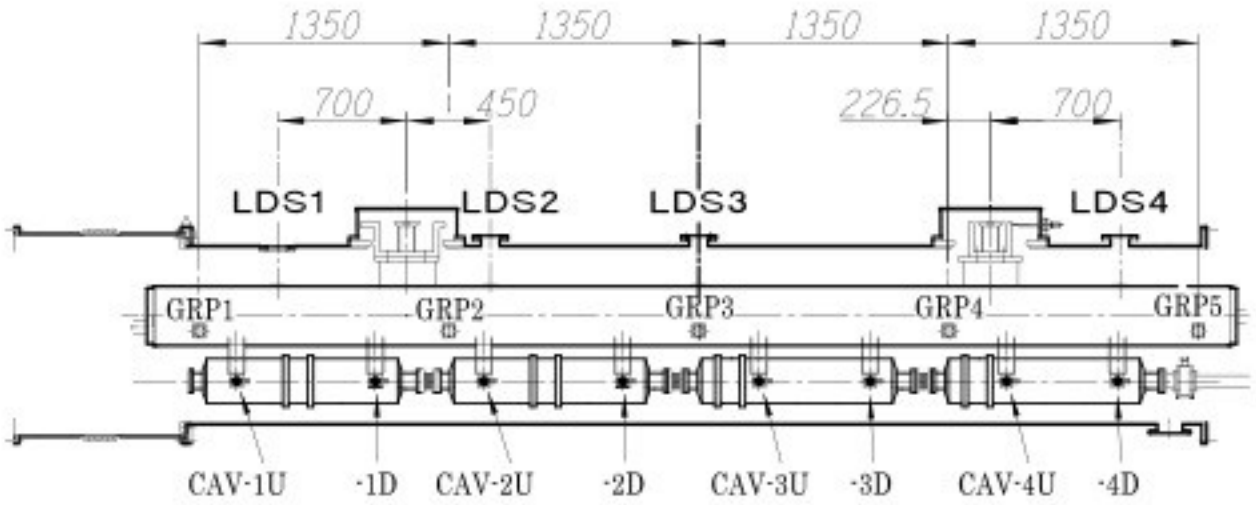
  In S1G experiment (2010 and 2011), we have measured the GRP/Cavity movement by using LDS and WPM.

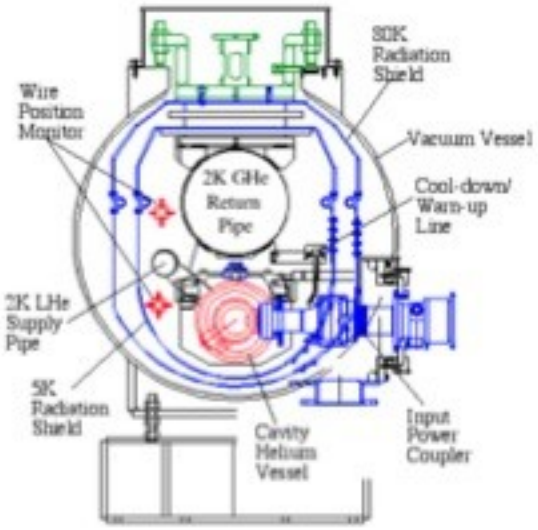
Measurement and set up for S1G experiment

Laser displacement sensors:

- four sensors; LDS1, LDS2, LDS3 and LDS4
- distance change (ΔY) between GRP and Vac vessel
- sampling time; 1 sec

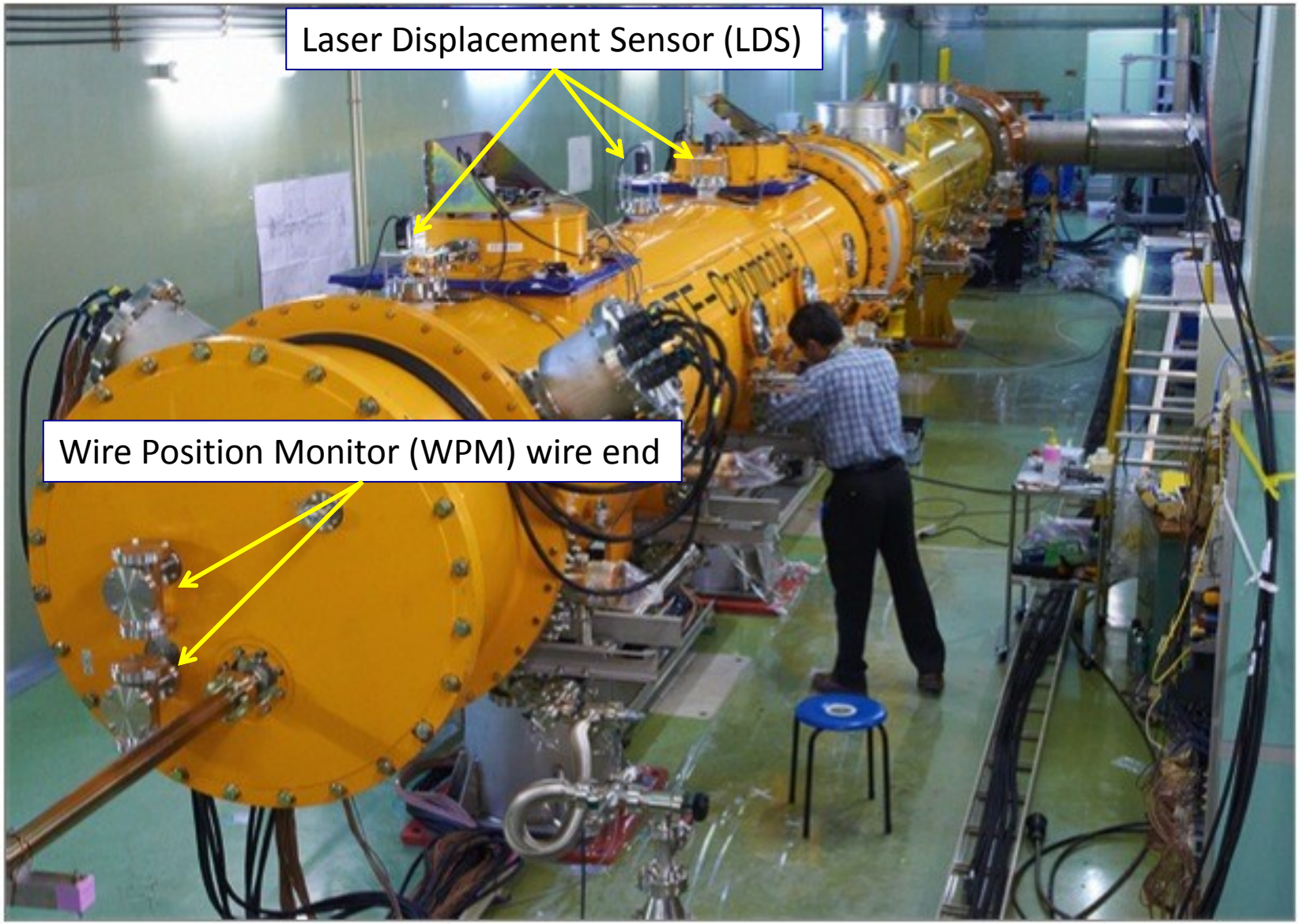
Wire Position Monitors: 5 monitors for GRP, ΔX and ΔY
8 monitors for four cavities, ΔX and ΔY



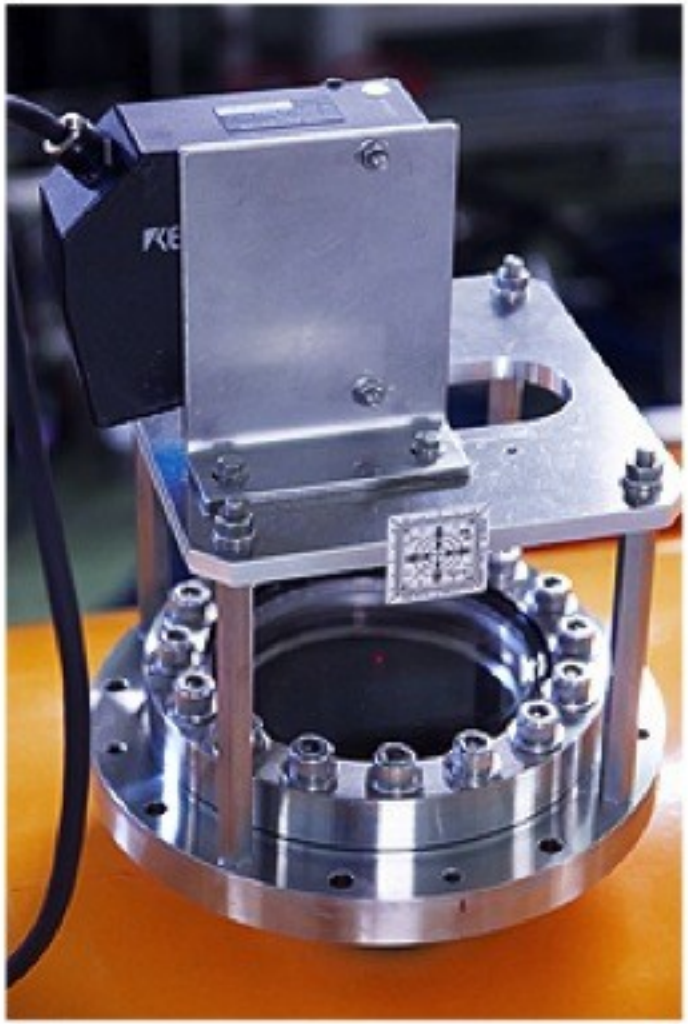


8 temperature monitors on GRP: front, center, rear part
top, bottom top, bottom top, bottom

S1G cryomodule



Laser displacement sensor

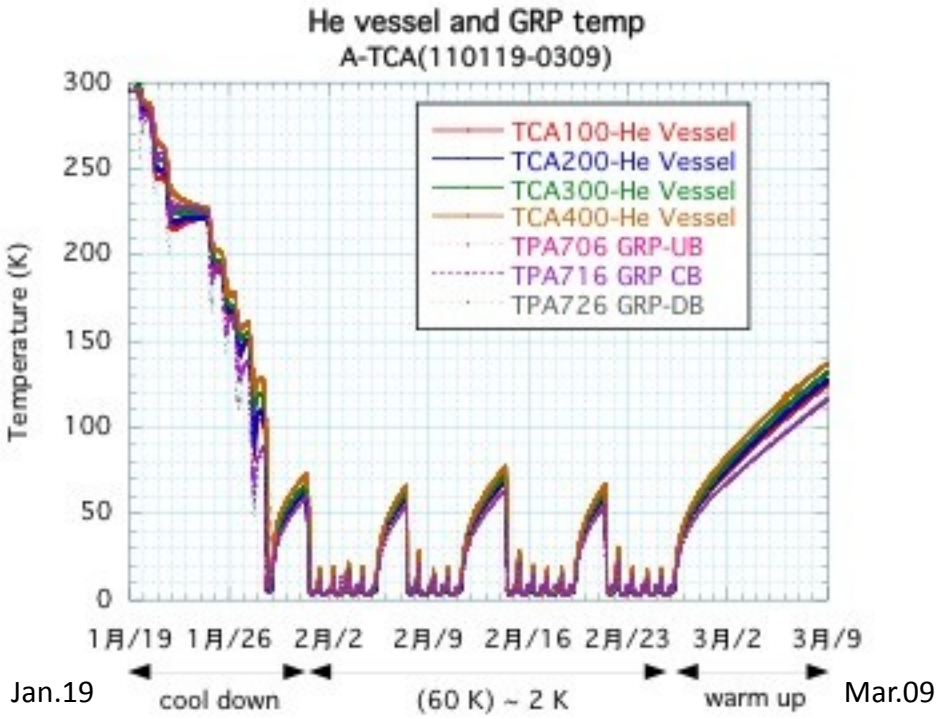


Keyence LK-G series laser displacement sensor specification

measuring range:	400 ± 100 mm
resolution:	2 μm
linearity:	± 0.05 % of F.S.
spot dia.:	approx. 290 μm

Cooling method

- Cooling down from RT to ~150 K : GHe (~80K), mass flow rate = ~1.5 g/sec
- Cooling down from 150 K to 2 K : LHe
  - at 4.2 K mass flow rate = ~0.35 g/s
  - at 2 K mass flow rate = ~0.4 g/s
- Feature : cooling system was operated only in the daytime (intermittent cooling)

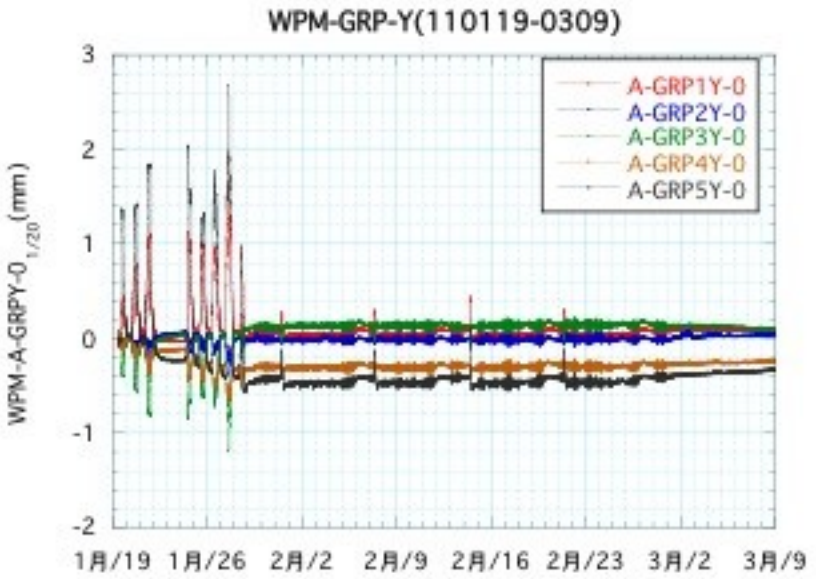


Two weeks: Cool-down

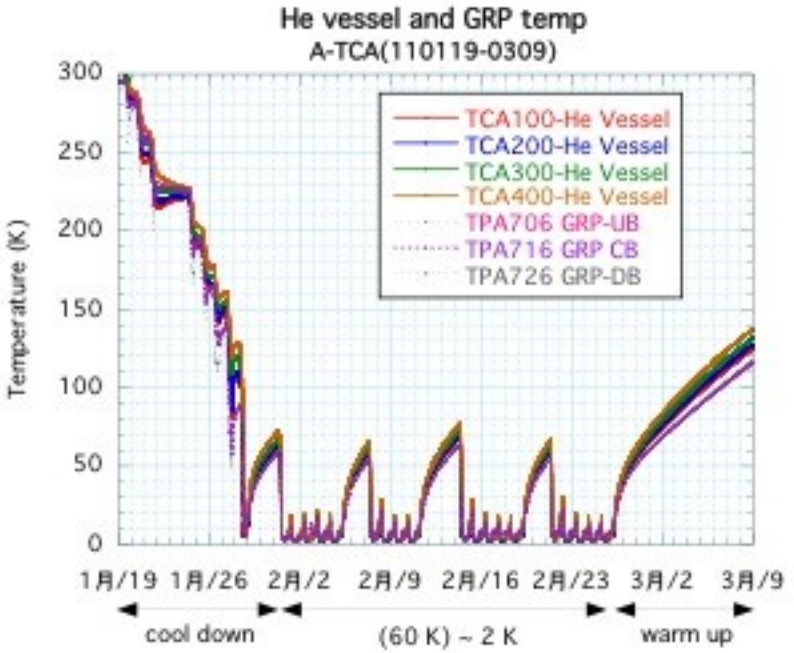
4 weeks: DRFS study

WPM-GRP-Y signal and temperature during the experimental period in 2011

WPM-GRP-Y signal



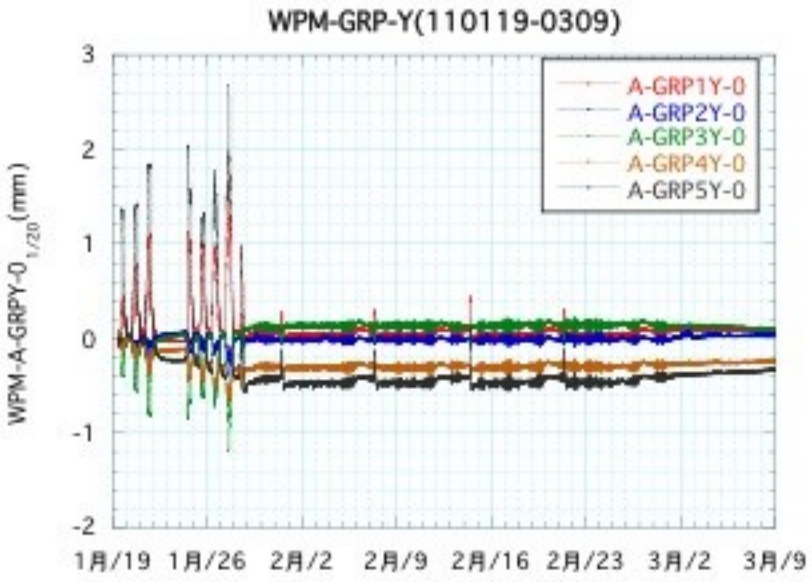
He vessel and GRP temp



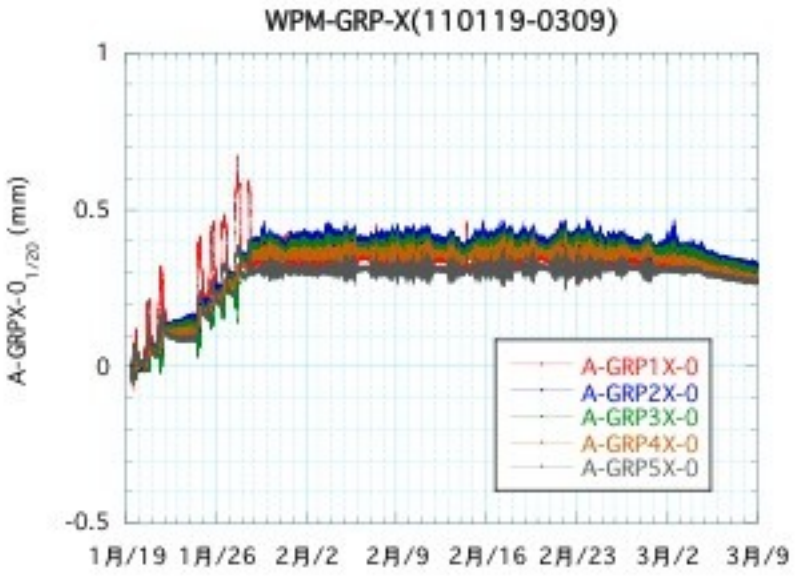
During the cool down period, large movement of GRP-Y is observed.
But the amount of displacement at 2 K obtained from WPM-GRP-Y is not consistent with the data of LD and/or the calculation (ΔY = - 0.22 mm).

WPM-GRP-Y and -GRP-X signal during whole experimental period in 2011

WPM-GRP-Y signal



WPM-GRP-X signal



The behavior of GRP-X during whole period seems to be reasonable, however, the amount of displacement at 2 K is much smaller than the expected value (0.62 mm).

A-GRP1X ? (signal was very unstable)

The displacement of GRP-Y at 2 K is very hard to understand.

During cool down period (Jan 19 ~Jan 28)

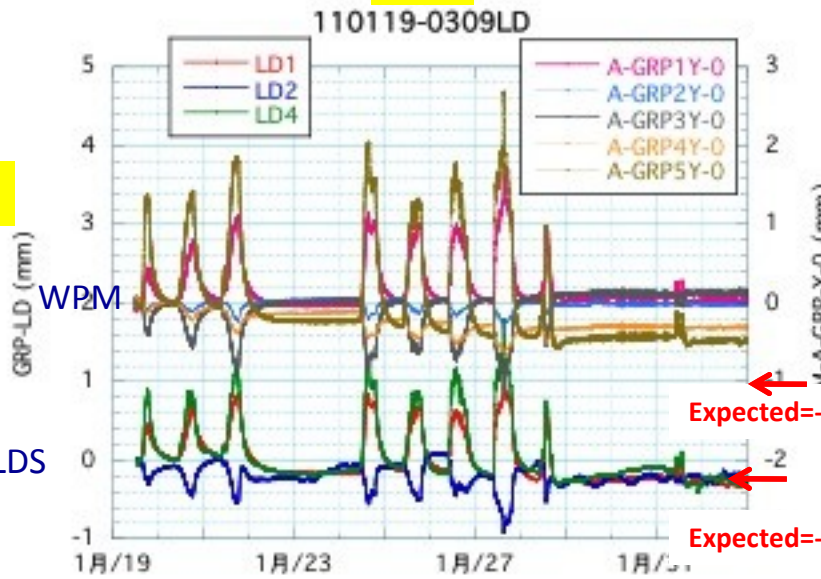
GRP

Cavities

Y

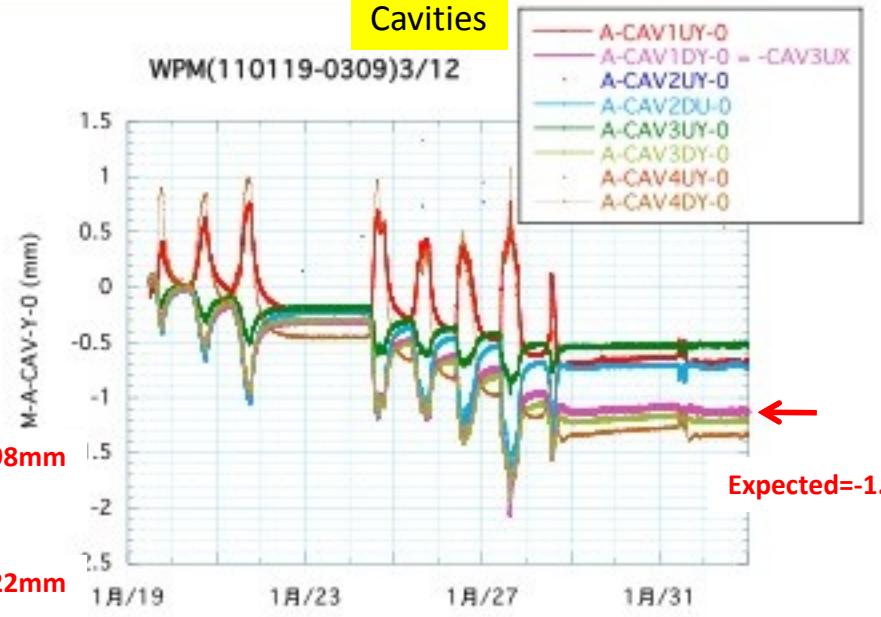
WPM

LDS



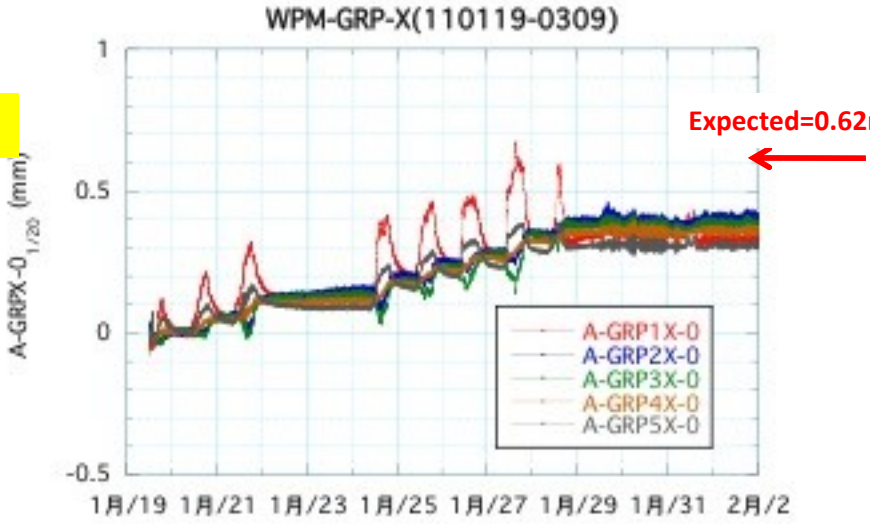
Expected=-0.98mm

Expected=-0.22mm

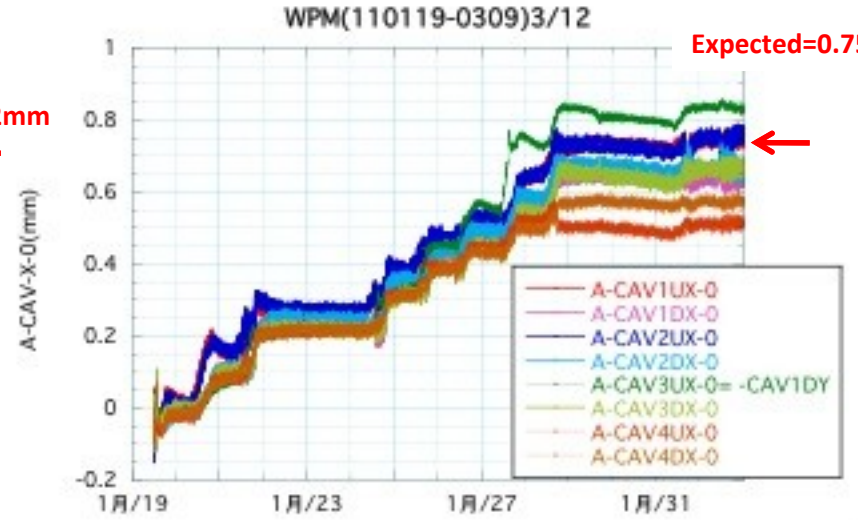


Expected=-1.07mm

X



Expected=0.62mm



Expected=0.75mm

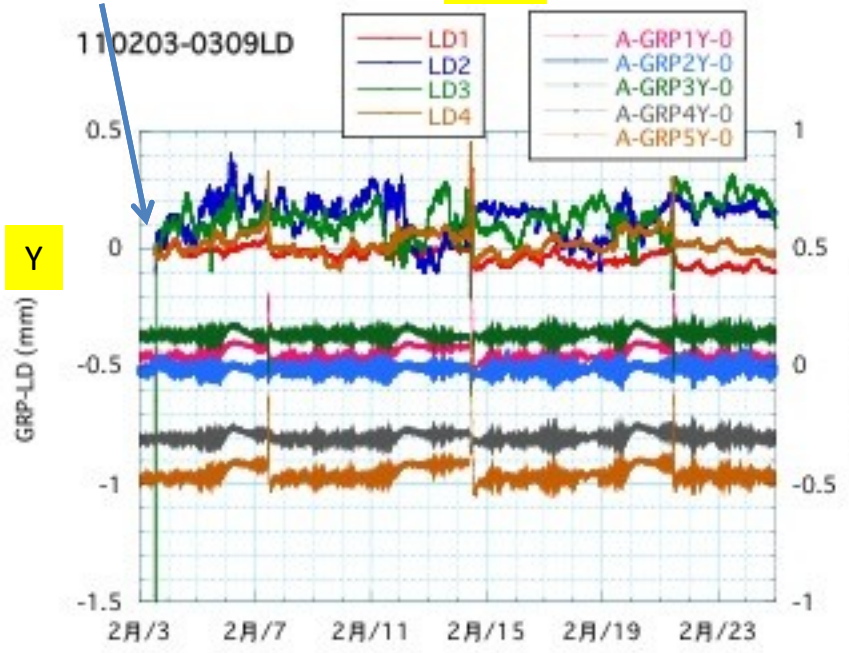
During cold state (Feb 3 ~ Feb 25) (1)

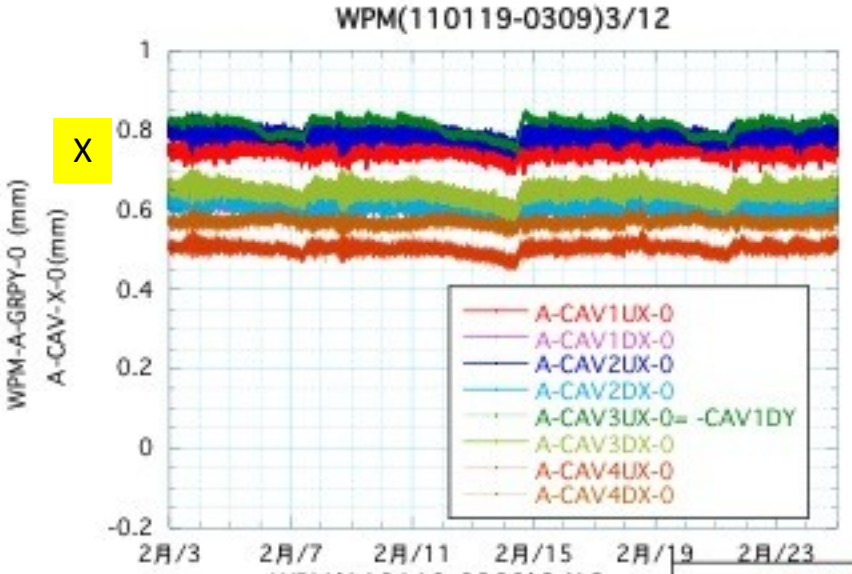
0 reset here

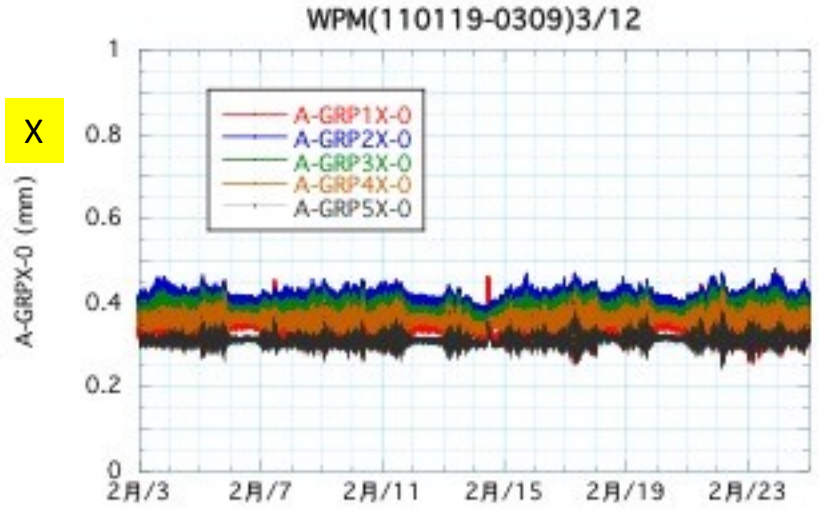
GRP

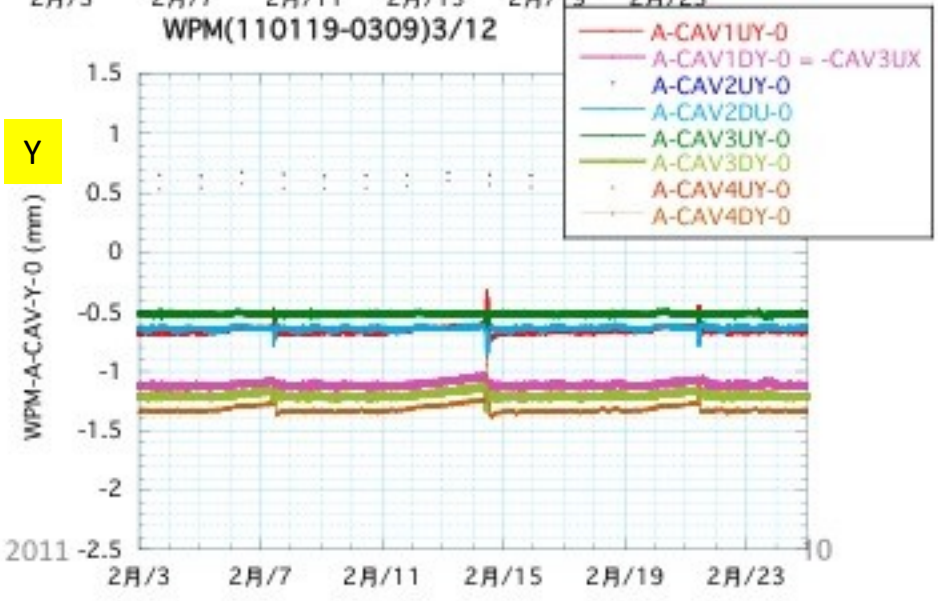
Stability in cold state

Cavities



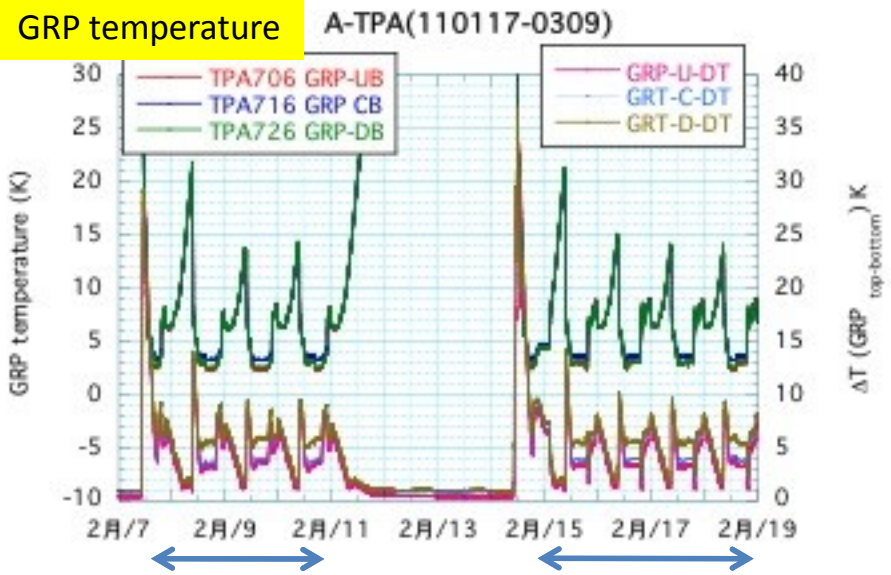


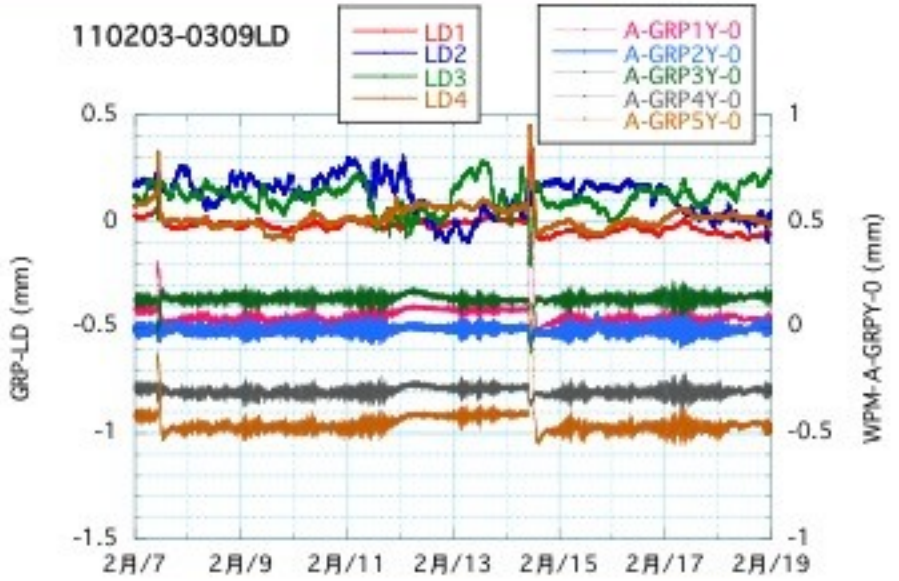


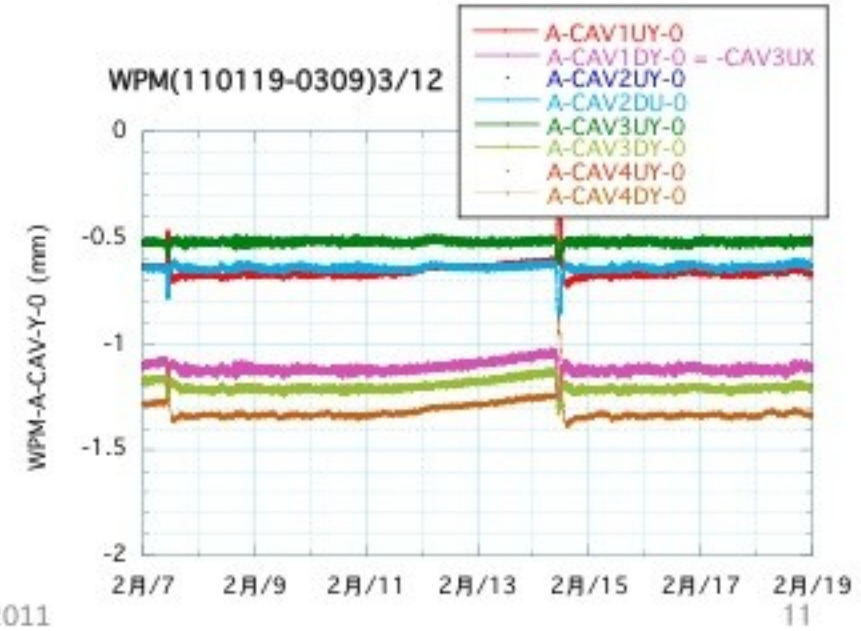


During cold state (Feb 3 ~ Feb 25) (2)

GRP temperature







During the periods of 7 Feb to 11 Feb and 15 Feb to 19 Feb , the system was kept at 2 K in the daytime .

The fluctuation widths of the LD signals during the periods are about 0.2 mm, however, those of the WPM-GRPY are smaller than 0.1 mm. The fluctuation widths of the WPM-CAV are also smaller than 0.1 mm.

The reason of this difference between LD and WPM is not clear yet ?

Summary

- During the cool down period, rather large vertical movement (max 2.7 mm) at the end parts of GRP was observed in the signals of LS and WPM.
  The amount of the GRP movement measured by WPM is roughly 1.4 times larger than that of LD.

- After the cavities are cooled down to 2 K, the fluctuation of GRP position measured by WPM is less than 0.1 mm, however, the data of LD is about 0.2 mm.
  The reason of this discrepancy is not clear yet.