

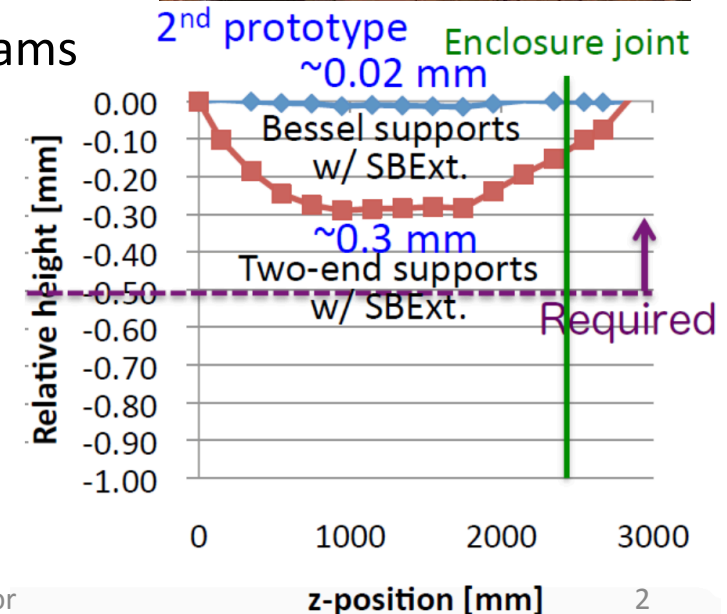
# Module Deflection Monitoring

**R.Omori**

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Belle II TOP Group

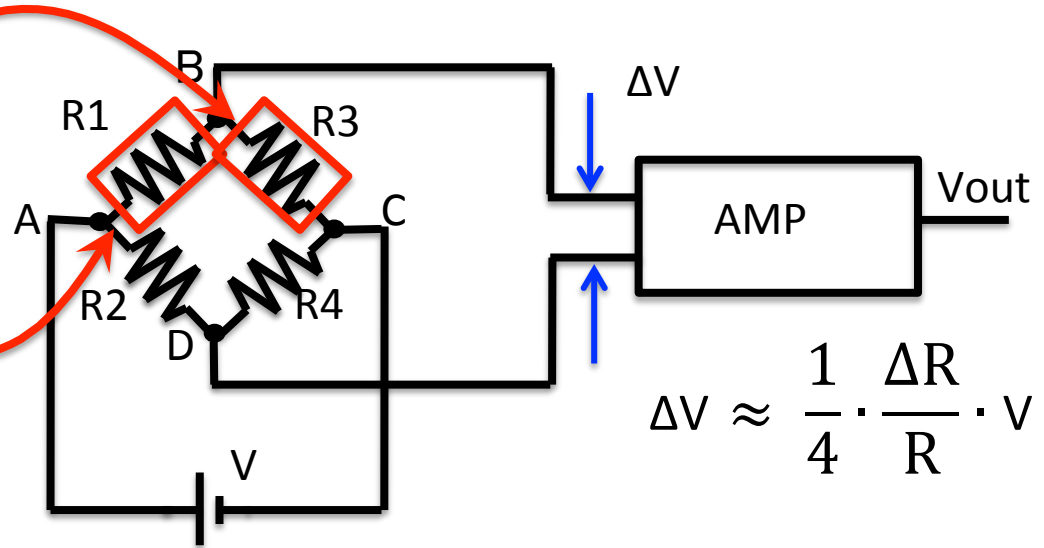
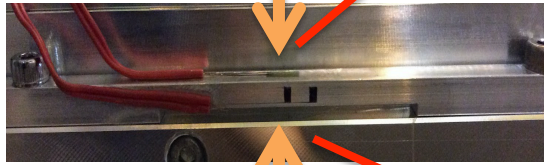
# Module deflection

- During installation, the module was supported by the slider on the guide pipe, at Bessel point. The deflection should be  $\sim 0.02$  mm.
- After installation in the Belle II detector, the module was supported at the two ends. The deflection should be  $0.3 \sim 0.4$  mm.
- After all modules are installed, all modules are joined together with the Z-beams and Strong Backs are removed. The deflection should be  $< 0.5$  mm.
- To check the deflection of the modules, we studied three types of monitors (SG(Omori, Inami-san), PPG(Suzuki-san), FPG(Inami-san, Kohriki-san)).



# Module deflection monitor(SG)

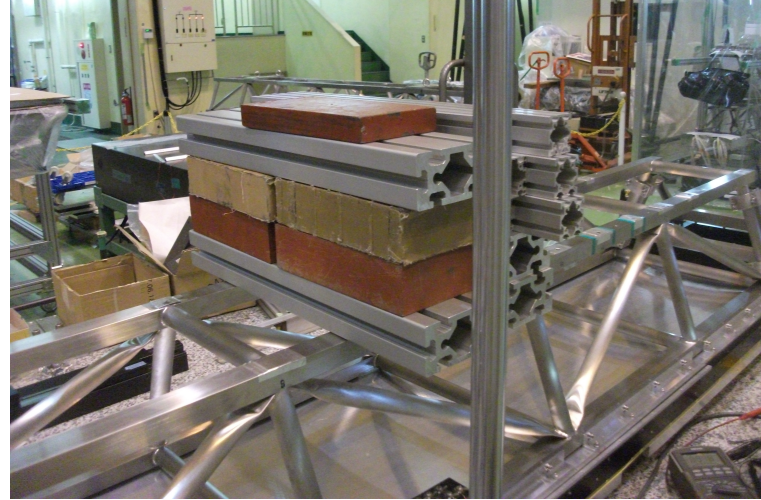
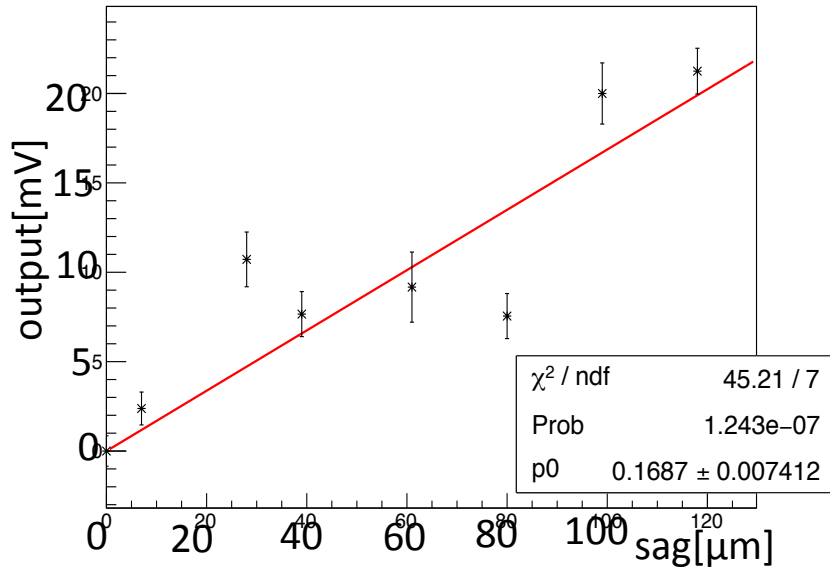
## Strain Gauge(SG)



- A strain gauge can measure a by means of a resistance change of the sensor due to deformation.
- Gauges are connected to bridge circuit and then signal is amplified.
  - AMP gain is ~10,000.
- Two gauges were glued on the Al bar.
- Suppress a temperature dependence by using two gauges.
  - However, the correction was not perfect.
  - We apply to correct temperature dependence.
- Sometimes the output was not stable during long-term measurement.
- Made several types and selected the most stable one.

# Calibration of SG

sag vs. output



Relation between the deflection and the output.

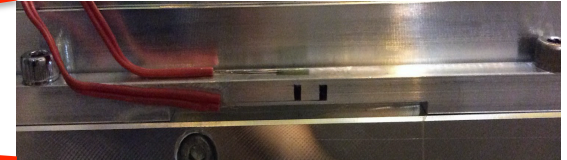
Make a deflection with weights, and measure outputs using the prototype module.

~16.9 mV / 100  $\mu\text{m}$

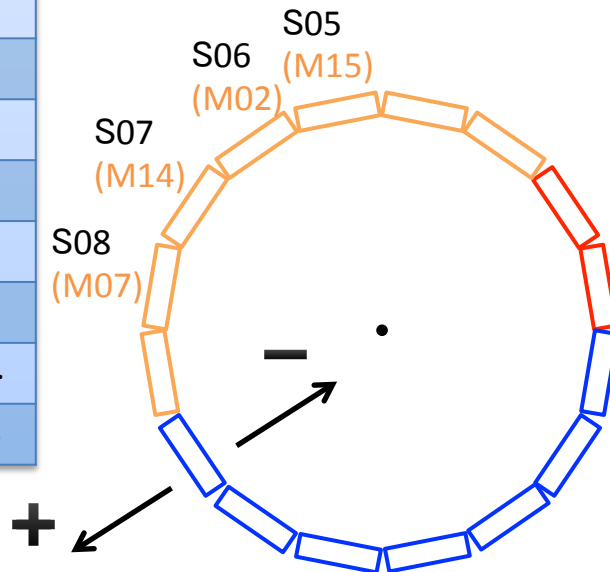
It have not been sufficient confirmation.

# Deflection during the installation(SG)

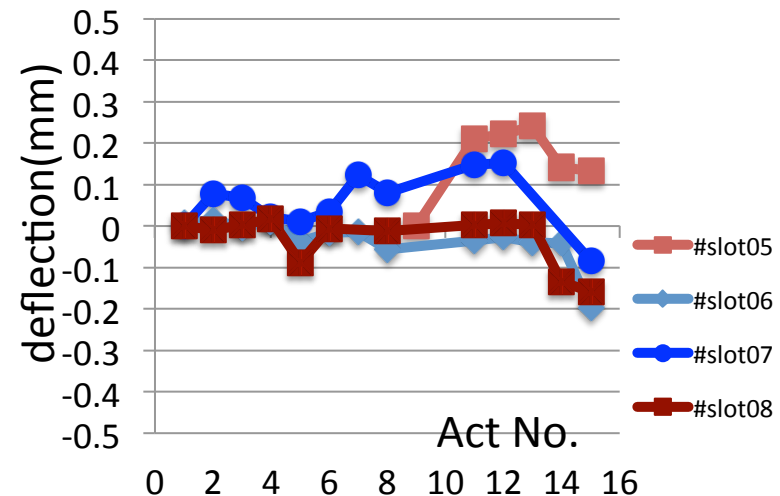
Act.#	action
1	Before the slide approach.
2	Sliders joined.
3	Lifted up.
4	Set the weight.
5	Rotated to the top position
6	Removed OP spacers.
7	Rotated to the slot position.
8	Moved to the lower position.
9	Slid in the barrel.
10	Tightened the shoulder bolts.
11	Tightened the flange bolts.
12	Removed the weight.
13	Removed the slider bolts.
14	Removed the upper L-fixtures.
15	Removed the lower L-fixtures.



The Al bar is fixed on the side rail using Z-beam screw holes.

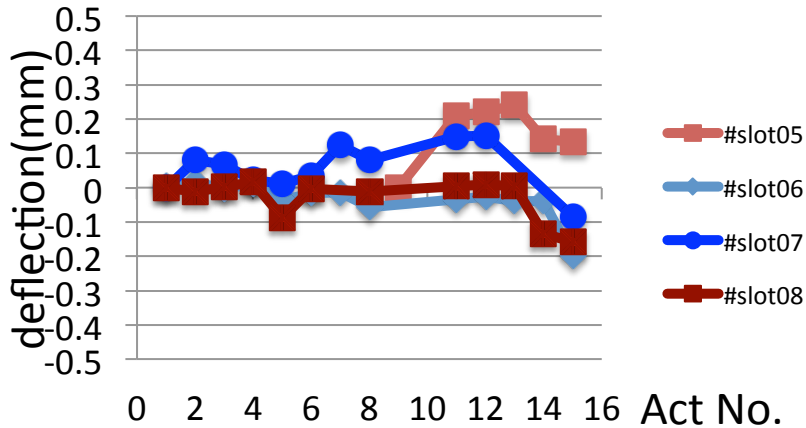


slot#05~slot#08

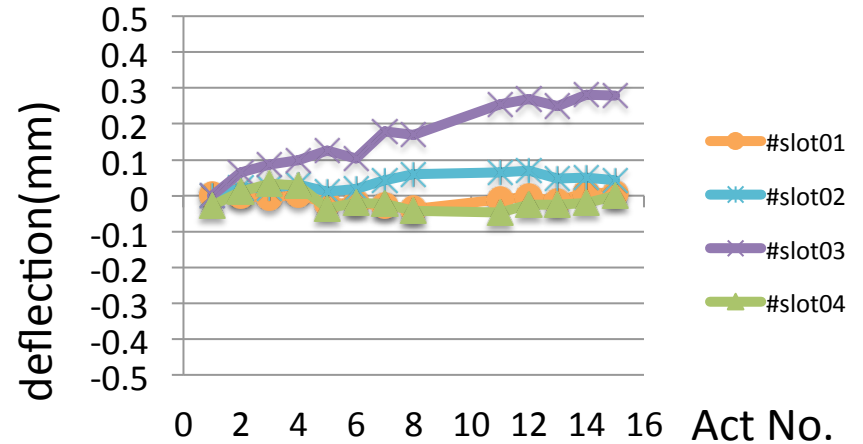


# Deflection during the installation(SG)

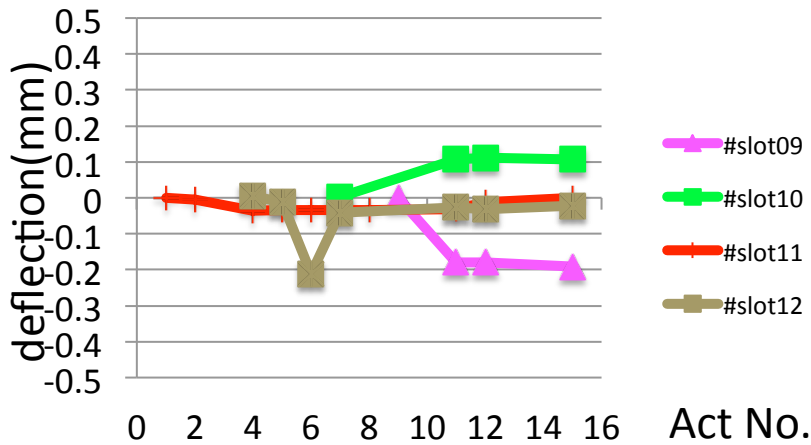
## slot#05~slot#08



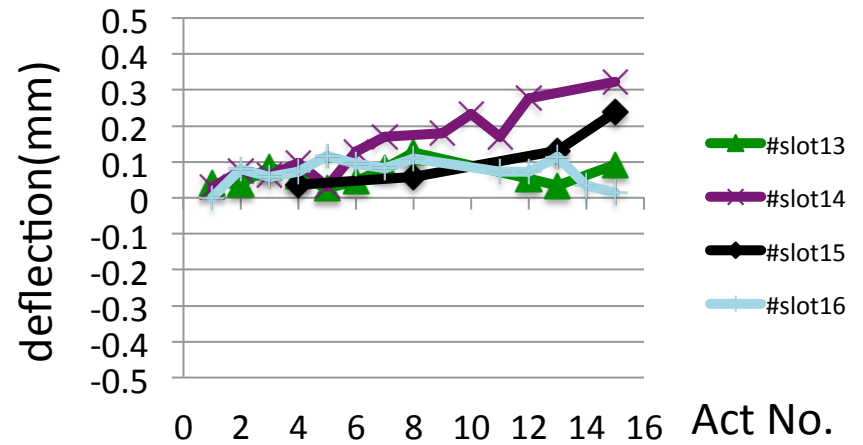
## slot#01~slot#04



## slot#09~slot#12



## slot#13~slot#16

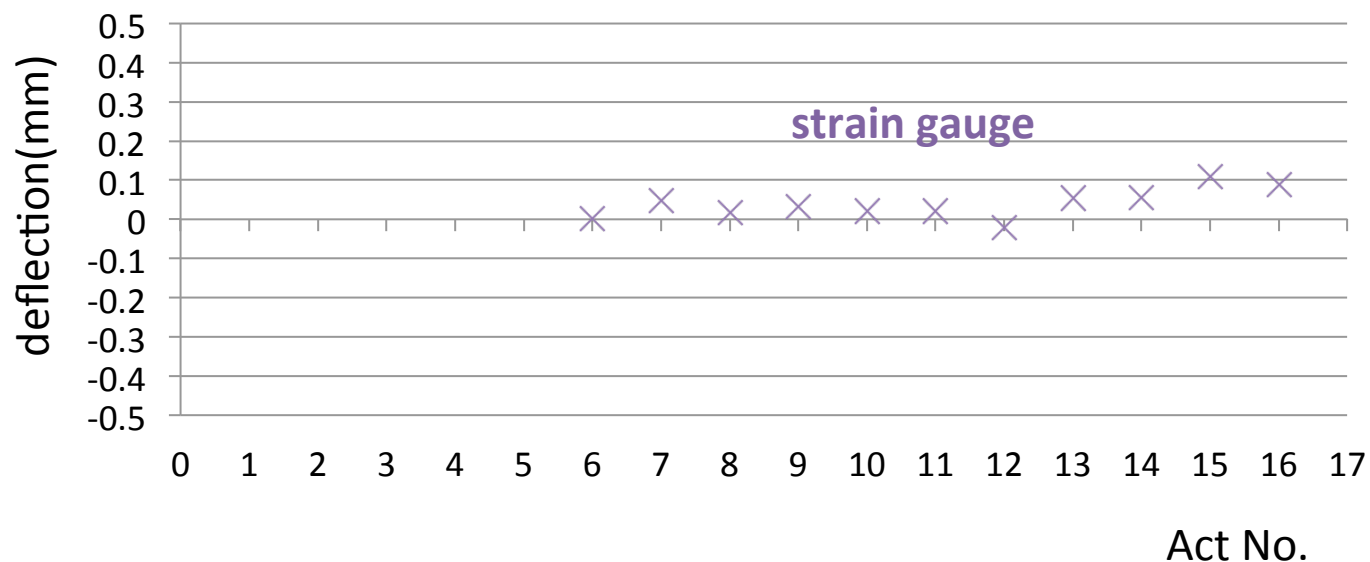


The deflection were < 0.5 mm.

# Strong Back removal(SG and FPG)

Measures with SG at S05(90°).

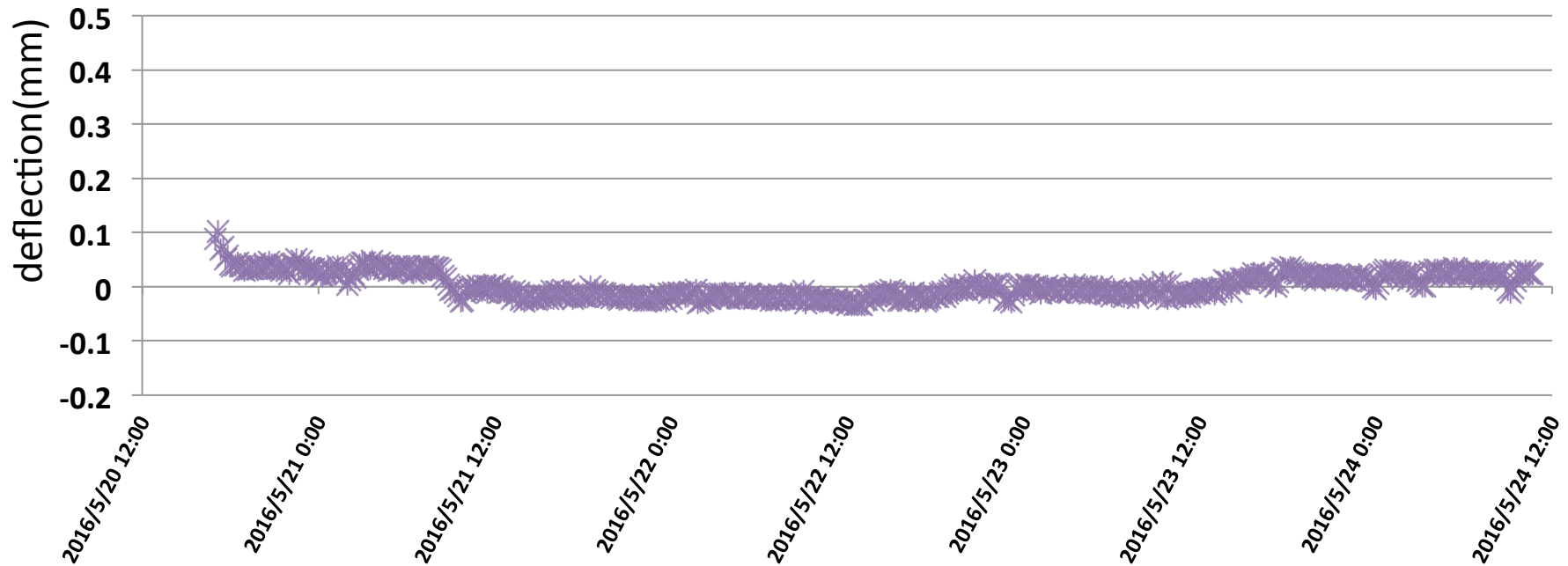
Act.#	action
0	Before removed SB.
1	Removed SB05.
2	Removed SB06.
3	Removed SB07.
4	Removed SB08.
5	Removed SB04.
6	Removed SB03.
7	Removed SB02.
8	Removed SB01.
9	Removed SB16.
10	Removed SB15.
11	Removed SB14.
12	Removed SB13.
13	Removed SB09.
14	Removed SB10.
15	Removed SB11.
16/07/2016	Removed SB12.



- SG was placed after SB04 removal.
- SG measured no large deflection.

# After Strong Back removal(SG and FPG)

Measures with SG at S05(90°) during 4days after SB removal.



It seems to be no large deflection after SB removal.  
TOP module is stable.



# Summary

- Measured module deflection with 3 types gauges during module installation, module joining, Strong Back removable.
- Deflections during module installation are  $< 0.5$  mm.
- There is no large deflections become a problem during Strong backs were removed.
- There is no large deflections after SB removal. TOP modules are stable.



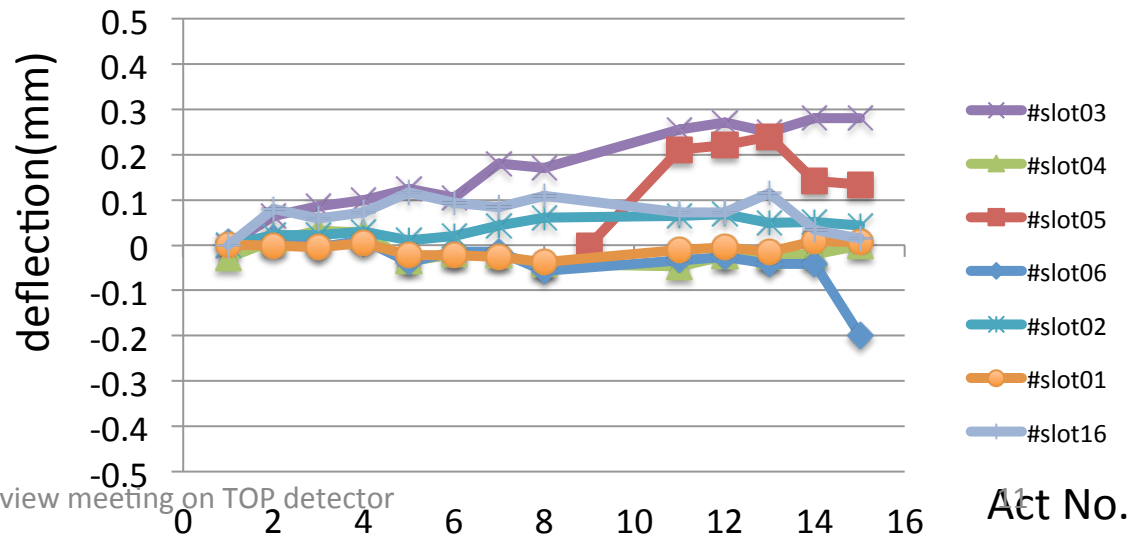
# Deflection during the instllation(SG and PPG)

Act.#	action
1	Before the slide approach.
2	Sliders joined.
3	Lifted up.
4	Set the weight.
5	Rotated to the top position
6	Removed OP spacers.
7	Rotated to the slot position.
8	Moved to the lower position.
9	Slid in the barrel.
10	Tightened the shoulder bolts.
11	Tightened the flange bolts.
12	Removed the weight.
13	Removed the slider bolts.
14	Removed the upper L-fixtures.
15	Removed the lower L-fixtures.

Portable Pipe Gauge(Suzuki-san)



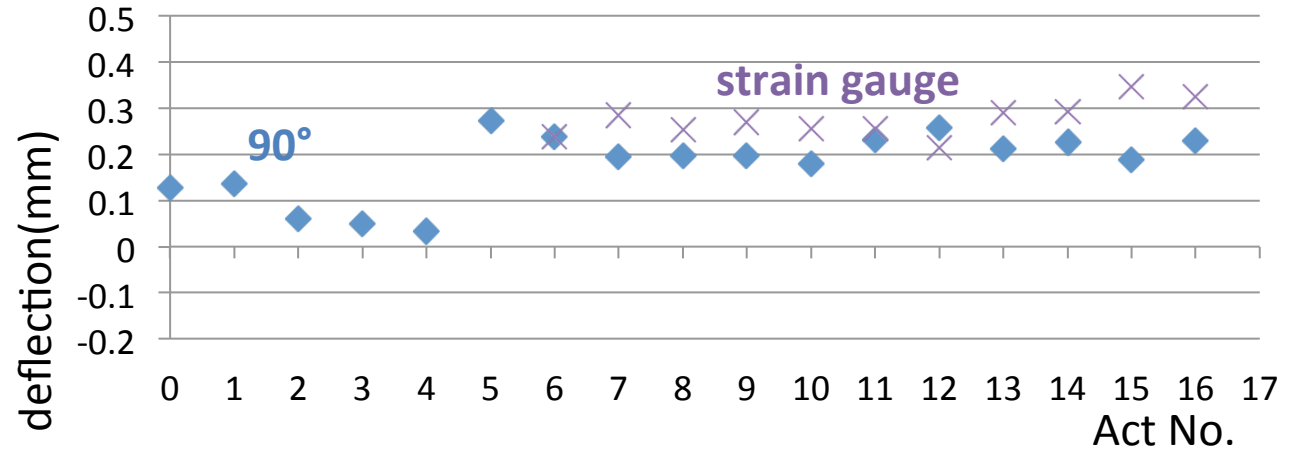
Strain Gauge



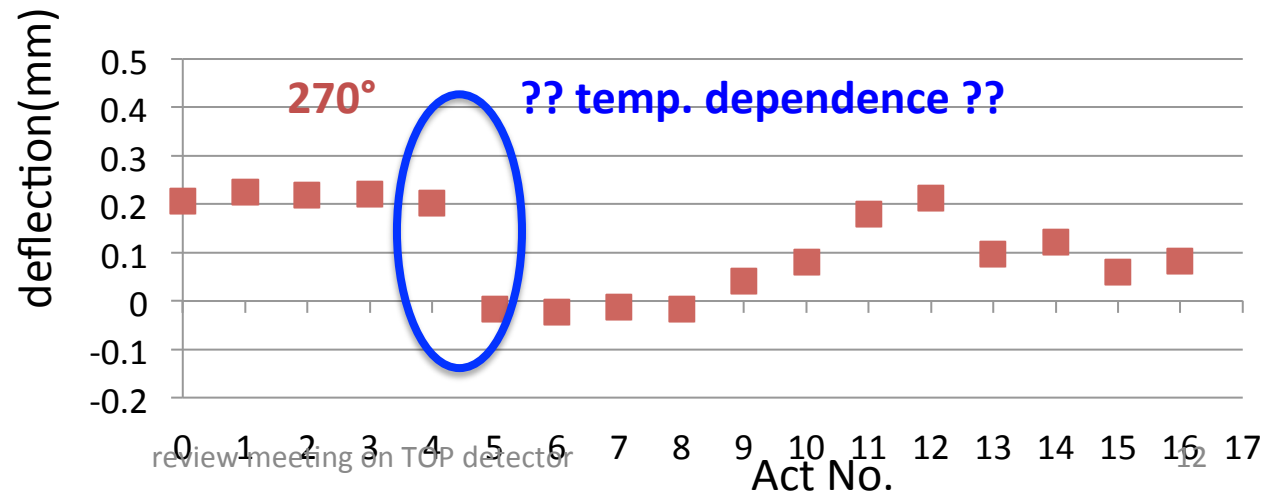
# Strong Back removal(SG and FPG)

Measures with SG at S05(90°) and FPG at S04(90°) and S12(270°).

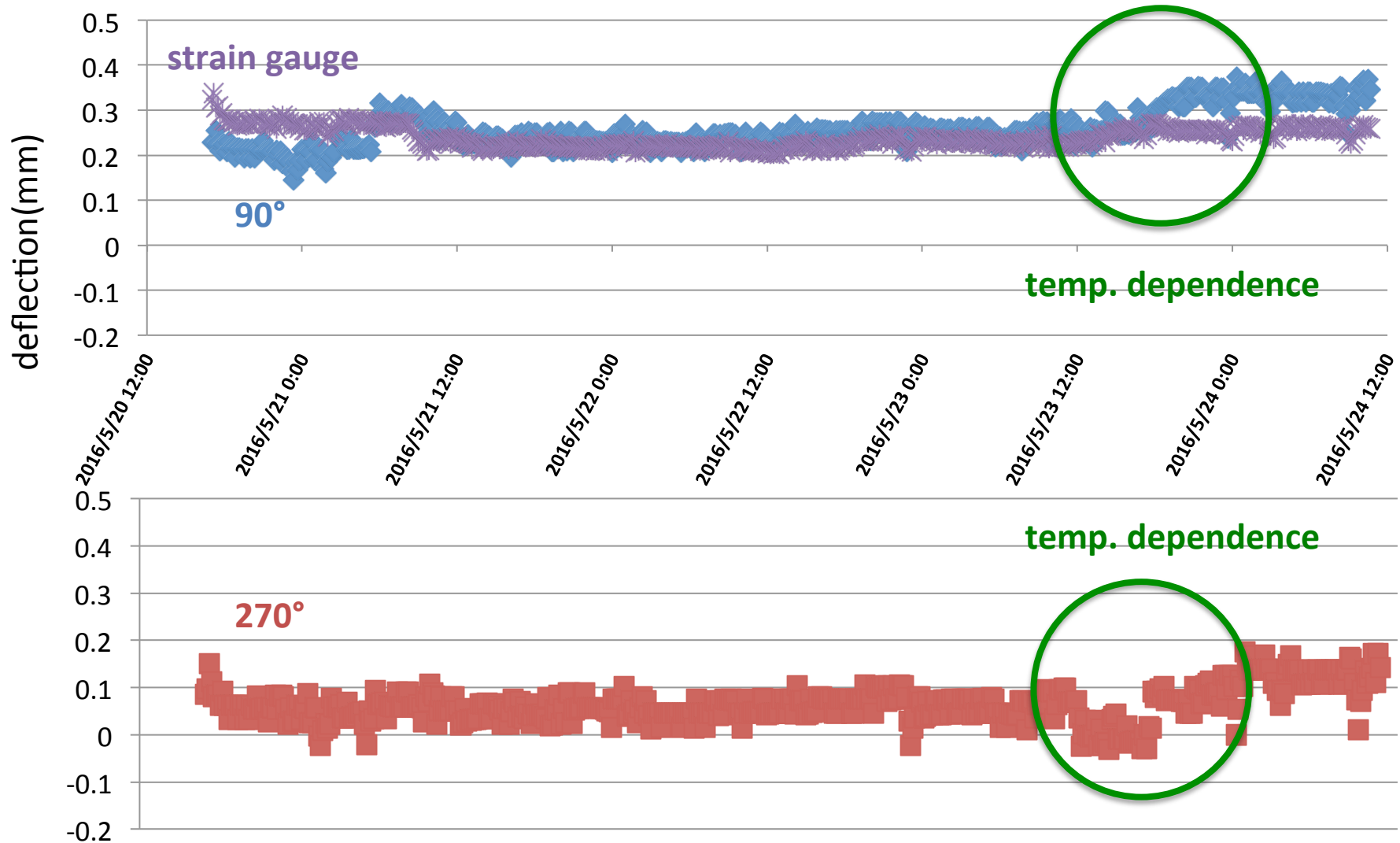
Act.#	action
0	Before removed SB.
1	Removed SB05.
2	Removed SB06.
3	Removed SB07.
4	Removed SB08.
5	Removed SB04.
6	Removed SB03.
7	Removed SB02.
8	Removed SB01.
9	Removed SB16.
10	Removed SB15.
11	Removed SB14.
12	Removed SB13.
13	Removed SB09.
14	Removed SB10.
15	Removed SB11.
16/07/2022	Removed SB12.



- SG and FPG measured no large deflection after removed SB03.
- The deflection on Act 5 is larger than the others.



# After Strong Back removal(SG and FPG)



It seems to be no large deflection after SB removal.

# 5/12~5/24 SB取り外し期間中のゲージ出力

