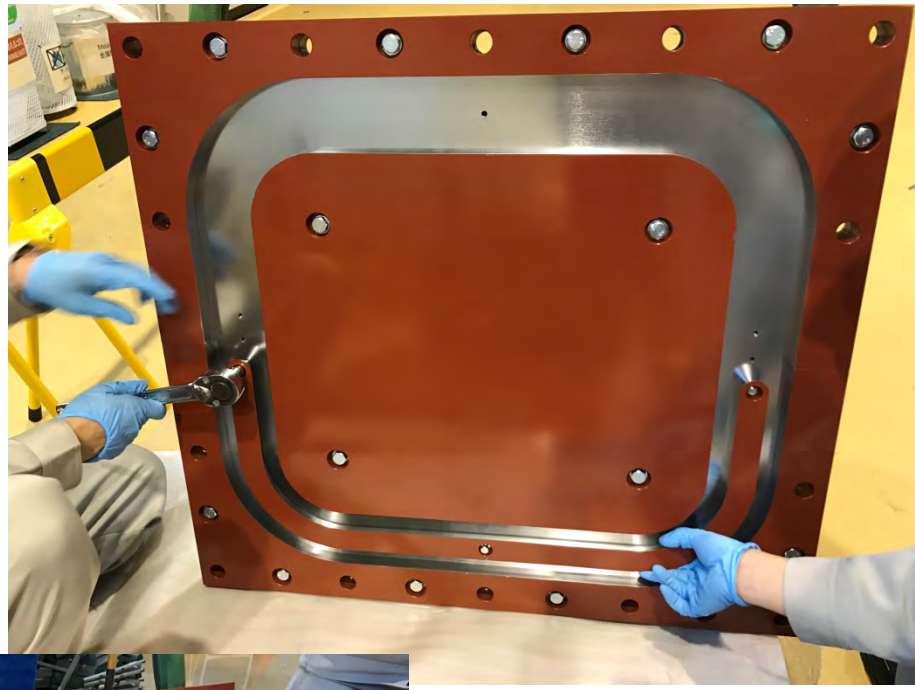
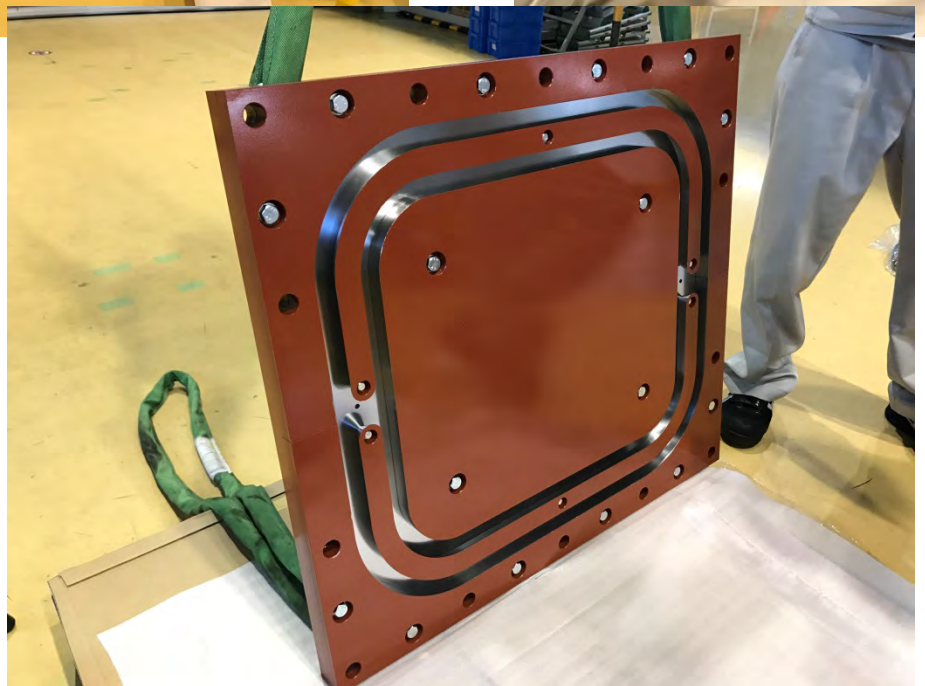
Summary of Hatch cover mock-up test in J-PARC

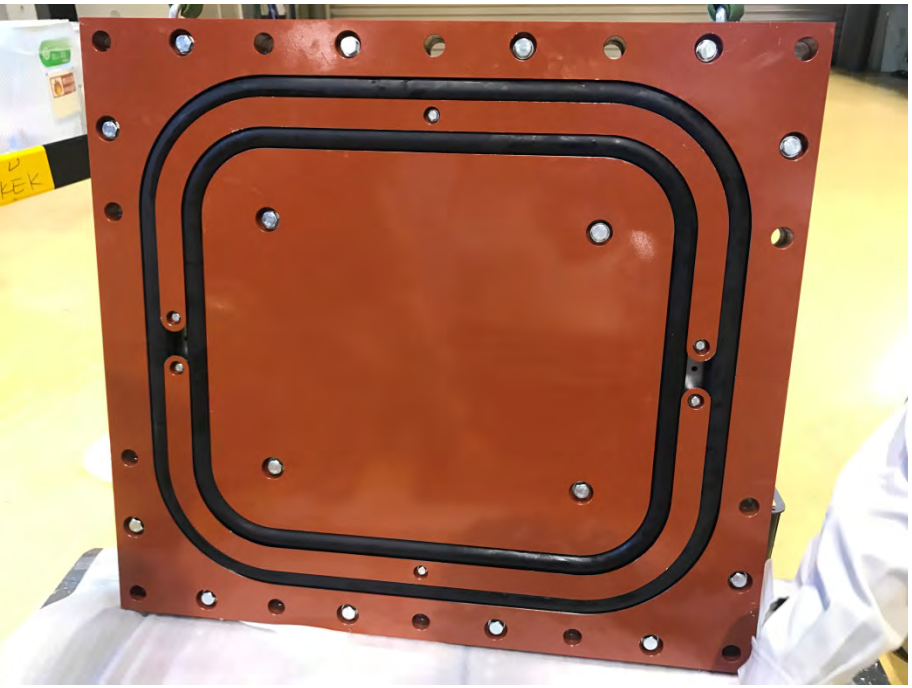
Oct. 21, 2019
Tada
KEK IPNS

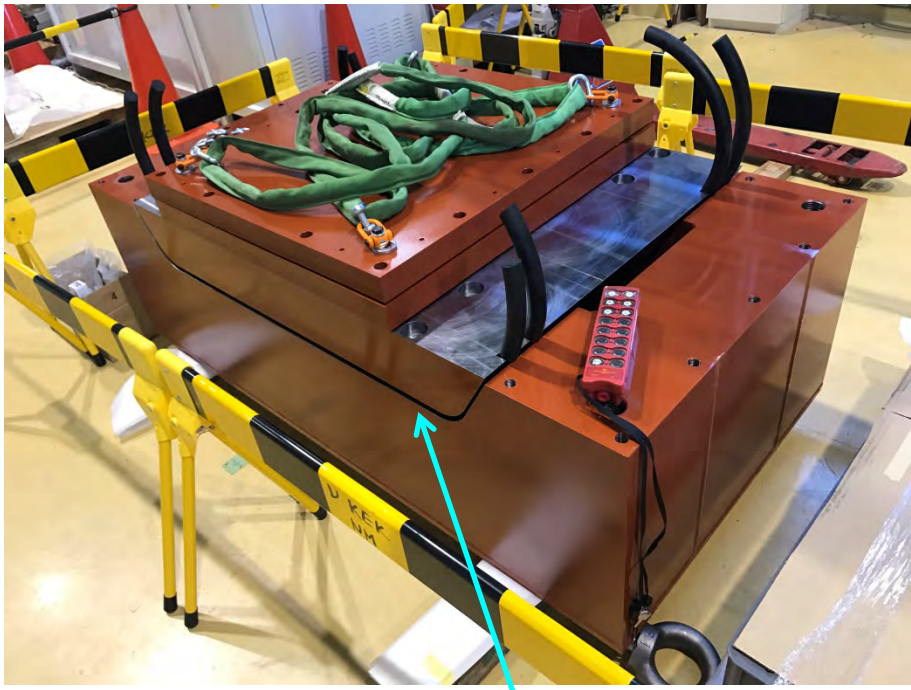
Hatch cover mock-up was delivered at J-PARC (Mar. 28)





Gaskets were installed by KEK members (Apr. 9)





The cross member did not fit neatly into the main body and there was about 5 mm of gap between the cross member and the main body.

Gaskets were exchanged by FNAL and KEK members (Apr. 18)

1) FNAL members checked the status.

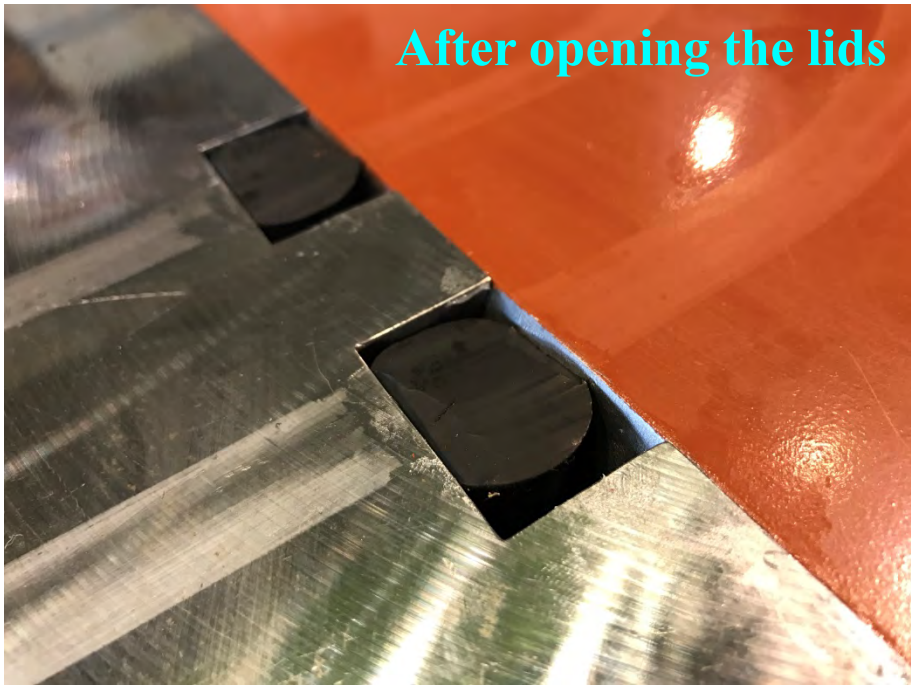
2) We put the cross member on the main body without gaskets and checked the gap.

-> ~ 0.5 mm

3) We exchanged the gaskets for the cross member from 28 mm diameter gaskets to 25 mm diameter gaskets, tightened bolts, and checked the gap.

-> ~ 0.5 mm

Vacuum test by FNAL and KEK members (Apr. 18)

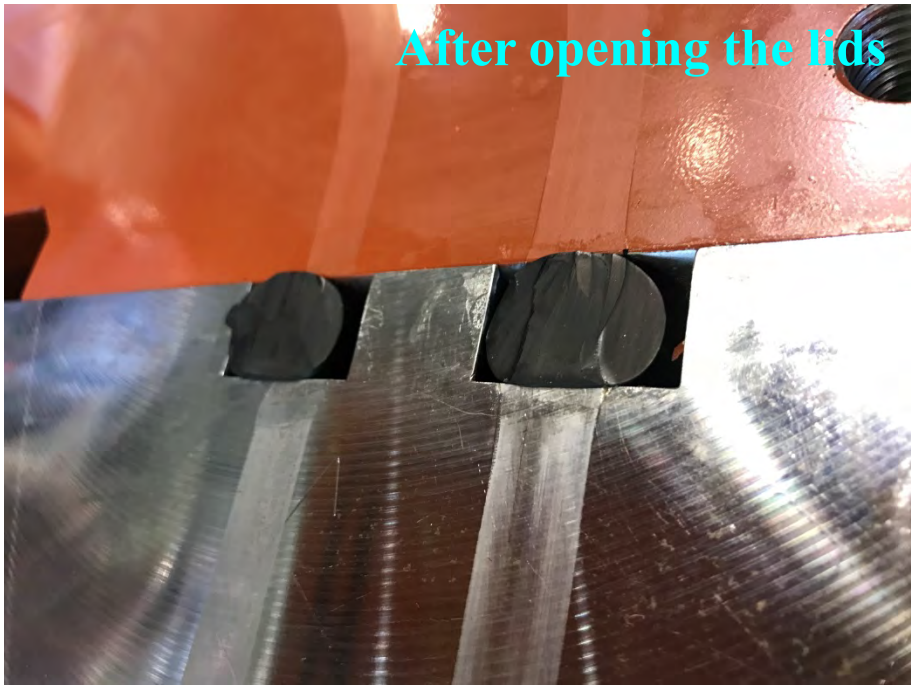


4) We cut the gaskets in such a way that the ends of gaskets were 2 ~ 3 mm above the surface of the cross member.

5) We closed the lids and tried to evacuate the mock-up.
-> We could not evacuate!

6) We opened the lids and checked the gaskets.
-> The ends of the gaskets fell under the surface of the cross member.

Vacuum test again by FNAL and KEK members (Apr. 18)



7) We installed new gaskets and cut the gaskets in such a way that the ends of gaskets were 5 ~ 6 mm above the surface of the cross member.

8) We closed the lids and tried to evacuate the mock-up.
-> We could evacuate! (The pressure went to a few Pa.)

9) We did pressurized test, sniffer test, leak test, and vacuum retention test.

10) We opened the lids and check the gaskets.
-> The ends of the gaskets were 2 ~ 3 mm above the surface.

Tests by FNAL and KEK members (Apr. 18)

1) Pressurized test

-> No pressure drop was observed during 30 minutes.

2) Sniffer test

-> The leak checker was broken! So we could not do sniffer test.

3) Helium leak test

-> See next slide.

4) Vacuum retention test

-> 330 Pa pressure rise during 16.5 hours

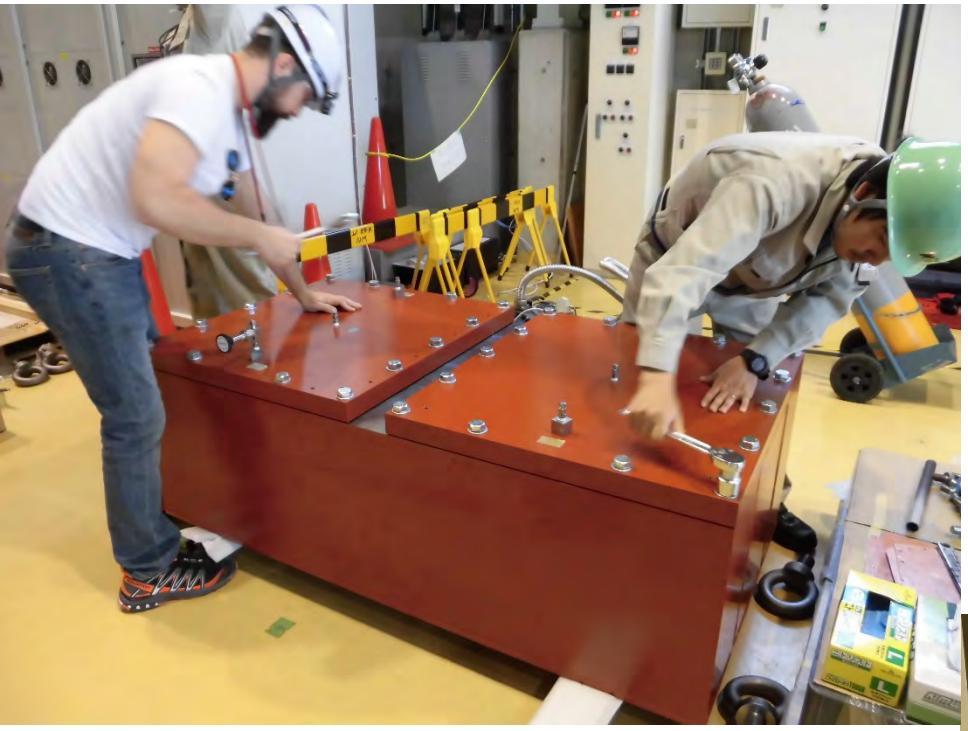
-> 6.8×10^{-4} Pa m^3 / sec

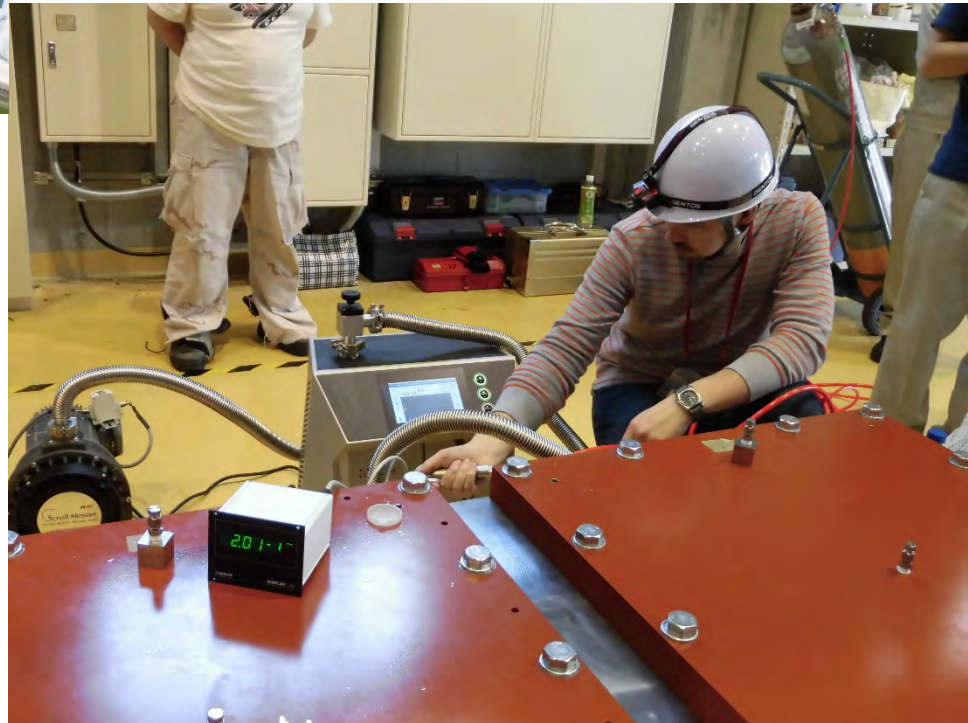
(as the inner volume of the mock-up is 0.12 m^3)

5) After these test, we opened the lids, checked the gaskets, closed the lids again, and did the leak test again.

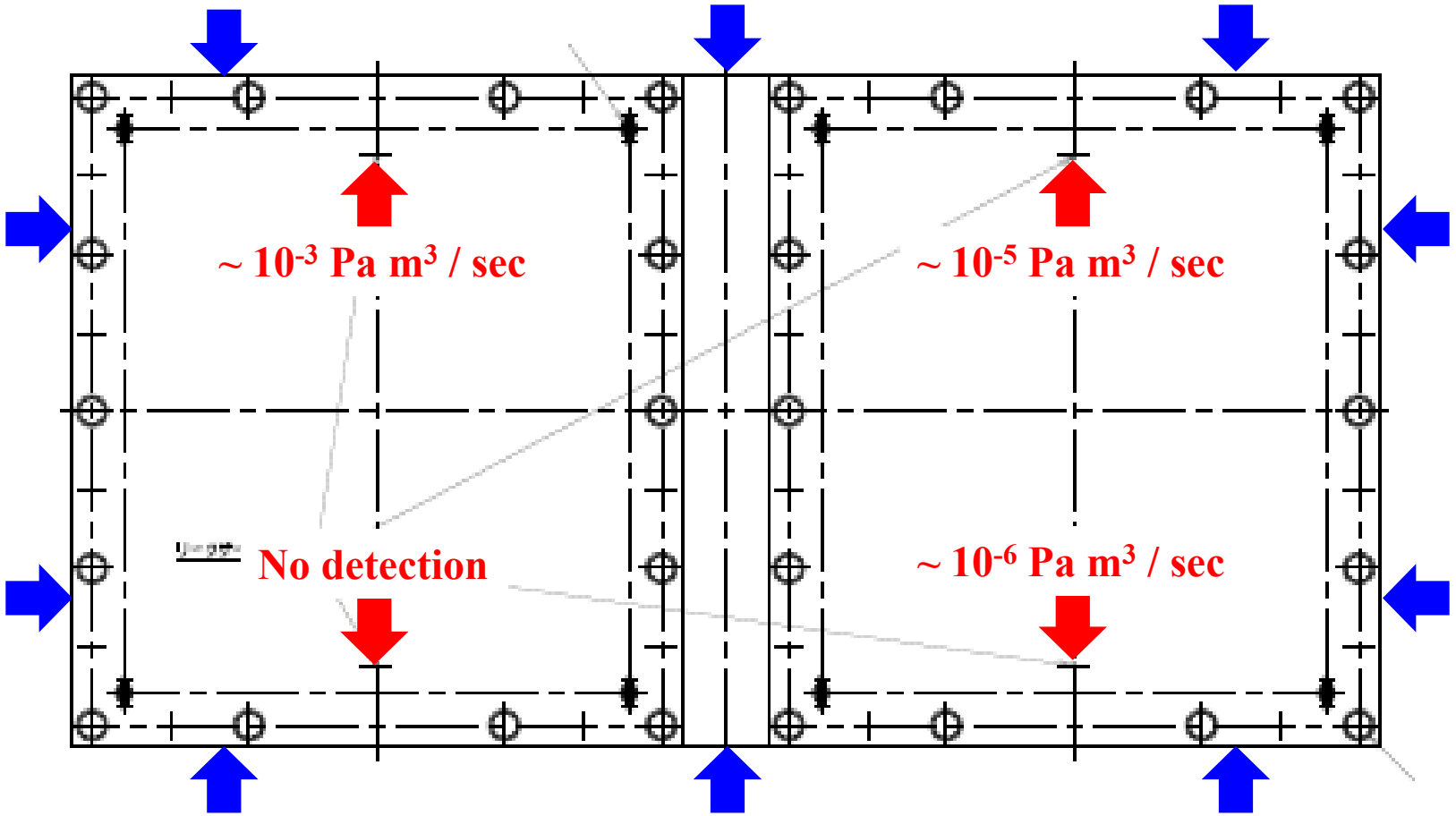
-> Almost the same results were obtained.

Tests by FNAL and KEK members (Apr. 18)





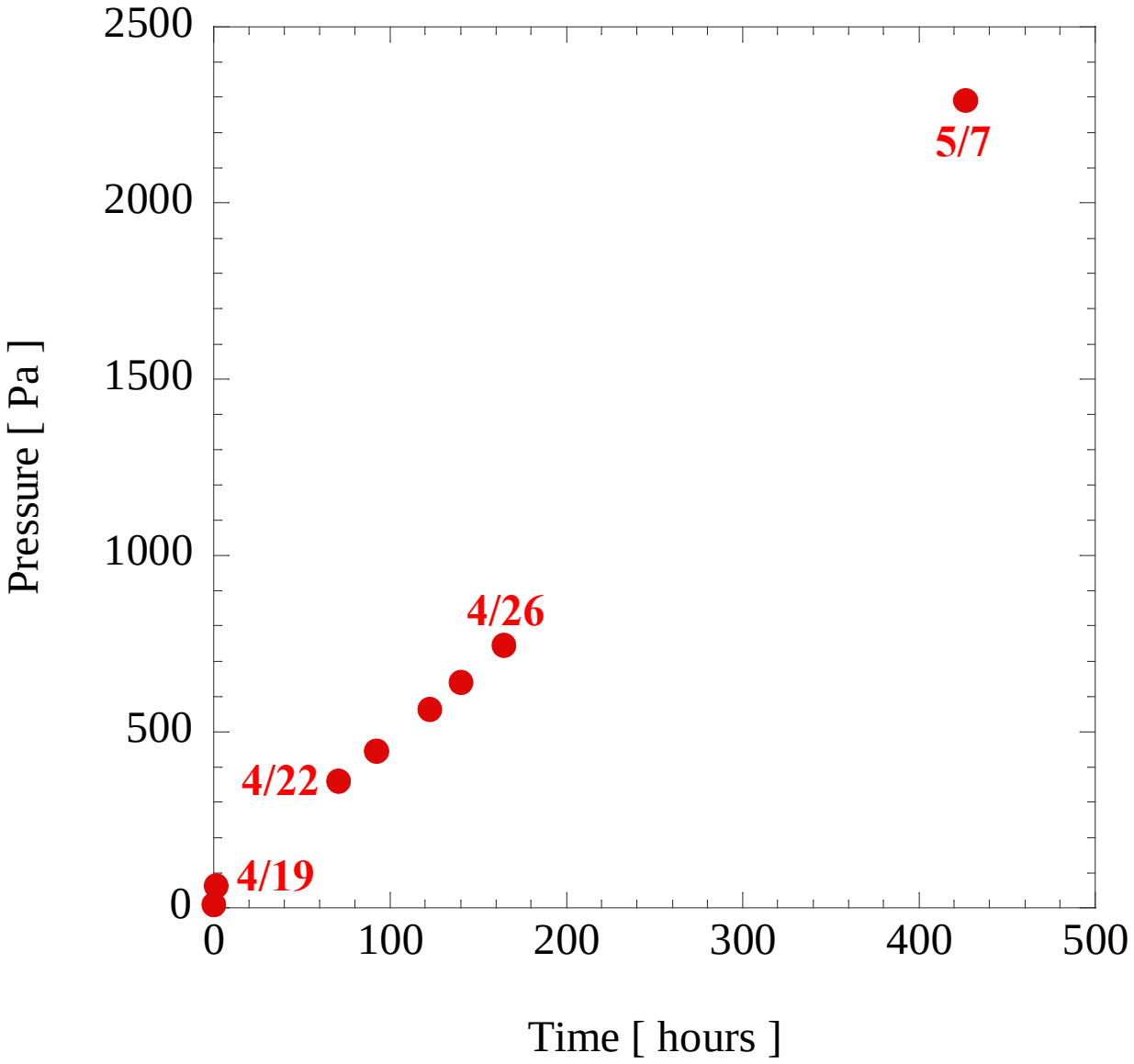
Helium leak test by FNAL and KEK members (Apr. 18, 19)



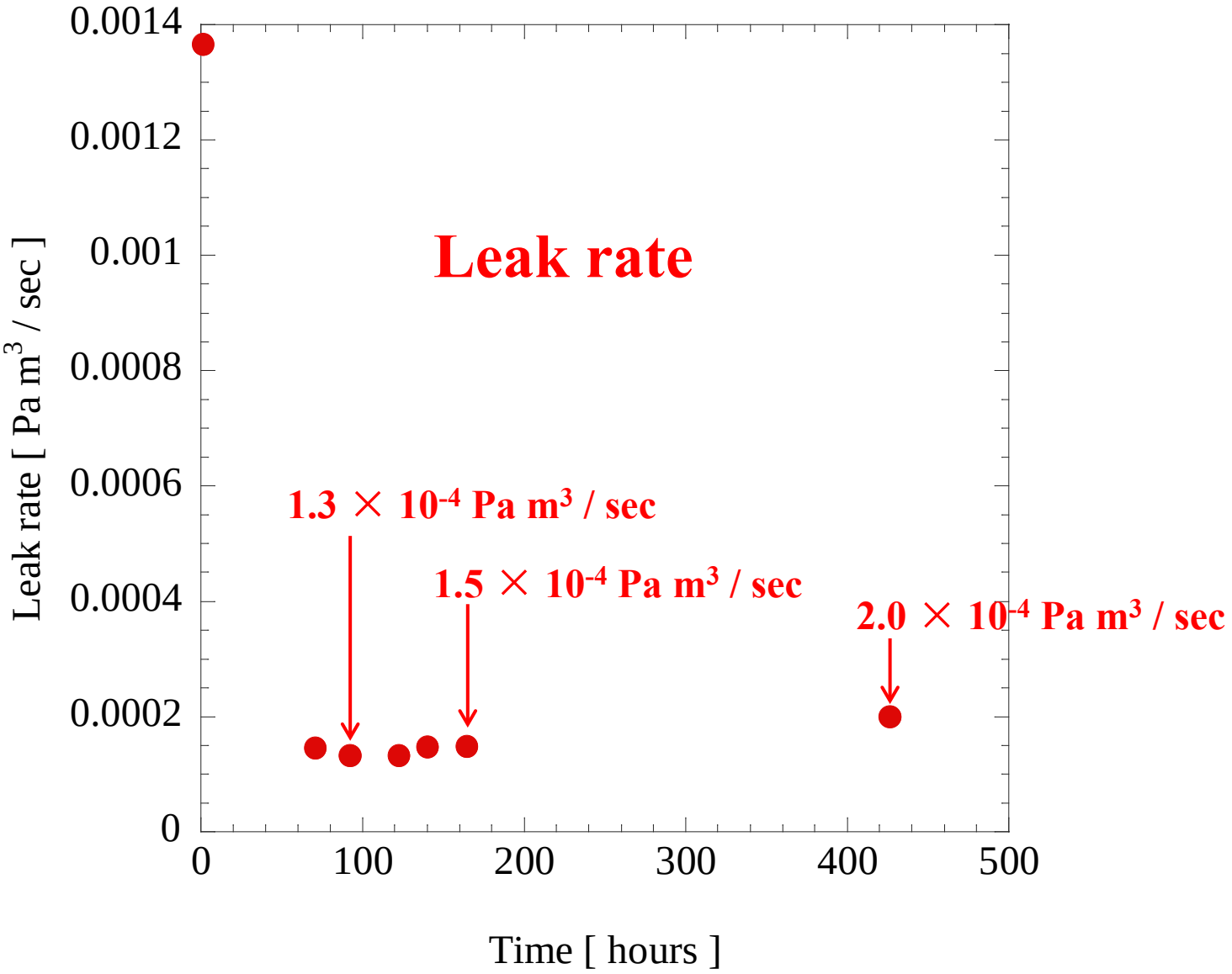
From outside -> No detection

From leak test port (between gaskets) -> Detection (shown above)

Long term vacuum retention test by KEK members (from Apr. 19 to May 7)



Long term vacuum retention test by KEK members (from Apr. 19 to May 7)



Long term pressurized test by KEK members (from May 23 until Jul. 6)

We did the long term pressurized test and observing the pressure drop.

Nitrogen gas, atmospheric pressure + 0.5 atom

← absolute pressure 150.0 kPa

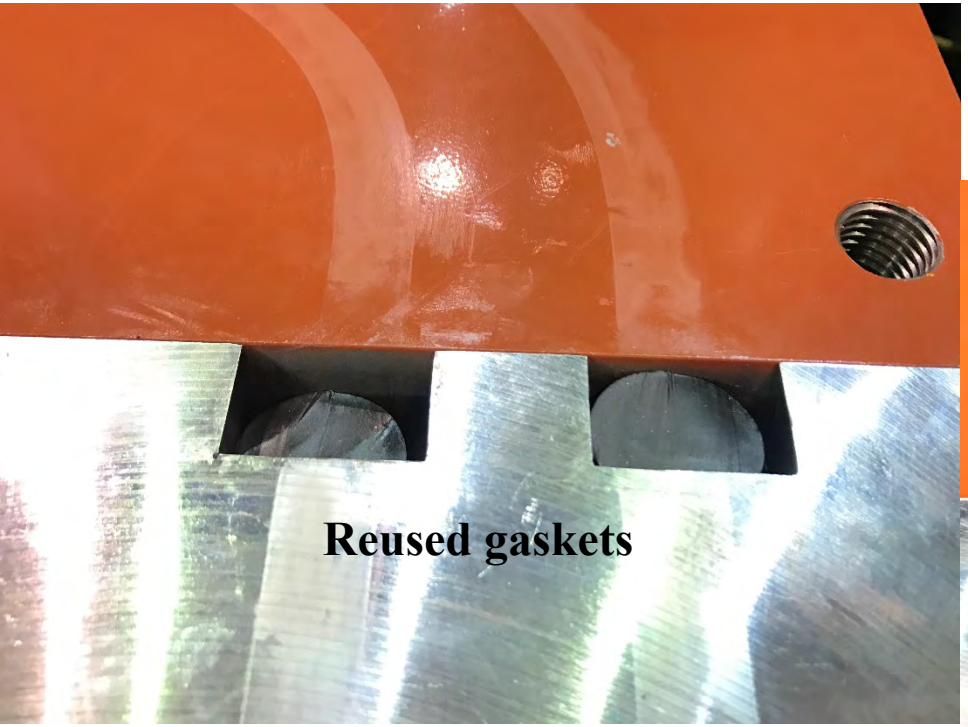
The test started on May 23

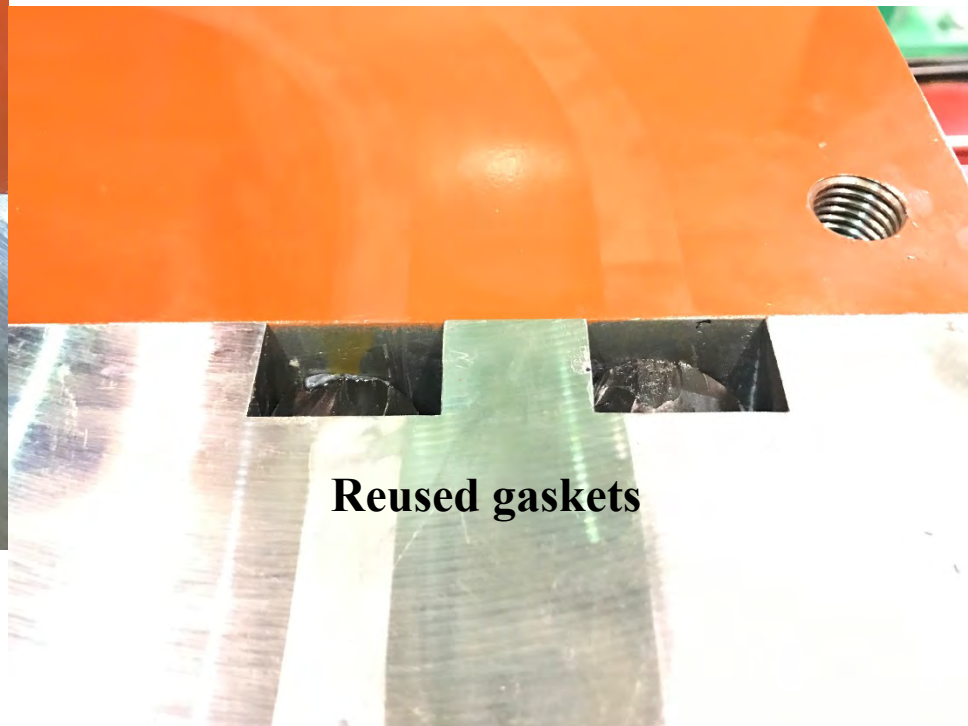
The pressure goes down 149.7 kPa on Jul. 6

0.3 kPa / 44 days -> 9×10^{-6} Pa m^3 / sec

Check repeatability by KEK members (Jul. 24)

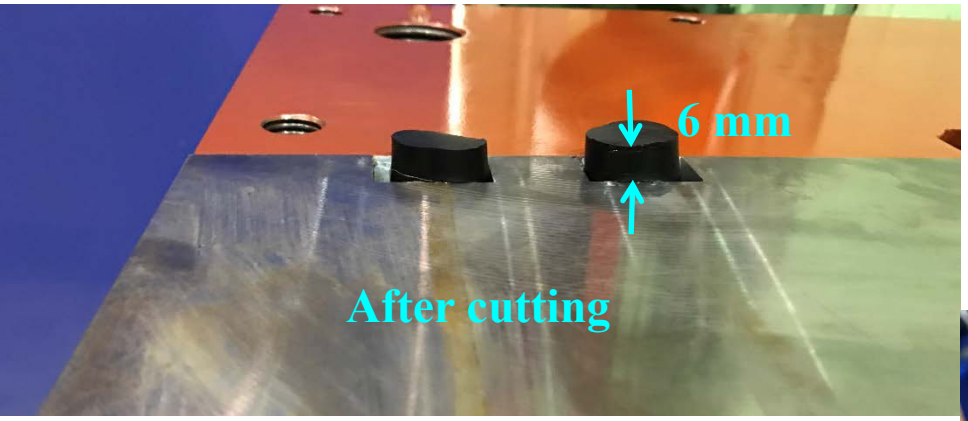
After long term pressurized test, we opened the top lids and the cross member.
Then we closed them with the same gasket to check repeatability.
But the gaskets went down from the top surface of the cross member.
We could not reuse the gaskets of the cross member.
Of course, the gaskets of the top lids were able to be reused.



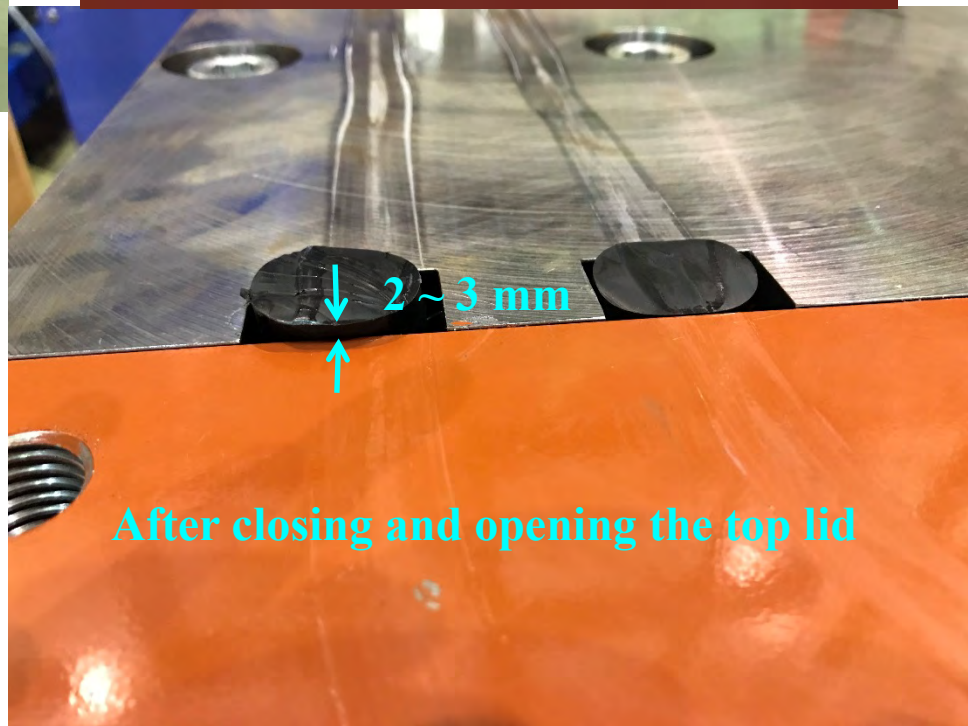


Check repeatability by KEK members (Jul. 25)

Next, we used new gaskets for the cross member and closed the mock-up.
We cut gaskets with a new cutting tool.
The gaskets of the top lids were reused.



After closing the top lid, we opened the top lid and checked the gaskets.
The cross member was kept closed.
We closed the top lid again and started the pressurized test again.



Long term pressurized test by KEK members 2 (from Jul. 25 until Sep. 17)

We did the long term pressurized test and observing the pressure drop again.

Nitrogen gas, atmospheric pressure + 0.5 atom

← absolute pressure 148.9 kPa

The test started on Jul. 25

The pressure goes down 149.6 kPa on Sep. 17

0.3 kPa / 54 days -> 8×10^{-6} Pa m^3 / sec

Transport from J-PARC to FNAL

We sent the mock-up hatch cover.
It left J-PARC on Sep. 19. and will arrive at FNAL around Oct. 25.

Summary

The mock-up test for the hatch cover has finished successfully in J-PARC.
The leak rate were 9×10^{-6} Pa m^3 / sec and 8×10^{-6} Pa m^3 / sec at the pressurized tests with nitrogen gas (atmospheric pressure + 0.5 atom).
At the helium leak test, no detection from outside and 10^{-3} Pa ~ 10^{-6} Pa m^3 / sec from the leak check ports.
The excellent design of FNAL was proved!

And my recommendation are :
1) Adding the bolt holes for the cross member to fit neatly into the main body with 28 mm diameter gaskets
2) Making the tool to cut the gaskets of the cross member uniformly and flat
3) Not reusing the gaskets for the cross member and replacing with new ones every time the cross member is opend.