Development of MO Seal

KEK

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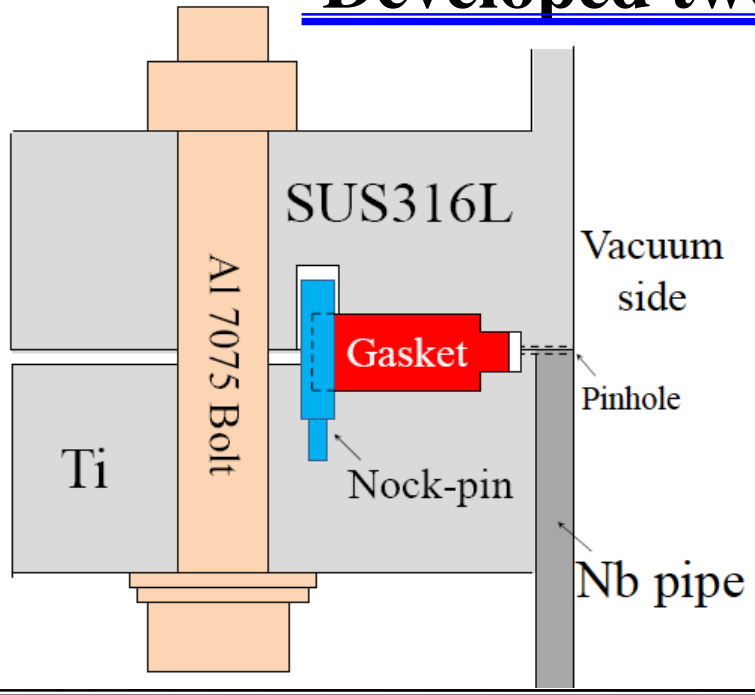
Gaskets used in SRF

Cross-section

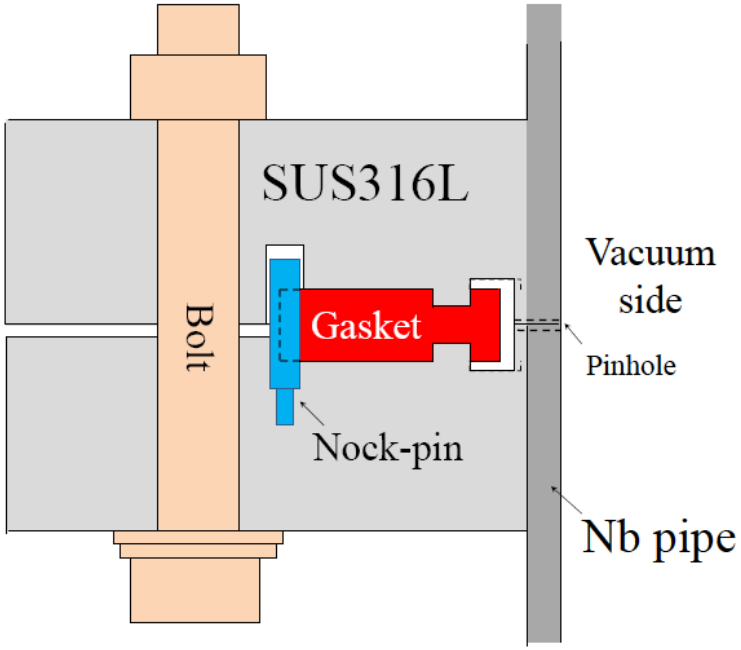
	Seal Type	Handling	Tightening Torque [Nm]	Gasket material	Cost US$
A	**Indium wire**	△	15	Indium	24
B	**DESY Diamond**	◎	30	Aluminum alloy	20
C	**Indium plated U-tight Seal**	○	13	Indium plated stainless steel	150
D	**MO Seal**	◎	15	Copper	10

Developed two kind of MO seal

Type A (one edged)

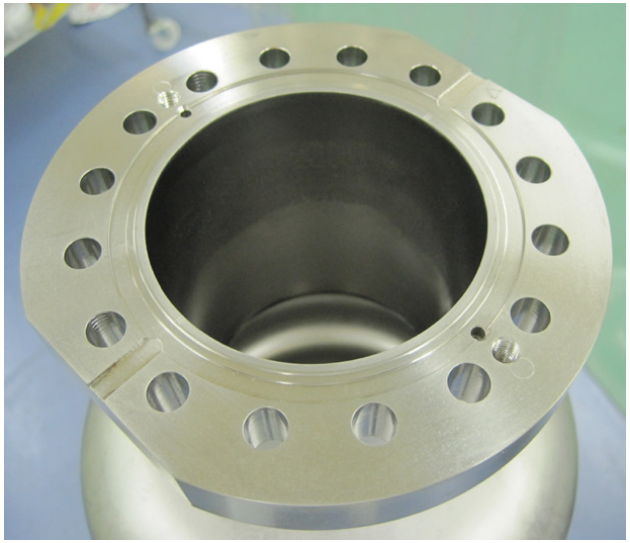


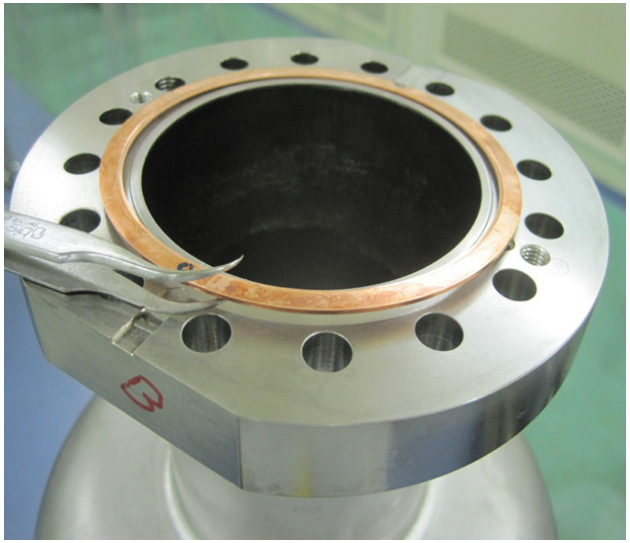
Type B (double edged)

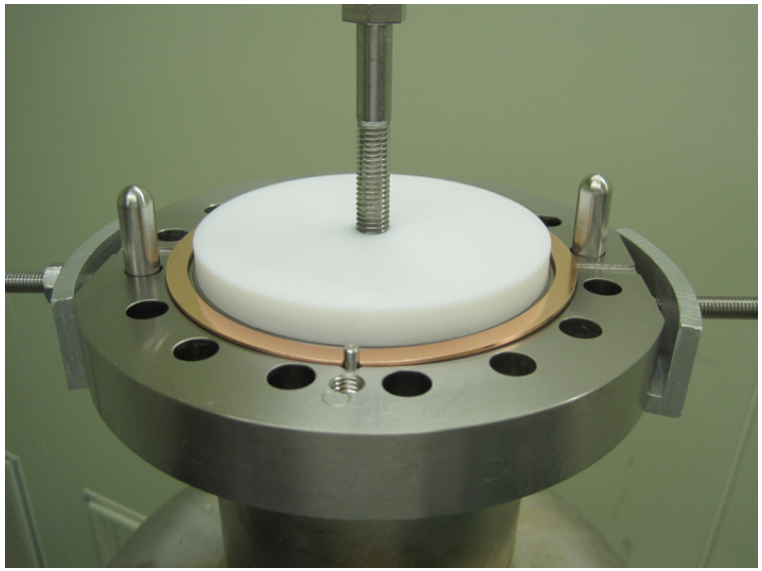


MO sealing

Developed MO seals and MO flanges

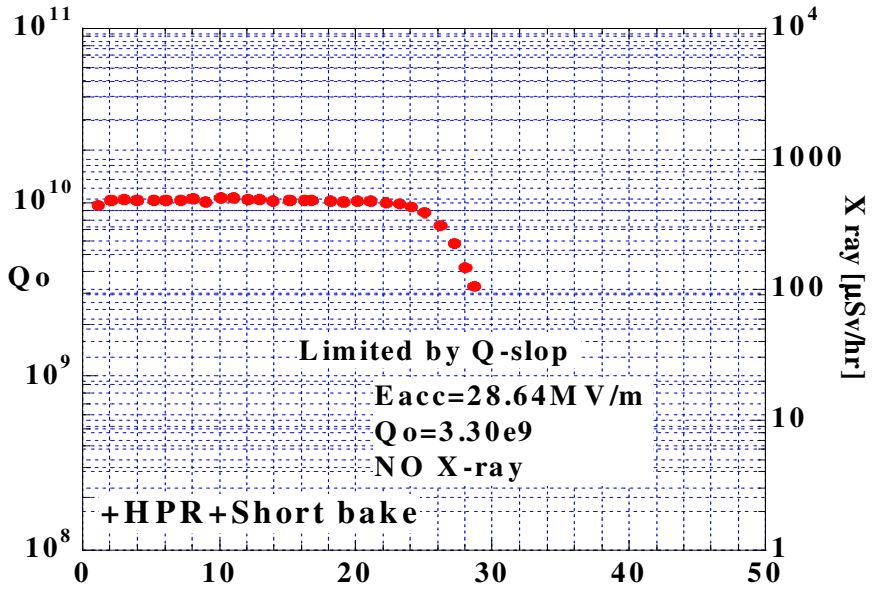


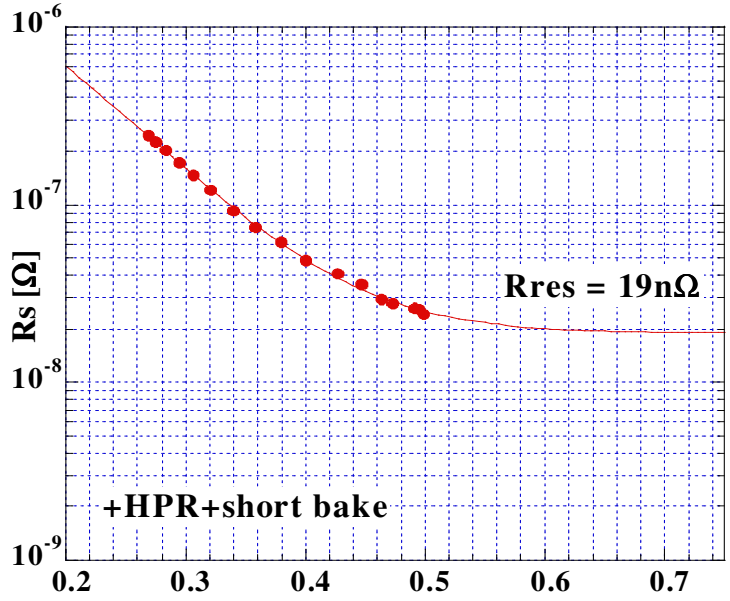




Cavity VT Test Results with MO seals

Type A

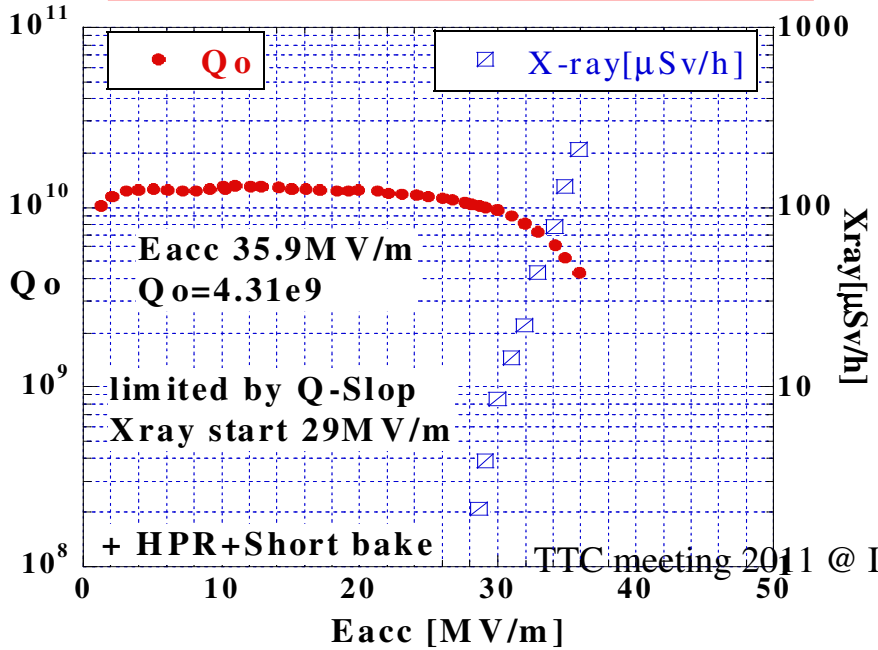


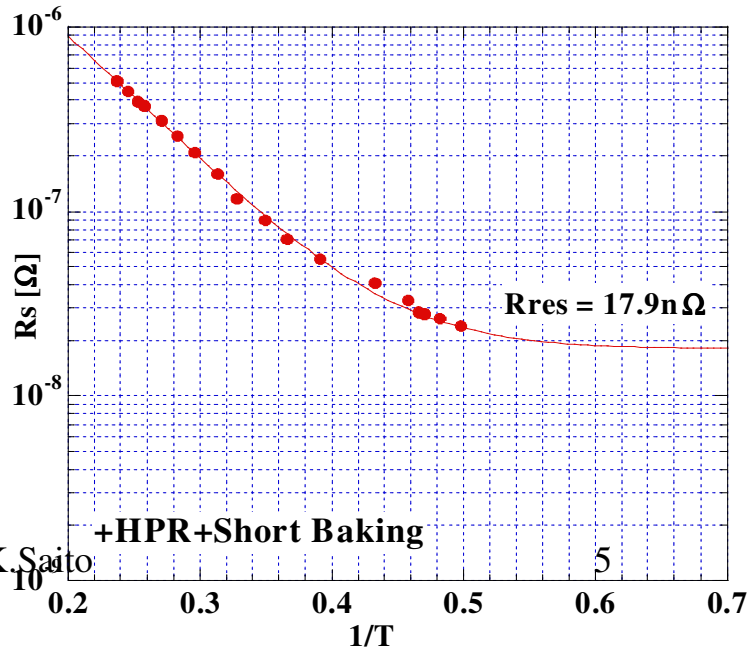


Both Cavities were treated by BCP.

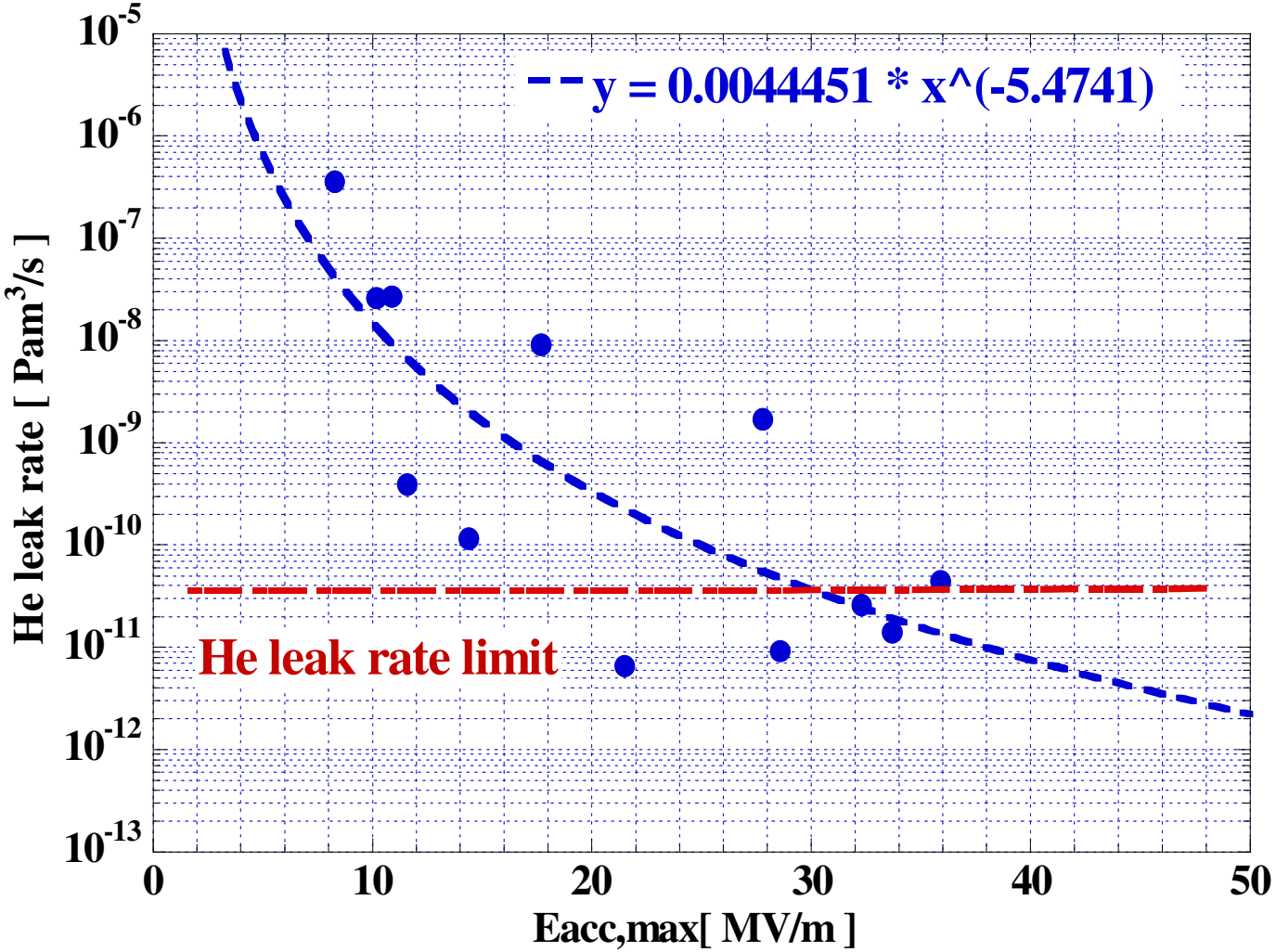
Results are fine but Q is low a little .

Type B





He Leak Rate Limit for High Gradient



He-II leak rate measurement: integrated method

Cavity was VT tested with metal closed valve, and held T < 2K for 3hr (10000s).

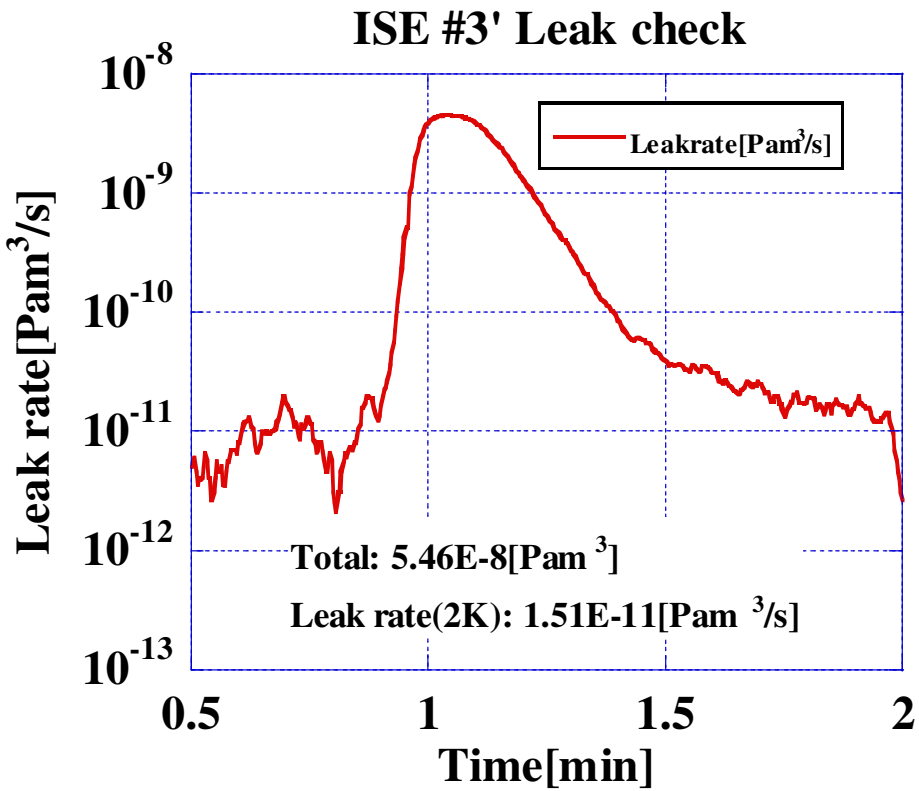
After warmed-up the cavity, He partial gas pressure was integrated and calculated the leak rate.

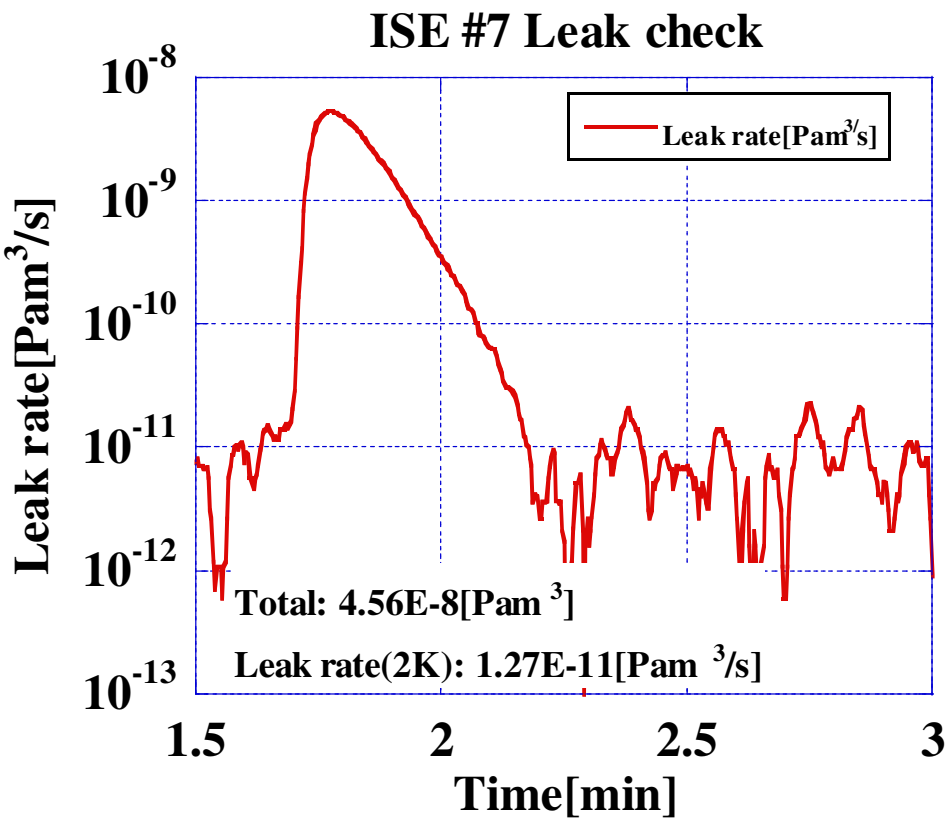
He-II leak rate should be better than ~4E-11 Pam³/s for the high gradient Eacc > 30MV/m.

Leak Rate Measurement and Comparison between MO(Cu) and Indium Seal

ISE#3' Double edged MO seal (copper gasket)
Leak rate 1.51E-11 [Pam^3/s]

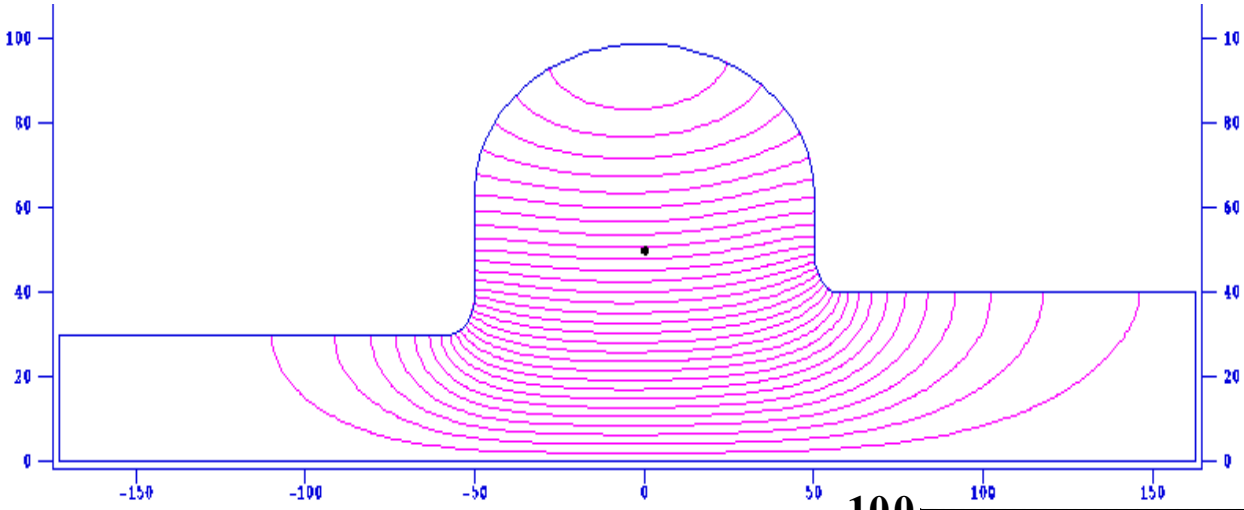
ISE#7 Indium seal
Leak rate 1.27E-11[Pam^3/s]





Both has a very similer He-II leak rate.

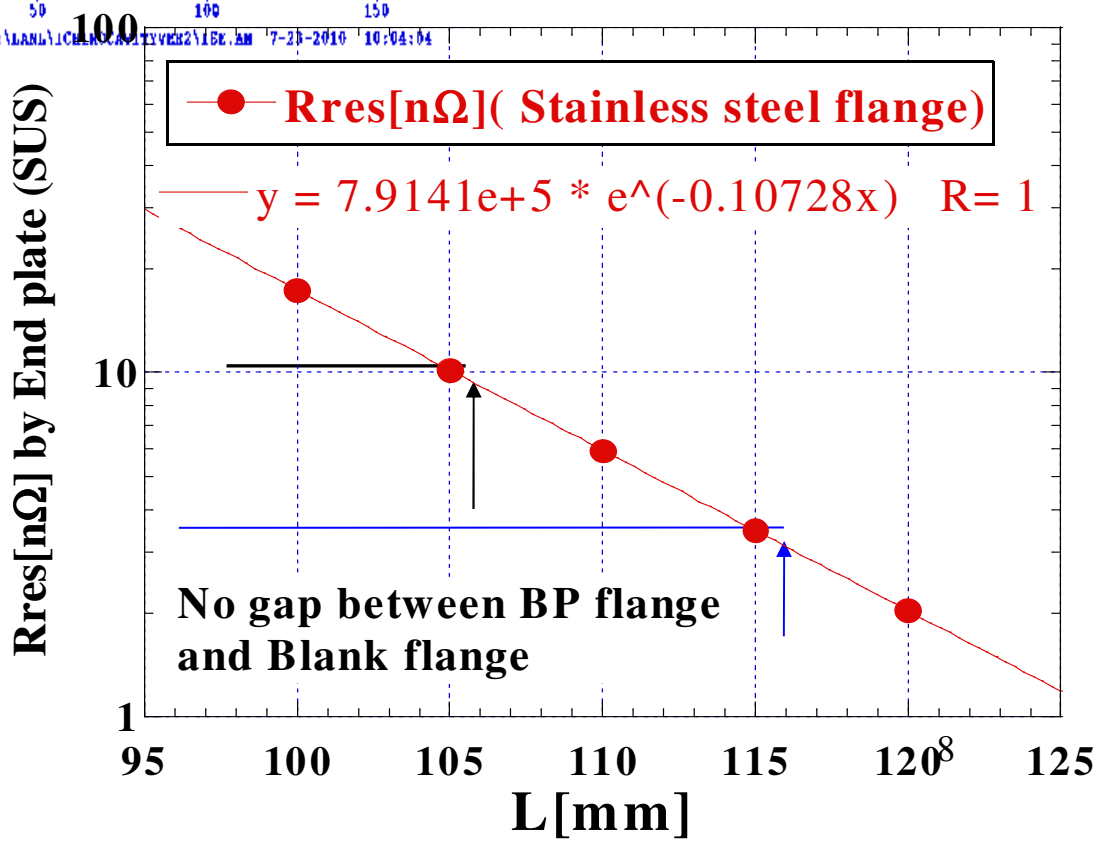
Why Q is low a little bit ?



Our reference BP length is 115mm. Rres~3nΩ is expected for SUS top flange.

ISE#3' and ISE4' were cut the flange, then re-welded MO flange. The BP length became shorter and 105mm.

Additional Rres of 7nΩ is expected by the closer top flange location.

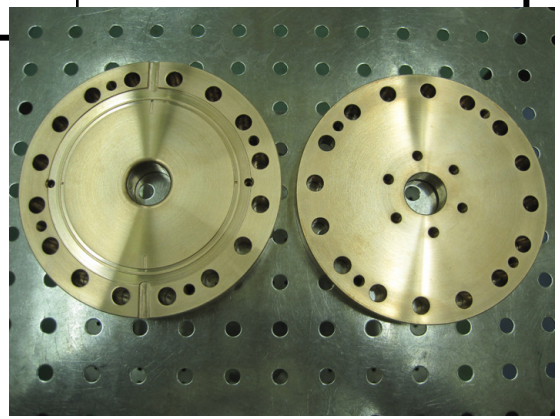


Rres test results using copper alloy MO top flange

Tight loop (HPR+VT)	ISE#4' (Type A, single edge)		ISE#3' (Type B, double edge)	
	Rres [nΩ]	Leak rate [Pam^3/s]	Rres [nΩ]	Leak rate [Pam^3/s]
1	8.5	6.5E-11	9.1	2.9E-12
2	12.9	3.6E-5	14.6	1.1E-12
3	14.8	9.8E-5	13.1	1.5E-11
4	10.1	9.3E-12	14.0	2.3E-12
Average	11.6	3.4E-5	12.7	5.4E-12
Scatter	2.8	4.6E-5	2.5	6.5E-12
Original test typical value	19.0		17.9	

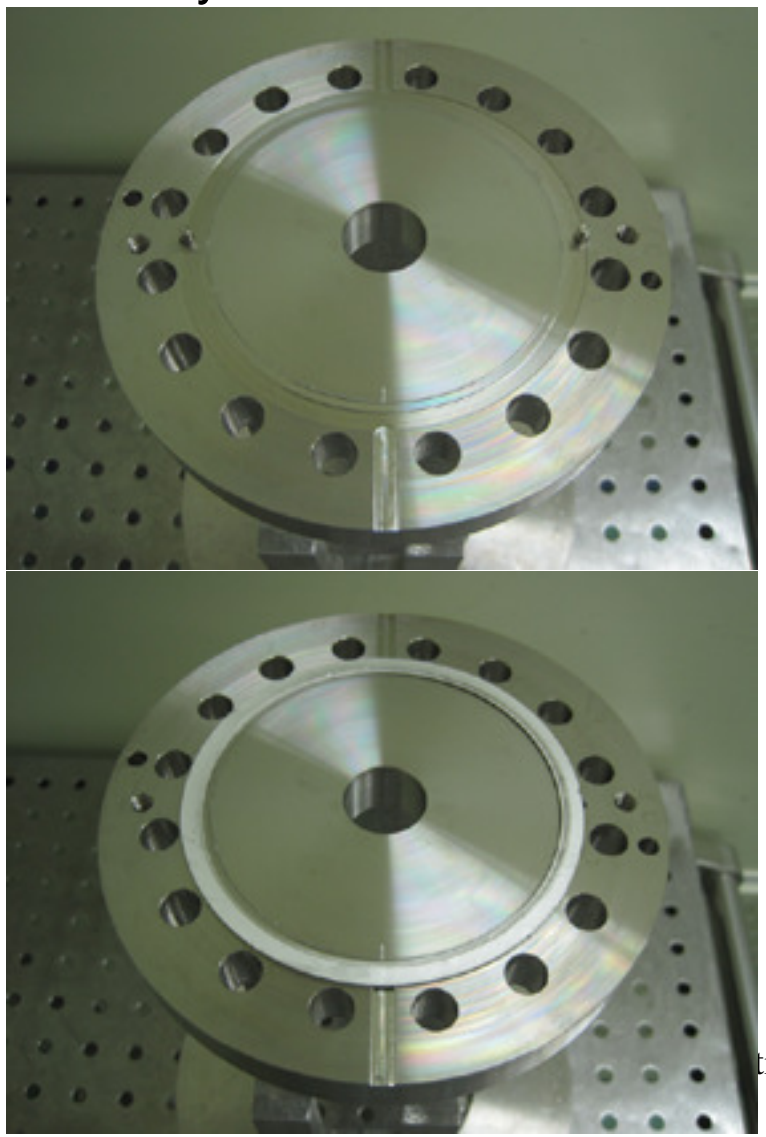
Rres is reasonably reduced by the copper alloy MO top flange.

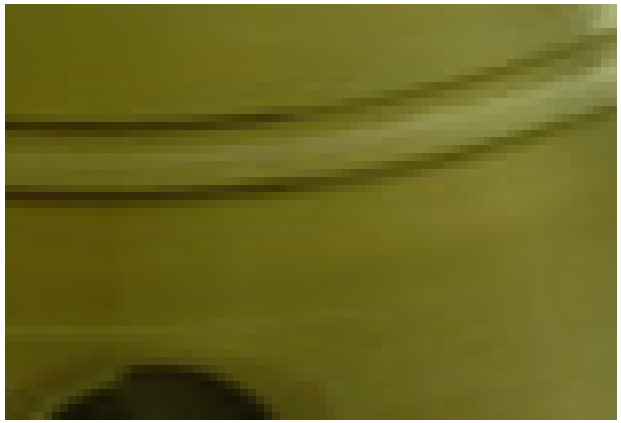
The double edged MO flange is more reliable for He-II leak tightness.

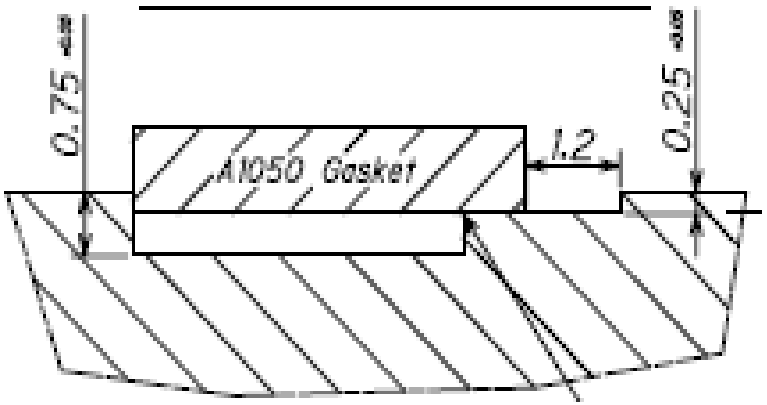


Leak tightness of MO seal (indium plated Al gasket)

Indium plated Al gaske on the one edge MO seal has been verified totally 7 times by the Ichiro#7 full 9-cell cavity at Jlab. It had never leaked.







Summary

- ***MO seal has been successfully developed.***
- ***Simple copper gasket can be use like ICF seal.***
- ***One edged MO seal has been verified to be leak tight on In/Al gasket at Jlab by Ichiro#7 full 9-cell cavity.***
- ***The double edged MO flange is more reliable and will keep the He-II leak rate less than ~1E-11 Pam^3/s.***