Experimental requirements for liquid absorber
&
Detail absorber design for MICE

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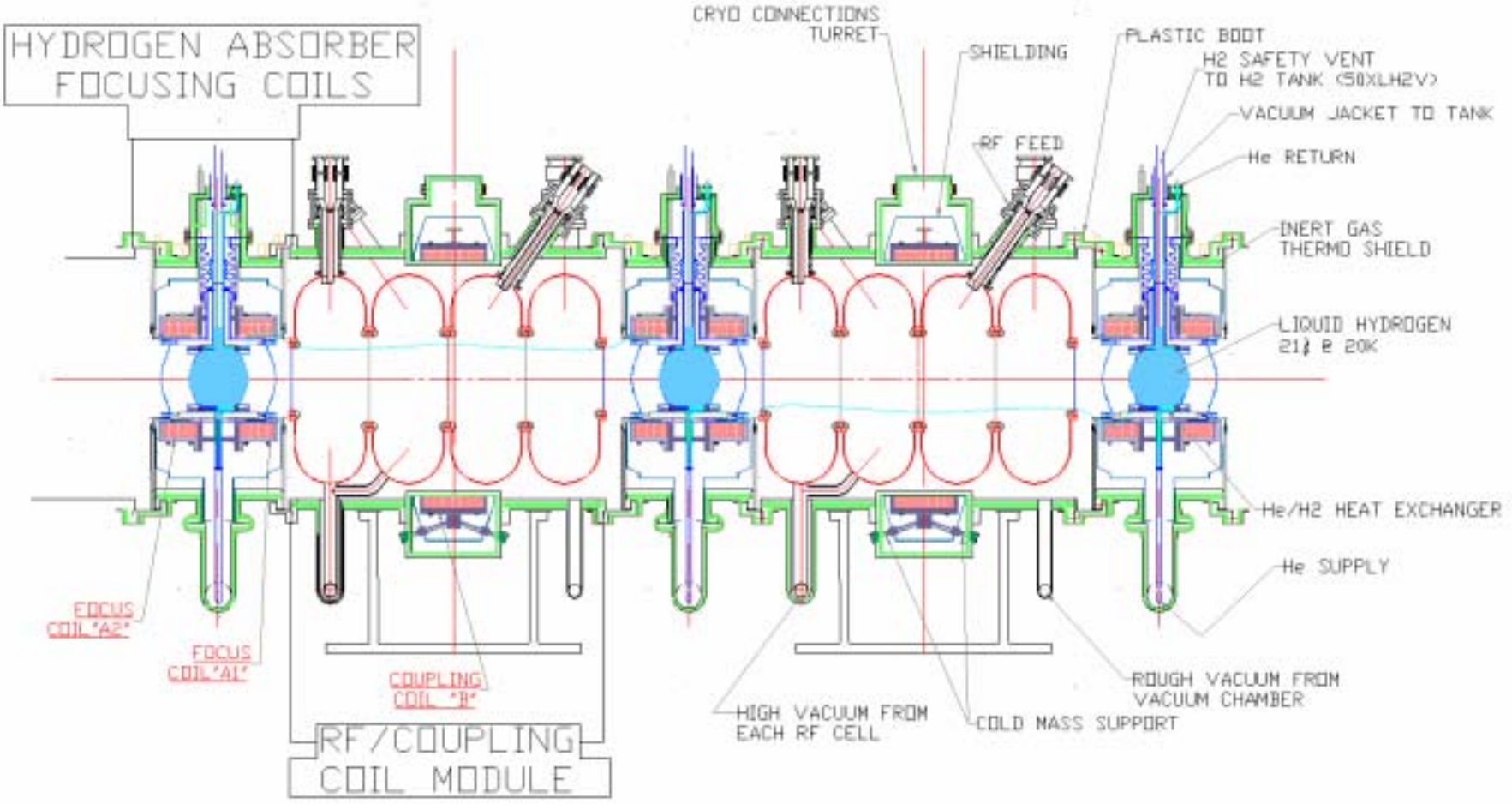
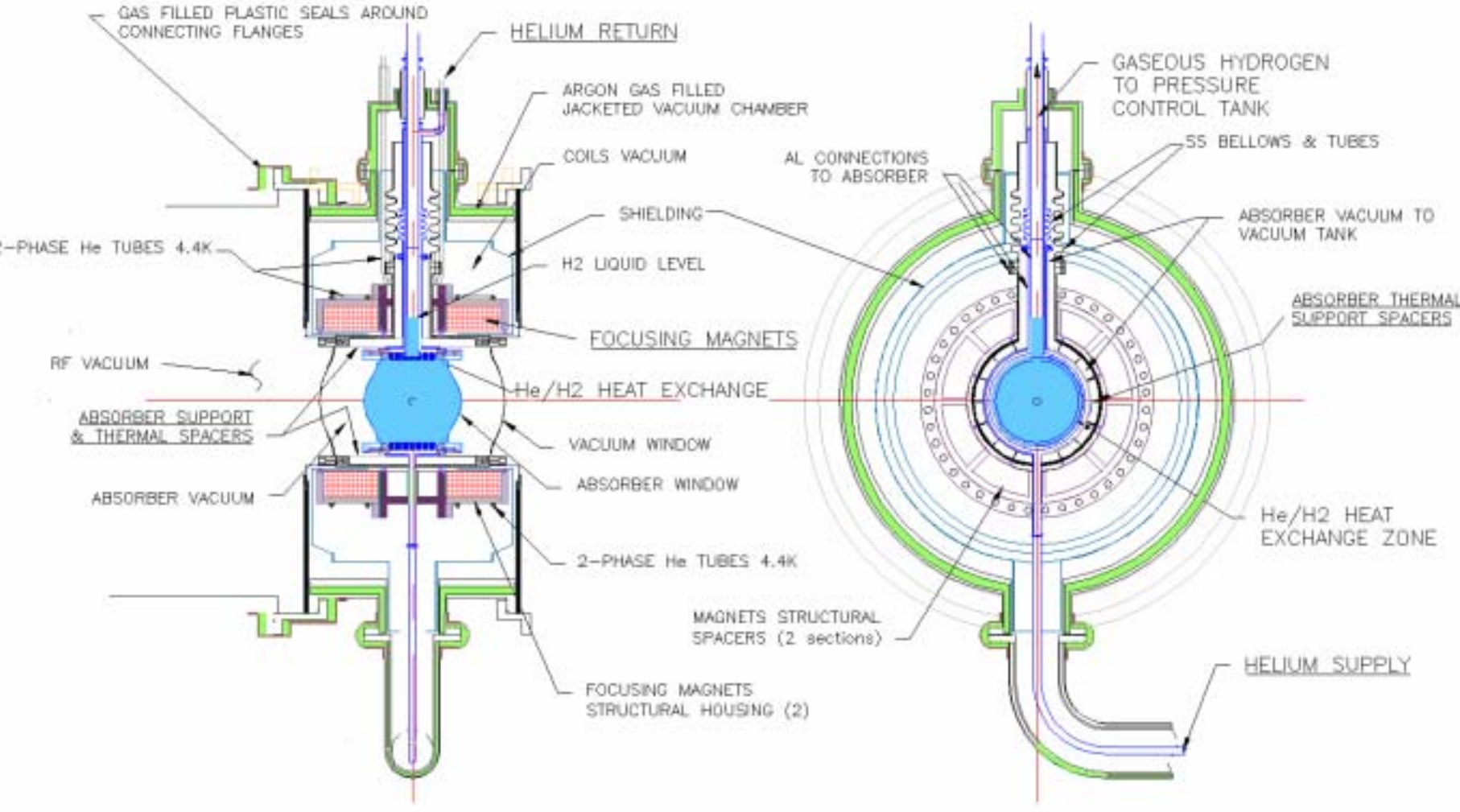
MICE collaboration meeting
27-29 MAR, 2003 at CERN

OUTLINE

1) Experimental requirements for liquid absorber
2) Detail absorber design for MICE
3) Requests to make the absorber safer and simpler


HYDROGEN ABSORBER
FOCUSING COILS
CRYO CONNECTIONS
TURRET
SHIELDING
PLASTIC BOOT
H2 SAFETY VENT
TO H2 TANK (50XLH2V)
VACUUM JACKET TO TANK
RF FEED
He RETURN
INERT GAS
THERMO SHIELD
LIQUID HYDROGEN
21ℓ @ 20K
He/H2 HEAT EXCHANGER
He SUPPLY
FOCUS
COIL "A2"
FOCUS
COIL "A1"
COUPLING
COIL "B"
RF/COUPLING
COIL MODULE
HIGH VACUUM FROM
EACH RF CELL
COLD MASS SUPPORT
ROUGH VACUUM FROM
VACUUM CHAMBER


GAS FILLED PLASTIC SEALS AROUND CONNECTING FLANGES
HELIUM RETURN
ARGON GAS FILLED JACKETED VACUUM CHAMBER
COILS VACUUM
SHIELDING
2-PHASE He TUBES 4.4K
H2 LIQUID LEVEL
FOCUSING MAGNETS
RF VACUUM
He/H2 HEAT EXCHANGE
ABSORBER SUPPORT & THERMAL SPACERS
VACUUM WINDOW
ABSORBER WINDOW
ABSORBER VACUUM
2-PHASE He TUBES 4.4K
FOCUSING MAGNETS STRUCTURAL HOUSING (2)
GASEOUS HYDROGEN TO PRESSURE CONTROL TANK
AL CONNECTIONS TO ABSORBER
SS BELLOWS & TUBES
ABSORBER VACUUM TO VACUUM TANK
ABSORBER THERMAL SUPPORT SPACERS
He/H2 HEAT EXCHANGE ZONE
MAGNETS STRUCTURAL SPACERS (2 sections)
HELIUM SUPPLY

Experimental requirements for liquid absorber

(1) Dimension

- L=300, D=300
- possible to change L' = 200 for example

→ Needs gasket flange ?

(2) Absorber center error; +/- 2 mm ?

(3) Total weight as light as possible

(4) Possible to change liquid LH2 ←→LHe

(5) Quick method for empty
(heater or heat exchange gas…)

Experimental requirements for liquid absorber

(6) Liquid level should be constant and full

(7) Liquid density should be constant; +/- 1% ?

→ T, P constant

→ Temperature uniformity

(8) Minimum bubble

(9) No or minimum solid (H2) in absorber

Experimental requirements for liquid absorber

(10) No leak any combination

absorber, He-system, vacuum chamber

(11) Vacuum (RF, Mag, Absorber vac.) and absorber system should be hold when any space failed to 1atm.

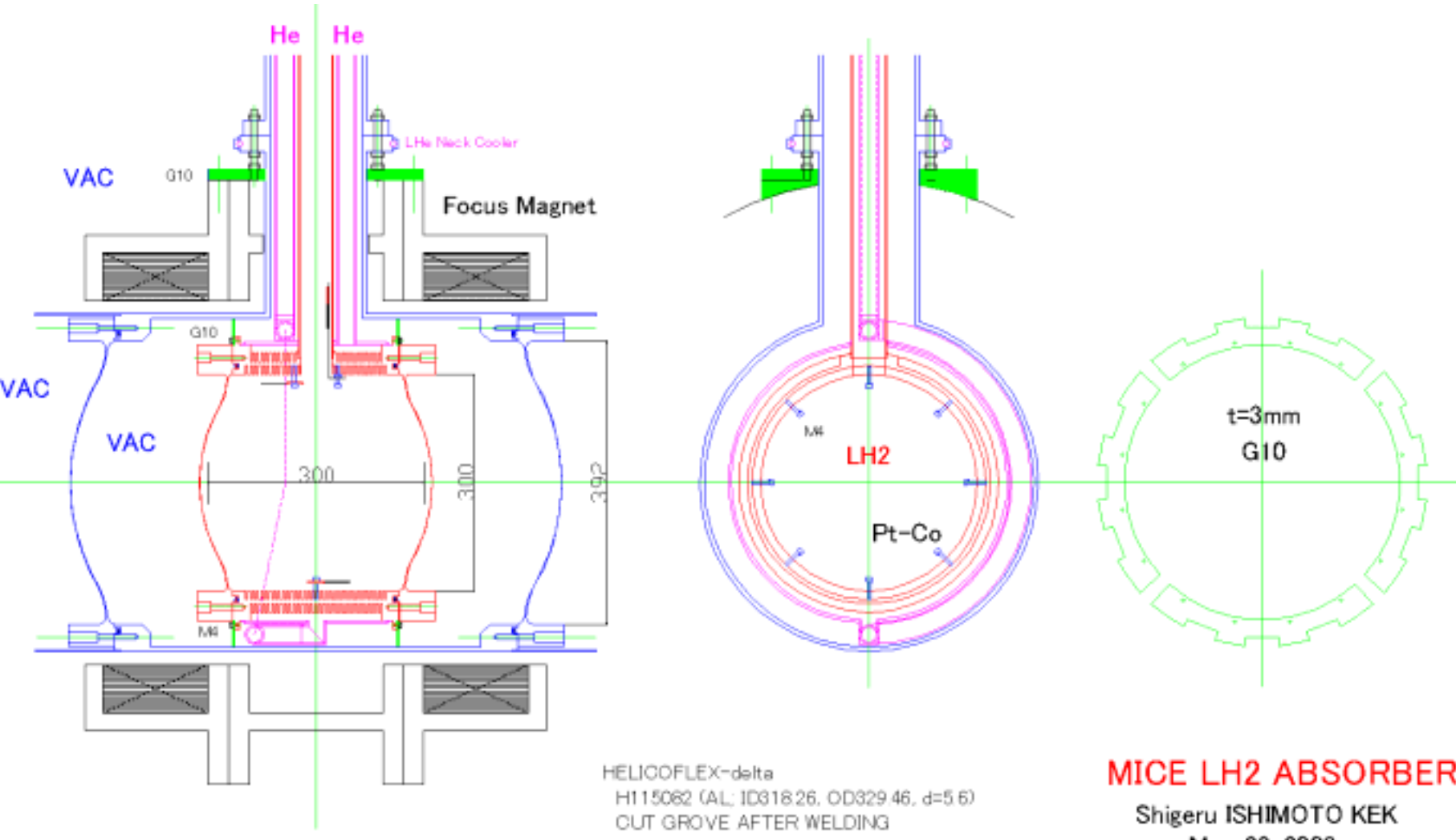
(12) Monitors

T, P, liquid level

(13) Requirement of He for absorber

- T; 4.2 - 14K

- Flow; 0 - 5 g/s

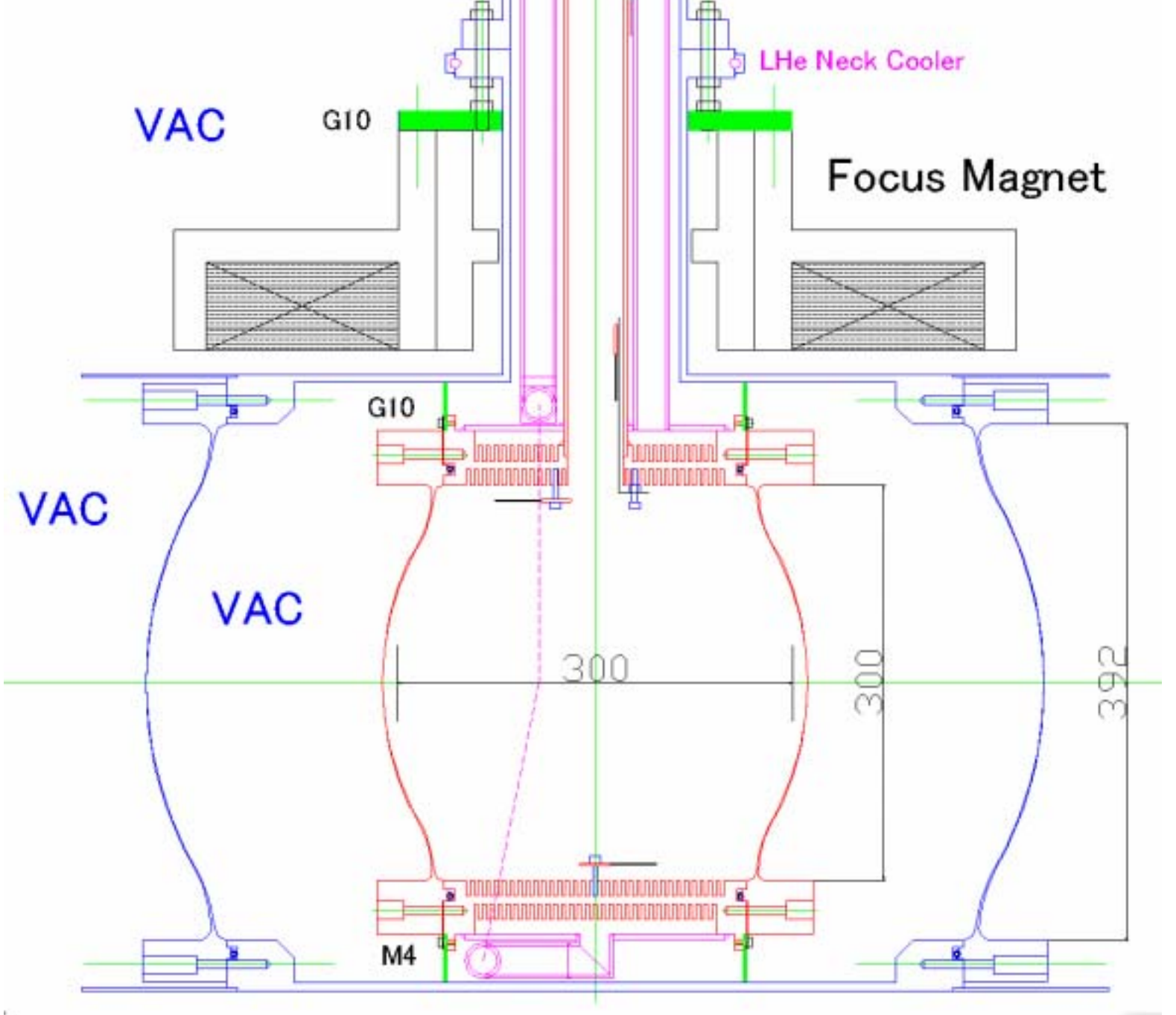


HELICOFLEX-delta
H115062 (AL; ID318.26, OD329.46, d=5.6)
CUT GROVE AFTER WELDING

MICE LH2 ABSORBER

Shigeru ISHIMOTO KEK

Mar-26, 2003


LHe Neck Cooler
VAC
G10
Focus Magnet
G10
VAC
VAC
300
300
392
M4

Helicoflex Delta® Δ Seal

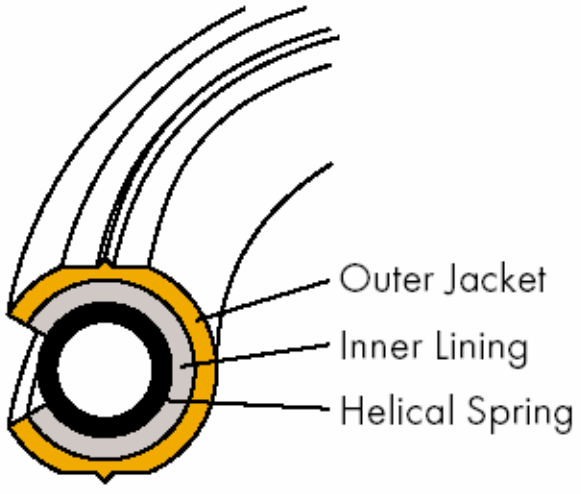
TECHNICAL DATA

Dimensions: Ø .150 to Ø 80 in.
(Ø 3.8 to Ø 2000mm)

Temperature: -458 to 1292 °F
-272 to 700 °C
+1.8 to 427 °K

Helium sealing level: $Q \leq 10^{-13}$ atm cm³/s

Seal Classification Type: HNV



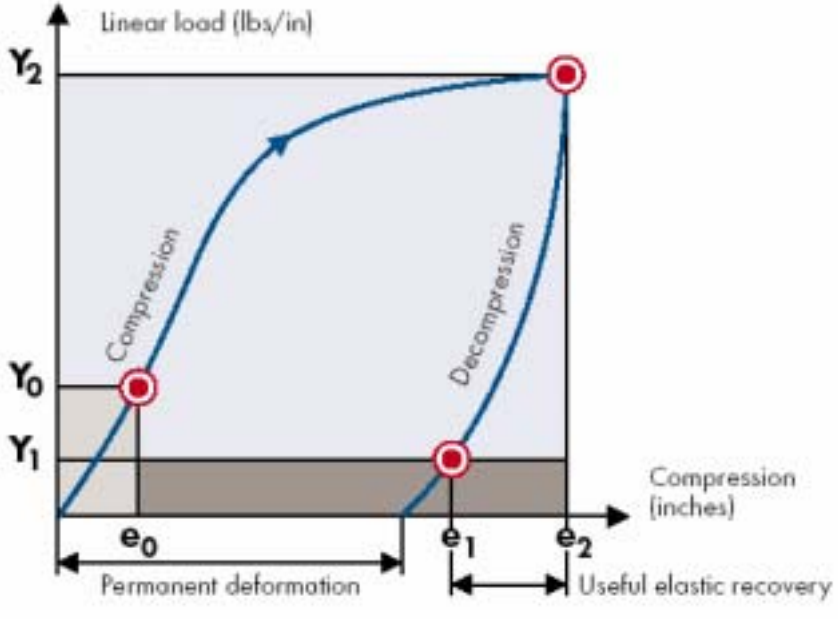
DEFINITION OF TERMS

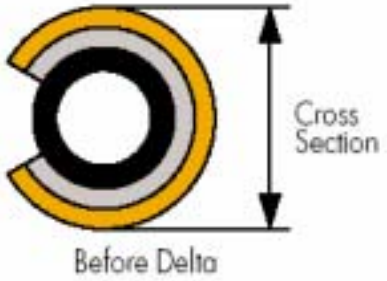
Y_0 = load on the compression curve above which leak rate is at required level

Y_2 = load required to reach optimum compression e_2

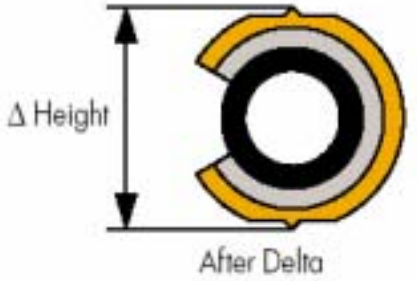
Y_1 = load on the decompression curve below which leak rate exceeds required level

e_2 = optimum compression





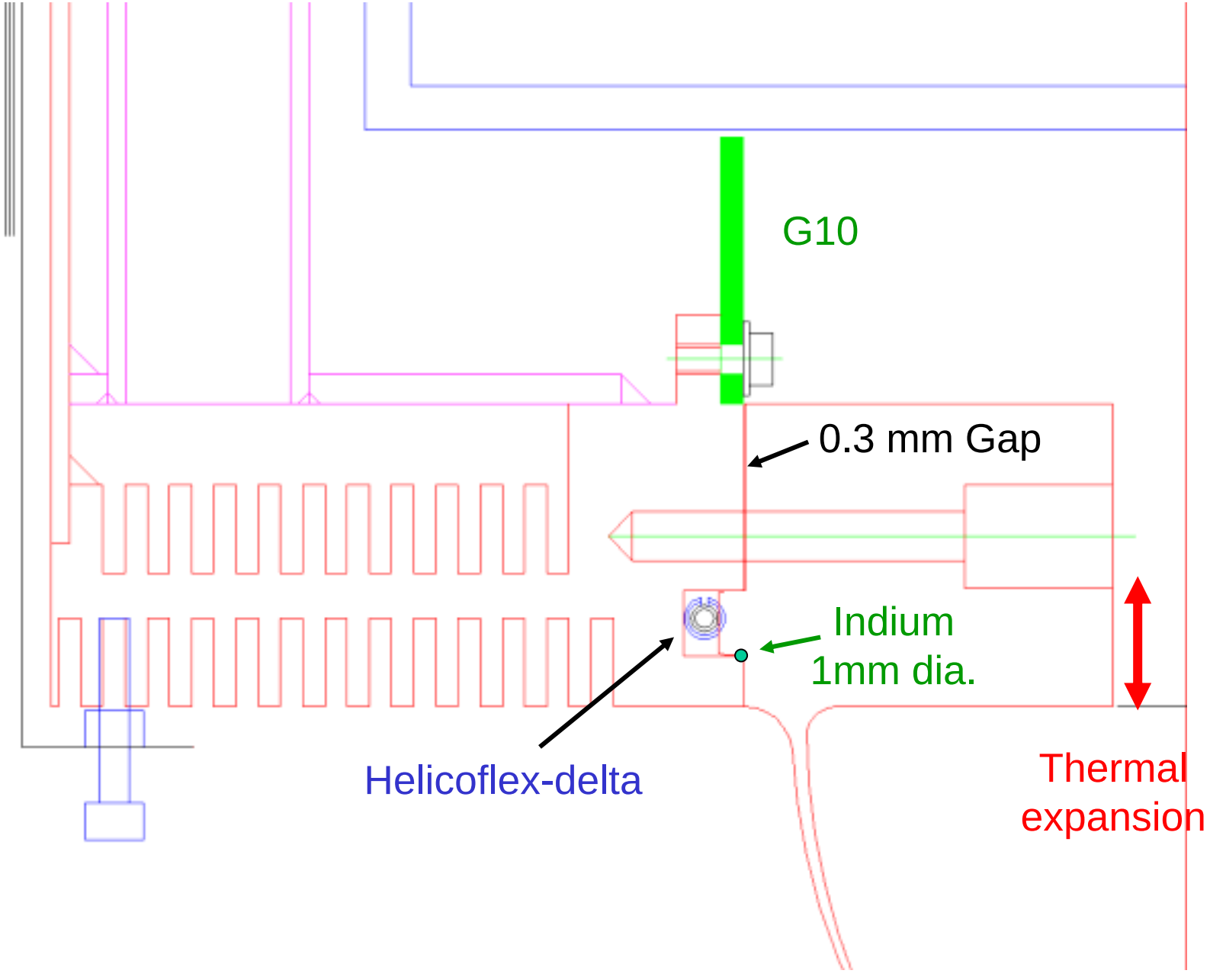
Before Delta



After Delta

JACKET	SEAL DESIGN INFORMATION											
	Seal				Compression		Helium		Flange	Maximum		
	Cross Section		Δ Height		e_2		Sealing Y_2		Hardness	Temp		
	in	mm	in	mm	in	mm	lb/in	daN/cm	HV minimum	°F	°C	
Aluminum	0.079	2.0	0.075	1.9	0.024	0.6	571	100	65	302	150	
	0.106	2.7	0.102	2.6	0.028	0.7	799	140	65	428	220	
	0.134	3.4	0.130	3.3	0.031	0.8	799	140	65	482	250	
	0.161	4.1	0.157	4.0	0.035	0.9	799	140	65	536	280	
	0.193	4.9	0.189	4.8	0.035	0.9	799	140	65	536	280	
	0.228	5.8	0.220	5.6	0.039	1.0	857	150	65	608	320	
	0.272	6.9	0.264	6.7	0.043	1.1	857	150	65	644	340	

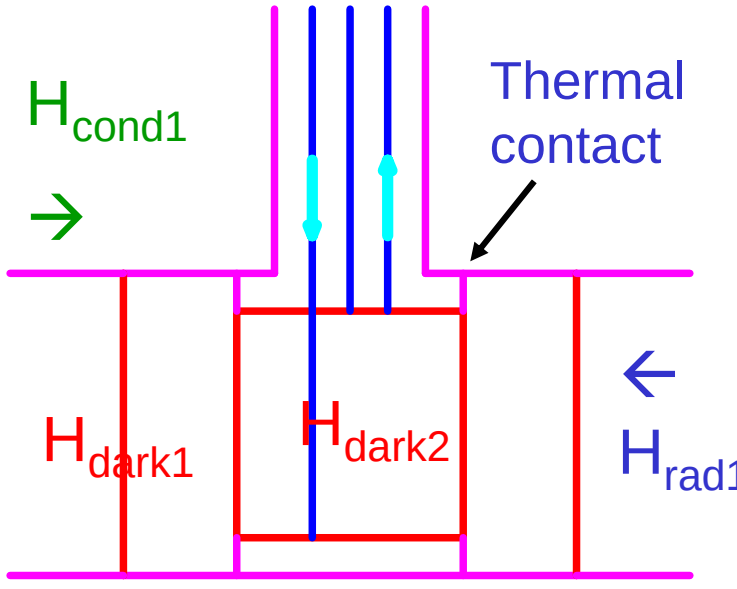
JACKET	GROOVE DESIGN INFORMATION											
	Seal Δ Height		Depth		Recommended Width		Mini Width		Clearance OD seal/OD groove		*Recommended Surface Finish*	
	in	mm	in	mm	in	mm	in	mm	in	mm	RMS	Ra in µm
Aluminum	0.075	1.9	0.051	1.3	0.195	5.0	0.100	2.5	0.020	0.5	≤ 32	≤ 0.8
	0.102	2.6	0.075	1.9	0.220	5.6	0.130	3.3	0.020	0.5	≤ 32	≤ 0.8
	0.130	3.3	0.099	2.5	0.250	6.4	0.162	4.1	0.030	0.8	≤ 32	≤ 0.8
	0.157	4.0	0.122	3.1	0.280	7.1	0.192	4.9	0.030	0.8	≤ 32	≤ 0.8
	0.189	4.8	0.154	3.9	0.320	8.1	0.225	5.7	0.035	0.9	≤ 32	≤ 0.8
	0.220	5.6	0.180	4.6	0.350	8.9	0.260	6.6	0.040	1.0	≤ 32	≤ 0.8
	0.264	6.7	0.220	5.6	0.395	10.0	0.308	7.8	0.040	1.0	≤ 32	≤ 0.8


G10
0.3 mm Gap
Indium
1mm dia.
Helicoflex-delta
Thermal
expansion

Heating of Absorber/Chamber

(1) Direct cooling

$$H_{abs}^{(1)} = H_{rad1} + H_{cond1} + H_{dark1} + H_{dark2}$$



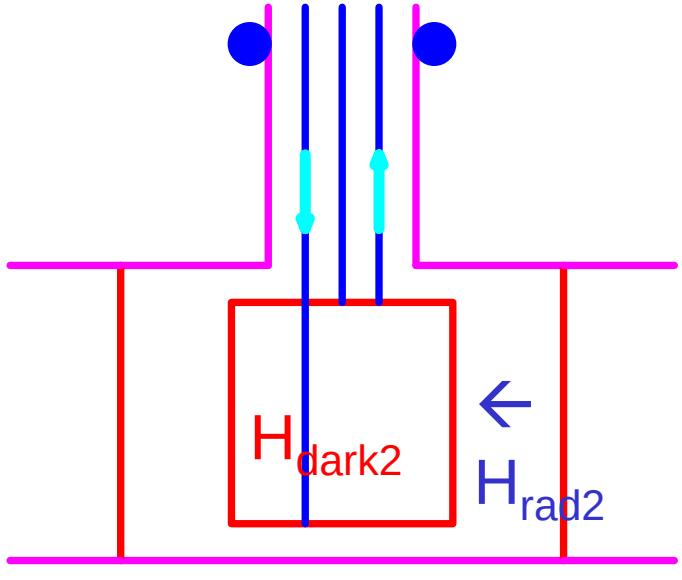
(2) Neck cooling

$$H_{abs}^{(2)} = H_{rad2} + H_{dark2}$$

$H_{rad2} << H_{rad1}$

$H_{dark1} \sim H_{dark2}$

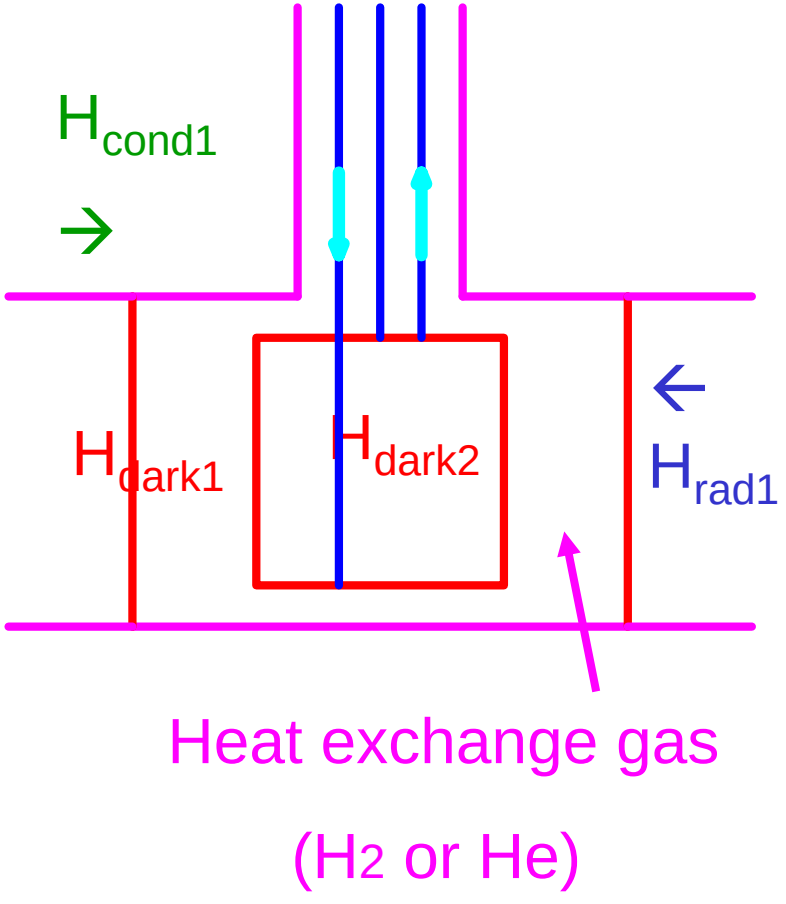
Then, $H_{abs}^{(1)} >> H_{abs}^{(2)}$



Heating at Absorber

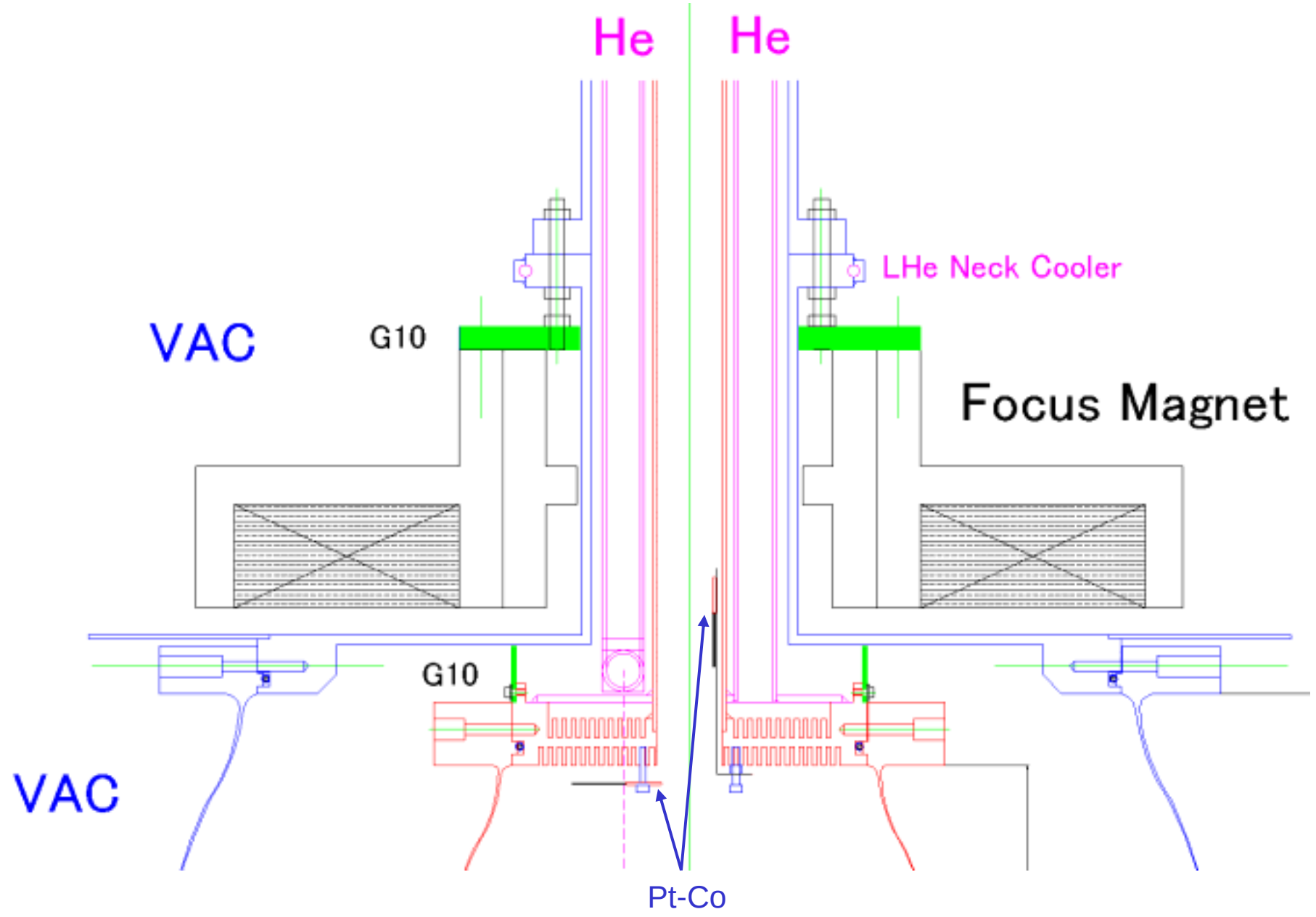
(3) Heat exchange gas cooling

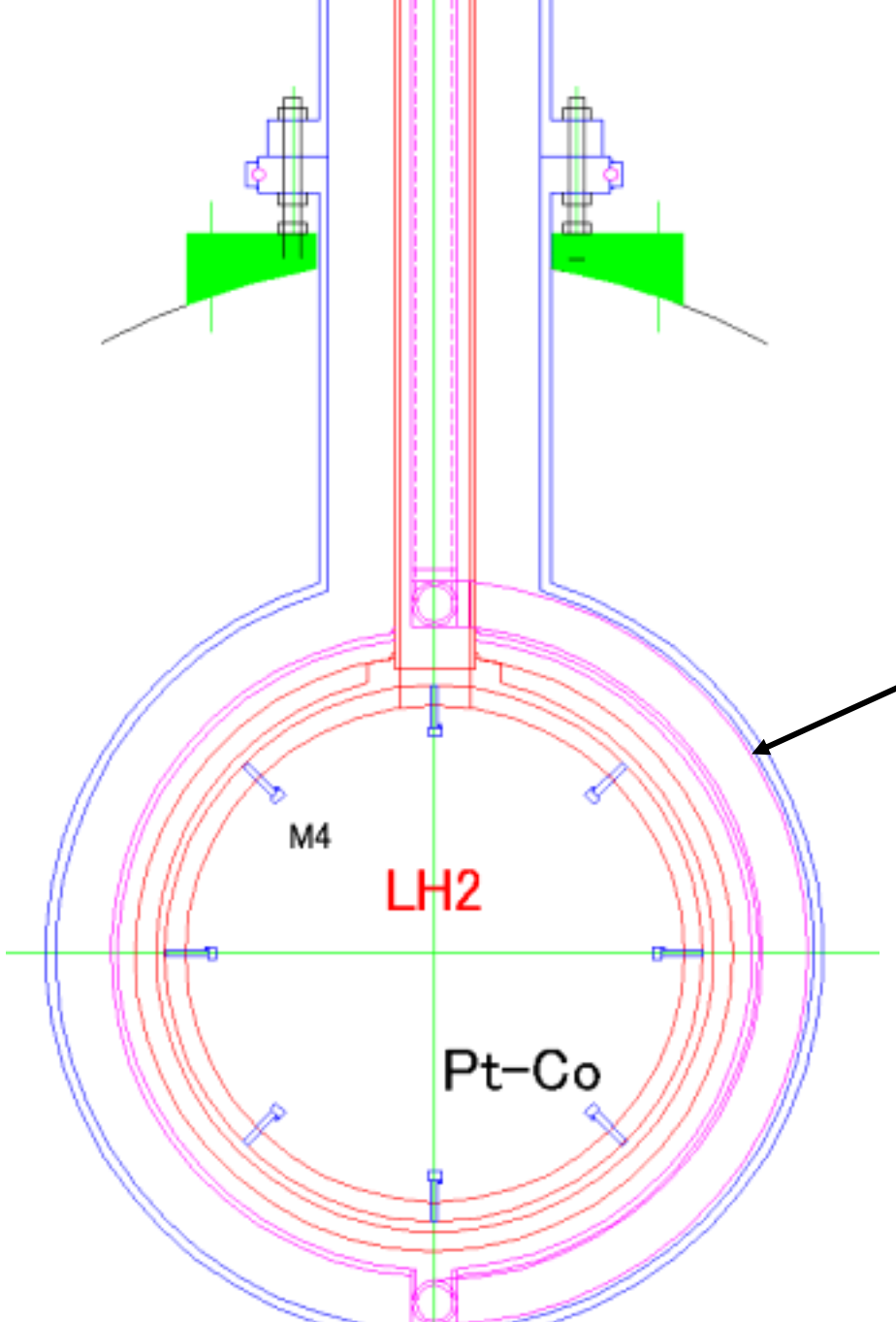
$H_{abs}^{(1)} = H_{rad1} + H_{cond1} + H_{dark1} + H_{dark2}$



- Almost same as (1)

- Can be control the heat conductance by changing the gas pressure


He
He
LHe Neck Cooler
VAC
G10
Focus Magnet
G10
VAC
Pt-Co



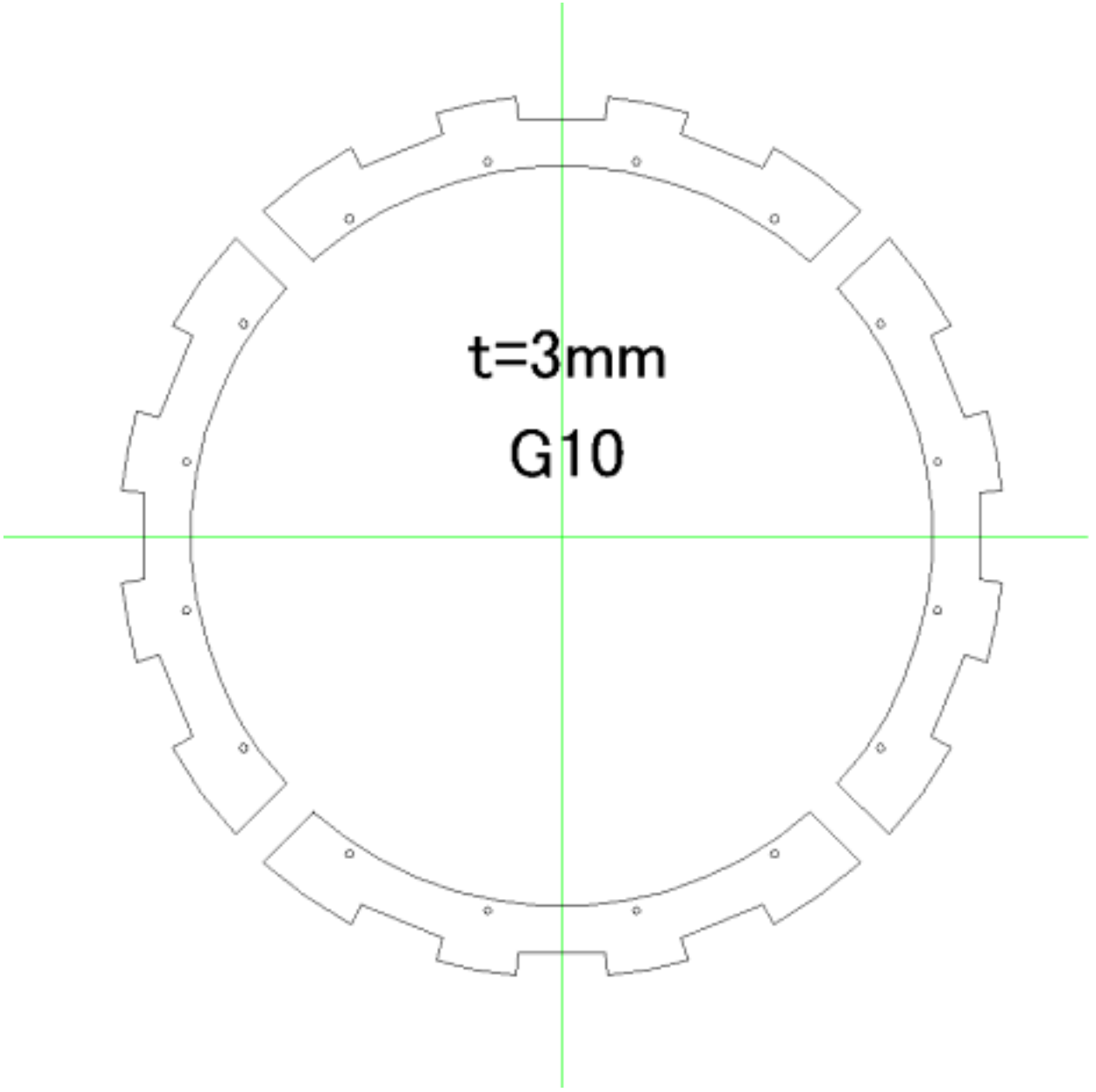
Gap=3mm

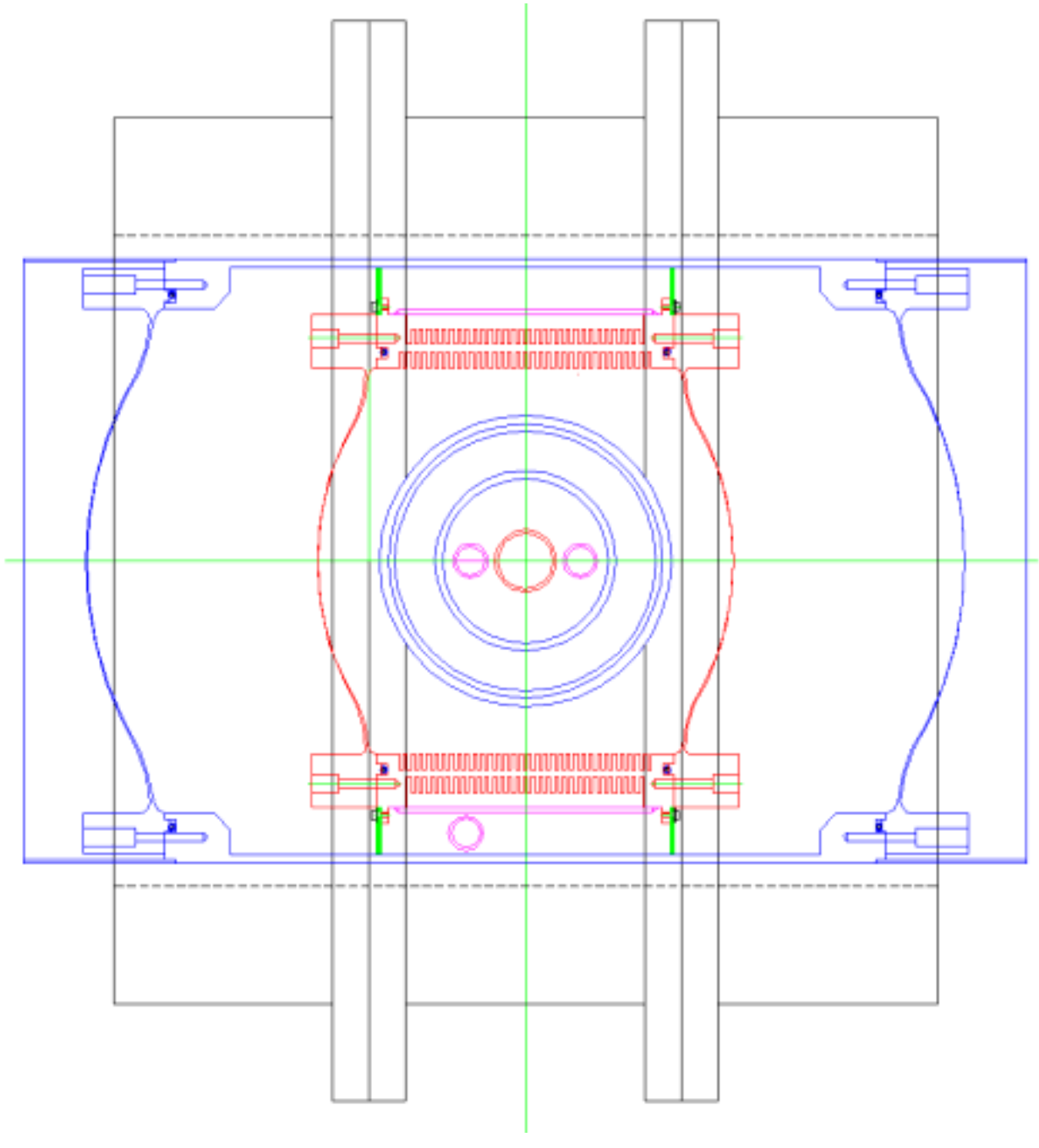
Gap= 8mm

ID_{abs}= 300 → 290

OR

ID_{mag} → -10


t=3mm
G10



Design Summary

1) He in/out tubes are independent and come from upside.
2) “Helicoflex” gaskets are used for windows seal. Grove and key structure to >protect thermal expansion. Indium seal are also possible in the preparation >stage.
3) Neck cooler to cool absorber vacuum can
4) G10 parts to hold the absorber body and the vacuum can
5) One more thermometer to measure and control the LH2 level

Requests to make the absorber safer and simpler, if it is possible.

1) Enlarge the diameter of vertical vacuum tube as much as possible.
2) Enlarge the diameter of horizontal vacuum tube, or shrink the absorber >diameter about 10 mm.