DoD heater replacement procedure

[Purpose]

This document describes heater replacement procedure of DoD16 detector.

[Limitation/Condition]

- Heater replacement shall be worked by trained service person. Usually ZSE or OLC supports are required.
- If heater burned at one of front or rear side, the other side might be damaged. When you replace one of front or rear heater, you need replace the other heater same time.

[Safety, Risk]

ESD protection

Lift about 25kg weight of detector assembly without lifter supporting

electrical short by tool (wrench)

cut finger by scraper

[Target system]

Detector

Model: 5400744, 5400744-57 (DOD16 Detector assembly)

System

Model (Brivo CT385): 5405619 (Hino), 5402412 (GEHW)

Model (Optima CT520): 5439126

[FRU part]

5654206 DoD heater replacement FRU kit

[Specific service tools]

- Heat gun
- Soldering iron
- Ionizer

[Specific consumables]

Description	GPN/STD	Qty
IPA or ethanol for removing adhesive	-	200cc
Waste to clean up adhesive		1 box
RTV-103 SILICON RUBBER ADHESIVE	46-170618P1	10g

[Overview of rail heater replacement steps]

6.5~8h, Min 2 persons operation. If the situation of the trouble matches with all conditions A~C, for easy process described below, 2 hours can be reduced.

- Remove gantry covers, fan plenum, top rail cover, Flex fix plates (30min)
- Disconnect cables and DMB that connected to detector (20min)
- Confirm "Condition A" (Electrical test before detector dismounting from gantry) for easy process. Refer to following [Detail Procedure] (10min)
- Dismount detector (Box assy) from gantry rotation base (10min)
- Remove rear heaters, clean up rear surface by alcohol (20min) or Confirm "Condition B" (Electrical test after detector dismounting from gantry) and "Condition C" (visual check of heater pattern) for easy process. Refer to following [Detail Procedure]. If easy process can be applied, go to step of mounting detector instead of whole heater replacement (30min).
- Put rear heater (15min)
- Remove front heaters and thermistor, clean up front surface by alcohol (20min)
- Put front heater (15min)
- Assemble cables by soldering, route cables, attach thermistors and thermostats, connection check (1~2h)
- Mount detector, connect cables, sanity function check (30min)
- BOW & ISO alignment, put all gantry covers, wait rail temperature back to normal (40min)
- Full calibration, IQ check (1.5h)

[Detail Procedure]

- Remove gantry covers – top/side/front/rear – to access to BOW screw
- Rotate gantry to detector at 12 o'clock position
- Lock the rotation – to stabilize the gantry balance at detector removal

Tips: It had better to fix BOW screws with tape or RTV. It might be possible to skip BOW adjustment when installing detector again.

- **1. "Condition A" confirmation**

  When detector is fixed on gantry before dismounting it, confirm resistance around heater circuit. Normal result is shown in table below. If failure condition match with following either a) or b). The easy process could be applied if it matches with other conditions B and C.

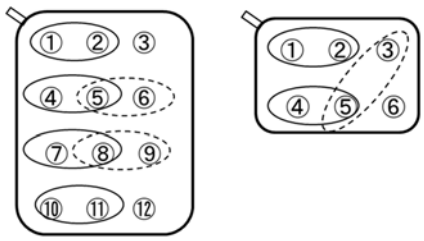
  a) 12 pos conn pin10~11 are normal and pin11~Frame are NOT insulated (Typical failure mode is zero ohm, 19.2ohm or 38,3 ohm).

  OR

  b) 6 pos conn Pin1~2 are normal and pin2~Frame are NOT insulated (Typical failure mode is same as above).

Normal condition

Connector	Pin#	Spec.	Description
Low ch side 12 pos connector	1~2	8.1~9.9 ohm	Center zone Heater
	4~5	9~11 k ohm at 25degC	Center zone Thermistor
	7~8	9~11 k ohm at 25degC	Low ch side Thermistor
	10~11	**35.4~41.2 ohm**	**Low ch side Heater**
	2~Frame	shall be insulated	Insulation of heater center zone
	5~Frame	shall be insulated	Insulation of thermistor center zone
	8~Frame	shall be insulated	Insulation of thermistor low ch zone
	11~Frame	**shall be insulated**	**Insulation of heater low ch zone**
	5~6	shall be insulated	Insulation of center thermistor shield
	8~9	shall be insulated	Insulation of low ch thermistor shield
High ch side 6 pos connector	**1~2**	**35.4~41.2 ohm**	**High ch side Heater**
	4~5	9~11 k ohm at 25degC	High ch side Thermistor
	3~5	shall be insulated	Insulation of high ch thermistor shield
	2~Frame	**shall be insulated**	**Insulation of heater high ch zone**
	5~Frame	shall be insulated	Insulation of low ch thermistor

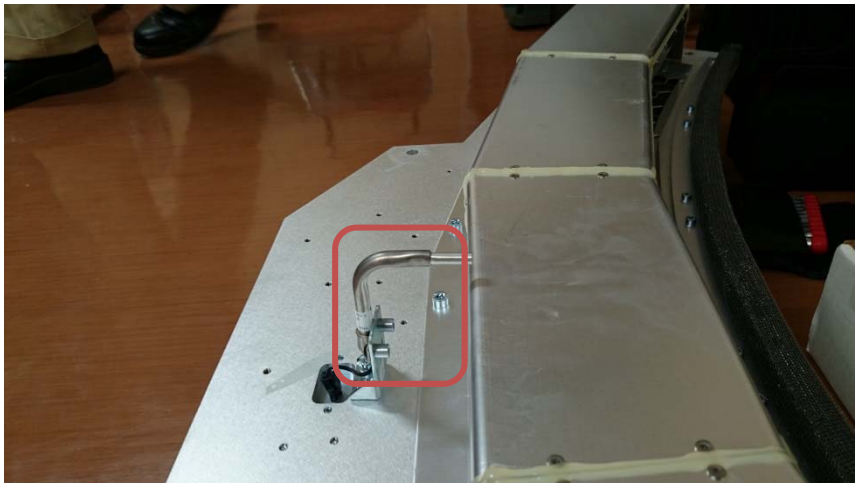


- **2. Remove fan plenum**

  Disconnect 2 cables (J2, J3A) on fan cable box from rotation base

  Remove 6 cap screws with orange arrows in the photo

Caution: Not to break sensor on back side of plenum when plenum put on floor.



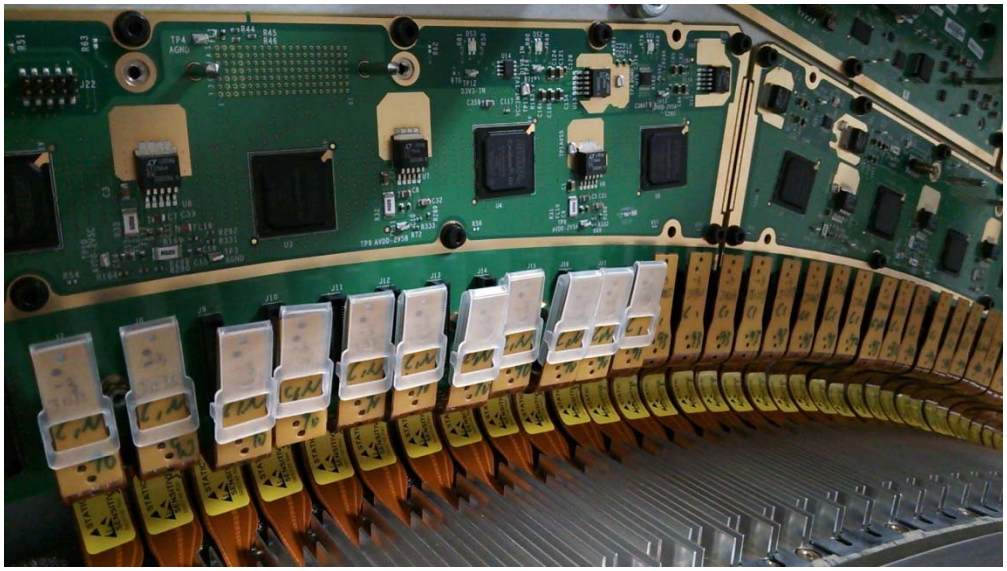
- **3-1. Remove Flex fix plates & disconnect flex cable from BP**

Be careful. It is easy to drop or lose small cap screws and washers.

Caution:

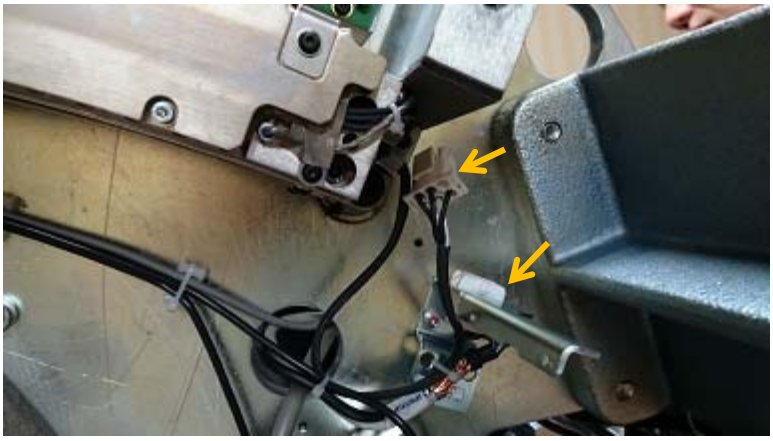
- ✧ ESD protection is mandatory when disconnect flex cable from back plane
- ✧ Unplug the connectors softly and straight. Easy to damage connector pins.

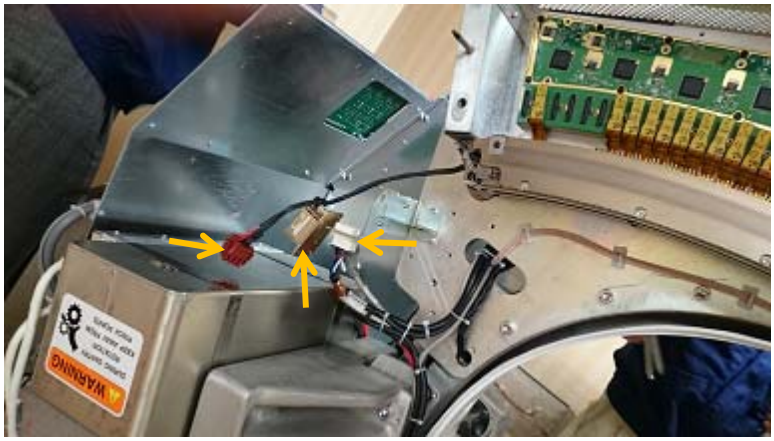
- **3-2. Put ESD protection covers on flexible cable connectors**



- **4. Disconnect cables**
- Disconnect both sides of cables from detector (6pos connector and 12pos connector) and dismount DMB assy (Detector memory board assembly)

  Cut the tie-wraps on the both cables. These cables become free from the gantry.





- **5. Dismount detector from rotation base**

  Loosen the both side of detector mounting screws (Do not take out screws to prevent detector drop off). Shift the detector toward front by loosening the center BOW screw. Keep the detector parallel to rotation base with pulling each side of detector as possible. Once center screw becomes free from rotation base, manually hold the detector and remove both sides of the detector mounting screws. Detector is free along to the direction of rotation axis. Only the detector guide pins at both sides hold the weight of the detector. Carefully pull out the detector forward front direction. Detector guide pins do not hold weight of the detector after pulling the detector away from gantry rotation base.

Overview of dismounted detector and DAS/Det chassis.



You need reuse guide insulators when you mount detector again. These insulators usually left on gantry side.

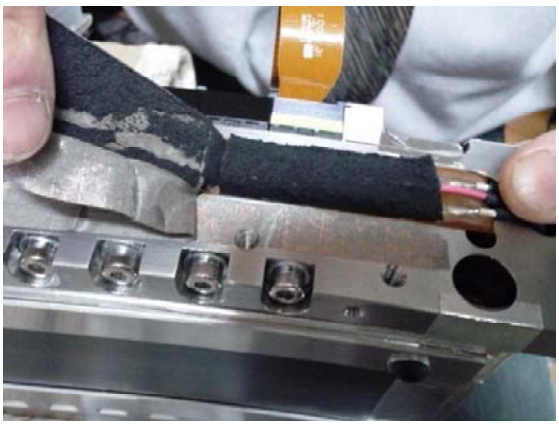
Be careful not damage to flex cables.

- **6. "Condition B" confirmation**

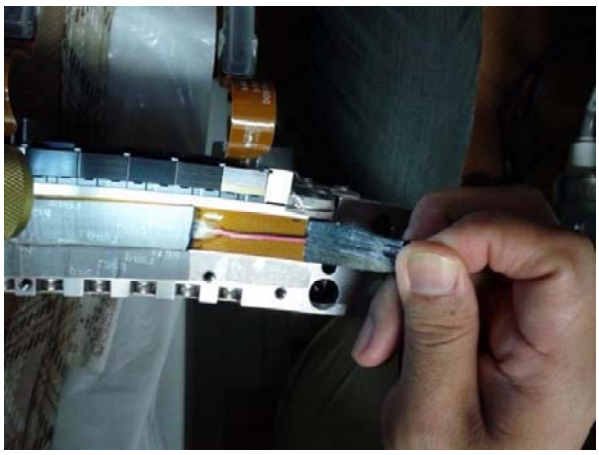
  When detector is removed from on gantry after dismounting it, confirm resistance around heater circuit. Refer to the table of "Normal condition" shown in chapter of "**1. "Condition A" confirmation**". If all pass and normal, the easy process could be applied if it matches with another condition 3. If not, easy process can NOT be applied and go to step **"9. Rear side replacement"**

- **7. "Condition C" confirmation**

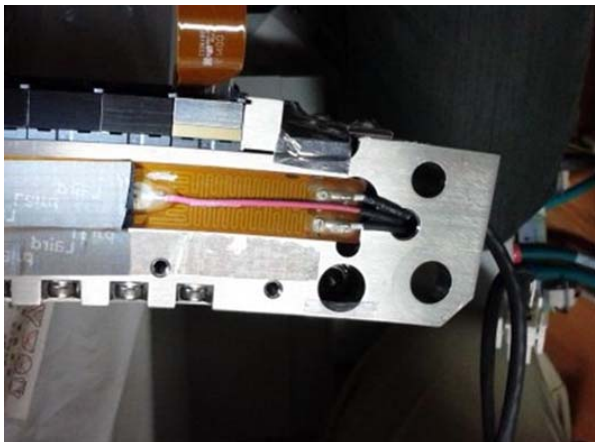
  - Peel-off and cut EMI tape approximately 5cm from both end of rear heater.



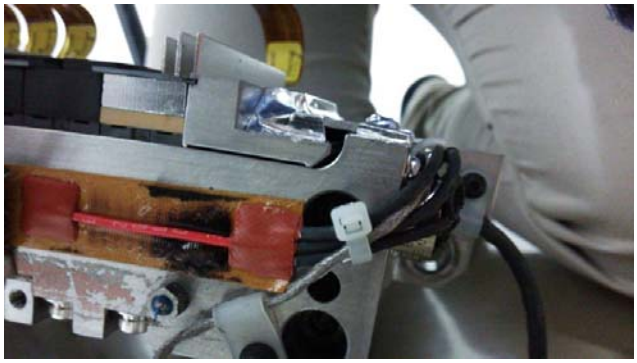
- Peel-off black thermal insulation rubber approximately 4.5cm which was attached on heater separately from center zone.



- Clean heater surface to confirm heater does not de-colored and damaged. Alcohol can be use if needed.



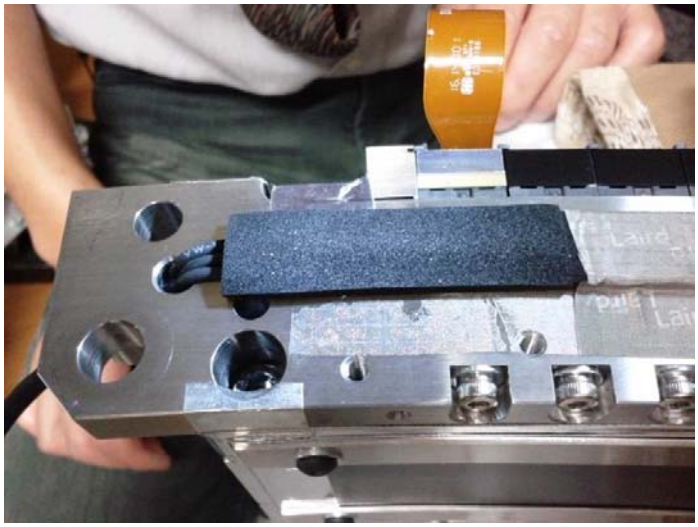
- If end zone of heater is/are colored/damaged, you need replace heater and go to step **"9. Rear side replacement"**. Photo below is an example of damaged heater in worst case.



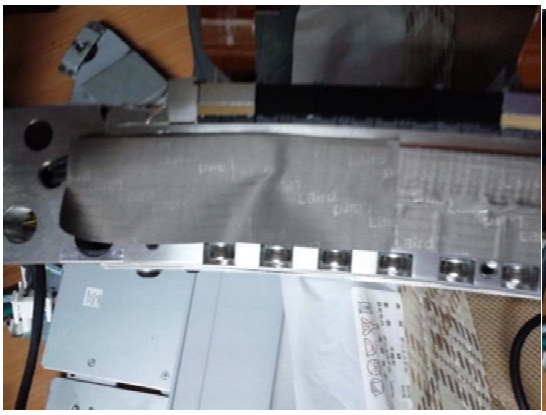
If heater end zone is not damaged, the easy process can be applied and go to next step for easy process.

- **8. Easy process; Attach pieces of thermal insulation rubber and EMI tape**

  - Attach a piece of insulation robber at end zone where old rubber was removed. New rubber is a little larger than old one, and it covers wire connection area not only actual heating zone.



  - Clean surface of detector frame to keep space for new EMI tape to be attached. Attach a piece of EMI tape to cover the rubber. This EMI tape is to be attached with over-wrapping on original remaining tape on center zone.




  Attach the other piece of rubber and EMI tape on the other end side of rear heater.

  Go to step **"14. Mount detector, connect cables, sanity function check"**.

- **9. Rear side replacement**

  [Technically important key points]

  - This heater has three heating zones which are independently controlled. Both end zones have higher heat density than center zone. It is very important to push out air from the gap of heater and detector at both end zones. Air void will cause the trouble in long term.

  - Adjustment of heater position will make heater deformation which unexpectedly keeps/traps air in the gap. To avoid air void at both end zones, don't adjust position during attaching heater end zone.

- Keep space for air escaping in between heater and detector, and attach heater to push out air one way direction. Once air is trapped in adhesive, it is difficult to push out air against sticky adhesive.
- At the center zone, adjustment of heater position is allowed. To peel and attach heater again is also allowed at center zone only once. The correct heater position is prioritized to avoiding air gap at center zone, because heat density of center zone is not so high. Good positioning of center zone will make it easy to attach end zone without position adjustment.
- Not allow air void at both end zones. If you find visible air void, remove the heater and order new heater kit. Never use used heater again. 1mm diameter air void induces heater open trouble again.

[Over view]

Cut wires of heater.

Remove heater and EMC protection tape

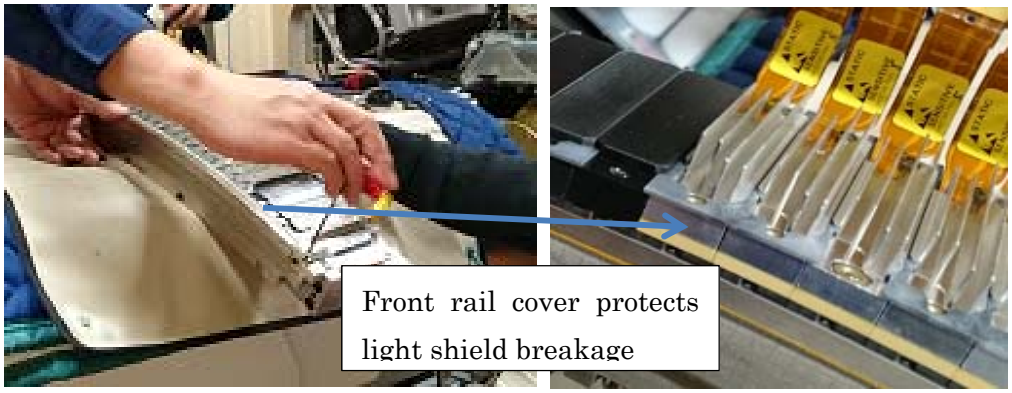
Remove adhesive and remained tape on detector surface with alcohol and scraper. Use alcohol to wet adhesive and make softer to make it easy.

After scraping adhesive with scraper, clean out remaining adhesive with using alcohol and paper or cloths.

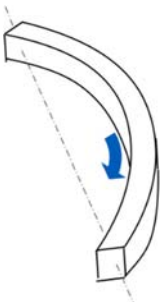
Attach new heater.

9-1 Preparation

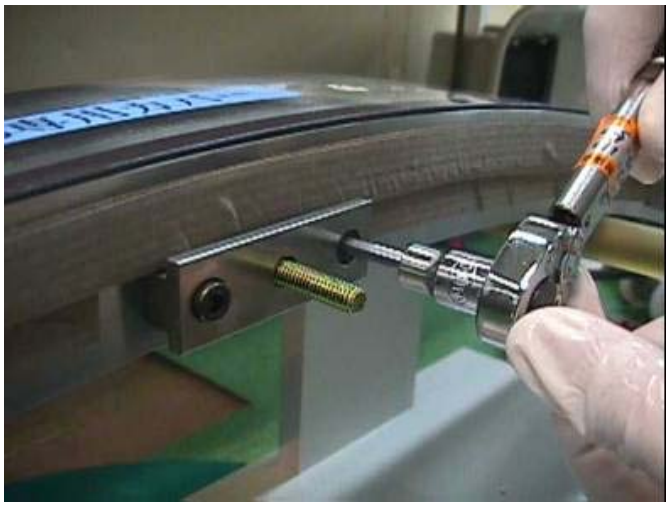
If Front Rail Cover is already removed, tentatively put a front rail cover on the detector. It protects the edge of the Light Shield Plate from damage when you put the detector with rear side up for easy operation.



When you will put detector with rear side up, please hold weight of center portion too, because holding only both ends makes unbalance which comes from arc shape.



9-2 Remove center BOW bracket on rear side.

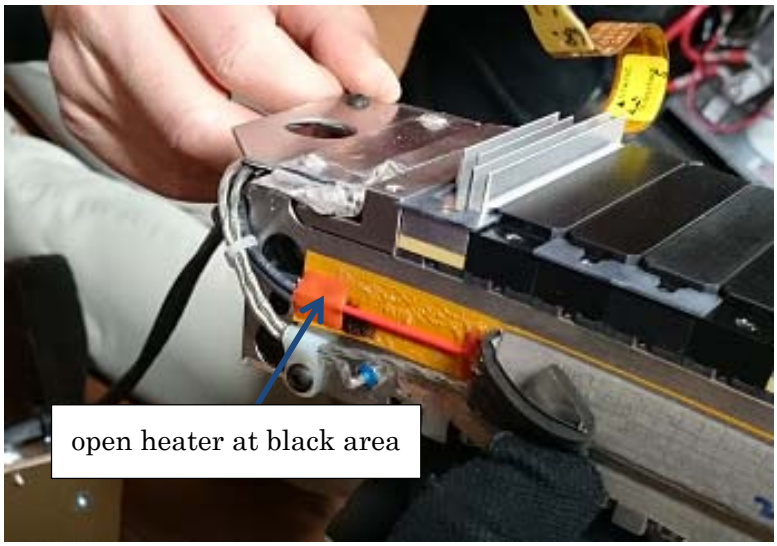


9-3 Removal of Rear Heater

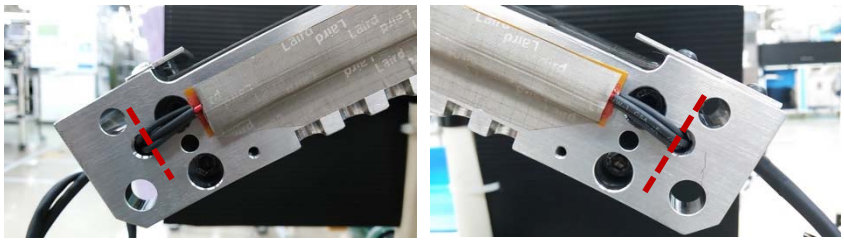
9-3-1 Record of failed heater

During removal of heater, if damaged portion is found with removal of EMC tape and thermal isolation foam, record the damaged location to the log sheet.

*refer design information in appendix A: reason of heater open at both rail end.



9-3-2 Cut wires from Rear Heater

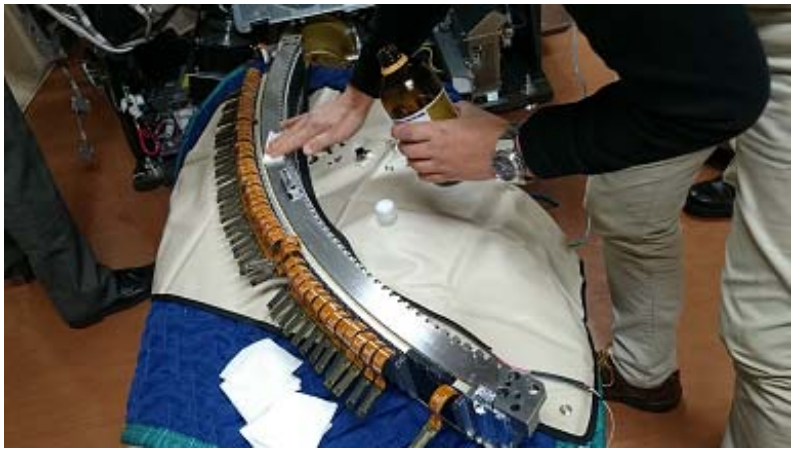


9-3-3 Peel off the Rear Heater and EMC tape.

Peel off the Rear Heater and EMC tape.

Wet remaining adhesive and tape with enough alcohol and remove them with scraper.

Also clean remaining adhesive with using alcohol and paper or cloths.



Final rail surface after cleaning. Remove front rail cover after clean up.

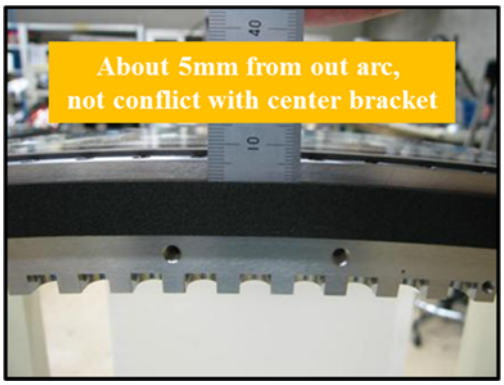
Confirm there is no remained adhesive on the detector surface and surface is smooth with sliding your finger on it.

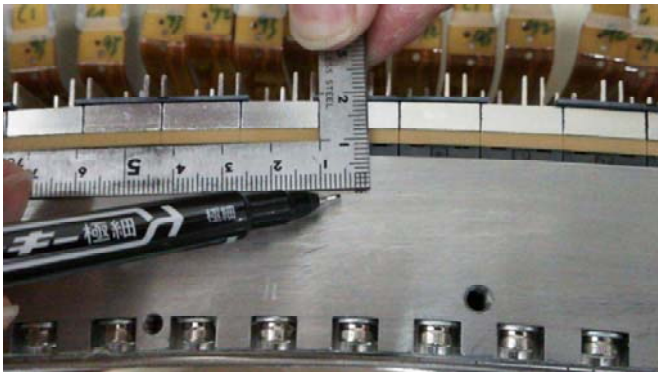
9-3-4 Attach Rear Heater

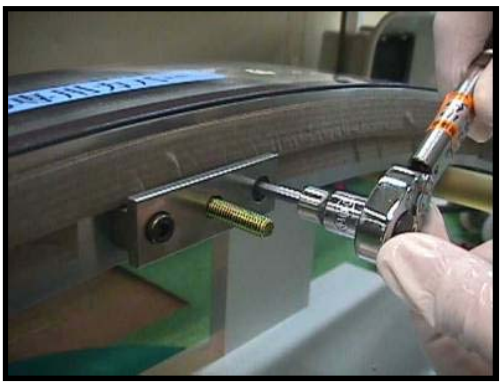
9-3-4-1 Preparation

Wipe rail surface by alcohol again before attaching new heater. If you touch the surface, oil remains on surface.

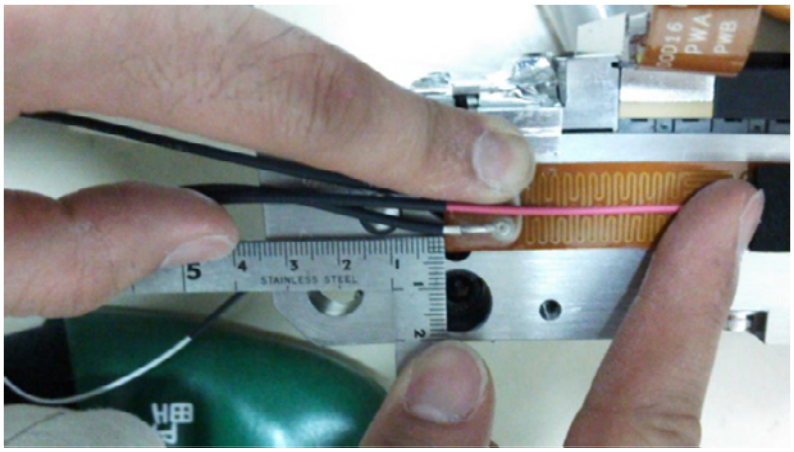
Mark several positions at the **4mm** distance from the O.D. (outer diameter) edge of the arc of detector rail for the reference of heater position. Confirm this marked position does not make interference of the heater to Center BOW bracket.

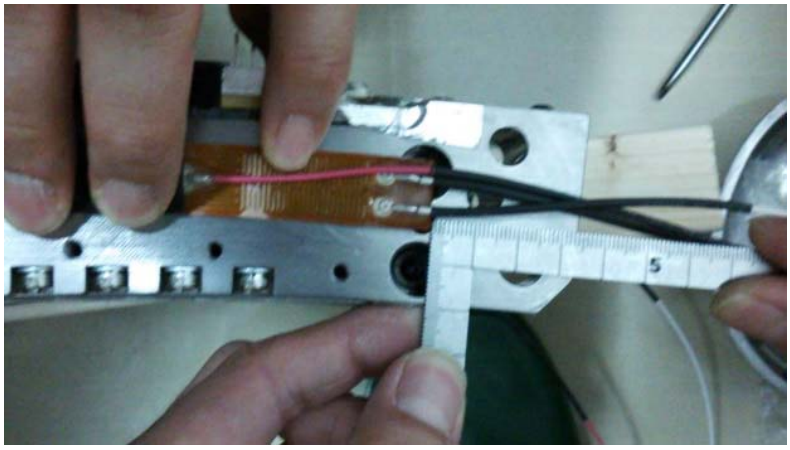






Also mark **34+/-2mm** position from both end of detector front rail for reference of heater longitudinal position.





9-3-4-2 Attach heater

9-3-4-2-1 Starting end zone

Place the rear heater (which doesn't have thermostat) on the detector with aligning to the marks.

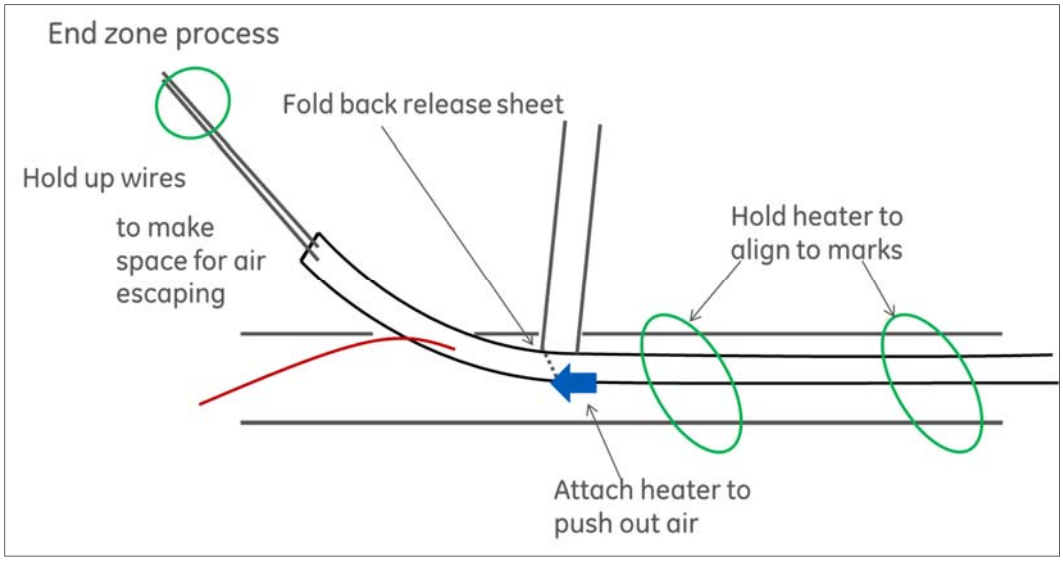
Hold heater by finger or something like an adhesion tape to aligned position. This holding defines the heater position and make the next step easy.

Peel the back sheet of end zone of heater with approximate 10cm length (non thermal isolation foam area + margin) and fold the peeled back sheet to align heater end zone onto the marks.

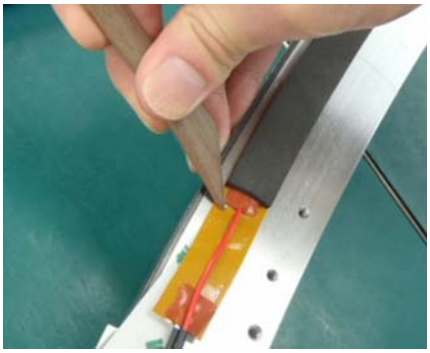
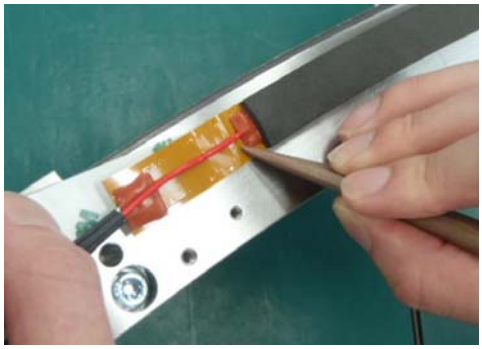
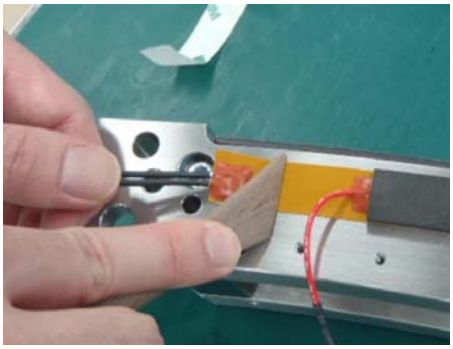
Hold up heater wire to make enough space of air escaping. Once air is trapped in adhesive, it is difficult to push out air against sticky adhesive.

Attach the heater end zone in one way direction from the center (which still remains back sheet) to the end direction as to push out the air from gap in between heater and rail.

Once starting heater end zone attaching, no position adjustment/correction is allowed. This position adjustment will make heater deformation and air void. No air void is allowed at this end zone.



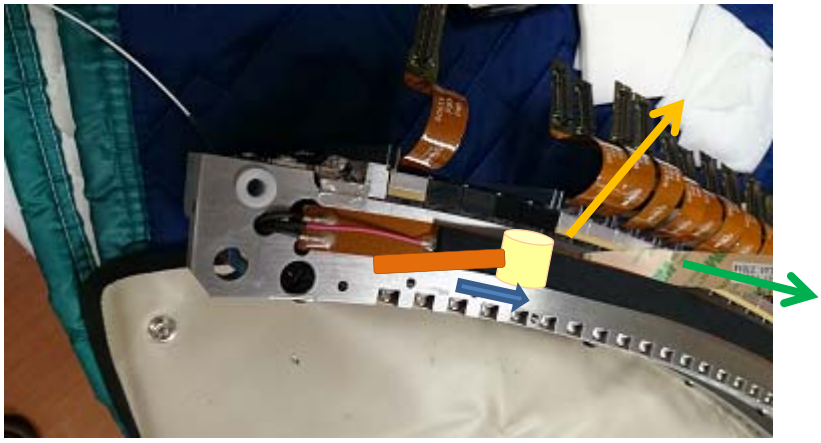
Push out remained air with wooden spatula. The spatula is used one direction to push out air. Not use “to-and-for”, this will keep air inside. It is very important to remove air void at this end zone.

9-3-4-2-2 Center zone

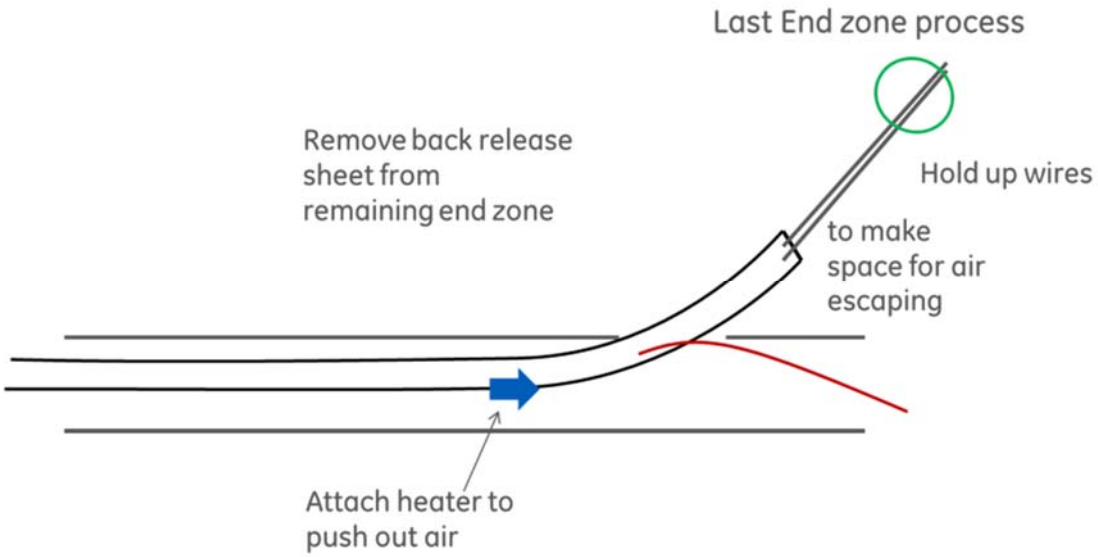
Peel off remaining back sheet little by little with aligning heater center zone to marks. And attach heater with handheld roller. Keep near distance from roller to peeling position during this operation for preventing air contamination.

During this attaching operation of center zone, you can adjust its position. Keep 5mm space from outer arc until end of thermal isolation foam area. Use roller to push heater. When remove release paper, better to pull the paper along with rail arc (green arrow), but large angle to rail (orange arrow). Green direction will make heater position adjustment easy. At the center zone, adjustment of heater position (peel and attach heater again) is allowed only once. The correct heater position is prioritized to avoiding air gap at center zone, because heat density of center zone is not so high. Good positioning of center zone will make it easy to attach end zone without position adjustment.



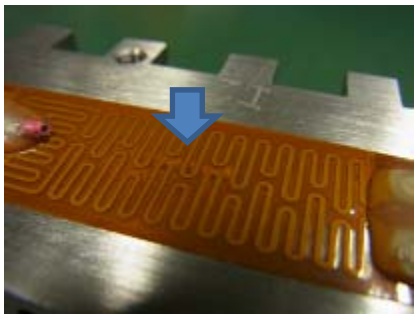
9-3-4-2-3 Last end zone

Last 10cm (no thermal isolation foam area + margin) is sensitive zone again. No adjustment / correction and no air void are allowed. Adjusting heater position might contain air void in the deformed gap. Hold up heater wire to make space for air push out. Remove all back release sheet. Attach heater as is to push out air to outside same way as previous starting side (Hold up wire, and push out air to end direction).



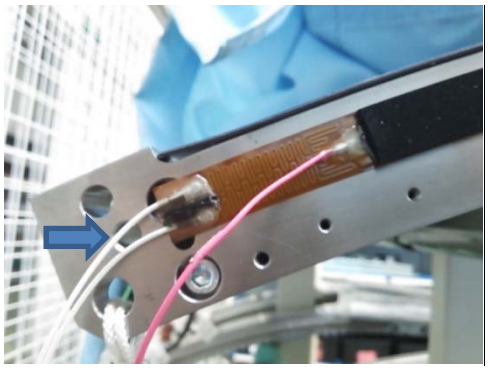
9-3-4-2-4 Air void example

If an air void exists in end zones, the heater shall be repaired again. Remove the heater with air void and use NEW heater, repeat process from 5-3-3. Air void can be identified by color difference as picture below.



9-3-4-3 Attach Thermal insulators and wire handling

Attach thermal insulation form on the both end zones.

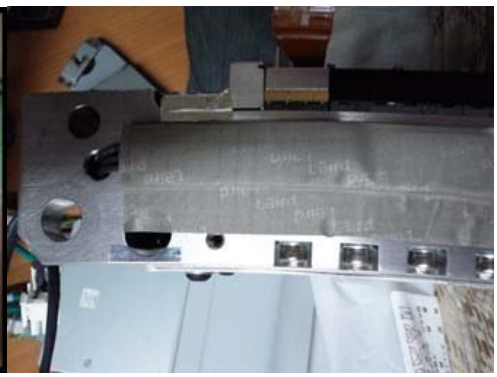


Insert Heater wires through holes on rear rail of detector.

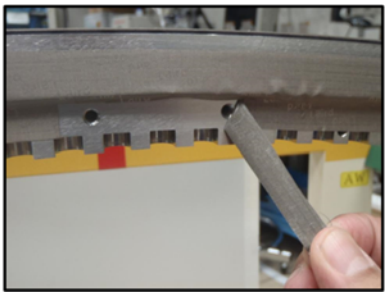
9-3-4-4 Attach EMC tape

Attach EMC tape on Rear Heater, aligning to O.D. edge of the heater.

Cut the portion of EMC tape which is over heater length. Then attach EMI tape to surface of the detector frame.



Cut EMC tape to make space for attaching Center BOW bracket.

Press EMC tape against Heater and Detector surface for close contact.

Confirm there is no EMC tape on the space for detector mounting screws and alignment spacer.

- **10 Front side replacement**

  [Over view]

  Remove thermistor and thermostat..

  Remove heater and EMC protection tape

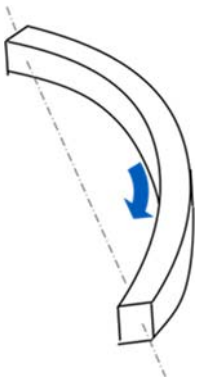
  Remove adhesive and remained tape on detector surface with alcohol and scraper. Use alcohol to wet adhesive and make softer to make it easy.

  After scraping adhesive with scraper, clean out remaining adhesive with using alcohol and paper or cloths.

  Attach new heater.

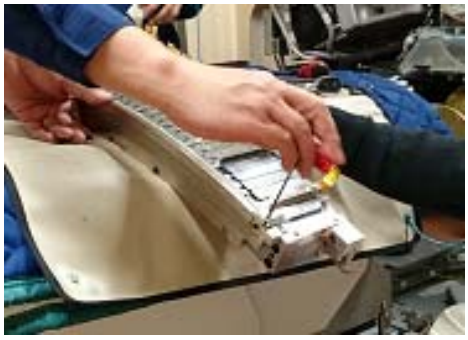
  10-1 Preparation

  If you can prepare three or four blocks with some cushion, these blocks can be used to support center and both end portions of detector. These may help to put detector with front side up for easy operation without damaging flexible cables. When you will put detector, please hold weight of center portion too, because holding only both ends makes unbalance which comes from arc shape.



  10-2 Remove front rail cover.

  Remove the 8 screws on the front side of the cover and 2 screws of the top side of L-angle brackets on it. The front rail cover can be manually pulled off from the front rail of detector, though it might be in close contact with detector.



10-3 Remove all thermostats ,thermistors and cable clamps

Cut wires if it's necessary. Not need to use the removed thermistors and thermostats. Keep the cable clamps and screw for them. These will be used later.

Center thermistor

Low ch thermistor

High ch thermistor

Low ch thermostat

High ch and Center ch thermostat

Keep the cable clamps and the screws for thermistors and other wires. These will be used later when recovering system. (Some systems do not have cable clamp for the thermistor on high ch side, you can keep as is)

10-4 Removal of Front Heater

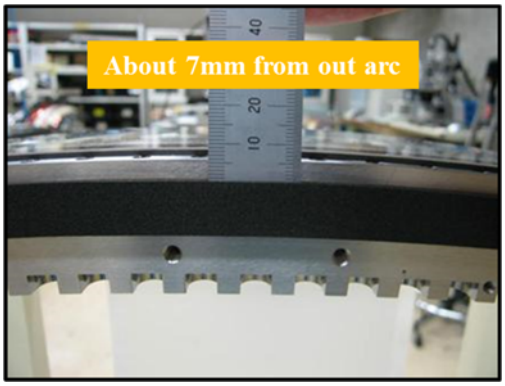
Do same way as rear heater removal and cleaning.

10-5 Attach Front Heater

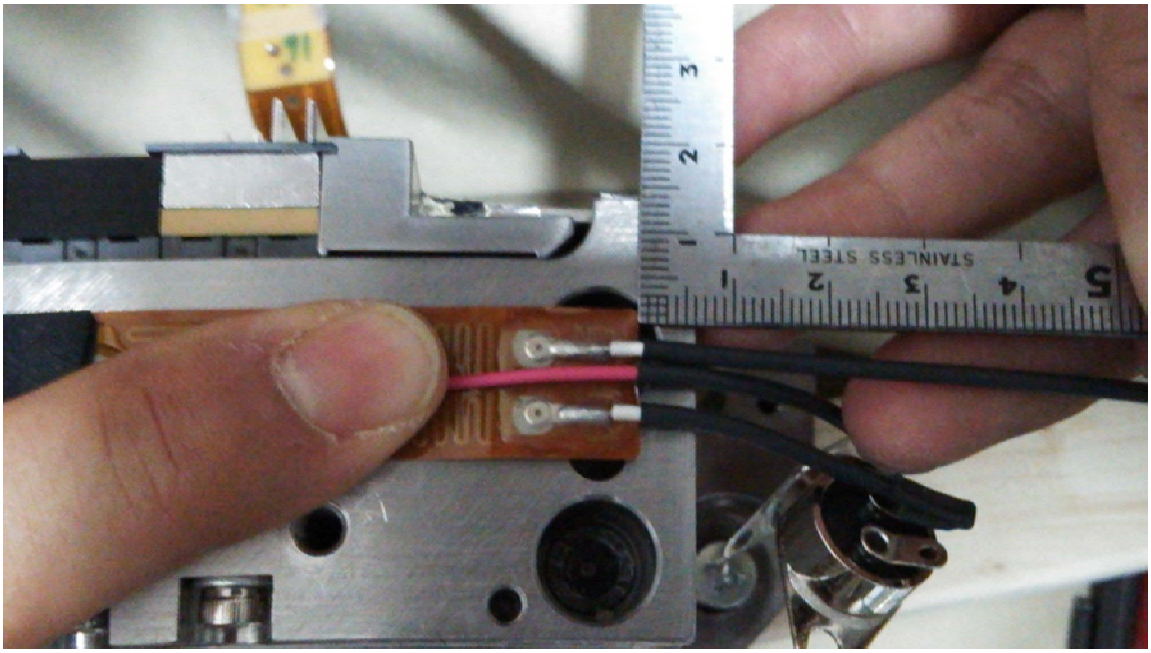
10-5-1 Preparation

Wipe rail surface by alcohol again before attaching new heater. If you touch the surface, oil remains on surface.

Mark several positions at the **7mm** distance from the O.D. (outer diameter) edge of the arc of detector rail for the reference of heater position.



Also mark **6+/-2mm** position from both end of detector front rail for reference of heater longitudinal position.



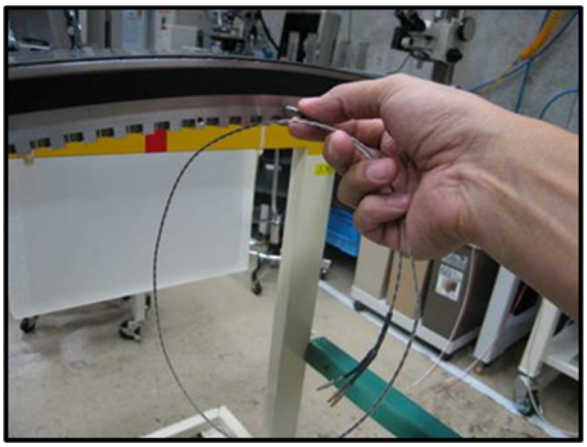
10-5-2 Front Heater Attach

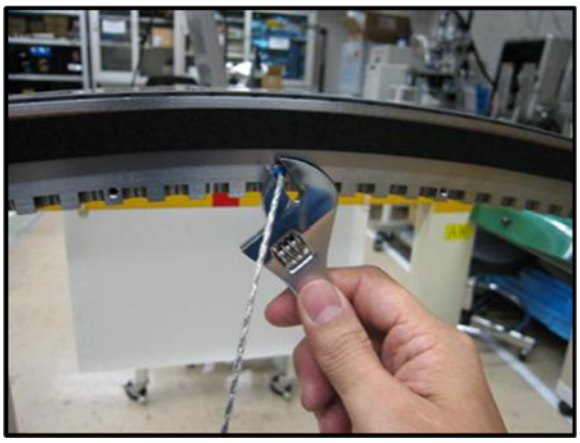
Do same way as rear heater attach before EMC tape.

10-6 Attach thermistors and EMC tape

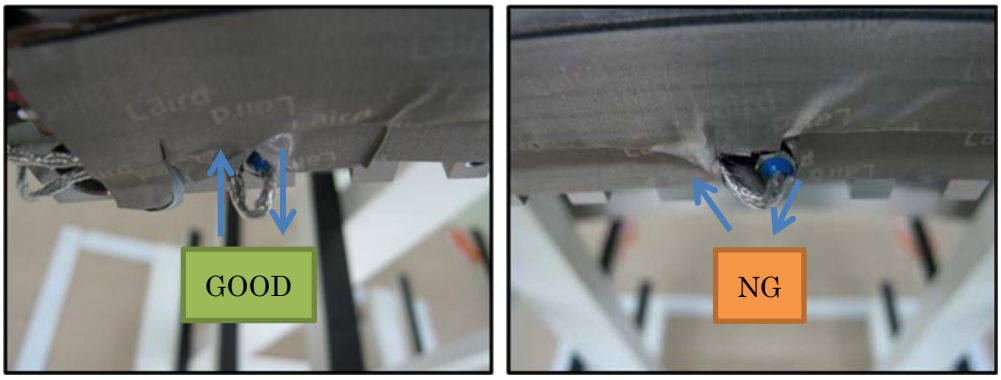
10-6-1 Thermistors

Install thermistors (center: long cable, both ends: shorter cable). Additional 1/4 rotate shall be applied with wrench.



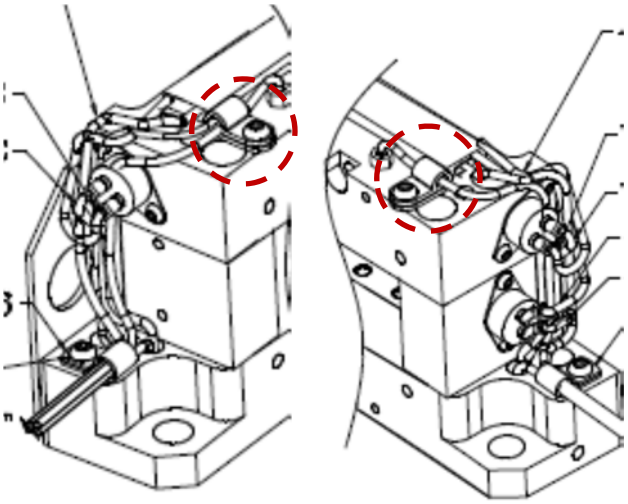


Form the thermistor cables not to add stress to cable joint to screw. (please ignore EMC tape in these photos)



Hold thermistor cables with the cable clamps and screws which originally used.

Tie tow thermistor wires (zone1 and 2) at low channel side, one wire (zone3) at high channel side.



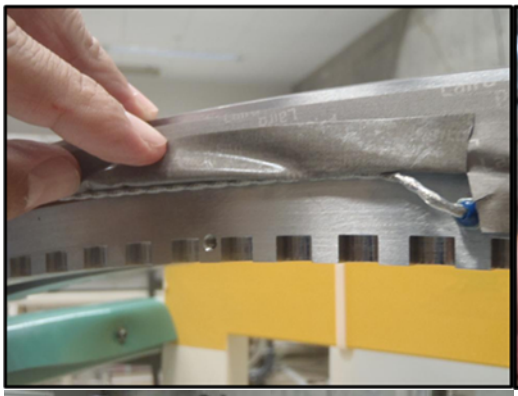
10-6-2 EMC tape

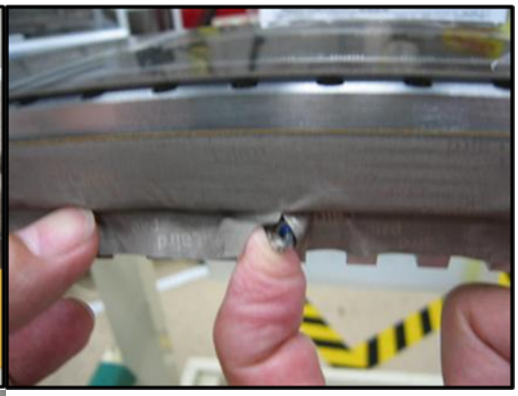
Attach EMC tape on Front Heater only, aligning to O.D. edge of the heater.

Cut the portion of EMC tape which is over heater length.

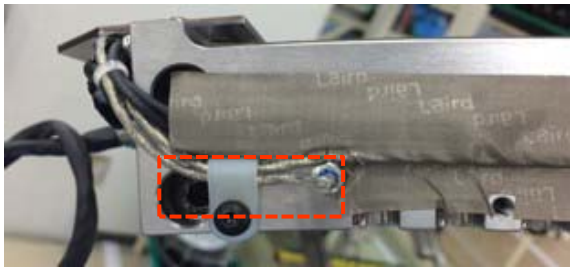
Also cut EMC tape about 10mm at three thermistor positions

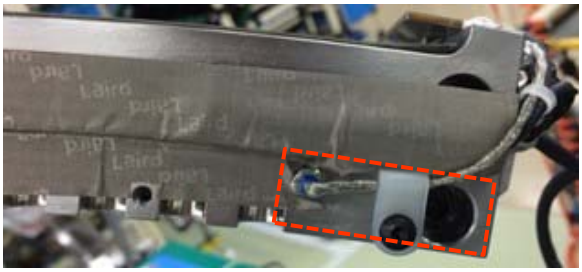
Route the center wire cable along to I.D.(Inner diameter) edge of the heater, and press EMC tape against Heater and Detector surface for close contact and for holding thermistor cable.



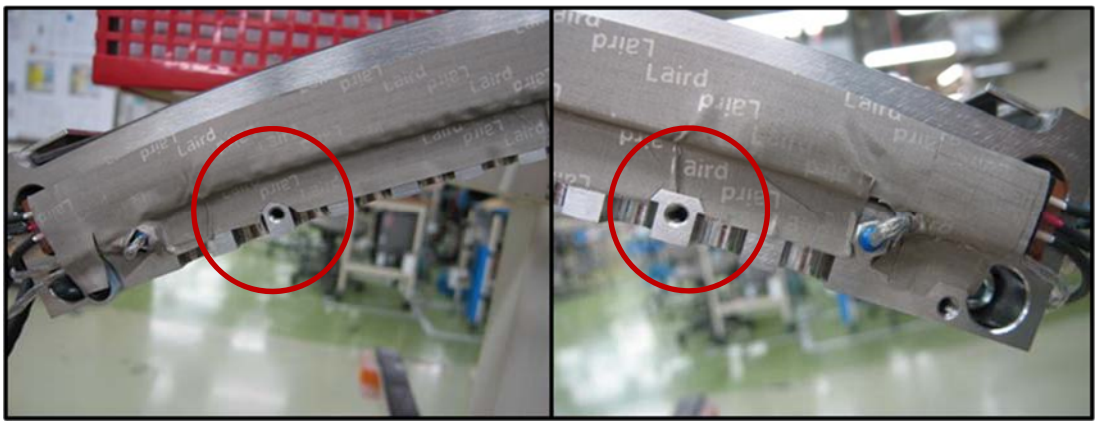


Cut EMI tape at the area for thermistor and cable clamp.





Make eight openings for the spaces for the screws for Front Rail Cover.



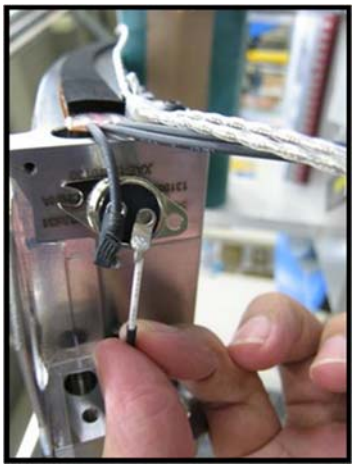
- **11. Heater cable, thermistor cable wiring - Low channel side**

  11-1. Soldering wire

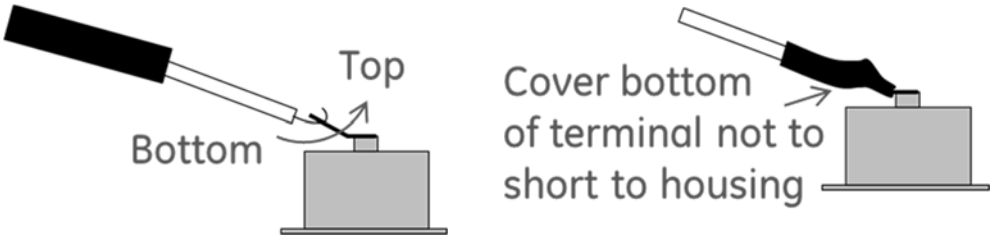
  Put the thermal-shrink-tube to the shorter white wire which comes from rear side.

  Recommendation is to hook the wire for easy soldering operation.

  Insert wire from bottom to top to avoid sharp point toward thermostat housing.



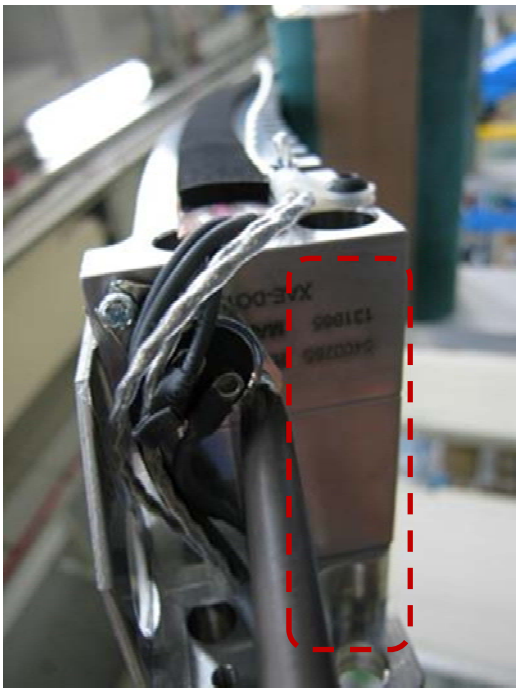
Solder them, move heat shrink tube to cover bottom of solder area and shrink it.



Solder white wire to thermostat, then cover thermal shrink tube onto terminal, apply heat to shrink the tube.

11-2 Mount thermostat

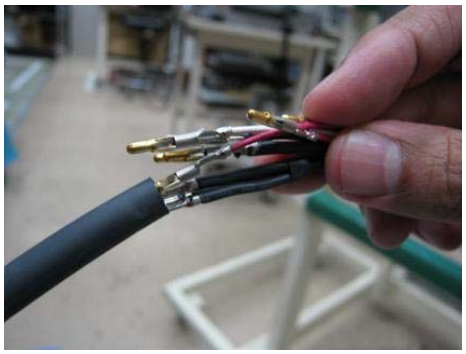
Fix the thermostat to rail end (60cNm). Wires should be positioned far from space for detector mounting screw.

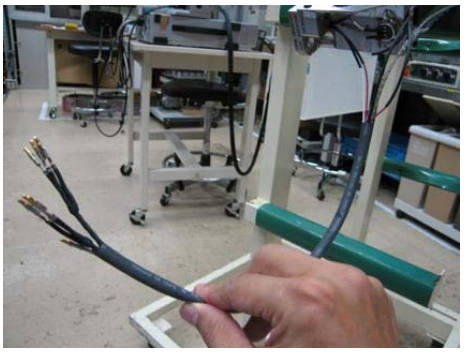


11-3 Wire treatment and connection

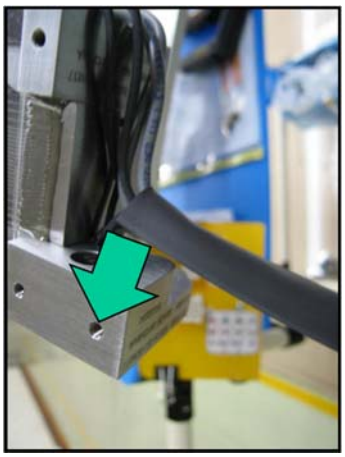
11-3-1 Thermal shrink tube

Insert 2 sets of thermistor cable (each has 3 wires) , two red wires and two white wires into a 30cm length thermal shrink tube.



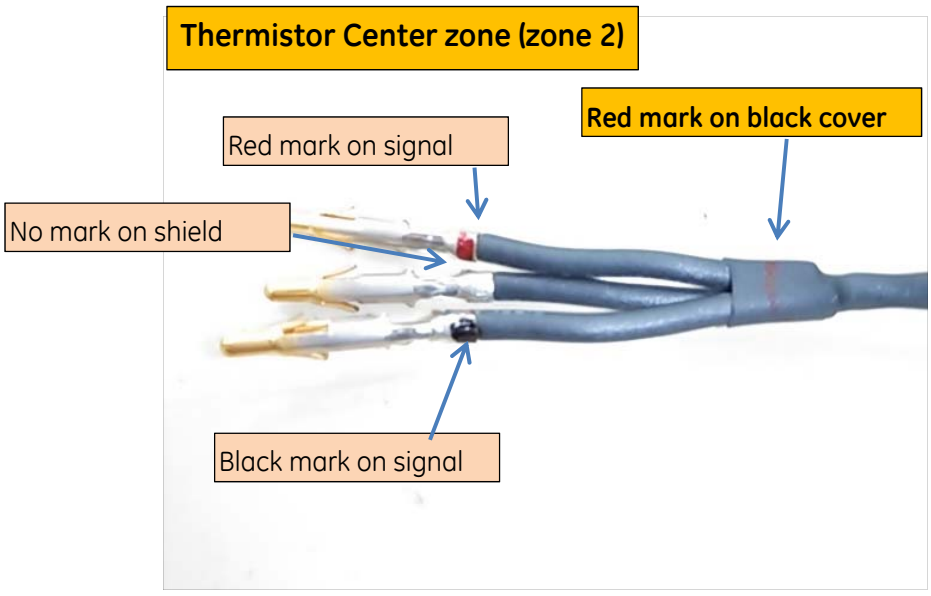


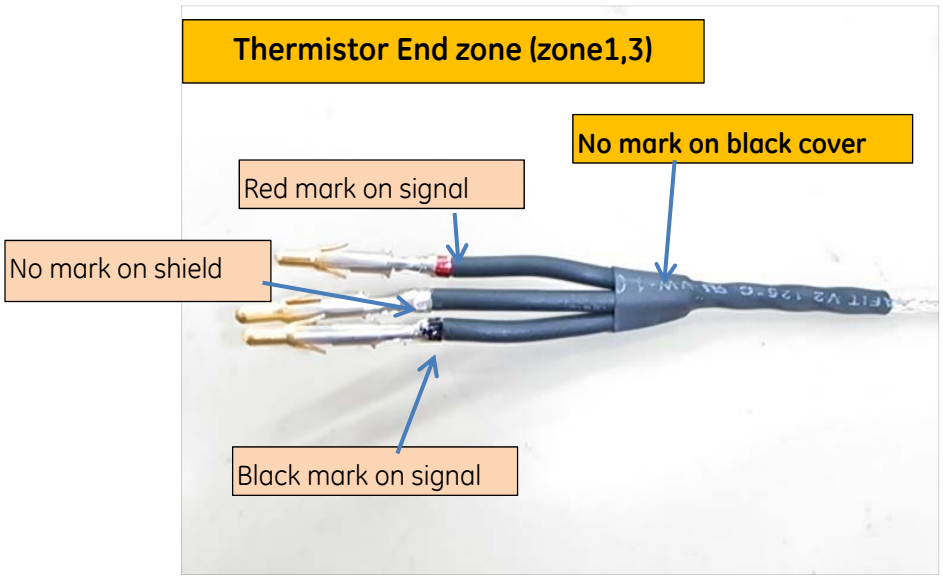
Move detector side end of thermal shrink tube to rear side to position it to cable clamp position with adjusting cable position in the tube.



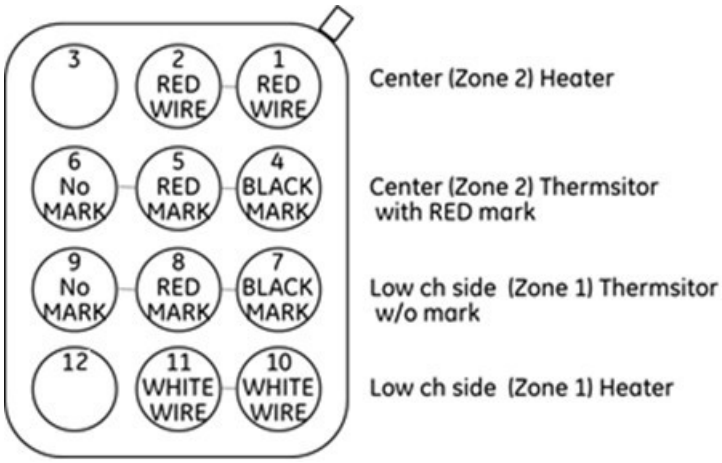
11-3-2 Wire contact insertion to connector housing

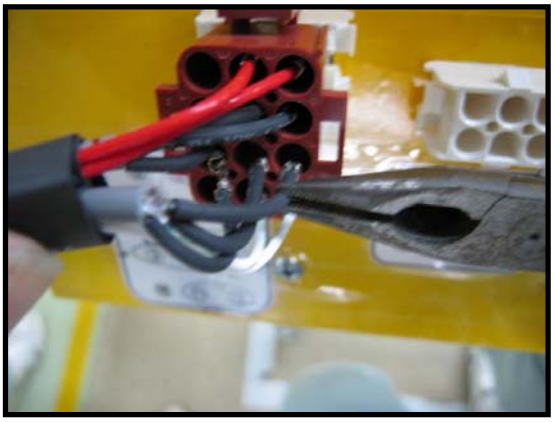
Difference of thermistors for center zone and end zone





Insert contactors to 12pos connector.





Confirm no stress on wires at 12pos connector.

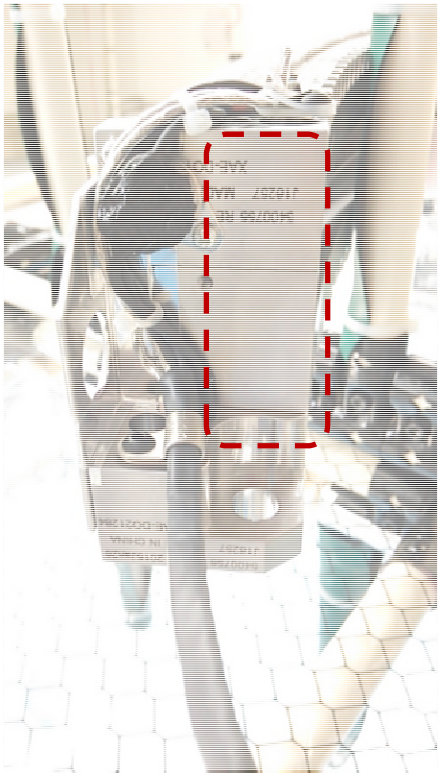
11-3-3 Fix wire

Apply heat to thermal-shrink tube.

Cramp cable to rear rail with the large size cramp (68.6cNm)


Tie wires as following photo to keep enough space for the wrench for detector mounting screw.

Low channel side final image of connection, routing:



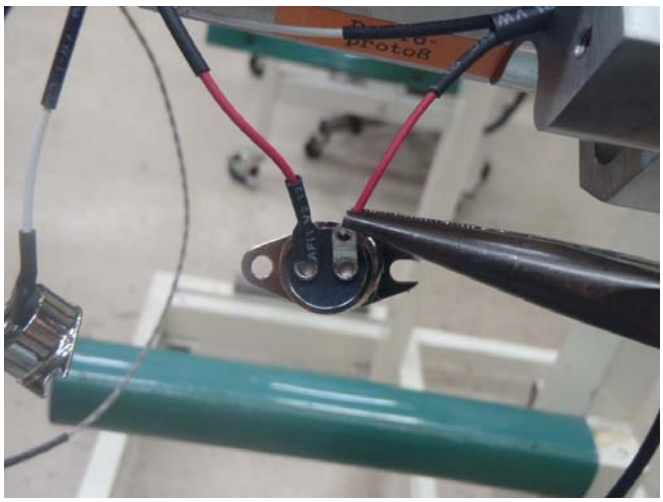
- **12. Heater cable, thermistor cable wiring - High channel side**

  12-1 Soldering wire

  Put the thermal-shrink-tubes to the red wire and the shorter white wire and which comes from rear side.

  Do same way as low channel side. Refer to following photos.

Solder red wire to thermostat that is connected to red wire.

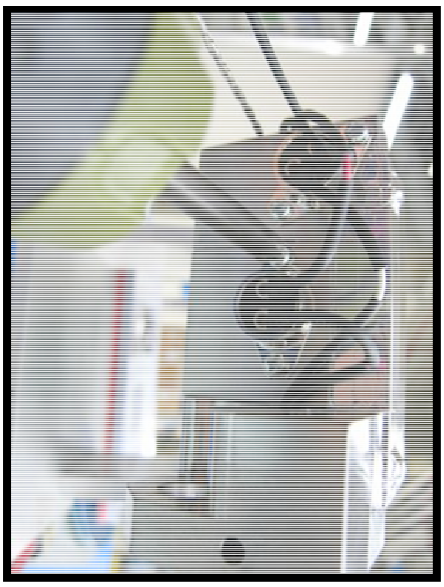


Solder white wire to thermostat that is connected to white wire.

Heat the thermal shrink tubes.

12-2 Mounting thermostats

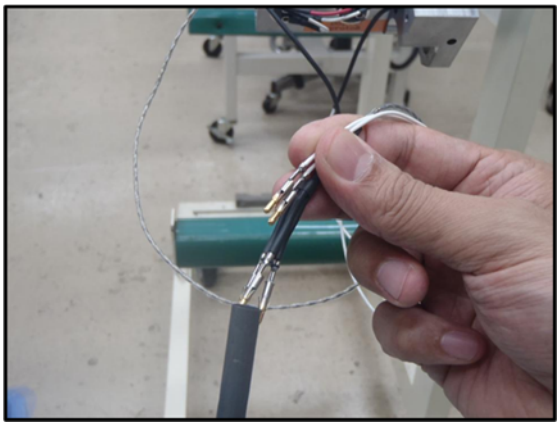
Fix two thermostats on end block (60cNm) as following photo.



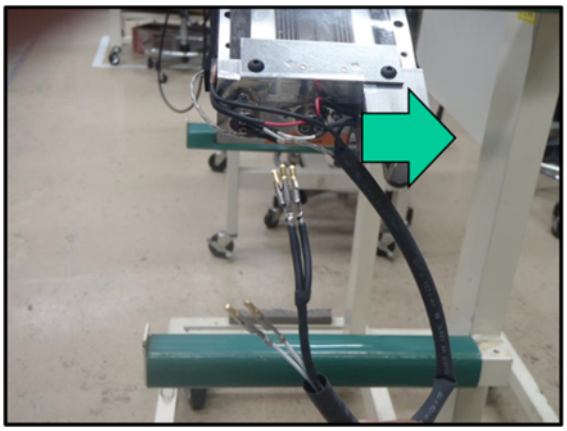
12-2 Wire treatment and connection

12-2-1 Thermal shrink tube

Insert one set of thermistor cable (3 wires) , one pair of white wires into a 30cm length thermal shrink tube.

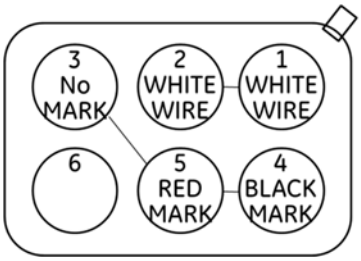


Move detector side end of thermal shrink tube to rear side to position it to cable clamp position with adjusting cable position in the tube.



12-2-2 Wire contact insertion to connector housing

Insert contactors to 6pos connector.



High ch side (Zone 3) Heater

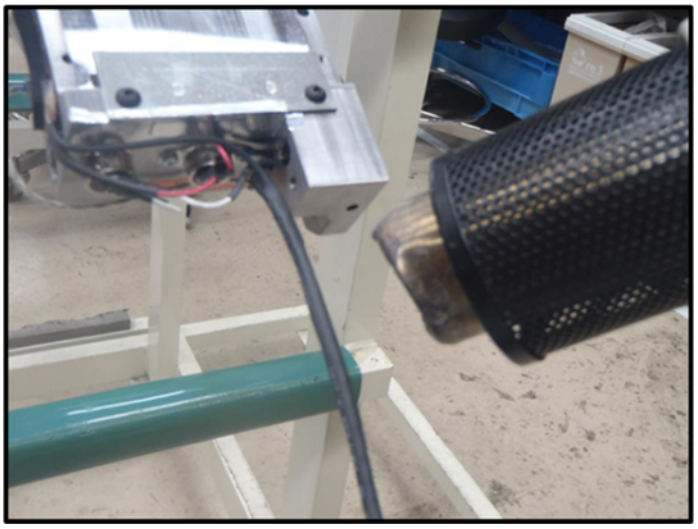
High ch side (Zone 3) Thermsitor

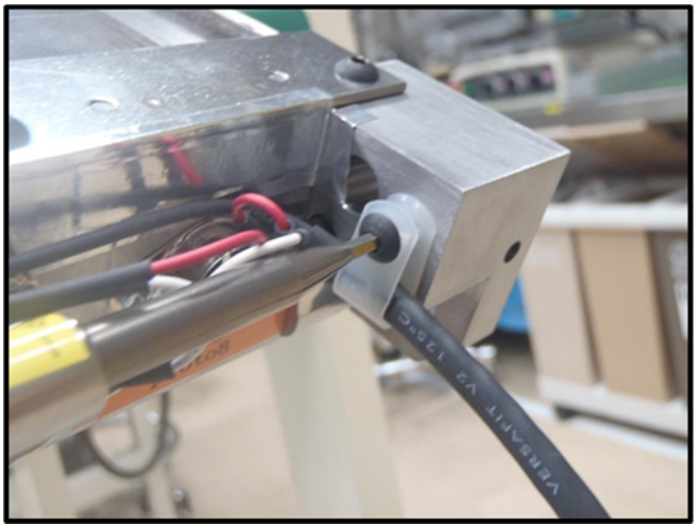
12-2-3 Fix wire

Confirm no stress on wires at 6pos connector.

Apply heat to thermal-shrink tube.

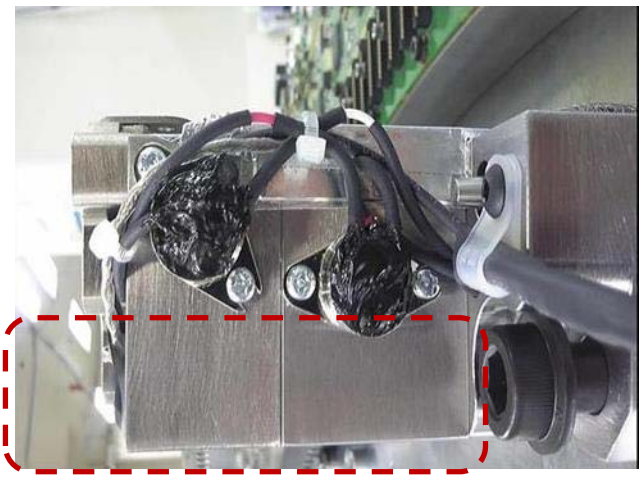
Cramp cable to rear rail with the large size cramp (68.6cNm)



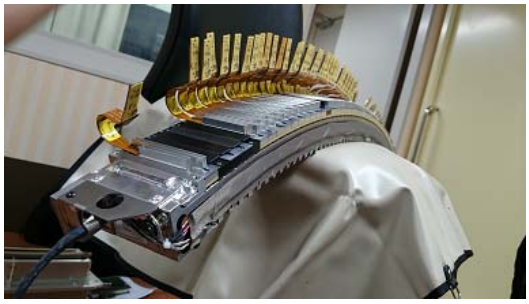


Tie wires as following photo to keep enough space for the wrench for detector mounting screw.

High channel side final image of connection, routing:



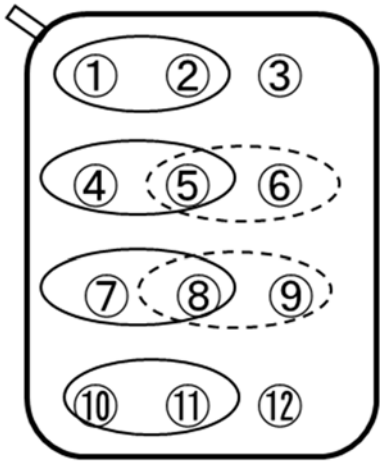
Final detector assy after routing.



- **13. Connection check**

  13-1 Low ch side 12pos connector

  View from contact side (opposite of wiring side)



1-2; Center zone Heater: normal value is 8.1～9.9ohm

4-5; Center zone Thermistor: 9~11kohm at 25degC

7-8; Low ch side Thermistor: 9~11kohm at 25degC

10-11; Low ch side Heater: normal value is 35.4～41.2ohm

2-Detector housing; Insulation of heater center zone2: shall be insulated.

5-Detector housing: Insulation of center thermistor: shall be insulated

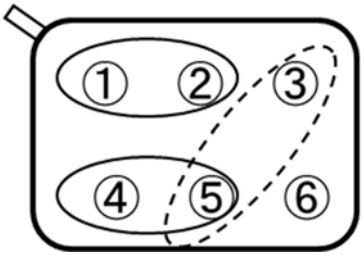
8-Detector housing: Insulation of low ch thermistor: shall be insulated

11-Detector housing: Insulation of heater low ch zone1: shall be insulated.

5-6: Insulation of center thermistor shield: shall be insulated

8-9: Insulation of low ch thermistor shield: shall be insulated

13-2 High ch side 6pos connector



1-2; High ch side Heater: normal value is 35.4～41.2ohm

4-5; High ch side Thermistor: 9~11kohm at 25degC

3-5: Insulation of high ch thermistor shield: shall be insulated

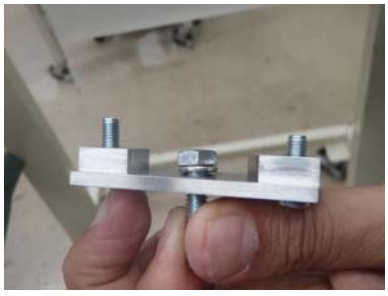
2-Detector housing; Insulation of heater high ch zone3: shall be insulated

5-Detector housing: Insulation of low ch thermistor: shall be insulated

- **14. Mount detector, connect cables, sanity function check**

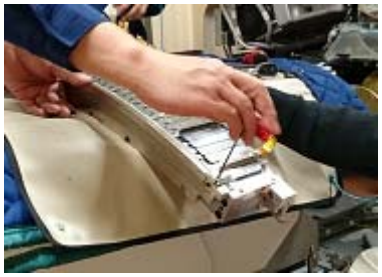
  14-1 BOW bracket

  Attach center BOW bracket to rear rail (5.0Nm). Use Loctite (263 is recommended)



14-2 Front rail cover

Put front rail cover with 8 screws for plate itself, tow screws for both end of L-brackets



14-3 Guide insulator

Put tow guide insulator into the holes on both end of detector. Guide insulator may be remaining guide pins on gantry.

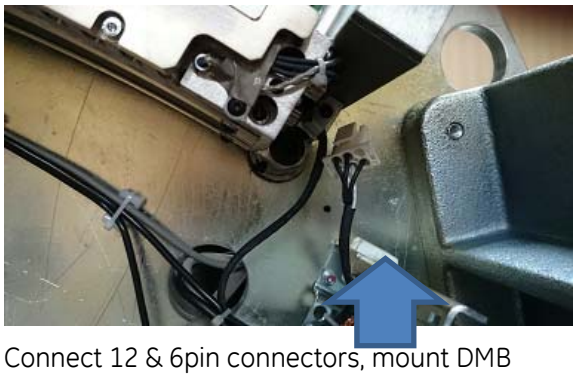
14-4 Dtector mounting on gantry

Mount detector to rotation base. Not stress to flex cables.

Take balance center BOW screw and both side. Apply torque after BOW.

14-5 Connection check and cabling

Perform Connection check shown in Step 13 again after mounting detector on gantry.



Connect 12 & 6pin connectors, mount DMB

Connect all flex to BP. Not bend connector pins.

Put Flex Fix Plate

Put fan plenum, connect fan cables.

- **15. Tentative electrical insulation of thermostat**

  Protect thermostat with something like a insulation tape. This prevents electrical short with the tool to access BOW screw after power ON.

- **16. Sanity function check**

  Monitor whether rail heater works

  Open Unix shell on console.

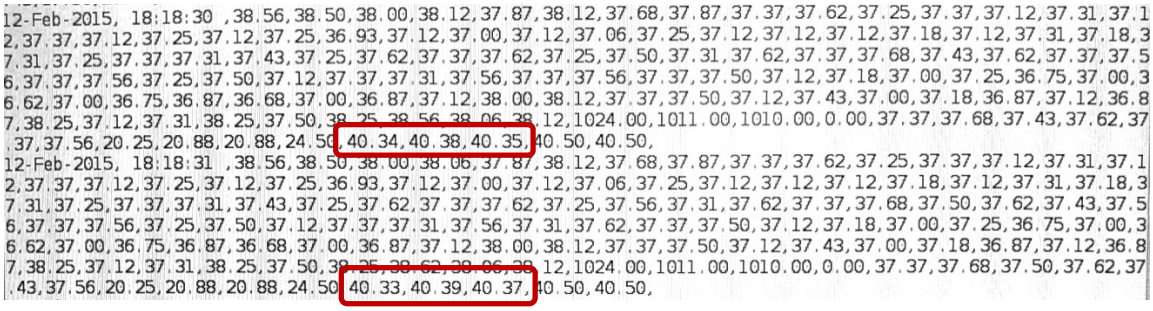
  >cd /usr/g/GEfirm

  >vdasTool -dod

  >81 (thermal monitoring)

  >XXXXXX.csv (XXXXXX is your defined file name for thermal log)

  Following image is a sample of thermal monitoring during BOW alignment.



  These shows thermistor reading of zone1,2 and 3.

  Test scan to check detector modules works

  Run default DAStool in service disktop. [Caution] ready to gantry rotation

  Check module connection to backplane if module(s) failed DAStool tests.

- **17. BOW & ISO alignment**

  Put tape on thermostat terminal to prevent rail heater short to ground at BOW screw adjustment. Run BOW & adjust. Apply torque to detector mount screws.

  Confirm ISO alignment. Adjust ISO if it's need.

- **18. Thermostat terminal protection**

  After BOW alignment, remove tentative insulation tape from thermostats. Put RTV on thermostat terminals.

- **19. Recovering hardware**

  Put all gantry covers, wait rail temperature back to normal

  Monitor detector temperature back to normal in syslog.

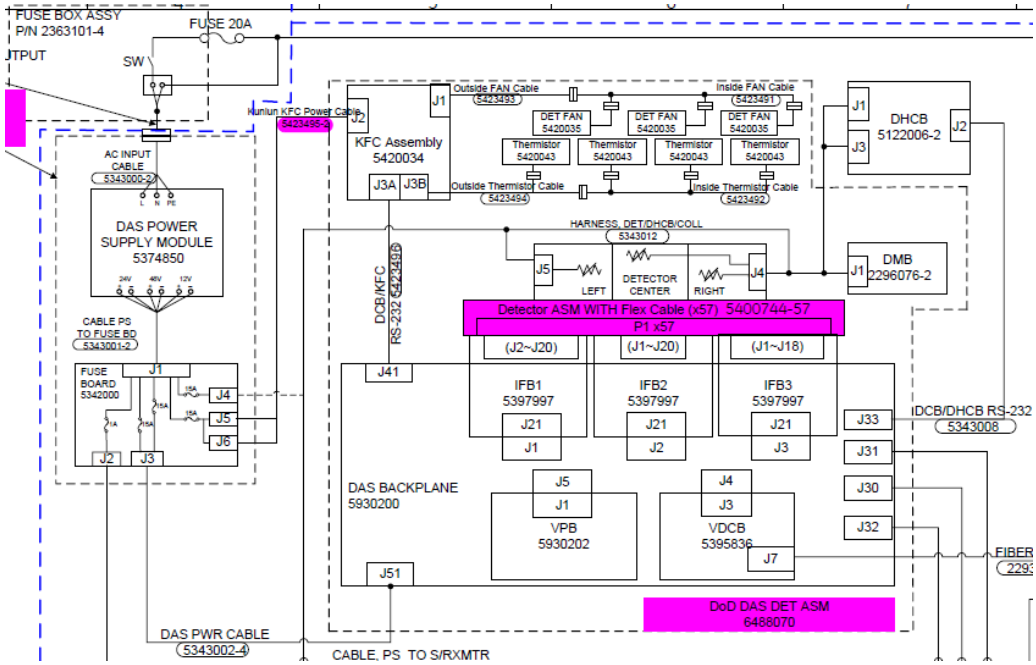
- **20. Full calibration, IQ check**

  Perform full calibration and IQ check

Appendix:

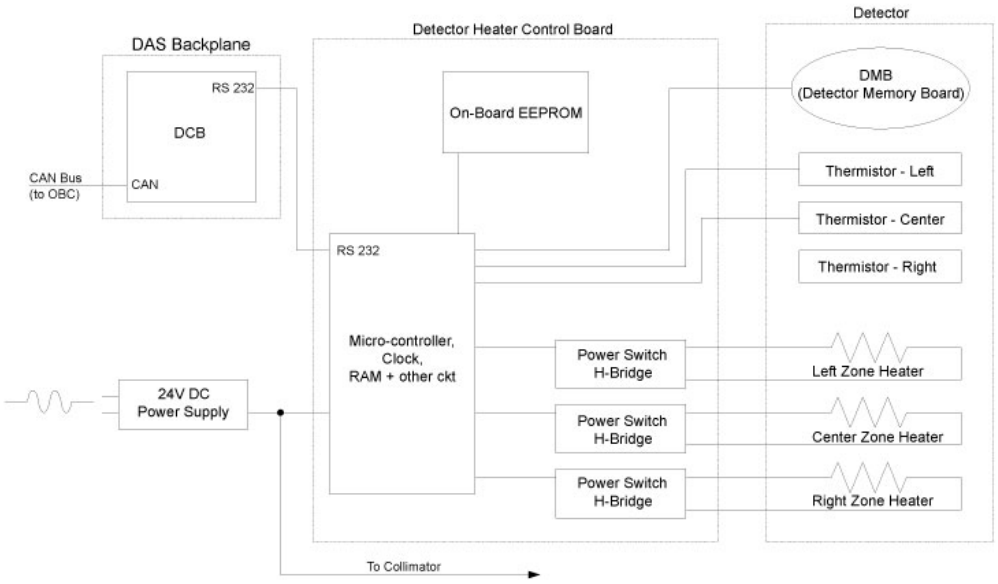
Reference documents

5448807SCH_Kunlun 1 5 gantry interconnection

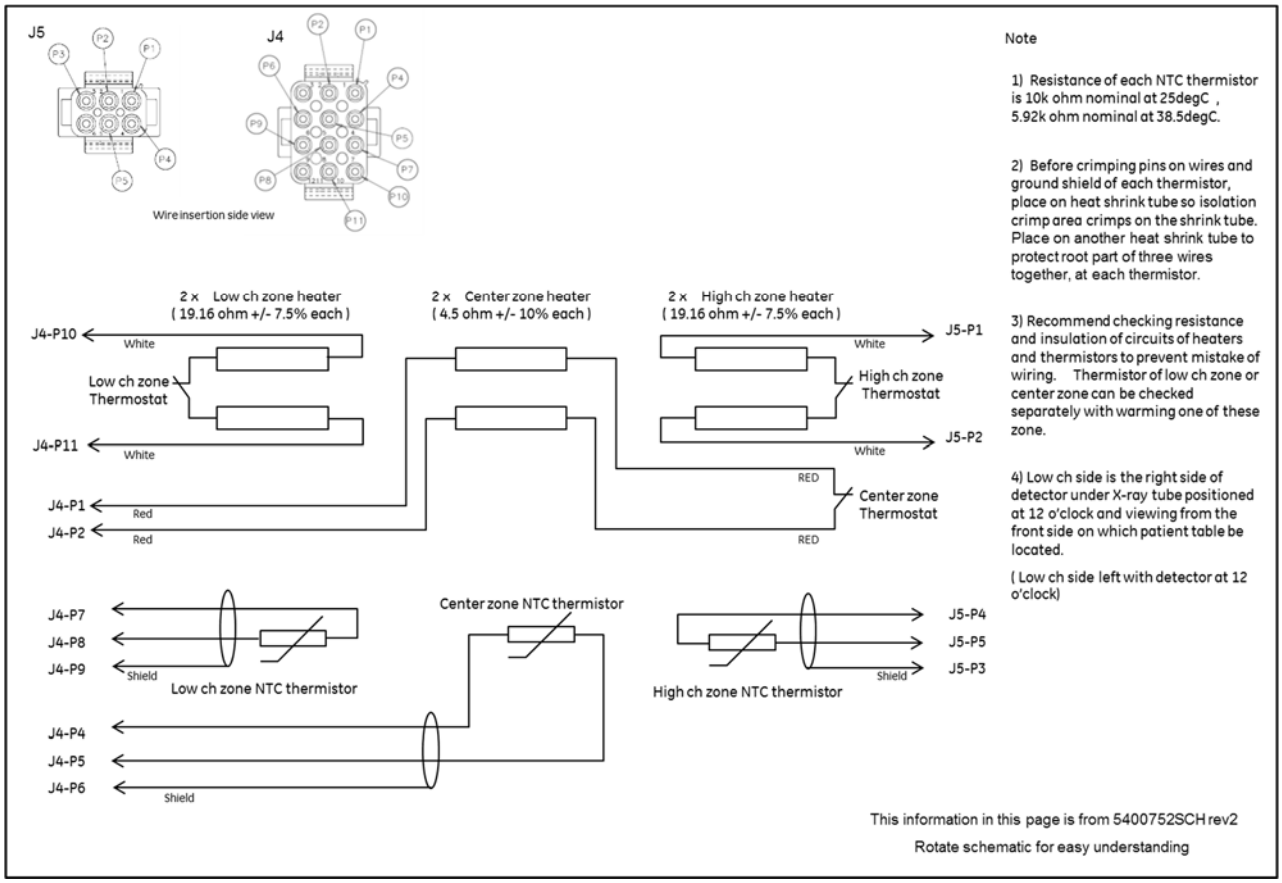


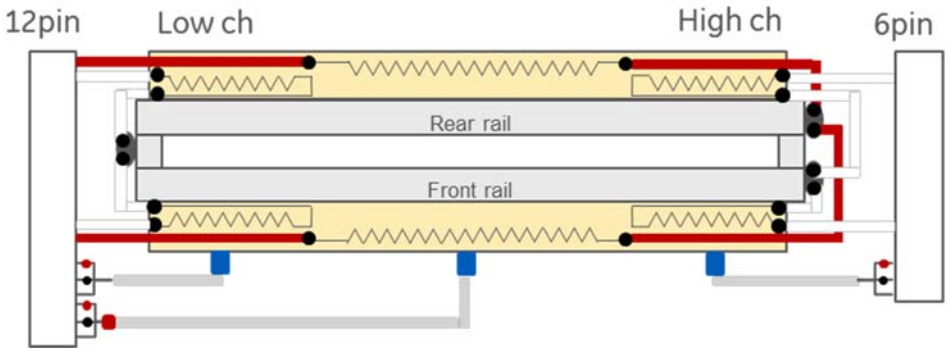
DHCB-Heater connection

Illustration 1: Detector Heater Control Board Block Diagram



Detector heater connection (2329398SCH)





Revision history

Rev.1~3

Draft document for peer review.

Rev.4 2015/03/10 Y.Kuroda, M.Moritake

Initial release for service validation.

Rev.5 2015/Jun/03 Y.Kuroda

5-3-4-2 update heater attachment pictures with wooden spatula.

5-3-4-2-4 add Air void example

Rev6 2016/Dec/2 M.Moritake

Add/insert easy process without replacing whole heaters.

Renumber of each detail process.

Update photo and some explanation to match with new heater

Update schematic form Watson detector to DoD detector