CRYOGEN-FREE DILUTION REFRIGERATOR

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LEIDEN CRYOGENICS B.V.

INSTRUCTION MANUAL

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Write new automatization

Add automatization description

Add principle of operation of the DR, Pulse tube, JT heat exchanger

Add weight and dimensions of the different parts of the CF

Specifications of:

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Electrical power (voltage 1 or 3 phase, power)
Compressed air (4-6 bar)

Table of countries with 110V and 220 V ac

Electrical specifications CryoMech Pulse Tube:

Parameter	*220/230 Volt 60 Hz Model	460 Volt 60 Hz Model	*200/220 Volt 50 Hz Model	380/420 Volt 50 Hz Model
Nominal voltage	220/230 VAC	460 VAC	200/220 VAC	380/420 VAC
Operating voltage range	200 - 253 VAC	414 - 506 VAC	180 - 242 VAC	342 - 462 VAC
Frequency	60 Hz	60 Hz	50 Hz	50 Hz
Phase	3	3	3	3
Mains supply voltage fluctuations	Up to ± 10% of the nominal voltage	Up to ± 10% of the nominal voltage	Up to ± 10% of the nominal voltage	Up to ± 10% of the nominal voltage
Input Power	See Appendix A	See Appendix A	See Appendix A	See Appendix A
Current	See Appendix A	See Appendix A	See Appendix A	See Appendix A
Dedicated circuit breaker	See Appendix A	See Appendix A	See Appendix A	See Appendix A

Safety:

PT safety

<u>Cold Head High Pressure Relief Valve</u>

The cold head high-pressure atmospheric relief valve is set at 425 ± 5 PSIG (29.3 ± .34 bar). At pressures above 425 PSIG (29.3 bar) the valve will open automatically and relieve pressure to the atmosphere.

DR savety

The closed circulation circuit of the mixture inside of the DR is designed in a way that might there be a power failure and all electrical valves might close, the mixture will still be recovered in the dumps if the pressure in the still exceeds 1.8 bar.

Description off all devices inside of the GHS

Add sketches with the electrical connections etc

Client needs to have prepared:

Countries with 110 V:

To prepare	CF cryostat	GHS	CryoMech compressor
Compressed air (6 bar)		x	
Water cooling		x	x
Power supply 1-phase (110 V)		x	
Power supply 3-phase (220 V)			x
N2 cooling connection	x		

Countries with 220 V:

To prepare	CF cryostat	GHS	CryoMech compressor
Compressed air (6 bar)		x	
Water cooling		x	x
Power supply 1-phase (220 V)		x	
Power supply 3-phase (380 V)			x
N2 cooling connection	x		

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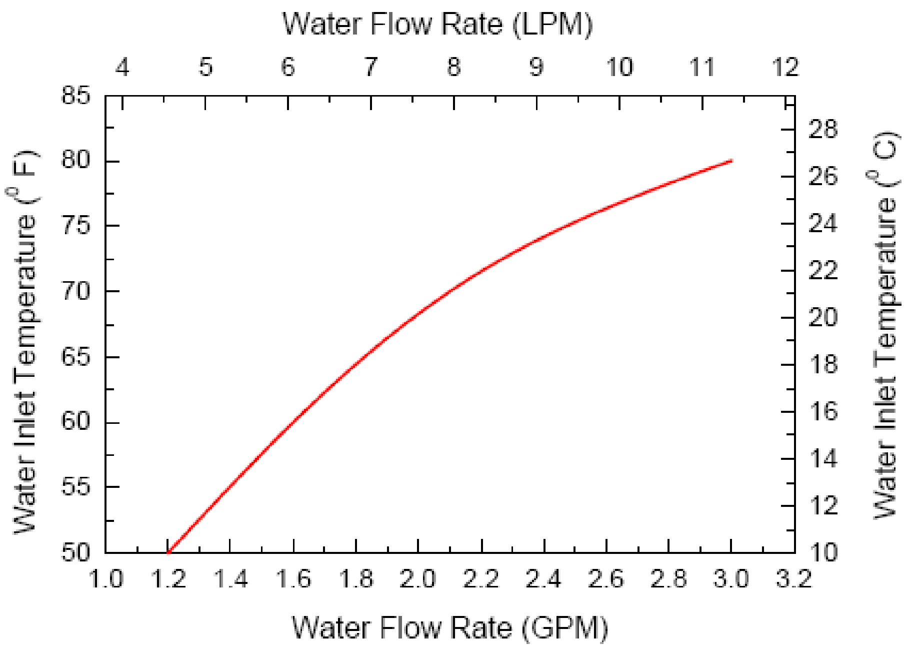
Input Power	See Appendix A			
Current				
Dedicated circuit breaker				

Cooling water requirements CRYOMECH Pulse Tube:



Cooling water requirements LC GHS (for Varian V551 turbo pump):

Cooling may be carried out either through an open circuit with eventual discharge of the water, or using a closed circuit cooling system.

The water temperature must be between +10°C and +30°C, with an inlet pressure between 3 and 5 bar. This allows a flow of about 200 l/h.

NOTE

The water electrical conductance must be ≤ 500 μs/cm. When the conductance is higher, in closed water circuit, the use of up to 20% of Ethyl-Glycole is suggested.

SECTION 1

1. SHORT DESCRIPTION

The **CRYO-FREE** dilution refrigerator consists of an integrated pulse tube – dilution refrigerator (**PT-DR UNIT)**, a **GAS-HANDLING SYSTEM (GHS)** and a **compressor** for the pulse tube**.** They are coupled to each other by flexible stainless-steel lines and cables for the valves and gauges fitted to the insert (see **Figure 1**). The mixture is circulated by means of one or more turbo-molecular drag-pumps backed by a dry rotary pump and a small compressor. A sorption pump is used as standard for the final evacuation of the IVC (Inner Vacuum Chamber) and OVC (Outer Vacuum Can).

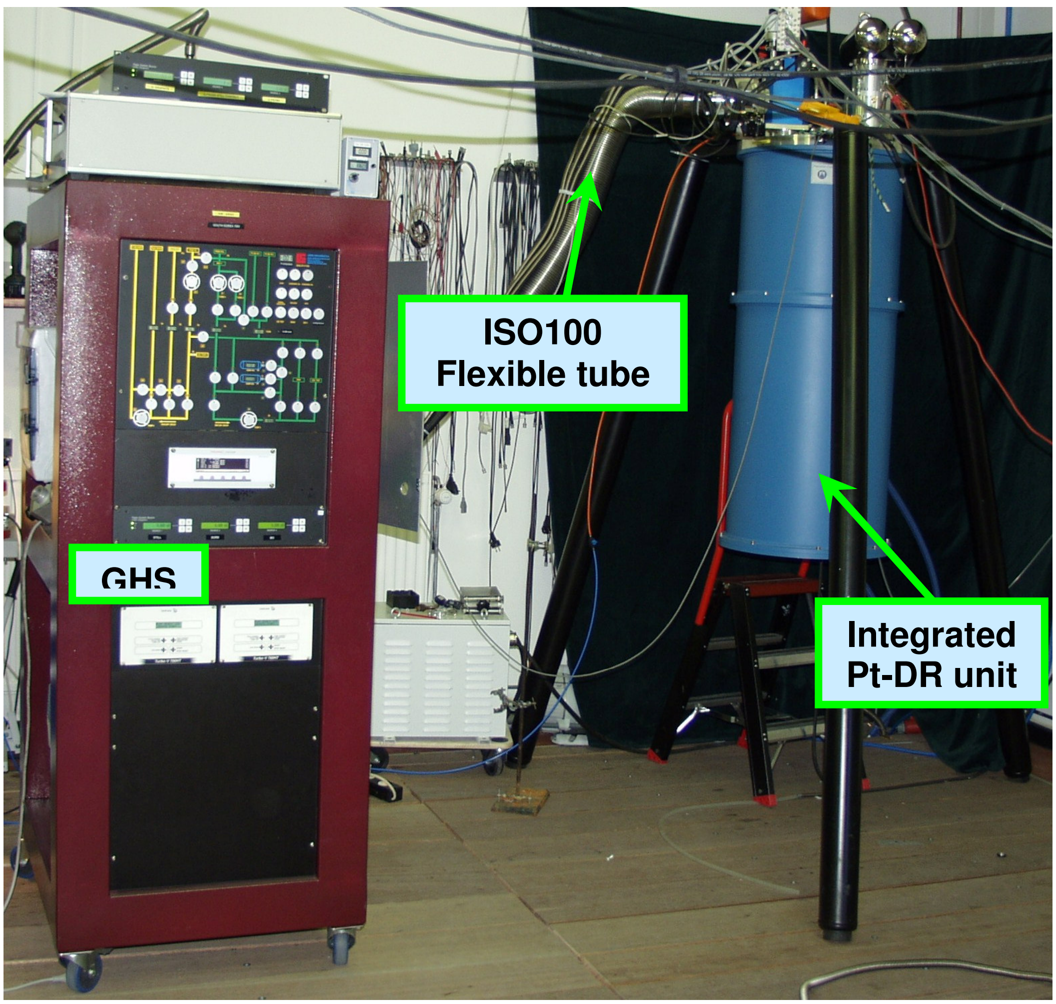


Figure 1 *The picture shows the main components of a CRYO-FREE DR cryogenic system. It consists of an integrated Pt-DR unit, a Gas Handling System (GHS) and a Pt compressor (not shown in the picture).*

2. SETTING UP THE SYSTEM AND QUICK START

1. In order to start working with your CF system you should assemble the legs of the cryostat (if you are going to use the tripod). Attach the three ears to the top flange with two bolts.

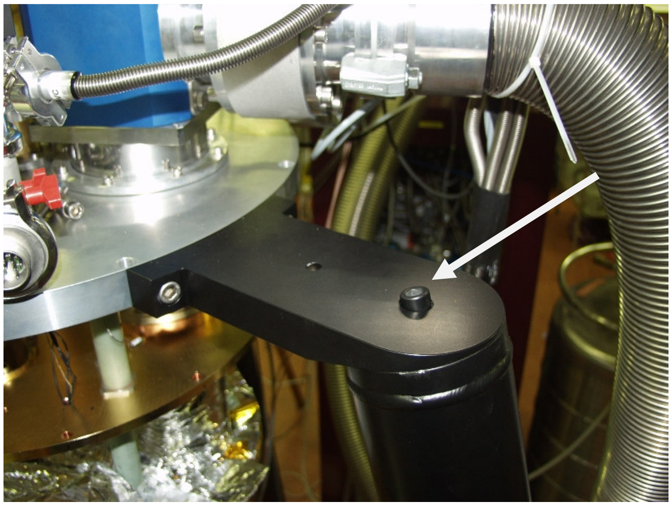
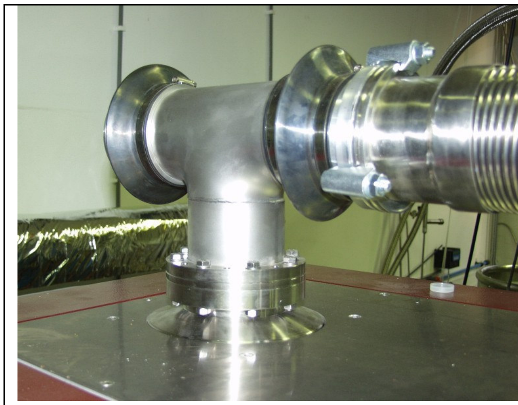


Figure 2 *The legs of the tripod are screwed to the ears of the insert with a single M10 screw per leg.*

Figure 3 *It is recommended to use a stacker to lift the cryostat.*

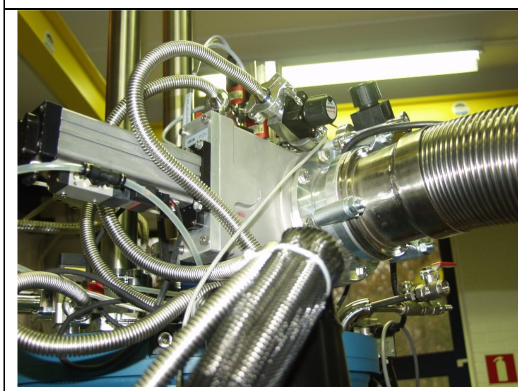
Lift the cryostat to the appropriate height and screw the upper part of the legs to the ears of the insert using a single M10 bolt per leg. Lift the cryostat further and attach the lower part of the legs using the M10 screw-rings. It is recommended to lift the cryostat with a stacker.

2. Fasten the T-piece to the flange on top of the GSH, using eight M8 bolts (for the CF-200 and CF-450 models) or 3 claw clamps (for the CF-650 model). Fasten the large 100mm flexible tube to the T-piece on top of the gas handling System (GHS) and to the gate valve on top of the dewar using 3 claw clamps each (see **Figure 4**).



a.

b.



c.

Figure 4

a. *For the CF-200 and CF-450 models, the T-piece is fastened with eight M8 bolts.*

b. *For the CF-650 models, the T-piece is fastened with three claw clamps.*

c*. The 100mm flexible tube should be connected to the T-piece on top of the GHS on one side and to the ISO100 gate valve of the CF insert on the other side.*

The four 10mm flexible lines go to the ^3He input, safety line, OVC and IVC. The ^3He input line and the safety line must be connected with a special high pressure NW16 o-ring that has a retainer outside the rubber o-ring since the condensing pressure can go up to 4 bar. The flexible lines are named with stickers ^3He input, safety, OVC and IVC. The OVC line should be connected to Valve A1 on the side of the top flange. For systems having a cold insertable probe, an extra 10mm flexible tube is used to pump out the vacuum tube of the probe.

All electrical leads are also labeled. Connect the vacuum gauge cables to the IVC, just on top of the gate valve, then that of the still (in the center of the blue top head of the insert) and that of the OVC (all pressure gauges are labeled).

Figure 5 *The picture shows the small valves 6, 17 and 7, with valve 6 and 7 for the 3He input lines and valve 17 for the bypass between still and the 3He input.The 3He input tube should be connected to the NW16 flange next to the three small valves. The flexible tube to the OVC should be connected to valve A1 on top of the cryostat. Note the labels on the NW16 flanges*

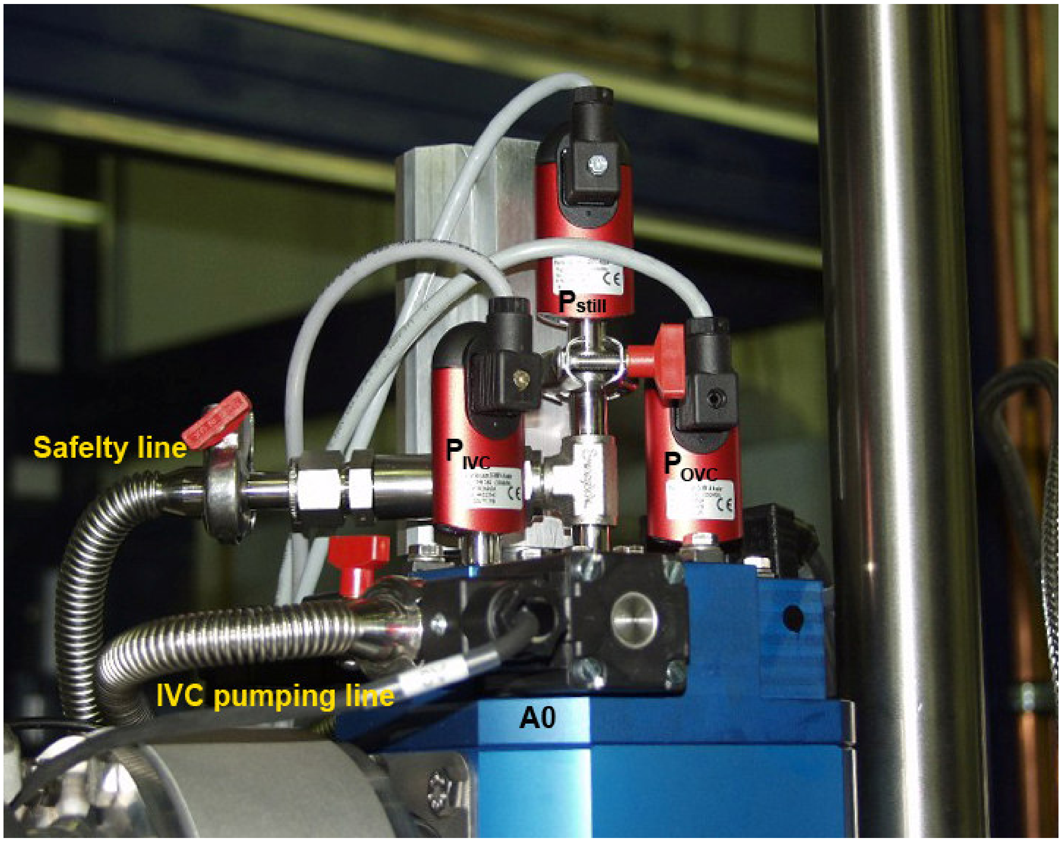


Figure 6 *The IVC flexible tube should be connected to the NW16 flange next to valve A0. The safety line should be connected to the T-piece below the still pressure gauge (see also the paragraph on "Safety line").*

Connect the heater unit to the Jäger connector on the top flange. For further information on the heater unit, see the chapter on the GHS.

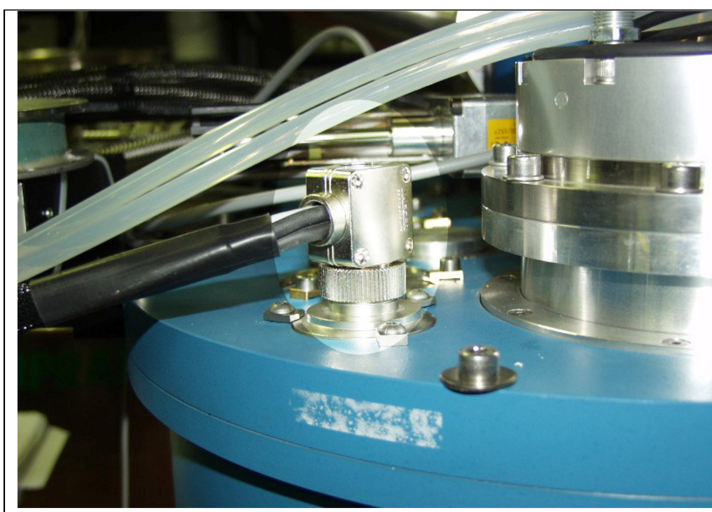


Figure 7 *Picture of the Jäger connector on the top flange of the cryostat.*

Safety line

In order to prevent the loss of 3He/4He mixture in case of a power failure, a safety line is installed directly on top of the still, connecting the still through a one-way over-pressure valve of 1.8 bar to Dump4.

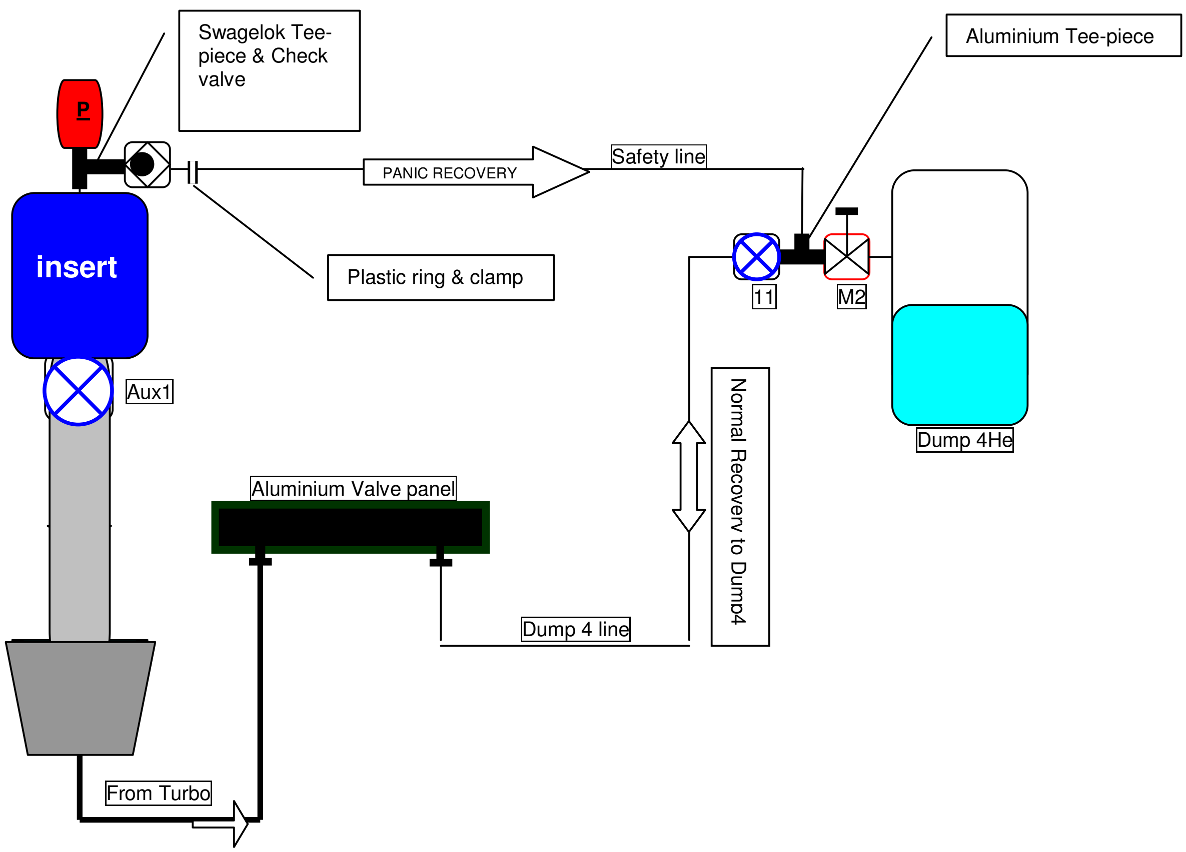


Figure 8 *Schematic view of the safety line connecting the still to Dump4.*

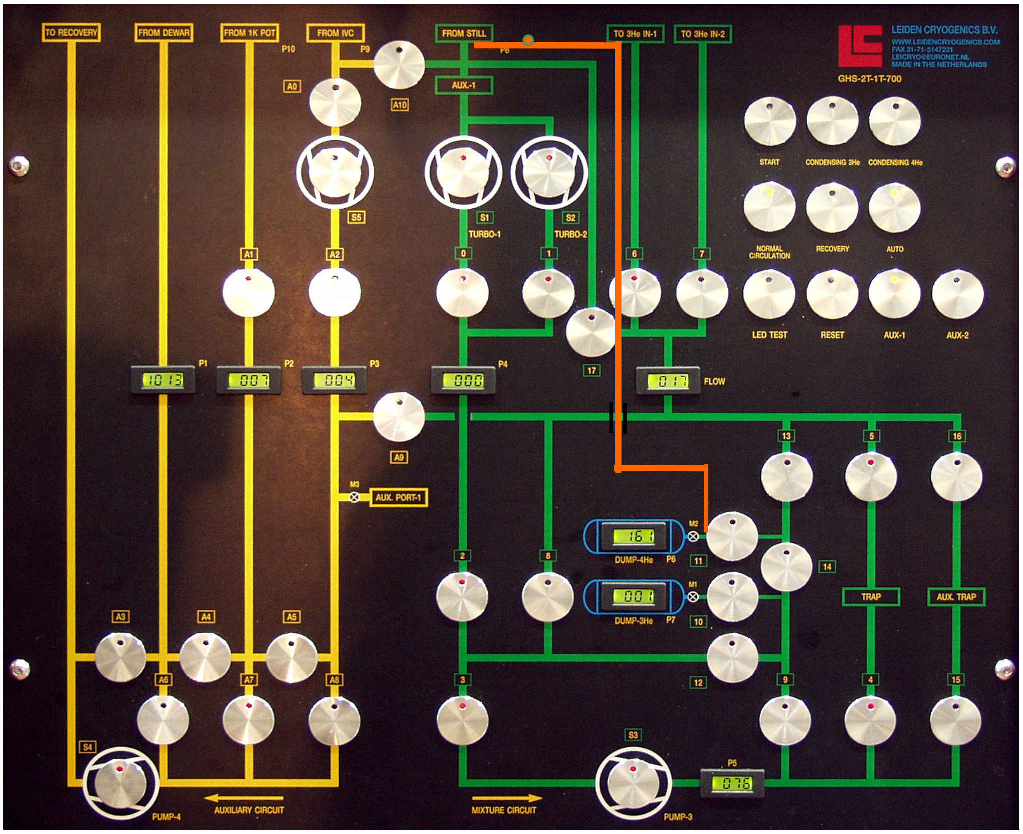


Figure 9 *Position of the safety line with respect to the valve panel.*

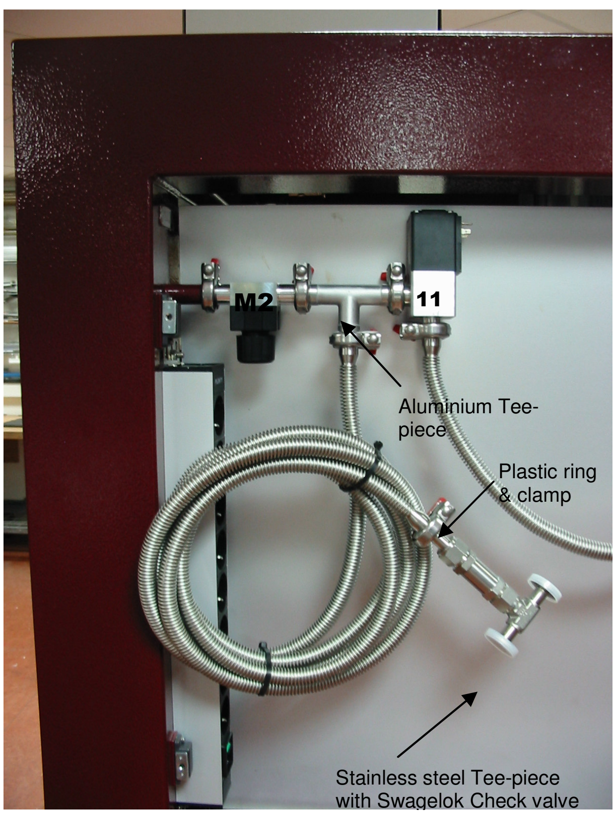


Figure 10 *Picture of T-piece inside of the GHS connecting the safety line to Dump4.*

3. Place the compressor in a convenient location not too close to the dewar, possibly in the room next to your lab.

   Connect the two flexible lines and the motor cord to the top of the PT, using the keys provided. Use some Teflon spray to facilitate the insertion, being careful to only spray the thread. The power is 11 kW so use a convenient 3-phase outlet. Connect the water cooling lines to the compressor and to the GHS. We use tap water but a convenient chiller might also be used.
   Use 200V-240V single phase50/60 Hz for the GHS cabinet and 380-50Hz or 460V or 60Hz for the PT cooler (or else 208 V 3Ph 60Hz if so specified). The gate valve (Aux1) and the valve for the OVC (A1) require 5-6 bar of compressed air.

   Open the dewar by removing the OVC can, normally consisting of two flanged Aluminum cylinders and a bottom lid bolted with 8 M8 screws for each flange. If the system has a magnet it could be attached to the still shield, to the IVC shield or it could be an external magnet with room-temperature bore. These systems have tail on the various shields. Remove the tail first, then the corresponding can. Remove the 50K shield, also in two parts. Remove the IVC. The leak-tightness is made with a Kapton ring. Use silicone grease to keep it from moving from its position. The Kapton o-ring can be used many times, as long as it isn't damaged. Remove the still and 50 mK tails and shields. Magnets, if any, are fixed to either the still shield or the IVC can. They will be removed with the supporting shield. The use of a simple electrical stacker as shown in **fig 6** is strongly advised in order to facilitate mounting and dismounting the various shields.

4. Samples can be mounted everywhere below or on top the mixing chamber plate. If you are going to put a sample inside the magnet you should provide a convenient cold finger that can be fixed to the copper plate coaxial with the magnet. Use W2 or W1 wire connectors for adding thermometers etc. Mount back the shields and vacuum can. Use a bit of Apiezon vacuum grease on the Kapton ring making sure no impurities are sticking to it. Make sure the super-insulation covers the IVC and the 70K shields and plates well.

Figure 11 *It is recommended to use a stacker to mount and dismount the radiation shields.*

5. **Pump out the dilution refrigerator and the traps**

   Make sure that manual valves M1 and M2 of the 3He Dump and the 4HE Dump are closed. Switch on **S4** and opening valves **A8**, **A9**, the **compressor bypass**, **13**, **11**, **5**, **16**, **8**, **2**, **0**, **Aux1**, **6** and **7**. When the pressure inside of the still is below 10 mbar, switch on turbo pump **S1** (and **S2** if you have two pumps). Pump until the pressure in the still drops to below $5x10^{-4}$mbar. (Valve **13** and **11** have to be opened to pump out the safety line. This only needs to be done when the safety line was exposed to air)

6. **Pump OVC and IVC**

   The IVC can be pumped already right after it has been closed. Switch on **S4** and open **A8** and **A0**. Once the OVC has been assembled, it can be pumped as well. Close **A8** temporarily to prevent air from the OVC to enter into the IVC. Open **A7** and **A1**. Once the pressure of the OVC approached the pressure of the IVC, open **A8** again to pump both volumes simultaneously. Once the pressure in the IVC has reached about 1 mbar, close **A8** and **A0** (and continue pumping the OVC)

7. **Put 10 mbar helium exchange gas in the IVC and in the still**

   The exchange gas is obtained from **Dump4**. Open manual valve **M2** and valve **11** and **13** and close **11** and **13** again. The volume between **A9**, **17**, **6**, **7**, **13**, **5** and **16** is now filled with helium gas. Open **17**. Open **A10** until the pressure inside the IVC (according to the Pirani pressure gauge) is 10 mbar. Close **A10** again. The pressure inside of the still will now be larger than 10 mbar. Pump the exceeding amount of helium gas from the still back into **Dump4** using pump **S3**. Switch on **S3**, open valve 9, 14 and 11. Open valve 3 and **8**. When the still pressure reads 10 mbar close **17**, the **compressor bypass**, **8**, **3**, **9**, **14** and **11**. Switch off pump **S3**.

8. **Start the cool down with the Pulse Tube**

   Switch on the Pulse Tube as described in the CryoMech manual.

9. **Start nitrogen pre-cooling**

   Connect the metal N2 tube to the nitrogen input and connect the other end to the nitrogen vessel. Connect a silicone tube to the nitrogen output and put the outer end inside an empty vessel. Open both valves of the nitrogen circuit and of the nitrogen vessel. The in- and output of the nitrogen pre-cooling circuit are denoted by arrows on the valves. At sufficiently low temperature the pressure will become lower than 5×10^{-4}, which is the lower limit of the Maxigauge. Stop pumping with S4 by closing valve A1 and A7 and switch off S4.

IMPORTANT: If the system still has the EPROM programmed for a conventional dilution refrigerator, at this point, **REMOVE THE CONNECTOR OF A1.** Since, if the automatization would go into the recovery mode, the OVC would be exposed to air.

Follow the platinum thermometer on the 50K plate with an Ohm-meter. It is a 1000Ohm thermometer so it will indicate about 1090 Ohm at room temperature. Follow the MC thermometer (thermometer wiring in Appendix of the manual).

10. Using the charcoal pump

Once the 3K plate approaches 3K, all exchange gas inside of the IVC will be absorbed and the DR unit will stabilize at a higher temperature. To release the exchange gas again from the sorb pump, heat the charcoal pump by running a current of about 25-30 mA through the resistor inside the charcoal pump (source 1 of the TCS (Tripple Current Source)). This hardly affects the temperature of the 3K plate since the pump is only loosely connected to the plate.

Once all DU plates have reached a temperature of about 3-4K (the thermometers start to saturate), the heater of the charcoal pump can be switched off and the pressure will drop below $5x10^{-4}$ mbar again.

11. Condensing the mixture

Open M1 and M2. Press “Condensing 3He” and then “Auto”. All valves shut down and then the condensation sequence begins. As soon as tank 3 opens turn on the mixture compressor by pressing AUX-2. The compressor will not start if the pressure at the input is too low (say below 200 mb or so) that is why it should be started only when tank 3 has opened.

When the pressure in tank 3 is below 700 mbar, close 9 and open 12 so that condensation goes faster but this is normally not needed. Make sure both circuits 6 and 7 are open if this didn't happen automatically and also the aux. trap. When the pressure in the tank reaches ~ 20 mb valve 10 closes automatically and valve 14 and 11 open, condensing the diluted mixture.

You should see the still cooling as soon as mixture enters the DR circuit. Make sure the sorb pump and thus the 3K plate is cold, even when condensing. The resistance thermometer is located inside the sorb pump. When ot heated it masures the 3K plate temperature. It should stay above 16-17 kOhm during condensation. Both thermometer #0 (sorb pump) as thermometer #1 (still) are 10 kOhm resistances whose standard calibration can be found in the automatization CD in the Docs file.

When all is condensed and the still pressure is low (a few 10^-2 mbar) put some current on the still, typically 12-15 mA (still pressure below 0.3 mbar)

The calibration of your mixing chamber thermometer and the typical test parameters of your CF refrigerator are given in appendix.

12. Condensing the mixture

To start the recovery of the mixture press “Recovery” and then “Auto”. The automatization will first shut down all valves and pumps in the Front Panel, and then start to recover the 3He first to Dump3. The value of the pressure in Dump3 at which it will switch to Dump4 can be set in the Front Panel program. The default value is 1000mbar. After all 3He has been recovered, the pulse tube can be switched off. This will decrease the time it takes to recover the 4He.

3. CF-DR UNIT

The CF-DR consists of a CryoMech pulse tube (Pt410 or Pt415) integrated with a dilution refrigerator insert. Two radiation shields are pre-cooled by the two stages of the pulse tube (50K and 3K). The 3K shield is also the Inner Vacuum Can (IVC). To condensate the 3He/4He mixture of the dilution refrigerator unit, a Joule-Thomson heat exchanger is installed between the 3K plate and the still.

The dilution refrigerator unit of the CF-DR series attaches to the 3K plate with 4 insulating tubes. The still is fitted with a capacitance level gauge, a heater and a 10kΩ RuO_2 resistance thermometer, all placed inside the liquid. The temperature of the 3K plate is measured with a similar thermometer in combination with a platinum thermometer (Pt1000) to cover the high temperature range (10-300K). The mixing chamber is fitted with a Speer 100 Ω thermometer that has been sliced and inserted into a special copper holder, together with small capacitance filters.

The **dilution refrigerator unit** consists of a **still**, a **cold-plate** and a **mixing chamber** plus a series of heat exchangers. The mixing chamber is made of an upper part of stainless steel and a bottom part of gold-plated copper where a large number of samples can be fastened.

The still is made of stainless steel with a gold-plated copper bottom, where a gold-plated copper shield is attached. A cold-plate (CP) usually at a temperature around 50mK is fitted between the still and the mixing chamber (MC) for thermal anchoring. A cylindrical cold-plate shield is standard but tails can be optionally added.

The unit has a tube-in-tube continuous heat exchanger (HE) followed by a silver HE, before the 50 mK plate, and a continuous silver HE between the cold-plate and the MC.

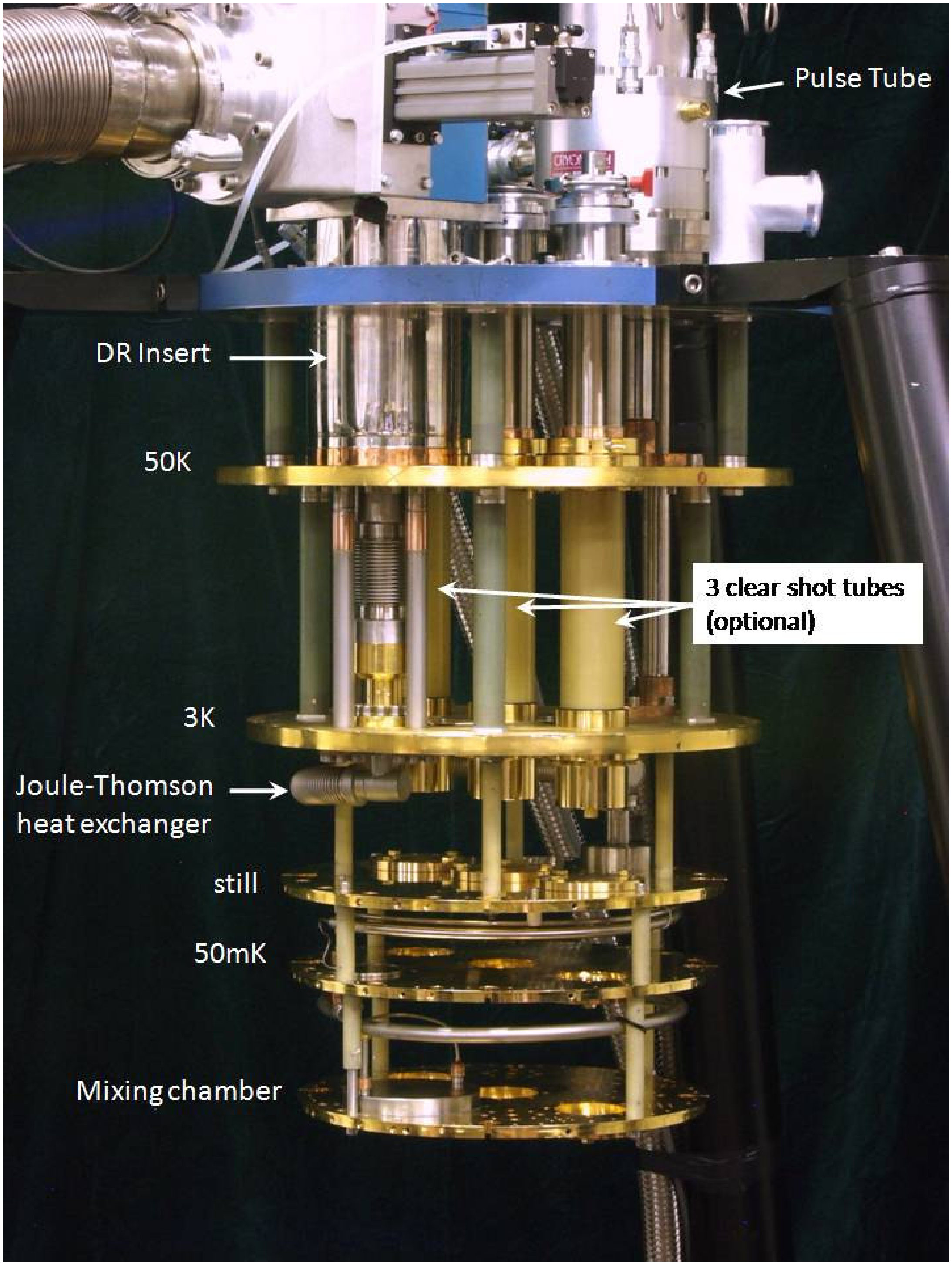


Fig 7 *Photograph of a CF-DR unit*

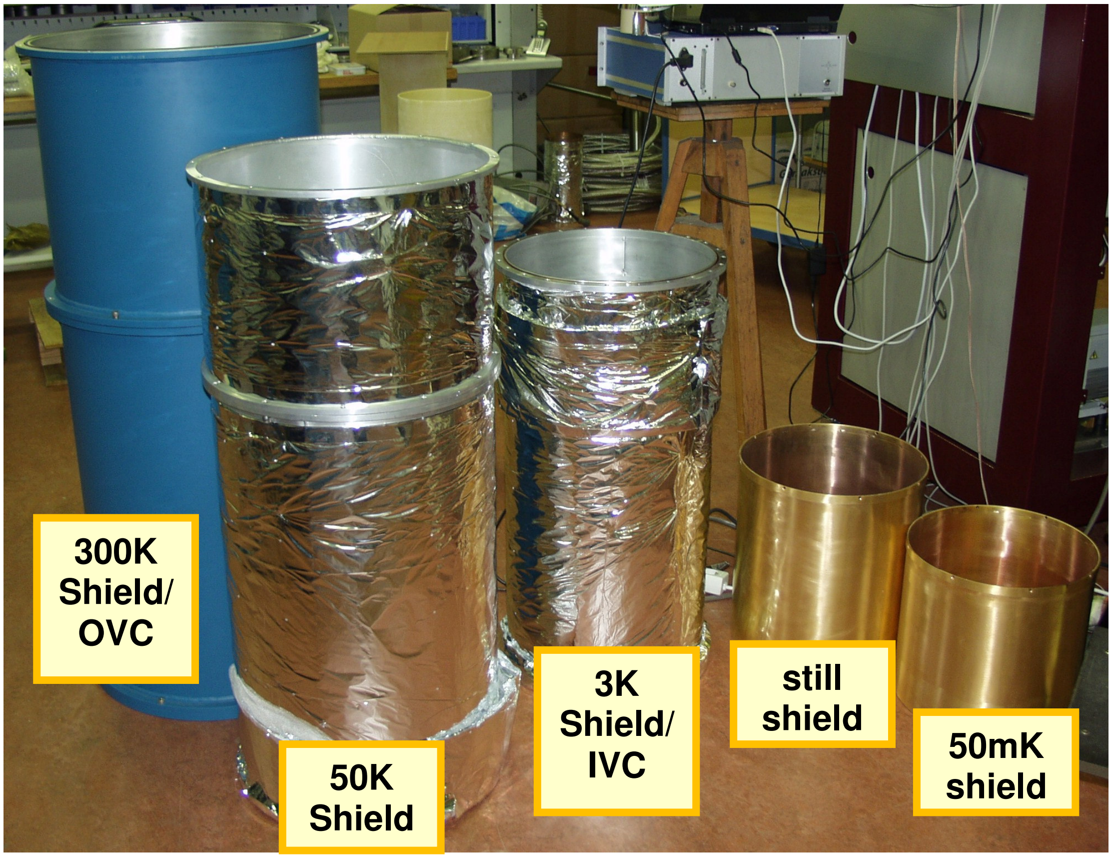


Fig 8 *Photograph of the radiation shields of the CF-DR unit.*

Description of the CF-DR top flange

The top flange is made of anodized aluminum. It is attached to an aluminum block where the pumping line is bolted by means of an ISO-100 flange passing first through a 100 mm gate-valve (standard). The bolts assure electrical contact between the parts. On the top flange there are a number of 24V DC valves and several inlet/outlet ports.

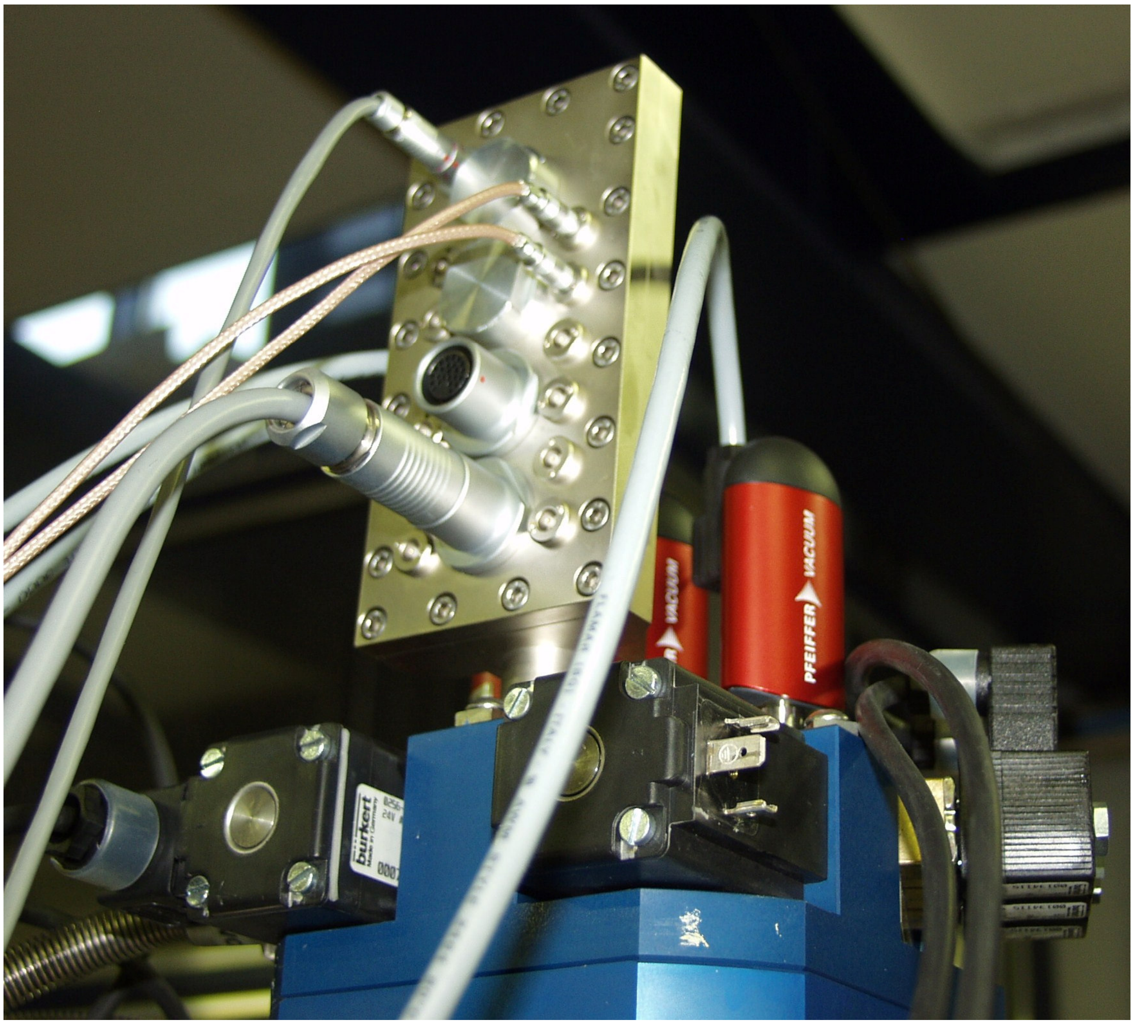


Figure 9 *Picture of the MNK126-TOF top flange (top-view). This picture shows the standard connector box with a 7-pins Fischer connector for the heaters (sorb pump, still and mixing chamber), the two 24-pins Fischer connectors (wires 1 and 2) and the 12 coax connectors.*

4-GAS HANDLING SYSTEM (GHS)

The cabinet

The standard gas handling system consists of a stainless steel cabinet made of hollow square tubes welded so as to make two leak-tight reservoirs. The upper one, tank #3, is used for storing ^{3}He. It has a volume of **36** liter. The lower one is used for the ^{4}He-rich mixture and has a volume of **142.5** liters. Mixture needed for the different models: Usually the mixture is slightly over-pressured in the tanks, depending on the model.

The cabinet of the GHS contains

On the front side (**Fig 10**):

- Control panel
- Controller for the turbo pump
- MaxiGauge vacuum gauge controller
- AVS47 resistance bridge - optional
- Triple Current Source (TCS) - standard

On the left side (**11**):

- Main relay box.
- 24V dc power supply (Error! Reference source not found.) for the Valve Board relay box.

Inside (Error! Reference source not found.):

- Valve board (VB)
- The valve board relay box
- Turbo pumps
- 2 pumps for 3He circulation and general vacuum
- Compressor
- Nitrogen dewar for the cold trap.

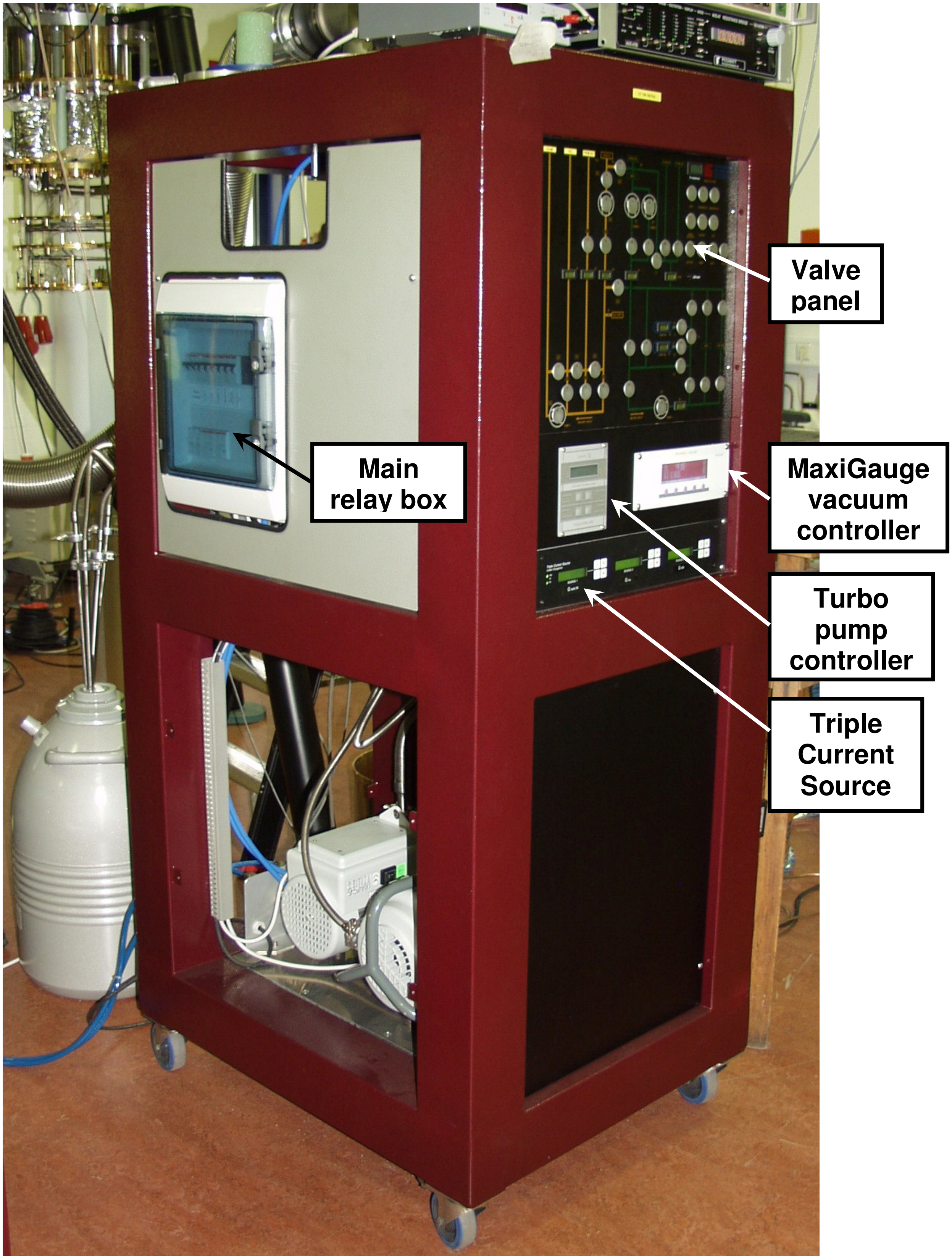


Fig 10 *View of the GHS*

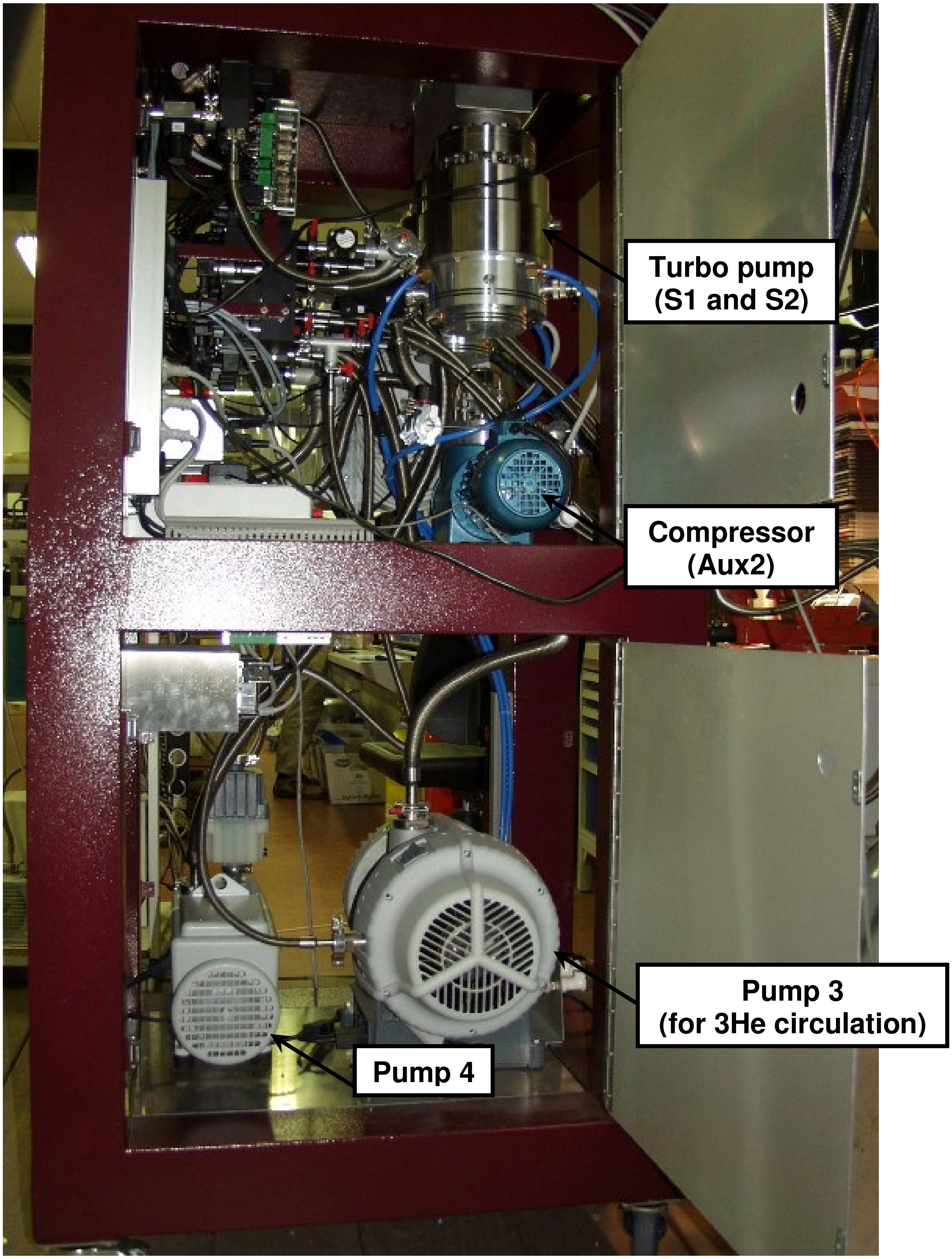


Figure 11 *Position pumps inside of the GHS.*

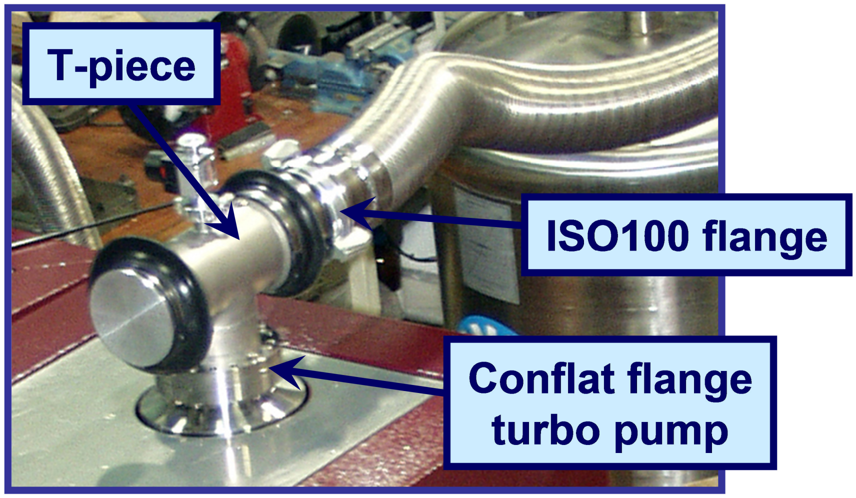


Figure 12 *View of the gas handling system (GHS). A T-piece with rubber bellows provides electrical and mechanical insulation to the insert. For extra vibration insulation it is advisable to mechanically anchor the NW100 flexible line to a wall or a heavy structure.*

Main Relay Box

The main relay box **(Fig 13)** is mounted at the left side of the GHS (**Fig 10**). It contains all the main switches for the pumps and the DC power supply for the Control Panel (**Fig 16**).

Fig 13 *Main relay box*

Control panel (CP)

Most valves of the Control Panel are integrated in an aluminum block, making it very compact and reliable (**Fig-14**).

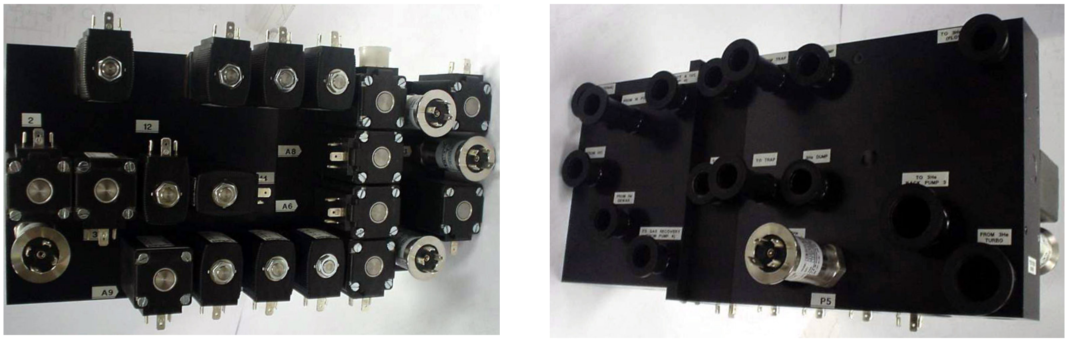


Fig 14 *Front and back view of the aluminum valve block*

The CP relay box is mounted on top of the valve block. Both can be accessed by opening the CP. This can be done by unscrewing the 2 upper screws of the CP (**Fig-15**). The electric valves are all 24 V DC and are controlled by piezoelectric switches coupled to a microprocessor. The 24V (12A) power supply is mounted beneath the main relay box. The microprocessor reads a pre-loaded EPROM programmed with the steps needed to automatically operate your refrigerator starting from 4K with the IVC under vacuum. The EPROM chip can be removed from its socket (**Fig 15**) without removing the back panel and replaced by a newer version if necessary. The serial number of the present version is written on the back of the EPROM and is visible through the window. A scheme of the CP relay box connectors is glued at the back of the CP (**Figure**).

Note: Modification of some of the values of the automatization program can be done using the Labview program. When disconnecting the computer, the changes stay in the EPROM.

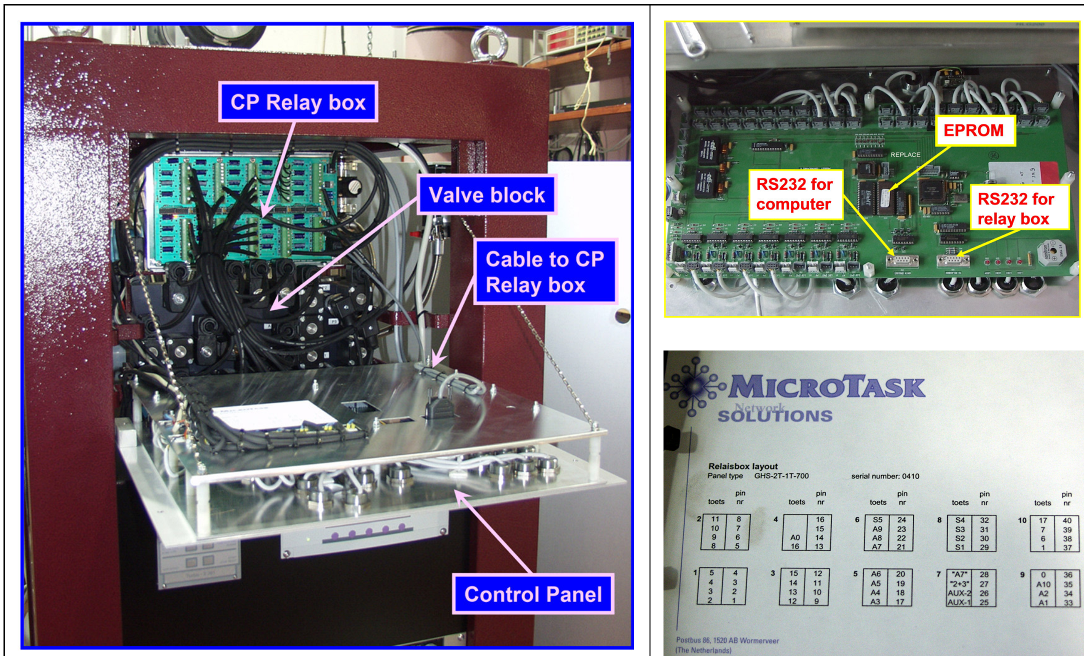


Figure 15

Left: *The CP can be opened to access the VB and CP relay box.*

Right up: *Printed plate at the back the Control Panel, with the cover removed. The cables on the left are for the pressure gauges LCD's. The RS232 on the right connects the board to the relay box. The RS232 socket on the left is for connecting the cable to the computer, for the automatization under LabView. The EPROM that can be removed for updating the automatization program is also shown. Upgrading the EPROM require4s disconnecting the main DC battery.*

Right down: *The scheme of the CP relay box is glued to the back cover of the CP.*

The Control Panel (see **Fig 16**) uses two colors, green and yellow. Green is used for the closed circuit of the ^{3}He-^{4}He mixture of the dilution refrigerator and yellow for the evacuation of the IVC. The valves of the yellow circuit are denoted by **A0**, **A1**, **A2**…..**A8**, while the valves of the green circuit are denoted by **0**, **1**, **2**,…..**16**. There are 4 manual valves in the system: **M1** to close the ^{3}He reservoir, **M2** to close the ^{4}He reservoir, one auxiliary valve **M3** (see **Fig**) and M4 that bypasses the mixture compressor. The switches of the pumps are denoted by **S1** – **S5**. (S5 is normally not connected, as well as A2 unless a auxiliary turbo-pump for the IVC is ordered.

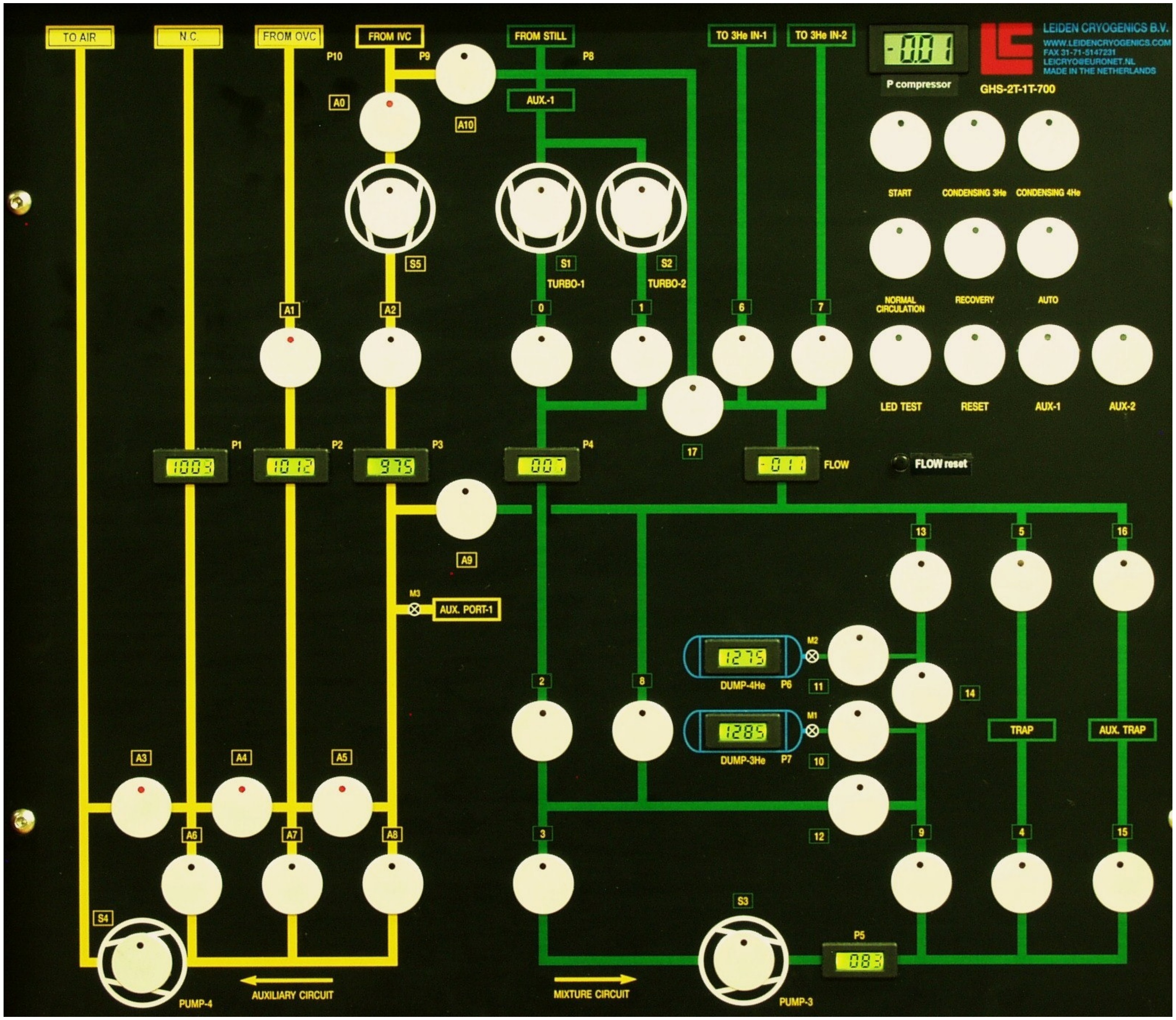


Fig16 *Control panel. The yellow circuit is used to evacuate the system and the green one for the 3He-4He mixture. The letters "**nc**" indicate the buttons that are not used in the CF-DR models. The "Aux2" button is used to switch on and off the compressor. Note the larger display on the upper right corner. It indicates the pressure after the compressor, at the input line. Make sure you always use the high pressure NW16 o-rings that we supply (or similar ones) on the high pressure side of the compressor.*

The CP is also used for other LC models. Not all valves and pumps are used for the CF models. The valves and pump which are not connected are denoted by **NC** (see **Fig 16**) Most valves are included in the valve block except for the valves **A0**, **A1**, **6, 7, 17** and **Aux1** which are mounted on the head of the insert (**Figure**). Valves **0**, **10**, **11** and the four manual valves **M1**, **M2**, **M3** and **M4** as well as the flow meter are mounted outside of the valve block in the GHS as is shown in **Fig , 17**. On the upper-right side of the CP there are 10 separate buttons used for the automatization

NOTE. As mentioned earlier, the automatization program is still the one used for the classic dilution refrigerators. You should only use the auto mode in condensing the mixture and for the normal circulation. Recovery should be done in manual mode for the moment. We will soon have the new program ready.

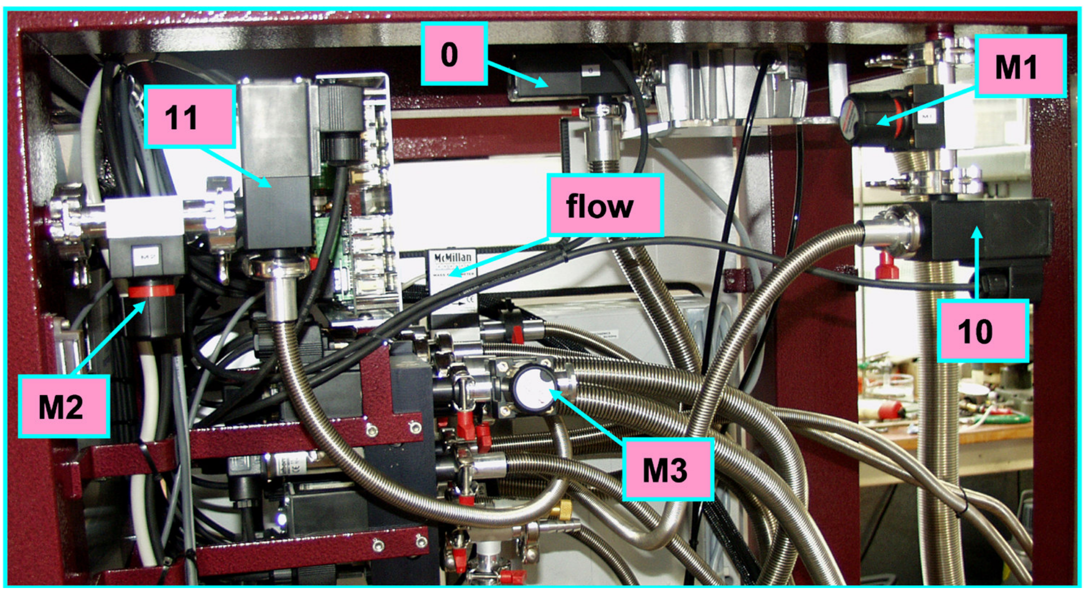


Fig 17 *Indication of the manual valves and of the electric valves which are not integrated in the aluminum valve block.*

The membrane compressor

The GHS has a membrane compressor (KNF) not indicated in the valve board placed just after the flow-meter line. It has been modified by adding two check valves. One opens with a pressure of 50 mbar in the direction of the flow. This valve keeps the pressure after the compressor in the condensing lines. A second valve, placed also on top of the compressor, opens backwards when the pressure in the condensing line is above a certain fixed value, typically 3-4 bar. Gas is thus fed back and the condensing pressure is kept from increasing too much. There is a manual valve (M4) not indicated on the valve board) that bypasses the mixture compressor. Its role is to open the way to the condensing line from the GHS since the checking valve closes it. Open the valve when cleaning the line or removing mixture from that section of the condensing line. When using the compressor this valve should be closed, of course. Check periodically that the rubber membranes are intact by leak-checking for a leak to the outside. The membranes are given for 2000 or more hours of continuous operation. Since the compressor is only used for a couple of hours during condensation it should be able to run for 100 cool-downs before needing replacement or thorough inspection by disassembling the head.

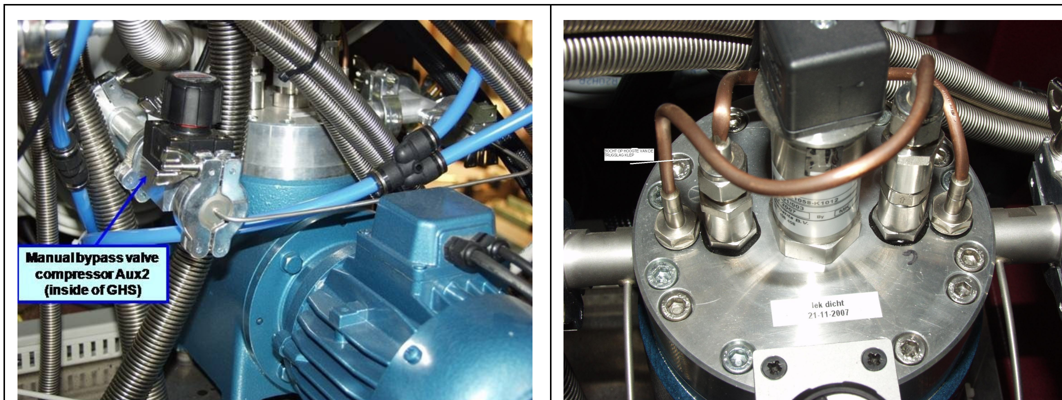


Fig 18 *Pictures of the compressor used for the 3He/4He condensation. The compressor can be switched on and off by using the "Aux2" button on the valve panel. The compressor has a manual valve **M4** as a bypass to pump out the condensing line before starting operation.*

MaxiGauge vacuum gauge controller

The MaxiGauge vacuum gauge controller is placed below the CP on the right side, in the front panel of the GHS. It is used to monitor the Pirani pressure gauges of the IVC and the still, but it accepts up to 6 vacuum gauges of different types (Pfeiffer Vacuum). The minimum pressure that can be read by the Pirani pressure gauges is 5.0×10^{-4} mbar.

Turbo pump controller

The turbo pump controller is placed below the CP on the left side, at the front panel of the GHS. The controller can be switched on and off using **S1** on the CP (remote mode) for the CF-150 to 450 models and **S1** and **S2** for the CF-600 and 1200 models, which have two turbo pumps.

AVS47 resistance bridge (optional)

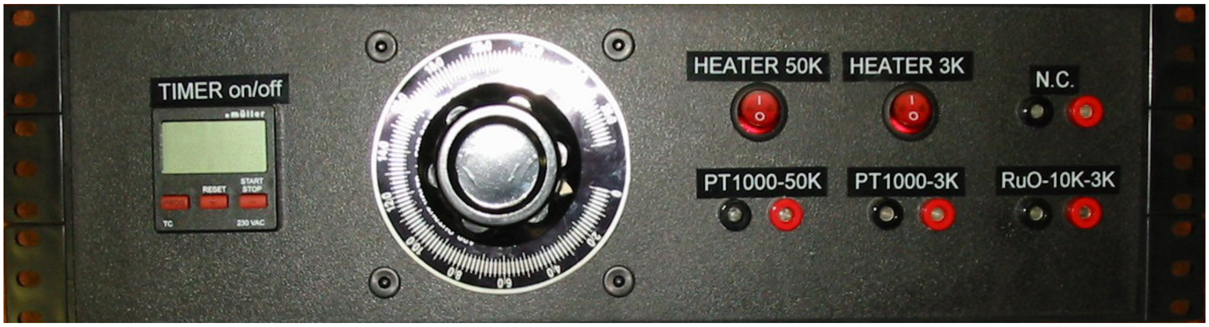
The AVS47 resistance bridge can be placed below the turbo pump controller and the MaxiGauge, at the front panel of the GHS. This bridge is strongly advised, because of its low noise and separate preamplifier hat can be placed close to the dewar, and because it can be used in combination with the standard Triple Current Source (TCS) to adjust the temperature.

Triple Current Source (TCS)

The Triple Current Source (TCS) is placed below the AVS47 resistance bridge, at the front panel of the GHS. It has 3 independent low-noise outputs for heating the sorb-pump, the still and the MC. It can be adjusted from 1μA to 100 mA. The manual is included in the DOC section of the automatization CD

Heater unit

All CF systems are equipped with a heater unit. This enables you to warm up the system within 9 hours using a voltage of 90V. Always use the timer when using the heater unit. The unit also allows you to measure the resistances of the thermometers of the 50K and 3K plates.



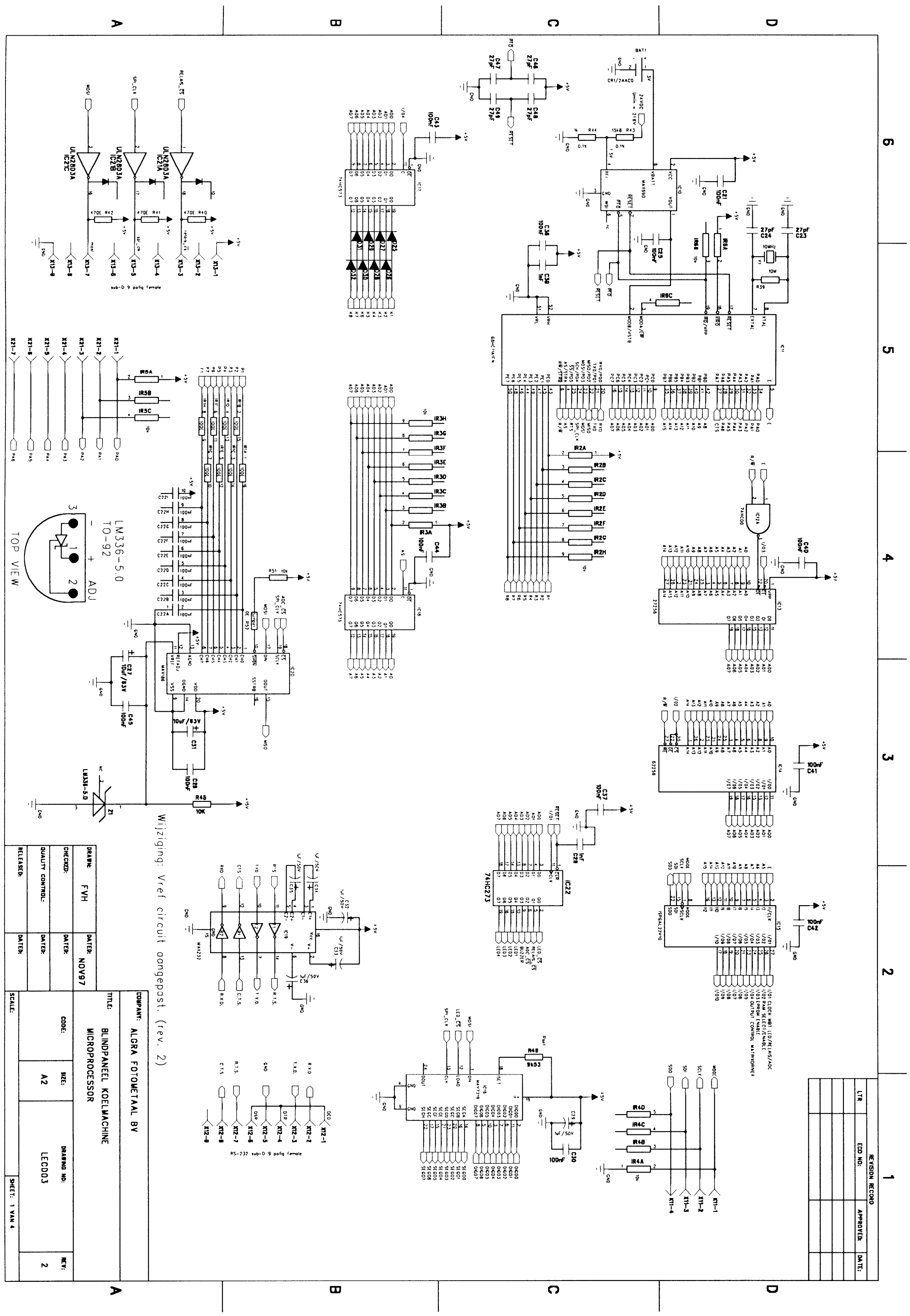
NOTE: If problems of power failure should occur frequently, it is advisable to use a back-up 24V car battery to keep the panel and safeties working. Only the mechanical pumps will be turned off, in this case.

NOTE: *If a power failure occurs, all valves close, nevertheless, if the pressure were to increase above 2 bar the mixture will go automatically into the tanks since the valves open with a 2 bar differential pressure. If the system were, for instance, in normal circulation mode and the mixture is still cold and condensed, push the "***NORMAL CIRCULATION***" button and then the "***AUTO***" button to open automatically the required valves.*

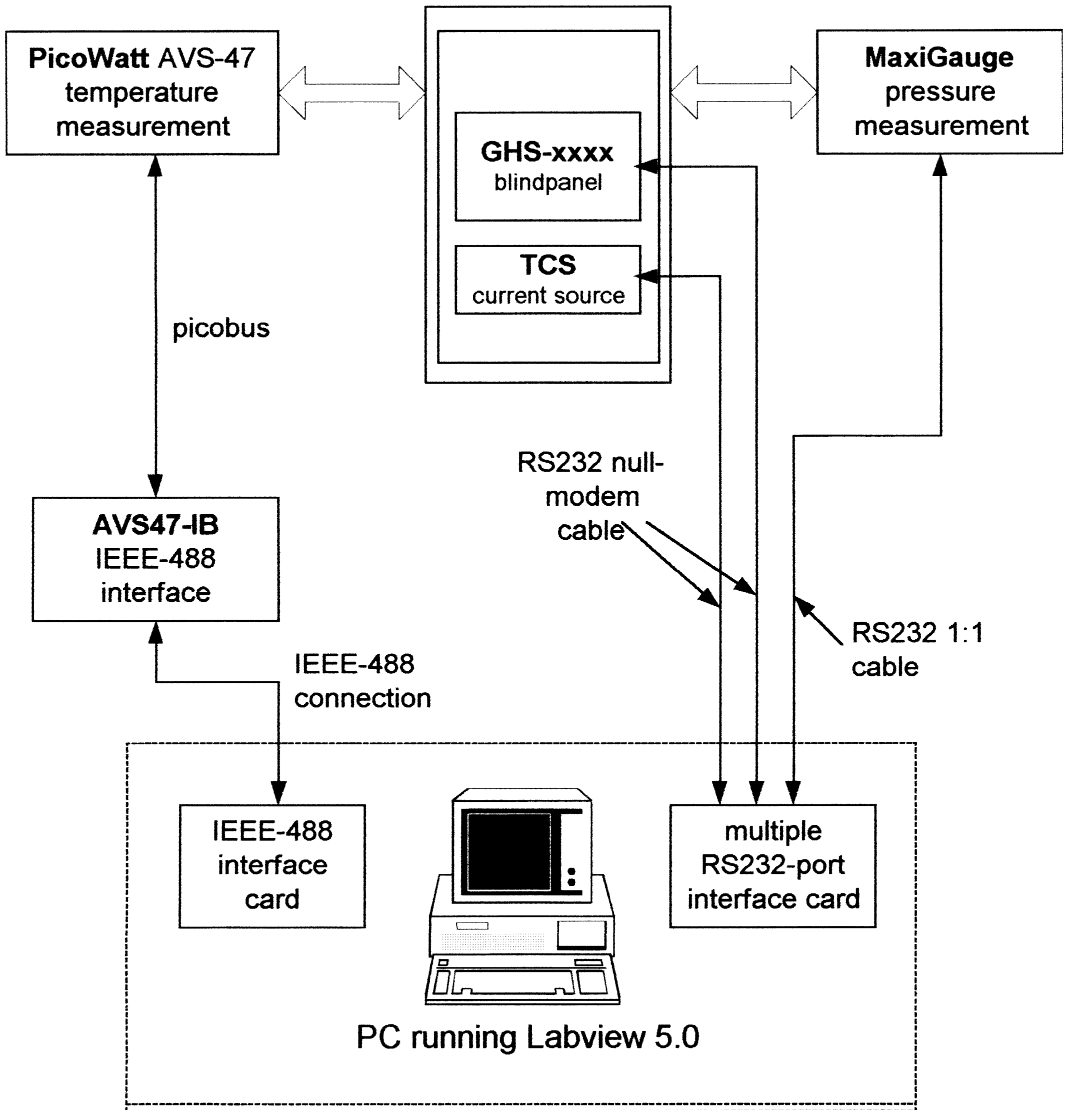
Trouble shooting

Problem description	Fix the problem
The LEDs on the control panel work, but the valves don't open and the pumps don't switch on	The fuse of the 24V power supply of the CP relay box could be burned
A valve doesn't open, although there are 24V across the input wires	The iron plunger of the valve could be stuck, Open the valve by removing the 4 screws. Clean the plunger and apply some vacuum grease. Close the valve.
Some valves do not open, because there is no voltage applied to the solenoid.	Open the CP and check that the connectors are well inserted into the sockets of the CP relay box (sometimes a connector gets loose during transportation).

APPENDIX 1: Schematics of the control electronics



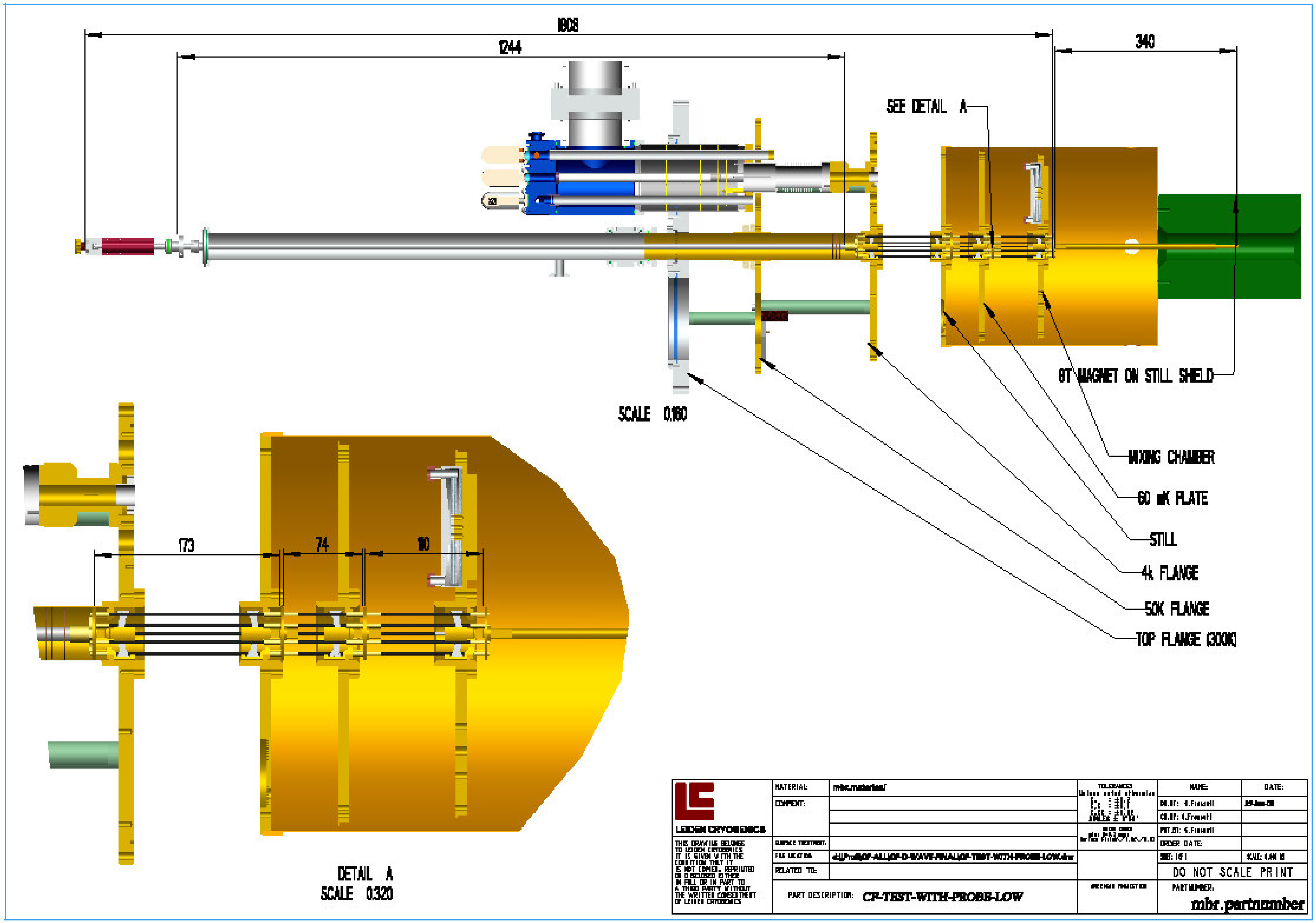
Measuring setup

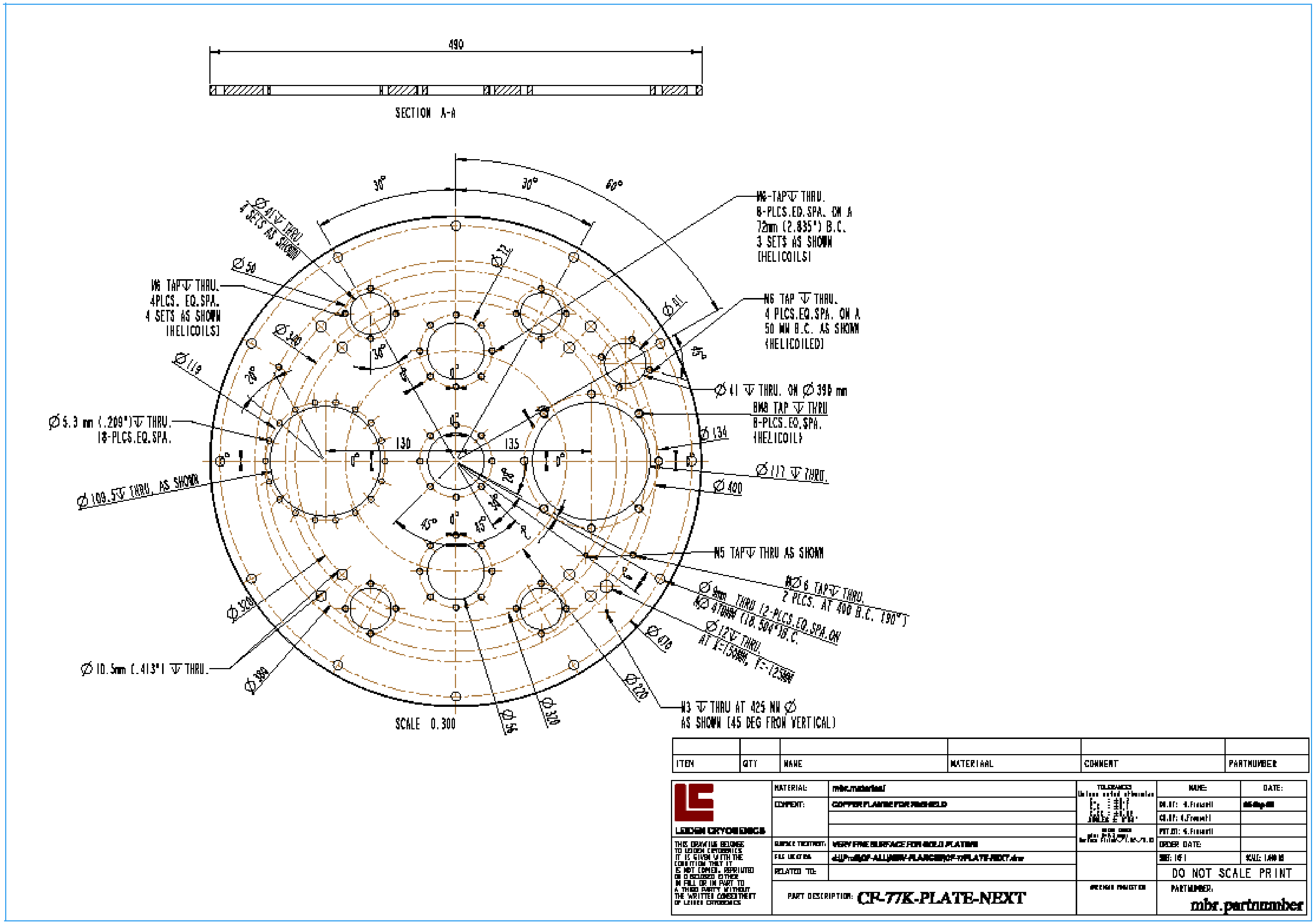


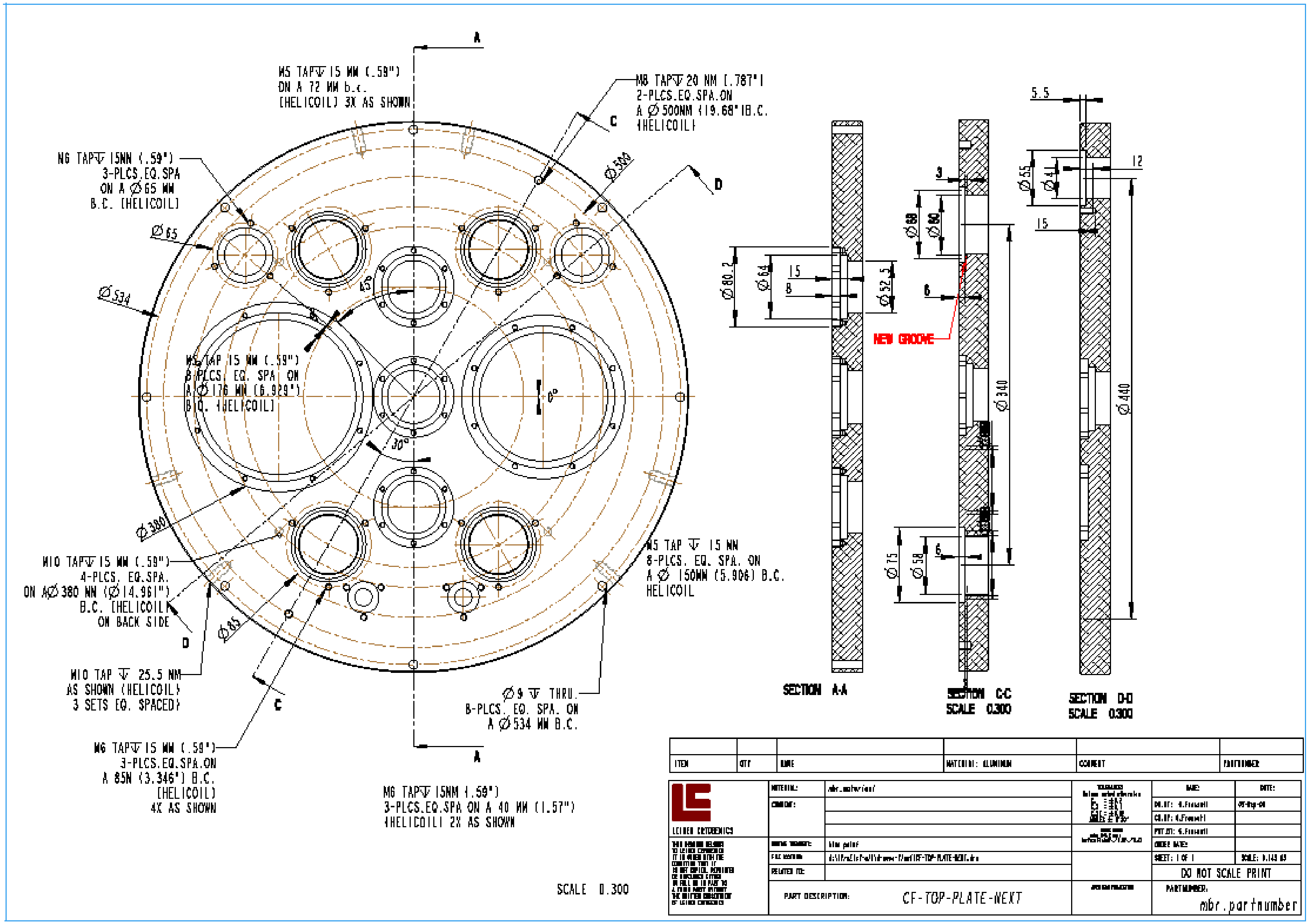
Document : Aansluittabel piëzotoetsen.

Type : GHS-1TPR-200-500
Datum : 06-10-1998
File : LEAT04-1.WPD

Connectornotatie op pcb	Blindpaneel piezodruktoets tekst	Schema notatie
X101	AUX-1	S1 / LED1
X102		
X103	15	S3 / LED3
X104	16	S4 / LED4
X105		
X106	RESET	S6 / LED6
X107	4	S7 / LED7
X108		
X109	5	S9 / LED9
X110	LED TEST	S10 / LED10
X111		
X112	9	S12 / LED12
X113	14	S13 / LED13
X114		
X115	13	S15 / LED15
X116	AUTO	S16 / LED16
X117		
X118	12	S18 / LED18
X119	10	S19 / LED19
X120		
X121	11	S21 / LED21
X122	18	S22 / LED22
X123		
X124	7	S24 / LED24
X125	S2	S25 / LED25
X126		
X127	6	S27 / LED27
X128	17	S28 / LED28
X129		
X130	8	S30 / LED30
X131	1	S31 / LED31
X132		
X133	S1	S33 / LED33
X134	3	S34 / LED34
X135		
X136	2	S36 / LED36
X137		S37 / LED37
X138		
X139	A10	S39 / LED39


1808
1244
340
SEE DETAIL A
8T MAGNET ON STILL SHIELD
SCALE 0.160
MIXING CHAMBER
60 mK PLATE
STILL
4k FLANGE
50K FLANGE
TOP FLANGE (300K)
173
74
110
DETAIL A
SCALE 0.320
LEIDEN CRYOGENICS
THIS DRAWING BELONGS TO LEIDEN CRYOGENICS IT IS GIVEN WITH THE CONDITION THAT IT IS NOT COPIED, REPRINTED OR DISCLOSED EITHER IN FULL OR IN PART TO A THIRD PARTY WITHOUT THE WRITTEN CONSENT OF LEIDEN CRYOGENICS
MATERIAL:
COMMENT:
SURFACE TREATMENT:
FILE LOCATION:
RELATED TO:
PART DESCRIPTION: CF-TEST-WITH-PROBE-LOW
TOLERANCES
NAME:
DATE:
ORDER DATE:
SHT: 1 OF 1
DO NOT SCALE PRINT
PART NUMBER:
mbr.partnumber


490
SECTION A-A
30°
30°
60°
M6-TAP THRU.
8-PLCS.EQ.SPA. ON A
72mm (2.835") B.C.
3 SETS AS SHOWN
[HELICOILS]
M6 TAP THRU.
4 PLCS.EQ.SPA. ON A
50 MM B.C. AS SHOWN
[HELICOILED]
Ø 41 THRU. ON Ø 390 mm
8M8 TAP THRU
8-PLCS.EQ.SPA.
[HELICOIL]
Ø 117 THRU.
Ø 400
Ø 134
M5 TAP THRU AS SHOWN
Ø 6 TAP THRU.
2 PLCS. AT 400 B.C. (90°)
Ø 9mm THRU (2-PLCS.EQ.SPA.ON
Ø 470mm (18.504")B.C.
Ø 12 THRU.
M3 THRU AT 425 MM Ø
AS SHOWN (45 DEG FROM VERTICAL)
M6 TAP THRU.
4PLCS. EQ.SPA.
4 SETS AS SHOWN
[HELICOILS]
Ø 5.3 mm (.209") THRU.
18-PLCS.EQ.SPA.
Ø 109.5 THRU. AS SHOWN
Ø 10.5mm (.413") THRU.
Ø 50
Ø 119
Ø 340
Ø 320
Ø 390
Ø 56
Ø 320
Ø 120
Ø 470
Ø 72
Ø 41
130
135
SCALE 0.300
ITEM
QTY
NAME
MATERIAAL
COMMENT
PARTNUMBER
LEIDEN CRYOGENICS
MATERIAL:
COMMENT:
SURFACE TREATMENT:
VERY FINE SURFACE FOR GOLD PLATING
RELATED TO:
PART DESCRIPTION: CF-77K-PLATE-NEXT
NAME:
DATE:
ORDER DATE:
DO NOT SCALE PRINT
PARTNUMBER:
mbr.partnumber


M5 TAP 15 MM (.59")
ON A 72 MM b.c.
[HELICOIL] 3X AS SHOWN
M8 TAP 20 MM [.787"]
2-PLCS.EQ.SPA.ON
A Ø 500MM (19.68")B.C.
(HELICOIL)
M6 TAP 15MM (.59")
3-PLCS.EQ.SPA
ON A Ø65 MM
B.C. [HELICOIL]
Ø65
Ø534
Ø500
M5 TAP 15 MM (.59")
8 PLCS. EQ. SPA. ON
A Ø 176 MM (6.929")
B.C. (HELICOIL)
Ø380
M10 TAP 15 MM (.59")
4-PLCS. EQ.SPA.
ON AØ 380 MM (Ø14.961")
B.C. [HELICOIL]
ON BACK SIDE
Ø85
M10 TAP 25.5 MM
AS SHOWN (HELICOIL)
3 SETS EQ. SPACED)
M6 TAP 15 MM (.59")
3-PLCS.EQ.SPA.ON
A 85M (3.346") B.C.
[HELICOIL]
4X AS SHOWN
M6 TAP 15MM (.59")
3-PLCS.EQ.SPA ON A 40 MM (1.57")
(HELICOIL) 2X AS SHOWN
M5 TAP 15 MM
8-PLCS. EQ. SPA. ON
A Ø 150MM (5.906) B.C.
HELICOIL
Ø9 THRU.
8-PLCS. EQ. SPA. ON
A Ø534 MM B.C.
SCALE 0.300
NEW GROOVE
SECTION A-A
SECTION C-C
SCALE 0.300
SECTION D-D
SCALE 0.300
ITEM
QTY
NAME
MATERIAL: ALUMINUM
COMMENT
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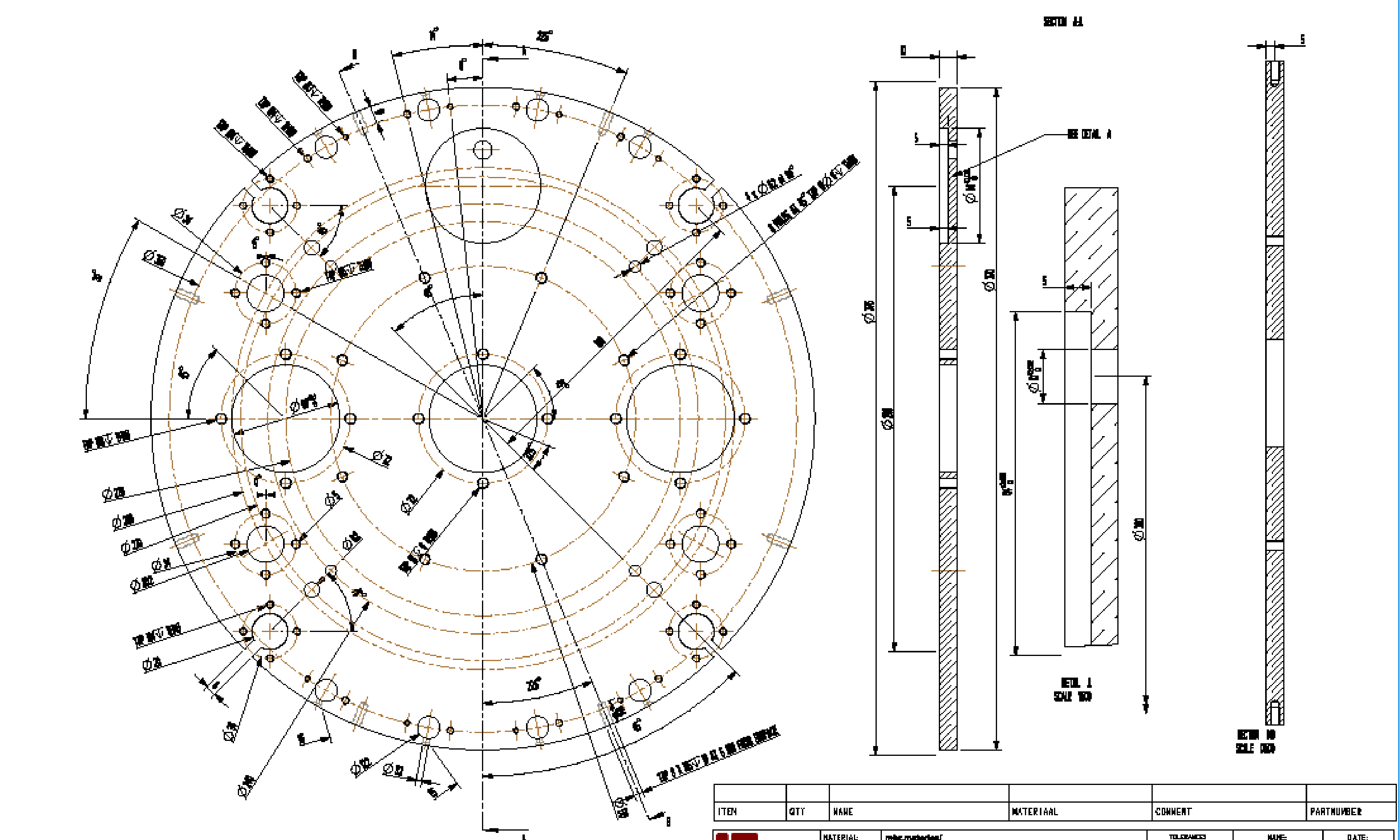
CF-TOP-PLATE-NEXT
PARTNUMBER:
mbr.partnumber



ITEM	QTY	NAME	MATERIAAL	COMMENT	PARTNUMBER

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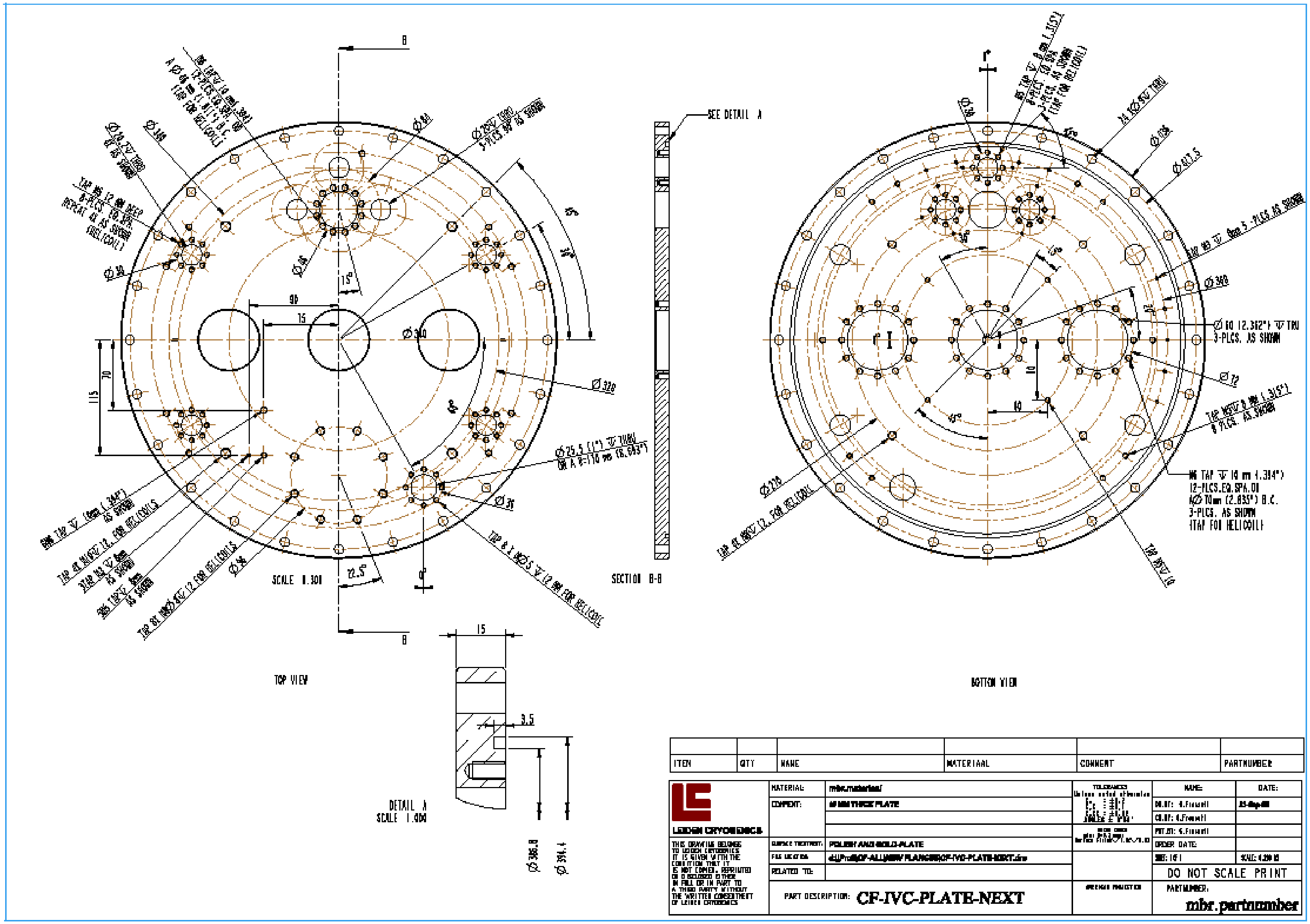
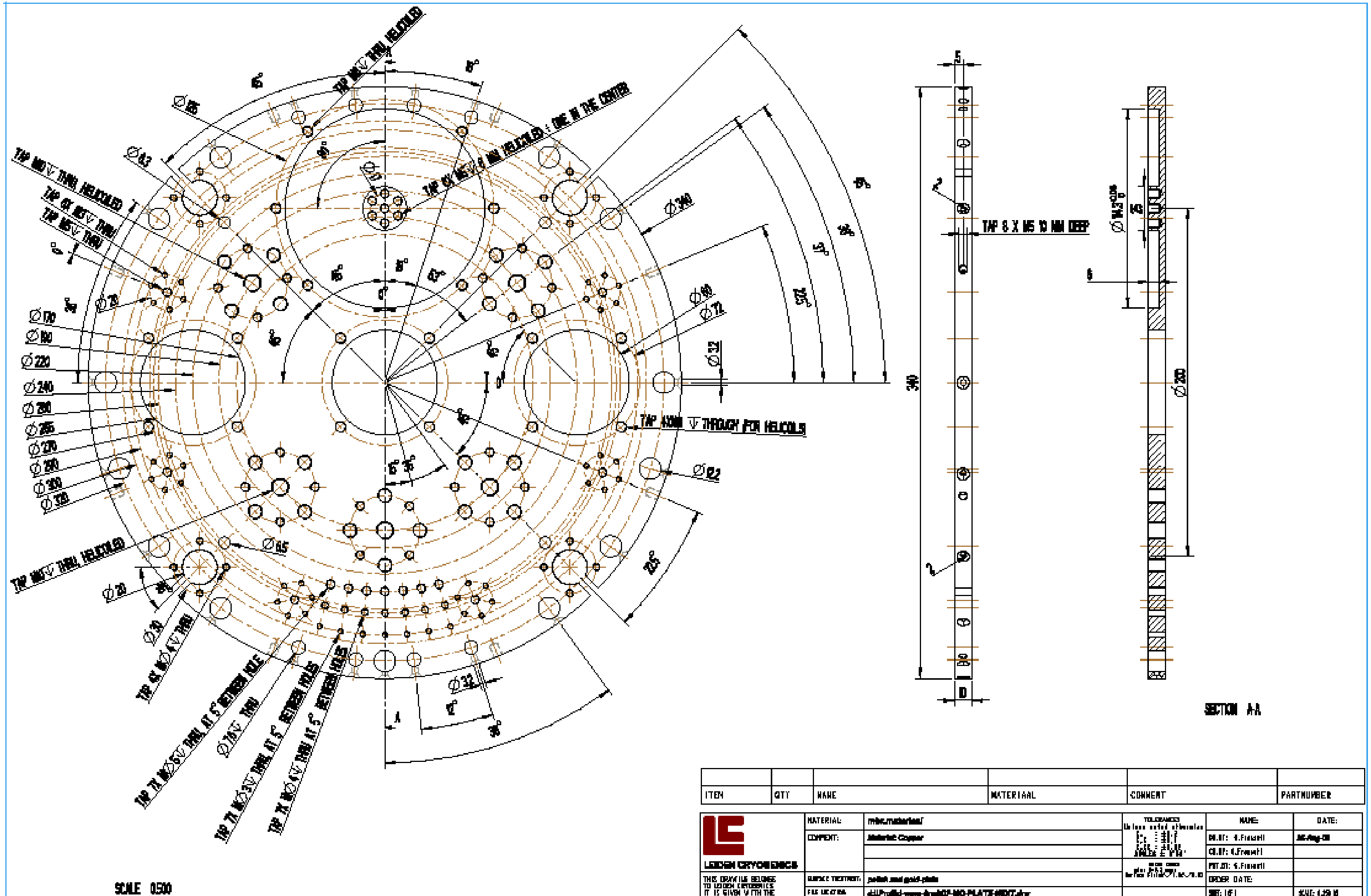
MATERIAL:	mbr.material	TOLERANCES Unless noted otherwise	NAME:	DATE:
COMMENT:				
	material: copper			
SURFACE TREATMENT:	gold-plated		ORDER DATE:	
FILE LOCATION:	CF-STILL-PLATE-NEXT.dwg			
RELATED TO:			DO NOT SCALE PRINT	
PART DESCRIPTION: CF-STILL-PLATE-NEXT			PARTNUMBER: mbr.partnumber	


TOP VIEW
SECTION B-B
SEE DETAIL A
BOTTOM VIEW
DETAIL A
SCALE 1.000
ITEM
QTY
NAME
MATERIAAL
COMMENT
PARTNUMBER
MATERIAL:
COMPONENT:
SURFACE TREATMENT:
POLISH AND GOLD PLATE
RELATED TO:
LEIDEN CRYOGENICS
PART DESCRIPTION:
CF-IVC-PLATE-NEXT
DO NOT SCALE PRINT
PARTNUMBER:
mbr.partnumber



ITEM	QTY	NAME	MATERIAAL	COMMENT	PARTNUMBER

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				CH.BY: G.Frossati	
				PRT.BY: G.Frossati	
	SURFACE TREATMENT:	polish and gold-plate		ORDER DATE:	
	FILE LOCATION:	[illegible] CF-MC-PLATE-NEXT.drw		SHEET: 1 OF 1	SCALE: 1:2.0
	RELATED TO:			DO NOT SCALE PRINT	
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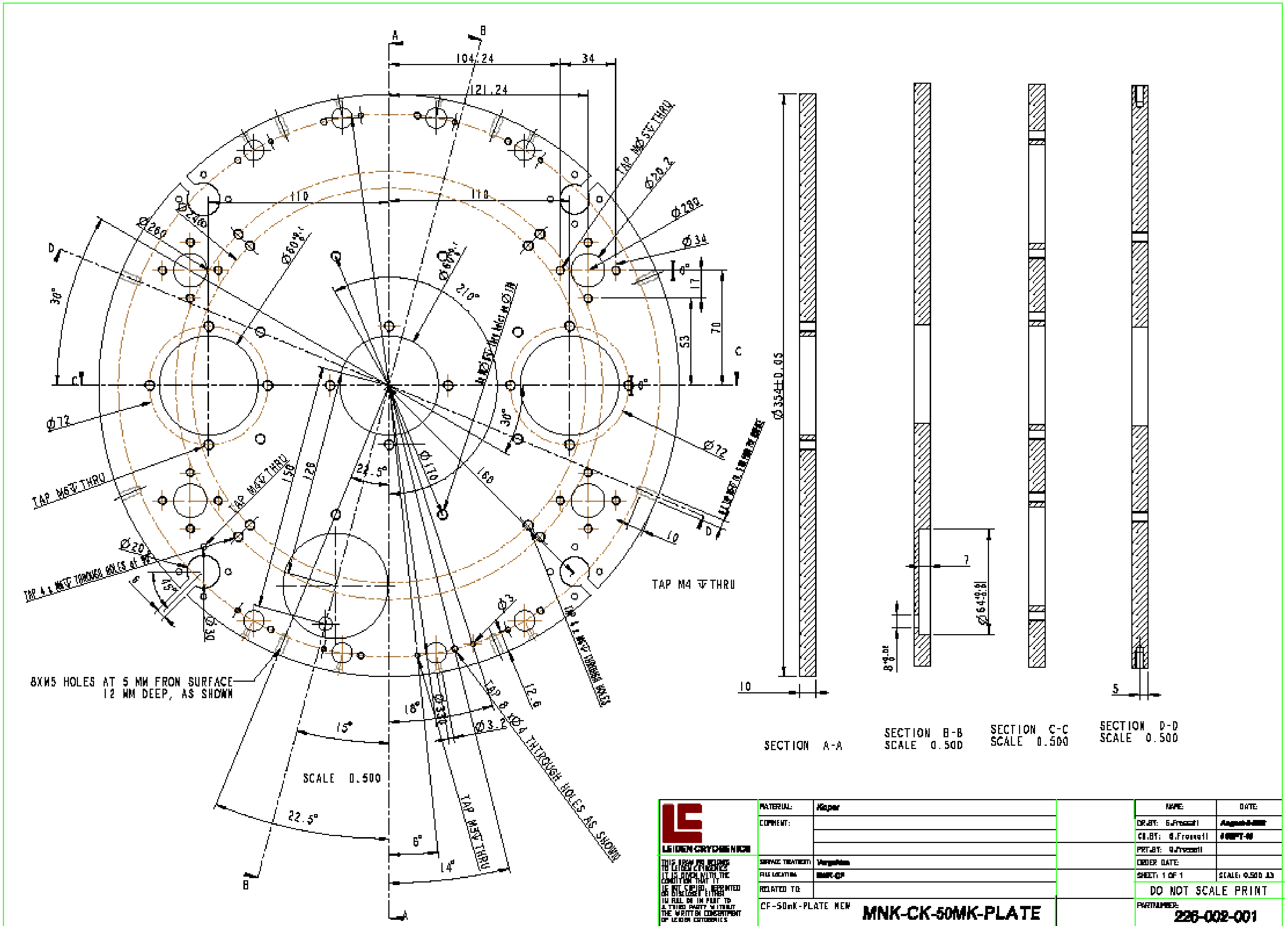
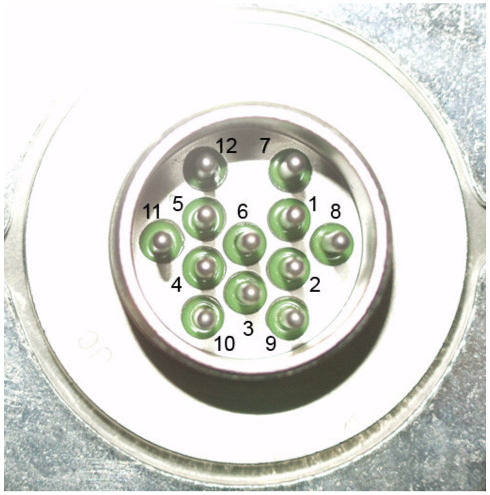
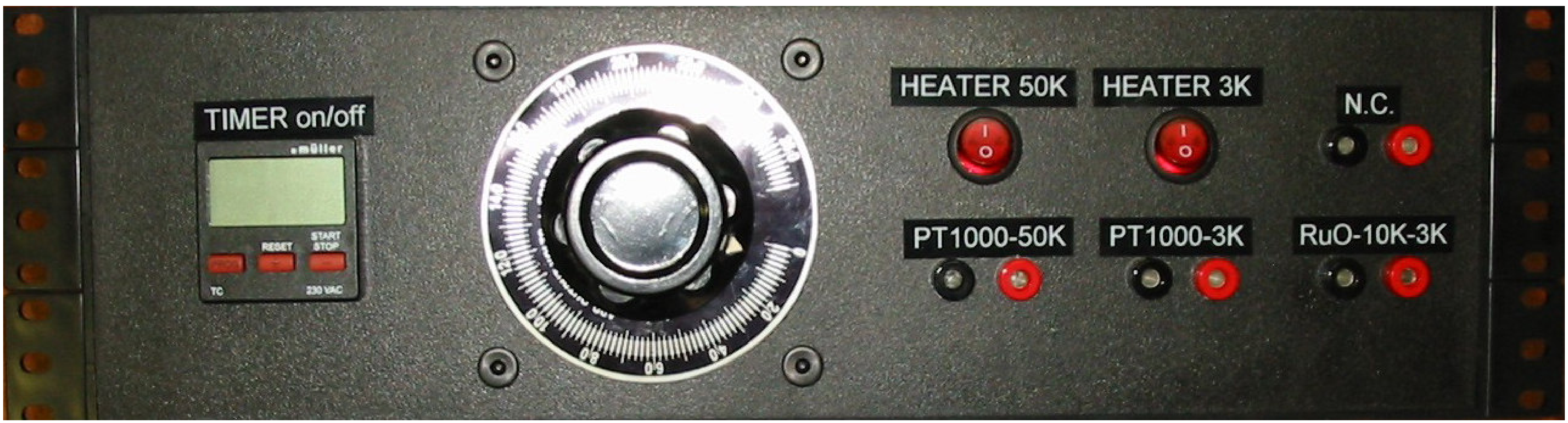

104.24
34
121.24
110
110
TAP M6 ∇ THRU
Ø20.2
Ø289
Ø34
Ø260
Ø246
Ø60
Ø60
210°
30°
17
53
70
Ø72
Ø72
TAP M6 ∇ THRU
Ø170
160
150
128
22.5°
30°
10
TAP M4 ∇ THRU
Ø20
Ø30
Ø3
8XM5 HOLES AT 5 MM FROM SURFACE
12 MM DEEP, AS SHOWN
18°
15°
SCALE 0.500
22.5°
6°
14°
Ø330
Ø3.2
12.6
TAP M3 ∇ THRU
8 XØ3.4 THROUGH HOLES AS SHOWN
Ø354±0.05
10
7
5
SECTION A-A
SECTION B-B
SCALE 0.500
SECTION C-C
SCALE 0.500
SECTION D-D
SCALE 0.500
LEIDEN CRYOGENICS
MATERIAL:
COMMENT:
SURFACE TREATMENT:
FILE LOCATION:
RELATED TO:
CF-50mK-PLATE NEW
MNK-CK-50MK-PLATE
NAME:
DATE:
DR.BY:
CH.BY:
PRT.BY:
ORDER DATE:
SHEET: 1 OF 1
DO NOT SCALE PRINT
PARTNUMBER:
226-002-001

3 : Wiring scheme CF-refrigerator; Jäger connector



1-2 Heater 50K
3-4 Heater 3K
5-6 Pt1000 50K
7-8 Pt1000 3K
9-10 RuO10k 3K



APPENDIX 3: TEST RESULTS

	DESCRIPTION	ROOM T							
1-2	C-STILL								

WIRES-2	DESCRIPTION	ROOM T	36 h LATER	Circulating
	I-Still			
	Flow (reading)			
# 0 (1-2)	10KΩ 3K-PL-SORB			
# 1 (3-4)	10KΩ STILL			
# 2 (5-8)	R1.5- on 60mK plate			
# 3 (9-12)				
# 4 (13-16)	Pt 1000 on MC plate			
# 5 (17-20)	Free			
# 6 (21-24)	Free			
Valve 6				
Valve 7				
Mixture comp.				
P-still				
P-in				

HEATERS	DESCRIPTION	ROOM T
1-2	Q-STILL (~ 100 Ω)	
3-4	Q-MC (100Ω)	
5-6	Q-Sorb (100Ω)	

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The Netherlands

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Fax: +31 71 5722734

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info@leidencryogenics.com