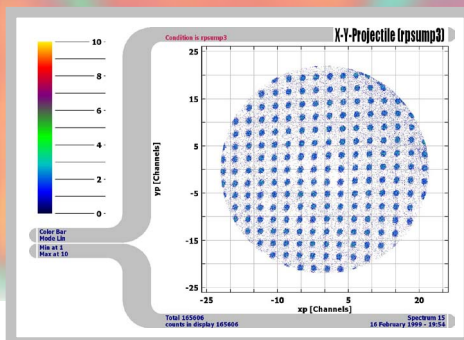
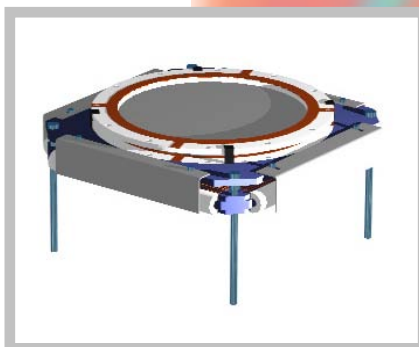
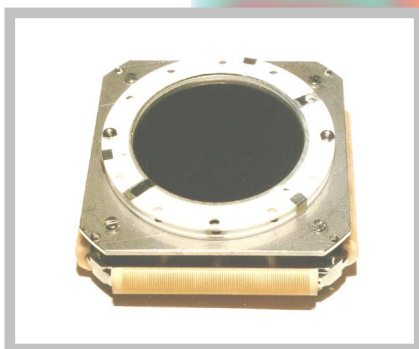


## MCP detector with timing anode Manual for MCP ToF detector DET40

(Version 9.5.1003.1)



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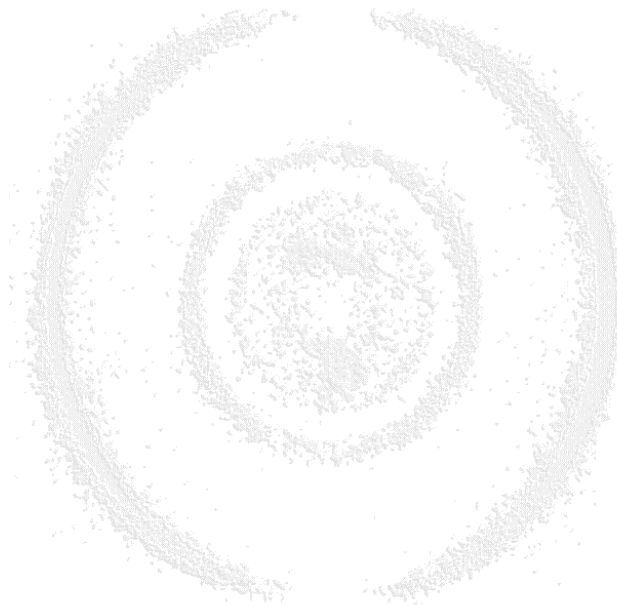
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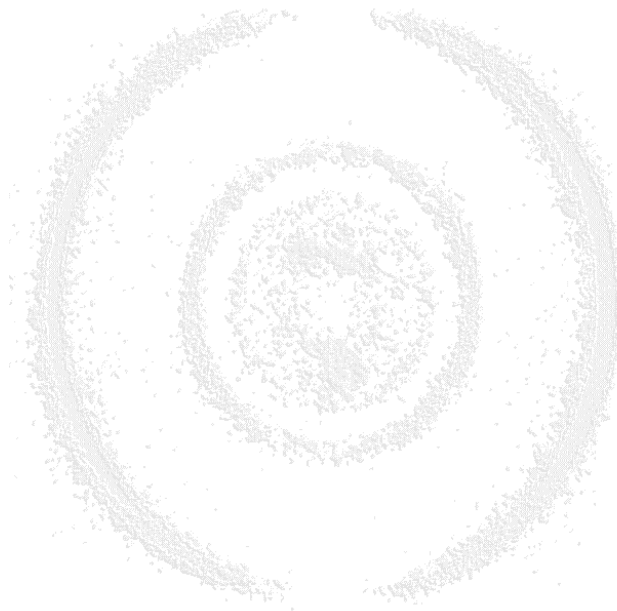
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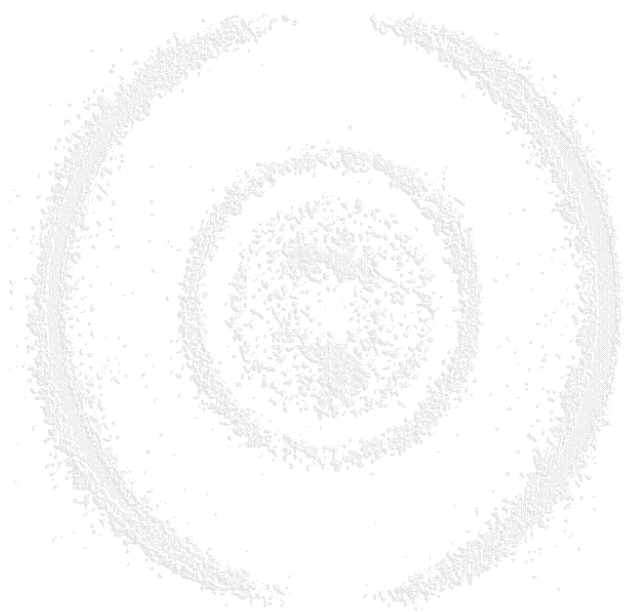
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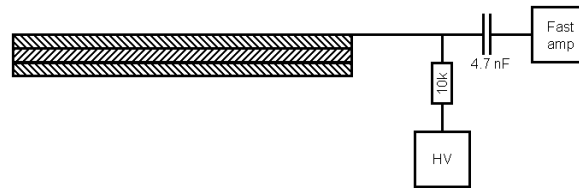
## 1. Introduction

The **DET40** detector is used to detect individual particles like electrons, ions and photons and to determine the arrival time of the particle with respect to an external trigger (Time-of-Flight).

It contains a MCP stack and a (transparent) timing anode. The MCP stack is a chevron configuration (two MCPs) mounted between two ceramic rings. The timing anode consists of a Gold (Germanium) coating on a ceramic substrate. The timing signal can be picked up from the MCP contacts (front or back) or from the timing electrode.

The transparent timing anode allows for a pick up of the image charge on a structured electrode pattern (e.g. a Wedge-and-Strip or LC-delay-line anode) behind the detector. It is recommended to pick up the timing from the MCP in this case.

The pick up of the timing signal (from anode or MCP contact) can be performed according to figure 1.1. It is recommended to use short cables between the detector and the amplifier or 50 Ohm coaxial cables with proper termination.



**Figure 1.1: RC-coupler for getting a fast timing signal from the MCP (here: Z-stack)**

The entire detector is bakeable up to 150°C (UHV-assembly only), the metal contacts on the ceramic rings/substrate are suitable for soldering.

The operation requires three DC voltages for MCP front and back contacts and for the anode layer and adequate vacuum feedthroughs, signal decouplers and timing electronics. Optional **RoentDek** products for **DET40** are

- 4-fold MHV feedthrough with signal pickup (**FT4TP**) and mounting flange (**FT4TP/100**)
- 2×4kV high voltage bias supply (**HV2/4**)
- Timing amplifier (e.g. **FAMP1**+amplifier and **CFD1b** or **ATR19-2**).

## 1.1 Characteristics

### 1.1.1 Physical Characteristics of Detector Specification

Mounting Diameter:	66mm
Mounting height	9mm
Baking Temperature:	150°C Maximum
Mounting Flange Size: (only with <b>FT4TP100</b> )	CF 100
Height above Flange:	≈ 100mm (adjustable)
Mounting Diameter:	94mm

### 1.1.2 Physical Characteristics of MCPs

# of MCPs in Chevron	2
Diameter:	50mm *
Active Diameter:	40mm
Quality Diameter:	40mm
Aspect Ratio (L/D):	80:1
Thickness:	1mm
Pore diameter:	12.5µm
Bias Angle:	20° *

\* for Photonis MCP: Outer Diameter 46mm, Bias Angle 13°, OAR 60%

Open Area Ratio:	70%
Operating Temperature Range:	-50 to 70°C
Operating Pressure:	$< 2 \times 10^{-6}$ mbar

### 1.1.3 *Electrical Characteristics of Detector*

Electron Gain @ 2400 Volts:	$1 \times 10^7$ Minimum
Operating Voltage:	2500 Volts Maximum

## 1.2 List of assembly parts

- 2 ceramic rings, partially metal coated
- timing anode (Gold or Germanium layer) on a ceramic substrate or metal anode)
- 2 micro-channel plates, matched in resistance
- 4 metal spring clamps
- 4 (spring) washers (not needed with metal mounting plate, product option **FT4TP/100**)
- M3 plastic screws with nuts (for pre-assembly of the MCP stack)
- M2 screws and special nuts (UHV assembly only)

## 1.3 Detector assembly

All parts, especially the MCP and anode should be handled with great care since the surfaces are very sensitive and should never be touched or scratched.

The ceramic rings should not be exposed to exceeding mechanical and thermal stresses and the assembly should take place under clean and dry conditions.

### 1.3.1 *Preparation:*

- A mesh can be spot-welded or soldered directly onto the front side of the front ceramic ring. The mesh is then placed 1.5 mm in front of the MCP surface.
- Prepare the connection cables for the MCP detector and the anode. You need 3 cables for the MCP front, MCP back and anode layer (a 4th if a mesh is used). The cables can be soldered directly onto the metallization of the ceramic rings and the anode. If so, use preferably the metallization strips which are not located on a hole in the ceramic parts. Please take care that no solder or flux is sprayed over the anode structure or the MCPs.
- Otherwise the cables on the anodes can be fixed by screws at the metallization rings located at holes in the ceramic parts. Before mounting be aware which holes should be used for that purpose. For the anode layer one of the screws which are used for fixing the anode can be used. **RoentDek** provides special contact clamps for the MCP (UHV assembly only).
- Clean all parts **except the MCPs and the anode** in an ultrasonic bath.

### Warning:

Although it is possible to clean also the anode or the MCP in an ultrasonic bath (iso-propanol) for very short time, there is a considerable risk for damage. If cleaning is necessary contact a **RoentDek** agent before.

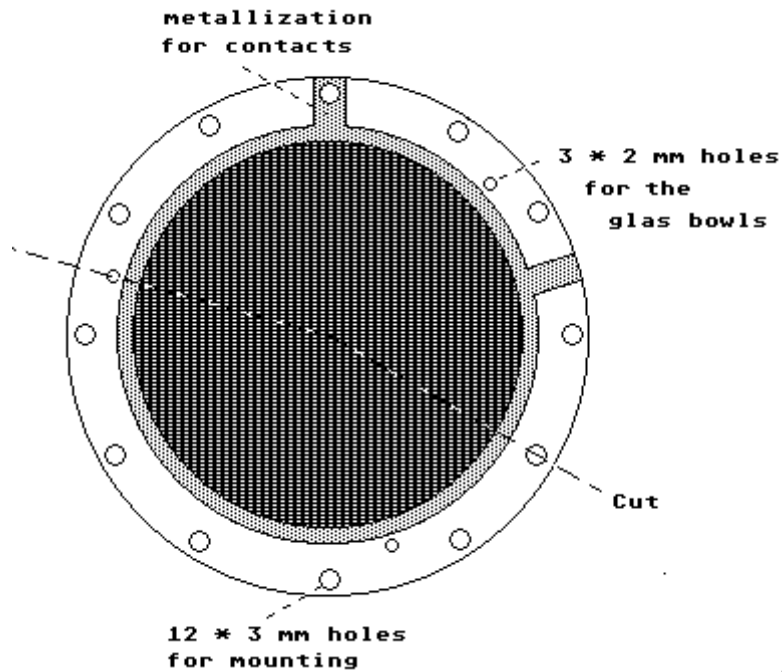


Figure 1.2: front view of the ceramic holder ring

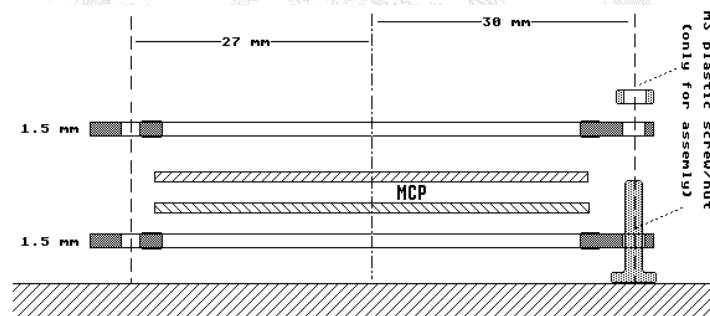


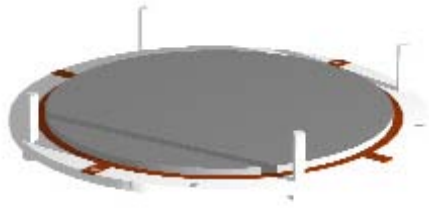
Figure 1.3: side view assembly step 1-3. Example is for chevron configuration

### 1.3.2 Now the detector can be assembled

(Preferably under clean room conditions).



1. Place the rear ceramic ring with the contact for MCP front side facing upward, with inserted plastic screws, on a flat table according figure 1.3 and the sketch below.
2. Remove the MCP carefully from their transport package and place them centered onto the metal contact of the ceramic ring. The shim ring should be placed in between the MCP for obtaining high gain. The delivered MCPs are matched in resistance within 10% for direct stacking.

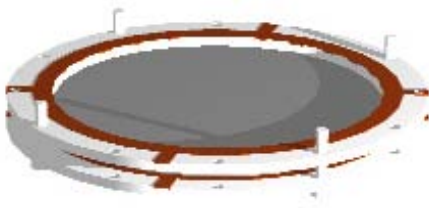


*It is especially important to avoid that dust particles settle between the MCP during assembly.* Dust particles can usually be blown away by spraying dry air on the MCP.

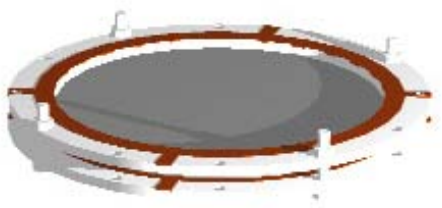
For MCP general handling see also instructions on the manufacturer's web sites or in the Appendix of this manual. Touch MCPs only with care along the rim, preferably with gloves. After the stack is piled you may check if it is well centered, adjustments can be done by carefully moving the MCPs on the ring.

If the MCPs need replacement mount a set with matching electrical resistance only.

Place the second ceramic ring (with the MCP front contact facing down) carefully on the MCP-stack. The plastic rods will guide the alignment. Note that the wire contacts on the ceramic rings should not be directly opposing each other when the stack is mounted.



Now fix the stack with the plastic nuts gently and very carefully.



The MCP holder stack can now be finally fixed with 4 spring clamps.



Now remove the plastic screws again. The MCP holder stack can be used as an independent unit.



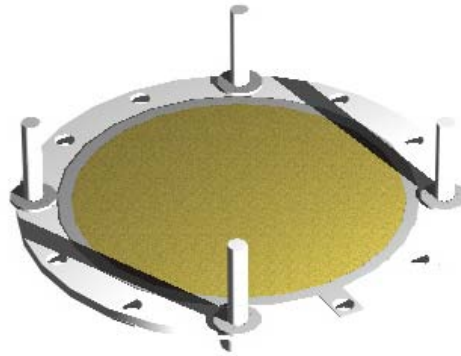
If you have ordered the **DET40** including flange mounting (**FT4TP/100**) please continue with 1.3.2.3

For use under vacuum conditions above  $1E-8$  mbar and baking below  $120^{\circ}C$  the plastic screws can also be used for the final mounting. Use the spring clamps as spacers between anode and MCP stack. Using plastic screws and soldering the cables

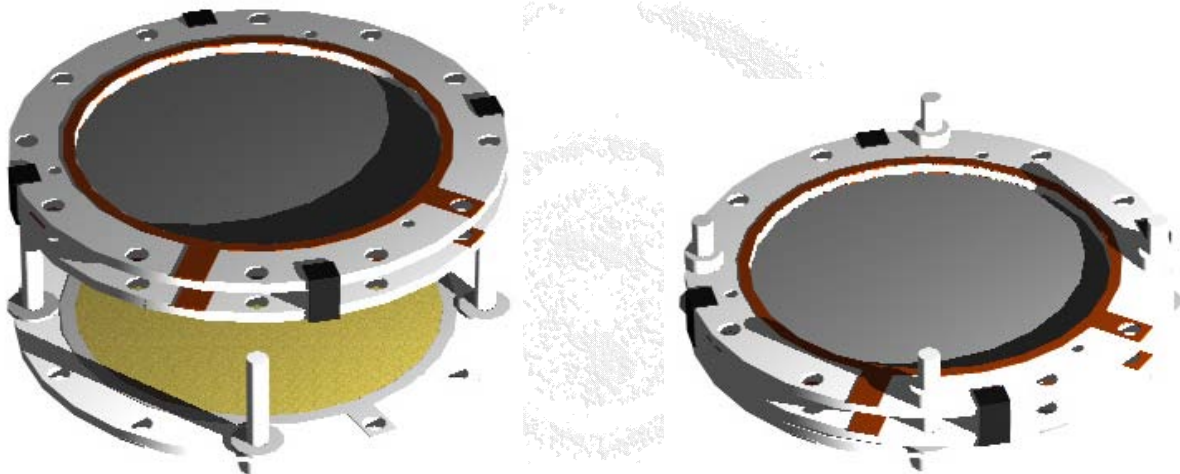
eases assembly and operation very much so that the following mounting is recommended. For UHV assembly please continue with 1.3.2.2.

### 1.3.2.1 Mounting of the anode (non-UHV)

- Place the anode with the coated side facing upward, with inserted plastic screws, on a flat table and put the spring washers over the screws. Make sure that you have found the desired orientation of the screws with respect to the contact pads.



- Now mount the MCP stack in the desired orientation to the anode and fix it with the nuts.



Of course you can also use these screws to mount the detector directly to your setup.

### 1.3.2.2 Mounting of the anode (UHV)

For the UHV mounting a set of special M2 nuts and screws is provided. The mounting is mostly analog to step 4 in the previous chapter. The MCP stack is fixed with special nuts that have to be placed between the ceramic rings in 3mm holes of the rear ring. One of those can also provide the contact to the coating (the active anode).

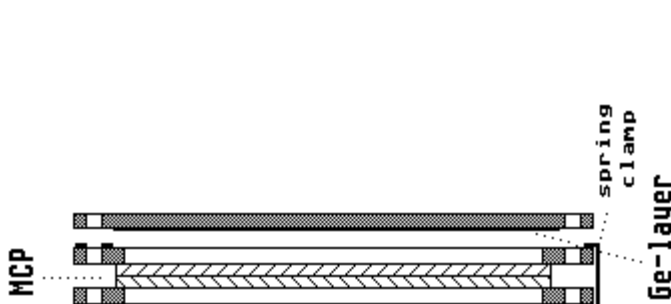


Figure 1.4: side view of the assembly after step 1-4 (chevron configuration)

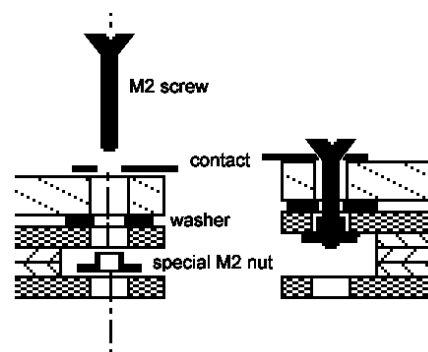


Figure 1.5: detail view of anode mounting

Similar screws/nuts or a special clamps are used to connect the MCP contacts.

Now the assembly of the ToF-MCP detector is complete.

For disassembly reverse all steps.

Before installation of the detector it is useful to check all contacts with an Ohm-meter again.

### 1.3.2.3 Connecting the MCP stack (UHV and version with metal mounting plate)

If the cables cannot be soldered to the contacts due to serious UHV-demands, MCP front and back side can be connected by clamping a cable with the supplied screw/special nut as shown in Figure 1.6.



Figure 1.6: Cable connection on MCP ring. Left: cable clamped to a “front” ring without using a lug. Middle/right: cable clamped to a back ring with 3mm lug, countersunk M2 screw and special M2 nut.

### 1.3.2.4 Mounting of the metal mounting plate (only if this option was ordered)

The MCP-stack is mounted to the metal mounting plate by inserting it into its butterfly-shaped indent and fixed with the two angle plates.

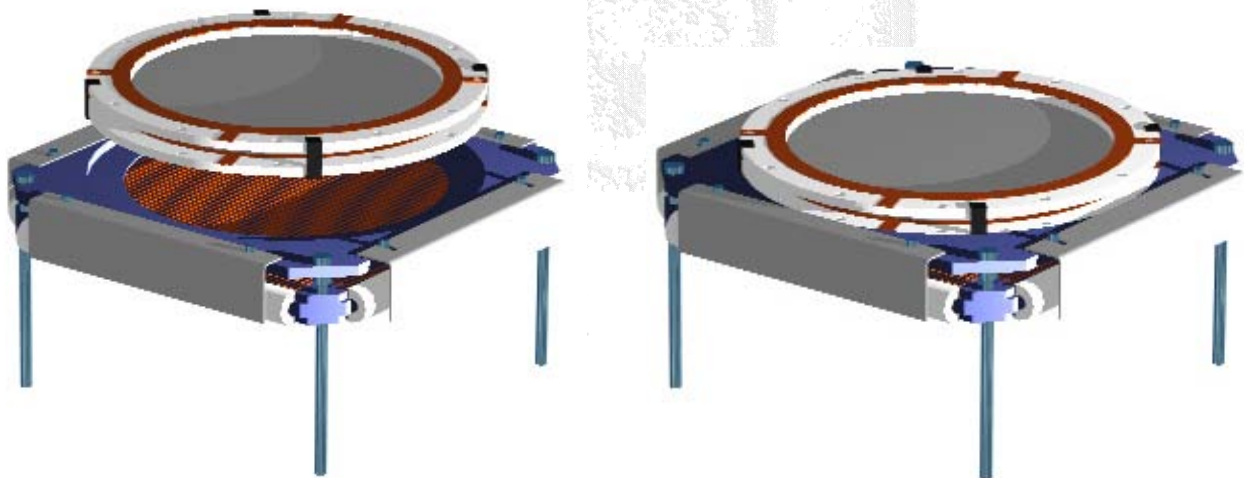


Figure 1.7: mounting of the metal mounting plate (shown is the similar mounting of a delay line anode)

### 1.3.2.5 Mounting the DET40 assembly

**RoentDek** provides a product option for each detector type to mount it to a flange of “Conflat” norm (here: FT4(TP)/100). If you are not using this option you may instead use the 3mm holes in the ceramic rings/plate to mount the detector to your experimental setup.

**Notice: It is important to have at least 2 mm distance between any part of the detector and any other metal part of a setup, unless the voltage difference is small during operation.**

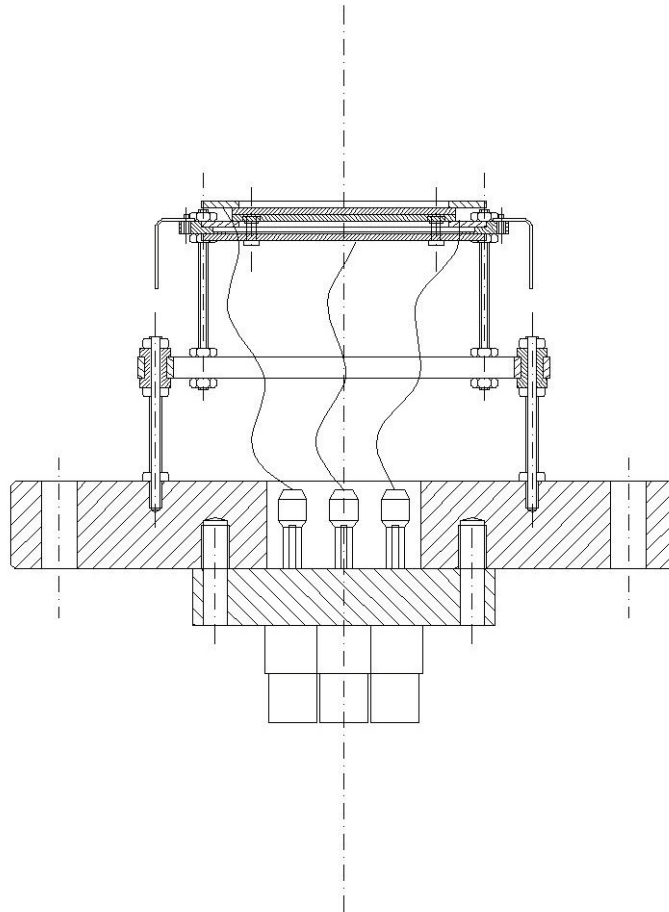
As a thumb-rule, you need at least 1mm distance for every 1000V of voltage difference, in the absence of sharp edges or tips.

***If this is not fulfilled, discharge can occur during operation with the consequence of possible damage of the detector or the electronics.***

If you have chosen the **FT4TP/100** flange mounting option you may refer to the movies about the mounting of a **DLD** detector to the mounting flange on our Web-Site in the *MOVIES* section. This mounting scheme is very similar to the mounting of the **DET40**.

Mount the stainless steel support ring with the 4 threaded M2 bolts to the metal mounting plate (anode), see **Error! Reference source not found.** You may use one of these threaded bolts to supply the anode voltage with an appropriate cable, fixed by a M2 nut. Adjust everything parallel to the flange and fix the nuts.

**Please note that the ceramic insulators will not tolerate extensive force when fixing the nuts.**



**Figure 1.8: Sketch of the detector with FT4TP/100 mounting**

The 4-fold MHV feedthrough flange and the provided Kapton cables of the **FT4TP/100** product option enable a convenient connection of the MCP front and back side and the metal holder plate.

### **1.3.3 Operation**

The MCP can be operated with a voltage of 1250V per plate, i.e. 2500V for a chevron configuration. However, sufficient gain can be obtained at lower voltage already.\*

**It is very important to follow the instructions of the MCP manufacturer when you apply voltage to the MCP-stack for the first time.**

It is advisable to use power supplies with current limitation and extremely fast voltage shutdown for protection of the MCPs (also available from **RoentDek**). During operation the vacuum should never exceed 1E-5mbar, conditions below

---

\* For Photonis MCP up to 3000V total voltage across the MCP stack can be applied.

1E-6mbar are recommended. The potential of the MCPs front is arbitrary (depending on the particles to be detected). The anode has to be on a slightly more positive (50V - 200V) potential than the back side of the MCPs.

Example for voltage supply for ion/photon detection (chevron-configuration)

MCP front	- 2300V
MCP back	ground
Anode	+200V

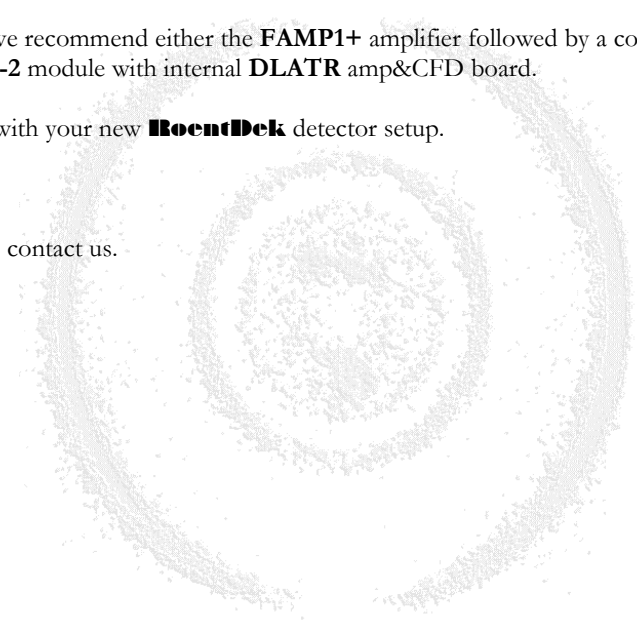
In order to pick up the timing signal from the detector, an RC-decoupling circuit as shown in Figure 1.1 must be used. It is advisable to have such a circuit on any detector contact, although it is only necessary to pick up the timing signal either from the anode (negative polarity) or on one of the MCP contacts (positive polarity). To reduce ringing of the signal, a potentiometer (0-250 $\Omega$ ) to “ground” should be used after the capacitor on the other contacts. Tuning these potentiometer settings will improve the timing signal.

The **FT4TP(/100)** product option provides adequate decoupling circuits. Please note that the **HFSD** and **HFST** in the **FT4TP** use 1M $\Omega$  resistors in line with the MCP contact. This alters the “true” voltage on the MCP back and MCP front contacts. For details please refer to the manual for the **RoentDek** delay-line detectors. If you use a mesh close to the MCP front face you should also connect it via an RC decoupling circuit with proper signal termination (potentiometer to “ground”).

For further signal processing we recommend either the **FAMP1+** amplifier followed by a constant fraction discriminator (e.g. **CFD1b**) or a standard **ATR19-2** module with internal **DLATR** amp&CFD board.

We hope you will be satisfied with your new **RoentDek** detector setup.

For further information please contact us.



## Appendix A      MPCs

# STORAGE, HANDLING and OPERATION of MICROCHANNEL PLATES

from Galileo Corp.

### *STORAGE*

Because of their structure and the nature of the materials used in manufacture, care must be taken when handling or operating MCPs. The following precautions are strongly recommended: Containers in which microchannel plates are shipped are *not suitable* for storage periods exceeding the delivery time. Upon delivery to the customer's facility, microchannel plates must be transferred to a suitable long term storage medium.

- Desiccator type cabinets which utilize silica gel or other solid desiccants to remove moisture have been proven *unacceptable*. MCPs proved to be more hydrophilic than silica gel.
- The most effective long-term storage environment for an MCP is an oil free vacuum.
- A dry box which utilizes an inert gas, such as argon or nitrogen, is also suitable.

### *HANDLING*

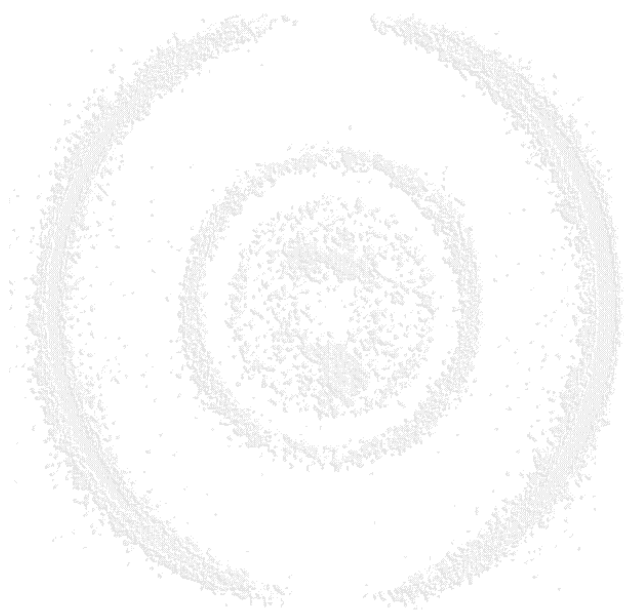
- Shipping containers should be opened only under class 100 Laminar flow clean-room conditions.
- Personnel should always wear clean, talc-free, class 100 clean-room compatible, vinyl gloves when handling MCPs. No physical object should come in contact with the active area of the wafer. The MCP should be handled by its solid glass border using clean, degreased tools fabricated from stainless steel, Teflon™ or other ultra-high vacuum-compatible materials. Handling MCPs with triceps should be limited to trained, experienced personnel.
- MCPs without solid glass border should be handled *very* carefully with great care taken to contact the outer edges of the plate *only*.
- All ion barrier MCPs should be placed in their containers with the ion barrier facing down.
- The MCP should be protected from exposure to particle contamination. Particles which become affixed to the plate can be removed by using a single-hair brush and an ionized dry nitrogen gun.
- The MCP should be mounted only in fixtures designed for this purpose. Careful note should be taken of electrical potentials involved.
- **CAUTION:** Voltages must not be applied to the device while at atmospheric pressure. Pressure should be  $1 \times 10^{-5}$  or lower at the microchannel plate before applying voltage. Otherwise, damaging ion feedback or electrical breakdown will occur.

### *OPERATION*

- A dry-pumped or well-trapped/diffusion-pumped operating environment is desirable. A poor vacuum environment will most likely shorten MCP life or change MCP operating characteristics.
- A pressure of  $1 \times 10^{-6}$  or better is preferred. Higher pressure can result in high background noise due to ion feedback.
- MCPs may be vacuum baked to a temperature of 480°C (*no voltage applied*) and operated at a maximum temperature of 350°C.

When a satisfactory vacuum has been achieved, voltages may be applied. It is recommended that this be done slowly and carefully. Current measuring devices in series with power supplies aid in monitoring MCP behaviour. Voltage drop across the meter should be taken into consideration when calculating the applied voltage.

- Voltage should be applied to the MCP in 100 volt steps. If current is being monitored, no erratic fluctuations should appear. If fluctuations do appear, damage or contamination should be suspected and the voltage should be turned off. The assembly should then be inspected before proceeding.



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