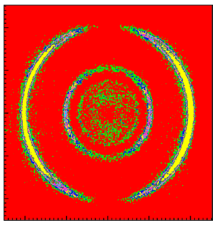
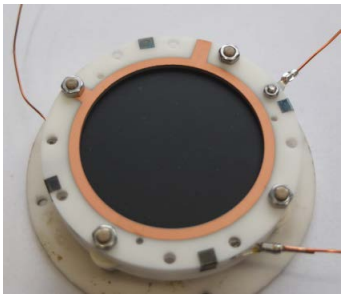
RoentDek
Handels GmbH

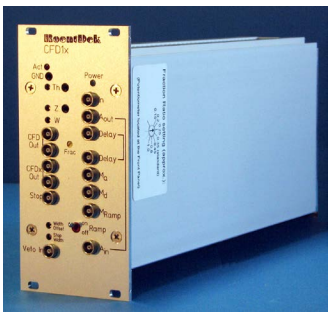
Supersonic Gas Jets
Detection Techniques
Data Acquisition Systems
Multifragment Imaging Systems

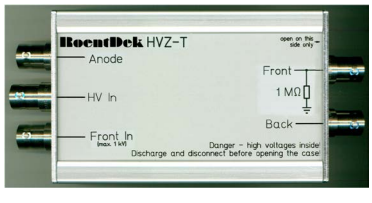


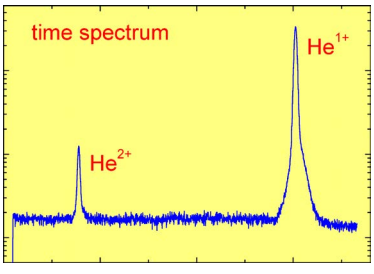
MCP detector with timing anode (or phosphor screen)
Manual for MCP ToF detector DET25/40/75/100/120(P)

(Version 11.0.2402.1)









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1 Introduction

The **RoentDek DET** "timing" detectors are used to detect (count) individual particles like electrons, ions and photons, and to determine their arrival time with respect to an external trigger (Time-of-Flight). The effective detection diameters range from 25 mm to 120 mm (optionally up to 150 mm). If you have received a different-size MCP please refer to a separate manual for the mounting procedure which may follow this manual as an appendix. However, most of the general information given here will be valid for any MCP mounting unless otherwise stated. You also may have received separate documentation in form of "short manuals" that are specific for your product and already contain the relevant information as in this general manual here.

The **DET25/DET40/DET75/DET100** product assemblies contains an MCP stack and a metal "timing anode" which can also be formed as a phosphor screen for additional optical read-out (…**P**), as a "multi-anode" or as an image charge transparent anode (only **DET40I**), allowing for induced charge pick-up by a custom structured electrode pattern*. The **DET** detectors can also be operated for "Total Yield" measurements, see **RoentDek DET** detectors.

The entire detector is bakeable up to 150 °C (250 °C on request) unless otherwise noted. The operation requires three DC potentials from high voltage supplies (HV) for MCP front and back contacts and for the anode. Additionally, a biased mesh can be mounted in front of the detector. Adequate vacuum feedthroughs, signal decouplers and timing electronics, as available from **RoentDek**, must be used to retrieve the timing information of signals, see below.

The MCP stack typically consists of a chevron configuration (two MCPs) for the standard sizes **DET40** and **DET75** fixed between two ceramic supporting rings. For other sizes metal support rings/plates are employed (optionally also available for the standard sizes). The timing signal is picked up from the anode and/or from an MCP contact (typically from front side).

The pick-up of the timing signal (from anode or MCP contact) can be achieved according to Figure 1.1.

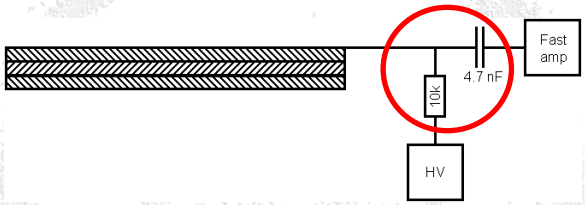
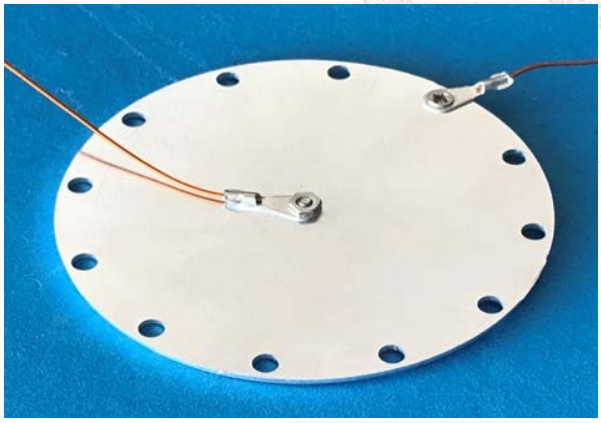
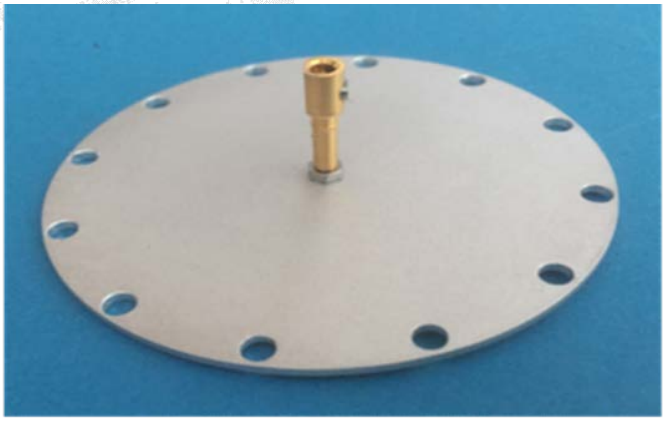


Figure 1.1: Basic RC-circuit diagram for decoupling a signal from high voltage (HV) load at an MCP contact. Signal pickup from the anode (see below) is achieved likewise via a screw contact either at center or near the rim. The default connection scheme (if space allows) employs a push-on pin on a long central screw (right below).





In order to achieve sufficient signal quality, the distance to the feedthrough flange should be kept as short as possible (<30 cm, ideally < 15 cm, with signal pickup/terminating circuits right behind on air-side). If this is not possible special circuits and cables must be placed in vacuum and/or specific feedthroughs must be used (see Appendix C).

Optional **RoentDek** products for standard signal pickup and amplification/noise discrimination for **DET** detectors are:

- 4-fold SHV feedthrough with signal pickup (**FT4TP**) and mounting flange (**…/100/150/200)**.
- Dual 4 or 6 kV high voltage bias supply (**HV2/4** or **HV2/6**) and optional **HVZ**(**-T**) voltage divider.
- Timing electronics, e.g. **LET+**, **FAMP1+** amplifier with **CFD1c/1x** or the **ATR19-2** amplifier & CFD unit.
- Digital read-out devices like the **fADC4** analog digitizer, **TDC4HM** time digitizer or **RM-6** counter & rate-meter.

* The flange-mounted version with air-side pickup-electrode (**RS-DET40**) is described elsewhere.

1.1 Characteristics

Typical characteristics of MCPs for DET40 and DET75

# of MCPs in Chevron stack:	2
Diameter:	50 mm/87 mm
Active Diameter:	>40 mm / >75 mm
Aspect Ratio (L/D):	80:1
Thickness:	1 mm
Pore diameter:	12 µm
Bias Angle:	20°
Open Area Ratio:	70%
Operating Pressure:	< 2 x 10^{-6} mbar
Operating Temperature Range:	-50 to 70 °C

The optional detector versions **DET25**, **DET40B, DET80**, **DET100** and **DET120** contain different MCPs, specifically defined.

Typical characteristics for the DET40 and DET75 detector assembly

Diameter:	80 mm/120 mm
Height:	12 mm/14 mm
Flange-mounted Diameter:	95 mm/146 mm (with **FT4TP100/150**)
Height above a mounting Flange:	about 100 mm (adjustable)
Baking Temperature:	150 °C Maximum
Electron Gain @ 2400Volts:	5*10^6 minimum

1.2 Detector assembly for DET40(P) and DET75(P) with ceramic rings

If you have a received a **DET40P/70(75/80)P** with a metal MCP front ring (i.e. after middle of 2021) please refer to Appendix E. For the **DET120(P)** detector please refer to Chapter 1.3 , for **DET25/DET40s** and other assemblies with metal rings for MCP clamping refer to Chapter 1.4.

All parts, especially the MCPs (and phosphor screen), should be handled with great care since the surfaces are very sensitive and should never be touched or scratched. It is recommended to wear powder-free clean area approved gloves. Normal high vacuum cleanliness procedures and practices must always be observed. The ceramic rings should not be exposed to exceeding mechanical and thermal stresses and the assembly should take place under clean and dry conditions.

1.2.1 Preparation:

A mesh can be spot-welded or soldered directly onto the front side of the front ceramic ring. The mesh is then positioned about 2 mm in front of the MCP surface. **RoentDek** also offers meshes that can be screwed onto the ceramic front ring. Please refer to Chapter 1.6 and the description in the corresponding Mesh Manual.

If not supplied, prepare in-vacuum connection cables for the MCP stack and the anode. Prepare 3 cable connections for MCP front, MCP back and anode contact (a forth if a mesh is used). Cable connections should be kept as short as possible. The cables to the anode can be connected after detector assembly. Cables for the MCP contacts should be fixed before stack assembly, they can be spot-welded or soldered directly onto the metallization of the ceramic rings (preferably use the metallization strips which are located between holes of the ceramic rings, prevent that solder or flux sprays over the MCPs). Otherwise, cables are to be fixed by screws on the metallization rings located at holes in the ceramic rings. It may be beneficial to connect the MCP back-side via a blocking-resistor. The metal anode is connected according to Figure 1.1, for connections to phosphor screens please refer to Chapter 1.7

You may clean all parts except for the MCPs (and except for an optional phosphor screen) in an ultrasonic bath.

1.2.2 Now the detector can be assembled

(Preferably under clean room conditions).

The default assembly is based on the mounting scheme via the standard carrier plate as it is also used for the **RoentDek** delay-line detector systems, see Figure 1.2 and Chapter 1.2.2.1. For other mountings please refer to Chapter 1.2.2.2. For assembly of a detector with phosphor screen, refer to Chapter 1.7 first.

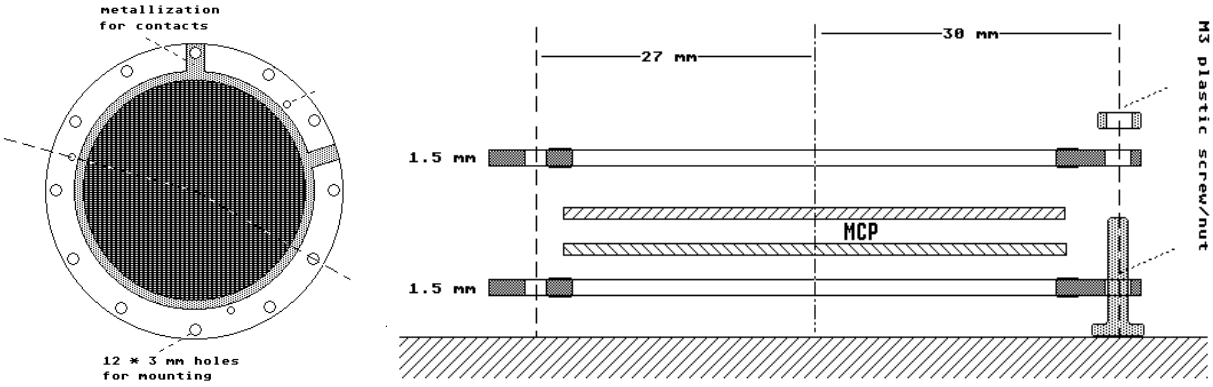
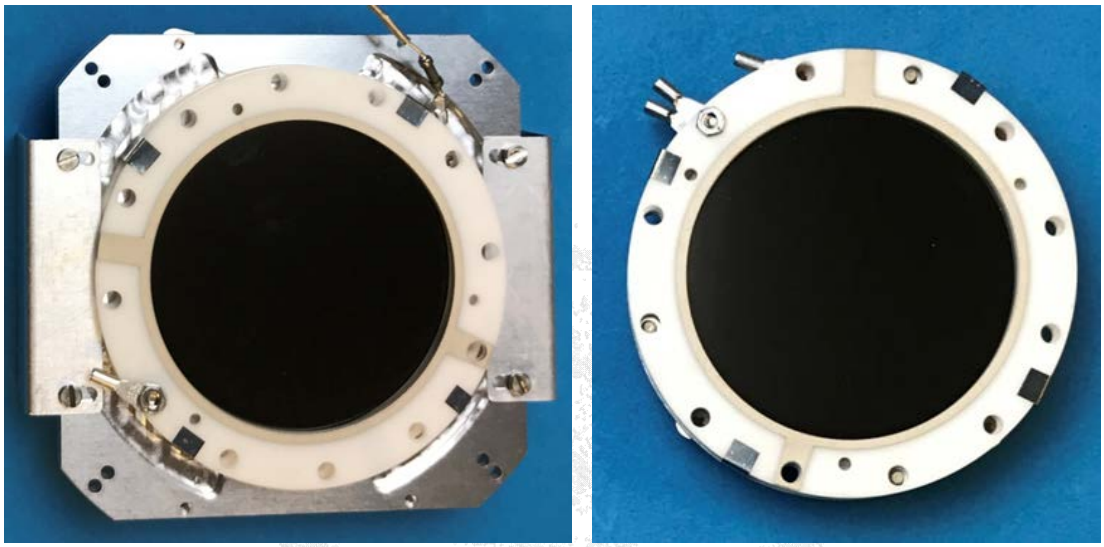


Figure 1.2: Sketch of MCP assembly in chevron configuration with ceramic rings as carriers, here for DET40. Below: assembled DET40 on standard holder plate (left) and for custom mounting (right)



In case you have purchased a mesh that shall be mounted right onto the MCP front ceramic ring, please refer to Chapter 1.6 first. It may be beneficial to mount the mesh first or at least to determine the mounting holes that shall be reserved for mesh mounting/contacting to avoid mechanical conflicts afterwards. Additional mounting instructions for MCP with central hole are found in Chapter 1.5.

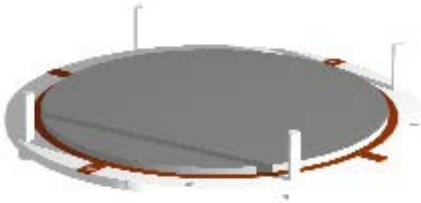
1.2.2.1 Standard MCP stack assembly (for timing anode fixed on carrier plate)

The following sketches show the assembly of the MCP stack in its most common version (**DET40** and **DET75**) with ceramic mounting rings as MCP carriers. At this stage all contact cables should be fixed to the appropriate sides of the front and back ceramic rings. Note, that a ceramic ring without metallization on one side (if supplied) should be used for the rear MCP side only (i.e. anode side).

1. Place the front ceramic ring (metallization on both sides) with the contact layer for MCP front side facing upward, with three or four assembly screws (guide pins) inserted on a flat table according to Figure 1.2 The screws will be removed later*. Please observe a certain recommended screw placement if you will later not use the standard mounting with the anode fixed behind the carrier plate (see below).

* Only some special assemblies rely on permanent PEEK screws for the mounting.

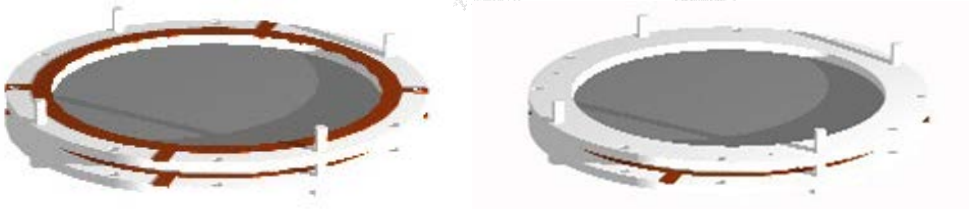
2. Remove the MCP carefully from their transport package and place them centered onto the metal contact of the ceramic ring. The MCP have a tilt angle marker (small triangle) on the rim of the input (front) side). This front side must face downwards for both MCPs.



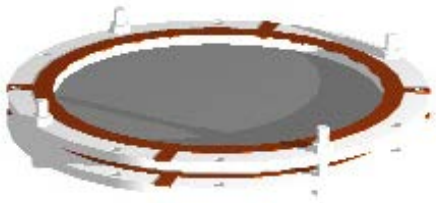
3. The angle marker of the second MCP must be rotated in azimuthal direction by about 180° (±20°) relative to the position of the marker on the first MCP. An optional shim ring can be placed in between the two MCPs. The delivered MCPs are usually matched in resistance within 10% for direct stacking. If the MCPs need to be replaced use a set with matching electrical resistance only. ***It is especially important to avoid that dust particles settle between the MCPs during assembly.*** Dust particles that may have settled can usually be blown away by spraying dry air on the MCP surface or may be removed with the help of a soft (!) brush.

   For MCP general handling see also instructions in Appendix A of this manual. Touch MCPs only with care along the rim, preferably with gloves. After the stack is piled up you may check if it is well centered, adjustments can be done by carefully moving the MCPs on the ring, ideally with plastic tools (e.g. tweezers).

4. Place the second ceramic ring (with the MCP back-side contact coating facing down) carefully on the MCP stack. The rods will guide the alignment. Take care that the wire contacts on the ceramic rings do not directly oppose each other when the stack is mounted. Note, that the rear-side of this ring may be un-coated.



5. Fix the stack with the provided plastic nuts gently and very carefully (only hand-tight!).



6. For those assemblies designed with permanent screws as mounting elements the MCP mounting is now complete. In all other cases the MCP holder stack assembly is now be finalized by placing 4 spring clamps. The clamp position must be chosen so that they do not touch any metallization. The first clamp should be placed near the MCP back contact, the others equally spaced at about 90° relative so that they later can rest in the corners of the carrier plate, once inserted (see Figure 1.2).

Then the screws/nuts can be removed. For disassembly reverse all steps

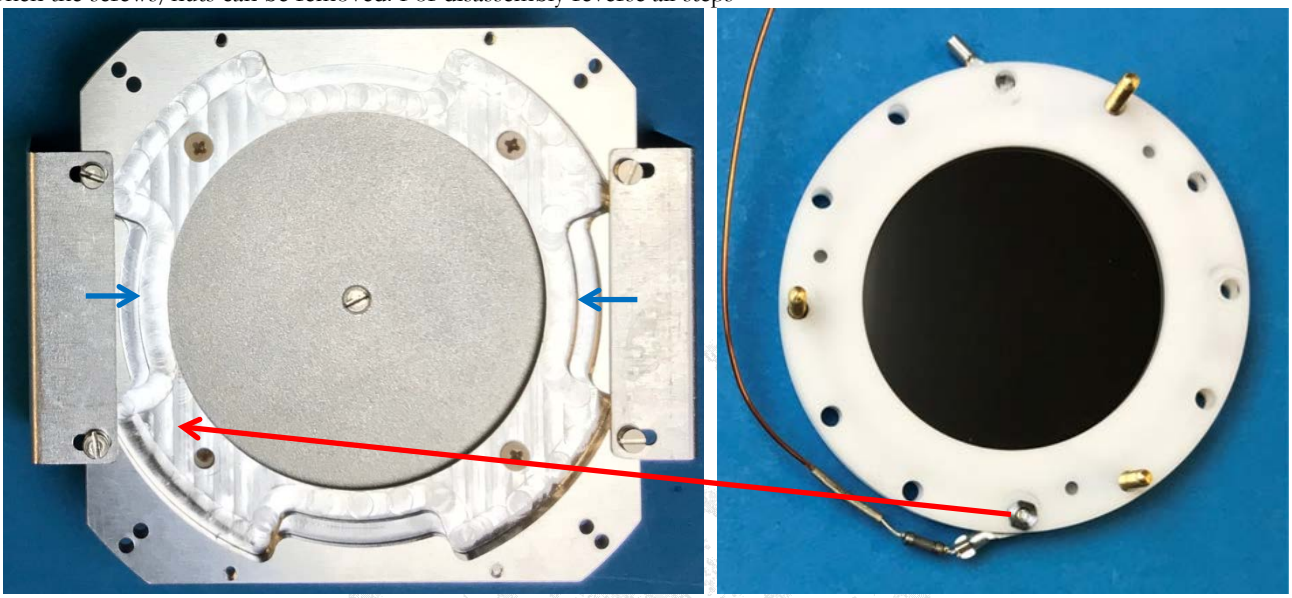


Figure 1.3: Carrier plate with timing anode mounted behind (left picture). Right above: MCP stack in an intermediate assembly stage, rear side facing up. After completion and flipping over the ideal orientation of the stack is with the MCP back contact screw near a corner of the carrier plate, only slightly rotated away from the corner hole in the carrier plate (see red arrow). Make sure that the back connection is not placed exactly at the corner position (should be rotated by about half a hole-to-hole distance), see also Figure 1.2 left.
Once in place, the stack is fixed by sliding the movable shields inwards (blue arrows), secured by fixing the screws.

1.2.2.2 Alternative MCP stack assembly (for timing anode not fixed on carrier plate)

If space restrictions prevent the use of the standard carrier plate for mounting the detector to an experimental setup, the **DET40/75** can be delivered with the timing anode pre-mounted to the rear ceramic ring.

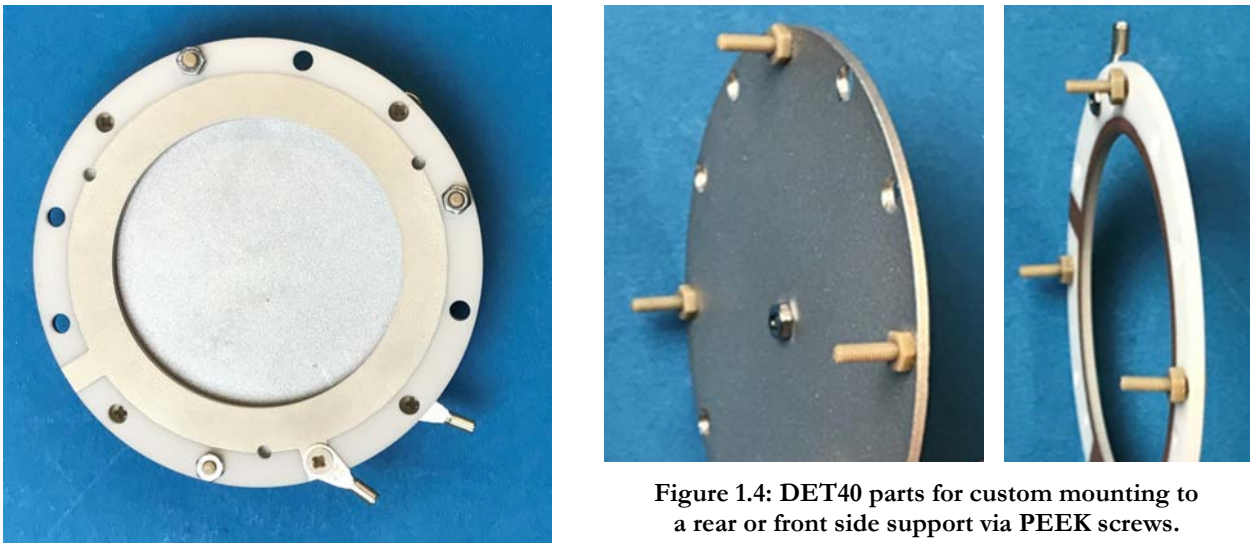


Figure 1.4: DET40 parts for custom mounting to a rear or front side support via PEEK screws.

In this assembly the back side ceramic ring is fixed to the anode plate via PEEK screws. Additional screws stick out from the anode towards the rear side for bolting on to a custom support plate. Alternatively, these screws can be relocated towards the front ceramic ring to allow for front side mounting likewise. Note, that in this case the PEEK screws must be set into vacant holes of the front ring (see Figure 1.5) already before the MCP stack assembly.

The MCP stack assembly follows the same steps as described in Chapter 1.2.2.1. Since fewer holes in the pre-assembled ceramic ring/anode rear part are vacant, the position of the guide pins in the must be well chosen. Alternatively, the stack can be assembled "bottom up", see Figure 1.5. The MCPs are then placed on the rear ceramic with their angle markers facing upward, then logically completing the assembly so that the stack looks as if it were assembled as described in Chapter 1.2.2.1. The picture series in Figure 1.6 describes the stages for this assembly. Note that the presence of a long contact pin on the anode's rear side may hamper this assembly method.

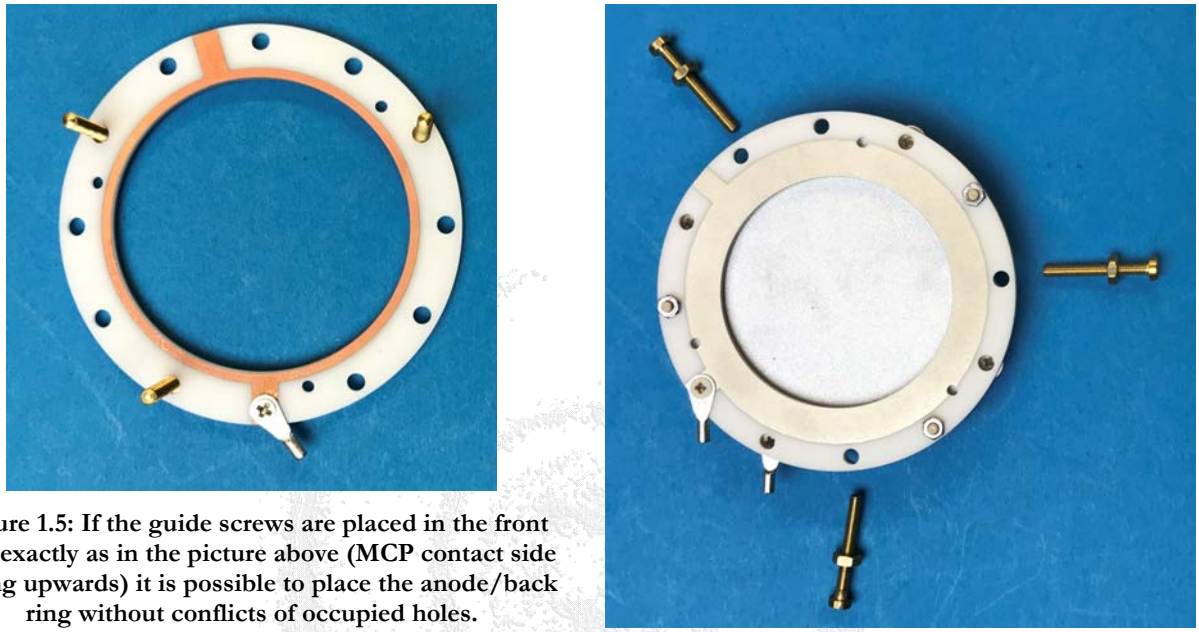
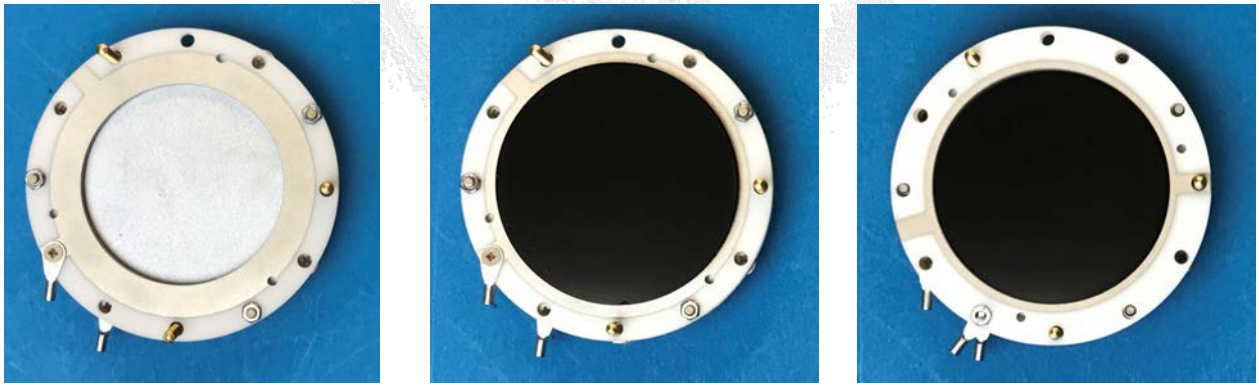


Figure 1.5: If the guide screws are placed in the front ring exactly as in the picture above (MCP contact side facing upwards) it is possible to place the anode/back ring without conflicts of occupied holes. Right: guide pin positions for alternative "bottom up" assembly.



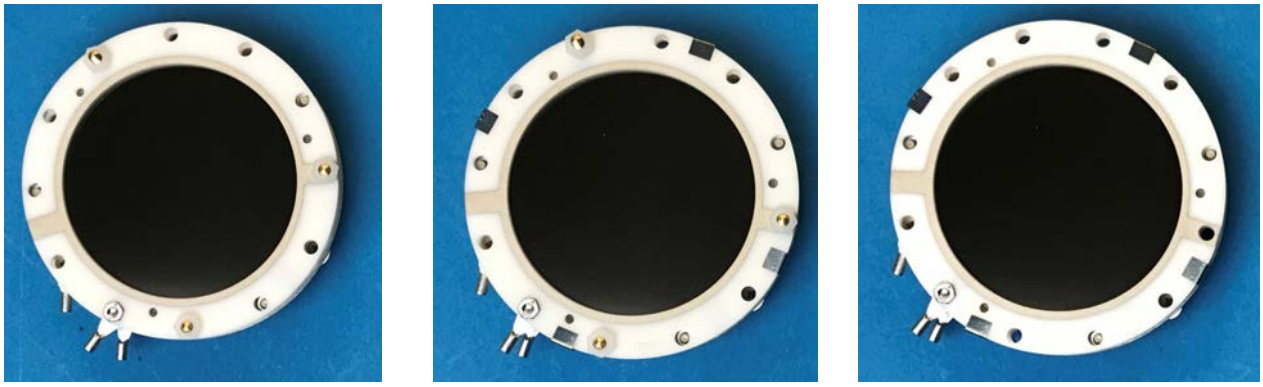


Figure 1.6: Picture series showing the "bottom up" assembly steps of the MCP stack beginning with the rear MCP ring (and anode mounted behind).

The such-assembled detector could now be mounted on the "flipped-over" standard carrier plate (with its indented side facing away from the MCP stack) shown in Figure 1.16.

1.3 Detector assembly for DET100(P)/DET120(P) with metal ring/plate

All parts, especially the MCPs (and phosphor screen), should be handled with great care since the surfaces are very sensitive and should never be touched or scratched. It is recommended to wear powder-free clean area approved gloves. Normal high vacuum cleanliness procedures and practices must always be observed. The assembly should take place under clean and dry conditions. You may clean all parts except for the MCPs (and except for an optional phosphor screen) in an ultrasonic bath. For MCP general handling see also instructions in Appendix A of this manual. Touch MCPs only with care along the rim, preferably with gloves.

At this stage the anode should be mounted to the back plate (not shown here). For assembling the MCP stack please follow the steps below. Unlike in the **DET40/75** stack with ceramic rings, the large MCPs are fitted between a metal square-shaped rear support plate and a metal front ring. The MCP stack is fixed by six M3 screws made from PEEK. For detectors with central hole please review Chapter 1.5 before continuing. For mounting of a **RoentDek** potential mesh on the MCP front ring please refer to the descriptions in the corresponding Mesh Manual first.

1. Place the rear support plate (which may be pre-mounted on the anode) with the indention for the MCP pointing upward according to the sketch below. If there is no indention use the centering ring to center the MCP, as it may be the case of **DET120P** (see Figure 1.22). You may leave the MCP back plate mounted on the anode. Screw three M3 guide rods symmetrically into M3 tapped holes (only one side of the rods may have a useful thread). Remove the MCPs carefully from their transport package and insert the first one (the designated rear MCP in the stack) centered into the indention, with the bias angle marker (triangle on the outer rim on one side) pointing upward. Handle MCPs only with care along the rim, preferably with gloves. Unless otherwise noted, any of the supplied MCPs can be selected for the position in the stack.

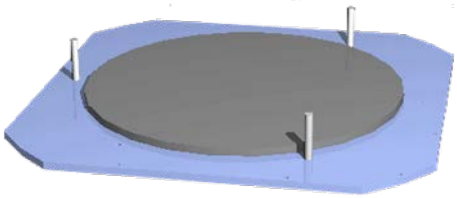


Figure 1.7: Assembly of MCP stack – Stage 1 (DET100/DET120 & DET100P/DET120P)

2. When placing the second MCP (and possibly a third) its angle marker Also facing upwards) must be rotated in azimuthal direction by about 180° (±20°) relative to the position of the marker on the MCP below. An optional shim ring can be placed in between the MCPs. The delivered MCPs are usually matched in resistance within 10% for direct stacking. If the MCPs need to be replaced use a set with matching electrical resistance only. ***It is especially important to avoid that dust particles settle between the MCPs during assembly***. Dust particles that may have settled can usually be blown away by spraying dry air across the MCP surface or may be removed with the help of a soft (!) brush.

   After the stack is piled up you may check if it is well centered, adjustments can be done by carefully shifting the MCPs, ideally with plastic tools (e.g. tweezers).

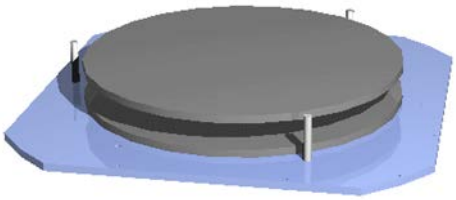


Figure 1.8: Assembly of MCP stack – Stage 2 (DET100/DET120 & DET100P/DET120P)

3. After stacking all MCPs make sure that all MCPs are well-aligned with each other and centered in the indention, adjustments can be done by carefully moving the individual MCPs on the ring. Now place the front metal ring with the indented side facing downward on the MCP. The guide pins will help in the alignment. **It is very important that the MCP stack is well centered and will fit into the indention of the front ring**.

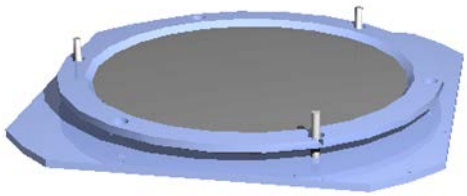


Figure 1.9: Assembly of MCP stack – Stage 3-1 (DET100/DET120 & DET100P/DET120P)

4. Now fix the front ring onto the stack with three plastic screws very carefully and only lightly. Due to the indentions in the rear support plate and the front ring, the MCP stack will not slip out even if the screws are not entirely tightly fixed. Remove the guide pins (for storage, they may be needed again) and add the other three screws. Once all screws are in place, fix them again slightly without excessive force.

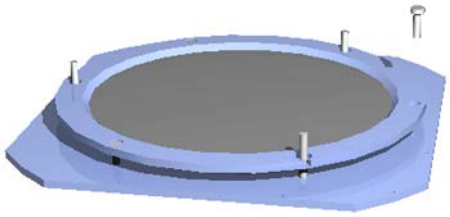


Figure 1.10: Assembly of MCP stack – Stage 3-2 (DET100/DET120 & DET100P/DET120P)

5. You need 3 cables for the MCP front, MCP back and anode (a forth if a mesh is used). Cables should be kept as short as possible. It may be beneficial to connect the MCP back-side via a blocking-resistor. The MCP back contact cable can be fixed to the rear MCP support plate on any of the M2 threads along the edges likewise, the MCP front contact cable to the front ring. **The screw must not protrude towards the rear metal plate**. Optionally, the MCP front cable can be mounted sunken on a recessed hole position. For this remove the respective M3 screw, insert the MCP front contact cable (e.g. on a 3 mm eyelet lug) and re-fix the screw as tight as the others.

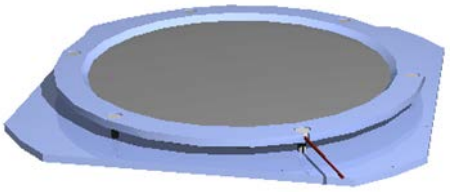


Figure 1.11: Assembly of MCP stack – Stage 3-3 (DET120 & DET120P)

1.4 Detector assembly of DET25, DET40(s) and DET75/80 with Cu rings

Alternatively, to the standard MCP mounting with ceramic ring assemblies, MCPs can be mounted using metal carrier rings, usually made from Cu. This is the designated assembly scheme for **DET25** and **DET40s** and can also be used for the standard **DET40/75** detectors, e.g. when MCP stacks with non-standard thickness or unmatched MCP stacks shall be used. The MCP stack is secured between the rings by three (**DET25**) or six M2 screws made from PEEK. The PCD of these M2 screws (countersunk type) is chosen such that they also safely center the MCPs on the ring. Length of screws must match to the total thickness of the MCP stack used. For stack thickness between 1 and 2.5 mm screws with 6 mm lengths shall be used, 8 mm long screws are needed for stack thickness between > 2.5 mm up to 4.5 mm.

All parts, especially the MCPs should be handled with great care since the surfaces are very sensitive and should never be touched or scratched. It is recommended to wear powder-free clean area approved gloves. Normal high vacuum cleanliness procedures and practices must always be observed. The assembly should take place under clean and dry conditions. You may clean all parts except for the MCPs (and except for an optional phosphor screen) in an ultrasonic bath. For MCP general handling see also instructions in Appendix A of this manual. Touch MCPs only with care along the rim, preferably with gloves.

For detectors with central hole please review Chapter 1.5 before continuing.

1.4.1 Preparation:

If not supplied, prepare in-vacuum connection cables for the MCP stack and the anode. You need 3 cables for the MCP front, MCP back and anode layer (a forth if a mesh is used). Cables should be kept as short as possible. Cables for the MCP contacts should be connected before stack assembly. It may be beneficial to connect the MCP back-side via a blocking-resistor.

If you have received a **DET25/40/75/80** for flange mounting via standard holder plate, the rear-side Cu ring is usually readily fixed to the holder plate and DC-bridged to it by a resistor: the holder plate is biased with the same potential as MCP back and (if no signal shall be picked up from there) its common potential can be supplied by fixing a bias cable anywhere on the holder plate. The same standard holder plate as used for the mounting with ceramic rings is employed*. Only the holder plate is flipped so that the flat side faces towards the MCP, see Figure 1.12.

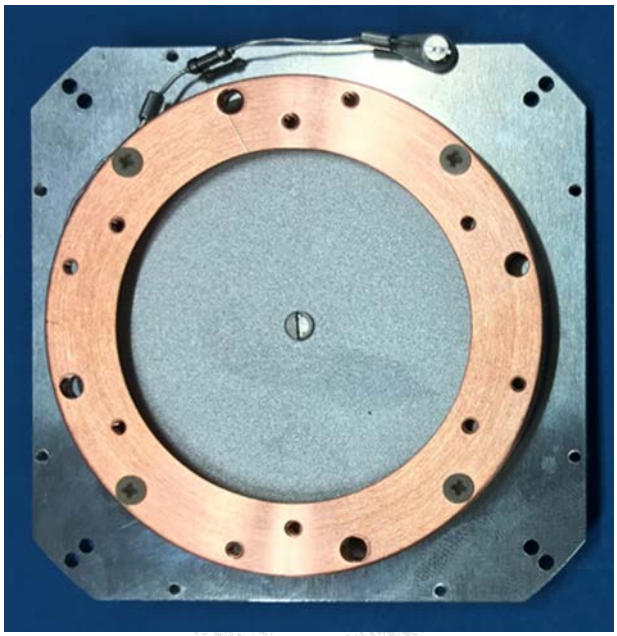


Figure 1.12: DET40 assembly with timing anode. Since the MCP back signal is usually not picked up, a resistor bridge links its DC potential to the holder plate here. MCP back can thus be biased via a cable connection at any convenient position on the holder, e.g. on a M2 thread, as indicated by the red arrow.

If the detector shall be fixed to a custom support (or to a standard **RoentDek** holder plate) PEEK screws must be mounted to the anode (protruding towards the detector rear-side) as shown for the assembly in Figure 1.4or may likewise be placed on the front ring. At this stage also the anode should be mounted behind the MCP back ring with contact cable provisions prepared.

For mounting of **RoentDek** potential meshes for near the MCP front surface please refer to the descriptions in the corresponding Mesh Manual.

1.4.2 Now the detector can be assembled

Figure 1.13 exemplifies the MCP assembly scheme using Cu-rings (also for mountings without standard holder plate). Screw the three M2 plastic guide rods symmetrically into three of the six M2 tapped holes (only one side of the rods may have a useful thread, the "bad" end is marked).

Remove the MCPs carefully from their transport package and insert the first one (the designated rear MCP in the stack) centered between the guide pins, with the bias angle marker (triangle on the outer rim on one side) facing upward. Unless otherwise noted, any of the supplied MCPs can be selected for this position in the stack.

* Only novel carrier plates with holes at PCD 60 mm (for **DET40**) or 98 mm, respectively (**DET75/80**) can be used.

When placing the second MCP (and possibly a third) its angle marker must also face upwards and be rotated in azimuthal direction by about 180° (±20°) relative to the position of the marker on the MCP below. An optional shim ring can be placed in between MCP. The delivered MCPs are usually matched in resistance within 10% for direct stacking. If the MCPs need to be replaced use a set with matching electrical resistance only. **It is especially important to avoid that dust particles settle between the MCPs during assembly**. Dust particles that may have settled can usually be blown away be spraying dry air across the MCP surface or may be removed with the help of a soft (!) brush.

Once all MCPs are stacked place the front Cu ring carefully over the guide pins onto the assembly (see Figure 1.13, upper right picture). Fix the front ring on the stack with three PEEK screws very carefully and only lightly. Note that in some cases (**DET25**) only three hole positions can be used for this while the others can only temporarily support the guide pins (then pre-mounted). Remove the guide pins (for storage, they may be needed again) and add the other three screws (not for the **DET25** since three screws are sufficient here). Once all screws are in place, tighten them carefully without excessive force.

For disassembly reverse all steps.

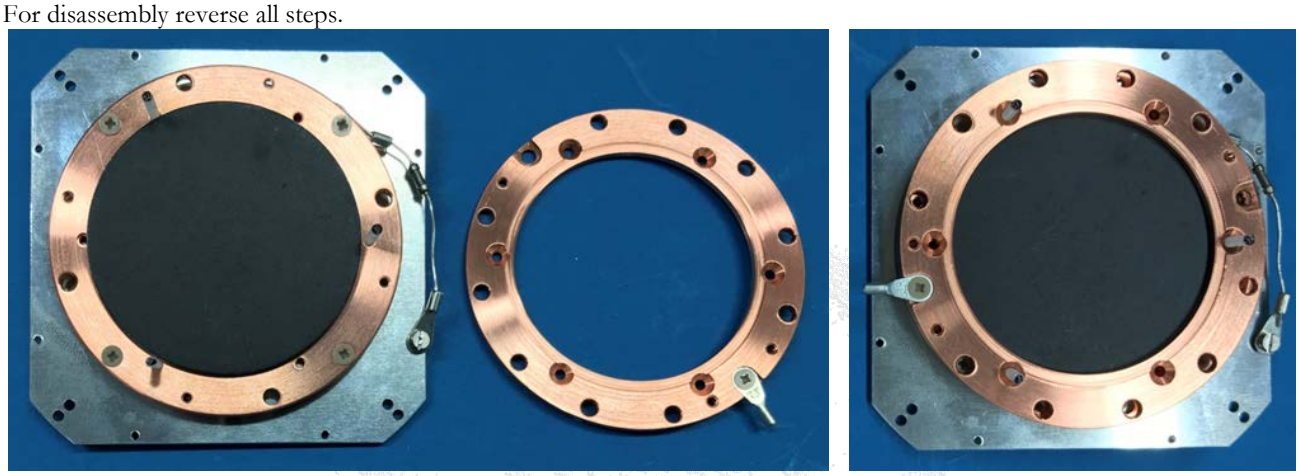
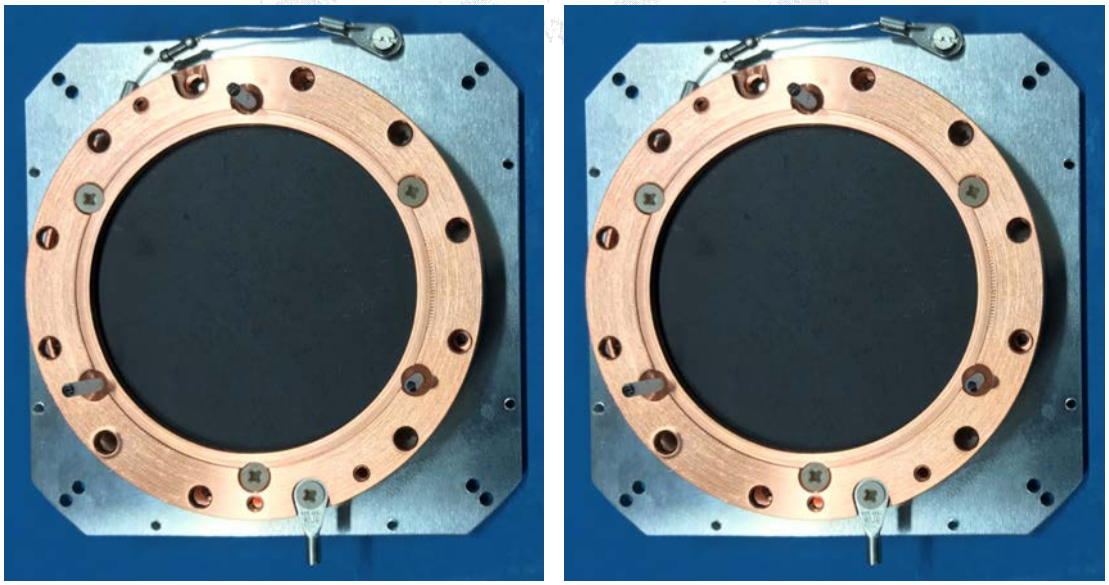


Figure 1.13: Mounting steps of the MCPs for DET40. The MCP front ring must be equipped already with a bias cable at this stage (here, only the connection lug is shown, fixed by a short PEEK screw and nut on a 3 mm hole). It is important that this connection is NOT made on a hole ending up along the diagonals of the holder plate. Alternatively, a cable can be connected on a M2 thread of the front ring. Store the guide pins after mounting.



The **RoentDek DET25** (and **DET40s**) use the same MCP mounting scheme, only the cable contacts to the Cu front and back rings are made via M2 threaded holes, see Figure 1.14. In case of lateral space restrictions all contact pins can be guided towards the rear side of the detector.

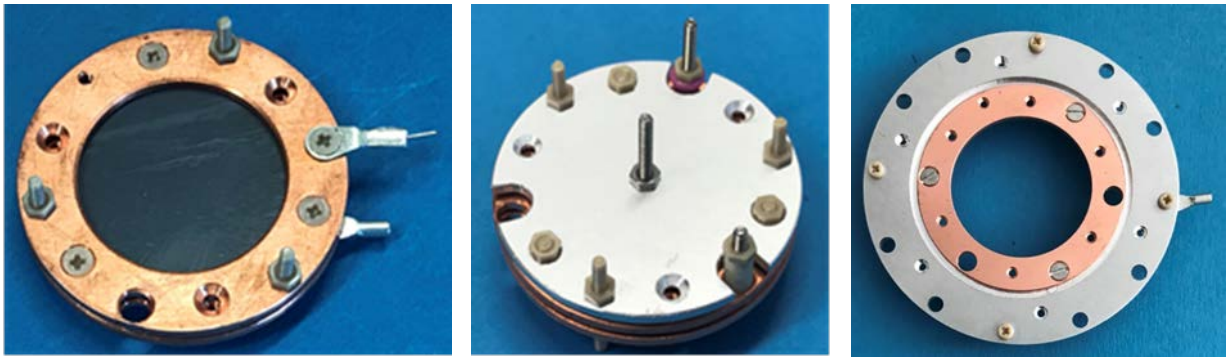


Figure 1.14: DET25 MCP assembly with Cu rings, left: front side view with optional mounting posts to a custom front side support, middle picture showing the option with rear-guided contact and mounting posts. The right picture shows the rear-side Cu-ring embedded in a frame to allow for mounting schemes corresponding to options available for DET40, providing identical outer diameter and fixing holes.

Depending on actual space restrictions the cable connections for MCP front and MCP back can either be guided sideways (left picture) or towards the rear side (right picture). **RoentDek** can provide long M2 rods and connecting pins such as used for anode bias. This allows space-saving mounting, i.e. inside a DN63CF port (as also possible for the **DET40s**). For mounting on DN100CF flange as in Figure 1.12 a pre-mounted adapter plate (see Figure 1.14 right) is provided to effectively enlarge the diameter of the back ring to the size of the **DET40** back ring.

1.5 MCP stack with central hole (DET40/o, DET80/o and DET120/o):

If you have received a detector with central hole the MCP back ring will be mounted on a special anode with provisions (”outer tube”) for inserting an “inner tube” that passes through the whole detector. Using such a tube is mandatory because biasing an MCP stack without a properly designed inner tube may cause charge feedback effects that can ultimately destroy the MCPs and connected electronics. The inner tubes must carry an **outer insulation layer specified up to at least 3 kV** voltage and should have a separate bias contact. Usually, such an inner tube is part of detector delivery (see Figure 1.15). It can be biased via a contact lug in the rear. Screwed-on caps on both ends fix the insulating Kapton sheet cover.

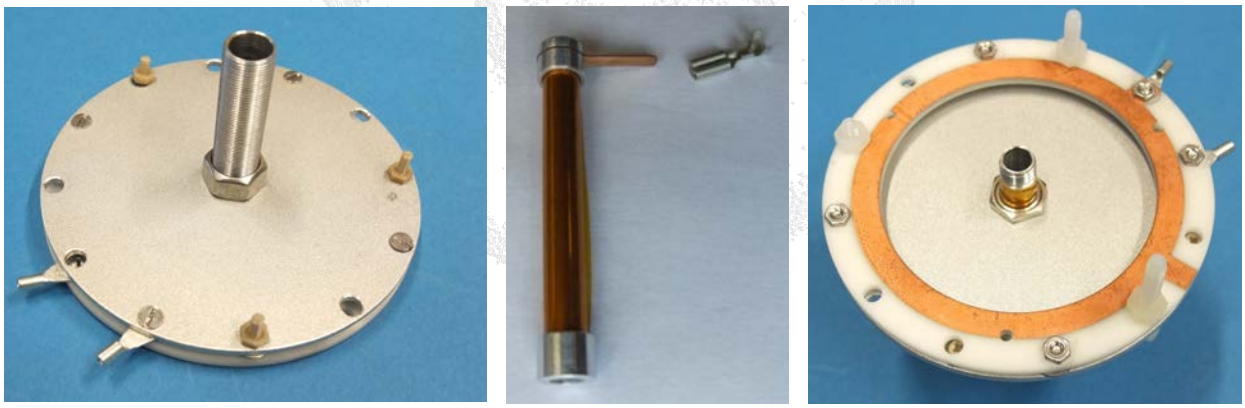


Figure 1.15: Left: rear view of a timing anode with tubing (here DET40/o) for supporting an electrically insulated inner tube (middle picture, with contact lug). After removing the front cap the inner tube can be inserted and shall protrude over the ceramic ring by about 10 mm (right picture). During assembly the detector must be placed on a provisional rear support or on its final mounting gear. Exceptionally, the temporarily placed plastic screws during MCP assembly with ceramic rings may be secured by nuts (MCP stacks with center hole are thicker than the nuts).

For mounting the MCP stack on the phosphor screen assembly, follow the directions given in Chapter 1.2.2.1 as for the standard **DET40/75/80**. **Special care has to be taken when placing the MCPs over the inner tube during MCP assembly**. When removing the guide pins the nut between front and back ring has to be held by an adequate wrench (5 mm for M2.5 or 5.5 mm for M3) to hold the nut between the ceramic rings, see Figure 1.20.

After having fixed the MCP stack with the front MCP ring the front cap can be screwed back onto the inner tube for securing the insulating Kapton sheet. During this procedure, the inner tube may have to be pushed further forward so that the cap never touches the MCP surface.

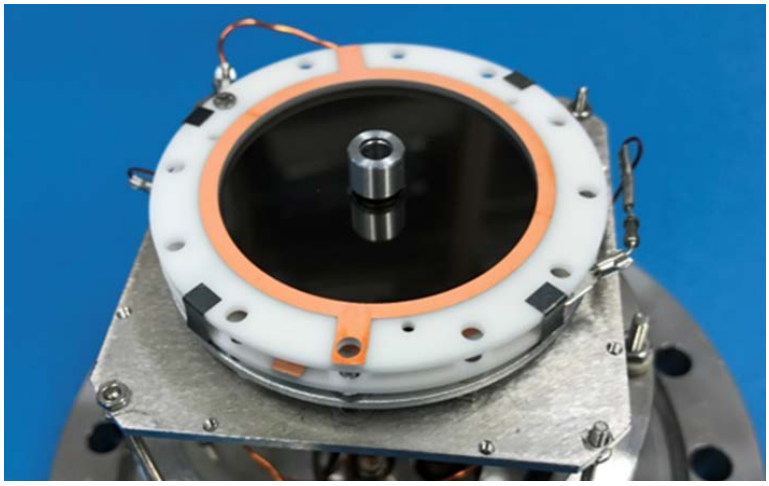


Figure 1.16: DET40/o mounted via a flipped-over standard carrier plate on a flange support.

If necessary, the position of the inner tube can now be finally adjusted: The distance between front cap and MCP stack must be sufficient to allow for operating a safe potential difference between tube and MCP front, as defined by the application. The friction from the Kapton insulation between inner and outer tube help to keep the inner tube at a chosen lateral position during adjustment. This position will be maintained once the detector is mounted, but it ***is necessary to secure the position against vibration by using a fairly rigid (form-stable) connection cable (i.e. as supplied by RoentDek on the inner tube's rear-end contact pin***.

Ideally, the inner tube should be biased at or near MCP front potential. This ensures that incoming charged particles are not deflected. Even if a different bias will be chosen during an experiment, it is recommended for the initial start-up procedure to use the same potential for the inner tube and for MCP front, **ideally drawn from the same high voltage supply channel**. This reduces the risk for operational mistakes. The inner tube can be biased through a vacant lead of the **FT4** feedthrough assembly.

1.6 Potential mesh

If you have purchased a free-standing mesh from **RoentDek** it is usually required to mount it onto the MCP front ring before MCP stack assembly. In case of assemblies with metal MCP carrier rings please refer to the separate descriptions in the Mesh Manual. When using ceramic rings, you may mount it to the front side of the front ceramic ring with the same M2 screws/recessed nuts as used for MCP contacting. It should be fixed on at least two opposing (for zero distance) or more positions and the bias cable can be connected on one end. It is recommended to connect the bias to the mesh either via a blocking resistor close to the mesh contact (i.e. in vacuum) or to use a **HFST**-type signal terminator.

Depending on the details of how the connecting scheme of the MCP bias contacts was made there may be mechanical conflicts to consider during mesh mounting. It may especially be required that the MCP front contact lug is placed on the MCP side of the ceramic ring. Make sure that the mesh is not touching any other biased part of the detector assembly (and none of the spring clamps) and that sufficient distance is kept between detector parts biased at different potential (> 500 V) relative to the mesh potential. Allow at least 1 mm distance per 1000 V potential difference (even more in presence of sharp edges). Use extra insulation (e.g. with Kapton sheet) when distances are too small in this respect.

The maximum voltage rating between mesh and MCP front potential is 2000 V if mounted right on the ceramic ring. If the mesh is bent or damaged corona discharges can appear between MCP and mesh which produce background and can damage the MCP stack.

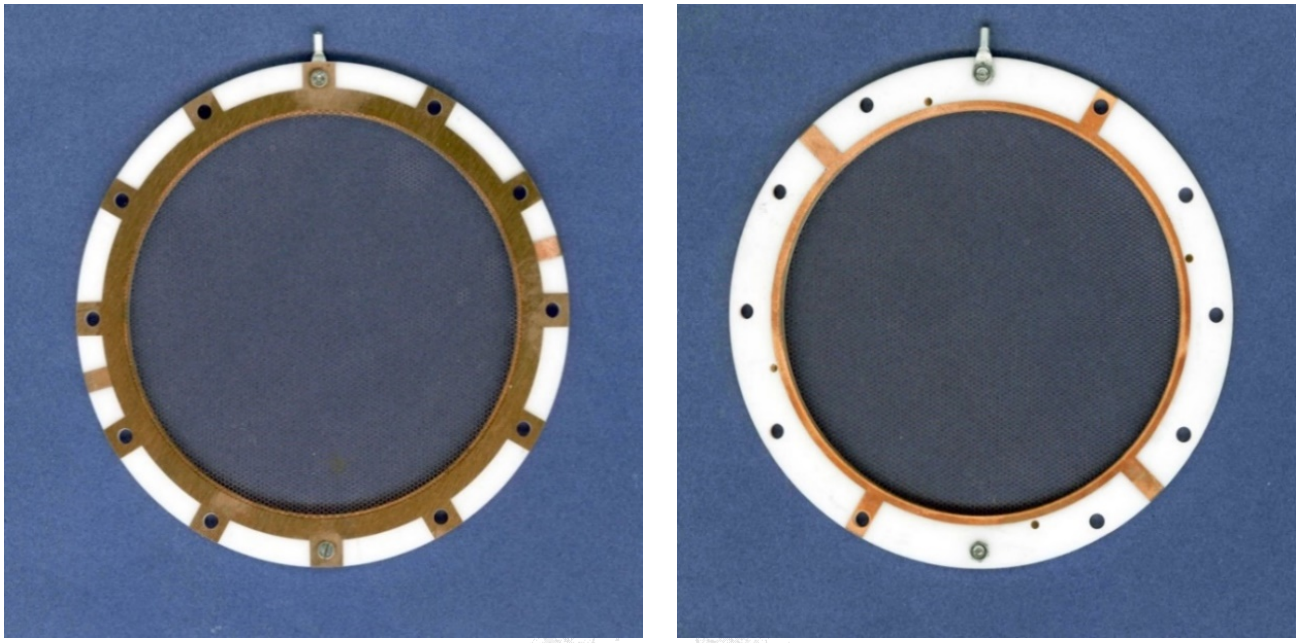


Figure 1.17: Free-standing mesh mounted to the MCP front ring (left: front side, right: rear side of the front ring). Unused lugs of the mesh can be cut away with a scissor to avoid conflicts with other contact pins A-mesh can also be mounted at a greater distance from the MCPs by introducing spacers.

RoentDek also offers woven meshes for use with the timing detectors. Please refer to the respective description sheet on the **RoentDek** website.

1.7 Detector assembly with phosphor screen

Usually, you will receive a **DET25P/40P/75P/80P/100P/120P** (with phosphor screen anode) partially pre-assembled. Only the MCPs have to be mounted. For storage in a dust-protected container over extended period, it is advisable to cover the phosphor screen against light exposure. Mounting details of the detector depend on MCP and anode size. These are described in the following sub-sections. Unless otherwise noted the maximum voltage rating of any detector part to ground is specified as 5 kV (e.g. biased via a **RoentDek HV2/6**). The maximum voltage between MCP back and phosphor screen (anode) is 2 kV or higher. The phosphorescent material (e.g. P47) is deposited with few microns thickness on a glass substrate that was prior coated with a conductive layer (ITO). There is no aluminum cover layer. The active diameter is about 25/40 mm (**DET25P/40P**), >70 mm (**DET75P/80P**) or >100/120 mm (**DET100/120P**). Provisions to mount a mesh later may already be installed on the front ring.

If you have received a **DET25P**, **DET40P** or **DET70**(**75**/**80**)**P** with metal MCP front ring, please refer to Appendix E.

1.7.1 DET40P and DET75P

The phosphor screen is typically delivered readily clamped between two metal rings, please refer to APP E. Only for the **DET40P** the phosphor screen may be clamped between two ceramic rings, one of them (middle ring) also serving as MCP stack rear side carrier, secured by thermoplastics (i.e. UHV compatible) M2 or M3 screws (typically PEEK) and nuts, with cable connections in place for biasing the phosphor screen and MCP back side. A third ceramic ring (usually also readily equipped with a bias contact cable and possibly with a mesh) is then supplied for clamping the MCP stack.

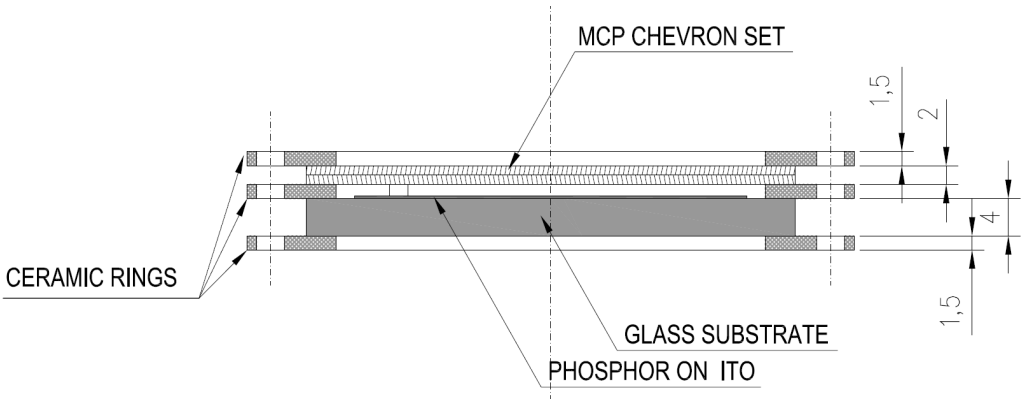
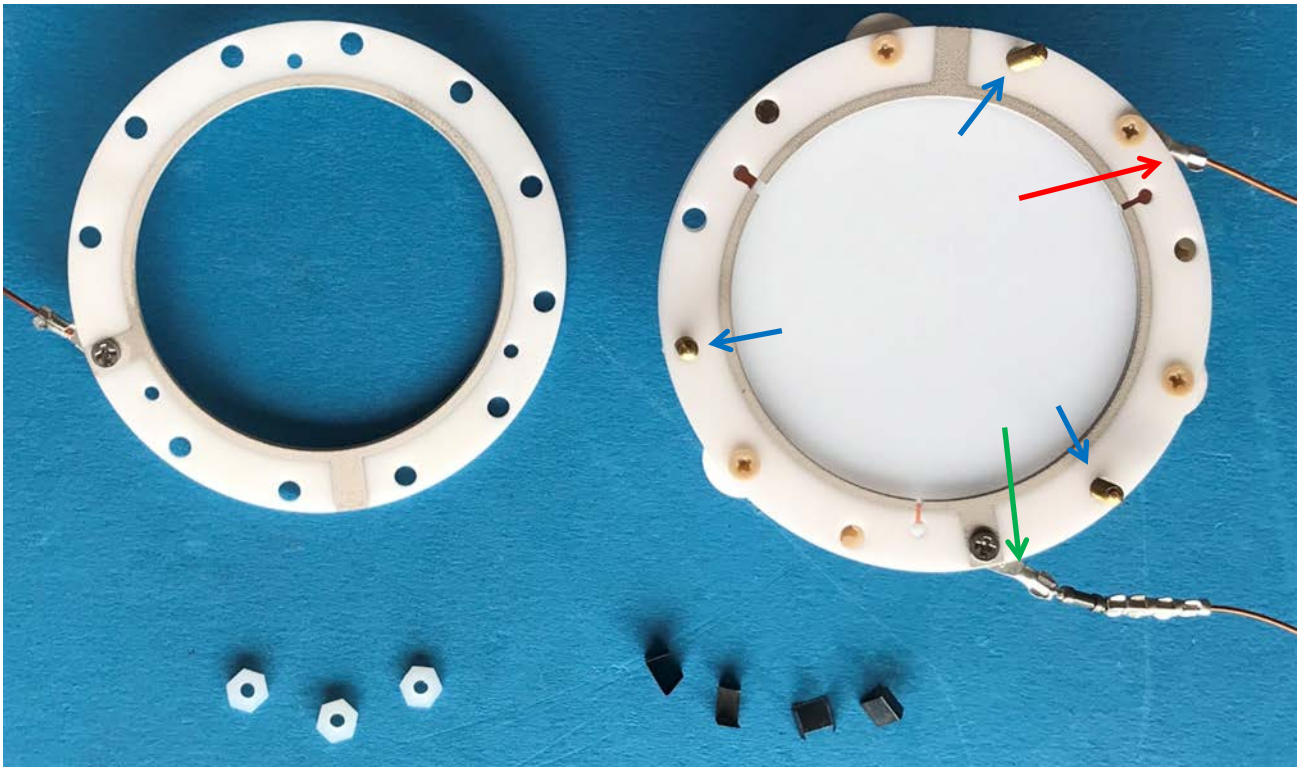


Figure 1.18: Above: side view sketch of DET40P with phosphor screen anode, older version. The screen (typical 4 mm thickness) is fixed between ceramic rings, with guide pins (blue arrows) for MCP mounting readily in place. Arrows also mark the anode (phosphor screen) bias cable (red) and the biasing cable for the MCP stack's back side (green). The front ceramic ring (MCP side facing up) is shown below left with its cable connection.



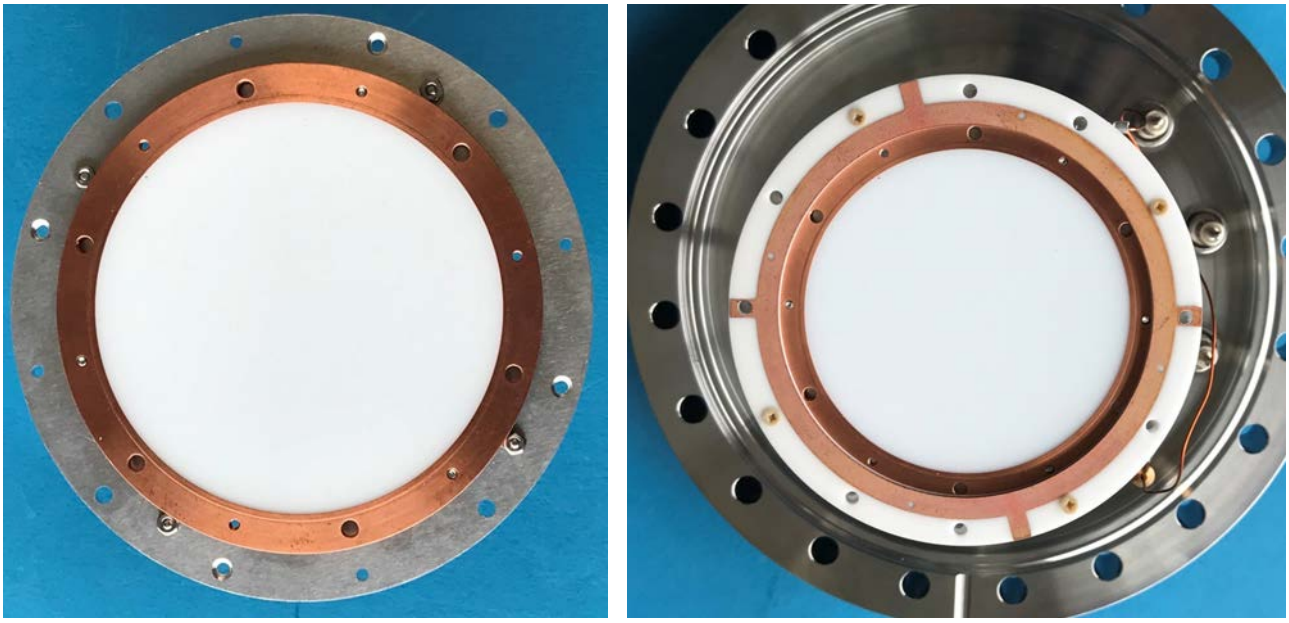


Figure 1.19: Left: Phosphor screen with min. 70 mm active diameter caged between metal rings (DET40P similar). Right picture: with rear ceramic ring (for MCP) and mounted on windows flange with high voltage feedthroughs.

For mounting the MCP stack on the phosphor screen assembly with ceramic rings for MCP clamping, follow the directions given in Chapter1.2.2.1 as for the standard **DET40/75/80** MCP mounting. While removing the guide pins, use an adequate wrench (5 mm for M2.5 or 5.5 mm for M3) to hold the nut between the ceramic rings, see Figure 1.20. Usually, guide pins for mounting MCP assemblies above phosphor screen anodes are formed as threaded rods with nuts on either side so that the rods can be removed either towards the anode side or the front side. The latter is of importance when the detector is mounted close to a rear side support.

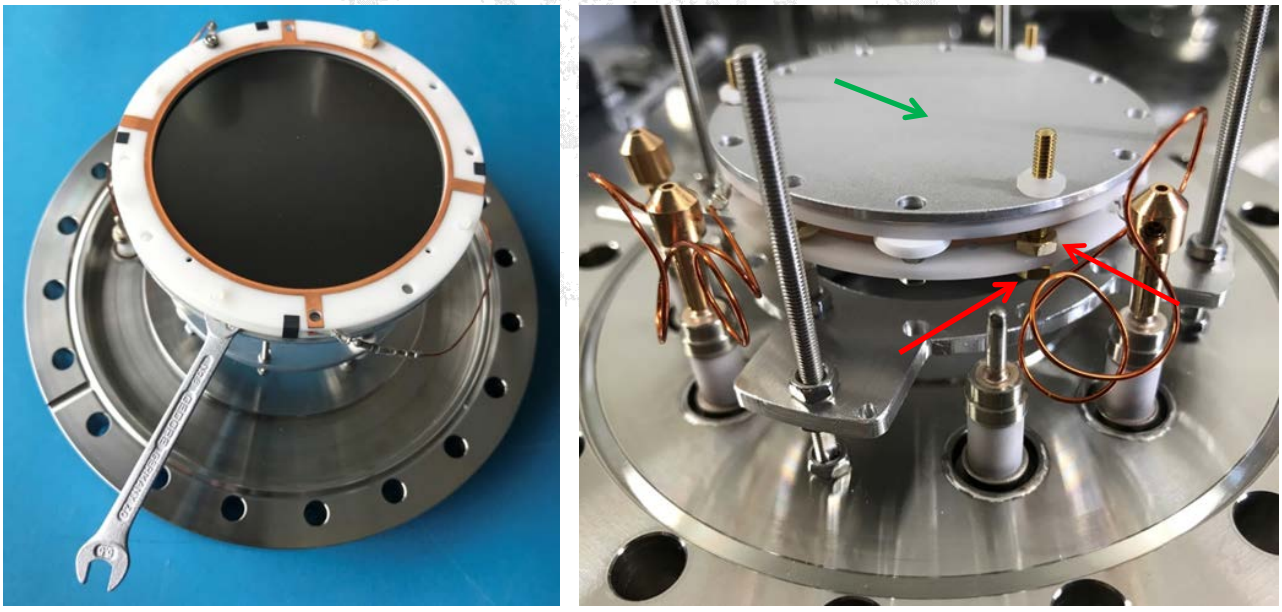


Figure 1.20: Removal of guide pins after MCP stack assembly is completed: guide pins can be retracted towards MCP front side or back side by unscrewing the rods with the fingers while taking hold of the nut(s) on the far side with a wrench, removing those (see red arrows in right picture) one by one while the rod is turned. The same rods and nuts as used for MCP mounting secure the provisional protective plate (green arrow) during shipping.

1.7.2 DET100P/120P

For **DET100P/120P** the phosphor screen (with active diameter > 120 mm) is clamped between metal rings and fixed to the MCP rear side carrier (see Figure 1.21).

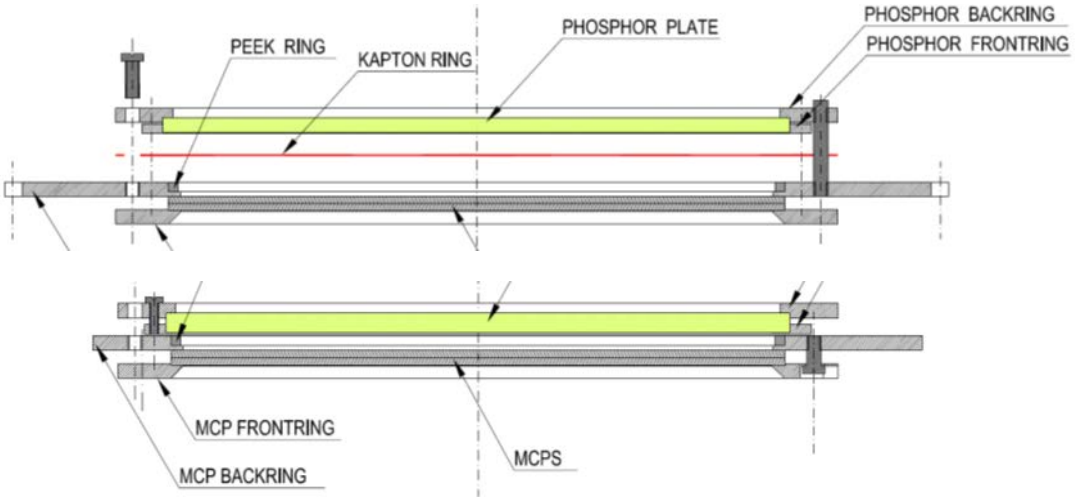


Figure 1.21: DET120P phosphor screen disc (yellow in sketch above) caged between a Cu (front) and Al (back) ring, mounted to the MCP stack rear plate. A thin Kapton ring (red in sketch above) provides insulation. Right below: MCP back support plate with mounted screen and optional temporary centring ring for placing the MCP.

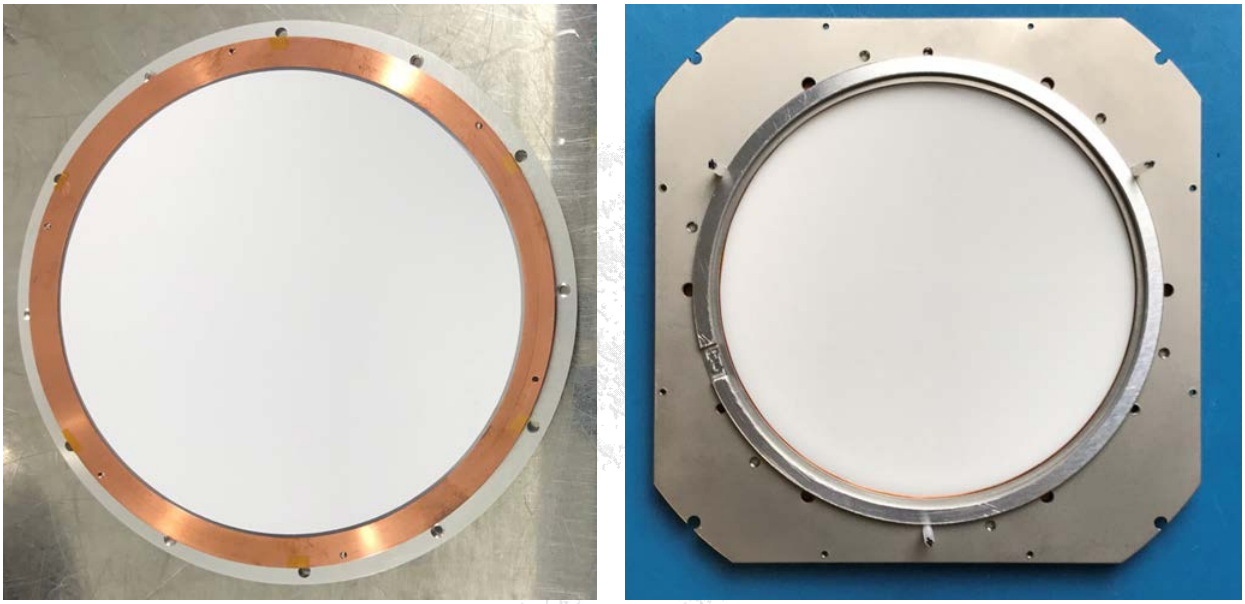


Figure 1.22: Left picture: the DET120P phosphor screen disc caged between metal rings, usually both of them electrically connected to the screen. Right picture: MCP back support plate with mounted screen and temporary centring ring for placing the MCP. The ring position is defined by the same guide pins as used during MCP mounting.

For mounting the MCP stack on the phosphor screen assembly, follow the directions given in Chapter 1.3 as for the standard **DET100/120**. As the **DET100P/120P** is also specified for operation with only one MCP (no timing information available in this case) a special back plate without indention may be supplied. In such case a separate temporary ring (see Figure 1.21) is also provided to true the MCP. The ring, centred by the same guide pins used during MCP stack assembly, must be removed before placing the front ring. Finally, the screen must be biased by fixing a connection cable to the rear Al ring which is on screen potential.

2 Installation of DET25/40/75/100/120(P)

Mounting of a **DET** to an experimental setup is usually achieved either by the standard **FT4(TP)/XXX** (XXX = 100, 150 or 200*) flange mounting option (rated up to 5 kV) or a similar custom mounting scheme obtained from **RoentDek** including adequate vacuum feedthroughs (**FT4**) and signal decouplers of type **HFSD** (completing the **FT4TP** product assembly).

Customers using a different detector mounting may still use the **FT4TP** feedthrough and signal decouplers on a nearby **DN40CF** vacuum port. If this is not sufficient for your application, please contact **RoentDek** for alternative "**XHV**" mounting and signal decoupling options.

To achieve a decent signal quality, it is mandatory to keep cable connection as short as possible, ideally < 15 cm. If this is not possible please refer to Appendix C. It may be beneficial to control signal ringing by placing blocking resistors on those contacts where no signal shall be picked up.

Before installation of the detector on the experimental setup it is useful to verify all contacts with an Ω-meter.

2.1 Mounting the DET25/40/75/100/120(P) assembly

If you have not purchased a mounting option the detector can be fixed to a custom support via designated hole positions as described before (see Figure 1.4). Mounting screws on the detector may already be provided. It is recommended contacting **RoentDek** for advice unless a specific **RoentDek** - approved mounting scheme is followed. Grounding MCP front or the anode directly may affect signal quality.

In any case: 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 1 mm distance for every 1000 V of voltage difference, in absence of sharp edges or tips, which may reduce the high voltage tolerance.

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 **FT4(TP)/100/150/200** flange mounting option you may refer to the movies about the mounting of a **DLD** detector to the mounting flange on the **RoentDek** website in the MOVIES_section and review the corresponding description sheet. An intermediate support ring is fixed to the flange through M3 rods, with the ring being insulated from the rods by ceramic spacers. When fixing the nuts do not use excessive force or the ceramic insulator may break.

The ceramic insulators will not tolerate extensive force when fixing the nuts.

Mount the holder/carrier plate to the support ring with threaded M2 rods.

The 4-fold SHV feedthrough flange and the provided Kapton cables of the **FT4(TP)/100/150/200** product assembly allow for a convenient cable connection of the MCP front and back side and the metal carrier plate rated up to 5 kV. For phosphor screen assemblies the feedthroughs are embedded in the mounting flange. The three contact lines (and a forth, in case of mesh use) shall consist of cables with minimum length (max. 30 cm). As a thumb rule: the shorter the cables, the better is the signal quality in terms of rise time, pulse width and ringing properties. It also may be beneficial to use "blocking resistors" (see below) on one or both of the MCP contacts (recommended on MCP back).

Once the detector is mounted to the vacuum chamber make sure to **always evacuate or vent the vacuum chamber slowly** (≤50 mbar/s for a **DET** without phosphor screen and <10 mbar/s for **DET_P** with phosphor screen and an **RS- DET**). This is to prevent turbulence near the detector as this can cause spurious dust particles settling on MCP or the anode, with very adverse effects. Furthermore, inherent to the design detectors with phosphor screen or resistive screen contain a volume of poor flow conductance between anode and MCP. If low/high pressure pockets build up during fast evacuation or venting the MCP may break.

The maximum recommended operating pressure for the detector is $2*10^{-6}$ mbar). Remember that the gauge pressure may not always reflect the vacuum conditions at the position of the detector.

* For **DET25** and **DET40s** a mounting scheme on DN63CF flange can also be achieved, please contact **RoentDek**.

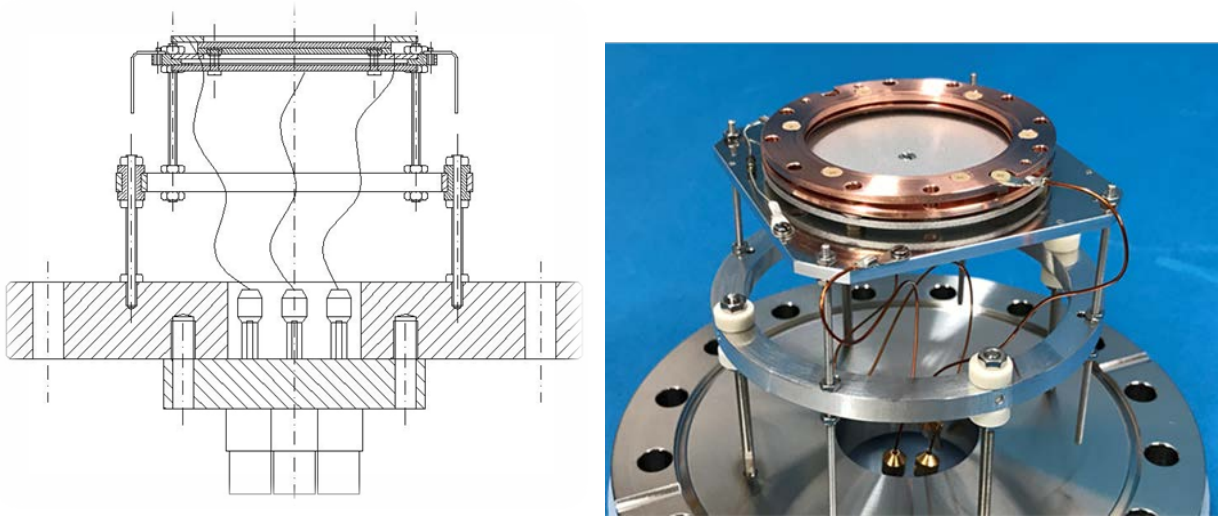


Figure 2.1: Sketch of a DET40 detector with FT4TP/100 mounting on a DN100CF flange (up left) via the standard intermediate support ring. Up right: picture of a DET40 with Cu-rings as MCP fixing assembly via a "flipped-over" standard carrier plate (MCPs are omitted for clarity here). Below: Phosphor screen assemblies employ a flange with central view port and off-center feedthroughs: DN160CF flange with DN63CF port for DET40P (or DET75P).

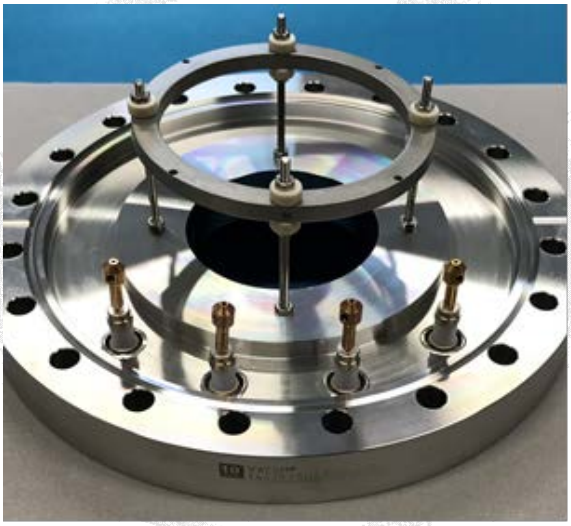
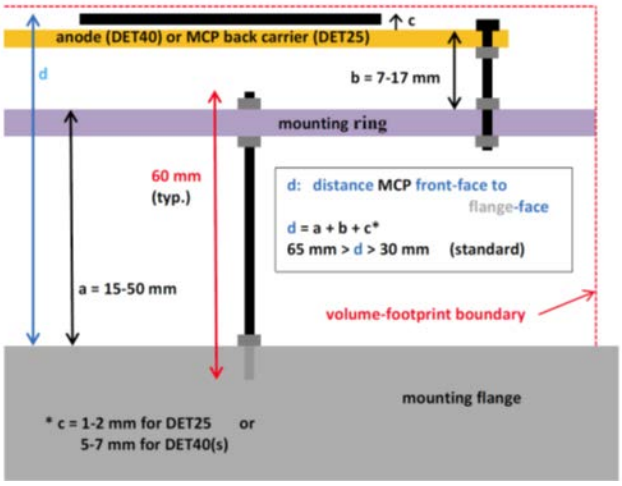
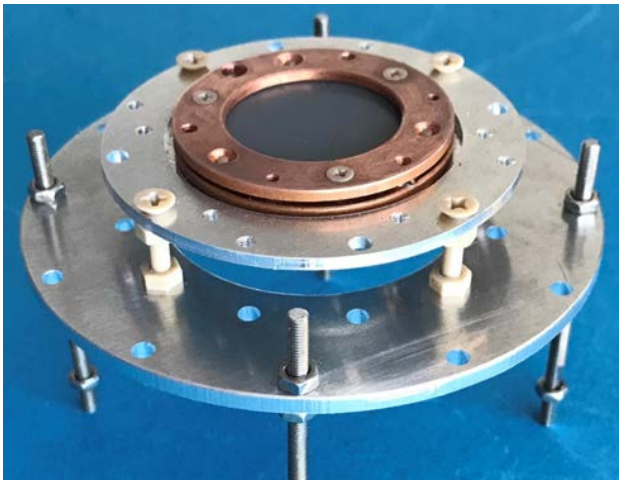


Figure 2.2: For DET40(P) and DET25 an alternative flange mounting scheme on a DN100CF flange is available which potentially allows operation at higher voltages and mounting at smaller MCP distance from the flange. Here, the mounting ring is at ground potential and insulation of the detector is achieved by long M3 PEEK screws.





2.2 General operation

For single particle counting the standard MCPs for **DET25/40/75/100/120** can be operated with a voltage of at least 1200 V per plate (**DET40/75/120**) or 800 V per plate (**DET25/100**). If you have received different MCPs please inquire for the default operation values. Sufficient gain is usually achieved already at voltages below the recommended values.

It is very important to follow the instructions of the MCP manufacturer when you apply voltage to the MCP stack for the first time (see Appendix A). A detailed startup procedure for MCP detectors is given in the RoentDek delay-line detector manual, see link "blocking resistors" below. For the RS-DETs and assemblies with phosphor screen or special read-out anode/screen mounting with reduced flow conductance to the space between MCPs and anode please give special attention to the precautions mentioned for evacuation and venting procedures in Chapter 2.1.

It is advisable to use power supplies with current limitation and fairly swift (controlled) voltage shutdown for protection of the MCPs (available from **RoentDek**). During operation, the vacuum should never exceed $2*10^{-6}$ mbar, conditions below $1*10^{-6}$ mbar are recommended. The potential of the MCP front surface is arbitrary (depending on the particles to be detected). The anode has to be on a slightly more positive (200 – 300 V) potential than the back side of the MCP stack (more for phosphor screen assemblies). An example for voltage supply for ion/photon detection (chevron-configuration) is

MCP front	- 2400 V (may be lower for **DET25(P)**, please contact **RoentDek**
MCP back	0 V (ground)
Anode	+250 V (+2000 V for phosphor screen anode)

For electron detection, all bias values should be shifted by about +2700 V with respect the values given above. When using an **HVZ-T** (see Appendix B) it is possible operating the **DET25/40/75/120** with only one high voltage supply, please contact **RoentDek**.

If a **DET25P/40P/75P/100P/120P** is used for single particle counting (rates < 1 MHz, MCPs operated in saturated mode as described above) timing signals can be decoupled as well (but not at lower MCP voltages that are mandatory at higher rates). Additionally, the light output from the phosphor screen can be used for verifying detector performance. Note that at low count rate, the light output may be too faint for visual inspection and a sensitive camera must be employed to observe the phosphor screen response.

It is important to note that a **DET25P/40P/75P/100P/120P** must not be operated with saturated (high) MCP bias if the incoming particle flux exceeds about 1 MHz. Then the MCP voltage has to be reduced with respect to the incoming particle flow so that the current through the MCPs does not exceed the specified strip current in saturated mode (at maximum bias) plus 10% of this value. Otherwise premature aging of the MCP stack may occur and the output response is strongly non-linear.* At high input flux ("current mode") the MCP stack operates as a physical charge amplifier, its gain depending on the MCP bias and individual particles cannot be counted via signal pickup.

The total light output is the product of incoming particle rate, quantum efficiency for the particle species, gain of the MCP stack and photon yield (per electron) of the phosphor screen. The latter is dependent on the phosphor material and the voltage between phosphor screen and MCP back. A typical value of photon yield is 50/keV energy loss for each electron, linear response up to 2-3 kV screen voltage (valid for P20). Thus, about 100 photons are emitted into 4π solid angle for each electron in the MCP output avalanche at 2 kV screen voltage (with respect to the MCP back potential). Other materials (e.g. P43) may have two or three times higher yield.

For picking up the timing signal from the detector, an RC-decoupling circuit as shown in Figure 1.1 must be used, e.g. a **RoentDek HFSD** on airside of a feedthrough. In order to control ringing of the signal, a potentiometer (0-200 Ω) to "ground" should be used after the capacitor on all other detector contacts (also on a mesh), e.g. a **RoentDek HFST** on airside of a feedthrough, or blocking resistors (> 10 kΩ) must be placed very close to each detector contact (i.e. ideally in vacuum) in line with the bias connection. UHV compatible resistors for this purpose are available from **RoentDek**.

When using the **RoentDek FT4TP** with signal decouplers of type **HFSD** and **HFST**, please refer to the manual for the **RoentDek** delay-line detectors, beginning with the header "blocking resistors" in Chapter 2.3 therein. It is followed by a description of an ***initial start-up procedure*** and descriptions of high voltage supplies and front-end electronic modules that you may have purchased for operating the **DET**.

For standard applications a "simple" in-vacuum connection scheme (up to 30 cm cable length) is sufficient and signal widths of < 5 ns are achieved even when both the MCP and anode signals are decoupled. When applying adequate read out electronics

* Local saturation effects may occur in case of spot-like illumination even before the global output charge limit is reached.

(i.e. CFDs) typical signals as in Figure 2.3, left picture, allow for temporal resolution of 100 ps FWHM or better for single particle detection. The trailing edge (possibly accompanied by spurious ringing) does not affect the timing precision. However, if signal quality and width is an issue for an application, **RoentDek** can propose different wiring schemes (depending on the mounting geometry and connection cable lengths, see Appendix C) which can reduce the signal rise time and width considerably (as in right picture of Figure 2.3).

For further signal processing we recommend the **FAMP1+** amplifier followed by a fast ADC (e.g. **fADC4**) or (only for true single particle counting applications) a constant fraction discriminator (e.g. **CFD1c**/**1x**) and TDC (e.g. **TDC4HM**) after the amplifier. Alternatively, the **ATR19-2(b)** module with internal **DLATR** amp & CFD board is available. For some applications the **LET** (Leading Edge Trigger) module may be sufficient. The **RM-6** module can be used as rate-meter and/or counter. Please contact **RoentDek** for other adequate timing digitizers and software to record the timing information.

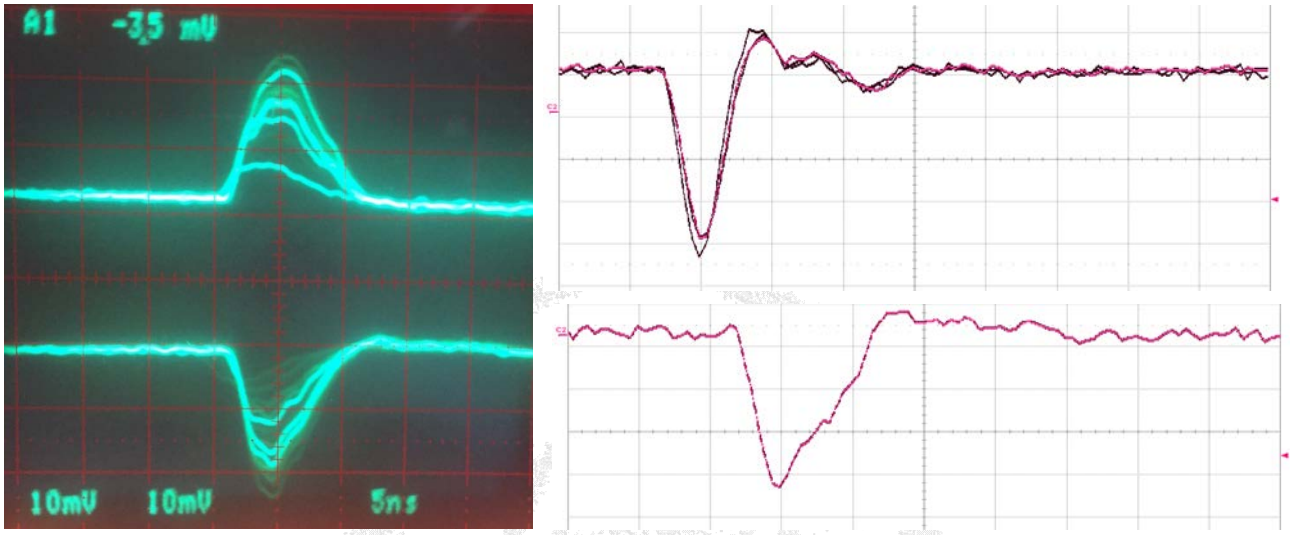


Figure 2.3: Left picture: typical signal traces at 5 ns per division picked up from MCP back (upper trace) and from the anode (lower trace). For optimized connection schemes rise time can be < 1 ns here with FWHM of 1.1 ns for very short distance (< 10 cm) between DET40 and FT4 feedthrough flange (upper trace of right picture, 2 ns per division). For cable lengths of 30 cm (trace right below) the trailing edge is significantly broadened.

Appendix A. MCPs

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 x 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 x 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.

Appendix B. The HVZ-T voltage divider for DET

For biasing the **DET** timing detectors **RoentDek** offers a special version of voltage divider for biasing all detector contacts with only two independent high voltage supply channels. This **HVZ-T** unit combines the function of the **RoentDek HVZ** and **HVT** units in a single case. Please refer to the respective sections in the Power Supply Manual for function description*.

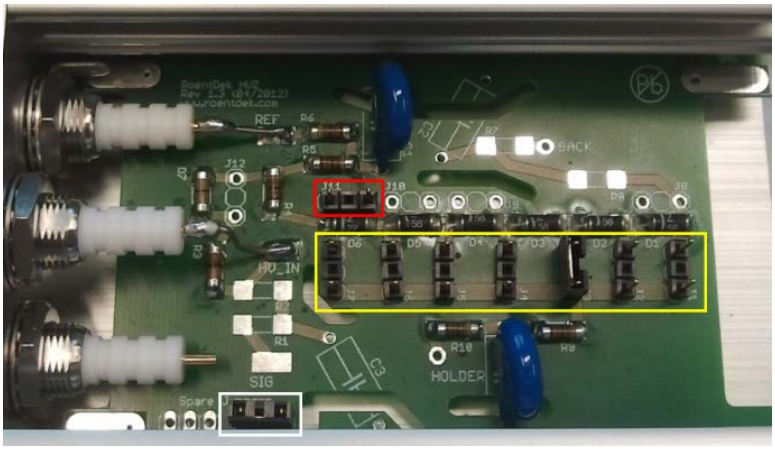
Figure B.1: HVZ-T module

To bias the detector through the **HVZ-T** connect the high voltage supply for the anode to the socket "HV In". Then connect the socket "Anode" to the anode's feedthrough (via a resistor or coupling circuit like in a **HFSD** or **HFST** unit) of the detector and the "Back" socket to the MCP back feedthrough likewise. The nominal voltage drop (approximately) between MCP back and anode can be set by jumpers. Note that there can be an offset drop as a function of the coupling resistance to MCP stack resistance ratio times the MCP bias. Usually it is recommended setting the highest value, see Figure B.2 and Figure B.3. **Note, that "HV In" potential must be more positive than MCP front potential AT ALL TIMES**.

If you want to use the **HVT** circuit of the unit connect the high voltage supply for MCP front to the "Front In" socket and the "Front" socket to the MCP front feedthrough accordingly.

Note, that the MCP front side line of the **HVZ-T** should only be used if the MCP front potential and the anode potential have same polarity and as long as the MCP front potential is < 1000 V. This is for example the case for low-energy electron detection tasks. For biasing schemes, with negative MCP front potential the power supply for MCP front is directly connected to the **HFSD**/**HFST** unit (or equivalent), i.e. not routed through the **HVZ-T** box.

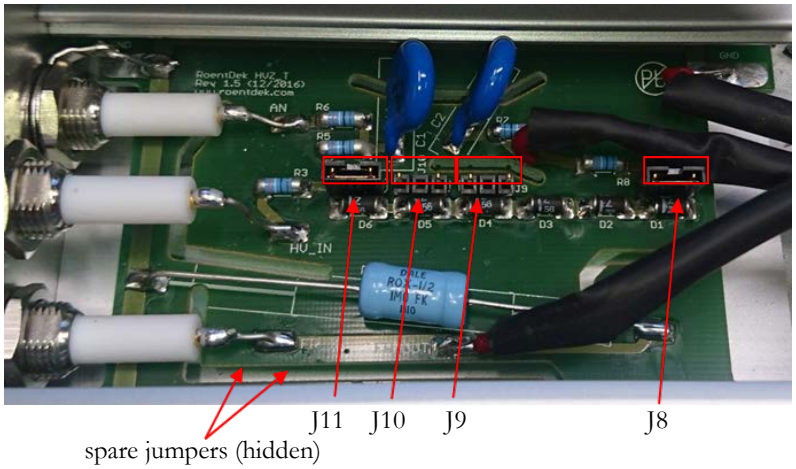
A connection scheme for different detector potential options is found under this link. Variations of the **HVZ-T** box are available for applications when anode potential can be fixed to ground (e.g. ion detection) or for electron detection with fixed positive potential on MCP front, see in the respective section in the Power Supply Manual.



Jumper set	Voltage	
	J11 open	J11 set
J1	307 V	270 V
J2	251 V	224 V
J3	195 V	168 V
J4	139 V	112 V
J5	83 V	56 V
J6	27 V	n.a.
J7	0 V	n.a.

Figure B.2: Inside view of the HVZ-T with jumper banks

* The **HVT** circuit (for MCP front bias) of the **HVZ-T** is completely independent from the **HVZ** part and can optionally be used on a different detector.



Jumpers J11, J10, J9	J8	Nominal Voltage
all 3 unset	unset	278
all 3 unset	set	251
any 1 set, other 2 unset	unset	222
any 1 set, other 2 unset	set	195
any 2 set, other 1 unset	unset	166
any 2 set, other 1 unset	set	139
all 3 set	unset	110
all 3 set	set	83

Figure B.3: Inside view of the HVZ-T with jumper banks (Revision 2.1)

Modified versions of the **HVZ-T** allow also for detector operations with MCP front potential > 1 kV positive (**HVZ-T4**), or for biasing of phosphor screen assemblies (**HVZ-T5**). For specific operation modes, **RoentDek** can offer custom versions. For a selection of specific versions, please refer to the **RoentDek** Power Supply Manual.

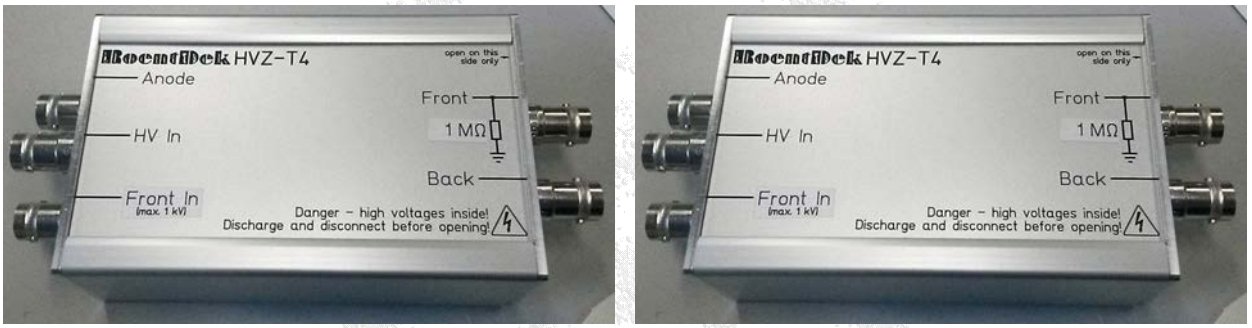


Figure B.4: HVZ-T4 versions with reconfigurable terminating resistance (pictures left above and below), or with fix 10 MΩ resistance (picture right above). If the unit is delivered with "T4" label (above) a 1 MΩ resistor is set parallel to the 10 MΩ resistor to ground (see picture left below). The total resistance is then 0.9 MΩ. By removing the solder connection as in picture right below the HVT resistance is changed to 10 MΩ. Additionally, a resistor bridge may be placed between Front and Back output sockets (backup resistor parallel to MCP stack).

Appendix C. Operation of a DET with long in-vacuum cables

As standard single-strand connection cables between feedthrough and detector get longer, signal quality suffers and may become inadequate for certain applications. Using a shielded and/or impedance-matched cable between detector and feedthrough becomes mandatory. The recommended cabling method involves the use of an additional feedthrough rated to transmit high frequency signals with GHz bandwidth at 50 Ω impedance with a corresponding coaxial signal line in vacuum.

Unless the signal is decoupled right at the detector from a DC load this cable must also be rated for high voltages. It is furthermore mandatory that the shield of the signal cable is not only thoroughly grounded at the feedthrough's end but also very near the detector, i.e. via a solid ground post or grounded support attached to the chamber wall.* Optimal signal quality is achieved only if the distance between grounding joint and the connection shield is ideally < 1 cm. Larger distances (which may be unavoidable for a given experimental setup) will give rise to inferior signal quality similar to the effects shown in the right picture of Figure 2.3.

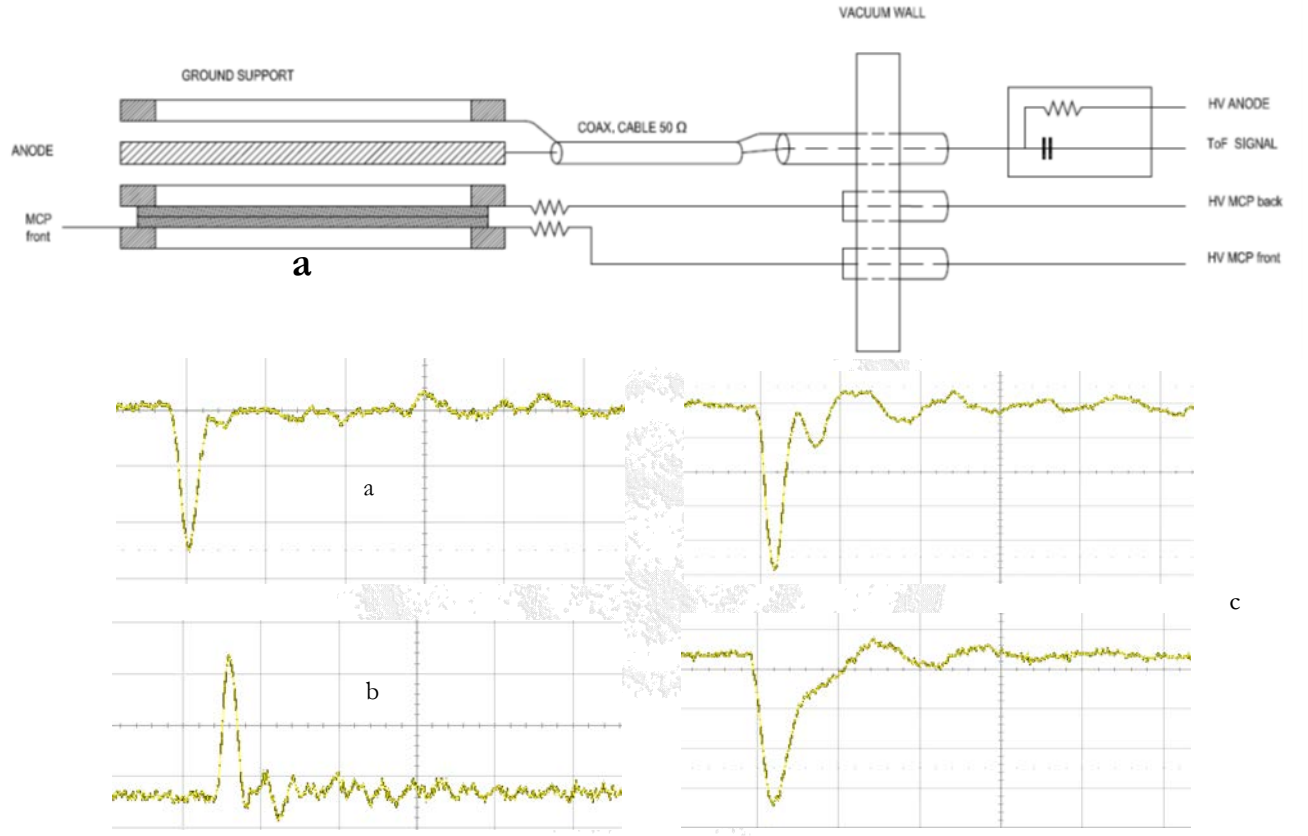


Figure C.1: Sketches of signal decoupling/cabling options to a distant feedthrough flange and corresponding signal traces (time scale 10 ns per division). Explanations see text.

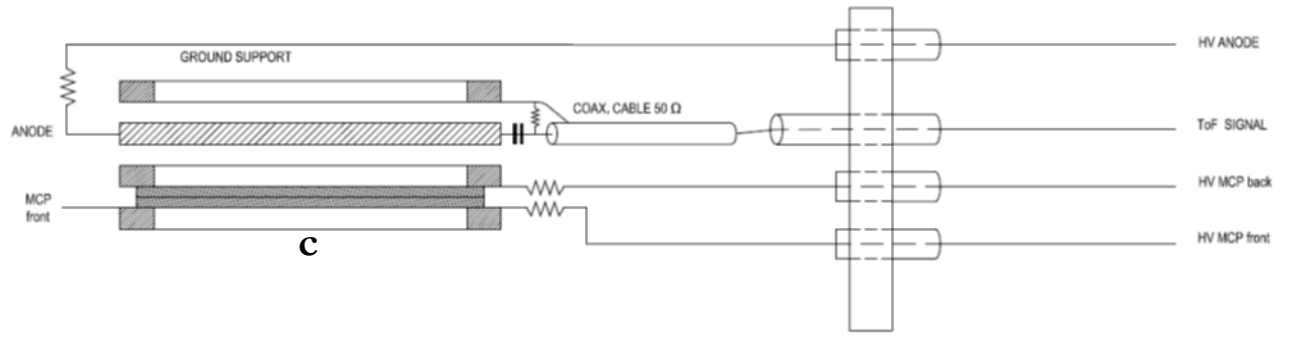


Figure C.1 shows schemes and signal traces for recommended wiring circuits with long shielded cables and a 50 Ω feedthrough for the signal line. Left side: Signal pick-up from either the anode (a) or MCP front contact (b) yield about the same signal quality (for "b" the cabling scheme of the anode and MCP front is swapped compared to the "a" sketch). Having this choice

* Note, that long cables with small cross section do not qualify as sufficient ground connection for high frequency signals.

may reduce requirements on the high voltage ratings of cable and feedthrough (here: SHV feedthrough). Alternatively (c), the high voltage load may be decoupled right on the detector by a capacitor (see sketch below the caption of Figure C.1 and signal traces on its right side). This allows the use of signal cable/feedthrough without specified high voltage ratings. Residual ringing effects can be reduced by placing on-detector HF termination circuits: the lower signal trace on the right was achieved by adding a RC circuit between MCP back plate and ground. However, such extra circuits can increase signal width.

Commercially available 50 Ω feedthroughs often have adverse effect on the vacuum or pumping duration even when specified for use in UHV environment. Depending on application demands, **RoentDek** can provide alternative solutions (for an example see Figure C.2)

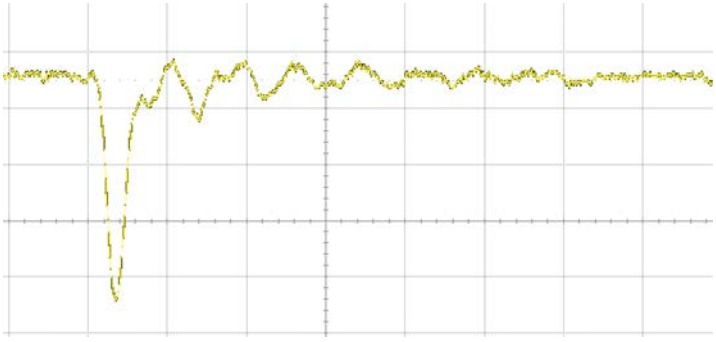


Figure C.2: Above: typical signal trace (time scale 10 ns per division) obtained from a DET40 with 75 cm long in-vacuum signal cable (50 Ω impedance, high-voltage rated) and "primitive" ground connection on a feedthrough flange with standard SHV feedthroughs (no impedance match).

Appendix D. Advanced timing anodes (Multi-anode)

Following the basic detector design of a standard metal timing anode, **RoentDek** can alternatively provide structured anodes with multiple independent detecting elements. An example is the **DET40_5** with five independent anode elements (**Pentanode**). Signals from each element can be picked up via rear-side contacts (see Figure D.1). The concept can be expanded to any custom-defined number of elements ("pixels") with variable shapes.

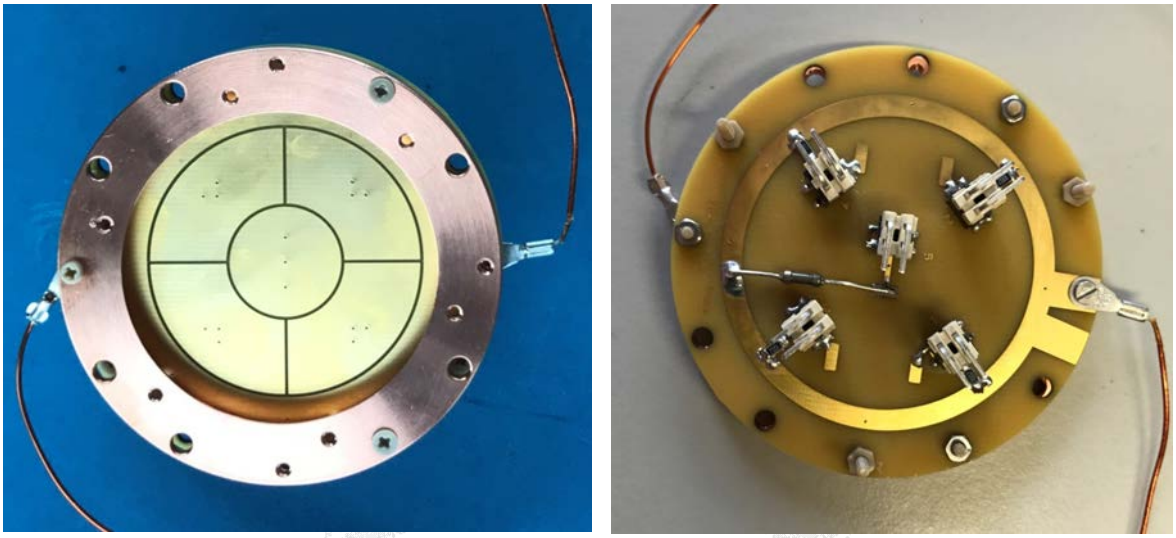


Figure D.1: Front and rear view of a Pentanode for 40 mm active detection diameter mounted to a rear MCP carrier ring. All elements are biased to the same potential via a single contact but have individual signal pickup leads.

Depending on the number of read-out elements **RoentDek** can provide adequate signal feedthrough and decoupling solutions based on the **FT4/12/16TP** product range, followed by standard timing electronics circuits or advanced read-out via fast ADCs (**RoentDek fADC4**) to allow for imaging applications with spatial resolution well below pixel size, employing charge-centroiding algorithms.

Appendix E. DET25/40/70(75/80)/120P with metal MCP front ring

Recent versions of the **DET** detectors with phosphor screen anode use a screen framed between metal rings and a metal MCP front ring. This requires a different MCP mounting procedure than described in Chapters 1.2 and 1.7. Please refer to the documentation (*short manual*) that came with the detector. A more general version of this document can be found here.

Figure 1.19. shows such a phosphor screen framing where the phosphor screen in such a frame can easily be replaced. This is described below:

- Provide dust-free environment for the procedure (ideally in clean room or flow box). Use gloves (Latex-type) throughout.

- Remove the screen cage from the MCP stack. Only for **DET40P** the screen cage disassembly may take place with the screen cage still mounted on the rear MCP ring.

- Before opening a phosphor screen cage, it must be placed face-down on a perfectly flat and clean table support. Note that the surface of the screen will only have 0.2 mm clearance to the table support. It is recommended to place the protective plate that came with this initial delivery, or a similar flat and large-enough clean disc/plate under the front side of the cage for extra safety.

- Keep record on the azimuthal orientation of the holes with respect to hole orientation on the front ring of the screen cage and also relative to the MCP stack. Remove the countersunk M2 screws on the back side, then the rear ring of the phosphor cage can be lifted. Before pulling the ring backwards hold the glass disc down in case it sticks to the phosphor cage rear ring.

- Carefully lift and remove the glass disc with the phosphor layer, only handling it on the rim and rear surface. Never touch the surface of the phosphor layer, nor bring anything in contact with it. Do not blow air over it.

Store the phosphor screen between a pair of appropriate watch-glasses in dry, dark and dust-free environment.

Before mounting another phosphor disc, it is recommended to place three M2 guide pins (same as used during MCP stack mounting) symmetrically into the (inner-circle) M2 holes of the front cage ring (not for **DLD25P**).

Then place the phosphor glass disc in the indention, phosphor layer pointing down. Handle it only on rim and rear side. Be careful not to touch the phosphor layer or to scratch the layer on the ring or on a guide pin.

Place the rear ring with the indented side (after rotating it to the default azimuthal orientation, see above and in figure caption below) over the disc so that it is safely embraced by the ring. Guide pins help in alignment. Place three M2 screws (use same length' screws as were used before!) symmetrically in the inner circle holes without force. Then remove guide pins, if any, and place the remaining screws. Then fix all screws. It is recommended to also use (only) tree PEEK screws (not for **DLD25P**).

The screen is now securely caged. For next steps (e.g. mounting it on the MCP stack) refer to the *short manual* that came with the detector delivery.

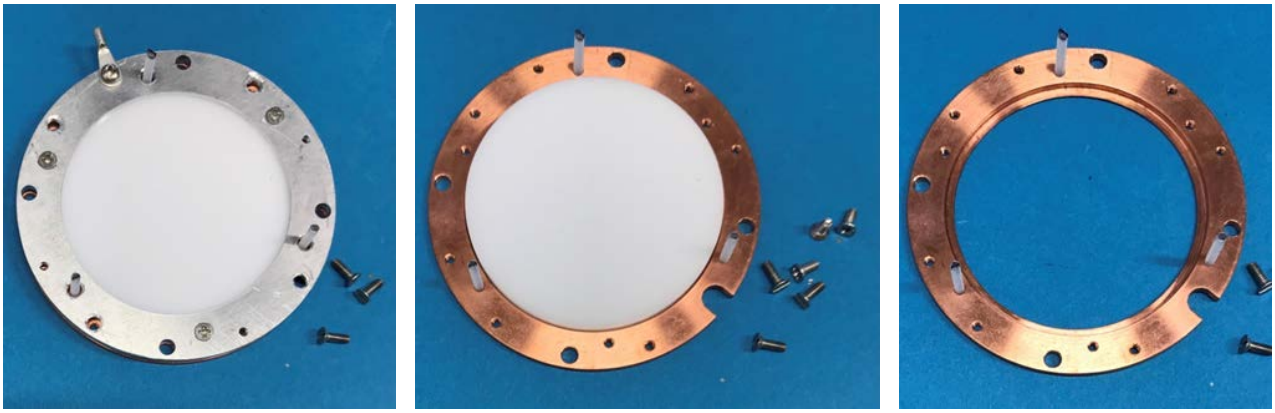


Figure E.1: Pictures of the phosphor screen cage (here: DET40P) at different steps during glass disc (un)mounting. Procedure is similar for DET70(75/80)P DET120P and DET25P (the latter has only 3 screws). For DET40P it is especially important that the 3.2 mm through holes of the cage rings are aligned (if not, rotate the rear ring by 120°).

List of Figures