



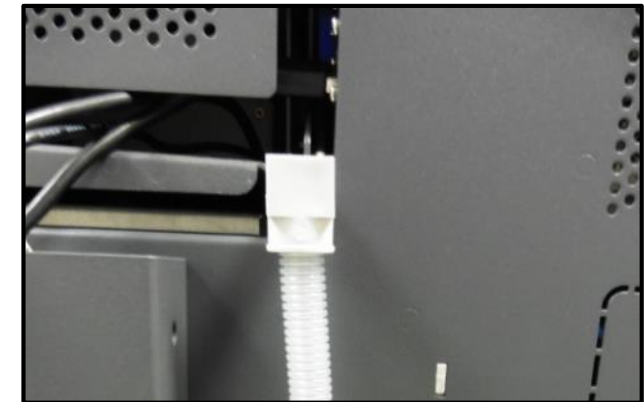
Orbitrap Exploris 480 Mechanics

Revision 00 – June 2019

- Covers removal
- Vacuum system
- Ion optics

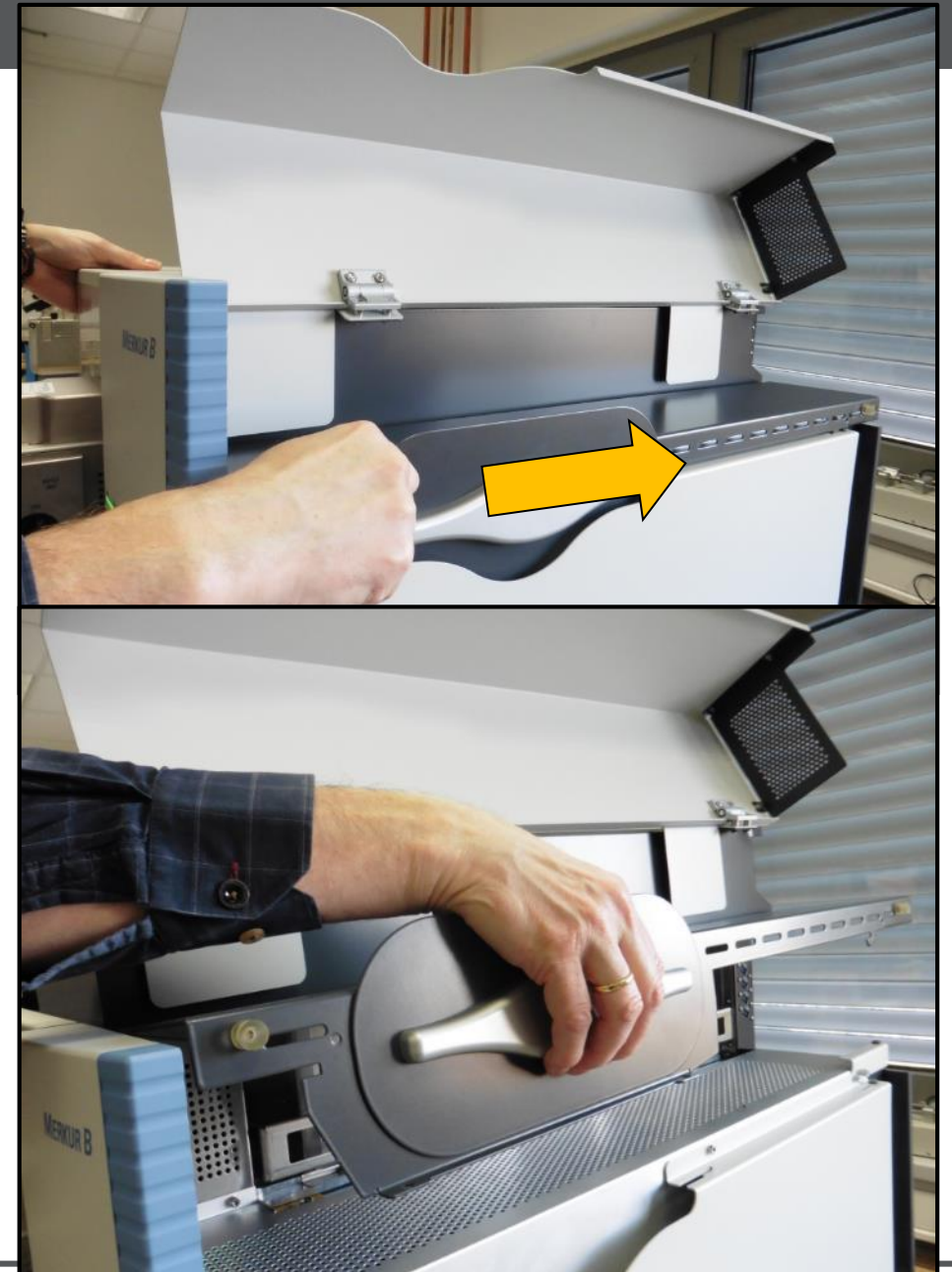
Top cover removal

- Open lid on right hand side.
- Unplug power & USB connections to syringe drive pump.
- Remove waste tubing on the back.
- Remove all accessories in the chamber.
- Remove the five red circled 3 mm screws.



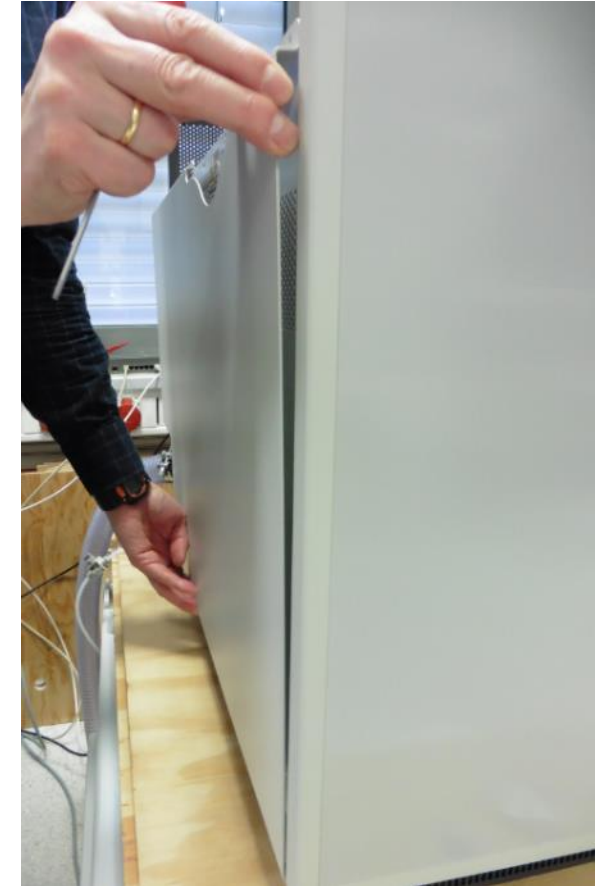
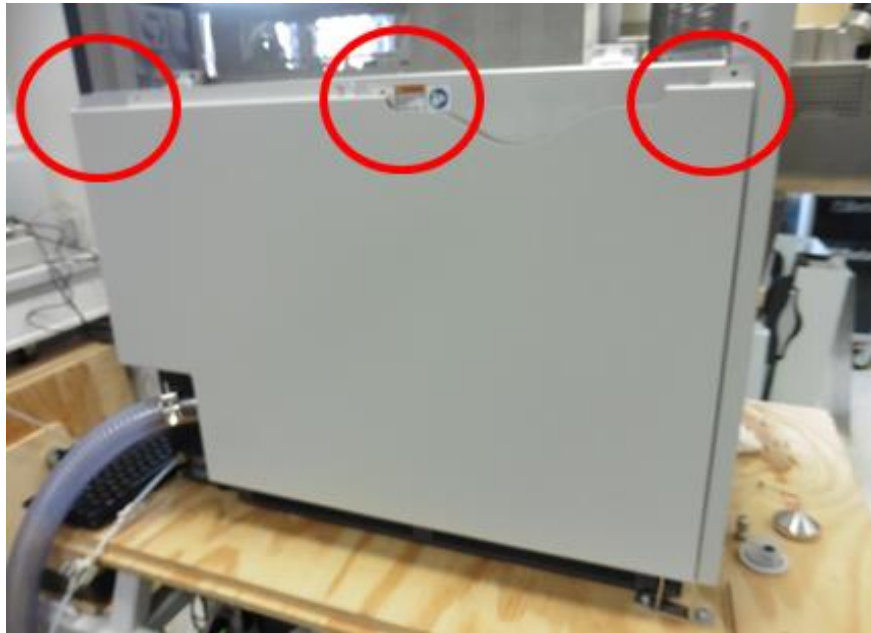
Top cover removal

- Grab the front cover with 2 hands from the front.
- Slide the cover to the back for about 1 cm.
- Now you can lift off the top cover.



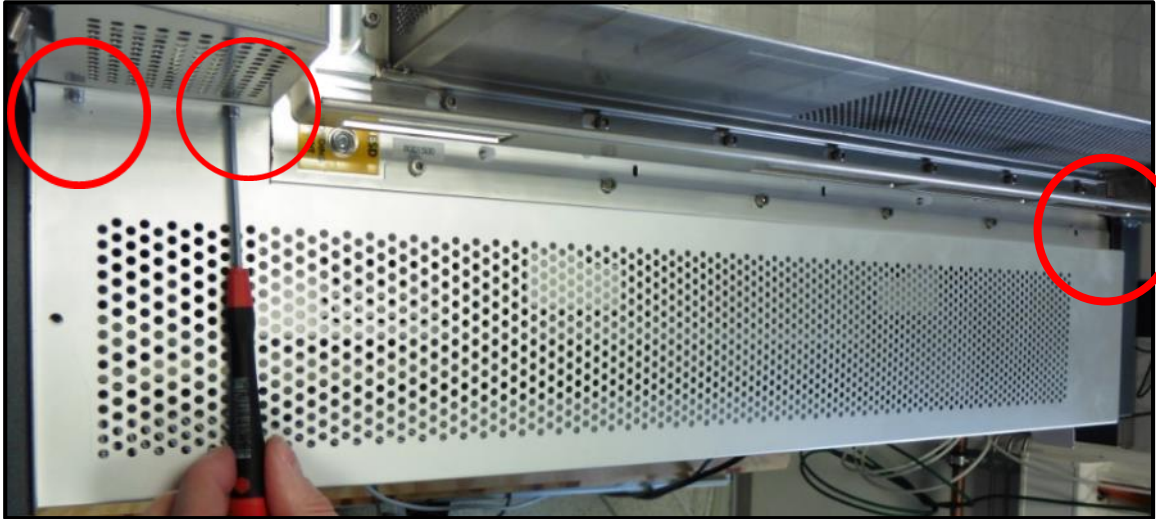
Side cover removal

- Undo the three 3mm red circled screws.
- Hold your hand underneath as the panel will drop on the table.
- Remove cover out of the way



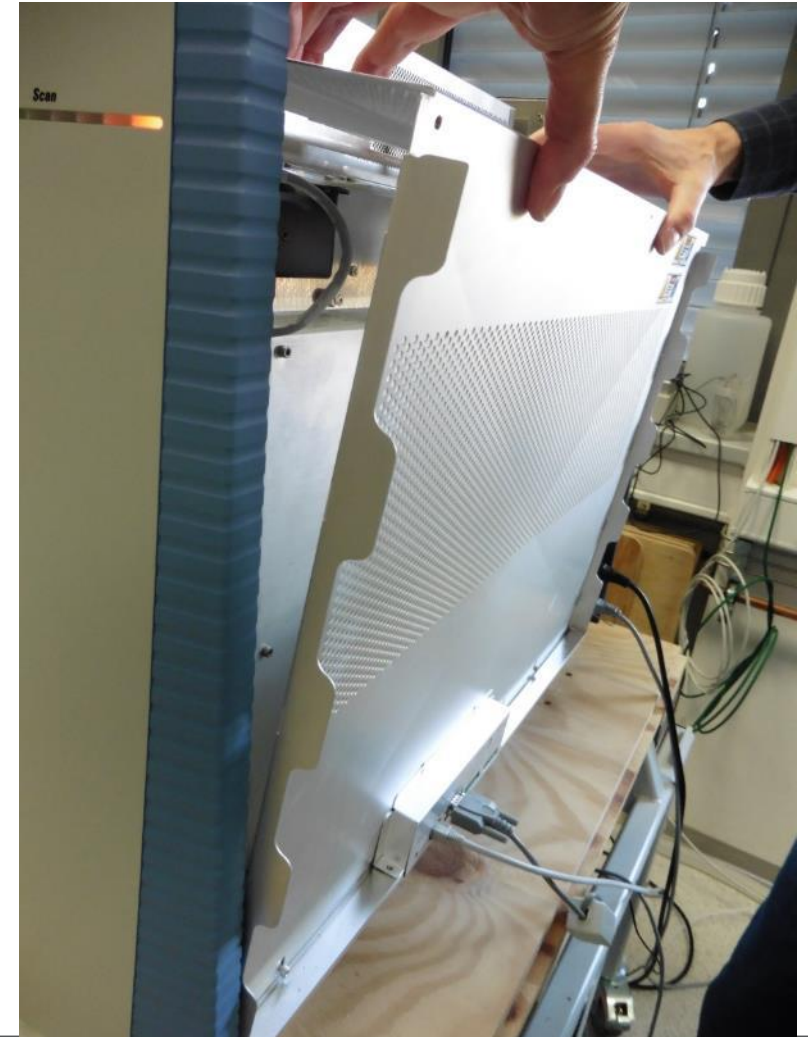
Side cover removal

- Remove the three red circled 3 mm screws both left & right side.



Side cover removal

- Undo all of the 3 mm screws (quite a lot) you can leave them in place.
- Push the back part of the cover slightly down, tilt the panel towards you.
- It is important when refitting the panels to tighten all screws as this is part of the EMC shielding.



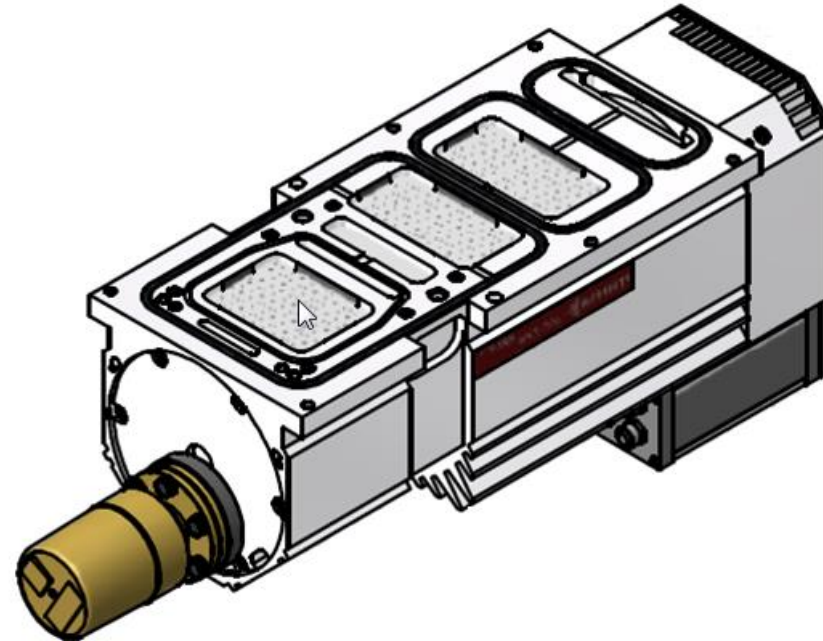
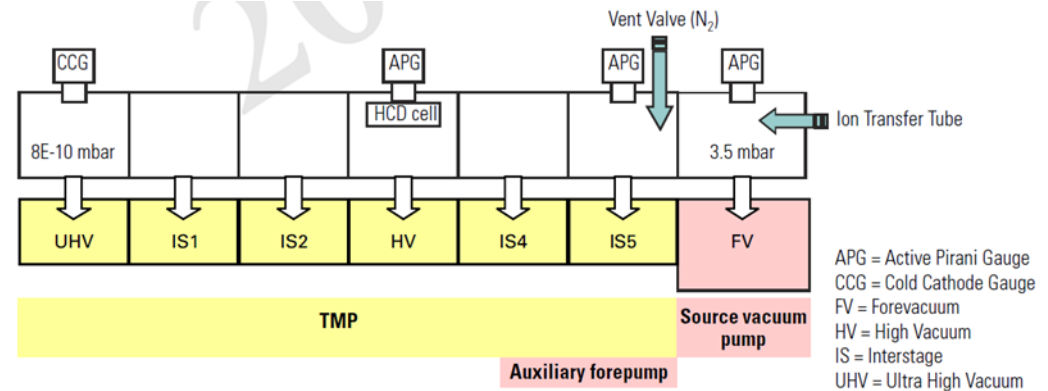
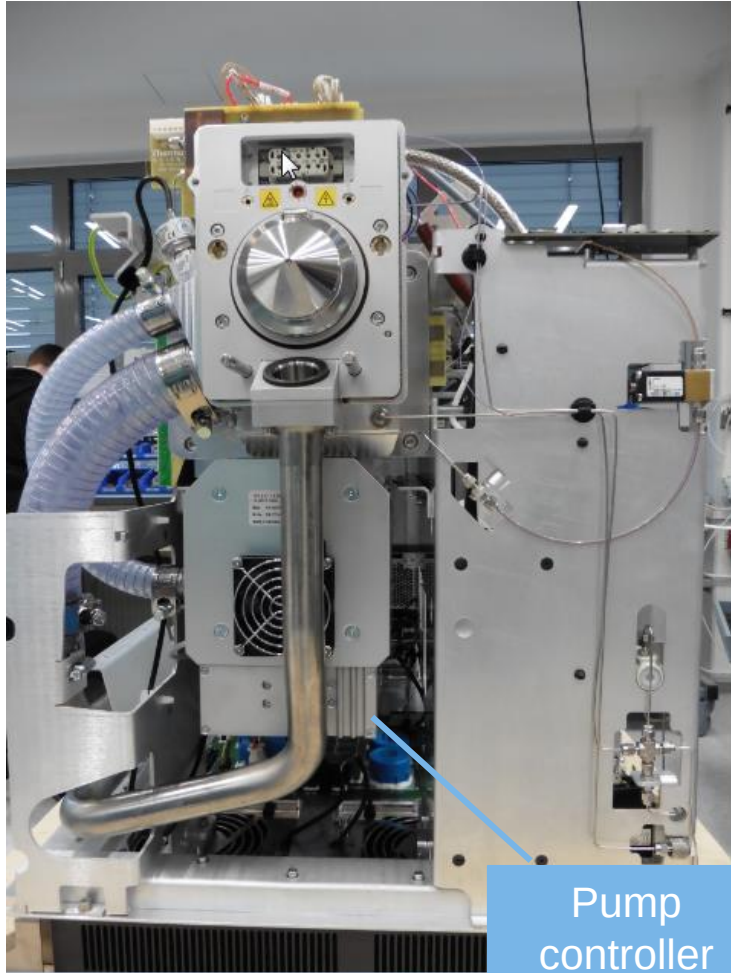
Required Tool for Repairs (additional to install tools)

- 19 mm open wrench
- Torque wrench for installation of orbitrap block and turbo 5 NM/10 NM (e.g. Proxxon MicroClick MC15)
- 5 mm long nut for torque wrench for Orbitrap Exchange

Vacuum System

- Chamber
- Pumps
- Vacuum Gauges & Pressures
- System Bakeout

6-Stage Turbo Pump – (P/N BRE0013937)



Vacuum rules

- Vacuum “okay”:
 - Fore vacuum > 3.7 mbar or < 4.5 mbar
 - UHV $< 5\text{E-}10$ mbar

Turbo pump exchange and maintenance

- See separate presentation
- KIT is available (Turbo pump including ion gauge and copper seal: BRE0013937)

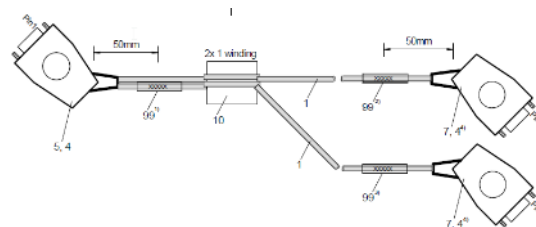
Duo 11 (Pfeiffer Vacuum)



- A two-stage rotary vane pump
- Supplies as auxiliary fore-pump the fore-vacuum for the TMP

Forepump (Leybold Sogevac SV120 BI FC – P/N BRE0015548)

- Single-stage rotary vane pump (SOGEVAC™ SV 120 BI, manufacturer: Oerlikon Leybold Vacuum) is used as source vacuum pump.
- It evacuates the funnel region of the vacuum manifold. The pump has a nominal pumping speed of ≥ 147 m³/h.
- Control cable is a Y-Adapter that connects both pumps to the instrument. Pump 1 is SV120.
- Pump will shutdown when not connected.



Noise reduction cover



Instrument back side



Unplugging the RS 232 will cause pump fore-pump shut down



Vacuum Gauges (Pfeiffer RPT010; P/N BRE0013940)

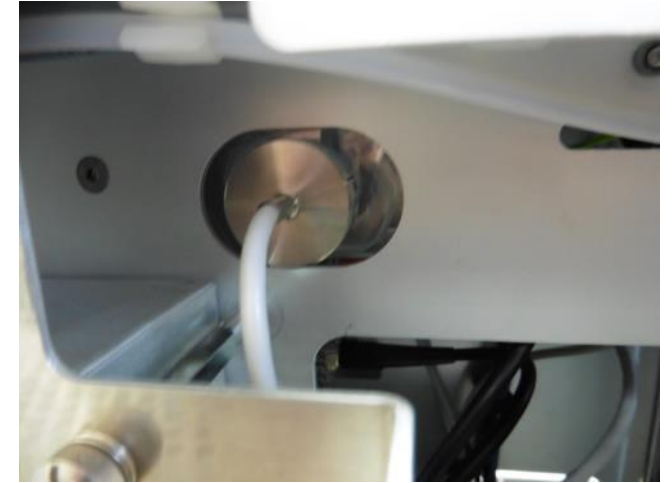
- Fore-pressure pirani gauge
- Inter-flatapole pirani gauge



- UHV Vacuum Gauge



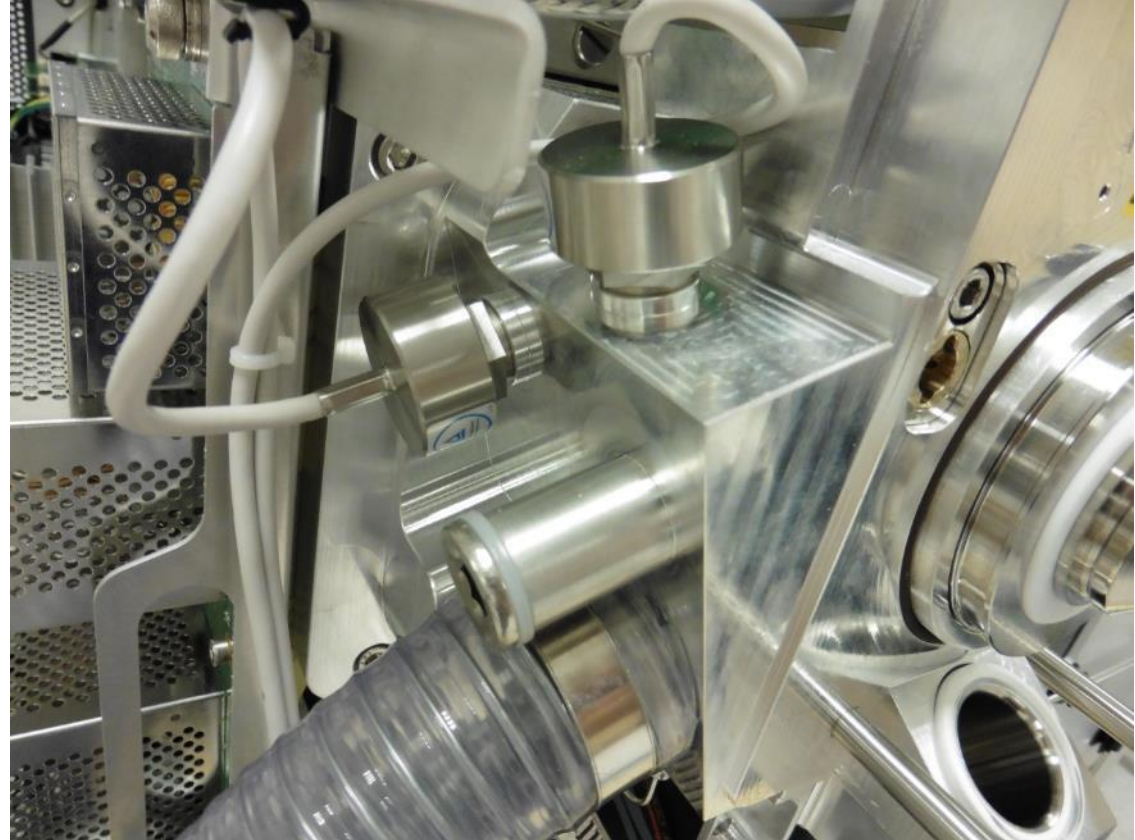
- IRM ion gauge
(HCD Cell pressure)



First instruments only.
Will change to RJ45
connection.

Vacuum Gauges (front) - Exchange

- Required Tools
 - 19 mm open wrench
- Steps for disassembly
 - Remove front cover to access connections at base plane
 - Disconnect cable
 - Remove gauge



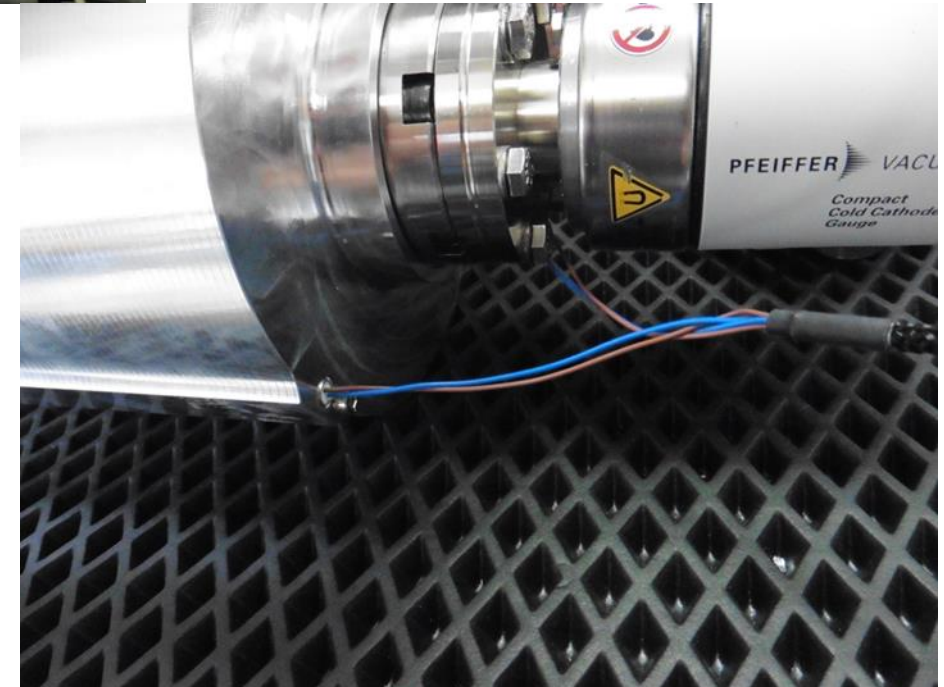
Vacuum Gauges (back) - Exchange

- Required Tools
 - 19 mm open wrench
- Steps for disassembly
 - Remove Orbitrap Supply PCB
 - Disconnect cable
 - Remove gauge



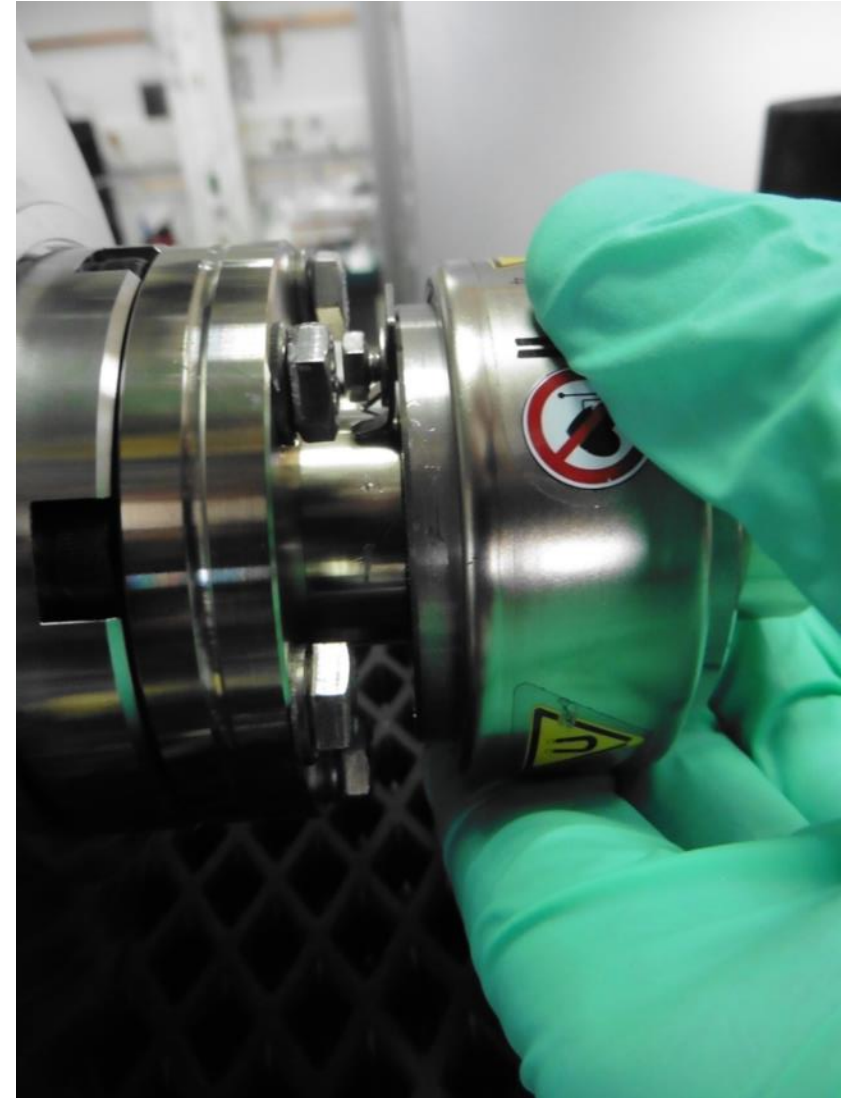
Vacuum Gauges (UHV – IKR 270; P/N XXXXXXXX)

- Attached directly to the UHV pump
- Order copper gasket (P/N 0550480) when exchanging pump
- No need to use peek screw due to active noise cancelling by instrument
- Last revision has external hex screws (10 mm)
- Gauge can be removed without removing magnet and electronics.



Vacuum Gauges (UHV – IKR 270; P/N XXXXXXXX)

- The exchange can be done w/o removing turbo pump
- Required Tools
 - 10 mm open wrench
- Steps for disassembly
 - Disconnect cable
 - Loosen bolts
 - Remove gauge

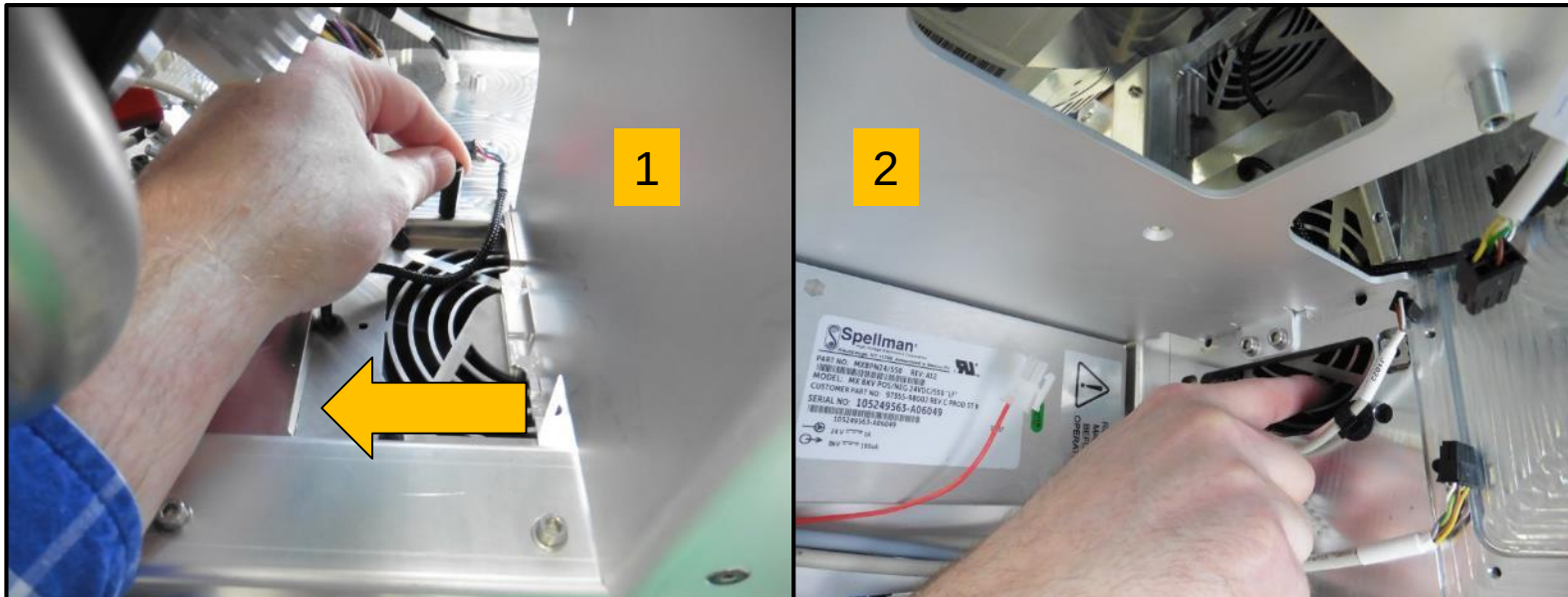


Temperature Management

- Fans
- Heating elements (Peltier & Co.)
- Sensors (PT100, Thermocouple & Co.)
- System bakeout

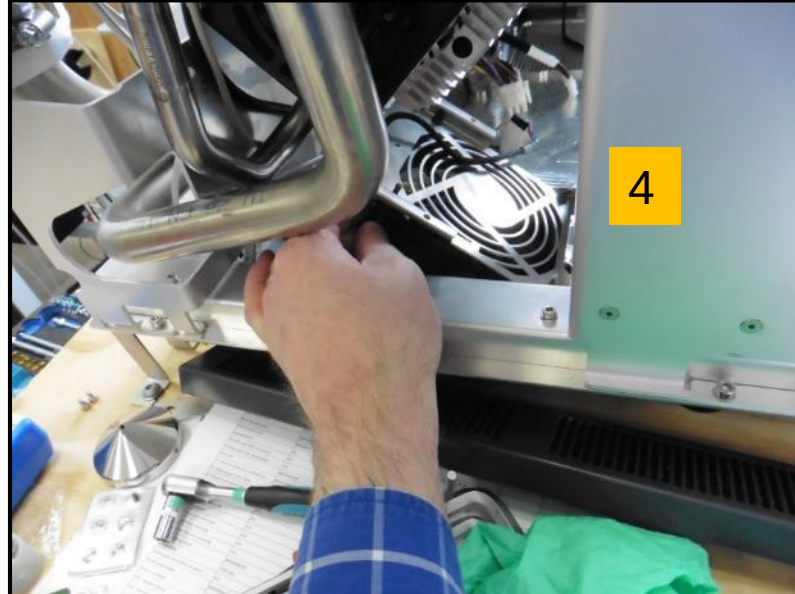
How to exchange the fan assembly

- Disconnect the cable from fan that needs to be exchanged.
- Undo the plastic stud see picture 1.
- Slide the fan assy to the right and push carefully on the right hand side of the fan assy as shown on picture 2.
- Note that the sliding direction differs on which side of the instrument the fan is located.



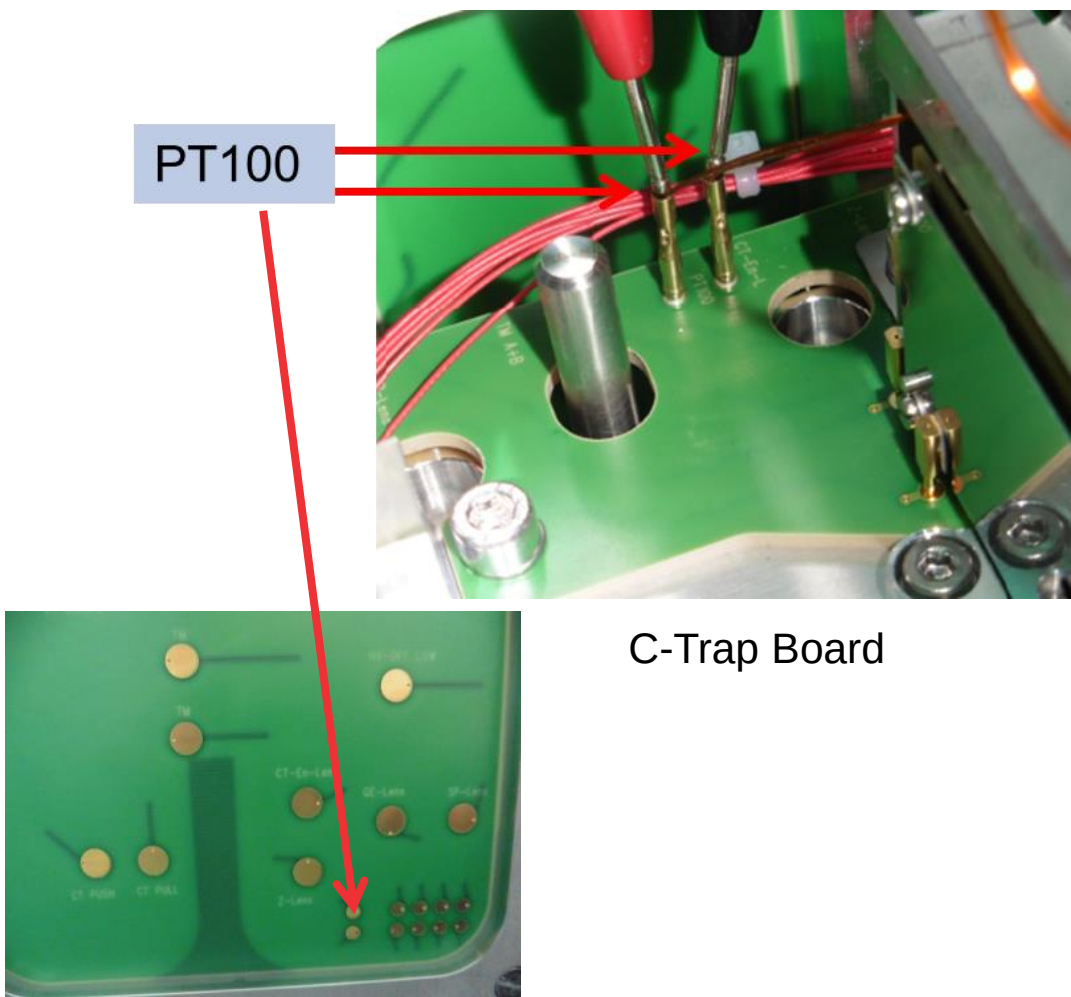
How to exchange the fan assembly

- Lift the fan assembly from the left-hand side as shown on picture 3.
- Lift the assembly up and move out of the instrument as shown on picture 4.
- Part number 2165900-02, all 3 are the same.



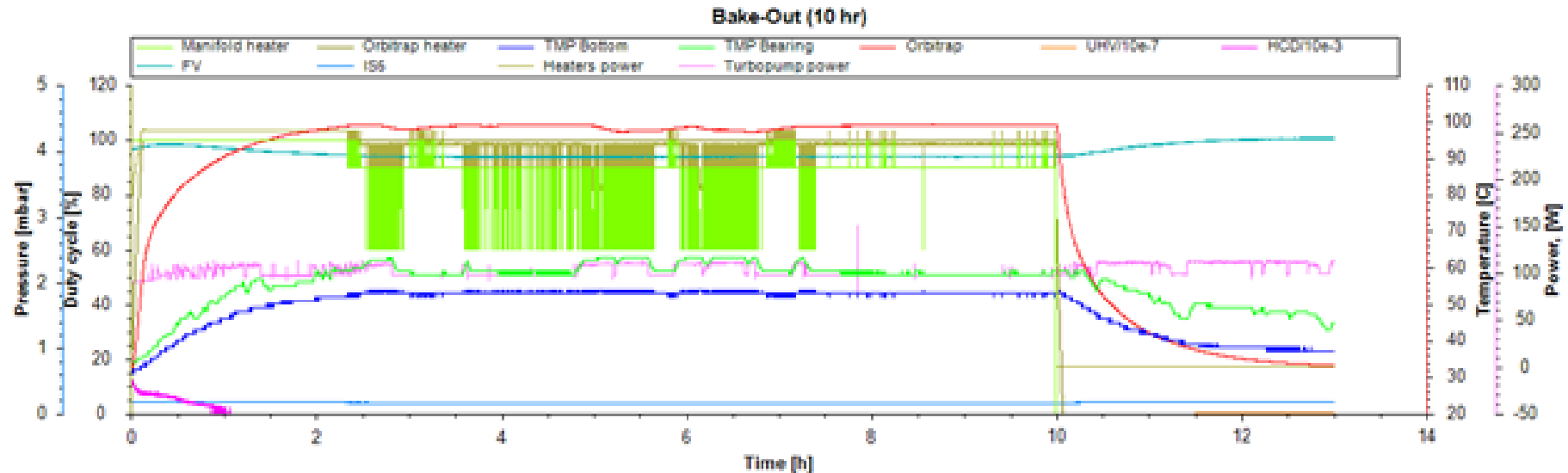
Fans	
Fan Fuse (act.)	0x1
▷ Right-front Fan Speed (act.)	2808 rpm
▷ Left-back Fan Speed (act.)	2820 rpm
▷ Left-front Fan Speed (act.)	2800 rpm





▲ C-Trap Board	
[OSPI Link]	Ok
Service Info	
▷ [Config/ID Mem]	
[FPGA Firmware]	Detected: 0005
▷ Board Internals	
▷ Reconfiguration Watchdog	Configuration Ok
▷ MUX & ADC Read-back Sampling Control	
▷ DC & RF Control	
▷ ICD Control	
▷ Ion Optics Set Voltages	
▲ Read Backs	
Predicted Orbitrap Temperature	+35.59 °C
▲ Orbitrap Block Temp. (act.)	35.5 °C
Orbitrap Block Temp. (Ohm)	+113.79 Ohm
C-Trap RF Amplitude (act.)	2060.25 V

- Regulated Bakeout: 10 h + 3 h cool down time



- Please note, the bake out will start automatically once the pumps are at speed and electronics is on after venting.

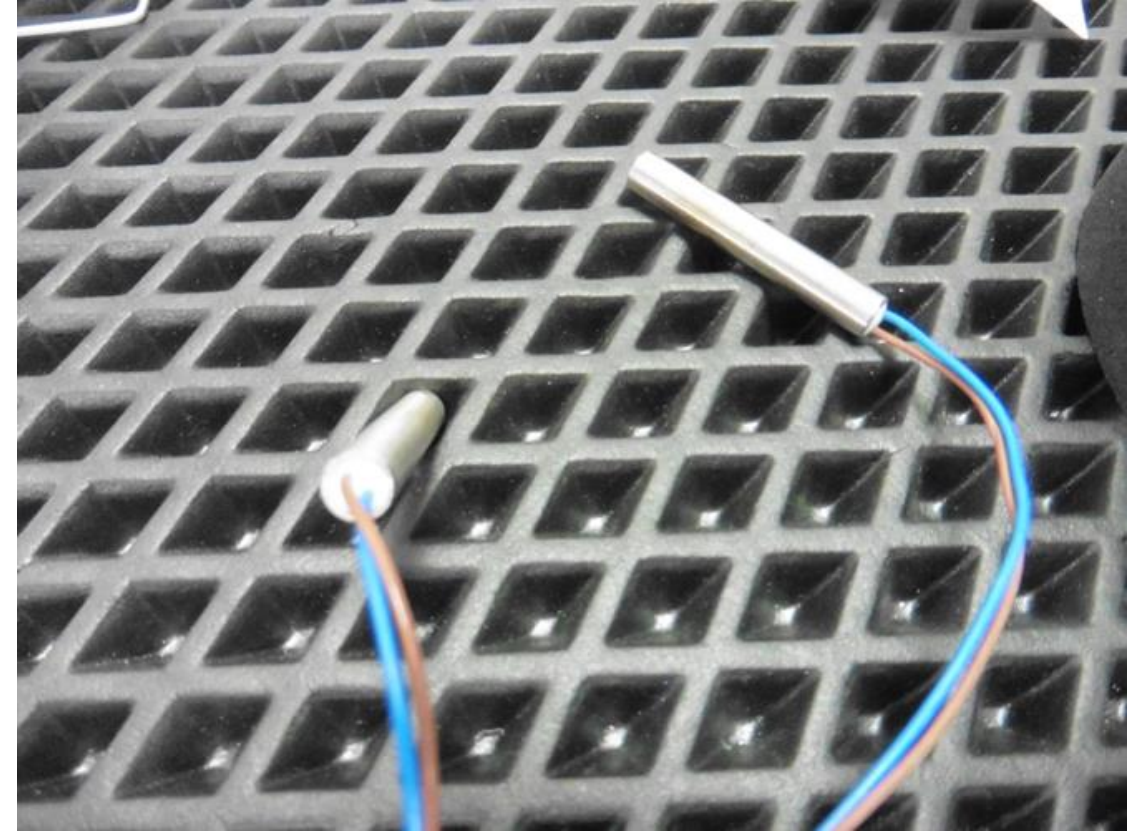
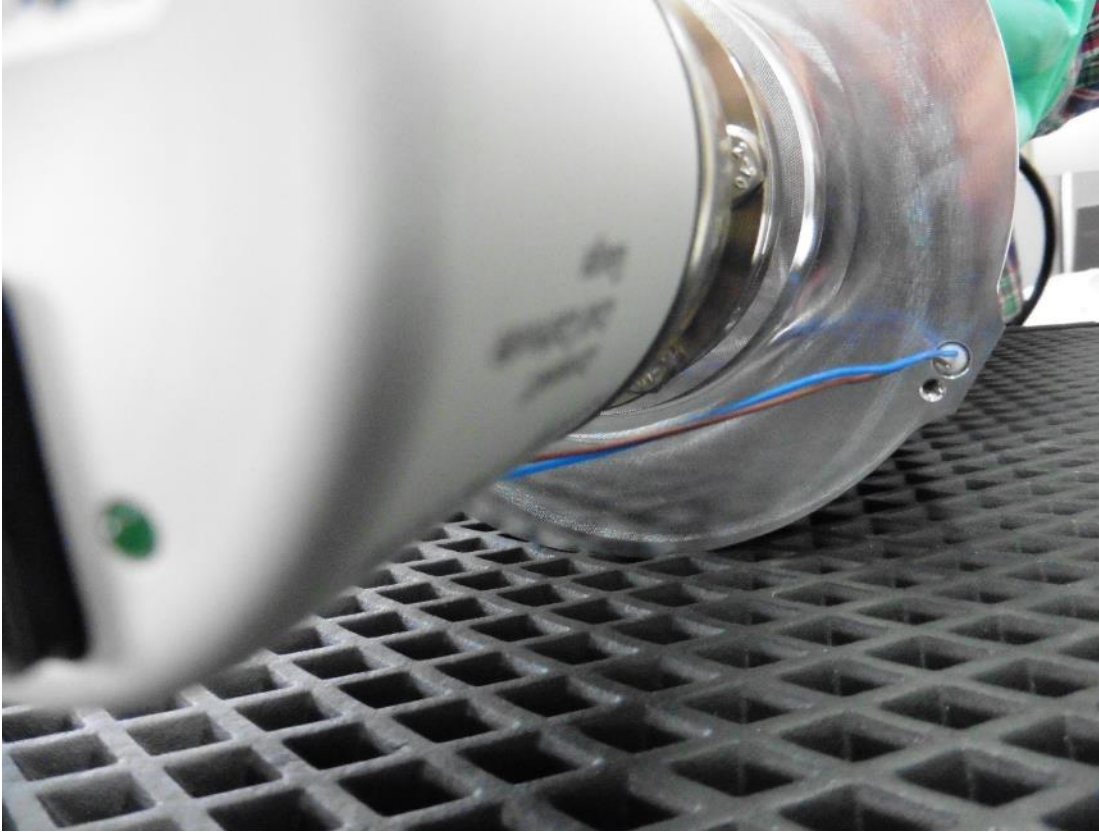
System Bakeout

- To deactivate the automatic system bakeout procedure (within 10 min. while the TMP spins up)

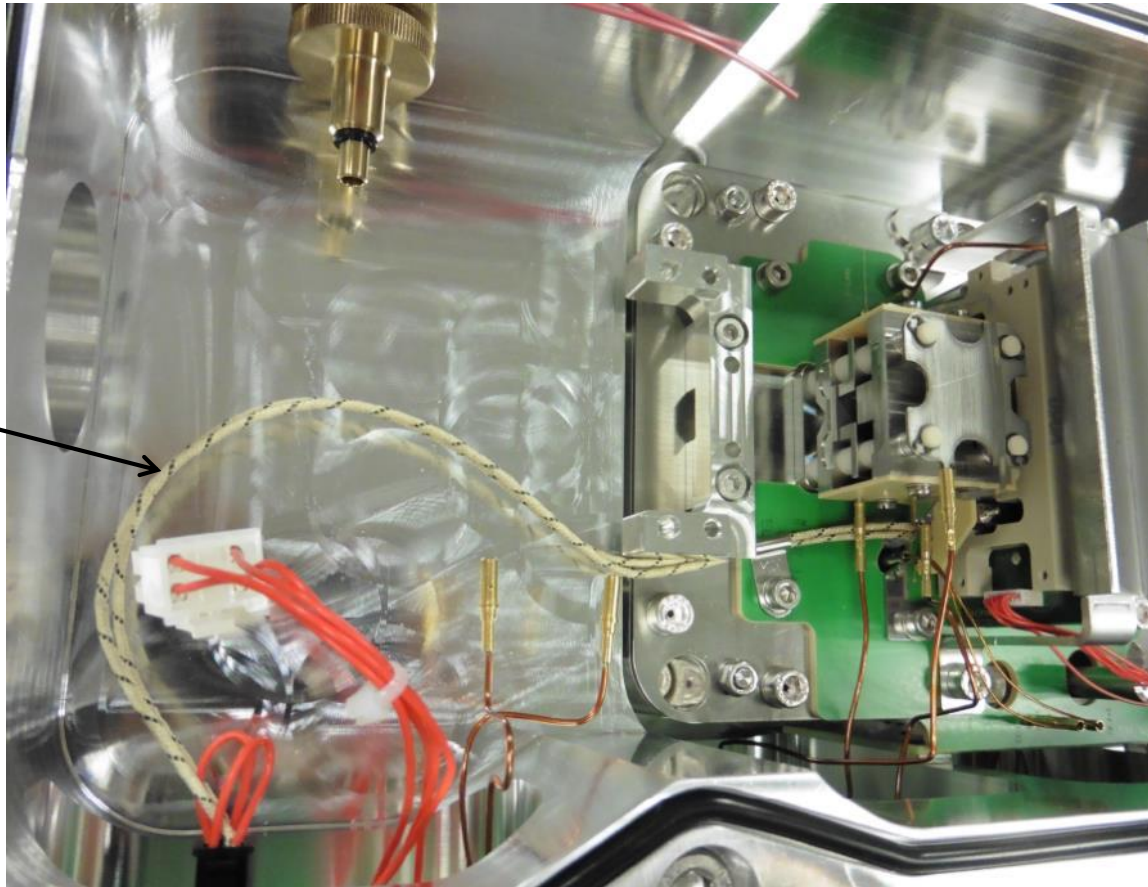
!	▲ Components	Atmospheric Interface - [M Funnellnj] - Funnel I
	▸ General	
✓	▲ Vacuum System	
	Calibration Bake Out IDs	
✓	System Status	OK
✓	Fore Vacuum Pumps	Power ON
✓	Fore Vacuum Gauge	3.52 mbar
✓	Interstage 5 Vacuum Gauge	0.15 mbar
✓	Turbomolecular Pump	1000 Hz
✓	HCD Cell Vacuum Gauge	1.10e-02 mbar
✓	Bakeout Control	n/a
✓	Ultrahigh Vacuum Gauge	→ ★ Add to Favorites
✓	Vacuum Controller	Deactivate
	▸ Analyzer Temperature Control	
✓	▸ Ion Source	

Exchanging the bake out heater @ Pump

- Remove the two heater cables from the pump (unscrew and pull out; 3 mm hex)

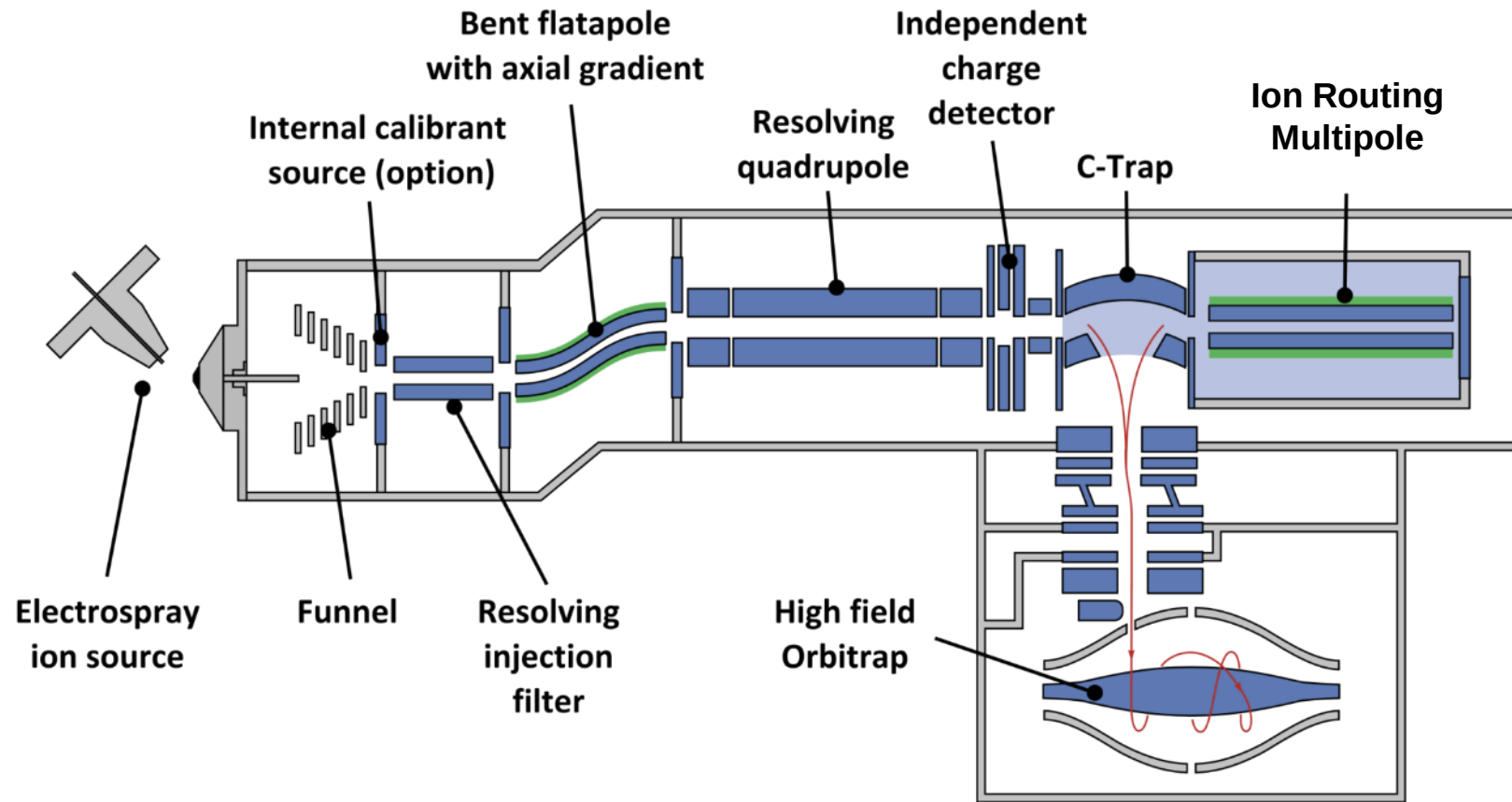


Bake out heater in Orbitrap



- Analyzer
- Ion Path and required voltages
- Ion Injection into Orbitrap
- Capacitances

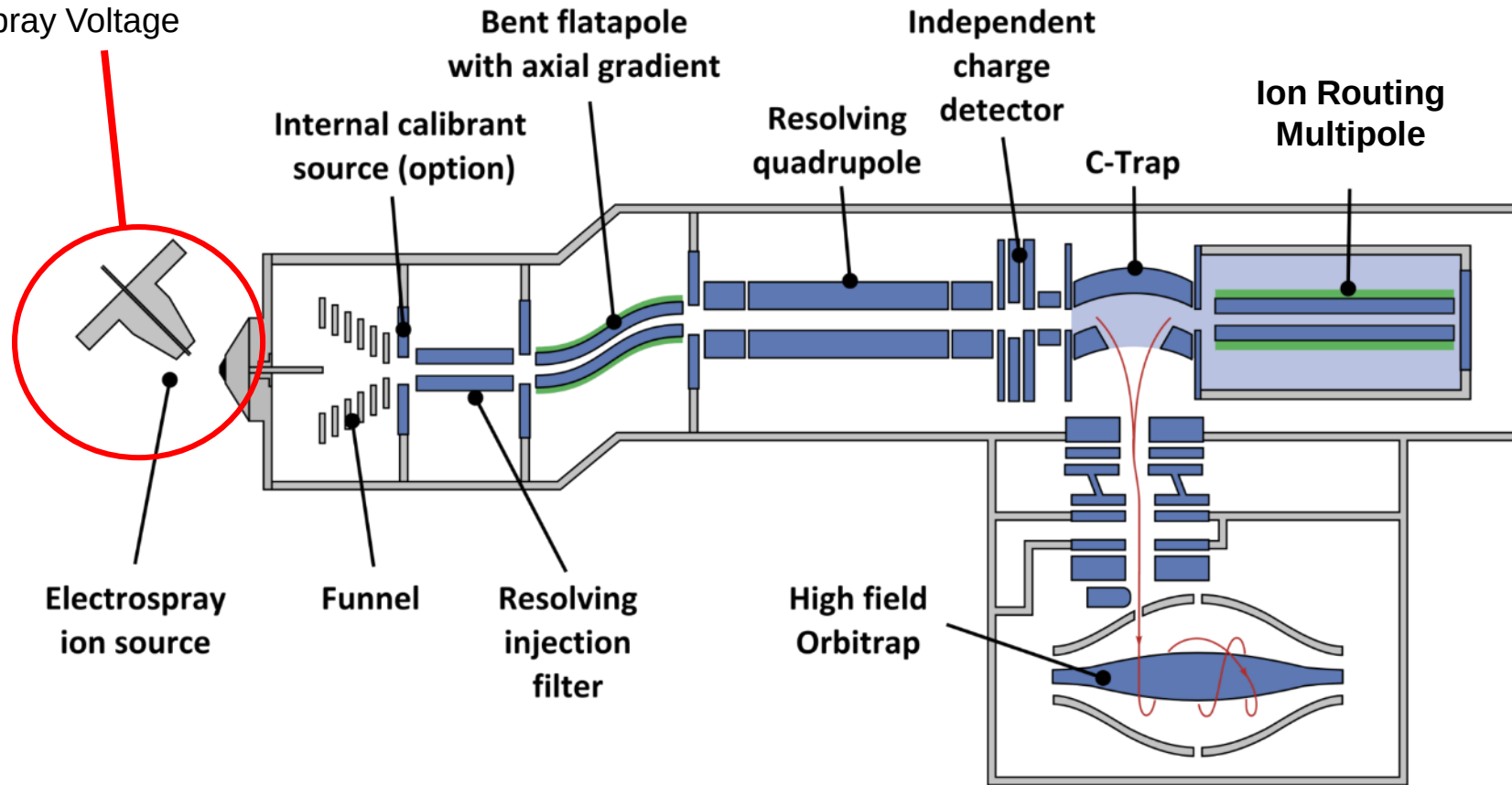
Ion Optics Analyzer



Ion Path and Required Voltages

Ions are generated in the
source (ESI, HESI, NSI)

Required:
Spray Voltage



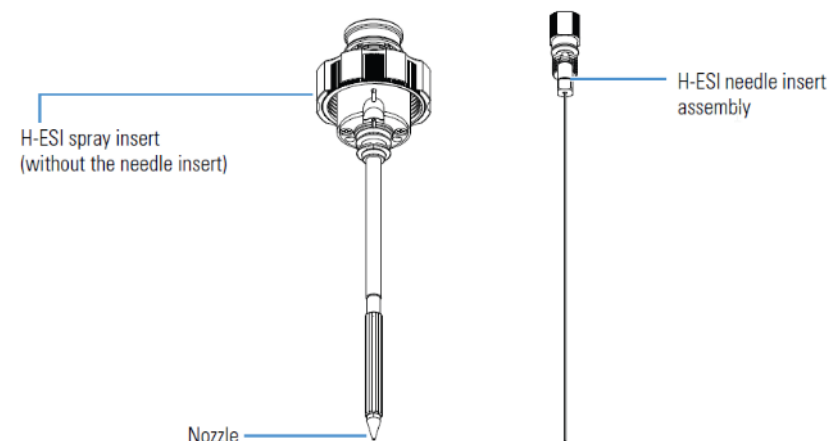
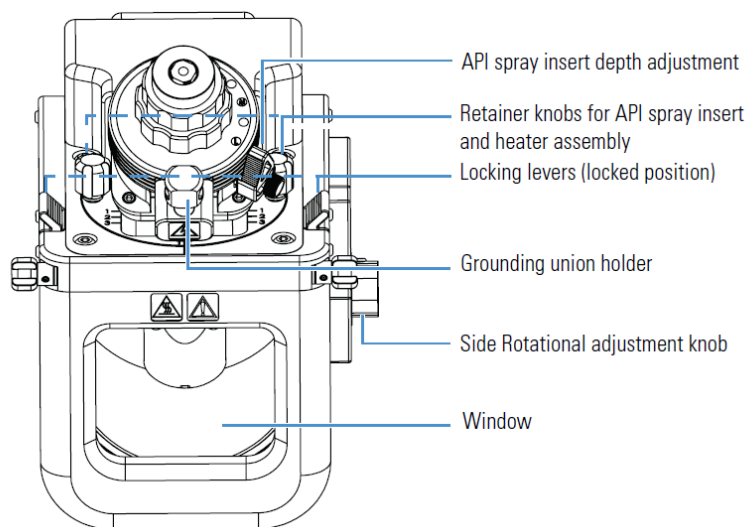
Optamax Source (BRE0014002)



HV connector
Spray voltage



Be careful when removing
the Ion source –
Capillary can be hot!

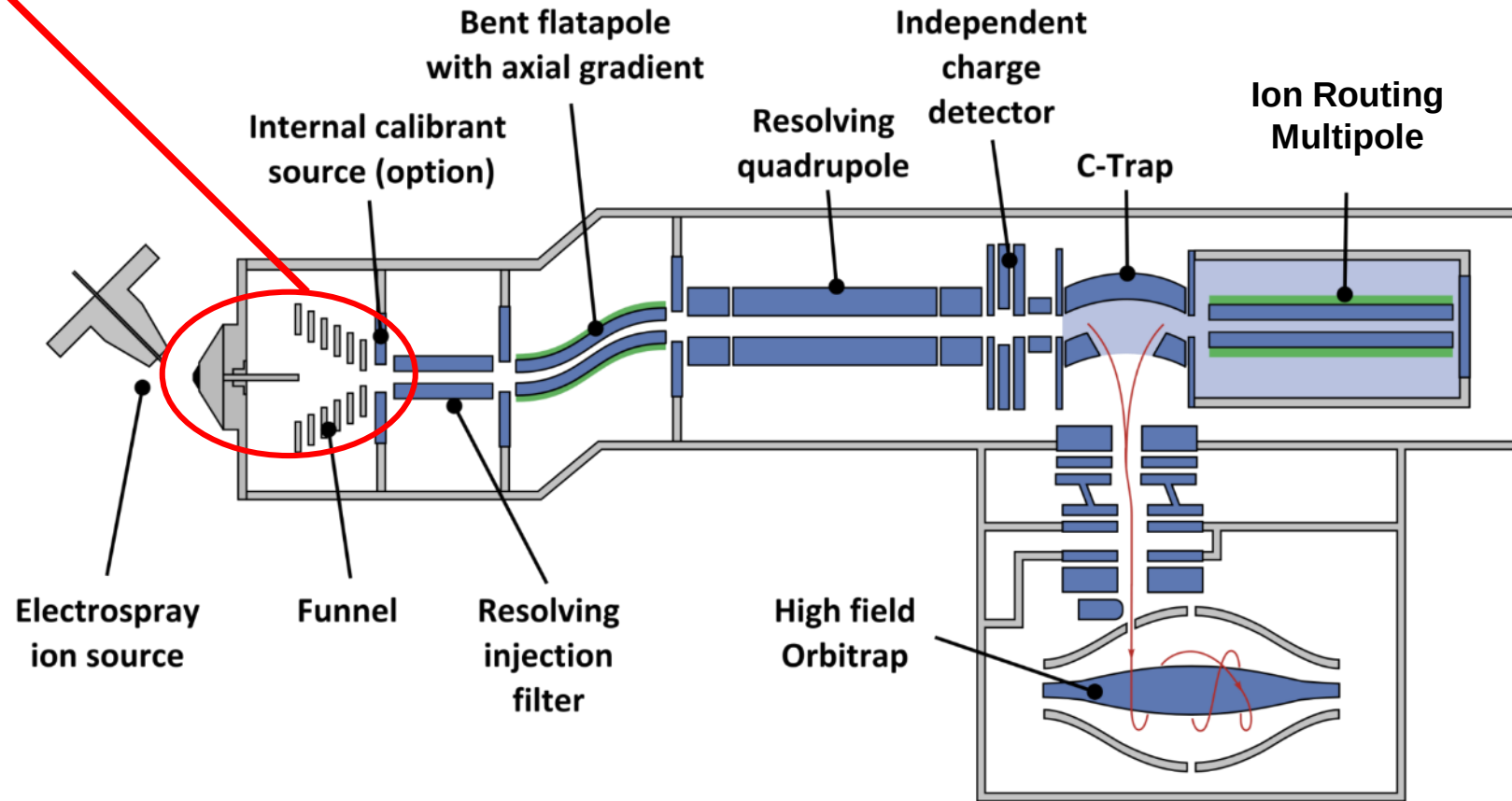


- The H-ESI spray insert includes a metal electrospray needle insert, a H-ESI nozzle, and the sheath gas and auxiliary gas plumbing.
- 2 different H-ESI needle inserts: one is for low flow (less than 10 $\mu\text{L}/\text{min}$) and the other, for high flow (greater than 10 $\mu\text{L}/\text{min}$).

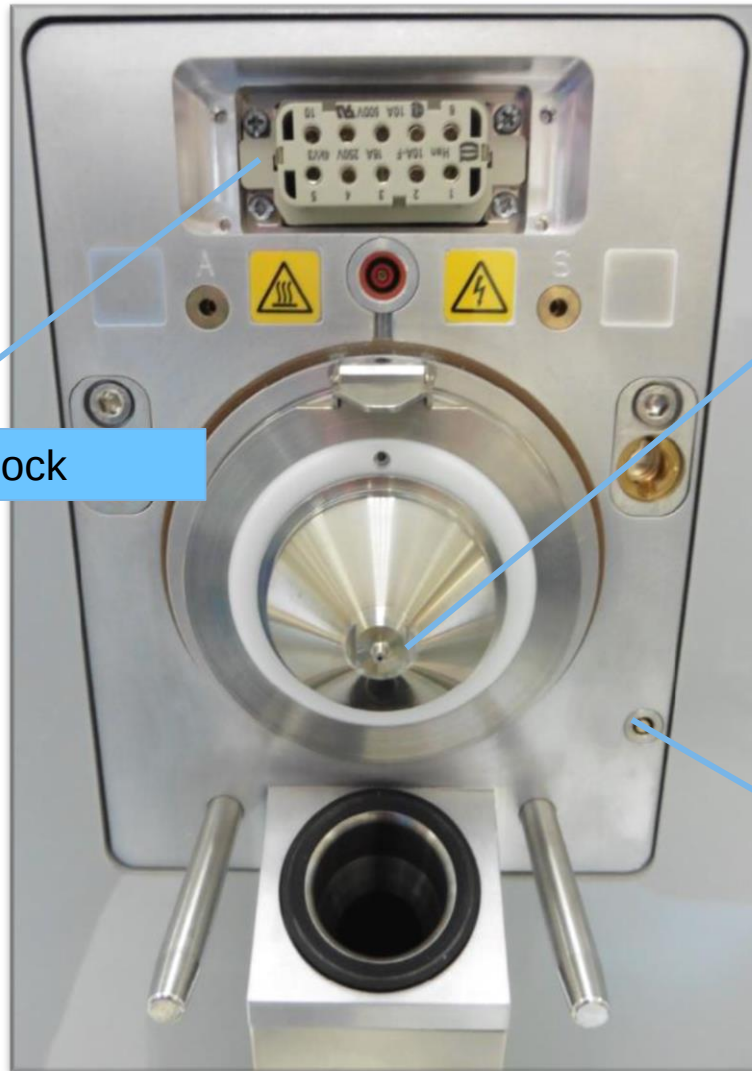
Ion Path and Required Voltages

Desolvation takes place

Capillary DC



Capillary



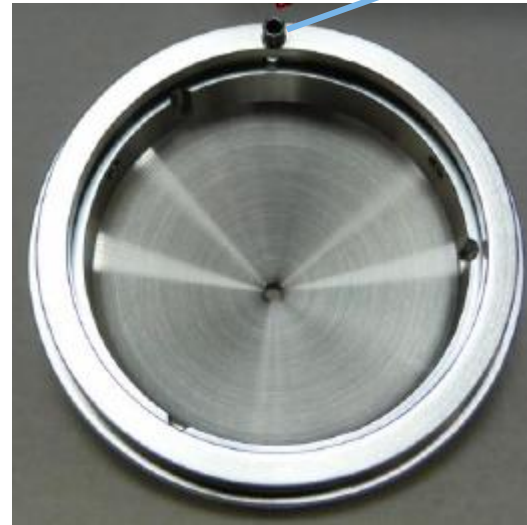
Safety interlock

Heated Capillary
Voltage Capillary DC from
Ion Optics Supply board
Switches off while ion
source is removed
due to interlock logic

Spring loaded
Interlock switch



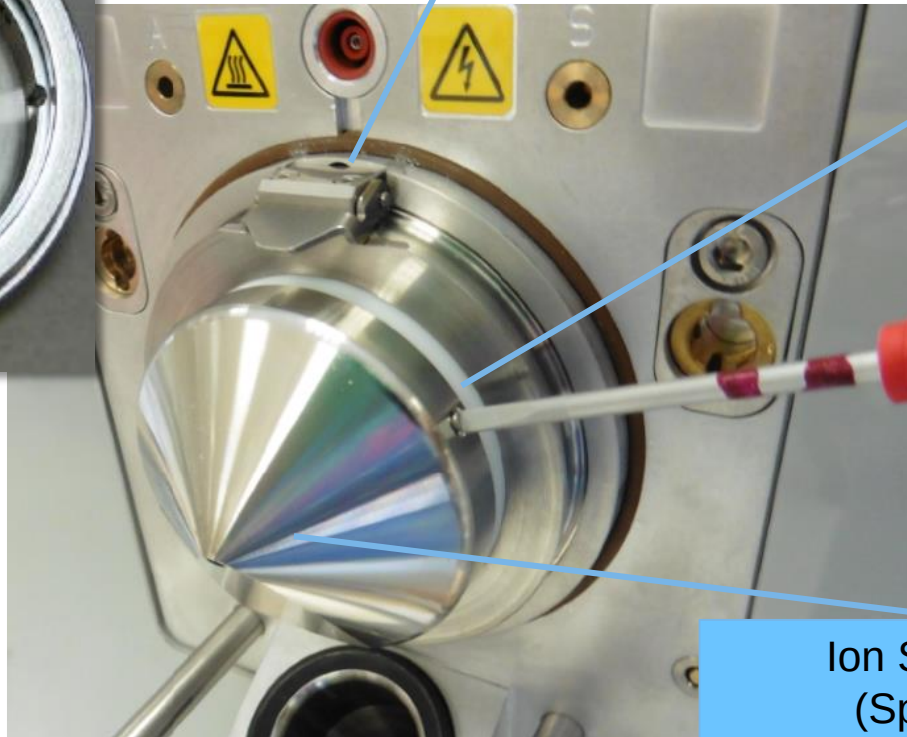
Sweep cone



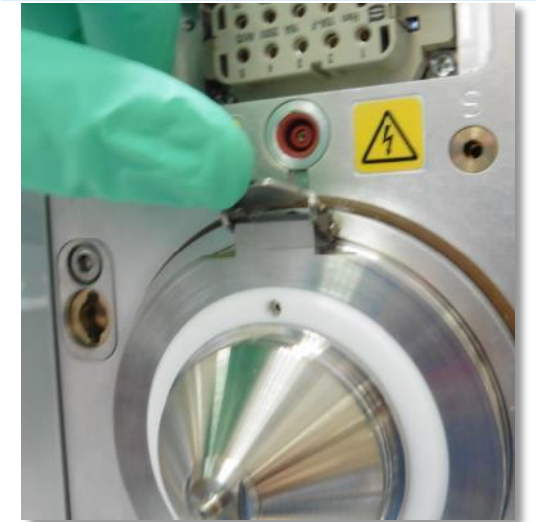
Vent for nitrogen
Gas is used to flush
space between cone and
capillary

Set Screw. Adjust so that
Cone is removable by hand

Lever to remove Inner cage
after vent

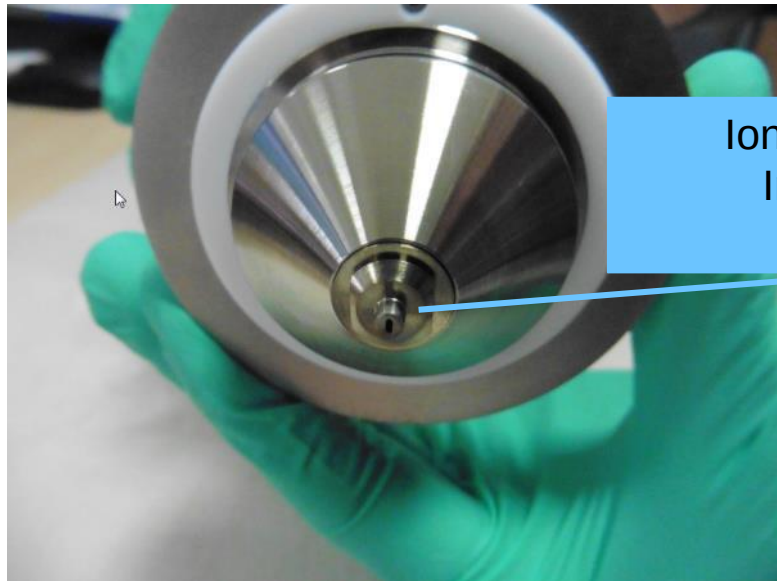


Ion Sweep Cone
(Spray Shield)

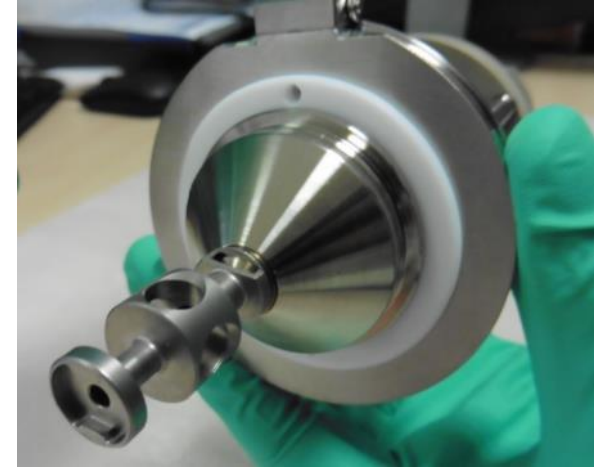
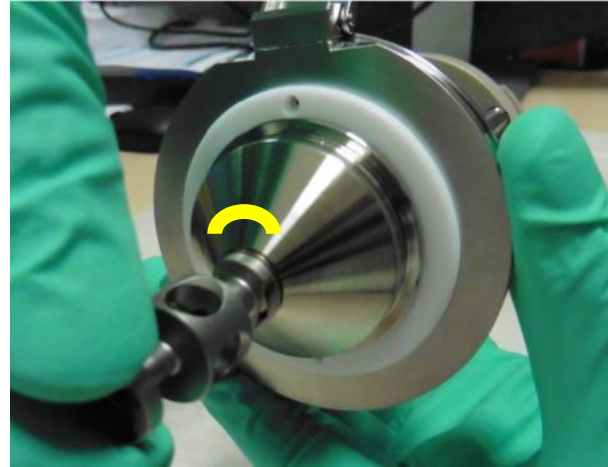


Capillary

- Use the removal tool shown on the photo to remove the ion transfer tube. $\frac{1}{4}$ quarter turn only (counterclockwise).
- Pull the ion transfer tube straight out and store it in a clean area.



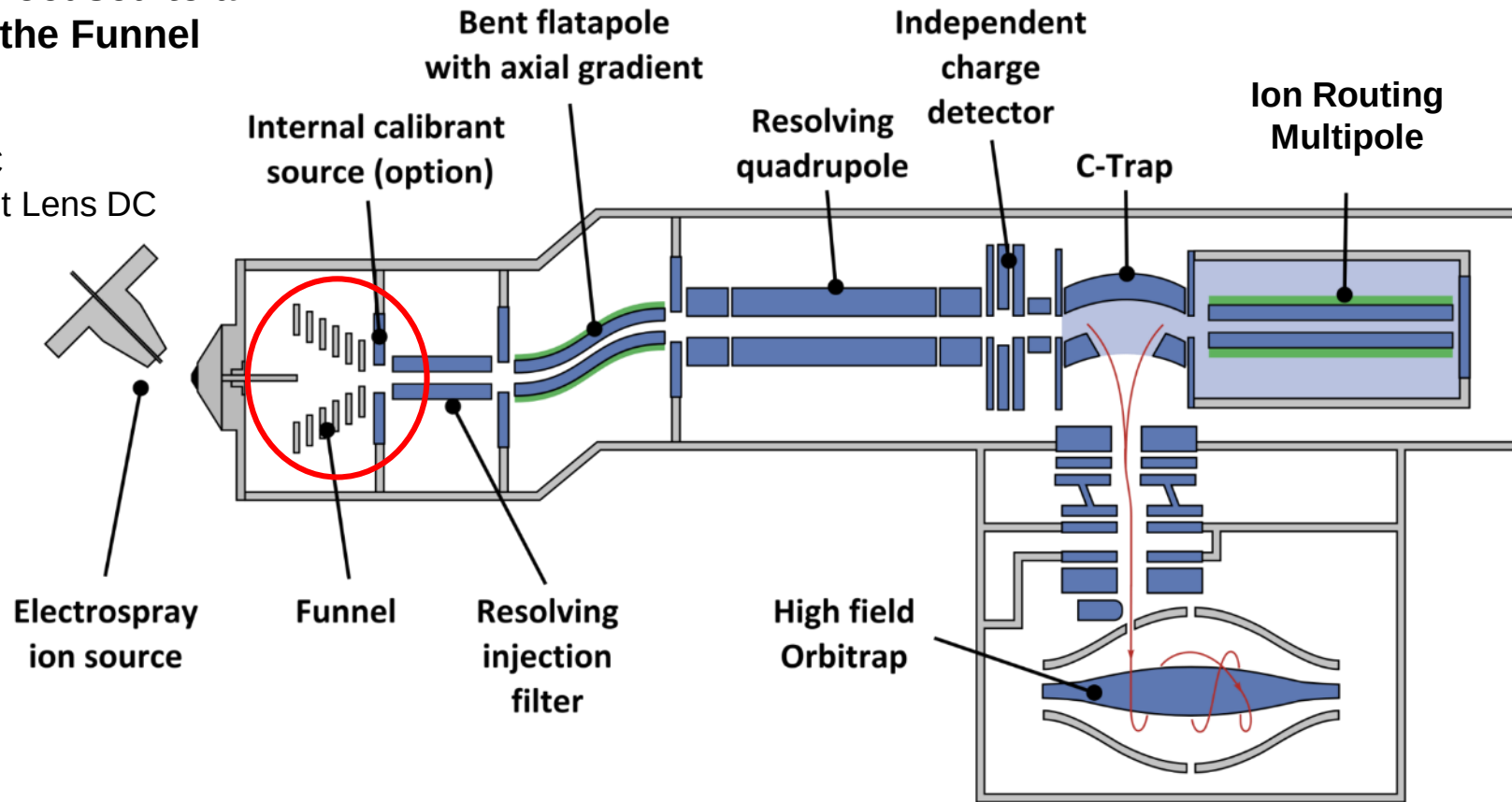
Ion Transfer Tube
Inlet Capillary
Letter Box



Ion Path and Required Voltages

Ions are focused to a beam in the Funnel

Required:
Funnel RF
Funnel DC
Funnel Exit Lens DC



- Orbitrap Exploris 480: Ion Funnel

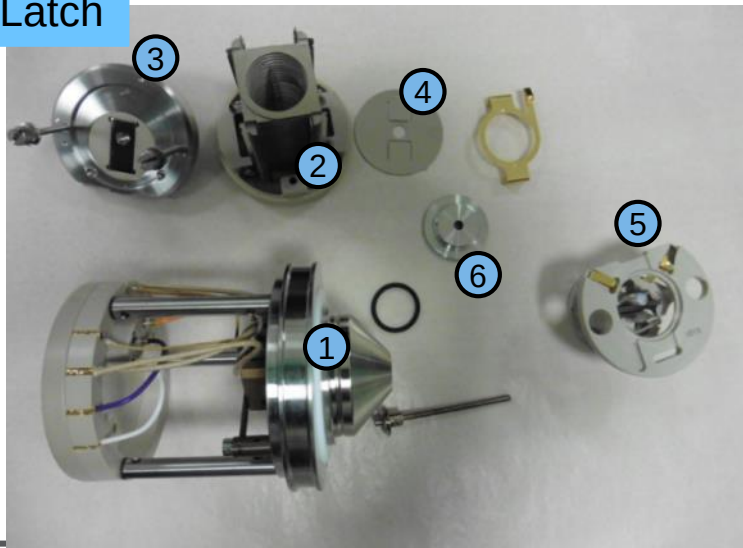
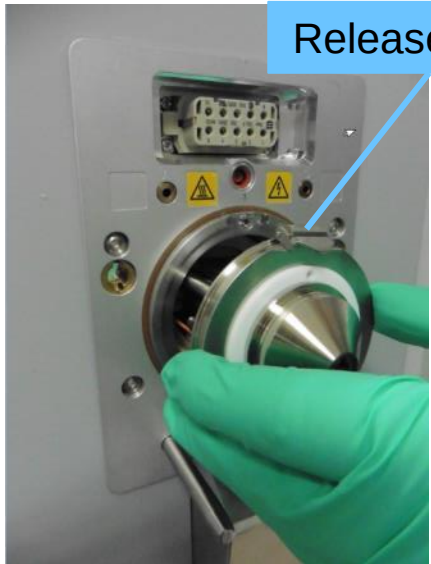


Cage, Funnel: How to remove and take apart?

- Lift up the release latch, grasp the API source interface with your fingers
- pull it out of the vacuum manifold
- Loosen the screws until they clear the thread to release injection filter.
- Grip the two screws and pull the entire Funnel and IC unit assembly straight out of the source cage.
- Continue to turn the screws until they get clear of the second thread.
- Remove IC Unit/Funnel Exit from the Funnel stack

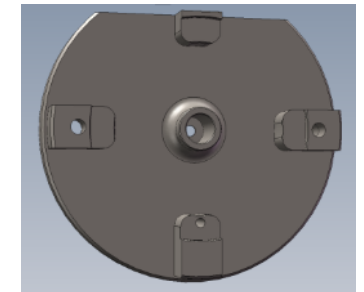


Release Latch



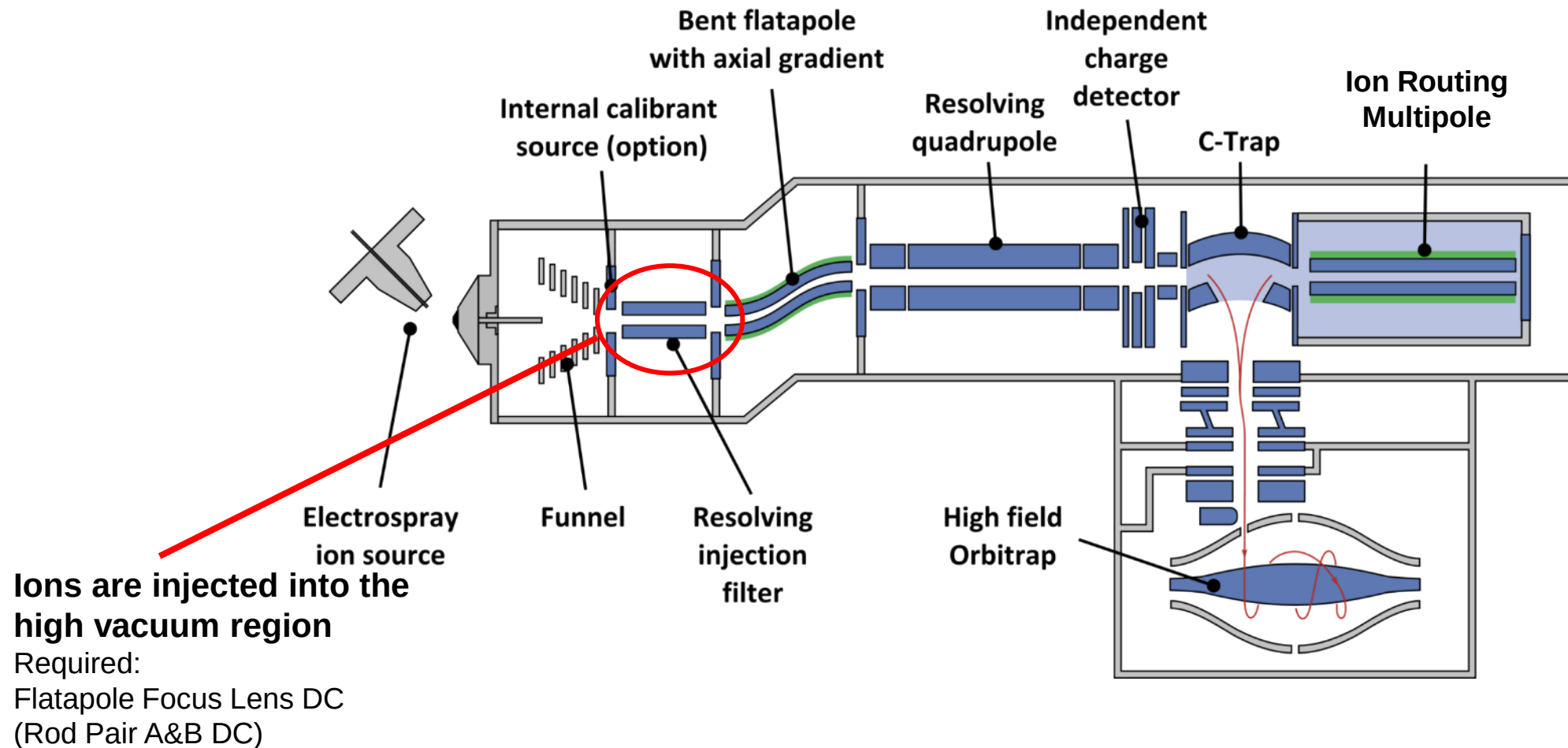
PN BRE0018506 (No IC)
PN BRE0018507 (with IC)

1. Source Cage
2. Funnel
3. Funnel Exit Lens/IC Unit
4. Source Retainer Plate
5. Injection Filter
6. Flatapole Focus Lens



Funnel Exit Lens
(non-Easy IC version)

Ion Path and Required Voltages

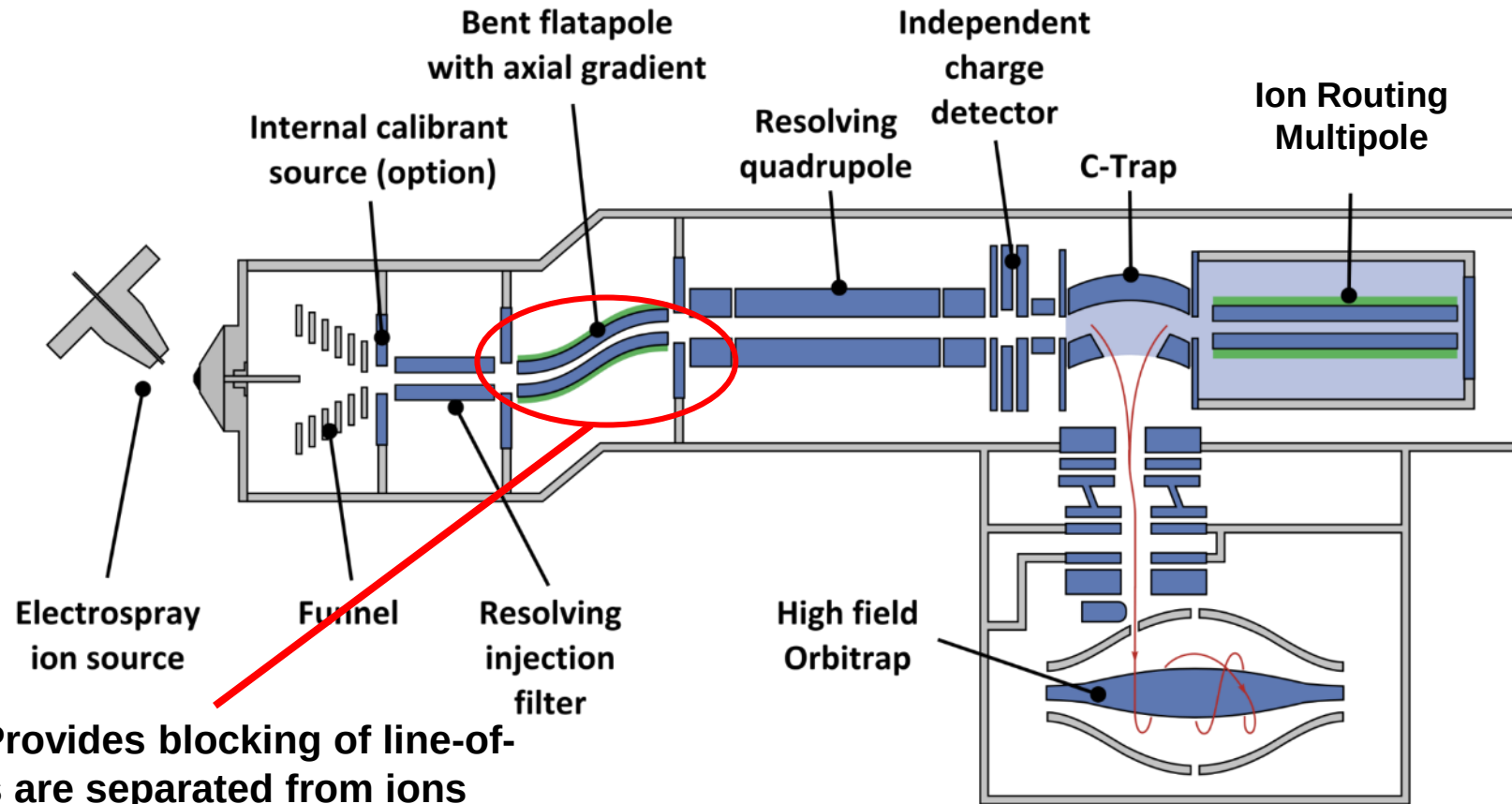


Injection Filter (P/N BRE0013933)

Injection Filter



Ion Path and Required Voltages

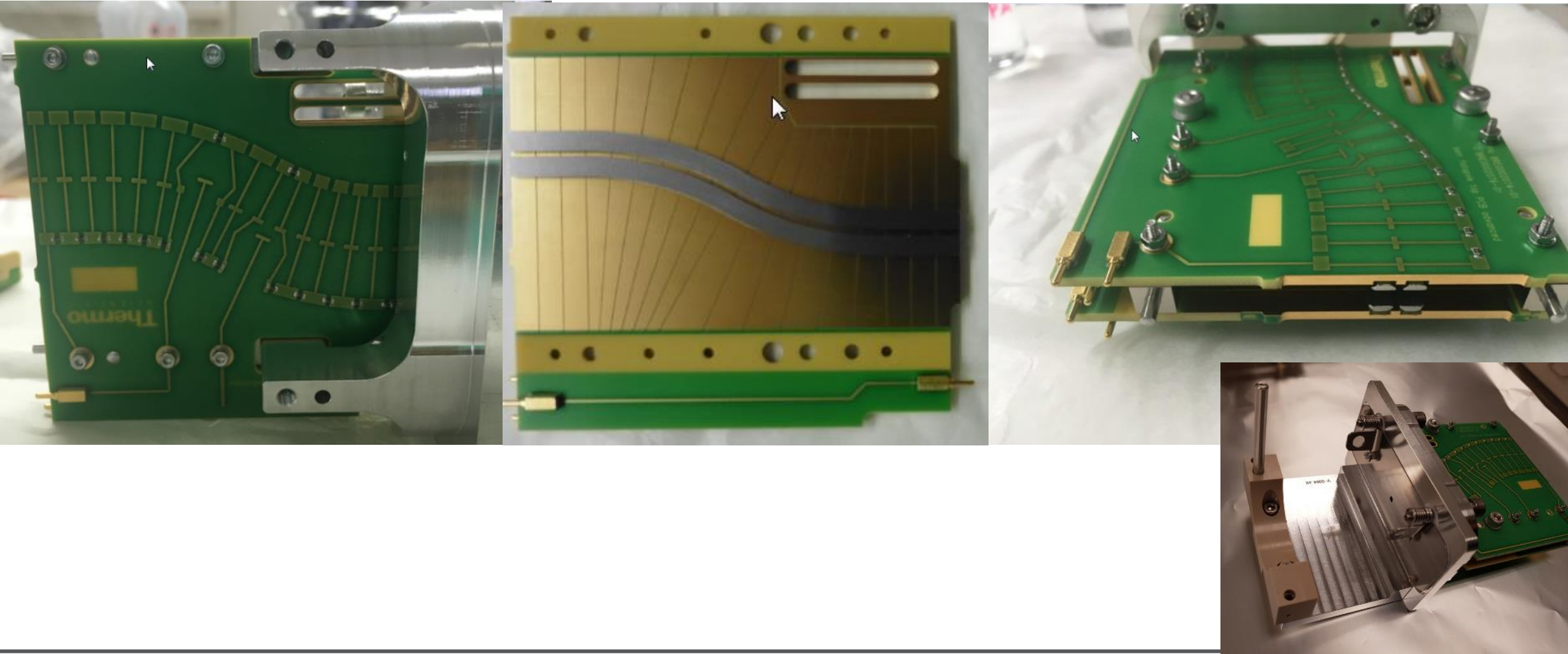


Bent Flatapole: Provides blocking of line-of-sight => Neutrals are separated from ions

Required:

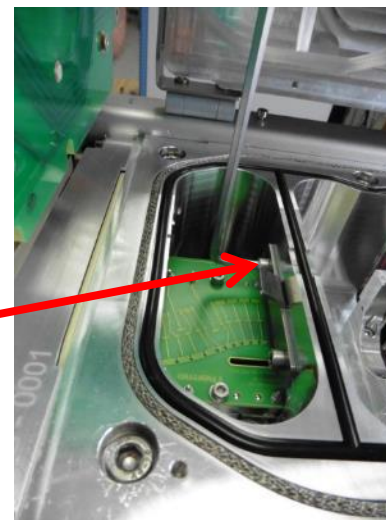
Bent Flatapole RF & DC (RF1)

Bent Flatapole (P/N BRE0018493)

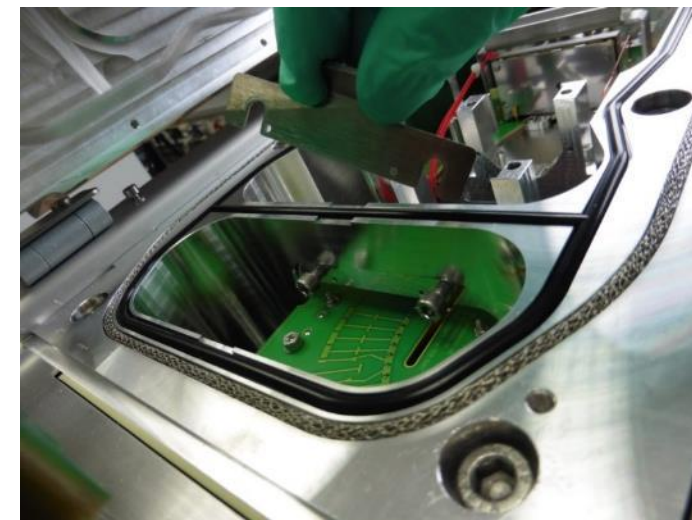


Bent Flatapole (P/N BRE0018493) Removal

- Power off and vent the instrument
- Remove the outer top cover
- Open the chamber lid
- Use gloves for handling the ion optics
- Loosen the screws on the retainer plate
 - 4 mm Hex & screwdriver (slotted) required
- Remove the quadrupole

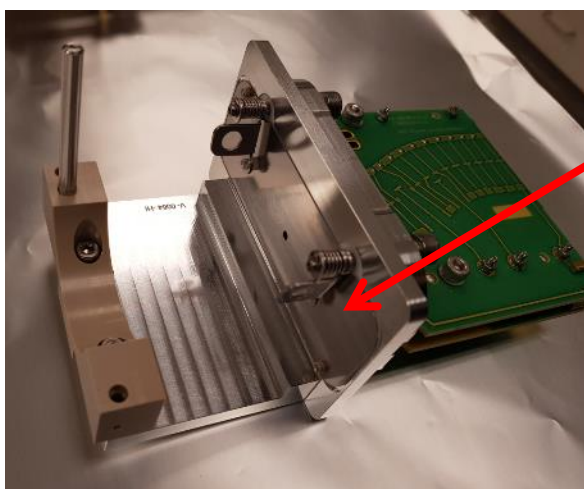


Neutral spot here

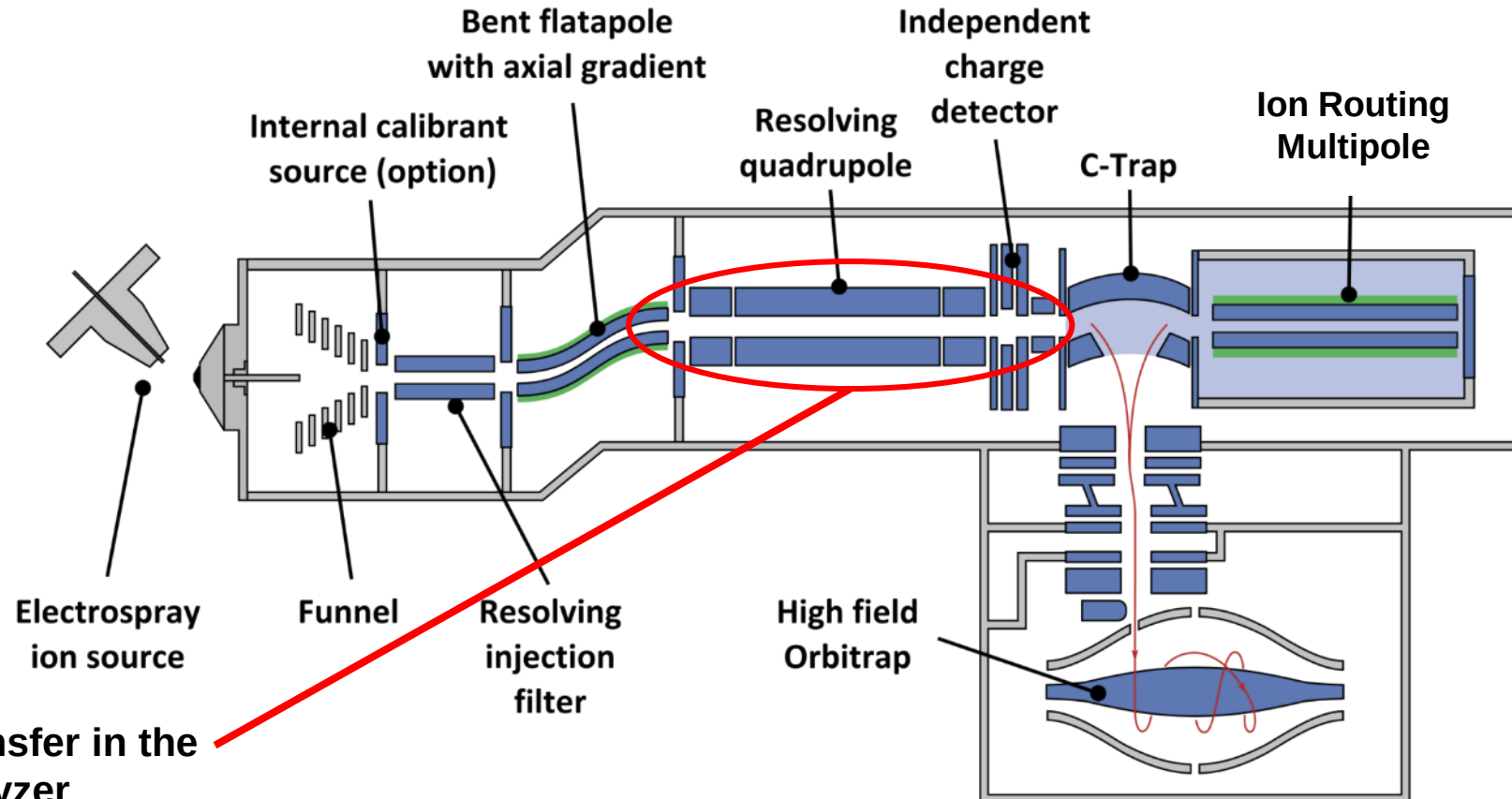


Bent flatapole exit lens

- Held in place with 2 little pins
- Turn the latches to release the lens



Ion Path and Required Voltages



m/z-selective transfer in the Quadrupole Analyzer

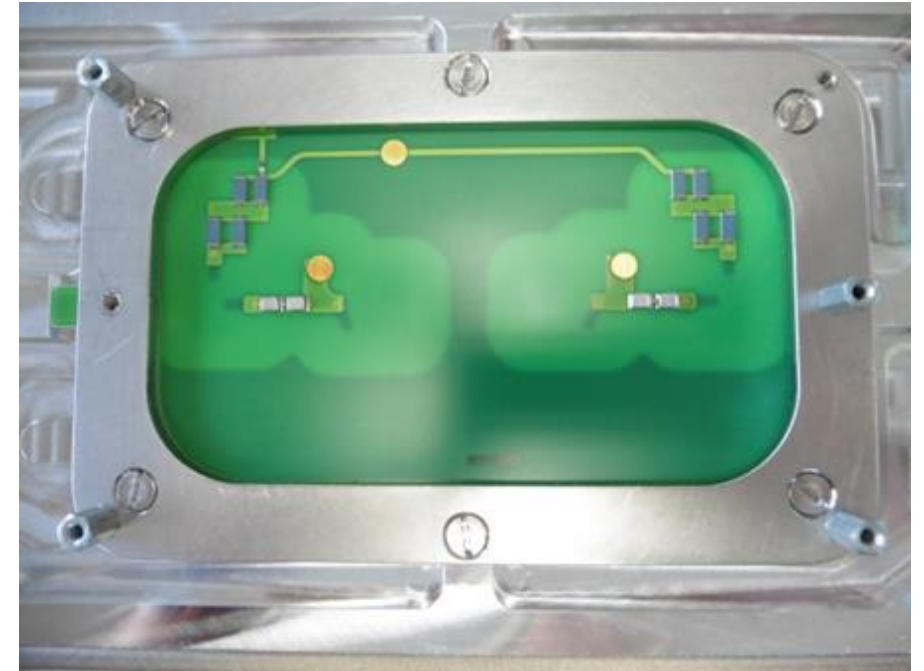
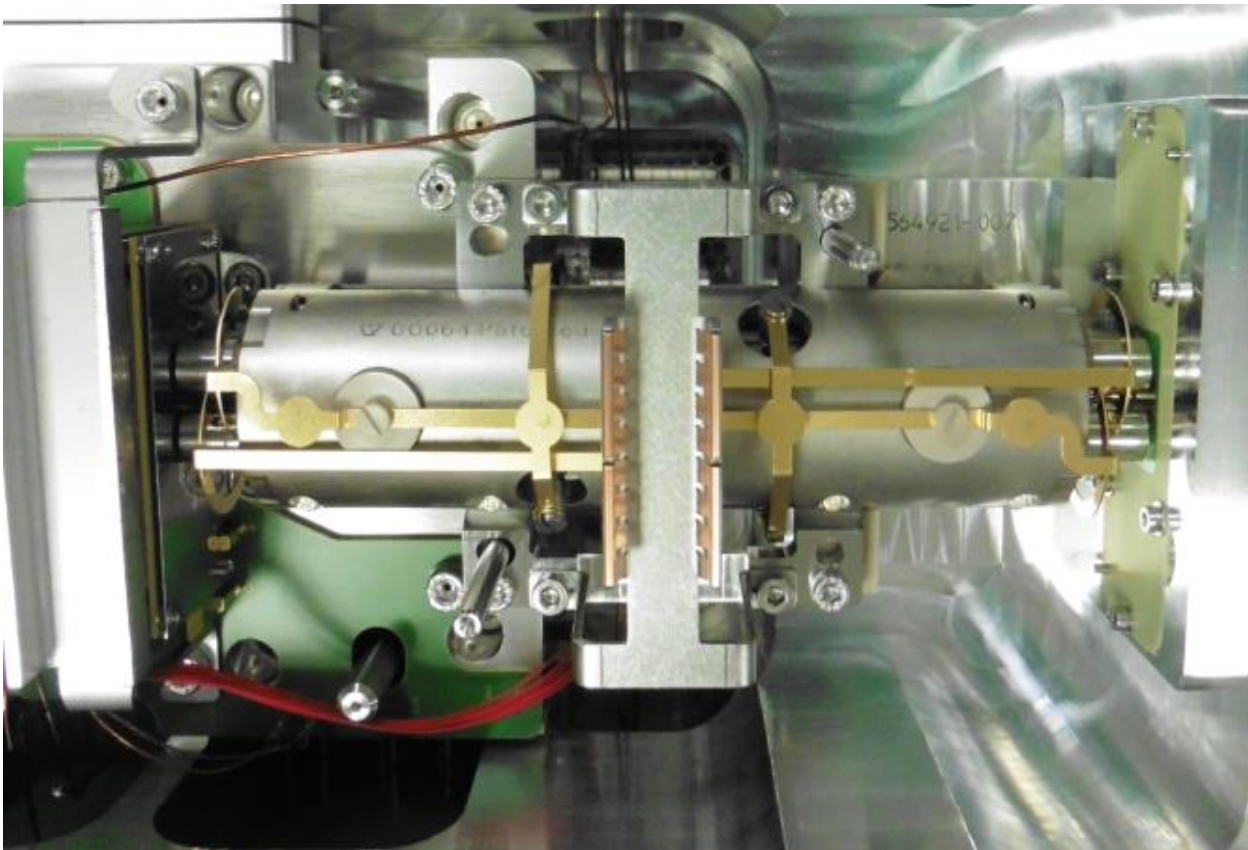
Required:

Quad RF & DC

Quad End segment RF&DC

Quadrupole (P/N BRE0018511) Orbitrap Exploris 480

- Quadrupole cleaning can be performed by customer



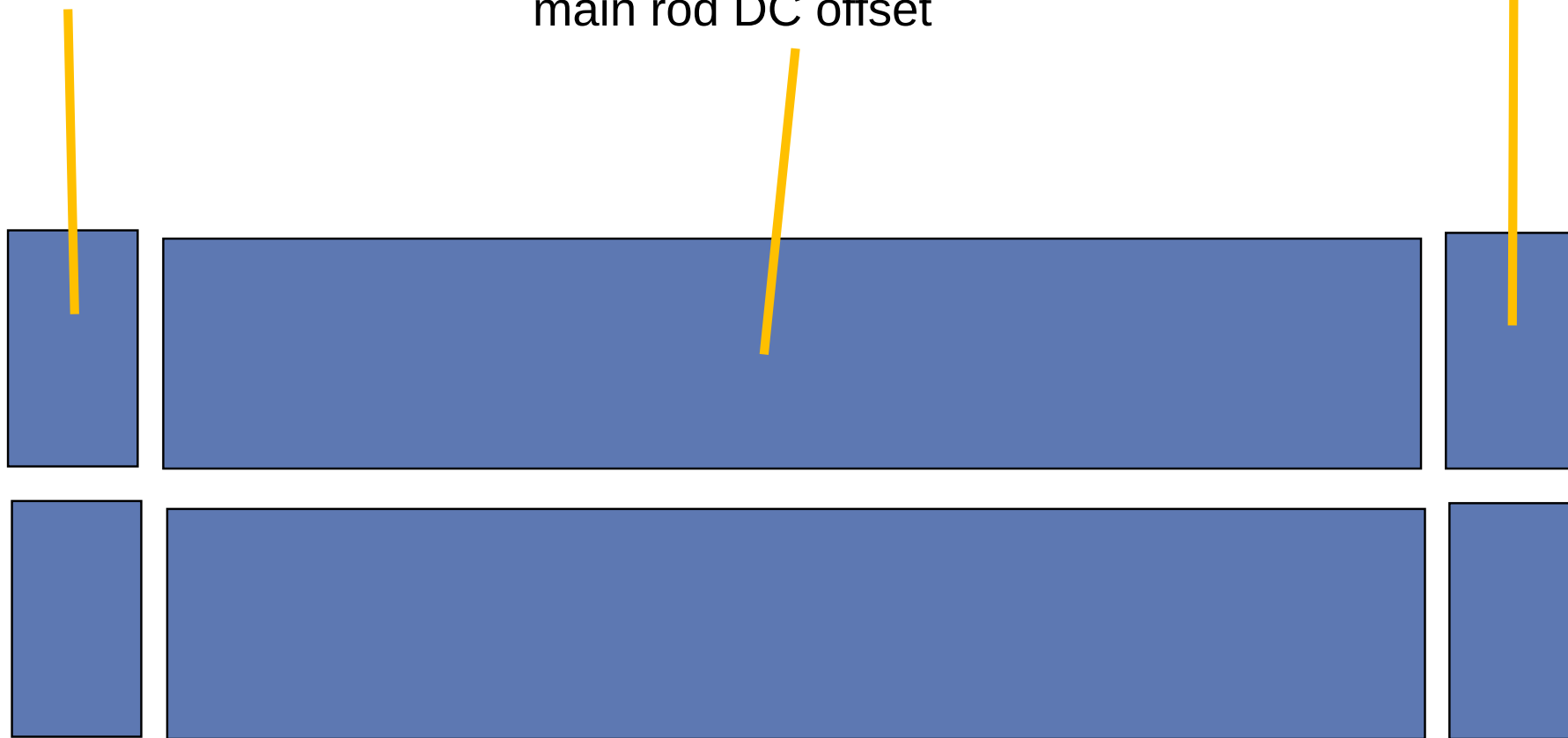
4 contacts:
Main Rods A
Main Rods B
End Segments Rods A
End Segments Rods B

Segmented Quad is used as in QE Plus/HF

RF-only, reduced amplitude with
end-segment DC offset

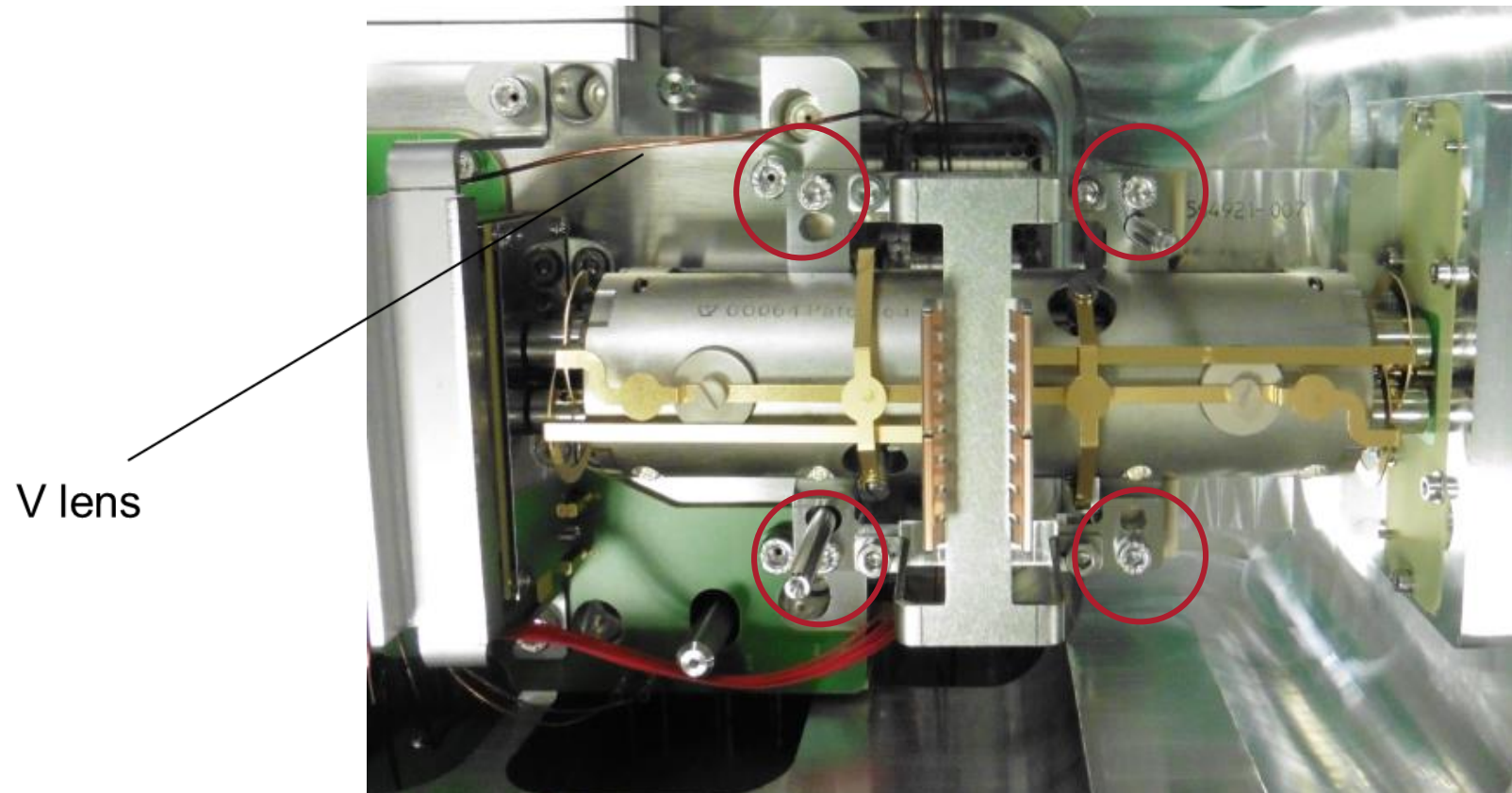
RF + resolving DC with
main rod DC offset

RF-only, reduced amplitude with
end-segment DC offset



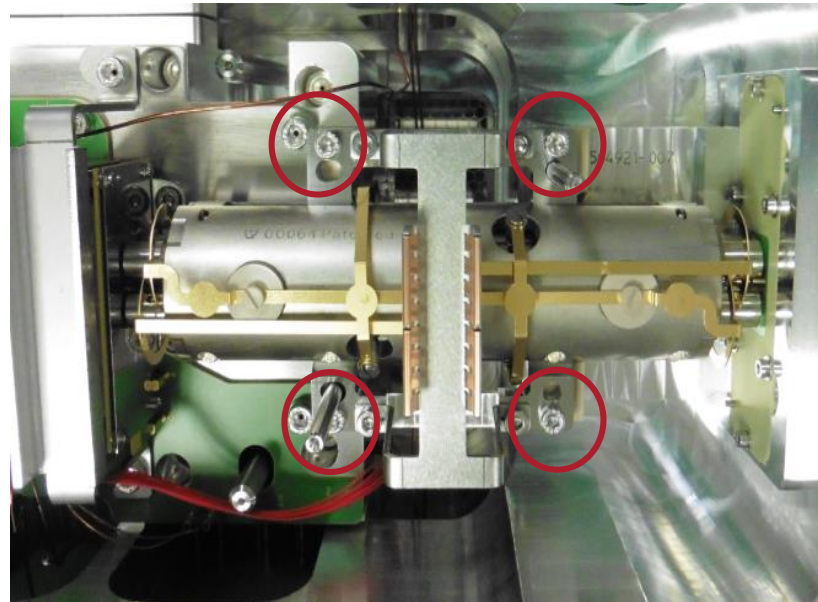
Quadrupole Removal

- Loosen the 4 screws holding the quadrupole.
- Lift the quadrupole straight up to remove it, store it in a clean environment.

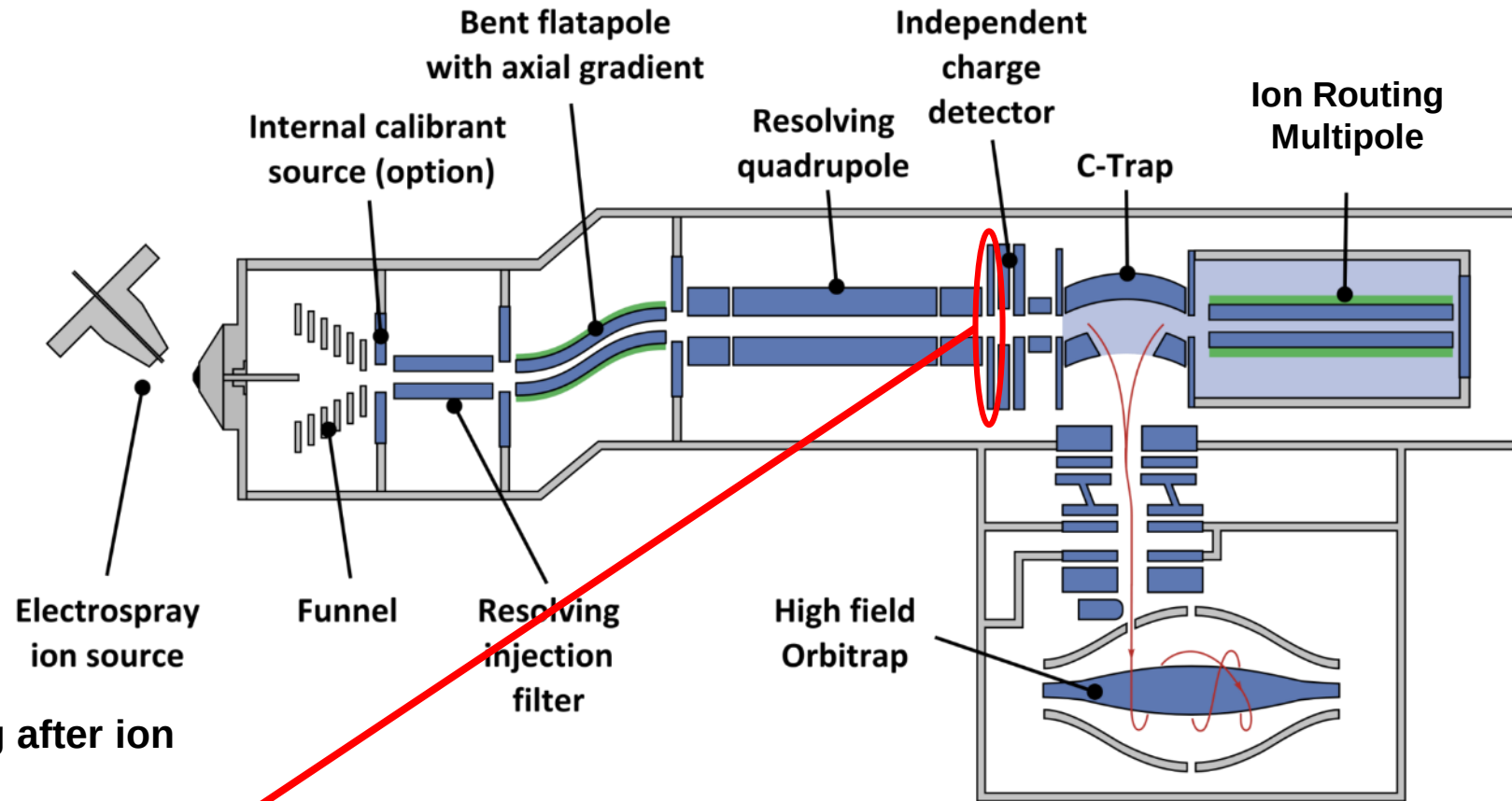


Quadrupole Installation

- Place the quadrupole onto the holders
 - Orientation: Design only allows installation in one direction
- Tighten the 4 screws holding the quadrupole.



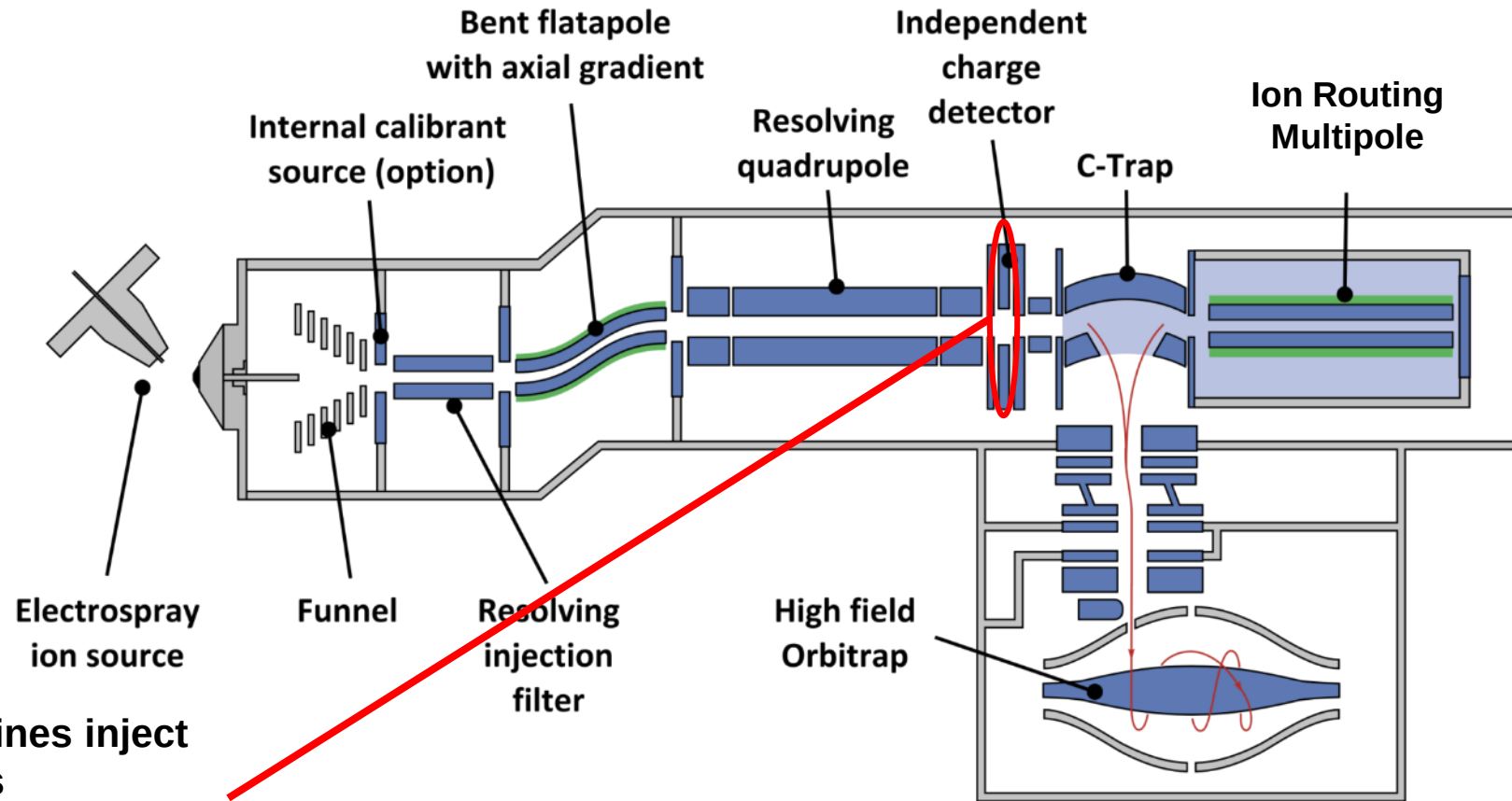
Ion Path and Required Voltages



Refocussing after ion selection

Required:
Quad Exit Lens DC

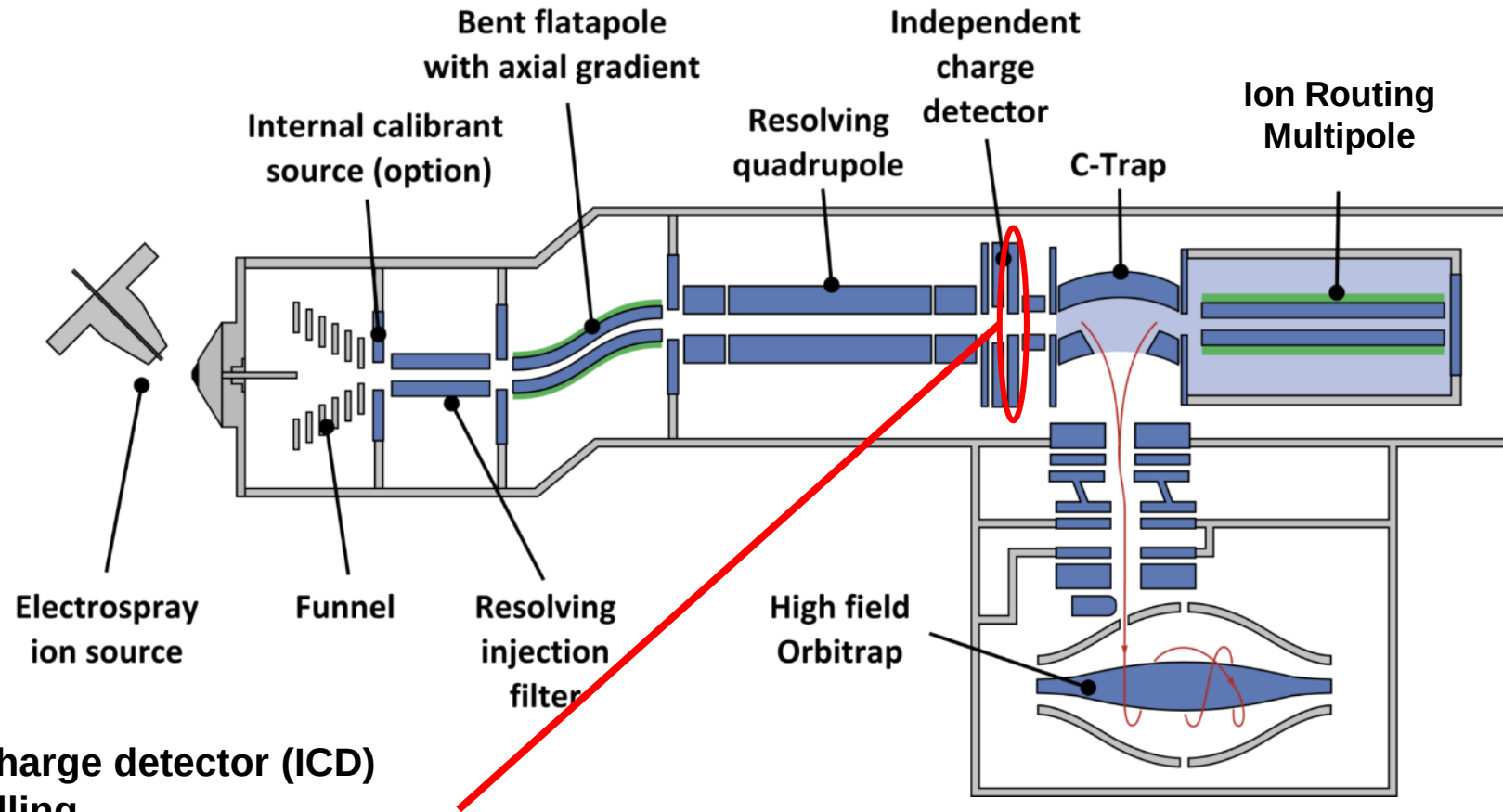
Ion Path and Required Voltages



Split lens determines inject times for the ions

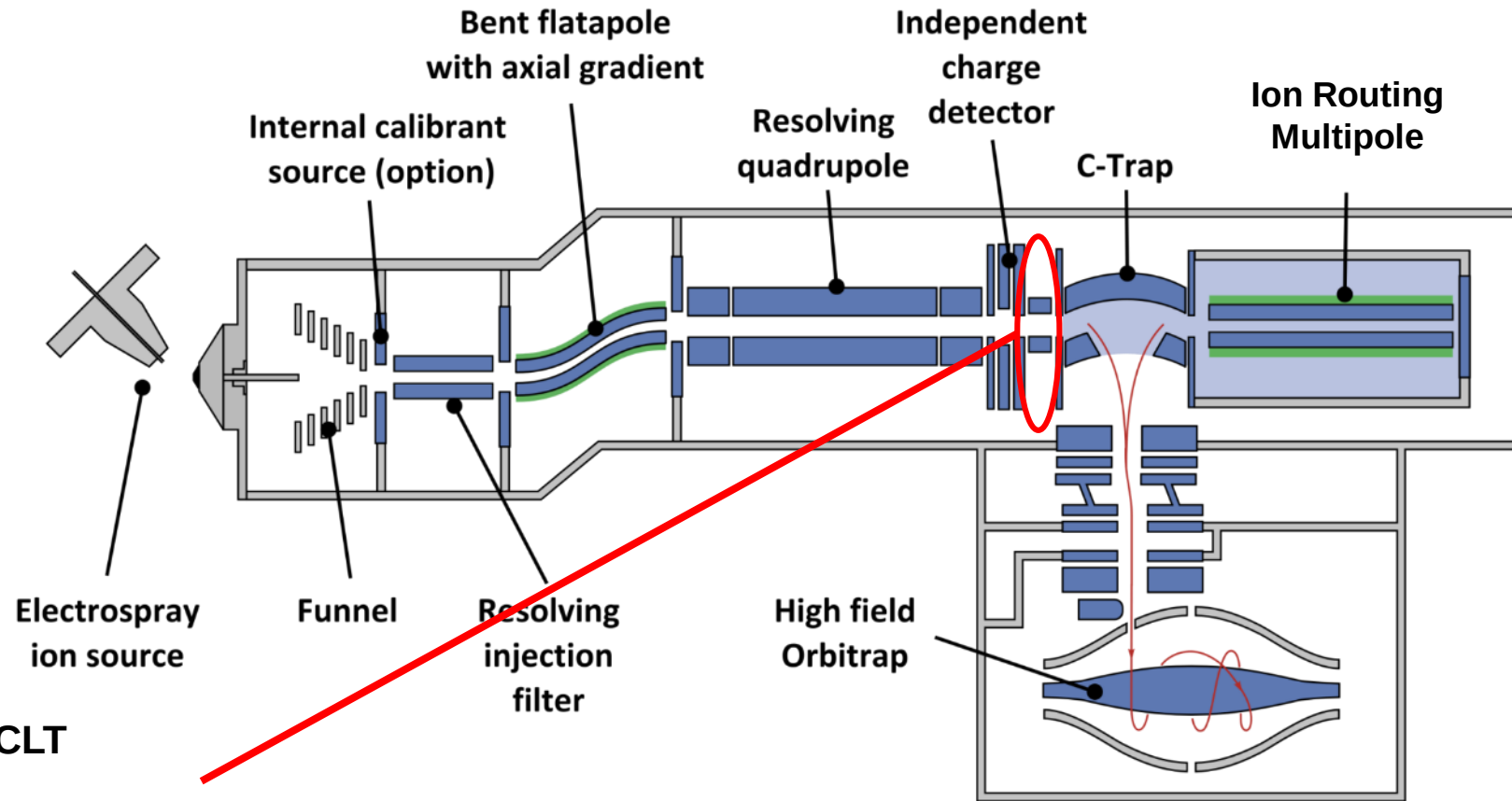
Required:
Split Lens HV

Ion Path and Required Voltages



**Independent charge detector (ICD)
to avoid overfilling**

Ion Path and Required Voltages

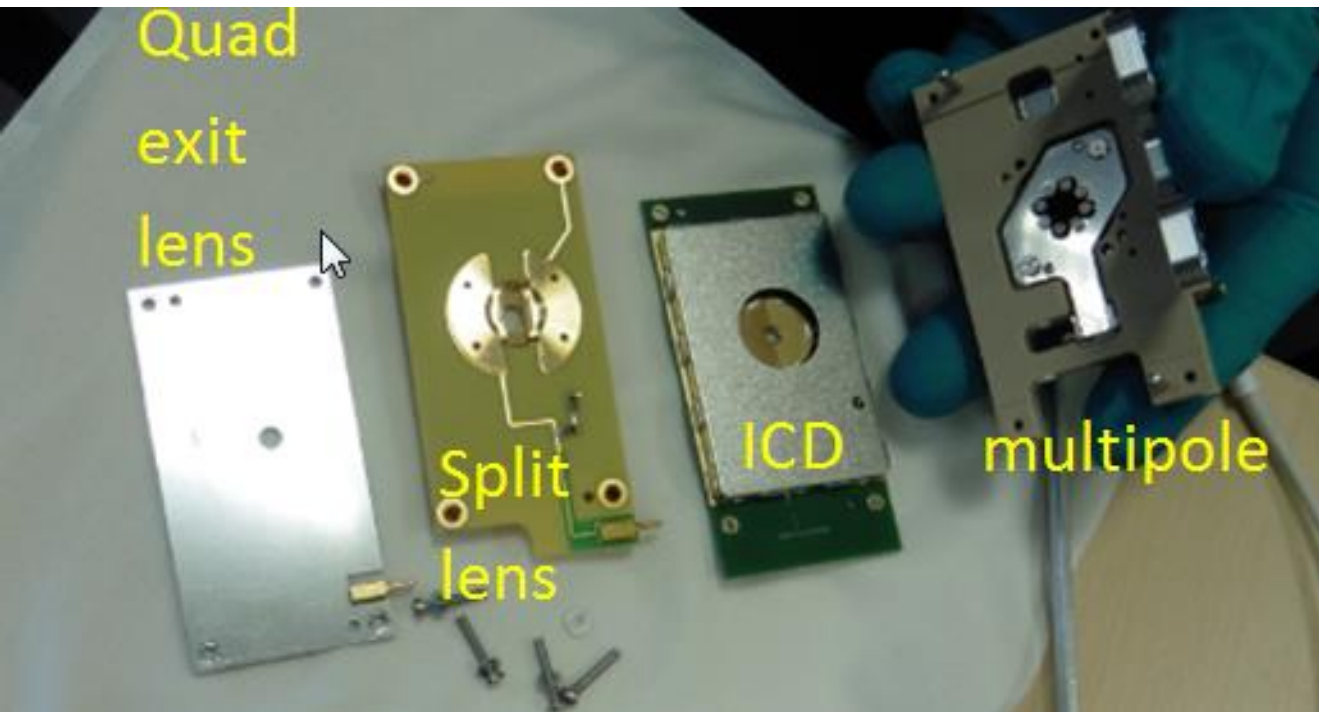


Transfer to the CLT

Required:
Transfer MP RF and DC

Independent charge detector (ICD) - BRE0013931

- “All in one” assembly
- Disassembly possible, but not recommended
- Split lens now has three “modes”:
 - Deflect to ICD
 - Deflect to dump
 - Open



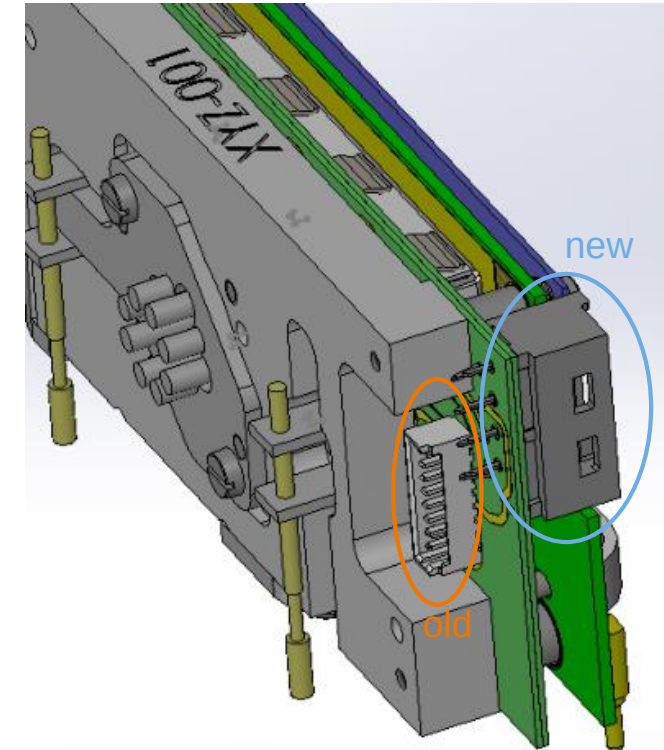
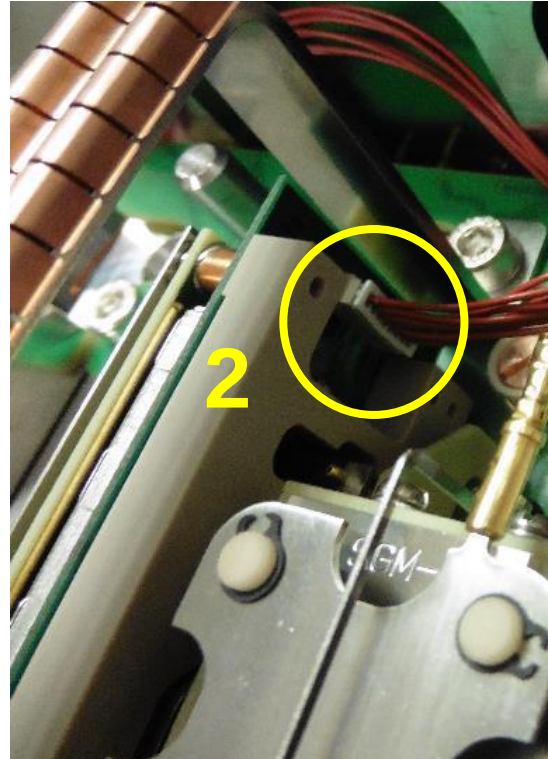
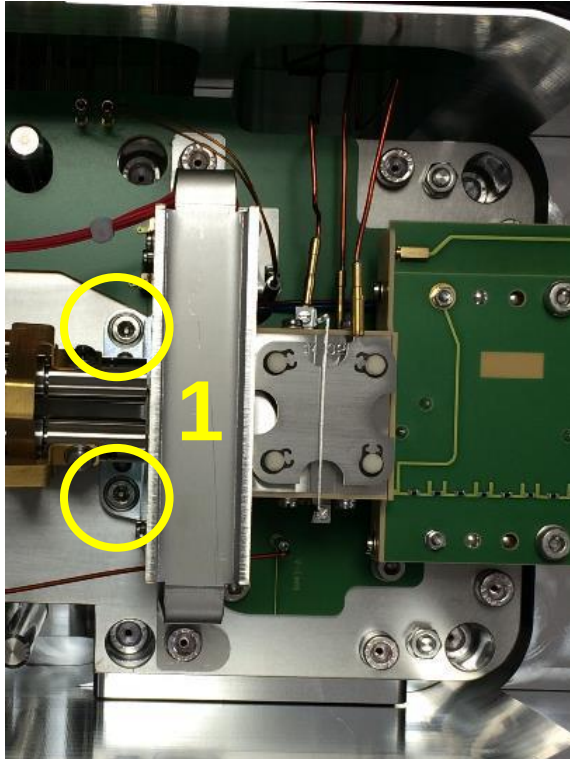
Regular cleaning is not expected to be required from long term contamination tests.

In the long run the ICD itself might collect deposits. In that case it will be an exchanged (consumable part), since cleaning will likely damage it.

Octapole and Quad Exit Lens could be cleaned.

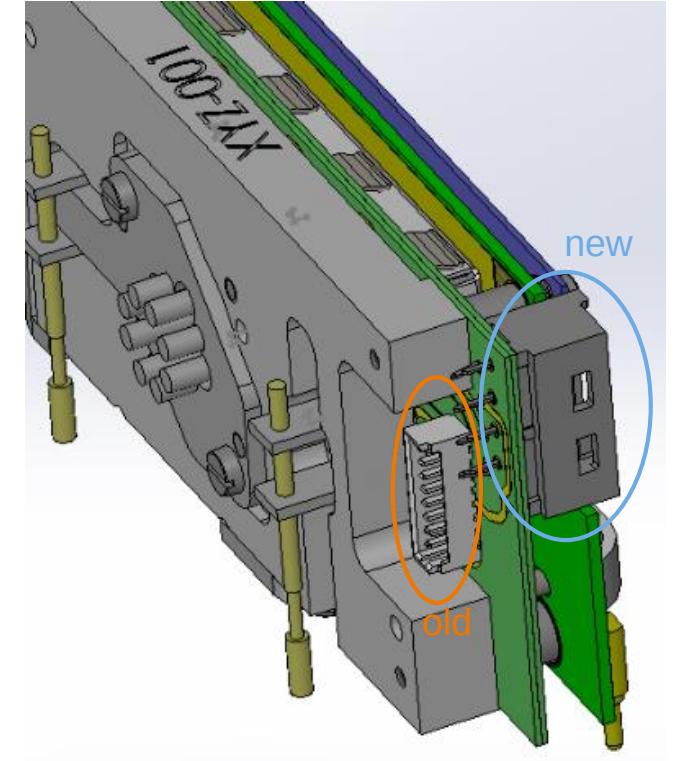
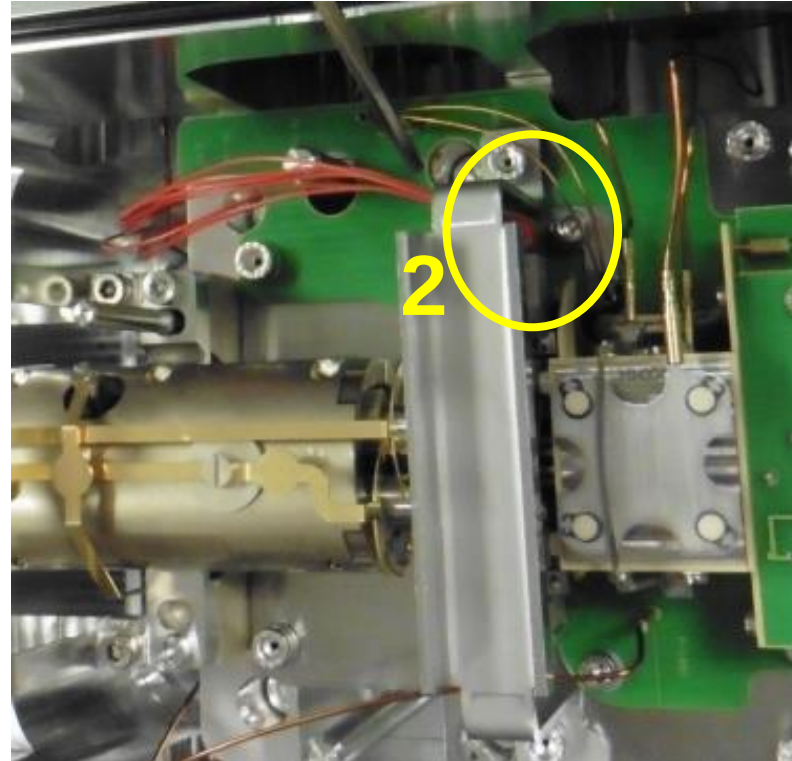
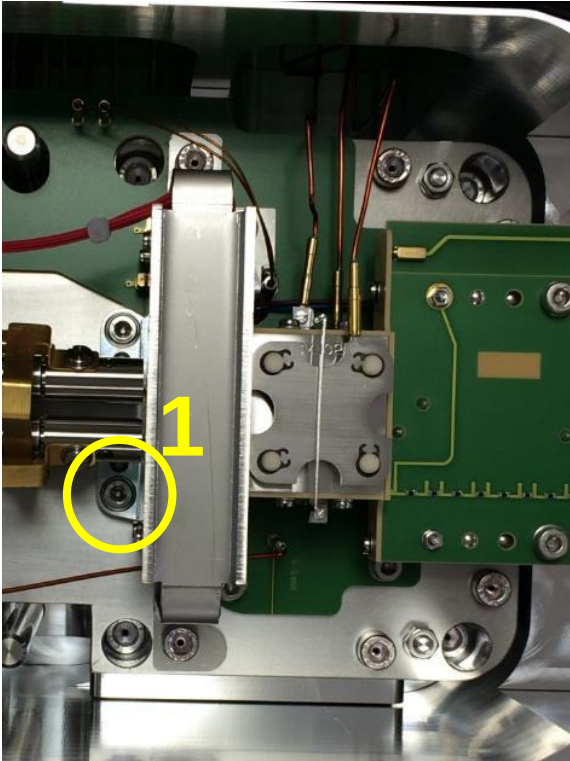
Independent charge detector (ICD) exchange (BRE0013931)

- Loosen the two screws and remove them (1), move the ICD to the left to facilitate cable removal (2)
- Disconnect the cable (2)
- Latest version uses different connector, but both types are available on the ICD assembly.
- Store the ICD in clean environment



Independent charge detector (ICD) exchange

- Install the ICD assembly
- Connect the supply cable to the ICD (2)
- Latest version uses different connector, but both types are available on the ICD assembly.
- Install and tighten the two screws (1)



ICD, PrOSA, and REIM: New names for old concepts

- The electrometer or EM device is now known as the “**Independent Charge Detector**” or **ICD**.
- The ICD can operate in three modes:
 - **PrOSA** (“Proportional Orbitrap Signal Adjustment” is the former CTCD mode)
 - **REIM** (“Rudimentary Electrometer Ion Mode”) -**Beam** (diagnostic)/**REIM-Chop** (diagnostic) = similar to “Check for ions with electrometer” procedure in Exactive Series

Control of the ICD function

Switching between ICD modes, setting mode specific parameters like integration times, injection times, etc.

Instrument >> Control >> Application/Method

Instrument	Electronic
Tree Tools	
Current Scan	
Control	
Define Scan	
Application/Method	
LC peak width (FWHM)*	15.0
AGC Details	
Application mode (requested)	Standard
Application mode (actual)	Standard
Bigmass Application mode (actual)	Off
Lockmass Details	
Aggressive HCD Scan-Speed Optimization *	Off
M ICD Settings	
M ICD PrOSA Support *	On
M ICD PrOSA Support Actual State (Calculated)	On
Timing in speed opti Mode	

Ion Path and Required Voltages

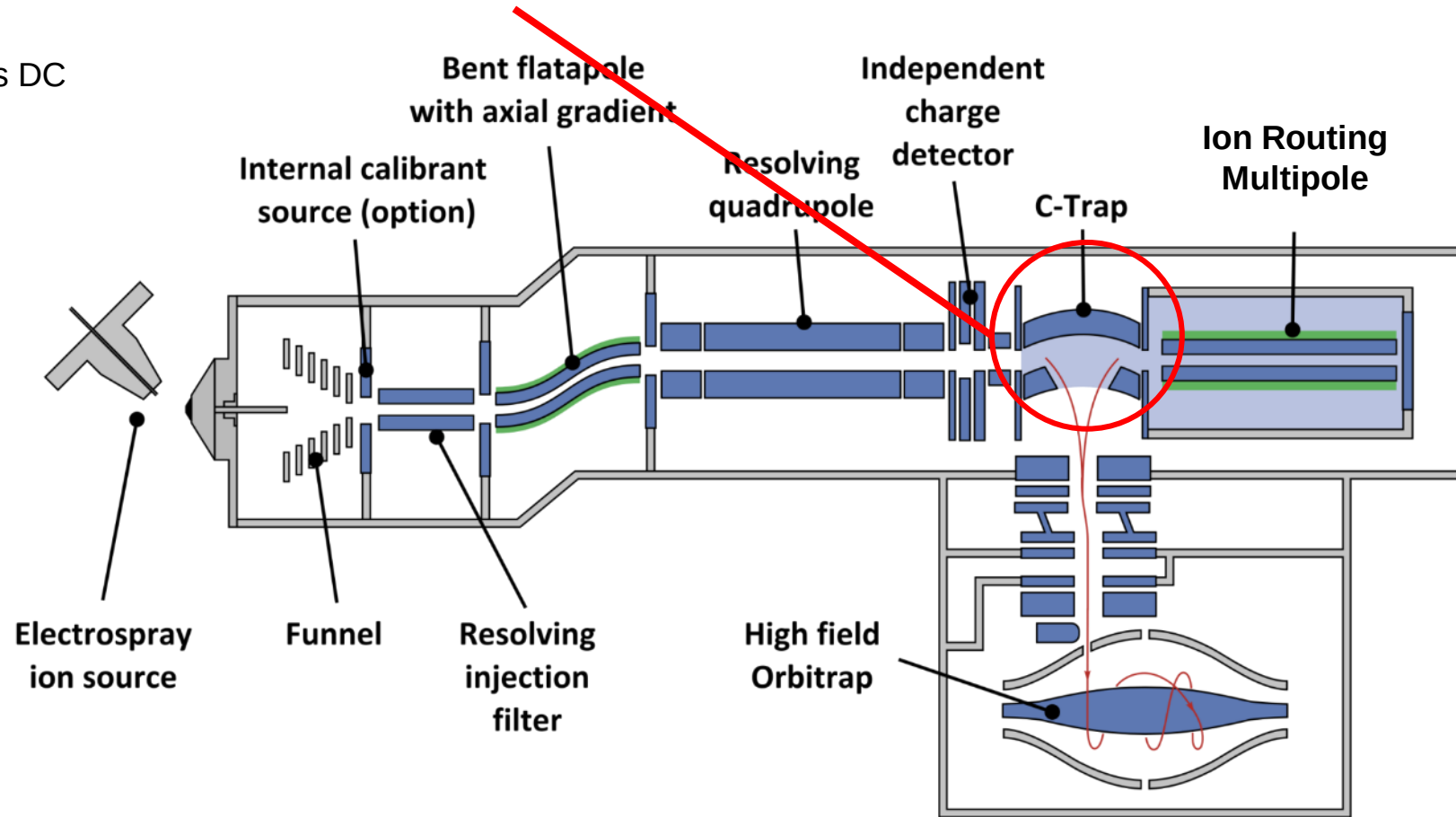
Ions are transferred to the Ion Routing multipole

Required:

CLT RF

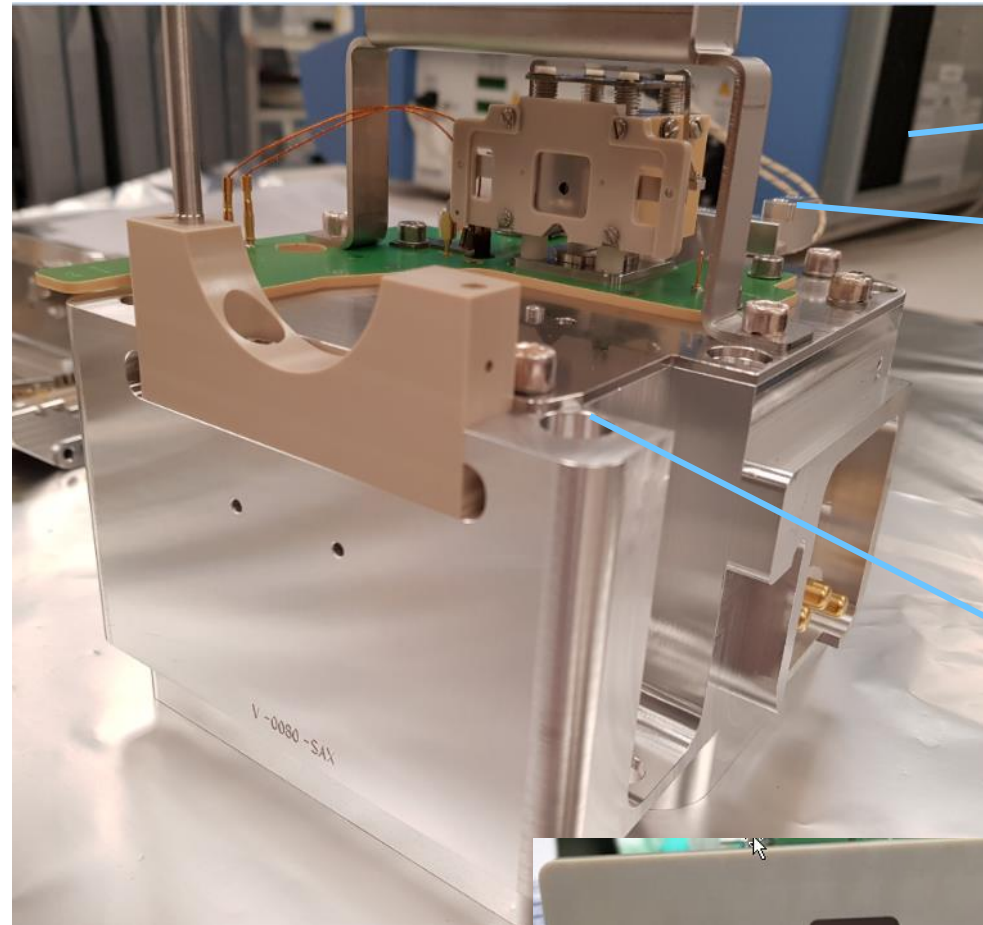
CLT Entrance Lens DC

CLT Exit Lens DC



C-Trap/Orbitrap assembly (BRE0018475)

- C-trap and orbitrap are combined
- Instructions for exchange: See separate presentation



C-Trap

C-Trap Entrance lens

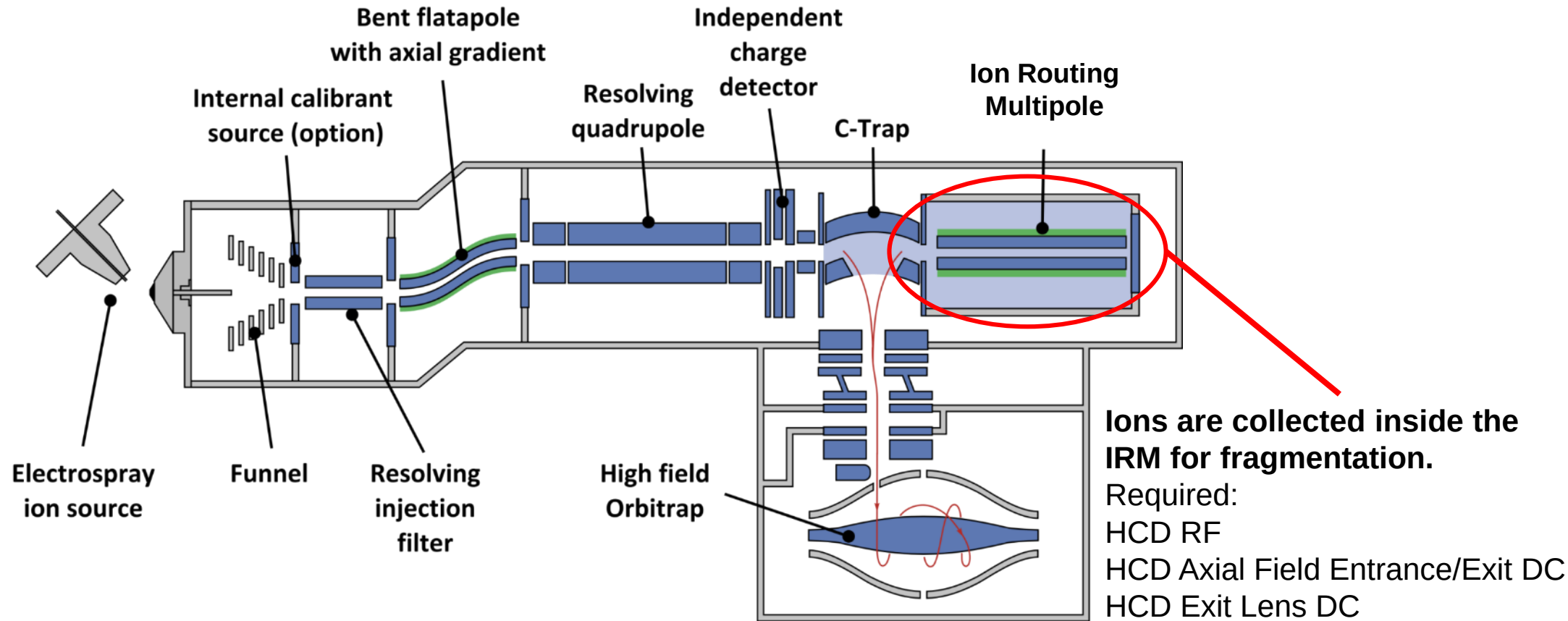
Orbitrap Holder

Quad Holder



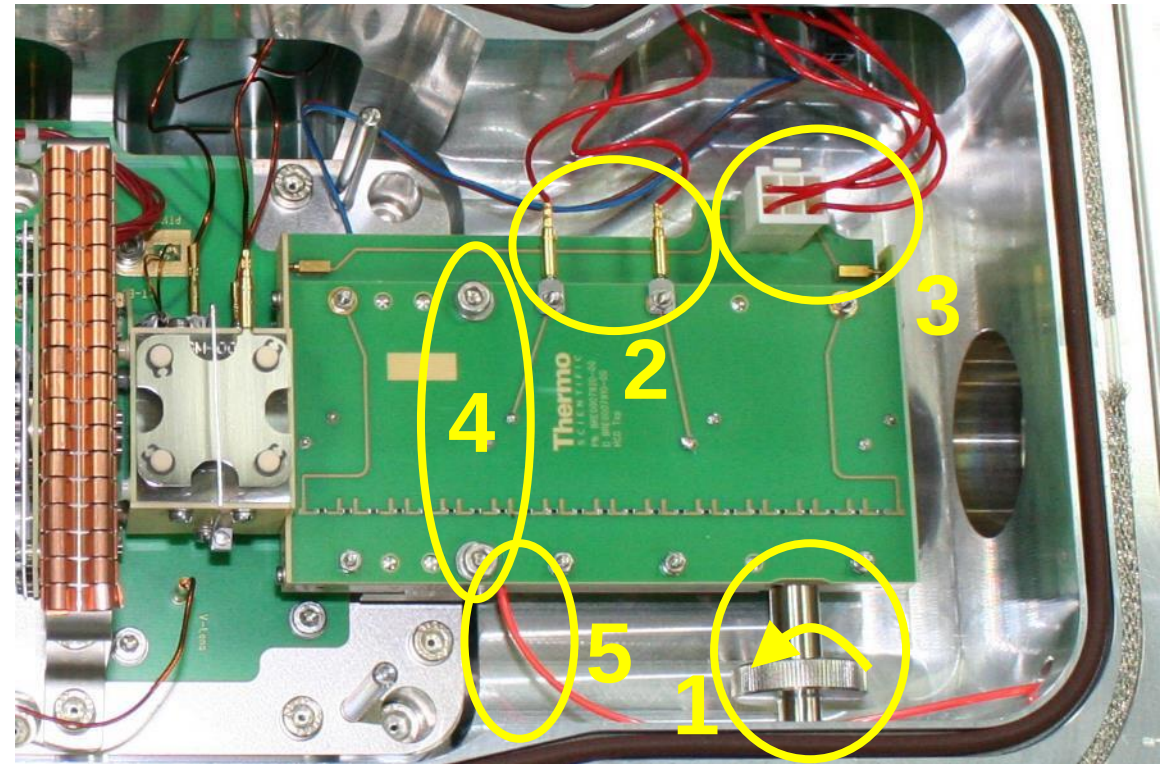
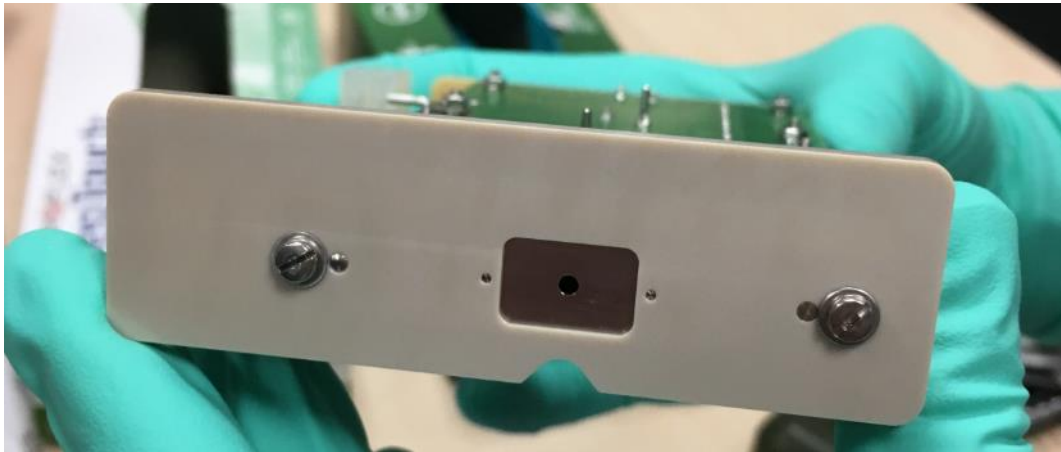
C-Trap Exit lens (mounted to the IRM)

Ion Path and Required Voltages



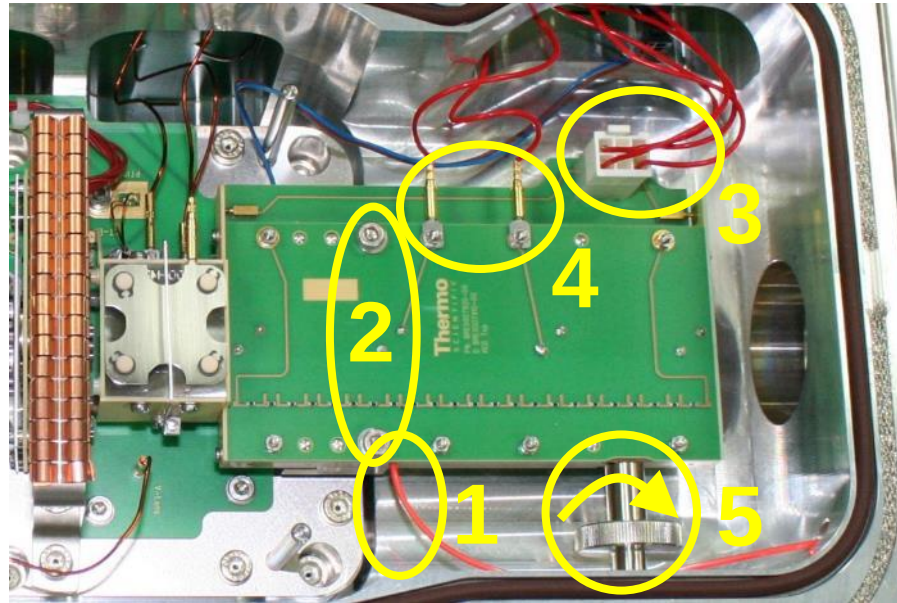
IRM removal (BRE0013930)

- Retract the tube to the vacuum gauge by turning it counterclockwise (viewed from analyzer wall) (1)
- Disconnect the two RF wires (2)
- Unplug the DC connector (3)
- Loosen the two holding screws (4)
- Pull out the gas line (5)
- Remove the IRM by lifting it upwards

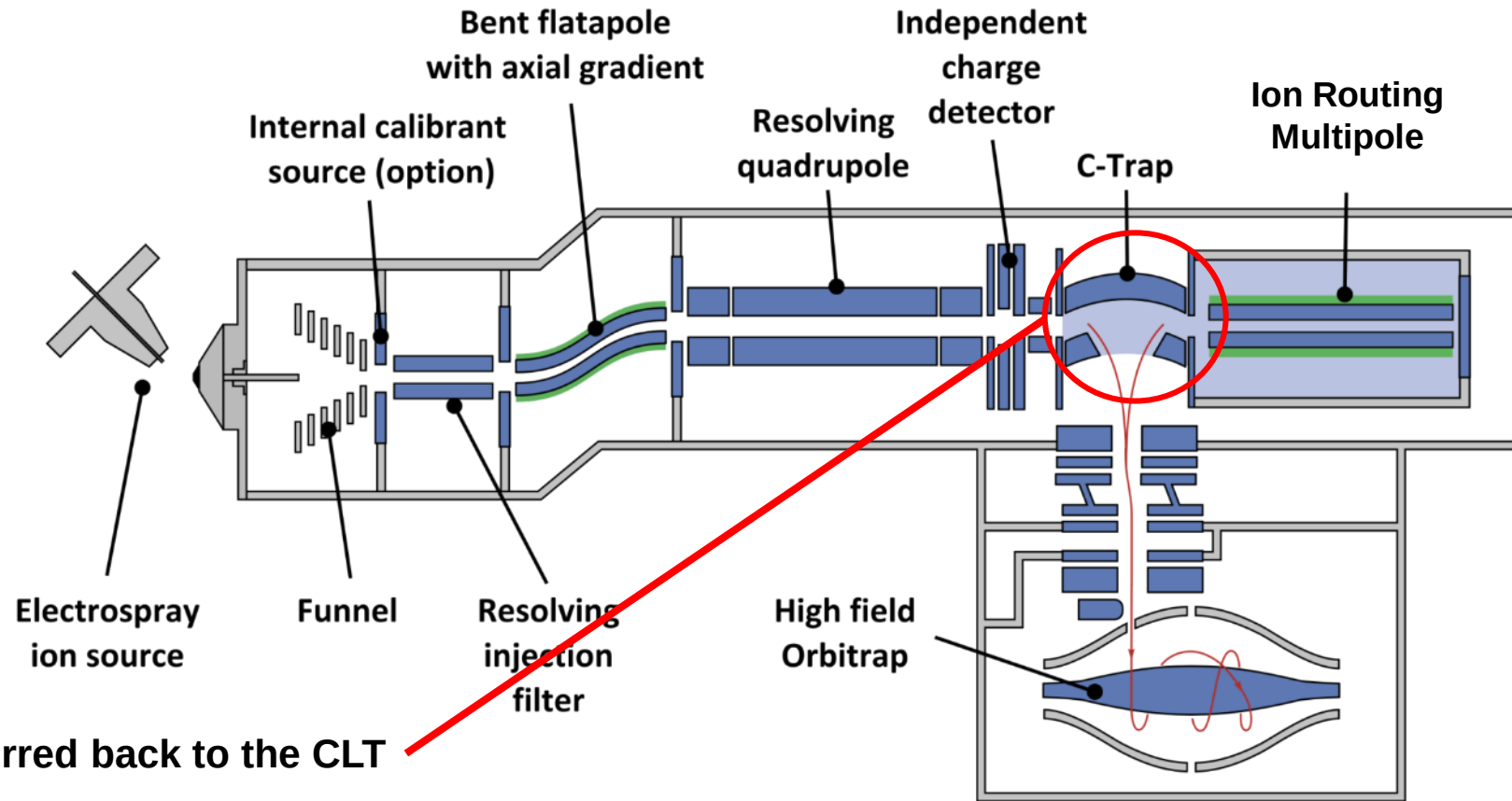


IRM installation (BRE0013930)

- Install the ion routing multipole (IRM)
- Insert the gas line, pushing it all the way in (1)
- Install and tighten the two holding screws (2)
- Plug in the DC connector (3)
- Connect the two RF wires (4)
- Extend the vacuum gauge tube until it is firmly against the IRM (5)

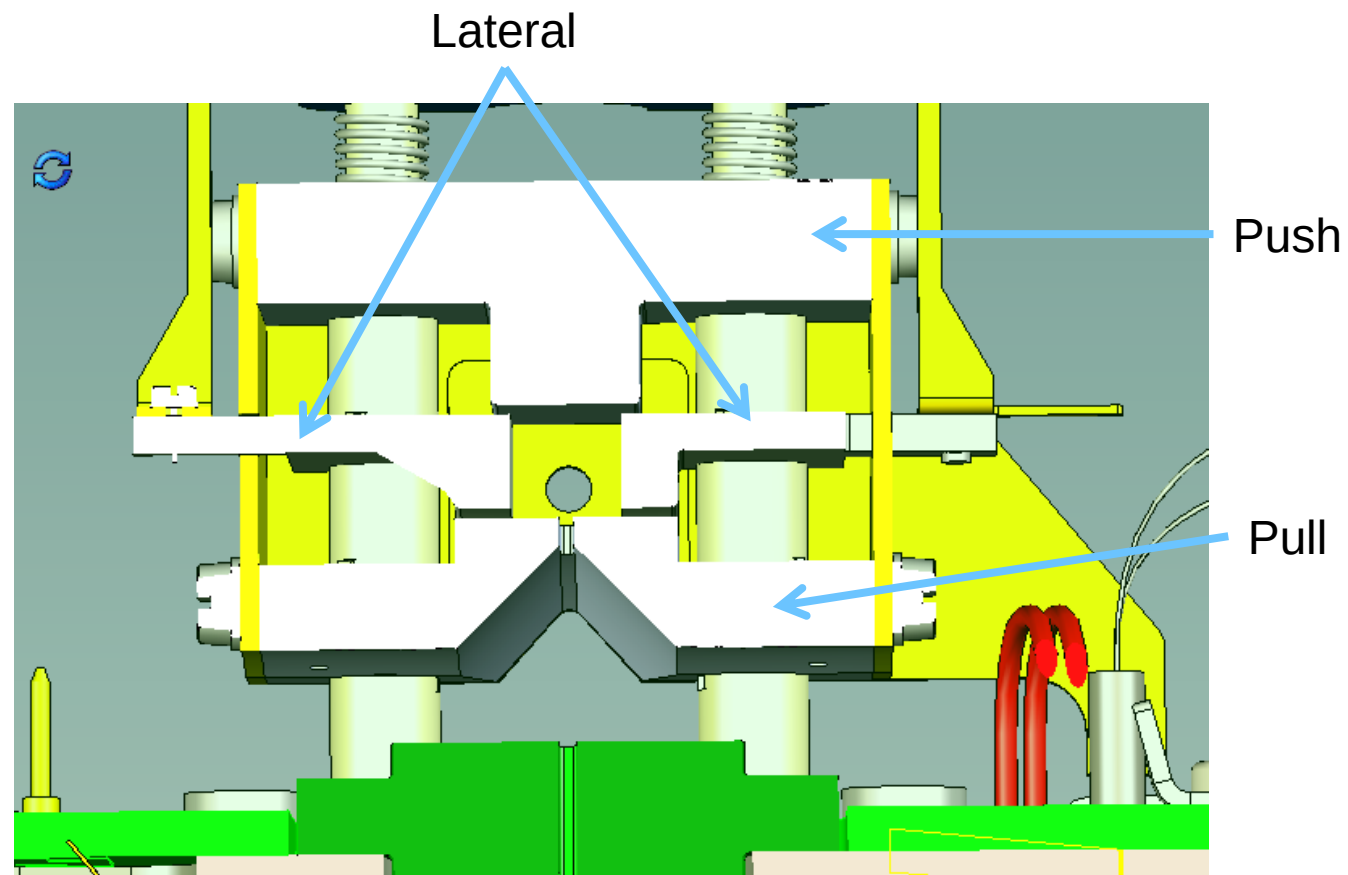


Ion Path and Required Voltages

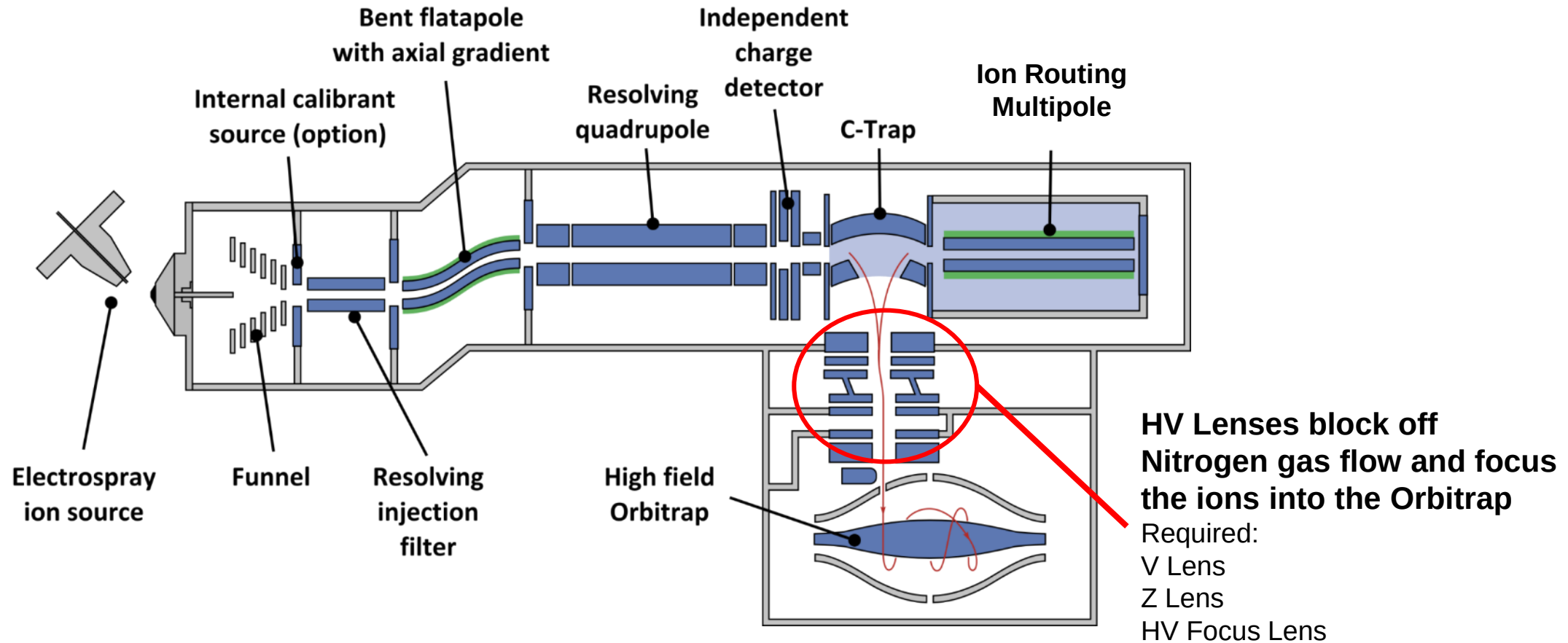


Ions are transferred back to the CLT

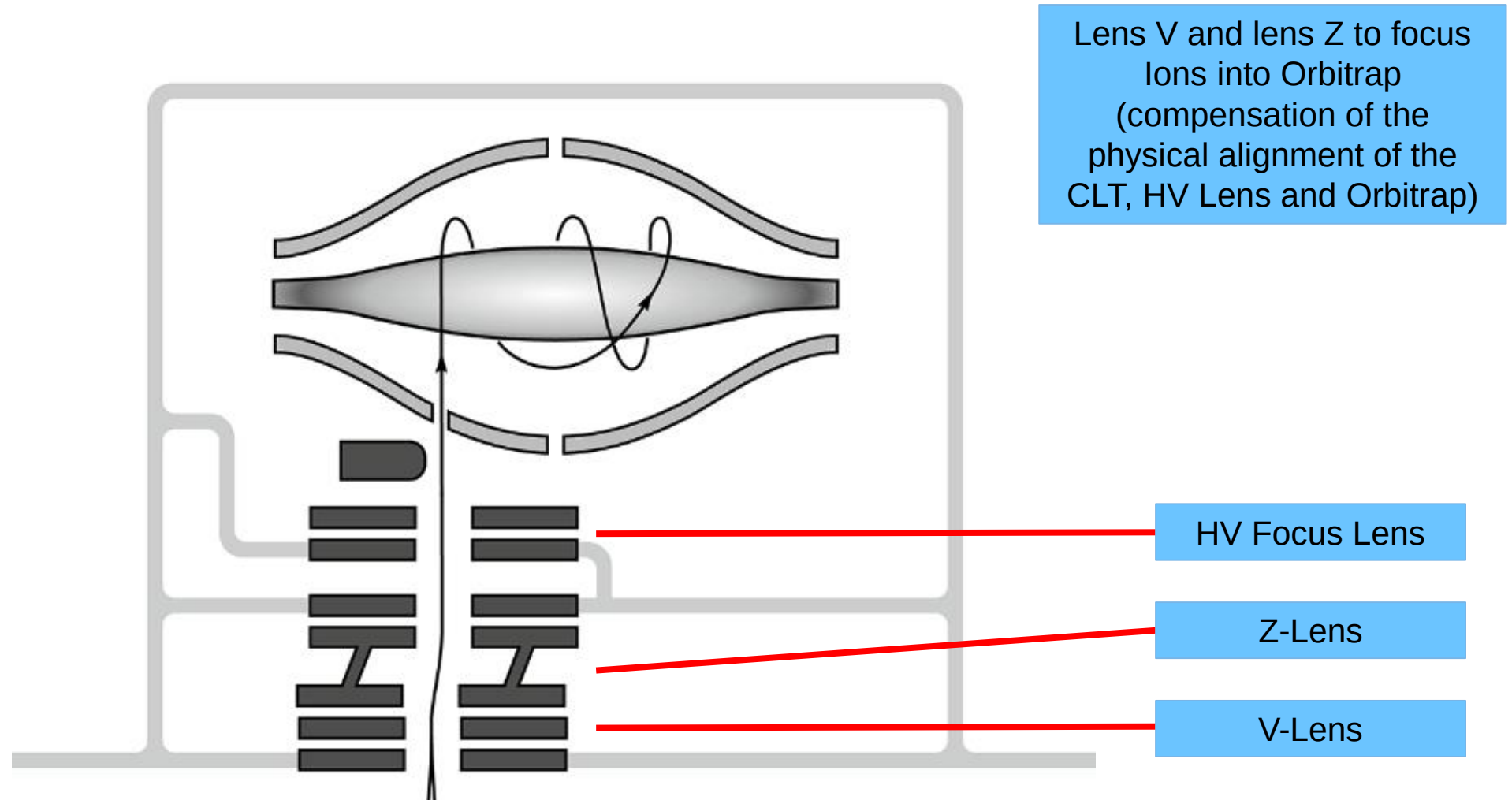
C-trap



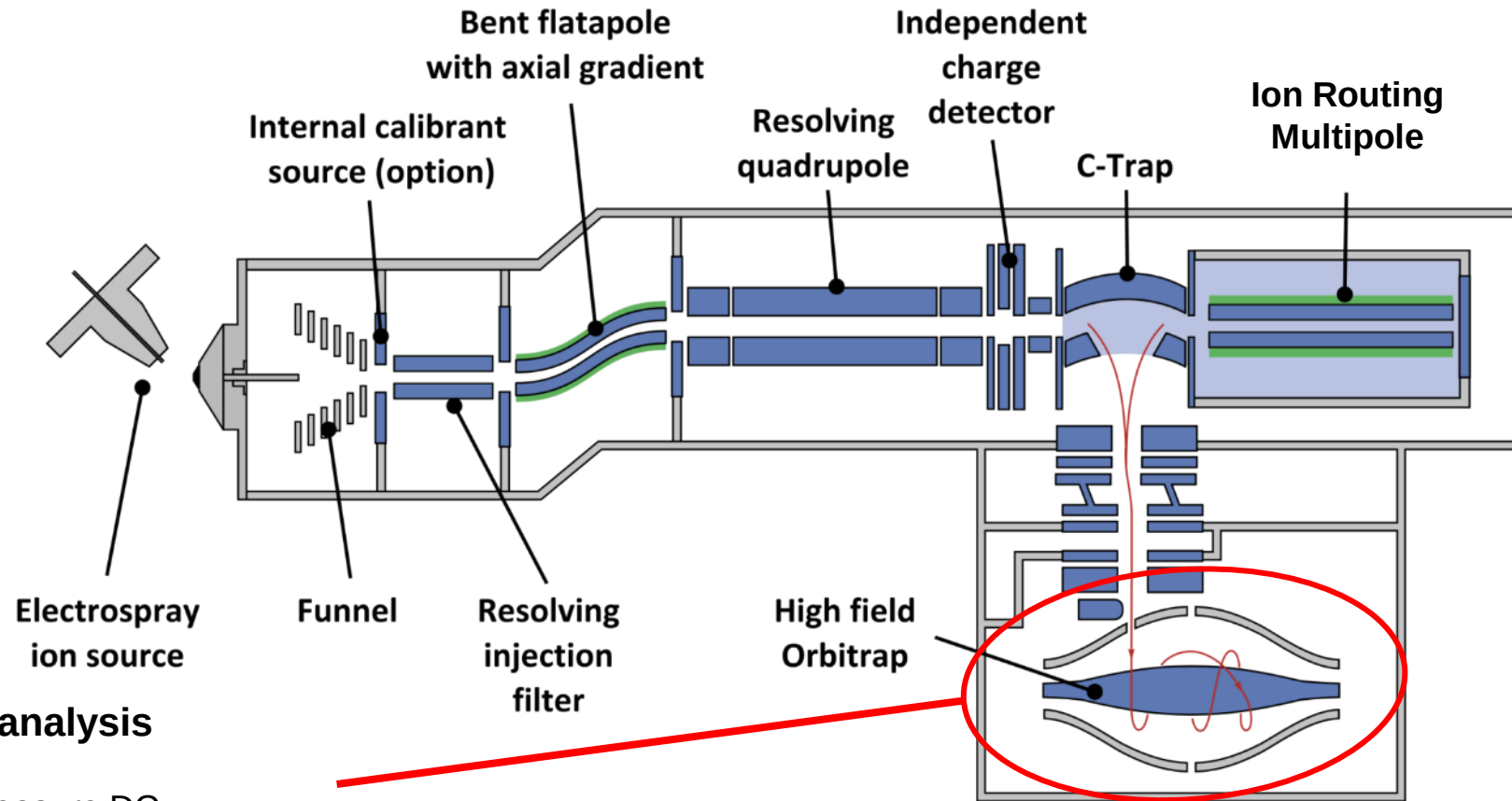
Ion Path and Required Voltages



HV Lenses



Ion Path and Required Voltages

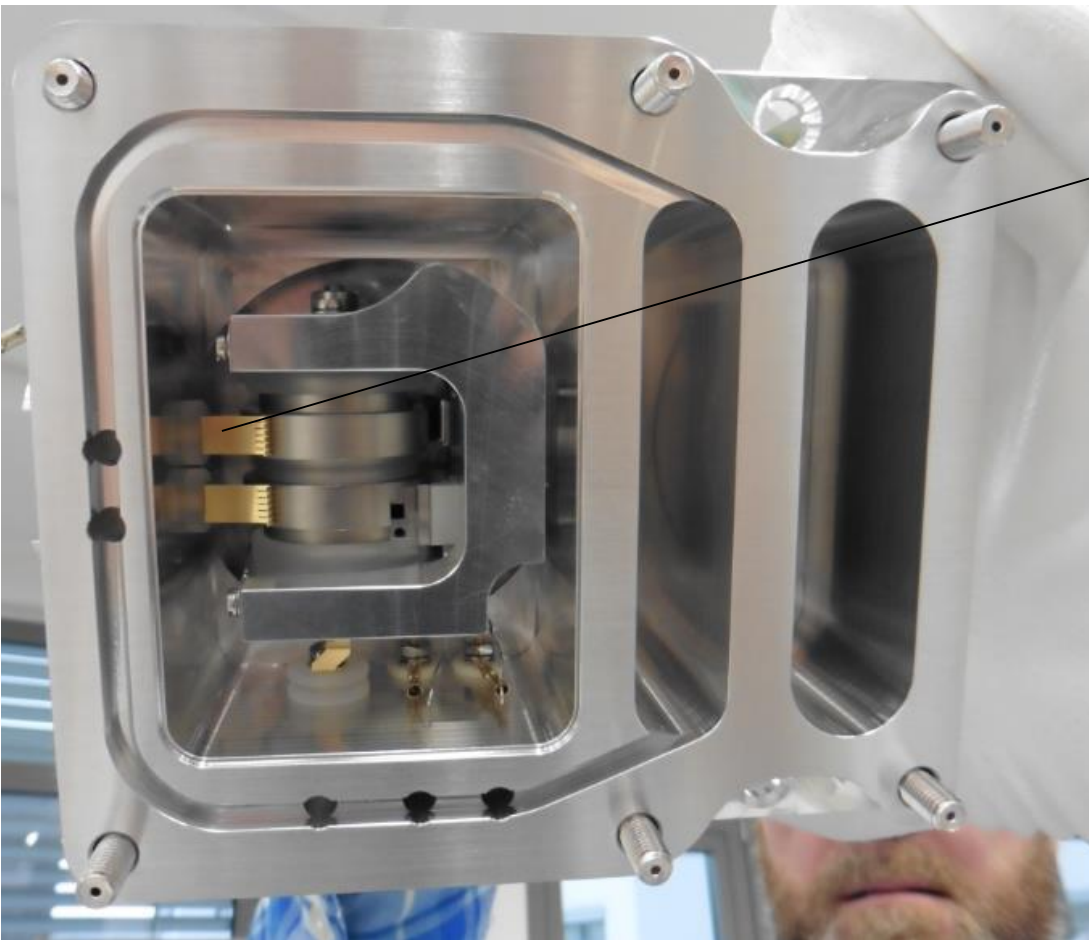


Orbitrap FT mass analysis

Required:

Deflector Inject and Measure DC

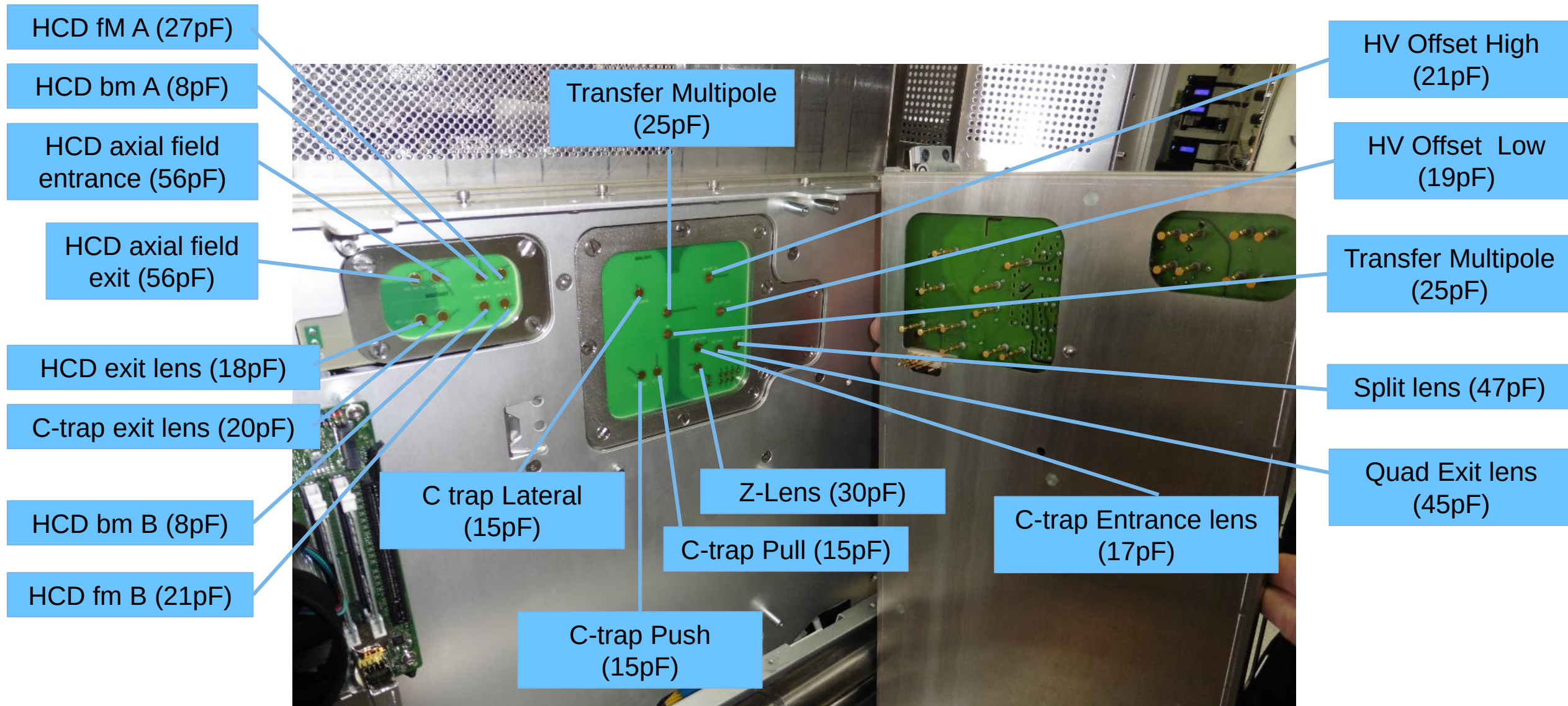
Central Electrode Inject and Measure DC



Contact pins

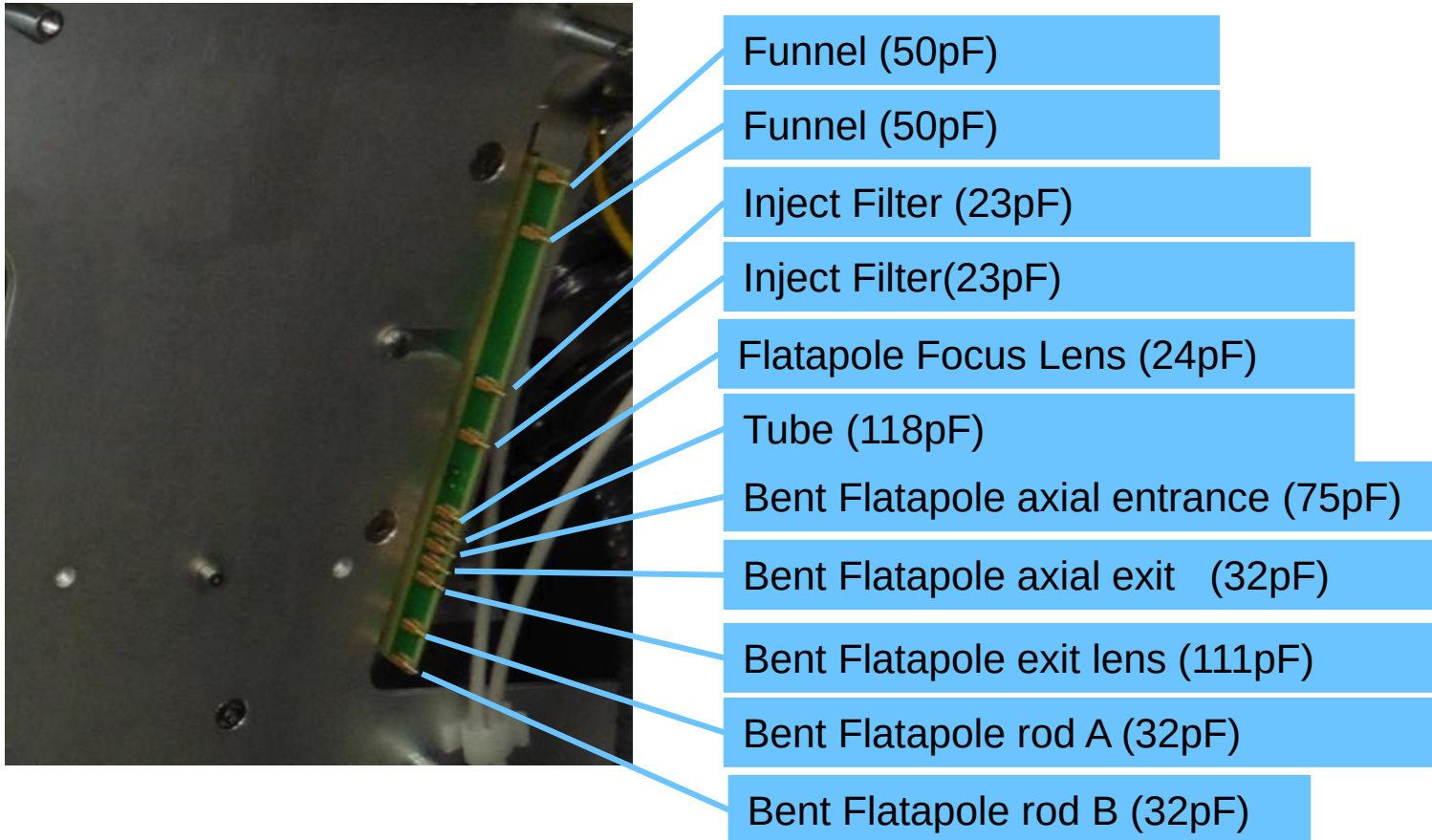
“Dummy deflector” to create same capacitance on both detect plates.

Typical capacity values to GND



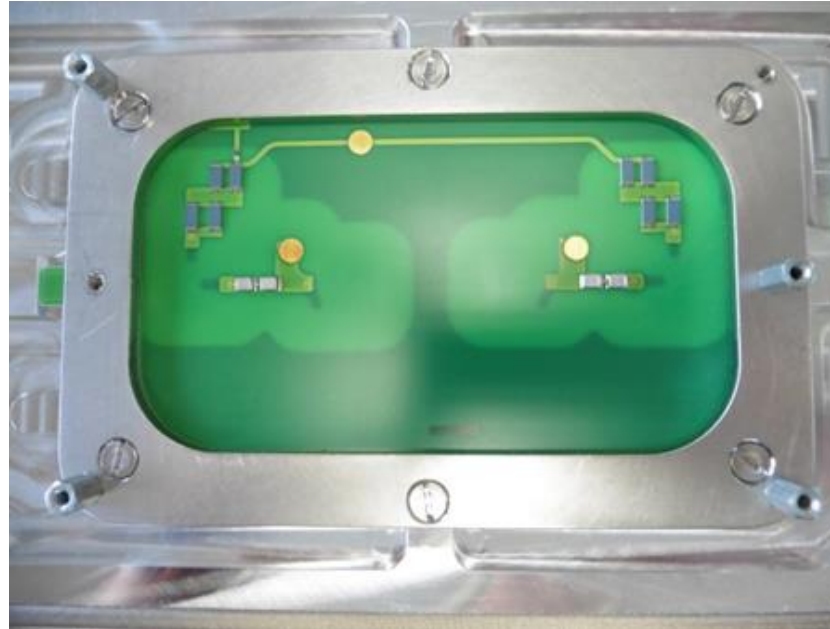
Ion Optic Supply - Connections

- Voltages are supplied through spring loaded contacts (pogo pins)
- Check pins before installing the board.



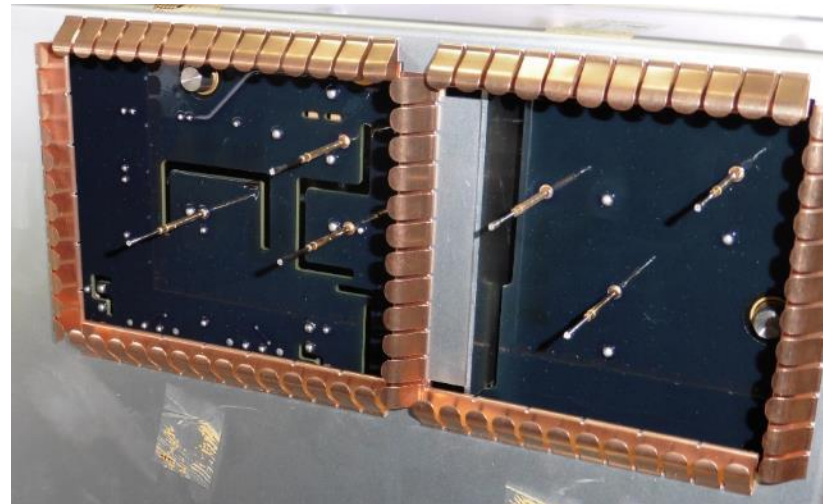
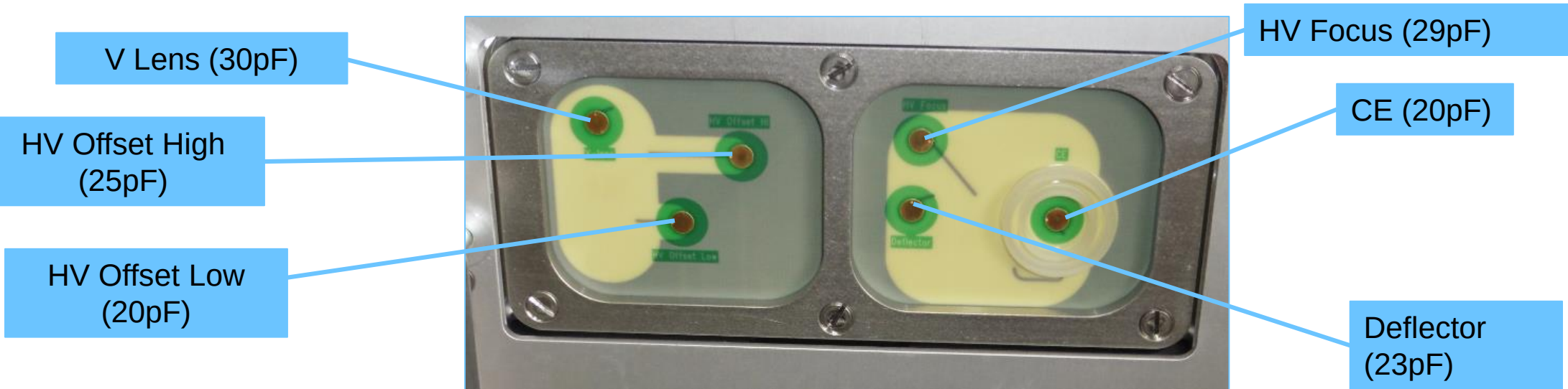
Capacitances Quadrupole

Between
Quad rods
Orbitrap Exploris 480 ~ 36



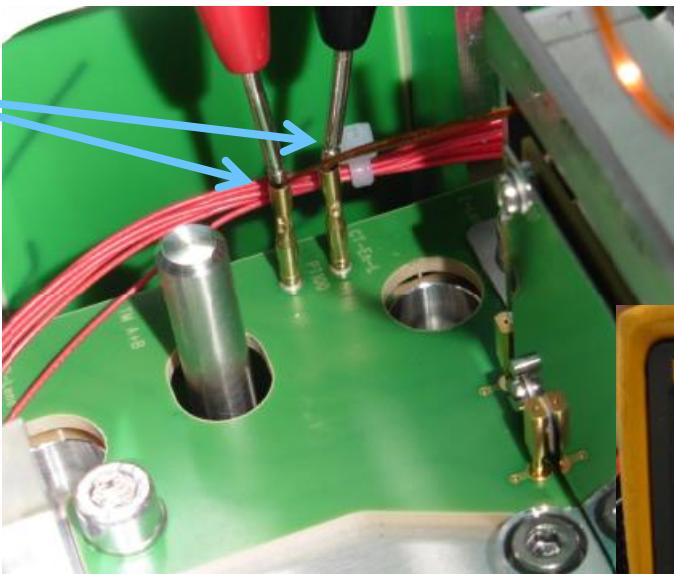
Quad rods to
GND
Orbitrap Exploris 480 ~ 62 pF

Spring loaded pins and contact surfaces at OTS



Resistance PT100

PT100



How to measure temperature
with a PT100?

Example: $R \approx 111\Omega \rightarrow$
Temperature $\approx 29^\circ\text{C}$



$^\circ\text{C}$	0	1	2	3	4	5	6	7	8	9
0	100	100,39	100,78	101,17	101,56	101,95	102,34	102,73	103,12	103,51
10	103,9	104,29	104,68	105,07	105,46	105,85	106,24	106,63	107,02	107,4
20	107,79	108,18	108,57	108,96	109,35	109,73	110,12	110,51	110,9	111,28
30	111,67	112,06	112,45	112,83	113,22	113,61	113,99	114,38	114,77	115,15
40	115,54	115,93	116,31	116,7	117,08	117,47	117,85	118,24	118,62	119,01
50	119,4	119,78	120,16	120,55	120,93	121,32	121,7	122,09	122,47	122,86
60	123,24	123,62	124,01	124,39	124,77	125,16	125,54	125,92	126,31	126,69
70	127,07	127,45	127,84	128,22	128,6	128,98	129,37	129,75	130,13	130,51
80	130,89	131,27	131,66	132,04	132,42	132,8	133,18	133,56	133,94	134,32
90	134,7	135,08	135,46	135,84	136,22	136,6	136,98	137,36	137,74	138,12
100	138,5	138,88	139,26	139,64	140,02	140,39	140,77	141,15	141,53	141,91