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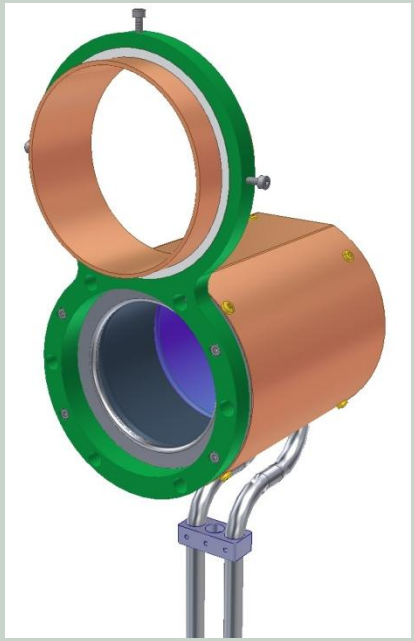
Space charge decompensator



by P. Savage

10th August 2011

Design for a

Space charge decompensator

Background information

•The FETS beam is made up of negatively charged ions (H^-).
•The like charges repel each other causing the beam to expand with time.

•If a gas is introduced into the beam pipe:
- •Atoms of the beam hit atoms of the gas.
- •High speed (and energy) electrons knock low energy electrons out of gas atoms.
- •Hence gas becomes ionised (positive)

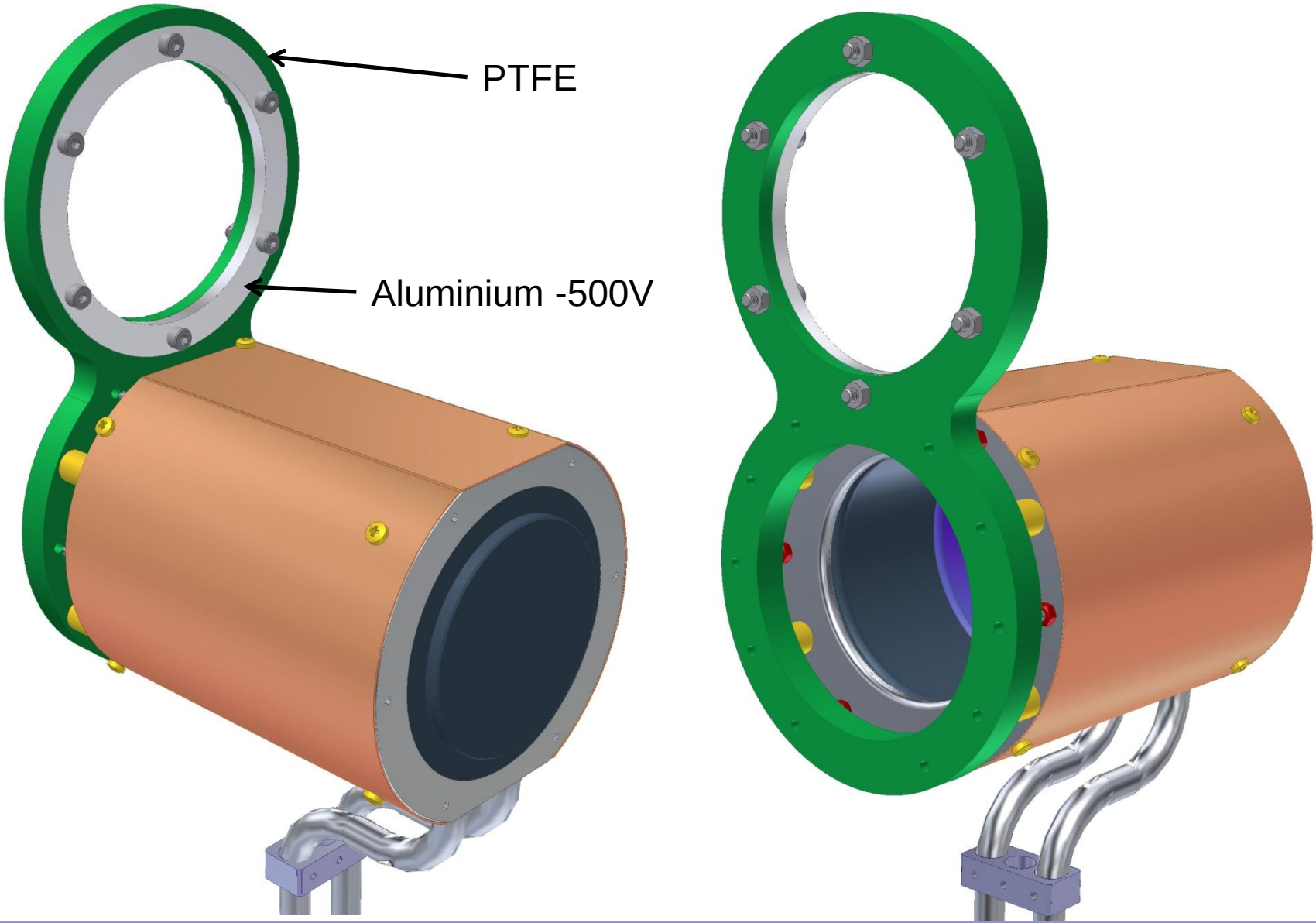
•The positive gas repels the negative beam.
•This is called ‘space charge compensation’.
•If the gas pressure is increased more collisions occur and more space charge compensation occurs.

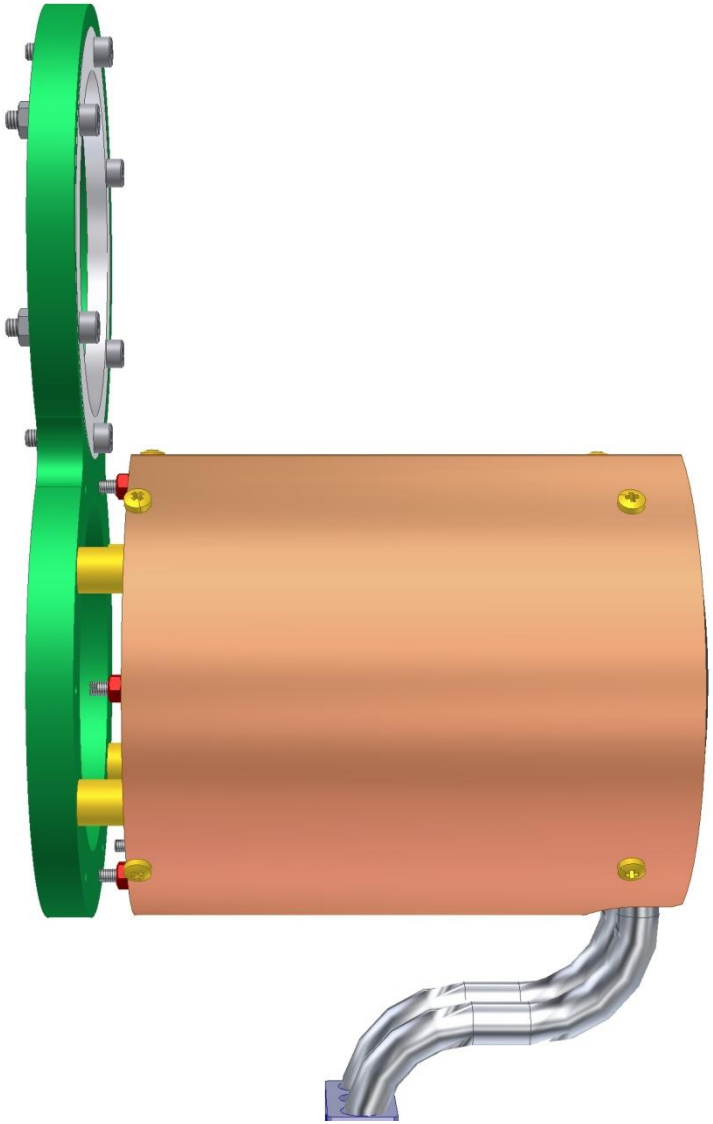
•Now imagine that the beam passes through a ring.
•And that the ring has a voltage applied to it, in this case -500V.
•The voltage will attract the ionised gas away from the beam, effectively turning off the space charge compensation.
•If the voltage to the ring is turned off then the space charge compensation will return.

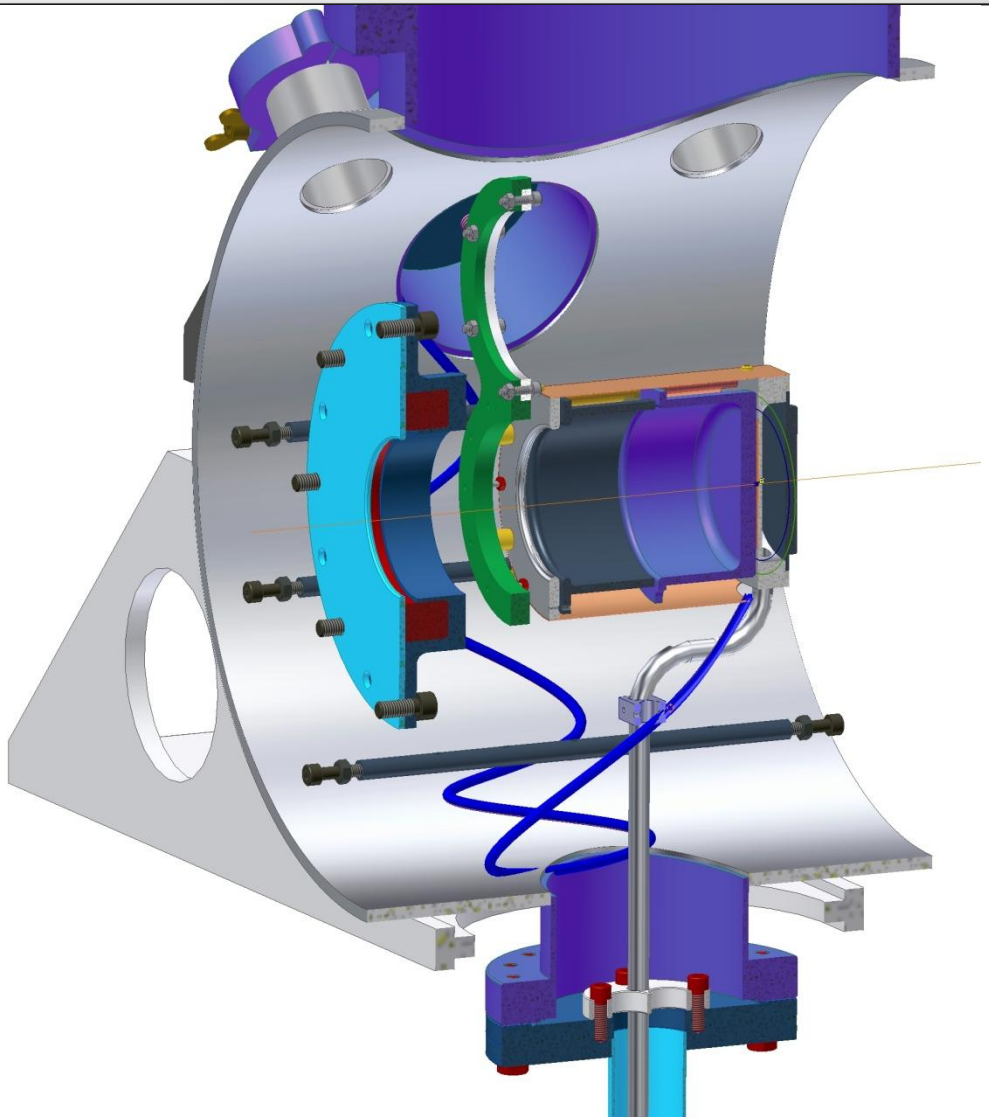
•This apparatus is being built to attempt to answer the question:

•Once the ring voltage is turned off how long does it take for the beam to be fully re-compensated once more? Juergen’s guess is that the voltage will disappear in about 1ms and the beam will be fully re-compensated in about 50ms and that time may be significant for some beamlines.

Design iteration 1.....


PTFE
Aluminium -500V





Design iteration 2.....

"J.P.
"my main concern is the amount of insulator that "can bee seen" by the beam. I would like to reduce this amount as much as possible and in return increase the amount of "electrode" surface seen by the beam.

As the whole thing will weigh nothing we can reduce the insulator to just a small piece - so if you can remove most of the PTFE rings and keep only enough to fix the PTFE to the front face. If you then make the aluminium ring ~ three times as long so it is sticking out in front and behind the PTFE part and a small screw from the inside of the ring through the PTFE should fix the ring to the rest."

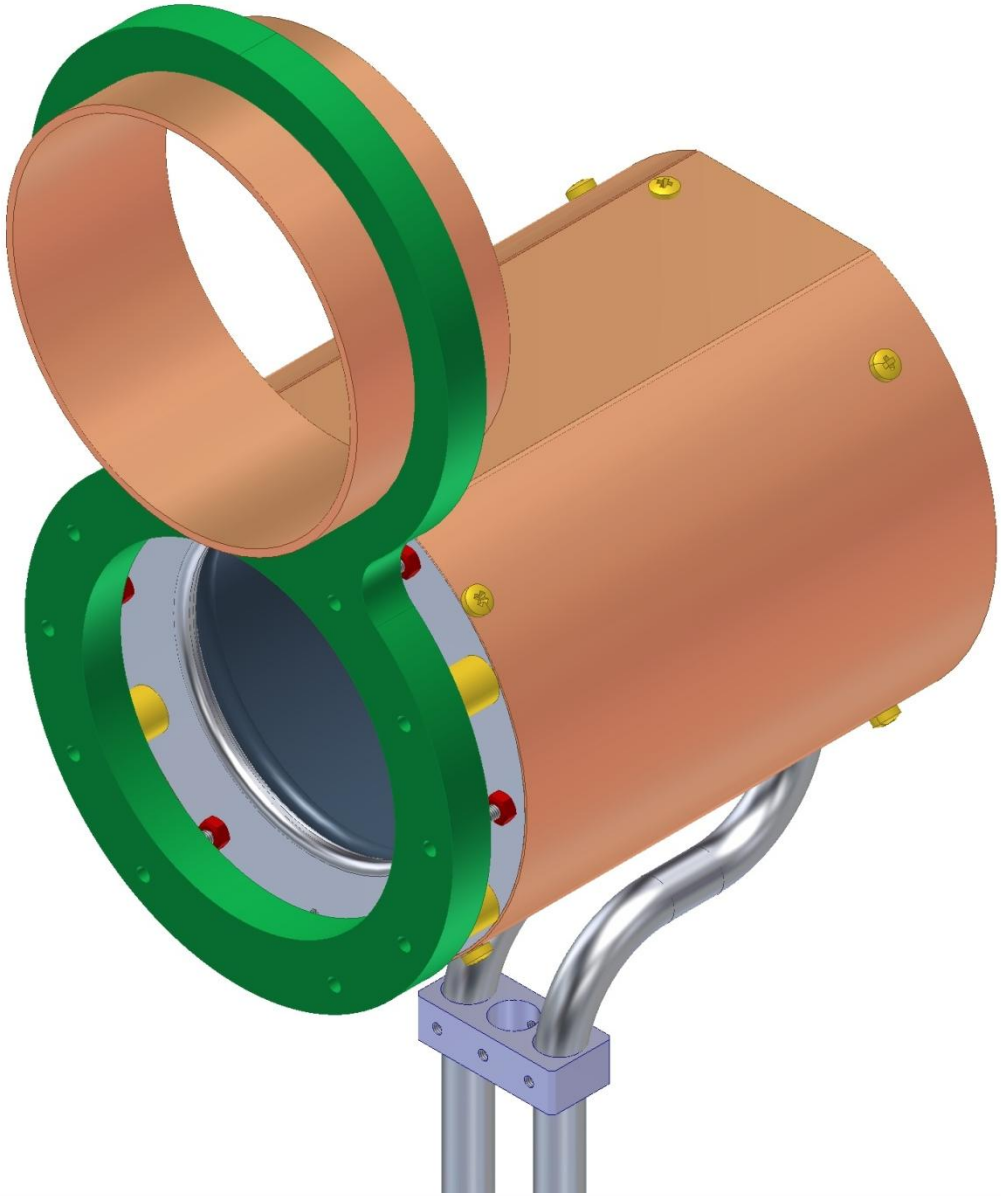
We have a piece of copper tube in stock that measures:

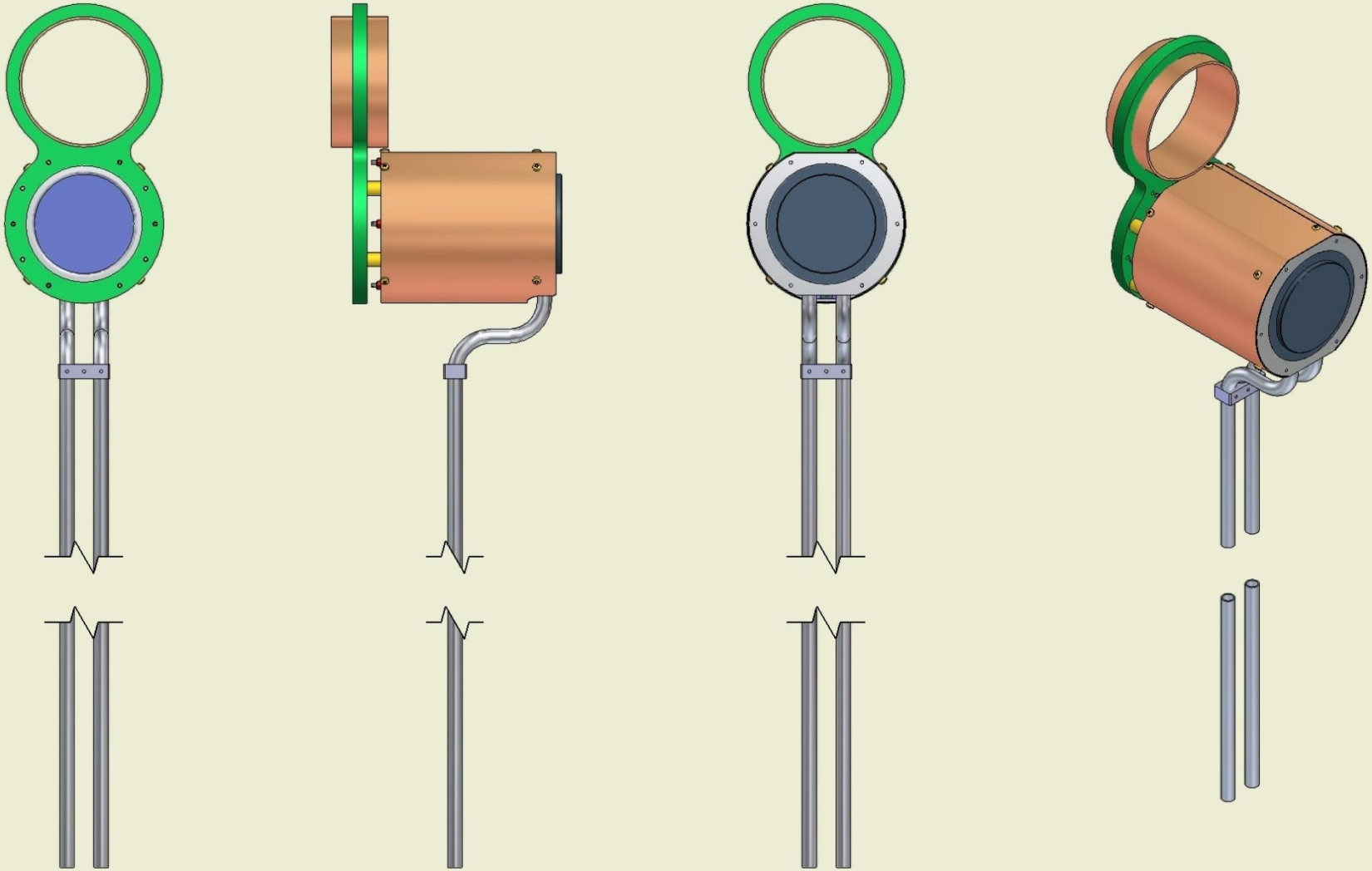
OD = 95.25 mm
ID = 88.50 mm
Length = 200 mm

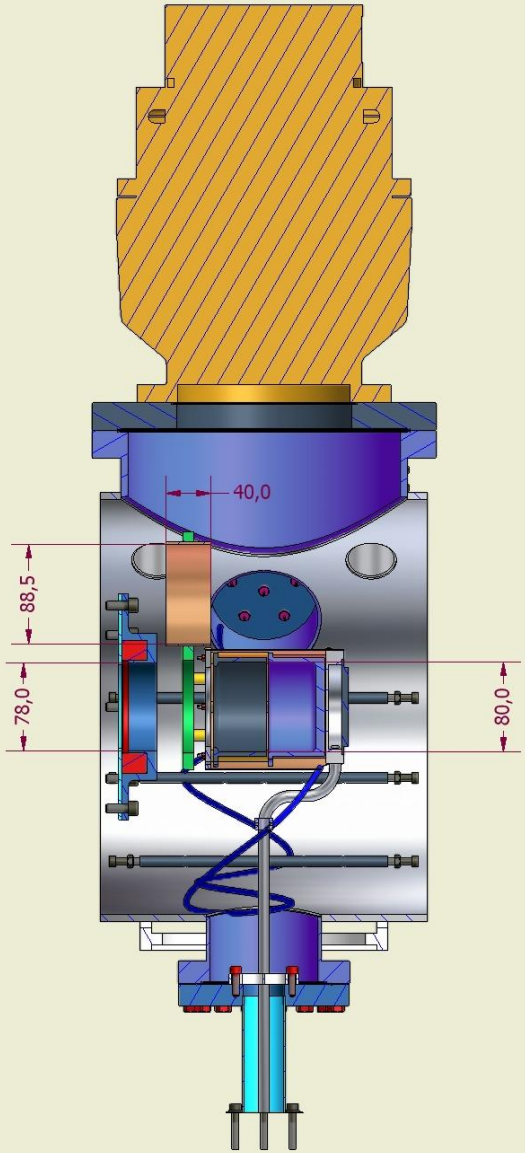
I propose turning the tube outside diameter to give the minimum practical wall thickness (to reduce weight). Here the design shows a wall thickness of just under 2mm. The length is shown as 40mm.

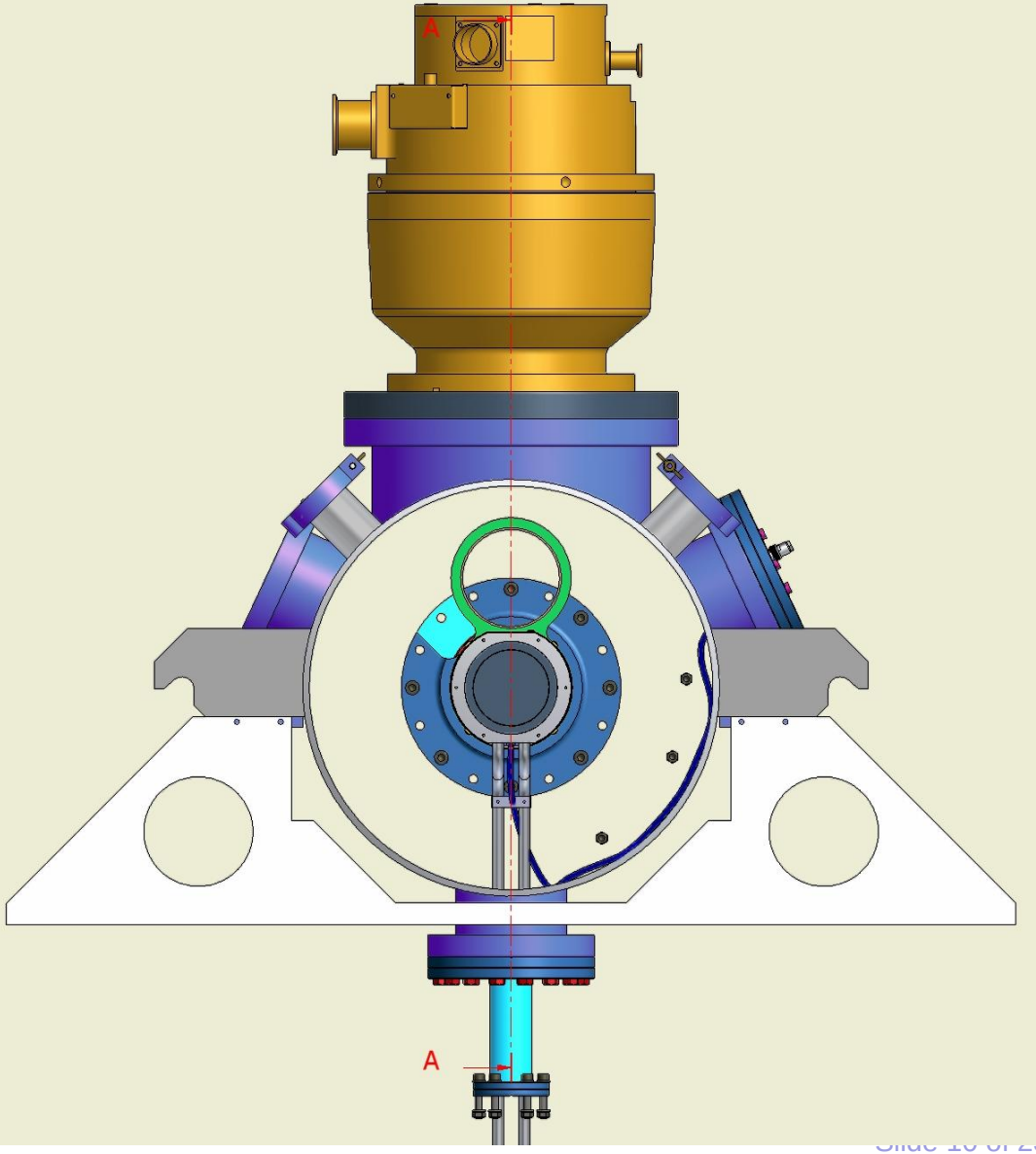
Masses:
Copper = 180 grams
PTFE = 100 grams.

We need to consider installation which will be through the vacuum port (top).






40,0
88,5
78,0
80,0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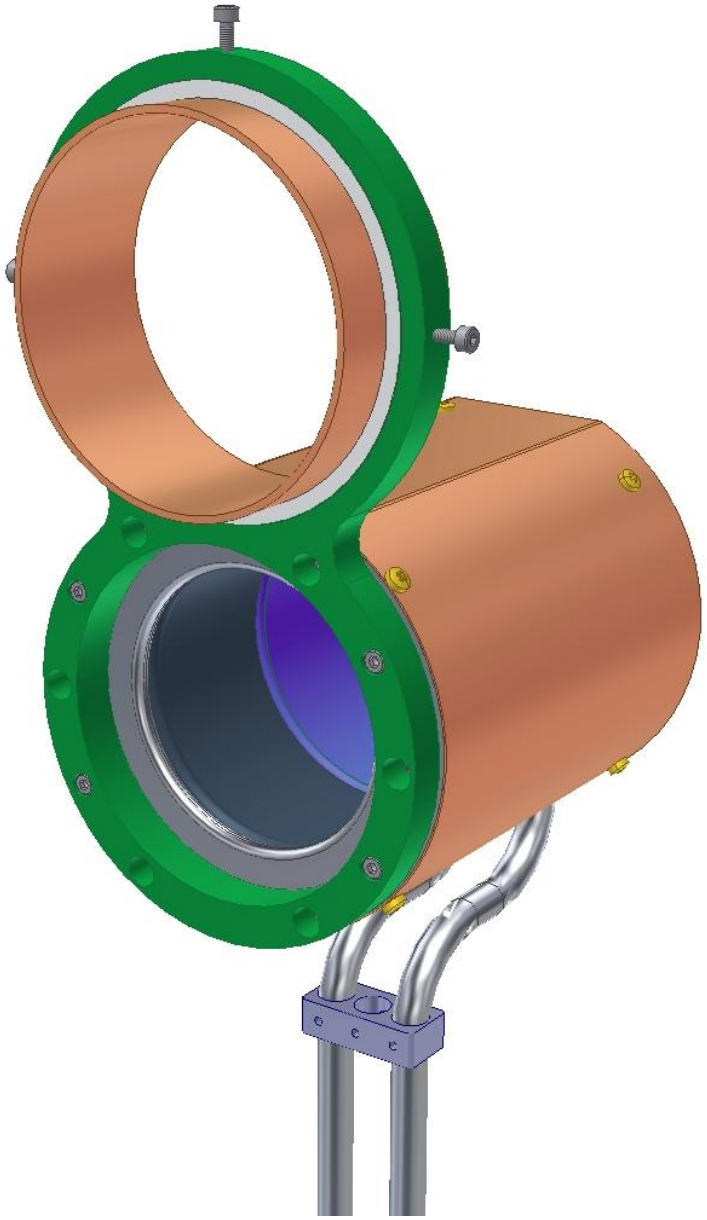
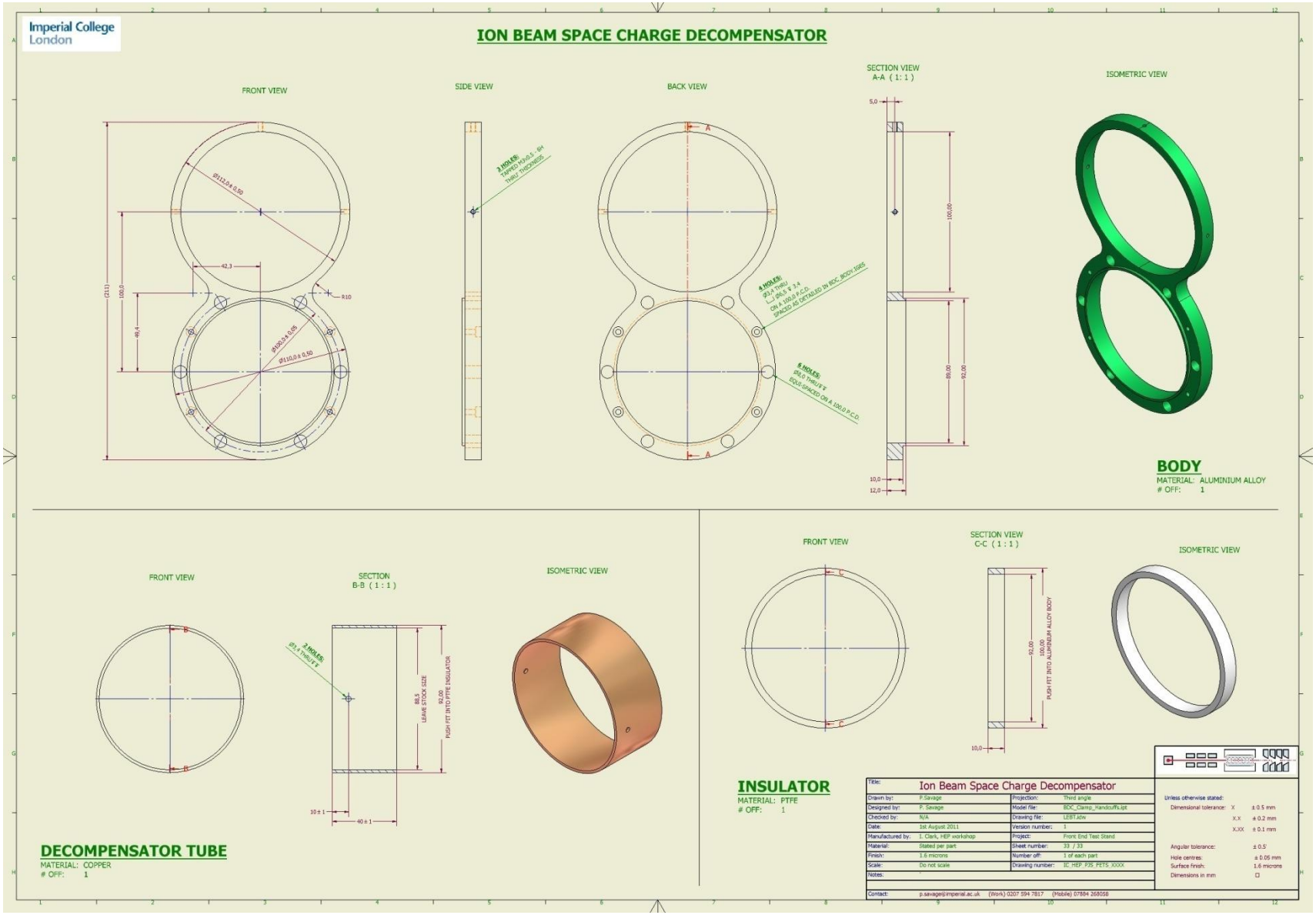
Design iteration 3.....

"J.P.
yes this looks more like it.... Now you left the PTFE as it was, for the use to decompensate this is fine, but if the cup is used as a beam dump the beam will go through the unshielded PTFE ring and the insulator can collect charges on the surface which will not be removed (insulator) and cause problems (the ring around the copper tube is sufficiently shielded....)"

The tube mount (green) is now made from Aluminium with a PTFE insulator sandwiched between the copper tube (at -500V) and the mount (at ground).

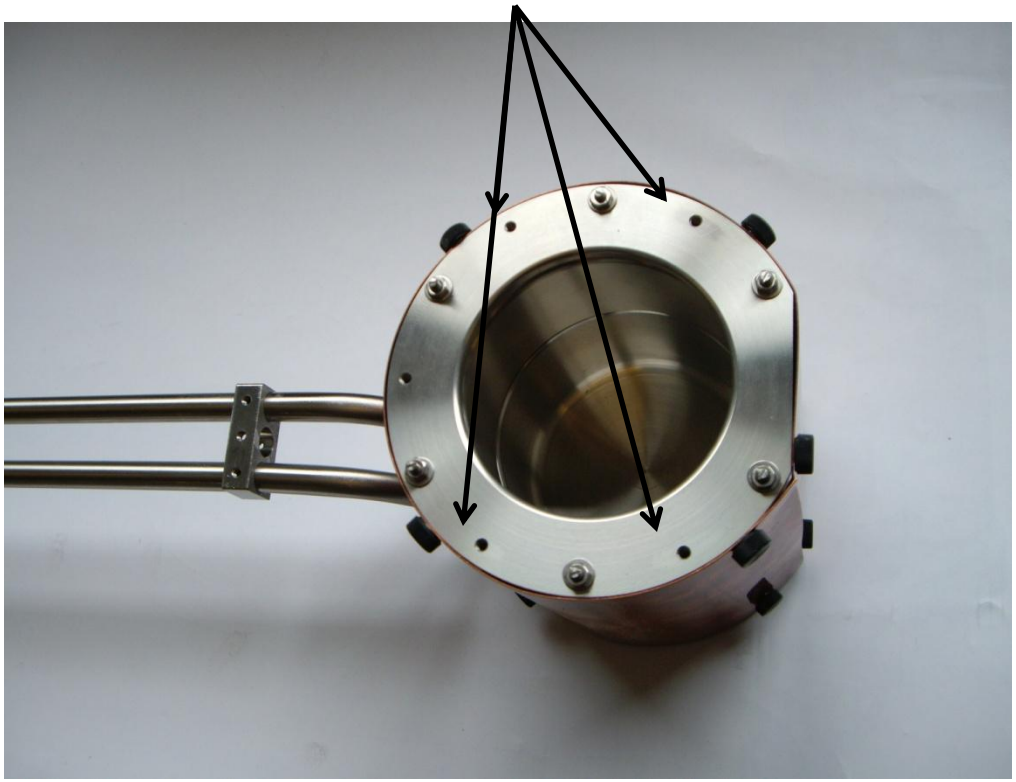
Now when the assembly is in it's original 'beam stop' position the tube mount will not collect charge.




Imperial College London
ION BEAM SPACE CHARGE DECOMPENSATOR
FRONT VIEW
SIDE VIEW
BACK VIEW
SECTION VIEW A-A (1 : 1)
ISOMETRIC VIEW
BODY
MATERIAL: ALUMINIUM ALLOY
OFF: 1
FRONT VIEW
SECTION B-B (1 : 1)
ISOMETRIC VIEW
DECOMPENSATOR TUBE
MATERIAL: COPPER
OFF: 1
FRONT VIEW
SECTION VIEW C-C (1 : 1)
ISOMETRIC VIEW
INSULATOR
MATERIAL: PTFE
OFF: 1
Ion Beam Space Charge Decompensator

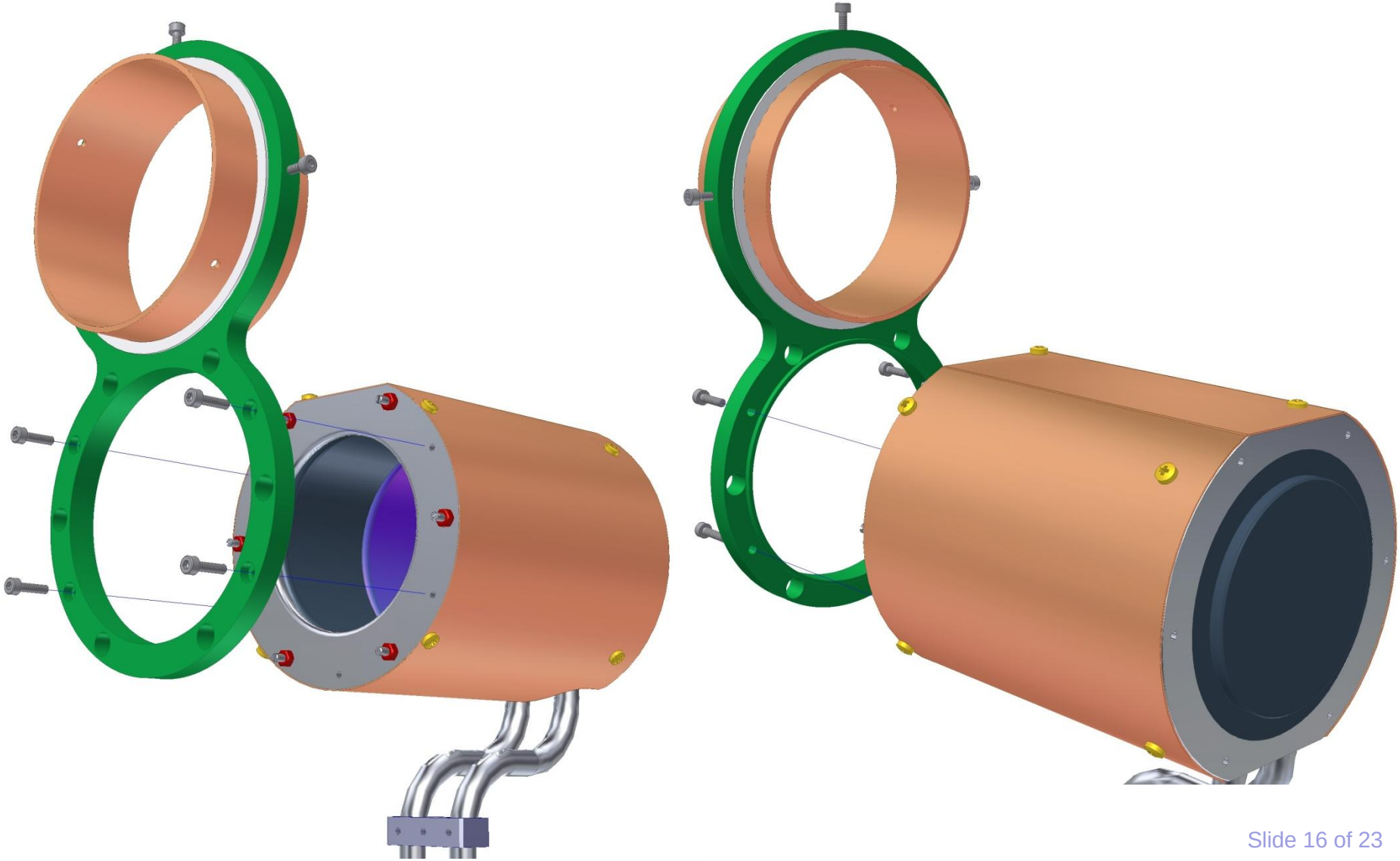
Faraday cup / beam stop assembly photos

Decompensator assembly mounts to 4 x M3 tapped holes on the faraday cup assembly

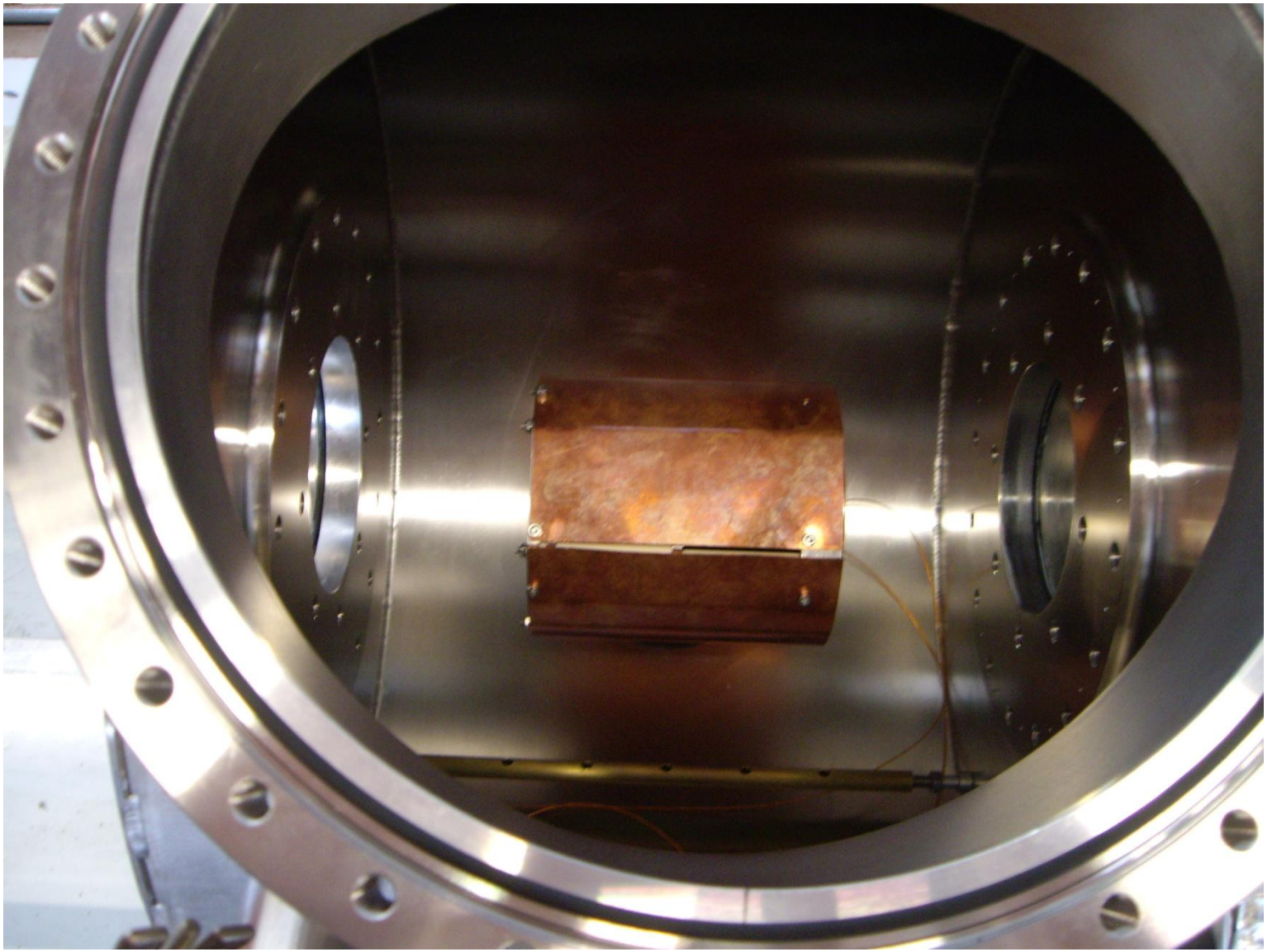


The completed assembly

Exploded views showing 4 x M3 mounting screw locations

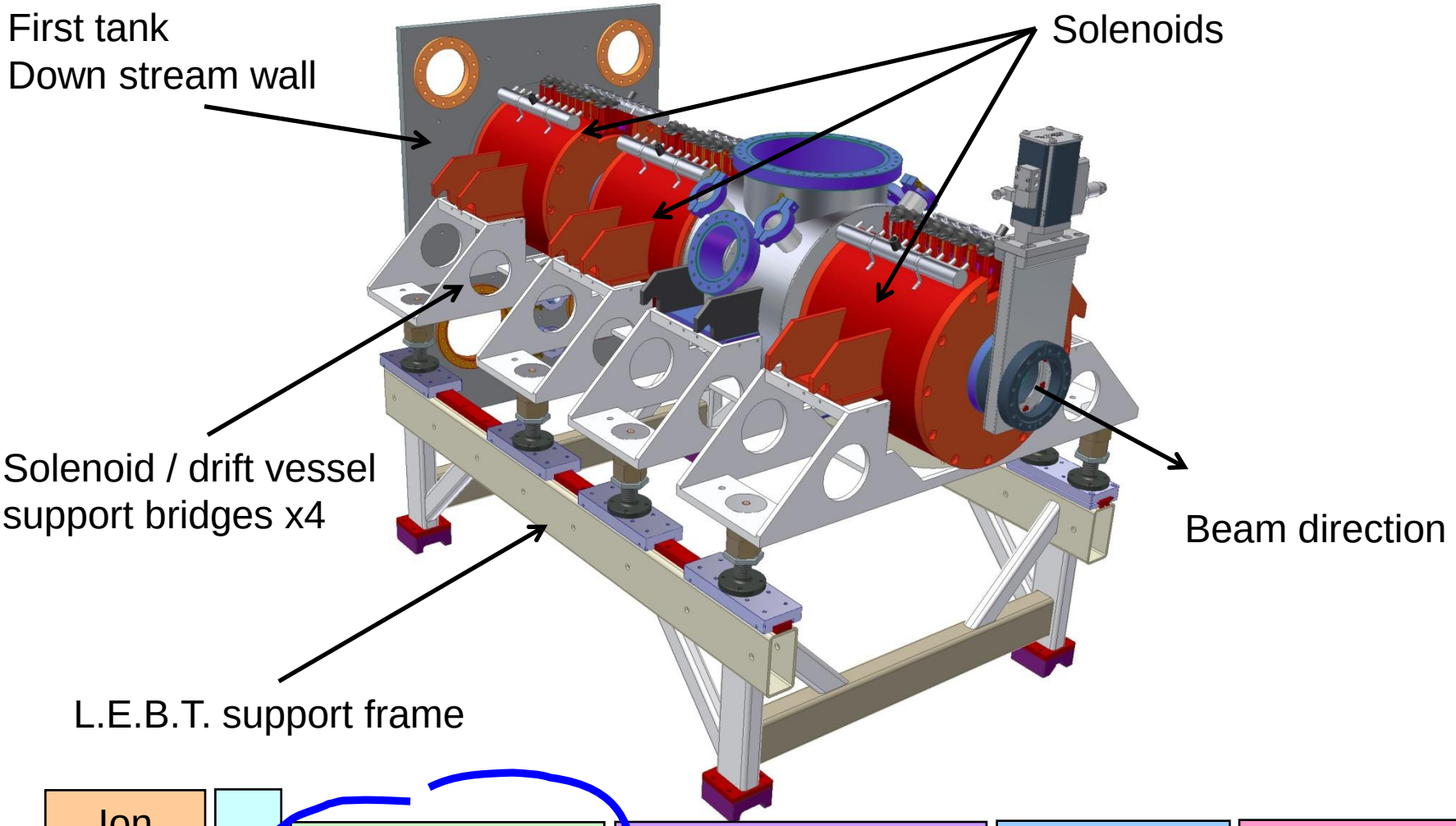


Looking down into the drift vessel through the top vacuum flange



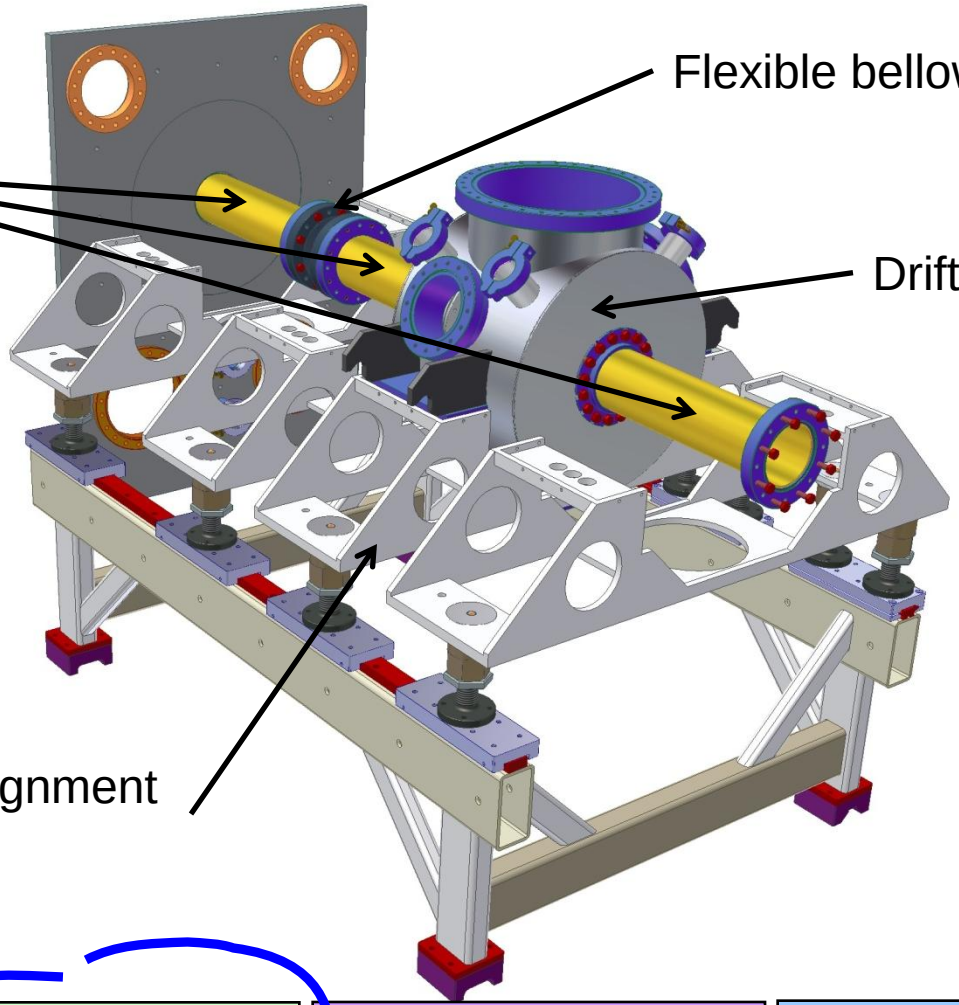
Supporting Info.....

LOW ENERGY BEAM TRANSPORT



Ion Source | L.E.B.T. | R.F.Q. | Chopper | Diagnostics

LOW ENERGY BEAM TRANSPORT

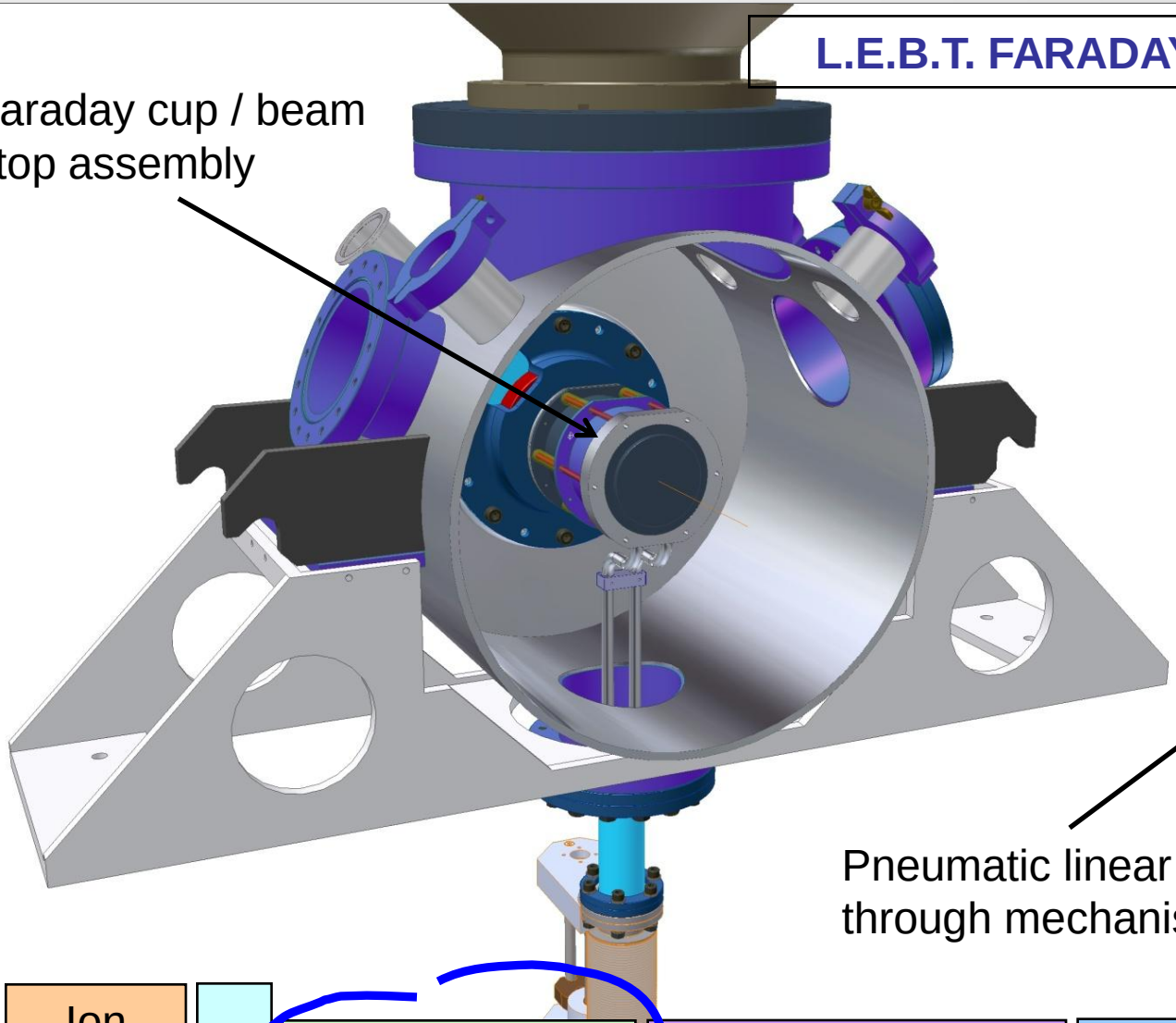


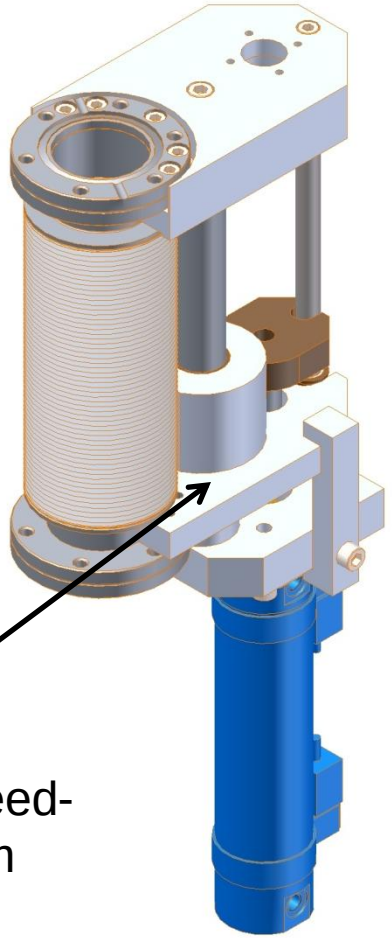
Drift lengths:
d1 = 25cm
d2 = 13.5cm
d3 = 35cm
d4 = 17cm

Ion Source | L.E.B.T. | R.F.Q. | Chopper | Diagnostics

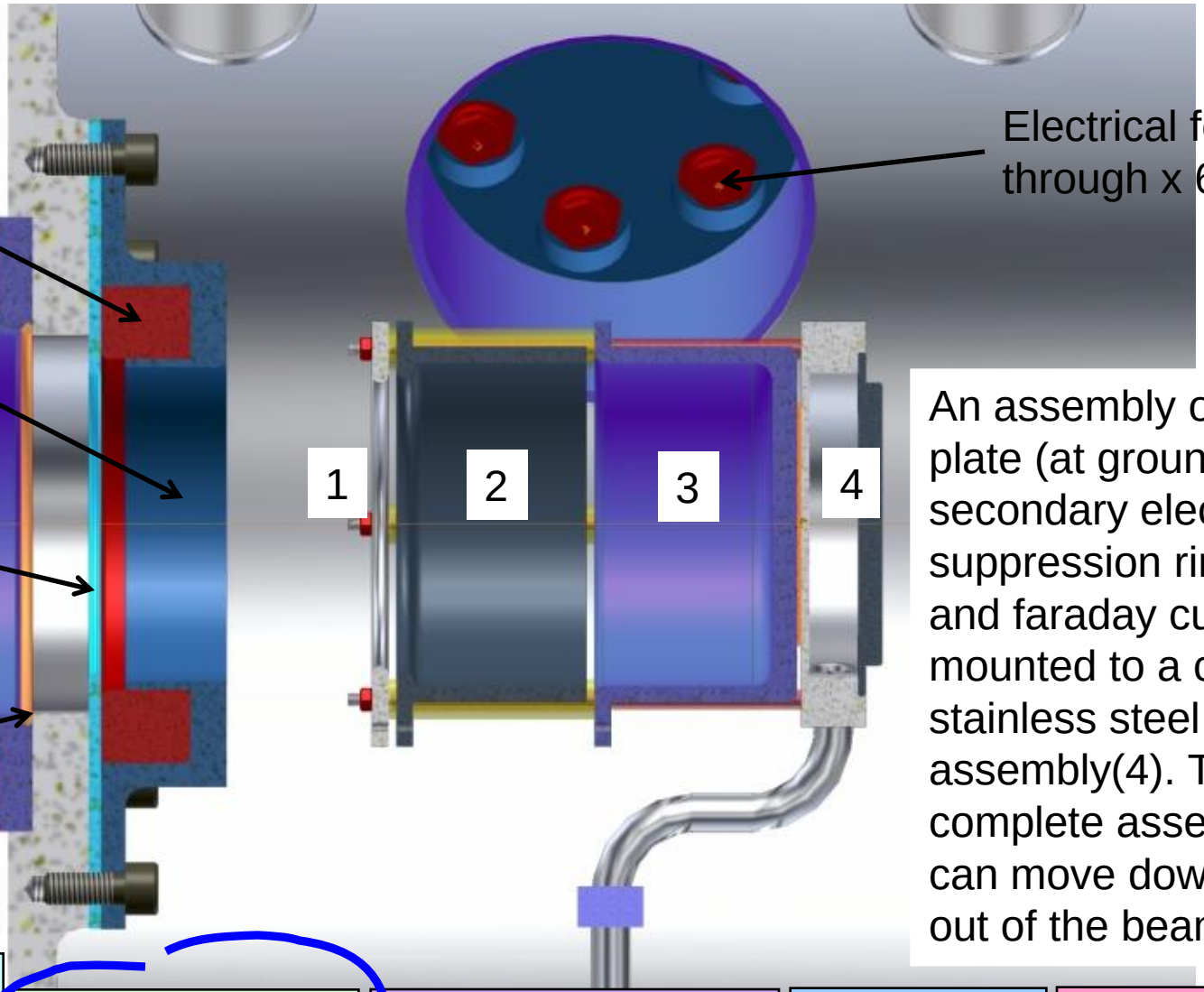
L.E.B.T. FARADAY CUP / BEAM STOP

Faraday cup / beam stop assembly





Pneumatic linear feed-through mechanism



An assembly of front plate (at ground) (1), secondary electron suppression ring (2) and faraday cup (3) all mounted to a cooled stainless steel welded assembly(4). The complete assembly can move downwards out of the beam path.

Ion Source | L.E.B.T. | R.F.Q. | Chopper | Diagnostics

End