Transfer IEC Equipment

My role was electric cable connection between each components

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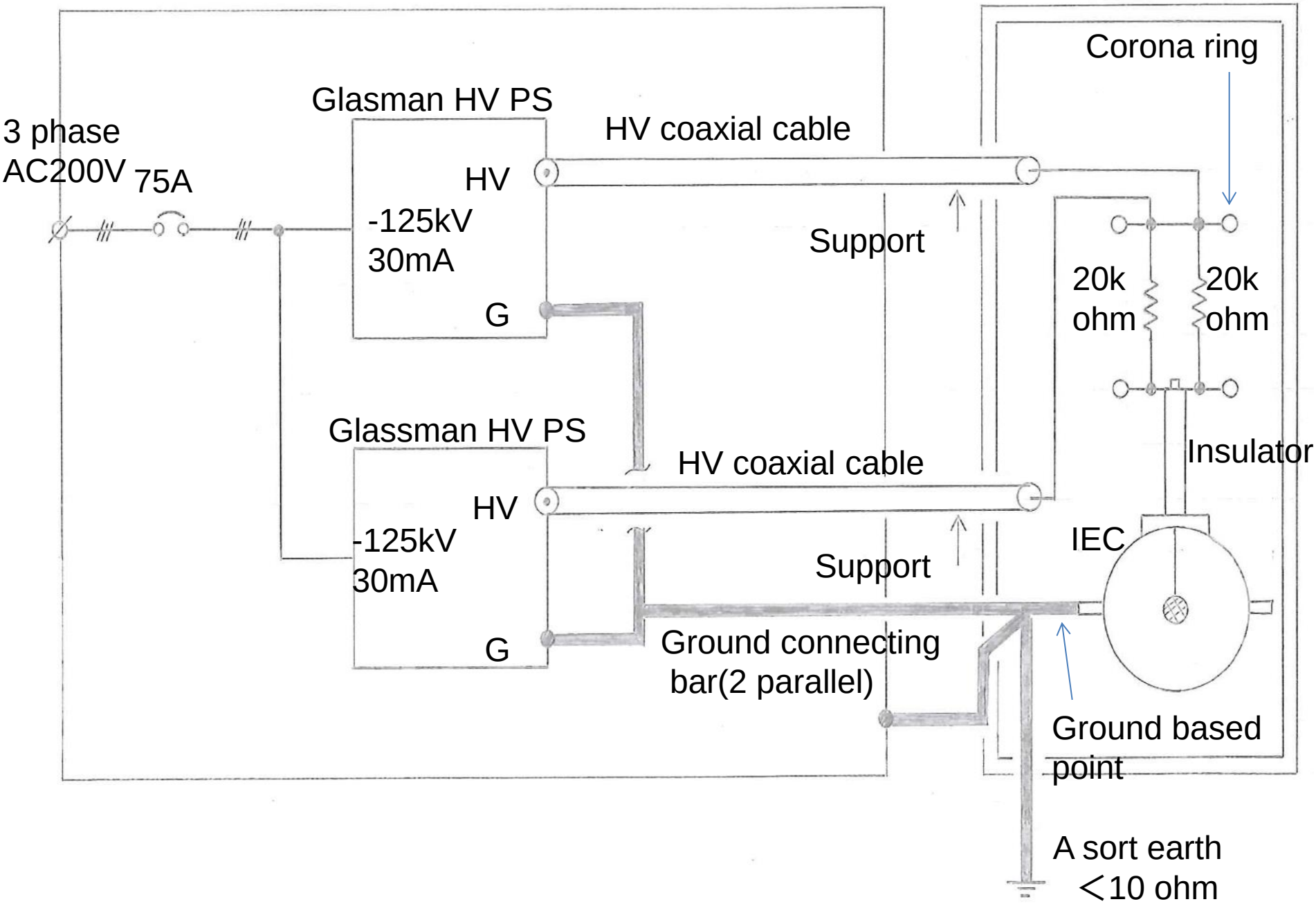
Introduction

- IEC equipment in Kansai University have been moved to Osaka University .
- Its aim is to operate using Tritium gas.
  It was a big job.
- My role was electric connection and wiring between power supply ,IEC chamber and distribution panel
- Not only connecting each component but also improved some of wiring have been done when it have moved to new place.
- I talk detail about these how's going this transfer and some improvement. ground bar, high voltage cable , corona ring , current limit resistor and so on.

Content

1. High voltage cable
2. Corona ring
3. Current limit resistor
4. Floating potential
5. Ground copper bar
6. Summary

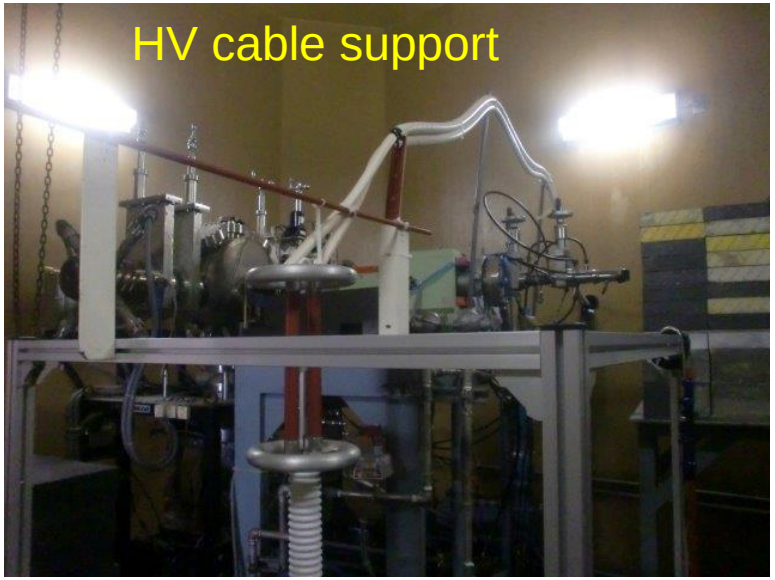
Block diagram of IEC circuit



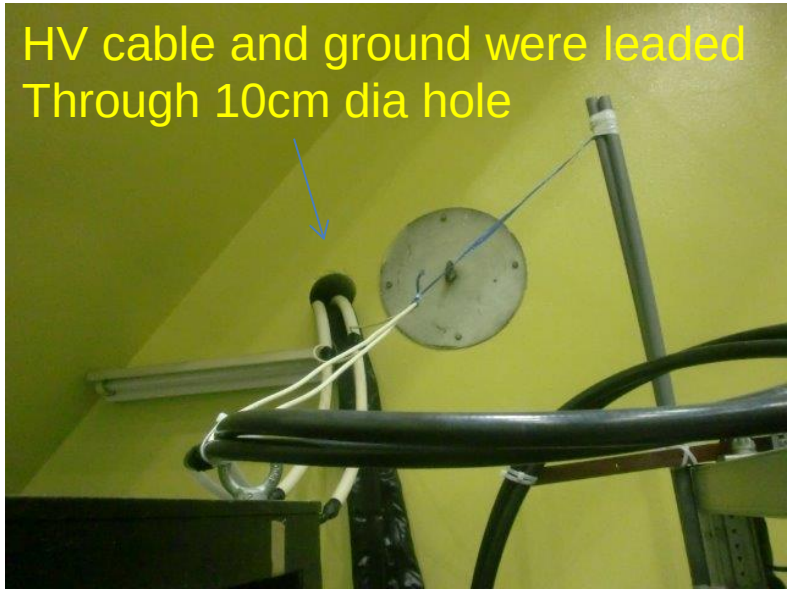
Some pictures before and after transfer

In Kansai University(before)

In Osaka University (after)



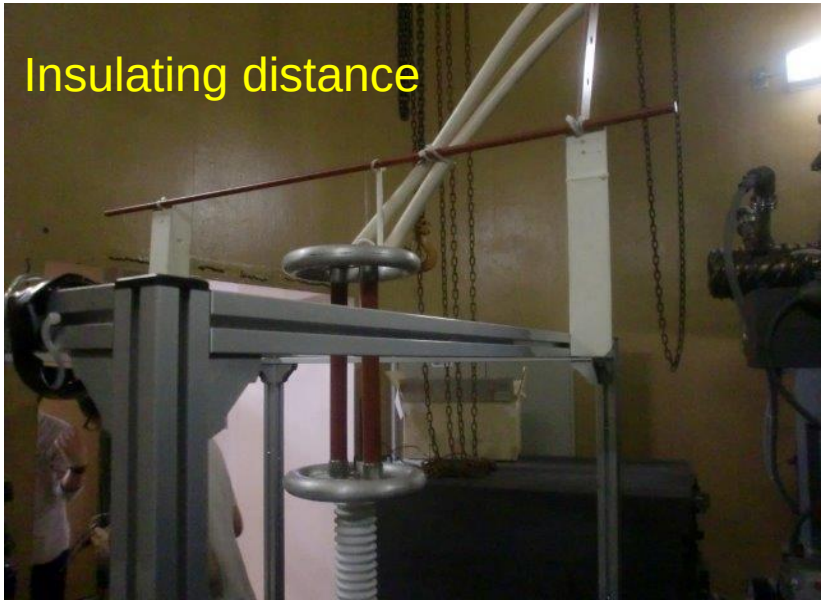
Moved to shied room



Outside of the shield room :HV cable

High Voltage Cable

1,This time I used 100kV silicon cable (with ground shield) . Because Glassman cable was too short to extend to shield room. I connected this cable.
2,I tried wiring through at high place by supporting insulator bar.
3,I always think of safety apart distance from HV point to the ground.
In the air : 4kV/cm and surface safety distance is 2.5kV/cm
So 100kV surface : 40cm so I set 50cm this time.
HV insulator surface shapes wave. it gains more surface distance much better than straight.
4, Only insulating distance is not enough. We have to use HV withstand cable. Otherwise cable itself makes so much corona noise.



Corona ring

1,When we are running with using high voltage corona ring is a must for calming electric field. Without corona ring increasing the voltage bigger and bigger noise. We can't go forward.

Every terminal and screw like this with high potential corona ring is needed.

2,Over 30kV it is a must. This level small ball shape is enough.

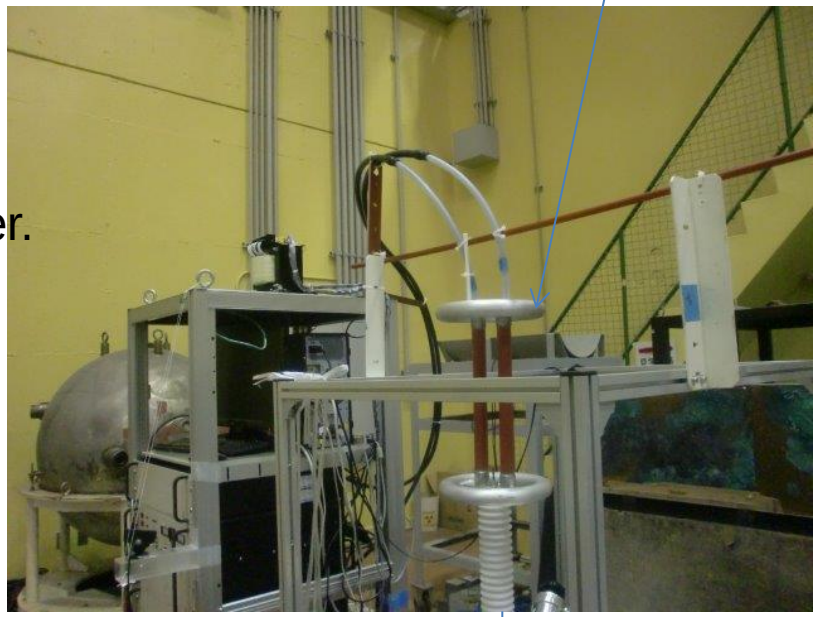
3, Over 50kV , about corona noise is written as follow.

No noise at 100kV
2.8cm section dia
20cm dia

50kV is OK
But not at 100kV
5cm dia

Without ring
Very noisy at 100kV

Current limit resistor



1,We set resistor between HVPS to IEC Chamber.

2,We expect these resistor limit the current when arcing were occurred inside the chamber.

3,How to choice these resistors.

(our example this time)

-100kV Running rated current 60mA

Let's calculate resistor drop under rated running.

100kV-(60mA*10kohm)=99.4kV

No problem this tiny 600V voltage drop.

When arcing were occurred

100kV/10kohm=10A so small.

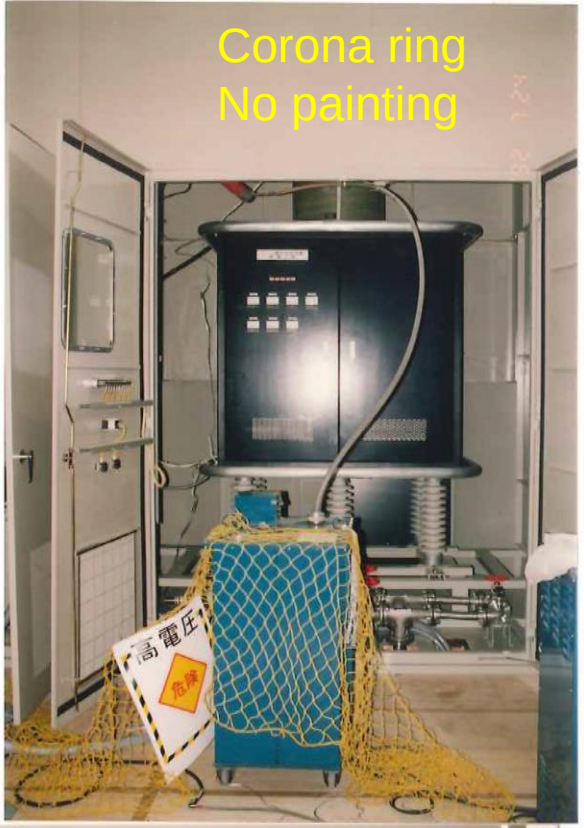
(Without the resistor over 1000A / under us flow the circuit.)

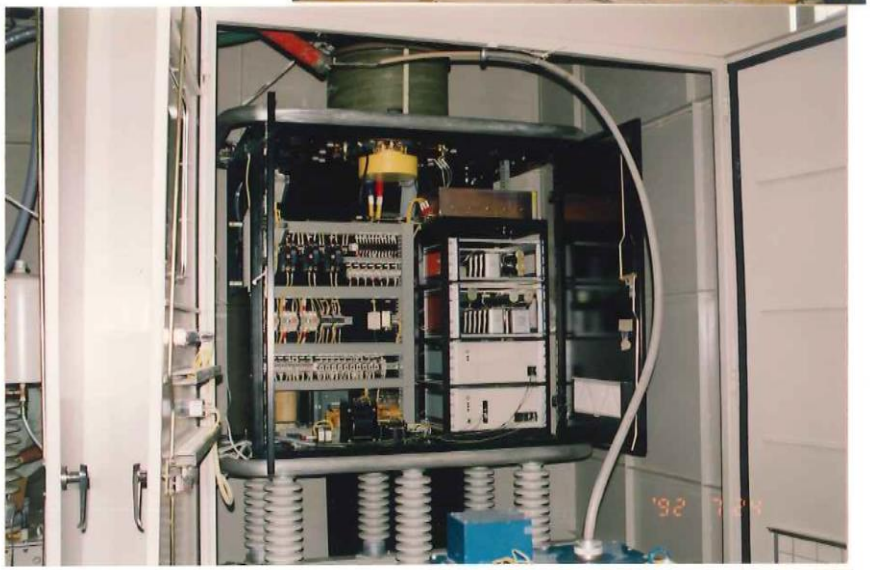
4,Over 10A current can't be flowed this system whatever happened inside the chamber.

It is a big help to become system stable.

Floating potential

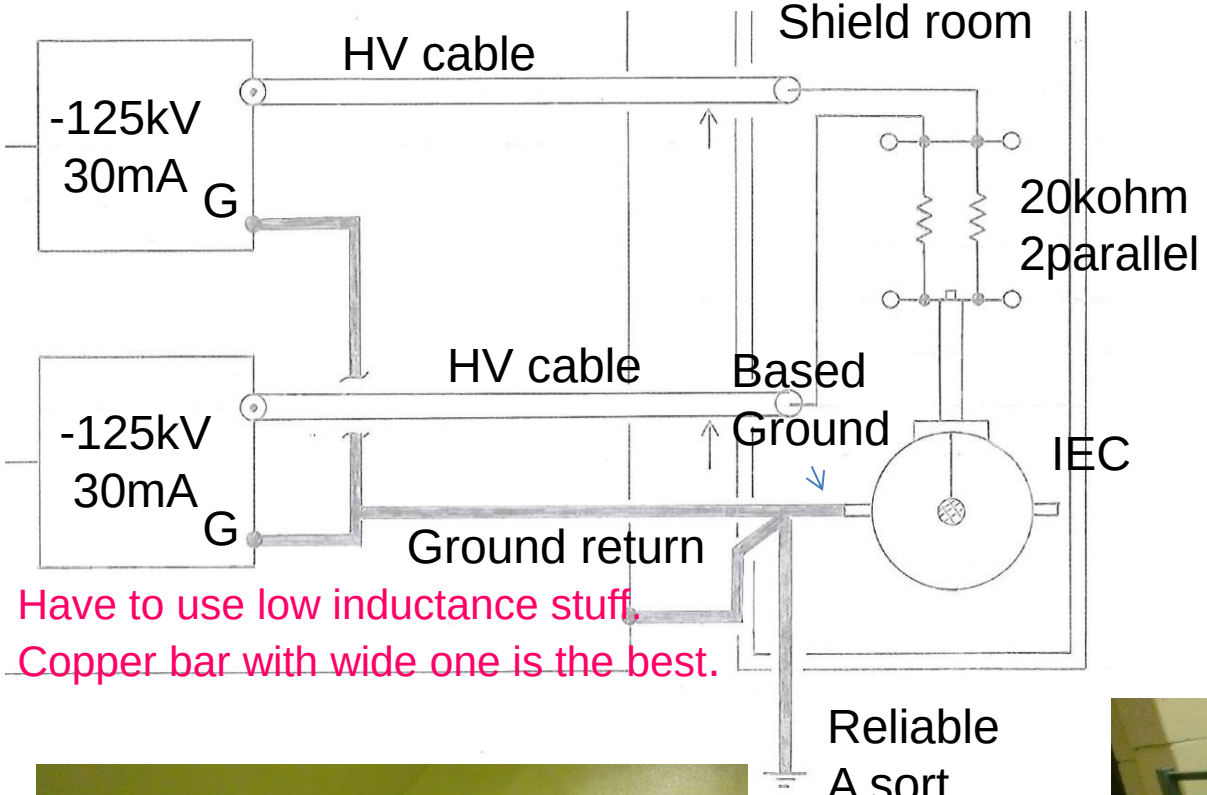
1,In high voltage potential field electric component without any potential are not allowed.
It makes easy to disturb near field , become easy to breakdown. Floating stuff disturb normal running.
2,I tried to fix all component this time. Especially alumite flame and other looks like floating one.
3,This example is 100kV high voltage power tube switch .
All black body is high potential when it running.
All component have to be fixed to any potential even all screw. Painting stuff is conductive . Also faced ground side also painted with conductive one.





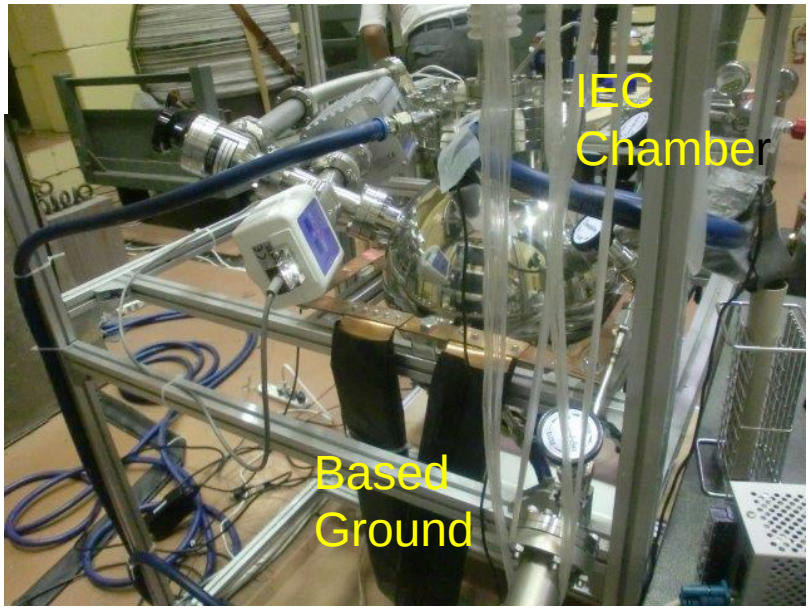
High voltage capture floating parts easily.

Ground connection



Have to use low inductance stuff.
Copper bar with wide one is the best.

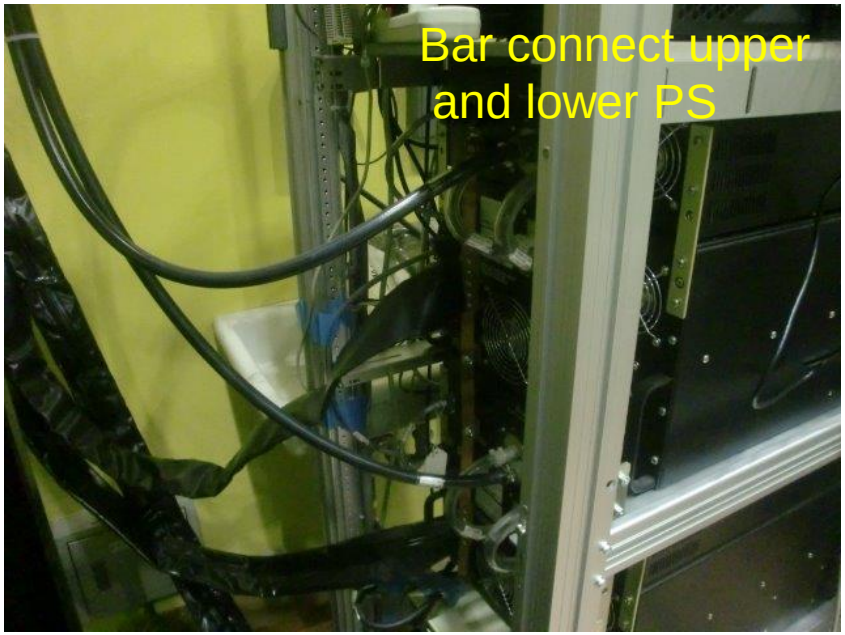
This time



1,While in IEC running we can't avoid arcing inside the chamber.
We want to deal with that one without problem.
Low inductance ground connection and limiting the current do work when arcing were occurred.

2,Low inductance means wide surface area and short distance.

3,I usually use 20cm wide copper plate but this time connecting hole to shield room was 10cm dia .So I choice 7cm wide 2pcs parallel.



Let's calculate sudden voltage increase when arcing occur.
This is a little bit extreme example though.

1, Formula V=-Ldi/dt
This mean both terminal between ground return connection , rapid current change makes big voltage difference.

2,Supporsed no resistor with poor wire ground connection –5m (1m about 1 uH)
When arcing occurred : 1000A in 100ns
V=-5uH 1000A/100ns=50kV
It looks like extreme but not far from real.
Ground wiring increase become 50kV !!
That's why discharge sound inside the cabinet or weak parts have become broken.

3,With 10kohm series . Low inductance copper bar 0.05uH /m inductance
(I supposed 5m, shorter the better as you know)
V=-0.25 uH 10A/100ns=25V
Looks perfect.
Low inductance copper bar and current limit resistor do work well
when big arcing have happened.
4, Do you think which is better?
It is clear.

Summary

1.We have transferred IEC equipment from Kansai University to Osaka University radiation shield room.

2.Running with High Voltage power supply is not easy.
Can't do work well only power supply itself.

3,This application we have to deal with "High Voltage cable with safety insulating distance" "Corona ring " " Floating potential " "Current limit resistor" and "Ground Connection with short and wide bar" and so one.

Thank you for attention!