Electrical Specifications for the HV Test at PC4

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KANSAS STATE UNIVERSITY

DUNE

Outline

- The team, and who's doing what?
- Outline of electrical circuit, structures, properties
- Schedule overview

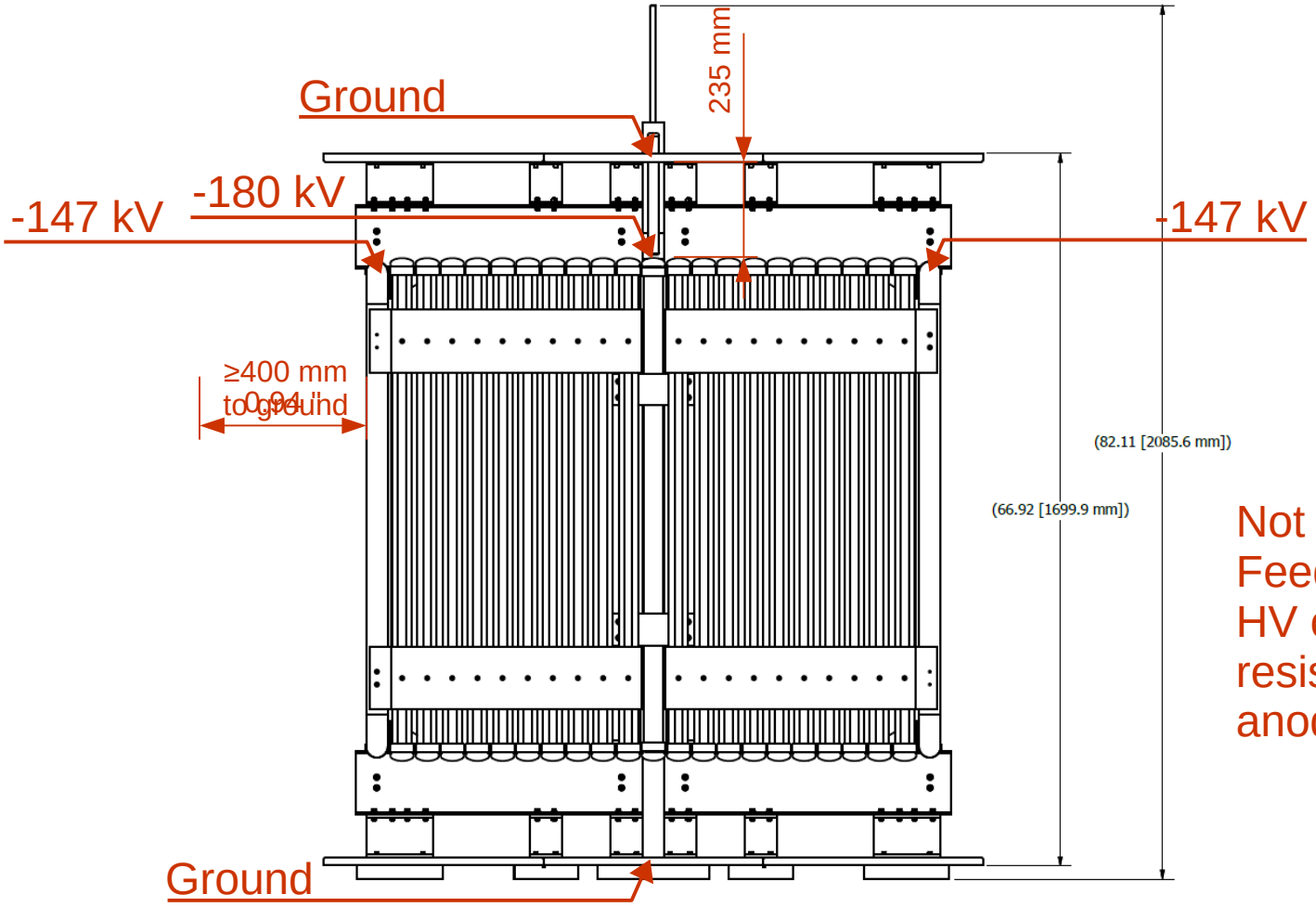
Team

- Lead coordinator (HV): Sarah Lockwitz
- Lead on HV delivery: Glenn Horton-Smith
- Institutions producing components
  - **CERN** (ground planes, CPA surface)
  - **Houston** (HV filter, corona monitor)
  - **Kansas State** (HV bus, CPA frame bias, anode-to-ground resistors)
  - **LSU** (field cage resistor boards)
  - **UCLA** (feedthrough, to be confirmed)
  - **UC Davis** (HV cup and arm, to be confirmed)

Components

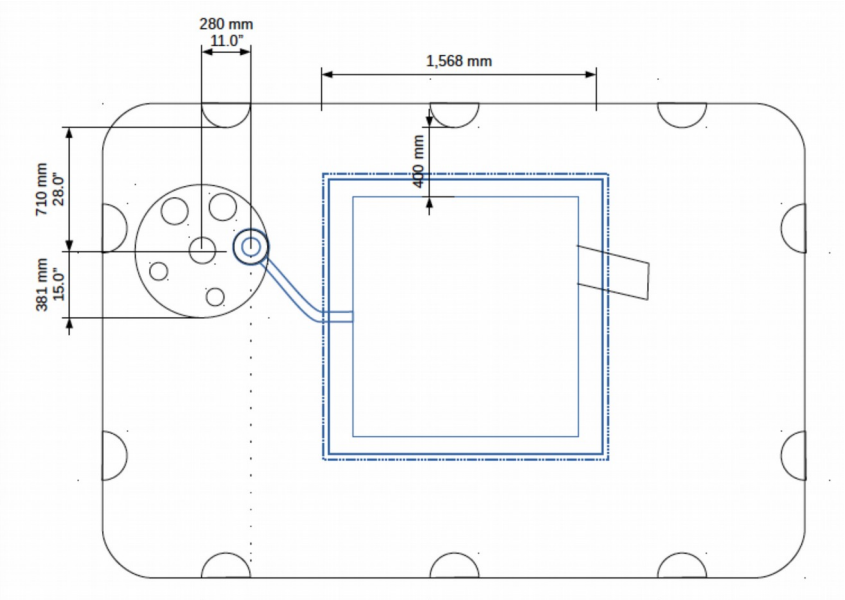
HV power supply (PS)	- tbd
HV filter, corona monitor	Houston
HV cables	- tbd (depends on PS and FT)
HV feedthrough (FT)	UCLA
HV cup and arm	UC Davis (to be confirmed)
HV bus	Kansas State
CPA surface, frame electrodes	CERN
CPA frame electrode bias	Kansas State
Field cage	- see Jeff's talk
Field cage resistor boards	LSU
Anode plane to ground resistors	Kansas State
Pickoff monitor	Kansas State

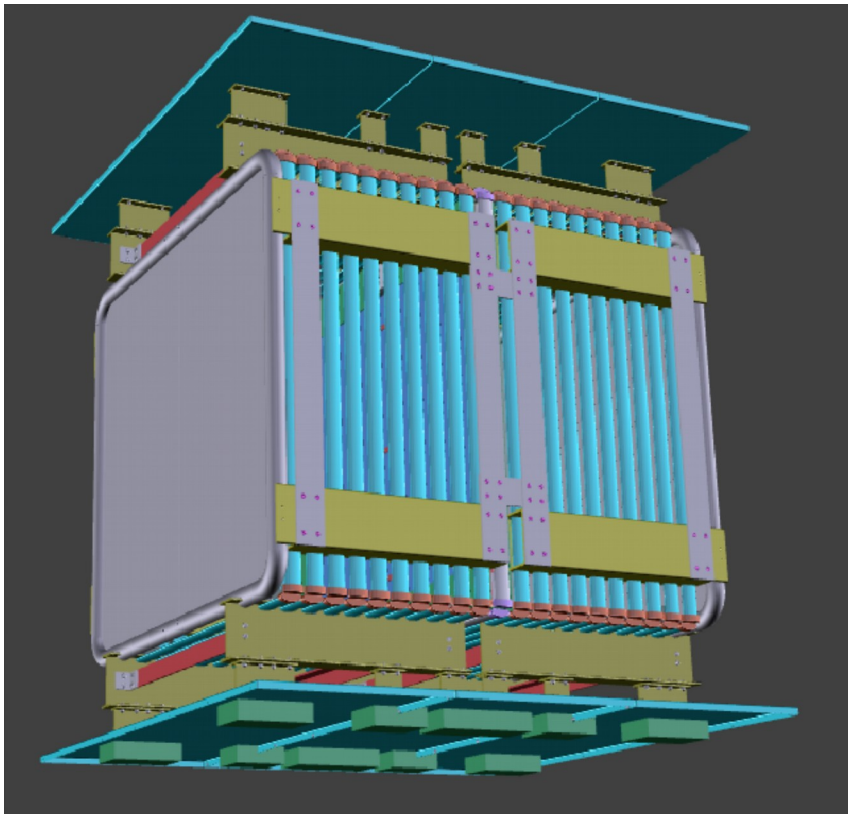
Structures



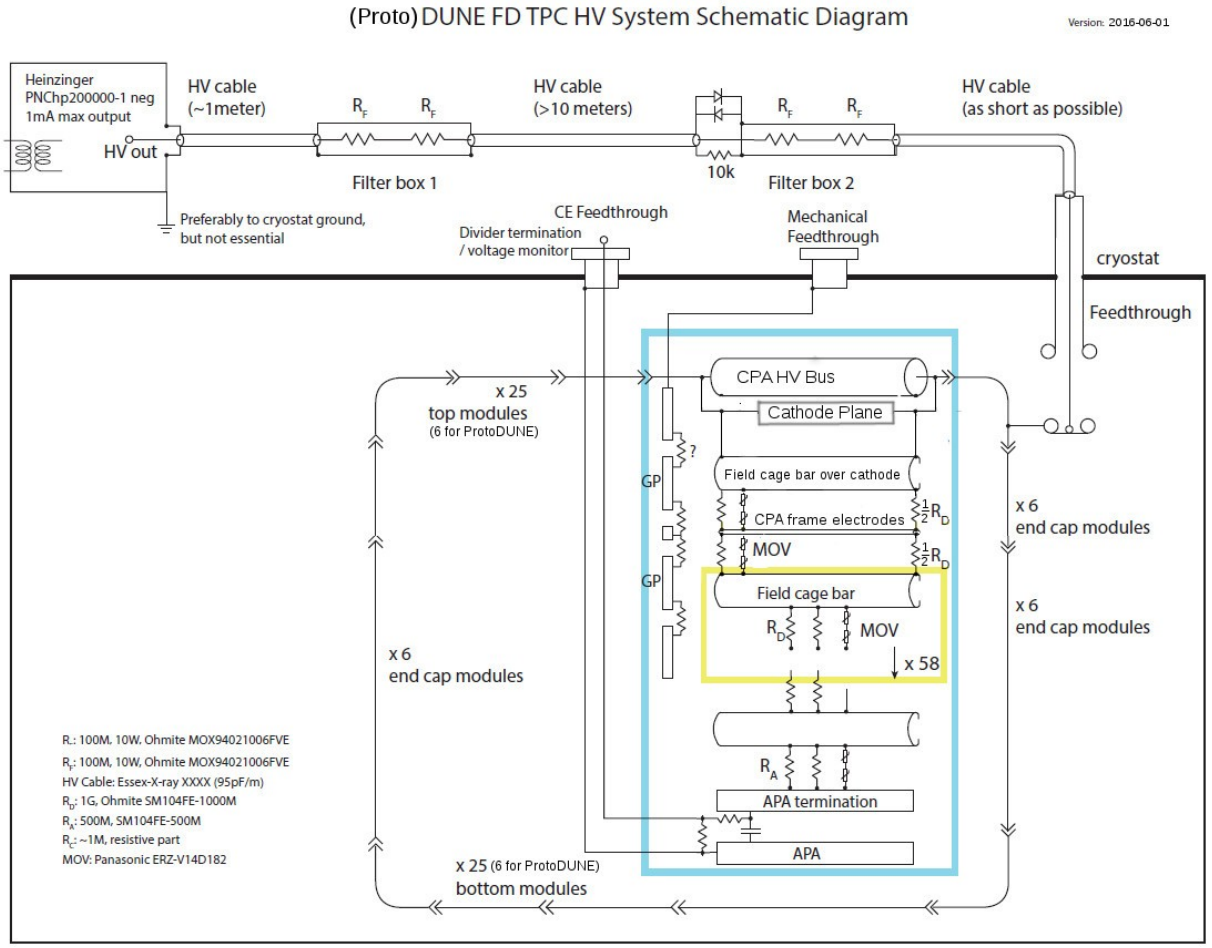
Not shown here: Feed-through, HV cup, and resistors from anode to ground

Floor plan and 3d view

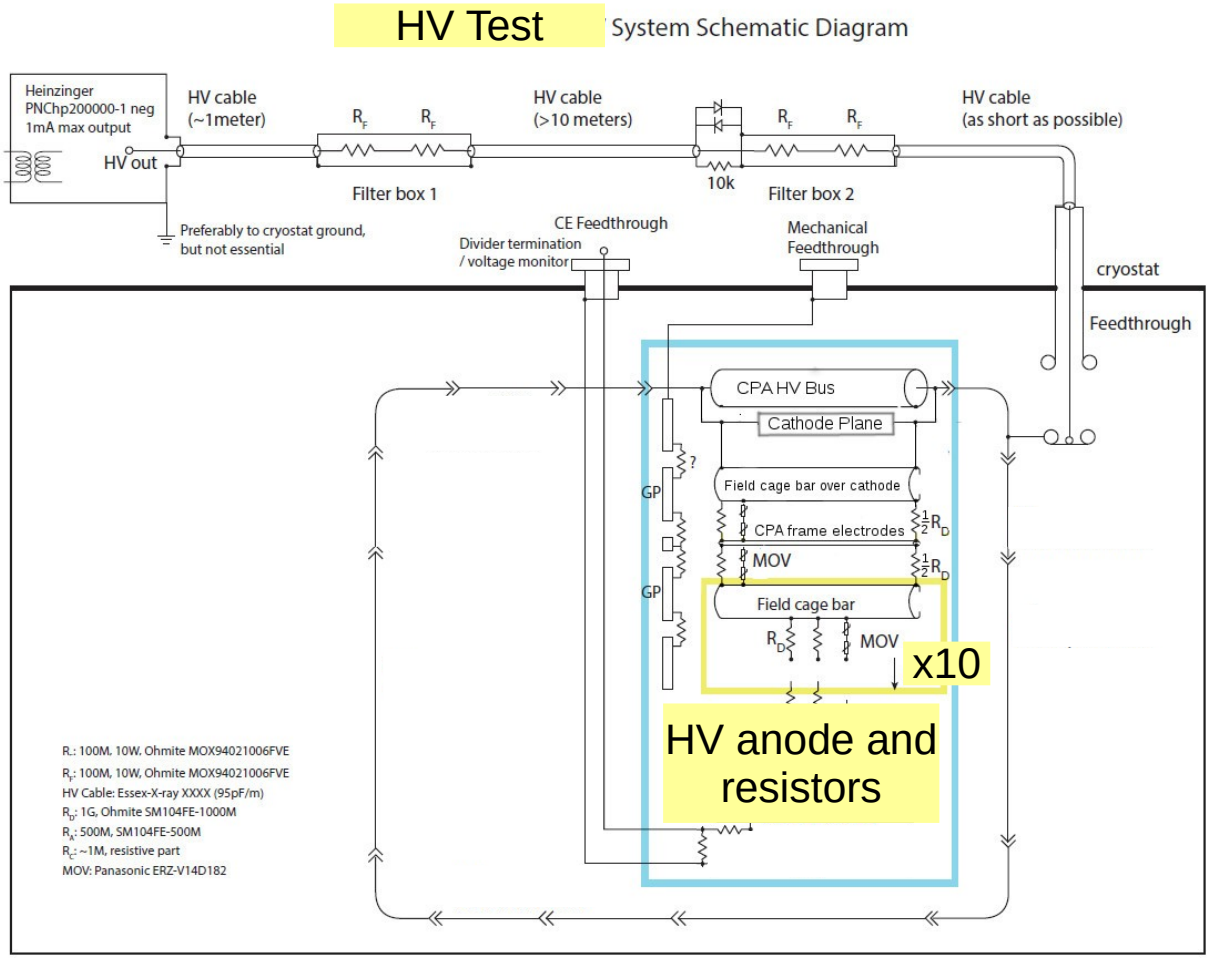




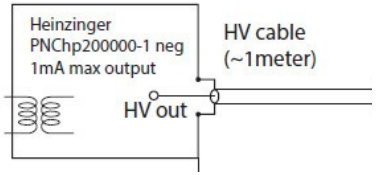
Electrical Circuit for ProtoDUNE



Electrical Circuit for HV Test

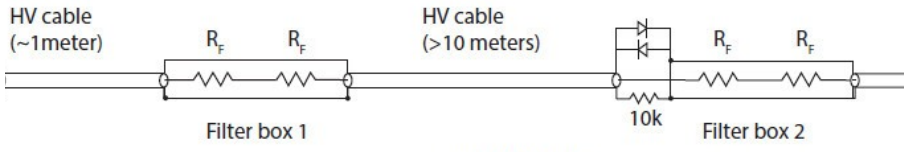


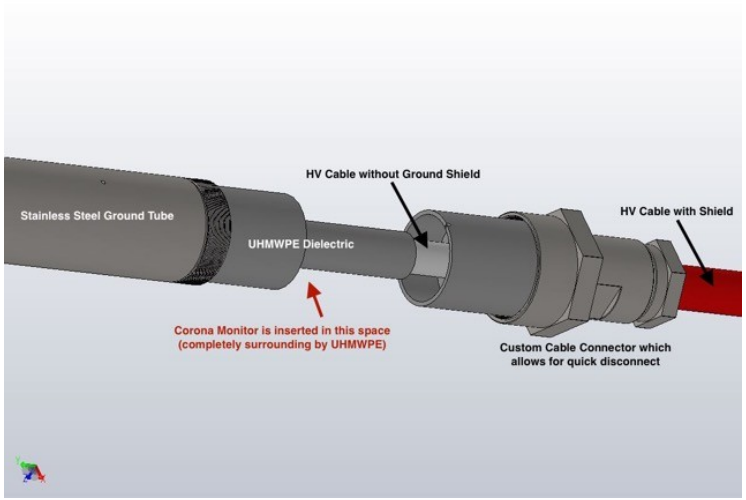
HV power supply



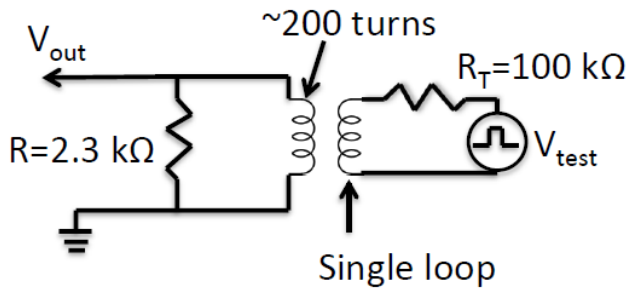
- BNL is coordinating a search for a suitable power supply.
- An ideal solution would be a matched feedthrough and Heinzinger power supply with correct cable
- Backup plan: old 200 kV Glassman from FNAL with analog 0-10V controls and readback. K-State would provide controls (working with FNAL), cable matching to be done in filter box.

HV filter and corona monitor

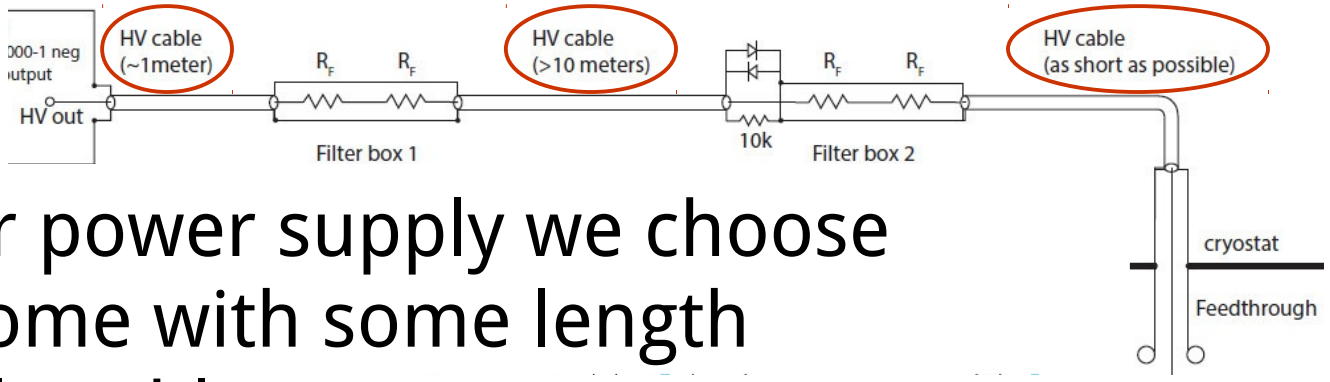




- Resistor in series plus cable capacitance provides filter.
- Toroidal transformer senses current spikes



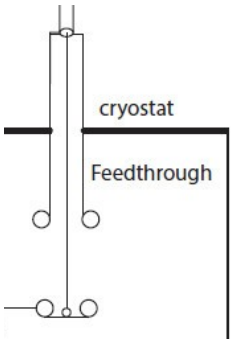
HV cables



- Whatever power supply we choose should come with some length of suitable cable.
- Additional cable will be purchased as needed. (BNL coordinating)

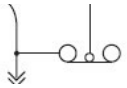
HV feedthrough

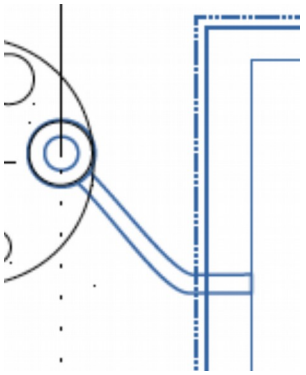
- See Bo's talk for latest on available options given schedule constraints.

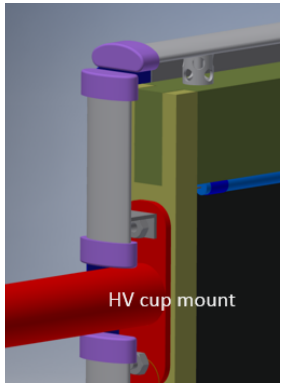


HV cup and arm

- Arm needs to be a particular size with a particular bend to match feedthrough placement to HV test object placement.
- This is unique to the HV test, not representative of ProtoDUNE. Far from ground everywhere.
- UCD has offered to make.

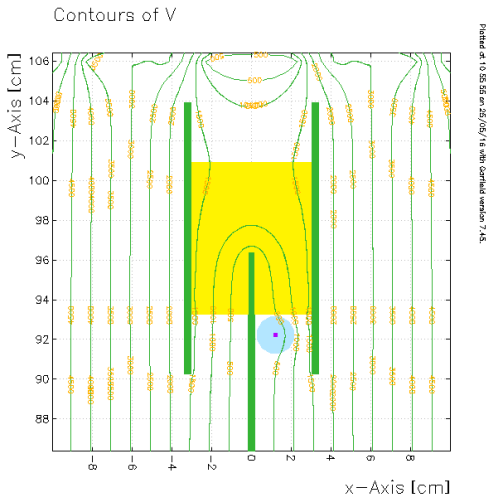




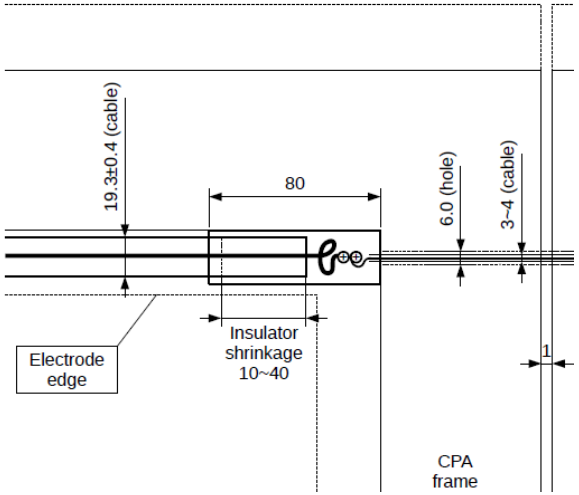


See also slides 11 & 25 in Bo's talk

HV bus

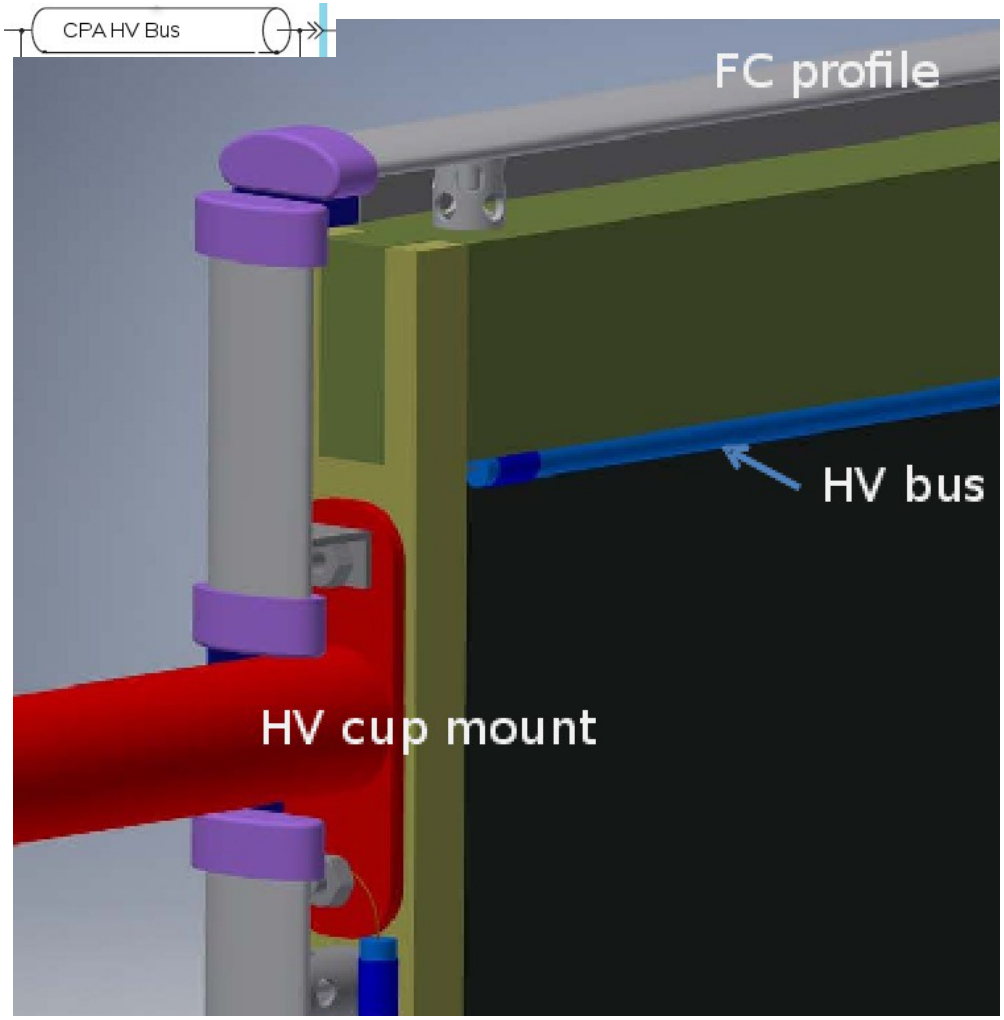


- HV Bus is a low resistance connection to all cathode planes.
- Located in the 500 V/cm field between frame electrode and cathode.
  - Use a 200kV cable so to avoid any chance of arc to cathode from unequal voltages during a discharge event.
- Flexible, lower-voltage cable OK for connections through frame.

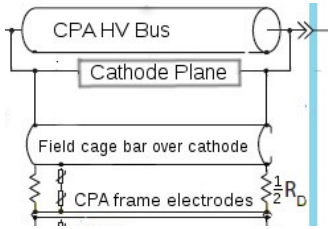


Another view of HV bus

- The CPA frame electrodes have been hidden in this view.
- HV bus installed as part of CPA assembly, before installation of frame electrodes.



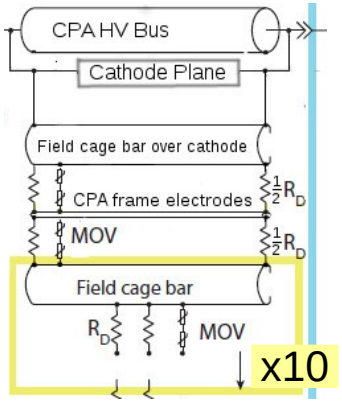
CPA surface and frame electrodes

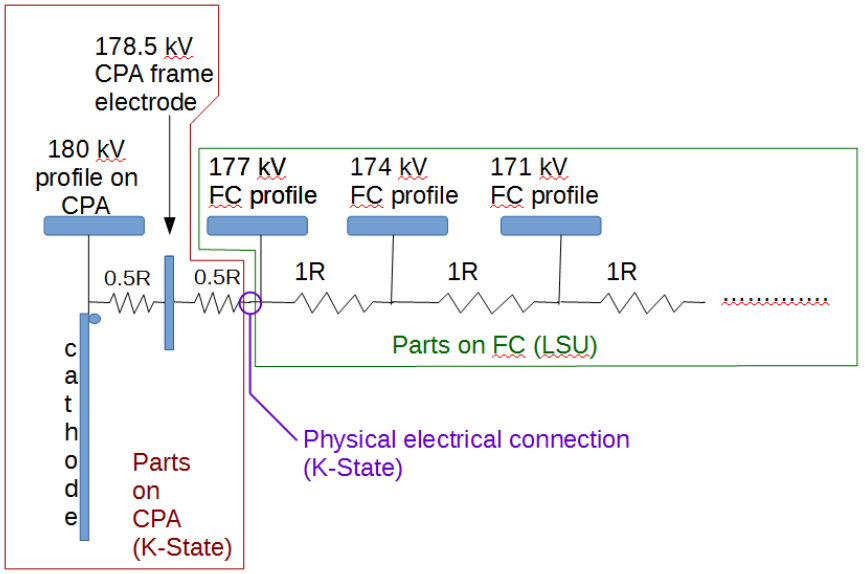


- The cathode sheets with resistive surface will be provided by CERN.
- The plan is to make CPA frame strips out of the same material.

CPA frame electrode bias

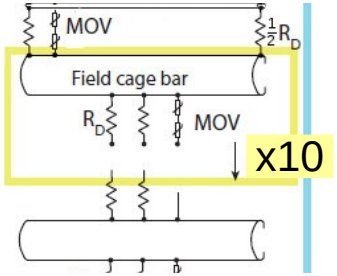
- The electrodes on the CPA frame are halfway between cathode and first FC element, half step in voltage.
- Resistors for providing the bias will be mounted on CPA. (also varistors)
- Install with frame electrodes.

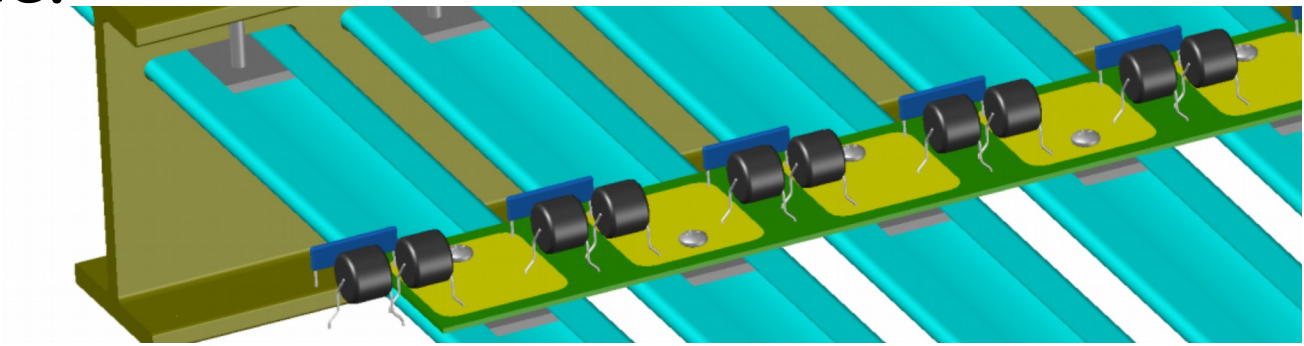




Field cage resistor boards

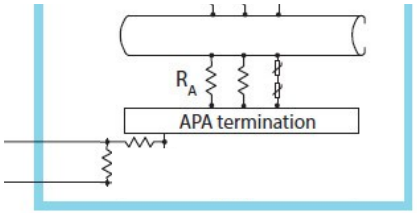
- Field cage resistor boards will be provided by LSU.
- They need to be installed on the interior side of the FC.
- They should be installed as part of FC wall assembly, before walls are put into place.

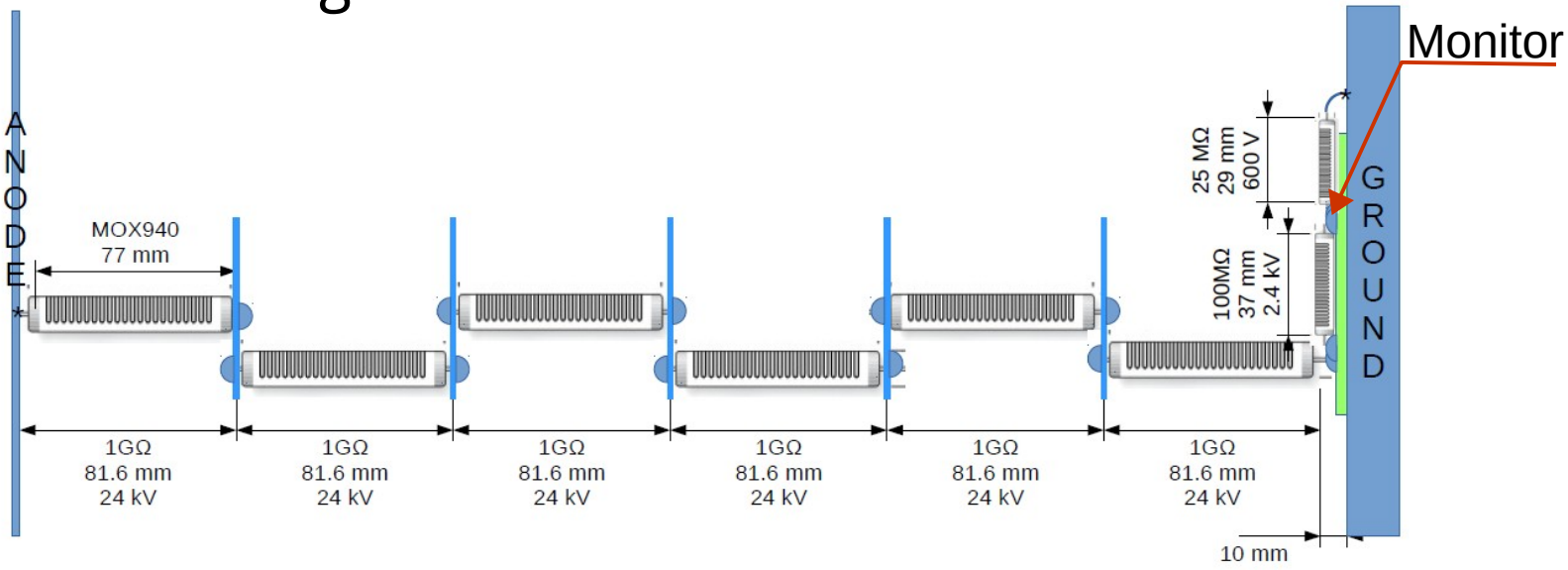




Anode plane to ground resistors, with “pickoff” monitor

- At 180 kV nominal HV, need to take 147 kV down to 0 kV, 25 μA current.
- Design below keeps uniform field over 50 cm within ratings of resistors.
- Monitor voltage of last resistor.





Phase II

- Beam plug will require additional current from HV bus, flows to ground by alternate path
- Plan to add resistors in parallel with standard circuit upstream of beam plug
- See Cheng-Ju's talk for details

Schedule

A rough straw schedule:

Item	Institutions	Install date	Optimistic target for acquisition
HV power supply	BNL coordinating	any time before November	Decision in August. Obtain in October?
HV filter with Coronal monitor	Houston	any time before November	Start after HV PS and FT cable decided
HV bus	Kansas State	November	End of August
HV feedthrough	UCLA	November	?
HV cup with connection to frame	UC Davis (tbc)	November	?
HV bias of anode planes	Kansas State	November	End of August
Resistor divider boards	LSU	November	Any time before November