Status of the HV System design
for the
CMS DT Muon Chambers
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The structure

The structure of the Muon DT Chambers as decided by the collaboration is the following:

- 250 Chambers distributed over 5 Wheels in 4 Stations coaxial to the beams.
- MB1, MB2, MB3 Chambers equippped with 3 Super-Layers, 2 in ϕ and 1 in ϑ
- MB4 Chambers equipped with only 2 SL in ϕ
- Each SL made of 4 Layers, alternately staggered by half a cell.

A few issues are relevat to the HV distribution system:

a) The particular structure of the SL is related to the trigger capability of the SL themselves; in such a structure the malfunction of one SL limits the efficincy, but does not destroy the trigger that can still be produced by 3 layers out of 4
b) As a consequence the HV distribution is organised by Layer, so to preserve the trigger capability in case of failure of one HV line.
c) The operating limits of the MB96 prototype chamber have shown the importance for the cell's integrity, that the voltage difference between Wires and Strips does not excede 1900÷2000 volt. For this reason the HV distribution system must foresee an automatic hardware protection against the overriding of this limit.
d) The detector is forcedly distributed in a large volume of iron, where the quality of the ground connections is not at all assured. This led to foresee the chambers as isolated with respect to the Iron yoke, implying floating LV and HV power supply systems
e) The metallic structure of the chambers is in itself the ground point for power supplies and signals; as a consequence the distribution tree of the power supplies must avoid the coupling of the chambers through connections and ground loops.

The Granularity

The MB96 prototype chamber has been built associating the three HV values **per Layer** with the following granularity:

	SL1-SL3	SL2	
1 connection per	**8 cells / layer**	**8 cells / layer**	**for Wires**
1 connection per	**24 cells / layer**	**32 cells / layer**	**for Strips**
1 connection per	**24 cells / layer**	**32 cells / layer**	**for Cathodes**

Such a granularity allowed for a detailed control of the chamber behaviour, particularly important in the prototyping phase.

The experience made on MB96 in the debugging and conditioning phase, suggested to the collaboration to mantain a comparable granularity also in the chamber production, at a stage when the cost estimate of the distribution system was not yet possible. It was foreseen to degrade the granularity as necessary, *externally to the chambers*, as a function of affordable costs for the HV system.

The actual design of the chambers implies the following *internal* granularity, accessible at the chamber HV connectors:

1 connection per	**8 cells**	**/layer**	**for Wires**
1 connection per	**16 cells**	**/layer**	**for Strips**
1 connection per	**16 cells**	**/layer**	**for Cathodes**

The choice of 48 pin HV connectors (+GND) for the SL of all the chambers allows for the standardisation of all the covers, assining 2 HV connectors to each SL.

The Layout

In order to match the granularity ratio among W, S & C, the basic element of the distribution, direcly connected to the chambers will provide 2 anode channels (W), 1 strip channel (S) and 1 cathode channel (C); this element is named the CF channel.

The available space for the HV distribution system is mainly localised on the balconies and only a limited space is available in MCR. Besides, given the not negligeable stray magnetic field and the nutron fluence in the balconies' region, the regulation & monitoring functions are better to be splitted with respect to the HV generation and control ones.

As a consequence, the CF channels housed on the balconies, will perform the regulation & monitoring functions, while the generation and control functions will be performed by the CC channels housed in the system crates in the MCR.

The System assumptions

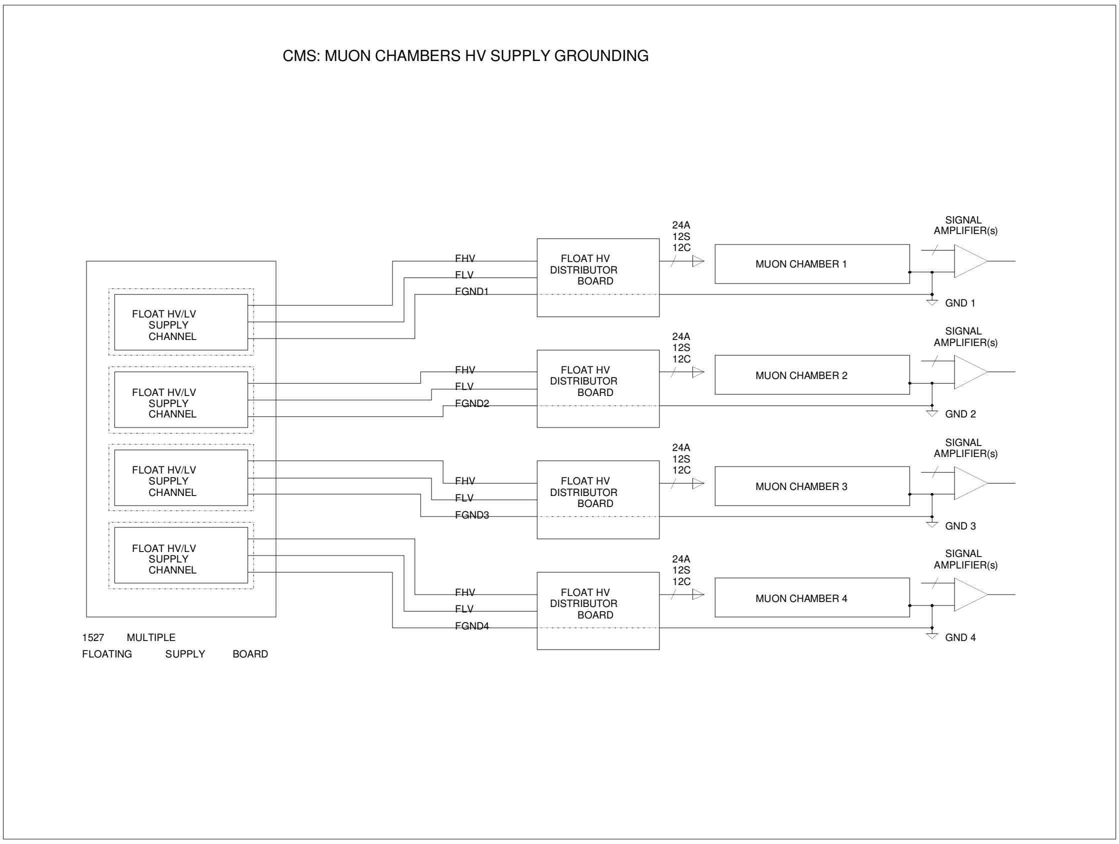
From a coarse and preliminary estimate of costs and affordable volumes for the HV distribution system, the following working hypothesis have been considered as the baseline for the design of the final prototypes of the system:

- 1 HV connector : 24 pins for W, 12 pins for S, 12 pins for C
- 2 HV connectors per SL ⇒ 6 HV connectors per Chamber
- 1 CF delivers 2W-1S-1C for ONE layer of a SL
- 12 CF per module - 8 modules per 6U crate
- 1CC per Chamber
- 4 CC per module – 8 modules per Main Frame – 8 MF Crates per CMS

As a consequence 1 CF module is adequate to feed 1 chamber in all cases, while MB4 chambers require CF modules equipped with only 8 channels instead of 12; the whole system will consist of:

CF Modules	250	(in 2 crates per balcony)
CC Modules	64	
MF (SY1527)	8	

The following scheme clarifies the basic connectivity of 1 CC module towards 4 CF modules and the relative 4 chambers.



Granularity

The above assumptions have the important implication that some reduction in the granularity must be applied externally to the chambers.

A possible simple solution would be to reduce:

- by a factor of 2 at the HV output connector level in the CF modules
- by the necessary factor (2 or 3) at the level of the HV cable connector on chamber

As a consequence only 1 HV cable per SL would be necessary, split on the two HV connectors.

In case of need the solution shown would still allow for a relatively quick intervention at the balcony level, plus a "difficult", but possible, intervention at HV connector level on chambers without the need to open the chamber enclosure.

Power Requirements

Specifications for CF channels:

- W1 10μA @ +4kV
- W2 10μA @ +4kV
- S 10μA @ +2kV
- C 20μA @ -2kV

Actual currents measured at GIF gave Max 1μA @ 3550V per 8 wires under CMS Barrel conditions.

- **12μA @ +4kV + 12μA @ -2kV (+12μA @ +2kV just for precaution)**
- **96 mW/CF channel** (2W+S+C)
- **1.5 W/CF mod for HV**

Safety margin: power calculated as if each CF load = MB4 layer.

LV necessary for CF mod.s require ~30W /CF mod, so

- **31.5 W/CF mod in balconies**
- **410 W/quadrant** (all dissipated in racks)

Assuming ~50% efficiancy in DC-DCconversion, and having 1 CC mod $\Rightarrow$ 4 CF mod,

- **250 W/CC mod**
- **2 kW/SYS crate** (1kW dissipated in CR)

UPDATE

The status of the HV system as updated to 28 October 1999 is the following:

A final prototype has been produced and delievered consisting of one system crate SY1527 housing one 4-channel CC module (4 times +4kV,-2 kV), plus one 12-channels CF module (12 times +4kV, +2kV, -2kV).
The prototype is now under test in LNL and an equal one will be tested by CERN under neutron irradiation.
A preseries production is foreseen by beginning 2000.
Pictures of the system in LNL are available at:
http://warco.pd.infn.it/cms/electronics/HV-hardware.pdf