HIGH VOLTAGE POWER SUPPLY SYSTEM FOR CMS FORWARD SUBDETECTOR

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The problems of the design of the high voltage power supply system for the photodetectors in the Hadron Forward Calorimeter (HF) of the CERN LHC CMS detector are discussed. A very economical high voltage (HV) system is proposed. In it up to 72 photomultiplyers with very similar gain on supply voltage dependences are supplied from common 3 HV channels. As a result the number of HV channels and their 165 m long cables is drastically decreased, as well as the price of the system.

1. INTRODUCTION.

The Compact Muon Solenoid (CMS) is one of the detectors for the new accelerator - Large Hadron Collider (LHC) in CERN [1]. The CMS Hadron Calorimeter [2] consists of three parts (fig. 1) – Barrel Calorimeter (HB), Endcap Calorimeter (HE) end Forward Calorimeter (HF). The HF calorimeter has two identical parts (HF1, HF2), located on both sides of the interaction point at about 11 meters. Each part con-

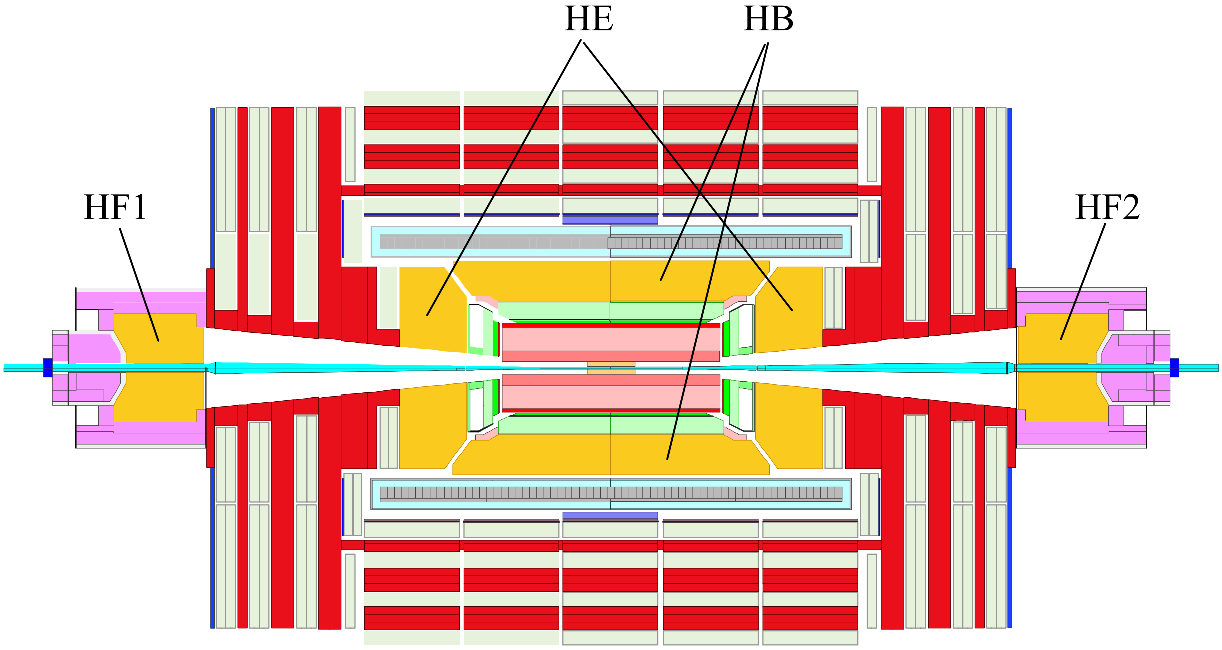

Fig. 1. CMS detector

sists of a large copper block that serves as absorber. The embedded quartz fibers in this absorber (parallel to the beam direction) constitute the active component of the detector: particles incident on the front surface of the HF detector produce showers in the copper/quartz matrix and a part of them generates Cherenkov light in the quartz fibers. Photomultiplyers (PMTs) in permaloy shielding will be used as photodetectors of Cherenkov light, because of relatively low magnetic field in this region of CMS detector.

About 1700 PMTs will be used in both HF subdetectors. In order to limit the number of high voltage channels and cables as well as the total power losses a specific structure of their high voltage power supply system had to be developed.

2. PROBLEM STATEMENT.

Normally for the power supply of a PMT a resistor divider is used, by means of which all voltages for the PMT anode and dynodes are generated. But the using of more than 1700 individual dividers for all HF has a few disadvantages:

- high power losses, resp. increased heating inside cavern;
- individual HV channel with a long (about 165 m) cable for each PMT, which will be very expensive.

On the other side the PMT current has a pulse characteristic and the average current throw each PMT is not very high. This peculiarity permits to use common power supply resistor dividers for a group of PMTs if their gain on supply voltage dependences are very similar. Accepting this basic line, a specific HF PMT power supply system is proposed.

3. RESULTS.

For many reasons [2] 8-stage PMT, type R7525 of Hamamatsu are chosen. Constructively the total HV-system will be composed of 72 read-out boxes ("roboxes").

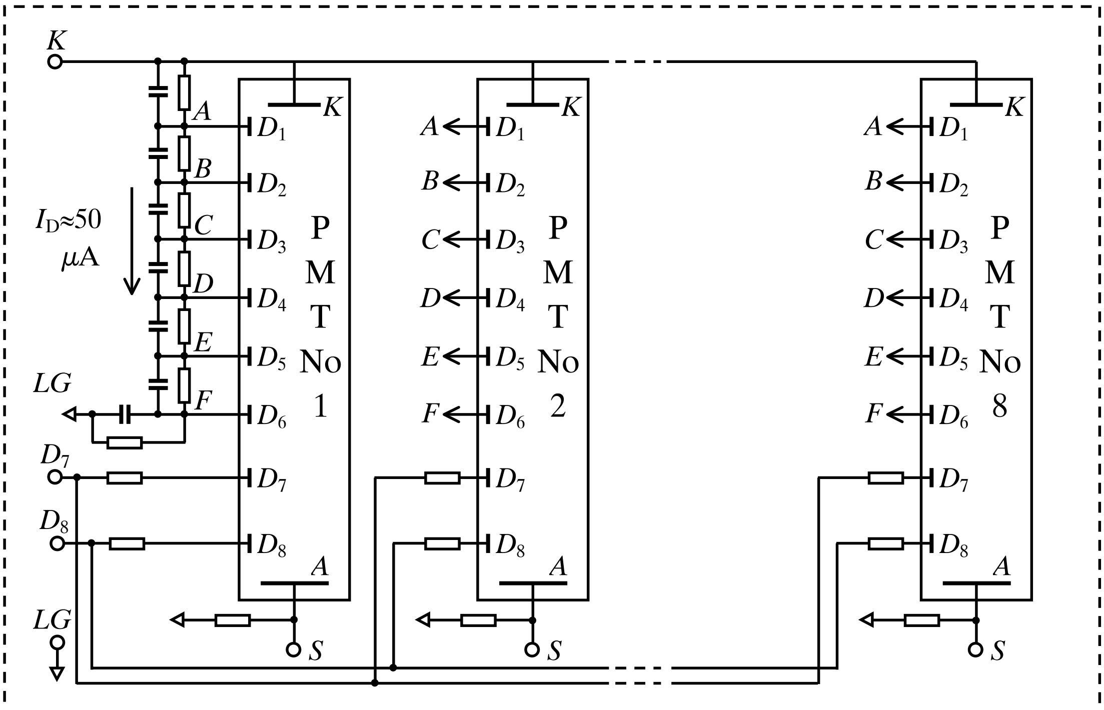

Fig. 2. One ROBOX PCB

The 36 roboxes of each HF will be divided in four groups of 9, corresponding to the four HF quadrants.

There will be in each robox three printed board circuits (PCBs) with 8 PMTs at one PCB. These 8 PMTs have to be selected with very similar gain on supply voltage dependences, because their namesake dynodes will be connected in parallel and will be supplied by the same voltage (fig. 2). Because of the relatively low current in the first 6 dynodes, they will be supplied from a common voltage divider, with a current of about 50 μA through it. Two separate HV channels are foreseen for supplying the groups of the last two dynodes (D_7 and D_8). In this manner, the highest dynodes cur-

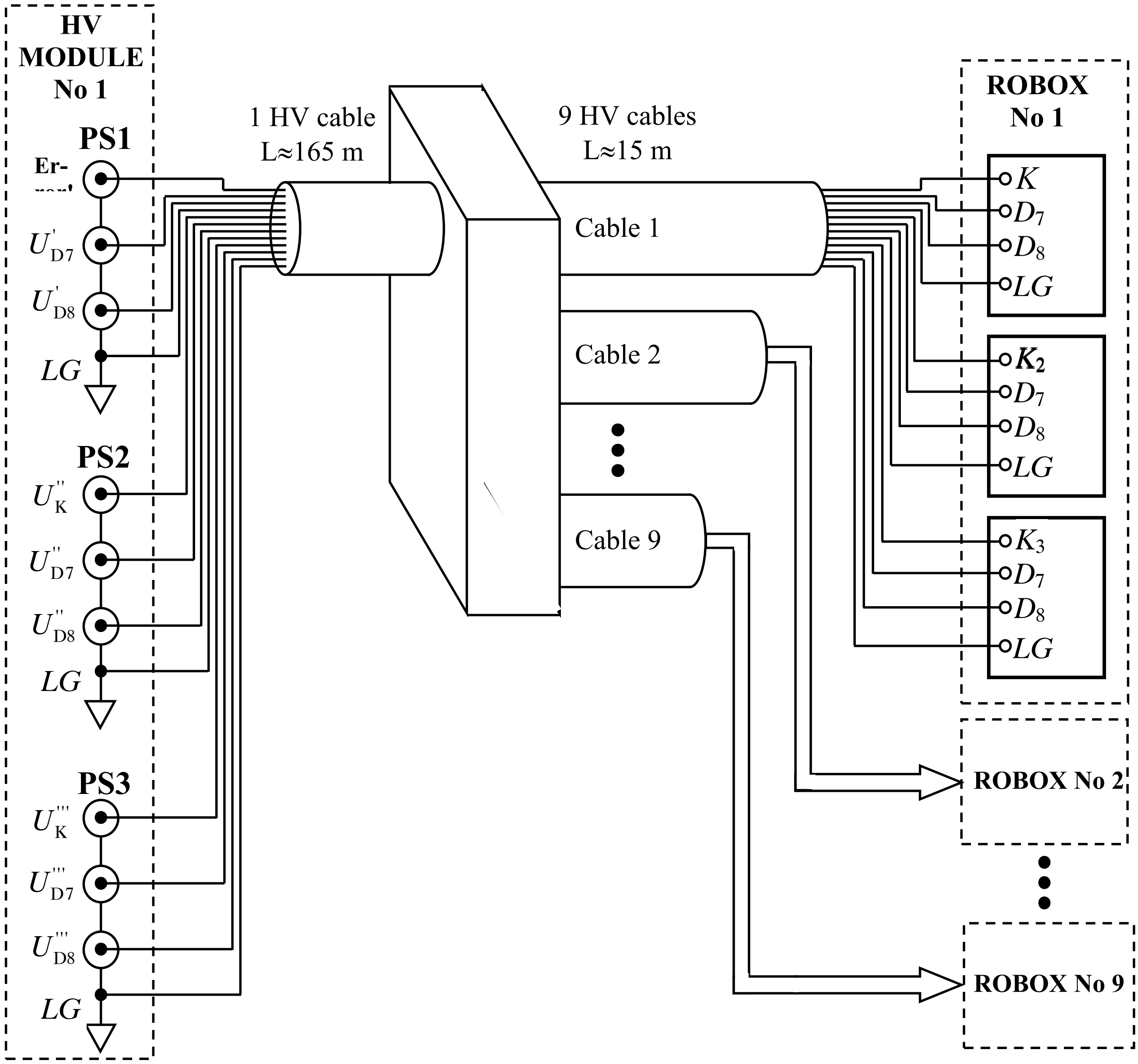

Fig. 3. One quadrant HV system structure

rents will be taken directly from the corresponding HV channels, without any voltage or power losses in intermediary resistors.

As could be seen, three different voltages are needed for one PCB: U_K - for the resistor divider, supplying in the same time the PMT cathodes; U_{D7} – for the group of dynodes D_7 and U_{D8} - for the group of dynodes D_8. In order to cover the differences between individual gain on supply voltage dependences of the PMTs, these 3 voltages will be different for the three PCBs, i.e. each robox will be supplied by 9 different voltages.

The number of the HV channels and cables of all system however will be decreased supplementary, by supplying the all 9 roboxes in one quadrant with the same 9 voltages (fig. 3). In such a case only one 12-wires cable with a length of about 150 m and nine 4-wires cable of about 15 meters are necessary for each quadrant (8x150 m. and 72x15 m for the all system).

Table 1. Basic parameters of the HF HV system.

PARAMETER	CHANNELS 1, 4, 7	CHANNELS 2, 5, 8	CHANNELS 3, 6, 9
Max. output voltage, V	2000	800	400
Voltage resolution step, V	1	1	1
Output ripple, mV_{P-P}	300	300	300
Floating output	Yes	Yes	yes
Max output current, mA	0,5	0,5	0,5
Long tem stability, %	<0,1	<0,1	<0,1

The nine HV channels necessary for each quadrant could be housed in one HV module and the all HV system will needs only 8 HV modules. The necessary basic parameters of the nine channels in each HV modules are shown in table 1. The HV power supply channels and modules as well as the computer control of the system are under development.

4. CONCLUSIONS

In the developed HV power supply system for the CMS HF subdetector some new decisions are applied:

- the PMTs are united in groups with very similar gain-suply voltage characteristics;
- only the first six dynodes of all PMTs are supplied by a resistor voltage divider; the last two dynodes are supplied from separate HV channels;
- 9 PCBs (each with 8 PMTs) are connected to each HV channel.

As a result the number of HV voltage channels and the long HV cables as well as the corresponding expenses are drastically decreased – 72 instead of 1728 HV channels and 8 instead of 144 cables. The power losses are reasonably limited too.

5. REFERENCES.

[1] CMS Collaboration. *CMS Technical Proposal*. CERN/LHCC 94-38, LHCC/ P1, 15 Dec. 1994.

[2] CMS Collaboration. *The Hadron Calorimeter Project*. Technical Design Report. CERN/LHCC 97-31, CMS TDR 2, 20 June 2003.