1. Brief overview of HV-systems <-> Muon chambers circuits

2. States of HV according LHC/LHCb conditions

3. Useful practical applications/knowledges/tools
GEM HV-system

Power Supply designed and realized at INFN, Frascati specifically for LHCb MUON GEM-detectors.

Provides Gas gain (GG) in 12 GEM-chambers in M1R1. Each chamber consists of two triple-GEMs detectors.

Gas mixture - Ar/CO2/CF4 (45 : 15 : 40)
Gain ~4300 at HV 3x415V
Safety limit on current - 8μA

Details on PS see on http://www.sciencedirect.com/science/article/pii/S0168900206020146

Oleg Maev
GEM Powering Circuit

Custom-made multichannel HV power supply, electrically equivalent to an active resistive divider

Detector current measured only on last GEM foil – all data logged by ECS

Protection resistors on HV filters on detector + 1 MΩ in series on sectors for each GEM foil
GEM HV-system

2012 Conditions - $L \sim 4 \times 10^{32} \text{cm}^{-2} \text{s}^{-1}$

Oleg Maev
CAEN HV-system

Commercial one. Consists of:

D3

SY1527 Mainframe with A1676A controllers

D3 Rack D3A05

A 3485 48V PS

“CARBON” 48V service module

home made

CAVERN

EASY 3000 crate with A3535P 32 chs PS board

D3 Rack D3A06

Oleg Maev
CAEN HV-system

Provides GG in 264 two-gaps MWPCs on M1 in regions R2-R4, 528 HV-channels, and in 144 four-gaps MWPCs in regions R1-R2 on M2-M5 stations, 576 HV-channels. 1104 HV-channels in total.

Gas mixture - Ar/CO2/CF4 (40 : 55 : 5)
Gas Gain ~44-49 000 at HV 2520-2650V

in the LHCb working region
ranges from $4.4 \times 10^4$ to $1.5 \times 10^5$

Davide Pinci, INFN-Sezione di Roma

Oleg Maev
PNPI HV-system

Distributes HV from primary PS with two-level linear regulators

Designed and realized at PNPI together with Florida University specifically for LHCb and CMS MUON MWPCs.

RACK D3A06

MATSUSADA PS
Commercial one

Master modules:
1st level of distributor

Matsusada-control

HVM-module (MSU)
USB-interface

CAVERN

RDBs – 2nd level of distributors

Oleg Maev

11.06.15
PNPI HV-system

Provides GG in 960 four-gaps MWPCs in regions R3-R4 on M2-M5 stations, **3840 HV-channels**.

**Just keep in mind:**

- OFF on 2nd level RDBs doesn’t mean HV=0
- It always propagates ~ 1000V from 1st level (Masters)
- To get HV=0 you should switch OFF Masters

Oleg Maev
## HV-system. ECS

<table>
<thead>
<tr>
<th>HV system</th>
<th>WINCC - project</th>
<th>Host (Linux) Virtual machine</th>
<th>Driver</th>
<th>Running on (Windows CCPC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEM</td>
<td>MUHVGEM</td>
<td>muhvgem01</td>
<td>OPC</td>
<td>mucc0503w</td>
</tr>
<tr>
<td>CAEN A-side</td>
<td>MUHVA02</td>
<td>muhva02</td>
<td>OPC</td>
<td>mucc0301w</td>
</tr>
<tr>
<td>CAEN C-side</td>
<td>MUHVC02</td>
<td>muhvc02</td>
<td>OPC</td>
<td>mucc0302w</td>
</tr>
<tr>
<td>PNPI A-side</td>
<td>MUHVA01</td>
<td>muhva01</td>
<td>DIM</td>
<td>mucc0801w</td>
</tr>
<tr>
<td>PNPI C-side</td>
<td>MUHVC01</td>
<td>muhvc01</td>
<td>DIM</td>
<td>mucc0802w</td>
</tr>
</tbody>
</table>

**Cold start and details on TWIKI (in progress):**
https://lbtwiki.cern.ch/bin/view/MUON/MuonPiquetTraining

Muon Piquet Training and Documentation

- Terminals and remote login (opening FSM and Presenter)
- Experiment control system (ECS)
- Readout:
  - muon shifter manual part 1: [ppt], [pdf]
- HV:
  - HV System Overview: [pdf]
  - CAEN HV
  - PNPI HV
  - GEM HV
- LV
- Gas System (pdf):
  - A photographic map of all the hardware
- Debugging of problems related to CDE boards
- Chamber Monitor Instructions [pdf], [pdf]

Oleg Maev

11.06.15
**HV-system. ECS**

**HV states:**

<table>
<thead>
<tr>
<th>OFF</th>
<th>STANDBY1</th>
<th>STANDBY2</th>
<th>READY</th>
<th>NOT READY</th>
<th>TRIP</th>
</tr>
</thead>
</table>

**FSM (WINCC) status:**

<table>
<thead>
<tr>
<th>DEAD</th>
<th>READY</th>
<th>NOT READY</th>
<th>ERROR</th>
</tr>
</thead>
</table>

Some important details on TRIP (I>thr. during 1s):
- **GEM** – never tripped (protective resistor) – reduce the HV
- **CAEN** – normal trip (HV->OFF)
- **PNPI** – trip only in the case of short or something serious (procedure for SOFT_TRIP implemented – reduce the HV)
# HV Monitor

### M1 Station

<table>
<thead>
<tr>
<th>SIDE C</th>
<th>M1 Station</th>
<th>SIDE A</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>32</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>31</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>30</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>29</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>28</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>27</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>26</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>25</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>24</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>23</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>22</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>21</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>20</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>19</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>18</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>17</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>16</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>15</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>14</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>13</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>12</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>11</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>10</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>9</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>8</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>7</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>6</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>5</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>4</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>3</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>2</td>
<td>STI</td>
<td>STI</td>
</tr>
<tr>
<td>1</td>
<td>STI</td>
<td>STI</td>
</tr>
</tbody>
</table>

Oleg Maev

11.06.15
HV Monitor

Control from MUSIDES
**HV Monitor**

Also with this Monitor you may operate with PSs, see status of the servers, Gas and also run the *Gaps Check Script* which is limited by 20 tripps and needs to be periodically rerun. This script makes tripped gap disabled, writes log entry, sends SMS to Piquet phone and produces the voice message in CR. Very useful tool.
HV Monitor
With left click you may open any chamber:

![HV Monitor Interface]

Oleg Maev

11.06.15
HV Monitor
And reach some subsystems with following trick:
GEM Current Monitor

HVGEM System Current Monitor

Oleg Maev
Side HV-panel – Main (CAEN) project

Oleg Maev

11.06.15