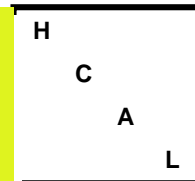




# CMS HCAL

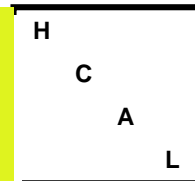


## Proposal for the rad-hard Monitoring Unit Chipset development

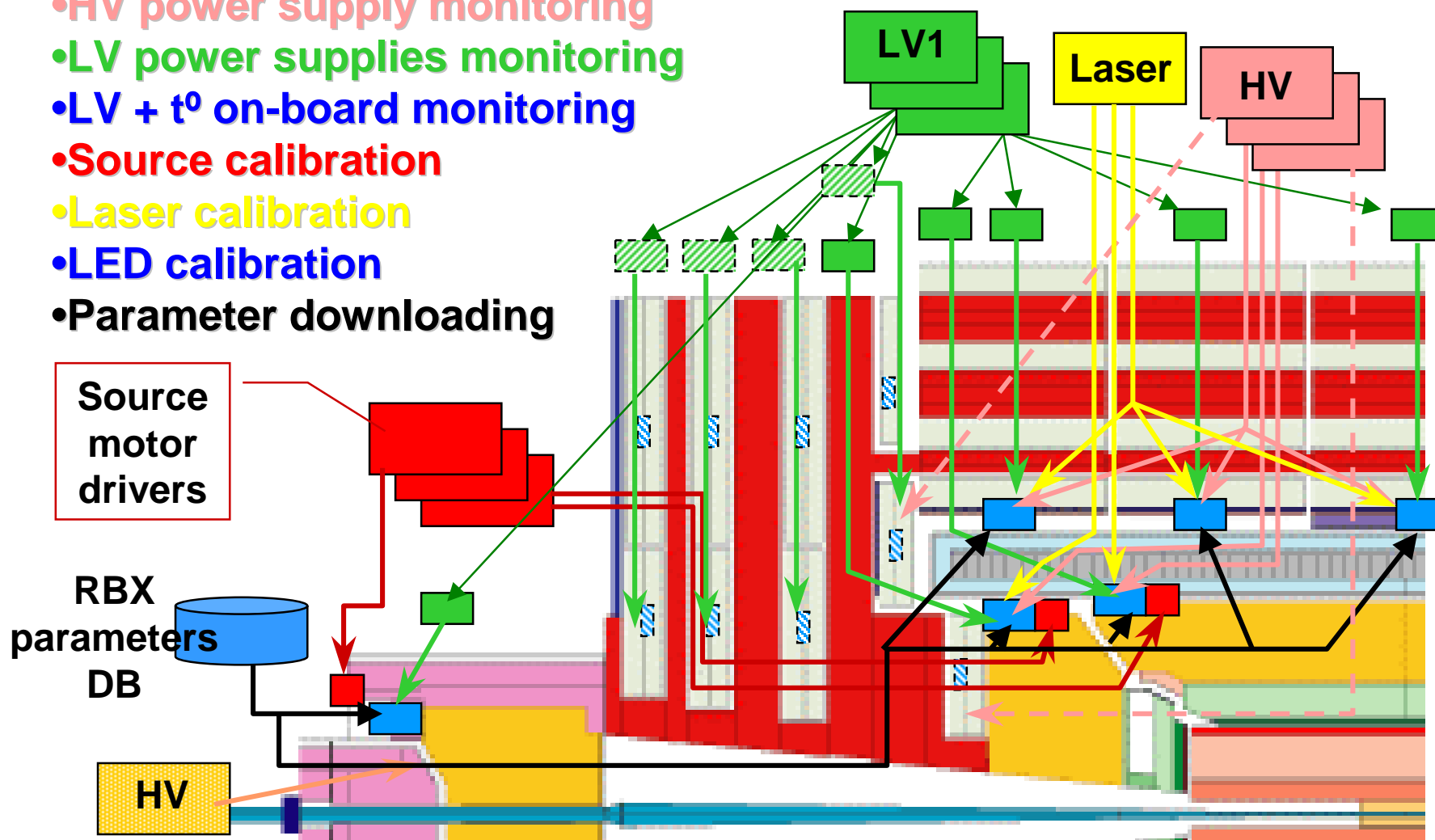
**S.Sergueev**  
**FNAL/JINR**



# HCAL Monitoring

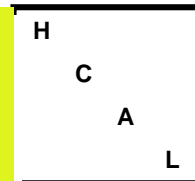


- HV power supply monitoring
- LV power supplies monitoring
- LV +  $t^0$  on-board monitoring
- Source calibration
- Laser calibration
- LED calibration
- Parameter downloading





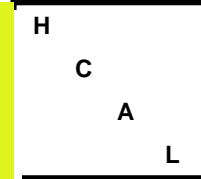
# Requirements to MU



1. Radiation levels (with safety factor 3)
  - neutrons > 100 keV:  $1.3 \times 10^{11}$  n/cm<sup>2</sup>
  - ionizing dose: 330 Rads
2. Not sensitive to SEU
  - No latch-up
  - No need to reload or reboot
3. Analog input number  $\leq 24$  (for ME1/1)
4. Moderate accuracy ( $\sim 1\% \Rightarrow$  8 bit ADC)
5. Up to 24 digital inputs/outputs (for ME1/1)
6. Simple external protocol
7. Interface to the internal RBX serial bus (downloading of less than 128 bytes)
8. Low transmission rate (4800 Bauds is well enough)



# Fieldbus choice



## RS485

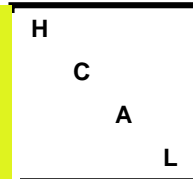
- The simplest one
- Any configuration
- Widely used in the industry (a lot of interface models at the market)
- Uses operating system middleware, needs Dim
- Cheap
- Exists in the HCAL
- Is not the CERN-recommended one

## CAN-bus

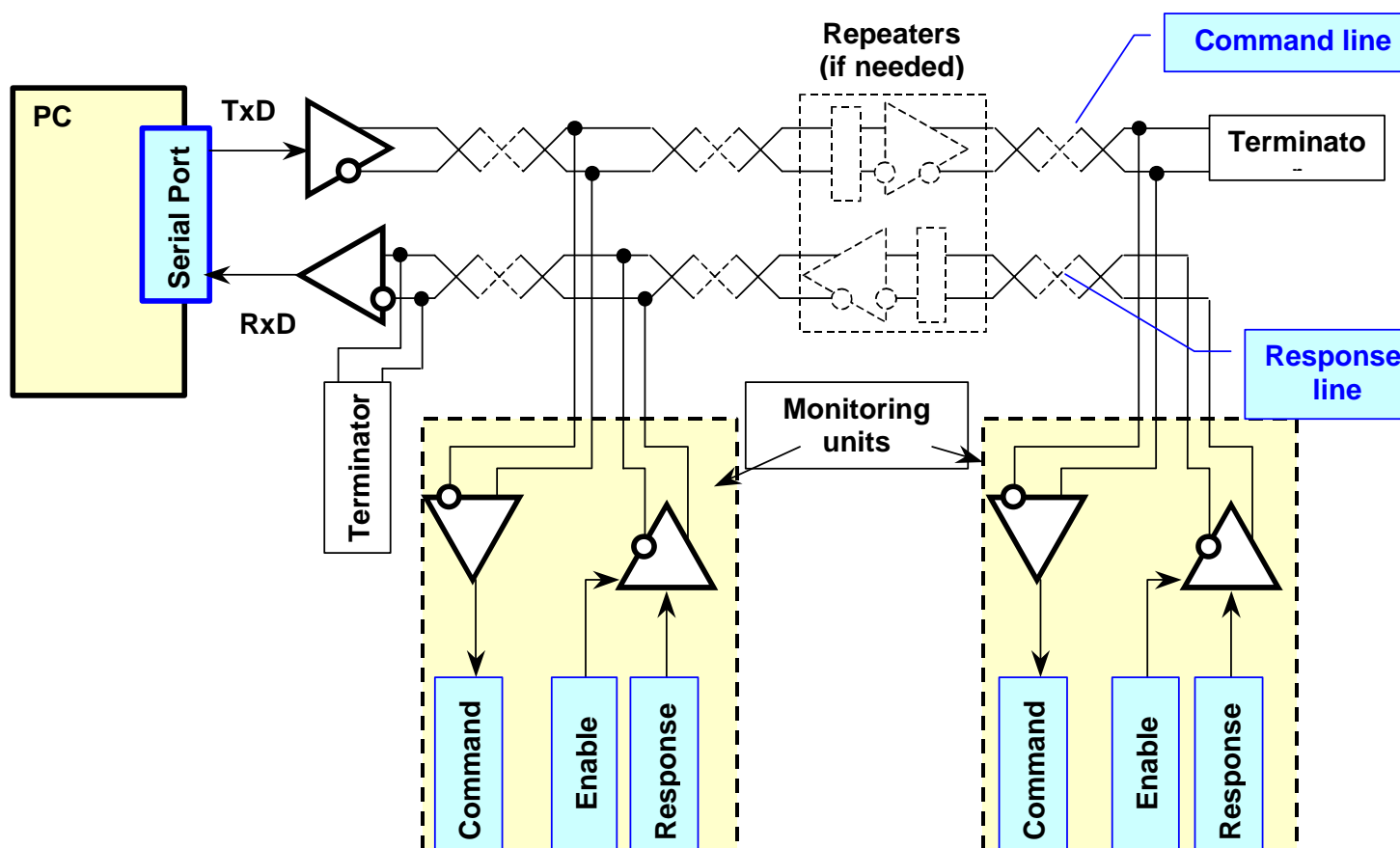
- Not so simple, for debugging special equipment is needed
- Daisy chain
- Supported by CERN (NI PCI interface recommended)
- The OPC server exists for NI PCI card
- Not so cheap
- Could be used with ELMB
- Is the CERN-recommended fieldbus (is CAN-bus discontinued?, replaced with TCP/IP?)



# Configuration of RS485

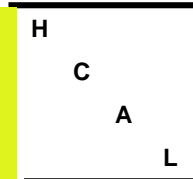


## Full-duplex RS-485 Single-Master Four Wire Mulpoint (Multidrop) Configuration

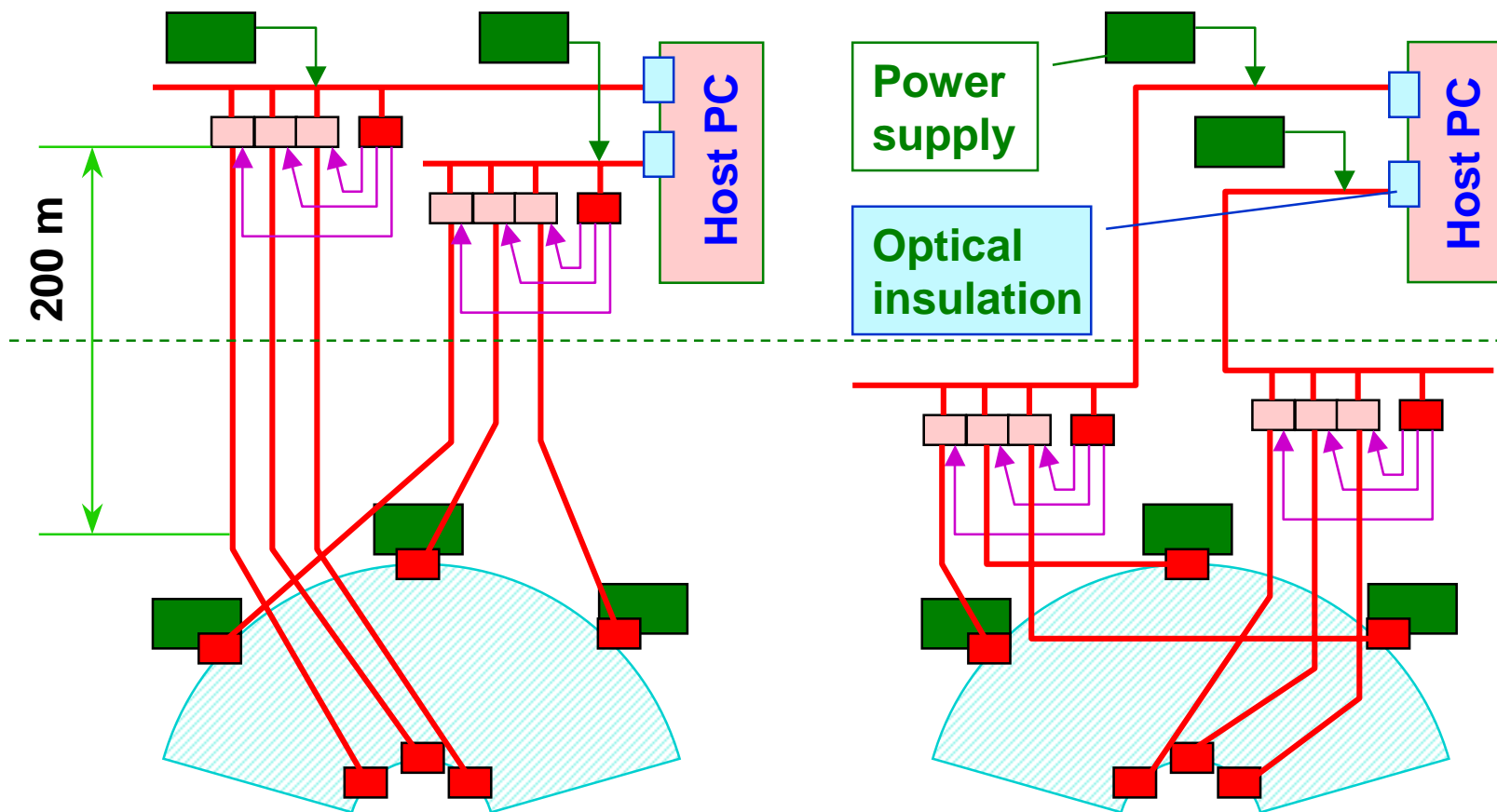




# Star-type architecture (I)

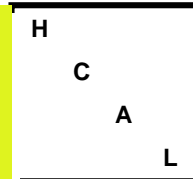


## Possible communication line architectures

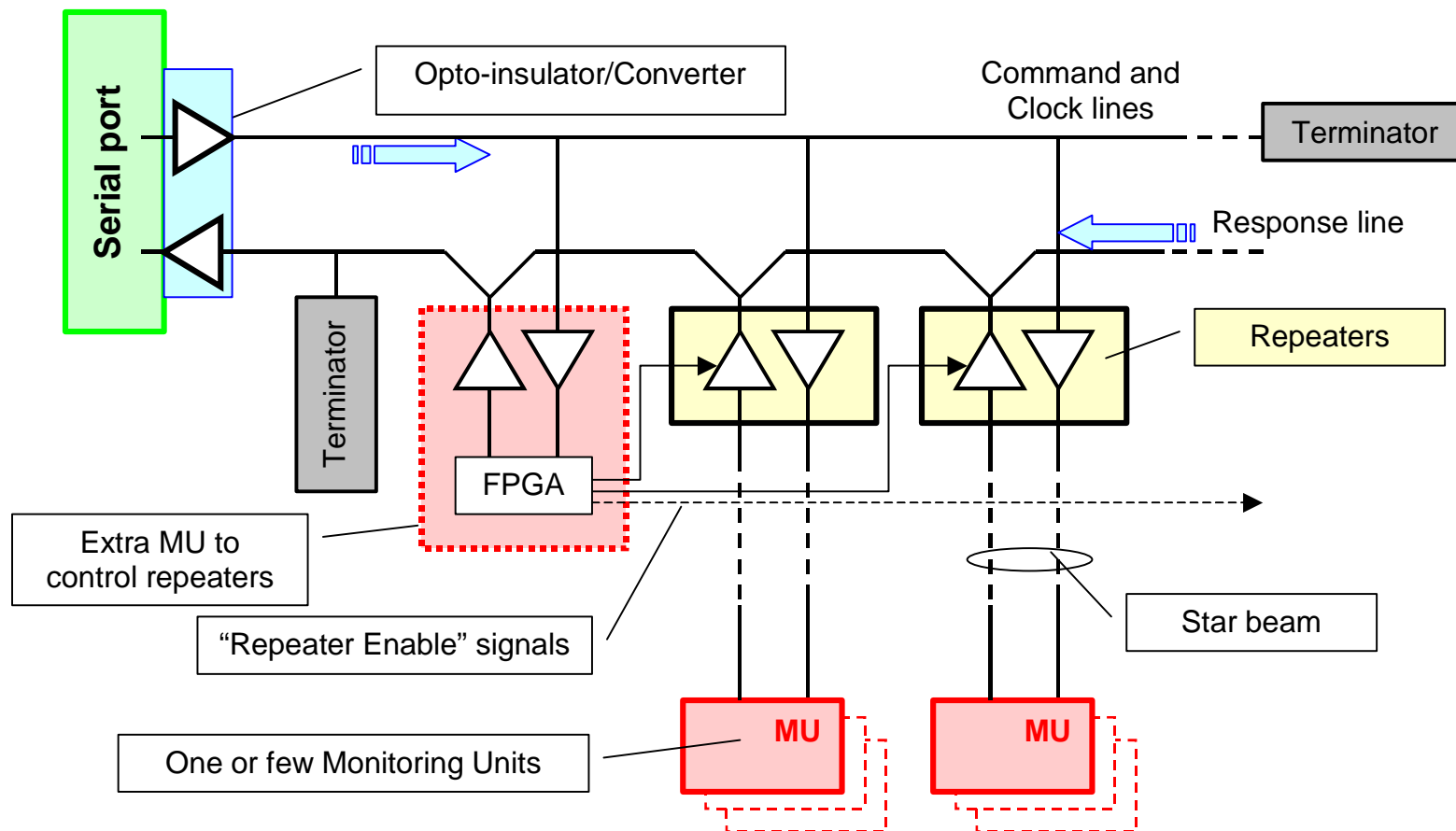




# Star-type architecture (II)

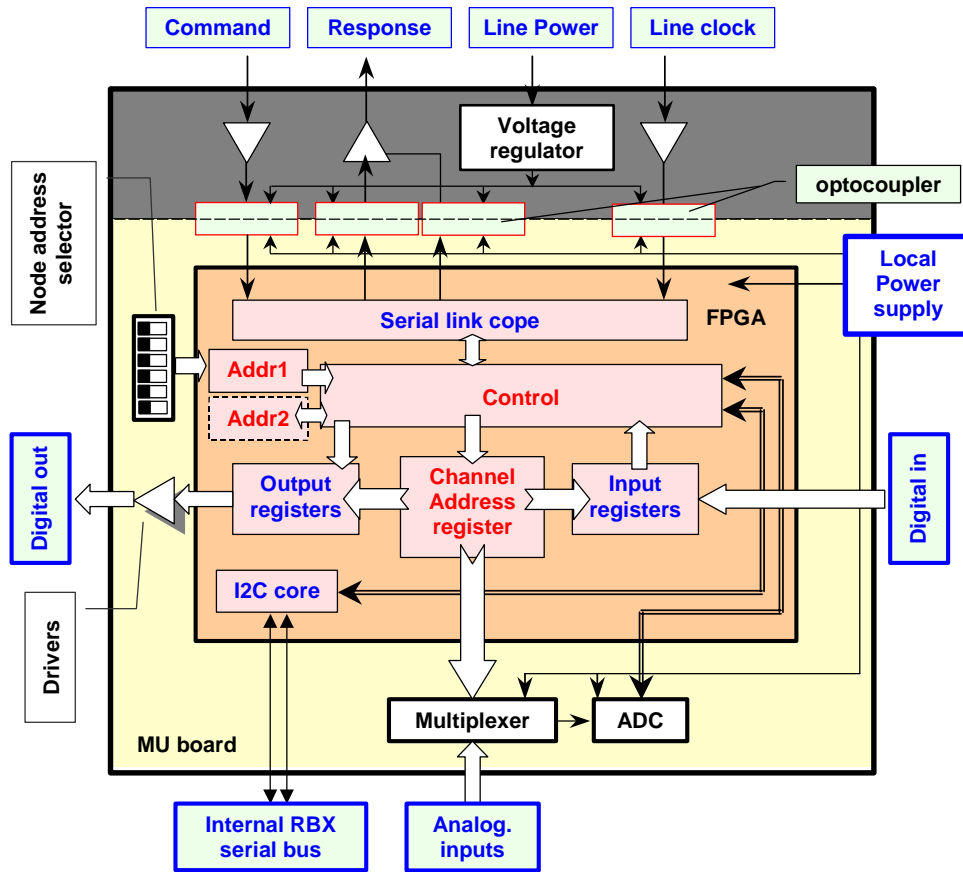
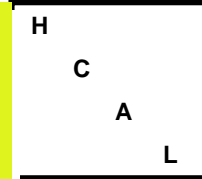


## Possible router scheme

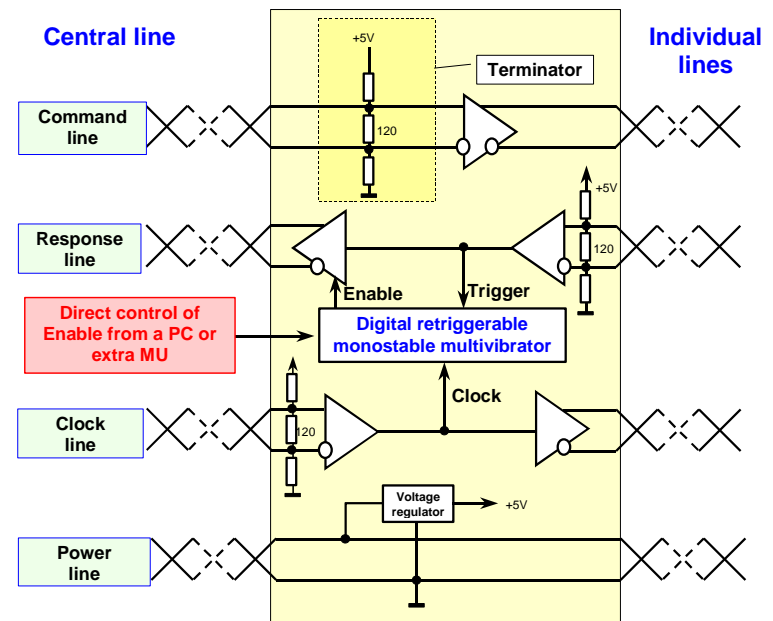




# MU and Repeater



Monitoring Unit

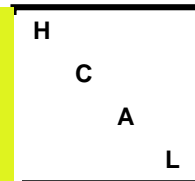


Repeater (Router)

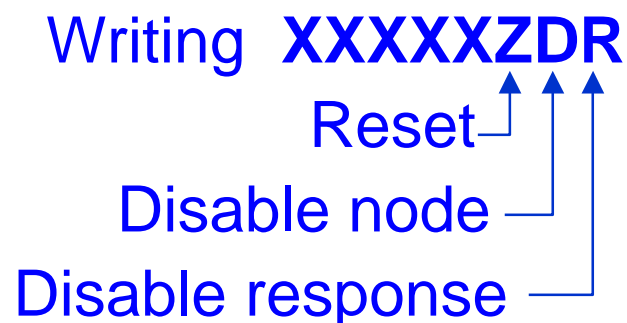
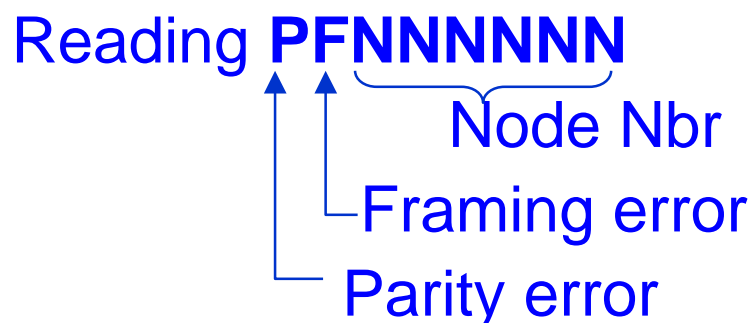




# MU internal addresses

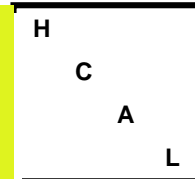


- Addresses **0-31** - analogous signal multiplexer with ADC (reading only).
- Addresses **32-47** - digital I/O registers (read/write).
- Addresses **48-61**- I2C communication core.
- Address **62** - the group number register (read/write).
- Address **63** - the status byte of MU. Writing to or reading from this byte **resets error bits**.





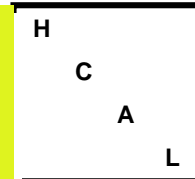
# Communication protocol



- Each byte transmitted in both CL or RL should have a parity check. Kind of parity Odd or Even should be fixed later.
- The commands received by nodes with parity or framing errors should be ignored by the node.
- The operations with node responses received by PC with errors should be repeated.
- The information read-out is performed by the permanent polling.
- The PC sends commands to all MUs in parallel.
- The command `XXYYYYYY` contains the command code itself (`XX`- 2 bits) and the operand (`YYYYYY` - 6 bits). The operand could be a number of the selected node or the content of the channel selection register.



## Communication prot. (II)



**XX=00** writes the operand content YYYYYY to the channel selection register. Operation is **common** for all nodes. No node response is needed.

**XX=01** requests the **read-out** of content of the **selected** input channel (ADC, input registers, I2C registers, status). YYYYYY contains the number of the selected node.

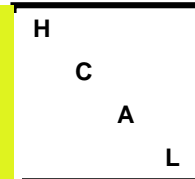
If the node response is enabled then the selected node responds with 3-byte message containing

1. Node number,
2. Node Status byte,
3. Selected channel content.

This operation uses **individual** node addresses only.



## Communication prot. (III)



**XX=10** is used to write **single** byte of information to the node. Both individual node numbers or group numbers could be used. The operand YYYYYY contains the **node or group number**.

The **second** byte of message contains a **byte of information** to write to the FPGA **register** selected by the **previous command** with XX=00.

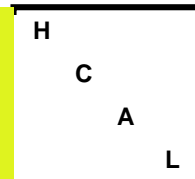
In case of **individual addressing** and if the node response is enabled then the selected node responds with the 2-byte message containing

1. Node number,
2. Node status byte.

If received command or data byte contain a **parity error** this information is **not transferred** to the corresponding register, but the **response** message is **always sent**.



# Communication prot. (IV)



**XX=11** is used to send an array of bytes. The operand **YYYYYY** contains an address of the **destination node** or group.

Second byte of the command contains the **length** of the array.

The rest of the command is the data array.

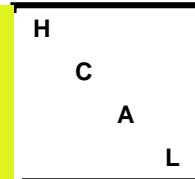
In case of the **individual** addressing and if the node response is enabled then the node **responds** with the 2-byte message containing

- Node number,
- Node status byte.

**Signal “BREAK”** resets and disables all nodes



# MU bus addresses



The addresses 0 and 63 are **reserved** for tests and debugging.

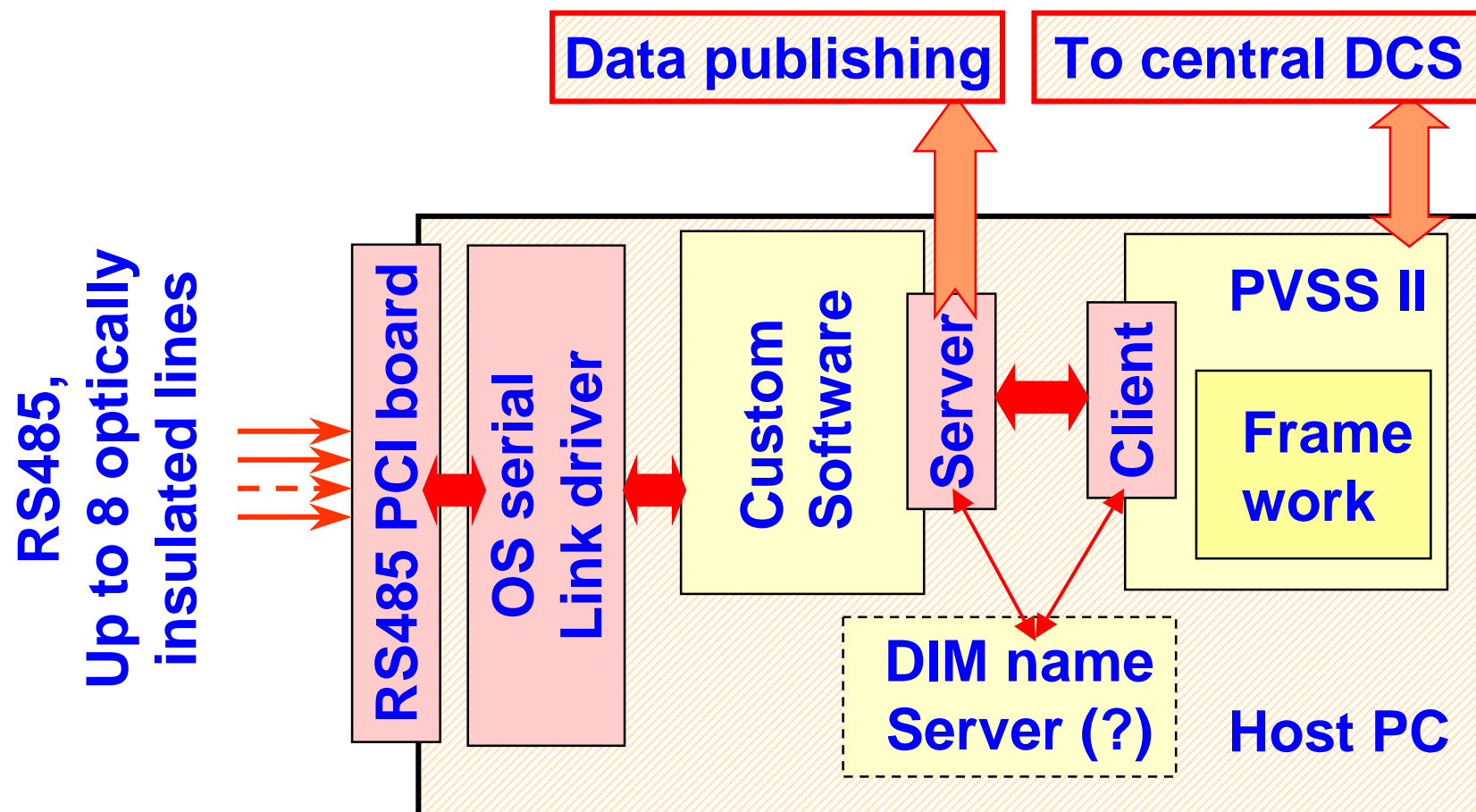
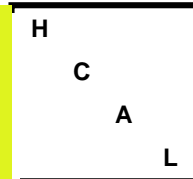
Address number **0 does not select** any MU and address number **63 selects all** boards for write-type operations.

Numbers from 1 to 36 - individual nodes in one branch.

Numbers 37-62 used for groups

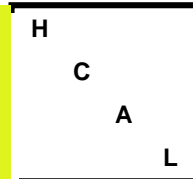


# System structure

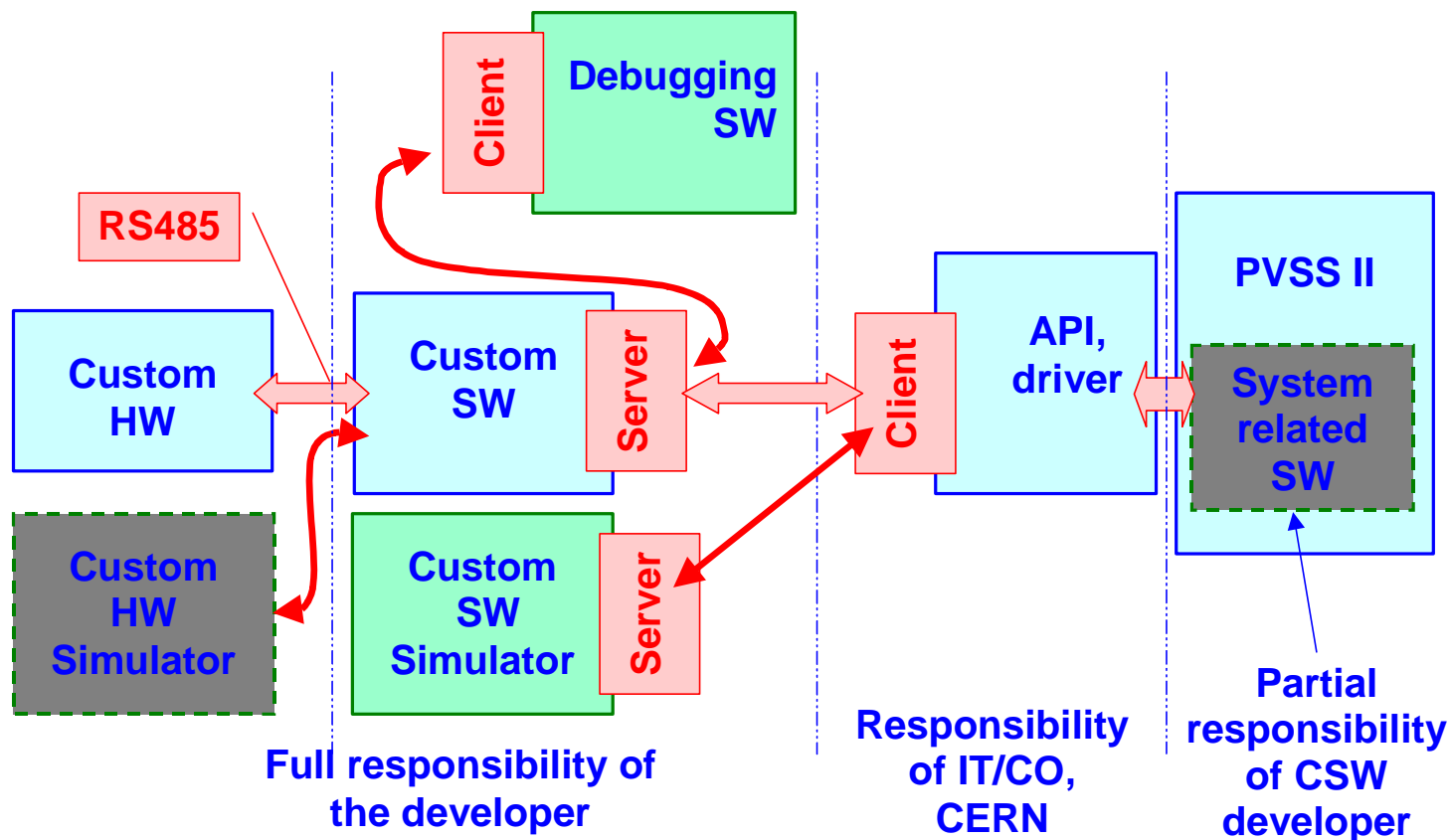




# Software structure



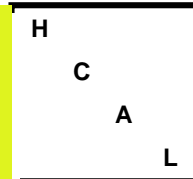
## Used software architecture



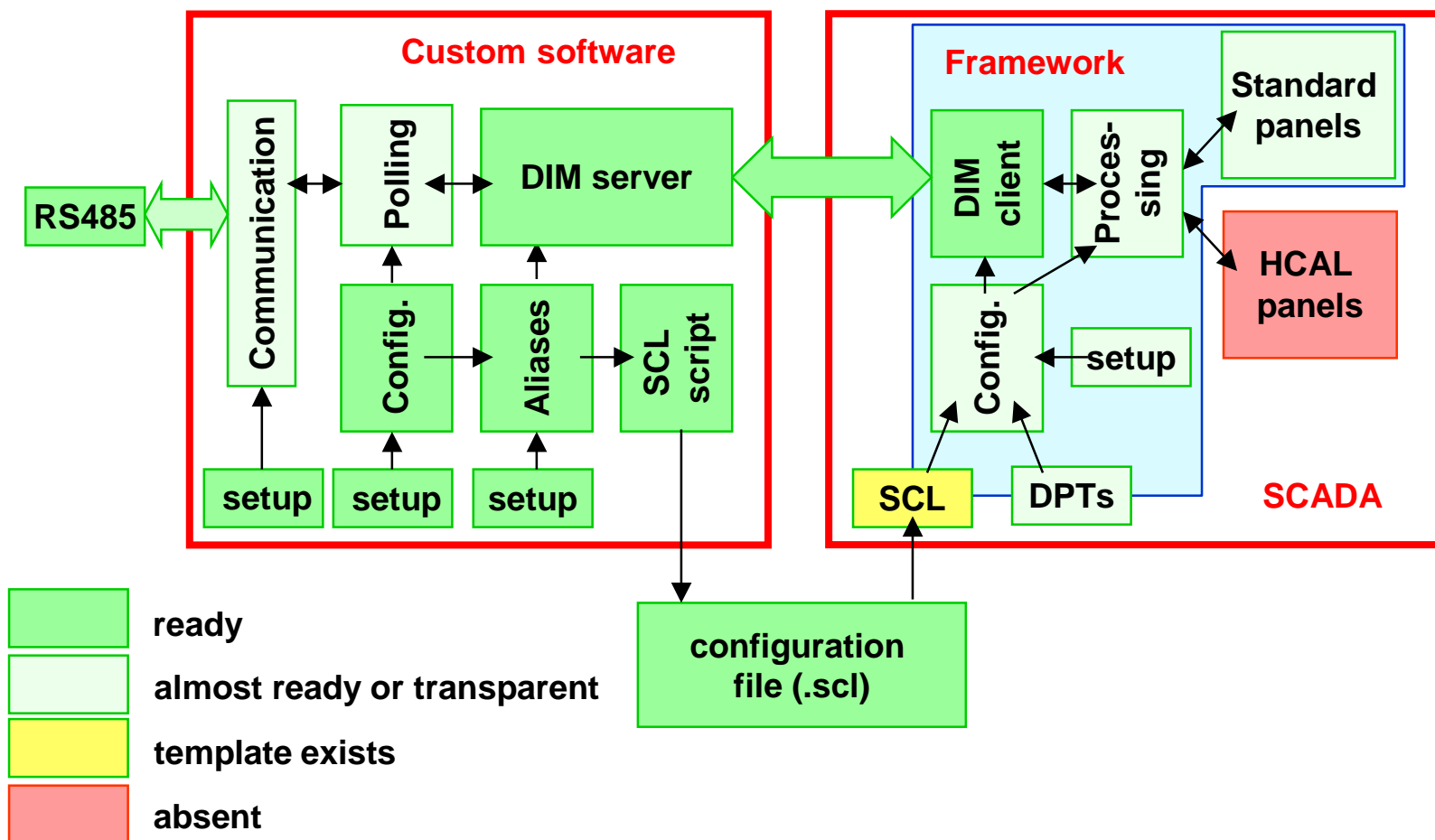




# HV system SW structure

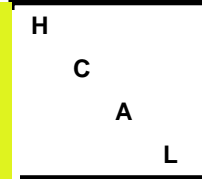


80% could be used for RS485 system





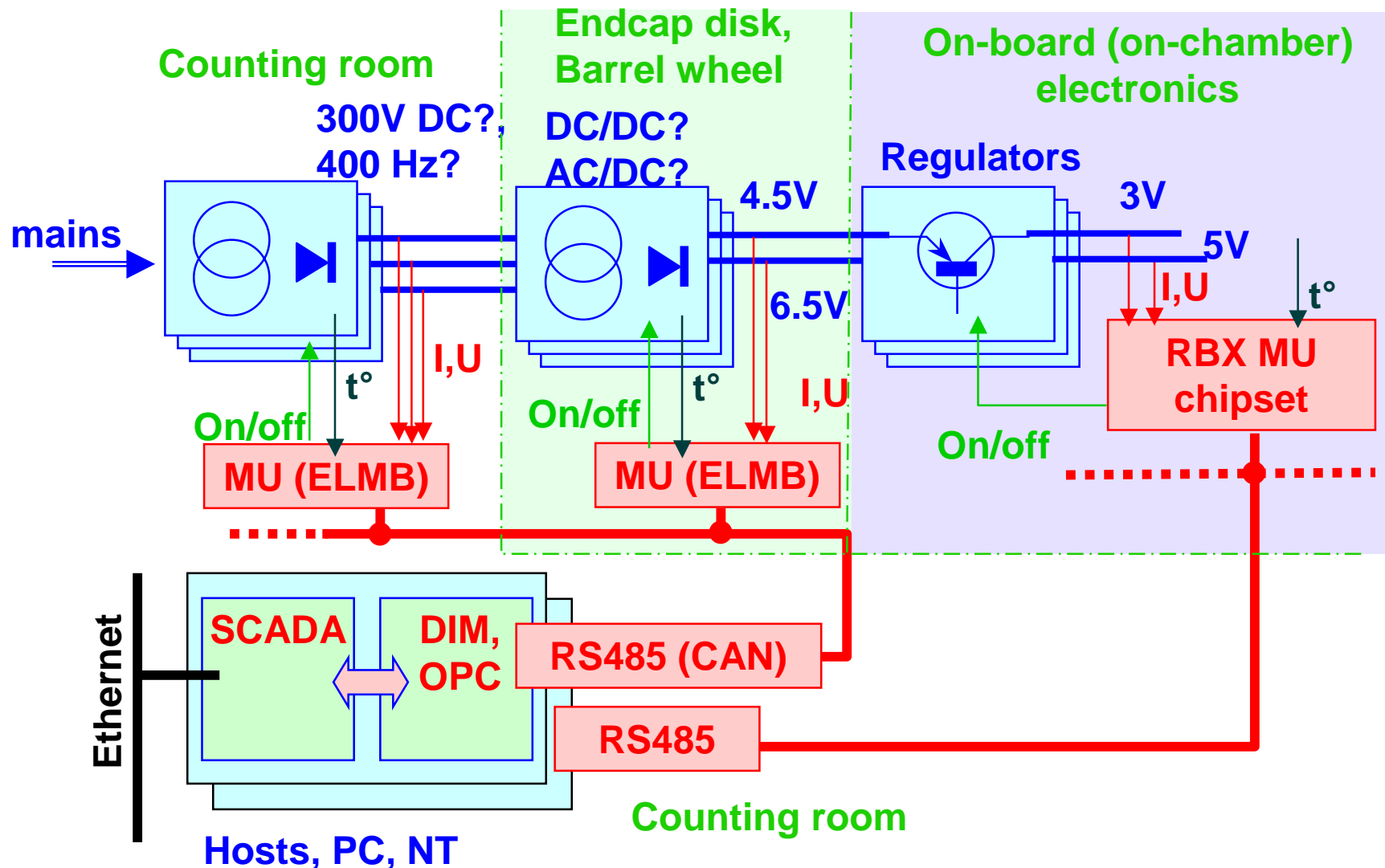
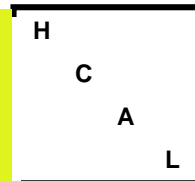
# HV Custom software



The screenshot displays the HV DIM server software interface. The main window, titled "HV DIM server", features a toolbar with buttons for Run, Stop, COM, Aliases, Config, SCL, DIM, and Close. On the left, there are sections for Startup Window (Normal, Minimized, Hidden), Autorun Status (Automatic, Manual), and a Trace section with fields for Command, Response, and Counter. The central "Configuration" window shows a tree view of the system hierarchy: System 1 On (Crate 1 On (HCAL type) - Module 0 On (Channels 0-9 On) - Module 1-5 On) - System 2-5 Off. The "COM ports settings" window is open for com1, showing a "mode" command field with "9600,n,8,2" and an "Execute" button. Below this, there are sections for Baud Rate (110, 200, 600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 56000, 57600, 115200, 128000, 256000), Parity (no, odd, even, mark, space), Data Bits (5, 6, 7, 8), and Stop Bits (1, 1.5, 2). A "Flags" section includes checkboxes for Parity, OutxCTSFlow, OutxDSRFlow, DSR Sensitivity, Null, TXContinueOnXoff, OutX, InX, and AbortOnError, along with input fields for Xon char code, Xoff char code, ErrorChar, Evt char code, and Eof char code. At the bottom, there are controls for DTR Control (Disable, Enable, Handshake) and RTS Control (Disable, Enable, Handshake, Toggle), with XonLim and XoffLim input fields. The window concludes with "Settings" and "Set Port" buttons, and "OK" and "Cancel" buttons at the very bottom.

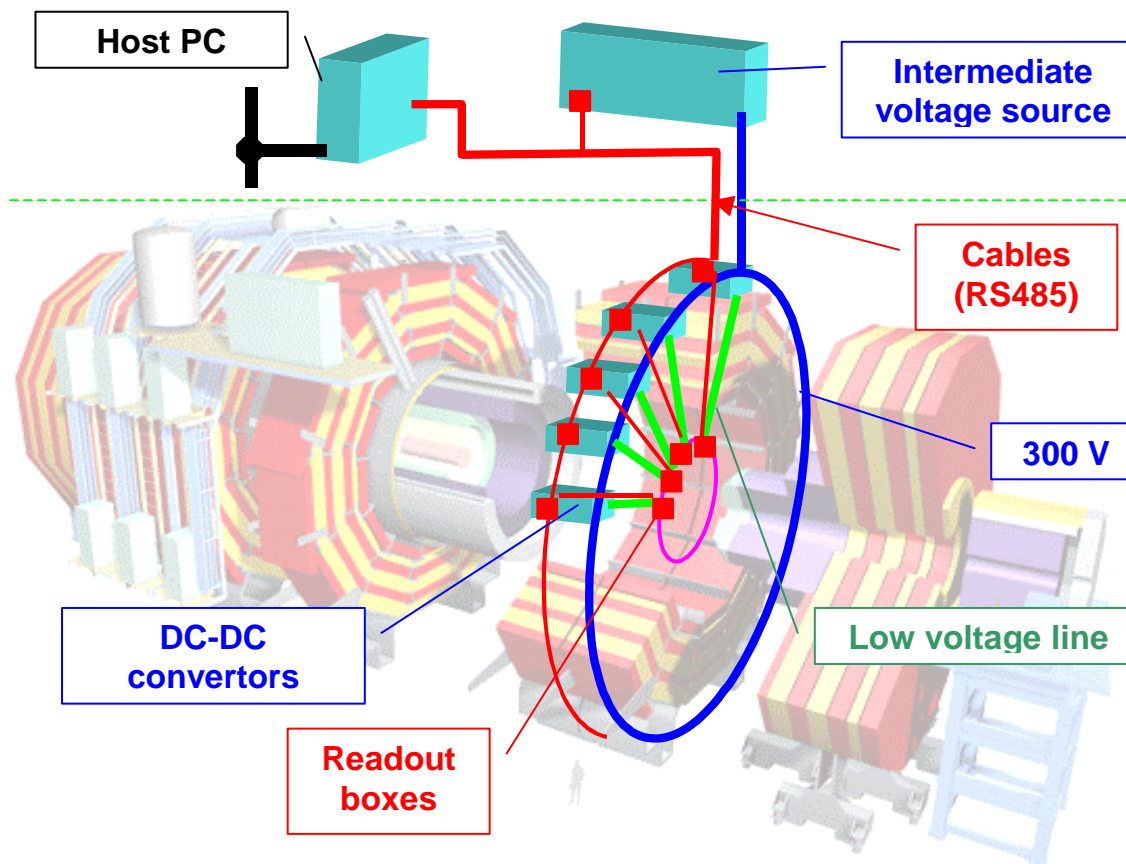
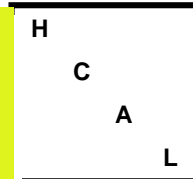


# Low Voltage control system(I)



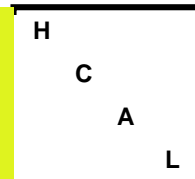


# Low Voltage control system(II)





# Power supply monitoring



## RS485-based MU

- This standard exists in HCAL
- Not sensitive to SEU
- Any connection architecture
- Maintenance (like other our equipment) is our problem

## ELMB

- No CAN-bus yet in HCAL
- Still sensitive to SEU
- Daisy chain
- ELMB itself be maintained by CERN