GE1/1 & GE2/1 Power System

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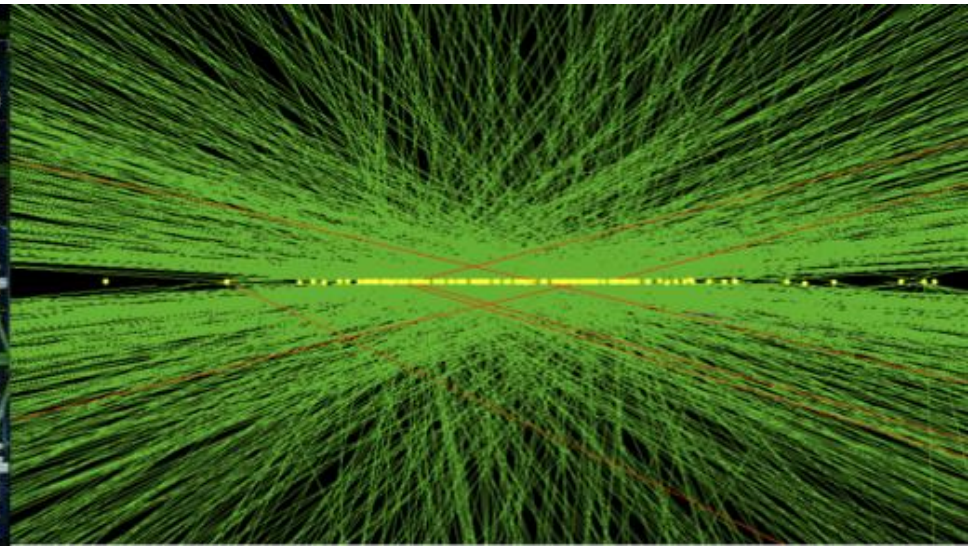
CMS GEM Workshop

October 3rd, 2019



Outline

- HV System
  - Overview
  - Status
  - Issues Debugging
- LV System
  - Overview
  - Status
  - Issues Debugging

HV System

GE11 HV System Overview

USC

2 HV racks

rearranged

S1G12 S1F12

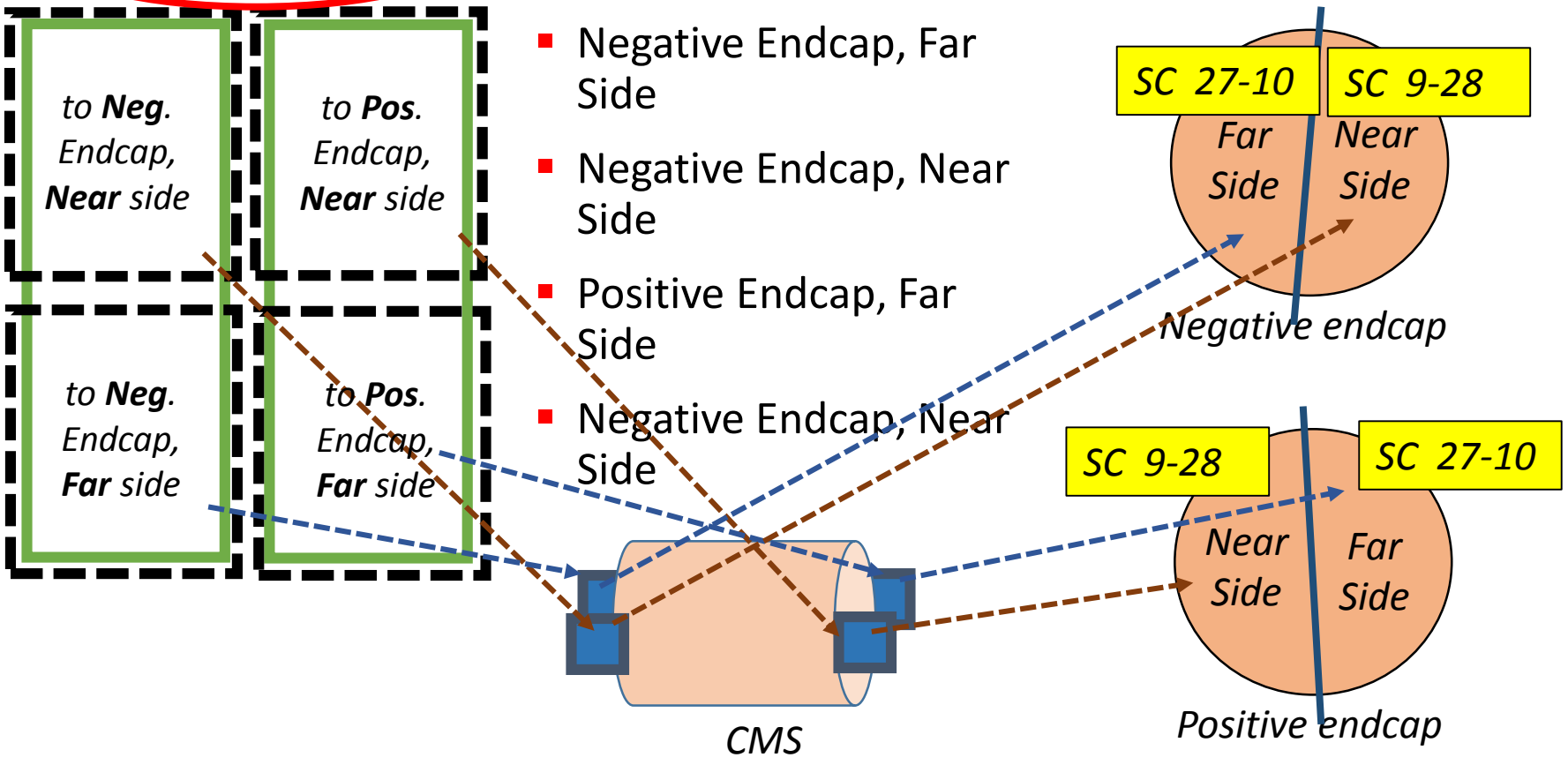
UXC

4 patch panels

- Negative Endcap, Far Side
- Negative Endcap, Near Side
- Positive Endcap, Far Side
- Negative Endcap, Near Side

Detector

A test-box to check the **correct connectivity** of all HV cables in P5 is prepared



GE21 HV System Overview

USC

2 HV racks

rearranged

S1G13 S1F13

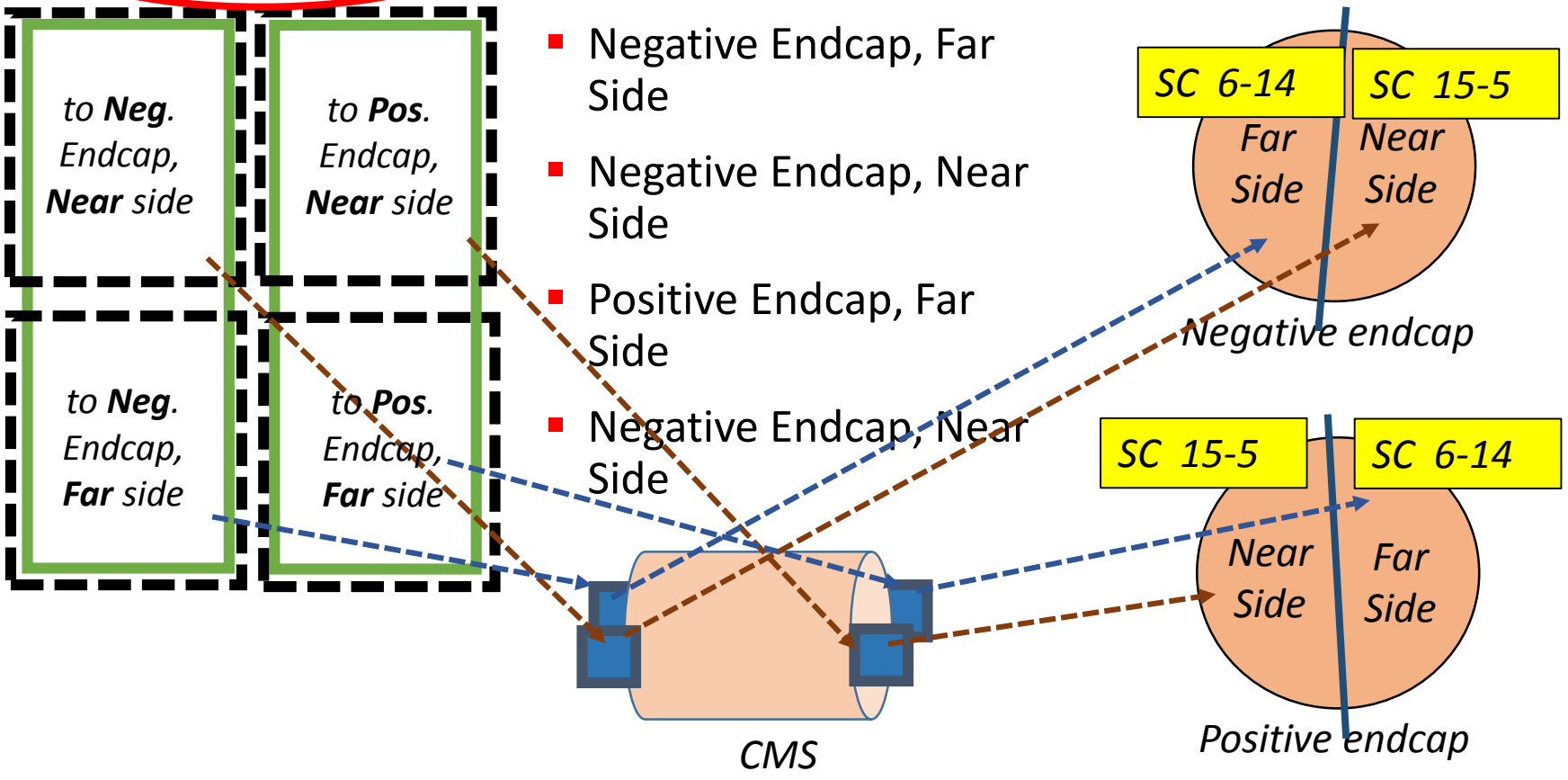
UXC

4 patch panels

- Negative Endcap, Far Side
- Negative Endcap, Near Side
- Positive Endcap, Far Side
- Negative Endcap, Near Side

A test-box to check the **correct connectivity** of all HV cables in P5 is prepared

Detector



GE1/1-GE2/1 HV: CURRENT STATUS

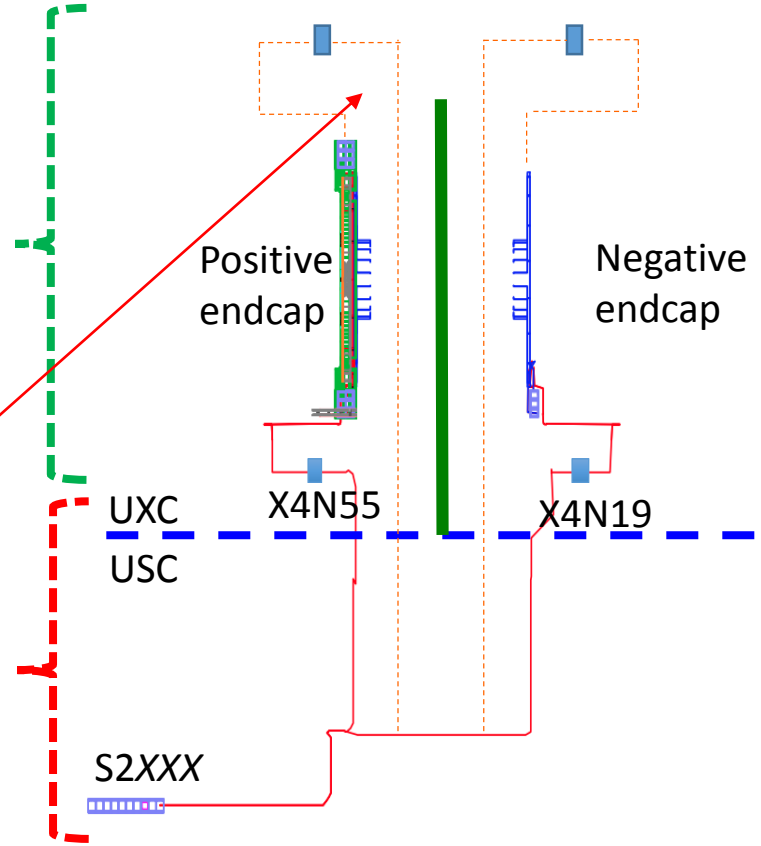
X4-to-detectors cables

→ **Cables through new cable chain**
(-X4 near and far)

- ✓ **GE1/1 Negative Endcap DONE**
- GE1/1 Positive Endcap: TO DO
  for installing the same cables on the Positive Endcap we have to wait for the new cable chain installation
- ✓ **GE2/1 Negative Endcap DONE**

USC-UXC cables (~100 m): TO DO

- 36(GE1/1)+72(GE2/1)=**108** thick cables (4x10 conductors) to be routed
- waiting for the installation of new **trays** along the path for GEM HV cables



HV System Issues&Debugging

Problem: We have observed in laboratory that sometimes HV channels become *unplugged*.

- if the channel was ON it remains ON although it is not possible to control/monitor it anymore
- A simple *clear alarm* does not solve the problem since the faulty condition persists
- The solution that worked most of the times (but not always probably due to some capacity not fully discharged during the cycle) was to power cycle the mainframe
- So far the average cross section is about 1 channel in error every 6-7 months per board (anyway the frequency was not constant with time) → about 1 error every 6 days with 32 boards (GE1/1)

→ Possible explanation by CAEN:
the communication is based on the **50Hz frequency** of the 220V. If it's not very stable, the motherboard and the channels communication might mismatch. Hence the motherboard is no longer able to correctly interpret the packages coming from the channels → communication error between them (unplugged)

Current solution: **Firmware 2.06 for A1515TG** was released by CAEN in July, with **2 main changes**:

1. Automatic procedure to recover unplugged channels without switching off the mainframe → **complemented from DCS** side to lock actions by the user during this procedure
   - The other 6 channels of the involved group are ramped down "normally"
   - The unplugged channel is killed and rebooted by cutting off its power for 10 seconds → this should restore the unplugged channel
2. In case of unplugged, the synchronization is reset

Firmware 2.06 used in all HV board in 904 lab **since 15 July → no more "unplugged" errors observed** until now

LV System

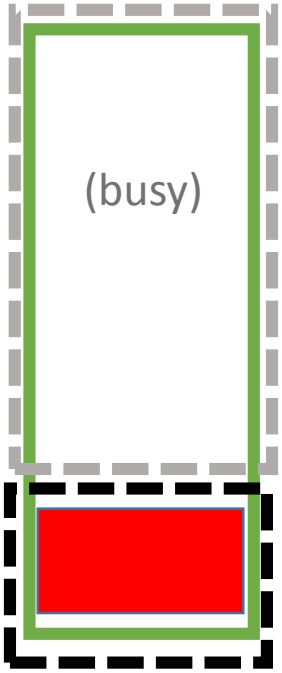
GE11 & GE21 LV System Overview

USC

1 LV rack

with 1 mainframe

S4F03



UXC

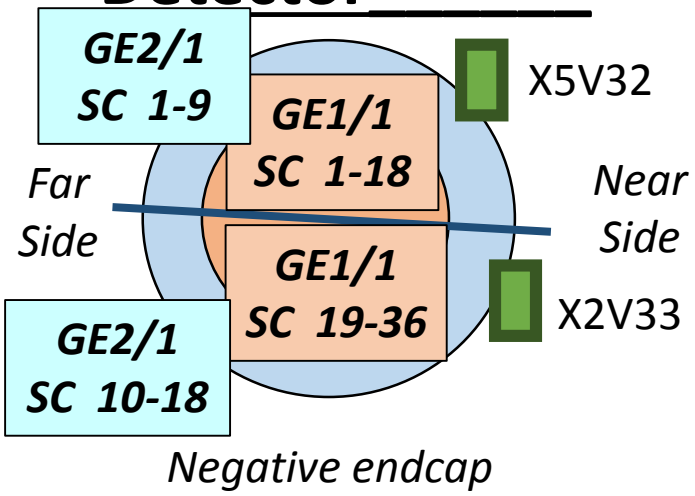
2 PATCH PANELS

- in rack X4N19 (Negative Endcap, Near Side)
- in rack X4N55 (Positive Endcap, Near Side)

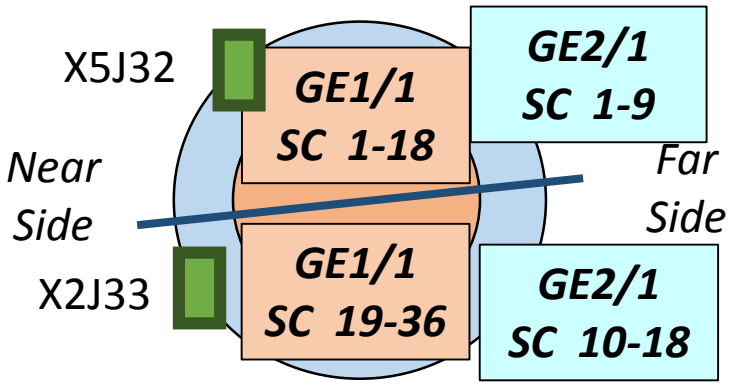
4 LV racks

- X2V33 and X5V32 (Negative Endcap, Near Side)
- X2J33 and X5J32 (Positive Endcap, Near Side)

Detector

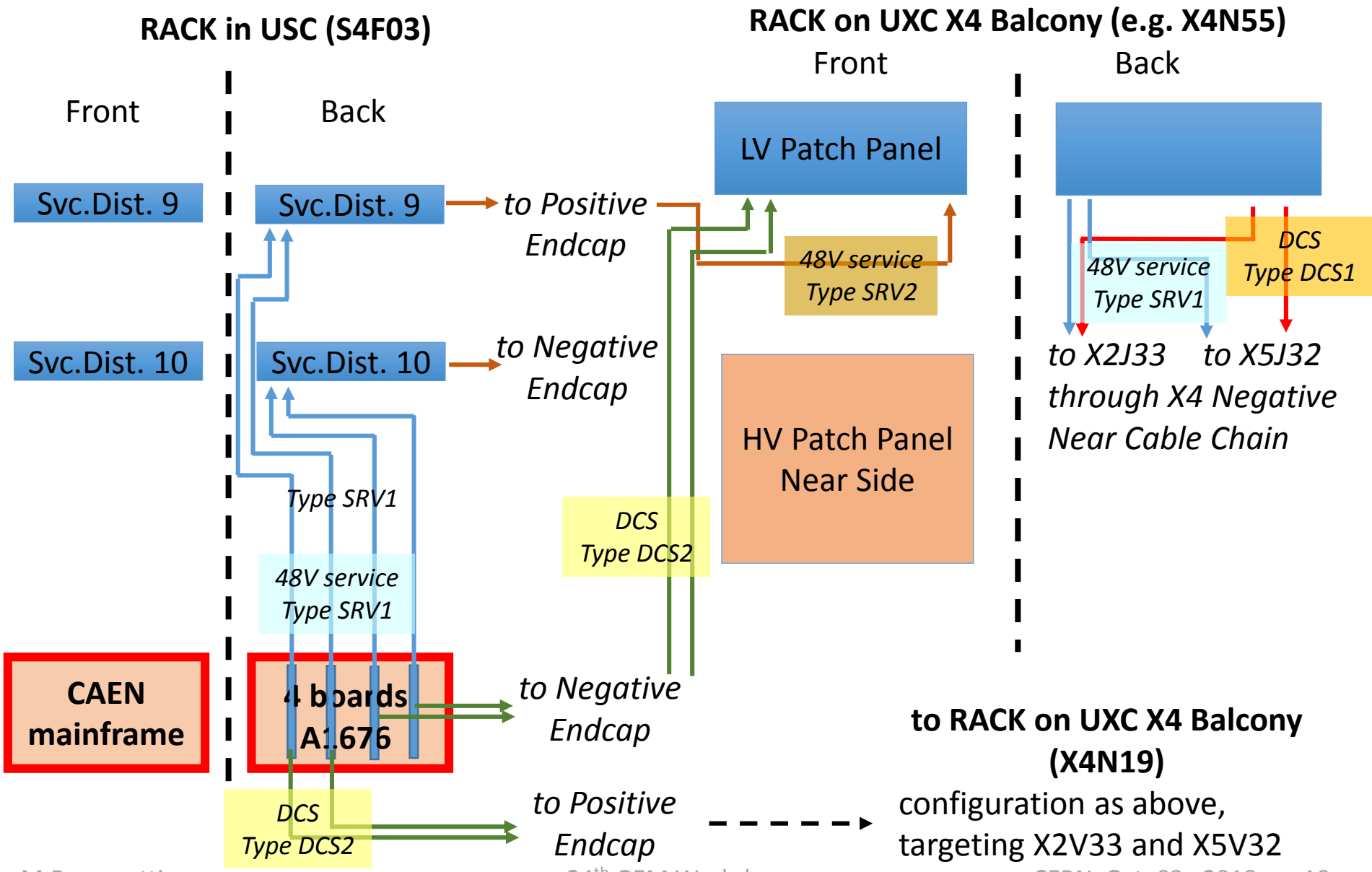


Negative endcap



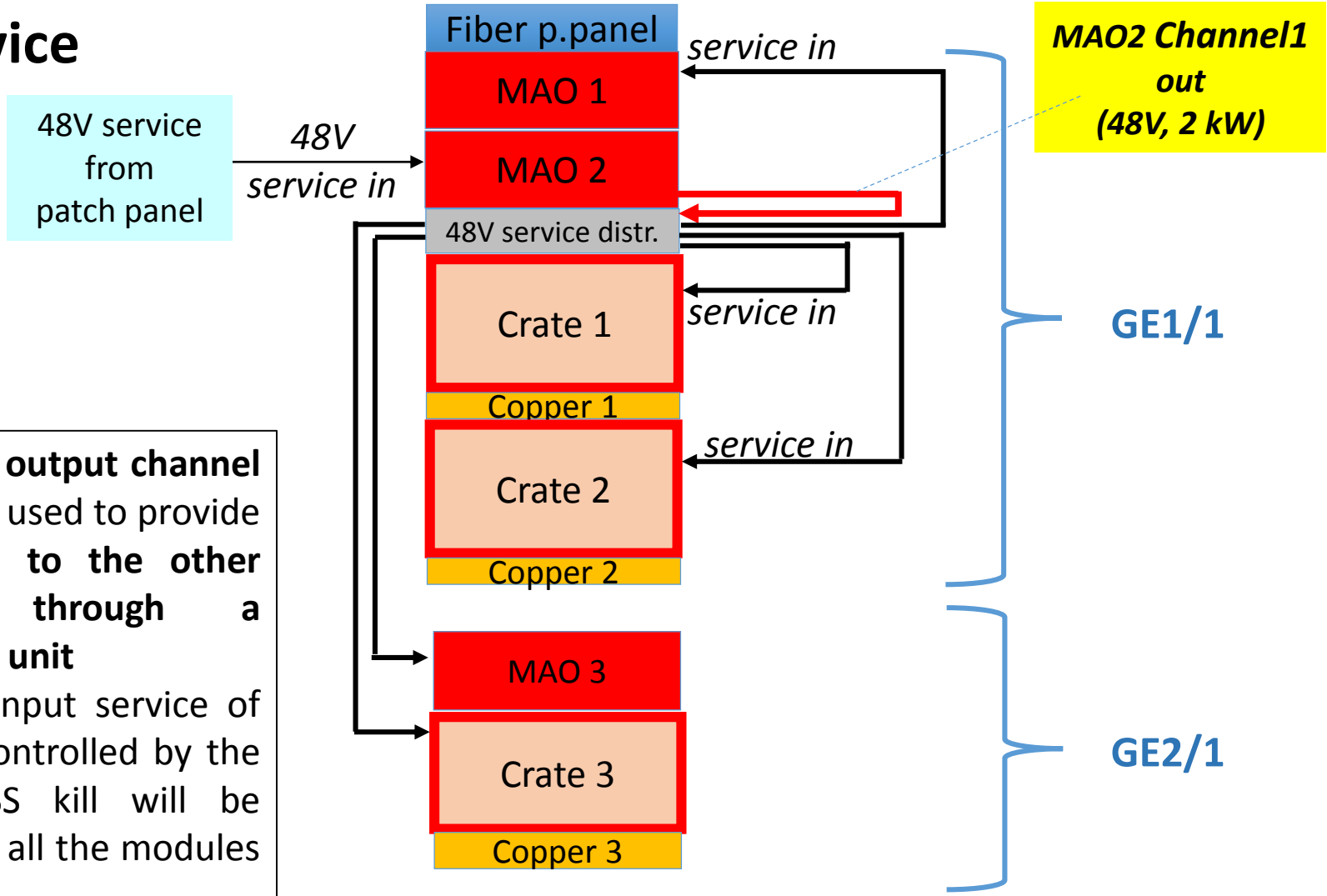
Positive endcap

GE1/1 LV System – USC + PP



GE1/1-GE22/1 LV – UXC rack

48V service

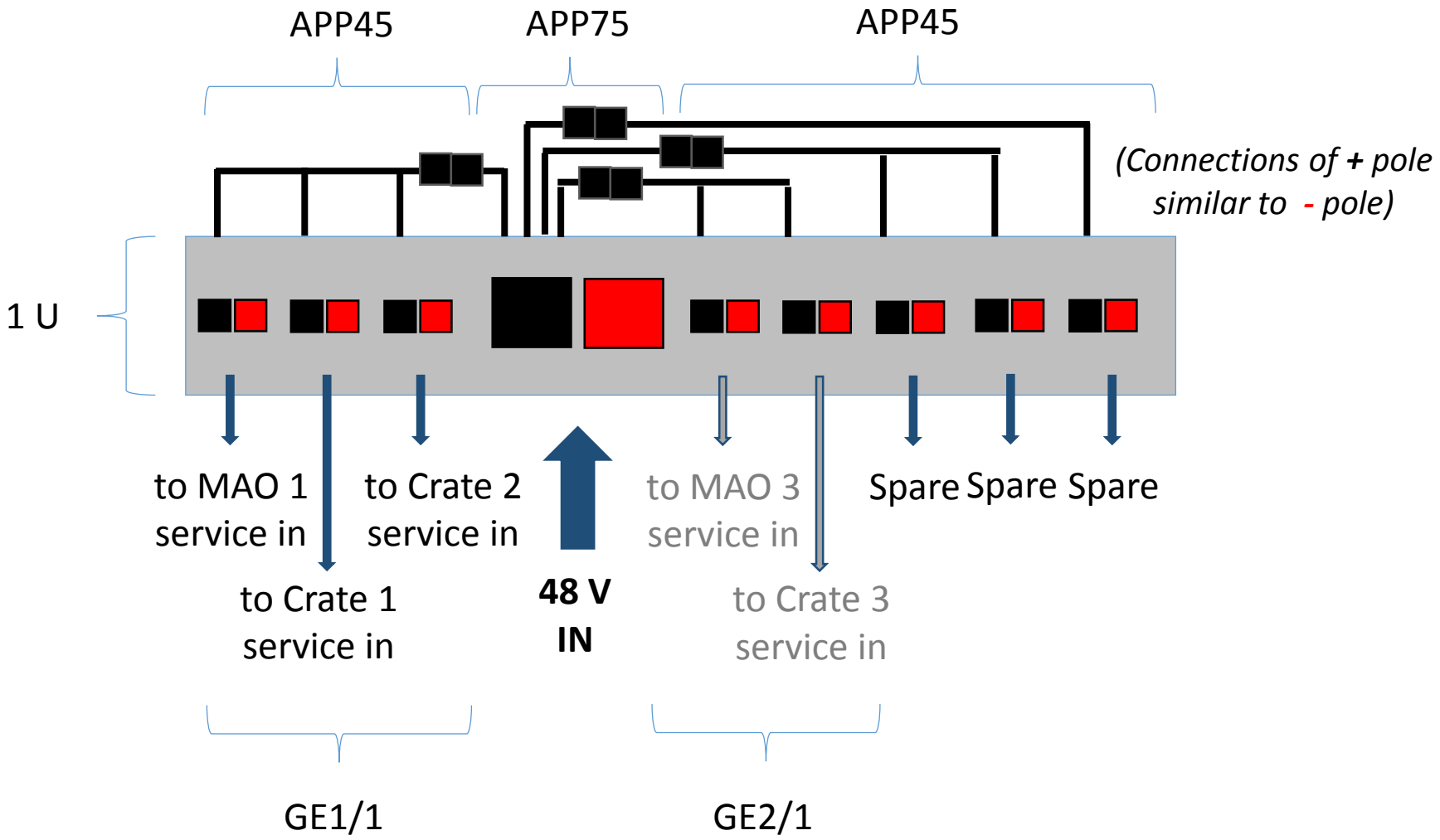


The **second output channel of MAO 2** is used to provide the **service to the other modules, through a distribution unit**

→ As the input service of MAO 2 is controlled by the DSS, a DSS kill will be effective on all the modules in the rack

GE1/1 LV System – UXC rack

48V Service Distr. Unit

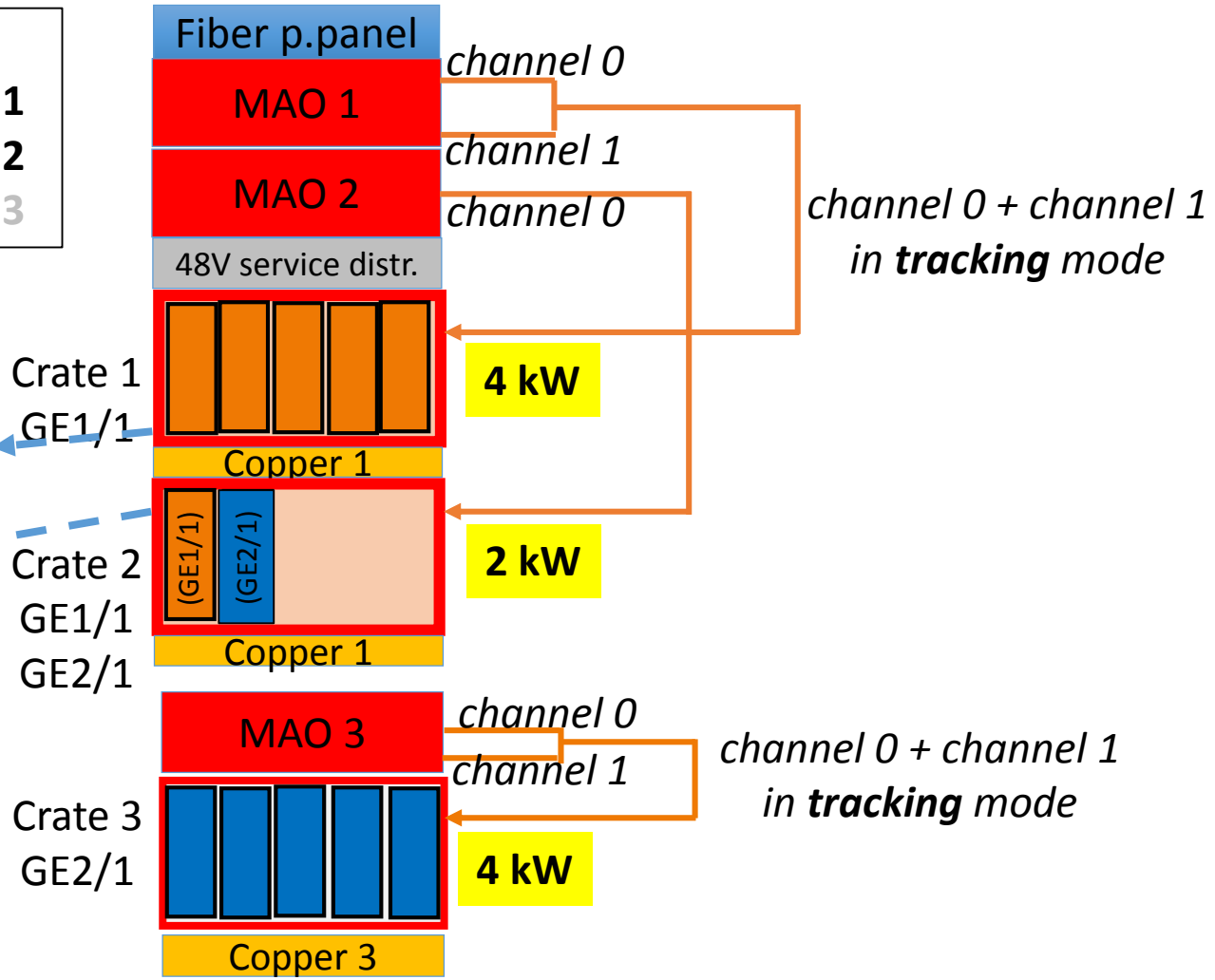


GE1/1 LV System – UXC rack

48 V power

Rule:
- **MAO 1** → supplies **Crate 1**
- **MAO 2** → supplies **Crate 2**
- **MAO 3** → supplies **Crate 3**

Expected power consumption:
- Crate 1 → 5 boards
  → ≈ 5x400 W = 2 kW (50% of max)
- Crate 2 → 1 board
  → ≈ 0.4 kW (20% of max)
- Crate 2 with GE2/1
  → 2 boards (A3016HP + A3009HP)
  → ≈ 400 W + 600 W = 1 kW (50% of max)
- Crate 3 → 5 boards
  → ≈ 5x600 W = 3 kW (75% of max)



GE1/1-GE2/1 LV: CURRENT STATUS

X4-to-X2/X5 cables (~30 m) Negative Endcap

→ **Cables through new cable chain** (-X4 near)

- ✓ **2x** DCS (communication & control)
- ✓ **2x** 48V service power
- ✓ **2x** tri-phase 220V for rack power

- ½ targets X2V33, ½ targets X5V32
- for installing the same cables on the positive endcap we have to wait for the new cable chain installation

USC-UXC cables (~100 m)

- ✓ **4x** DCS (communication & control)
- ✓ **2x** 48V service power
  (2 service power for GEM in each cable)
- ✓ **4x** tri-phase 220V for rack power

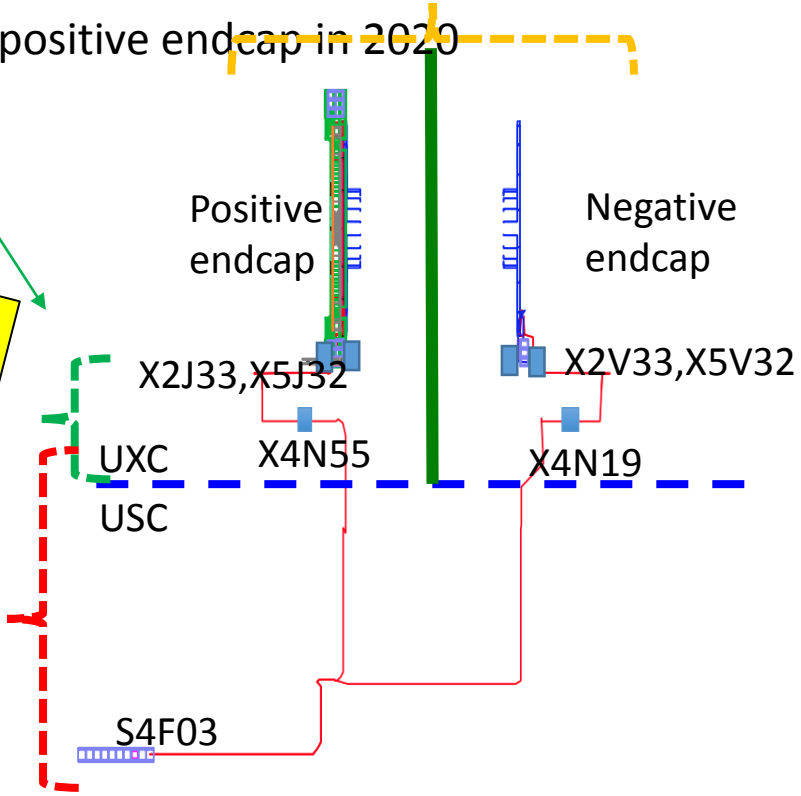
- all cables start in S4F03 rack
- ½ targets X4N55, ½ targets X4N19

USC-UXC cables routed for **both** endcaps, for **both GE1/1 GE2/1**

X2/X5-to-detectors cables Negative Endcap

- ✓ **all 72 SC GE1/-1** LV cables in place
- ✓ **all 144 SC GE2/-1** LV cables in place

- Installation of same cables on the positive endcap in 2020



GE1/1-GE2/1 LV: CURRENT STATUS

X4-to-X2/X5 cables (~30 m) Negative Endcap

→ **Cable**

- ✓ **2**
- ✓ **2**
- ✓ **2x** tri-phase 220V for rack power

- ½ targets X2V33, ½ targets X5V32
- for insta
we have

TO DO:
- Connectorization of cables on both ends

X2/X5-to-detectors cables

Nega

- ✓
- ✓
pl

- Inst

endcap in 2020

TO DO:
- Connectorization of 72 (GE1/1)+144 (GE2/1) cables on rack side (**ongoing**)

TO DO:
- 2x Patch panels
  - to joint DCS, 48V service and 220V power cables in the two X4 racks
  - *provided by S.Lusin*

endcaps

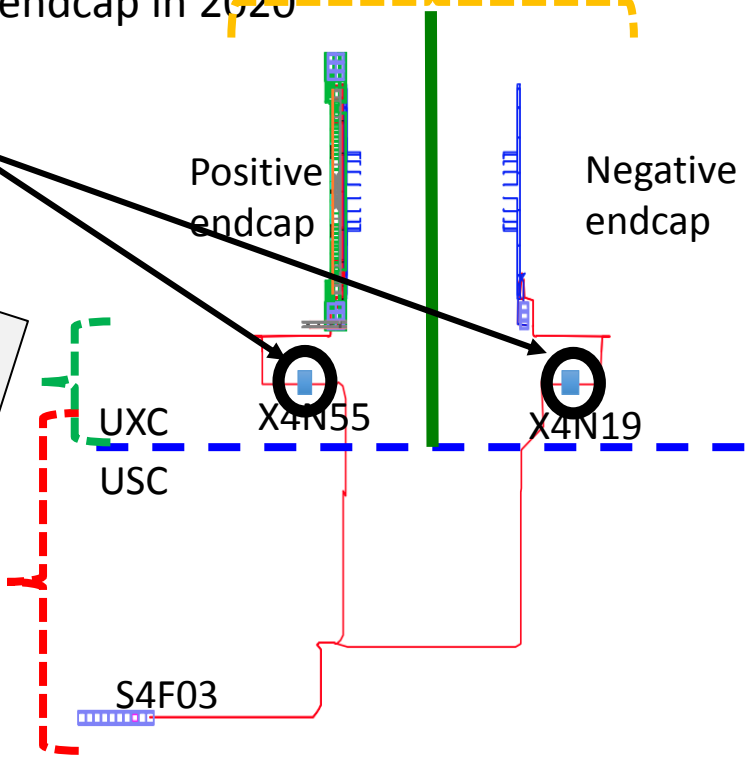
USC-UXC

- ✓ **4x** DCS (communication & control)
- ✓ **2x** 48V service power
(2 s

- ✓

- all ca
- ½ targets X4N55, ½ targets X4N19

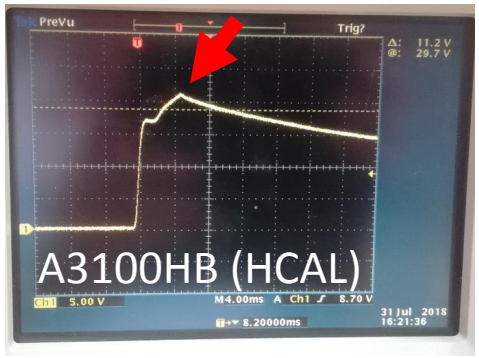
TO DO:
- Connectorization of cables on both ends



LV System Issues&Debugging

Summary of HCAL case:

In 2018 following a power interruption in CMS an HCAL power supply is suspected of having produced a voltage spike that killed the FEASTMP

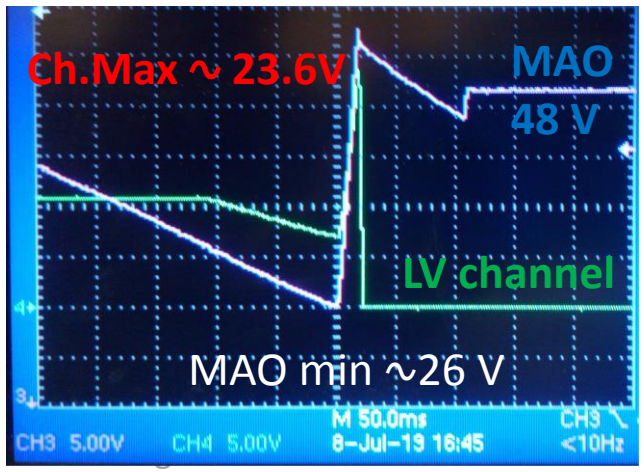


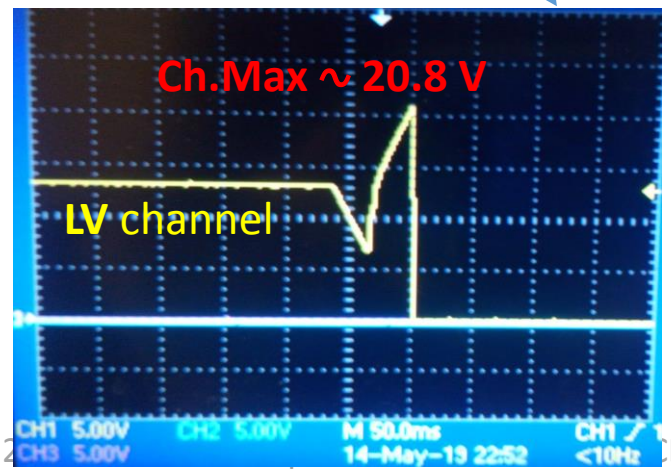
Could this happen also with A3016 boards?

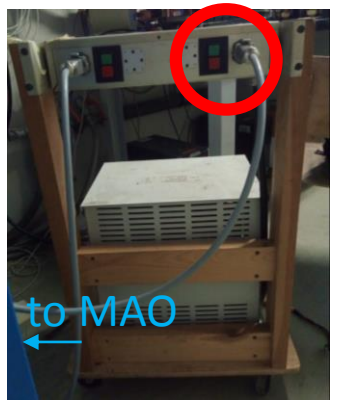
We discovered **2 ways** to produce transients in laboratory on **3016(HP) boards**:

1. ON command to MAO channel already ON (with MAO firmware ≤ 2.4 → problem fixed in next fw version)
2. Short "glitch" on the input power (220 V) of the MAO, obtained acting on the button (circuit breaker) of the 400/220 V transformer

A3016HP (GE1/1)





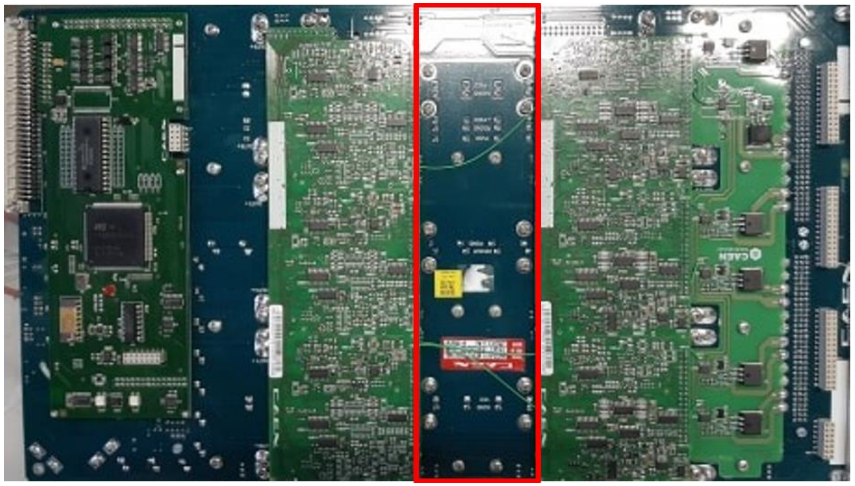


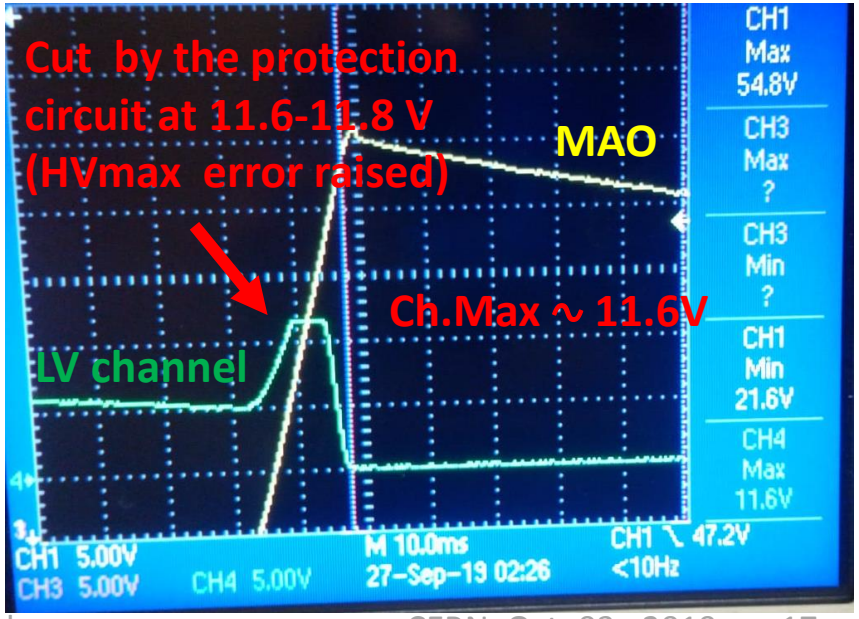
LV System Issues&Debugging

SOLUTION

- CAEN will provide an upgraded version of the LV boards with an additional protection circuit
  - It cuts the voltage above a fixed threshold
  - The threshold is determined by resistors in the protection circuit (→ can be modified by caen)
- 1st board (#175) declared with threshold of 11.8 V successfully tested in 904 lab
  - Verified that transients are cut at 11.6-11-8 V in all 6 channels
  - Verified that all FEASTMPs have survived (120 trials in total)

→ ALL BOARDS for P5 will be equipped with this protection circuit





Backup

GE1/1 HV System Mapping

e.g.:

HV Board (Slot)	SC Powered
0	SC 08 / SC 09
1	SC 06 / SC 07
2	SC 04 / SC 05
3	SC 02 / SC 03
4	SC 36 / SC 01
5	SC 34 / SC 35
6	SC 32 / SC 33
7	SC 30 / SC 31
8	SC 28 / SC 29
0	SC 10 / SC 11
1	SC 12 / SC 13
2	SC 14 / SC 15
3	SC 16 / SC 17
4	SC 18 / SC 19
5	SC 20 / SC 21
6	SC 22 / SC 23
7	SC 24 / SC 25
8	SC 26 / SC 27

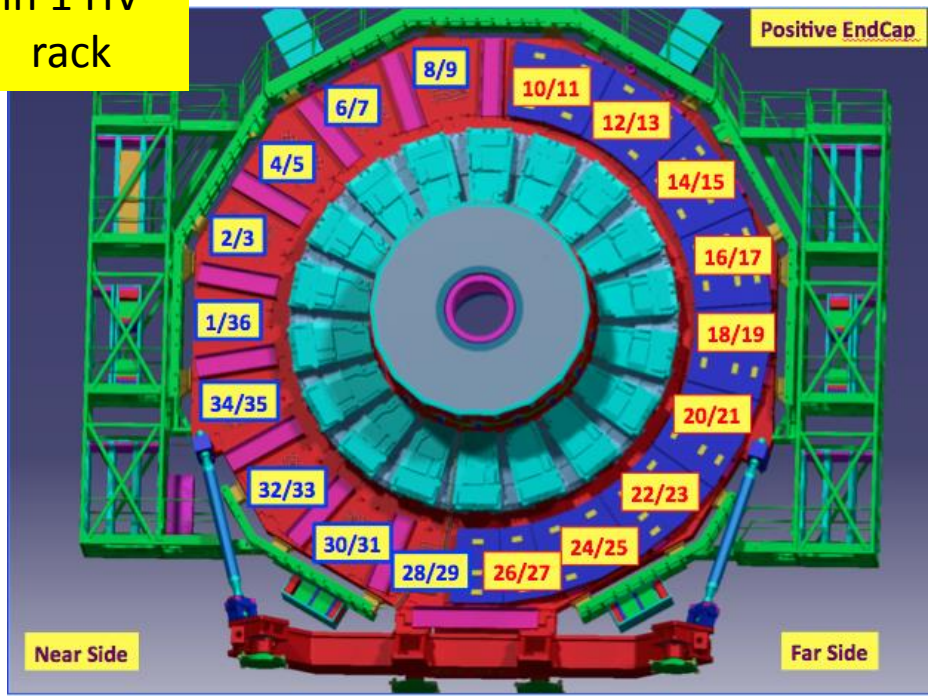
SC	Layer	Board channel
06	Ly 1 & Ly 2	Channel 0-6 (“group 1”)
07	Ly 1 & Ly 2	Channel 7-13 (“group 2”)

to Far Side

to Near Side

in 1 HV rack

A test-box to check the **correct connectivity** of all HV cables in P5 is prepared



** Same mapping for Positive and Negative Endcap*

GE1/1 HV System Mapping

HV Board (Slot)	SC Powered
0	SC 08 / SC 09
1	SC 06 / SC 07
2	SC 04 / SC 05
3	SC 02 / SC 03
4	SC 36 / SC 01
5	SC 34 / SC 35
6	SC 32 / SC 33
7	SC 30 / SC 31
8	SC 28 / SC 29

in Mainframe to Near Side

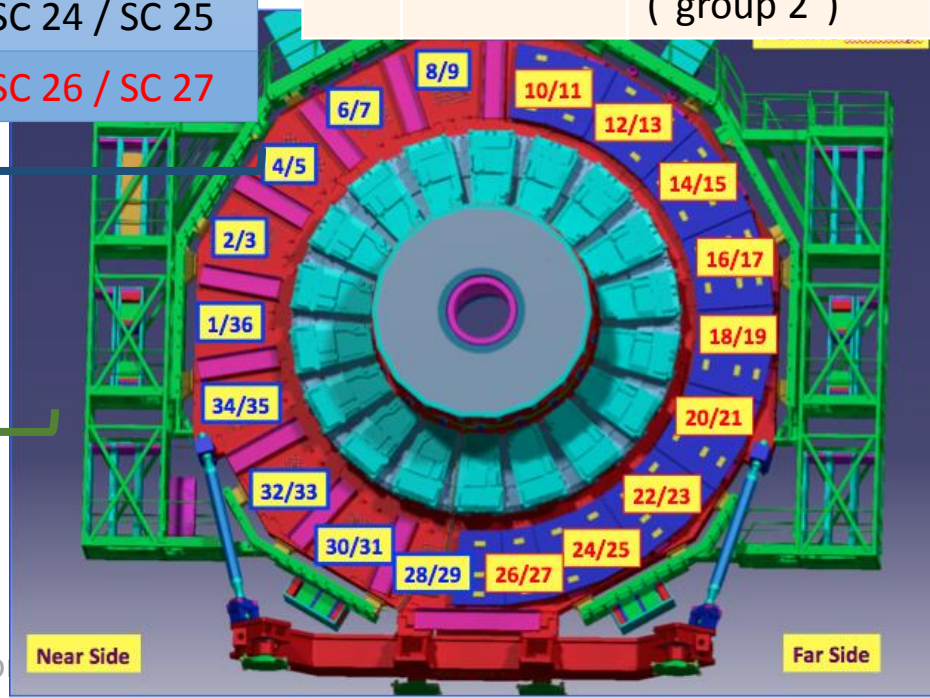
HV Board (Slot)	SC Powered
0	SC 10 / SC 11
1	SC 12 / SC 13
2	SC 14 / SC 15
3	SC 16 / SC 17
4	SC 18 / SC 19
5	SC 20 / SC 21
6	SC 22 / SC 23
7	SC 24 / SC 25
8	SC 26 / SC 27

in Mainframe to Far Side

e.g.:

SC	Layer	Board channel
12	Ly 1 & Ly 2	Channel 0-6 (“group 1”)
13	Ly 1 & Ly 2	Channel 7-13 (“group 2”)

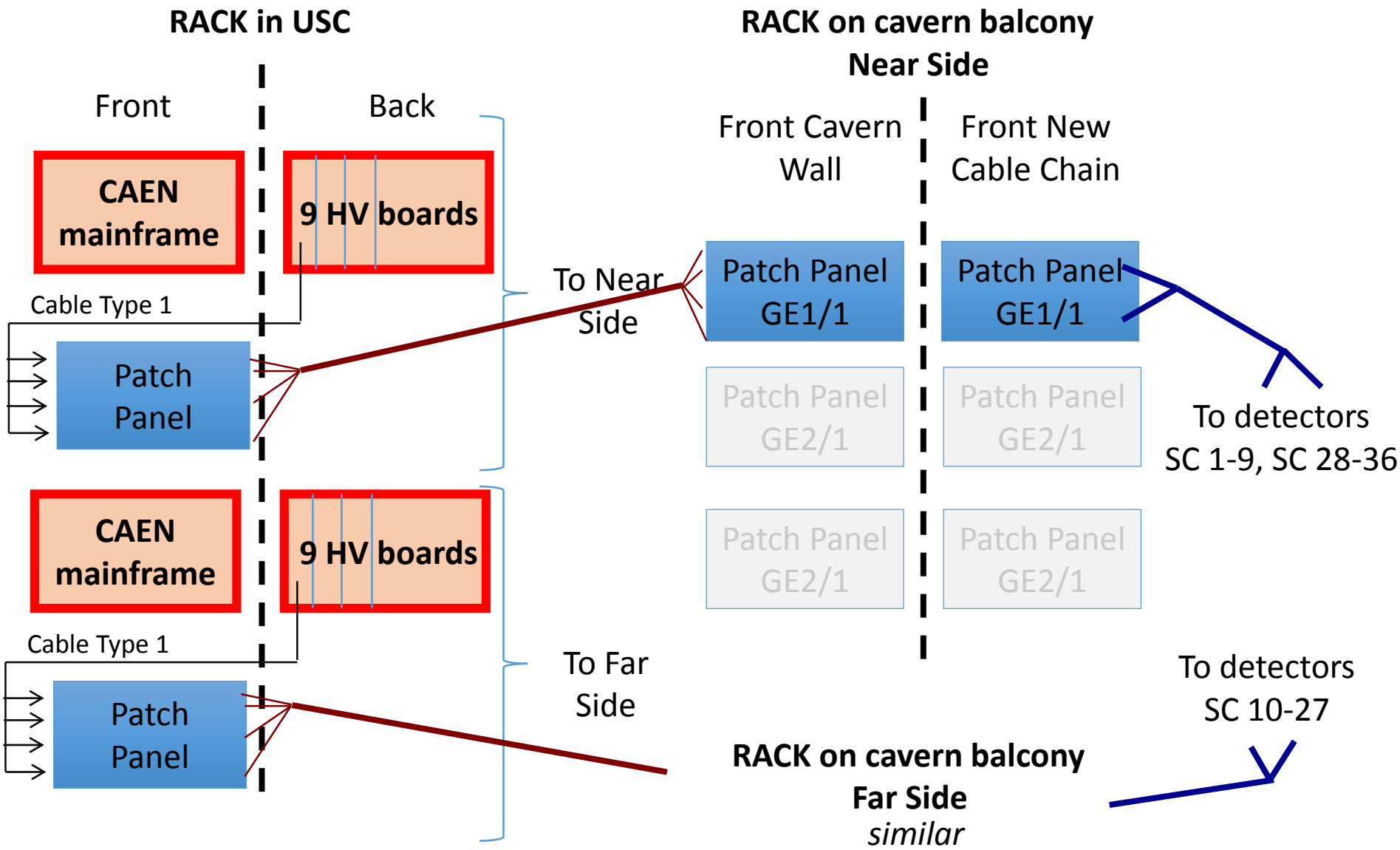
SC	Layer	Board channel
36	Ly 1 & Ly 2	Channel 0-6 (“group 1”)
01	Ly 1 & Ly 2	Channel 7-13 (“group 2”)



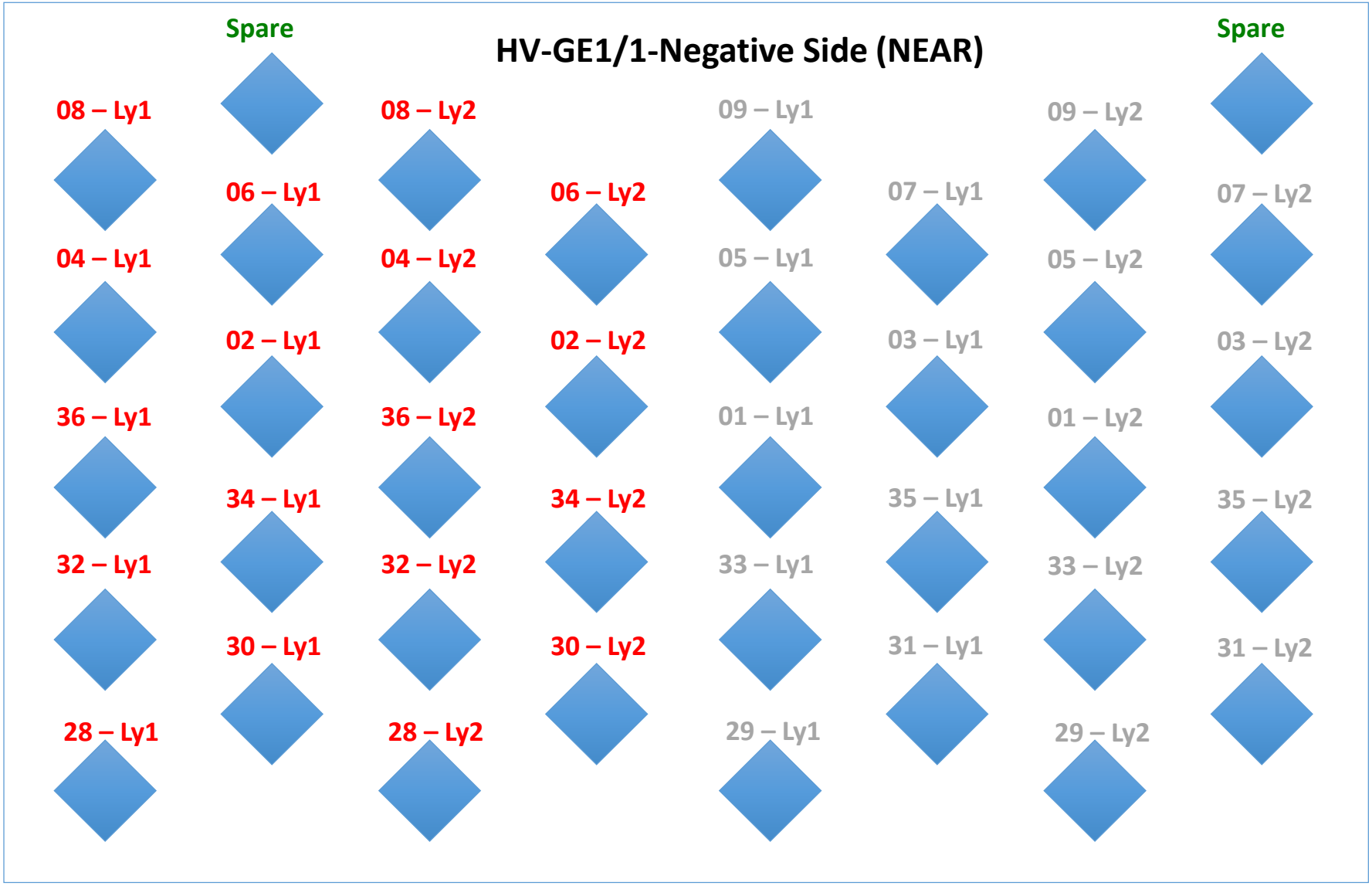
in 1 HV rack

** Same mapping for Positive and Negative Endcap*

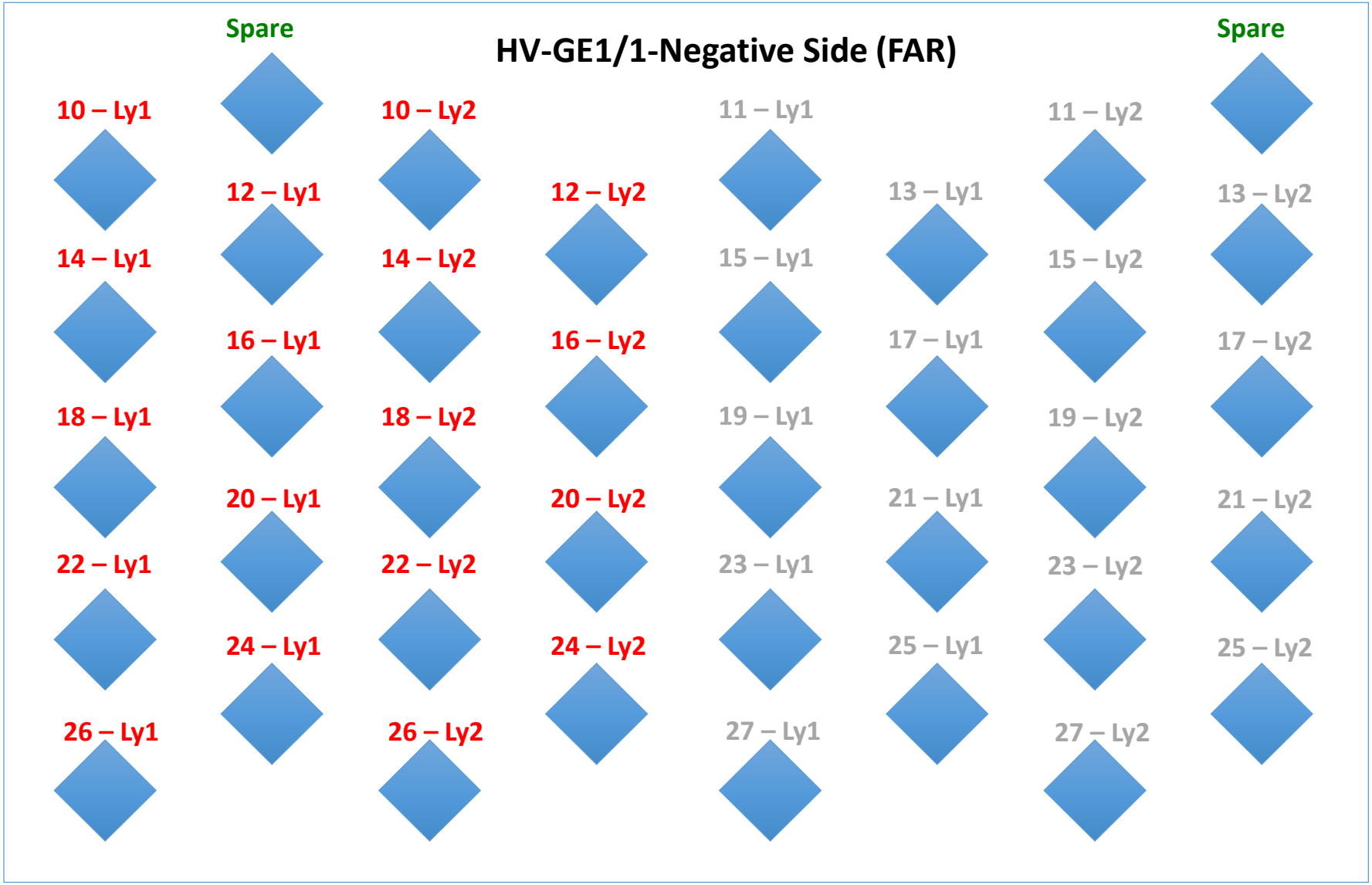
GE1/1 HV System for 1 endcap



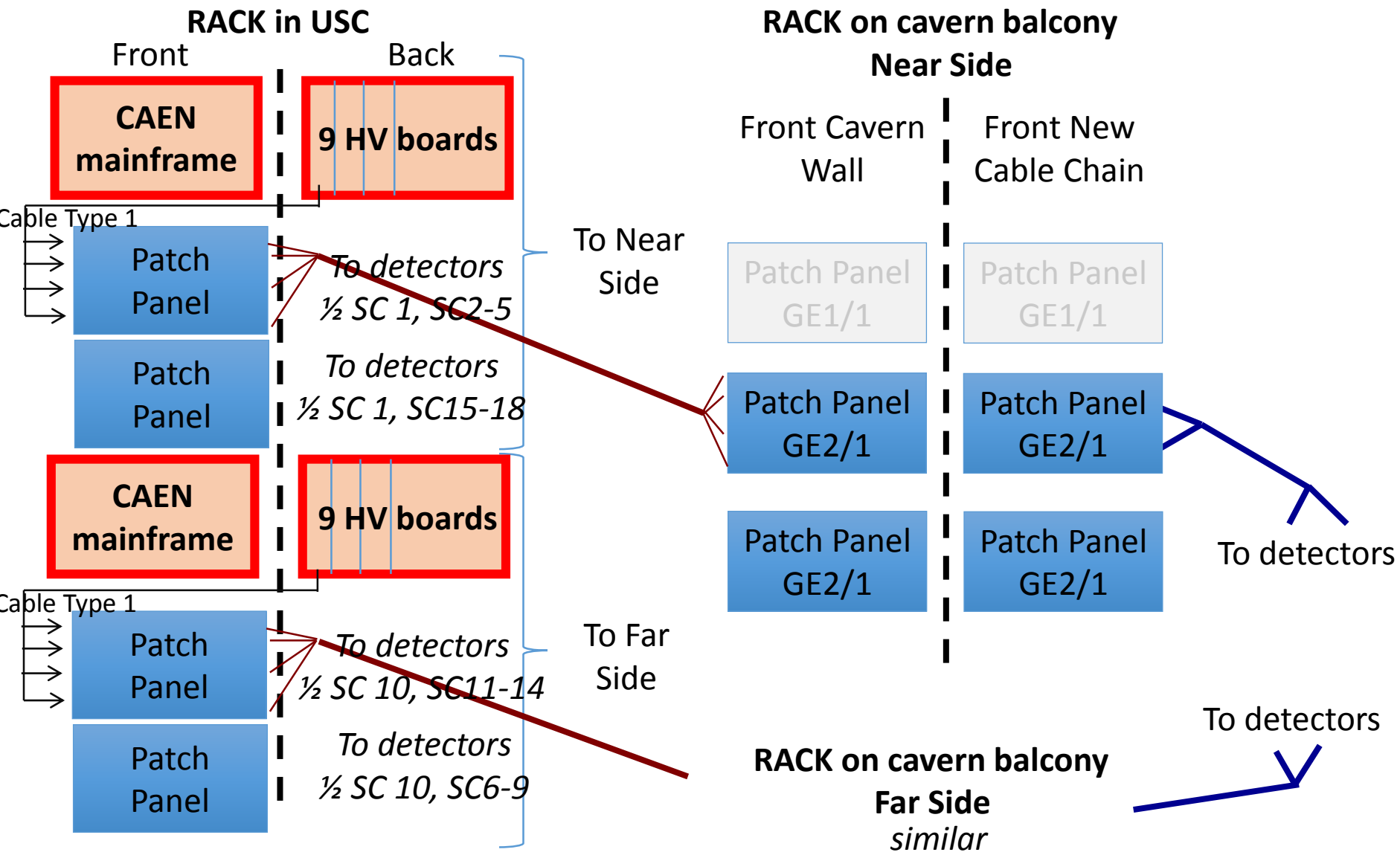
HV patch panel (USC)



HV patch panel (USC)



GE2/1 HV System for 1 endcap



GE2/1 HV patch panel-1

"Near" side (USC)

GE2/1 HV patch panel-2

"Near" side (USC)

GE2/1 HV patch panel-1

"Far" side (USC)

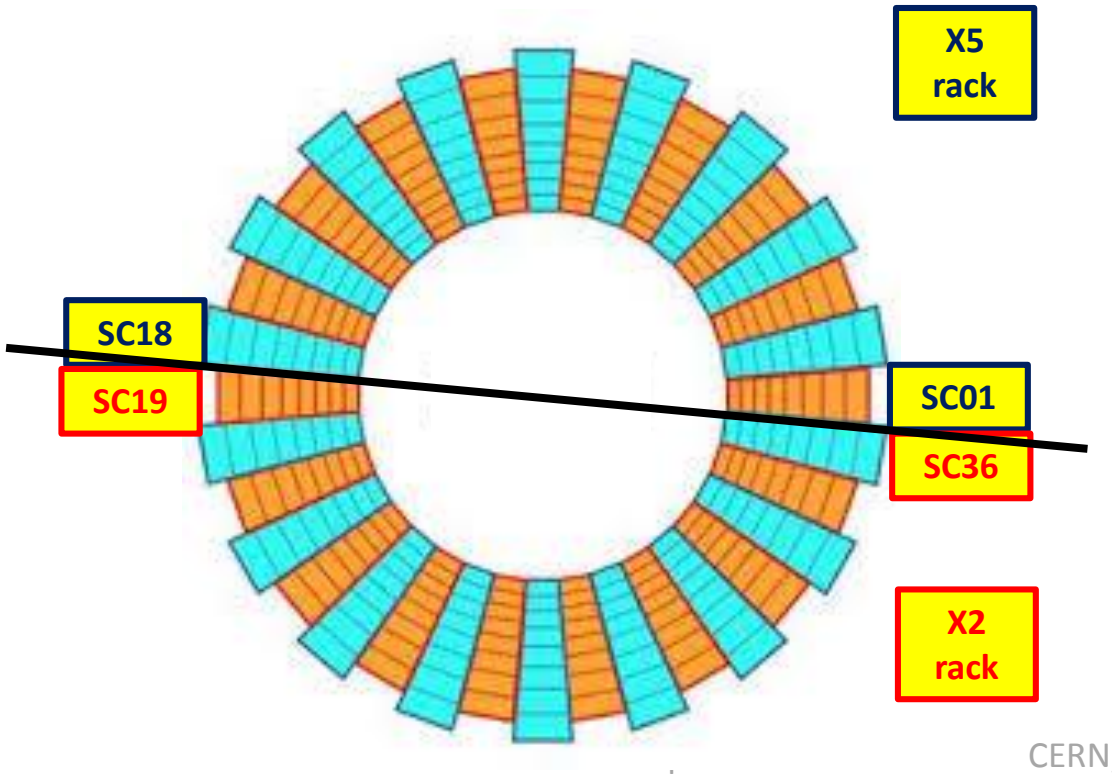
GE2/1 HV patch panel-2

"Far" side (USC)

LV System Mapping - USC

Board (A1676 Slot *)	Target Endcap	Target Rack in UXC	SC Powered
2	Positive	X5J32	SC 01 to SC 18
5	Positive	X2J33	SC 19 to SC 36
8	Negative	X5V32	SC 01 to SC 18
11	Negative	X2V33	SC 19 to SC 36

** Slots are numbered from slot 0*



LV System Mapping – UXC **X2** Level

Crate	LV Board (Slot)	LV channel	SC Powered
1 (**EasyCrate2** in DCS)	1	0	SC 19 – Ly 1
		1	SC 19 – Ly 2
		2	SC 20 – Ly 1
		3	SC 20 – Ly 2
		4	SC 21 – Ly 1
		5	SC 21 – Ly 2
	5	0	SC 22 – Ly 1
		1	SC 22 – Ly 2
		2	SC 23 – Ly 1
		3	SC 23 – Ly 2
		4	SC 24 – Ly 1
		5	SC 24 – Ly 2
	9	0	SC 25 – Ly 1
		1	SC 25 – Ly 2
		2	SC 26 – Ly 1
		3	SC 26 – Ly 2
		4	SC 27 – Ly 1
		5	SC 27 – Ly 2

Crate	LV Board (Slot)	LV channel	SC Powered
1 (**EasyCrate2** in DCS)	13	0	SC 28 – Ly 1
		1	SC 28 – Ly 2
		2	SC 29 – Ly 1
		3	SC 29 – Ly 2
		4	SC 30 – Ly 1
		5	SC 30 – Ly 2
	17	0	SC 31 – Ly 1
		1	SC 31 – Ly 2
		2	SC 32 – Ly 1
		3	SC 32 – Ly 2
		4	SC 33 – Ly 1
		5	SC 33 – Ly 2
2 (**EasyCrate3** in DCS)	1	0	SC 34 – Ly 1
		1	SC 34 – Ly 2
		2	SC 35 – Ly 1
		3	SC 35 – Ly 2
		4	SC 36 – Ly 1
		5	SC 36 – Ly 2

in 1 UXC LV rack

** Same mapping for Positive and Negative Endcap*

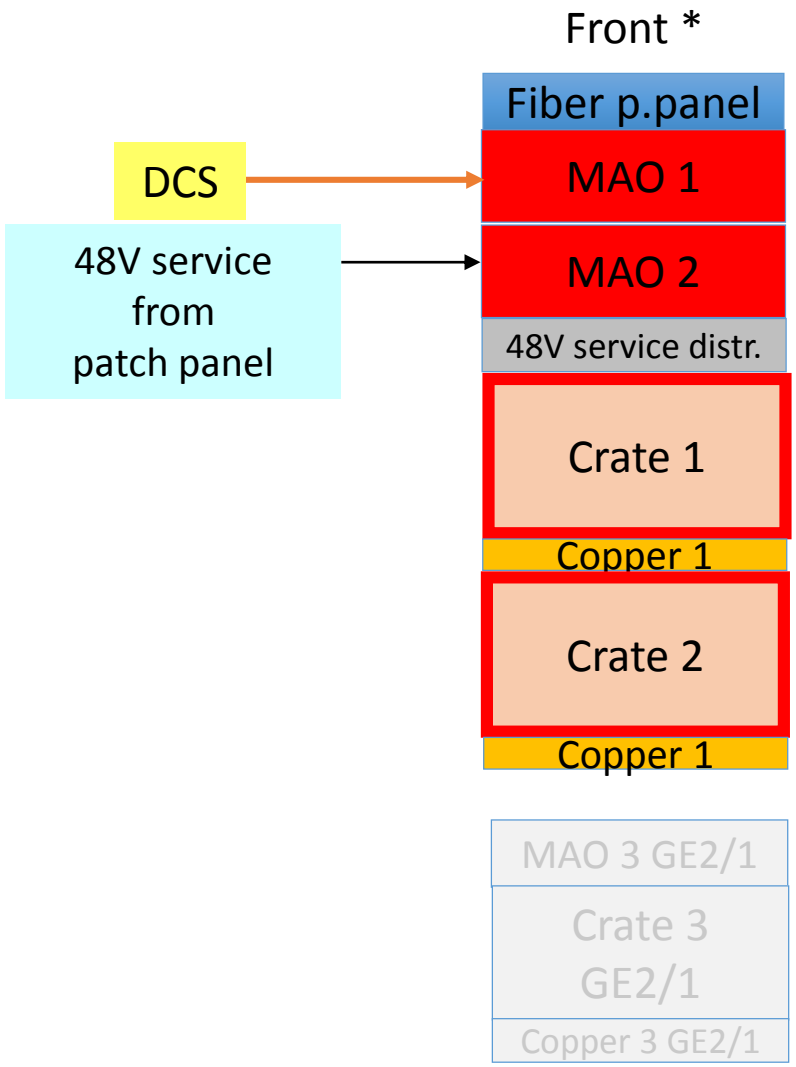
LV System Mapping – UXC **X5** Level

Crate	LV Board (Slot)	LV channel	SC Powered
1 (**EasyCrate2** in DCS)	1	0	SC 01 – Ly 1
		1	SC 01 – Ly 2
		2	SC 02 – Ly 1
		3	SC 02 – Ly 2
		4	SC 03 – Ly 1
		5	SC 03 – Ly 2
	5	0	SC 04 – Ly 1
		1	SC 04 – Ly 2
		2	SC 05 – Ly 1
		3	SC 05 – Ly 2
		4	SC 06 – Ly 1
		5	SC 06 – Ly 2
	9	0	SC 07 – Ly 1
		1	SC 07 – Ly 2
		2	SC 08 – Ly 1
		3	SC 08 – Ly 2
		4	SC 09 – Ly 1
		5	SC 09 – Ly 2
1 (**EasyCrate2** in DCS)	13	0	SC 10 – Ly 1
		1	SC 10 – Ly 2
		2	SC 11 – Ly 1
		3	SC 11 – Ly 2
		4	SC 12 – Ly 1
		5	SC 12 – Ly 2
	17	0	SC 13 – Ly 1
		1	SC 13 – Ly 2
		2	SC 14 – Ly 1
		3	SC 14 – Ly 2
		4	SC 15 – Ly 1
		5	SC 15 – Ly 2
2 (**EasyCrate3** in DCS)	1	0	SC 16 – Ly 1
		1	SC 16 – Ly 2
		2	SC 17 – Ly 1
		3	SC 17 – Ly 2
		4	SC 18 – Ly 1
		5	SC 18 – Ly 2

in 1 UXC LV rack

** Same mapping for Positive and Negative Endcap*

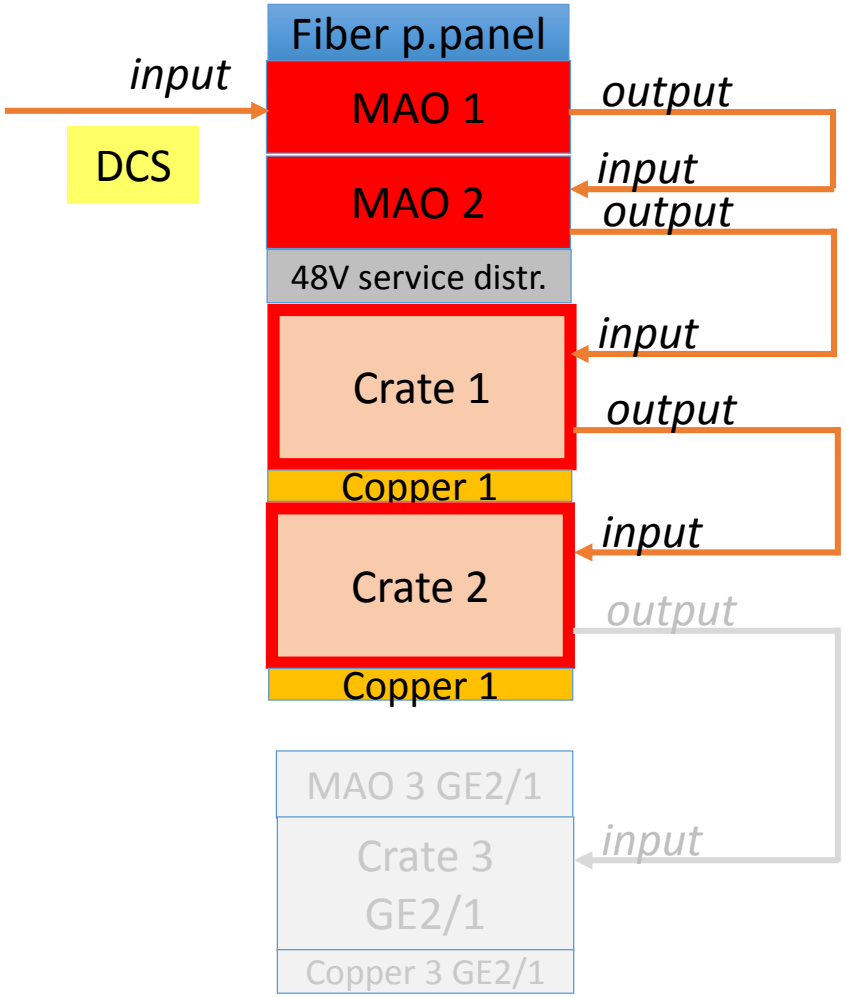
GE1/1 LV System – UXC rack



** All modules in the rack need to be accessed only from the front*

GE1/1 LV System – UXC rack

DCS



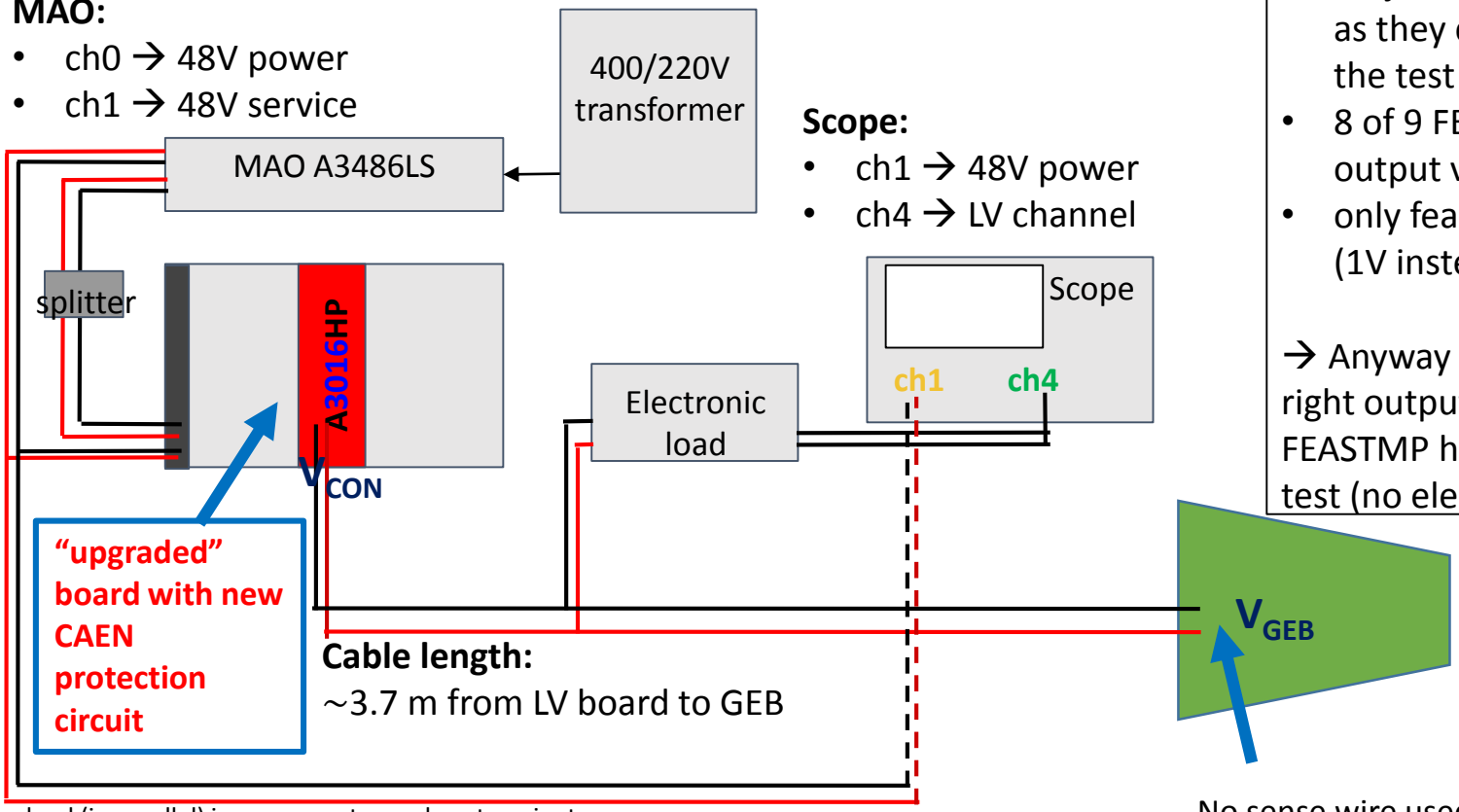
Unplugged Procedure

Procedure to be implemented in the new firmware of the HV boards to recover unplugged channels:

Step		Error in DCS	Error in ssh / GECO / …
1	Channel X becomes unplugged	Unplugged	Unplugged
2	The other 6 channels are switched off “normally” (i.e. with the rDwn set, following the offOrder if in GEM mode)	Unplugged	Unplugged
3	The unplugged channel is killed by cutting off the power of the channel for 10 seconds • During this 10 s the rDown depends on the impendence of the line	PwrFail	PwrFail
4	After this 10 s power is repristinated and the output is put to ground • the rDown depends on the load The microcontroller of the channel at this point is rebooted, and hopefully with a working communication with the microcontroller of the base	Unplugged + PwrFail	Unplugged
5	All 7 channels are now OFF	Unplugged + PwrFail	Unplugged
6	It is necessary to acknowledge the problem by clearing the alarm before powering the channel group		

Setup

MAO:
- ch0 → 48V power
- ch1 → 48V service



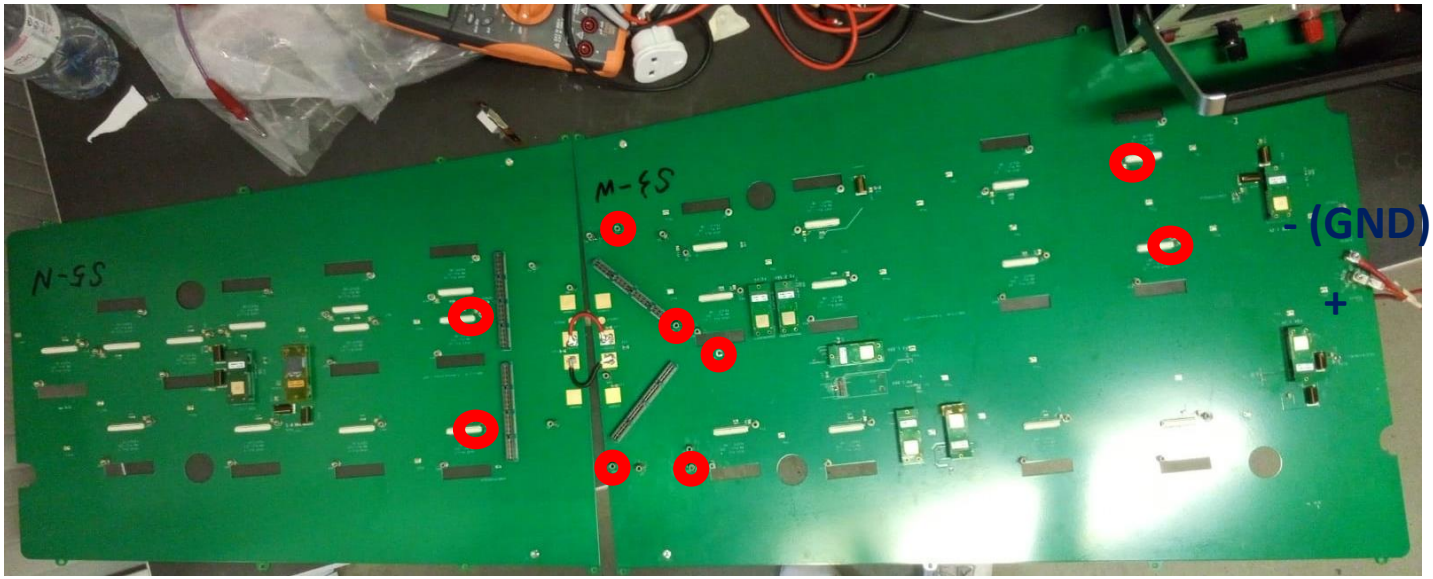
GEB:
- Old version GEB
- «rejected» FEASTMPs used, as they could be damaged in the test
- 8 of 9 FEASTMP with correct output voltage
- only feast FQC "wrong" value (1V instead of 1.2V)

→ Anyway we suppose that the right output voltage of the FEASTMP has no influence on the test (no electronics powered)

The load (in parallel) is necessary to produce transients
→ Not able to produce them with Imon=0
→ More easily produced at higher load

No sense wire used, V_{GEB} **measured here** with voltmeter

Test if FEASTMPs are ALIVE



"Health" of all 9 FEASTMPs verified by measuring with the voltmeter if there is voltage on the following 9 points (w.r.t. GEB ground):

- **VFAT pos 15** (or similar powered by FEAST QA)
- **VFAT pos 23** (or similar by FEAST QB)
- **VFAT pos 3** (or similar by FEAST QC)
- **VFAT pos 11** (or similar by FEAST QD)
- **OH1**
- **OH2**
- **OH3**
- **OH5**
- **OH6**

Unplugged Procedure

Remarks

- The user should not try to switch on channels or clear alarms while they're rebooting
  → locking all 7 channels and the clear alarm command could be implemented on DCS side
- In the DCS the presence of the errors "unplugged + pwrFail + unplugged" in a predeterminate sequence indicates that the micro was rebooted because the unplugged error appeared

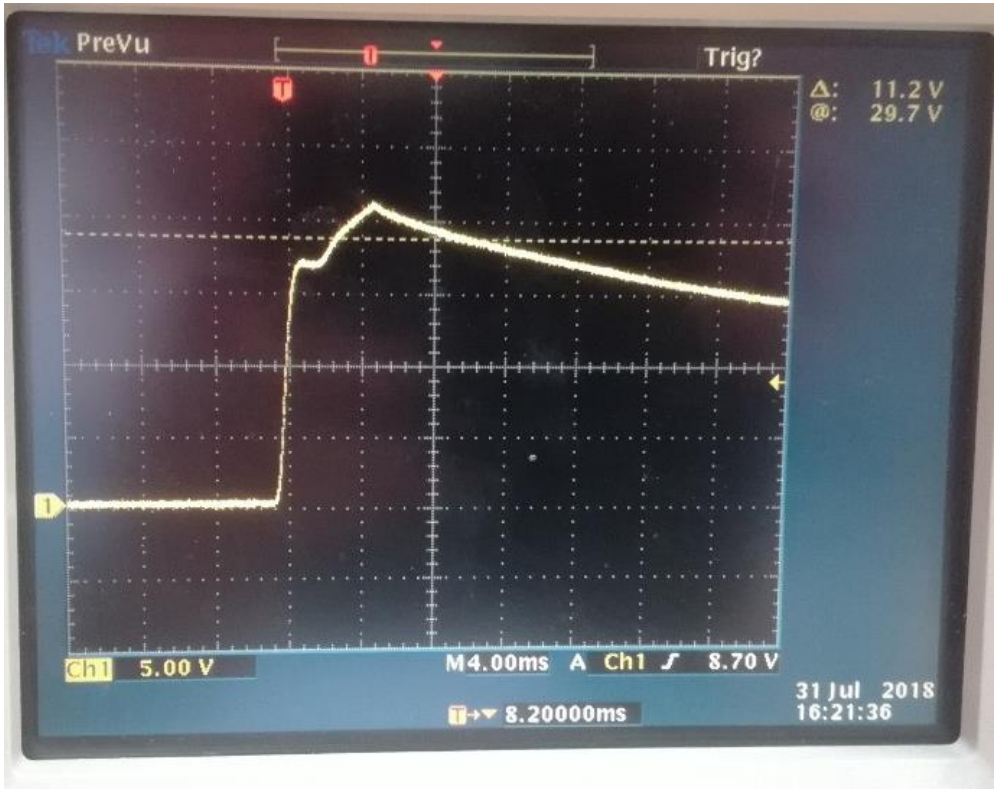
Summary of HCAL case (1/2)

On June 30th, following a power interruption in CMS the power supply (#130) A3100HB [One channel 8 ÷ 14 V, 600 W]

- was failing to switch on due to OvHVMax errors
- showed Cal-Error error [= error detected in reading the Eprom that contains all the calibration parameters], that could be cleared allowing to switch the channel on again (appeared a few times also later in the lab tests)
- Despite replacing the module, there was no communication with ngFEC, so the affected HEM sectors were lost.

- In next slide is what **killed** them (notably the **FEASTMPs**) …

Summary of HCAL case (2/2)



Both CAEN and HCAL (German) were able to reproduce the issue:

- When the channel was switched on, a transient of 20V was produced before the OverHVMax trip turned off the channel
- The length of the transient over 15V with a load of 2A was around 10 ms

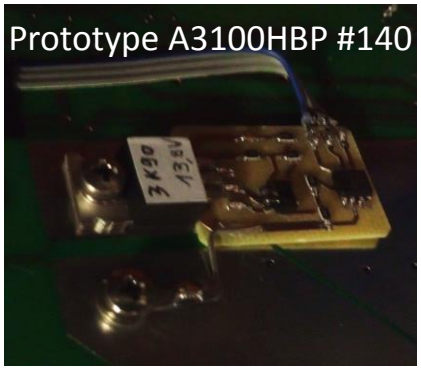
- Reproducing the issue is not systematic, it is necessary to repeat a test many times to see the event (about few times over 100 tests as reported by German)

LV System Issues&Debugging

Two possible solutions to protect against voltage transients:

1. CAEN has developed a protection circuit to be installed on LV boards that kills the output (Vcon=0) whenever the Vcon overcomes a fixed threshold Vmax

2 prototypes of A3100HBP with CAEN protection circuit produced
→ they are **currently under test** in collaboration with German (HCAL)
→ It can be implemented also on A3016HP boards once "approved"



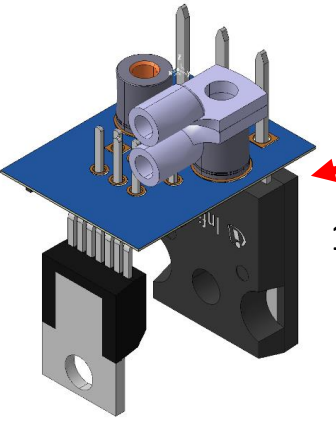
2. HCAL (German) has developed an external protection circuit

- The choice of the components defines the threshold voltage vMax (e.g. 12 V) and the reset voltage (e.g. 10 V)
- If Vcon>vMax a large current (200 A) flows in the circuit (*not* at the load) and causes the module to trip after the tripTime
- The proper operation is restored when the voltage gets below the reset voltage

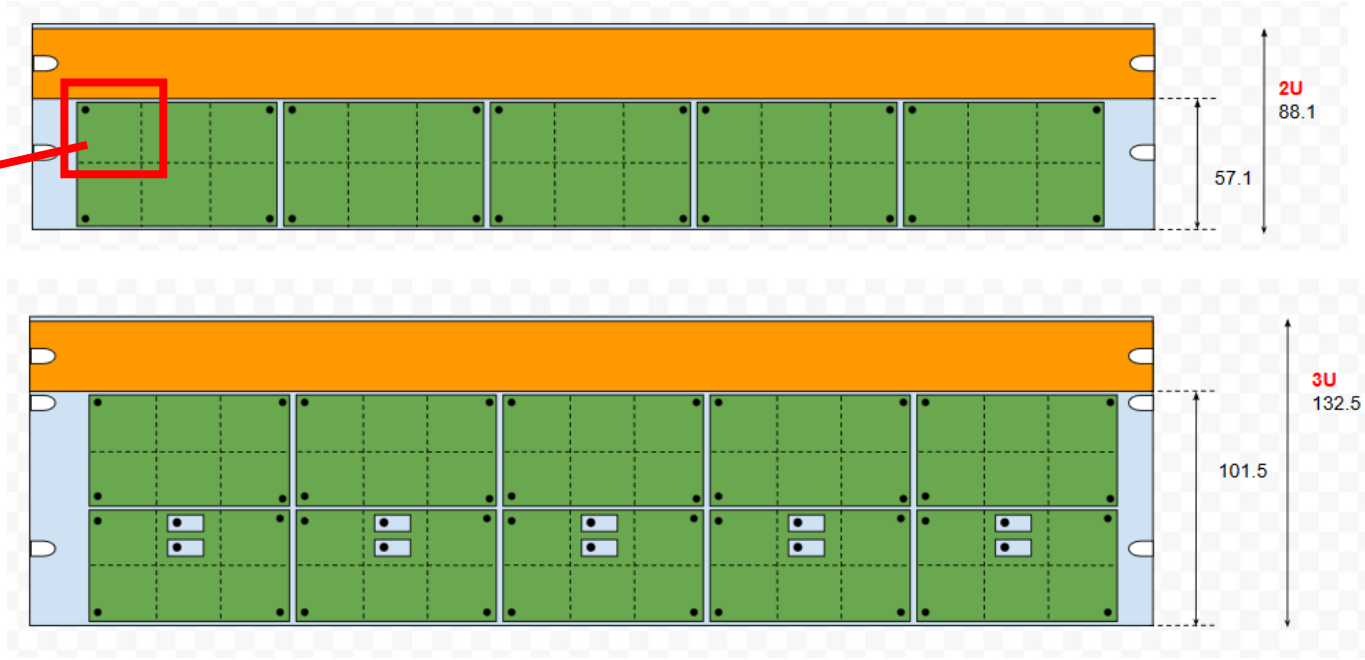
GEM community also designed a similar (to HCAL) solution. Due to the fact that A3016HP when operated with CAEN MAO system doesn't suffer of spike problems, implementation is staged

Deisgn of protection circuit #1

- Panel for **rack mounting**, based on (86 x 47.75) mm PCB with a matrix of 3x2 protection circuits ? (in figure: merged with copper bar for grounding, to save space)
- 2U panels for GE11 and GE21, 3U panels for MEO (2x number of LV channels)
- Difficult implementation for complexity of realization and space → the space for such panels was initially not foreseen in the racks



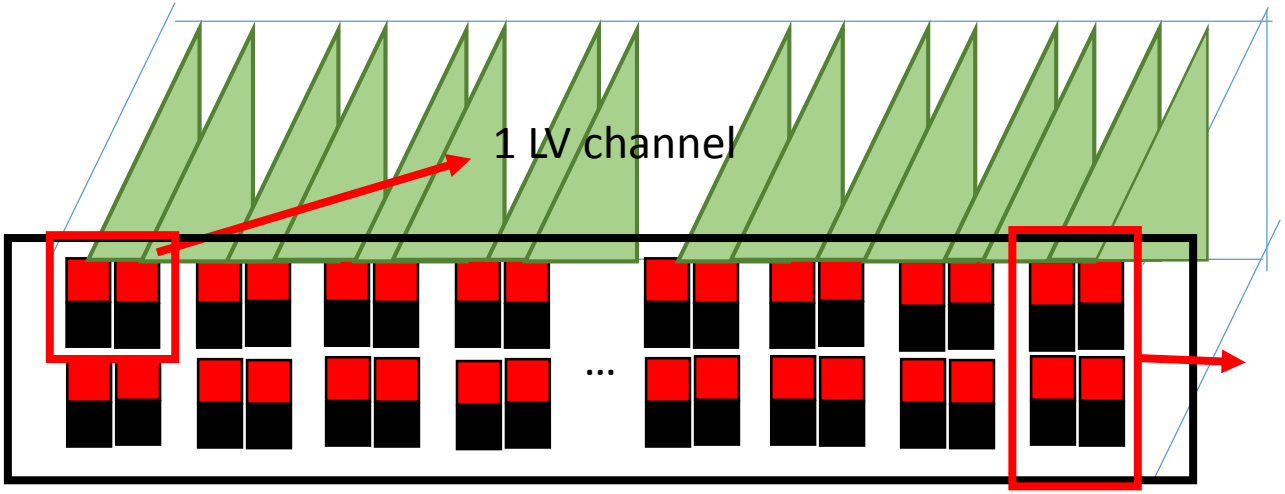
1 LV channel



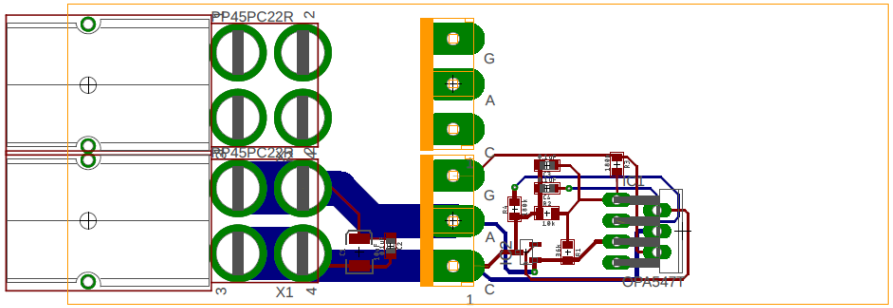
A. Peck

Deisgn of protection circuit #2

- Panel for **rack mounting**
- The circuits are inside the rack, perpendicular to the front panel
- On the front panel there are 4x APP45 connectors for each LV channel



Front view (not to scale)



Side view

Z. Szillasi

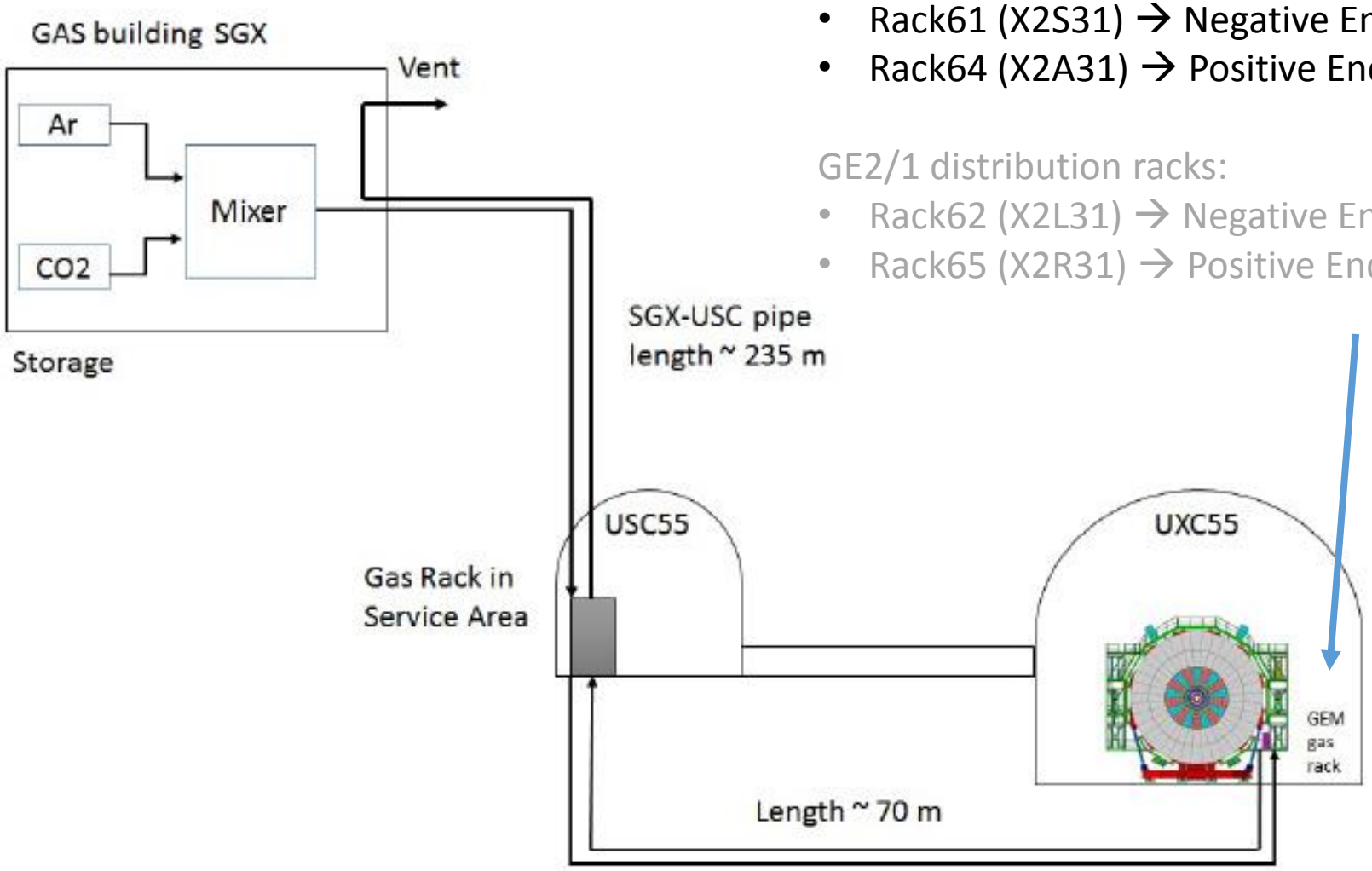
Gas System

GE1/1 distribution racks:

- Rack61 (X2S31) → Negative Endcap
- Rack64 (X2A31) → Positive Endcap

GE2/1 distribution racks:

- Rack62 (X2L31) → Negative Endcap
- Rack65 (X2R31) → Positive Endcap

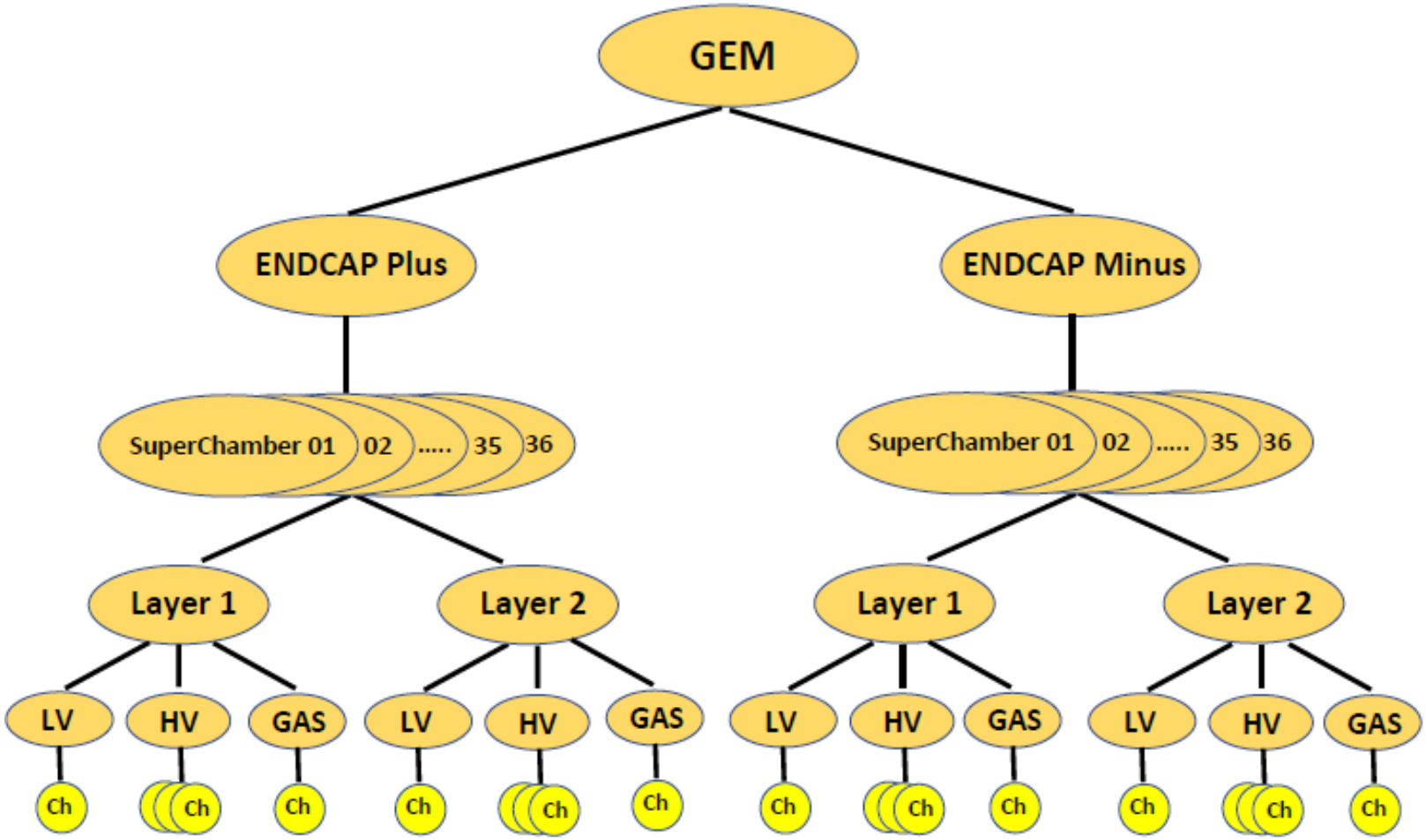


Gas System Mapping

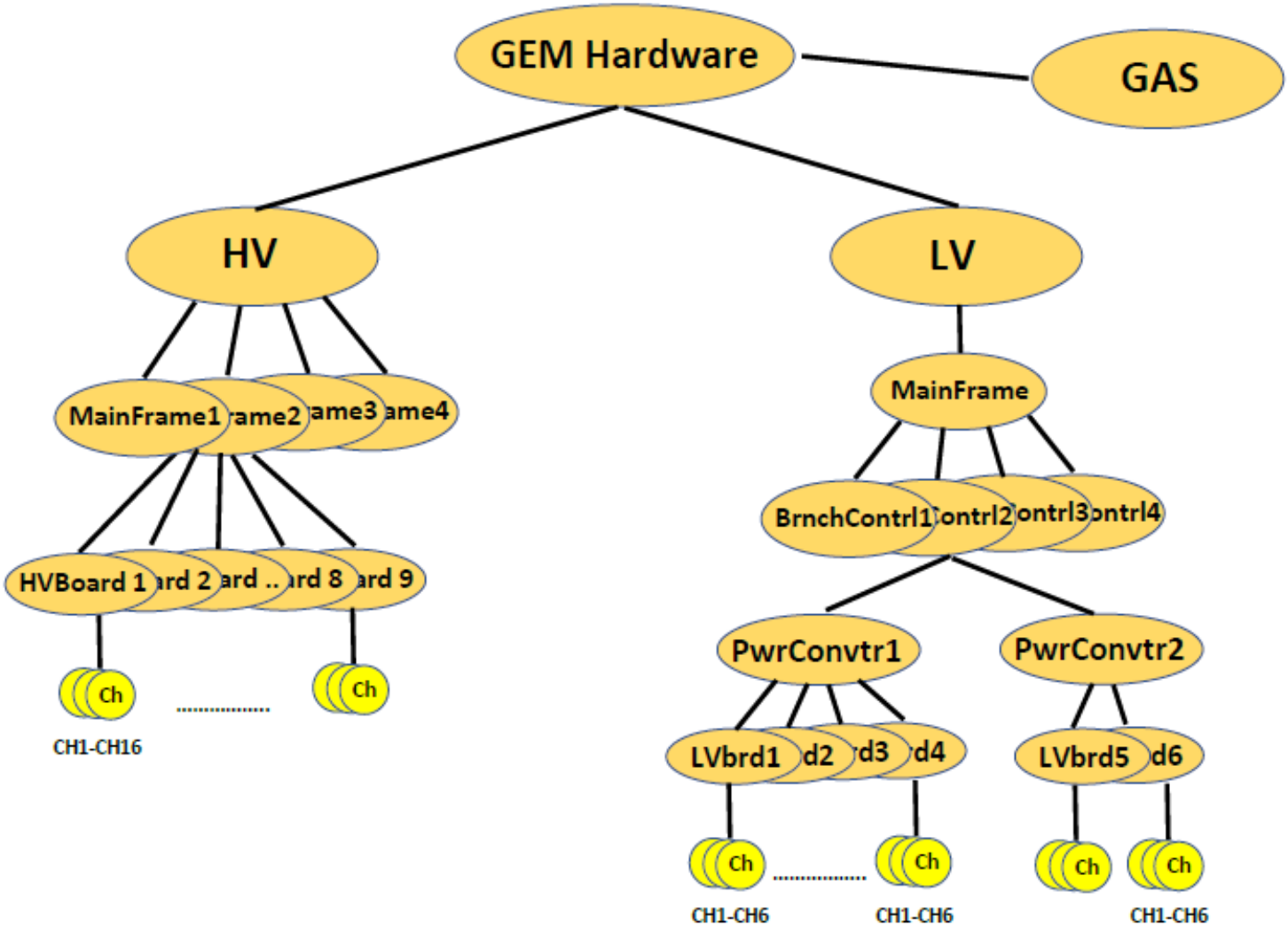
- Each gas rack hosts 13 (12 used) gas channels
- 1 gas channel supplies 6 (single) layers of different SCs (to minimize coverage holes in case of failures)

Negative Endcap	
SC 4 to 9 – Ly 1	SC 22 to 27 – Ly 1
SC 4 to 9 – Ly 2	SC 22 to 27 – Ly 2
SC 10 to 15 – Ly 1	SC 28 to 33 – Ly 1
SC 10 to 15 – Ly 2	SC 28 to 33 – Ly 2
SC 16 to 21 – Ly 1	SC 34 to 3 – Ly 1
SC 16 to 21 – Ly 2	SC 34 to 3 – Ly 2

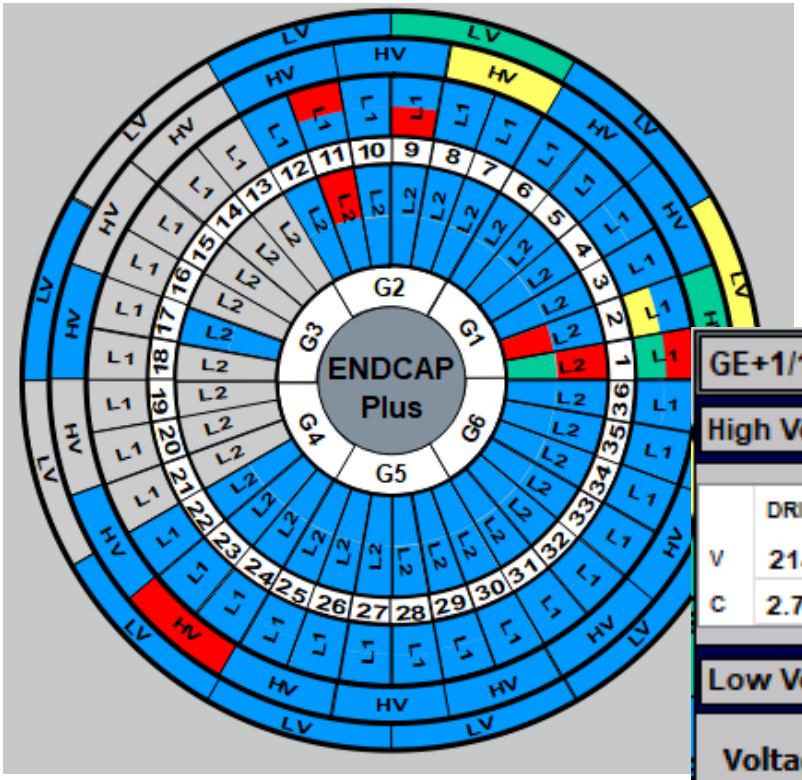
FSM – Detector View



FSM – Hardware View



Chamber Status Popup Panel



GE+1/1/01/1 ERROR Change Settings

High Voltage (HV) ERROR Last Updated 2018.10.03 14:53

	DRIFT	G1TOP	G1BOT	G2TOP	G2BOT	G3TOP	G3BOT
V	2145	891	854	412	256	338	200
C	2.711	2.656	2.200	1.756	1.244	0.844	0.300

Low Voltage (LV) ON Last Updated 2018.10.17 11:45

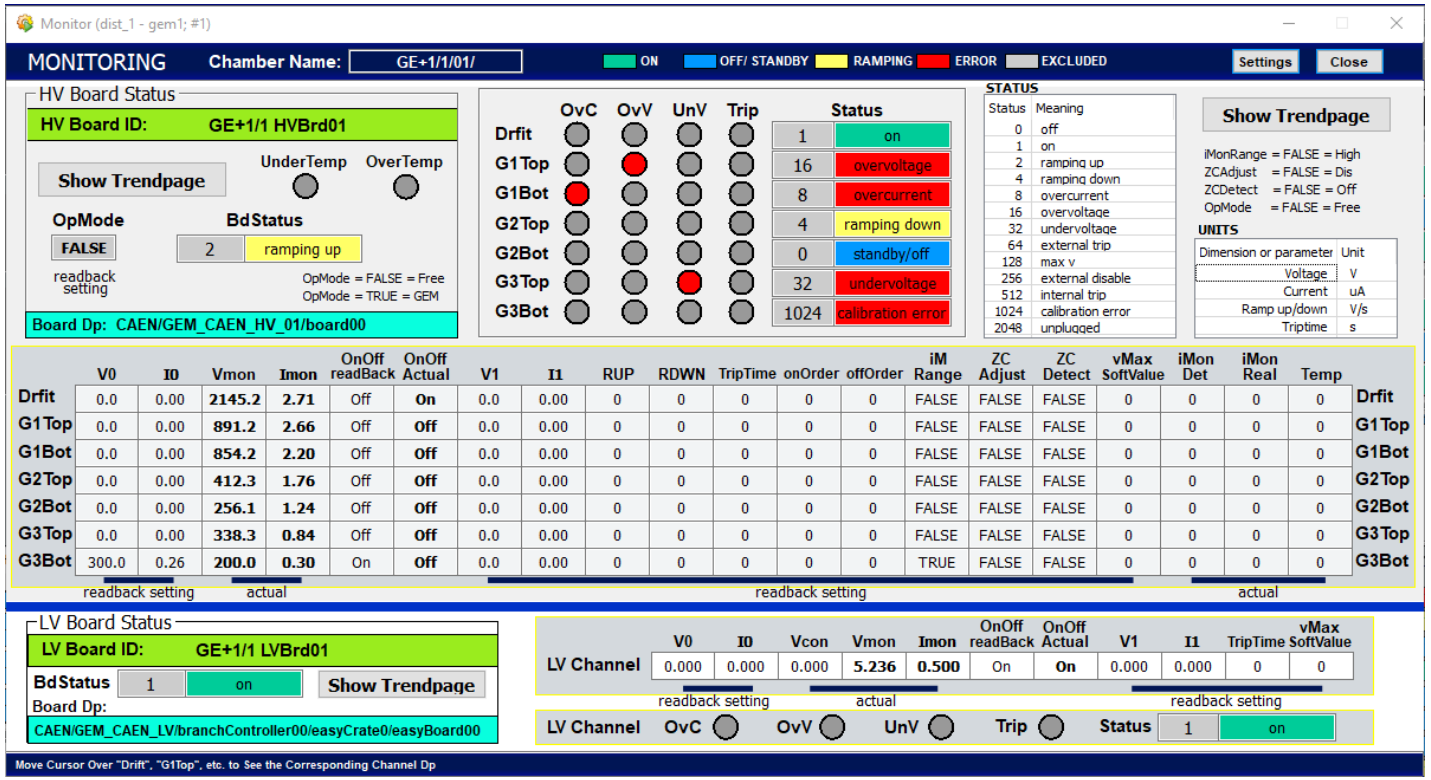
Voltage 5.236 Current 0.499995

Temperature Last Updated 2018.08.15 14.23

1	2	3	4	5	6
loading	loading	loading	loading	loading	loading

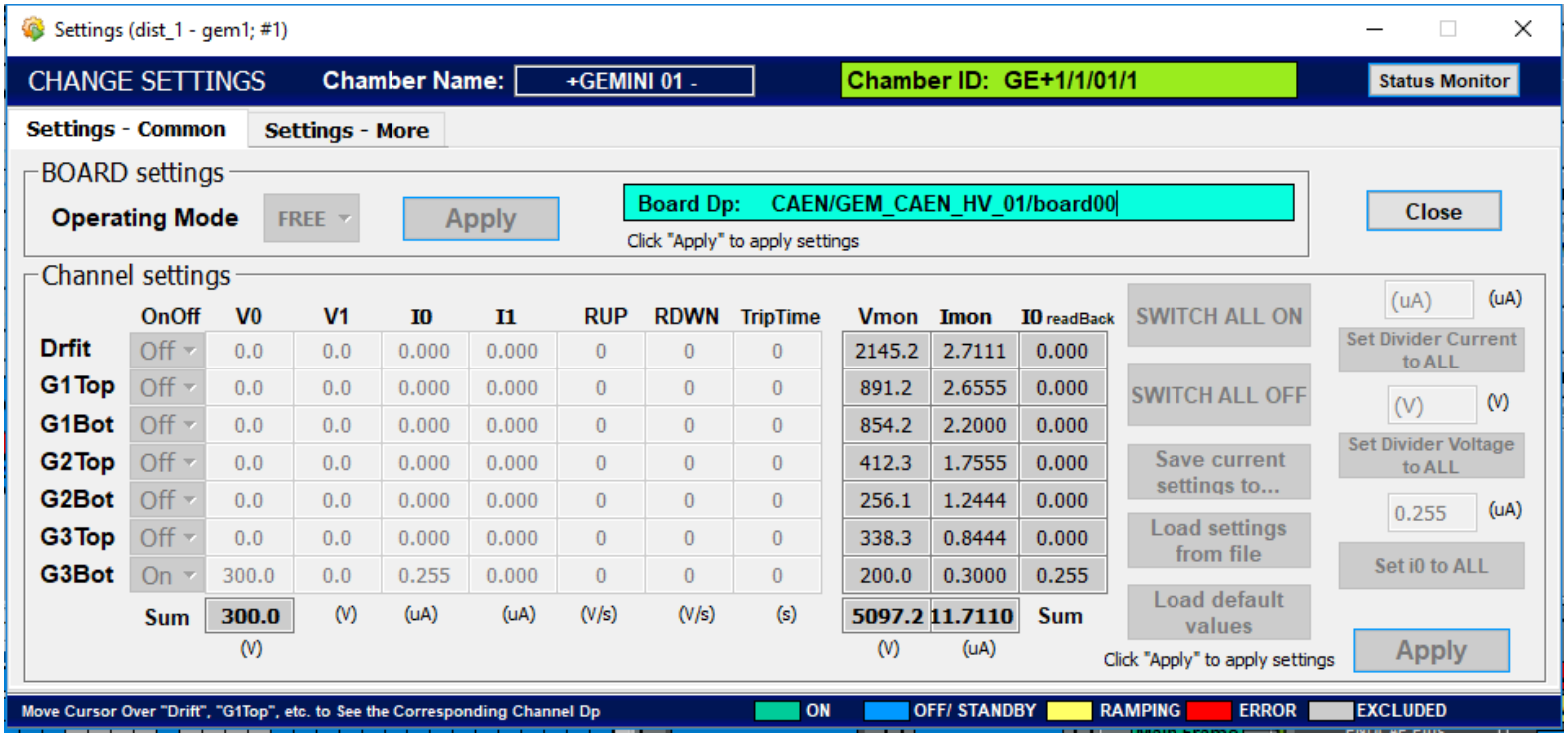
Status Monitor Show Trends Alarm Screen

Chamber Status Monitor Panel



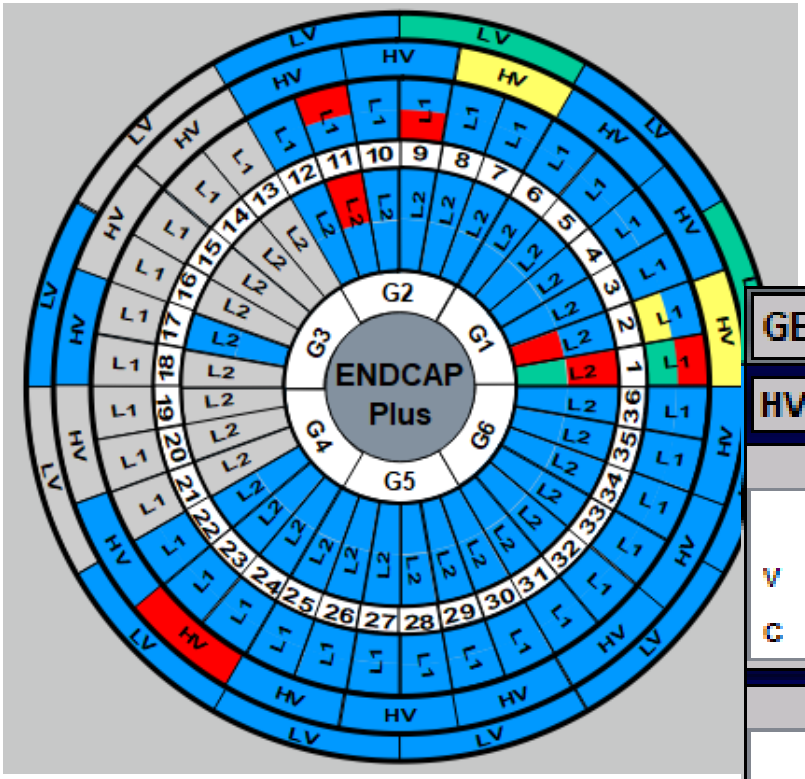
- **Using this panel, user can monitor,**
  - LV and HV channel DP values connected to the selected chamber
  - LV and HV channel status
  - LV and HV channel error status
  - Relevant LV and HV Board status
  - LV and HV Board trend pages
  - Channel trend page

Chamber Settings Panel



- **Using this panel, experts or operators can change,**
  - HV channel DP values connected to the selected chamber
  - Relevant HV Board operating mode
  - Can save current settings, load settings and load default settings
  - Can set divider current and voltages by clicking a single button

HV Board Status Popup Panel



GE+1/1 HVBrd1 | ON | Change Settings

HV Board Status | RAMPING | Last Updated 2018.10.17 13:04

Super Chamber No 1 , Layer1 & Layer2

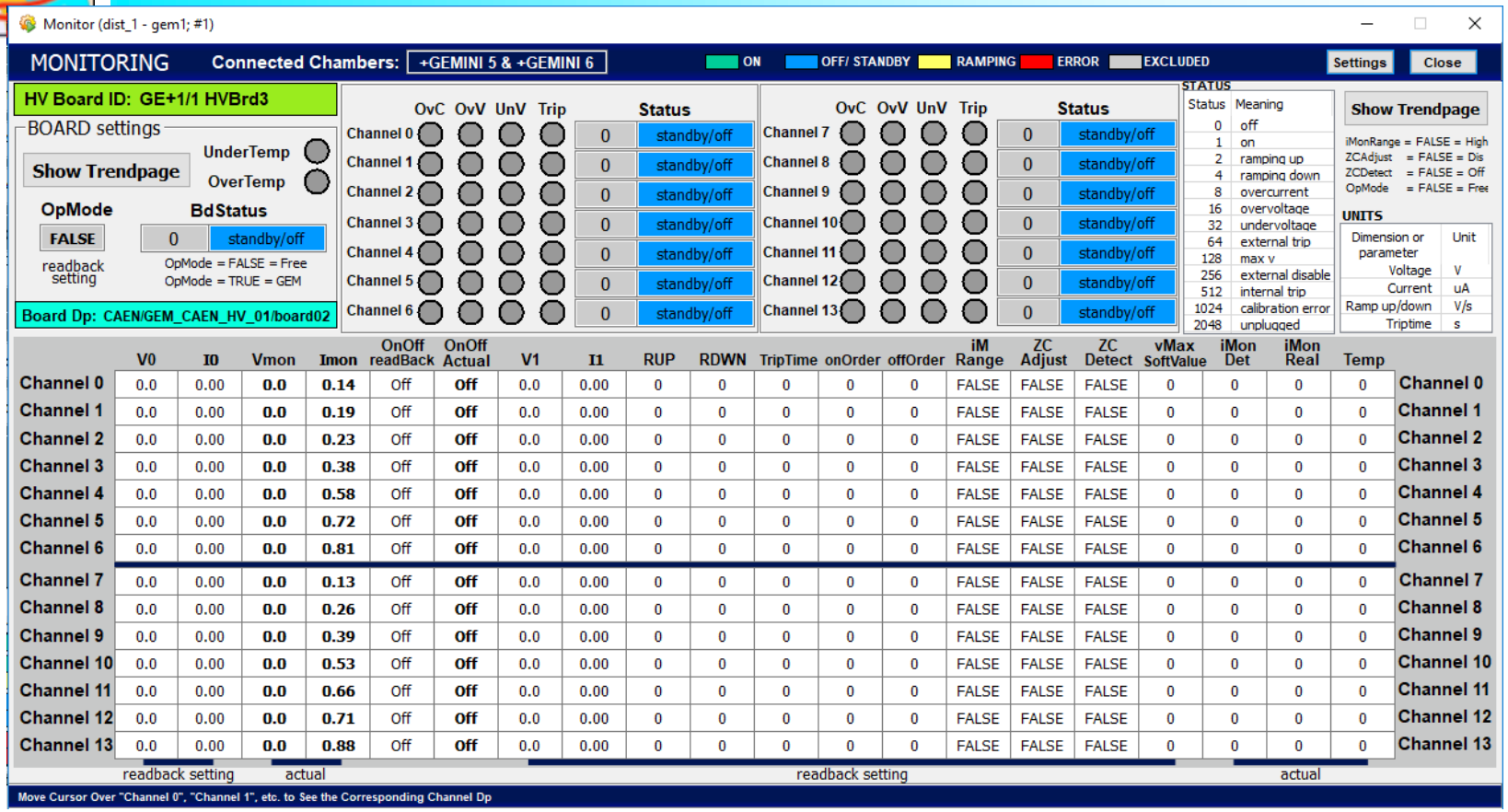
	Ch 0	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6
V	200	338	256	412	854	891	2145
C	0.300	0.844	1.244	1.756	2.200	2.656	2.711

Super Chamber No 2 , Layer1 & Layer2

	Ch 7	Ch 8	Ch 9	Ch 10	Ch 11	Ch 12	Ch 13
V	0	0	0	0	0	0	0
C	0.000	0.000	0.000	0.000	0.000	0.000	0.000

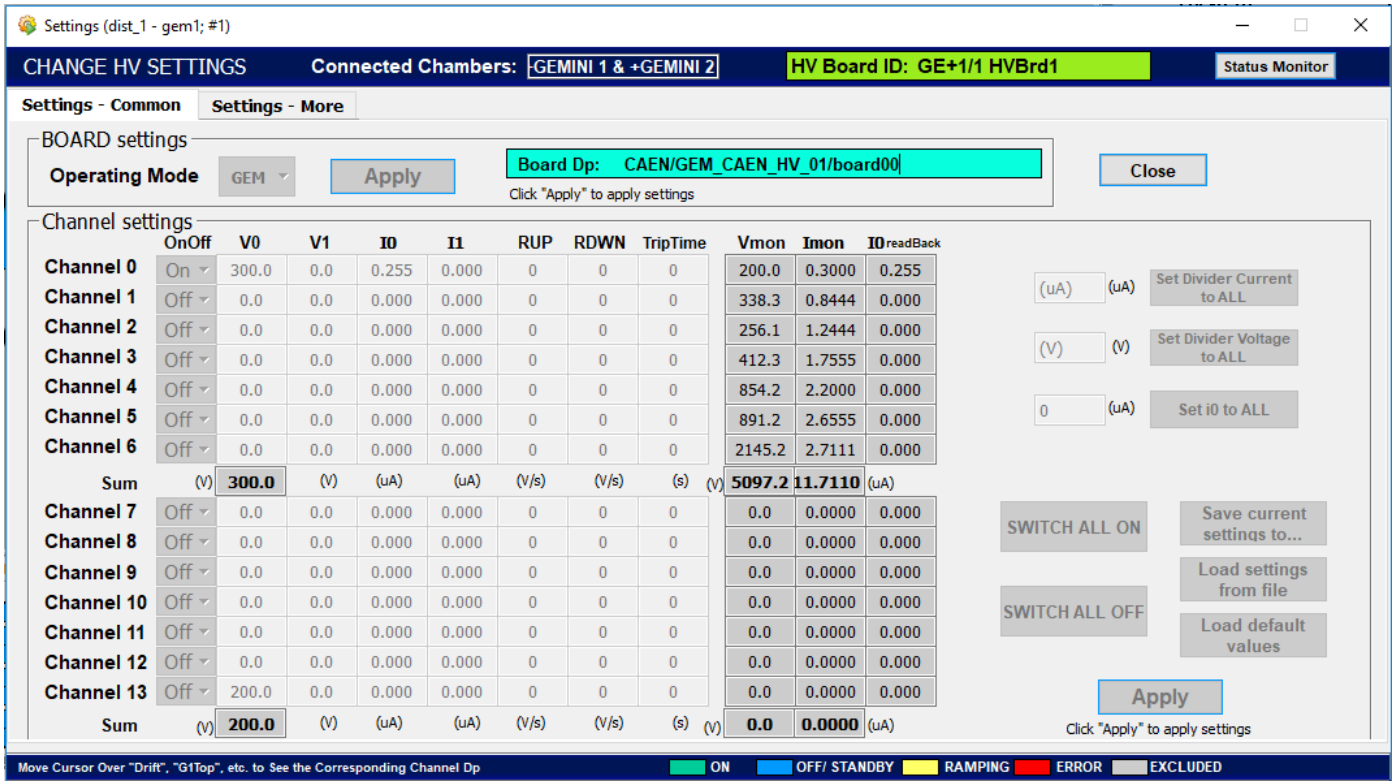
Status Monitor | Show Trends | Alarm Screen

HV Board Status Monitor Panel



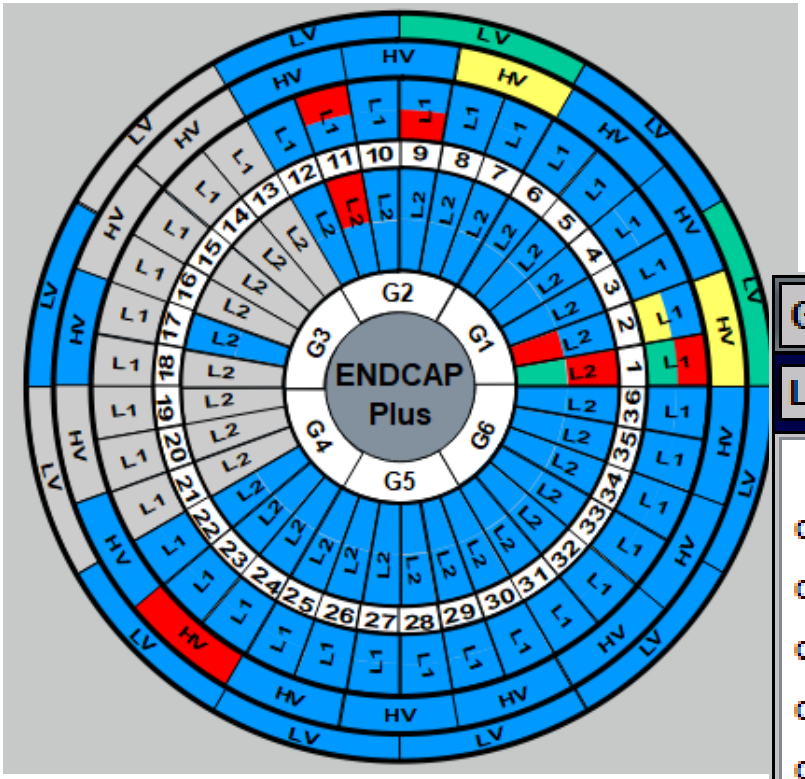
- **Using this panel, user can monitor,**
  - HV Board status
  - HV channel DP values of selected HV board
  - HV channel status
  - HV channel error status
  - Board and Channel trend pages

HV Board Settings Panel



- **Using this panel, experts can change,**
  - All HV channel DP values of selected HV board
  - HV Board operating mode
  - Other features are same as Chamber Setting panel
  - It will popup a message when user is going to apply changes, if relevant LV channel is off

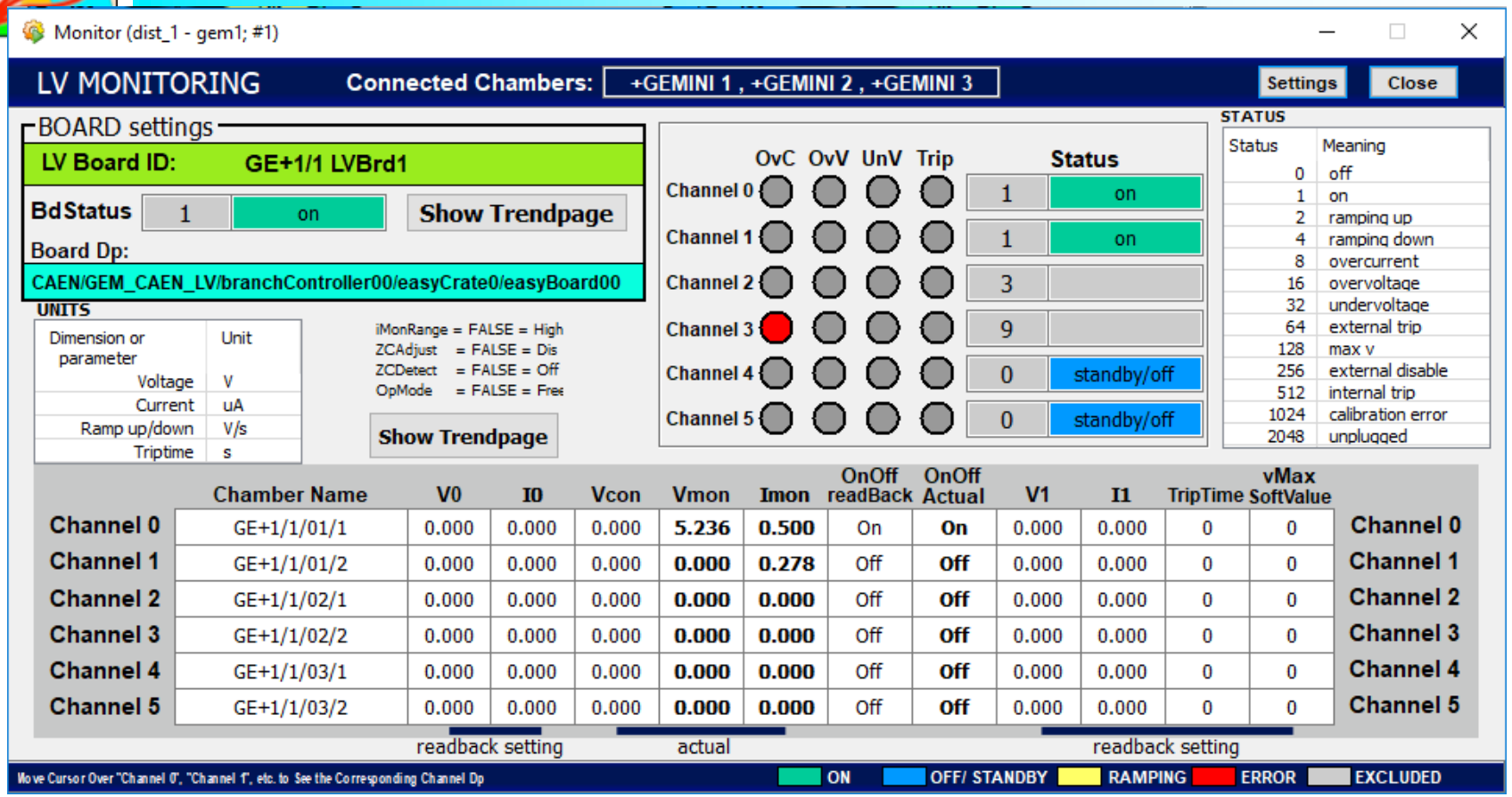
LV Board Status Popup Panel



GE+1/1 LVBrd1	OFF	Change Settings	
LV Board Status	ON	Last Updated 2018.10.17 12:34	
	Voltage	Current	SChmbr. Name	Layer
Channel 0	5.236	0.500	GE+1/1 C1	Layer 1
Channel 1	0.000	0.278	GE+1/1 C1	Layer 2
Channel 2	0.000	0.000	GE+1/1 C2	Layer 1
Channel 3	0.000	0.000	GE+1/1 C2	Layer 2
Channel 4	0.000	0.000	GE+1/1 C3	Layer 1
Channel 5	0.000	0.000	GE+1/1 C3	Layer 2

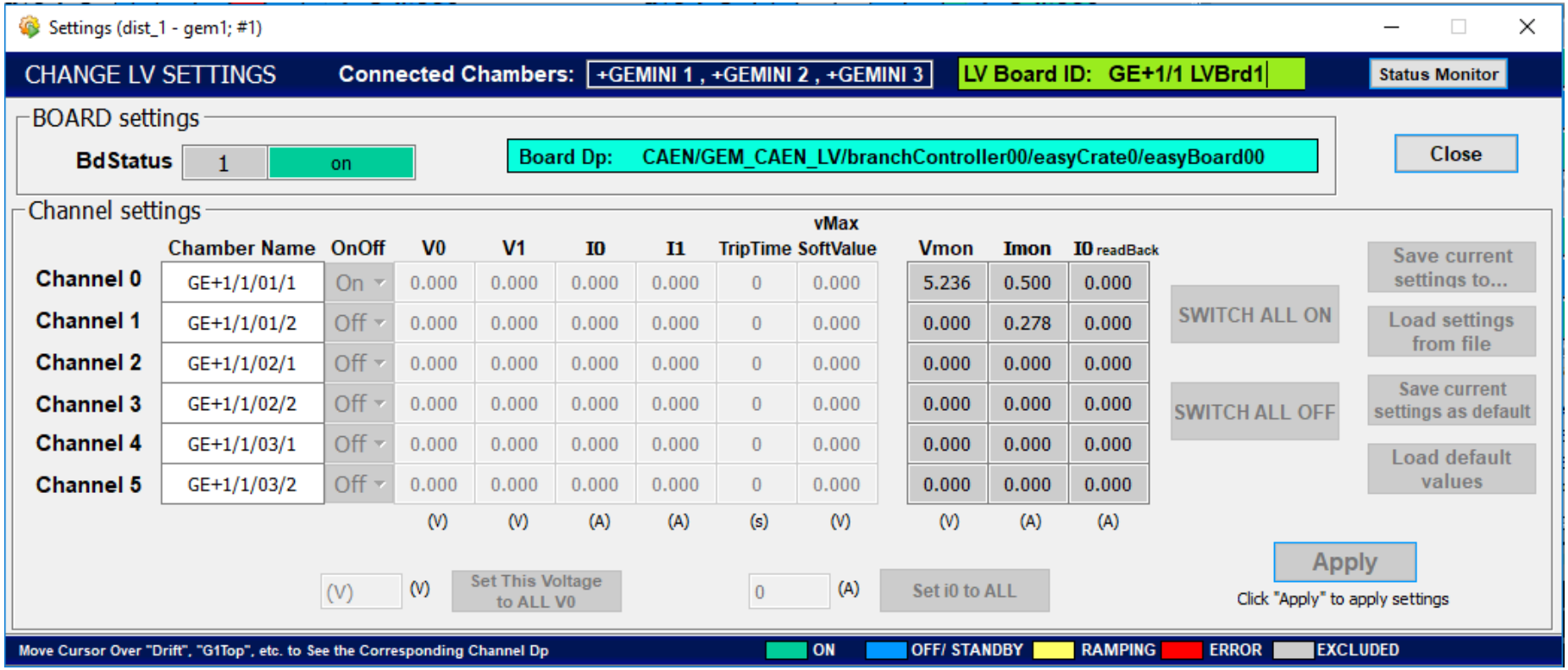
Status Monitor | Show Trends | Alarm Screen

LV Board Status Monitor Panel



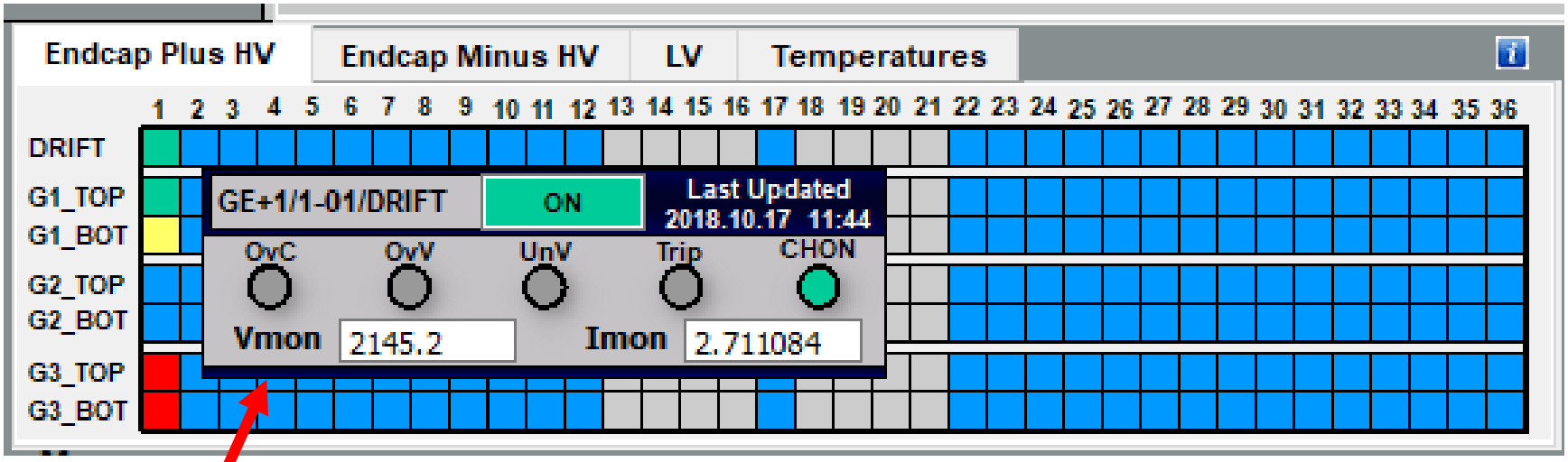
- **Using this panel, user can monitor,**
  - LV Board status
  - LV channel DP values of selected LV board
  - LV channel status
  - LV channel error status
  - Board and Channel trend pages

HV Board Settings Panel



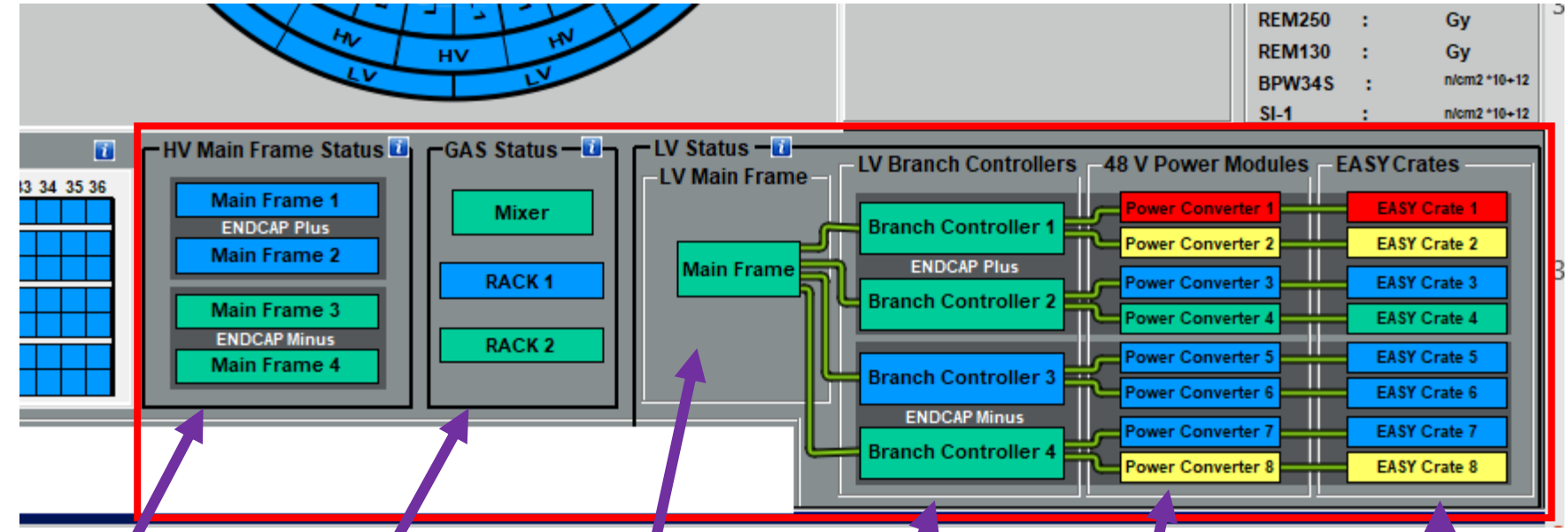
- **Using this panel, experts can change,**
  - All LV channel DP values of selected LV board
  - Other features are same as Chamber Setting panel

Gem Foil HV Status



GEM Foil status

Main Frame, MAO and Crate Status



HV Main Frame Status

Gas Rack and mixer Status

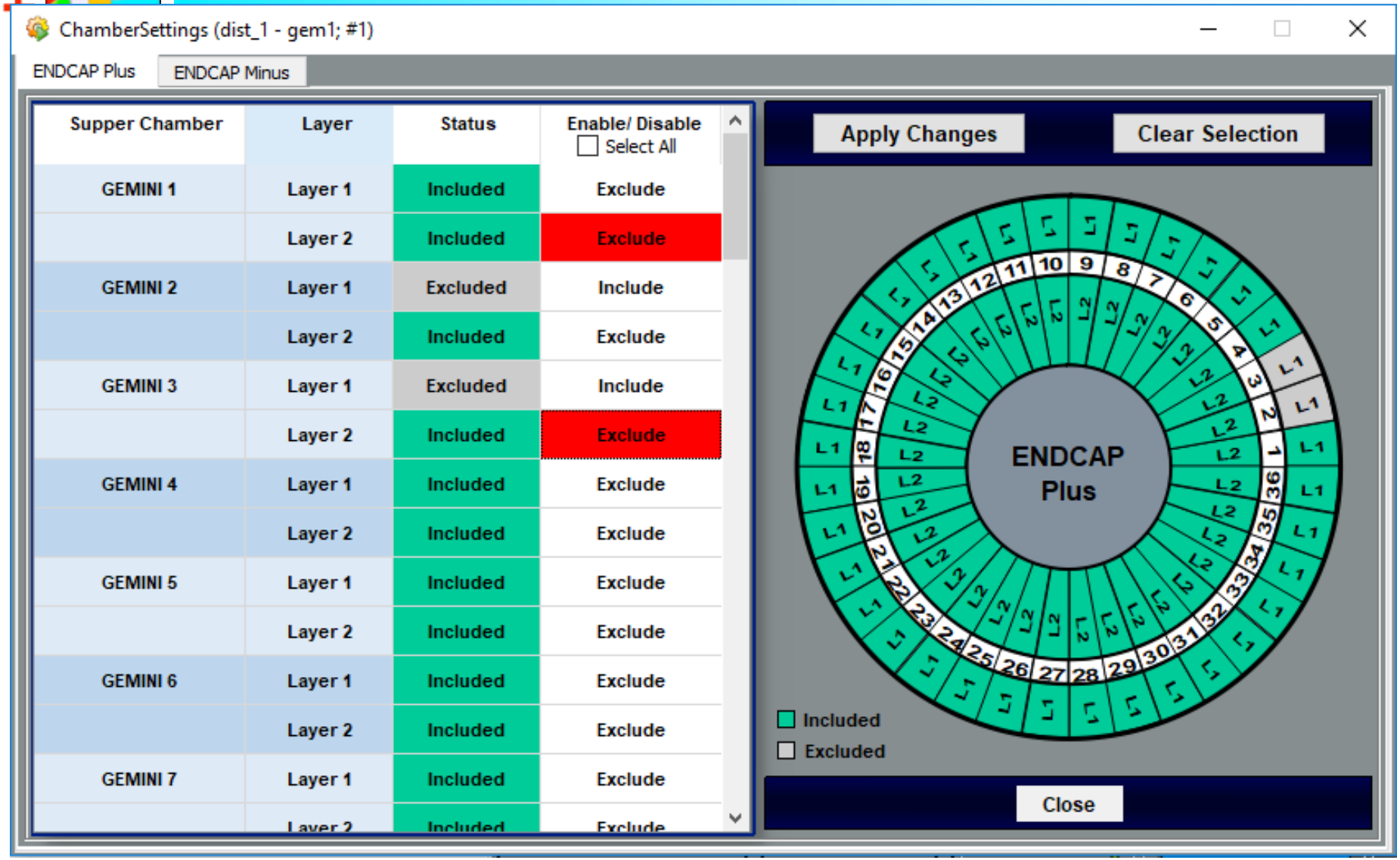
LV Main Frame Status

Branch Controller Status

48 V Power Supply Status

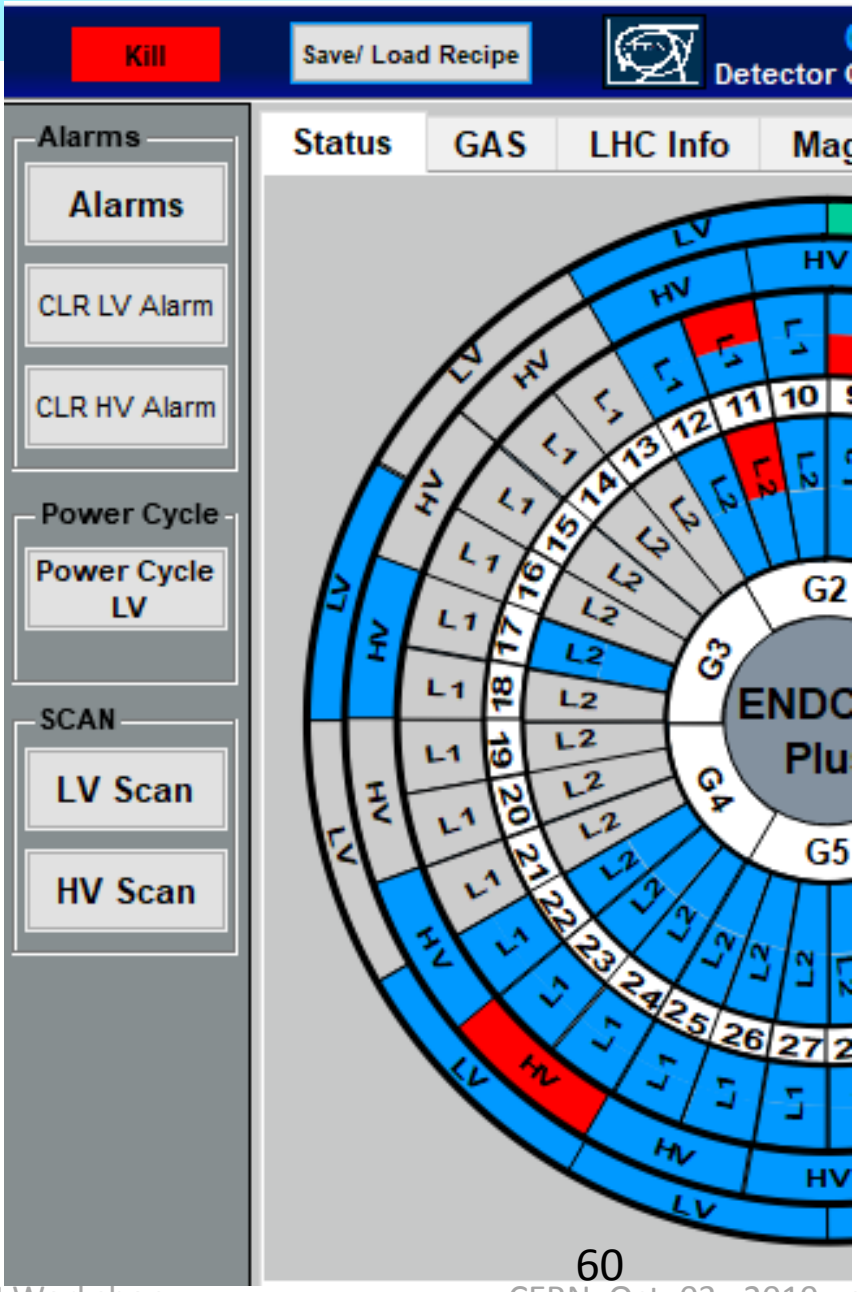
EASY Crate Status

Chamber Include/ Exclude Panel

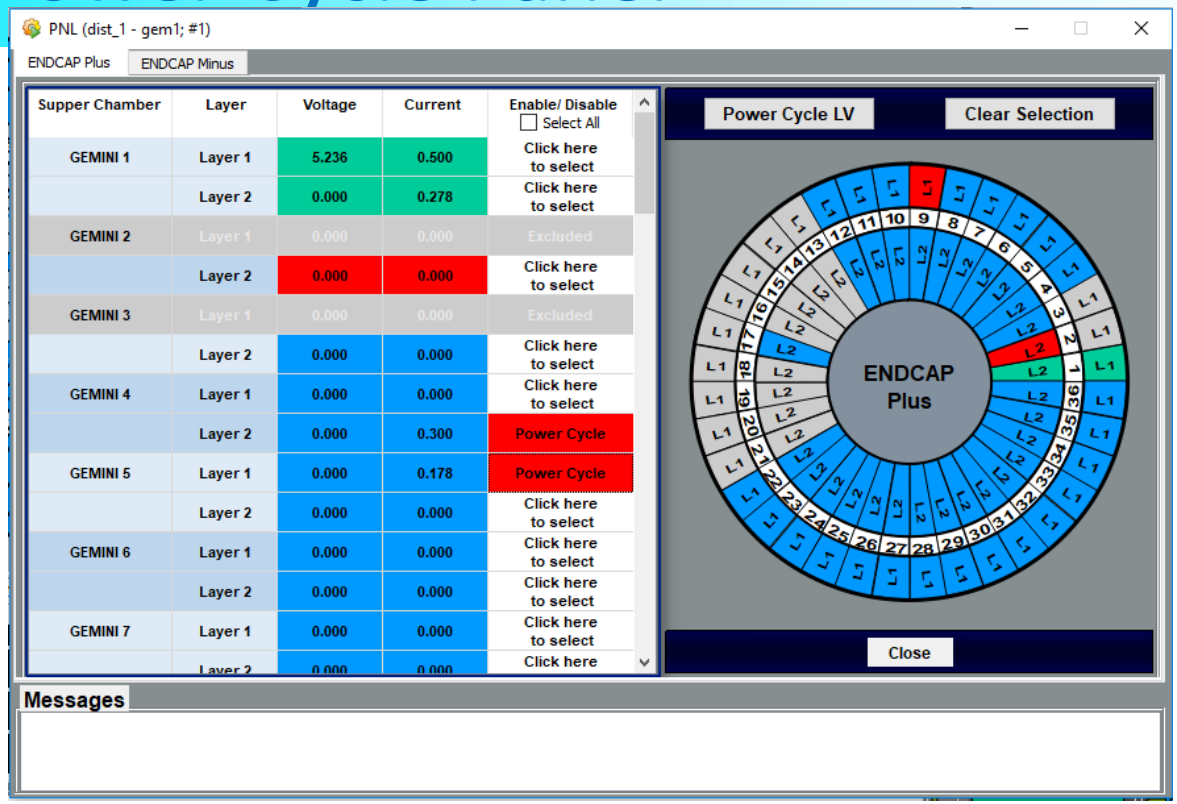


Main Panel

- Alarms
- Power Cycle LV
- Low Voltage Scan
- High Voltage Scan



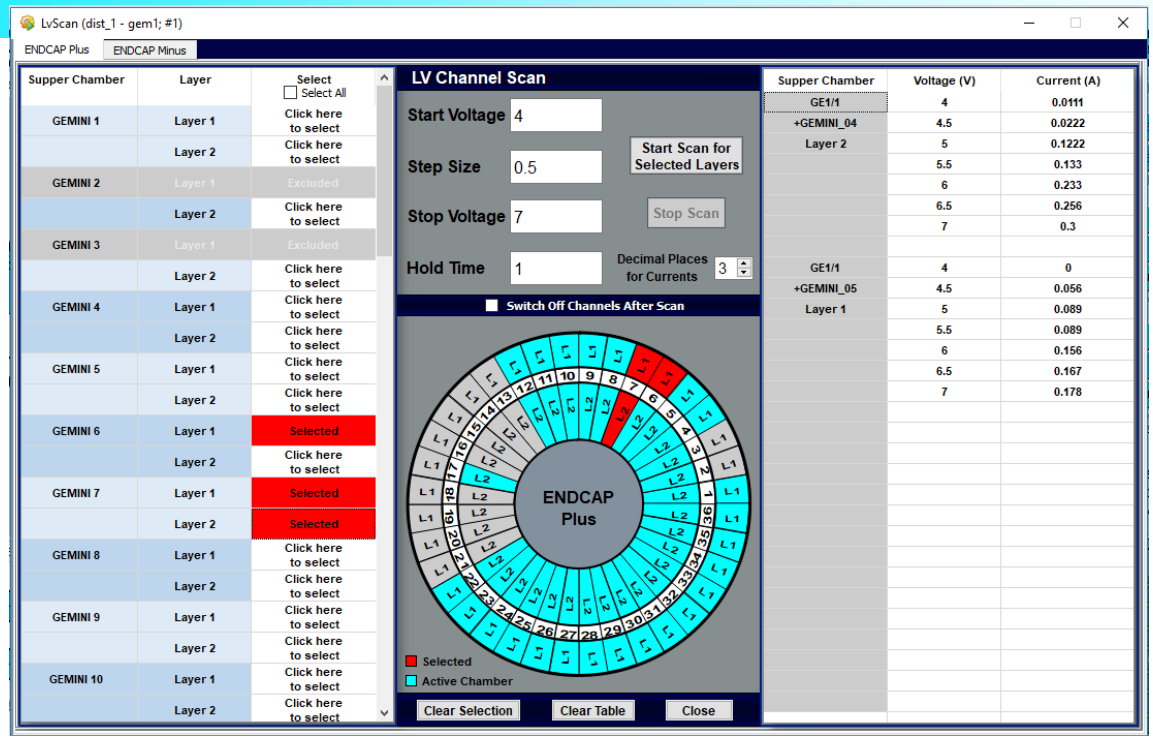
LV Power Cycle Panel



❖ **Features :-**

- ❖ User can select multiple chambers at once
- ❖ Selections will be highlighted in red color
- ❖ Displays the current voltage, current and state on the table and graphical area
- ❖ Two separate tabs for ENDCAP Plus and Minus
- ❖ When “Power Cycle LV” is clicked, selected chambers will be power cycled one by one
- ❖ **Power cycling status for each chamber will be shown in “Messages” area**

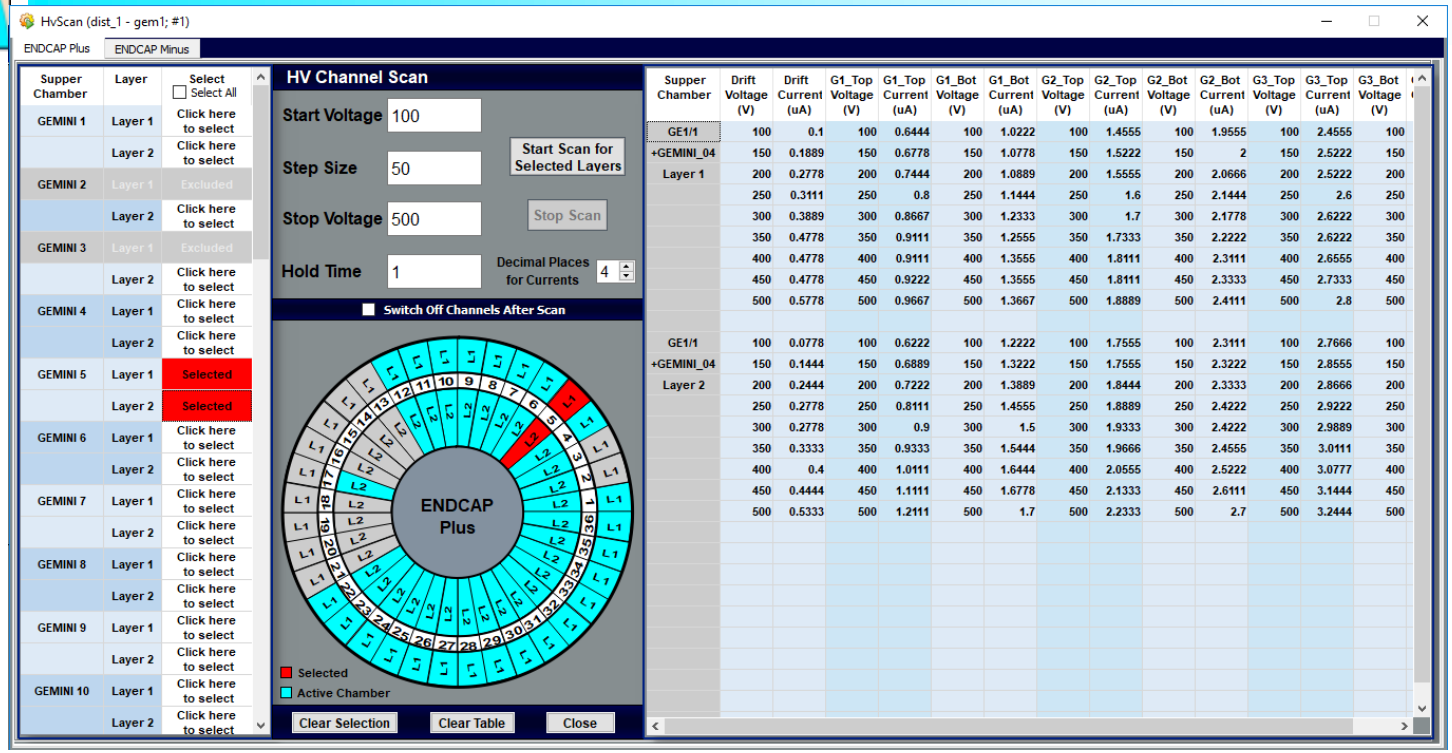
LV Scan Panel



❖ **Features :-**

- ❖ User can select multiple chambers at once
- ❖ Selections will be highlighted in red color in both table and graphical area
- ❖ User should set start and stop voltages, step size and hold time
- ❖ When “Start Scan” button is clicked, selected chambers will be scanned one by one
- ❖ User can abort the scan by clicking “Stop Scan” button

HV Scan Panel



❖ **Features :-**

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