Test and preparation of the GE1/1 low voltage system

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GE11 LV System at CMS

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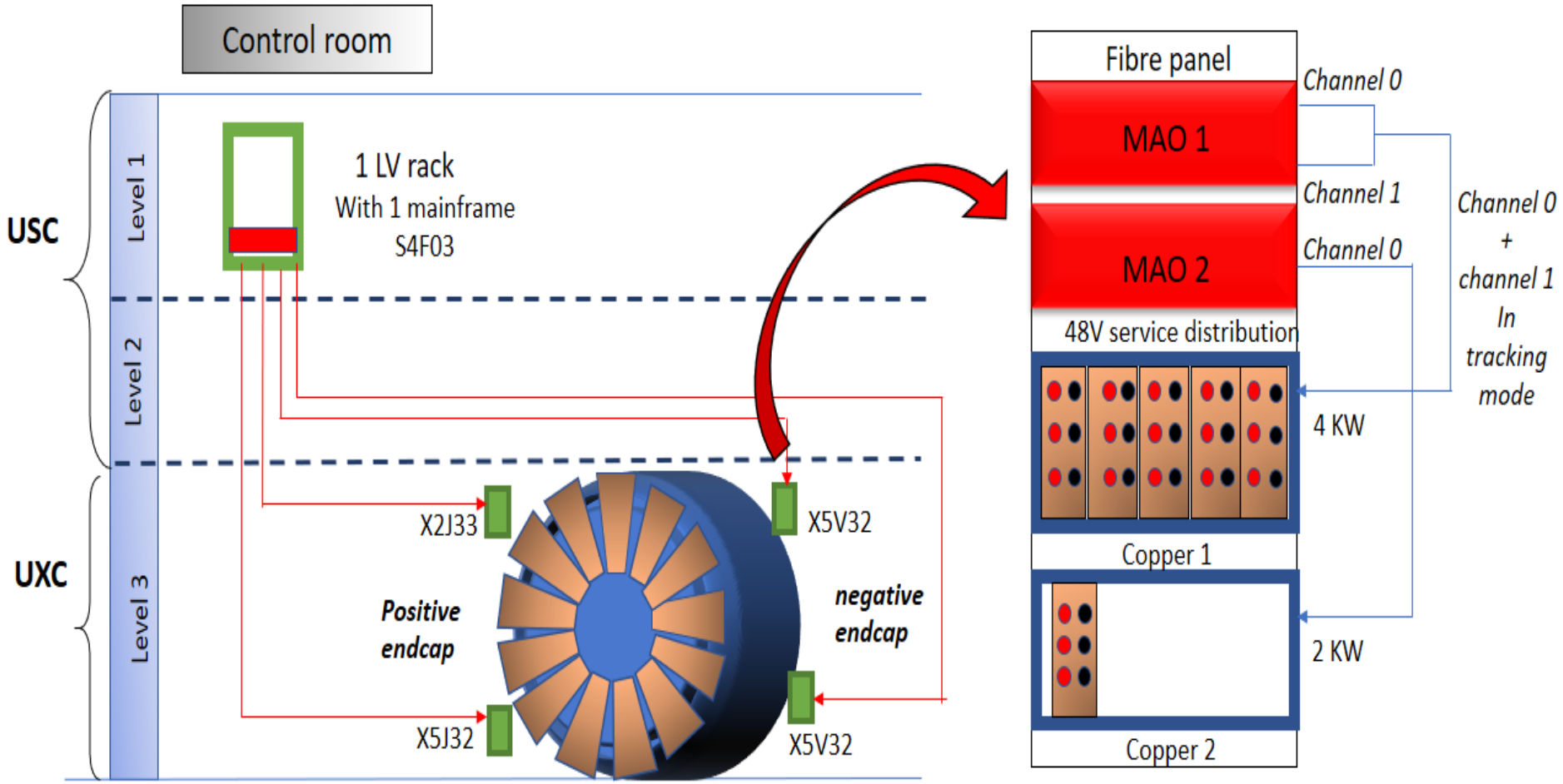
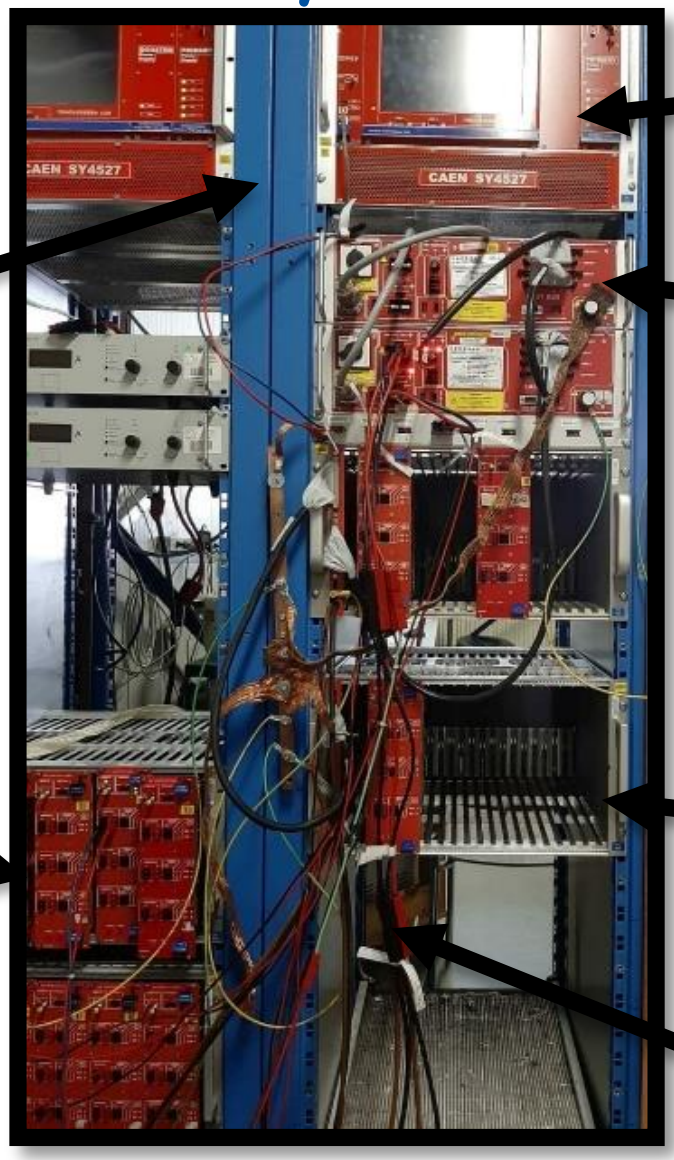


- In each LV rack there are 6 boards and each rack provides power to 18 superchambers.
- (4 LV racks)*(6 board)*(6 channels) = 144 channels
- (2 endcap)*(36 superchamber)*(2 layers) = 144 detectors

Laboratory test setup



Mainframe

MAOs

Rack

Boards

Crate

Cables

Motivation

- After a power cut at CMS an HCAL power supply was failing to switch on and the FEASTMPs were damaged. The occurance of voltage spikes was noticed but the reason for their occurance was not known.

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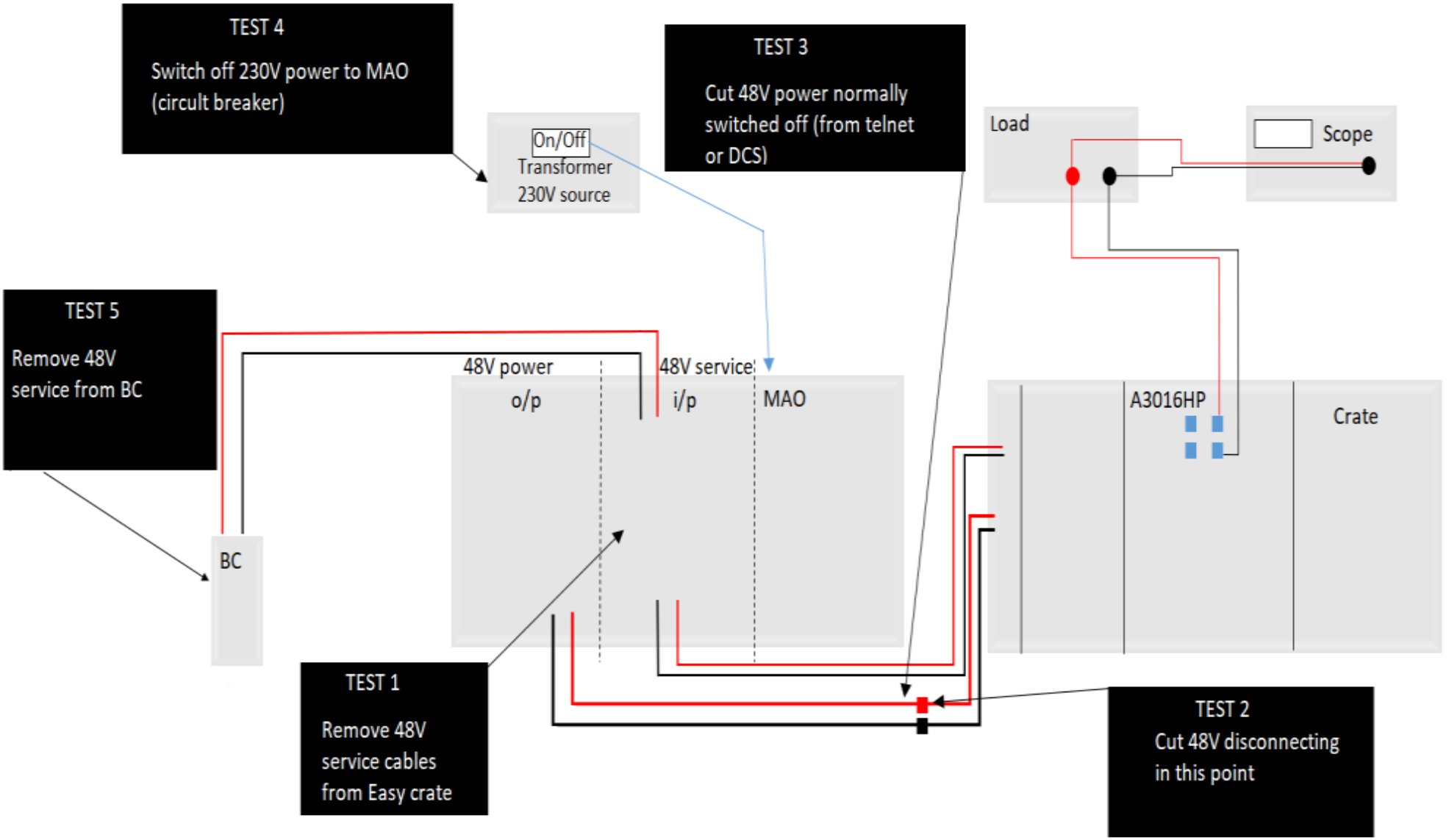
Motivation

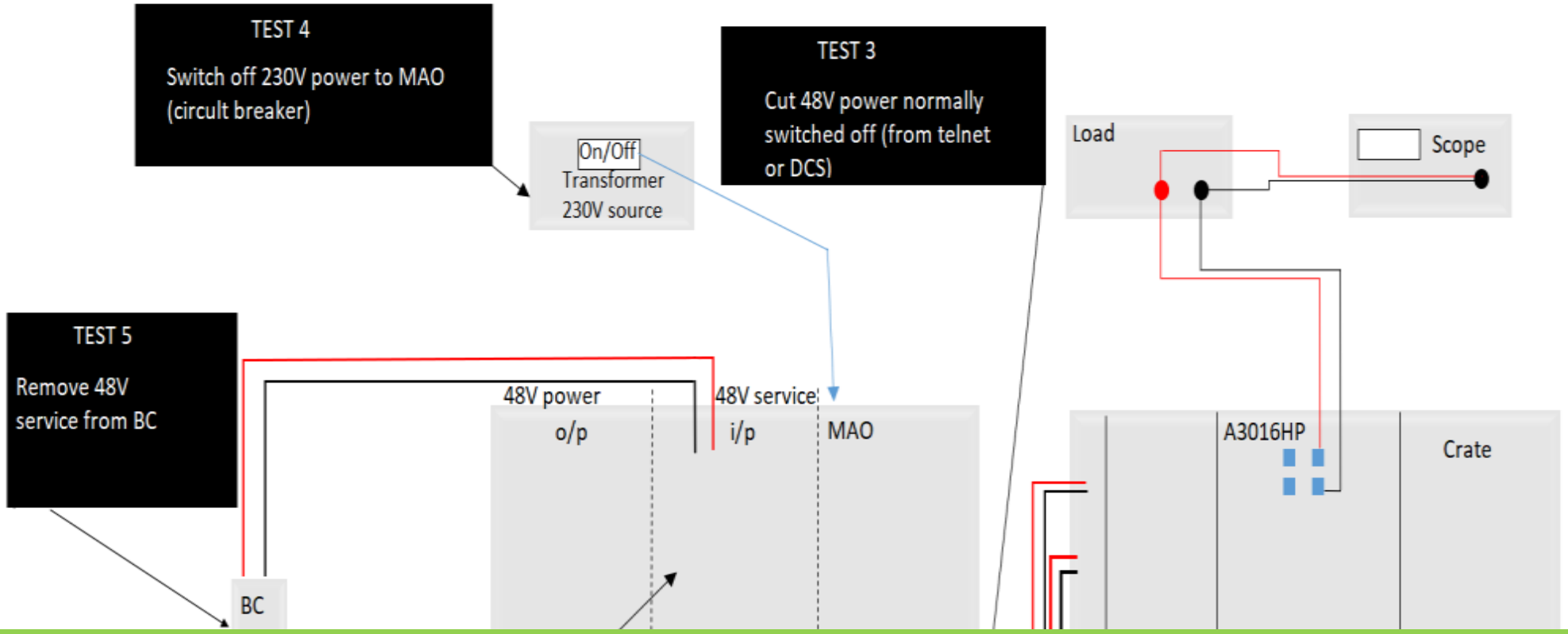
QUESTION: Can this also happen with A3016HP (used by GEM)?
→**we tried to** reproduce this issue with GEM LV boards

This is how the transient looked like…

Test procedures (1)



Test procedures (1)



- Previous studies by HCAL reported that the transient is not systematic, but happens a few times over 100

→ 100 trials made for each configuration

Test procedures (2)

- Observing and analysing the waveforms of MAO and channel signals (maximum of the channel and the minimum of the MAO) in the oscilloscope for each type of tests, the behaviour of the transient was studied.

TEST 1 to 5 → **NO TRANSIENT IN ANY CONFIGURATION**

TRANSIENT ← **TEST 4** If the power to MAO is switched off and restored in a specific time interval

What the signal may look like (1)

If the time interval between switching MAO power on and off is too short then LV channel has no time to start ramping down

→ final state: ON, no transient

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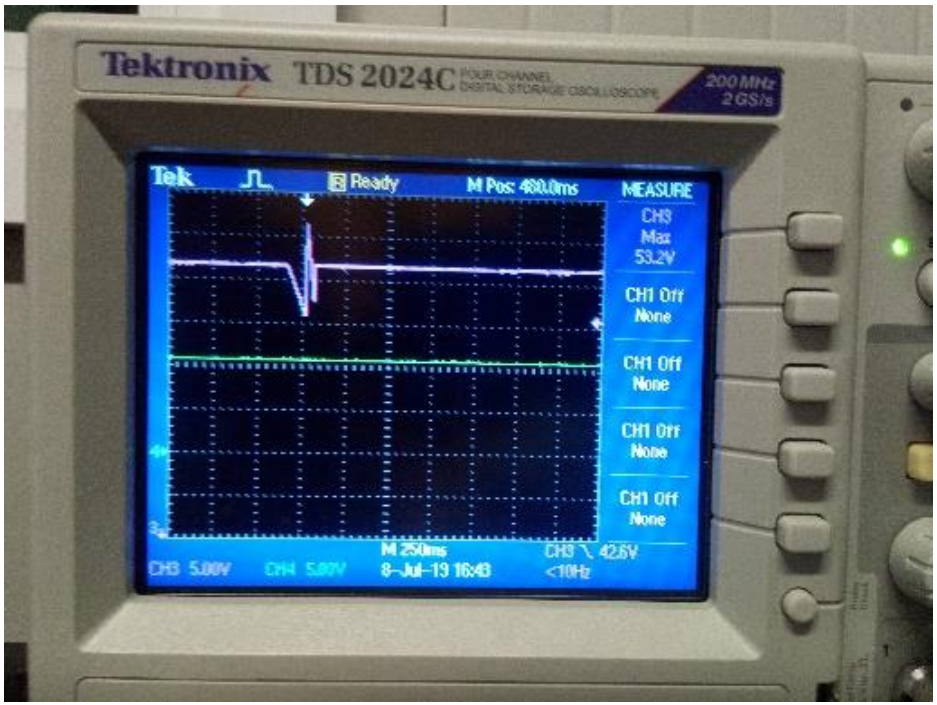

MAO

LV CHANNEL

What the signal may look like (2)

If the time interval between switching MAO power on and off is too long then LV channel goes off before MAO ramps up to 48V

→ final state: OFF, no transient

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If the time interval between switching MAO power on and off is done in a way that LV channel is still ramping down when MAO ramps to 48 V
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LV CHANNEL

What the signal may look like (3)

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23.6V

MAO

LV CHANNEL

Time between buttons VS load

Power[w]	Load[A]	Time gap*[s]
80.7	8.07	1.18-1.33
70.7	7.07	1.2-1.39
60.1	6.01	1.33-1.54
50.1	5.01	1.57-1.72
40.1	4.01	1.49-1.59

*time elapsed between manually switching on and off the transformer powering the MAO

The value of the voltage is the same in all cases and is 10V

Time between buttons VS load

Power[w]	Load[A]	Time gap*[s]
30.1	3.01	1.57-1.72
40.1	4.01	1.49-1.59

By decreasing the values of the current (power) the time gap becomes shorter and transients become harder to reproduce i.e. the probability of their occurrence decreases!

*time elapsed between manually switching on and off the transformer powering the MAO

The value of the voltage is the same in all cases and is 10V

Problem solution

- CAEN provided us with new boards with internal protection circuit
- The protection circuit kills the channel whenever the output exceeds some fixed threshold
- The threshold can be set to any value by CAEN adjusting the resistor values

Modified (protected board)

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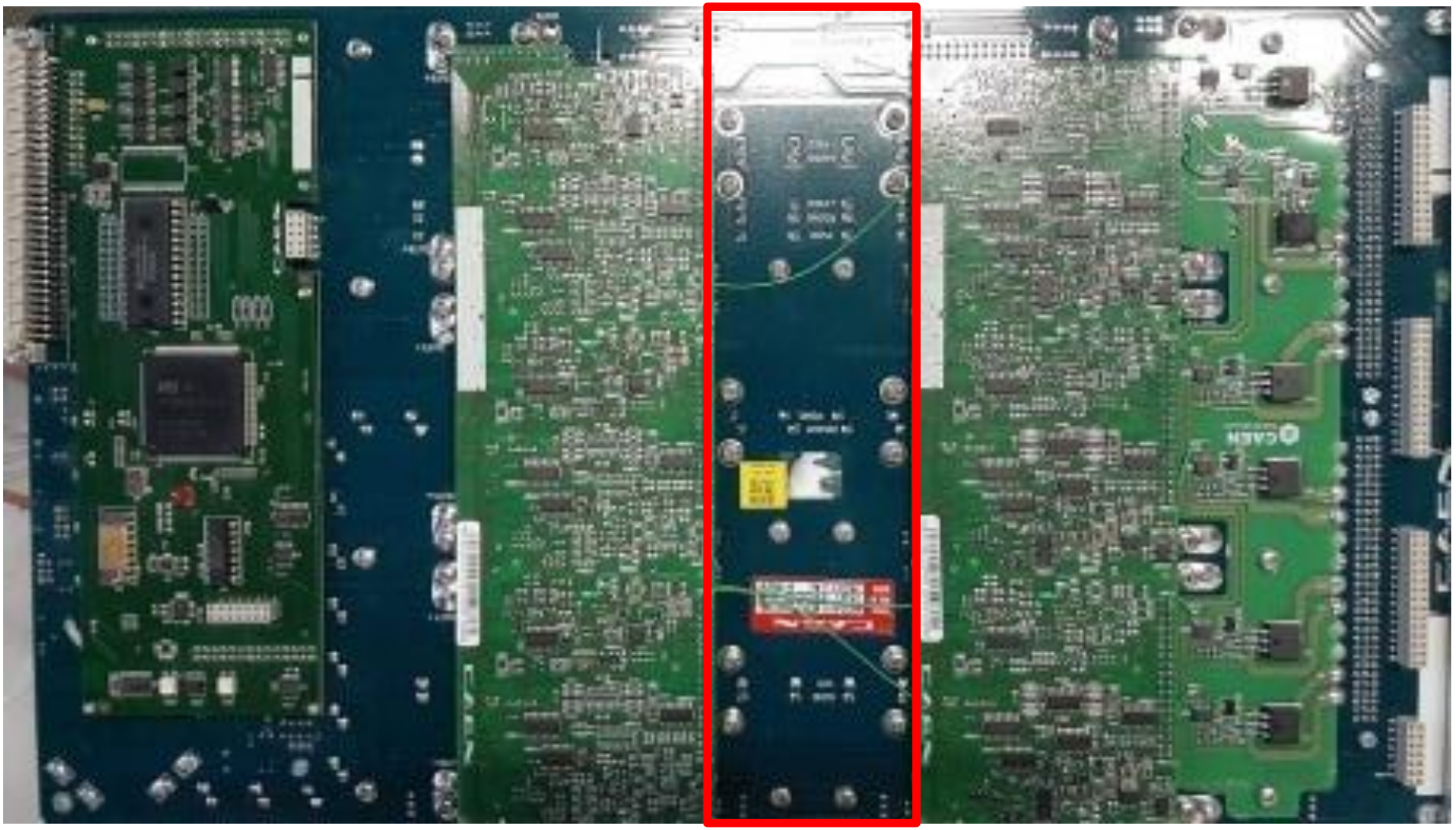


Testing the protection circuit

- Unlike in test 4 when the transients were induced by switching off the MAO power on the 230V source transformer (pressing ON/OFF buttons), transients in new tests (with the protected boards) were induced by sending another ON command to the MAO channel when it is already ON
  - made possible by using a dedicated WinCC OA Detector Control System (DCS)
  - this is based on a bug of the MAO firmware present up to version 2.04 --> bugfix already released by CAEN, we used "buggy" version for testing purposes

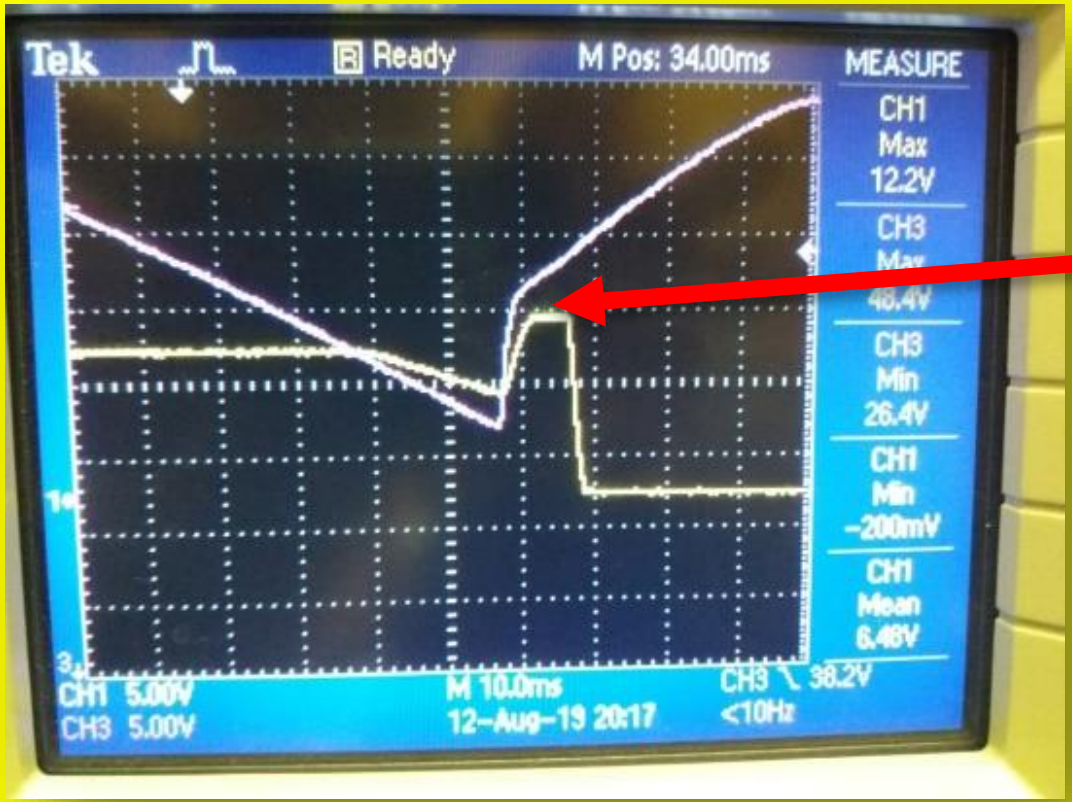
- One board was inserted in the crate per test
  - as the production of transients also depends on the total number of boards inserted in the crate
- Tests were done with different loads

Testing the protection circuit

Result:

→in all cases the protection circuit has successfully cut the transient at 12.2-12.4V

For example:



A point at which "cut" takes place

Summary and Conclusions

- We were able to show that voltage transients up to about 20 V are possible also with A3016HP boards that will be used for GEM detectors
- transients seem to take place when there's a drop in the output voltage of the MAO (e.g. caused by a voltage drop in the MAO input)
- a protection circuit was developed to kill such transient potentially dangerous for FEASTMPs
- we successfully tested the first LV board prototypes equipped with the protection

THANK YOU FOR YOUR ATTENTION

QUESTIONS?