GETTING RID OF THE MMFE8 NOISE

MM WEEKLY MEETING
MAY 2, 2017

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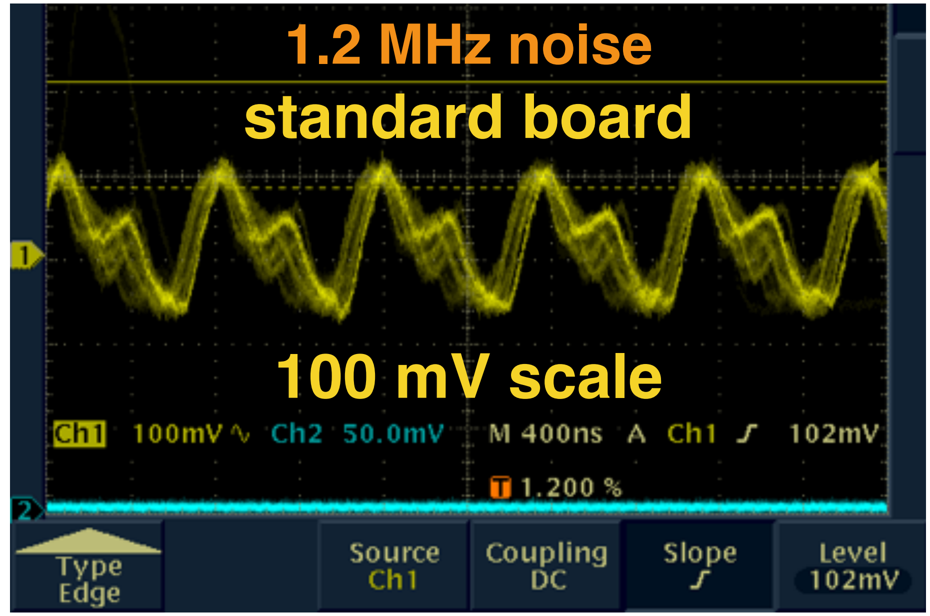
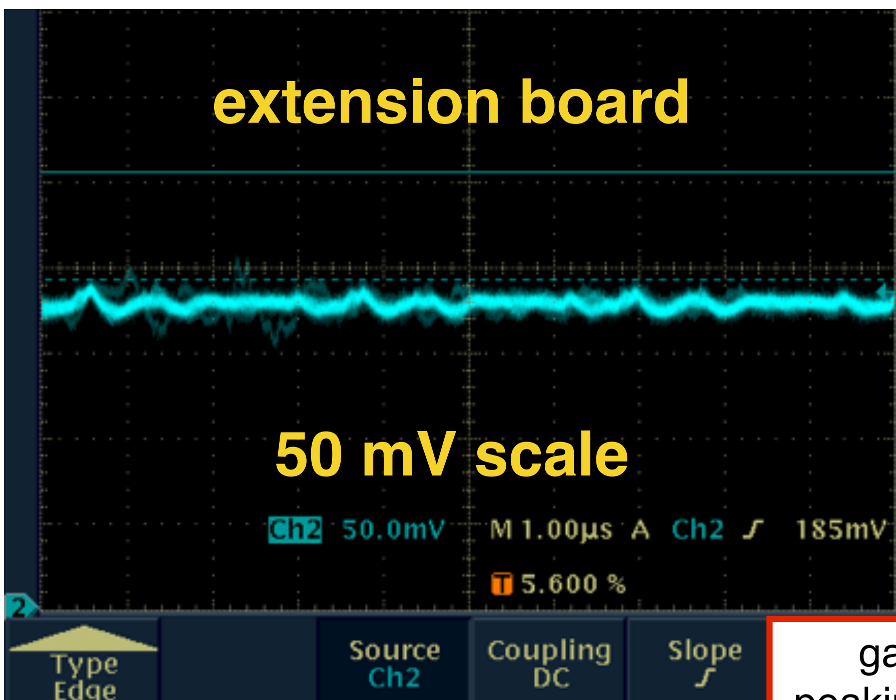
INTRODUCTION

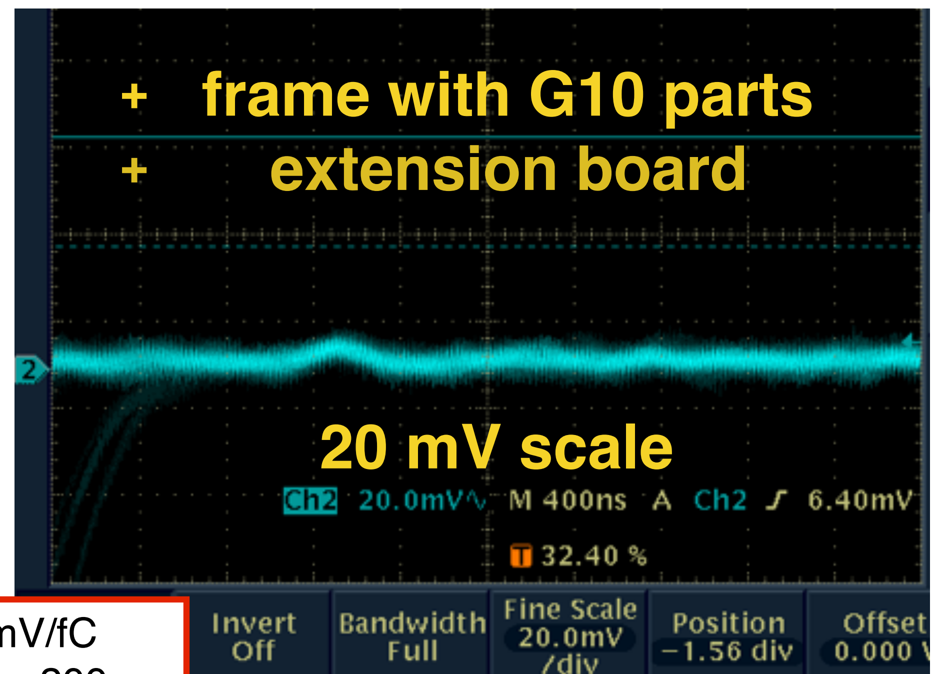
- Noise is an issue for the MMFE8 readout of MM chambers
- Previous talk in February on reducing the MMFE8 noise, part 1
- We measured that:
  - (1) Taking the DC-DC converters off the MMFE8 onto an extension board resulted in a ~6x reduction of the noise
  - (2) Noise injected through direct connections to the MM frame made its way to the VMM input through large AC couplings between the readout plane and the Al octuplet structure. We got rid of the AC couplings by replacing a lot of Al with a lot of G10

PREVIOUS NOISE STUDIES

- Moving the DC-DC converters off of the MMFE8 to the "extension board" configuration reduced the noise
- Removing some large AC couplings by modifying the MM frame reduced the DC-DC converter noise as shown in the scope images below (see previous talk for more details)







gain: 9 mV/fC
peaking time: 200 ns

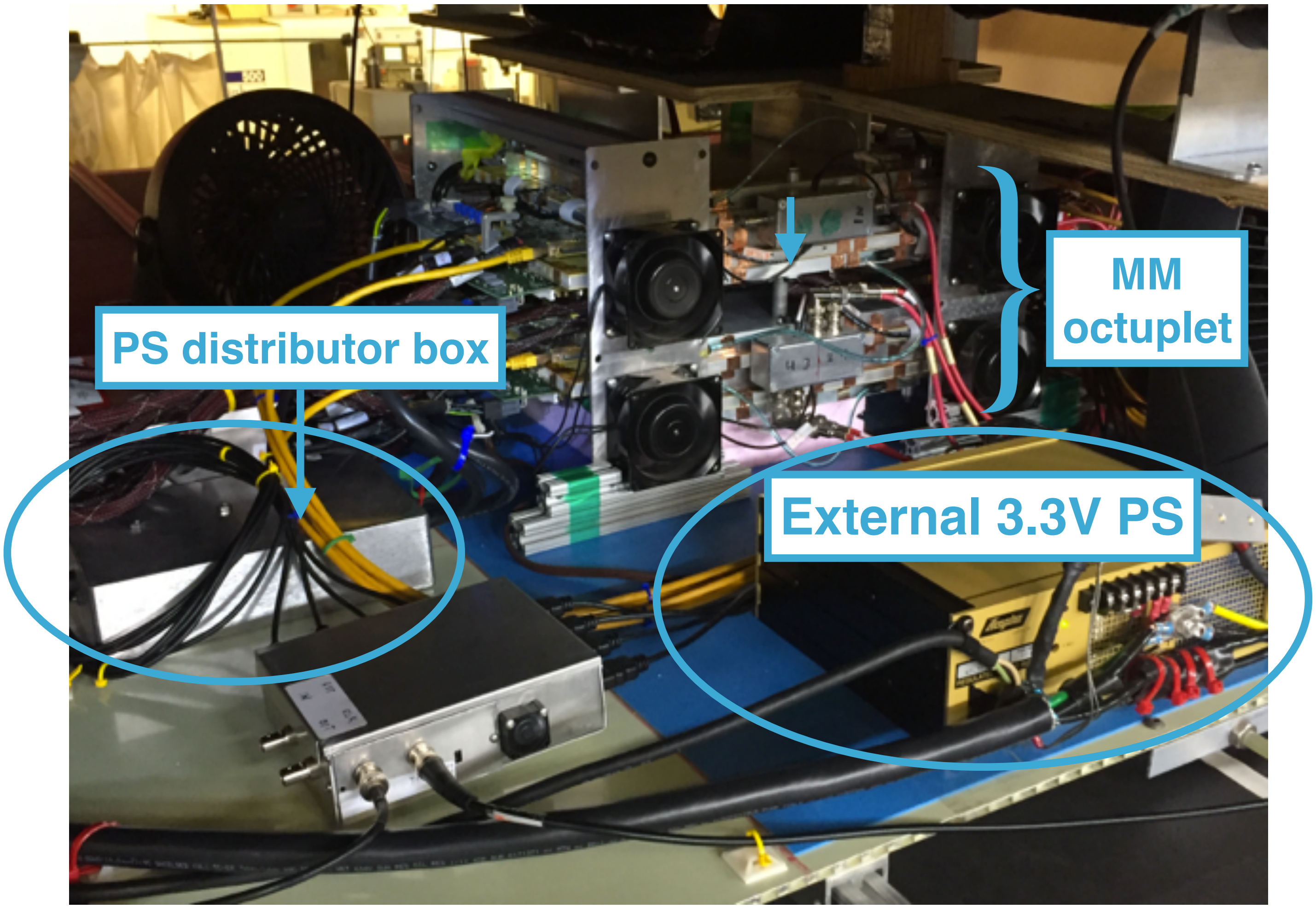
REMOVING THE DC-DC NOISE SOURCE

- With both modifications each board contributes ~5-10 mV of noise
- With many boards (8 in our case, about 40 for a NSW module), the noise will be hugely magnified
- Furthermore, **each** chamber frame would have to be modified to remove the AC couplings, which isn't feasible for the NSW
- As a result, we took a different direction and bought a single 3.3V power supply.

POWER SUPPLY DISTRIBUTION

- We made new extension boards which convert 3.3 V into 1.8V, 1.2V, 2.5V, 1.0V. Each board draws 16 amps
- The 3.3 V PS is ~0.5 m away, connected to **2** boxes which in turn power **4** MMFE8s (one box for each side of the octuplet)
- From the PS to the distributor box, we use shielded cables which contain four gauge-6 wires
- From the distribution box to the extension card, we use shielded cables, which contain four gauge-12 wires

FULL OCTUPLET SETUP

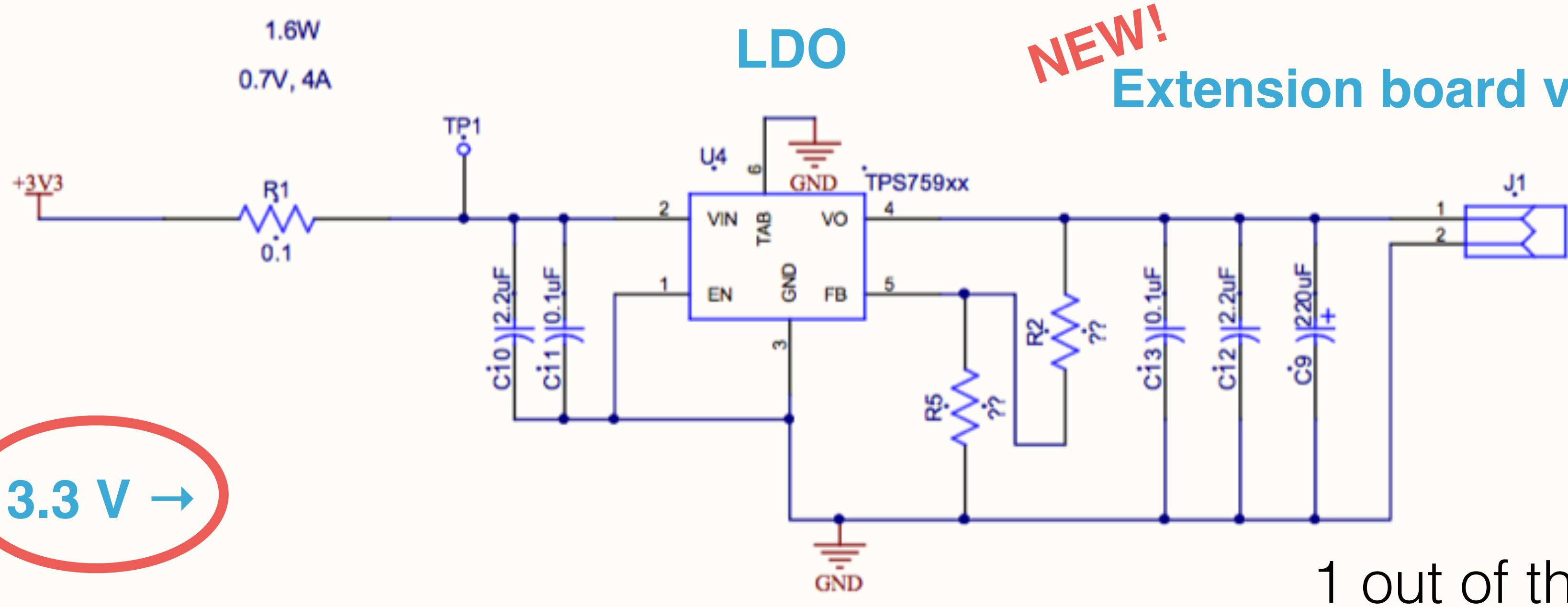


- This results in a voltage drop between the PS and the octuplet cage of ~30 mV
- The ADDC and trigger synchronization box are grounded to the octuplet (**not** the external PS) because of the 30 mV voltage drop

EXTENSION BOARD VERSION 2

LDO

NEW! Extension board v.2

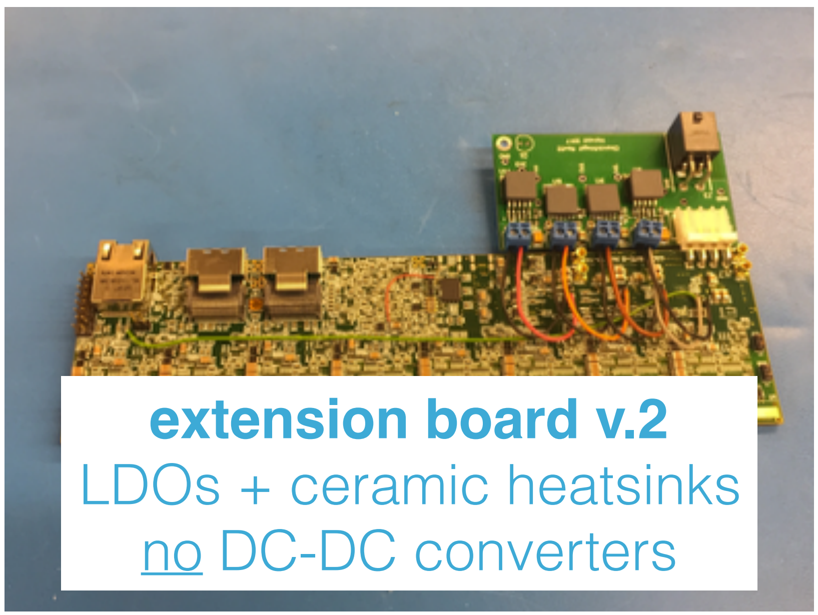


to P1: 1V5A, est 3.4A
changed to 1V8

3.3 V →

1.8 V →

1 out of the 4 channels



extension board v.2
LDOs + ceramic heatsinks
no DC-DC converters

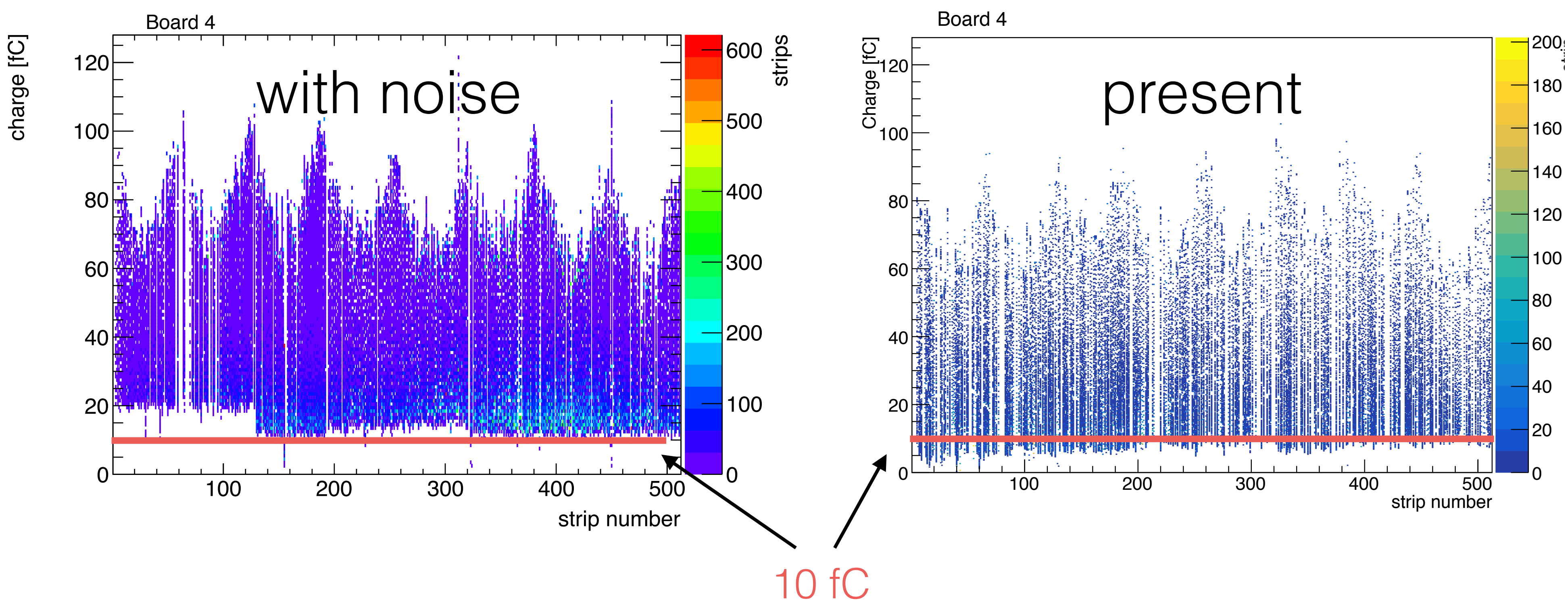
NOISE WITH NEW PS SETUP

- With these modifications, we do not see any power supply noise on the octuplet
- There remains a little bit of white noise *not* from the power supply
- We are able to run at a threshold of ~220 mV for all boards in an octuplet, where before we had to run between 300 and 400 mV for all of the boards

for reference:
pedestal at ~180-200 mV

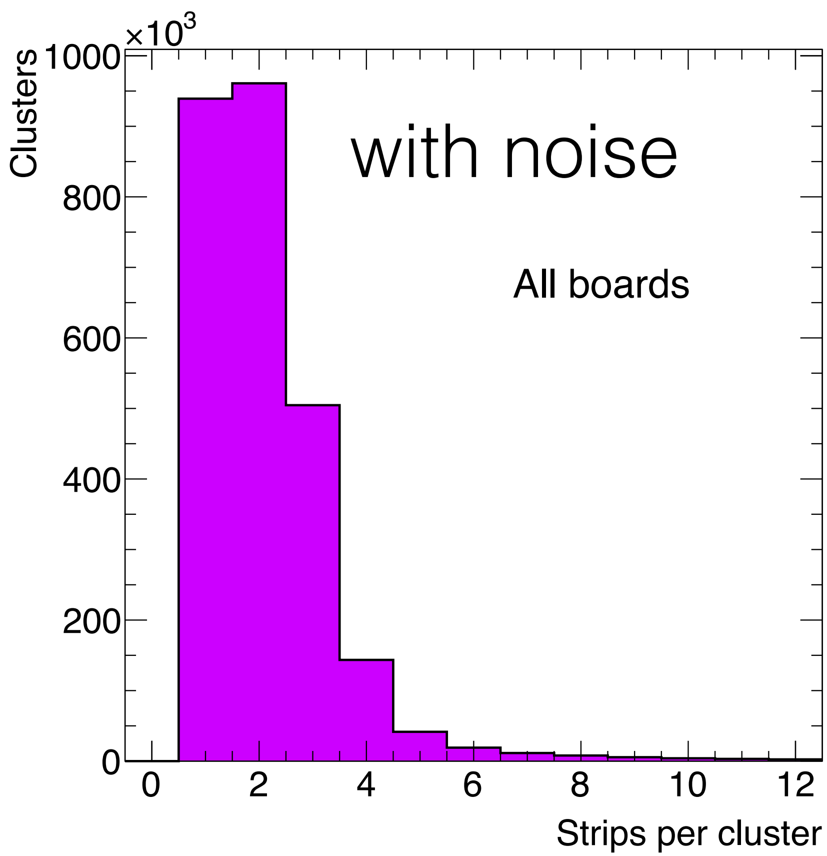
PRELIMINARY DATA IN A NOISE-FREE WORLD

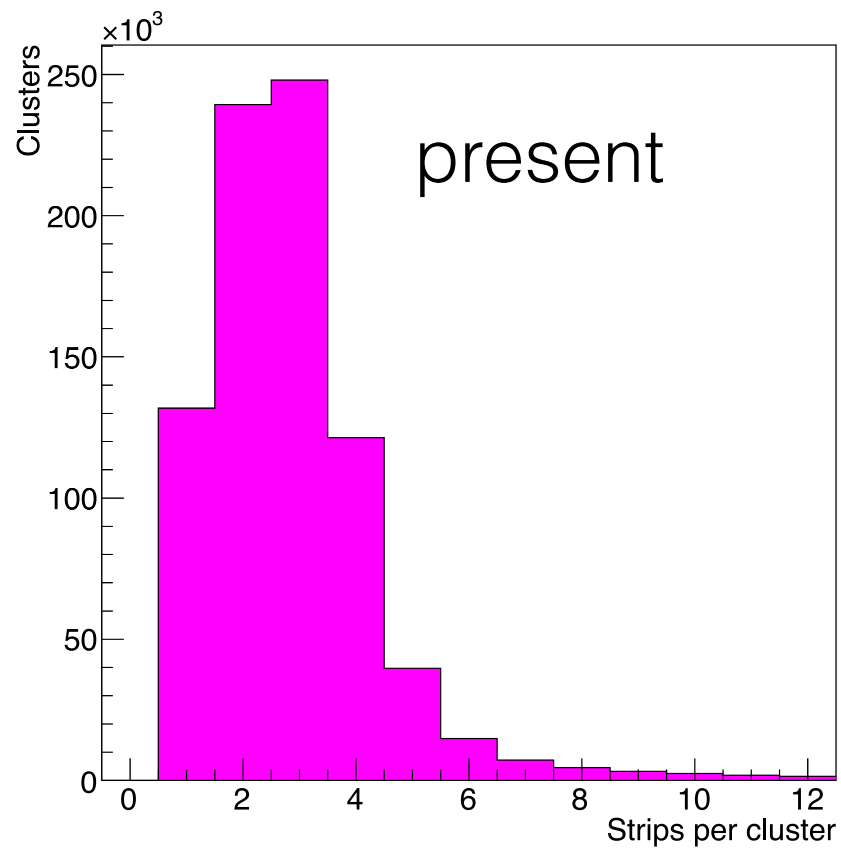
- We are taking cosmic data with the low-noise MMFE8s
- PDO charge values collected from cosmic-ray data are much lower than the previous cosmic run (see Alex's talk at Muon week) due to lower VMM thresholds



PRELIMINARY DATA IN A NOISE-FREE WORLD

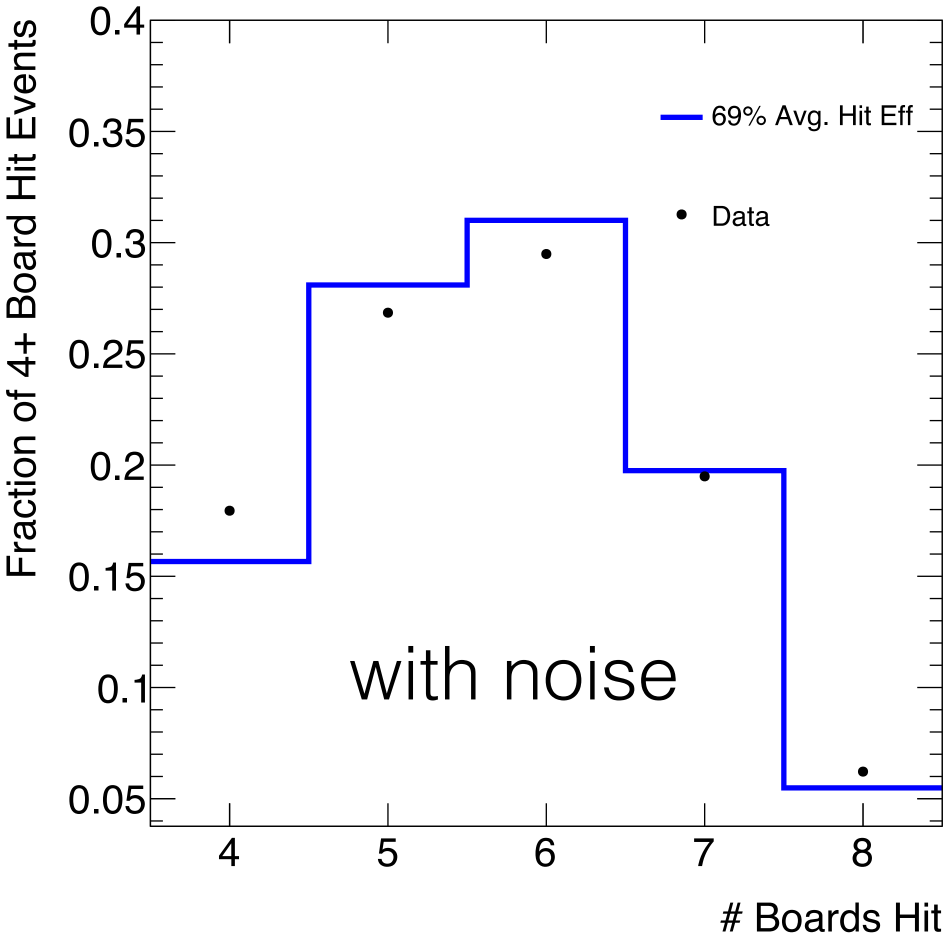
- The average strip multiplicity per board goes from 1-2 strips to 2-3 strips
- Full results coming soon, along with trigger data too!

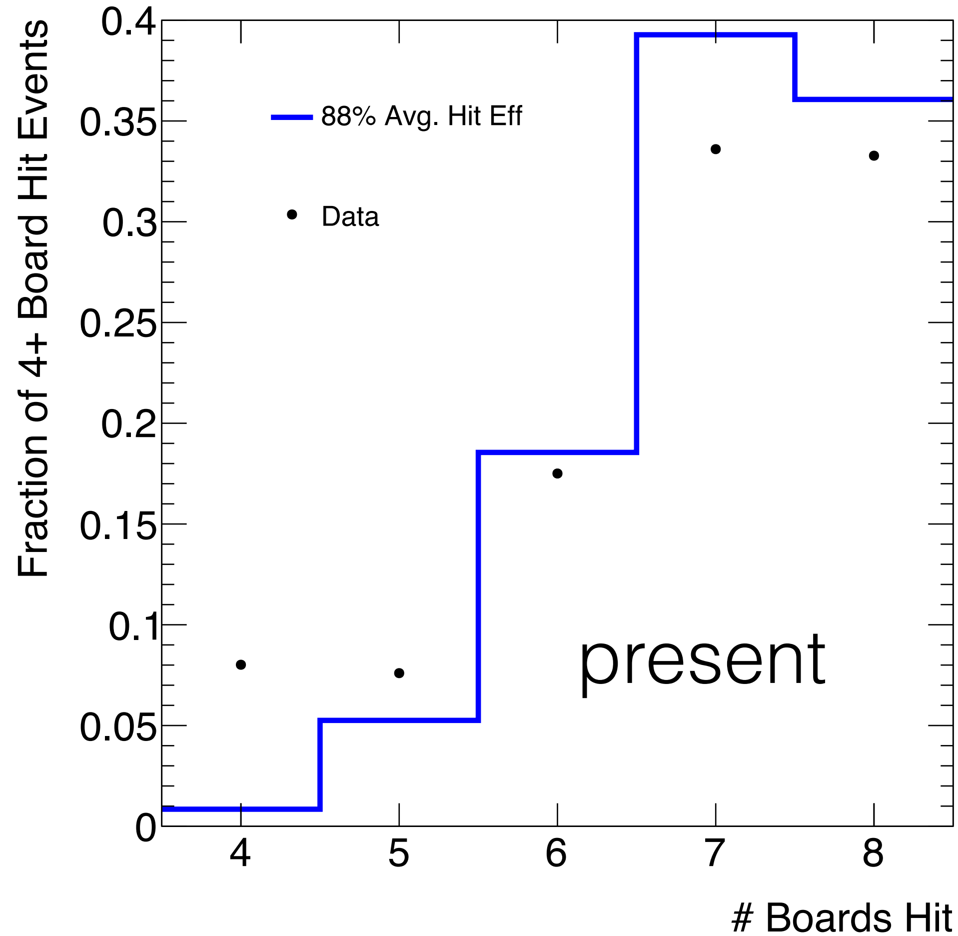




PRELIMINARY DATA IN A NOISE-FREE WORLD

- Number of planes in track reconstruction has increased from ~5-6 planes to ~7-8 planes





CONCLUSION

- We verified that removing the DC-DC converters eliminates the major source of noise

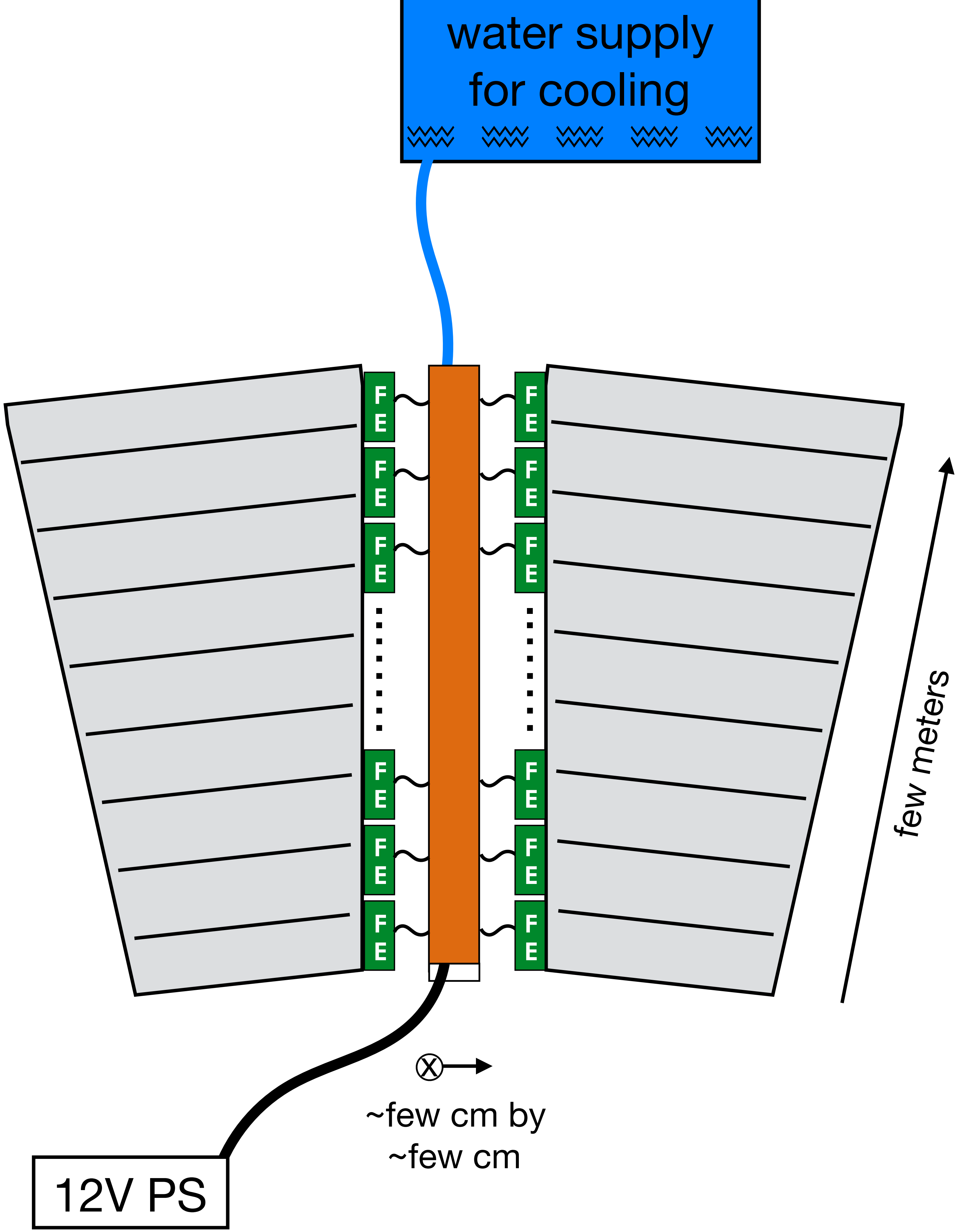
a proposal

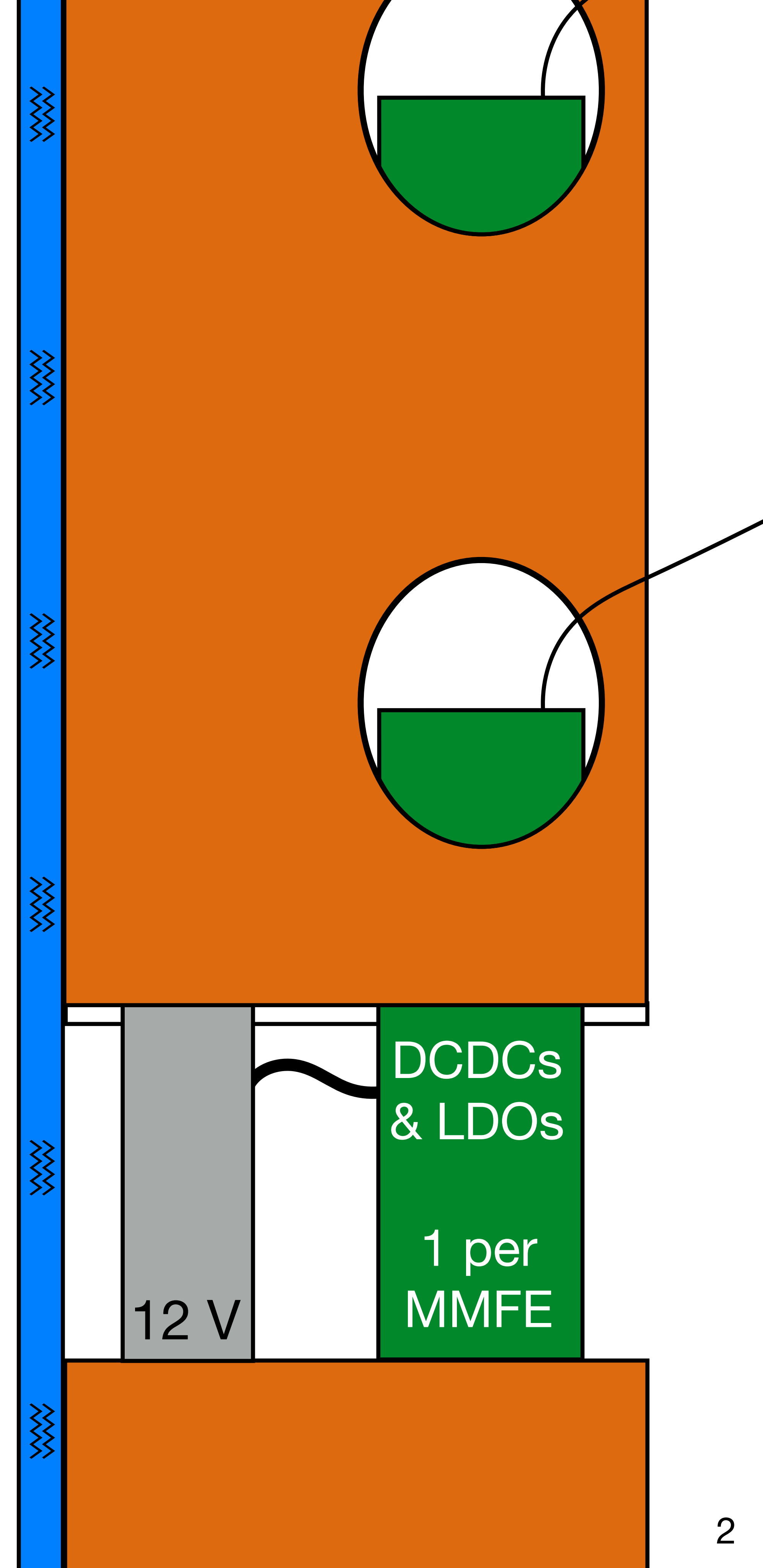
the MMFE / VMM needs a few voltages,
but DCDC converters cannot exist on or next to the board

proposal: put DCDC in pipe between chambers

copper pipe shields DCDC noise from MMFE,
“extension” cards could be small (DCDC & LDO),
copper pipe cooling is straightforward

caveat: radiation tolerant LDOs rated for 3A,
MMFE8 draws more than this





NB: rad. hard LDO rated for ~3A