# dRICH LV power distribution

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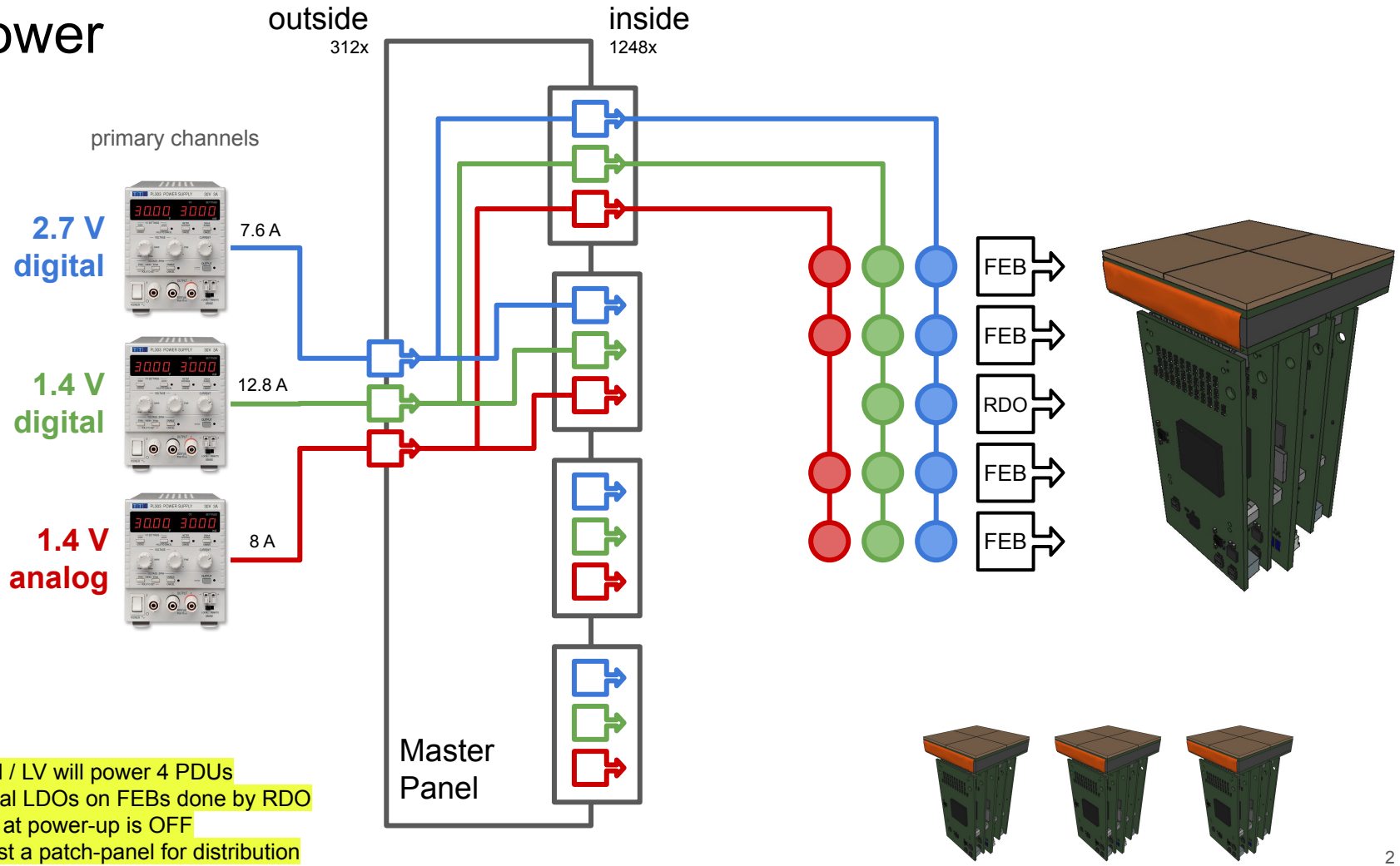
# FEE power








1 primary channel / LV will power 4 PDUs
control of individual LDOs on FEBs done by RDO
default FEB state at power-up is OFF
MasterPanel is just a patch-panel for distribution

# Cables and boards for FEB and RDO power

To be updated in the document **"ePIC Interface Control Document for Services"**

- **FEE analog 1.4V**
  - power for ALCOR analog
  - 1.4V 8A for each channel → AWG 11
  - 1 primary channels / 4 PDUs → 312 + 312 cavi (output + return)
  - 39x CAEN A2551 boards (possible choice)
- **FEE digital 1.4V**
  - power for ALCOR and RDO digital core
  - 1.4V 12.8A for each channel → AWG 9
  - same as above, but A2551 boards have not enough Amps
- **FEE digital 2.7V**
  - power for ALCOR and RDO digital I/O
  - 2.7V 7.6A for each channel → AWG 11
  - same as above

A2551 ★ New
8 Channel 8 V/12 A Full Floating Channel Board

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8 Channel 8 V/12 A Full Floating Channel Board


this scheme would almost work using a commercial CAEN board (60W/channel)
similar reasoning holds for the Wiener MPOD system (50W/channel)
although the MPOD has lower power and lower Amps / channel than CAEN commercial boards (max 10A/channel)

# Development with CAEN for a new LV board

to fit the current budget we would need to

- either change the power aggregation scheme
  - from 4 PDU / primary channel to 3 PDU / primary channel
  - number of boards increases from 117 to 156 (~2.5 kEUR/board = 100 kEUR more + crates, space, cables)
- or double the channels for the FEE digital 1.4V
  - instead of 39 boards, use 78 (~2.5 kEUR/board = 100 kEUR more + crates, space, cables)

- **FEE digital 1.4V**
  - power for ALCOR and RDO digital core
  - 1.4V 12.8A for each channel → AWG 9
  - same as above, but A2551 boards not enough Amps

A2551 ★ New

8 Channel 8 V/12 A Full Floating Channel Board


initiated a **discussions with CAEN for a development** of a similar LV board with same power output / channel (60W) with customisation

- reduce max voltage, 0-5V
- increase max current, 0-16A

dRICH FEE does not need up to 8V voltages, but benefits for more current

development costs with CAEN (can this be a PED?) are low compared to potential cost saving (~ 100 kEUR)

# Development with CAEN for a new LV board

the development of this new CAEN board (5V 16A) would have multiple advantages

- solve the 12A current limit for the FEE digital 1.4V (currently estimated at 12.8A)
- allow to group more PDUs in the same channel
- at the same projected cost/board as the currently-available commercial boards
    - understanding from CAEN is that it will commercialised as a new product

grouping more PDUs
FEE analog 1.4V, currently 4 PDU/channel → could become 6 PDU/channel
FEE digital 1.4V, currently 4 PDU/channel → would stay 4 PDU/channel
FEE digital 2.7V, currently 4 PDU/channel→ could become 6 PDU/channel

FEE analog 1.4V, currently 312 cables (39 boards) → could become 208 cables (26 boards)
FEE digital 1.4V, currently 312 cables (39 boards) → would stay 312 cables (39 boards)
FEE digital 2.7V, currently 312 cables (39 boards) → could become 208 cables (26 boards)

solves a issue in FEE digital 1.4V that would require more channels ( ~ 100 kEUR)
and reduces total number of boards by 26 boards, ~ 70 kEUR
potential saving costs for dRICH FEE of ~ 170 kEUR

understood that this development can be in a PED ~ 20 kUSD

# Cables and boards for FEB and RDO power

projection with the new CAEN board 5V 12A

- **FEE analog 1.4V**
  - power for ALCOR analog
  - 1.4V 12A for each channel → AWG 9
  - 1 primary channels / 6 PDUs → 208 + 208 cavi (output + return)
  - 26x CAEN A2551-mod boards (possible choice)
- **FEE digital 1.4V**
  - power for ALCOR and RDO digital core
  - 1.4V 12.8A for each channel → AWG 9
  - 1 primary channels / 4 PDUs → 312 + 312 cavi (output + return)
  - 39x CAEN A2551-mod boards (possible choice)
- **FEE digital 2.7V**
  - power for ALCOR and RDO digital I/O
  - 2.7V 11.4A for each channel → AWG 9
  - 1 primary channels / 6 PDUs → 208 + 208 cavi (output + return)
  - 26x CAEN A2551-mod boards (possible choice)

A2551 future

8 Channel **5V/16A** Full Floating Channel Board

A2551 future

8 Channel **5V/16A** Full Floating Channel Board

A2551 future

8 Channel **5V/16A** Full Floating Channel Board


this scheme is with the new developed board with CAEN

# Cables and boards for SiPM e MasterLogic power

Current status of the document **"ePIC Interface Control Document for Services"**

- **Ancillary Power**
  - power for MasterLogic boards
  - 7V 5.2 A for each channel → AWG 13
  - 1 primary channel / 208 PDUs (readout box) → 6 + 6 cables (output + return)
  - 1x CAEN A2551 board (possible choice)
- **SiPM bias voltage**
  - power for SiPM sensors
  - 64V 1.3 A for each channel → AWG 19
  - 2 primari channels / 208 PDUs (readout box) → 12 + 12 cables (output + return)
  - 2x CAEN A2554 boards (possible choice)
- **SiPM annealing voltage**
  - power for SiPM sensors
  - 12V 3.2 A for each channel → AWG 15
  - 8 primary channels / PDU (each primary is shared among 8 PDUs) → 1248 + 1248
  - 156 CAEN A2552 boards (possible choice)

A2551 ★ New

8 Channel 8 V/12 A Full Floating Channel Board

A2554 ★ Coming Soon

8 Channel 64 V/1.5 A Full Floating Channel Boar

A2552 ★ New

8 Channel 16 V/6 A Full Floating Channel Board


this scheme works using a commercial CAEN board (60W/channel)
similar reasoning holds for the Wiener MPOD system (50W/channel)

# SiPM annealing power

presently, in the scheme the same annealing power channel is shared / multiplexed among 8 PDUs
the multiplexing happens inside the dRICH electronics, that can select to which PDU to direct annealing power

annealing is a process that needs time and temperature (power)
we can reduce the annealing power needs by increasing the sharing from 8 to 16

what fraction of the detector will be capable to perform annealing at a given time depends on the amount of power available.
less annealing power available, longer time needed to perform annealing over the full detector

we can workout various scenarios based on recent measurements in a realistic annealing setup
but the message is that on the annealing side there is in principle margin to reduce

# Crates and racks for power (as of now)

- 39x CAEN A2551 boards for FEE analog 1.4V (ALCOR analog)
- 39x CAEN A2551 modified boards for FEE digital 1.4V (ALCOR and RDO digital core)
- 39x CAEN A2551 boards for FEE digital 2.7V (ALCOR and RDO digital I/O)
- 1x CAEN A2551 board for Ancillary Power (MasterLogic)
- 2x CAEN A2554 boards for SiPM bias voltage
- 156x CAEN A2552 boards for SiPM annealing voltage

**total 276 boards** compatible with the
CAEN Universal Multichannel Power Supply System

commercial crate CAEN SY4527 (19", 8 U)
one crate → 16 slots, 5500 W

**we need 18 crates**, 4x 42U racks
8x crates for the FEE, 2x 42U racks
10x crates for the annealing, 2x 42U racks

# Crates and racks for power (with new CAEN board)

- 26x CAEN A2551 boards for FEE analog 1.4V (ALCOR analog)
- 39x CAEN A2551 modified boards for FEE digital 1.4V (ALCOR and RDO digital core)
- 26x CAEN A2551 boards for FEE digital 2.7V (ALCOR and RDO digital I/O)
- 1x CAEN A2551 board for Ancillary Power (MasterLogic)
- 2x CAEN A2554 boards for SiPM bias voltage
- 156x CAEN A2552 boards for SiPM annealing voltage

**total 250 boards** compatible with the
CAEN Universal Multichannel Power Supply System

commercial crate CAEN SY4527 (19", 8 U)
one crate → 16 slots, 5500 W

**we need 16 crates**, 3.2x 42U racks

6x crates for the FEE, 1.2x 42U racks
10x crates for the annealing, 2x 42U racks

# Crates and racks for power (with also ½ annealing power)

- 26x CAEN A2551 boards for FEE analog 1.4V (ALCOR analog)
- 39x CAEN A2551 modified boards for FEE digital 1.4V (ALCOR and RDO digital core)
- 26x CAEN A2551 boards for FEE digital 2.7V (ALCOR and RDO digital I/O)
- 1x CAEN A2551 board for Ancillary Power (MasterLogic)
- 2x CAEN A2554 boards for SiPM bias voltage
- 78x CAEN A2552 boards for SiPM annealing voltage

**total 172 boards** compatible with the
CAEN Universal Multichannel Power Supply System

commercial crate CAEN SY4527 (19", 8 U)
one crate → 16 slots, 5500 W

**we need 11 crates**, 2.2x 42U racks

6x crates for the FEE, 1.2x 42U racks
5x crates for the annealing, 1x 42U racks

~40% less

# considerations on bPOL48V module from CERN

10A max current
we likely would need 1248 of them just for the FEE
(exclude annealing for the moment)

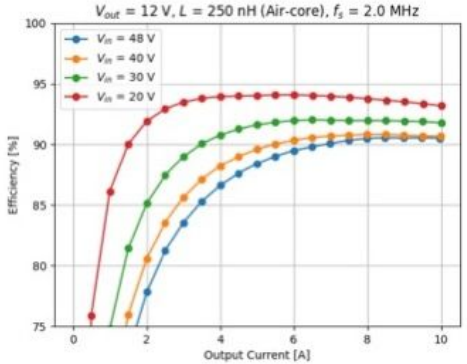
Cost: 100 CHF/each? if 125 kCHF only the module
(compared to 400 kEUR for commercial CAEN modules it does not seem a big saving)

Space: 1.6 $m^2$ area only the module is put flat (where to put them?)

or an additional 5.5 cm in the envelope if the module is put vertical (where to put them?)

Module optimised in volume, available in large numbers
Hosting:

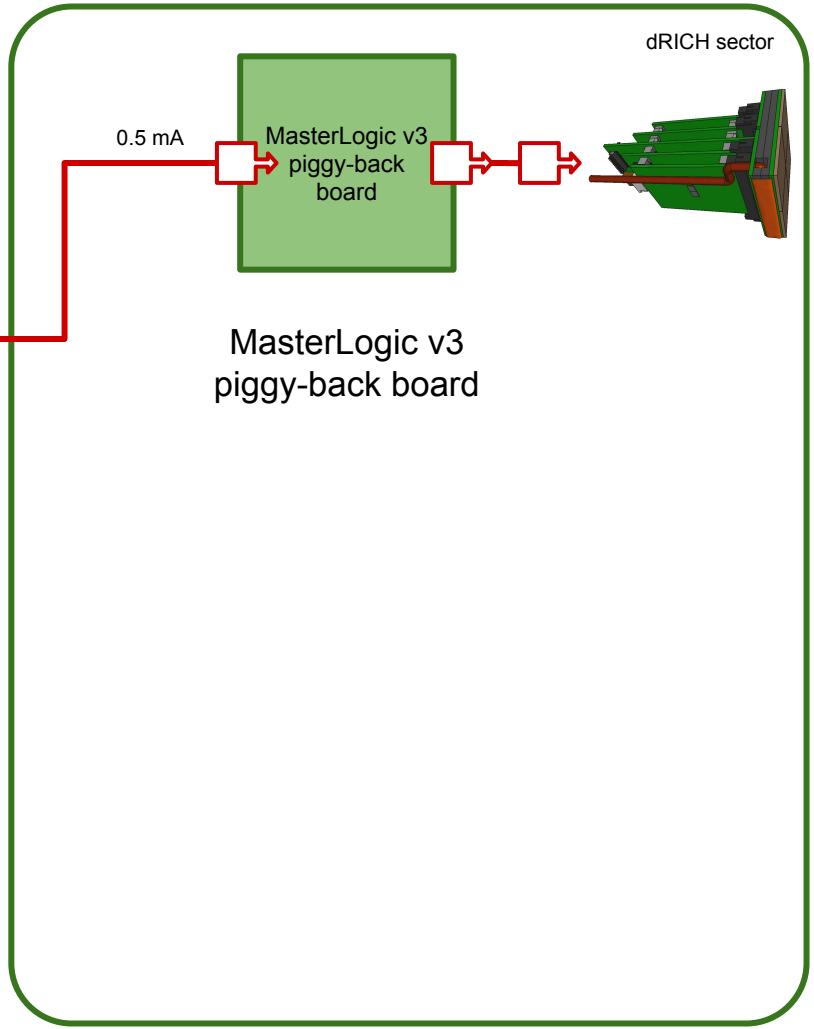
- CERN GaN_controller ASIC
- CERN custom PCB air core inductor
- Commercial Gallium Nitride power stage




55mm x 24mm x 3mm

# Vbias distribution

64 V
0.2 A




una scheda MasterLogic-v3 per PDU
in un settore ci sono 208 PDU

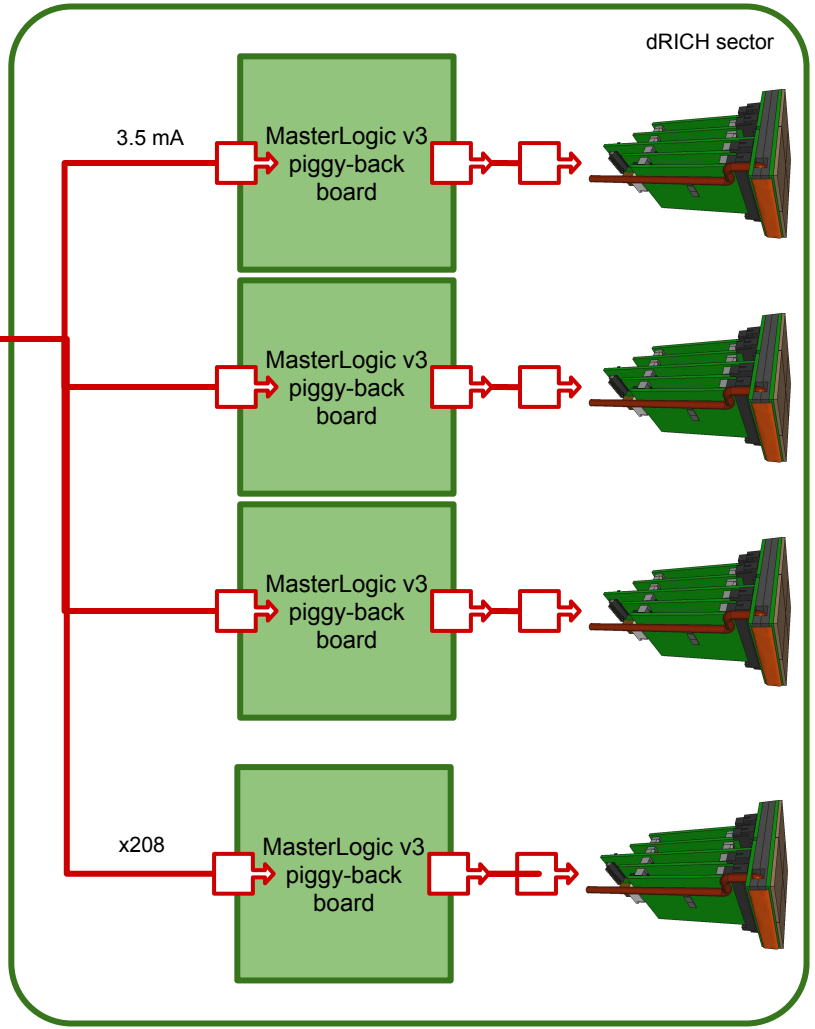
sulla MasterLogic v2 i regolatori
consumano ognuno
3.3 mA quando l'uscita è a 50 V

assunzione che consumo sia lo stesso
nella nuova MasterLogic-v3

è meno, verosimilmente 0.5 mA

# Vbias distribution

64 V
1.3 A

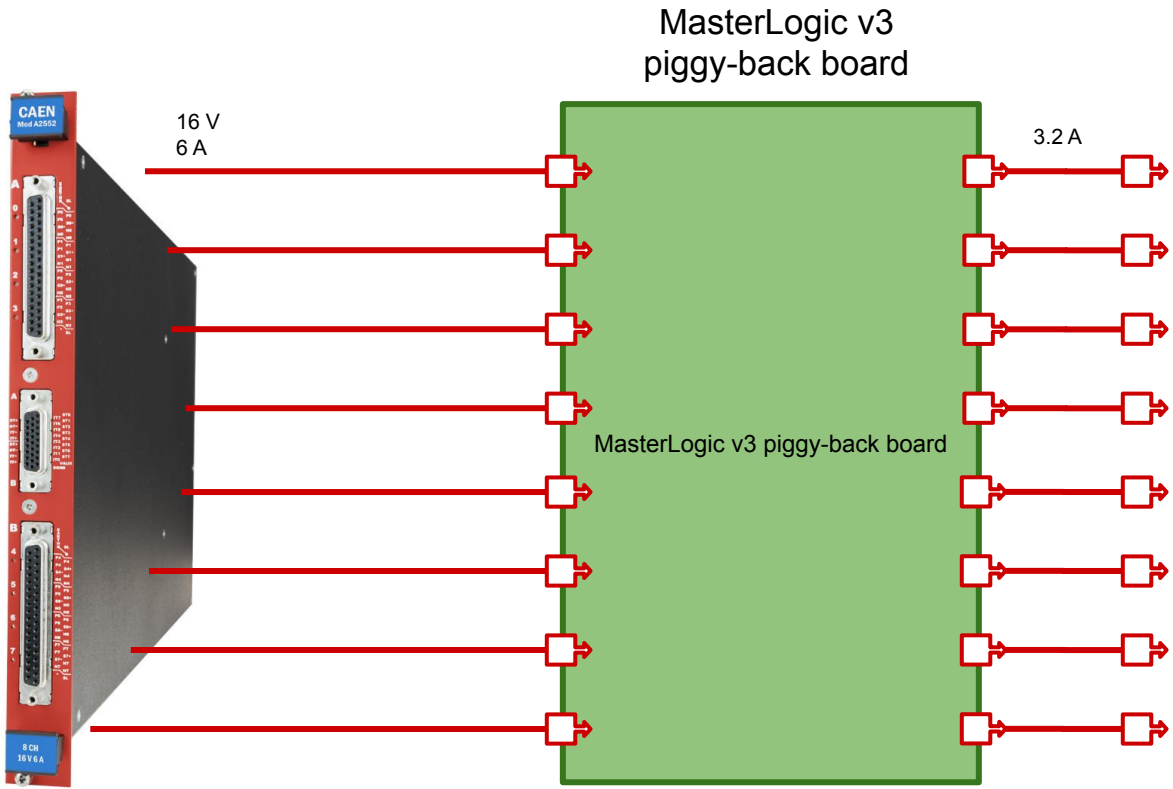



una scheda MasterLogic-v3 per PDU
in un settore ci sono 208 PDU

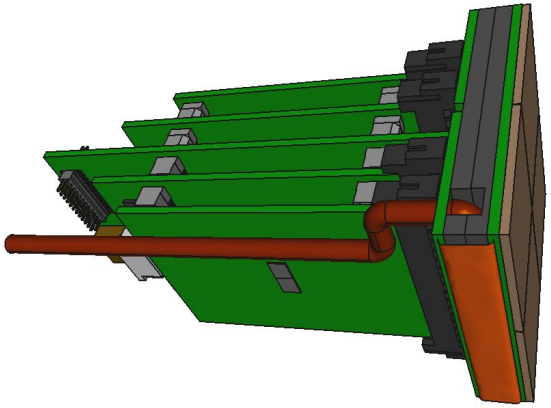
sulla MasterLogic v2 i regolatori consumano ognuno
3.3 mA quando l'uscita è a 50 V

assunzione che consumo sia lo stesso nella nuova MasterLogic-v3

# Vannealing distribution




2 Vbias input lines for each FEB
32 SiPM / Vbias input line
= 3.2 A for each line during annealing (max)



but, 1248 8-channel CAEN boards are a bit too much and are not needed given that we do not do annealing all at the same time
(that would be 150-300 kW)

fan-out to 8 PDUs

# Vannealing distribution

the same LV channel will be shared by 8 PDUs
the MasterLogic decides if the PDU is doing annealing