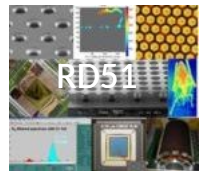




# Assembly of a full SRS Eurocrate for 8 FECs and VMM readout

Michael Lupberger  
(University of Bonn)

RD51 Collaboration Meeting, Santiago de  
Compostela  
07.10.2020



# Eurocrate V1

## SRS 19' Eurocrate

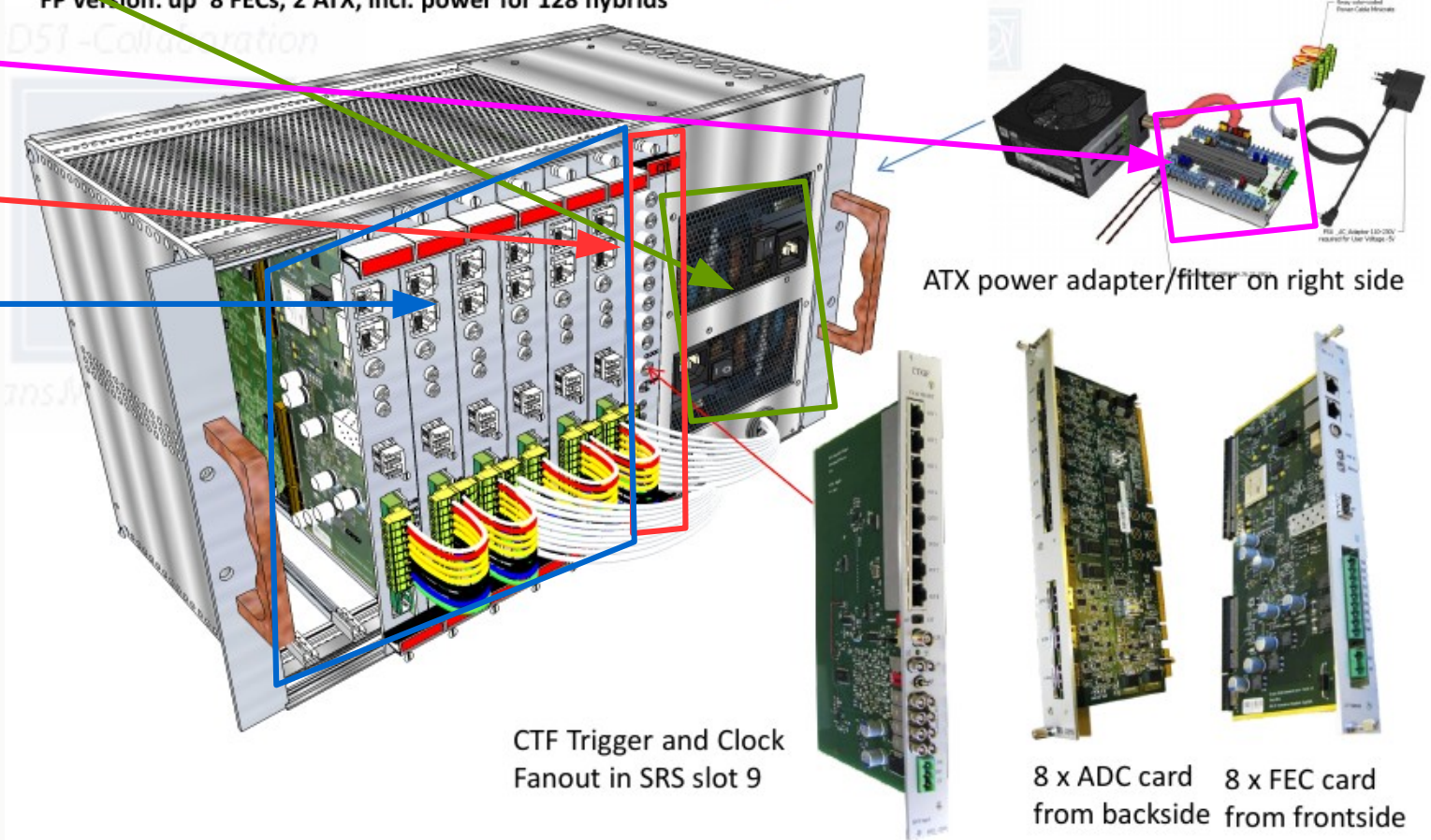
a scalable solution for up 16 k channels/crate

HP version: up 4 FECs, 1 ATX, incl. power for 64 hybrids  
 FP version: up 8 FECs, 2 ATX, incl. power for 128 hybrids

→ CERN Store SCEM 07.89.00.030.8

Housing for:

- 2 ATX power supplies
- 2 ATX adapters
- 1 CTF
- 8 FECs



16/04/2012

Hans.Muller@Cern.ch

# Current status of Eurocrate components

Standard layout for APV25:

- older version of ATX adapter
- ATX power supply for APV25 needs
- Severe quality problems with SRS Eurocrate V1  
=> CERN store stopped sales

=> Since ~2015 obvious: need SRS Eurocrate V2  
Hans plans:

- Account for APV25 → VMM transition
- SRS FEC FPGA firmware needs more power
- Direct powering of VMM hybrids from Eurocrate

=> revision of ATX adapter, stronger ATX power supplies

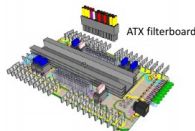
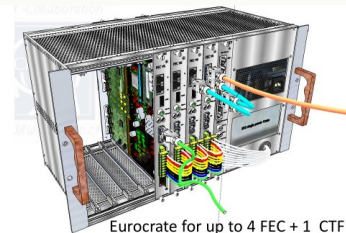
## Eurocrate / ATX filter V2

Severe quality problems with SRS Eurocrate V1 :  
CERN store stopped sales

### Eurocrate 2 features

- > 40 Ampere on 3V3 ( for up to 64 APV hybrids)
- ATX filter V2 with integrated -5V PSU and resettable fuses
- CTF power connector
- SRU power plug
- 5 slots (4 x FEC + 1 x CTF)
- Aux. power panel (+12,+5,+3.3,-5 V- fused) with 2mm Banana jacks

05/06/2016



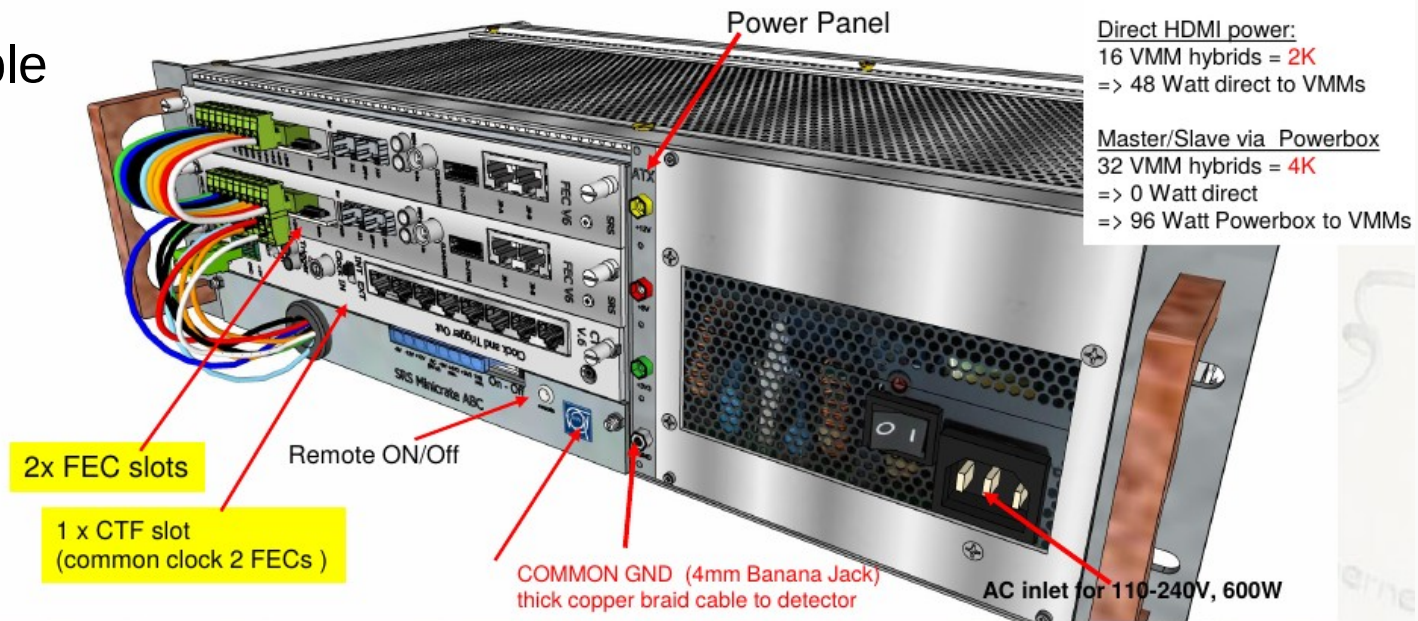
# First steps to revised SRS powering

## Minicrate ABC (VMM frontend)

slots for 2 FEC + 2 DVM, 1 CTF and direct HDMI power for VMM

Hans revised minicrate

- Crate as before  
→ older crates upgradeable
- 2 FEC slots
- 1 CTF slot
- New ATX power supply
- New ATX adapter



1/6/2019

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=> Minicrate ABC, 10 prototypes built  
commercial production started (NEOHM)

=> CERNstore

# Prototype Eurocrate V2 by Hans

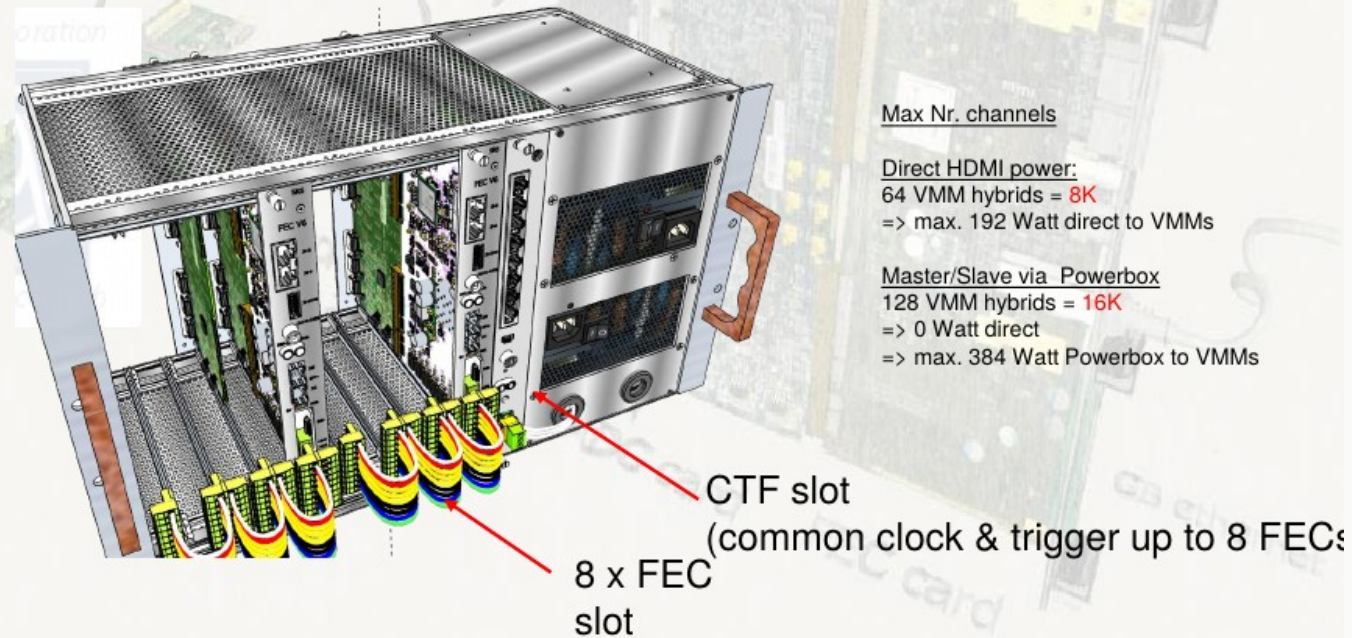
Eurocrate V2, 8 FEC slots prototypes built by Hans,

## Eurocrate V2

for up to 8 FEC+DVM, 1 CTF and direct HDMI power for VMM

DVMcards inserted from backside

Remote ON/Off on Power backpanel



1/6/2019

Hans.Muller@cern.ch

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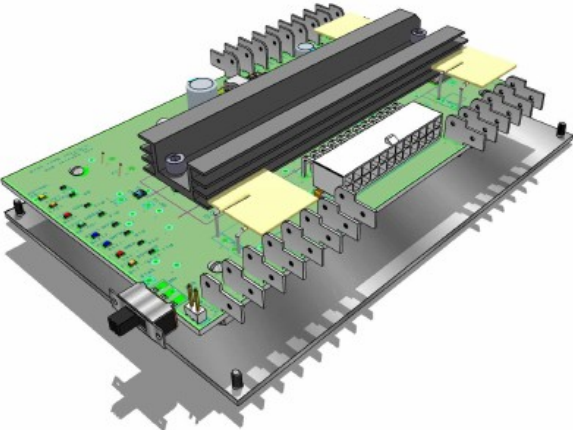
commercialization planned 2020

# ATX adapter V3.2

Minicrate ABC/Eurocrate V2 prototype => Detailed and clear manual by Hans


## SRS Scalable Readout System

***Chapter 3.2: ATX adapters V3.2 Minicrates ABC and Eurocrates V2***



SRS Scalable Readout system Document , ATX adapter

Hans.Mueller@cern.ch




Scalable Readout System

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**RD51 Collaboration**  
rd51-public.web.cern.ch

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This information contained is protected by CERN licence agreement [IN2288/IT/PH/2008](#) SCALABLE READOUT SYSTEM, SRS

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Author:  
Hans.Mueller@cern.ch

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this chapter:  
**ATX adapter**

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**Creation Date**  
May 9, 2011

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**Last revision**  
February 21, 2019

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**Page Nr**  
**1** of 28

=> We were able to build our own Eurocrate V2

07.10.2020

Michael Lupberger

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# ATX adapter V3.2

Designed for Minicrate ABC (power 2 FECs, 1 CTF, VMM hybrids)



Questions: sufficient to power 4 FECs, 1 CTF (and VMM hybrids)

# Testing of ATX adapter V3.2





# Testing of ATX adapter V3.2

Procedure: measure voltages on FEC and on power board

- Connect one FEC after the other
- Compare to old ATX adapter

3 states:

- Idle (no FEC connected)
- FEC powered (FPGA code not loaded)
- FEC programmed (FPGA code running on FEC)

1st test with 0 → 1 → 2 FECs

Main (qualitative) findings:

- VMM firmware draws **SIGNIFICANTLY** more power than APV firmware
- Only one power critical for FEC operation: “1V8” (supplies FPGA)

# 1<sup>st</sup> test of ATX adapter V3.2

Measurements of 1V8 on FEC (FEC GND → 1V8 on input)

Requirements on this voltage by FEC:  $1V8 > 1.6 \text{ V}$

	Old ATX board 1V8 / V	New ATX board 1V8 / V
Idle	2.81	2.97
1 FEC connected	2.41	2.65
1 FEC programmed	1.82	2.07
2 FECs connected	2.17	2.51
2 FECs 1 programmed	1.60	2.10
2 FECs 2 programmed	Not possible	1.60

1V8 at the edge for 2 FECs running VMM firmware (APV firmware less demanding)

# 1<sup>st</sup> test of ATX adapter V3.2

Current on 1V8 for 2 programmed FECs: 6.2 A

- 1V8 on ATX board: 1.78 V (1.6 V on FEC), FECs in crate → better GND return helps

Exchange with Hans Muller:

- test at 5.6 A → 1.98 V on FEC

Check components on ATX board:

- 3.3 V from ATX is 3.4 V at idle → 2.9 V for 2 programmed FECs
- 3.3 V ATX sense soldered to filter input → little effect (+0.05 V on FEC)
- Power diodes ok (1V8 from 3.3 V)
- filters ok
- solder ok

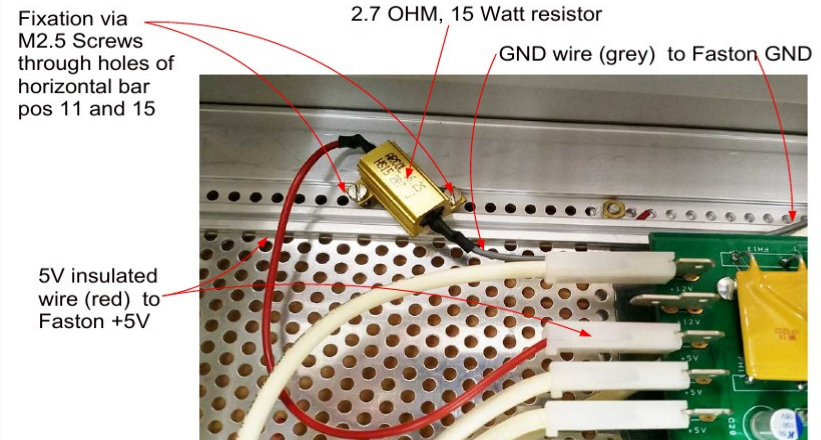
Check ballast resistors on ATX board:

- 22 Ohm (10W) 12 V → GND ok
- 2.7 Ohm (15 W) 5 V → GND NOT OK

=> put 5V → GND ballast correctly

## Minicrate: Ballast resistor ( 5V -> GND )

A ballast resistor is required for proper power-up of the 500W ATX power supply



## 2<sup>nd</sup> test of ATX adapter V3.2

	Old ATX board 1V8 / V	New ATX board 1V8 / V (only 22 Ohm ballast 12 V → GND)	New ATX board 1V8 / V (both ballast resistors)
Idle	2.81	2.97	2.85
1 FEC connected	2.41	2.65	2.66
1 FEC programmed	1.82	2.07	2.42
2 FECs connected	2.17	2.51	2.57
2 FECs 1 programmed	1.60	2.10	2.36
2 FECs 2 programmed	Not possible	1.60	2.14

=> 3.3 V from ATX stable even for two programmed FECs at 3.4 V

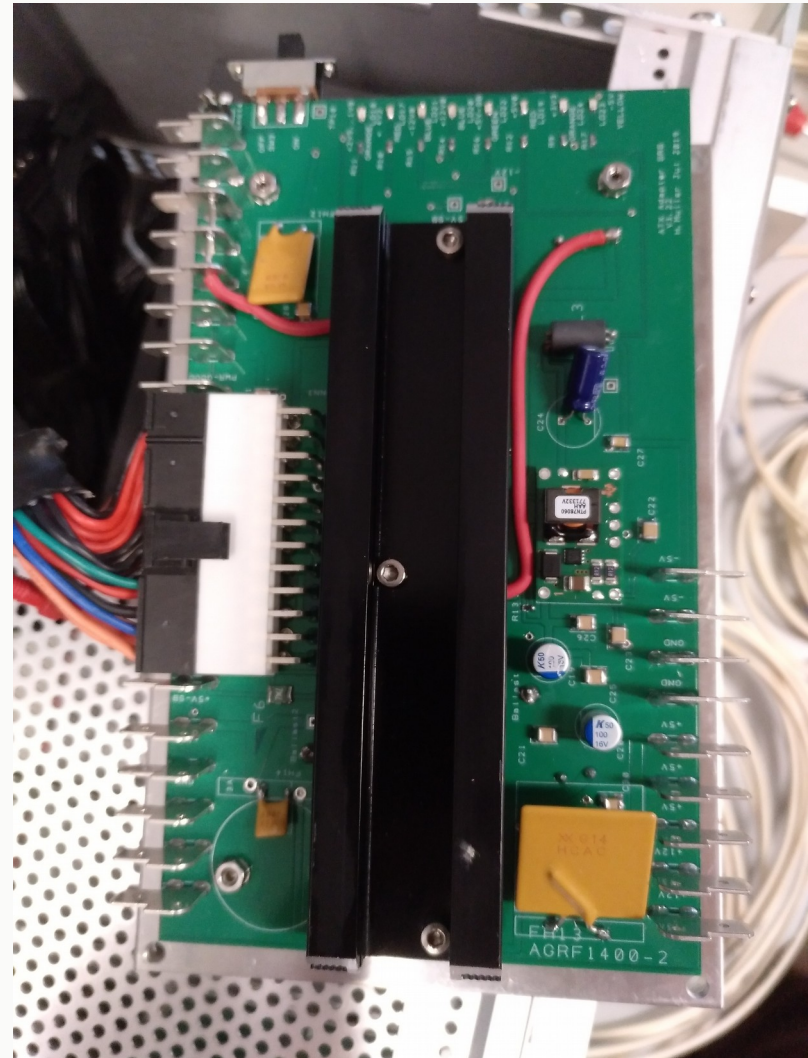
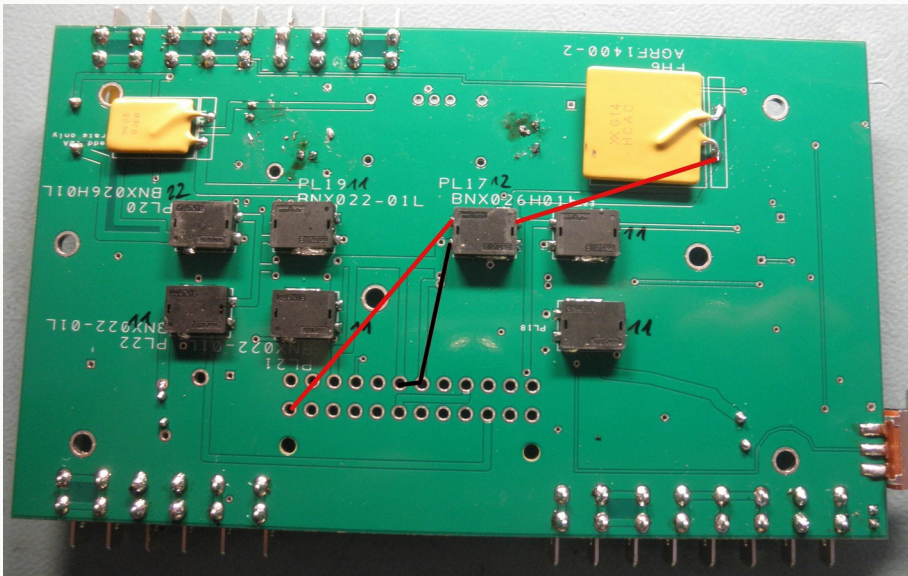
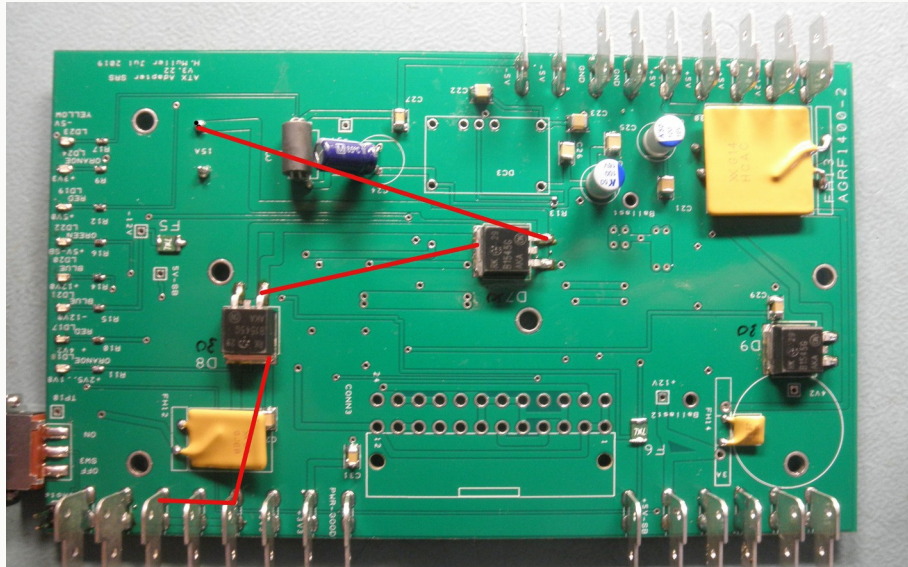
Check if other ballast resistor really needed: 22 Ohm ballast 12 V → GND:  
programming of 2<sup>nd</sup> FEC not possible due to voltage breakdown

## 3<sup>rd</sup> test of ATX adapter V3.2: More FECs

	Old ATX board 1V8 / V	New ATX board 1V8 / V (only 22 Ohm balast 12 V → GND)	New ATX board 1V8 / V (both ballast resistors)
Idle	2.81	2.97	2.85
1 FEC connected	2.41	2.65	2.66
1 FEC programmed	1.82	2.07	2.42
2 FECs connected	2.17	2.51	2.57
2 FECs 1 programmed	1.60	2.10	2.36
2 FECs 2 programmed	Not possible	1.60	2.14
3 FECs connected			2.48
3 FECs 1 programmed			2.28
3 FECs 2 programmed			2.10
3 FECs 3 programmed			1.90
4 FECs connected			2.39
4 FECs 1 programmed			2.20
4 FECs 2 programmed			2.02
4 FECs 3 programmed			1.80 (2.0 on board)
4 FECs 4 programmed			Fuse triggered

# 3<sup>rd</sup> test of ATX adapter V3.2

Changes on ATX board: (in addition to 3.3 V sense) improve critical PCB traces



## 4<sup>th</sup> test of ATX adapter V3.2

Effect of improved PCB traces:

- Fuse not triggered any more
- All 4 FECs can be programmed:
  - **2.00 V** on FEC 4 (before: 1.80 V when 3 FECs programmed, 1 not programmed)
- 2.05 V on FEC 4 when FECs in crate (better ground return)

Power consumption on 1V8:

- 4 FECs idle: 3.1 A
- FPGA programmed adds 2.2 A / FEC  
=>  $4 * 2.2 + 3.1 = 11.9$  A

1V8 Fuse designed for continuous 12A current (was probably triggered before)

=> Conclusion: ATX adapter V3.2 (with some improvements) capable to power 4 FECs

=> Feedback for Hans → Improvements implemented:

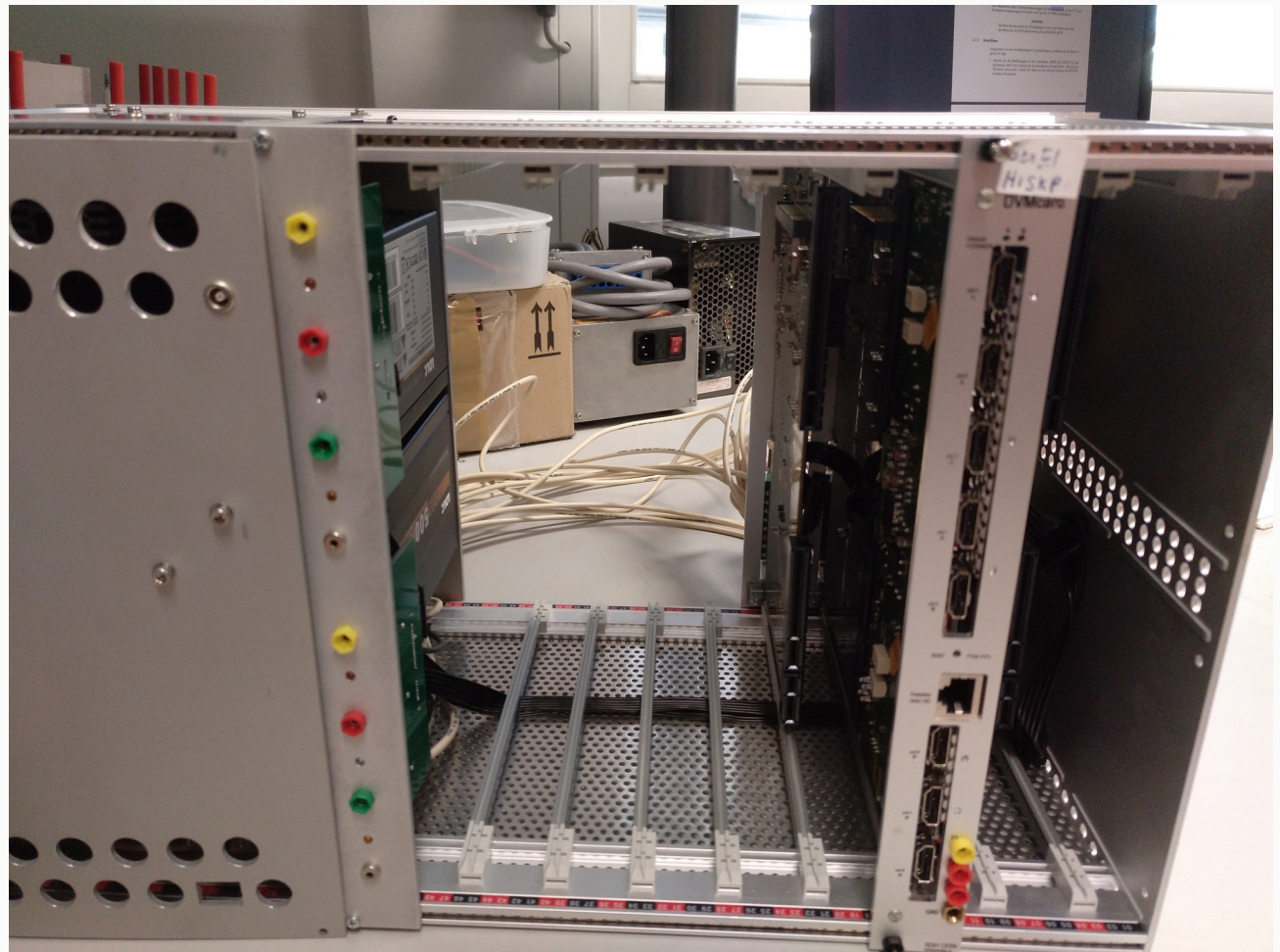
- Thicker PCB traces
- Improve GND plane and contact to ATX connector
- All filters employ 15 A version

Todo: test if each ATX power supply can power 32 hybrids

# Pictures of full Eurocrate V2



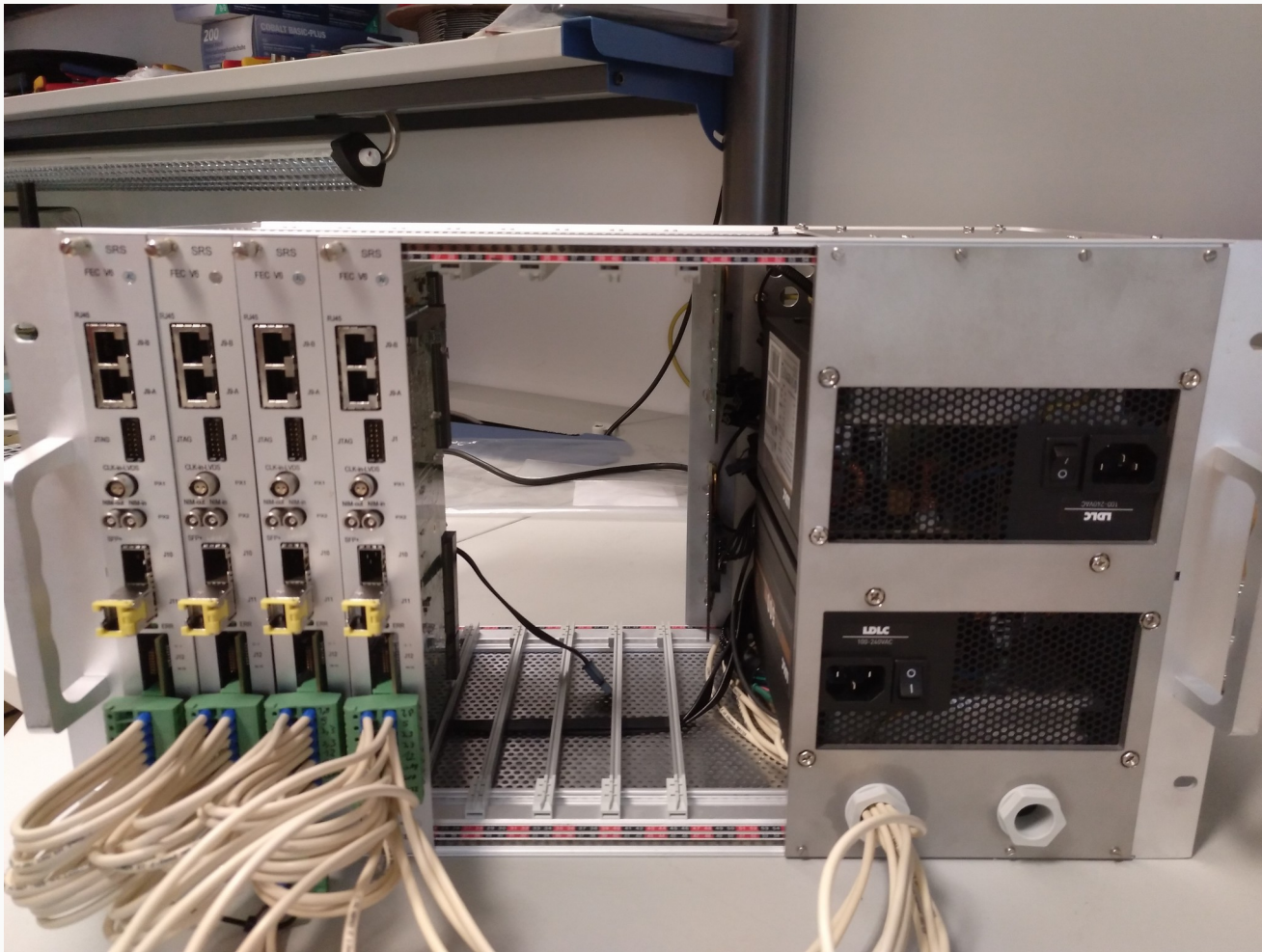
ATX power supplies  
AUX monitor cards



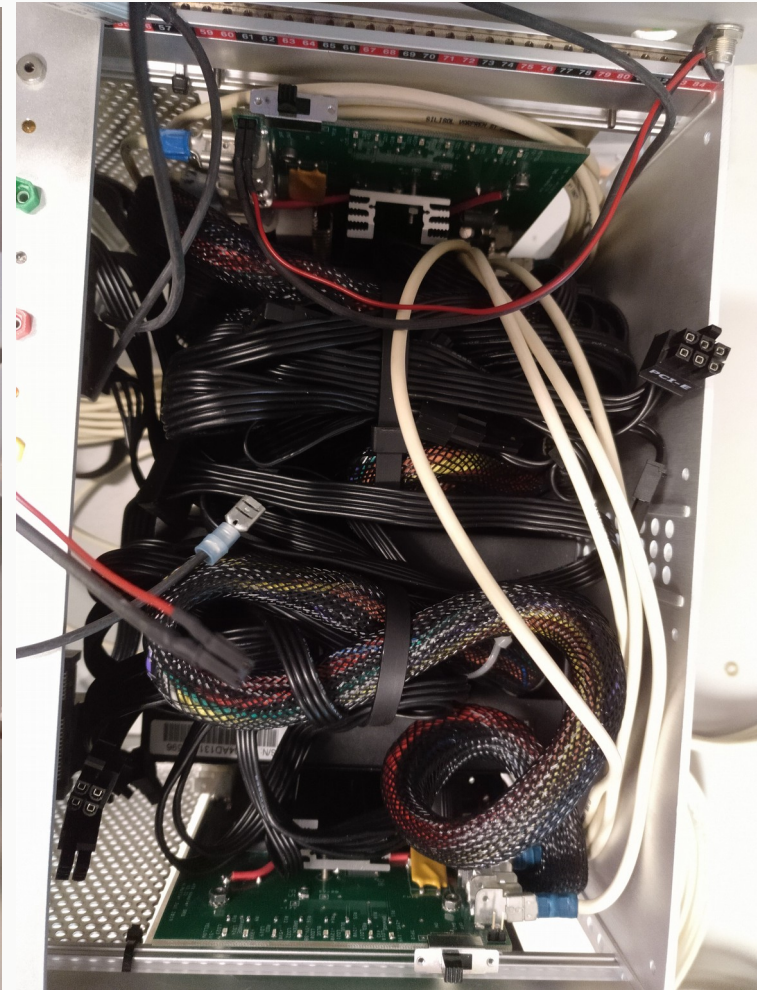
4 FECs, 1 DVMM card in Eurocrate  
SATA power cables for direct VMM hybrid power via DVMM



# Pictures of full Eurocrate V2



4 FECs, 1 DVMM card in Eurocrate  
First half of power cables installed

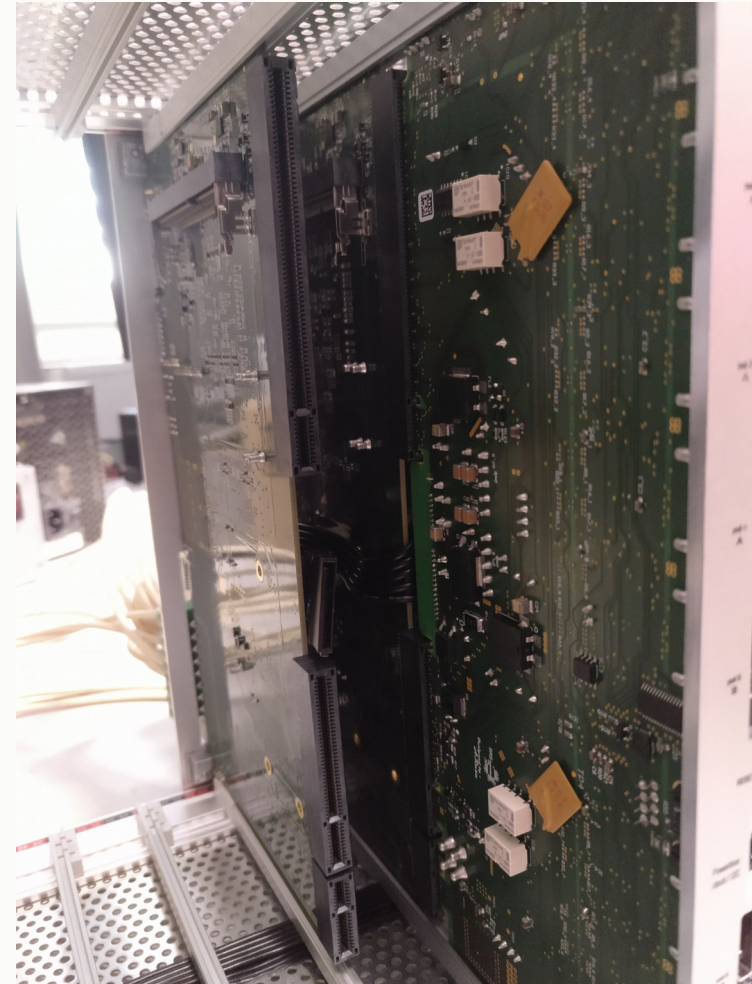


Inside before backplate mounting

# Pictures of full Eurocrate V2

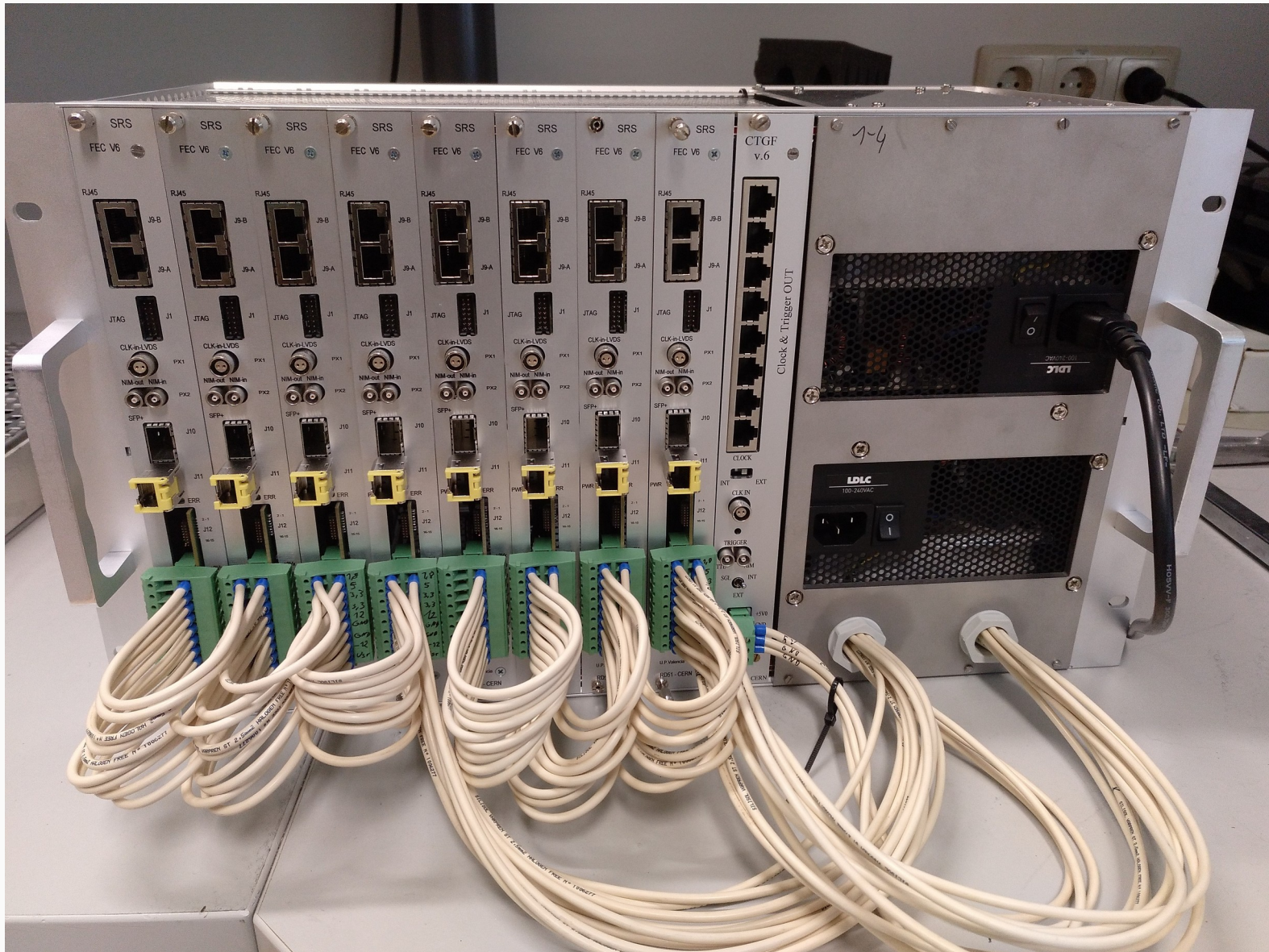


2 FECs and FEC with DVMM  
SATA cable for all DVMMs in place



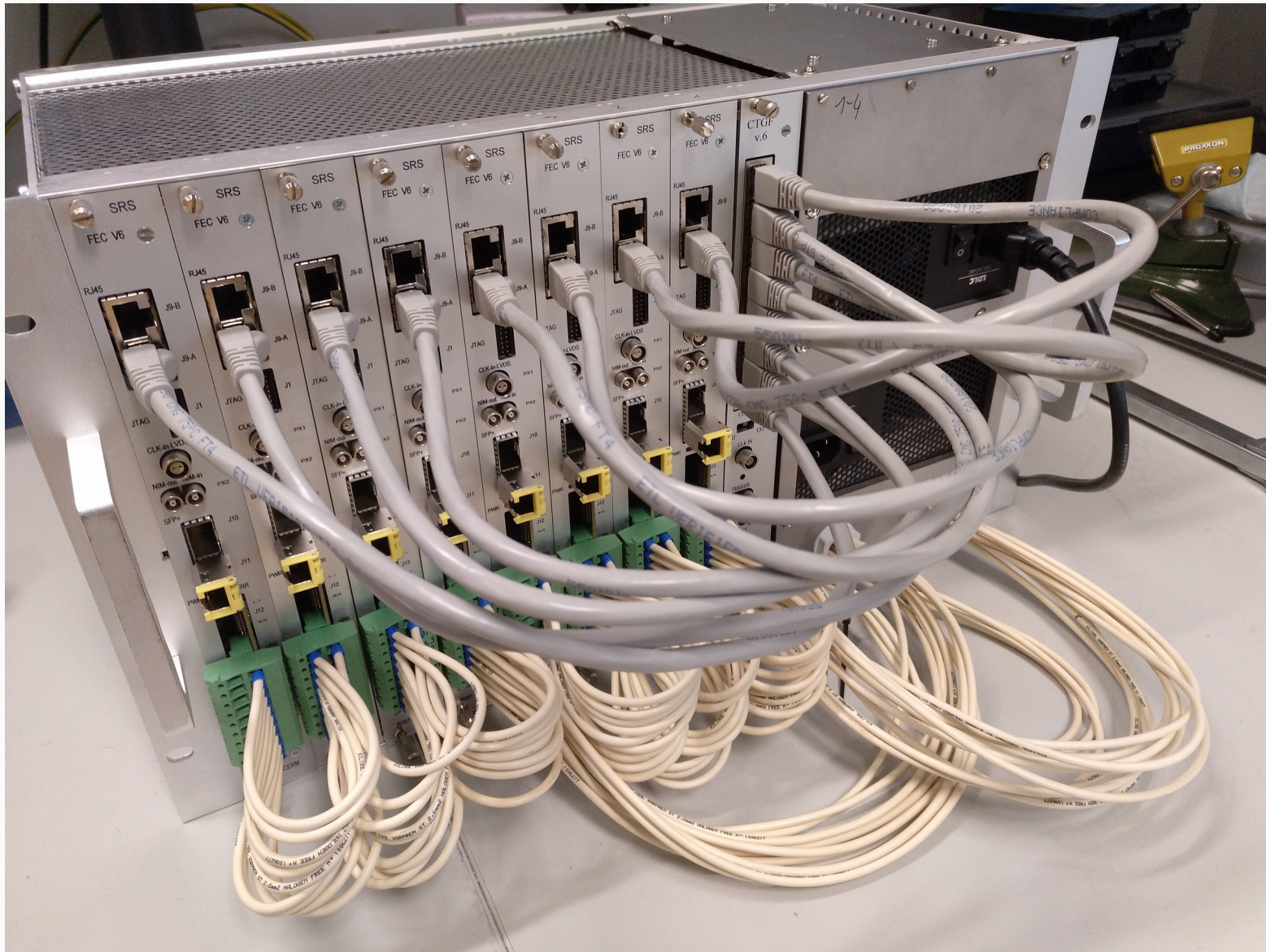
FEC and FEC with DVMM  
SATA cable for DVMM in place

# Pictures of full Eurocrate V2



Fully equipped Eurocrate v2 with 8 FECs and 1 CFT

# Pictures of full Eurocrate V2



Fully equipped Eurocrate v2 with 8 FECs and 1 CFT

Temperature of FPGAs:

72° C core temperature without cooling!  
(even with only 4 FECs in crate, of which only 1 FEC had a DVMM)  
→ expect much less air circulation with all DVMMs attached

=> active air circulation required

→ put a rack fan unit on top of Eurocrate  
=> 52° core temperature

**COOLING required!**

## Conclusion

ATX adapter v3.2 (with small modifications) capable to power 4 FECs

Setup of Eurocrate V2 with new ATX power supplies and adapter board  
→ Great help from Hans (communication, manual)

# THANKS HANS!

Fully equipped with FECs and CFT, all DVMM cards we have  
→ Cooling with rack fans required!

Next step:

Test powering of 32 VMM hybrids with 1 ATX supply and adapter card  
→ need to wait for more hybrids from late 2020 production