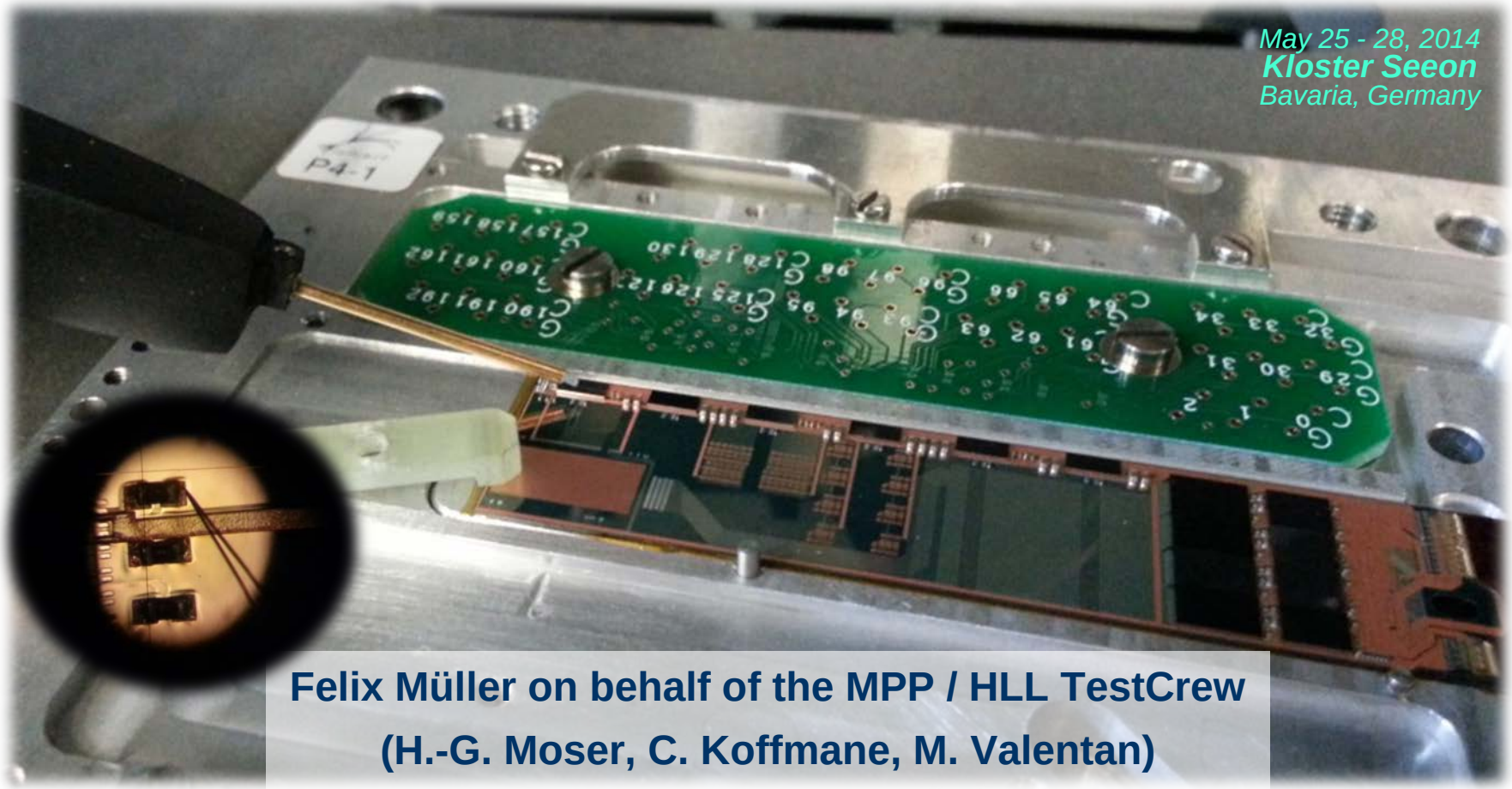
# Electrical Test of EMCM




**Felix Müller on behalf of the MPP / HLL TestCrew**

**(H.-G. Moser, C. Koffmane, M. Valentan)**

# Outline

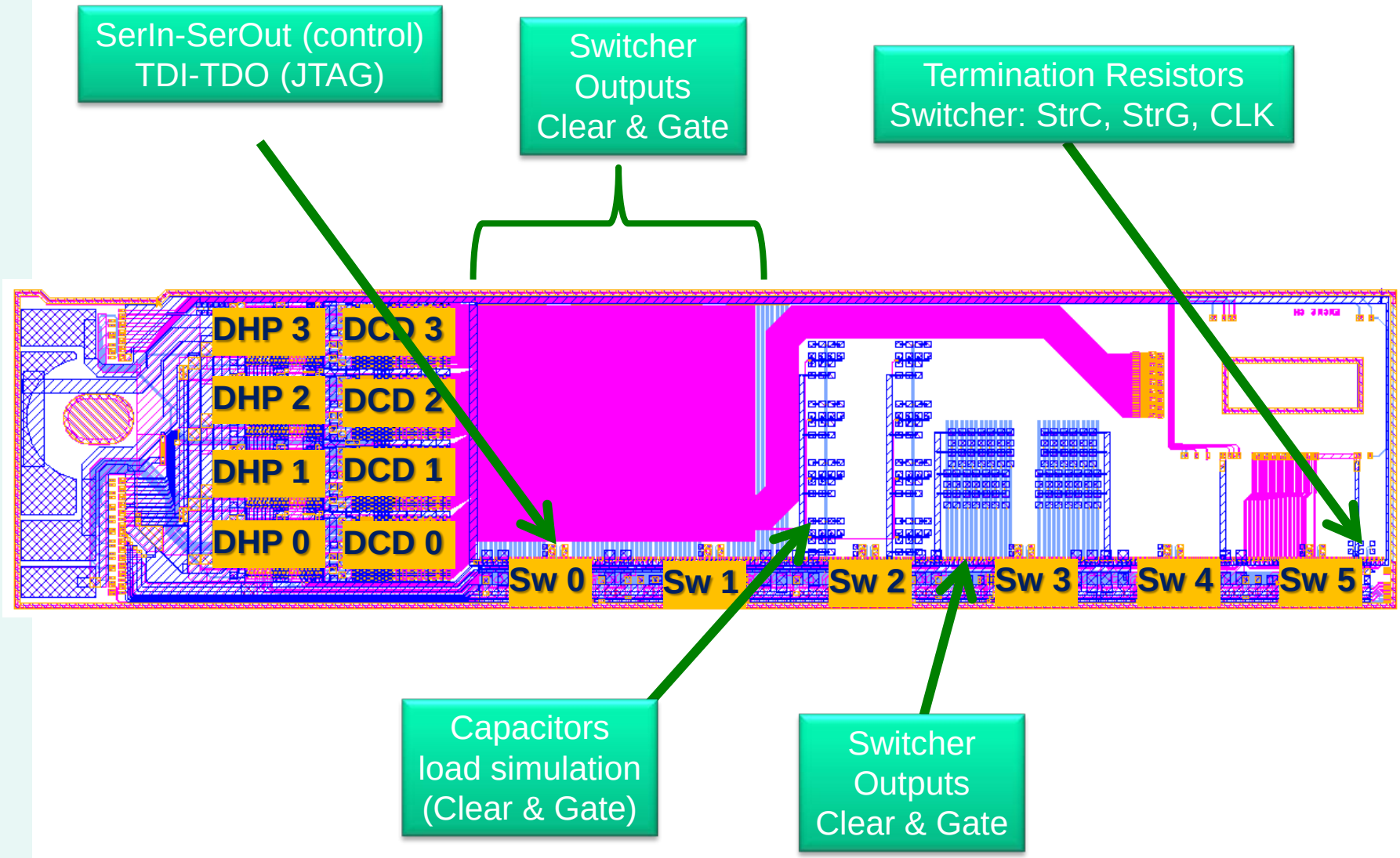
1. Overview of EMCMs
2. Nomenclature
3. Setup
4. EMCM (fully populated one)
5. DCD ADC characterization
6. Latest Test Devices
7. Drawbacks
8. Conclusion and Outlook

# Overview of EMCMs

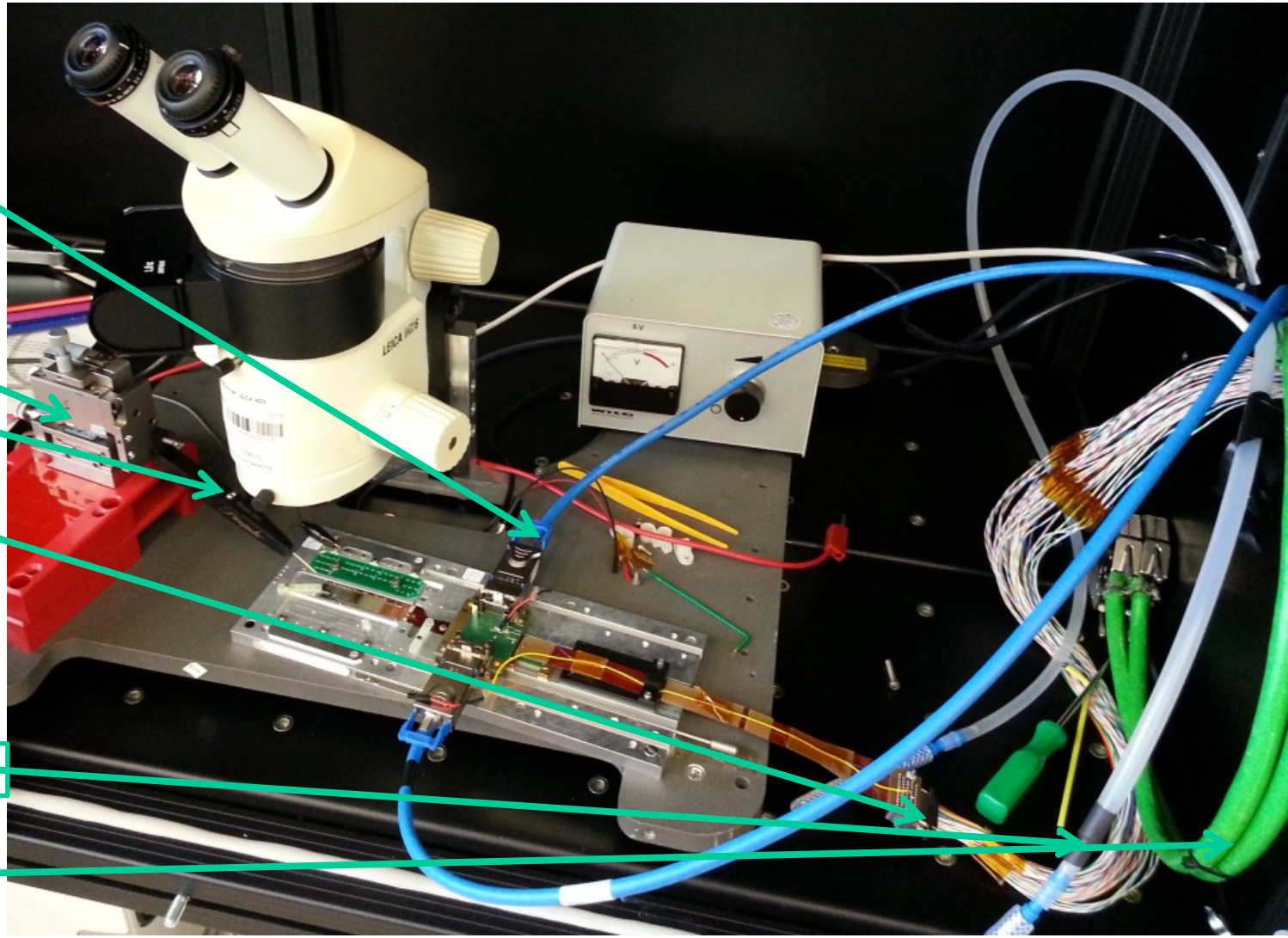
| ID | Project | DHP 0.2 | DCD Bv2 | Sw B18v1 | Location | Comment / Status |
|---|---|---|---|---|---|---|
| P4-1 | ZMI5 | 4 | 4 | 6 | MUC | Fully populated |
| P6-1 | EMCM_1 | 1 | 1 | 1 | MUC | |
| P6-2 | EMCM_2 | 1 | 1 | 1 | BN→MUC | |
| W2-4 | | 1 | 1 | 1 | MUC | Matrix glued (DESY) |
| W9-1 | EMCM_2-2 | 1 | 1 | 6 | MUC | Short of term. resistors |
| W9-2 | EMCM_2-2 | 1 | 1 | 6 | MUC | Short of capacitors |
| … | EMCM_3-2 | | | | | |
| … | EMCM_3-2 | | | | | |
| … | EMCM_3-2 | | | | | |
| … | EMCM_3-2 | | | | | |
| … | EMCM_3-2 | | | | | |

many more

# Overview of EMCM - Nomenclature



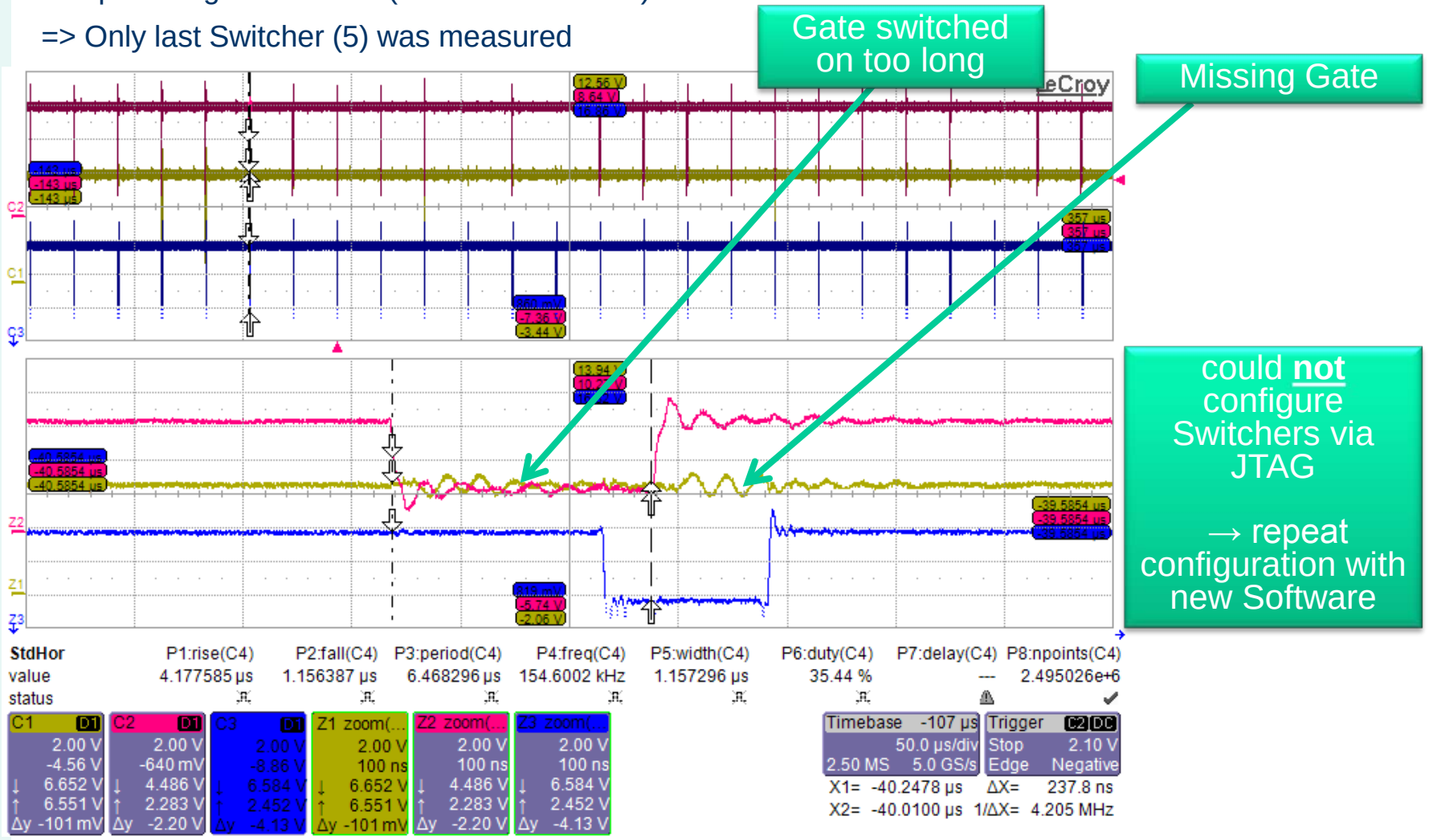
# Measurement Setup @ Semiconductor Laboratory



# EMCM P4-1 -- Switcher

Switcher: Output signals; falling edge of the gate signal is much too slow after problems with the powering of the SWB (bond wires melted)

=> Only last Switcher (5) was measured




timing problems

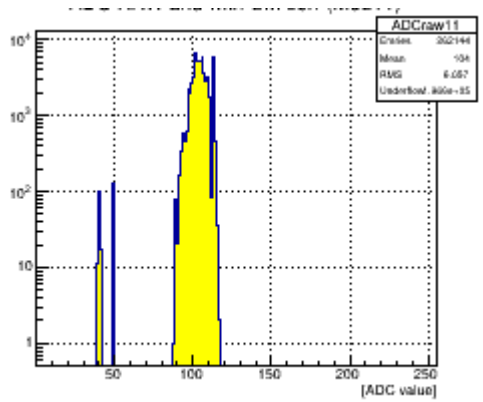
# EMCM P4-1 -- DCDs

DCD0 and DCD3 seem to work

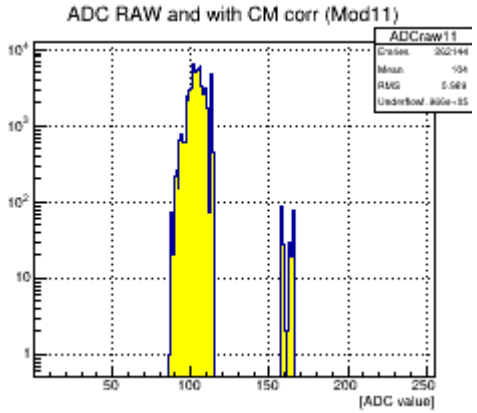
DCD1 does not react on changes VNSubIn (0-127), maybe trans-impedance amplifier is damaged

In addition, only if EnMonIn is off, one can see a test current 'peak'. One can see a double structure => is it an artifact of odd and even ADCs ? (has to be further investigated)

DCD2: Auroralink crashes when one tries to read a "full frame" from DHP2. Moreover, all Auroralinks (DHP0,1,2,3) break.

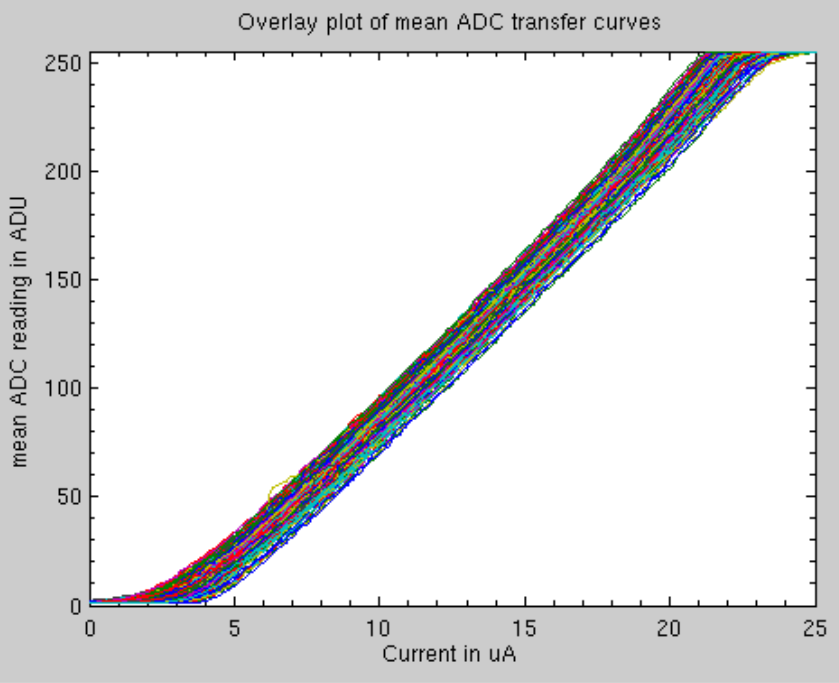


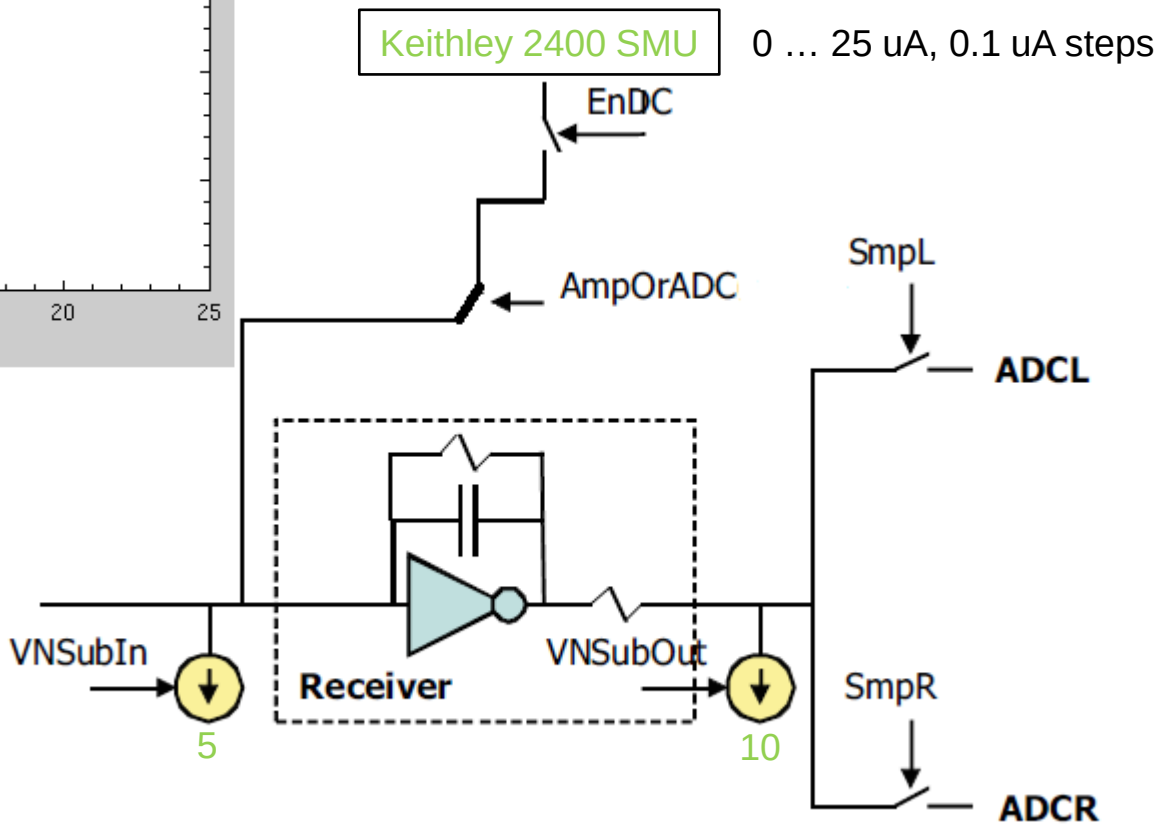

DCD0,
EnMonIn off,
VNSubIn 2, VNSubOut 10,
SMU: 4uA, 1.8V,
ADC-channel 128




DCD0,
EnMonIn on,
VNSubIn 2, VNSubOut 10,
SMU: 4uA, 1.8V,
ADC-channel 128

# EMCM P4-1 -- DCDs



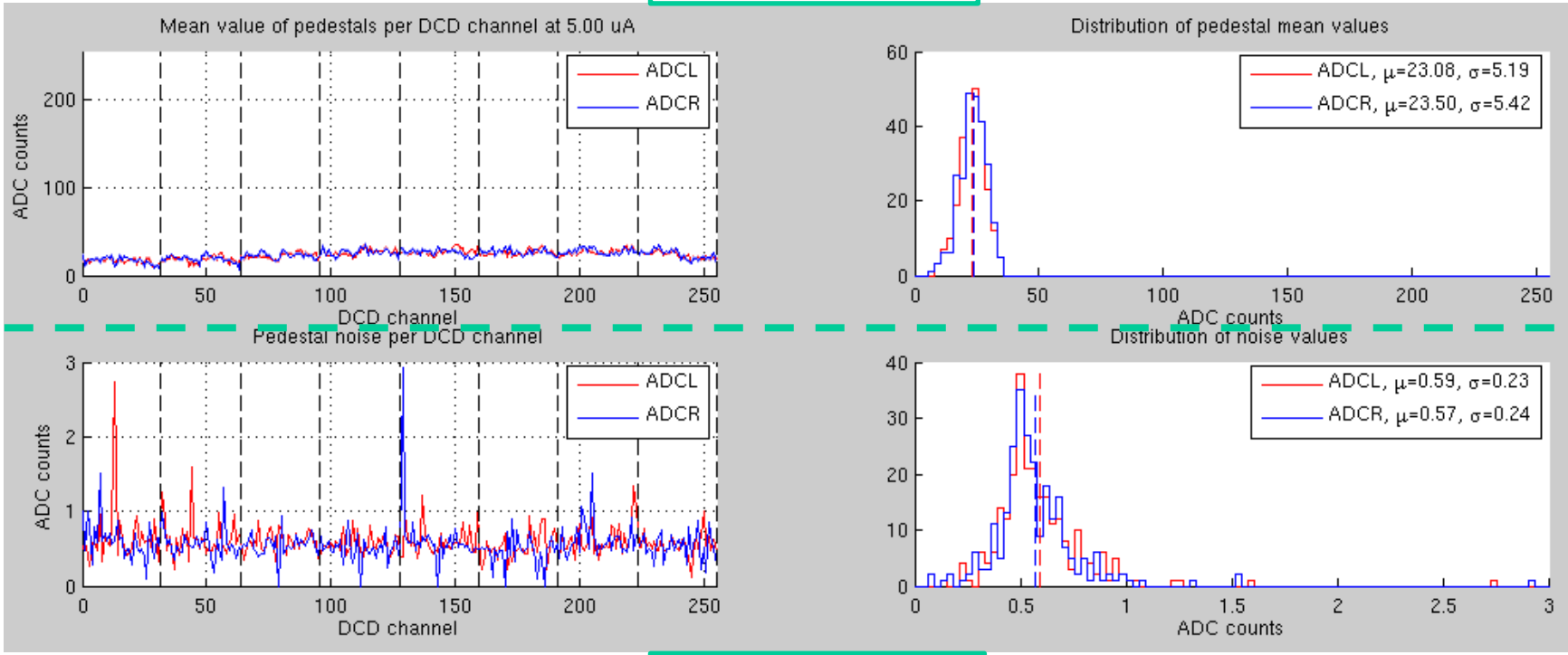

Setup is prepared for automatic characterization of ADC transfer curves: still needs couple of hours

scan was done with 250MHz

# DCD Characterization - Noise

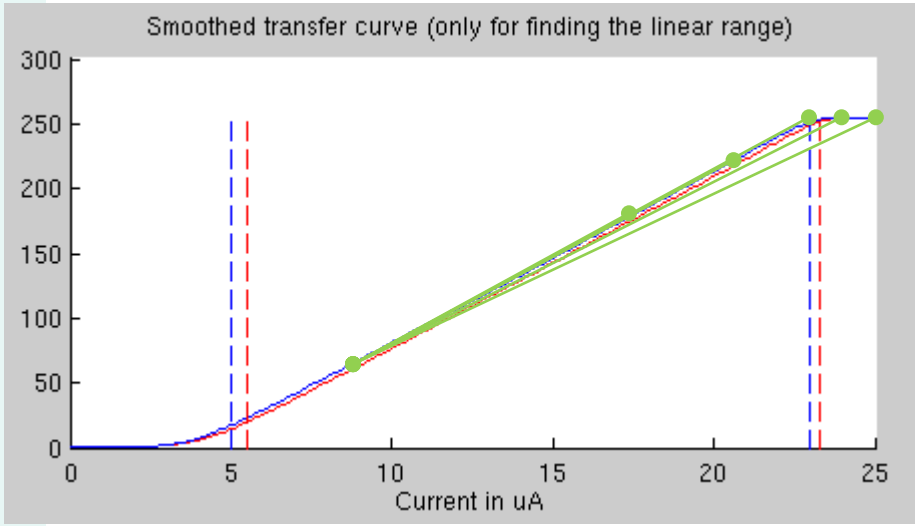
128 Measurements of each ADC

**Pedestals Mean**

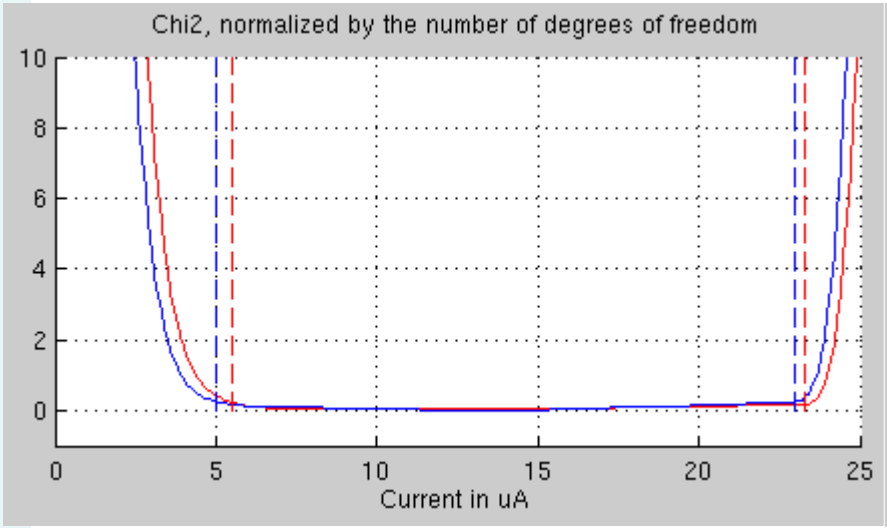


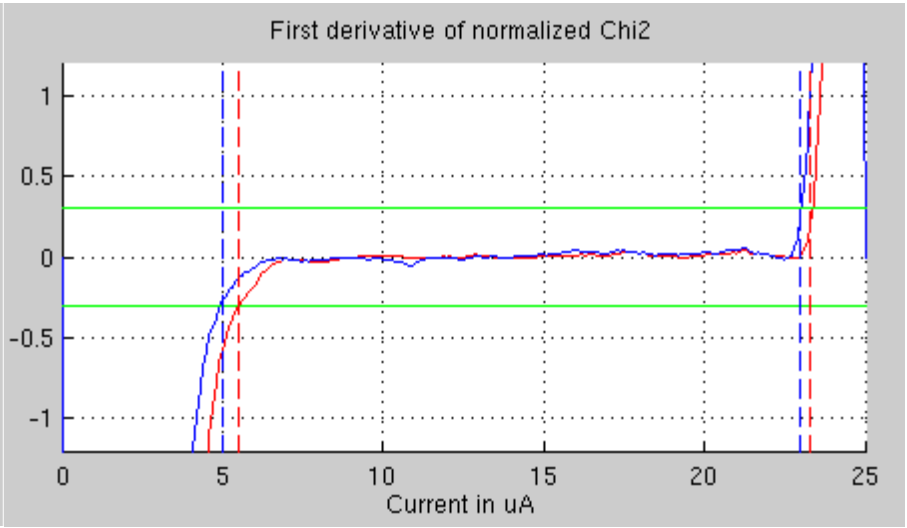

**Pedestals Noise**

# DCD ch. - Detailed analysis: Finding the linear region

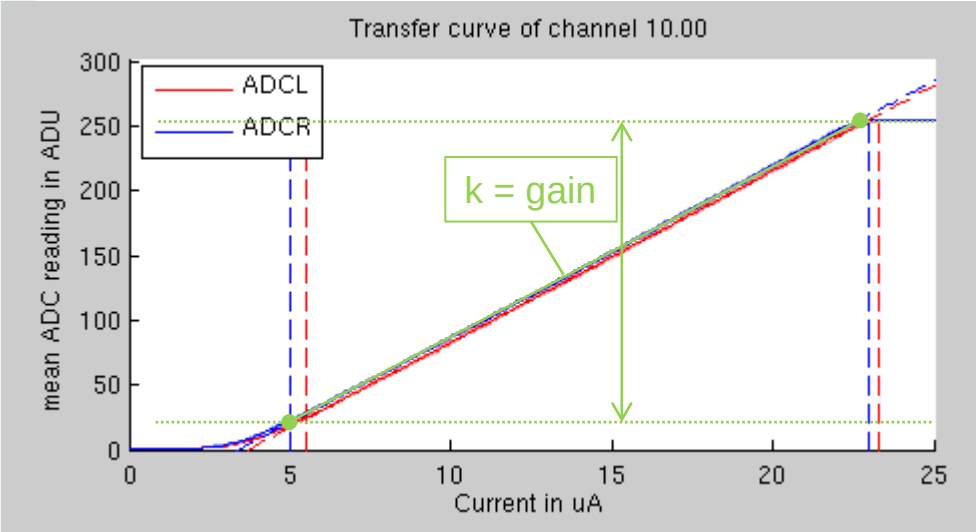


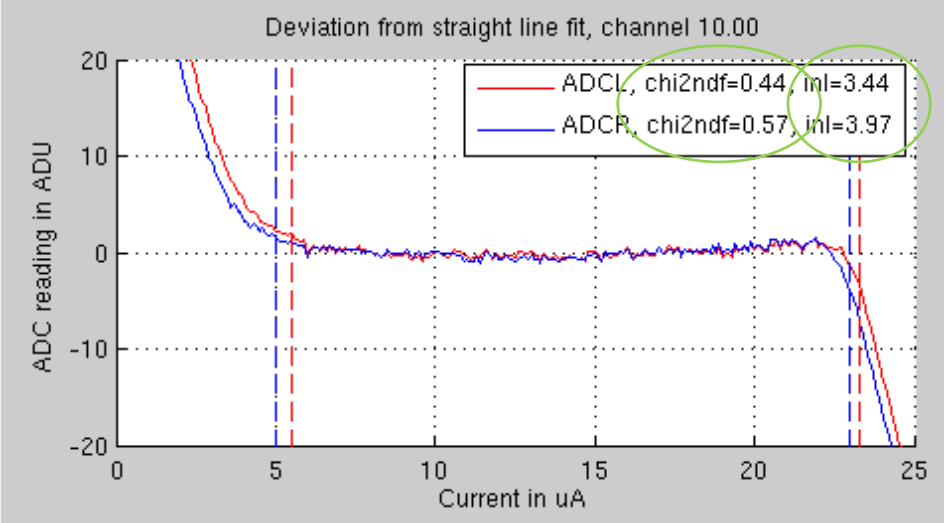

1) Smoothen the curve: each point is the average of 10 adjacent points
2) Linear fit to upper part of the curve, repeat as function of upper limit. Calculate sum of square deviation ($\chi^2$), divide by number of degrees of freedom (= #points – 2 fit param).
3) Same for lower part of the curve
4) Calculate gradient, arbitrarily define linear region as “gradient < 0.3”



# DCD ch. - Detailed analysis: Observables calc. for every channel



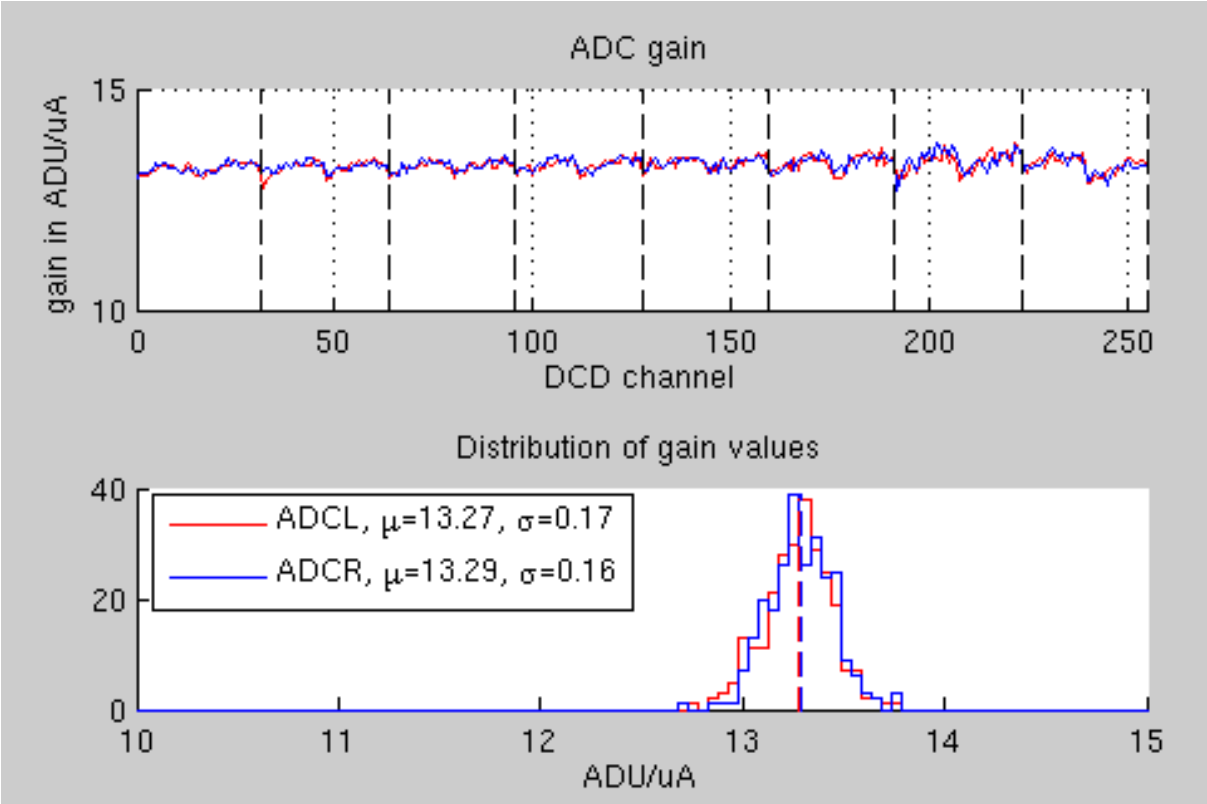

From transfer curve:

1) Gain: Fit to linear range, find inclination
2) Linear region in ADUs

From deviation from fit line:

3) Integral nonlinearity: maximum deviation from fit line (within the linear region)
4) Sum of square deviation from fitline, normalized by the number of degrees of freedom (within the linear region)

# DCD characterization - Results




periodic structure w.r.t. half columns

# EMCM P6-1 & P6-2

P6-1 (1x Switcher, 1x DCD, 1x DHP):

- Switcher: output signals don´t toggle after accident during probing (bond wires touching)
- DHP & DCD ok
- DCD has not been characterized

P6-2:

- Clear to Source short → not suited for PXD6 matrix
- SWB, DHP and DCD ok
- Item was located at Bonn ⇒ is currently sent to Munich
- Switcher outputs have to be measured again (⇒ Rework - slide 17)

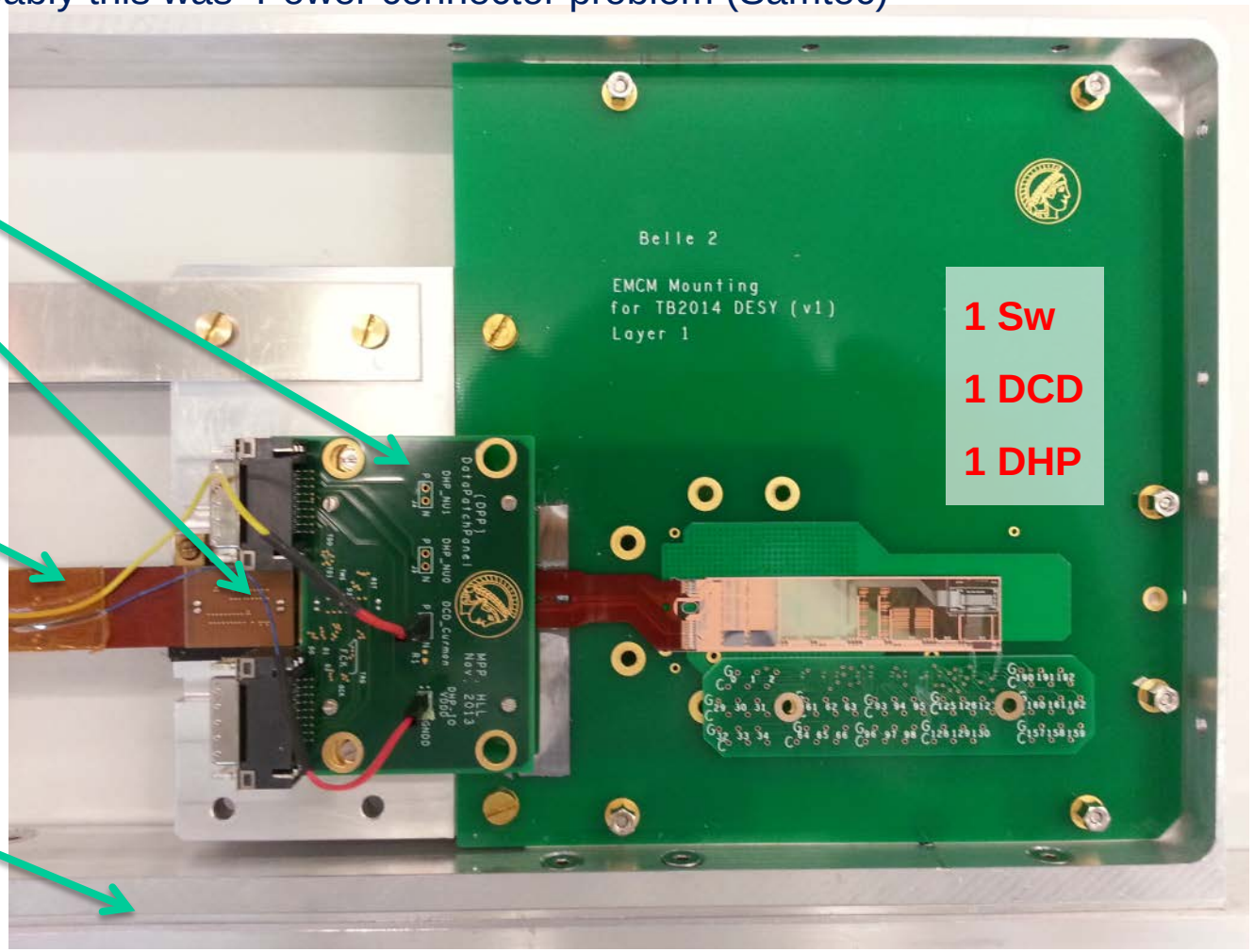
# EMCM W2-4

Backup solution for Beam Test in January

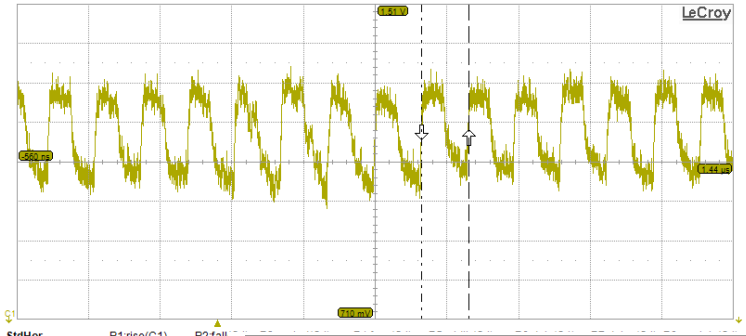
⇒ was brought untested to DESY (due to missing test devices in MUC)

⇒ showed strange voltages & currents (Clear, Gate)

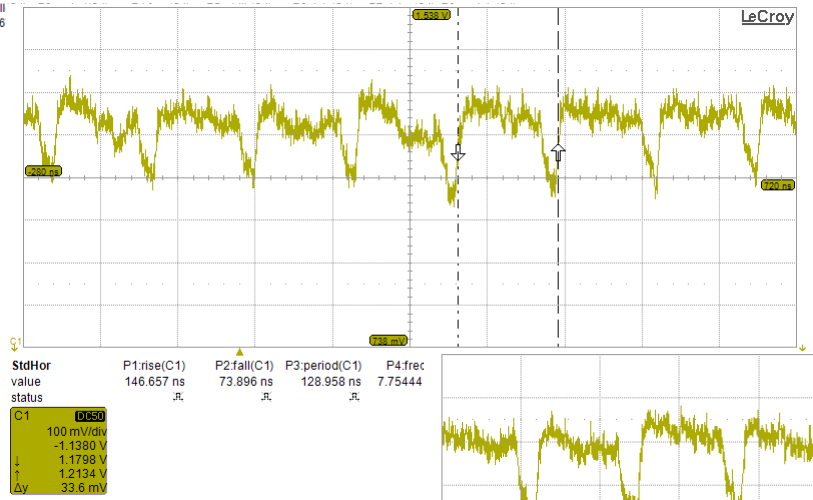
⇒ most probably this was  Power connector problem (Samtec)



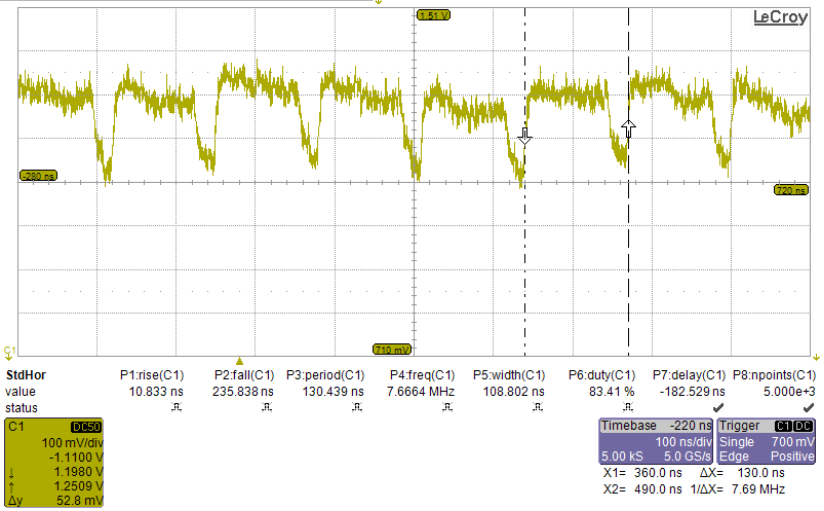
# EMCM W2-4 -- Switcher




Clock
~130 ns




Strobe Clear
~130 ns



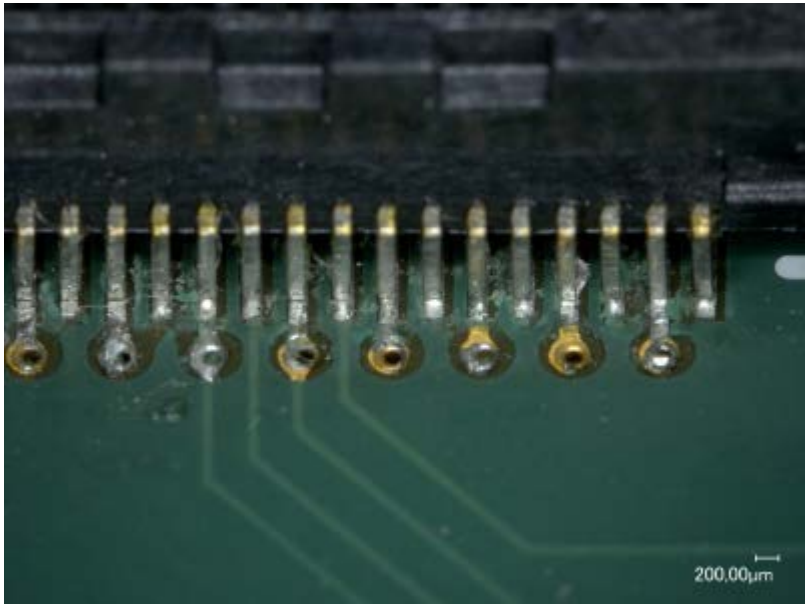

Strobe Gate
~130 ns

Probe signals after last switcher (5) at the termination resistors

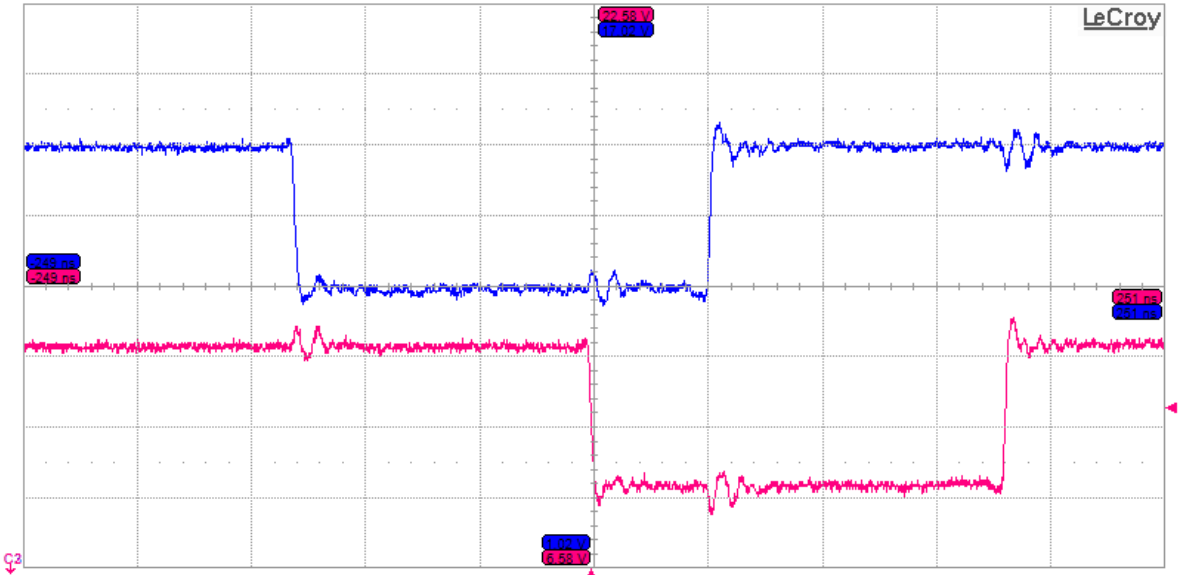
# EMCM W2-4 – Power Patch Panel

SWB: output signals don´t toggle, Clear channels are stuck to ClearOn potential

⇒ Repair of Samtec Power Connector



# EMCM W2-4 -- Switcher

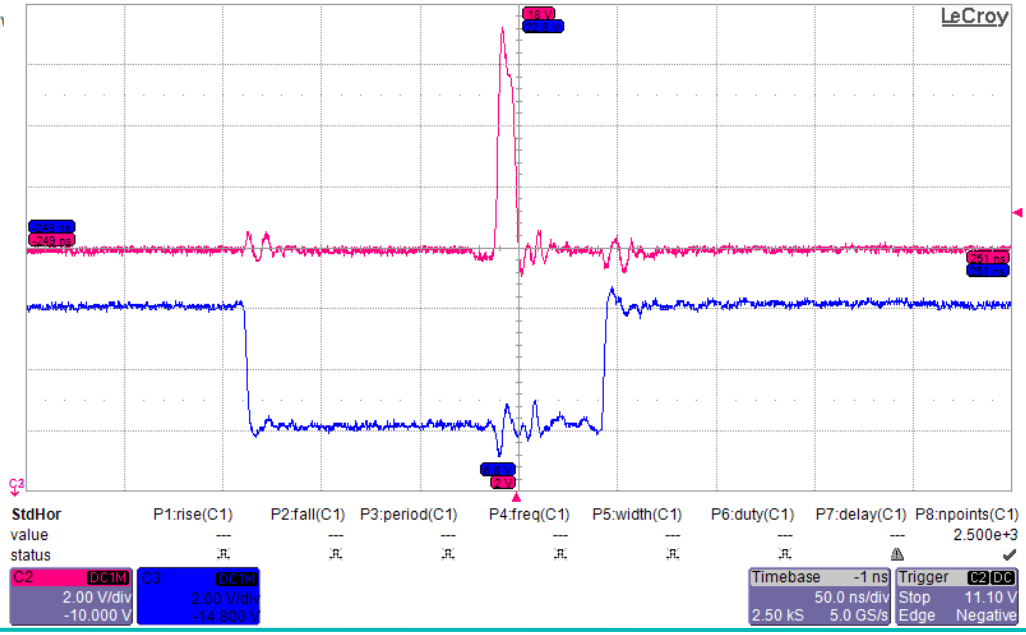



**row 190 - Gate**

**only 1 Switcher (5) assembled**

**row 190 - Clear**

**row 190 - Gate**



# EMCM W9-1

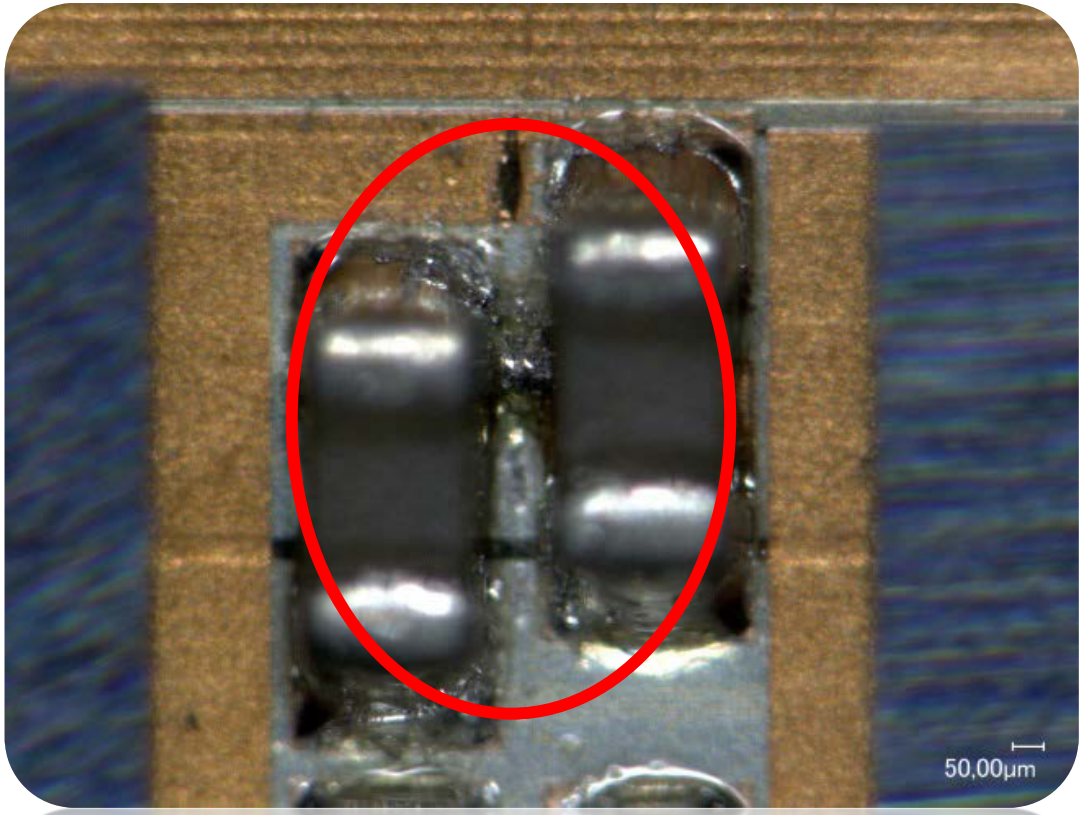
Shorts of Termination Resistors of LVDS Switcher Signals

=> does not work

# EMCM W9-2

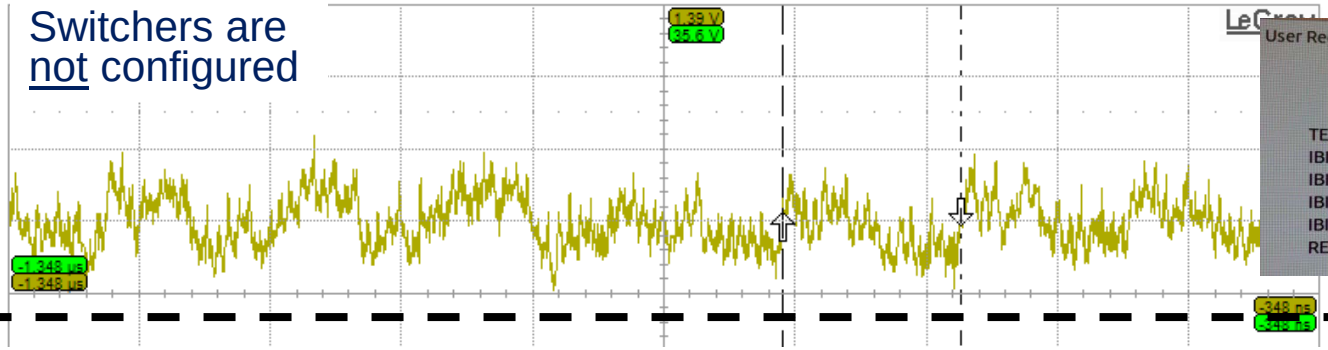
DCD: RefIn is shorted to GNDA

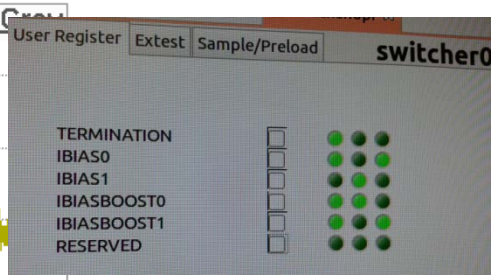
=> not suited for matrix since DCD cannot work properly



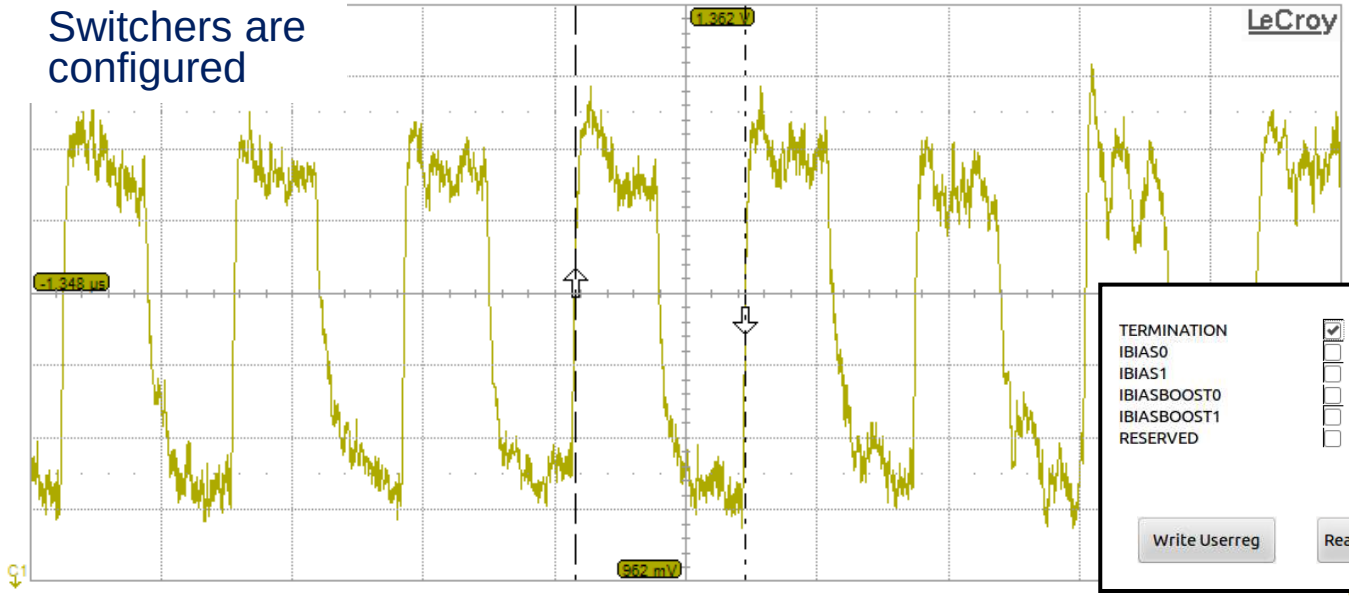
# EMCM W9-2 – Switcher Clock

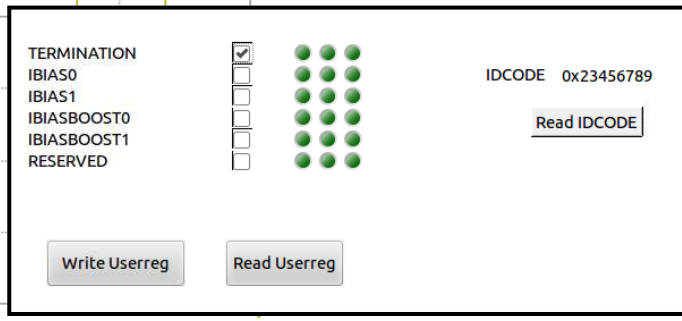
Switchers are not configured




Switchers are configured




| StdVer | P1:pkpk(C1) | P2:ampl(C1) | P3:max(C1) | P4:min(C1) | P5:sdev(C1) | P6:mean(C1) | P7:base(C1) | P8:top(C1) |
|---|---|---|---|---|---|---|---|---|
| value | 322 mV | 211.2 mV | 1.320 V | 999 mV | 100.9 mV | 1.1521 V | 1.0362 V | 1.2474 V |
| status | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |

C1 DC50
50.0 mV/div
-1.1620 V
↓ 1.1341 V
↑ 1.1784 V
Δy 44.2 mV

Timebase 848 ns
100 ns/div
5.00 kS 5.0 GS/s

Trigger C1 AC
Stop 205.0 mV
Edge Negative

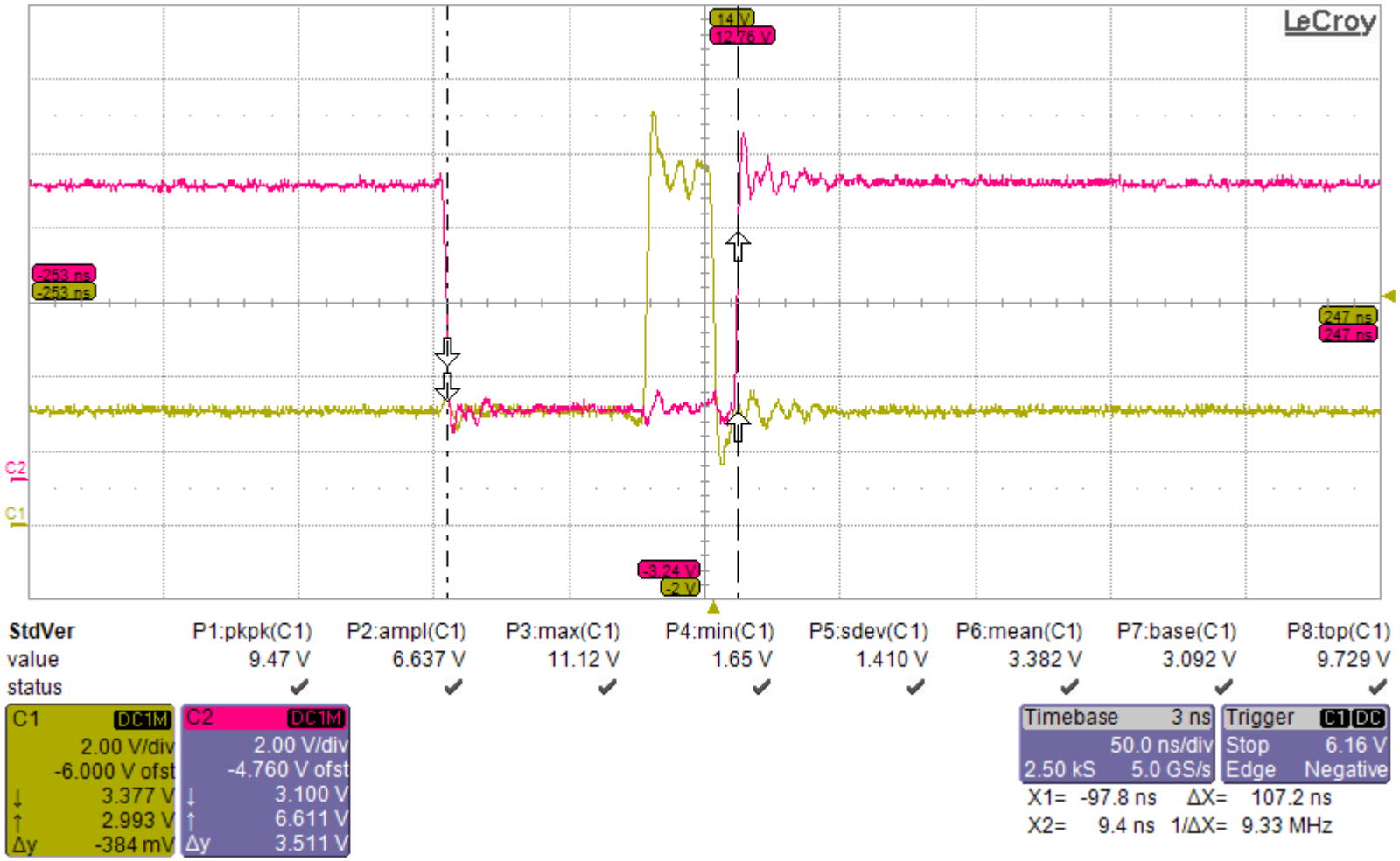
X1= -803.0 ns ΔX= -129.4 ns
X2= -932.4 ns 1/ΔX= -7.73 MHz

# EMCM W9-2 - Switchers

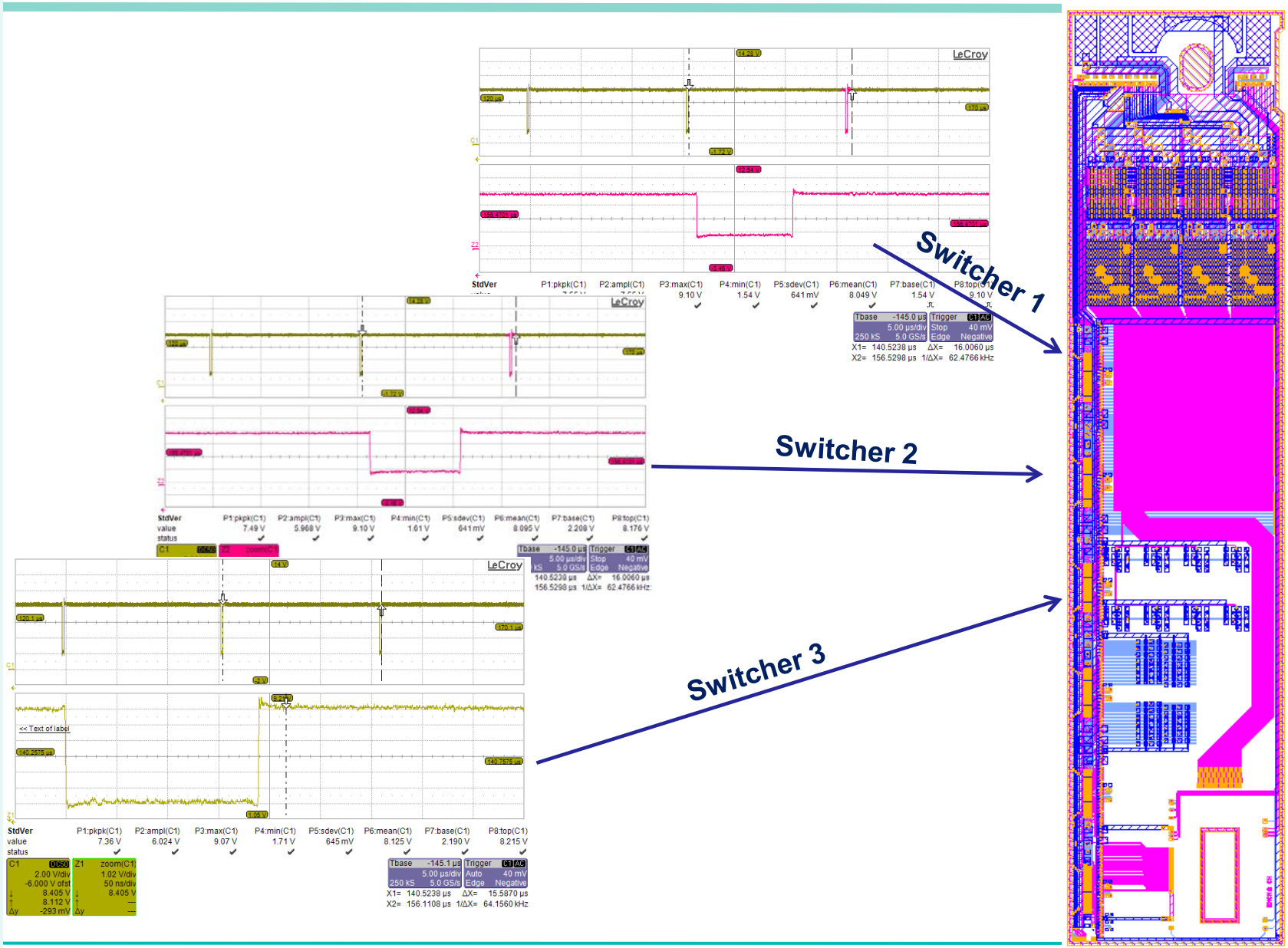
Switcher 6: Output of 3 consecutive Gates (190, 191, 192) **305MHz**

# EMCM W9-2 - Switchers

Switcher 6: Output of Gates & Clear, Channel 191 **305MHz**



# EMCM W9-2 – Switchers 1-3



# Software (JTAG)

DCD Settings and Switcher (Termination Resistors) are configured via JTAG

→ is **required !**

Software for 4 DCDs/DHPs and 6 Switchers is different compared to

Software for 1 DCD/DHP and 1 Switcher

(Bitarray, Bitstream, Dummy Bits)

not fully understood (Assembly problem?, DCD problem?)

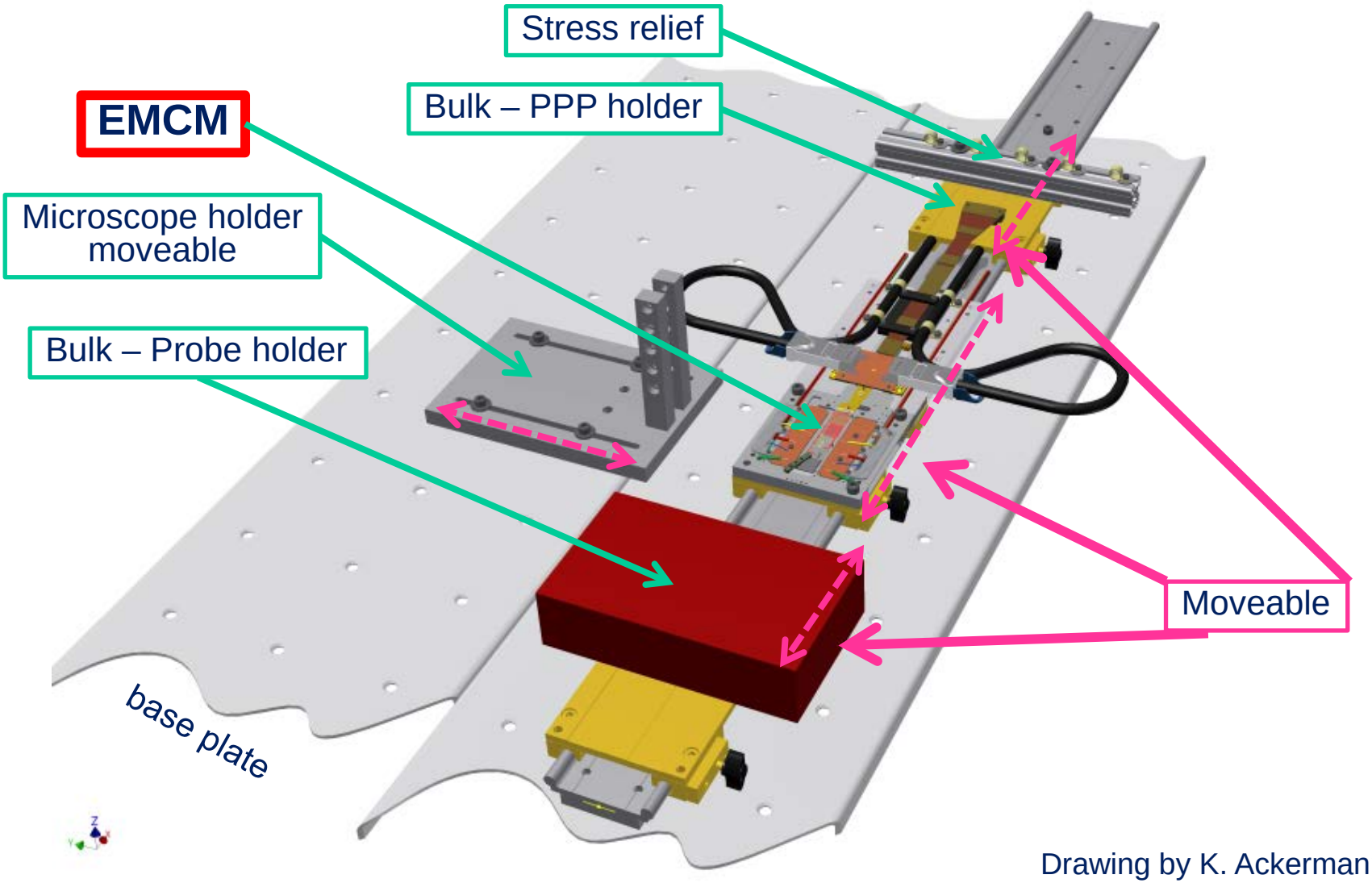
→ *in discussion with Ivan, Igor, Dima, Florian …*

# Drawbacks

- Connectors (Power Samtec and Infiniband) – bulky cables
  - ⇒ finding the cold / bad solder connection is a mess!
  - ⇒ Ordered additional Power Patch Panel
  - ⇒ 5 ‘new’ Data Patch Panel are assembled
- Software / Bitstream
- Switcher-B18v1.0 → cannot apply nominal voltages → use ClearHigh only 13V
  - ⇒ hard / impossible to operate small PXD6 test matrix

| ID | Project | DHP 0.2 | DCD Bv2 | Sw B18v1 | Location | Comment / Status |
|---|---|---|---|---|---|---|
| P4-1 | ZMI5 | 4 | 4 | 6 | MUC | Fully populated |
| P6-1 | EMCM_1 | 1 | 1 | 1 | MUC | |
| P6-2 | EMCM_2 | 1 | 1 | 1 | BN→MUC | |
| W2-4 | | 1 | 1 | 1 | MUC | Matrix glued (DESY) |
| W9-1 | EMCM_2-2 | 1 | 1 | 6 | MUC | Short of term. resistors |
| W9-2 | EMCM_2-2 | 1 | 1 | 6 | MUC | Short of capacitors |

# Improved Setup – Inside the Dark Box




Drawing by K. Ackermann

# Conclusion and Outlook

Done:

6 Switchers are working properly (still some timing issues)

One Aurora link crashes (at fully populated EMCM)

Bitstream Shifts

To do:

PXD6 operation on EMCM

Faster DCD Characterization

Gated Mode

We need:

data base