Characterization of the Belle II final chipset and matrix on Hybrid 5

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Hybrid 5

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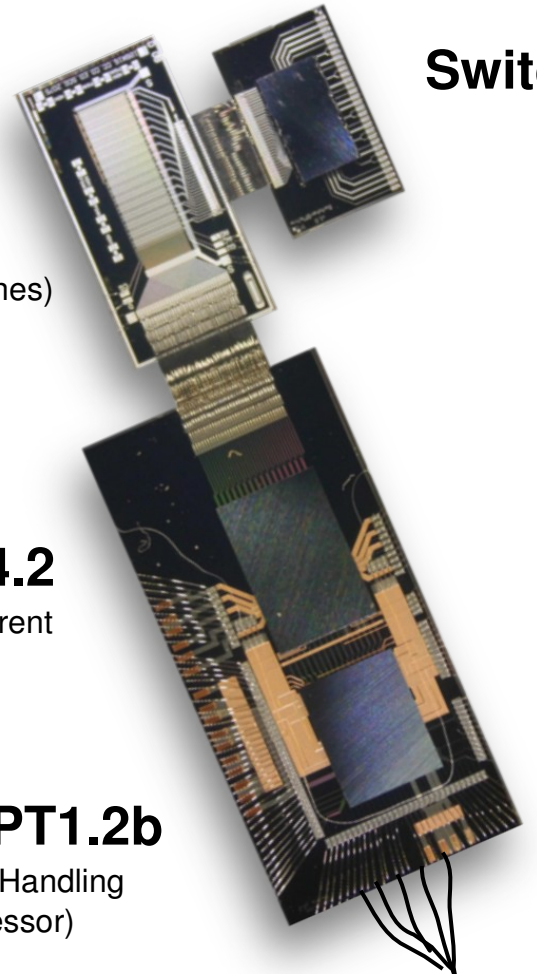


Switcher 2.1

Small matrix
(64 x 32 pixels /
16 gates, 128 drain lines)

DCD 4.2
(Drain Current
Digitizer)

DHPT1.2b
(Data Handling
Processor)

- Scans of DCD-DHP communication with final chipset & frequency (76.23 MHz):
  - High Speed (HS) link
  - Delays
  - ADC curves
- Short look into matrix functionality
- Time estimates for scan duration

Backend

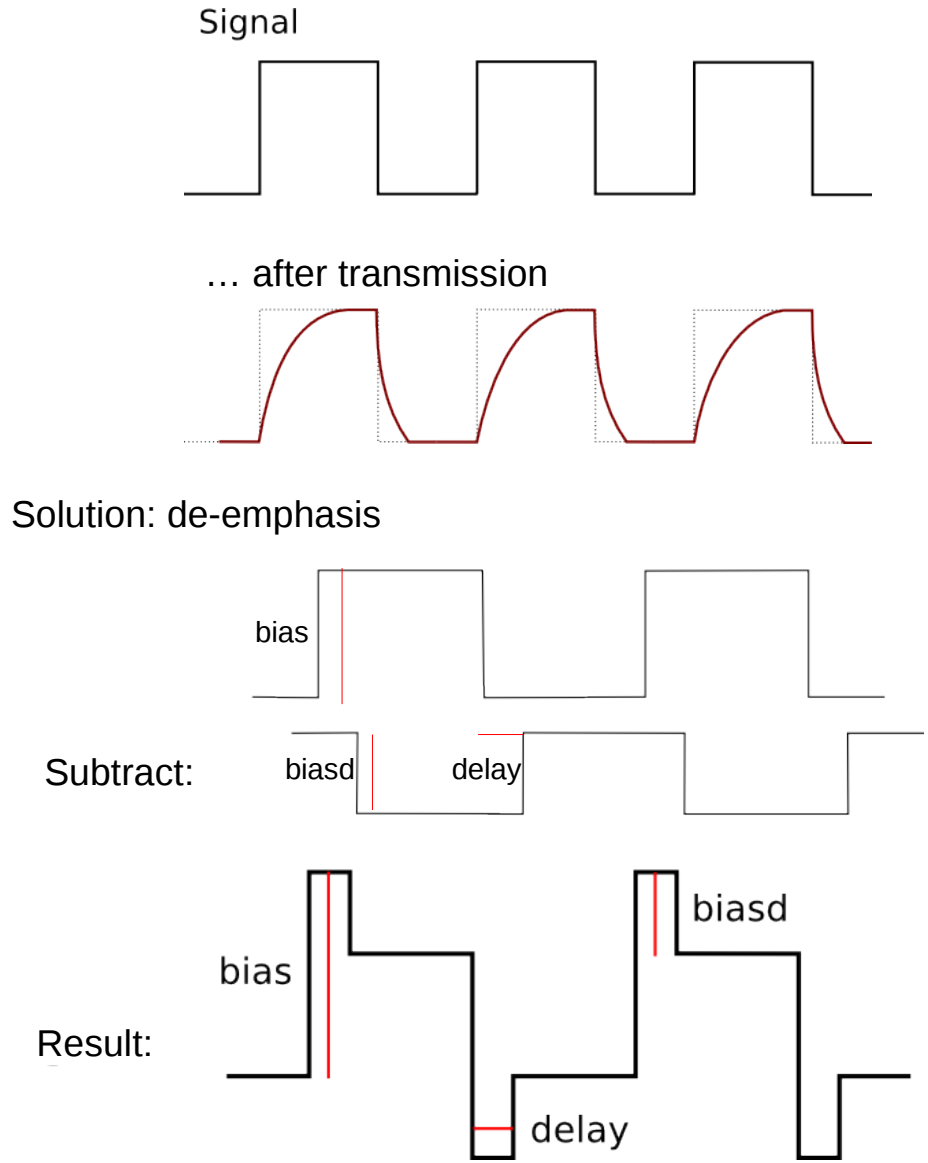
HS link scan

- To find optimal settings to transport the signal to the backend electronics
- Three parameters:

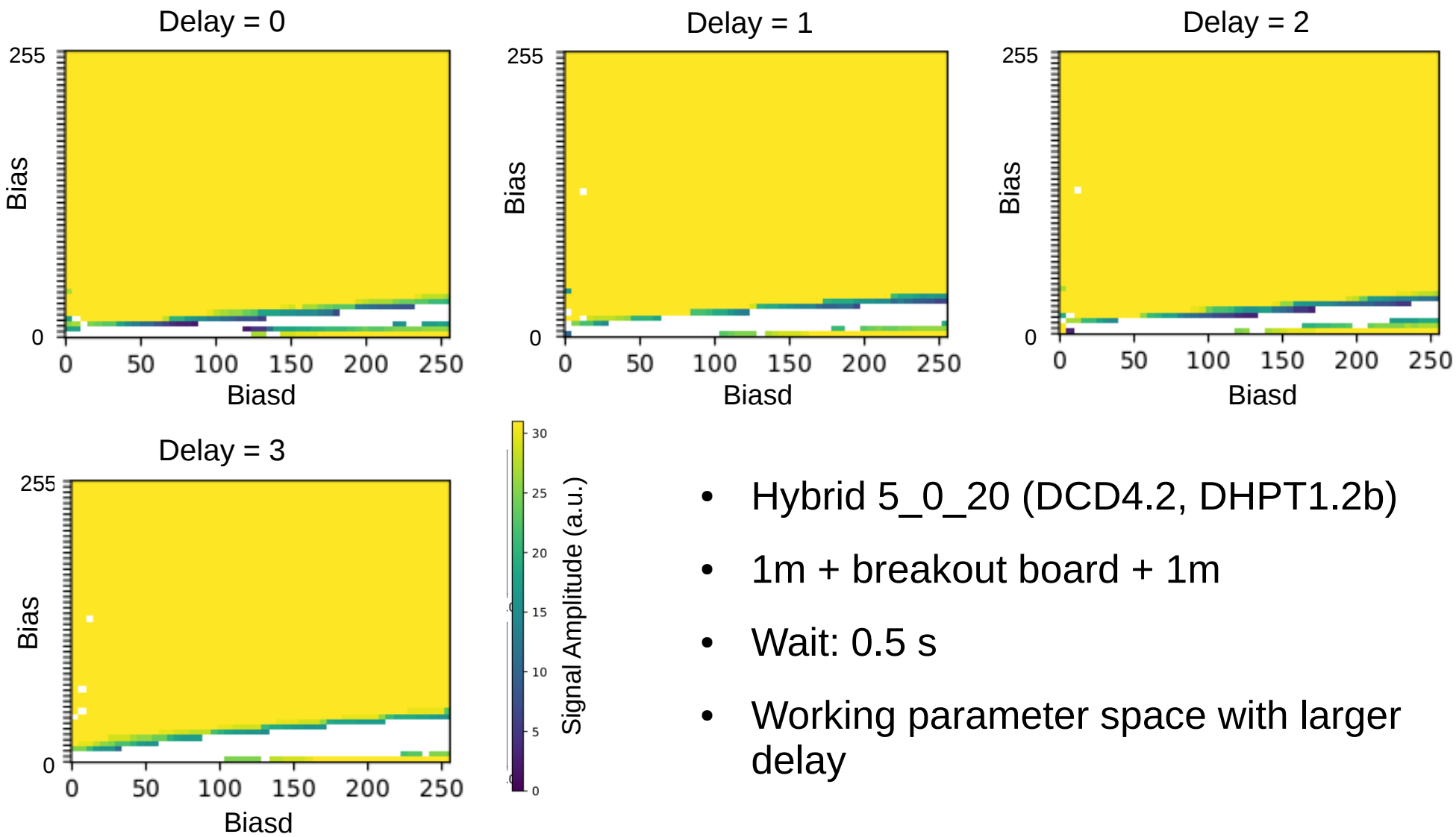
  delay: shift of inverted signal

  bias: amplitude of original signal

  biasd: amplitude of subtracted signal

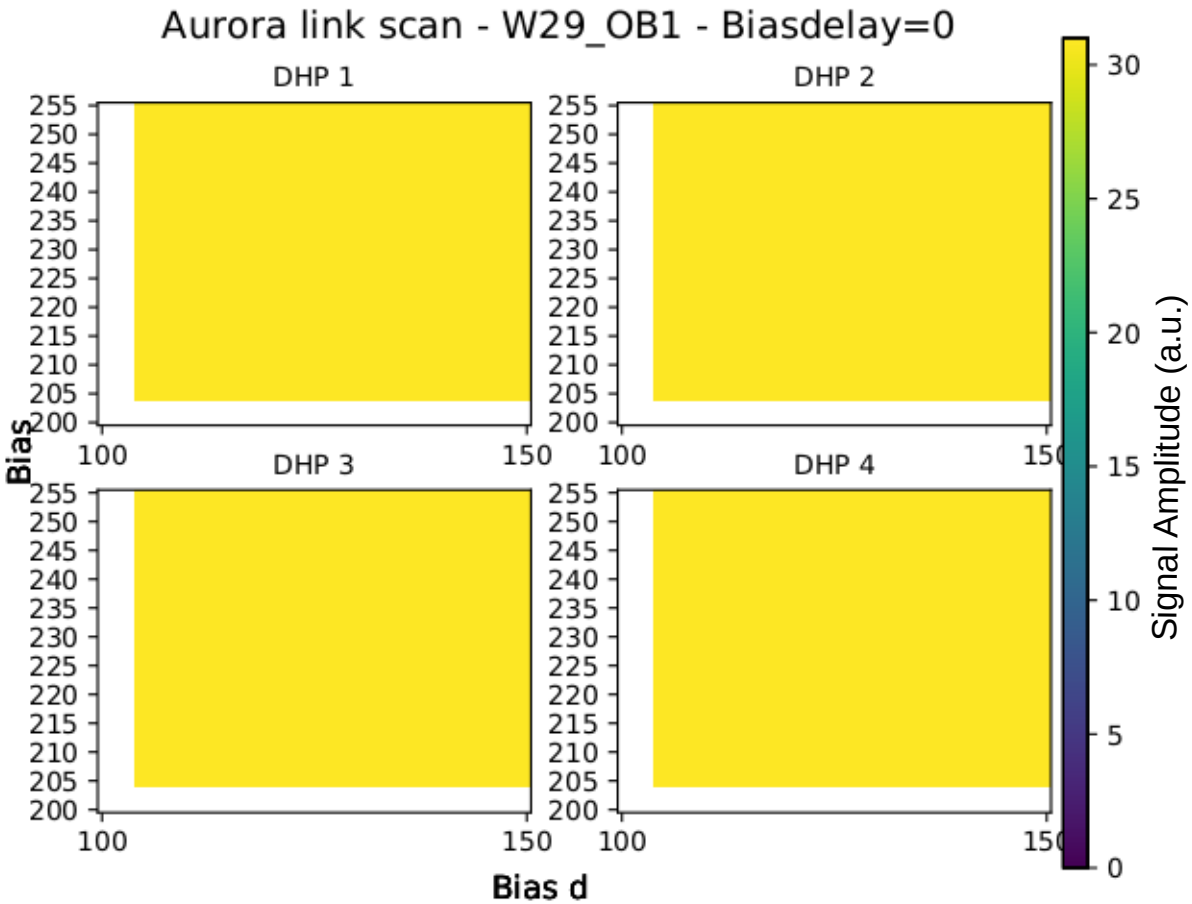


HS link scan - Results



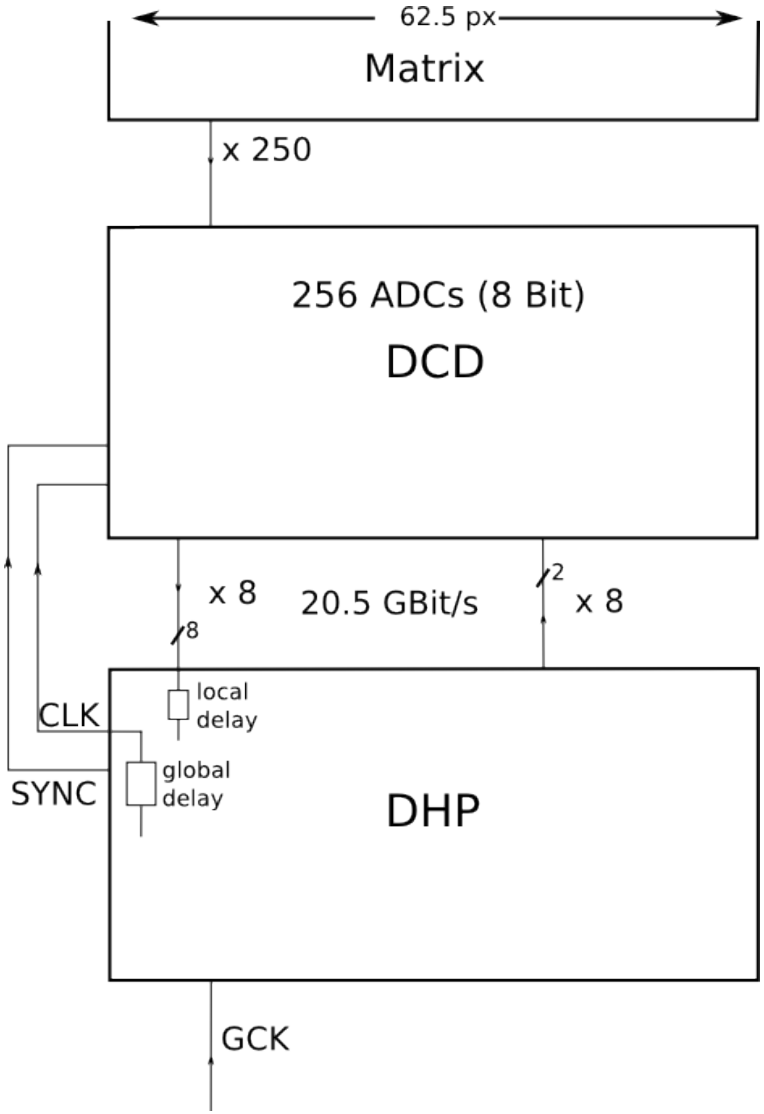
- Hybrid 5_0_20 (DCD4.2, DHPT1.2b)
- 1m + breakout board + 1m
- Wait: 0.5 s
- Working parameter space with larger delay

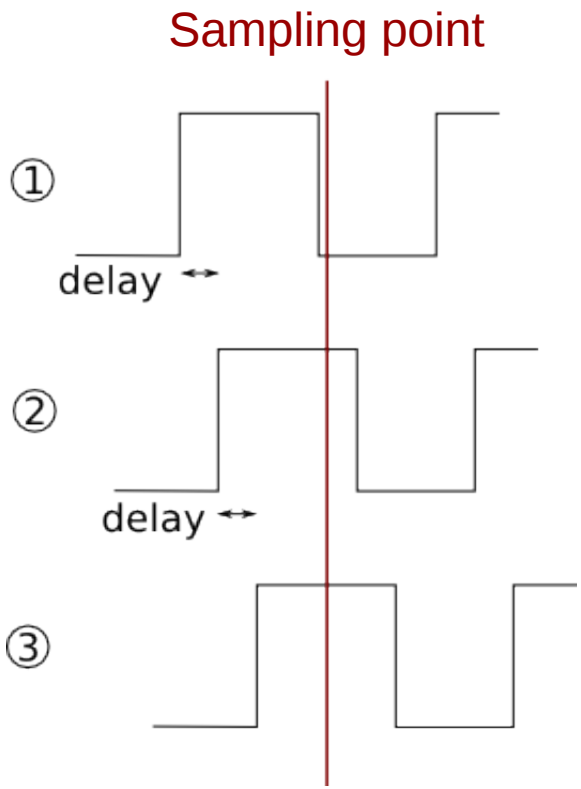
HS link scan – stability checks



- Scan over smaller range
- 3 m infiniband cable
- Wait: 5 min
- Wide possible range of possible settings

DCD-DHP communication

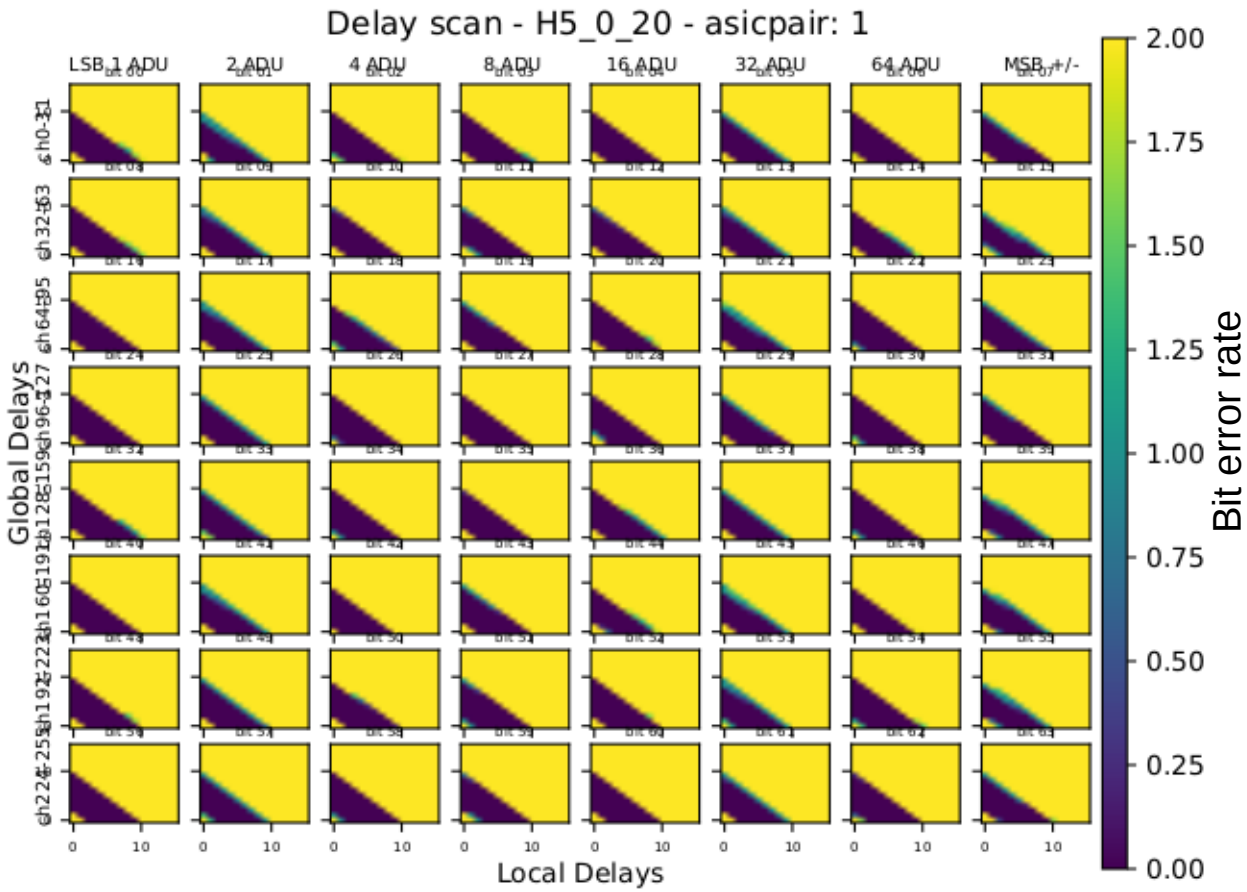




- Goal: Ensure error-free signal sampling by DHP

Delay scan

- Send known testpattern
- Scan for every global delay (0-15) through local delays (0-15)
- Compare measured data with testpattern, calculate differences (bit errors)
- Wide violet band without any bit errors
- Typical parameters:
  global delay: 0
  local delay: 4-6



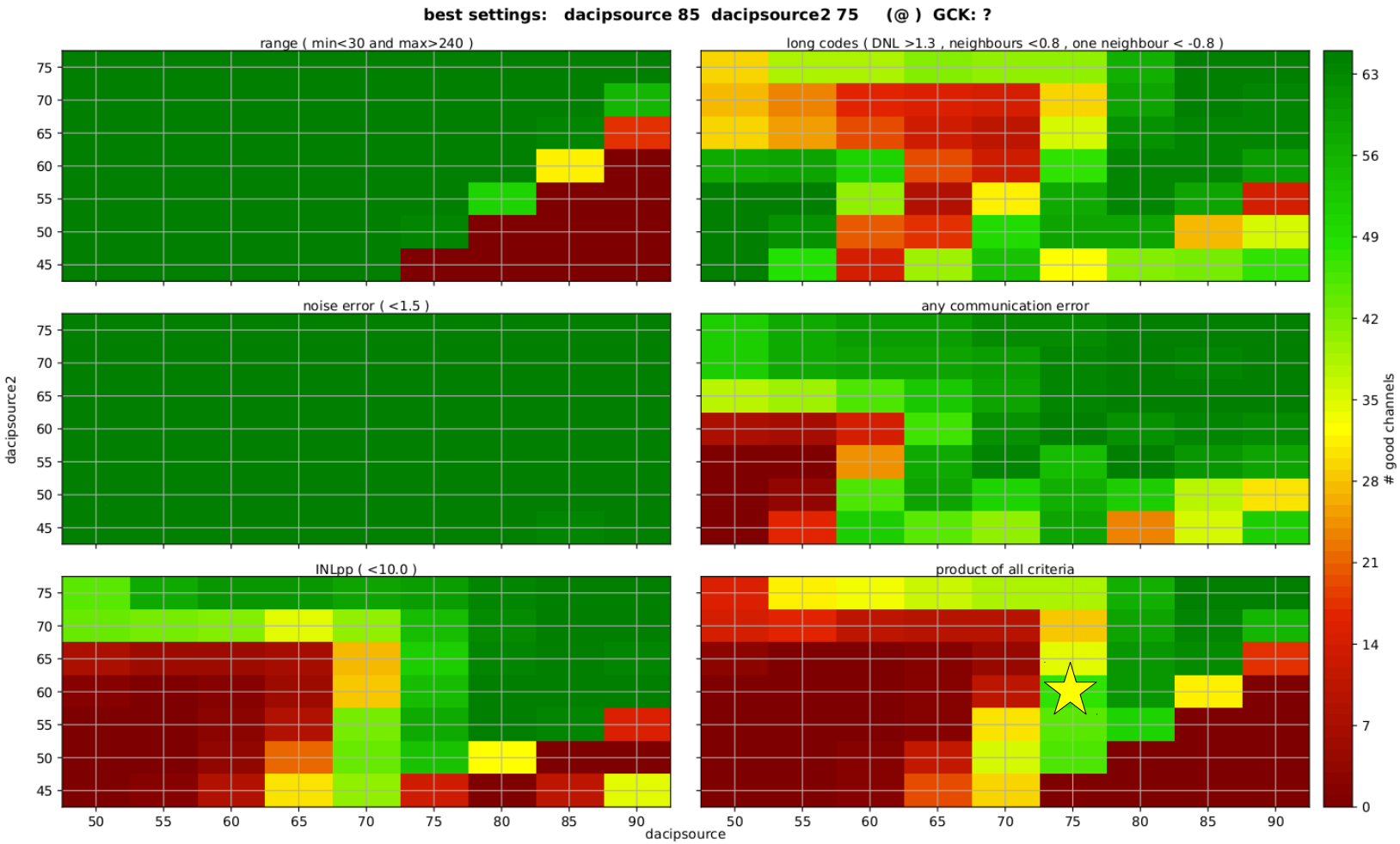
Hybrid 5_0_20 (DCD4.2, DHPT1.2b)

ADC curves

- Find working parameters for current sources within the DCD
- DHE generates constant current in small steps, read out ADC value
- Earlier identified working parameters for Hybrid 5 (by Göttingen without matrix):

IPSource: 75	IPSource2: 60
AmpLow: 250	RefIn: 750
IFBPBias: 75	

ADC curves – Results (IPSource/IPSource2)



- **only unconnected channels**

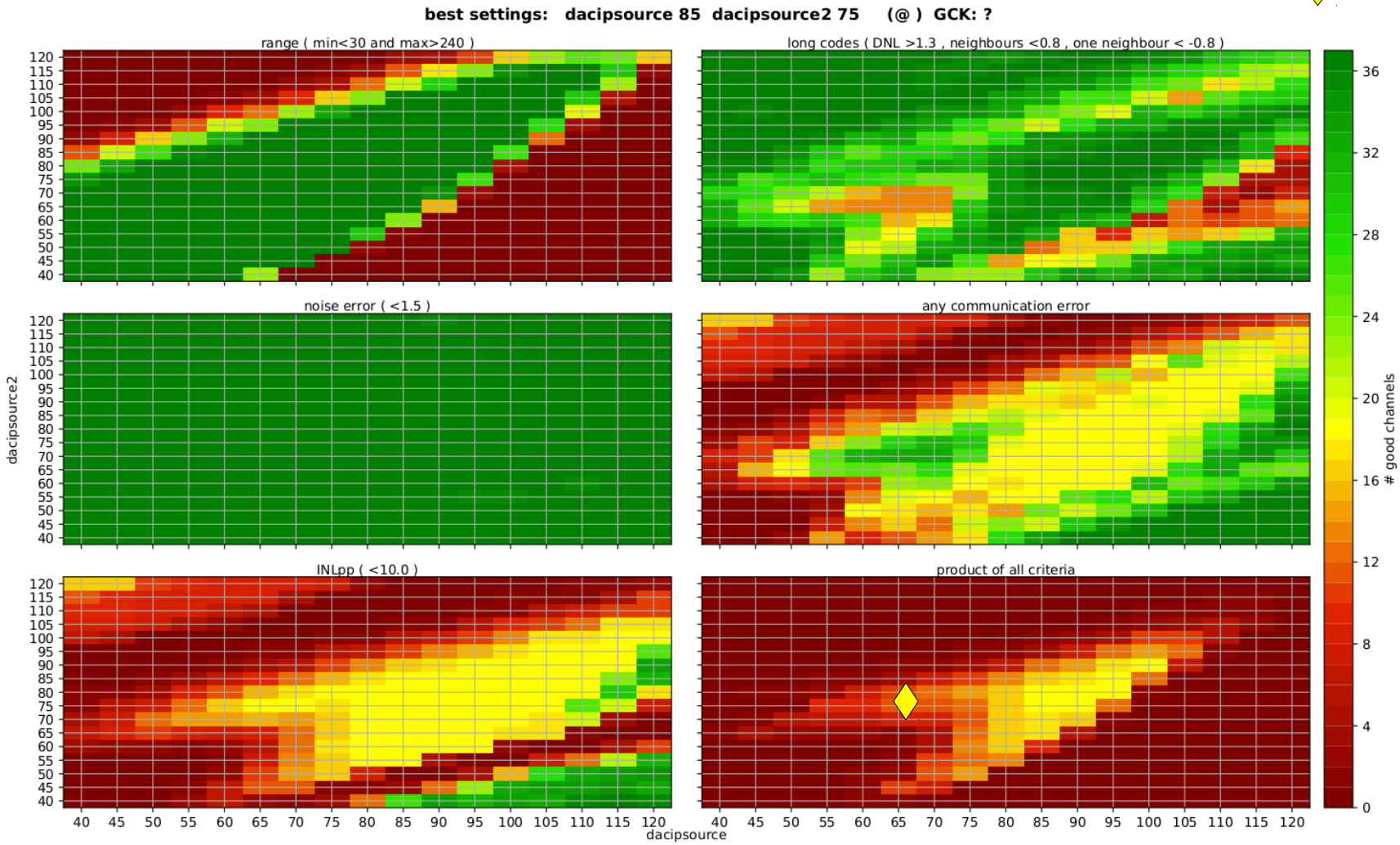
★ IPSource and IPSource2 as Göttingen

Hybrid 5_0_21 (DCD4.2, DHPT1.2b, matrix & switcher)

ADC curves – Wider parameter space

Every 7th channel of the DCD – **connected & unconnected**

Göttingen

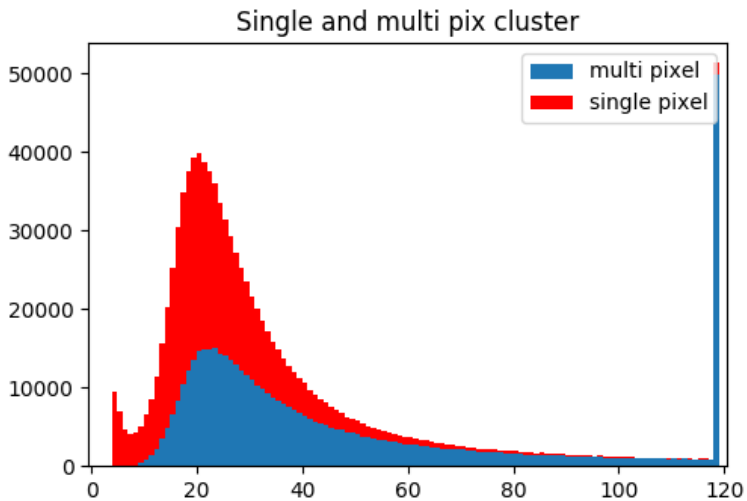


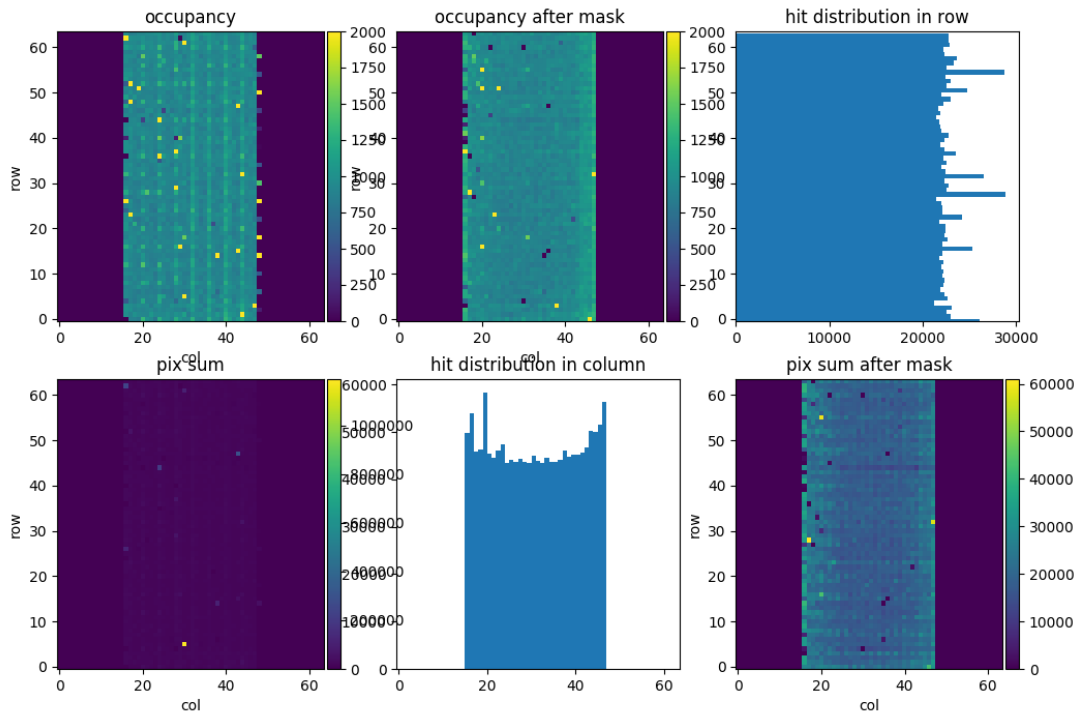
Hybrid 5_0_21 (DCD4.2, DHPT1.2b, matrix & switcher)

Source scan with matrix

- Switched on matrix and put ^{90}Sr on top
- No optimization of parameters

⇨ low noise, high signal-to-noise-ratio, Landau, homogeneous response

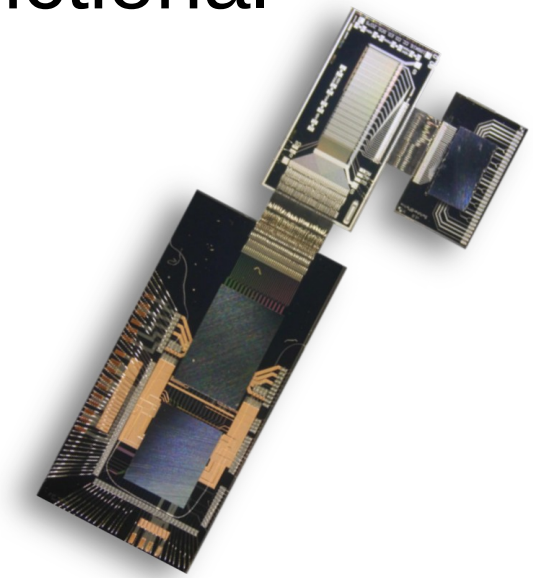




Hybrid 5_0_21 (DCD4.2, DHPT1.2b,
matrix: W31 ~~C02~~)
F00

Summary

- Scans are almost compliant to coding guidelines now (small things still to be changed)
- Identified working subset for Hybrid 5 with final chipset
- (Small pixel) matrix on Hybrid 5 functional
- More investigation to be done (e.g. DCD settings with matrix connected)



Duration of scans

- HS link scan
  - Measurement: ~18 min
  - Analysis: ~ 30 sec
  - Whole module: ~ 20 min (four asicpairs can be done in parallel)
- Delay scan
  - Measurement: ~ 6 min
  - Analysis: ~ 30 sec
  - Whole module: ~ 10 min (four asicpairs can be done in parallel)
- ADC curves (ipsource - ipsource2)
  - Measurement: ~ 11 h
  - Analysis: ~ 1:30 h
  - Whole module: 4 x 12:30 (but possibility of using DEPFET current and larger step size for thorough scan)

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Thank you

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Settings for ADC curves

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values matrix

- bulk = 10000 mV
- clear off = 20000 mV
- clear on = 20000 mV
- gate off = 5000 mV
- gate on = 3000 mV
- source = 7000 mV
- ccg = -1000 mV
- hv = 0 mV
- drift = -5000 mV

values DCD

- IFBPBias = 75
- IPSource = 75
- IPSourceMiddle = 72
- IPSource2 = 60
- IPDel = 127
- ITCP = 30
- ITCPL = 30
- IPSourceCasc = 64
- IFBRef = 64
- INMOS = 120
- VNSubIn = 9
- VTCSFN = 60
- VNDel = 127
- RefNWell = 64
- IAmpPBias = 60
- VPMOS = 120
- gain = En90

- AmpLow = 250 mV
- RefIn = 750 mV

Settings for source scan

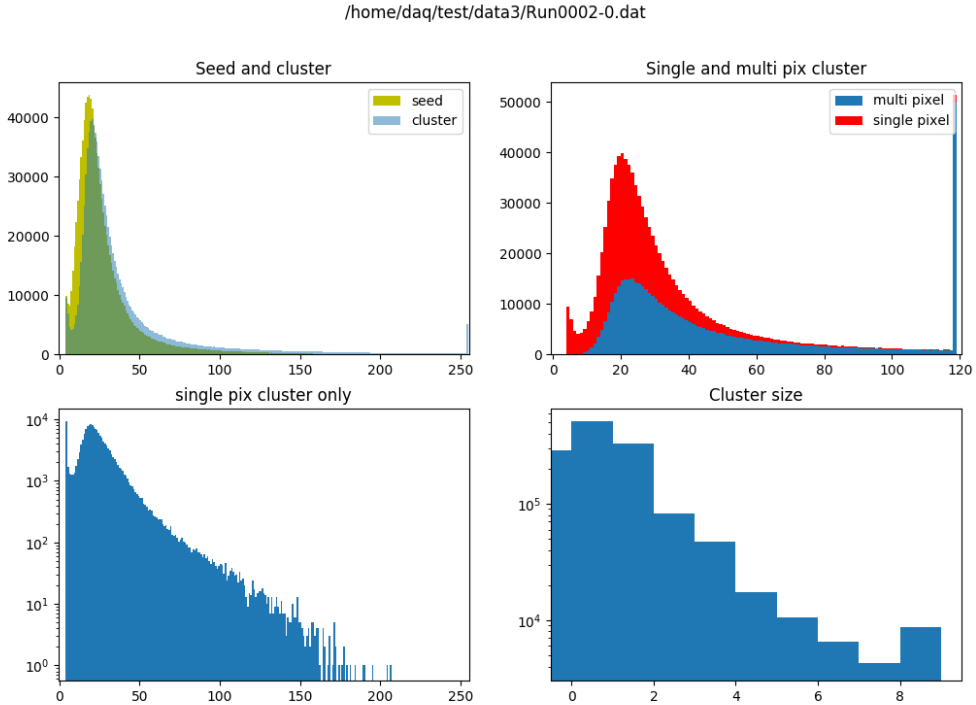
values matrix

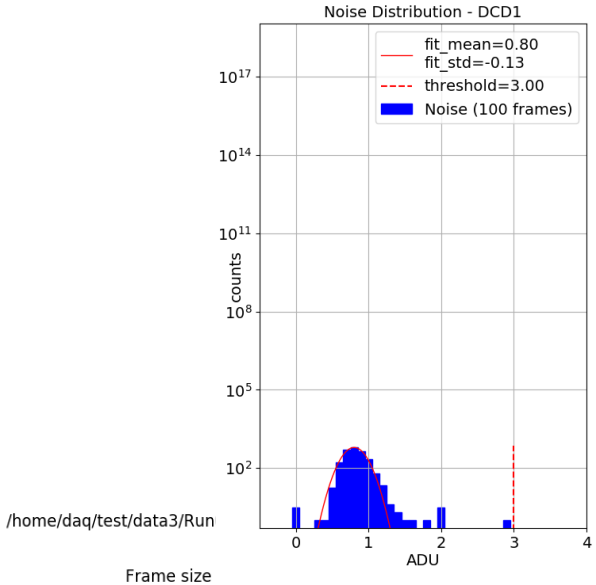
- bulk = 10000 mV
- clear off = 6000 mV
- clear on = 19000 mV
- gate off = 3000 mV
- gate on = -2500 mV
- source = 7000 mV
- ccg = -1000 mV
- hv = -7000 mV
- drift = -5000 mV

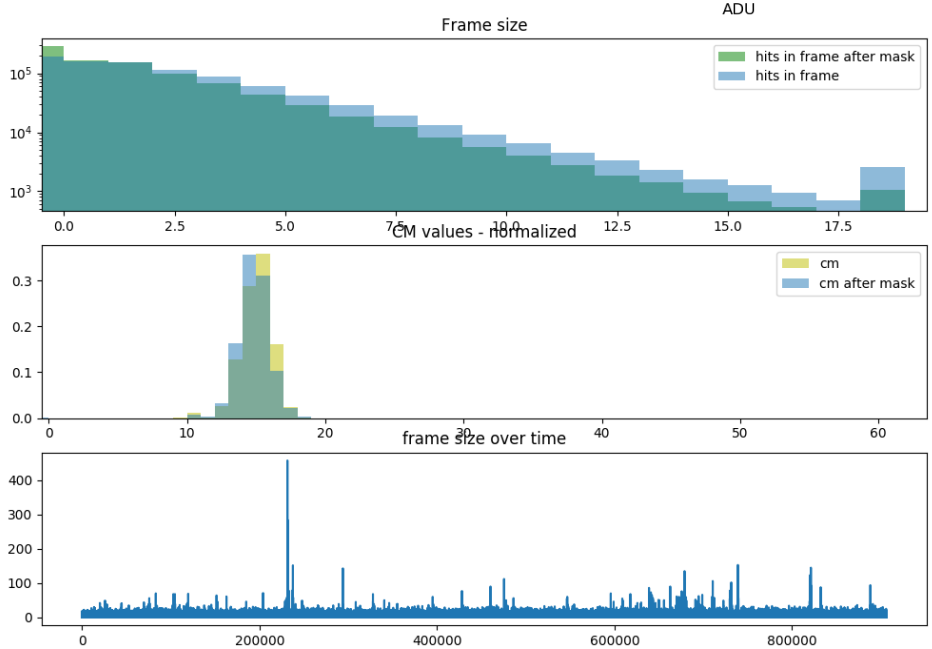
values DCD

- IPAddOut = 0
- IFBPBias = 75
- IPSource = 75
- IPSourceMiddle = 72
- IPSource2 = 60
- IPDel = 127
- ITCP = 30
- ITCPL = 30
- IPSourceCasc = 64
- IFBRef = 64
- INMOS = 120
- VNSubIn = 40
- VTCSFN = 60
- VNDel = 127
- RefNWell = 64
- IAmpPBias = 60
- VPMOS = 120
- gain = En90
- AmpLow = 250 mV
- RefIn = 750 mV

Source scan – more plots







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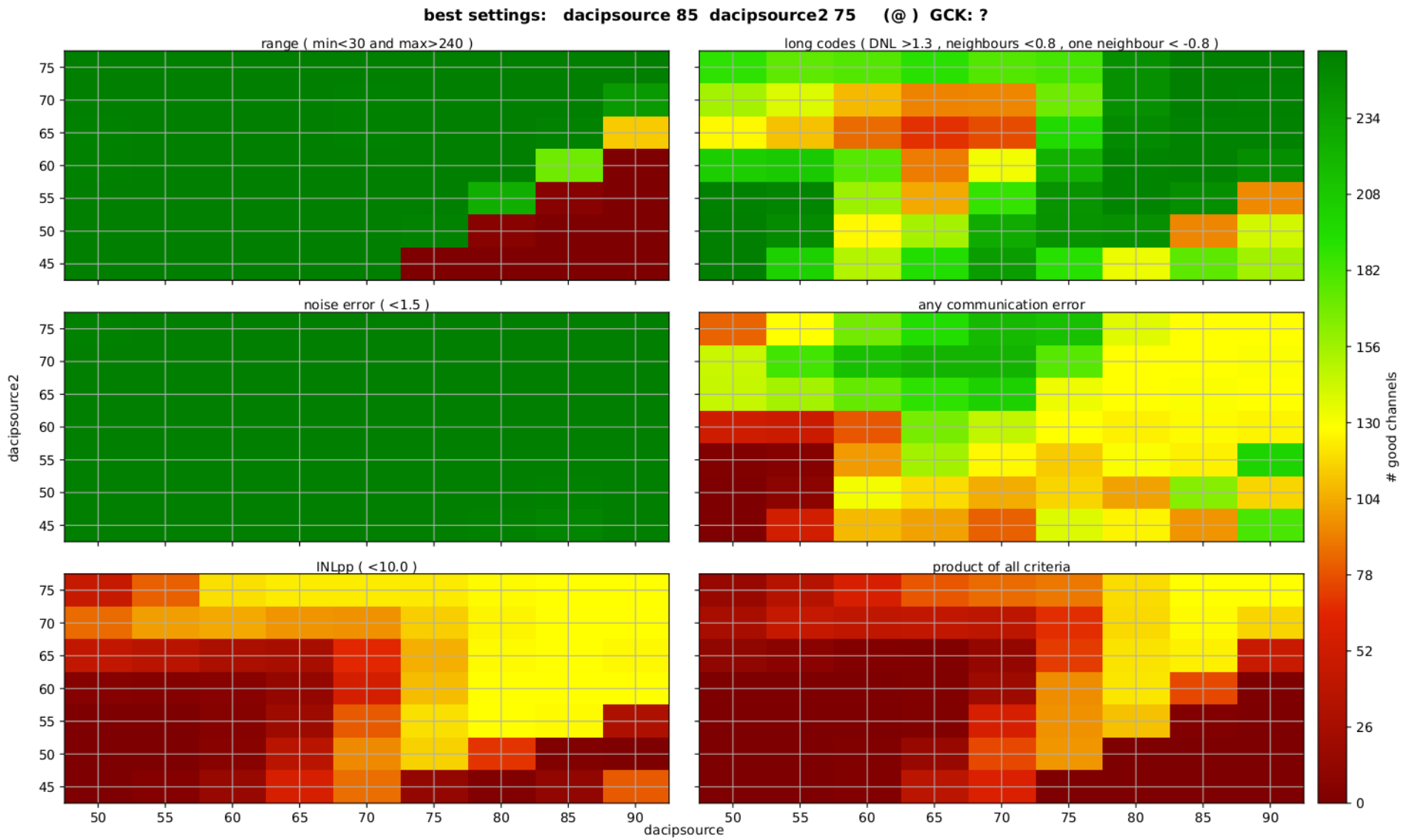
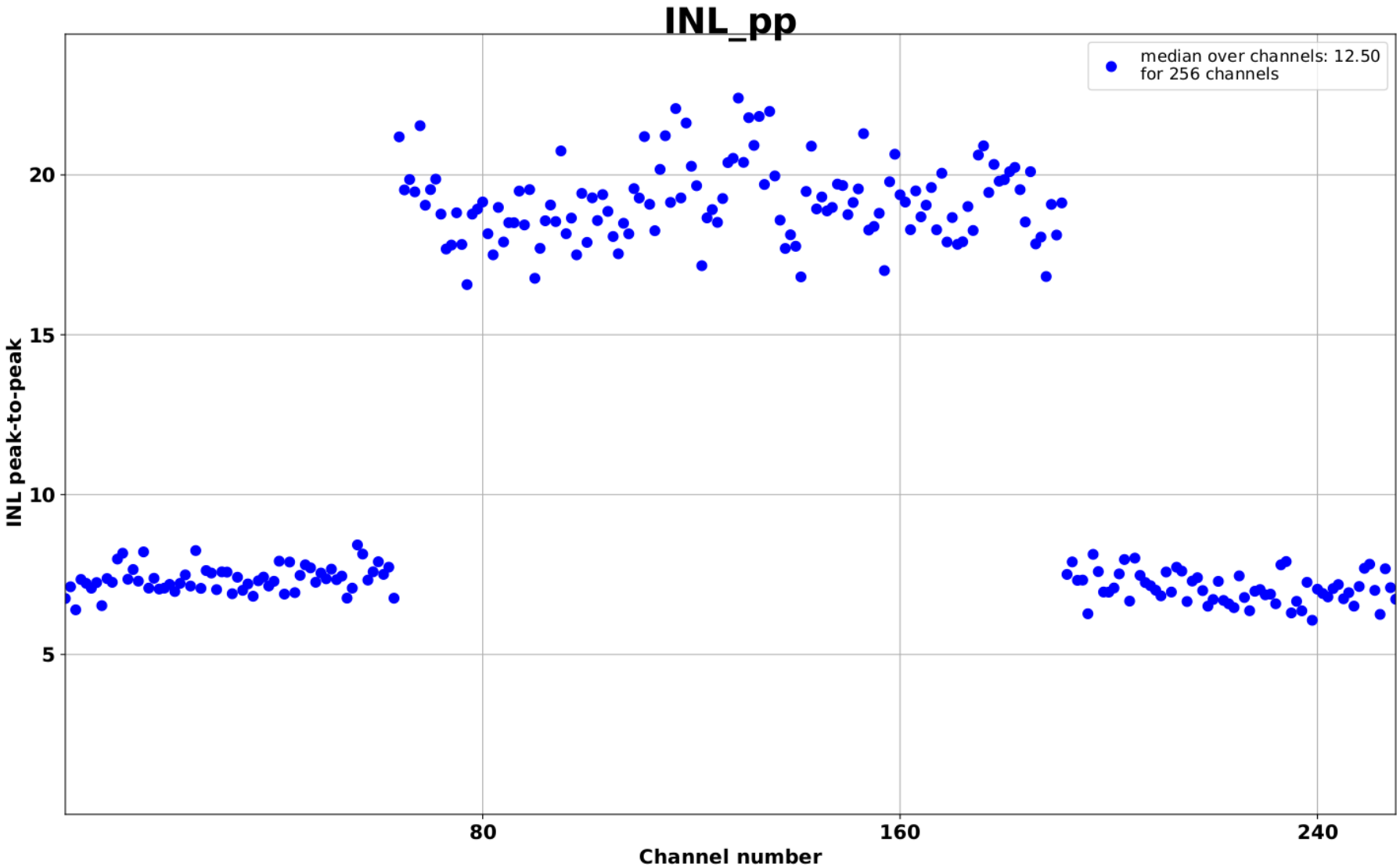
ADC: small parameter set, all DCDs

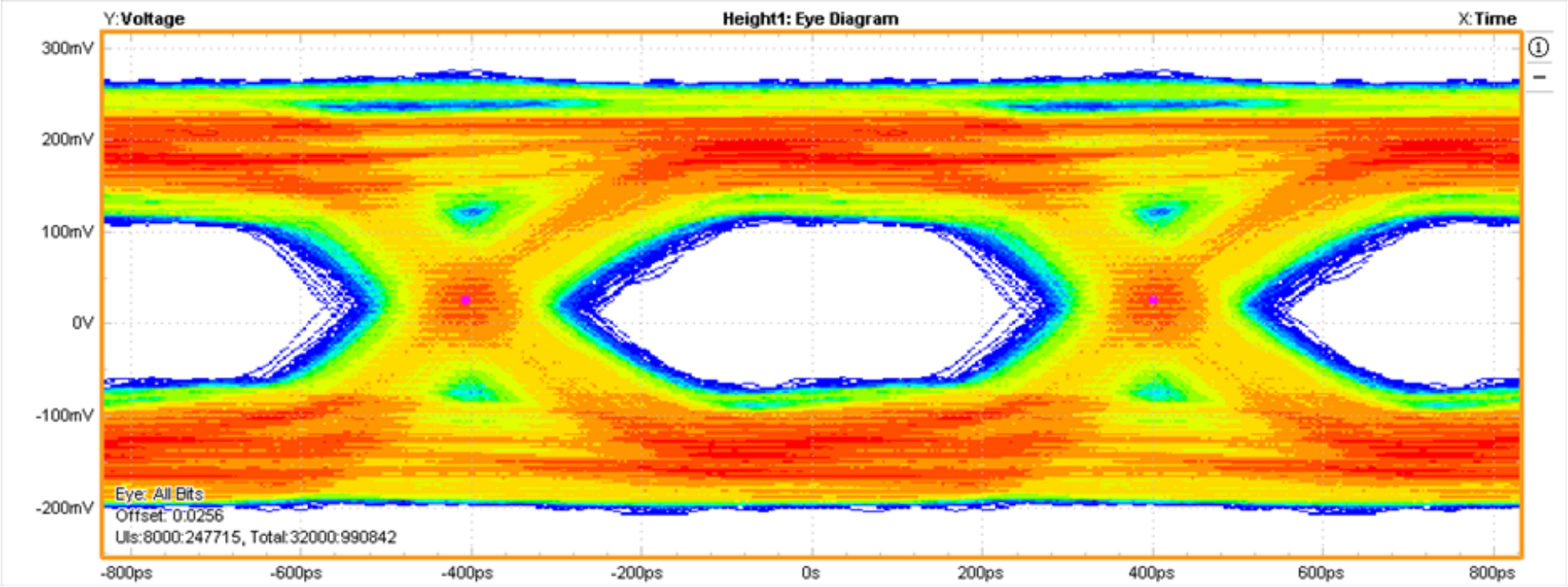


ADC: small parameter set, all DCDs - INL



Hybrid 5_0_21 (DCD4.2, DHPT1.2b, matrix & switcher)

Eye diagram


Y: Voltage
Height1: Eye Diagram
X: Time
300mV
200mV
100mV
0V
-100mV
-200mV
Eye: All Bits
Offset: 0:0256
UIs:8000:247715, Total:32000:990842
-800ps
-600ps
-400ps
-200ps
0s
200ps
400ps
600ps
800ps