

SK2A Test results analysis

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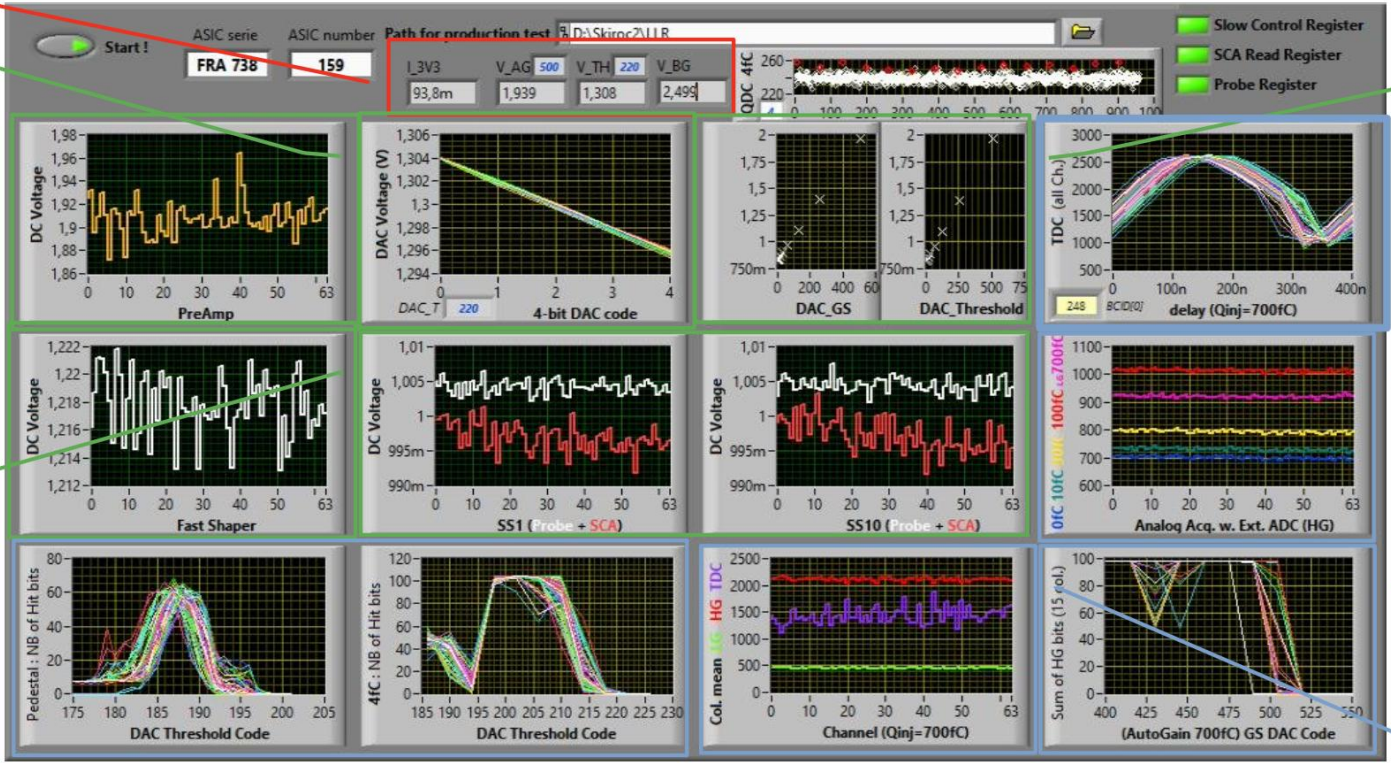
Institut Polytechnique de Paris



Measurements

LabView testing SW : Digital & Analogue probing ⌚ 9 mins per ASIC (optim) © S. Callier

- Powering
- Fine Thr Adjust /ch
- VDC Pre-Amp /ch
- VDC Fast Shaper /ch
- VDC Slow-Shaper /ch
- G1, G10
- Probe & SCA
- DAC Thr scan / ch
- Pedestal
- MIP (4fC)



- DAC Scan with probe:
 - auto-gain (GS)
 - Global Thr.
- TDC Delay scan /ch
- Analog Readout/ch
- AutoTrigger delayed by FPGA
- HG : 0, 10, 30, 100 fC
- LG: 700 fC
- AutoGain efficiency (SCA 0–14) Qinj = 700fC
- Eff. per Ch. vs Gain code
- ADC <SCA0–14>/ch
- Qinj = 700fC
- HG, LG, TDC(SCA0)

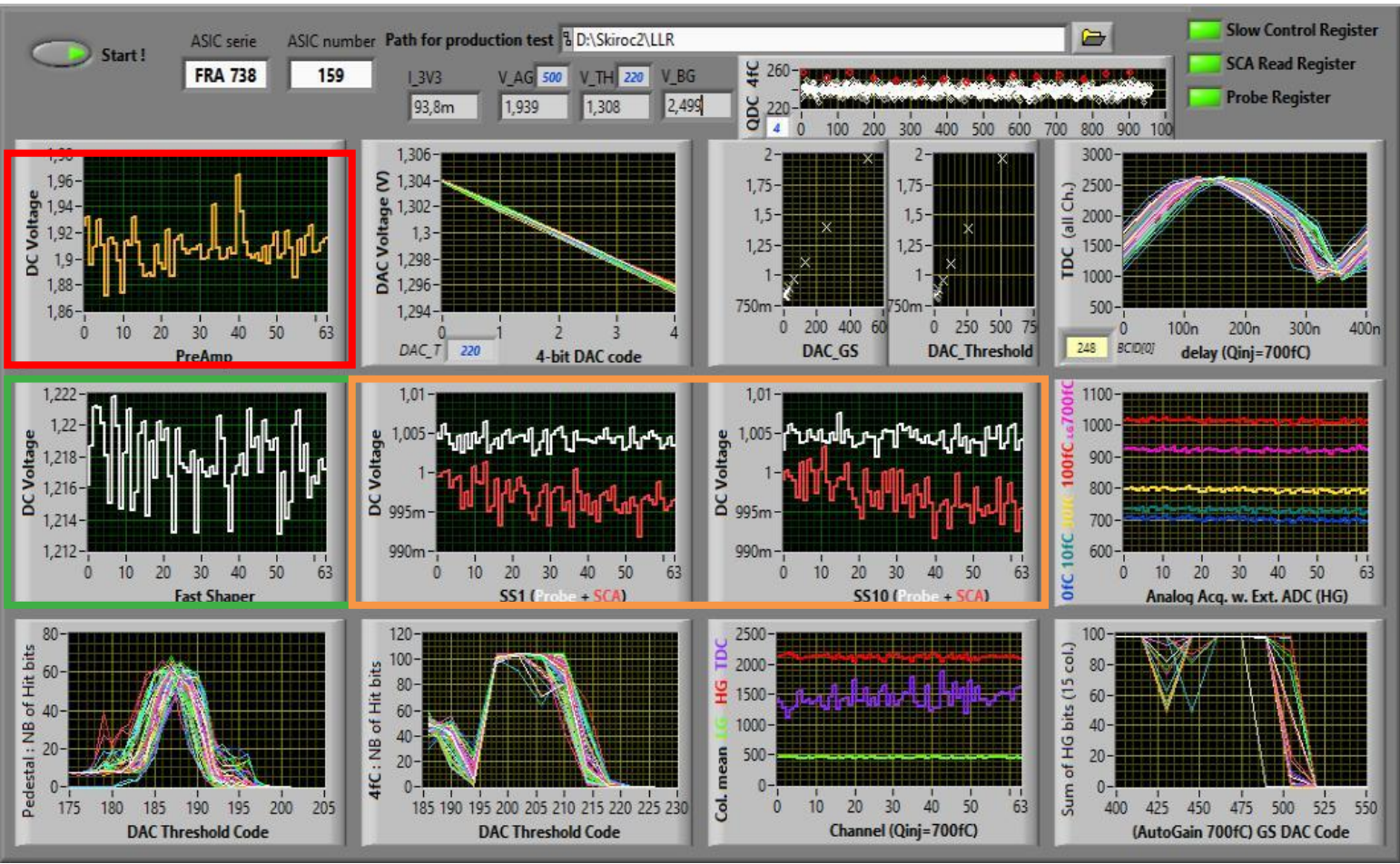
Channel Scans:

VDC Pre-Amp /ch

VDC Fast Shaper /ch

VDC Slow-Shaper /ch

- G1, G10
- Probe & SCA

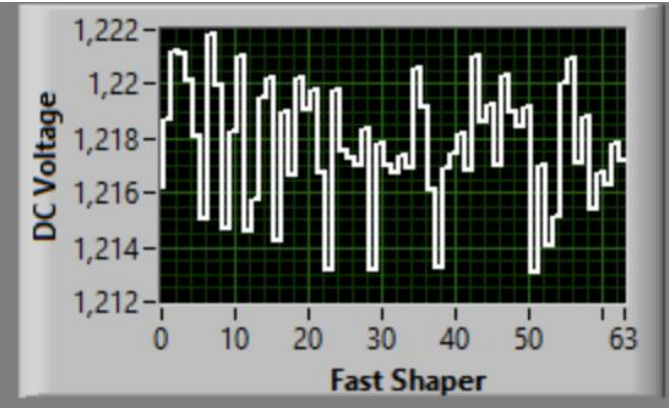


Channel Scans: Output csv files: stats and outliers

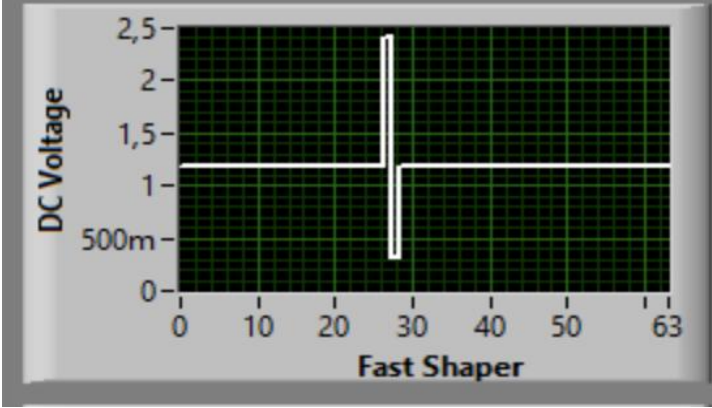
- single measurements from 64 channels
- Find mean and standard deviation
- Fit to Gaussian by MLE method, extract fitted mean and std

```
value_range = {'VDC_FS':[0.9,1.7], 'VDC_SS10':[0.5,1.5], 'VDC_SS1':[0.5,1.5],
               'VDC_PA':[1.6,2.4], 'VDC_SCA10':[0.5,1.5], 'VDC_SCA1':[0.5,1.5]}
```

ASIC	number of valid channels	mean	std	fitted mean	fitted std
738-159	64	1.2177	0.002220	1.2177	0.002203



ASIC	number of valid channels	mean	std	fitted mean	fitted std
738-202	62	1.1851	0.001506	1.1851	0.001494



- Outliers (outside 3 std from the mean)

ASIC	channel	distance
738-261	34	3.4829

ASIC	channel	distance
2127-251	34	-3.4044

Distance = (value - mean)/std

Channel Scans: Summary **VDC_PA**

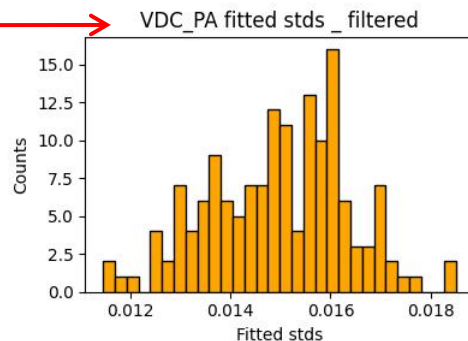
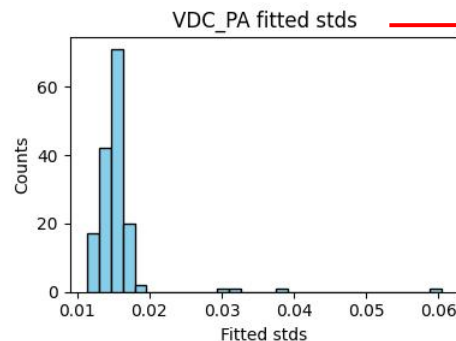
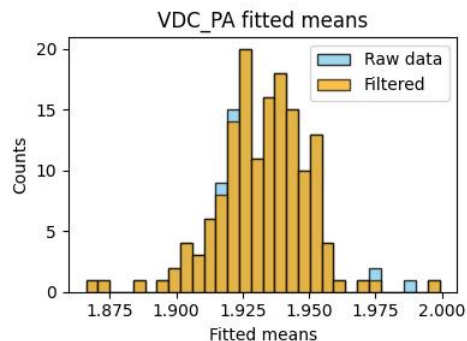
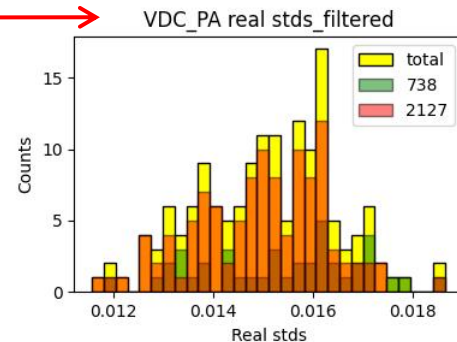
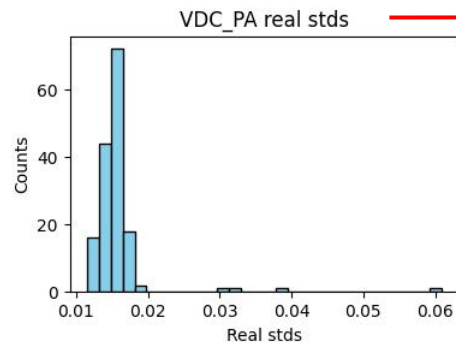
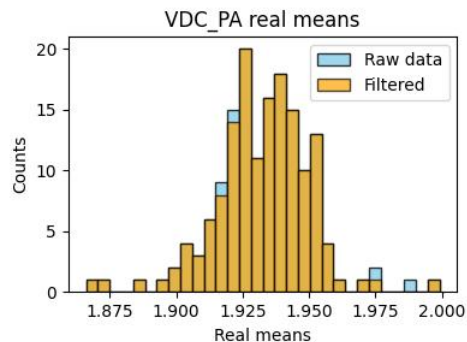
- Filter by standard deviation

```
std_range = {'VDC_FS': [0, 0.003], 'VDC_SS10': [0, 0.002], 'VDC_SS1': [0, 0.02],
            'VDC_PA': [0, 0.02], 'VDC_SCA10': [0, 0.004], 'VDC_SCA1': [0, math.inf]}
```

- Total no. of ASICs: 156
- valid ASICs: 152

ASICs of filtered std outliers:

ASIC	std
27	2127-209 0.039015
55	738-264 0.029789
61	2127-178 0.031462
143	2127-264 0.060818
total no. of ASICs: 156	
number of excluded ASICs: 4	
number of valid ASICs: 152	



Channel Scans: Summary VDC_SS1

- Filter by standard deviation

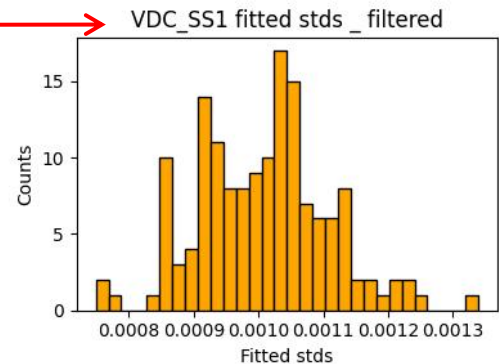
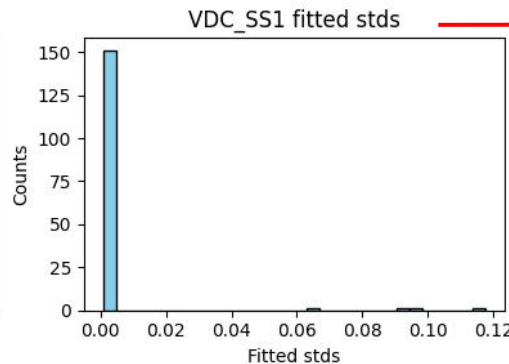
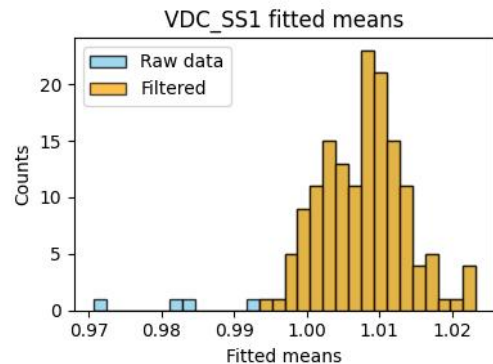
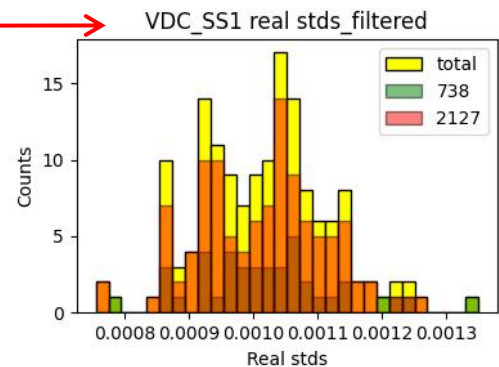
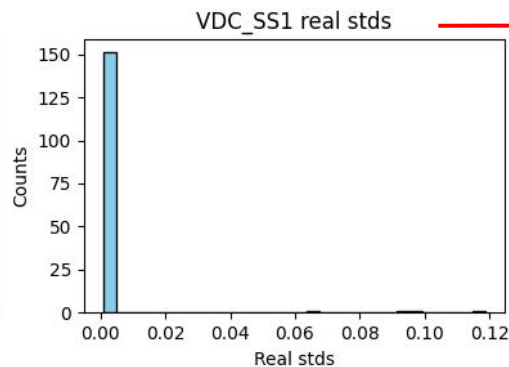
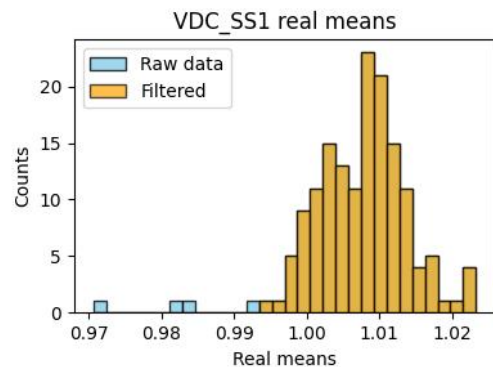
```
std_range = {'VDC_FS': [0, 0.003], 'VDC_SS10': [0, 0.002], 'VDC_SS1': [0, 0.02],
            'VDC_PA': [0, 0.02], 'VDC_SCA10': [0, 0.004], 'VDC_SCA1': [0, math.inf]}
```

- Total no. of ASICs: 155
- valid ASICs: 151

ASICs of filtered std outliers:

	ASIC	std
20	738-167	0.095356
87	2127-415	0.093840
114	2127-390	0.118829
150	2127-391	0.065169

total no. of ASICs: 155
 number of excluded ASICs: 4
 number of valid ASICs: 151



Channel Scans: Summary VDC_SS10

- Filter by standard deviation

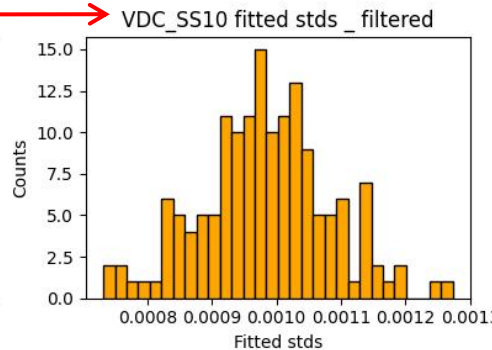
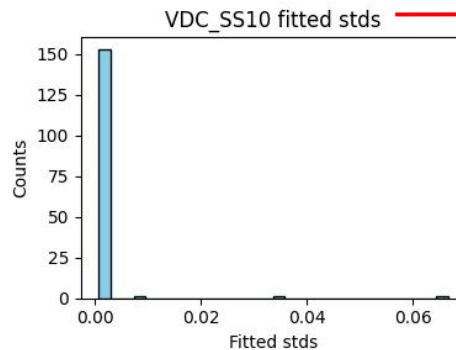
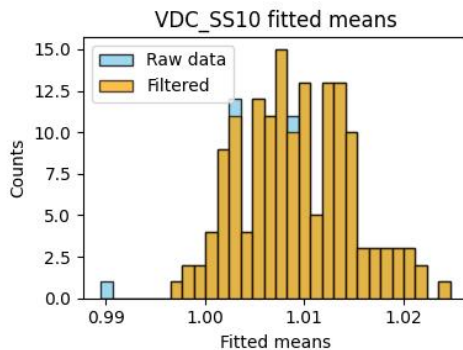
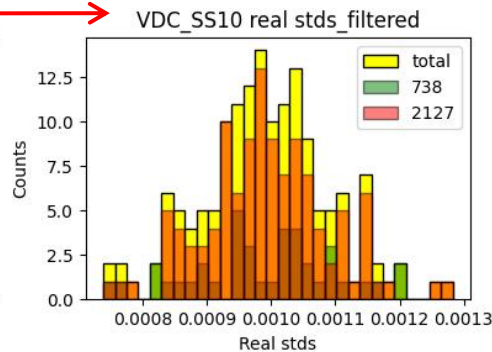
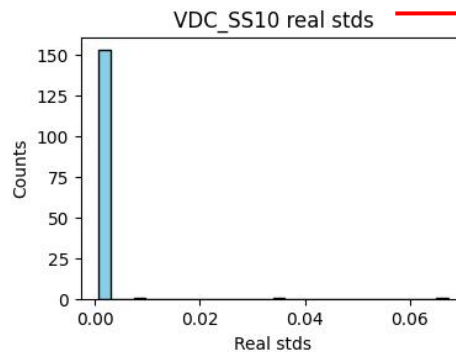
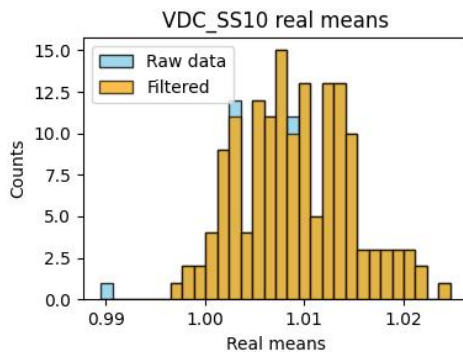
```
std_range = {'VDC_FS': [0, 0.003], 'VDC_SS10': [0, 0.002], 'VDC_SS1': [0, 0.02],
            'VDC_PA': [0, 0.02], 'VDC_SCA10': [0, 0.004], 'VDC_SCA1': [0, math.inf]}
```

- Total no. of ASICs: 156
- valid ASICs: 153

ASICs of filtered std outliers:

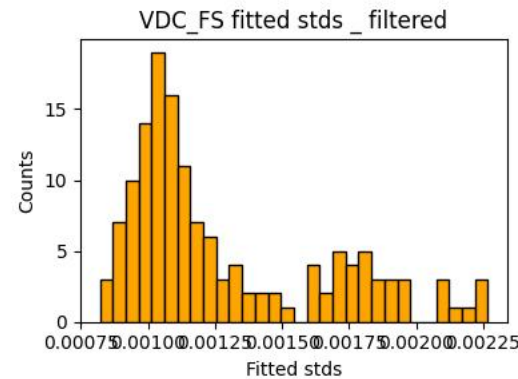
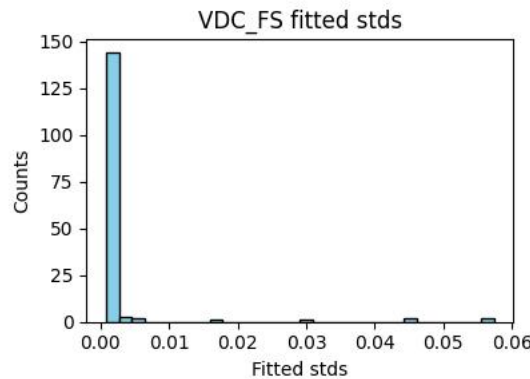
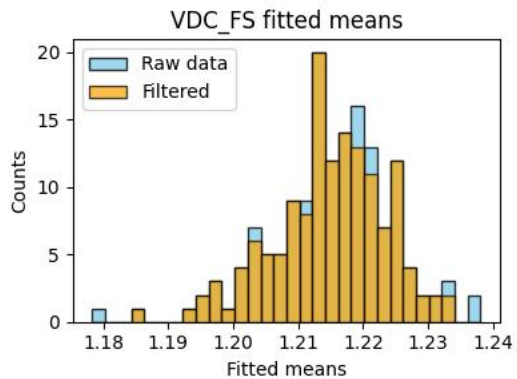
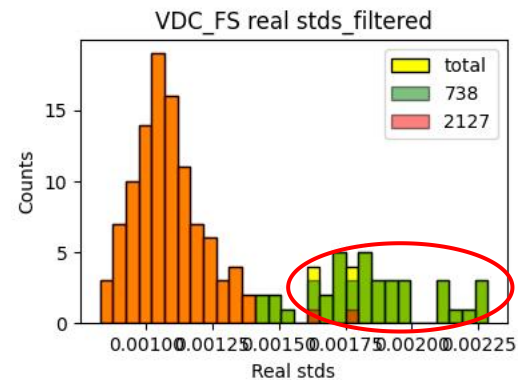
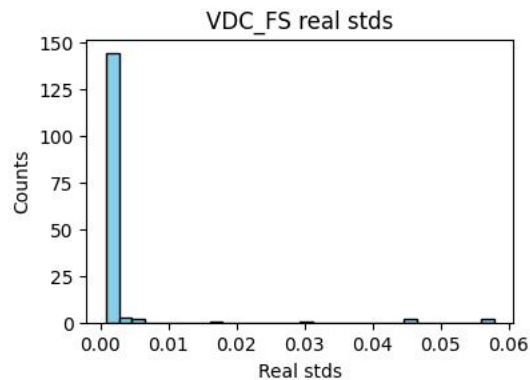
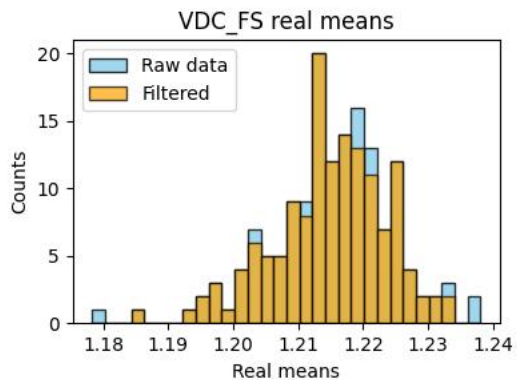
	ASIC	std
1	738-202	0.009274
34	738-15_	0.067224
142	738-264	0.035039

total no. of ASICs: 156
 number of excluded ASICs: 3
 number of valid ASICs: 153



Channel Scans: dependence on packaging **VDC_FS**

- Particular **VDC_FS**
- 39 ASICs “outside” the Gaussian in filtered std
- Different **packaging**
- Total no. of ASICs: 155
- valid ASICs: 144



ASICs of filtered std outliers:

	ASIC	std
34	2127-254_chn62off	0.003949
37	2127-264_chn41off	0.045919
43	2127-282	0.005098
63	738-264	0.016618
70	2127-129	0.057840
80	2127-254	0.003949
85	2127-177	0.004103
94	2127-264	0.046293
103	2127-129_chn6off	0.057476
117	2127-262	0.030707
149	2127-256	0.006103

total no. of ASICs: 155

number of excluded ASICs: 11

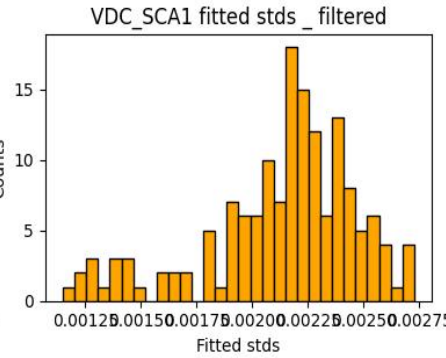
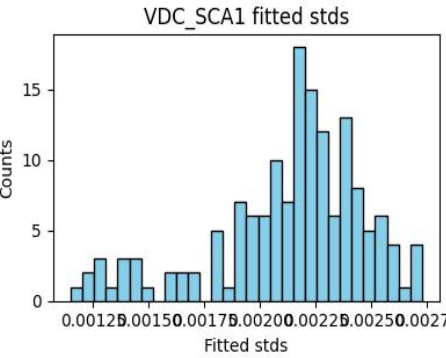
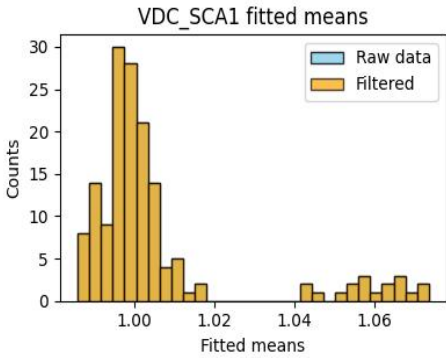
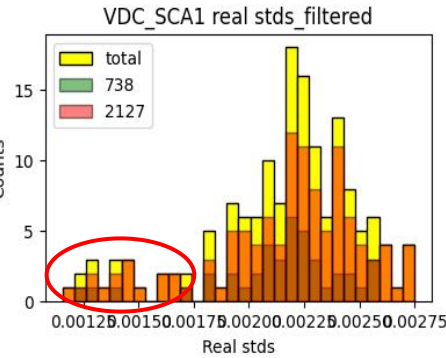
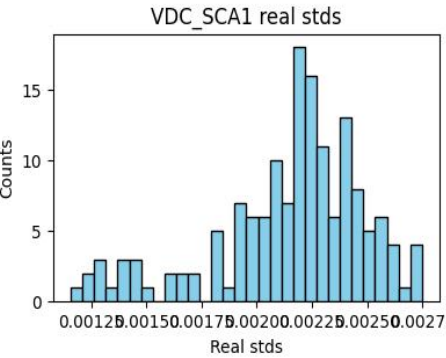
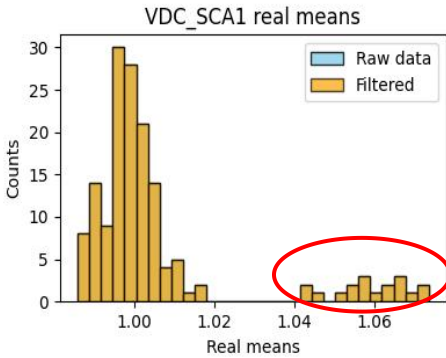
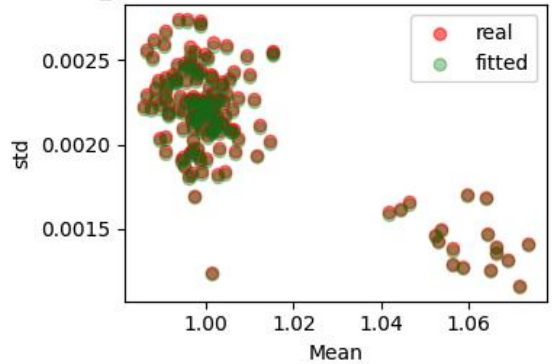
number of valid ASICs: 144

Channel Scans: 2 groups of mean data **SCA1**

- Notch of data that is “outside” Gaussian in mean and filtered std as in **red circle**
- Scatter plots show correlation between mean and std.

- Total no. of ASICs: 155
- valid ASICs: 155

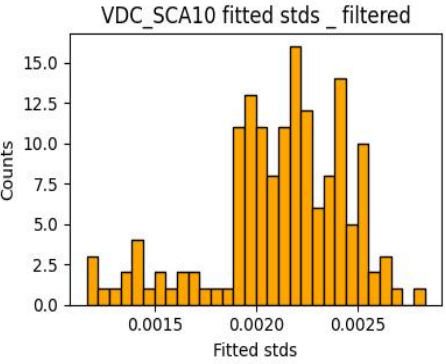
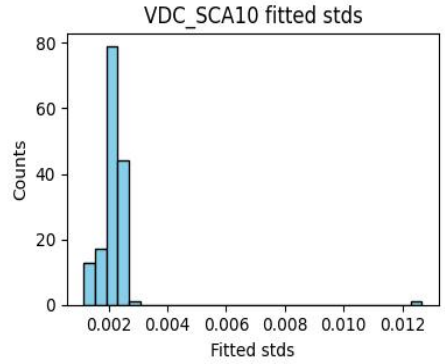
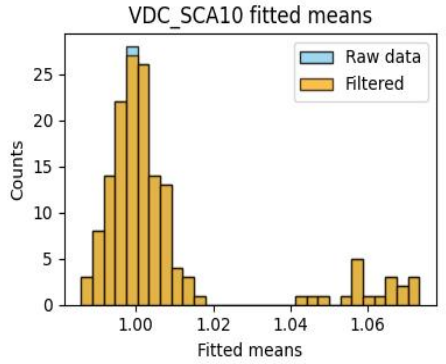
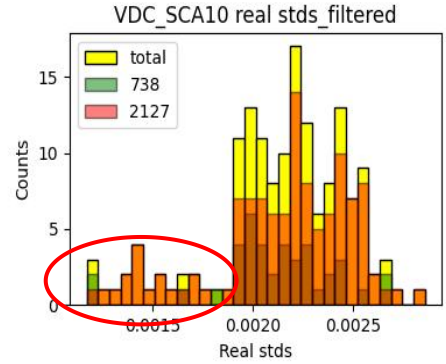
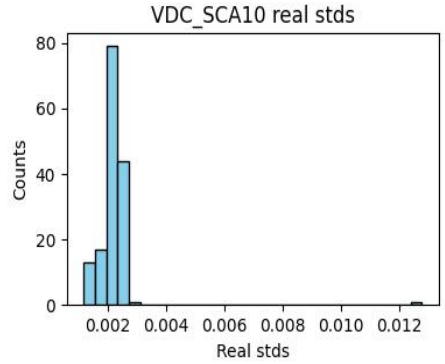
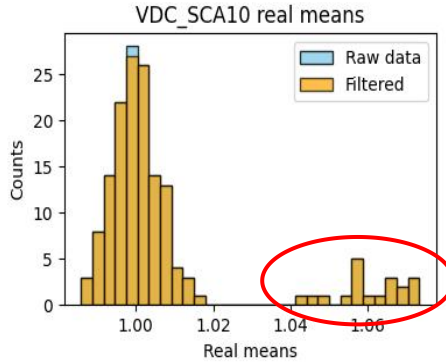
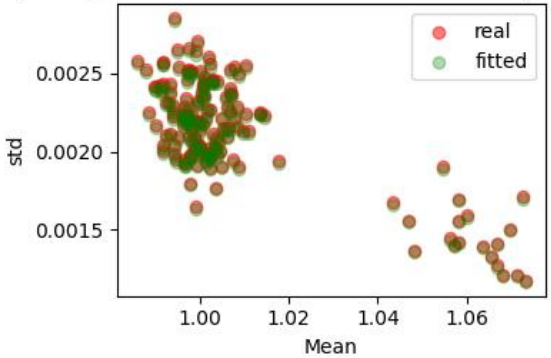
a) VDC_SCA1: Scatter fitted mean vs. std (filtered)



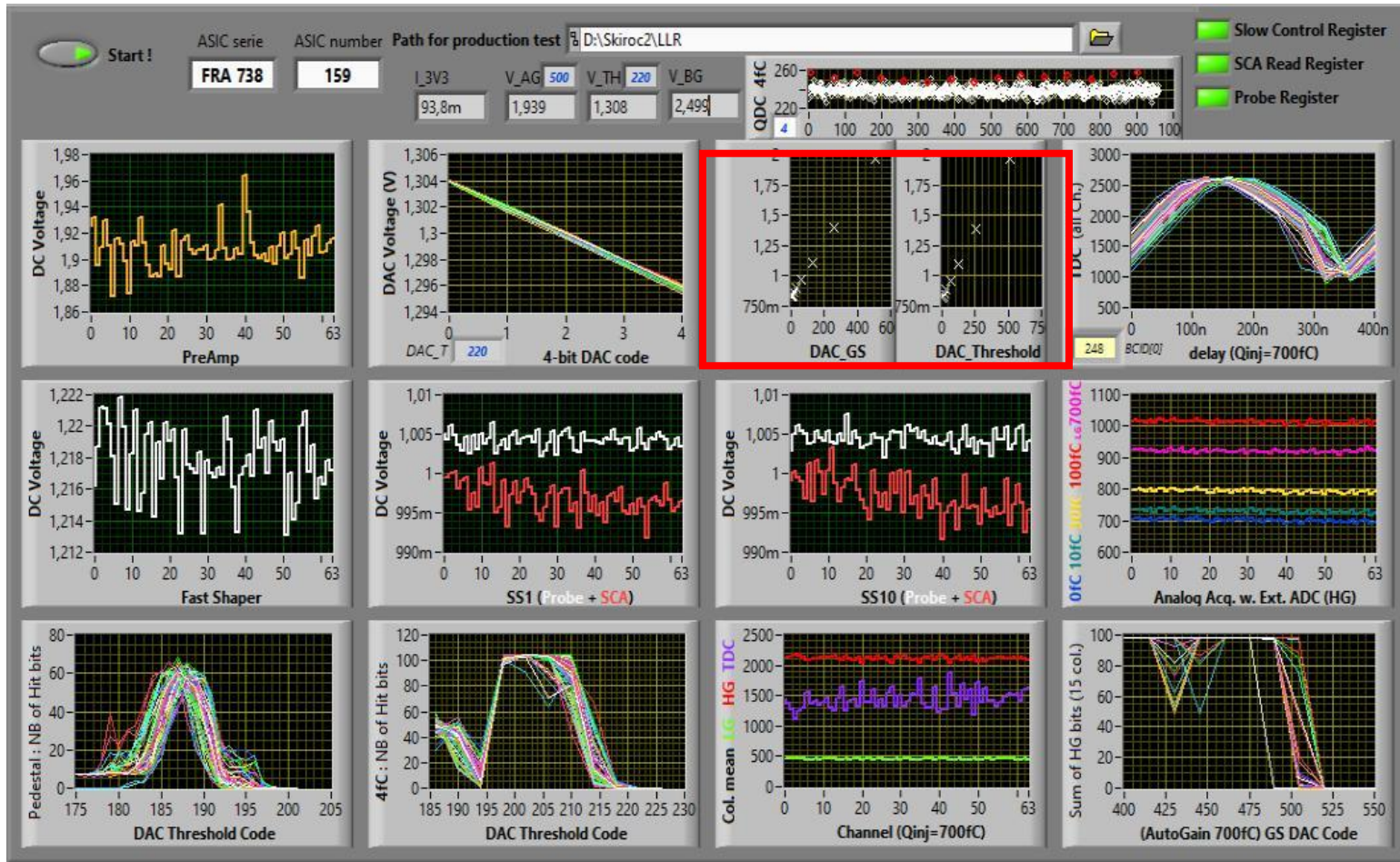
Channel Scans: 2 groups of mean data **SCA10**

- Notch of data that is “outside” Gaussian in mean and filtered std as in **red circle**
- Scatter plots show correlation between mean and std.
- Total no. of ASICs: 156
- valid ASICs: 155

ta) VDC_SCA10: Scatter fitted mean vs. std (filtered)



Parameter Scans:



DAC Scan with probe:

- auto-gain (GS)
- Global Thr.

Parameter scan: retrieved data file

DAC linearity V_TH

0 1 2 4 8 16 32 64 128 256 512

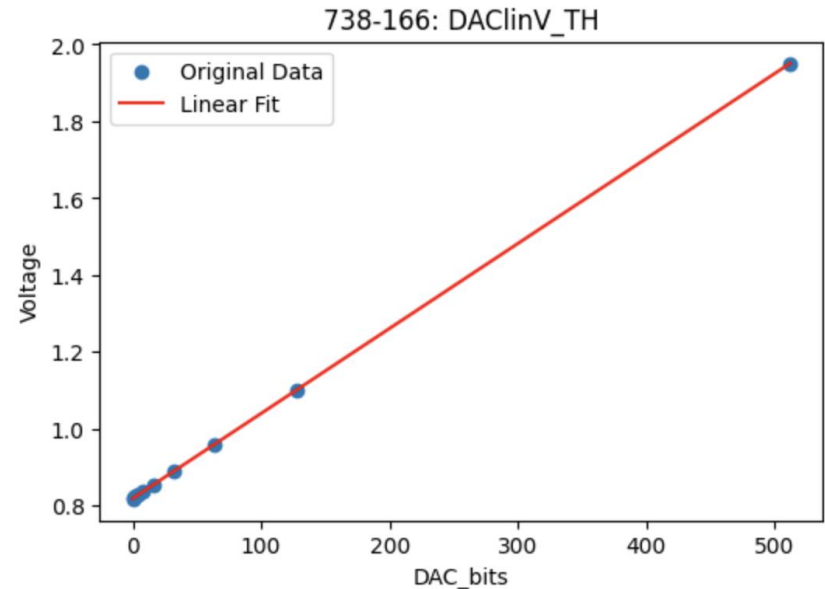
0,8185536 0,8209090 0,8229595 0,8273524 0,8362206 0,8543637 0,8898767 0,9599614 1,1015056 0 1,9504651

- Linear fit with **y-intercept = voltage value at DAC = 0**
- excluding zeros (if $V_0 = 0$, extrapolate)
- Extract slope

738-166: DAClinV_TH

Equation of the linear fit:

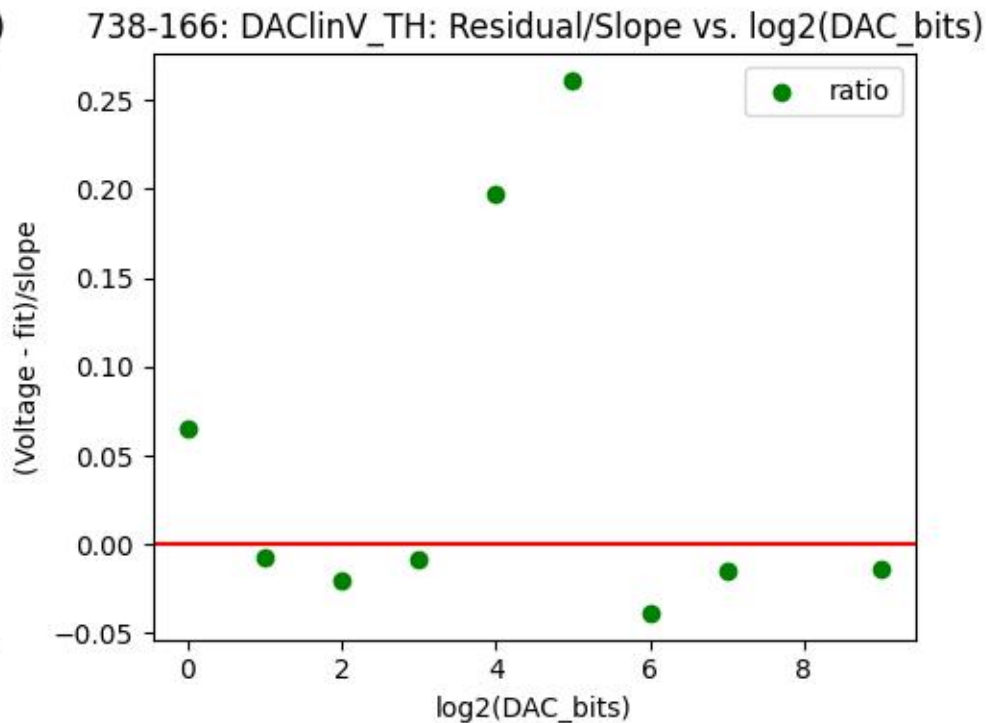
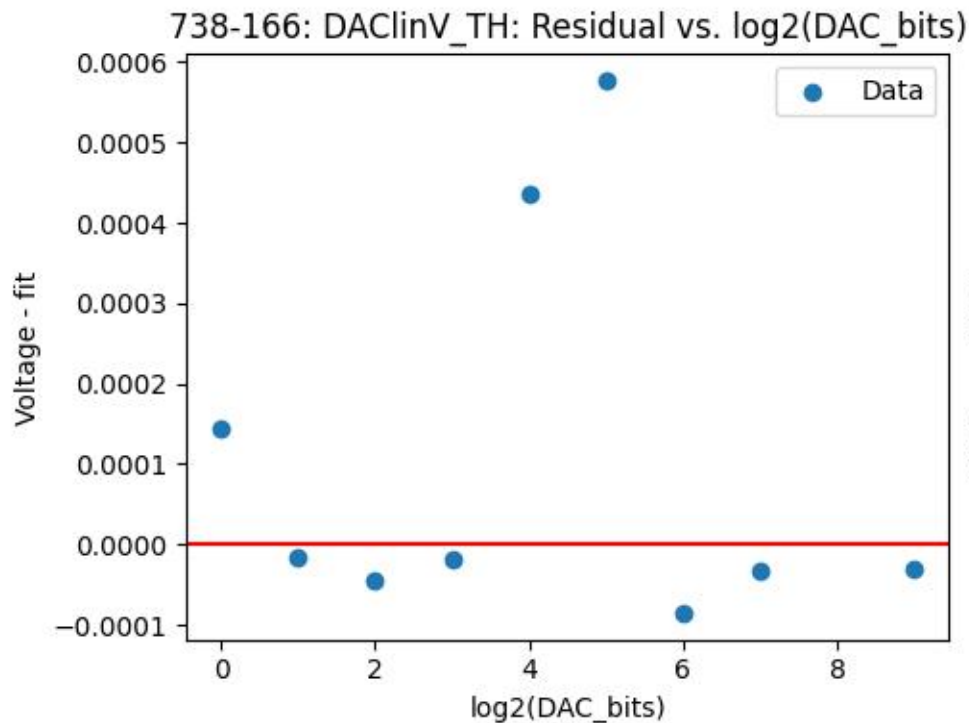
Voltage = $0.0022108238079647283 * \text{DAC} + 0.8185536$



Parameter scan: Analysis of a single chip

- Plot residual vs. log2 of DAC
- residual = data - fit

- **Ratio** = residual/slope: **how well the fit is**
- slope = smallest step of voltage when changing DAC value



Parameter scan: output file

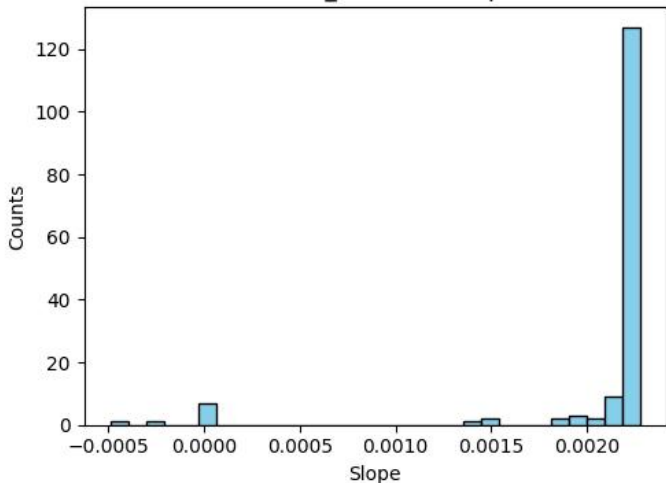
ASIC	V0 != 0	Fitted slope	Max abs. residual/slope ratio	V0(intercept)
738-159	TRUE	0.002247538	0.327114922	0.8154298

- Steps of voltage to reconstruct scan

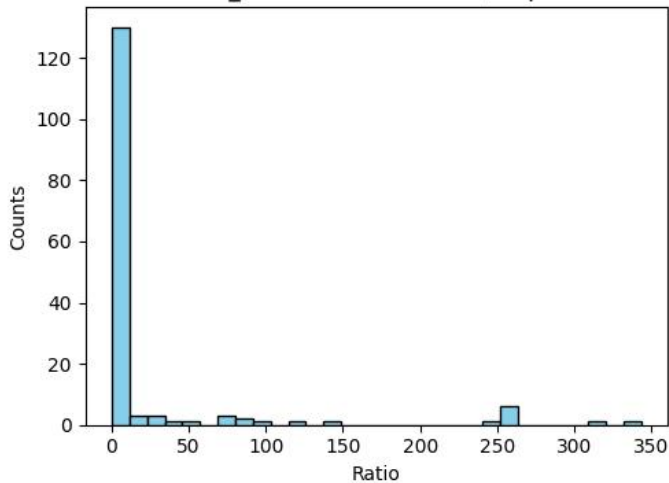
Step: V1-V0	Step: V2-V0	Step: V3-V0	Step: V4-V0	Step: V5-V0	:
0.0022154	0.0044222	0.0087106	0.0172451	0.0352937	
Step: V6-V0	Step: V7-V0	Step: V8-V0	Step: V9-V0	Step: V10-V0	
0.0722203	0.1443503	0.2871824	0.5751005	1.1509523	

Parameter scan: Summary analysis of **DAClinV_AG**

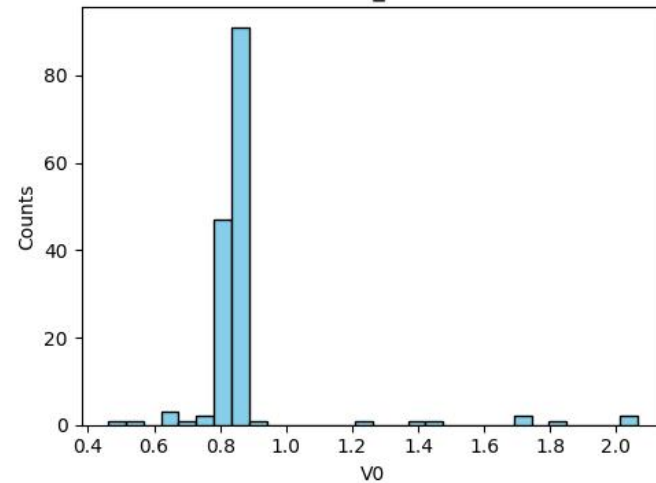
DAClinV_AG: Fitted slope



DAClinV_AG: Max abs. residual/slope ratio

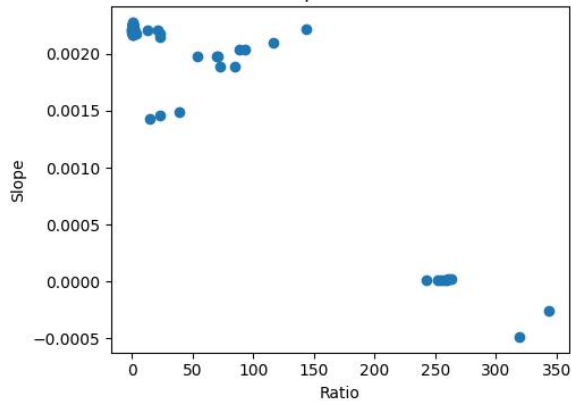


DAClinV_AG: V0

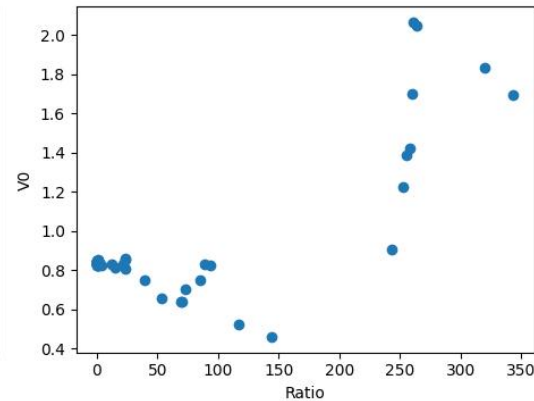


Scatter plot showing correlation of slope and V0 with ratio:

Slope vs ratio

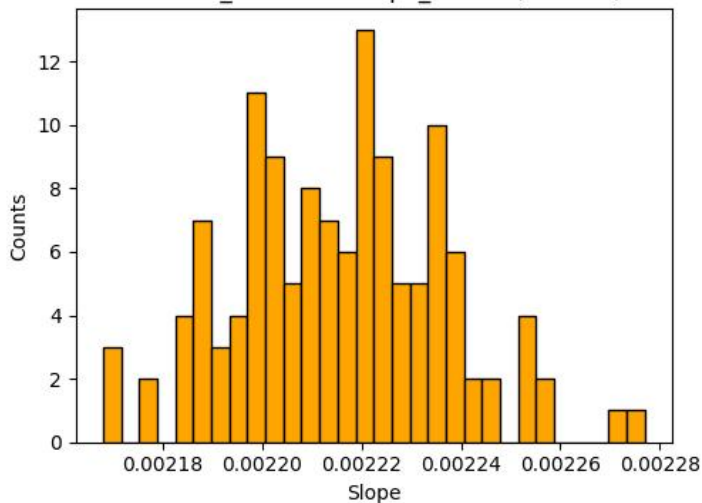


V0 vs. ratio

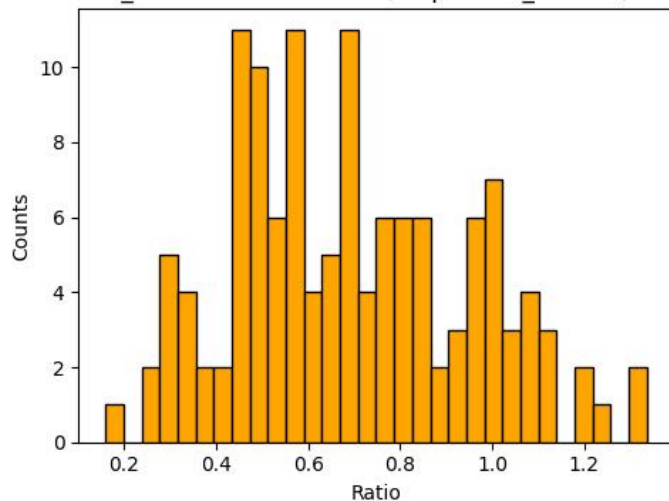


Parameter scan: Summary analysis of DAClinV_AG

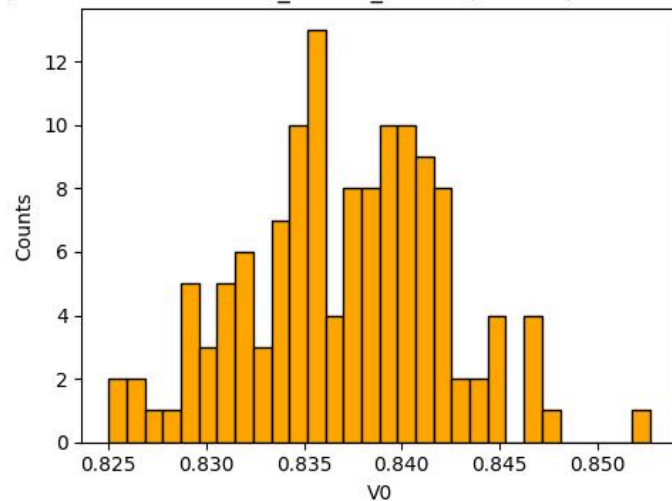
DAClinV_AG: Fitted slope_filtered(ratio<2)



DAClinV_AG: Max abs. residual/slope ratio_filtered(ratio<2)



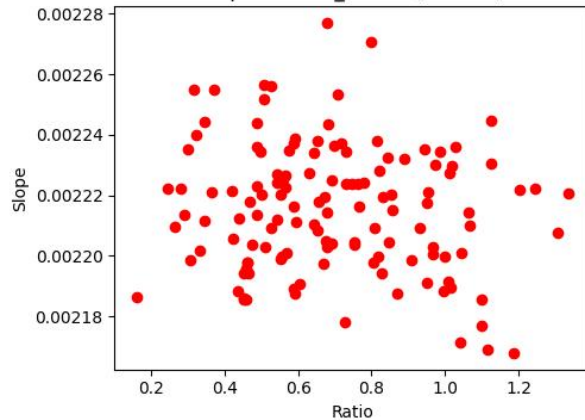
DAClinV_AG: V0_filtered(ratio<2)



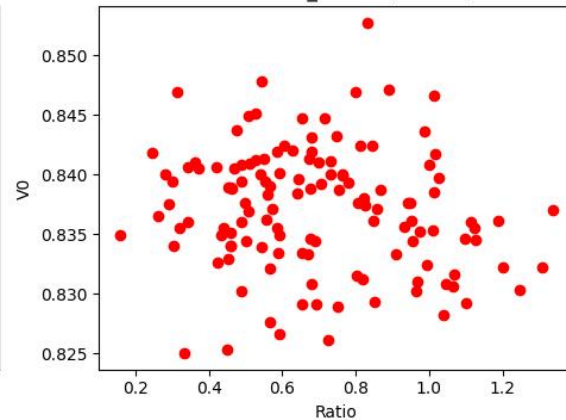
Filtered ratio < 2

total number of ASICs: 154
number of excluded ASICs: 25
number of valid ASICs: 129

Slope vs ratio_filtered(ratio<2)



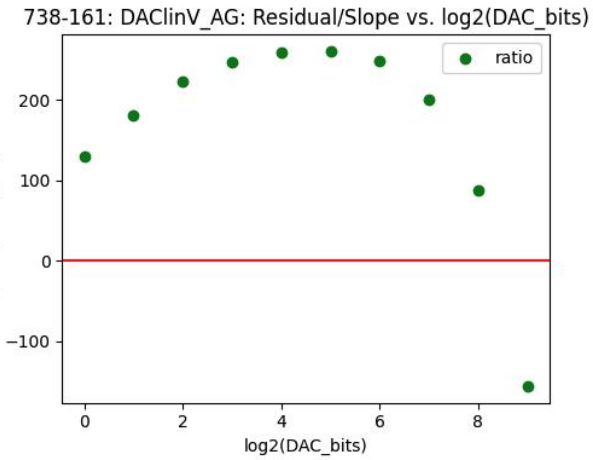
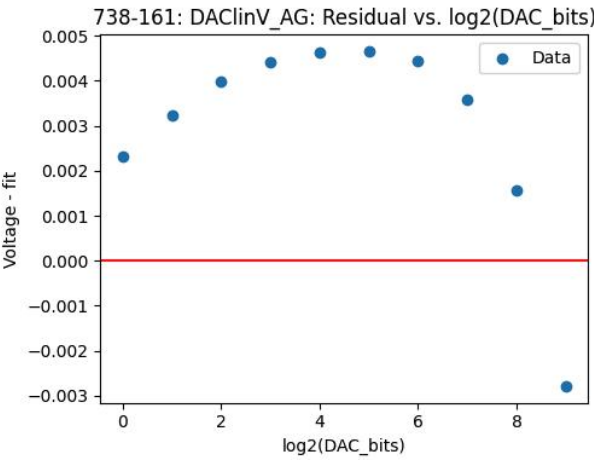
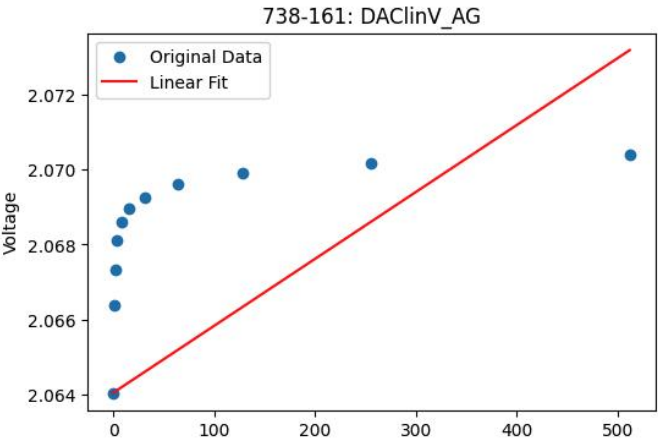
V0 vs. ratio_filtered(ratio<2)



Parameter scan: Problem shoot (738-161: DAClinV_AG)

extremely small slope —> large ratio

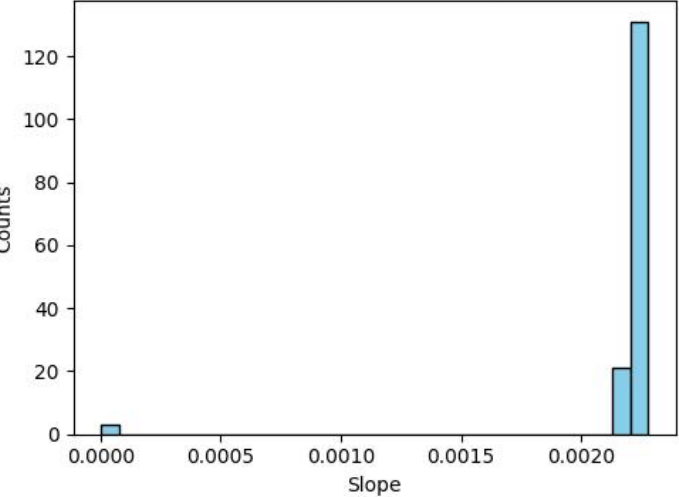
DAC linearity	V_AG
0 1 2 4 8 16 32 64 128 256 512	
2,0640459	2,0663909 2,0673200 2,0680968 2,0685892 2,0689519 2,0692666 2,0696222 2,0699148 2,0701681 2,0704014



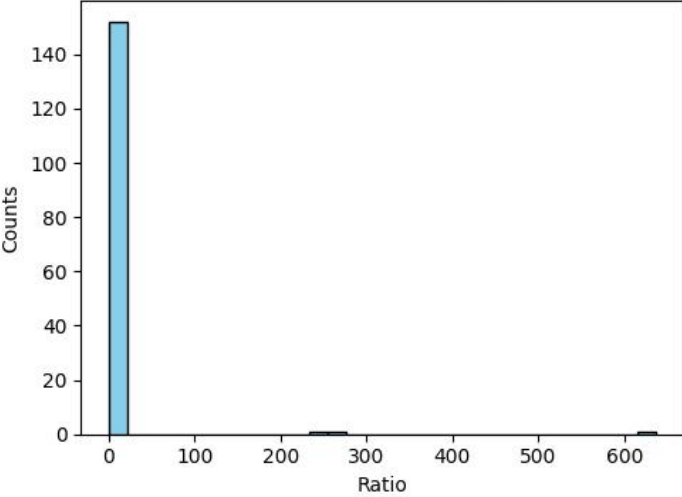
738-161: DAClinV_AG
 Equation of the linear fit:
 $Voltage = 1.7842507510690275e-05 * DAC + 2.0640459$

Parameter scan: Summary analysis of **DAClinV_TH**

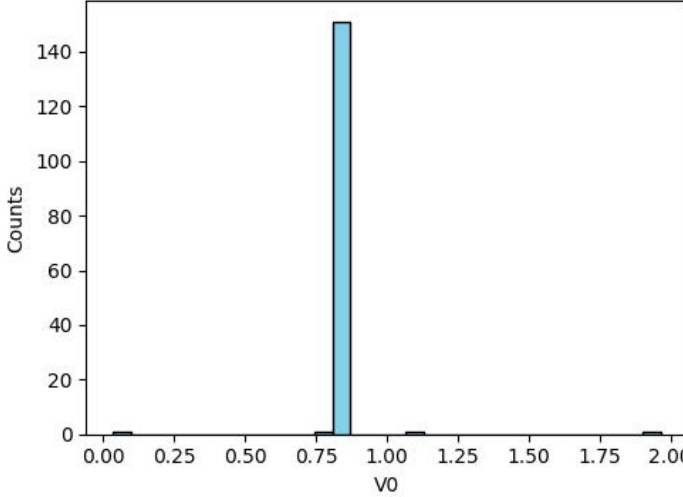
DAClinV_TH: Fitted slope



DAClinV_TH: Max abs. residual/slope ratio

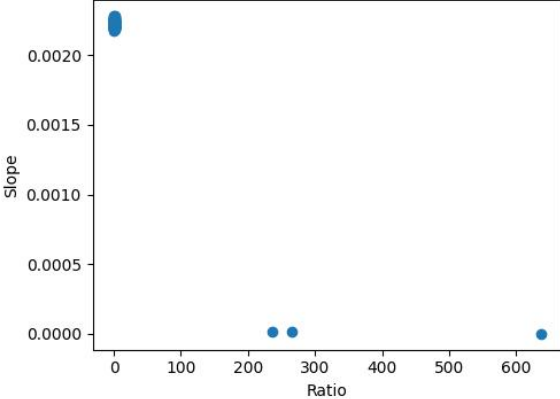


DAClinV_TH: V0

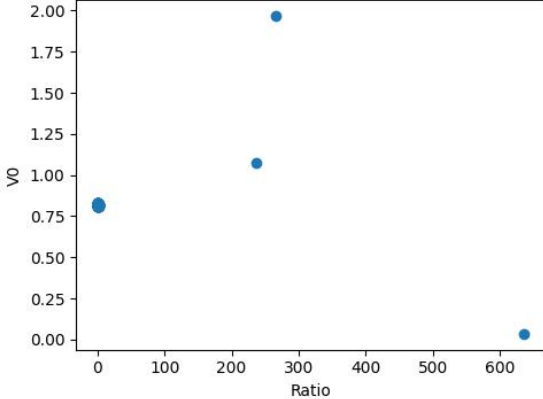


Scatter plot showing correlation of slope and V0 with ratio:

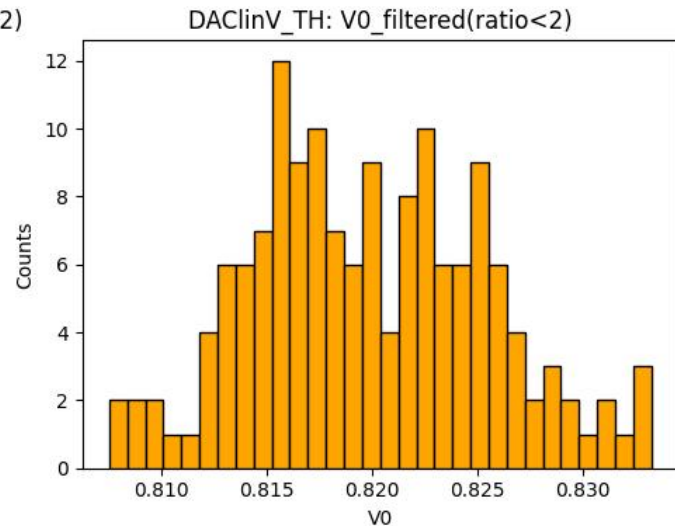
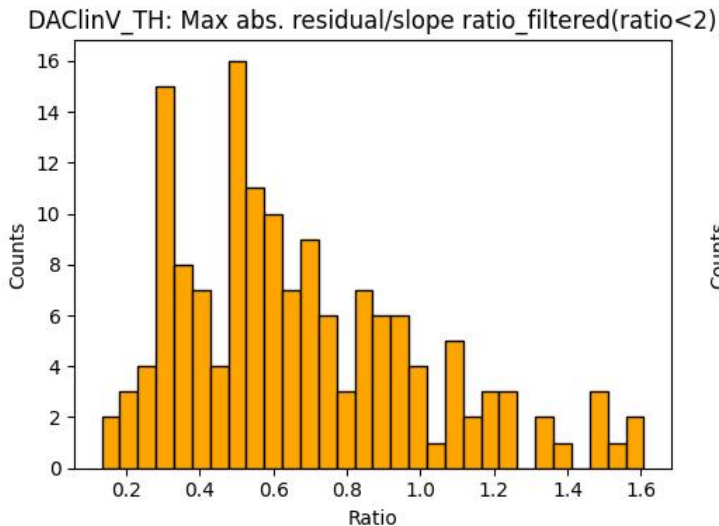
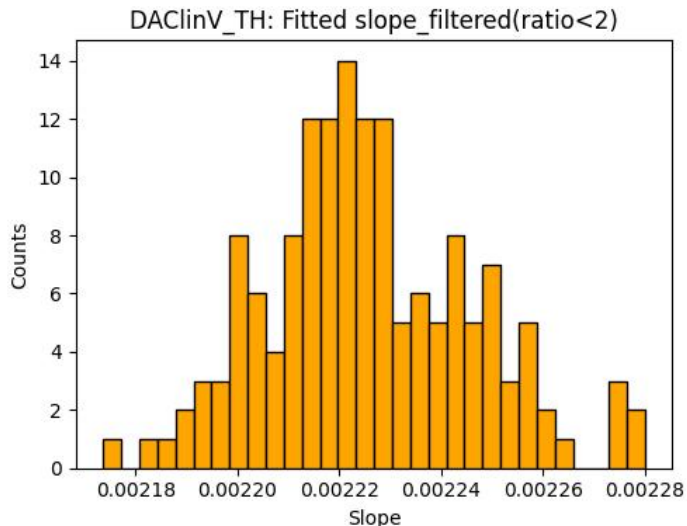
Slope vs ratio



V0 vs. ratio



Parameter scan: Summary analysis of DAClinV_TH

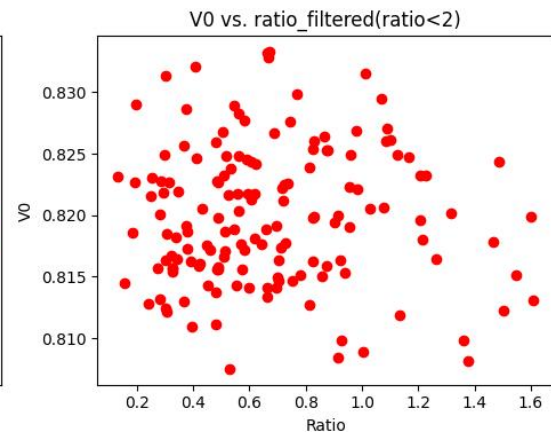
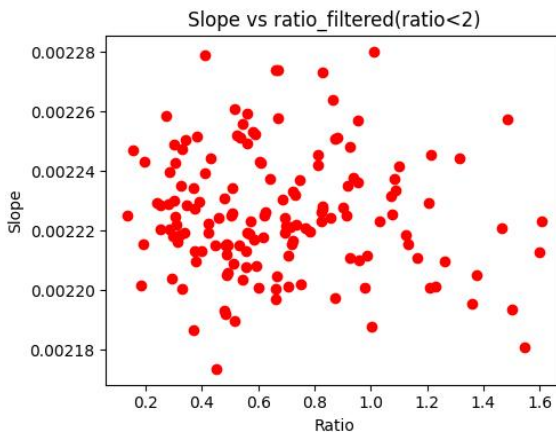


Filtered ratio < 2

excluded ASICs: (ratio >=2):

ASIC	Max abs. residual/slope ratio
3 738-251	636.565522
23 2127-407	265.956669
74 2127-403	2.365320
131 2127-274	236.147975

total number of ASICs: 154
 number of excluded ASICs: 4
 number of valid ASICs: 150



Conclusion:

- Data analyzed from 158 chips
- Channel Scans (single measurement by external device from 64 channels)
 - Non Gaussian distribution of std in VDC_FS,
 - Fast shaper -----> **packaging** 738 twice the std of 2127
 - VDC_SC1 and VDC_SC10: two groups of mean and std -----> correlations
- Parameter scan
 - Auto-gain: measurements completely off (values almost the same)