Cavity BCM Digital Receivers Study

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Cav4c Hardware Registers Settings

Vary DAC4 input and measure the digital receiver's output with a multimeter

Info from John Musson:
The DAC is 18-bits, which fully represents the signal data. But, the "DAC Set" operation is only 16 bits (utilizing the top 16 bits of the 18 bit output). Hence, we can only manually step the output by 305 uV, not the expected 76 uV.

Cav4c Digital Receiver's DAC4 Output vs Input (Shown in December)

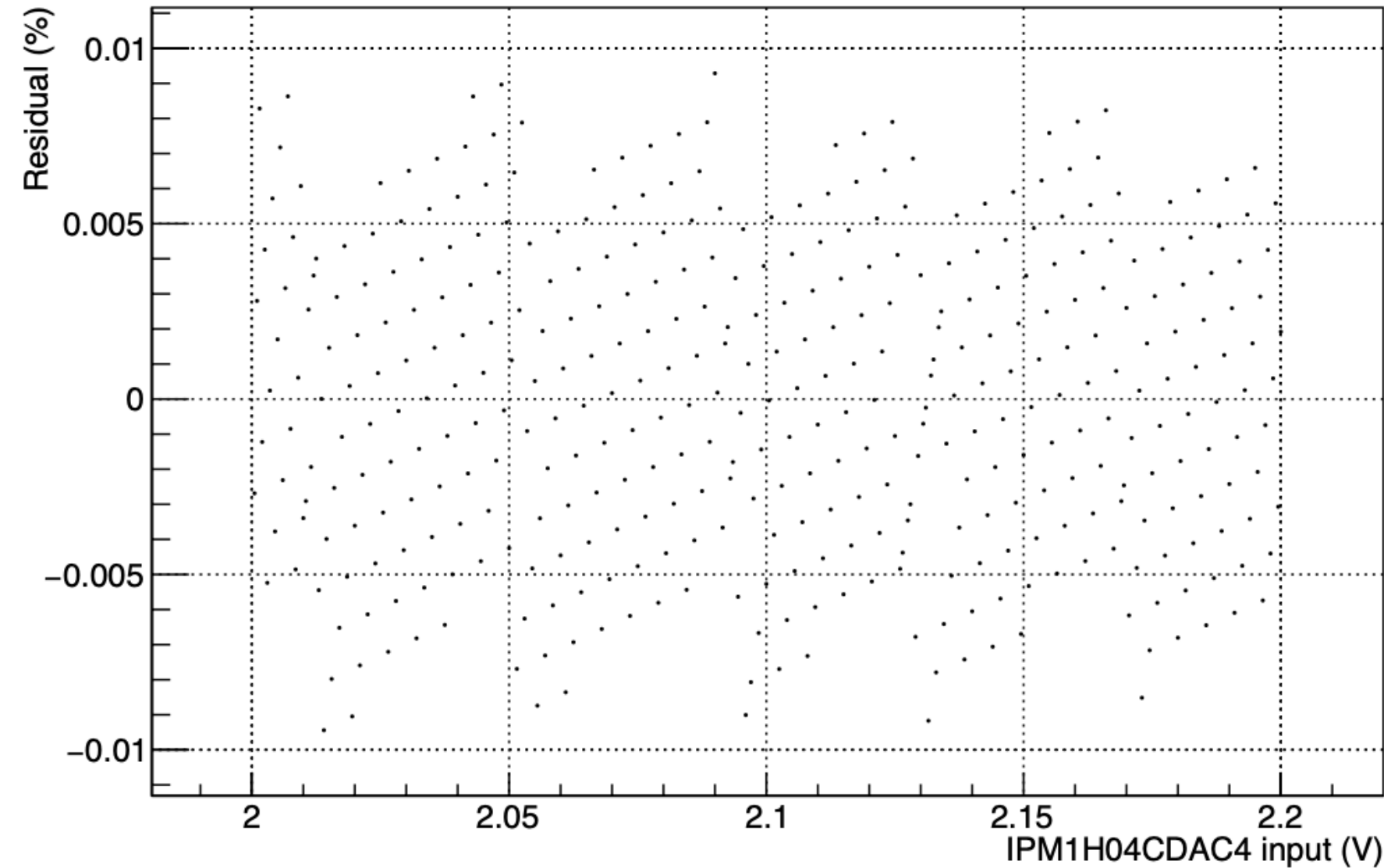## DAC4 Multimeter Reading vs IPM1H04CDAC4 input
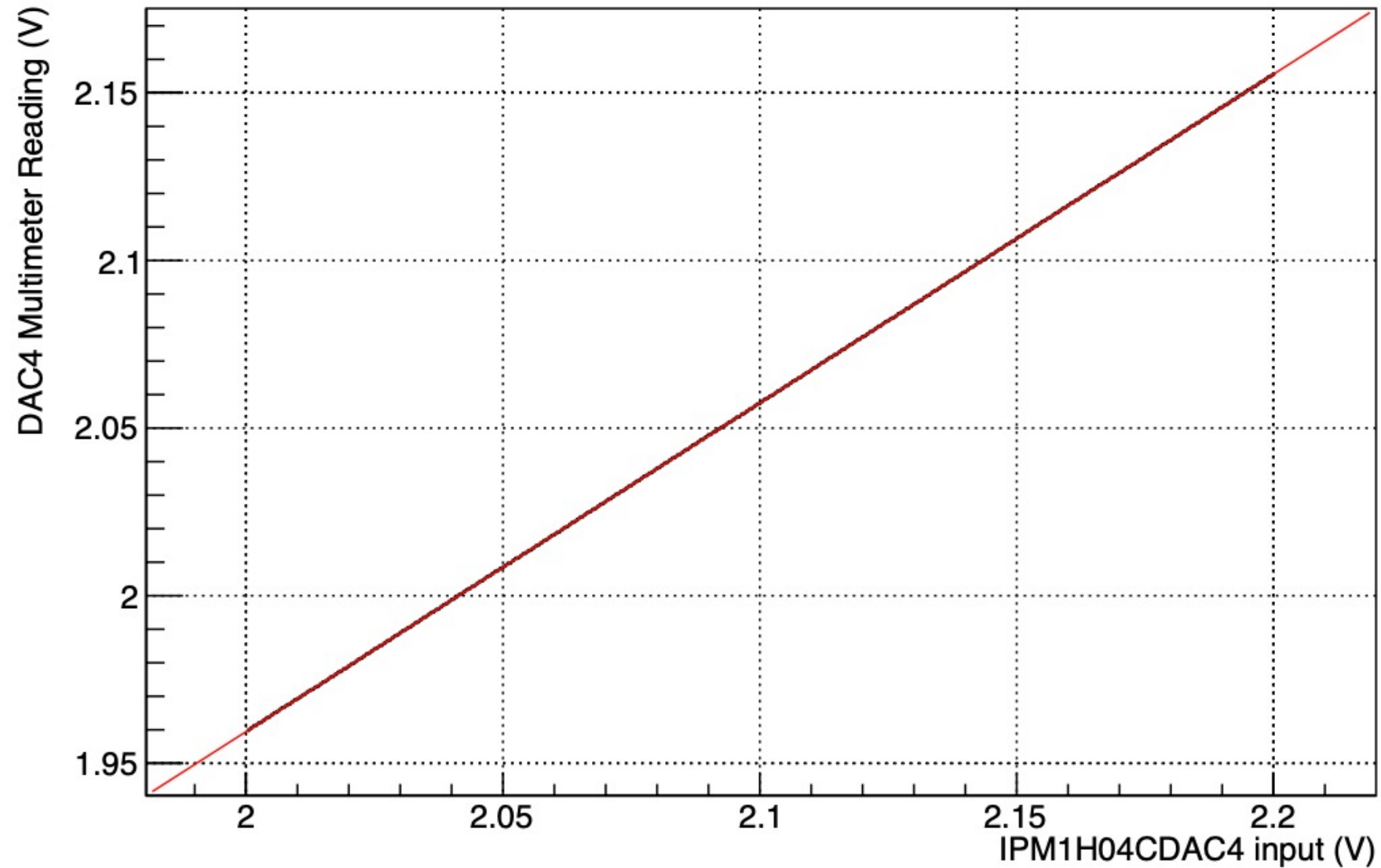
Part of data just to show the pattern

IPM1H04CDAQ4	DAC4 Multimeter Reading	A_1-A_0
2.0000	1.9596	
2.0005	1.9599	0.0003
2.0010	1.9605	0.0006
2.0015	1.9611	0.0006
2.0020	1.9614	0.0003
2.0025	1.9620	0.0006
2.0030	1.9623	0.0003
2.0035	1.9629	0.0006
2.0040	1.9635	0.0006
2.0045	1.9638	0.0003
2.0050	1.9644	0.0006
2.0055	1.9650	0.0006
2.0060	1.9653	0.0003
2.0065	1.9659	0.0006
2.0070	1.9665	0.0006
2.0075	1.9668	0.0003
2.0080	1.9674	0.0006
2.0085	1.9677	0.0003
2.0090	1.9683	0.0006
2.0095	1.9689	0.0006
2.0100	1.9692	0.0003
2.0105	1.9697	0.0005
2.0110	1.9703	0.0006
2.0115	1.9707	0.0004
2.0120	1.9713	0.0006
2.0125	1.9718	0.0005

Cav4c Digital Receiver's DAC4 Output Residual vs Input (Shown in December)

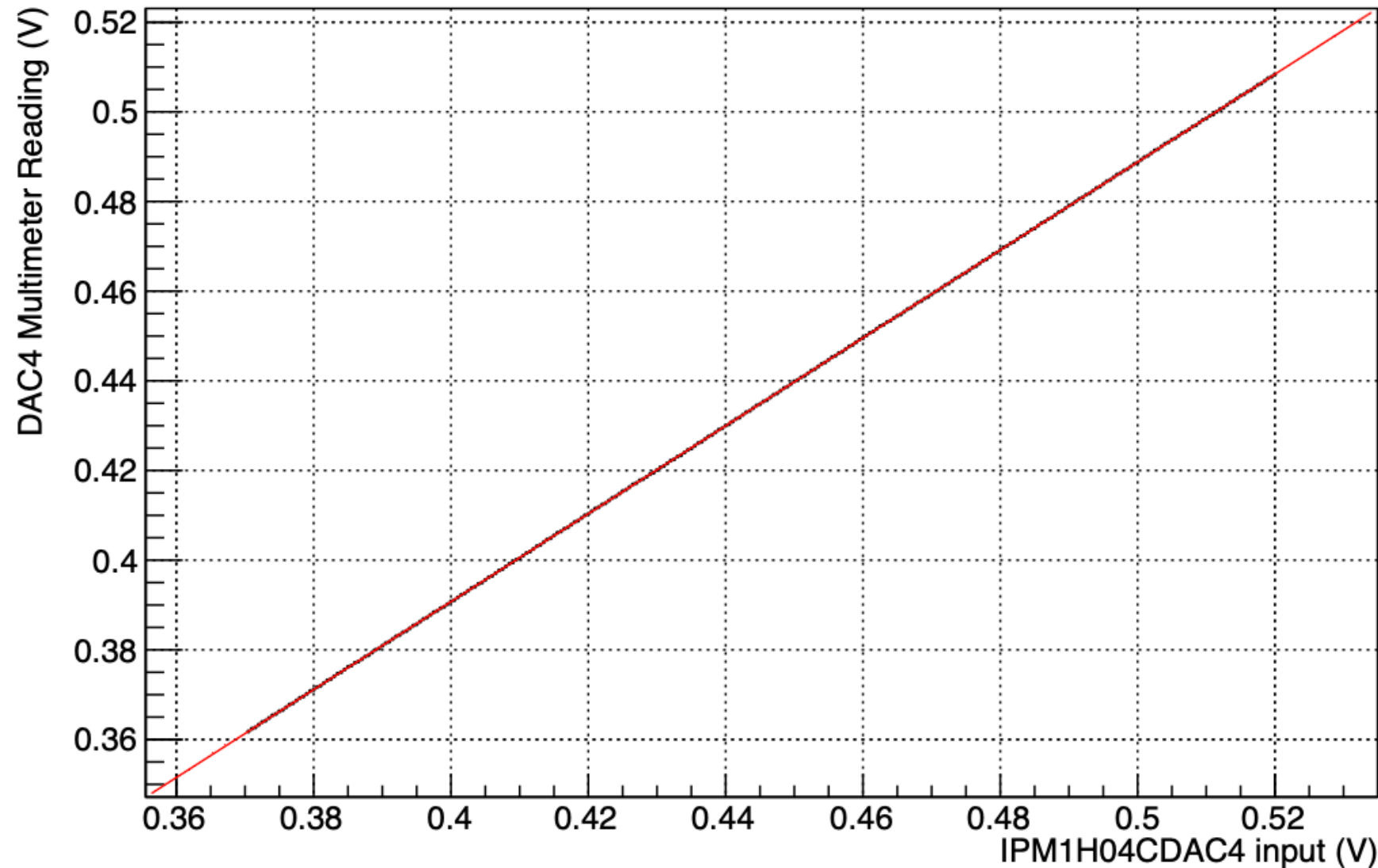DAC4 Multimeter Reading Residual vs IPM1H04CDAC4 input

- Residual = data – linear fit
- Two observations:
  - A specific pattern is seen
  - Periodic peaks are seen up to ±0.01 %.

Recommendations from December Meeting

1. Conduct a scan of the digital receiver's output with the multimeter at a lower voltage level, approximately 0.5 V. It's important to note that the previous scan was performed at around 2 V, while the parity runs were taken at the 0.5 V level.

2. Adjust the digital receiver's gain and take parity data at a higher voltage level, say 5 or 6V.

Cav4c Digital Receiver's DAC4 Output vs Input (Shown in December)

## DAC4 Multimeter Reading vs IPM1H04CDAC4 input

Part of data just to show the pattern

IPM1H04CDAQ4	DAC4 Multimeter Reading	A_1-A_0
0.3700	0.3612	
0.3705	0.3618	0.0006
0.3710	0.3624	0.0006
0.3715	0.3627	0.0003
0.3720	0.3633	0.0006
0.3725	0.3639	0.0006
0.3730	0.3642	0.0003
0.3735	0.3648	0.0006
0.3740	0.3654	0.0006
0.3745	0.3657	0.0003
0.3750	0.3663	0.0006
0.3755	0.3666	0.0003
0.3760	0.3672	0.0006
0.3765	0.3678	0.0006
0.3770	0.3681	0.0003
0.3775	0.3687	0.0006
0.3780	0.3693	0.0006
0.3785	0.3696	0.0003
0.3790	0.3702	0.0006
0.3795	0.3708	0.0006
0.3800	0.3711	0.0003
0.3805	0.3717	0.0006
0.3810	0.3720	0.0003
0.3815	0.3726	0.0006
0.3820	0.3732	0.0006
0.3825	0.3735	0.0003

Cav4c Digital Receiver's DAC4 Output Residual vs Input (Shown in December)

DAC4 Multimeter Reading Residual vs IPM1H04CDAC4 input
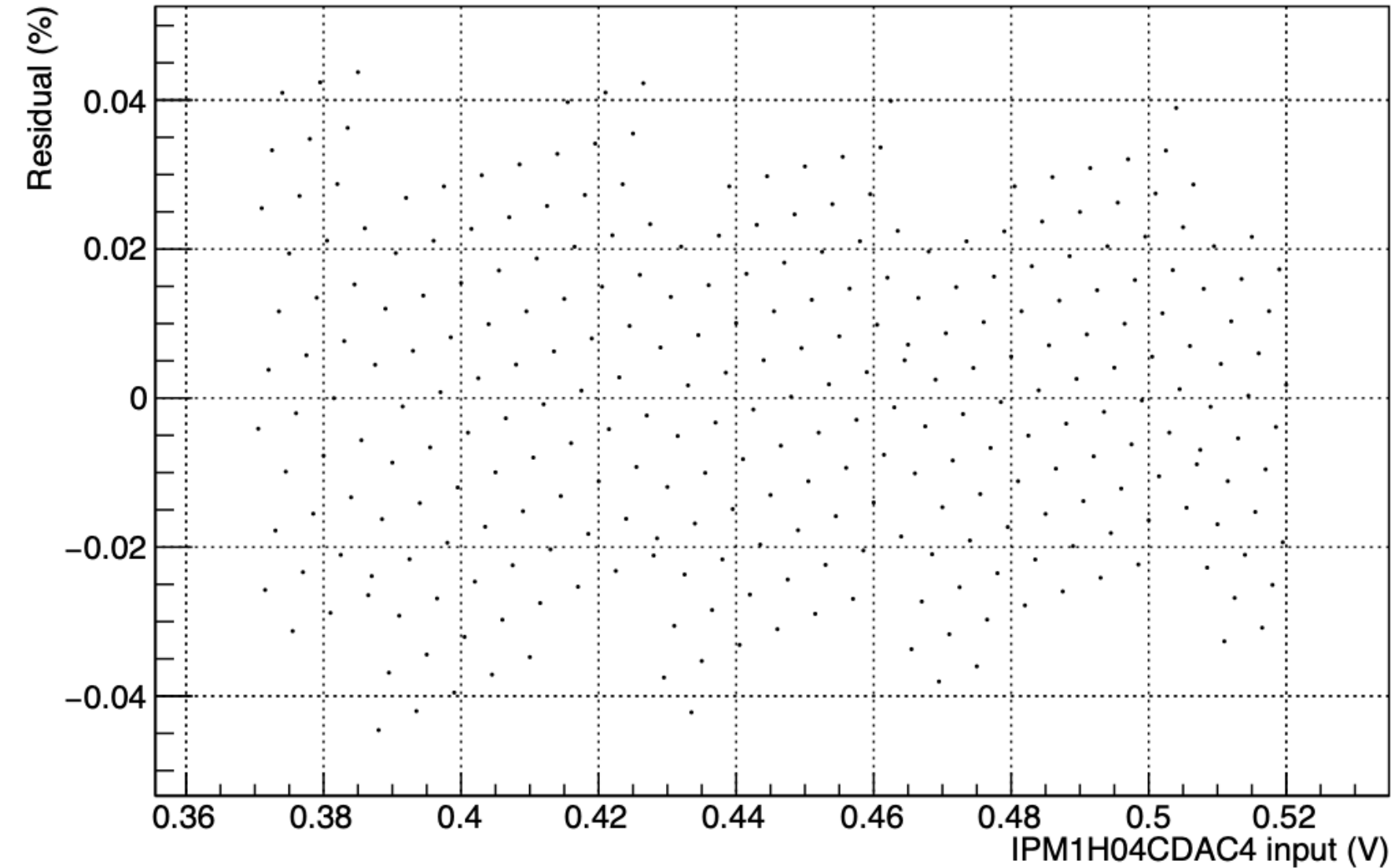
- Residual = data – linear fit
- Observations:
  - The pattern remains the same as in higher (2 V) output case
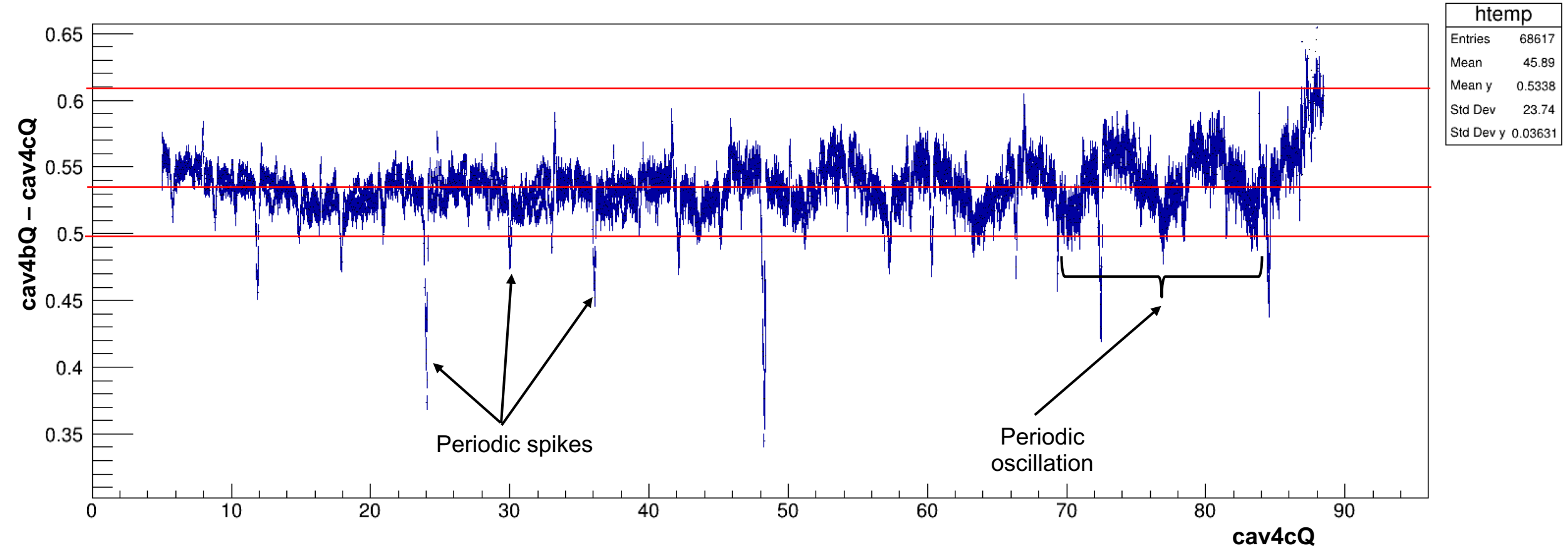 - Periodic peaks are larger ±0.04 % (a factor of four).

What Next?

1. Adjust the digital receiver's gain and take parity data at a higher voltage level, say 5 or 6V, using RF source.

Thank You

🙏

Double difference profile plot between cav4bQ and cav4cQ

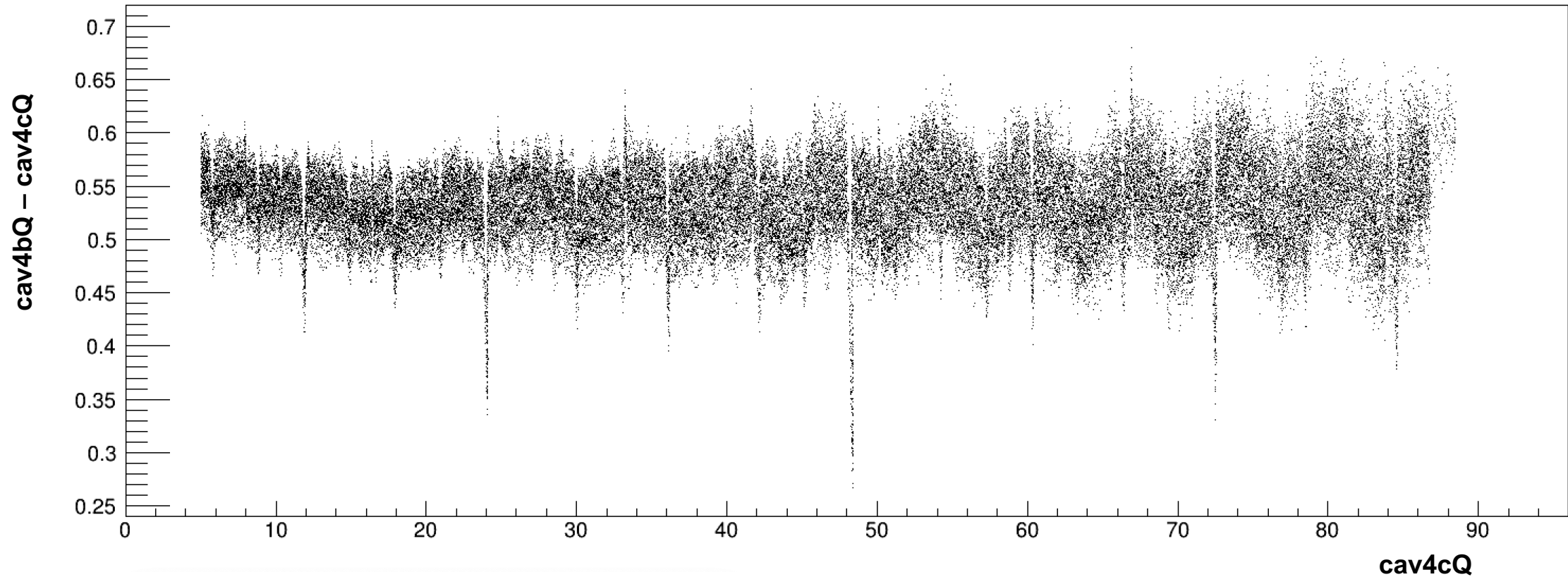cav4bQ/1.265-cav4cQ/0.9:cav4cQ {CodaEventNumber>36.28e3&&cav4cQ>5}

htemp	
Entries	68617
Mean	45.89
Mean y	0.5338
Std Dev	23.74
Std Dev y	0.03631

Periodic spikes

Periodic oscillation

Two important features are observed:
1. Periodic spikes
2. Periodic oscillation, whose amplitude increases as a function of current
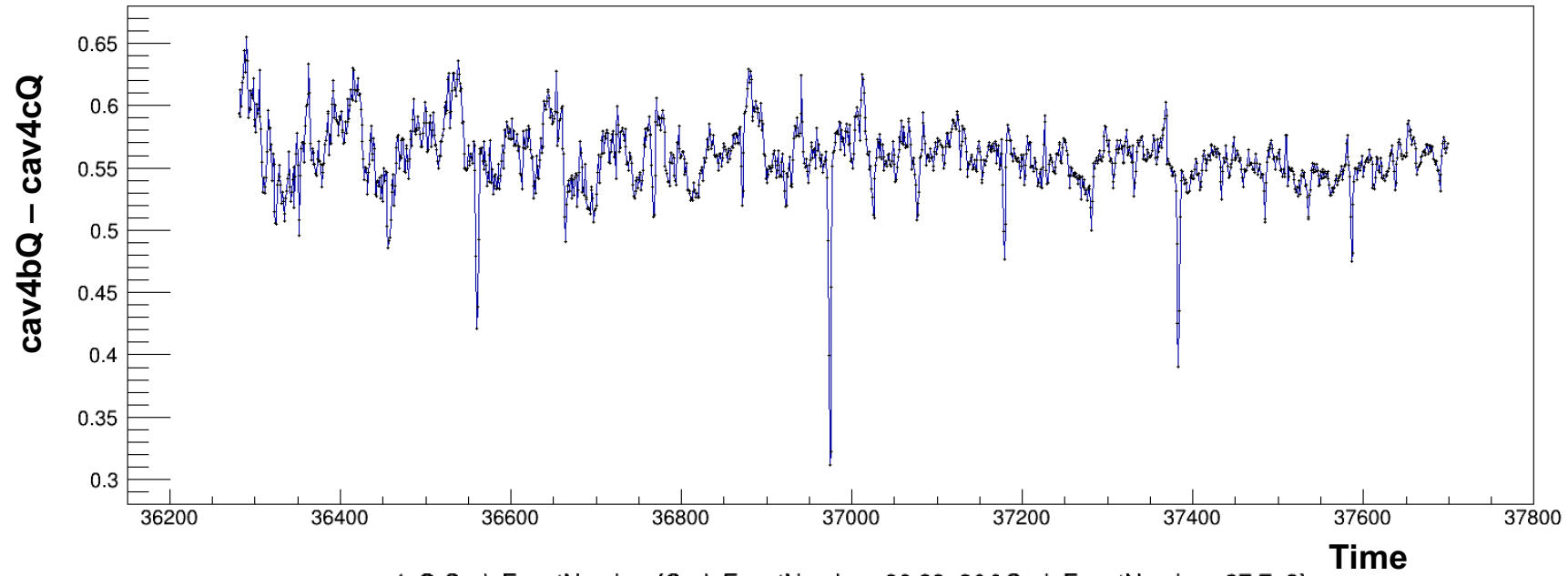3. ~0.1% differential nonlinearity

Double difference profile plot between cav4bQ and cav4cQ

cav4bQ/1.265-cav4cQ/0.9:cav4cQ {CodaEventNumber>36.28e3&&cav4cQ>5}

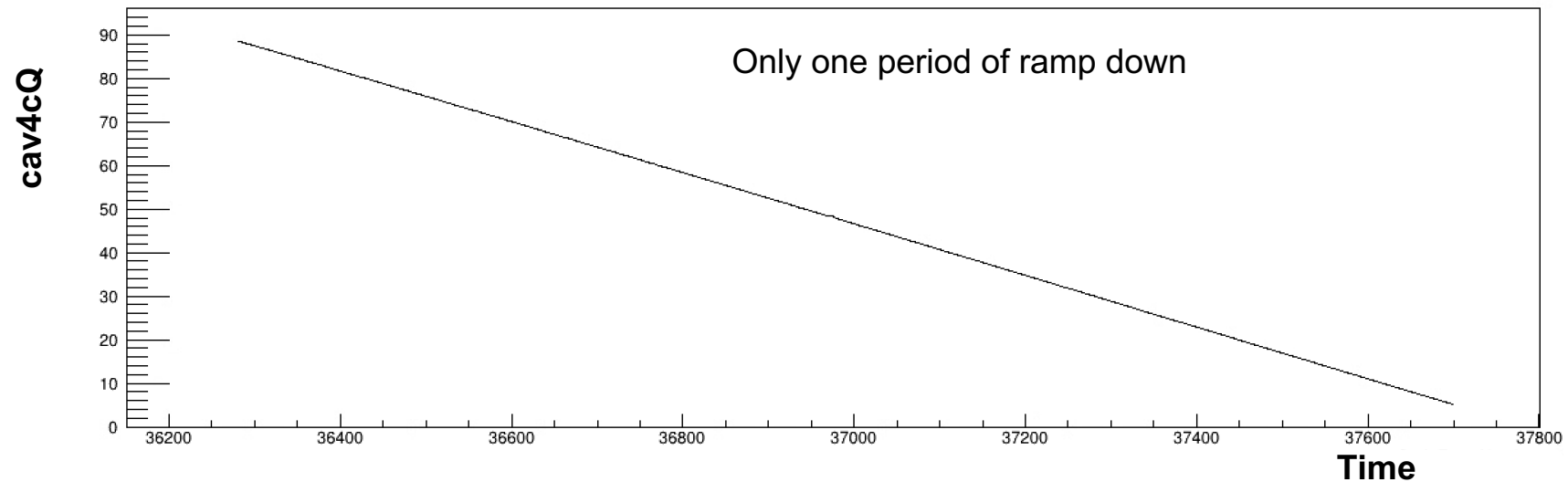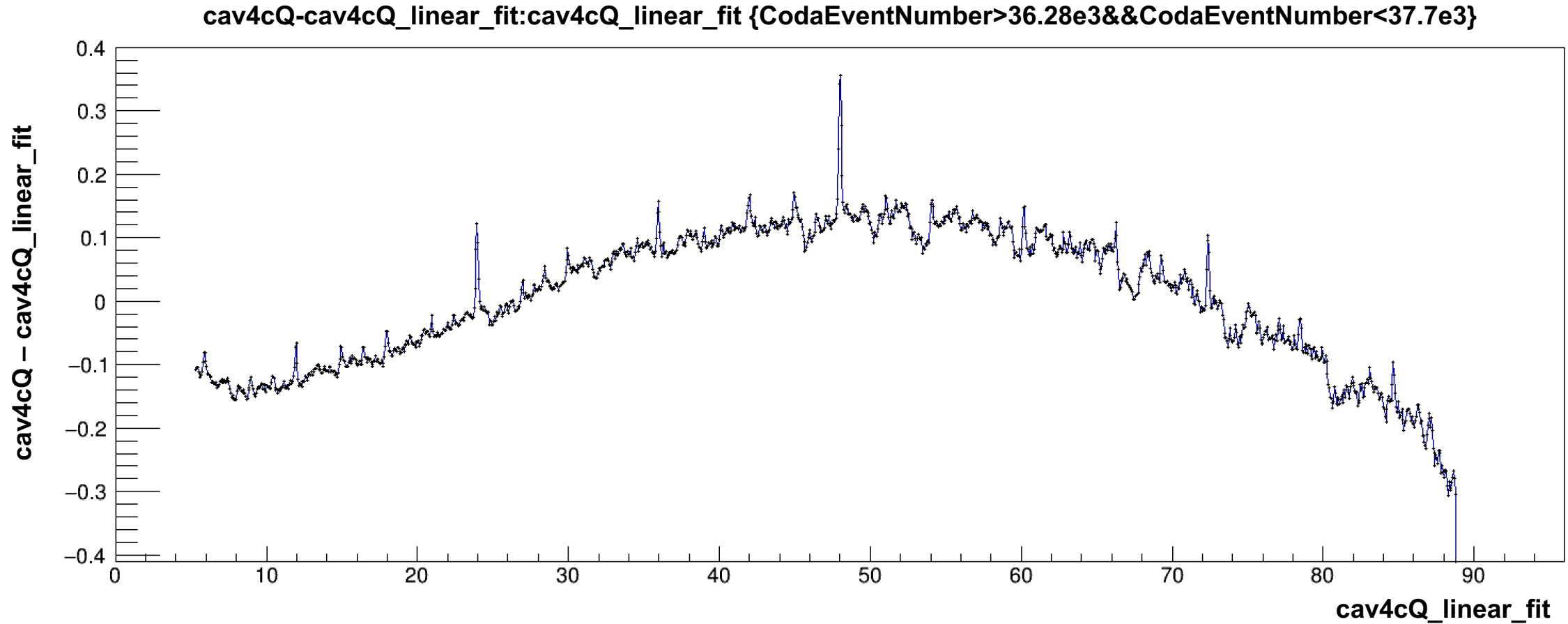# Double difference between cav4bQ and cav4cQ over time

cav4bQ/1.265-cav4cQ/0.9:CodaEventNumber {CodaEventNumber>36.28e3&&CodaEventNumber<37.7e3}

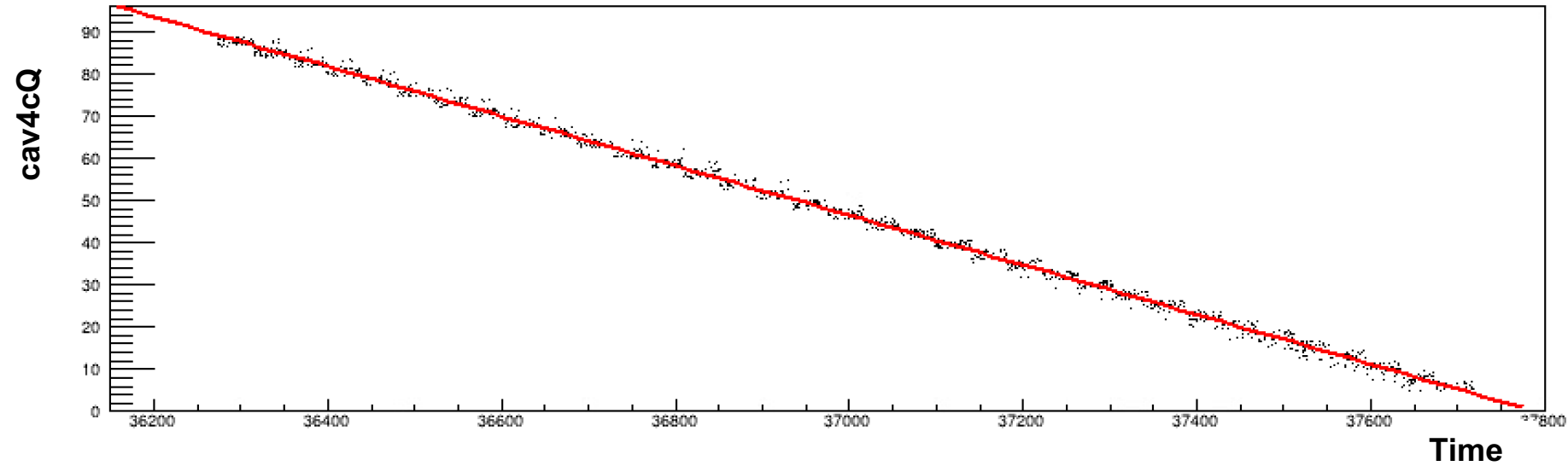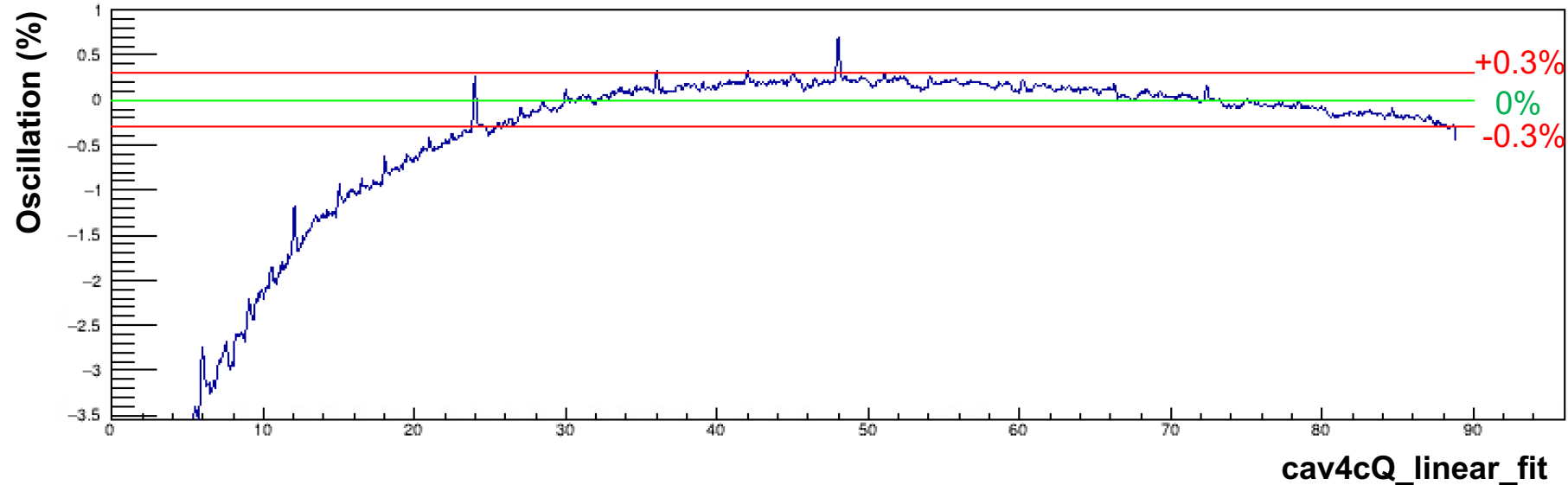cav4cQ:CodaEventNumber {CodaEventNumber>36.28e3&&CodaEventNumber<37.7e3}

Only one period of ramp down

Residual plot for cav4cQ

cav4cQ-cav4cQ_linear_fit:cav4cQ_linear_fit {CodaEventNumber>36.28e3&&CodaEventNumber<37.7e3}

cav4cQ sees up to 0.3 % level of amplitude oscillation for 25 µA – 90 µA
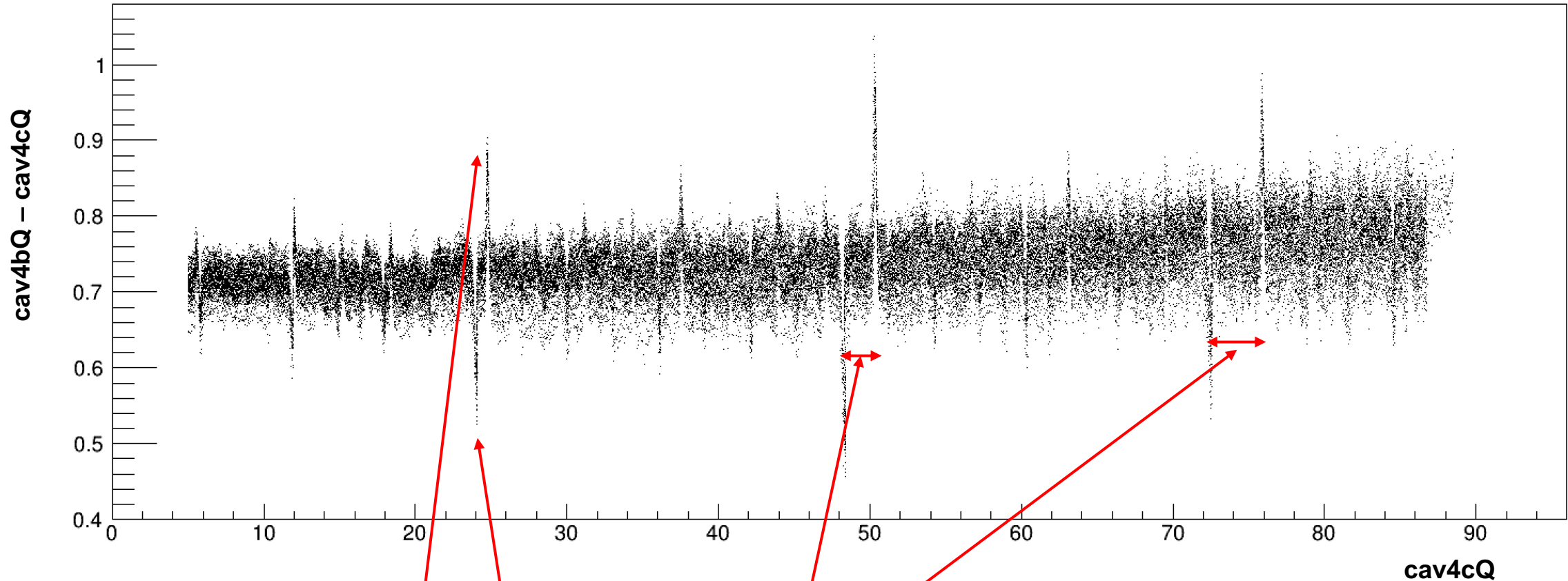
Double difference profile plot between cav4dQ and cav4cQ

Double difference scatter plot between cav4dQ and cav4cQ

cav4dQ/1.096-cav4cQ/0.9:cav4cQ {CodaEventNumber>36.28e3&&cav4cQ>5}

- Periodic spikes up and down; possibly the two receivers spike at different times
- The gap between the up and down spikes gets larger as the current increase
- A larger spike appears after a few smaller spikes (periodically)