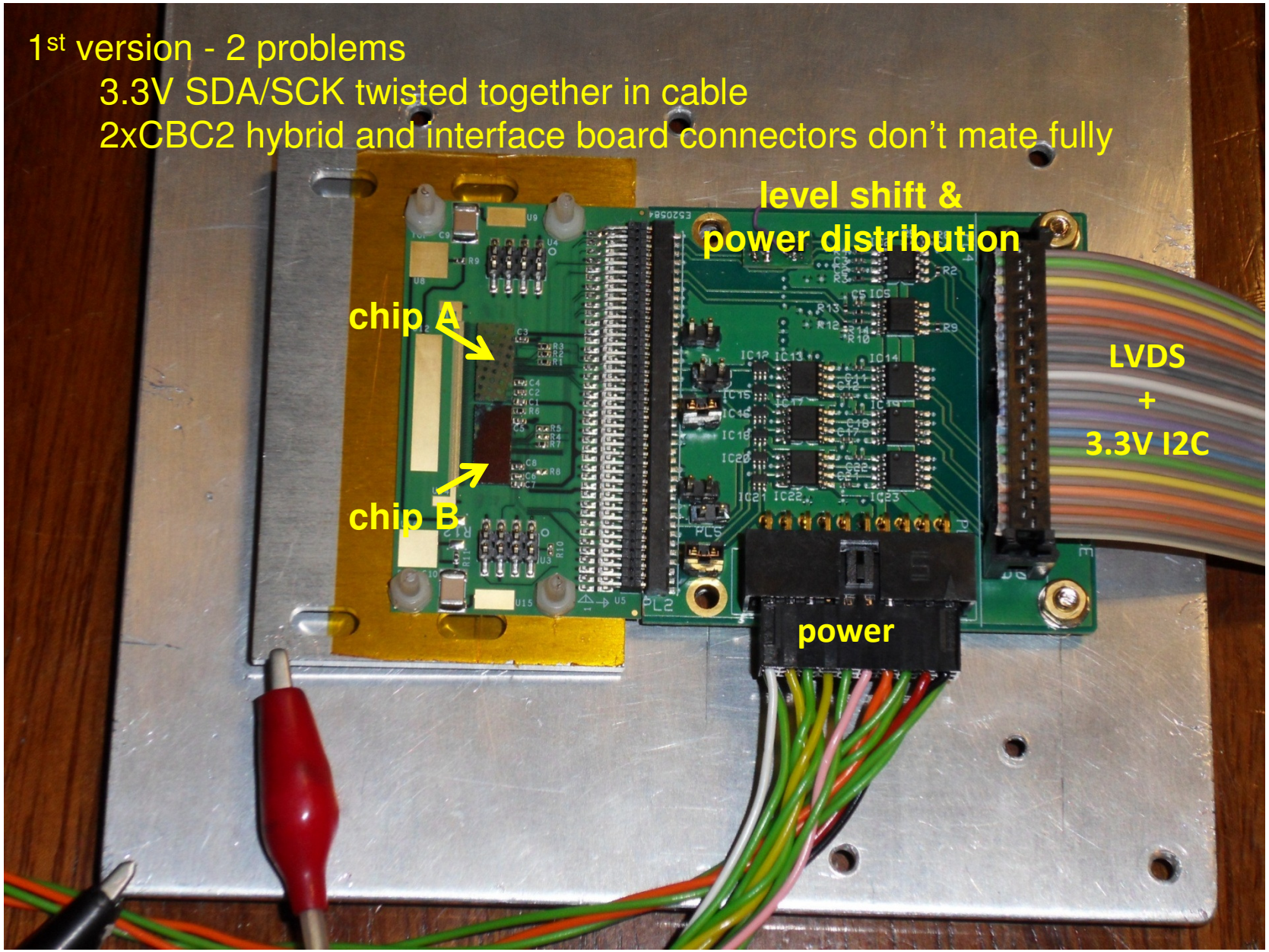
CBC2 hybrid & module testing

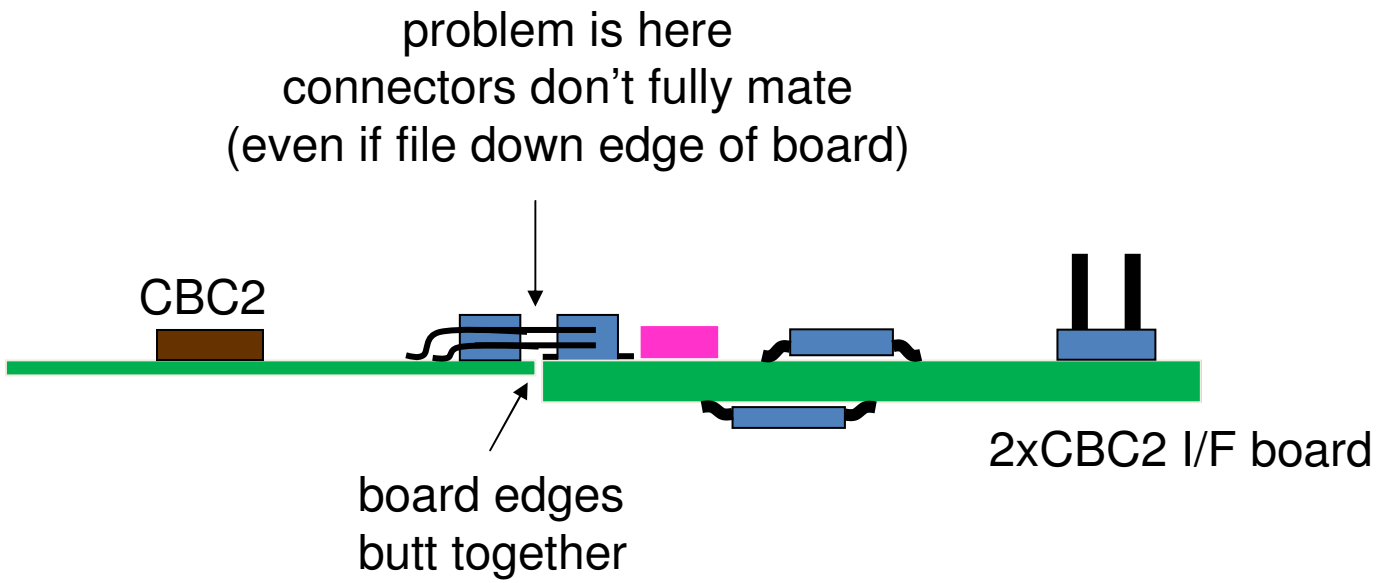
- update on 2xCBC2 hybrid interface card
- 2xCBC2 hybrid electrical test setup early results
- mini-pT module (Infineon sensors) early results

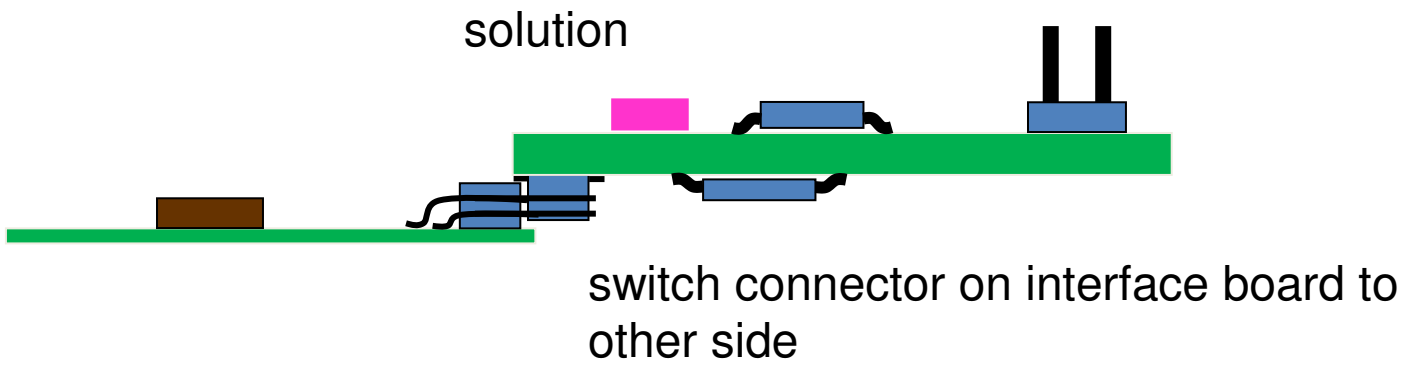
CMS Tk phase II electronics meeting – June 18th, 2013

2xCBC2 hybrid interface card

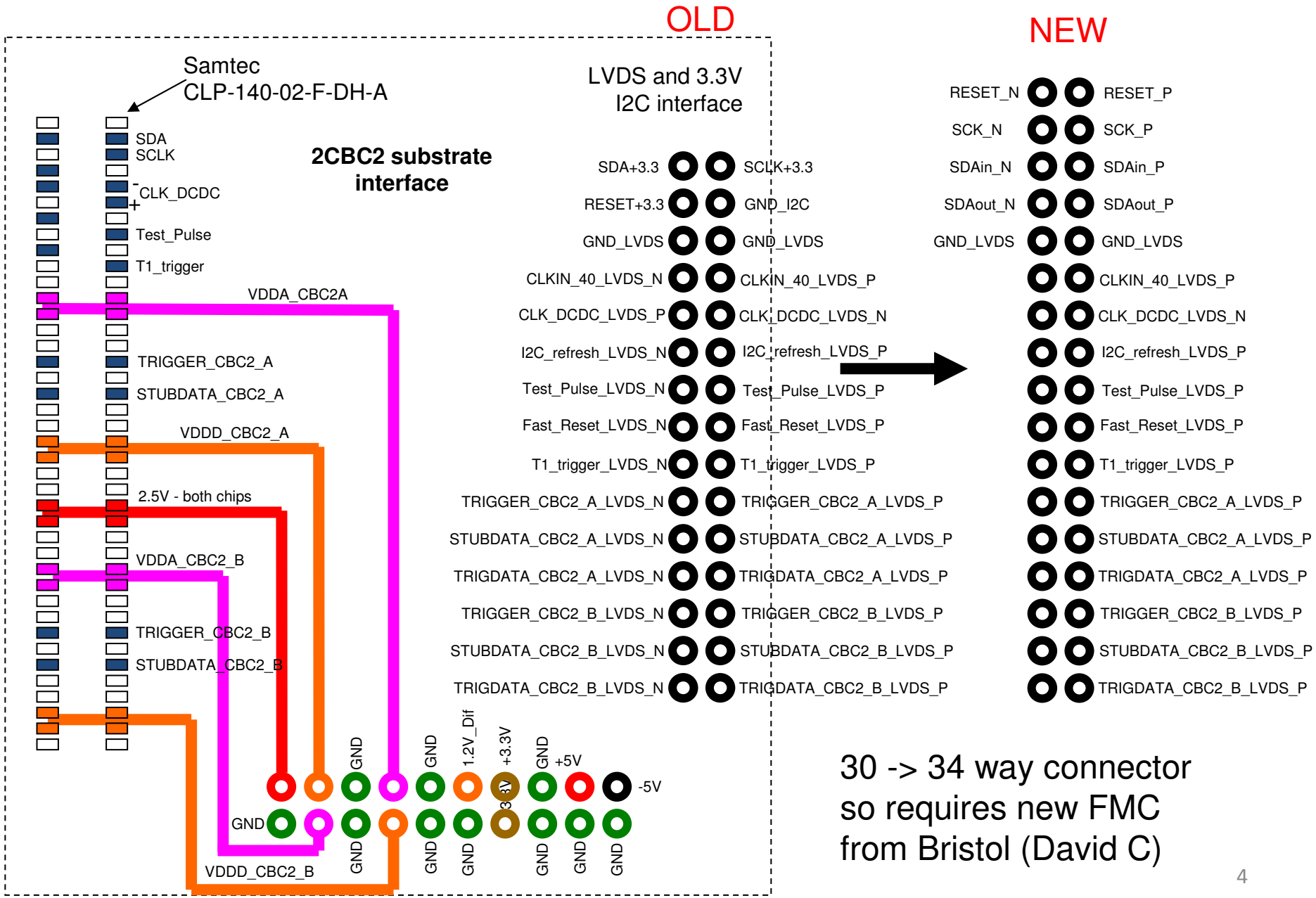


2xCBC2 hybrid interface card 1st version problems



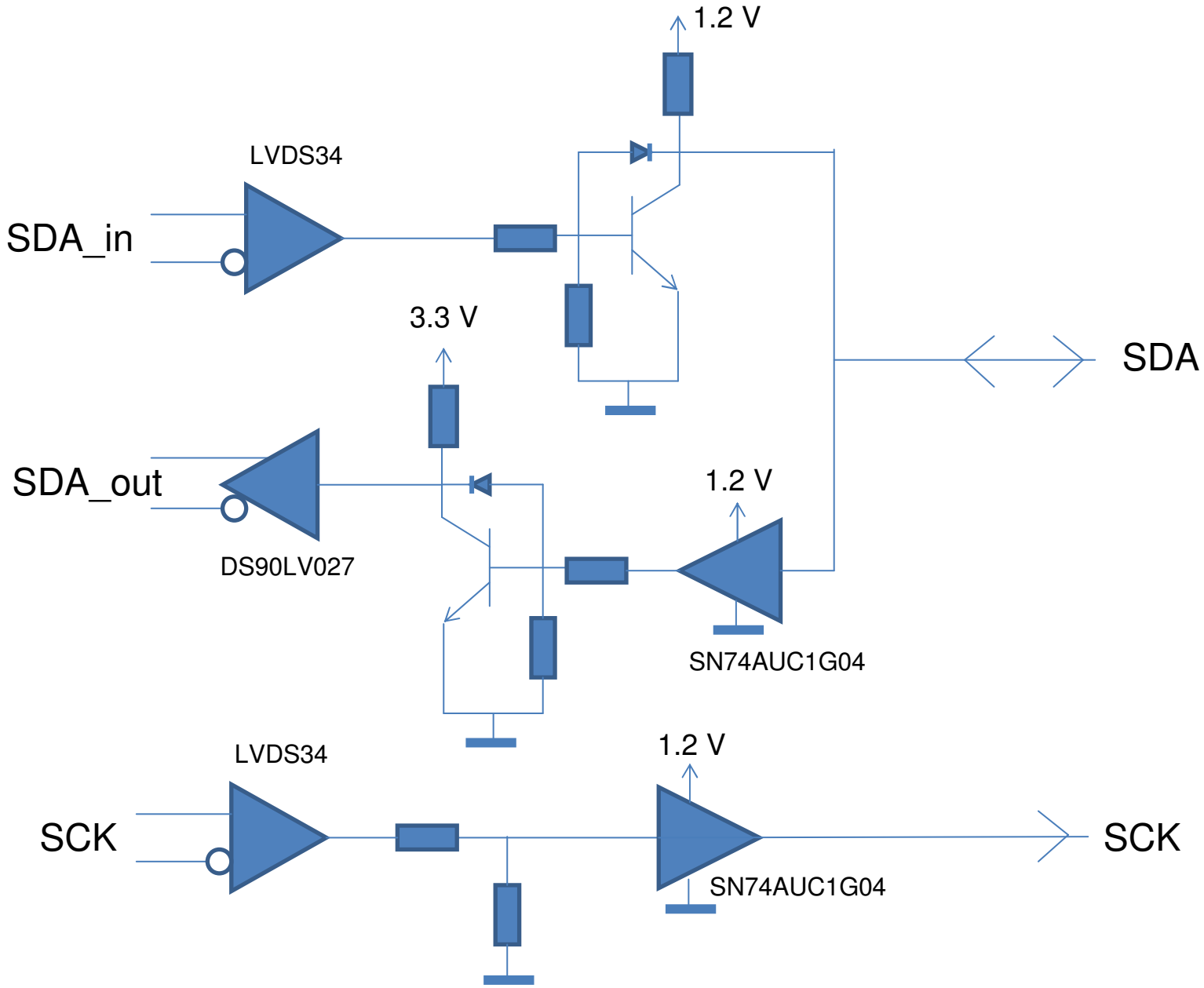


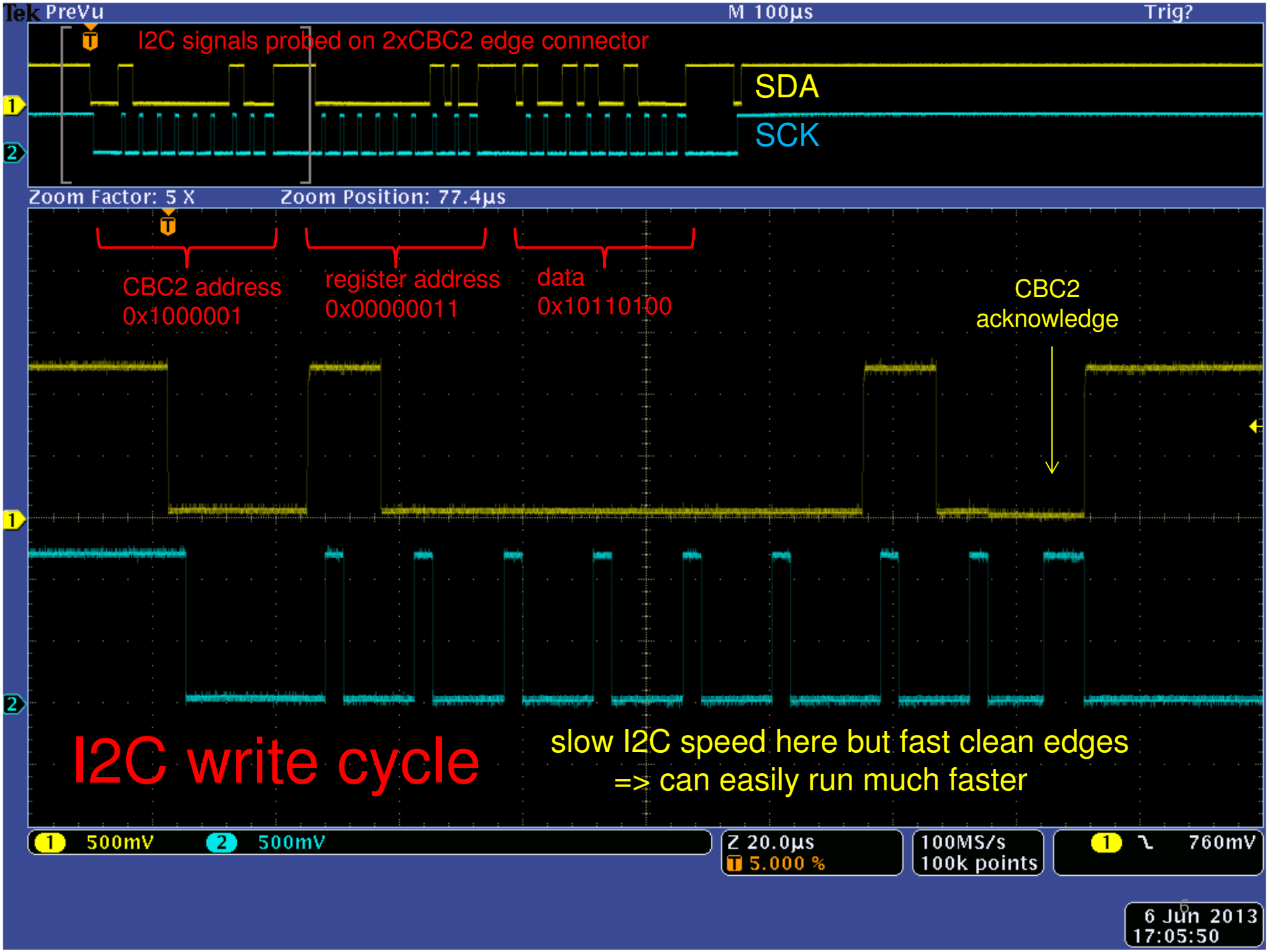
all interface signals now LVDS

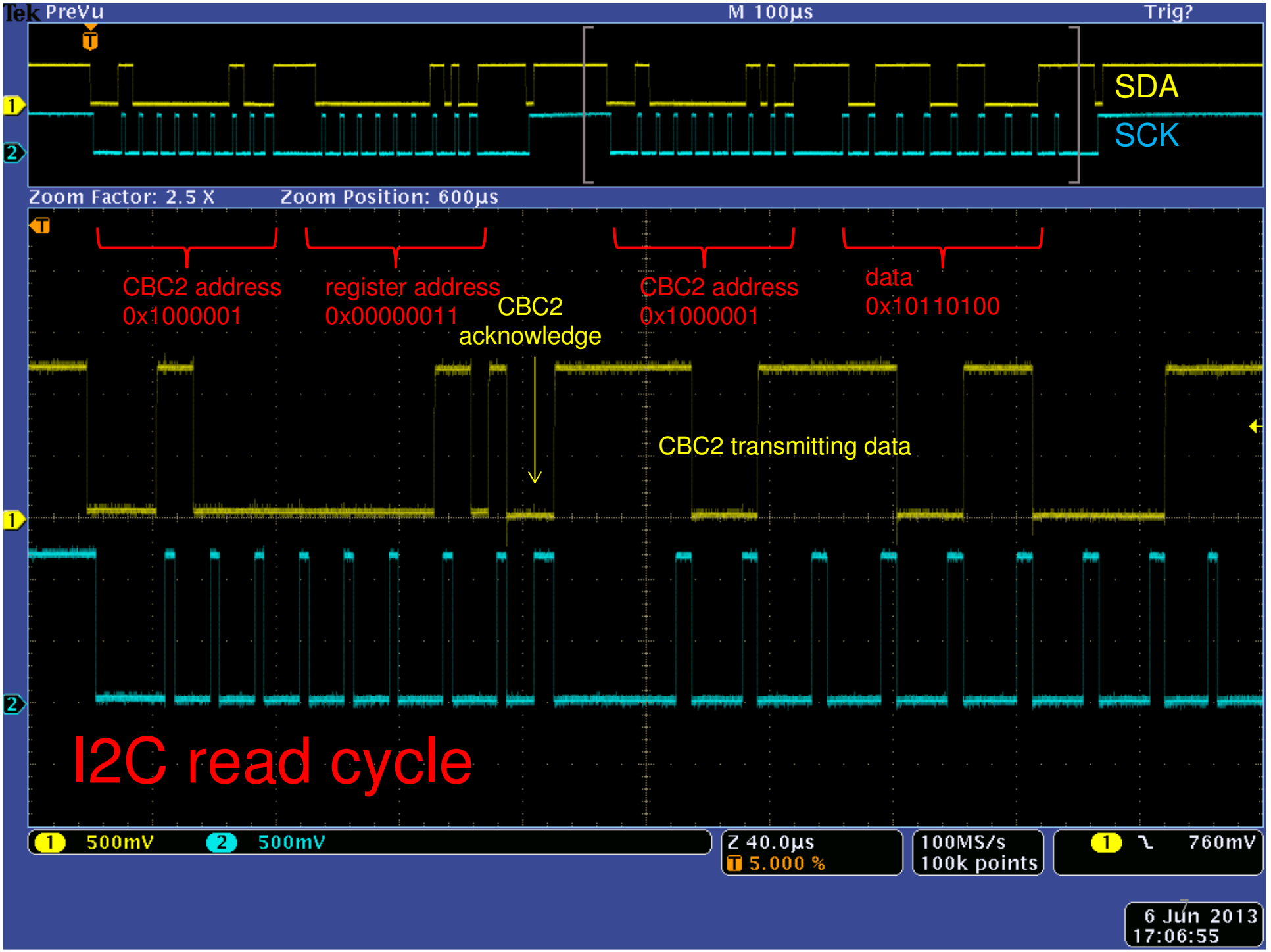


30 -> 34 way connector
so requires new FMC
from Bristol (David C)

new I2C interface on 2xCBC2 interface card

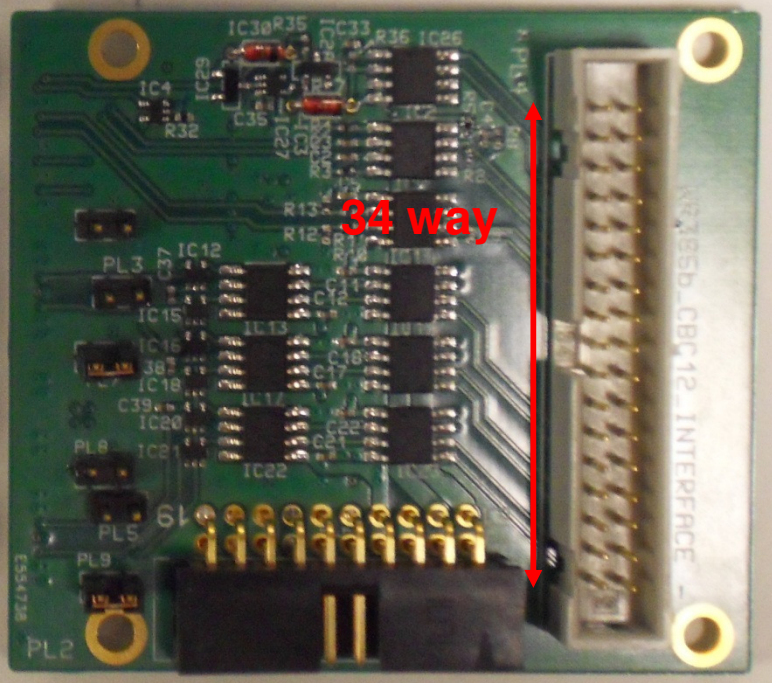



Tek PreVu
M 100µs
Trig?
I2C signals probed on 2xCBC2 edge connector
SDA
SCK
Zoom Factor: 5 X
Zoom Position: 77.4µs
CBC2 address
0x1000001
register address
0x00000011
data
0x10110100
CBC2
acknowledge
I2C write cycle
slow I2C speed here but fast clean edges
=> can easily run much faster
1 500mV
2 500mV
Z 20.0µs
T 5.000 %
100MS/s
100k points
1 760mV
6 Jun 2013
17:05:50


Tek PreVu
M 100µs
Trig?
SDA
SCK
Zoom Factor: 2.5 X
Zoom Position: 600µs
CBC2 address
0x1000001
register address
0x00000011
CBC2
acknowledge
CBC2 address
0x1000001
data
0x10110100
CBC2 transmitting data
I2C read cycle
1 500mV
2 500mV
Z 40.0µs
T 5.000 %
100MS/s
100k points
1 760mV
6 Jun 2013
17:06:55

old

new



2xCBC2 hybrid interface card summary

current status

should stop using 1st version 2xCBC2 interface cards
- only one outside IC
  - Bristol (David C) has complete 2xCBC2 hybrid/old interface card system to verify 1st FMC <-> GLIB system

3 new cards so far populated, more on the way
- up to 30 possible

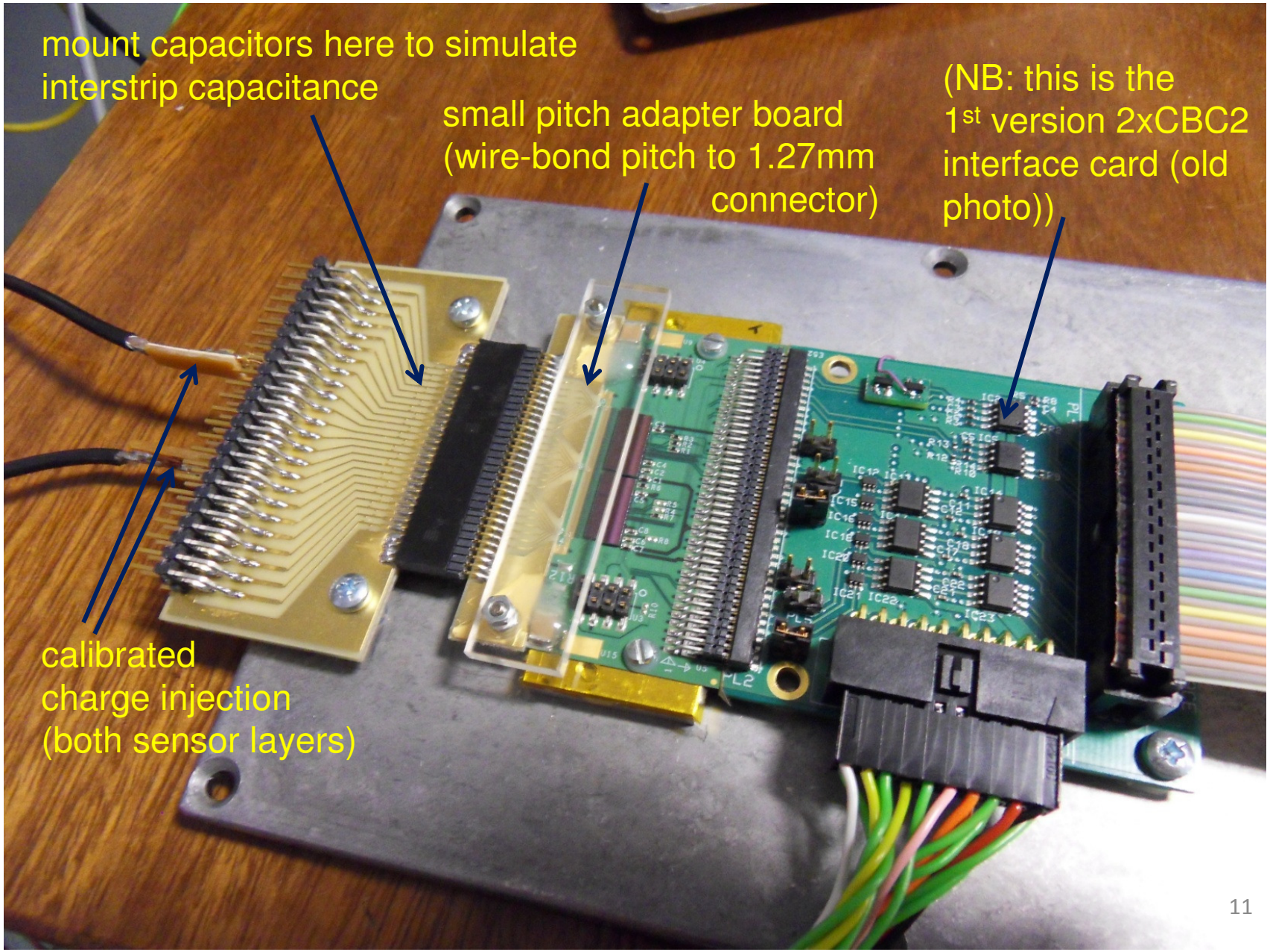
- 1 for mini-pT module
- 1 for 2xCBC2 electrical test setup

propose to pass 1 to Bristol to verify functionality with 2nd FMC version (available soon)

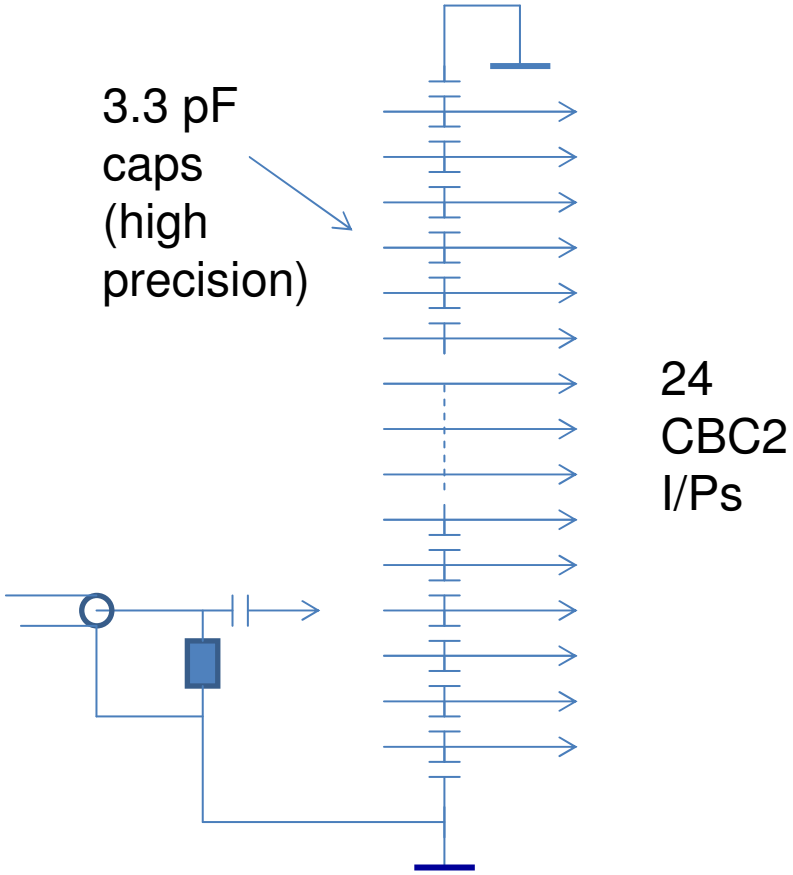
should develop plans for distributing 2xCBC2/interface card/FMC systems
- can we verify full chain functionality before handing over?

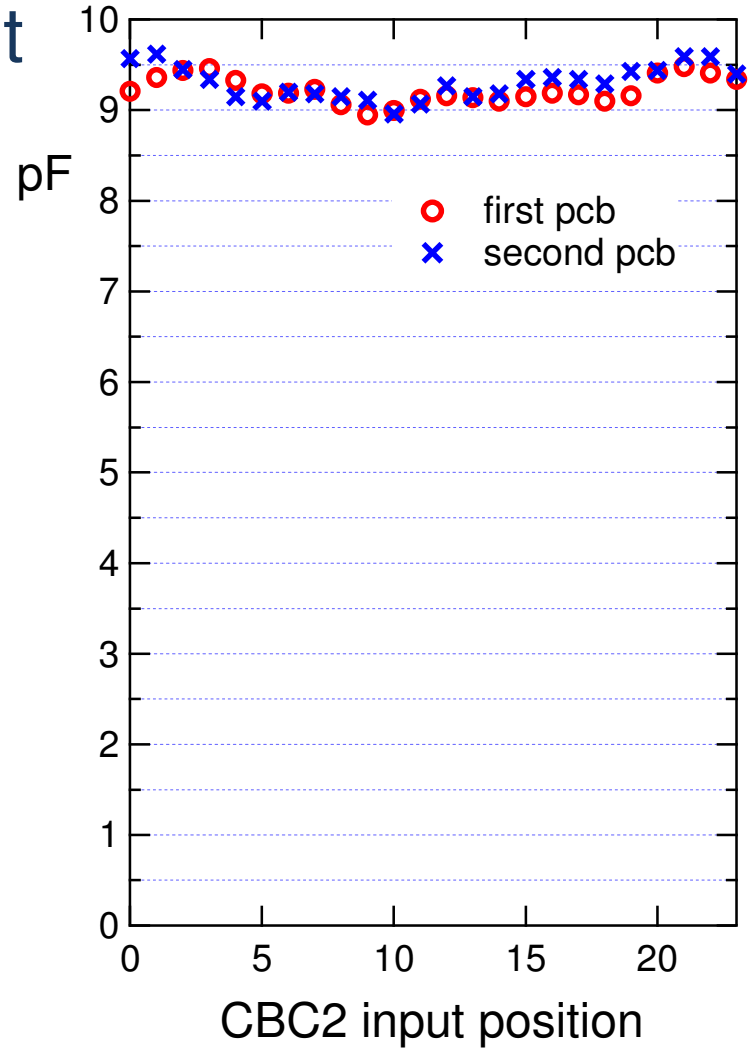
2xCBC2 electrical test setup

2xCBC2 electrical test setup



inter-channel cap. measurement





capacitance measured between centre position to 4 nearest neighbours both sides

quite uniform ~ 9.25 pF
(but doesn't include stray capacitance on small pitch adapter board or 2xCBC2 hybrid)

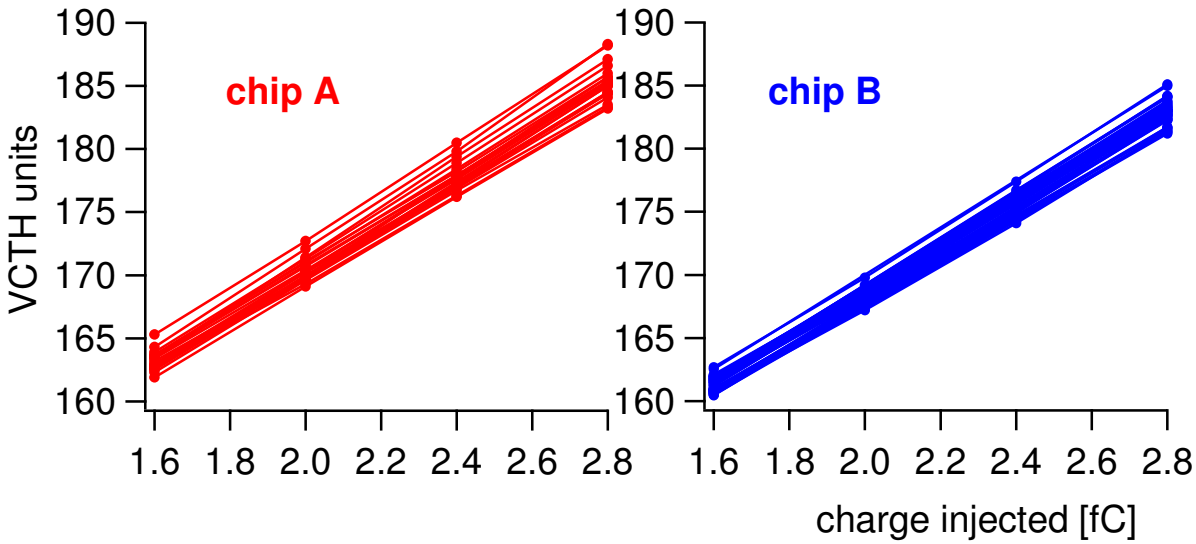
(other boards with different capacitors envisaged, but measurements only with this one at the moment)

gain measurements

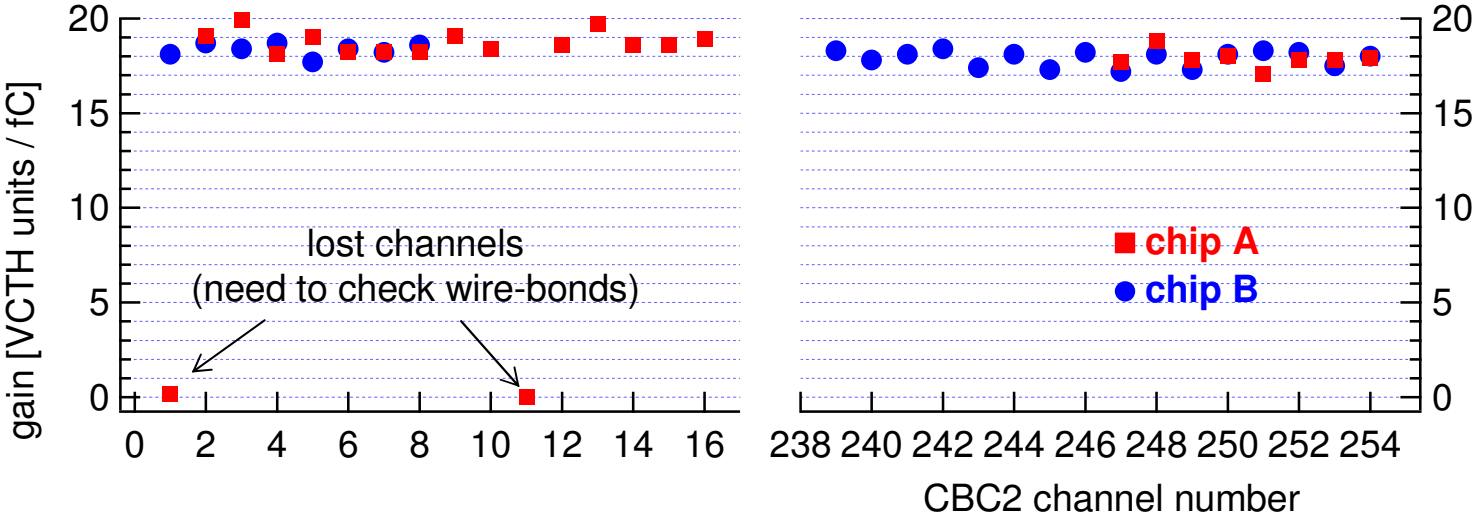
can now measure gain using known input signal

plot s-curve mid-points vs. charge

linear fit gives gain in comparator threshold units / fC



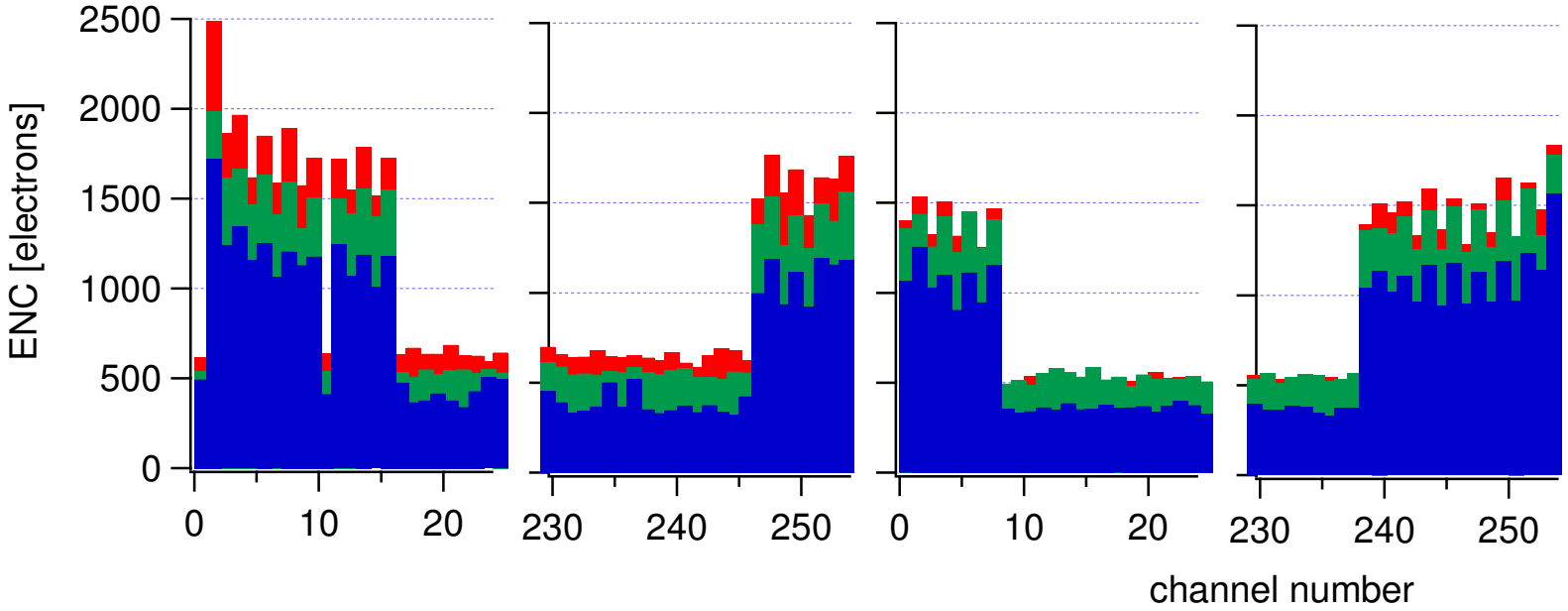
gain uniformity

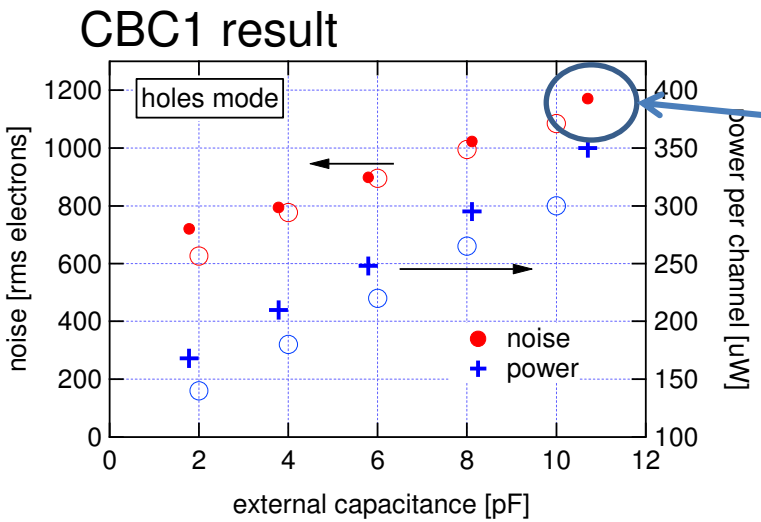


chip	min value	average	max value
A	17.1	18.4	19.9
B	17.2	18.0	18.7

+/- ~ 10% pk-pk spread

noise measurements





noise measured from s-curves acquired using different test-pulse amplitudes
- in the right region for measured capacitance

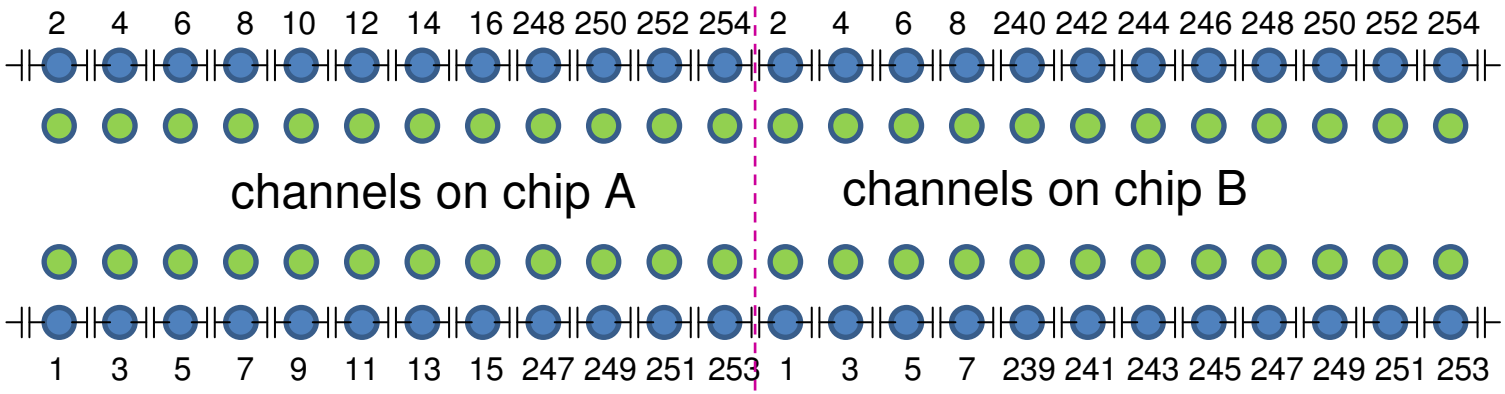
noise higher for larger TP amplitudes
- needs understanding - appears worse for chip A
- (probably test pulse generation related?)

systematic difference between upper and lower channels
- upper channels higher noise

some edge effects visible, but not at chip boundaries

crosstalk measurements

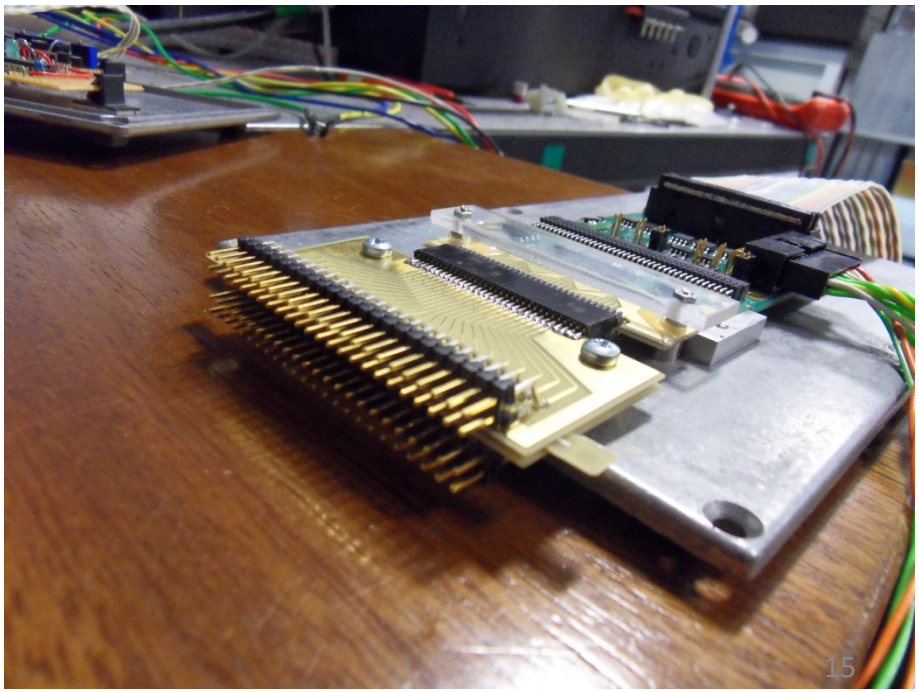
arrangement of channels on charge injection connectors



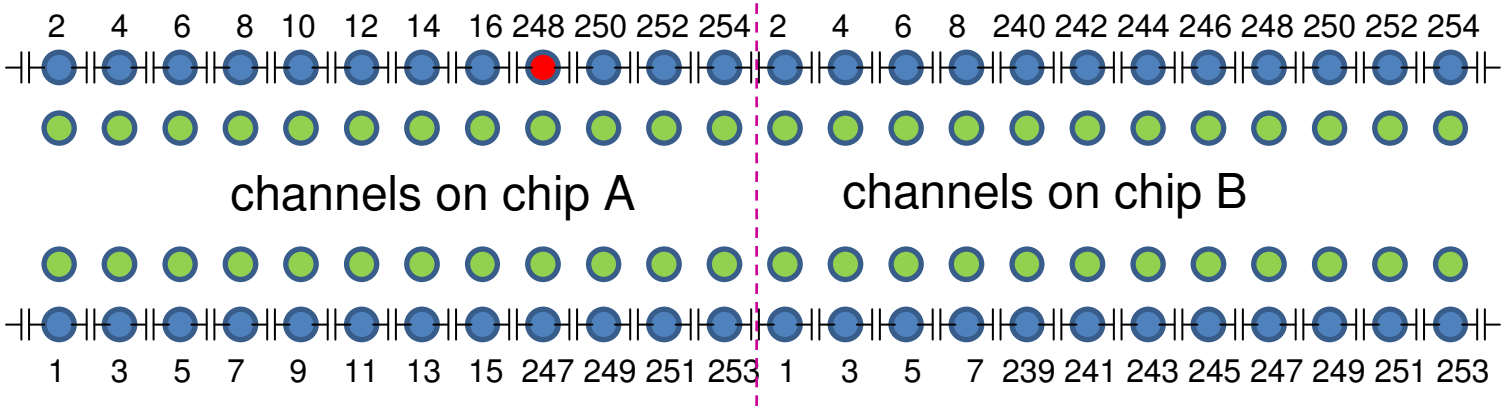
2 possibilities

crosstalk on chip
e.g. channel 7 talks to 6 and 8

crosstalk dominated by interchip C
channel 7 talks to 5 and 9

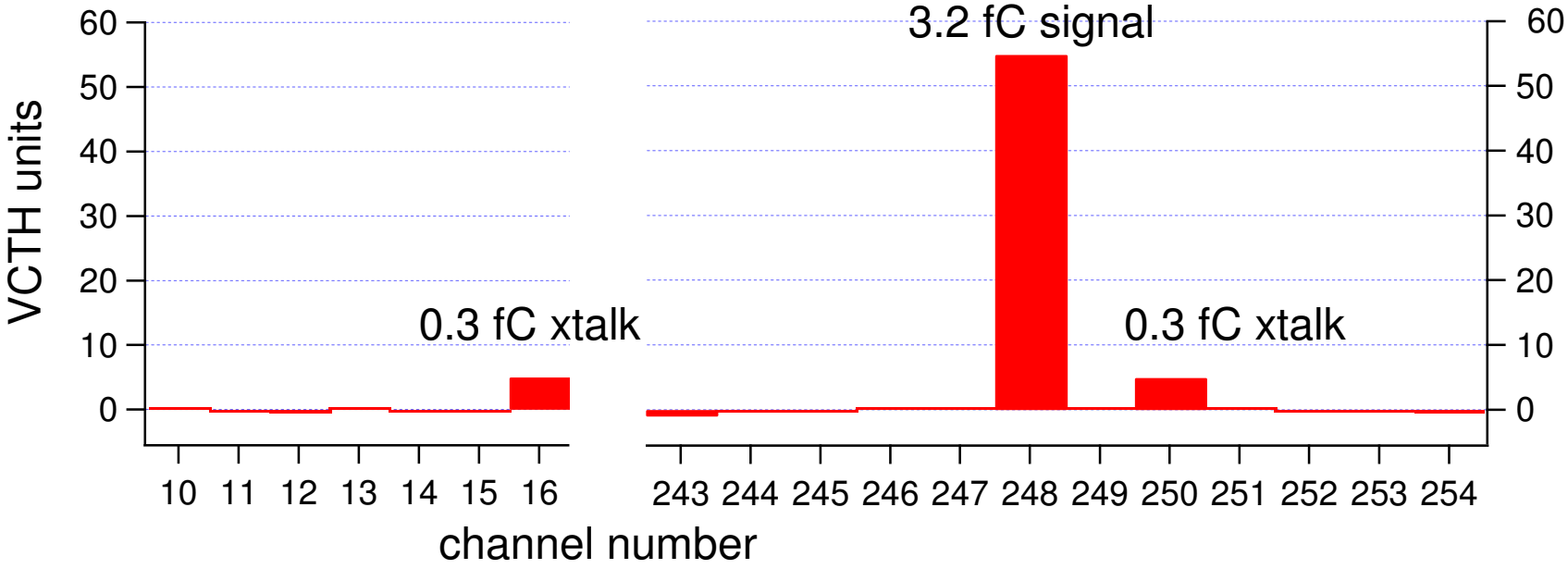


results(1)



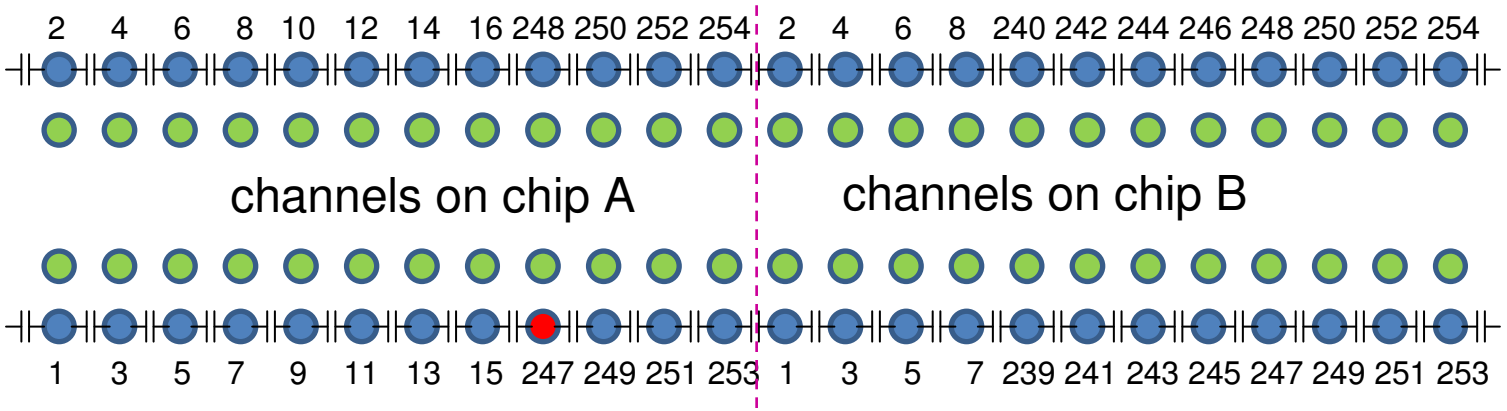
method

inject charge on chosen channel (e.g. chipA/chan248)
acquire s-curve and find mid-point
remove signal, re-acquire s-curve (mid-point = pedestal), subtract pedestal

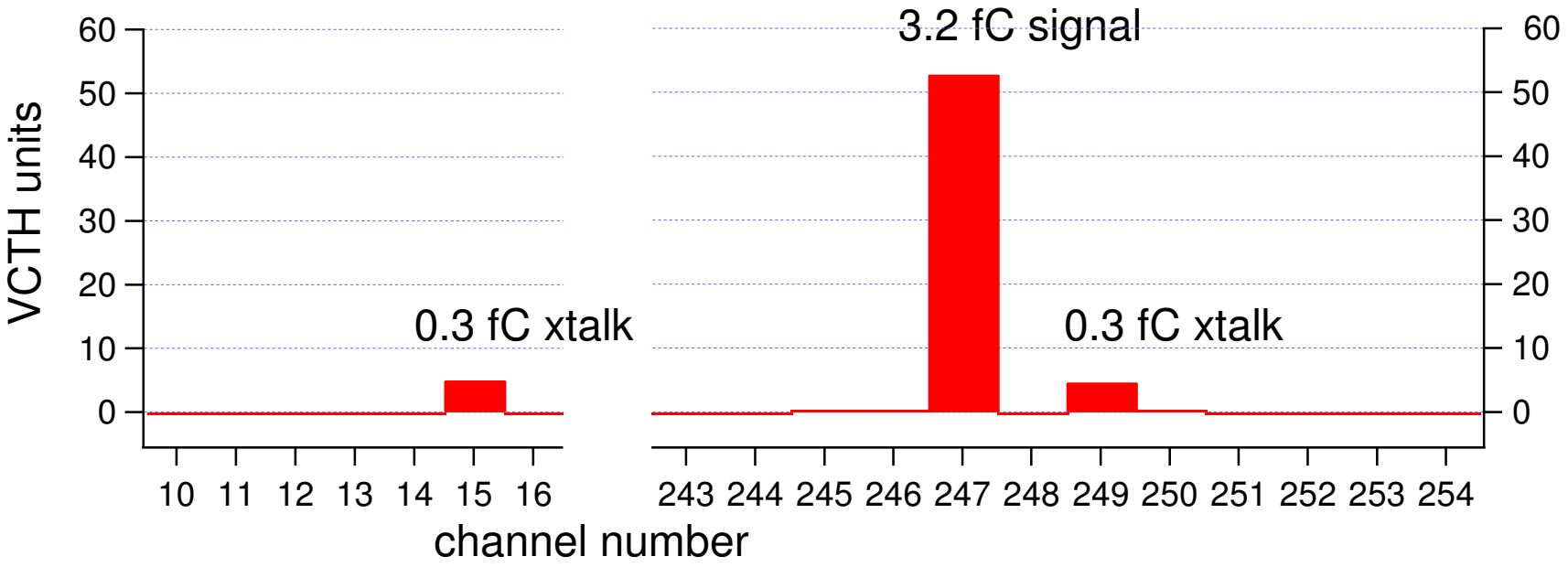


=> all significant crosstalk due to interstrip C, ~9% to nearest neighbour

results(2)

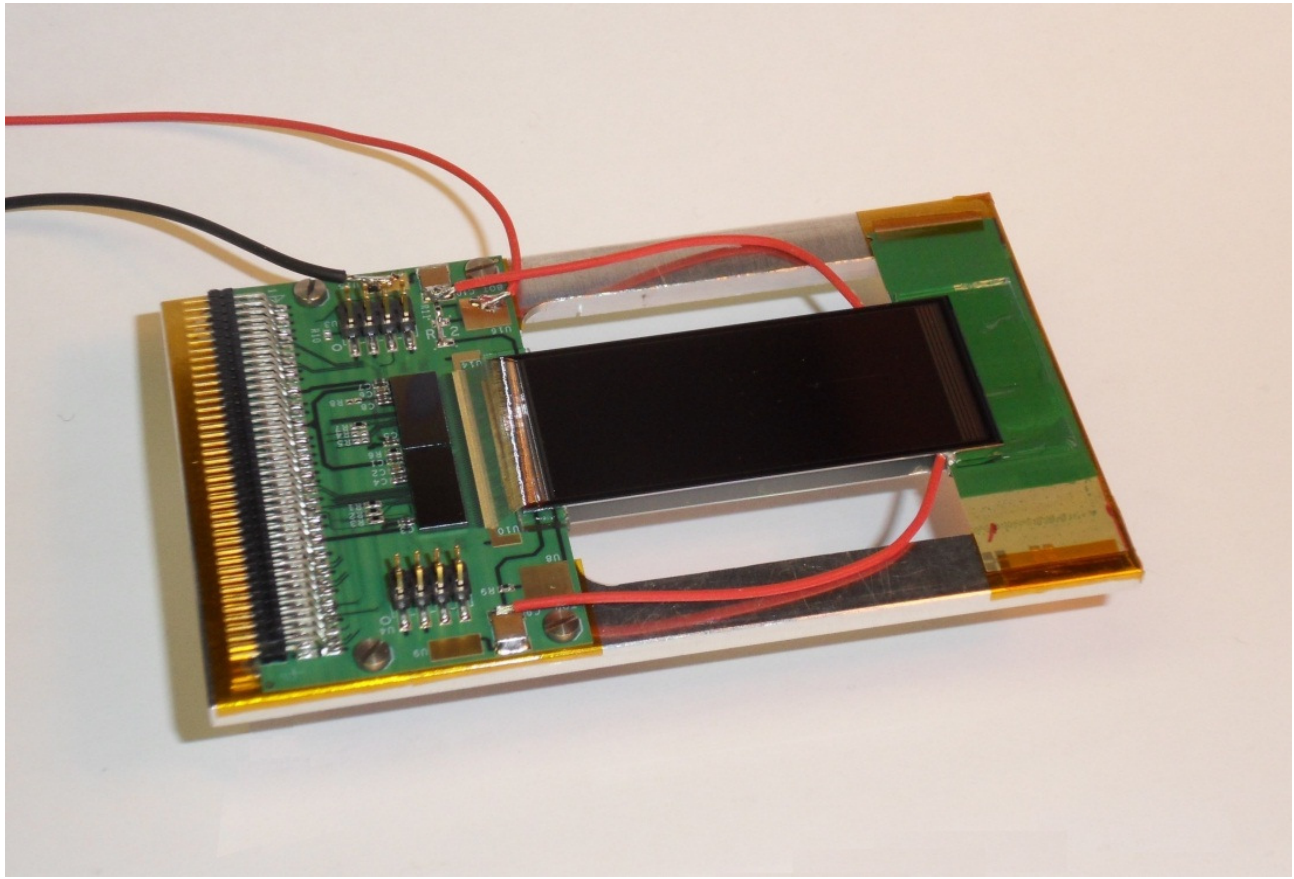


any significant difference if inject signal on lower layer?



=> no

2xCBC2 pT mini-module first results

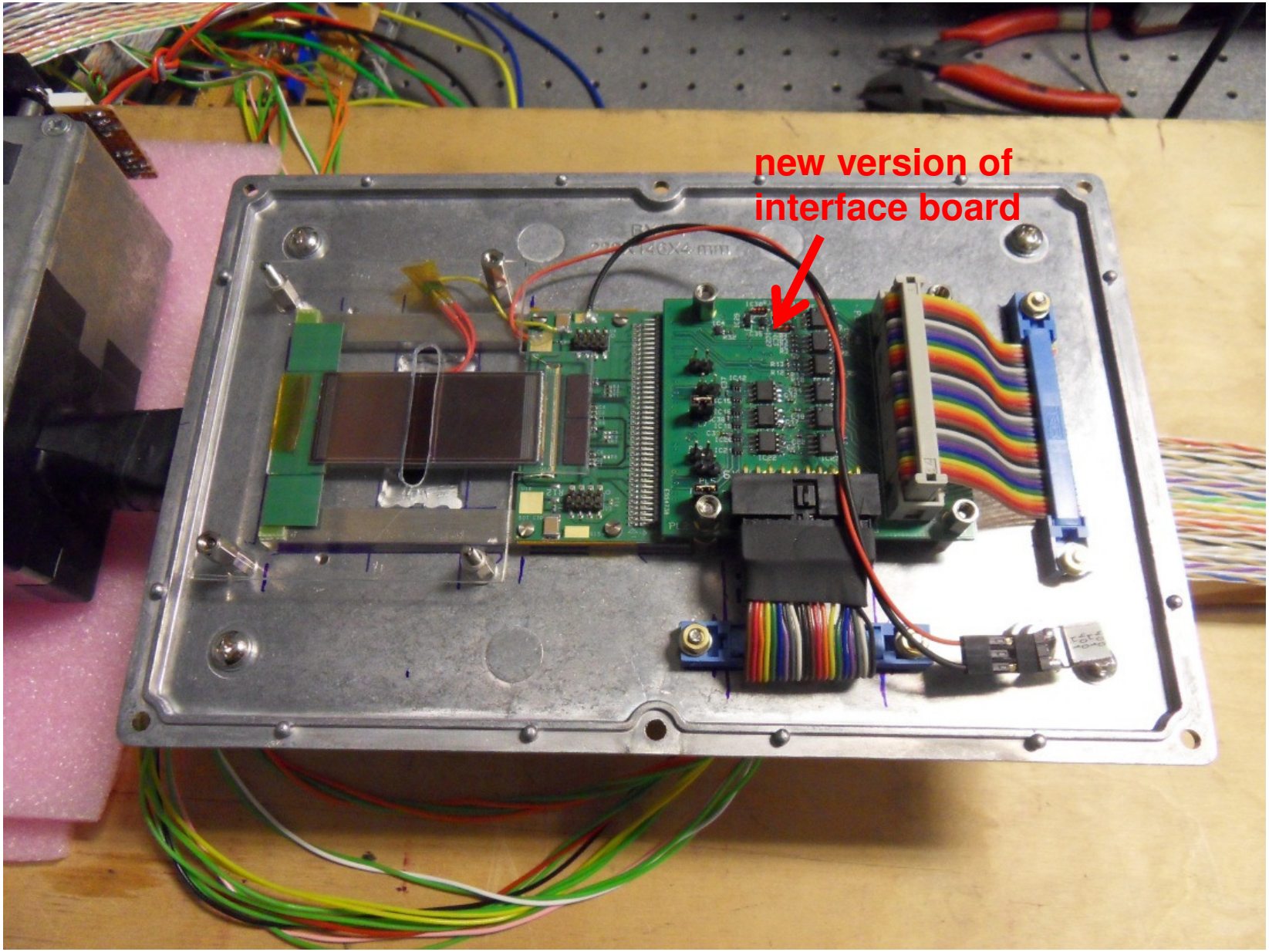


2 modules bonded : small differences in mechanical frame but essentially the same

1st module total leakage ~ 8 uA
2nd module total leakage ~ 2 uA (have concentrated on this one)

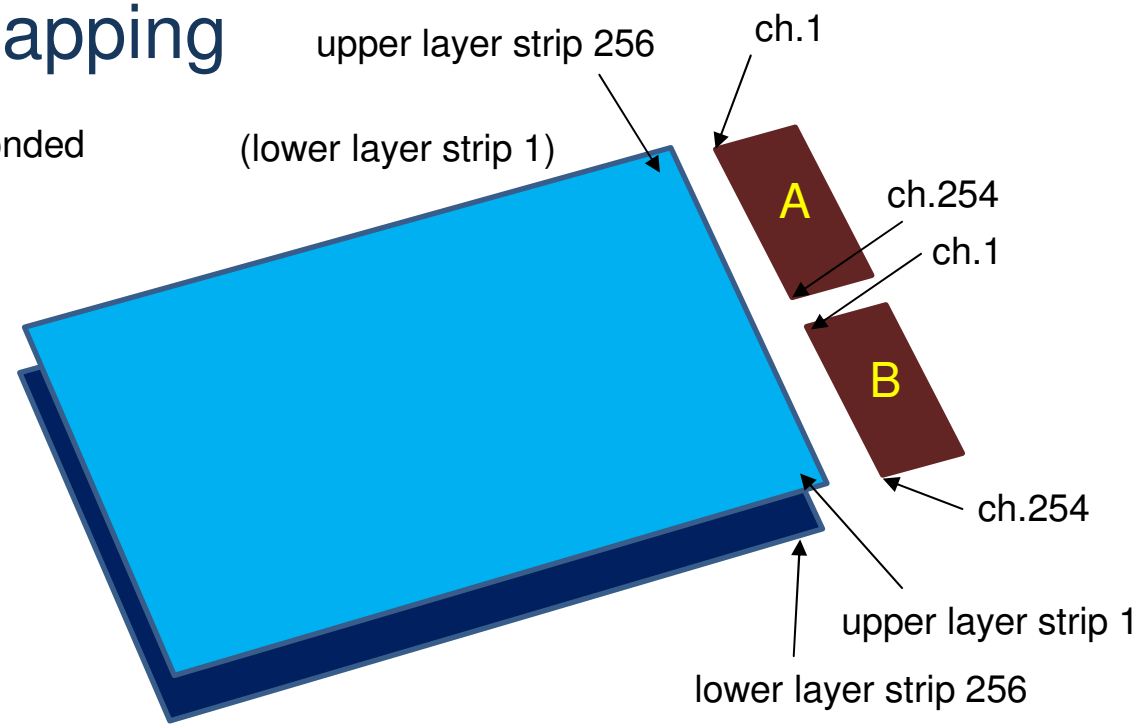
300V bias

mounted for readout



channel to strip no. mapping

2 edge channels on each sensor not bonded
(i.e. strips 2 - 255 inclusive bonded)



chip channel vs. sensor strip #

	chip A									chip B						
	2	4	6	8	.....	.....	250	252	254	2	4	6	....	....	248	250	252	254
upper sensor	255	254	253	252	.....	....	131	130	129	128	127	126	....	...	5	4	3	2
	chip A									chip B						
	1	3	5	7	.....	.....	249	251	253	1	3	5	....	....	247	249	251	253
lower sensor	2	3	4	5	...	....	126	127	128	129	130	131	...	...	252	253	254	255

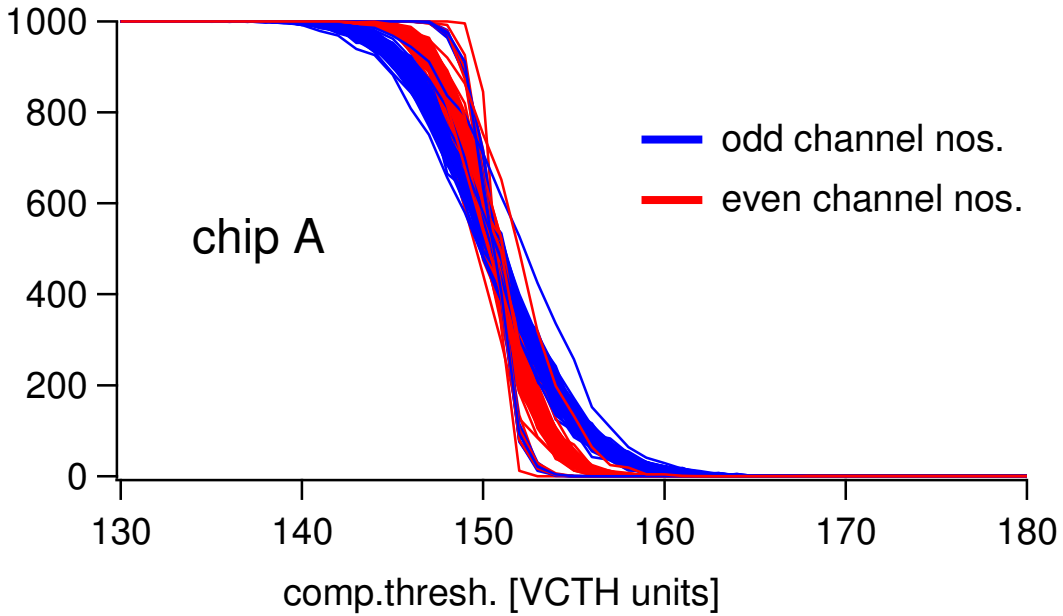
start with s-curves

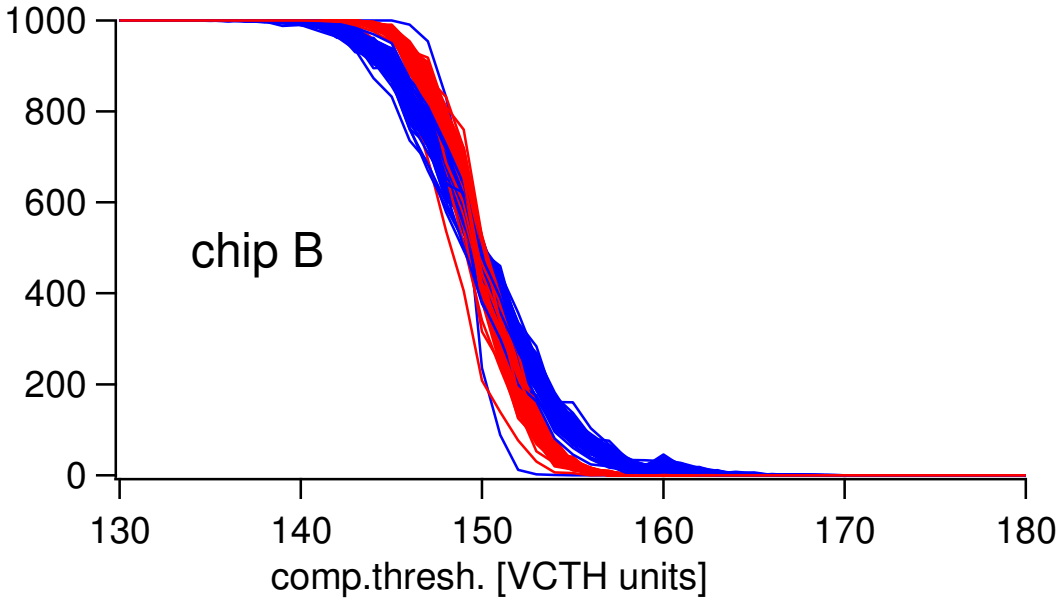
acquired using on-chip test pulse

2 clear families corresponding to
odd & even chip channel numbers

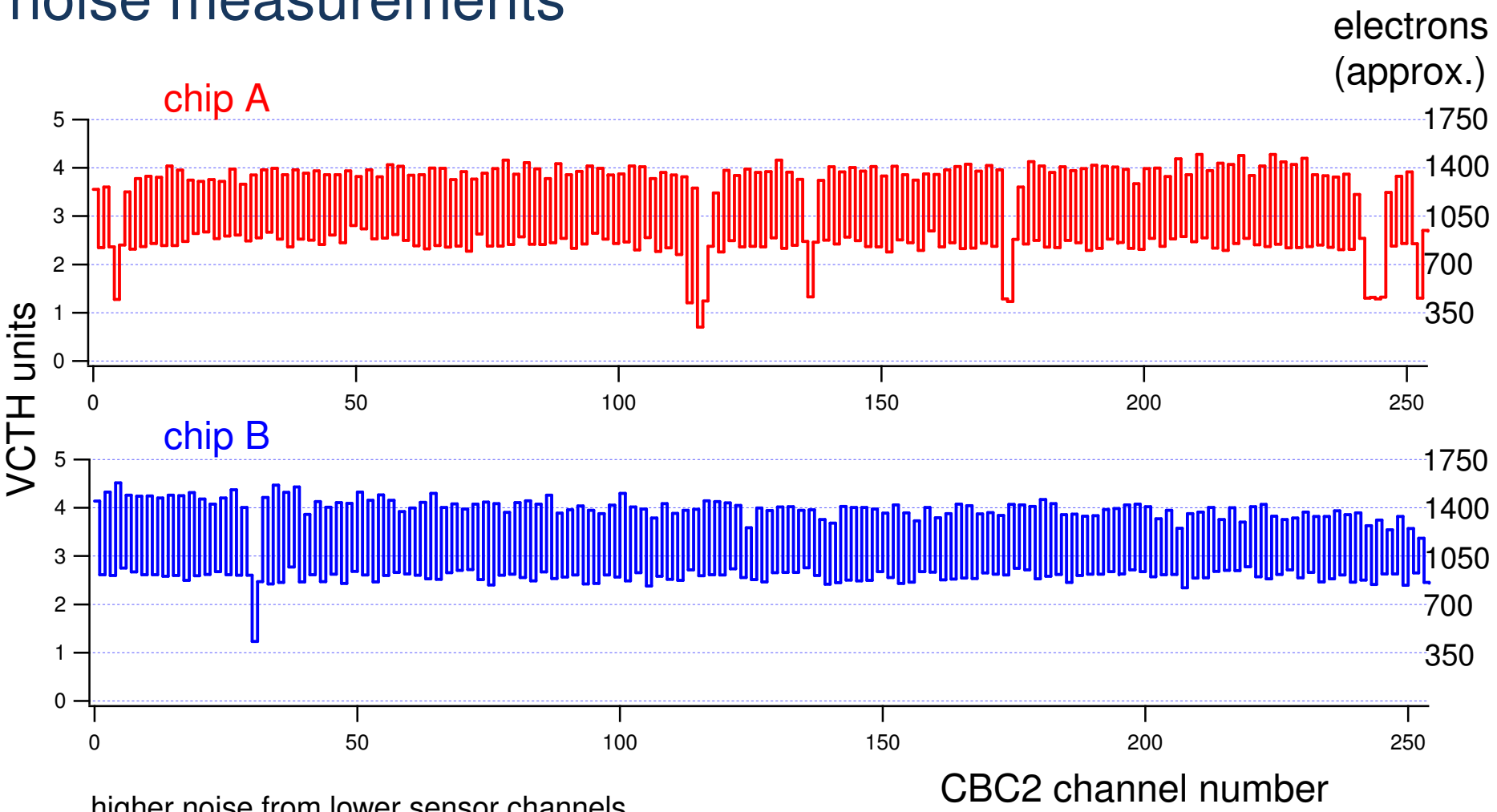
odd CBC channels show more “stretched out” s-curves
=> higher noise

odd channels correspond to lower sensor





noise measurements

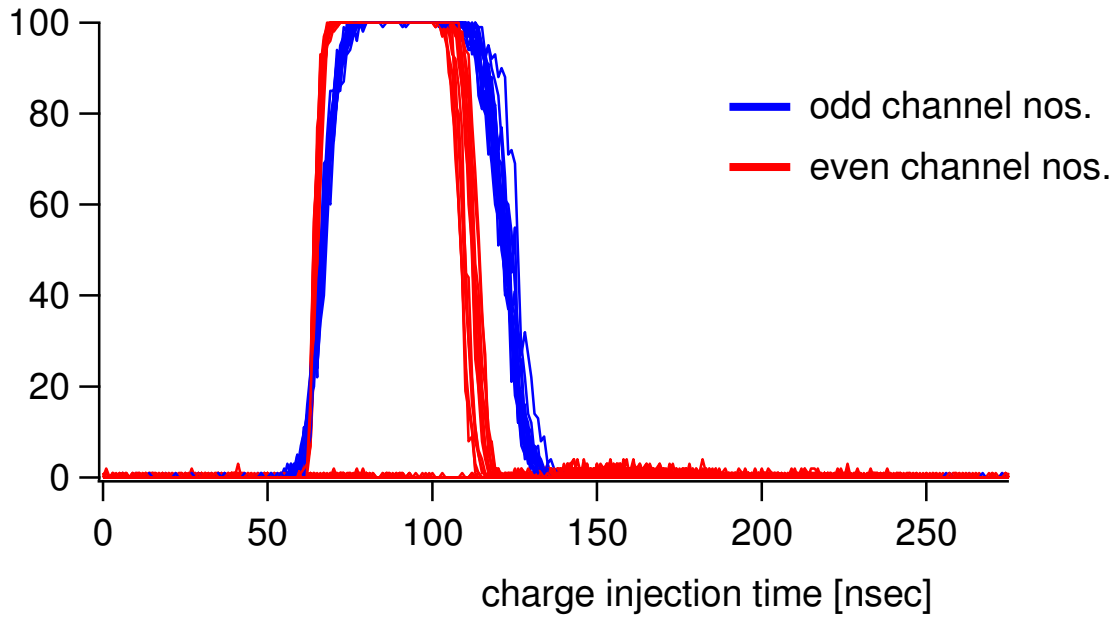


higher noise from lower sensor channels
not clear why

no explanation for anomalously low noise channels either
would seem to indicate no sensor-to-hybrid contact

note: no anomalous edge strip behaviour with sensors

test pulse charge injection time sweep



slower edge times for odd channels (lower sensor) => slower pulse shape => higher capacitance

consistent with higher noise

seems to indicate lower sensor not properly depleted?

note: other module not studied in such depth
but shows broadly similar results
significant?

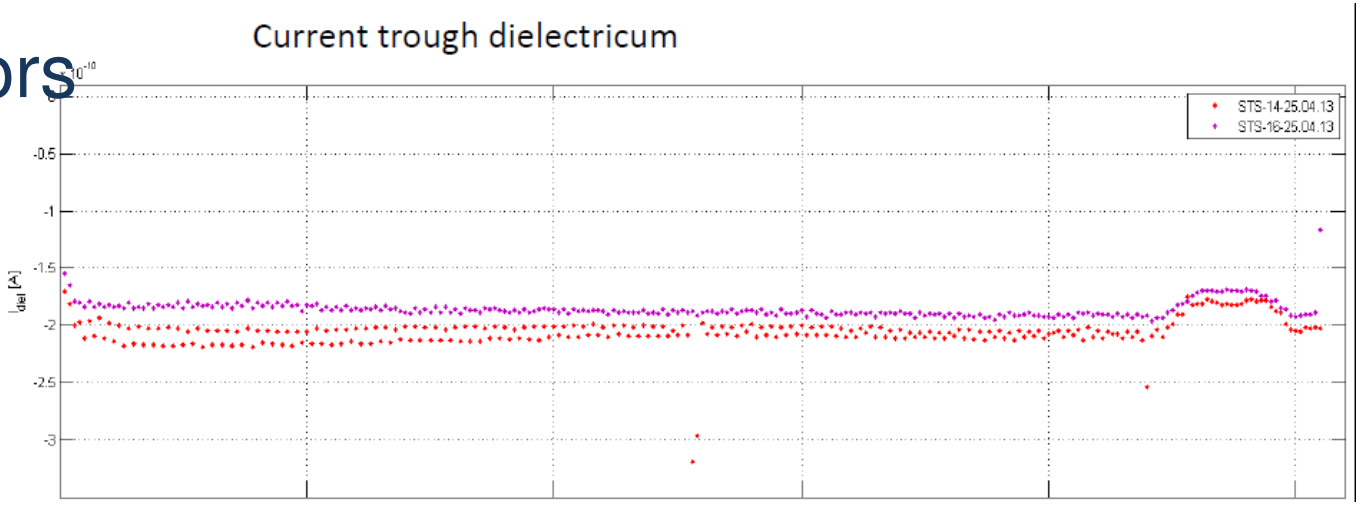
info on sensors from Vienna (Marko)

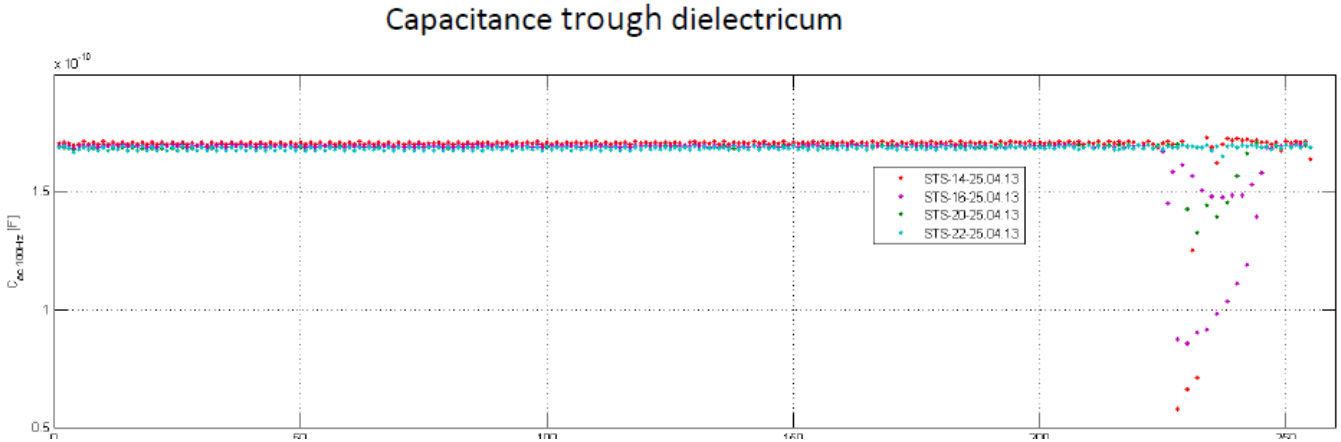
anomalous behaviour between strips 220 - 250

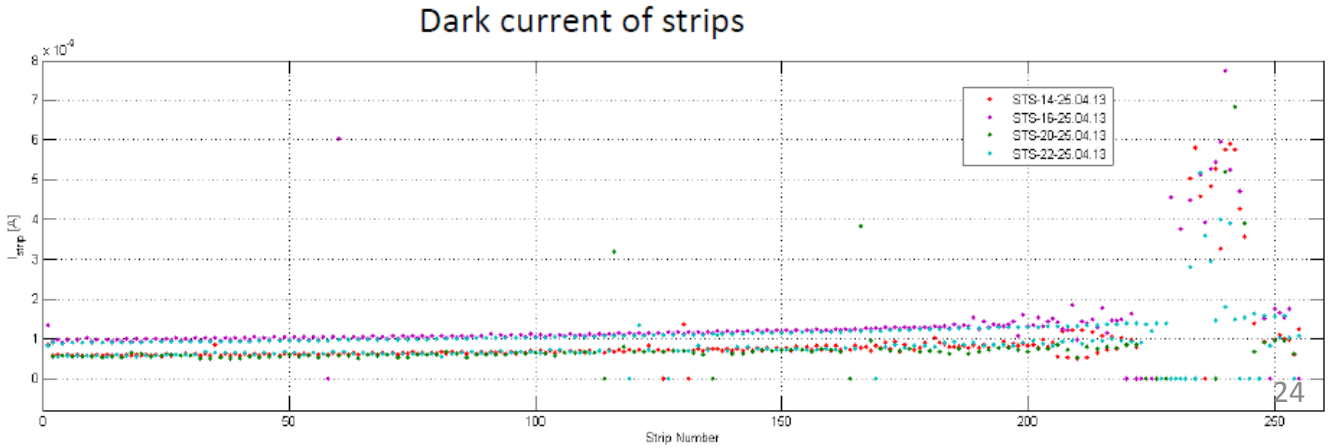
upper sensor
chip A even channels
between 10 - 70

lower sensor
chip B odd channels
between 185 - 245

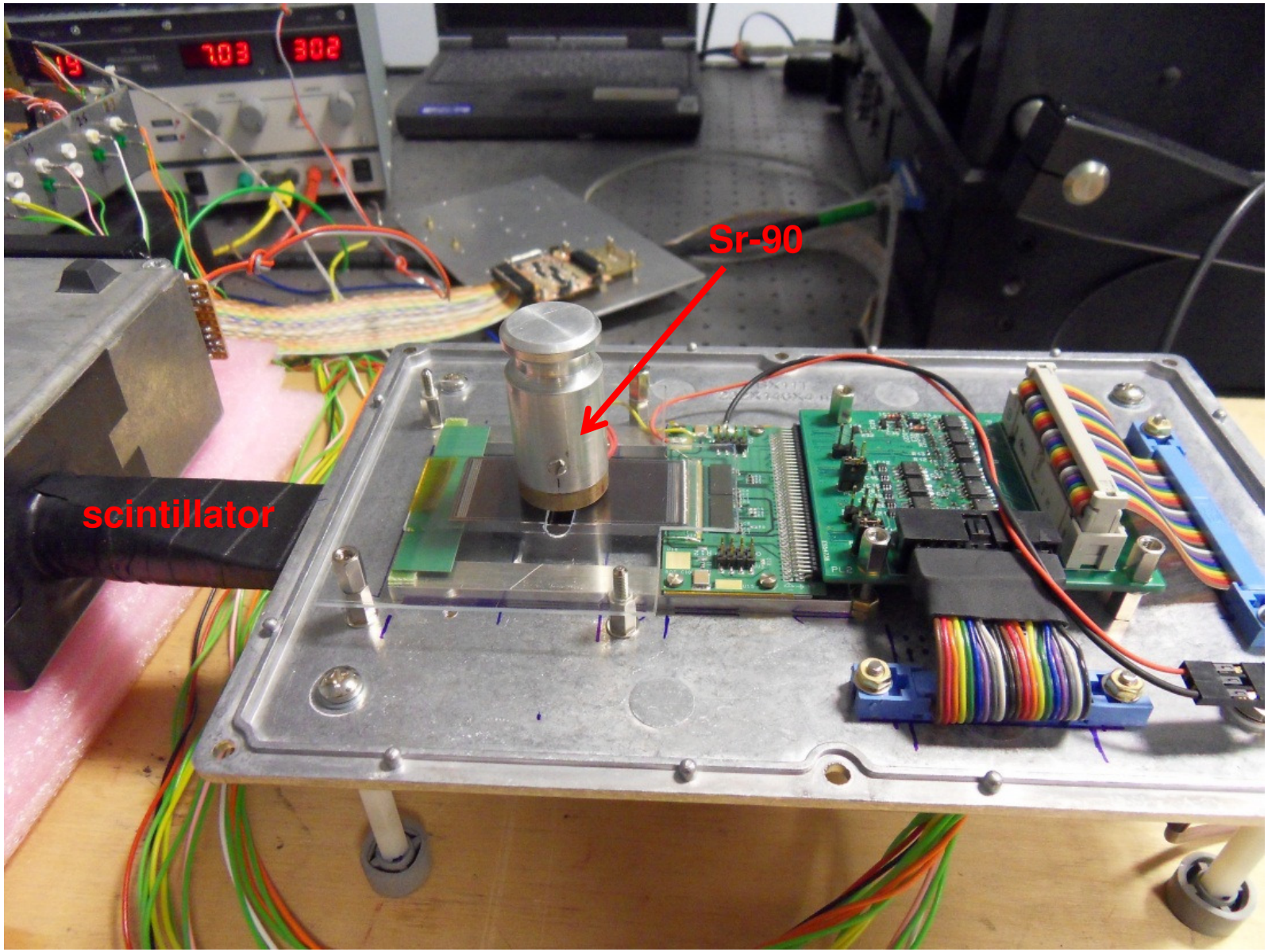
no clear correlation with any module measurement so far



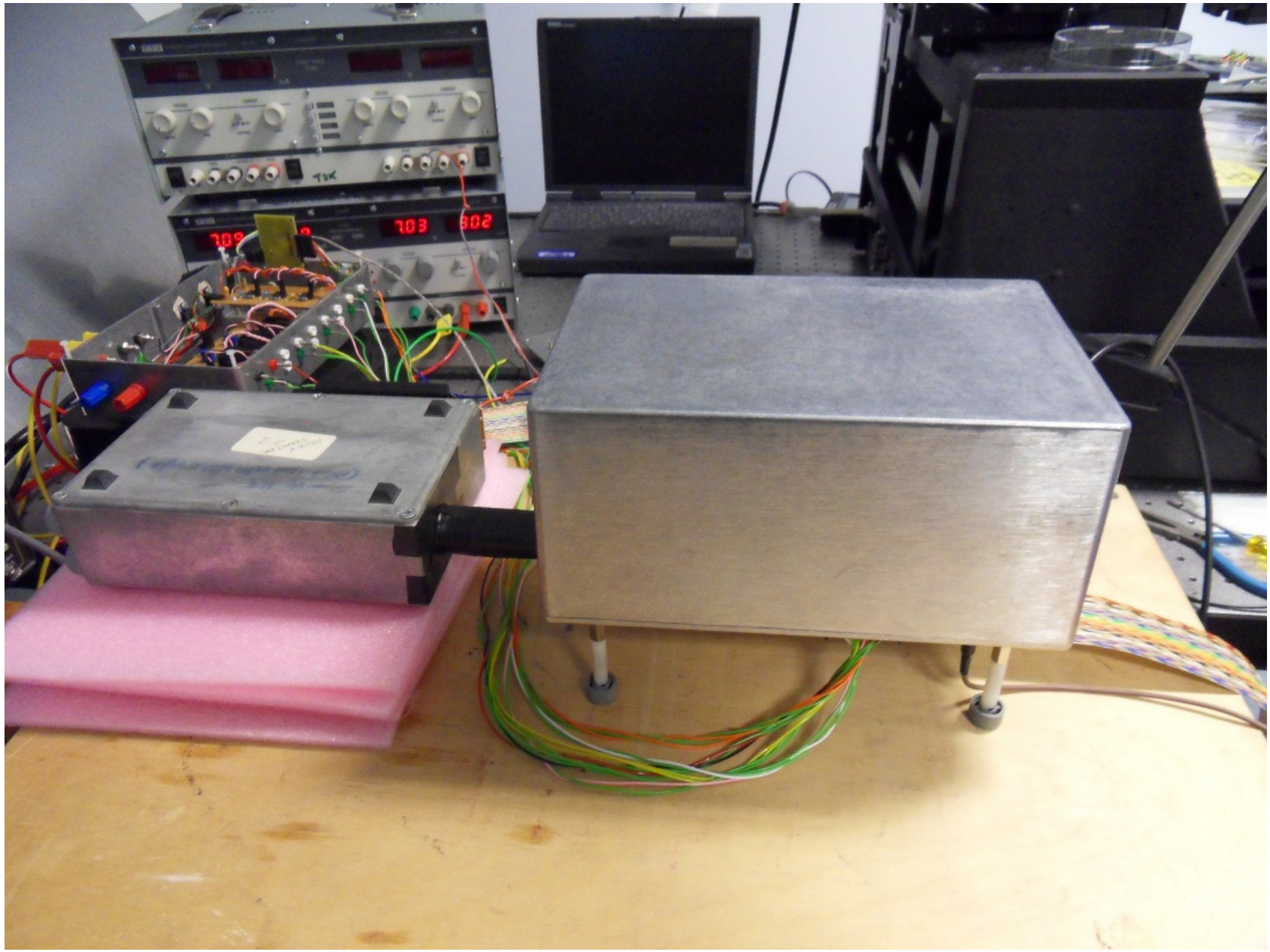


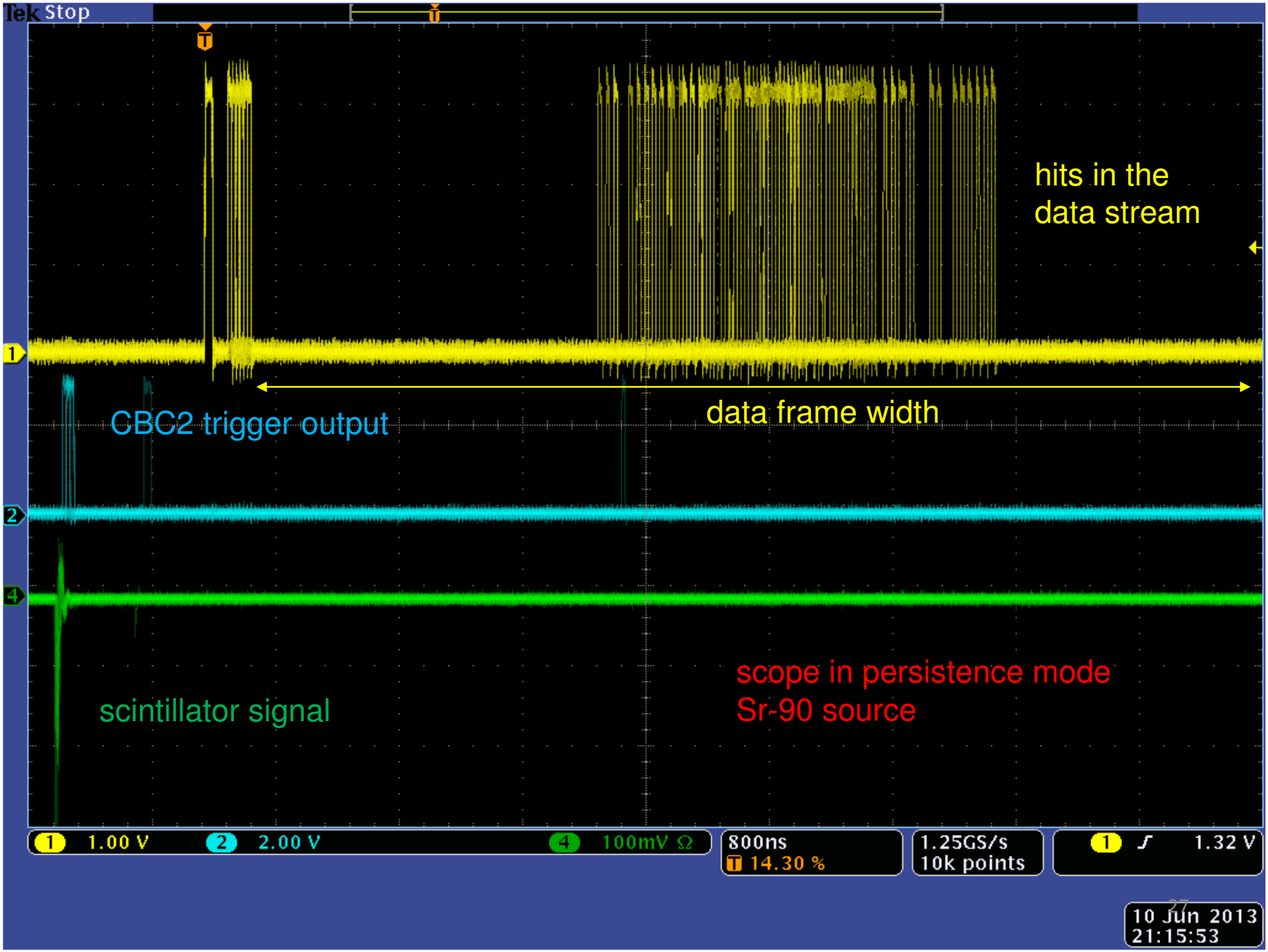


results with source and cosmics

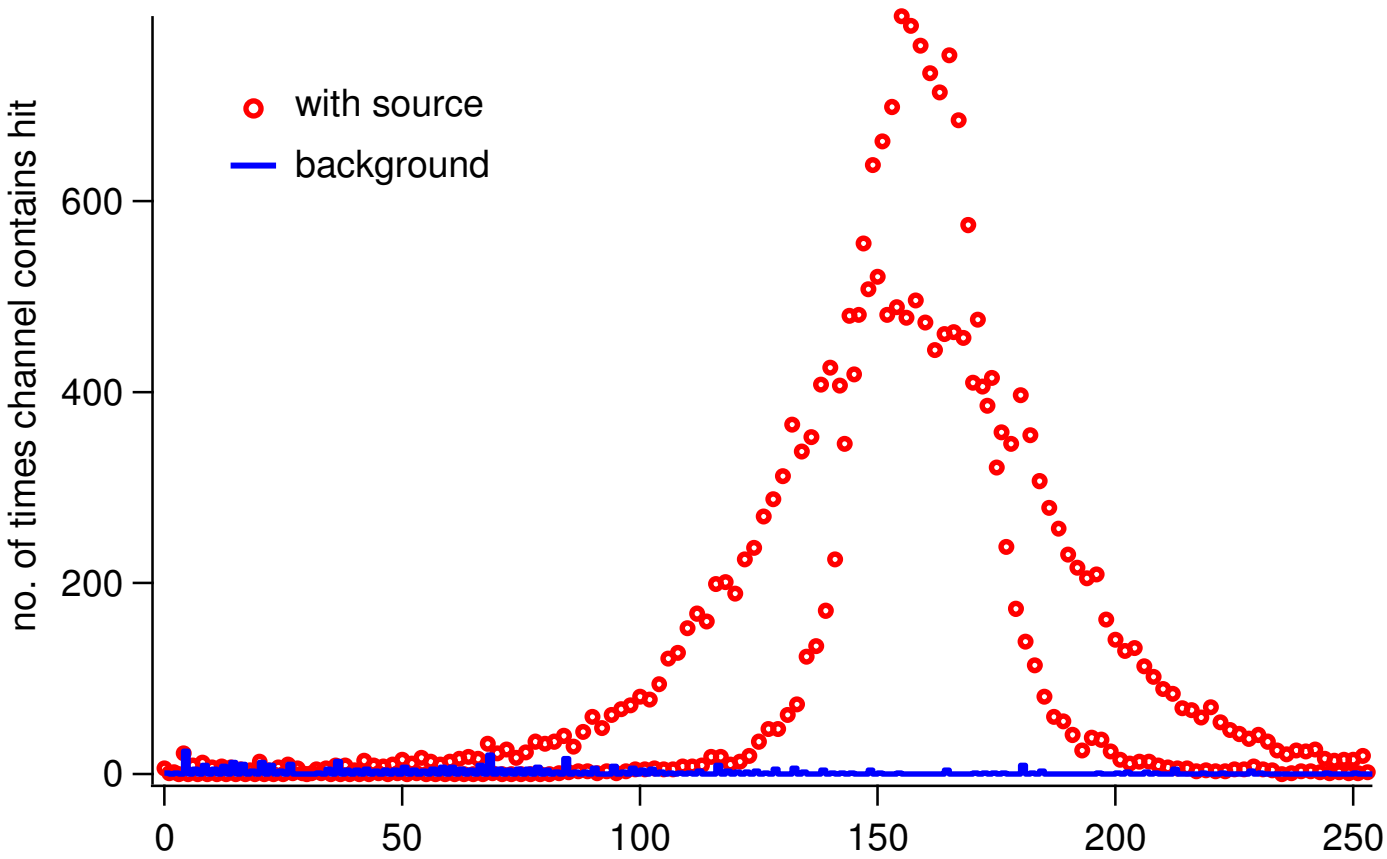


light tight



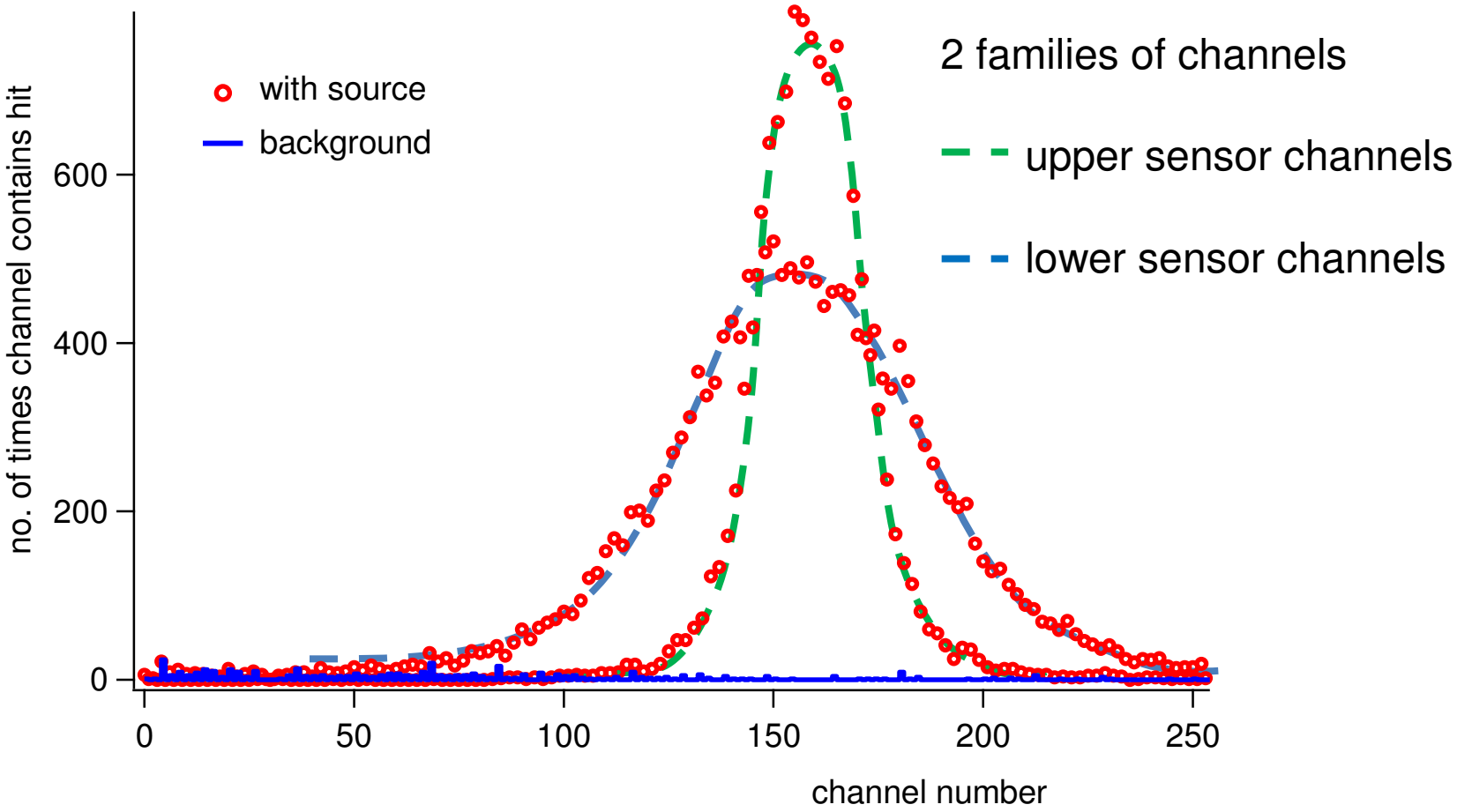

Tek Stop
hits in the
data stream
data frame width
CBC2 trigger output
scintillator signal
scope in persistence mode
Sr-90 source
1 1.00 V
2 2.00 V
4 100mV Ω
800ns
14.30 %
1.25GS/s
10k points
1 1.32 V
10 Jun 2013
21:15:53

Sr-90 beta source profile

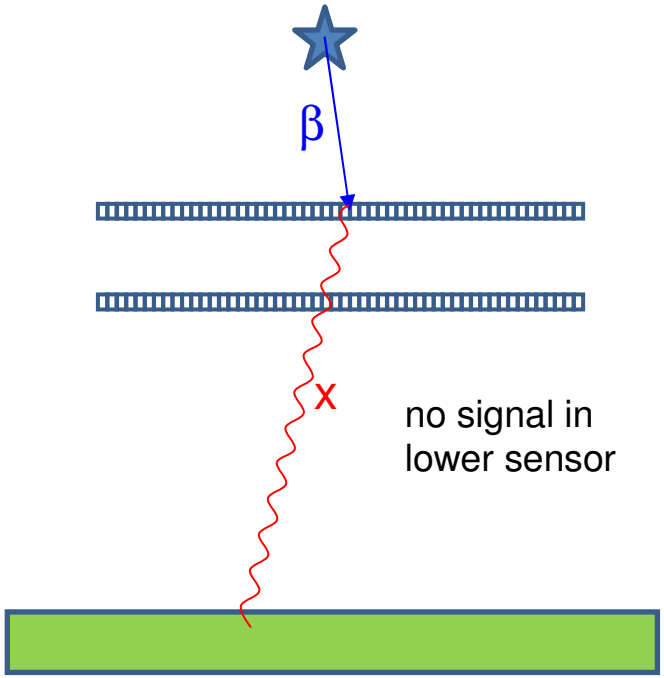


take 10,000 scintillator triggers
count number of times channel contains a hit (not number of clusters)

Sr-90 beta source profile

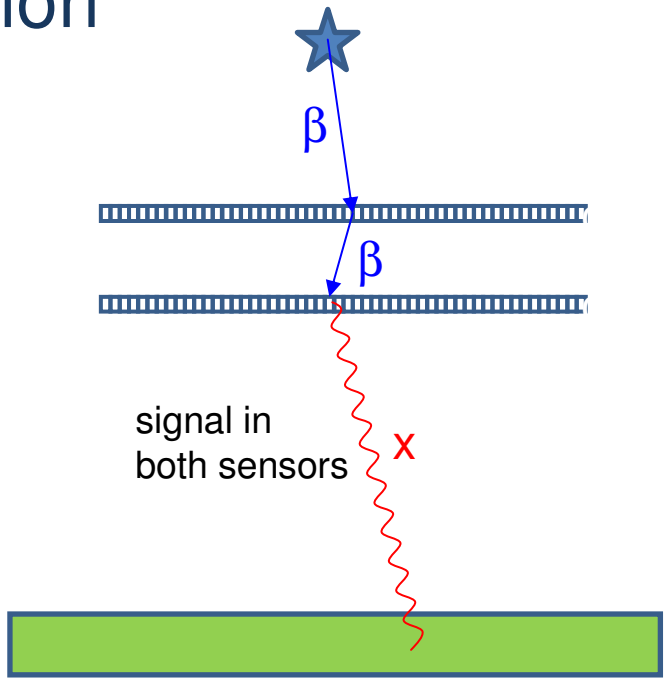


Sr-90 beta source profile interpretation

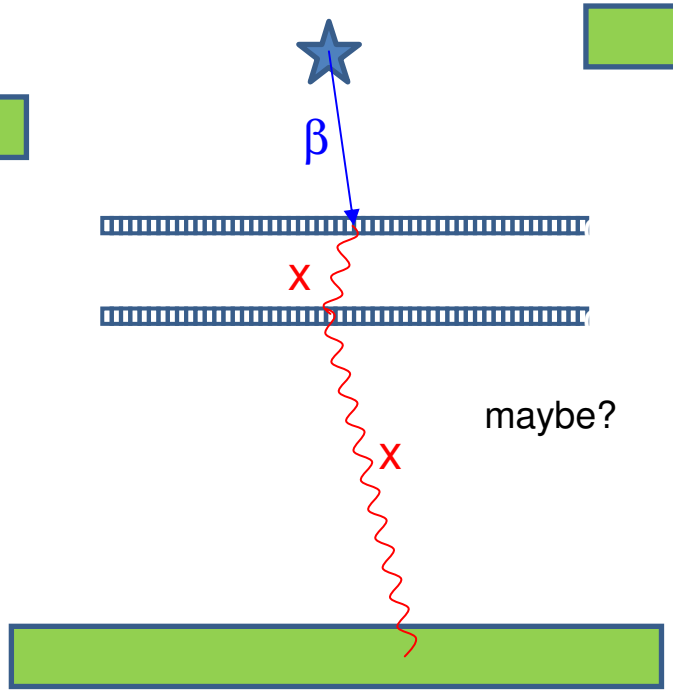


no signal in
lower sensor

max β energy
2.28 MeV



signal in
both sensors



maybe?

cosmic results

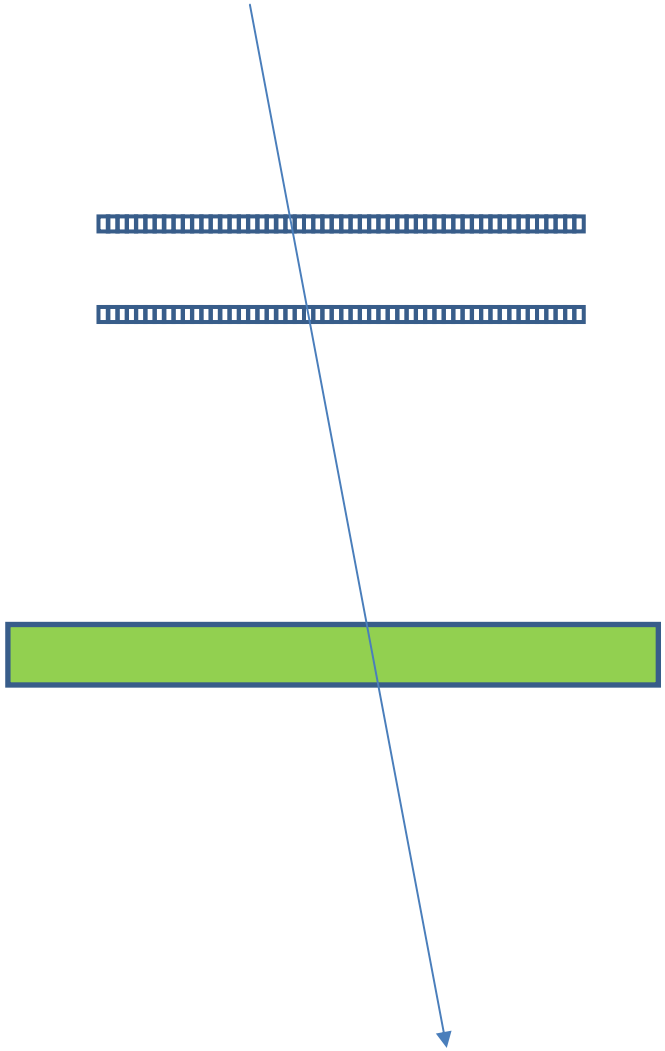
coincidence window set to max in upper sensor
to maximize sensitivity

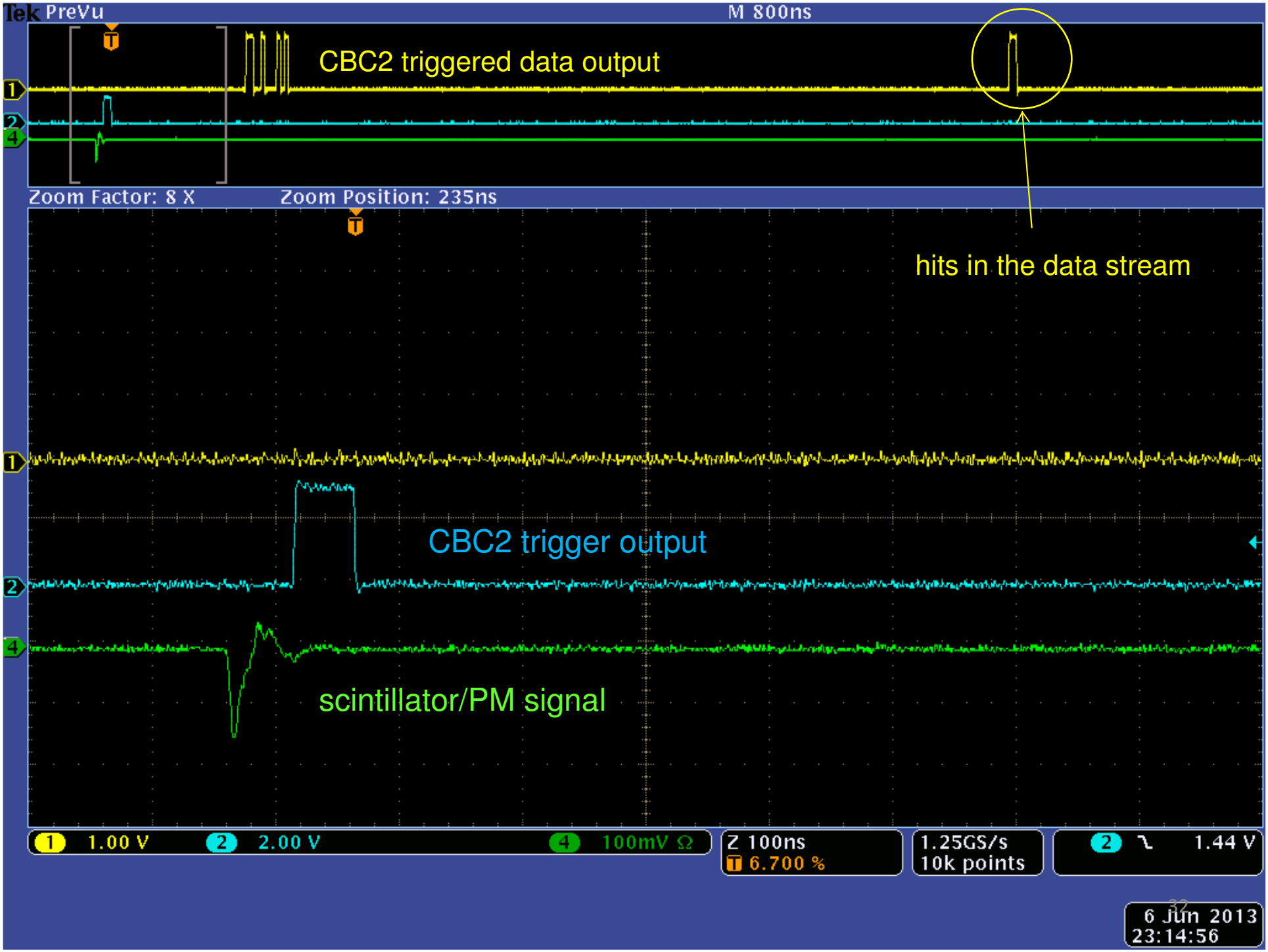
+/- 8 strips

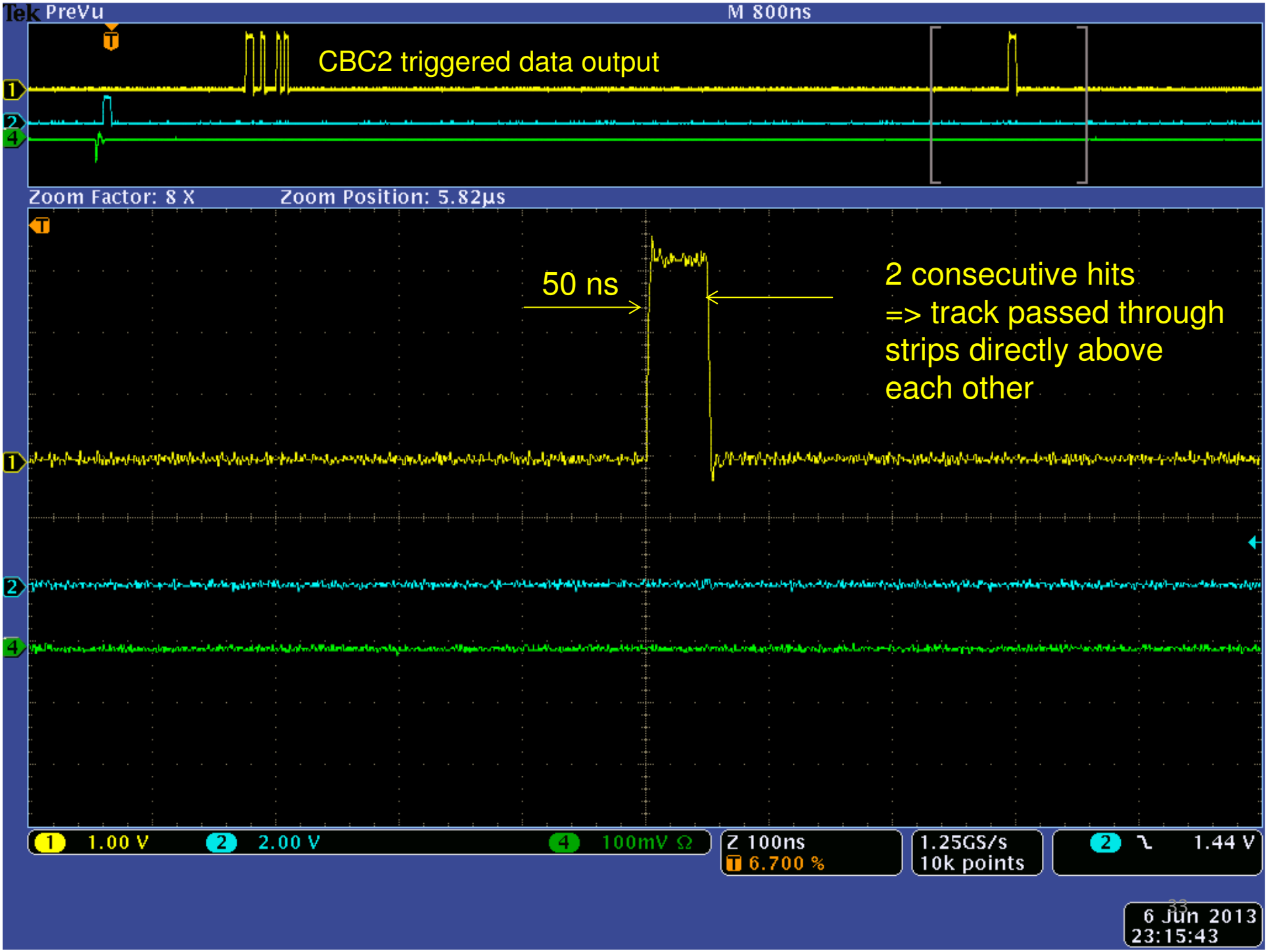
rate still very low

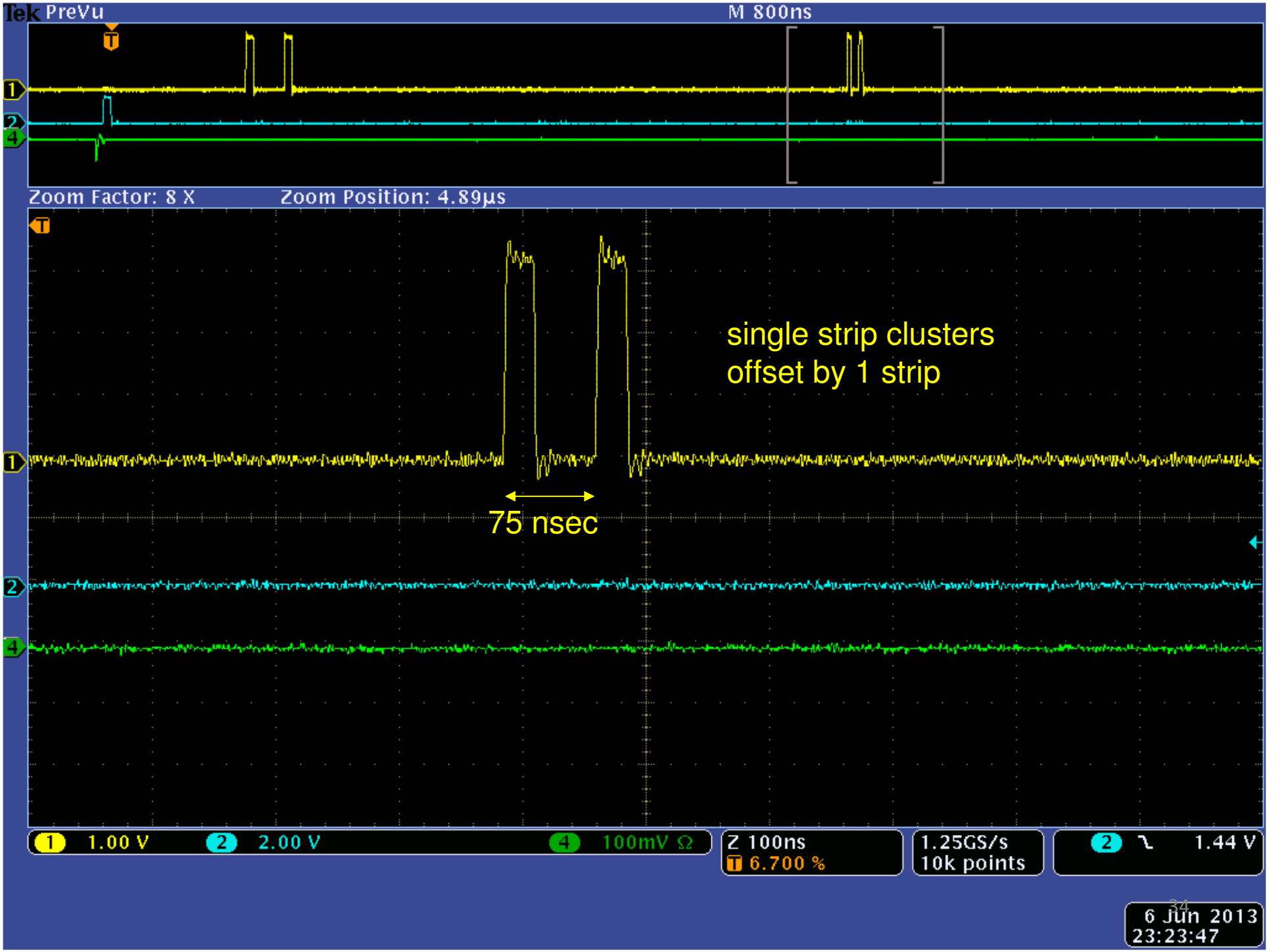
<< 1 Hz

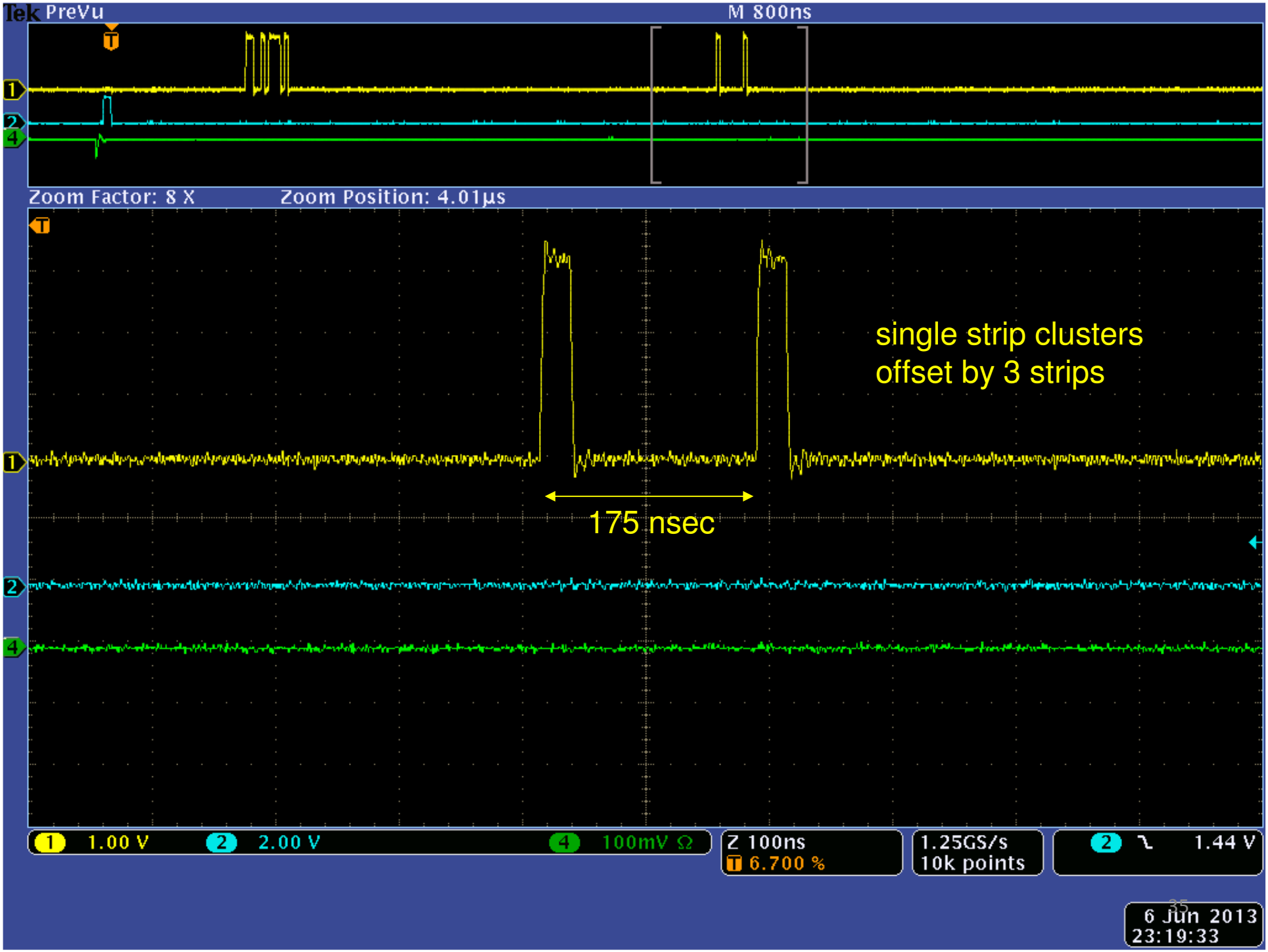
scope pictures of event examples follow

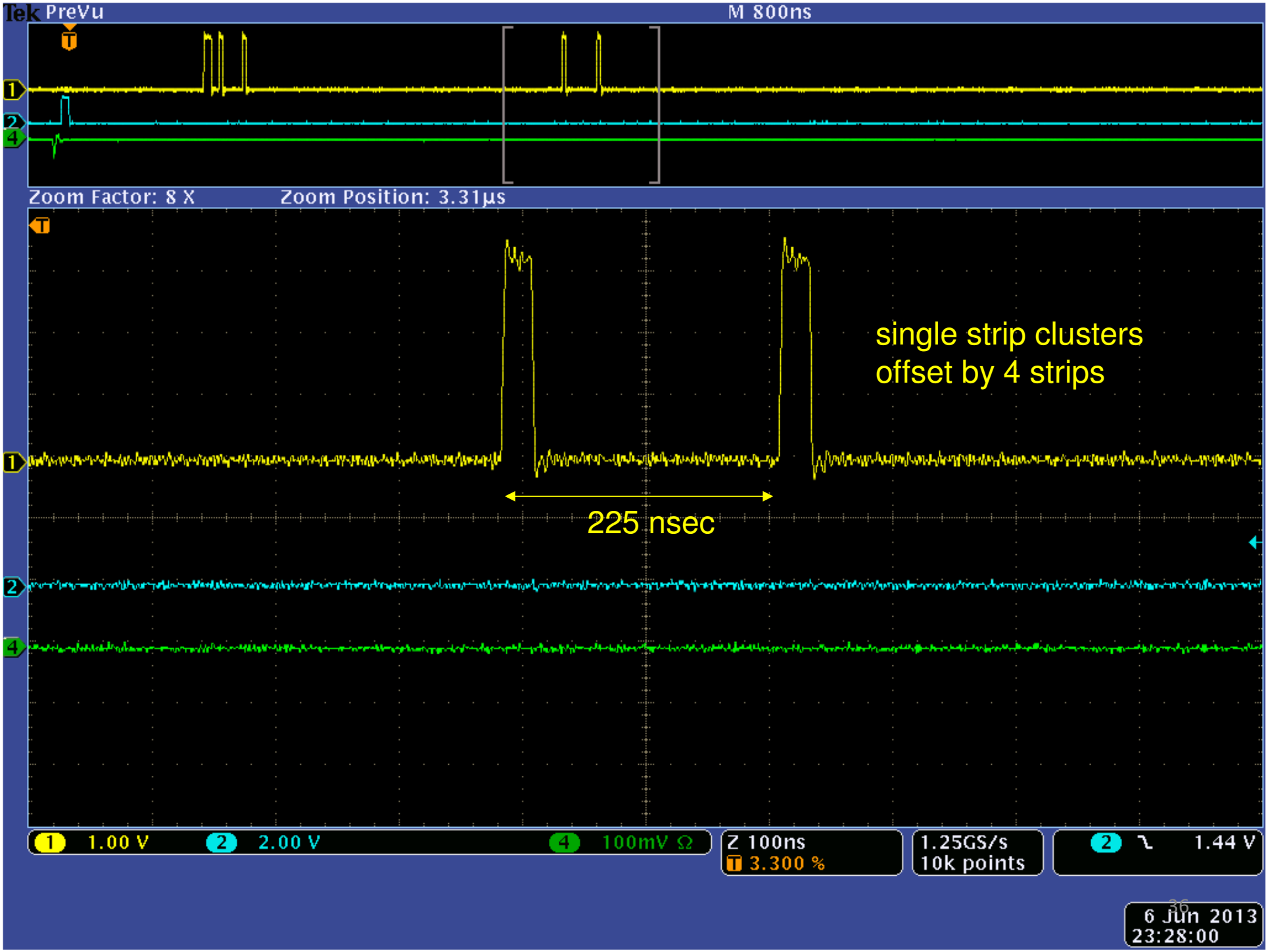


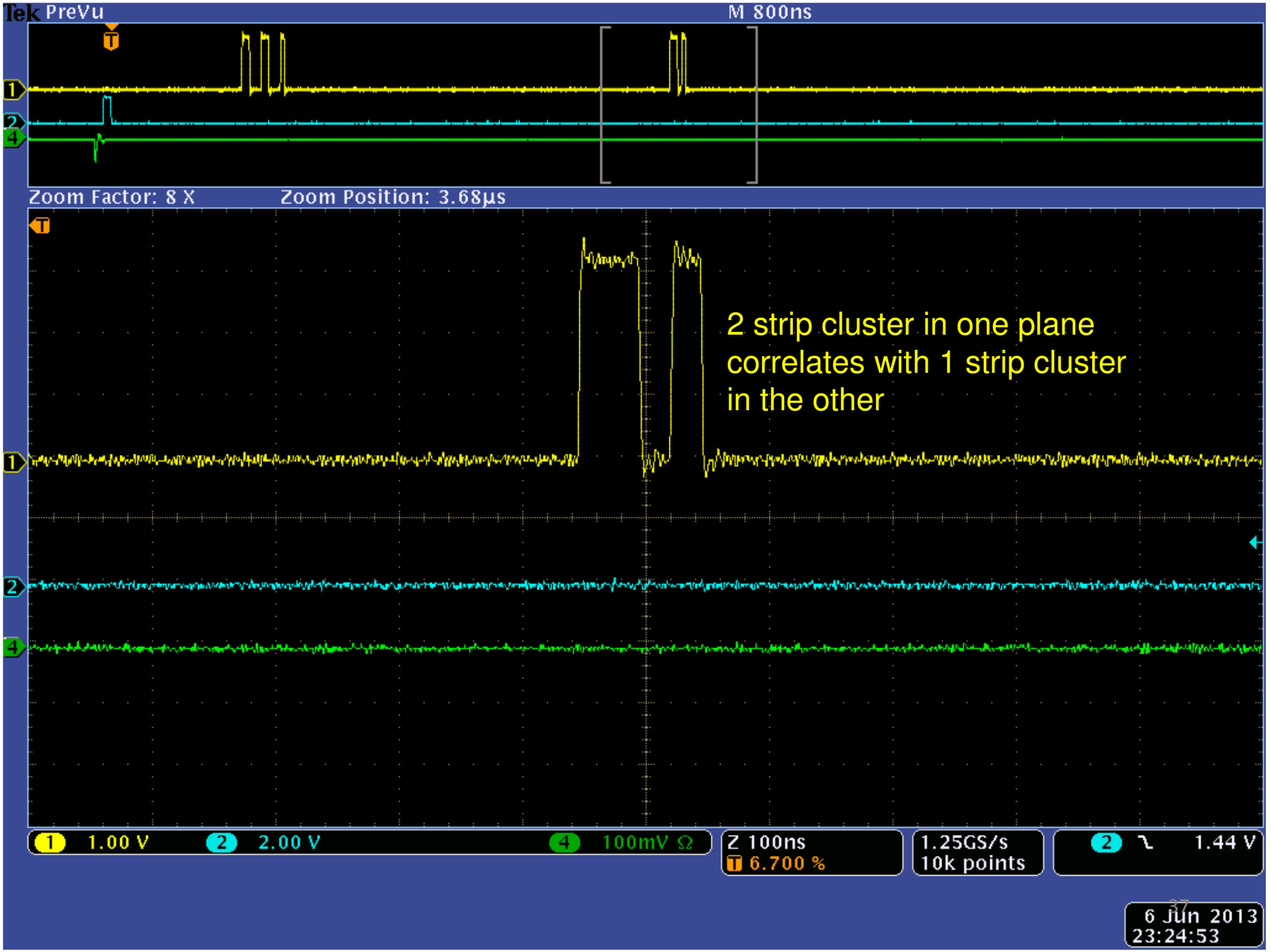

Tek PreVu
M 800ns
CBC2 triggered data output
hits in the data stream
Zoom Factor: 8 X
Zoom Position: 235ns
CBC2 trigger output
scintillator/PM signal
1 1.00 V
2 2.00 V
4 100mV Ω
Z 100ns
T 6.700 %
1.25GS/s
10k points
2 1.44 V
6 Jun 2013
23:14:56

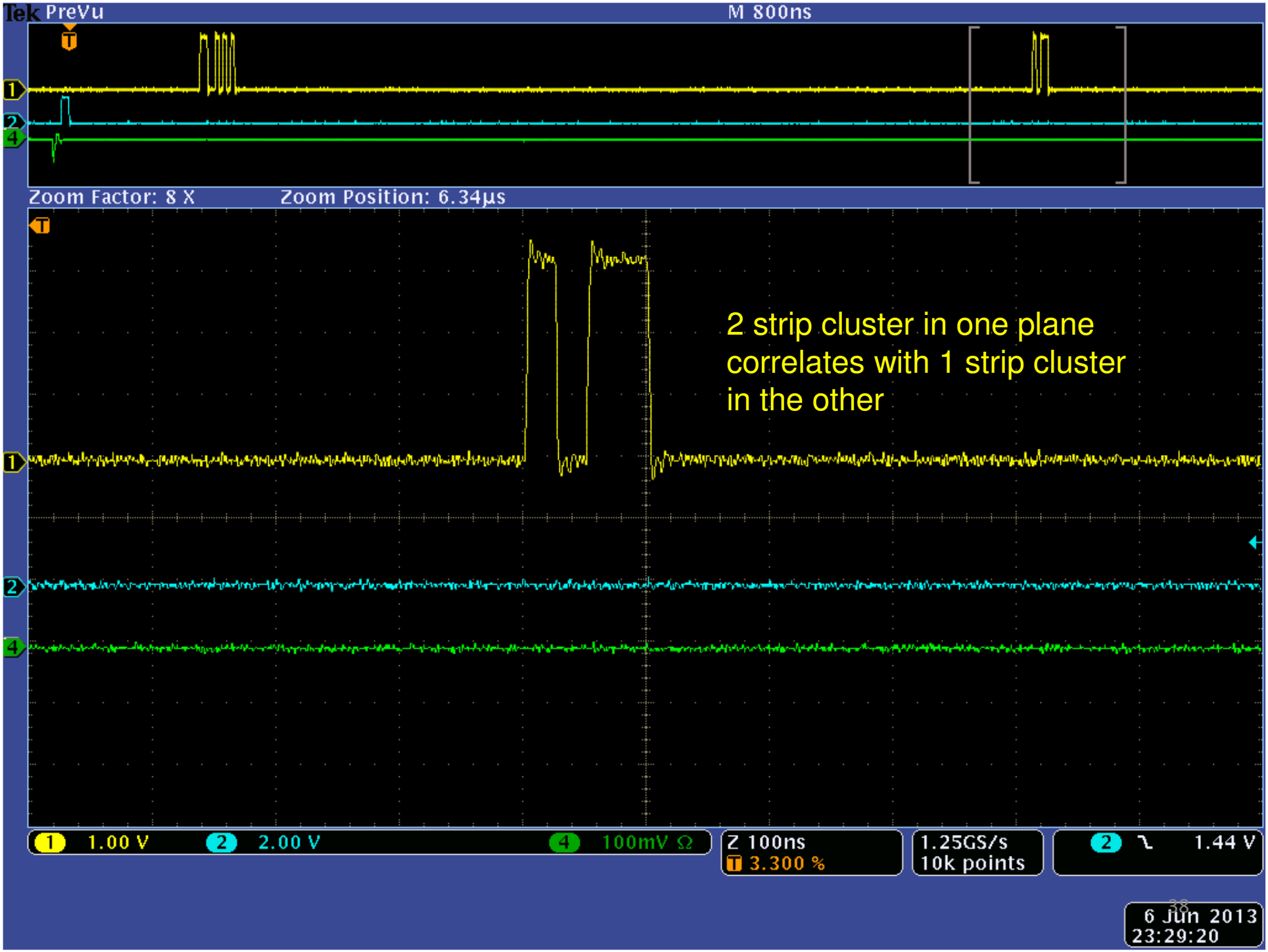

Tek PreVu
M 800ns
CBC2 triggered data output
Zoom Factor: 8 X
Zoom Position: 5.82µs
50 ns
2 consecutive hits
=> track passed through
strips directly above
each other
1.00 V
2.00 V
100mV Ω
Z 100ns
6.700 %
1.25GS/s
10k points
1.44 V
6 Jun 2013
23:15:43

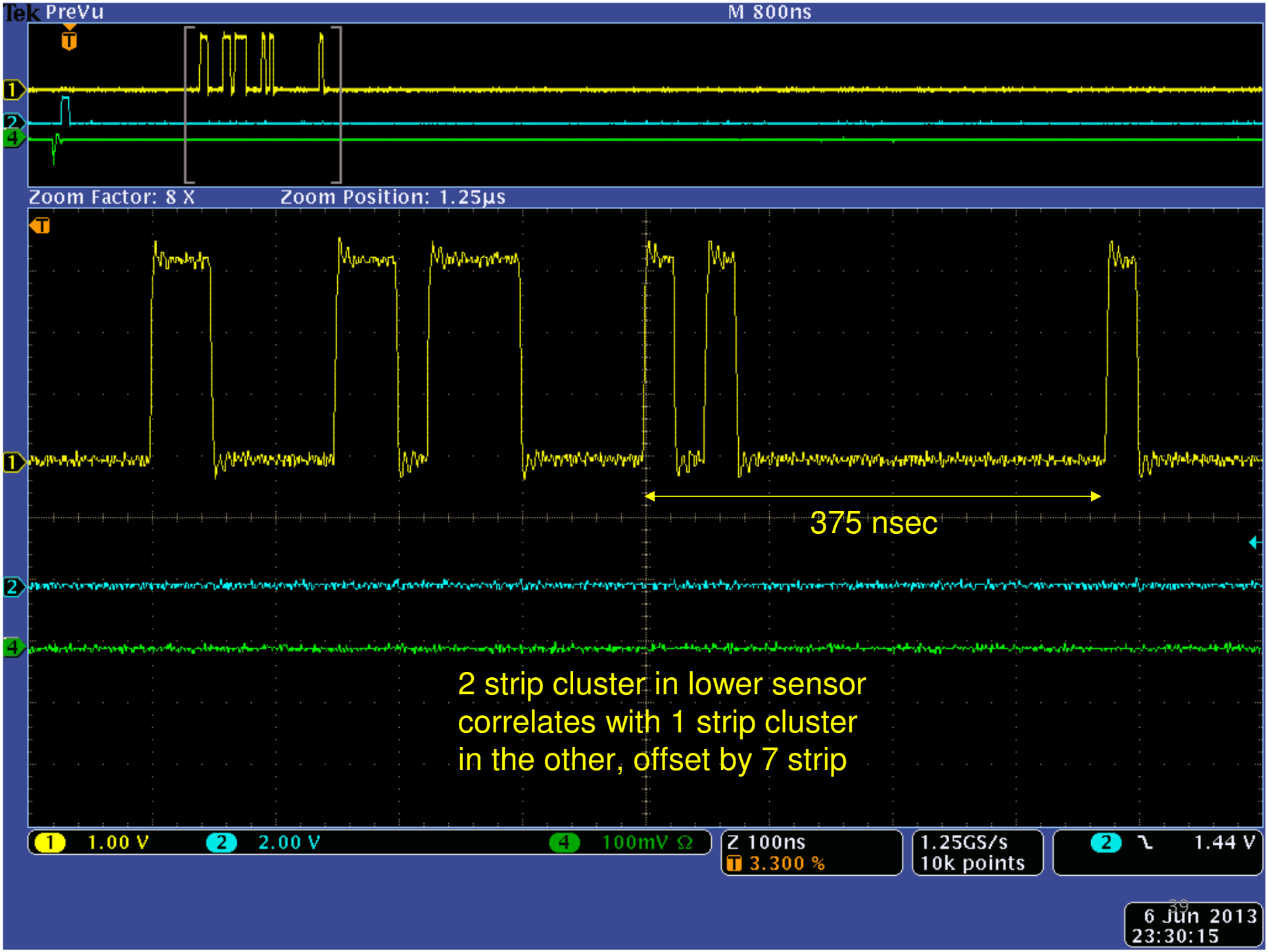

Tek PreVu
M 800ns
Zoom Factor: 8 X
Zoom Position: 4.89µs
single strip clusters
offset by 1 strip
75 nsec
1.00 V
2.00 V
100mV Ω
Z 100ns
6.700 %
1.25GS/s
10k points
1.44 V
6 Jun 2013
23:23:47


Tek PreVu
M 800ns
Zoom Factor: 8 X
Zoom Position: 4.01µs
single strip clusters
offset by 3 strips
175 nsec
1 1.00 V
2 2.00 V
4 100mV Ω
Z 100ns
T 6.700 %
1.25GS/s
10k points
2 1.44 V
6 Jun 2013
23:19:33


Tek PreVu
M 800ns
Zoom Factor: 8 X
Zoom Position: 3.31µs
single strip clusters
offset by 4 strips
225 nsec
1.00 V
2.00 V
100mV Ω
Z 100ns
3.300 %
1.25GS/s
10k points
1.44 V
6 Jun 2013
23:28:00


Tek PreVu
M 800ns
Zoom Factor: 8 X
Zoom Position: 3.68µs
2 strip cluster in one plane
correlates with 1 strip cluster
in the other
1.00 V
2.00 V
100mV Ω
Z 100ns
6.700 %
1.25GS/s
10k points
1.44 V
6 Jun 2013
23:24:53


Tek PreVu
M 800ns
Zoom Factor: 8 X
Zoom Position: 6.34µs
2 strip cluster in one plane
correlates with 1 strip cluster
in the other
1 1.00 V
2 2.00 V
4 100mV Ω
Z 100ns
T 3.300 %
1.25GS/s
10k points
2 1.44 V
6 Jun 2013
23:29:20


Tek PreVu
M 800ns
Zoom Factor: 8 X
Zoom Position: 1.25µs
375 nsec
2 strip cluster in lower sensor
correlates with 1 strip cluster
in the other, offset by 7 strip
1 1.00 V
2 2.00 V
4 100mV Ω
Z 100ns
T 3.300 %
1.25GS/s
10k points
2 1.44 V
6 Jun 2013
23:30:15

final remarks

- 2xCBC2 modules with/without sensors

  lots of things to study

  clearly functional but not everything fully understood at present

  would be nice to have module with known good sensors

    would help to discriminate between sensor and hybrid issues
    doesn't have to be right pitch or length or all channels bonded

- new 2xCBC2 hybrid interface card now available

  all differential interface should be much more reliable

- CBC2 wafers

  have made some progress with wafer screening software but still some way to go

  if diced chips requirement imminent then can scan another wafer by hand (takes ~ 1 day)