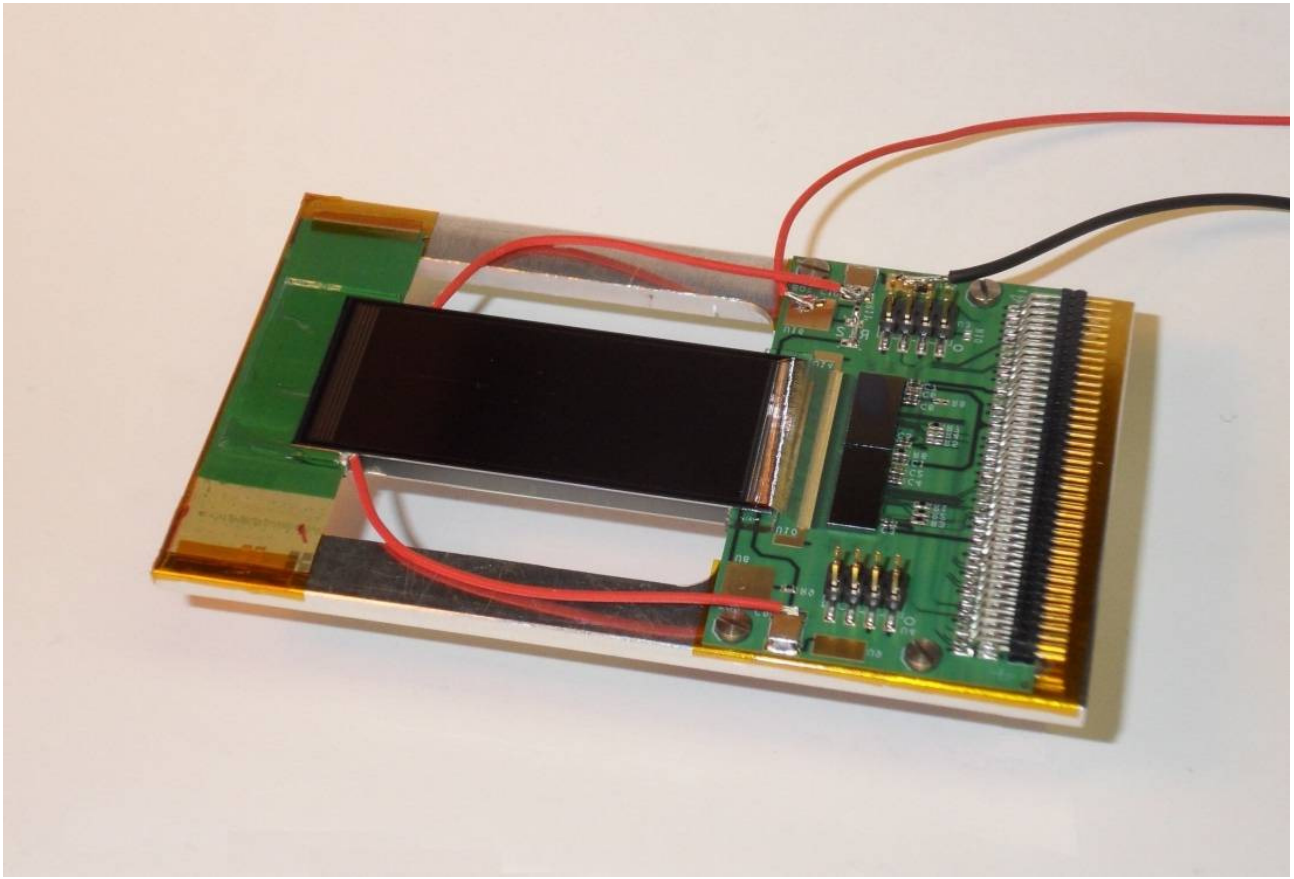
2S mini-module tests



CBC2 recap

CBC2 chip

- CBC2 works well - front end performance similar to CBC1 (CBC1 bugs fixed)
- new stub-finding logic confirmed working
- very high yield of good chips from first 2 wafers probed (~ 95%)

2CBC2 hybrids

13 passed through detailed screening - all working, strong evidence of very high yield of bump-bond connectivity

for further details see:

CBC2 chip performance

http://www.hep.ph.ic.ac.uk/~dmray/CBC_documentation/Phase_2_elec_CBC2_May_2013.pdf

Hybrid testing

http://www.hep.ph.ic.ac.uk/~dmray/CBC_documentation/Phase_2_elec_2xCBC2_May_2013.pdf

recent summary talks at Hiroshima and TWEPP conferences

http://www.hep.ph.ic.ac.uk/~dmray/CBC_documentation/Geoff_Hiroshima.pdf

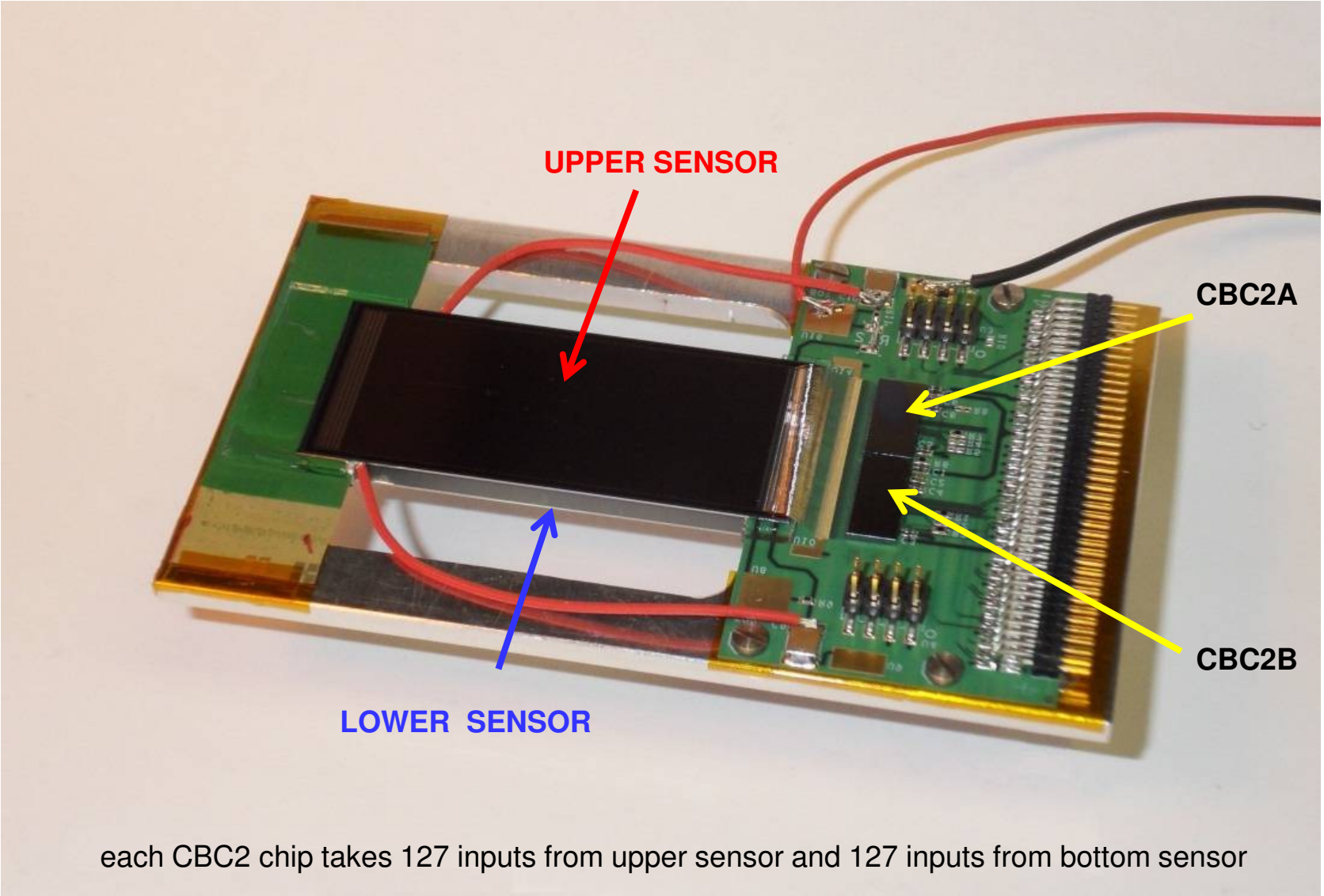
http://www.hep.ph.ic.ac.uk/~dmray/CBC_documentation/CBC2_TWEPP13.pdf

talk today follows on from mini-module testing talk in August

http://www.hep.ph.ic.ac.uk/~dmray/CBC_documentation/Phase_2_elec_CBC2_Aug_2013.pdf

will give brief summary of previous info

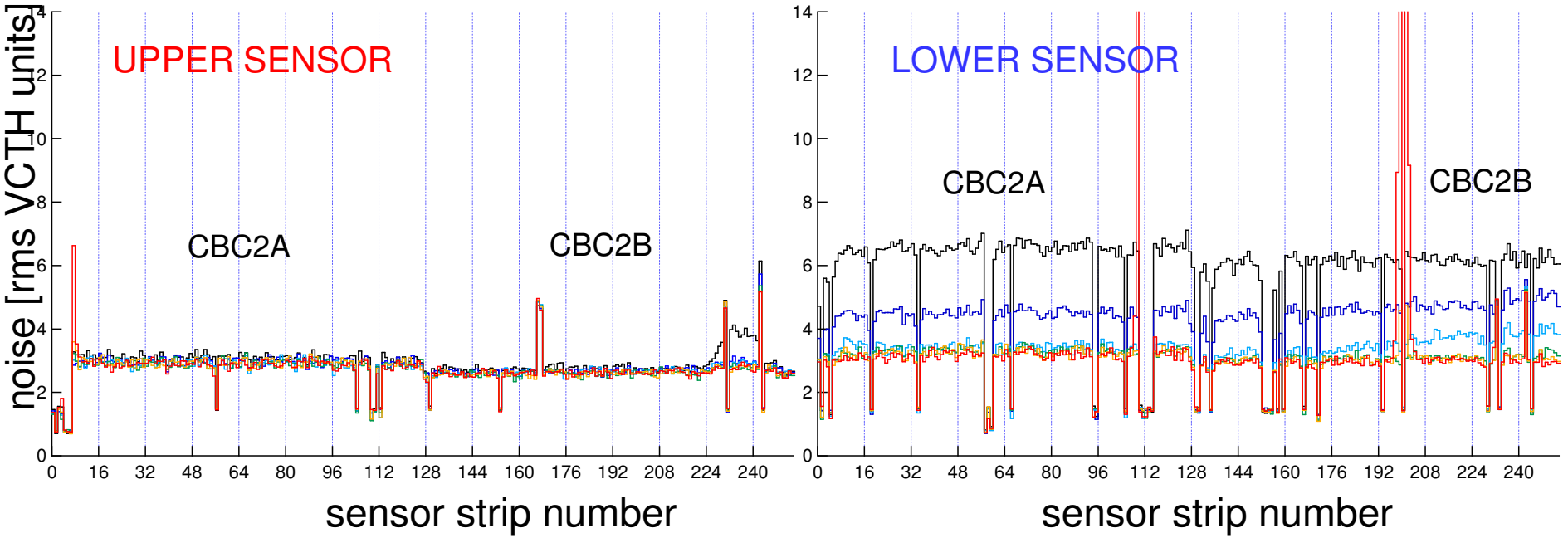
module layout reminder



each CBC2 chip takes 127 inputs from upper sensor and 127 inputs from bottom sensor

mini-module#1: noise vs bias, both sensors

Vbias: 20 - 400 V



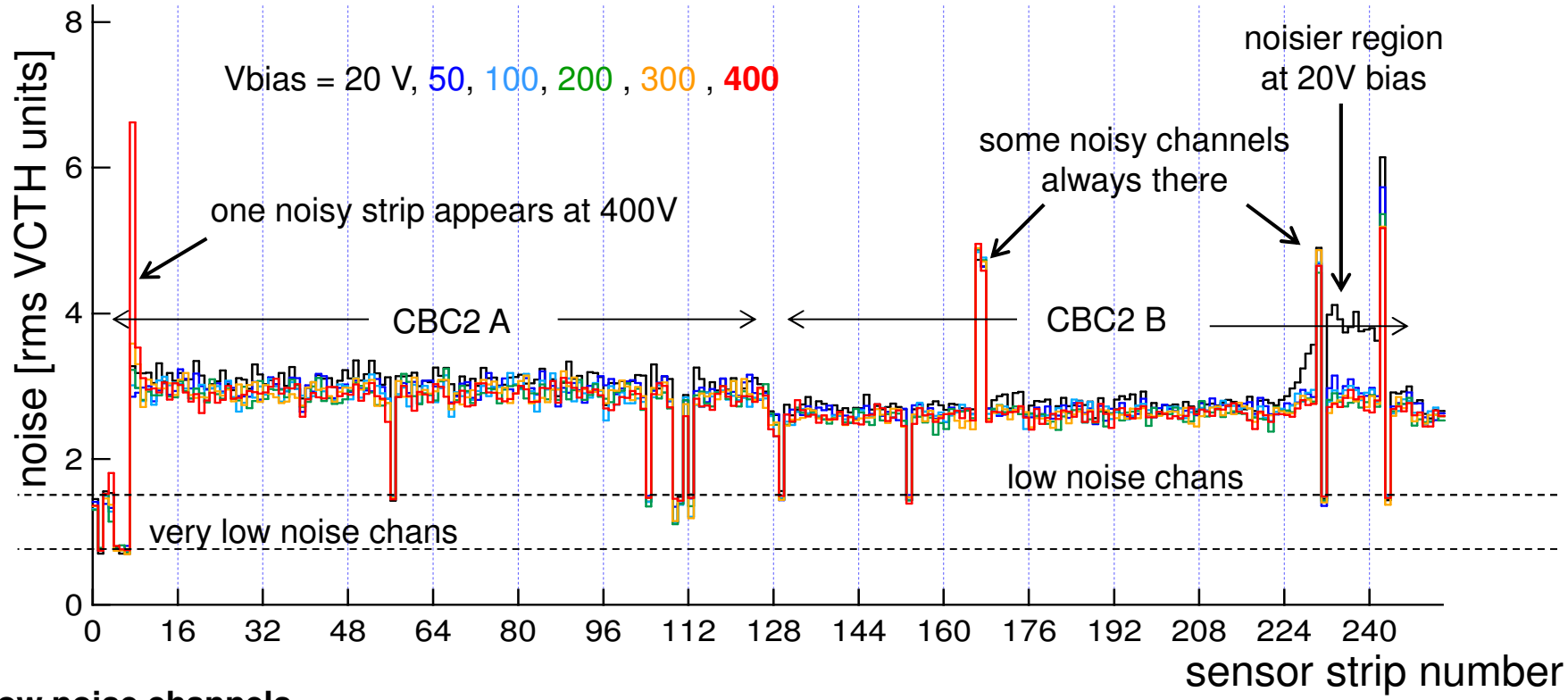
lower sensor needs higher bias (>100V) before noise reaches minimum value

final levels ~same - lower and upper
behaviour suggests different capacitance dependence on bias for lower sensor

mini-module#2 shows similar behaviour for lower sensor

seems to point to an effect due to the hybrid? (turns out **not** to be the case)

mini-module#1: low noise channels, upper sensor



low noise channels

these channels have somehow become disconnected at bump-bond level

they still respond to the test pulse

presumably during module assembly and bonding (the hybrid is very flexible)?

very low noise channels

these channels damaged - no test pulse response

higher noise channels

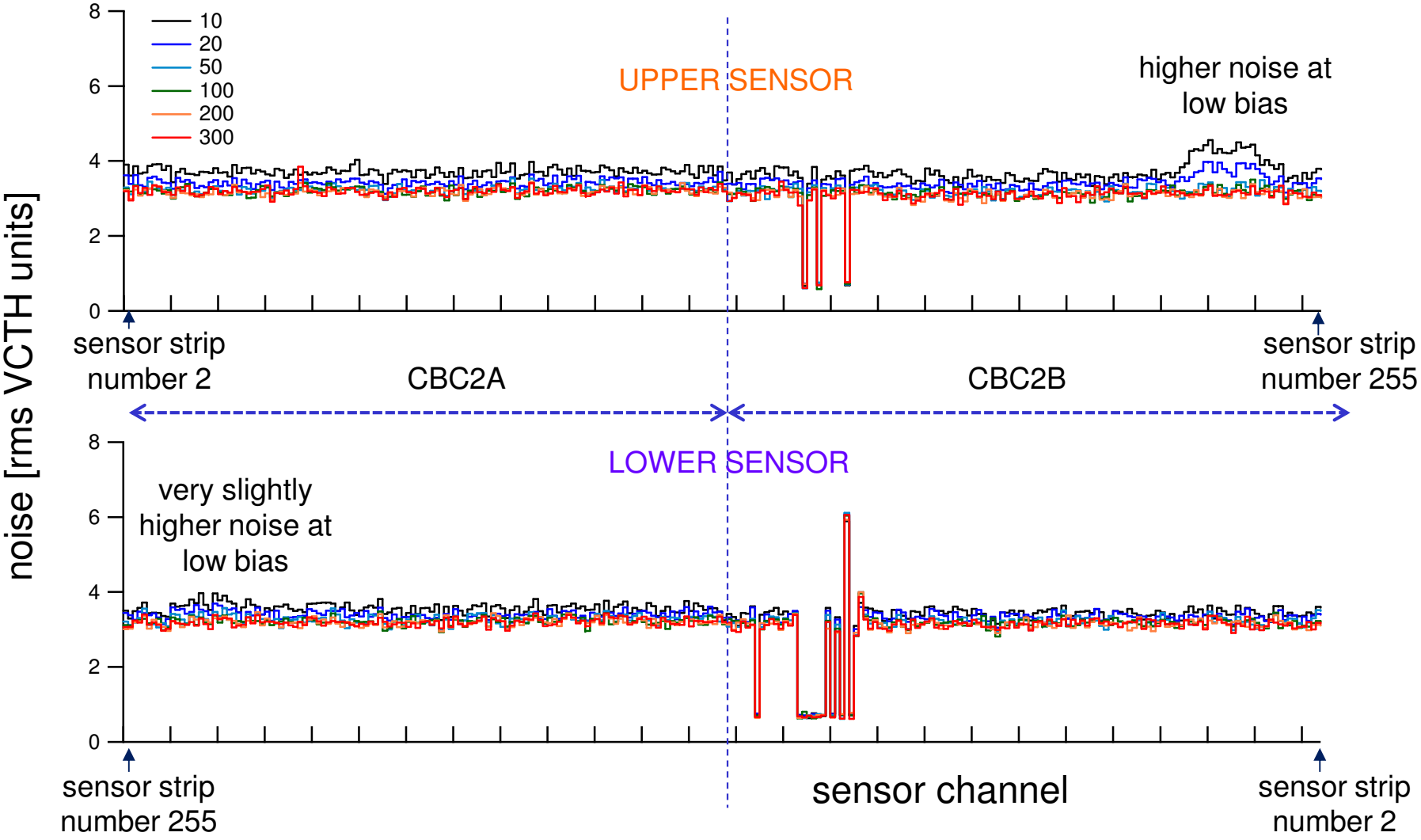
behaviour ~consistent with two channels shorted together

minimodule#3

this module made with hybrid with under-filled chips (bonds encapsulated)

- should not be possible to disturb bump-bonds
- extra checks on wire-pad to amplifier connectivity for all channels
- Infineon sensors carefully selected

mini-module#3: noise vs. bias, both sensors

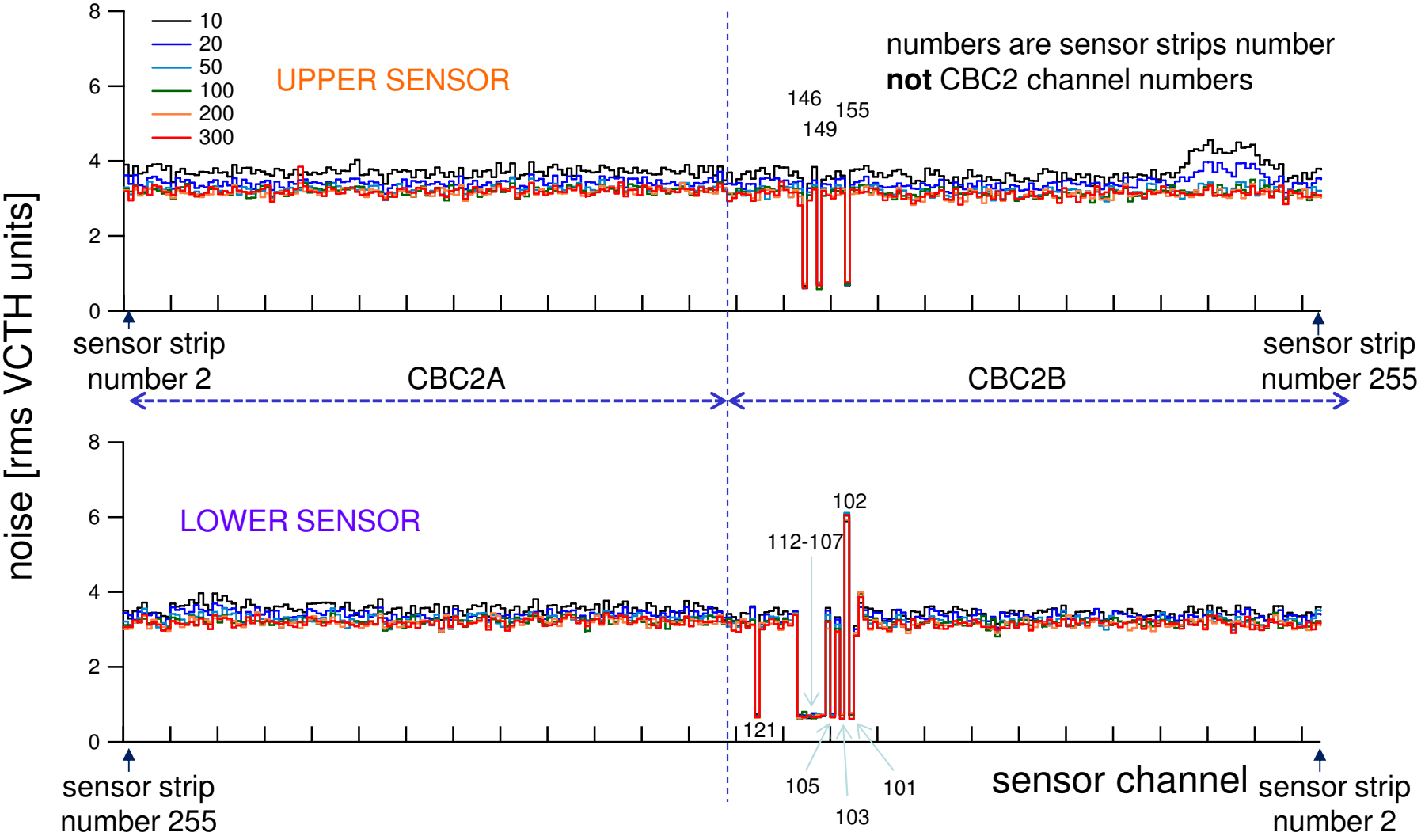


from these results can conclude:

=> previous upper/lower noise behaviour differences **not** due to hybrid

must be characteristic behaviour of the particular sensors used on modules 1 & 2

mini-module#3: odd behaving strips region



all low noise channels are **very** low noise channels - not responsive to test pulse
all associated with CBC2B - both layers (but more associated with lower layer)
high noise channel 102 does respond to test pulse (just a noisy channel)

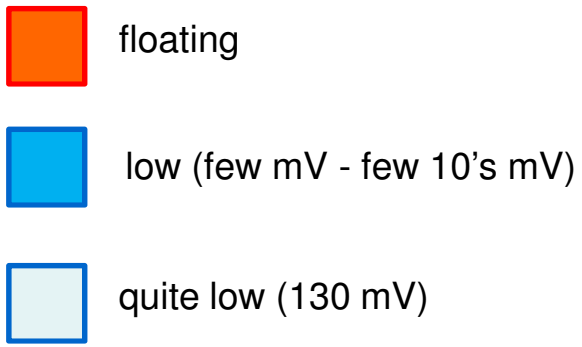
CBC2B bad chans on mini-module#3

probe lowered on to tracks adjacent to wire-bond pads

good (normal) channels show a voltage ~ 250 mV
which corresponds to the input FET gate voltage

some of the bad channels appear floating
scope just shows pickup - same as when
not in contact with anything

some of the bad channels have abnormally low voltages
appear to be being pulled down



CBC2B pad pattern on hybrid (CBC2 channel nos.)

4	2	3	1		
10	8	6	9	7	5
16	14	12	15	13	11
22	20	18	21	19	17
28	26	24	27	25	23
34	32	30	33	31	29
40	38	36	39	37	35
46	44	42	45	43	41
52	50	48	51	49	47
58	56	54	57	55	53
64	62	60	63	61	59
70	68	66	69	67	
76	74	72	75		

for more details of these measurements see:
http://www.hep.ph.ic.ac.uk/~dmray/systems_talks/minimodule_systems_Oct13.pdf

conclusions from mini-module#3

modules 1 & 2 noise vs. bias behaviour for lower sensor must be due to sensors
- **not** to some kind of hybrid effect

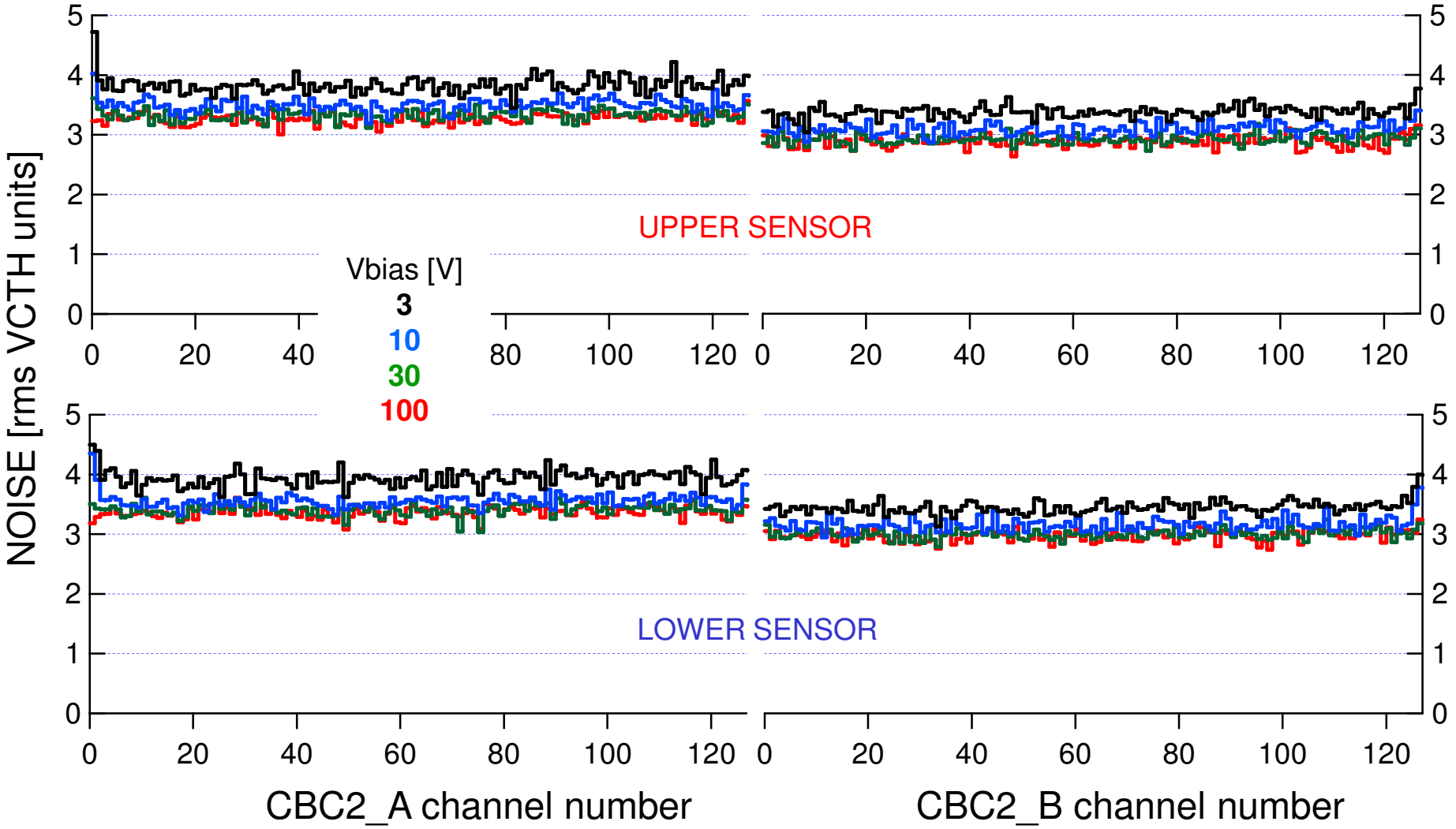
a small region of channels in module#3 have got damaged somehow
characteristics of behaviour and damage mechanism not yet understood
ESD?
there are protection diodes (though minimal)
will try and damage some channels electrically and see if can reproduce symptoms

nevertheless mini-module#3 is mostly working well
- will go into Desy test beam

further module production

2 more modules now constructed using CNM sensors (N on P) and under-filled hybrids

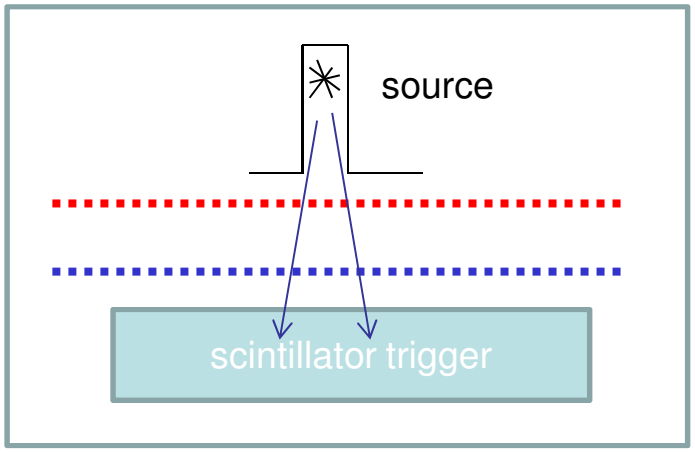
mini-module#4: noise vs. bias, both sensors

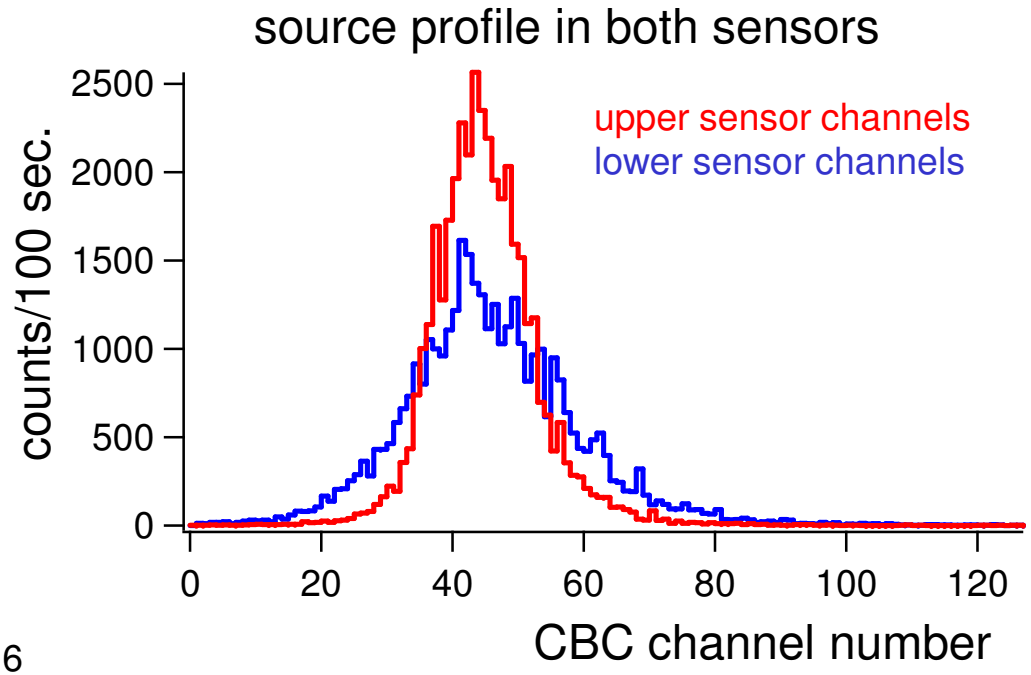


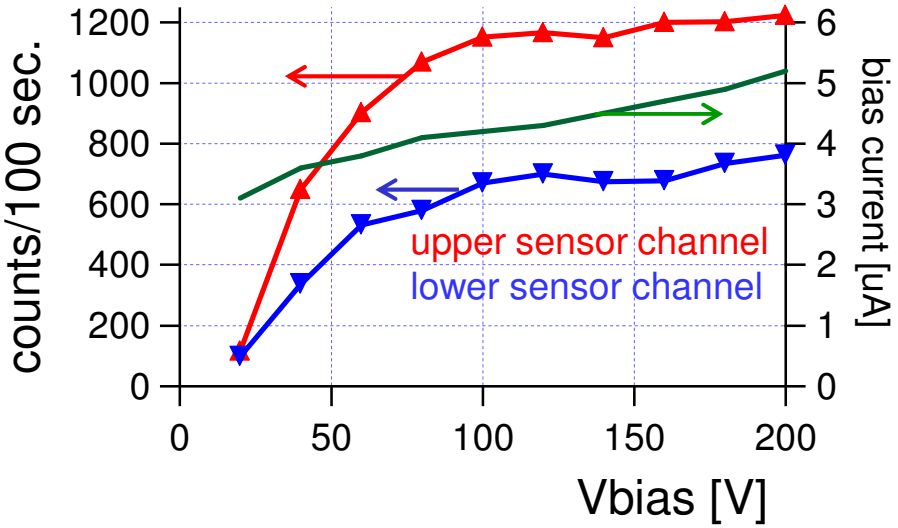
both sensors behave the same, **NO** bad channels, all respond to test pulse

same for mini-module 5 lower sensor (upper sensor not present)

mini-module#4: response to Sr-90





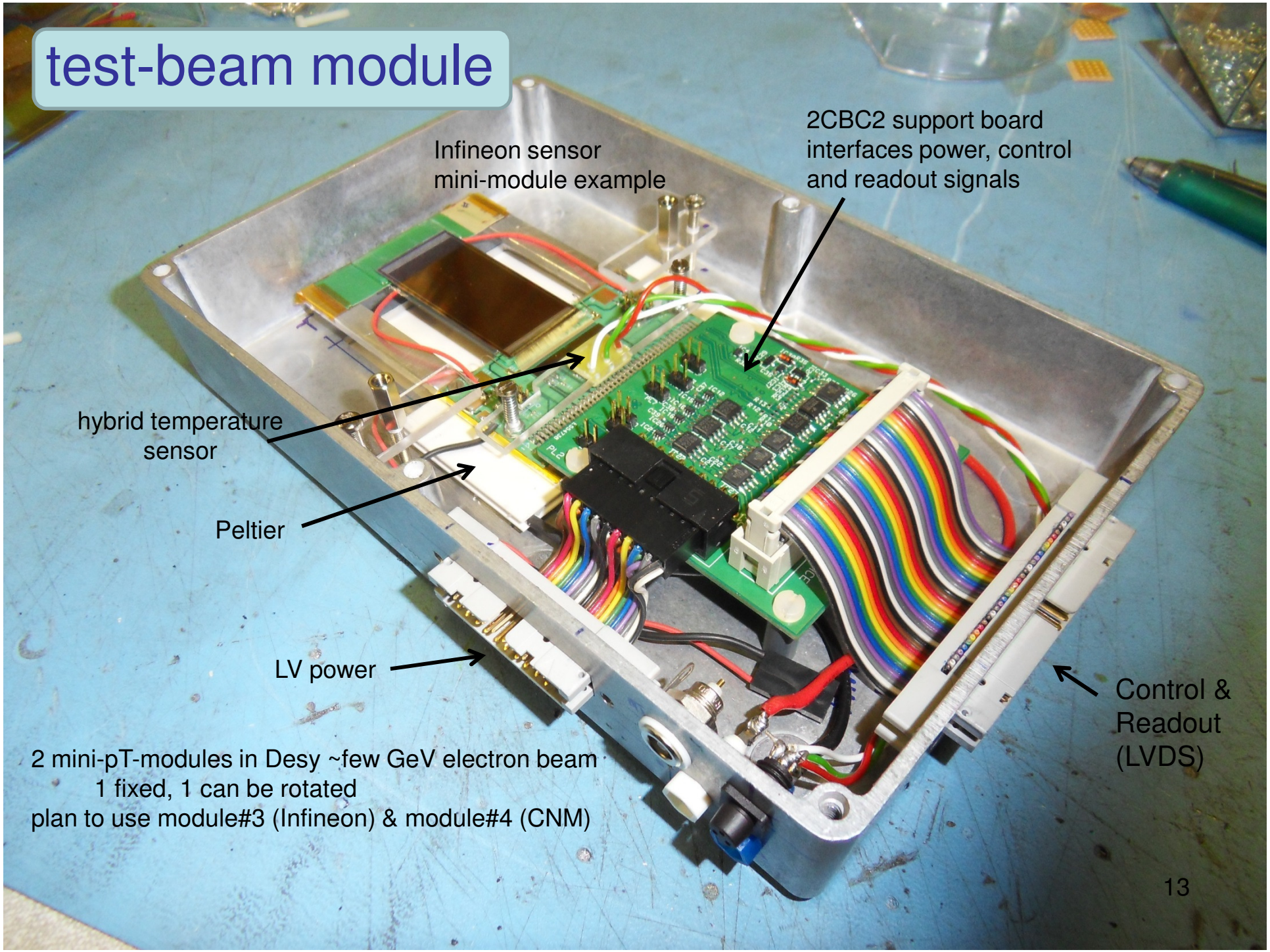


look at 1 channel from each layer in centre of area exposed to source

← counts/100 sec. vs. bias saturates at ~ 100V

bias current well-behaved (both sensors supplied from common bias source here)

test-beam module



2 mini-pT-modules in Desy ~few GeV electron beam
1 fixed, 1 can be rotated
plan to use module#3 (Infineon) & module#4 (CNM)

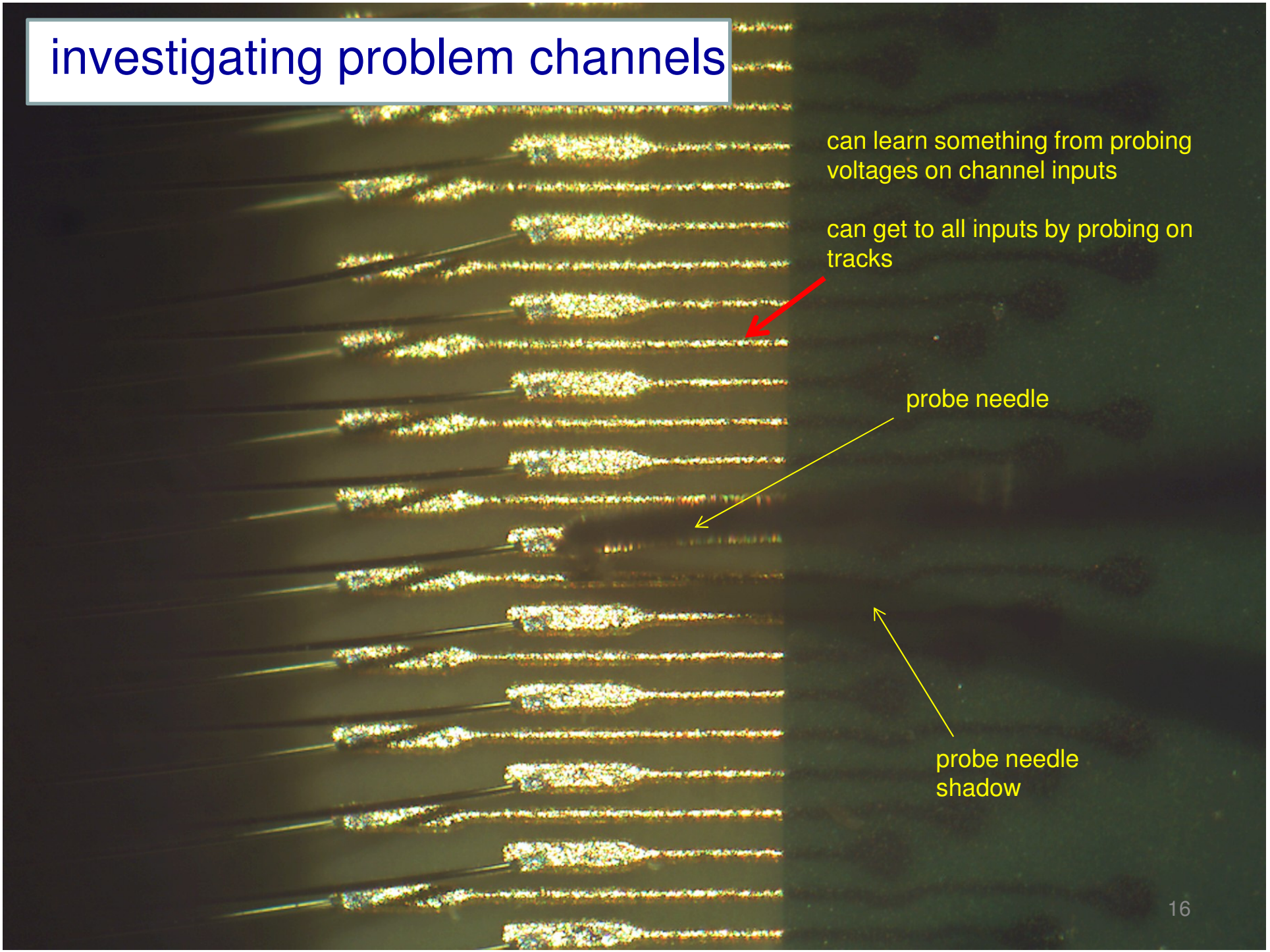
summary

module #	sensors	2CBC2 hybrid	comments
1	Infineon	not underfilled	strange noise vs. bias behaviour for lower sensor, many low-noise channels
2	Infineon	not underfilled	strange noise vs. bias behaviour for lower sensor, many low-noise channels, 1 CBC2 chip damaged
3	Infineon	underfilled	small patch of bad channels, but mostly good
4	CNM	underfilled	all good channels
5	CNM	underfilled	all good channels but 1 sensor only

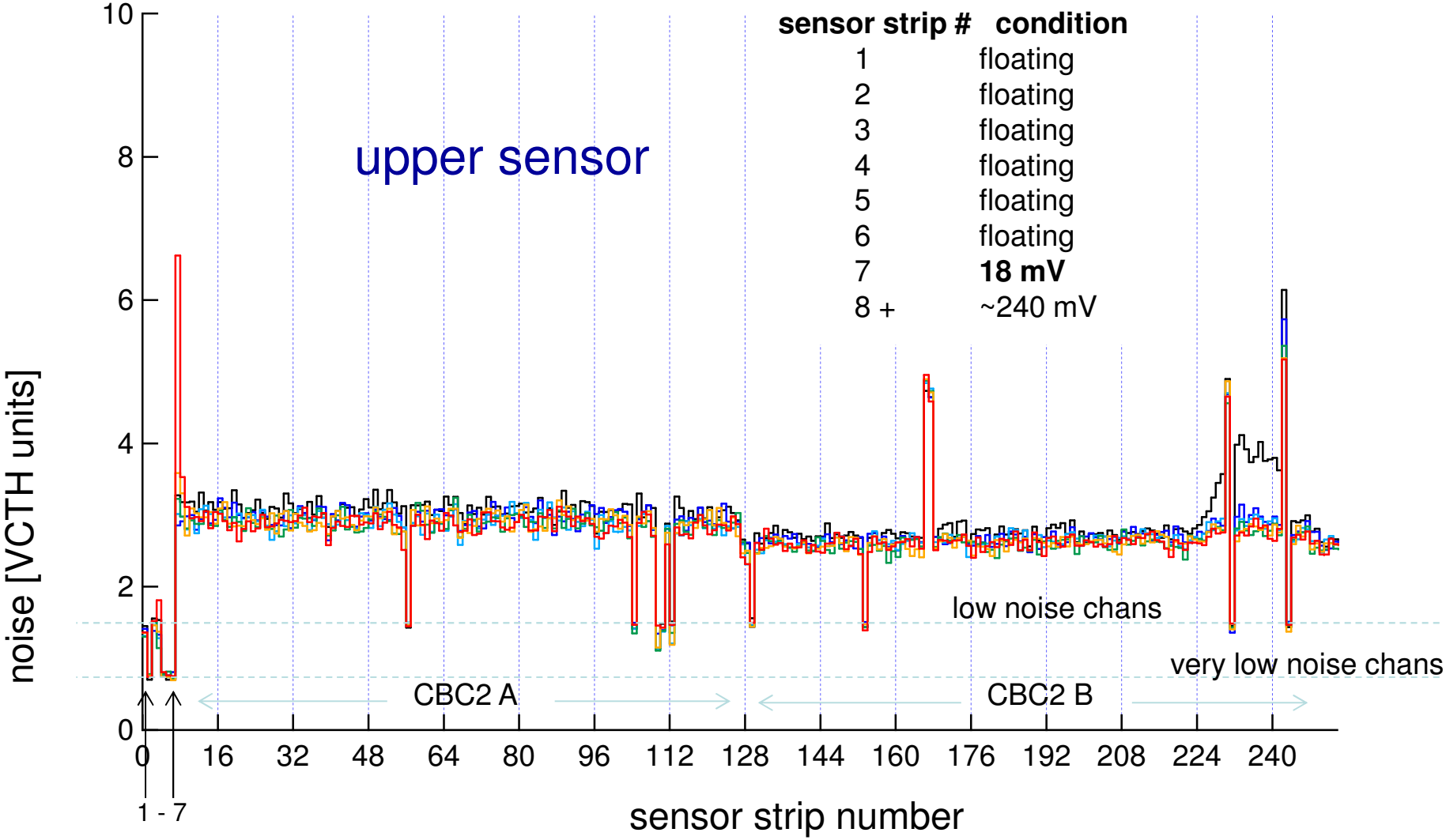
- strange noise vs. bias behaviour for lower sensors in modules 1 & 2 **not** due to 2CBC2 hybrids
- use of underfilled hybrid substantially reduces occurrence of low noise (bad) channels
  symptoms and causes of bad patch of channels on module 3 not understood
- modules 3 & 4 will go into test beam next week

extra

investigating problem channels

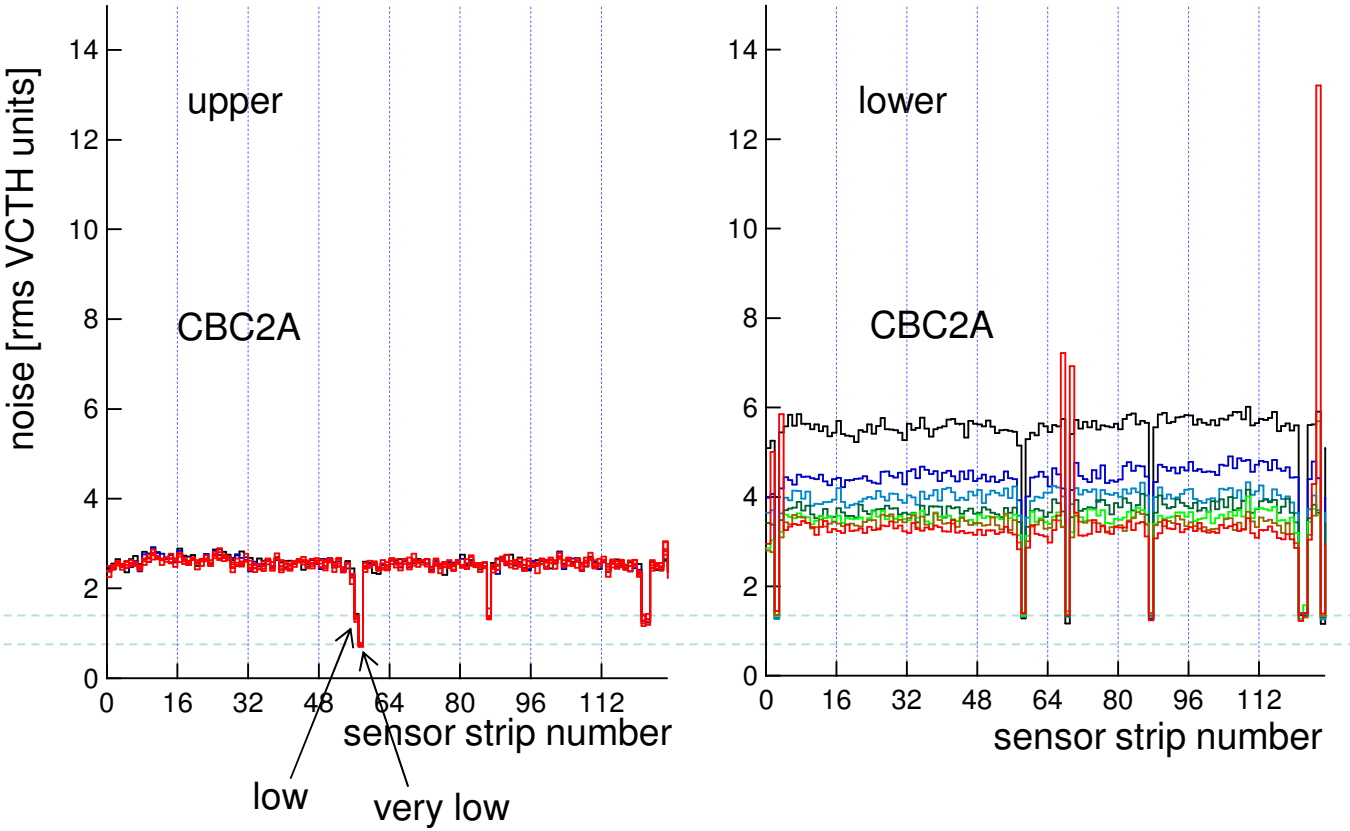


probing channel voltages on mini-module#1



very low-noise channels don't respond to test pulse
low noise channels do
all bad channels floating - except channel 7

probing channel voltages on mini-module#2

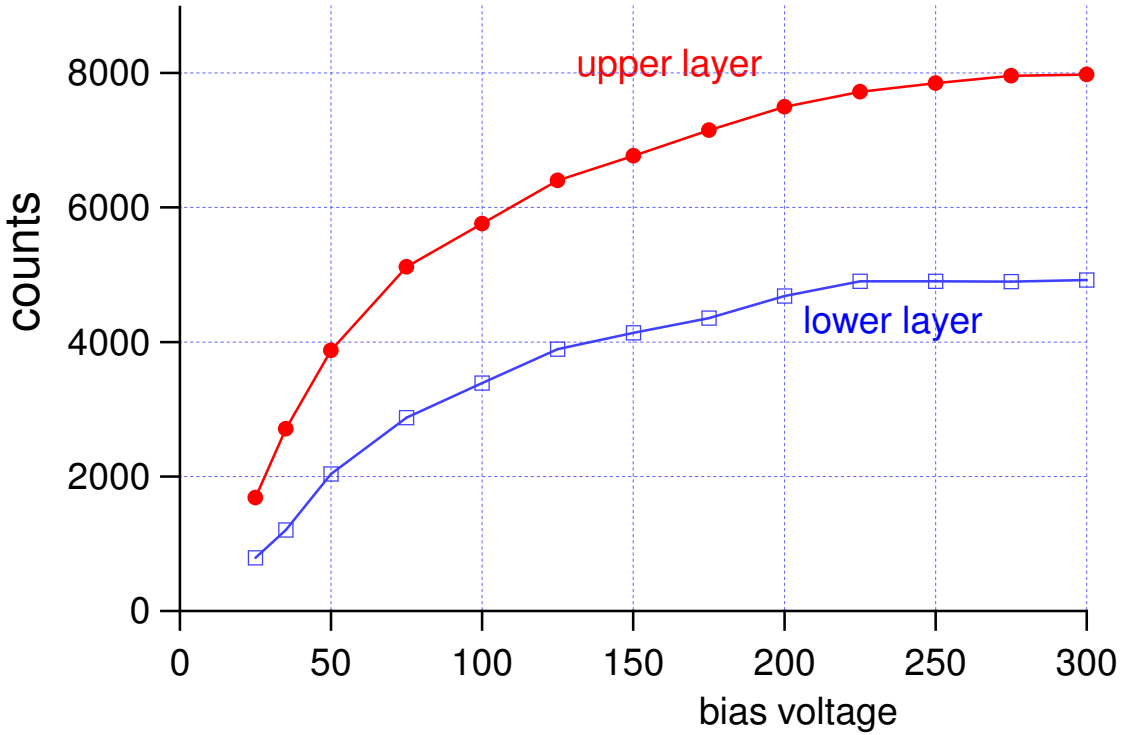


Vbias: 50 - 600 V

both of these channels (low & very low) appear floating

only very low noise channel does not respond to test pulse on this chip

signal vs. bias - mini-module#1



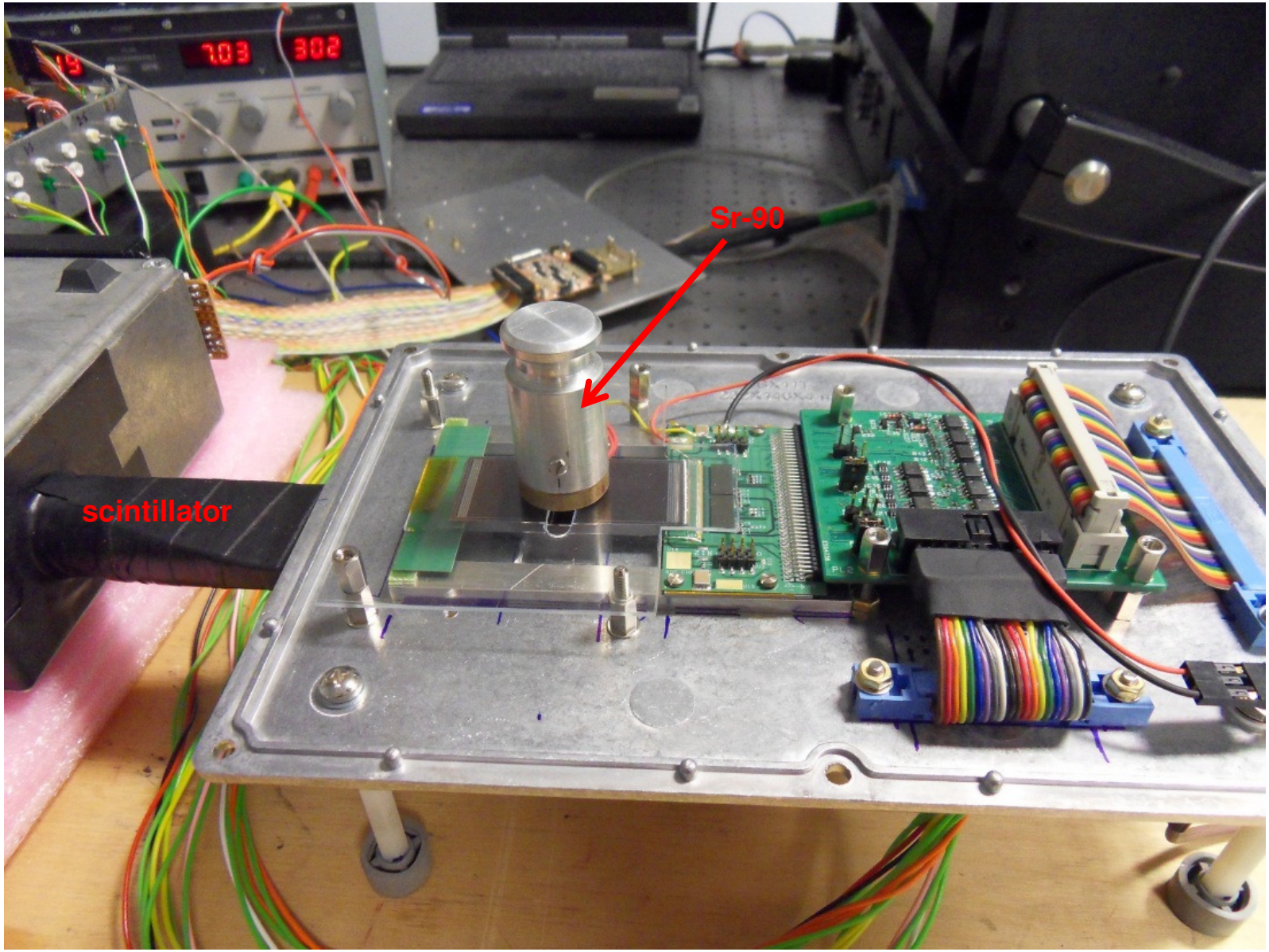
method:
threshold set at ~ 1 fC, Sr-90 source
look at one channel from each layer in middle of area “illuminated” by source
count number of times comparator fires for 100,000 scintillator triggers

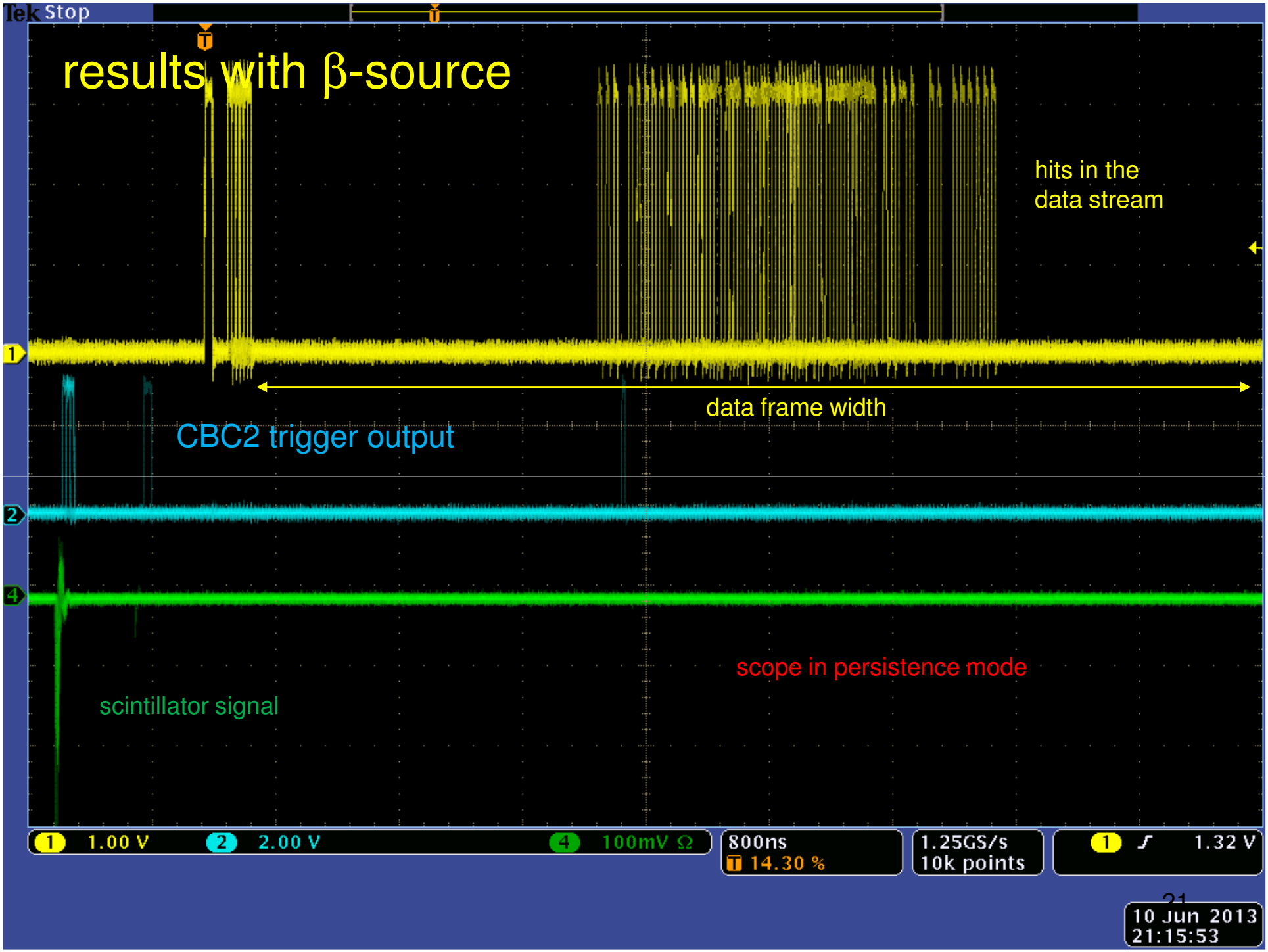
counts saturate as bias voltage approaches 250 Volts

consistent with depletion behaviour measured in Vienna

(other module behaves similarly)

mini-module in test setup




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

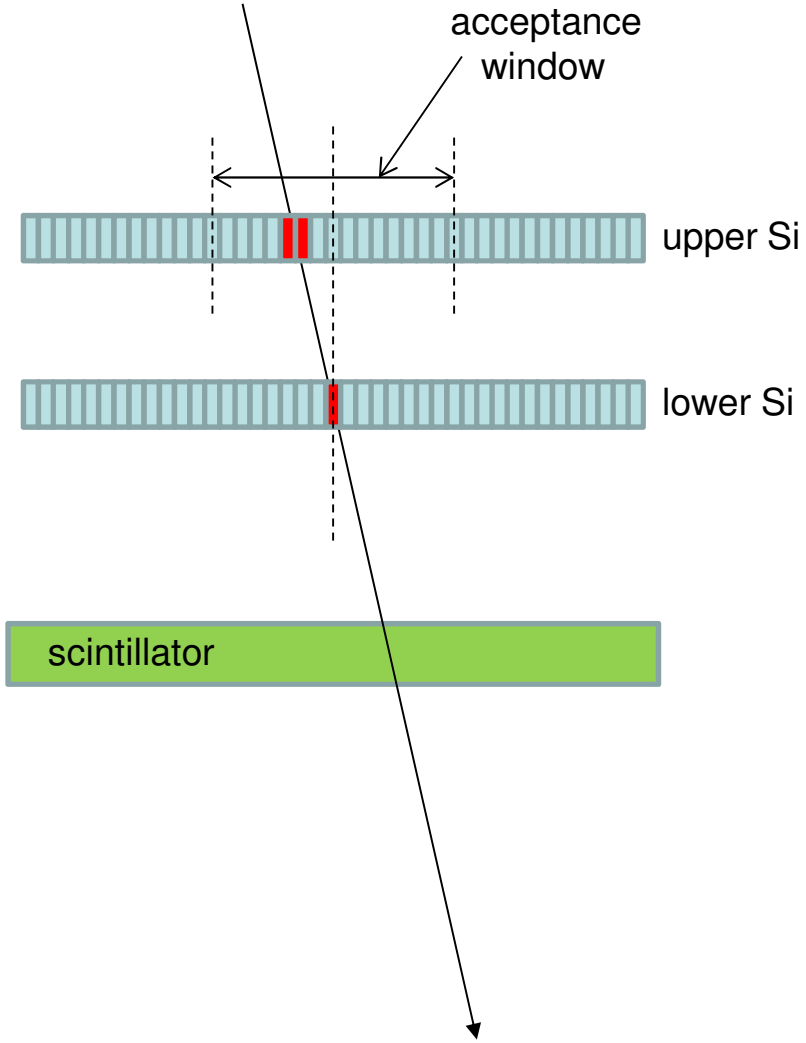
results with cosmics

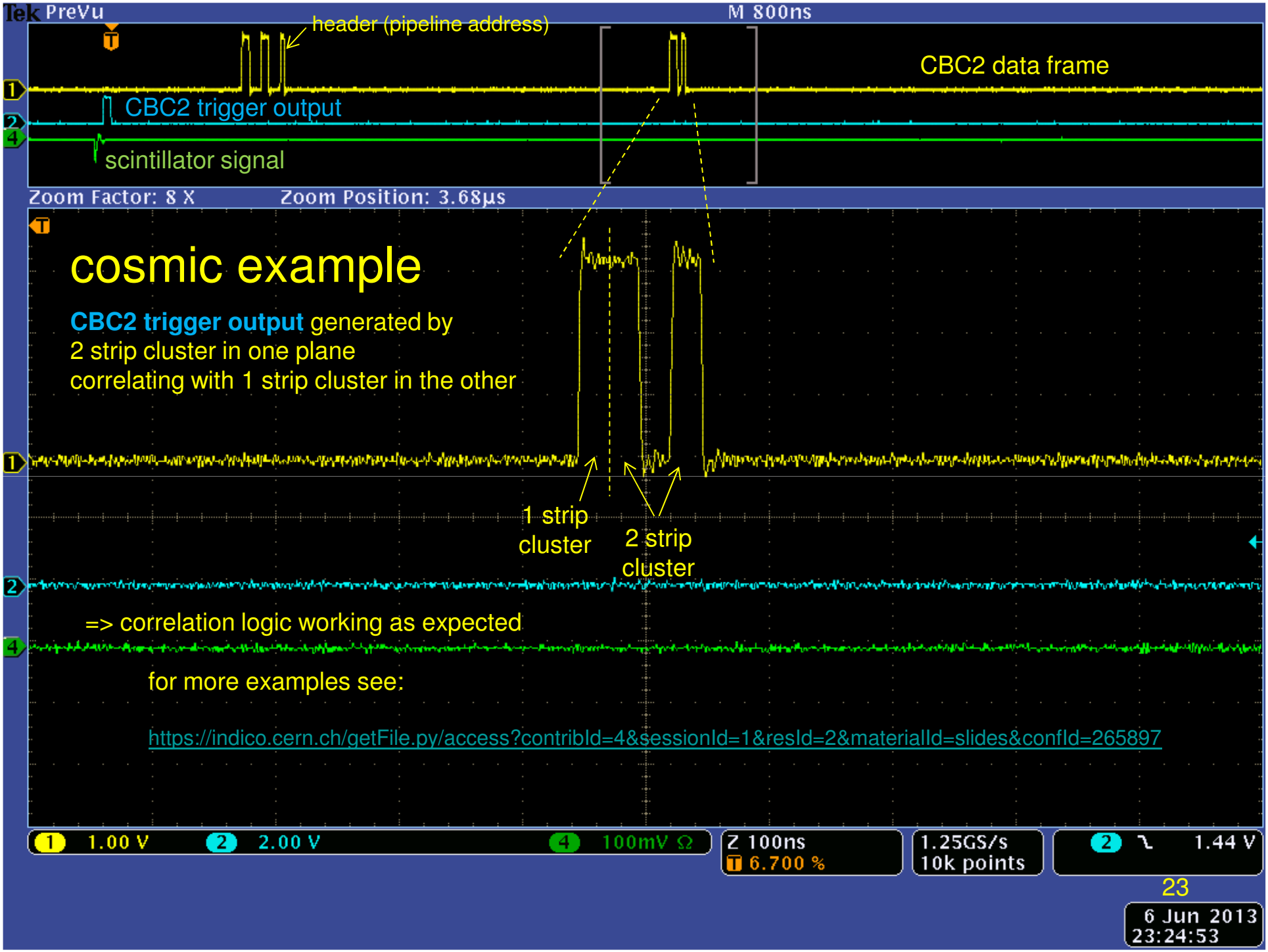
coincidence window set to max in upper sensor
to maximize sensitivity

+/- 8 strips

rate still very low

<< 1 Hz




Tek PreVu
M 800ns
header (pipeline address)
CBC2 data frame
CBC2 trigger output
scintillator signal
Zoom Factor: 8 X
Zoom Position: 3.68µs
cosmic example
CBC2 trigger output generated by
2 strip cluster in one plane
correlating with 1 strip cluster in the other
1 strip cluster
2 strip cluster
=> correlation logic working as expected
for more examples see:
https://indico.cern.ch/getFile.py/access?contribId=4&sessionId=1&resId=2&materialId=slides&confId=265897
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
23:24:53