results with the (partially) installed BLD/BLM system at the ESRF

" alone we can do so little, together we can do so much " (H. Keller).

so we install 128 + units . . . !

overview of this presentation :

1) short recall of the new BLD / BLM system

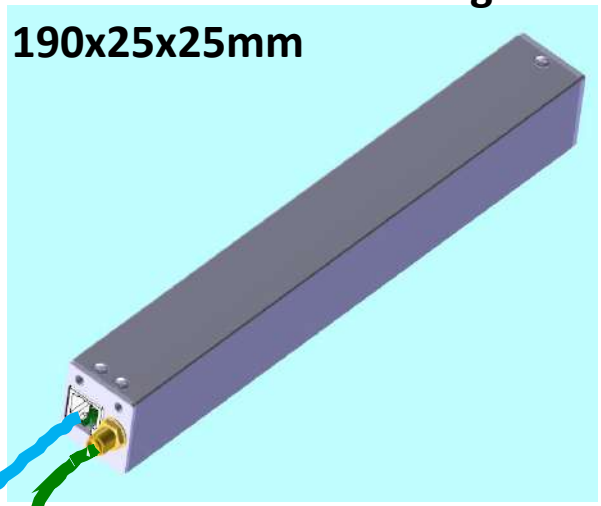
2) quick review of ESRF BeamLoss monitoring → old systems in place >10…20 years

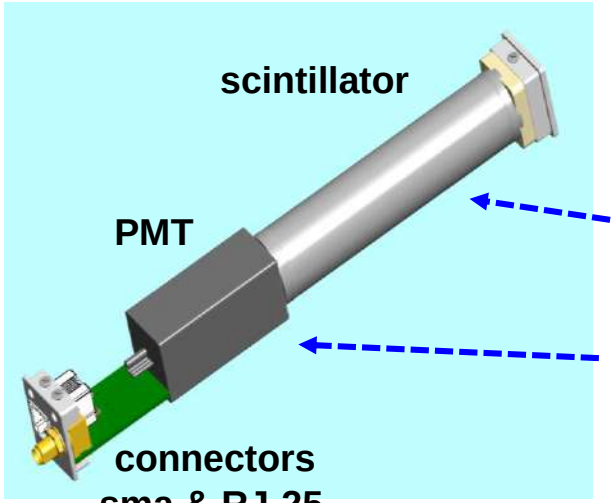
3) new Storage Ring (EBS) in 2020 → but upgrading the BLM system completely NOW (2017)

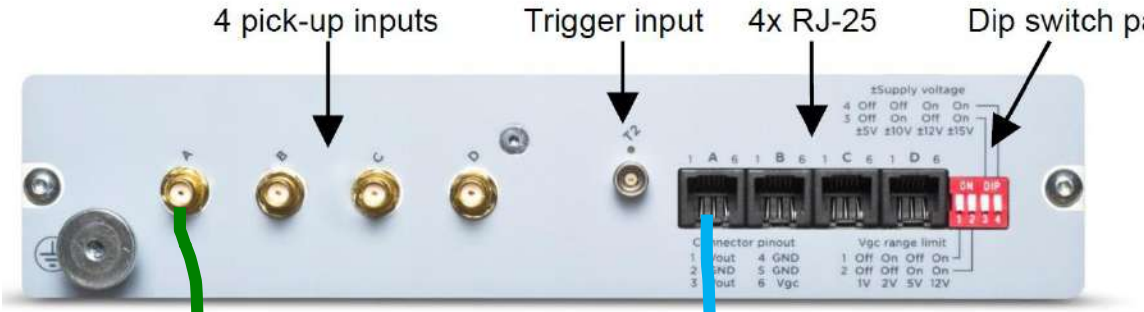
4) state of today's installation (end May 2017)

5) results so far : -a- immunity against X-rays
-b- ADC recordings showing non-perfection of the injection
-c- filling-pattern verifications

BLD with its Alu housing
190x25x25mm



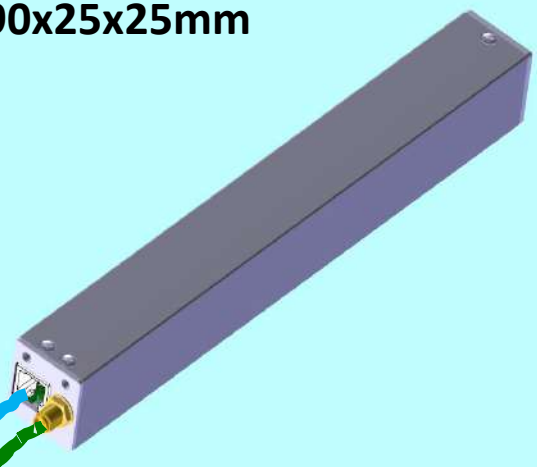




BLD-signal

power-supply &
gain-control

BLD with its Alu housing
190x25x25mm

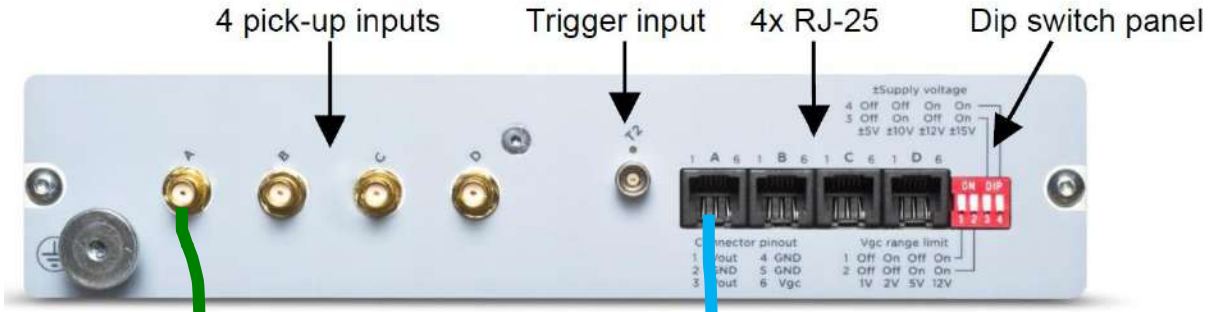


BLD :

- entirely powered (+5V) & gain-controlled from the BLM
- several orders of magnitude with 0-1V gain-control
- can drive 50ohm load
- Hamamatsu 10721 PMT
- EJ200 scintillator 38cm^3

BLM :

- 4 independent channels
- 14 bit ADCs, +/- 5V to +/- 150mV full-scale (adjustable)
- >10MHz bandwidth
- 50ohm or HiZ input
- PoE
- Embedded Tango-DS



BLD-signal

power-supply &
gain-control

BLM (Libera-BLM)

although it looks like a “Spark”

1) TODAY :

per cell
already in the present Storage Ring :

all with 10mm Pb shielding

- ionization chambers : **2**
- **old BLDs** : **2**

same position

2) SOON :

per cell
added now to present Storage Ring :

4 (extra) new-BLDs :

- **2** i.e. coupled to old-BPMs
- **2** “free” position

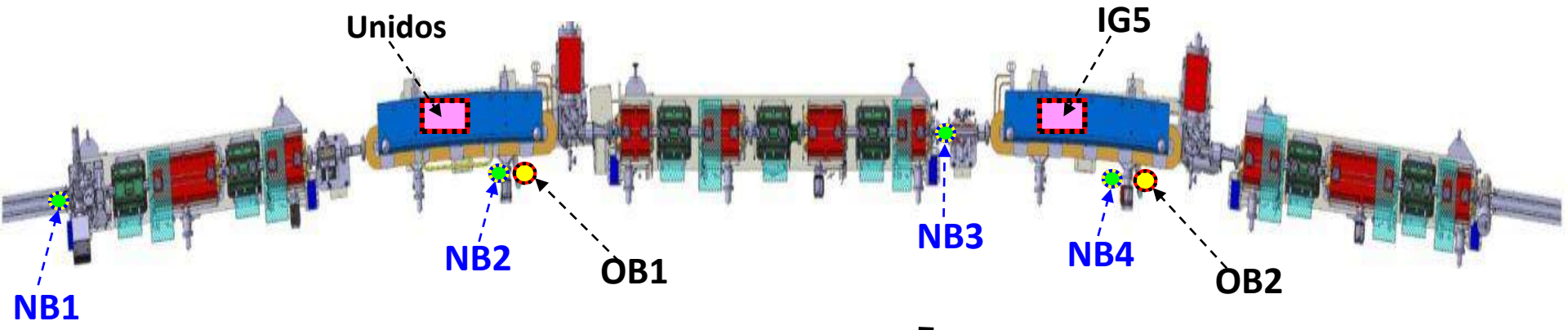
3) LATER :

2019/20 re-installing
in the new EBS Storage Ring :

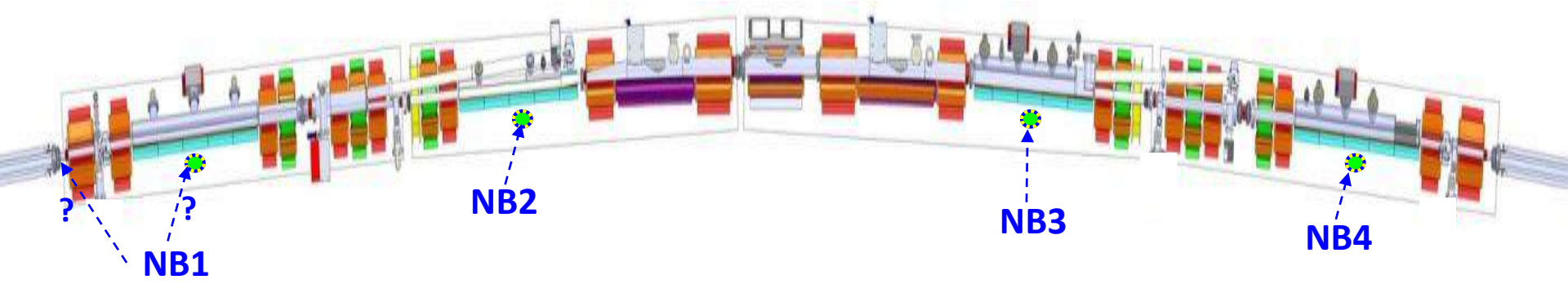
4 new-BLDs :

precise position still to
be determined position

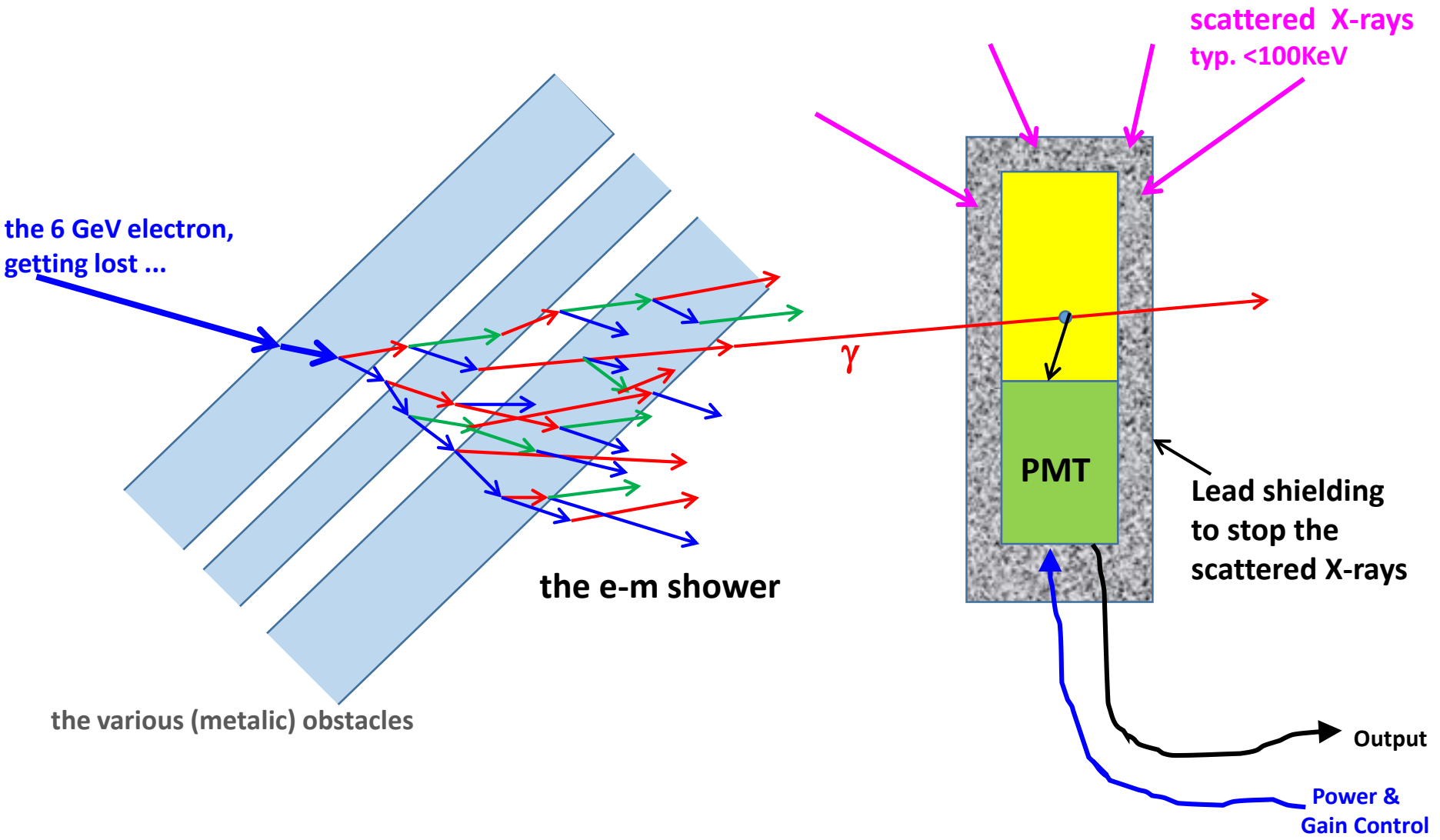
old ESRF *double-bend* Lattice: ε_x= 4 nm



full replacement
in 2019



EBS *7-bend* Low Emittance Lattice: ε_x= 0.15 nm



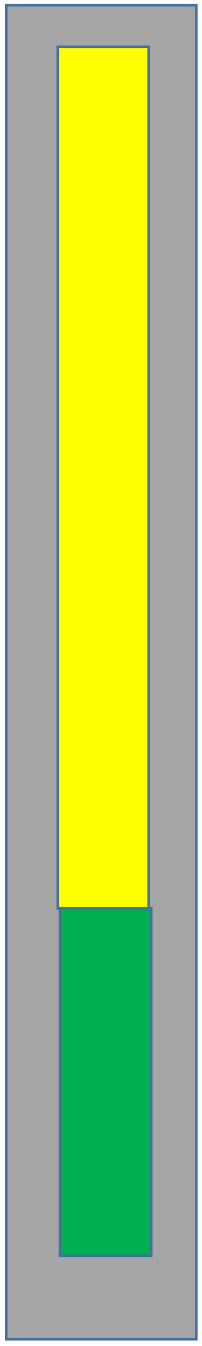
the scintillator is (very) sensitive to both X-rays and gammas

so **Lead shielding** is needed to **stop the** X-rays

if not the BLD is just a beam-current monitor ….

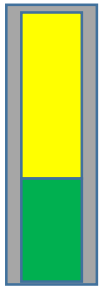
old BLD

roughly
to scale



10mm of
Lead (14Kg)

new BLD



2 or 3mm of
Lead (<1Kg)

how much lead to make the BLD
immune to scattered X-rays ?

1) depends on the energy of scattered X-rays
thus : - beam energy (but remains at 6GeV)
- dipole fields (weaker in EBS)

2) the BLD position w.r.t. the X-ray absorbers

State of installation & progress :

Recall : ESRF has 32 cells, → 4 regular BLDs = 128 units inside the Ring
each cell will get : → 1 BLM = 32 units in the cubicles

Later : more specific BLDs at injection & extraction points, down-stream :
In-Vac undulators, scrapers, collimators etc. total → 160 BLDs & 40 BLMs

Status : Cells 4 to 26 now fully equipped : 4 BLDs per cell → 23 cells = 92 units =72%
now fully equipped the rest (9 cells) in June shut-down (now)

Servers (provided by the I-Tech company) :
- globally very satisfactory
- stress tests not completed yet …
- initial start-up conditions …
- polling rates on some attributes …

a global server above all these (128) individual servers is now needed
at the moment all data collection is done through matlab routines talking to 92 units …

in-situ calibration with Cesium source was tested, but not yet used.

Also :
- Lead shielding increased from 2 to 3mm
- re-positioning of BLD #3

} to make immune to X-rays

assessing the non-immunity to scattered X-rays

Method :

- at : low beam currents (20, 10, 5, 0mA)
and
high beam lifetimes (>200hrs)

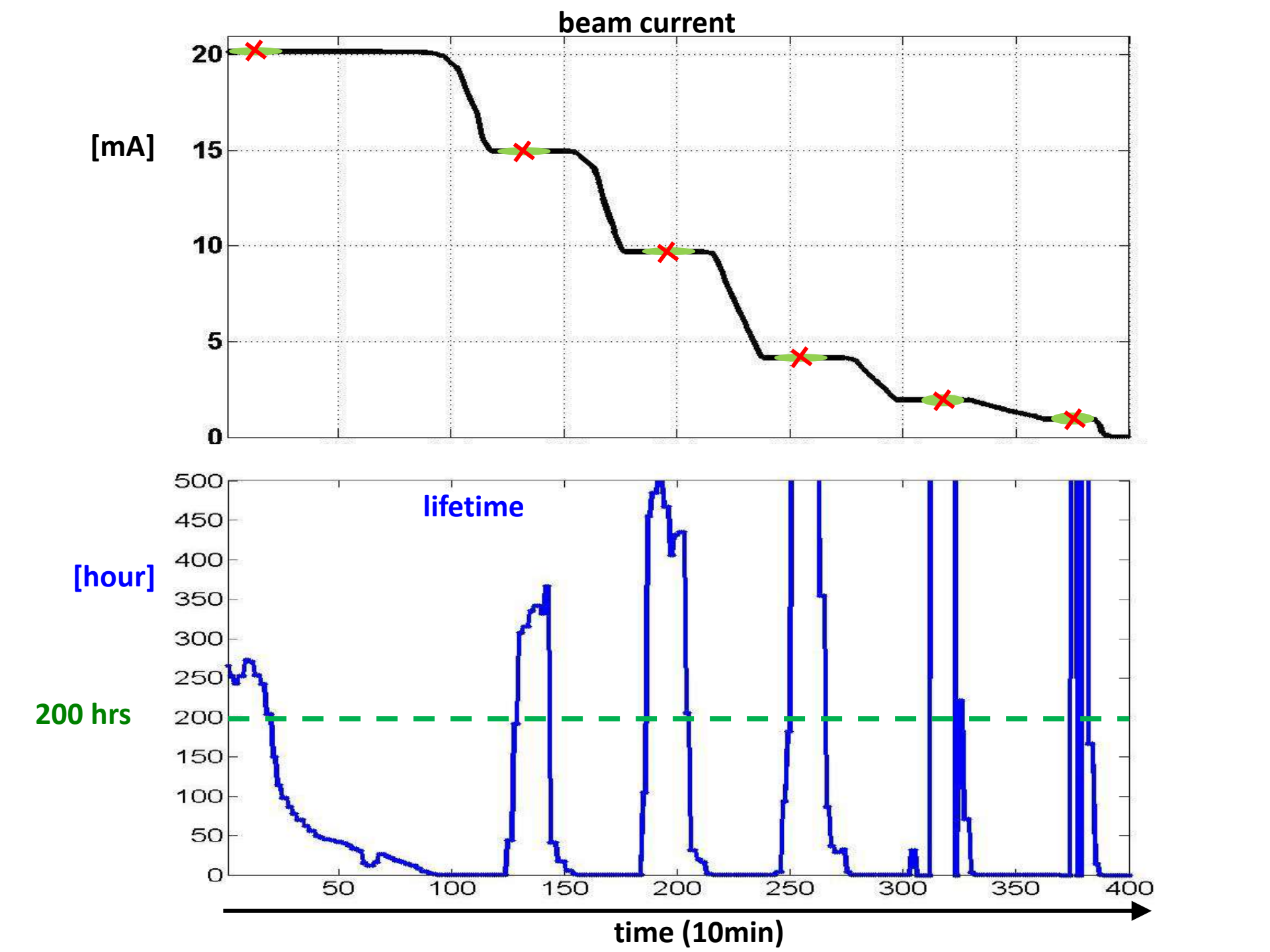
} **negligible losses**

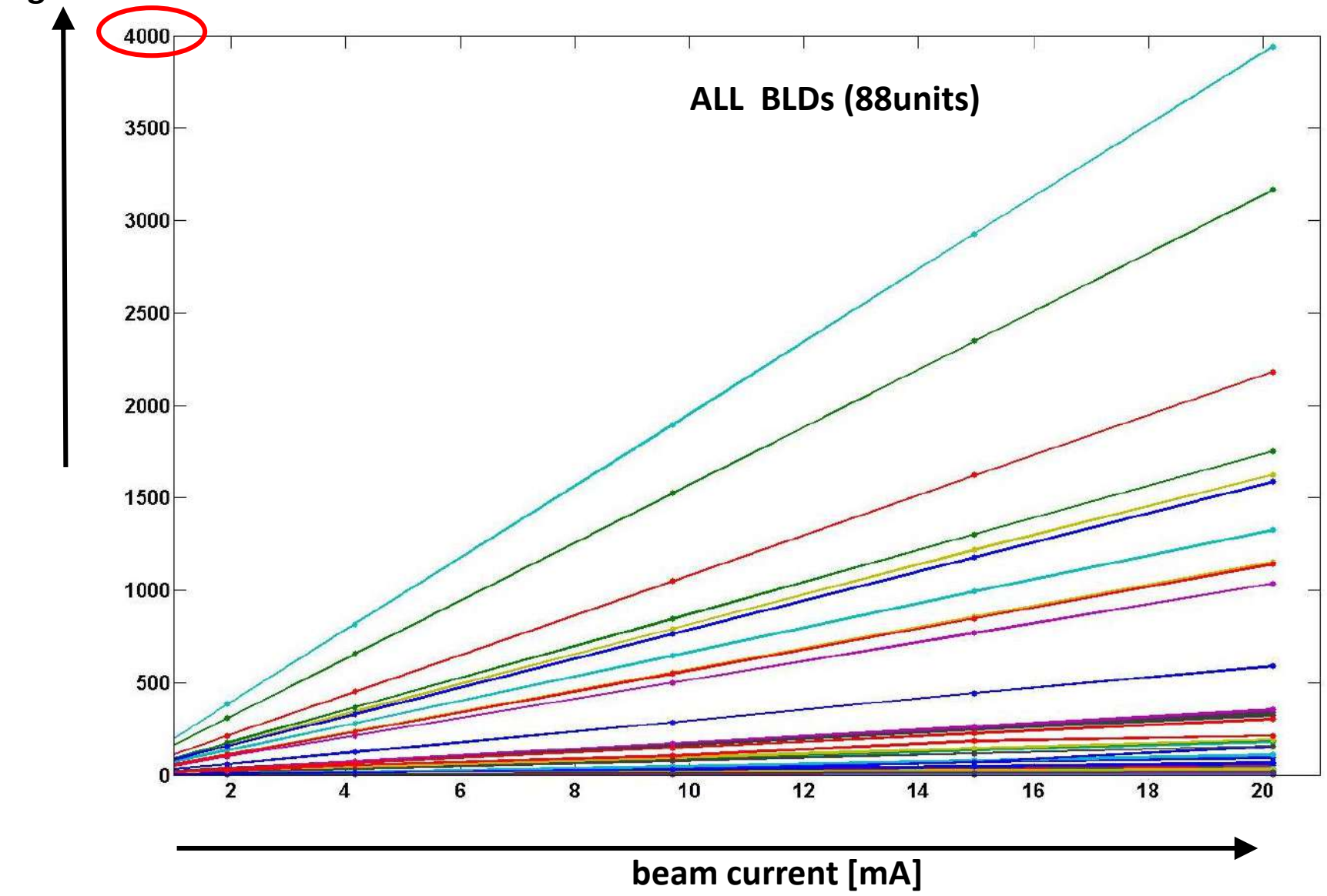
- measure the BLD signal (should be zero, ideally)

Also :

- while scraping from 20 → 10 → 5mA etc. etc.

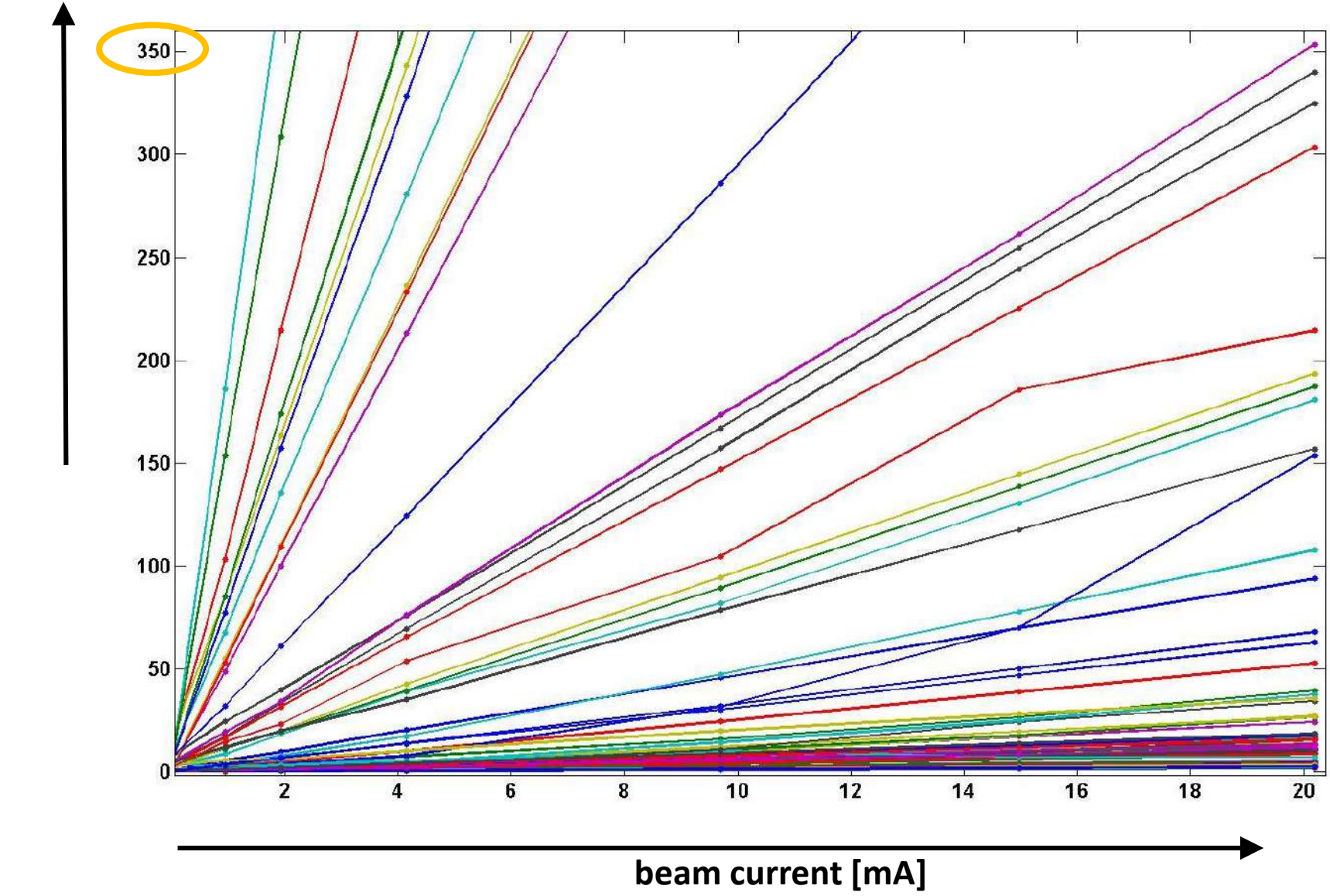
- compare : the old-BLDs (10mm Pb) with the
the new-BLDs (2mm Pb)
that are both at the <u>same position</u>


beam current
[mA]
20
15
10
5
0
lifetime
[hour]
200 hrs
500
450
400
350
300
250
200
150
100
50
0
50
100
150
200
250
300
350
400
time (10min)


BLD [a.u] but relatively calibrated signal
ALL BLDs (88units)
4000
3500
3000
2500
2000
1500
1000
500
0
2
4
6
8
10
12
14
16
18
20
beam current [mA]

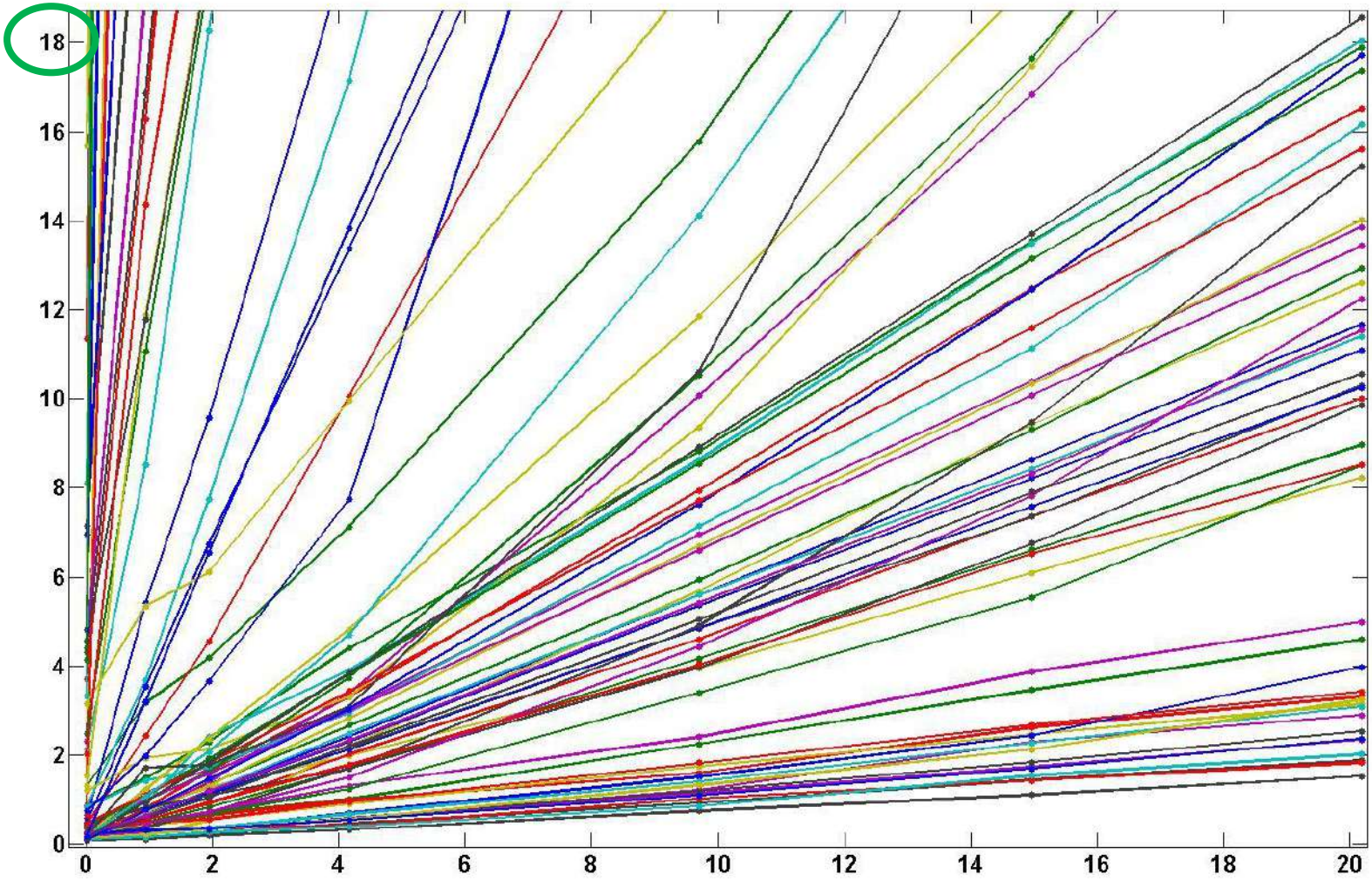
fraction of BLDs

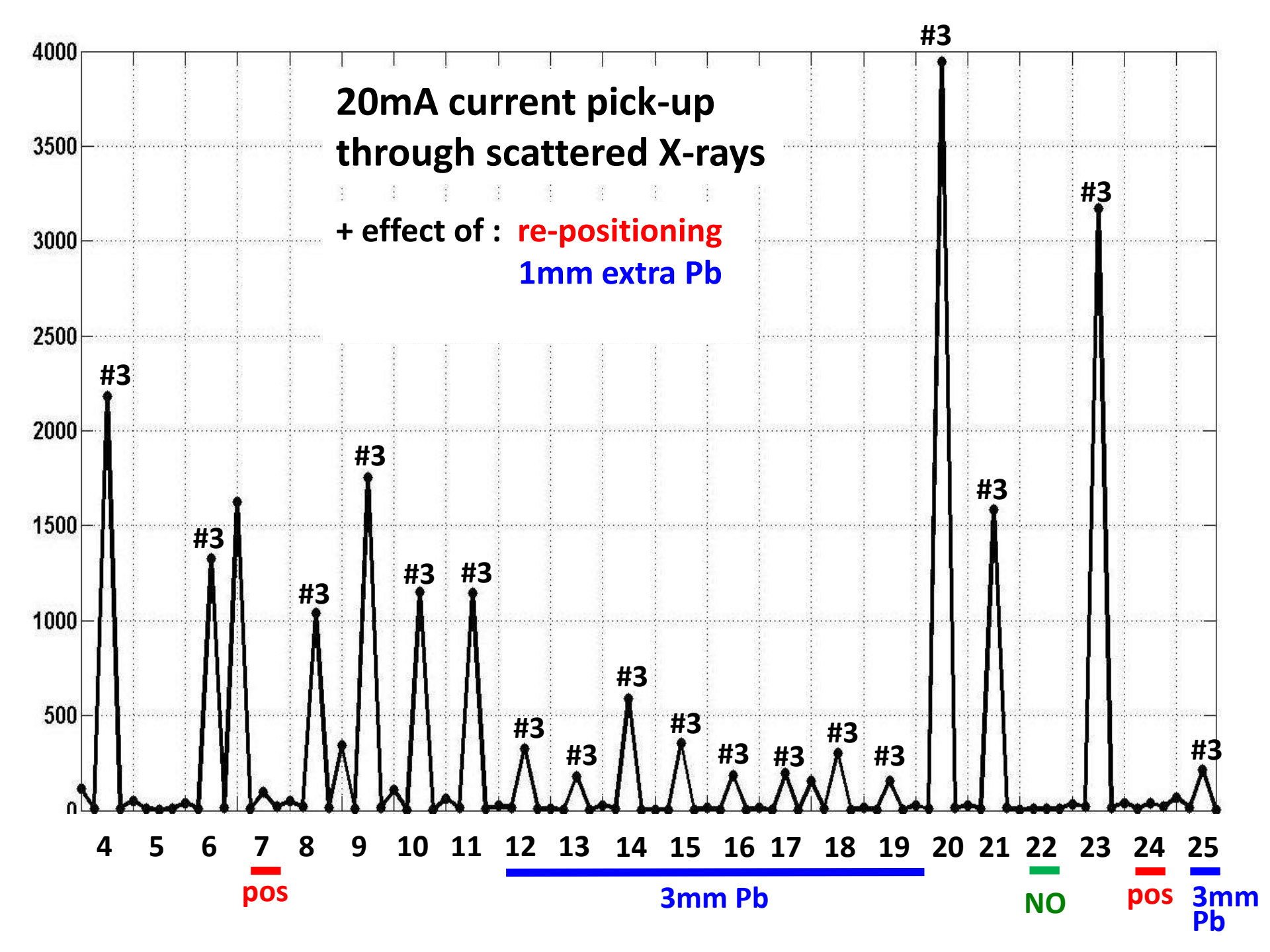
BLD signal [a.u] but relatively calibrated

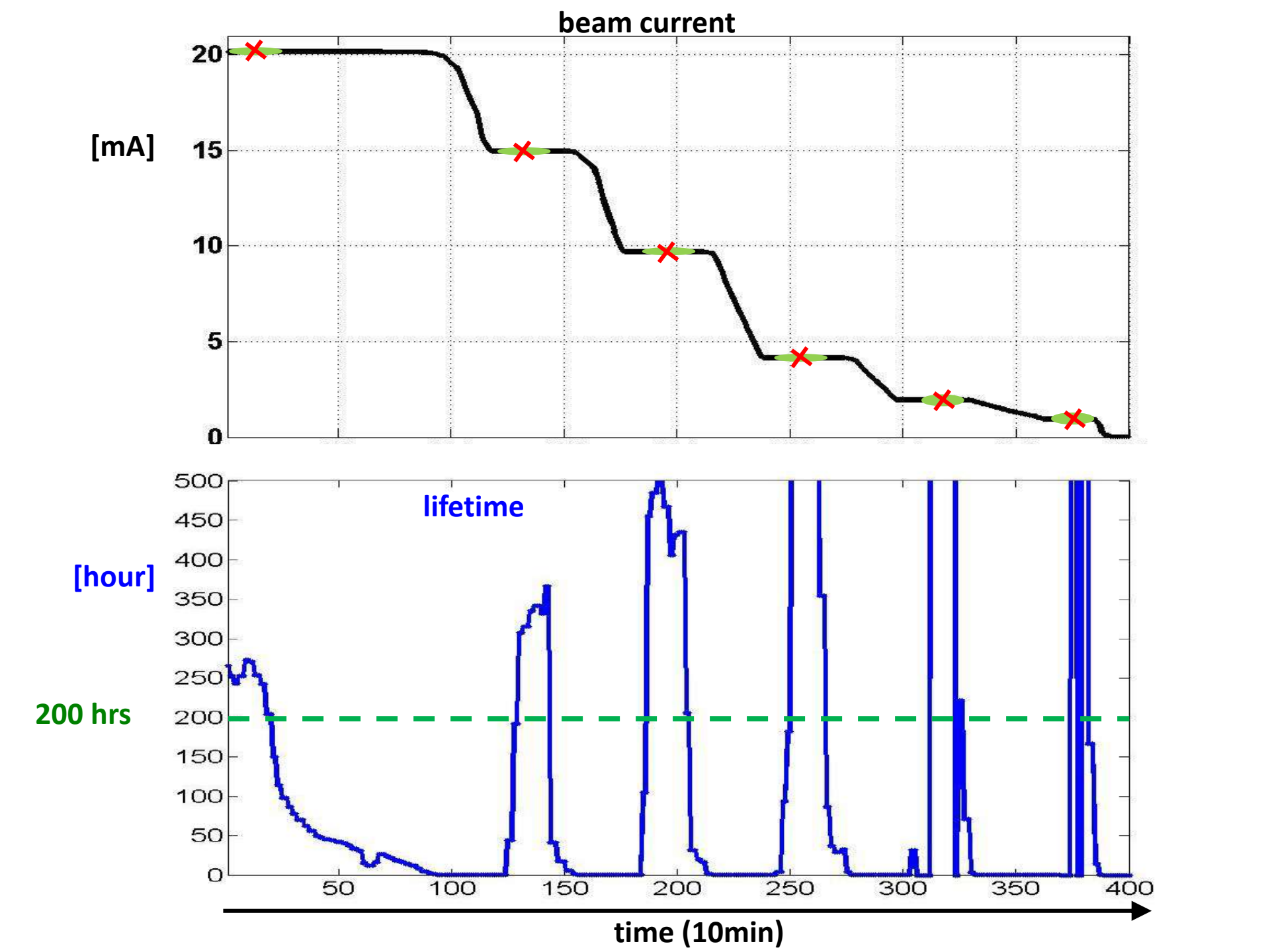


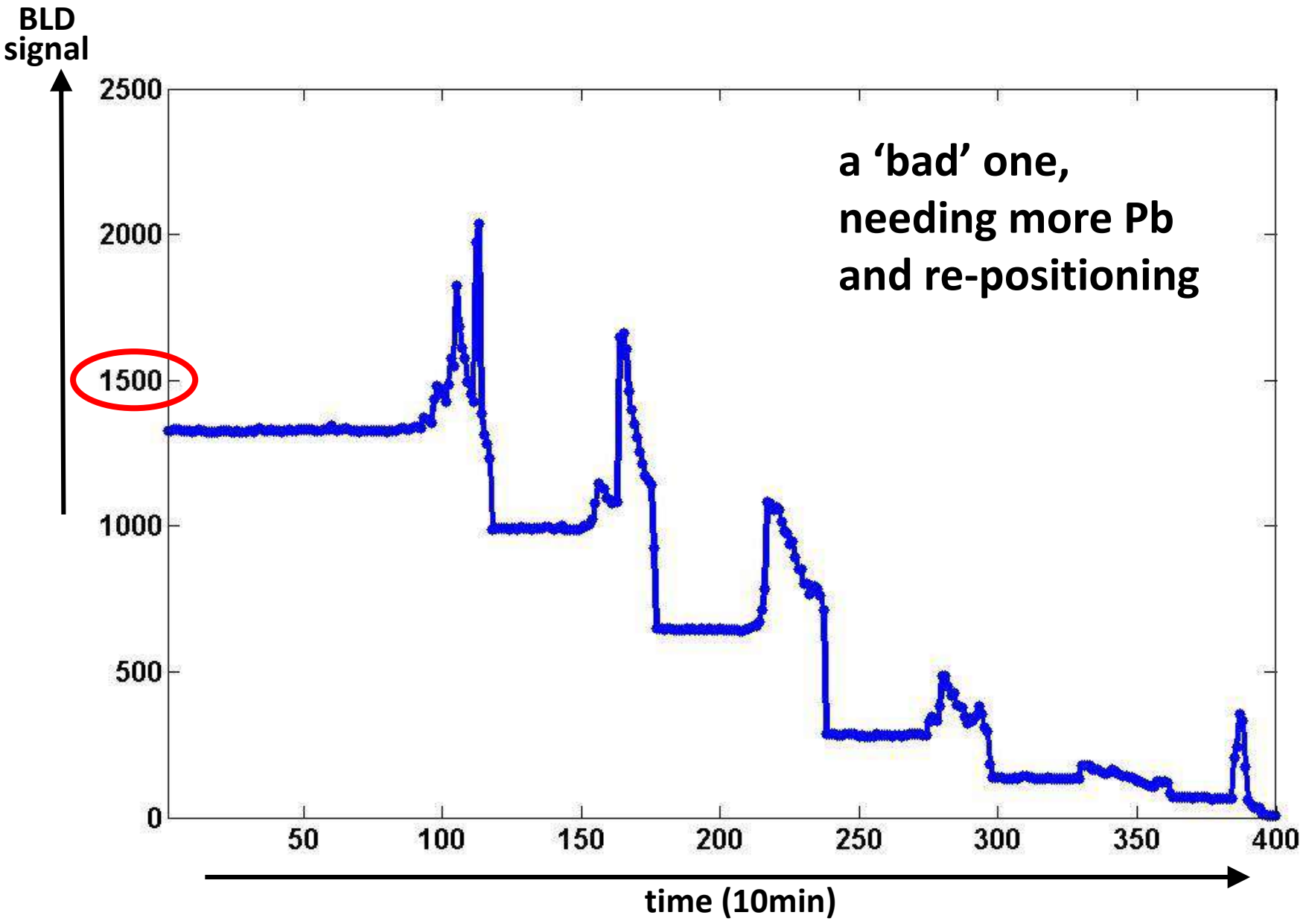
fraction of BLDs

BLD signal [a.u] but relatively calibrated

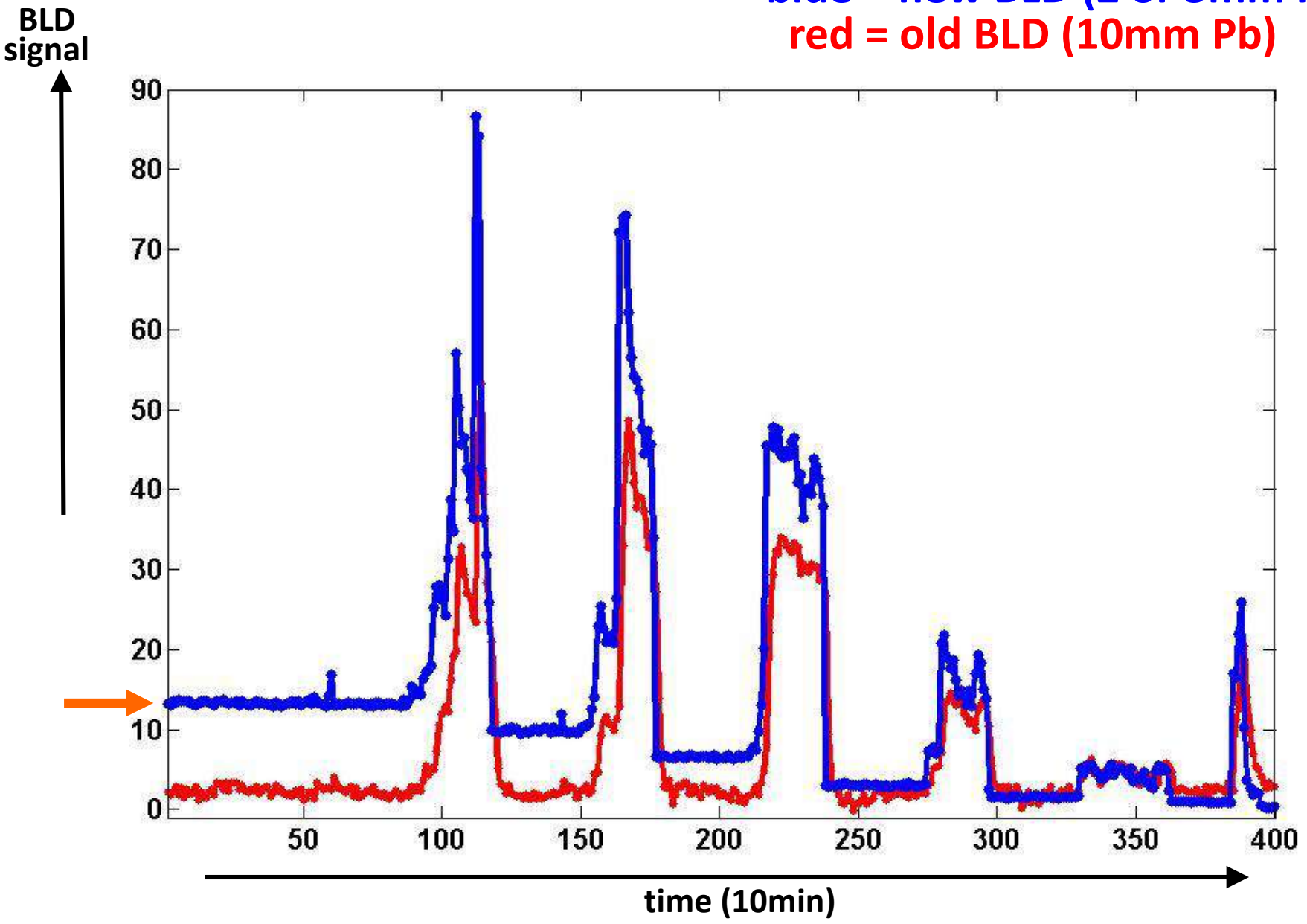



20mA current pick-up
through scattered X-rays
+ effect of : re-positioning
1mm extra Pb
#3
4000
3500
3000
2500
2000
1500
1000
500
0
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
pos
3mm Pb
NO
pos
3mm Pb

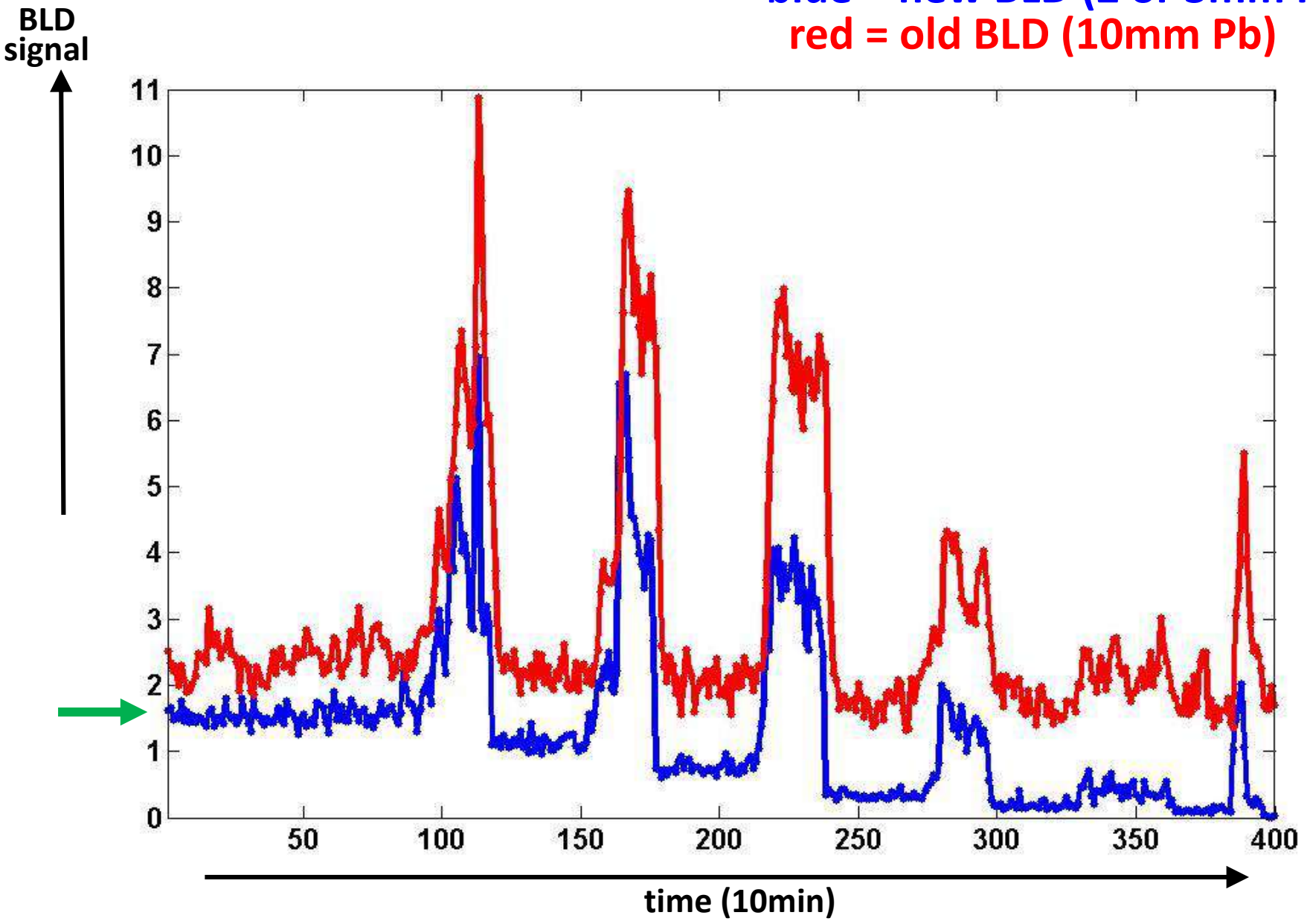

beam current
[mA]
20
15
10
5
0
lifetime
[hour]
200 hrs
500
450
400
350
300
250
200
150
100
50
0
50
100
150
200
250
300
350
400
time (10min)


BLD signal
2500
2000
1500
1000
500
0
50
100
150
200
250
300
350
400
time (10min)
a ‘bad’ one,
needing more Pb
and re-positioning

blue = new BLD (2 or 3mm Pb)
red = old BLD (10mm Pb)

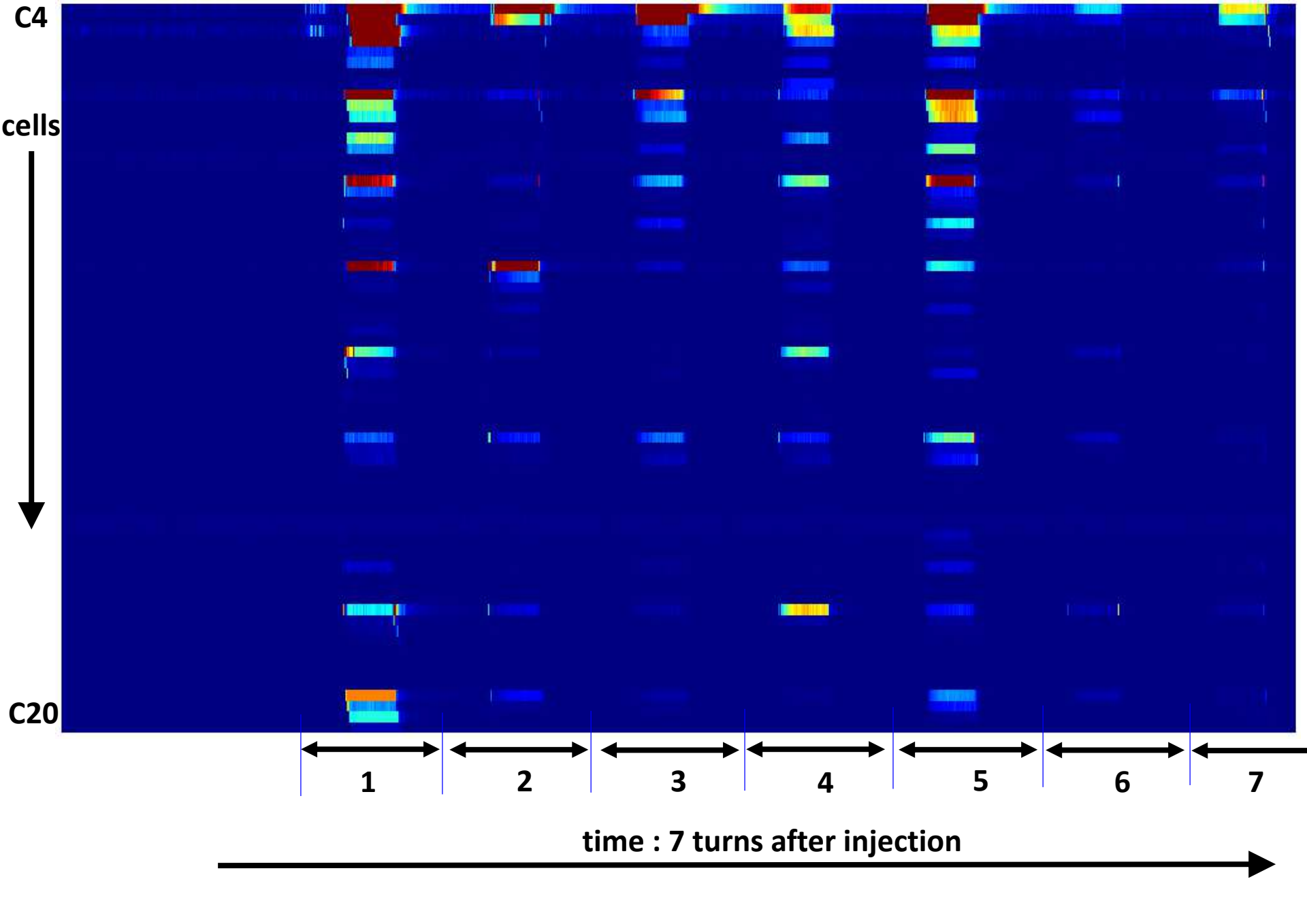


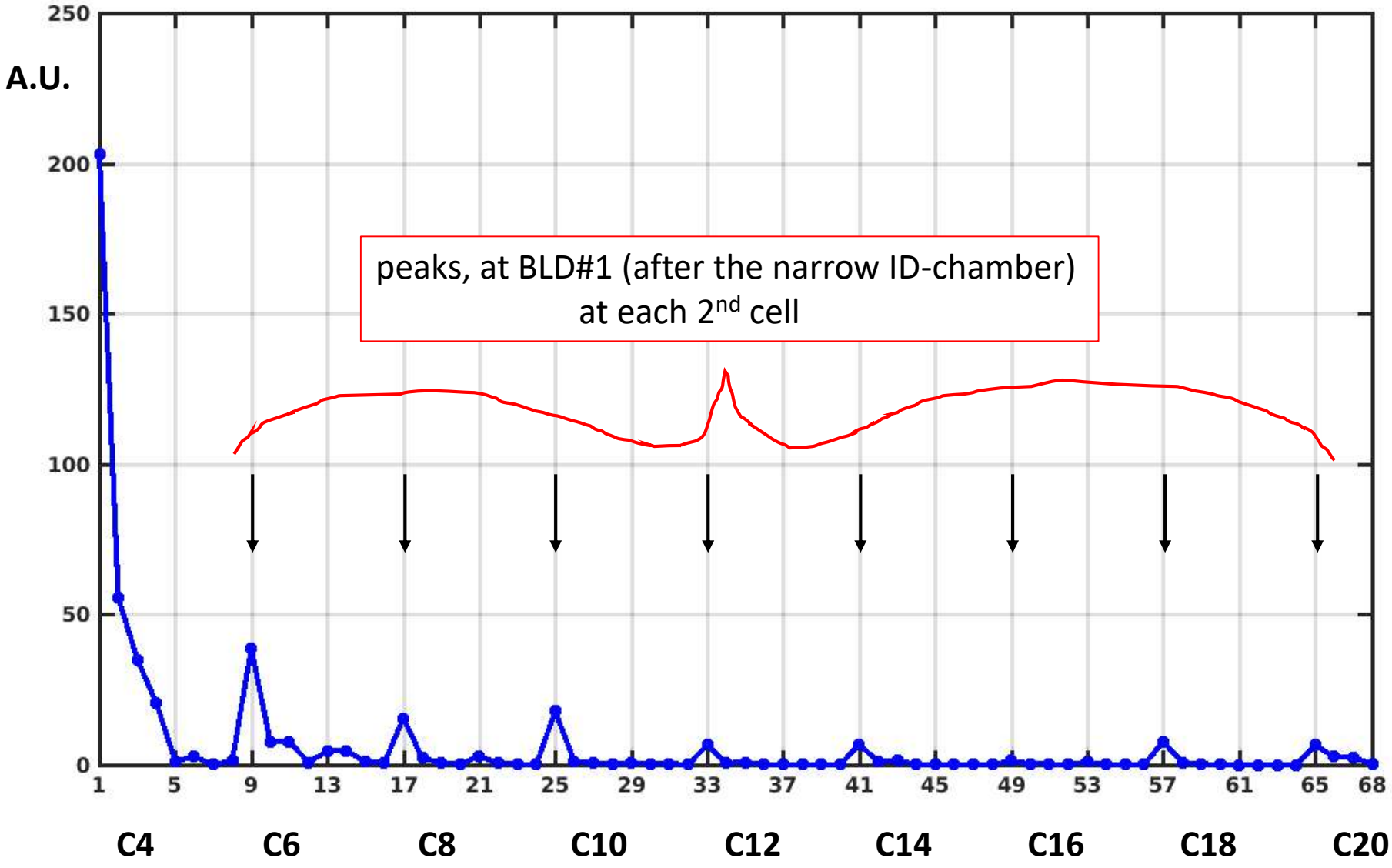
blue = new BLD (2 or 3mm Pb)
red = old BLD (10mm Pb)

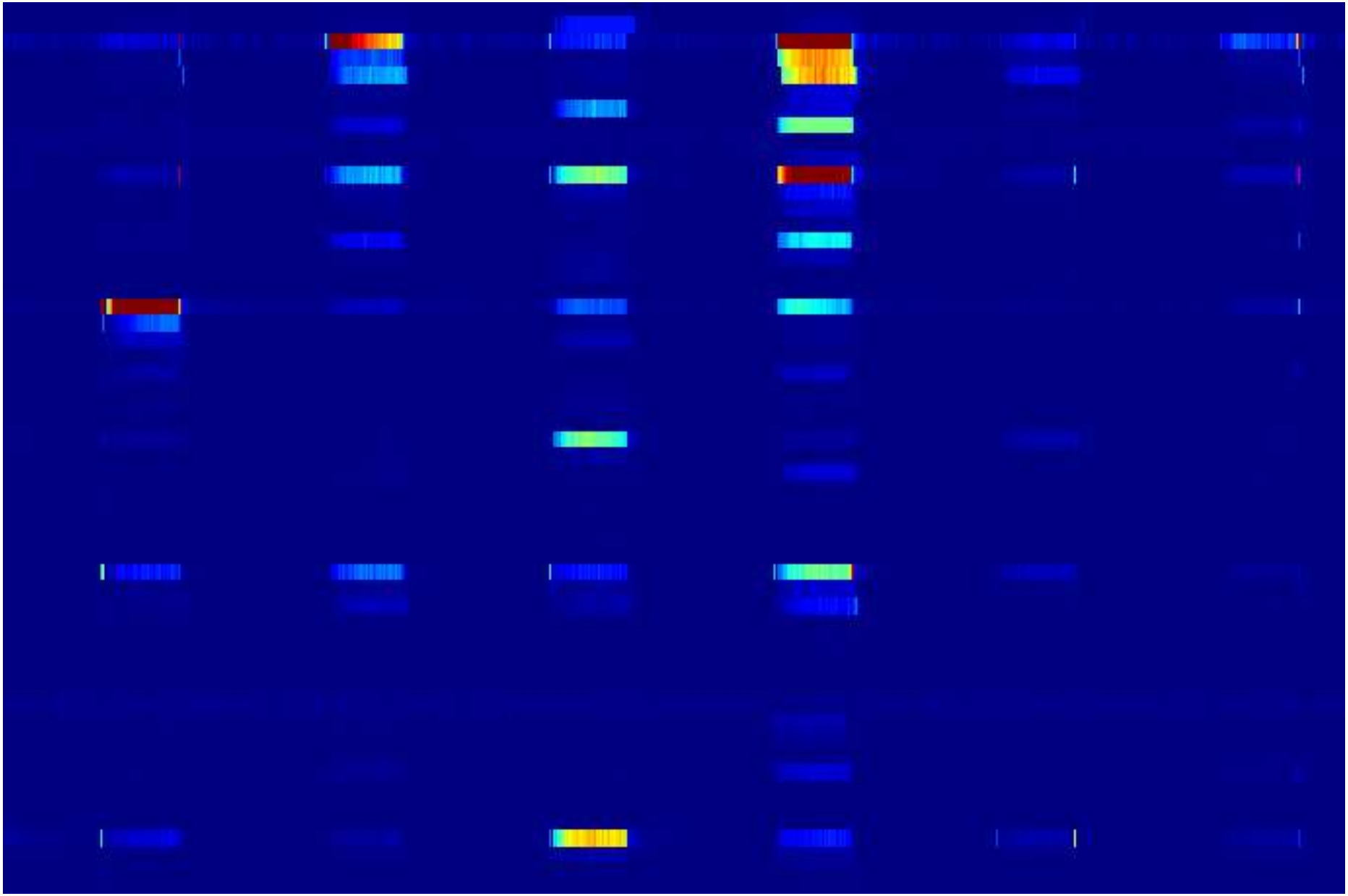


Strong & Fast losses (e.g. during injection)

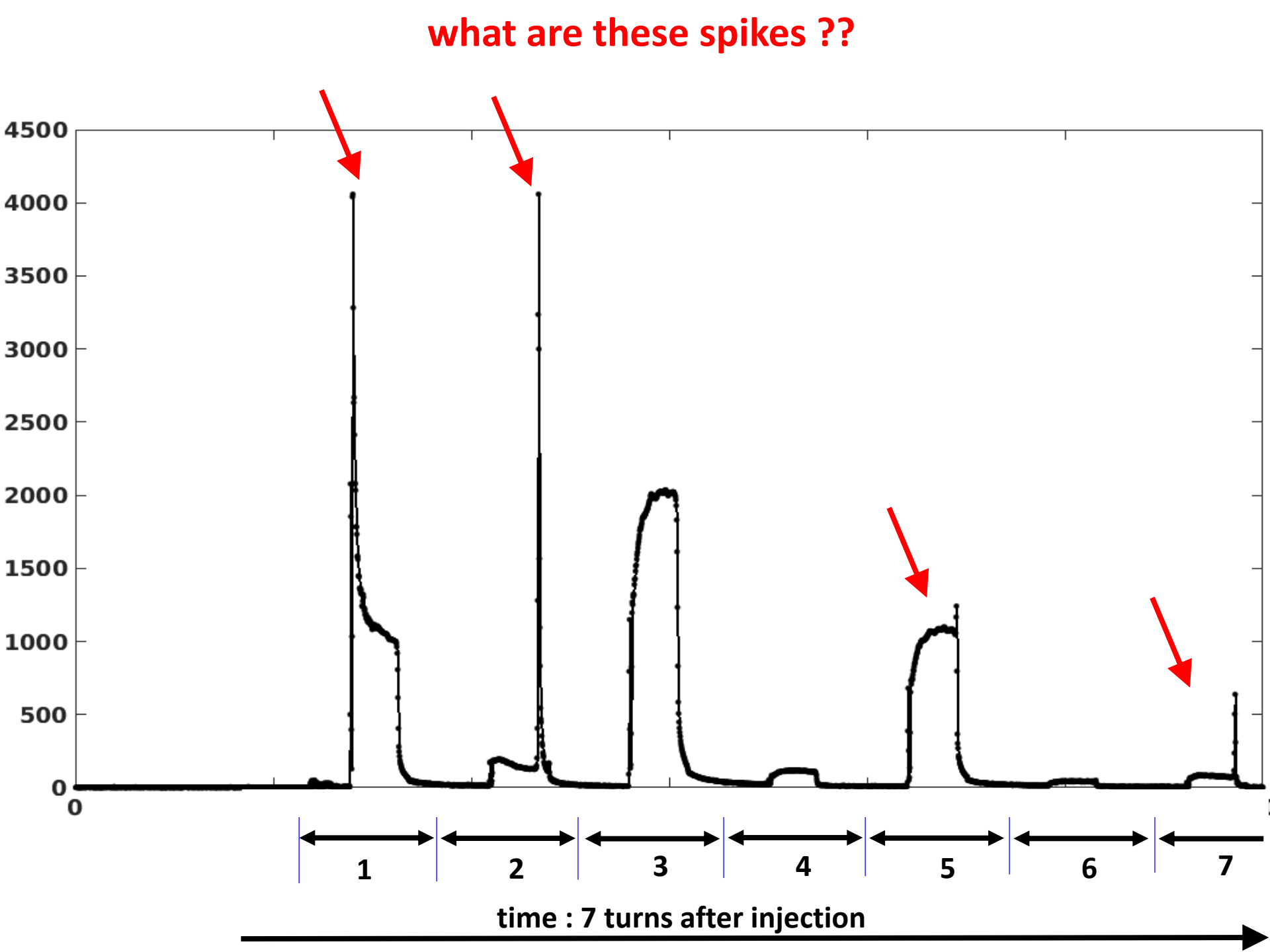
- the BLM is operated with 50Ω input load
- typically the BLD is then operated with higher GCV
- the BLM is triggered (i.e. synchronous with injection)
- the triggered Buffers (ADC and/or TbT) are acquired


C4
cells
C20
1
2
3
4
5
6
7
time : 7 turns after injection

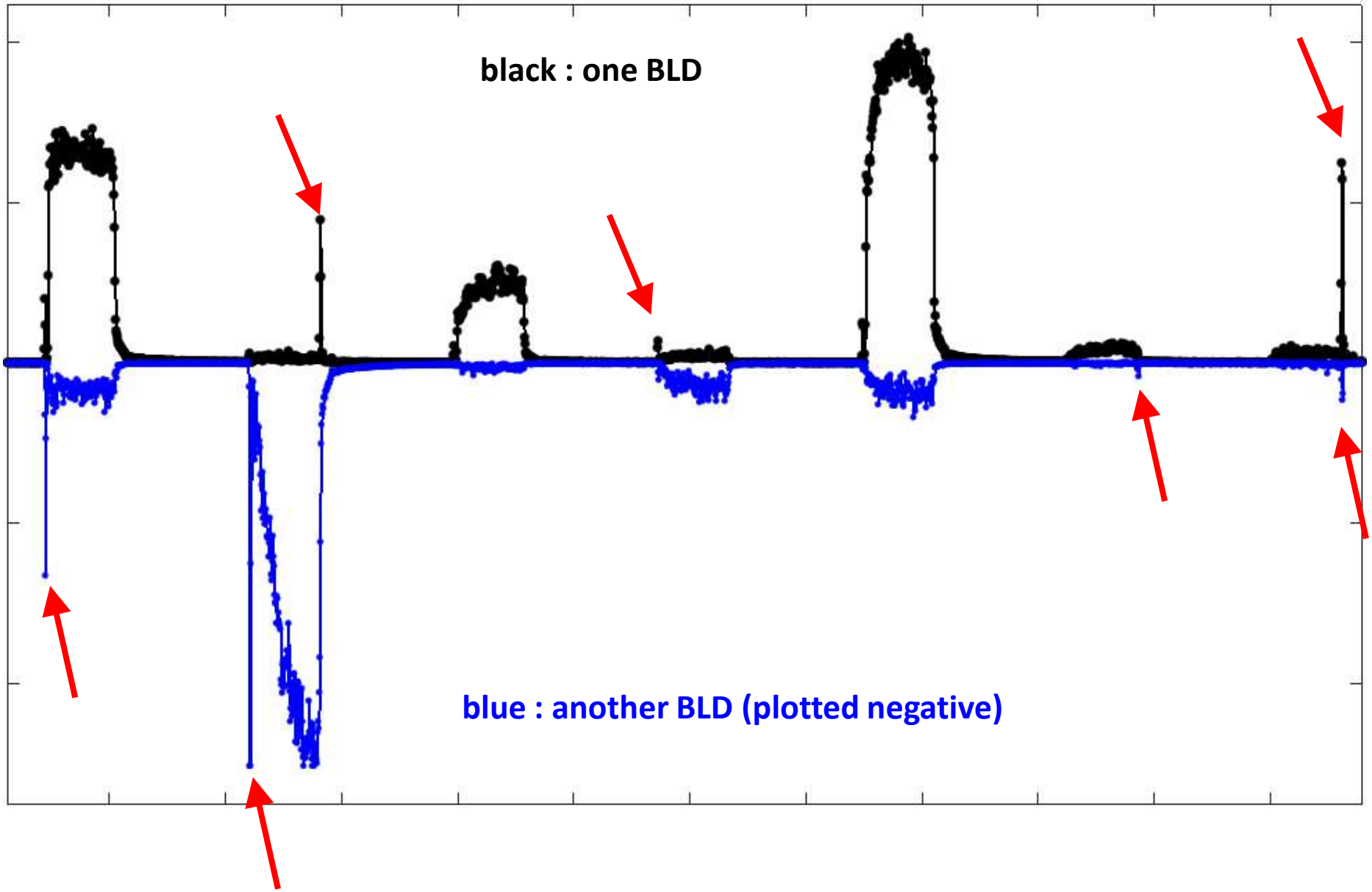

Sum of losses in the first 7 Turns
A.U.
250
200
150
100
50
0
peaks, at BLD#1 (after the narrow ID-chamber)
at each 2nd cell
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
68
C4
C6
C8
C10
C12
C14
C16
C18
C20



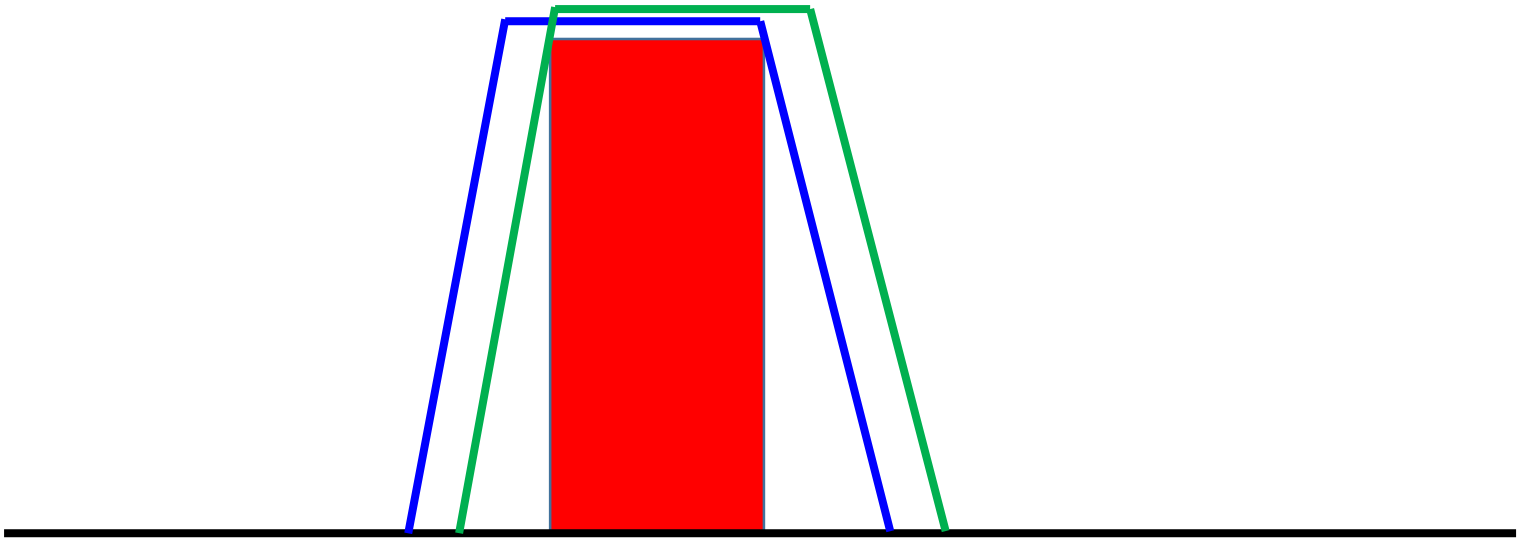
ZOOM : what are these spikes … ?


what are these spikes ??
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
1
2
3
4
5
6
7
time : 7 turns after injection

what are these spikes ??



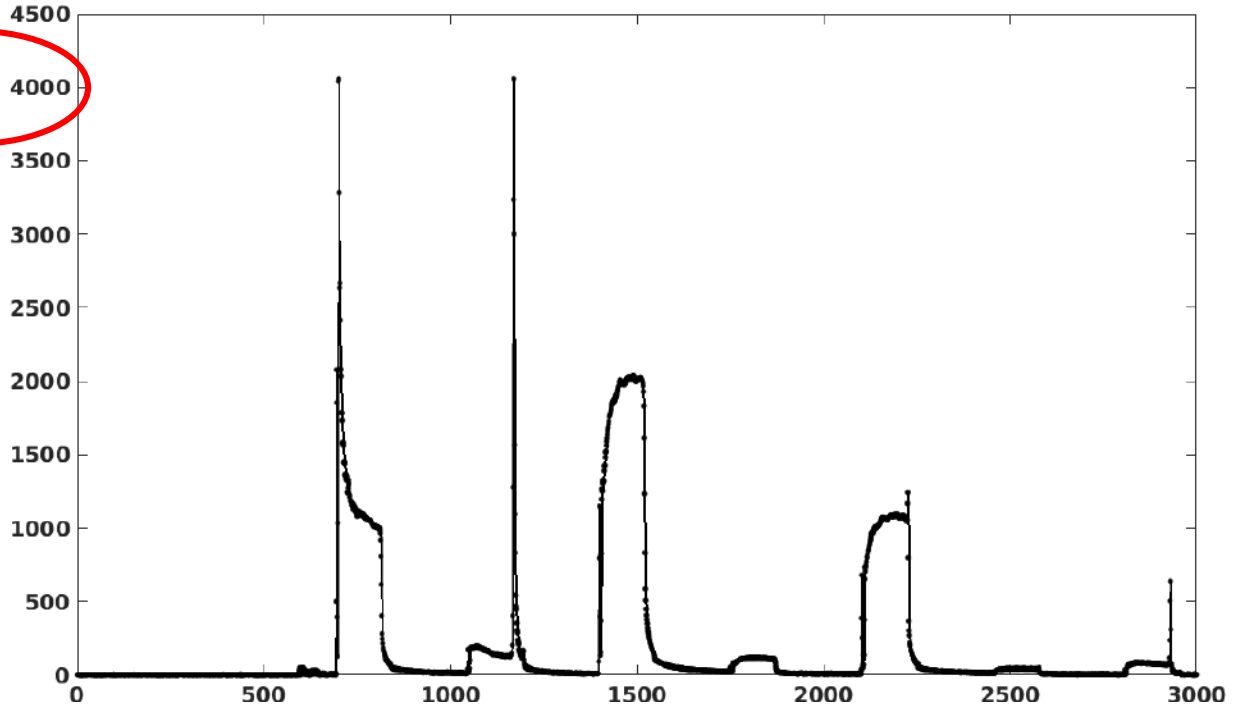
4 fast kickers, all 4 should be synchronized & stable :
with the flat kick well-centered on the injected beam



if not : edges of the injected beam
will get a (strongly) distorted injection path,
causing more losses at these edges

4000

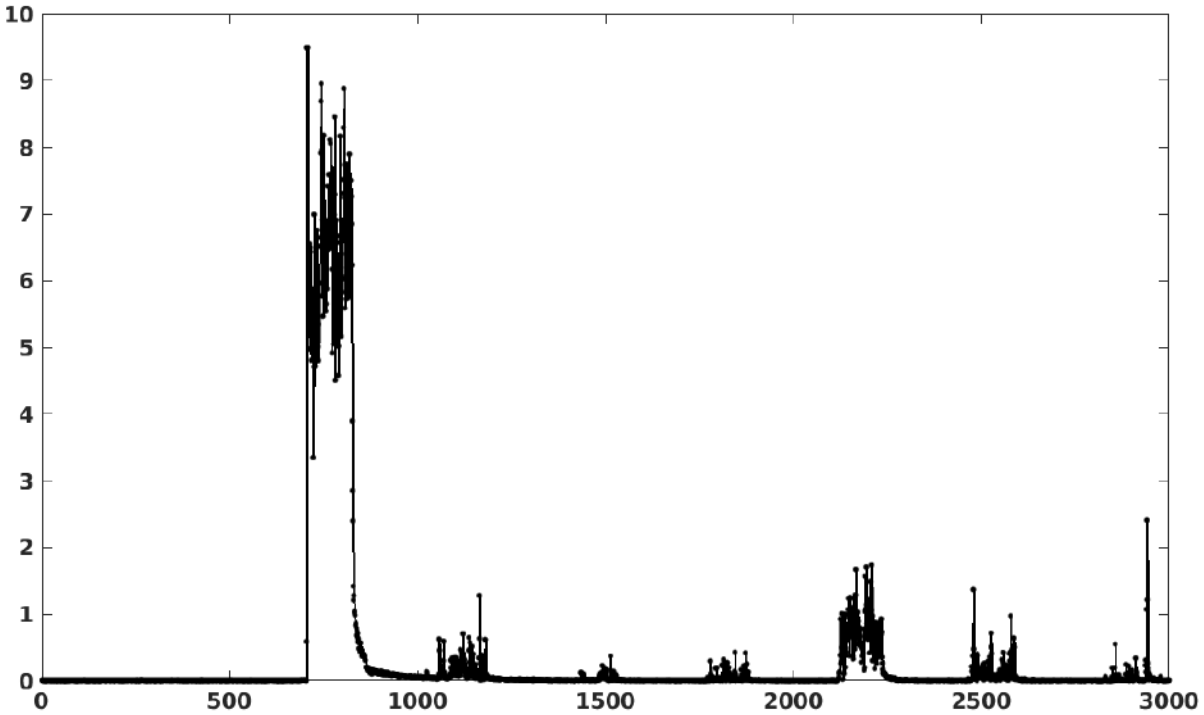
strongest :
C4-1



A.U.s but
relatively
calibrated

9

a weak one :
400 X weaker !

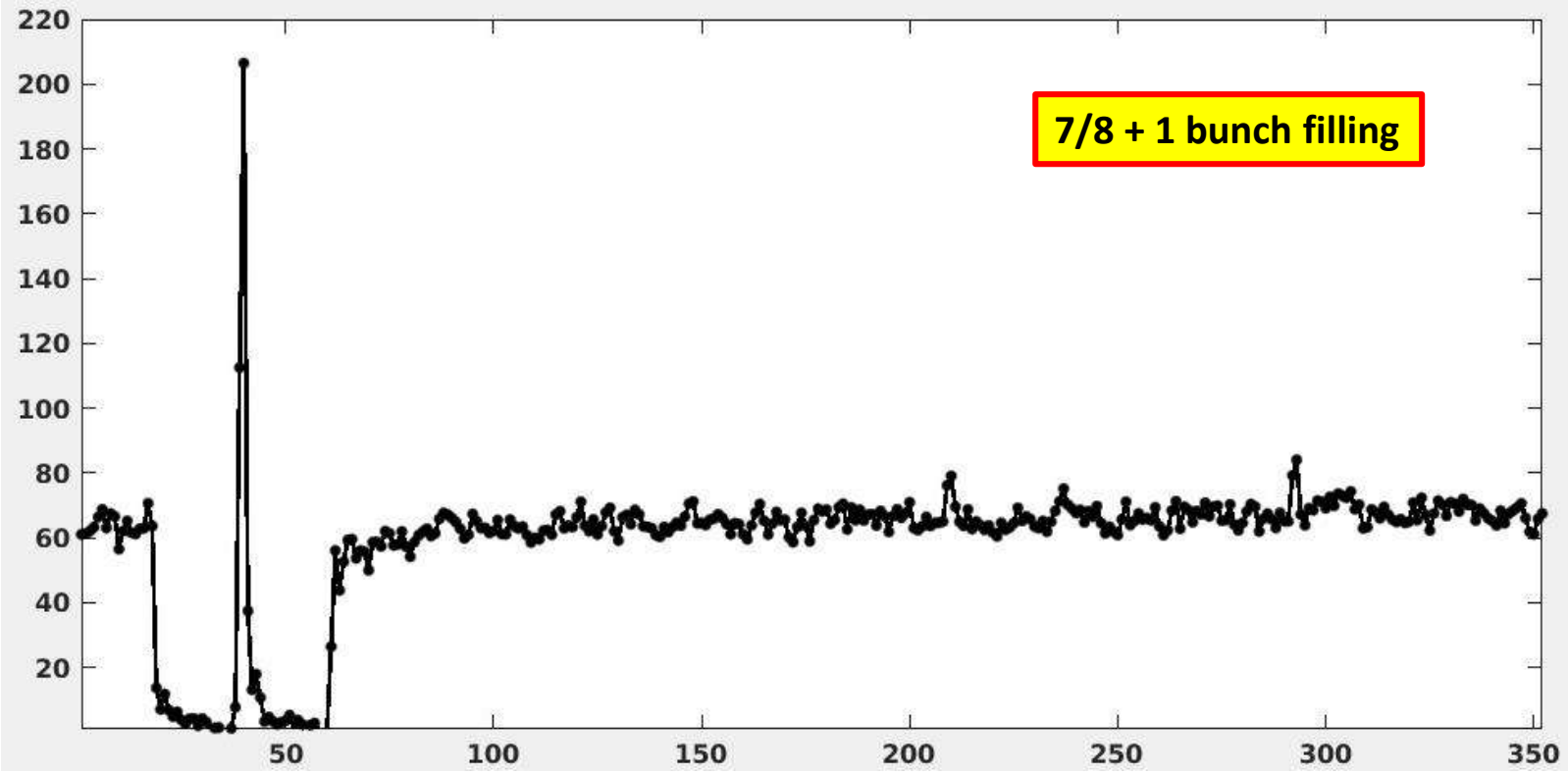


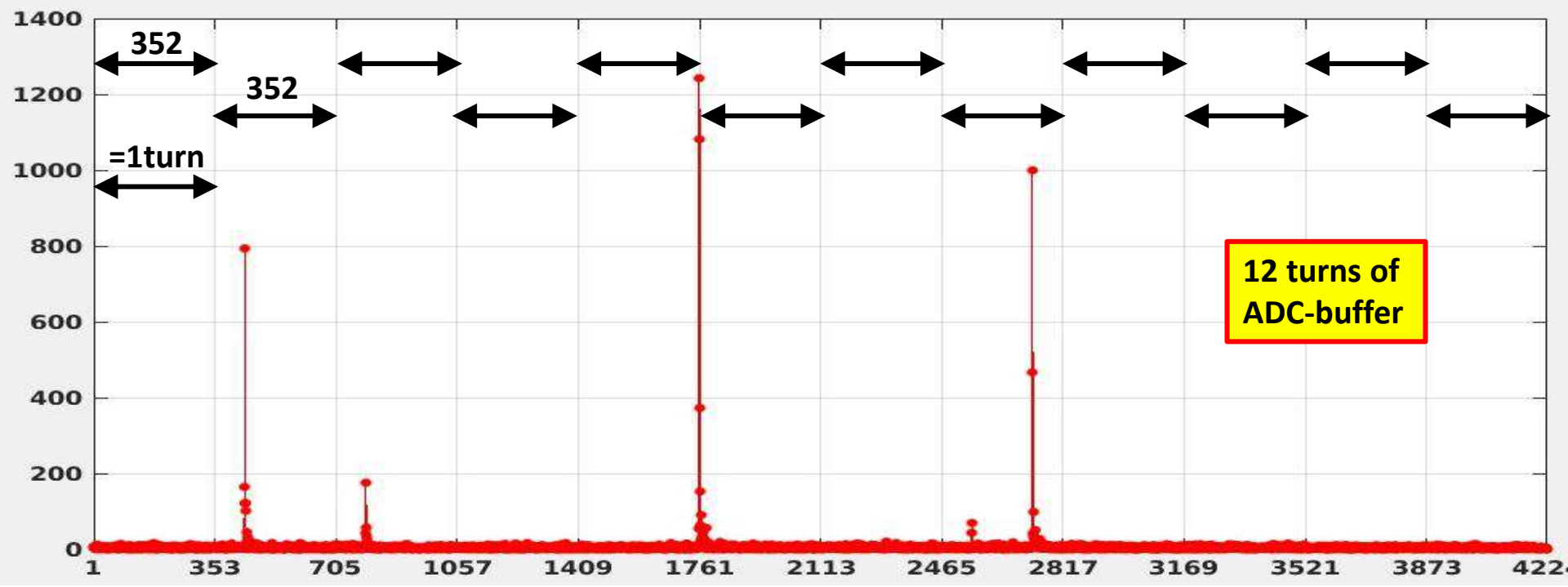
filling-pattern verifications

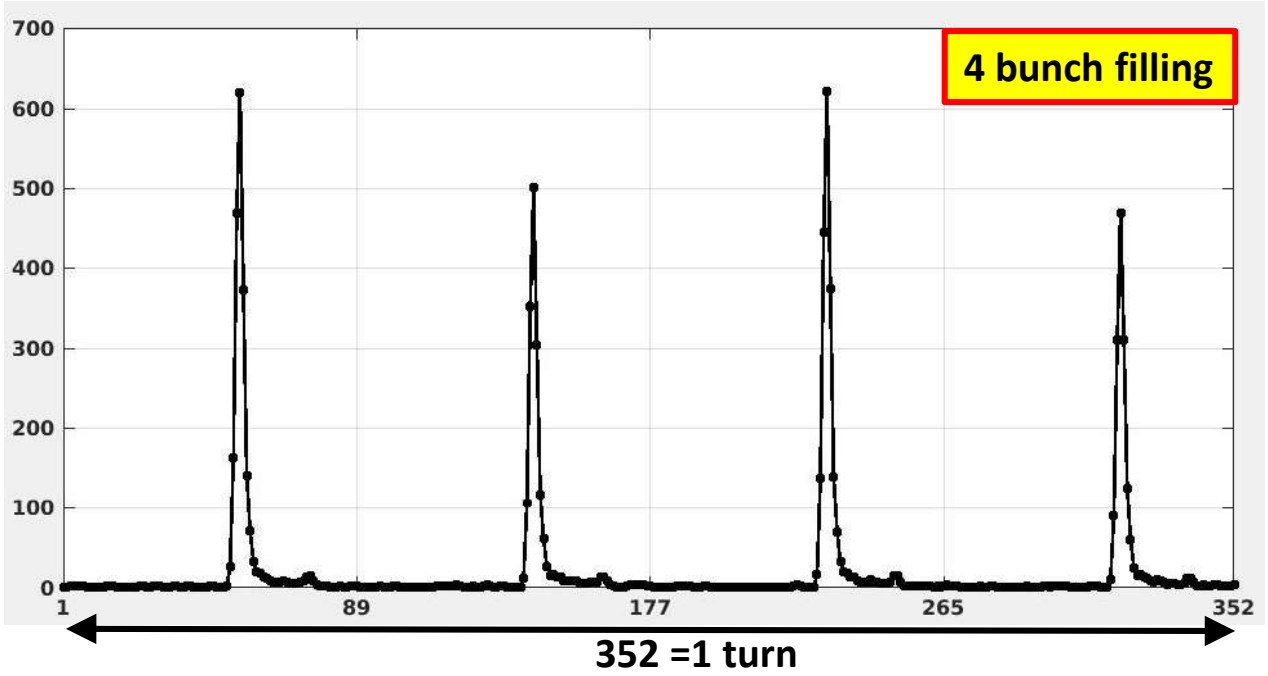
during slow-beam-decay (i.e. weak-losses)

from a long ADC-buffer, i.e. covering many Turns

and then <u>reshaped & integrated</u> to only → <u>1 Turn of ADC-data</u>




352
352
=1turn
12 turns of
ADC-buffer
1400
1200
1000
800
600
400
200
0
1
353
705
1057
1409
1761
2113
2465
2817
3169
3521
3873


4 bunch filling
700
600
500
400
300
200
100
0
1
89
177
265
352
352 =1 turn

results with the (partially) installed BLD/BLM system at the ESRF

Conclusion :

thank you for your attention !