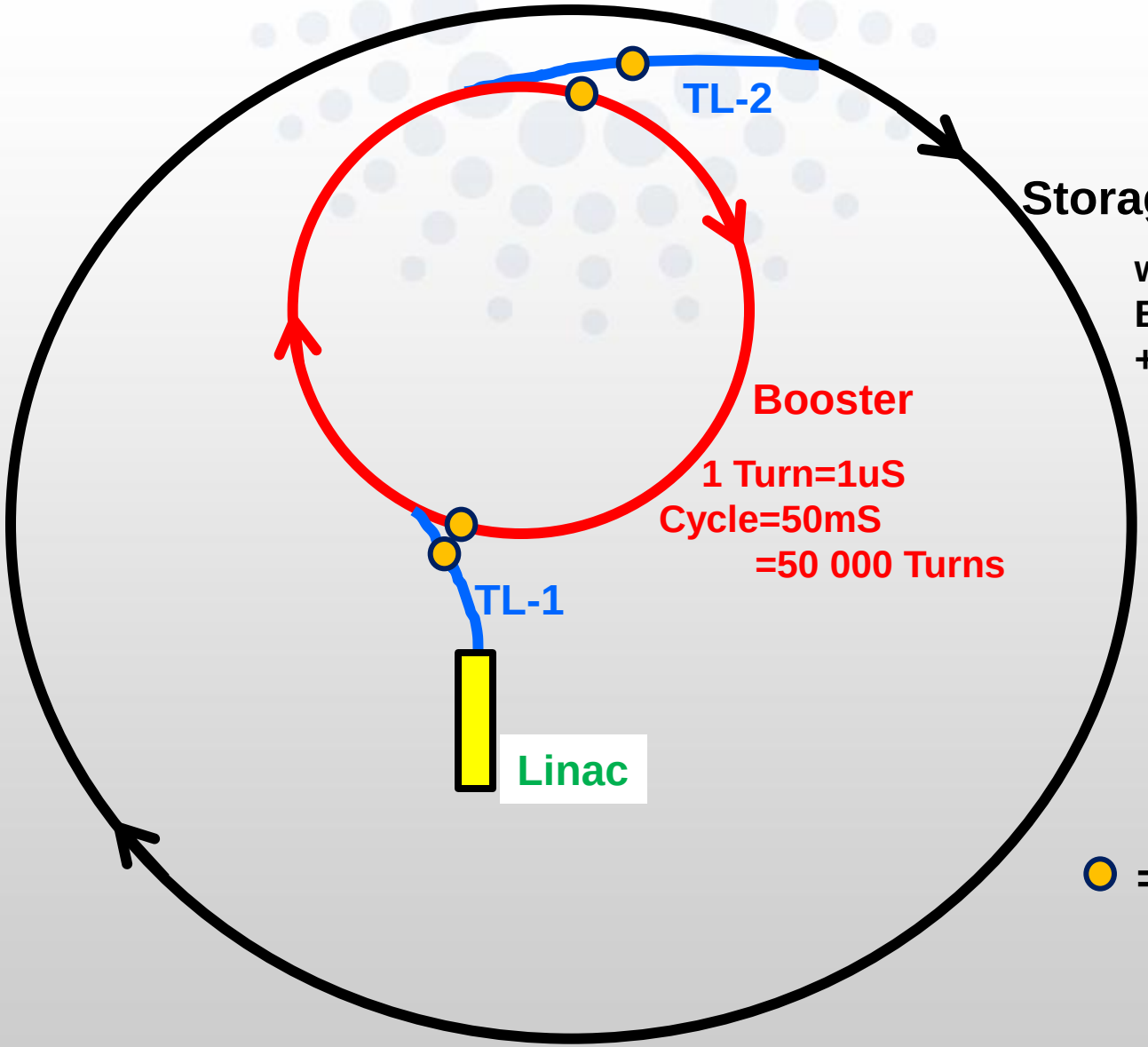
The use of the 4 Single-Pass-Liberas in the ESRF Injector system

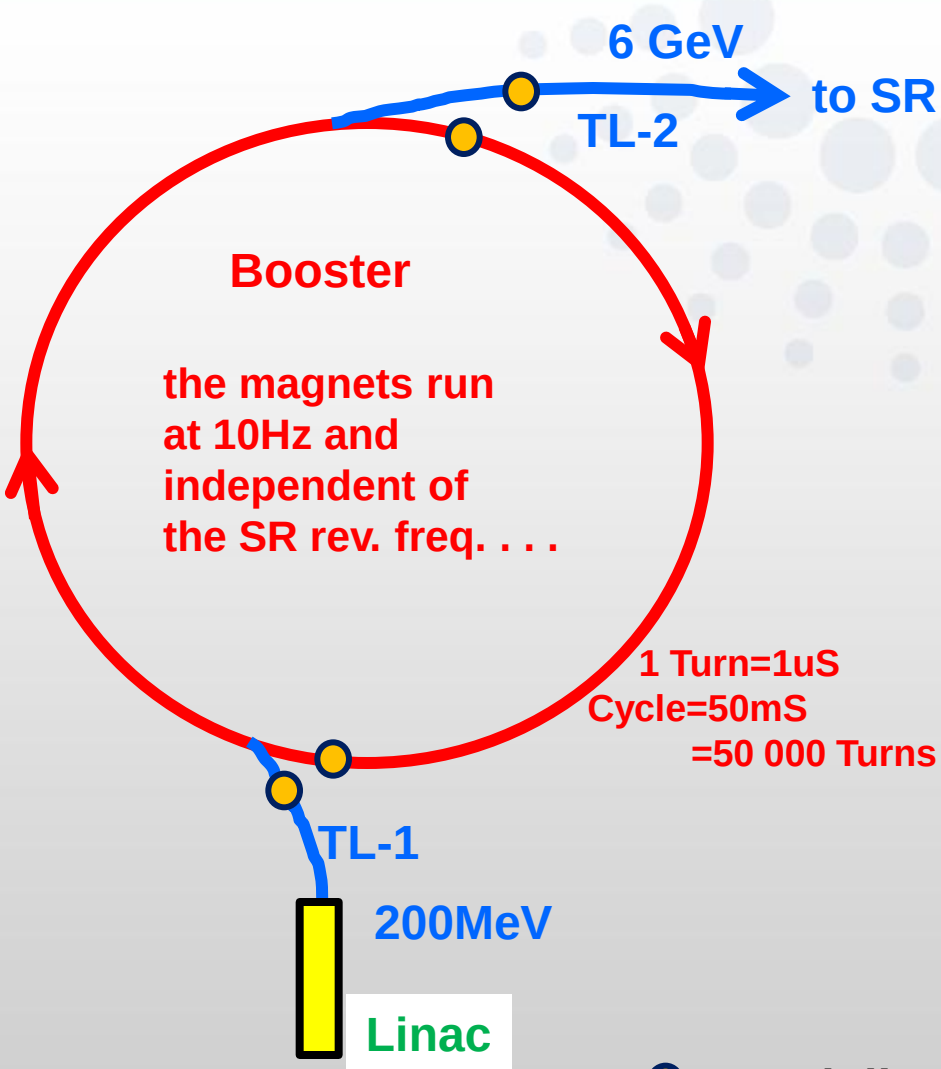
- In combination with ¼ λ striplines

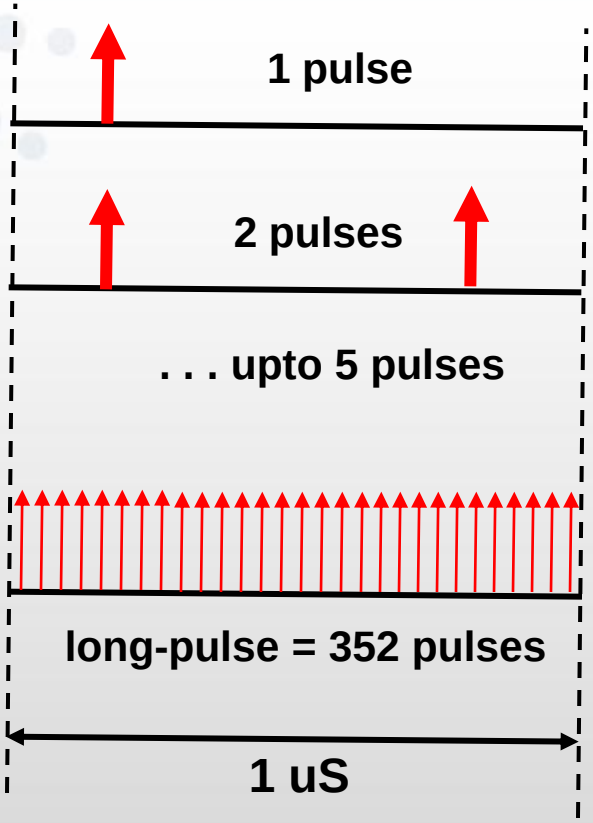
- In principle for high sensitivity Beam-Charge measurement

  → for Charge-Transfer-Efficiency measurement between different (parts of the) accelerators :
  Linac → TL-1 → Booster → TL-2 → Stor. Ring

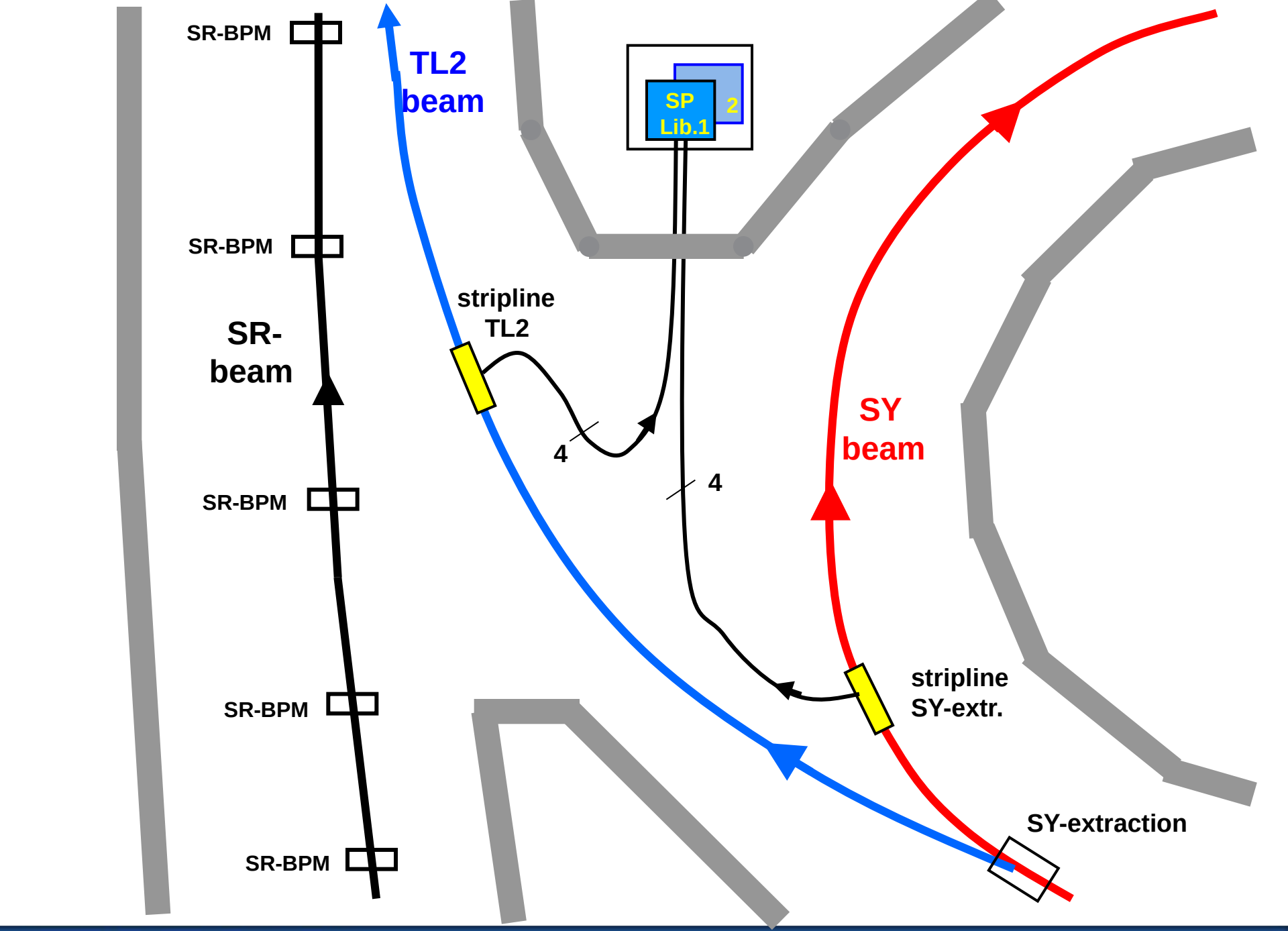
- Also application as ‘sub-pulse-duration’ BPM


TL-2
Storage Ring
with 224
Button BPMs
+ Libera-Brill.
Booster
1 Turn=1uS
Cycle=50mS
=50 000 Turns
TL-1
Linac
= stripline +
SP-Libera

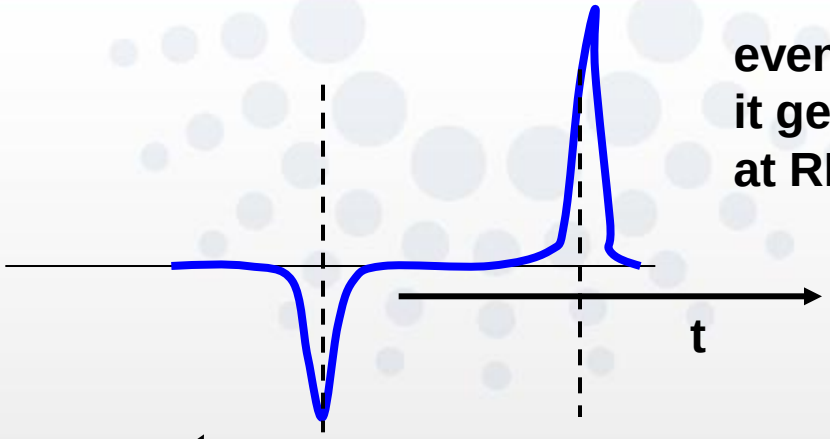


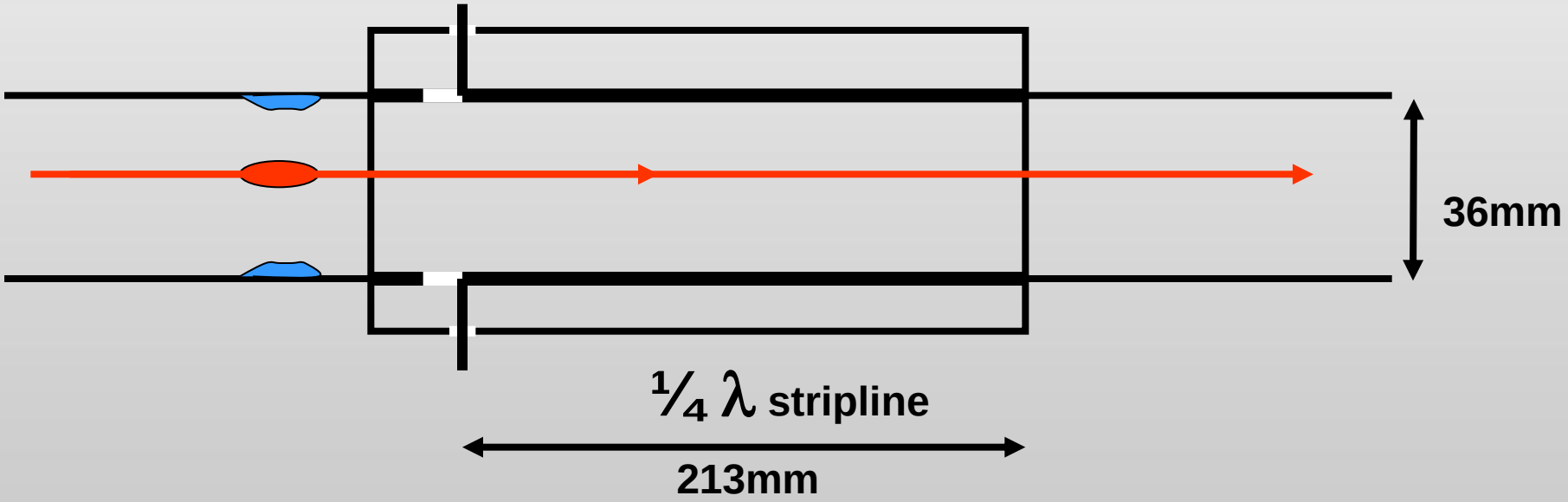


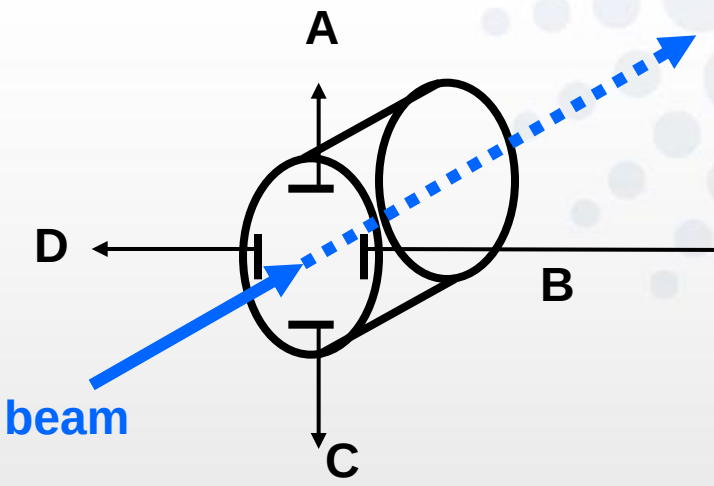
● = stripline +
SP-Libera


SR-BPM
SR-BPM
SR-BPM
SR-BPM
SR-BPM
SR-
beam
TL2
beam
SP
Lib.1
2
stripline
TL2
4
4
SY
beam
stripline
SY-extr.
SY-extraction

even with single bunch
it generates 2 pulses
at RF freq. (ESRF 352MHz)







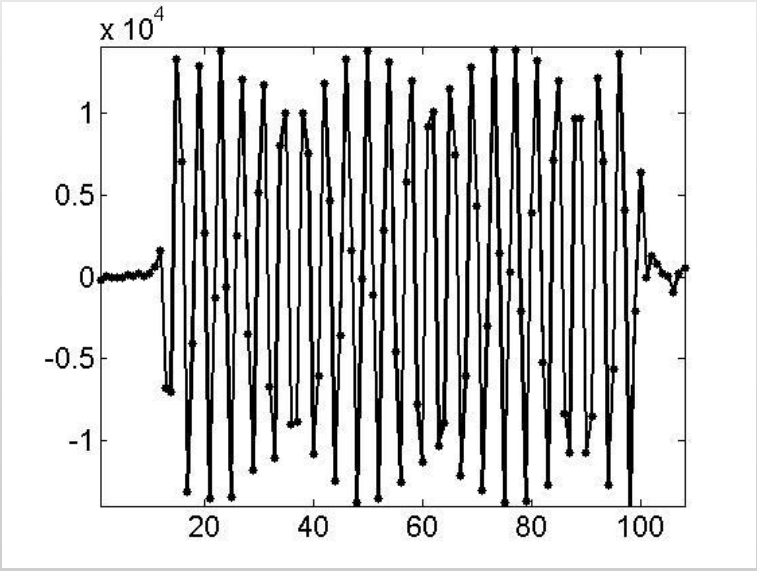
Bandpass @352MHz filters 40MHz BW

SP-Libera

saw-filters & fixed attenuators removed

variable RF attenuators maintained

Trig.
1 or 10Hz

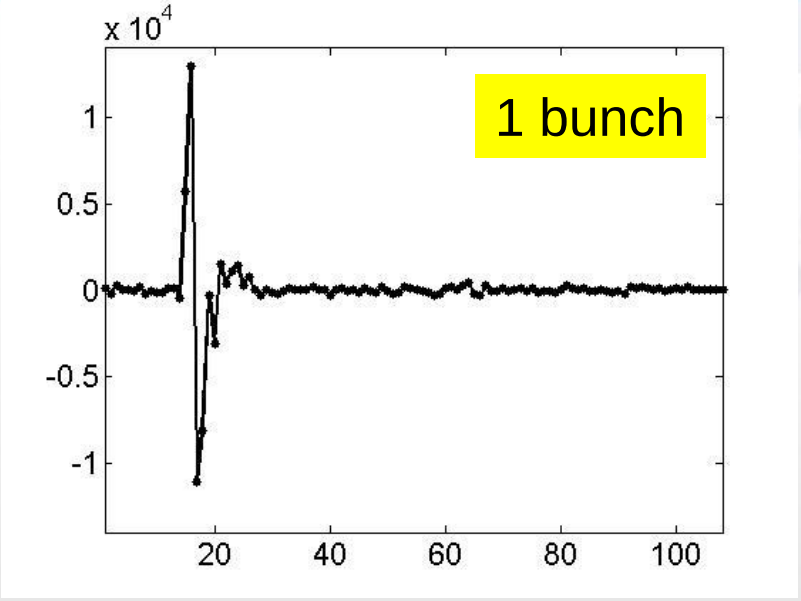


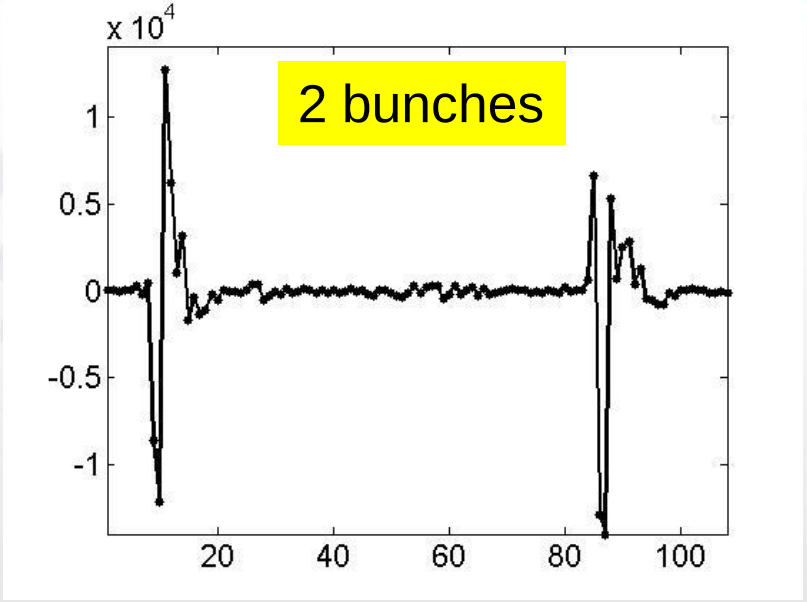
108 samples = 1uS

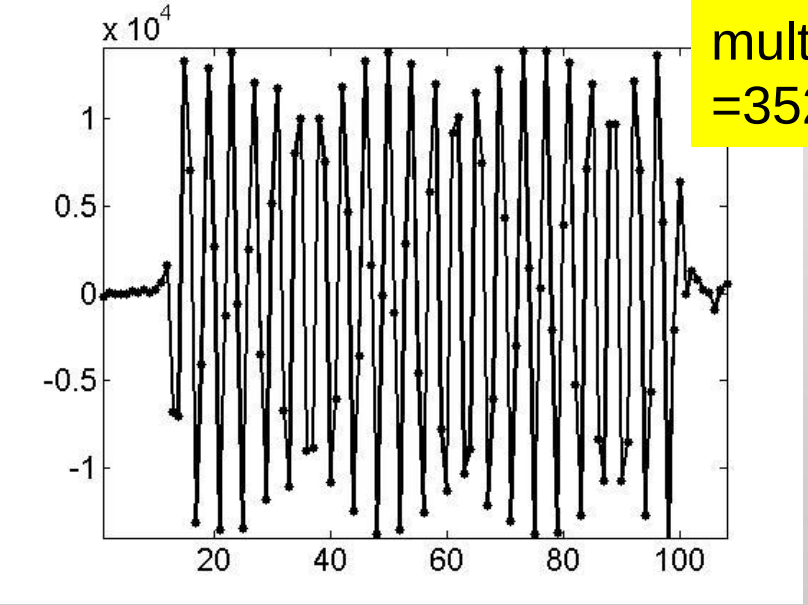
the SP-Libera is basically
a 4 channel ADC
for RF signals (Fc >352MHz)
at 108MHz sample rate
with 8192 samples / shot

NO : RF-switching & calibration
NO : DSC or numeric treatment

Ethernet
for ADC
read-out

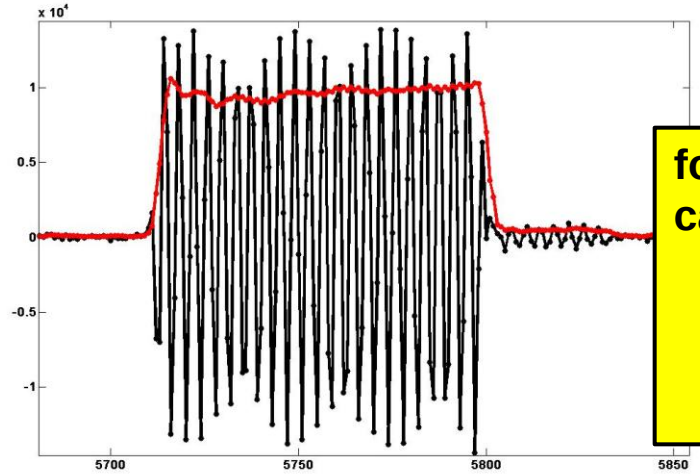






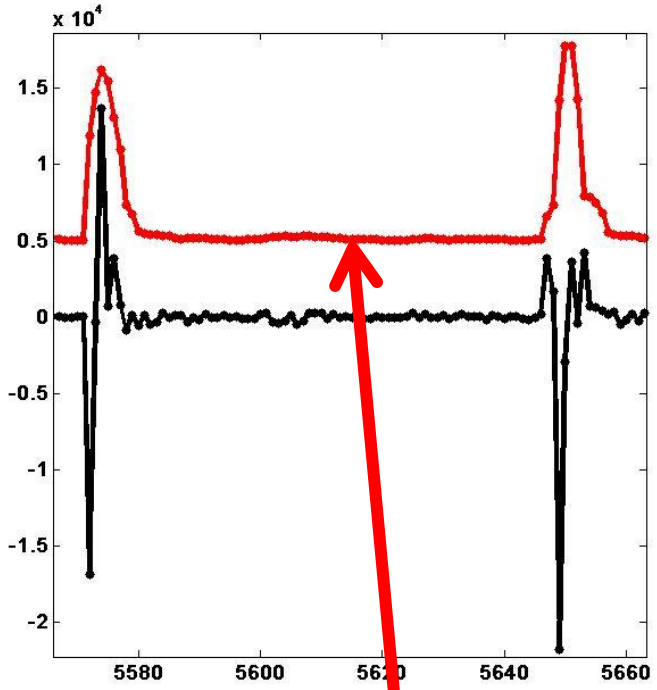
NOTE : The ADC under-sampling (108MHz of 352MHz signal) produces the 'weird' & 'ugly' signal shapes,

but the info (beam-charge) is contained, and can be retrieved by appropriate signal processing



for the signal strength calculation on a button :

$$sA = \sqrt{\sum_{1:n} A_n^2}$$

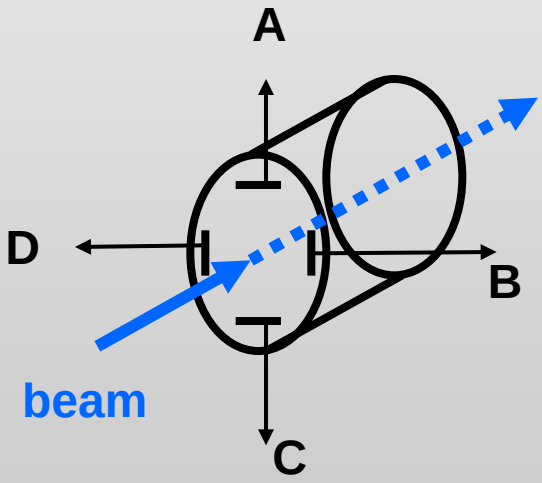


for Charge calculation :

$$\sum (sA\ sB\ sC\ sD)$$

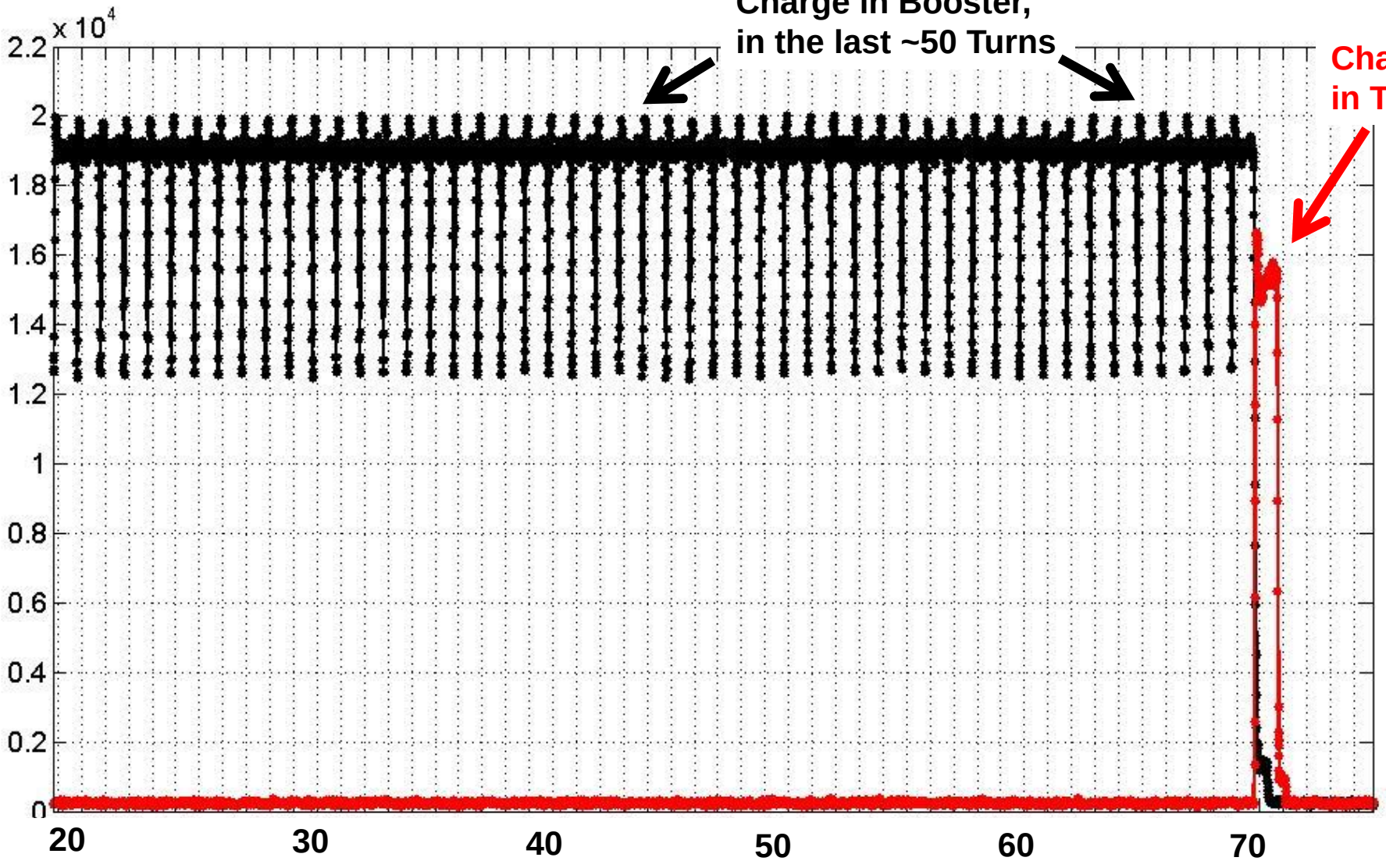
for the 'visualization' :

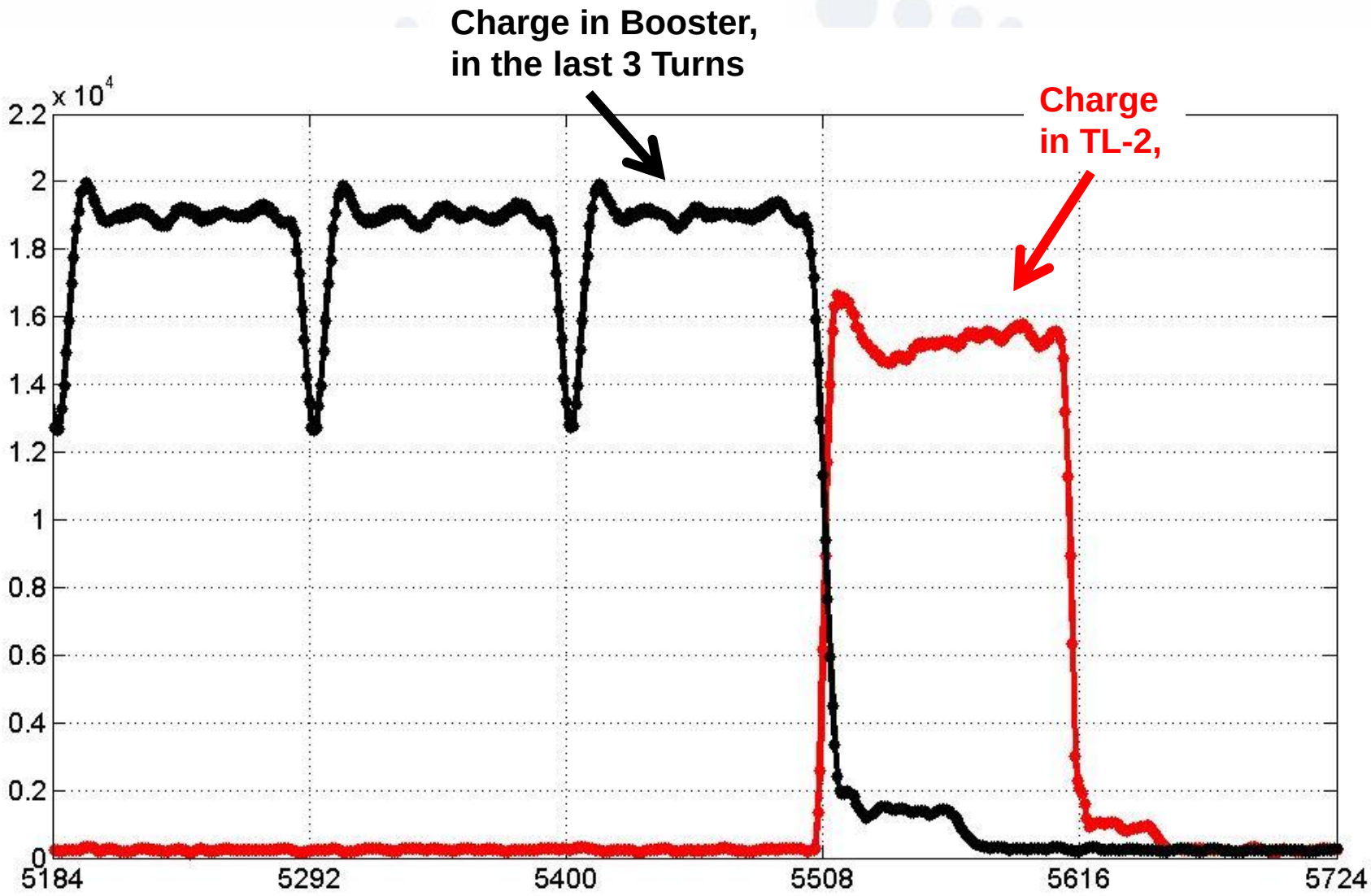
$$\sqrt{A^2 \times filter}$$



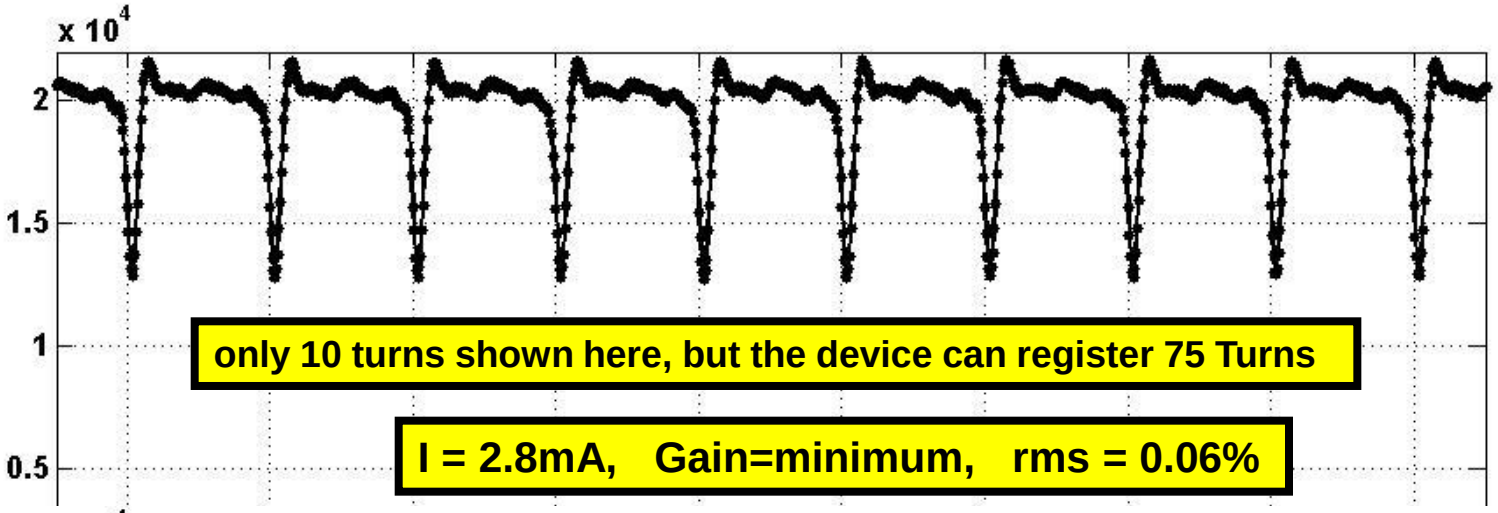
for Position calculation :

$$Z = 18mm \times \frac{sA - sC}{sA + sC}$$


Charge in Booster,
in the last ~50 Turns
Charge
in TL-2,
x 10^4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
20
30
40
50
60
70

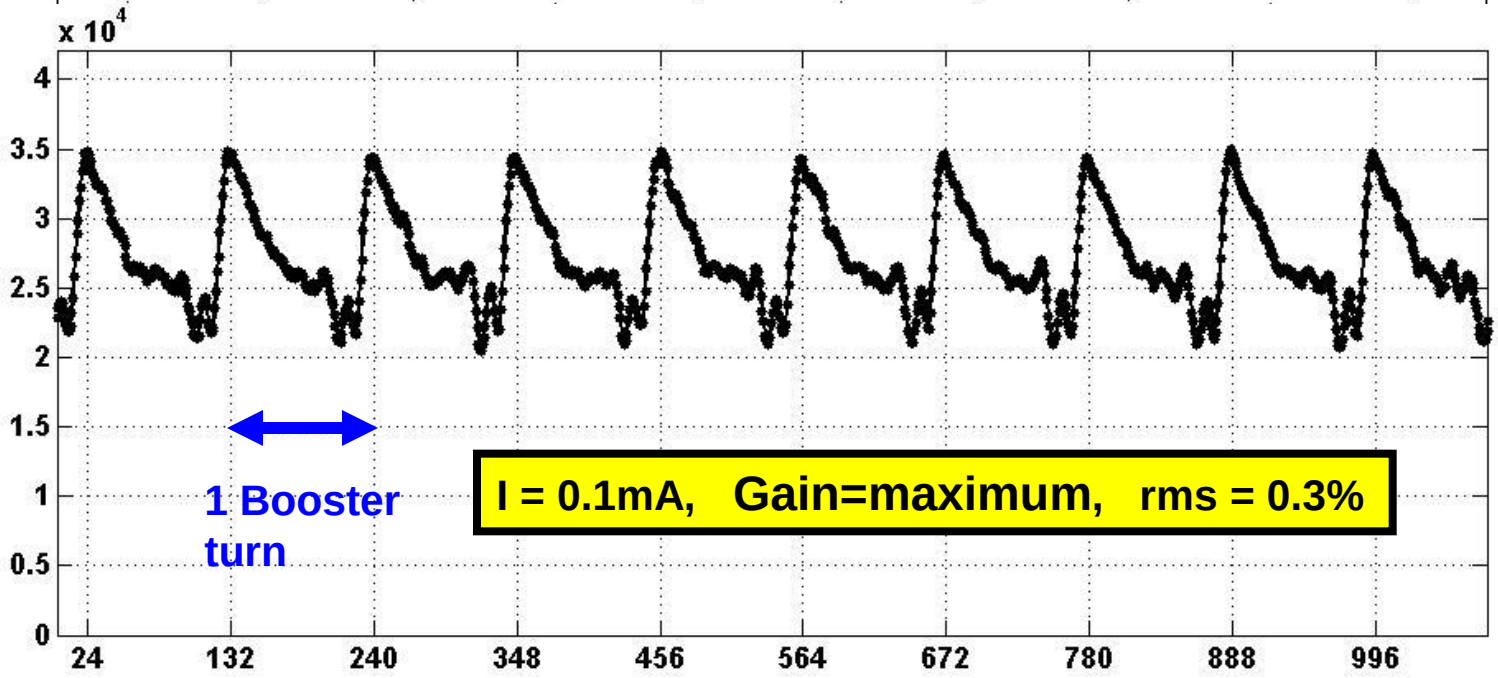

Charge in Booster,
in the last 3 Turns
Charge
in TL-2,
x 10^4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5184
5292
5400
5508
5616
5724

reproducibility measurements

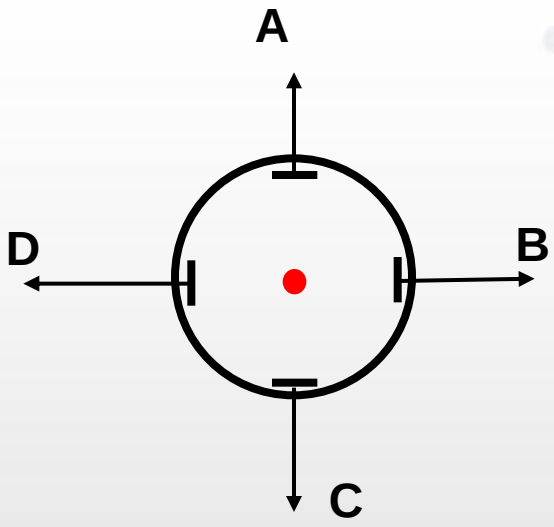


only 10 turns shown here, but the device can register 75 Turns

I = 2.8mA, Gain=minimum, rms = 0.06%



I = 0.1mA, Gain=maximum, rms = 0.3%



Originally forseen to yield only precise & very sensitive beam-Charge measurements,

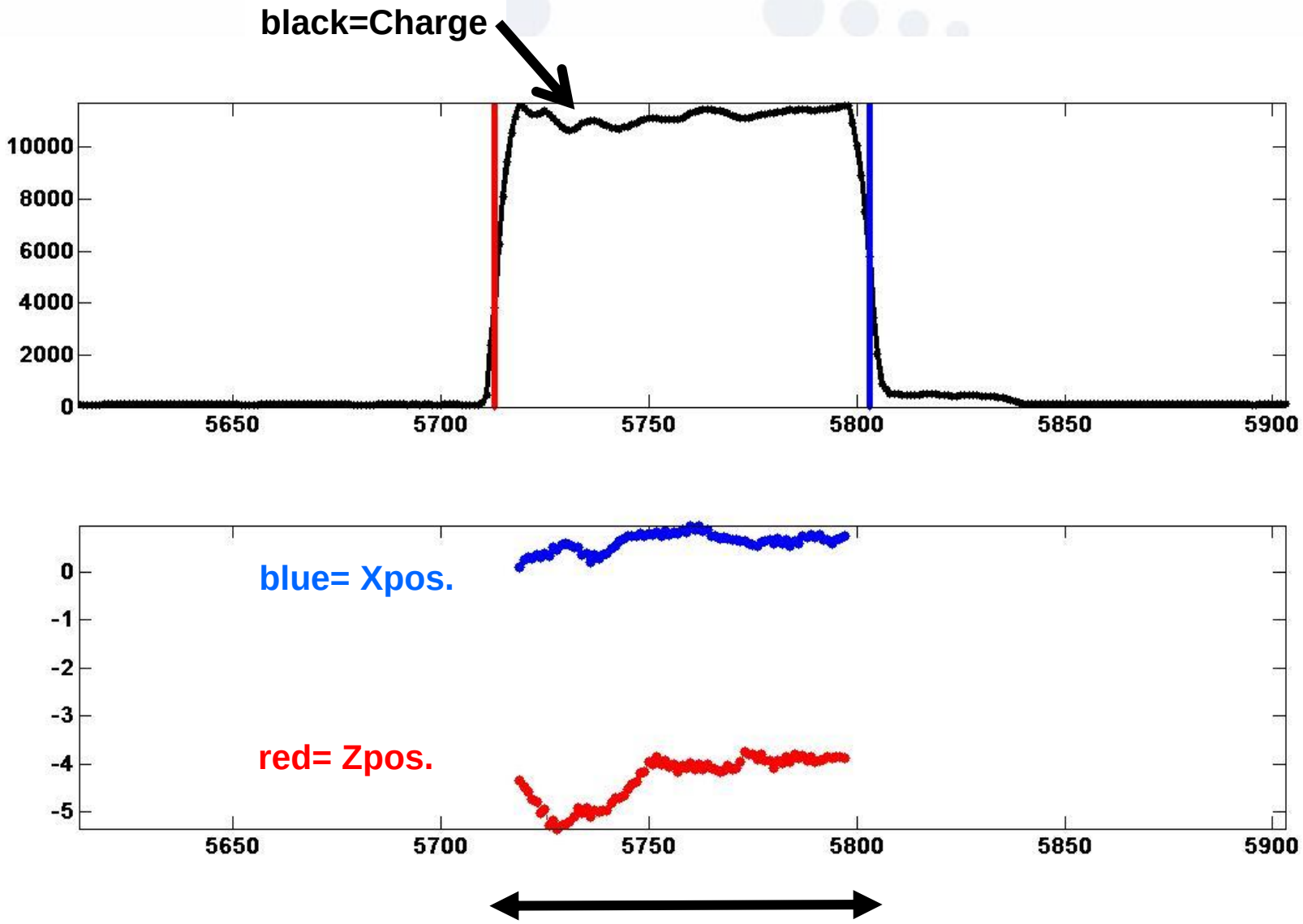
it is now also appreciated as a BPM that yields T-b-T info of 75 Turns, and of sub-Turn time resolution

in case of the 1 uS 'long-pulse' (with 352 bunches)

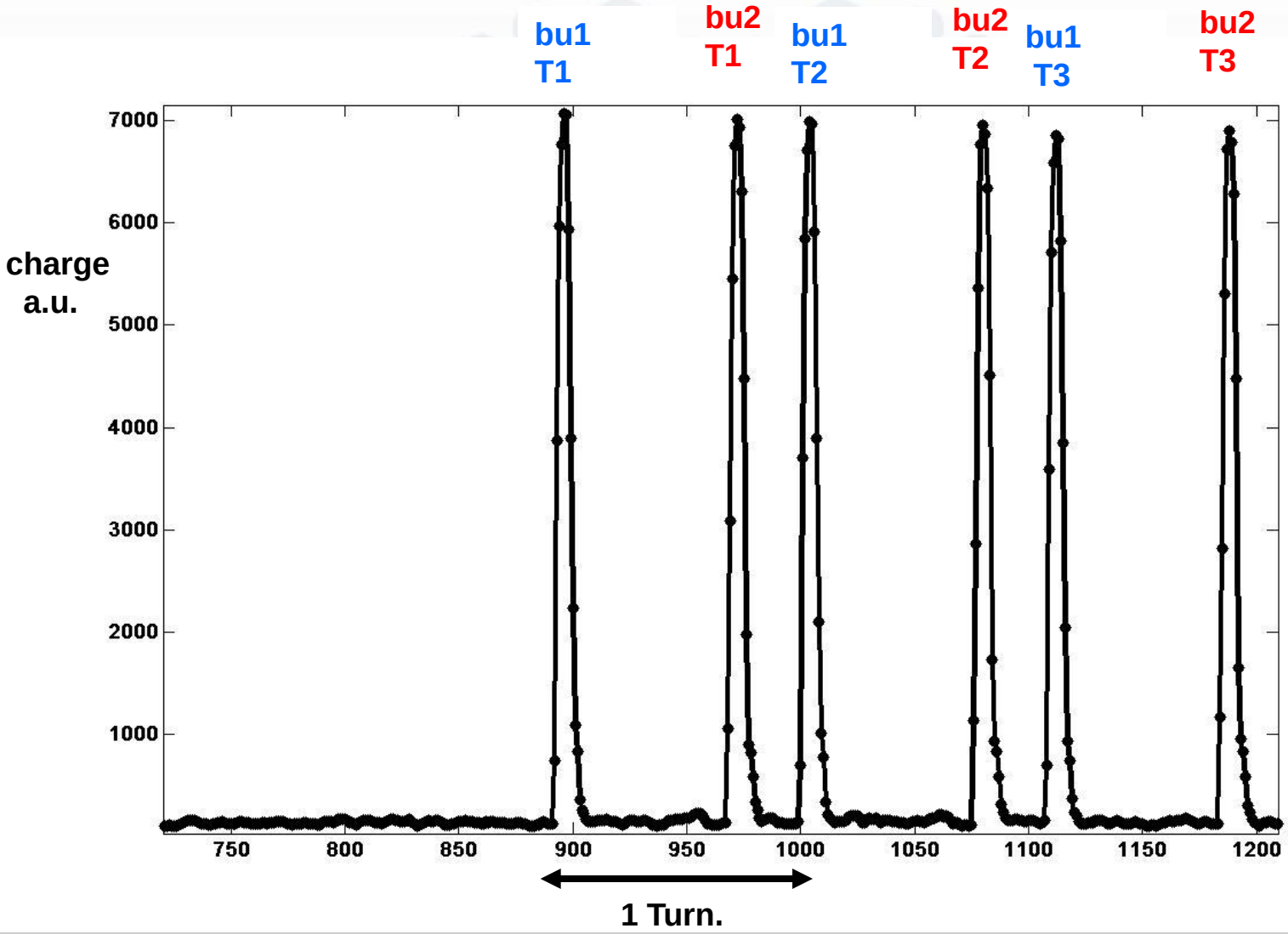
or

to distinguish the 1 – 5 single bunches in each Turn

the ‘long-pulse’ (1us) seen in TL-2

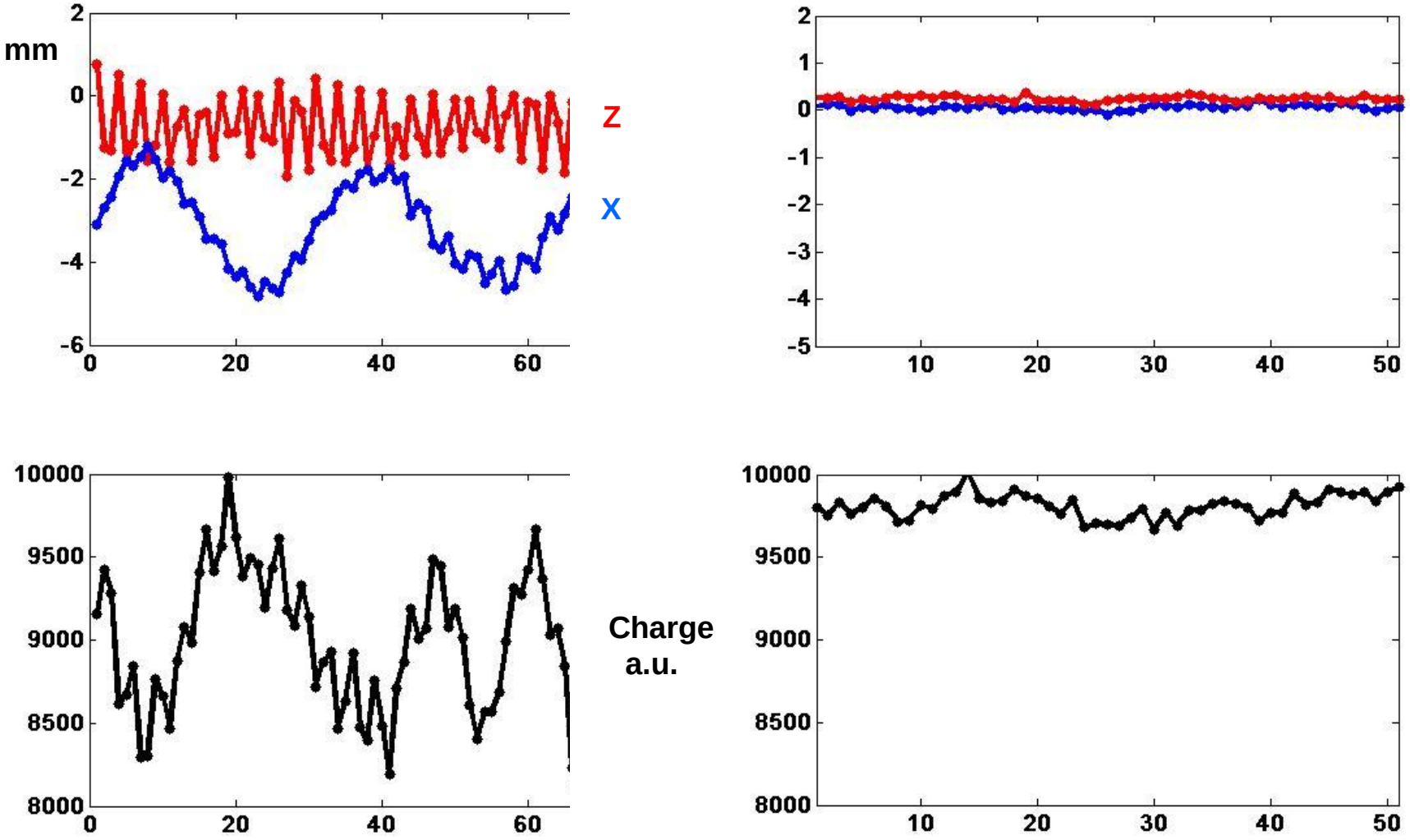


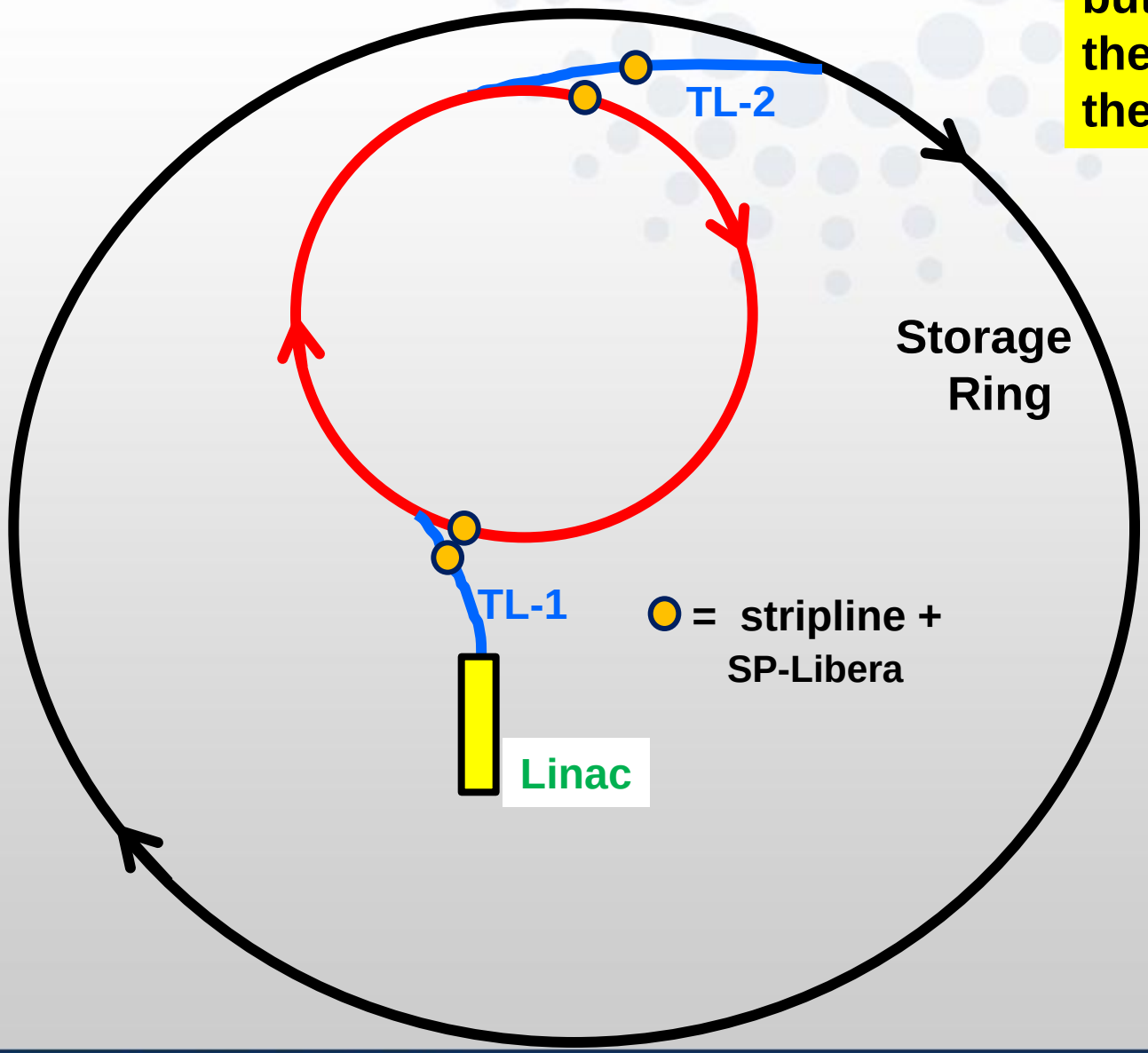
2 bunch filling at Injection



first 70 Turns after Injection

last 50 Turns before Extraction



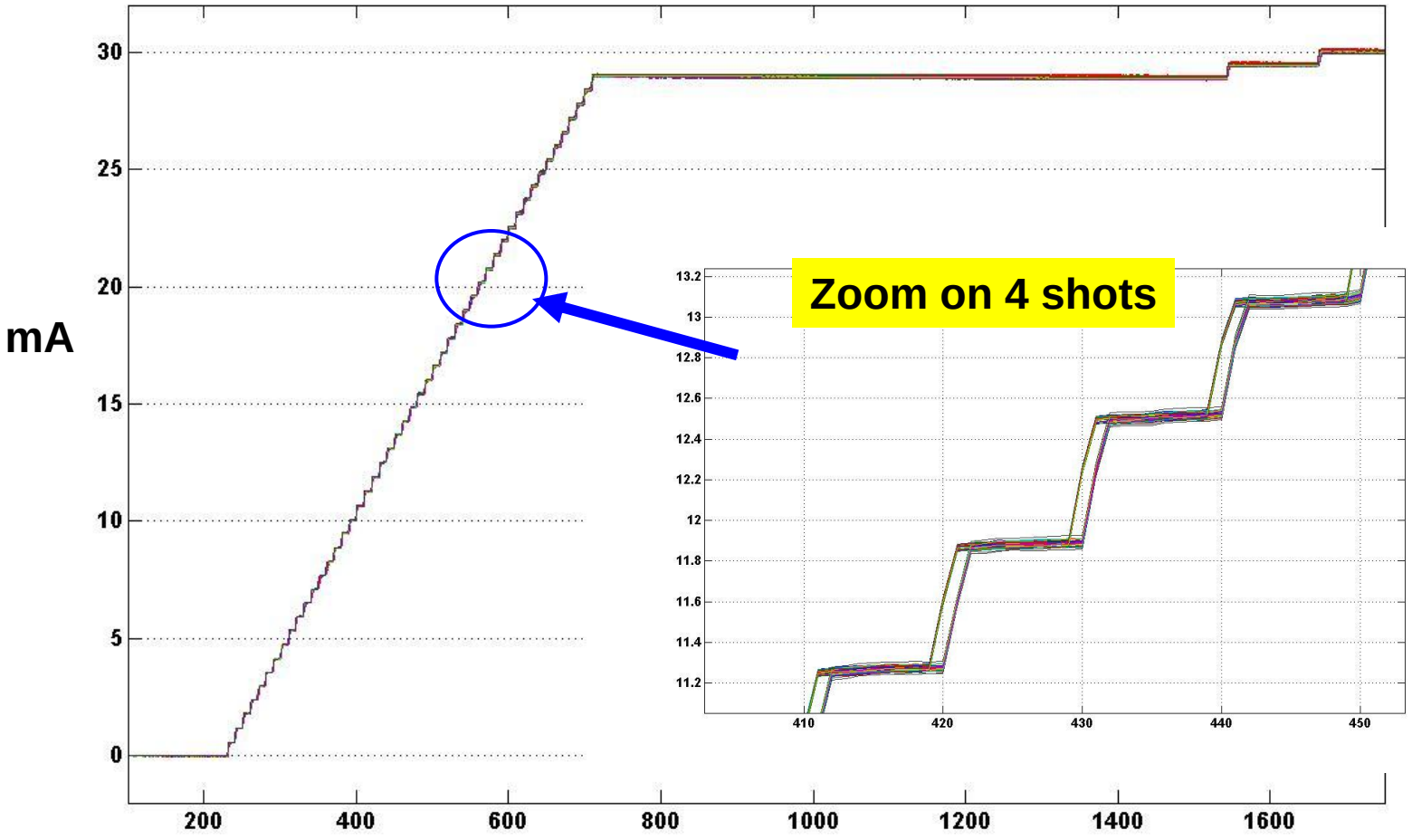


but how do we measure the efficiency into the Storage Ring ???

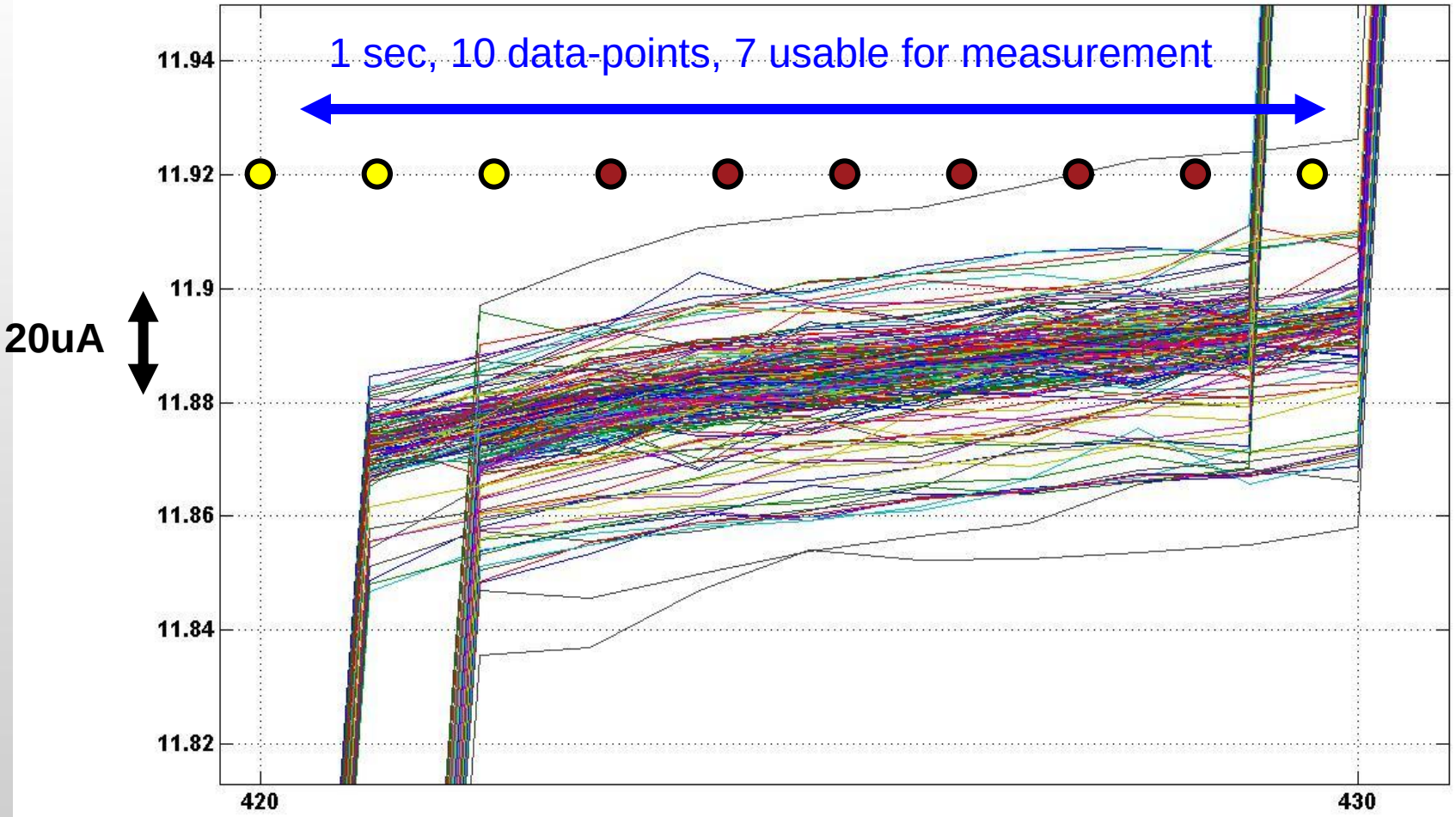
with the 224 Button BPMs + Libera-Brilliance !!

SA Sum output (10Hz)

Added Current [mA] , derived from Sum of 4 buttons

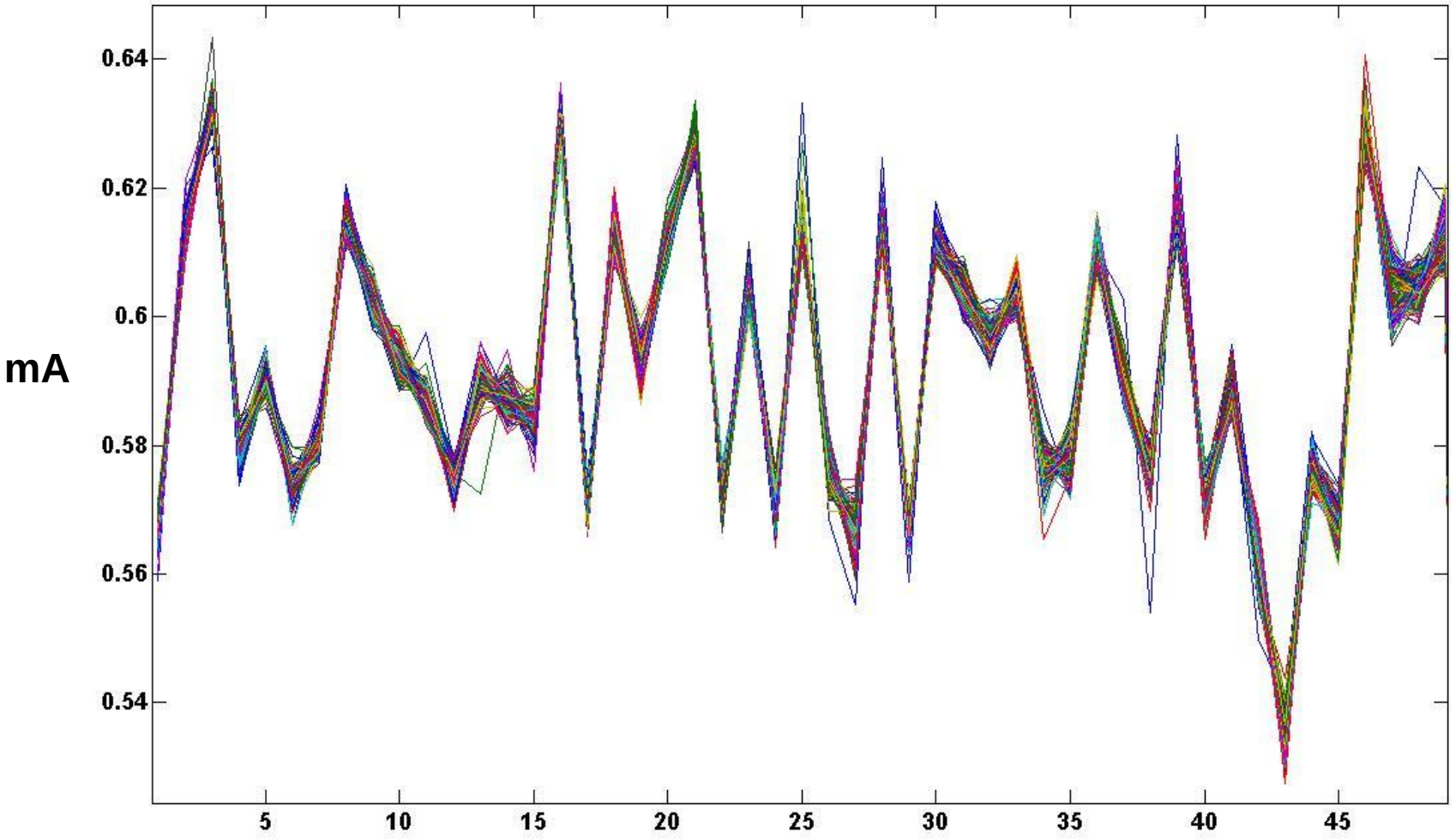


Added beam current of all 224 BPMs



Injection at 1Hz, 1/3 fill

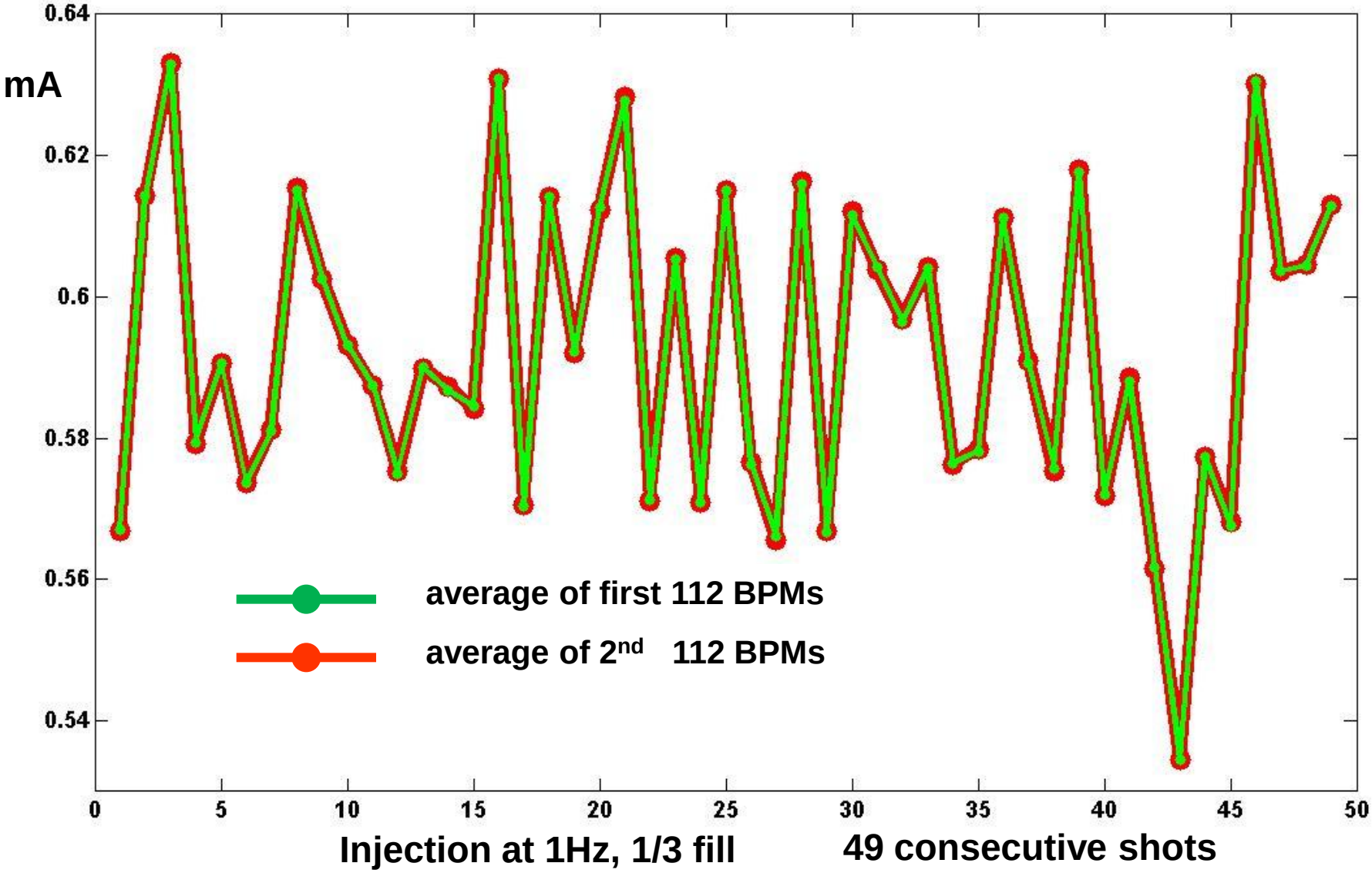
Added current [mA] per shot, all 224 BPMs

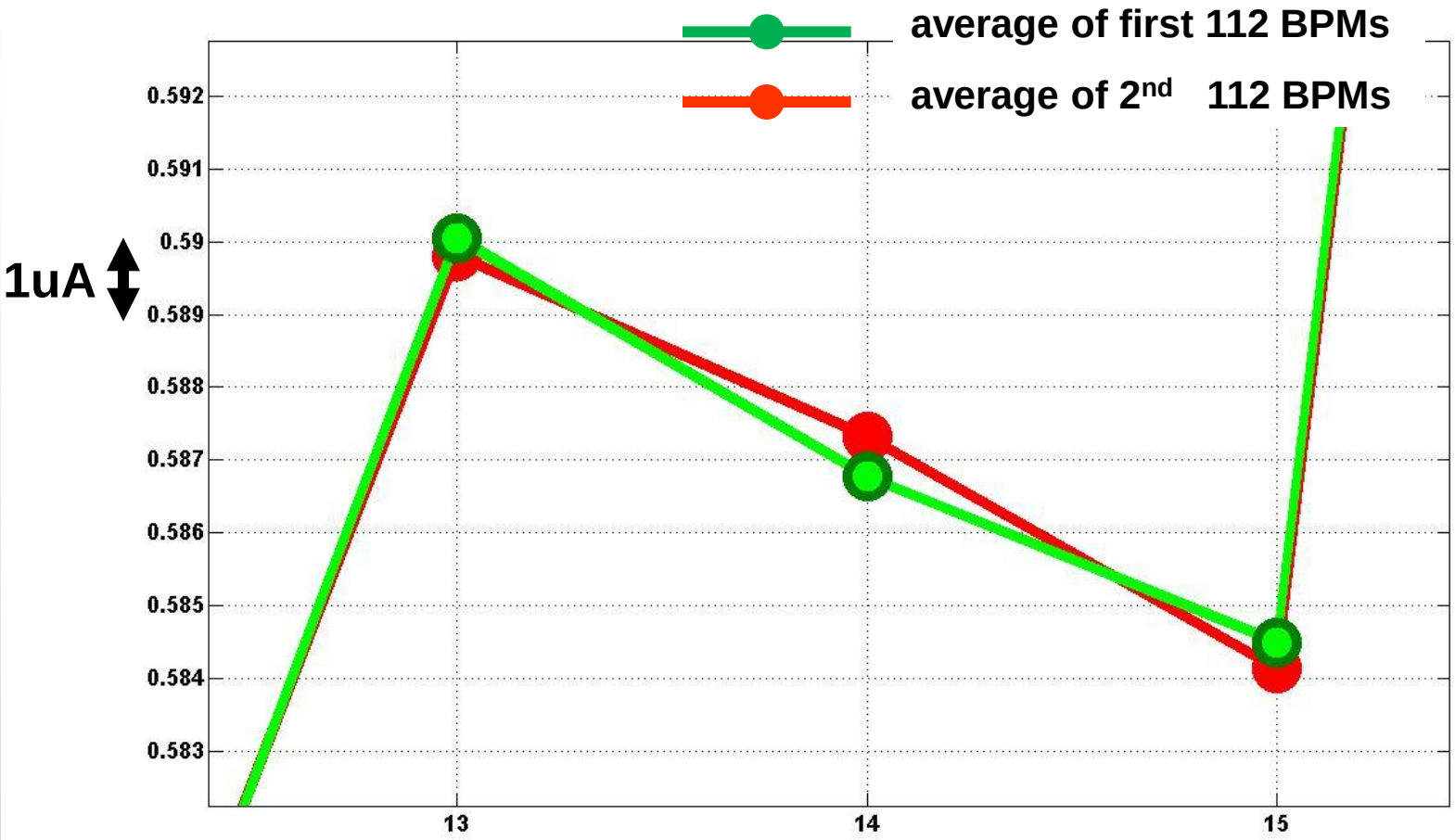


Injection at 1Hz, 1/3 fill

49 consecutive shots

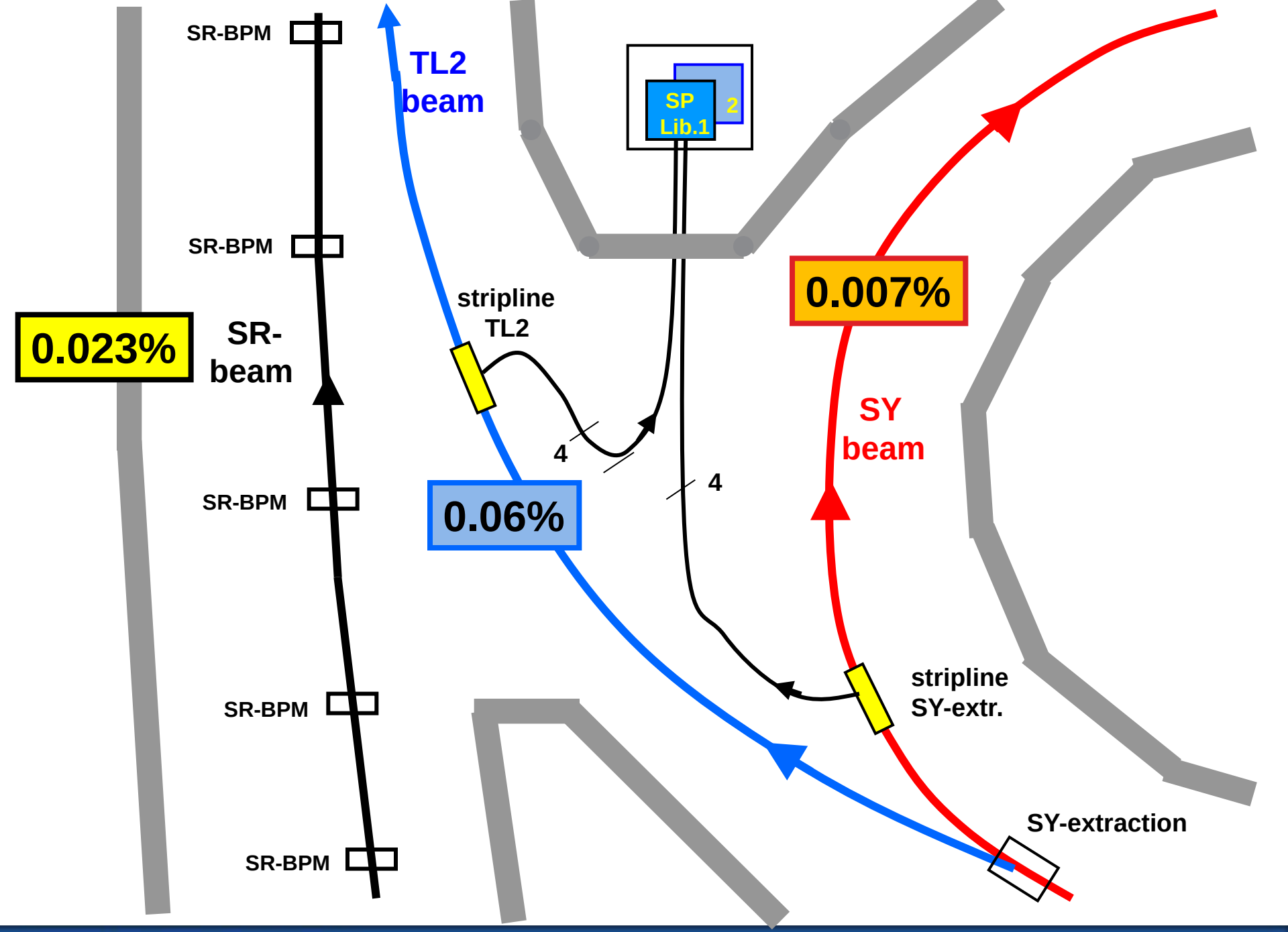
Added current [mA] per shot

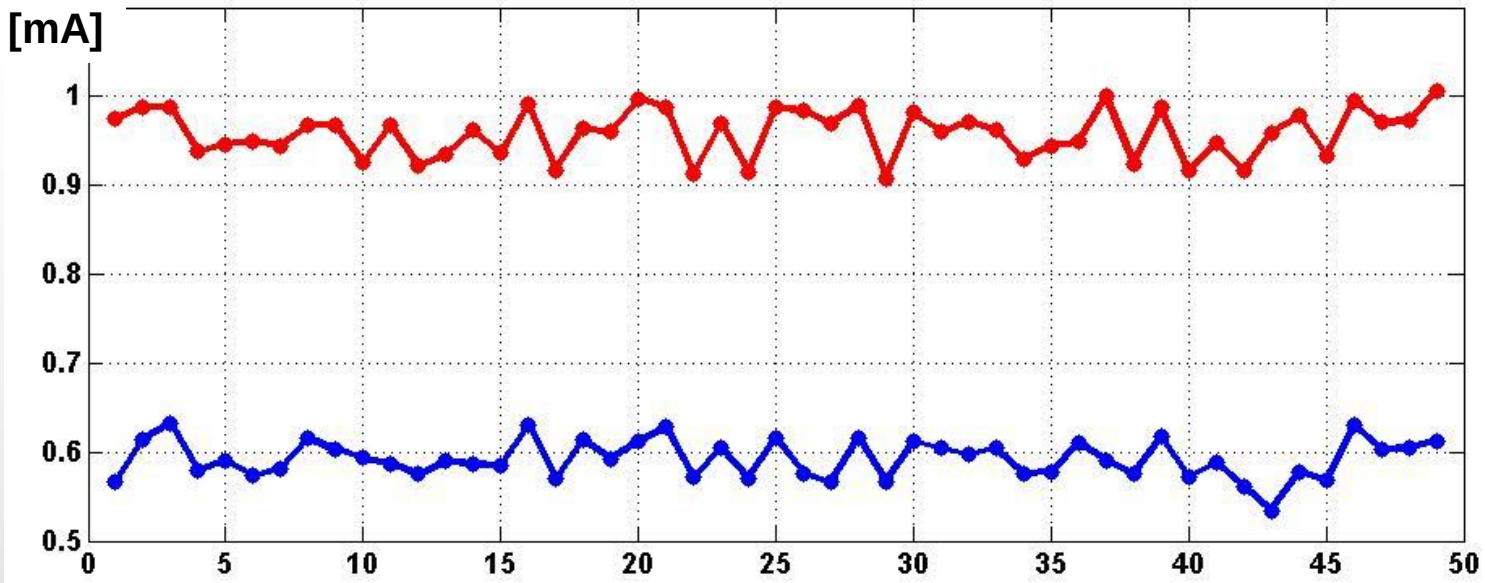




The rms on all 224 = 2.1uA which is 0.35% on 0.6mA

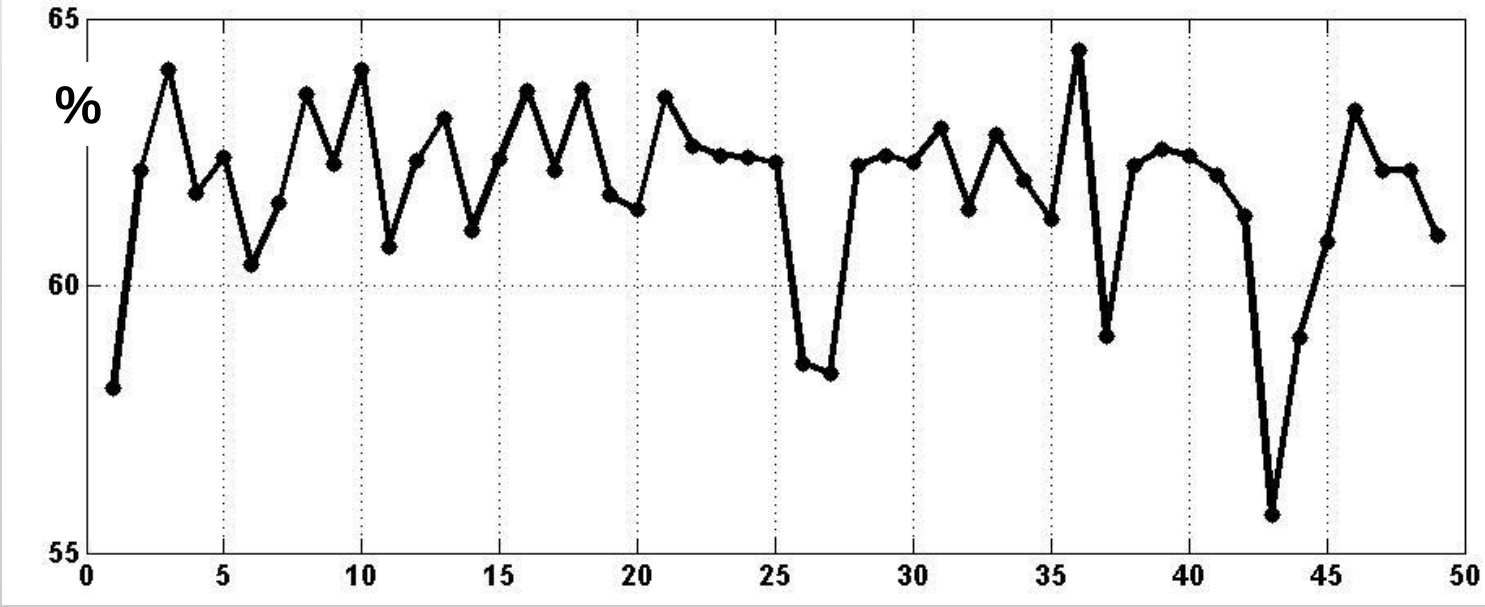
averaging all 224 gives an ultimate resolution of $\frac{0.35}{\sqrt{224}} = \underline{0.023\%}$


SR-BPM
SR-BPM
SR-BPM
SR-BPM
SR-BPM
0.023%
SR-
beam
TL2
beam
stripline
TL2
4
4
0.06%
SP
Lib.1
2
0.007%
SY
beam
stripline
SY-extr.
SY-extraction



current
TL2 [mA]
rms = 2.8 %

current
SR [mA]
rms = 3.7 %



efficiency [%]
TL2 ➔ SR
rms = 2.7 %

Status today (October 2010)

The SP-Libera (try-out) could first be used with our existing (Tango-) device-server (for 'ordinary' Liberas)

But for the 4 units delivered later, the firmware & CSPI had been radically changed :

we need to re-write an optimized (low-level) device-server, not done yet, ESRF software engineer is tackling it now,

but also awaiting I-Tech's reply on some excessive time-response (not allowing to run it at 10Hz rate)

Once this is available, then a higher-level server/application will progressively exploit all the features available with this system :

- **precise beam diagnostics in Injector**
- **high quality Charge-Transfer Efficiency Monitor**

The use of the 4 Single-Pass-Liberas in the ESRF Injector system

many thanks !

for your hospitality

and your attention