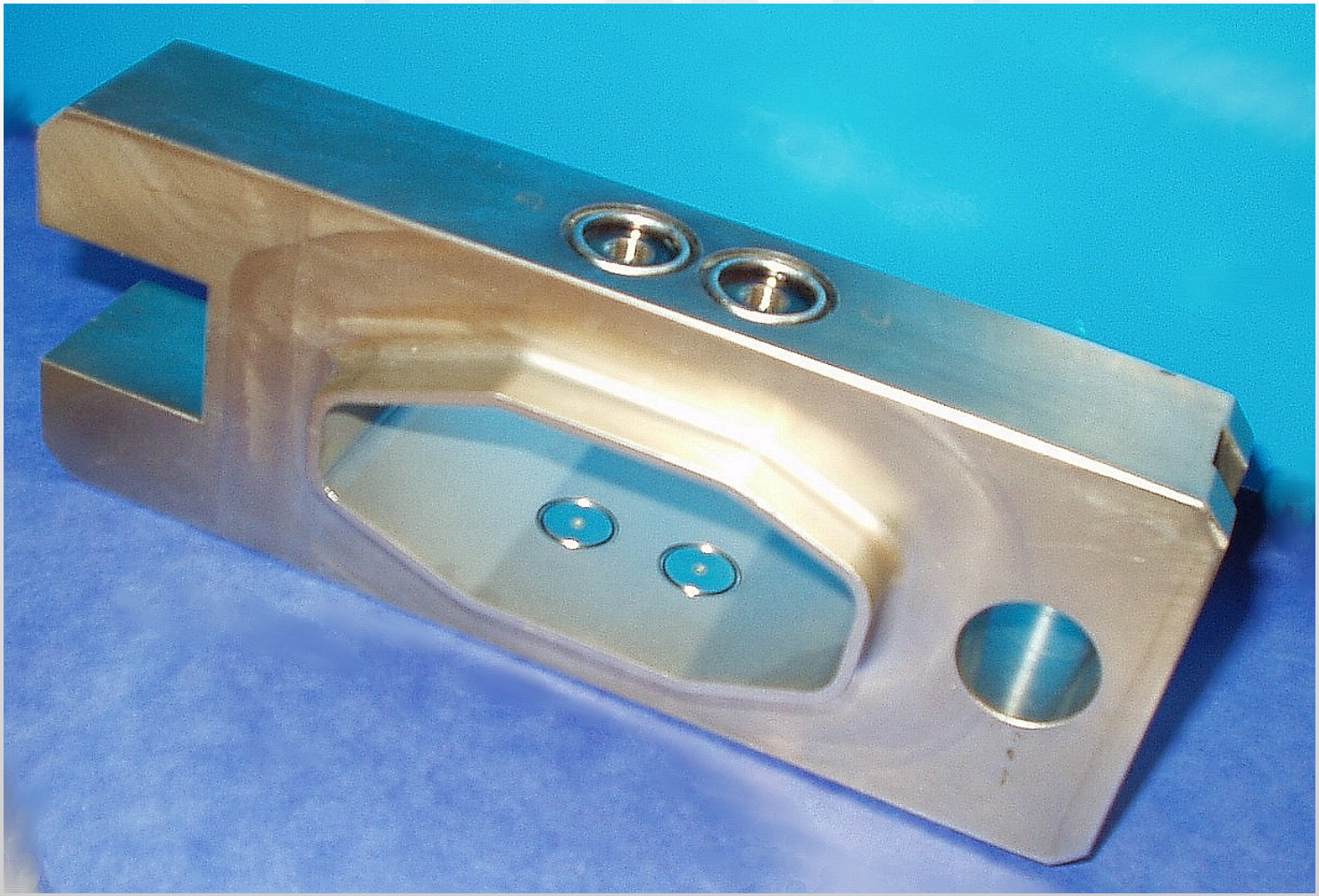
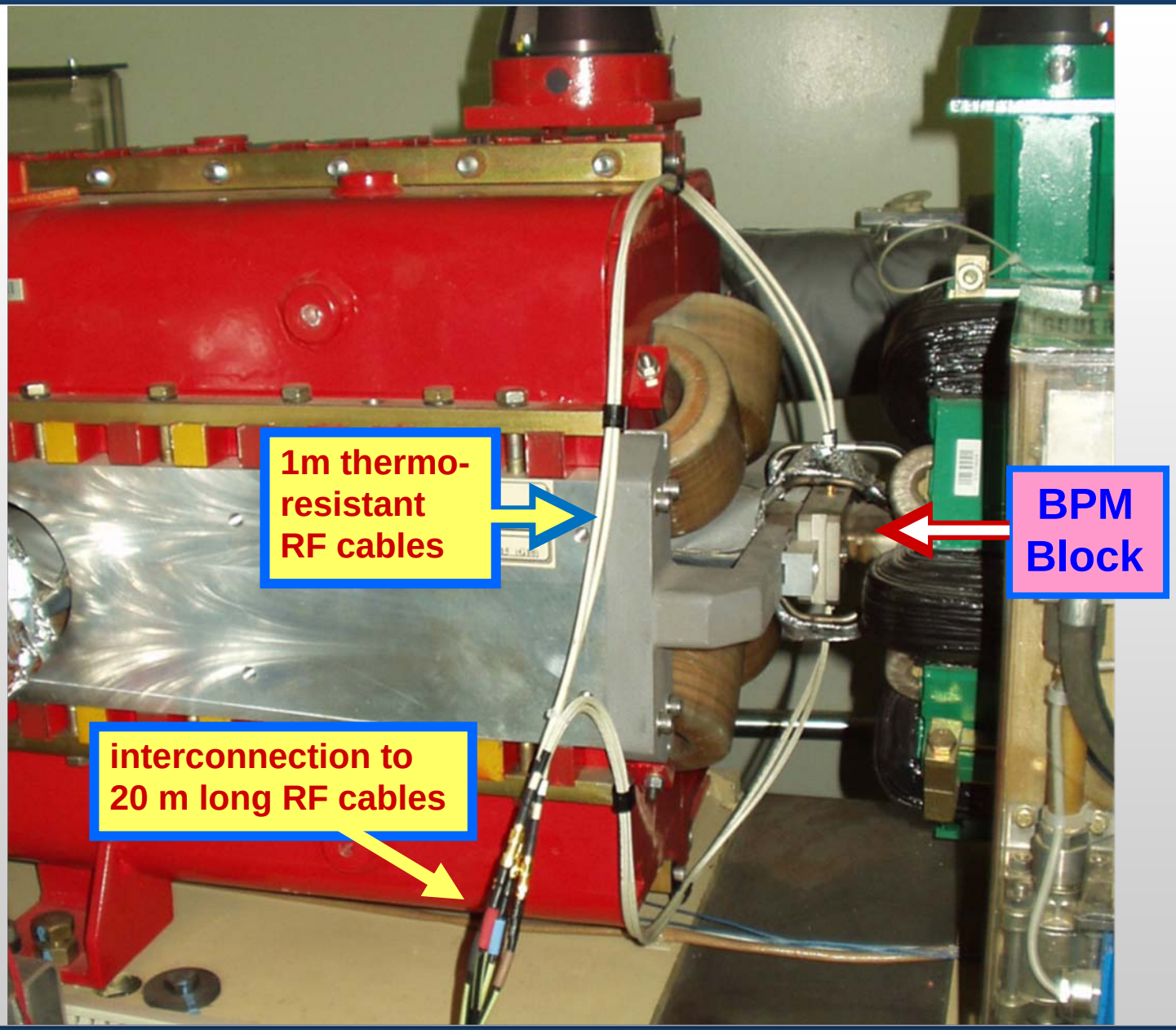
Increased Performance and Functionality of the Libera BPMs in the ESRF Storage Ring

- Using the **ADCs** for verifications on the Kickers — **108 MHz**
- Using the **T-b-T** output with **different** filters for Injection-Trajectory studies & H.Q. lattice studies — **355 KHz**
- Using a dedicated output & distribution network for the near-future's use in Fast/Slow full global orbit stabilization — **10 KHz**
- The output for precise & strict survey of the beam's **AC** position stability — **5.5 KHz**
- The output for the survey & control of the **'slow'** beam position stability — **10 Hz**
- The **Sum** output for H.Q. Lifetime & 'beam-drop' & 'accumulation' monitoring

The BPM block with its 4 capacitive buttons




1m thermo-resistant RF cables
BPM Block
interconnection to 20 m long RF cables

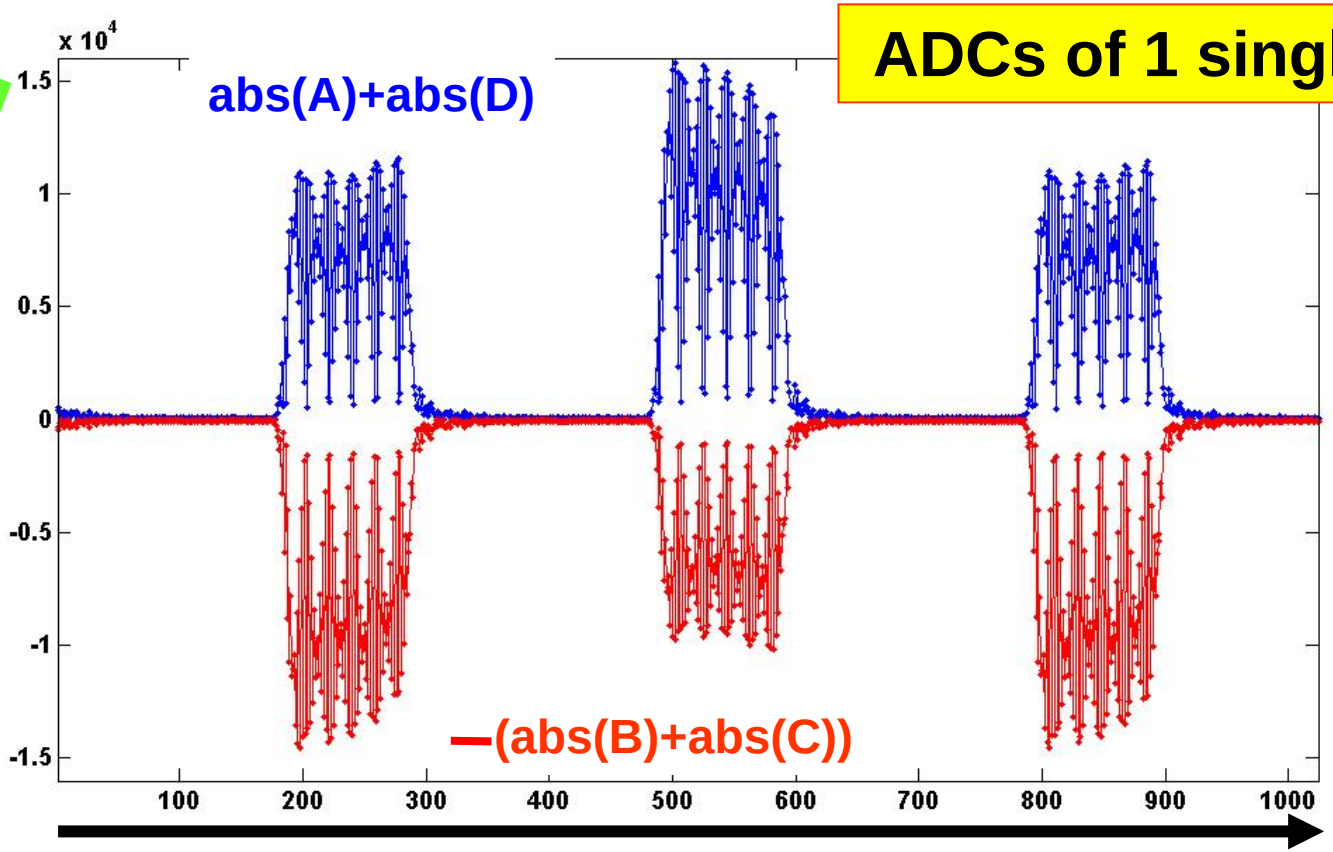
108 MHz

Using the ADCs for verifications on the Kickers

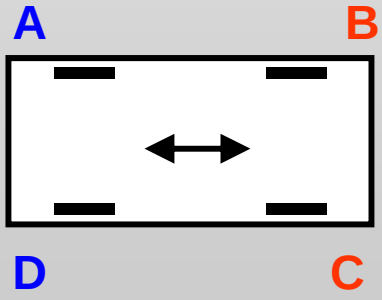
- **correct timing ,**
- **‘skew’ ,**
- **overshoot & after-pulse etc.**

108 MHz

ADCs of 1 single BPM

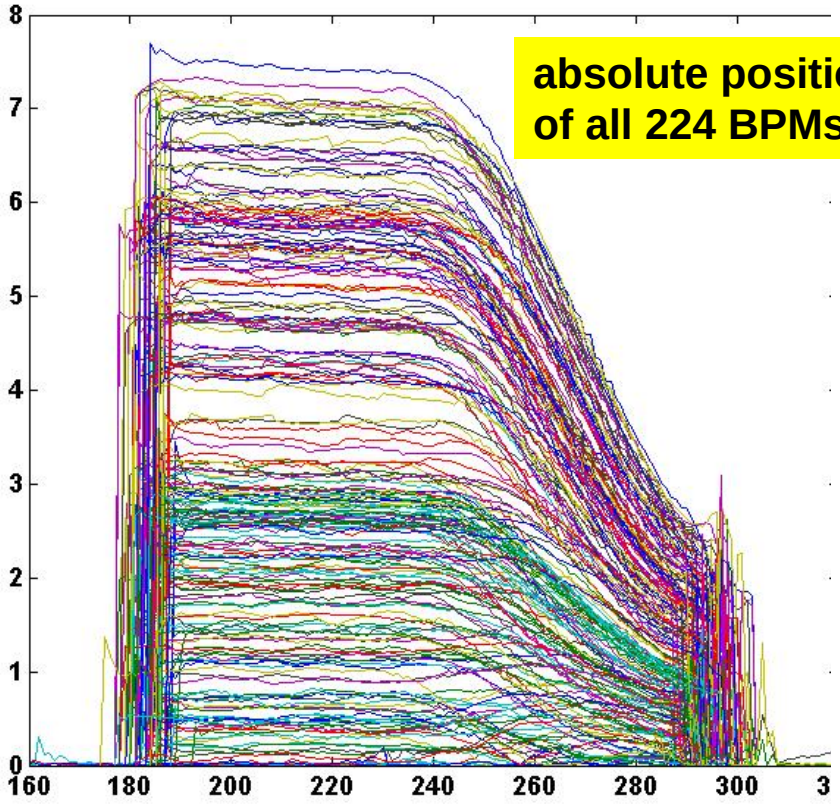


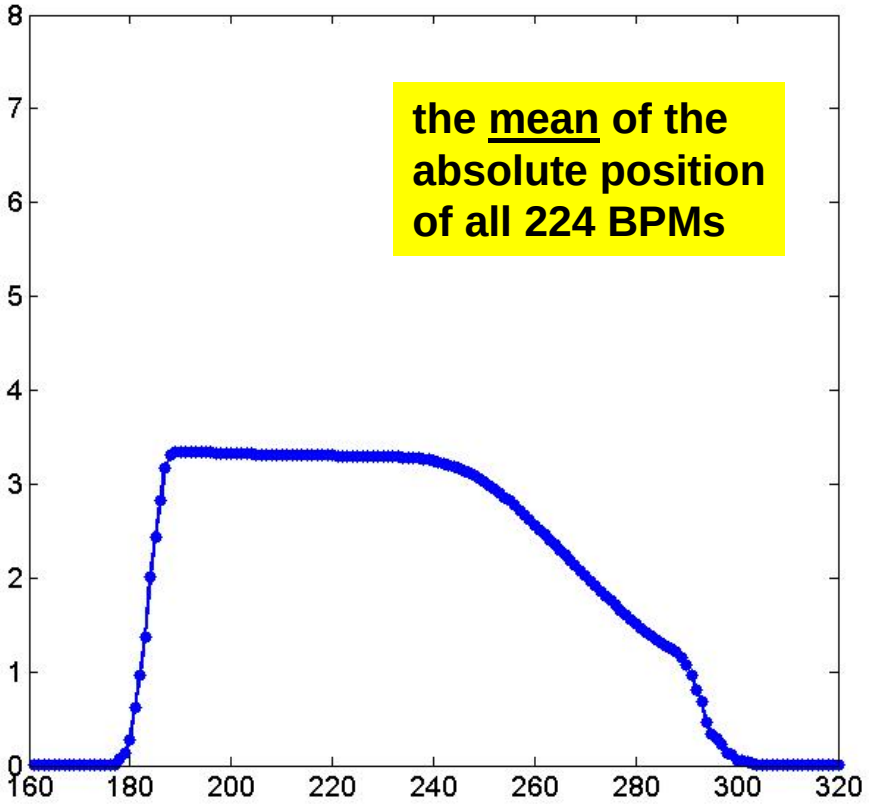
1024 ADC samples (~10nS) → see 3 Turns (~10uS)



Beam being (single-Turn) kicked,
by 1 single injection kicker
but the kick is NOT flat,
but skewed . . .

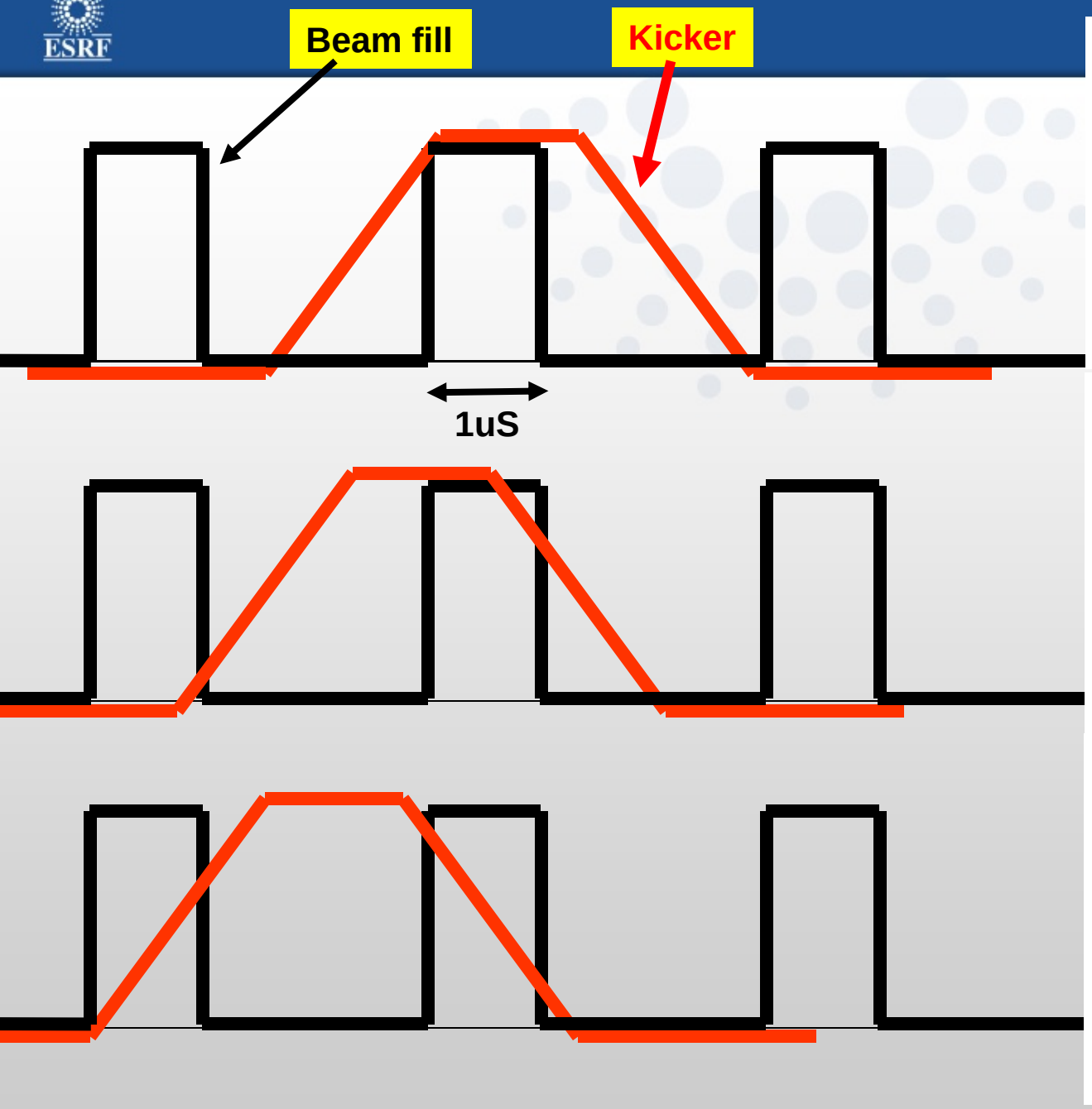
108 MHz

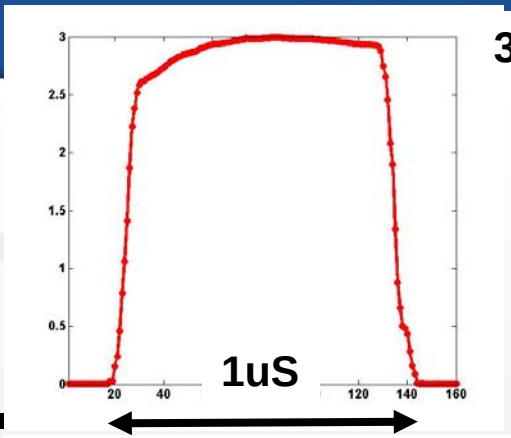


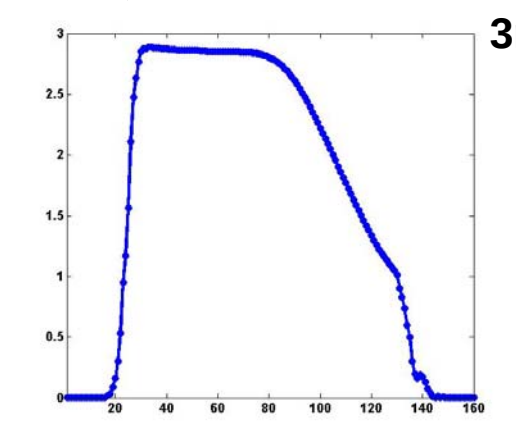


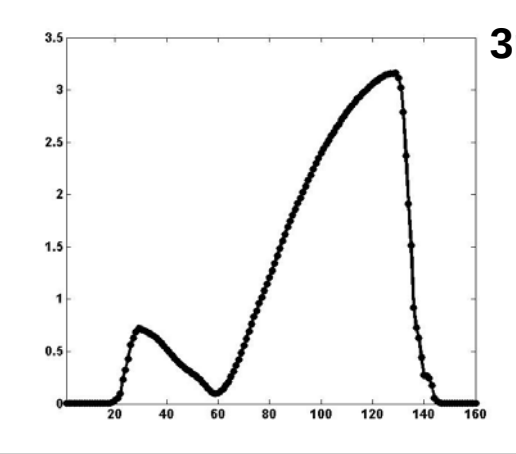
~100 ADC samples (~10nS)
(= 1 uS = 1/3 fill)

~100 ADC samples (~10nS)
(= 1 uS = 1/3 fill)

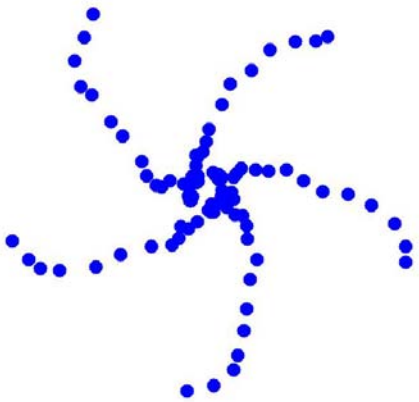

Beam fill
Kicker
1uS

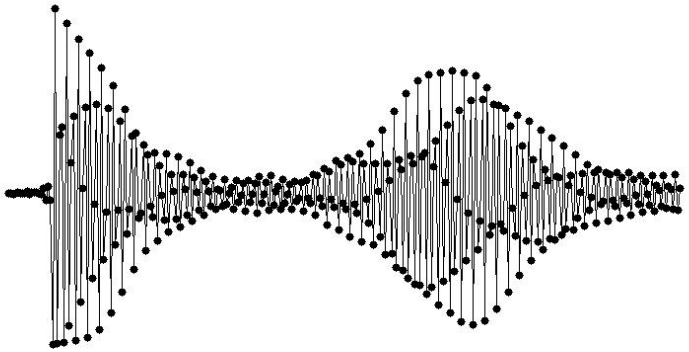

3mm
1uS


3mm


3mm

355 KHz





Turn-by-Turn measurements :

-- Kick the beam transversely

-- Measure positions on all BPMs at each orbit Turn

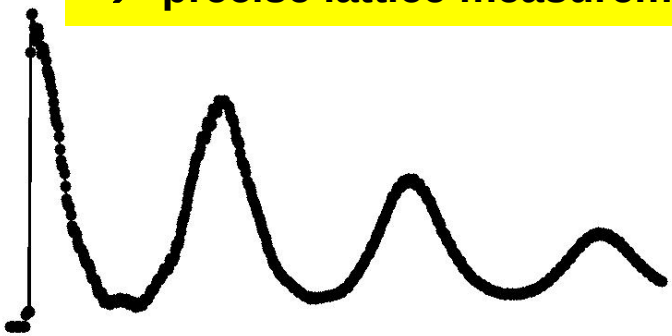
→ precise lattice measurement

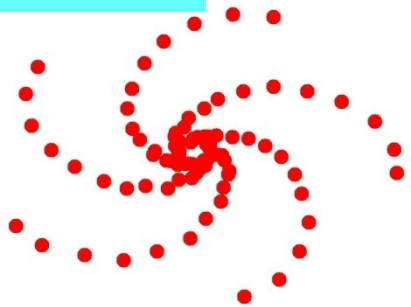
1rst Turn Trajectory measurements :

-- Inject the beam in an empty Ring

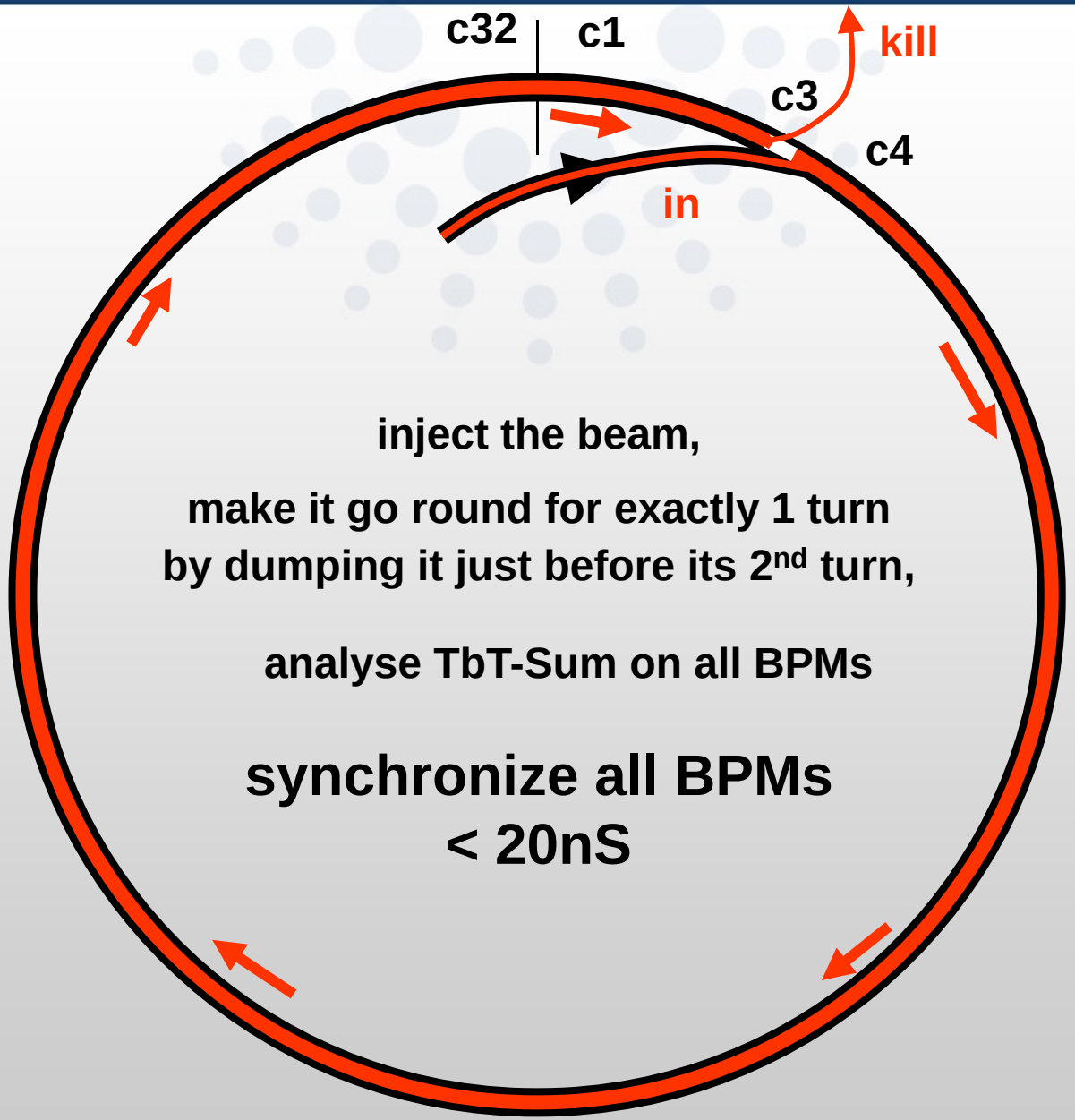
-- Measure positions on all BPMs at Turn(s) 1, 2 ,3 or more

→ find errors in the Ring lattice, or in the injector system





355 KHz



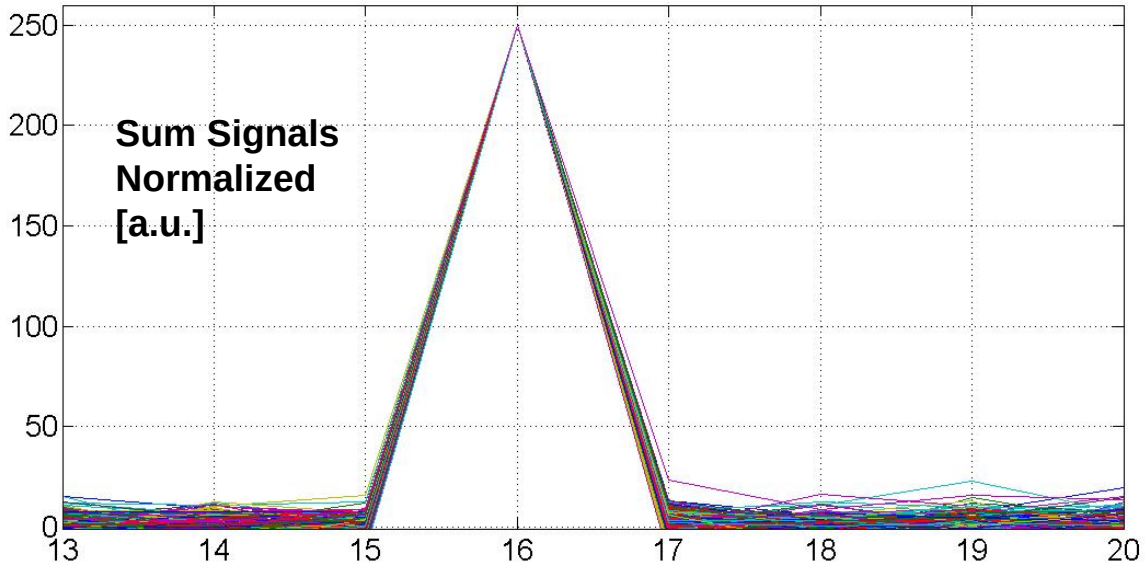
inject the beam,

make it go round for exactly 1 turn
by dumping it just before its 2nd turn,

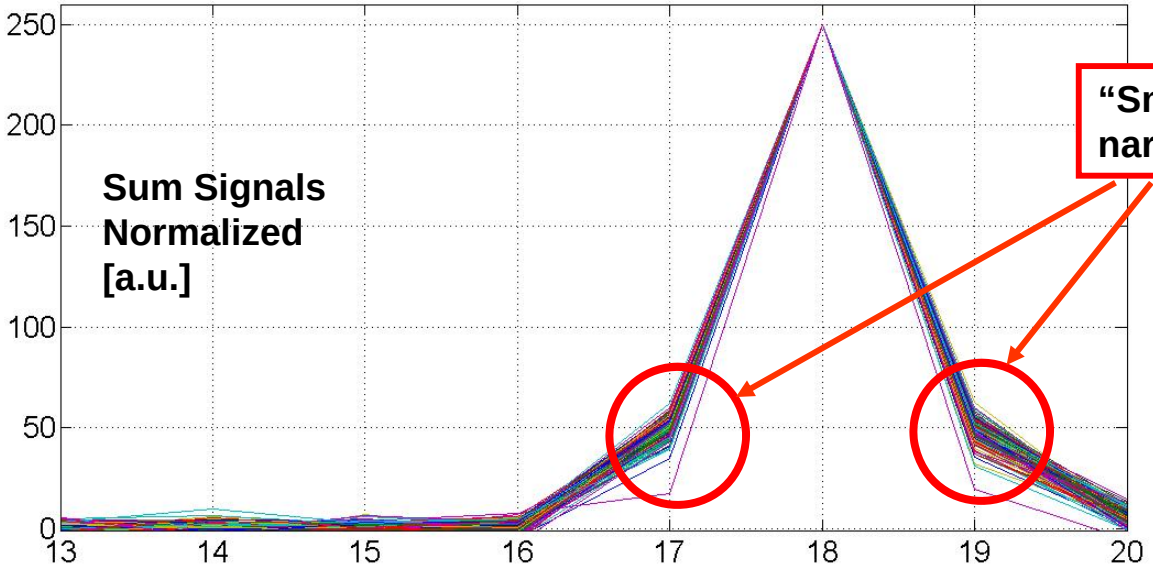
analyse TbT-Sum on all BPMs

synchronize all BPMs
< 20nS

355 KHz



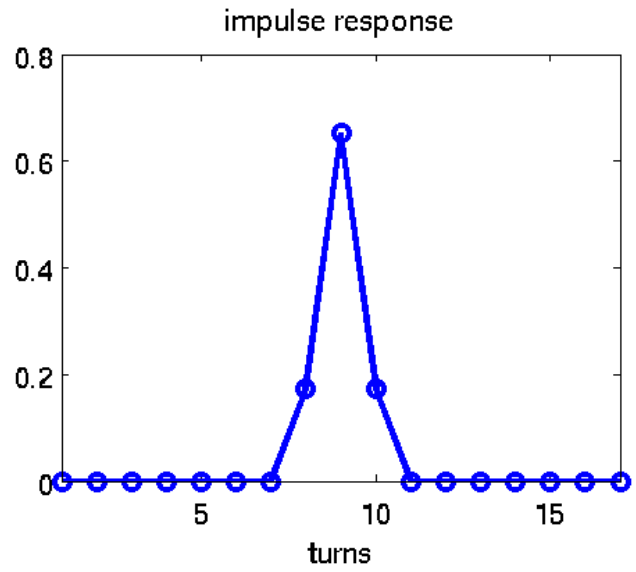
optimized
T-b-T filter



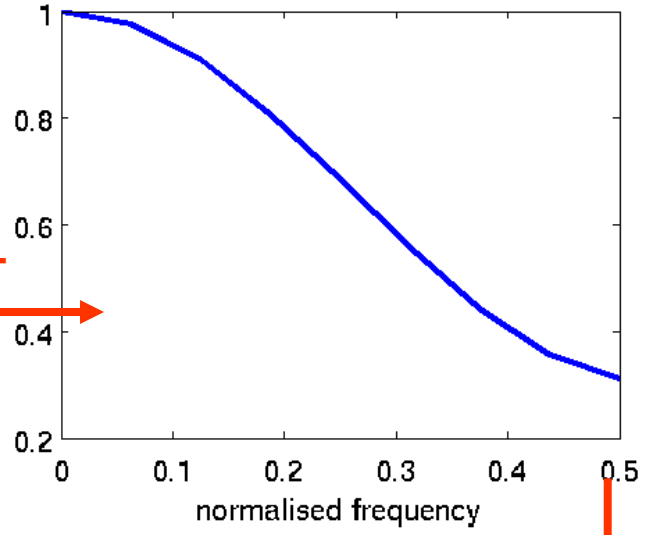
"Smearing" due to
narrow digital filter

Standard
T-b-T filter

a Compensation Filter
courtesy of G.Rehm DLS

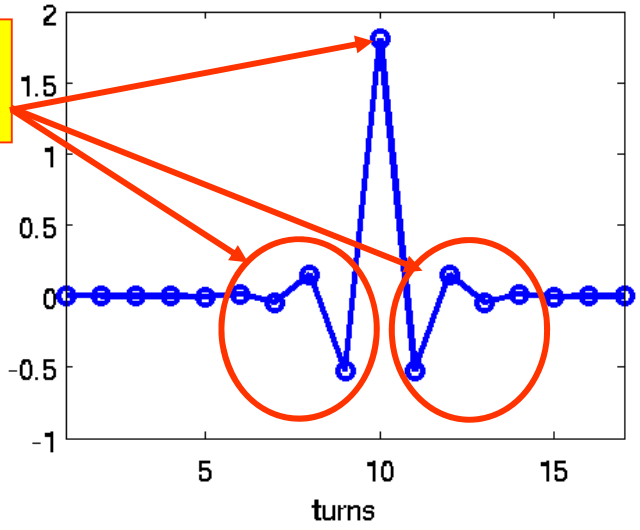


FFT

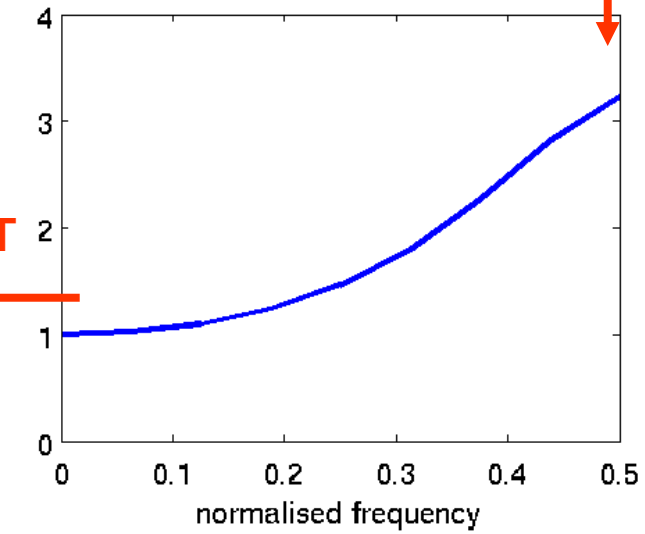


Inverse

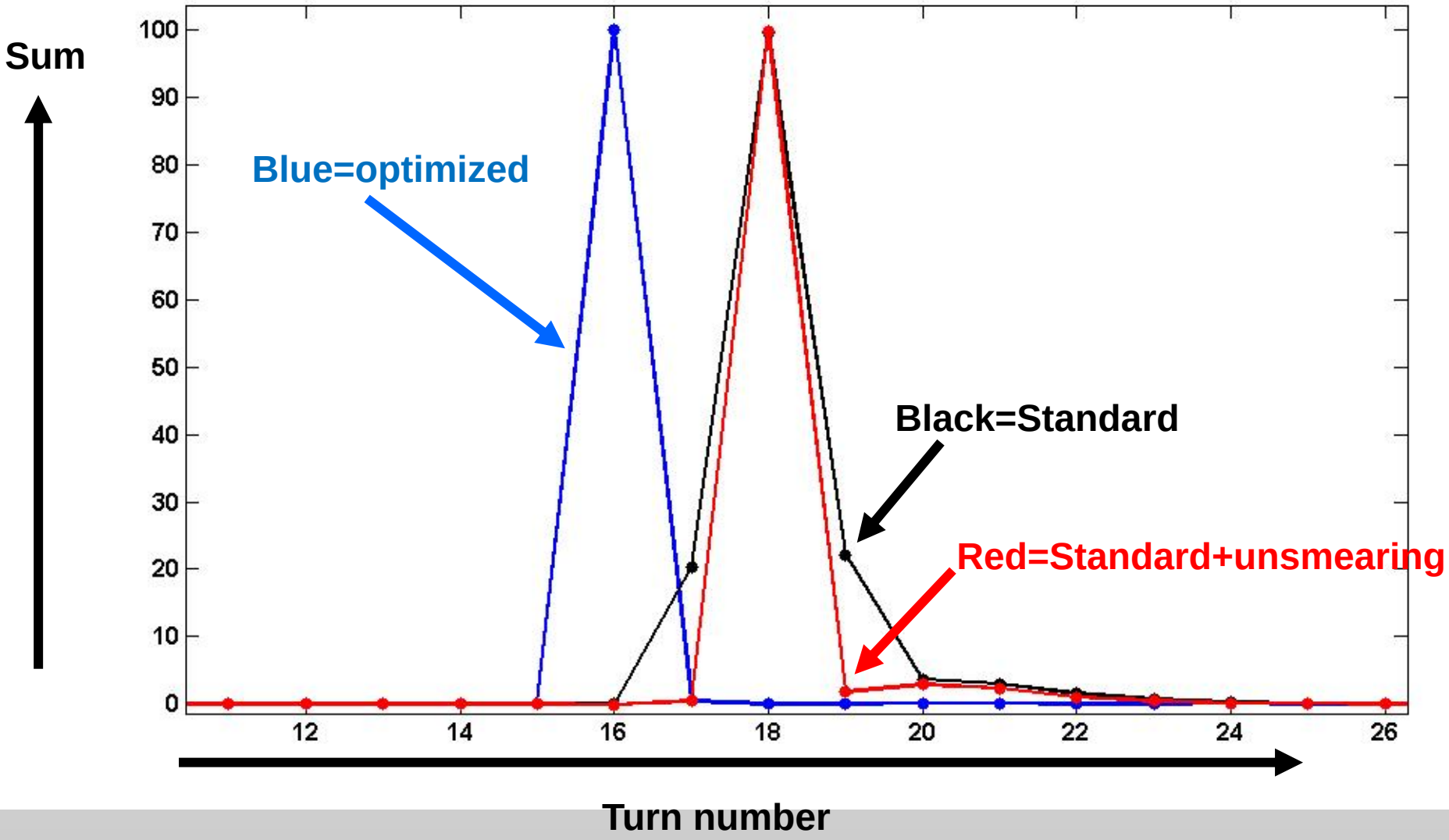
Anti-smear coefficients



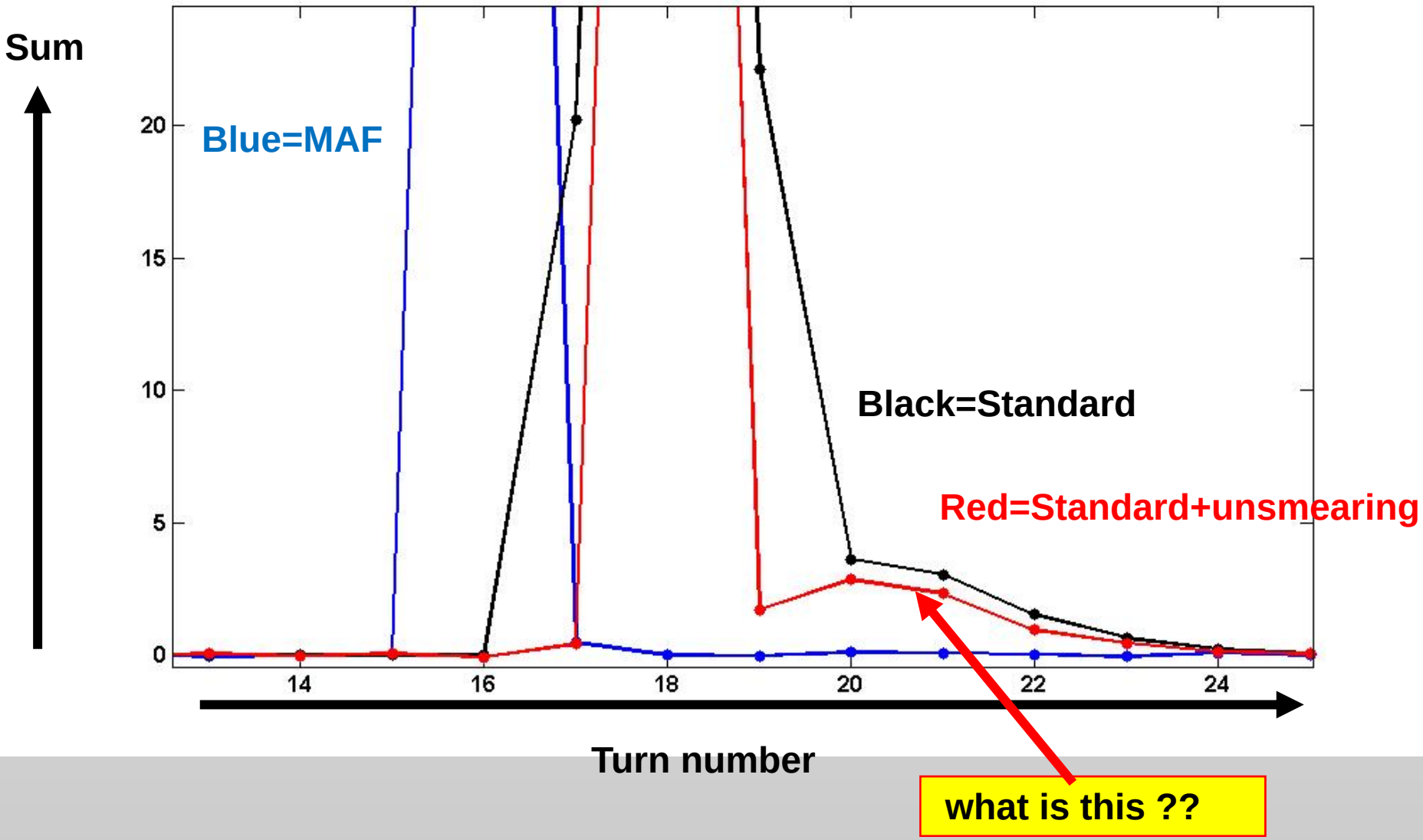
IFFT



Beam injected, and lost after 1 single Turn



Zoom on the “low-level-smearing”



355 KHz

Turn-by-Turn measurements :

-- Kick the beam transversely

-- Measure positions on all BPMs at each orbit Turn

→ precise lattice measurement

we use the **Optimized** filter,

information on detailed lattice parameters is <u>better & more precise</u>

price to pay :

- 2 x10min switching-over time
- slow outputs have reduced precision & resolution

1rst Turn Trajectory measurements :

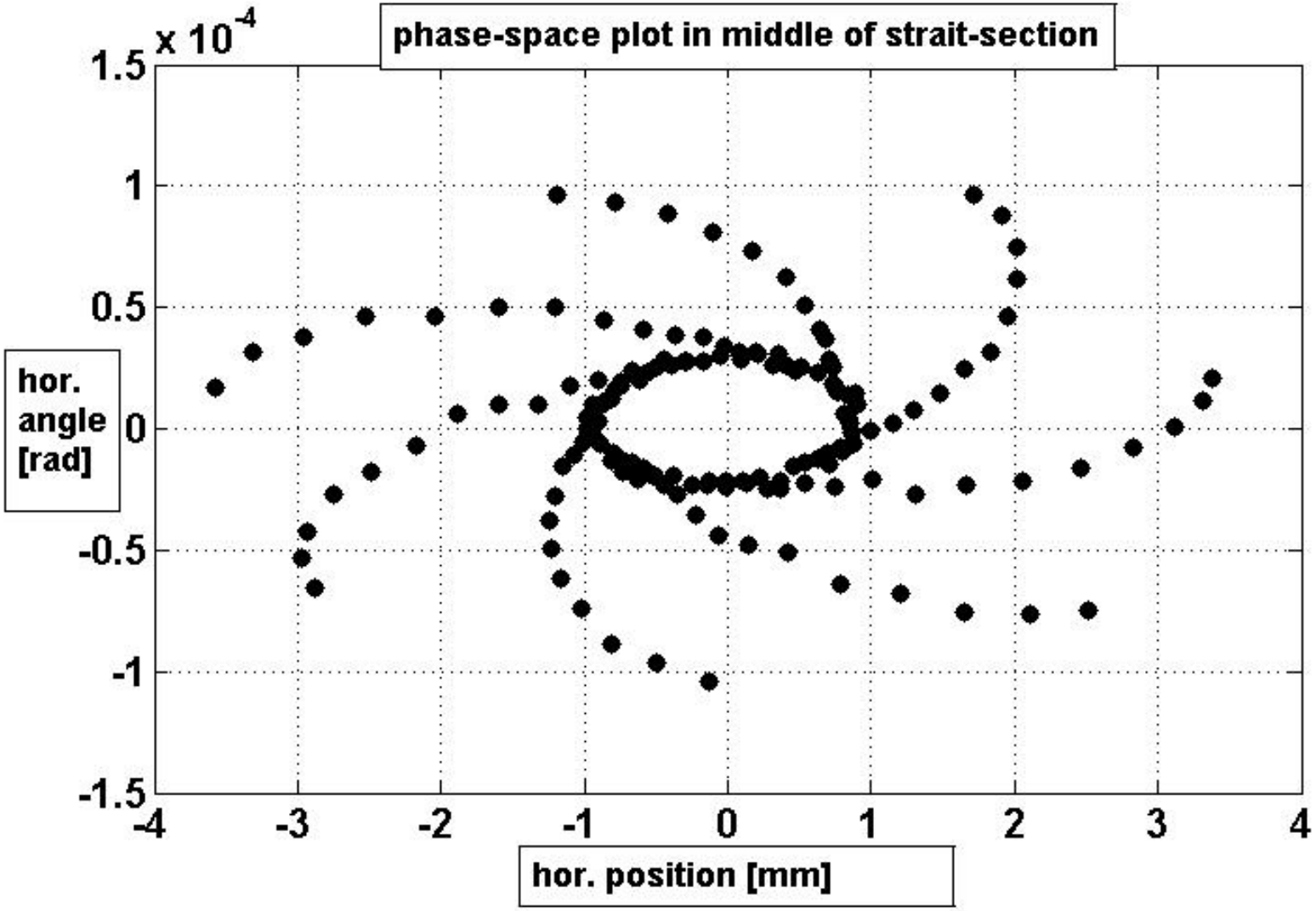
-- Inject the beam in an empty Ring

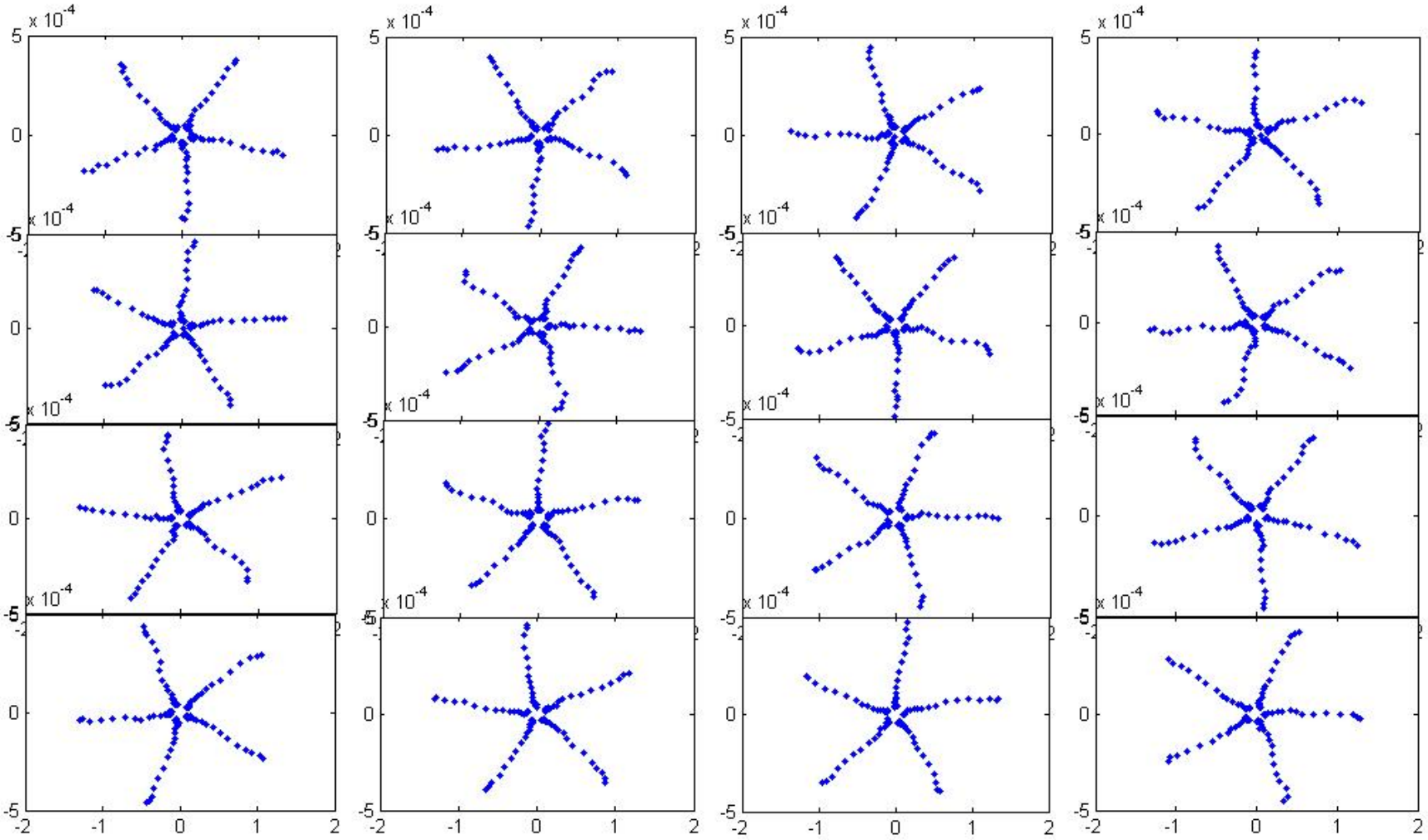
-- Measure positions on all BPMs at Turn(s) 1, 2 ,3 or more

→ find errors in the Ring lattice, or in the injector system

We use the **Standard** filter with 5-points anti-smearing,

- good enough precision,
- easy & strait-forward to use,


phase-space plot in middle of strait-section
x 10^-4
1.5
1
0.5
0
-0.5
-1
-1.5
hor. angle [rad]
-4
-3
-2
-1
0
1
2
3
4
hor. position [mm]



Vertical phase-space plot in 16 (even) strait sections

to follow : some examples of 1rst Turn Trajectory measurements

1rst Turn Trajectory measurements :

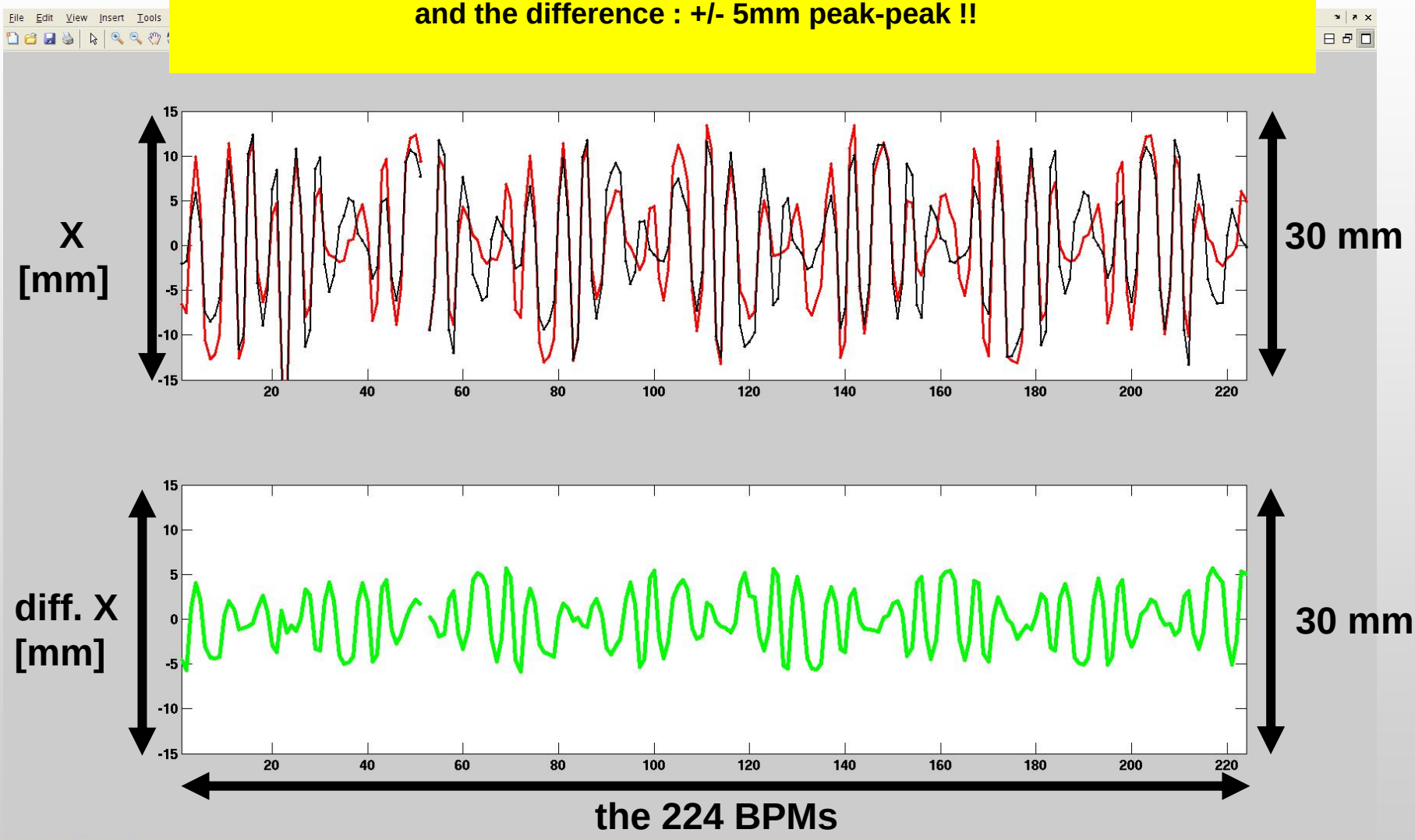
-- Inject the beam in an empty Ring

-- Measure positions on all BPMs at Turn(s) 1, 2 ,3 or more

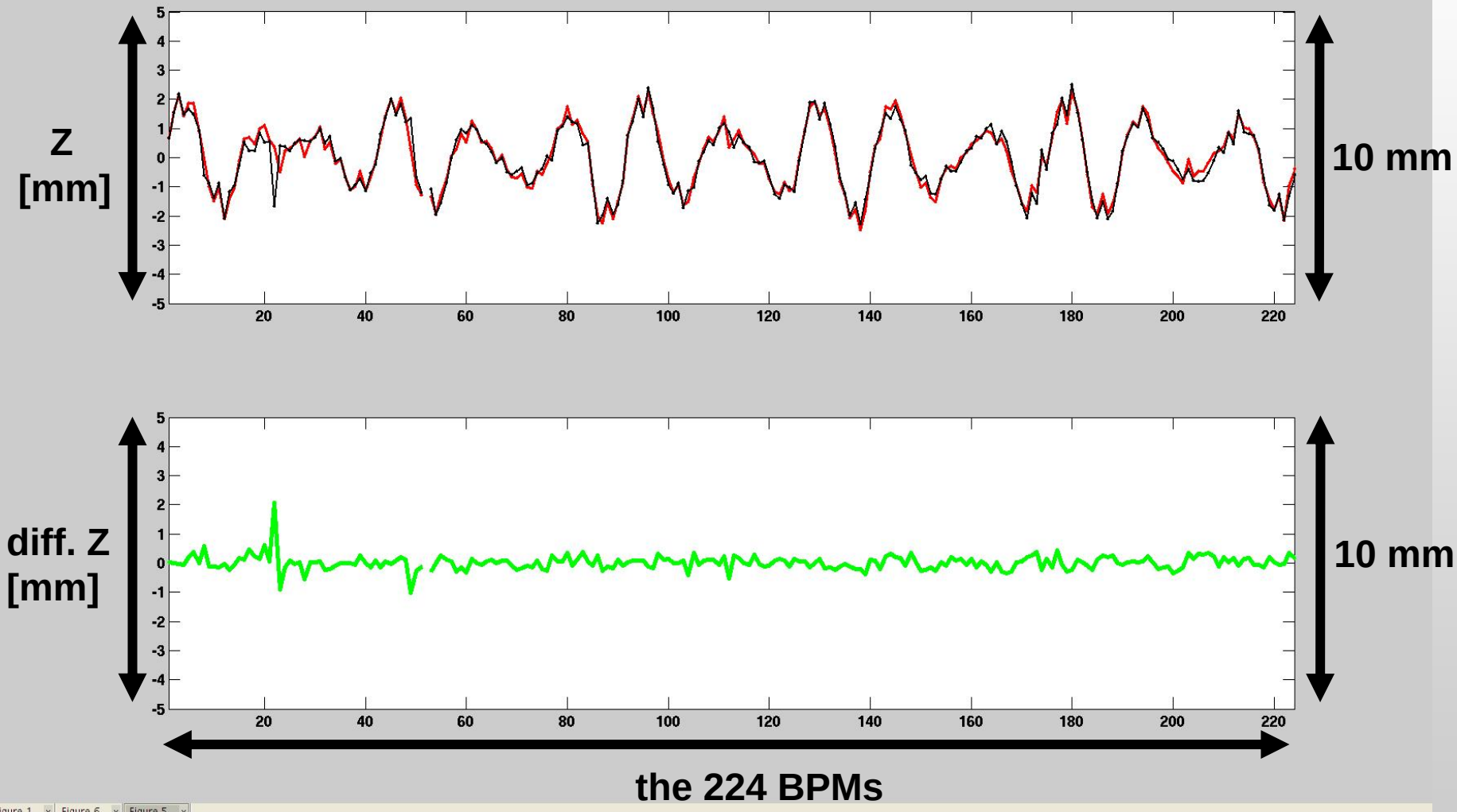
→ find errors in the Ring lattice, or in the injector system

Reproducibility of the first-turn measurement :

2 Horizontal Trajectories of the injected Turn are shown over the whole Ring and the difference : +/- 5mm peak-peak !!

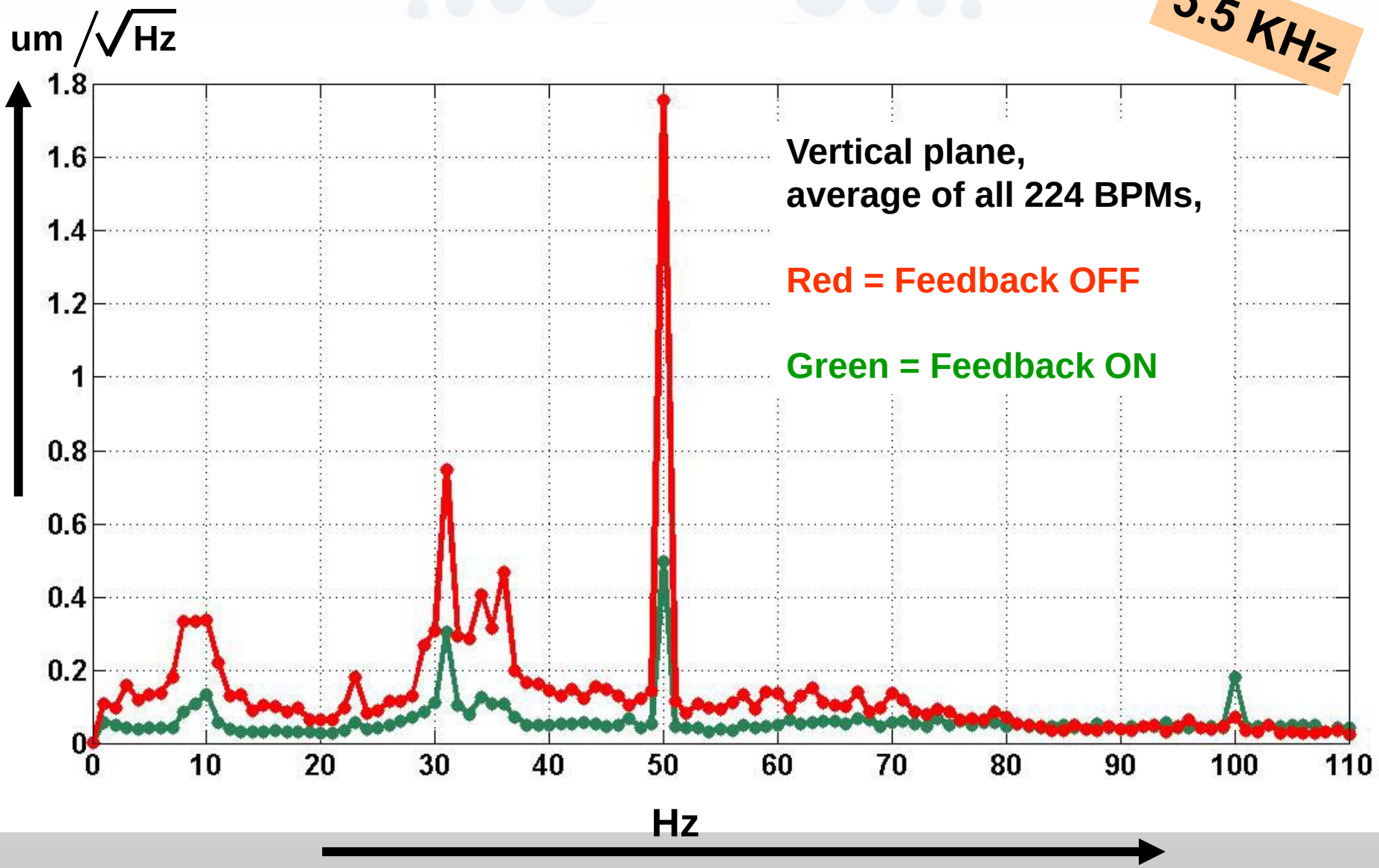


Reproducibility of the first-turn measurement :
The Vertical Trajectories of the injected Turn have a much better reproducibility



Stability in the low AC domain (1Hz ~ 100Hz)

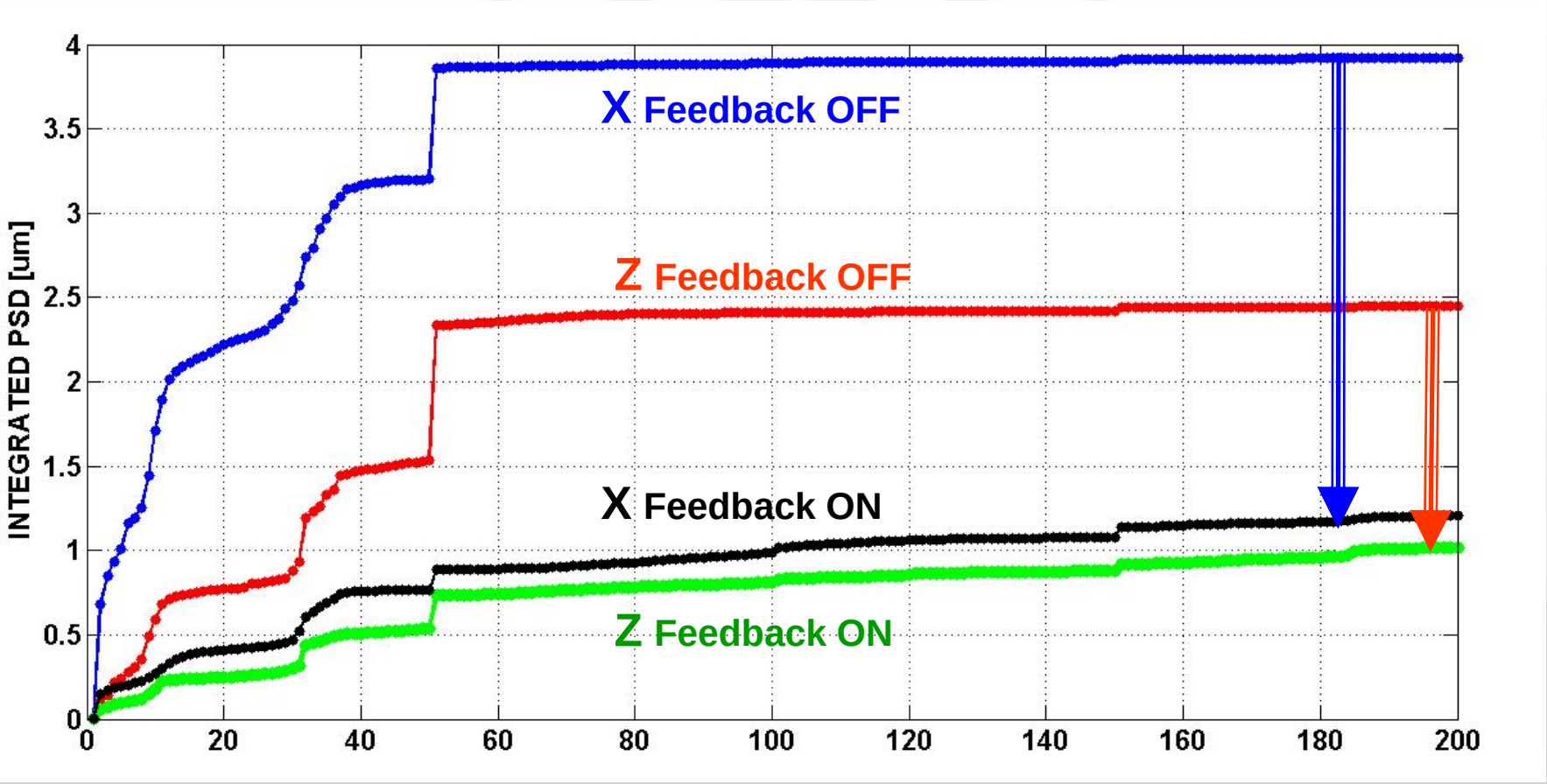
5.5 KHz



Stability in the AC domain (1Hz – 2KHz)

5.5 KHz

Average of all 224 BPMs, X & Z , FastFeedback On & Off



Status of Fast-Orbit Feedback

10 KHz

Liberas using the I/O-Rocket ports
+ C.C. + extensive network of copper & fiber links

Ready !

96 Horizontal & Vertical steerers housed in the Sextupoles

almost Ready !

The *benefits*, now and in the future, for beam stability

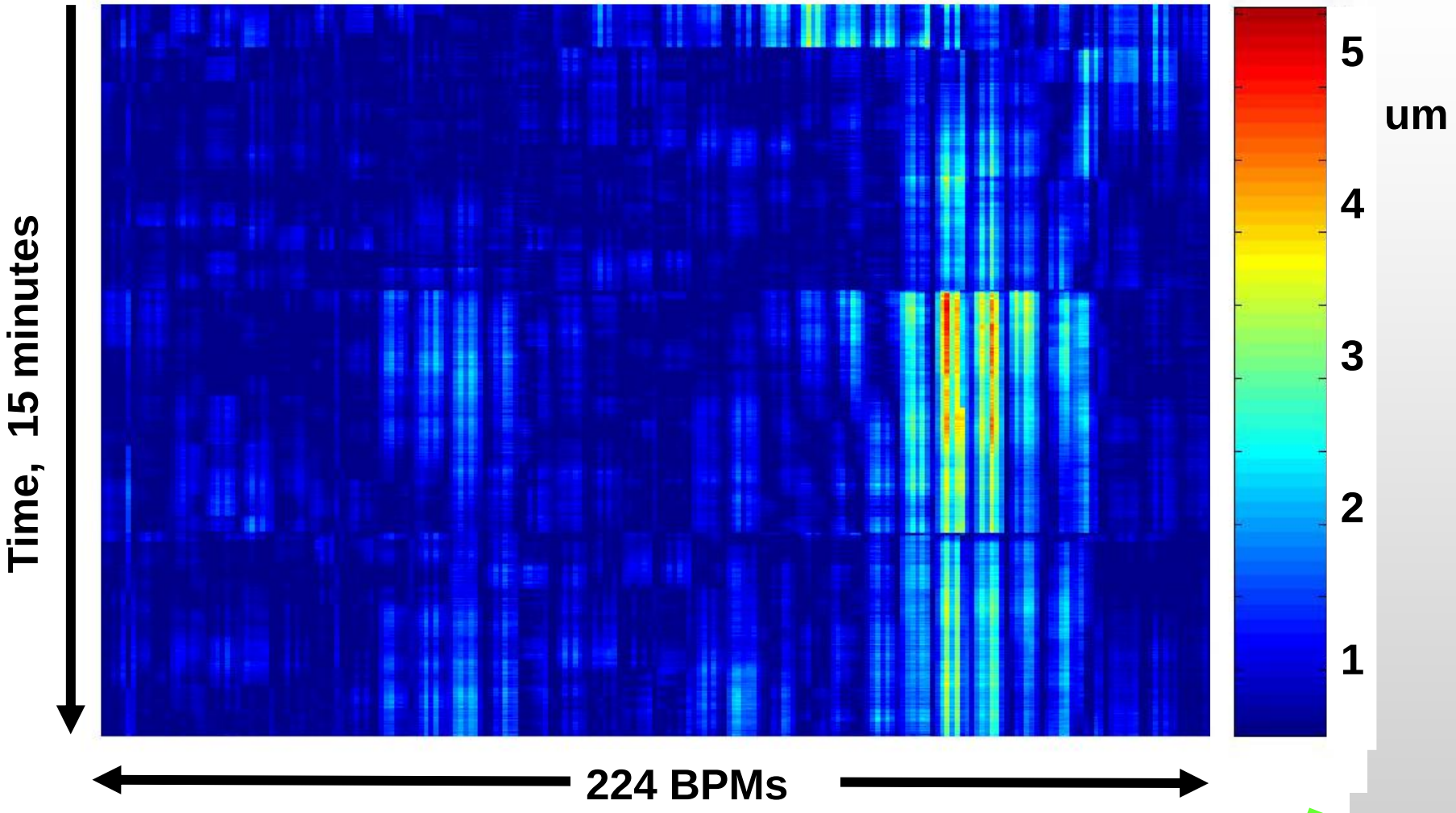
Future : the combined Slow-Fast-Orbit-Stabilization system uses :

224 Libera BPMs (done)	(today only : 32 Hor-Fast-BPMs 32 Vert-Fast-BPMs)
96 AC-DC Steerers (early 2011)	(today only : 32 AC Hor-Steerers 16 AC Vert-Steerers

Now : - much better survey of beam motion & stability

- some instabilities & motions have been suppressed

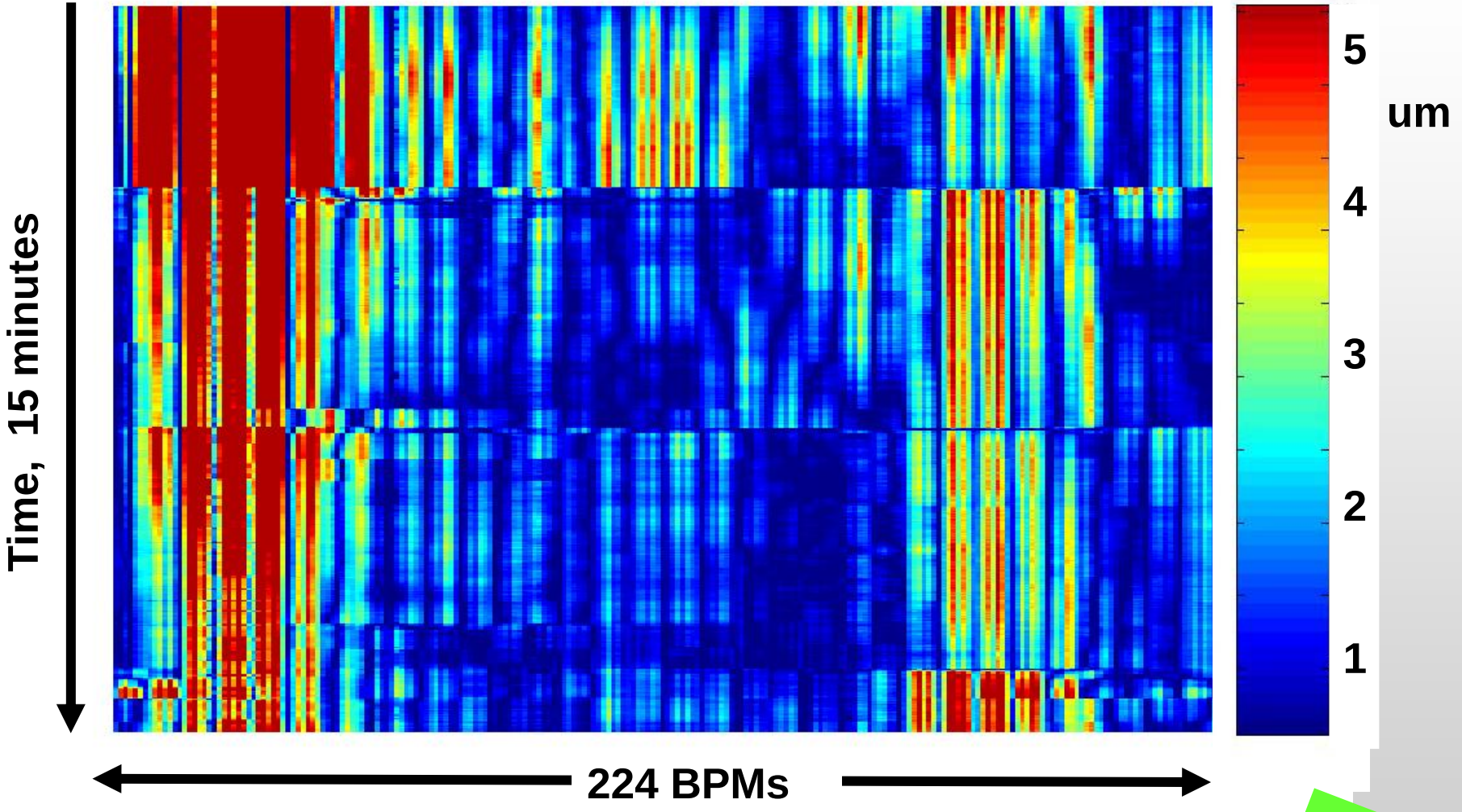
Stability in an intermediate time domain, 0.5sec to 15min



10 Hz

Stability judgment : typical, not too bad . . .

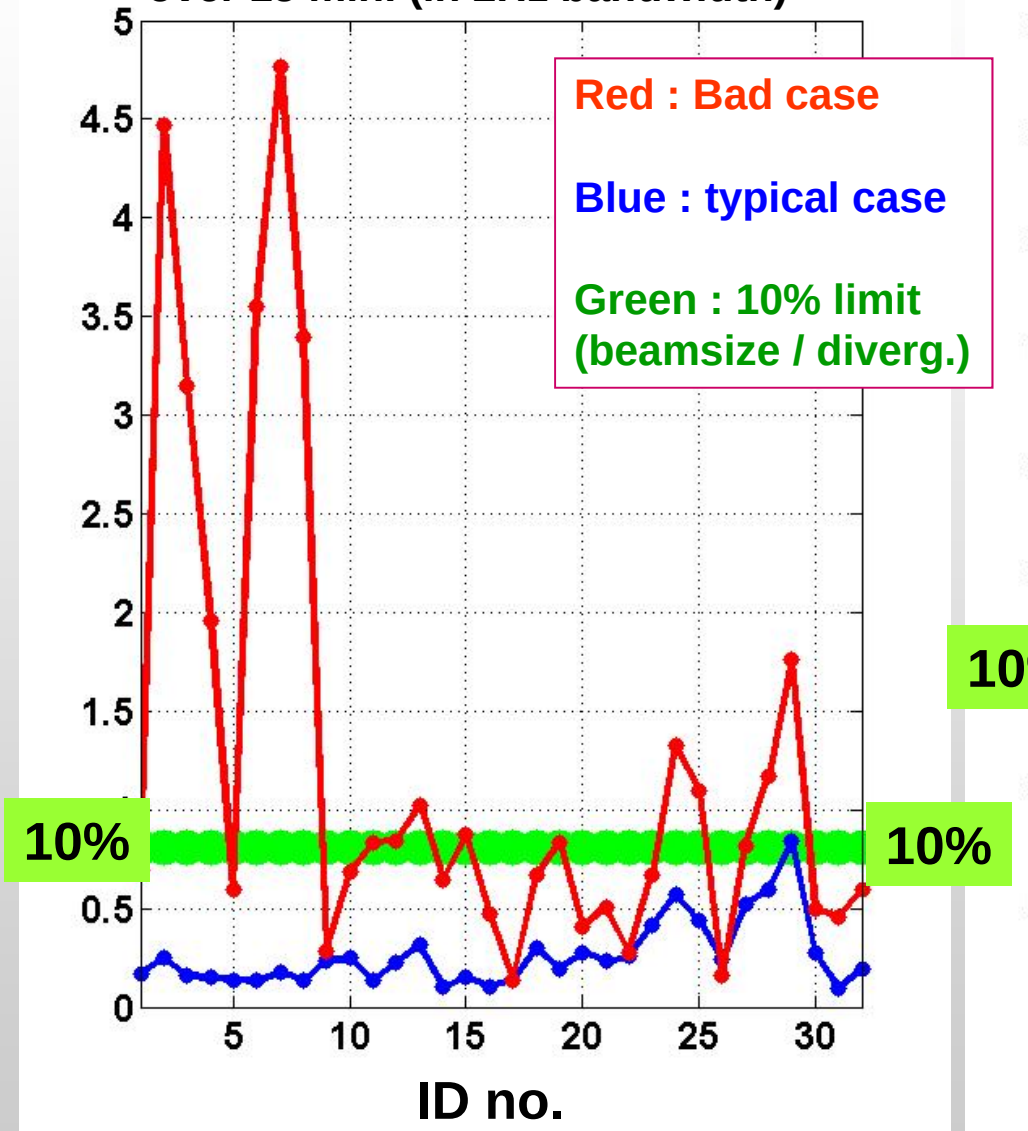
Stability in an intermediate time domain, 0.5sec to 15min



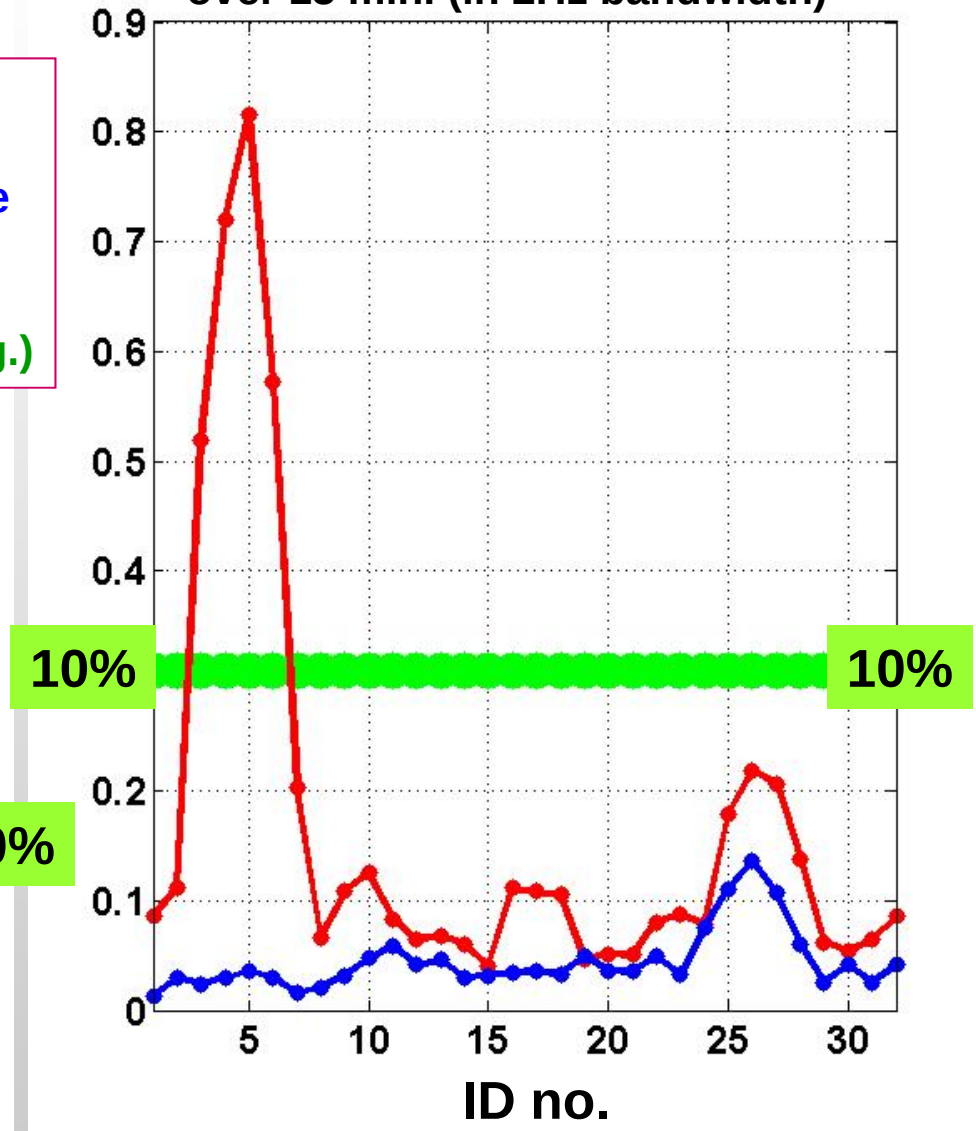
10 Hz

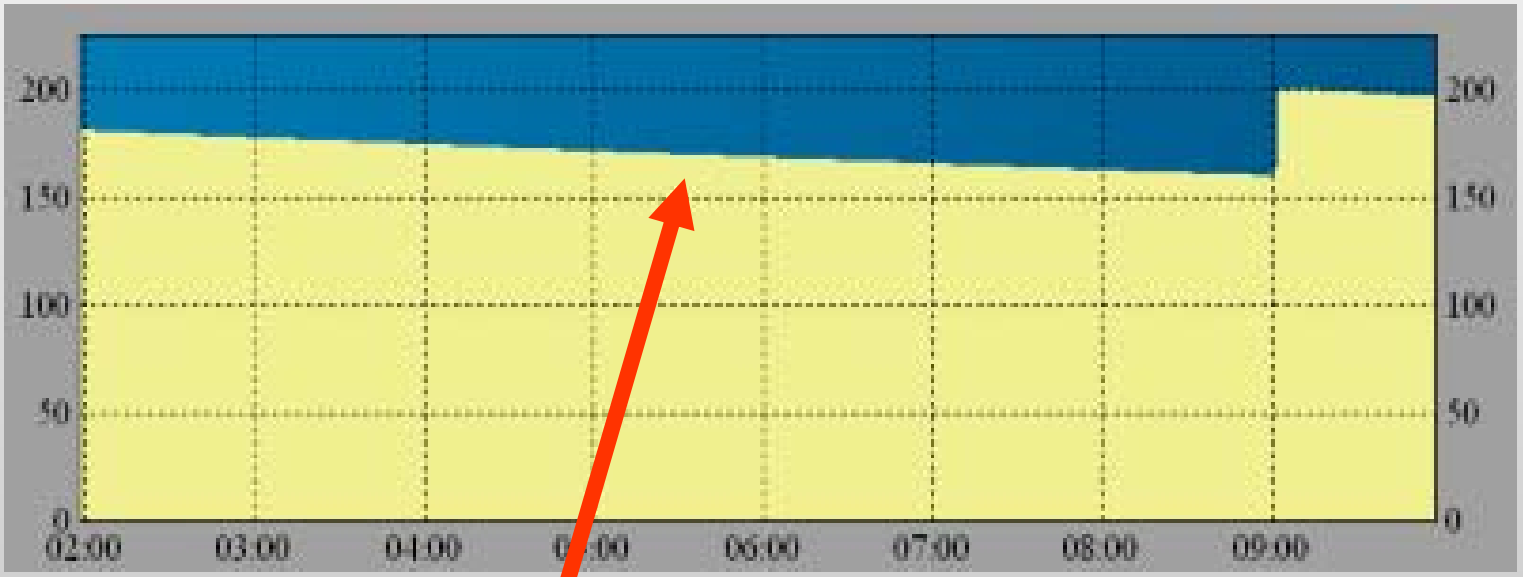
Stability judgment : BAD

IDs Vert. position stability [um rms] over 15 min. (in 2Hz bandwidth)

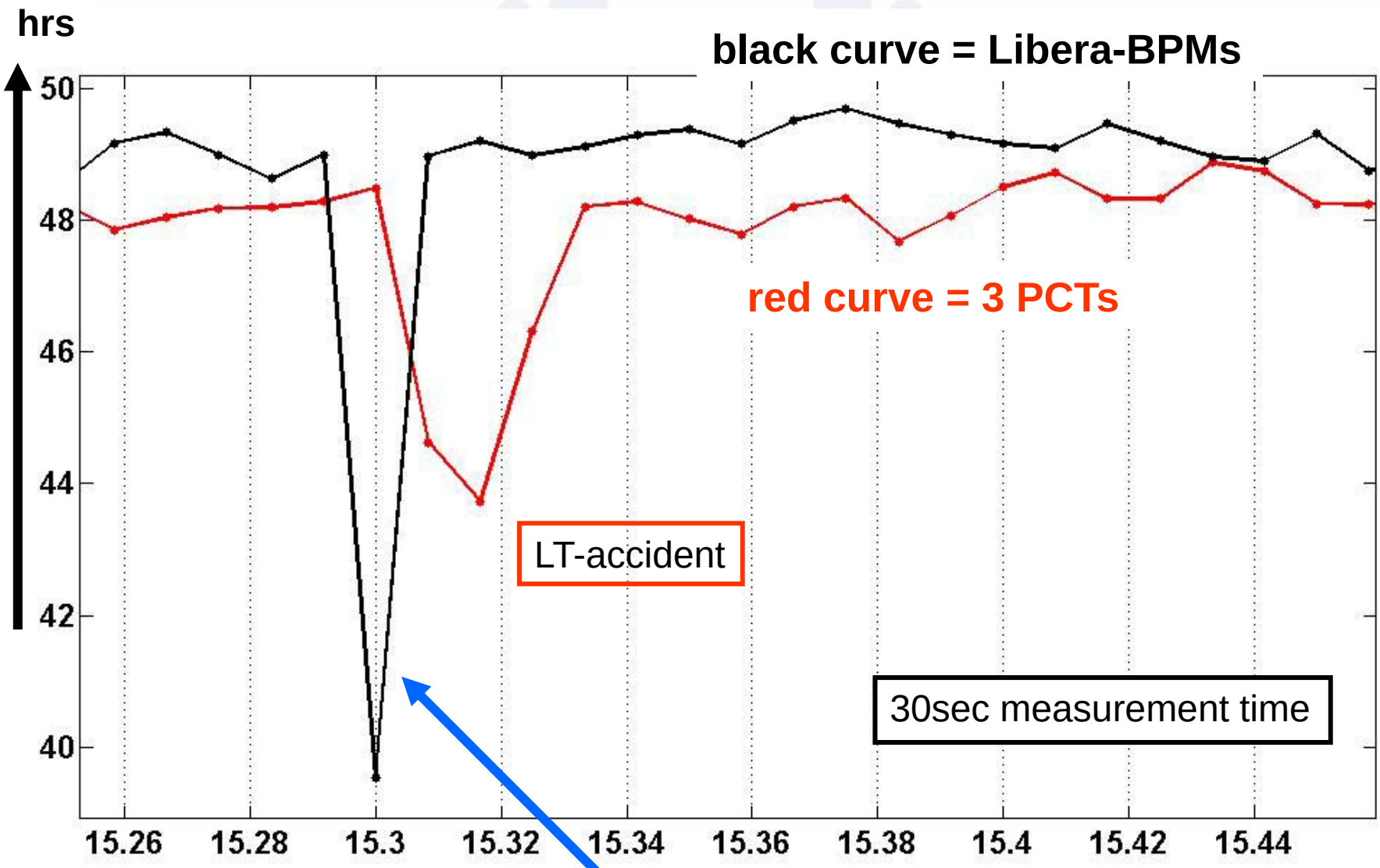


IDs Vert. angle stability [urad rms] over 15 min. (in 2Hz bandwidth)



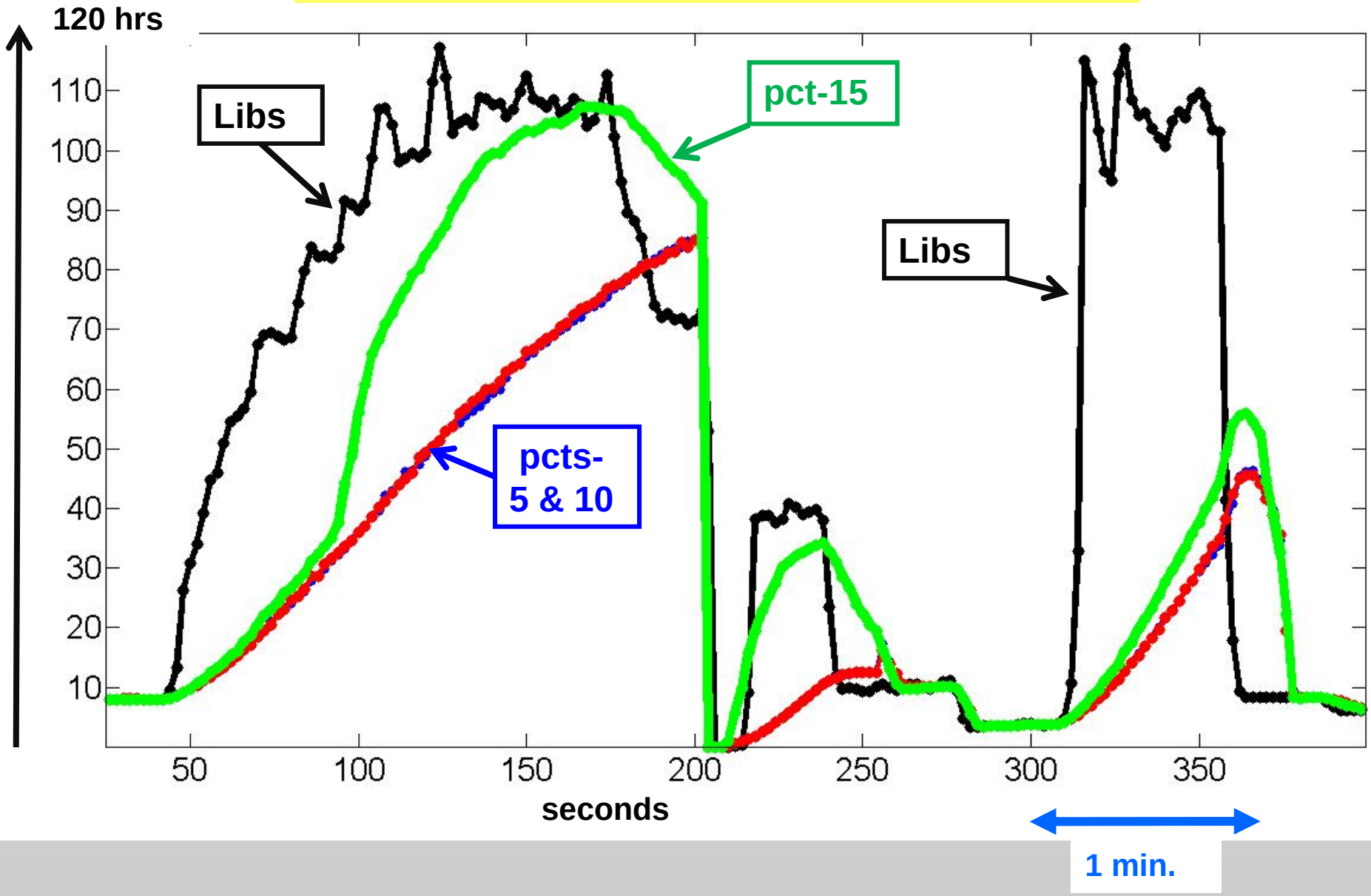


Lifetime is this slope

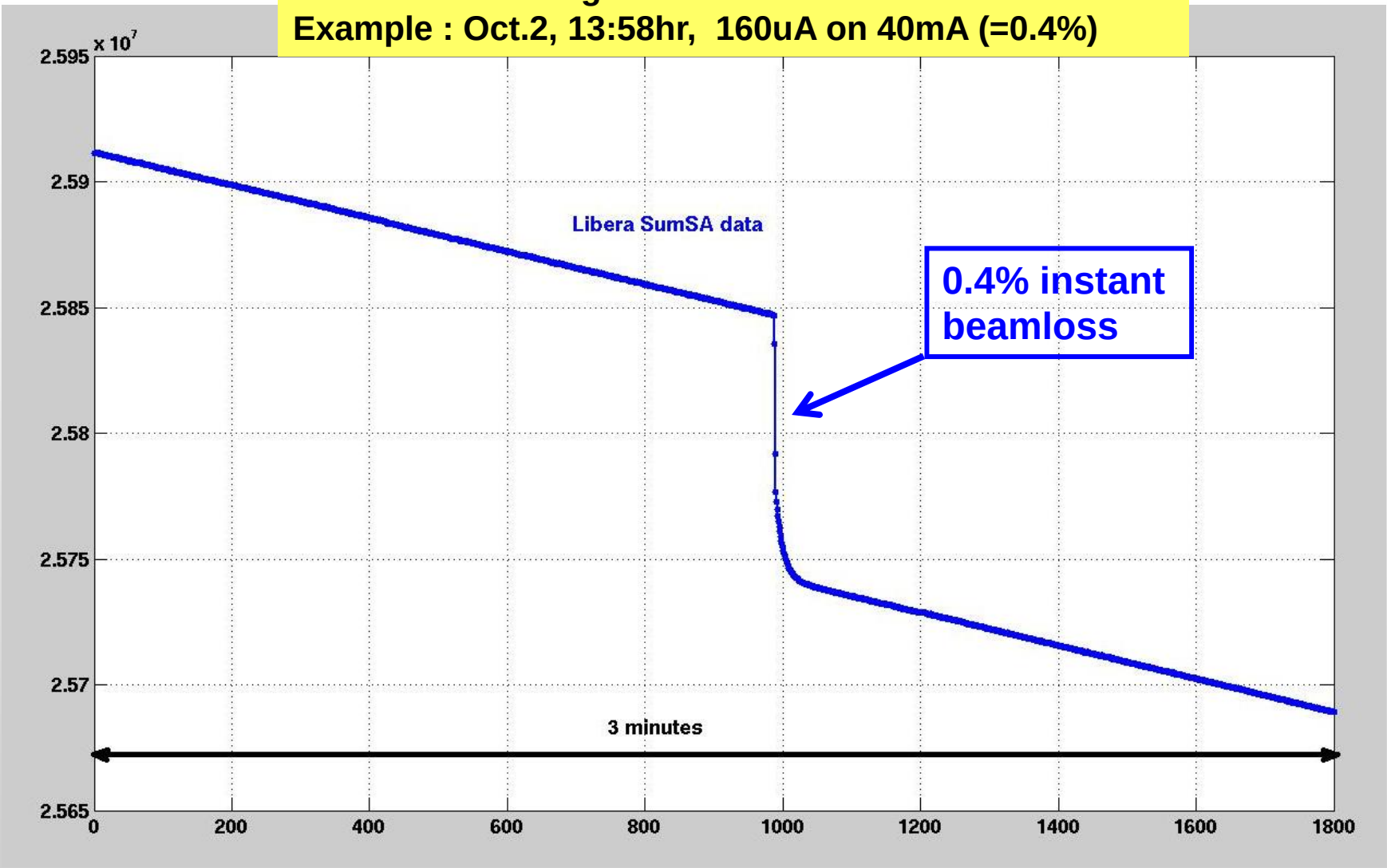


Conclusion : Liberas are faster

Lifetime measurements during special studies : response times of 3 PCTs and the Liberas



Use of the SUM signal : Instant-Partial-Beam-Losses
Example : Oct.2, 13:58hr, 160uA on 40mA (=0.4%)



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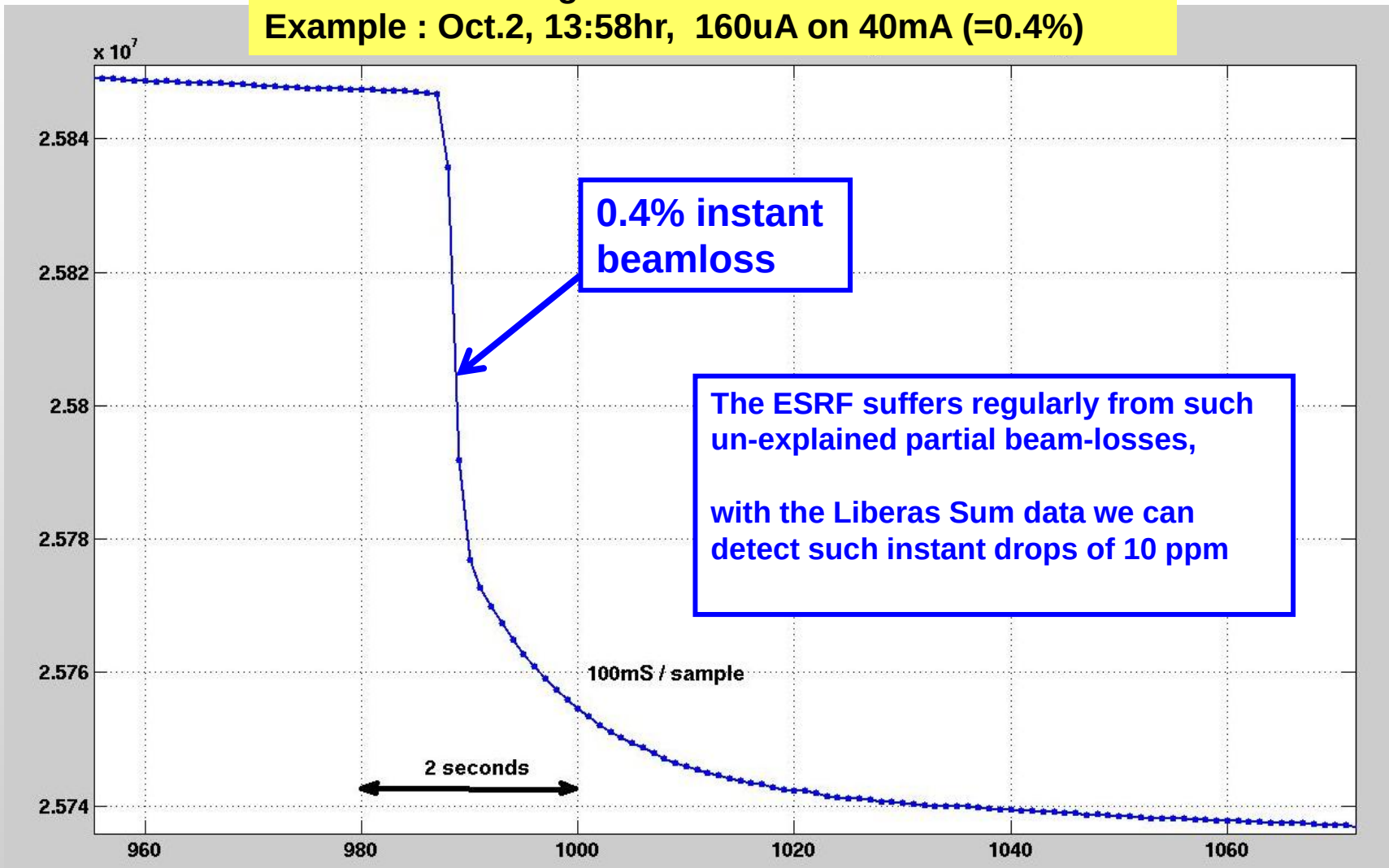
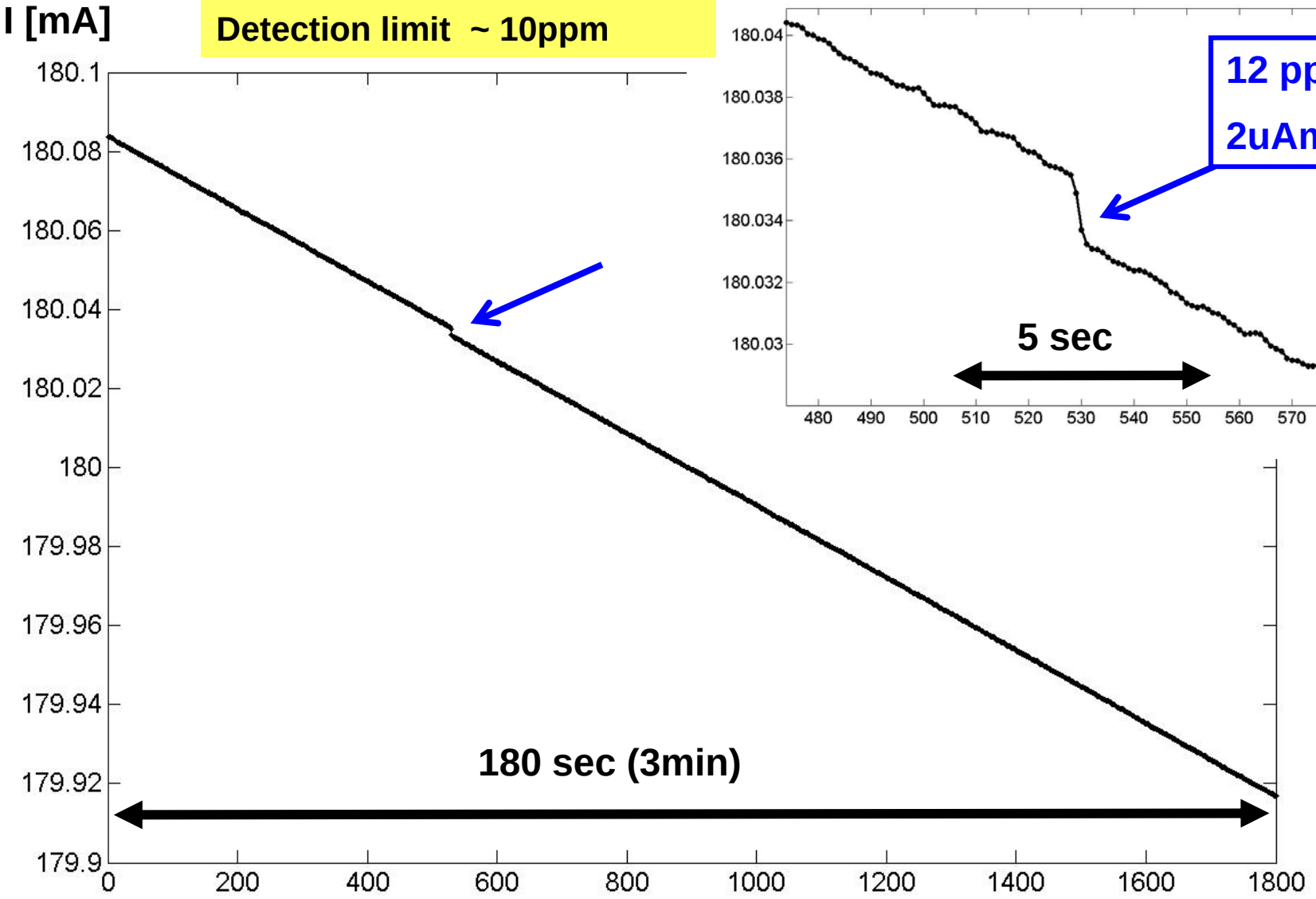
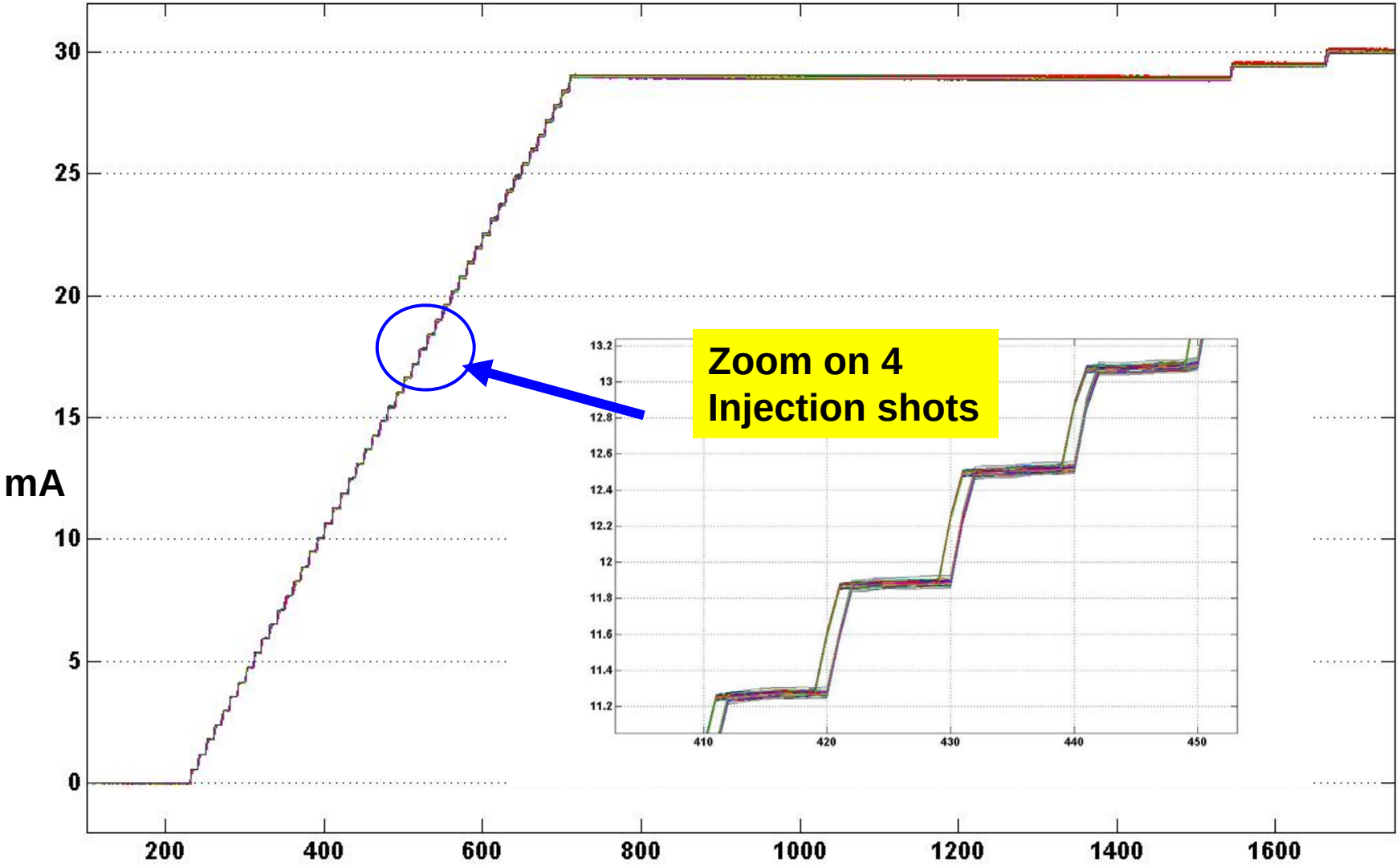


Instant-Partial-Beam-Losses

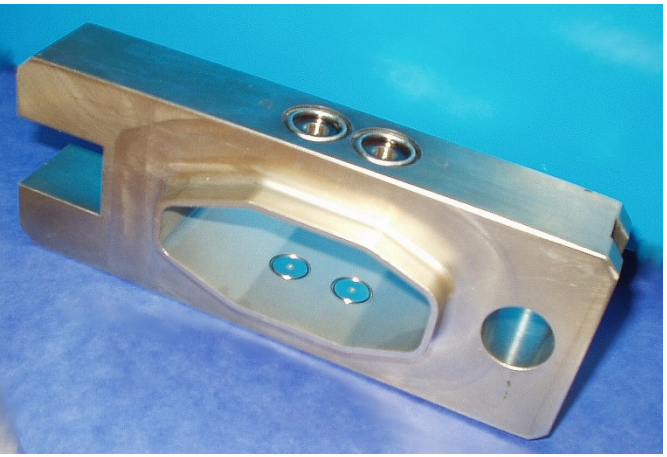
Detection limit ~ 10ppm

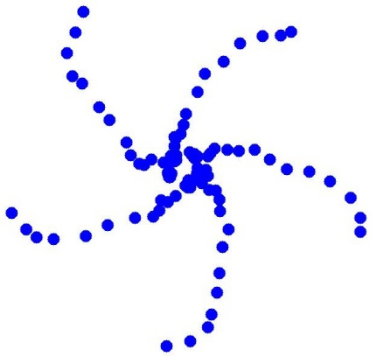


Added Current [mA] , derived from Sum of 4 buttons



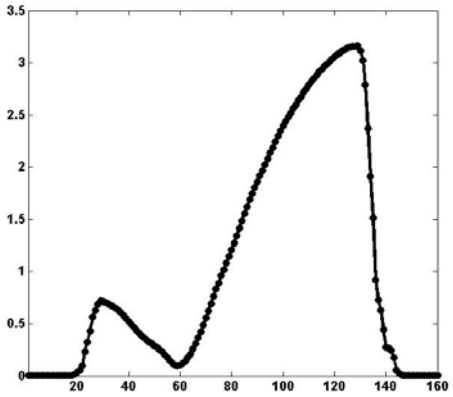
Increased Performance and Functionality of the Libera BPMs in the ESRF Storage Ring

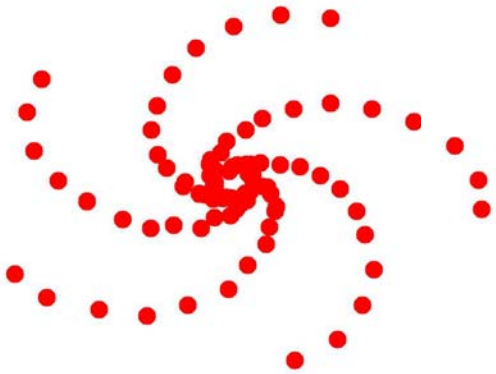




many thanks

for your attention





2 uAmp !!