DEELS-2017

Upgrade of BPMs and SRMs for the ALBA Booster to Storage Ring transfer line.

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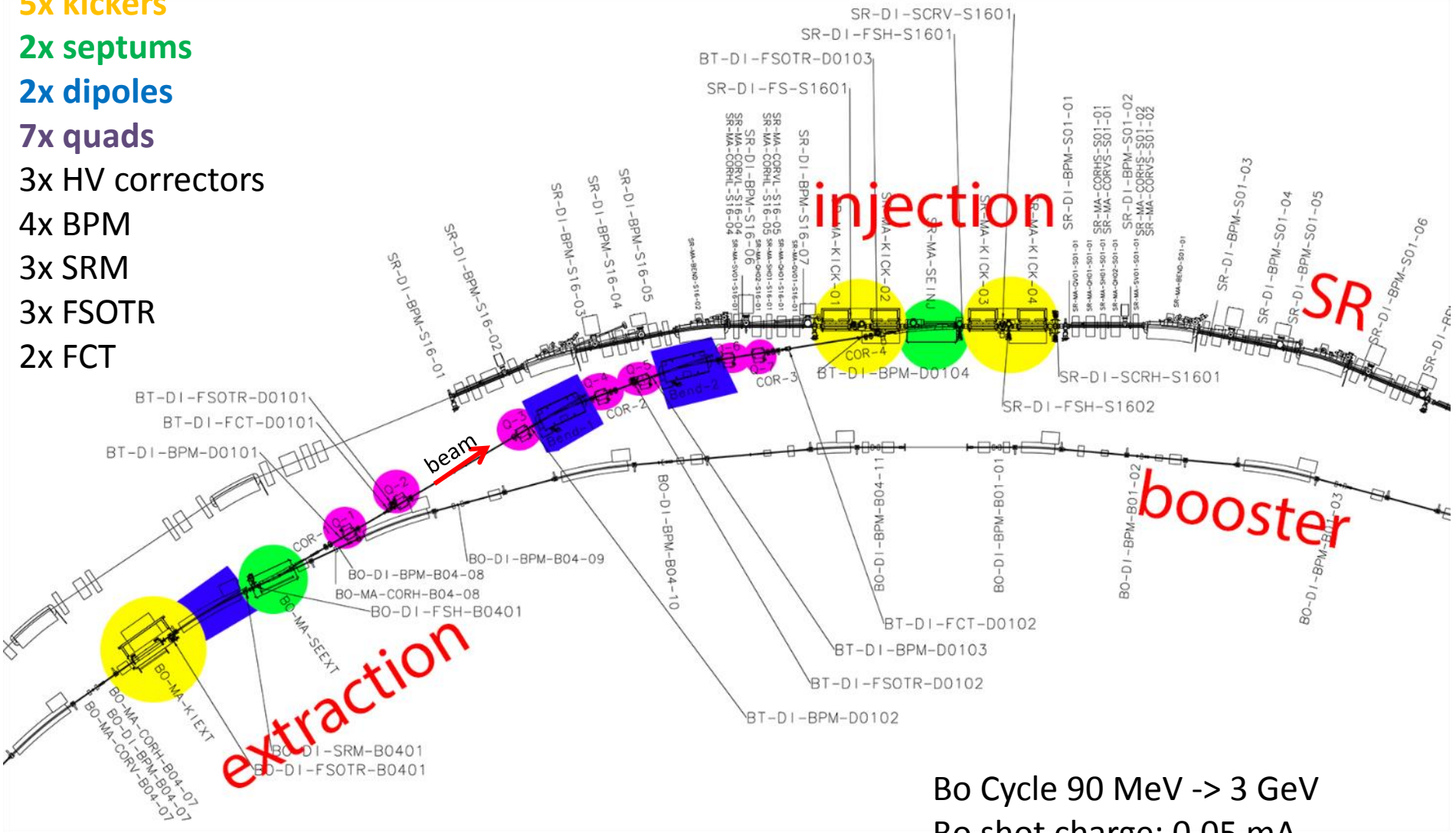
in collaboration with : G. Benedetti, M. Alvarez, U. Iriso, X. Rodriguez

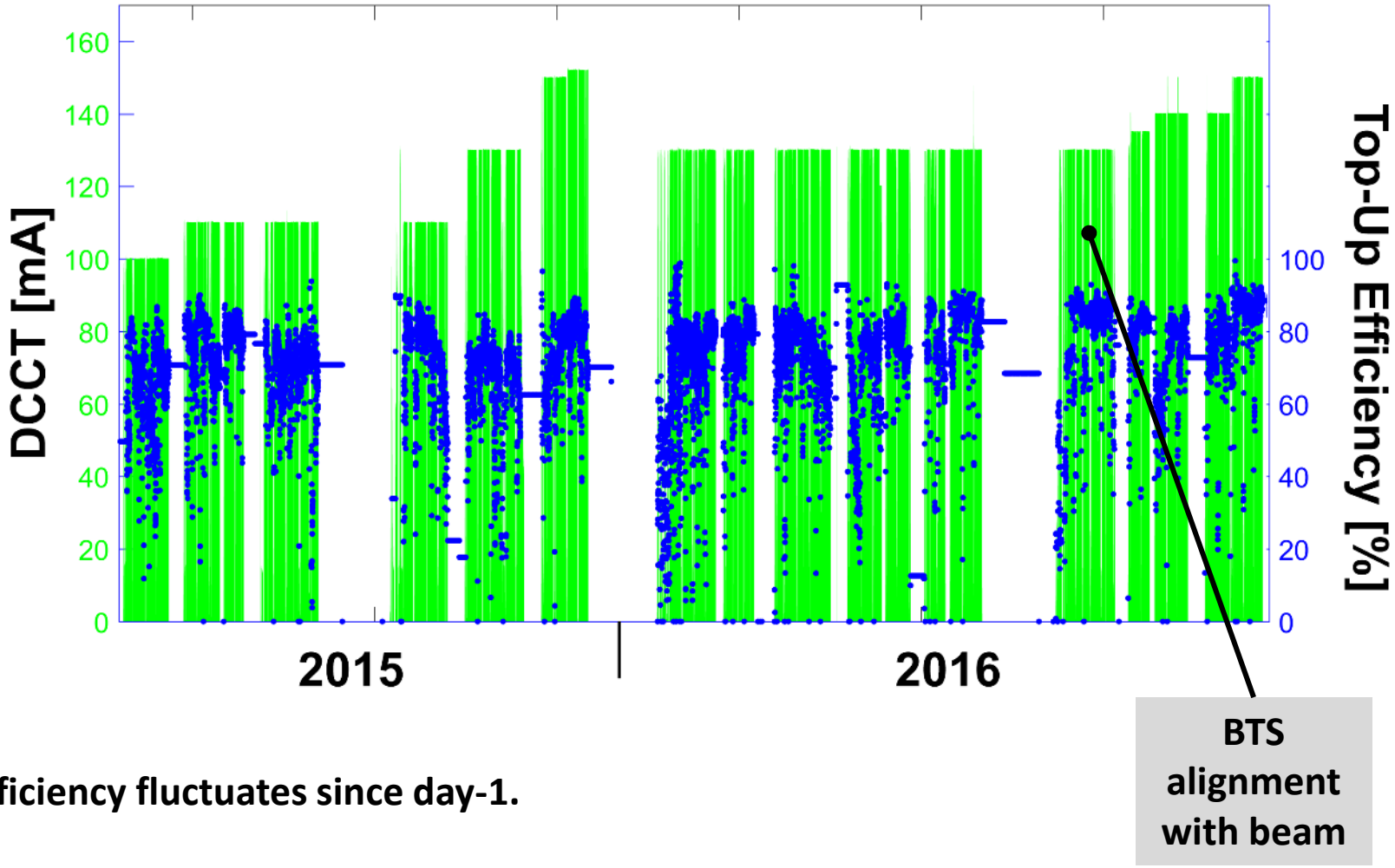
Booster to Storage (BTS) transfer line of ALBA:

5x kickers
2x septums
2x dipoles
7x quads
3x HV correctors
4x BPM
3x SRM
3x FSOTR
2x FCT



Bo Cycle 90 MeV -> 3 GeV
Bo shot charge: 0.05 mA
Linac charge: 0.2 nC
3Hz shots from Linac

BTS historical transfer efficiency



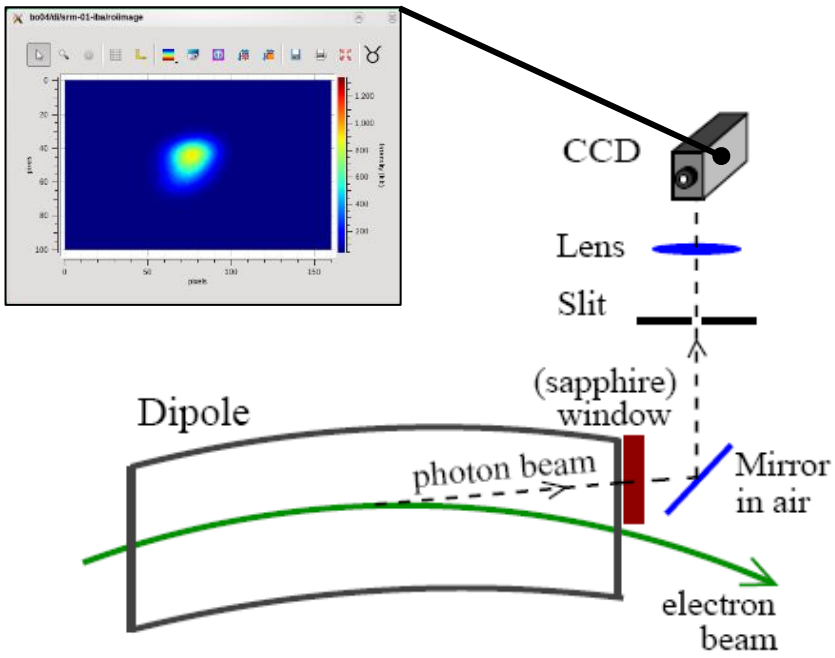
Efficiency fluctuates since day-1.

The aims of recent BTS diagnostics updates are to improve the efficiency and reduce MTTR (mean time to recover).

BTS Synchrotron Radiation Monitors

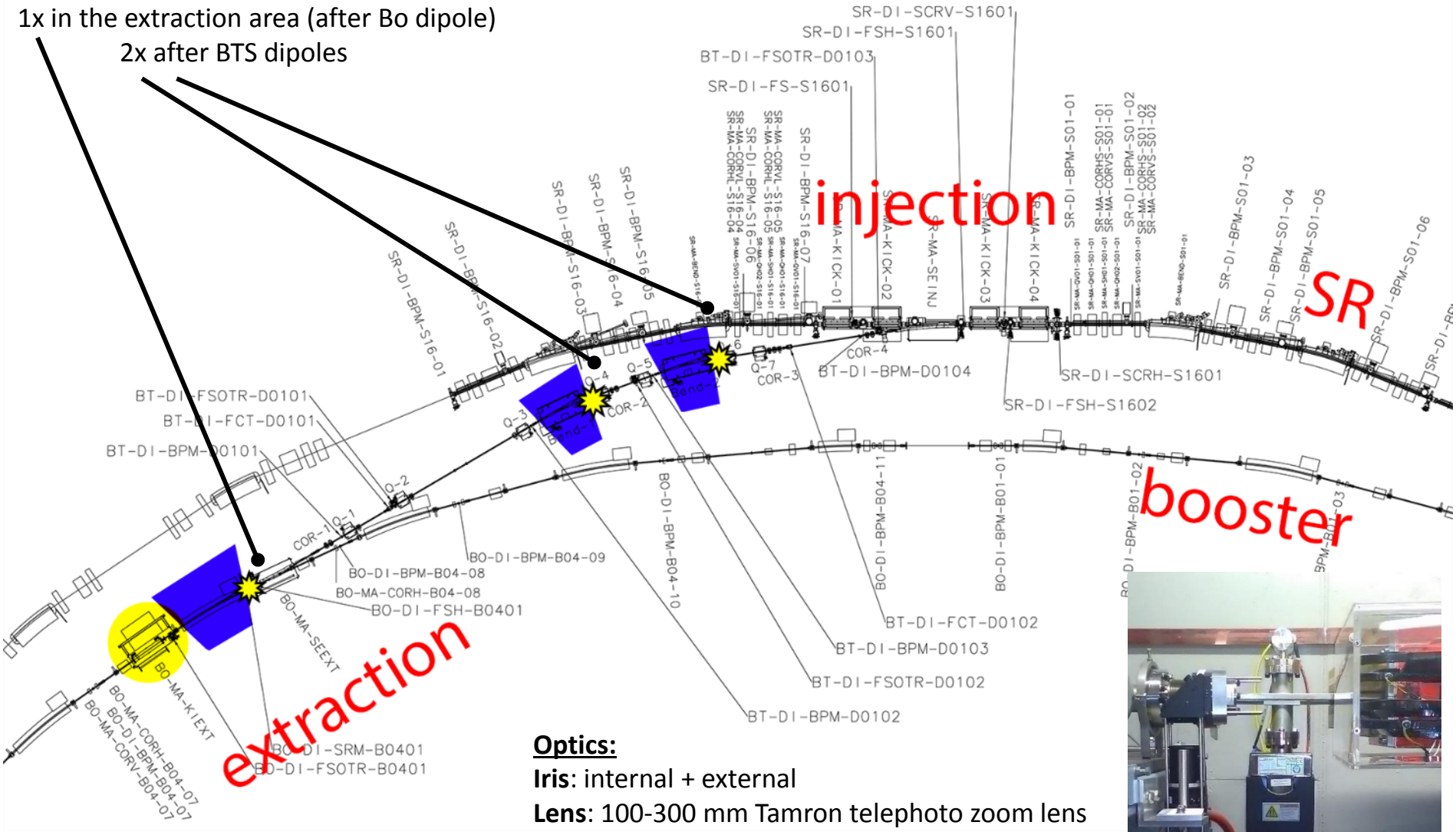
Uses the synchrotron radiation produced when the e-beam traverses a bending magnet.
The visible light is guided away from SR path by a 45^0 mirror into the CCD optics, producing a transverse beam profile image in real-time.

Non-destructive diagnostic. Due to angular nature of synchrotron radiation, image is diffraction limited; however, this is not a big issue in the BTS line.



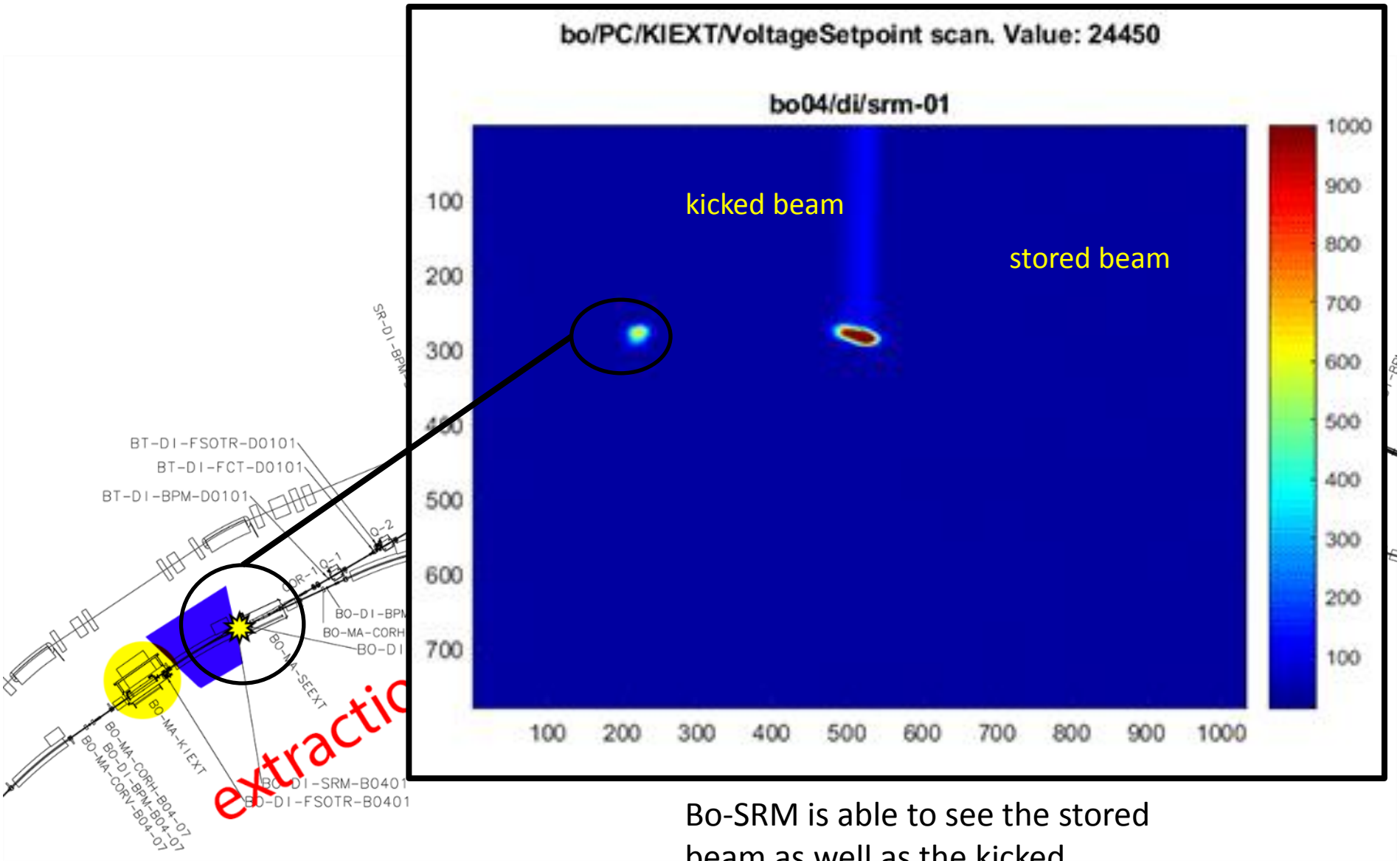
BTS SRMs:

3 locations :
1x in the extraction area (after Bo dipole)
2x after BTS dipoles



Optics:
Iris: internal + external
Lens: 100-300 mm Tamron telephoto zoom lens
CCD: Basler Scout (scA1300-32gm)
Exposure: 20 ms
Source point: 1.5 m (dipole center)

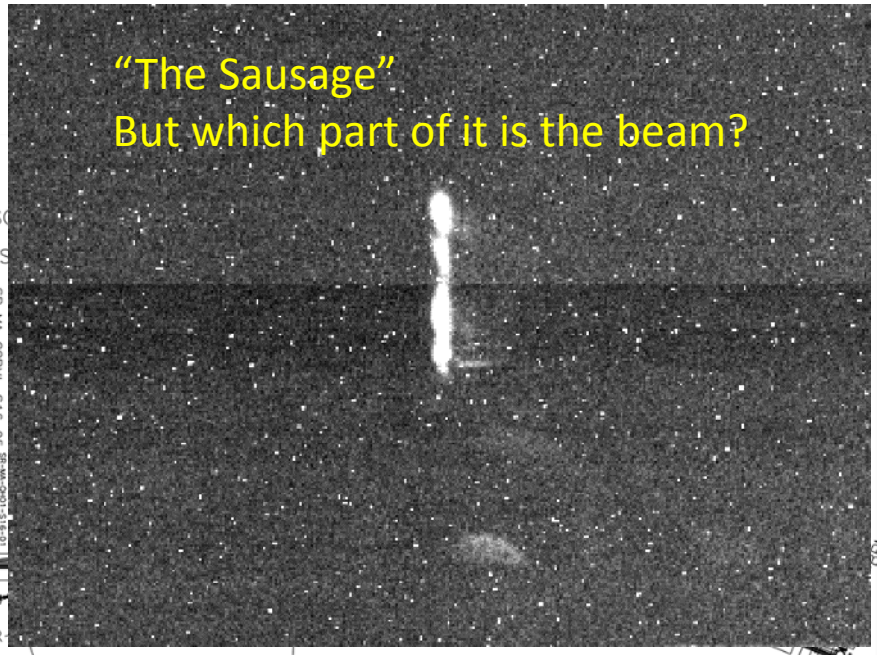
Booster SRM:



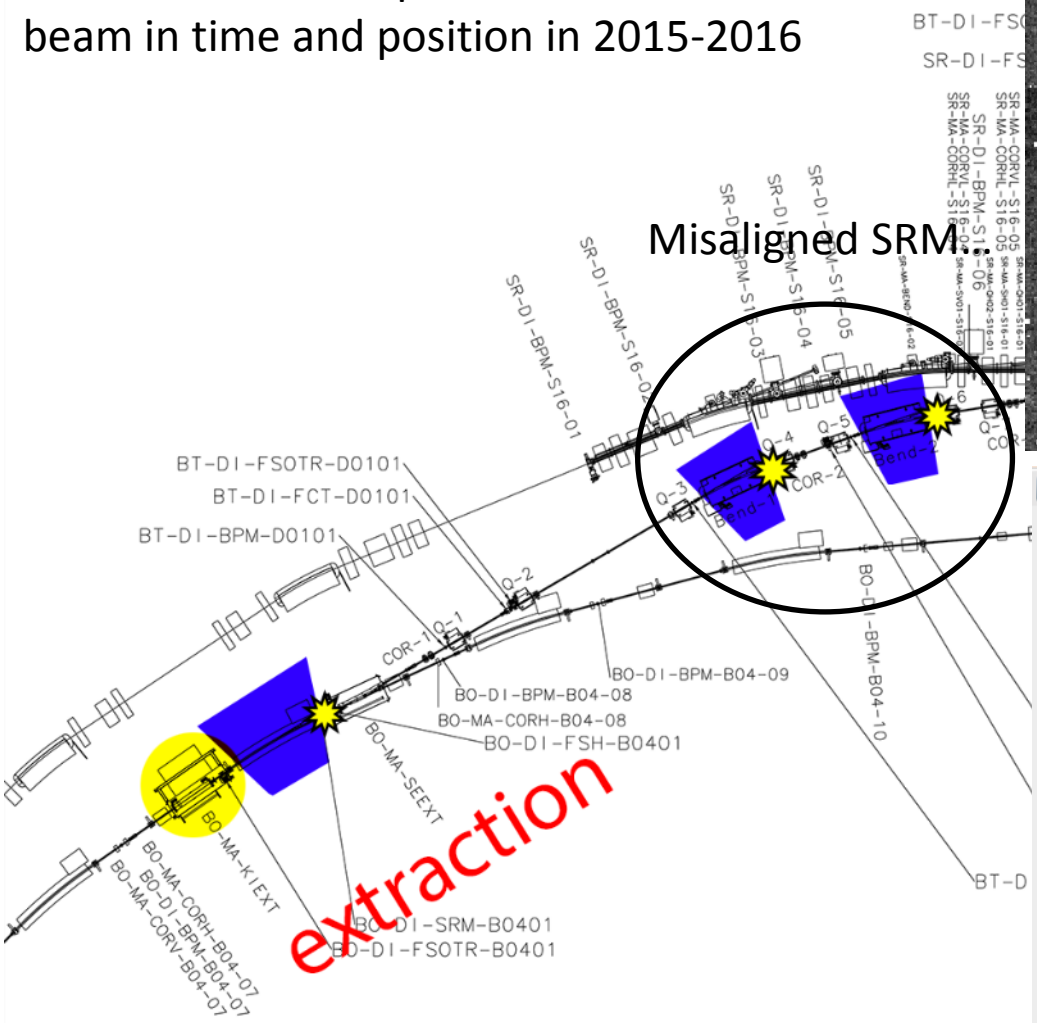
Bo-SRM is able to see the stored beam as well as the kicked

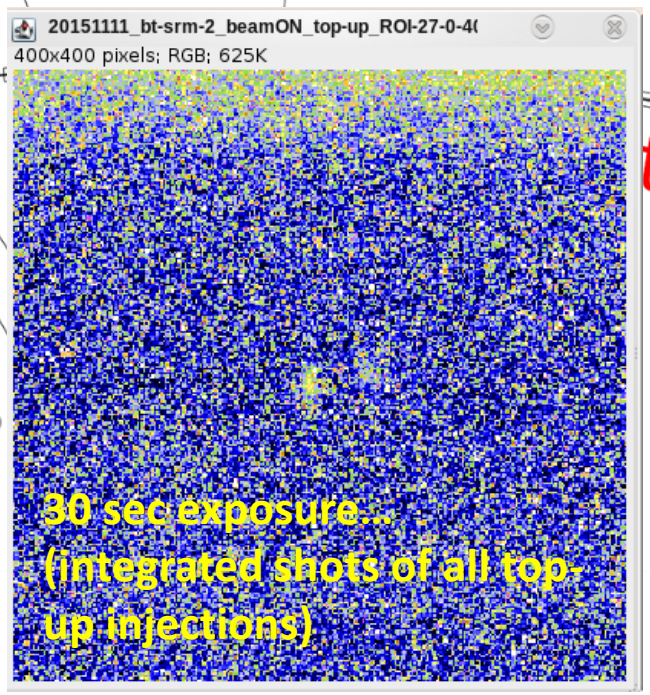
Transfer line SRMs:

unsuccessful attempts to catch the SR beam in time and position in 2015-2016



Misaligned SRM…

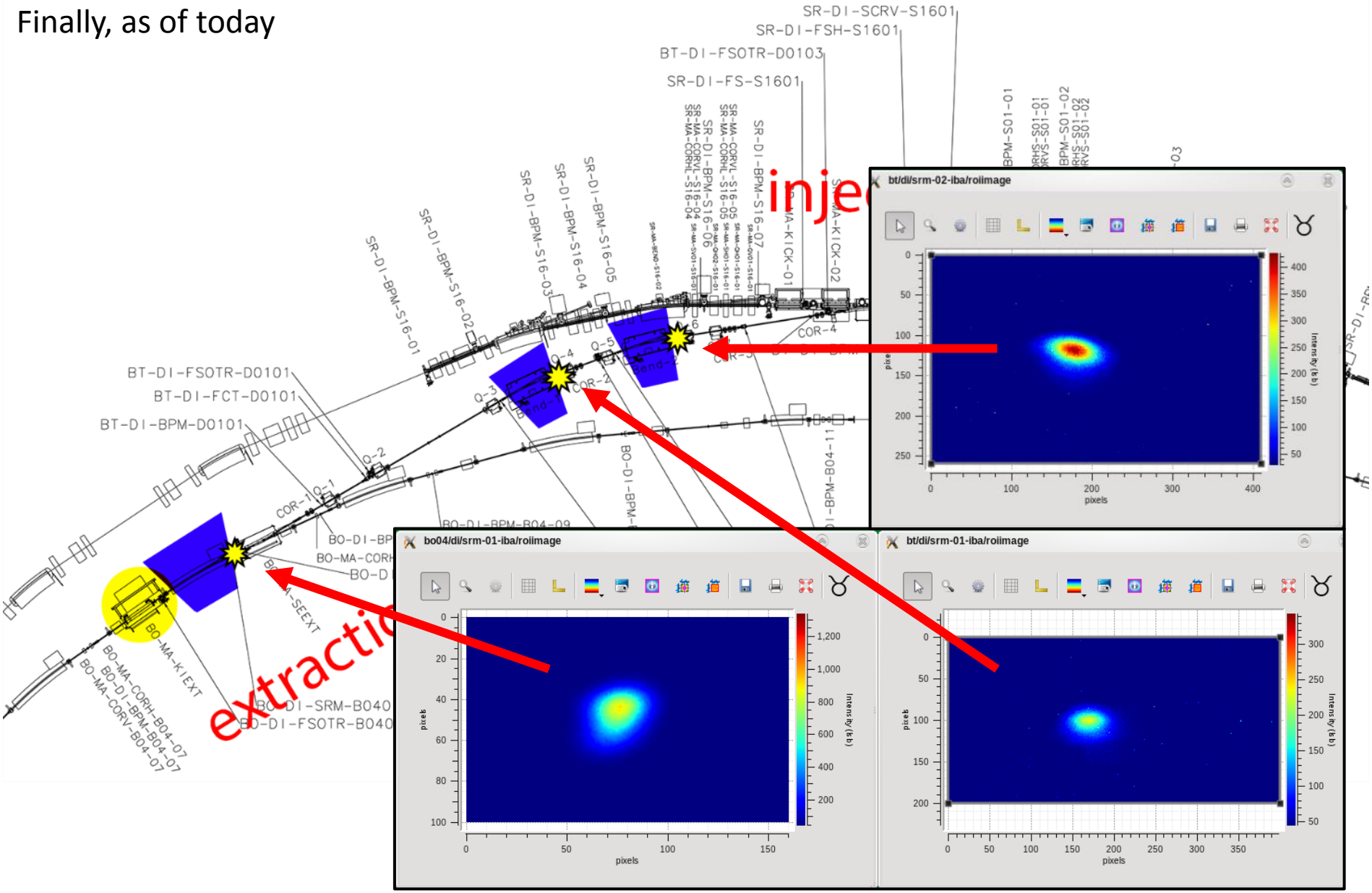




Internal iris closed…

BTS SRMs:

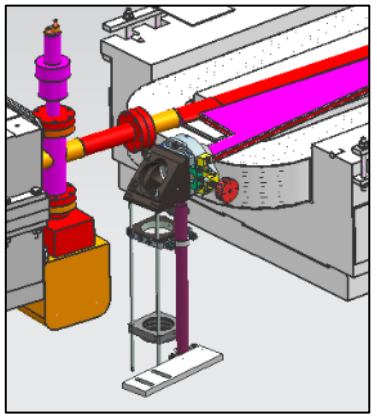
Finally, as of today



BTS SRM improvements:

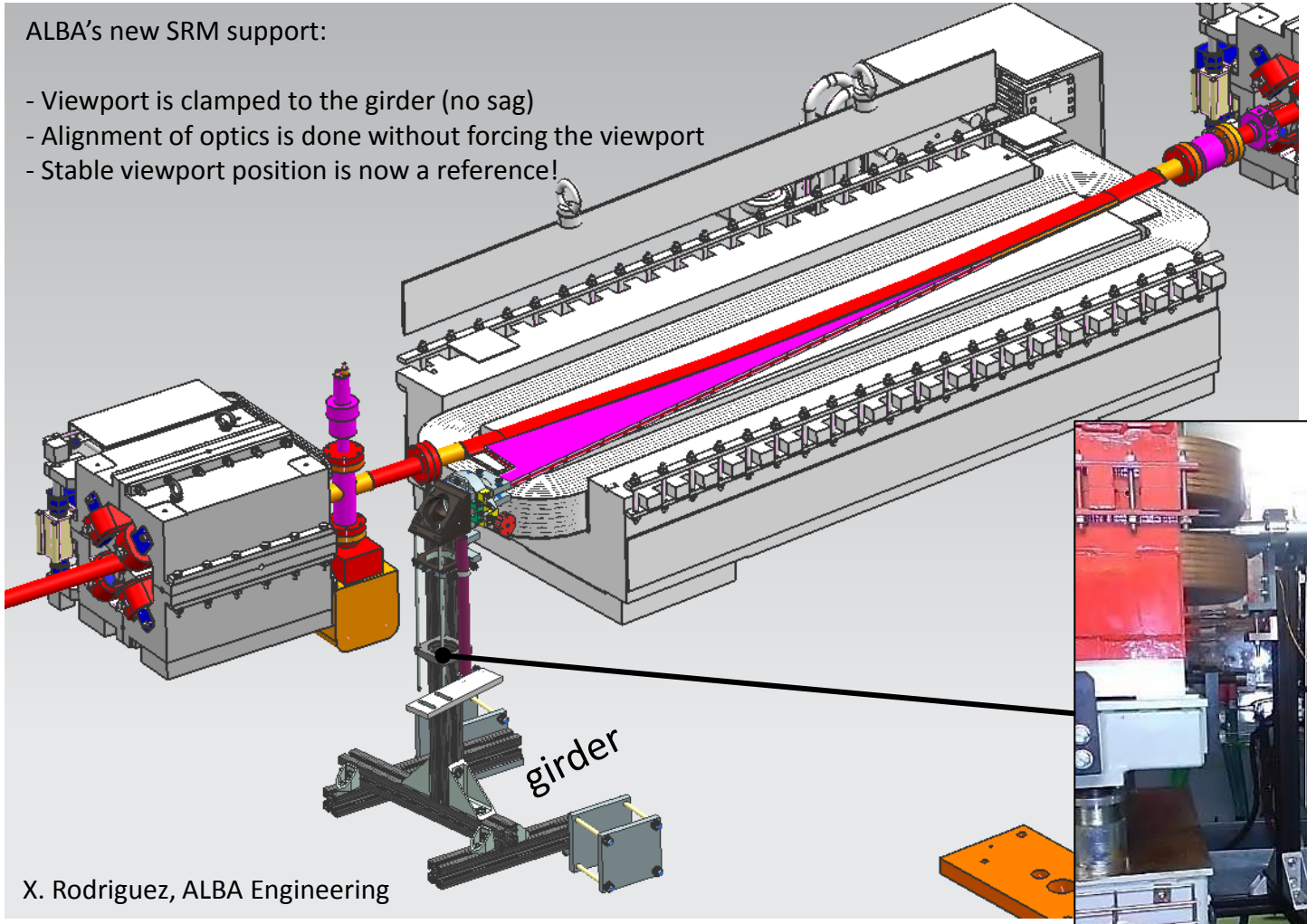
1. mechanical stability

Initial design



ALBA's new SRM support:

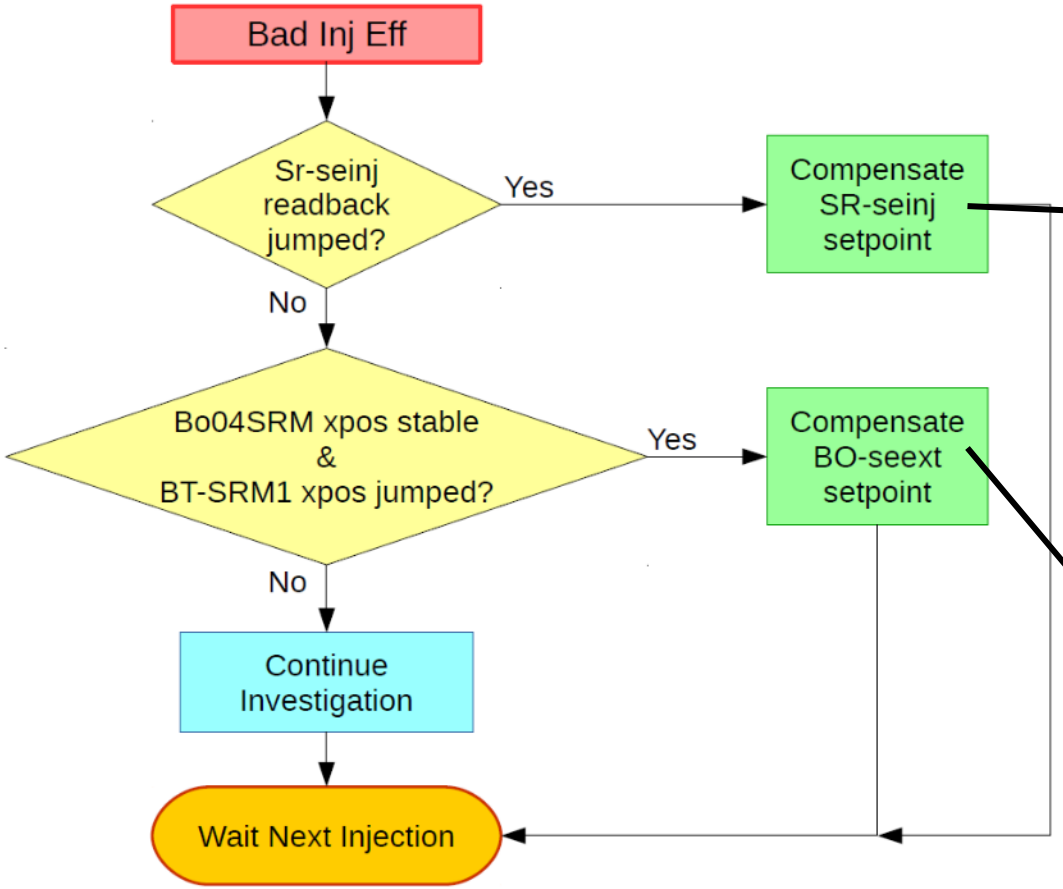
- Viewport is clamped to the girder (no sag)
- Alignment of optics is done without forcing the viewport
- Stable viewport position is now a reference!

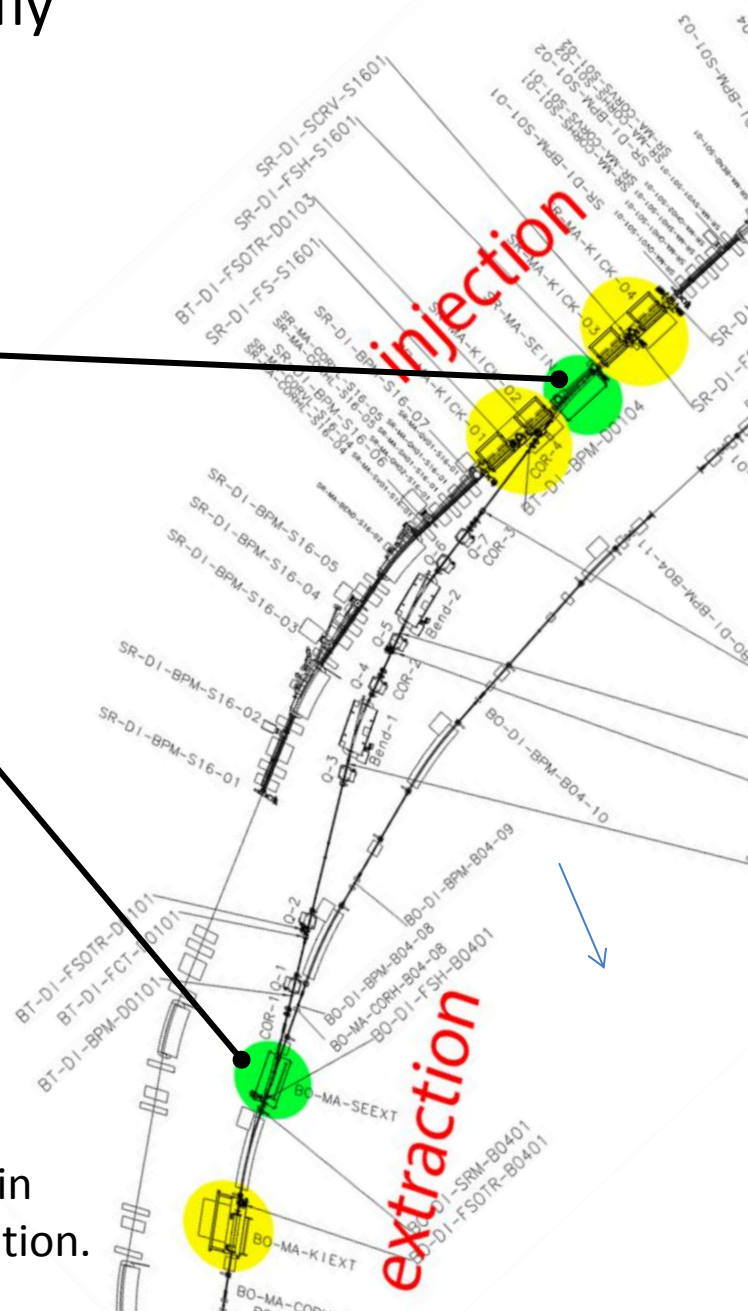


X. Rodriguez, ALBA Engineering

BTS SRM improvements:

2. “Bad top-up efficiency” diagnostic on the fly

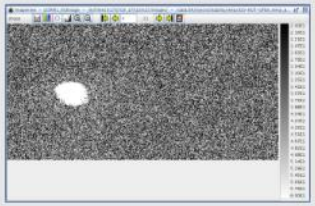




After the “Bad Efficiency” alarm sounds, an operator can (in most cases) quickly narrow down the problem and its solution.

BTS SRM diagnostics:

Detecting Extraction Septum jumps/drops during top-up operation.

	16h53	17h13	17h53
Bo2Sr eff (%)	88	64	87
BO-seext (Vsp)	425	425	424
BT-SRM-1 Xpos (mm)	10.9	9.0	10.7
BT-SRM-1 ROI img			

Example 1:

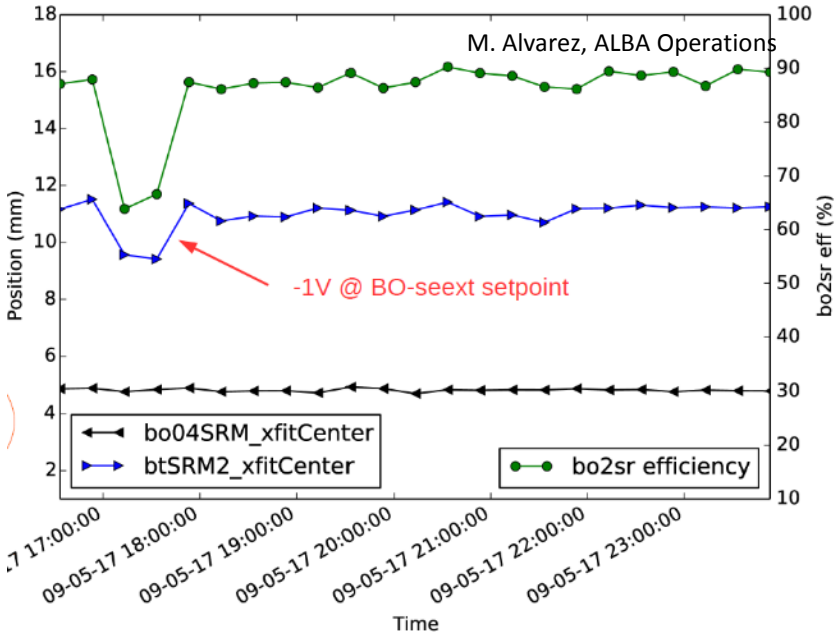
What happened: suddenly the nominal beam spot position in the BT-SRM1 has changed by 2 mm.

Reaction: an operator quickly tunes the extraction septum setpoint.

Why the septum? Flat signal in Bo-SRM (black curve) => it wasn't the Extraction kicker's fault. it was the Extraction Septum!

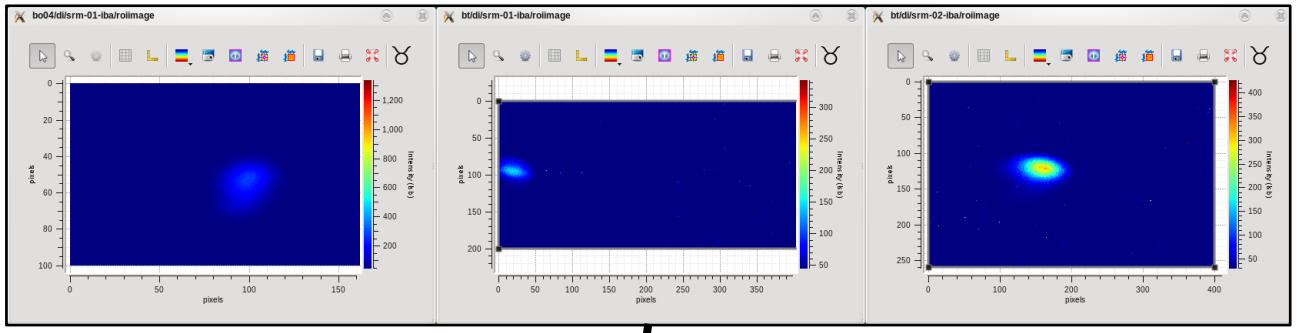
Why SRM diagnostic helps in this case? We have no readback from scope for the SEEXT, so SRM is the only fast diagnostic tool for this.

The septum jumps repeat 2-3 times a week, so the real-time SRM screens are very useful to improve the MTTR (in 1-2 top-up injections).



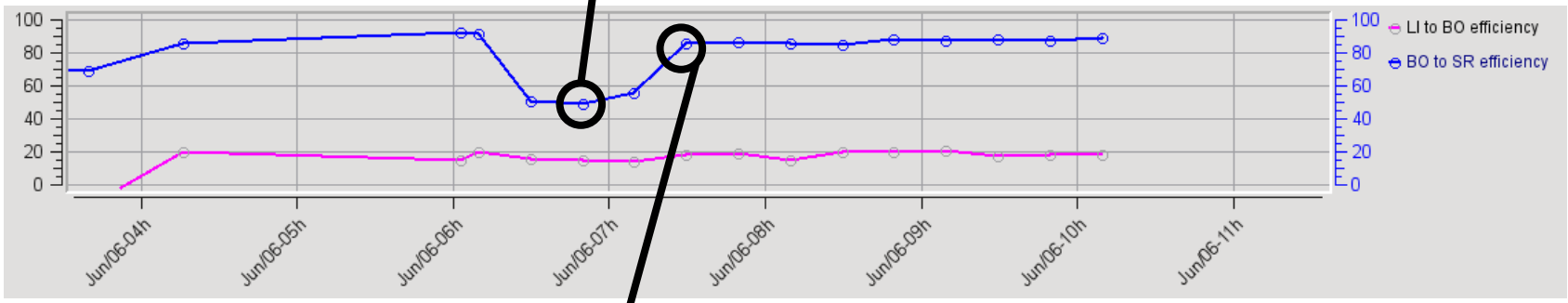
BTS SRM diagnostics:

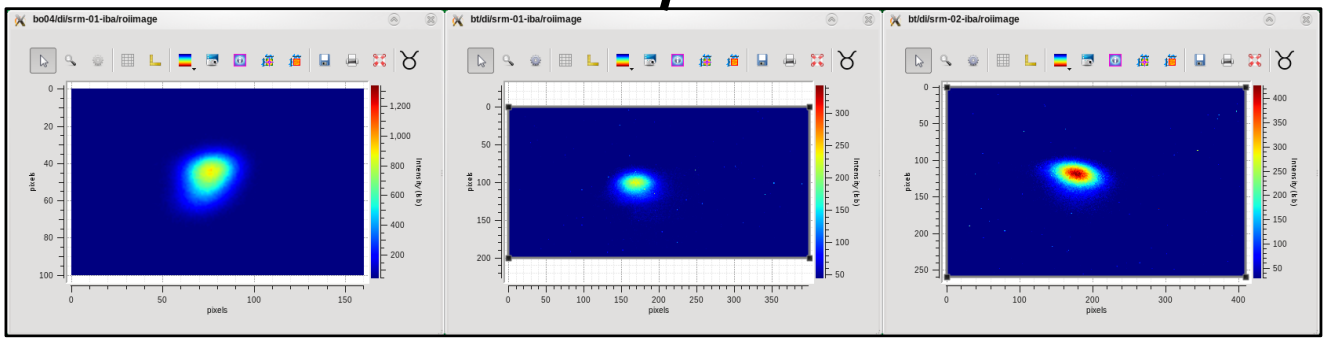
Wrong setpoints during machine startup after shutdown/maintenance



Example 2:

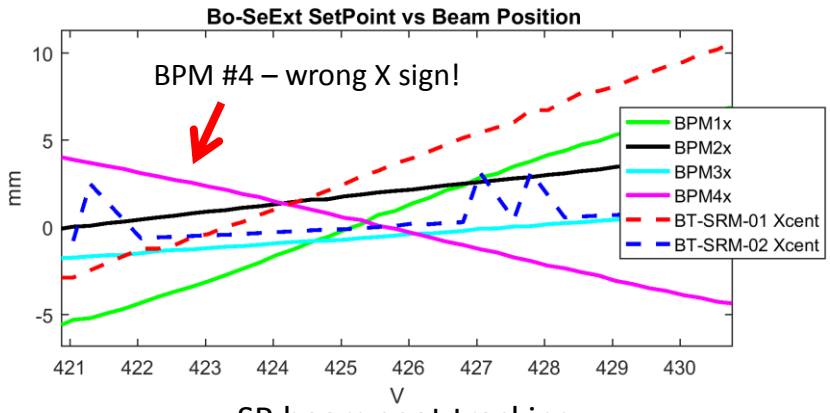
Two test-top-ups before 7 am show low transmission. Again, the BT-SRM1 screen hints on the Extraction Septum.



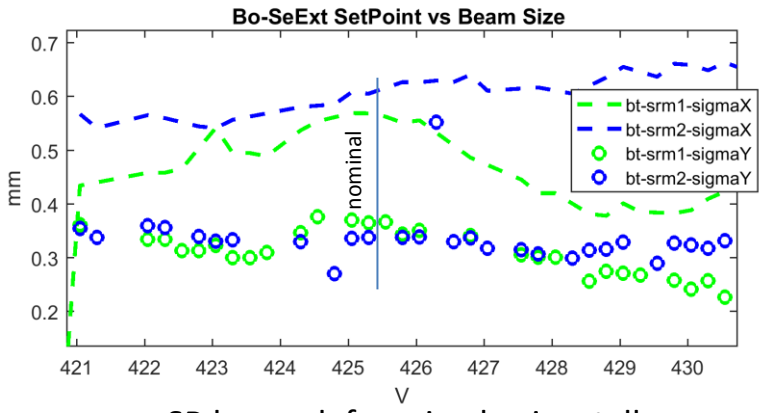


BTS SRM studies

1. SRM vs BPM polarity check while scanning the extraction septum:

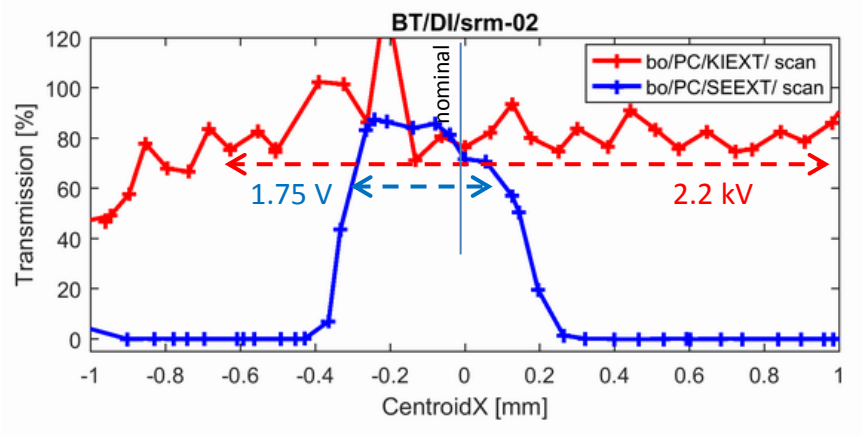


SR beam spot tracking



SR beam defocusing horizontally

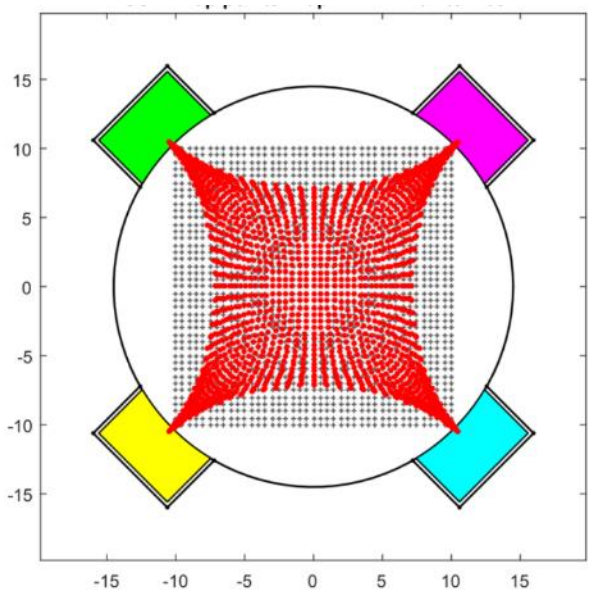
2. Efficiency optimization scans:
estimating effective window of Extraction Kicker & Septum:



This is a “window” scan based only on 1 optical element and fixed settings of others.

“Window” scans for different lattice setpoints could provide a more flexible transmission tuning.

BTS Beam Position Monitors



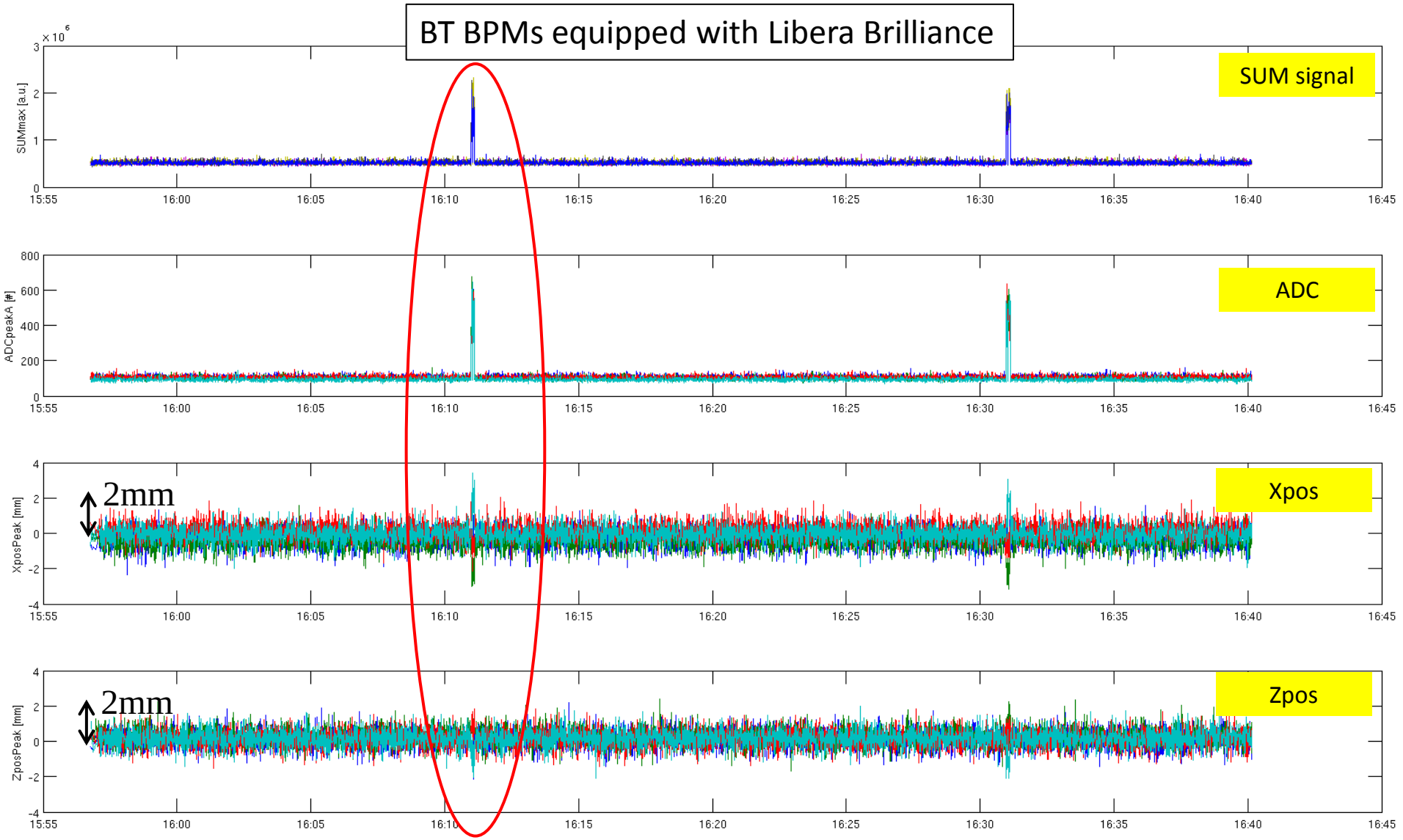
injection

beam

extraction

SR-DI-BPM-S16-01
SR-DI-BPM-S16-02
SR-DI-BPM-S16-03
SR-DI-BPM-S16-04
SR-DI-BPM-S16-05
R-DI-BPM-S16-07
SR-MA-KICK-01
SR-MA-KICK-02
SR-MA-KICK-03
SR-MA-KICK-04
SR-MA-SEINJ
BT-DI-BPM-D0104
BT-DI-FSOTR-D0101
BT-DI-FCT-D0101
BT-DI-BPM-D0101
BO-DI-BPM-B04-08
BO-MA-CORH-B04-08
BO-DI-FSH-B0401
BO-MA-SEEXT
BO-DI-BPM-B04-09
BO-DI-BPM-B04-10
BT-DI-BPM-D0102
BT-DI-FSOTR-D0102
BT-DI-BPM-D0103
BT-DI-FCT-D0
BO-DI-BPM-B04-11
BO-DI-BPM-B01-01
Bend-1
Bend-2
Q-2
Q-4
Q-7
COR-2
COR-3
BO-MA-KIEXT
BO-DI-SRM-B0401
BO-DI-FSOTR-B0401

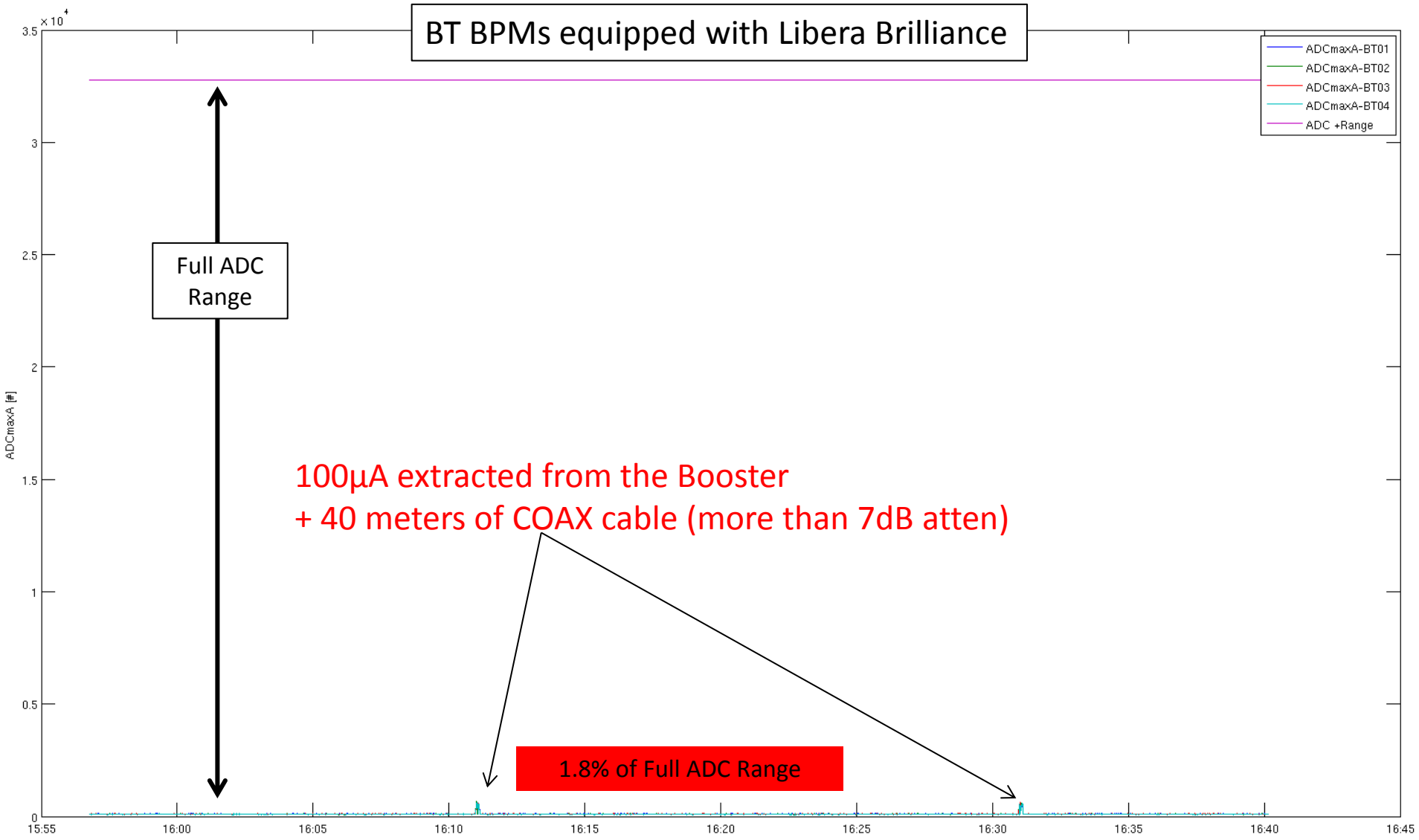
Position resolution on BT BPMs



Position resolution on BT BPMs

mm Position fluctuations @ 0dB input attenuation !!!

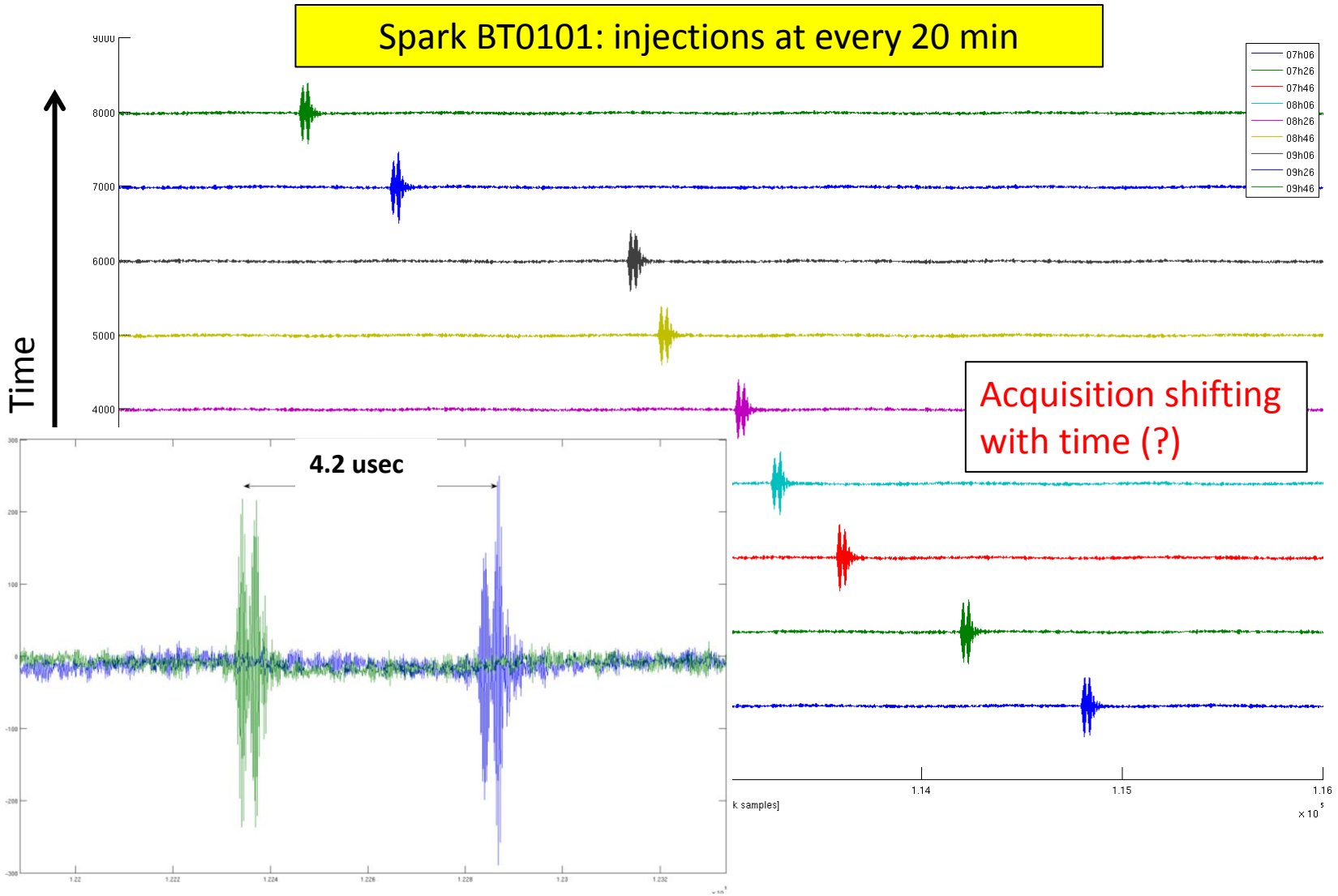
Position resolution on BT BPMs



Let’s give a try to Single Pass electronics (Libera Spark EL)

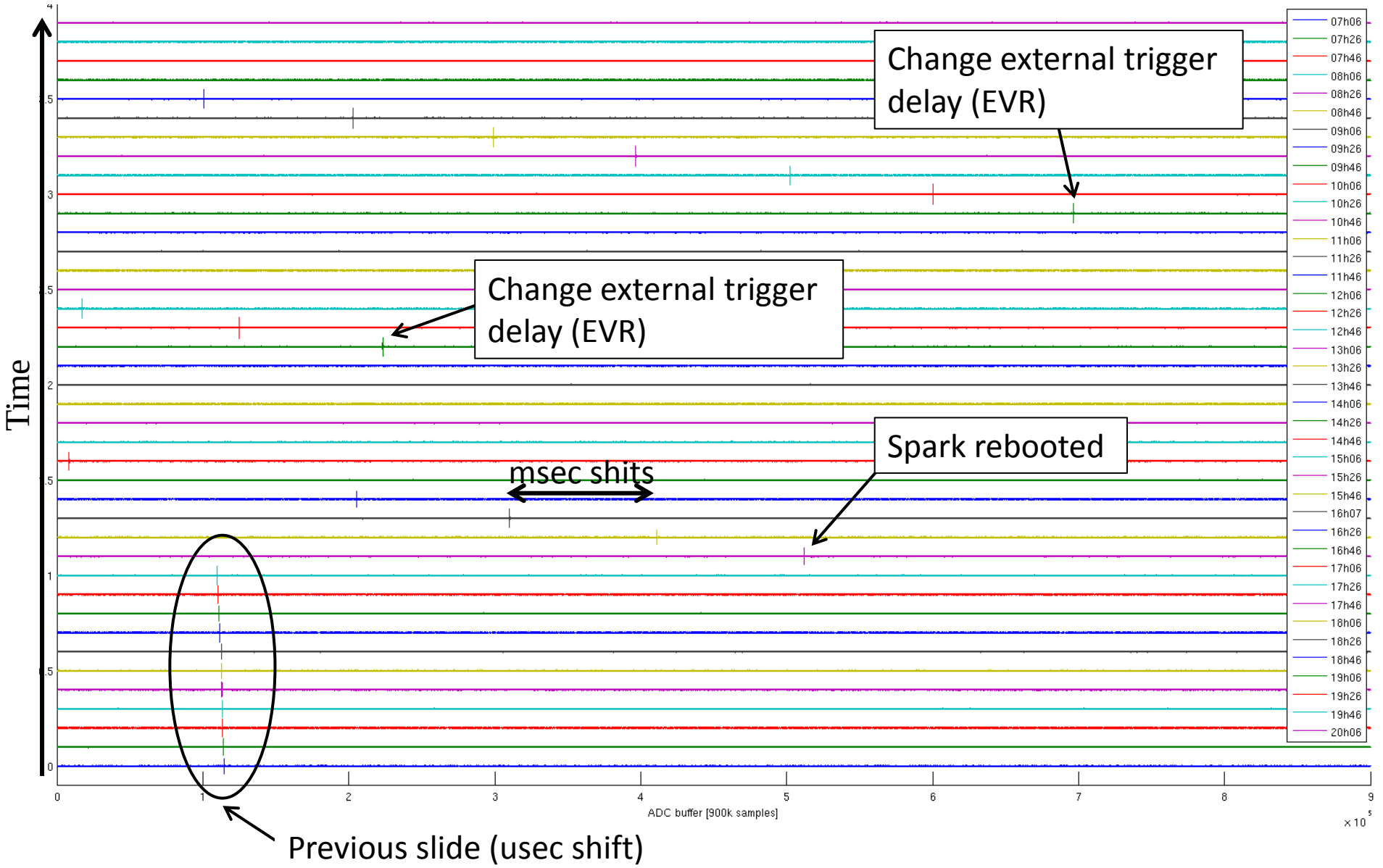
Sync Problem on Libera Spark

- New Spark installed in BT0101 while other BT BPMs kept with Libera Brilliance
- Problems to synchronize the acquisition with the passing beam



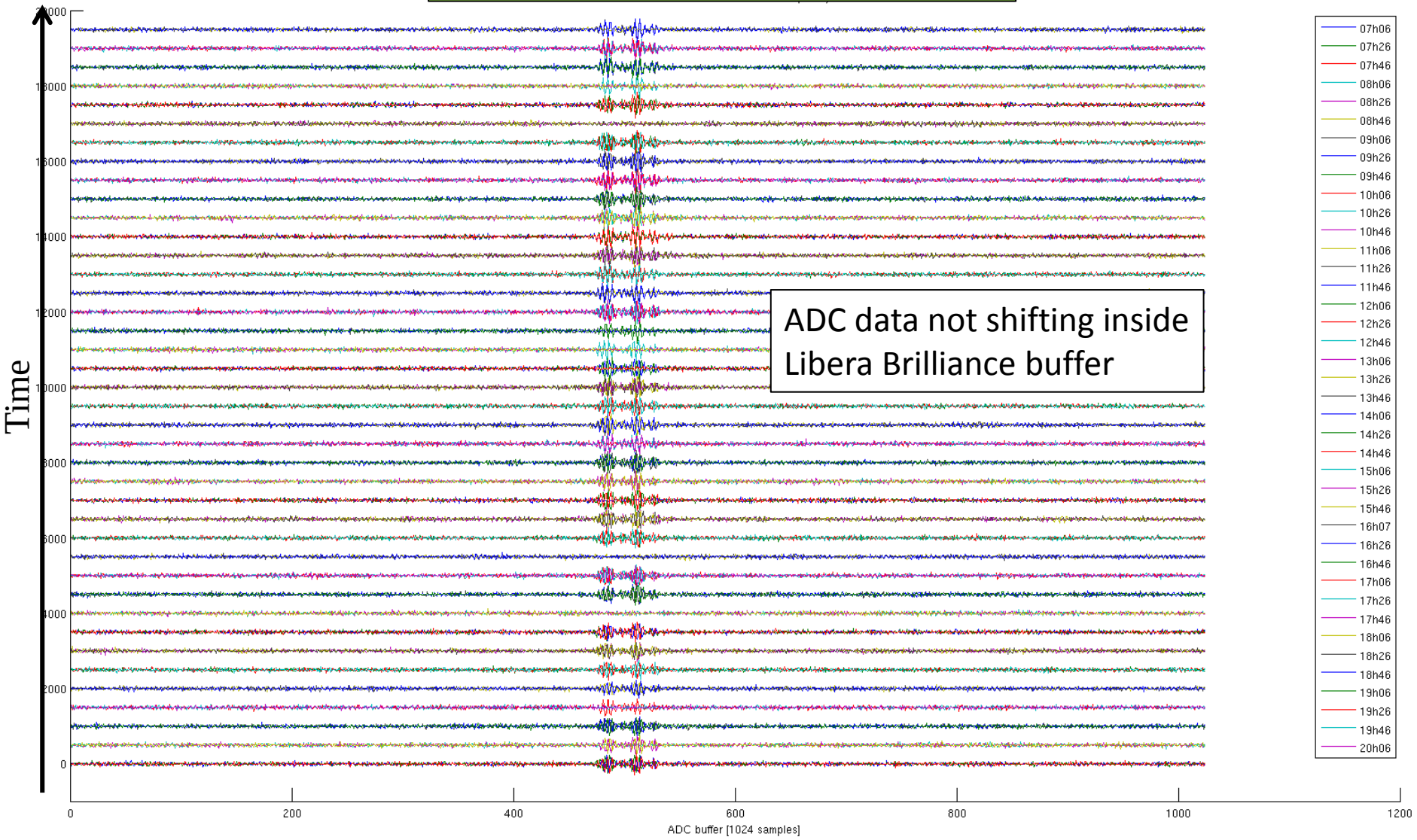
Sync Problem on Libera Spark

Spark BT0101: injections at every 20 min



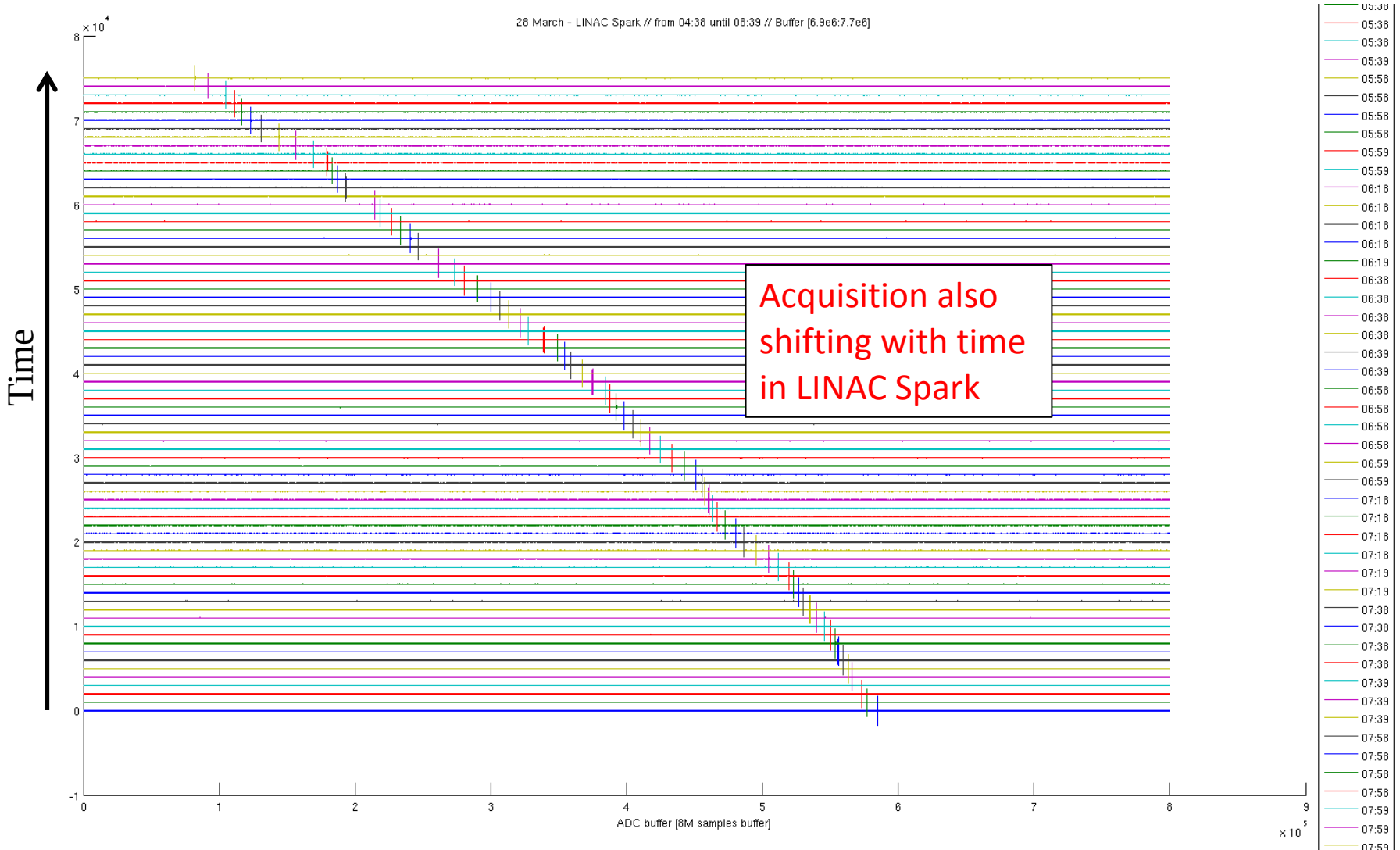
Sync Problem on Libera Spark

Brilliance BT0102 - 20min Injections



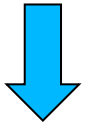
Sync Problem on Libera Spark

- We also installed one Libera Spark in the LINAC
- Same data shifting problem as we got for the BT Spark

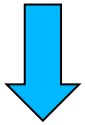


Sync Problem on Libera Spark

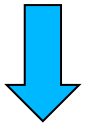
We reported to Instrumentation Technologies all the problems with Sparks



ITech finally was convinced that there could be a problem in their device



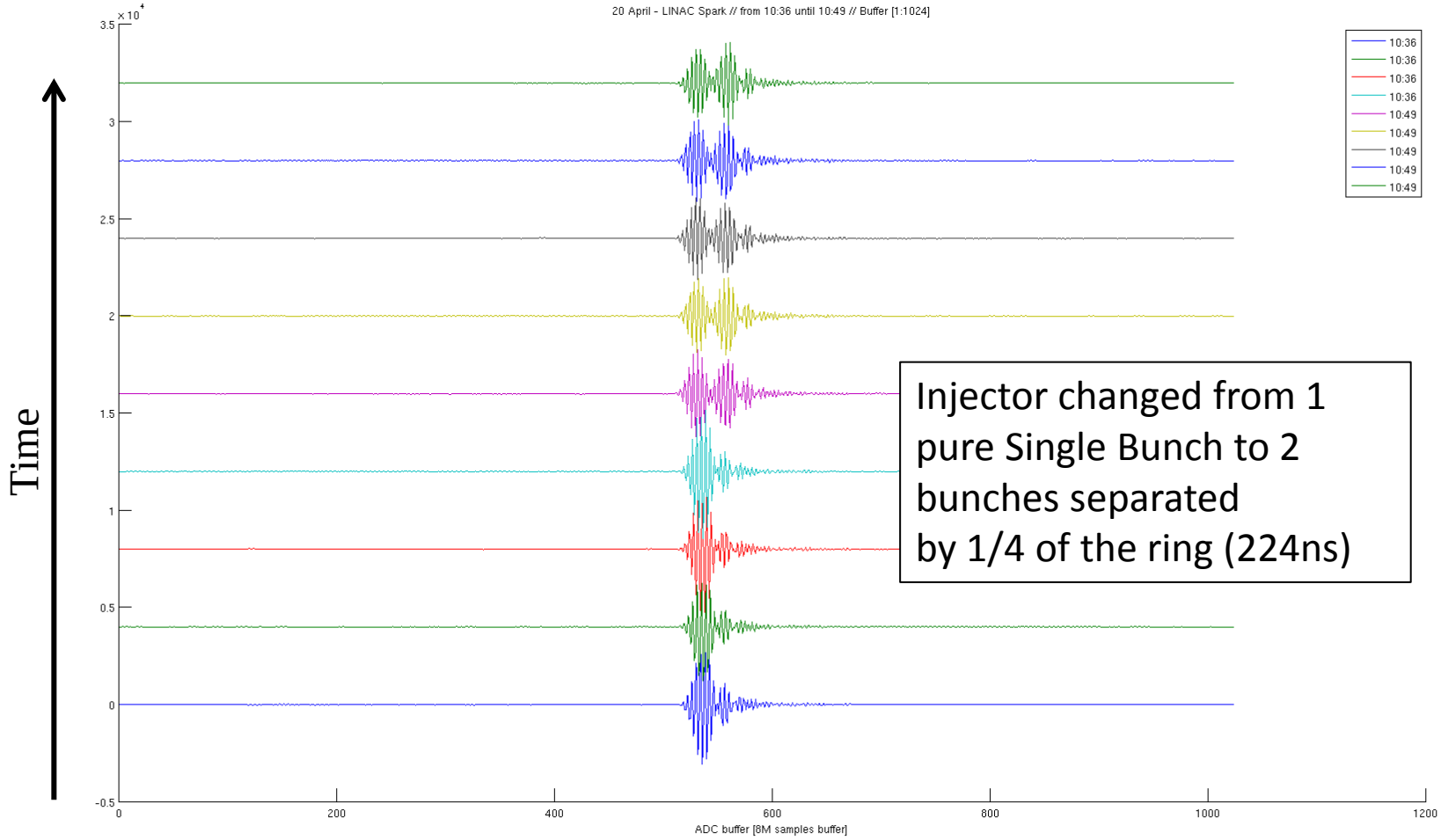
They checked and found the reason: a bug while storing big ADC buffers



Software patch implemented to solve the problem

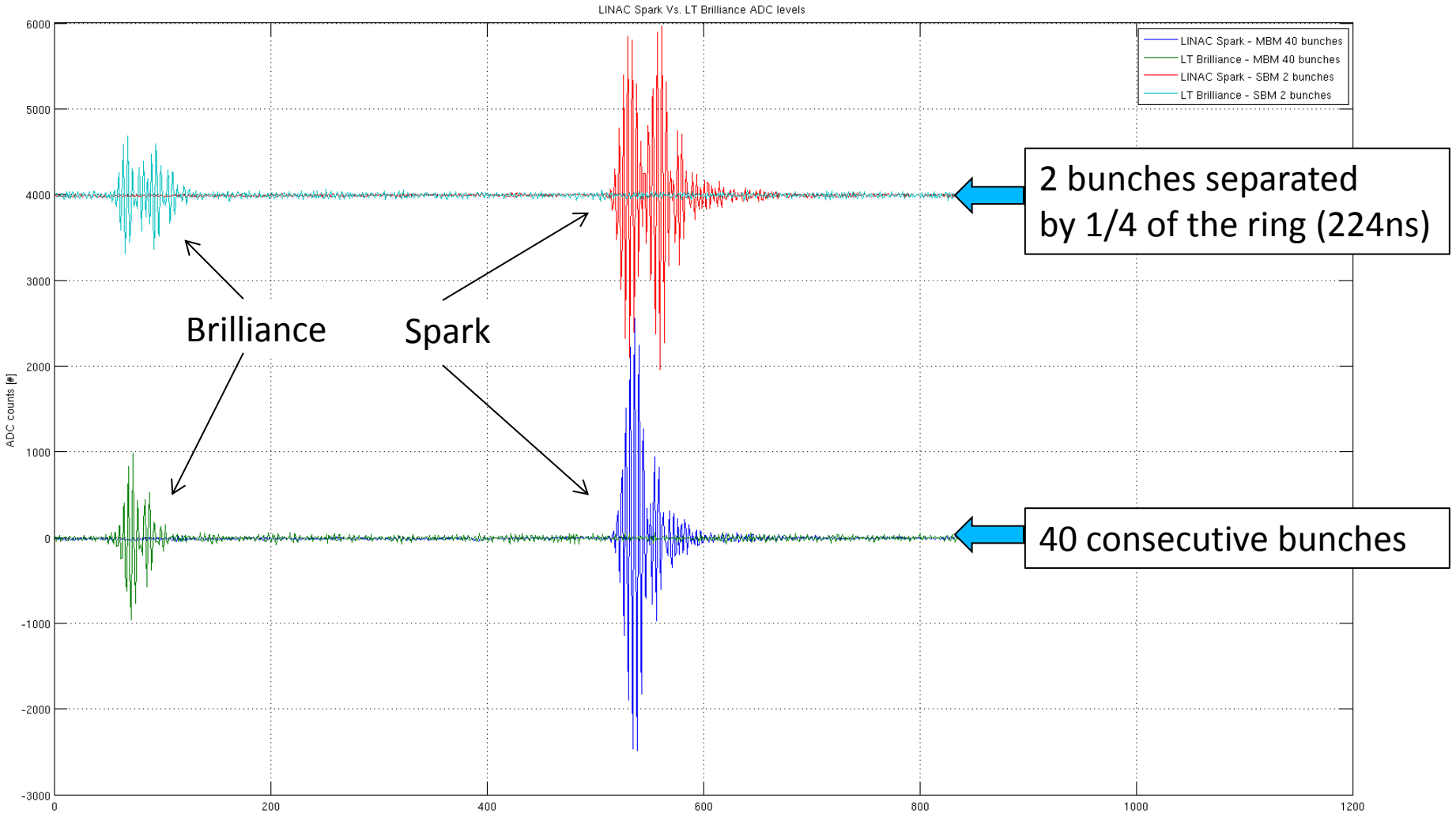
Sync Problem on Libera Spark

- Software patch solved the issue
- Below 1-Single Bunch and 2-Single Bunches injections → no data shifting



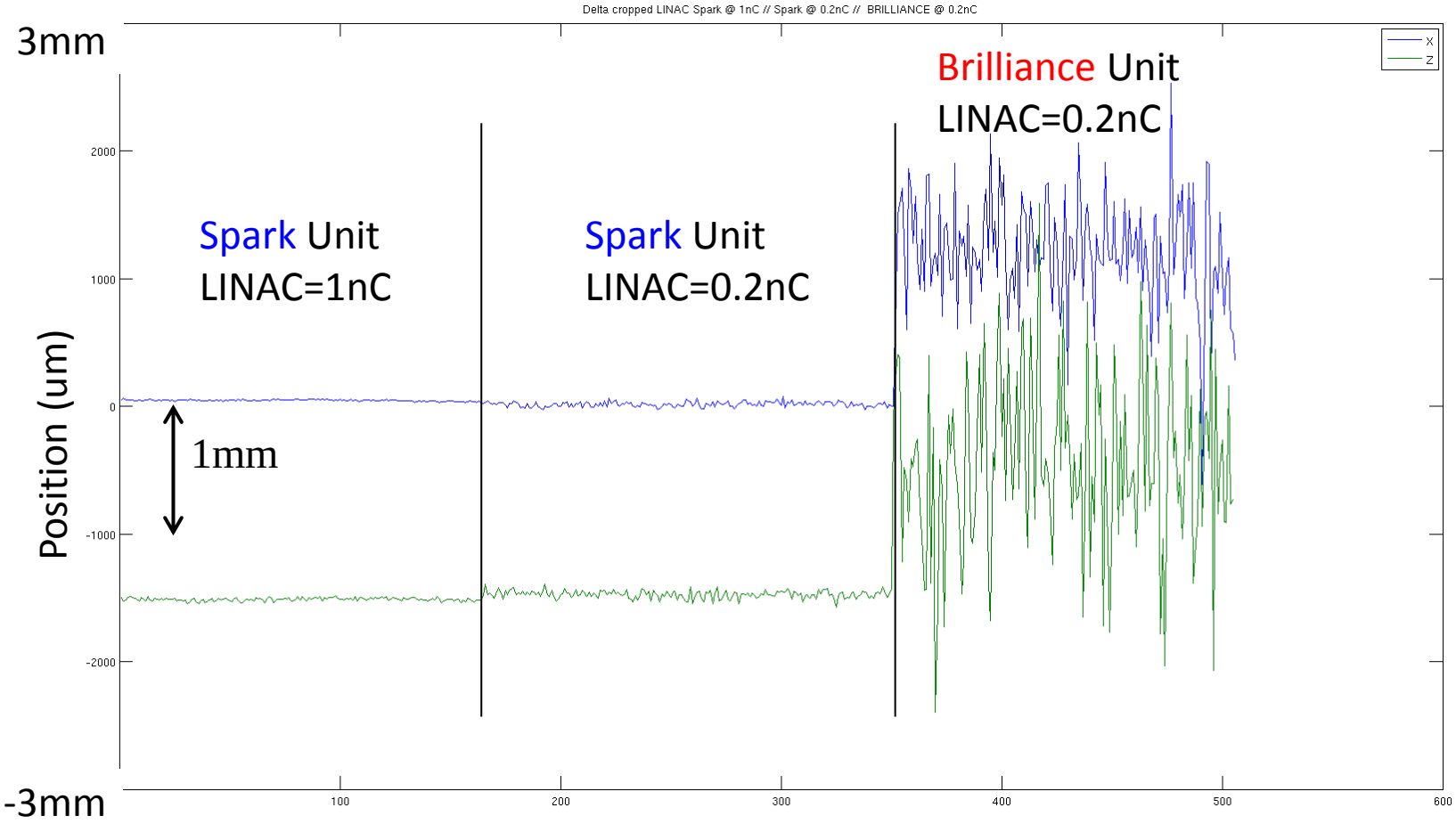
Spark improvements wrt Brilliance

- Higher beam signal caught by Sparks
- Examples below for Multi-Bunch and Single Bunch fillings



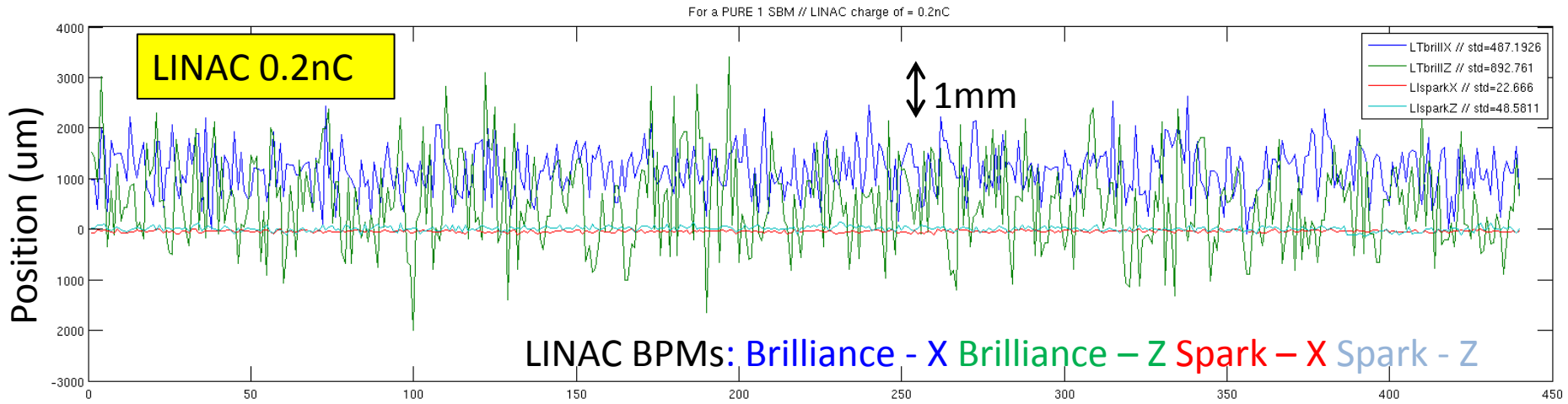
Spark improvements wrt Brilliance

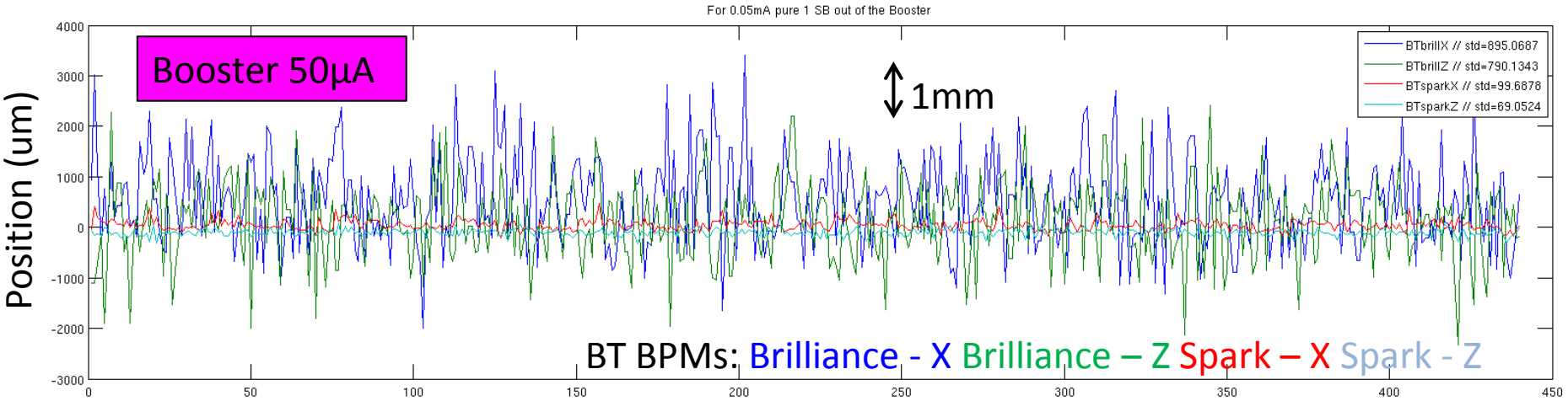
LINAC BPMs // MultiBunch filling



Spark improvements wrt Brilliance

LINAC & BT BPMs // 1 pure **Single Bunch**



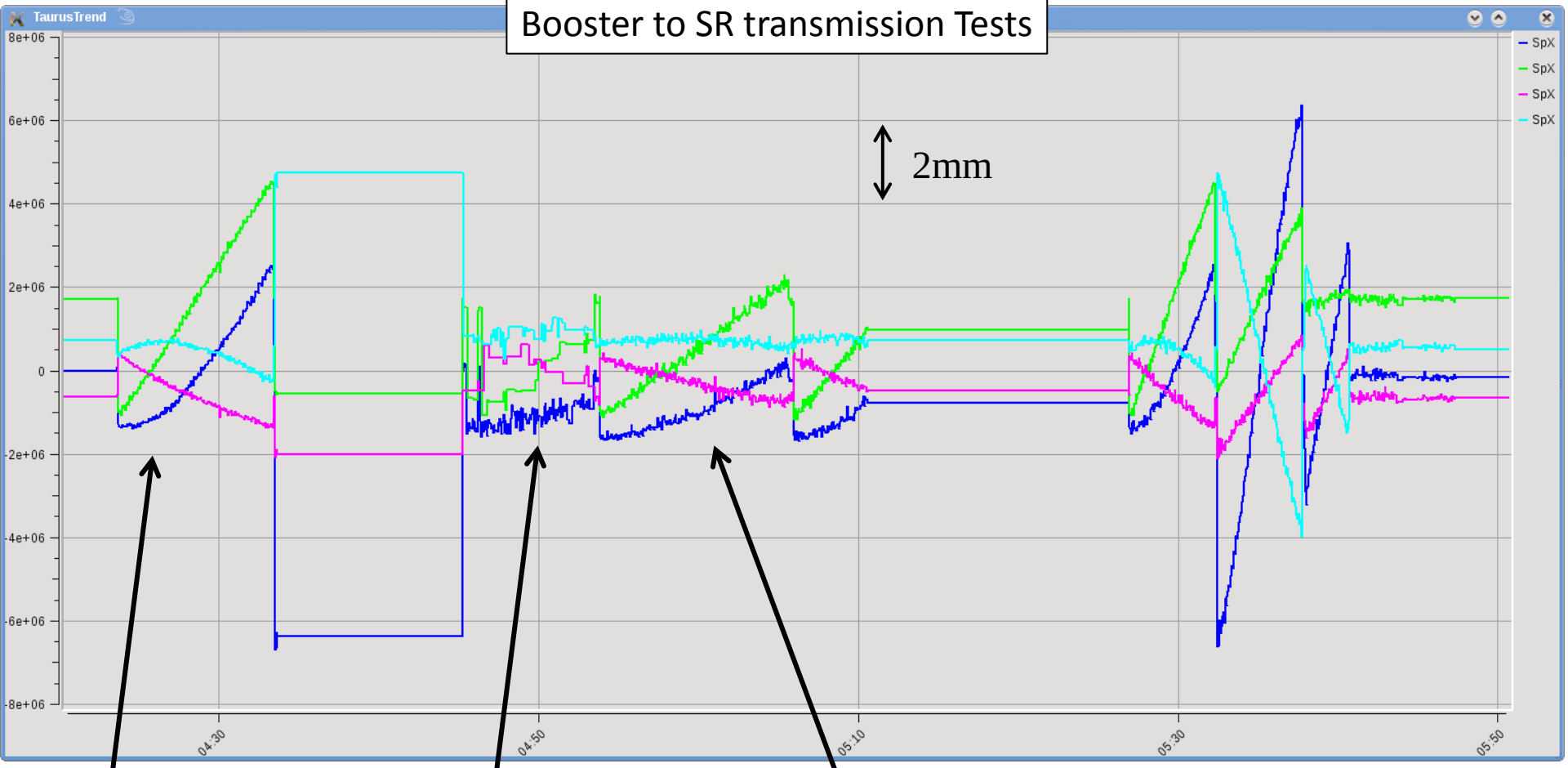


Factor >10 better resolution (std) on Position measurement

Spark improvements wrt Brilliance

Very low beam current measurements

Booster to SR transmission Tests



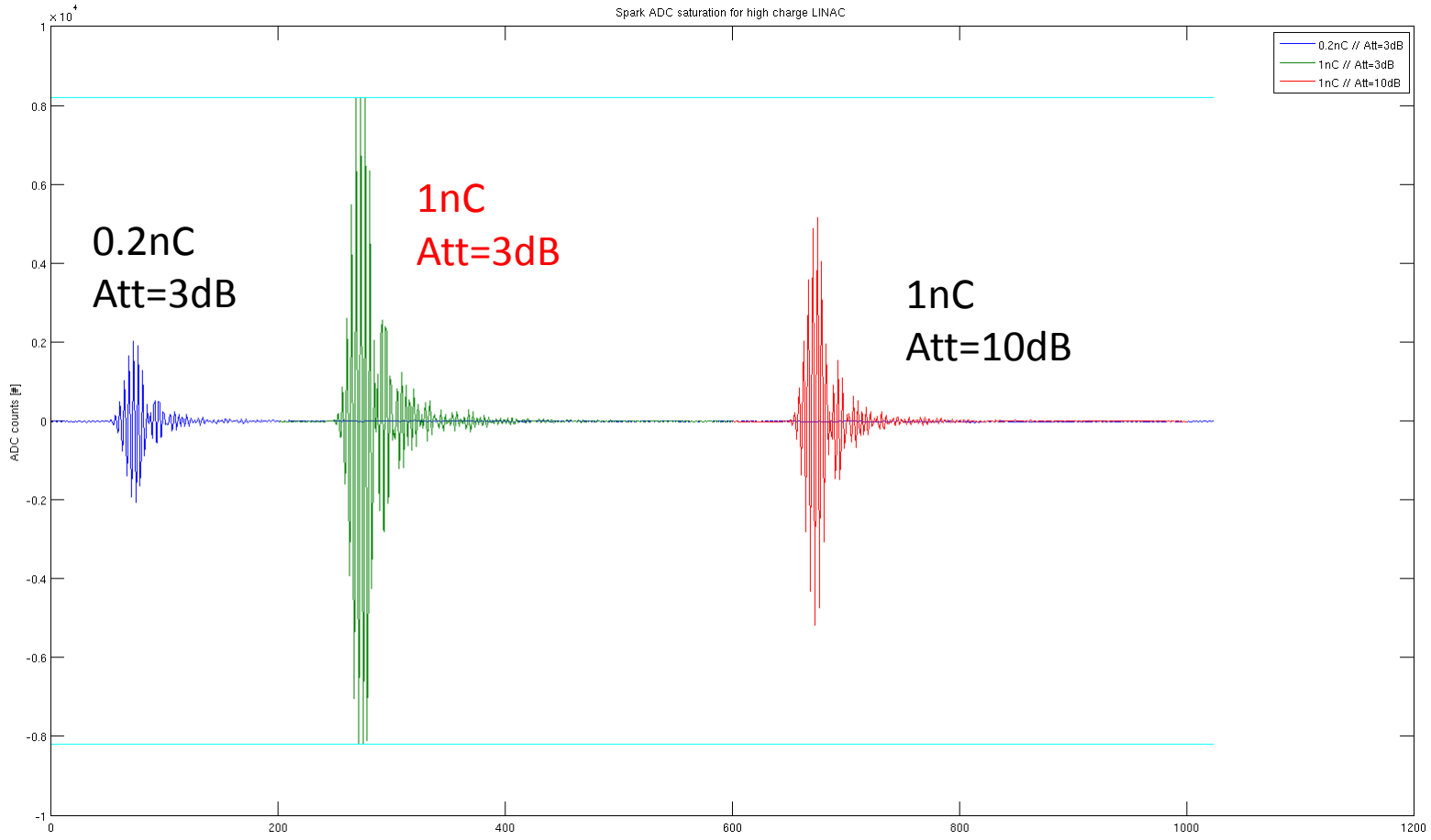
Booster @ 100µA

Booster @ **10µA**

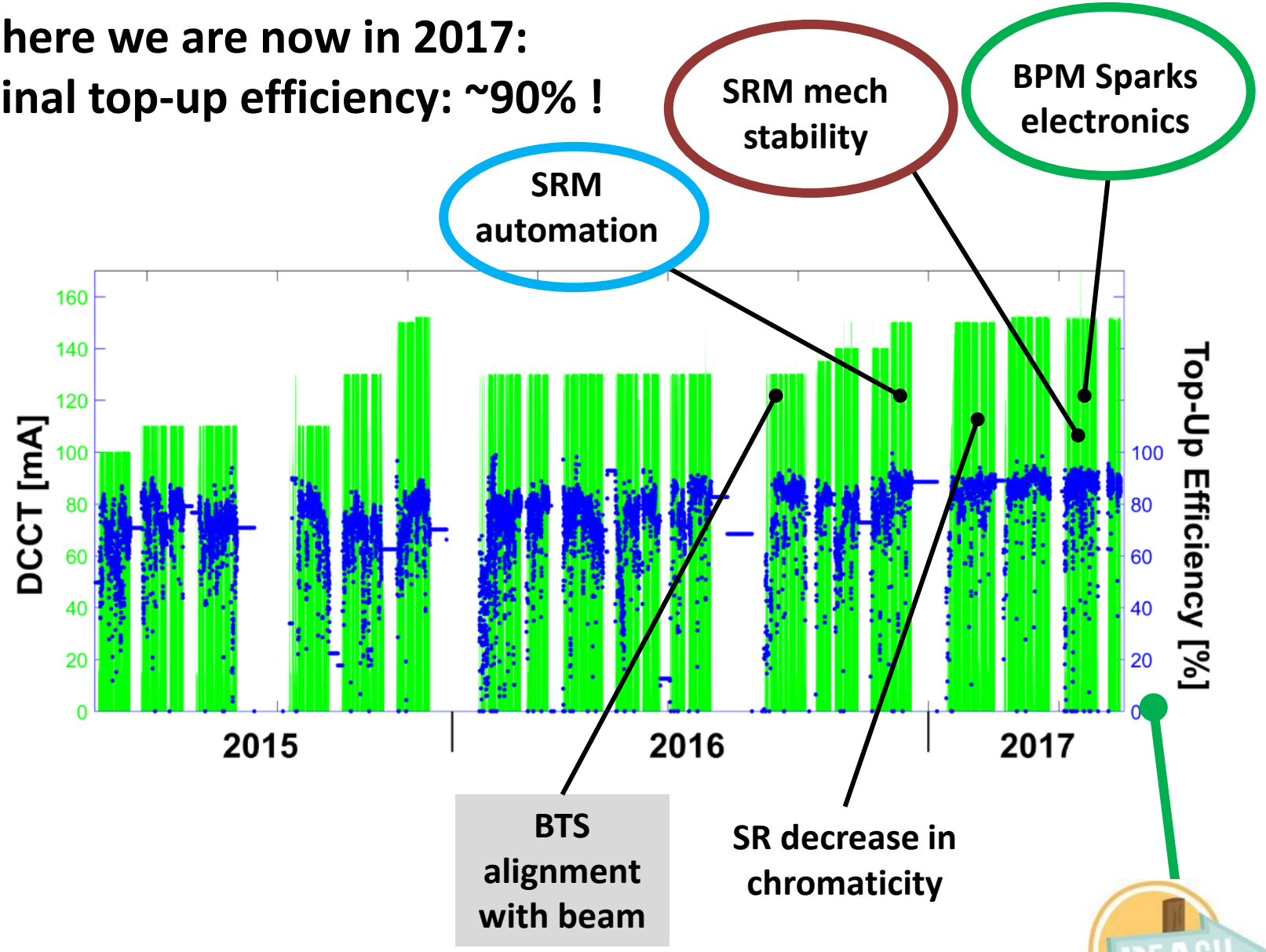
Booster @ 50µA

Spark drawbacks wrt Brilliance

- Problem with ADC saturation
- When changing from TopUp operation LINAC charge to Machine studies, Sparks ADC could be saturated
- Sparks doesn't have Automatic Gain Control, so an external software will be required to avoid saturation (Tango Device Server)



And here we are now in 2017:
nominal top-up efficiency: ~90% !



Merci de votre attention!