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Libera Brilliance Advanced Functionality and Issues

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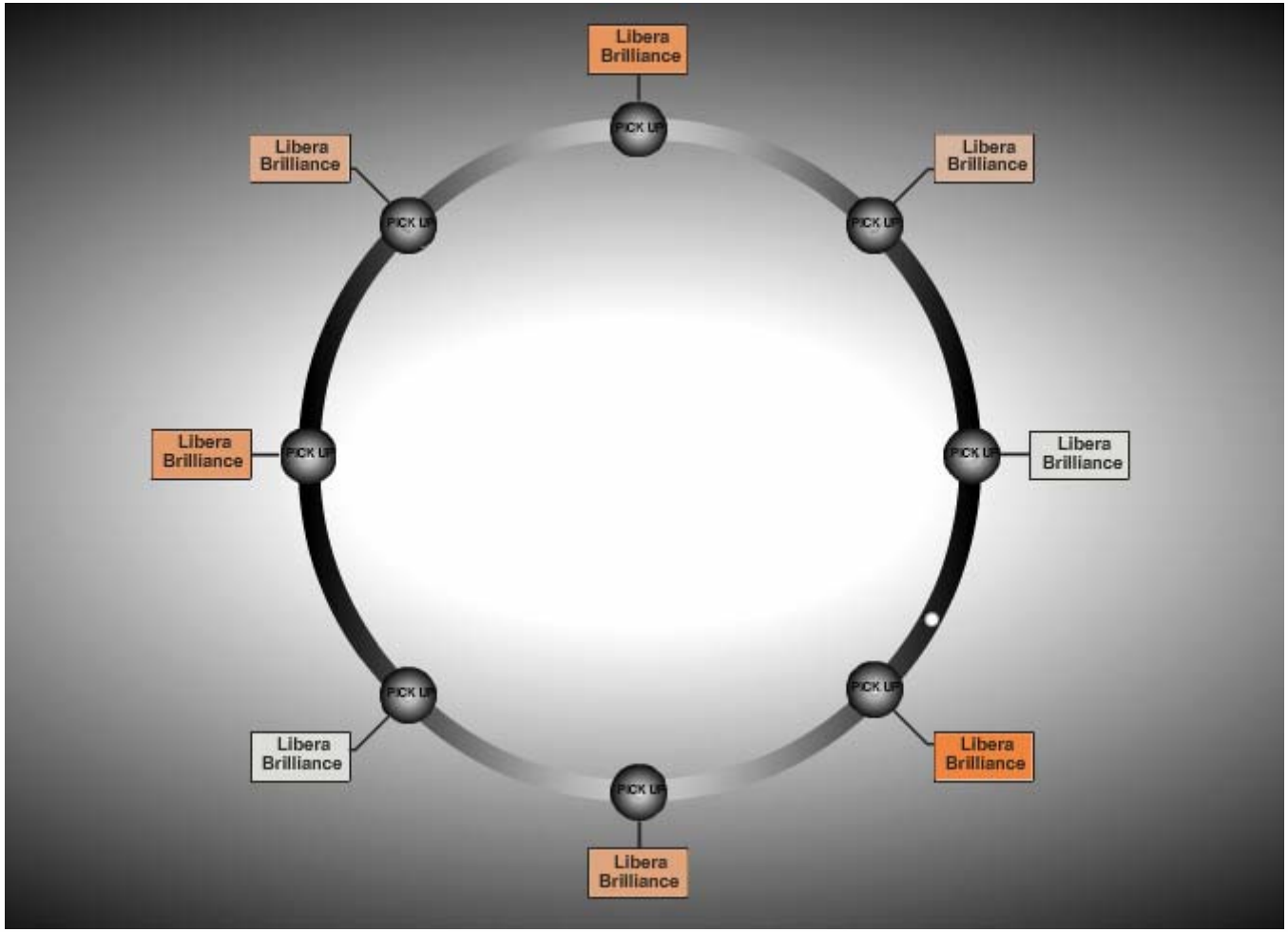
- Different fill patterns and the corresponding levels

Synchronization of the Acquisition

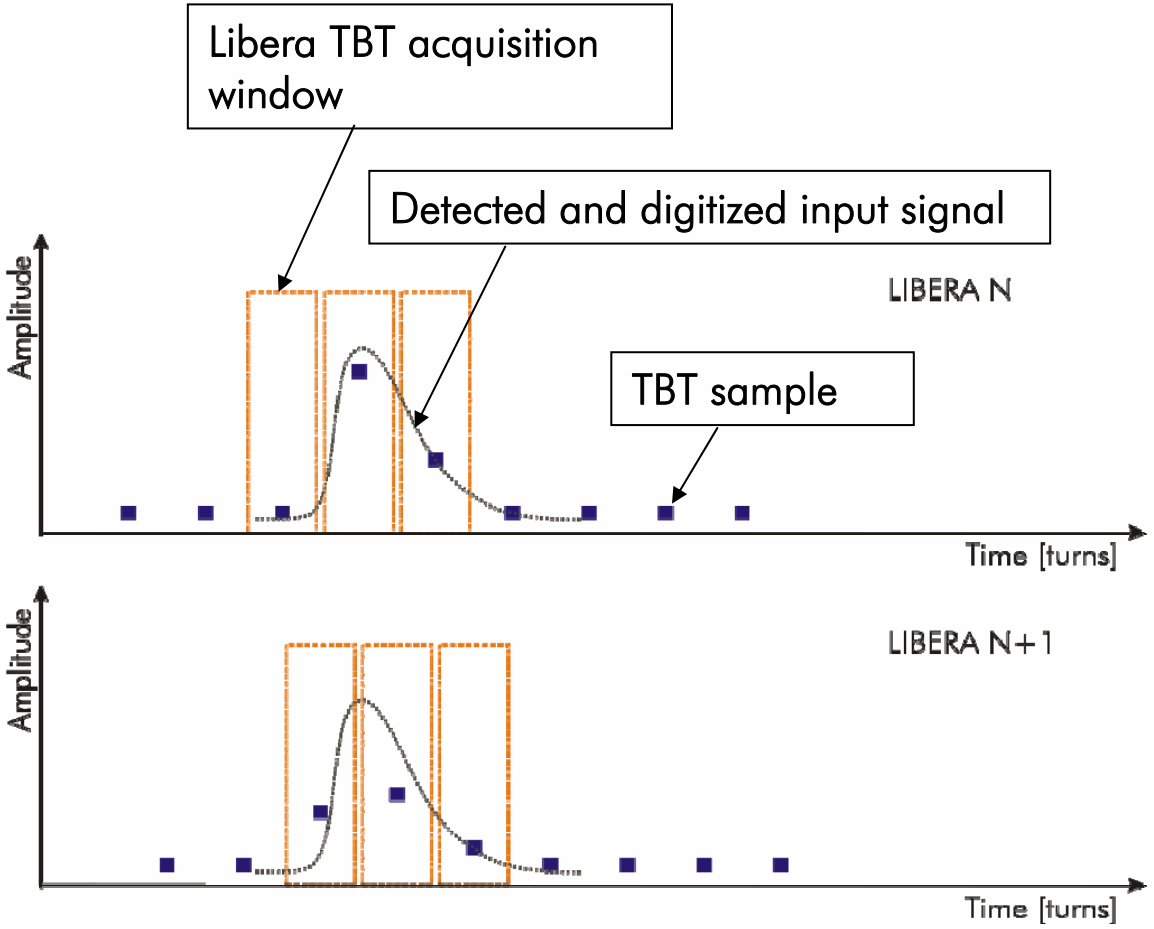
- Fine synchronization between Liberas in frequency is done through MC reference signal, delivered to Liberas continuously.
- Absolute synchronization between liberas is done through set_time trigger.
- The synchronization is effective for TBT, FA and SA data.
- TBT data: Libera acquires TBT data continuously, which means that the circular buffer is constantly filled. On acquisition trigger, only its timestamp is recorded and the corresponding data is taken from the buffer through the driver towards the application.

Synchronization of Acquisition,1a

Liberas synchronized in frequency only, through MC.

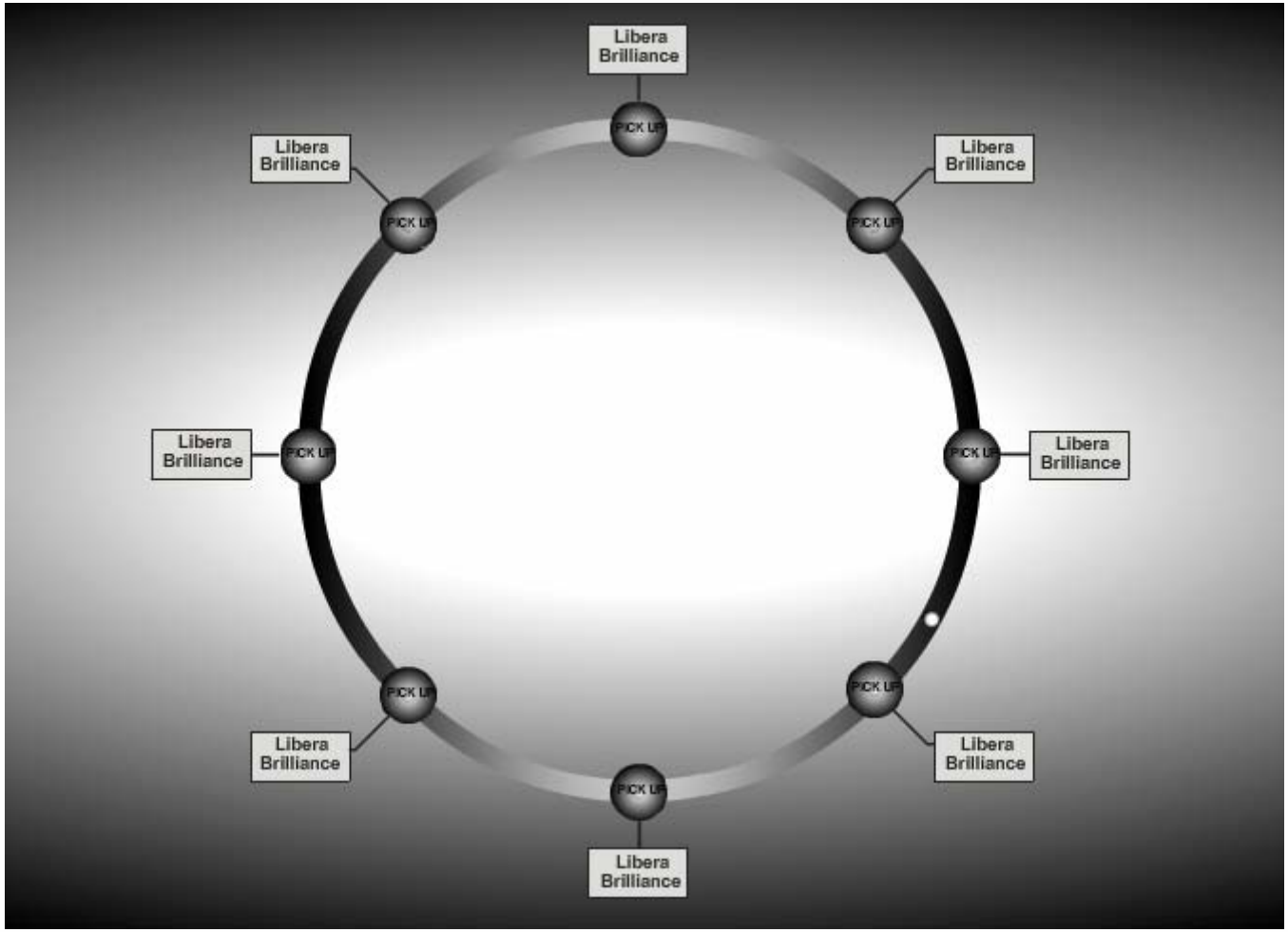


Synchronization of Acquisition,1b

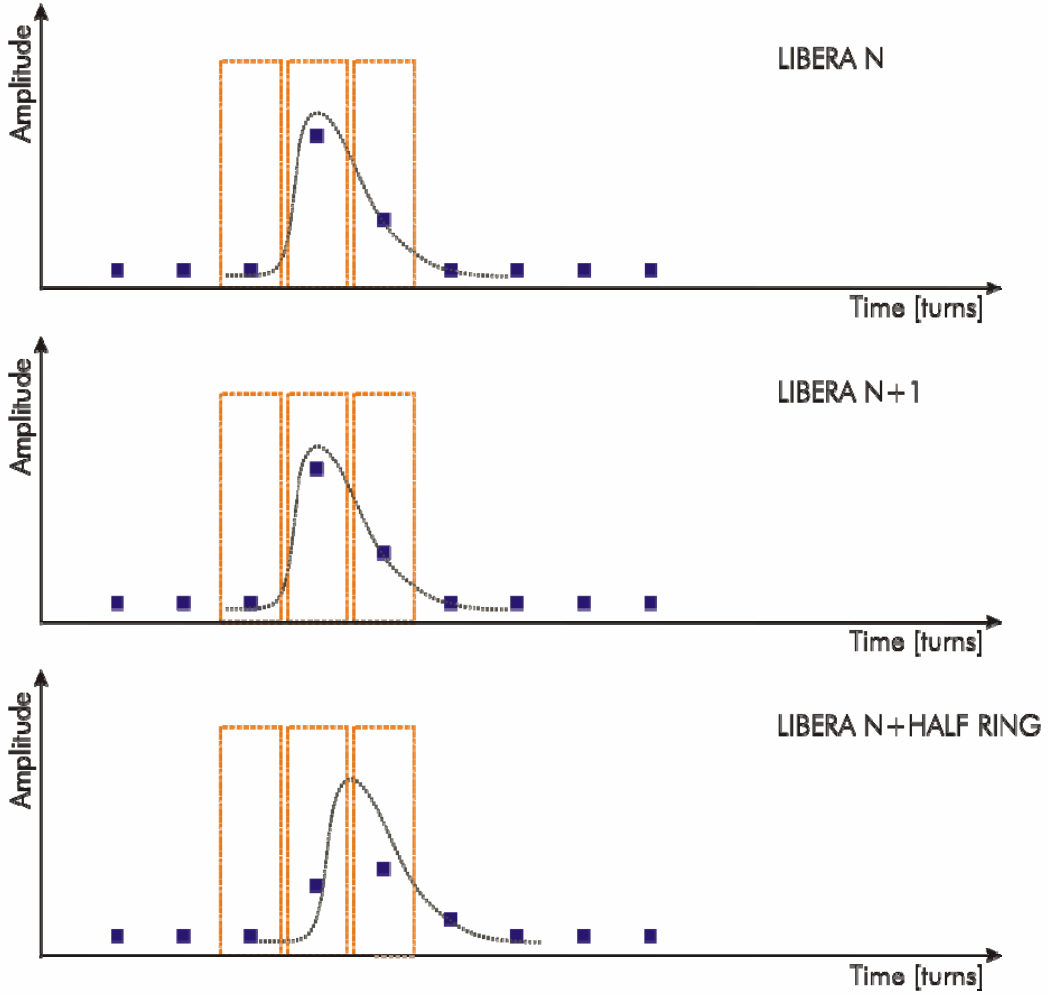


Synchronization of Acquisition,2a

Liberas synchronized in frequency, through MC, and in absolute time, through set_time trigger.

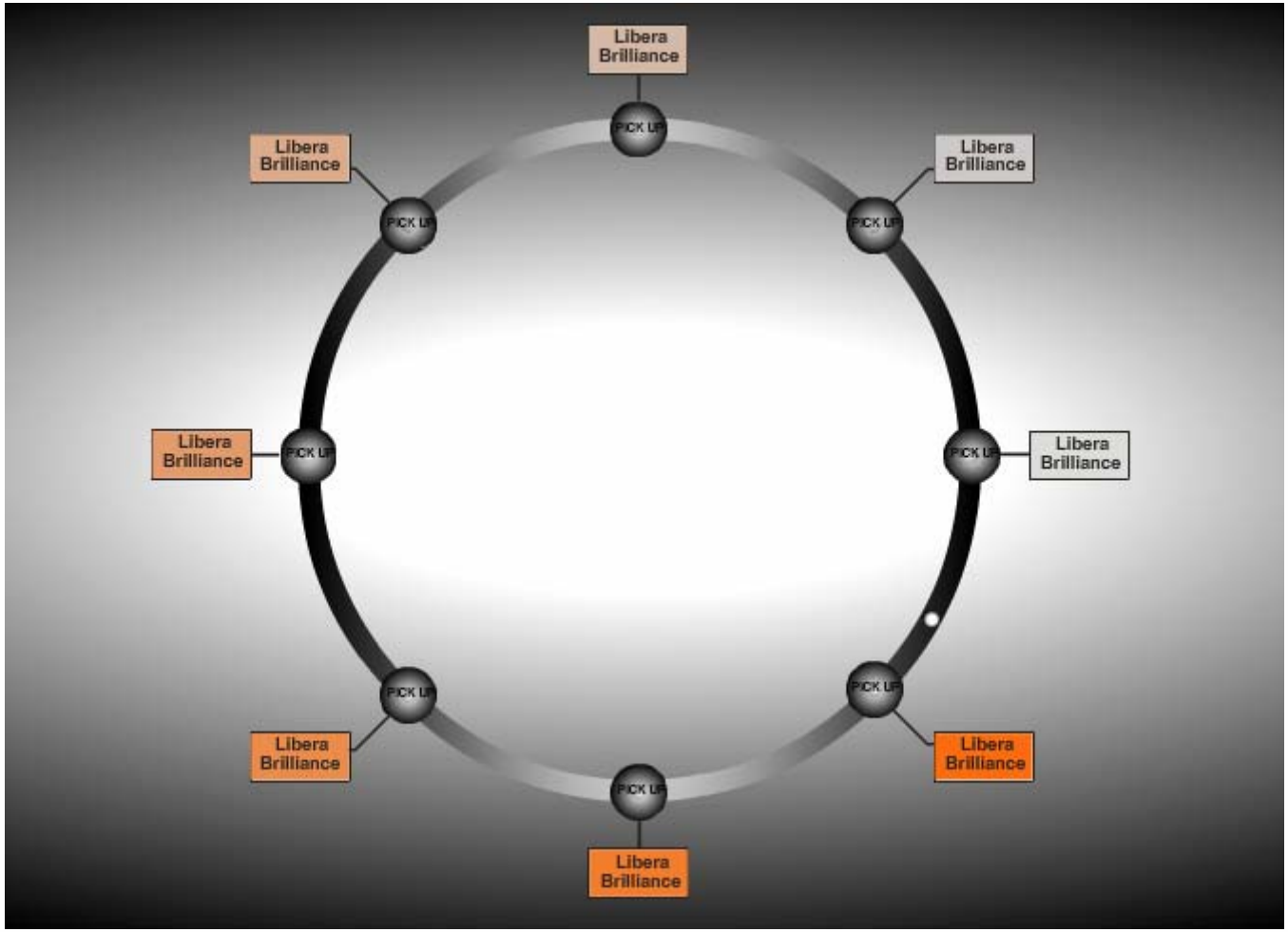


Synchronization of Acquisition,2b

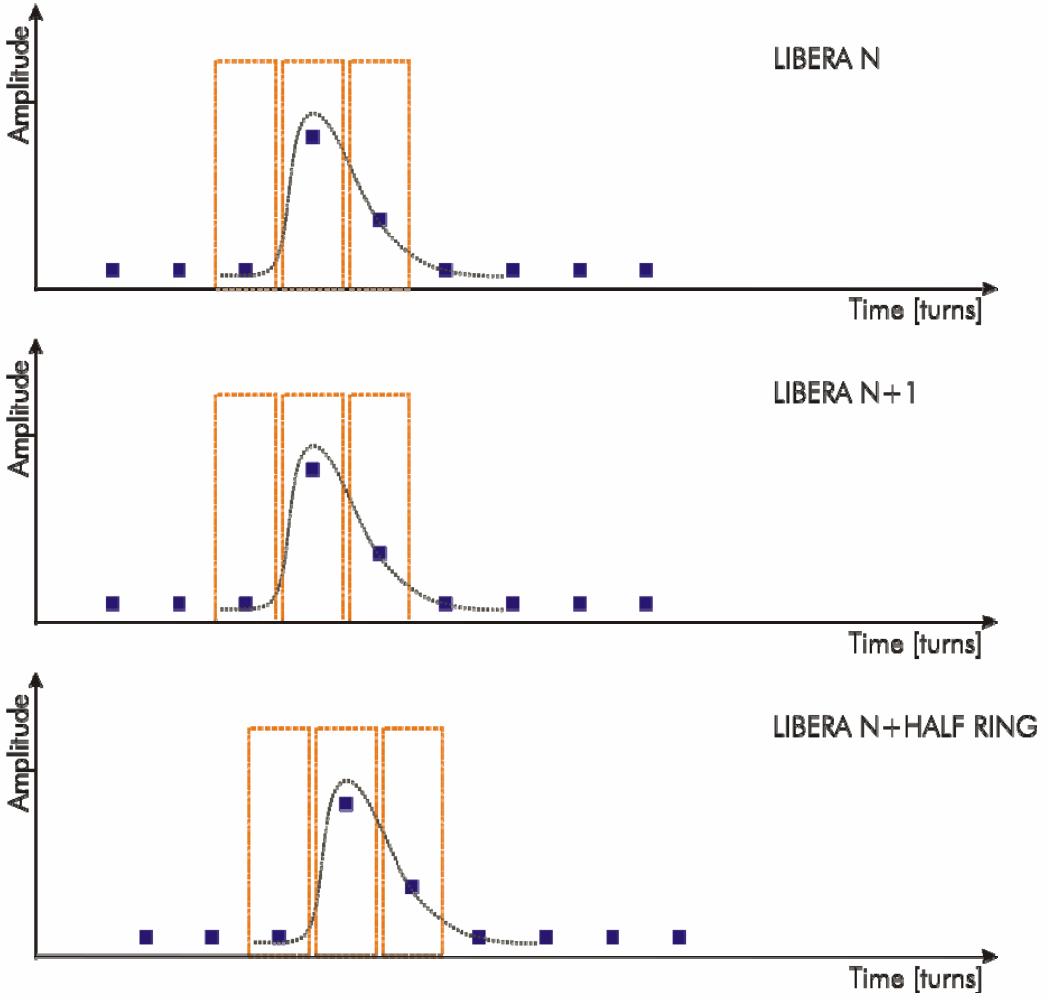


Synchronization of Acquisition,3a

Liberas synchronized in frequency, through MC, and in relative bunch time, through set_time trigger and offset.



Synchronization of Acquisition,3b



Synchronization of Acquisition,4

In principle, the trigger has the resolution of the ADC rate. There are two scenarios for TBT data:

• If the trigger (marked with * below) comes before half of the n-th TBT cycle:

____|___*__n_____|_____n+1_____|_

then the timestamp _|_ before the trigger is taken into account. The first acquisition window of your buffer is marked with n in this case.

• If the trigger comes after half of the n-th TBT cycle:

____|_____n___*__|_____n+1_____|_

Then the timestamp _|_ after the trigger is taken into account. The first acquisition window is marked with n+1 in this case.

Synchronization of Acquisition, Future Plans

The solution with externally delayed trigger (no offset within Libera), is also possible. In this case there are no problems with acquisition window (previous slide).

- **The downside: The System Time (ST) synchronization is also delayed in this case, meaning that it is not running with exactly the same phase on all Liberas.**

The solution with internally hard delayed triggers (within FPGA) is in work, probably will be implemented in near future.

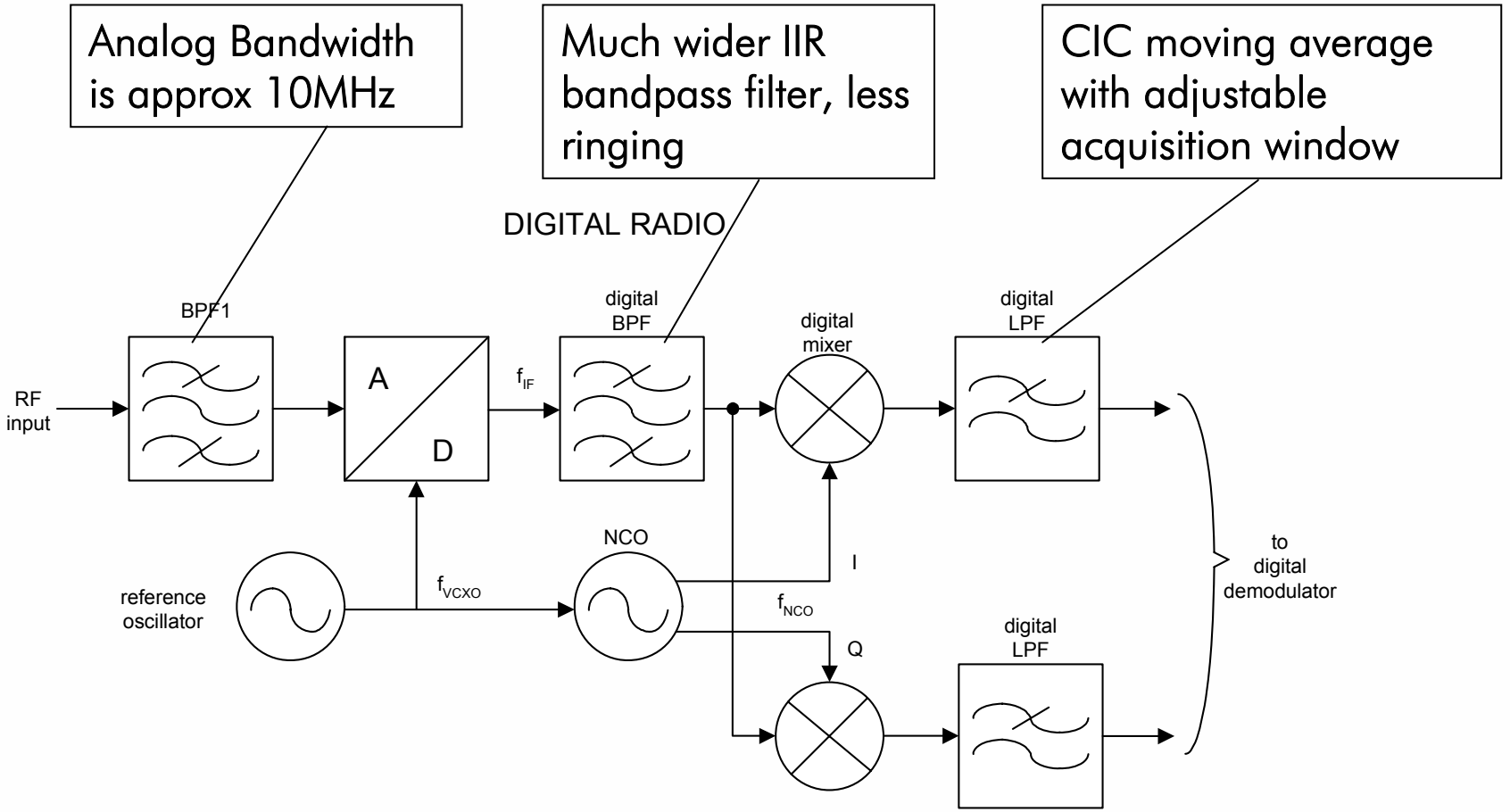
Modified DDC Filters Removing Smearing, 1

- Idea by Kees Scheidt, ESRF.
- Scheidt: the 'smearing' of the T-b-T output data is a real problem for the precise measurement of certain accelerator characteristics (called lattice parameters, like the local Beta-Values and the phase-advance).

Main Requirement:

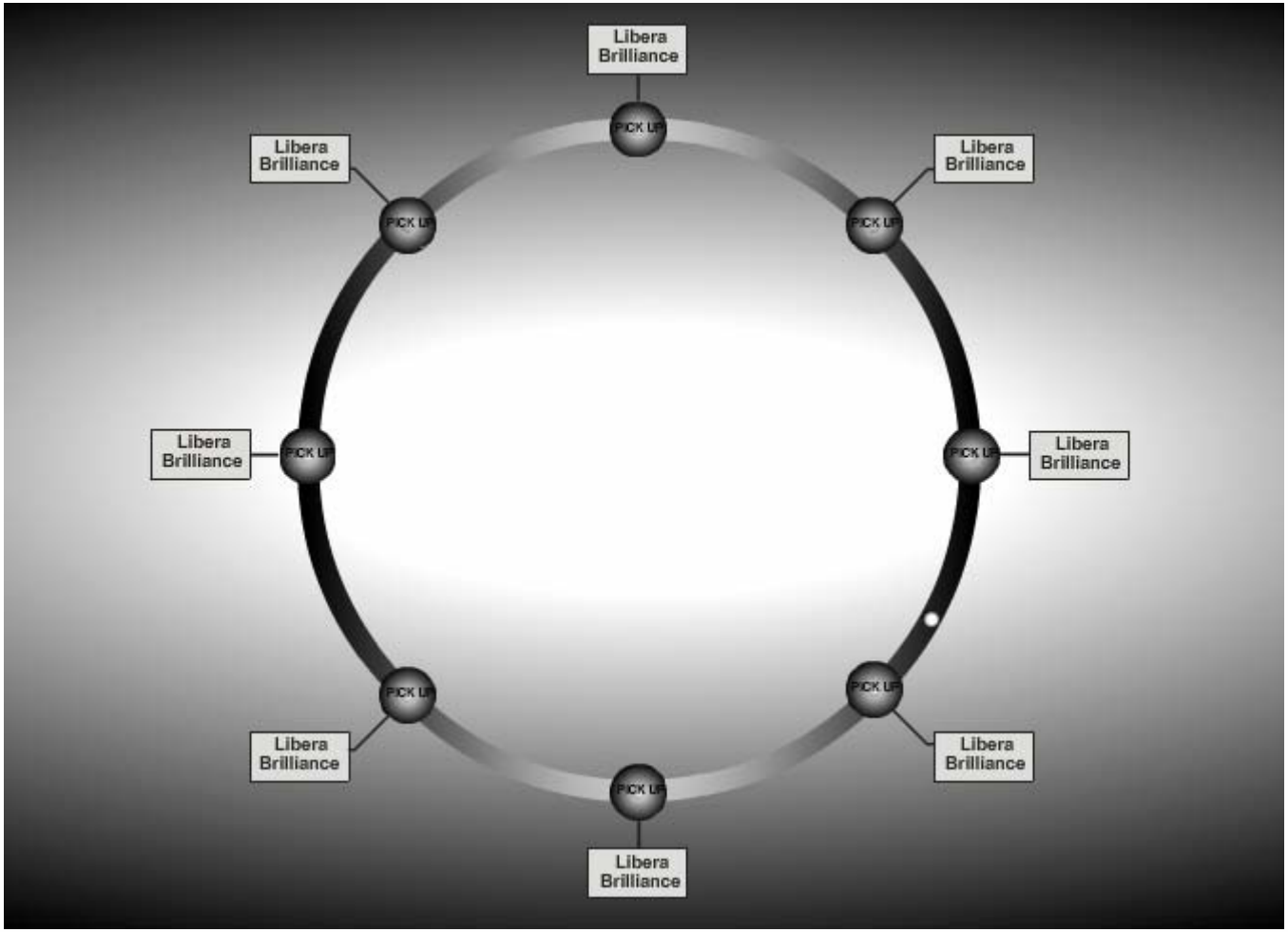
- Removing smearing between adjacent TBT samples, especially with partial fill pattern.
- IIR bandpass filters much wider to reduce ringing.
- Moving average filter processes only the data with signal (when partial fill), neglecting the part of the data without beam.

Modified DDC Filters Removing Smearing, 2

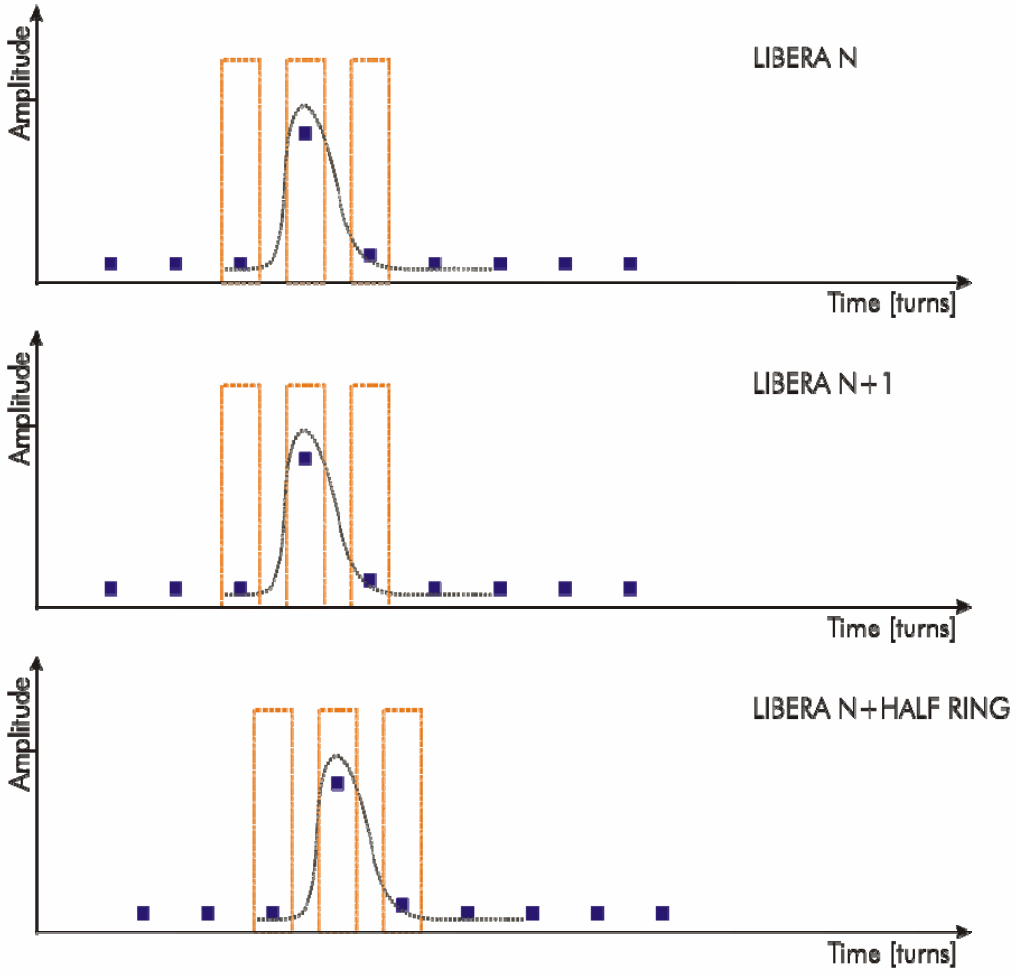


Modified DDC Filters Removing Smearing, 3

Liberas synchronized in frequency, through MC, and in relative bunch time, through set_time trigger and offset. The acquisition time is shorter, optimizing partial fill acquisition.



Modified DDC Filters Removing Smearing, 4

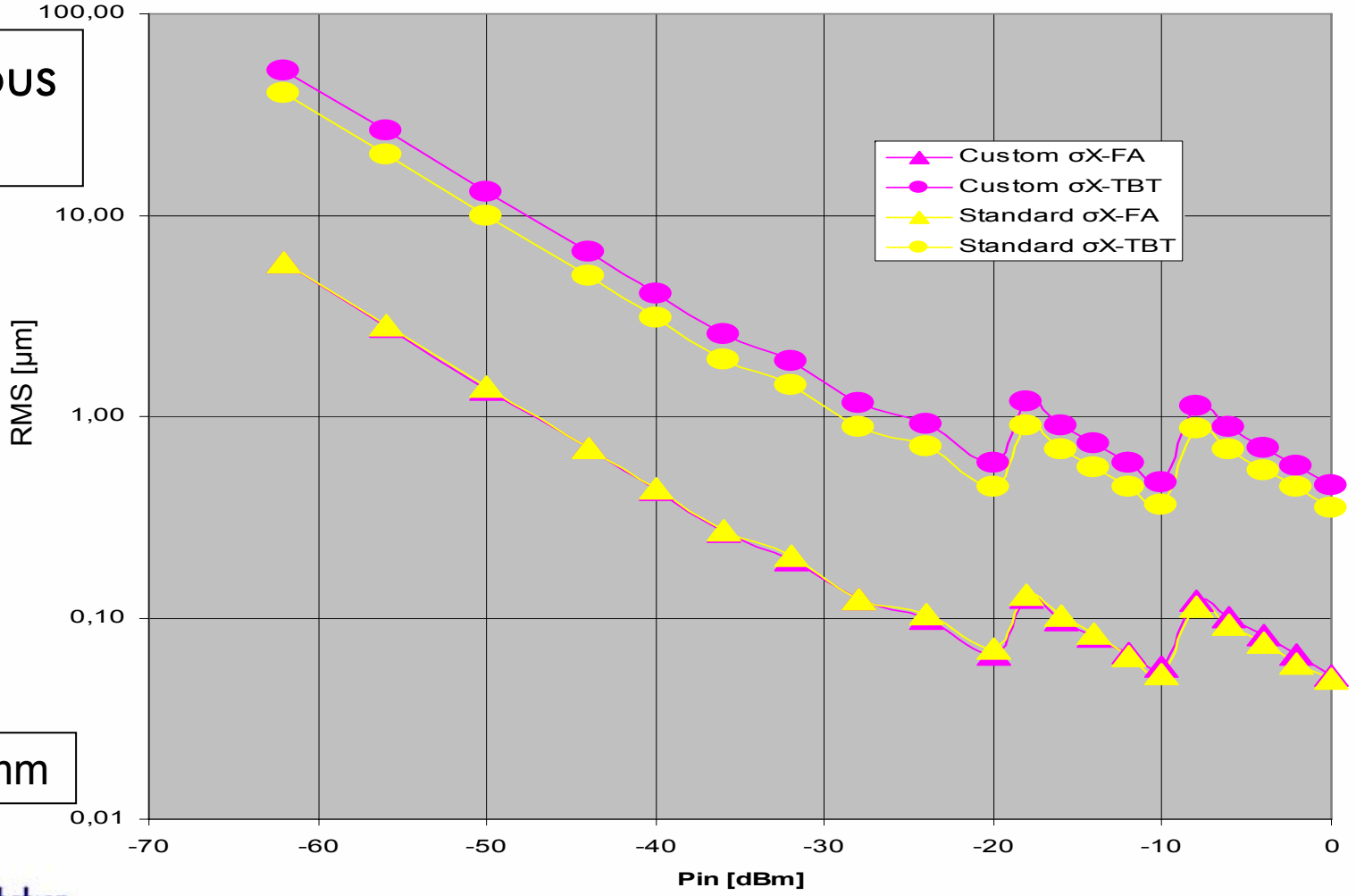


Modified DDC Filters Removing Smearing, 5

- Tests showed marginal degradation of the TBT RMS with cw signal due to wider IIR filters.
- Improved TBT RMS when in partial fill mode, especially with low % filling.
- The delay and length of the acquisition window are run time adjustable.

Modified DDC Filters Removing Smearing, 6

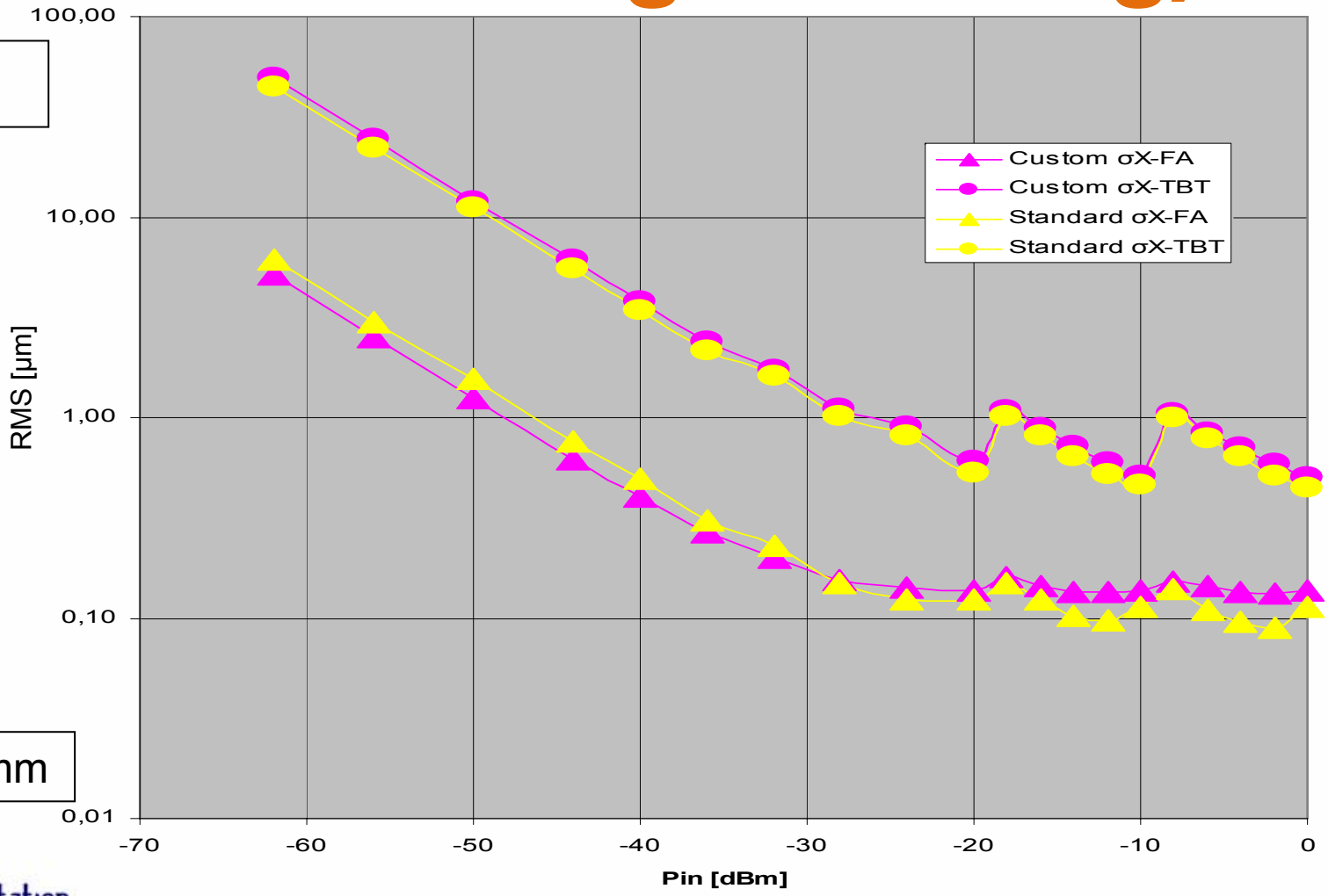
Continuous wave



kx, ky =10mm

Modified DDC Filters Removing Smearing, 7

66% fill



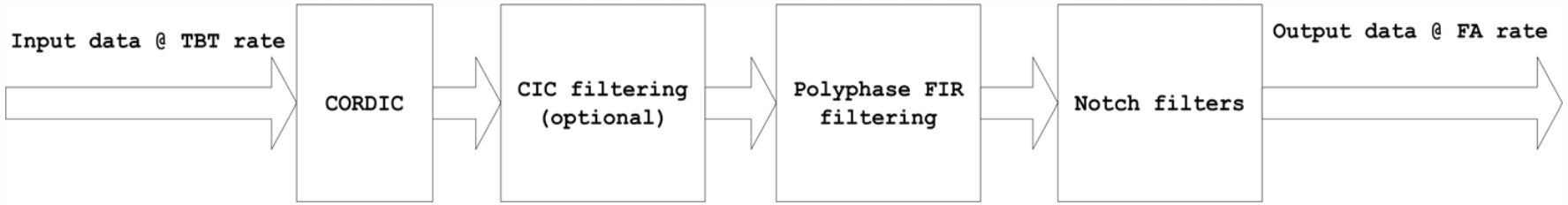
kx, ky =10mm

FA Latency and Group Delay

Initial Requirements:

- **Output sample rate 10 kSps.**
- **-3 dB point at 2 kHz.**
- **the group delay of the signal is less or equal to 160 µs.**

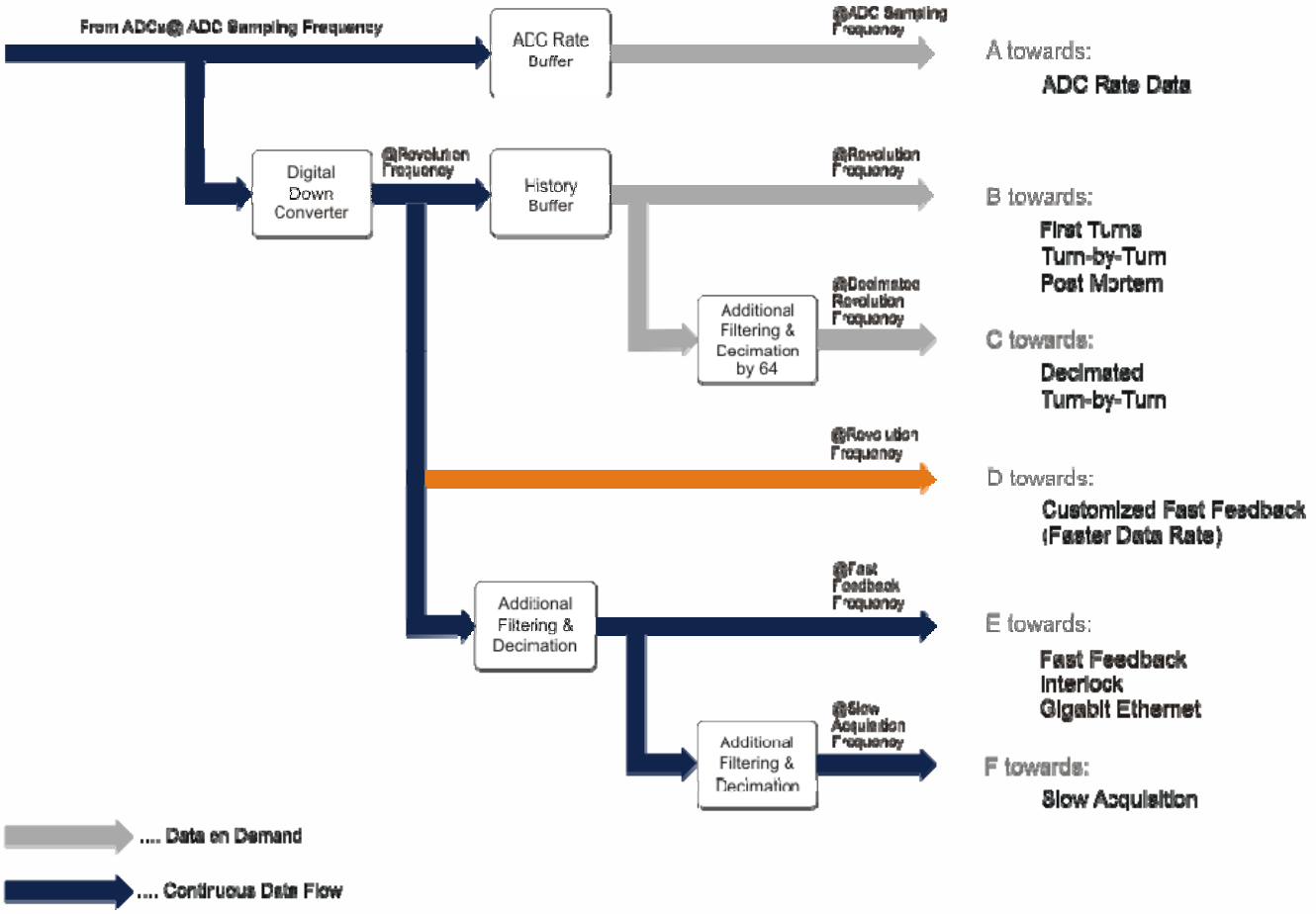
FA filtering block:



FA Latency and Group Delay

- The filter structure and required decimation is predefined.
- FIR and notch filter coefficients are Libera boot-time adjustable.
- Group delay is a critical parameter for the Fast Global Orbit Feedback building.
- Group delay on Libera Brilliance is ~160μs.
- Latency is an important parameter for i.e. Interlock triggering.
- Latency on Libera Brilliance is ~280μs.

Adjustable FA processing chains, 1



Adjustable FA processing chains, 2

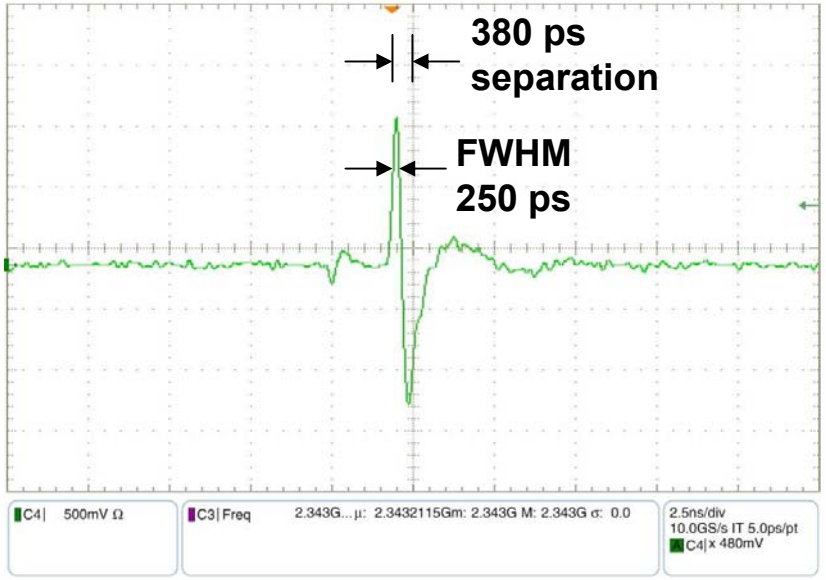
- Faster output data rate.
- Main motivation is to reduce the group delay, making the Fast Global Orbit Feedback more efficient.
- Speed up to ~40kSps data rate already tested.
- Usual (10kSps) FA rate is parallel and needed for Interlock detection as well as for SA rate input.
- This feature is added on demand only.

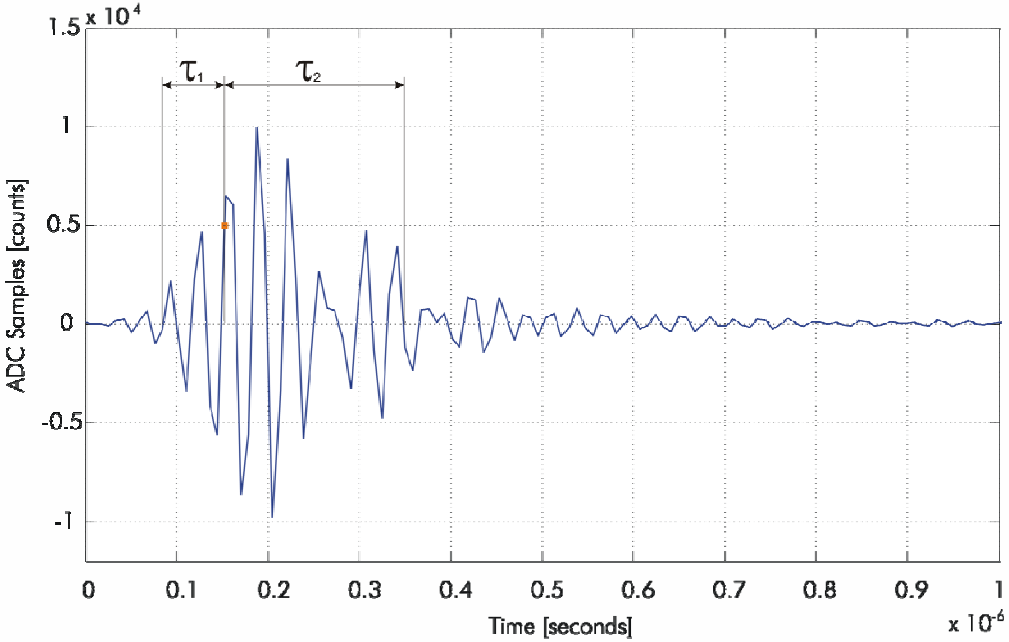
Usage of Libera Brilliance for Single Pulse Measurement, 1

Motivation:

- **Standard TBT data is not very efficient for measuring single pulse phenomena.**
- **To demonstrate the usage of Libera Brilliance for single pulse applications, including single bunch.**

Usage of Libera Brilliance for Single Pulse Measurement, 2





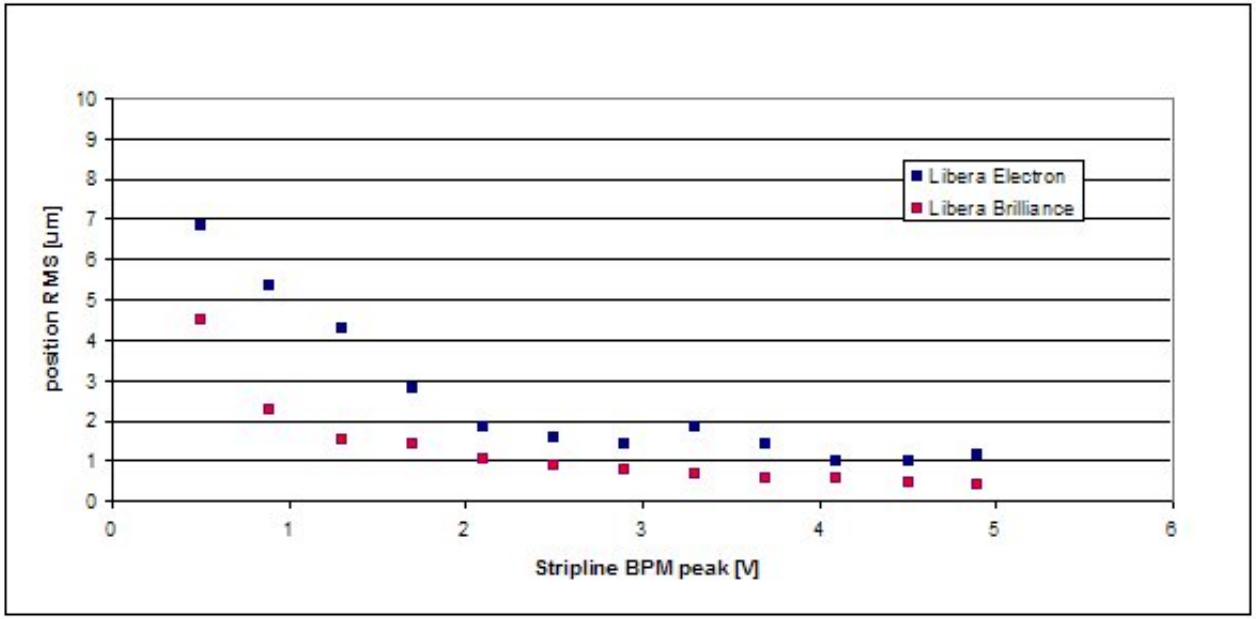
Position calculation:
-Signal is located (threshold)

-The window is determined (τ1+ τ2)

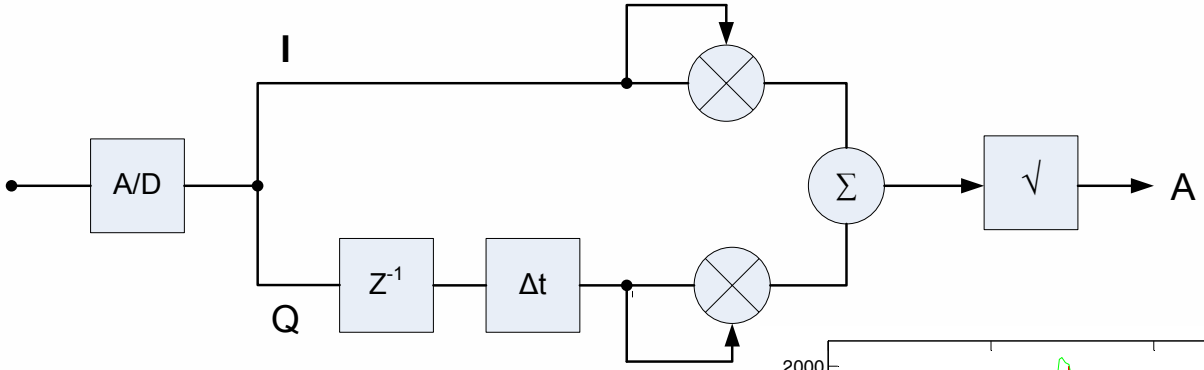
$P = k_1 \Sigma v_i^2$
$Amp = k_2 \sqrt{P}$
$X, Y = \Delta / \Sigma$

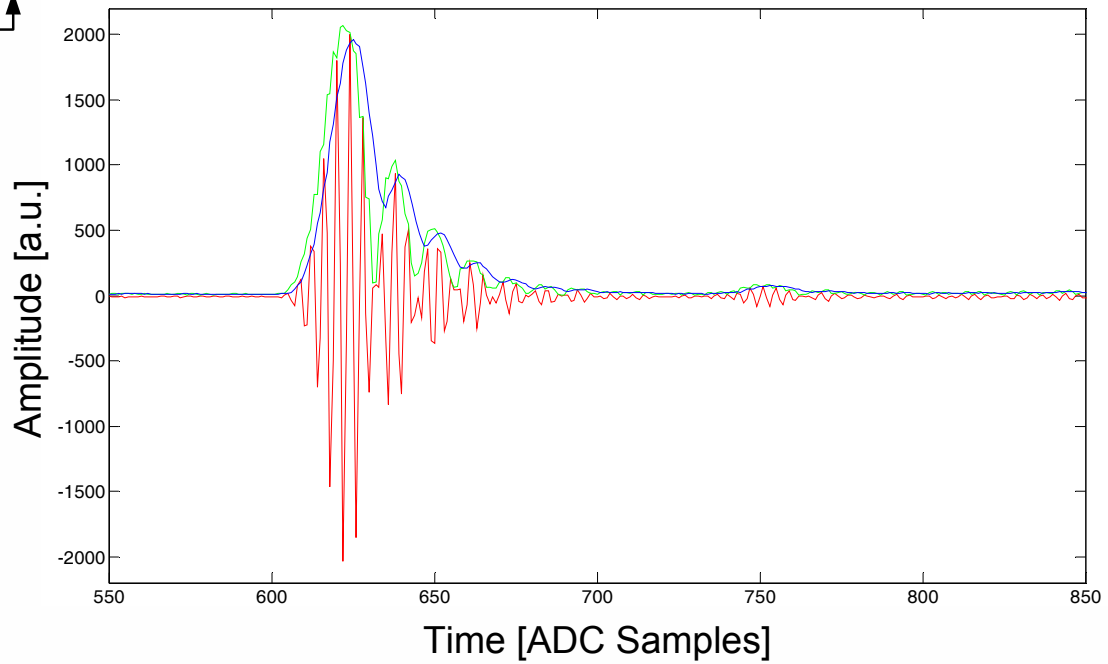
Usage of Libera Brilliance for Single Pulse Measurement, 3

- Simulated graph of position RMS over stipline peak voltage
- The value at the 1V voltage was confirmed with measurement
- Libera Brilliance is capable of submicron resolution

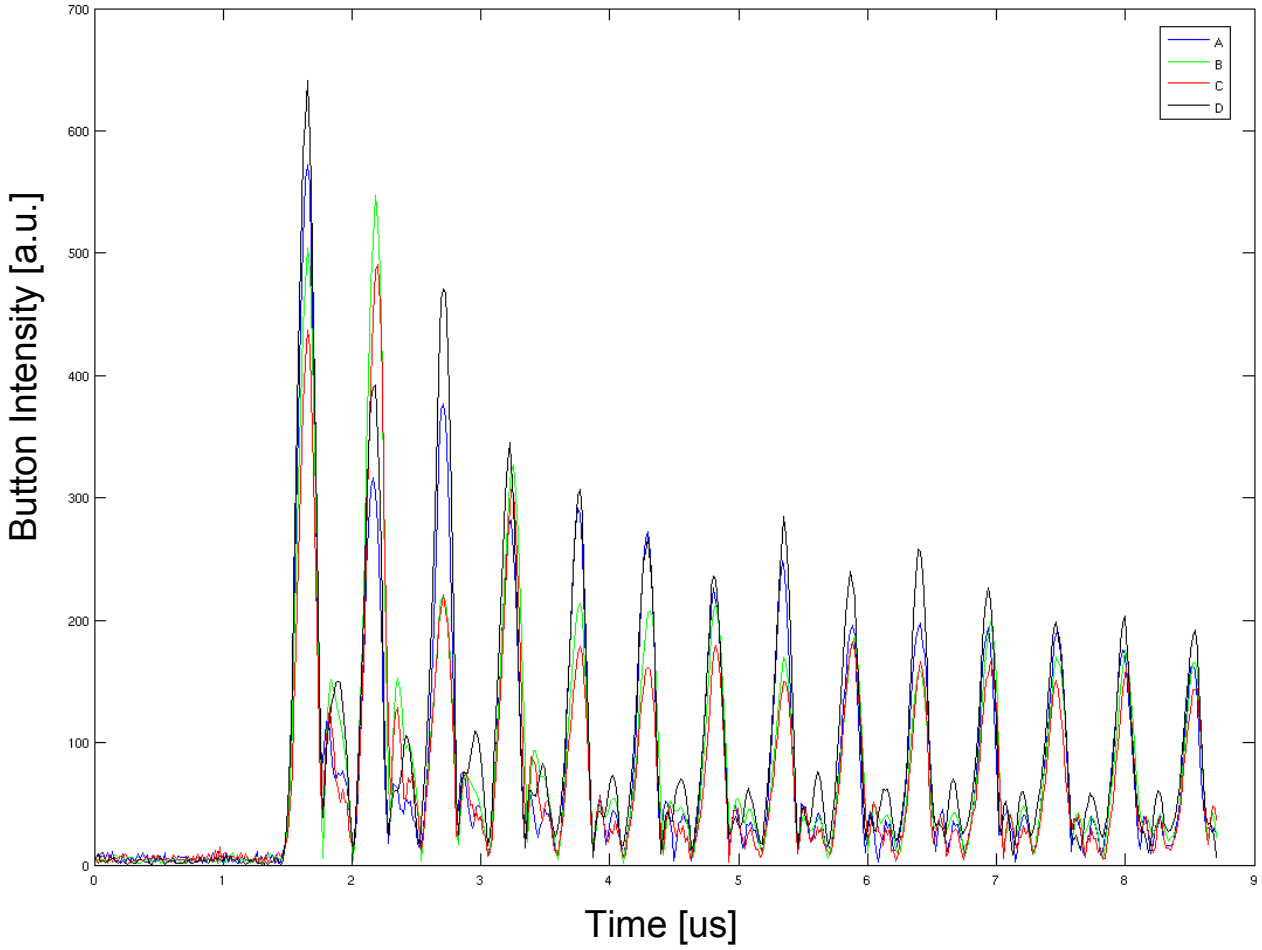


Usage of ADC data, Pulse Shape Calculation





Usage of ADC data on Diamond Booster



Different Fill Patterns and the Dynamic Range

- The maximum input level (close to saturation of ADCs) for Libera Brilliance is (by default) 4dBm at cw at 500MHz.
- This means that the same current with different fill pattern can cause the ADC saturation.
- Example: 33% fill, same current -> 3 times higher counts on ADCs.
- Possible solutions:
  - External attenuators.
  - Internal 6dB attenuators, placed just in front of ADCs. Better solution, since Noise Figure is being just slightly affected.