



ELENA LLRF status update

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Studies: S. Hancock
HLRF: A. Jones, S. Energico, M. Paoluzzi

Ring + extraction lines LPU's part of RF workpackage but not included here

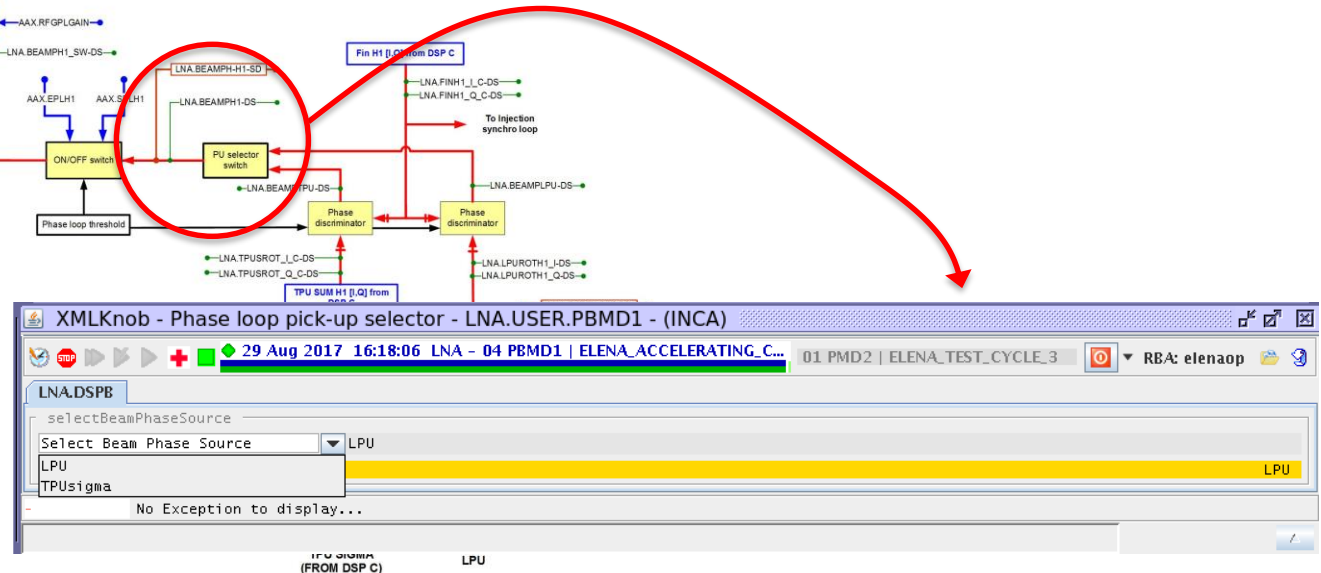
ECC 31 August 2017



1. Improvements wrt last status report (16/03/'17)
2. Operation with source
3. Operation with pbars
4. Next tasks
5. Conclusions



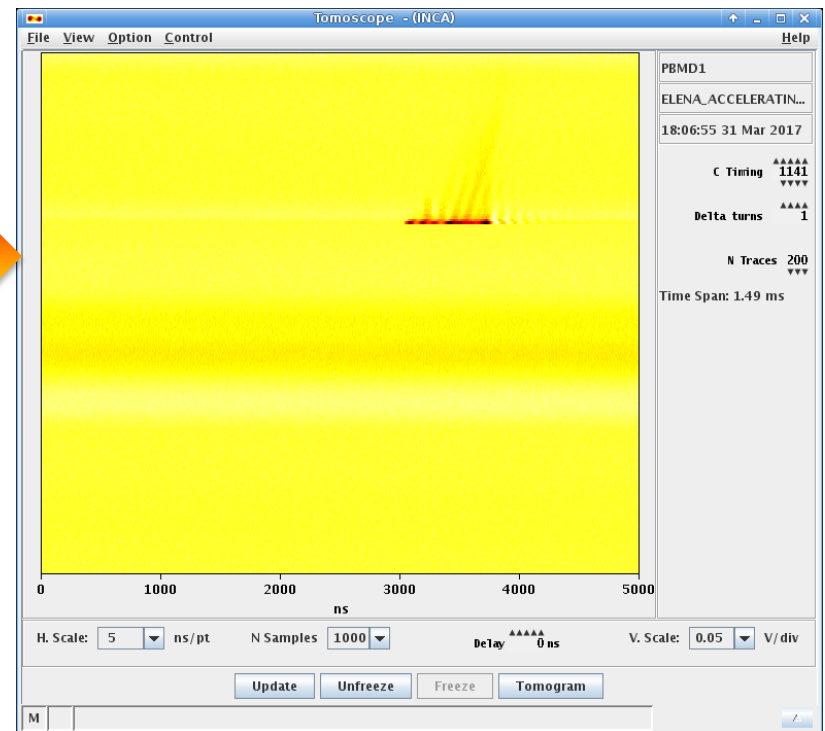
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2. Operation with the source

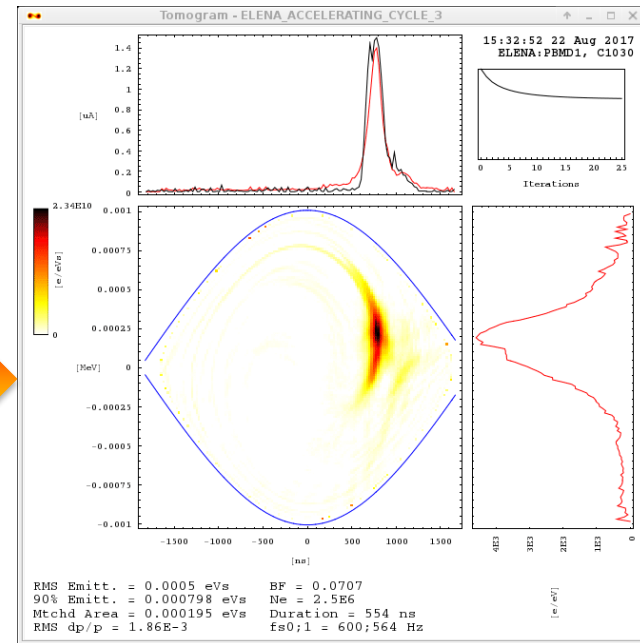
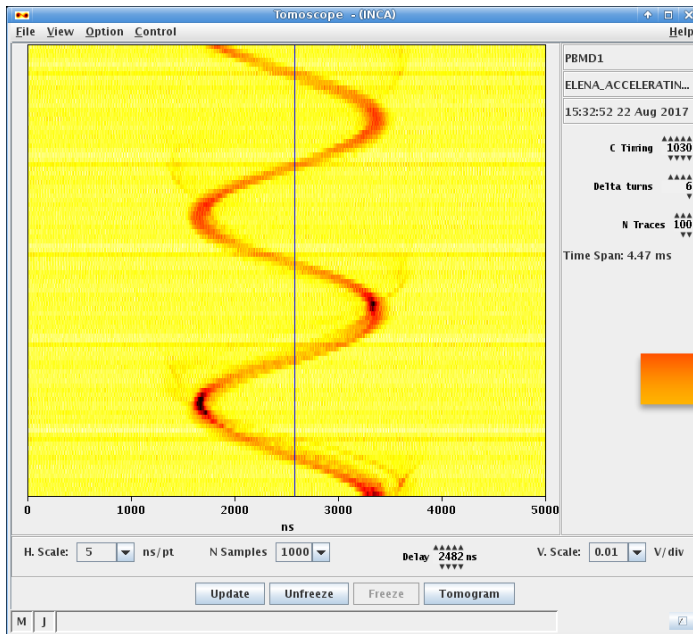
- ❖ **Operational requirement:** no synchro source—ELENA. No bunch-to-bucket transfer, but capture of debunched beam
- ❖ Very poor beam lifetime (~ 6 to ~ 12 turns on 22/08), shorter than beam debunching time \rightarrow cannot work with the RF!

Picture with RF OFF from 31/03,
identical to what we had on 22/08.



2. Operation with the source (cont'd)

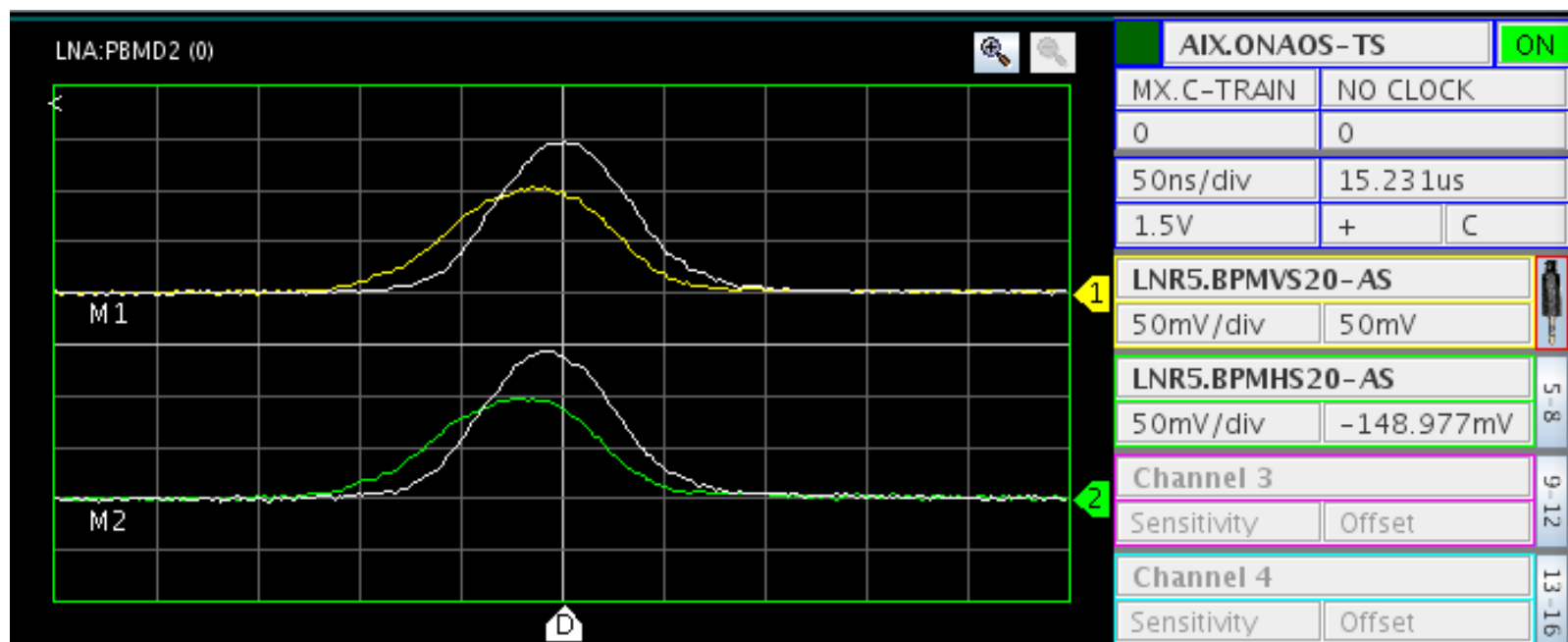
- ❖ Tests done with unsynchronised bunch-to-bucket transfer (source to LLRF)



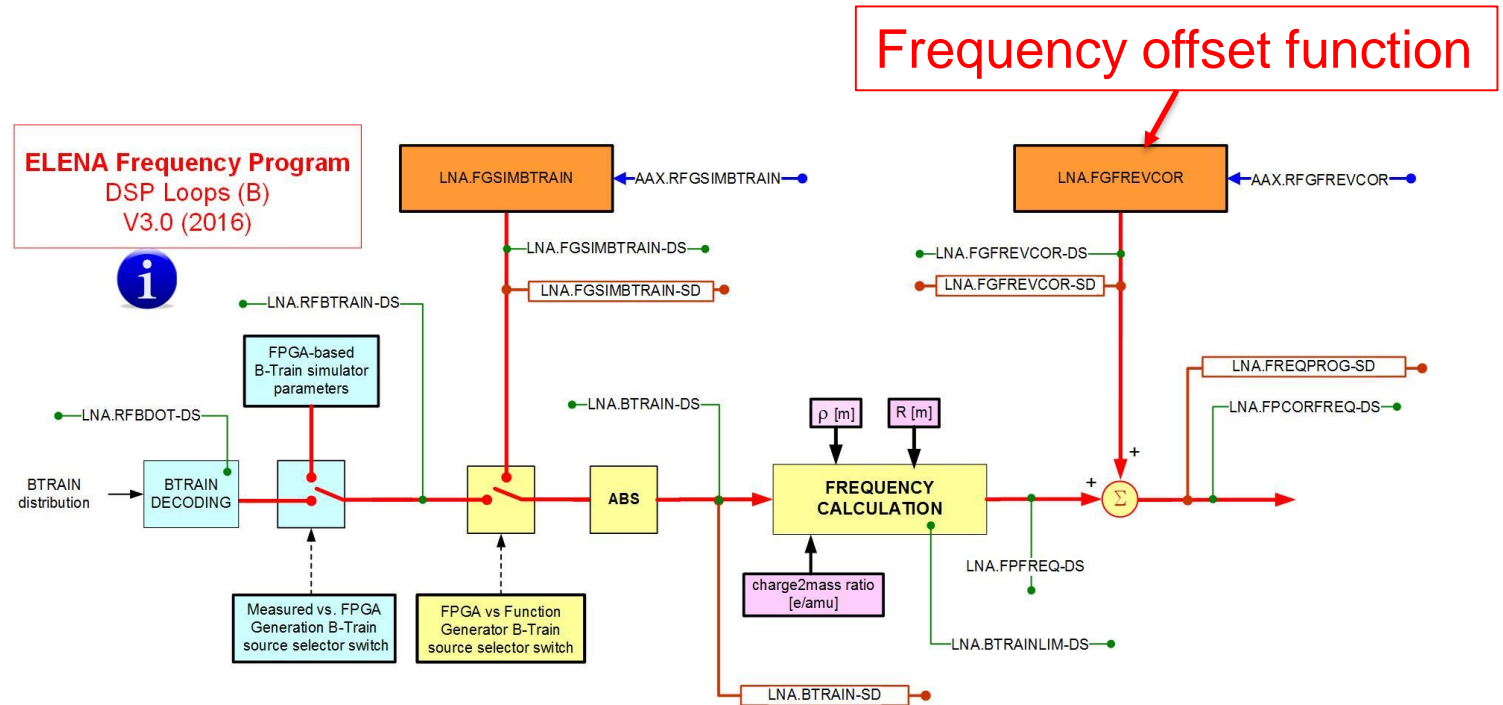
Higher priority problems to be solved before needing extraction synchro loop

3. Operation with pbars

- ❖ **Operational requirement:** AD-ELENA bunch-to-bucket transfer.
- ❖ AD-ELENA synchronisation loop not available yet → need to capture the debunched pbar beam. Good beam lifetime so this is feasible.
- ❖ Estimated intensity (on 23/08): $\sim 2E7$ (vs. $2.6E7$ extracted from AD)



3. Operation with pbars: frequency offset

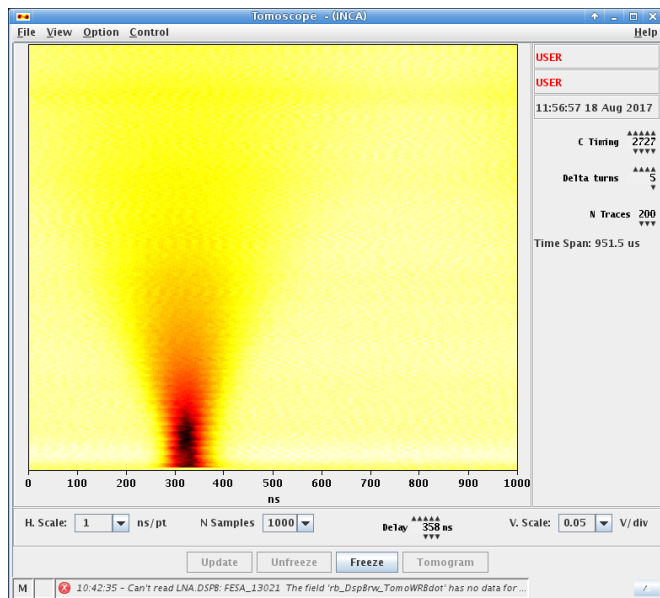


Aims of frequency offset function:

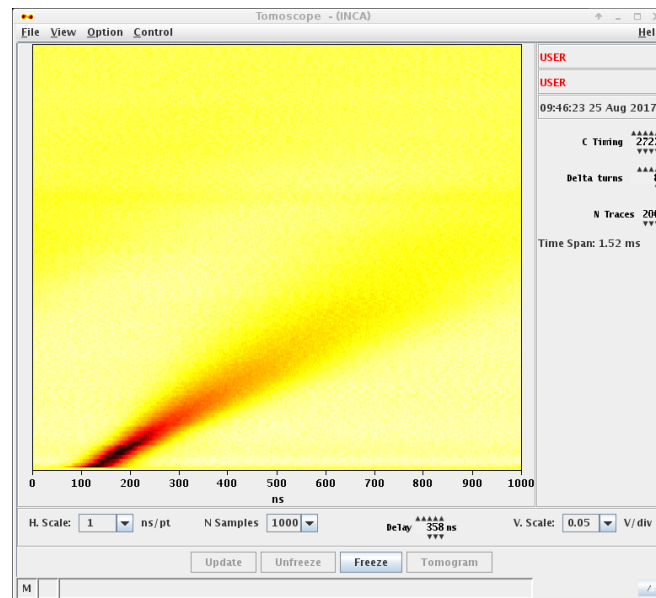
- to vary the RF frequency to compensate for repeatable variations of Bfield or beam energy.
- to steer radially the beam when required (you could do it also with the radial loop).

3. Operation with pbars: frequency offset

How to find the good frequency offset: do not bunch the beam, look at the tomoscope and vary the frequency offset. The desired frequency offset is achieved when the beam debunches in a straight line as seen on the Tomoscope. Ideally the frequency offset should be of 0 Hz.



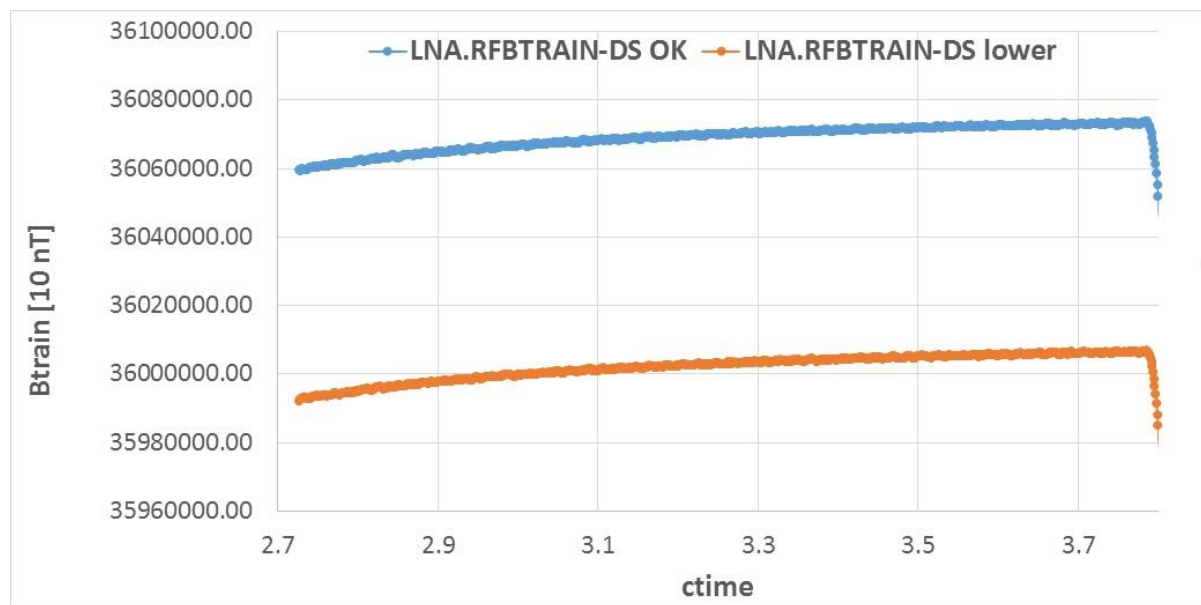
Correct frequency offset



Wrong frequency offset

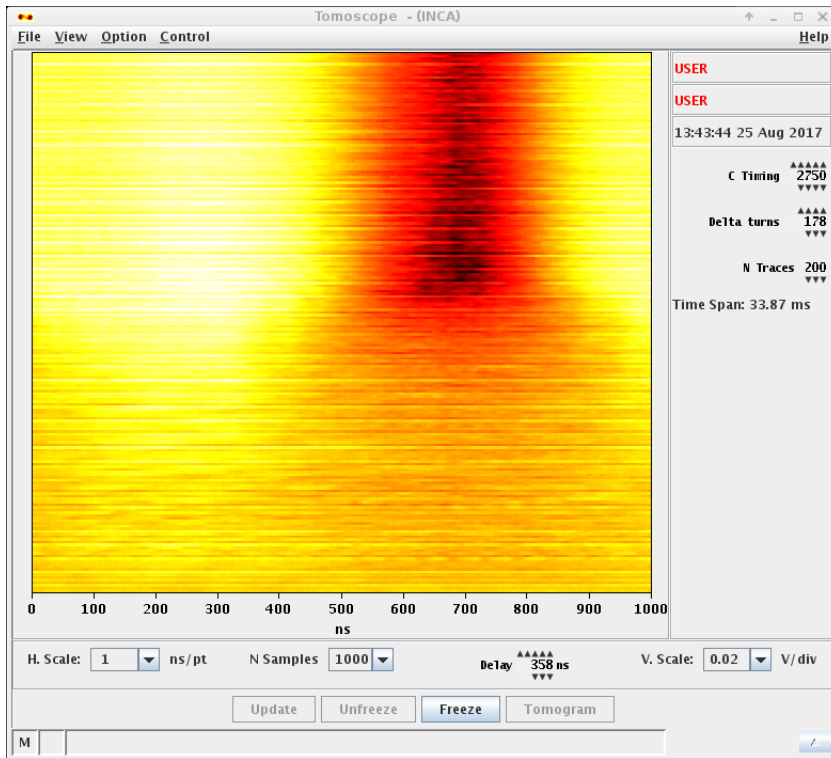
3. Operation with pbars: Btrain (cont'd)

- ❖ Problem with Btrain calibration and shot-to-shot stability.
- ❖ Calibration: done on 18/08 , see http://elogbook.cern.ch/eLogbook/event_viewer.jsp?eventId=2426448
- ❖ Stability: two sets of values spaced by ~ 2 kHz. WRONG!!!!
- ❖ Frequency offset of -1.4 kHz is adapted to higher Btrain dataset only.

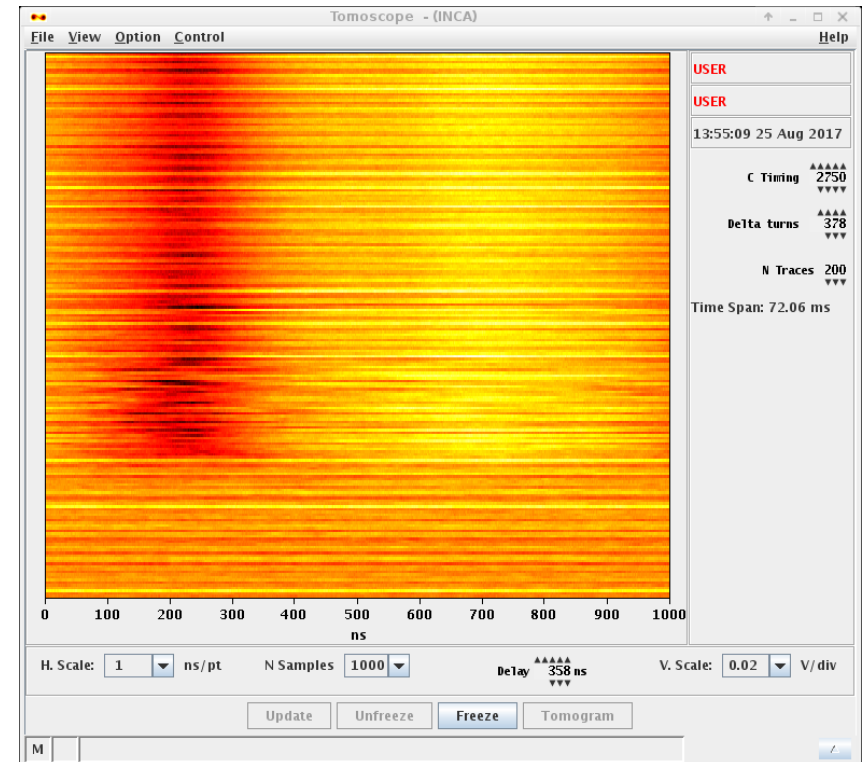


← Data acquisition from Oasis LLRF signals for two cycles

3. Operation with pbars: Btrain (cont'd)



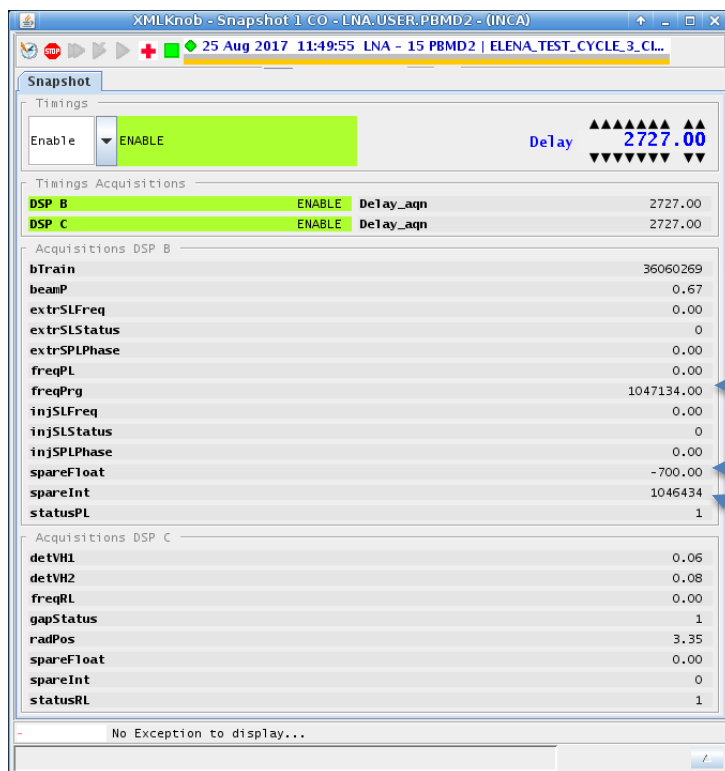
Beam captured with higher
Btrain dataset & frequency
offset of -1.4 kHz



Beam captured with lower
Btrain dataset and frequency
offset of -1.4 kHz

3. Operation with pbars: Btrain (cont'd)

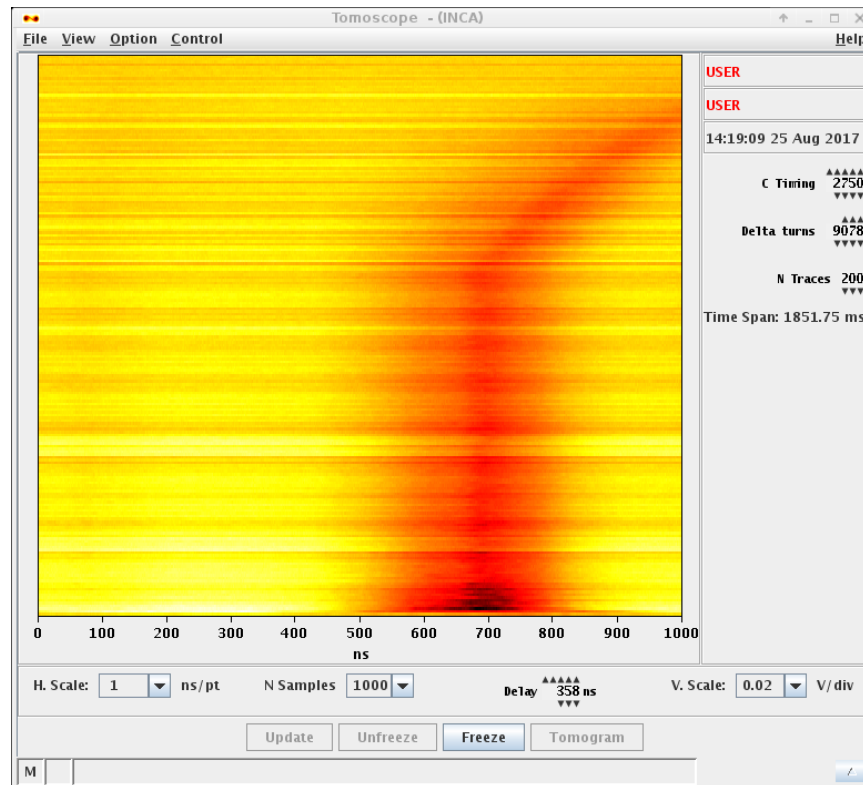
- ❖ LLRF “snaphost” diagnostics helps to acquire single-point values. See http://elogbook.cern.ch/eLogbook/event_viewer.jsp?eventId=2430808



- ❖ Data acquired from LLRF Oasis signals to see longer timespan.

3. Operation with pbars: results (cont'd)

- ❖ Beam captured (ctime 2750) and decelerated, see http://elogbook.cern.ch/eLogbook/event_viewer.jsp?eventId=2430949
- ❖ No loops, constant frequency offset, beam kept for at least 1.8 s.



4. Next tasks

- ❖ Solve problem with Btrain oscillation (pbar, also ions?)
- ❖ Improve ions lifetime
- ❖ Re-calibrate servoloop (changes in LLRF/HLRF since last calibration).
Action: Mic, John, Anthony.
- ❖ Understand problem with phase loop inputs. Action: Mic, John
- ❖ Once source beam is stable, problems solved and radial/phase loops commissioned with source beam, implement and commission extraction synchronisation loop. Action: Mic, MEA
- ❖ Integrate LLRF Fesa classes with RF Cycle editor . Action: Mic, MEA, Lajos. Discussions already re-started.

5. Conclusions

- ❖ Lots of progress and problem understanding recently, even with scarce manpower spread over several projects.
- ❖ Beam captured with pbars and decelerated.
- ❖ Identified several points that have to be addressed.
 - ❖ In the Btrain: remove dual set of values
 - ❖ In the machine: guarantee a longer beam lifetime
 - ❖ In the LLRF: do cavity servolop calibration, look at I/Q data acquisition problem.

Important: do not skip steps! Extraction loop is needed only when machine is more reliable and beam has (much) longer lifetime!!!!