

# Libera performance improvements using software release 2.09

DEELS14

12-13May - ESRF

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# OUTLINE

Brief History Of Libera Release 2.09

Reported On Libera Workshop'13

ITECH Workarounds And Tests At ALBA

Experience With DSC 2.09

ADC Glitches and Level jumps

Higher Temperature

Temperature Regulation

Summary

## Brief History Of Libera Release 2.09

Similar complains on Digital Signal Conditioning (DSC) functionality from different users **during years**

### **May/July 2011 - ESRF**

DSC was learning on noise and coeffs did never recover afterwards  
Modification of DSCD\_MINTBT\_LEARN\_LIMIT seemed to work at that time

### **September 2011 - DESY**

Detected problem of DSC learn cycle during an inadvertent beam dump  
**Reported on Libera Workshop'11**

### **November 2011 - ALBA**

When beam was killed, Liberas still calculated phase coeffs at very low Level values (-60dBm)

### **February 2012 - ITech visit to ALBA to fix the problem**

Found ideal DSCD\_MINTBT (6e6) but still wrong learning on beam dumps

## Brief History Of Libera Release 2.09

We continued having noisy position measurements and faulty interlocks from time to time, during months

ALBA did a dedicated presentation on DSC malfunctions on Libera Workshop 2013 and requested ITech to correct it

Users on that workshop also pushed the company to correct the DSC

ITech finally agreed on improving the DSC performance

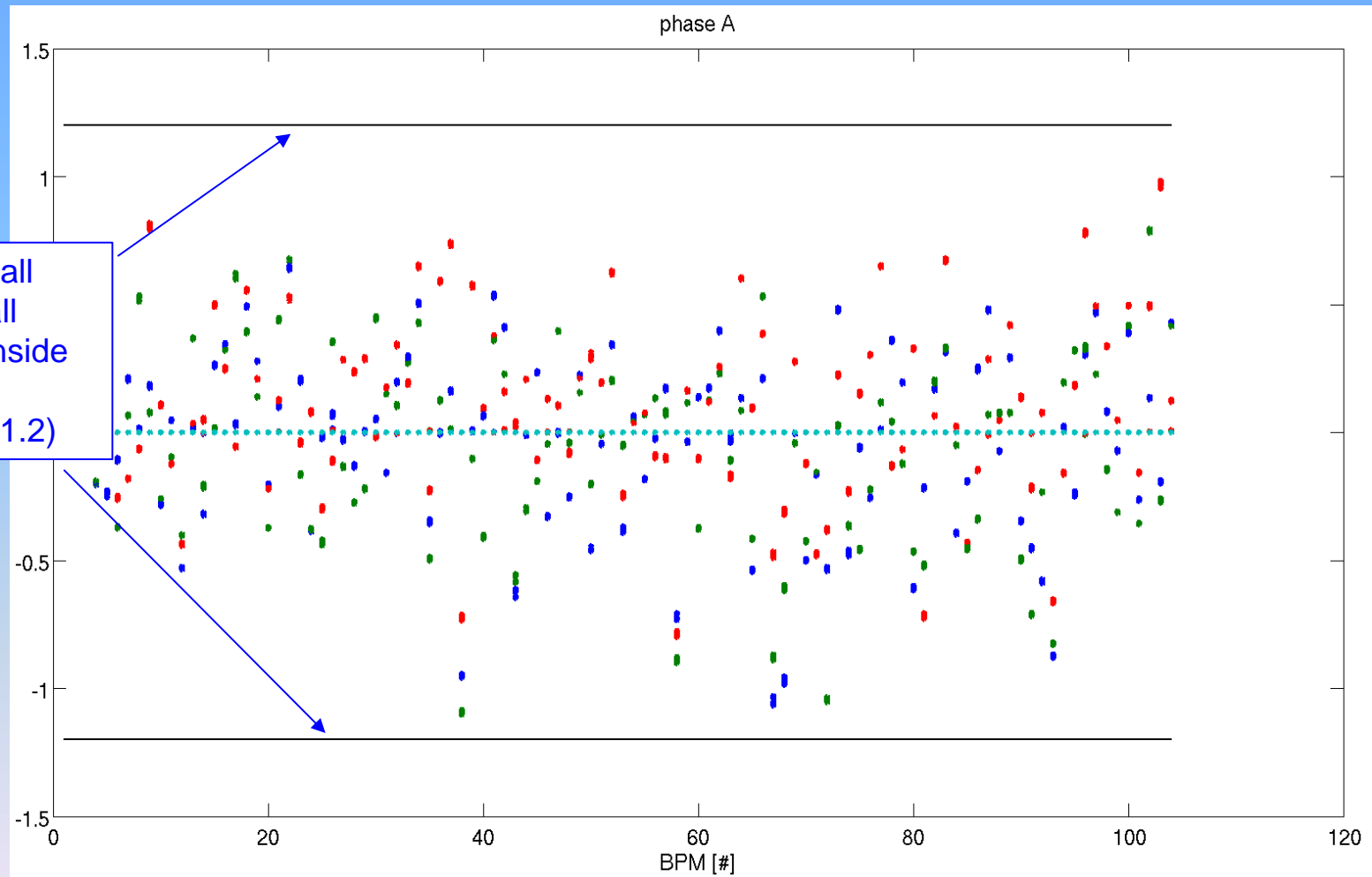
ALBA collaborated with ITech on the testing of different DSC patches

Official release 2.09 arrived by the end of 2013

It includes DSC correction and also patch on ADC glitches

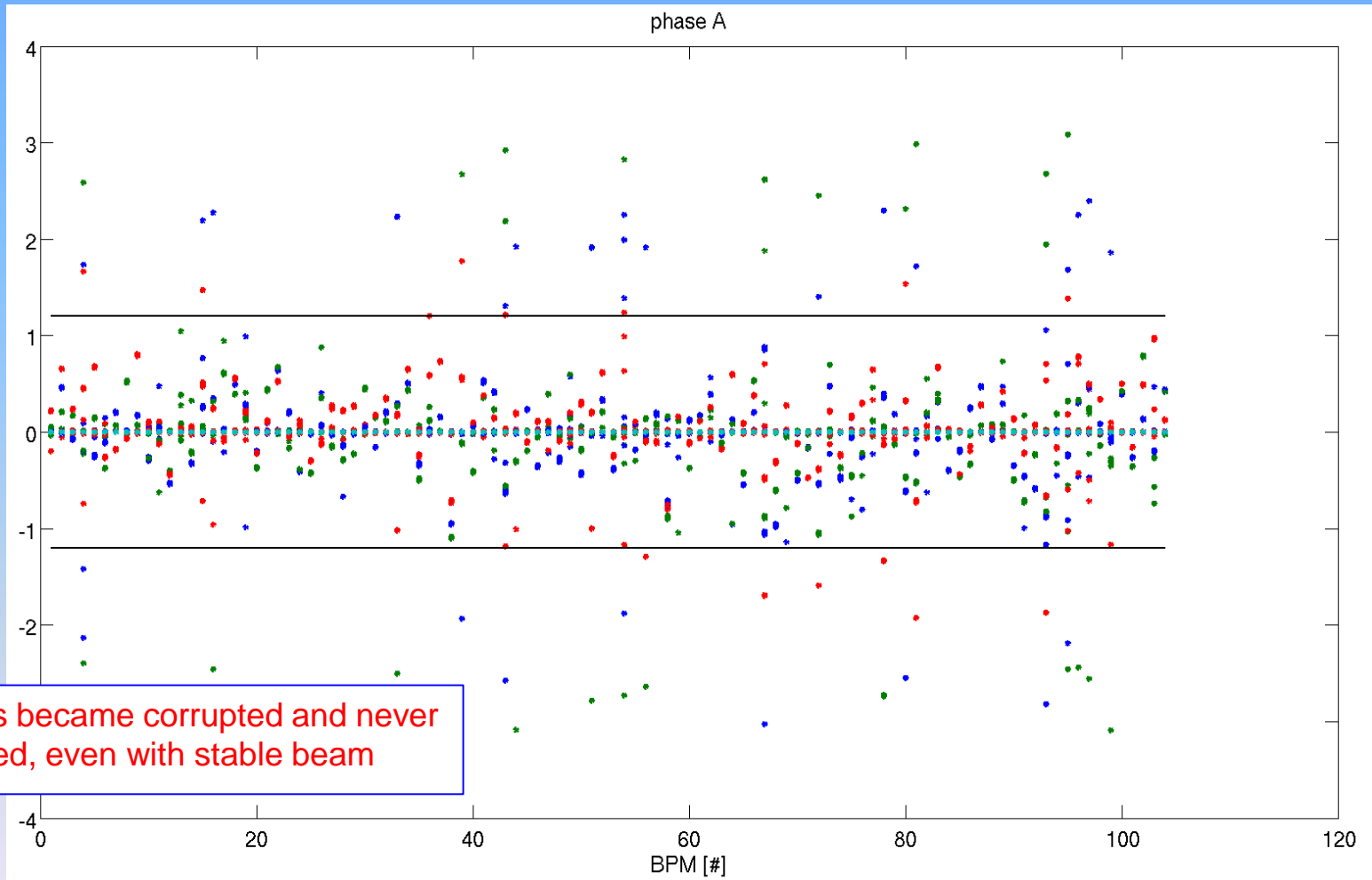
# Reported On Libera Workshop'13

## Phase Coeffs right after DSC learning



# Reported On Libera Workshop'13

## Phase Coeffs after some sudden beam losses



# Reported On Libera Workshop'13

Not only an ALBA issue

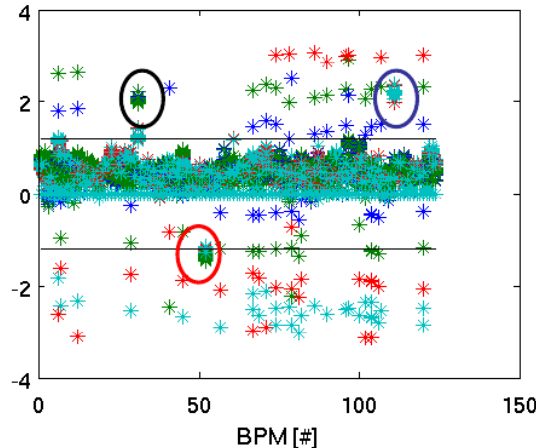
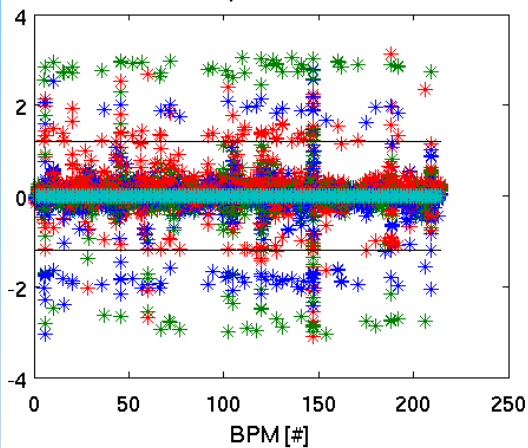
ESRF

SOLEIL

PETRA III  
(reported on 2011)

phase A

phase B



## BPM System Critical Issues (DSC, 4)

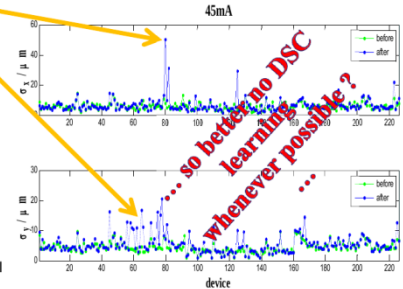


... but DSC learning can (at least) be affected by spontaneous beam losses!

- Calculation of incorrect DSC coefficients (amplitude, phase) based on noise signals shall be inhibited by „MinTbLearnLimit“ parameter threshold detection (new: 40000 for Libera Brilliance at PETRA III)
  - does yet not work correctly

Test procedure used:

- Establish a certain beam current at absolute stable beam conditions (60 bunches, FOFB etc.)
- Let AGC settle the gain level
- Let DSC learn
- take 1<sup>st</sup> measurement („before“)
- Keep gain level (AGC off)
- Dump the beam (80% → 20% in 70μs)
- Turn DSC off (keep AGC off)
- Reestablish the former beam current level
- Take 2<sup>nd</sup> measurement („after“)
- (repeat sequence for other beam currents ... → similar results found at different other beam currents)



(similar effect expected on steep beam current gradients due to DSC coefficients calculation → currently under investigation)

## Reported On Libera Workshop'13

Status Pre-2.09 on different machines

### **ALBA / ESRF / DESY**

- Phase coeffs are corrupted when a sudden beam dump happens
- Coeffs do not recover, even with stable beam

### **DESY**

- Invented a workaround in Petra III top-up mode to reduce the risk of DSC coefficient corruption due to inadvertent beam dumps

### **DIAMOND**

- Have developed their own DSC algorithm
- No problems regarding sudden beam drops

### **SOLEIL**

- Calculation has to be disabled when there is no beam to avoid wrong coefficients
- Beam losses on position interlock when the libera tried to use wrong coeffs



## ITECH Workarounds And Tests At ALBA (Brilliance Only)

After Libera Workshop (April'13), ITech finally decided to correct their DSC problems

Why?:

- Because it was proved that their DSC algorithm was not OK
- That affected most of the users
- (my guess) Because ESRF won't buy more Liberias (~160) as long as it was not resolved

Users insisted to adapt the Diamond version and make that one available to all users

ITech (at first) decided not to adapt the Diamond algorithm, just correct their one

# ITECH Workarounds And Tests At ALBA

May'13 – ALBA received a patched version for testing

What was new?

- Variance of the channels was calculated and compared to the minimum of the Amplitudes
- If the variation was above the tolerance, the coeffs from the current calculation period were discarded
- Diamond DSC daemon does all this very similar

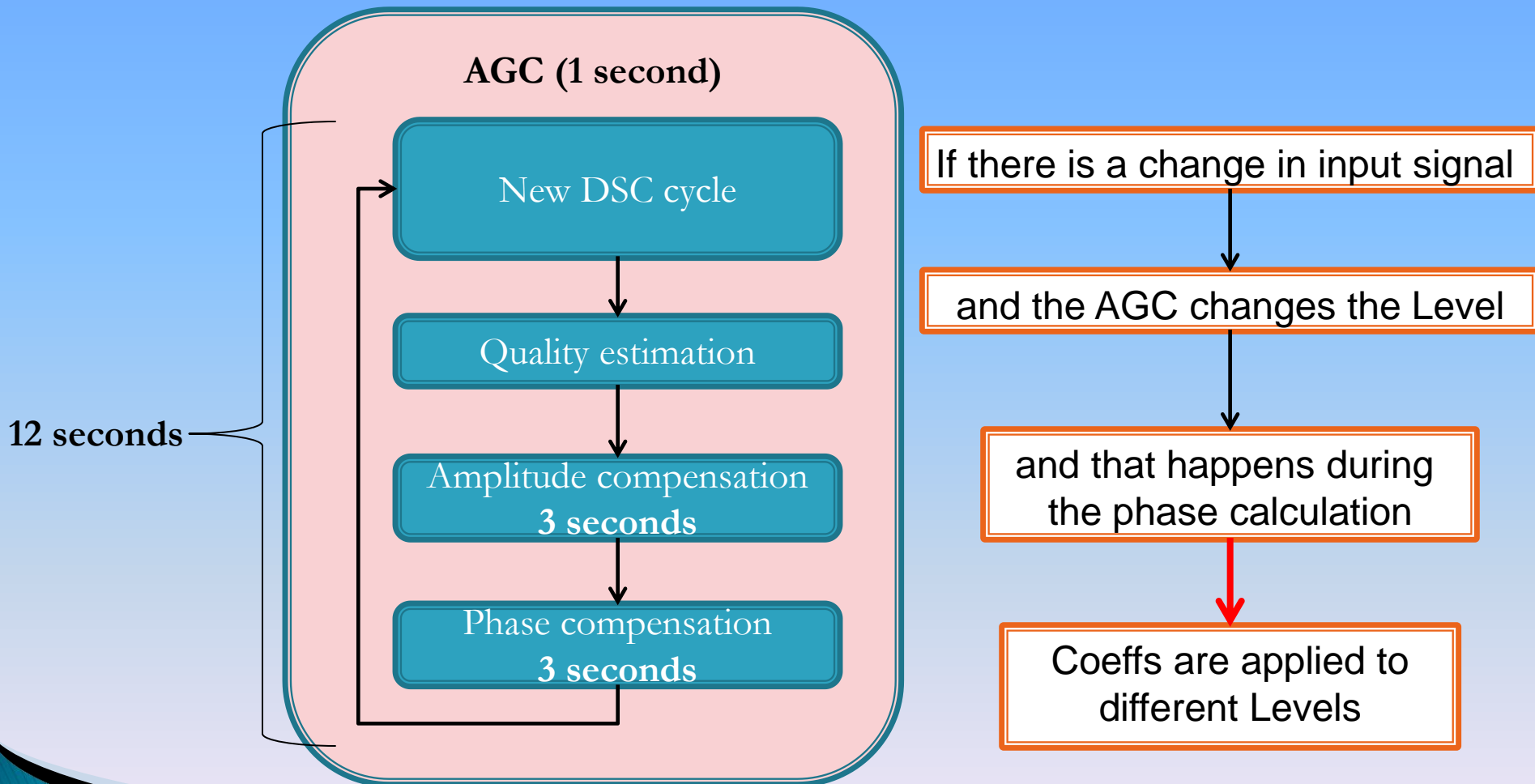
## Test results @ ALBA

No phase coeffs going to too high values, but...

- 1 - Still a couple of Liberas that had calculated coeffs at very low currents, outside the threshold defined by DSC\_Min\_TbT value
- 2 – Still the Liberas had amplitude coeffs at a determined Levels but no phase coeffs

# ITECH Workarounds And Tests At ALBA

Why there are amplitude coeffs but no phase coeffs?

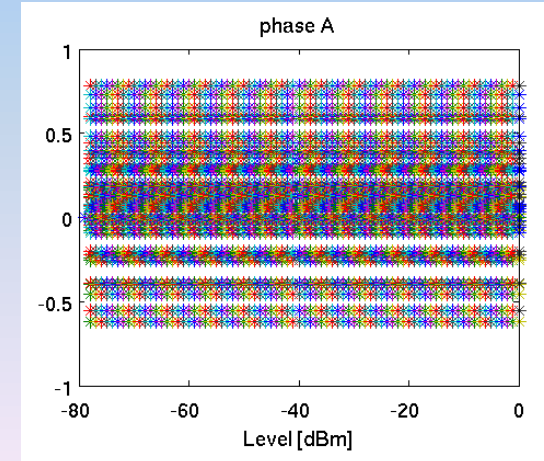
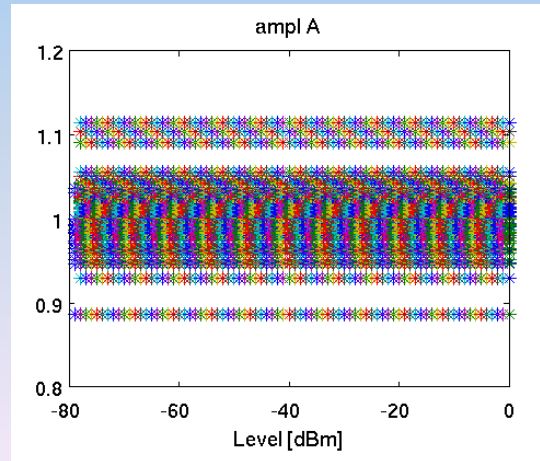


# ITECH Workarounds And Tests At ALBA

September'13 – ALBA received the Pre-release 2.09

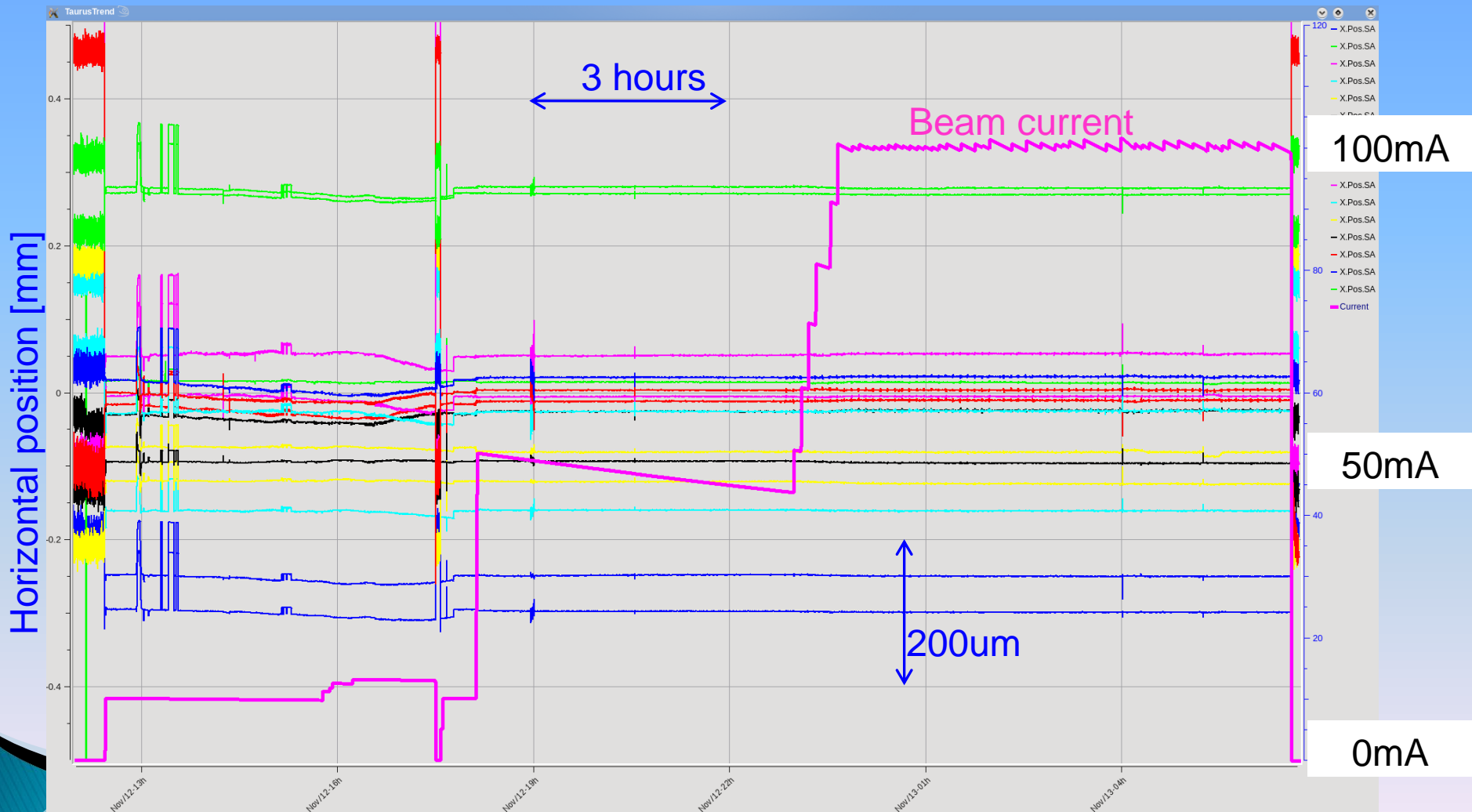
What was new?

- ITech followed Diamond principle (once again)
- DSC does not store any coefficients for a particular Level but works with one set only
- Coeffs table kept for compatibility
- Table is a copy of last calculated coeffs to all Levels
- No need for long learning cycles → reduce steps at Level values with default coeffs



# Experience With DSC 2.09

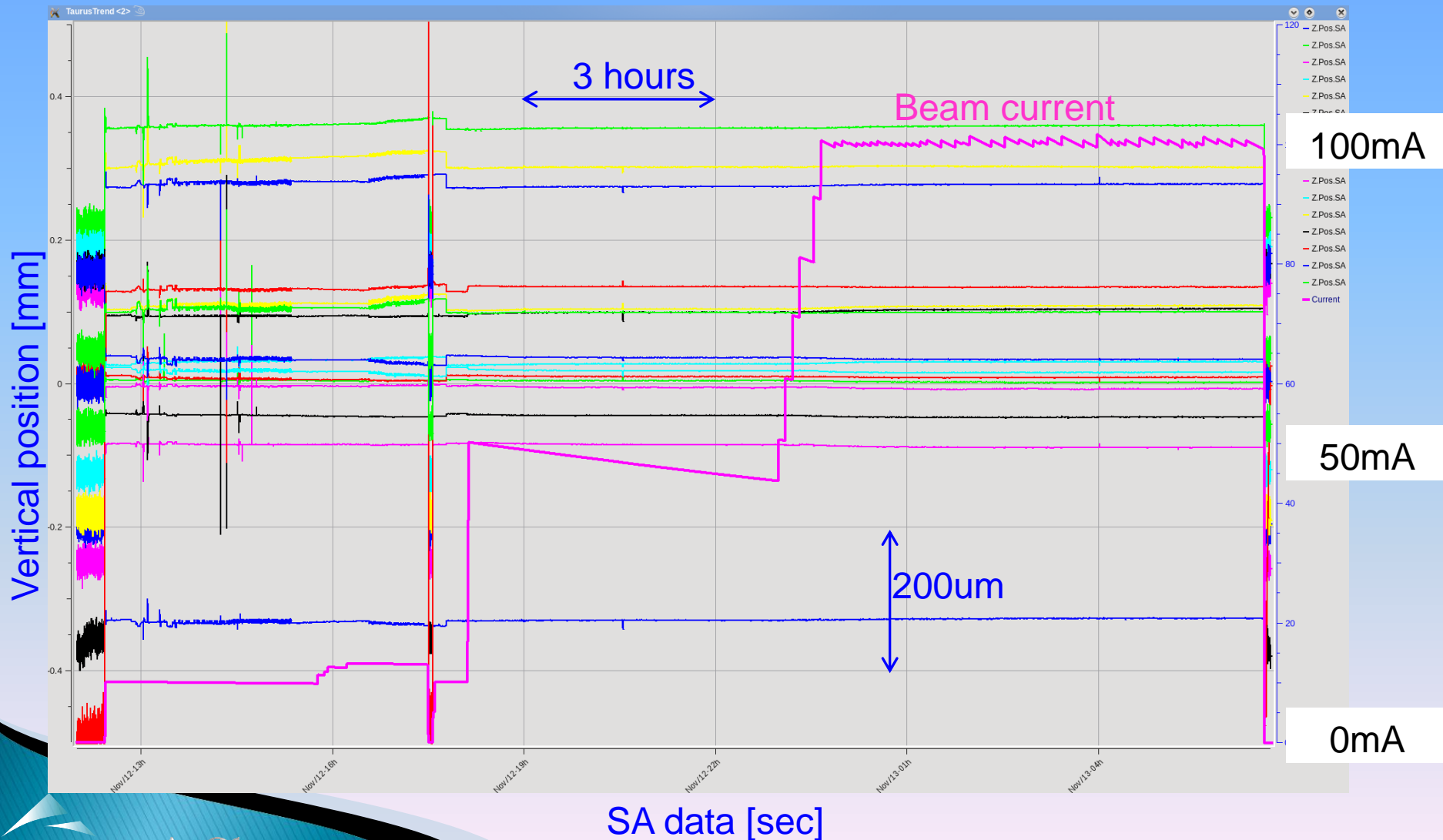
Jumps in position when Level changes has been reduced



SA data [sec]

# Experience With DSC 2.09

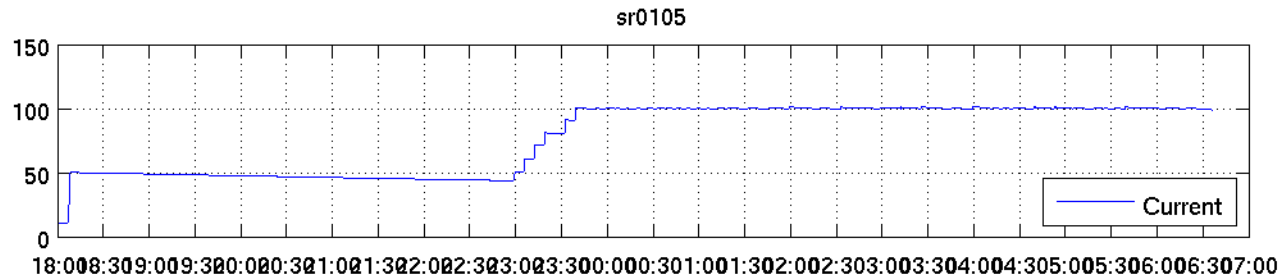
Jumps in position when Level changes has been reduced



# Experience With DSC 2.09

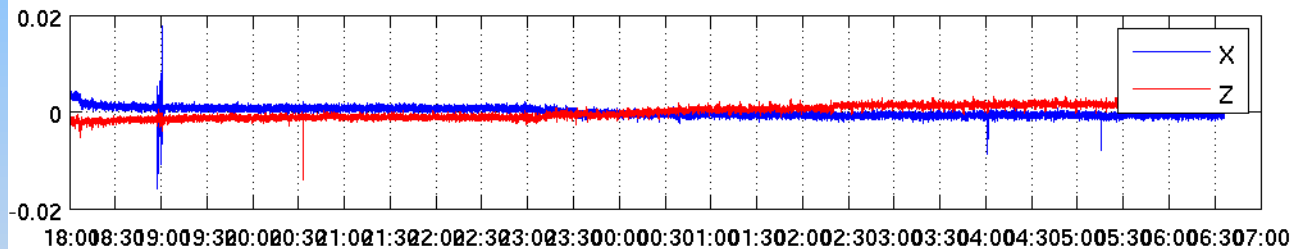
Position changes due to DSC, Level changes ... inside noise level

Beam  
current

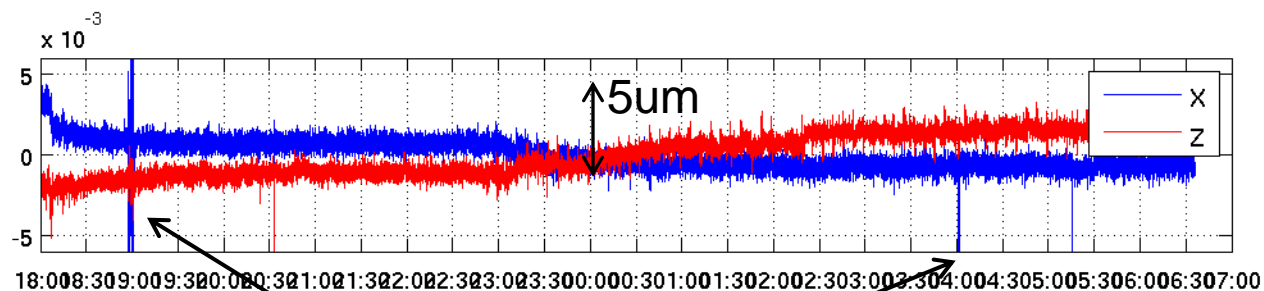


From 10 to  
100mA

Detail of  
BPMSR0105



Zoom In  
BPMSR0105

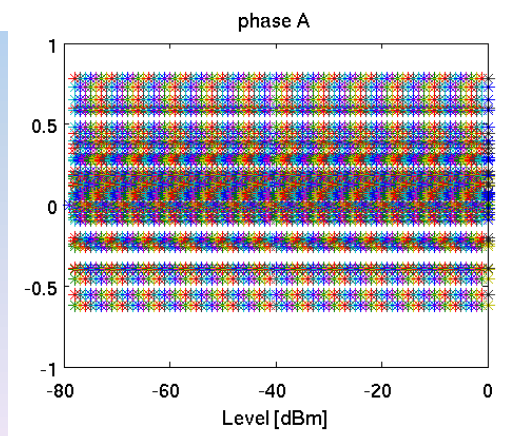
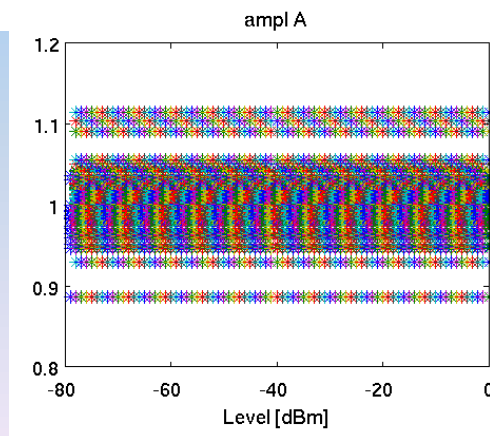
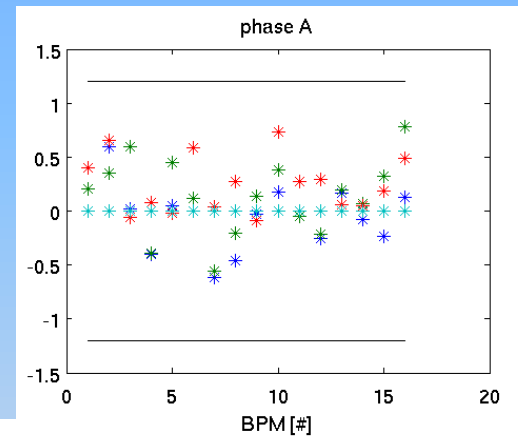
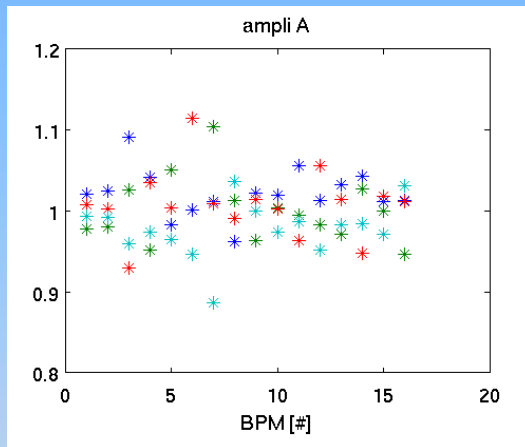


Glitches and big position jumps common to all BPMs are due to SR tests (machine studies, corrections...)

# Experience With DSC 2.09

Until now, the phase and amplitude coeffs look reasonable

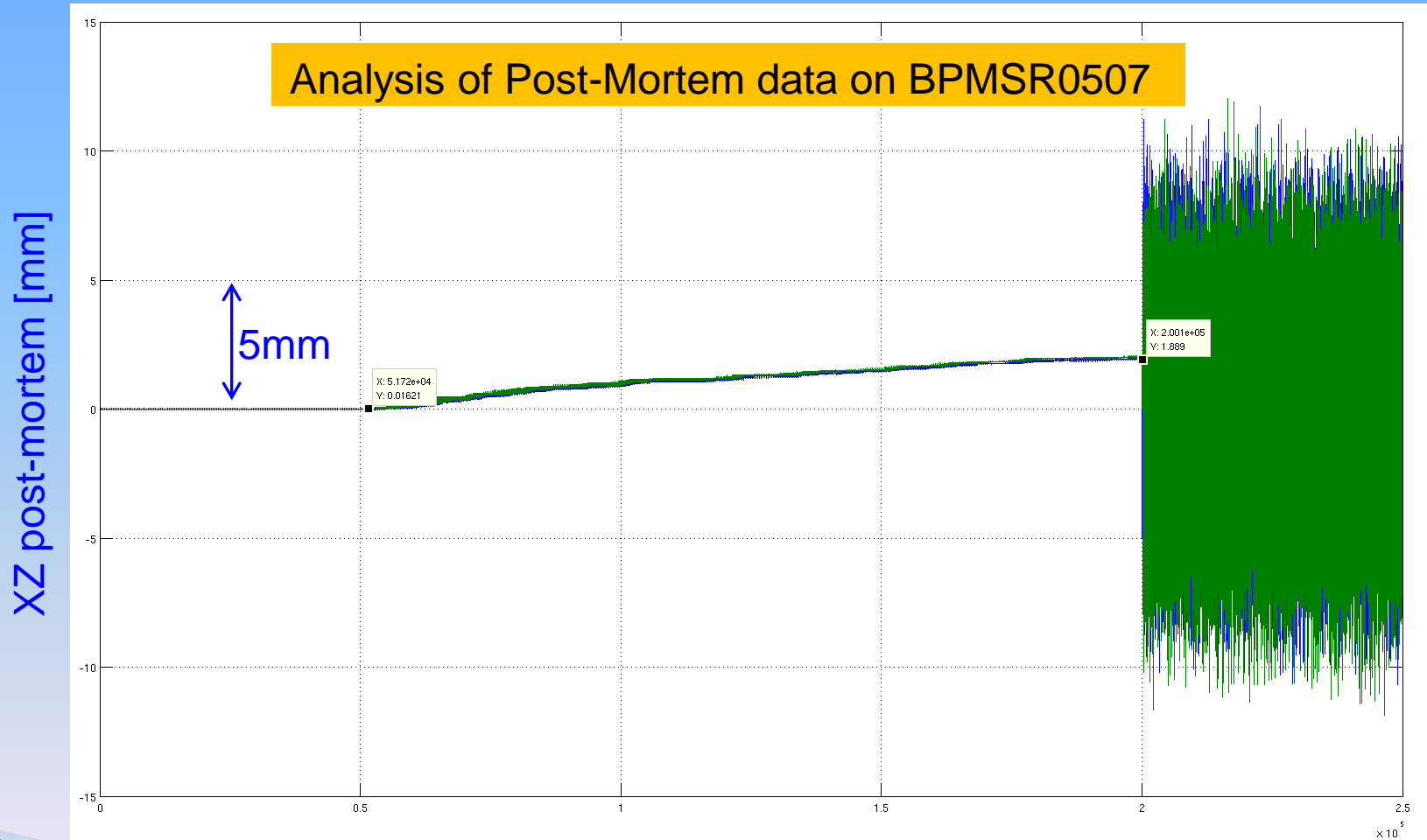
Obviously Levels with phase coeffs but no amplitude coeffs do not exist anymore





# Experience With DSC 2.09

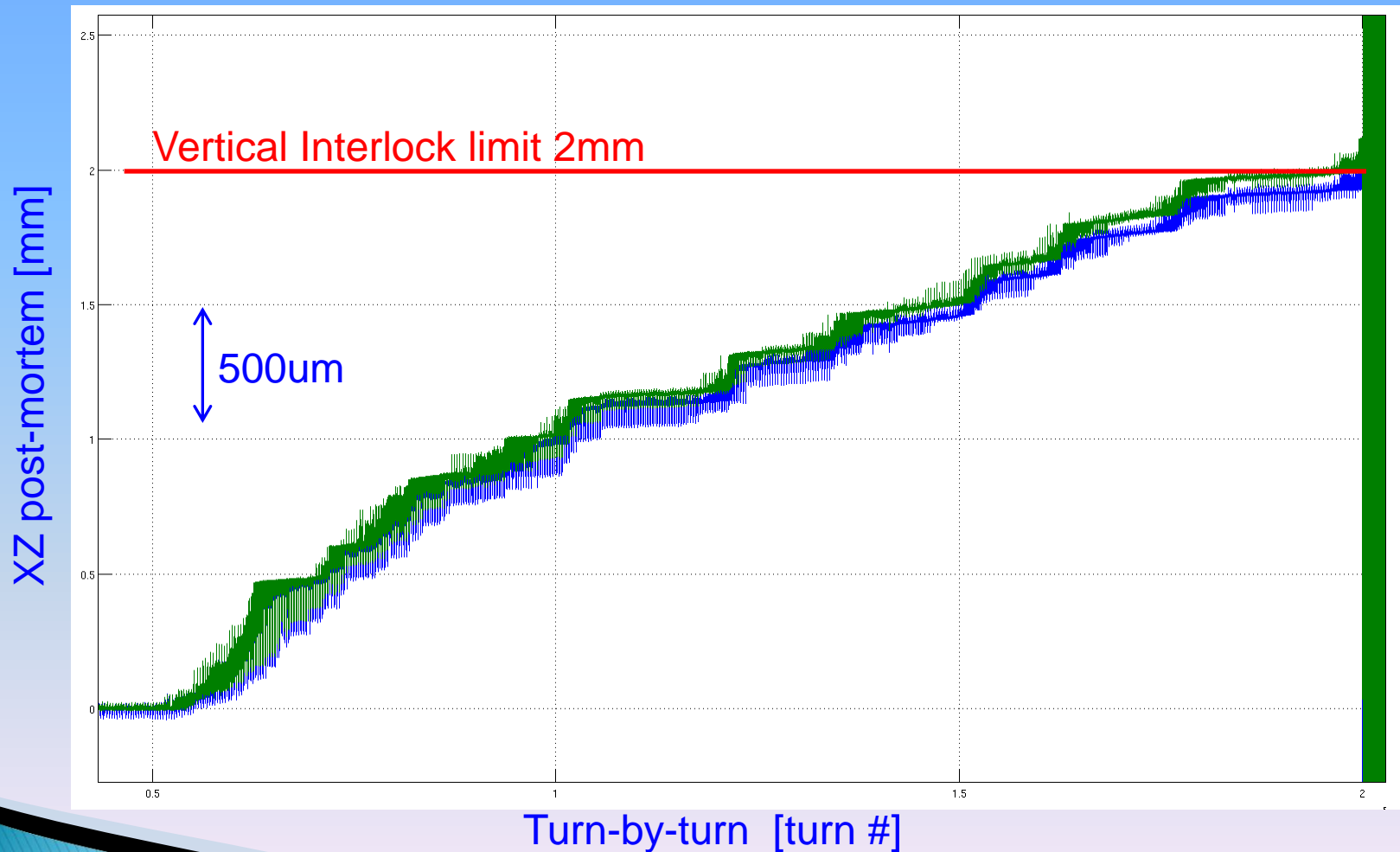
Only one **unexplained beam interlock** due to BPMs



## Experience With DSC 2.09

Position starts to drift only on that BPM

Beam dumped by Machine Protection System 133ms after (148382 Turns)

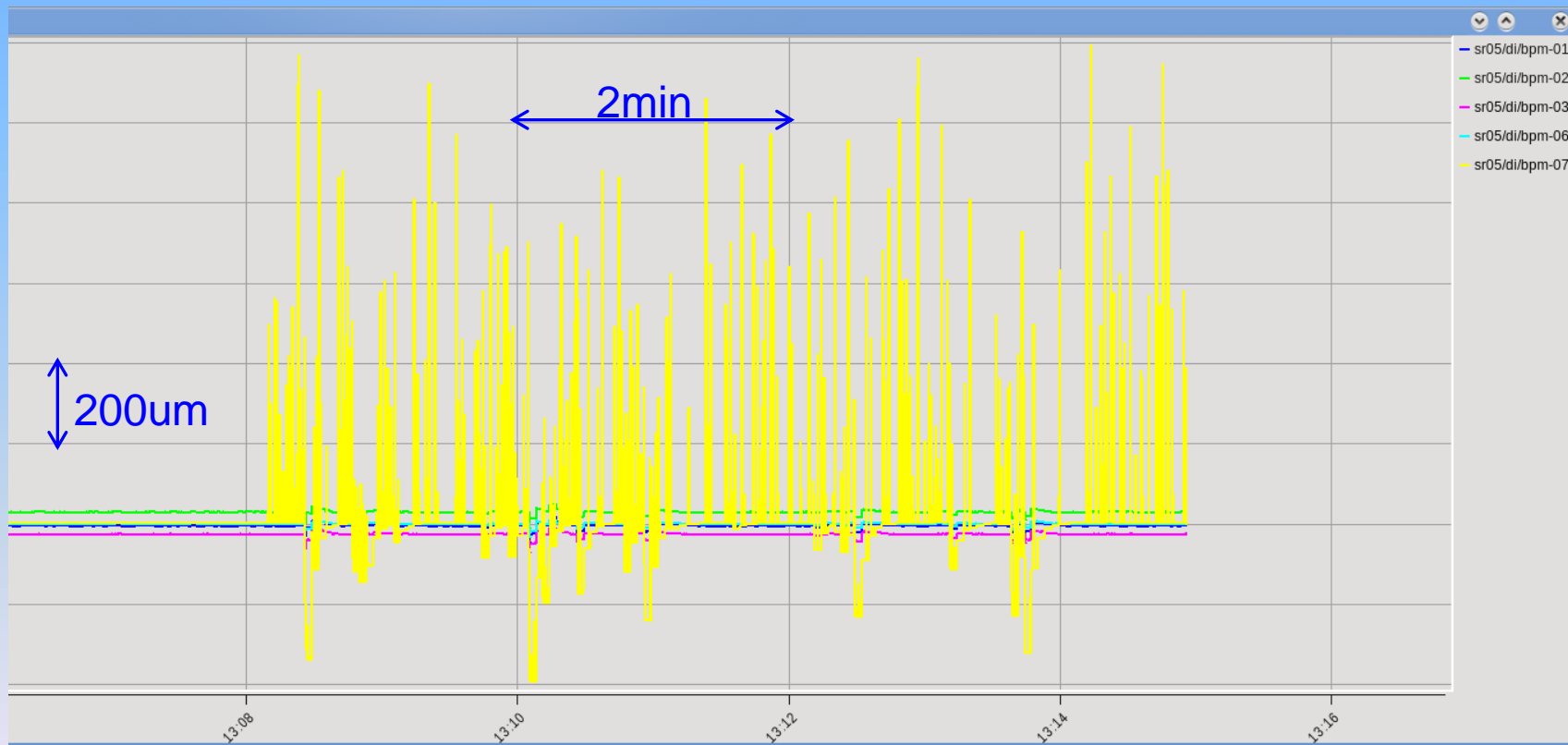


## Experience With DSC 2.09

Reinjection after beam dump, keeping Liberass as they were

No effect before 15mA beam current

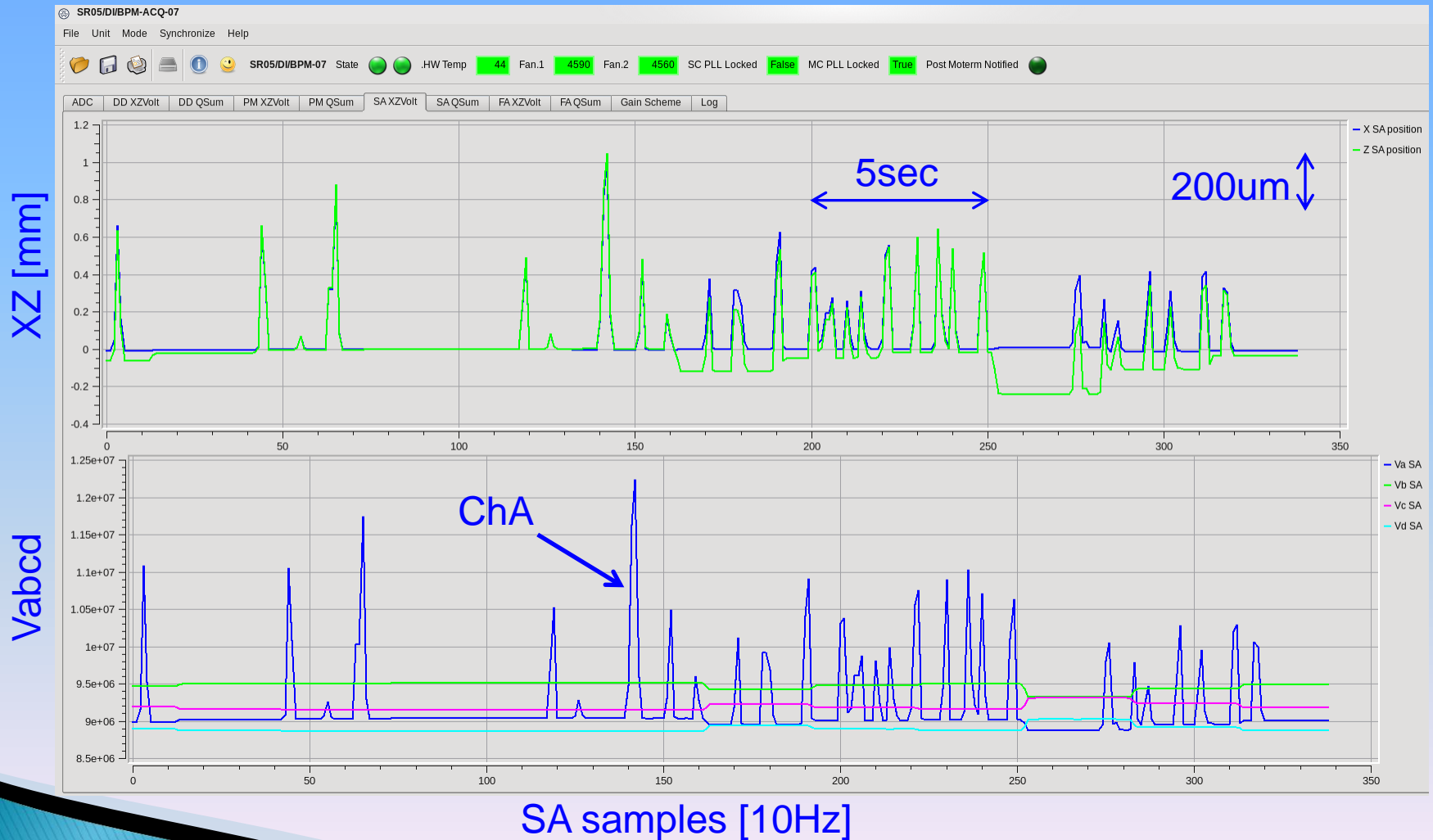
Big position jumps on BPMSR0507 from there on



SA data [sec]

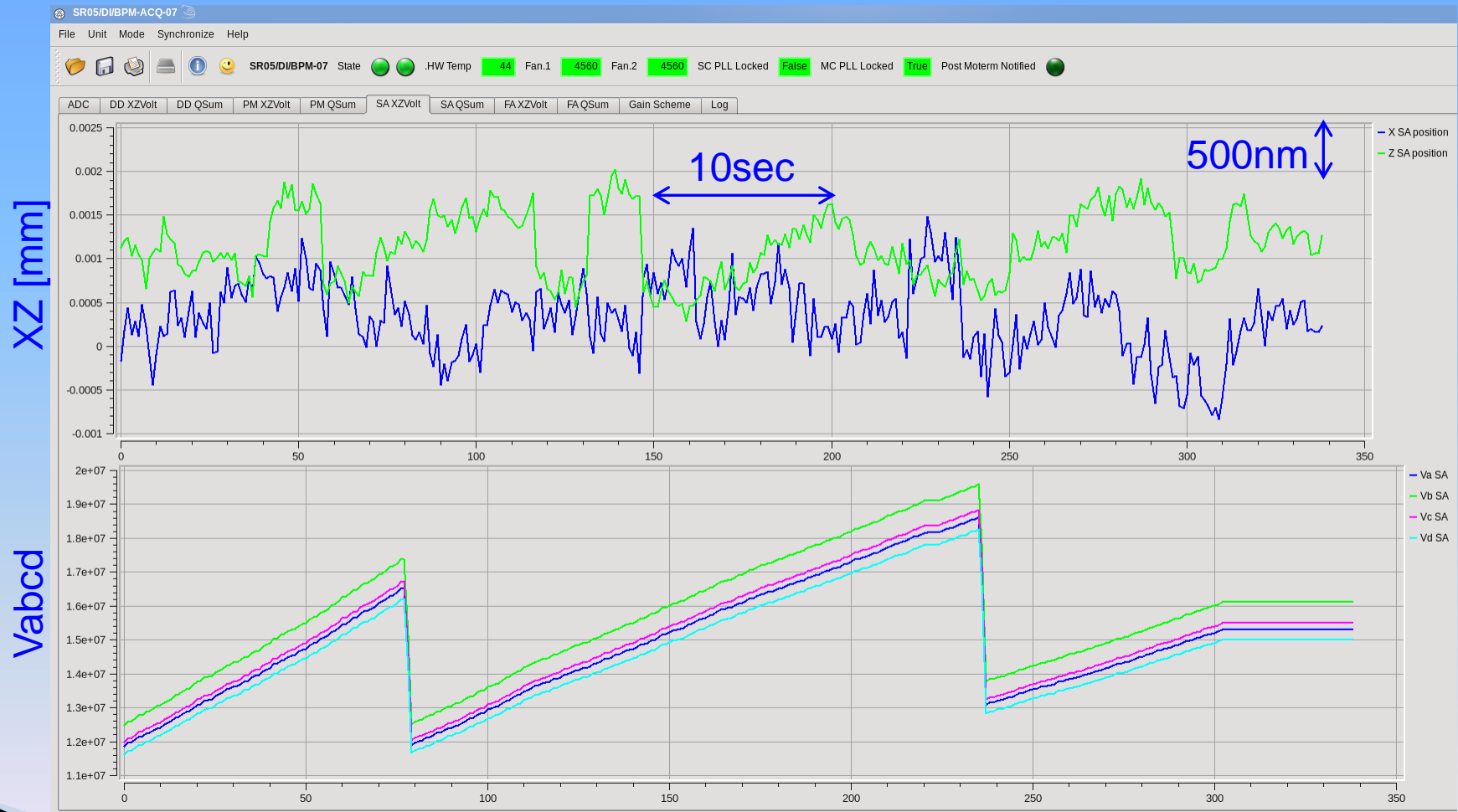
# Experience With DSC 2.09

Problem only on Channel A. We suspected of a HW problem on that RF channel (ADC, Variable attenuator, ...)



# Experience With DSC 2.09

After a Libera reboot and injecting up to 120mA → problem disappeared



SA samples [5Hz]

## Experience With DSC 2.09

So it was not a HW problem

Could it be something related with bizarre DSC coeffs?



We don't know because we did not save the DSC coeffs at that time



From then on, we save not only PM data and INT time-stamp but also DSC coefficients files on each beam dump



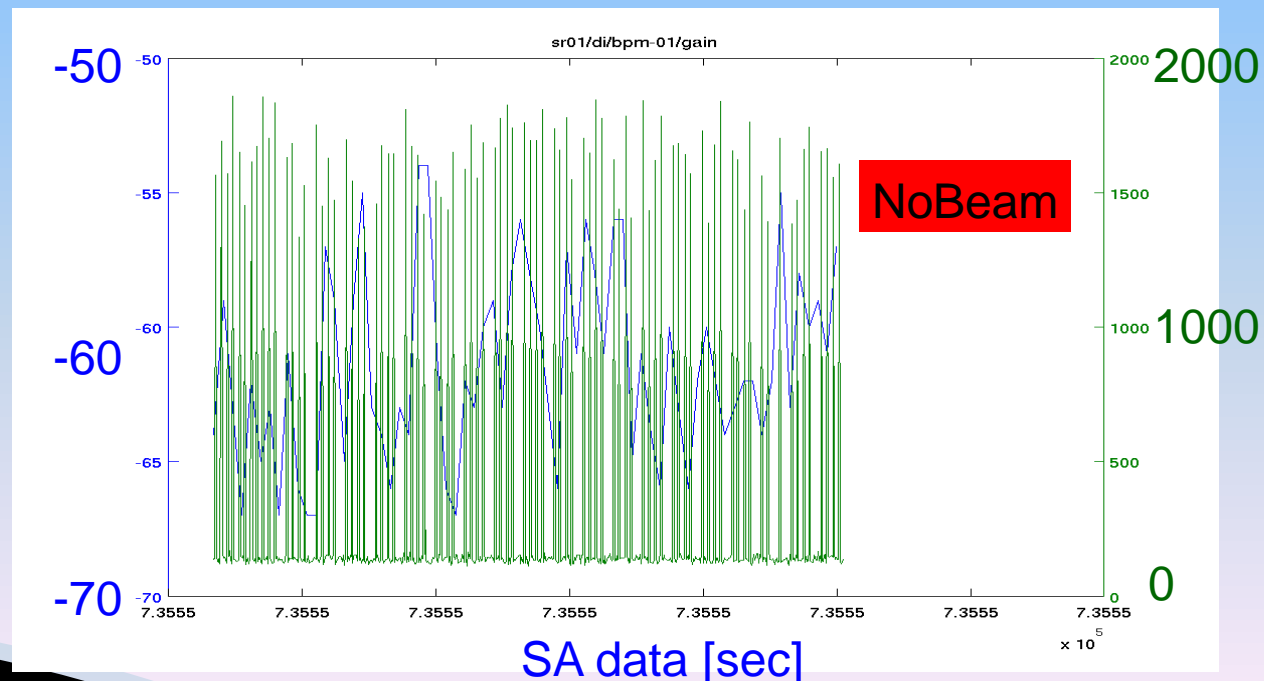
To judge if that was because of DSC, we have to wait for it to happen again

## ADC Glitches and Level jumps

Last 16 Libera units received from ITech (2011) had some HW differences:

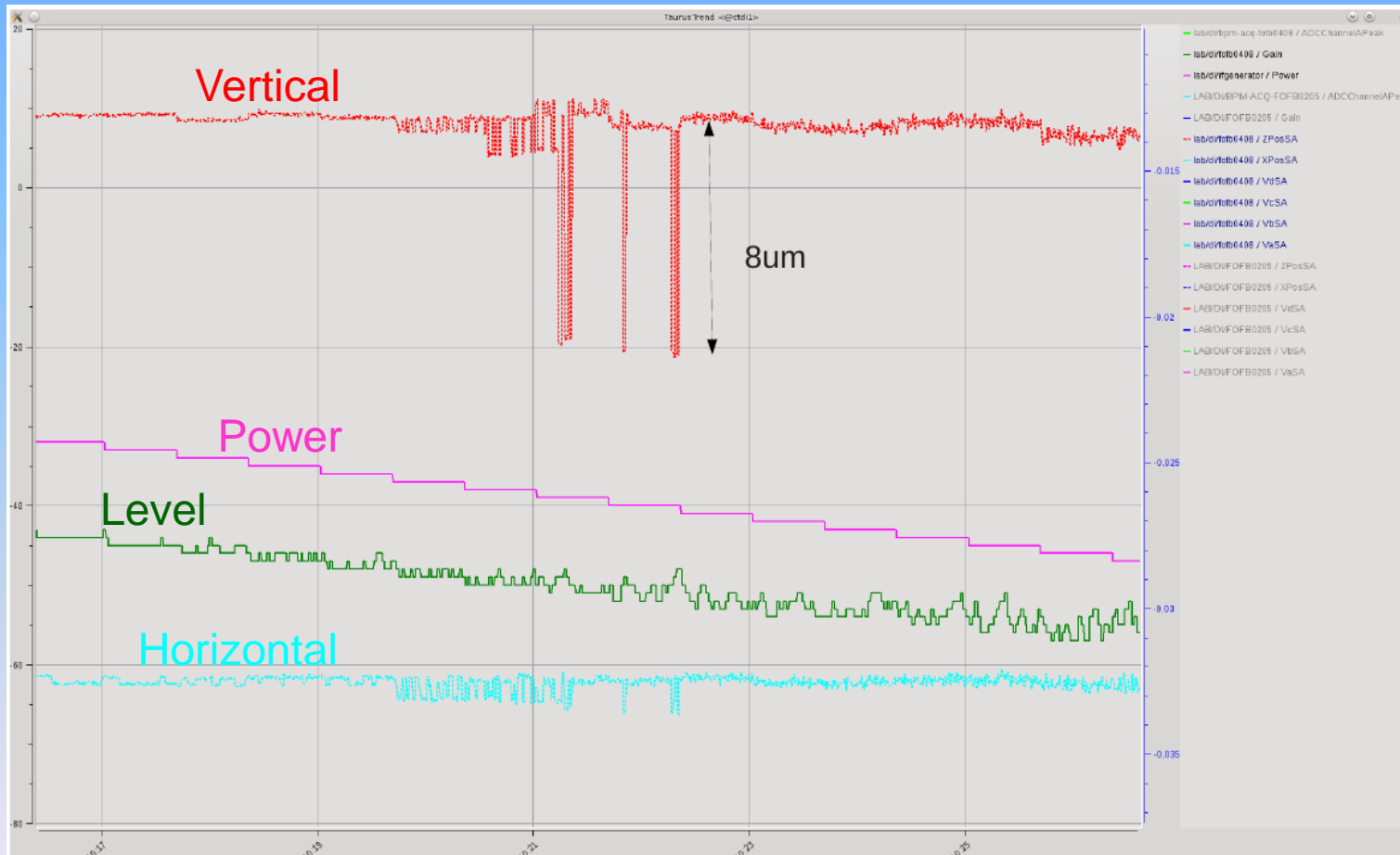
- New SAW filter at the RF channels: less insertion loss, more reliable, bandwidth wider (approximately 19 MHz compared to 10 MHz in previous version)
- Programmable VCXO instead of 2 VCXOs

We detected high glitches on ADC @ low current and also high jumps in Level settings because of the ADC glitches.



# ADC Glitches and Level jumps

Combination of new SAW filter, switching, AGC, Levels jumps .... affected the position



SA data [sec]



## ADC Glitches and Level jumps

We showed these problems to ITech during the 2013 workshop, without any feedback from them at that moment

Annoying thing is that this issue was already reported by Diamond in December 2011 but never considered important and never solved

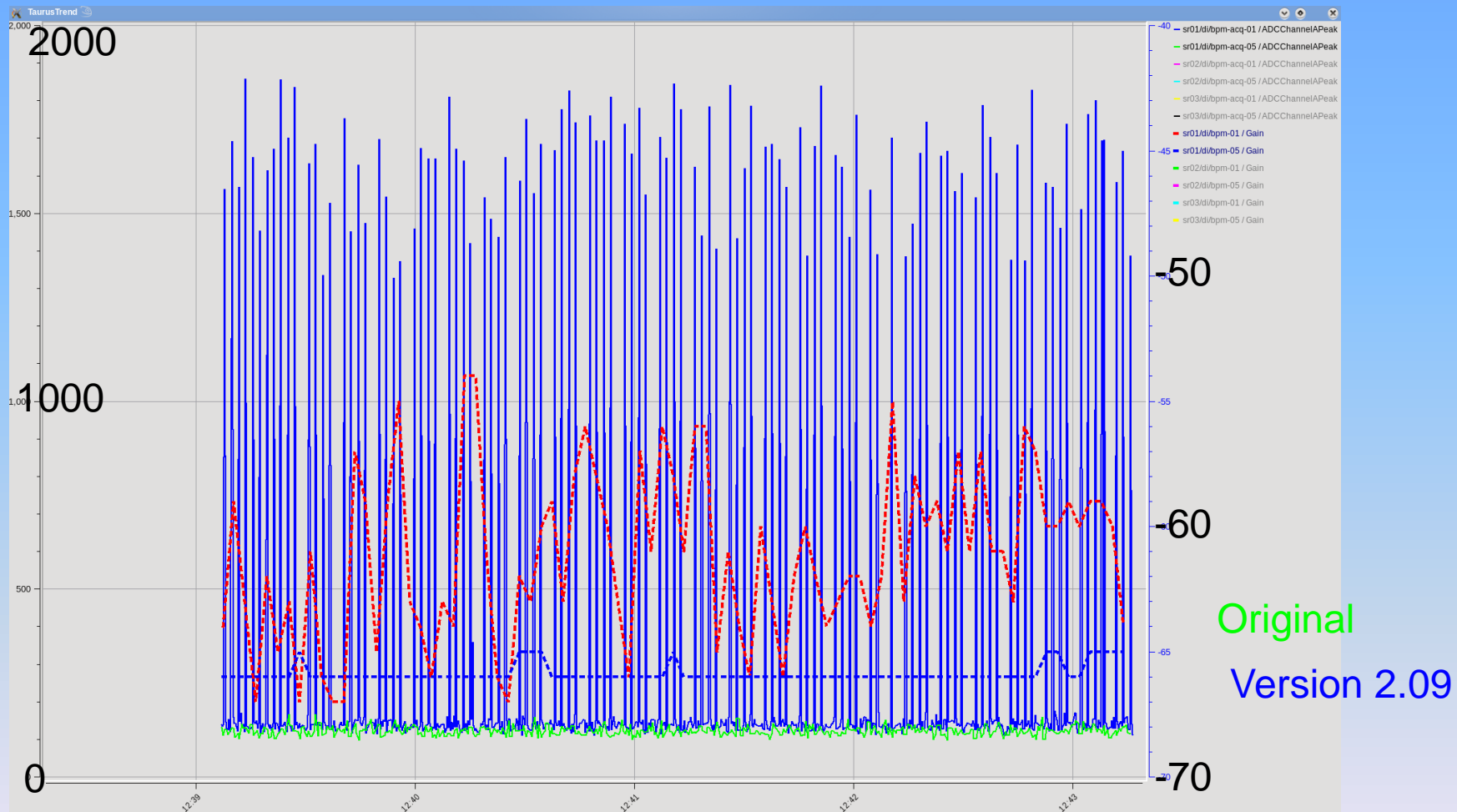
ITech concluded that higher ADC glitches were a consequence of the wider filter's bandwidth

DIAMOND: found boards with the new SAW filter which did not show the ADC glitches on switching

ITech solution (as far as I know) is based on the detection and removal of the glitches

# ADC Glitches and Level jumps

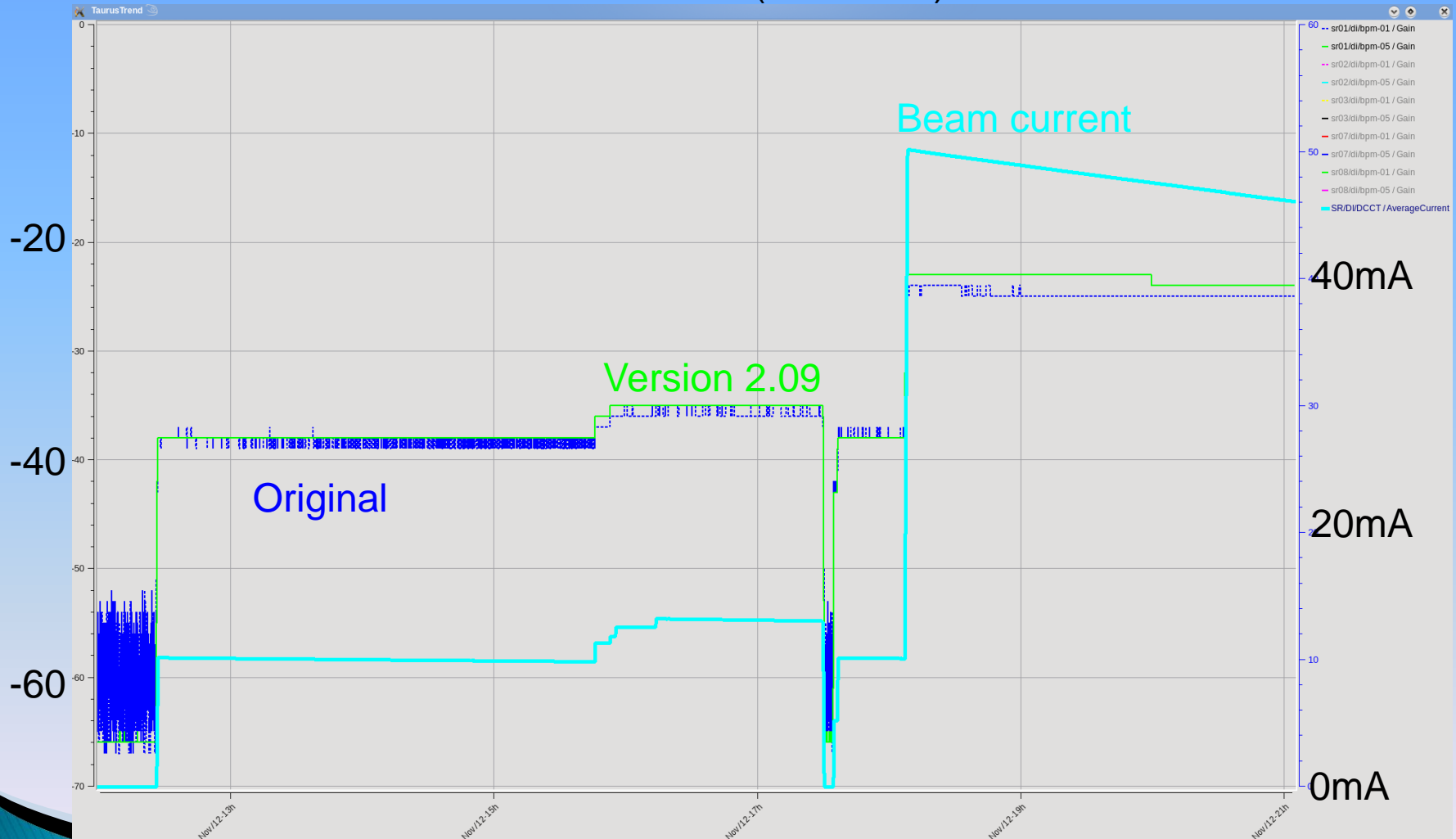
## Test without Beam



Solid --> ADC peaks (left axis)  
Dashed --> Gain (right axis)

# ADC Glitches and Level jumps

Test with Beam (0 – 50mA)



## Higher Temperature

Together with the problems on ADC glitches, we detected that these new units became warmer than the “old” ones (old SAW filter and 2 VCXOs)



## Higher Temperature

ALBA reported ITech about these warming problems on last batch of Liberass



First reply from ITech

So far, the "new" Liberass are working (large quantity) at many institutes already without a single report of issues



After many tries to convince them

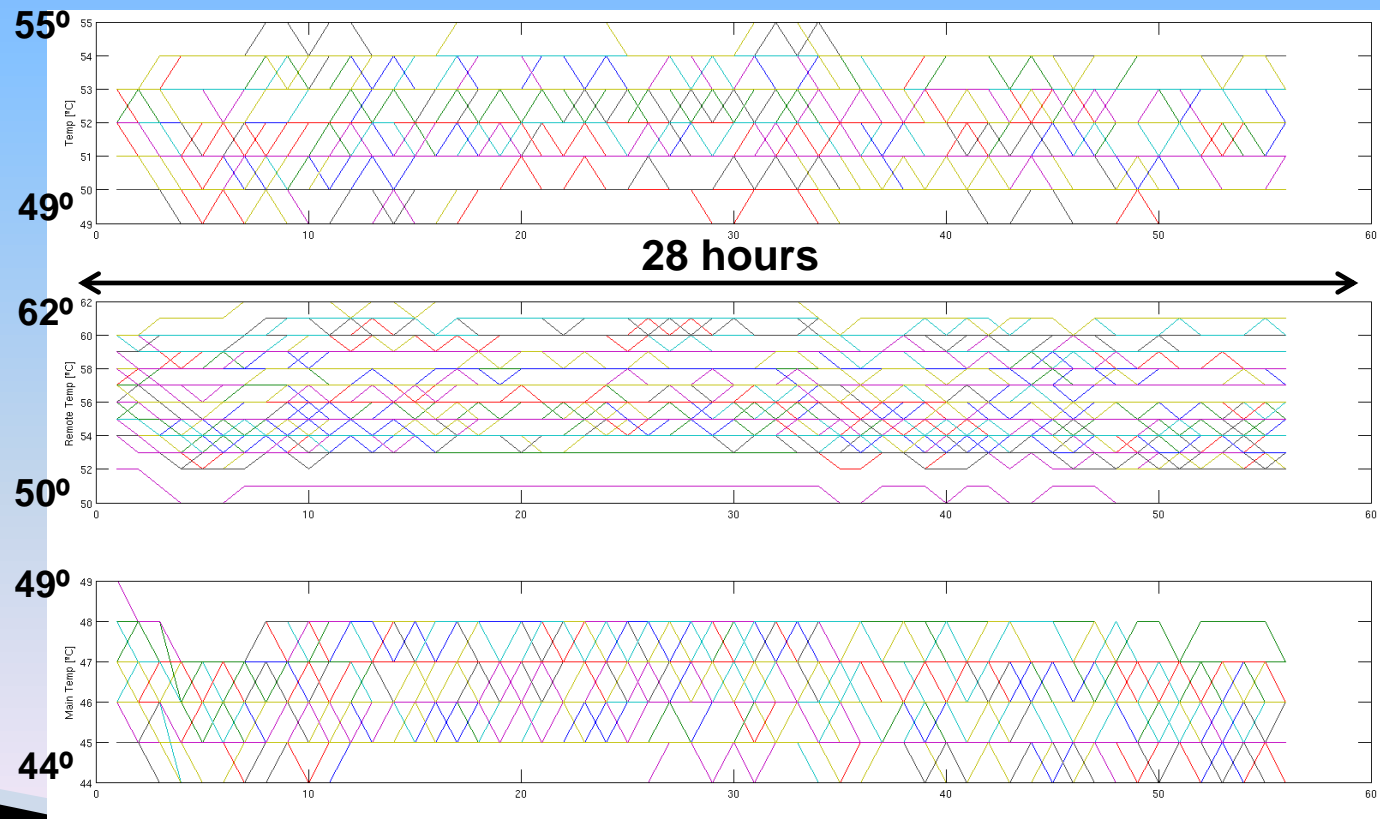
ITech did some temperature tests in their lab and concluded that:

- The temperature sensor in "new" Libera Brilliances reports higher temperature than the real one is. This is the contribution of 3-4 degC
- And the "new" analogue board is actually hotter by 3-4 degC. We do not know the reason yet

# Temperature Regulation

Fans speed changes affect the quality of the BPMs SUM signal and so the Lifetime measurements based on that (already showed by Kees many times)

Tests disabling the control loop (stopping health daemon while keeping fixed RPMs) showed good results but over-temperature control was lost



## Temperature Regulation

ALBA asked ITech to have some means to:  
- read all temperatures & set the RPMs we want  
while keeping the over-temperature control



First reply from ITech

ITECH: Your 2 requests are present in the Libera Brilliance Feature Pack



\$\$\$\$\$\$

ALBA: No, no way to pay for solving a design problem



Following replies

The components operate within their specified operating temperature range

FAT and SAT confirmed the "new" Libera Brilliances are within measuring specs

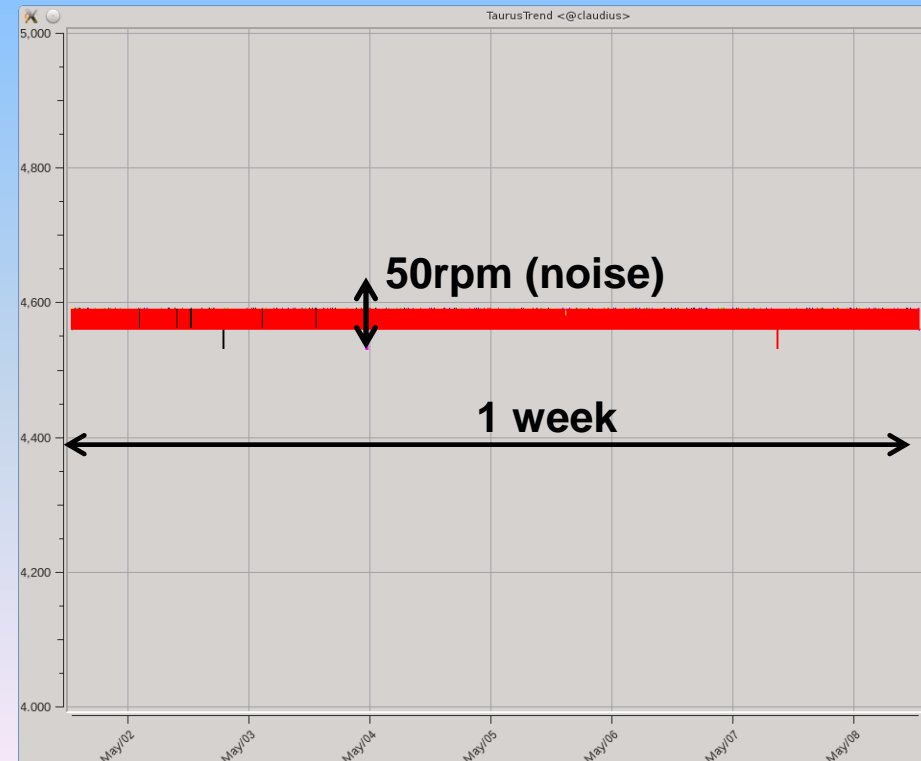
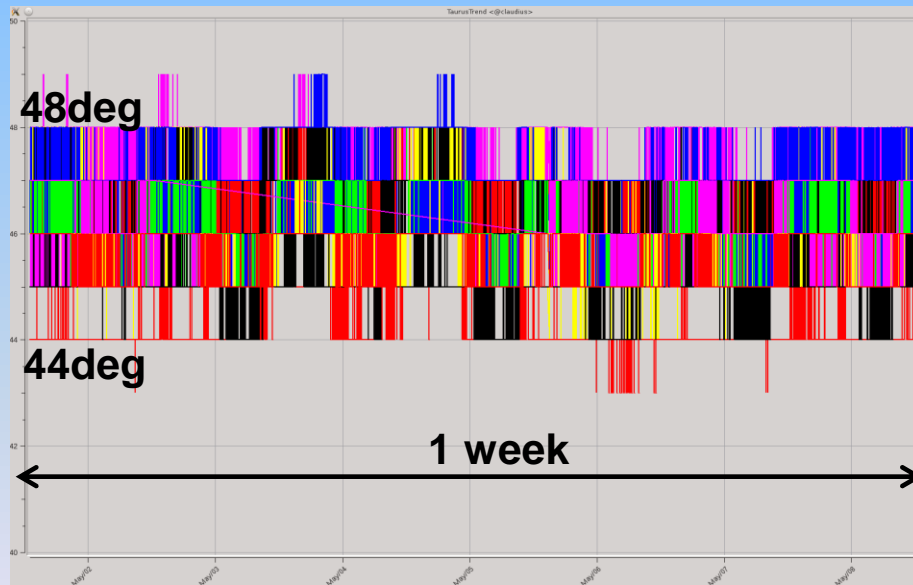
We omit further investigation

# Temperature Regulation

But again, after many hours doing tests to convince ITech, we got an extra control of Fans on release 2.09

Fans can be fixed to a constant RPM but keeping the over-temperature control (that was already included in Package 2.20)

We can also implement our own fans control ... but now not really necessary





## Libera Release 2.09: Summary

It has taken ages to convince ITech to spend time solving these problems (since 2011)

We have spent hundreds of hours to demonstrate the problems and to test the company solutions

### Digital Signal Conditioning DSC daemon

More stable and robust than previous versions

Reduces the position jumps when changing Levels to the noise

No more corrupted/weird coeffs seen (for the time being)

No more faulty interlocks due to BPMs since Xmas (or maybe just one)

## Libera Release 2.09: Summary

### Glitches on ADC data

Not clear yet from where they come (SAW filter, switches, both, ...)  
Solved by removing the glitches on digital processing

### Temperature and Fans regulation

Also not fully clear why last batch of Liberias are warmer  
There's a way (nasty, but anyway a way) to control the fans by ourselves  
But for the time being, there's no need because the fans are "quiet"

## Summary - B

Never give up requesting ITech to solve the problems  
You will have to spend a lot of your time to convince them about the failures  
"Better" if also other labs do suffer from the same problem  
Much better if you have a future order of hundreds of Liberias 😊