

# SETTING-UP OF THE SPS BEAM FOR UA9 CRYSTAL COLLIMATION STUDIES IN 2009

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## ◆ Introduction

- What was planned
- What was finally obtained

## ◆ Unusual losses observed on SFTPRO on MO 25/05

## ◆ The different MDs

- 1) TH 18/06 (~ 20:00) to FR 19/06 (~ 07:00)
- 2) TU 30/06 (08:00) to WE 01/07 (07:00)
- 3) MO 13/07 (17:00) to TU 14/07 (09:00)
- 4) TU 11/08 (01:00 to 17:00)
- 5) TU 22/09 (08:00) to WE 23/09 (08:00)
- 6) WE 04/11 (from 05:00 to 23:00)

## ◆ Conclusion

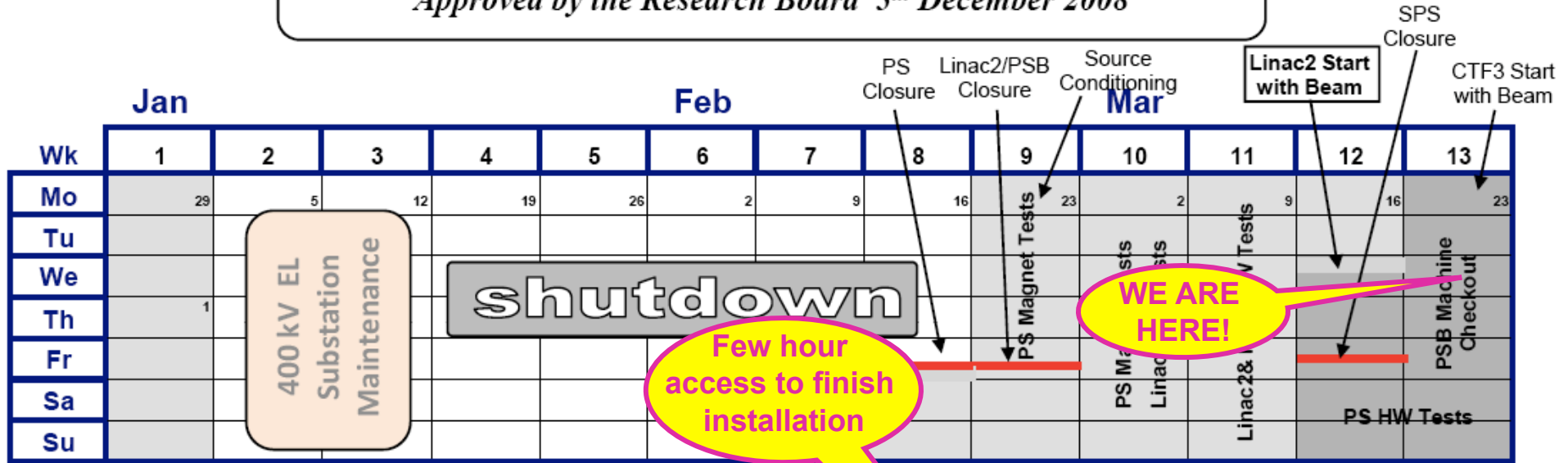
# INTRODUCTION (1/4)

## WHAT WAS PLANNED

at the 4th Crystal Channeling Workshop, CERN, 24–27/03/2009

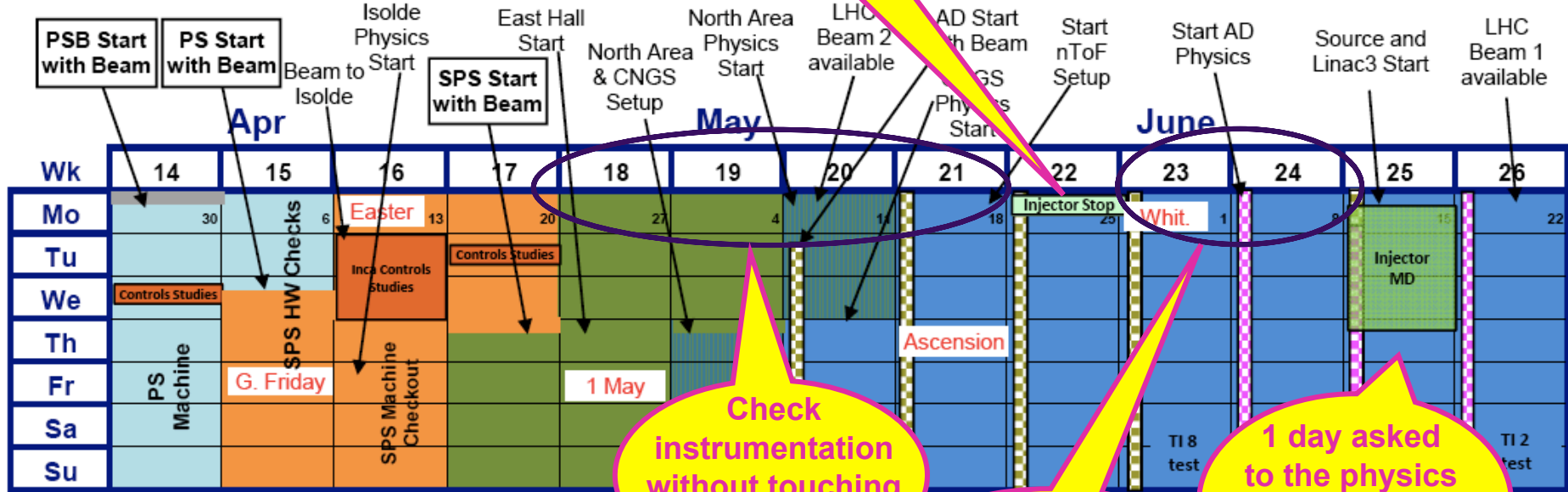
# 2009 Injector Accelerator Schedule

*Approved by the Research Board 5<sup>th</sup> December 2008*



**Few hour access to finish installation**

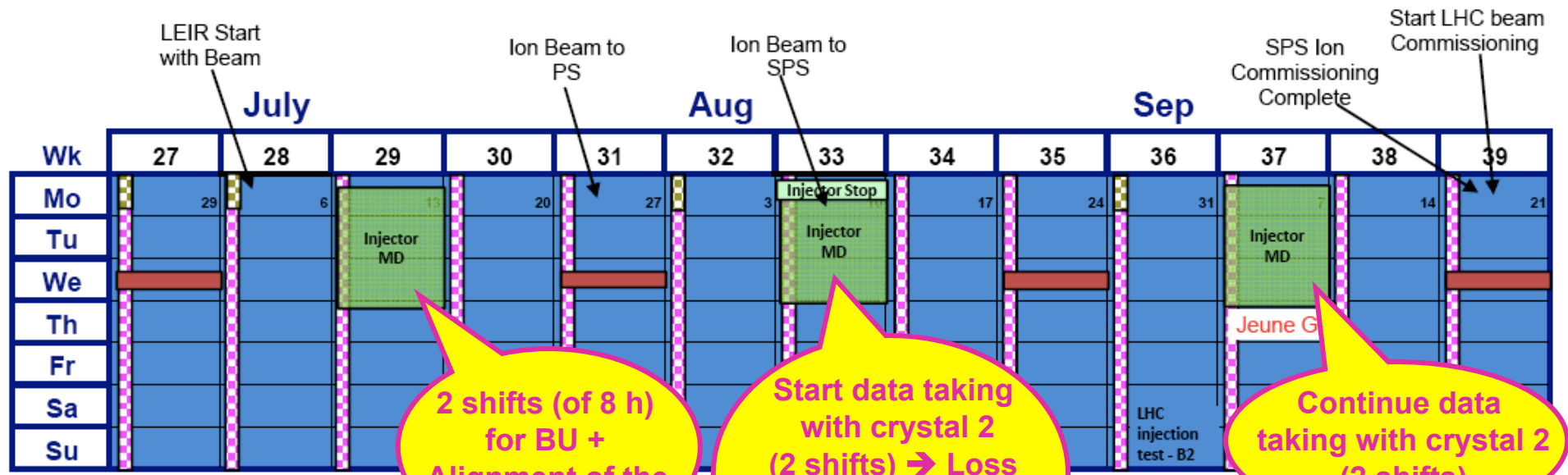
**WE ARE HERE!**



**Check instrumentation without touching anything!**

**Checks after new installation**

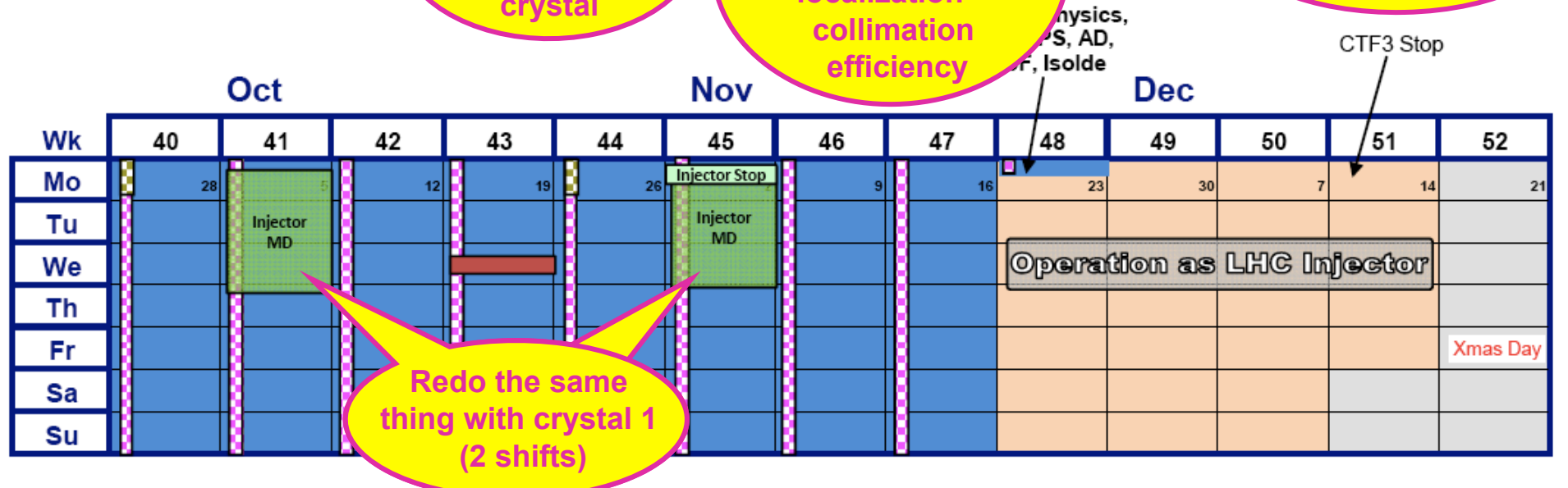
**1 day asked to the physics coordinator for cycle setting-up + BU**



2 shifts (of 8 h) for BU + Alignment of the crystal

Start data taking with crystal 2 (2 shifts) → Loss localization + collimation efficiency

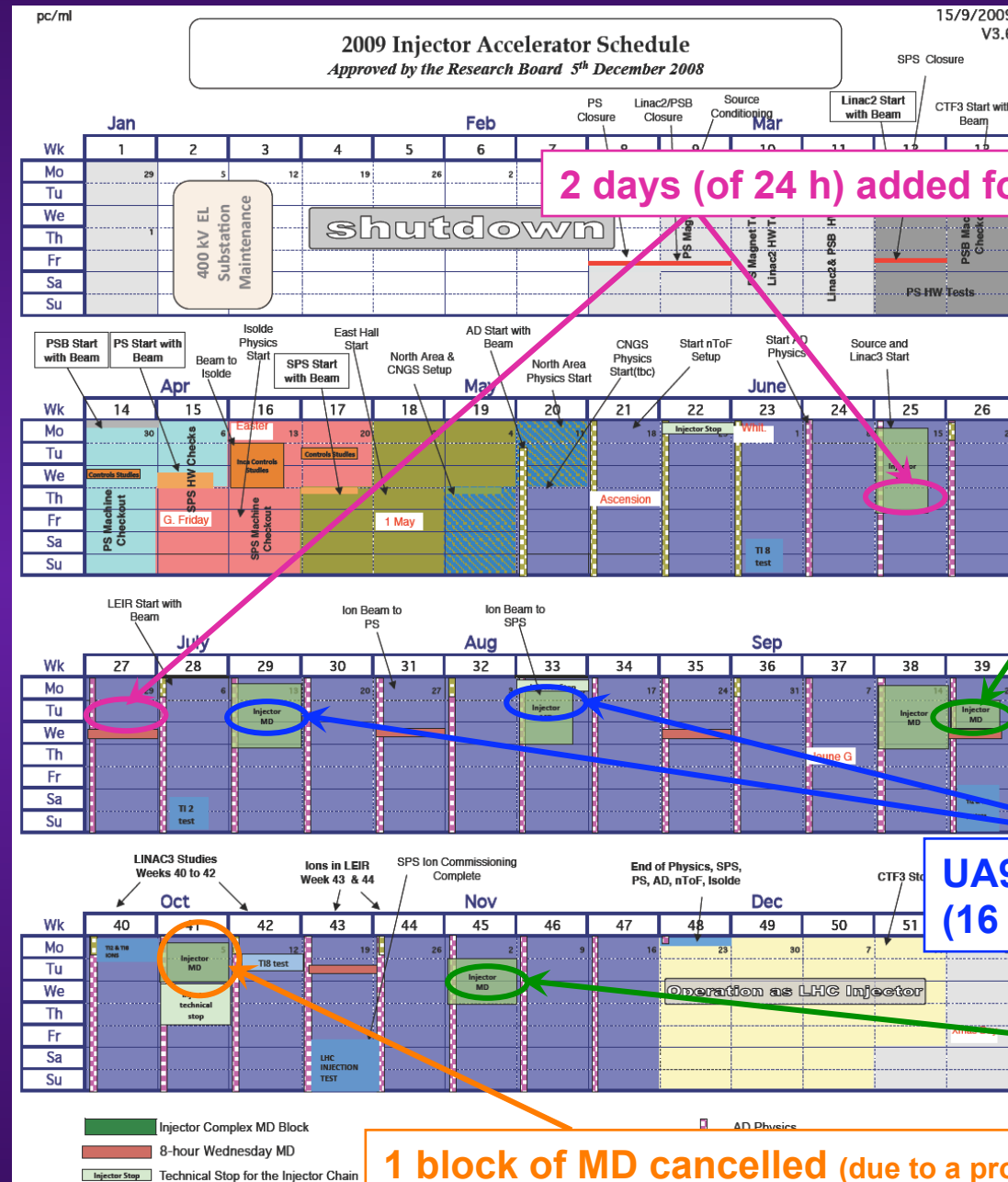
Continue data taking with crystal 2 (2 shifts)



Redo the same thing with crystal 1 (2 shifts)

- Injector Complex MD Block
- 8-hour Wednesday MD
- Injector Stop Technical Stop for the Injector Chain
- AD Physics
- AD Setting-up & Studies

# INTRODUCTION (4/4): WHAT WAS FINALLY OBTAINED



2 days (of 24 h) added for UA9 setting-up

UA9 MD of 24 h (instead of 16 h)

UA9 MDs as foreseen (16 h each time)

UA9 MD of 18 h (instead of 16 h)

1 block of MD cancelled (due to a problem with PS injection septum 42) => 16 h lost for UA9

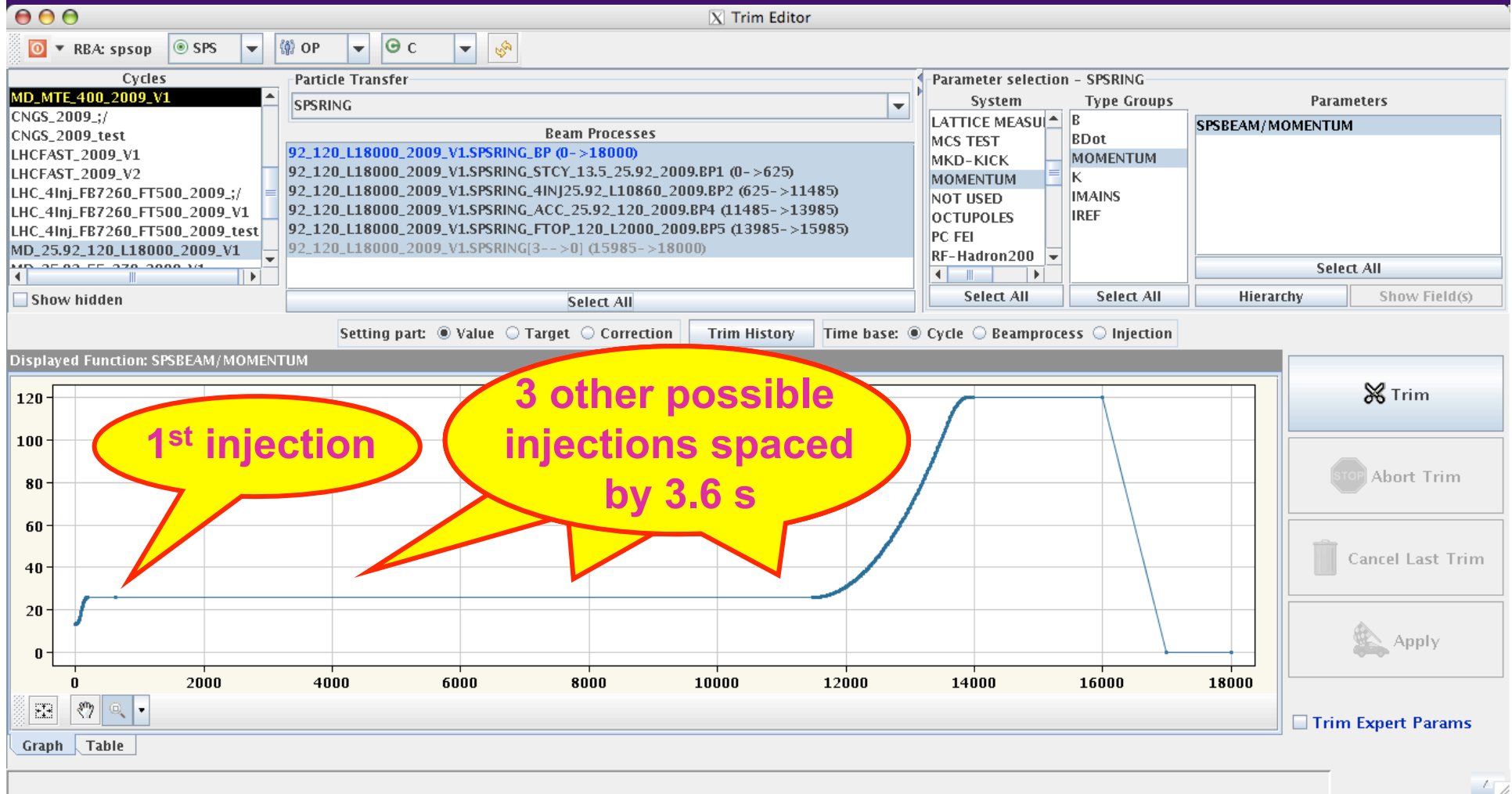
## UNUSUAL LOSSES OBSERVED ON SFTPRO ON MO 25/05

- ◆ **During the SFTPRO slow extraction operation, beam losses were observed in LSS5 (in 518), where usually no losses are observed**
- ◆ **The newly (during the week before) installed quartz for the crystal experiment was rapidly identified as the culprit**
- ◆ **As it was not possible to remove the losses by retracting remotely the quartz to its (maximum) parking position, it was decided to make an intervention to try and move it locally**
- ◆ **It was indeed possible to retract the quartz even further by 5 mm (in total), which made the losses disappear. The motor was also disconnected at the same occasion to be sure that nothing would move during beam operation**

## 1<sup>st</sup> MD: TH 18/06 (~ 20:00) to FR 19/06 (~ 07:00) (1/3)

- ◆ On TH morning a long access was given to UA9 to fix the crystal that was too close to the beam
- ◆ The access and vacuum recovery took more time than expected (as it was scheduled to restart around 15:00), and was made more complicated by a power cut around lunch time
- ◆ Coasts with beam only started in the early morning, and many controls issues were encountered and (partially) solved or bypassed
- ◆ Eventually some coasts were made and some basic checks were performed with the UA9 detectors
- ◆ Jonathan Emery took the opportunity to go to BA5 to investigate false measurements with SPS BLM monitors

# 1<sup>st</sup> MD: TH 18/06 (~ 20:00) to FR 19/06 (~ 07:00) (2/3)



- ◆ SPS user timing of the pulsed function = LHC2
- ◆ Coast cycles => COASTPR1, COAST1 (timing = 15625), COASTRE1



## 1<sup>st</sup> MD: TH 18/06 (~ 20:00) to FR 19/06 (~ 07:00) (3/3)

- ◆ **Measured tunes:  $Q_x = 26.125$  and  $Q_y = 26.173$**
- ◆ **The BLMs acquisition was not working**
- ◆ **The wire scanner BWS519H had not yet the option to work in coast. A knob “Scan Now” was implemented after this MD and used during the following sessions**
- ◆ **The orbit had to be corrected on the pulsed function, as one could not do it in coast**
- ◆ **Frequent trips of the SMQ (main quadrupole) power converter stations were observed at the time of the recovery after a coast. These were understood only after the end of the machine study session of 13-14/07/09 and were found to be due to a timing definition problem**
- ◆ **Trims on coasts can be done using the last 2 points (on the flat top) of the pulsed function (LHC2) in the Trim Editor**

**2<sup>nd</sup> MD: TU 30/06 (08:00) to WE 01/07 (07:00) (1/2)**

◆ **Status for the instrumentation in coasts:**

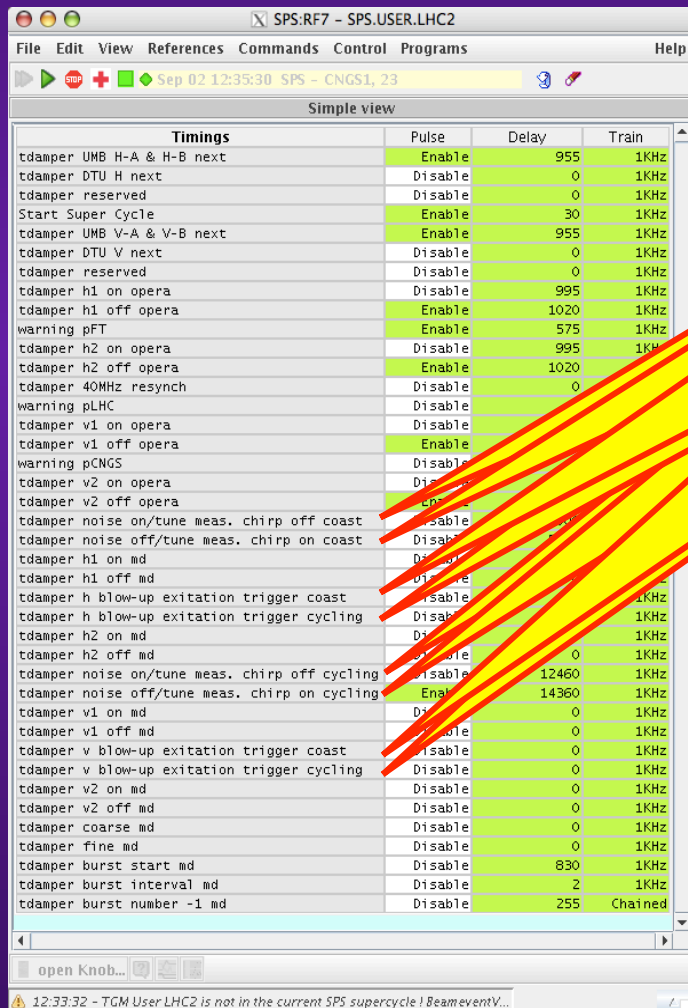
- **BCT => “Acquisition in COAST” button and it works**
- **FASTBCT => “Acquisition in COAST” button and it works**
- **ORBIT => “Acquisition in COAST” button. However, it does not work. Therefore, the orbit has to be adjusted in the pulsed cycle**
- **SPS-BLM => Works also in coast**
- **BWS => A knob has been implemented this year (2009) in the new application to be able to acquire in coast: click on the "Scan Now" button**
- **SPS-MultiT (1000 turn) => Works also in coast**

## 2<sup>nd</sup> MD: TU 30/06 (08:00) to WE 01/07 (07:00) (2/2)

- ◆ Transverse beam profile measurements **were performed with the BWS519H both** in pulse and coast mode, **and** without and with coherent excitation from the transverse dampers, **as was used in the past**
- ◆ **In fact for the next MD, a noise excitation, more adapted to the current situation, was implemented and successfully used**

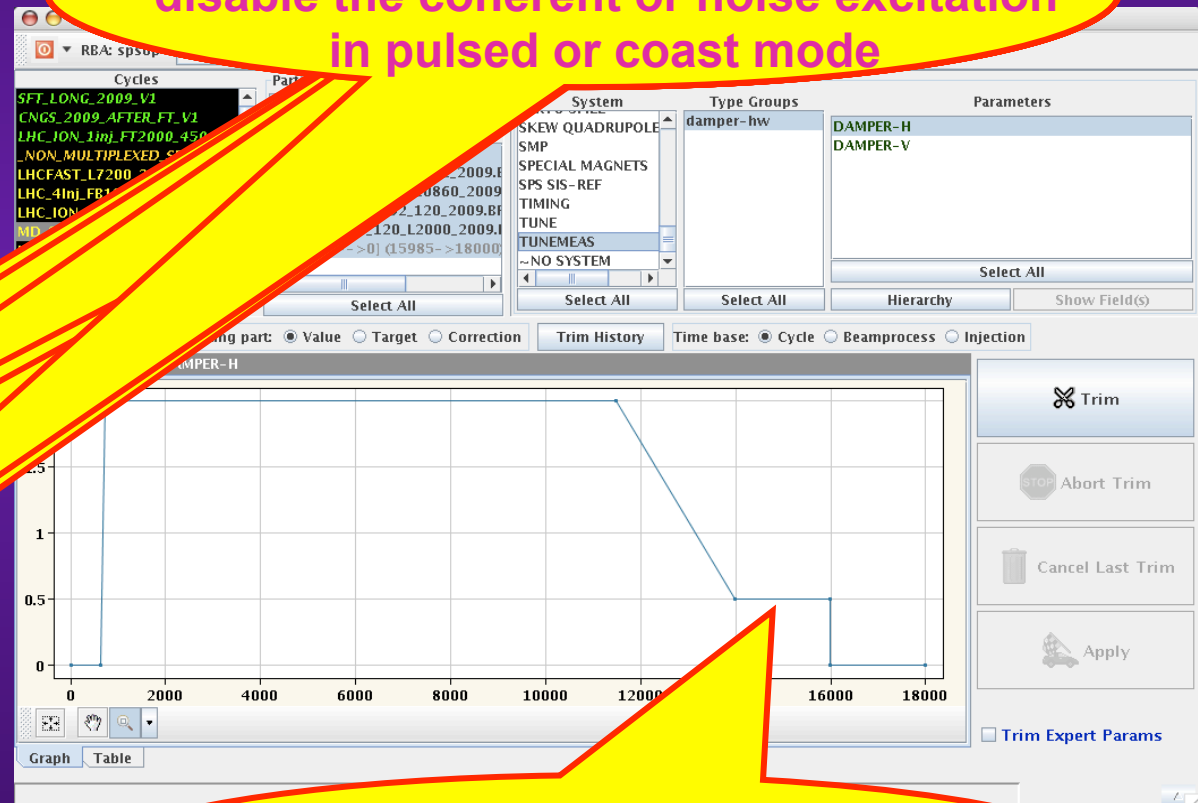
# 3<sup>rd</sup> MD: MO 13/07 (17:00) to TU 14/07 (09:00)

- ◆ A noise excitation (in addition to coherent excitation) from the transv. dampers was available for this MD (thanks to W. Hofle)



Timings	Pulse	Delay	Train
tdamper UMB H-A & H-B next	Enable	955	1KHz
tdamper DTU H next	Disable	0	1KHz
tdamper reserved	Disable	0	1KHz
Start Super Cycle	Enable	30	1KHz
tdamper UMB V-A & V-B next	Enable	955	1KHz
tdamper DTU V next	Disable	0	1KHz
tdamper reserved	Disable	0	1KHz
tdamper h1 on opera	Disable	995	1KHz
tdamper h1 off opera	Enable	1020	1KHz
warning pFT	Enable	575	1KHz
tdamper h2 on opera	Disable	995	1KHz
tdamper h2 off opera	Enable	1020	1KHz
tdamper 40MHz resynch	Disable	0	
warning pLHC	Disable		
tdamper v1 on opera	Disable		
tdamper v1 off opera	Enable		
warning pCNGS	Disable		
tdamper v2 on opera	Disable		
tdamper v2 off opera	Enable		
tdamper noise on/tune meas. chirp off coast	Disable		
tdamper noise off/tune meas. chirp on coast	Disable		
tdamper h1 on md	Disable		
tdamper h1 off md	Disable		
tdamper h blow-up exitation trigger coast	Disable		1KHz
tdamper h blow-up exitation trigger cyclng	Disable		1KHz
tdamper h2 on md	Disable		1KHz
tdamper h2 off md	Disable	0	1KHz
tdamper noise on/tune meas. chirp off cyclng	Disable	12460	1KHz
tdamper noise off/tune meas. chirp on cyclng	Enable	14360	1KHz
tdamper v1 on md	Disable	0	1KHz
tdamper v1 off md	Disable	0	1KHz
tdamper v blow-up exitation trigger coast	Disable	0	1KHz
tdamper v blow-up exitation trigger cyclng	Disable	0	1KHz
tdamper v2 on md	Disable	0	1KHz
tdamper v2 off md	Disable	0	1KHz
tdamper coarse md	Disable	0	1KHz
tdamper fine md	Disable	0	1KHz
tdamper burst start md	Disable	830	1KHz
tdamper burst interval md	Disable	2	1KHz
tdamper burst number -1 md	Disable	255	Chained

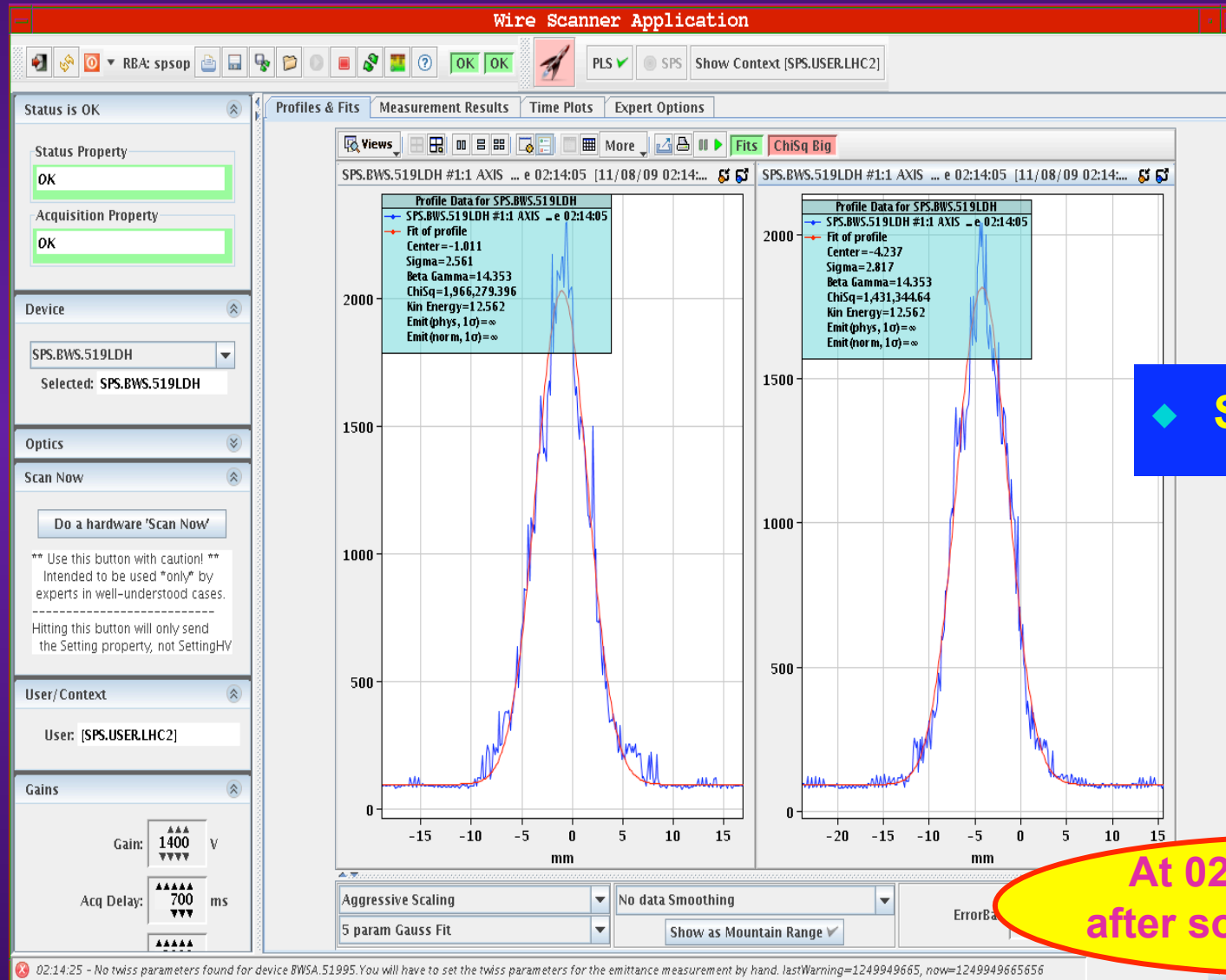
SPS RF 7 timing to enable or disable the coherent or noise excitation in pulsed or coast mode



DAMPER-H in the Trim Editor to adjust the amplitude of the noise excitation

# 4<sup>th</sup> MD: TU 11/08 (01:00 to 17:00) (1/2)

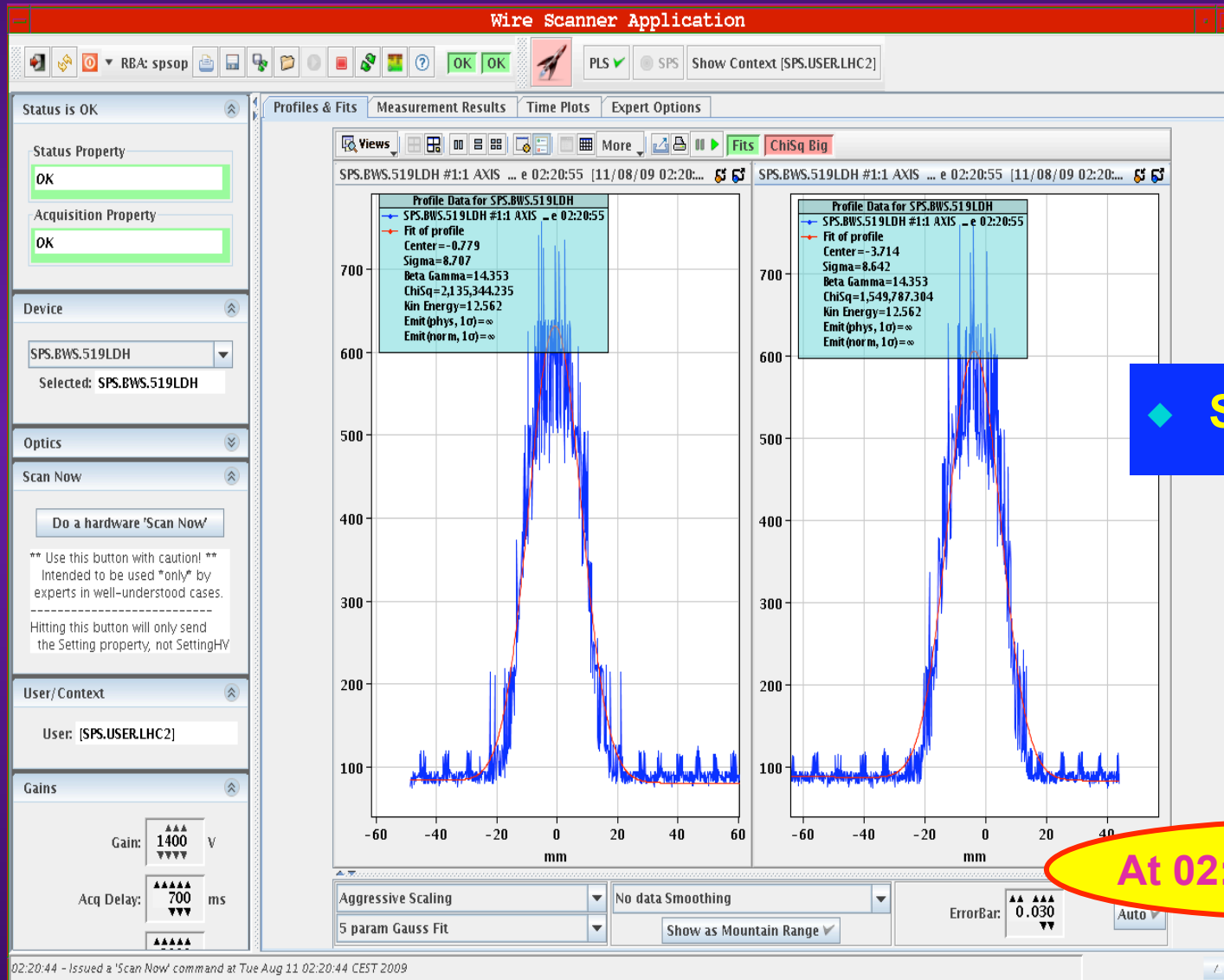
- ◆ Example of transv. emittances vs. time in coast for DAMPER-H = 2



◆ **Sigmax = 2.6 μm**

At 02:14:05 (already after some time in coast)

# 4<sup>th</sup> MD: TU 11/08 (01:00 to 17:00) (2/2)



◆ **Sigmax = 8.7 μm**

**At 02:20:55 (already)**

## 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (1/8)

- ◆ During this 24-h MD, the idea was to devote the 1<sup>st</sup> shift of 8 h to prepare the different beams which could be used during the next 2 shifts: the 1<sup>st</sup> part dedicated to measurements with low-intensity (for MEDIPIX etc.) and the 2<sup>nd</sup> to measurements with “high intensity” (for the loss maps etc.)
- ◆ The planning for the machine setup was decided beforehand and was the following:
  - 1) 4 bunches: LHCINDIV in PS and PSB (4 rings) in 1 batch
  - 2)  $4 \times 4 = 16$  bunches: LHCINDIV in PS and PSB (4 rings) in 4 batches
  - 3)  $4 \times 12 = 48$  bunches: TSTLHC25 in PS and LHCA in PSB (4 rings) in 1 batch
  - 4)  $4 \times 12 = 48$  bunches: TSTLHC25 in PS and LHCA in PSB (1 ring) in 4 batches

## 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (2/8)

- ◆ **Jonathan Emery came to check the SPS BLM in LSS5 =>**

### Summary:

- **We are at the limit of what the system can do with 900 m cable and the offsets and leakages of the electronics (with high gain and amplification settings)**
- **According to the designer of the system (FERIOLI Gianfranco) the only way to measure at this settings (high gain and amplification settings) is to make differential measurement between a reference signal (Beam off or controlled initial conditions) and the measured event**



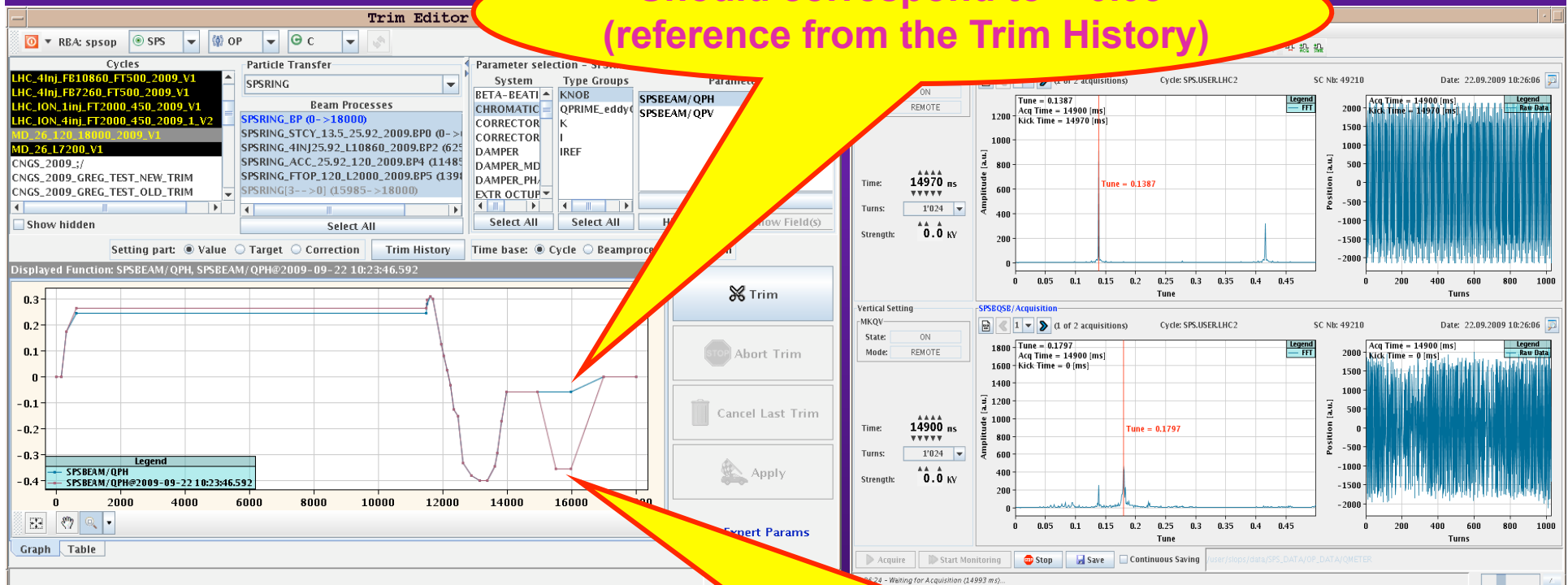
## 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (3/8)

- ◆ **Stephen Jackson came to see whether he could modify YASP to acquire the orbit in coast => Summary:**
  - **The acquisition of the orbit in coast did not work in the previous MDs as the electronics configuration of the COAST1 user was incorrect**
  - **It was still set to trigger on the prepulse1 instead of the warning event**
  - **This has the effect of not starting the acquisition and old data being returned on subsequent orbit requests**
  - **Now it seems everything is working fine. The remaining issue is the precise time when the measurement is made, as there is still some uncertainty**
  - **One should therefore make the measurements at 0 ms and this should be fine within some few turns**

# 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (4/8)

- ◆ The chromaticities on the flat top of the pulsed cycle (which will be the values during the coasts) have been reduced to a minimum to try and maximize the beam lifetime => This was done by looking at the (non) decoherence as can be seen below

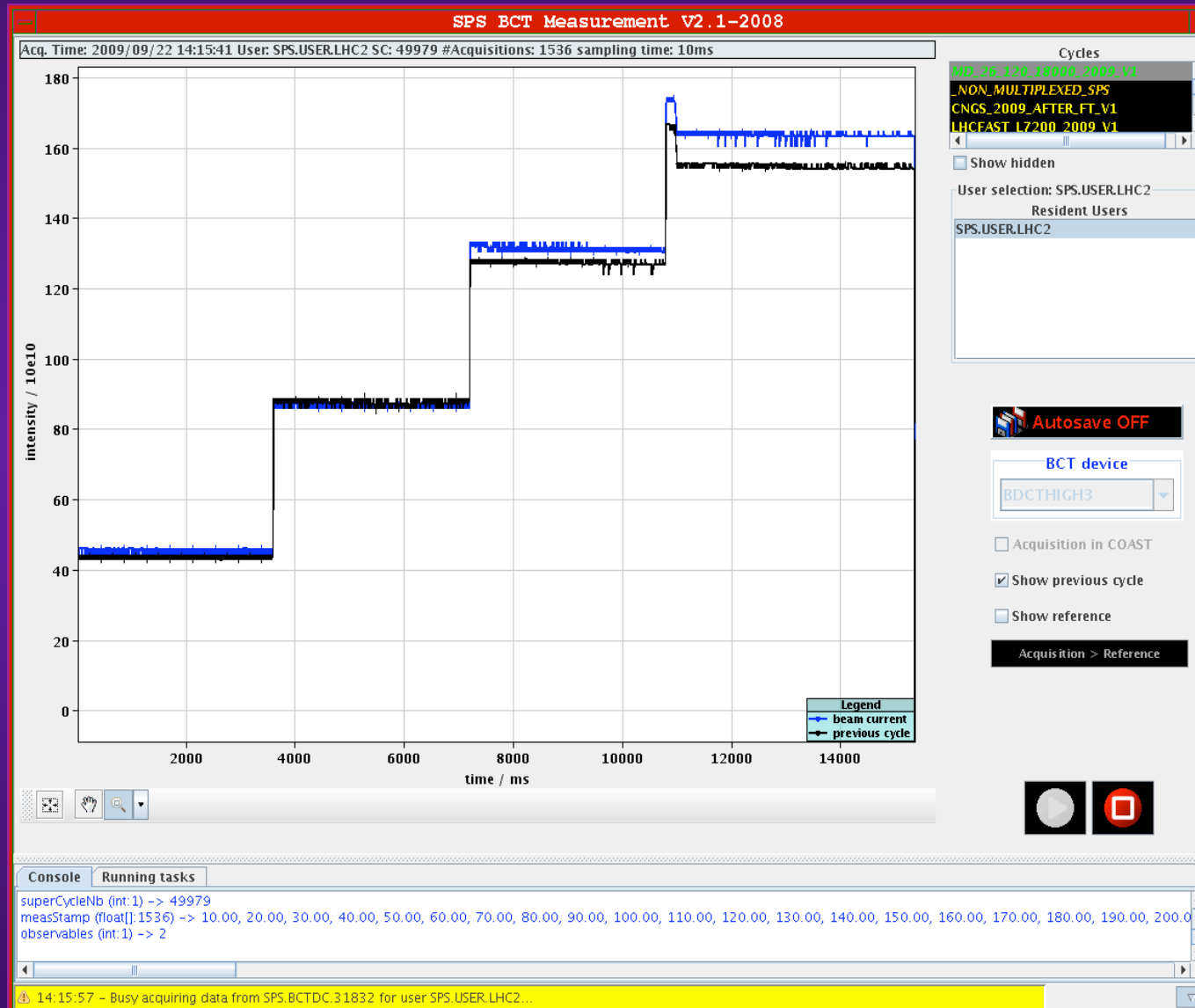
Should correspond to ~ 0.05  
(reference from the Trim History)



It was decreased to this "setting" value  
looking at the decoherence

# 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (5/8)

- ◆ Result with  $4 \times 4 = 16$  bunches



## 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (6/8)

- ◆ **The sequence was then changed and** we tried to redo the same thing with 4 batches of 12 TSTLHC25 bunches
  - **More difficulties were faced with this beam after the 3rd batch and some** beam was lost at ~ 9200 ms
  - **We** did not have much time to study and understand the problem (~ 3 h lost due to a fire of an RF amplifier of the Transmitter TRX8), since in addition we lost ~ 1 h of beam due to a water pump problem in the source
  - **After discussion with Walter** it was agreed that the beam with 4 batches of 4 LHCINDIV bunches will be sufficient to make the high intensity tests

## 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (7/8)

- ◆ **It was then decided** to try and put the momentum scraper (TIDP. 11434) to its closest position to the beam and to make a local bump to scrape the beam
- ◆ **This was done by adding several bumps (=> resonant bump), as the strength of the correctors was not sufficient at this energy (the limit of current in the CODDs is 3.5 A)**

Momentum Scraper - TIPD Position Controller v0.1.1 - Apr. 2009

Sep 22 18:59:28 SPS - COAST1 COAST1 - 01

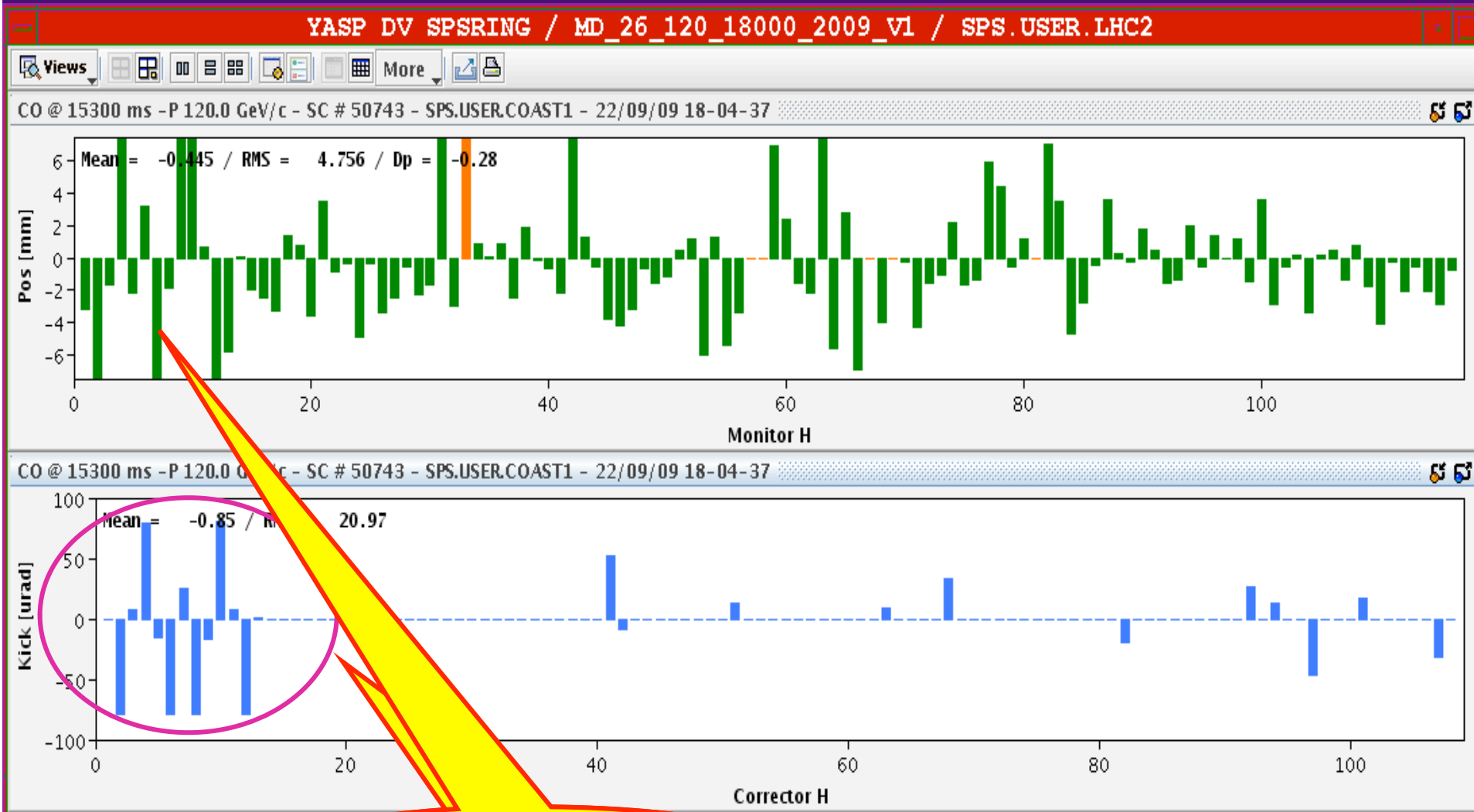
MIN position, scrapper OUT of beam : 0 mm  
MAX position, scrapper IN the beam : 33 mm

Demanded Position		Read position		TIDP Status		TIDP Control Mode	
33	mm	Up position	Down position	Upstream	Ok	Upstream	Remote
Upstream	33	32.61	mm 32.58	Downstream	Ok	Downstream	Remote
Downstream	33						

Refresh

17:05:06 - Final position reached!

# 5<sup>th</sup> MD: TU 22/09 (08:00) to WE 23/09 (08:00) (8/8)



## 6<sup>th</sup> MD: WE 04/11 (from 05:00 to 23:00) (1/3)

- ◆ Spikes were observed on the LHC BLM close to the crystal (it happened also sometimes in the previous MD)!!!
- ◆ We tried to switch off many power supplies but we could never get rid of them
- ◆ These spikes on the BLM signals perturbed us most of the day (they were also seen at other equipments such as the TAL) and “seemed to be correlated with normal working hours as they seemed to stop during usual breaks...”

## 6<sup>th</sup> MD: WE 04/11 (from 05:00 to 23:00) (2/3)

- ◆ Detailed scan with the bump at the TIDP.11434 => Example of BCT and SPS.BLM.115 for a measured amplitude of a bump on BPH.11408 of -26.5 mm

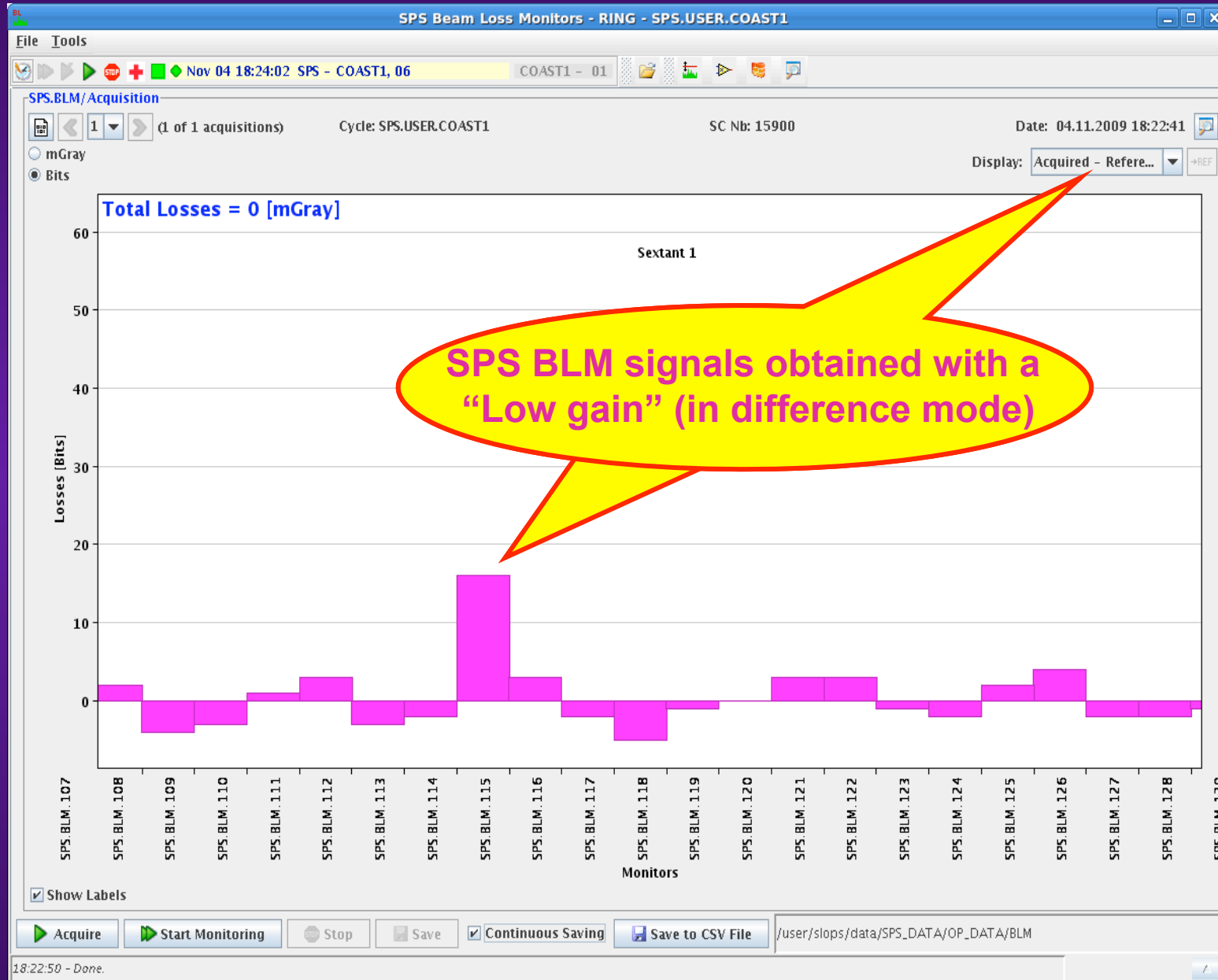


Constant loss from 1 turn to the next

Loss due to the bump at the TIDP



# 6<sup>th</sup> MD: WE 04/11 (from 05:00 to 23:00) (3/3)



# CONCLUSION

- ◆ **More MD time was given in 2009 than the one initially planned (which was already a lot!) => It was the 1<sup>st</sup> year, many new equipments installed, very sensitive measurements etc.**
- ◆ **Many thanks to all the operators (and RF, BI etc.) for their precious help during the whole year!**
- ◆ Some references
- ◆ Setting-up of all the UA9 MDs in 2009
- ◆ Some MD results for UA9 (ELogBook)