ADT and ObsBox

M. Söderén for the ADT team

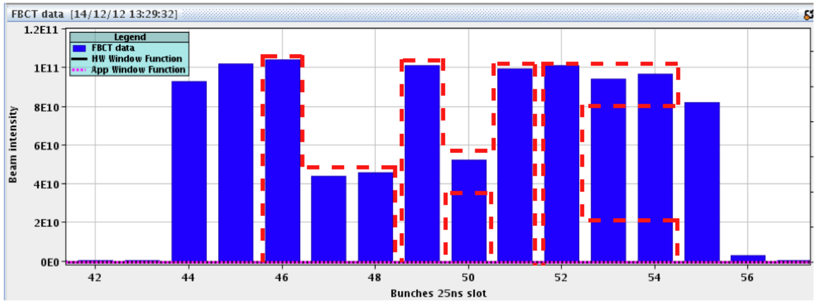
ADT: An executive summary…

Design specification in 2006:

Actual situation in 2018:

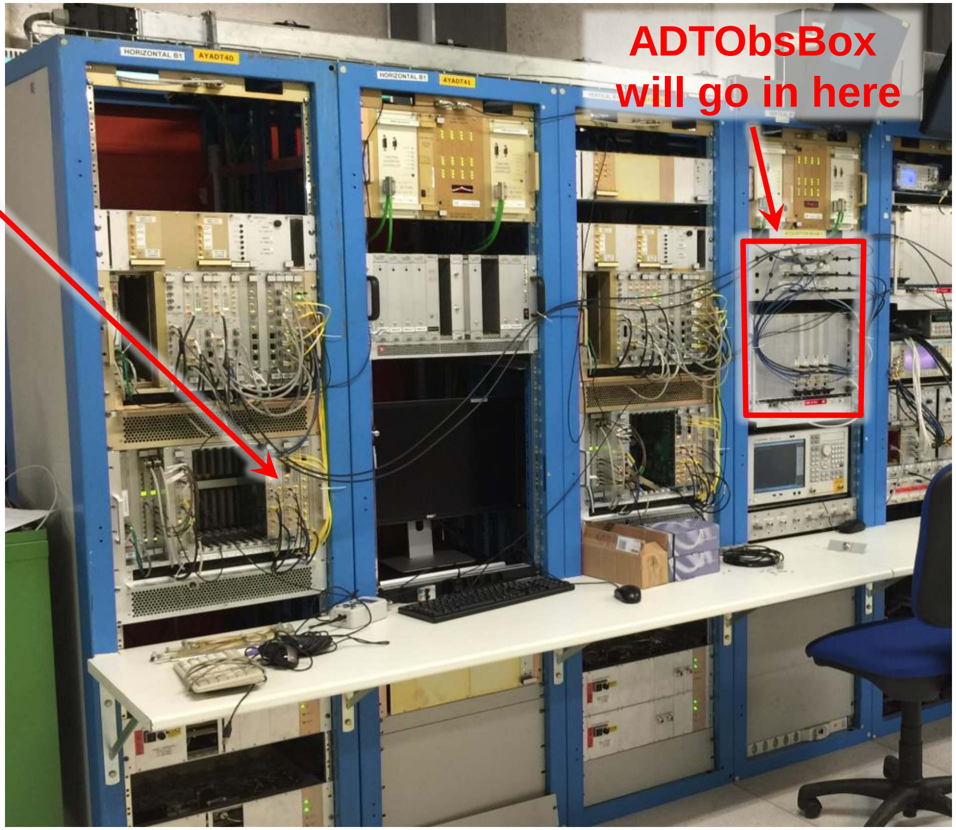
ADT timeline

- 2011
  - Injection and abort gap cleaning
  - Batch selective transverse emittance blow-up
  - Start retrieving bunch by bunch data from damper signal processing system
- 2012
  - Cleaning and blow-up used in regular operation
  - Introduction of “standard bandwidth” and “extended bandwidth” operation
  - Gain modulation within a turn – introduction of the witness region
  - A single bunch within a 25ns train blow-up and excitation demonstrated for the first time!



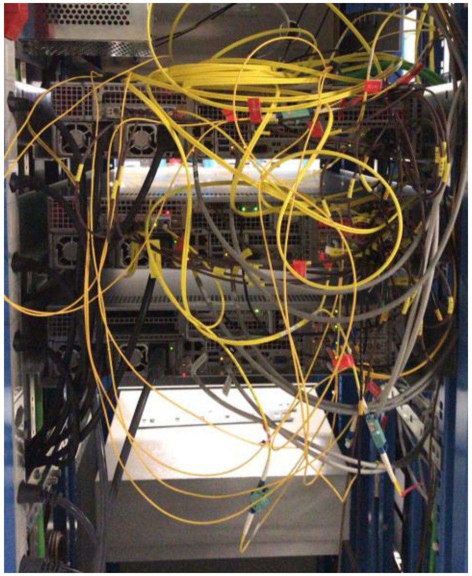
ADT timeline

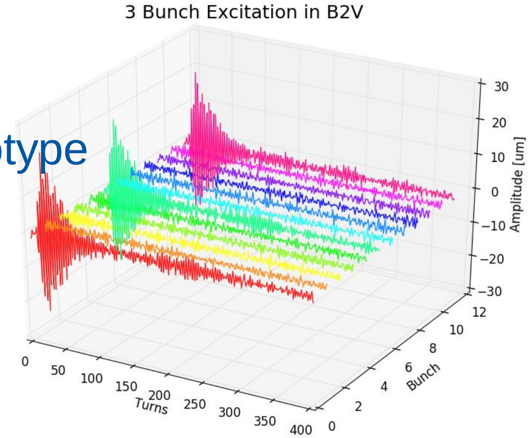
- LS1 2013-2014:
  - Replacement of all pickup cables (tunnel to SR4), introduction of new pickups (Q8, Q10)
  - New, more powerful signal processing hardware
  - Decoupled main feedback and witness bunches
  - A dedicated cleaning channel
  - A dedicated excitation channel



ADT timeline

- 2015:
  - Introduction of ObsBox system (in the transverse plane known as “ADTObsBox”)
- 2016:
  - Bunch by bunch damping time and tune at injection
  - Real time instability detection, transverse activity monitor
- 2017:
  - Linear coupling measurement,
  - Long time bbb data storage at ADTObsBox data servers
  - more advanced excitation modes – ADTACDipole
- 2018 (November):
  - On demand bunch by bunch tune measurement prototype
  - Finally!!! 4 pickups!
  - ADT used as a controlled source of complex machine impedance, ADT with larger tune spread acceptance
  - Stable operations with few faults





ADT in MDs 2017-2018

- 4506: Aperture measurements with AC dipole
- 4147: 50Hz harmonics perturbation
- 4145: Studies of Landau damping with an antidamper
- 4143: Noise studies with new ADT pickup electronics
- 4063: New ADT signal processing for large tune spread acceptance
- 3318: Impedance Contribution of Secondary and Tertiary Collimators
- 3310: Complex tune shift as a function of the intensity for single bunches at top energy
- 3291: Emittance growth in collision with optimized ADT settings
- 3289: Determination of the optimal ADT gain for beam stability at flat top
- 3288: Instability latency with controlled noise
- 3283: Active halo control using colored noise excitation
- 3246: 16L2 UFO dynamics investigation
- 3206: Dump with ADT crabbed beam
- 2901: Asymmetric collimator settings in IR7
- 2193: Impedance measurements of TCPSM collimator

ADT for ABP 2017-2018

- 4.6 TB of data stored since late 2017
  - 336 GB: Every injection, all bunches, 4k turns
  - 474 GB: Post mortem data, all bunches, 65k turns
  - 3700 GB: Instability data, all bunches, 65k turns
  - 72 GB: Other data (e.g. dedicated MDs)

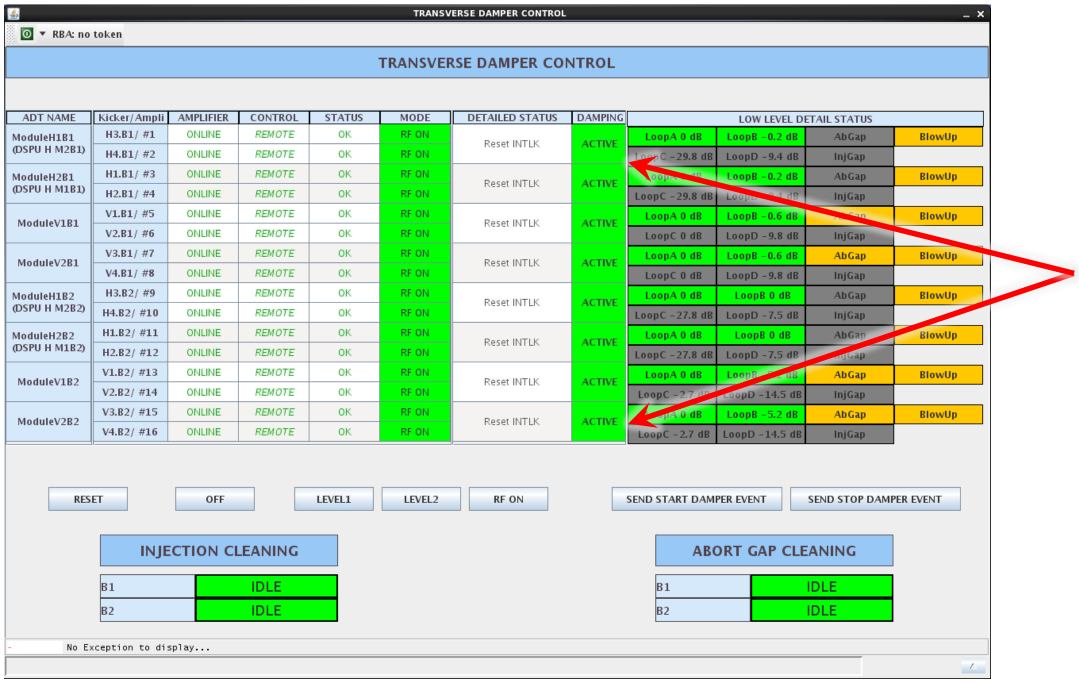
- Since fill 6030 stored to a dedicated server (unlimited storage time) with backup to CASTOR

- ADTObsBox™ data used for: Injection drift observation, Post-mortem analysis, Instability cause analysis, MDs, Generating cool animated plots for meetings and papers

- On top there is 1264 variables logged in TIMBER

Performance and status monitoring

- Currently available diagnostics tools in the CCC

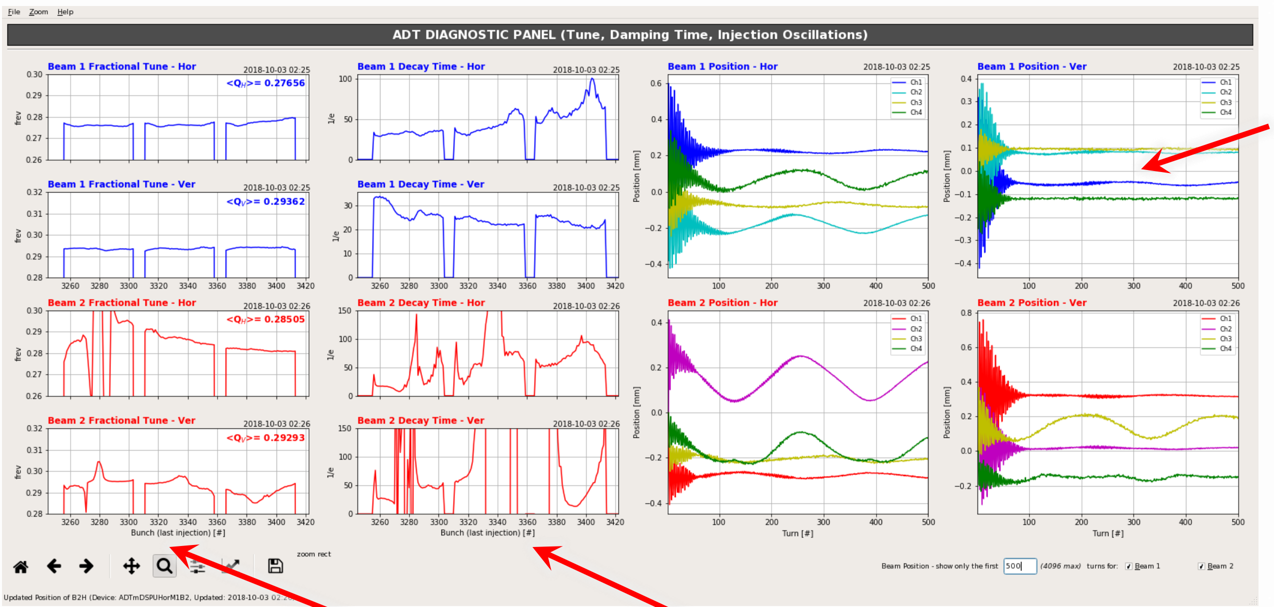


Is ADT switched on?

8 green: yes it is switched on

Performance and status monitoring

- Currently available diagnostics tools in the CCC



Is the damper damping?

- Data from 16 pickups? ✓
- No saturation? ✓
- Do I see a decay? ✓
- No activity after 100 turns? ✓

4 green:
Yes it is damping

A bonus: Bunch by bunch tune and damping time

The tune value is already available (and accurate) after 5 turns only!

Performance and status monitoring

- A new proposal came from the operations team:

  "Can you make an application, which will tell in a human understandable form, what the damper is doing and how is it set up?"

- A good idea, we can prepare something like:

  ADT Horizontal Beam 1:
  Set for pilot intensity <$1x10^{10}$ p/bunch
  Standard bandwidth, Damping time 50 turns
  Cleaning enabled, Abort gap, Idle
  Blow-up enabled, attention: "strong mode"

- Please tell us what would you like to see…

Parameter space for Run III

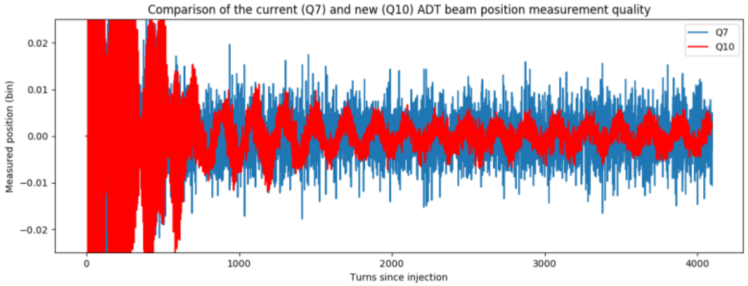
- What are we getting ready for (based on ABP input):

Parameter	Value	Note
Optics	ATS	Quite flexible as long reasonably high β values around point 4…
Intensity per bunch	1.8×10^{11} p	Anything from 5×10^{9} to 1×10^{12} with a dynamic range of ~10 dB
Damping time	50 turns	Single bunch within a train, with both standard and extended bandwidth
Q nominal	~0.27-0.32	Close to ½ integer possible with a dedicated commissioning effort
Q spread acceptance	±0.025	For 50% increase in damping time
Measurement noise floor	$< 0.9\ \mu m_{RMS}$	Foreseen improvement by a factor 2-4 wrt. Run II

- ADT performance after LS2 is expected to be the similar as during Run II (with some upgrades and improvements)
- ***Any specific new requirements have to be communicated NOW!***

Changes in LS2

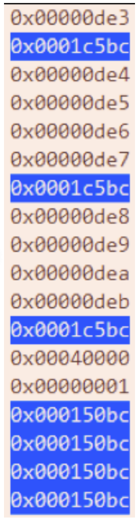
- A lot of work ahead, mostly not visible from the CCC
  - Power system – new anode resistors
  - Thorough LLRF firmware clean up, FESA clean up
  - Better expert diagnostics
  - Beam position module upgrade →



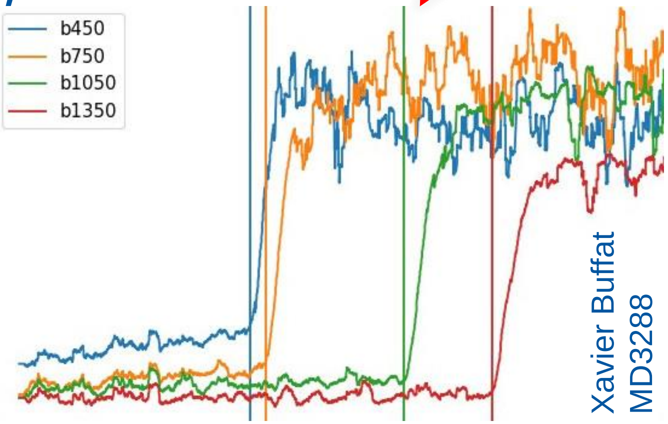
- What will be visible from CCC
  - A complete rebuild of the high level controls
  - LSA setting management, parameters calculated from optics
  - Sequences
  - New user interfaces (CCC displays and Inspector panels)
- A new generation ObsBox (Project **Ö**)

(ADT)ObsBox in LS2

- The system has been a great achievement but…
- The current machines are obsolete and impossible to buy anymore
- The software is the very first feasibility study version – many “due to historical reasons” “features”
- Gathered 4 years of experience how to do things…
- A new generation with ambitious specs is coming…



Then a miracle occurs…



Xavier Buffat
MD3288

(ADT)ObsBox in LS2

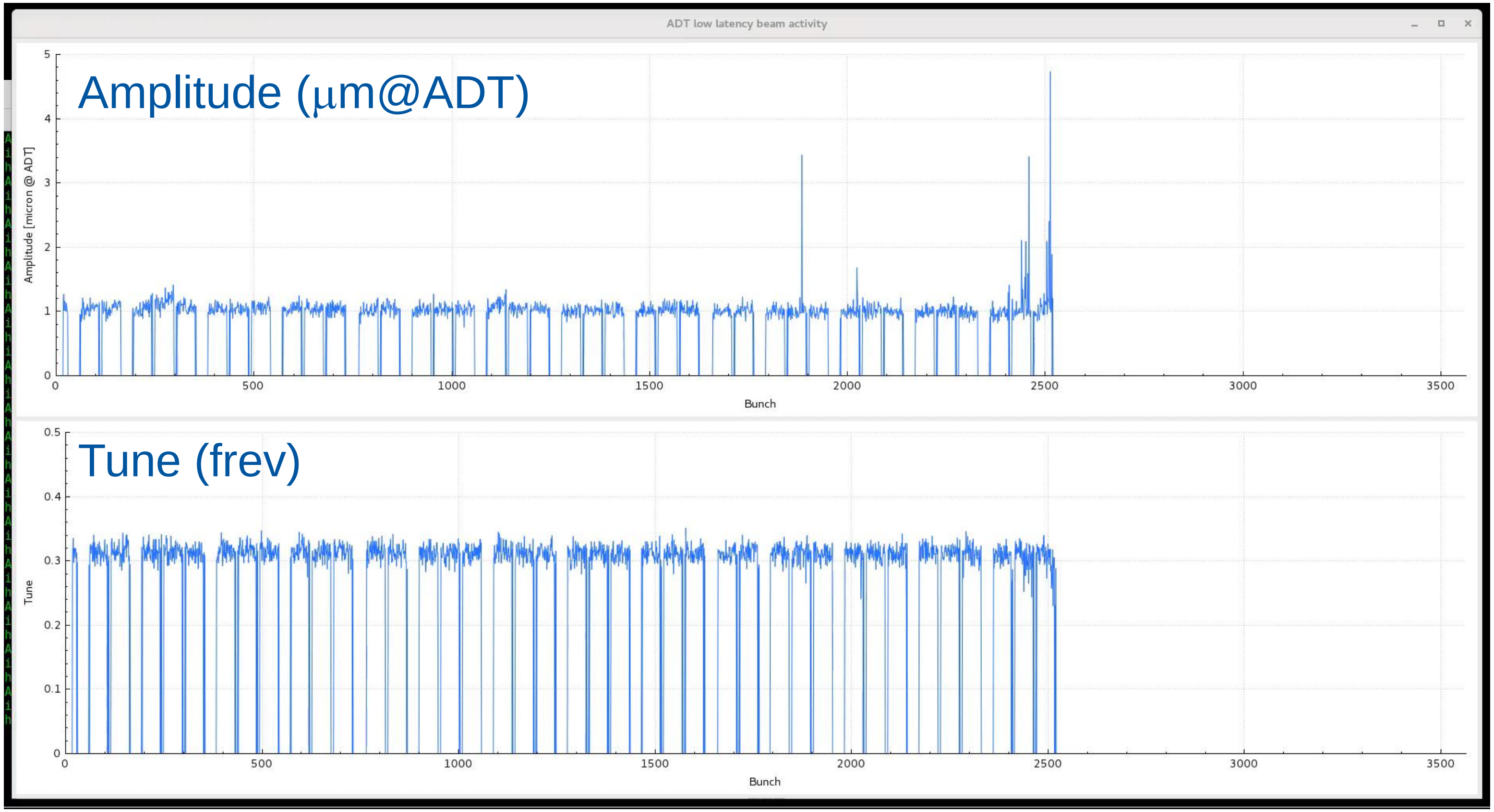
- New powerful servers to handle the high demand for the data and real time analysis
- New acquisition cards (one card replaces 10 SPEC-cards and supports 2.5Gb/s per link)
- Rewrite ObsBox FESA class
- Dedicated fibers to our NFS server in the CCR
- Lower latency from source to analysis
- Proper DIAMON diagnostics
- Provide a platform for simpler online analysis for ABP (Python, C++)

(ADT)ObsBox in LS2

```
from RBOX import RBOXClient

def calculation(data):
        print(data.getData())

client = RBOXClient(“python_test_instance”)
client.addSubscription([“ObsBox.LHC.ADT.B2H.Q7”],calculation)

client.start()
```

(ADT)ObsBox in LS2

- A real "Real time" bunch by bunch tune and transverse activity monitoring [1]. ***Any ideas for fixed displays?***



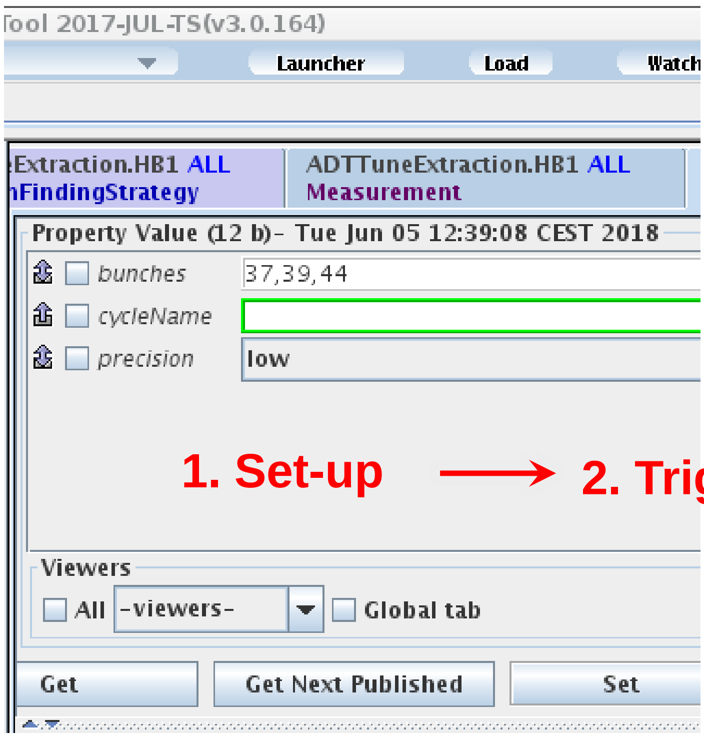
(ADT)ObsBox in LS2

- Introduction of a full machine, bunch by bunch, turn by turn data buffer for the past 8 hours (36 TB total)
- Local storage, user can retrieve any “slice” (i.e. 4 TB/hour, 77 GB/min, 1.3 GB/s…)

- Other possible applications:
  - Finalize the real time, passive, bunch by bunch tune measurement from the ADT pickup data
  - Finalize the on demand Tune measurement system (with excitation)
  - Automated high precision tune extraction with excitation and data from all pickups (used in MDs)
  - Post mortem data analysis immediately after dump?

On demand b-b-b tune measurement by ADT (with active excitation)

Set-up and trigger



1. Set-up → **2. Trigger** → **3. Collect data**

- The prototype FESA class is running, it has to be made a proper operational tool

First train of colliding bunches

Index	
[][82]	0.0
[][83]	0.0
[][84]	0.30666077
[][85]	0.0
[][86]	0.0
[][87]	0.0
[][88]	0.30954924
[][89]	0.30853128
[][90]	0.0
[][91]	[illegible]
[][92]	0.0
[][93]	0.0
[][94]	0.0
[][95]	0.0
[][96]	0.0
[][97]	0.3077234
[][98]	0.30847853
[][99]	0.3079932
[][100]	0.31022993
[][101]	0.0

First train of colliding bunches after -0.003 Q trim

Index	
[][82]	0.0
[][83]	0.0
[][84]	0.30430645
[][85]	0.0
[][86]	0.0
[][87]	0.0
[][88]	0.30624196
[][89]	0.30520934
[][90]	0.0
[][91]	0.0
[][92]	0.0
[][93]	0.0
[][94]	0.0
[][95]	0.0
[][96]	0.0
[][97]	0.3062962
[][98]	0.30579346
[][99]	0.30344343
[][100]	0.3030966
[][101]	0.0

ADT re-commissioning strategy

- New, never before operated beam position modules
- A major upgrade of the high level control
- New way the functions will be generated
- New applications and user interfaces

- After LS2, the ADT will be considered *"as new"* – therefore a much longer commissioning time will be needed
  - A typical time required in Run II: 2-3 shifts
  - A 10dB increase, plus a couple of ramps is a reasonable estimate

Thank you for your attention

- [1] “Kotzian algorithm”
- Kotzian, Gerd : Transverse Feedback Parameter Extraction from Excitation Data
- http://cds.cern.ch/record/2289132/files/tupik094.pdf