

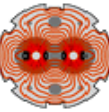
Bunch by Bunch Measurements @ LHC

E. Calvo, J.J. Savioz, L. Jensen, J. Gonzalez, D. Belohrad, M. Ludwig, S. Bart-Pedersen, M. Gasior, R. Steinhausen, A. Jeff, A. Boccardi, E. Bravin, G. Papotti, E. Effinger, E. Griesmayer, B. Dehning, J. Emery, A. Guerrero, T. Lefevre, J.J. Gras, A. Rabiller, F. Roncarolo, M. Favier, R. Jones

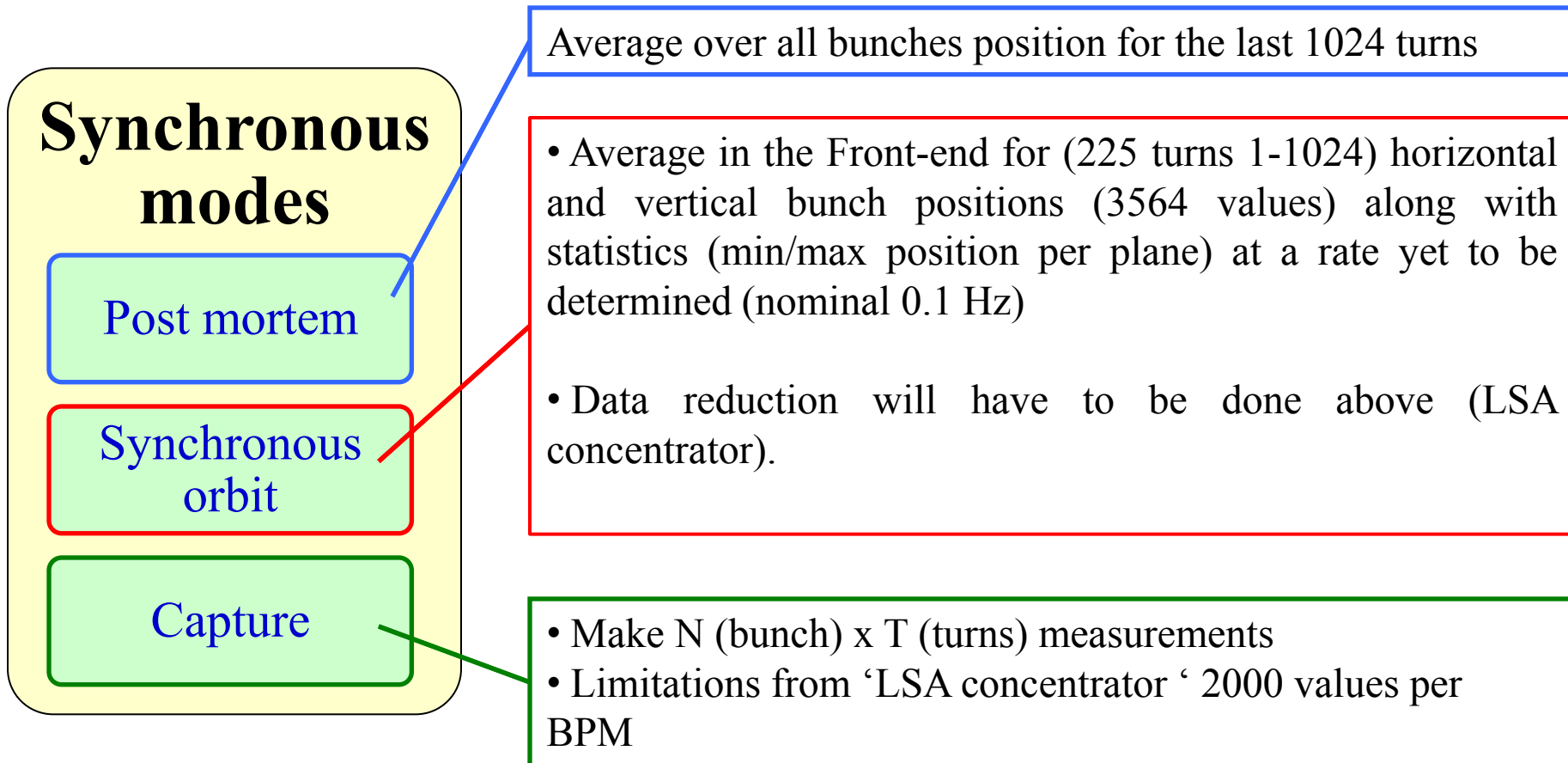


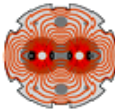
Bunch by Bunch Measurements @ LHC

- Beam Position Monitors and Head-Tail monitors
- Longitudinal measurements: WCM, LDM
- Transverse beam size measurements: Wire Scanners - Synchrotron Light
- Schottky monitors
- Luminosity monitors
- Fast BLM's



- The front end electronics work by **default in bunch by bunch basis**. Each BPM in the machine measures the position of each bunch. The orbits and trajectories are calculated at the firmware and software level.
- All the beam intensity range is covered – Work in parallel to asynchronous mode





Synchronous modes

Post mo

Synch
or

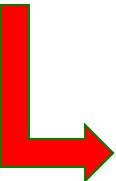
Cap

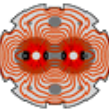
- Injection oscillations – bunch selection through injection sequencer via the LSA concentrator
 - YASP (injection regions LSS2 B1 and LSS8 B2)
 - IQC (injection quality checks)
- Beta-beat measurements (bunch selection through selected

*More details on the performances and future plans of Beam Position Monitors in the following talk by **Eva***

- Bunch by Bunch and Turn by Turn data
- Few selected BPMs

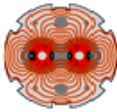
Proposed upgrades:

- 
- In the front end, provide turn by turn data averaged over all bunches and return it as a new field/property (to be discussed) to be used by YASP/ IQC
 - For few selected devices, Installation of dedicated DABs (higher memory 512k) on the less used VME systems in SR1 (BPME) and possibly SR5 (TOTEM)

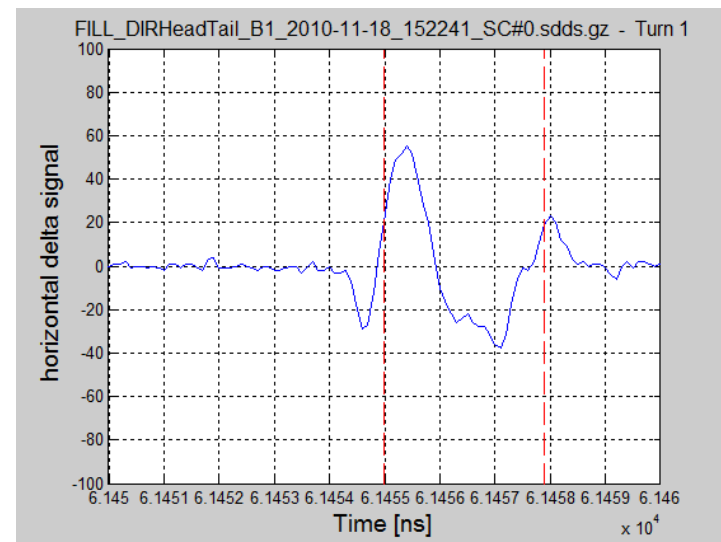
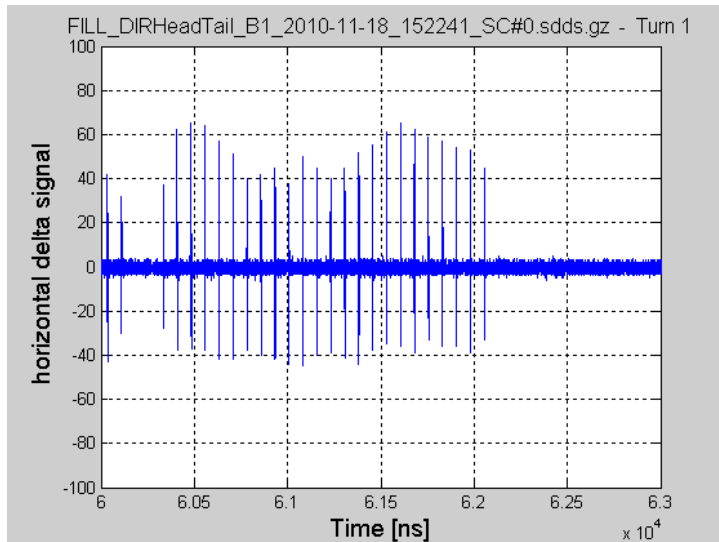
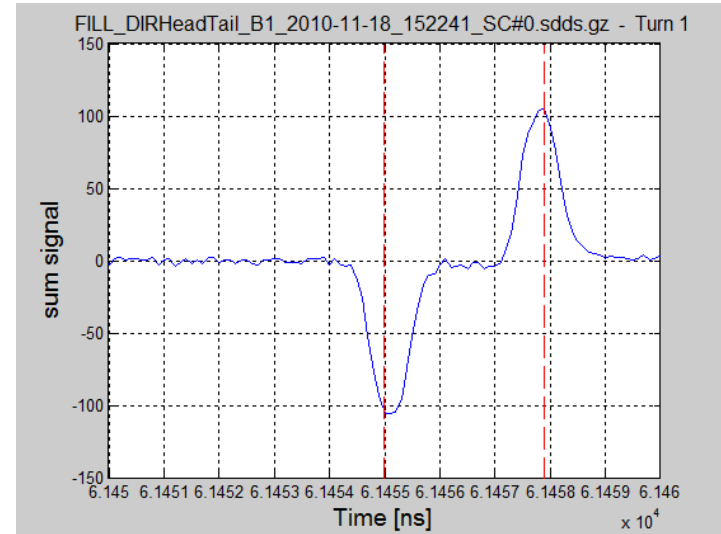
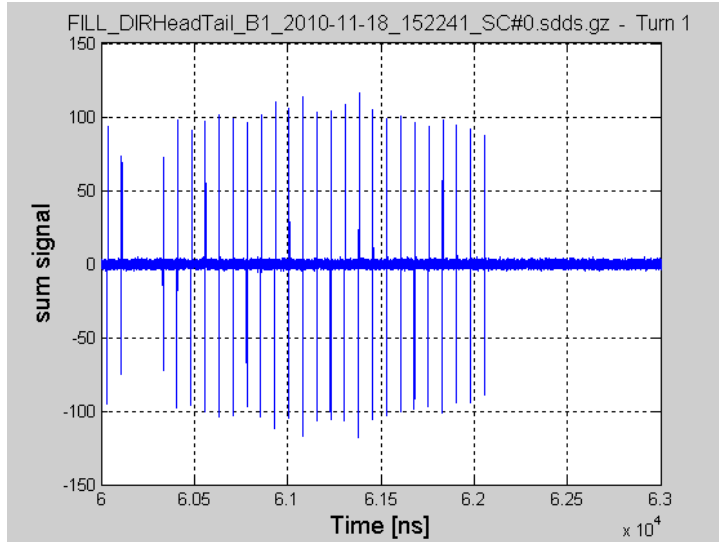


Stripline BPM connected to a fast Oscilloscope (3GHz – 10GSa/s)

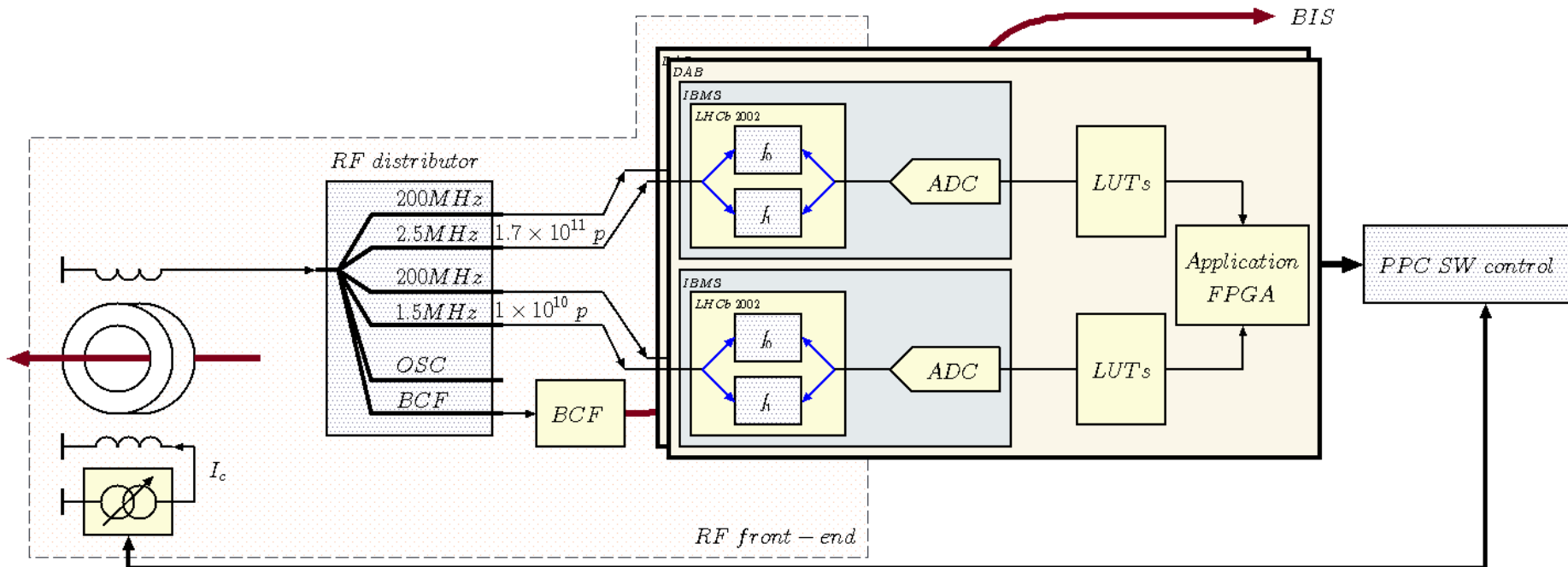
- One oscilloscope per beam
- Sum- and Delta- 'frame-length x number of turns' limited by scope memory, e.g.: 100 us x 10 turns, 500 ns x 5000 turns or 2 trains of up to 500 ns x 2500 turns
- Gains needed to adjust for pilot/nominal bunches



Provide intra-train and intra-bunch position oscillation turn by turn



- Bunch by bunch measurements provided by two dynamic ranges (*threshold $\approx 1 \times 10^{10}$ charges/bunch*)
- Typical measurement noise floor 10^7 to 10^8 charges
- Measured using two Digital Acquisition Board:



- Bunch by bunch measurement resolution: $\approx 1.5 \times 10^6$ charges on high gain, and $\approx 2.2 \times 10^7$ charges on low gain respectively

- Tools and Logging

- Bunch intensities are averaged over 1 second and logged every minutes (vector with 3564 slots)
- Fixed display available

- *B/B FBCT has the same limitations as the FBCT:*

- Calibration procedure in HIBW not accurate and not understood
- Residu
- Bunch
- Issues



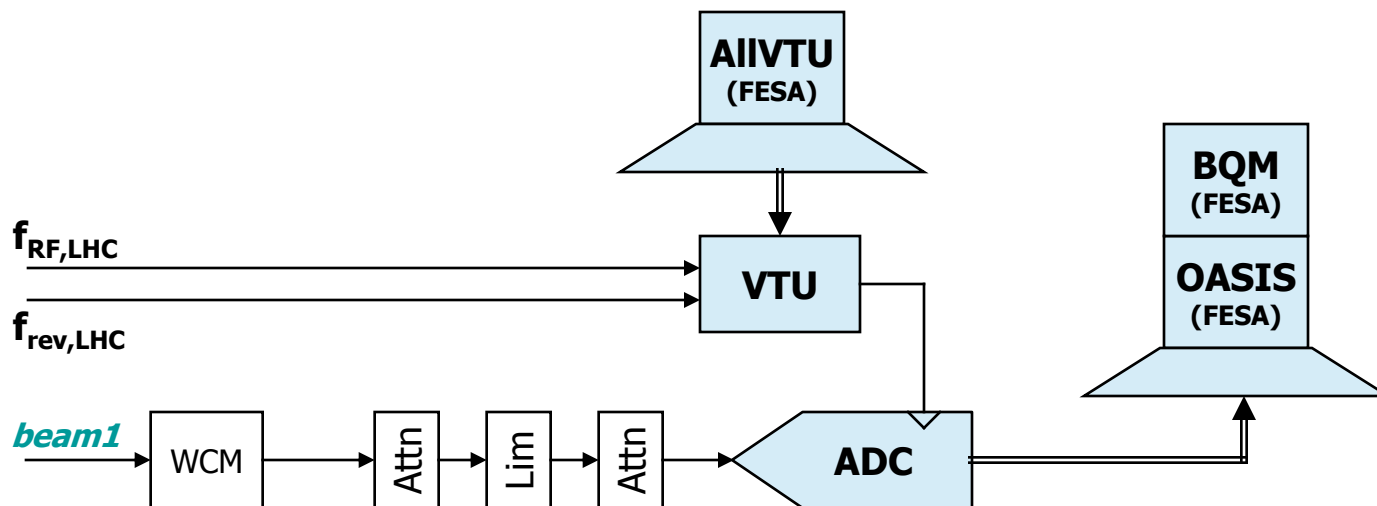
More details on 2011 plans during the lumi days in January

-DC

- IP6 FBCTs sometimes do not catch data when beam dump triggered: related to late triggering of acquisition, cable installation on-going to get hardware triggering

Wall Current Monitor used for the Beam Quality Monitor

- ADC 8GSa/s 10bits – 100 μ s – single acquisition every 5s (800000points)
- Precise trigger from the RF
- Post processing – FWHM bunch length – Bucket number (Analysis based on an algorithm developed first on SPS)
- Logging - filled bucket, bunch length & peak amplitude, statistic,...

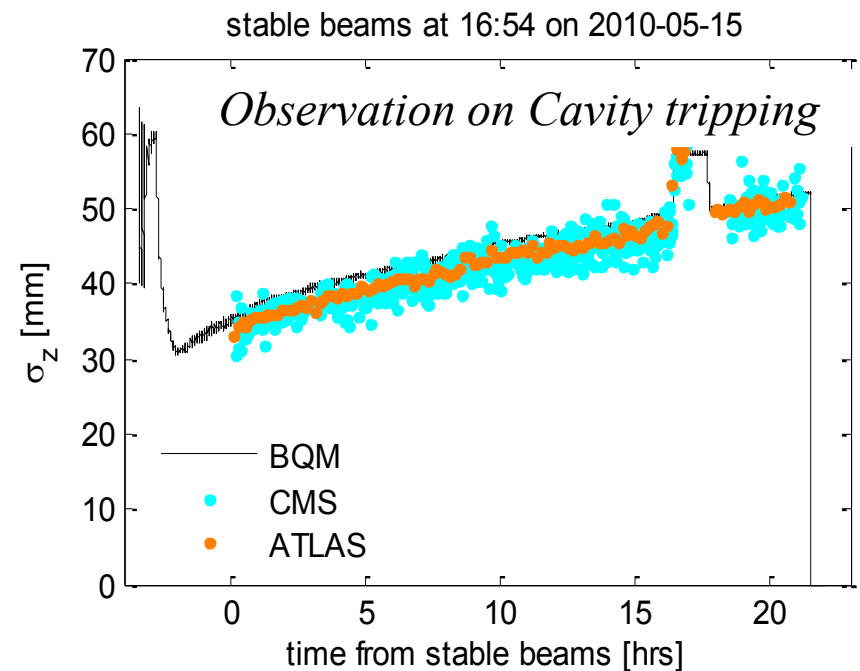
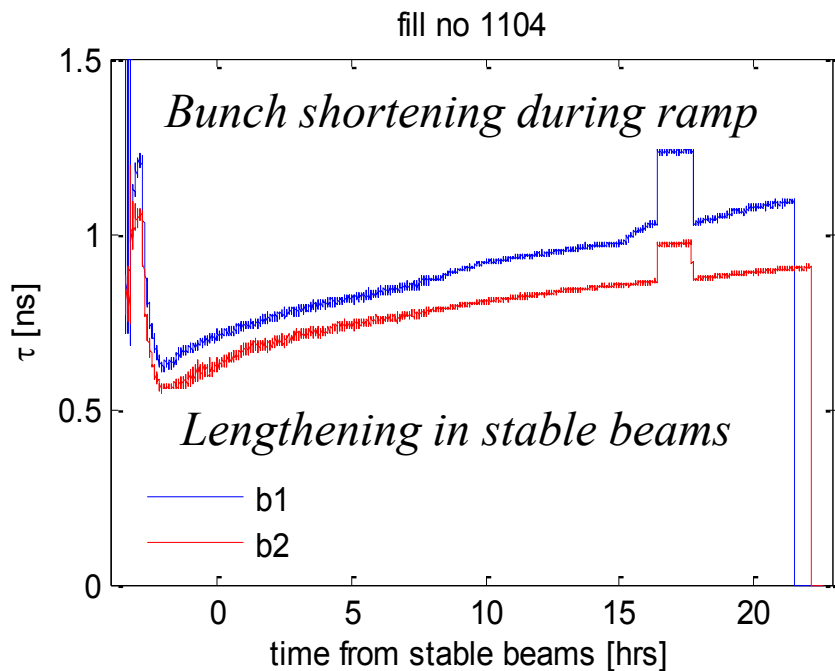


Beam Quality Monitor - Fixed display

- Use for daily operation for 2010 for online bunch length measurement
- Use or IQC for bunch filling pattern verification from injection sequencer
- Use for feedback during longitudinal blow-up



Beam Quality Monitor



Upgrades for 2011

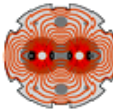
- Multiple acquisition : looking for longitudinal oscillations and stability
- Limitations to be investigated: how fast and how many turn

Wall Current Monitor in BI

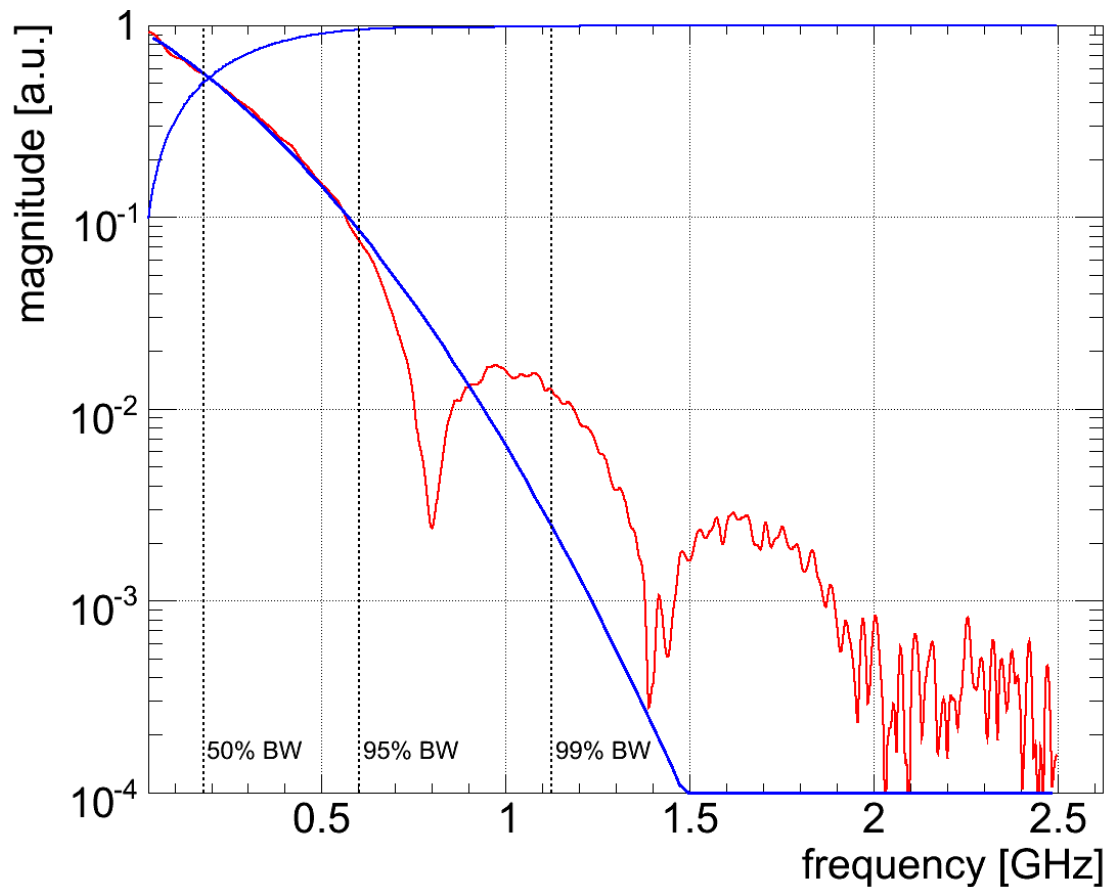
- Direct measurement on a 3GHz – 10GSa/s
- Slow 0.1 Hz acquisition but all bunches and satellites
 - Increase dynamic range (few per mil) - 300 turns for each beam every 10s

Various beam parameter estimates:

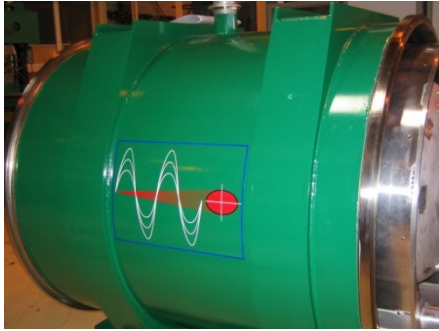
- **Number of bunches & satellites**
- **Bunch and satellite intensity estimates**
- **Bunch length and shape estimates:** Cos²-, Parabolic-, Gaussian-distribution
- Bunch power-bandwidth containing 50/95/99% of bunch power/intensity
- Bunch peak voltage, Luminous intensity in the IP, ...
- **parameters are stored on a bunch-by-bunch basis and logged at 0.1Hz**
 - statistics of each parameter per beam for quick analysis in LDB:
 - e.g. '_MEAN', '_MAX', '_MIN', '_STDEV', '_MEDIAN' (?)
 - Example: 'BUNCH_INTENSITY_MEAN', etc....



- Maximum frequency that contains 50%, 95% and 99% of bunch-spectral power (\leftrightarrow bunch intensity)



- Illustrates also the difference between a Gaussian- and real-life bunch shape**
- subtle information such as $<1\%$ variations in the bunch intensity is stored up to a few GHz



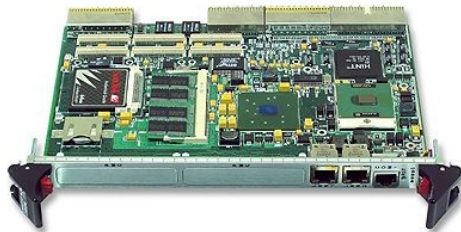
Synchrotron light
from undulator
and dipole



Geiger-mode
Avalanche photodiode
converts photon to
electrical pulse



Time to Digital
converter records
pulse arrival time



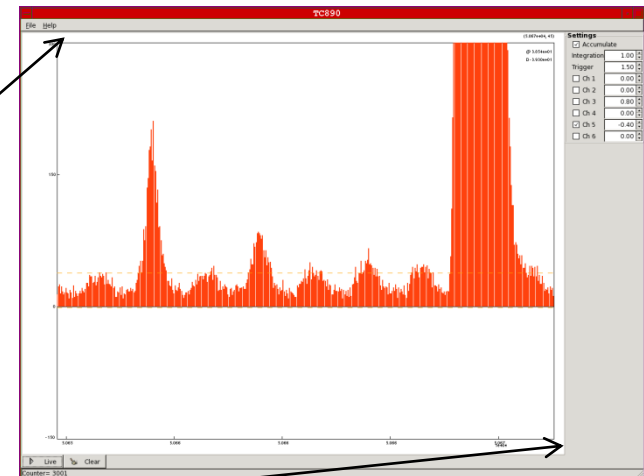
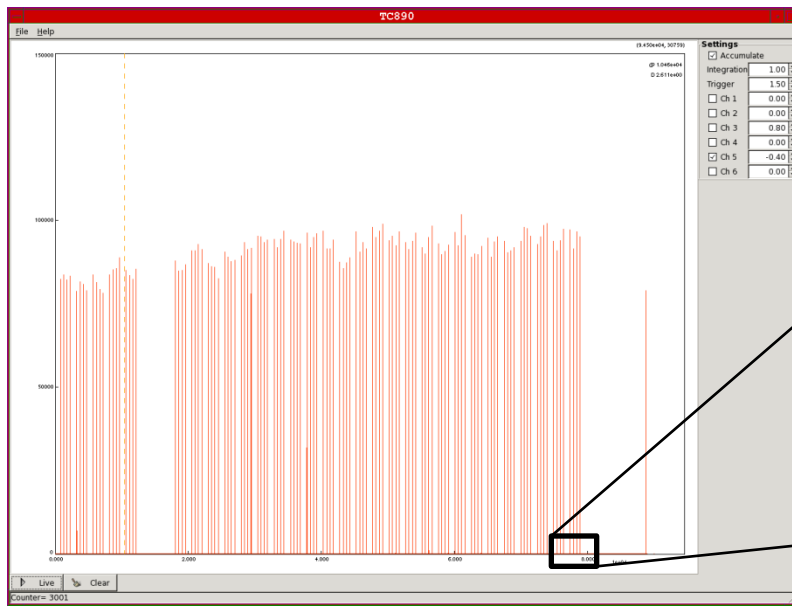
cPCI computer makes
histogram and corrects for APD
dead-time and afterpulsing

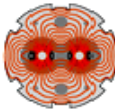
Specifications:

- The LDM is requested to produce a longitudinal profile of the entire ring with 50ps resolution.
- A very large dynamic range should make it possible to see ghost bunches as small as $5e5$ protons / 50ps with long integration.

Current status:

- The LDM is installed on beam 2 and operates on demand.





Performance :

- The whole ring is sampled with a 50ps resolution
- Dynamic range can be 2000 but needs long ($>10\text{mn}$) integration time. (Limited by after pulsing)
- Average bunch length could be determined much faster (specification: 10ms) by combining bunch data. This would be a software fix so can run in parallel with the slower full-ring profile.

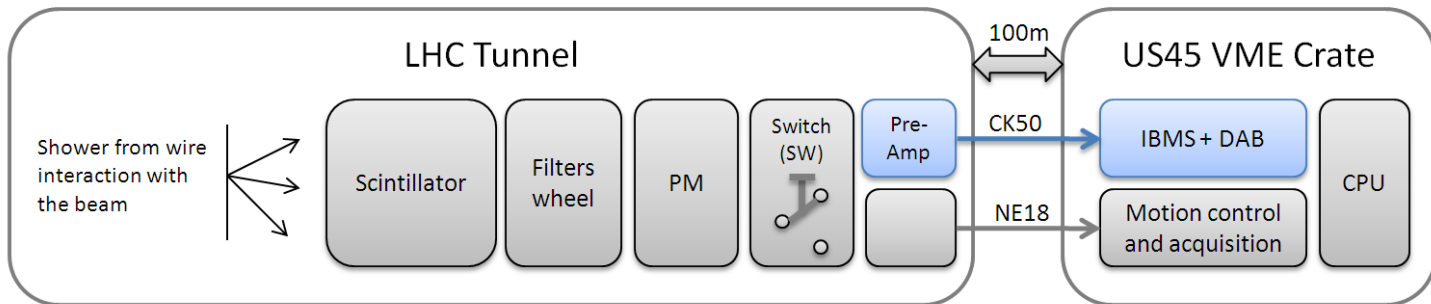
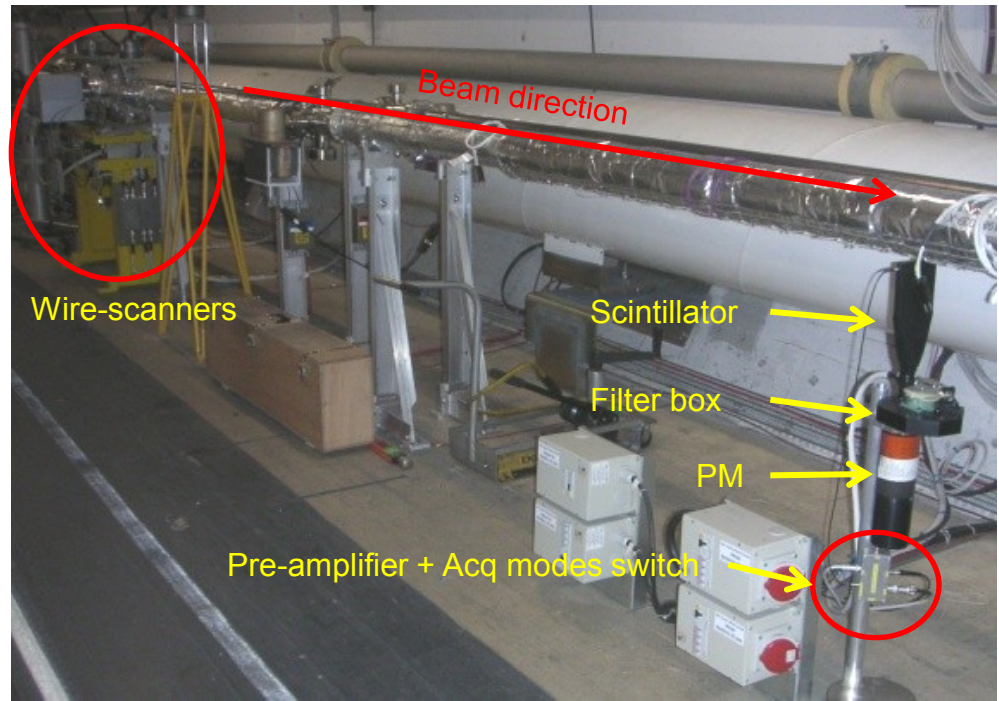
Outlook:

- Work on an optimized algorithm to compensate for after pulsing
- A similar system will be installed on beam 1 during the shutdown.
- Both beams are to be integrated into FESA and logged.
- An optically gated detector is under development which will increase the dynamic range of the system.

B/B size measurement with Wire Scanners

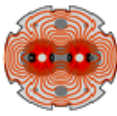
Bunch-by-Bunch hardware

- Tunnel switch between acquisition modes (Turn-by-Turn / Bunch-by-Bunch)
No parallel acquisitions
- Common material for the 2 modes: Scanners/Scintillator/Filter box/PM
- Specific B-by-B (tunnel):
Pre-amplifier (THS3001)
Cable CK50 (~100m)
Total bandwidth > 200MHz
- Specific B-by-B (US45):
IBMS+DAB integrator card
Firmware from FBCT
- Uses the Beam Synchronous Timing (BST)

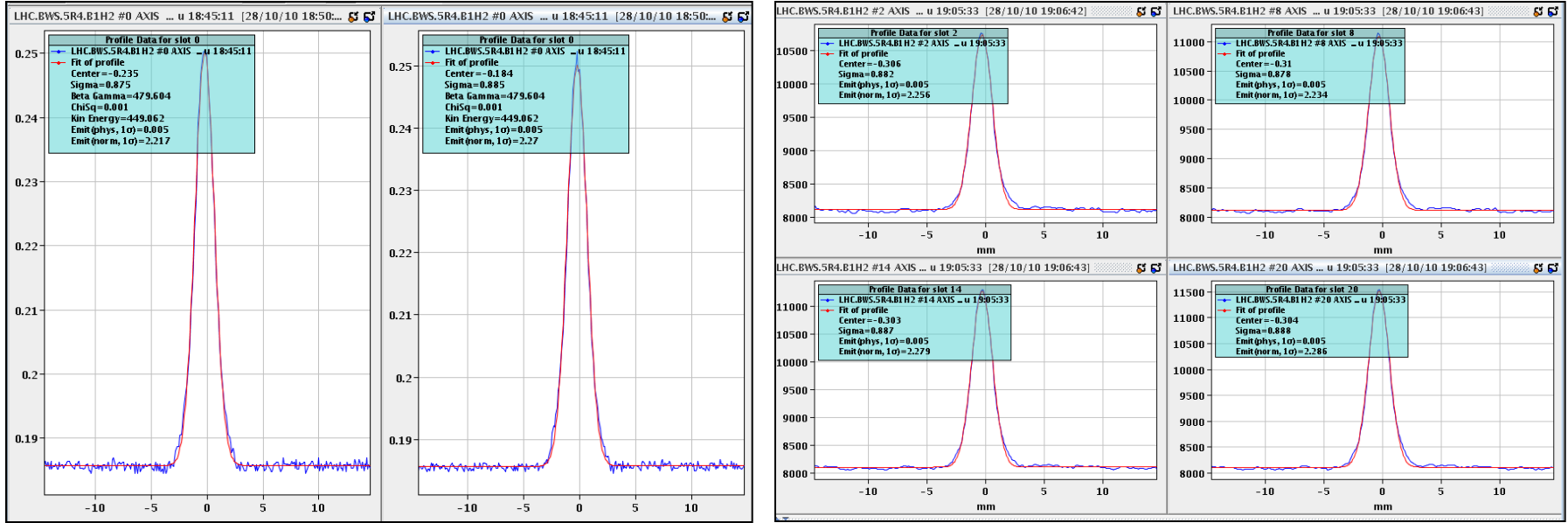




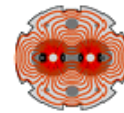
B/B size measurement with Wire Scanners



Turn (left) and bunch by bunch (right) acquisition of the same beam



Preliminary comparison between the Turn and 40MHz acquisition measurements within 10% emittance



Operational issues and performances in 2010

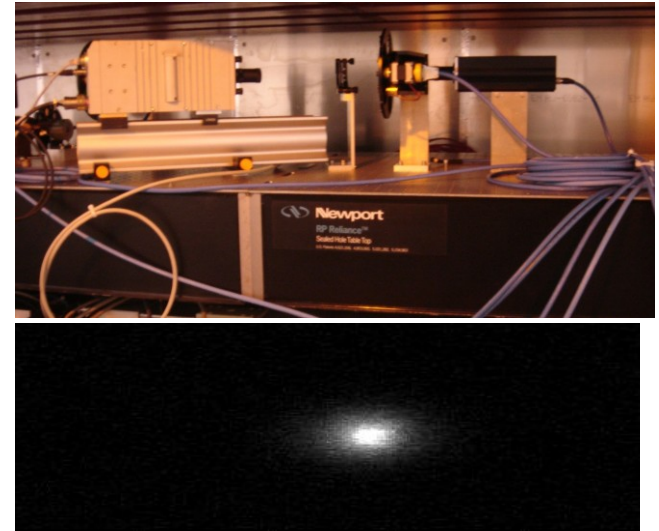
Improvement foreseen for 2011

- Maximum number of bunches per acquisition (75) limited by the front-end memory & firmware. (close to specifications: PS Batch) →
- During the present run attenuation was not enough for profile measurement of nominal bunches (1 or 2 slot delay to avoid saturation). →
 - 50 ns spaced bunch pattern measurements have crosstalk.
- Application updated to use 40MHz acq.
 - BunchxBunch selection modified
 - Easy access to acq type requested (instead of acq delay)
 - G. Crockford follows issues and requests

- Not an issue ? Intensity threshold interlock !
- Reduction of signal amplitude by lowering pre-amp gain (Christmas break)
Check relation between pre-amp gain and crosstalk
- Systematic comparison between acquisition modes & reproducibility with beam
- Implementation/validation Photo-Multiplier saturation detection as for the PSB

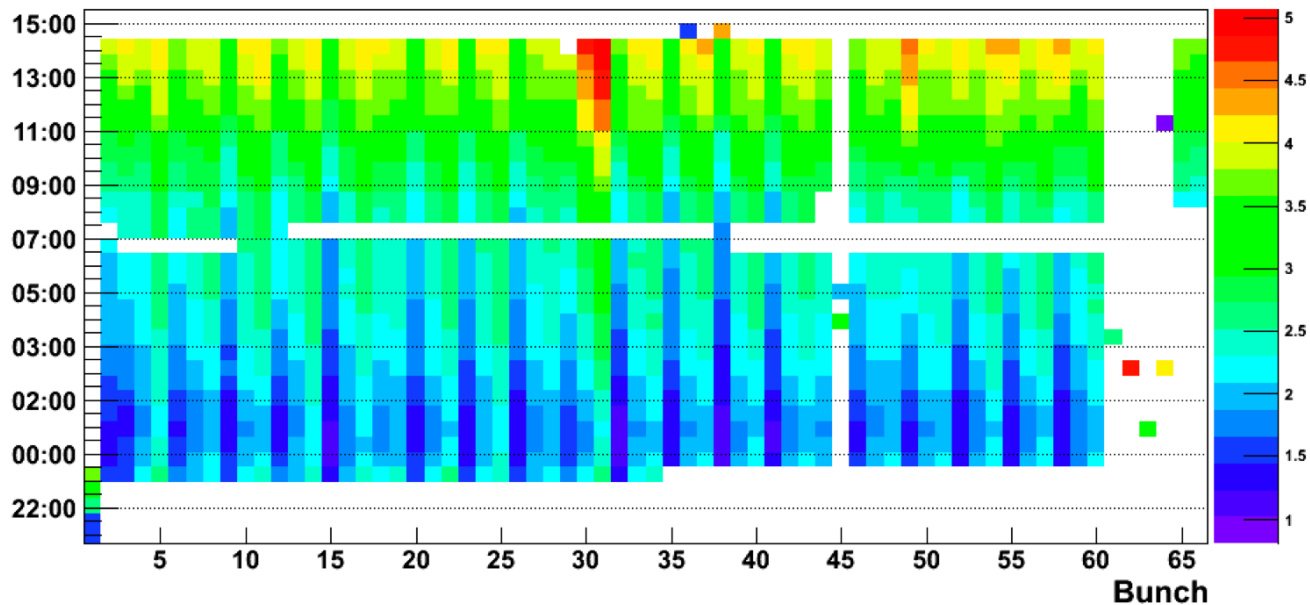
Current status:

- The intensified CCD camera used for continuous beam size observation can be gated down to 25ns
- Data logged at 1Hz
- Choose the operation mode: 'Gated' or not
- Slot scans available from BI experts



B2 Ver. Emittance

Each point corresponds to an averaging over few seconds



Performance :

- Reliable measurement for relative bunch by bunch beam size fluctuations
- Relatively long scanning time : tens of minutes
- Limitation in light intensity:
 - Protons are fine: Pilot bunch can be seen at injection energy

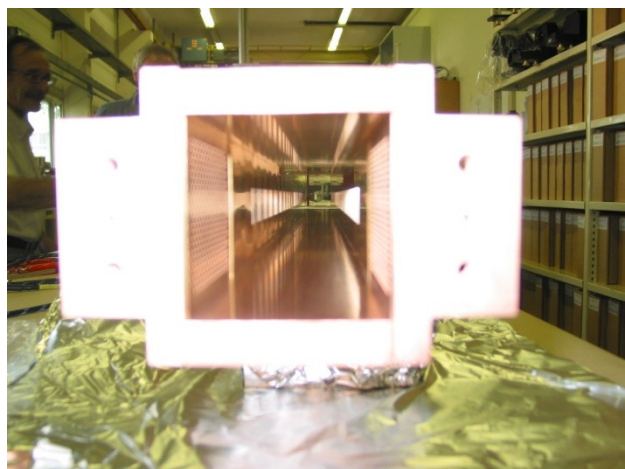
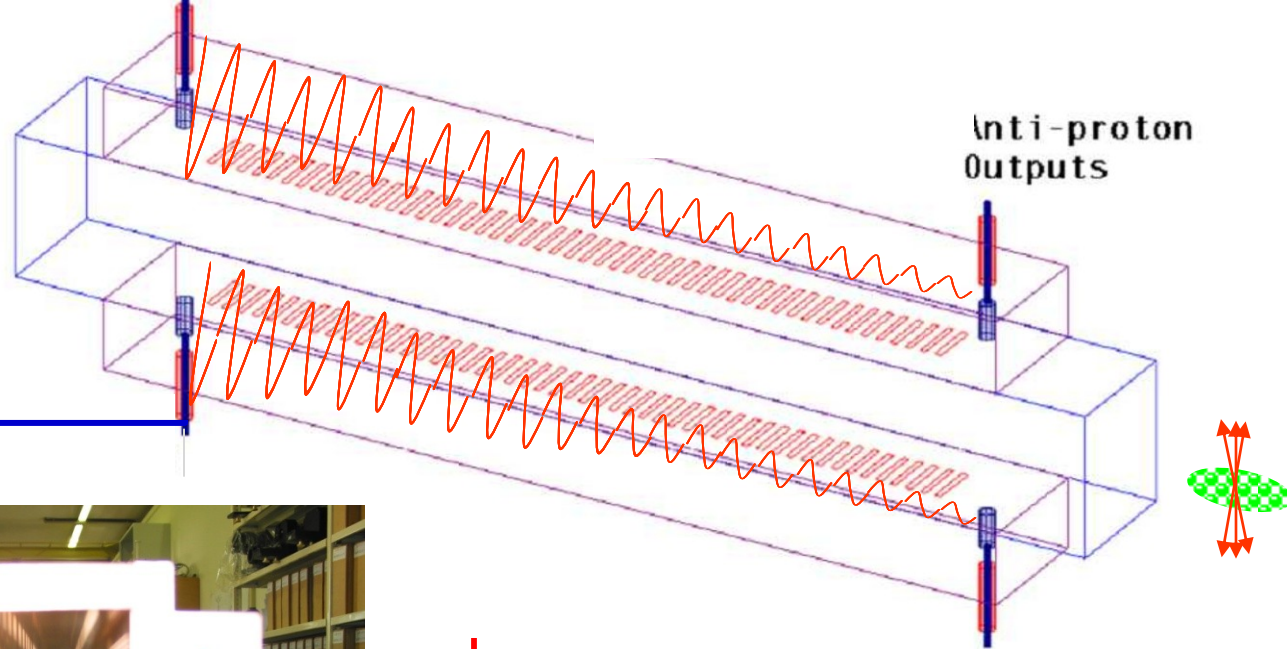
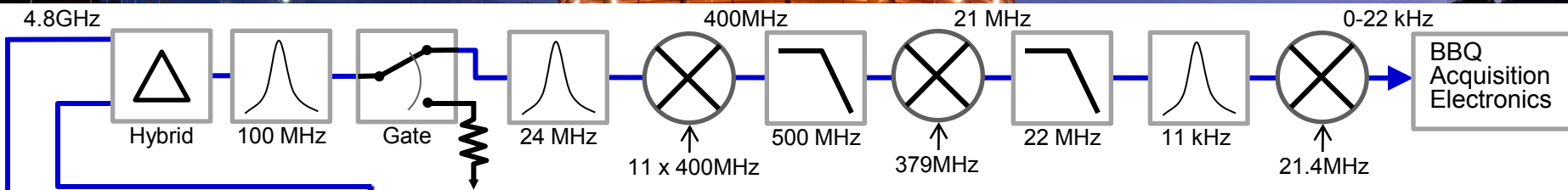
*More details on the performances and future plans of
Synchrotron light monitor in the next talk by **Federico***

Outlook fo

- Install two fast cameras providing turn by turn and bunch by bunch measurement:
Will speed up the scanning time
- Both beams are to be integrated into FESA and logged.
- OP application with slot scan ?

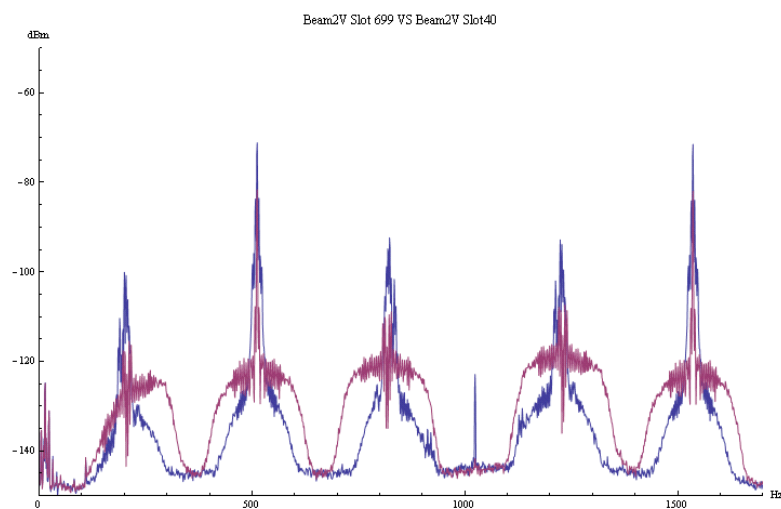
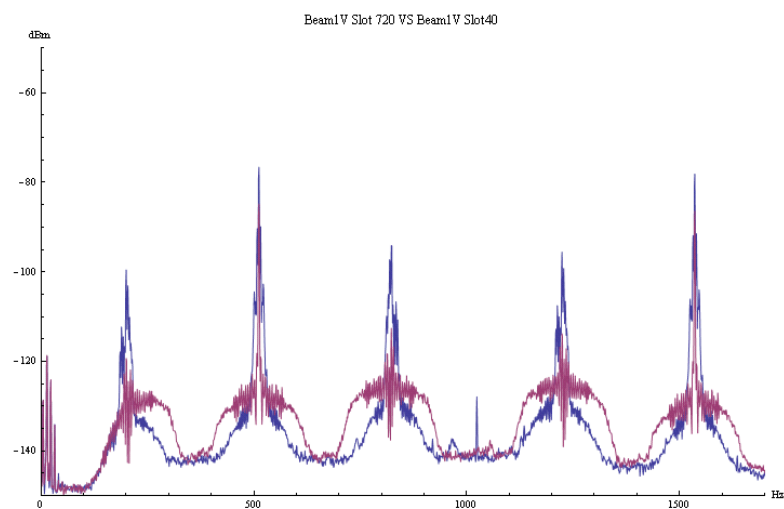
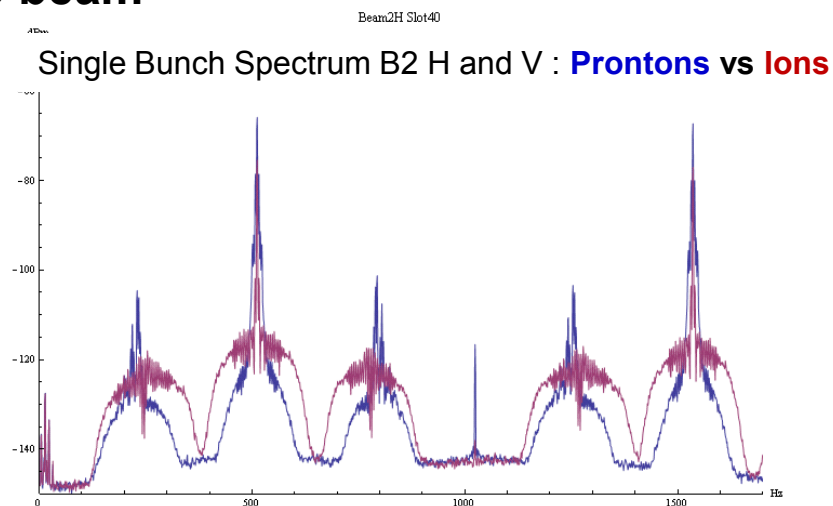
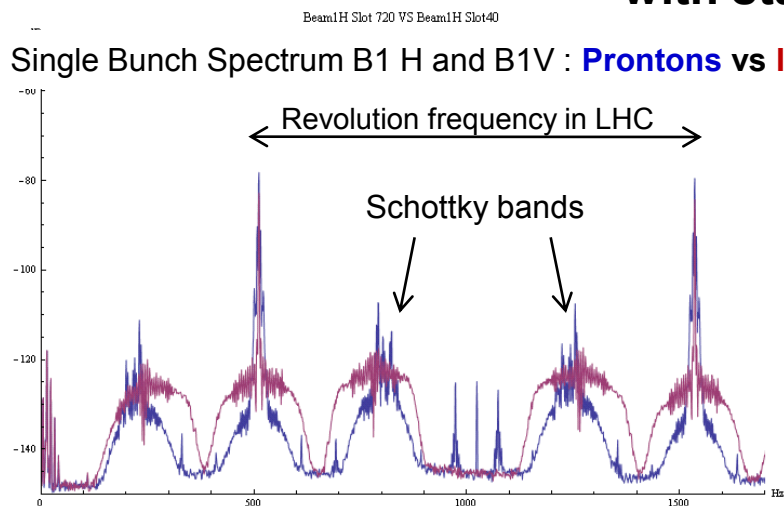
Dynamic range: 60+ dB





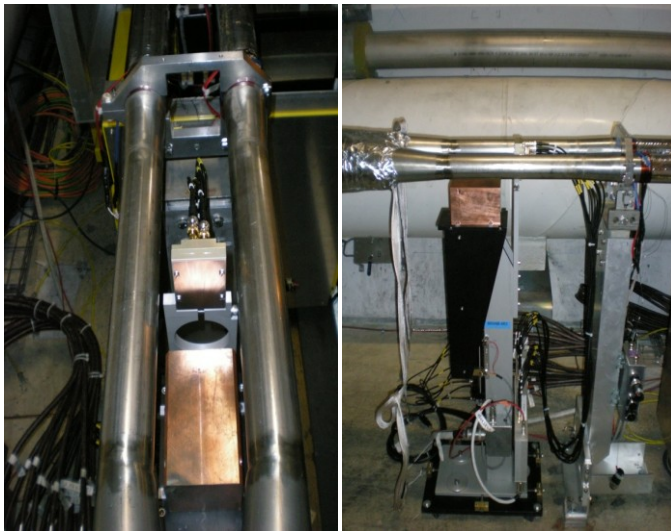
*4.8 GHz Slotted Waveguide Structure
60 x 60 mm aperture x 1.5 meters long
Gated, triple down-mixing scheme to baseband
Successive filtering from bandwidth of 100MHz to 11kHz
Capable of Bunch by Bunch Measurement*

Comparison of Ions and Protons Bunch to Bunch Spectra with stable beam



- Status in 2010
 - Schottky made operational towards the end of the year
 - GUI & calculation daemon provided by FNAL
 - Now logging tune, chroma, emittance & dp/p
 - Consistency of emittance & dp/p still to be verified
 - Proton signals not useable during ramp
 - Longitudinal blow-up wreaks havoc!
 - Ion signals text book beautiful!
- Plans for 2011
 - Incorporate automatic bunch cycling on selected bunches in GUI (currently via expert program)
 - Add electronic pick-up centring to try and reduce coherent signal levels

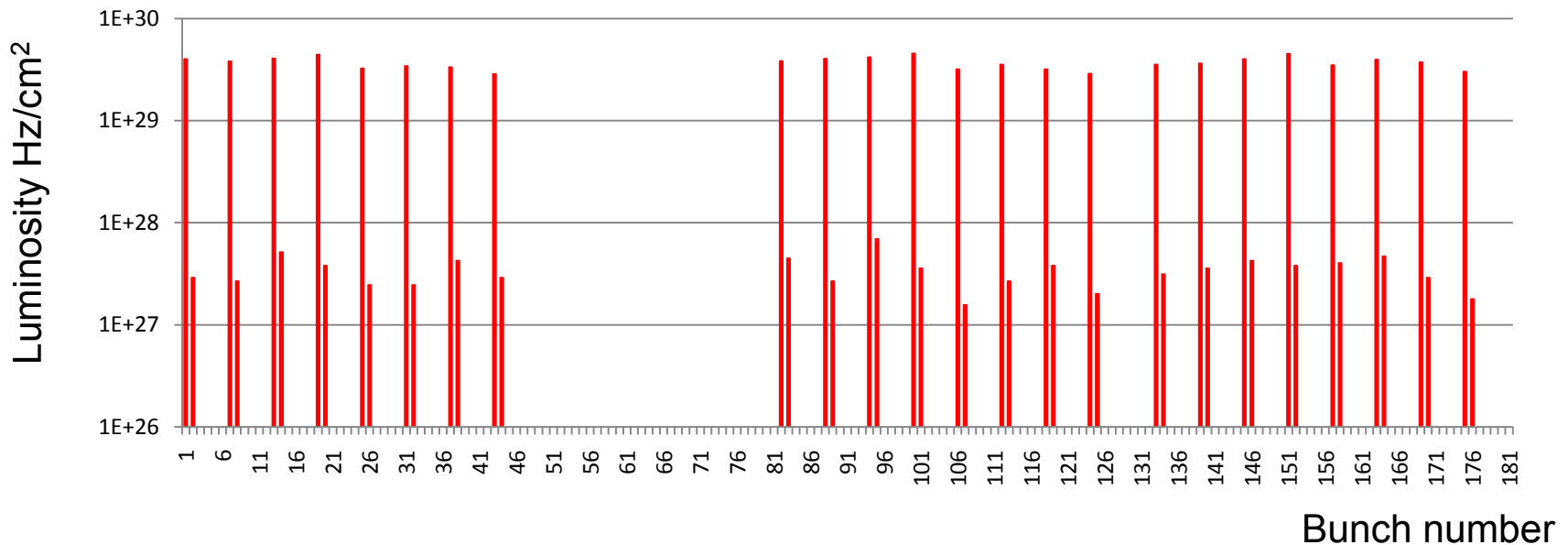
- The BRAN detectors monitor the collision rates around the luminous IPs
- There were 3 different BRAN systems in 2010
 - BRANA – ionization chamber from LBNL, IP1, IP5
 - BRANB – CdTe CERN/CEA-LETI, IP2, IP8
 - BRANP – plastic scintillator, IP1, IP5
- All have bunch by bunch capability - Logging at 0.1Hz
- FESA class fully implemented, just need a few touch-ups



BRAN - pile-up

- All detectors work in counting mode
- For BRANB and BRANP this is the only available mode
- The bunch luminosity already relatively high \rightarrow pile-up
- Need to introduce a correction next year. Have to tune the algorithm first
- Absolute calibration not yet reliable
- BRANA has a pulse height mode for the high multiplicity, but it is not working yet, may be limited to $\text{lumi} > 10^{33}$

BRANP FILL 1453



BRAN - acquisition

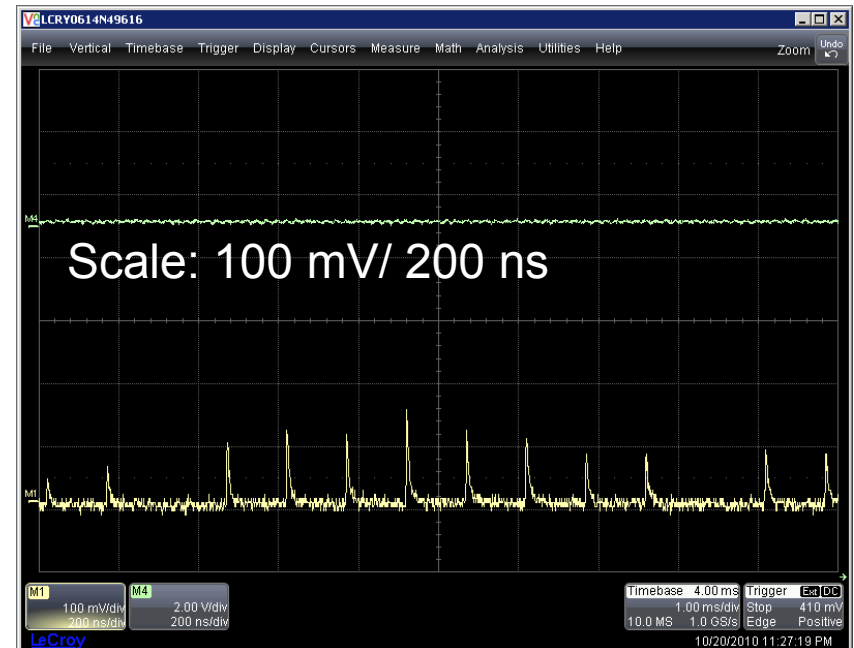
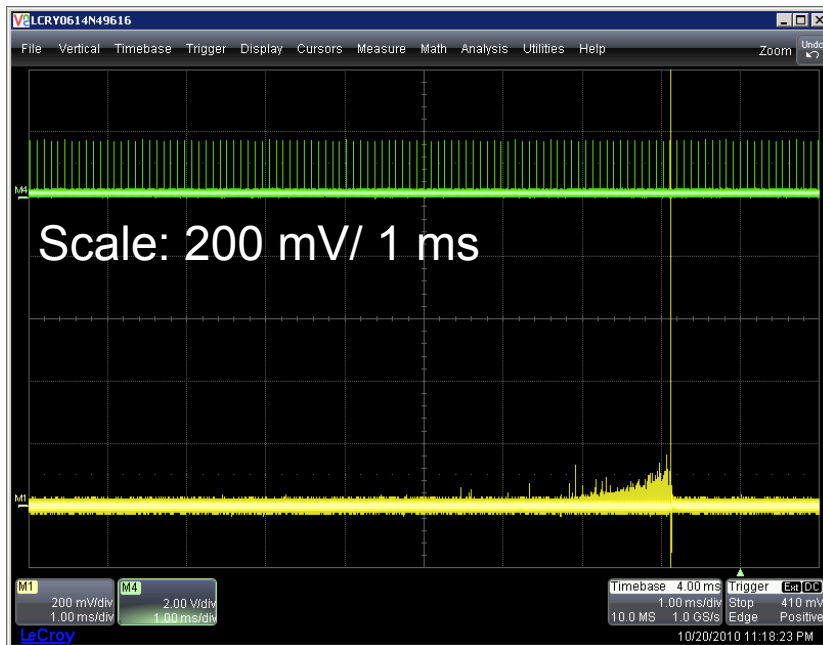
- Total luminosity published and logged at 1Hz – B/B luminosity at 0.1 Hz
- Fixed displays - Several expert/guru applications available
- Average and bunch by bunch luminosities work in parallel all the time
- Some leakage in neighbour slots, 25ns filling would lead to errors in the b/b values otherwise it should be ok
- **Only change for 2011 is pile-up correction and better calibration**

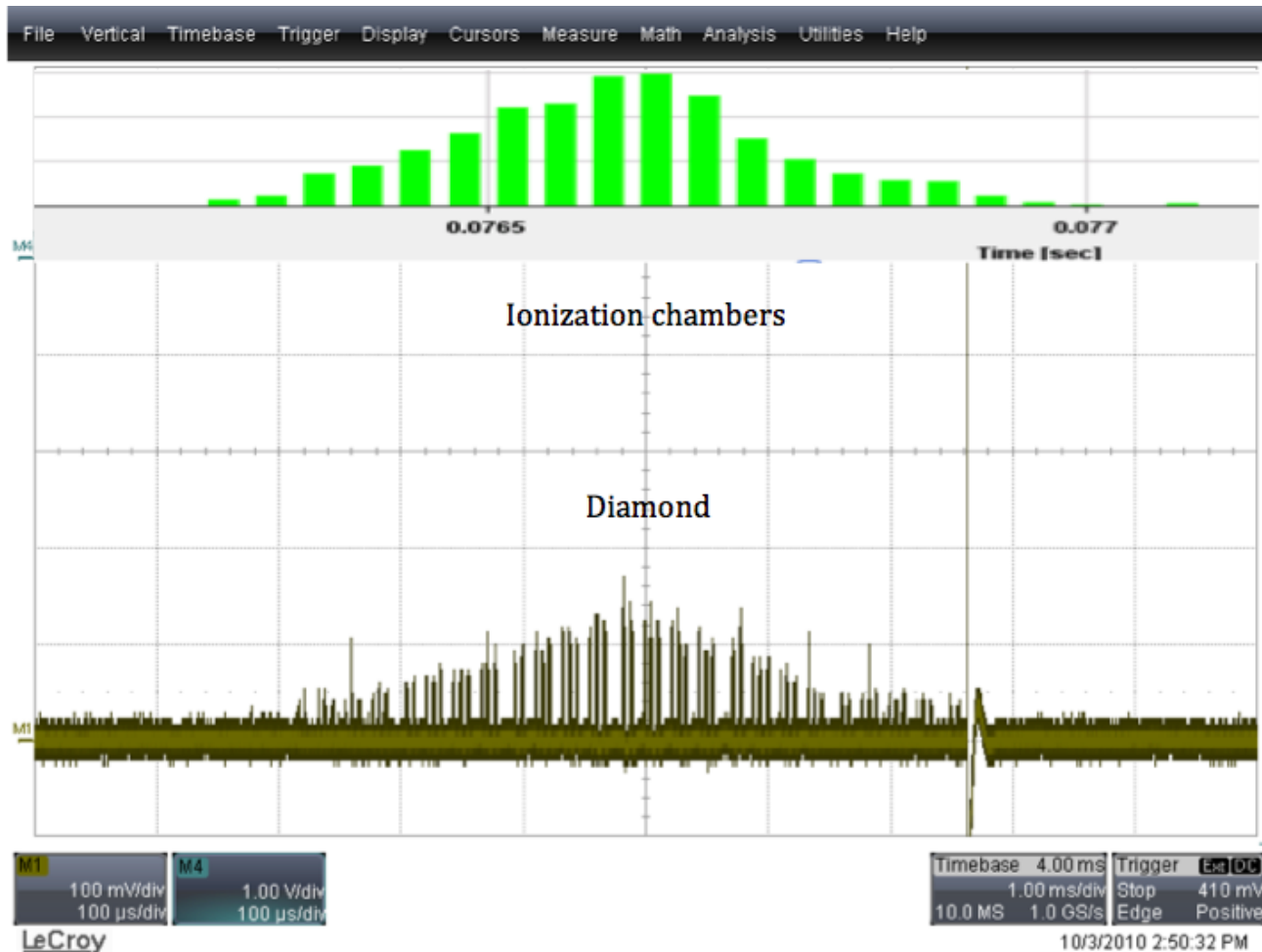
BRAN - HW issues

- BRANP is not radiation hard and will have to be removed before next run as remote handling is not possible with the present detectors
- In collaboration with LHC-f a new rad-hard scintillator will be tested on one side of IP1, details still to be worked out
- In 2011 will have to rely only on the BRANA system, which is not well suited for very low luminosities ($<10^{30}$)
- Due to interference with ALICE ZDC the BRANB in IP2 can not be used with ions

Post Mortem Trigger Beam Loss Acquisition, LHCb UFO Event

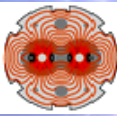
- Diamond detector as fast response BLM (Point 7)
- Minimum loss pulse width 5ns
- Memory length present 10 ms, 2E6 values





- Plans for 2011 : 4 detectors in total
 - x1 in point 2 & 8 for injection snapshot measurement triggered by injection sequencer
 - x2 in point 7 for UFO observation triggered by PM

- 11 Instruments can provide B/B measurements
- 9 of them can do it in parallel to normal continuous beam observation (limitation on beam size monitoring at the moment)
- 2 Gated measurements (Schottky and BSRT), 2 devices operating in counting mode (Lumi and LDM)
The others can do full ring/train measurements
- Most of the systems are still under commissioning and many improvements can be foreseen done
- Only half of the monitors have operational applications for the moment !
- Is this covering all needs ?

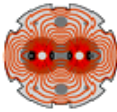


Thanks for your attention

E. Calvo, J.J. Savioz, L. **Jensen**, J. Gonzalez, D. Belohrad, M. Ludwig, S. Bart-Pedersen, M. Gasior, R. Steinhagen, A. Jeff, A. Boccardi, E. **Bravin**, G. Papotti, E. **Effinger**, E. Griesmayer, B. Dehning, J. Emery, A. Guerrero, T. Lefevre, J.J. Gras, A. **Rabiller**, F. Roncarolo, M. Favier, R. **Jones**, E. Calvo, J.J. Savioz, L. Jensen, J. Gonzalez, D. Belohrad, M. Ludwig, S. **Bart-Pedersen**, M. Gasior, R. Steinhagen, A. Jeff, A. Boccardi, E. Bravin, G. Papotti, E. Effinger, E. Griesmayer, B. **Dehning**, J. **Emery**, A. Guerrero, T. **Lefevre**, J.J. Gras, A. Rabiller, F. Roncarolo, M. **Favier**, R. Jones, E. Calvo, J.J. **Savioz**, L. Jensen, J. Gonzalez, D. Belohrad, M. Ludwig, S. Bart-Pedersen, M. Gasior, R. **Steinhagen**, A. Jeff, A. Boccardi, E. Bravin, G. **Papotti**, E. Effinger, E. Griesmayer, B. Dehning, J. Emery, A. Guerrero, T. Lefevre, J.J. **Gras**, A. Rabiller, F. Roncarolo, M. Favier, R. Jones, E. Calvo, J.J. Savioz, L. Jensen, J. **Gonzalez**, D. Belohrad, M. **Ludwig**, S. Bart-Pedersen, M. **Gasior**, R. Steinhagen, A. Jeff, A. **Boccardi**, E. Bravin, G. Papotti, E. Effinger, E. **Griesmayer**, B. Dehning, J. Emery, A. **Guerrero**, T. Lefevre, J.J. Gras, A. Rabiller, F. Roncarolo, M. Favier, R. Jones, E. **Calvo**, J.J. Savioz, L. Jensen, J. Gonzalez, D. **Belohrad**, M. Ludwig, S. Bart-Pedersen, M. Gasior, R. Steinhagen, A. **Jeff**, A. Boccardi, E. Bravin, G. Papotti, E. Effinger, E. Griesmayer, B. Dehning, J. Emery, A. Guerrero, T. Lefevre, J.J. Gras, A. Rabiller, F. **Roncarolo**, M. Favier, R. Jones,



B/B Position monitoring



Navigation Tool 2.10

File Automate

Device Selection

- cfv-sr1-bpmb1la
 - LHC.BPM.SR1.B1LB
 - GD000000000000
- cfv-sr1-bpmb1lb
 - LHC.BPM.SR1.B1LB
 - GD000000000000
- cfv-sr1-bpmb1ra

Cycle Selection

- ALL
- LHC.USER.LHC

Property Selection (dbl-click = new)

- ExpertSetting
- FipSettings
- FipSettingsSmpl
- GetCapData
- IntCalSettings
- PickupSettings
- PostModernData

Class: BPMLHC
Version: 1
FEC: cfv-sr1-bpmb1lb
Device: LHC.BPM.SR1.B1LB
Cycle: ALL
Property: GetCapData

cfv-sr1-bpmb1lb:LHC.BPM.SR1.B1LB@ALL:GetCapData

Property Value (38,051 b) - Fri Nov 26 13:20:43 CET 2010

bstStamp: 1290769833980603
nbOfCapTurns: 20
nbOfCapBunches: 4
nbOfBpms: 17

Get Get Next Published Subscribe

Table view on LHC.BPM.SR1.B1LB@null:GetCapData.horPosition {sequential=true}

Index	Value#1	Value#2	Value#3	Value#4	Value#5	Value#6	Value#7	Value#8	Value#9	Value#10
5	-2.656807	-3.4584684	0.0511933...	0.46279782	0.0049265...	-0.13831528	-0.40546545	-0.21215713	-0.3788538	-0.7889
6	-2.8852885	-3.185151	0.39376298	0.5114882	0.0541339...	-0.13831528	-0.30866146	0.0048660...	-0.25834426	-0.8129
7	-3.2004113	-3.0640004	0.39376298	0.8532674	0.3748351	-0.42590788	-0.50216097	0.0048660...	-0.13764285	-0.8370
8	-3.137058	-3.185151	0.32023144	0.90224034	0.25130522	-0.23428991	-0.4779969	0.1015171...	-0.25834426	-0.8129
9	-1.7271359	-2.8222084	0.32023144	0.12277414	-0.14250563	0.12625434	0.1041367...	-0.64465046	-0.76335937	-0.4756
10	-1.6364925	-3.2457976	-0.0220374...	-0.07097195	-0.06882422	0.31932357	-0.23598282	-0.7165669	-0.28246108	-0.1856
11	-1.8179661	-3.2457976	0.0023664...	0.0016411...	-0.19158956	0.29515725	-0.0904176...	-0.45265833	-0.47513273	-0.2585
12	-2.0216086	-3.185151	-0.0952129	0.0258563...	-0.09339215	0.24685344	-0.23598282	-0.47667575	-0.3306721	-0.2826
13	-1.8636237	-1.8596088	1.1088794	0.7798806	-0.4610685	-0.28223446	0.0311130...	0.0048660...	-0.73937225	-0.8129
14	-1.3156631	-1.9196398	0.8613137	0.5114882	-0.4121292	-0.21030708	0.27485317	-0.40460652	-0.83528936	-0.5482
15	-1.4756695	-1.8295959	1.0344898	0.36550844	-0.4121292	-0.06625608	0.32371774	-0.3084321	-0.95507556	-0.6205
16	-1.430006	-1.7695763	0.7872578	0.68216157	-0.48552936	-0.06625608	0.4705621	-0.45265833	-0.90717494	-0.4276
17	-2.6140912	-2.792027	0.7132941	0.8777489	-0.2651625	-0.2582656	-0.21174163	0.1015171...	-0.25834426	-0.9811
18	-2.7500997	-2.3702989	0.8613137	1.02485	-0.14250563	-0.4737486	-0.21174163	0.14989163	-0.5713051	-1.1969
19	-2.5014777	-2.2800903	0.9849547	1.0739678	-0.19158956	-0.7603255	-0.13897121	0.14989163	-0.6433689	-1.0530
20	-2.6596336	-2.3402238	0.9802045	1.1477268	-0.21612082	-0.54546535	-0.0904176...	0.1015171...	-0.52323186	-1.2688
21	-2.386096	-3.306494	0.0023664...	0.14701836	-0.04424847	0.19858666	-0.40546545	-0.3805719	-0.427007	-0.5241
22	-2.7911568	-3.4584684	0.10004609	0.2197887	0.0295261...	-0.18631716	-0.45382634	-0.3805719	-0.21008748	-0.7167
23	-2.6562657	-3.397637	-0.0952129	0.31690753	0.0049265...	0.0540005...	-0.30866146	-0.21215713	-0.25834426	-0.7408
24	-2.837132	-3.4280457	-0.0708270...	0.36550844	0.10337445	-0.0181777...	-0.45382634	-0.13988076	-0.13764285	-0.7408
25	-1.4988132	-2.4304655	0.4673682	0.38981956	-0.38765058	0.19858666	-0.0175249...	-0.35653135	-0.6913819	-0.3068
26	-1.3613511	-2.5809891	0.36924443	0.29261765	-0.04424847	0.22271544	0.1041367...	-0.57269174	-0.7153799	-0.2826
27	-1.544599	-2.8825974	0.2957368	0.05007712	-0.04424847	0.31932357	0.07978652	-0.64465046	-0.6673782	-0.2826
28	-1.566989	-2.6713867	0.2957368	0.1435389	-0.21612082	0.27100065	-0.06612851	-0.62066907	-0.6193537	-0.3068

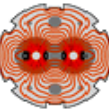
Navigation Context

BPM channels

N=4 bunches

Consecutive turns

Displayed in base 10



ASYNCHRONOUS ACQUISITION - FIFO MODE : ...to store up to 32768 bunches.

SYNCHRONOUS CAPTURE ACQUISITION

turn-by-turn for selected slots (bunches). The maximum number of acquisitions is limited to 128K.

SYNCHRONOUS ORBIT ACQUISITION

The orbit process includes the 'Bunch Sum' mode: accumulation of the valid data for each slots for a selected number of consecutive T turns (1...1023).

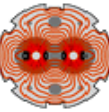
INTERLOCK ACQUISITION

The Interlock process consists of a bunch-by-bunch and turn-by-turn acquisition of Horizontal and Vertical data, and an algorithm to decide whether to trigger the dump signal when the measurement data are outside the configurable parameters.

By JJS



FBCT - Fesa



File Automate

RBA: belohrad

Device Selection

- ppcbidv12
- cfv-ua47-bctfrb
- dleitst1
- cfv-ua47-bctfra
 - LHC.BCTFR.A6R4.B1
 - LHC.BCTFR.A6R4.B2
 - G00000000000000

Cycle Selection

- ALL
- LHC.USER.LHC

Property Selection (dbi-clk = new)

- ExperimentAcquisition
- ExperimentTriggeredInte
- ExpertAcquisition
- ExpertSettings
- GuruAcquisition
- GuruSettings

Class BCTFRLHC
Version 2
FEC cfv-ua47-bctfra
Device LHC.BCTFR.A6R4.B1
Cycle LHC.USER.LHC
Property ExpertSettings

Property Value (170,741 b)- Fri Dec 03 14:36:07 CET 2010

-viewers-	arbitratorFlag	online
-viewers-	operationalMezzanineLOBW	HIGH_GAIN
-viewers-	operationalMezzanineHIBW	HIGH_GAIN
-viewers-	historyIntensity	array-float
-viewers-	historyIntensityTS	array-long long
-viewers-	historyTurnIntensity	array-float
-viewers-	historyBunchIntensity	array2D-float
-viewers-	acqTime	Fri Dec 3 14:36:07 201
-viewers-	acqStamp	129138336707110480
-viewers-	bunchPopulationMask	array-short
-viewers-	bunchPopulationThreshold	3.0E9
-viewers-	averageBeamIntensity	3.412199314285714E8
-viewers-	averageBunchIntensities	array-float
-viewers-	wholeBeamIntensity	0.0
-viewers-	bestLifetime	0.0

Summing →

Bunch-bunch →

Get Get Next Published Subscribe

2D view on LHC.BCTFR.A6R4.B1@LHC.USER.LHC:Acquisition.averageBunchIntensities (#traces=1 sequential=...

Generic Graph [03/12/10 14:36:07]

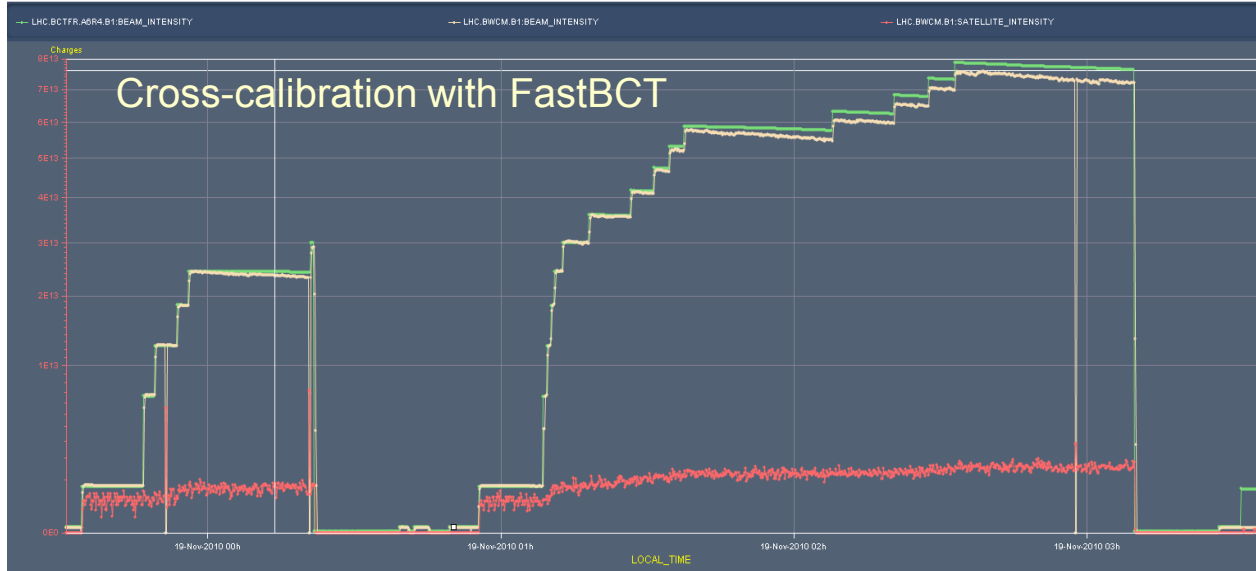
Bunch-bunch

2D view on LHC.BCTFR.A6R4.B1@LHC.USER.LHC:Acquisition.historyIntensity (#traces=1 sequential=true a...

Generic Graph

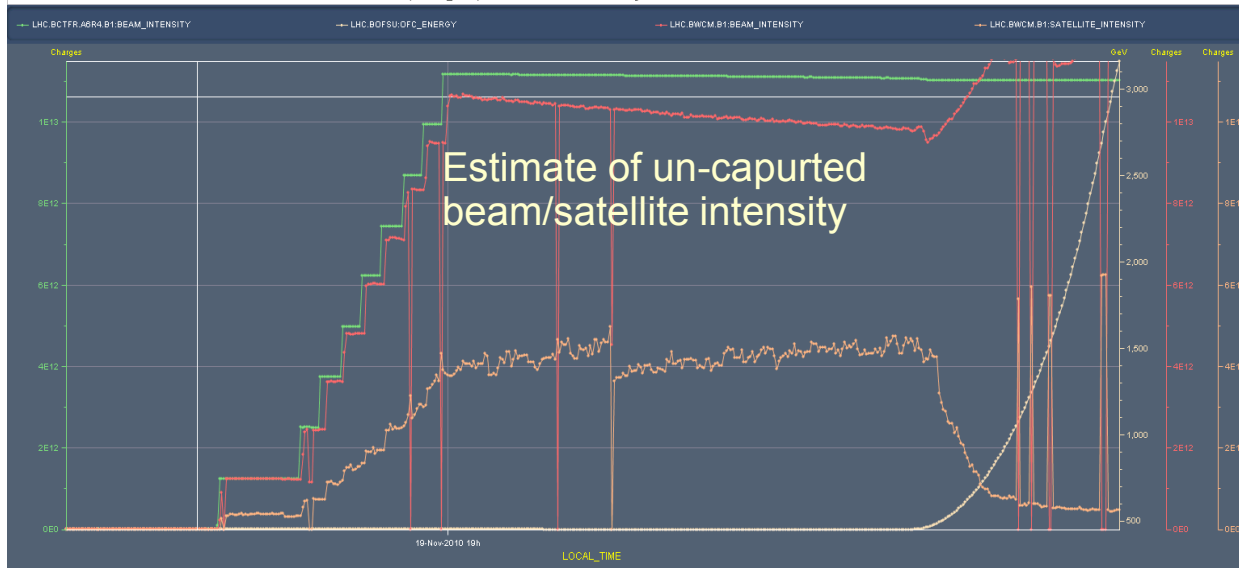
Summing

Timeseries Chart between 2010-11-18 23:30:59.000 and 2010-11-19 03:35:00.000 (LOCAL_TIME) Timescaled with REPEAT every 10 SECOND

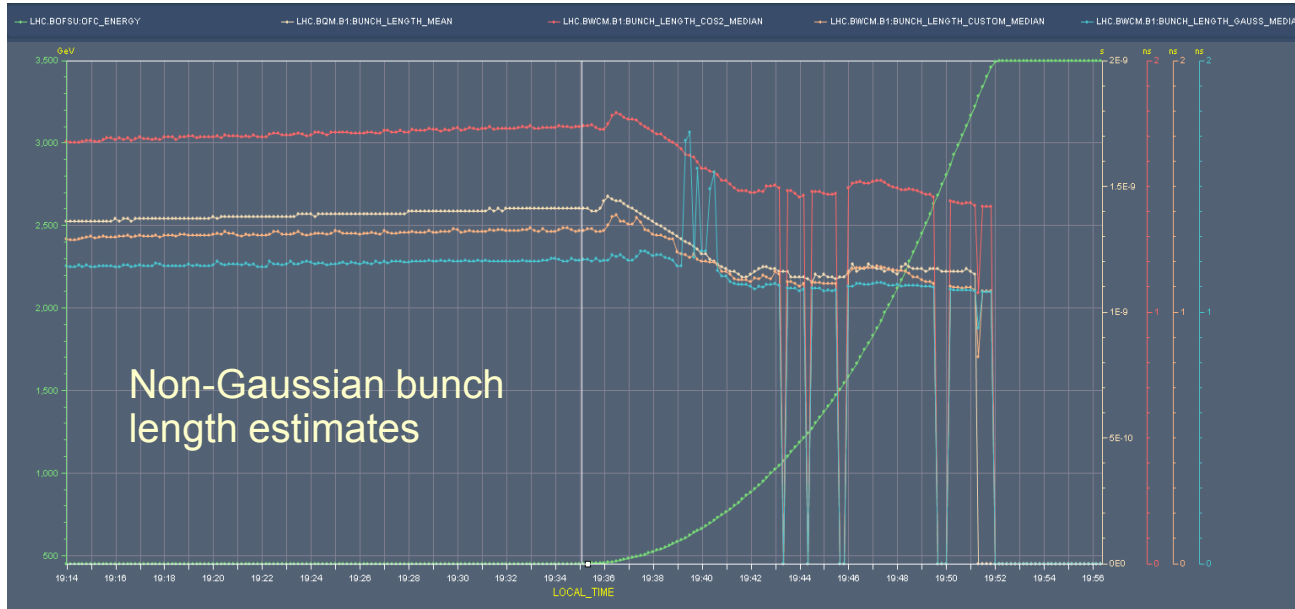


WCM @ LHC

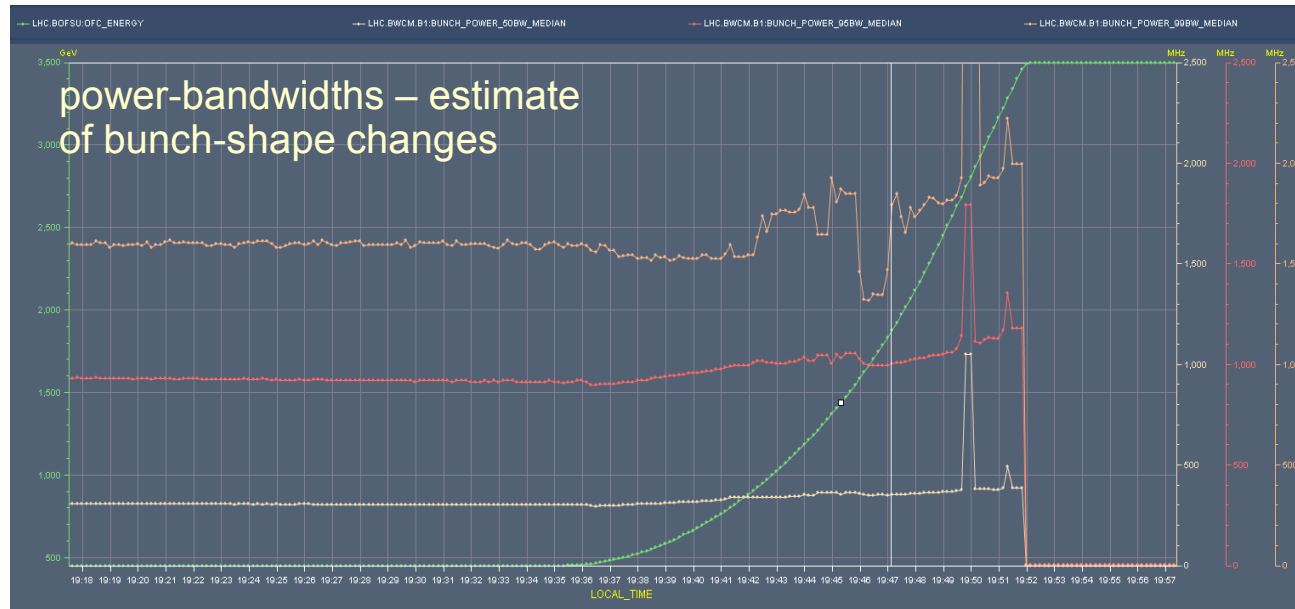
Timeseries Chart between 2010-11-19 18:30:59.000 and 2010-11-19 19:50:59.000 (LOCAL_TIME) Timescaled with REPEAT every 10 SECOND



Pb with the scope to be replaced or repaired during shutdown

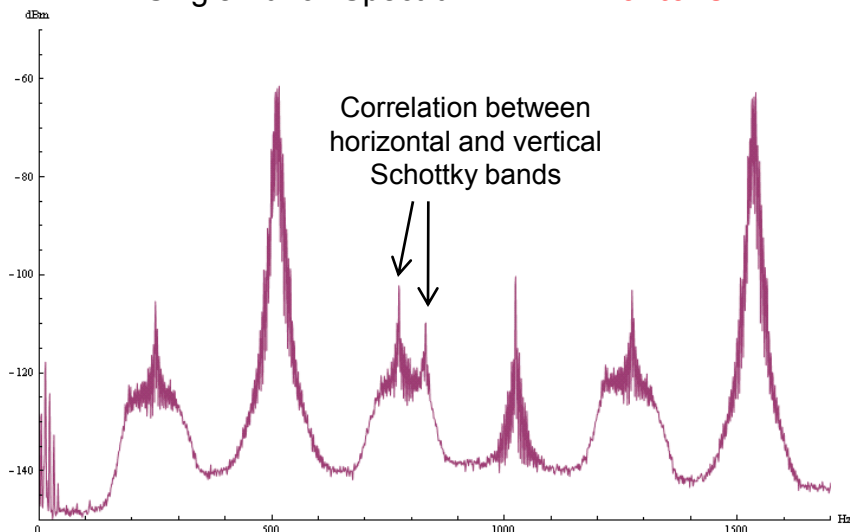


WCM @ LHC

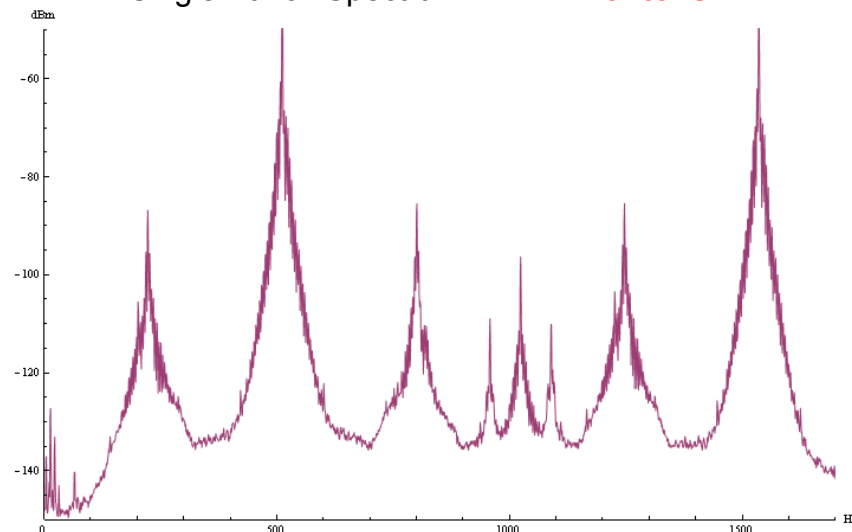


Bunch per Bunch Spectra of Protons Beam during dumping

Single Bunch Spectrum B1 H : **Prontons**

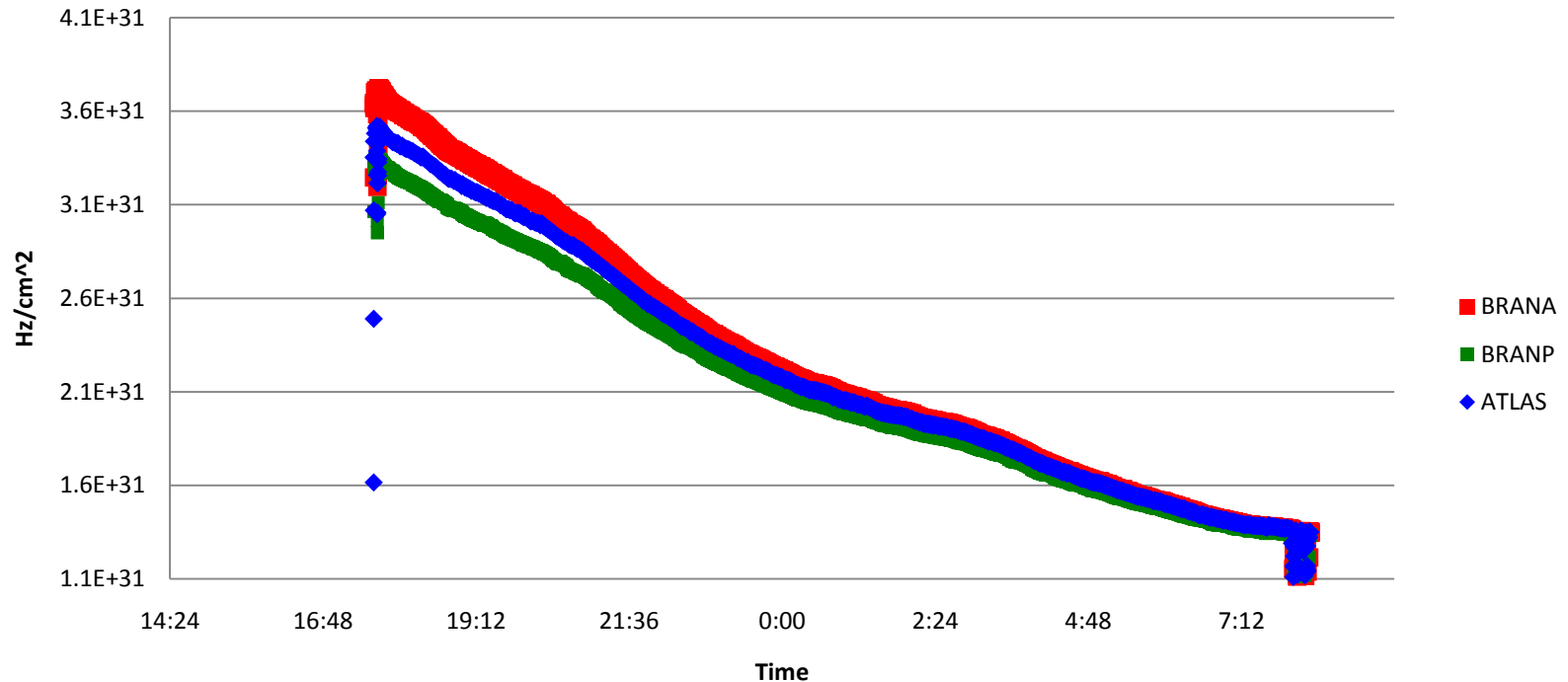


Single Bunch Spectrum B2 H : **Prontons**



- **Schottky is very sensitive:** many factors can strongly influence the observations and hence the measured beam parameters as injection, ramping, dumping...

BRAN - Pile-up effect



BRANA : Threshold high low counting / Pile up effect inverse /
Correction to be implemented (Algorithm to be finalized - DSC
limited already – virtual server ? New cpu/man)