



Status of the beam instrumentation after LS1

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6th Evian workshop – Evian, 15-17 December 2015

Outline

Systems

- BPMs
- Transformers
- BBQ
- BTV
- BRAN
- Schottky
- BSRL

Aspects

- Changes w.r.t. Run 1
- Performance in 2015
- Remaining issues
- Plans for the future

WS, BSRT, BLM, BSRA, FB, HT, etc.
covered in other talks

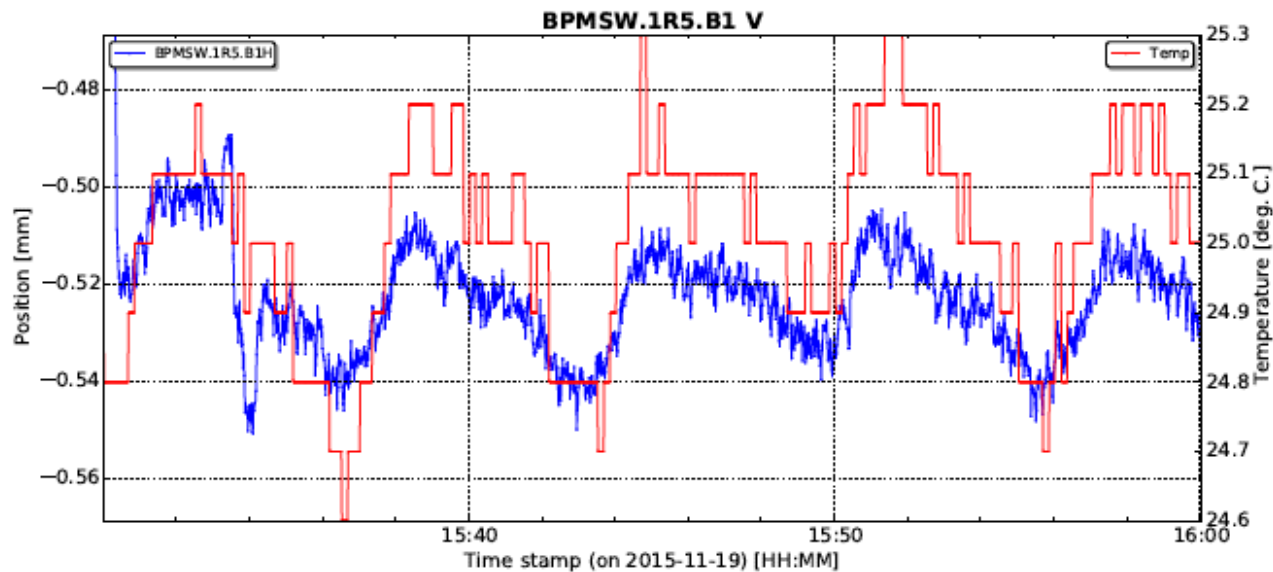
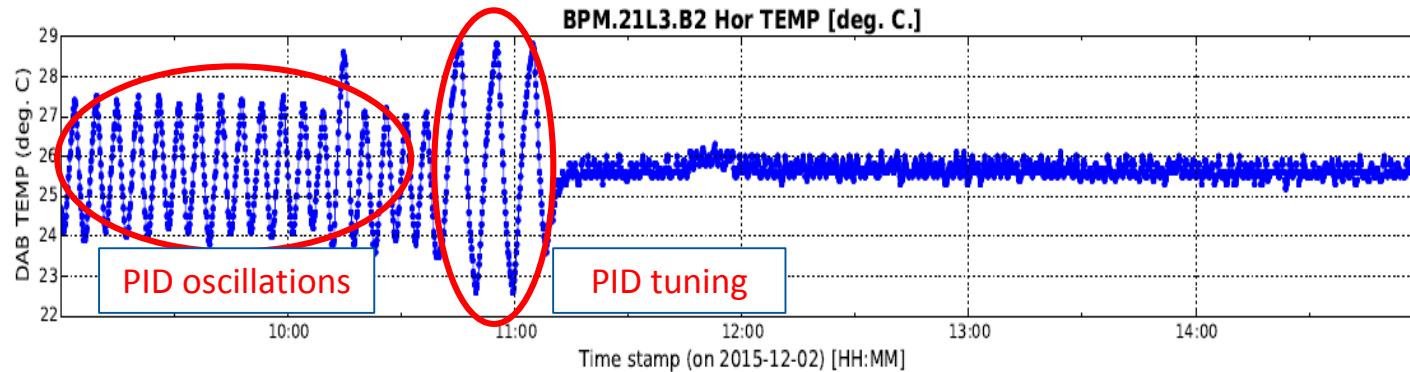
BPM main changes w.r.t. Run I

- New thermalized racks everywhere
- Addition of one new BPM and renaming of some existing ones
- FEC CPUs replacement ppc4 to L865
- FESA class from FESA2 to FESA3
- All FE cards dusted and optical fibres cleaned
- Implementation of cross terms corrections in FE
- DOROS on TCTs with buttons and in parallel to normalizer for Q1 in IP1 and IP5

BPM performance / status

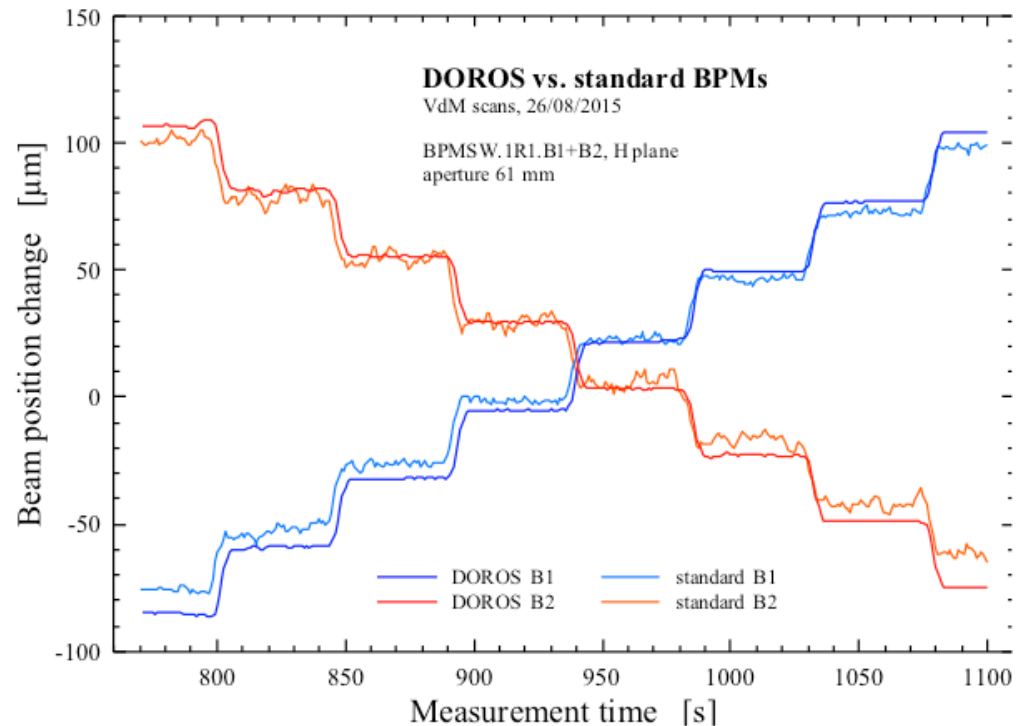
- Cable inversions on some channels (corrected)
- Some channels problem inside cryostat (not fully understood, bad connection?)
- 48 channels masked at the end of the run (out of 2160, ~98% available)
- Temperature stability during typical fill $\sim 0.5^{\circ}\text{C}$
 - Corresponds to orbit drifts of 10-20 μm
- Temperatures monitored and linked to LASER
- Acquisition system not designed for 5ns spaced bunches
 - workaround use synchronous orbit on normal bunch

BPM temperature control



BPM DOROS

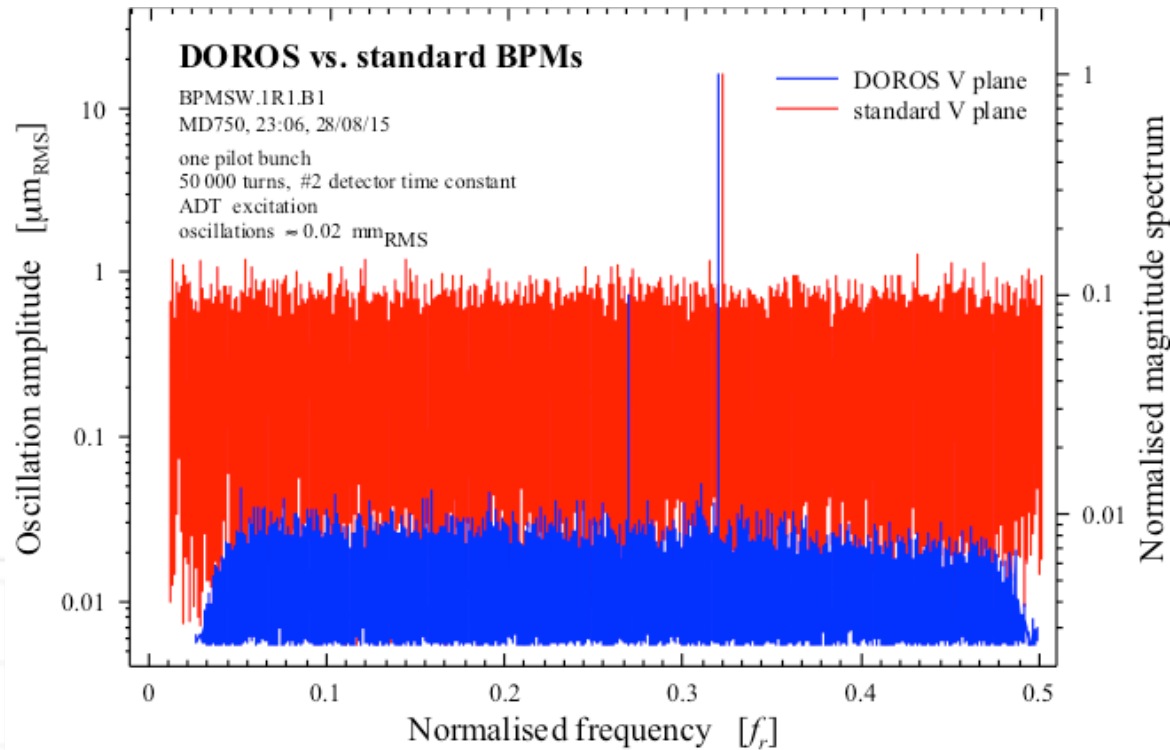
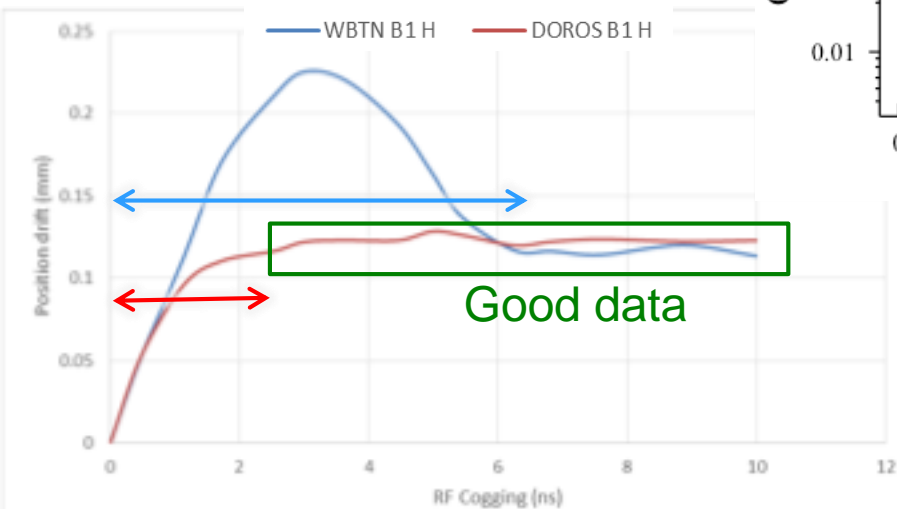
- Different way of processing BPM signals (similar to BBQ)
- Better S/N for orbit measurement
- Includes an oscillations channel (BBQ)
- Resolution $\sim 1\mu\text{m}$



16 DOROS FE installed in 2015
10 for collimators 6 for normal BPMs

DOROS oscillations/directional

DOROS performs better than standard BPM system also for the directional couplers (dual beam BPMs)



Possible BPM Improvements

- Improve T stabilisation and/or re-introduce T corrections for further reducing drifts
- Improve phasing & understand why we diphase
- Interference between orbit and capture modes
 - Requires big change in FW to fix, workaround 2015 disable orbit during capture.
- Cross term corrections and scales verification
- Scaling between DOROS and WBTN
- DOROS vs. unequal bunch intensities (adjust time constant)

BPM Plans for YETS 2015

- New firmware for DABs
 - Should cure capture/orbit conflict
- Separate control of sensitivity for IBPMs
- Fix faulty channels
 - phase compensation for pickup cabling issues
 - Replace electronics as required
- Investigate scales and cross terms
- New firmware for DOROS
- Install DOROS for Q1 in IP2 and IP8
 - Is there an interest to extend further into triplet?

BCTDC Changes w.r.t. Run I

Topic	Before LS1	After LS1	Status
FESA	2	3	OK
FEC CPU	PP4	MEN/A20	OK
OS	LynxOS	Linux	OK
ADC (4 ranges + auxiliary signals)	MPV 908 12 bit	VD80 16 bit	OK Validated by experiments (C.Barschel)
Reception of the 24 bit ADC data stream	System A & B: VME RF MUX	System A: VME RF MUX System B: VFC-HPC	OK validated

BCTDC status and outlook

- System works nicely
- SBF limit at 6.5 TeV comparable with BCT noise level
 - Caused SBF flickering (and beam dumps)
 - Solution: increased SBF integration time above 500 GeV
- SBF stuck after calibrations, to be investigated
- Lifetime available again both for DC and Fast BCTs (may require some tuning)
- Main change for 2016
 - 24bit system to become operational system

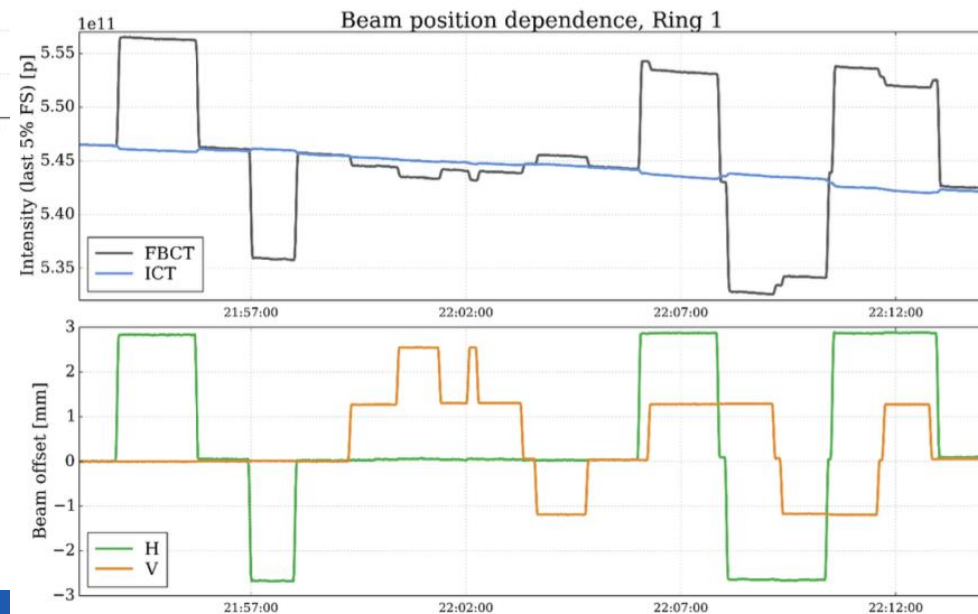
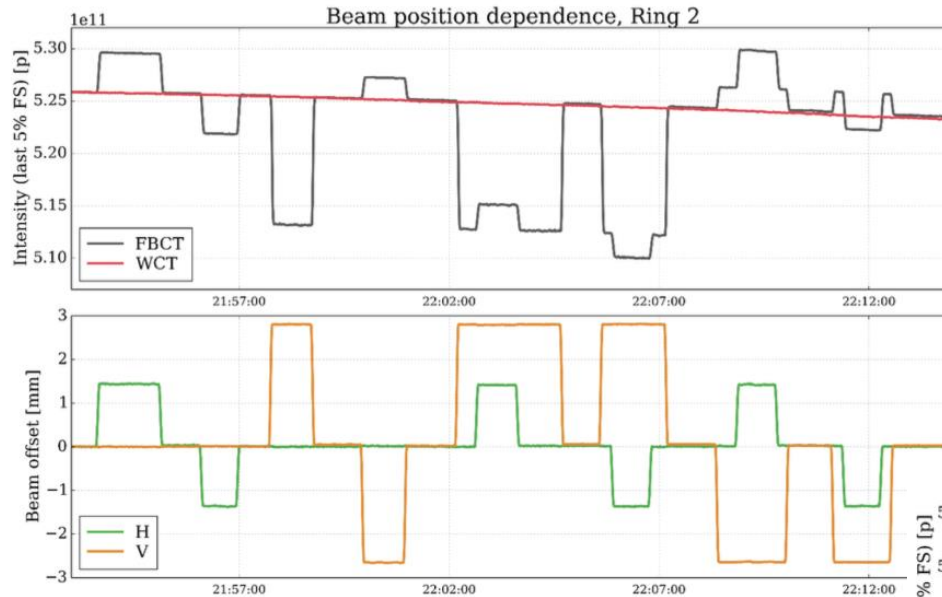
BCTFR Changes w.r.t. Run I

- FE server rewritten in FESA3
- DAB FW modifications
- New transformers for testing on system B (ICT, WCT)
- New FESA3 server for calibration

BCTFR Issues

- Present operational transformers suffer from
 - Position dependency
 - Signal tails $> 25\text{ns}$?
- Present acquisition electronics
 - Based on interleaved integrators
 - Need individual calibration
 - Not an issue for 50ns beams
 - Combined with signal tails sensitive to phase
- Bad measurements when ion bunches exceed $2\text{E}10$ (auto-range switching)

BCTFR toroid comparison



BCTFR Outlook

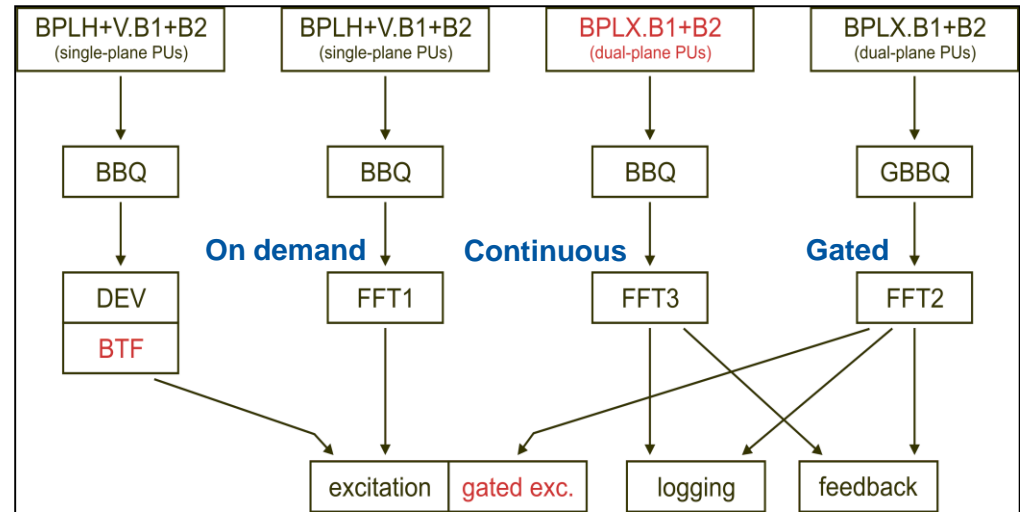
- Operational transformers to be replaced by Wall Current Transformers
 - ECR in circulation
- System B transformers to be kept as now (one Wall Current and one ICT)
- Acquisition upgrade
 - Analogue integration replaced by digital integration
 - Should make the system more robust (calibration & phase)
 - To be tested in early 2016 & deployed operationally end 2016 or for 2017

BBQ w.r.t. Run I

- 2 new pick-ups (BPLX)
- System split among two FE crates
- Gated system fully integrated
- Added Beam Transfer Function functionality
- Consolidated code, corrected few bugs, improved filter algorithms
- Fixed post mortem data

BBQ Status Outlook

- System operated quite stably
- Still some small issues under the hood



- Will port to FESA3
- New firmware (will fix lost irq issue)
- More code consolidation

BTV

- RF contacts repaired during LS1
- Rad hard cameras replaced by standard CCD in most locations
- Added second camera on the BTVDD (splitting the light)
- Porting to FESA3 during YETS
- Need to check/tune BTVDD “delay” algorithm and source selection in XPOC

BRAN

- New Cherenkov detectors developed and installed in IP2 and IP8 (replace CdTe)
- BRANA ported to FESA3, BRANC will follow
- Both worked reliably during the year
 - Regularly used to find/verify beam overlap while going in collisions
- Signs of radiation ageing of the Berkeley system (IP1 and IP5)
 - Preparing a test for Cherenkov detectors inside the TAN in IP1

Schottky w.r.t. Run I

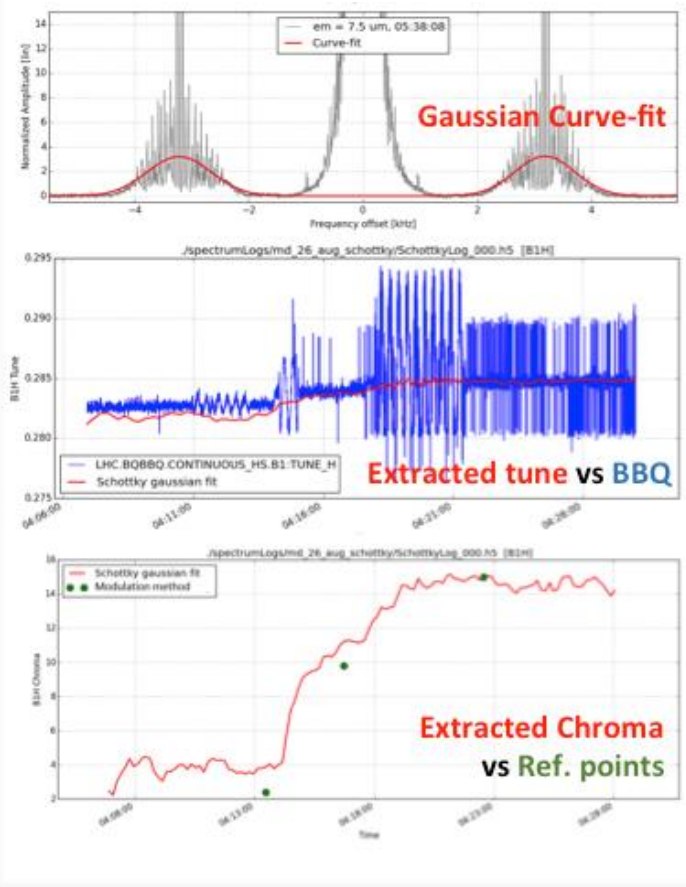
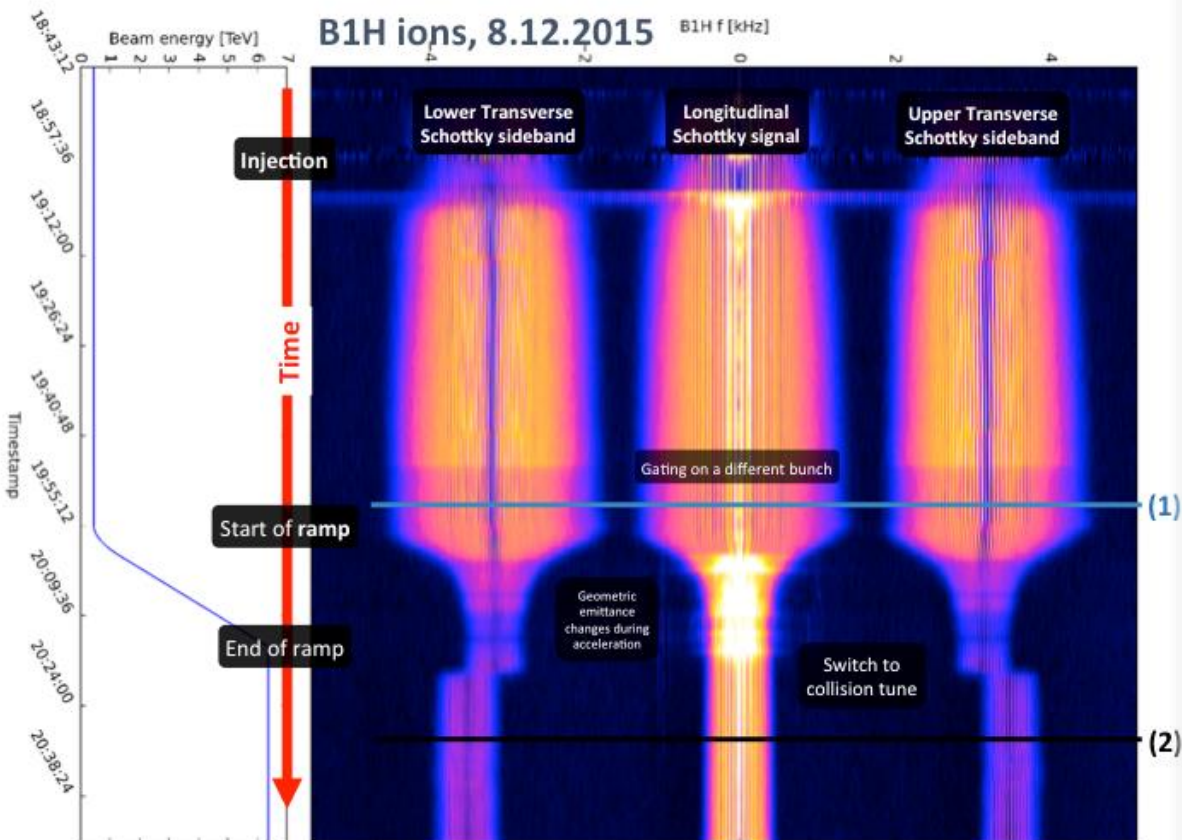
- Overhauled Schottky pickup's
- Modified front end electronics
- Added scopes and spectrum analysers
 - For system analysis and trouble shooting
- Written lots of expert tools

Schottky status

- Worked well with ions
 - Confirms improvement from rebuilding of monitors during LS1
- With protons still suffers from huge coherent signals
 - Need to accurately electronically subtract any position offset
 - Observed long ringing in signal 100s of μs after bunch passage)
- Complete rebuild of front-end electronics on one system
 - Gives much better performance
 - To be extended to all other systems in YETS
- Aim
 - Provide on-line chromaticity measurements
 - Provide bunch by bunch tune for MDs

Schottky signals

Protons - MD377



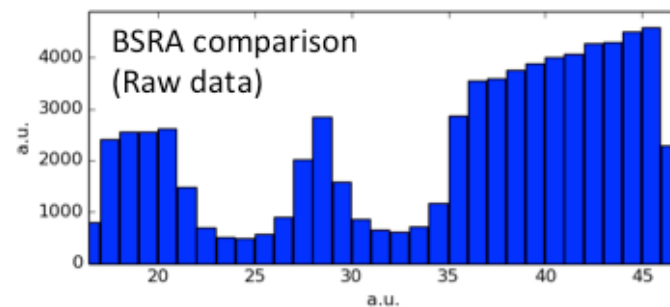
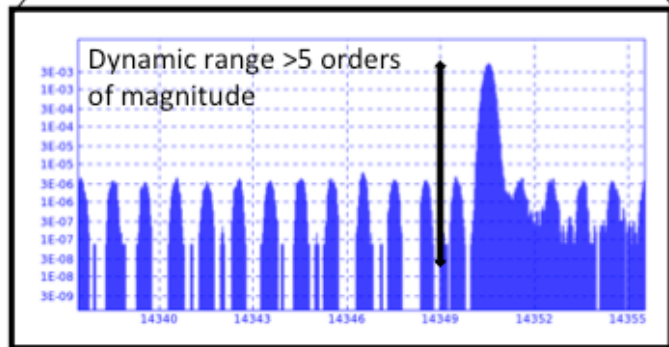
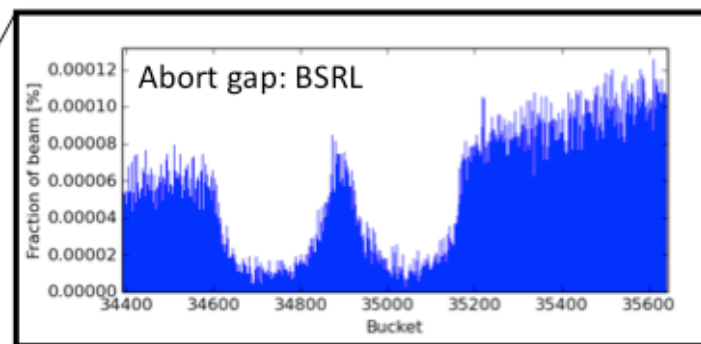
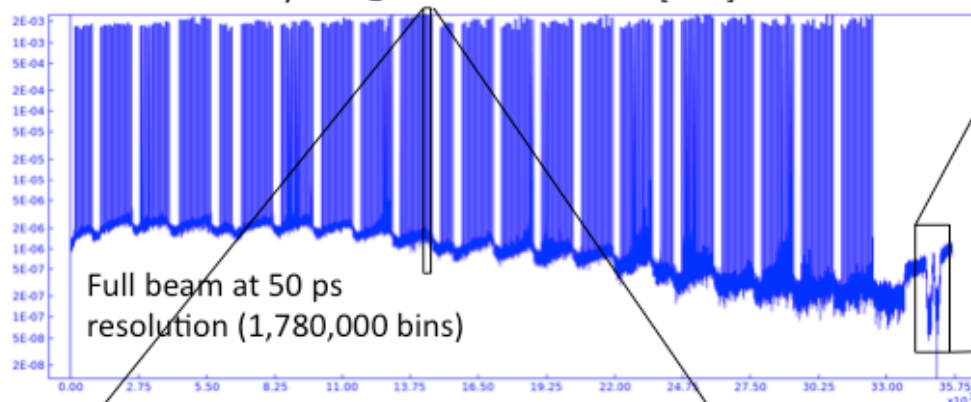
BSRL (LDM)

- New optics layout, better decoupling from BSRT
- New detectors
 - Hybrid PMT much better than APD
- New data correction algorithms
- New GUI for data display analysis:
 - population with 50ps resolution and 5 orders of magnitude
 - Bunch current, length, bunched fraction, comparison w.r.t. BCTFR and BQM and much more

LDM highlights

Hybrid performance

Ions: B1 Hybrid @ 2015-12-06 09:58 [UTC]



AOB

- Software is now a major ingredient of all devices
- Lots of changes in the infrastructure during LS1
- Many system had to be ported to FESA3 without adequate tools and documentation
- Main request from BI is to concentrate on consolidating the present infrastructure and to (re)introduce specialised tools

Conclusions

- Very successful year for the beam instrumentation
- Many changes during LS1 requiring some debugging during 2015
- Instrumentation ready for the upcoming production years
- Still a lot of challenges for the R&D systems
- BI can now focus toward HL-LHC