Beam Instrumentation with SPS Crabs

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on behalf of the Beam Instrumentation group

Crab Cavity SPS Tests Day II – 8th May 2018
Introduction

- Based on MD parameters, no major issues foreseen for standard SPS BI systems:
  - MOPOS BPMs
  - Fast & DC BCTs
  - BLMs
  - Wire scanners
  - BBQ
  - …
Introduction

- Covered in this talk:
  - BPMs on cryo-module
  - Head-Tail Monitor
  - BSRT
  - BGI
BPMs

- Button beam-position monitors (BPMW) are installed on either side of the cryo-module
BPMs

- Button beam-position monitors (BPMW) are installed on either side of the cryo-module
- Provides beam position reference w.r.t. cavity

- DOROS acquisition system, provides:
  - Sub-micrometre orbit measurement
  - Turn-by-turn “oscillation” measurements

- Front-end electronics installed
- Deployment of FESA devices still to be done
Head-Tail Monitor

- Major upgrades to SPS Head-Tail Monitor during YETS17-18:
  - New digitizers
    - 43 turns → 1782 turns
    - 8-bit ADC → 10-bit ADC
  - PPM controlled variable step attenuator
    - Can optimise signal levels for low beam intensity
  - Much faster readout
Head-Tail Monitor Calibration

- First calibration of new acq. done with vertical bumps of ±5mm in BPCL.421 with 2e10 ppb
  - N.B. BPV.421 is disconnected, so interpolation of the orbit to the HT is tricky!
Head-Tail Monitor Baseline Correction

- HT suffers from residual “baseline” signal due to imperfections in acquisition chain
- For instabilities, correction by subtraction of average of all turns
  - This cancels any “static” response which is constant between turns
  - Will remove crab response
- Instead store “reference” dataset and subtract from each acquisition
  - Should be done as often as possible during MDs
Head-Tail Monitor Baseline Correction

Correction of Baseline

Voltage [V]

Delta @ 0 mm
Delta @ +1 mm

Time [ns]
0 5 10 15 20 25

Voltage [V]

Delta @ +1mm (corrected)
Sigma

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Head-Tail Operational Aspects

- Careful setup of Head-Tail gain required during MDs to optimise SNR and avoid saturation
- If possible, beam should be kept centered in BPCL.421 to minimize common-mode offset
- Minimum resolution depends on the above and number of turns averaged:
  - O(100um) single shot
  - O(10um) averaged over 1k turns
- Work on Python scripts to extract crab cavity parameters in progress (L. Carver)
BSRT

- SPS BSRT now operational for coasting beam above 270 GeV
  - FESA class operational
  - VISTAR deployed
  - OP GUI under development
SPS BSRT

Configuration
- GATED
- ND2

MCP Voltage
- 4000.0

Gate
- bunch: 0-9

Image Saturated
- False

Acq Status
- IDLE

Power Status

10:12:54.7
LHCPilot # 13

E: 451 GeV

cp://multicast-bevspspbst:1234
BSRT

- SPS BSRT now operational for coasting beam above 270 GeV
  - FESA class operational
  - VISTAR deployed
  - OP GUI under development
- Calibration w.r.t. wire scanners expected by the end of this month
- N.B. absolute horizontal emittance calculation is compromised by dispersion at BSRT location
During 2017, has been routinely used in coast at 270 GeV to monitor emittance growth:
Recommissioned in 2017
- Measurements of single bunch beams demonstrated
- Very clean profile after background subtraction
- Smallest intensity that can be detected in a single cycle = \( \sim 10^{10} \) p
- Systematic comparison to WS planned
BGI Software

- FESA integration ongoing
  - Adjustment of high voltage to match beam intensity
  - Provide clean (background subtracted) beam profiles

- Hand over to OP to use operationally ASAP

- OP application under development
Synchronous Triggering

- Requirement from the MD proposal document:
  - “Synchronous triggering of BLMs, HT, and BPMs with cavity failure”

- This is not something which is possible today with higher precision that 1ms (GMT)...
  - Is this required?
Conclusions

- BPMs on cryo-module connected
  - Equipped with DOROS acquisition
- Head-Tail
  - New acquisition provides higher resolution
  - Variable attenuation for low intensity beams
- BSRT
  - Operational above 270 GeV
- BGI
  - Potential for single bunch emittance measurements throughout cycle
Thanks…