



# Beam Instrumentation with SPS Crabs

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on behalf of the Beam Instrumentation group



Crab Cavity SPS Tests Day II – 8<sup>th</sup> May 2018

# Introduction

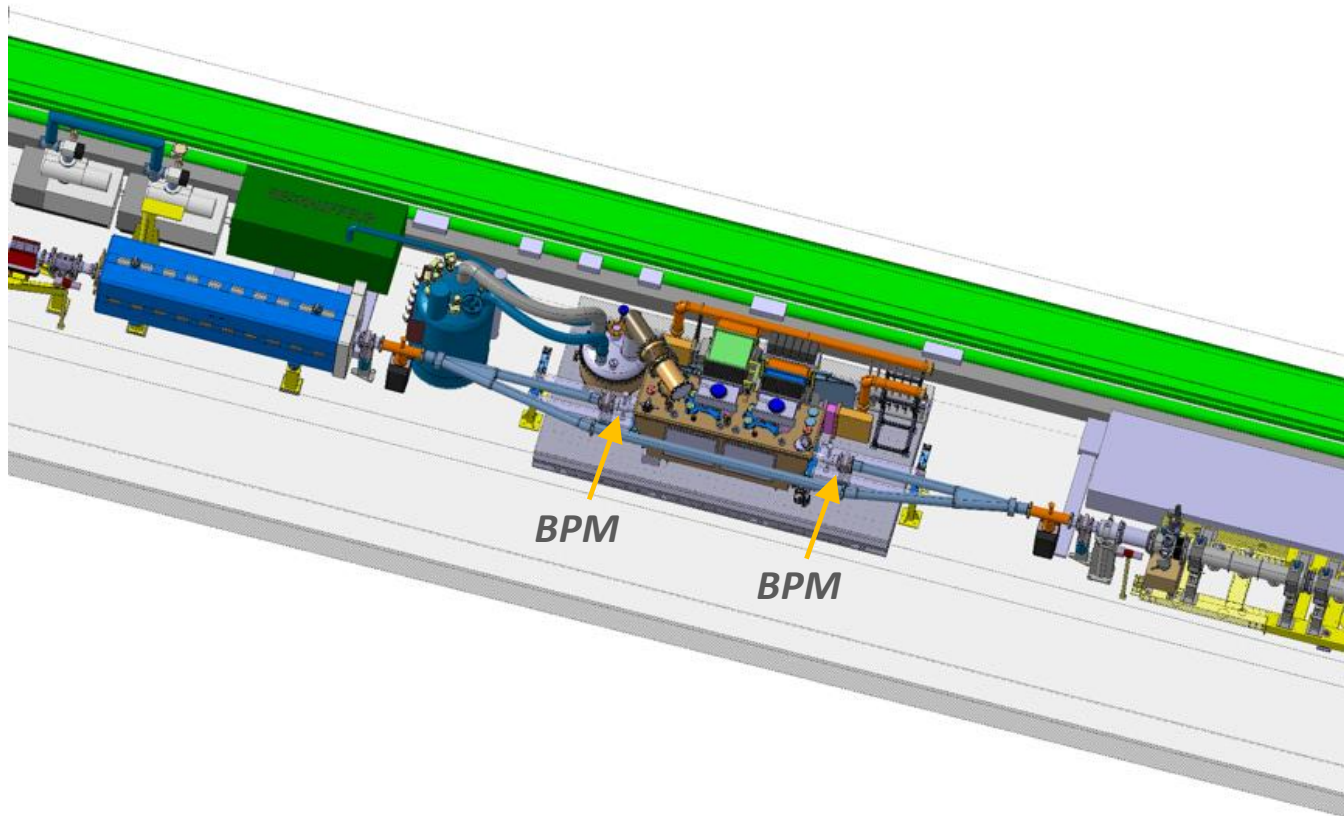
- Based on MD parameters, no major issues foreseen for standard SPS BI systems:
  - MOPOS BPMs
  - Fast & DC BCTs
  - BLMs
  - Wire scanners
  - BBQ
  - ...

# 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

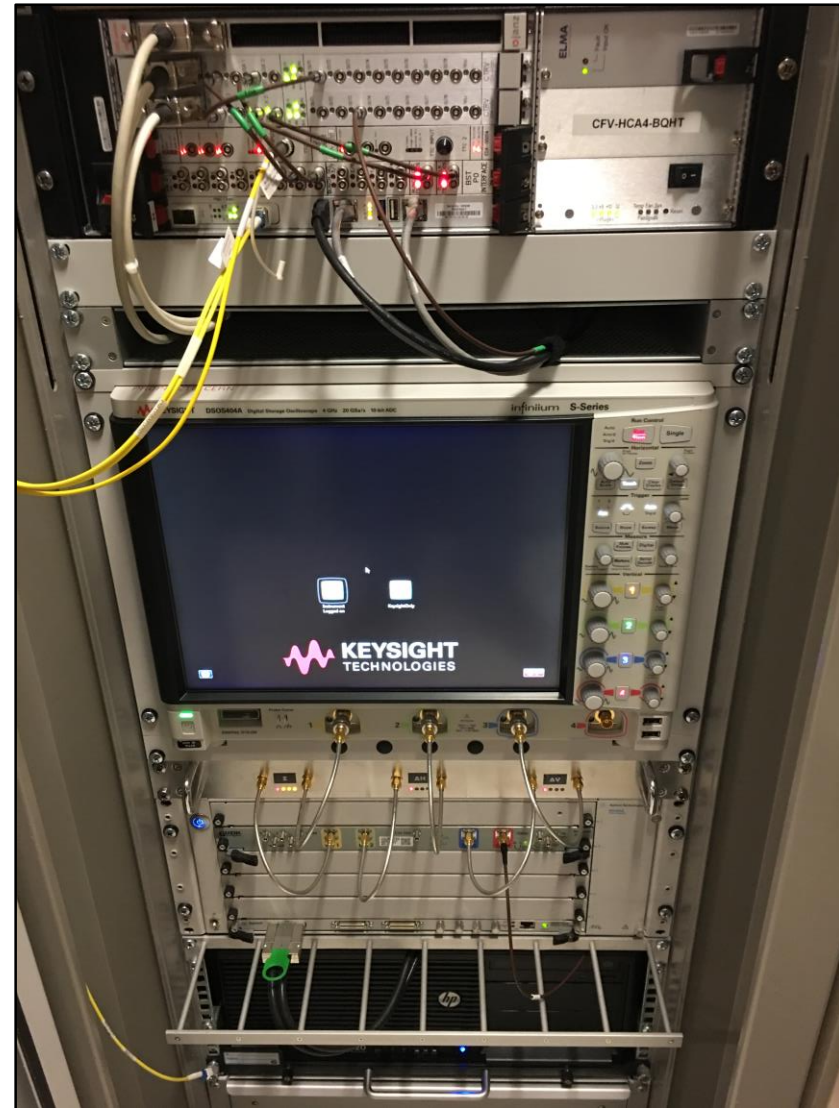


# BPMs

- 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

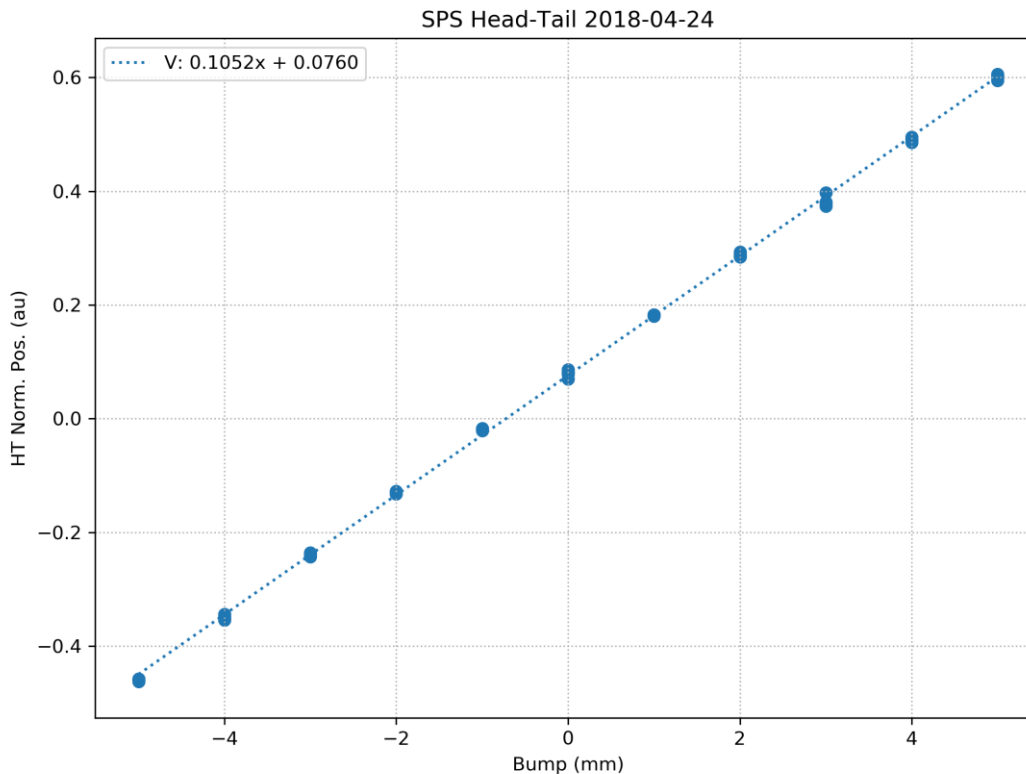
# Head-Tail Monitor

- 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  $\pm 5\text{mm}$  in BPCL.421 with  $2e10$  ppb
  - N.B. BPV.421 is disconnected, so interpolation of the orbit to the HT is tricky!

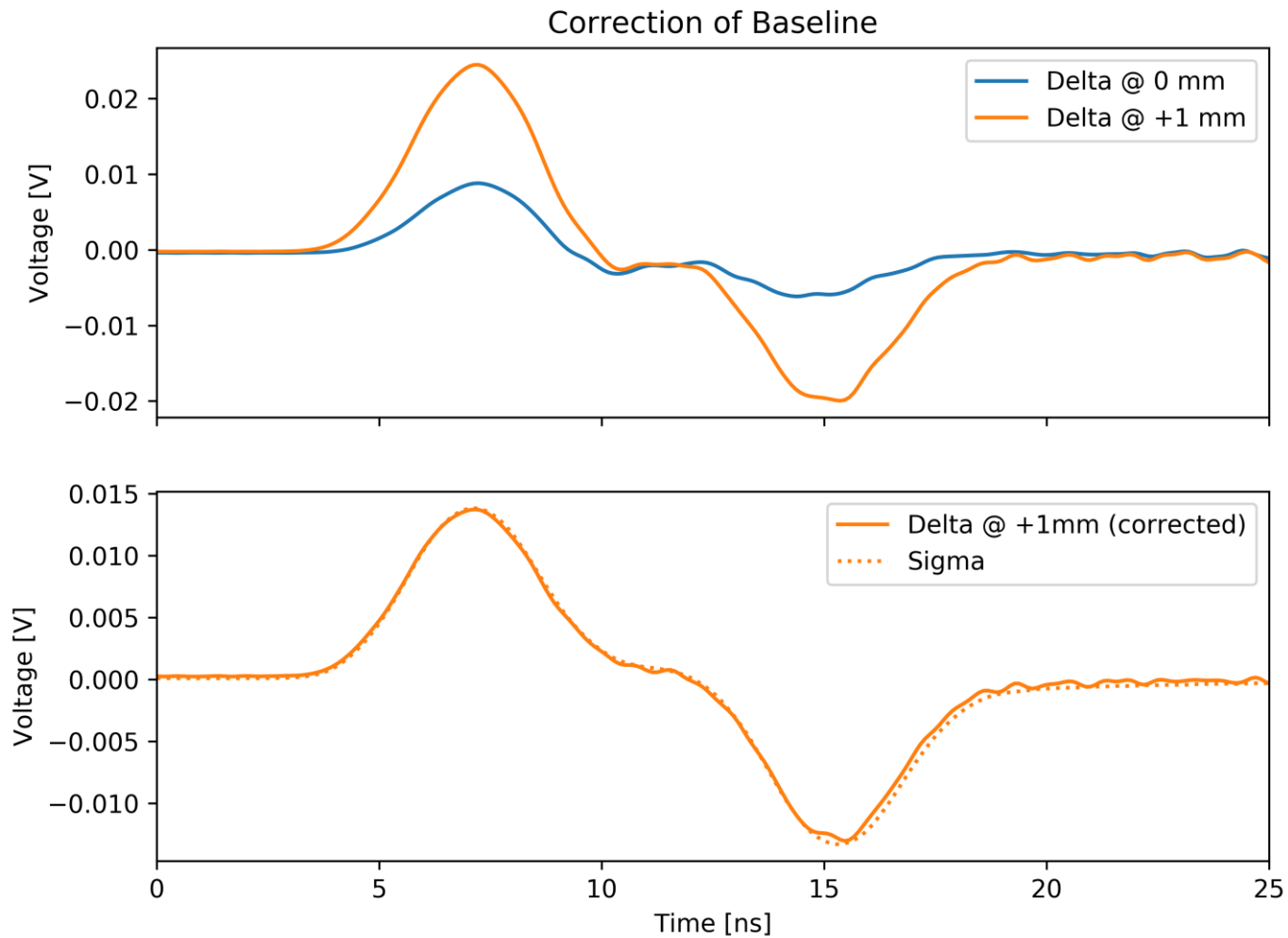


# Head-Tail Monitor Baseline Correction

- 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



# 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 BPCCL421 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

# BSRT

udp://multicast-bevpsbsrt:1234 - VLC media player

Media Playback Audio Video Subtitle Tools View Help

## SPS BSRT

SFTPRO2 MD4 **LHCPILOT** MD4

**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

03/21/18 10:12:59

udp://multicast-bevpsbsrt:1234

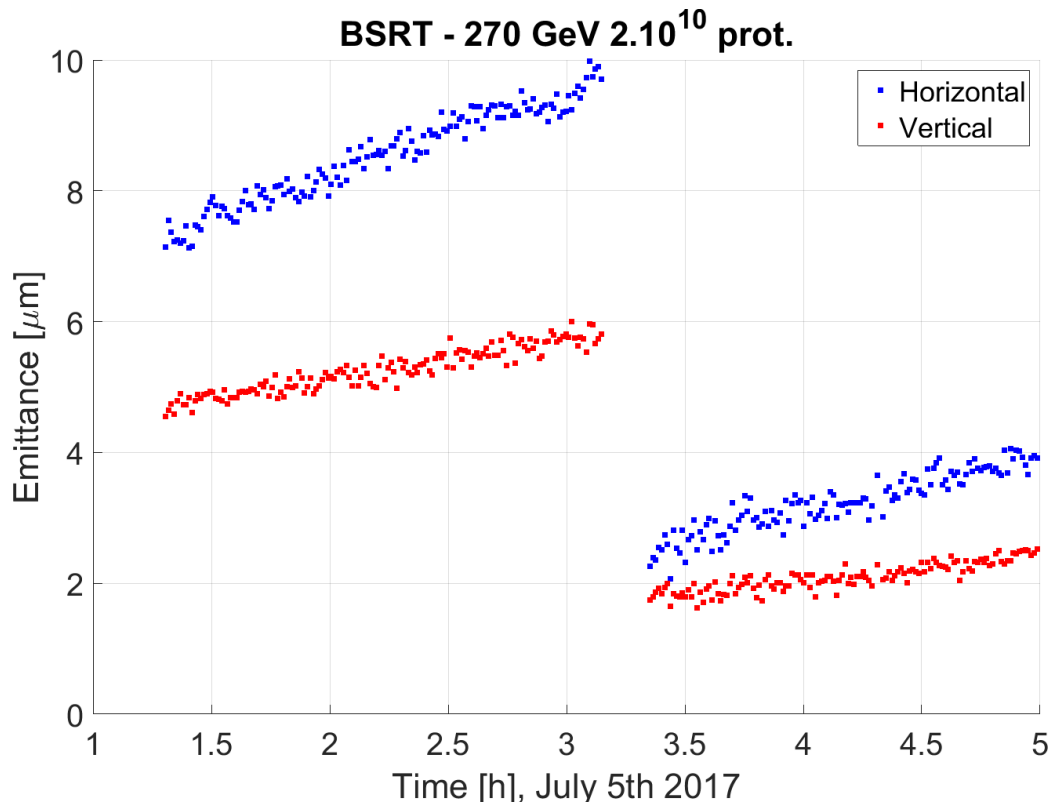
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# BSRT

- 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

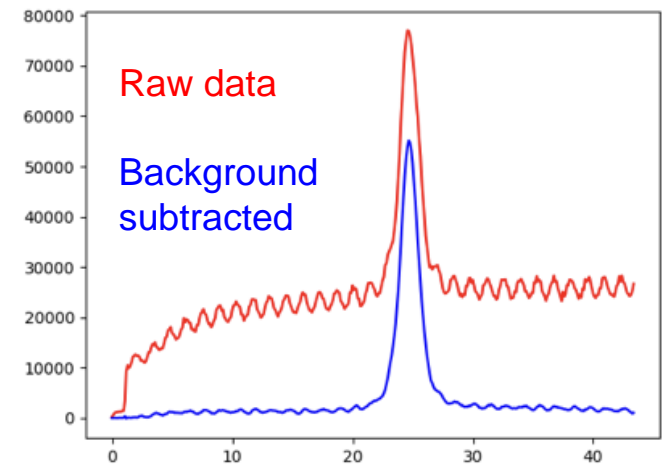
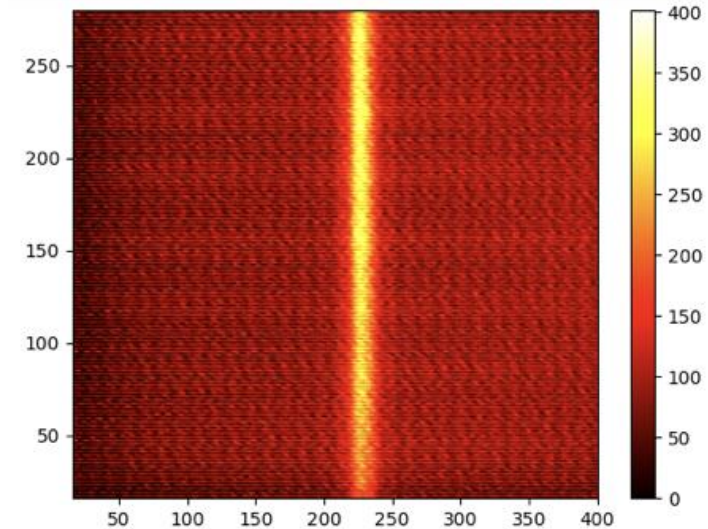
# BSRT

- During 2017, has been routinely used in coast at 270 GeV to monitor emittance growth:



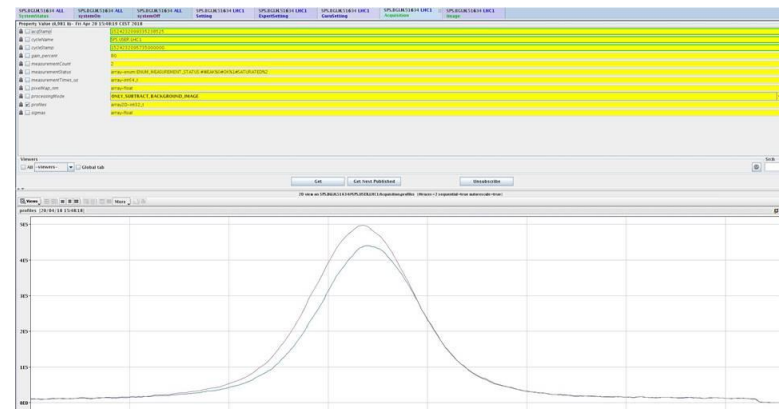
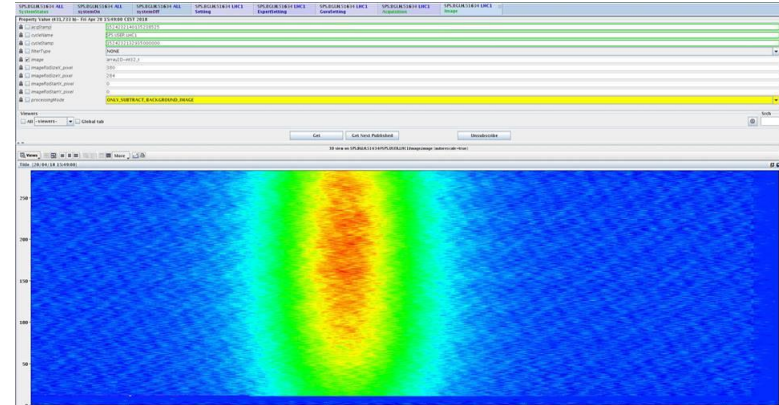
# BGI

- 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 =  $\sim 10e10$  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 than 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...***

