

Summary of experience with LHC and SPS IPM monitors in 2011 & 2012 (& 2013)

Mariusz Sapinski, CERN BE/BI

DITANET

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Proton and Heavy Ion Accelerators



Outlook

- High-brightness beams
- Short description of SPS and LHC IPM

-HV

- Gas injection
- Magnets
- Imaging, signal distortion (along the path)
- Hardware failures
- Calibration methods



Beams

- Beams with emittance as small as 0.7 μ m·rad (pPb run)
- Typical emittance for high-intensity protons: 1.5 μ m·rad
- (designed emittance 3.5 μ m·rad)
- Up to 1.7·10¹¹ protons/bunch
- Beam size: at 7 TeV, β=100 m: 100 μm
- 2800 bunches



System: HV cage











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System: gas injection

- needed in LHC (normal vacuum 10⁻¹¹ mbar)
- gas injection up to 10⁻⁸ mbar
- PVSS application
- manual control (3-4 steps)

• timeout after 12 h beam intensit				ity /		
LHC.BCTDC.A8R4.82:BEAM_INTENSITY MRBH.UA83.MKCBI.A82	E_CH1 VGI.881.5R4.R.PR		pres	sure		
	max after	•~2h on flat	t top		- 4000 - 3500 - 2500 - 2500 - 2000	-7E-9 -6E-9 -5E-9 -4E-9 2E-9 -2E-9 -1E-9
	U	ITC_TIME				

VBGL.JR4.K					
GAS INJ IN PROGRESS					
Manual Man ON					
Mode Read INJECTION					
GAS INJ IN PROGRESS					
Mode Set. INJECTION					
- Error					
Warning					
-Object Status					
Injection In Progress					
- Operation					
Start Increase Decrease Stop					
-Ini Countdown					
11:55:02.0949					
J					
140 W					
E Gas					
bottle					



System: magnetic field

- Magnetic field needed to keep minimize beam space charge effect
- 0.2 T magnets originally from ISR, yoke modified to extract light
- Need to exchange power converters on SPS magnets to allow cycling.
- magnets are compensated (ie. 2 magnets/detector/plane in the same circuit)
- length 43 cm
- 20 cm space between poles
- Field quality:





Aimant type IMHH



























Hardware failures (other than already mentioned)

- HV ctrl card problem with compatibility with VME (linux CPU)
- 5 CID cameras stopped working, in most cases we suspect that intensifier reached MTTF (tbc by ThermoFischer).
- failures of MCPs
 - "conditioning effect" for MCPs
 - too high input electron current might kill MCP
 - abrupt HV change might kill MCP (and dump the beam!)

Killed MCP: creation a conducting channel through the plate: cannot set HV anymore, cannot amplify the signal.

Fit and amplitude dependence

- ROOT fitting library (the same as for BSRT)
- there is a dependence of measured beam sigma on the signal amplitude
- amplitude feedback is crucial (we do it through camera intensifier gain) (changing HV on the MCP in the vacuum is risky)



Cern Calibration from specifications

- Camera pixel size: 11.5 μm * 1.6 (taper)
- Optical system magnification: 0.2

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Calibration = 92 \mum/pixel
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Calibration in the lab



The value found: 115 ±3 μm/pixel



Beam-based calibration

- Interpolate beam position from neighbor BPMs.
- Make an orbital bump
- Error on orbit position in BGI location: 100 μ m (interpolation error)





Cross-calibration (WS, BSRT)

- Because of old MCPs BGI sensitivity starts where WS cannot measure
- But for ions there was an overlap
- BSRT uses cross-calibration with WS, so calibration with BSRT is of







Ramp-based calibration





It is possible to optimize the fitting procedure, but is the quadratic correction enough to correct for all errors, especially the beam space charge?



Conclusions

- 1. LHC IPM deals with beams of unprecedented brightness.
- 2. System was in commissioning for the whole period. Almost not used for operation during Run 1 because of difficulties to calibrate it.
- 3. But a lot of studies were done, a lot of data collected, significant upgrades.
- 4. We suspect that there are strong physical reasons behind calibration issue.
- 5. We think that we need a stronger magnetic field.
- 6. SPS IPM was renovated but noise on video signal was too large for most beams to use it.
- 7. There are some hints on how to reduce it.
- 8. A series of upgrades during LS1 is planned but we are happy to hear your advices.