



BGI status

M. Sapinski

Operation
principle

Subsystems

Gas injection

HV system

Magnets

Imaging system

Software

Results

2D image

Profiles and fitting

Calibration with
orbital bump

Gyroradius effect

Cross-calibration
with BSRT/WS

Summary

Status of Beam Gas Ionization Monitor (BGI)

Mariusz Sapinski

CERN BE-BI

LBOC July 10th 2012



Outline

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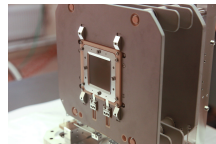
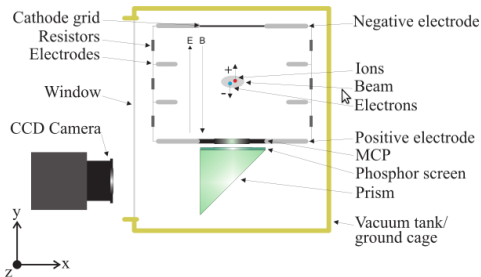
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Summary



- HV seen by beam: 4 kV (2 kV seen by electrons)
- magnetic field: 0.2 T
- EGP for correction of MCP degradation



Gas injection system

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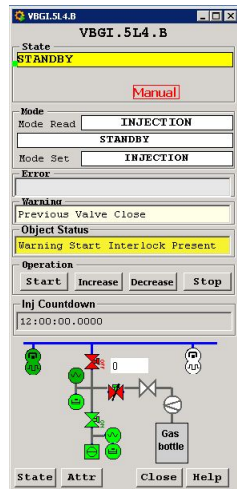
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Summary

- responsible VAC
(V. Baglin, D. Cagliari, F. Bellorini)
- works OK
- manual start of injection (from PVSS application, lhcop can do it)
- manual stop of injection or automatic stop after 12 hours
- no gas injection in SPS (enough signal)





HV system

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Summary

- controller: CERN-made VME card (1990's)
- lack of spares (used also for WS PMT)
- gave problems when switching to linux CPU
- CERN-made power supply
(up to 12 kV, used up to 6 kV)
- instabilities observed (system shuts down)
- instabilities source: physics or software, recently
diminishing (conditioning?)
- no operation on HV with beam in machine
(wait for end of fill)





Magnets

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Summary

- 0.2 T, modified to allow extraction of light
- LHC: one compensator, both on single power converter, always on, no issues
- SPS: two compensators (3-corrector bump), two power converters, potentially dangerous when one fails (investigate solutions for LS#1)
- in addition one of the vertical correctors have short-circuit, will be exchanged during TS#3 (J. Bauche)





Imaging system

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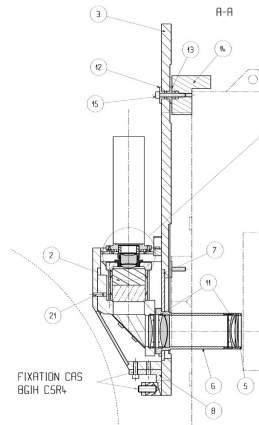
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Summary

- MCPs on beam 1 exchanged during winter TS (and have better sensitivity), but one broke during scrubbing run
- phosphor screen - signs of use
- one prism in vacuum
- 7-lens and one prism system outside vacuum, resolution $22\ \mu\text{m}$ (D. Kramer et al., CERN-AB-2005-072)
- rad-hard camera Thermo Scientific CID8712D1M-XD4, pixel $11.5\ \mu\text{m} \times 1.6$
- overall sensitivity: between 50 and 800 proton bunches (MCP ageing)





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Summary

Software at various levels of development.

Main pieces:

- FE server, standard FESA classes by Ana
- expert application by Ana
- two fixed displays by Laurette and Maria
- Online Image Processing (BgiOIP) tool by Bogna
(testing processing algorithms, fits)
- root analysis toolbox

A test crate in the lab with optical testbench
(right now off - manufacturing elements which went to SPS)



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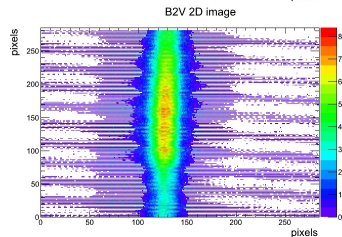
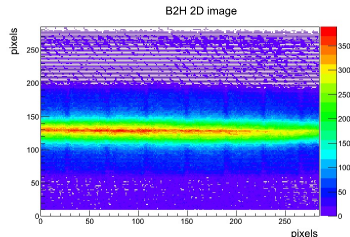
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Summary

- maximum size: 768H x 575V
- line-to-line noise
- cameras rotation (TS#2)
- Cgrid wires issue
- image processing:
 - correction for gain variation over MCP surface
 - subtract constant noise
 - correction for grid wires (tbd)
- images are saved manually (csv) or BgiOIP
- profiles saved every 4 s to logging DB





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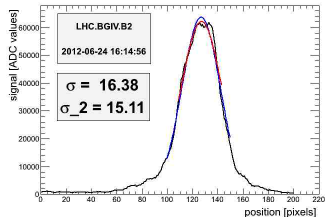
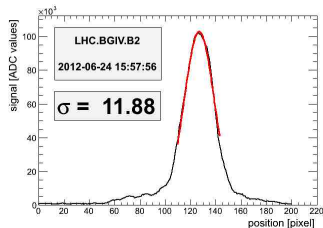
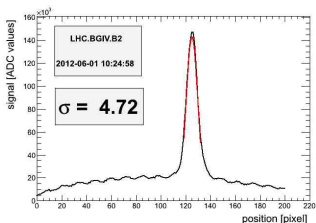
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Summary

- avoid tails, fit beam core
- special procedure tested, not optimal for large beams
- plots from MD June 24th - beam blowup with ADT at injection
- and 4 TeV flat top





Calibration with orbital bump

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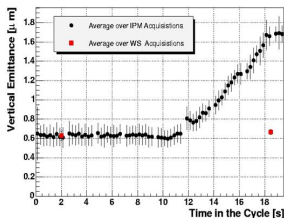
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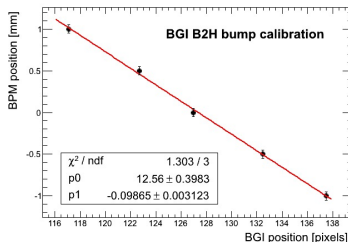
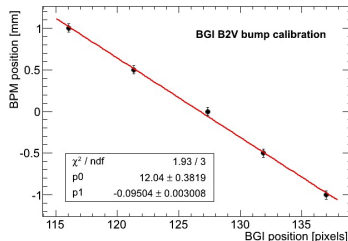
Cross-calibration with BSRT/WS

Summary

- simple procedure, profiting from BPM precision
- BGI in YASP this year - easier operation
- 95 – 110 $\mu\text{m}/\text{pixel}$
- camera tilt 1 – 2°
- $\sigma_{\text{beam}} = p_1 \cdot \sigma_{\text{BGI}}$ not enough



(2004 SPS data, blamed: optical resolution)





Gyroradius effect - Geant4 simulations

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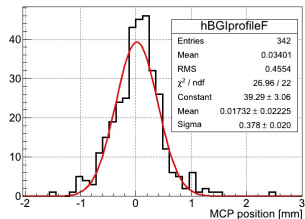
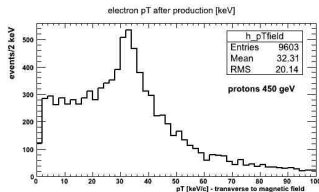
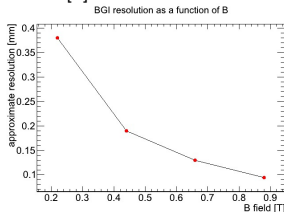
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Summary

- discussion with Reine triggered fast Geant4 simulation
- electrons are generated transversely to the beam with average $p_T^{\text{Bfield}} = 32 \text{ keV}/c$
- $\text{gyroradius}[m] = 3.3 \frac{p_T[\text{GeV}/c]}{B[T]} \approx 0.5 \text{ mm}$





Cross-calibration with BSRT/WS

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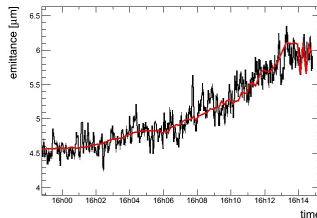
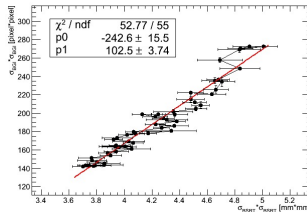
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Summary

- plan B: use the simplest model with PSF (as BSRT)
- $\sigma_{beam} = \sqrt{(C\sigma_{BGI})^2 - \sigma_{corr}^2}$
- use Federico method to cross-calibrate
linear fit $\sigma_{BGI}^2 = a\sigma_{beam}^2 + b$
- continue modelling, because our PSF is not really gaussian
- add space charge effect
- continue cross-calibration with BSRT(B2) and WS(B1)
- BSRT itself relies on cross-calibration with WS



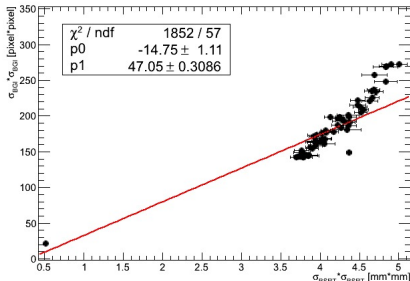


Cross-calibration with BSRT/WS

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Example of difficulties, maybe quadratic correction is not enough?



Possible reasons:

- nongaussian PSF
- space charge effect
- ...
- Emittance during ramp - problematic!
- How to get intermediate emittance data?



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Summary

- **Hardware is ready** for continuous monitoring of beam emittance
- except of LHC.B1V (serious problem - LS#1) and SPS.V (working on it)
- The reinforcements arrived (Bogna and Marcin)
- BGI measurement is **model dependent** (not like WS)
- Need to take **more data** especially cross-calibration
- After recalibration (to be done after TS) we'll start providing emittance data based on quadratic correction
- Continue work on model



Further reading I

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Appendix

Further reading



Calibration of LHC BGI monitors with orbital bump
EDMS-1130606



Geant4 simulation of electron trajectories in BGI
EDMS 1182412



BGI results of BI MD June 24, 2012
EDMS-1230249