Simulation and measurement of
Detector response can be folded with spectra
Characterization of the LHC BLM detector
will be installed around the ring. The lost beam particles initiate hadronic showers through the magnets, which are measured by the monitors installed outside of the cryostat around each quadrupole magnet. They probe the far transverse tail of the hadronic shower.

Proton energy: 6 BLM detector are longitudinally distributed on top of the crystal (transverse tail of hadronic showers), six around each quadruple.

Challenges:
- Reliability (tolerable failure rate 10^-7 per hour per channel).
- Large dynamic range (10^7 - pA - mA).

Hadronic Shower Measurements at HERA

Part of the error estimation of the LHC BLM system calibration with Geant4. Verification of the transverse hadronic shower tail simulations.

6 BLM detector are longitudinally distributed on top of the HERA proton beam dump (red box)

Proton energy:
- Injection energy 40 GeV
- Top energy 920 GeV

Intensity range:
- 1.3x10^11 to 1.3x10^15 protons

Difficulties:
- Ionization chambers probe far tails of shower distribution (simulation uncertainties).
- High flow of low energy neutrons and gammas

Preliminary Results:
- Significant difference in longitudinal shape between measurement and simulation.

Successful longterm test of the complete LHC BLM System in real accelerator environment.

Verification Measurements

1 Mixed radiation field measurements at CERN target area (CERN-EU High Energy Reference Facility), simulation agrees with measurement, except position 1 (lower energy spectra, 21%).
- Linearity of the detector verified over 1 order of magnitude.
- Lower energetic spectra
- Higher energetic spectra

2 Protons at 400 GeV/c
- SPS extraction line at CERN
- Systematic error of 20% due to beam position uncertainty.

3 Gamma Calibration at the TIF-IBP Calibration Laboratory for Radiation Protection Instruments (CERN) with Ca137 sources (662 keV)

LHC and its BLM System

- Circumference: 26.7 km
- Injection energy: 450 GeV
- Top energy: 7 TeV in four counter rotating beams
- ~ 350 M J stored energy per beam
- 11 QJ stored energy in the magnet system
- ~ 3x10^11 protons per beam
- Superconducting magnets
- Magnetic field 8.3 T (1.9 k)
- Factor 4 ~ 20 more sensitive to beam losses compared to existing hadron machines

Quench Risk BLM System

Purpose:
- Machine protection against damage of equipment and magnet quench.
- Localization of beam losses and identification of loss mechanism.
- Machine setup and studies.

Location:
- BLM mounted outside of cryostat (transverse tail of hadronic showers), six around each quadruple.

Verification

- Simulations performed
- Presented in this poster

Detected energy in the machine component

Quench and damage level of the machine component

Irradiation chamber

- Design: Diameter ~ 2.9 cm
- Length 80 cm
- Volume: 1.5 litre
- Gas: 1.5% H2O and 14.5% CO2
- Gap: 0.1 (1 Torr)
- Wire bias voltage: 1500 V

Fuller's spectrum up- and down-stream position (H. Vinko)

LHC BLM System

- Simulations performed
- Presented in this poster

Calibration of the BLM System

Number of locally lost beam particles

Deposited energy in the machine component

BLM Tunnel installation:
- 4000 detectors outside of the cryostat in the horizontal plane of the beam.

Verification of simulation by analytic calculations for muons with Bethe-Bloch formula

- Agreements within 13%, determined by systematic uncertainty (23%) in beam position

Test measurements have been performed at CERN and DESY and compared to Geant4 simulations.

Proton energy: 400 GeV protons
- Comparison within 13%, determined by systematic uncertainty.

Preliminary data

- Score deposited energy in dump
- Compare it to deposited energy in an LHC magnet.

LHC BLM System in real accelerator environment.

Outlook

- Detector calibration measurements in Uppsala University (Sweden), November 2006.
- Fine-tune calibration of the LHC BLM electronics and study saturation effects of ionization chamber.
- Relate the detector signal to the deposited energy in HERA dump and to LHC beam abort thresholds.

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Measurements and Simulations of Ionization Chamber Signals in Mixed Radiation Fields for the LHC BLM System

Abstract: The LHC beam loss monitoring (BLM) system must prevent the super conducting magnets from quenching and protect the machine components from damages. The main monitor type is an ionization chamber. About 1000 of them will be installed around the ring. The lost beam particles initiate hadronic showers through the magnets, which are measured by the monitors installed outside of the cryostat around each quadrupole magnet. They probe the far transverse tail of the hadronic shower. The specification for the BLM system includes a factor of 2 absolute precision on the prediction of the quench levels. To reach this accuracy a number of simulations are being combined to calibrate the monitor signals. To validate the monitor calibration the simulations are compared with test measurements. This paper will focus on the development of the hadronic shower tail and the signal response of the ionization chamber to the various particle types and energies. Test measurements have been performed at CERN and DESY and compared to Geant4 simulations.