LHC Luminometer Development and Operations

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Outline

Overview of Lumi Detector Status and Plans

Control Room Application

System calibration and configuration expert panels

Lumi calibration and V d M scans

Comments and conclusions

System Status

With 2011 shutdown, all forward (ZDC) detectors have been removed

TANs are now configured for high luminosity operation

Different absorbers (see H. Matis talk)

Only instrument available during MDs

Regular shifts normally use the published experiments luminosity

Steady performance through 2011

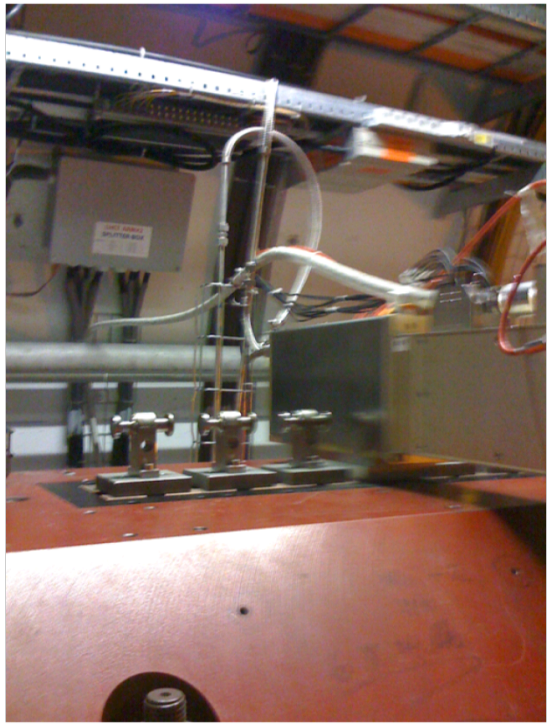
One analog channel damaged

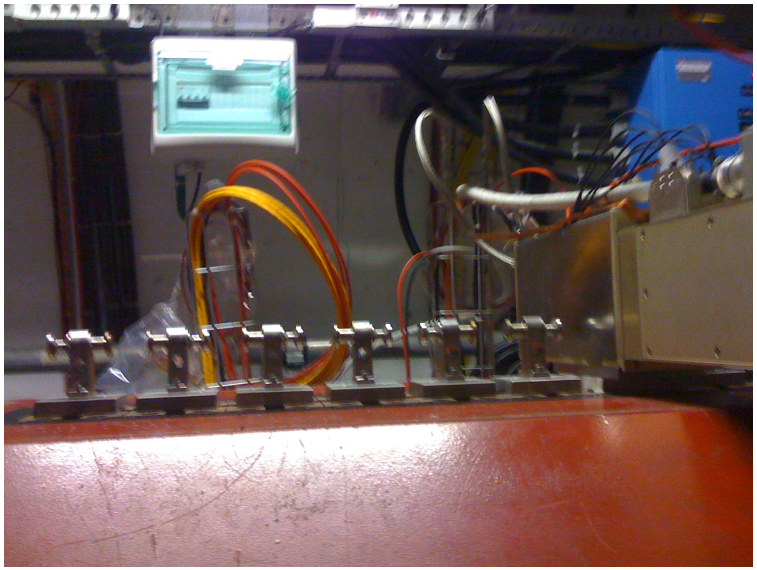
Need to adjust for ever improving luminosity

Watch for peak bunch by bunch luminosity

ATLAS Configuration

TAN with absorbers – no ZDCs or LHCf





Plans for 2012

Optimize detector performance

- DAQ readout
- Analog chain to match digitizer operating range

Monitor possible radiation damage

Test de-convolution in 25ns MDs

Complete FLUKA modeling

- Prepare for p-Pb collisions

Deliver all spares

Operator Interface

Presented at CM17

Allows operators to monitor parameters in the system

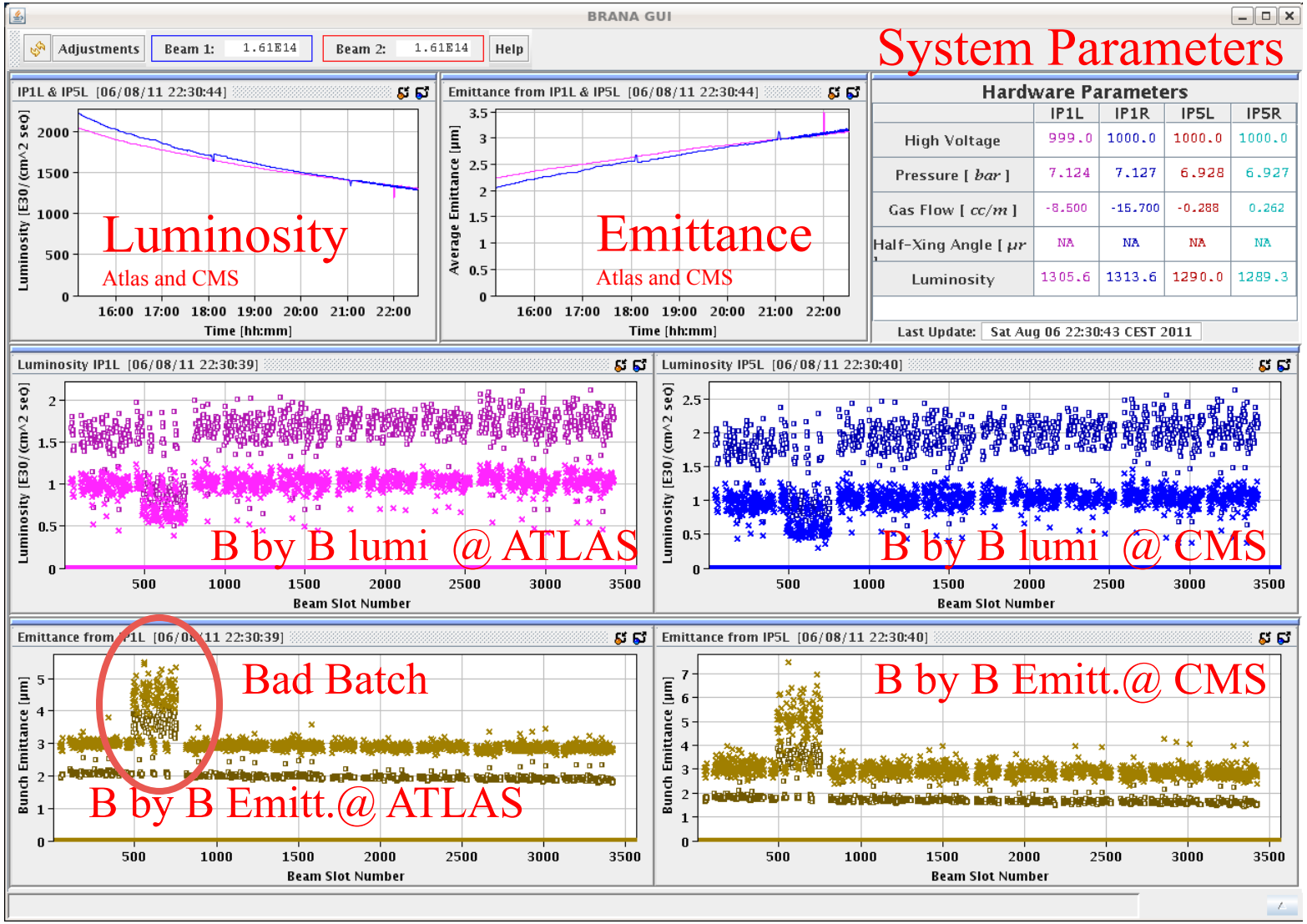
Plots bunch by bunch luminosity at both IPs

Calculates B-byB emittance from luminosity measurements

Allows user to save relevant data

Displays the operating parameters of the system

New GUI for use in the CCC



E. McCrory (FNAL), T. Lehay (SLAC)

Analog Configuration

As performance improves, we monitor for radiation damage and signal processing integrity

Low levels of integrated dose so far

Only expect single event upsets, if any

Higher luminosity collisions could saturate the detector

Electronics saturates much before ionization chamber

Starting to optimize readout chain – not as urgent for relative measurements

One pre-amplifier channel damaged in 2011

not sure what caused the failure

switched to spare channel during winter shutdown

Analog performance

Calibrated all analog quadrants with test pulse

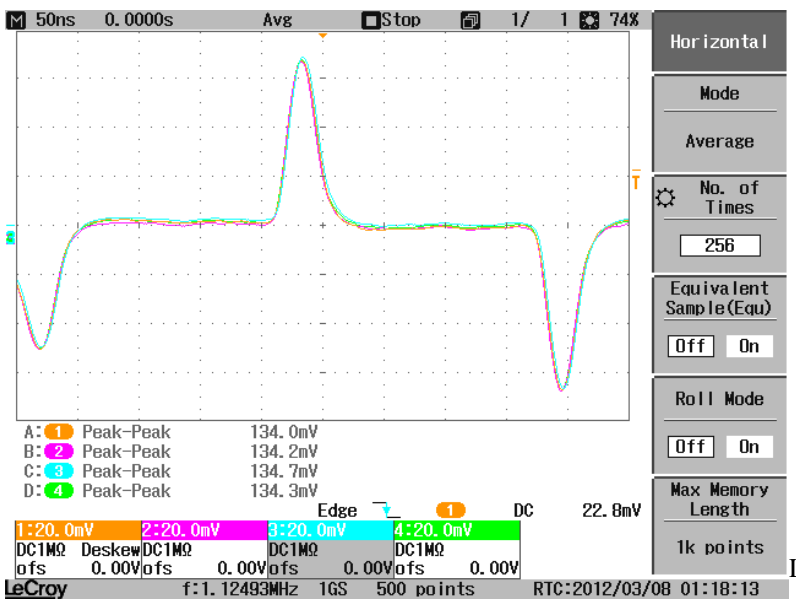
adjusted shapers gains and time constants

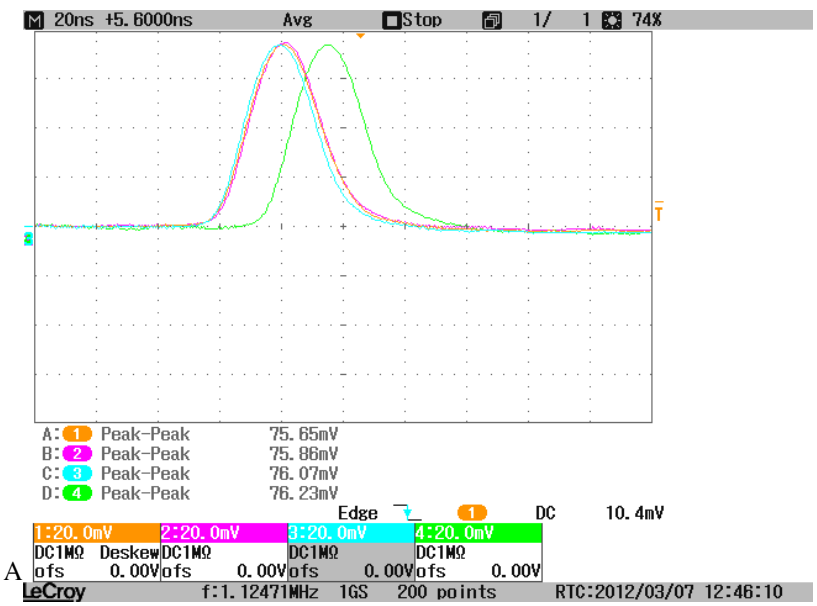
Time delays can be different due to different cable lengths

Can be corrected in the DAQ system

Different amplitudes between two sides of IP due to cable lenghts

Biggest at Pt 5





Two methods of readout

All four quadrants read out for each bunch and turn

Data is processed in two ways

- Counting Mode (currently recorded for left side of each IP)
  - Each bunch is counted as a "1" if exceeds a certain threshold
  - Software integrates over a specific number of turns
  - At lower luminosity this is linear as BRAN has a low acceptance
  - At higher luminosity can saturate
- Pulse Height Mode (currently recorded for right side of each IP)
  - The signal voltage for each bunch is collected and summed for a number of turns
  - This higher statistical fluctuations but linear up to maximum digitization of the ADC (There are several ways to reduce the signal)

Due to the small detector acceptance, counting is still effective, but not as accurate as PH

Expert tool

Timber records a limited set of data

Counting mode @ left side, Pulse Height @ right of both Ips

Script by Enrico Bravin allows to record simultaneously all detector parameters, bunch by bunch

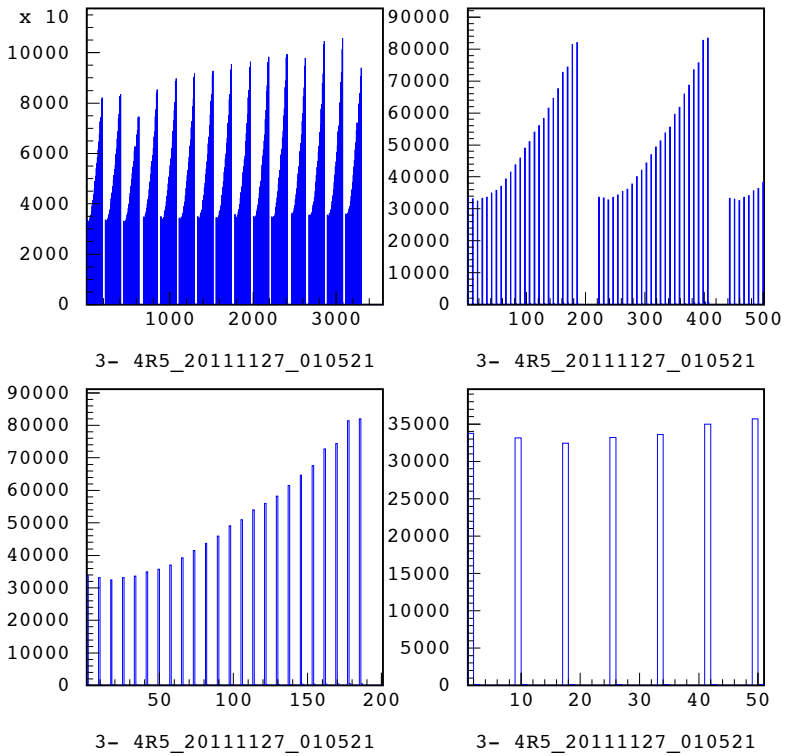
Use to monitor performance of counting vs. PH

Allows also monitor background and noise levels

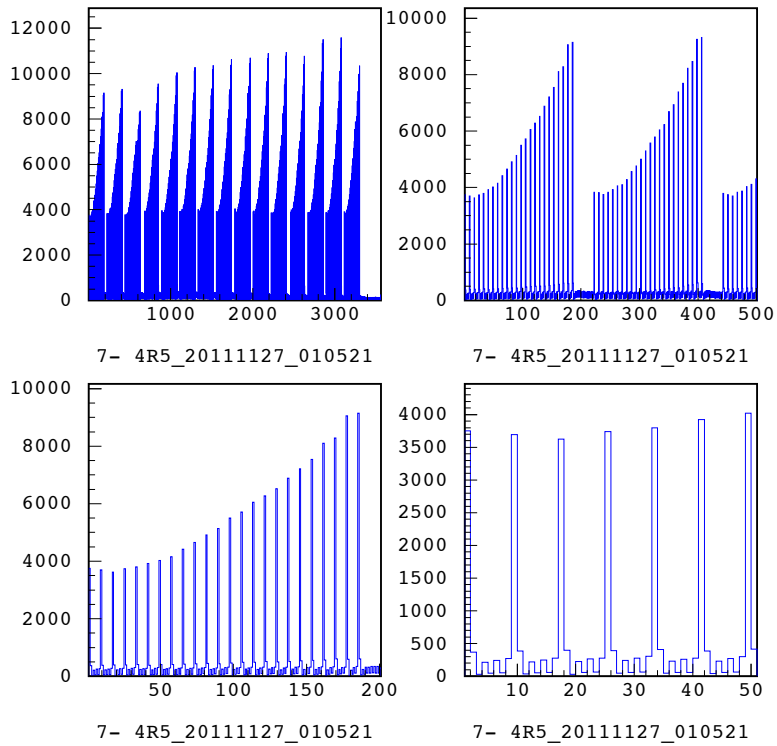
Early indication of radiation damage

Signal Analysis

Counting Mode



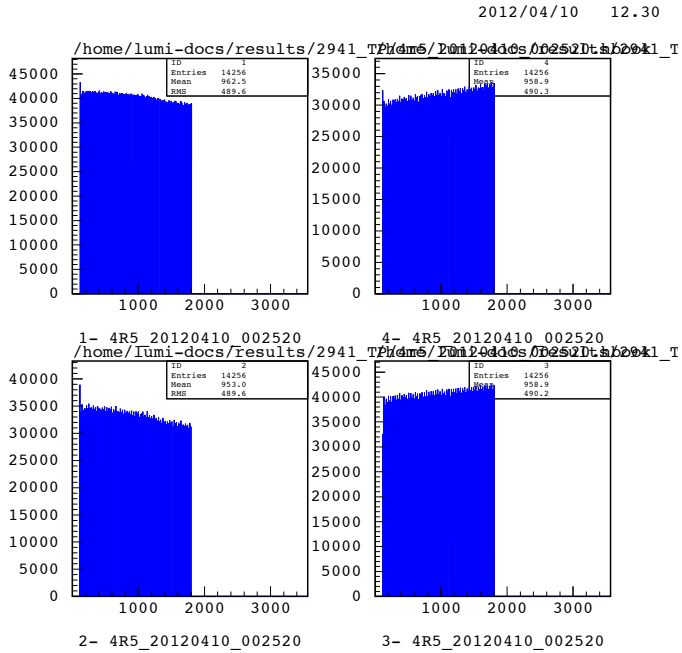
Pulse Height Mode



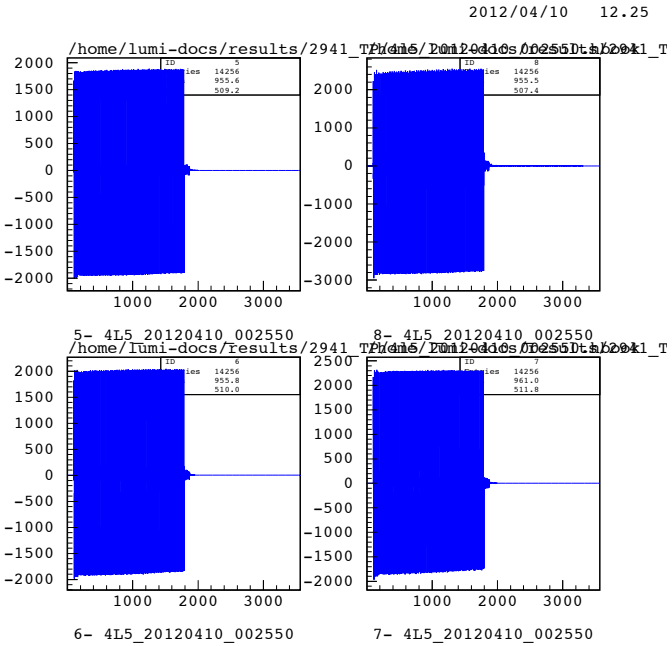
Data from Enrico's script during the 2011 Pb-Pb run

Performance measurements

Counting Mode

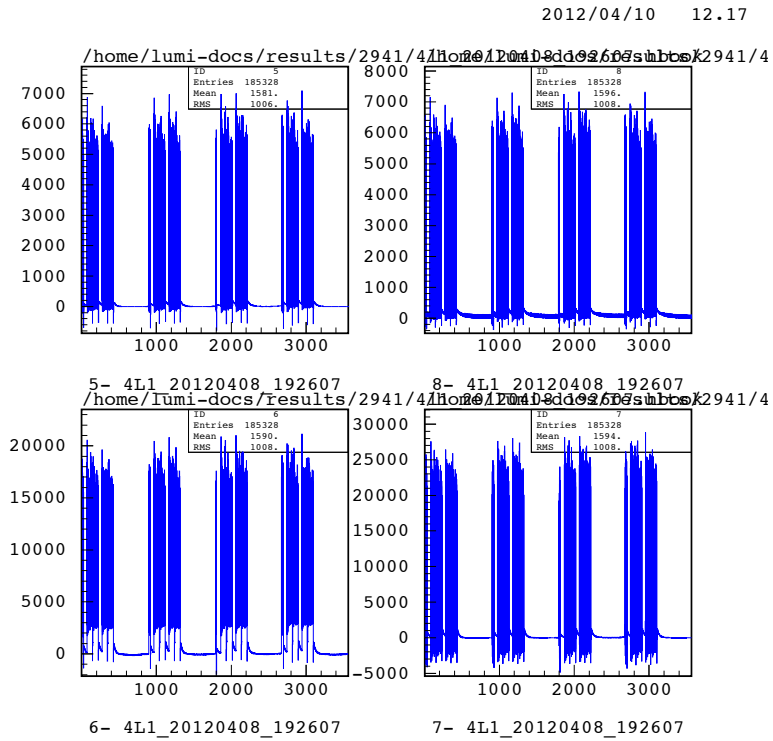


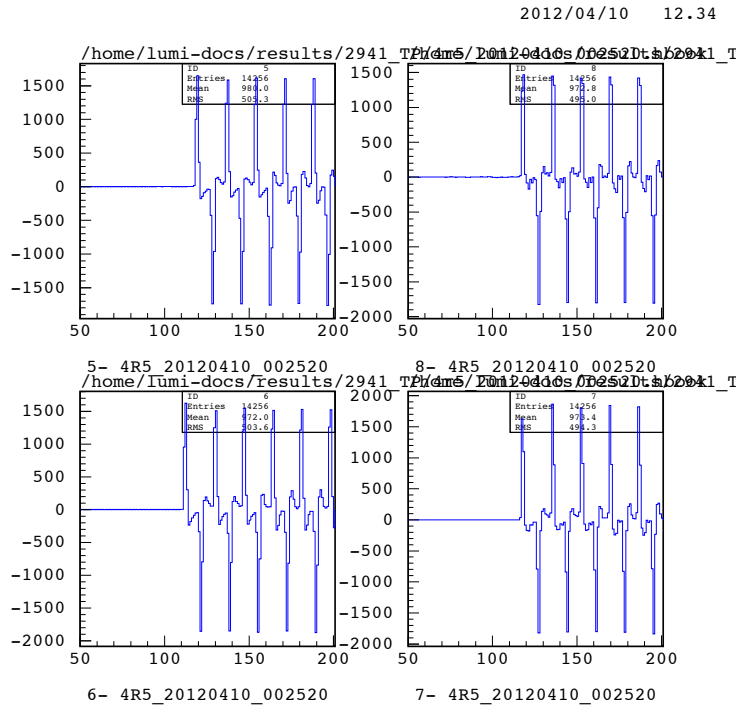
Pulse Height Mode



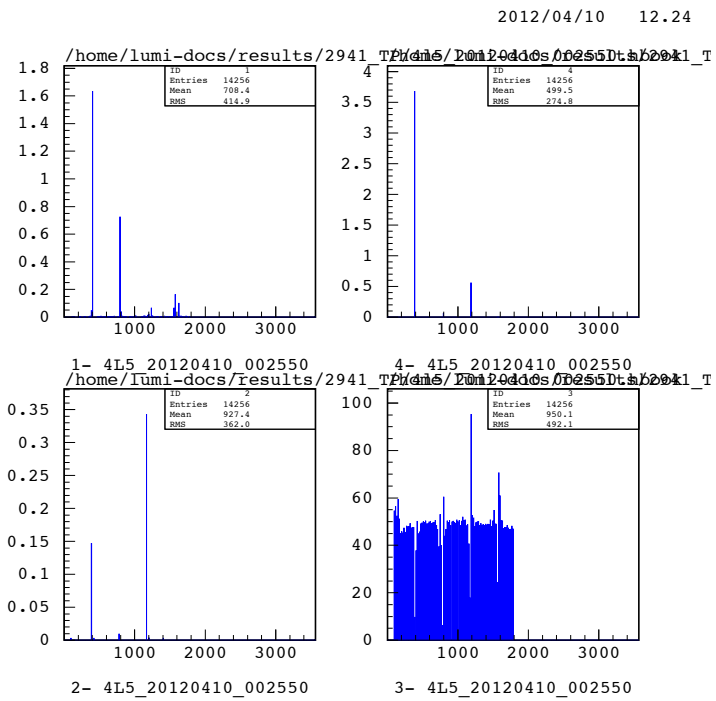
Pt 5 – response to an external calibration pulse

Performance measurements





Misconfigured Counting Mode at 5L



Similar analysis allowed to identify damaged pre-amp

Peak analyzer

Test pulses are ~ 100 ns wide

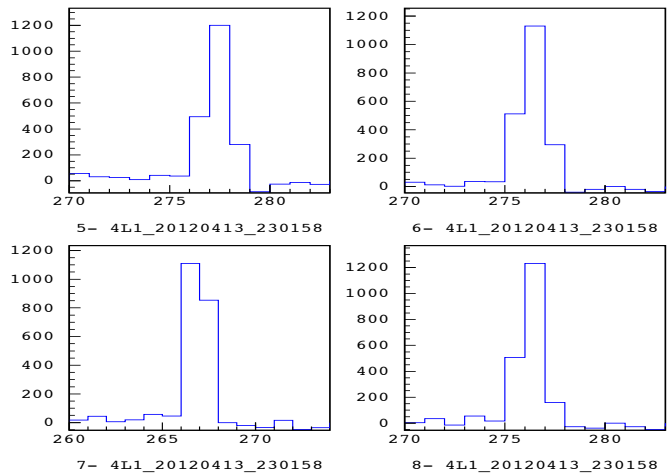
- Captured in multiple readings at 25 ns
- Data mostly falls in three groups depending upon location of the main peak

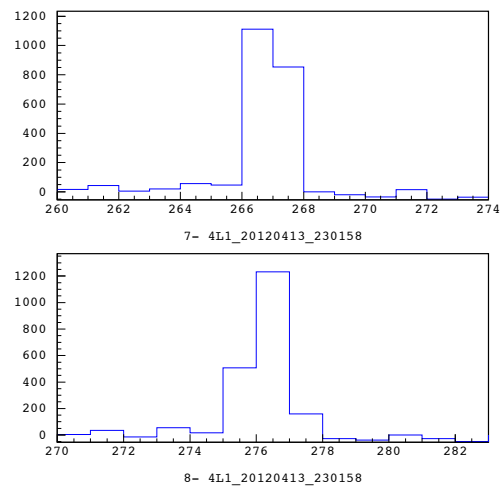
Simple tool developed by Howard Matis to identify pulse peaks

- Depends upon DAQ trigger timing

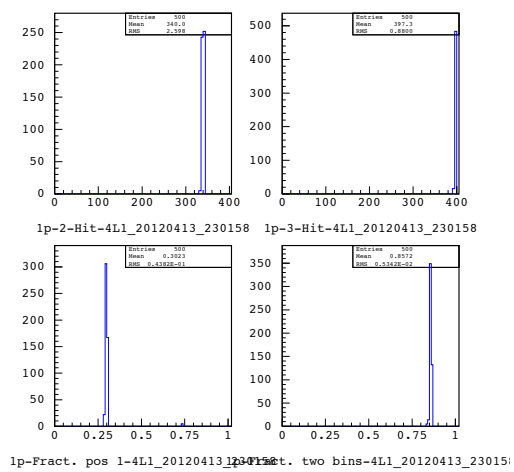
Allows to analyze DAQ setup of each quadrant

Peak analysis





Pt 1 – one quadrant timed differently



% of pulses with 1 or 2 peaks

System calibration summary

Tested through external pulser all four quadrants on all four detectors

Developed simple analysis tool to determine configuration errors

- adjusted timing on all quadrants
- verifying gain next

Calibration scans

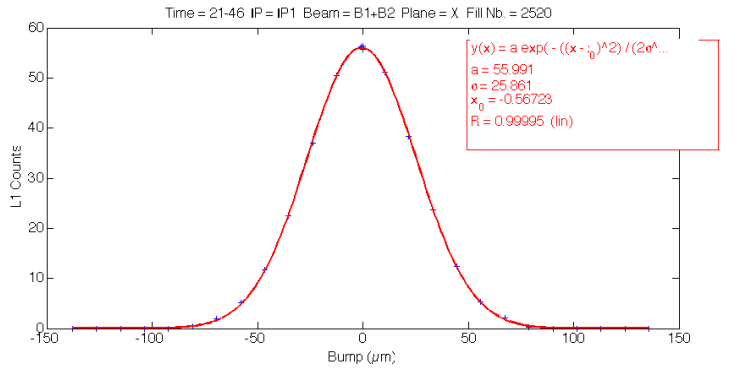
Van der Meer scans during dedicated MDs

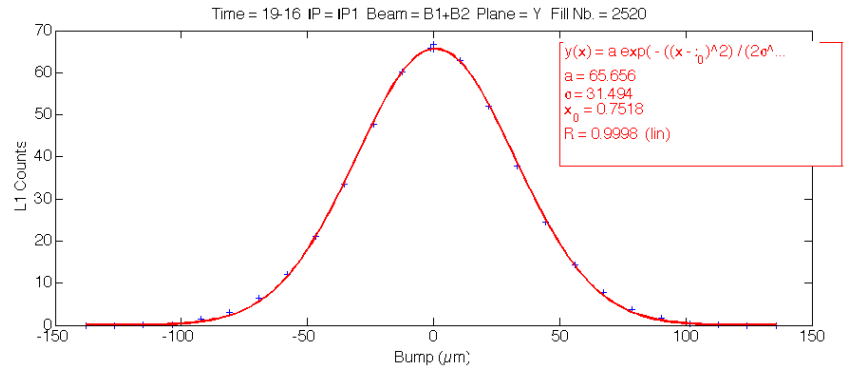
Experiments use them to calibrate internal luminosity algorithms

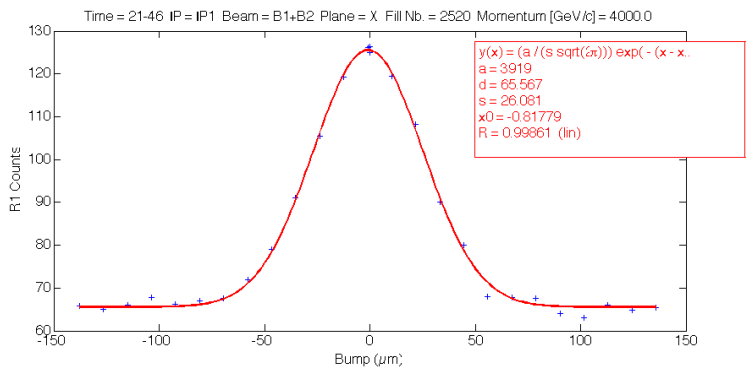
Data collected for all detectors, including BRAN

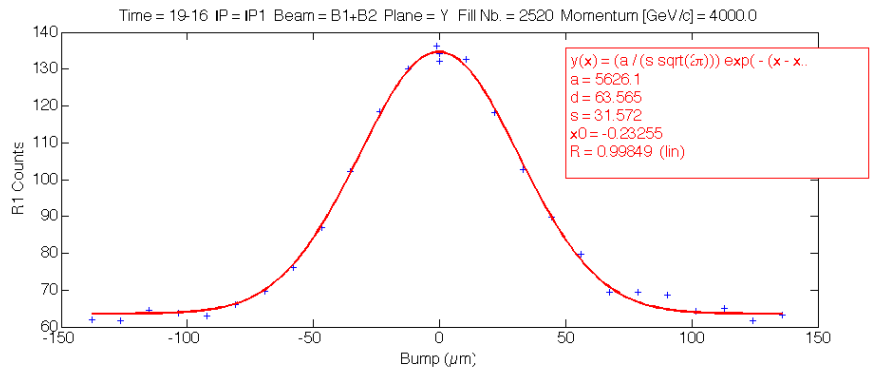
Can measure transverse dimensions of the beam at the IP

Scan results – IP1 X and Y



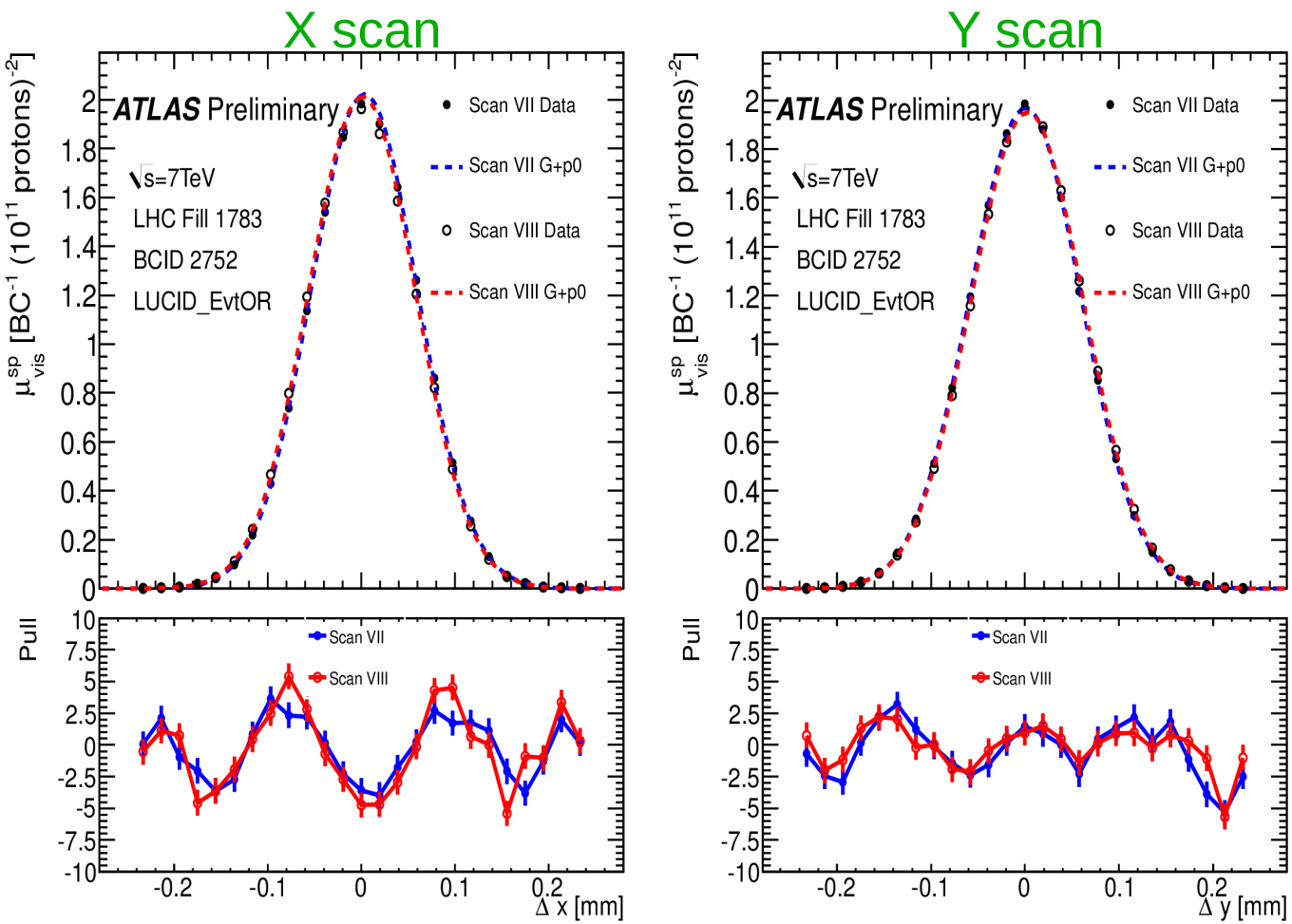






Pt 1 – offset to be studied

2011 scan results at ATLAS



Conclusions

Following the progress of the detector with improving LHC luminosity

Operator interface provides good diagnostics tools for machine optimization

Expert DAQ script provides strong diagnostics tools for the configuration of the readout system

Calibration scans confirm reliable detector operation

You'll see that FLUKA studies support detector operation – next talk