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# Luminosity determination in pp collisions with the ATLAS detector at LHC

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**Summary.** — Results of the luminosity measurements with the ATLAS detector at LHC in *pp* collisions at $\sqrt(s) = 7\,\text{TeV}$ in 2011 are presented. Several luminosity monitors are calibrated in dedicated runs and their long-term stability and accuracy are evaluated. A final luminosity uncertainty of $\delta L/L = \pm 3.7\%$ is reached.

PACS 13.75.Cs – Proton-proton interactions.
PACS 13.85.Dz – Elastic scattering, hadron-induced.

## 1. – Luminosity measurements in ATLAS

An accurate and precise measurement of the delivered luminosity is a key component of the ATLAS program: the uncertainty on this measurement is one of the dominant systematic uncertainties on the error on cross-section measurements of both Standard Model and new physics processes [1].

ATLAS has several detectors able to perform luminosity measurements. LUCID and BCM perform both bunch-by-bunch and time-integrated measurements. ALFA can measure the absolute luminosity during dedicated runs. ZDC is dedicated to the luminosity measurement during heavy-ion runs. The data from LUCID, BCM and ZDC are analysed according to the inclusive EventOR algorithm (one hit detected in any of the two sides) and the coincidence EventAND algorithm (one hit detected in both sides). TileCal and FCal calorimeters perform measurements of the relative integrated luminosity through the collected electromagnetic transverse energy, that is then calibrated with LUCID and BCM results. The long term stability of the luminosity calibration is studied by comparing the results obtained with different calibration techniques.

## 2. – Luminosity calibration using a Van der Meer scan method

The ATLAS relative luminosity in 2011 is calibrated using the results of two Van der Meer scans. For each step of the beam scan, the relative beam separation and the

 

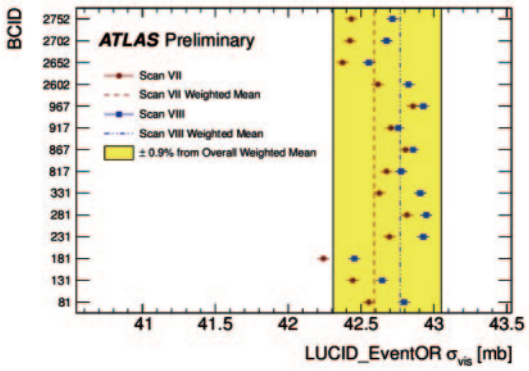


Fig. 1. – Measured calibration constant as a function of bunch number, for two Van der Meer scans. For LUCIDEventOR, LUCIDEventAND, and BCMEventOR the variation is ±0.6%.

rate measured by the luminosity monitors active in that moment are recorded and the luminosity is inferred from these data.

The stability and reproducibility of the calibration technique is demonstrated by studying the variation of the calibration constant between scans and its bunch-by-bunch consistency. For the most precise quantities (LUCIDEventOR, LUCIDEventAND, and BCMEventOR) this variation is about ±0.6% as shown in fig. 1. The main source of uncertainties on the luminosity are listed in table I [2].

## 3. – Calorimeter calibration and long-term stability

TileCal was calibrated to LUCIDEventOR separately in 2010 and 2011. The stability in 2010 was about 0.2%. FCal was calibrated to LUCIDEventOR in 2010 and to BCM in 2011. In 2010 the stability was about 0.5%. Both LUCID and BCM calibrations in 2011 must cope with some effects that affect the value of the calibration constant: changes

TABLE I. – *Main sources of uncertainty (in percent) for* $2\,\mathrm{fb}^{-1}$ *of data collected until August* 2011 *(middle column), and preliminary projection for* $5\,\mathrm{fb}^{-1}$ *(right column).*

| | 2/fb | 5/fb |
|---|---|---|
| DCCT | 2.73 | 0.23 |
| FBCT | 1.30 | 0.20 |
| Ghost Charge | 0.18 | 0.18 |
| Total BCP | 3.0 | 0.35 |
| Total vdM | 1.5 | 1.75 |
| SubTotal uncertainty | 3.4 | 1.8 |
| Long Term Stability | 1.0 | 1.0 |
| $\mu$ dependence | 1.0 | 1.0 |
| Afterglow | 0.2 | 0.2 |
| SubTotal Monitoring | 1.4 | 1.4 |
| Total 2011 7 TeV pp | 3.7 | 2.3 |

in hardware setup, afterglow in the bunches following collisions, LUCID dependence on mean number of collisions, LUCID PMT current corrections. After all these corrections, the calibration value remains constant in time and the comparison between the calibrations obtained with all the different methods are in agreement. No deviation beyond 1% is visible in the long term stability. The final systematic uncertainty on the luminosity for the data until August 2011 (2/fb) is 3.7%. The preliminary projected systematic uncertainty on $5\,\mathrm{fb}^{-1}$ of data is at the 2.3% level [3].

REFERENCES

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