# Alignment of the Inner Detector of the ATLAS Experiment

The ATLAS Collaboration

## 1 Introduction

The ATLAS Inner Detector consists of about 6000 modules in its Silicon Tracker. Each of these module determines the position of passing particle tracks with a precision of about $20\mu m$. However, the position of the devices is only known to about $100\mu m$ and therefore a track based alignment procedure has to be applied to determine the absolute position of the sensitive devices to a better precision. The position precision required by physics is about $10\mu m$.

## 2 Method

The determination of the alignment constants is closely related to the solution of a system with a large number of degrees of freedom. In the case of the ATLAS Inner Detector we have about 35000 degrees of freedom. The different approaches are envisaged and they can be basically be divided into global and local fit method:

- In the local methods, the position of a single module is determined iteratively by repeating a local $\chi^2$ minimization and refitting tracks at each step.
- In global methods changes in the alignment constants and tracks parameters are handled together in the minimization procedure.

Both methods have been used successfully in previous experiments. The ATLAS experiment follows both approaches. The mathematical description of the alignment problem and its implementation into the current software framework will be presented. First tests using simulated events are shown. The advantages and disadvantages of both approaches will be discussed in detail and the expected precision is estimated.

## 3 Constraints

The information gained from simple tracks is not sufficient to solve the complicated system, leading to undetermined degrees of freedom. For this reason

additional constraints need to be added to the system, like track pairs originating from resonance decays. Additional information can either be added directly to the equation or by enriching the number of dedicated tracks.
The possible degeneracy of the solution of the alignment constants and its implication on the geometry of the detector will be discussed. The various possible constraints and their impact on the solution are shown. In addition information from interferometry based alignment systems will enter in the determination of the alignment constants.

# 4 Results using tracks from a test beam and cosmic rays

Both alignment approaches have been used in the past to align a test setup using tracks from a testbeam. The results and the problem of the test setup will be discussed. Recently tracks from cosmic rays are used to align parts of the ATLAS Inner Detector. The position determined from cosmic ray tracks will be compared to the position determined by a optical survey measurement.