Alignment of the ATLAS Inner Detector

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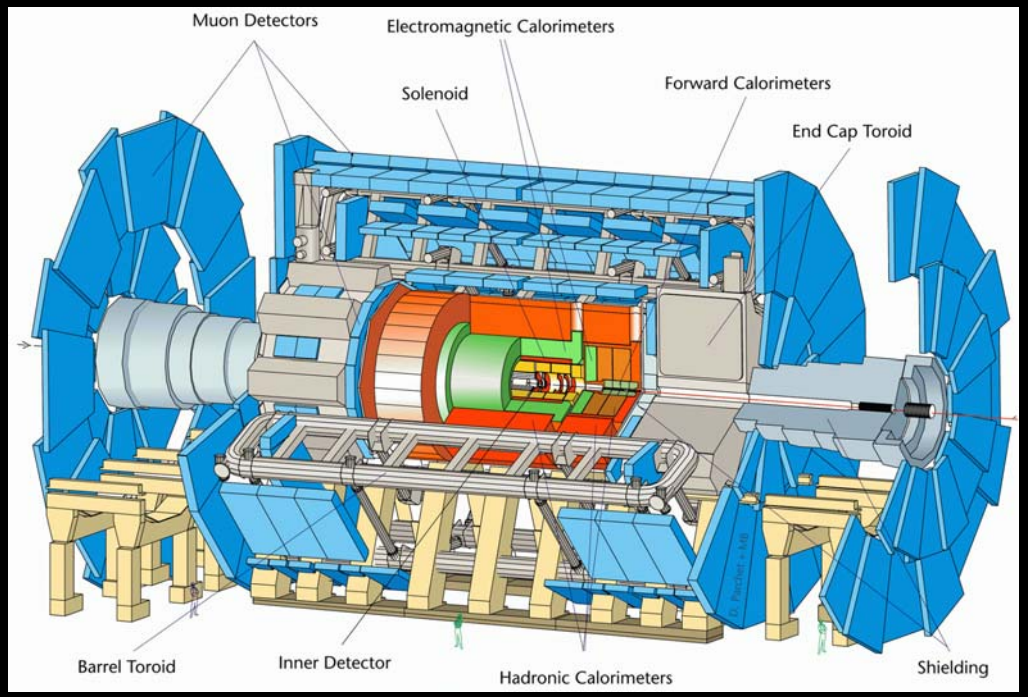
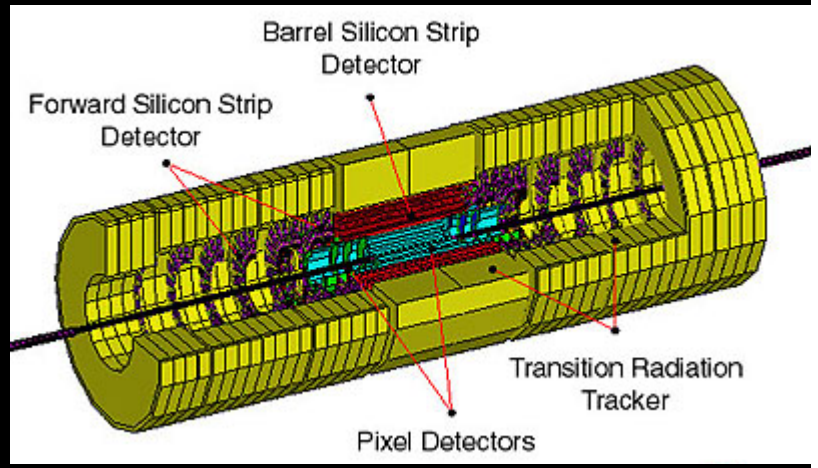
Overview

- SemiConductor Tracker (SCT)
  - SCT Setup
  - Production at MPI
- Alignment
  - Purpose
  - Different approaches
  - My strategy

ATLAS Inner Detector

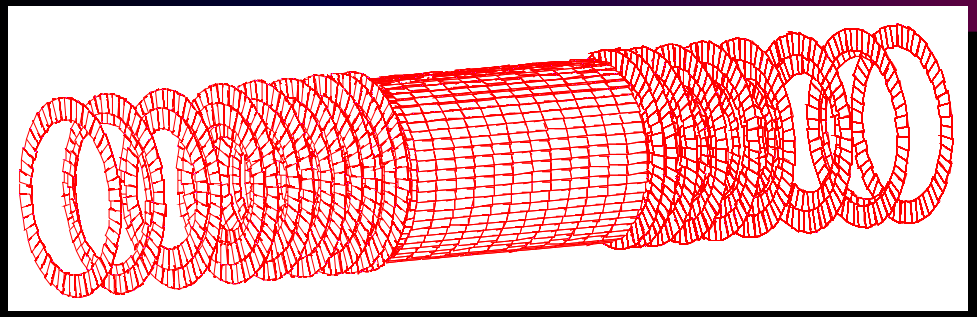


ATLAS Inner Detector

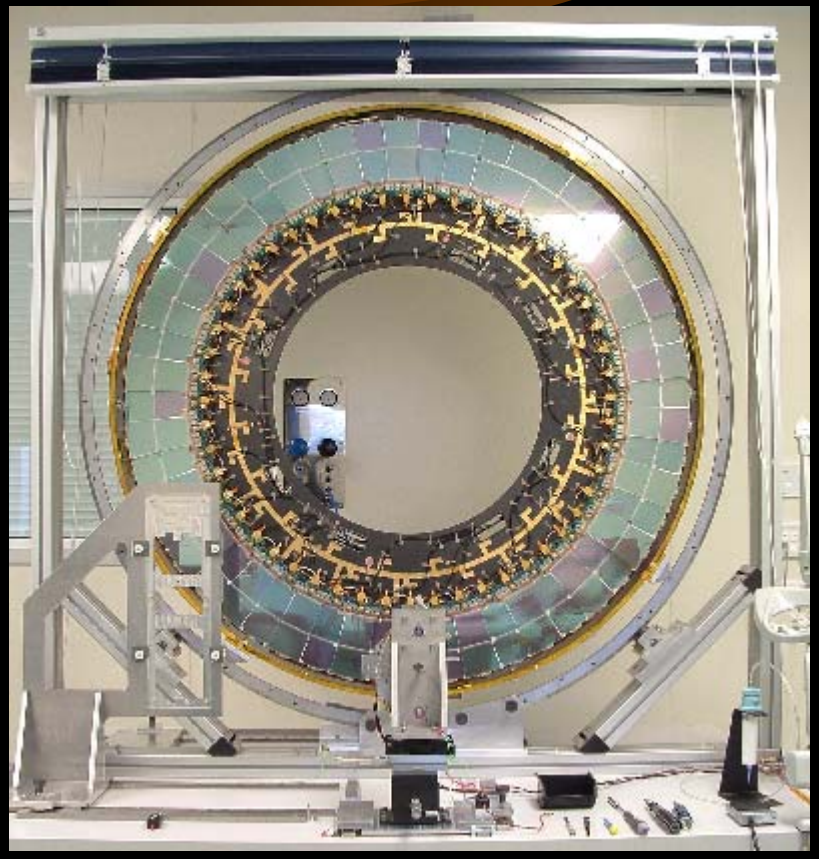


Inner Detector used for particle track reconstruction

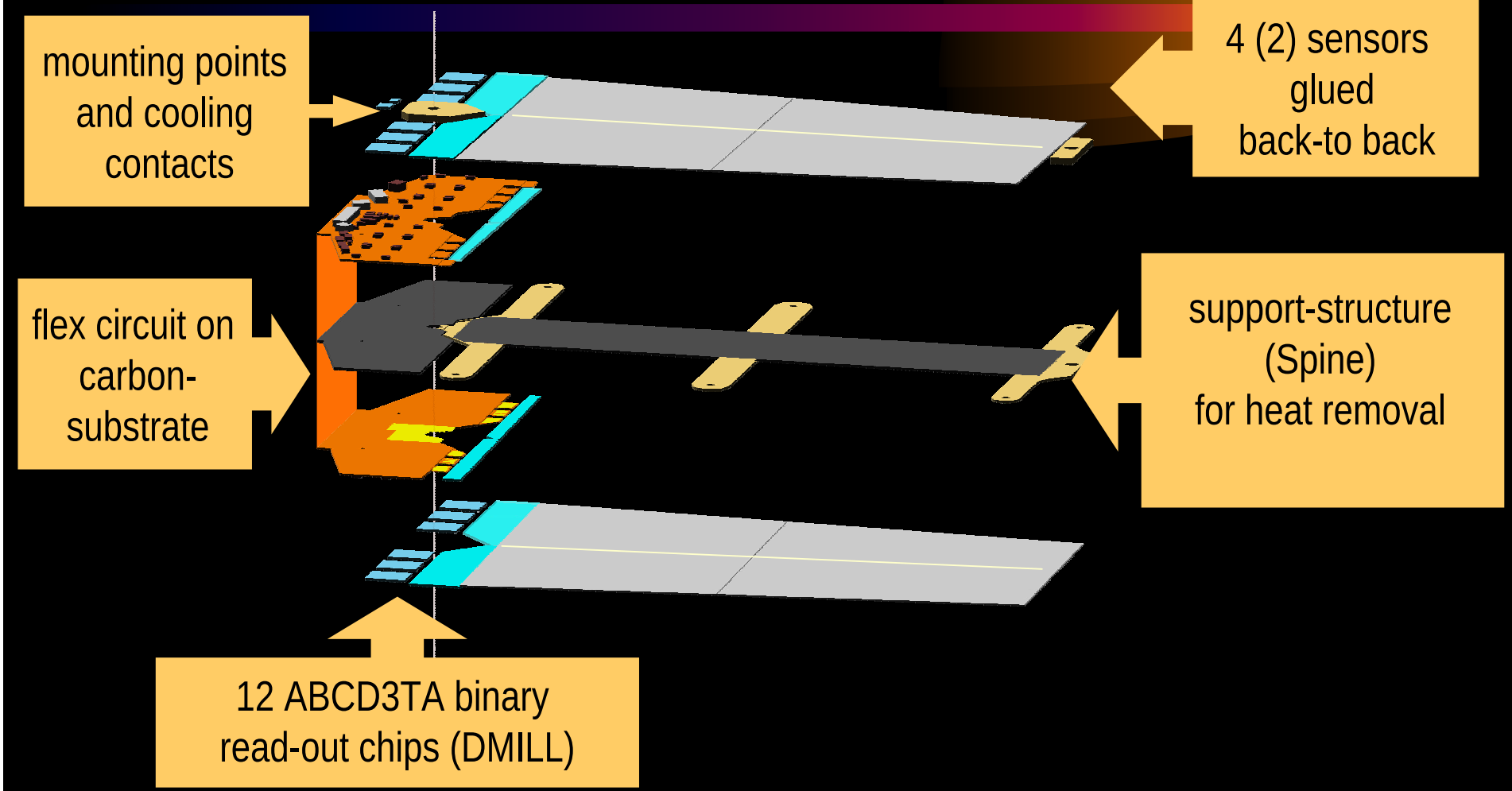
SCT Setup



Disc 9C

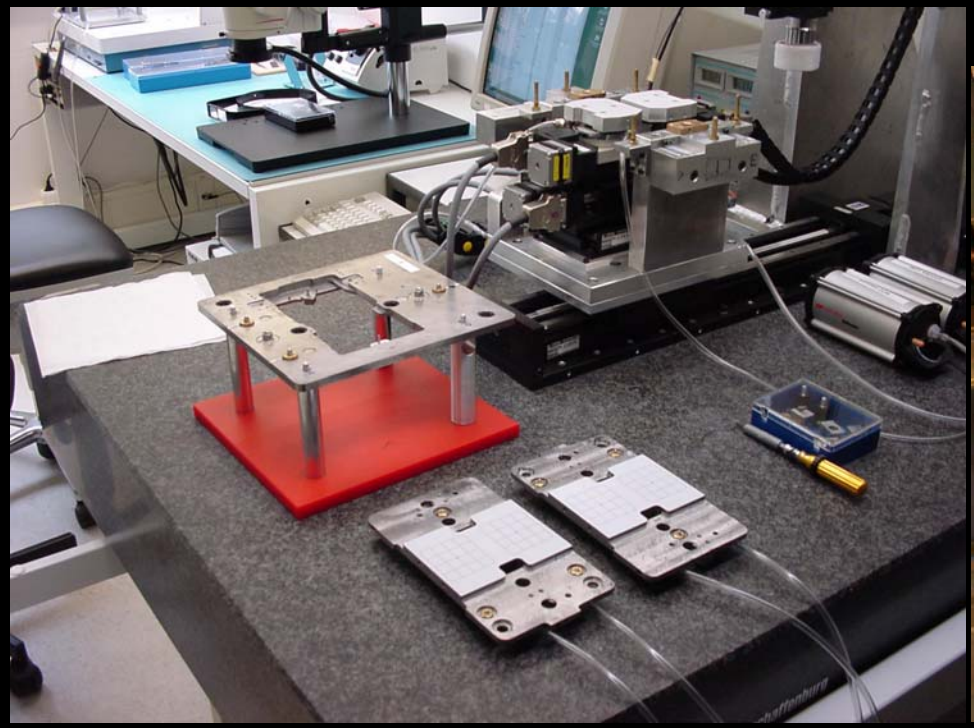


SCT Module Assembly

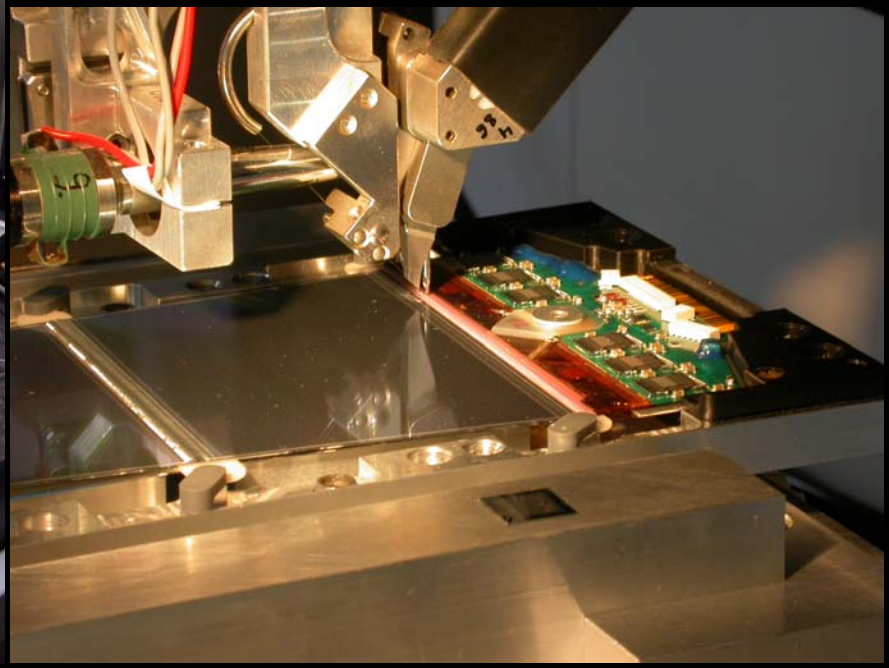


SCT Production at MPI Munich

Mechanical construction

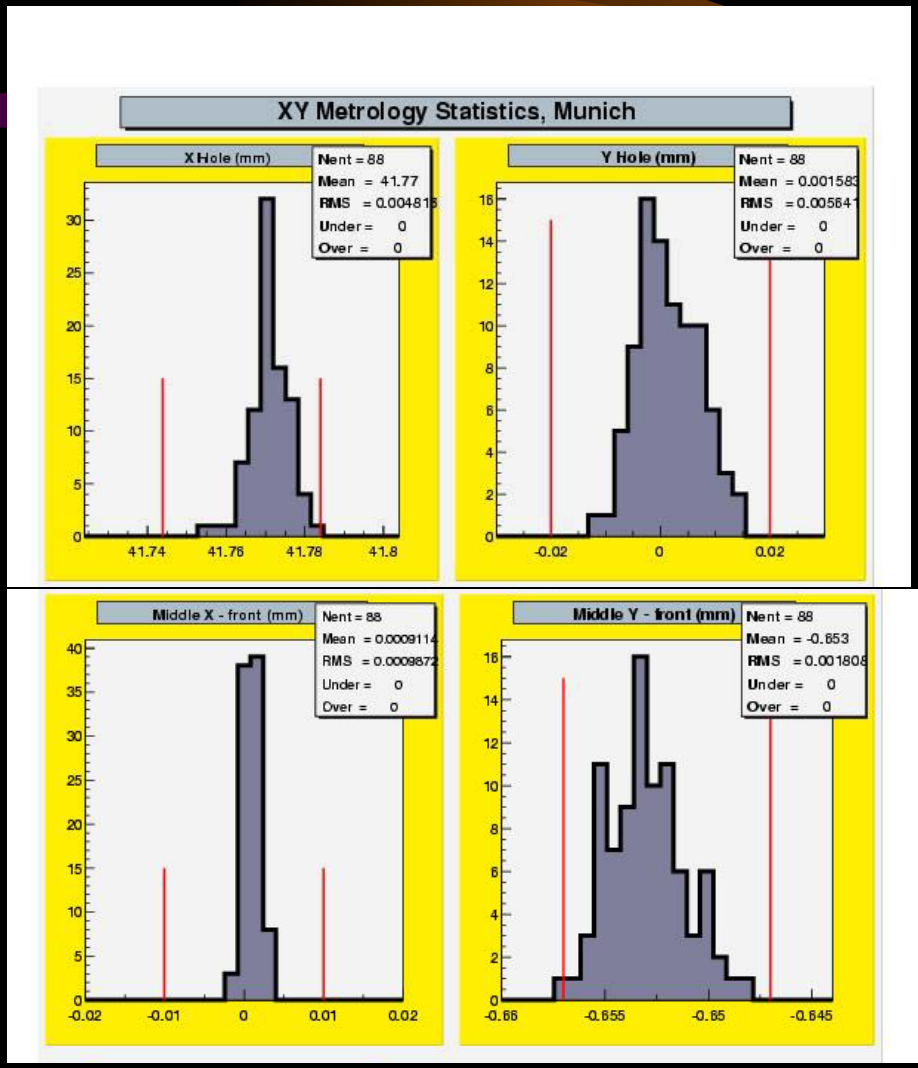


Bonding



SCT Module Specification

Optical Survey machine



Alignment

- Process of deducing position of each module in the Inner Detector
- Misalignments can be corrected for in track reconstruction software
- Modules are not moved back into nominal position

Purpose of Alignment

- Quality of particle track reconstruction
- Resolution of measurements of track properties
- Eliminate systematic errors from measurement

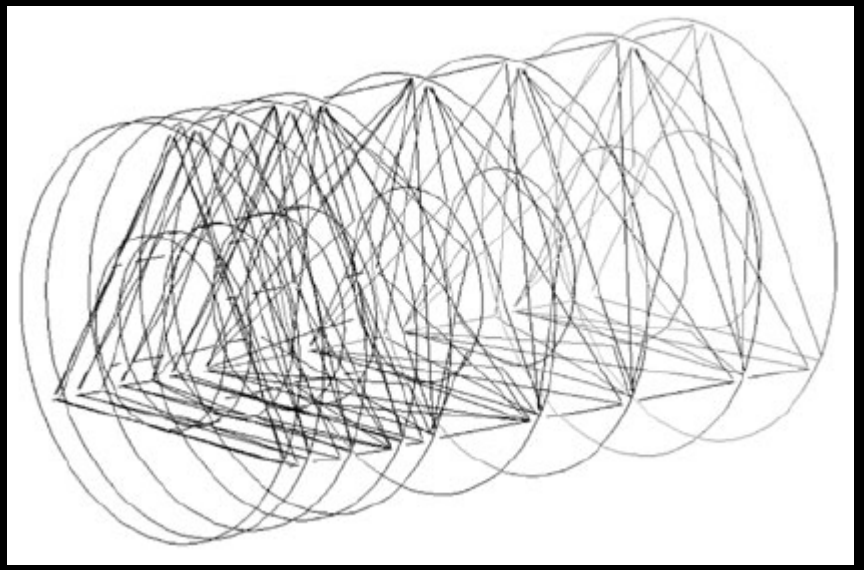
Steps of Alignment

- Survey
- Online Alignment (FSI)
- Offline Alignment (using particle tracks)

Online Alignment - FSI

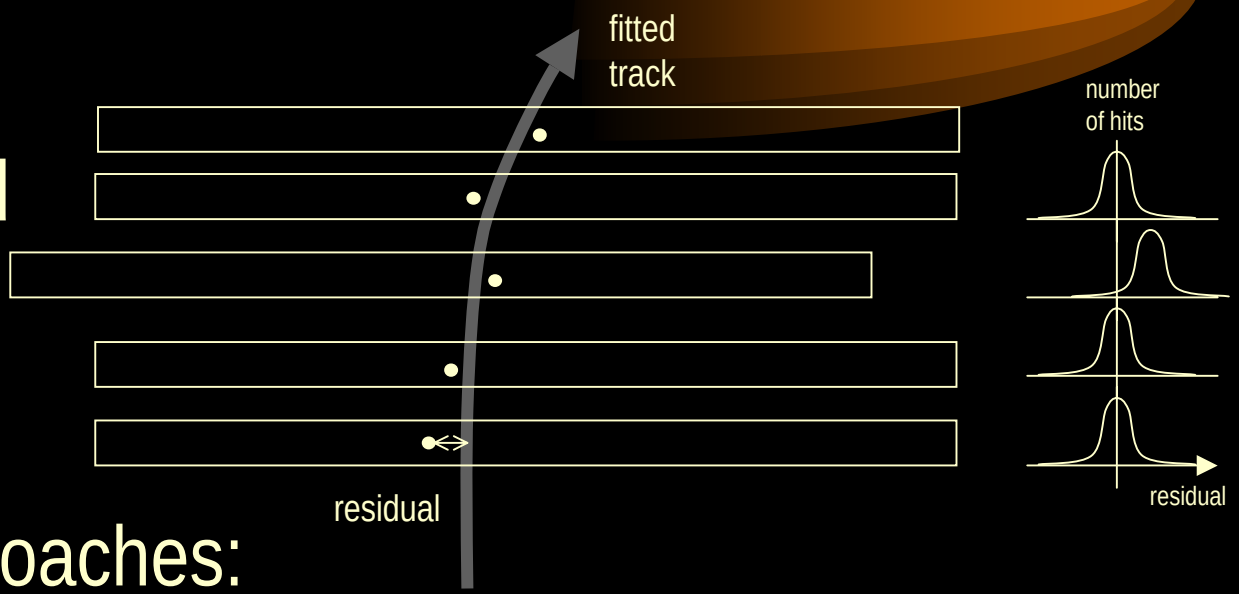
- Frequency Scanning Interferometry
- Uses network of interferometers for precise distance measurements of Inner Detector

Interferometer network for SCT Discs



Offline Alignment using Tracks

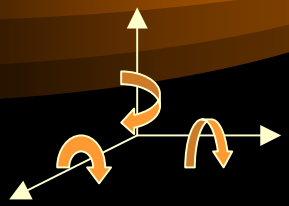
Use residual between fitted track and hit position



Different approaches:

- Global χ^2
- Robust Algorithm
- Module-by-Module χ^2

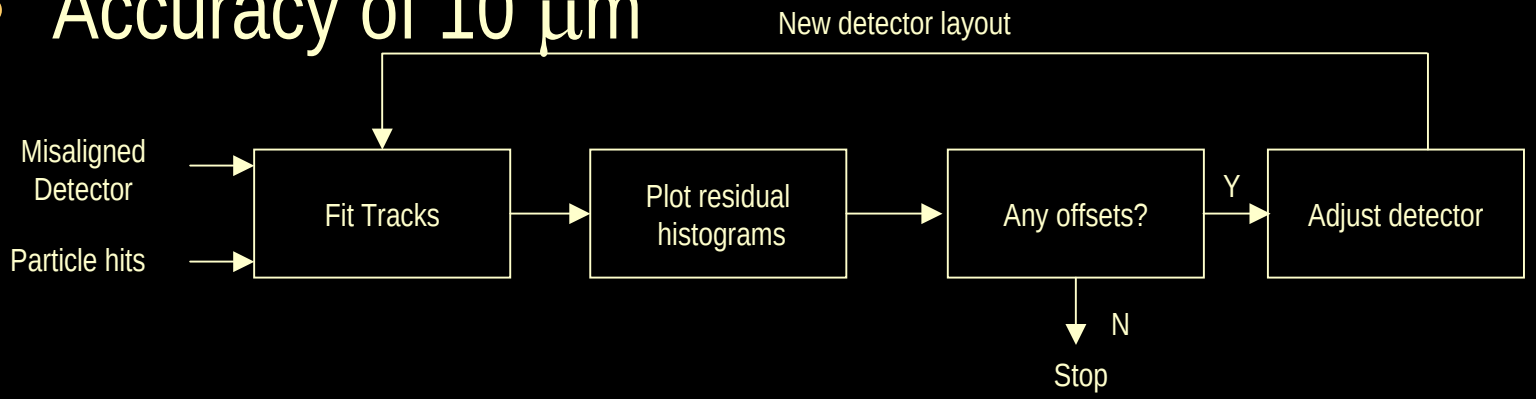
Global χ^2 approach



- ~ 7000 Silicon modules
  each with 6 degrees of freedom
- ~ 42000 alignment parameters
- Global fit of alignment parameters to
  hit information using χ^2-minimization
- Requires inversion of a 42000x42000 matrix
- Possible to achieve accuracy of 1μm

Robust Algorithm

- Determines alignment parameters based on interpretation of hit residual histograms
- Iterative approach
- Problems in the alignment easy to trace
- Accuracy of 10 μm



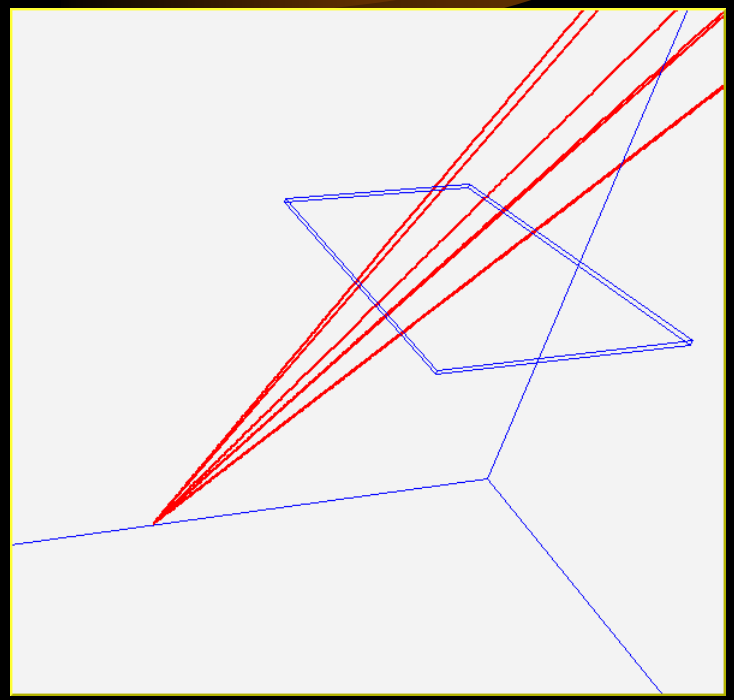
Module by Module χ^2

- Take the best from “Robust Algorithm” and “Global χ^2”
- χ^2-minimization for residual of each module
- Algebra much easier (Inversion of 6x6 matrix)
- Iterative alignment of the Inner Detector
- Problems in the alignment easy to trace
- Alignment-Method used for BaBar (5 μm accuracy)

Work done so far

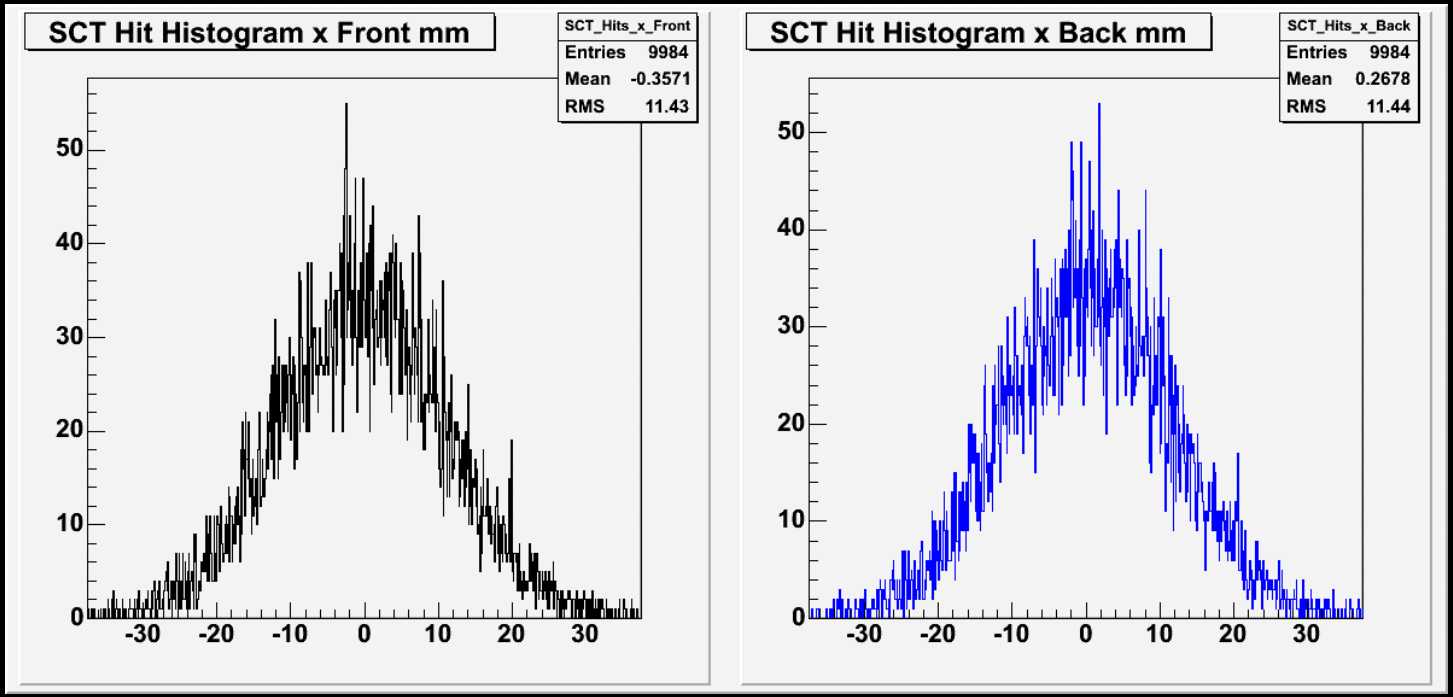
Developed “toy program” in ROOT

Simulation of charged particle tracks hitting a single SCT module.
Each hit produces signal on the front and back side of the SCT module



Work done so far

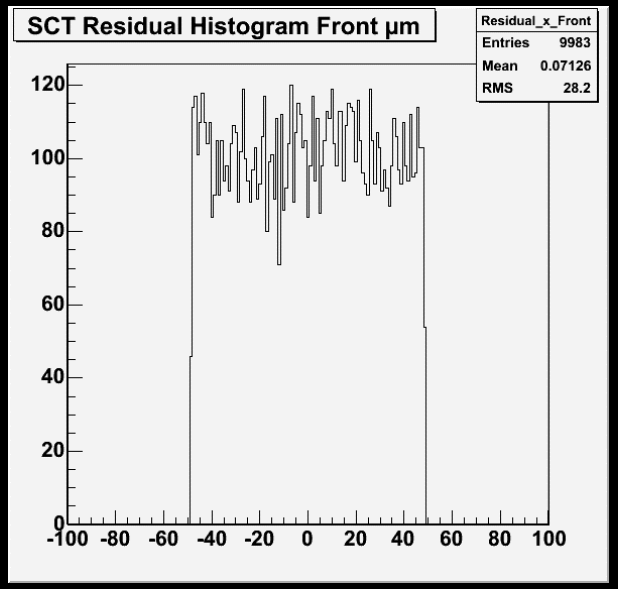
Hit signals from the SCT module are read out



Work done so far

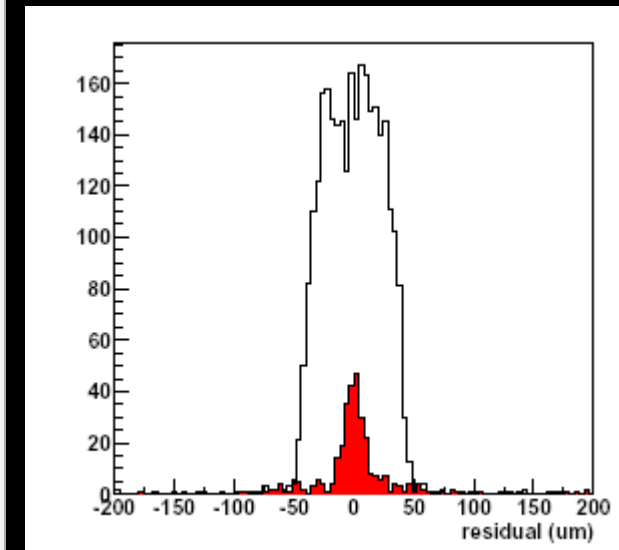
Hit residuals are calculated with the “toy program”

Toy program residual

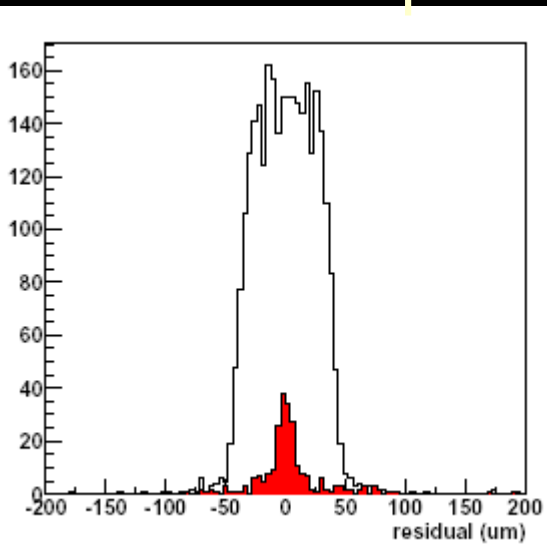


Testbeam Residual

Barrel



Endcap



Work in the near Future

- Use “toy program” to determine alignment parameters
- Compare results with the other approaches

Work in the not so near Future

- Implement “Module-by-Module” alignment algorithm within ATLAS software framework (Athena)