Design of a control and monitoring system for the mirror alignment of the CBM RICH detector

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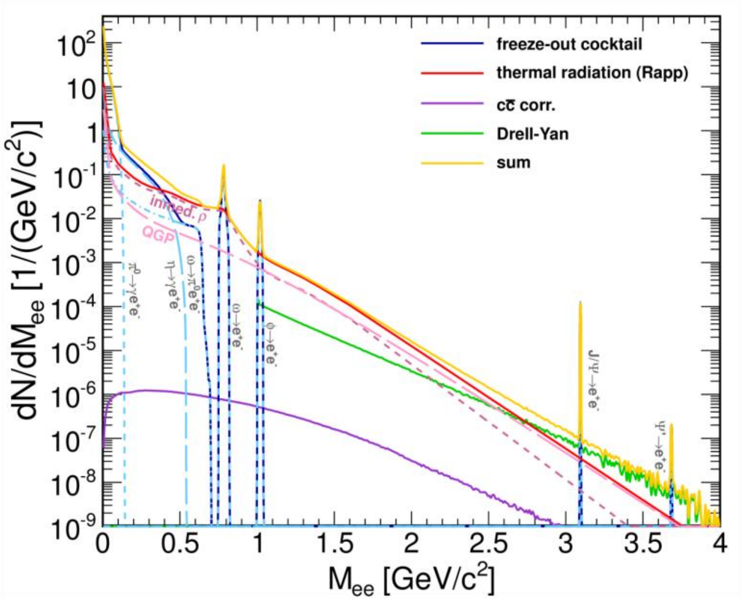
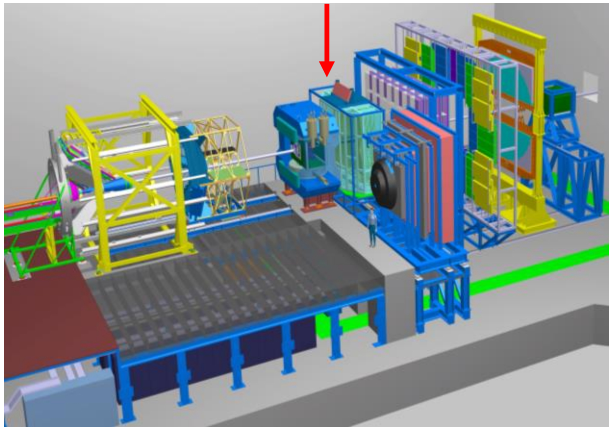
CBM Experiment, RICH Detector – JLU Gieβen – 27th-31st March

Introduction

- CBM at FAIR: explore QCD phase diagram in the region of high baryon density using A+A collisions
- Energy range (for Au-Au) from 2 up to 11 AGeV beam energy @SIS100
- EM probes:
  - In low mass region (π0, η, ρ, ω, φ)
    Photons: access to early temperature of the fireball
    Low mass vector mesons: hadron dynamics
  - Intermediate mass region
    Slope indicating thermal radiation of the fireball
    Also hints for a quarkyonic phase?
  - High mass region:
    Investigation of the charm quark propagation (J/Ψ)
- $e^{+/-}$ Identification with RICH detector

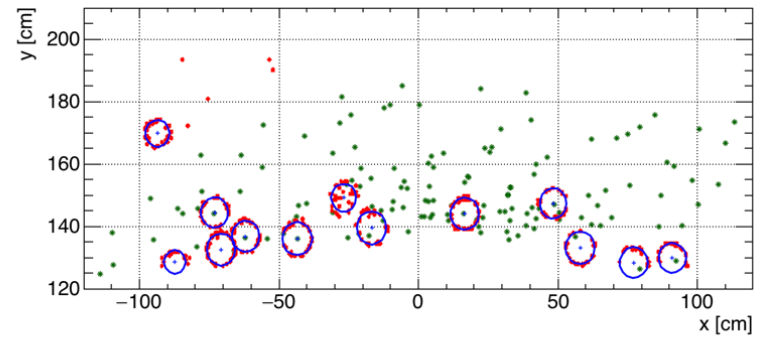


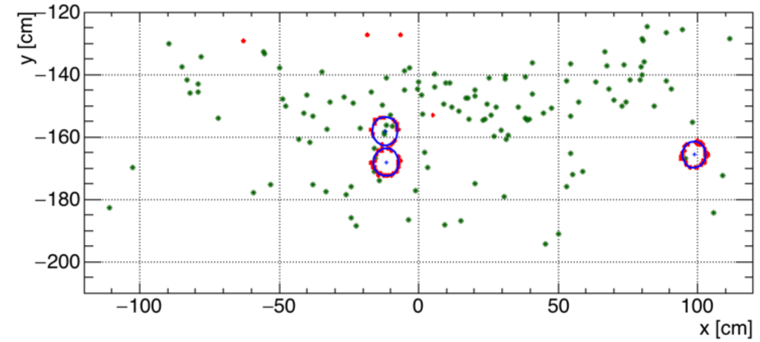


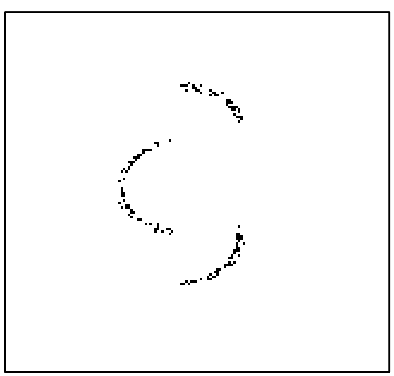
Introduction

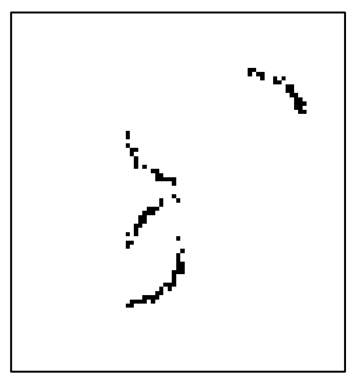
- CBM: high ring density environment
  - reconstruction efficiency of 97% (Au-Au @8GeV)
- RICH has to be exchanged on a yearly/bi-yearly basis:
  - Movements by crane inducing misalignments of the mirror system, which will result in:
  - Efficiency losses in ring reconstruction: ring splitting, ring distortion, double ring, ring-track mismatching
  - Misidentification due to distorted ring parameters
- Perfectly aligned and stable mirror system is required for accurate and highly efficient ring reconstruction
- Development of an alignment correction cycle in software

8 AGeV

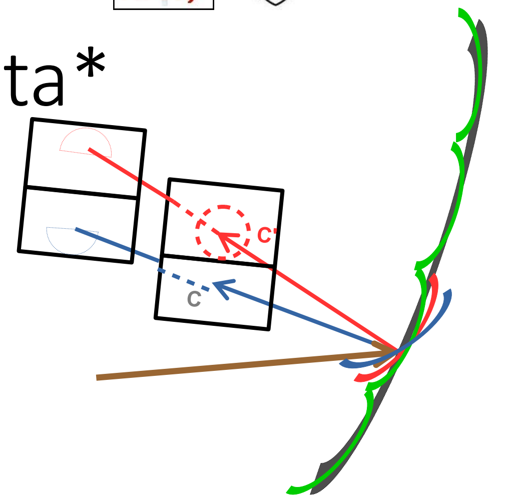




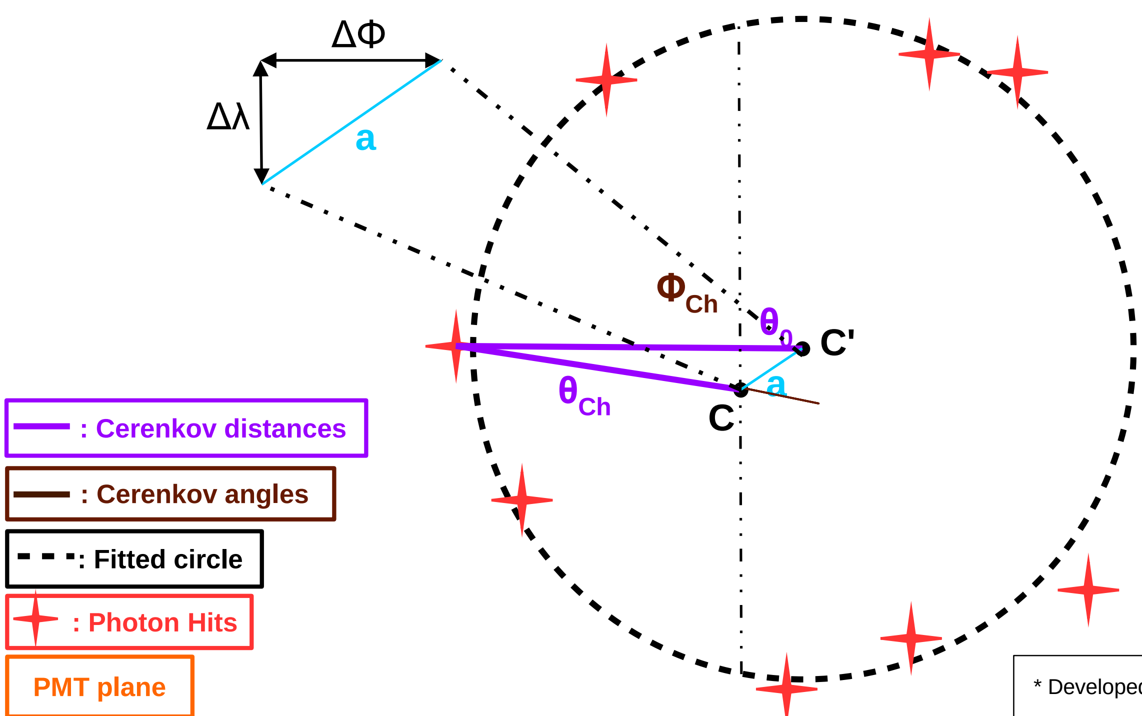


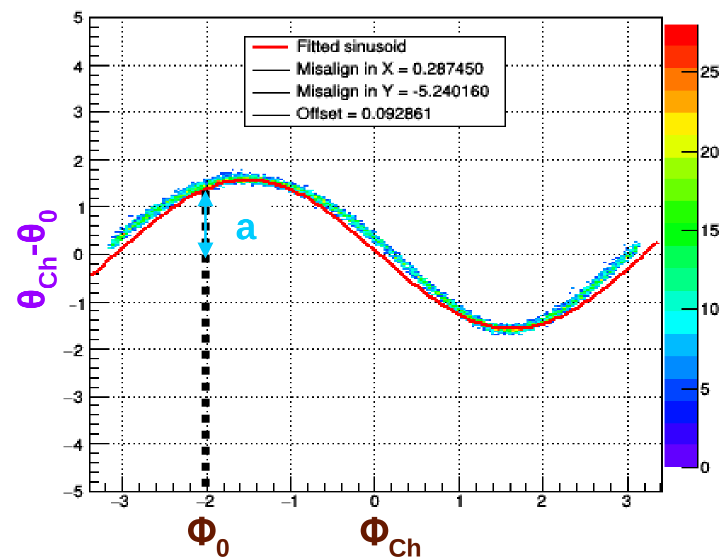


Principle of the correction with data*



- Fitted ring center **C'** and extrapolated track hit **C**
- Displacement a
- Calculation of Cerenkov distances θ_{ch} and angles ϕ_{ch}
- Sinusoidal behavior: $\theta_{ch} = \theta_0 + \Delta\Phi * \sin(\Phi_{ch}) + \Delta\lambda * \sin(\Phi_{ch})$

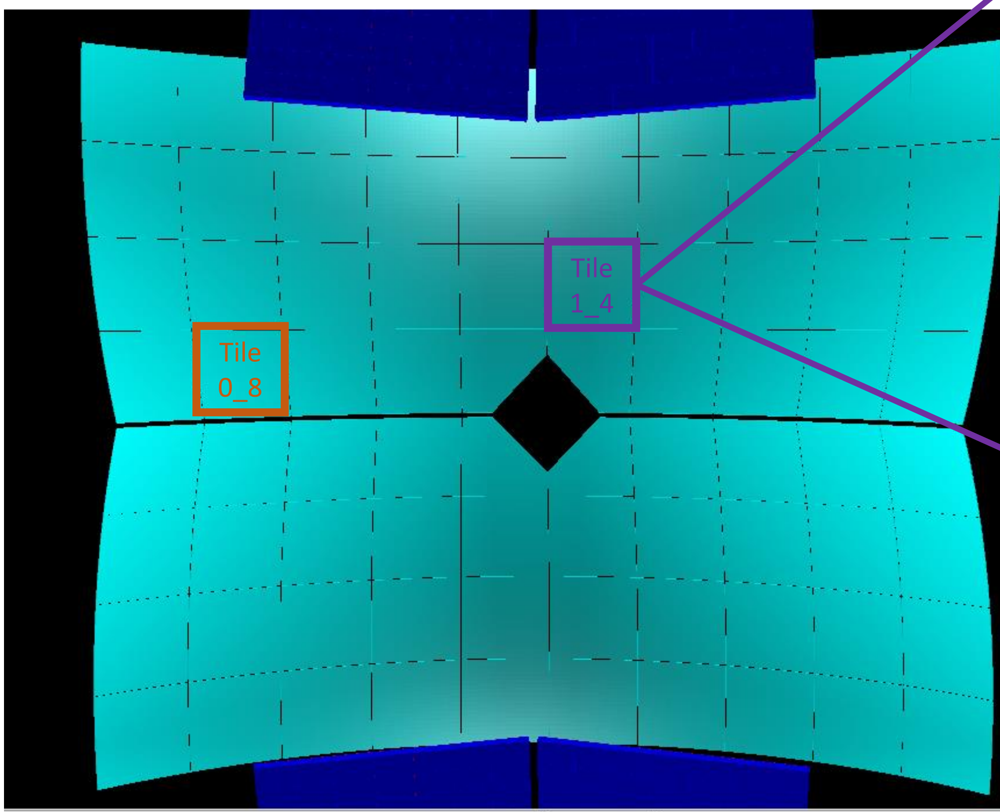


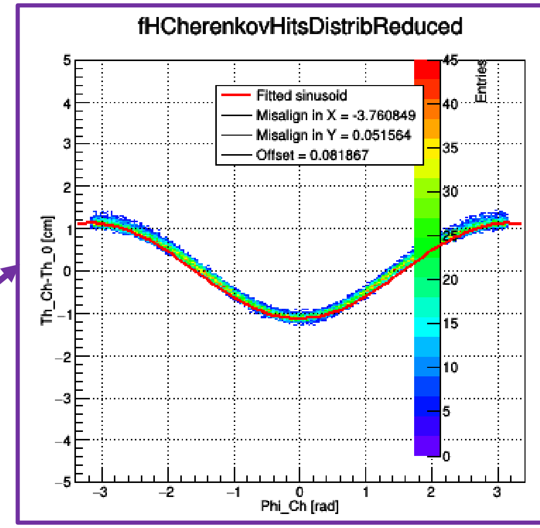


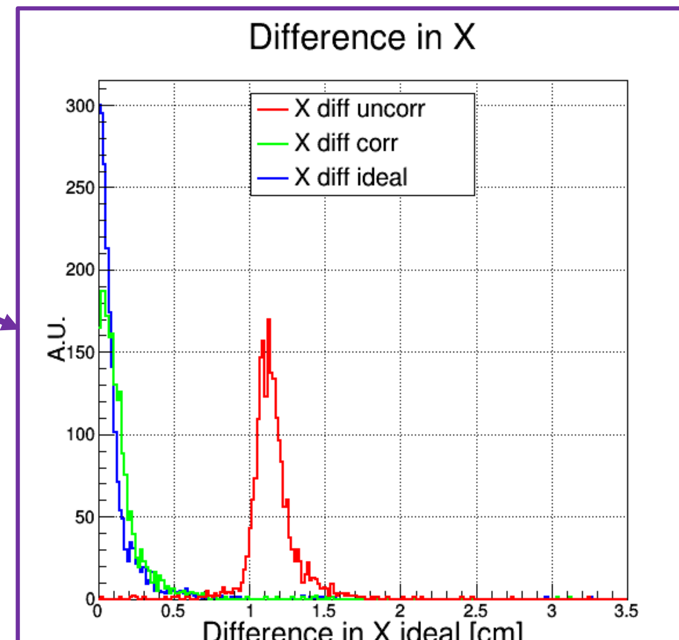
* Developed by the HERA-B experiment – Nucl. Instr. Meth. Phys. Res. A 433 (1999) 408

Method efficiency

- Method is working
- Study its accuracy, depending on the mirror wall position
    - Misalignments applied around vertical and horizontal axes for different mirror tiles
    - Study for central and outer tiles
    - Range of rotation values: 0.1; 0.2; 0.3; …; 2; 3; 4; 5 mrad

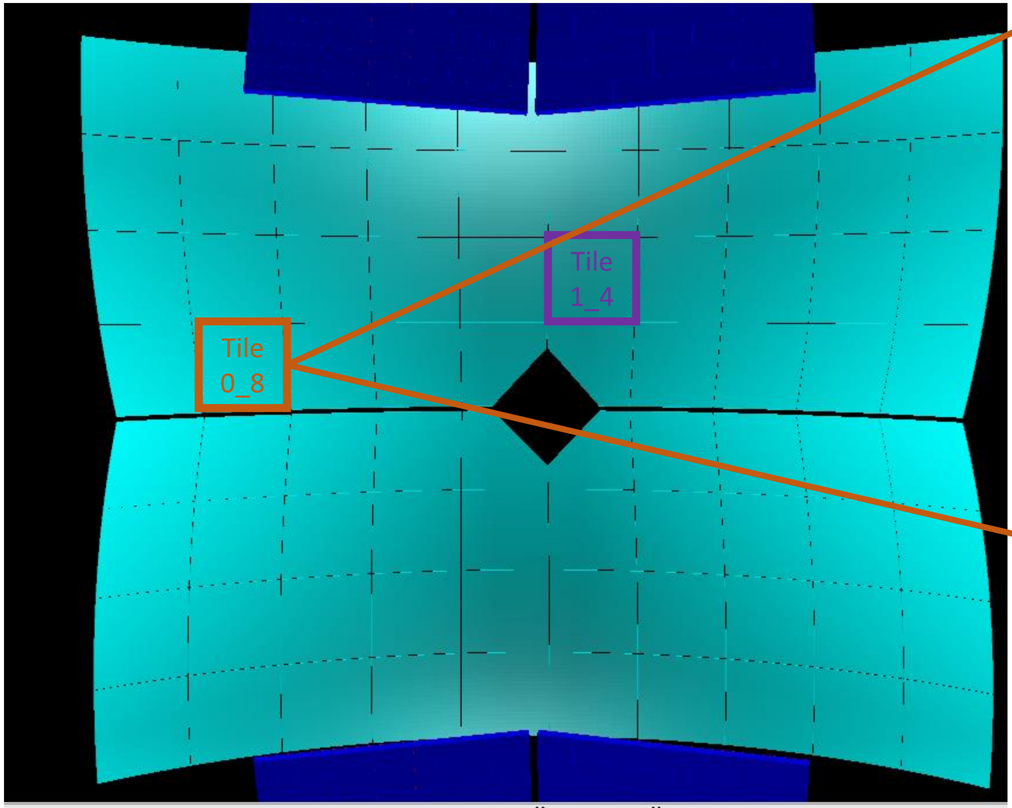


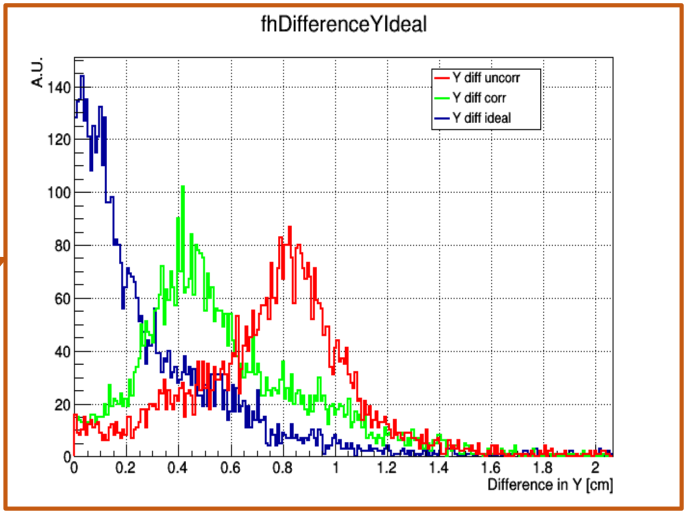


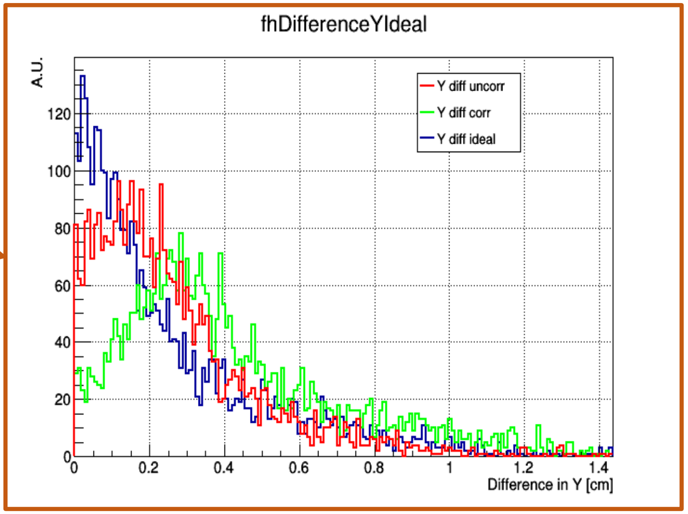


Method efficiency

- Method is working
- Study its accuracy, depending on the mirror wall position
  - Misalignments applied on central and outer tiles
  - Values range: [0.1; 0.2; 0.3; …; 2; 3; 4; 5]

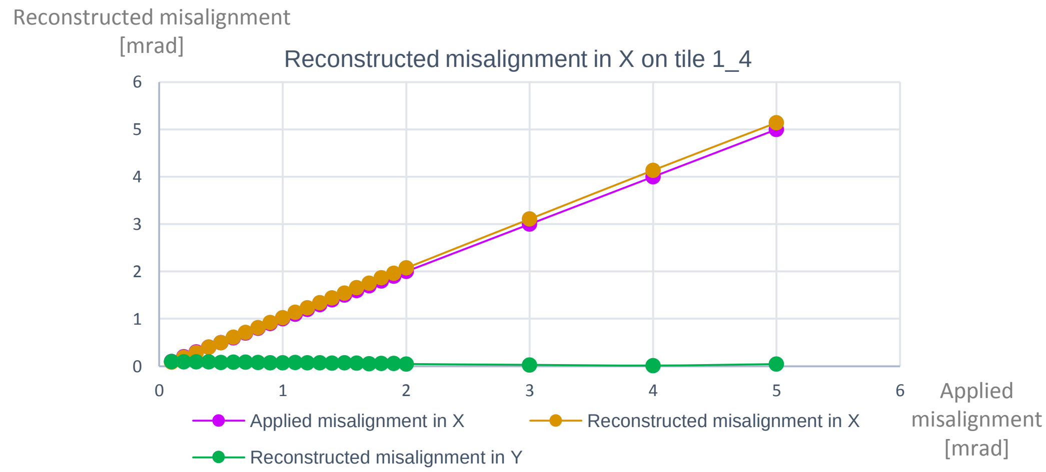


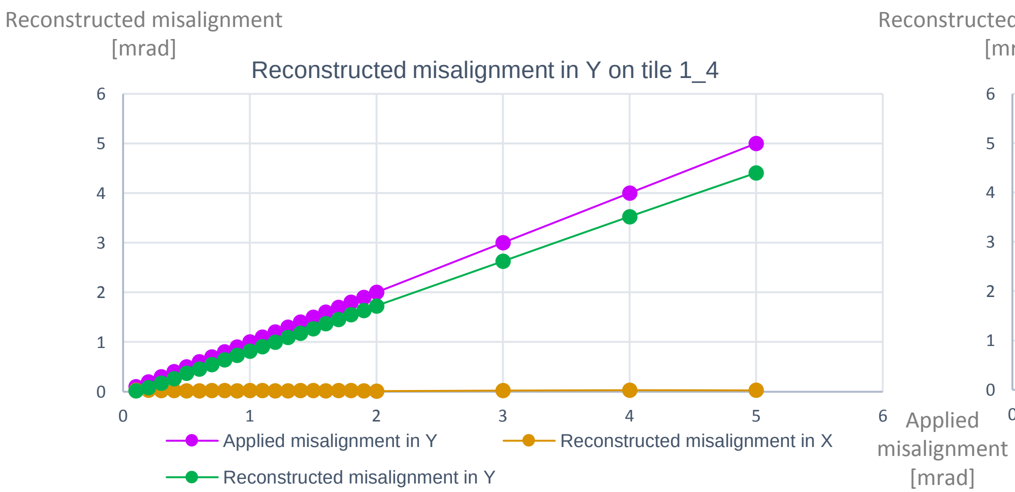


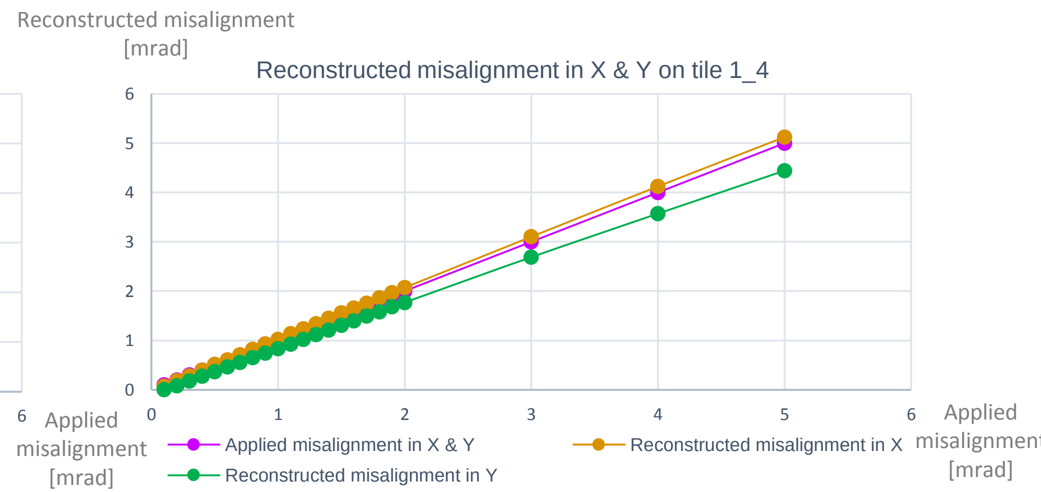


Mirror wall position study – central region

- Misalignments applied on central tile
  - Rotations around one axis
  - Rotations around both axes
- Color code:
  - Applied misalignment: purple
  - Reconstruction in X: orange
  - Reconstruction in Y: green
- Correction for central tiles yields good results

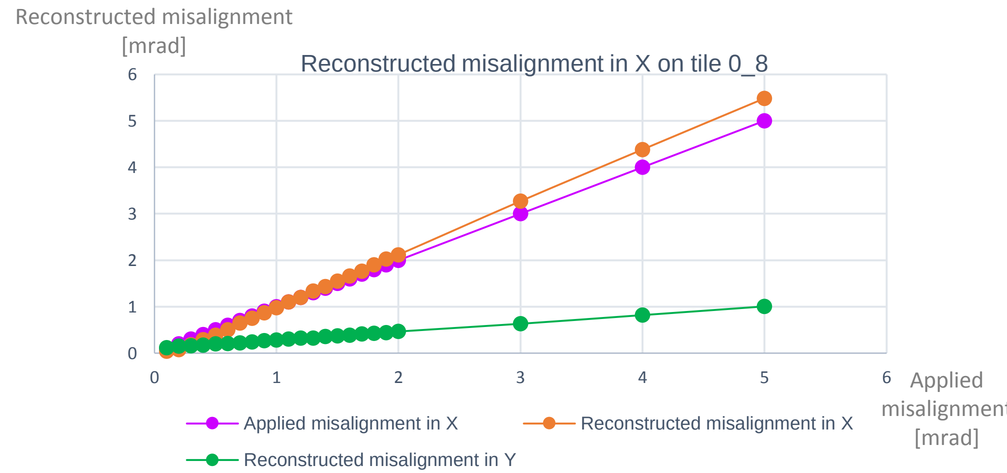


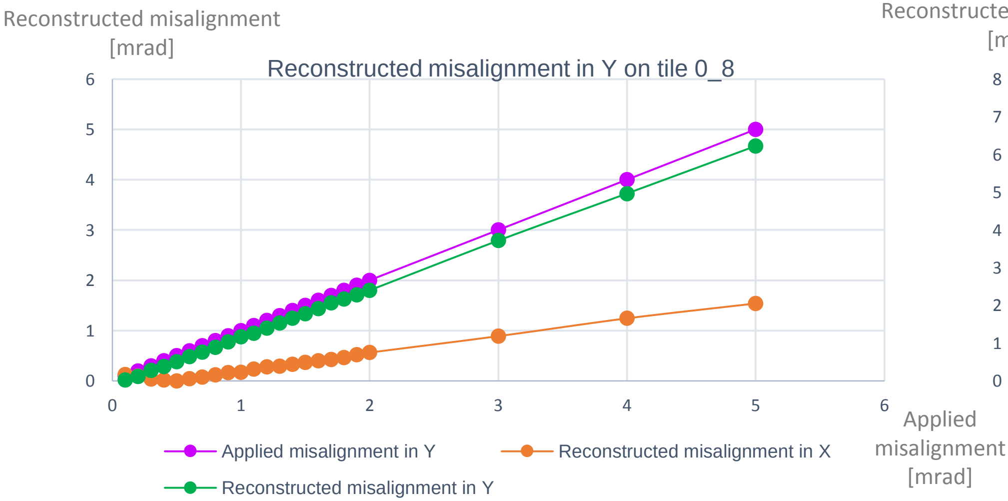


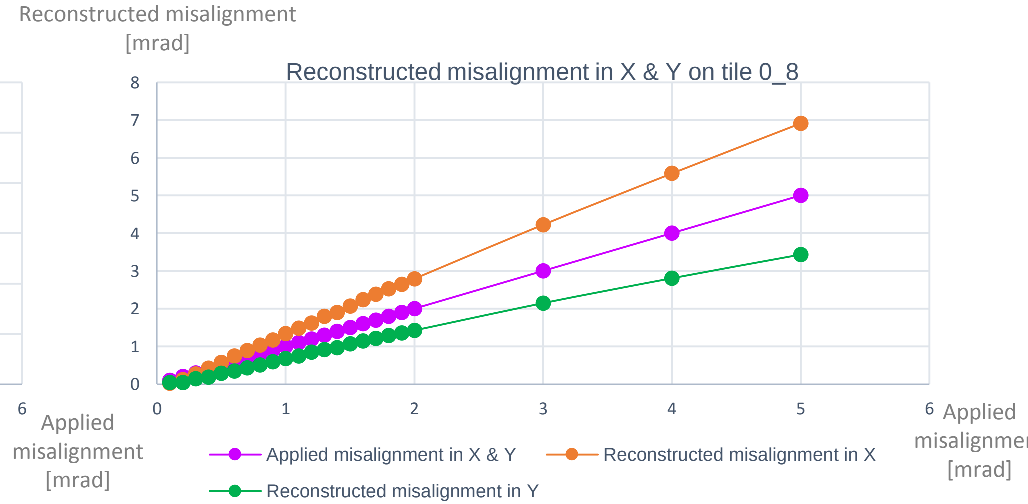


Mirror wall position study – outer region

- Misalignments applied on outer tile
  - Rotations around one axis
  - Rotations around both axes
- Color code:
  - Applied misalignment: purple
  - Reconstruction in X: orange
  - Reconstruction in Y: green
- Correction for outer tiles carries an increasing error
  - Due to detector geometry

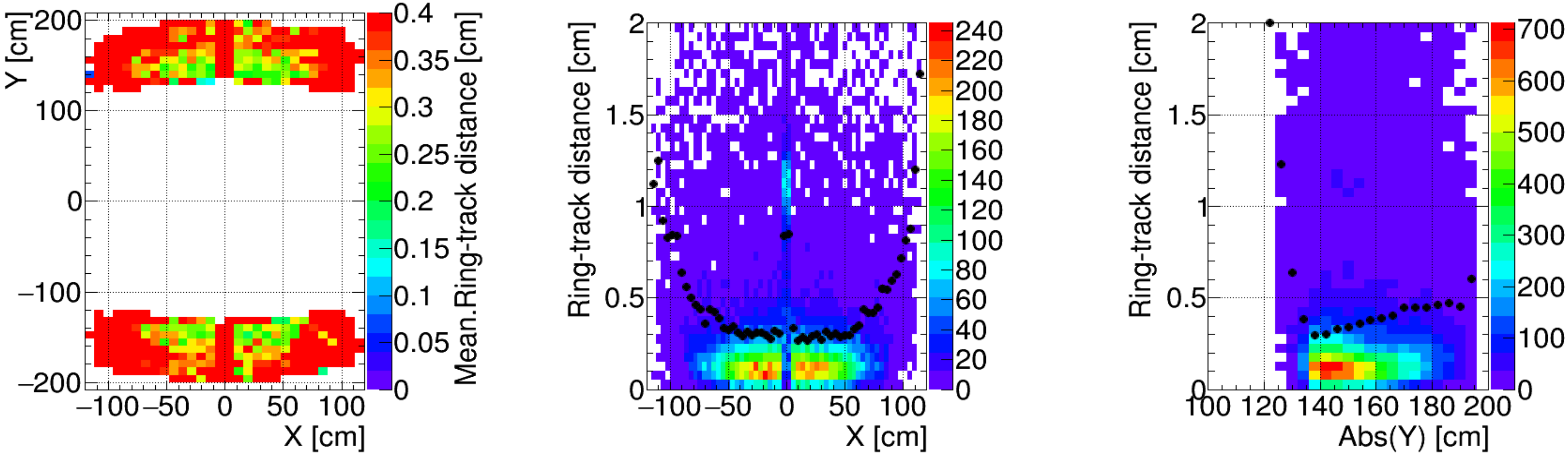






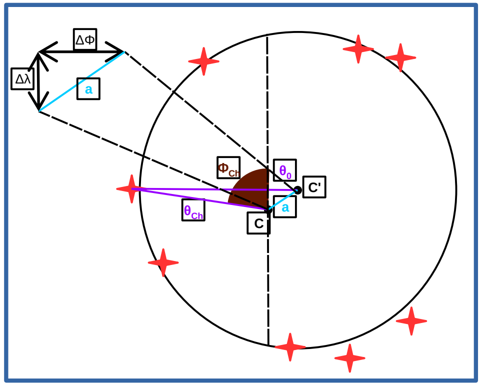
Mirror wall position study – outer region

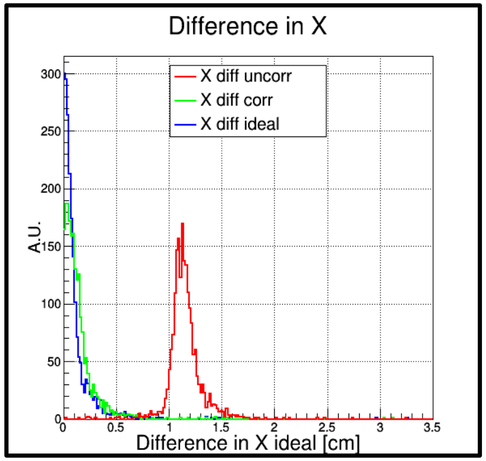
- More on problem appearing in the outer region
- Due to detector geometry
- Mean Ring-Track distance study
  - Larger in the outer region
  - Limiting factor for the corrections

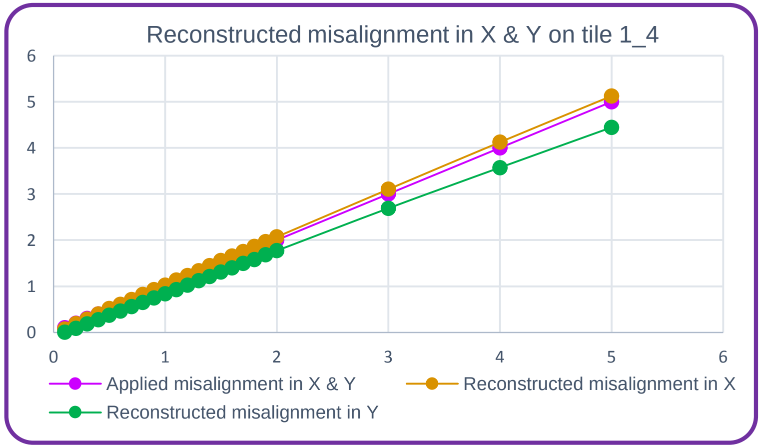


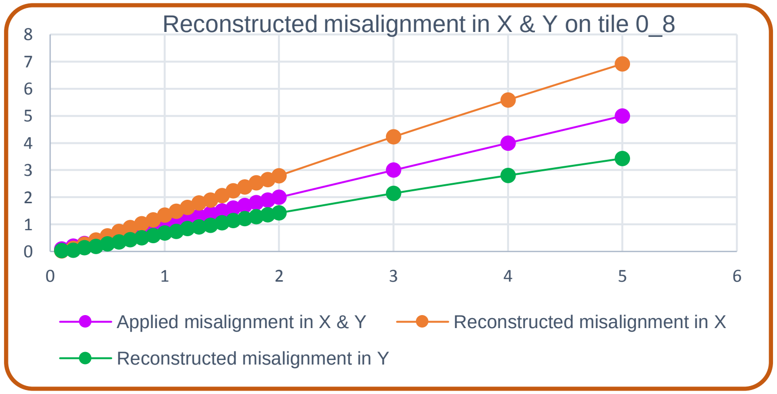
Outline

- Method established and performances studied
- Presentation of the full correction cycle
- Study of the correction technique efficiency depending on the mirror wall position
  - Discrepancy between two cases studied
  - Investigation for the outer region shown
- Study the distribution of Ring-Track distance on the PMT plane
- Study impact of correction cycle on ring-track matching efficiency









Thank you for your attention