Alignment of small and large MDT chambers with tracks

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Muon Software Workshop, Ringberg, 31.03.2006

Scope of the “Alignment with Muon Tracks”

- Many muon chambers don’t have projective optical alignment sensors – no full chamber position measurement for them
  - small barrel chambers
  - BEE chambers
  - BIS8 chambers
- Tracks passing through overlaps between these chambers and optically aligned chambers must be used to obtain their relative positions – a dedicated alignment service is needed
- Input to such alignment service: muon calibration data stream from LVL2 trigger (muon digits within LVL1 RoI)
- Output of the alignment service: data for tracking projective “pseudo” sensors to be used in global refit of optical + tracking data by ASAP/ARAMyS

Design considerations for “Alignment with Muon Tracks”

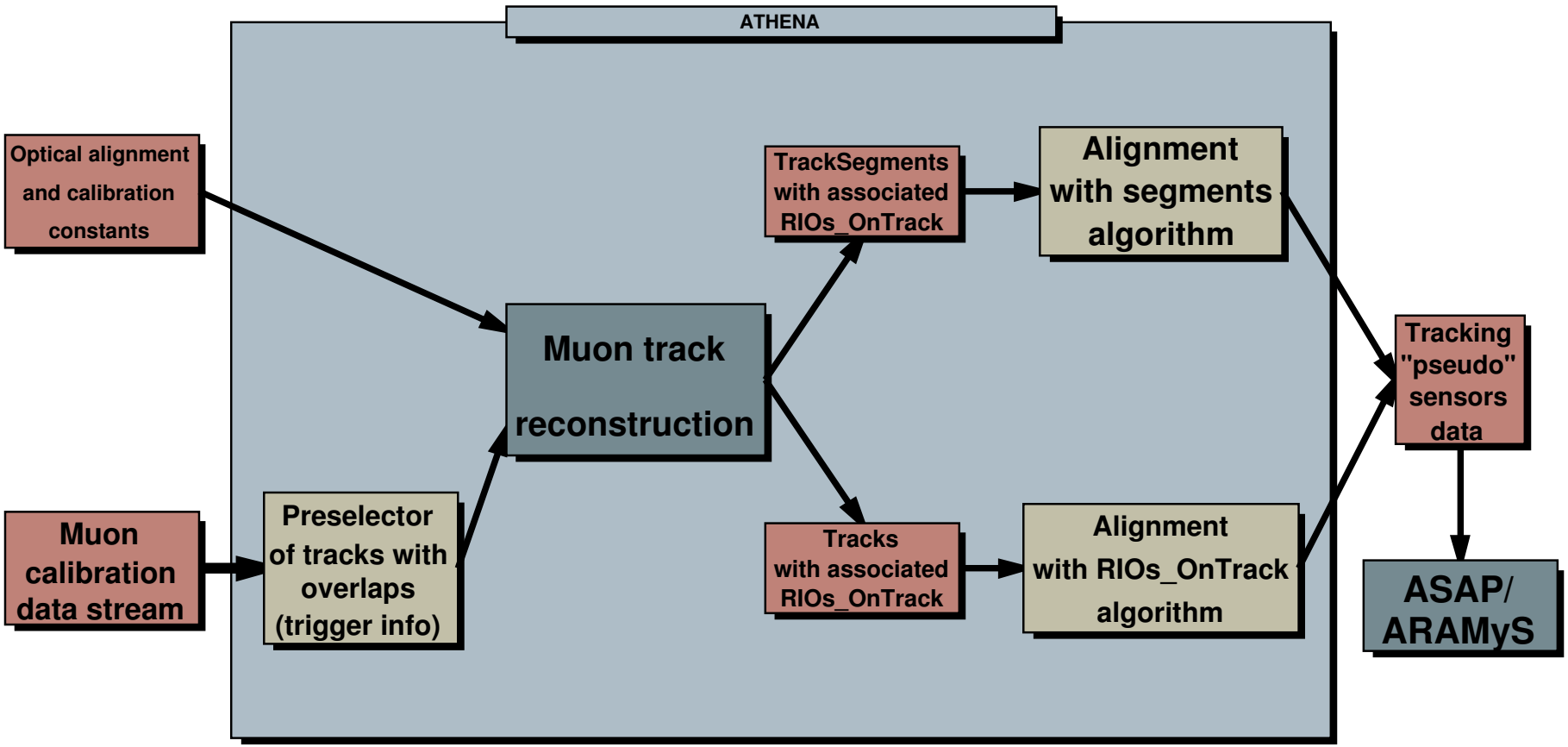
Core features:

- It should be an algorithm within ATHENA framework
- This algorithm should make full use of new tracking EDM (be able to run on both Mounboy and MOORe output)
  - operate with TrackSegments, RIO_OnTrack data objects
  - use TrackFitters, TrackExtrapolaters and other common tracking tools
- Optical alignment and calibration constants accessed via Conditions Database

Additional features:

- Possibility for later inclusion of the alignment of Muon Spectrometer with respect to Inner Detector
- Access to local optical alignment and calibration databases, if needed (bypassing the Conditions Database)

Data flow in “Alignment with Muon Tracks”



- “alignment with RIO_OnTrack” is a universal algorithm
- “alignment with segments” has specific use cases:
  - runs with magnetic field off
  - “very misaligned detector” scenario at start-up

“Alignment with RIOs_OnTrack” algorithm

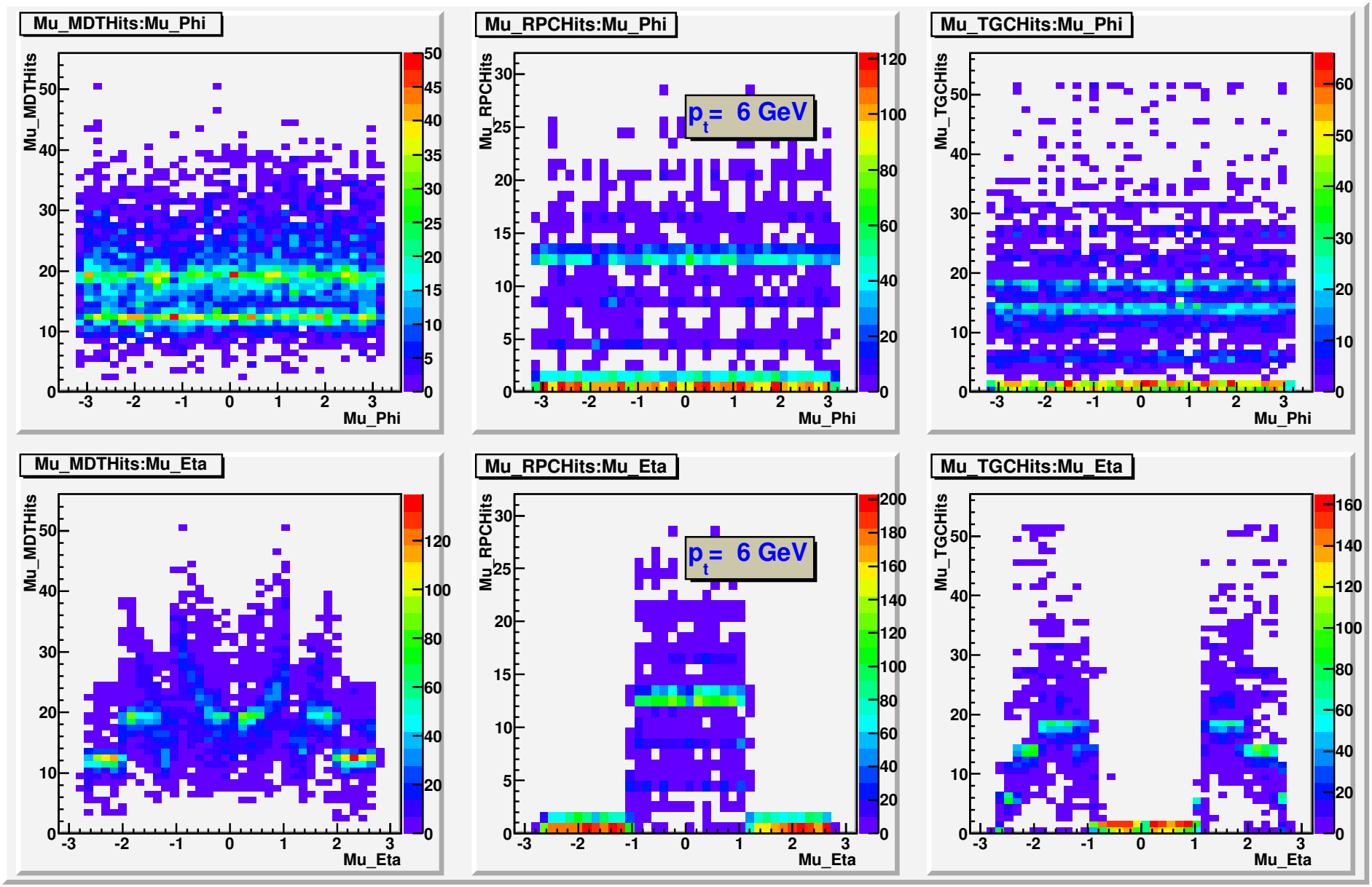
- select an overlap region Track with associated RIOs_OnTrack collection from standard muon reconstruction
- devide this collection into two parts: RIOs_OnTrack coming from large chambers and RIOs_OnTrack coming from small chambers
- refit the “large chambers” RIOs_OnTrack collection with TrackFitter from common tracking tools, using original track as a seed
- extrapolate this “large chambers” track into small chambers with TrackExtrapolater and get track’s extrapolated parameters
- further devide “small chambers” RIOs_OnTrack collection into collections of RIOs_OnTrack for each small chamber separately
- refit these individual small chamber RIOs_OnTrack collections with TrackFitter, using extrapolated “large chambers” track parameters as seeds
- differences between the refitted individual small chamber tracks and the extrapolated “large chambers” track are the tracking “pseudo” sensors output for ASAP

Study of rates of muon tracks with overlaps

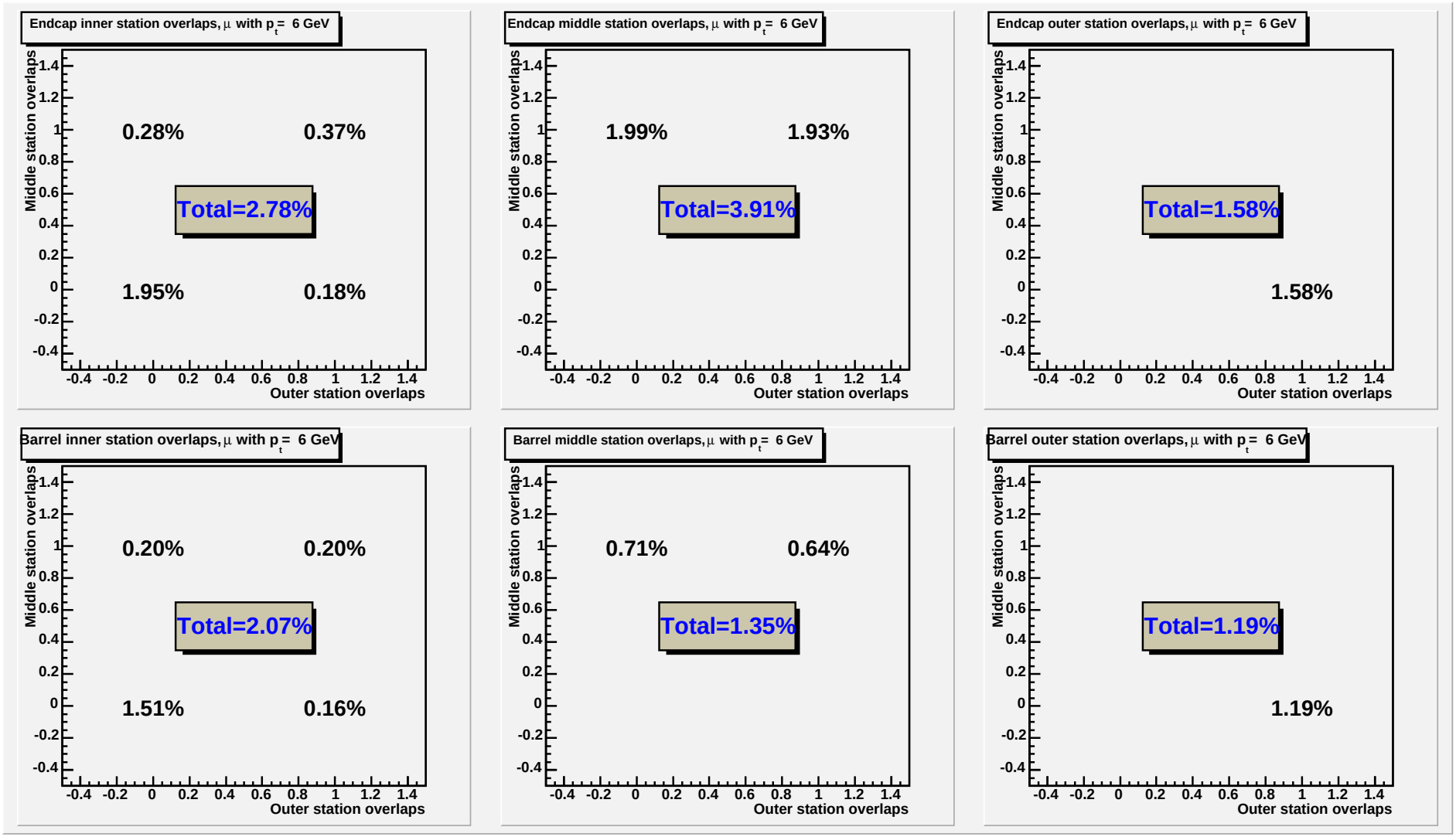
How many reconstructed muon tracks pass through overlapping regions of small and large chambers?

- MC samples produced by N. Benekos with 11.0.4 release (layout Q)
- Muons with p_t of 6, 20, and 100 GeV flatly distributed over η and ϕ
- Muon tracks are reconstructed by Muonboy with default settings
- Overlaps counting: muon track has at least 3 hits in adjacent small and large chambers

Muon track hit multiplicities: $p_t = 6$ GeV

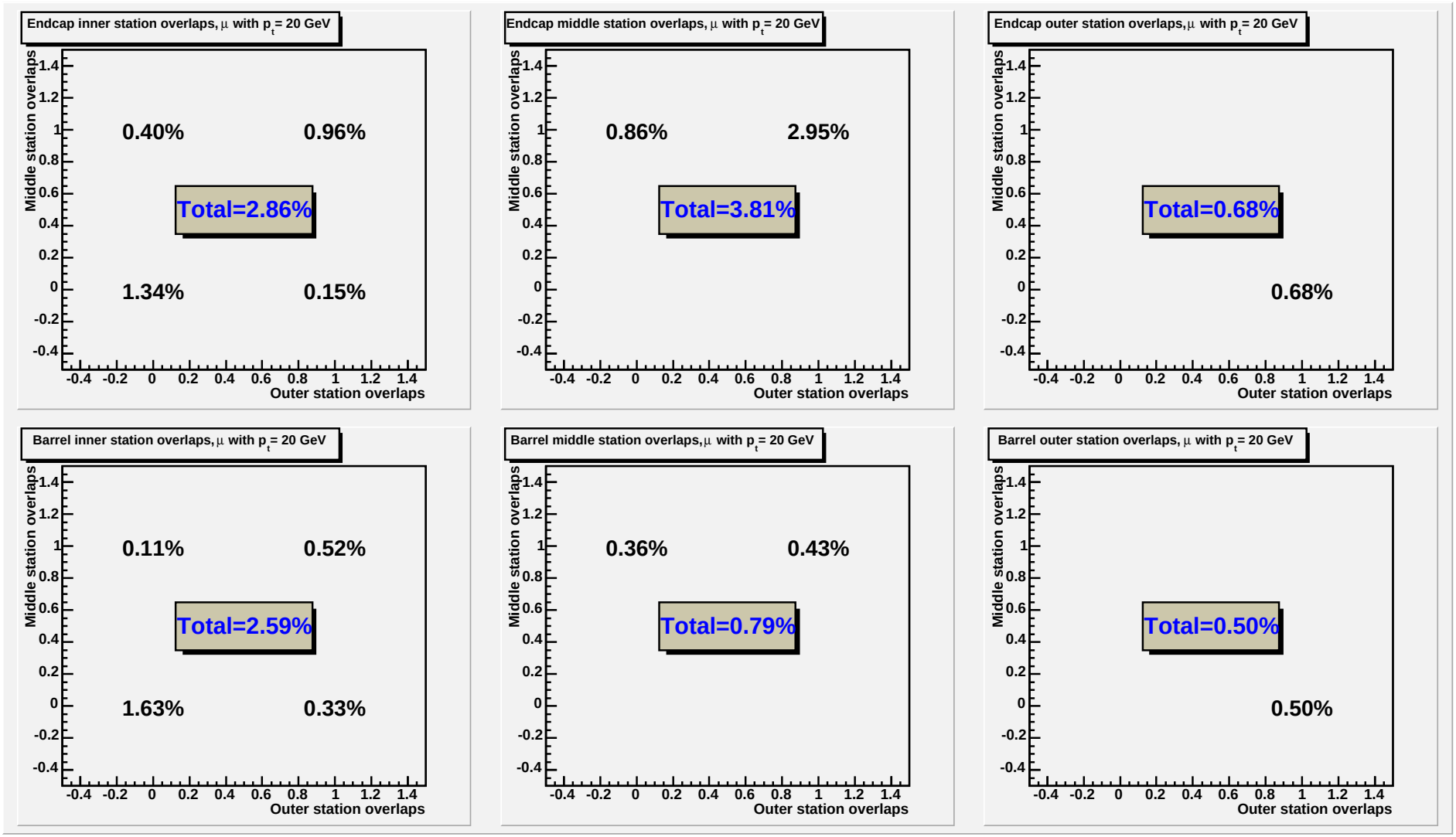


Rate of muon tracks with overlaps: $p_t = 6$ GeV



- $\sim 4.6\%$ of barrel and $\sim 8.3\%$ of endcap muon tracks with $p_t = 6$ GeV have overlaps

Rate of muon tracks with overlaps: $p_t = 20$ GeV



- $\sim 3.9\%$ of barrel and $\sim 7.4\%$ of endcap muon tracks with $p_t = 20$ GeV have overlaps

Summary

Main tasks for “Alignment with Muon Tracks”

- Code development of the “alignment with RIO_OnTrack” algorithm
- Preselector of tracks with overlaps and trigger issues
  - mapping of LVL1 trigger RoI to overlap regions?
  - using Mu2CTP overlap bit?
- Code development of the “alignment with segments” algorithm
- Tools for monitoring and validation of tracking “pseudo” sensors data

Rate of muon tracks with overlaps

- assuming flat distribution of muon tracks in η and ϕ, $\sim 4\%$ of barrel and $\sim 8\%$ of endcap tracks will have overlaps in adjacent small and large chambers
- with 2 kHz trigger rate for muon calibration data stream this means 30k of track with overlaps per small barrel chamber and 60k per small endcap chamber per day $\Rightarrow$ alignment with segments might be doable