Impact of ID and MS Misalignments on Z' Analysis

Antonio Salvucci, Claudio Gatti
Tor Vergata University, Roma
Laboratori Nazionali di Frascati, INFN

INFN
Istituto Nazionale
di Fisica Nucleare

Outline

- ID & MS Misaligned Geometry Tag
- Reconstruction Method from RDO files
- Impact on momentum resolution
- Impact on track and trigger efficiency
- Impact on selection
- Conclusions

ID & MS Misaligned Geometry Tag

MS → a misalignment of o(500 μm) on MS chambers (shifts and rotations)

ID → curl (charge asymmetry) weak mode.

For curl deformation, 2 terms are introduced:

$$\Delta\Phi = c_1 R + \frac{c_2}{R}$$

Leading to bias in curvature and thus reconstructed track transverse momentum

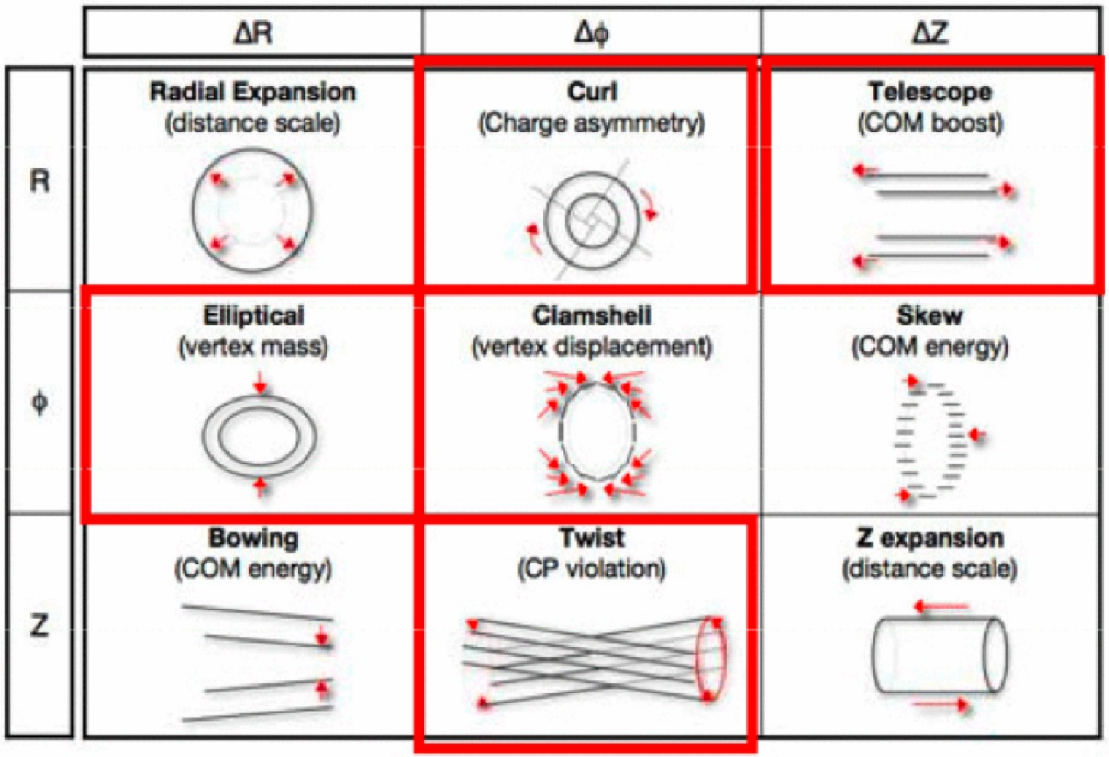
causing a Φ-dependent shift of the reconstructed perigee positions and thus a possible performance loss in reconstructing primary and secondary vertices.

A constant error on track sagitta

2 types of curl deformations:

Curl-Large → with maximum SCT Mod. Shift of 250 μm

Curl-Residual → obtained running alignment procedure on Curl-Large



Reconstruction Method from RDO files

This study was performed with a small Z' → μμ dataset of 1250 events

mc08.105601.Pythia_Zprime_mumu_SSM1000.digit.RDO.e352_s462_d126_tid026144

For reconstruction we used:

Athena: 14.2.25.6 (r617)

Job-tranform: csc_reco_trf.py with a properly modified skeleton.csc_esd.py

RunArgs: ConditionsTag = OFLCOND-SIM-00-00-06, GeometryVersion = ATLAS-GEO-02-01-00, DBRelease = DBRelease-6.5.1, JobConfig = SetJetConstants-02-000.py, TriggerConfig = lumi1E31_no_Bphysics_no_prescale

Misaligned geometry tag loading (lines added to skeleton.csc_esd.py)

ID Geometry

```
siOverride = 'InDetSi_CSCMisaligned_RDeltaPhi_03'          #04 for Cur-Residual, 03 for Curl-Large
trtOverride = 'InDetTRT_CSCMisaligned_RDeltaPhi_03'        #04 for Cur-Residual, 03 for Curl-Large
from IOVDbSvc.CondDB import conddb
include ("DetDescrCondAthenaPool/DetDescrCondAthenaPool_joboptions.py" )
conddb.addOverride('/Indet/Align', siOverride)
conddb.addOverride('/TRT/Align', trtOverride)
```

MS Geometry

```
from MuonGeoModel.MuonGeoModelConf import MuonDetectorTool
MuonDetectorTool.OutputLevel = VERBOSE
MessageSvc.setDebug+=["MGM::MuonDetectorManager::updateAlignment"]
ToolSvc.MGM_AlignmentDbTool.OutputLevel = DEBUG
from IOVDbSvc.IOVDbSvcConf import *
print "henri-0.5 (500 microns smearing)"
conddb.addFolder("MUONALIGN","/MUONALIGN/MDT/BARREL<tag>MuonAlignMDTBarrelAlign-SIMU-0004</tag>")
conddb.addFolder("MUONALIGN","/MUONALIGN/MDT/ENDCAP/SIDEA<tag>MuonAlignMDTEndCapAAlign-SIMU-0004</tag>")
conddb.addFolder("MUONALIGN","/MUONALIGN/MDT/ENDCAP/SIDEC<tag>MuonAlignMDTEndCapCAlign-SIMU-0004</tag>")
```

Impact on p_T resolution (Inner Detector)

Geometry tags considered in this study are:

Ideal alignment	MS500	Curl-Residual
Curl-Large	MS500+Curl-Residual	MS500+Curl-Large

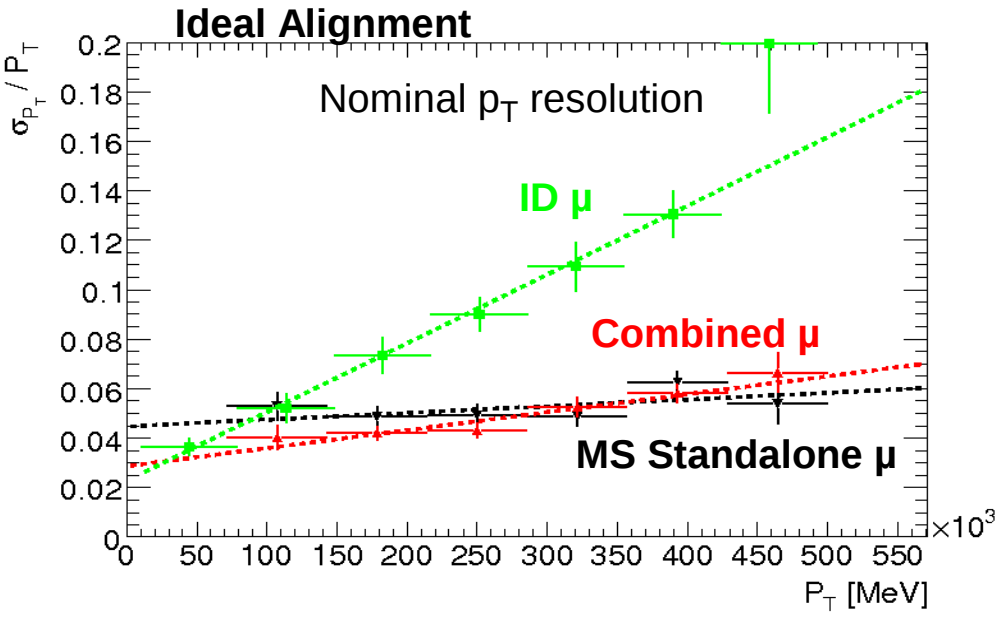
The resolutions are estimated by fitting with a Gaussian function the residual distribution $p_T^{reco} - p_T^{true}$ for several vaules of p_T^{true} , in a region within +- rms around the mean value.

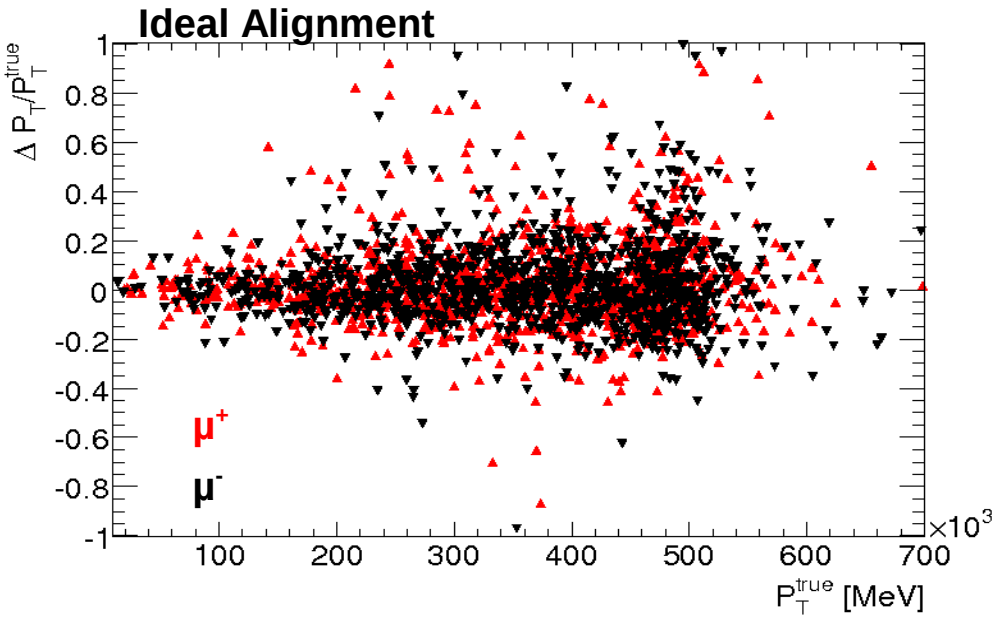
We have considered only muons with $|\eta|<2.5$ and $p_T>20 \quad GeV$

The matching between true MC muons from Z' and reconstructed tracks, is obtained by choosing the best match $\Delta R=\sqrt{\Delta\eta^2+\Delta\phi^2}$ and rejecting cases with:

$\Delta R>400 \quad mrad$ for MS standalone tracks

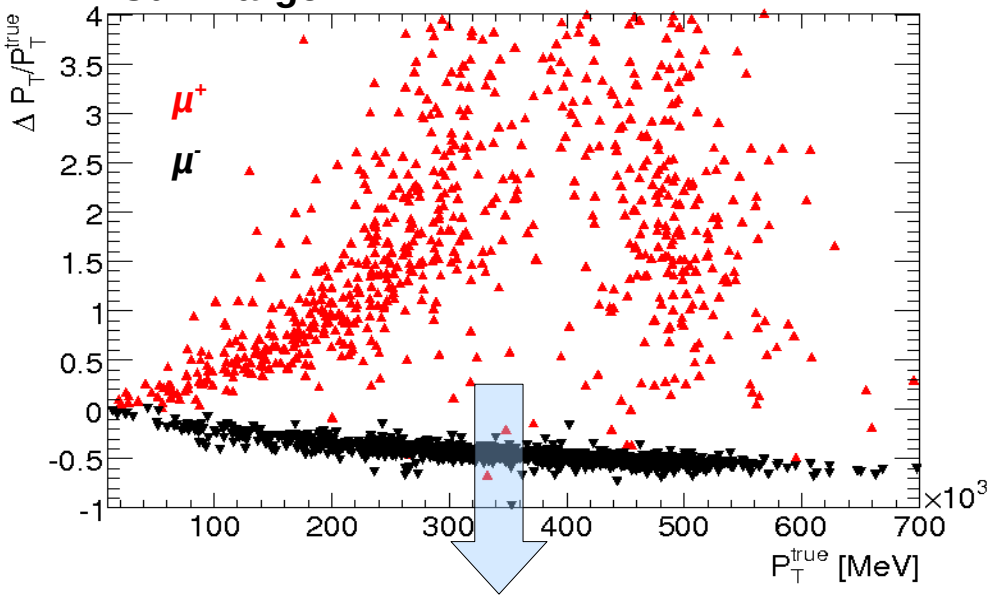
$\Delta R>50 \quad mrad$ for ID and combined tracks



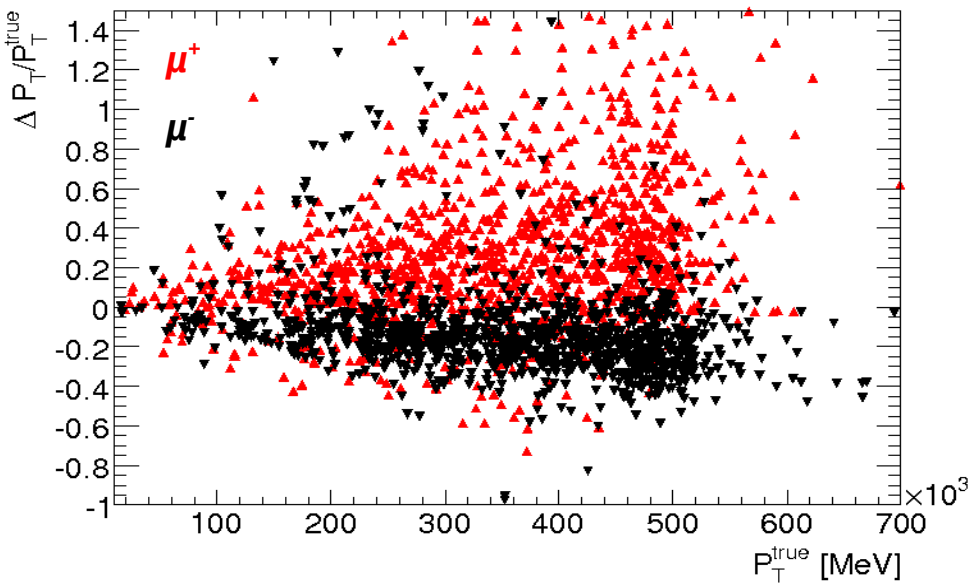


Impact on p_T resolution (Inner Detector)

Curl-Large

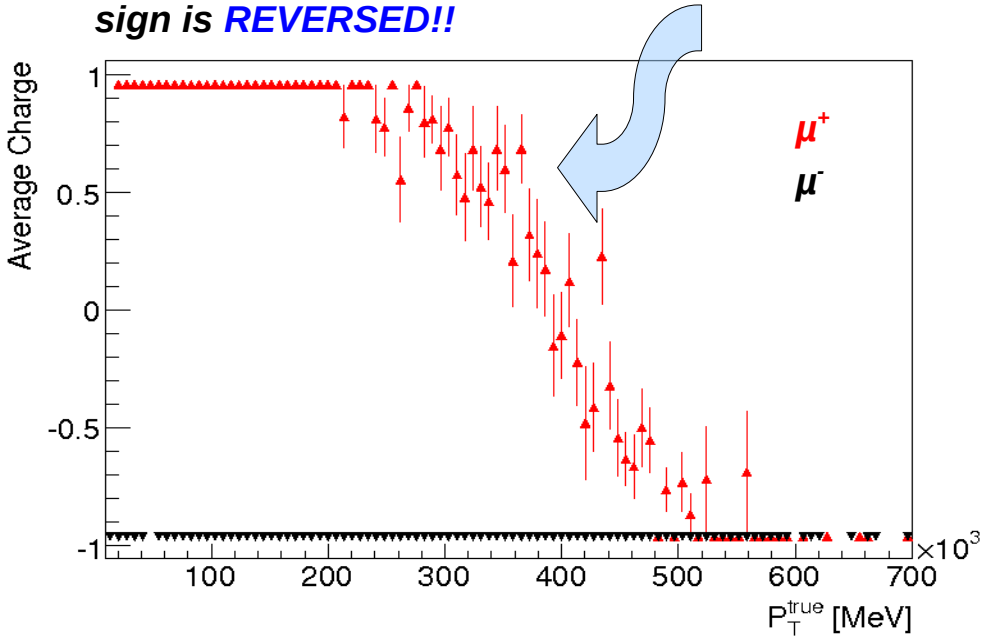


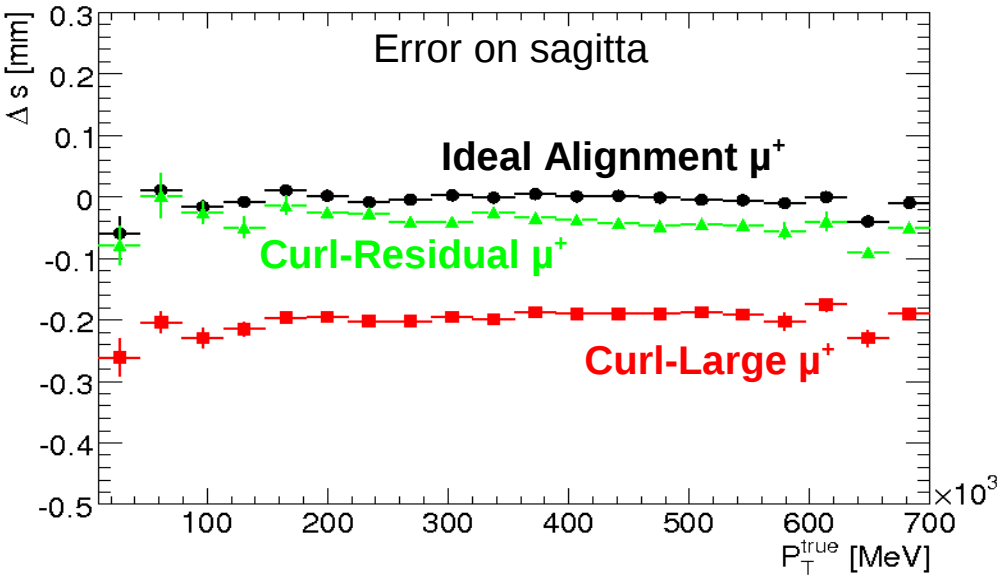
Curl-Residual



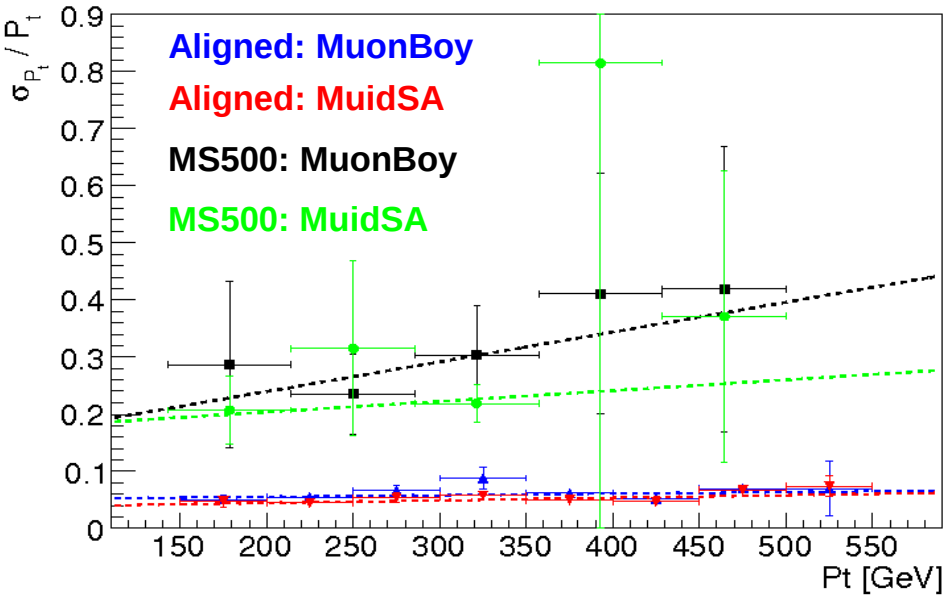
For p_T ~300 GeV for μ^+, the measured momentum goes to infinity and the charge sign is REVERSED!!

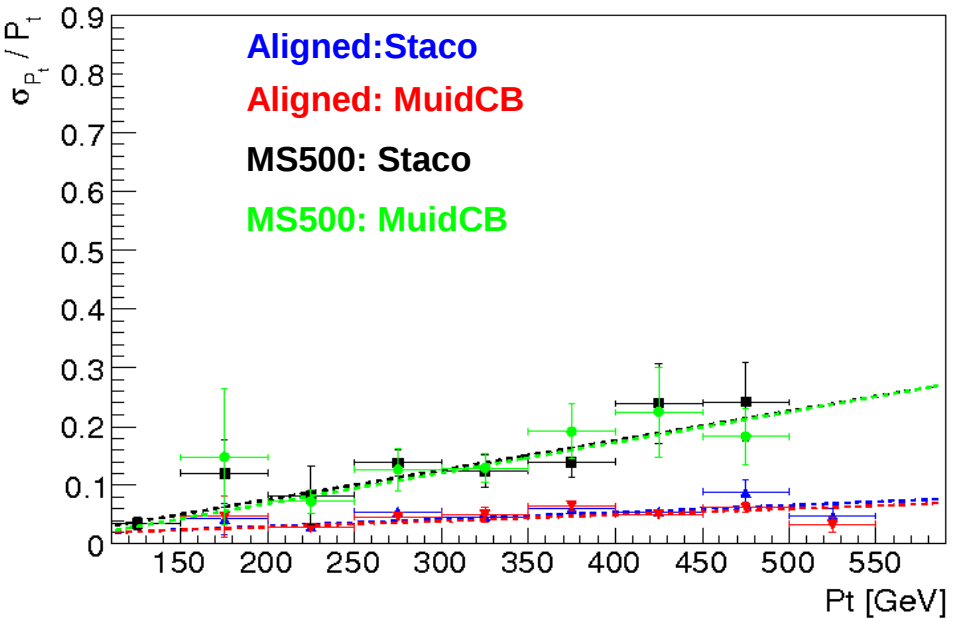
With Curl-Residual the effect of charge asymmetry is mostly recovered and error on sagitta is reduced from about 200 μm to about 40 μm.



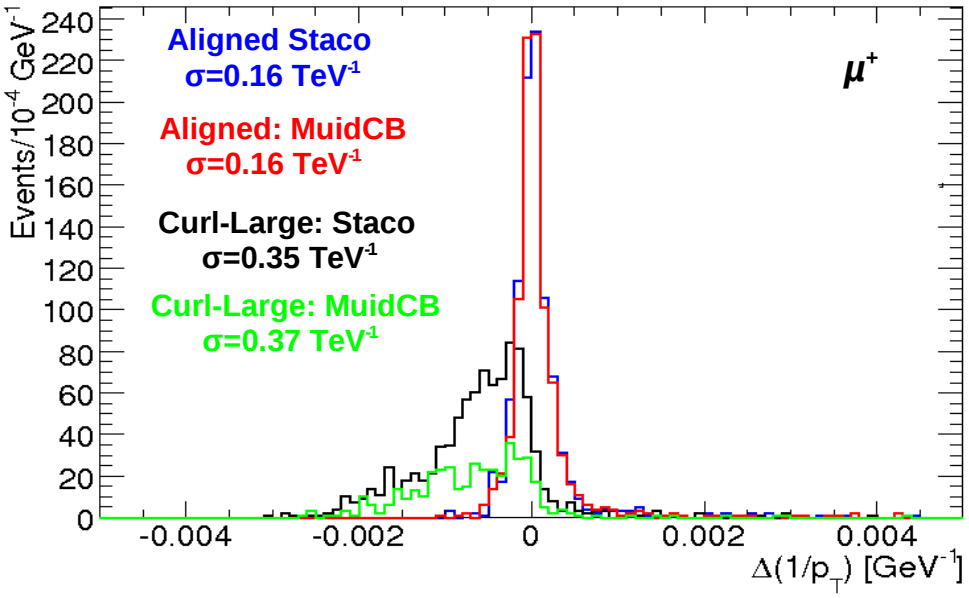


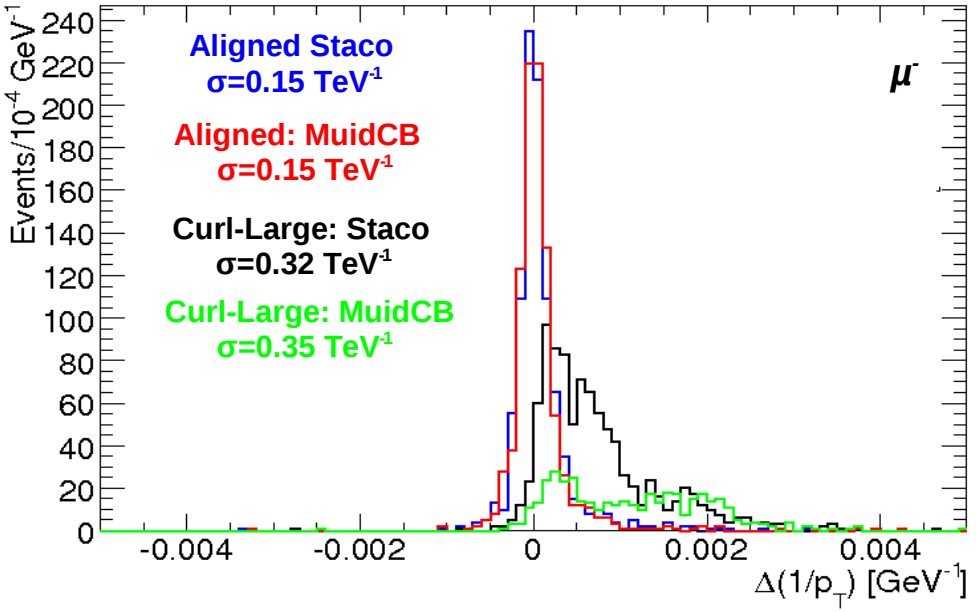
Impact on p_T resolution (Muon Spectrometer)





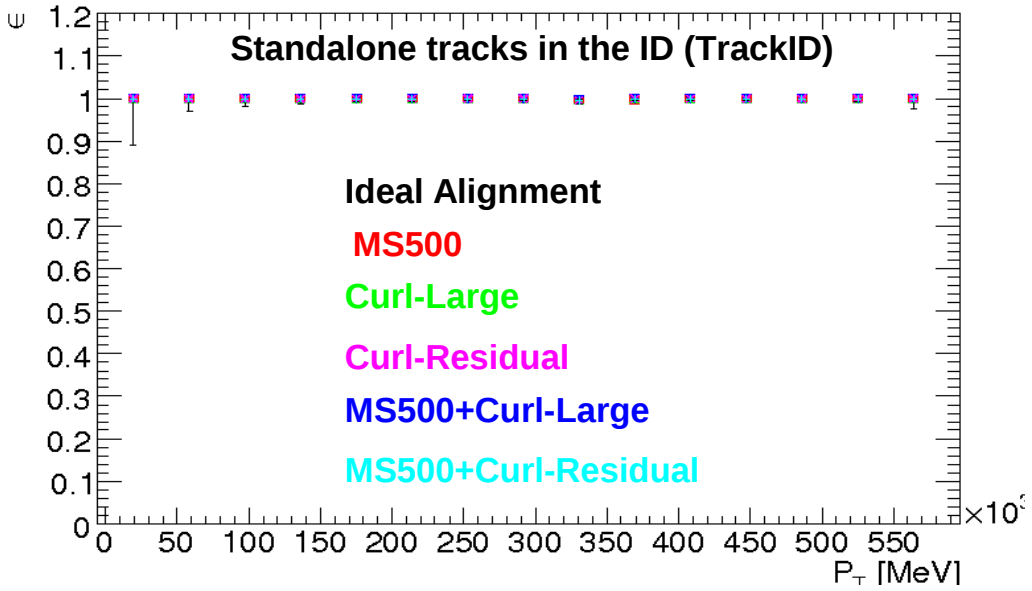
With Curl-Large geometry, the standalone is unchanged with respect to ideal alignment, while for combined the error on ID sagitta reflects on momentum resolution.

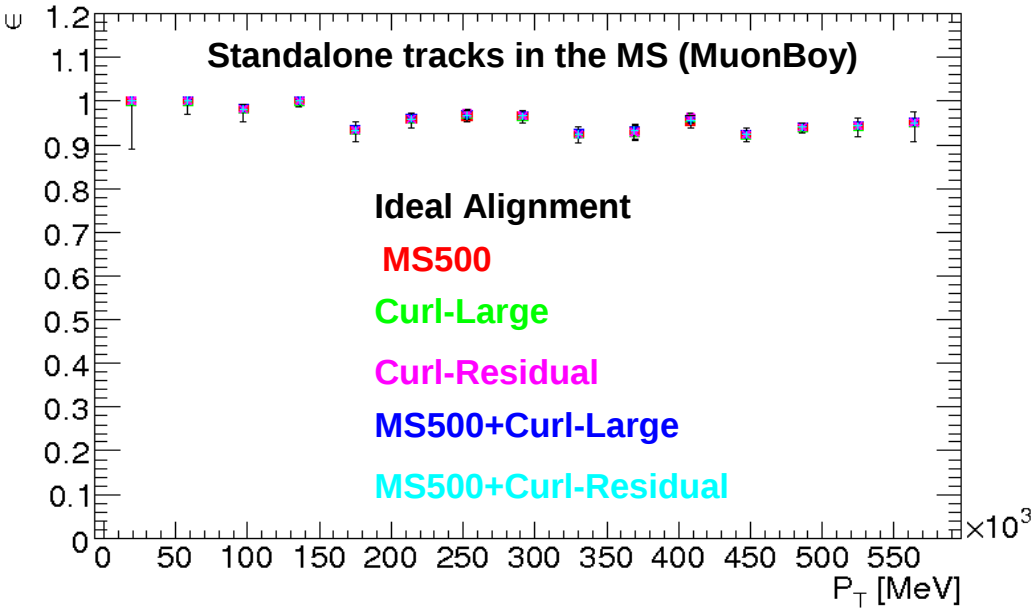


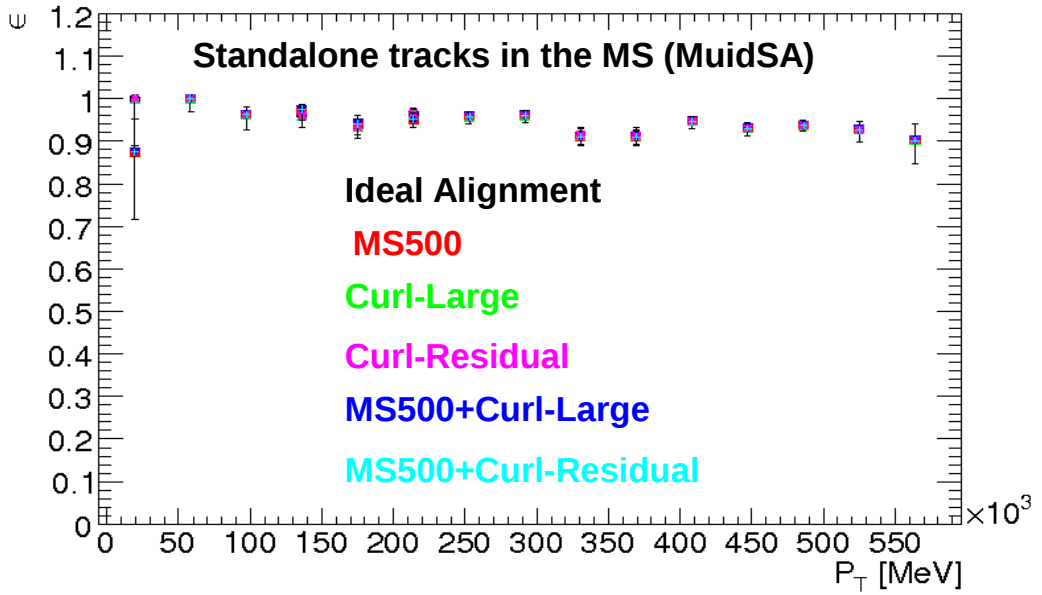


Impact on track efficiency

In the search of new physics channel it is essential to keep the *selection efficiency as high as possible.*







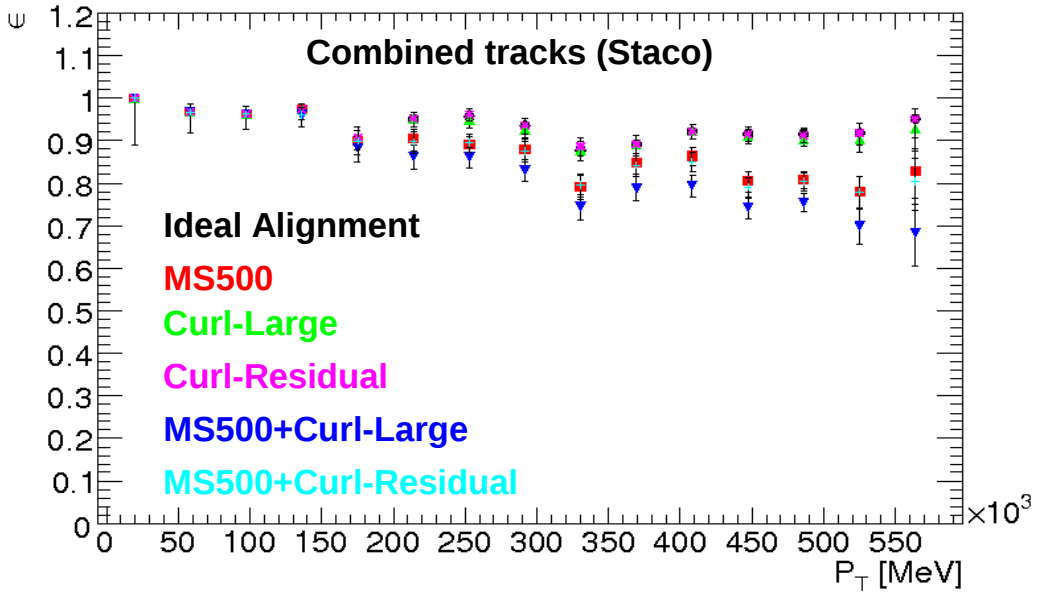
Reconstruction efficiencies are obtained by counting the fraction of true muons from a Z' matching a reconstructed track.

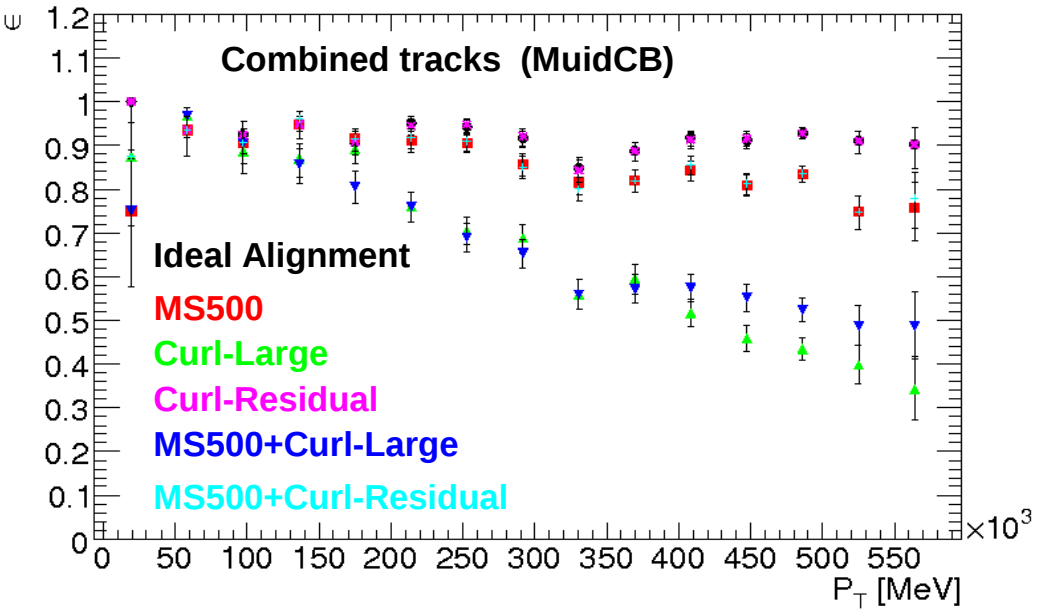
The standalone reconstruction is essentially insensitive to the even maximal misalignments considered.

Impact on track efficiency

We can see a different situation when the efficiency in combining the two tracks is considered.

In fact, in this case, reconstruction efficiencies drop to lower values at higher p_T.





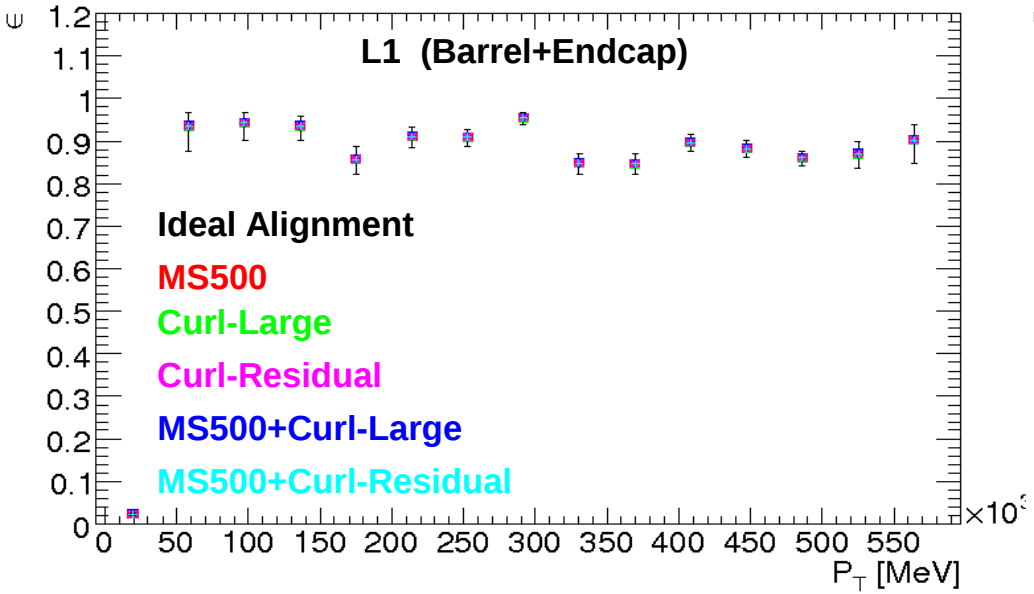
When **MS500** geometry is used, the drop in *efficiency is very similar for both Staco and MuonBoy.*

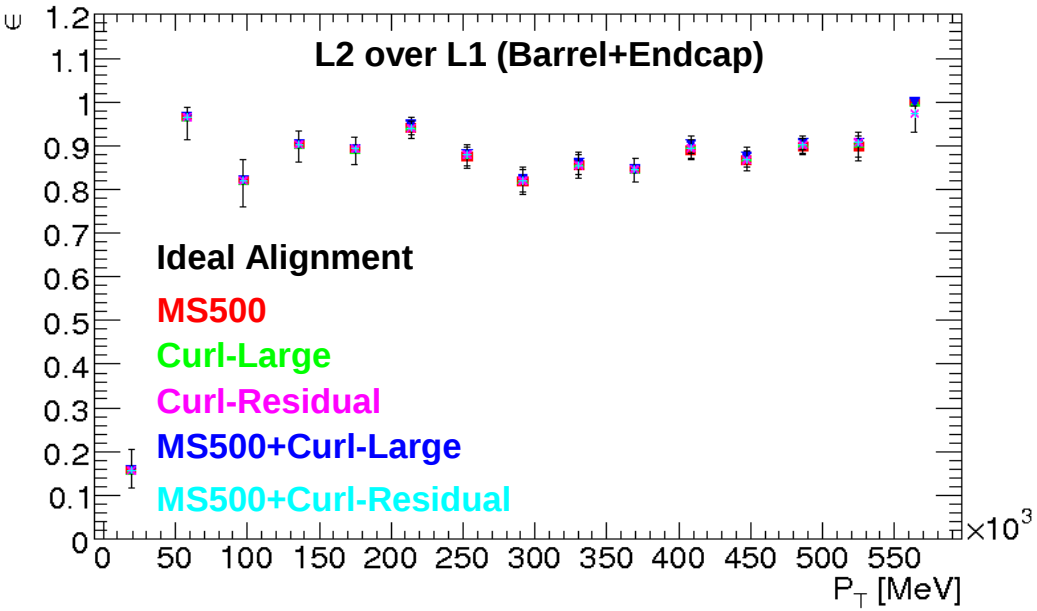
Instead, when **Curl-Large** geometry is used, the reconstruction *efficiency* for *MuidCB* algorithm *drops down to 40%*, while the *Staco* algorithm *is less sensitive*.

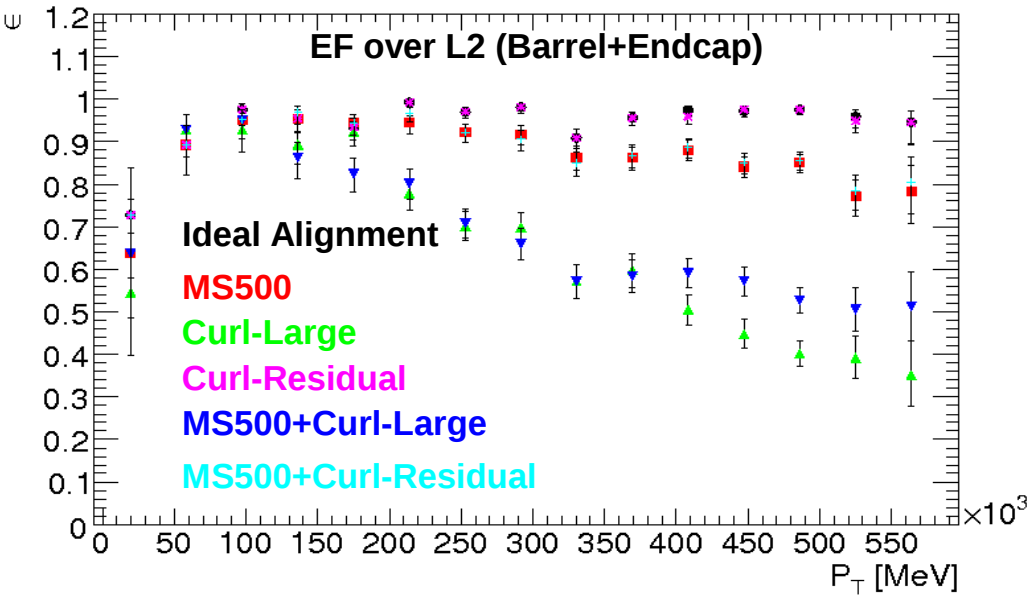
Clearly, since the standalone efficiencies are unchanged when the misalignments are introduced, this effect is due to the probability of combining the ID and MS tracks.

Impact on trigger efficiency

Since the software trigger level (EF) uses MuidCB as tracking algorithm, the impact of misalignments on track efficiency reflects on the trigger perfomance.







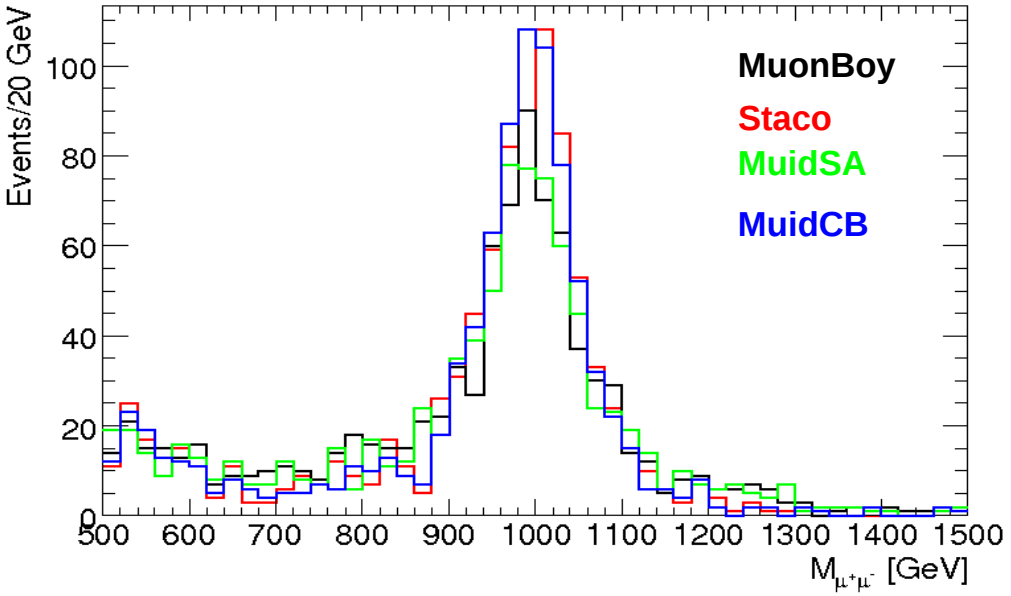
The matching between true μ and L1 ROI's or L2 and EF trigger features has been done in a way similar as done fro the track.

The size of matching cone, ΔR, has been choosen equal to 300, 100 and 50 mrad for L1, L2 and EF respectively.

While L1 and L2 are insensitive to the misalignments, the *EF level reproduce the same behavior of track efficiency observed for MuidCB algorithm*.

Impact on selection

Z' events are selected by requiring 2 reconstructed muon tracks (SA or CB), with opposite charge, $|\eta|<2.5$ and $p_T>20$ GeV. We keep all events with invariant mass within 500 and 1500 GeV and satisfying the μ20 trigger chain.

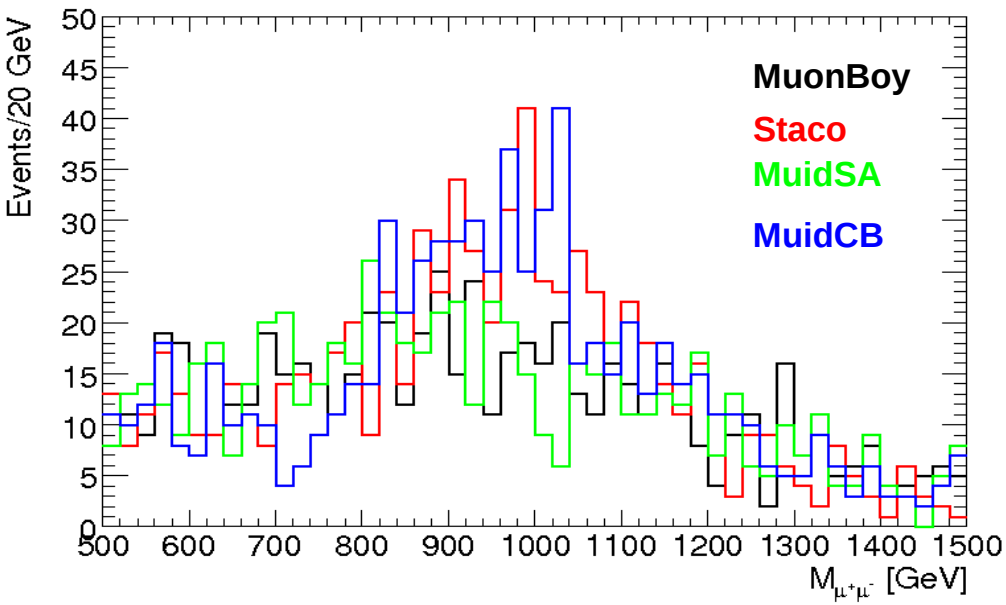


MS500

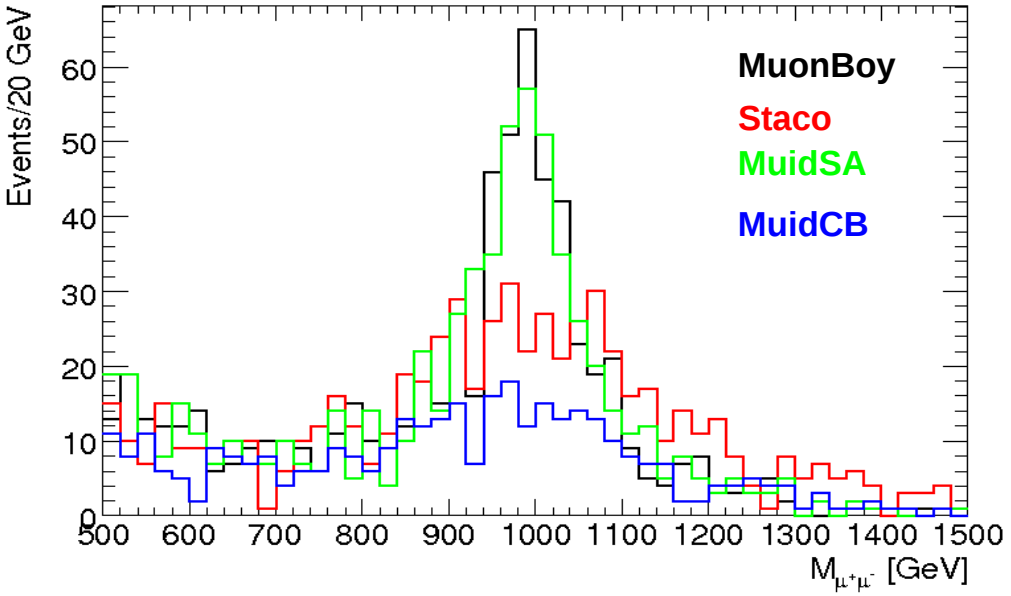
Algorithm	2 tracks	p_T cut	charge	Muu cut	trigger
MuonBoy	83.5 %	79.4 %	71.2 %	54.3 %	51.0 %
Staco	66..4 %	66.5 %	65.3 %	60.5 %	56.8 %
MuidSA	82.4 %	76.7 %	68.6 %	53.9 %	50.5 %
MuidCB	65.5 %	64.3 %	64.2 %	59.3 %	57.0 %

Ideal Alignment

Algorithm	2 tracks	p_T cut	charge	Muu cut	trigger
MuonBoy	83.9 %	80.1 %	77.9 %	72.6 %	70.1 %
Staco	77.0 %	76.2 %	76.0 %	73.8 %	71.2 %
MuidSA	82.8 %	76.8 %	75.0 %	71.4 %	68.6 %
MuidCB	75.7 %	74.8 %	74.8 %	72.6 %	70.3 %



Impact on selection

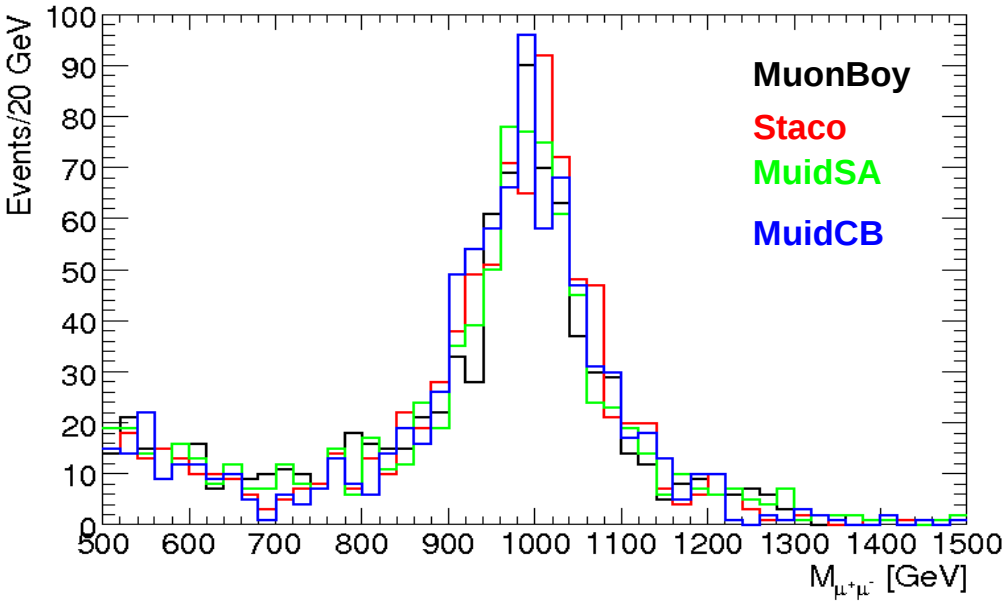


Curl-Large

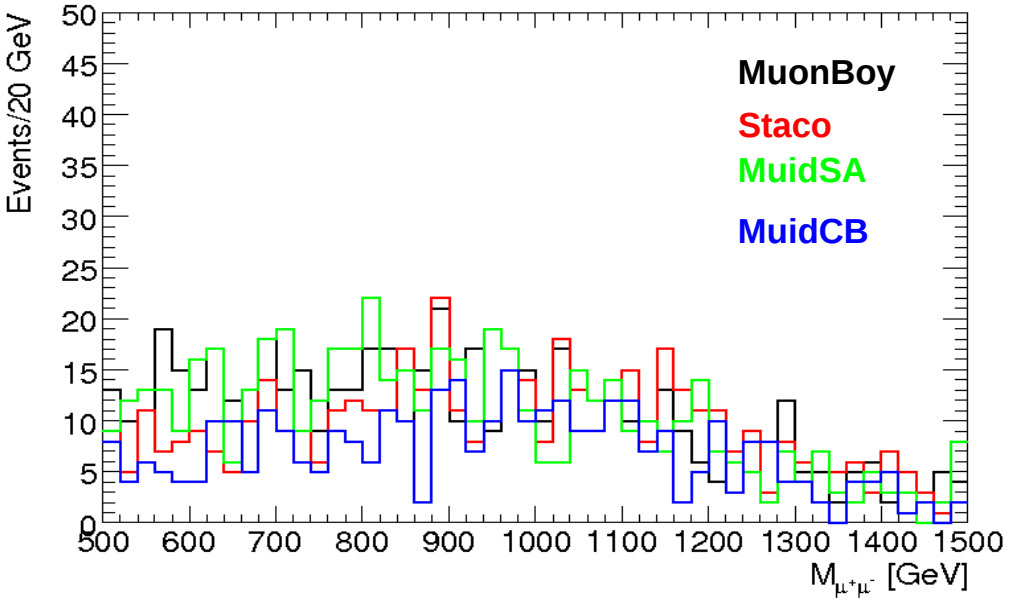
Algorithm	2 tracks	p_T cut	charge	Muu cut	trigger
MuonBoy	83.9 %	80.1 %	77.9 %	72.6 %	51.8 %
Staco	75.9 %	75.1 %	74.4 %	68.4 %	49.3 %
MuidSA	82.8 %	76.8 %	75.0 %	71.4 %	51.1 %
MuidCB	34.6 %	33.0 %	32.9 %	29.4 %	28.2 %

Curl-Residual

Algorithm	2 tracks	p_T cut	charge	Muu cut	trigger
MuonBoy	83.9 %	80.1 %	77.9 %	72.6 %	70.2 %
Staco	77.1 %	76.3 %	76.2 %	73.4 %	70.9 %
MuidSA	82.8 %	76.8 %	75.0 %	71.4 %	68.8 %
MuidCB	75.8 %	74.9 %	74.7 %	72.1 %	69.8 %



Impact on selection

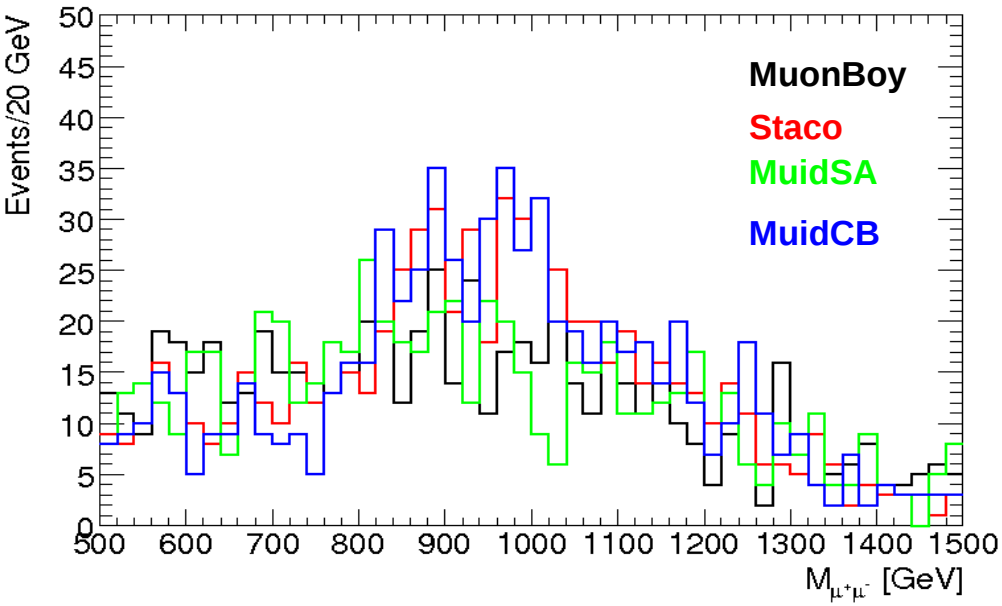


MS500+Curl-Large

Algorithm	2 tracks	p_T cut	charge	Muu cut	trigger
MuonBoy	83.5 %	79.4 %	71.2 %	54.3 %	41.8 %
Staco	58.2 %	57.2 %	55.8 %	48.8 %	38.8 %
MuidSA	82.4 %	76.7 %	68.6 %	53.9 %	41.6 %
MuidCB	35.0 %	33.4 %	32.6 %	28.5 %	27.8 %

MS500+Curl-Residual

Algorithm	2 tracks	p_T cut	charge	Muu cut	trigger
MuonBoy	83.5 %	79.4 %	71.2 %	54.3 %	50.8 %
Staco	65.8 %	64.8 %	64.4 %	59.7 %	55.9 %
MuidSA	82.4 %	76.7 %	68.6 %	53.9 %	50.4 %
MuidCB	65.4 %	64.3 %	64.1 %	58.0 %	55.8 %



Conclusions

- The larger effects of misalignments are observed for combined tracks, in particular for the MuidCB algorithm, the only used for reconstructing and combining MS tracks at trigger level.
- In the ID, we observe a μ^+ charge mis-identification.
- Curl-Large and MS500 geometry must to be considered as pessimistic cases: for early data we expect for the ID something similar to Curl-residual, while for the MS we expect misalignment of the order of 100 μm.
- It is foreseen to have a MS-standalone trigger to avoid any effect related to the inter-calibration of the two detectors.
- In the future we plan to study the effects of other kind of misalignments, and to determine the impact on the discovery potential.