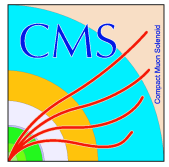


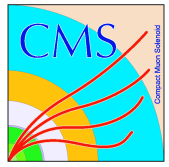
Realistic CRAFT1 MC Scenario

Jim Pivarski

Texas A&M University

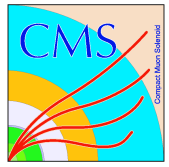
February 24, 2009

Realistic CRAFT1 MC Scenario



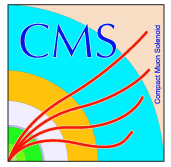
- A snapshot of the current state of the muon geometry, for use in MC for CRAFT1 analyses, can be generated via a deterministic script (random number seed is specified)
- To run the script, check out V02-08-10 of Alignment/MuonAlignment
  - `Alignment/MuonAlignment/python/MCScenario_CRAFT1_22X.py`
- To look at it on the web, go to
  - `http://cmssw.cvs.cern.ch/cgi-bin/cmssw.cgi/CMSSW/Alignment/MuonAlignment/python/MCScenario_CRAFT1_22X.py?view=markup`
- For a copy of the SQLite file (to upload to the database), see
  - `/afs/cern.ch/user/p/pivarski/public/MCScenario_CRAFT1_22X_V02-08-10.db`
  - Only DTAlignmentRcd and CSCAlignmentRcd are meaningful (APEs should be zero, as they are in data)
  - SQLite file tag names are equal to the record names

The basic idea for DTs



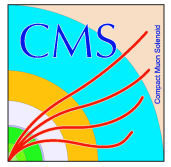
- Many DT chambers were observed with globalMuons, but only the best-measured ones were aligned
- The residuals plots give us a good idea of where the rest of them are, with 1–2 mm uncertainty because we haven't decided that we can trust the residuals plots at a finer scale yet
- Randomly generate DT chamber positions using observed residuals as the mean and 1–2 mm as the sigma of the Gaussian
  - 1 mm of the "1–2 mm" is correlated between chambers in the same sector (because they lie on the same track)
  - another 1 mm is uncorrelated (a two-level hierarchy)
- Any gaps in the residuals plots are filled in with Gaussians as wide as the corrections (4.5 mm in local x, 2.3 mm in y, and 1.0 mrad in ϕ_z)
- Local x, y, and ϕ_z were best determined, local z inferred from typical slopes of residuals, and ϕ_x, ϕ_y estimated from $\vec{B}$-field plots

The basic idea for CSCs



- CSC positions were observed with photogrammetry, and these corrections haven't been used in data processing yet
  - therefore, they are currently a known error (on the chamber-relative-to-disk level)
- Disk-bending corrections were derived from DCOPS, which have a 1.4 mm uncertainty (in $\vec{B} = 0$ data, with respect to photogrammetry)
  - this is correlated among all the chambers in the same ring that were corrected in z and ϕ_x
- Whole-disk positions have some uncertainty in CMS global coordinates
- Three-level hierarchy: disk $\longrightarrow$ disk-bending $\longrightarrow$ individual chambers
  - actually four levels, including layer-by-layer misalignments, but these are very small
- CSC Overlaps information used to determine scale of chamber-by-chamber ϕ_y misalignments and layer misalignments

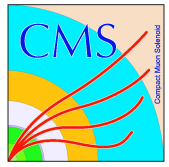
What's on slides 6–70



- More explicit justification for each parameter (pages 6–13)
  - including plots and references to talks which present them
- Plots of every constant (pages 14–70)
  - you can see some of the correlation-trends
  - photogrammetry CSC distribution is not exactly Gaussian
- This is the last slide in the basic overview

DT local x and y

(these are global $r\phi$ and z, respectively)

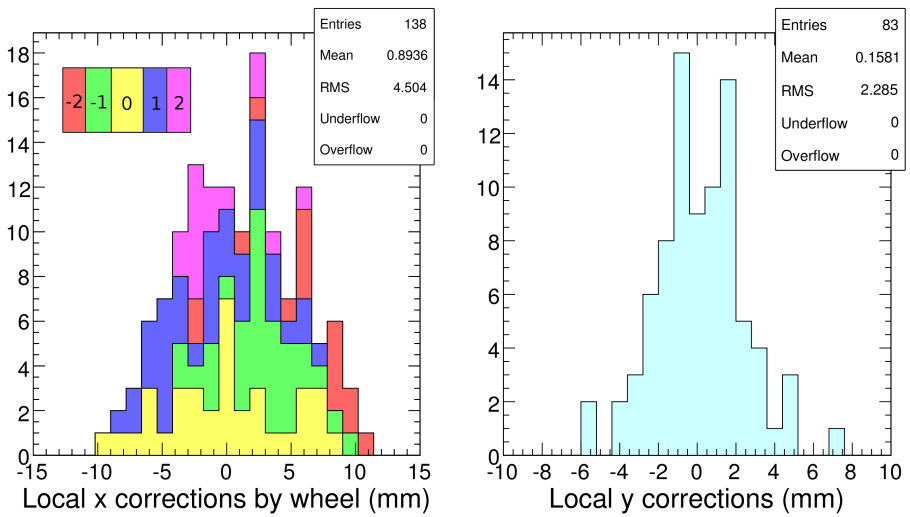


- After a globalMuon alignment, uncertainties are not correlated on the station or wheel level
- But they are correlated roughly by sector, due to the fact that chambers in the same sectors largely share tracks
- The "1–2 mm" uncertainty is thus divided as
  - 1 mm independent chamber-by-chamber error
  - 1 mm correlation within each sector (sector⊗wheel pairs, actually)
- This is much more than the reproducibility of the procedure (0.098 mm in x and 0.186 mm in y), so we are conservatively assuming a 1–2 mm error in the technique
- The above only applies to aligned chambers; the other two categories are
  - unaligned due to low statistics, but obvious from the residuals plots* what the true misalignment is (to the nearest millimeter)
  - too few tracks on the chamber to even appear in the plots

* "more information" `http://indico.cern.ch/conferenceDisplay.py?confId=51267`

DT local x and y (continued)

- Therefore I looked at each chamber, wrote down the apparent misalignment, and used that as a mean for the Gaussian-generated errors
  - e.g. a chamber looks misaligned by 6 mm, and we trust the procedure to 1 mm, so we generate a random misalignment with mean 6 mm and sigma 1 mm
- The table of "observed by hand" misalignments are in the script
- Chambers with too few tracks to appear in the plots were randomly generated with a mean of 0 and a sigma of 4.5 mm (x) and 2.3 mm (y)

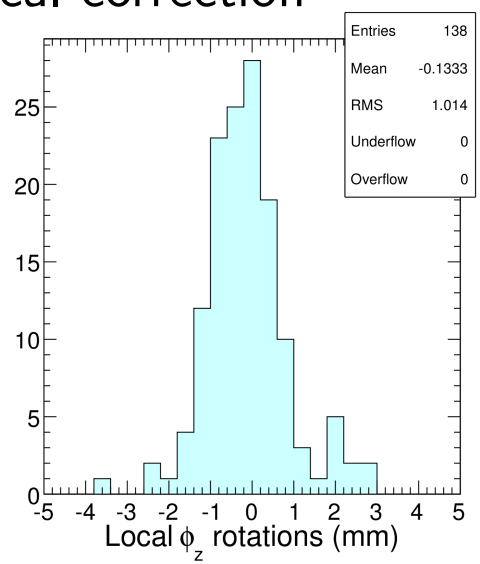


- The scenario will therefore have the right resolution(ϕ, z) dependence

DT local ϕ_z

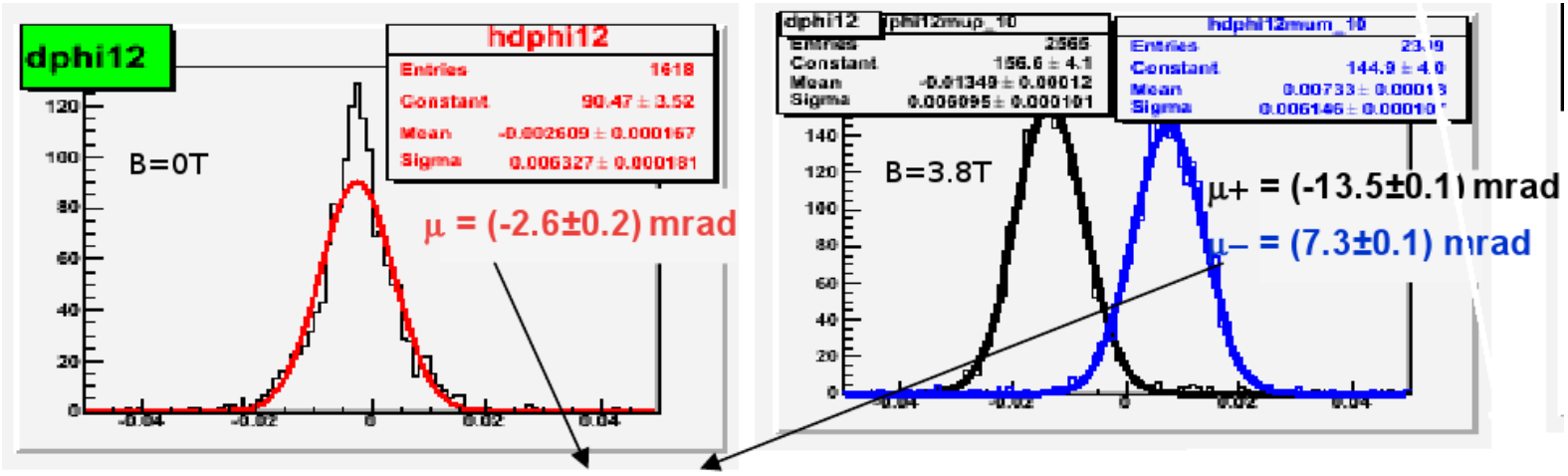
(this is rotation in the layer's measurement plane)

- Unlike the x and y translations, ϕ_z is a local measurement, depending only on the difference between nearby residuals
- One can imagine biases which distort the track source with a "low multipole" dependence (e.g. $\sin\phi$, $\cos 2\phi$, z, $z^2 \ldots$), but this has minimal impact on ϕ_z
- Therefore, take the ϕ_z misalignment for aligned chambers to be the reproducibility of the procedure (RMS of second-iteration corrections): 0.058 mrad
- For unaligned chambers, it's 1.0 mrad, the typical correction (plot label should be "mrad", not "mm")



DT local ϕ_x and ϕ_y

- Magnetic field measurements compared track and segment angles, observed ϕ_y misalignments as a by-product of measuring field



- Conclude from slide 12 of Sara's talk at
  `http://indico.cern.ch/conferenceDisplay.py?confId=51559`
  that 3 mm ϕ_y angles are typical
- Assume the same for ϕ_x
- Note: this comes from only one measurement!

CSC hierarchy

- CSCs have never been (robustly) measured by globalMuons, so uncertainties are still correlated via the following hierarchy:
  - CSC disks: aligned in the cavern with photogrammetry
  - CSC rings (disk bulging): z and chamber-ϕ_x corrections with DCOPS/SLMs (correlated within each ring)
  - CSC chambers: uncorrected translations/rotations known from photogrammetry data (except ϕ_y, that comes from CSC Overlaps)
  - CSC layers: observed tiny misalignments, put them in the scenario anyway

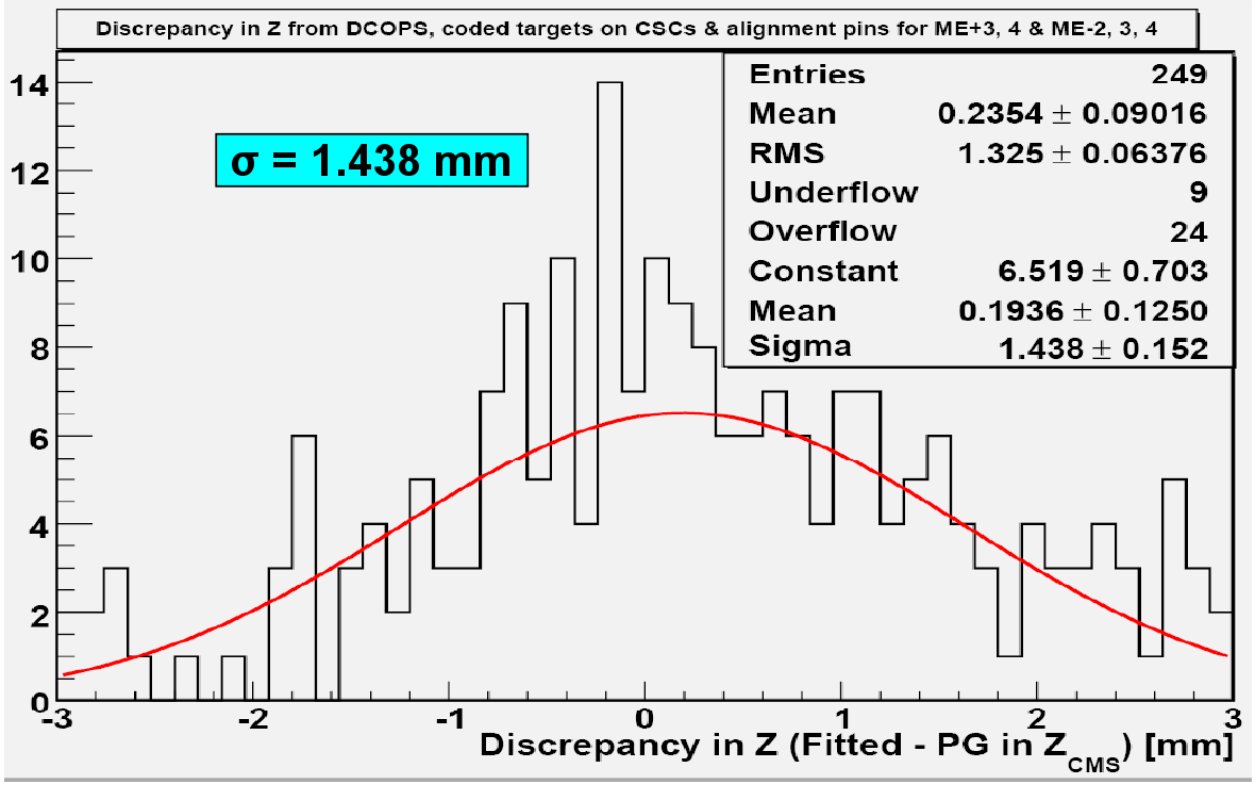
CSC disk precision

- 0.5 mm x-y precision, 3 mm z, and 0.5 mrad in all three angles

CSC ring precision

(z and ϕ_x to represent disk bulging)

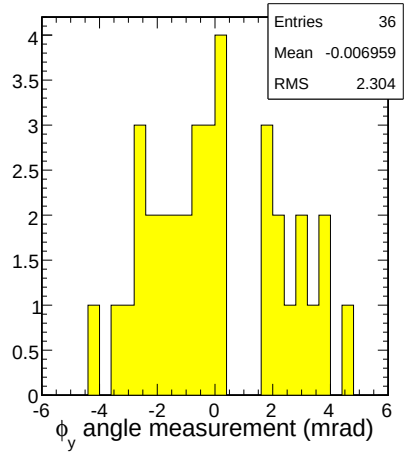
- DCOPS/PG comparison in z_{CMS}: page 7 of Samir's talk on
  `http://indico.cern.ch/conferenceDisplay.py?confId=39027`

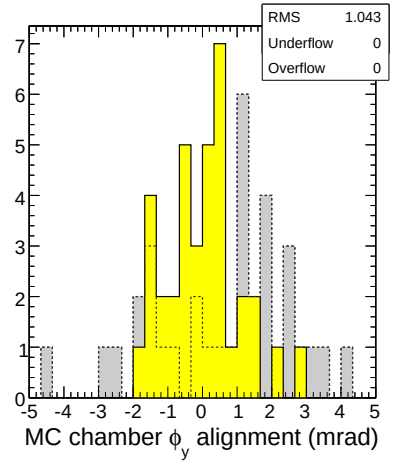


- Implies z uncertainty is 1.438 mm and ϕ_x uncertainty is 0.57 mrad

CSC chamber misalignments

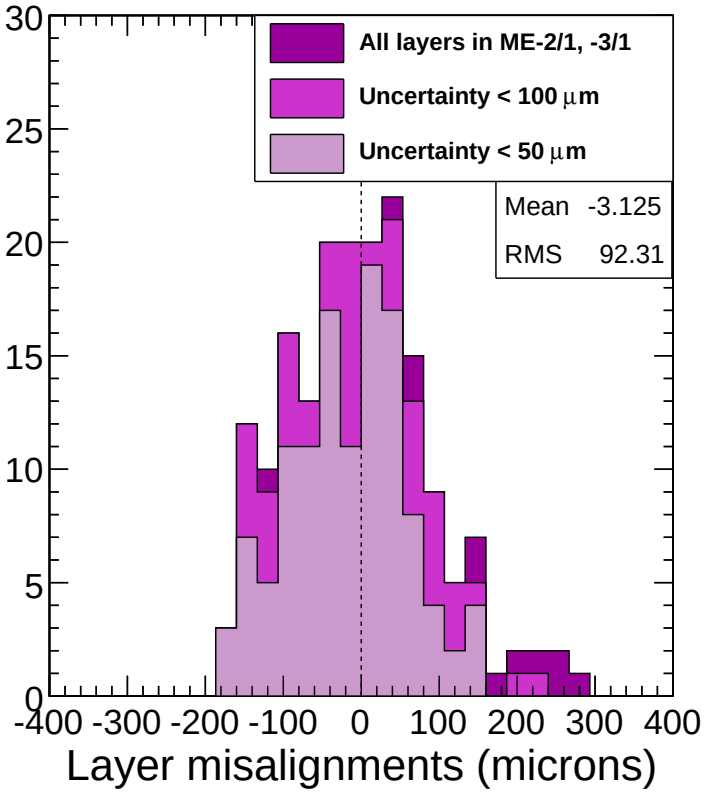
- Karoly has converted all CSC photogrammetry into a CSCAlignmentRcd, so it should be considered for the next reprocessing (whenever that is)
- In the meantime, these are known, uncorrected-for constants, which exactly quantifies our error (up to any changes the $\vec{B}$-field might make)
- When chambers have no photogrammetry information (ME1/1 and incomplete data in other rings), we use the RMS of the others:
  - 1.2 mm in x, 1.0 mm in y, 1.2 mm in z, 1.1 mrad in ϕ_x, 0.56 mrad in ϕ_z
- Two alignment pins cannot determine ϕ_y; get an RMS of that from beam-halo CSC Overlaps measurement (left: measured, right: MC to gauge the precision)





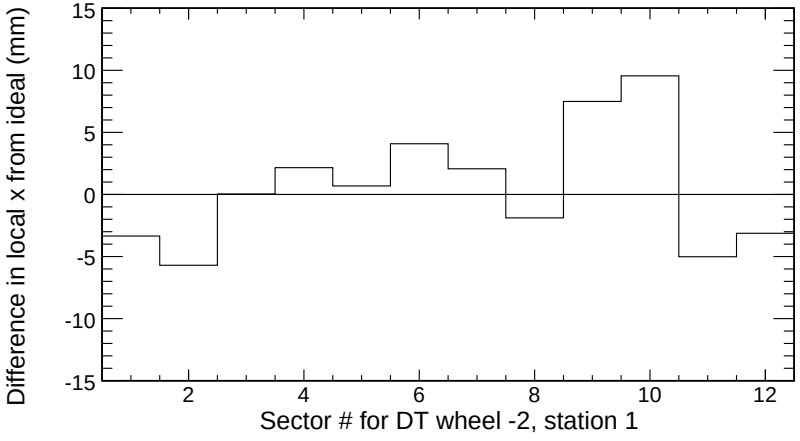
CSC layer misalignments

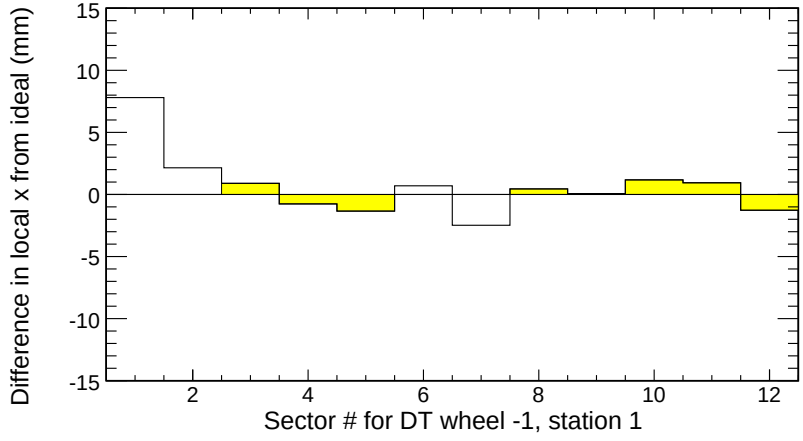
- We've never modelled layer misalignments in an MC scenario before
- They are small (0.092 mm in x)
- I put this into the scenario anyway (x only)

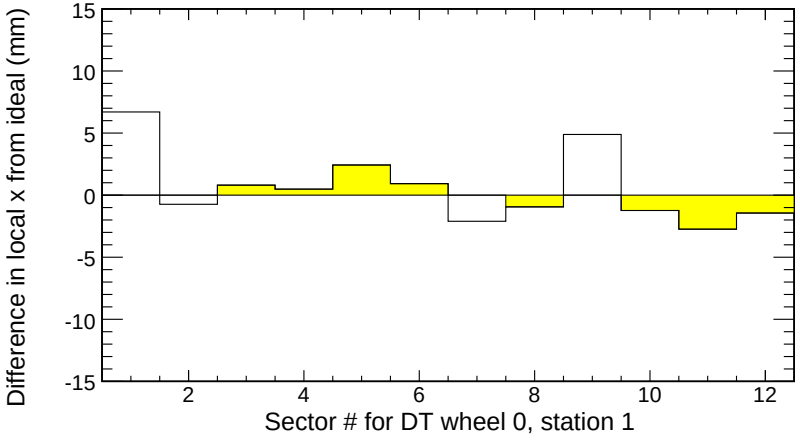


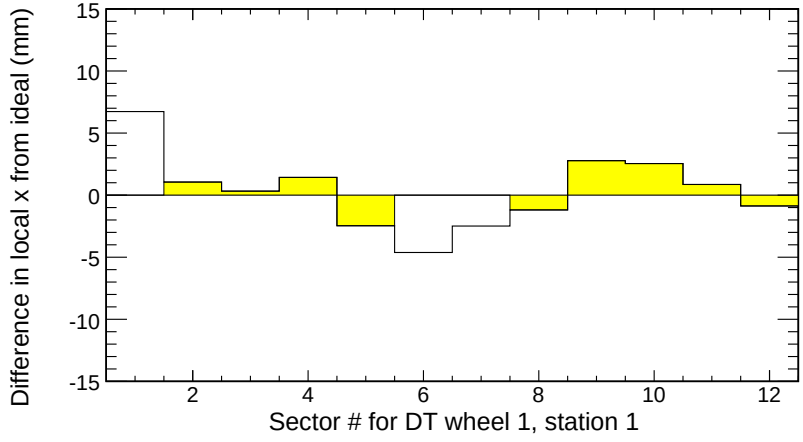
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



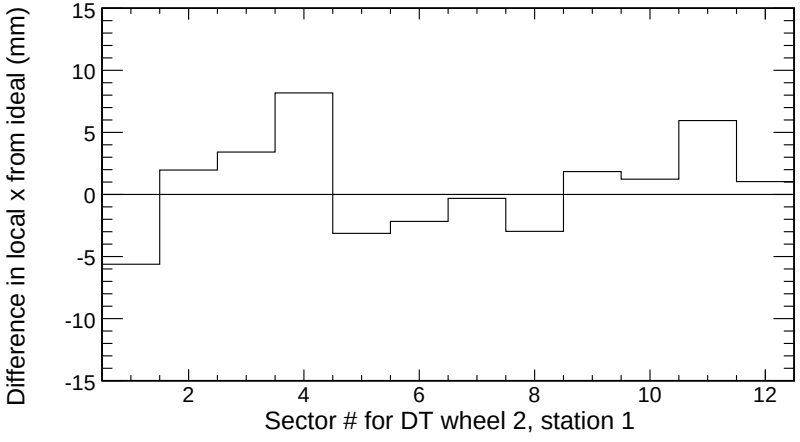


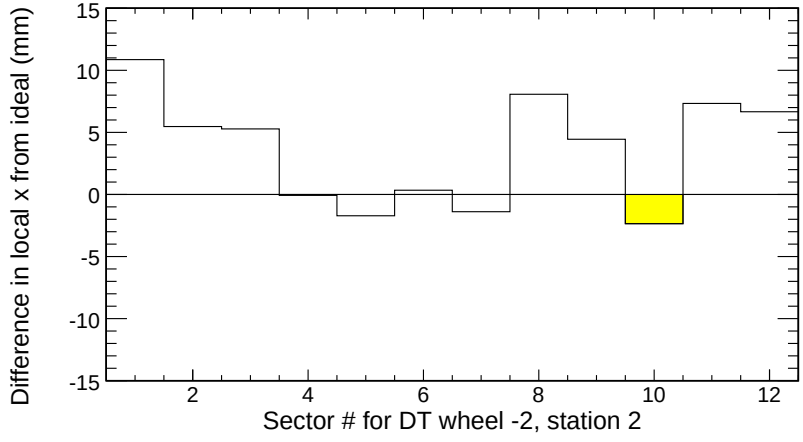


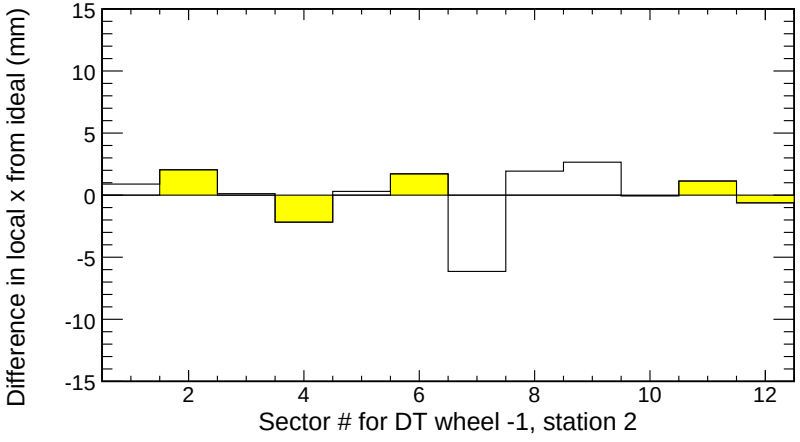


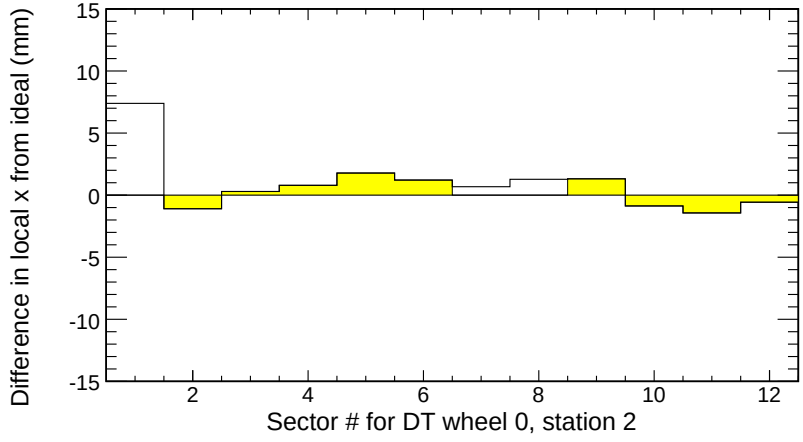
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



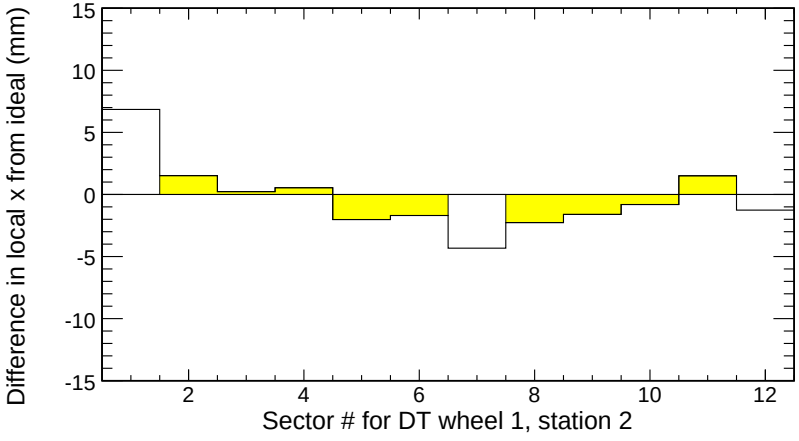


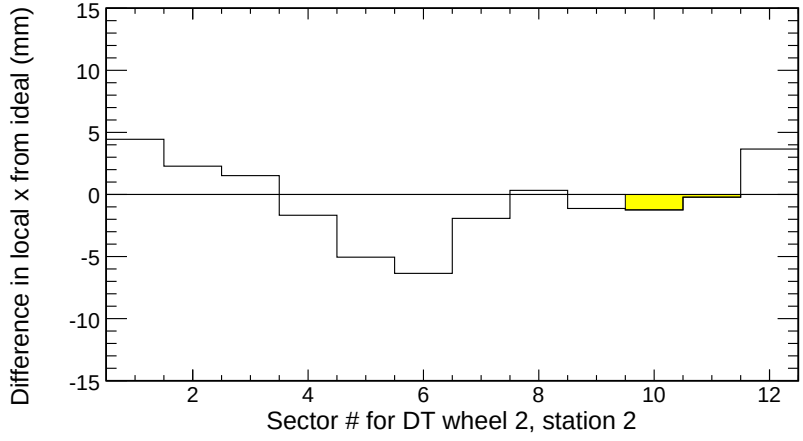


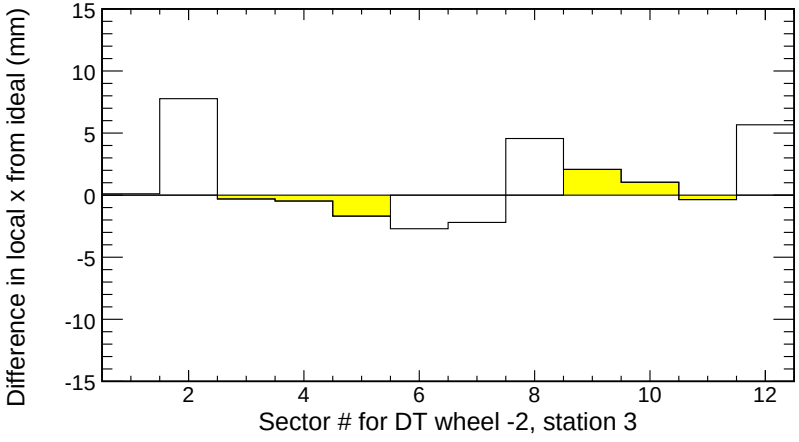


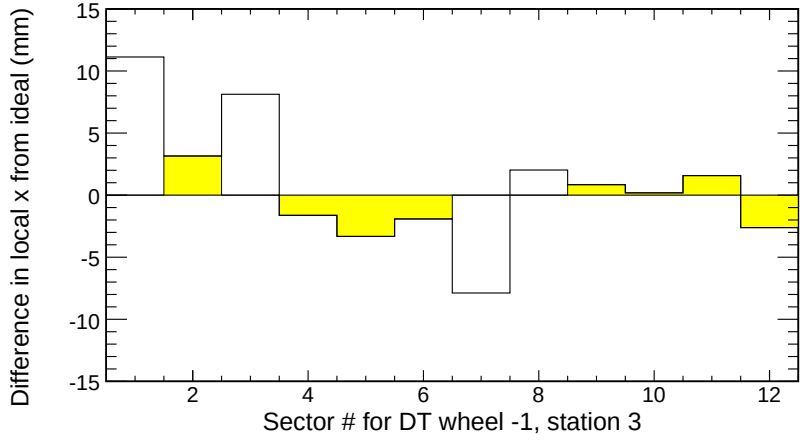
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



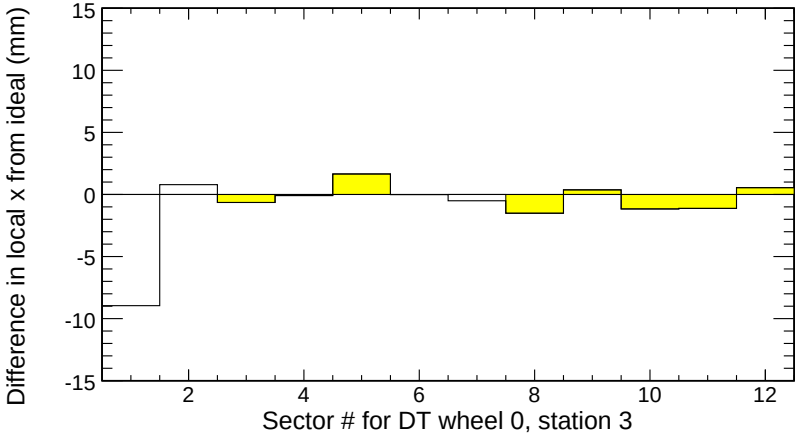


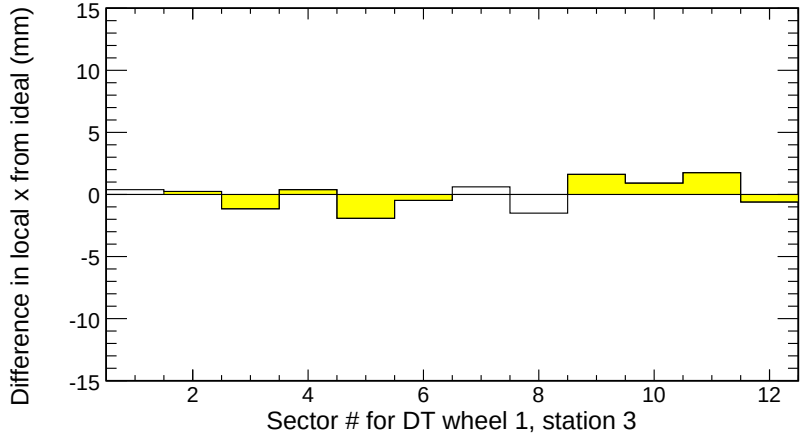


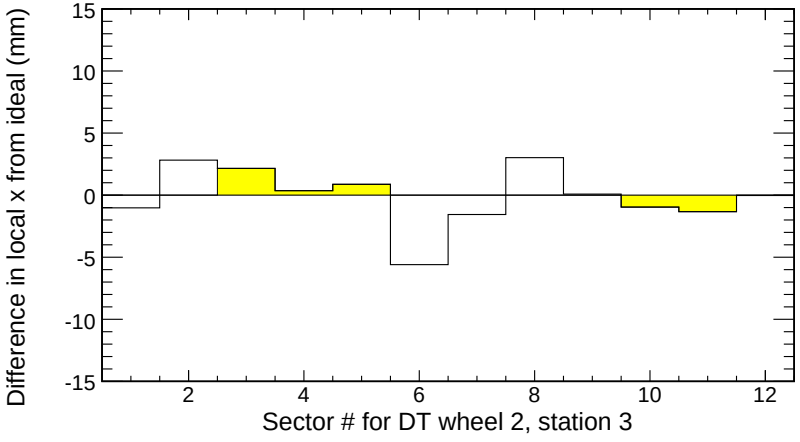


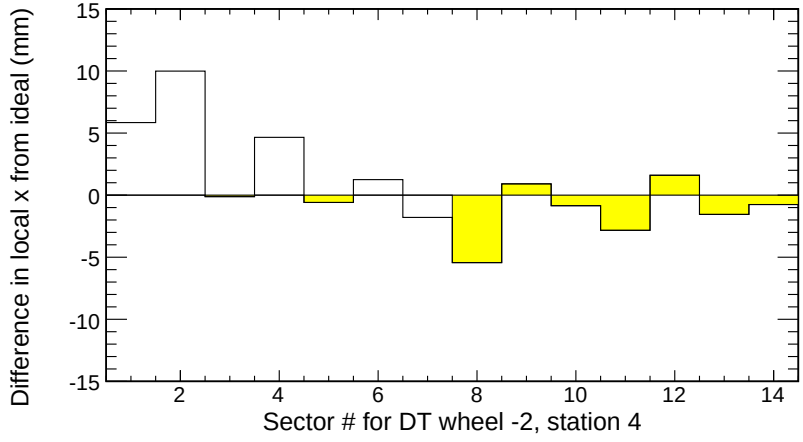
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



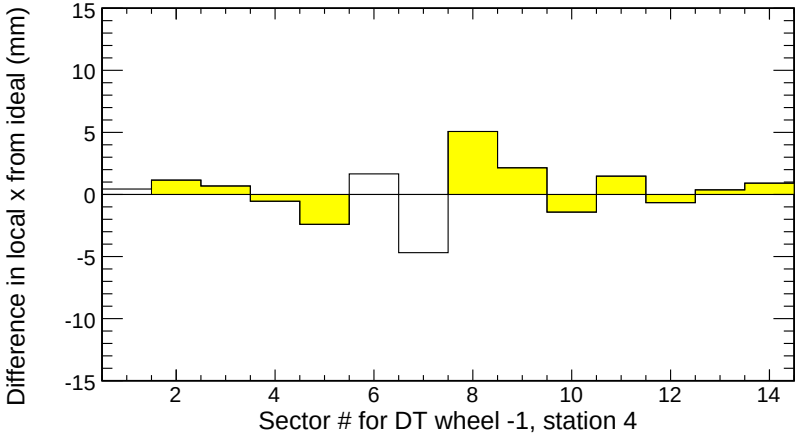


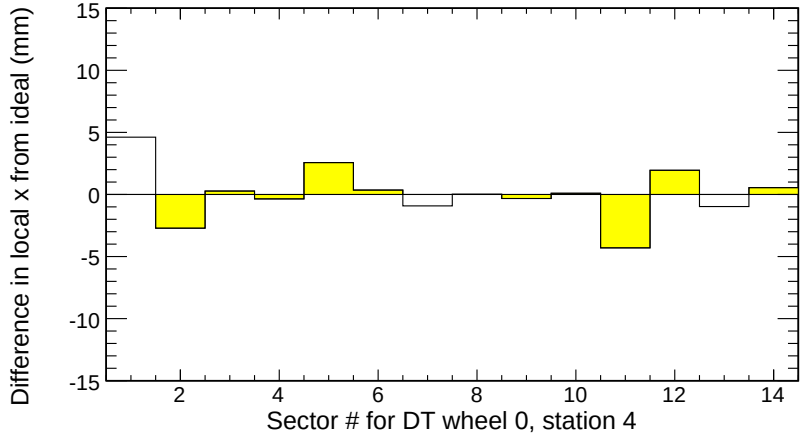


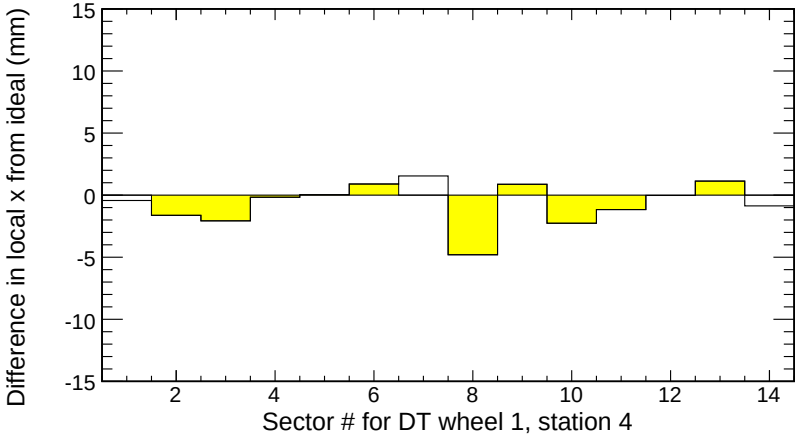


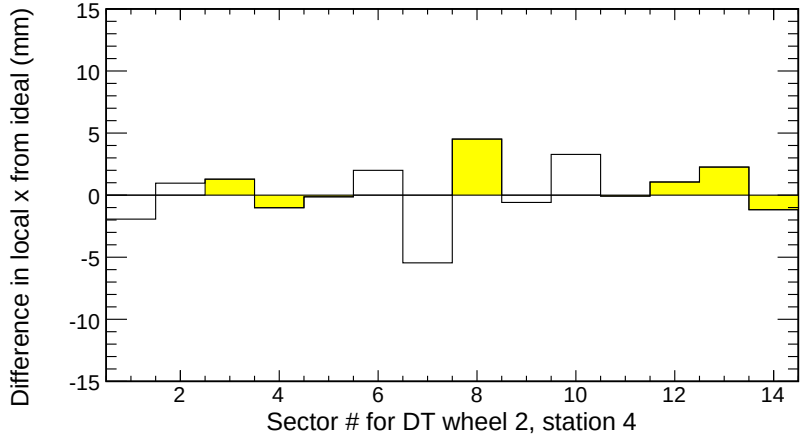
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



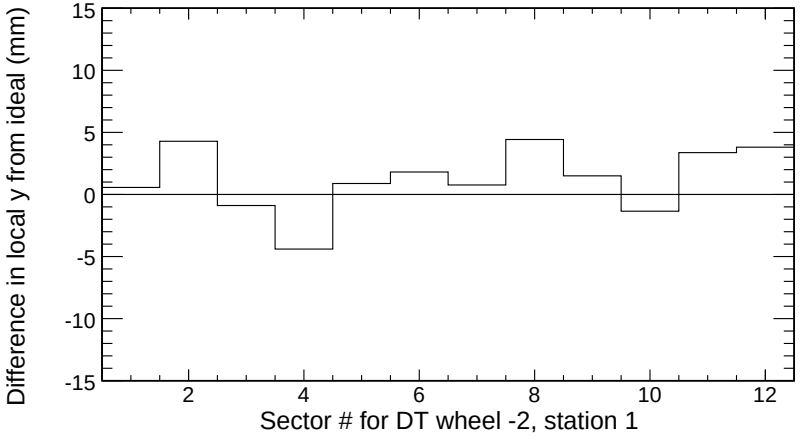


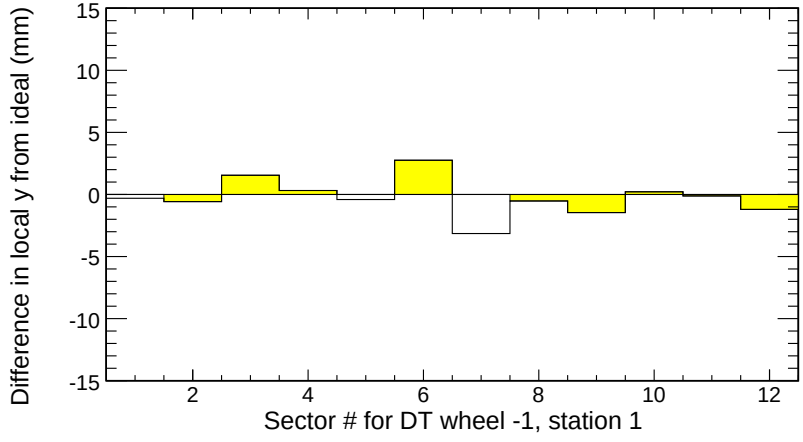


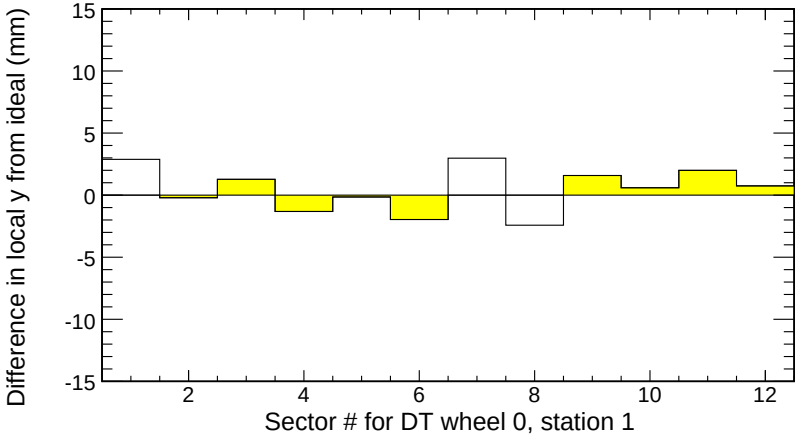


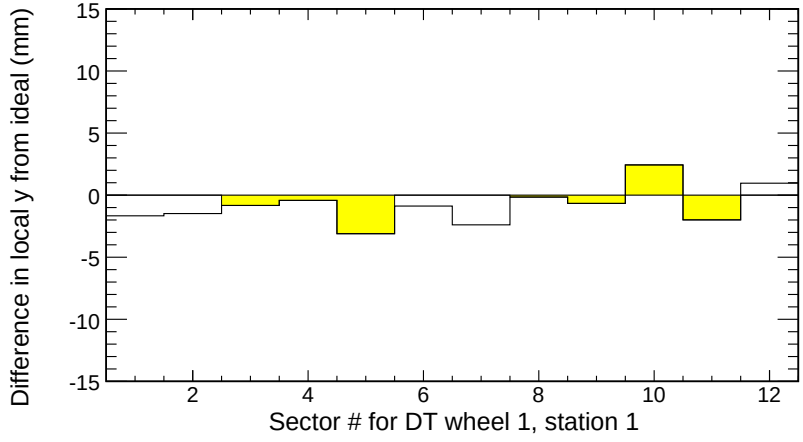
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



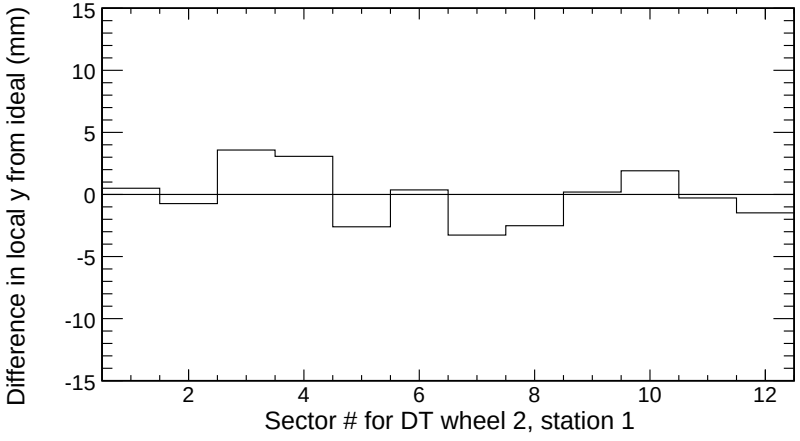


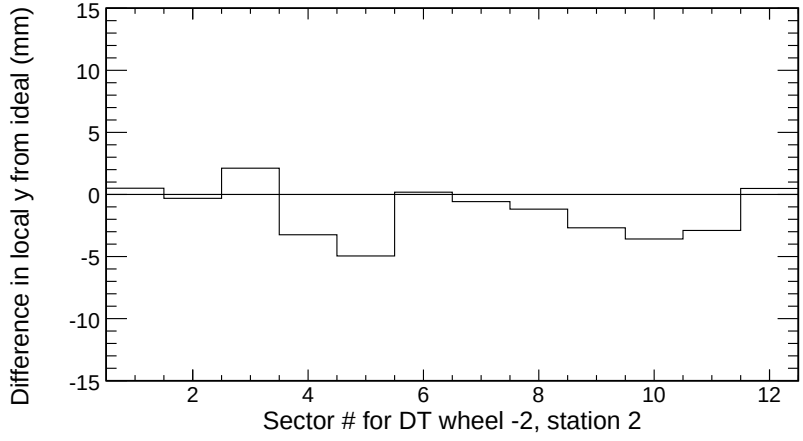


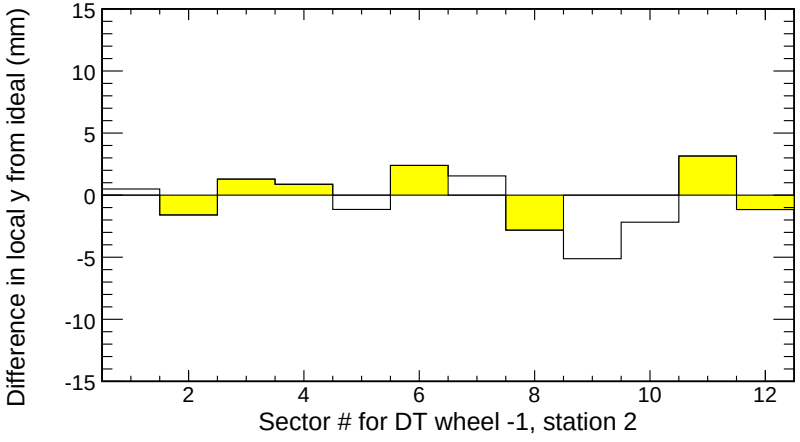


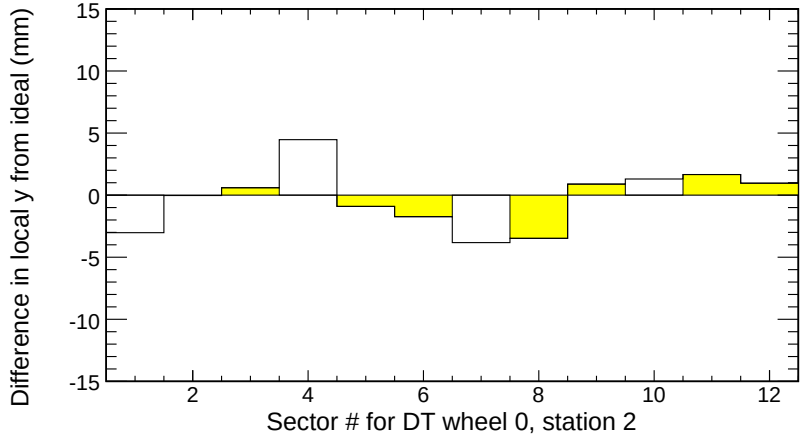
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



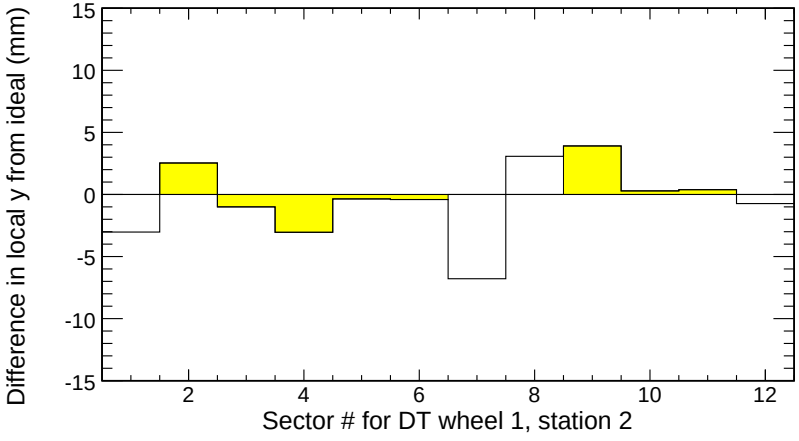


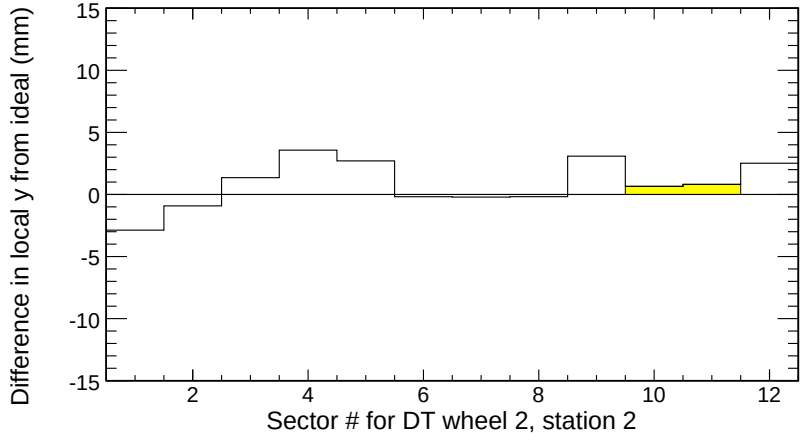


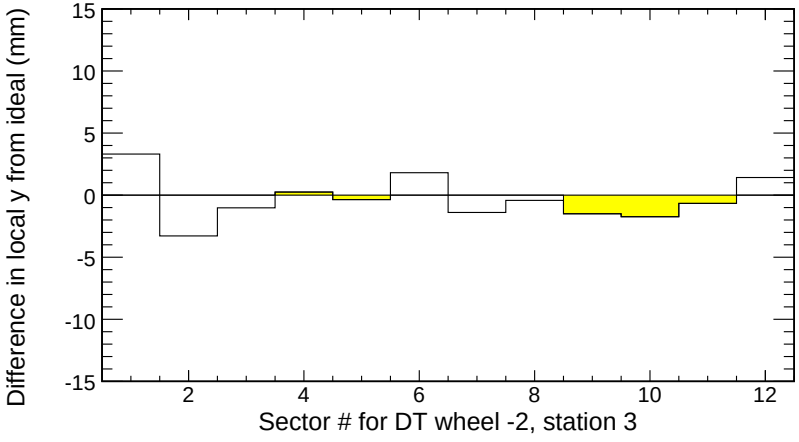


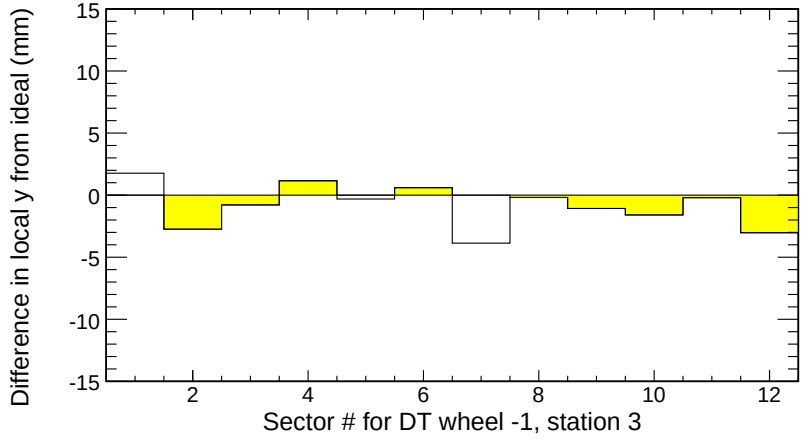
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



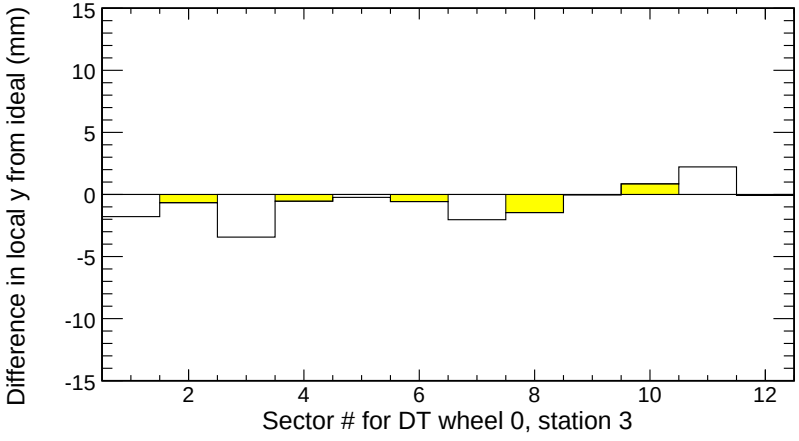


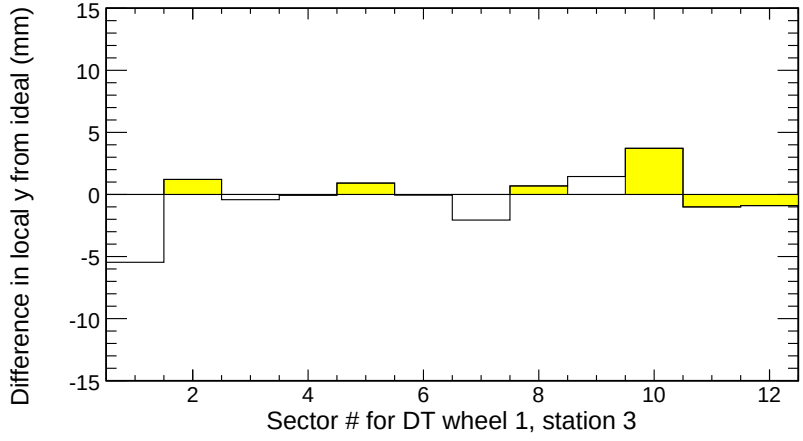


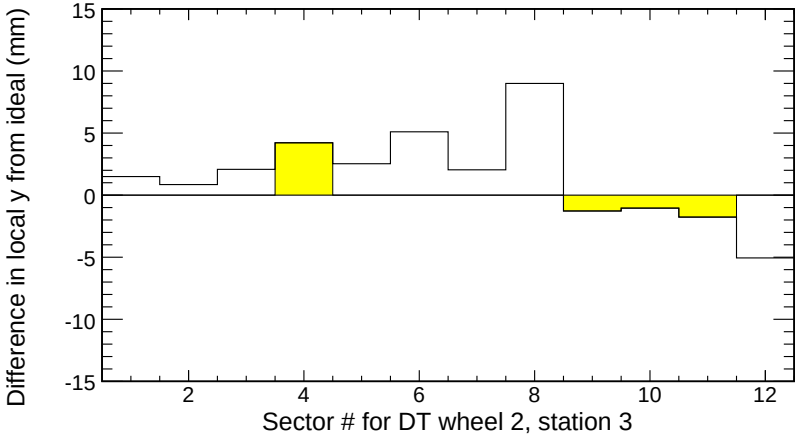


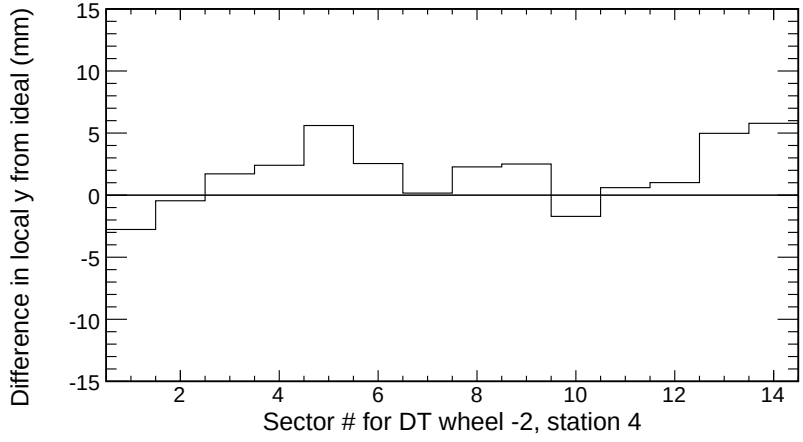
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



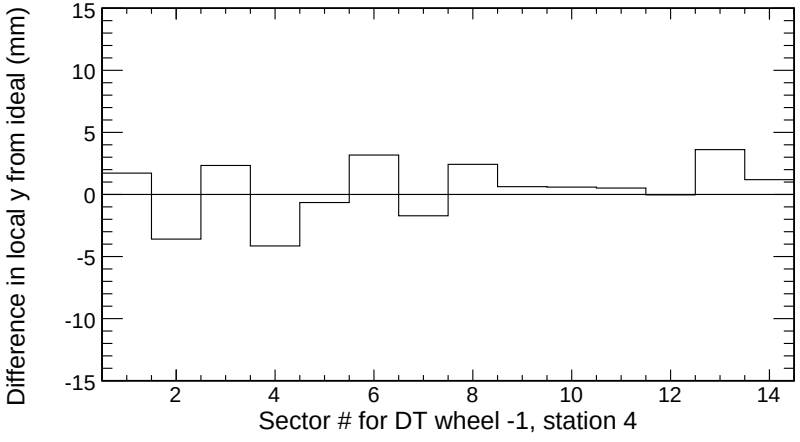


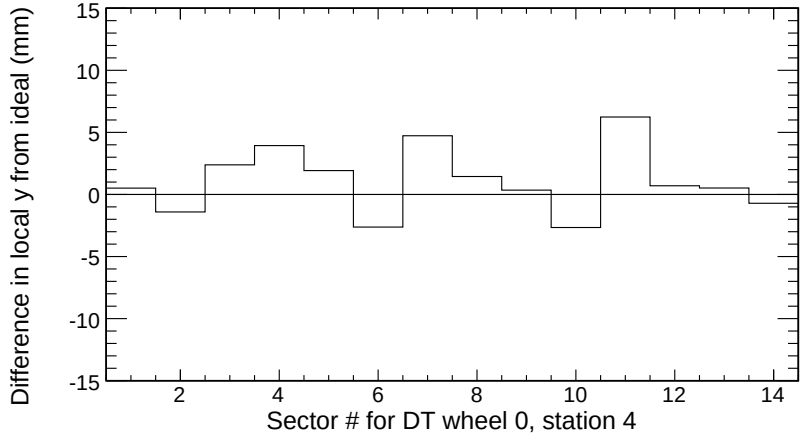


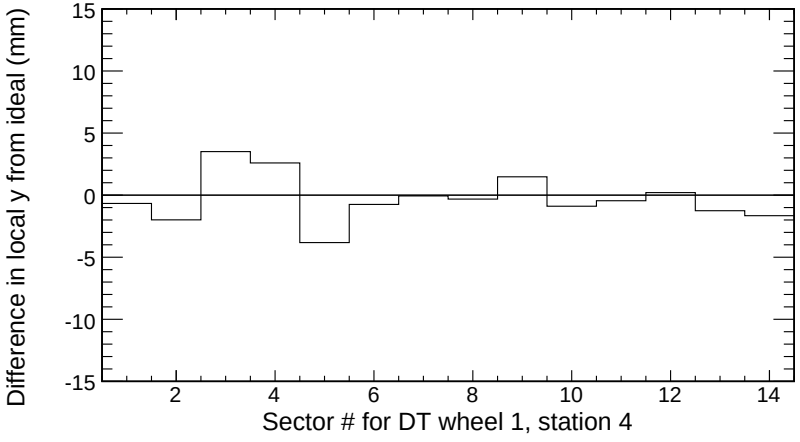


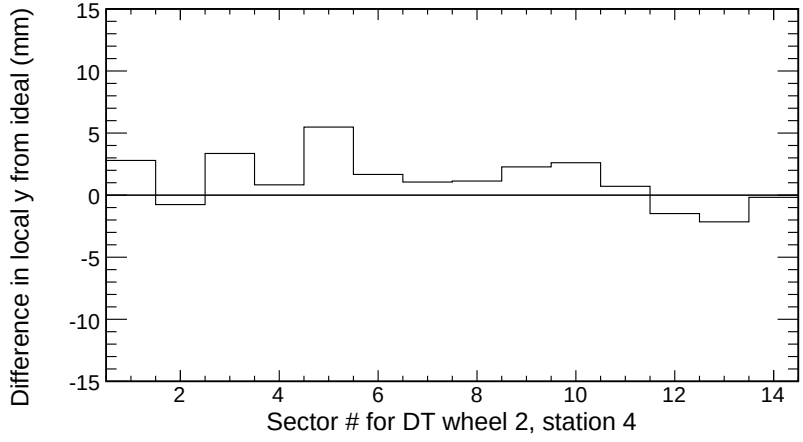
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



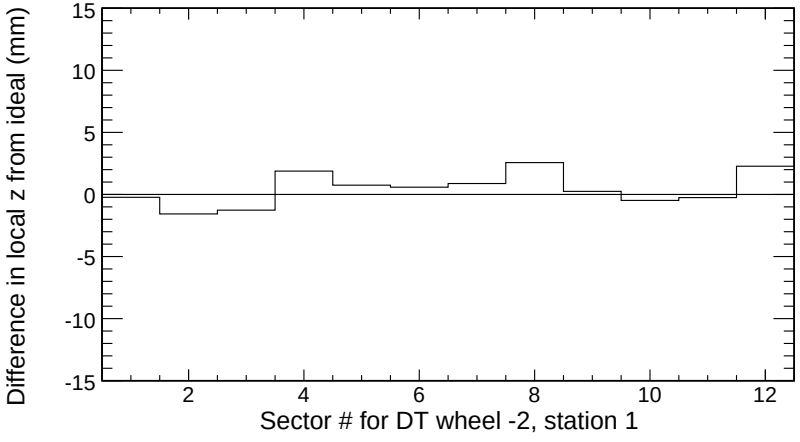


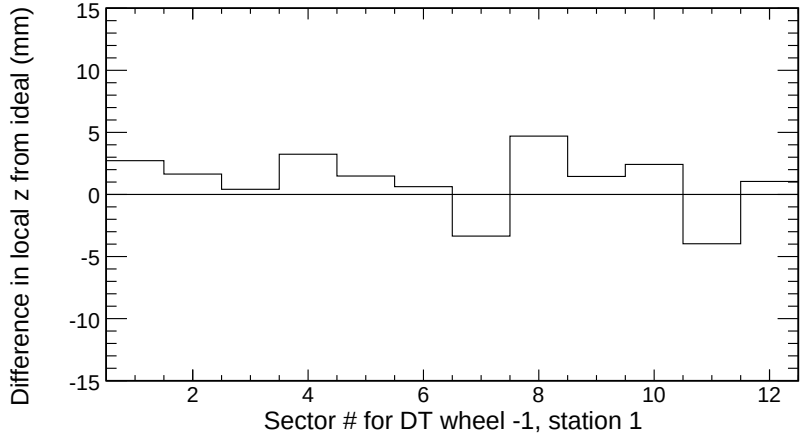


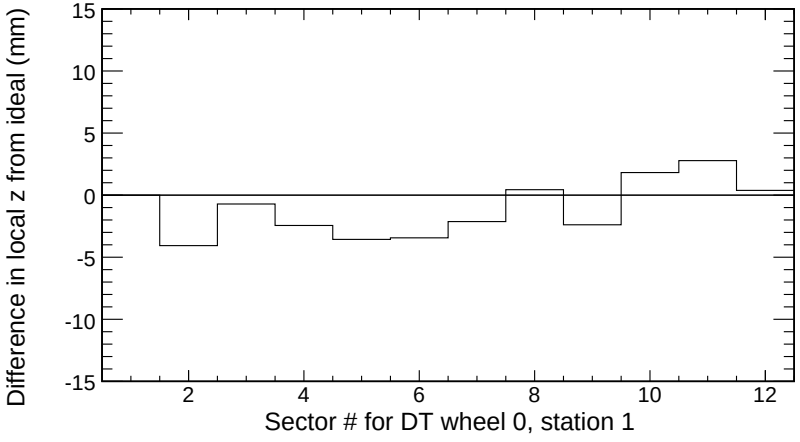


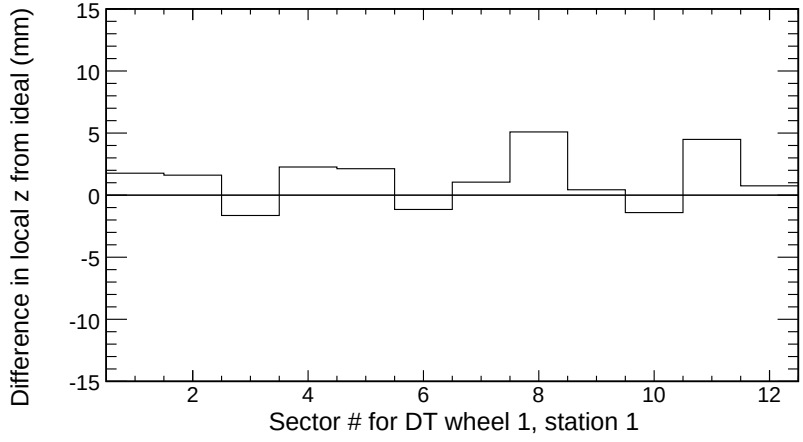
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



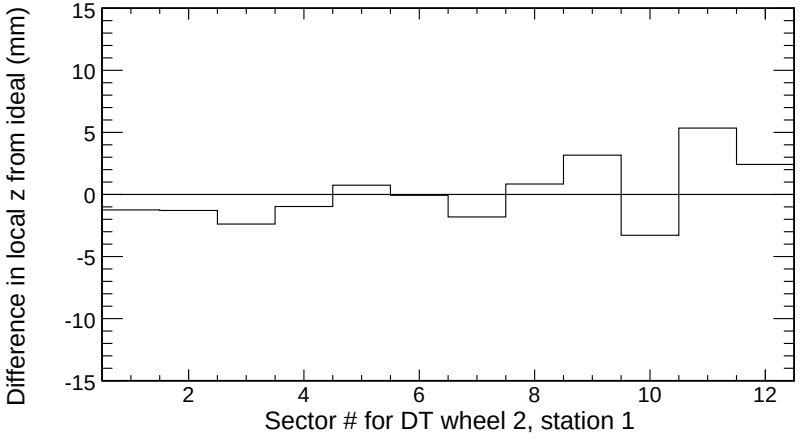


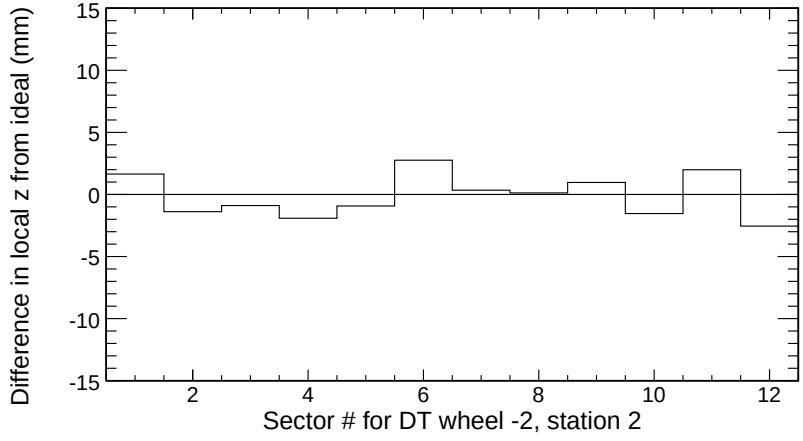


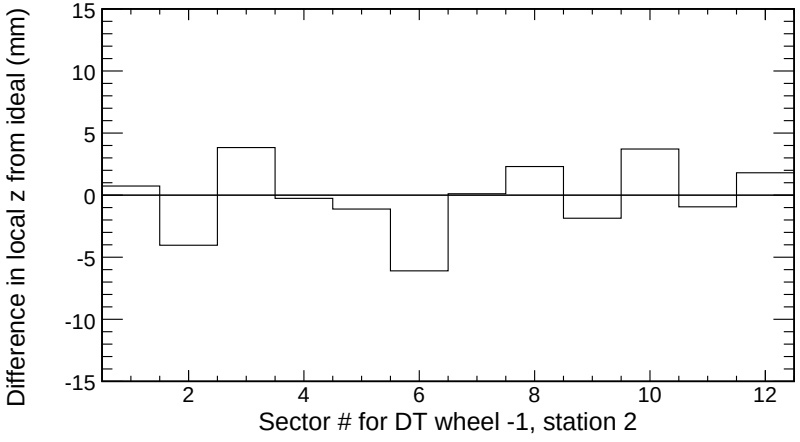


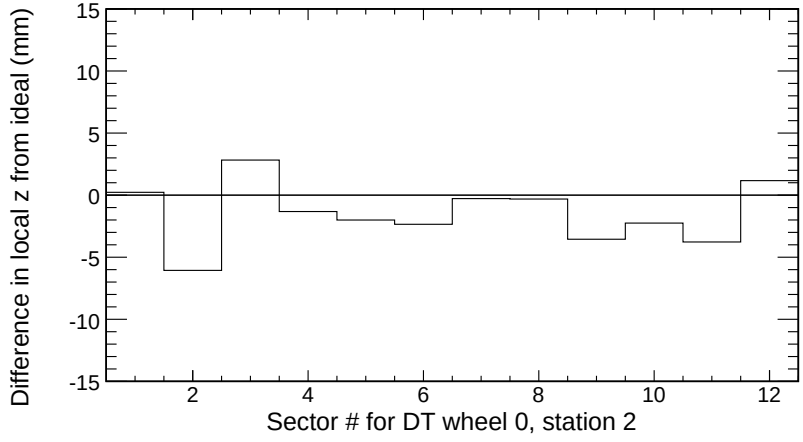
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



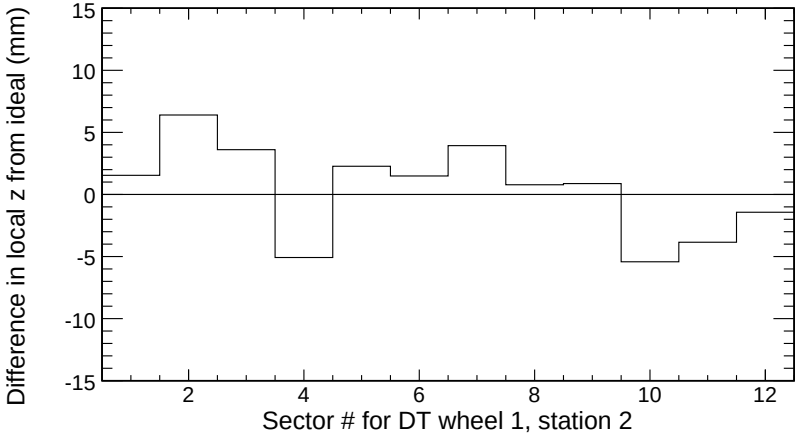


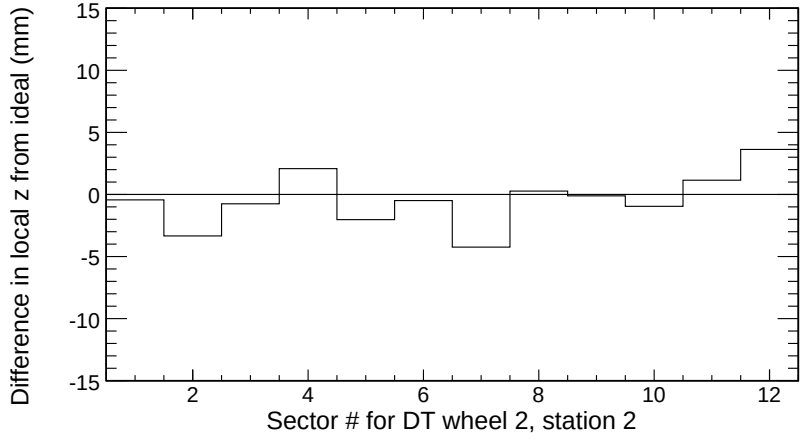


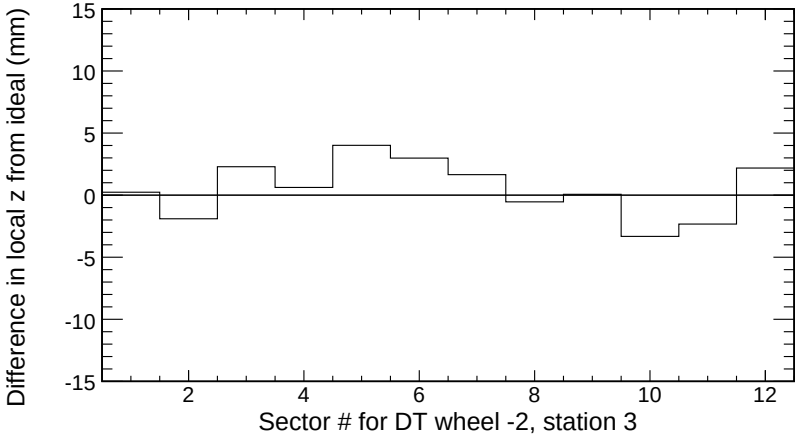


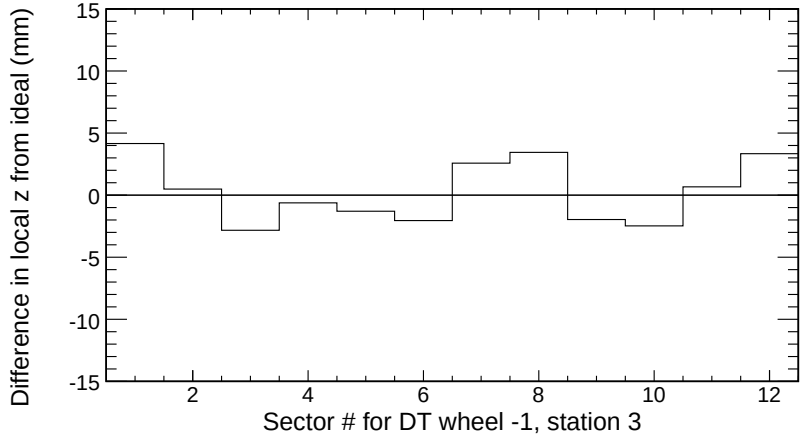
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



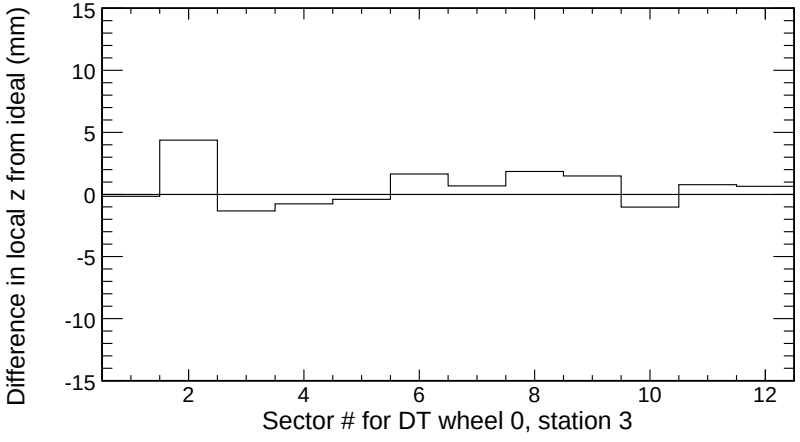


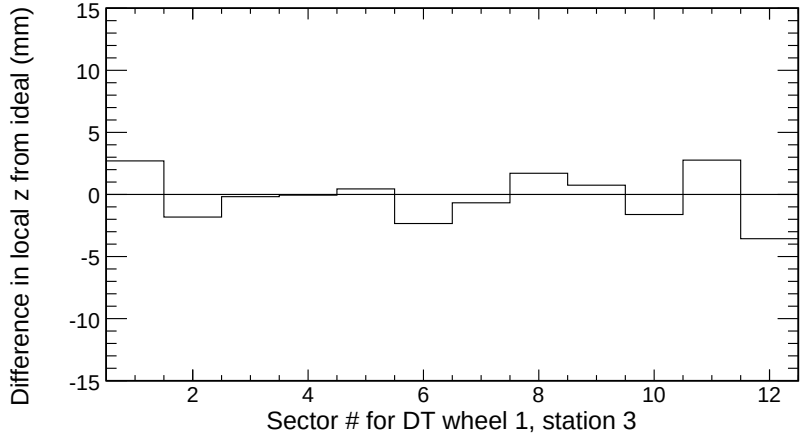


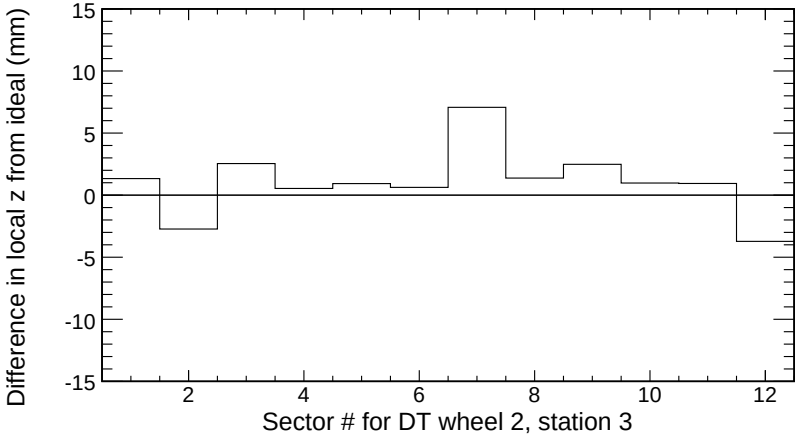


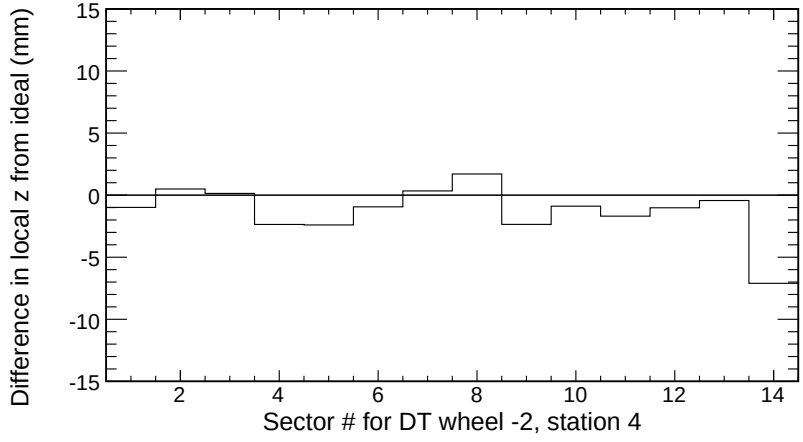
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



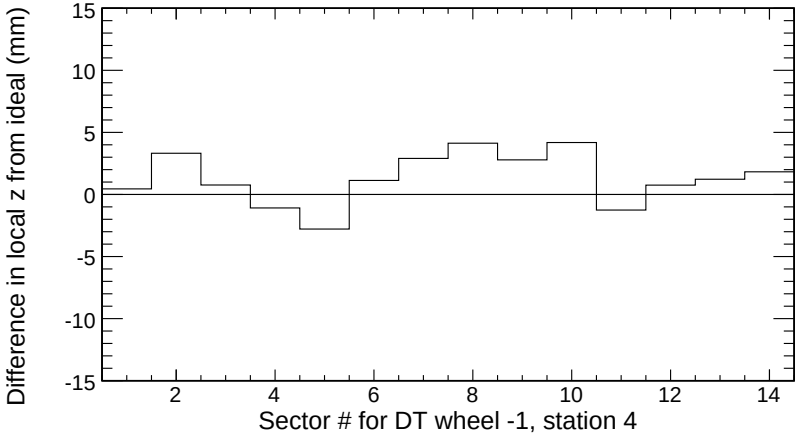


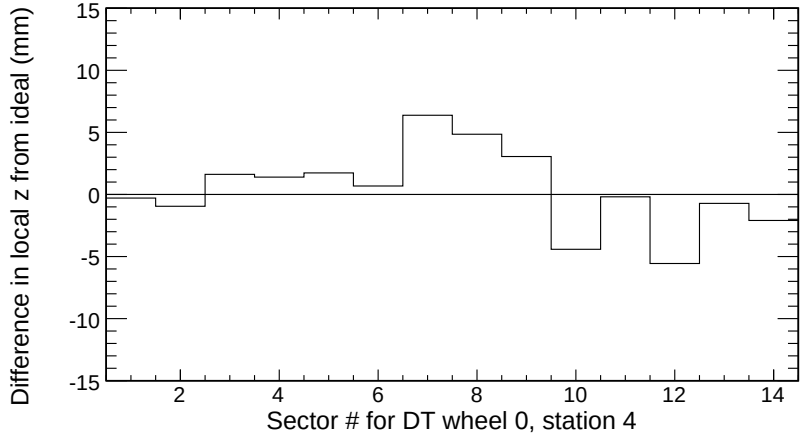


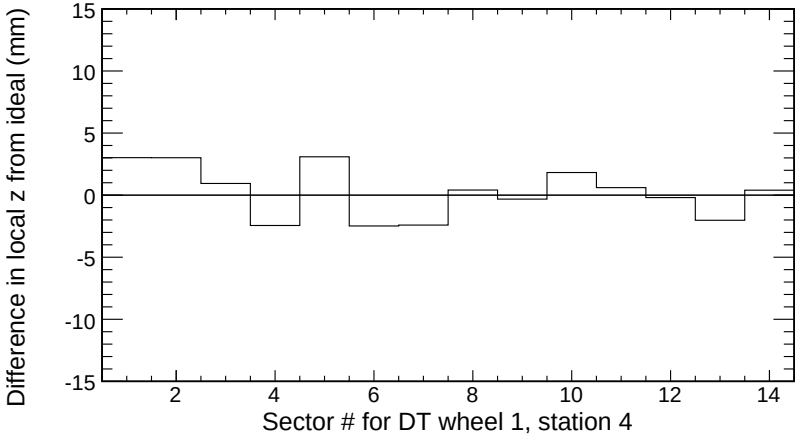


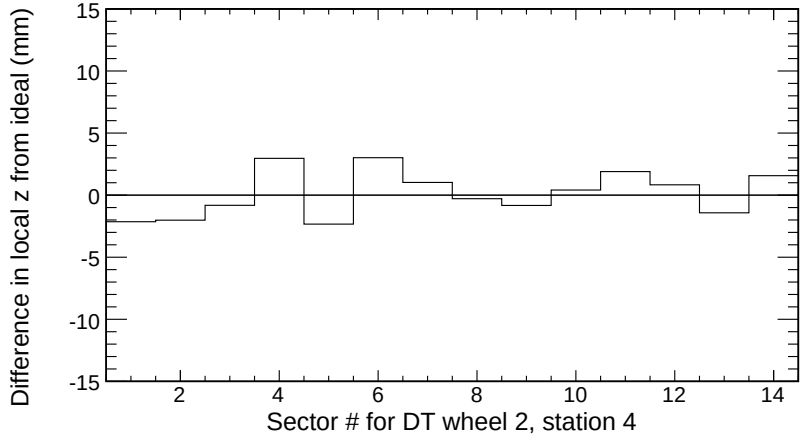
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



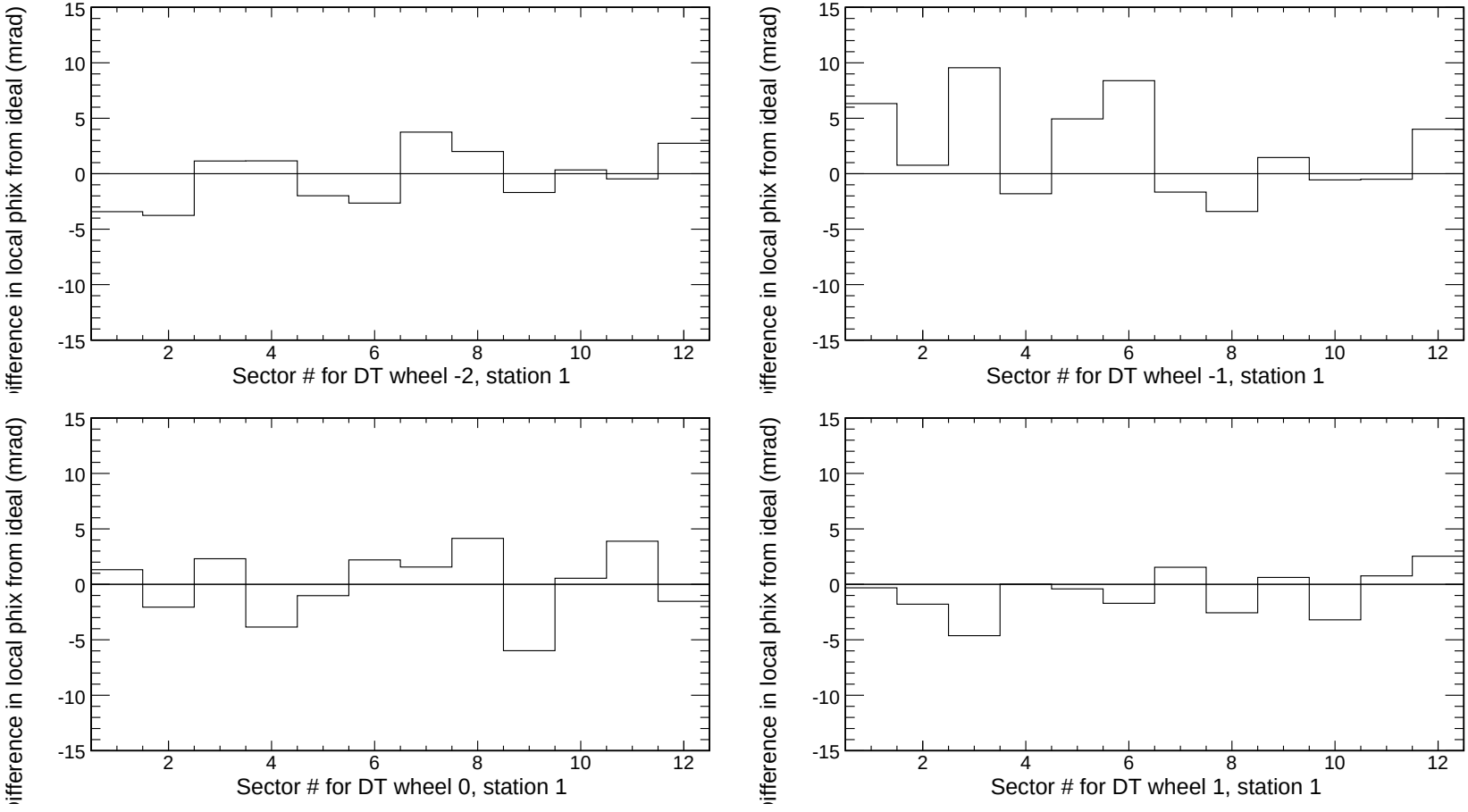






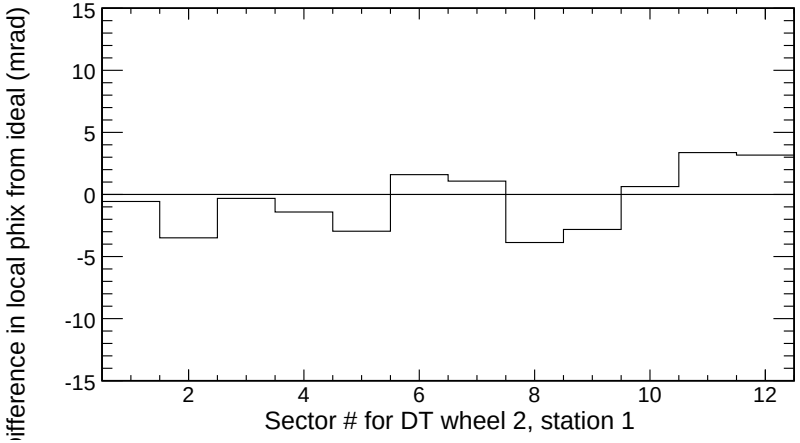
Reference: all the constants

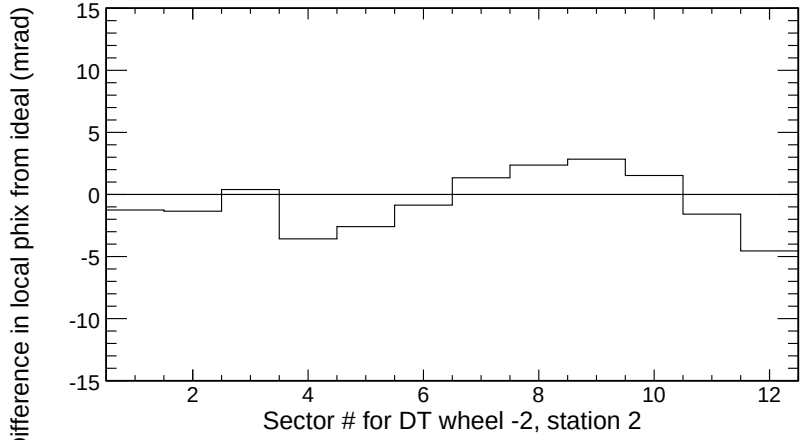
Yellow denotes a parameter that was aligned with globalMuons

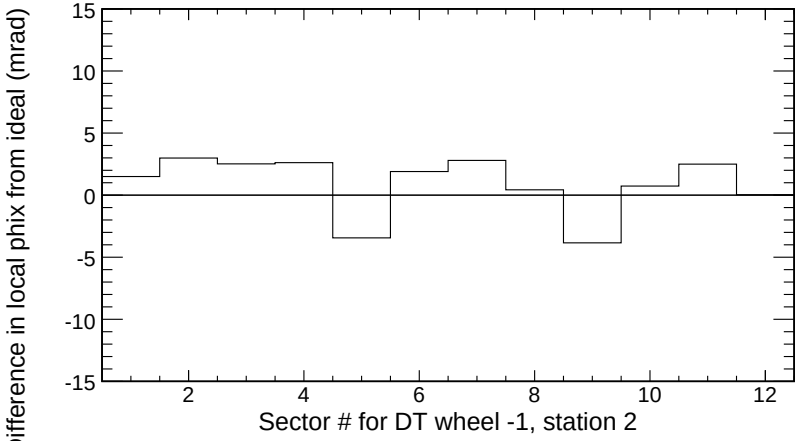


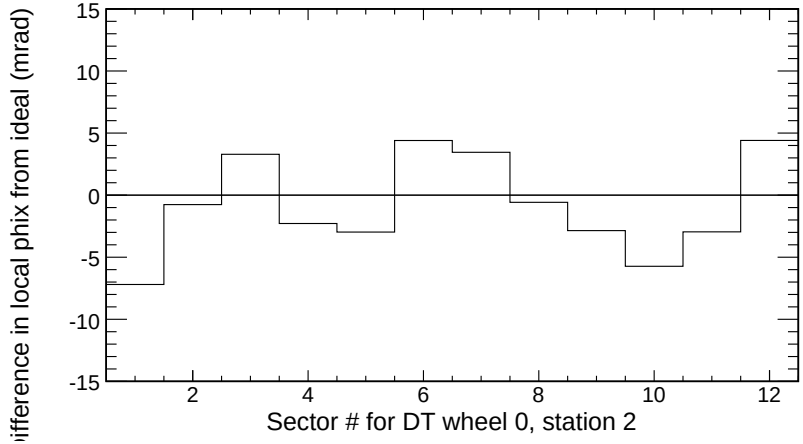
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



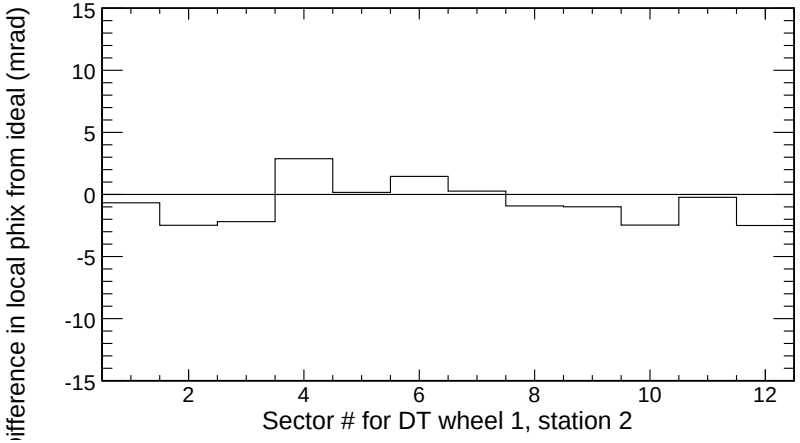


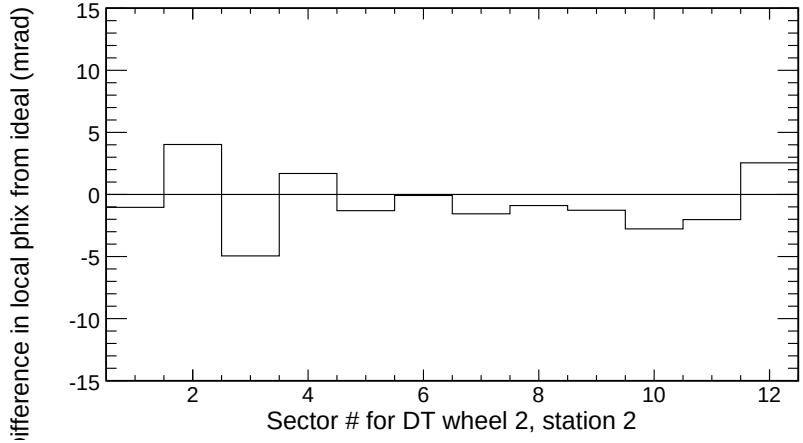


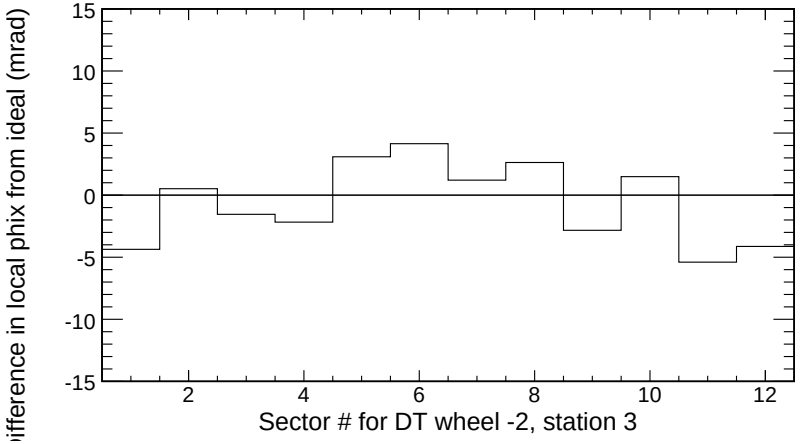


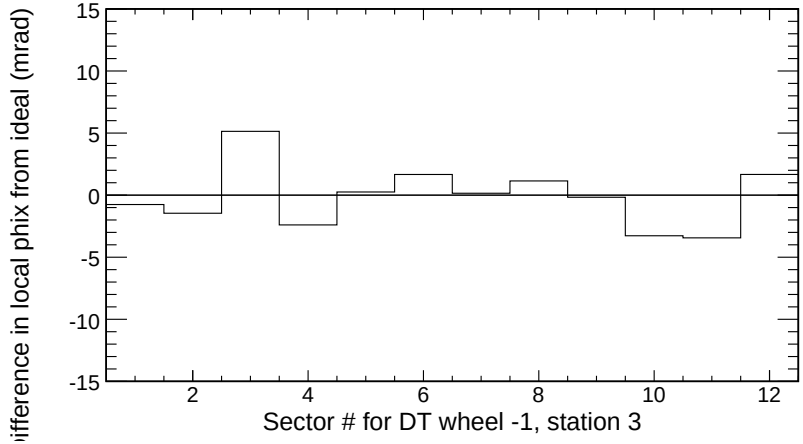
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



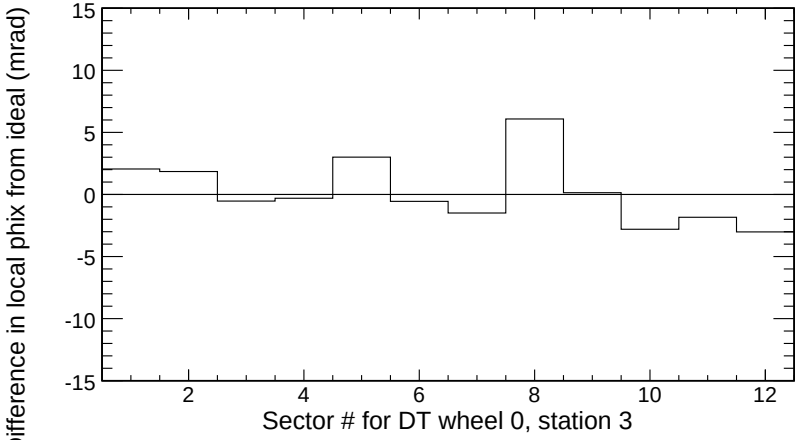


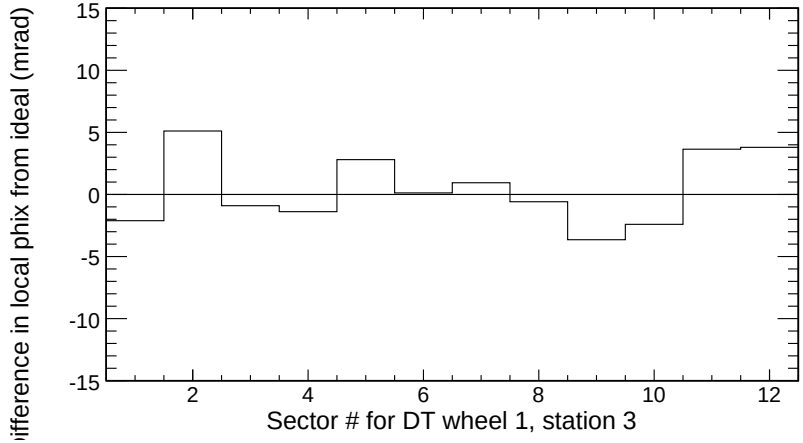


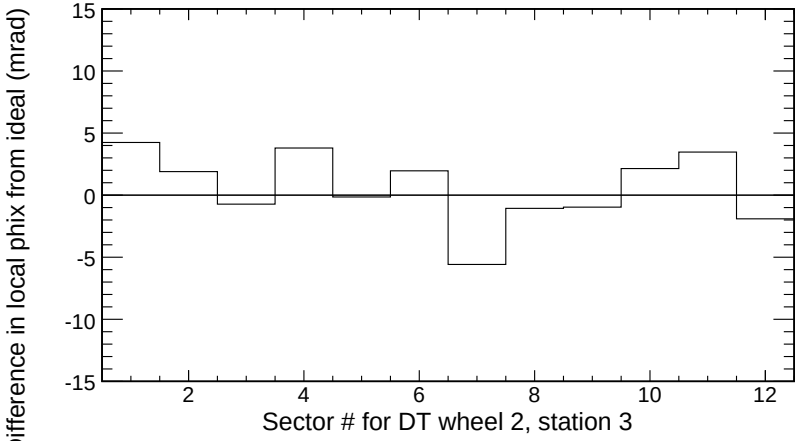


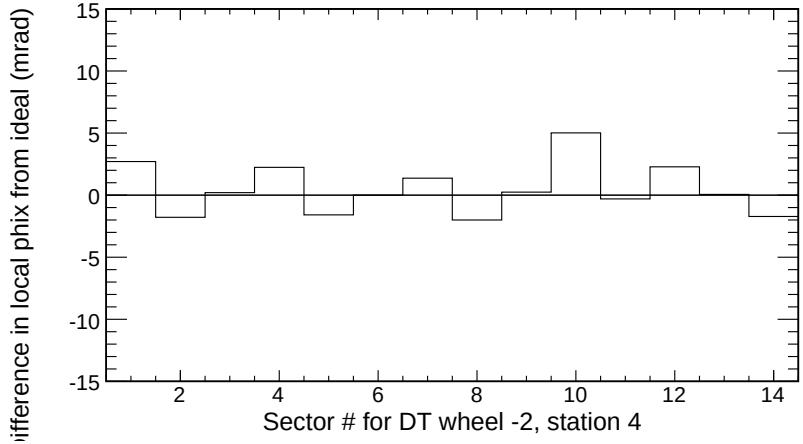
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



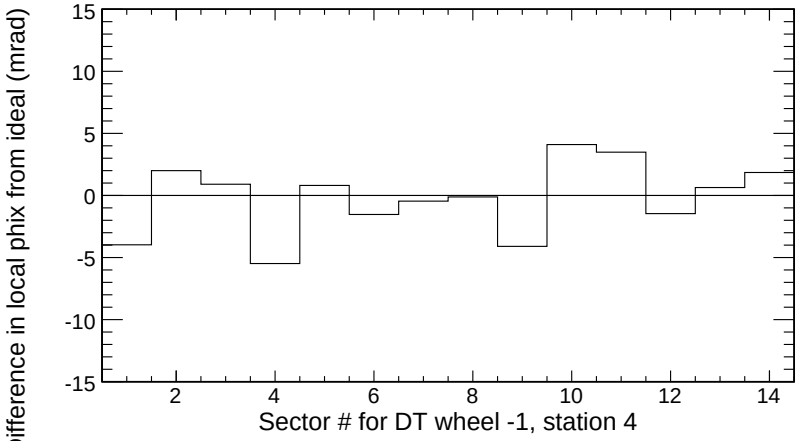


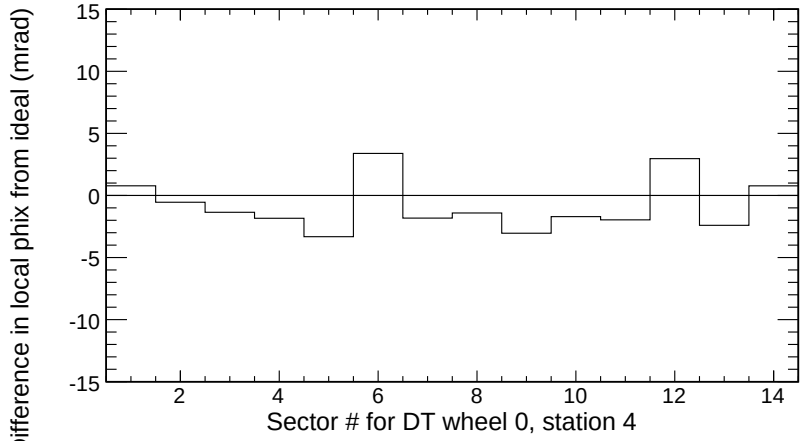


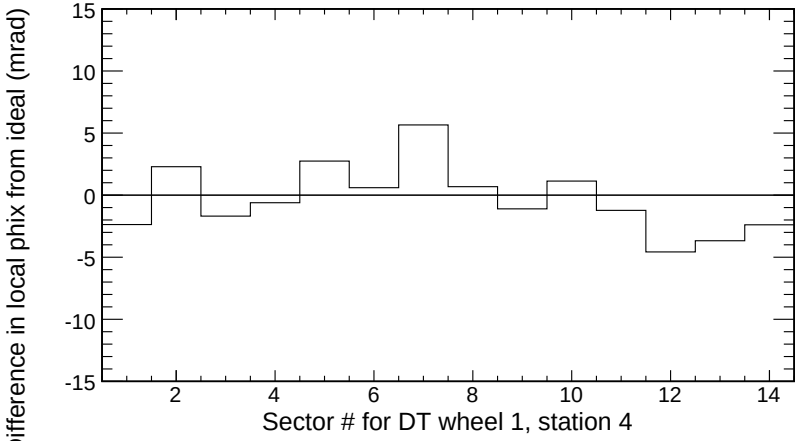


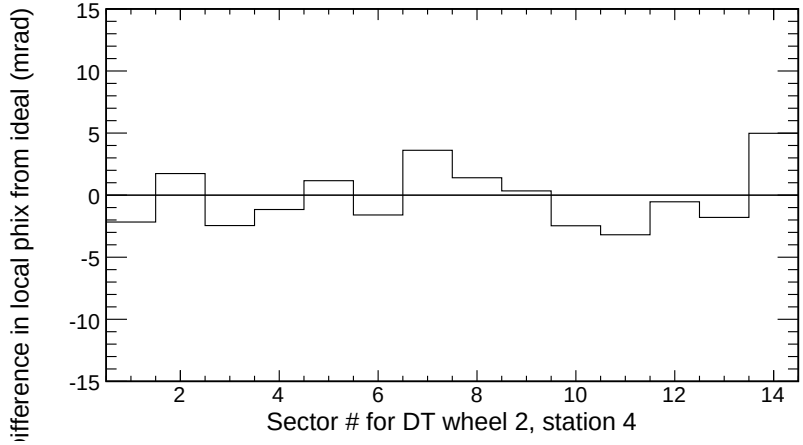
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



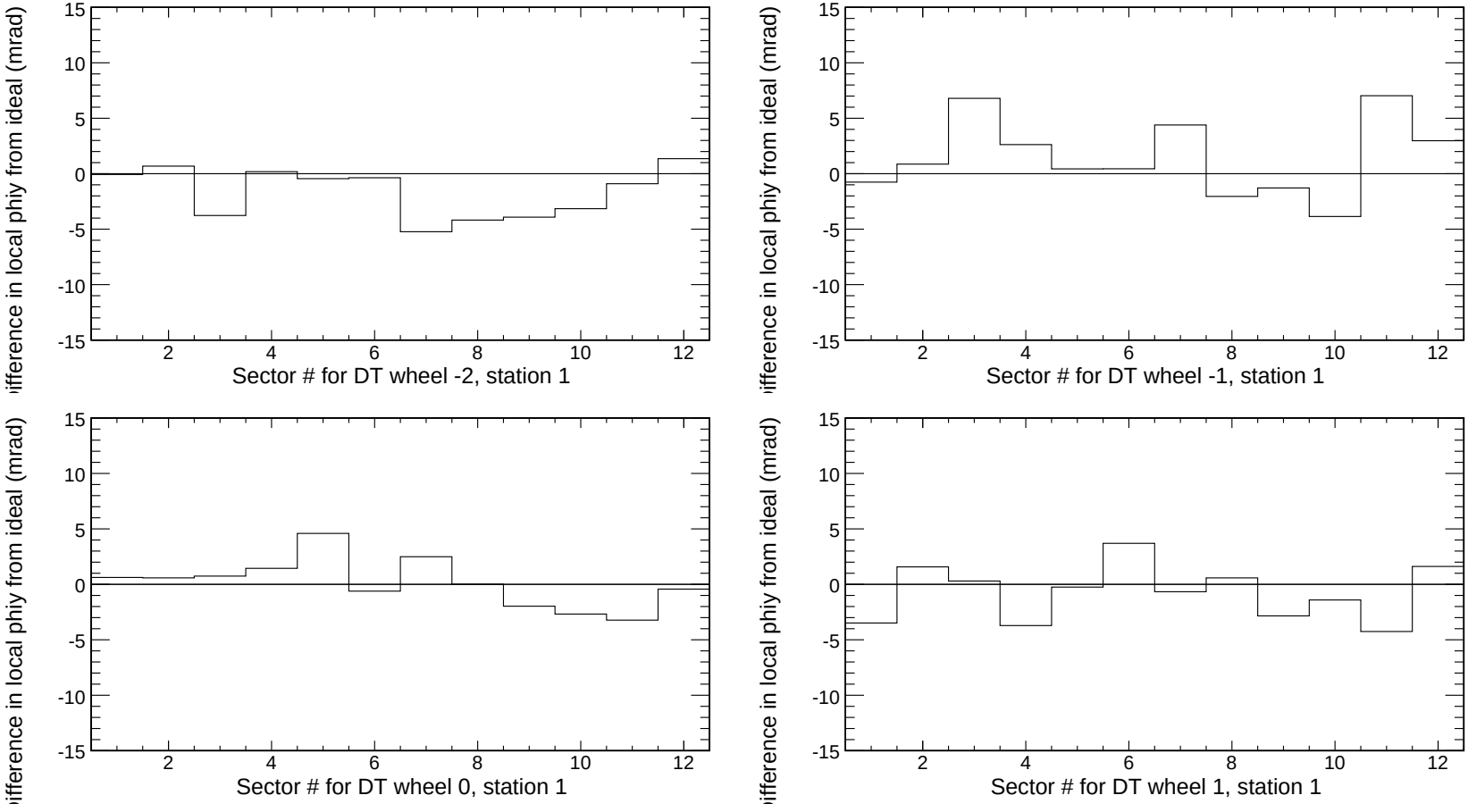






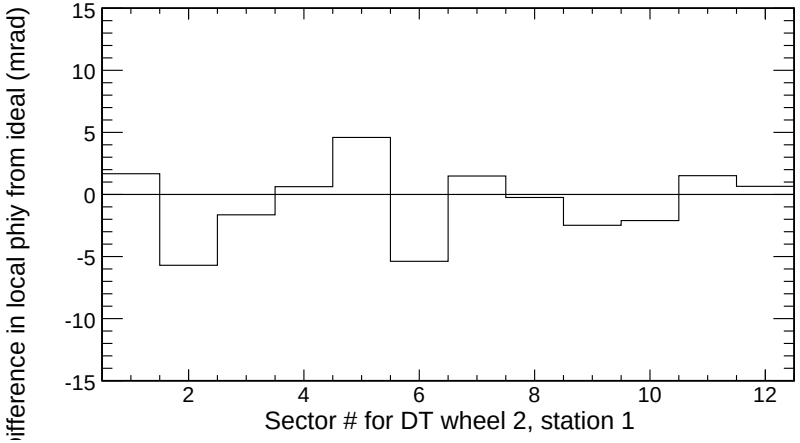
Reference: all the constants

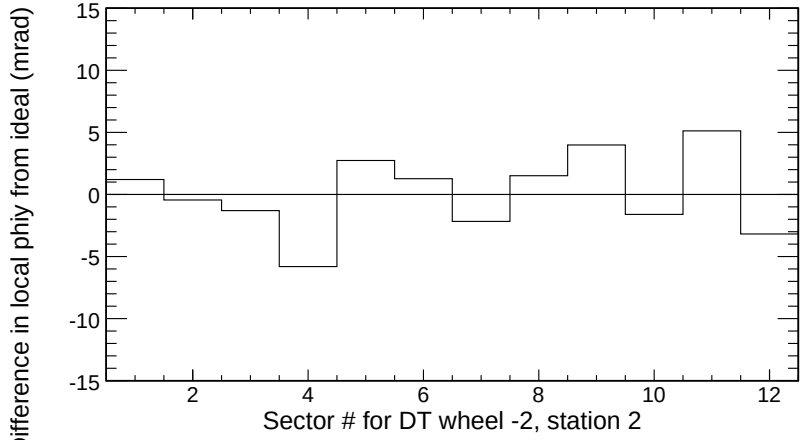
Yellow denotes a parameter that was aligned with globalMuons

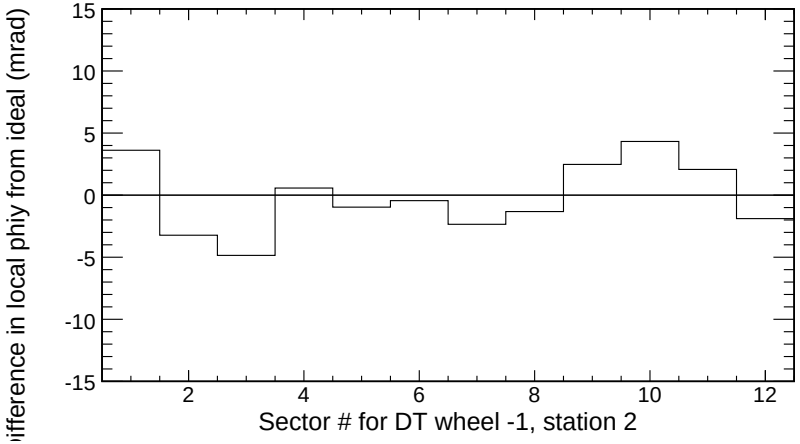


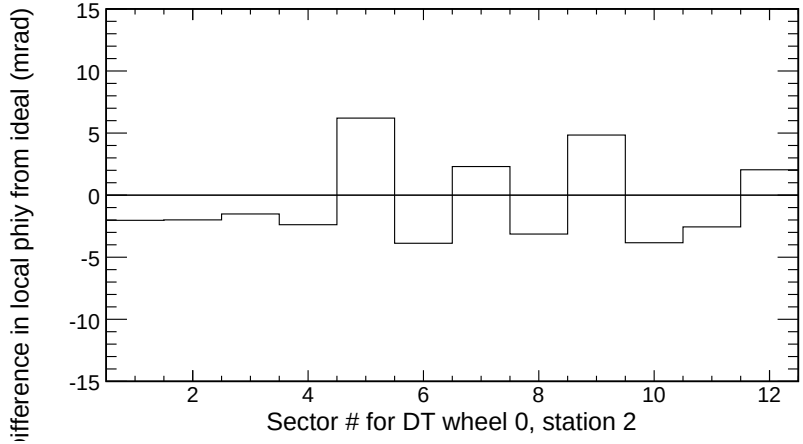
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



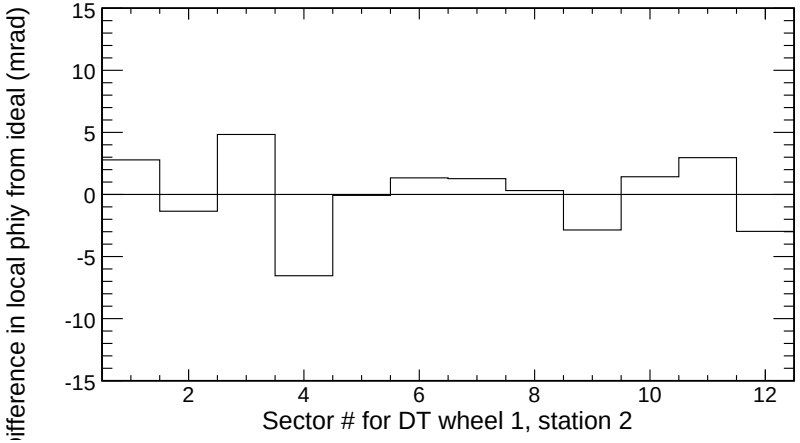


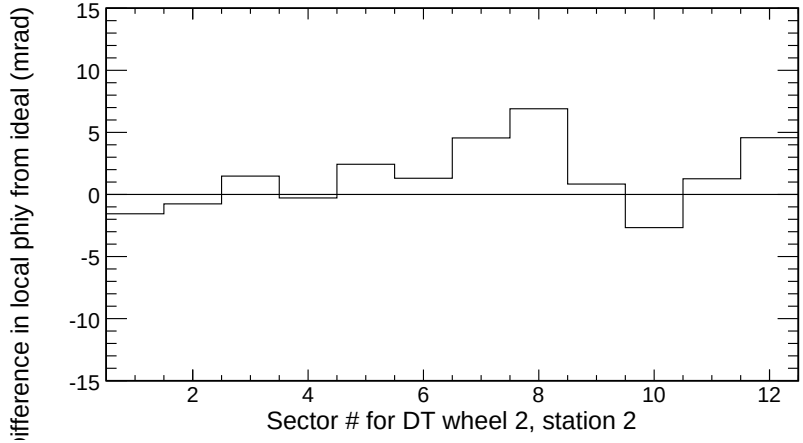


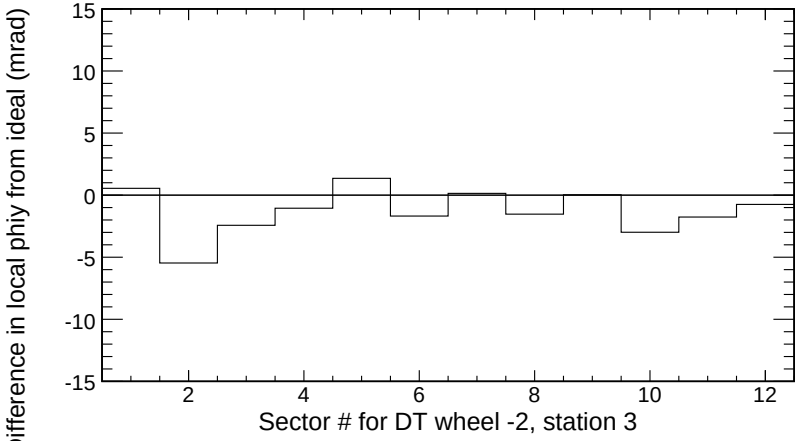


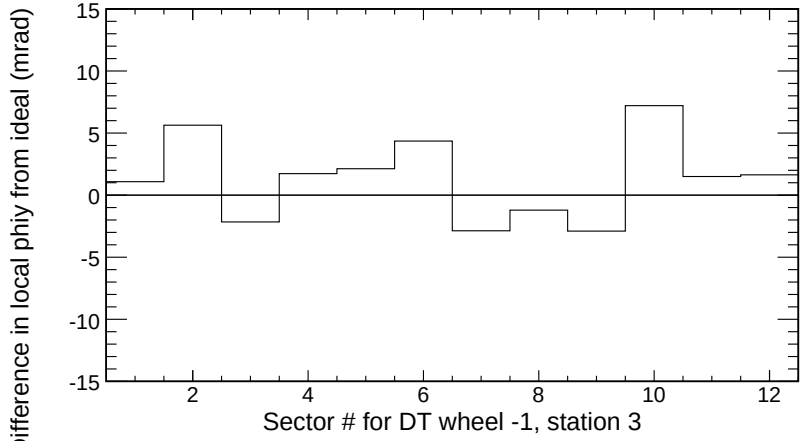
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



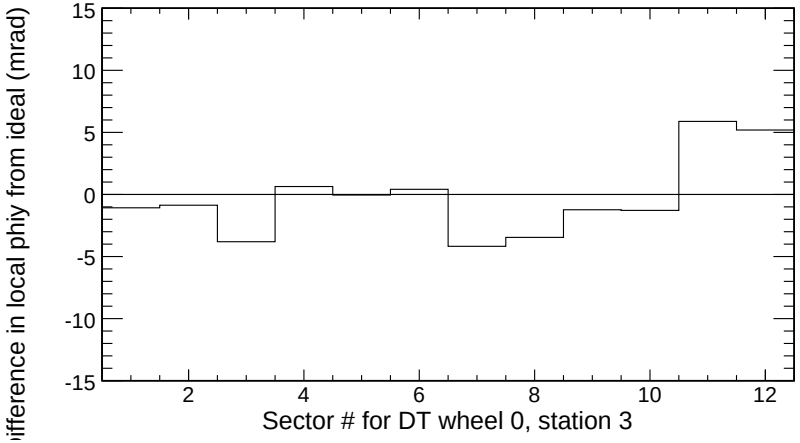


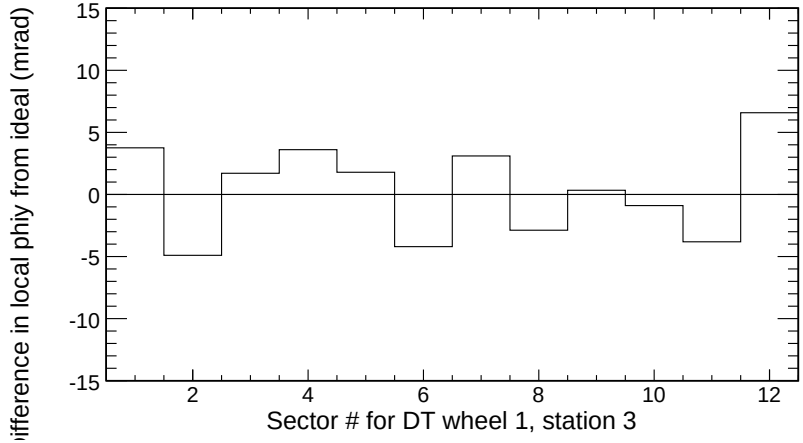


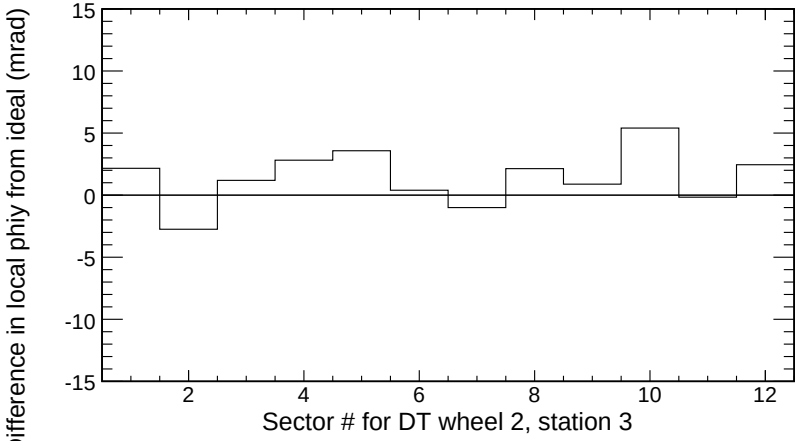


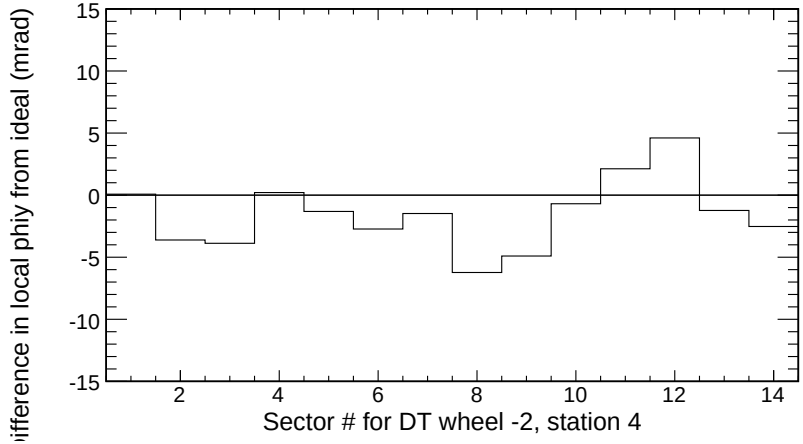
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



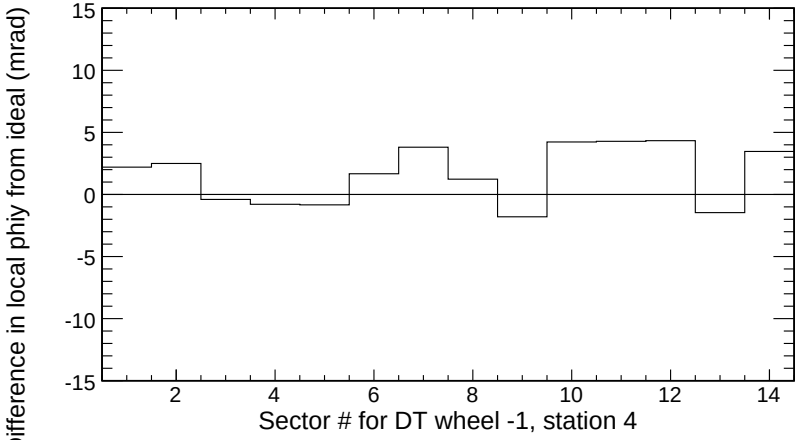


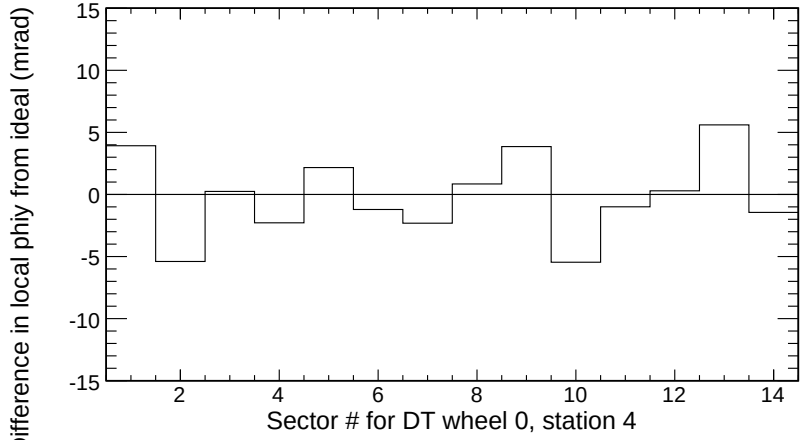


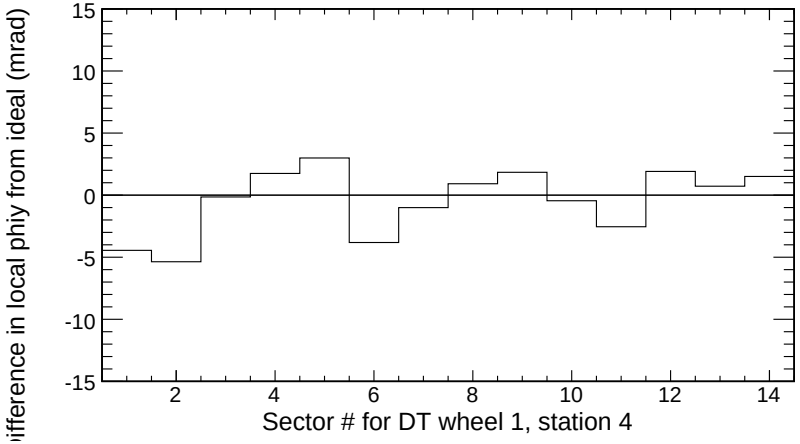


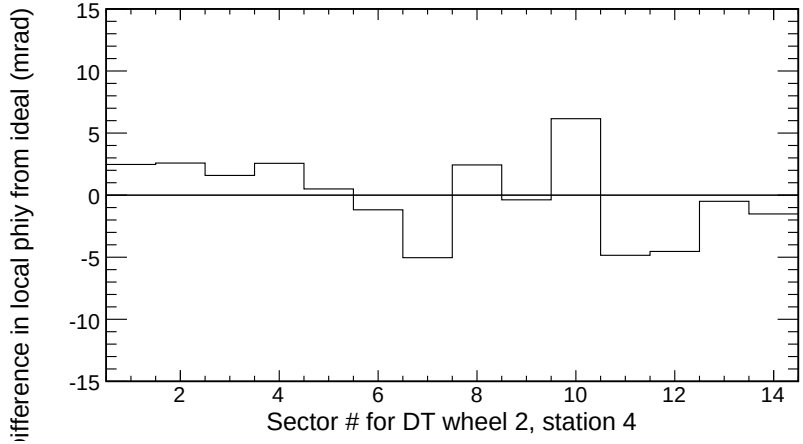
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



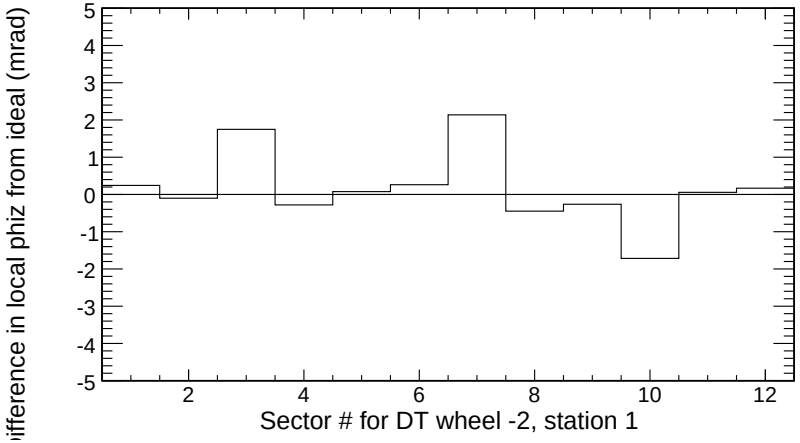


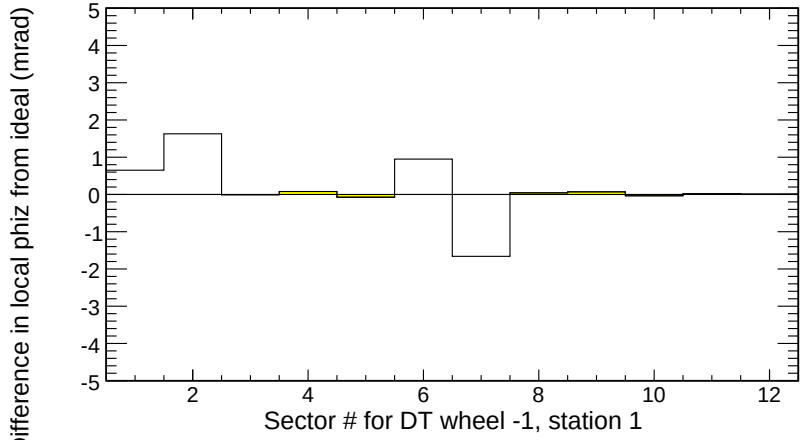


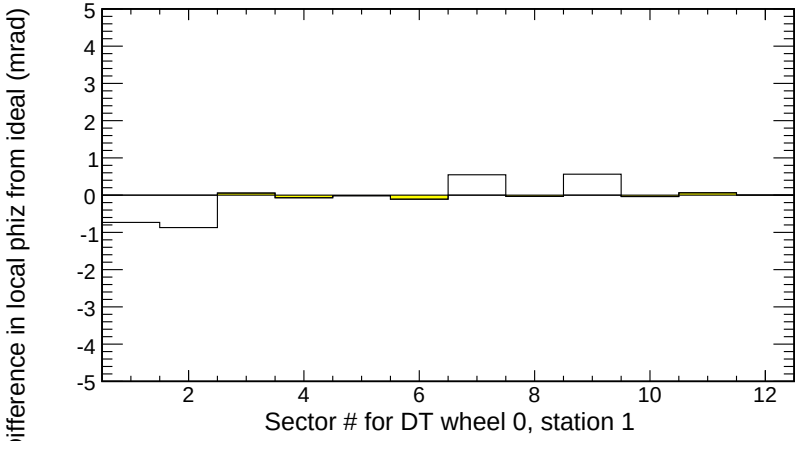


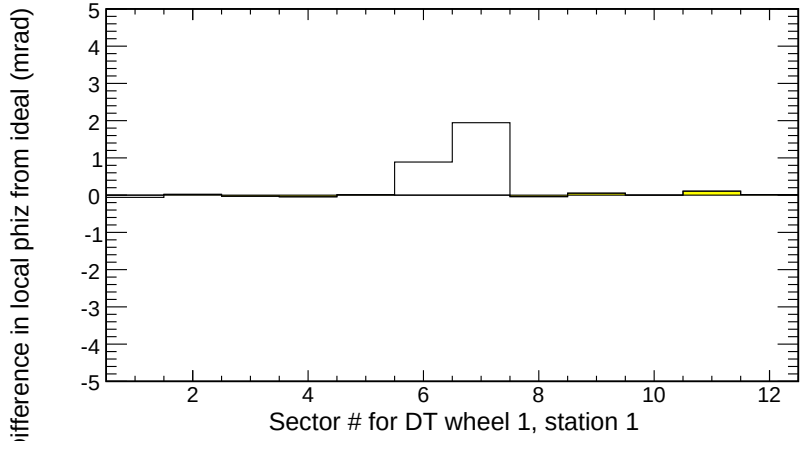
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



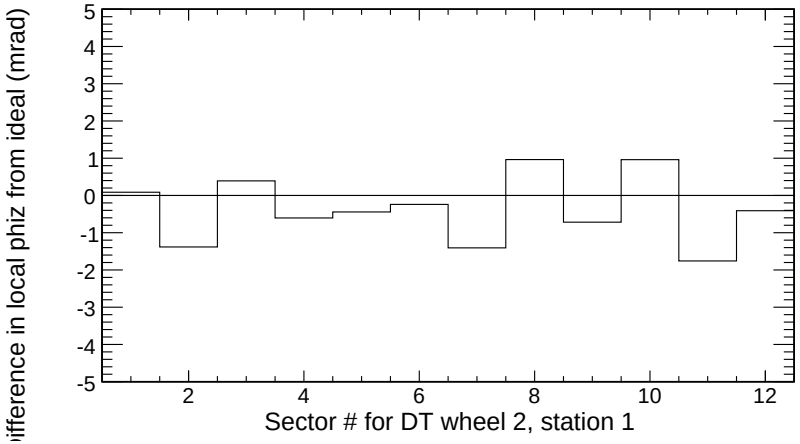


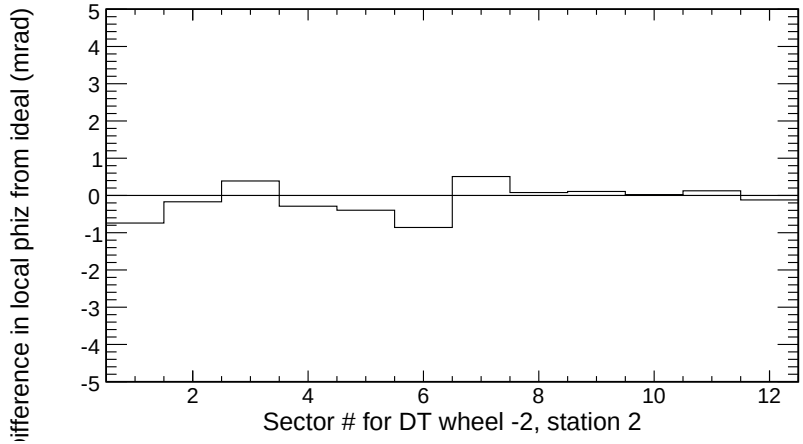


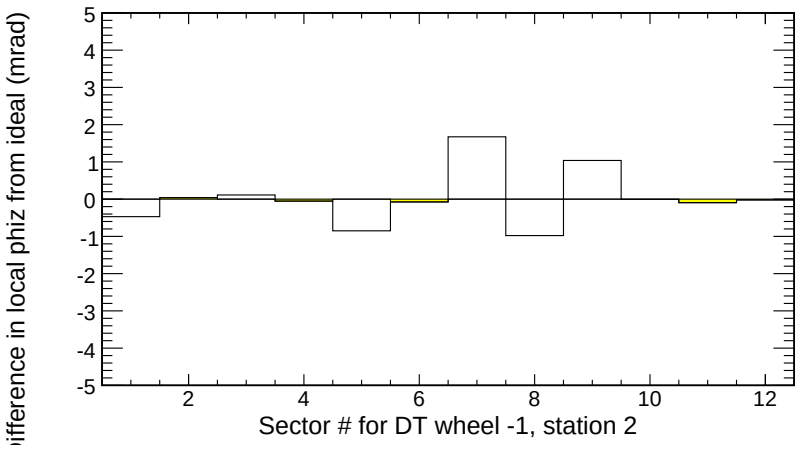


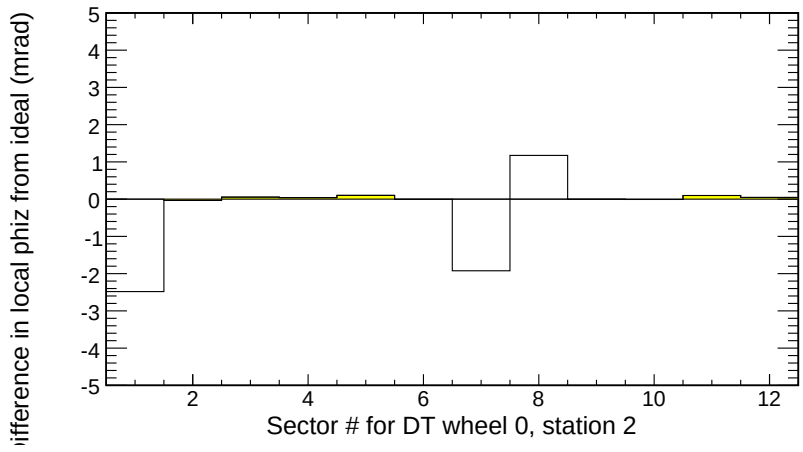
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



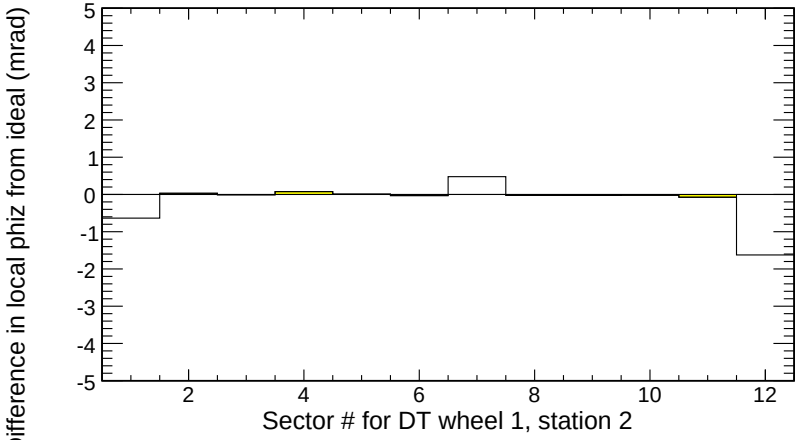


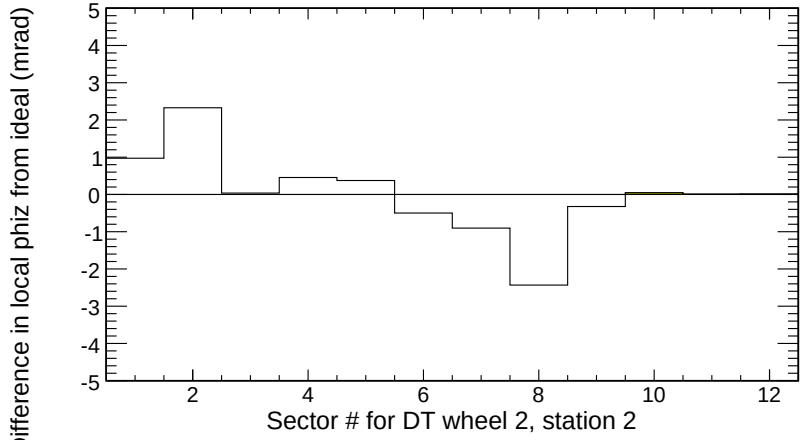


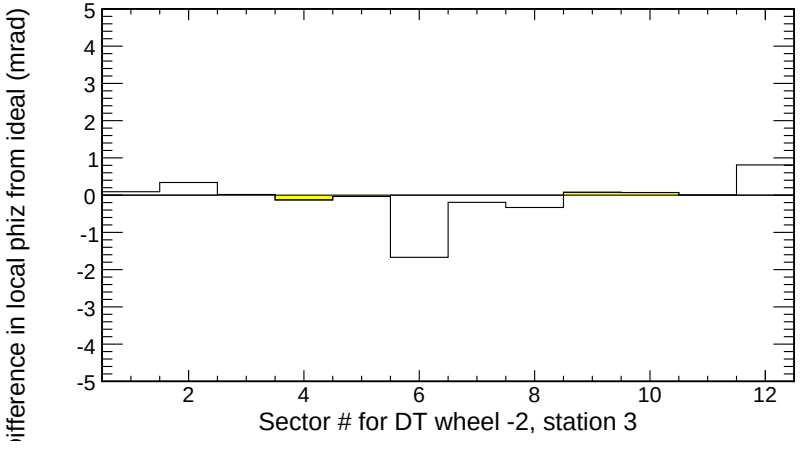


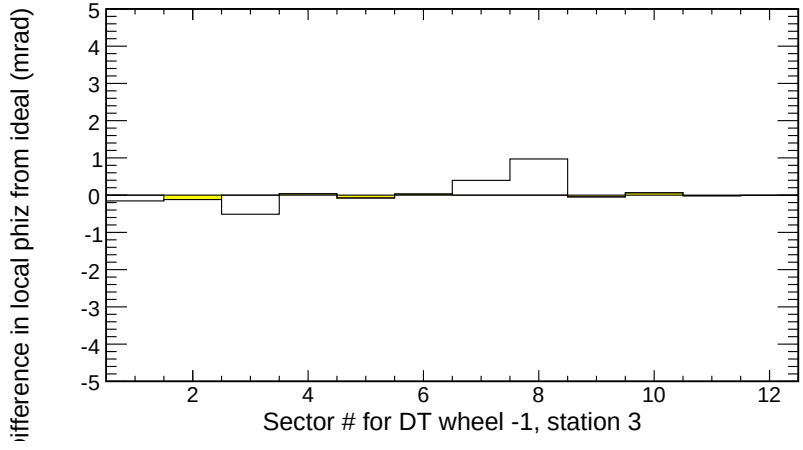
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



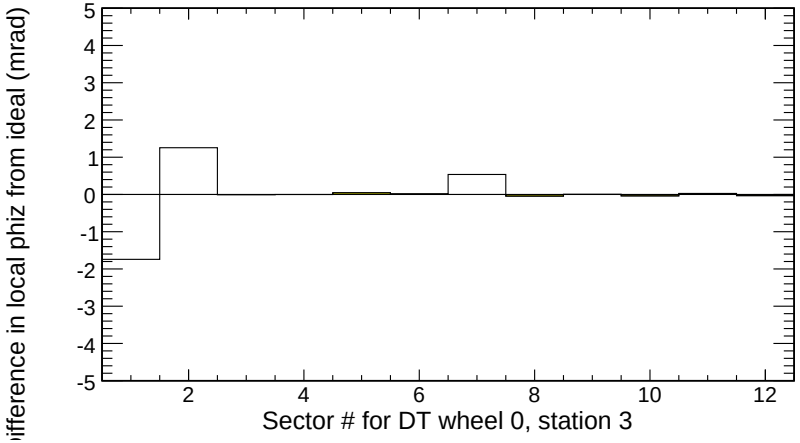


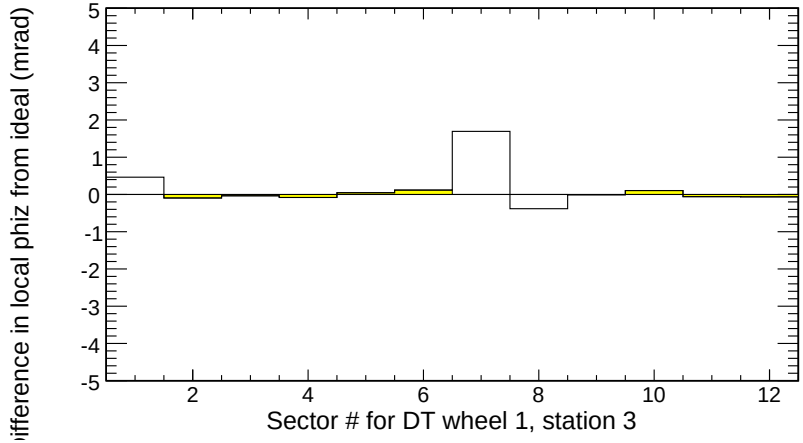


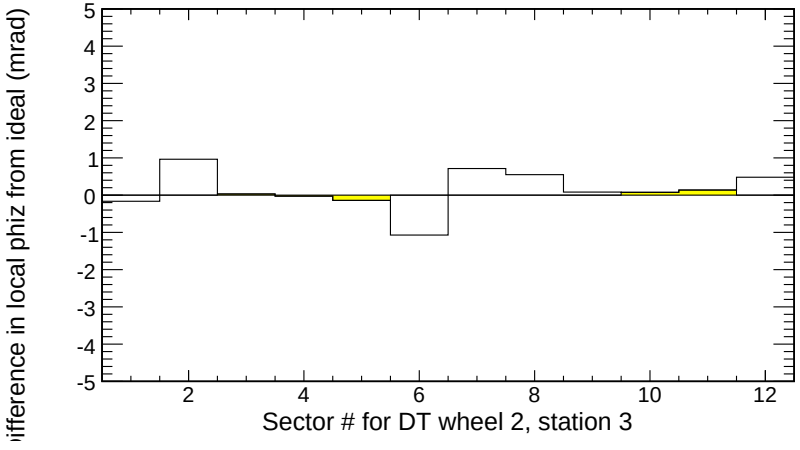


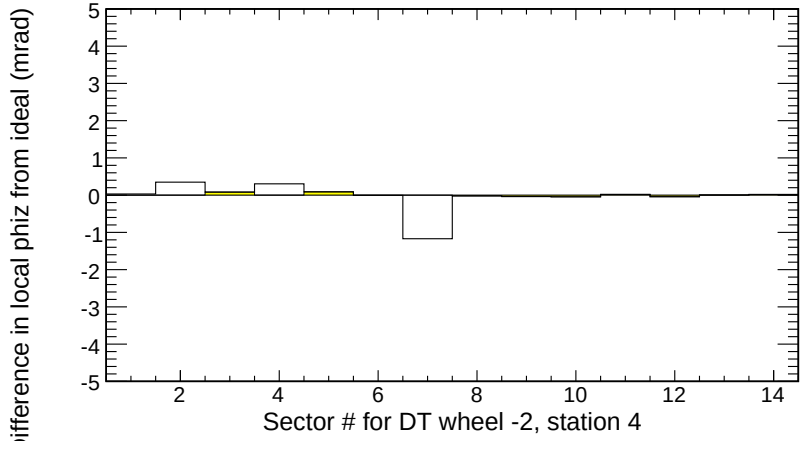
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



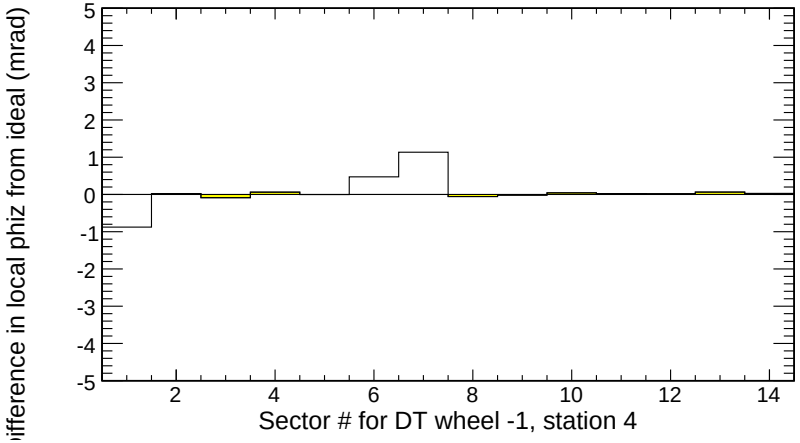


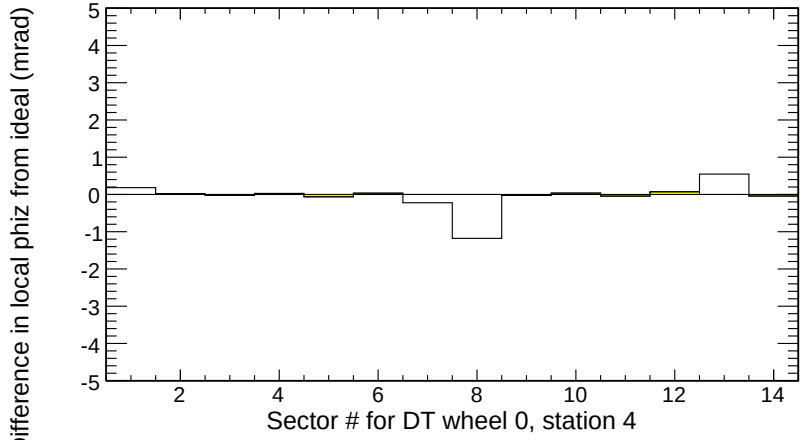


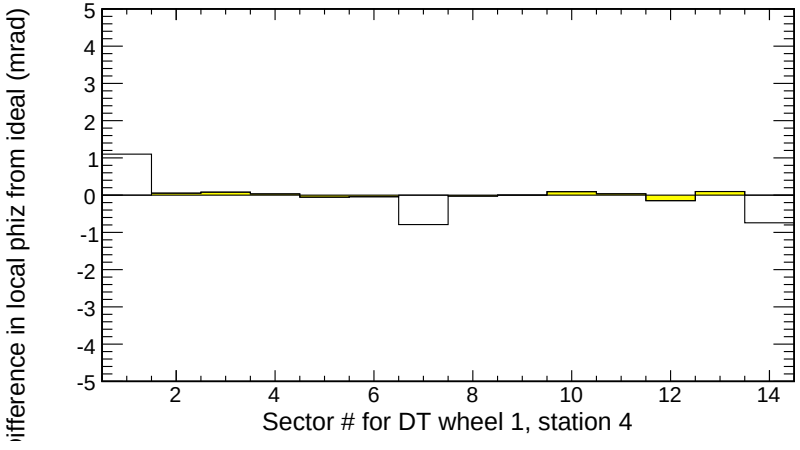


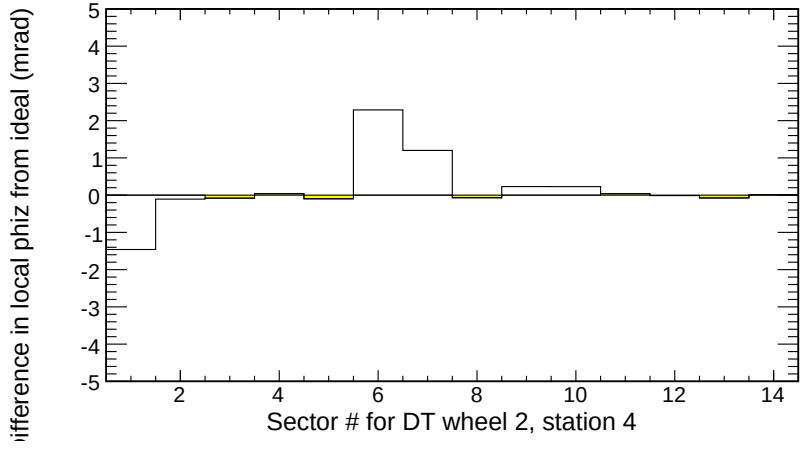
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



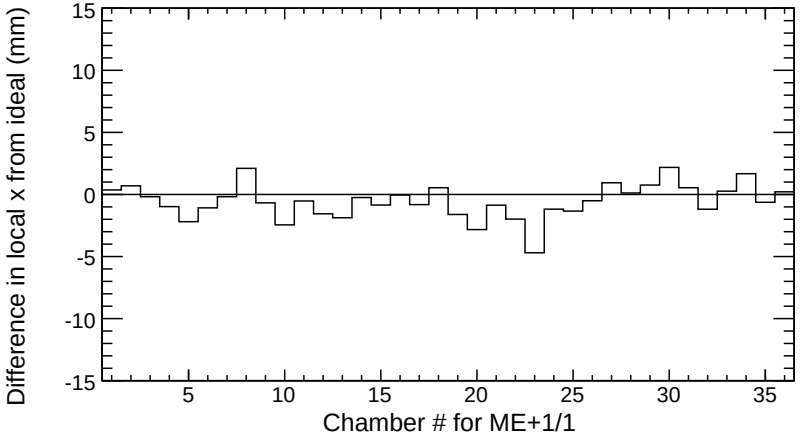


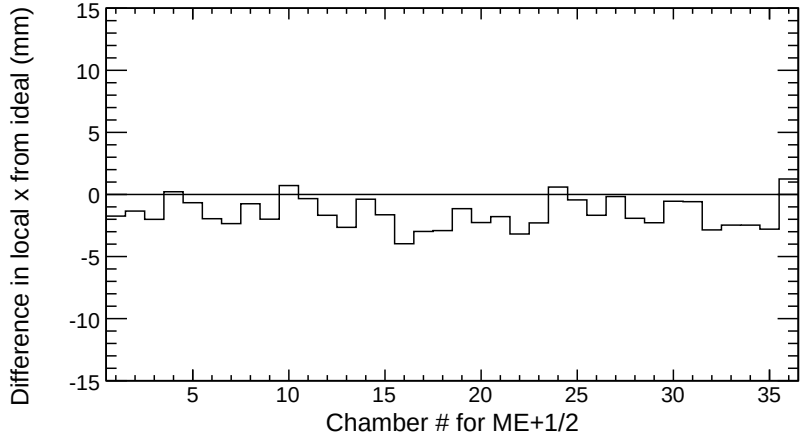


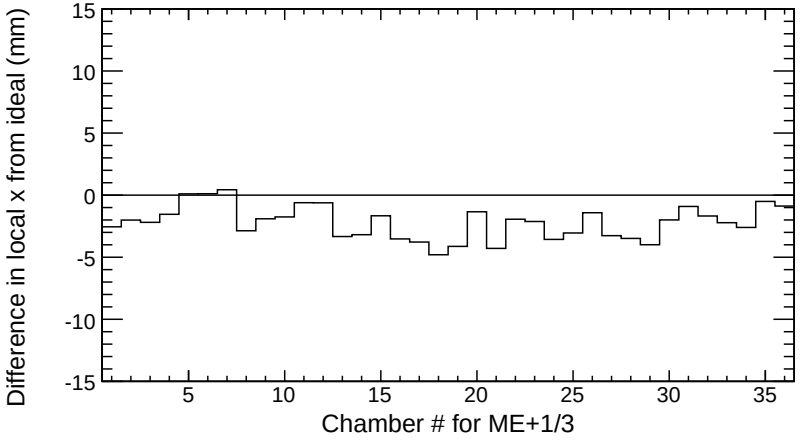


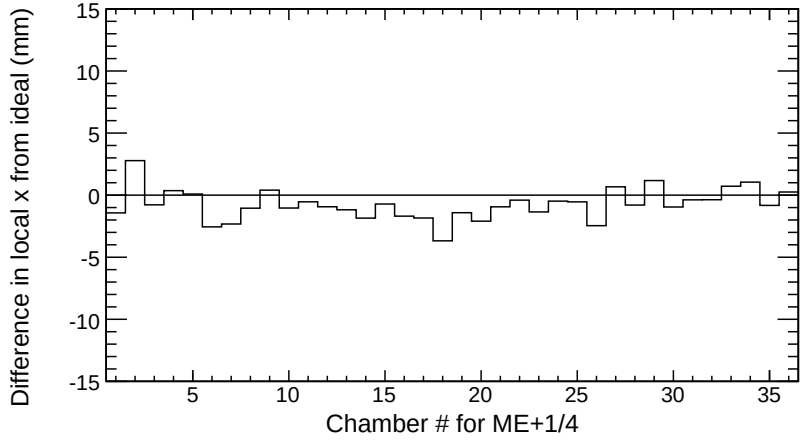
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



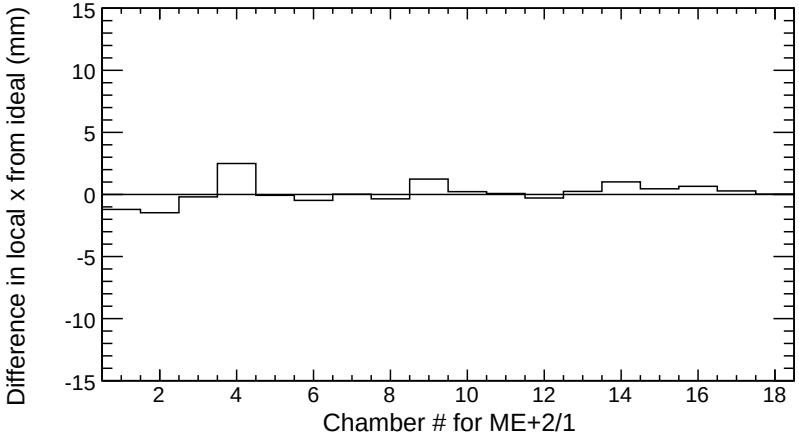


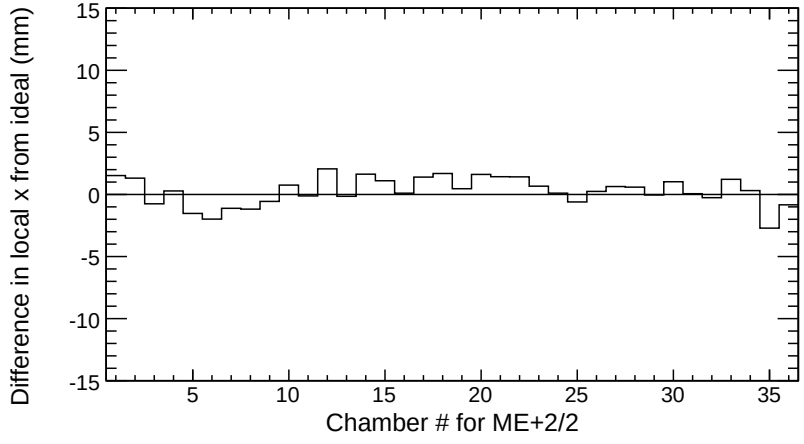


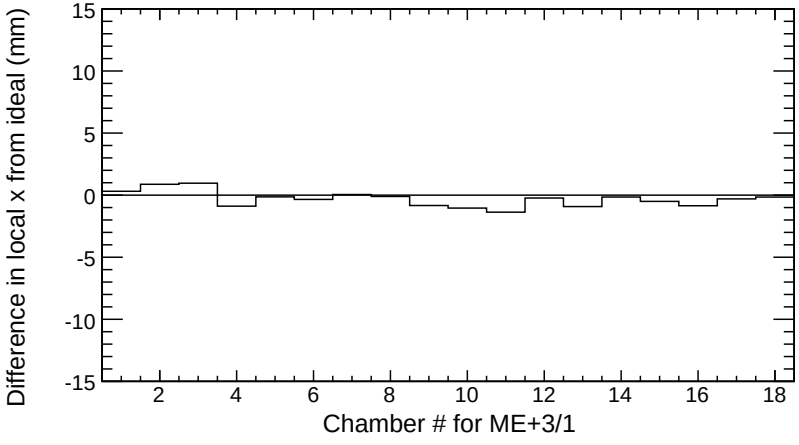


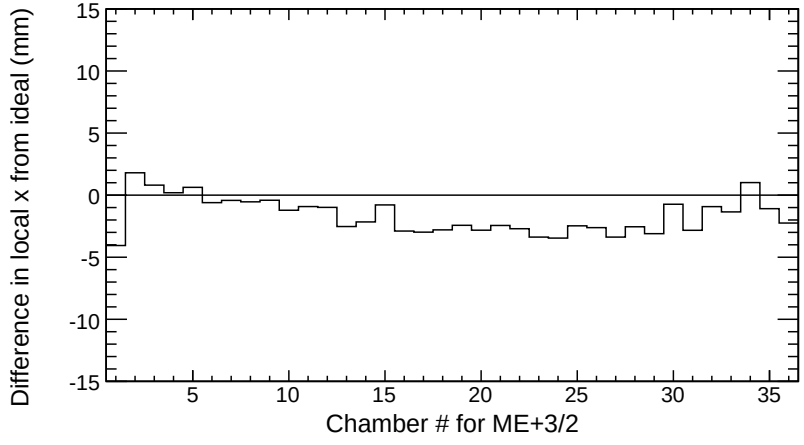
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



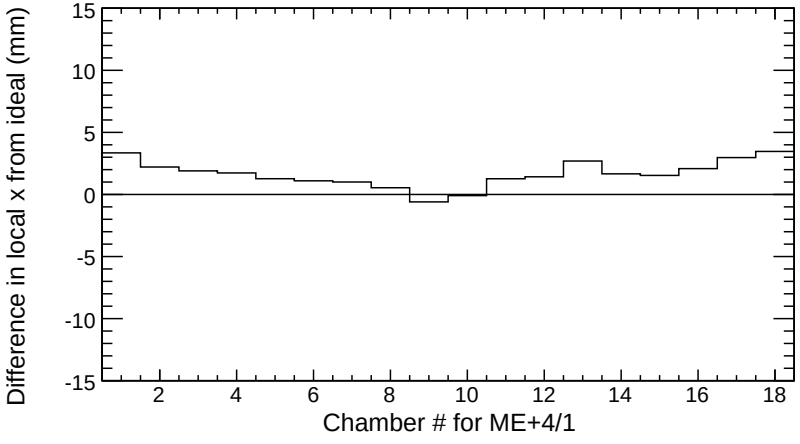


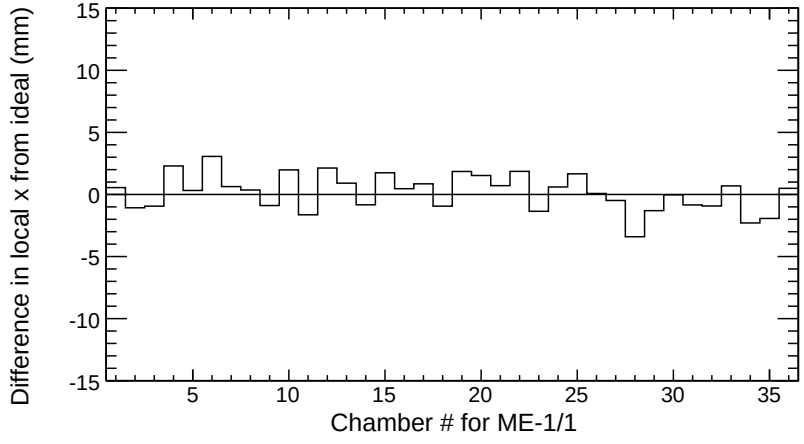


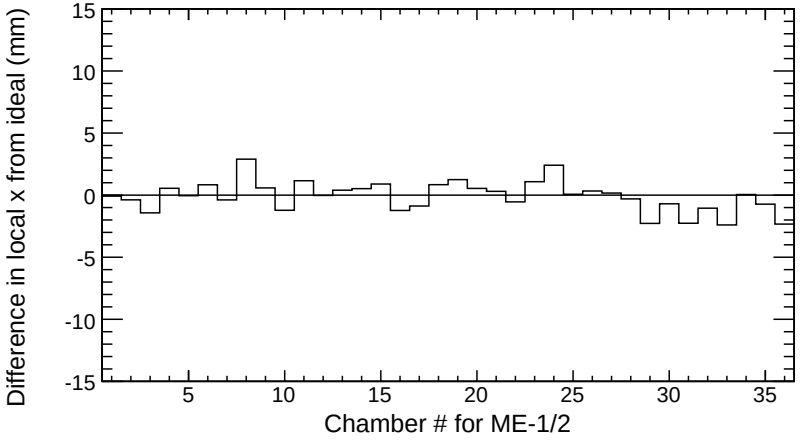


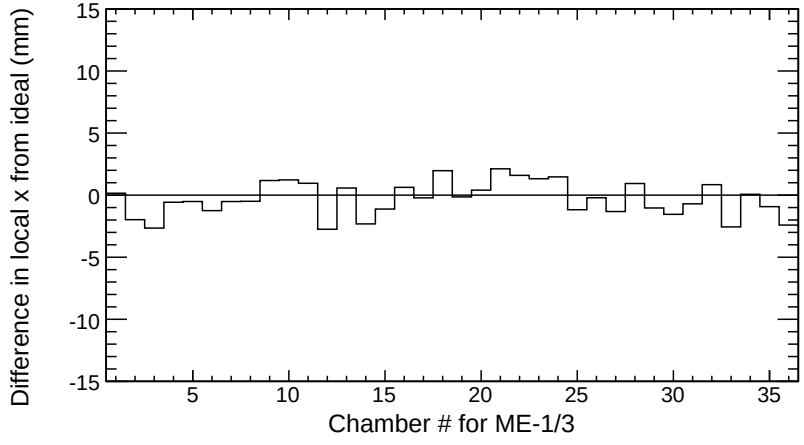
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



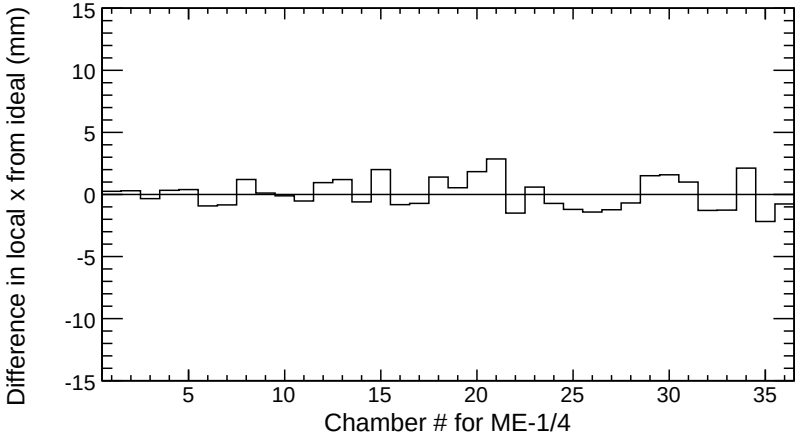


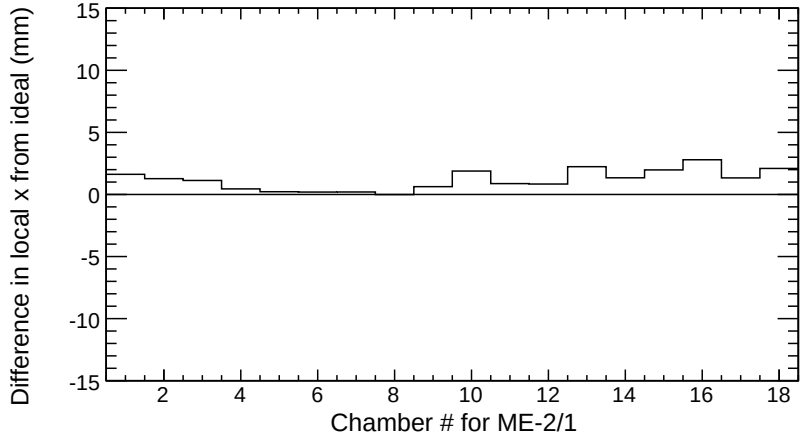


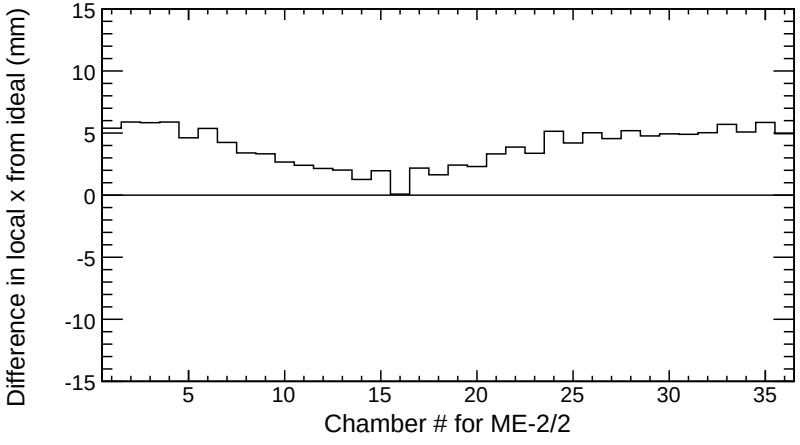


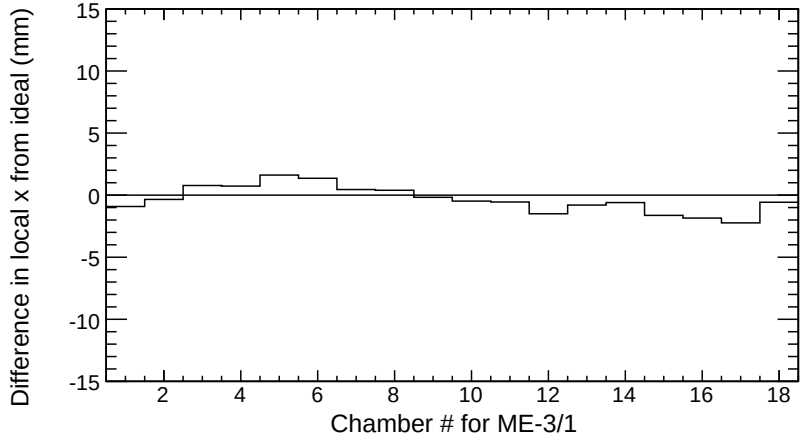
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



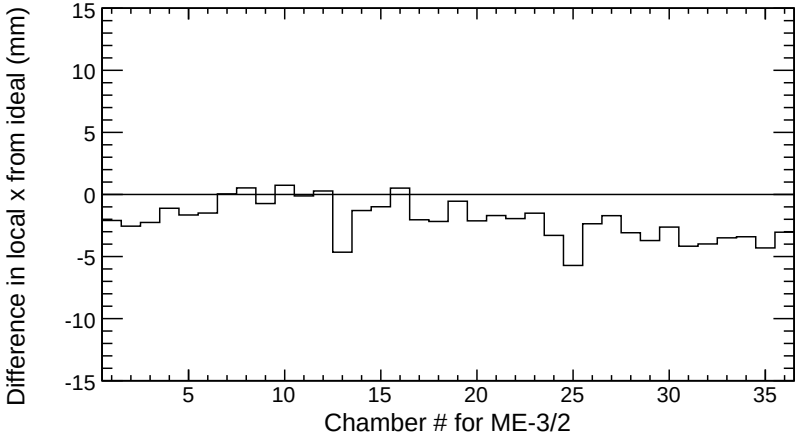


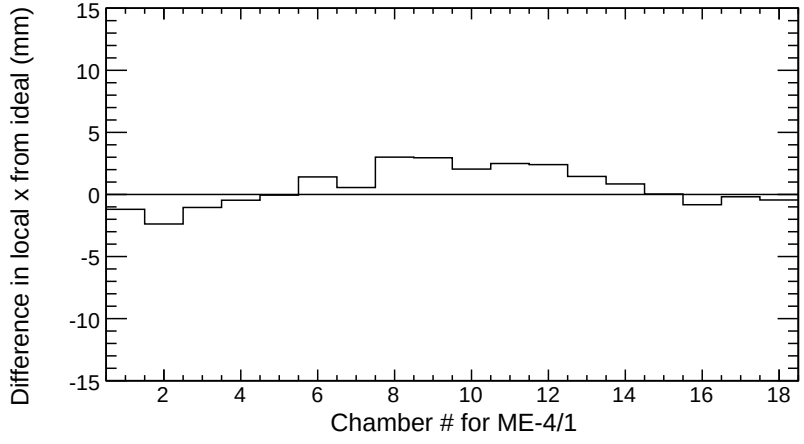


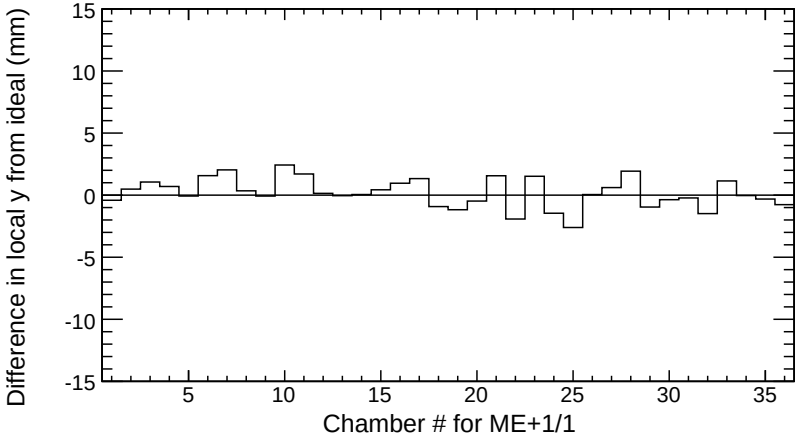


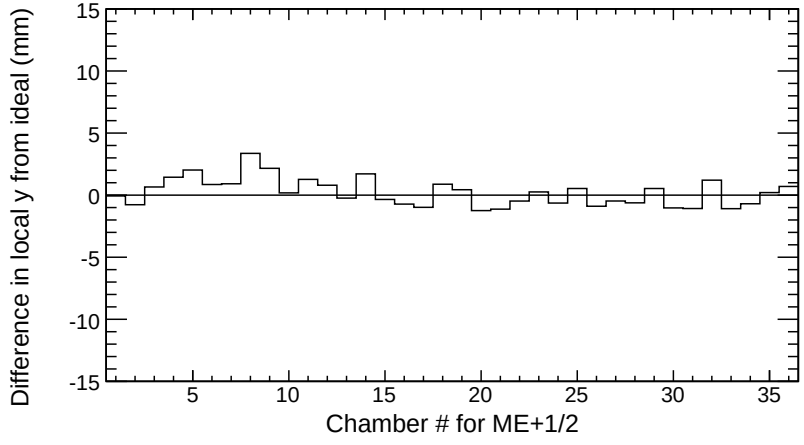
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



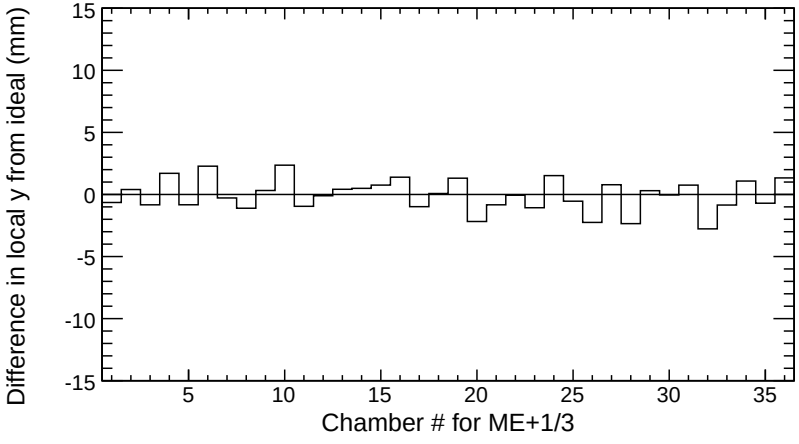


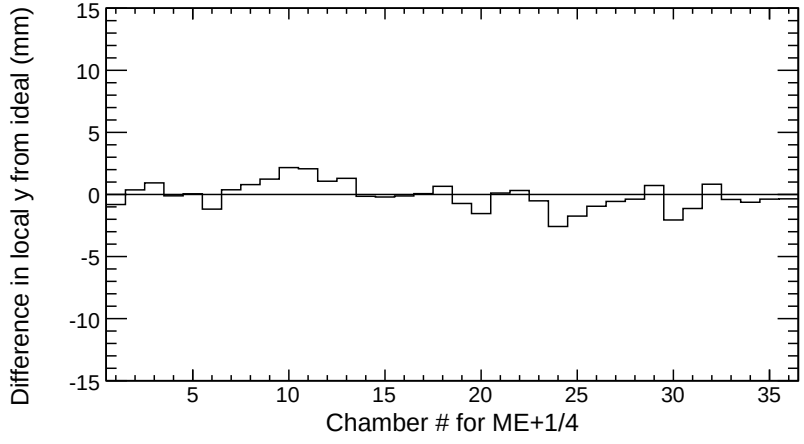


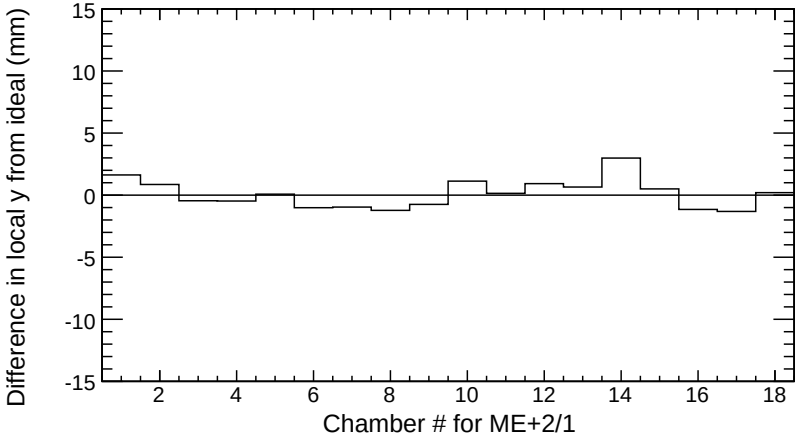


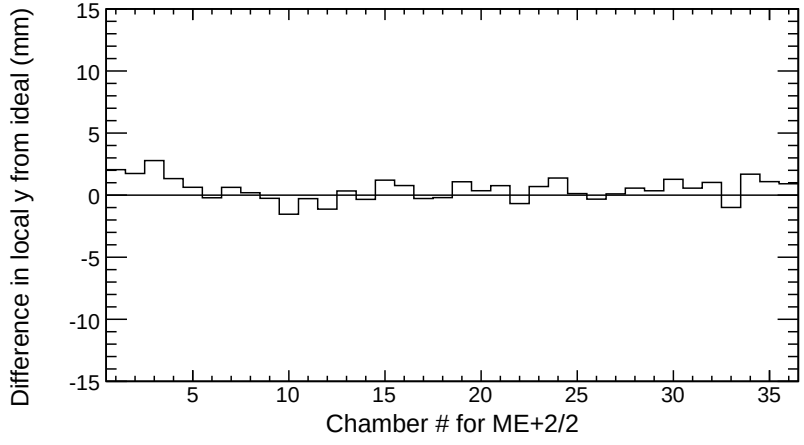
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



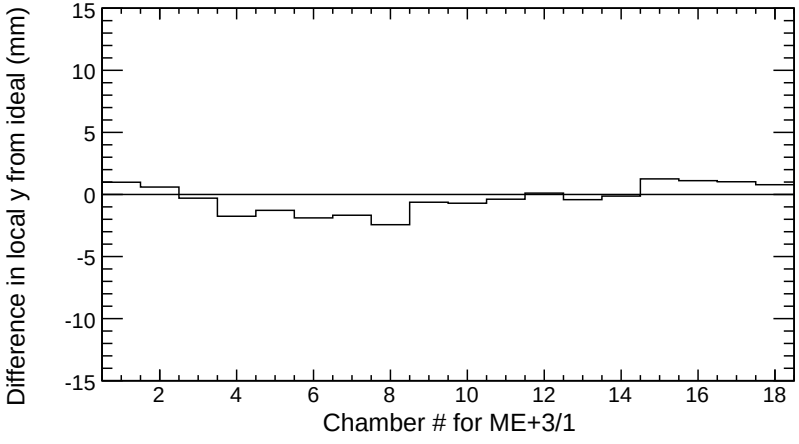


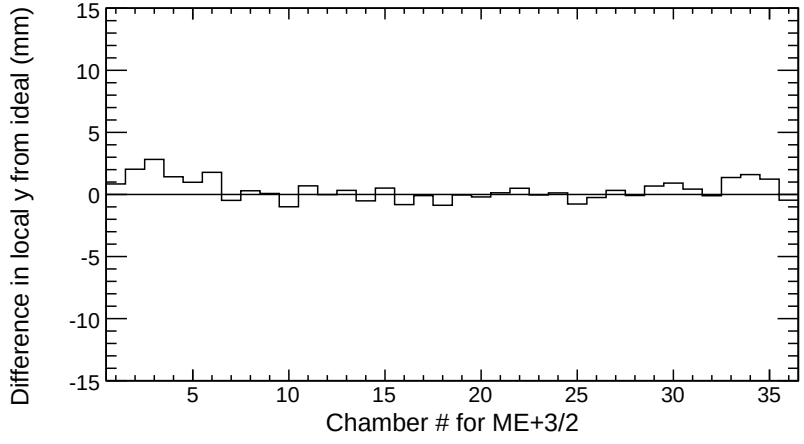


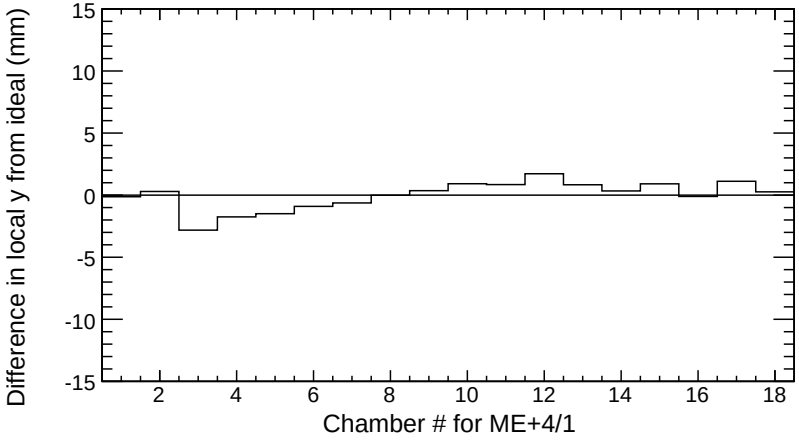


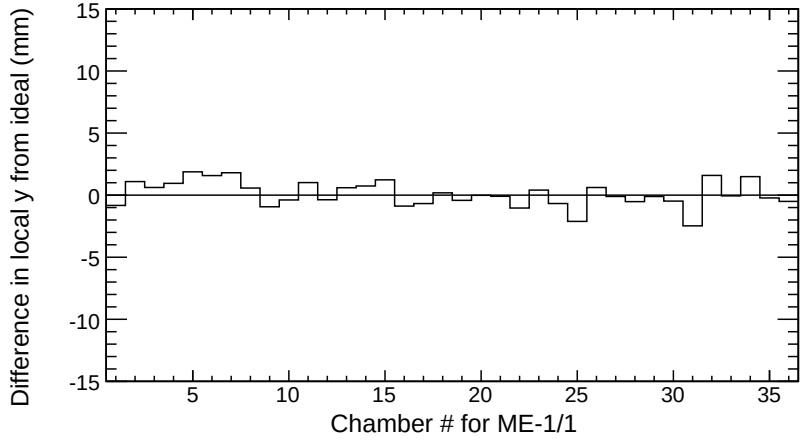
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



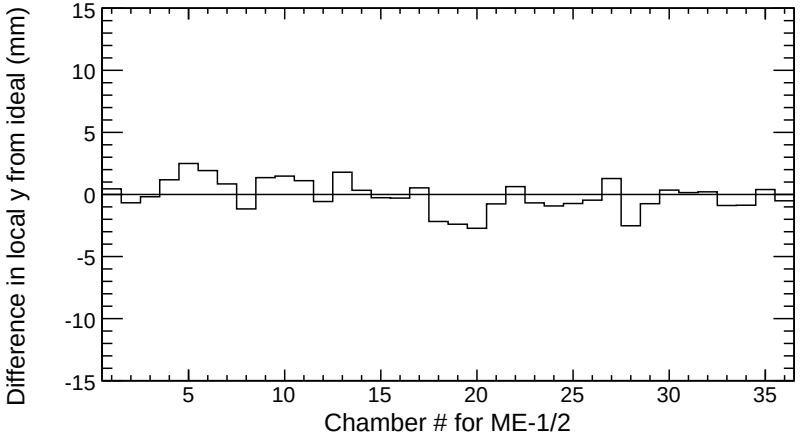


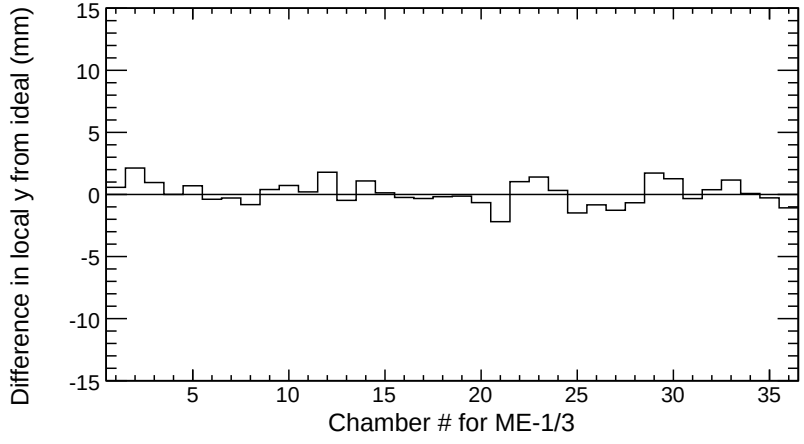


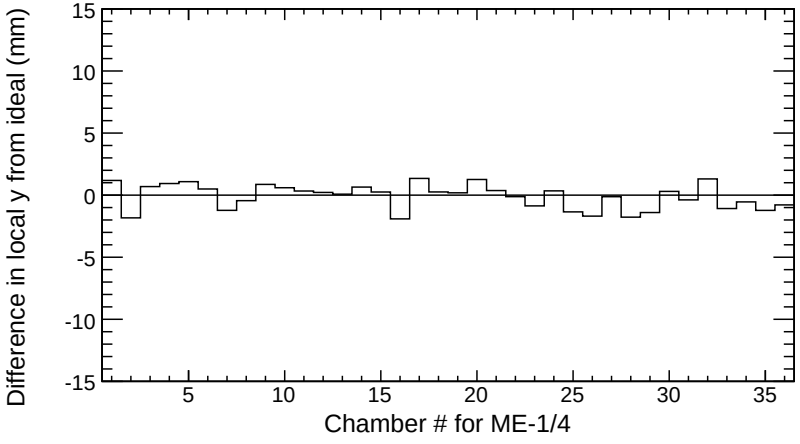


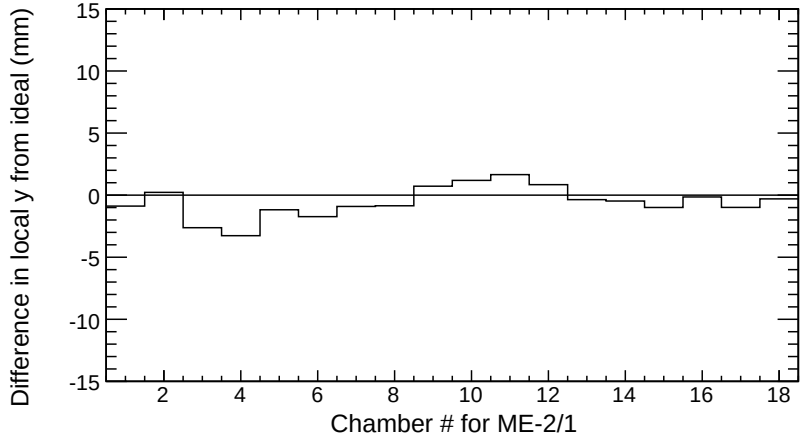
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



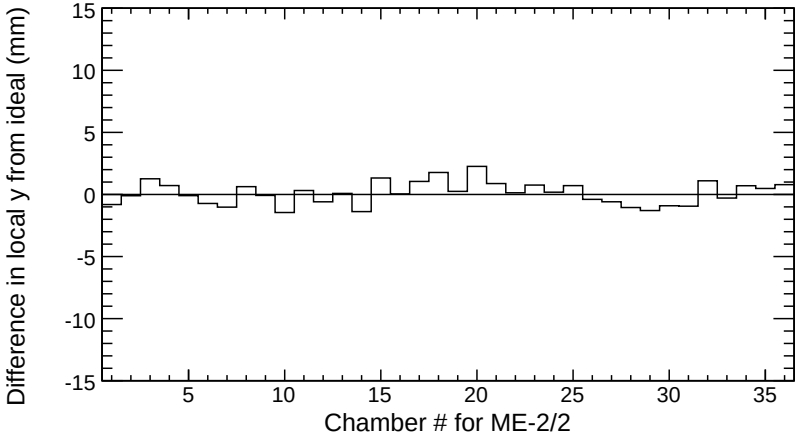


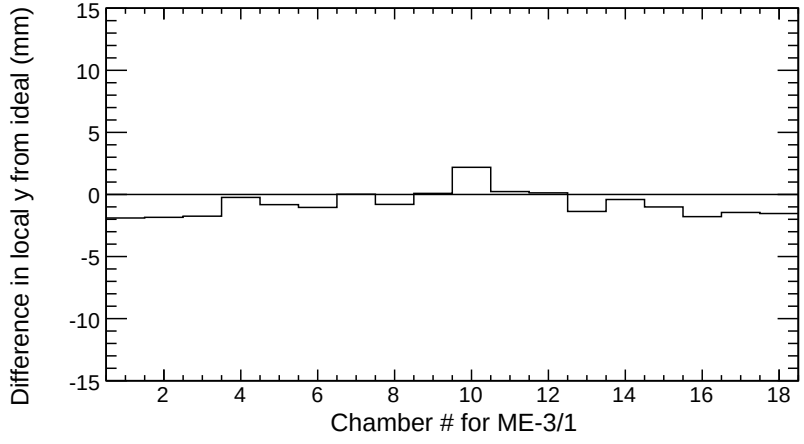


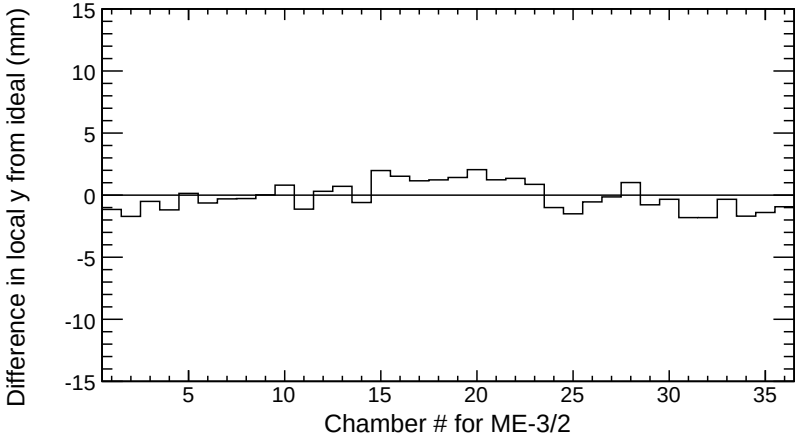


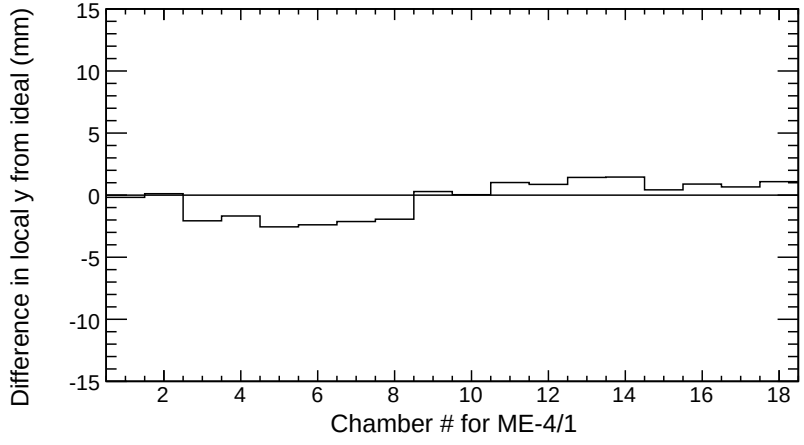
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



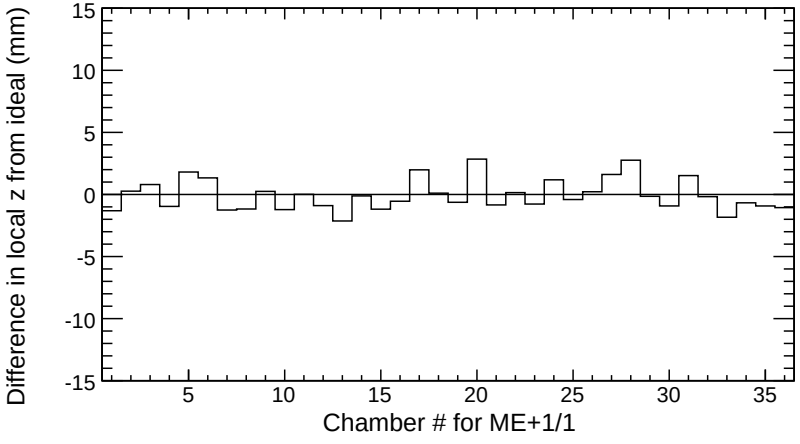


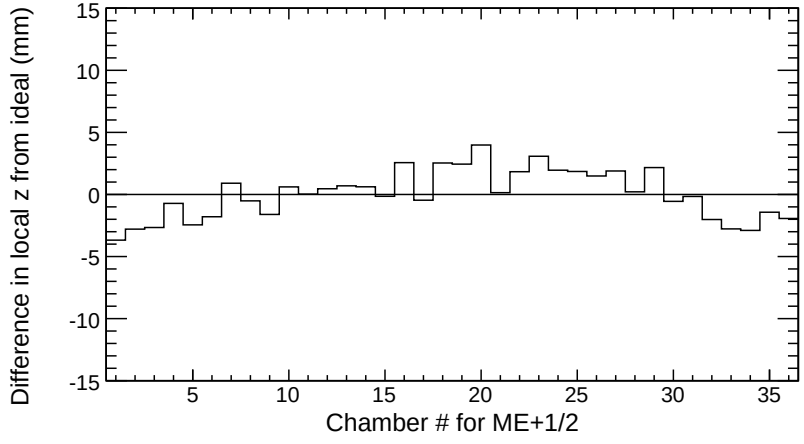


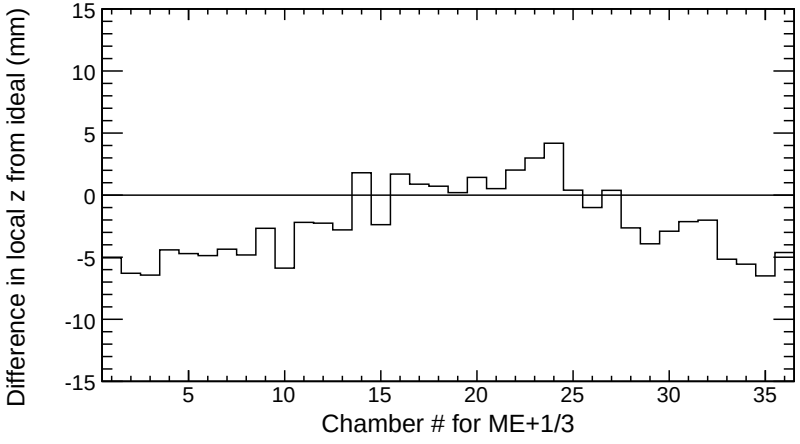


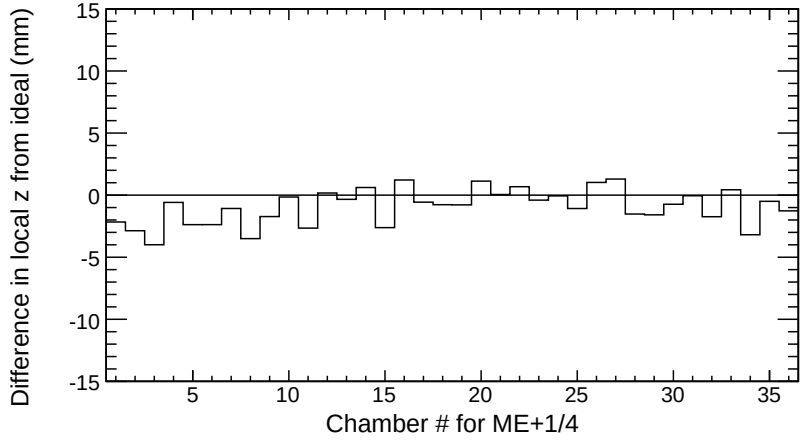
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



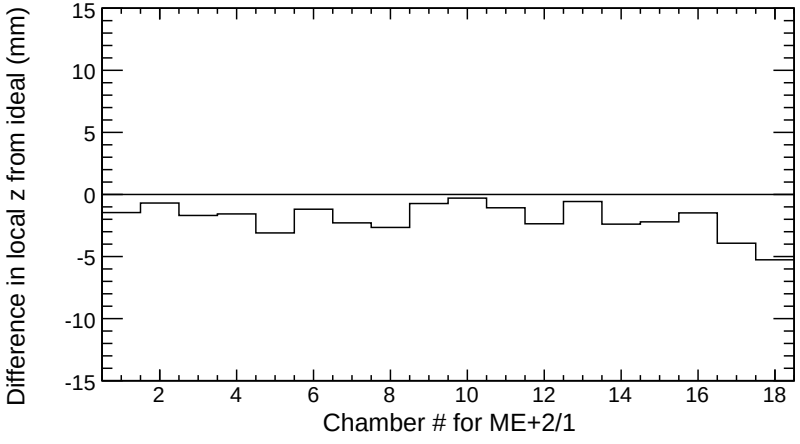


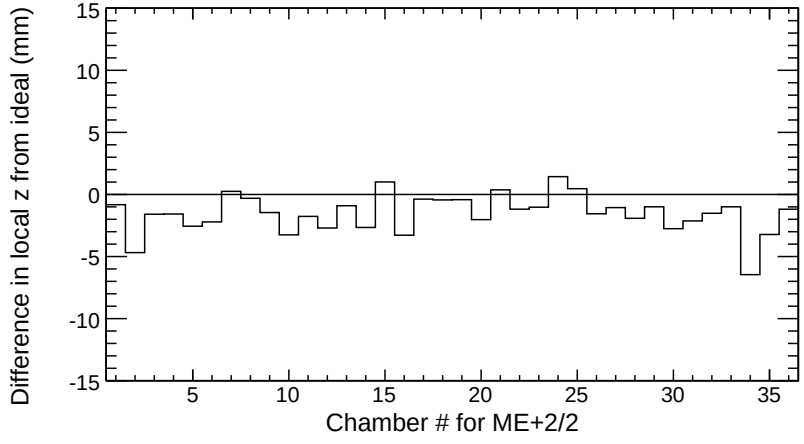


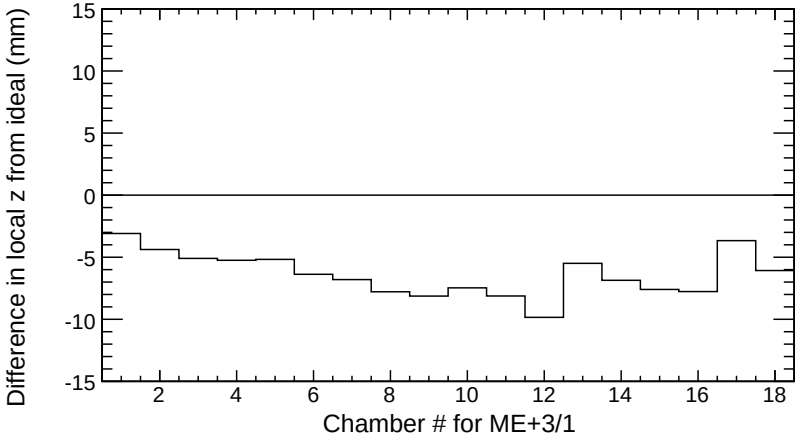


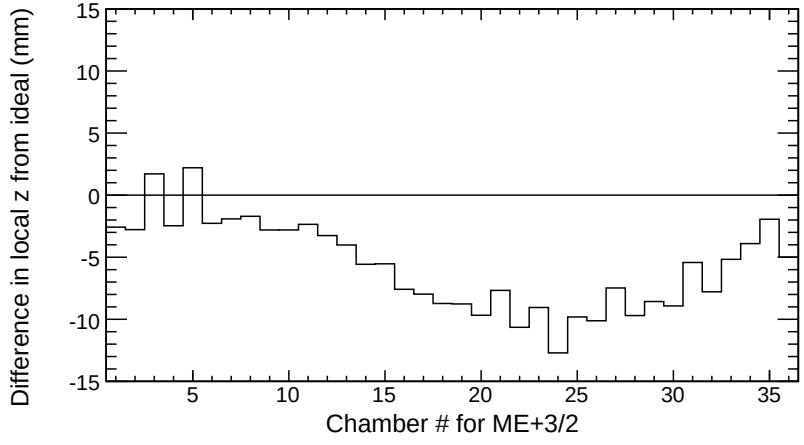
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



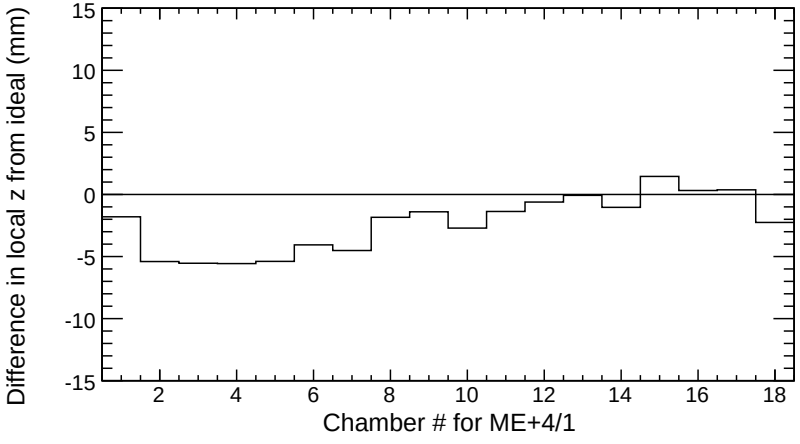


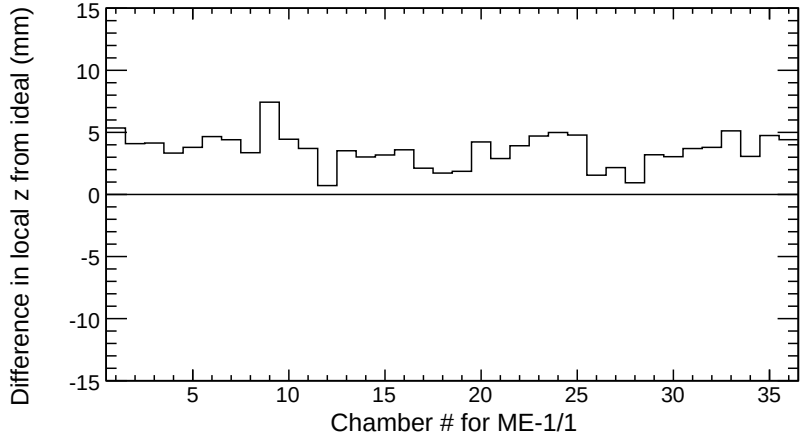


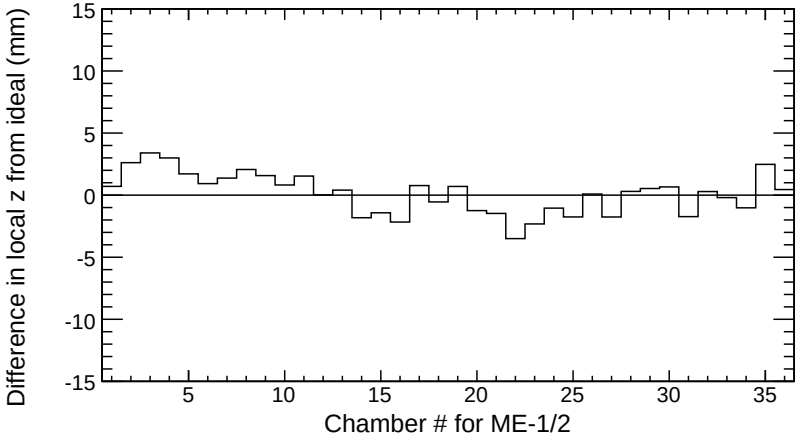


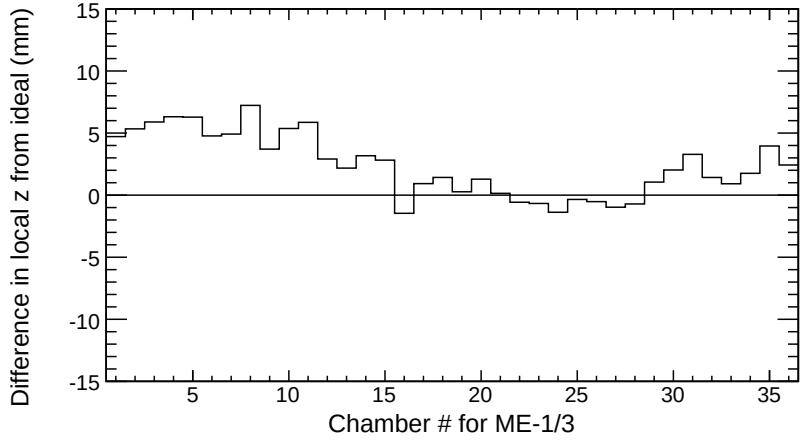
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



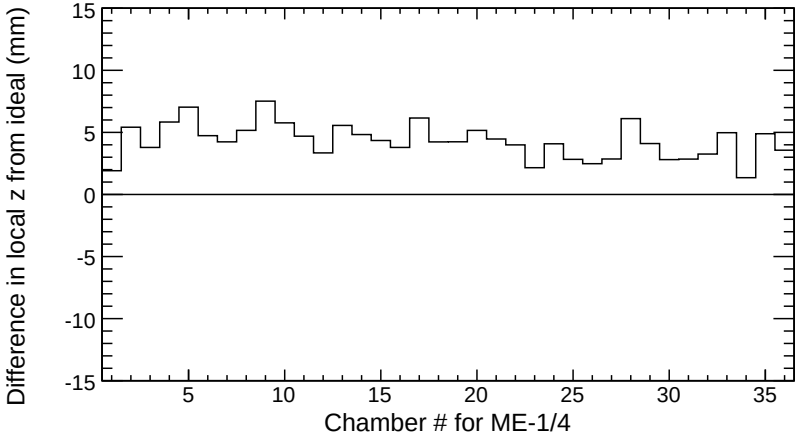


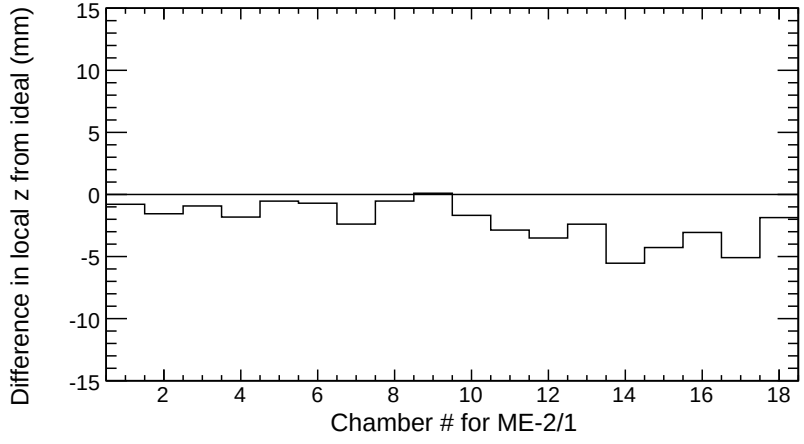


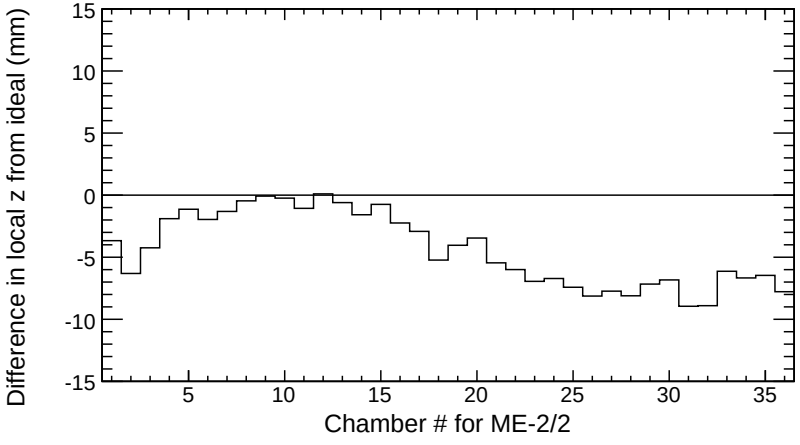


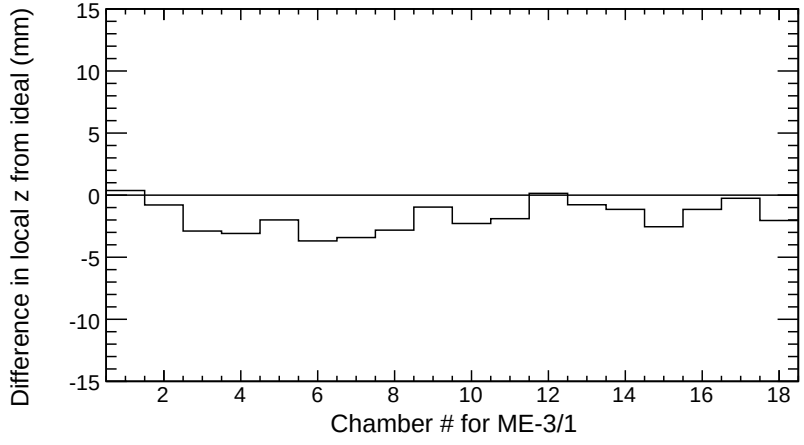
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



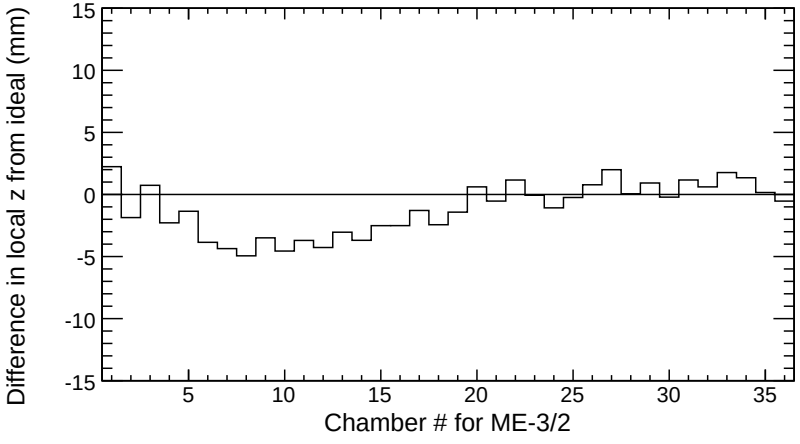


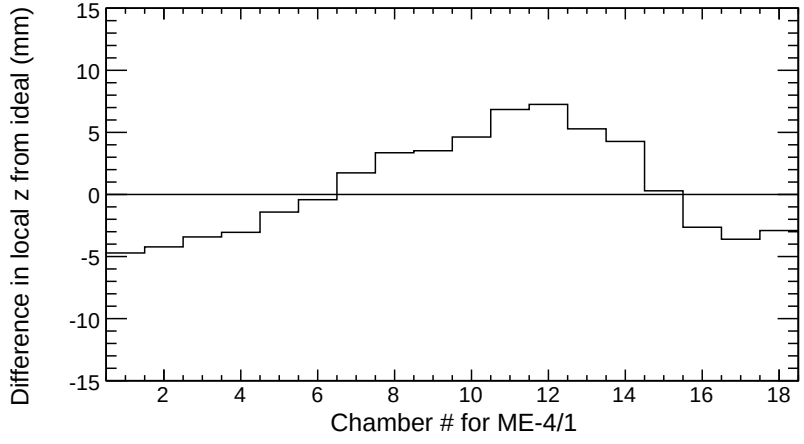


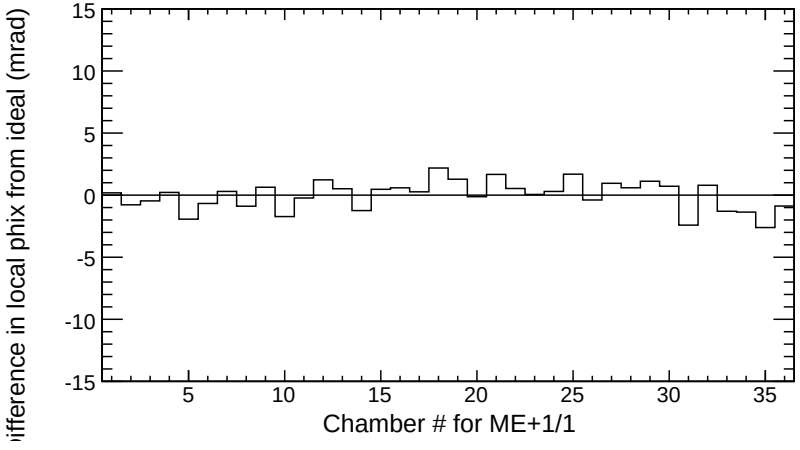


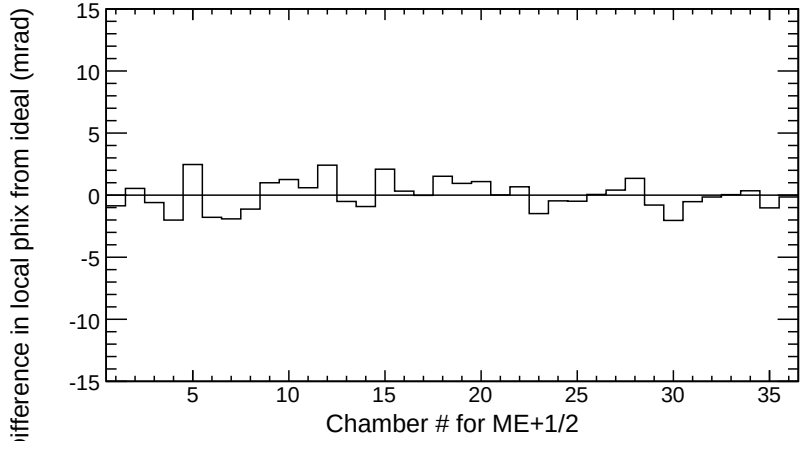
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



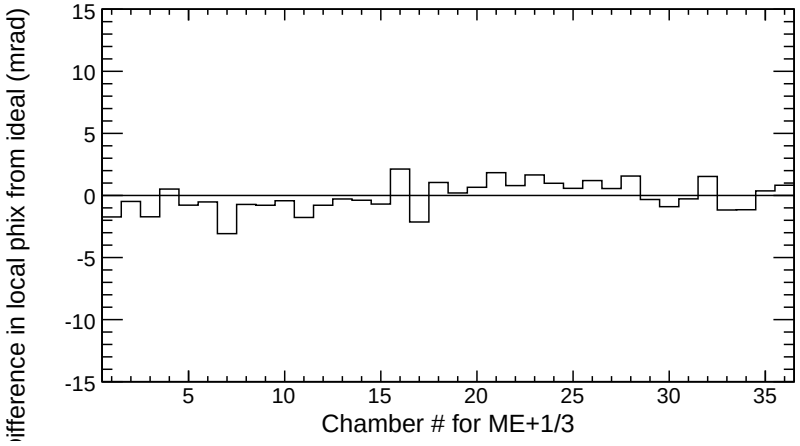


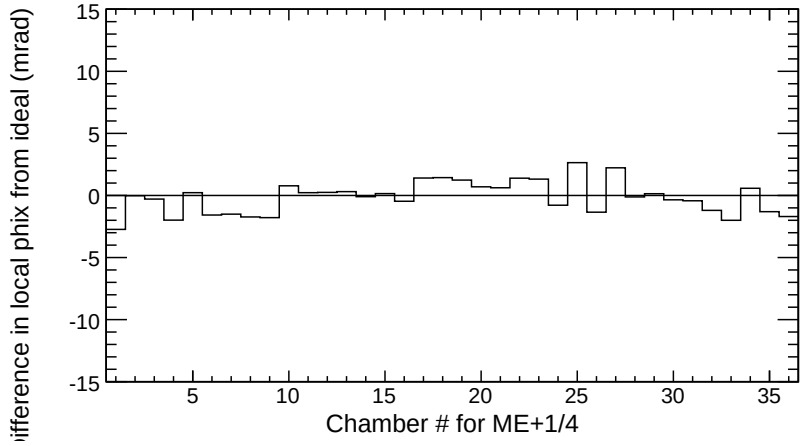


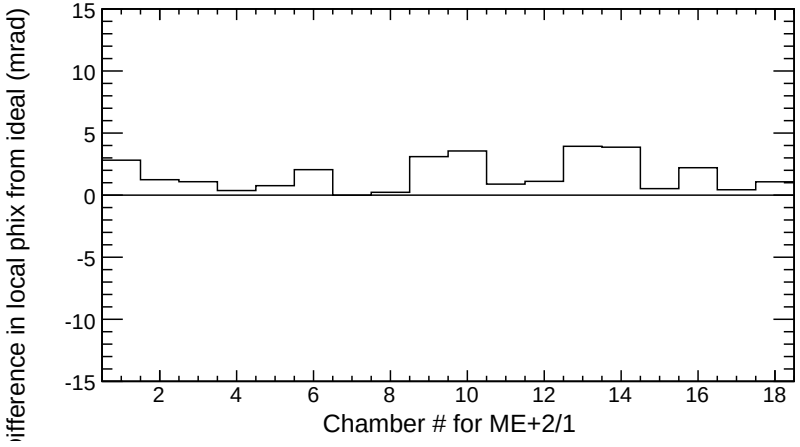


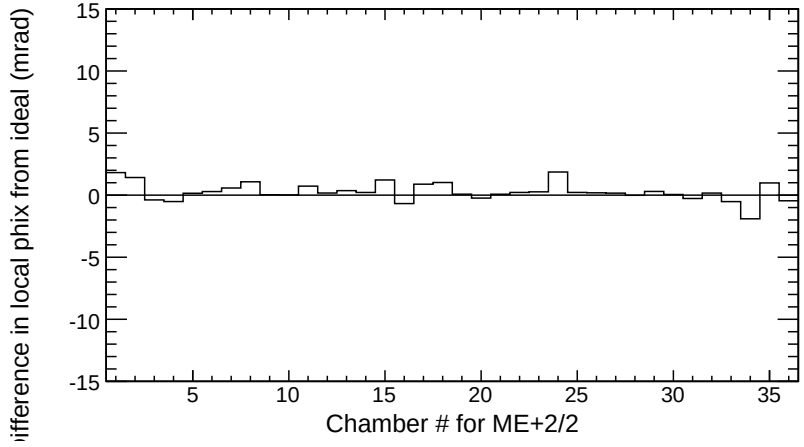
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



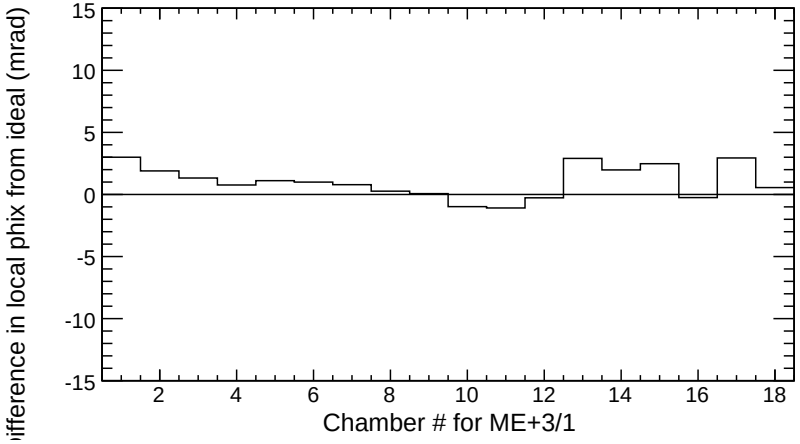


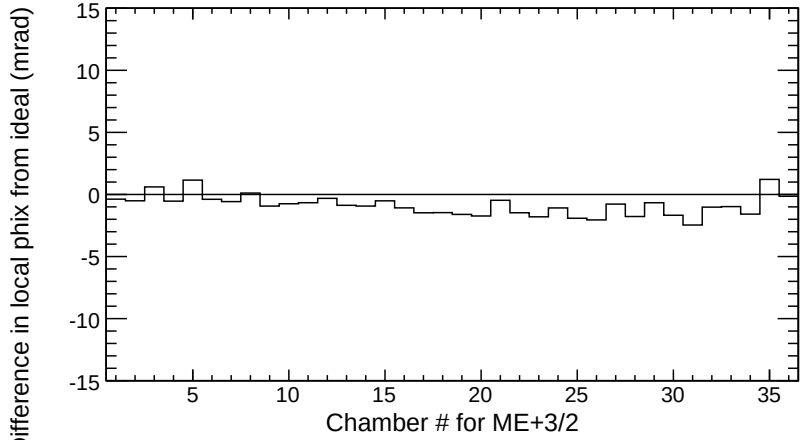


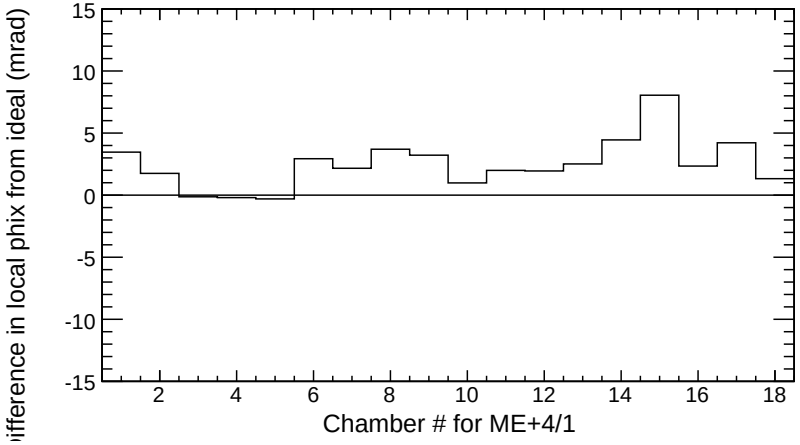


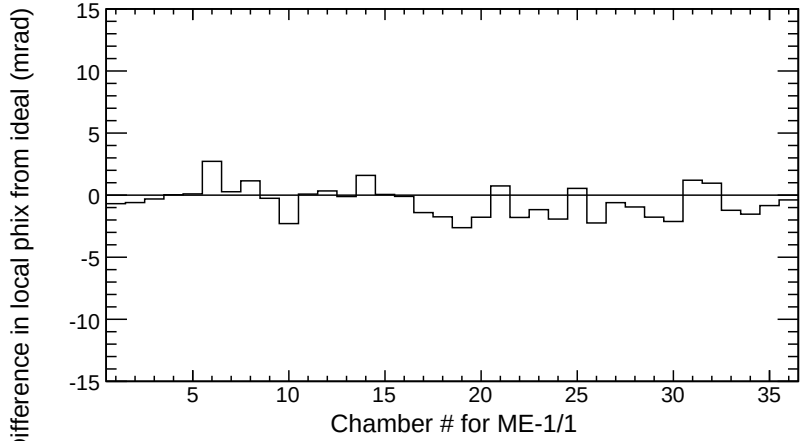
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



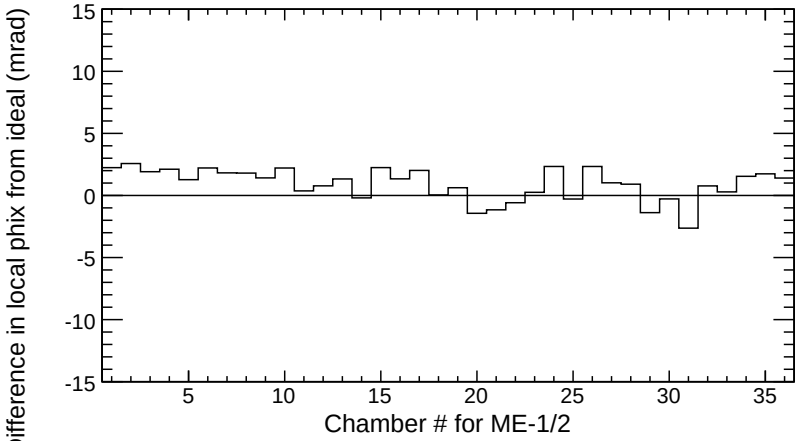


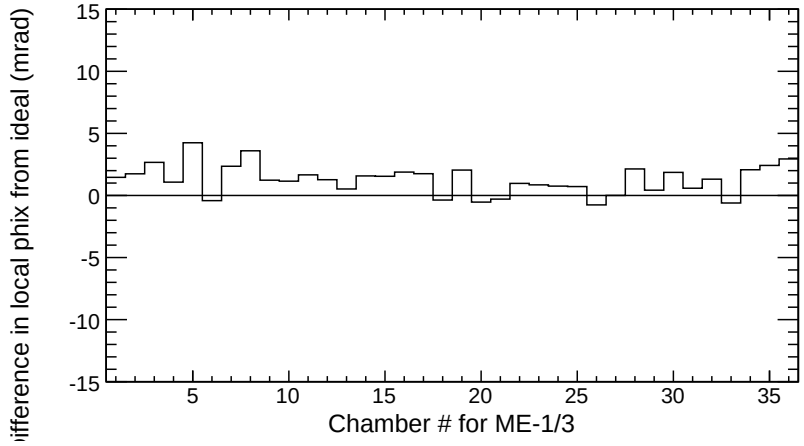


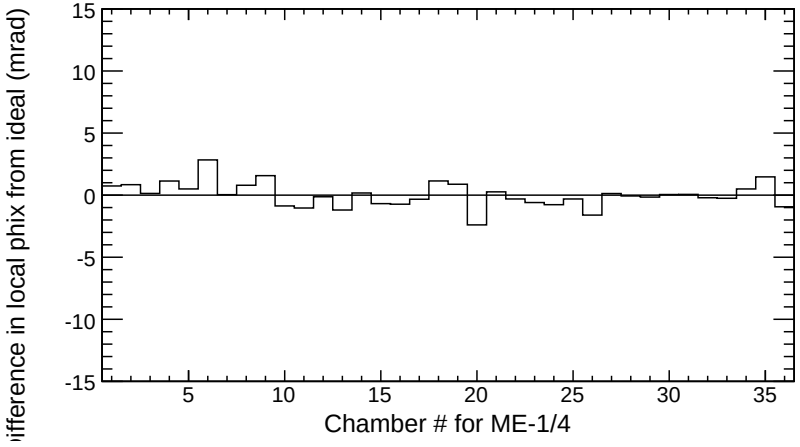


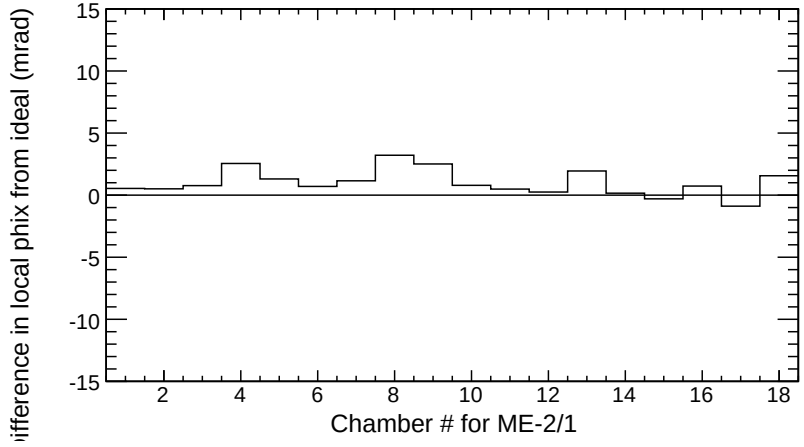
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



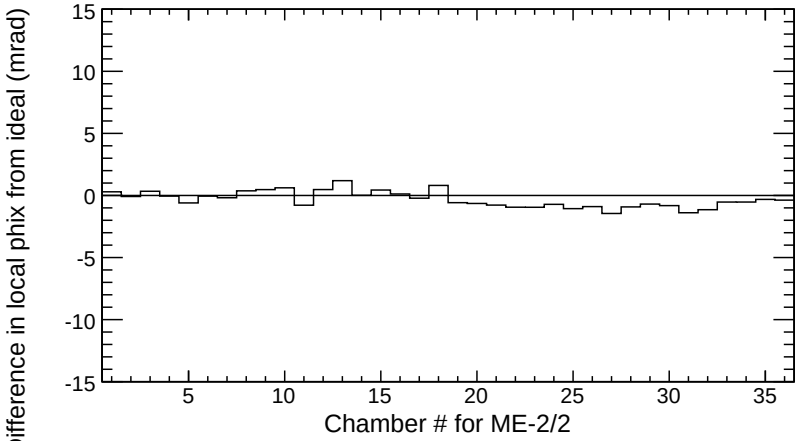


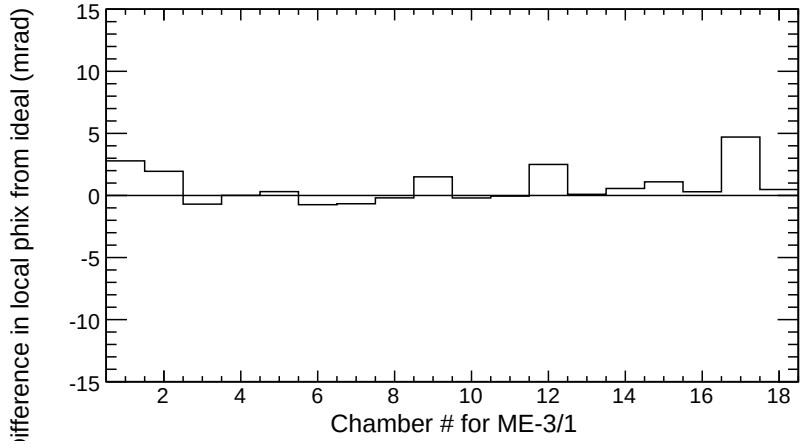


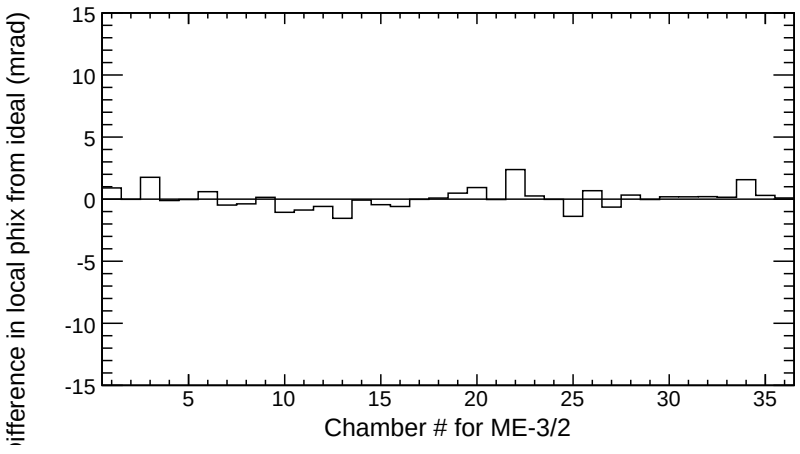


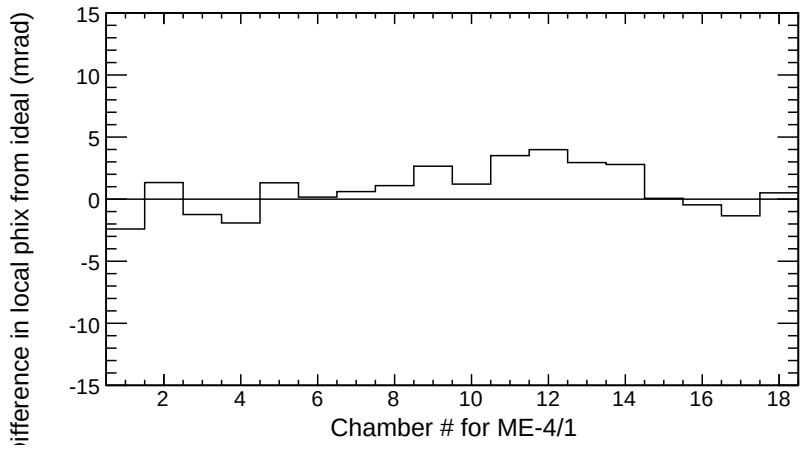
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



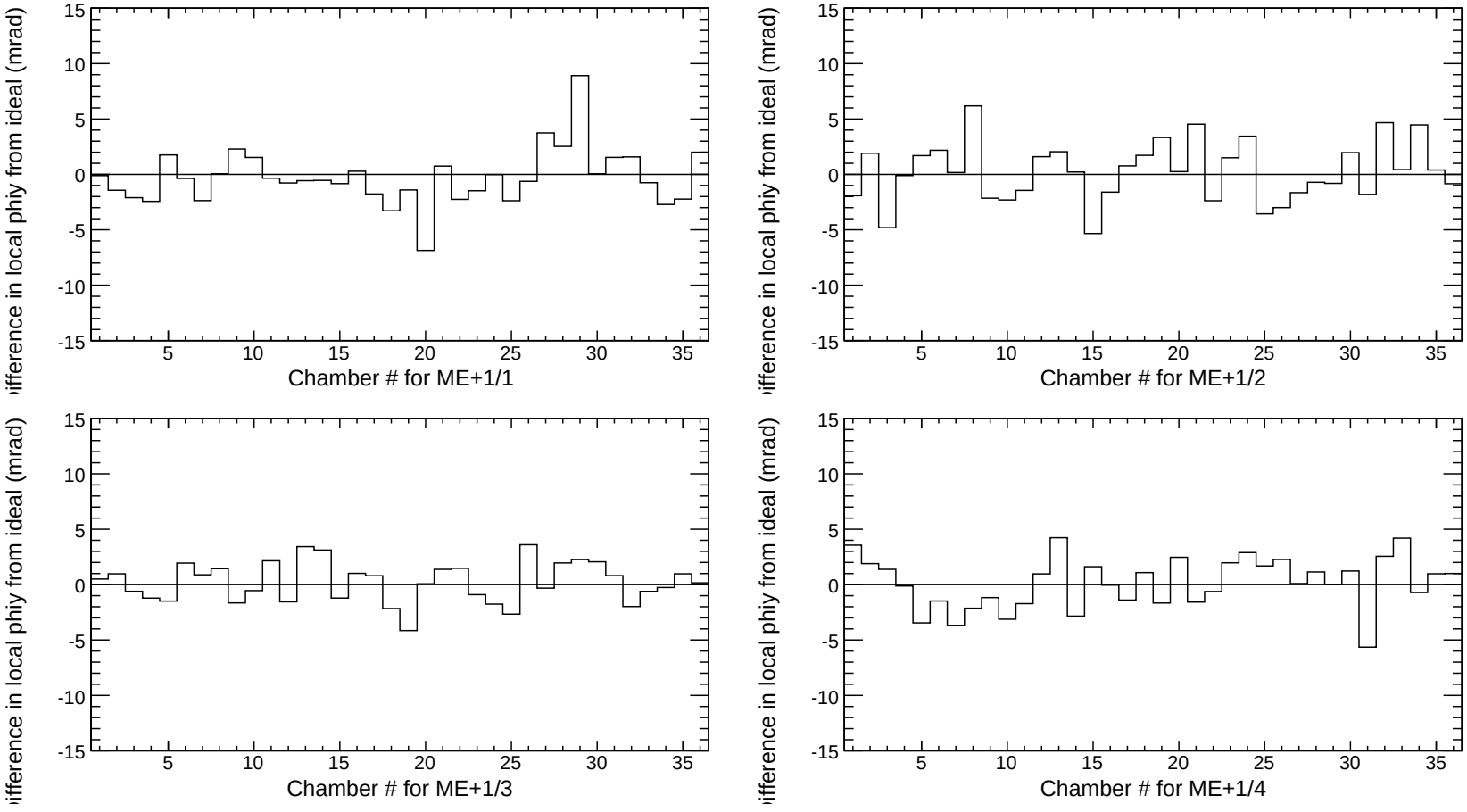






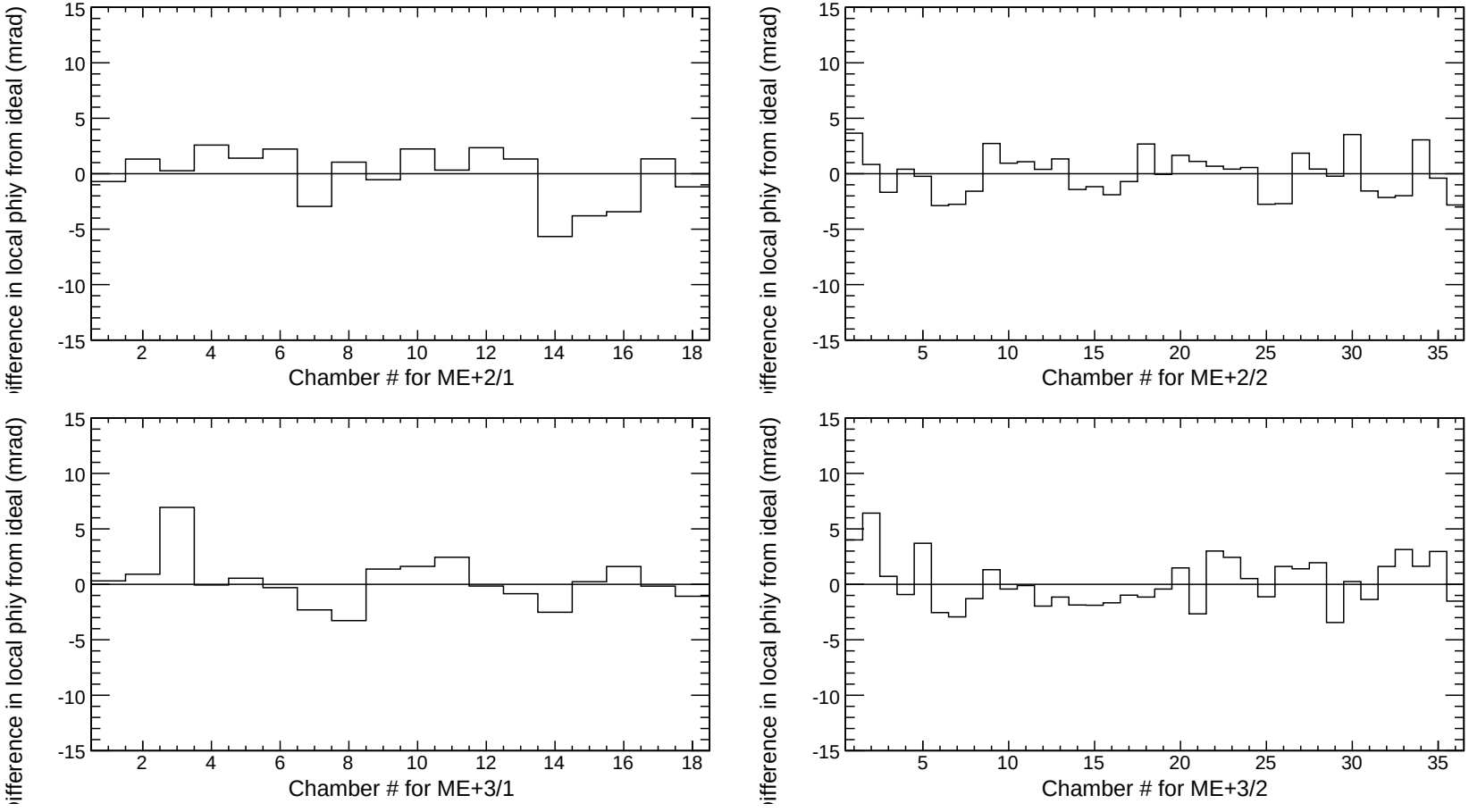
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



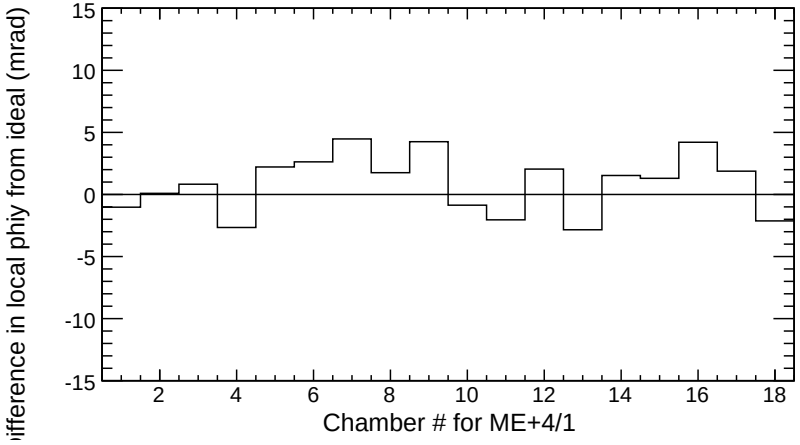
Reference: all the constants

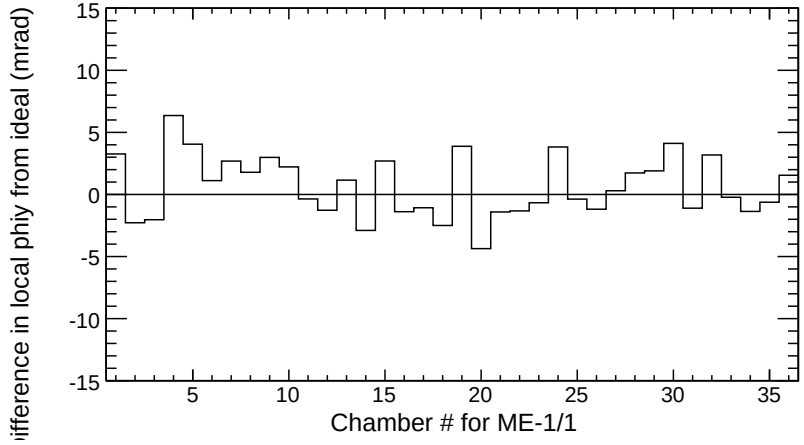
Yellow denotes a parameter that was aligned with globalMuons

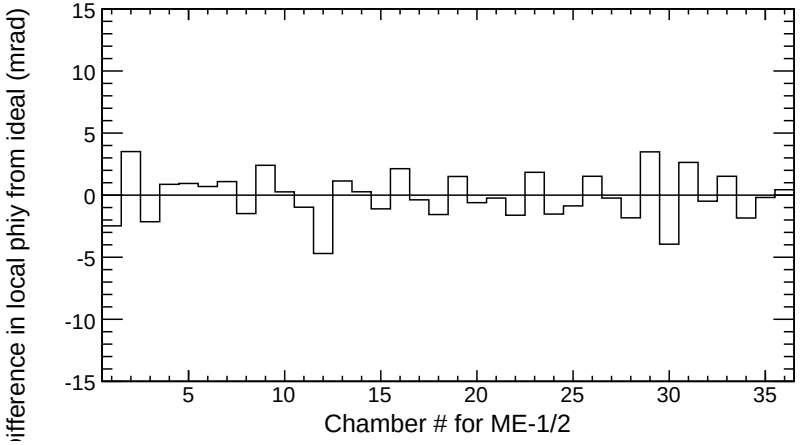


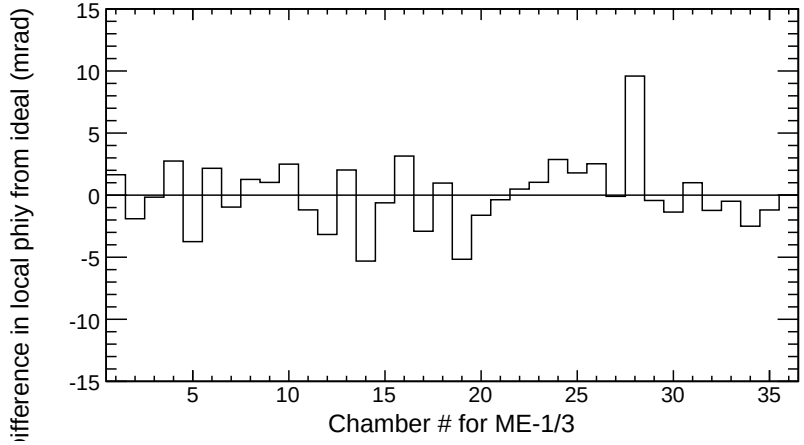
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



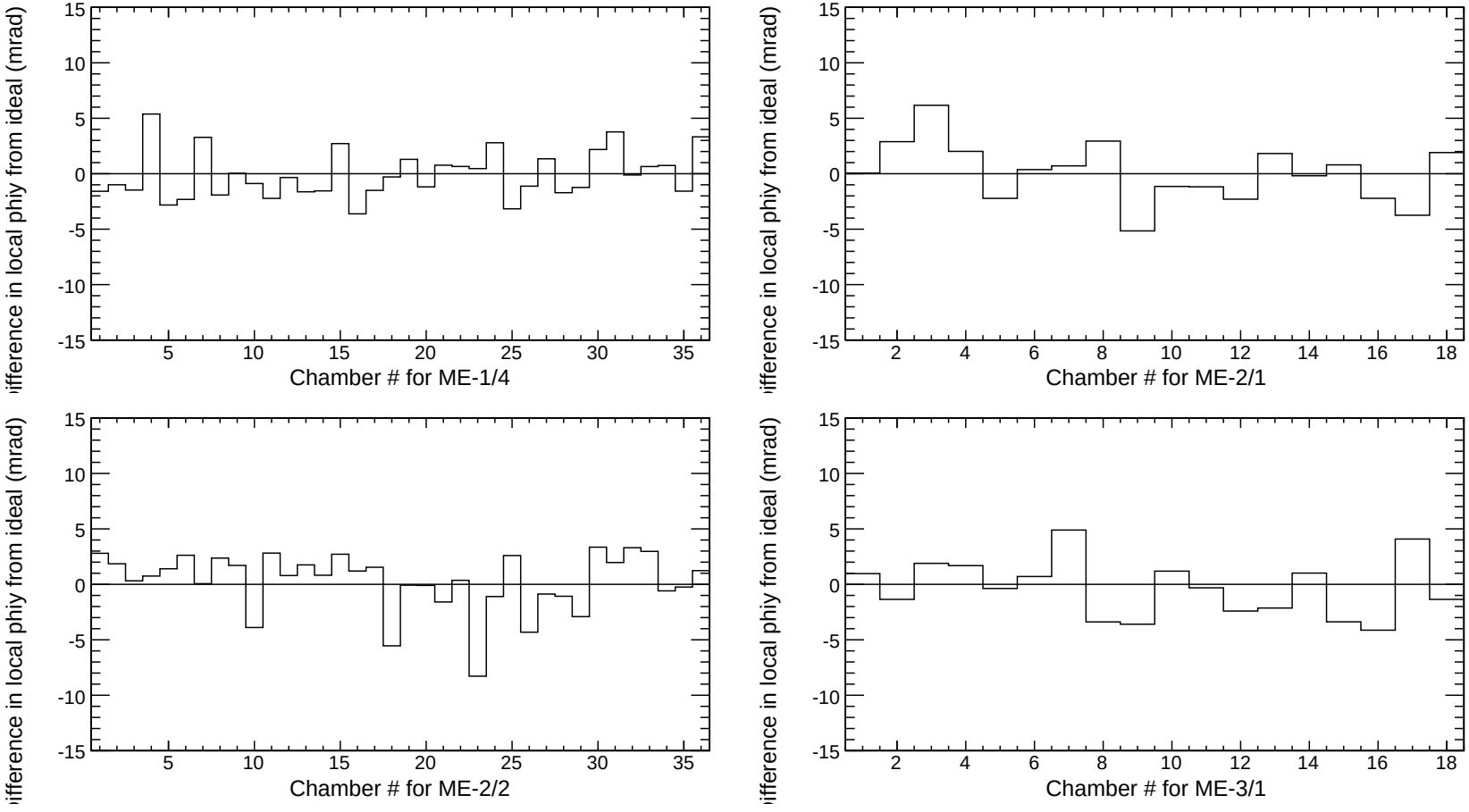






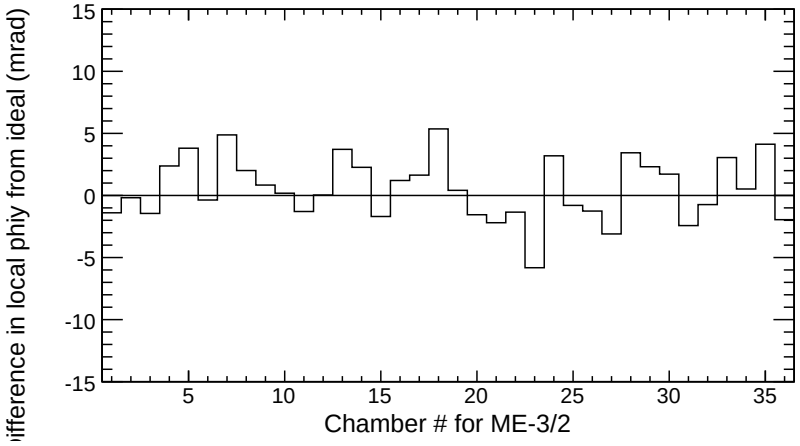
Reference: all the constants

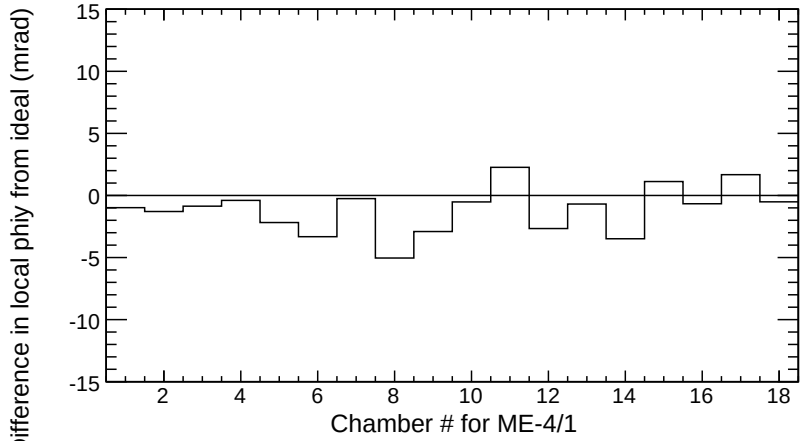
Yellow denotes a parameter that was aligned with globalMuons

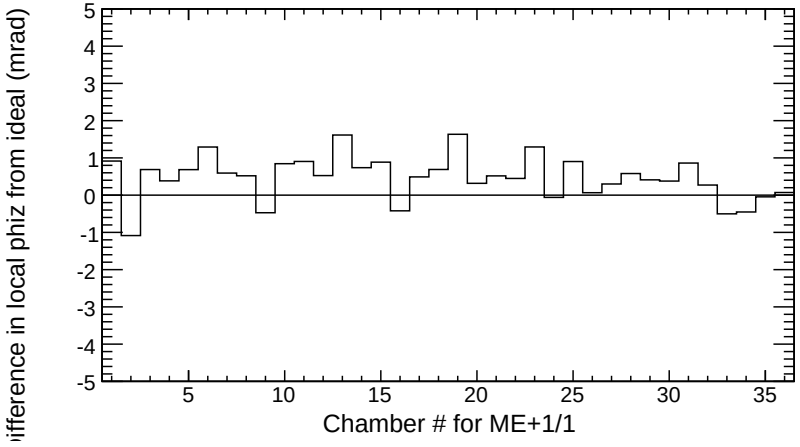


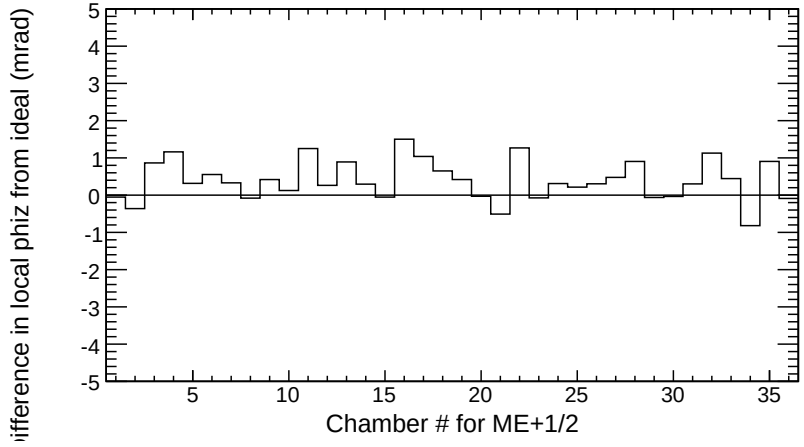
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



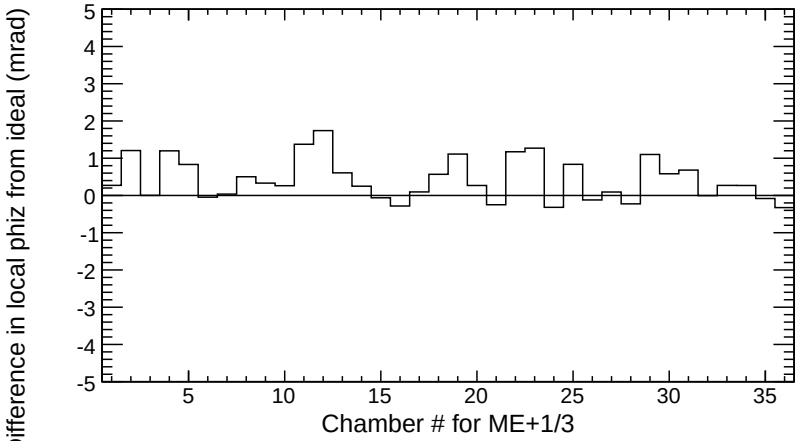


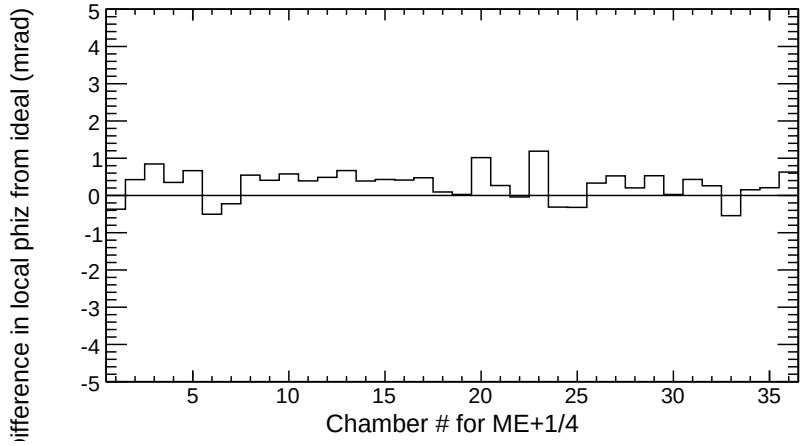


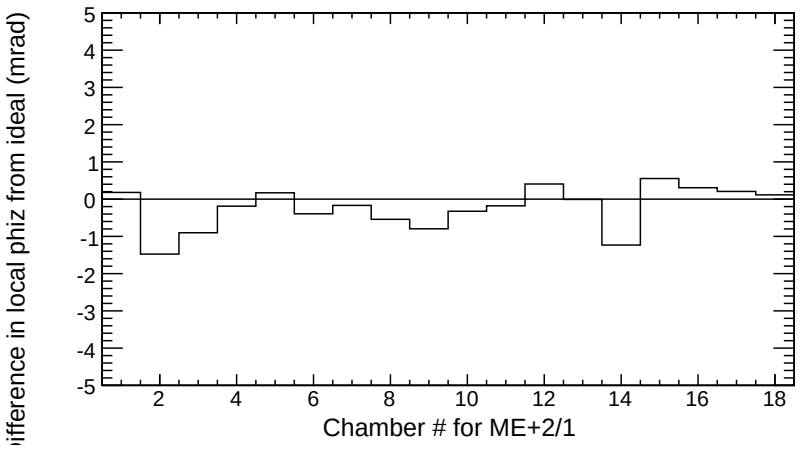


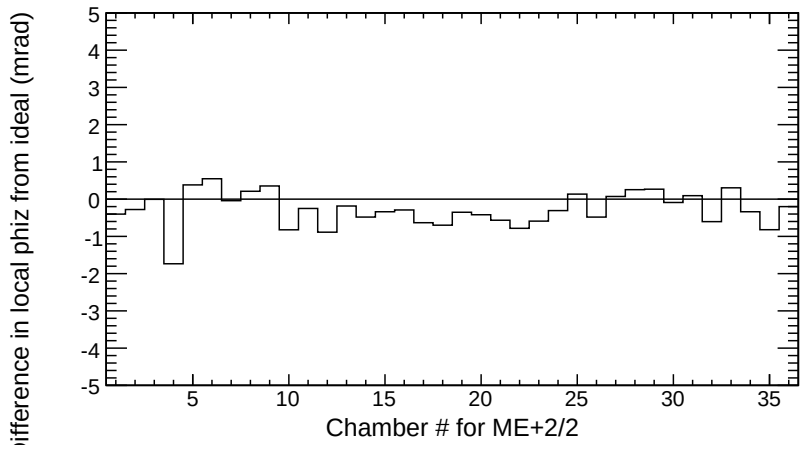
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



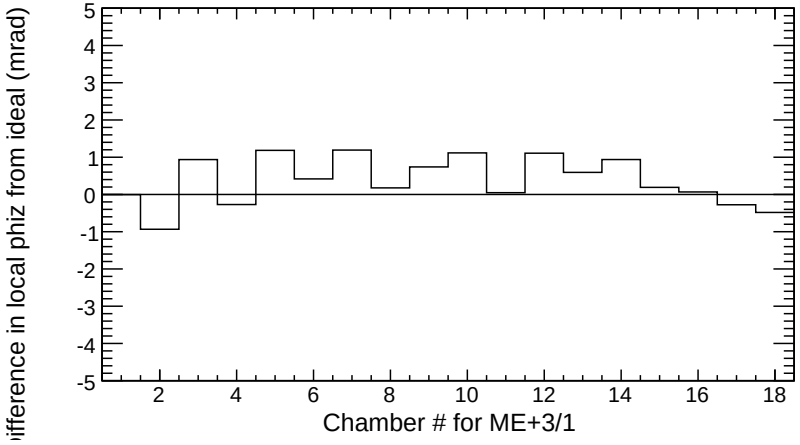


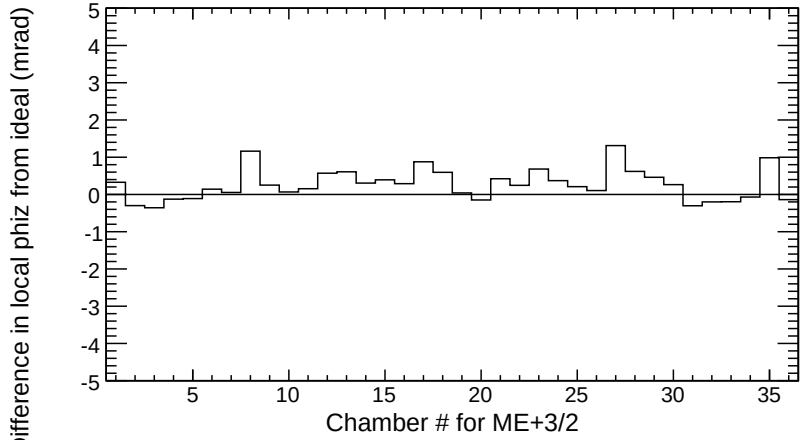


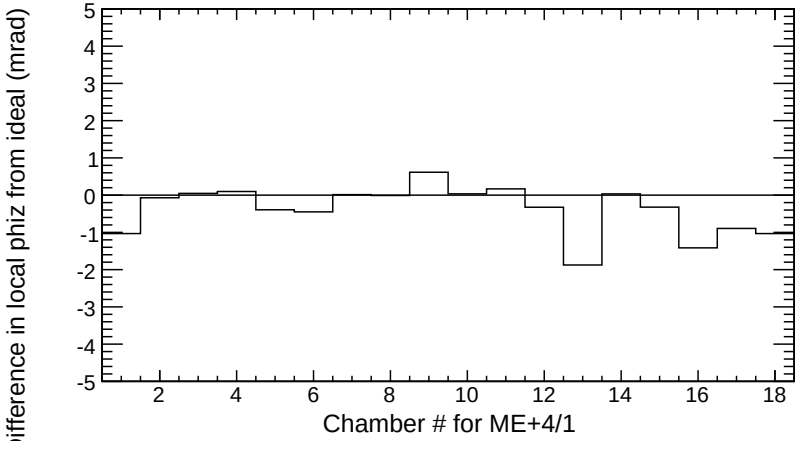


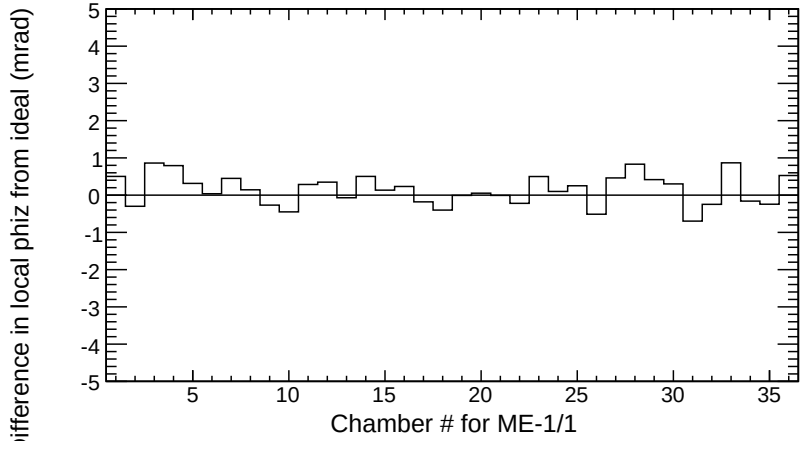
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons



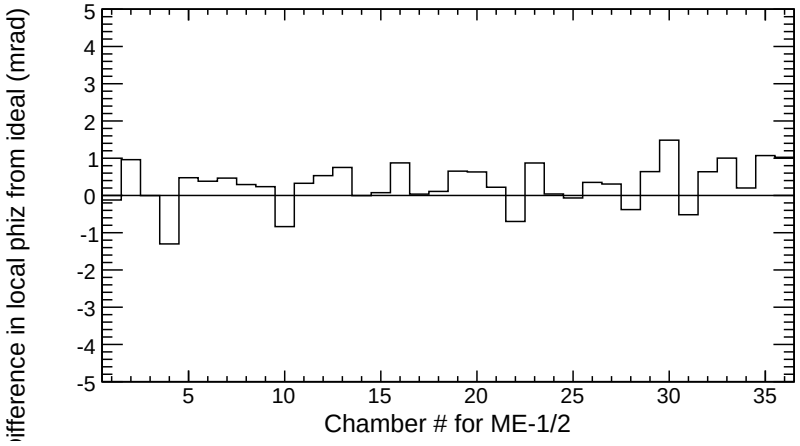


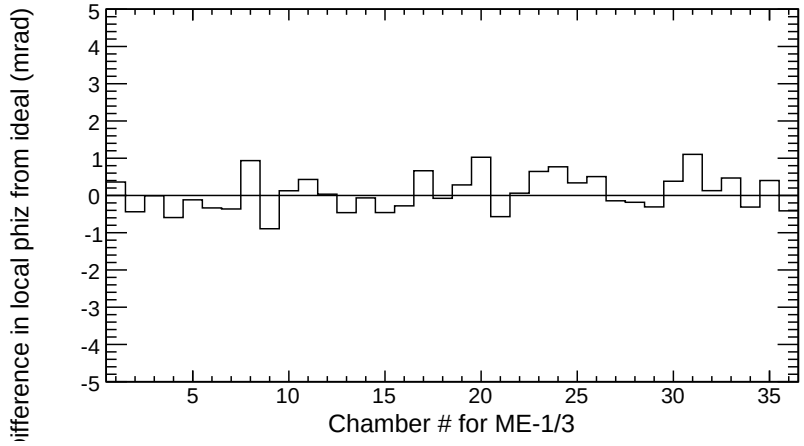


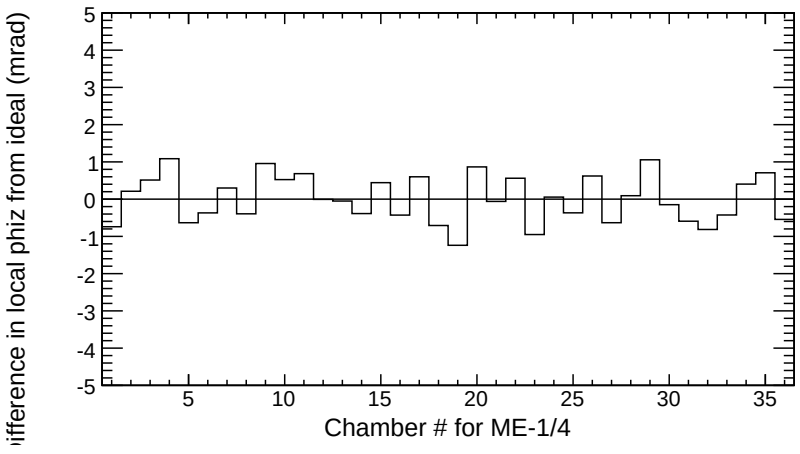


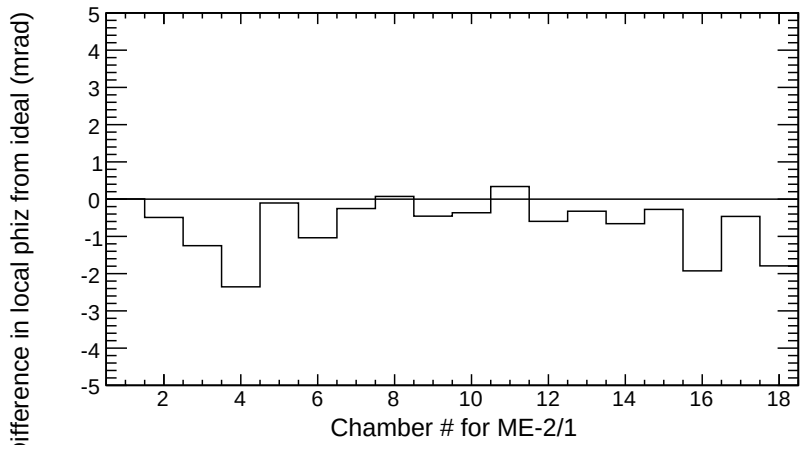
Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons









Reference: all the constants

Yellow denotes a parameter that was aligned with globalMuons