# 2016 05 cycle run plan

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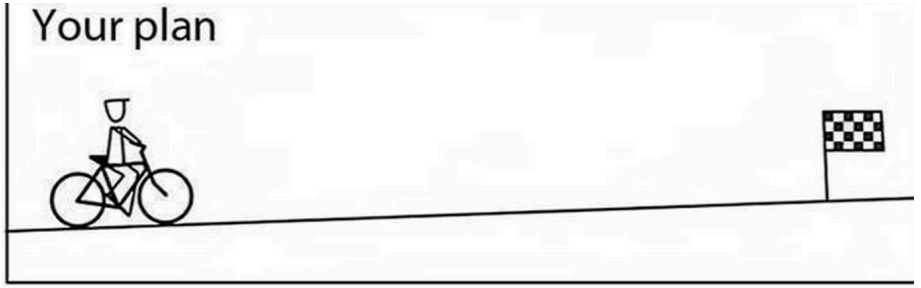
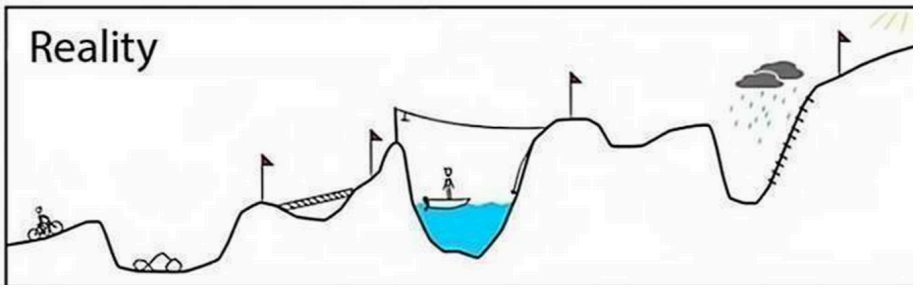
Fermilab



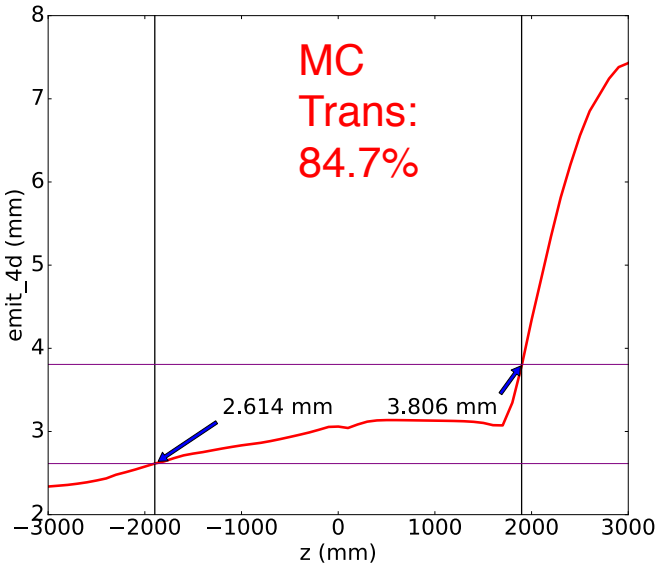



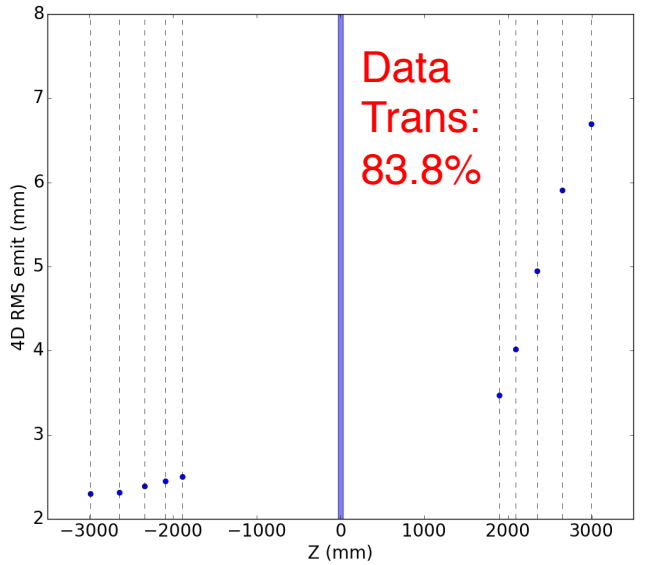
# Our data in 2016/04 -- summary

- The data has been arranged by their settings, with each combination of beamline (including diffusers) and Cooling Channel (CC) a different setting
  - Each combination is referred by its “unique tag” since I’m using not only one or two runs but all the runs for a unique tags
  - CC tag was not in the DB but now it is
  - In order to get all the runs for a unique tag one needs to loop through all the runs in a cycle to match the combination
- The run numbers, number of TOF2 triggers and magnet currents have been summarized
  - It is attached to the Indico page of this talk.
- All together, for 140, 200, and 240 MeV/c we had ~ 12 M TOF2 triggers, really nice amount of data.

# Our data in 2016/04 – 140 MeV/c, MAUS 2.7.0

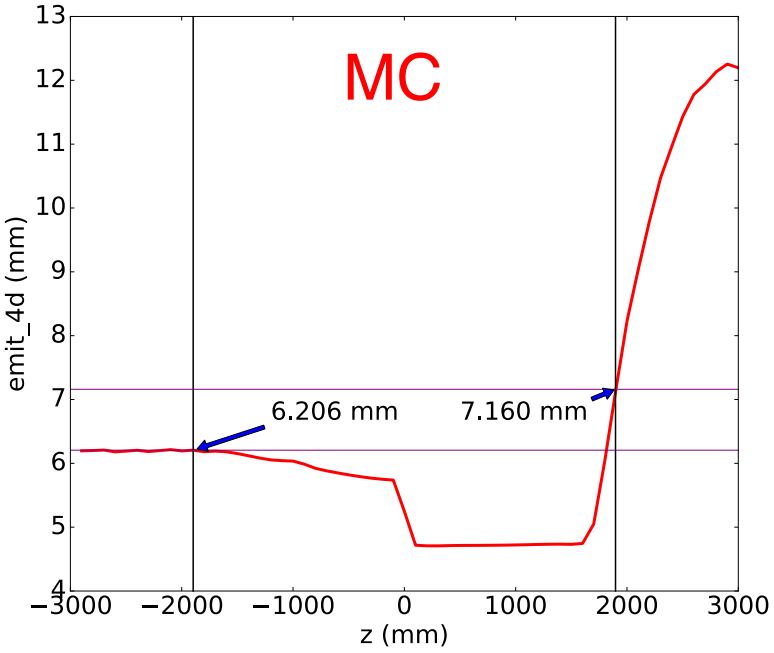
- Tag: 140_Diff0_lattice1_5_LiH
- Transmission of muons agreed by 1%
- Discrepancy of RMS emit. of good muons between MC and data goes up to 11.1% at TKD STN5 starting from 1.3%
- Possible reasons (to be evaluated):
  - Alignment: I realized that the position of the **Tracker1 in the geometry moved by -93 mm, while ECE coils moved by -12 mm,** compared with that in July 2016, trackers are asymmetrically placed w.r.t. LiH. (Artificial geom. Error?)
  - Field difference in MC;
  - Existing recon inefficiency
- In general data recon'ed by MAUS 2.7.0 agreed well with MC

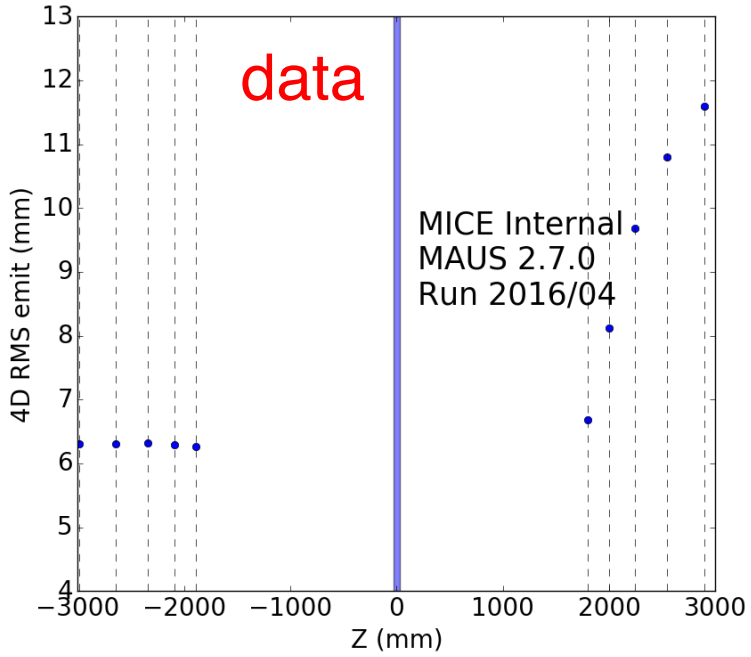


# Data with diffuser 15 at 140 MeV/c

- Diffuser setting 15 – highest setting (140_Diff15_lattice1_5_LiH)
- Using the reconstructed muon beam at TKU STN5
- MC: 35.2% transmission; Data: 33.2%
- Reminder: TKD was moved ~ -100 mm in recon data
- Beam across the absorber without good muon cut has 10% emit reduction
- Francois showed you the core density increase, preserving the abs. effect



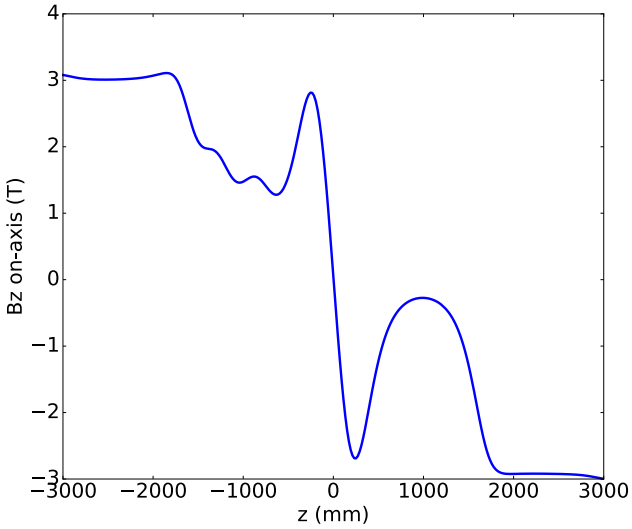



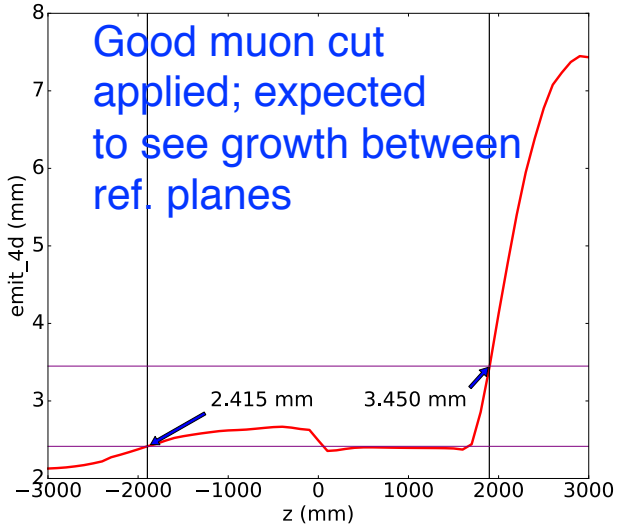
# Plan for the next run cycle

- As you all know this cycle is starting in flip mode to show emittance reduction
- Ramping should have started (in principle) when this talk is being given
- The plan is to first take the un-diffused beam without diffuser, do the magnet alignment, then put the diffusers in;
  - If diffusers don't extract they will fine be that way in the settings to follow
- There were CC currents designed to cool the un-diffused beam
  - CC tag 2016-05-4
- There were CC currents designed to cool the matched diffused beam – diffusers needed

# 2016-05-4 with our un-diffused beam

- Currents obtained by the GA
- Objective was to maximize the emit. reduction across the absorber and the transmission
  - Emit. reduction across is always evaluated before the good muon cut: ignorable nonlinearities and scraping
  - Two ways to measure cooling:
    - Extrapolation from trackers to the absorber with little sampling effort;
    - Use the core density evaluation that should preserve the cooling effect across the absorber
- Expect 85% transmission and 10% emit. reduction – very tight focusing



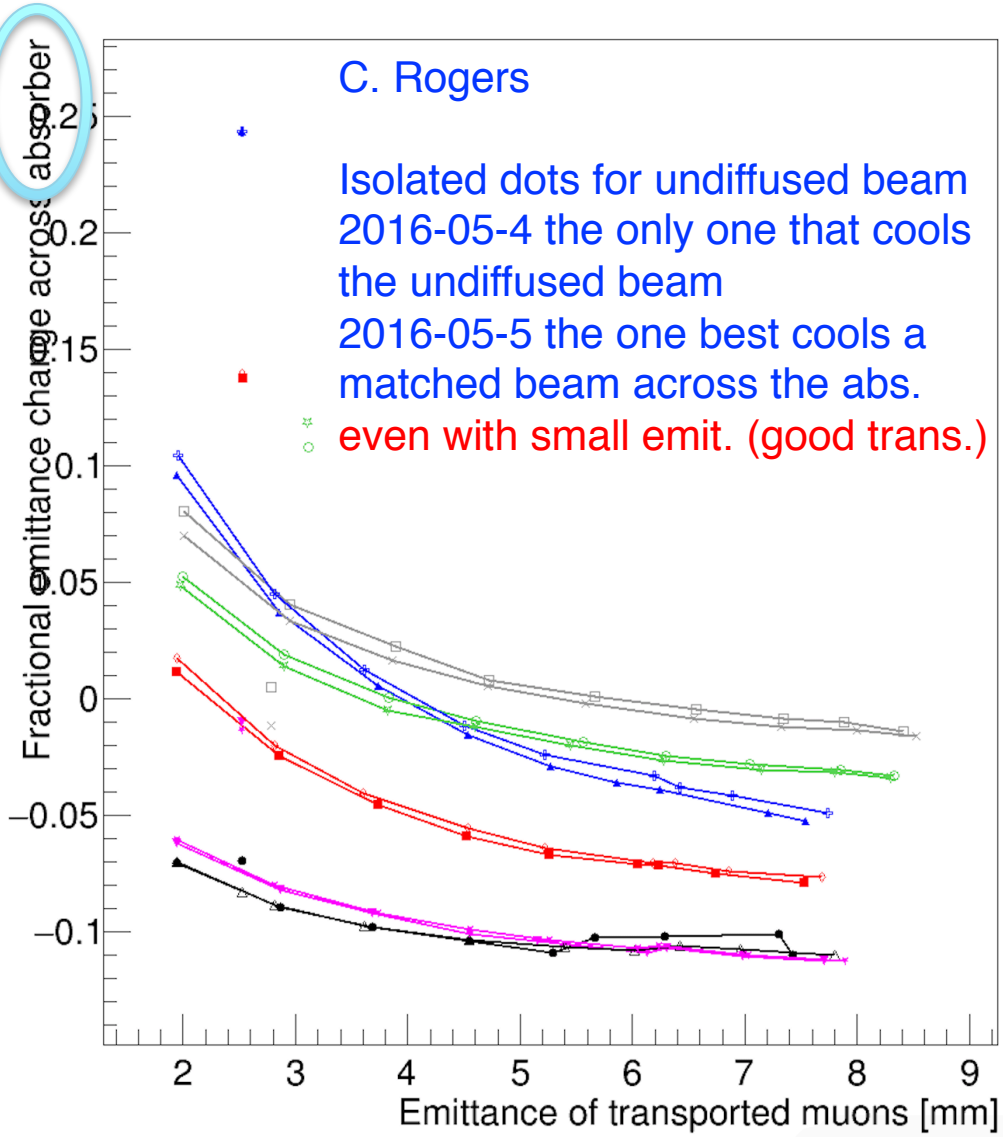



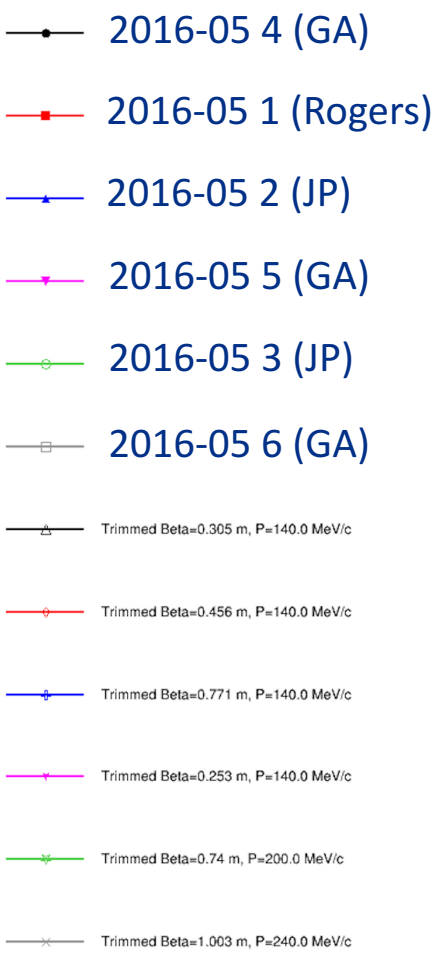
# CC design with matched diffused beam

- The optics team especially C. Rogers and J. Pasternak have done extraordinary work to design the CC for a matched beam
  - Chris has been doing designs by testing the parameter space and looking for the minimum beta function at the abs. and the best transmission;
  - Jaroslaw has been doing fine tuning of the currents to get the minimum beta function at the absorber while limiting the over all maximum beta function

| Name | p [MeV/c] | beta [m] | Force [t] | Optimisation Name |
|---|---|---|---|---|
| *2016-05 1* | 140 | 0.44 | 13.6 | *2016/05-rogers-2 3* |
| *2016-05 1 Trimmed* | 140 | | | *Trimmed 2016/05-rogers-2 3* |
| *2016-05 2* | 140 | 0.77 | 13.9 | *2016/05-jp 9* |
| *2016-05 2 Trimmed* | 140 | | | *Trimmed 2016/05-jp 9* |
| *2016-05 3* | 200 | 0.83 | 14.8 | *2016/05-jp 3* |
| *2016-05 3 Trimmed* | 200 | | | *Trimmed 2016/05-jp 3* |
| *2016-05 4* | 140 | 0.31 | 11.3 | *2016/05-v1 1* |
| *2016-05 4 Trimmed* | 140 | | | *Trimmed 2016/05-v1 1* |
| *2016-05 5* | 140 | 0.25 | 14.3 | *2016/05-v1 2* |
| *2016-05 5 Trimmed* | 140 | | | *Trimmed 2016/05-v1 2* |
| *2016-05 6* | 240 | 1.09 | 14.2 | *2016/05-v1 8* |
| *2016-05 6 Trimmed* | 240 | | | *Trimmed 2016/05-v1 8* |

# Comparing performance with MC tracking



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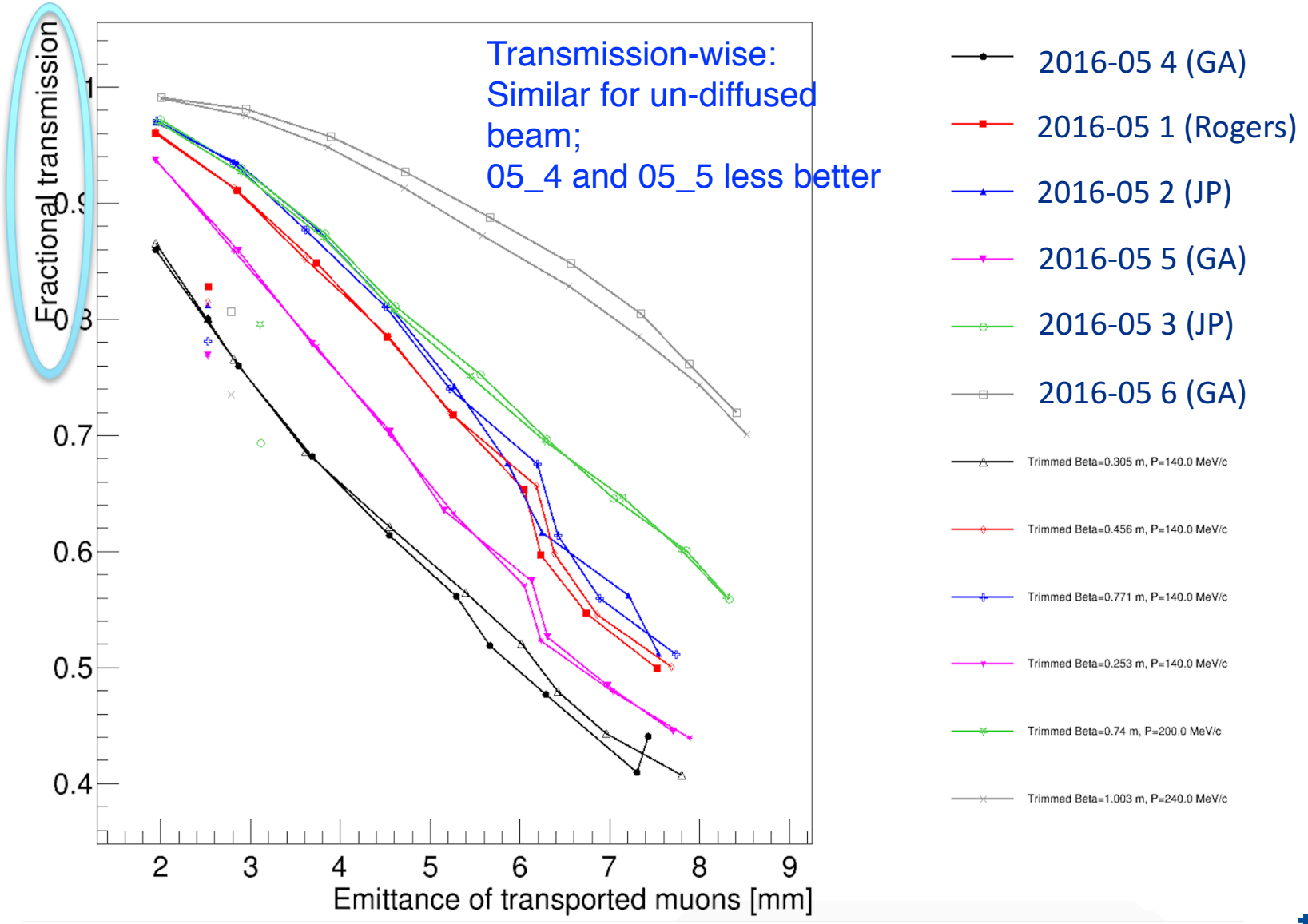

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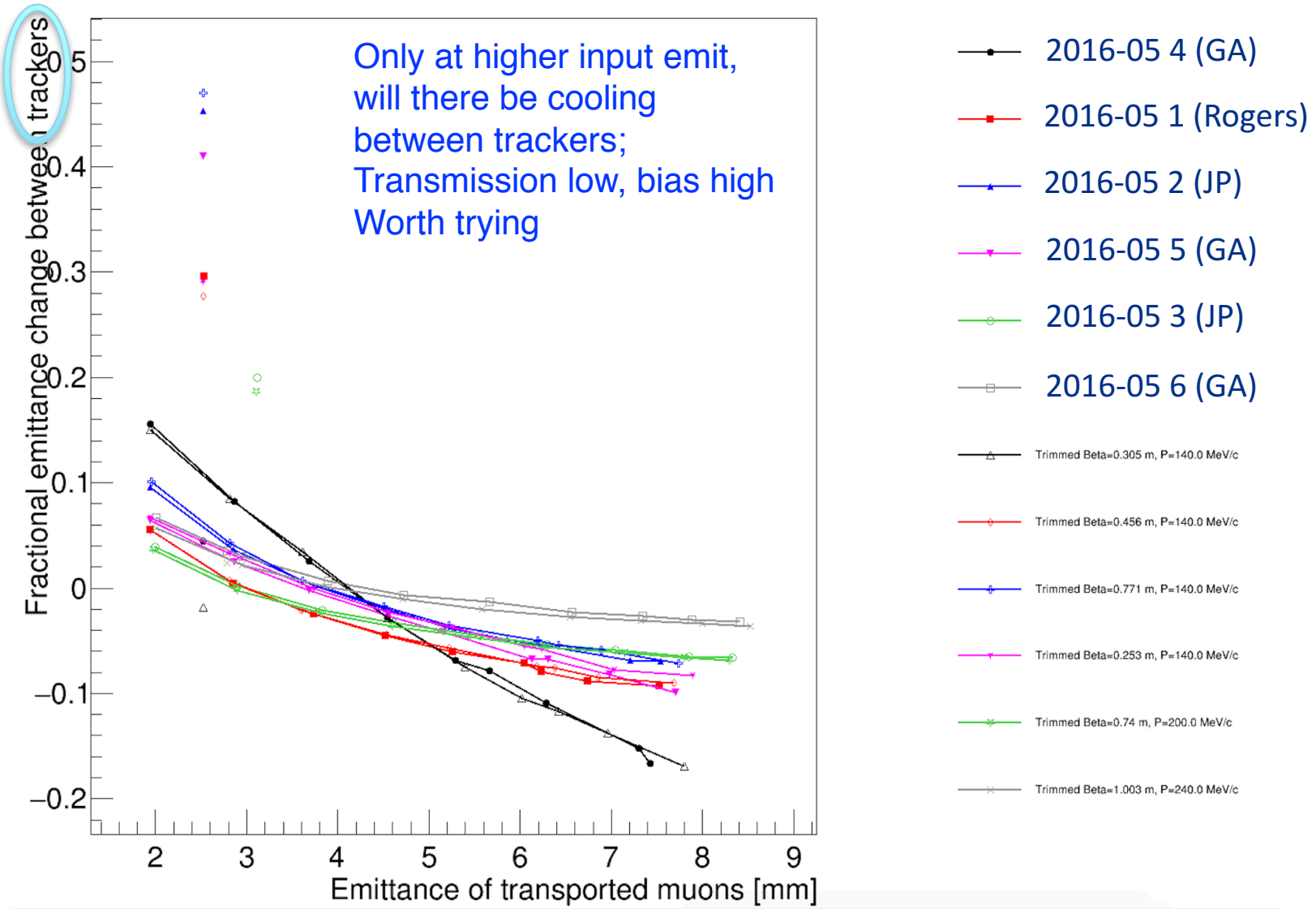
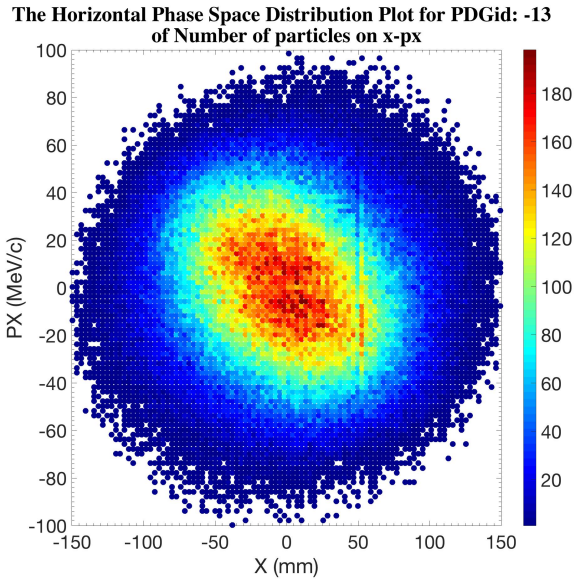
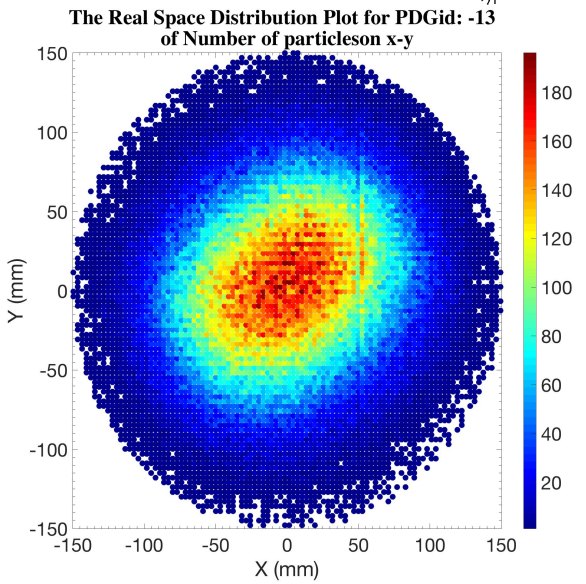


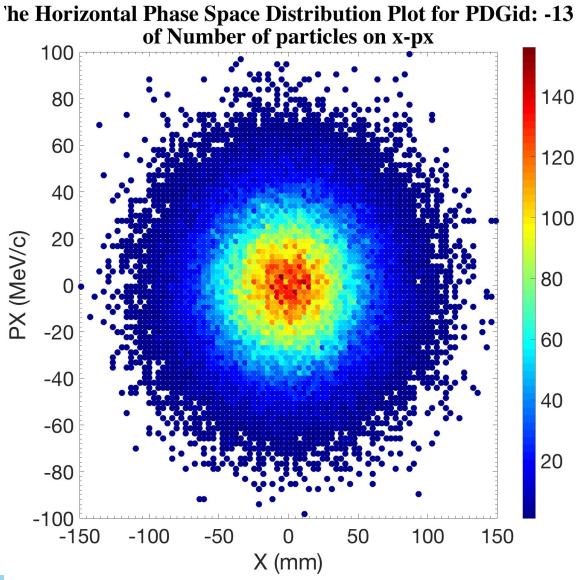
# Data with diffuser 15 at 140 MeV/c

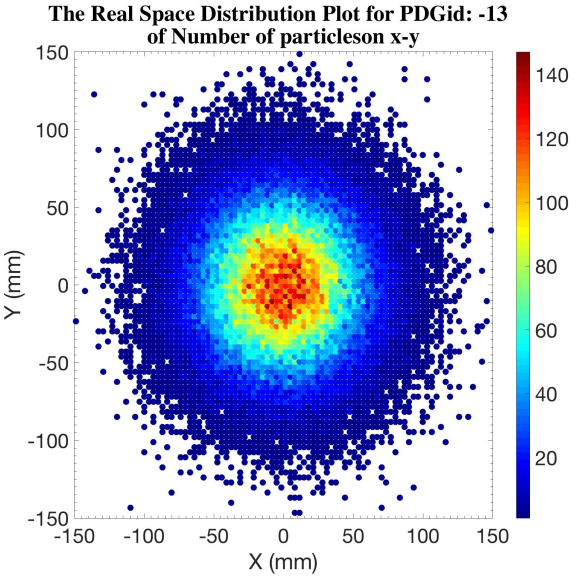
- TKU STN 5 muon beam:



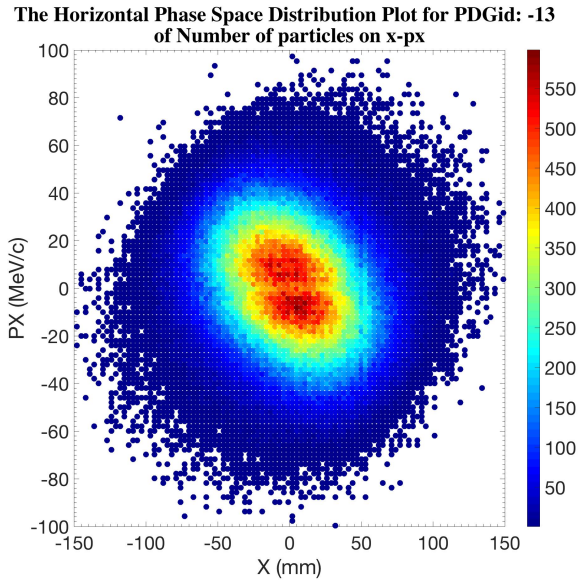

- 6 mm matched:

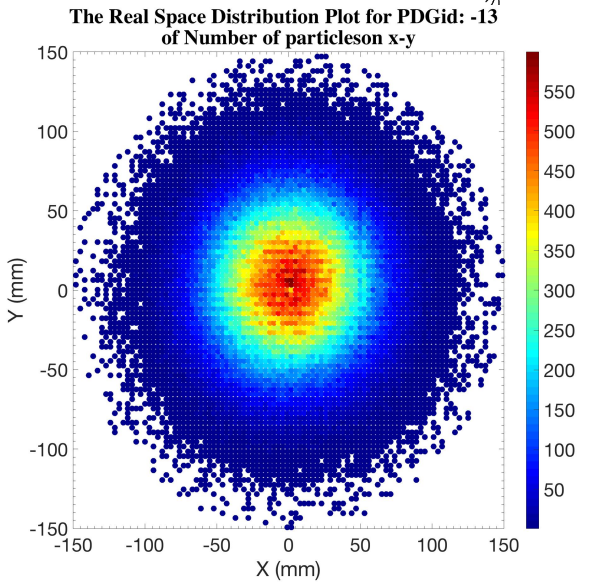


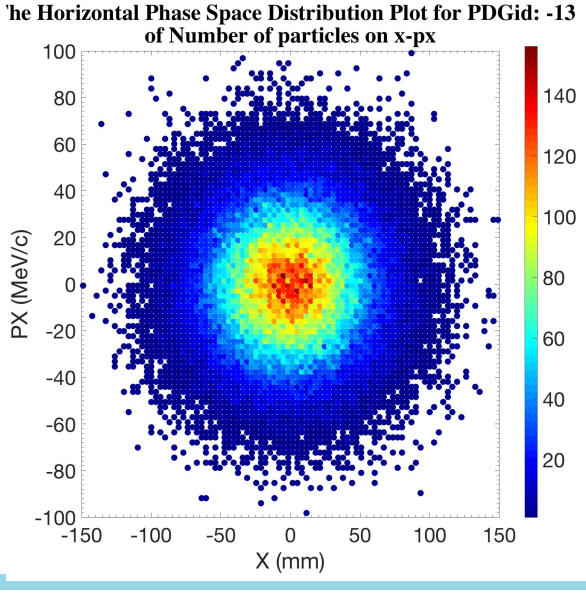
# Data with diffuser 4 at 140 MeV/c

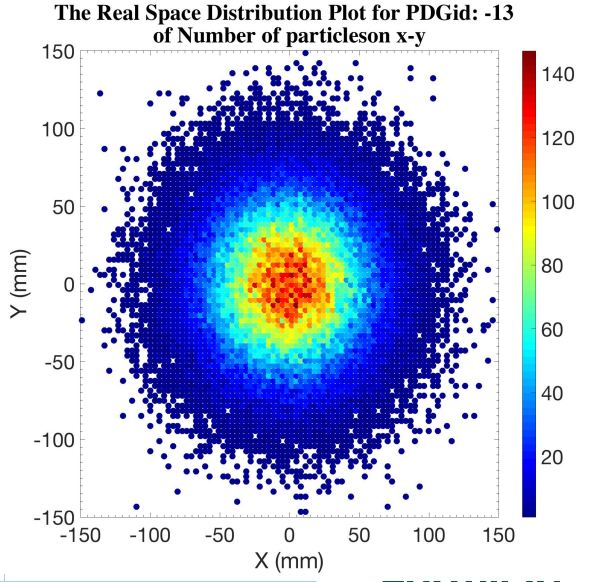
- TKU STN 5 muon beam:



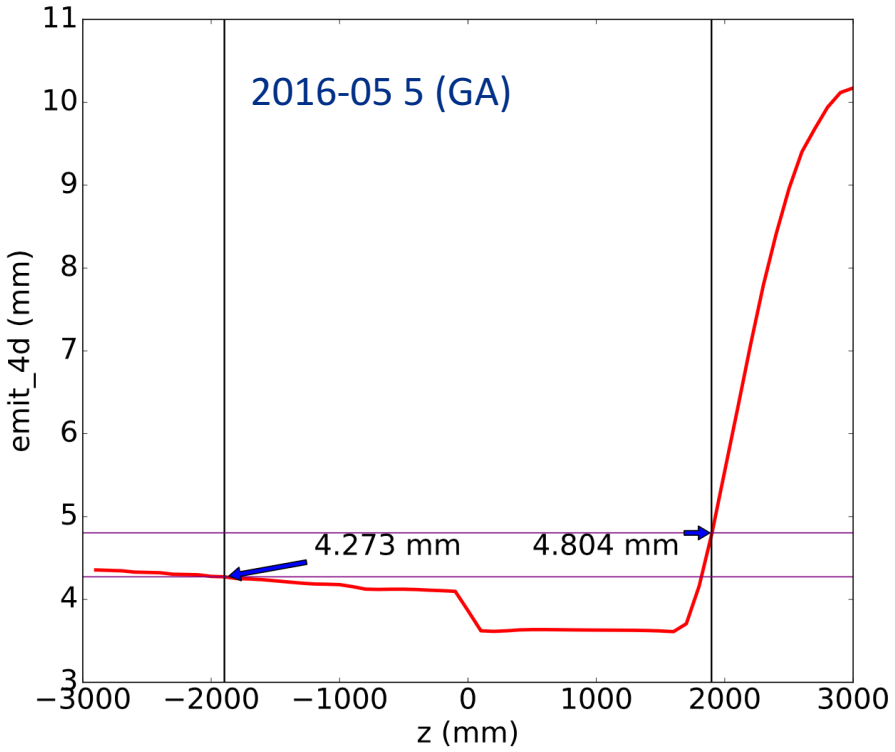

- 6 mm matched:

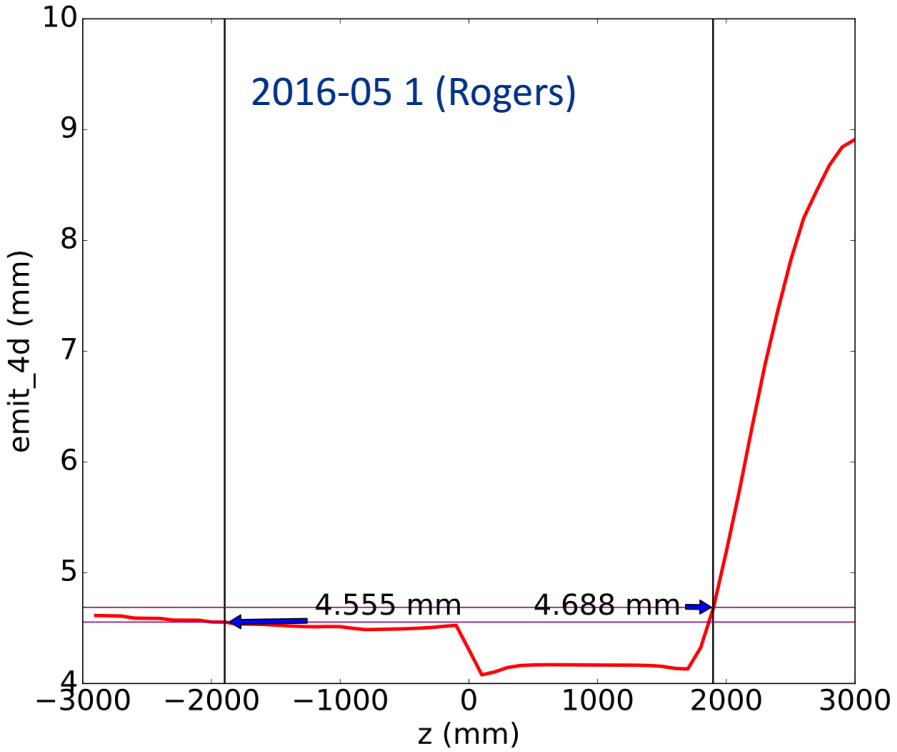


# Re-evaluating the matched settings

- Using the real diffused beam (6 mm at TKU STN 5), redo 4D RMS emittance evolution, both with good muon cut




- Similar reduction at the tracker; Similar transmission (68% v.s. 76%, respectively). 05_1 is better in this case.

# Run plans

- The current run plan in more details:

**Task H13 - Emittance Reduction**

| Task | Momentum | # Triggers | Beamline Tag | CoolingChannel Tag | Similar runs | Final Event Tally (k) |
|---|---|---|---|---|---|---|
| H13a | 140 | 630K TOF2 | 3-140+M3-Test2 | 2016-05-4 | | |

**Task H14 - Magnet alignment**

| Task | Momentum | # Triggers | Beamline Tag | CoolingChannel Tag | Similar runs | Final Event Tally (k) |
|---|---|---|---|---|---|---|
| H14a | 170 | 5e5 TOF1? | 3-170+M3-Test1 | 2016-05-4 | | |
| H14b | 200 | 5e5 TOF1? | 3-200+M3-Test1 | 2016-05-4 | | |
| H14c | 240 | 5e5 TOF1? | 3-240+M3-Test1 | 2016-05-4 | | |

**Task H13 - Emittance Reduction**

| Task | Momentum | # Triggers | Beamline Tag | CoolingChannel Tag | Similar runs | Final Event Tally (k) |
|---|---|---|---|---|---|---|
| H13b | 140 | 315K TOF2 | 6-140+M3-Test2 | 2016-05-4 | | |
| H13c | 140 | 200K TOF2 | 10-140+M3-Test3 | 2016-05-4 | | |

- With no diffusers, we should be getting 630 k TOF2 triggers (200 k TKD muons) in 12 hours (with 1 hour contingency)
- The above tasks should be done in a full day, then follow the other settings

# Conclusion

- We took a huge amount of data in the last run cycle
- Data recon'ed by MAUS 2.7.0 agreed well with MC with some more details (a.k.a. discrepancy) to be resolved;
- We have designed the CC based on multiple criteria
  - GA-based, absorber-cooling oriented optimization provided the only setting that cools the undiffused beam across abs., and the best setting for a matched beam with low input emit. and high transmission;
  - Linear optics and parameter space search based optimizations provided the best cooling of good matched muons, and the real 6 mm muon beam
  - Worth a check on GA optimizations directly using this input beam
- Alternatives to measure cooling, including sampling, extrapolation, and core density evolution will be examined
- We have a good plan ahead and things should proceed as we desire
  - If they don't, buy 100 fortune cookies and you'll find that fortune