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2016/04 Data – Enjoyable melancholy

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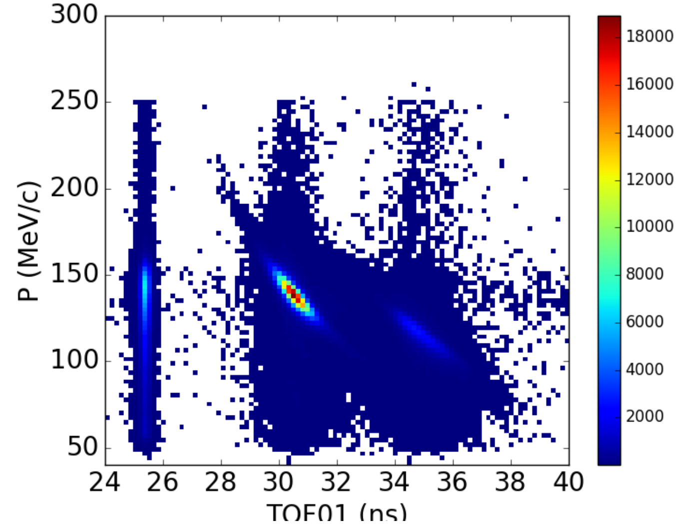
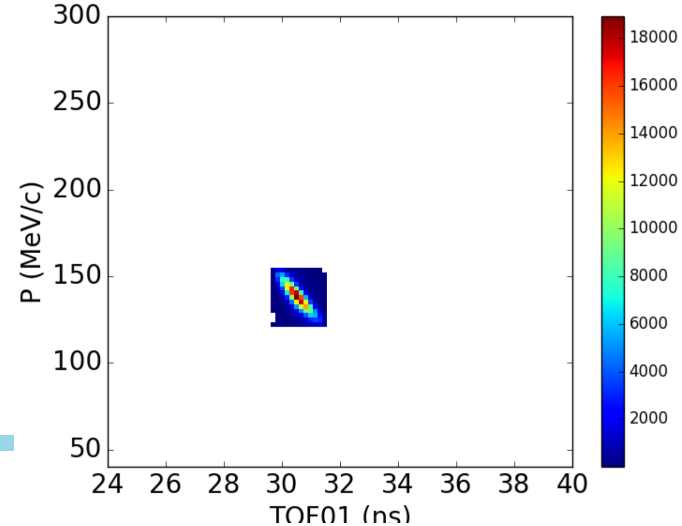
Our data in 2016/04 -- summary

- 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”
  - This tag does not exist in DB yet but I highly recommend this so we could get run numbers based on that, or, one will have to dig like I did.
- The run numbers, number of TOF2 triggers and magnet currents have been summarized
  - You’ll need this if you want more statistics for a certain setting
  - It is attached to the Indico page of this talk.
- All together, for 140, 200, and 240 MeV/c we had ~ 12.5 M TOF2 triggers, really nice amount of data.

Our data in 2016/04 – 140 MeV/c, MAUS 2.6.5

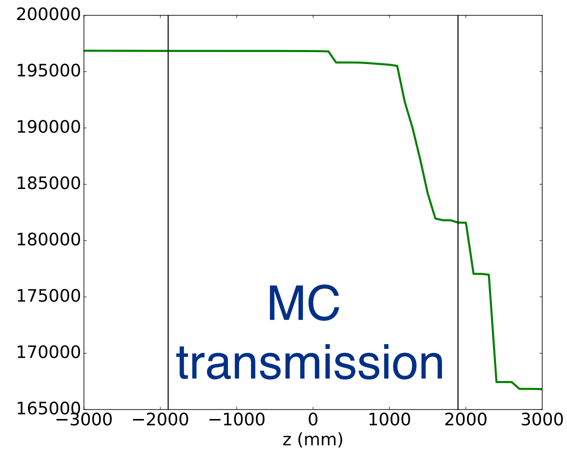
- At 140 MeV/c we had 3 CC settings, each with diffuser setting from 0 to 15, and beamline adjusted accordingly
  - All together with ~ 5 M TOF2 triggers
- Take CC setting 2016-04-01.5, no diffuser as an example
  - This setting was designed for a 6 mm “matched” beam
  - “matched” means the input beam was supposed to be a Gaussian, with a covariance matrix determined by B_z [Penn’s note, 2000]
  - Muon selection always done based on TOF01 and P as before:

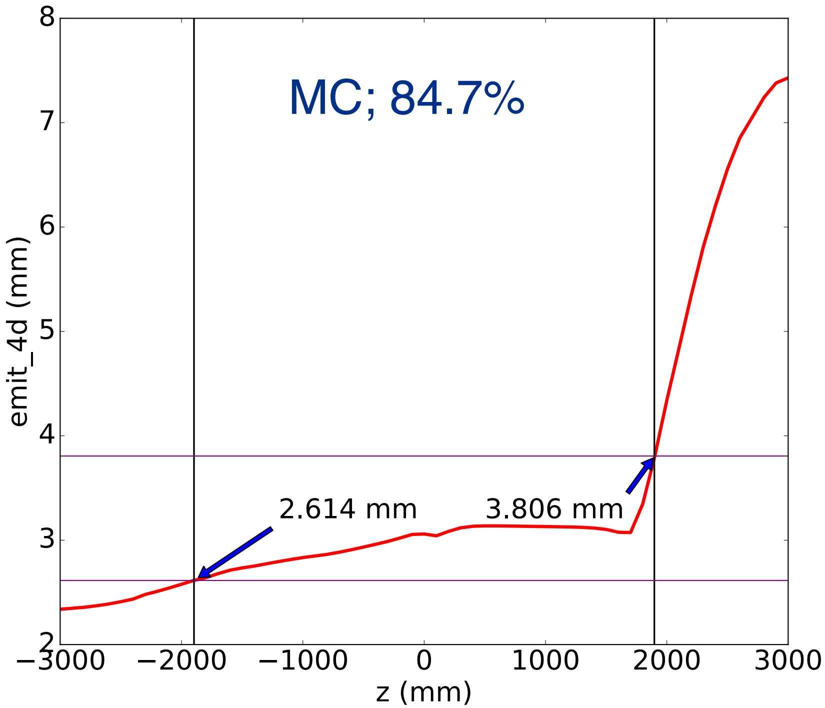


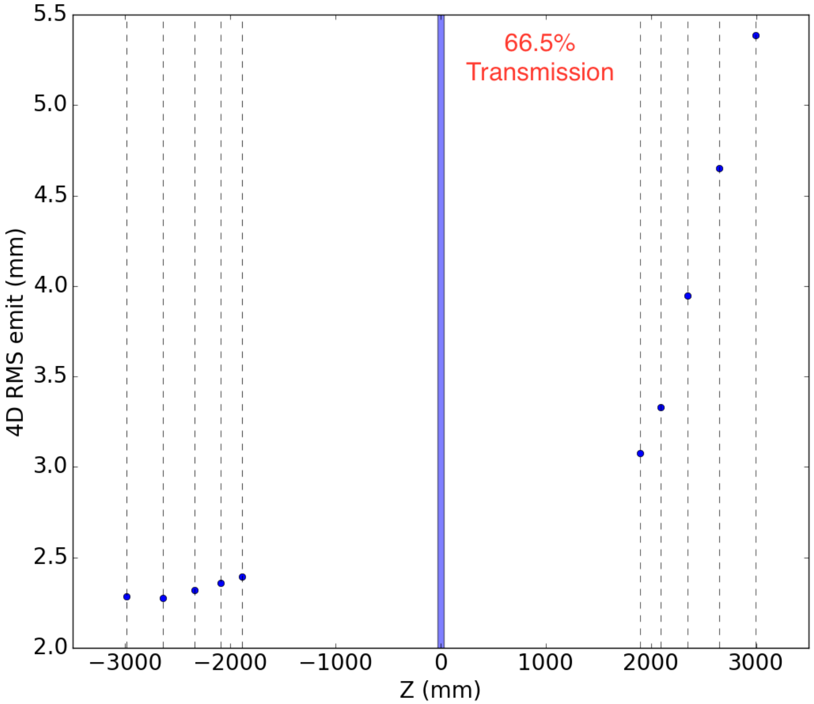


Our data in 2016/04 – 140 MeV/c, MAUS 2.6.5

- Transmission-wise, MC and data had 18.2% discrepancy
  - Input beam at TOF1 from back-tracking using data in Oct 2016
- Data has bigger growth the cooling channel



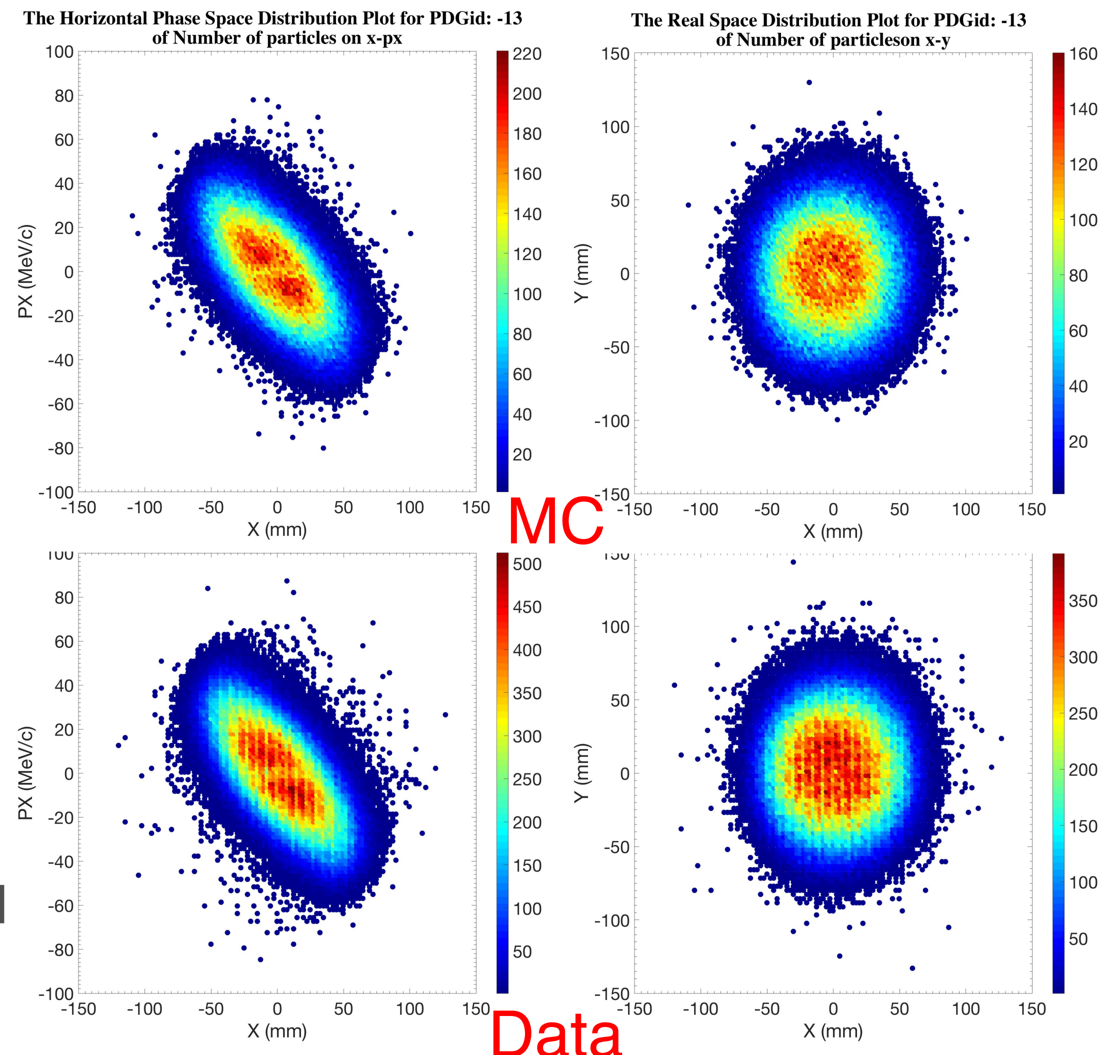




Our data in 2016/04 – 140 MeV/c, MAUS 2.6.5

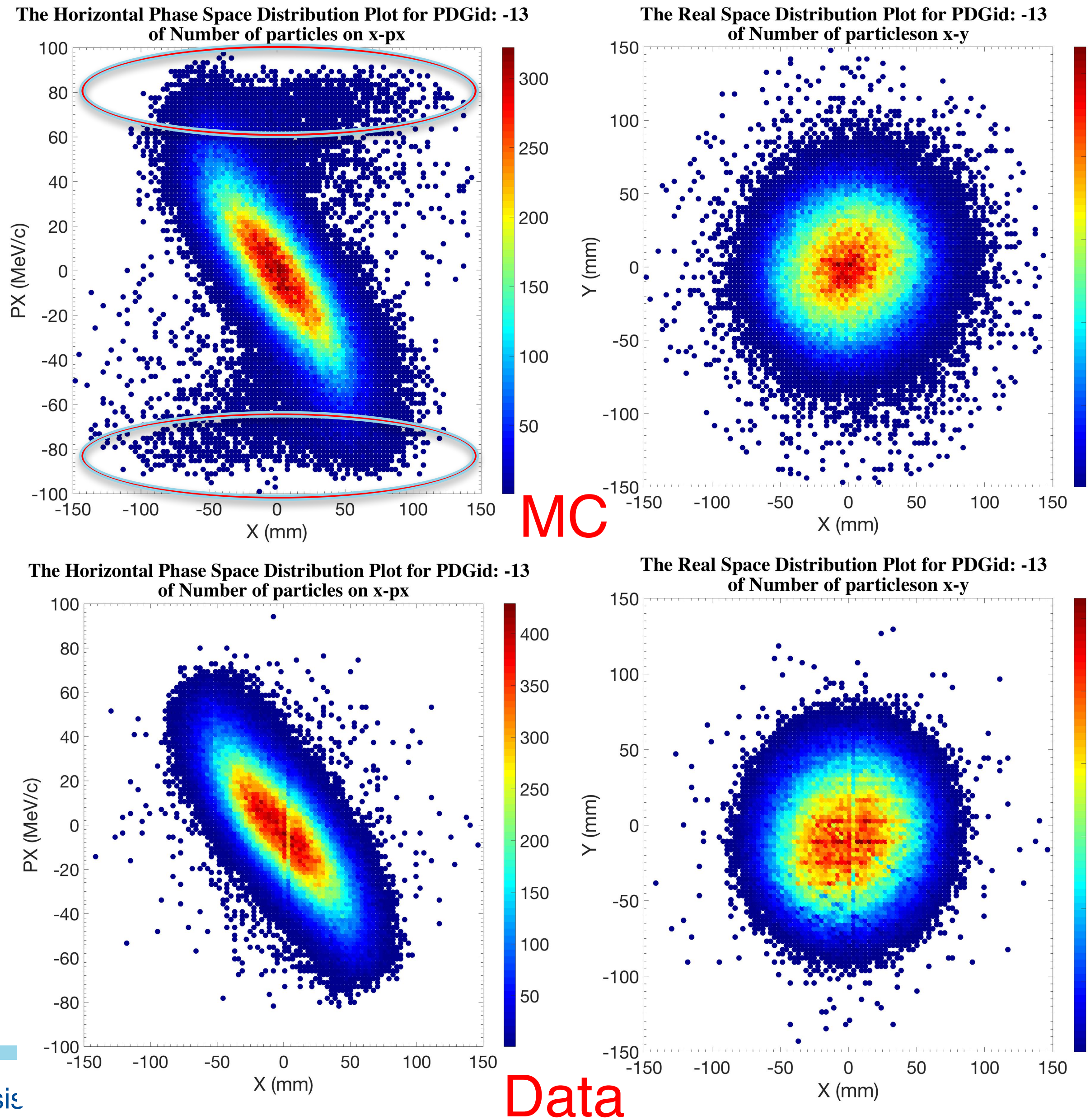
- Comparisons of the phase space and real space distribution show good agreement:
  - Simulation from TOF1 to TKU STN5;
  - TOF1 beam was the backtracked beam from Oct, 2016
- 1.3% difference in 4D RMS emittance at TKU STN5 (no transmission cut) and 5.7% difference at TKU STN1
  - Alignment and field studies to be done to find the 5.7%

TKU STN5



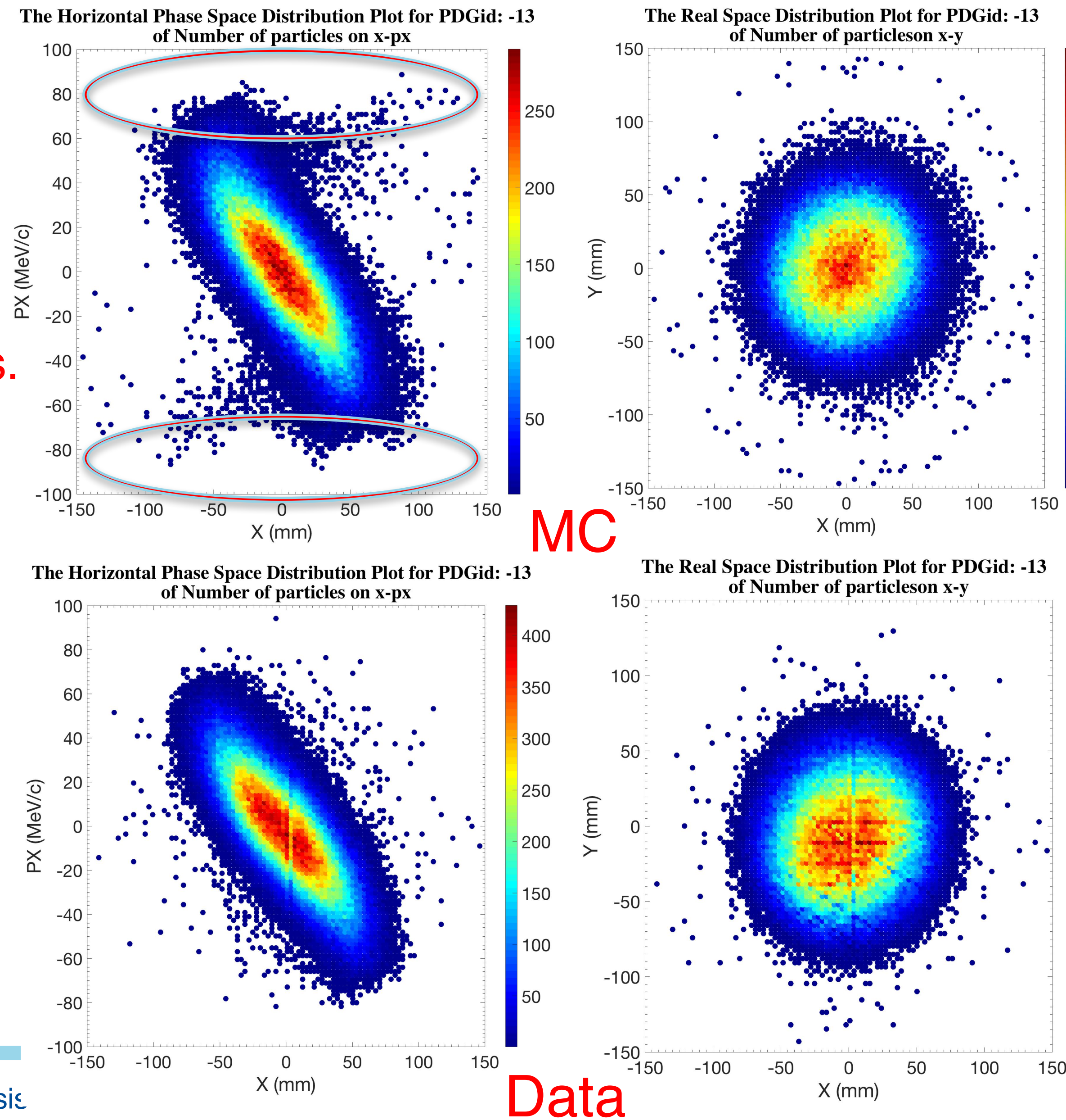
Our data in 2016/04 – 140 MeV/c, MAUS 2.6.5

- Now look at TKD STN1 before transmission cut
- RMS emit from MC 68% larger than measured, before transmission cut
- Was that because of the large amplitude particles like those in the red circles?
  - Should be lost quickly in the tracker so unlikely to be recon'ed
  - Apply trans cut



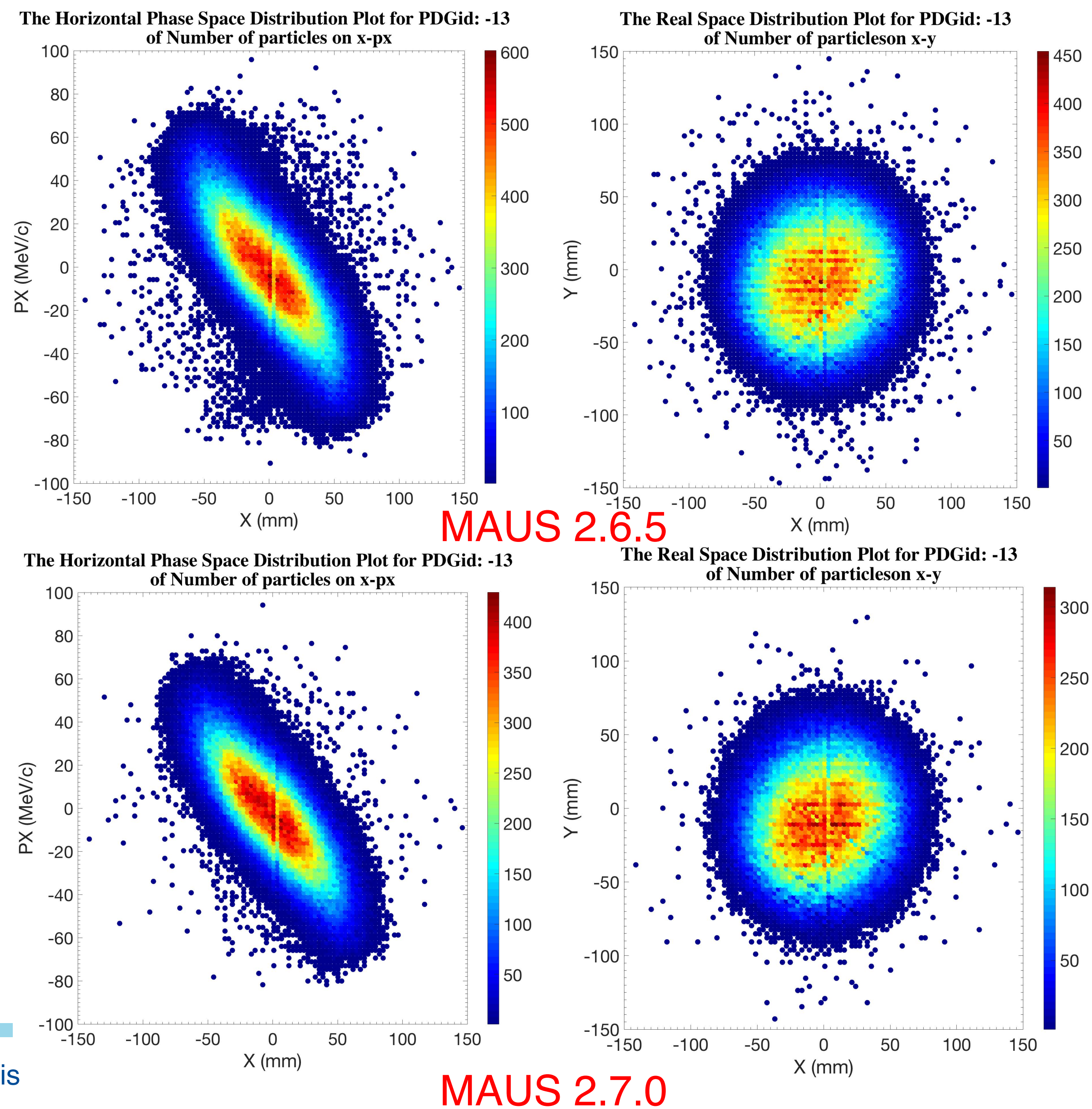
Our data in 2016/04 – 140 MeV/c, MAUS 2.6.5

- Now look at TKD STN1 after transmission cut
- RMS emit from MC 22.2% larger than measured, after trans. cut.
- Outliers contribute significantly to the RMS, but the core is (almost) preserved
- Where could the remaining 22.2% come from?



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

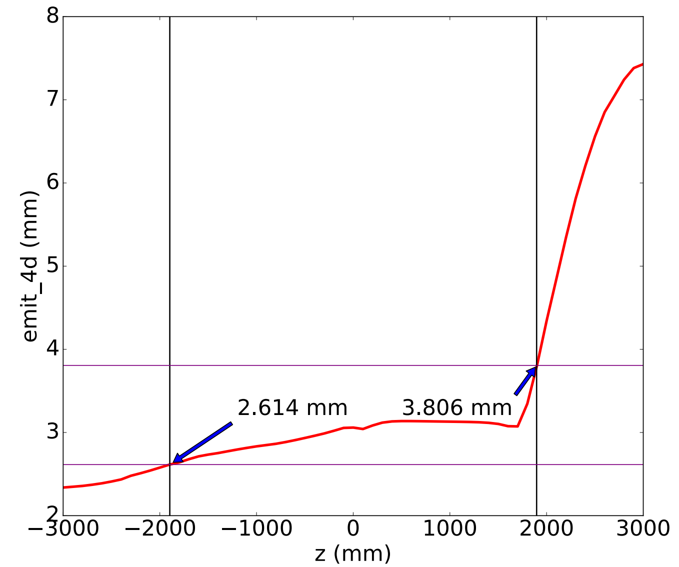
- Try to match the transmission – MAUS 2.7.0 has better recon efficiency, how does that change the RMS emit?
- MAUS 2.7.0 gives 83.8% transmission, recovering many large amplitude particles, yielding a much larger on RMS emit. : discrepancy drops to 7.7%

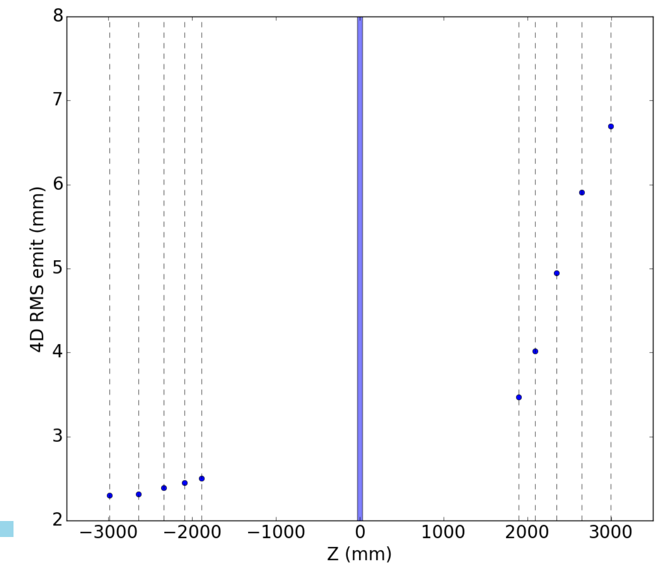


Our data in 2016/04 – 140 MeV/c, MAUS 2.7.0

- RMS emit. discrepancy went up to 11.1% at TKD STN5 while the transmission already agreed
- 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;
  - Recon inefficiency at low amplitude (still deficit in the core of TKD)

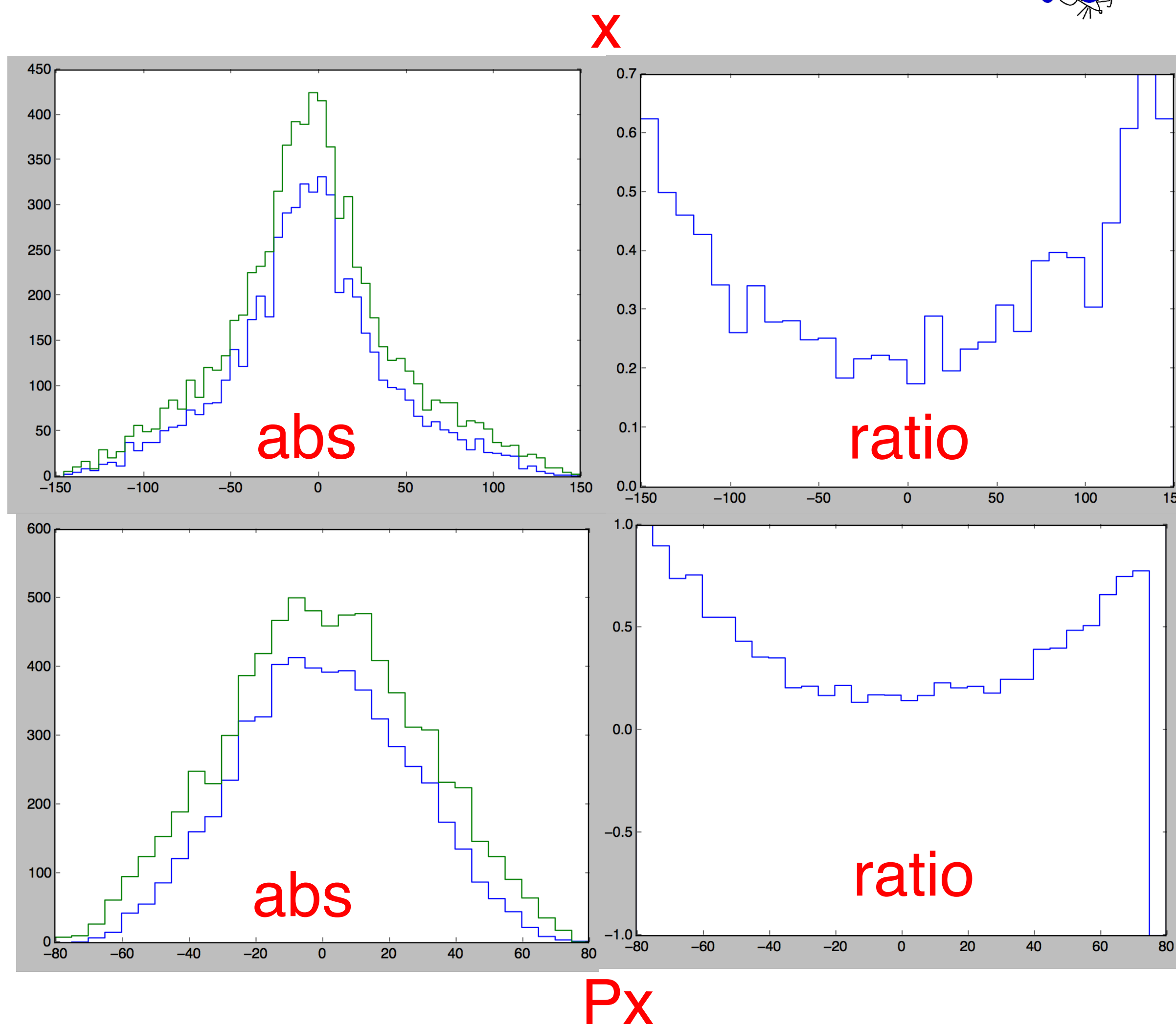
- In general data recon'ed by MAUS 2.7.0 agreed well with MC





Reconstructing MC tracks in MAUS 2.7.0

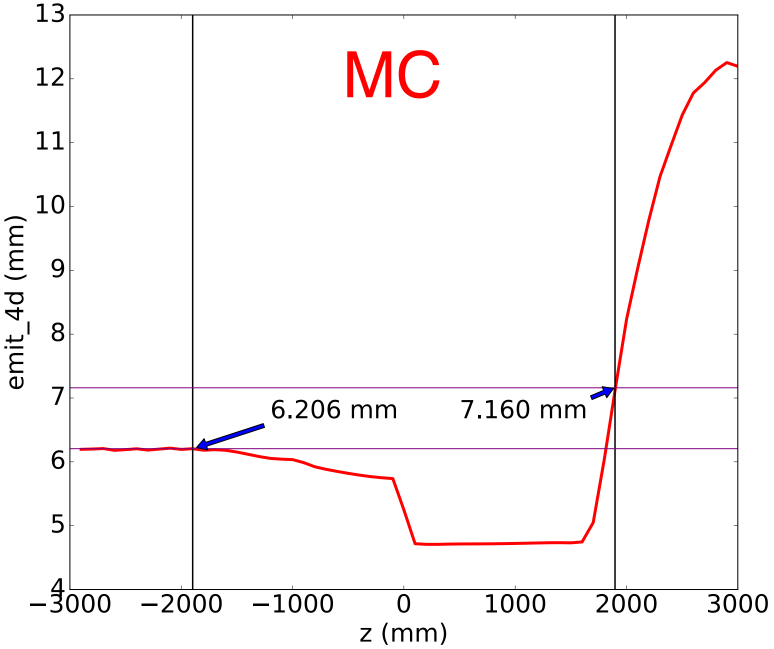
- Using 10,000 particles from TOF1, same setting before
- Compare the MC tracks and the reconstructed MC tracks
- Transmission in MC: 80%; in recon MC: 63%
- Right figure shows x and Px real (green)and recon'ed (blue)
- Checked I was using 2.7.0… But it looks like the inefficiency is still there.

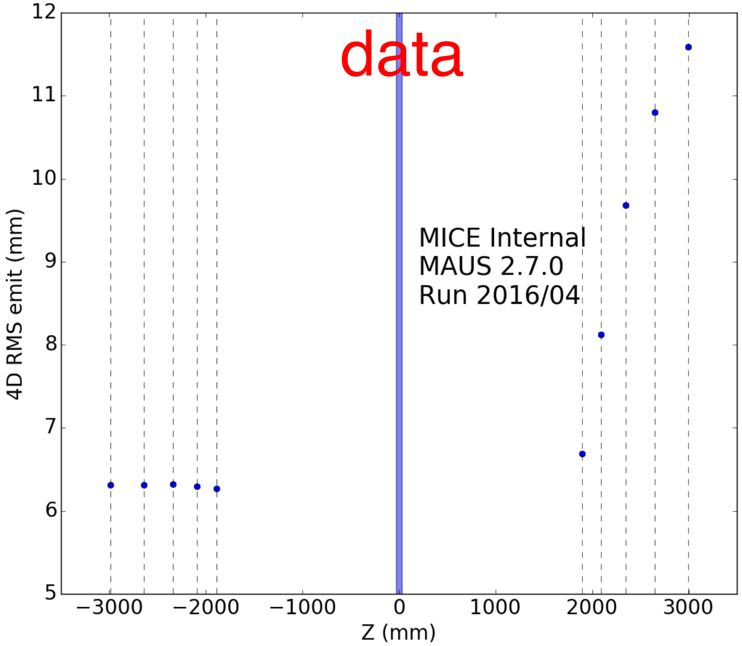


Are there tricks to use the new recon?

Data with diffuser 15 at 140 MeV/c

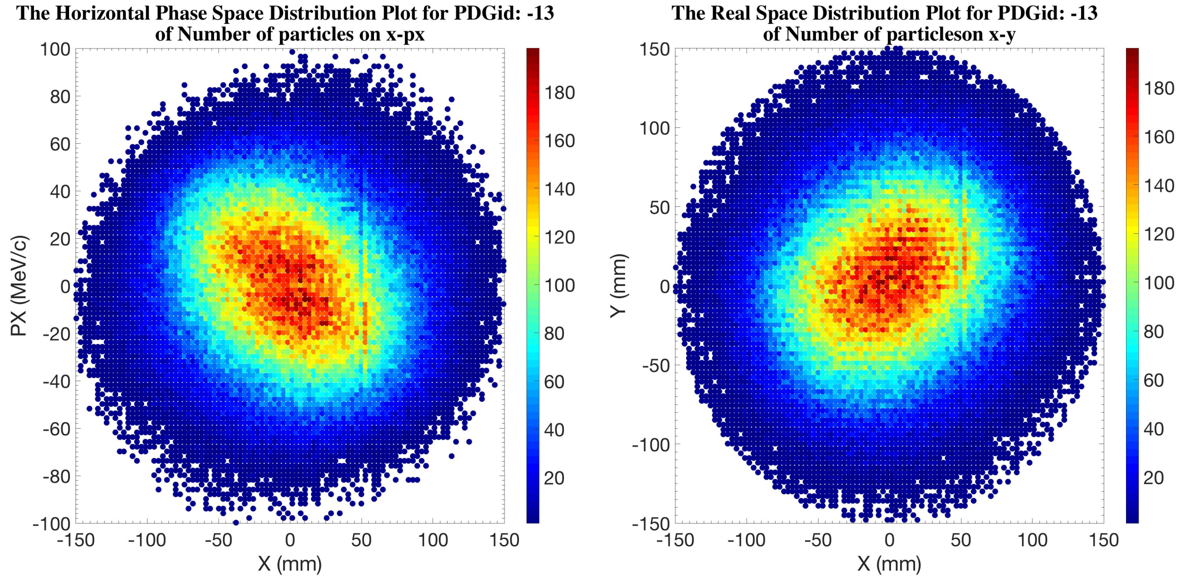
- Diffuser setting 15 – highest setting (140_Diff15_lattice1_5_LiH)
- Using the reconstructed muon beam at TKU STN5
- MC: 35.2% transmission; Data: 33.2%
- Reminder: TKD was moved ~ -100 mm in recon data
- Beam across the absorber without good muon cut has 10% emit reduction
- Francois is going to show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



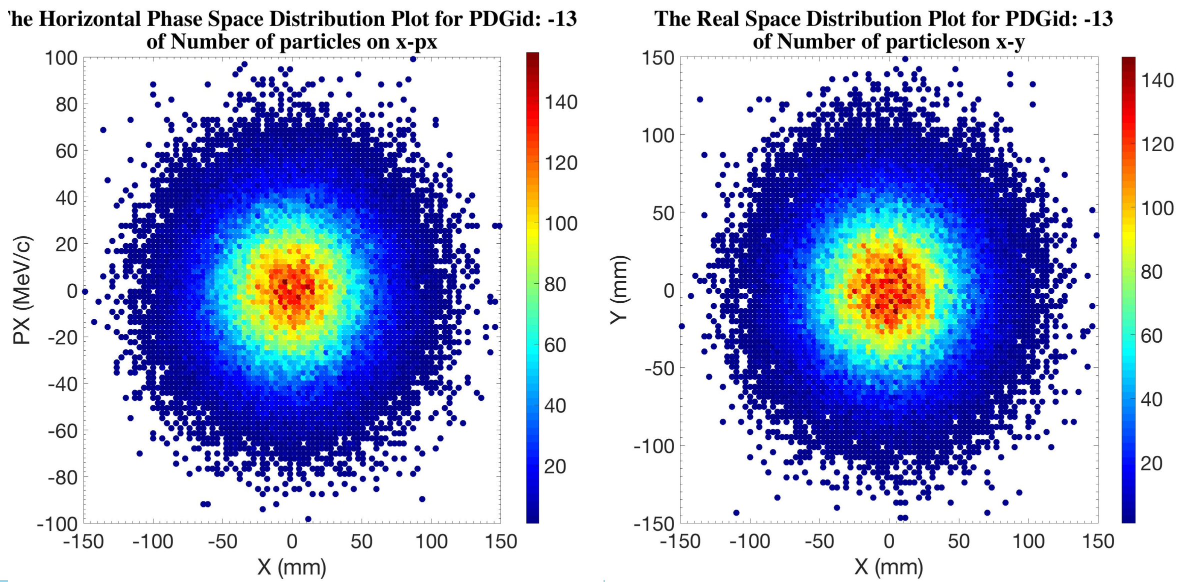


Data with diffuser 15 at 140 MeV/c

- Input muon beam:

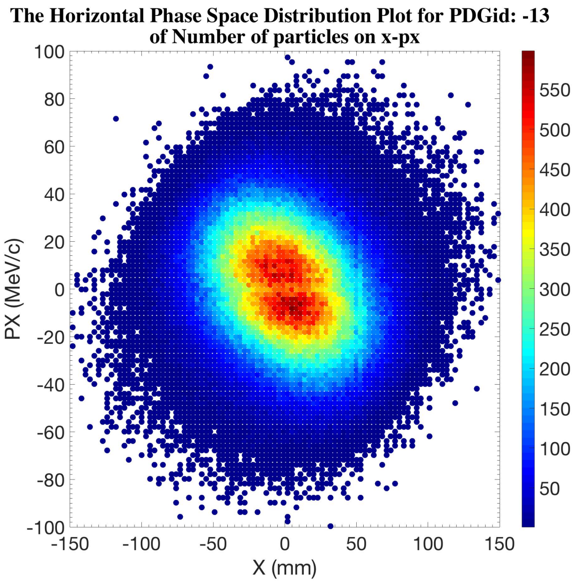


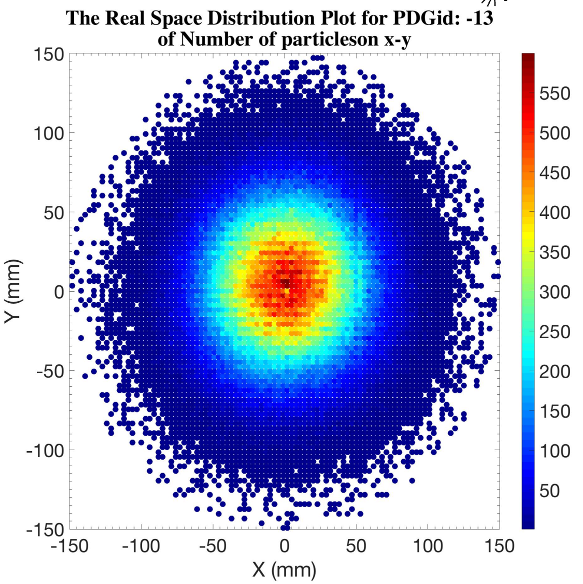
- 6 mm matched:



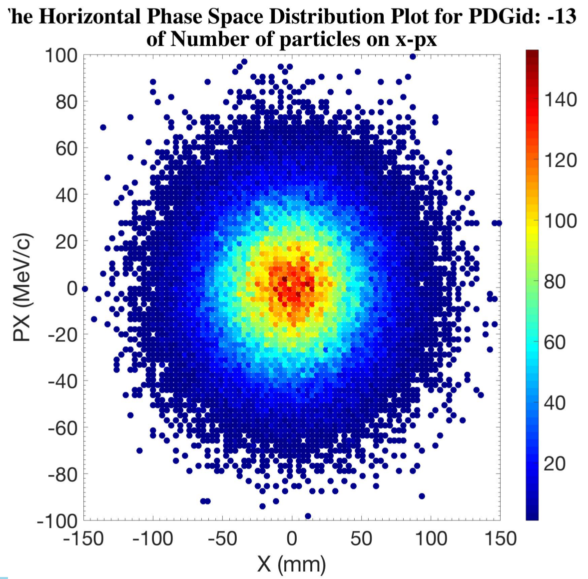
Data with diffuser 4 at 140 MeV/c

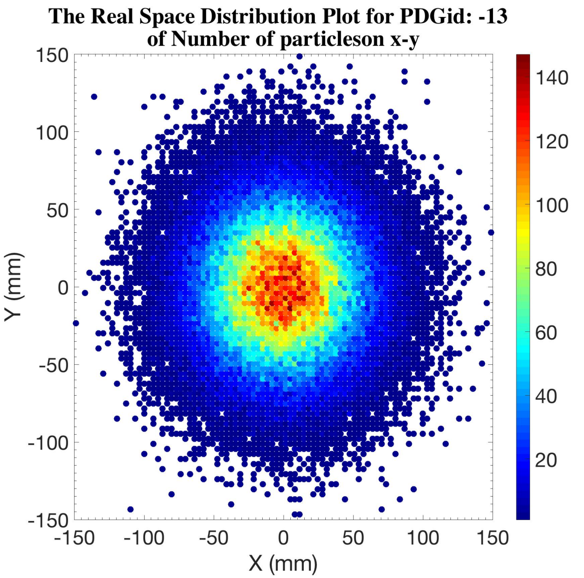
- Input muon beam:





- 6 mm matched:



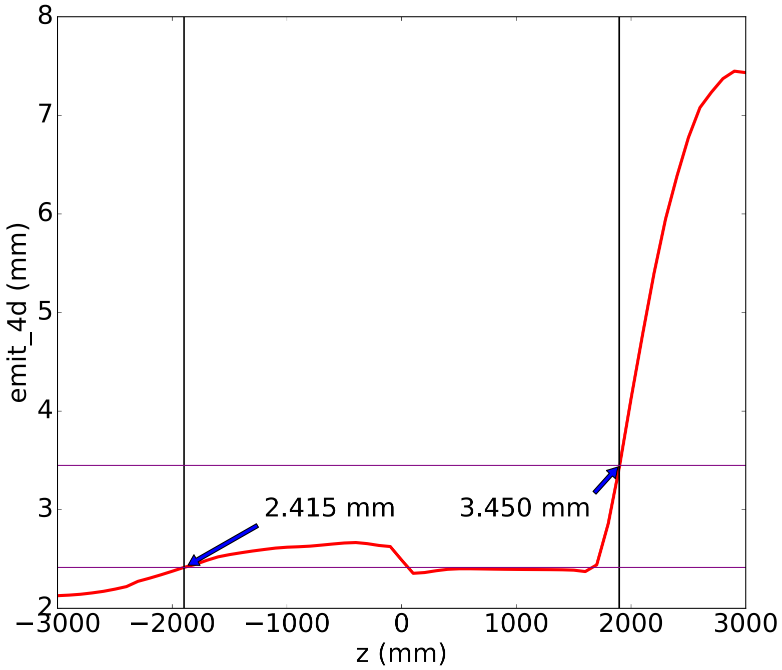


What does the previous examples say

- Input beam still mismatched, causing a big beam loss in the channel;
  - Simulation results from a matched beam can not be directly applied to conclude the CC performance
- The beam cools across the absorber but the 4D RMS emit (both from MC and from data) at the reference planes grows from us to ds, covering the real cooling effect;
- There are ways to uncover the cooling:
  - Core density increase (Francois will show his example) which preserves the real cooling;
  - A very careful selection of the beam, based on no knowledge about the transmission (i.e. one is given only the TKU STN5 beam and CC design, he/she selects a desired distribution)
- The higher transmission, the less bias

Designing the CC for the undiffused beam

- Using the emit. Reduction across the absorber as the criteria, there were settings proposed for the unmatched beam, e.g.
- Aim for core density increase, or an easy sampling algorithm to show cooling, or extrapolation if MC and data agrees perfectly (after all alignments etc. are done)



CC designs for the diffused beam

- There are matched settings proposed
  - Based on matched input beam
- Need to re-evaluate with our real beam after diffusers
- I think it is necessary to re-optimize the CC based on the real beam to maximize cooling
  - This can be done fairly quickly
  - A module to calculate core density is going to be helpful
- On the other hand, turning on M2D will be extremely helpful for our performance (next next cycle?)
- It’s an enjoyable melancholy