

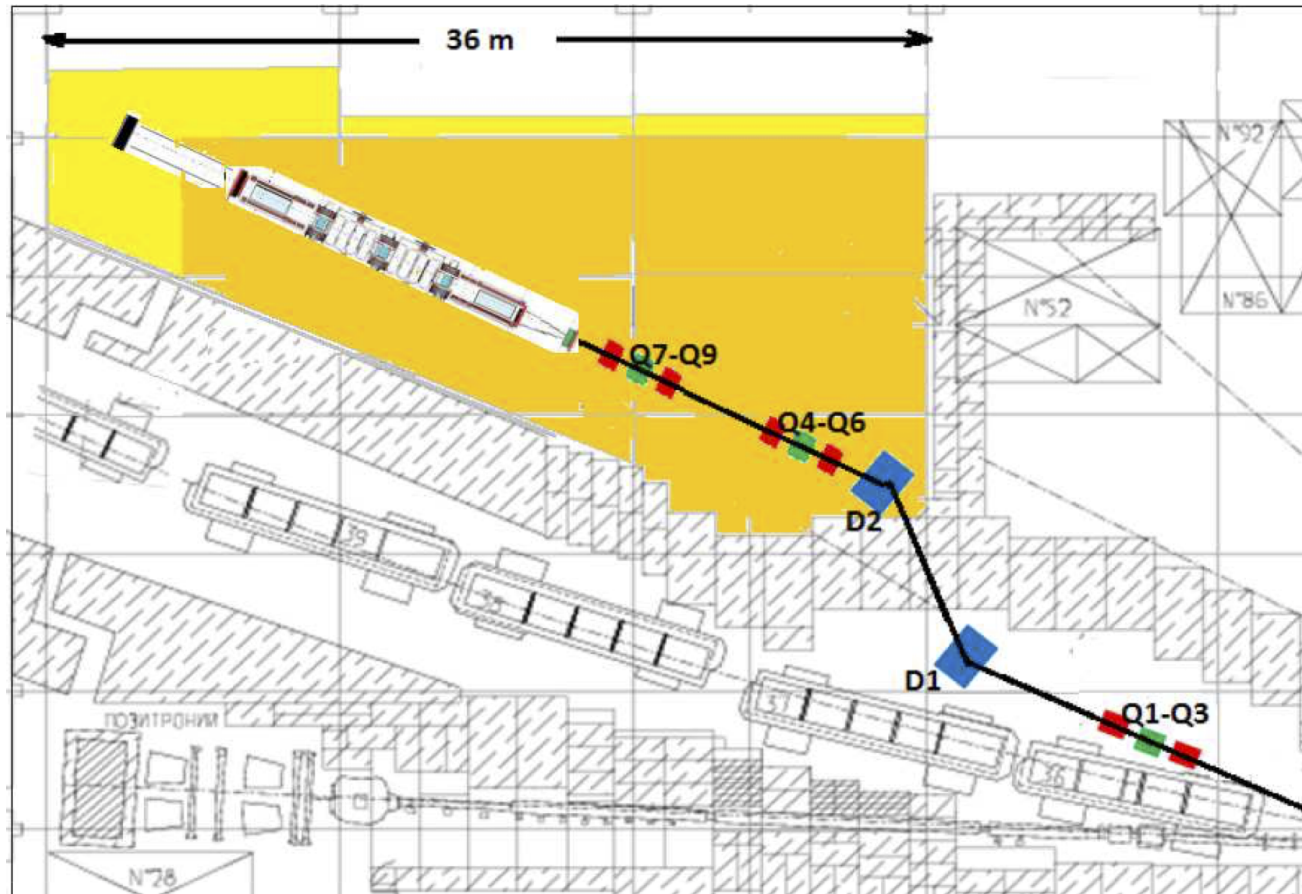
# Ideas for a 6D Demo Beyond MICE

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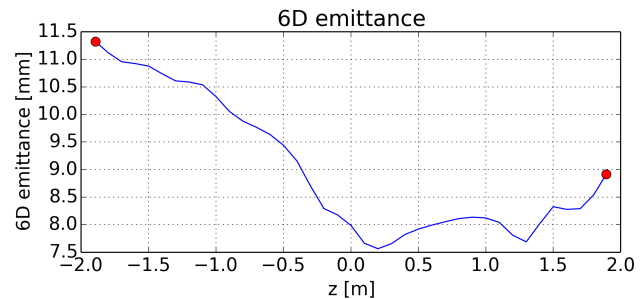
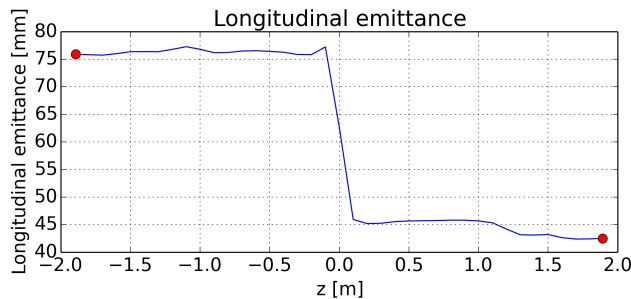
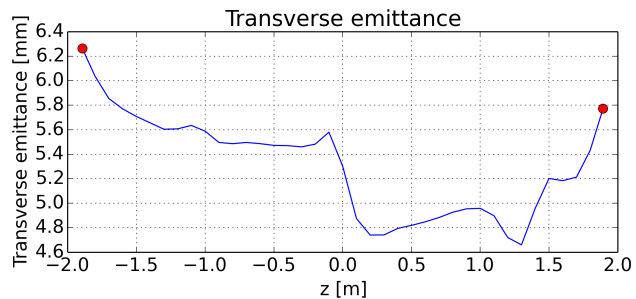
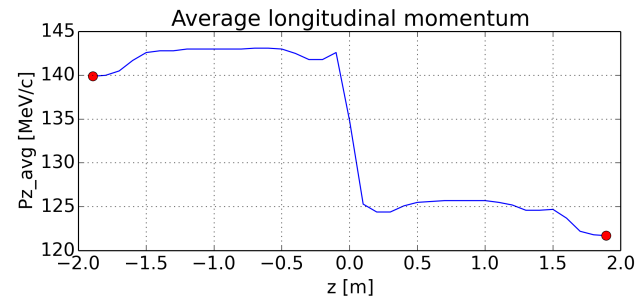
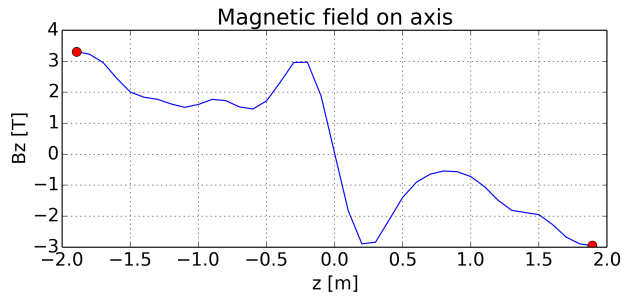
# MICE at IHEP discussion



- At the previous CM (Belgrade) Alexander Zaitsev talked about the possibility of muon cooling demo at IHEP
- Shown here is the experimental hall layout, MICE beamline and MICE in its Step VI configuration
- I was tasked with providing some ideas on how this experiment could be modified further to do a 6D ICE demo

# MICE with a wedge (Step IV, M2D on)

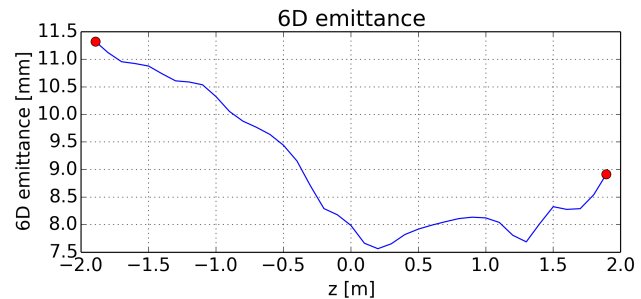
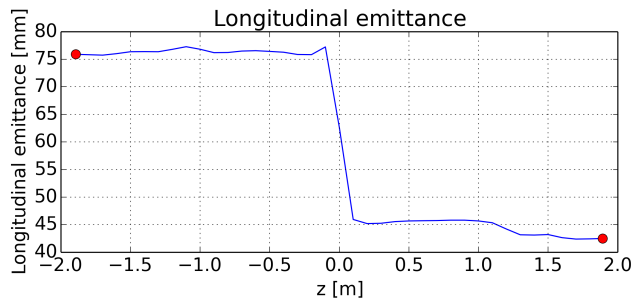
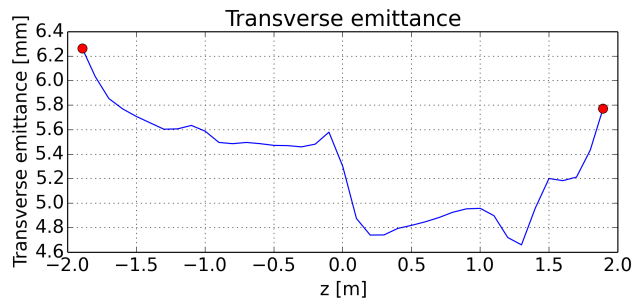
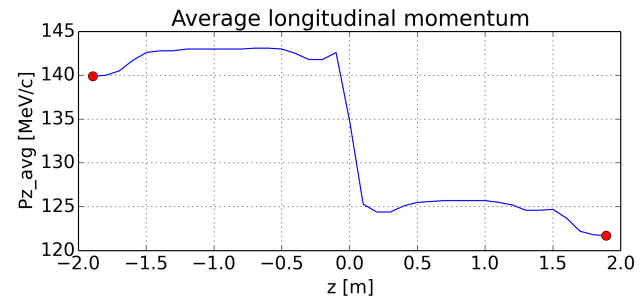
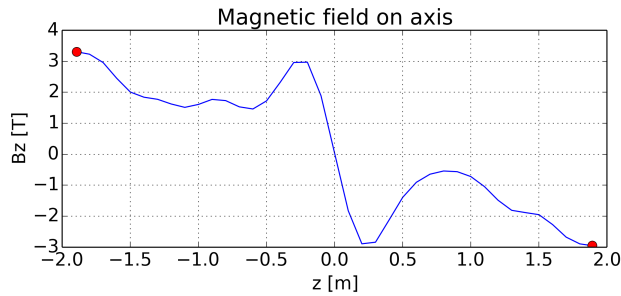
As shown at the last CM, simultaneous transverse and longitudinal emittance reduction is possible in Step IV configuration with a polyethylene wedge



- M2D on
- Wedge angle  $45^\circ$ , on-axis length 52 mm
- Transmission: 92% (86% after momentum cut)
- Momentum cut:  $P_z$  in [100,400] MeV/c
- Transverse emittance: 6.26  $\rightarrow$  5.77 mm (7.8%)
- Longitudinal emittance: 75.9  $\rightarrow$  42.5 mm

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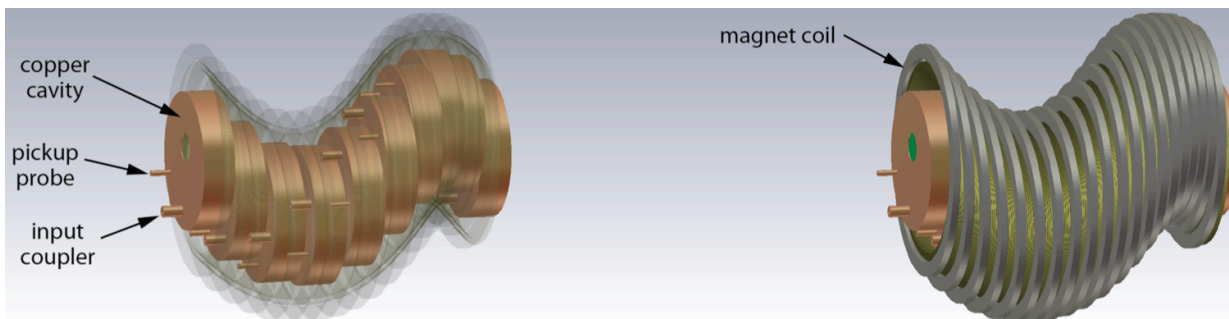
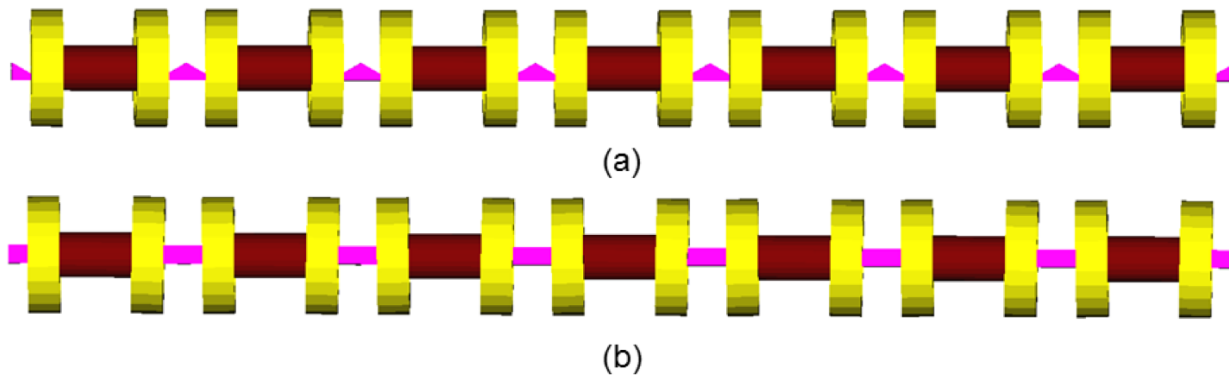
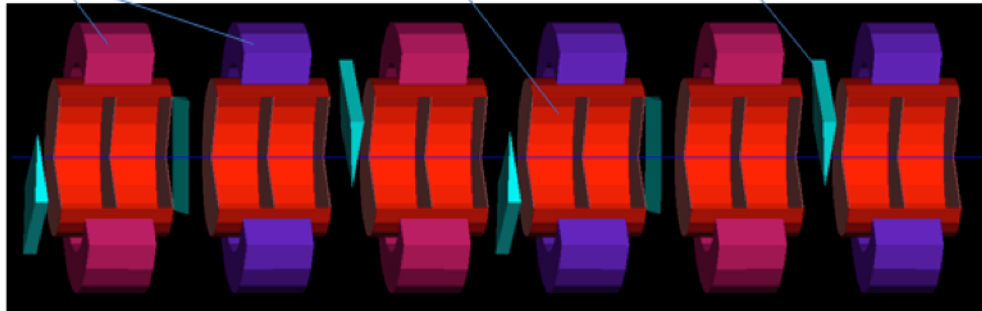
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If we have Step VI or similar configuration at IHEP, emittance reduction could only improve

# Beyond MICE

# 6D cooling options

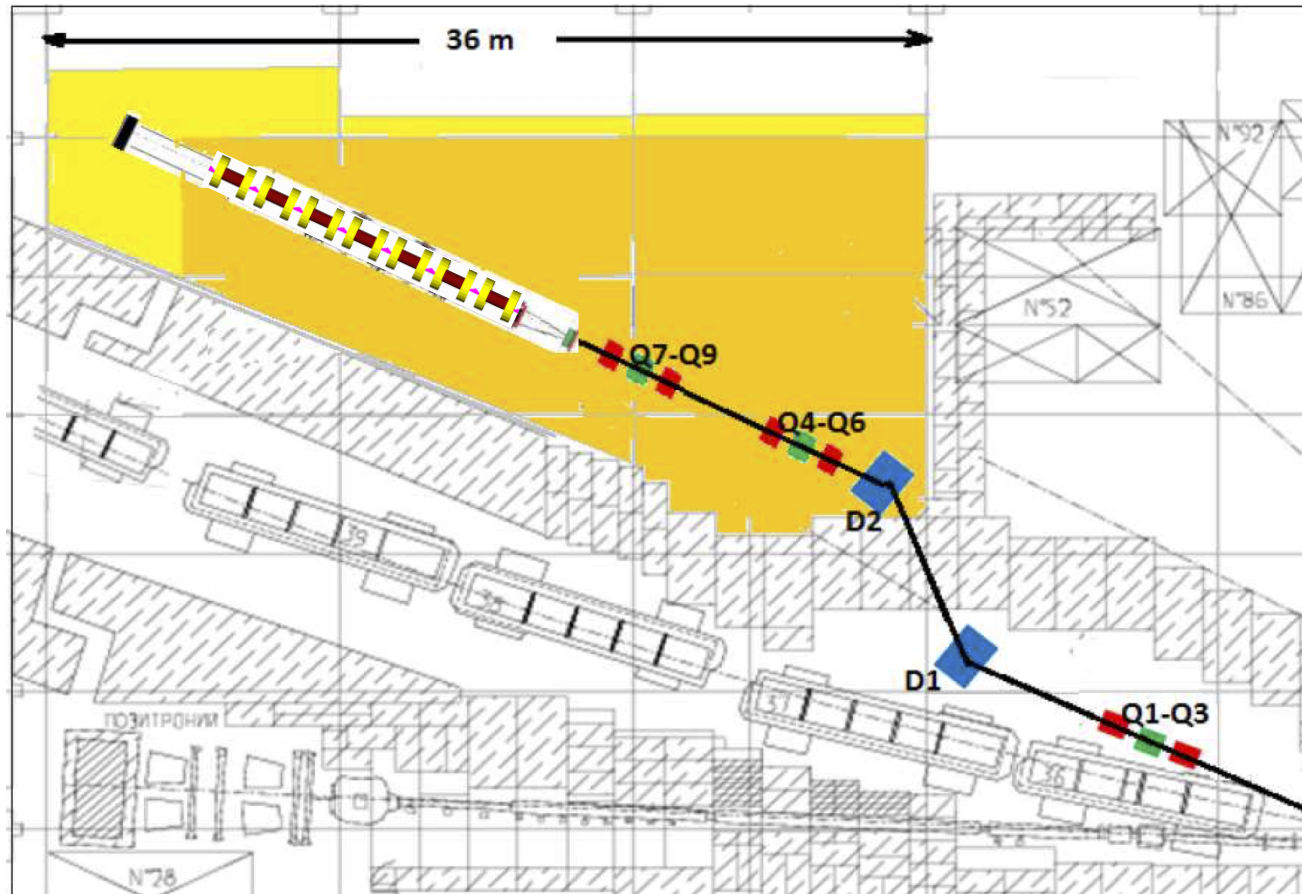
coils:  $R_{in}=42\text{cm}$ ,  $R_{out}=60\text{cm}$ ,  $L=30\text{cm}$ ; RF:  $f=325\text{MHz}$ ,  $L=2\times 25\text{cm}$ ; LiH wedges



We have multiple 6D cooling channel options that were studied so far:

- Helical FOFO channel proposed and studied by Y. Alexahin
  - More complicated geometry compared to the rectilinear channel
- Rectilinear cooling channel proposed by V. Balbekov and studied in details by D. Stratakis, R. Palmer and others
  - The most straightforward configuration
- Helical cooling channel proposed and studied by Muons Inc.
  - Need Muons Inc. onboard to pursue

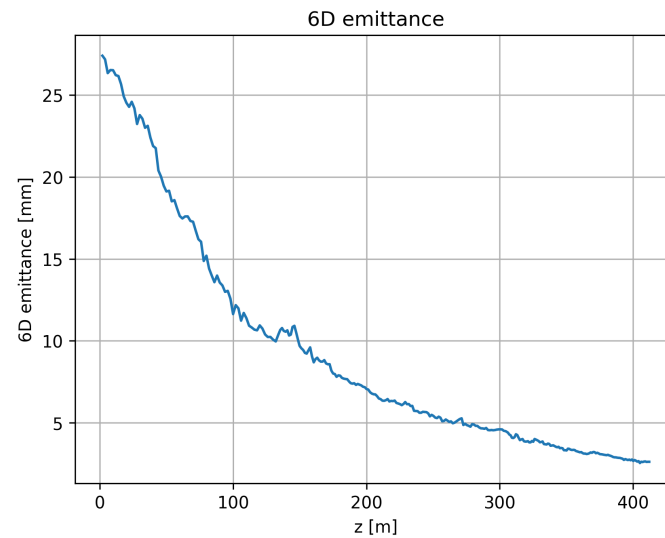
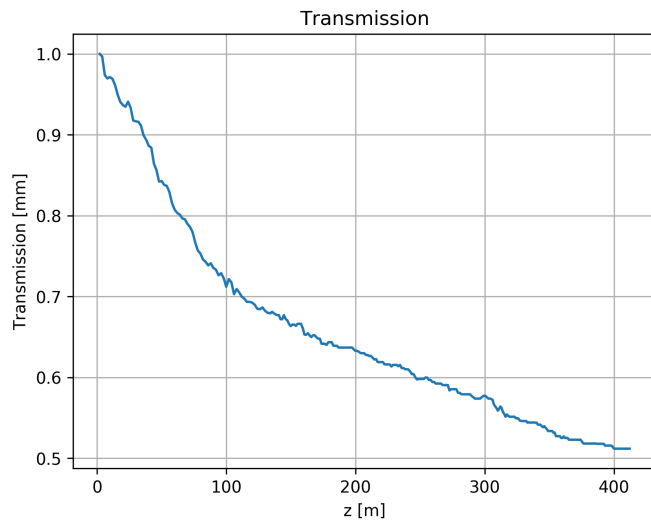
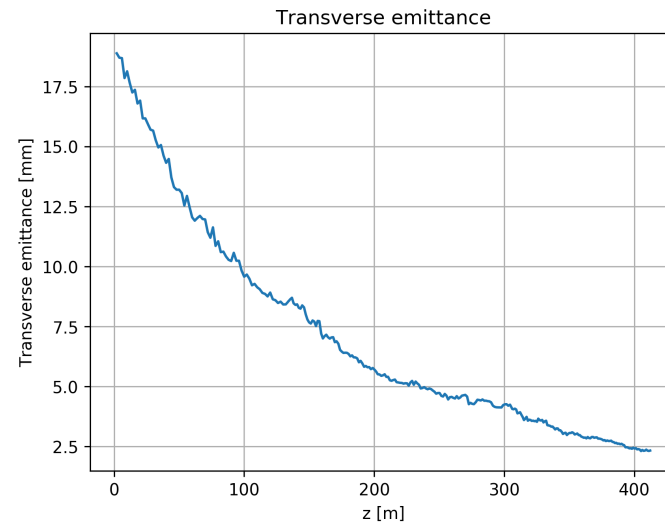
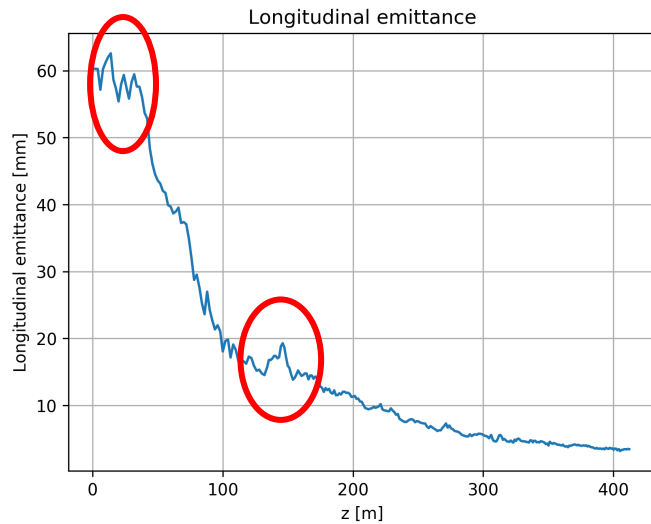
# Rectilinear 6D cooling channel at IHEP



- I'm concentrating on the vacuum rectilinear channel
  - Early stage of the cooling capable of handling the beam from the phase rotator
  - Magnetic coils are tilted, but at least tilted in the same plane
  - Wedge absorbers could be LH2 or LiH
  - The overall length will be approximately 20-30 m, there should be enough room
  - If we are talking "beyond MICE", might as well consider the channel that has been studied in detail as part of MAP effort.



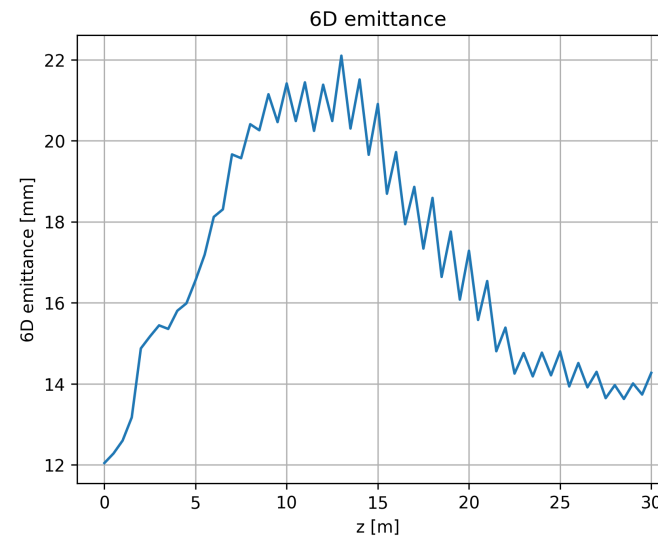
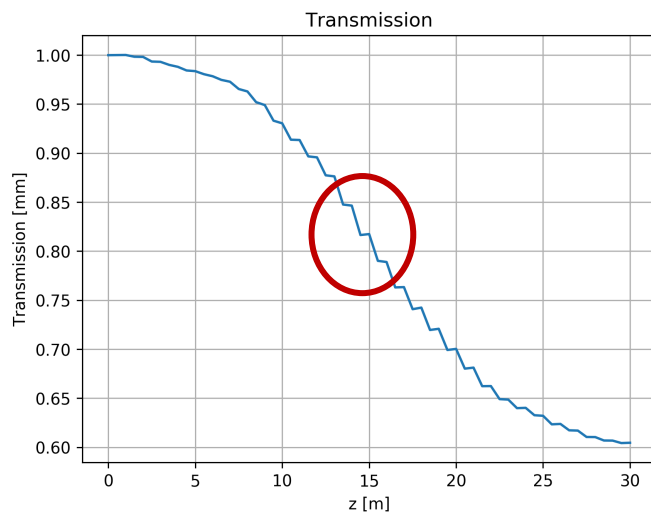
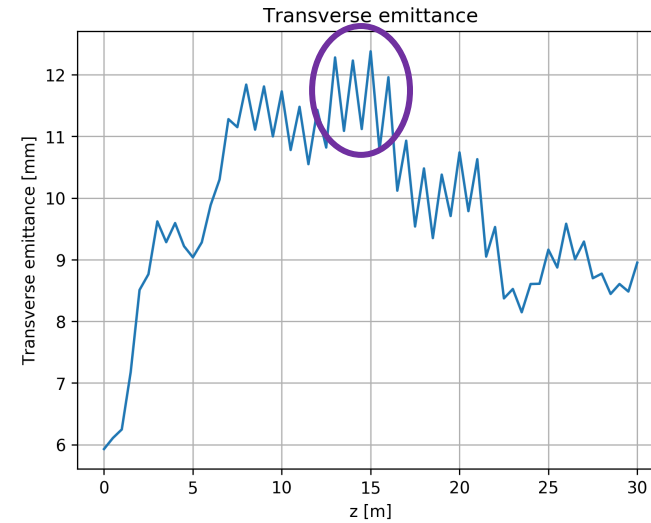
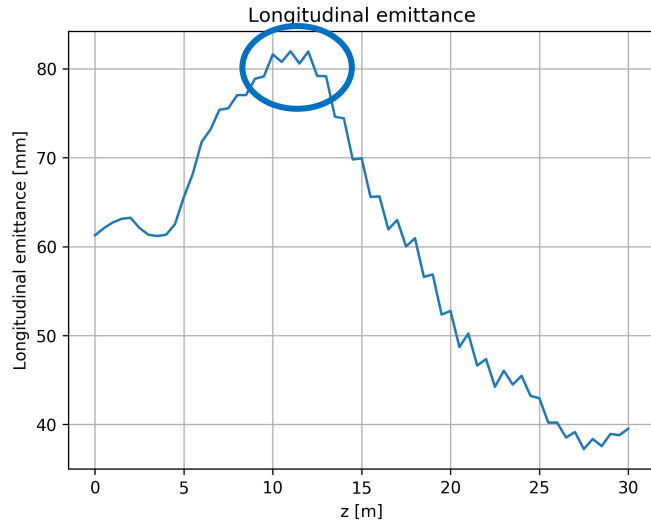
# Cooling issue: long matching



- The diagrams on the left show cooling in the first three stages of the rectilinear cooling channel (lower equilibrium emittance in each stage)
- **Issue: long section with no longitudinal cooling at the beginning of each stage**
- A small deviation on the 400-m scale, but a crucial obstacle for a short demo
- However:
  - Rectilinear channel uses the NF front end beam
  - What happens if we start with a MICE beam (6-200)?



# MICE beam in the rectilinear channel



- The beam distribution is  $6\pi$  mm at 200 MeV/c with linear dispersion matching the absorber orientation
- Particles are tracked through Stage 1 rectilinear cooling channel for 30 m
- No matching section implied
- Beam starts to cool both **longitudinally** and **transversely**, and **transmission start improving** after 12-15 m
- Significant cooling after the next 15 m
- A matching section could significantly shorten the time it takes before the beam starts cooling
  - Shorter overall length, fewer cells
  - Better transmission

# Summary

- The most straightforward approach is to use wedges (in whatever configuration is implemented at IHEP)
- Beyond MICE, a section rectilinear channel is the most straightforward scheme
- Matching into the channel is an issue that needs to be addressed
- D. Stratakis and V. Balbekov are available (for the time being) for consultation