



Flip mode emittance analysis

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Overview

- Current status of refining the beam selection routines
- Sampled beams that have matched optics in the Upstream Tracker in order to improve the cooling performance
- For the results presented here FULL LH2 and NO ABSORBER 6 mm, 140 MeV/c, FLIP mode data were used
- UPDATE: Analysis with Full Transmission imposed + preliminary hybrid MC comparisons



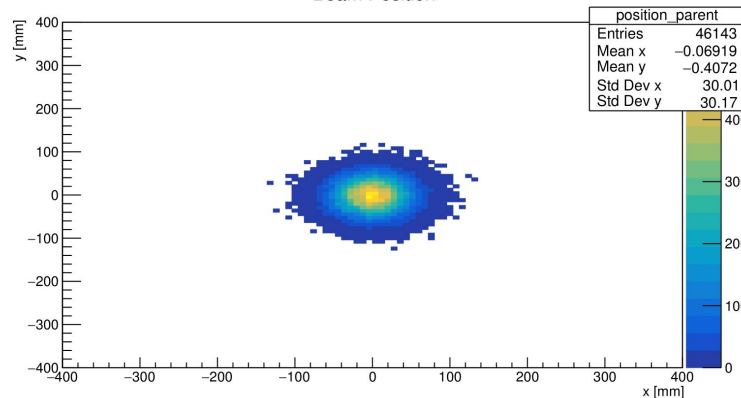
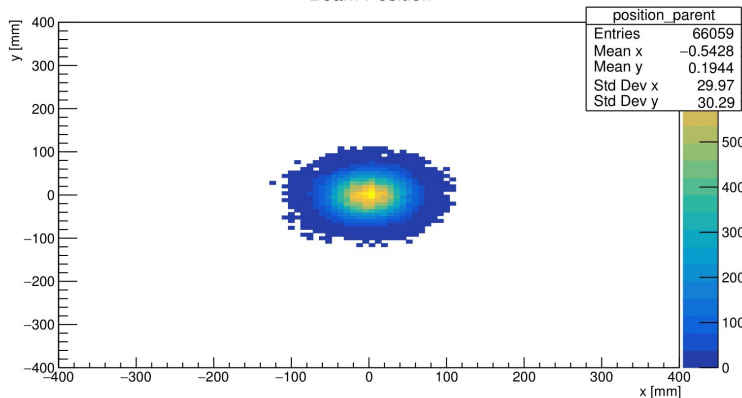
Sampled Beam Evolution - xy

NO ABSORBER

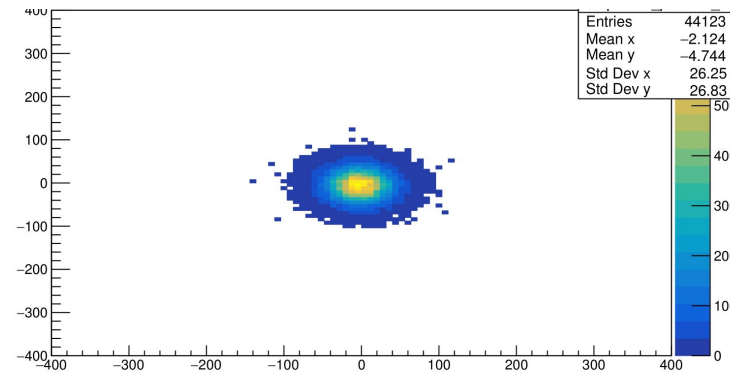
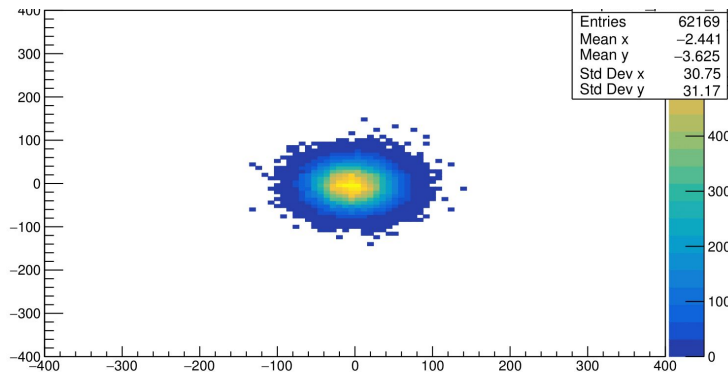
LH2

Upstream

Beam Position



Downstream

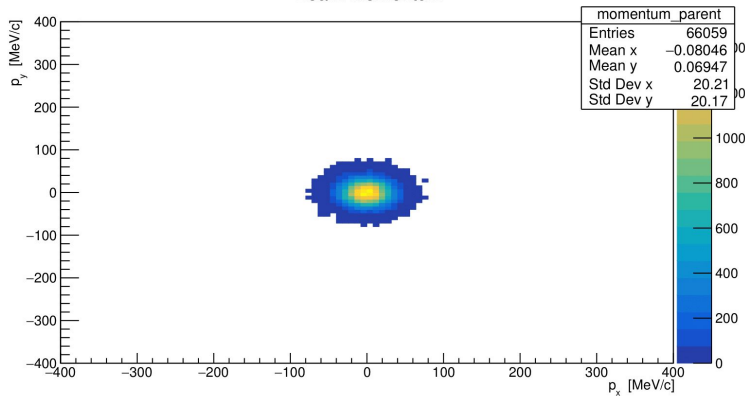




Sampled Beam Evolution - PxPy

NO ABSORBER

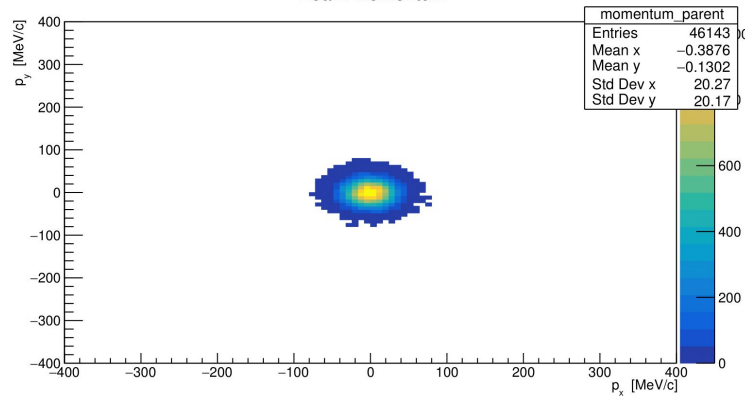
Beam Momentum



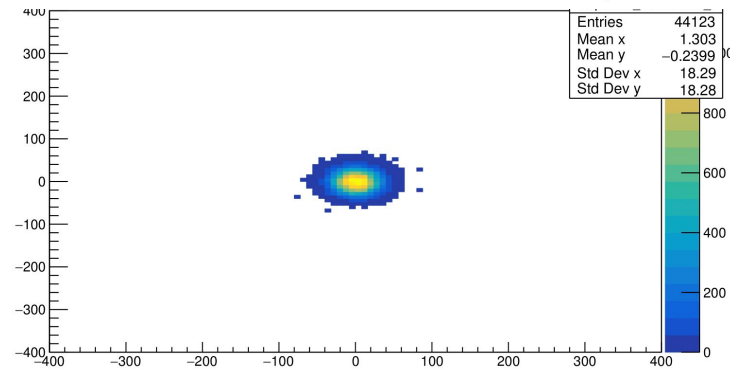
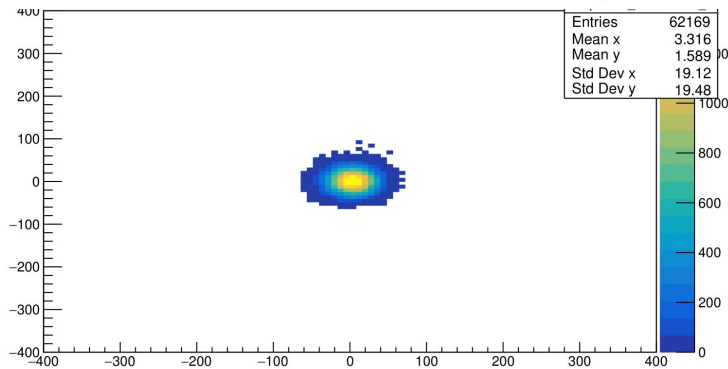
Upstream

LH2

Beam Momentum

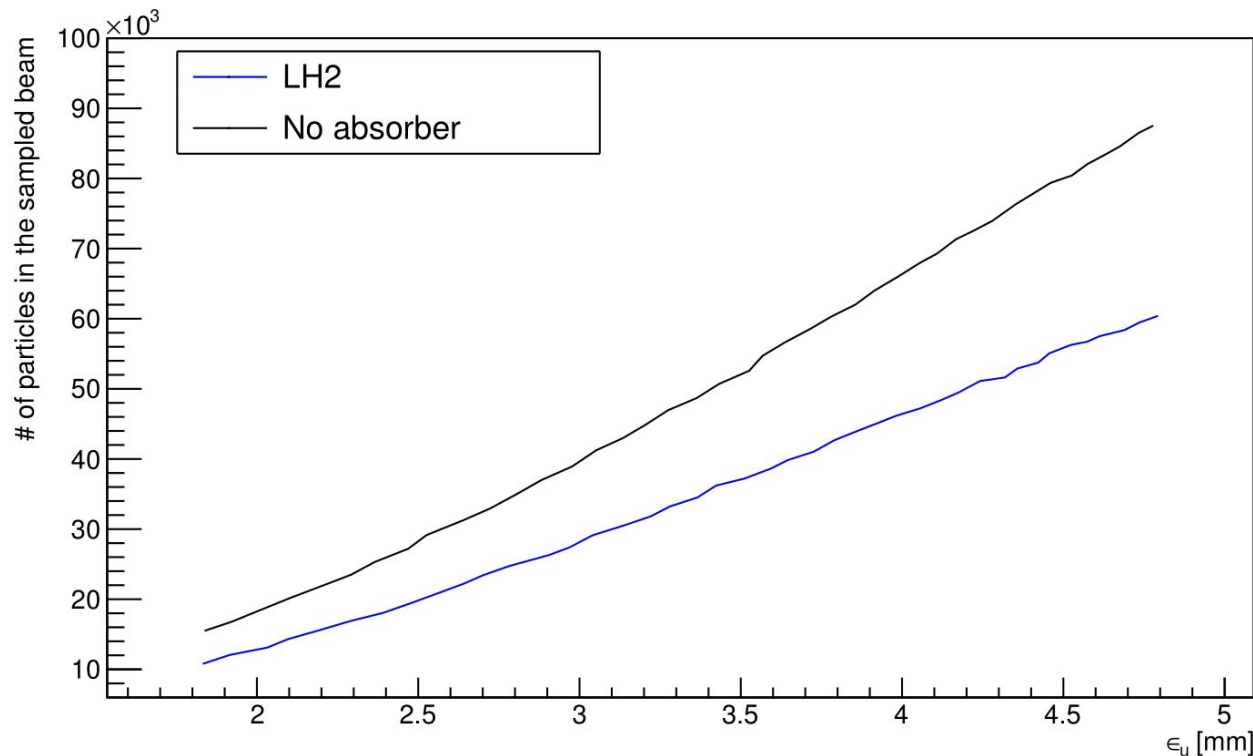


Downstream





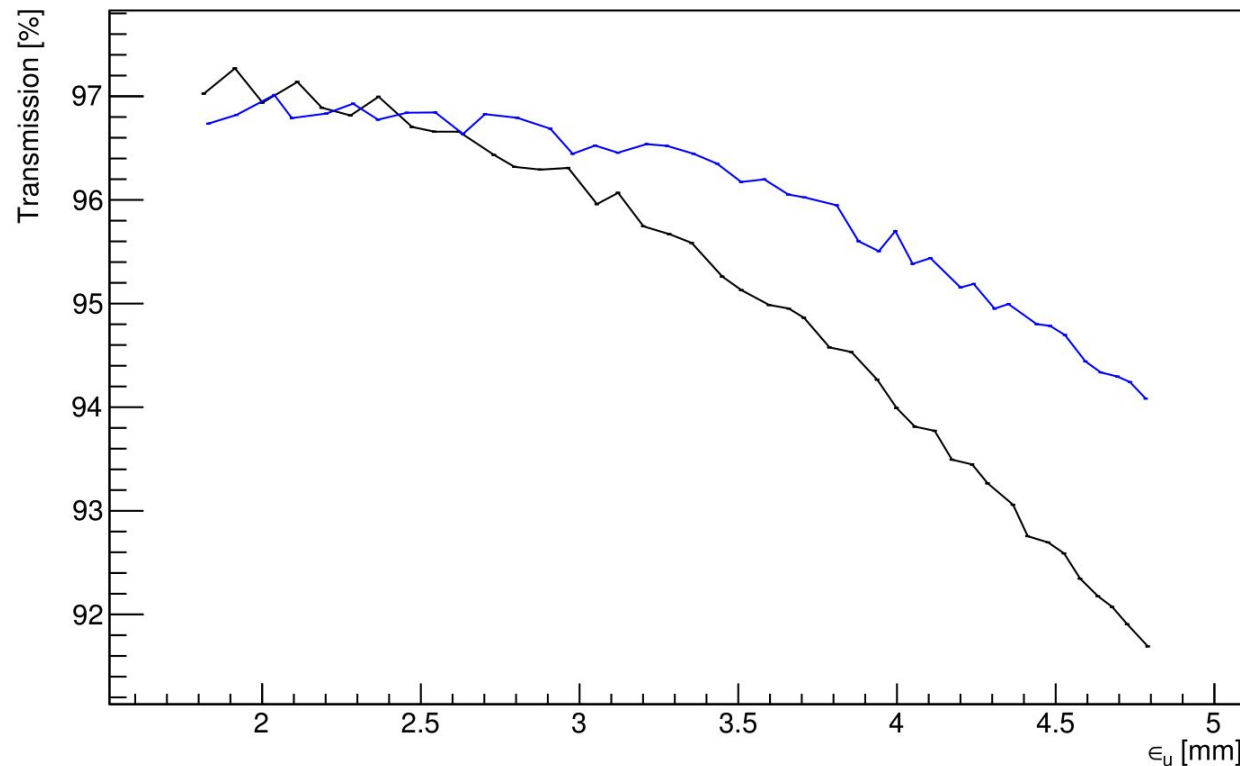
- Number of particles in the sampled beams
- Relatively low statistics (at low emittance) can be improved by using the 4 mm and potentially the 10 mm beams for the parent distribution





Transmission

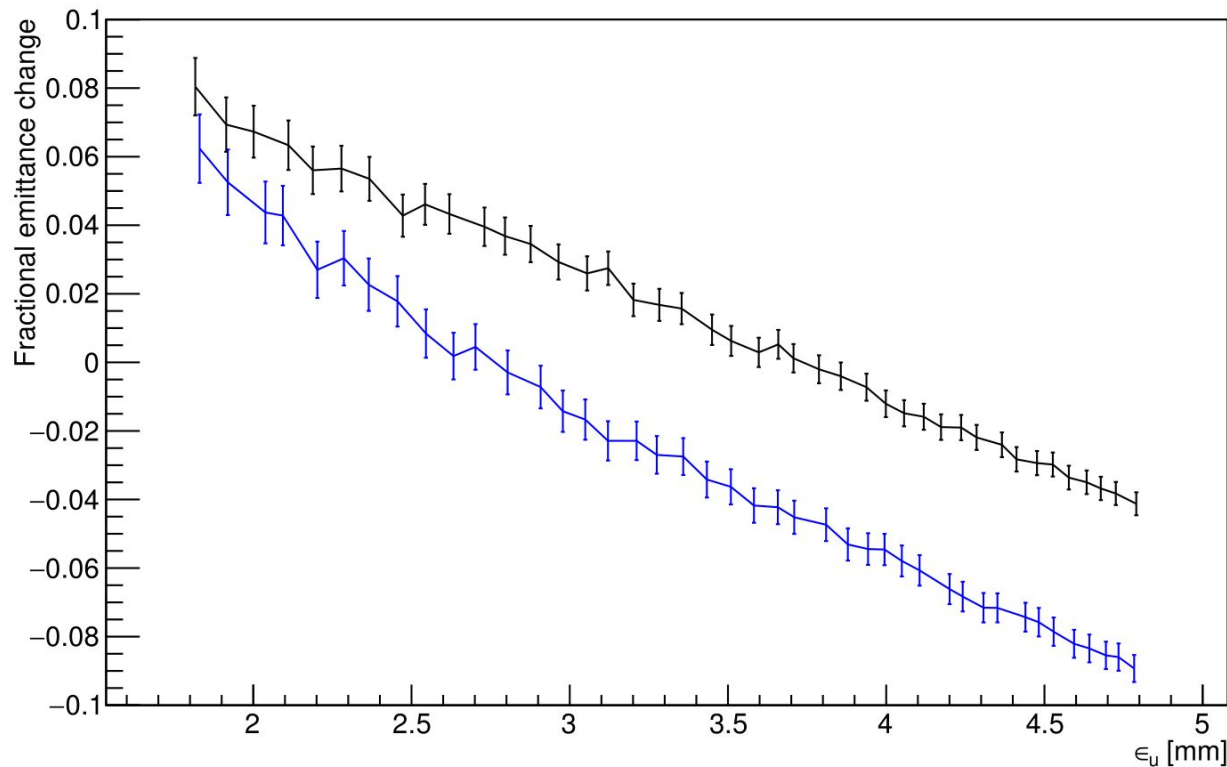
- Blue - LH2
- Black - No absorber
- Trends cross at about [ϵ_u 2.6] mm
- Calculated equilibrium emittance (for $\beta \sim 540$ mm) is ~ 2.3 mm
- Cooled beams present lower transmission loss above the equilibrium emittance





Fractional emittance change

- Blue - LH2
- Black - No absorber
- In the No absorber case the trend is caused solely by transmission loss
- In the LH2 case the trend is due to cooling and transmission loss
- Equilibrium emittance ~ 2.6 mm





FULL TRANSMISSION ANALYSIS

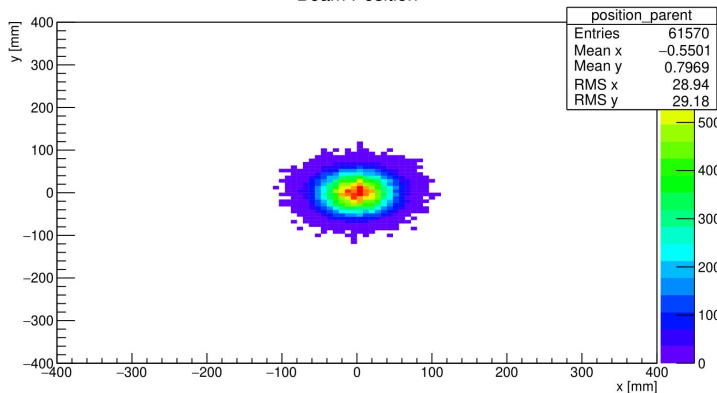
(Only events that have one track upstream and downstream are kept)



Sampled Beam Evolution - xy

NO ABSORBER

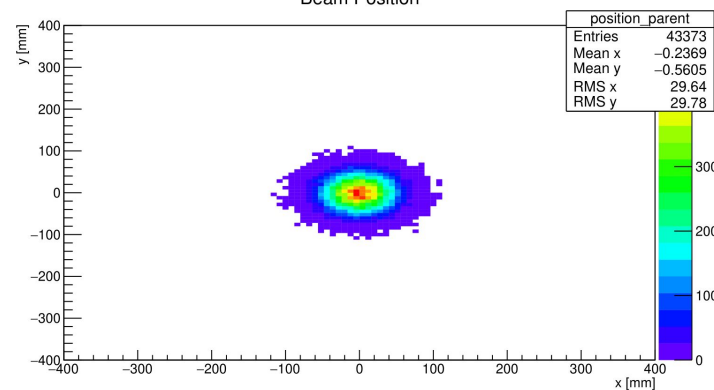
Beam Position



Upstream

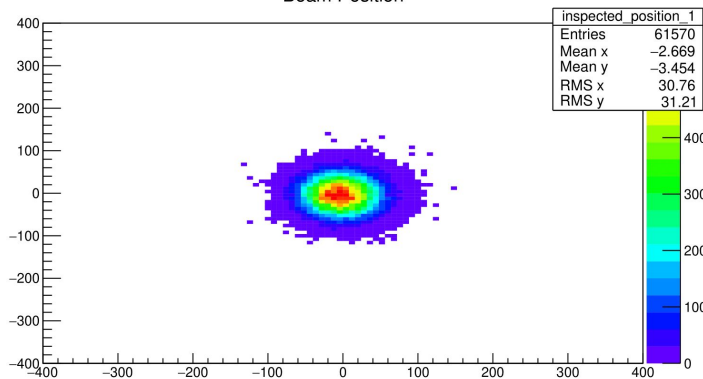
LH2

Beam Position

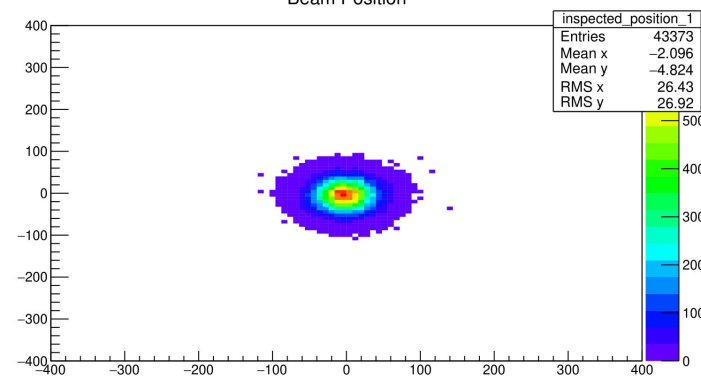


Downstream

Beam Position



Beam Position

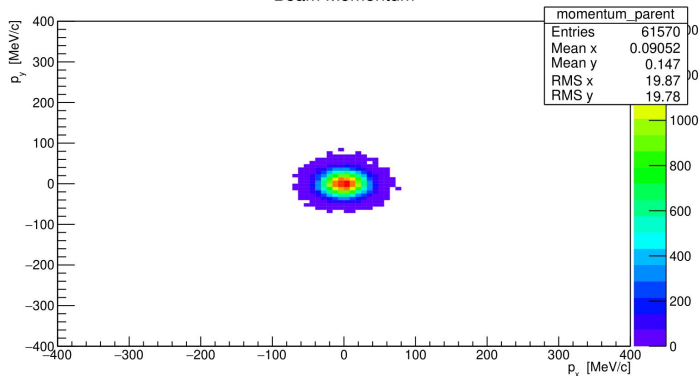




Sampled Beam Evolution - PxPy

NO ABSORBER

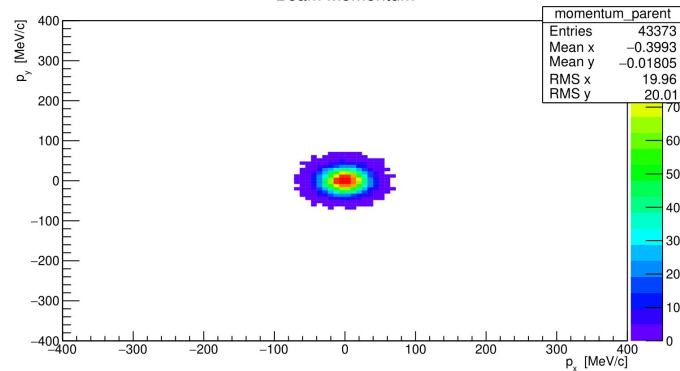
Beam Momentum



Upstream

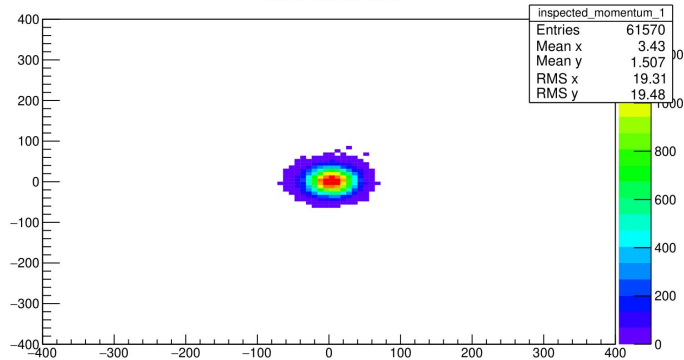
LH2

Beam Momentum

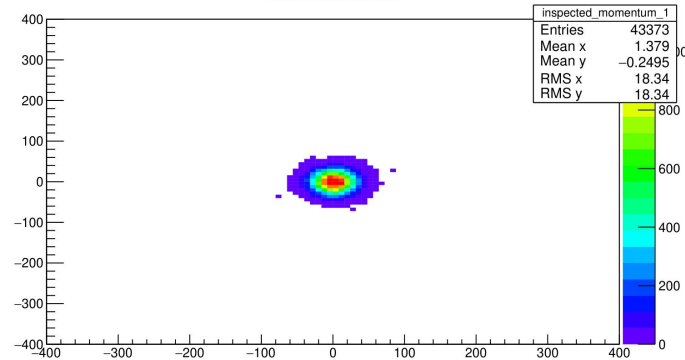


Downstream

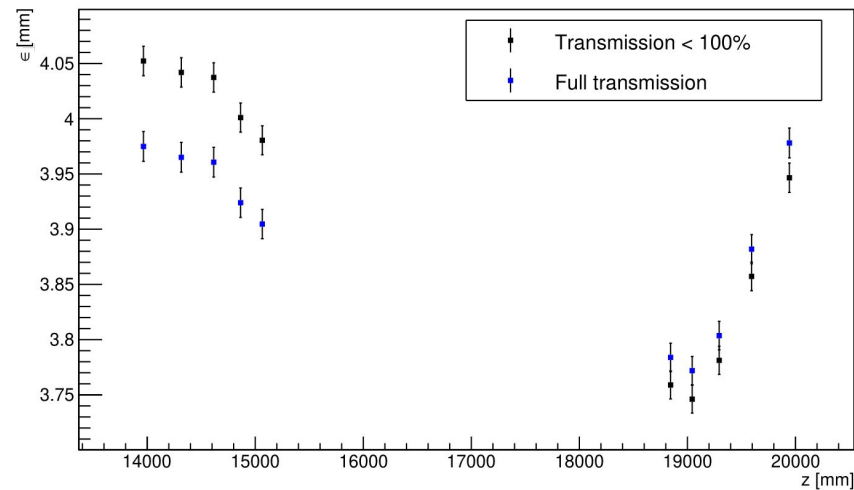
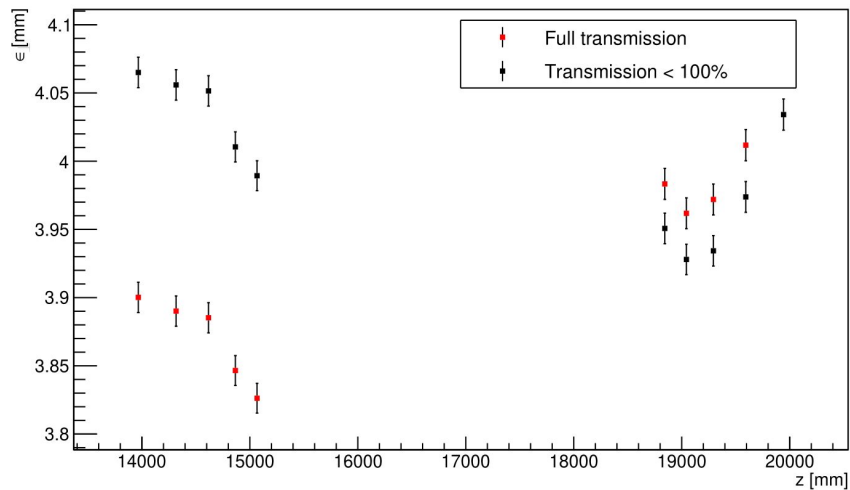
Beam Momentum



Beam Momentum



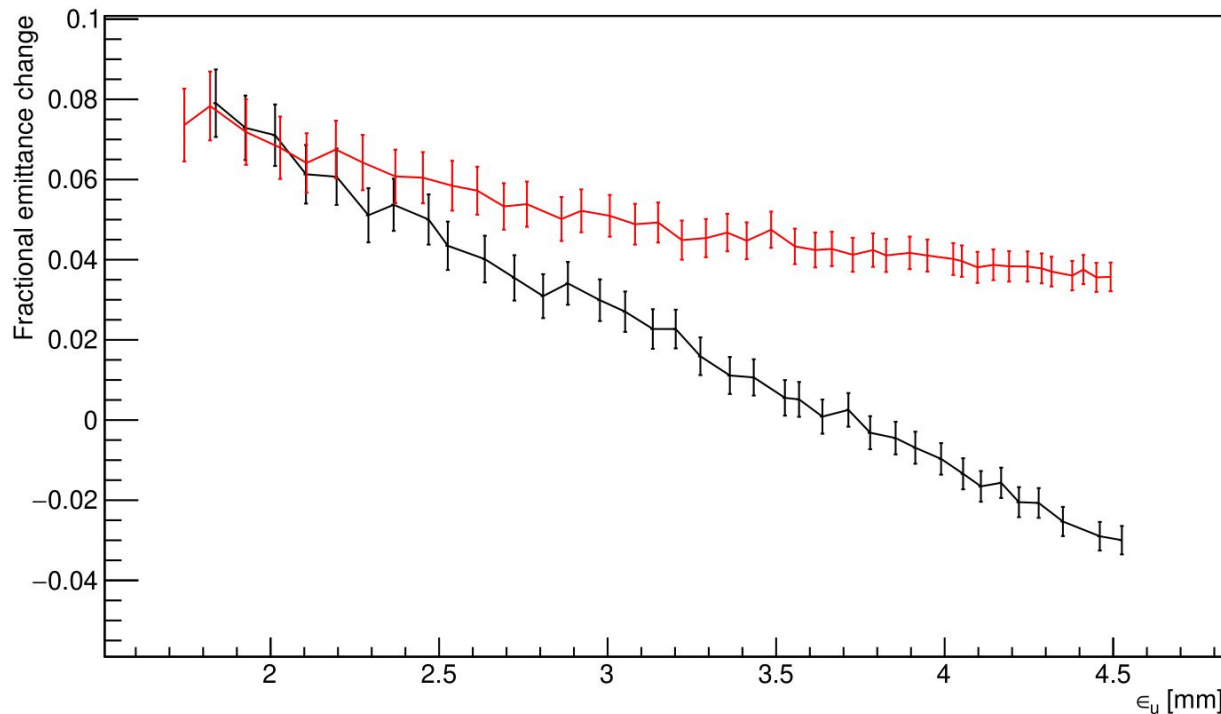
Effect on reconstructed emittance





NO ABSORBER

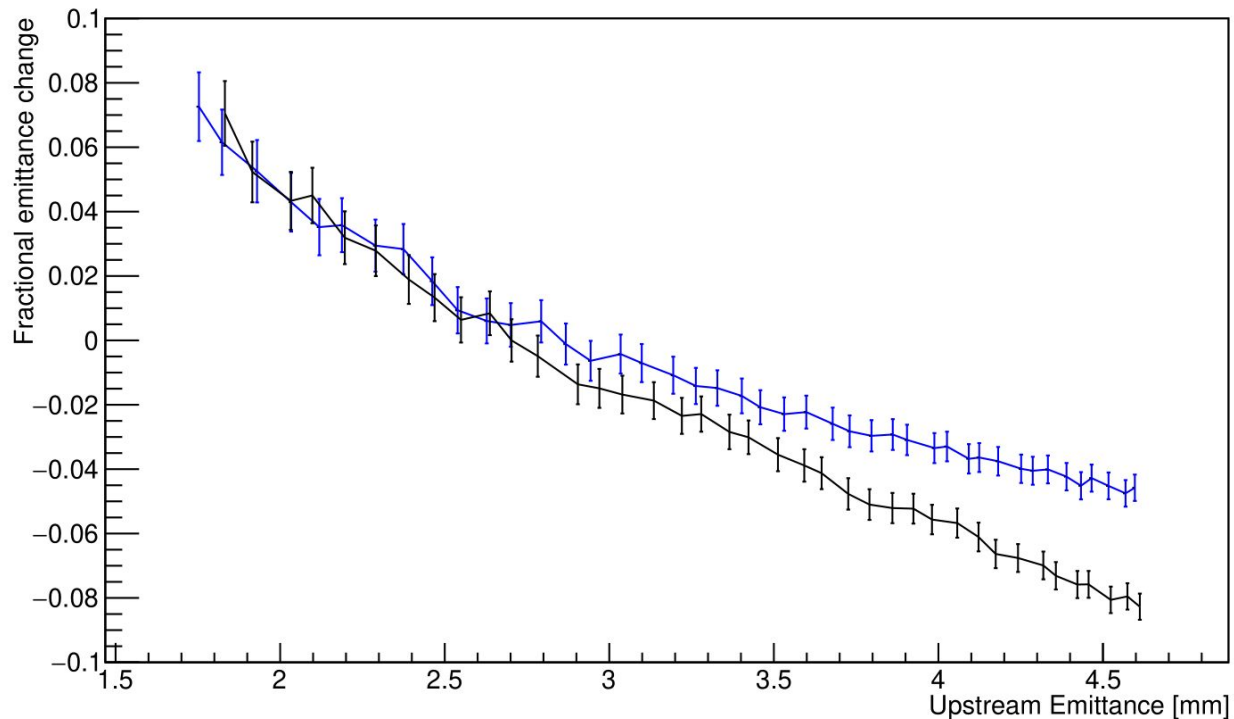
- Black - limited transmission
- Red - 100% transmission; shows (optical) heating is present for all the beams, decreases with increasing upstream emittance
- Possible cause could be the varying optics (see slide 15)
- To be studied with hybrid MC





LH2

- Black - limited transmission
- Blue - 100% transmission





Full transmission - LH2 vs No Abs vs Theory

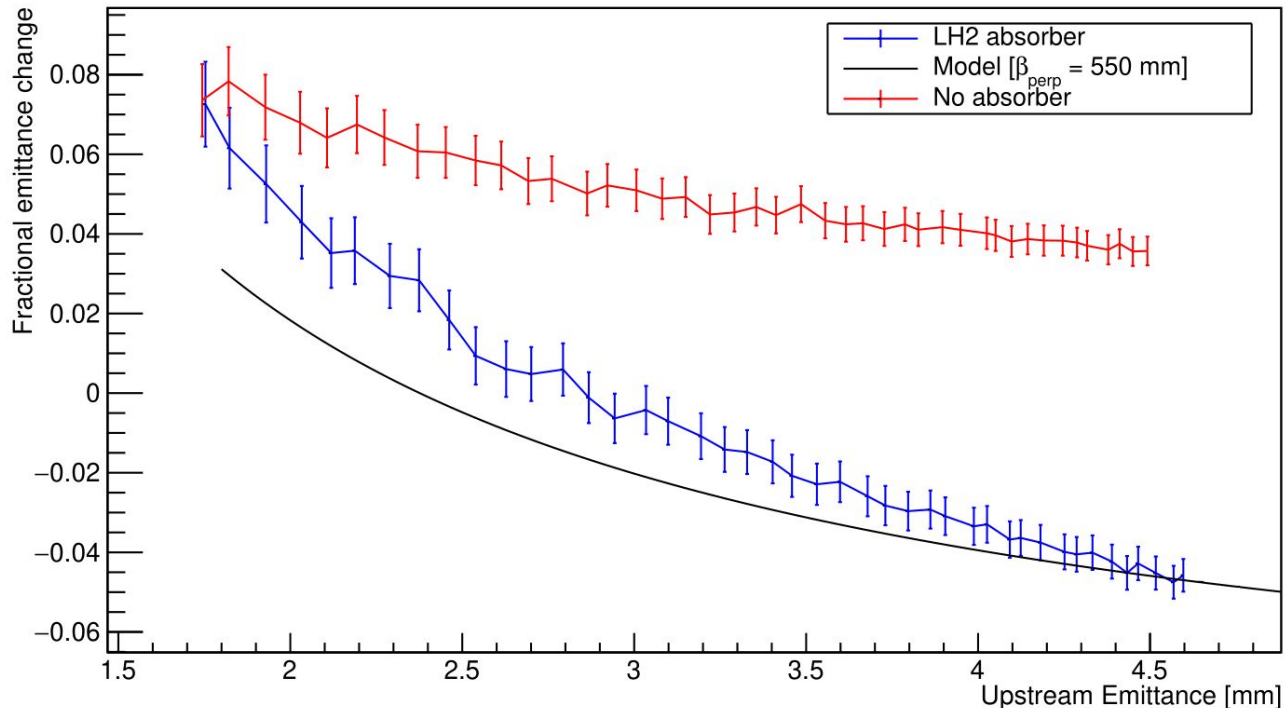
- Black line - Theoretical calculation

$$\frac{\Delta\epsilon}{\epsilon_u} = (1 - e^{-az}) \left(\frac{\epsilon_{eqm}}{\epsilon_u} - 1 \right)$$

where \mathbf{a} is the cooling term in the cooling term in the cooling eqn.
and \mathbf{z} is the mean path length through the absorber

- Equilibrium emittance expected at 2.4 mm;
observed at ~2.85 mm

Ionisation cooling
Full Transmission

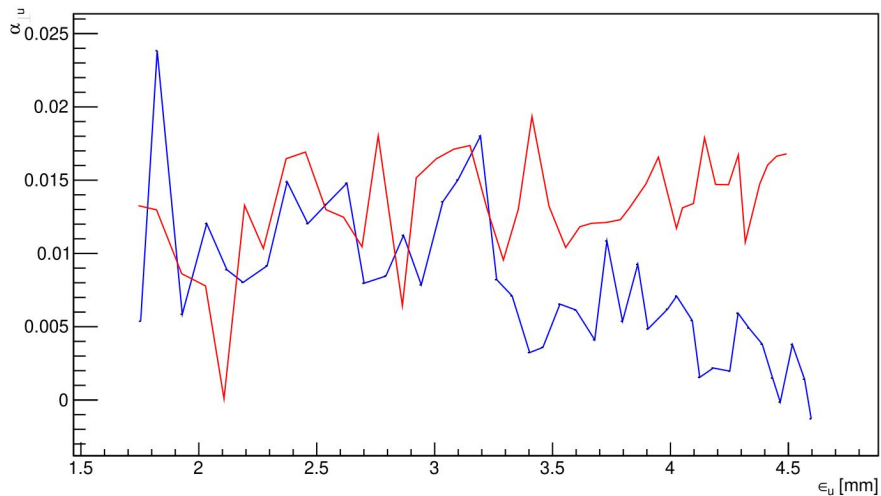




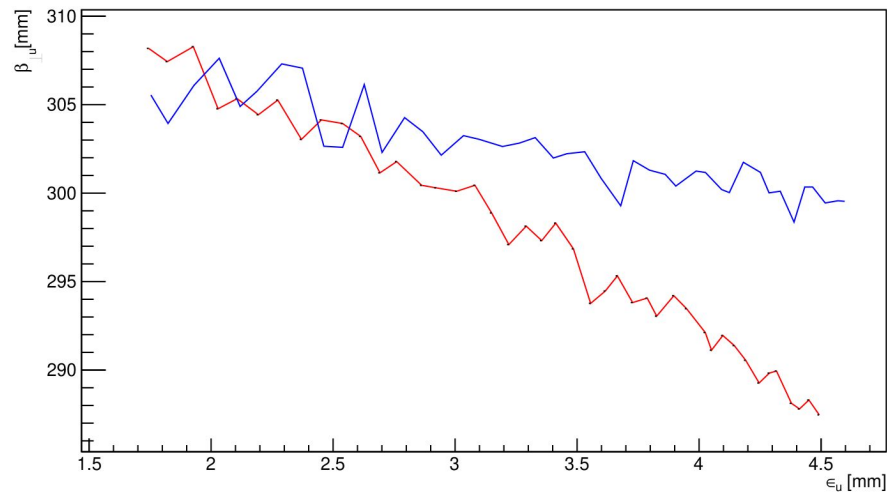
Optics at the upstream reference plane

RED - no absorber, BLUE - LH2

Alpha



Beta



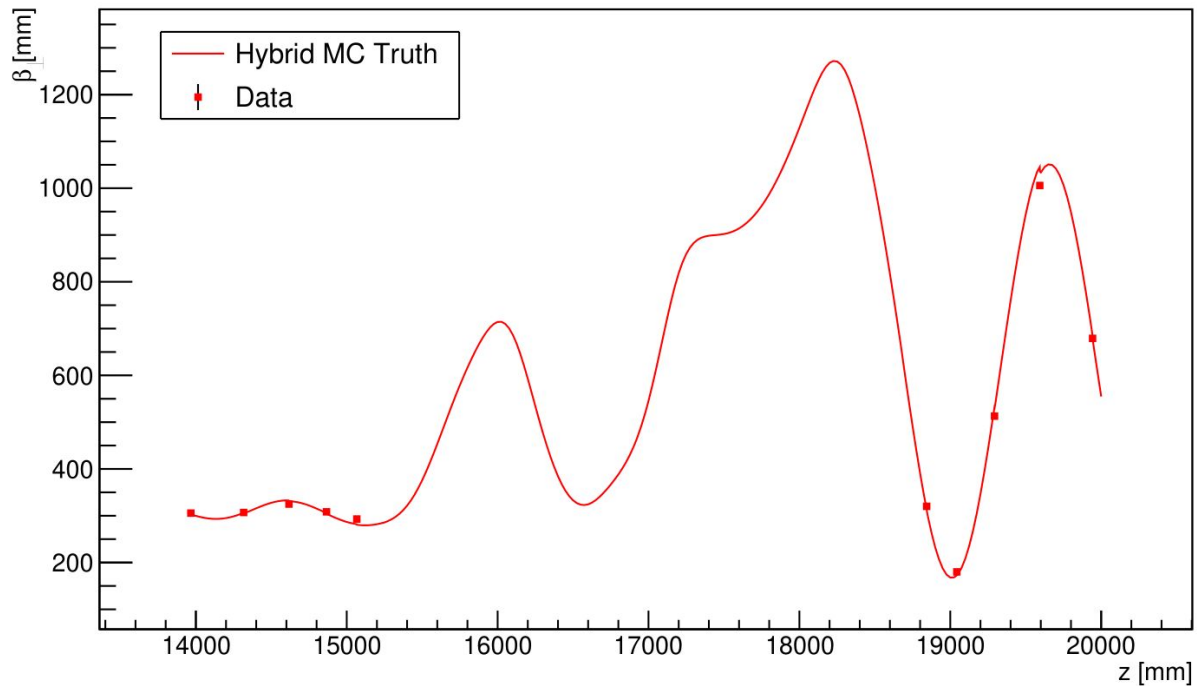


Hybrid MC comparisons

- preliminary comparisons with hybrid MC truth
- however, p_T hole at low transverse momenta is present; the current hybrid MC production routine does not include the TOF Tracker patch

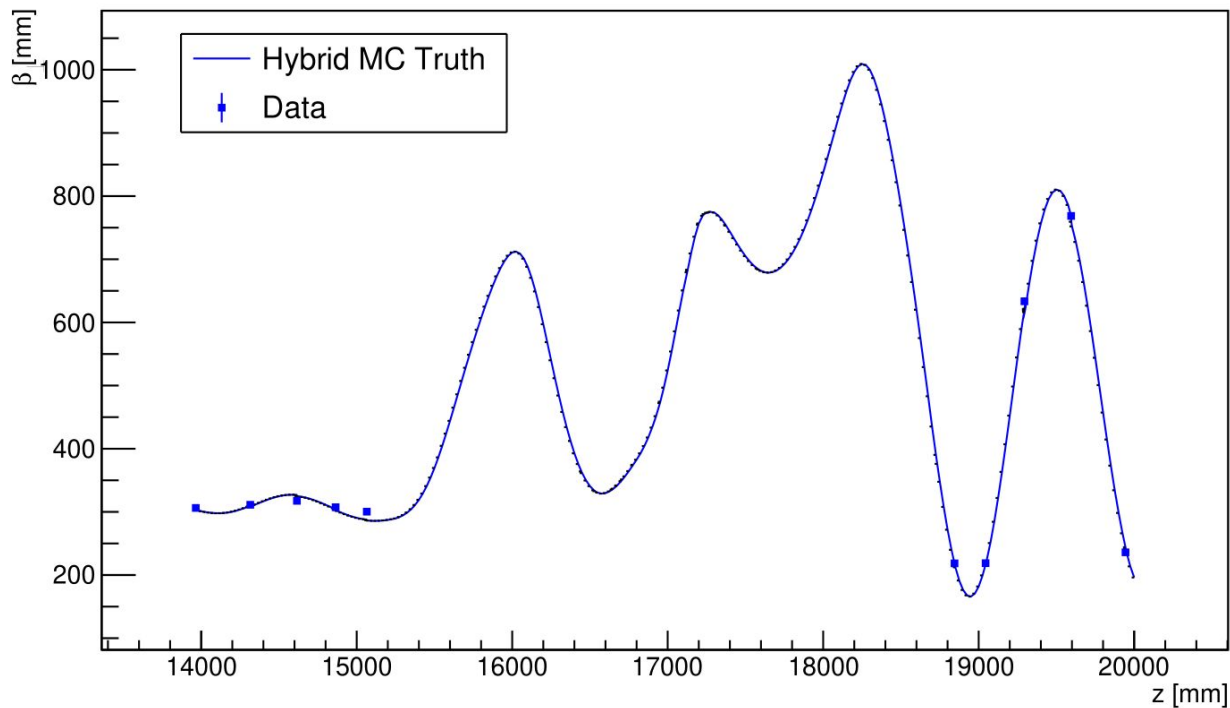


Beta - No absorber



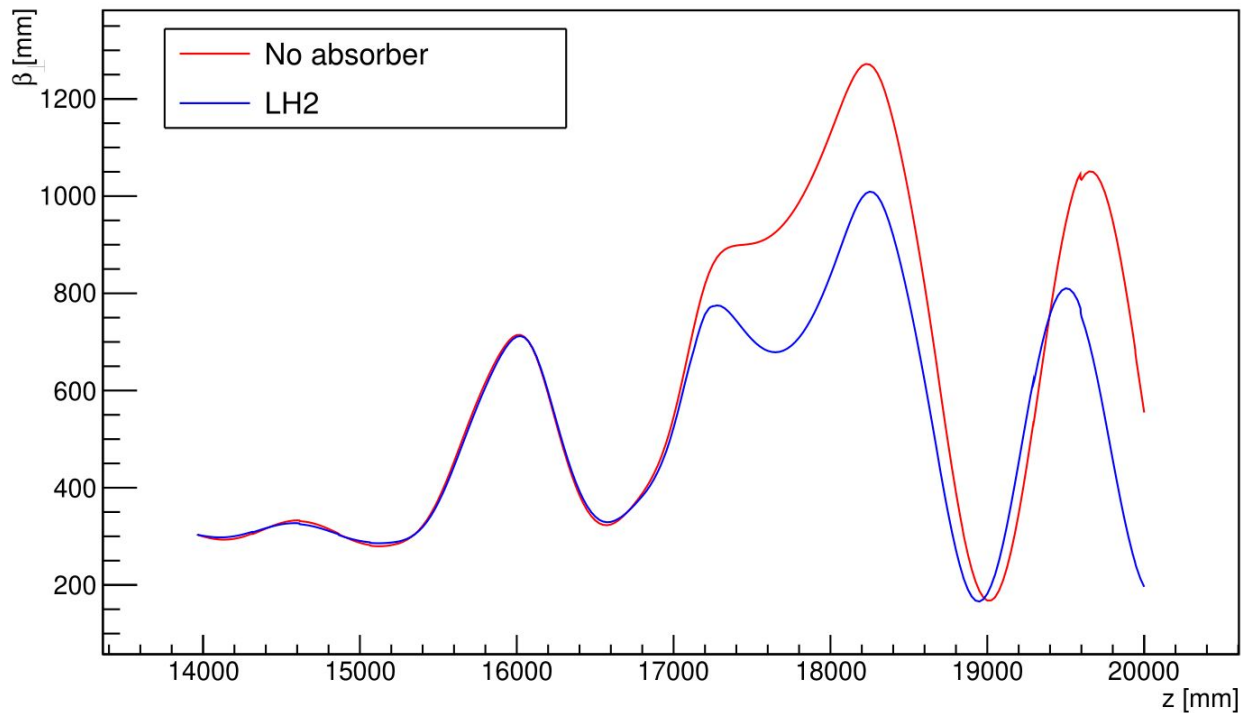


Beta - LH2



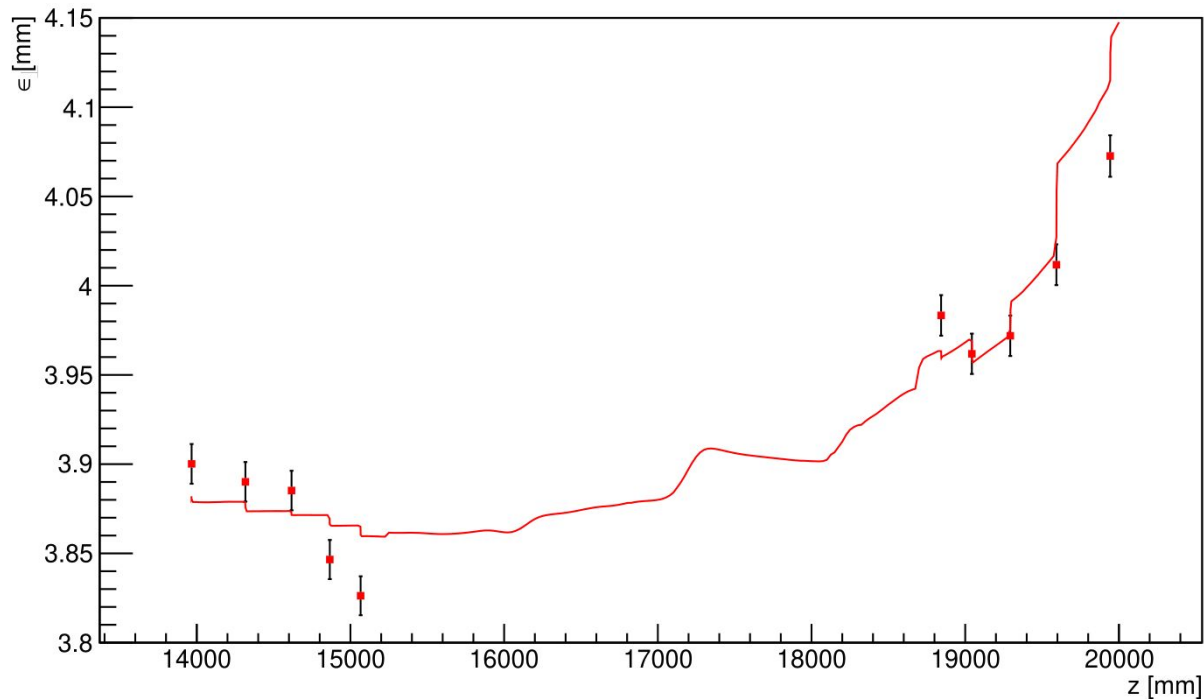


Beta - No absorber VS LH2 (truth)



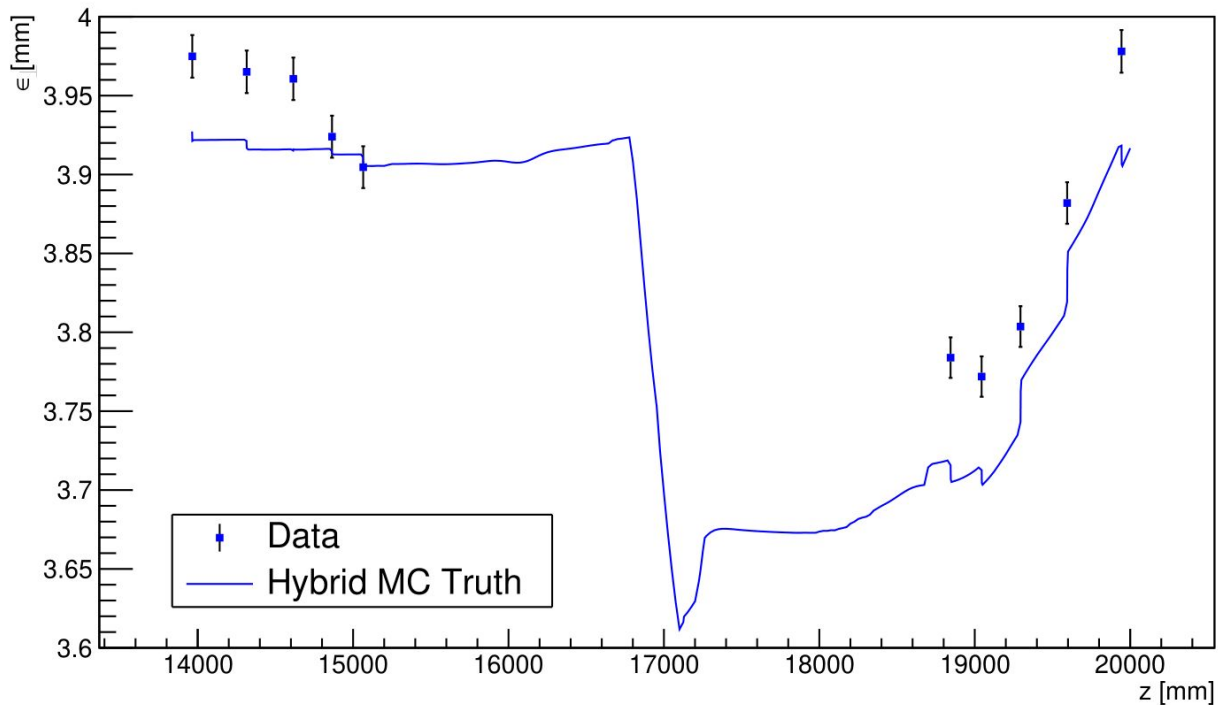


Emittance - No absorber

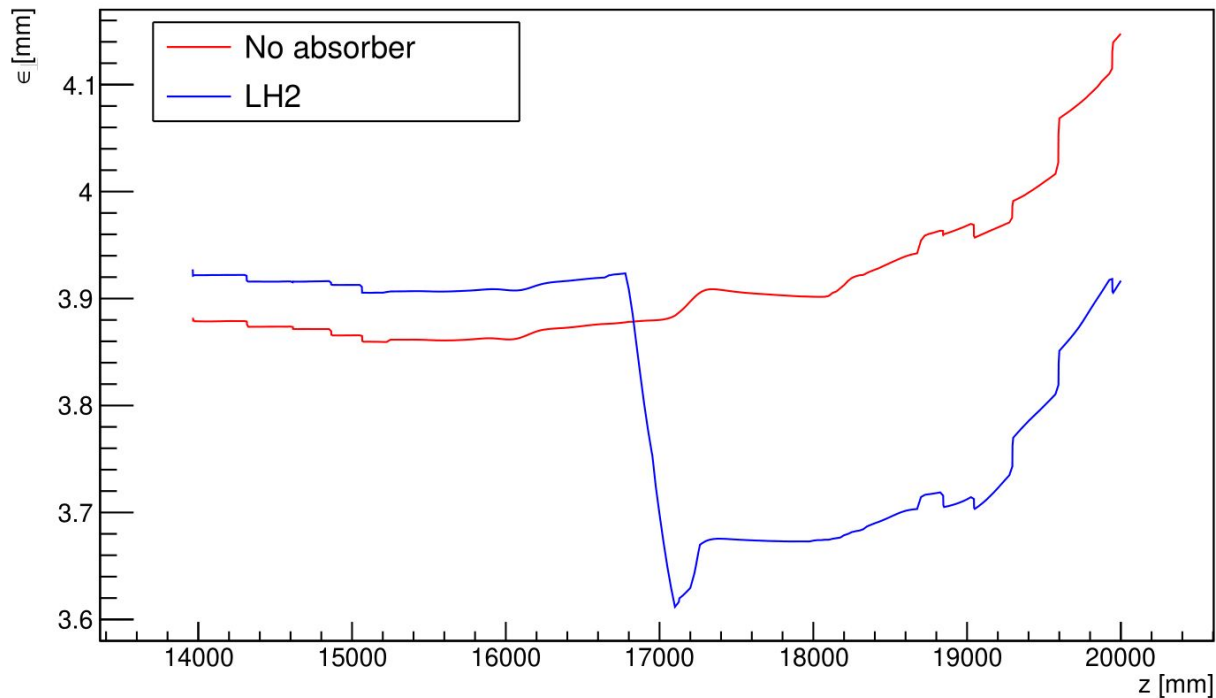




Emittance - LH2



Emittance - No absorber VS LH2 (truth)





Summary

- the full transmission requirement removed the emittance change bias due to particle loss
- there is still optical heating dependence on initial emittance
- Good optics agreement between data and MC truth; emittance not completely understood (low transverse momentum hole)
- next steps:
 - study optical heating as function of optics and initial emittance (both for no absorber and absorber case)
 - hybrid MC production - needs TOF Tracker combined fit
 - MC production
 - improve beam selection: MCMC Hastings-Metropolis sampling?



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