



Flip mode emittance evolution: Beam Sampling

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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



Beam Sampling

- The downstream matching coil issue led to an improperly matched beam into the cooling channel, affecting the cooling performance
- By selecting the appropriate beam parameters would allow for the recovery of the lost cooling performance
- Procedure:
 - Generate some data
 - Find a function that describes the data - the parent (e.g. KDE)
 - Define a function that describes the target distribution - the daughter (e.g. multivariate Gaussian)
 - Randomly select events based on the probability between the parent and the daughter. For a given x :
 $P(\text{selection}) = \text{Daughter}(x) / \text{Parent}(x) * \text{Normalization}$



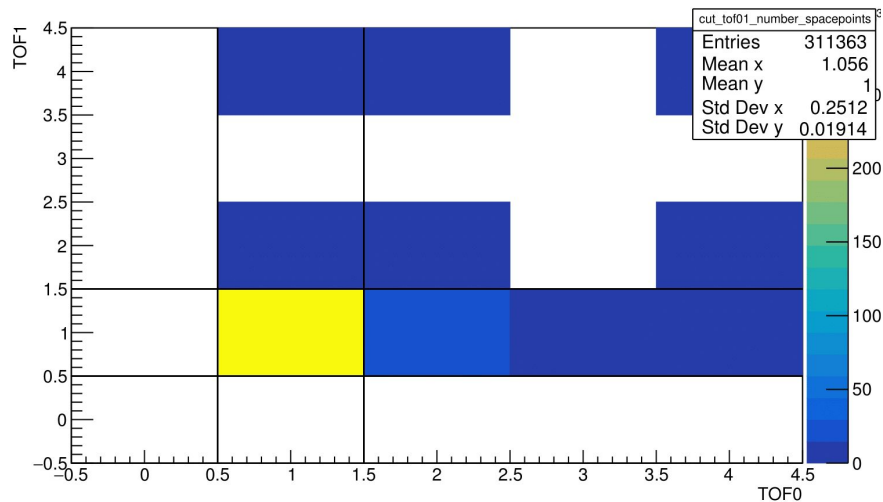
Parent Beam: Sample selection

- Upstream
 - 1 SP in both TOF0 and TOF1
 - TOF01 consistent with muon peak
 - Banana plot cut
 - $135 \text{ MeV}/c < \text{Total momentum} < 145 \text{ MeV}/c$
 - $\chi^2 / \text{ndf} < 8$
 - Diffuser radius cut: $r < 90 \text{ mm}$
 - Fiducial cut: $r < 150 \text{ mm}$
- Downstream
 - $90 \text{ MeV}/c < \text{Total momentum} < 170 \text{ MeV}/c$
 - $\chi^2 / \text{ndf} < 8$
 - Fiducial cut: $r < 150 \text{ mm}$
- The particles cut downstream are considered as lost between TKU and TKD and thus contribute to the transmission calculation

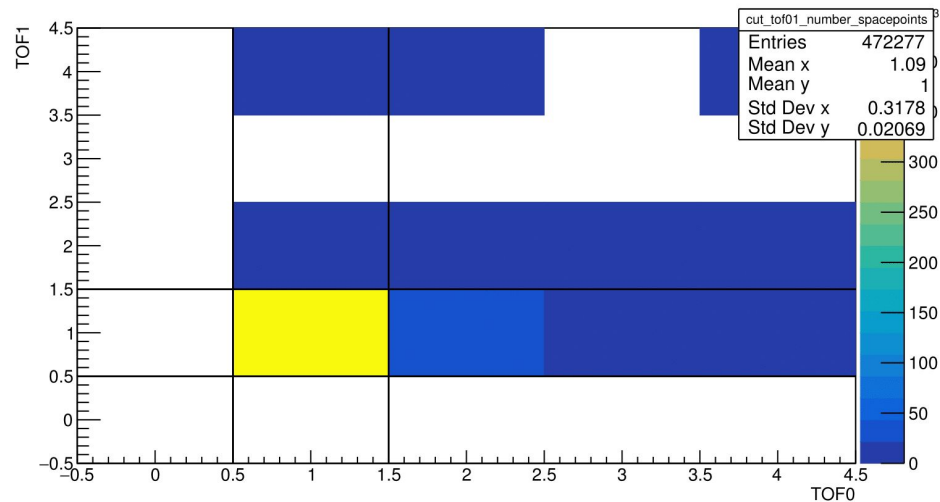


TOF0 and TOF1 spacepoints

LH2



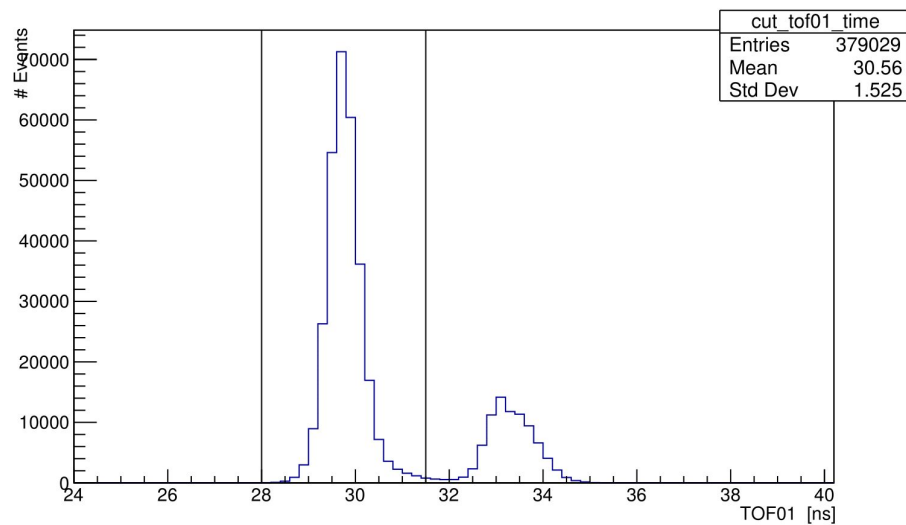
NO ABSORBER



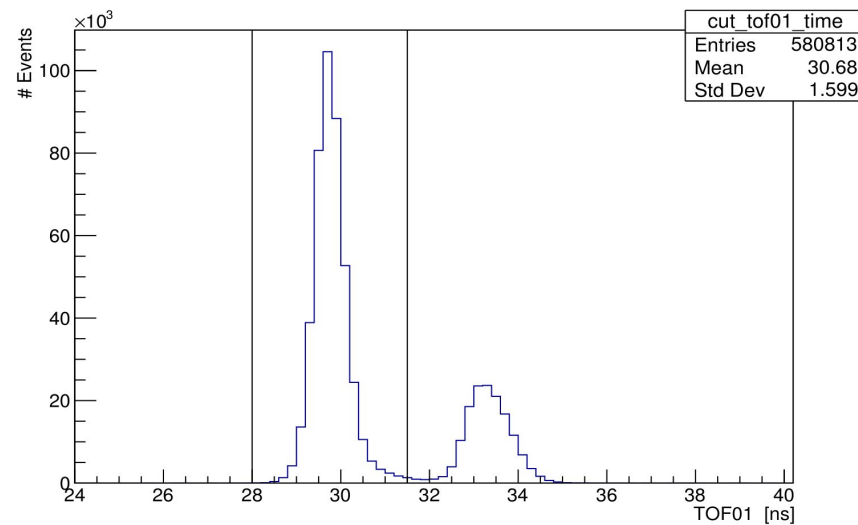


TOF01 time

LH2



NO ABSORBER

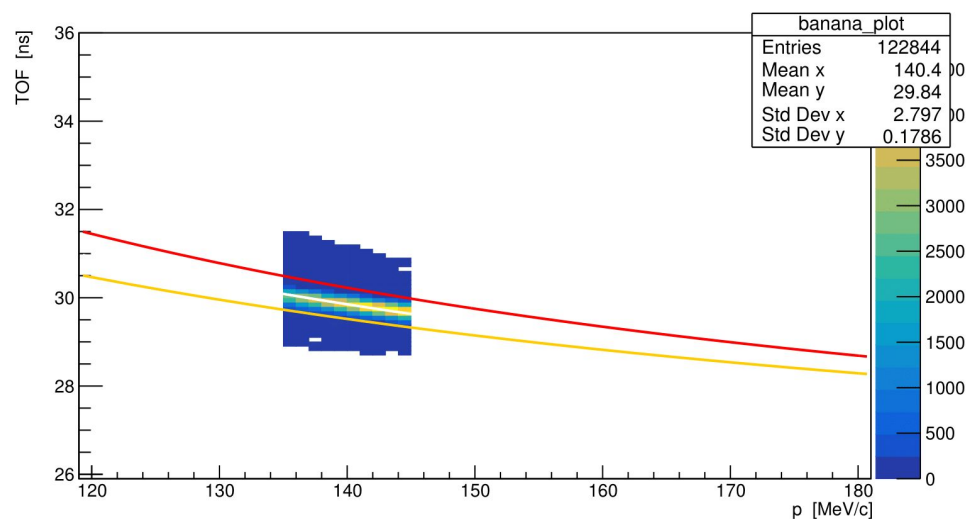
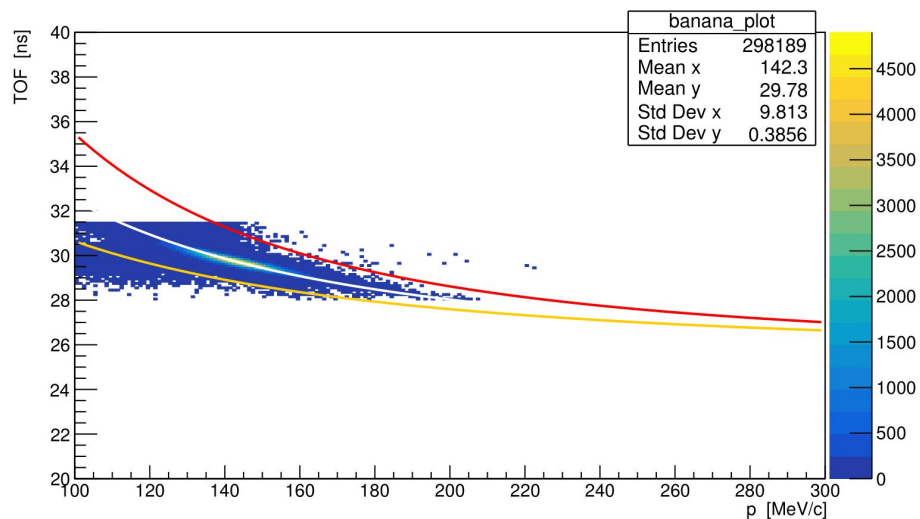




Banana plot - LH2

Old cut

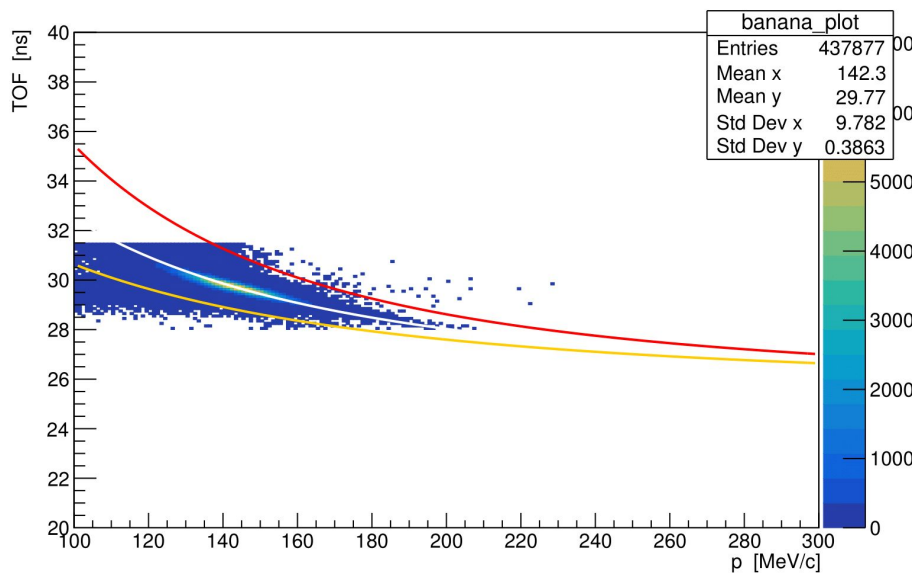
Updated cut



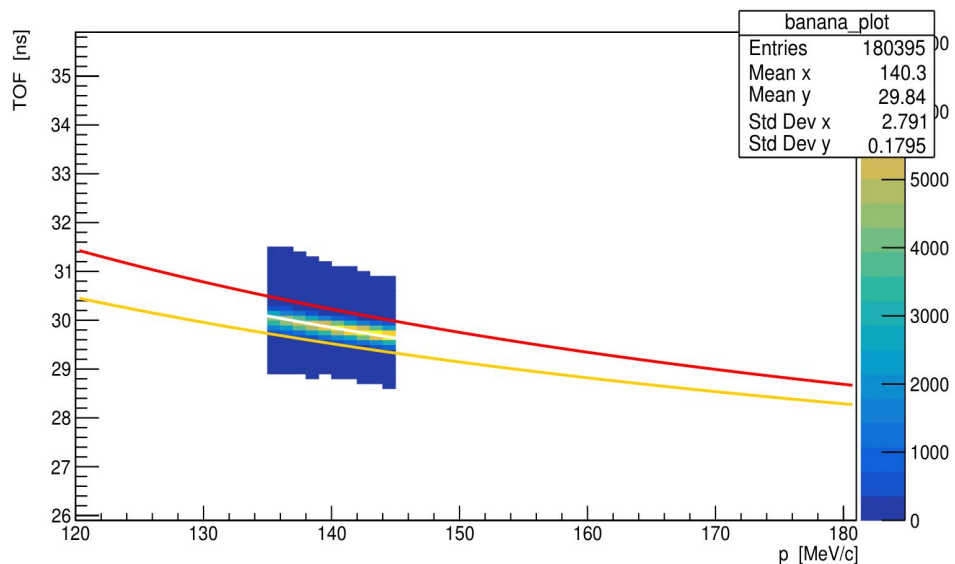


Banana plot - NO ABSORBER

Old cut



Updated cut



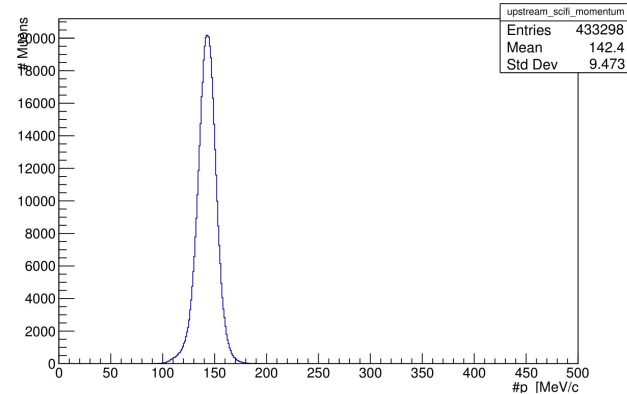
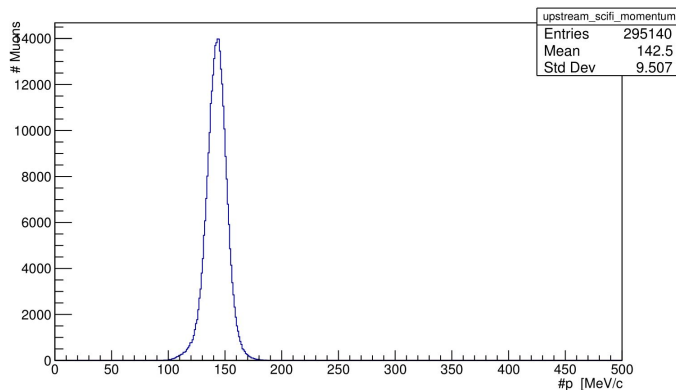


Total Momentum

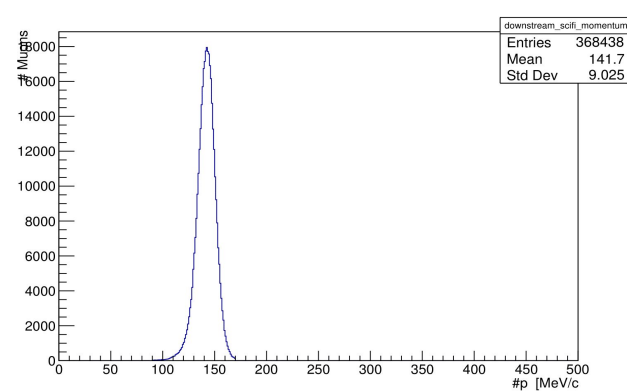
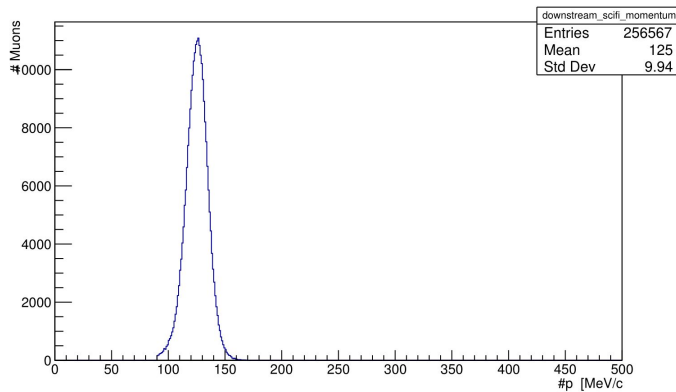
LH2

NO ABSORBER

Upstream



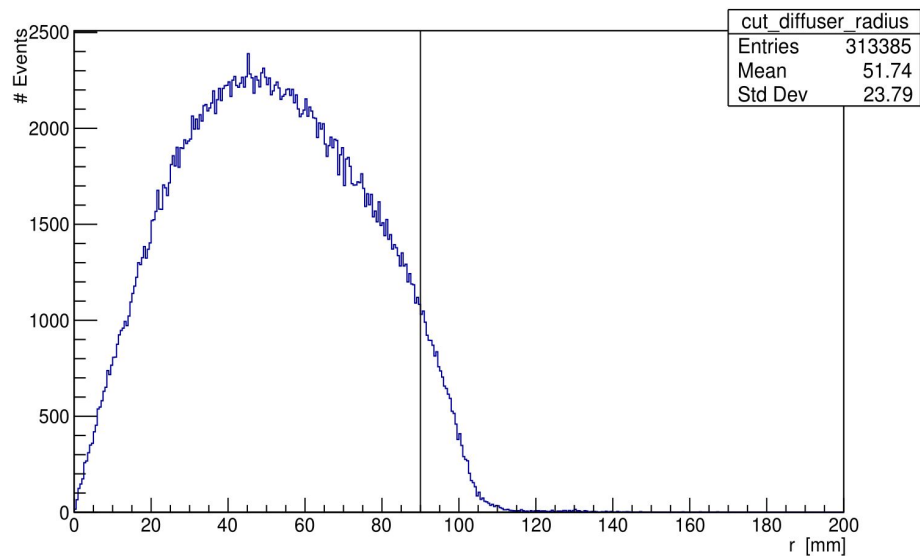
Downstream



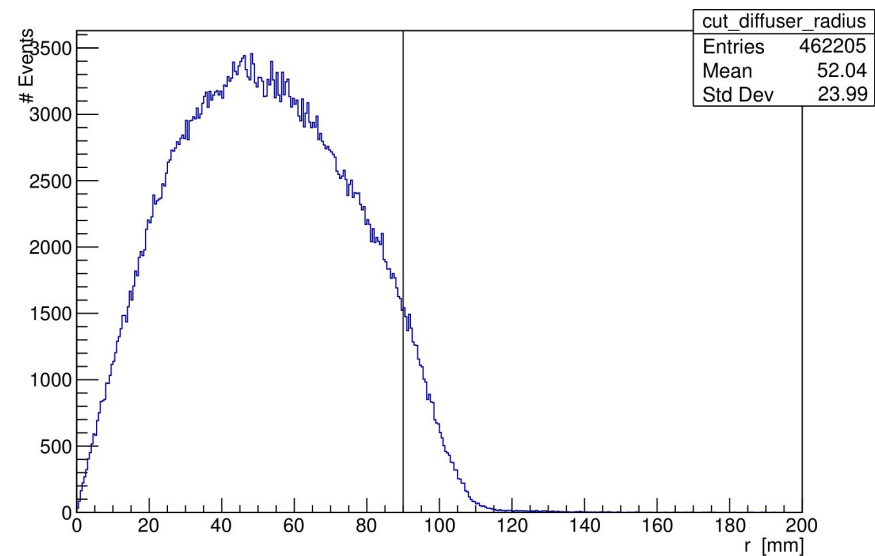


Diffuser radius cut

LH2



NO ABSORBER



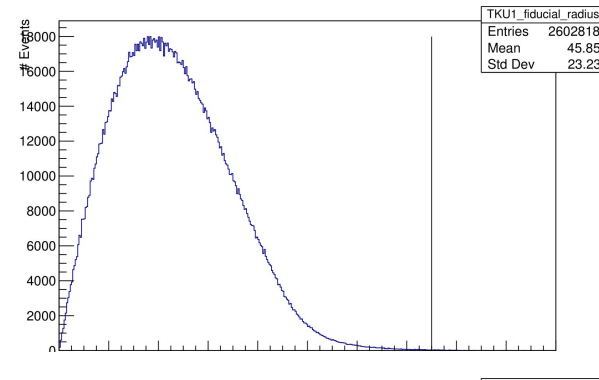
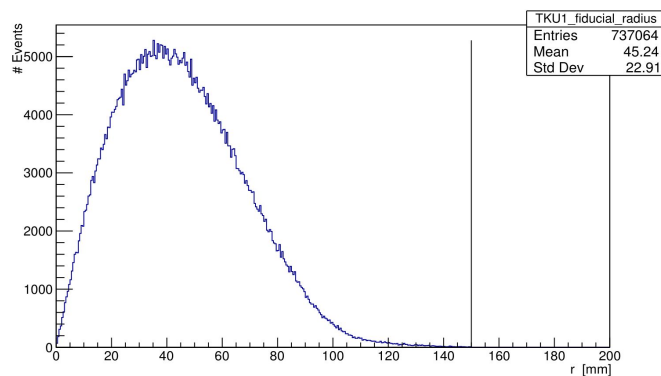


Fiducial cut

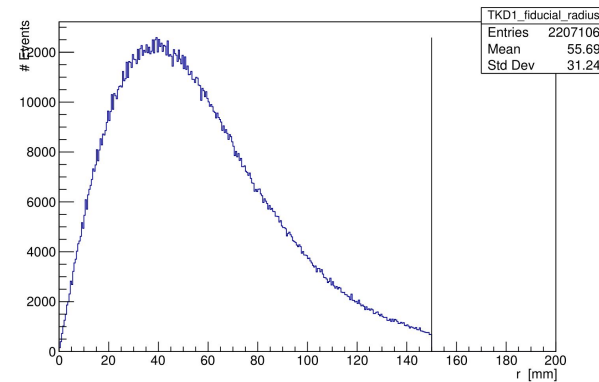
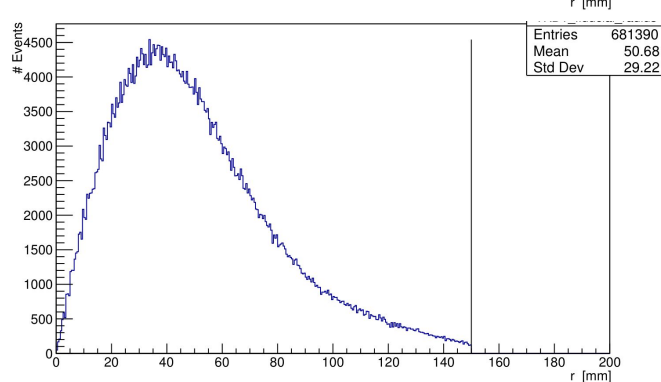
LH2

NO ABSORBER

Upstream



Downstream





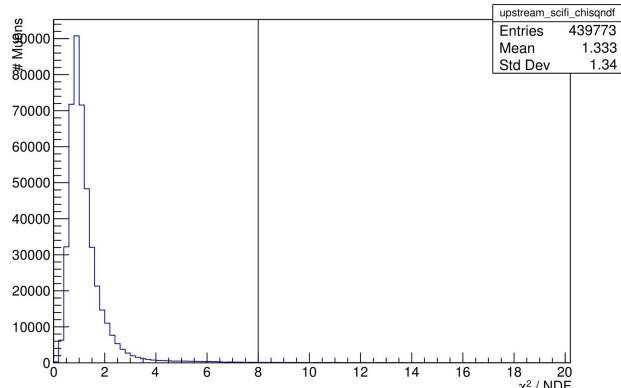
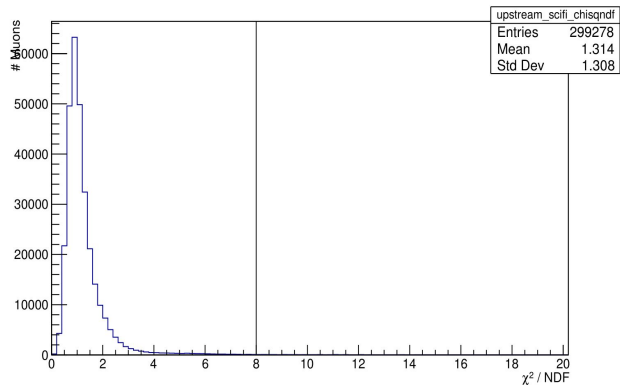
χ^2 / ndf

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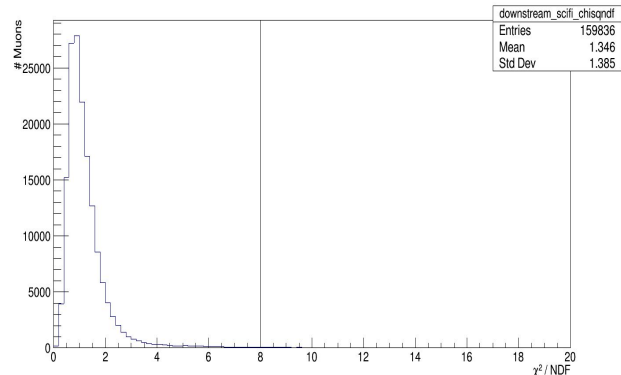
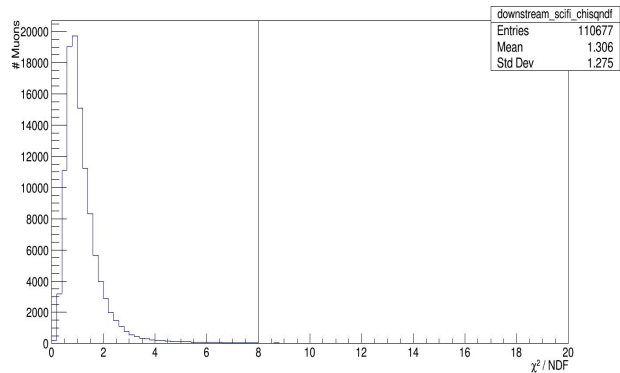
LH2

NO ABSORBER

Upstream



Downstream

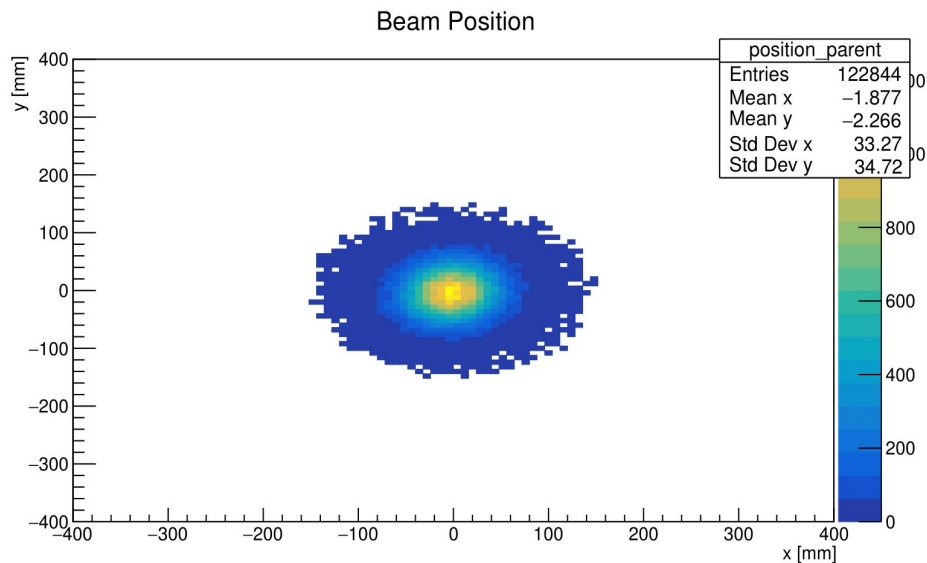




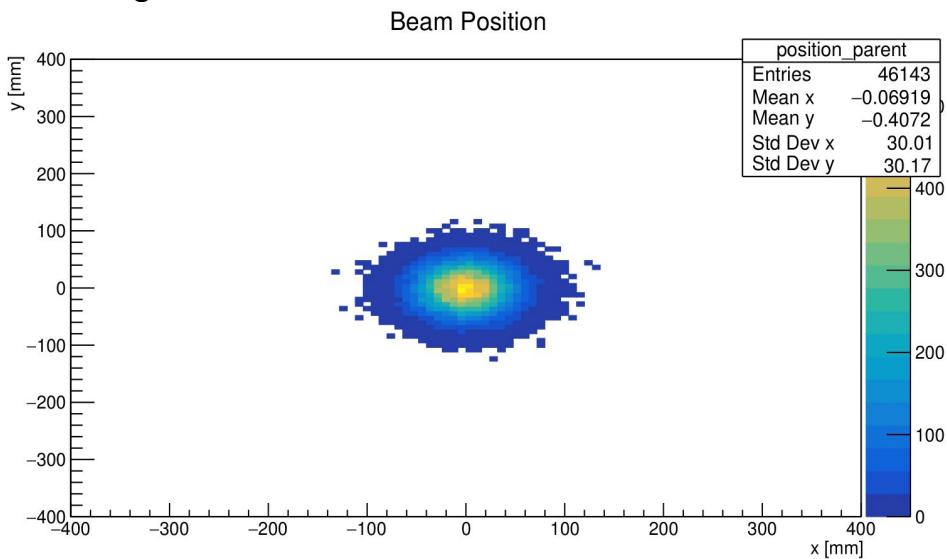
Beam Sampling

- Sampling routine is applied to the upstream ensemble
- Sampling parameters: $\alpha = 0.0$, $\beta = 310$ mm, $\epsilon = [1.8, 6.0]$ mm, $L = 1.1$
- Phase-space plots shown for target emittance of 4.6 mm, LH2

Parent



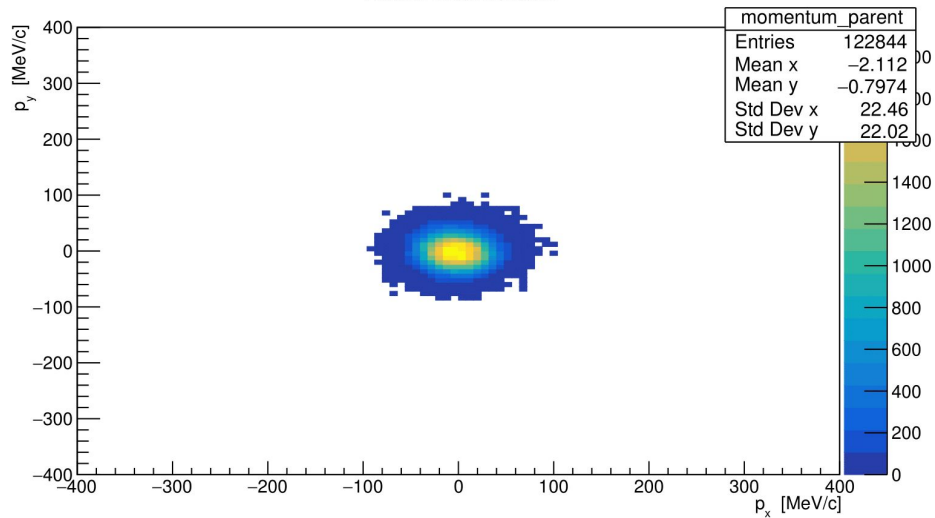
Daughter





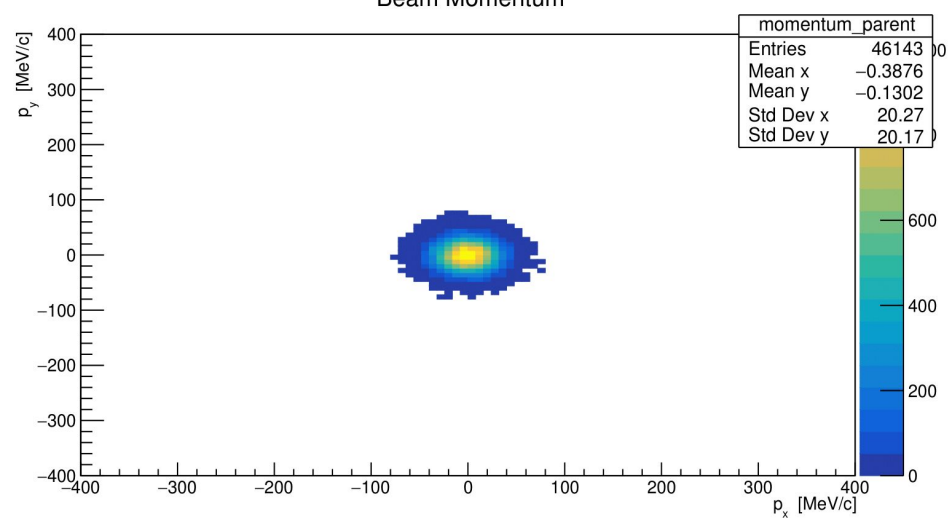
Parent

Beam Momentum

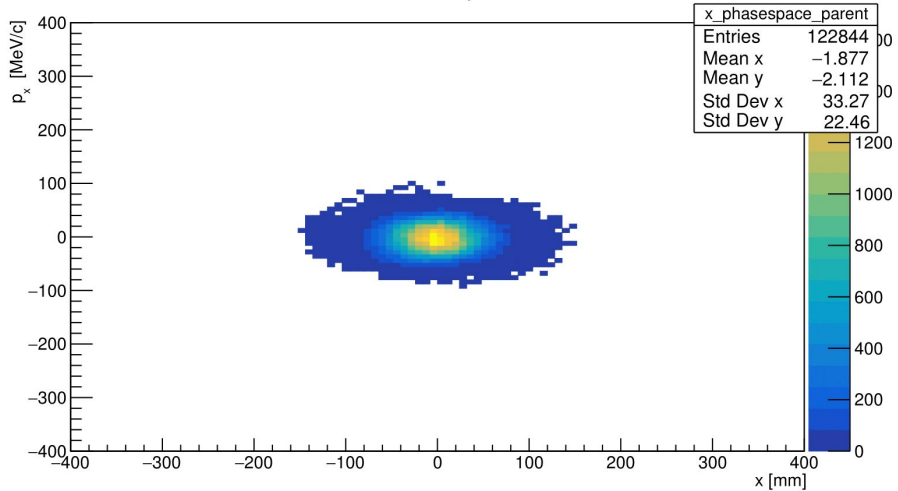


Daughter

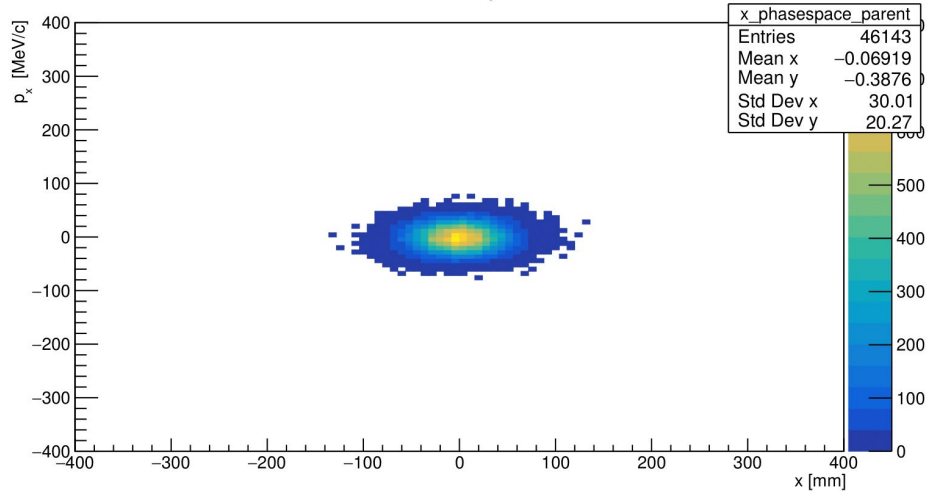
Beam Momentum



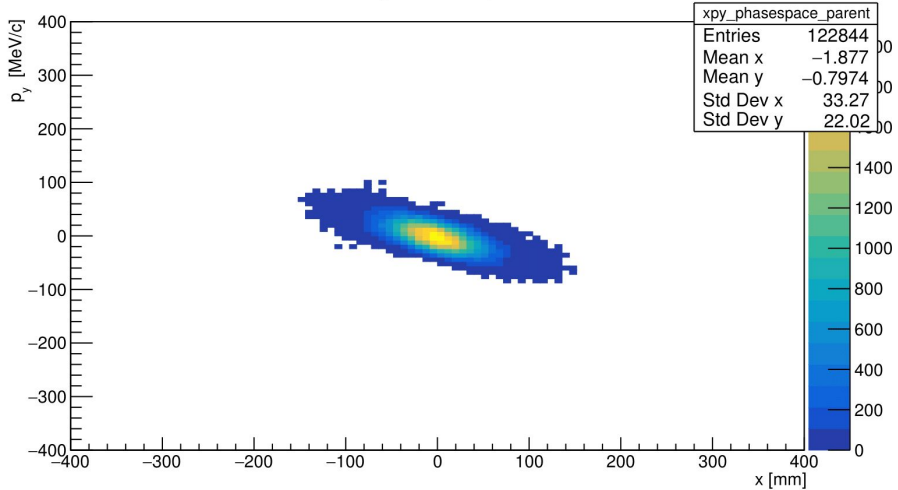
X-Phasespace



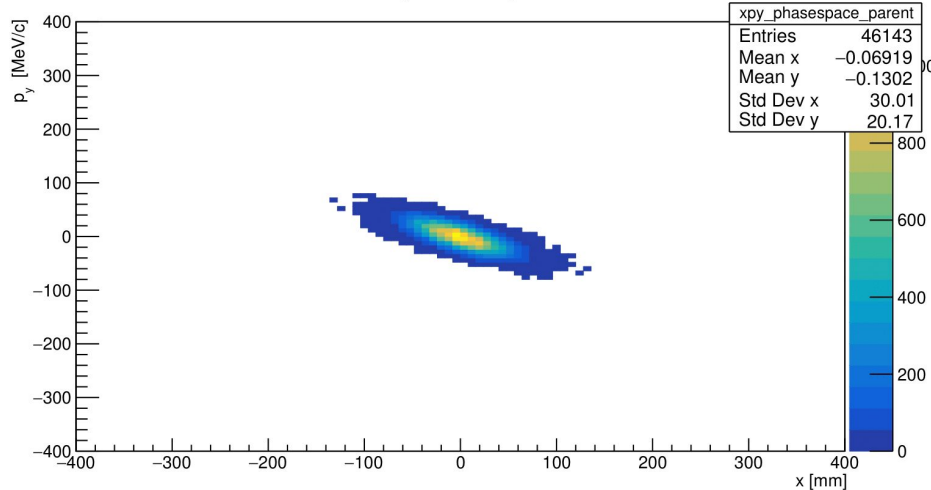
X-Phasespace



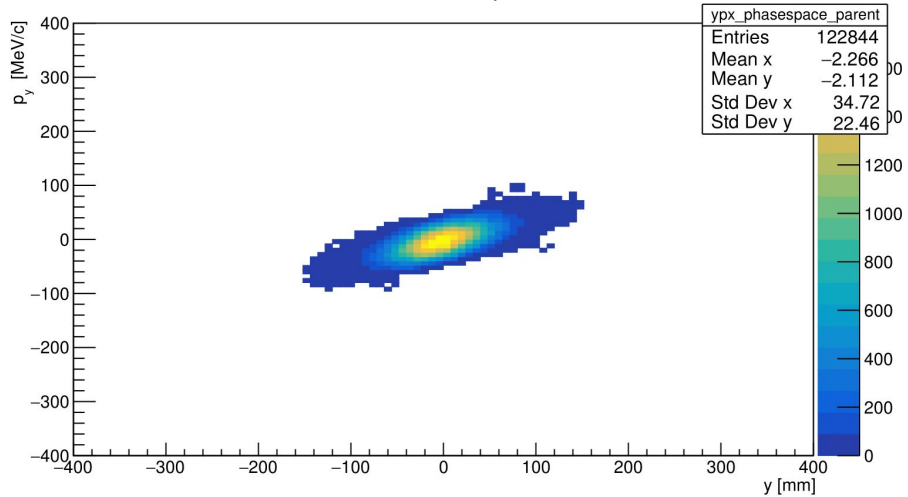
X-Py-Phasespace



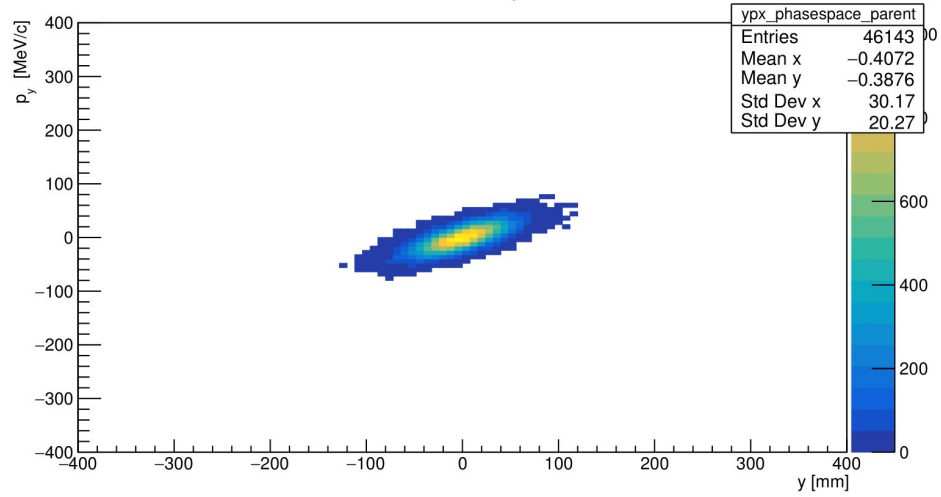
X-Py-Phasespace



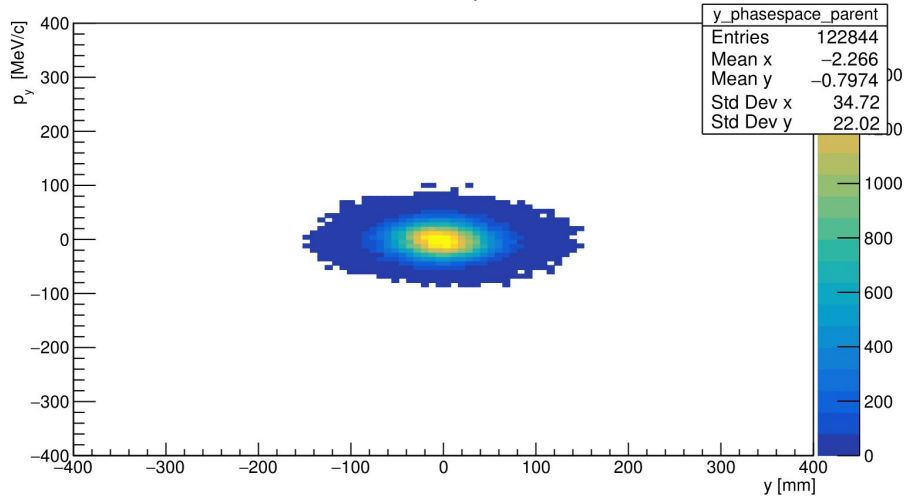
Y-Px-Phasespace



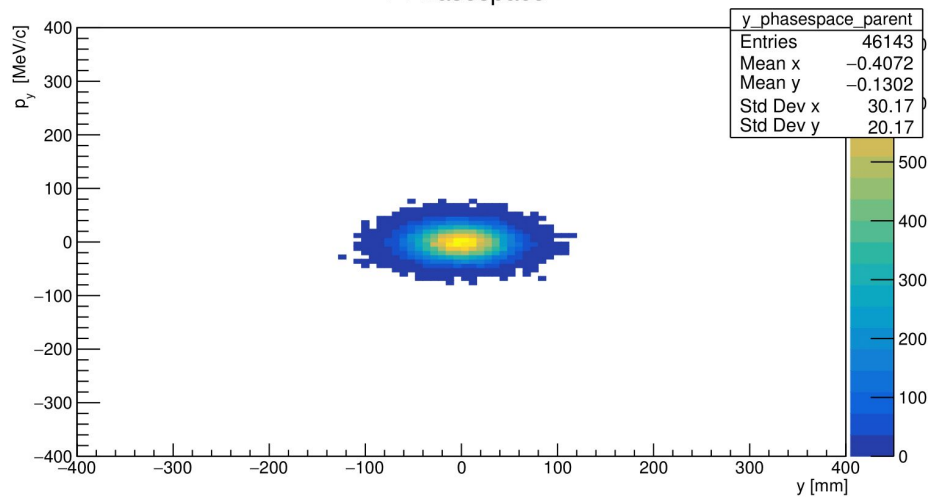
Y-Px-Phasespace



Y-Phasespace



Y-Phasespace





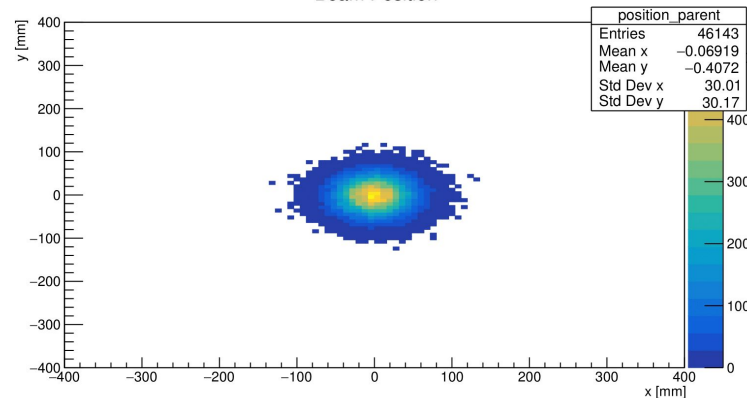
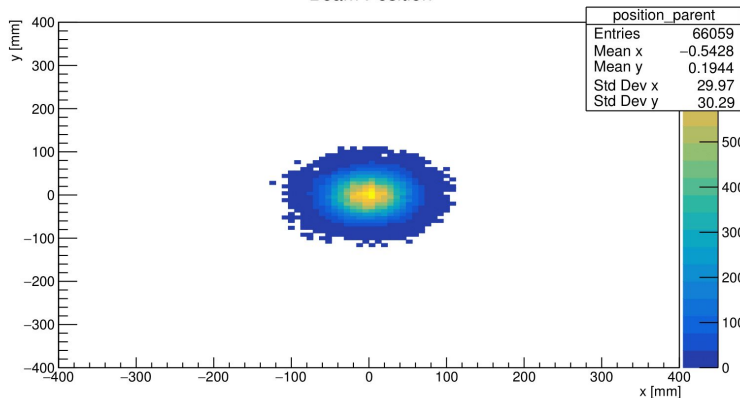
Sampled Beam Evolution - xy

NO ABSORBER

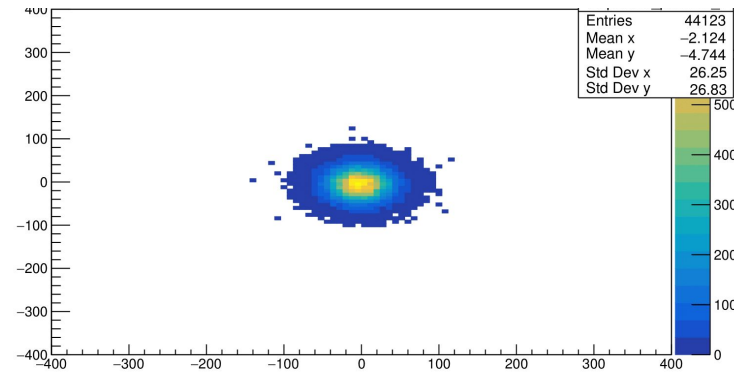
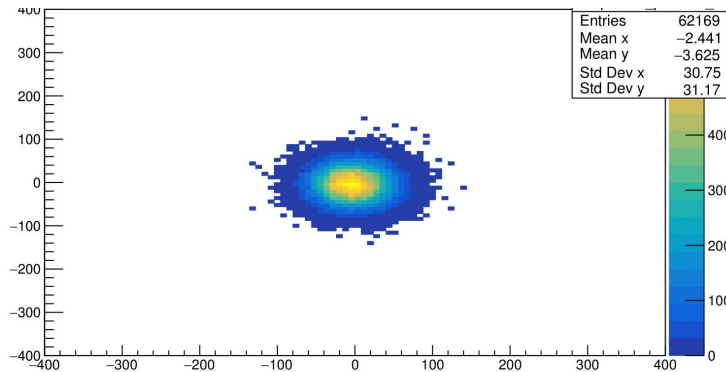
LH2

Upstream

Beam Position



Downstream

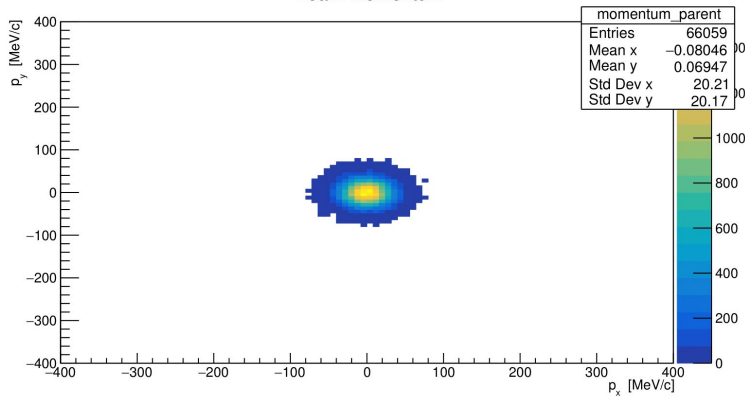




Sampled Beam Evolution - PxPy

NO ABSORBER

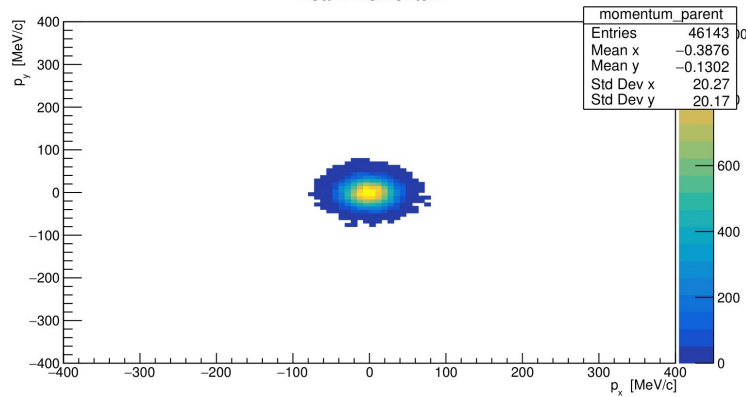
Beam Momentum



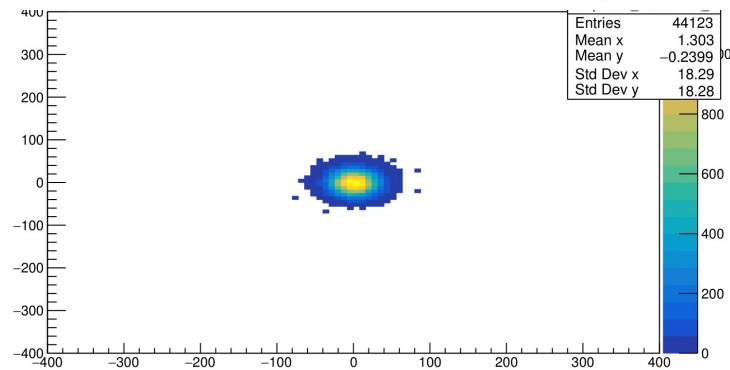
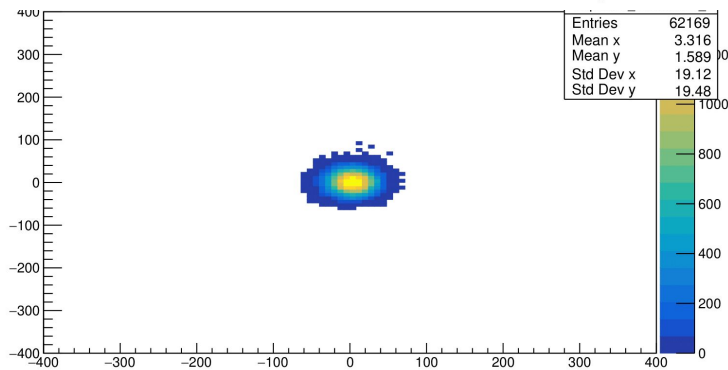
Upstream

LH2

Beam Momentum



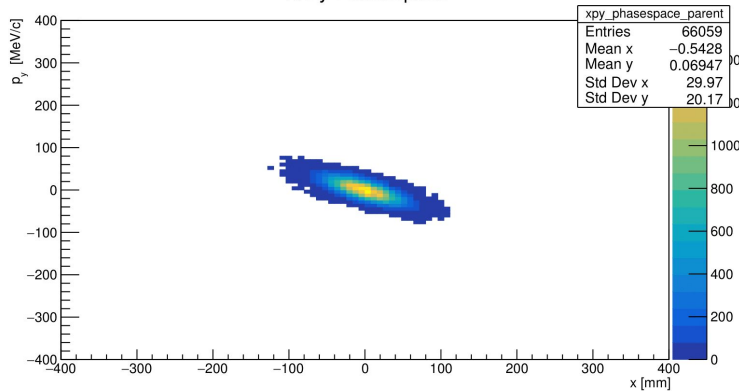
Downstream



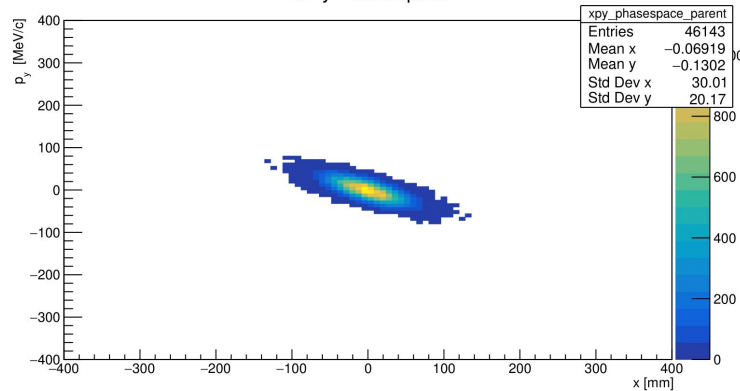


Sampled Beam Evolution - xPy

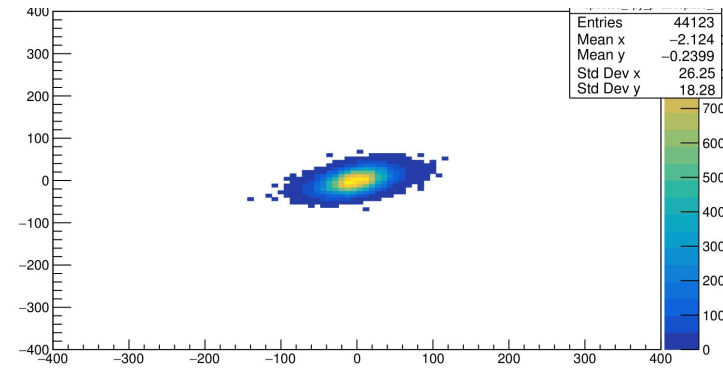
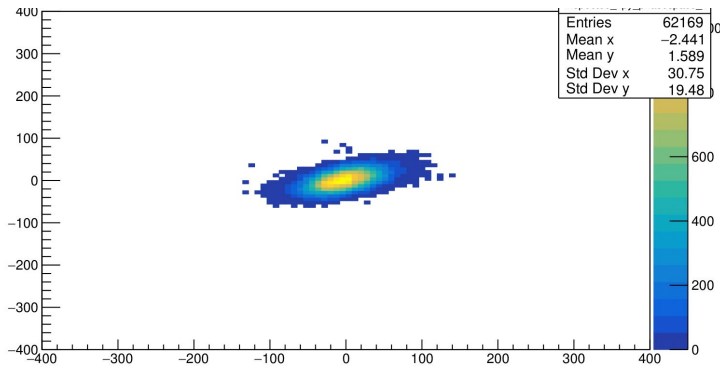
NO ABSORBER
X-Py-Phasespace



LH2
X-Py-Phasespace



Downstream





Sampled Beam Evolution - yPx

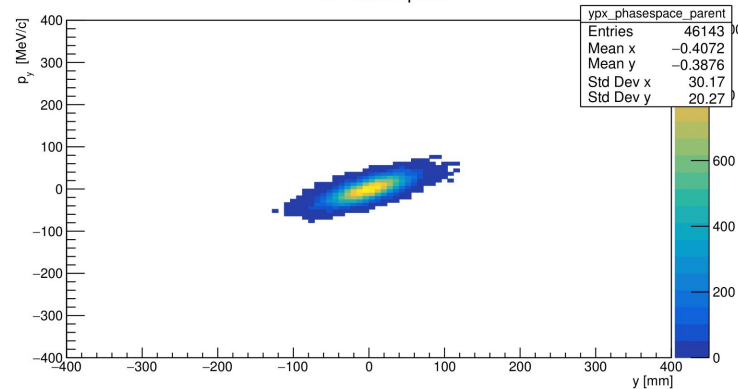
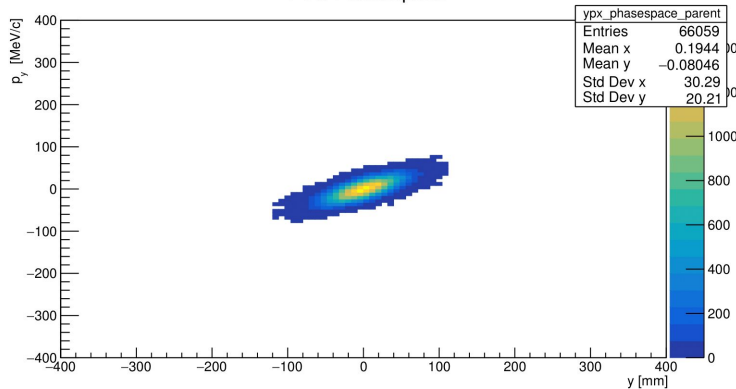
NO ABSORBER

LH2

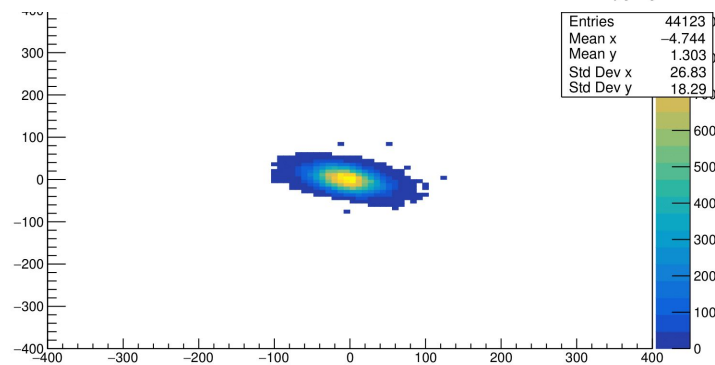
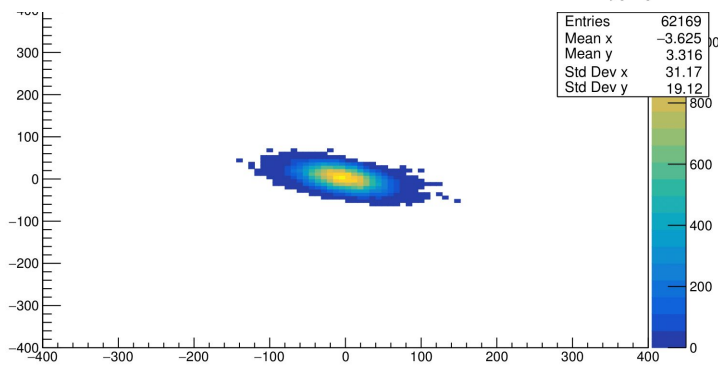
Y-Px-Phasespace

Y-Px-Phasespace

Upstream

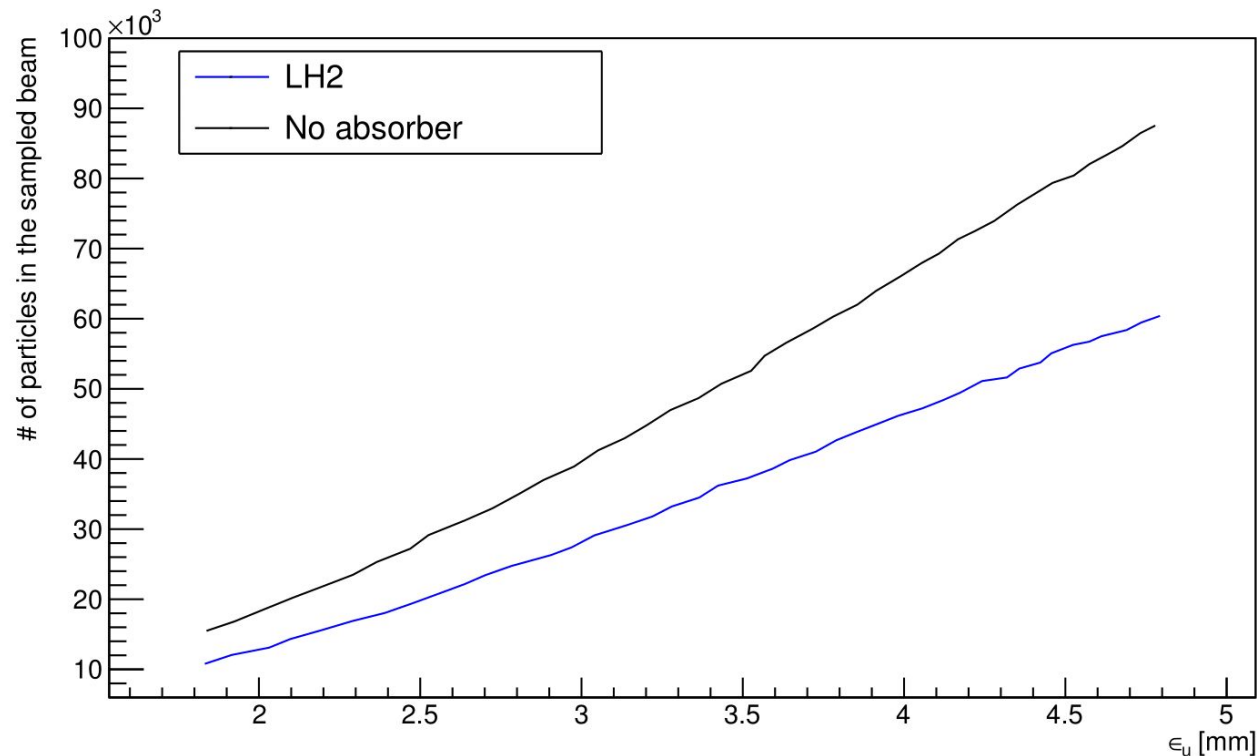


Downstream





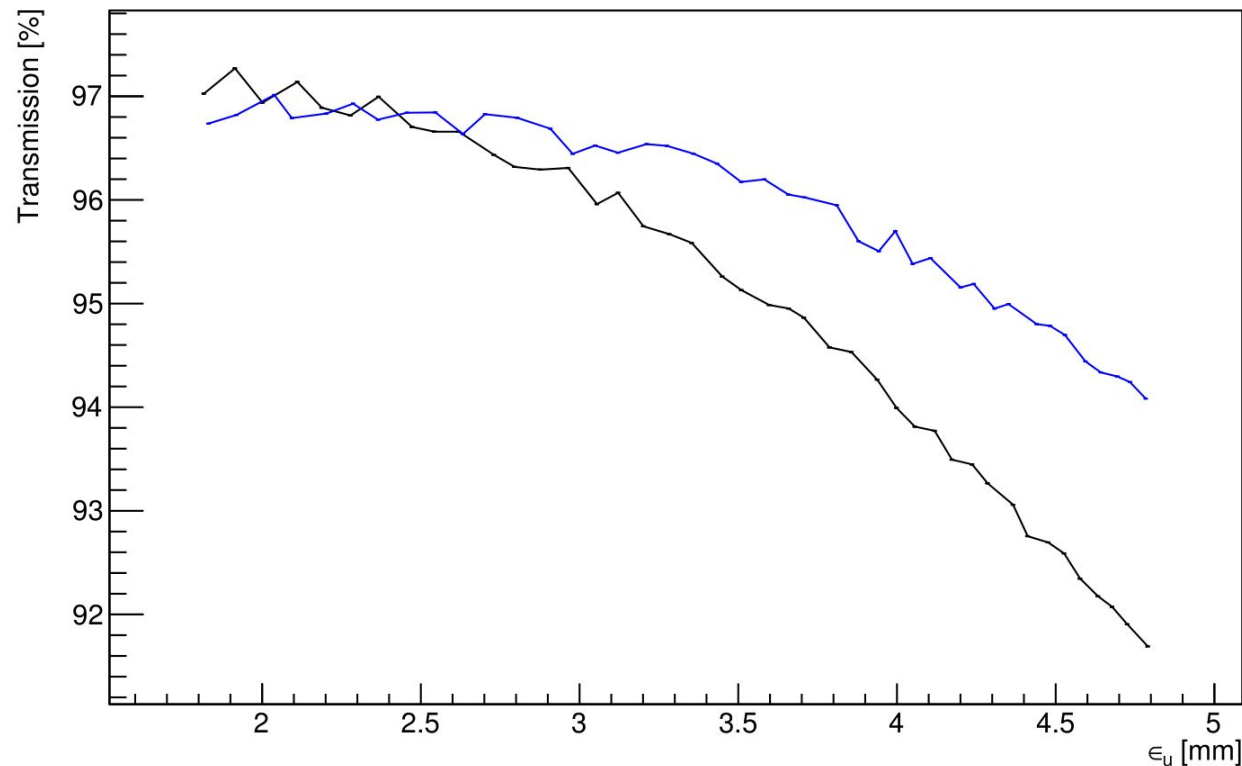
- Number of particles in the sampled beams
- Relatively low statistics (at low emittance) can be improved by using the 4 mm and potentially the 10 mm beams for the parent distribution





Transmission

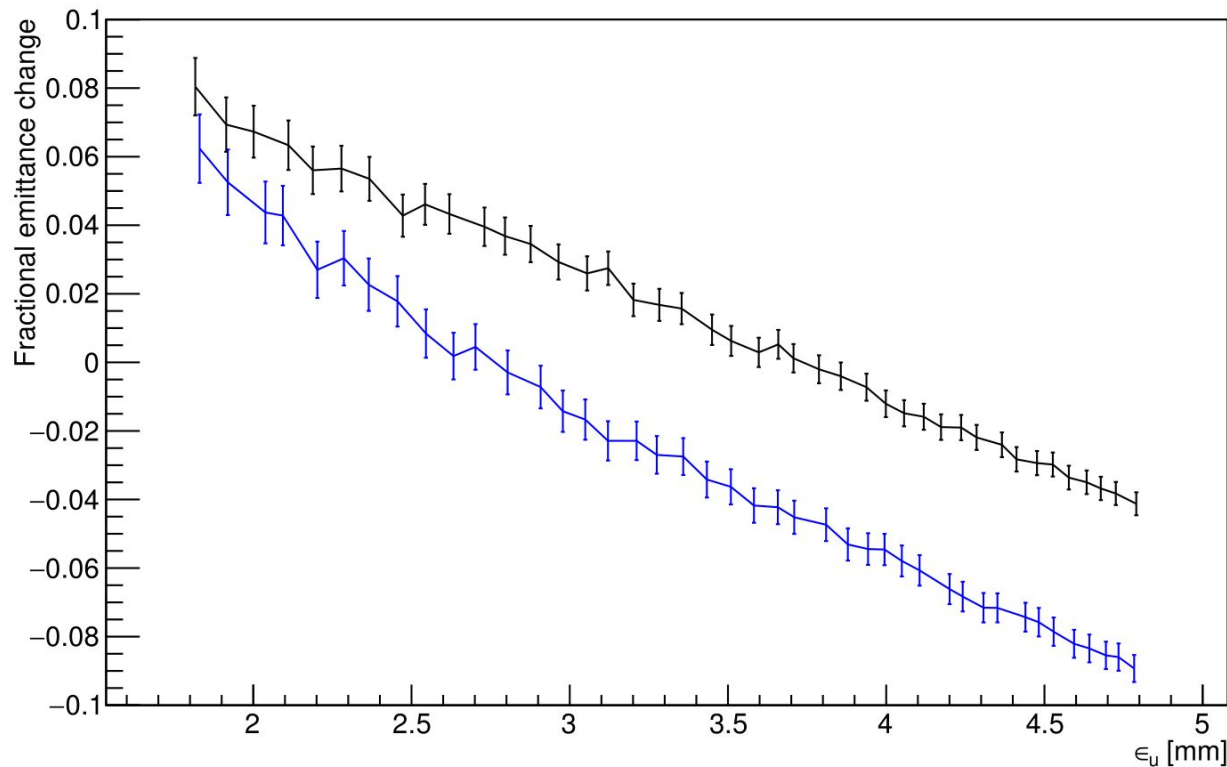
- Blue - LH2
- Black - No absorber
- Trends cross at about [ϵ_u 2.6] mm
- Calculated equilibrium emittance (for $\beta \sim 540$ mm) is ~ 2.3 mm
- Cooled beams present lower transmission loss above the equilibrium emittance





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





Summary

- Applied the beam sampling routine to the 140 MeV/c, 6 mm, *LH2* and *No absorber* beams
- The presence of the absorber indicates cooling
- However, the absolute emittance change is biased by the transmission
- Next steps:
 - Increase statistics by adding 4 mm and potentially 10 mm beams to the parent distribution
 - Produce MC for comparison. Need to fix bug in the sampling routines wrt to hybrid MC
 - Implement a procedure to account for the transmission bias



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BACKUP

