

Measurement of Reverse Emittance Exchange with KDE

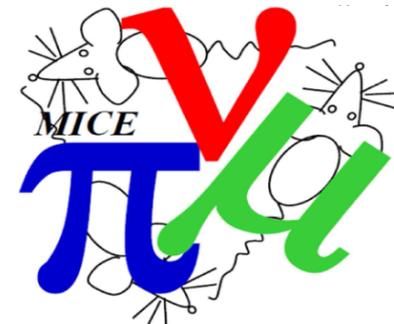


Tanaz A. Mohayai

Video Conference

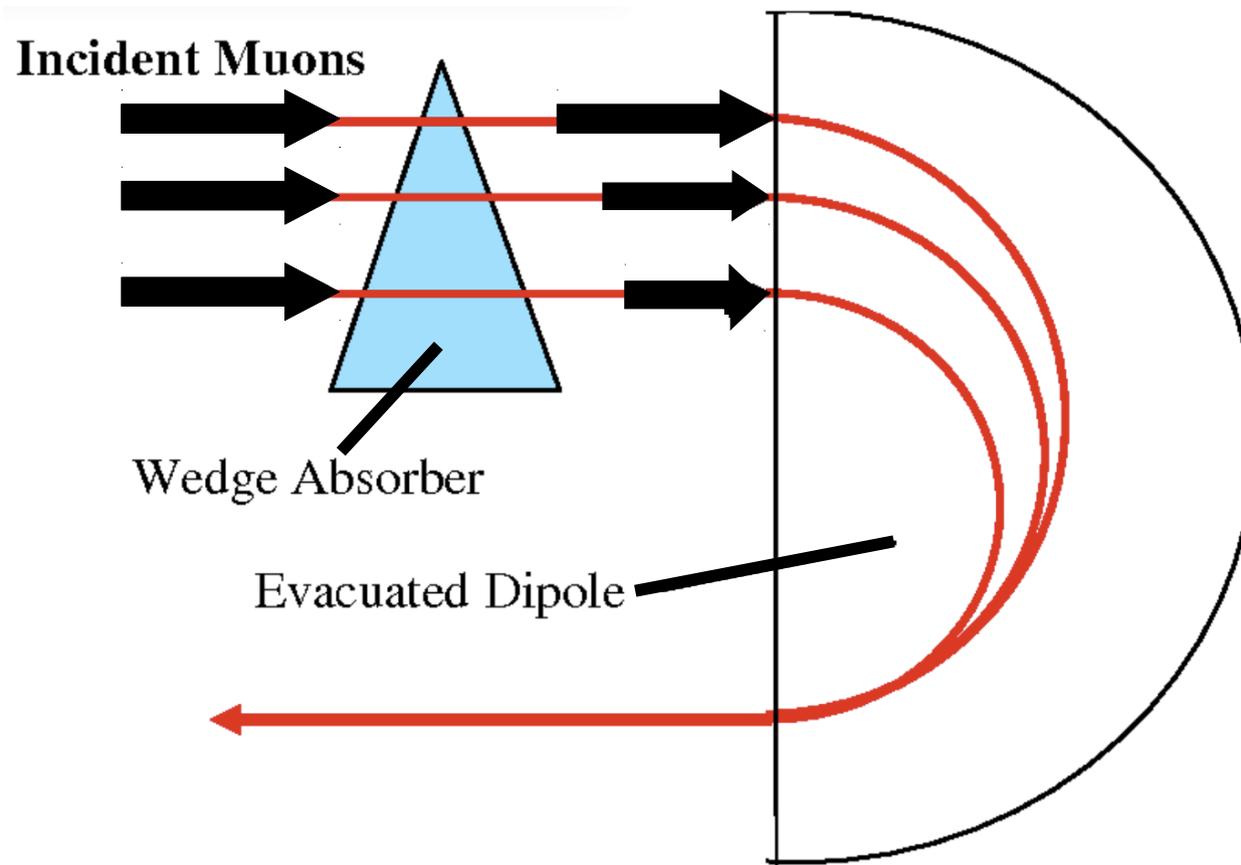
Aug. 2, 2018

ILLINOIS INSTITUTE
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Motivation

- Measure reverse emittance exchange using MICE wedge data
- ★ Possible to demonstrate reverse emittance exchange → longitudinal heating and transverse cooling – lengthens the bunch to increase luminosity



- Wedge data and MC specifications: 6 mm input emittance and 140 MeV/c reference momentum throughout

Cut Specifications

Data Type	Cut Variable	Cut Value
Recon (data and MC recon)	ToF [ns]	$28 < \text{ToF} < 32$
	ToF0 Spacepoint	Single
	ToF1 Spacepoint	Single
	P [MeV/c], TKU	$130 < P < 150$
	Tracker Track, TKU	Single
	P [MeV/c], TKD	$80 < P < 200$
	Tracker Track, TKD	Single
MC	PID	-13
	Fiducial [mm]	150

Cut Specifications – MC Recon

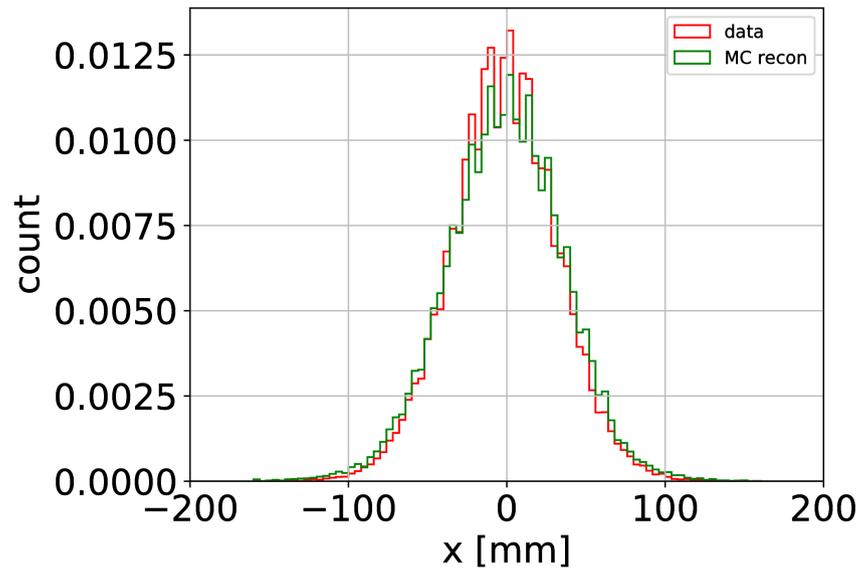
Data Type	Cut Variable	Sample Size Before Cut	Sample Size After Cut
TKU Reference Plane	ToF0 Single Spacepoint	311,560	282,004
	ToF1 Single Spacepoint	282,004	255,711
	ToF PID	255,711	121,027
	Single Track, TKU	121,027	120,898
	P, TKU	120,898	73,591
TKD Reference Plane	ToF0 Single Spacepoint	140,710	131,060
	ToF1 Single Spacepoint	131,060	122,304
	ToF PID	122,304	92,318
	Single Track, TKU	92,318	92,162
	P, TKU	92,162	90,437
	TKD cut to ensure that only TKU-after-cut sample is included in TKD	90,437	60,691

Cut Specifications – Data

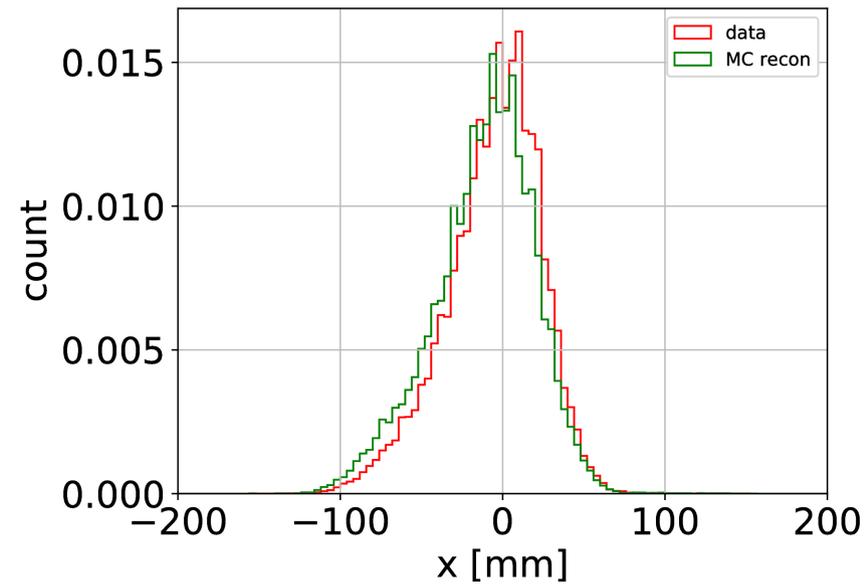
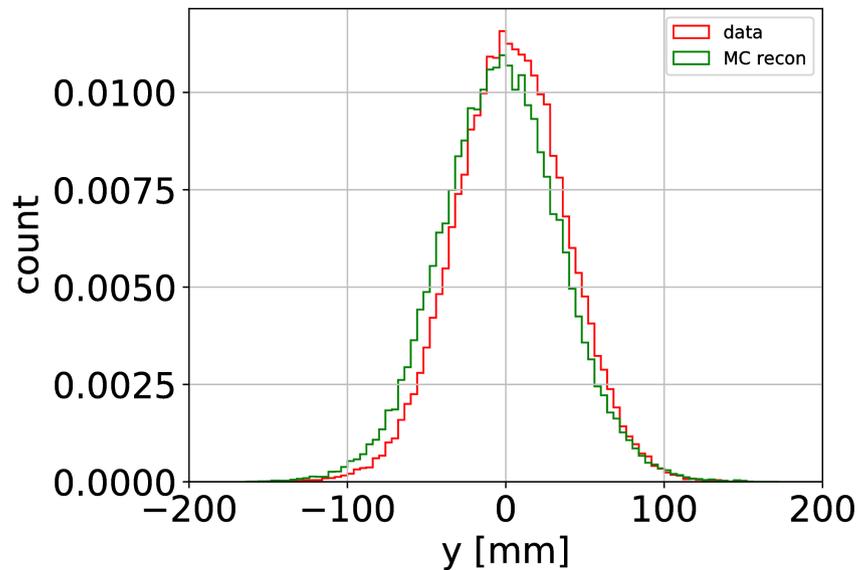
Data Type	Cut Variable	Sample Size Before Cut	Sample Size After Cut
TKU Reference Plane	ToF0 Single Spacepoint	316,382	207,753
	ToF1 Single Spacepoint	207,753	201,723
	ToF PID	201,723	105,333
	Single Track, TKU	105,333	104,698
	P, TKU	104,698	72,134
TKD Reference Plane	ToF0 Single Spacepoint	187,411	124,193
	ToF1 Single Spacepoint	124,193	121,400
	ToF PID	121,400	88,743
	Single Track, TKU	88,743	88,272
	P, TKU	88,272	86,980
	TKD cut to ensure that only TKU-after-cut sample is included in TKD	86,980	62,923

Phase-space Plots

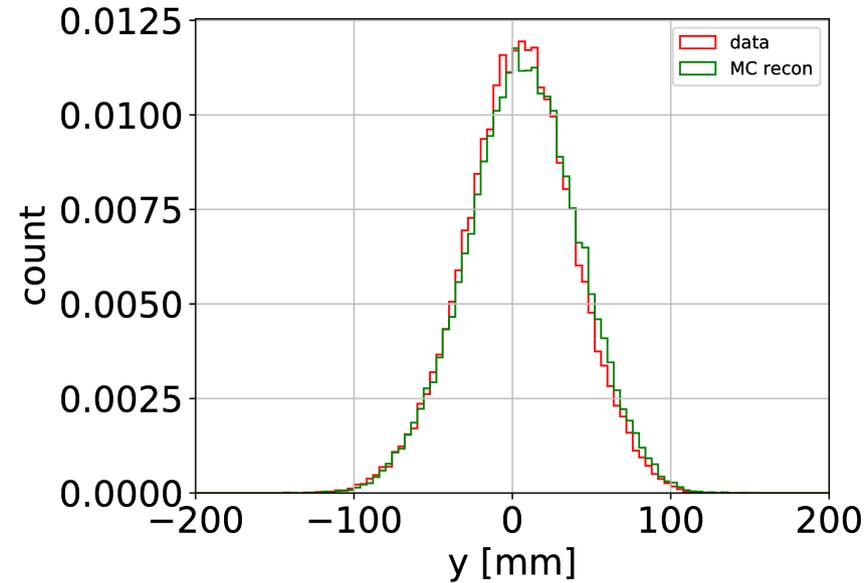
- **Transverse position distributions at the tracker reference planes**



Upstream Reference Plane

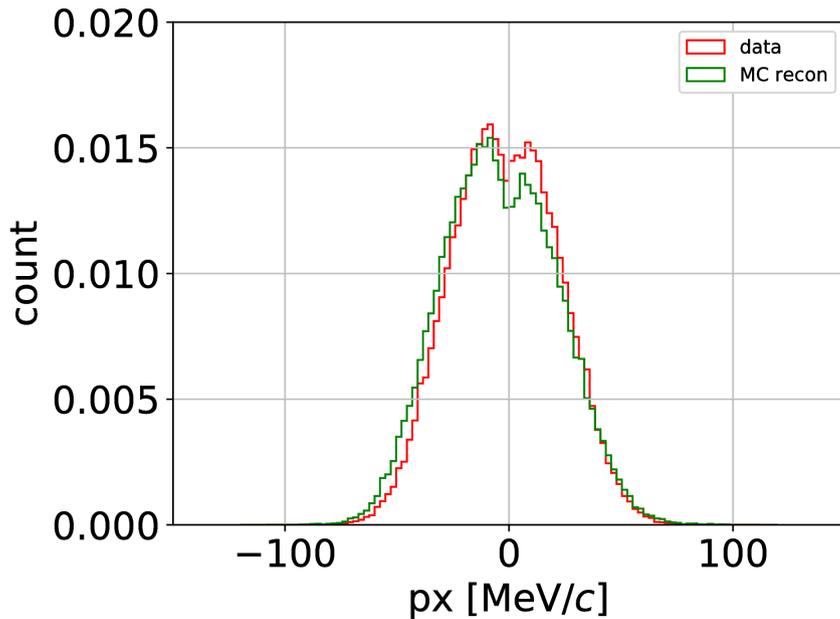


Downstream Reference Plane

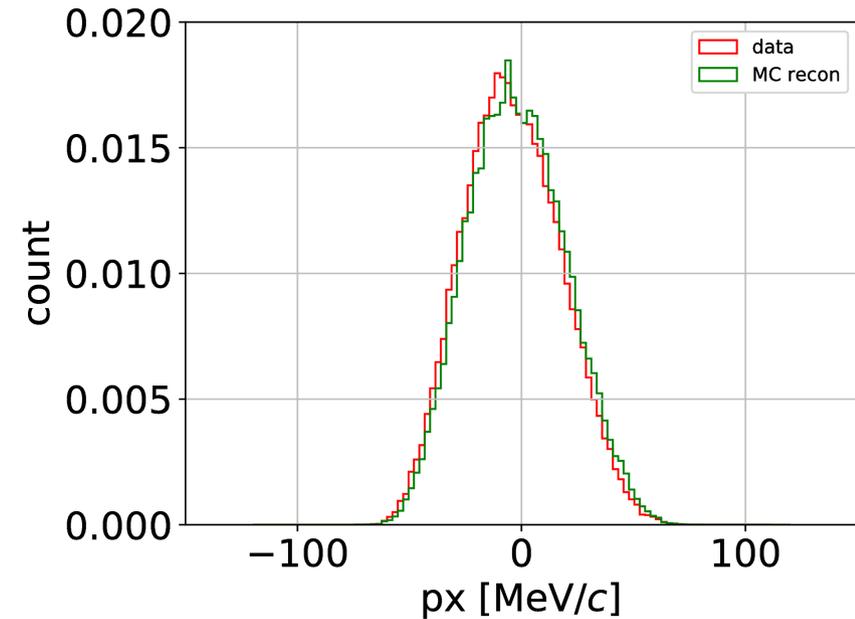
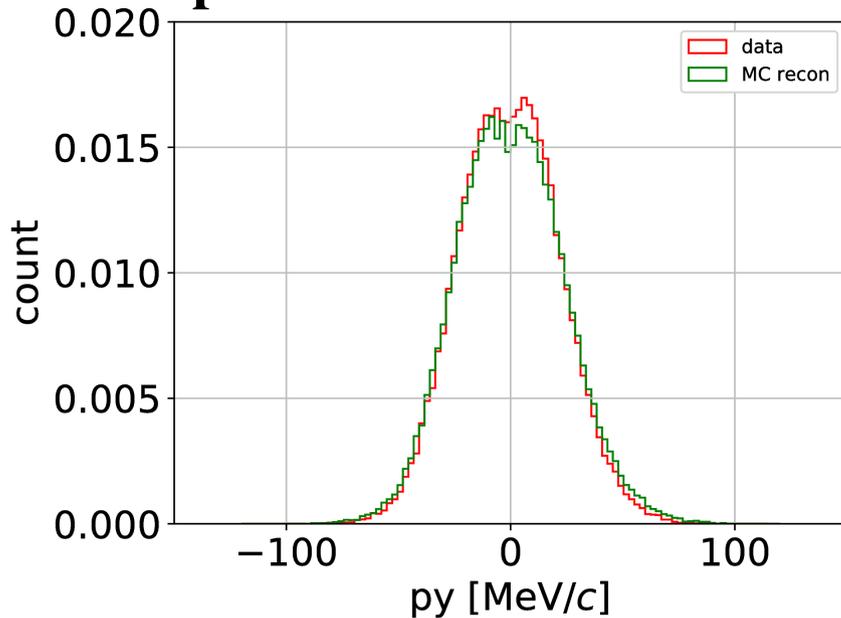


Phase-space Plots

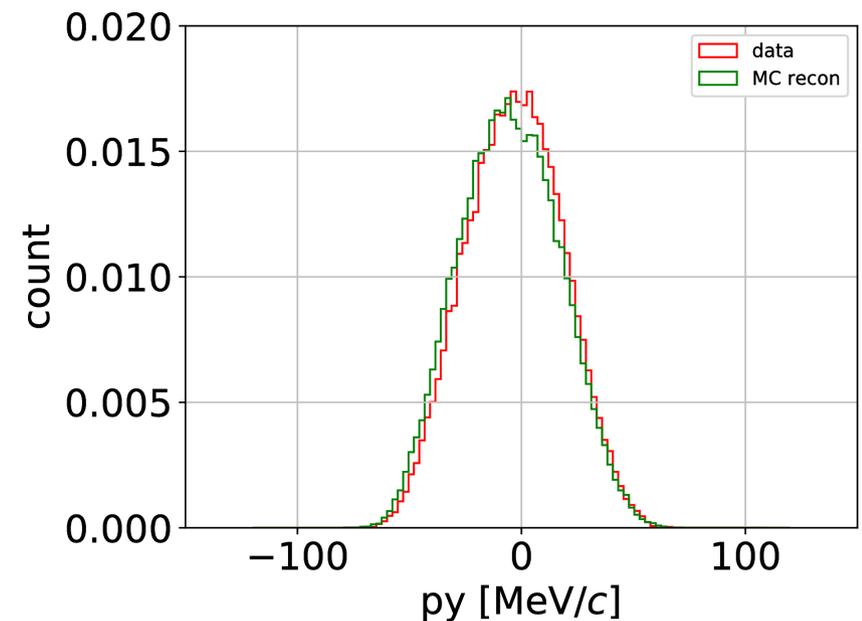
- **Transverse momentum distributions at the tracker reference planes**



Upstream Reference Plane

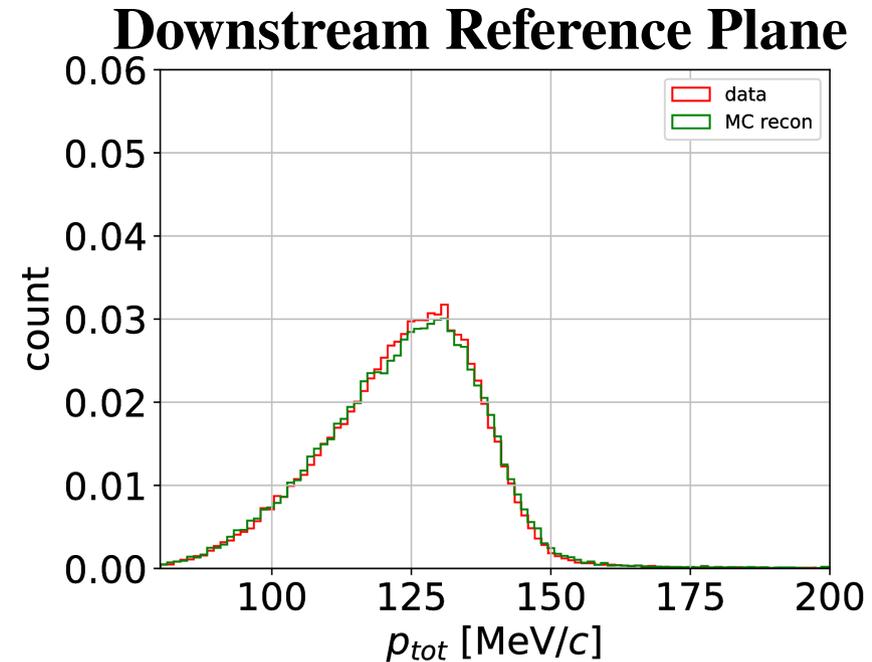
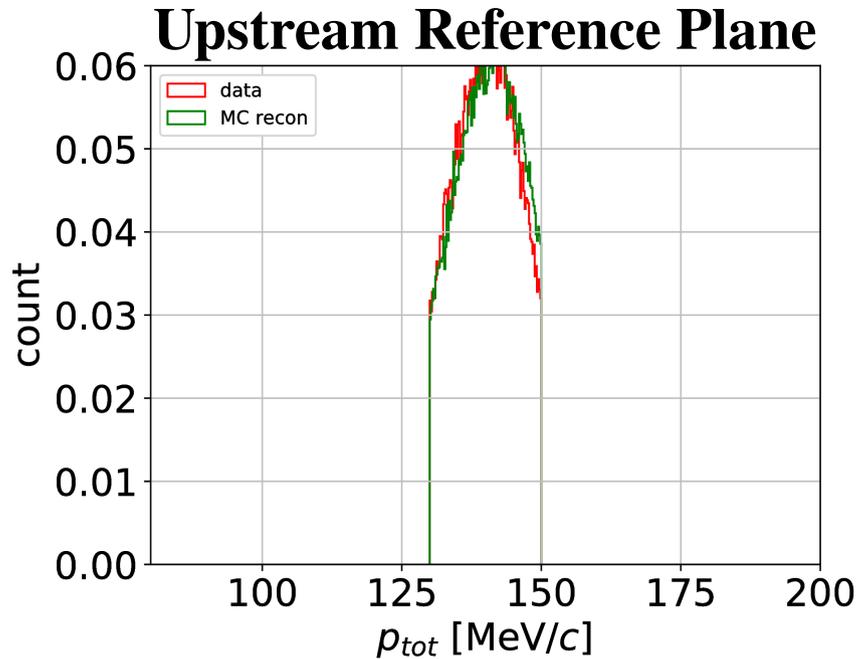
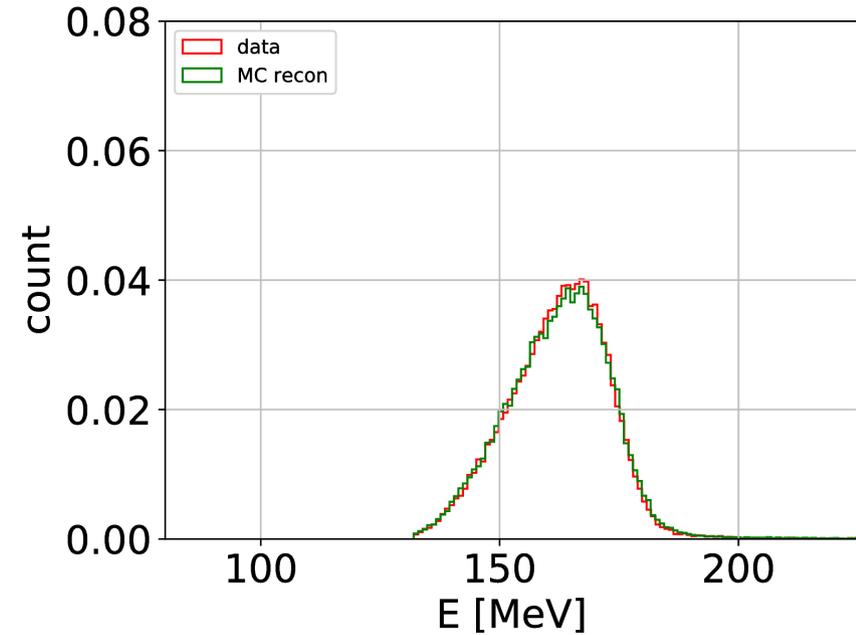
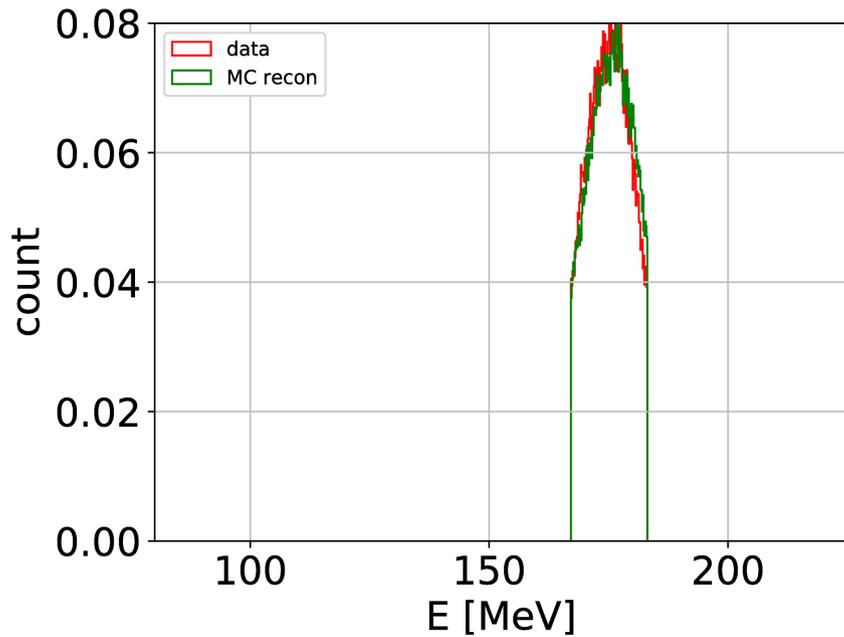


Downstream Reference Plane

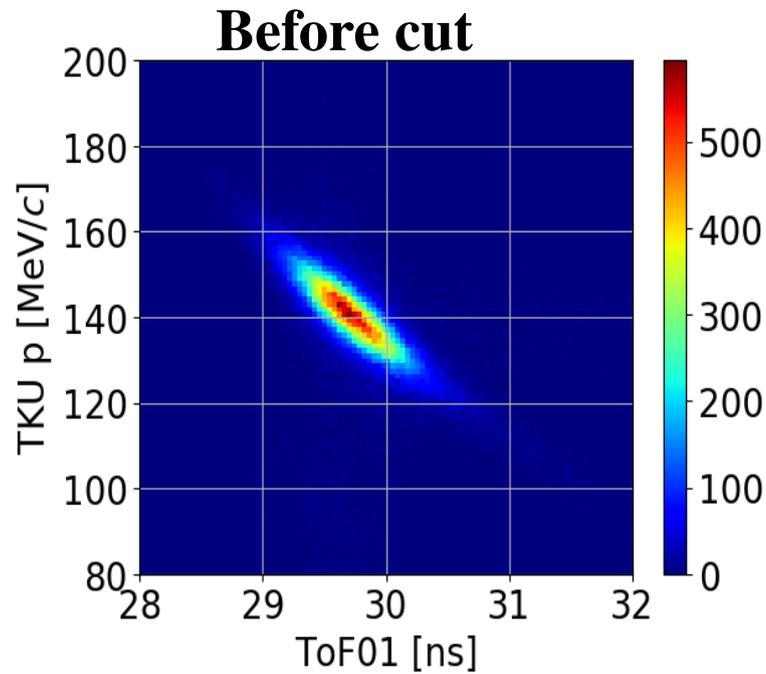


Phase-space Plots

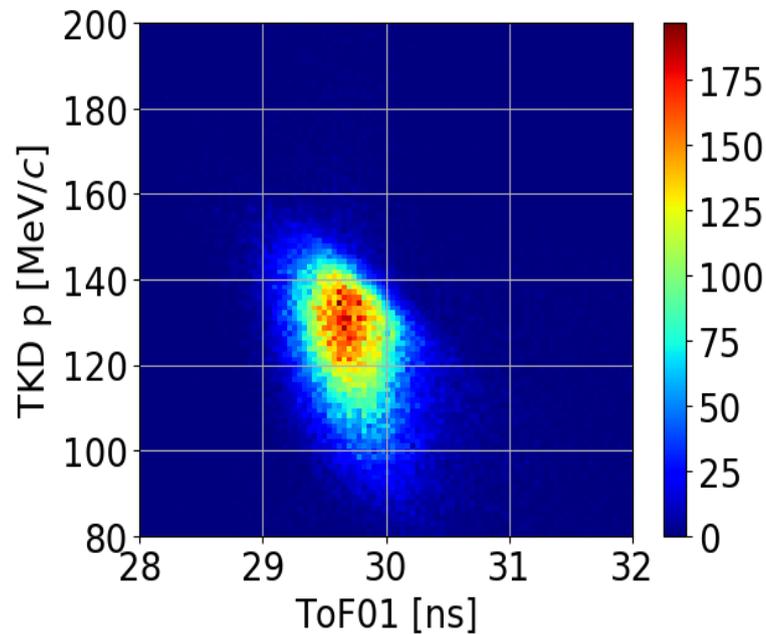
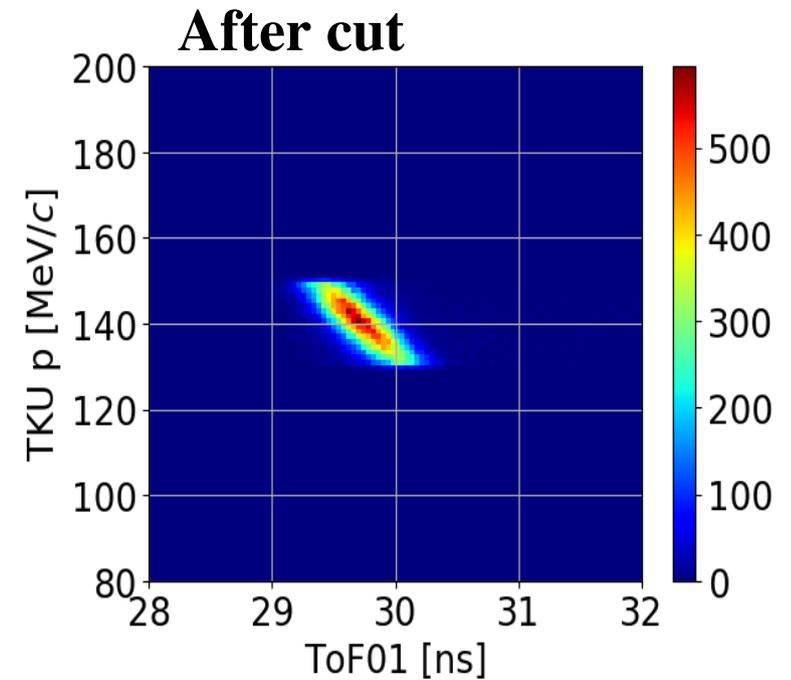
- Energy and total momentum distributions at TRPs



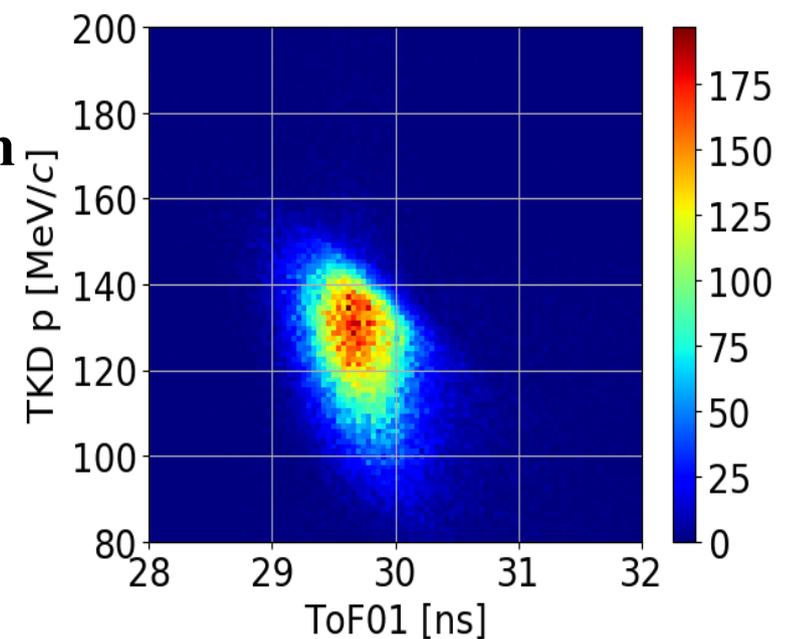
ToF vs p Plots – Data



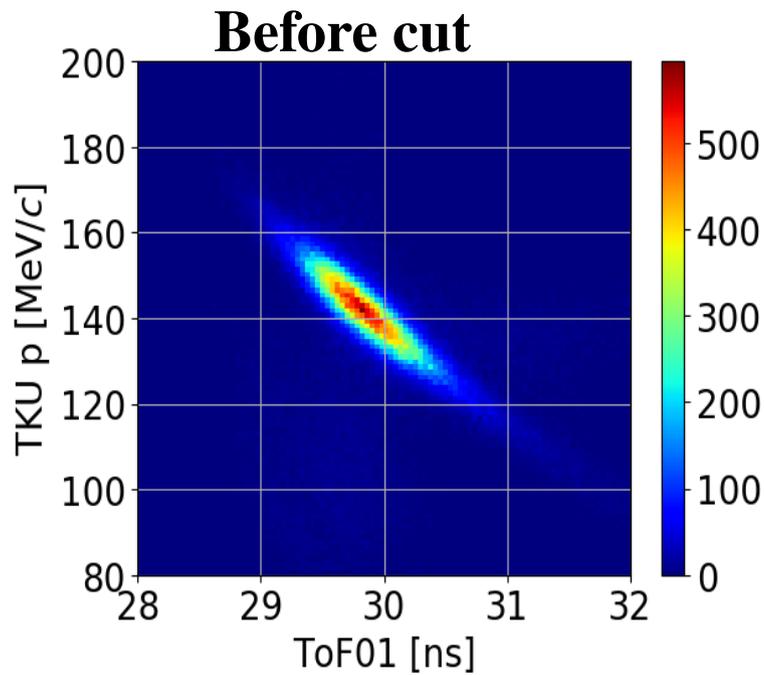
**Upstream
Reference
Plane**



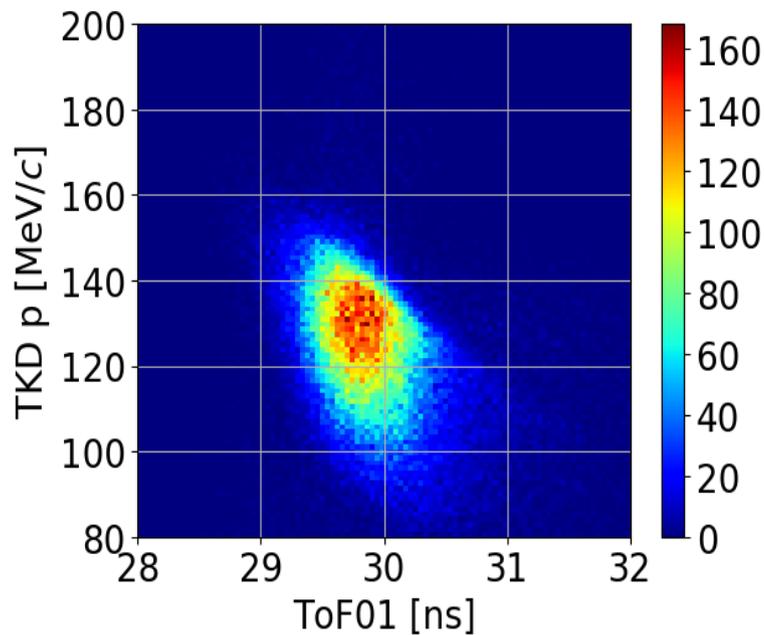
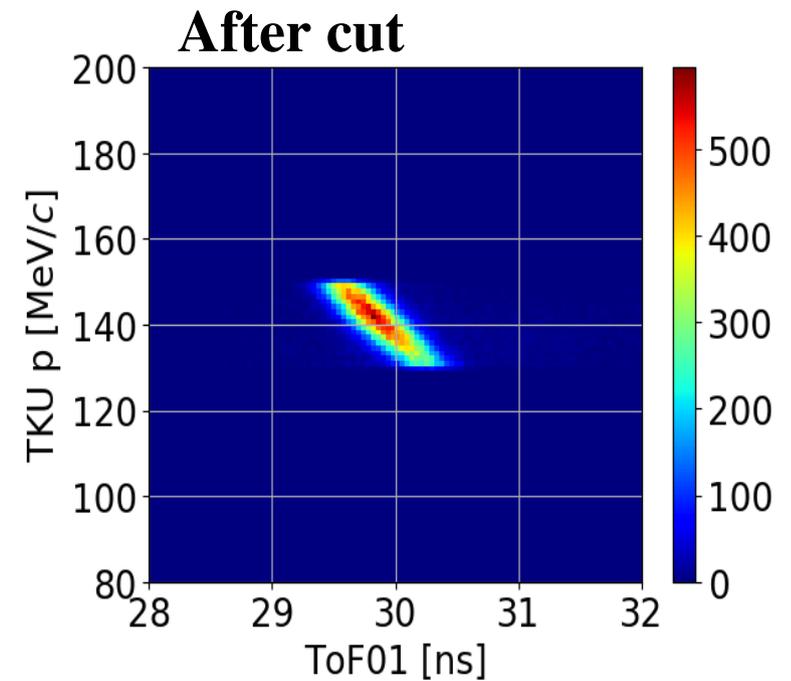
**Downstream
Reference
Plane**



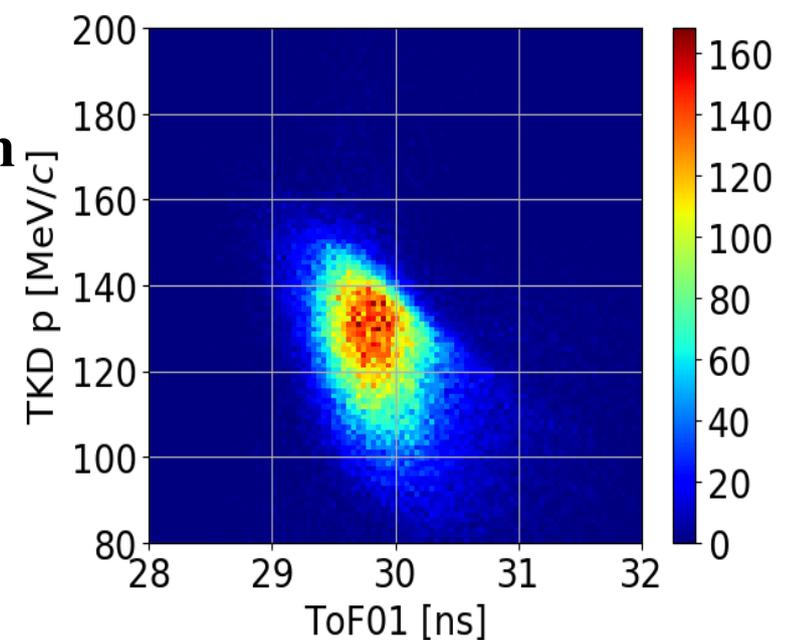
ToF vs p Plots – MC Recon



**Upstream
Reference
Plane**

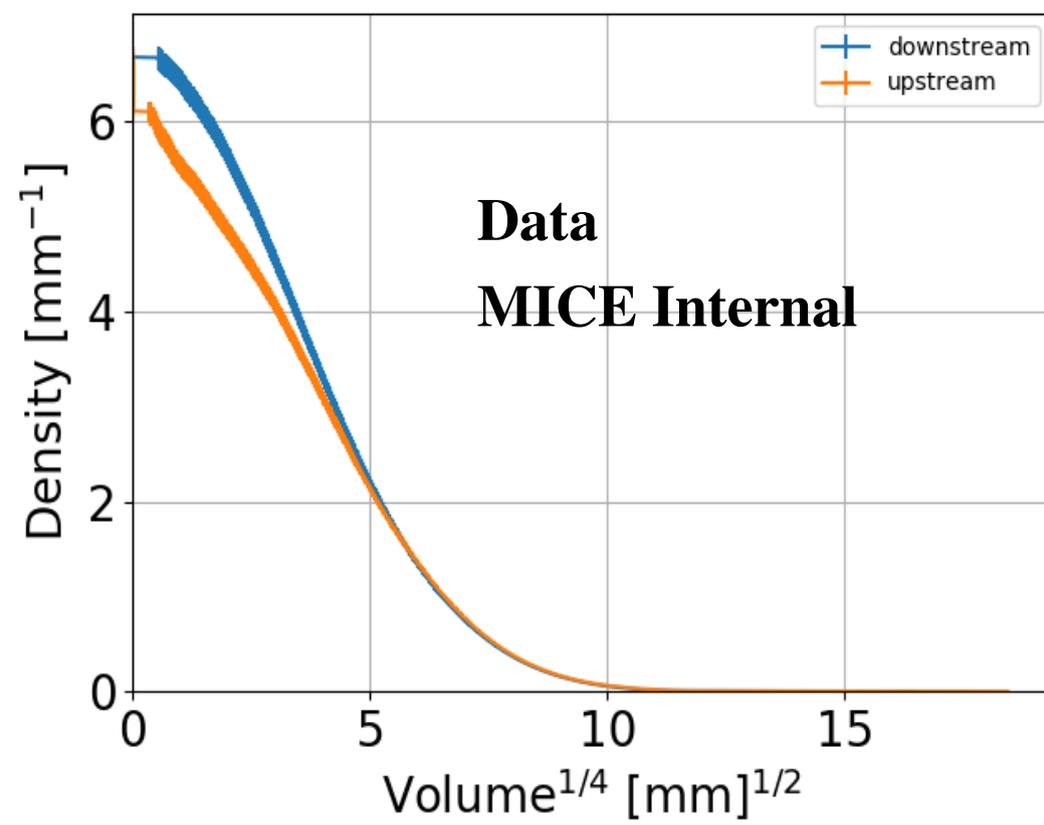
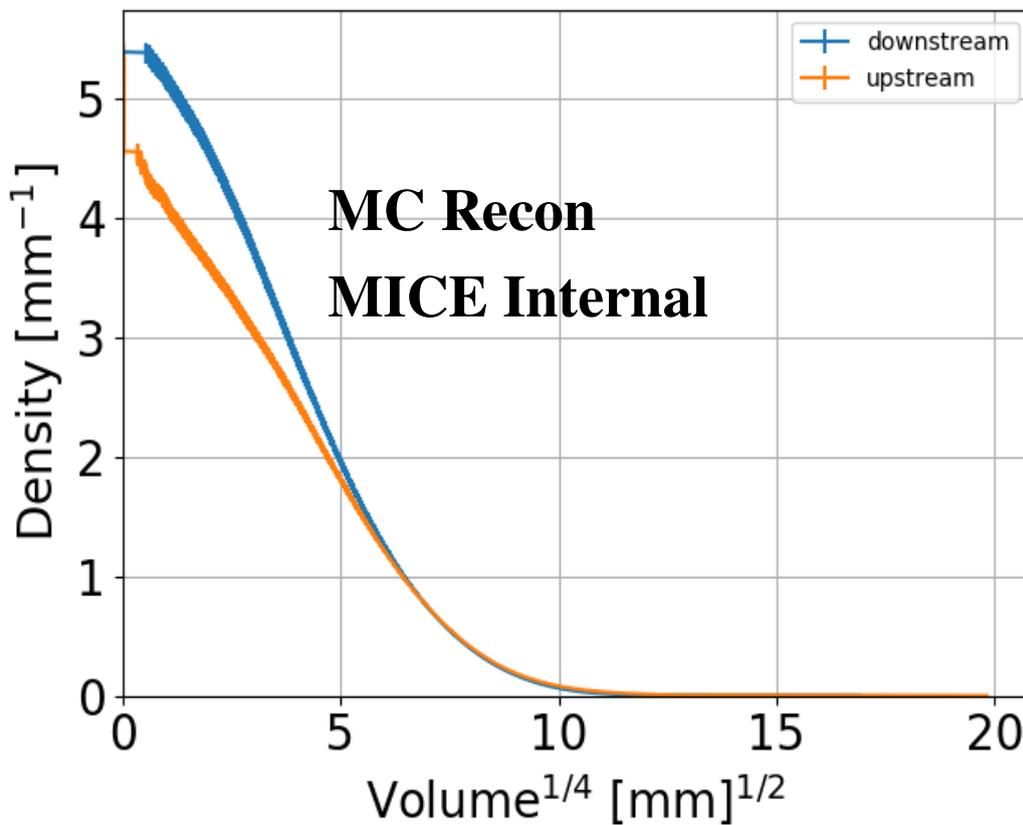


**Downstream
Reference
Plane**



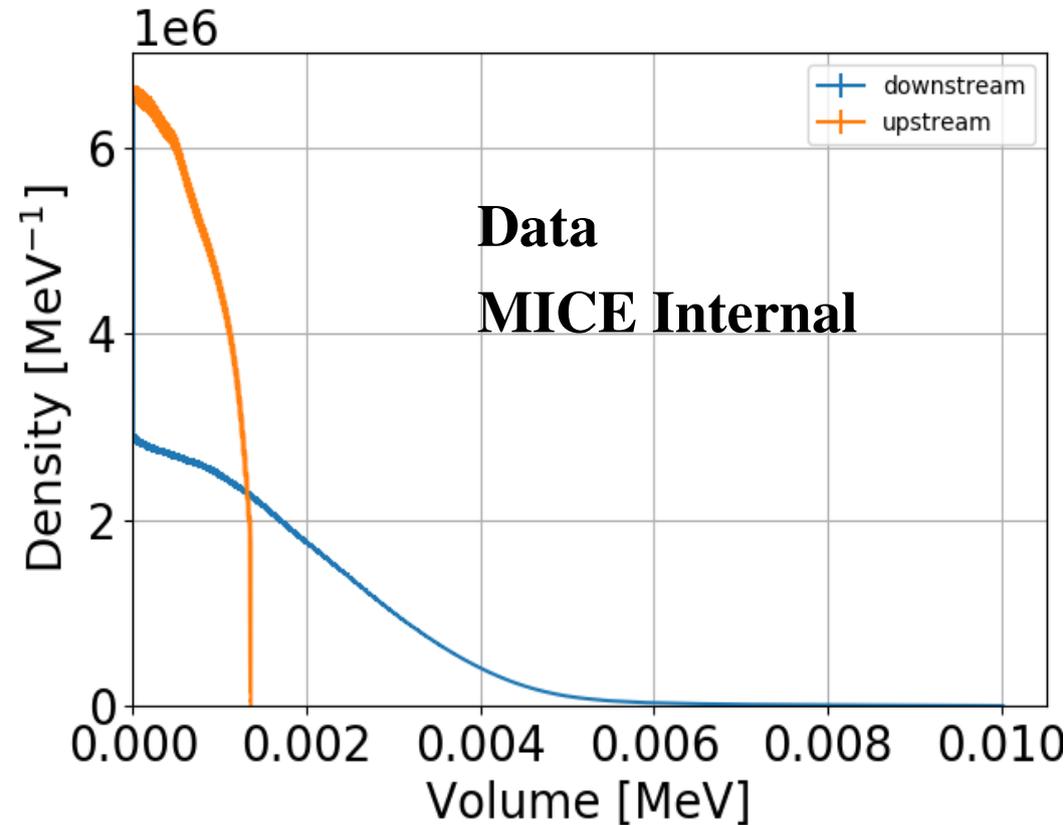
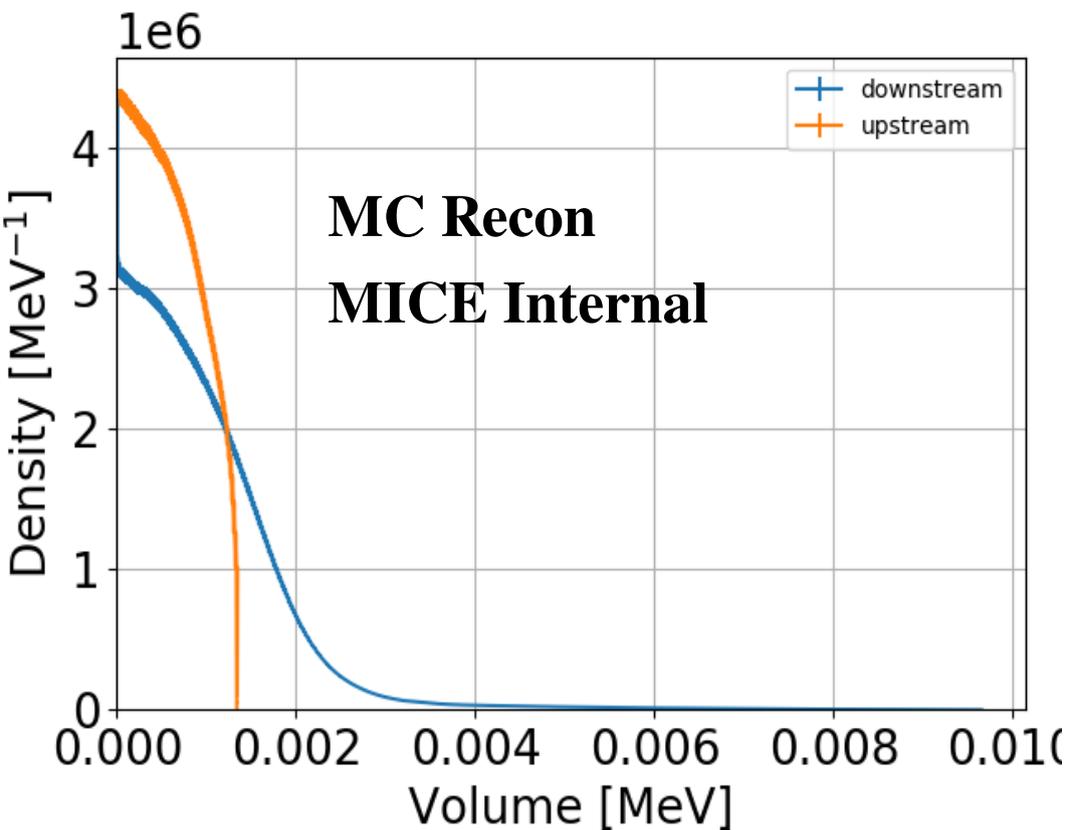
KDE Density vs Volume – Transverse

- Density (using KDE technique) of the contour versus the contour volume enclosed – transverse cooling demonstrated
- Different transmission loss between MC recon (82%) and data (87%) → giving rise to discrepancy



KDE Density vs Volume – Longitudinal

- Density of the contour versus the contour volume enclosed – longitudinal heating demonstrated

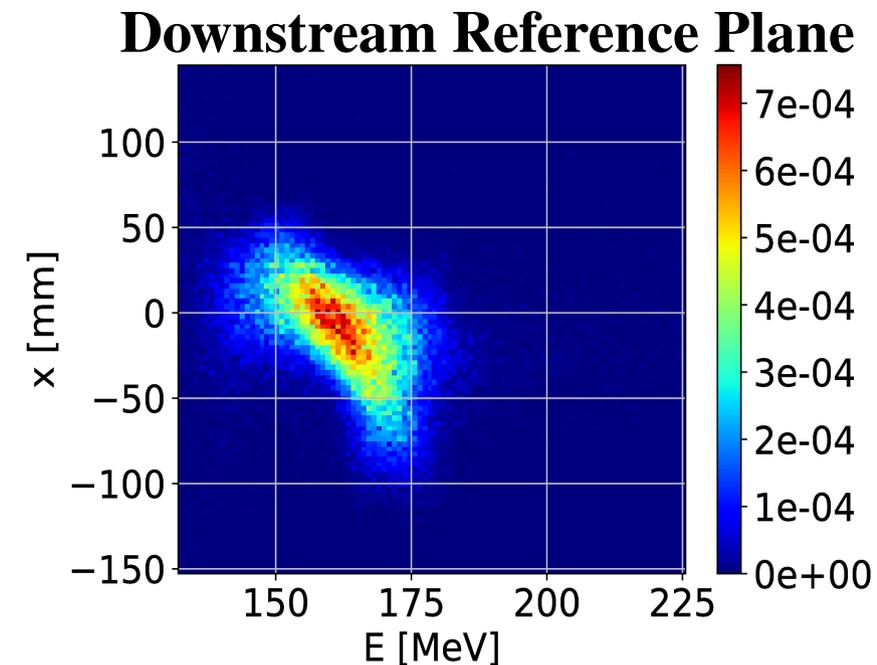
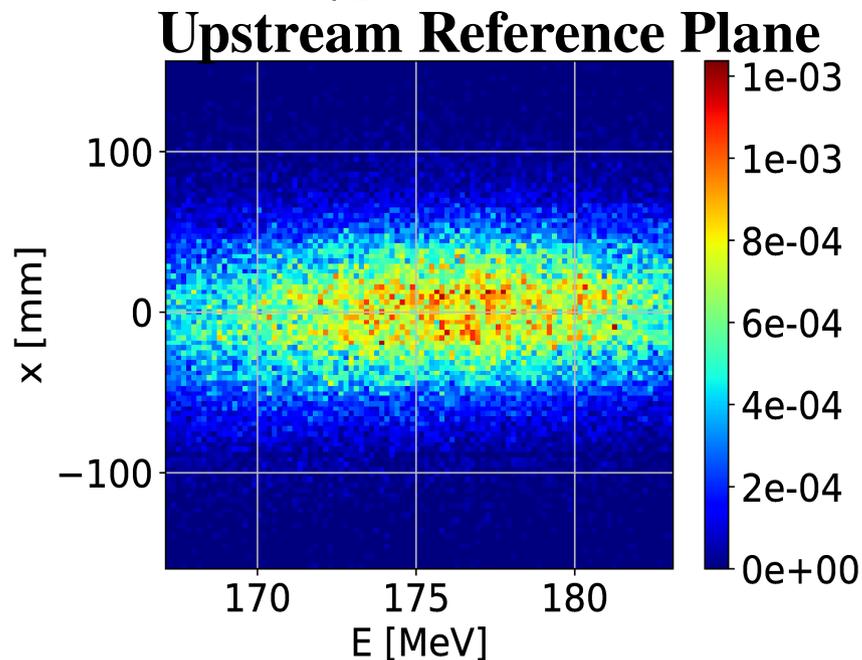
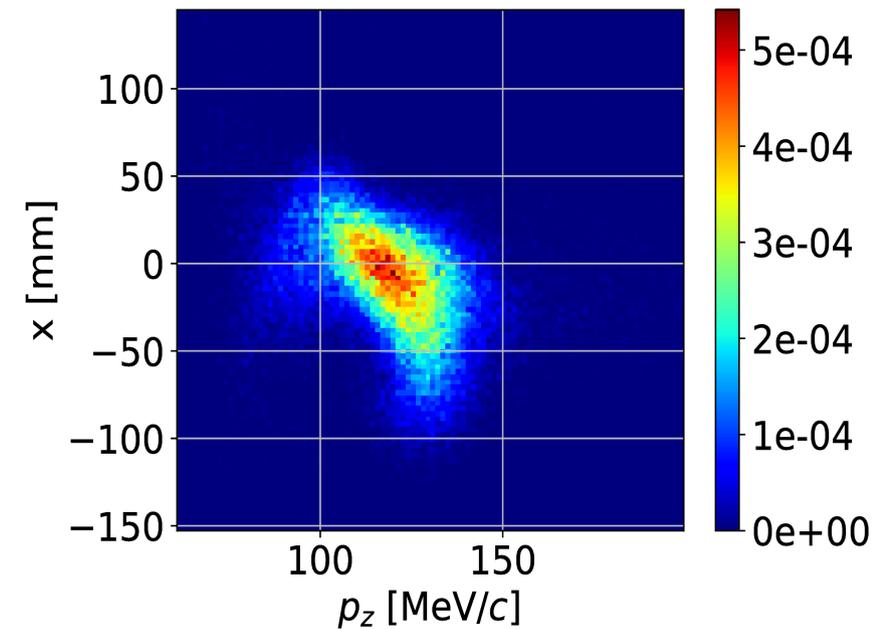
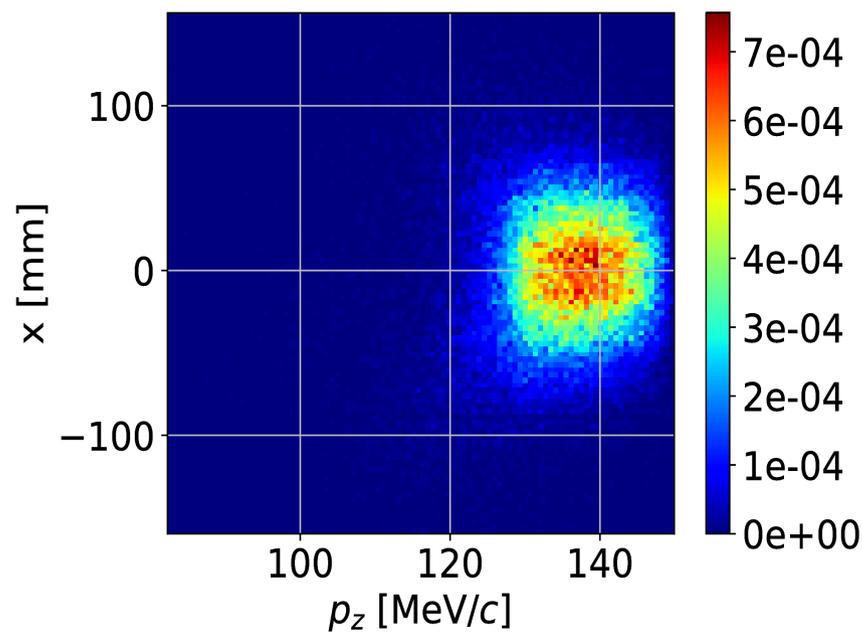


Conclusions

- Preliminary reverse emittance exchange observed – full analysis underway
- Systematic analysis on-going

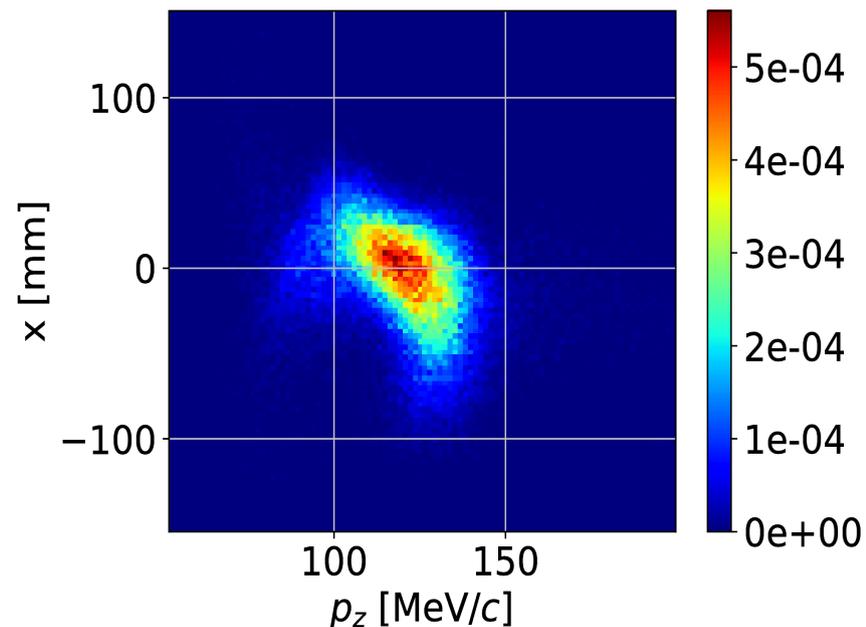
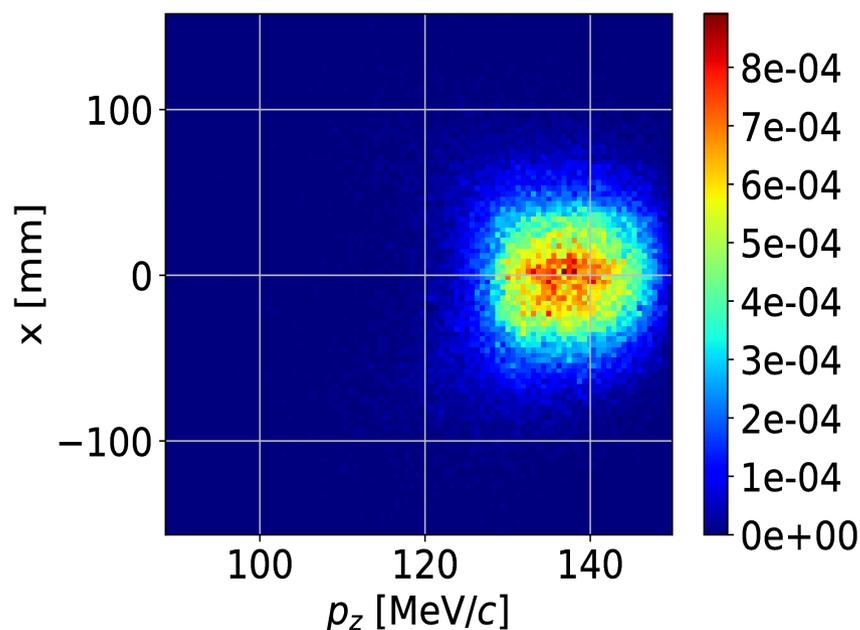
Phase-space Plots – MC Recon

- Energy change (from mean energy) and total momentum distributions at TRPs

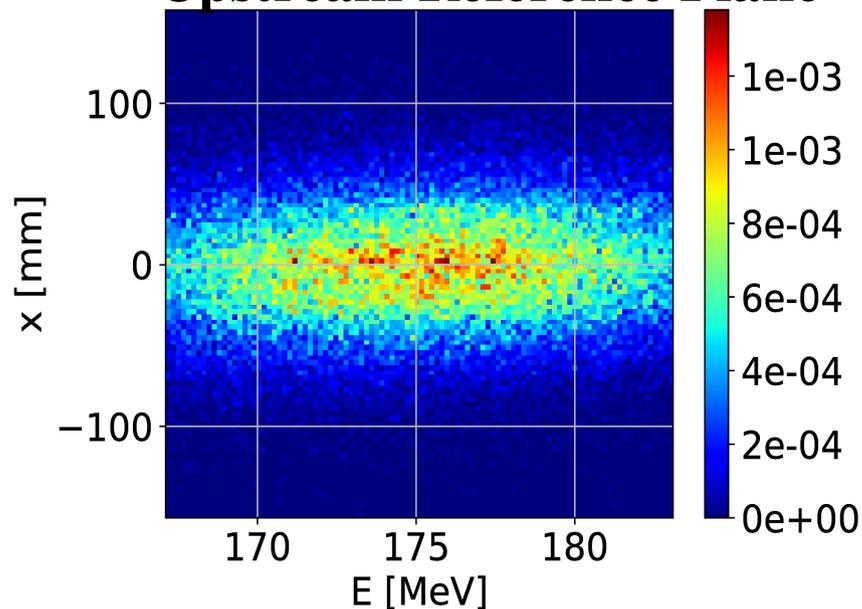


Phase-space Plots – Data

- Energy change (from mean energy) and total momentum distributions at TRPs



Upstream Reference Plane



Downstream Reference Plane

