



Turn-by-Turn Electron Injection Trajectories and Efficiencies with Offsets in the Injected Beam Energy

-- Arc pretzel lattice 20150106 --

-- Symplectic tracking through the 27-term undulator model --

-- 3 March 2015: Added slide 5 on injection twiss matching --

-- 9 March 2015: Added slide 6 on horizontal distribution at CCU --

** 23 March 2015: CCU electron tracking bug fixed 3/21/15. See talk 3/23/15 **

Jim Crittenden

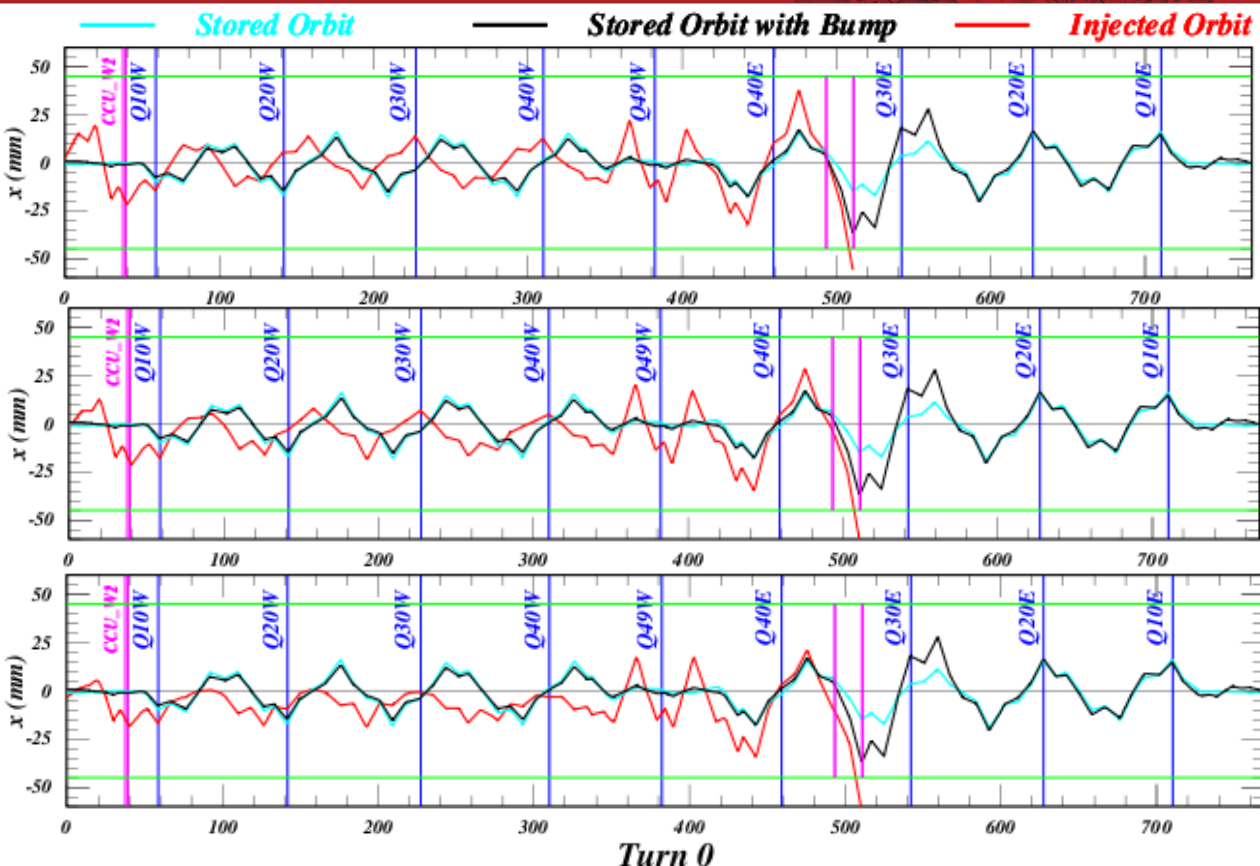
CHESS Simulation Working Group

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Injection turn electron trajectories and 40-turn survival efficiencies



No energy offset
Efficiency: $16.5 \pm 1.2\%$

Energy offset -0.3%
Efficiency: $20.0 \pm 1.3\%$

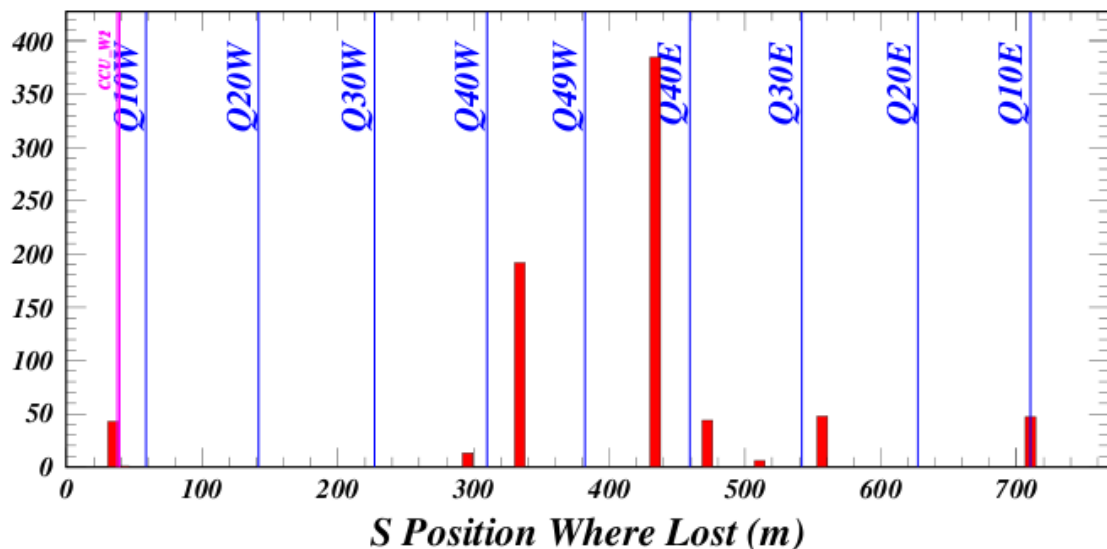
Energy offset -0.5%
Efficiency: $10.9 \pm 0.8\%$

The injection trajectory on the injection turn moves toward the inside of the ring with increasing energy offset up to the undulator, but also slightly more toward the center of the undulator.

The horizontal and vertical synchrotron emittances are each modeled as 110 nm-rad.
The efficiency improves with 0.3% energy offset, but decreases with 0.5% energy offset, as observed during the machine studies on February 24 for single-beam injection.



Critical apertures for electron injection



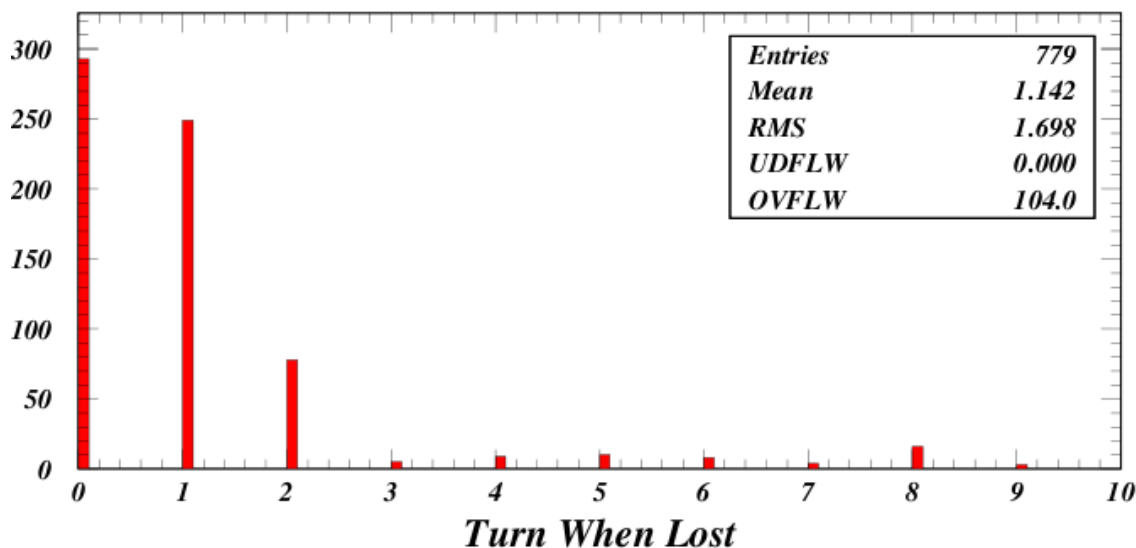
The losses occur predominantly during the first three turns

Most losses are at the scraper at 43W and the collimator at 43E.

The modeled vertical aperture is ± 3.5 mm at the scraper and ± 5 mm at the collimator.

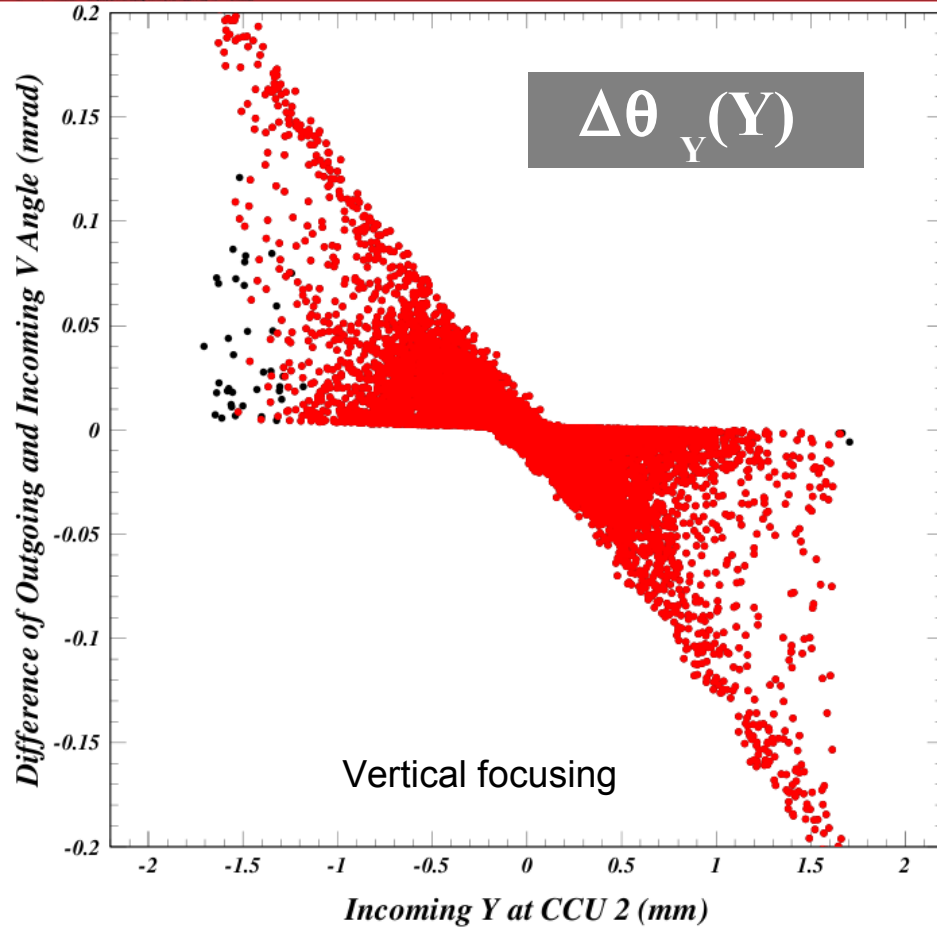
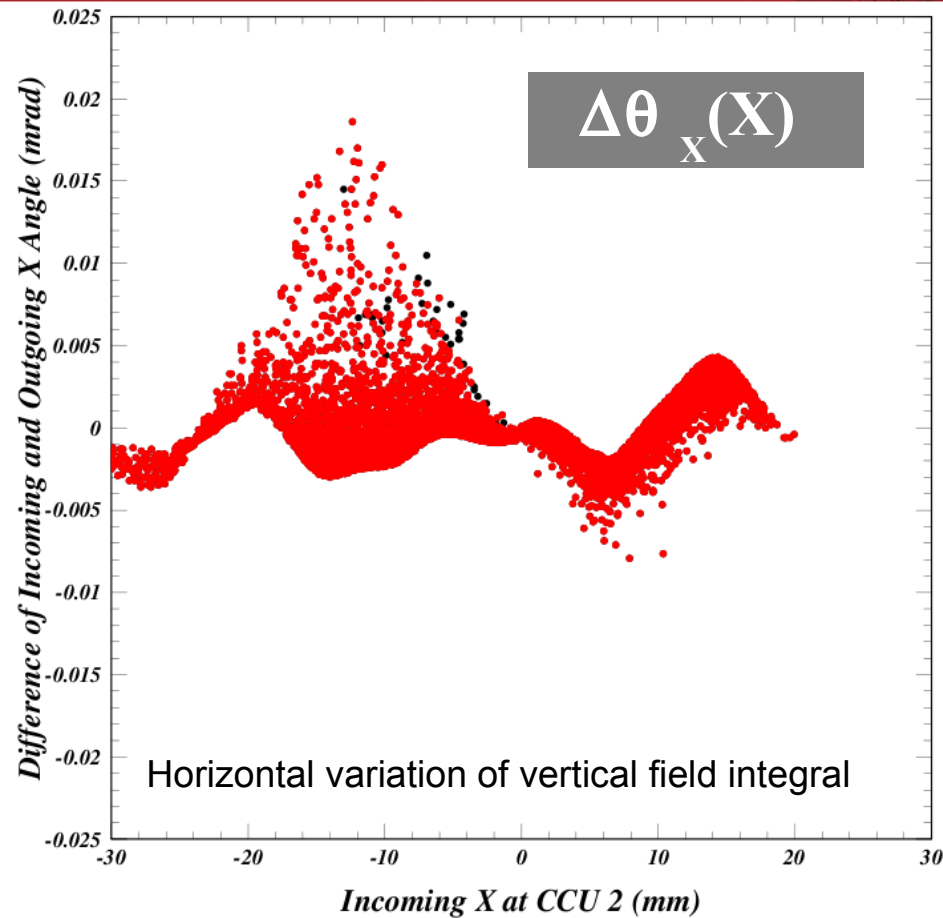
There are some losses at the vertical aperture of the undulator, despite its much smaller vertical beta function.

The modeled upper and lower apertures at the two ends of each undulator range between 2.0 and 2.5 mm.





Undulator transfer function populations (Electrons reach CCU 2 before CCU 1)



The six injection coordinates at 34E are each varied independently over $\pm 3\sigma$.

The black points indicate electrons which did not survive the turn.



Effect of Injection Twiss Matching

Accepted horizontal injection phase space

Synchrotron twiss in CHESS simulations 2001-2009

$$\beta_x = 20 \text{ m} \quad \alpha_x = 0 \quad \eta_x = 1.2 \text{ m} \quad \eta'_x = 0.009$$

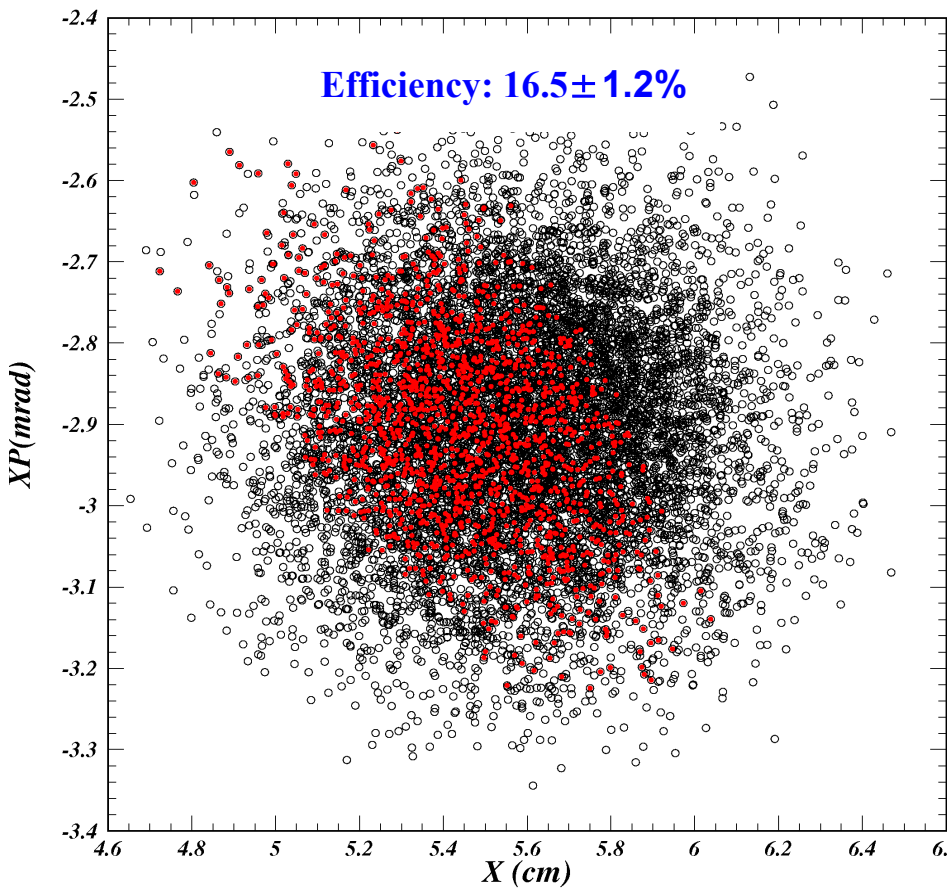
$$\beta_y = 20 \text{ m} \quad \alpha_y = 0 \quad \eta_y = 0 \text{ m} \quad \eta'_y = 0$$

Synchrotron twiss set to CESR Q34E values

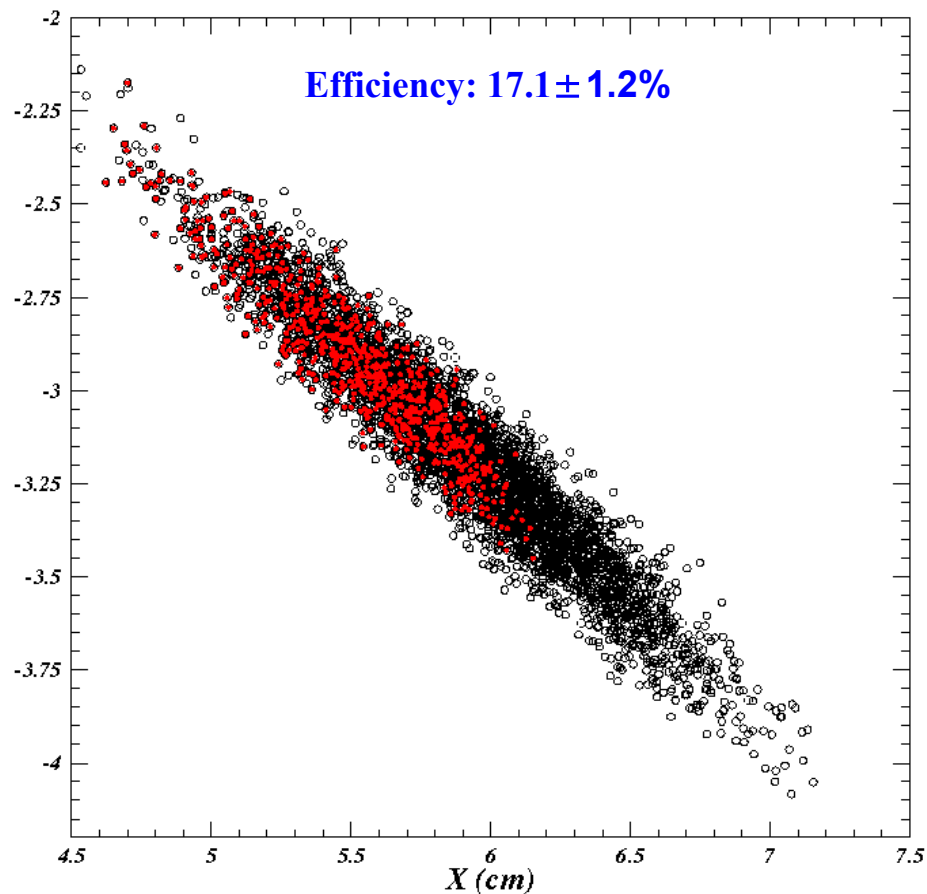
$$\beta_x = 47 \text{ m} \quad \alpha_x = -3.2 \quad \eta_x = 1.65 \text{ m} \quad \eta'_x = 0.12$$

$$\beta_y = 22 \text{ m} \quad \alpha_y = 1.6 \quad \eta_y = 0 \text{ m} \quad \eta'_y = 0$$

Injected and Accepted Phase Space for Job 2364



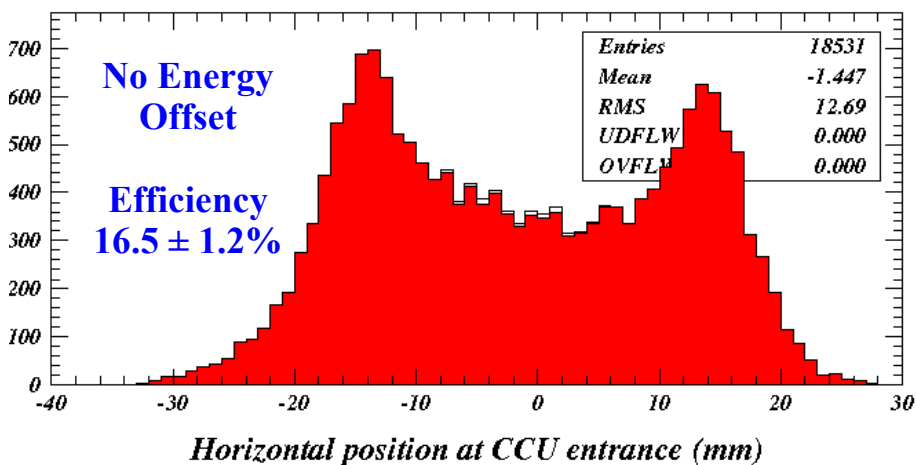
Injected and Accepted Phase Space for Job 2367



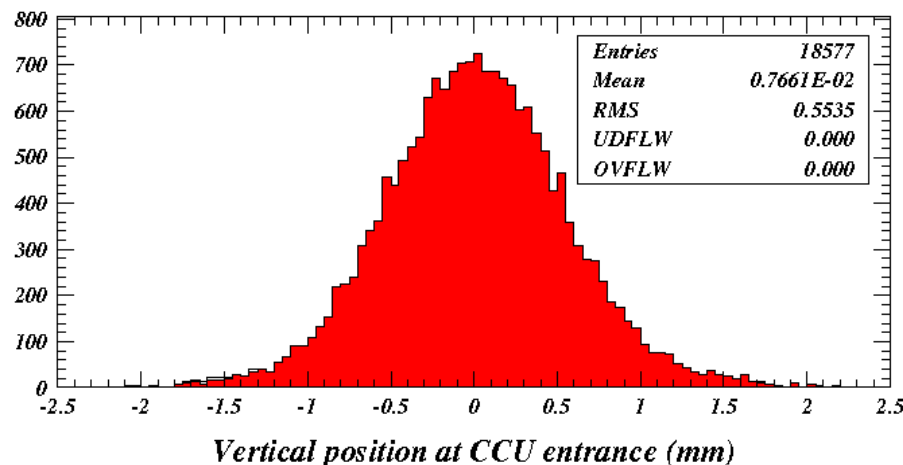
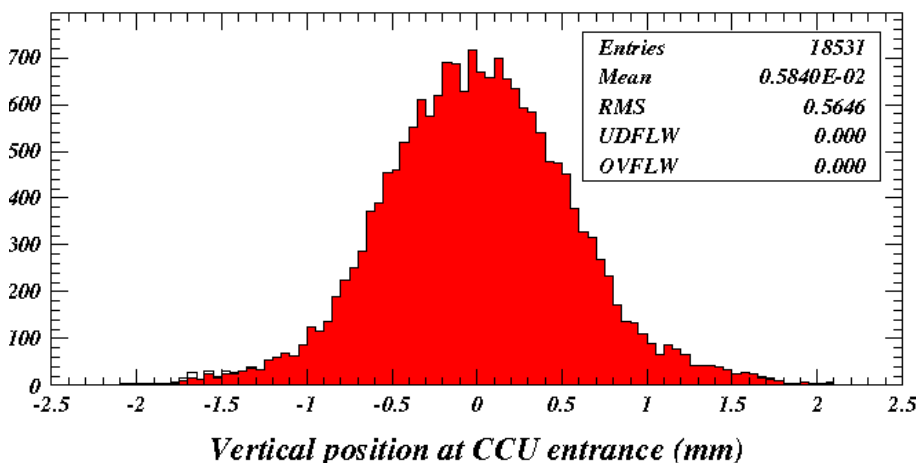
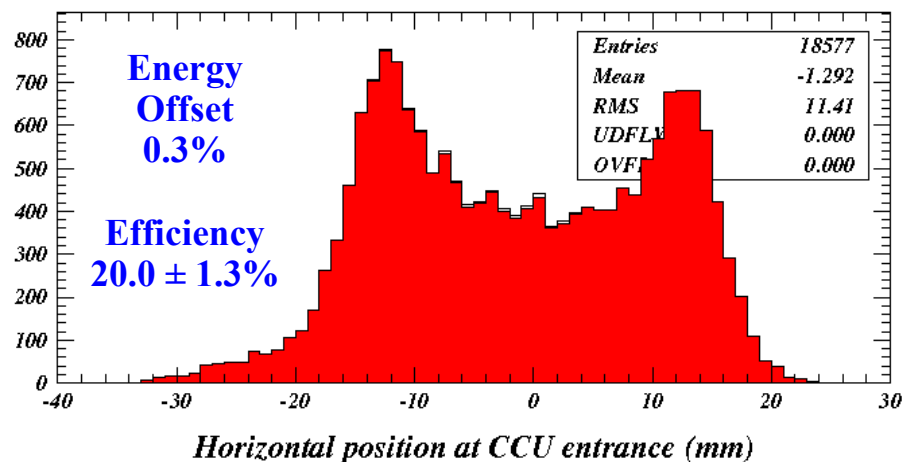


Horizontal and vertical distributions incident on the CCU

Energy Offset 0%: CCU Entrance X and Y (red = survived turn)



Energy Offset -0.3%: CCU Entrance X and Y (red = survived turn)



**Why isn't the horizontal distribution narrower for the off-energy case?
What is the reason for the improved injection efficiency?**