



Update to Turn-by-Turn Electron Injection Trajectories and Efficiencies with Injected-beam Energy Offset

-- Arc pretzel lattice 20150106 --

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

**** BMAD bug in CCU tracking for electrons removed on 21 March 2015 (DCS) ****

Jim Crittenden

CHES Simulation Working Group

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

Incoming and outgoing coordinates for all turns are plotted for CCU2.

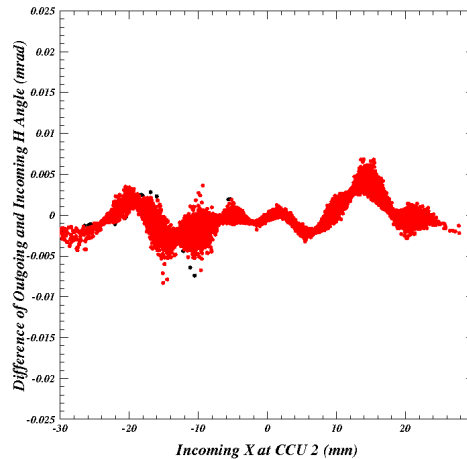
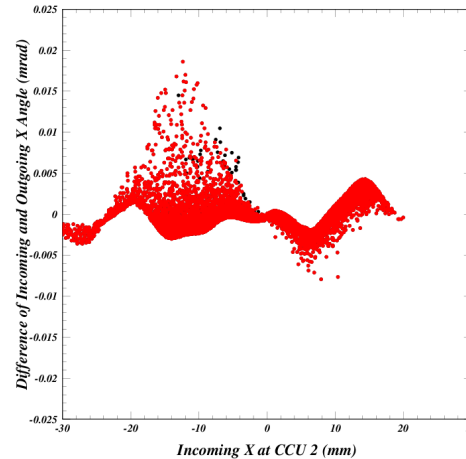
The black points indicate electrons which were lost between the CCU2 entrance and L0.

Before bug fix

After bug fix

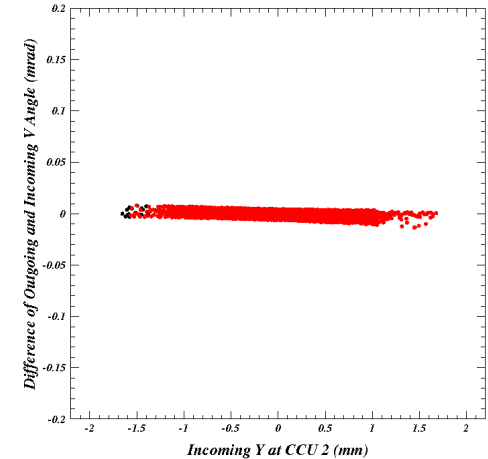
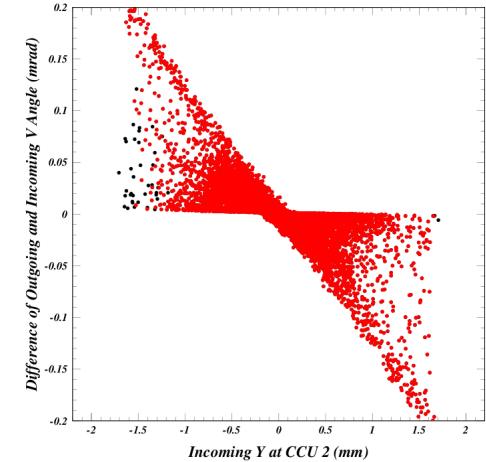
$$\Delta\theta_X(X)$$

Horizontal variation of vertical field integral



$$\Delta\theta_Y(Y)$$

Vertical focusing



The anomalous large kicks are now gone. In particular, the very large vertical kicks were specious.



Modeled efficiency dependence on synchrotron emittances

Turn-by-turn injection simulations (JAC, CHESS 2011)

	<u>H</u>	<u>V</u>
β (m)	20	20
α	0	0
η (m)	1.2	0
η'	0.094	0
ϵ (m-rad)	0.11e-6	0.11e-6

$$\sigma_x = 1.7 \text{ mm}$$

$$\sigma_Y = 1.5 \text{ mm}$$

$$\sigma_{x'} = 0.084 \text{ mrad}$$

$$\sigma_{Y'} = 0.074 \text{ mrad}$$

$$\sigma_Z = 16.1 \text{ mm}$$

$$\sigma_E / E = 6.6\text{e-}4$$

Tune scan injection simulations (SW/ST, 24 June 2008)

	<u>H</u>	<u>V</u>
β (m)	20	20
α	0	0
η (m)	1.2	0
H'	0.094	0
ϵ (m-rad)	0.6e-6	0.086e-6

$$\sigma_x = 3.6 \text{ mm}$$

$$\sigma_Y = 1.3 \text{ mm}$$

$$\sigma_{x'} = 0.18 \text{ mrad}$$

$$\sigma_{Y'} = 0.066 \text{ mrad}$$

$$\sigma_Z = 16.1 \text{ mm}$$

$$\sigma_E / E = 6.6\text{e-}4$$

On-energy 40-turn efficiency

$$46.9 \pm 2.2\%$$

Choose these emittances because
efficiency more similar to observed.

$$26.7 \pm 1.6\%$$



Effect of CCU on 40-turn survival efficiencies

Injection efficiency with
CCU elements on

Injection efficiency with
CCU elements off

No energy offset

$26.7 \pm 1.6\%$

$28.0 \pm 1.6\%$

-0.3%

$22.2 \pm 1.4\%$

$23.8 \pm 1.4\%$

-0.5%

$8.1 \pm 0.6\%$

$5.7 \pm 0.5\%$

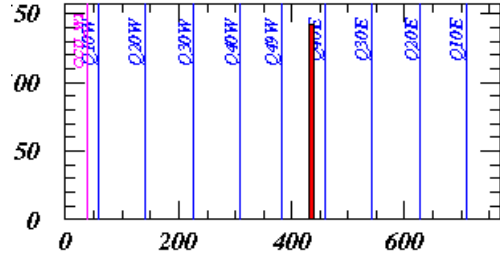
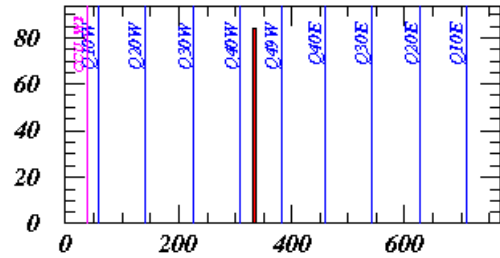
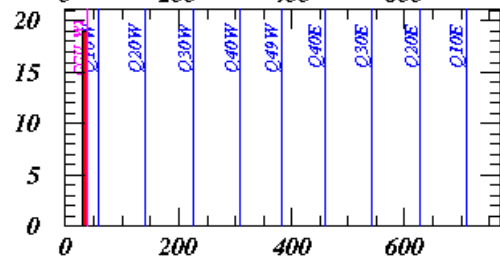
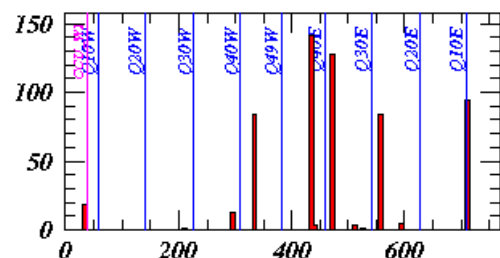
The energy offset does not improve efficiency with these parameters.

The effect of the CCU elements is small.

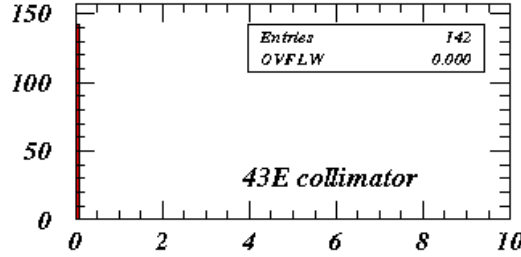
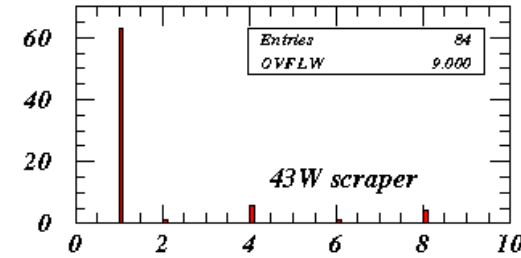
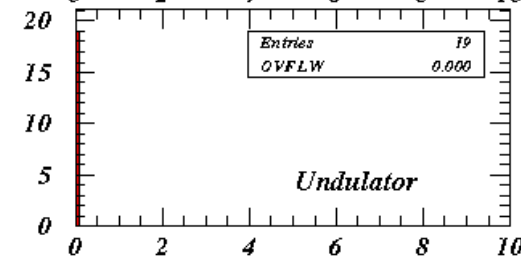
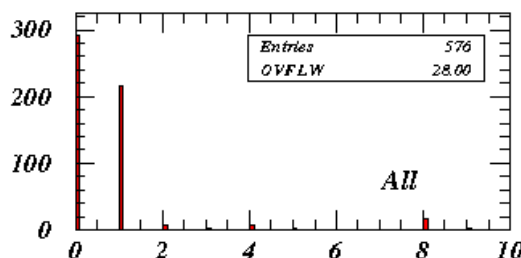


Turn-by-turn critical apertures for electron injection

Energy Offset 0%



S Position Where Lost (m)



Turn When Lost

The losses occur predominantly during the first two turns.

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

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

About 40% of the losses are at the 43W scraper or the 43E collimator.

About 50% of the losses are at the horizontal apertures at Q10E, Q28E and Q38E.

The losses at the undulator occur on the injection turn.

50% of the injection-turn losses occur at the 43E collimator, the other half at Q38E.