

Study description

This is a summary of measurements of beam transmission vs beam intensity vs quad current in the Booster. The location and width of traversed resonances (dip in transmission) is extracted and plotted vs beam intensity. Space charge effects should change the location of the dip. Since these effects depress the beam tune, a higher quad strength should be required to drive the same resonance (see FNAL EXP-67, September 1974, for a similar measurement done with the Main Ring). A preliminary analysis indicates a tune shift $\Delta \nu_x$ on the order of 0.04 between 1 and 9 turns of injected beam in the Booster.

Data set description

The data were collected on the 30th of January. The Booster was running DC, the beam was captured at ~38 MHz with 4 RF stations on.

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We measured [transmission](#) (CHG1, CHG2) vs QL and QS settings for different beam current (number of injected turns) in the machine.

The tune was measured and the program calibrated (tune vs QL and QS) for 1 injected turn.

Data header (1 turn dataset, tune vs current calibration point)

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Reset      $17
Snap flag
Min E12    0.100000
Max Qx     0.250900
Min Qx     -0.249100
Num Qx     20
Max Qy     0.187600
Min Qy     -0.312400
Num Qy     20
Qx0        0.749100
Qy0        0.812400
dIQL       -0.100000
dQxdIQL    -0.010000
  
```

$$\begin{aligned}
 dQ_y dI_{QL} & 0.024900 \\
 dI_{QS} & -0.100000 \\
 dQ_x dI_{QS} & -0.043200 \\
 dQ_y dI_{QS} & 0.006600
 \end{aligned}$$

We recorded: dQx, dQy, dIQS, dIQL, pdcs, chg1, chg2, for 20×20 Qs, QL current values.

Results: tune shift vs injected beam current from y half-integer resonance

Calculating the relationship between measured tune difference (dQ) and the space-charge tune shift (ΔQ_{sc}):

$$Q = Q_0 + \Delta Q_{sc} + \Delta Q_{quad}$$

$$\Delta Q_{quad} = \frac{dQ}{dI} (\Delta I_{quad})$$

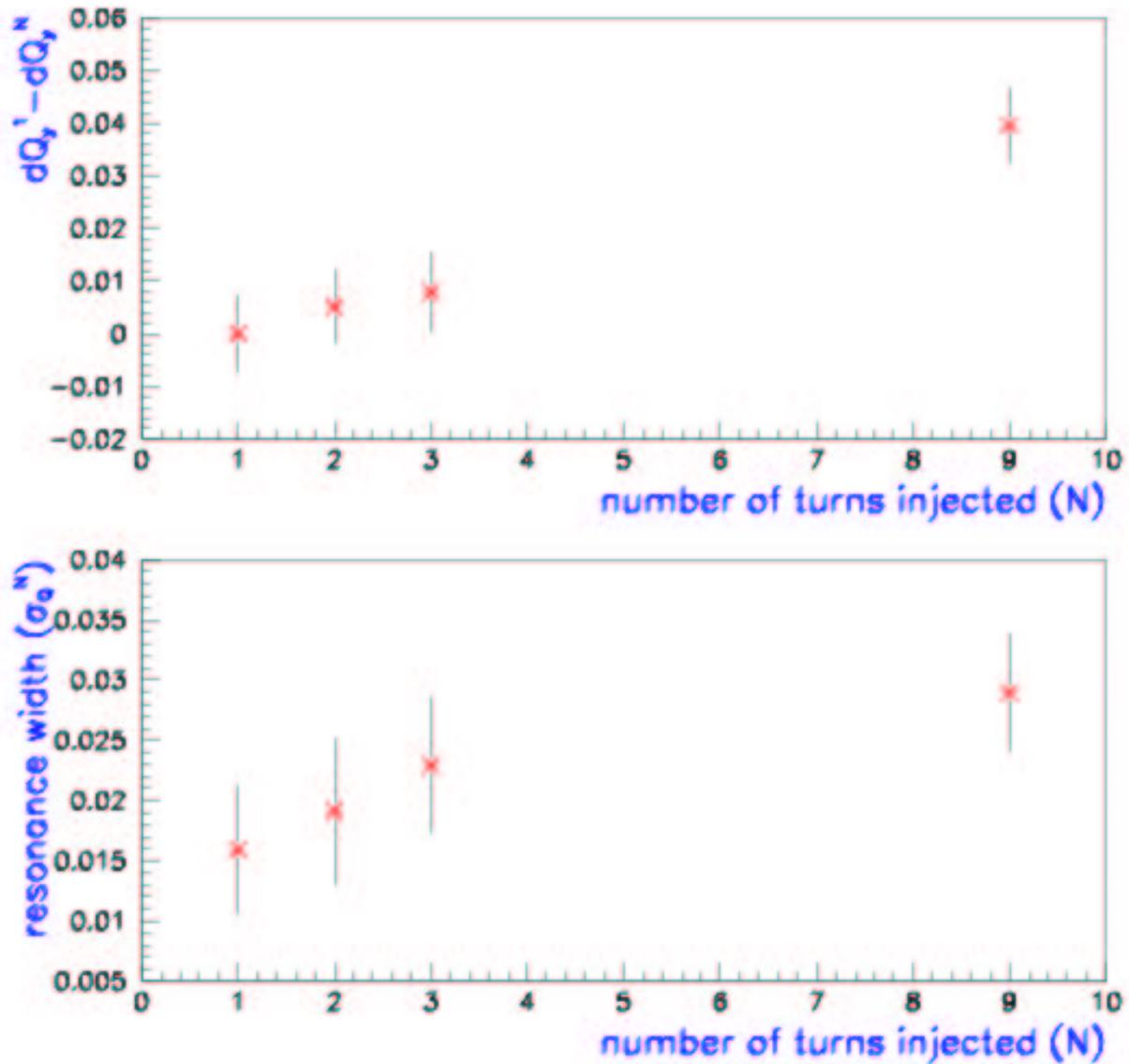
$$A : \frac{1}{2} = Q_0 + \Delta Q_{sc}^1 + \frac{dQ}{dI} (\Delta I_Q^1)$$

$$B : \frac{1}{2} = Q_0 + \Delta Q_{sc}^N + \frac{dQ}{dI} (\Delta I_Q^N)$$

$$B - A : 0 = \Delta Q_{sc}^N - \Delta Q_{sc}^1 + \frac{dQ}{dI} (\Delta I_Q^N - \Delta I_Q^1)$$

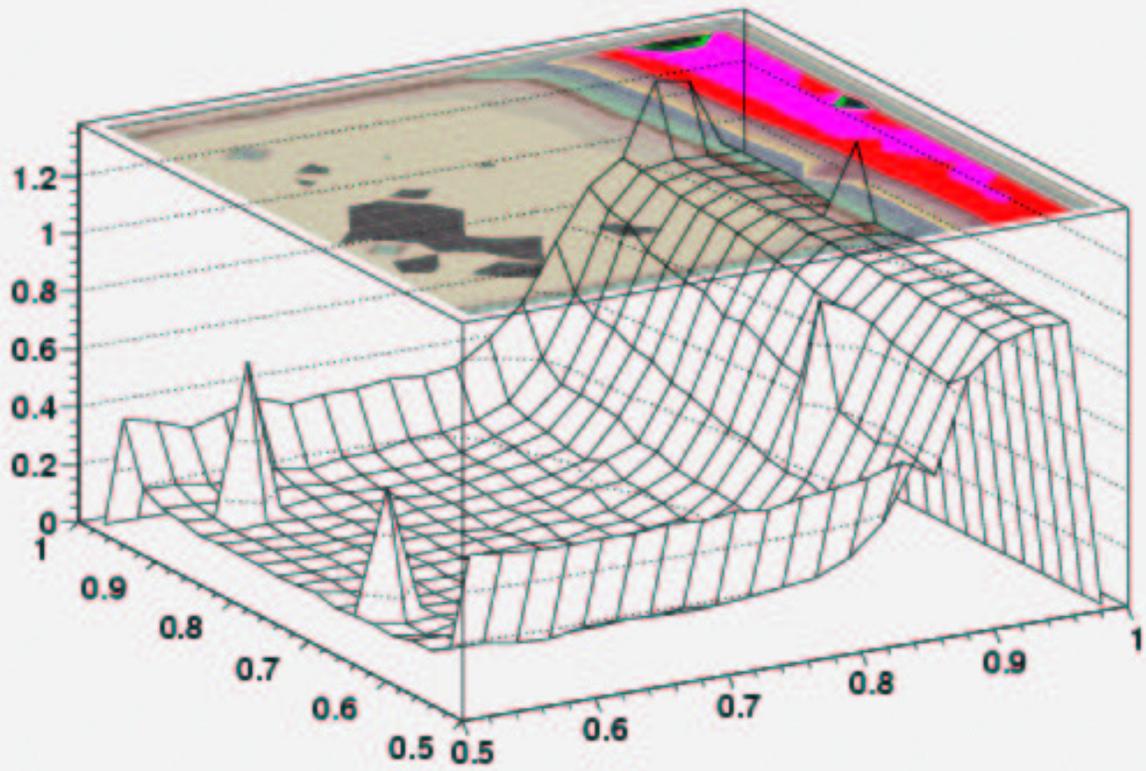
$$\Delta Q_{sc}^N - \Delta Q_{sc}^1 = \frac{dQ}{dI} (\Delta I_Q^1 - \Delta I_Q^N)$$

$$\Delta Q_{sc}^N - \Delta Q_{sc}^1 = dQ_{(x/y)}^1 - dQ_{(x/y)}^N$$

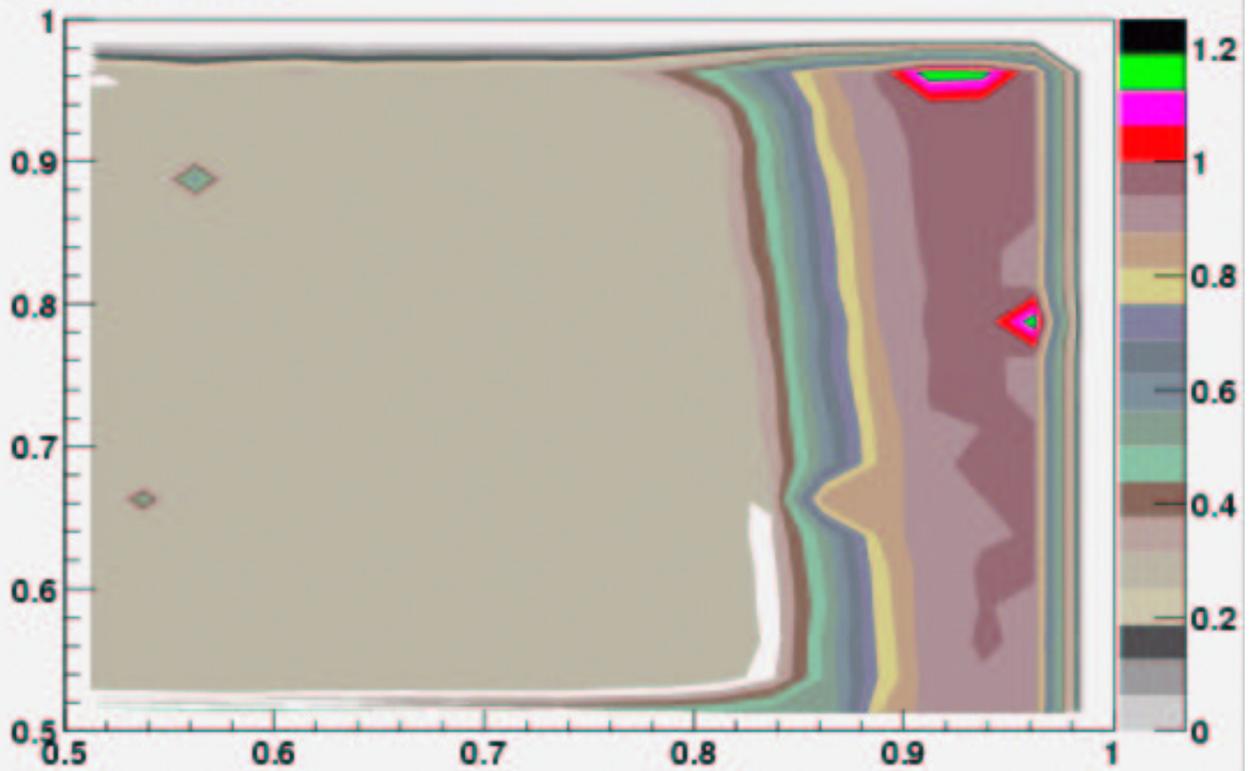


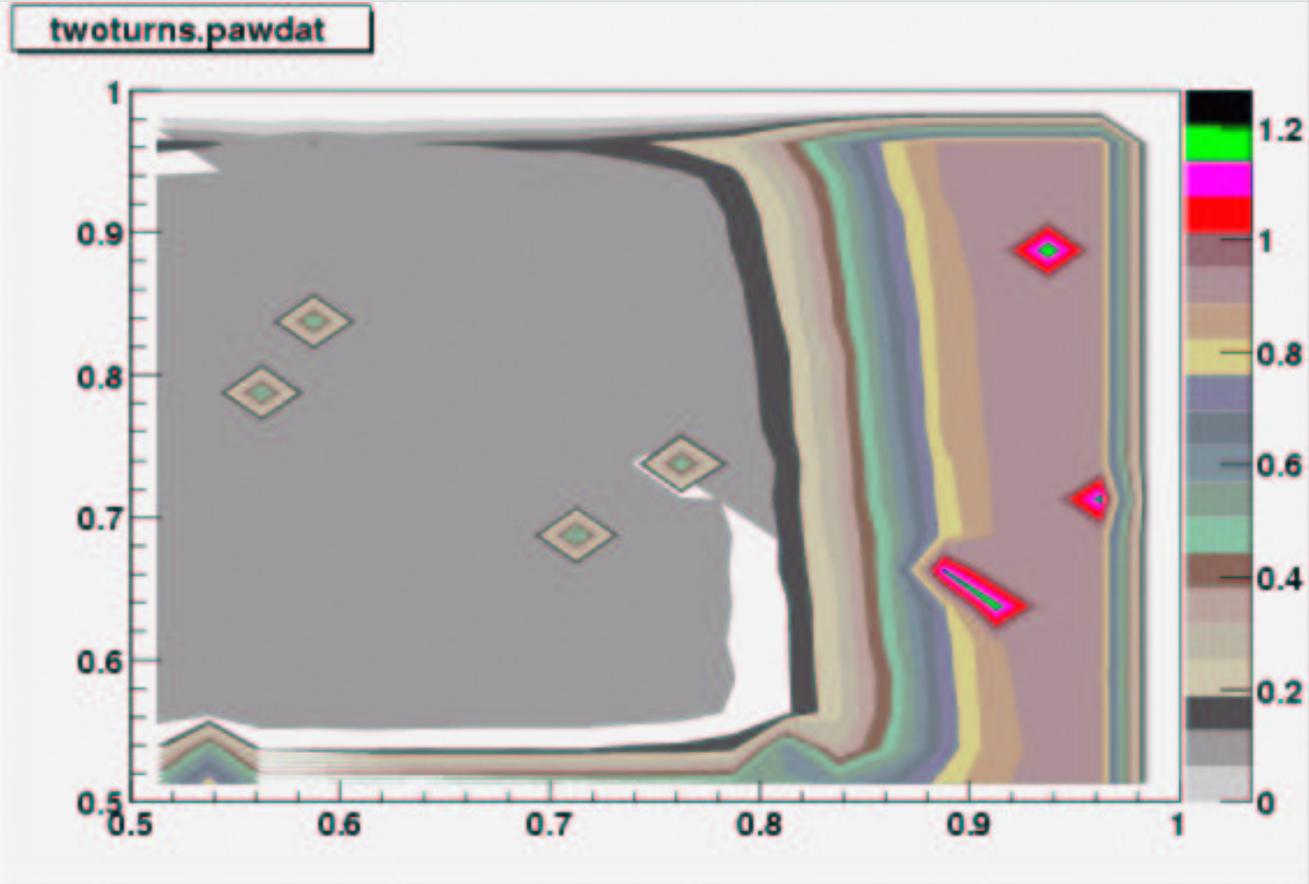
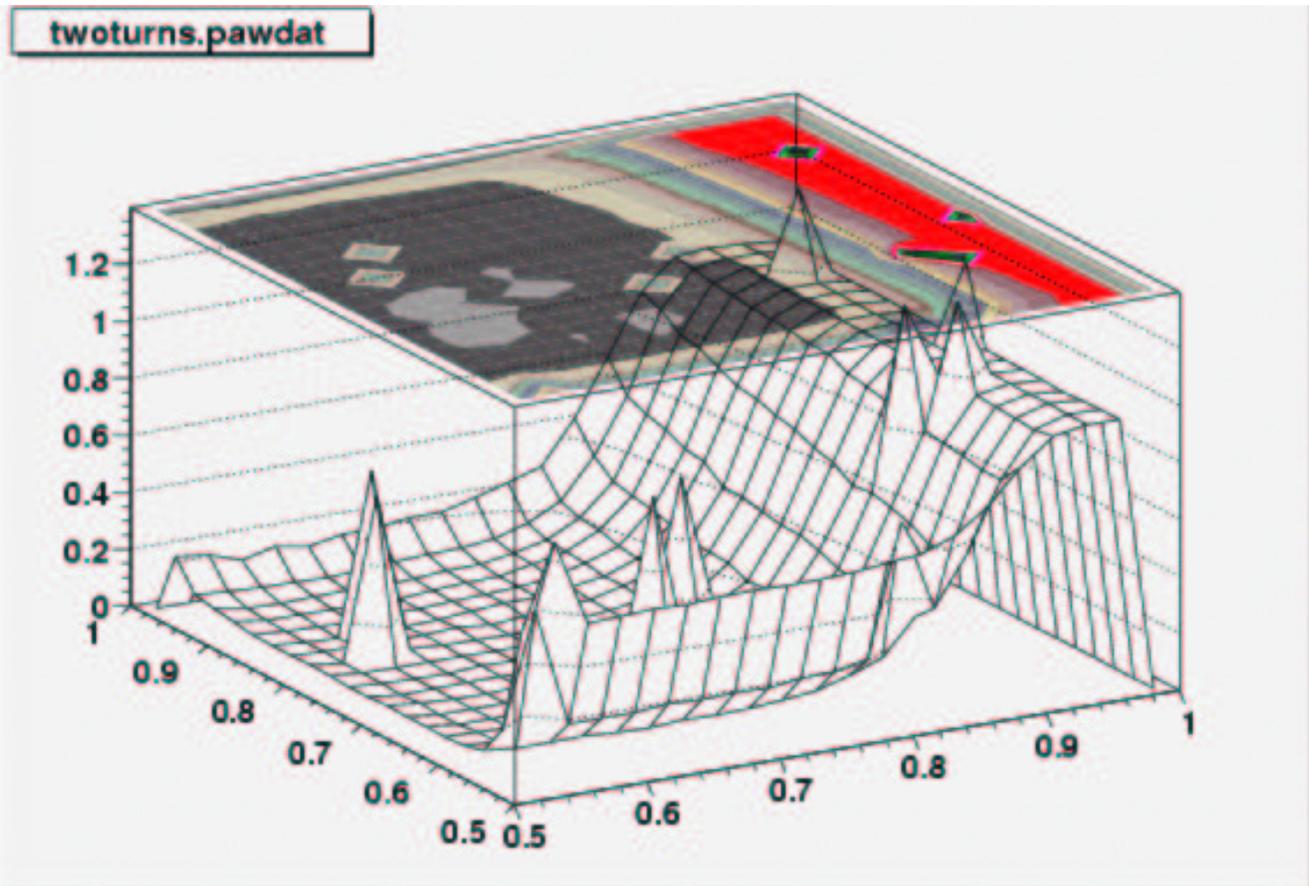
Surface and Contour plots of absorption (1-chg1/pdcs) vs tune

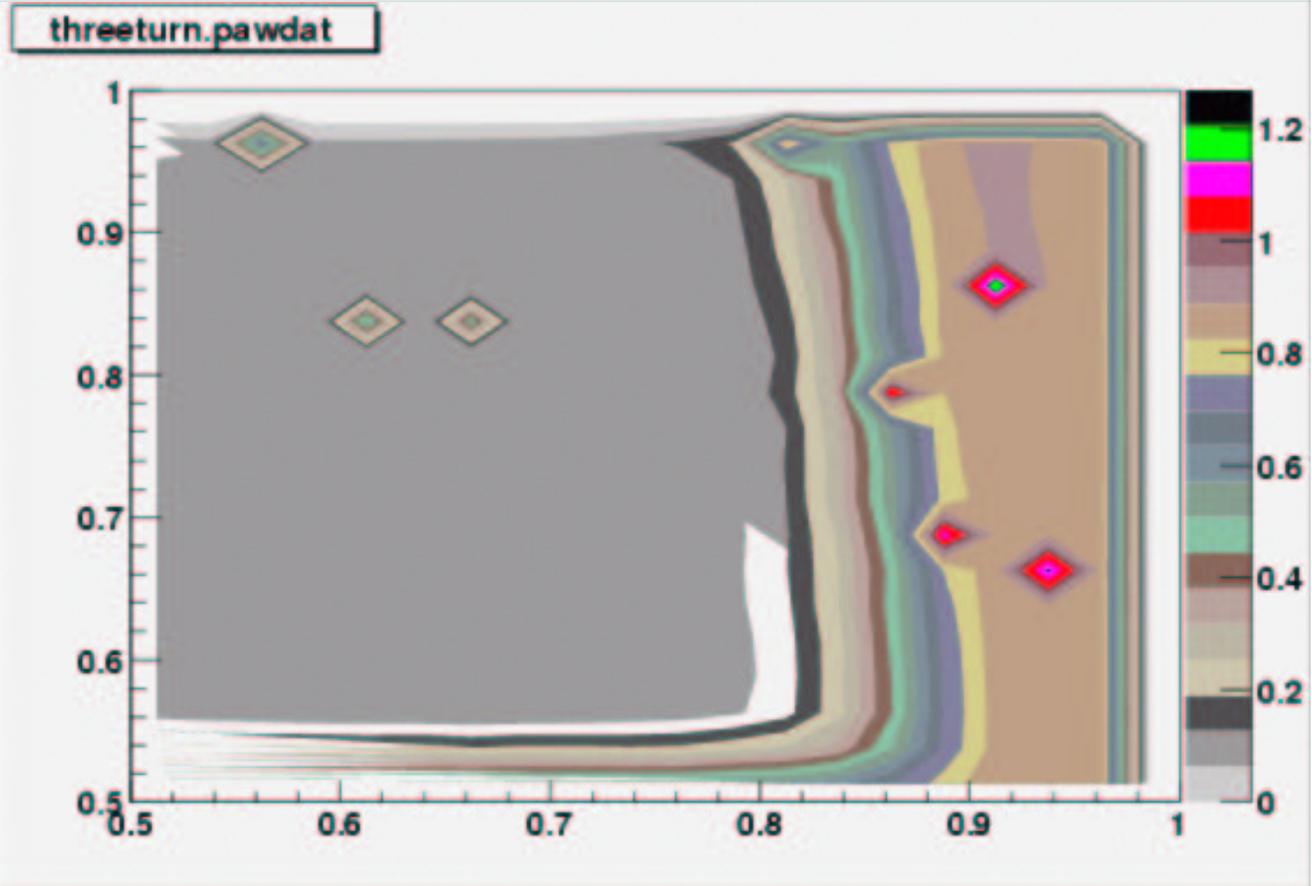
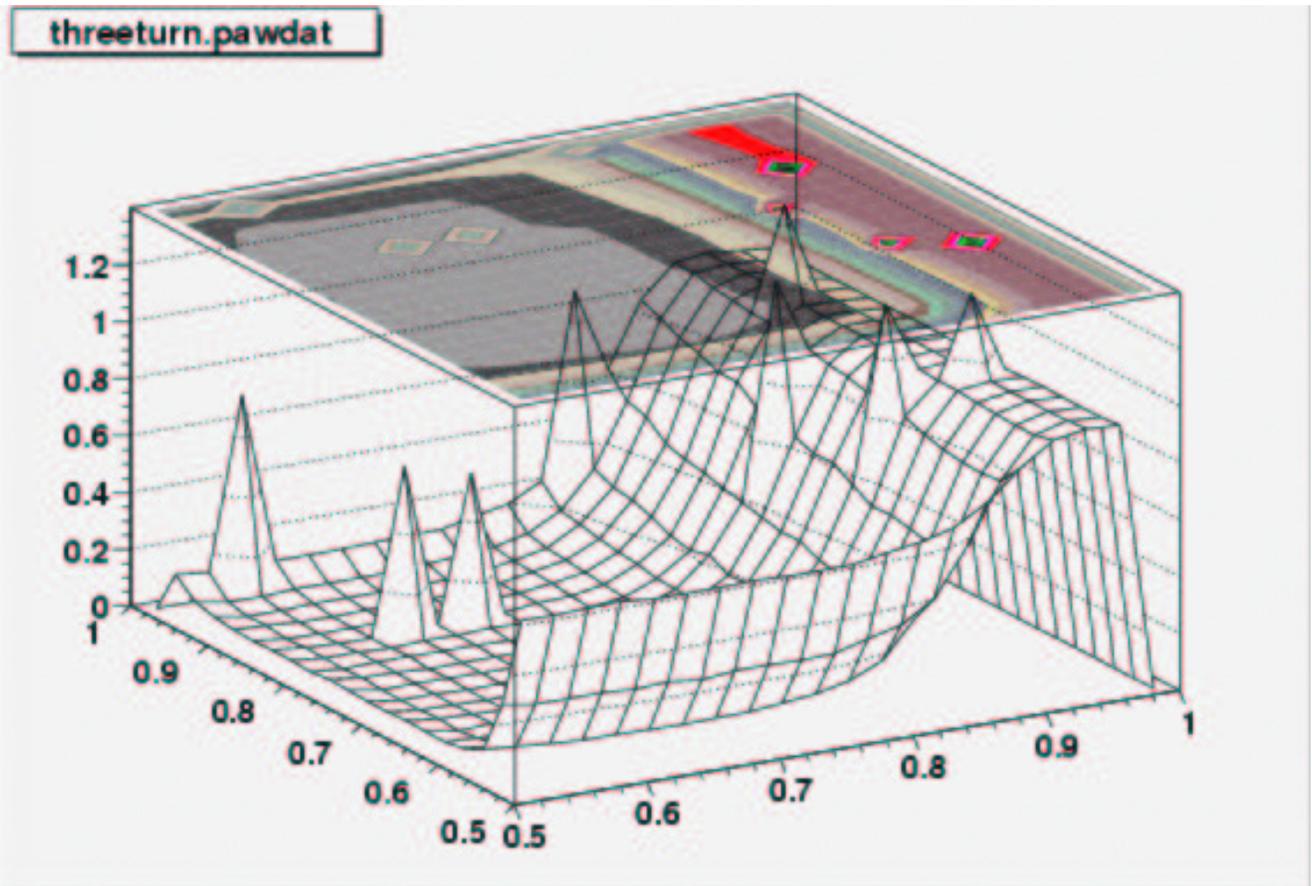
firstturn.pawdat



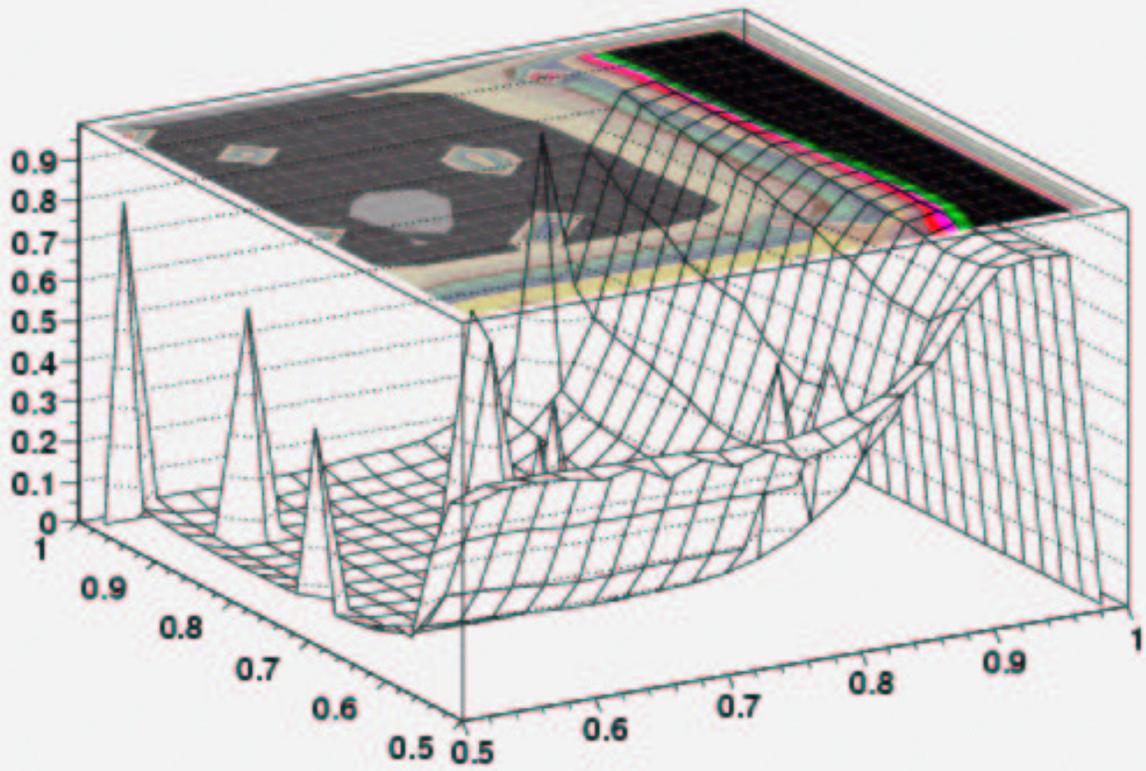
firstturn.pawdat



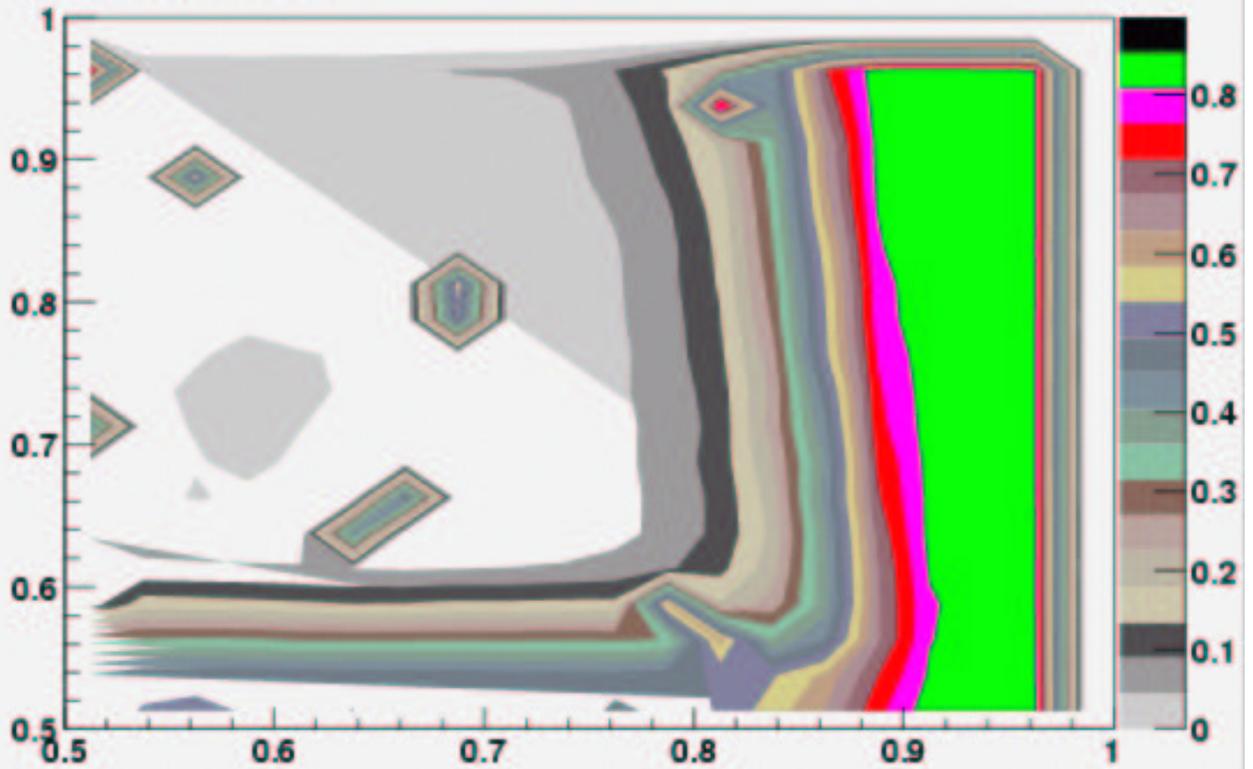




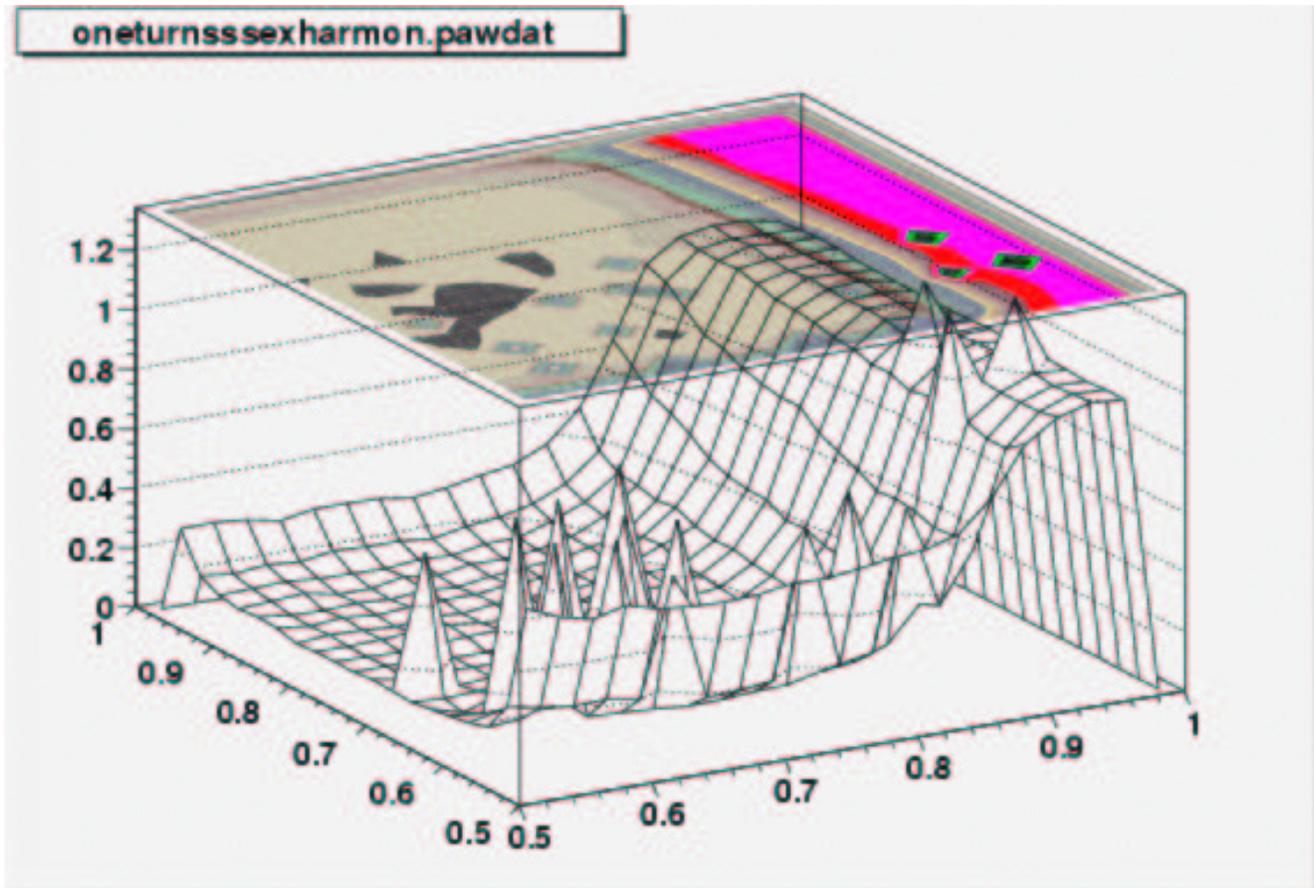
nineturns.pawdat

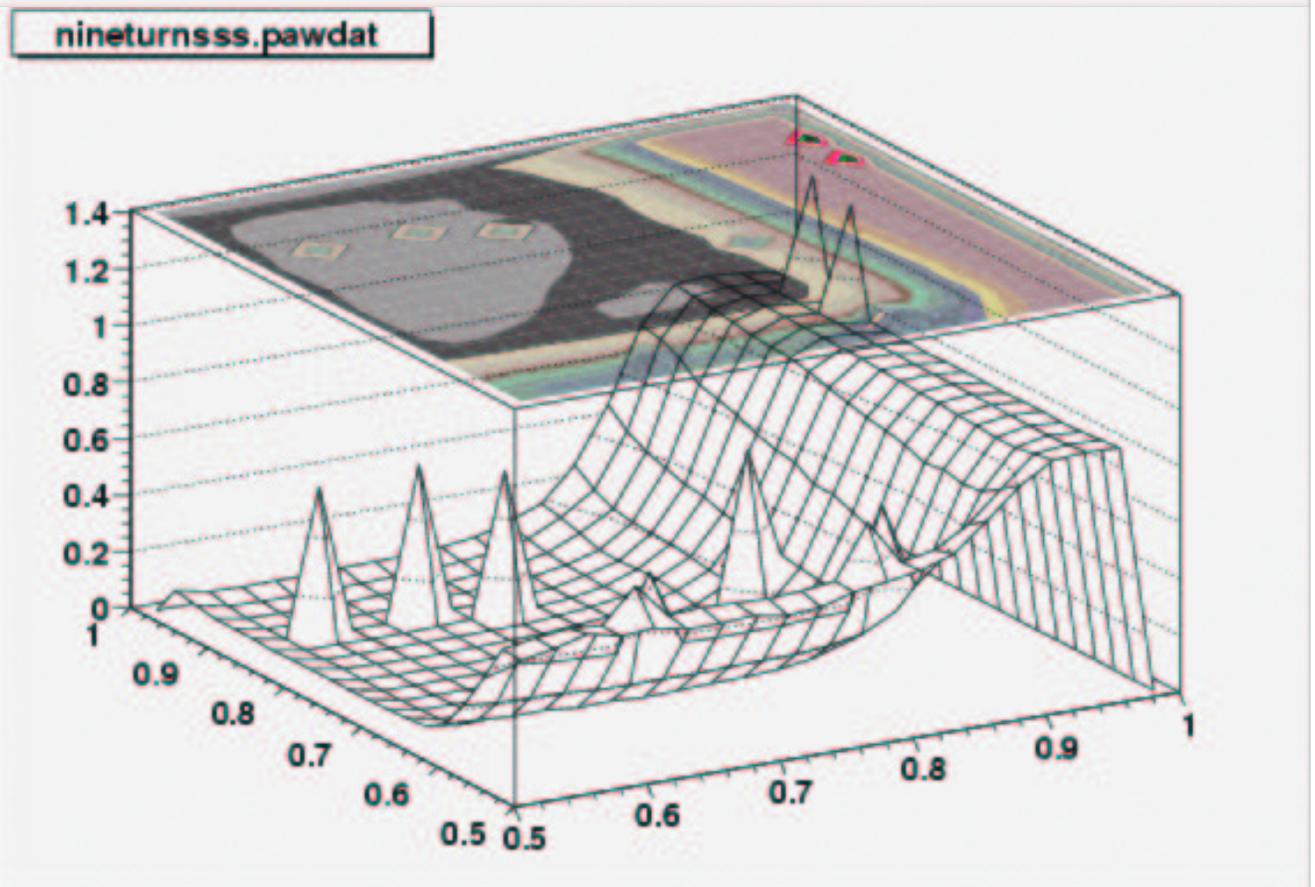
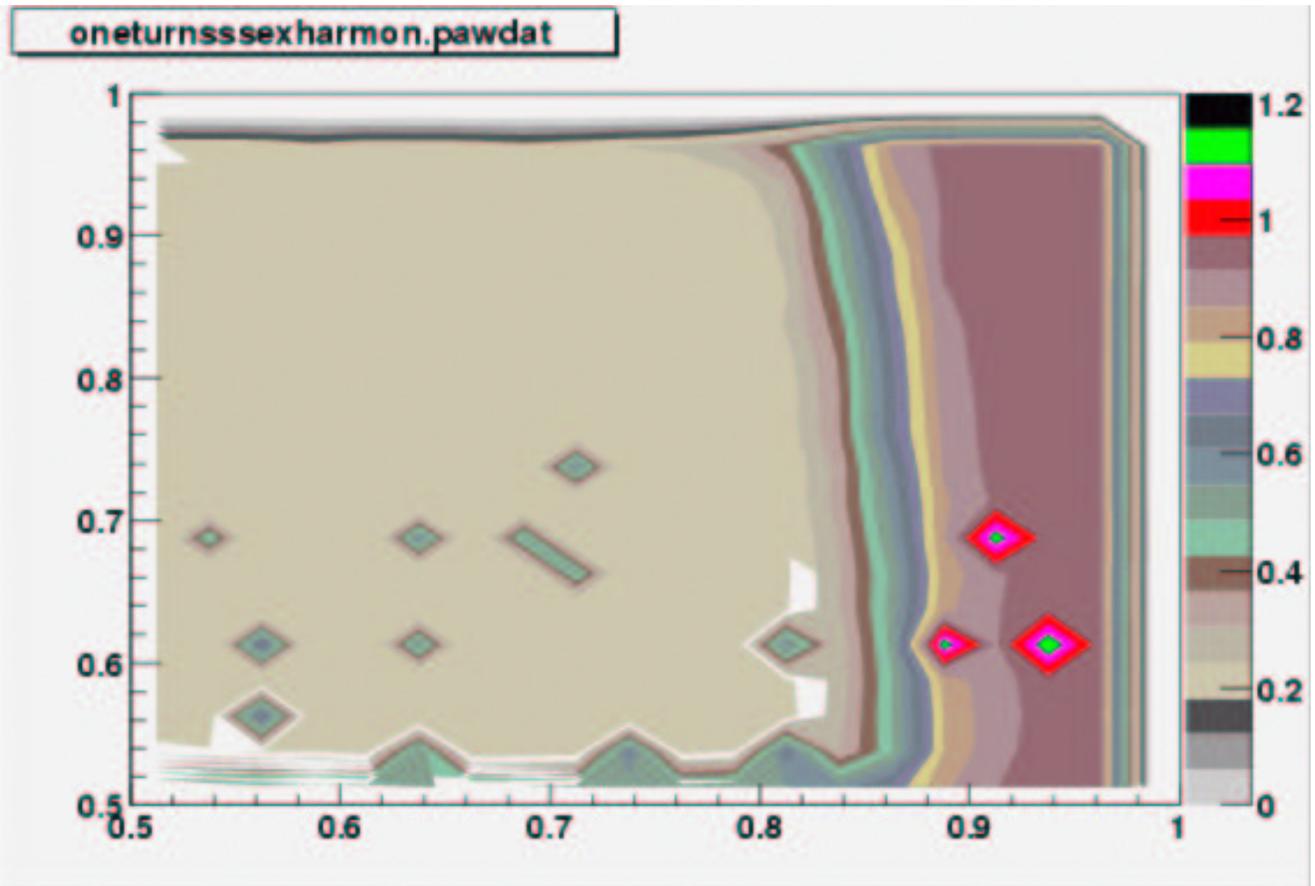


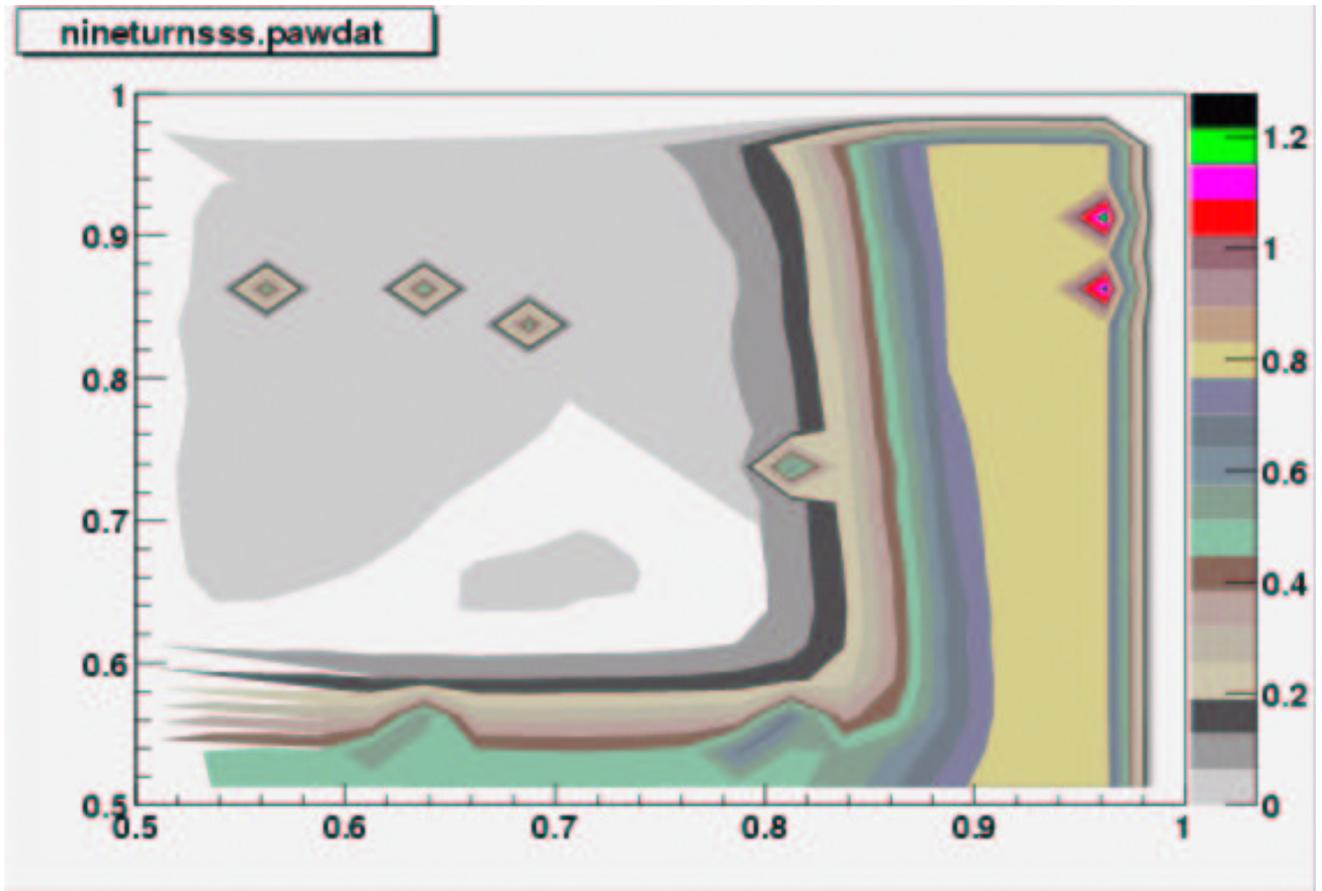
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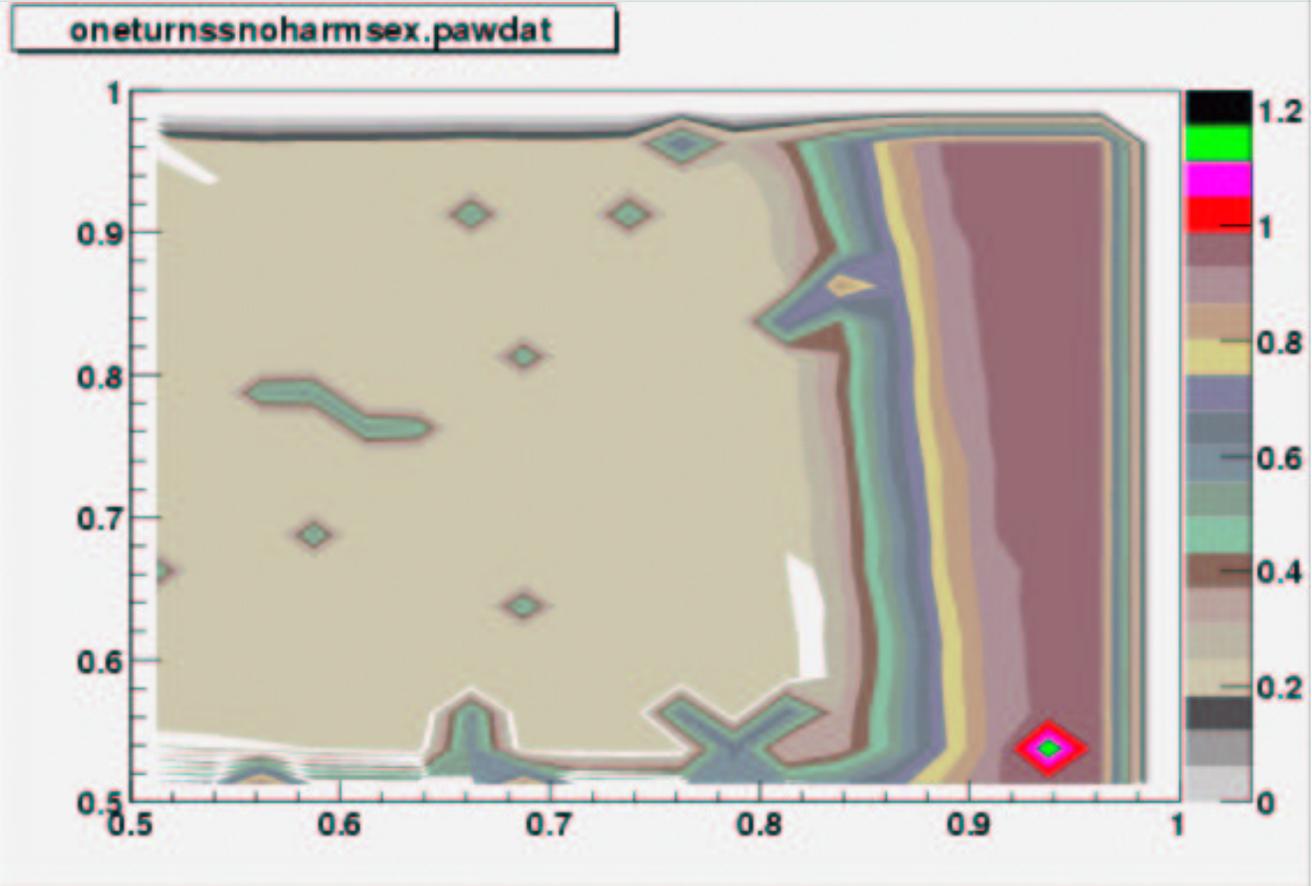
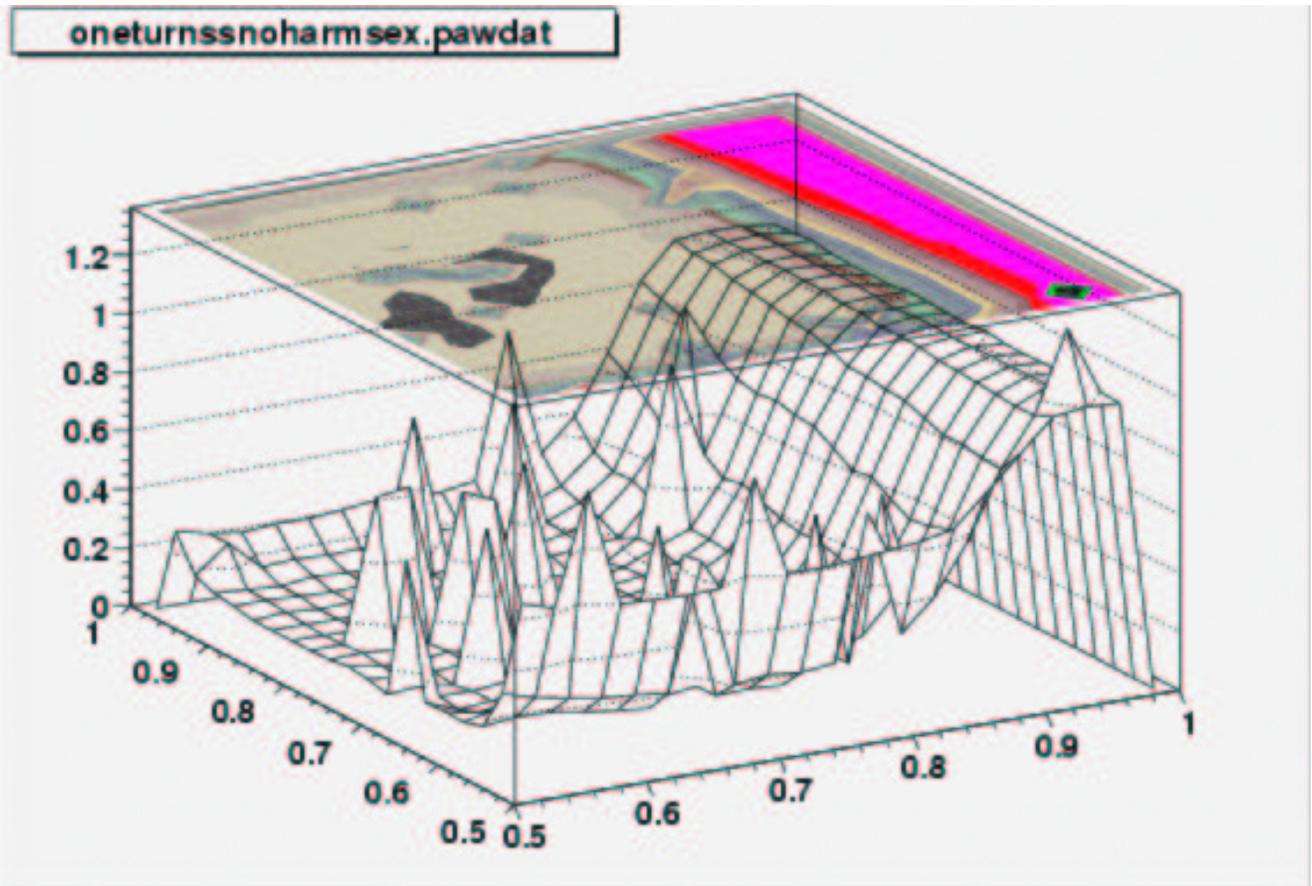
One, two, three, and nine turns in the machine. The plots show **absorption vs tune**, where the tune is calculated using the one turn calibration. The integer and half integer tunes appear to move and broaden, because the $IQL=IQS=0$ tune shifts from its one turn injected (calibration) value.



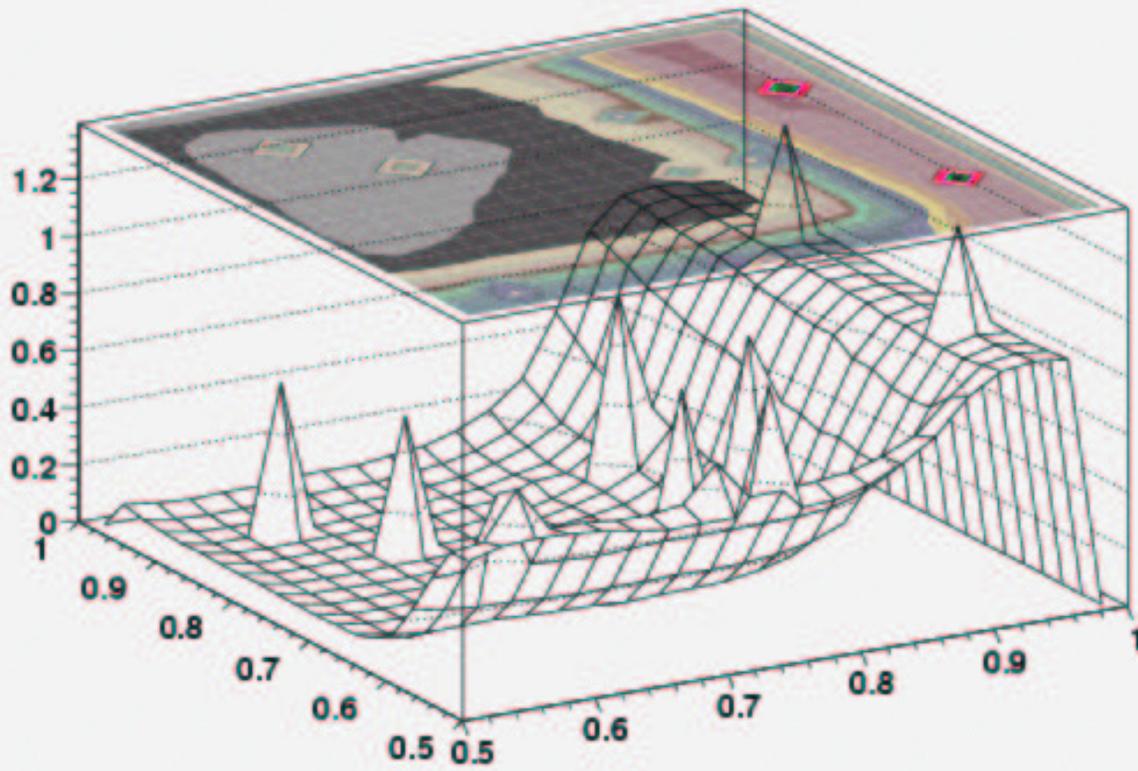




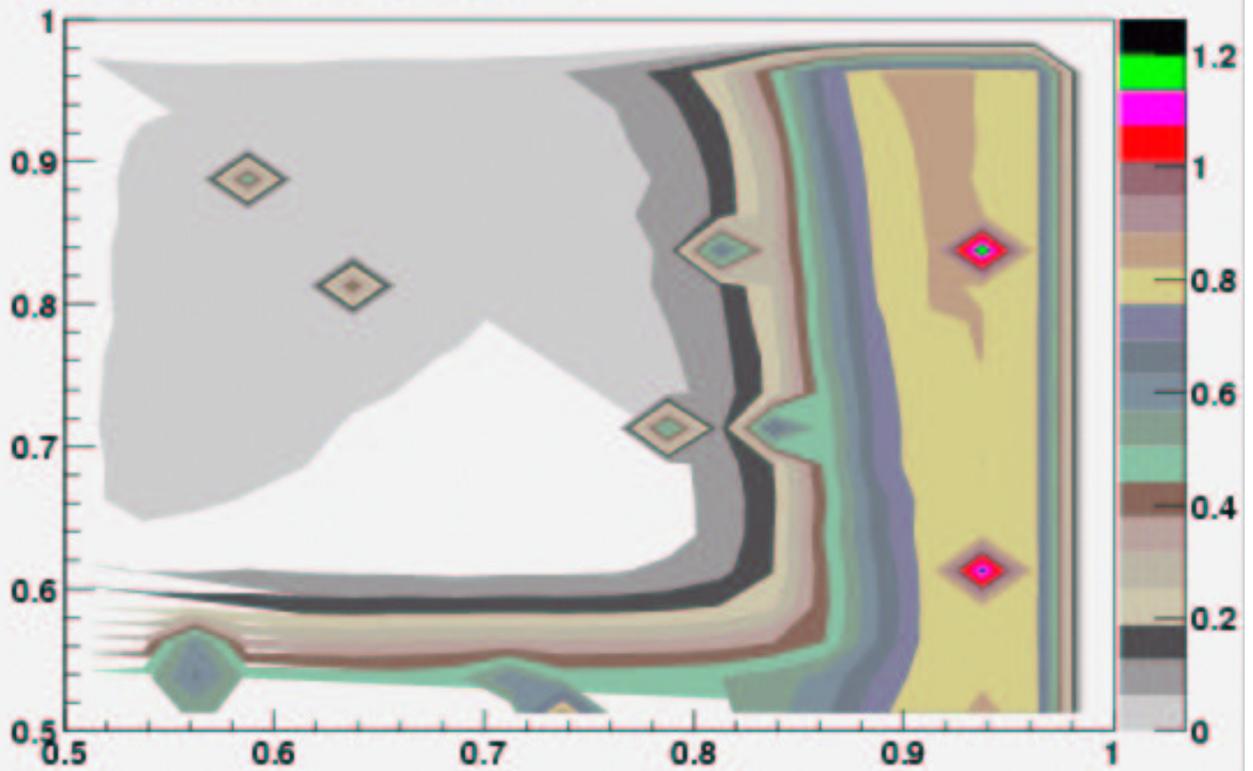
One and nine turns with SS at 0.044 amps



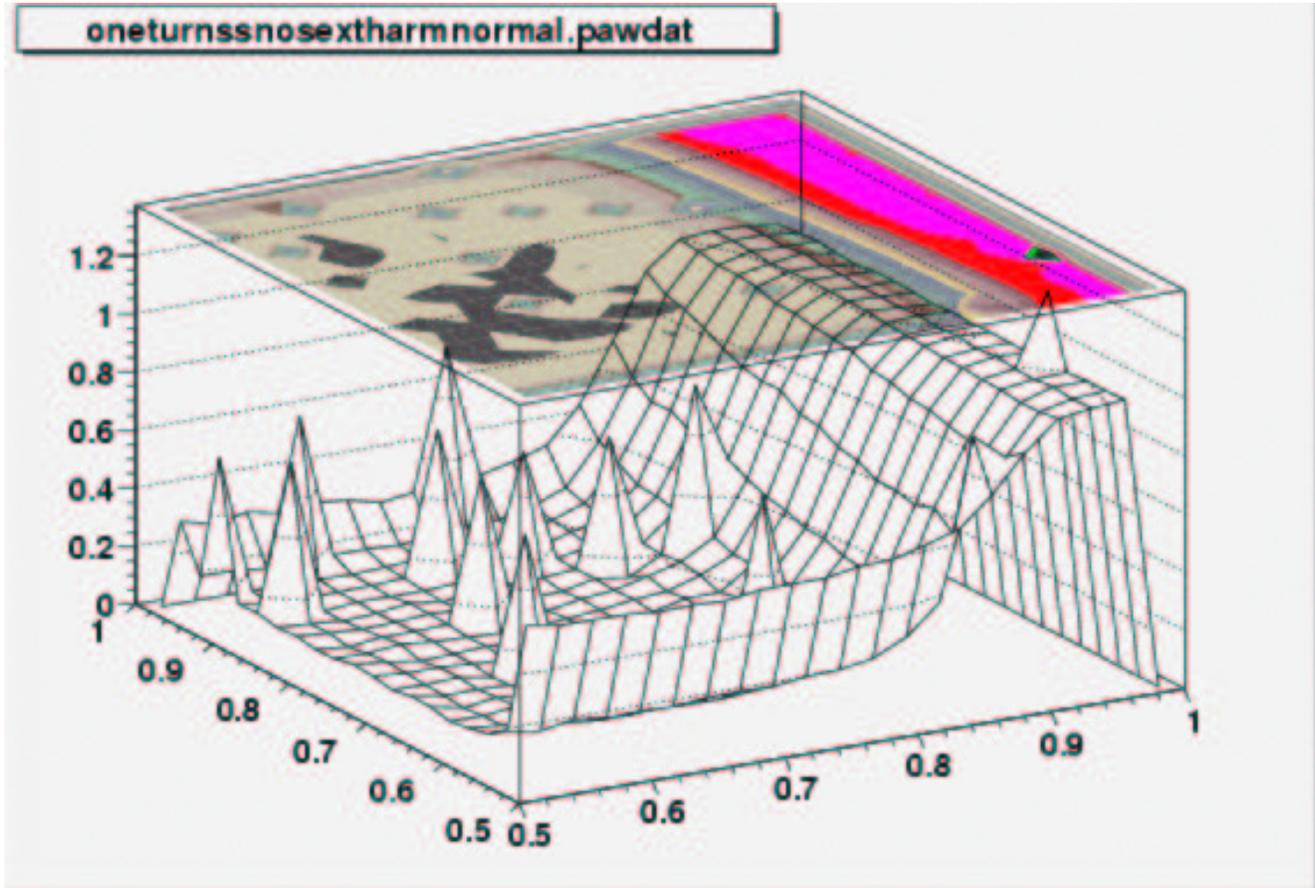
nineturnssnoharmsex.pawdat

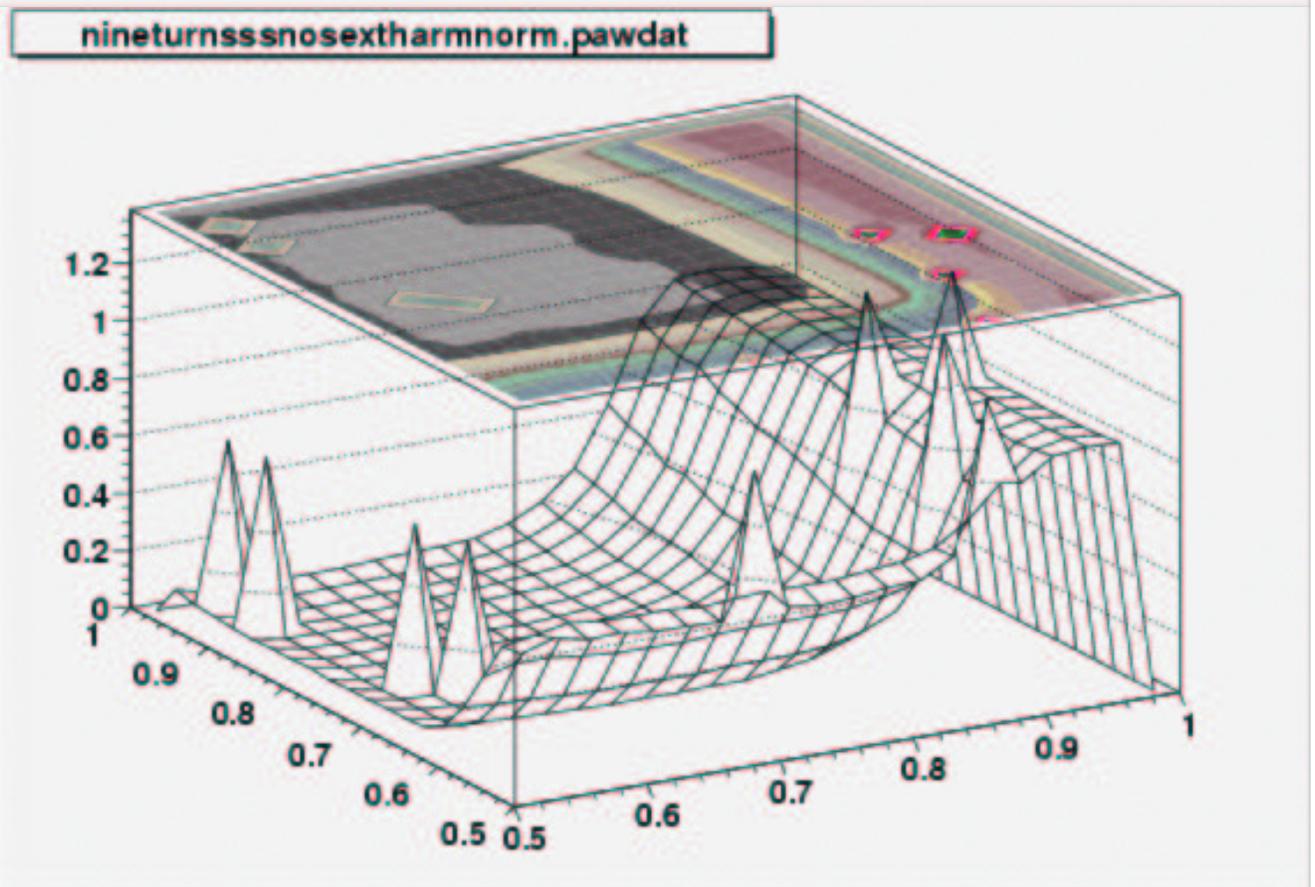
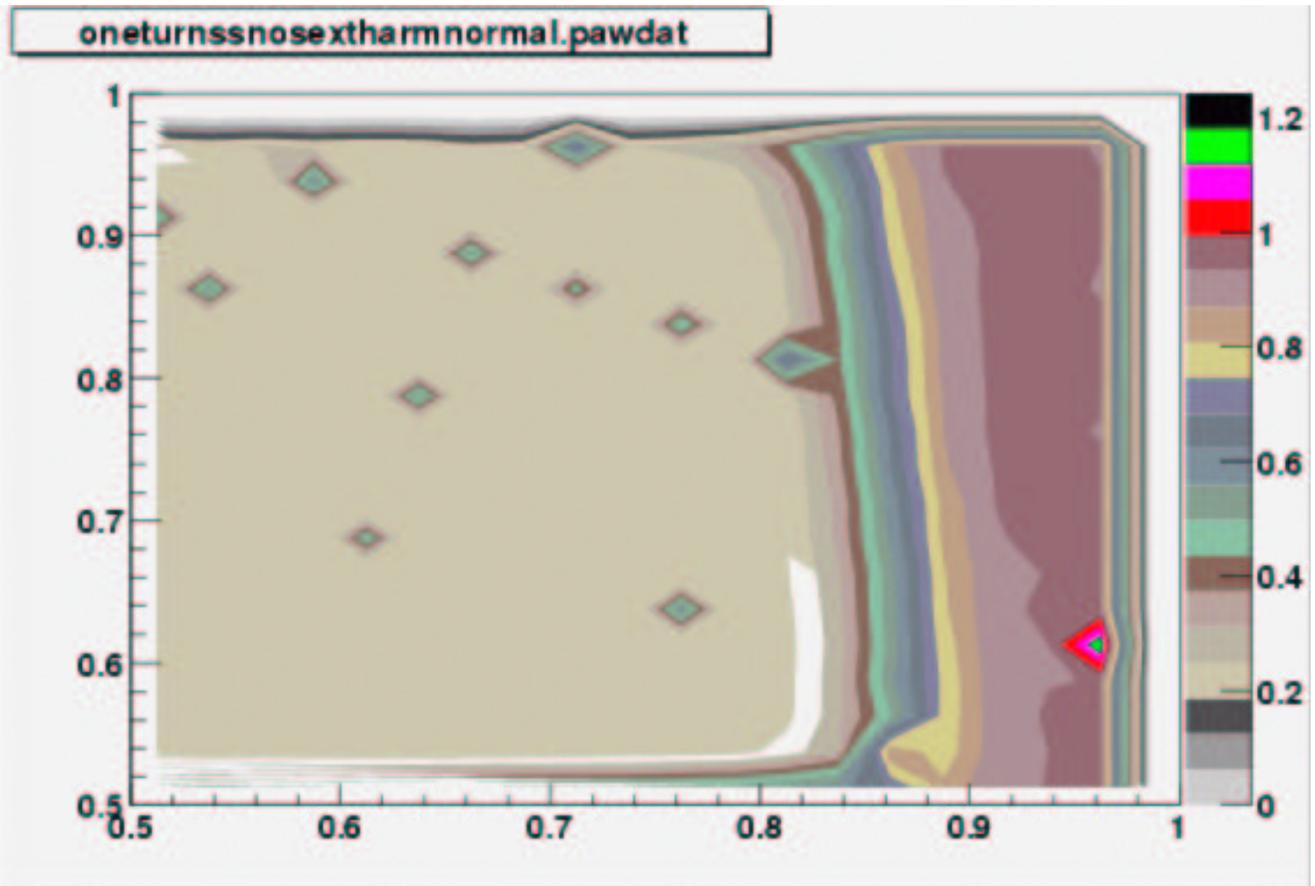


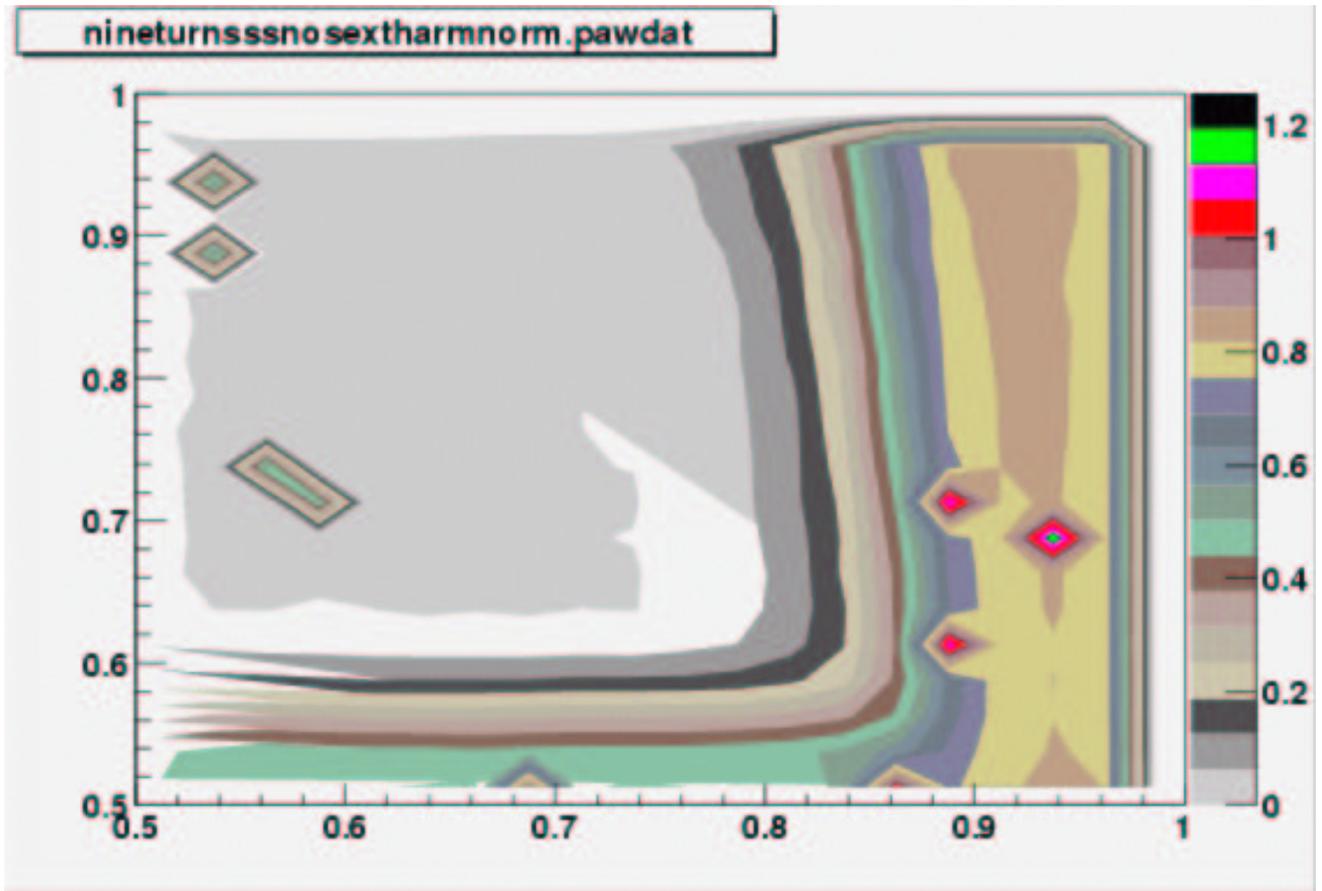
nineturnssnoharmsex.pawdat



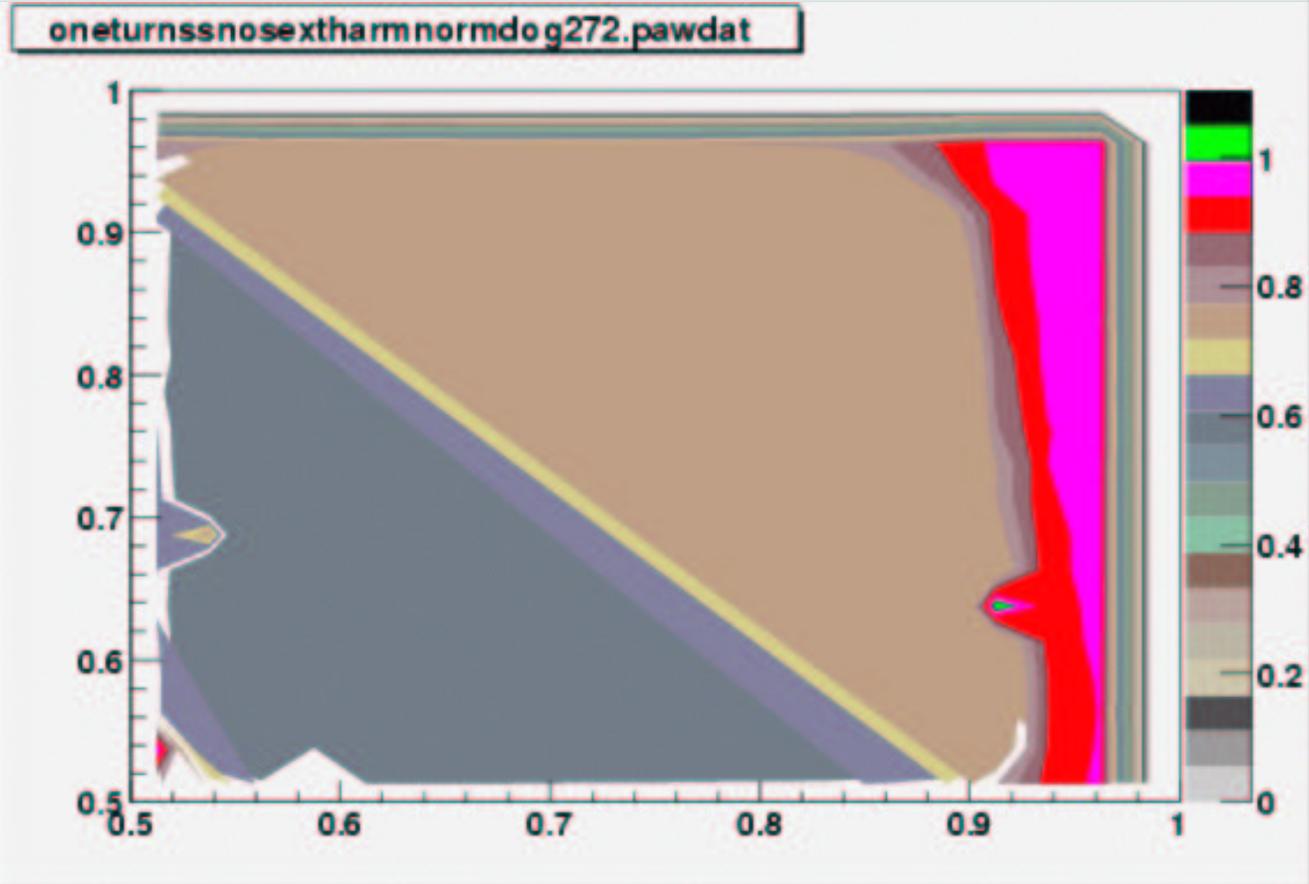
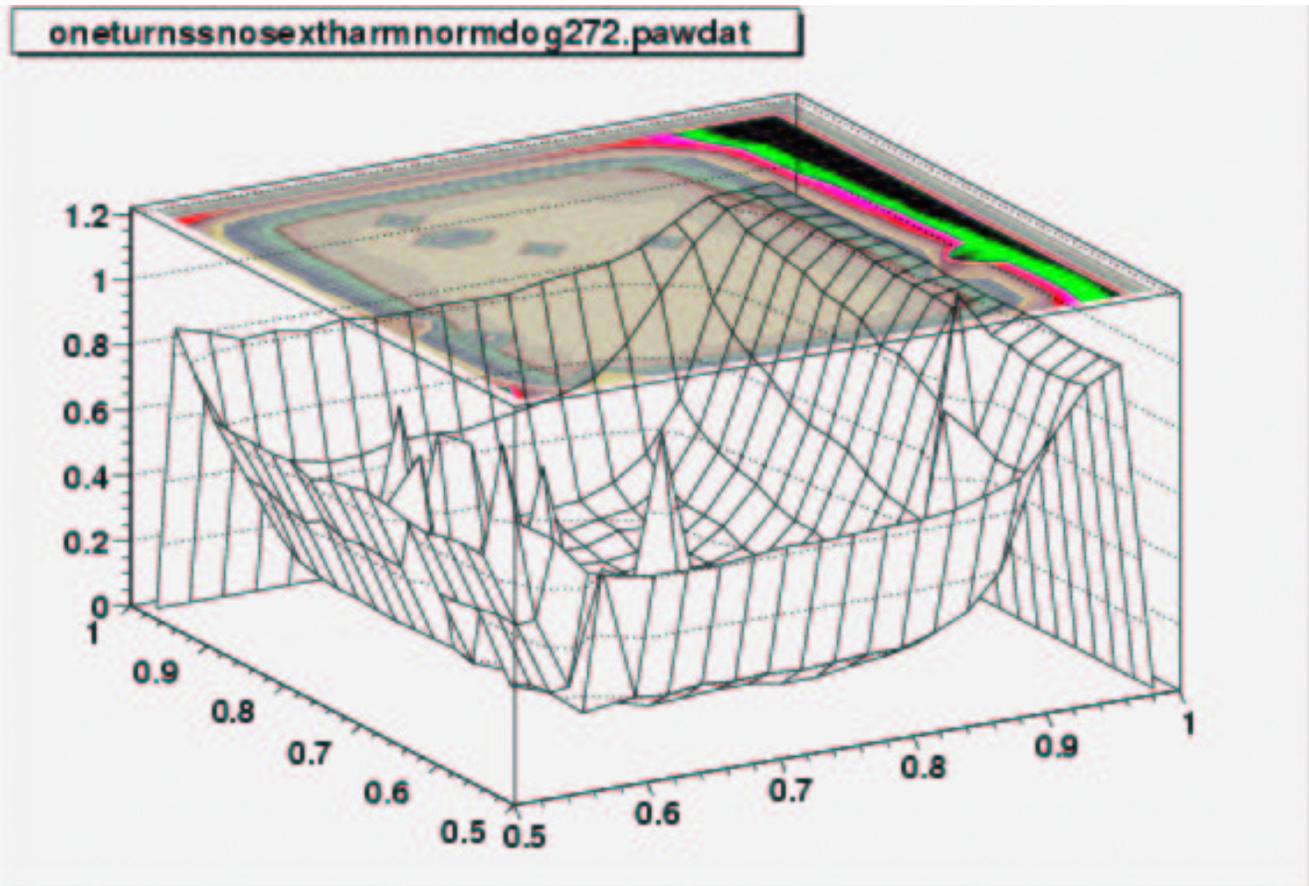
One and nine turns with SS as above, no harmonic sextupoles







One and nine turns as above with additional condition normal sextupols off



As above, dog leg -300 amps.

Last updated 2/06/03 by [P. Spentzouris](#)