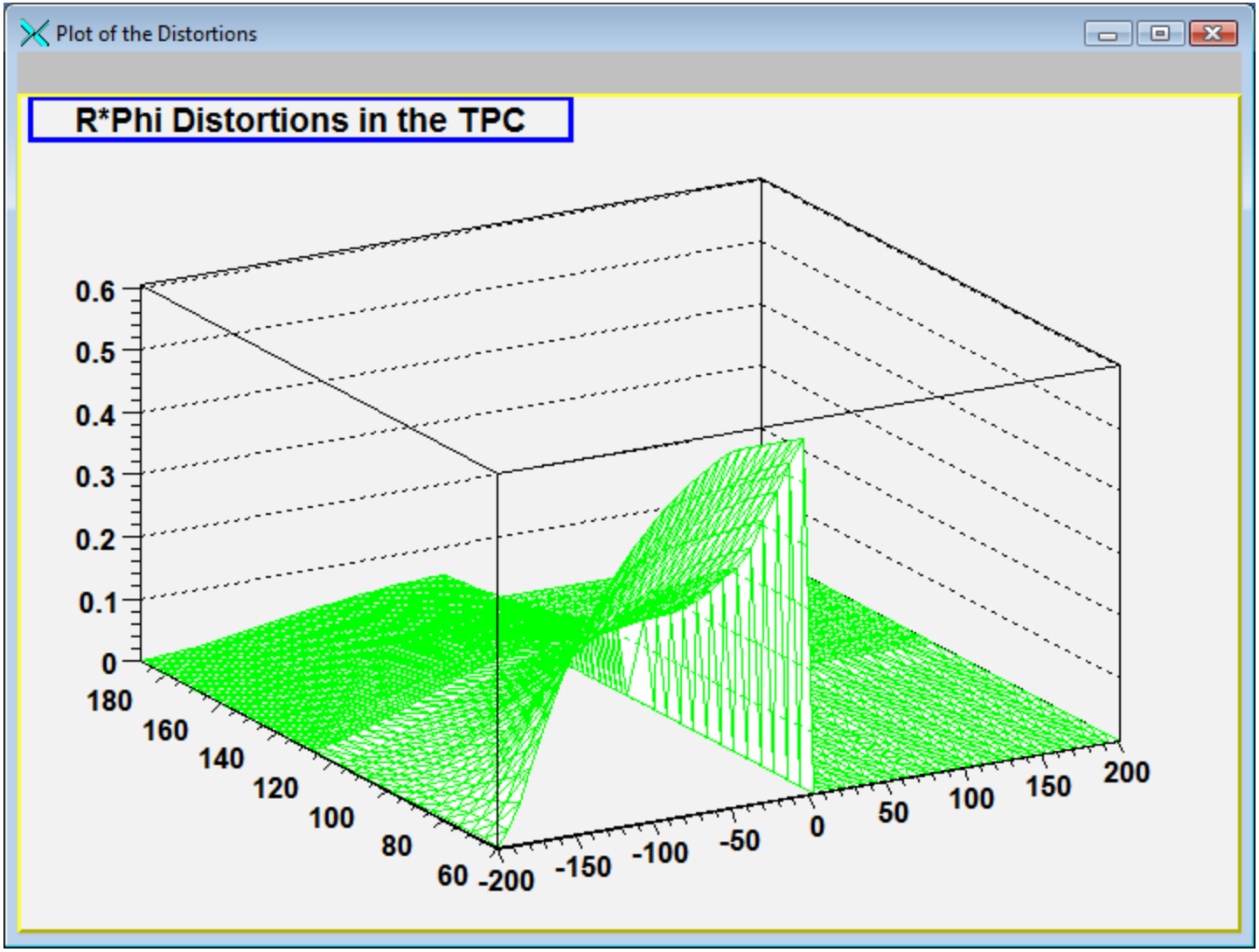
A Quick Look at Some Systematic Errors in the TPC

By

Jim Thomas

Shorted Ring Distortion



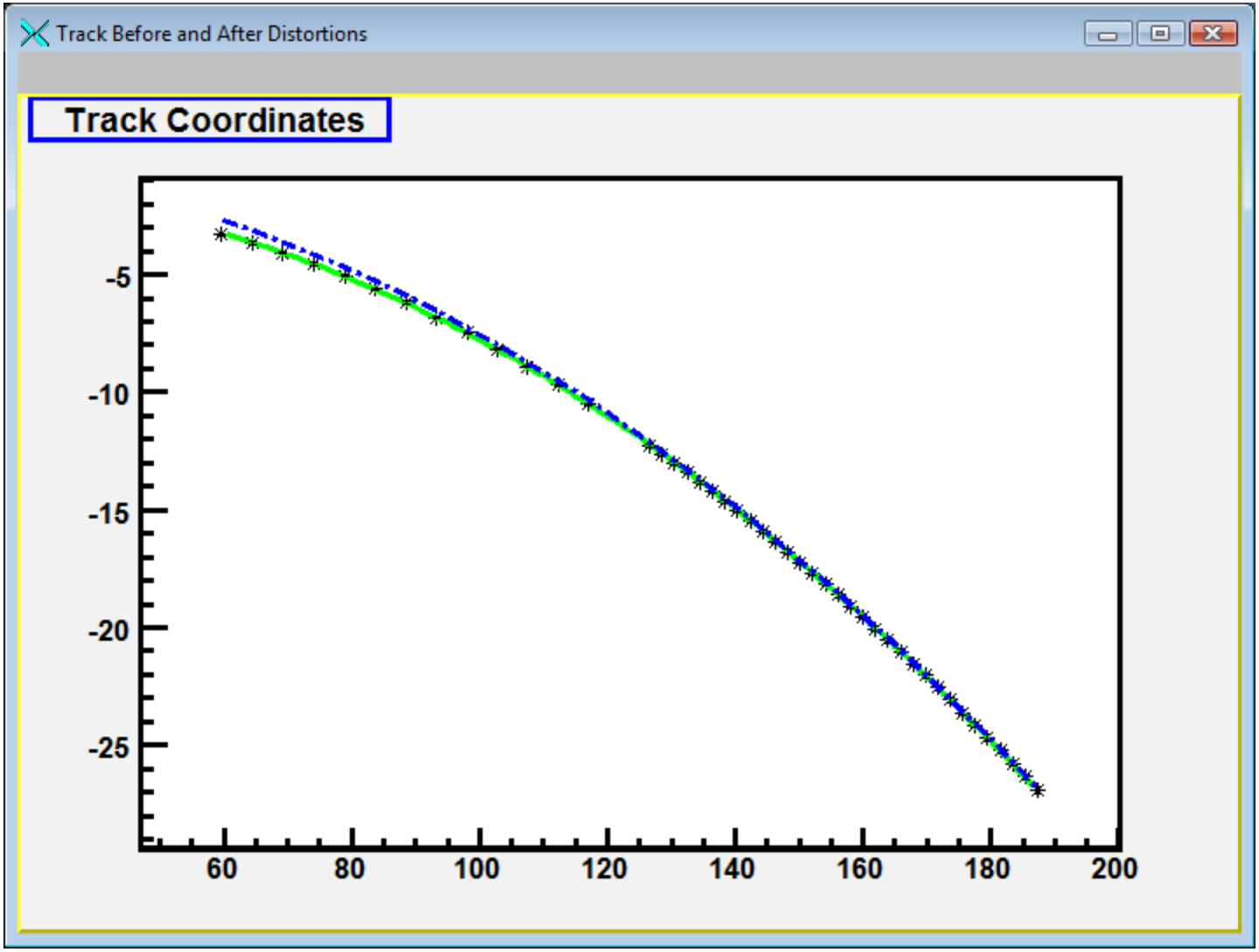
Rings 169 and 170 are shorted together

This is a real distortion

Two years ago, it wandered around hour by hour … depending on the humidity and temperature, but Alexei has fixed that problem :-)

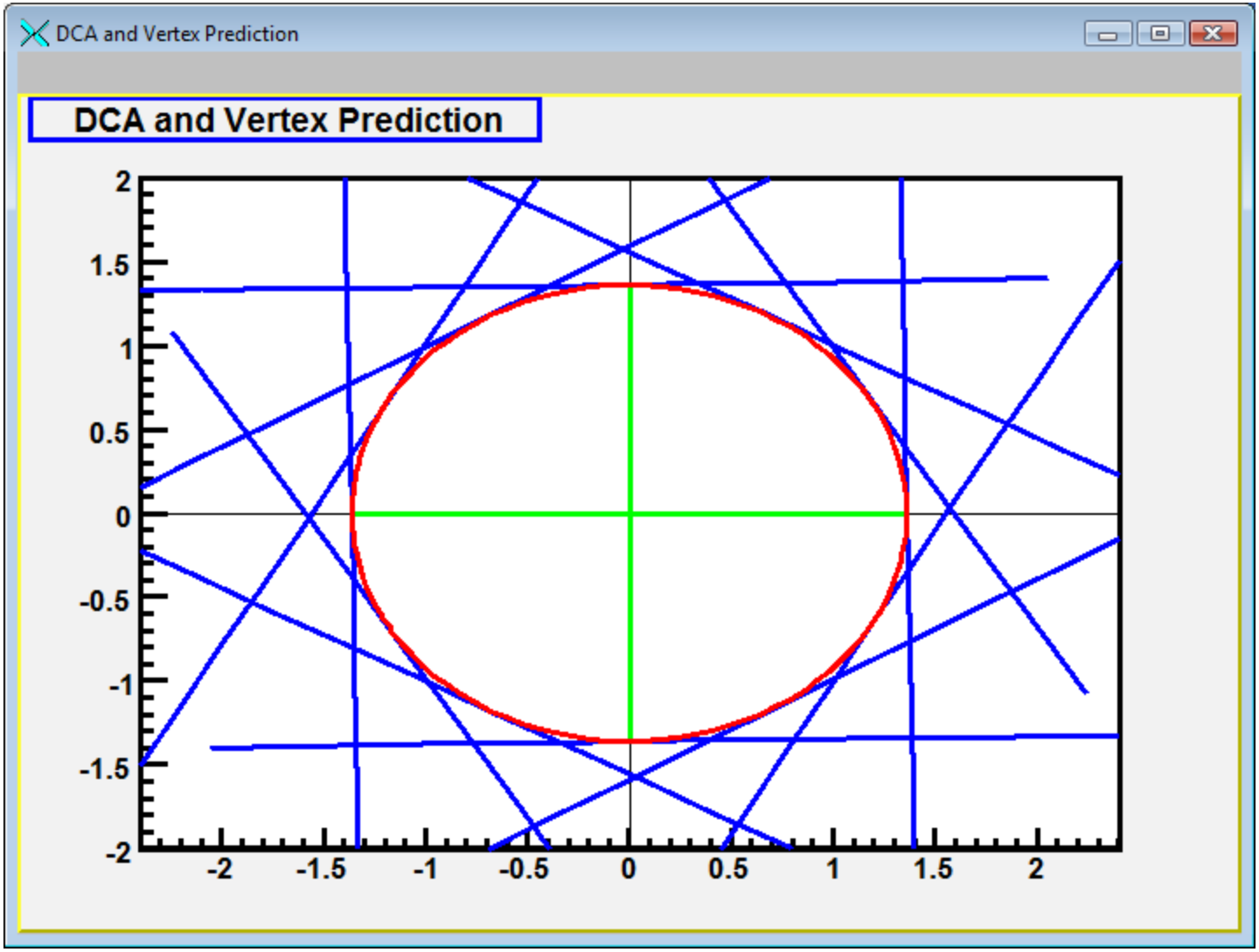
It also depended on eta, pt, and Z, but I don't want to scare you …

The effect on a track



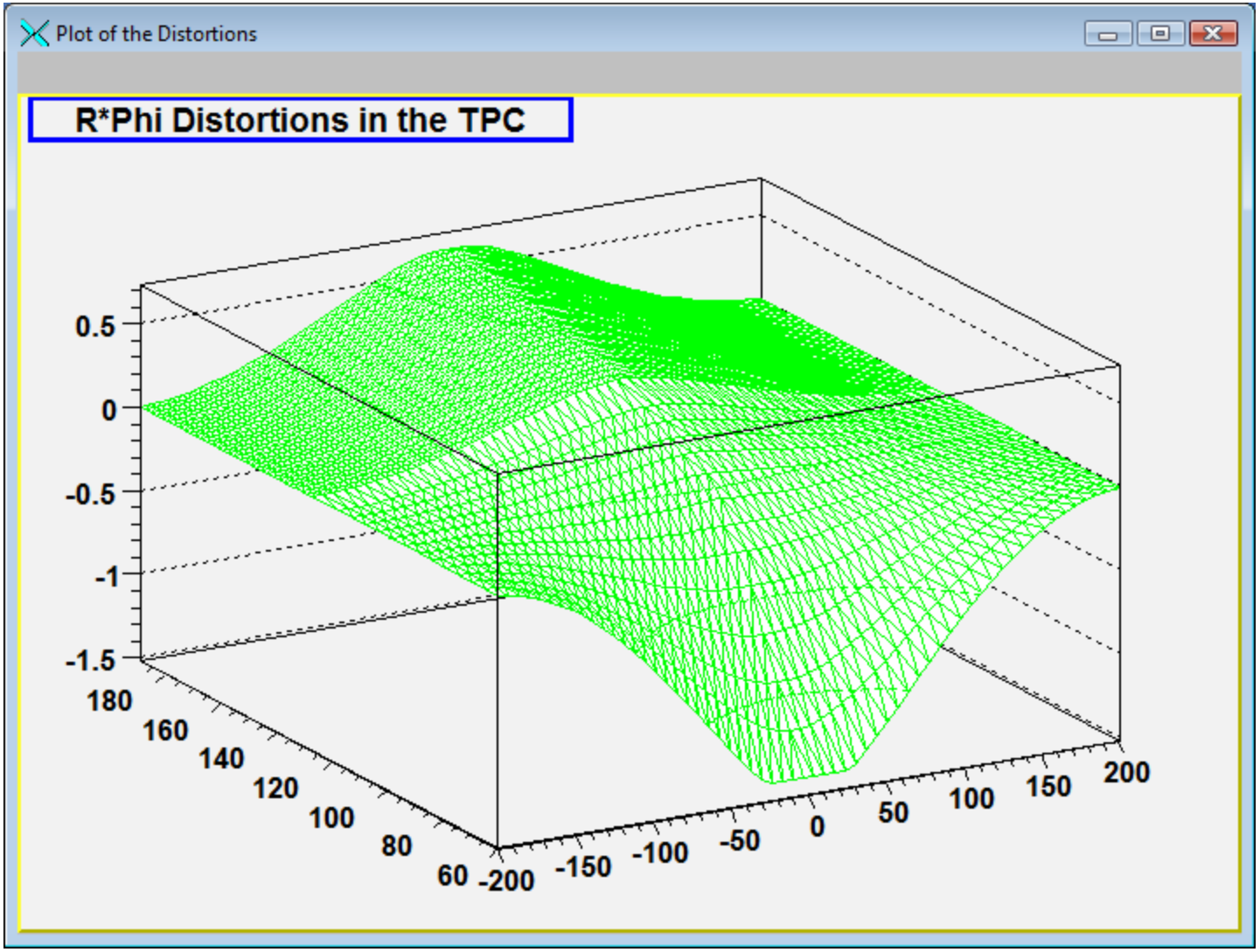
- Track in blue
- Distorted hits in black
- Refit in green
- Note the projected DCA error at zero is going to be large
- Distortion on first few pad rows is few mm

DCA error due to shorted ring ~1.4 cm



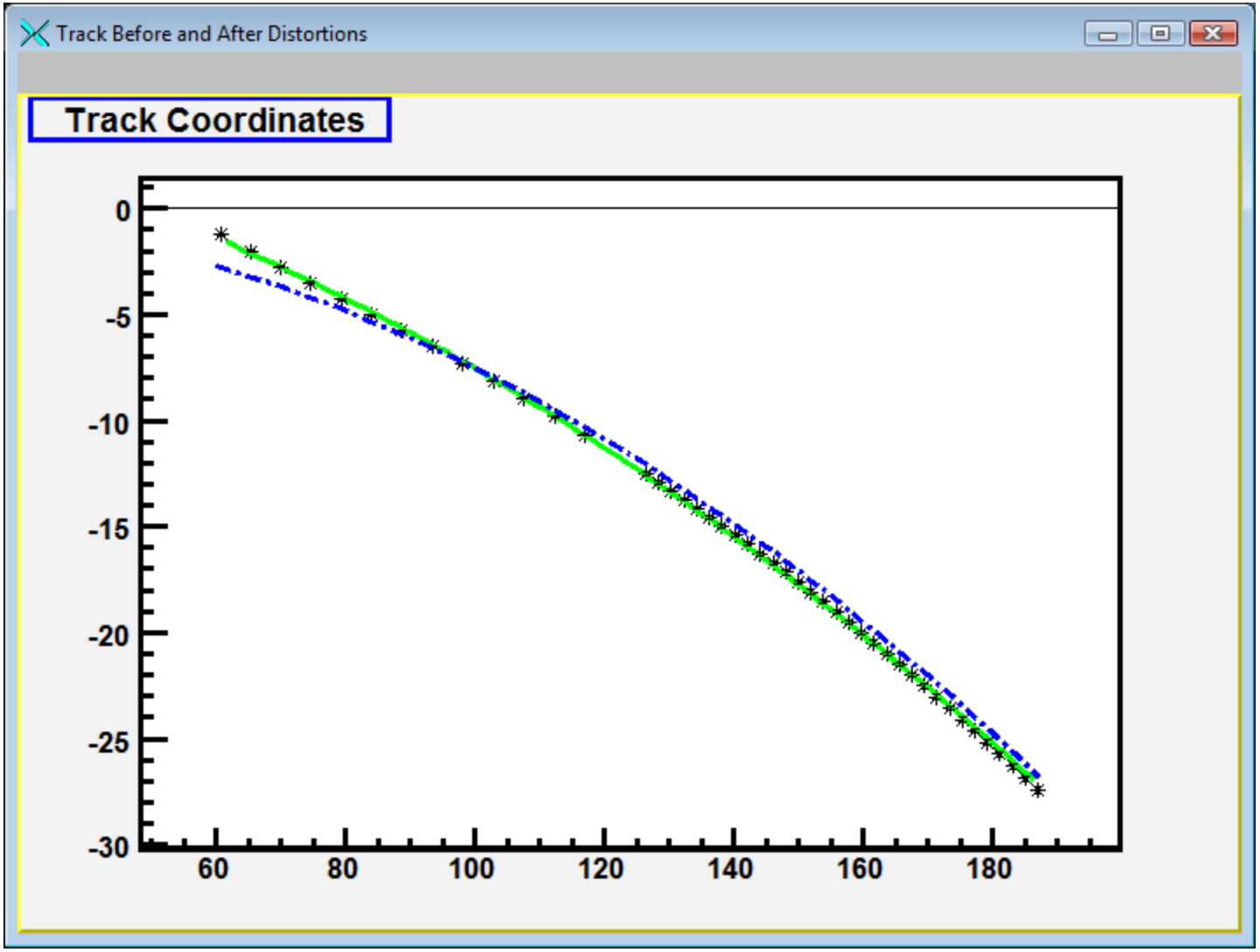
- Once again, this is real and we have dealt with it for 2 or 3 years
- This is currently our biggest systematic distortion in the TPC
- It won't be … in the future.

Space Charge under RHIC II Conditions



ZDC rate = 80 kHz

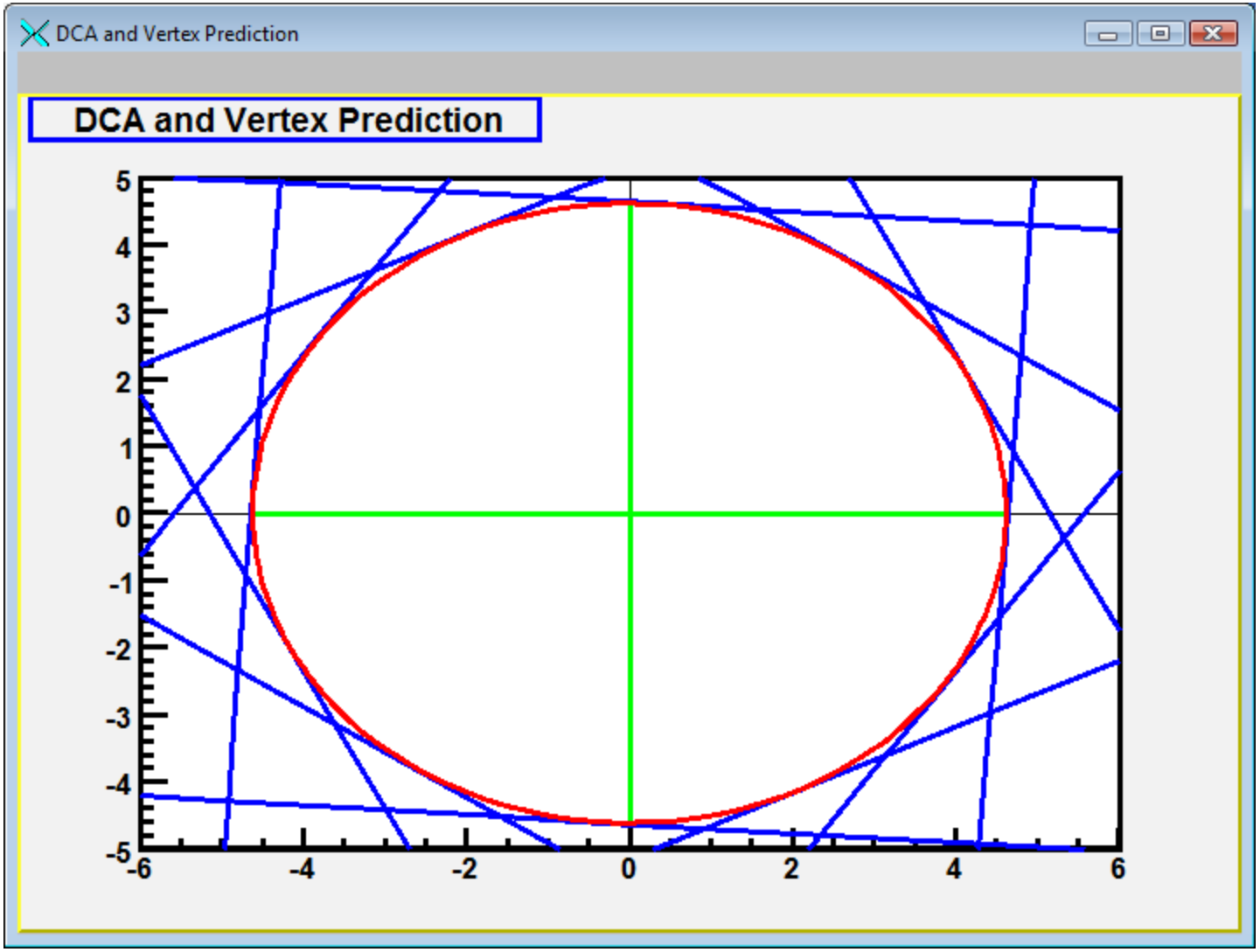
Space Charge at RHIC II



- Track in blue
- Distorted hits in black
- Refit in green

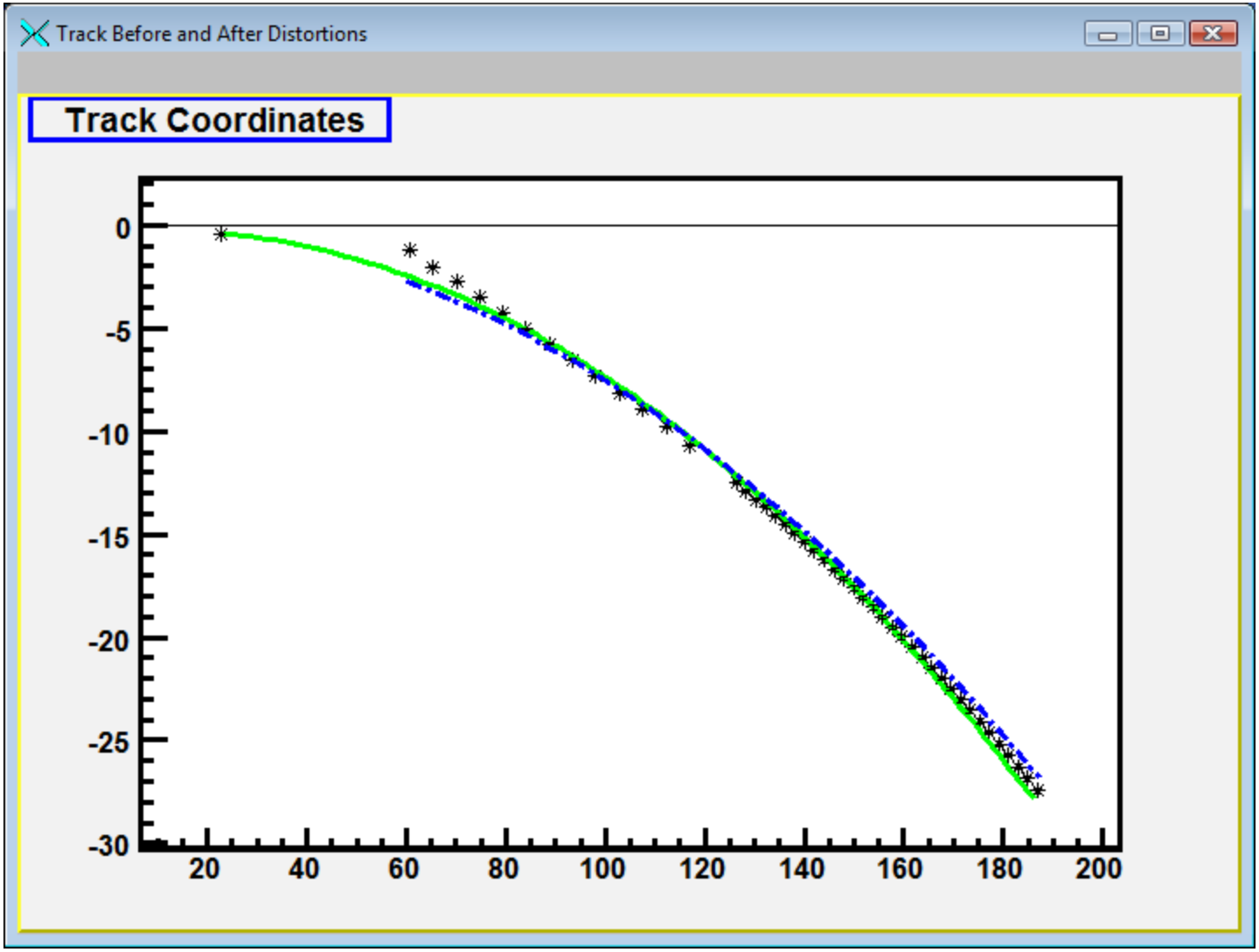
- Distortion on first few pad rows will be > 1 cm (moves from one pad to another)

Space charge at RHIC II as projected to Vertex



- Note CM scale on Horizontal axis.
- Radius of this circle is 4.6 cm
- Inside TPC the shift is ~ 1cm on first pad rows
- At 14 cm radius, it will ‘only’ be 3.8 cm shift

The power of an intermediate tracker



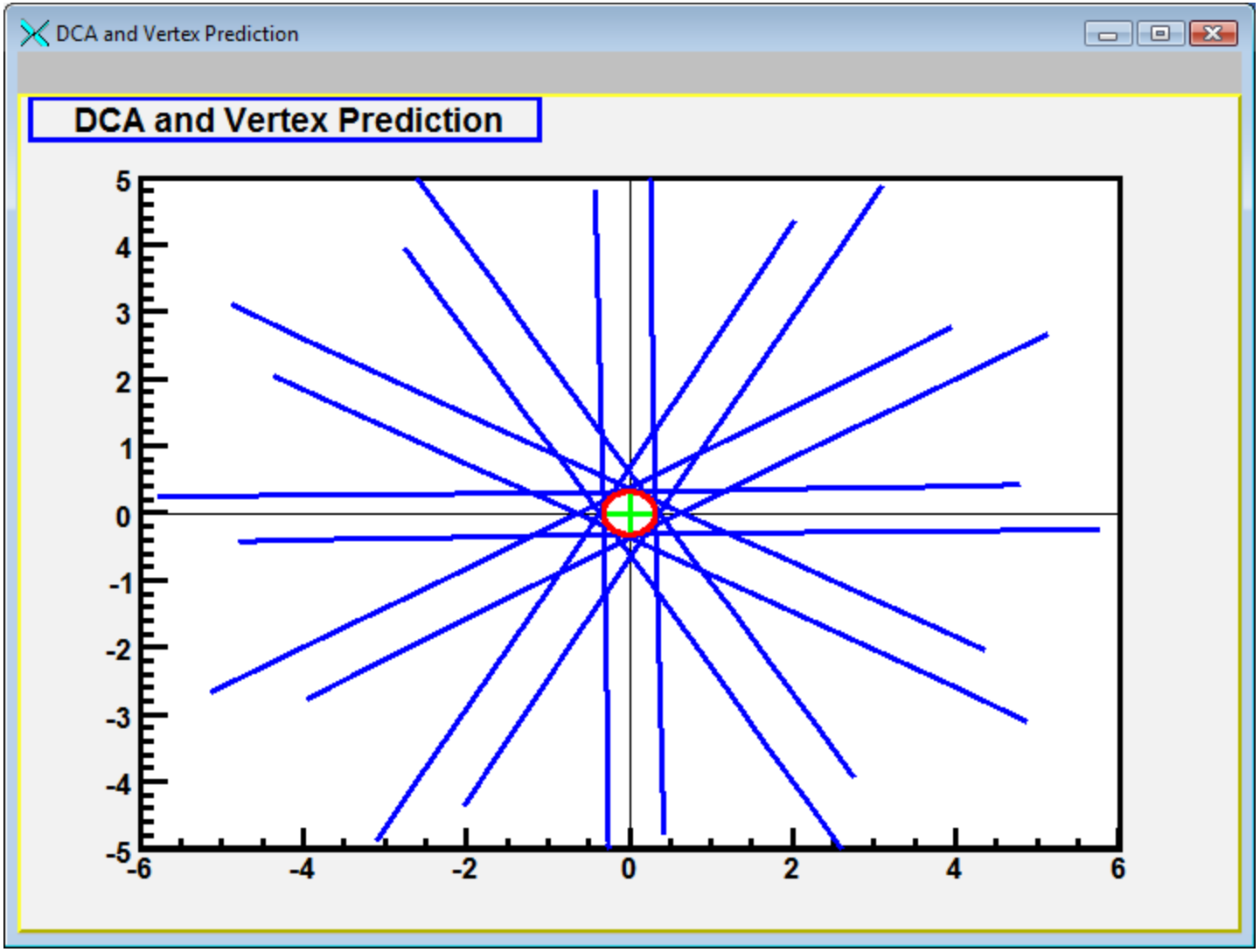
Add a good SSD (or IST) hit

If you can make the correct hit association

(i.e. with high efficiency)

then the reconstruction can be recovered

With the SSD (or IST) at work …



DCA is 3 mm at the vertex

(without other space charge corrections)

Very important for global tracks and any sort of topological reconstruction technique

The SSD may be very useful as a stand alone detector in high luminosity running

Still need the HFT for Charm and Beauty :-)

Control of systematic errors to 2%

- **Under good conditions, we think we can do the space charge corrections and control these systematic error to about 2%**
- **Note that space charge wanders second by second**
  - **Ions take about ½ second to drift to cathode**
  - **Varies as luminosity wanders**
    - **Beam tune**
    - **Alignment**
    - **Magnets wiggle at 10 Hz**
    - **Even the moon**
- **So if we can calculate the deflection at the IST (or SSD) to within 2% then we can reduce the systematic error to a random error**
  - **About 750 microns sigma**

This sort of thing makes charge sign determination at high pt very difficult. Look at Bedanga's p-bar p paper with pride.

Conclusion

- **Space charge will be our largest systematic error in the era of high luminosity running at RHIC**
  - **Approximately 3x what we have dealt with in the past**
- **We think we can control these distortions to ~2% in magnitude**
  - **This is a work in progress**
  - **There is always a surprise, and new ideas needed, with each year's run**
- **After correction, systematic errors become (smaller) random errors**
- **The systematic errors due to space charge acting on the SSD (or IST) are approximately equal to the pointing error to that layer.**

In other words, multiply the previously calculated pointing errors by √2 to finalize the design of the detectors