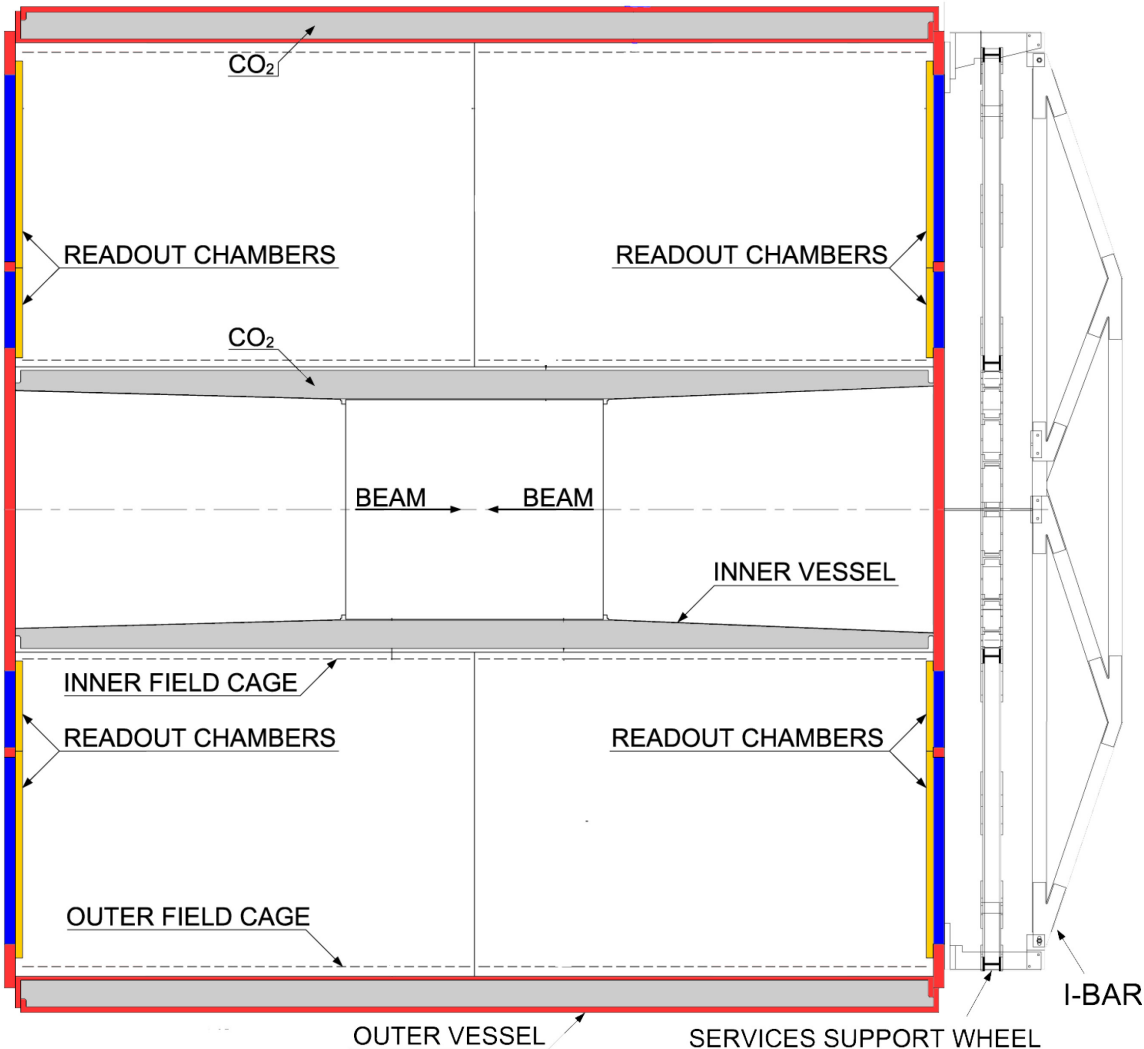

Shifted Rod Distortions Some Possible Scenarios ...

Jim Thomas

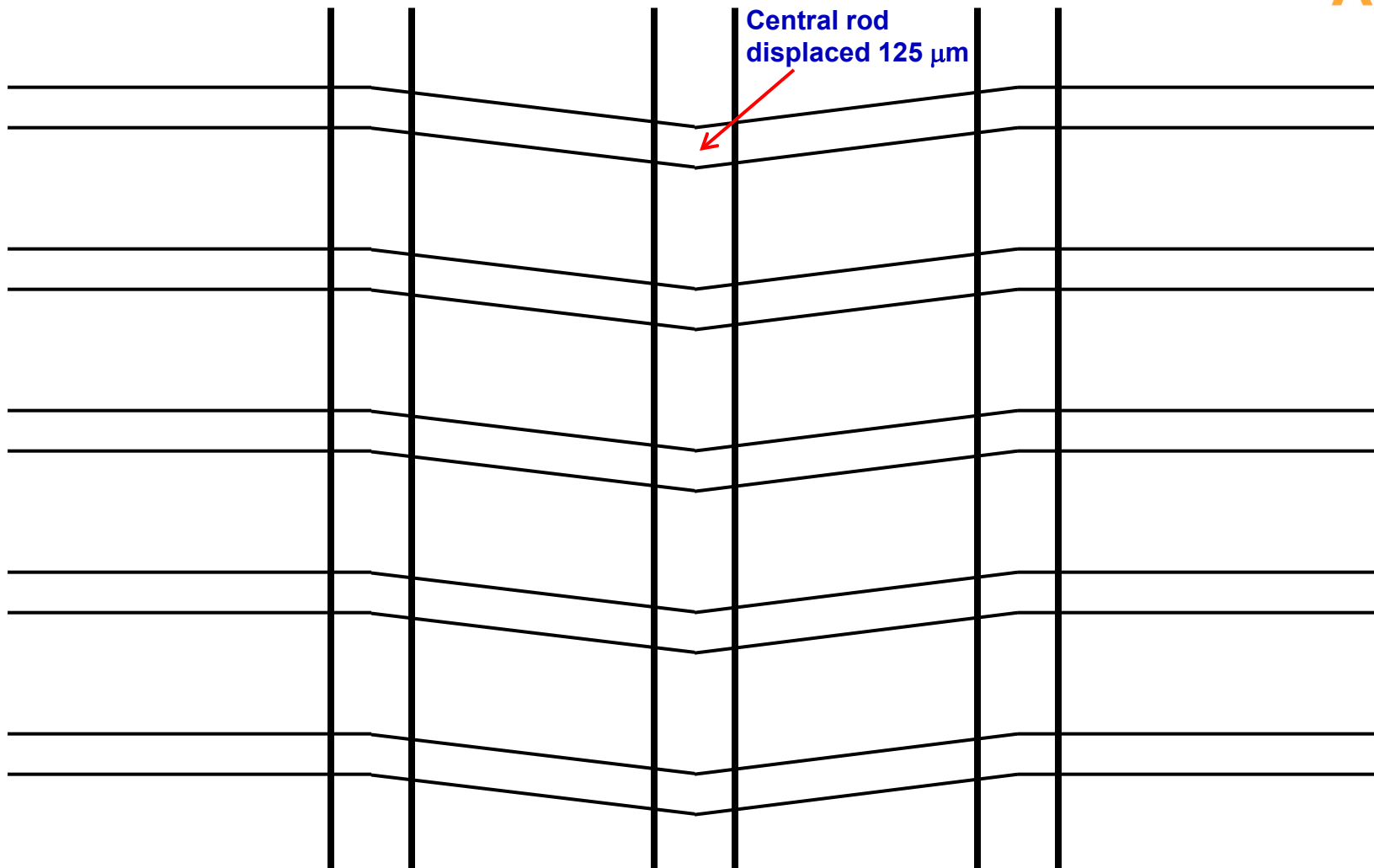
15 - July - 2010

Rods to support the HV strips are semi-independent



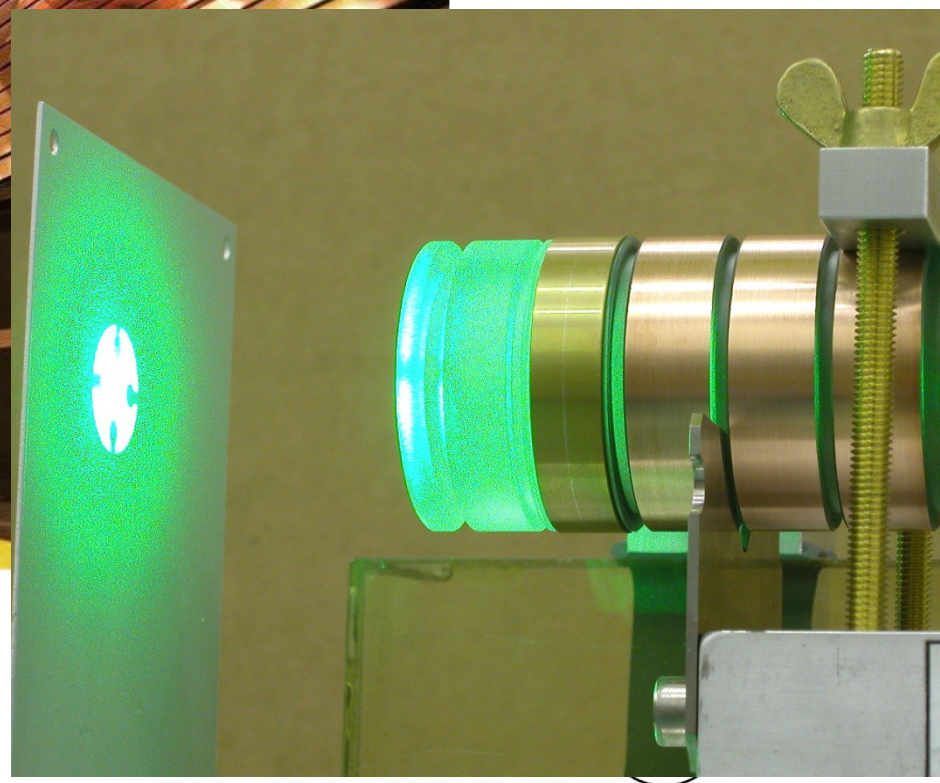
- At the scale of $100 \mu\text{m}$, each rod can move independently
- e.g. $125 \mu\text{m}$ is equivalent to a 5 volt error
- Thus, a rod in the wrong place will distort the drift field

Assumed Strip Deformation



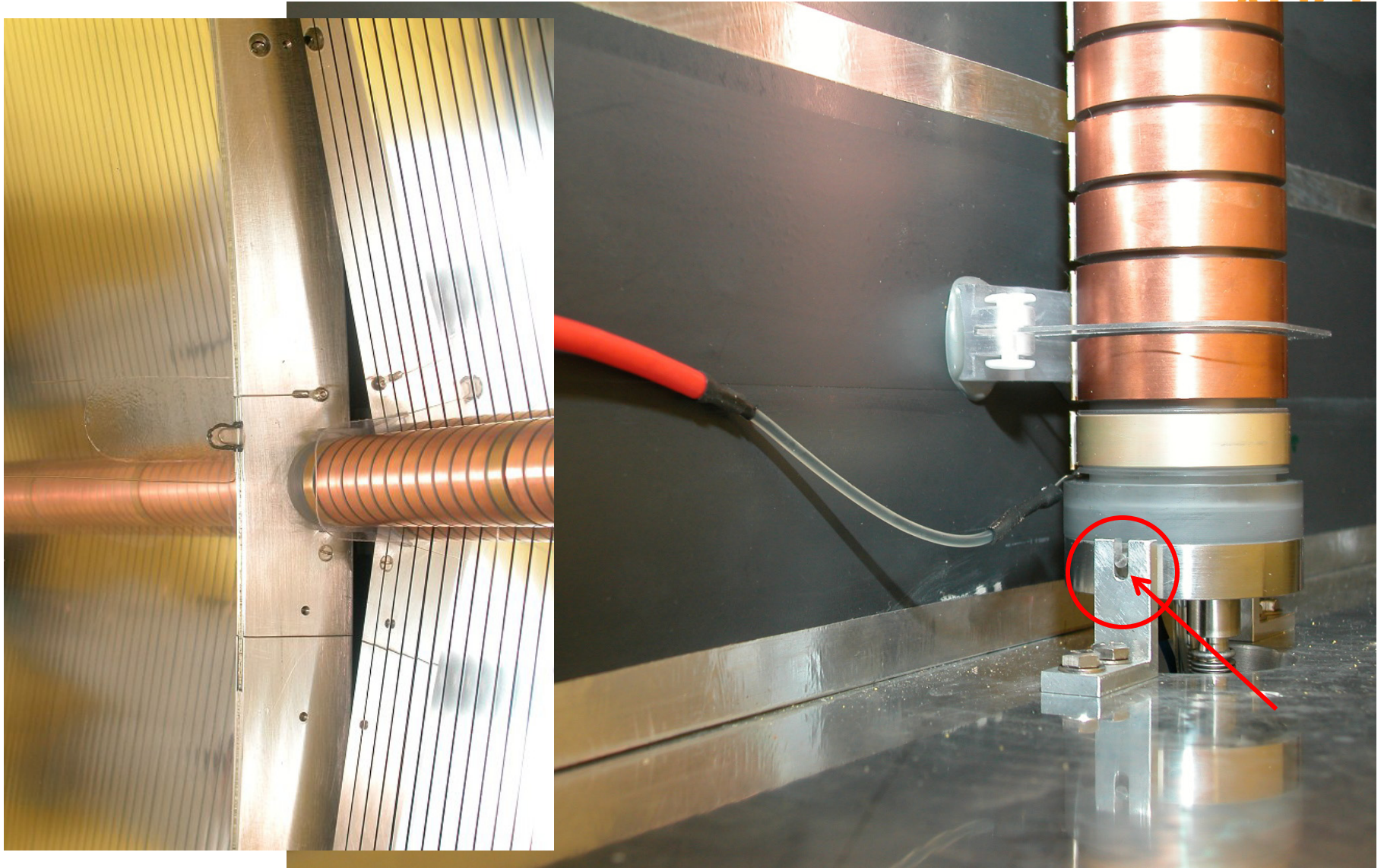
Use error potentials to describe the boundary conditions

Rod Mounting and Construction

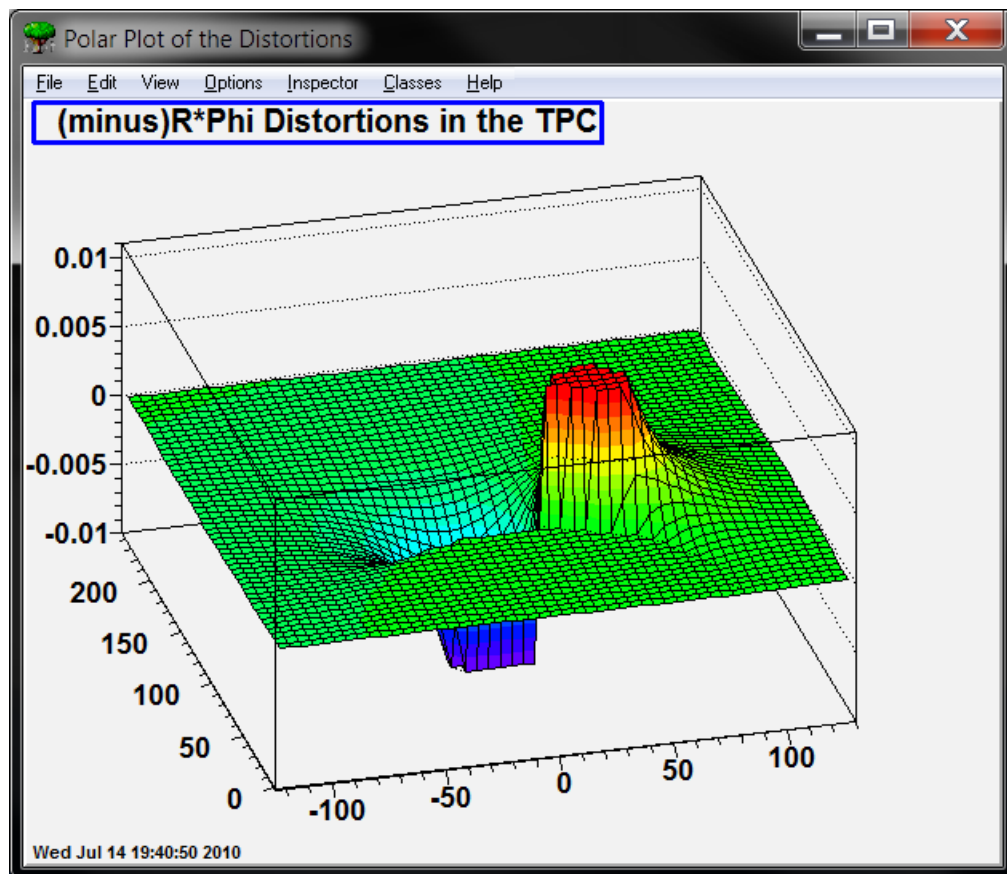


The rods are independently located and could be displaced from their ideal locations by $\sim 100\text{-}200\ \mu\text{m}$.

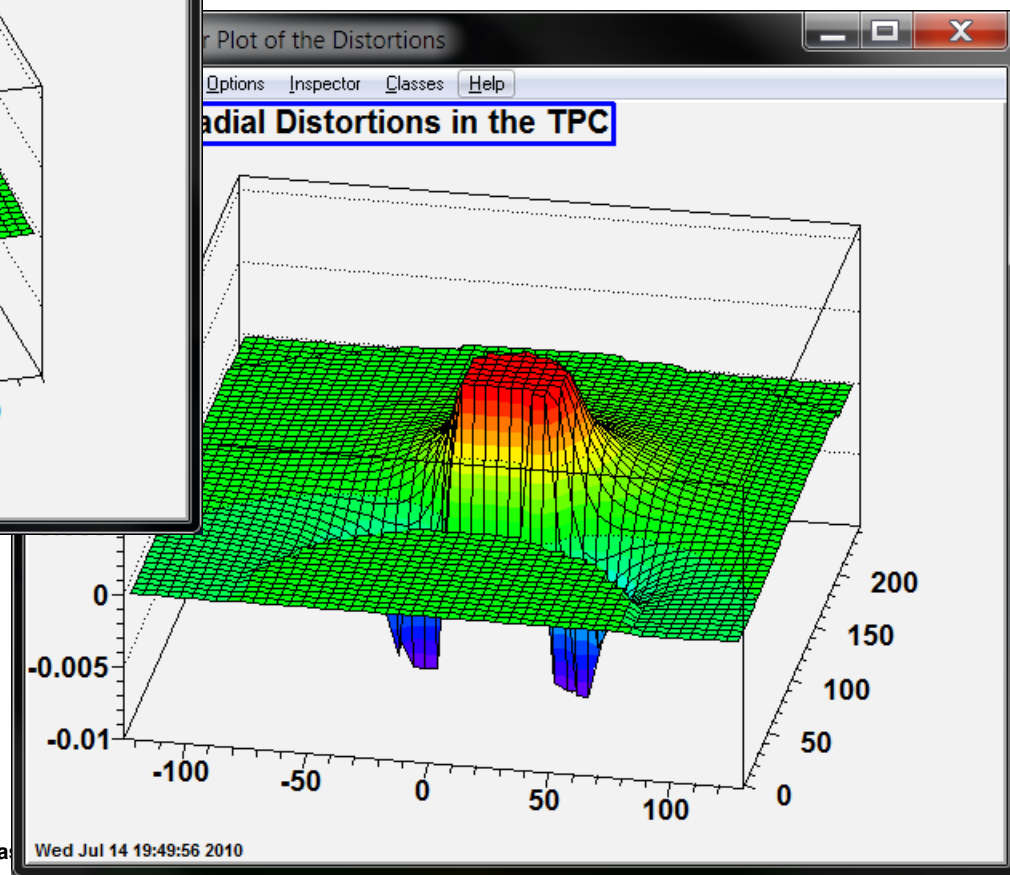
End Detail – Rods are not hard mounted at EP



Inner Rod Shifted – B Field On

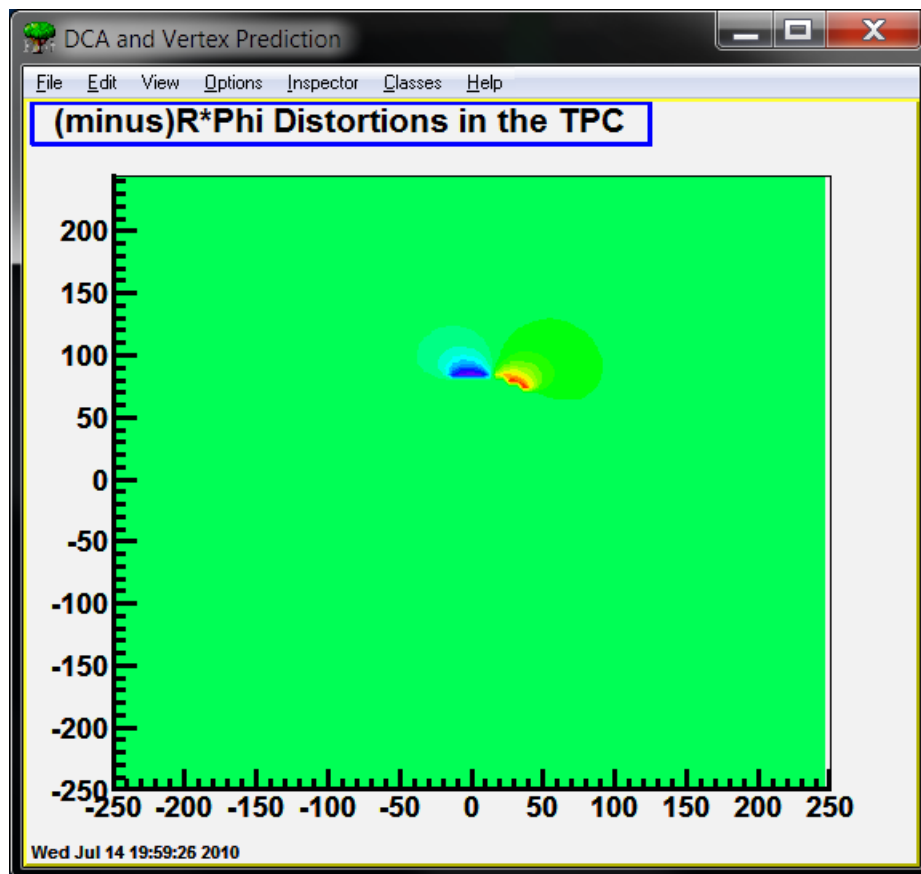


- Rod 4 (at 80°) shifted
- Viewed in X-Y plane (transverse), 100 cm from the Central Electrode

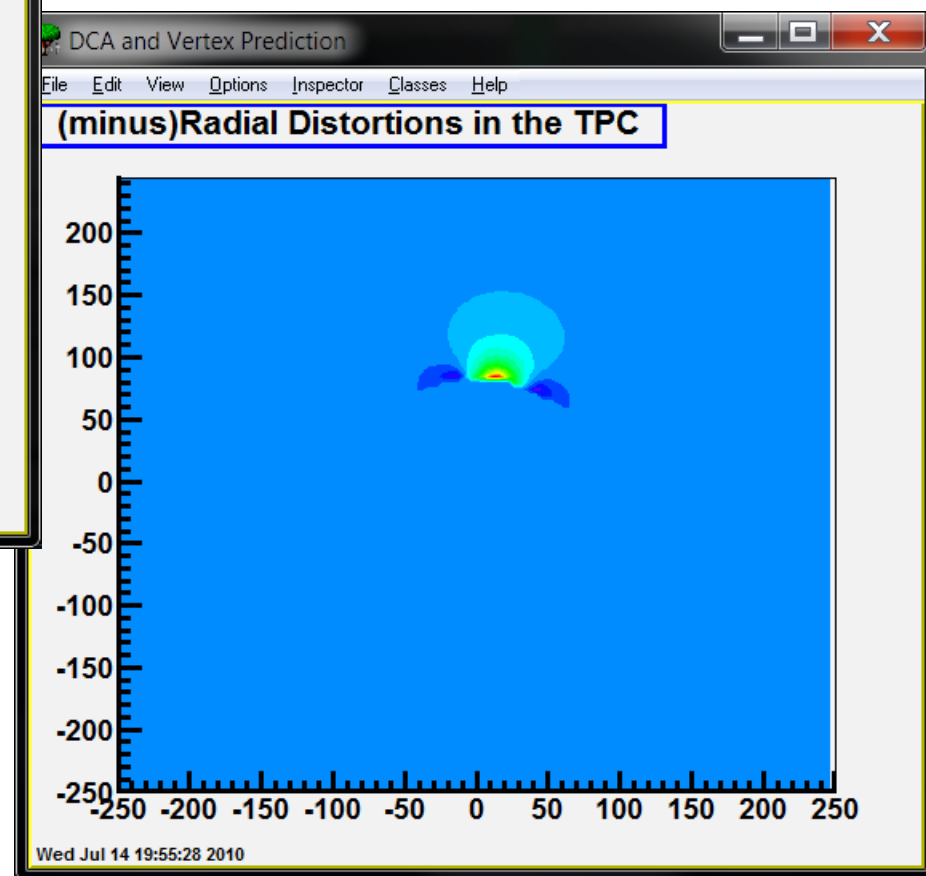


- R-Phi threshold set to 100 μm , R-Phi unzoomed peak at $\sim 600 \mu\text{m}$, Radial peak $> 1 \text{ mm}$

Inner Rod Shifted – B Field On

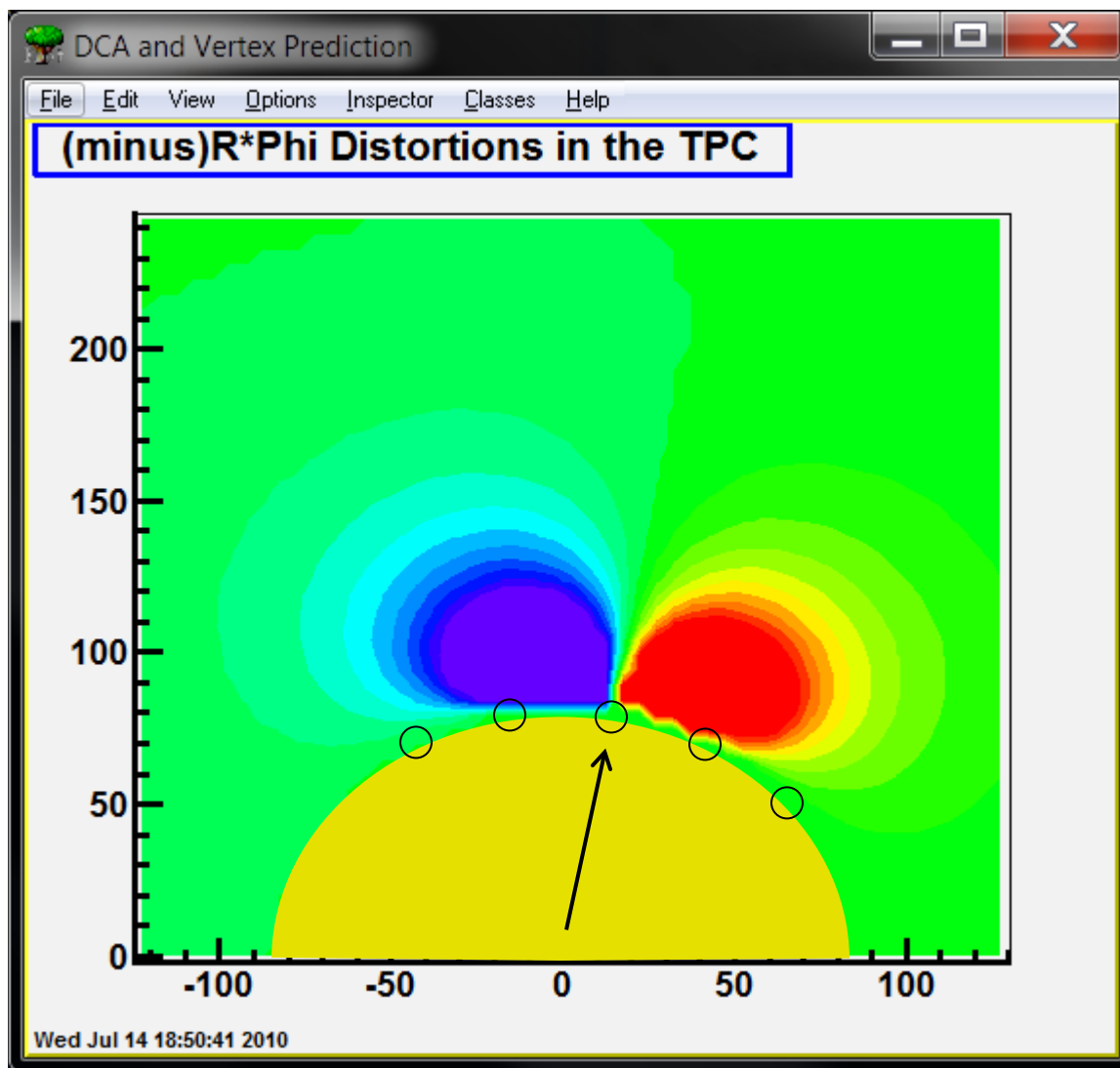


Transverse Plane,
viewed from one
end of the TPC

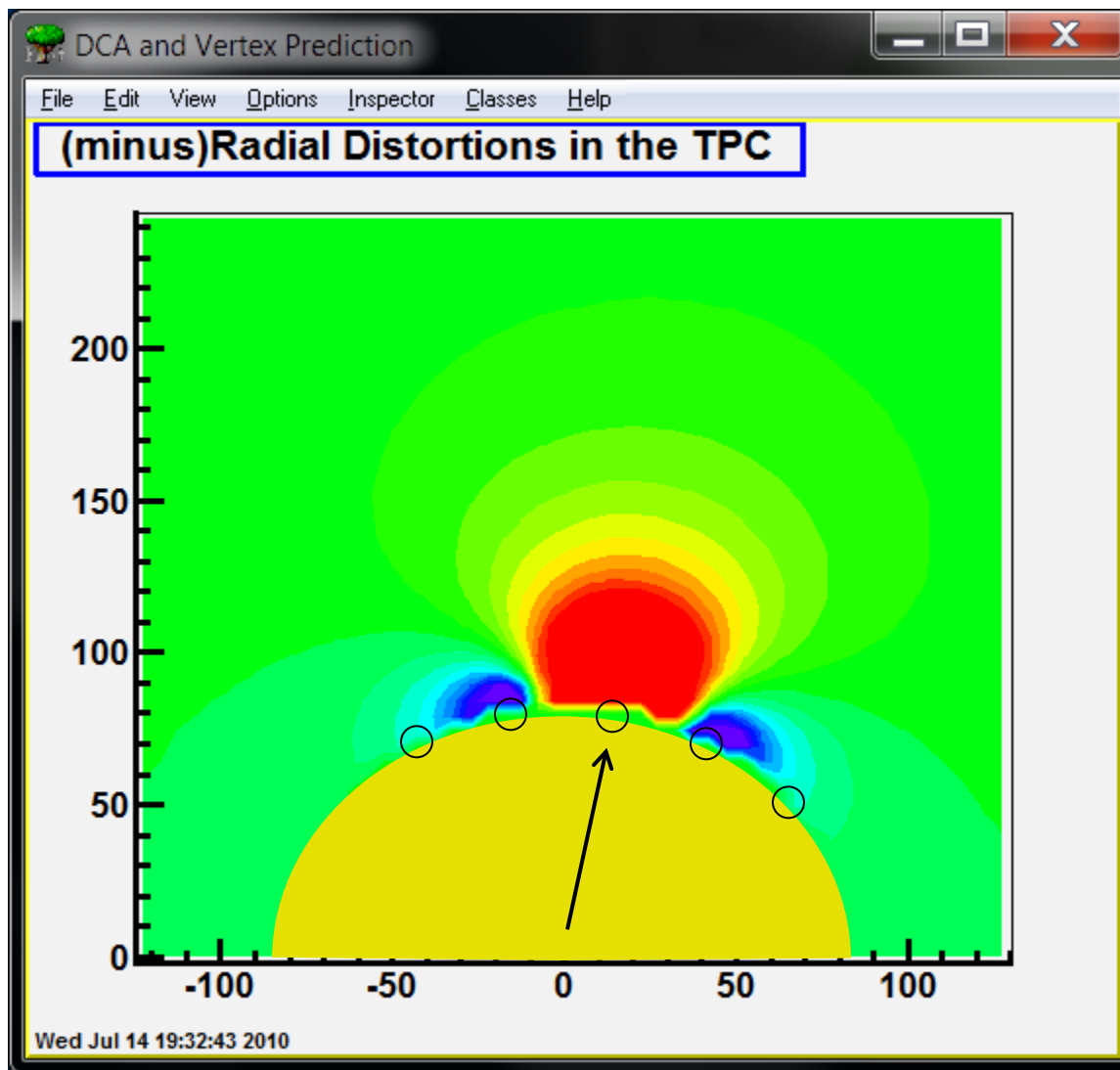


Full 3D solutions of Maxell's
equation's in cylindrical coordinates

R-Phi: Very low threshold for shifted rod distortion

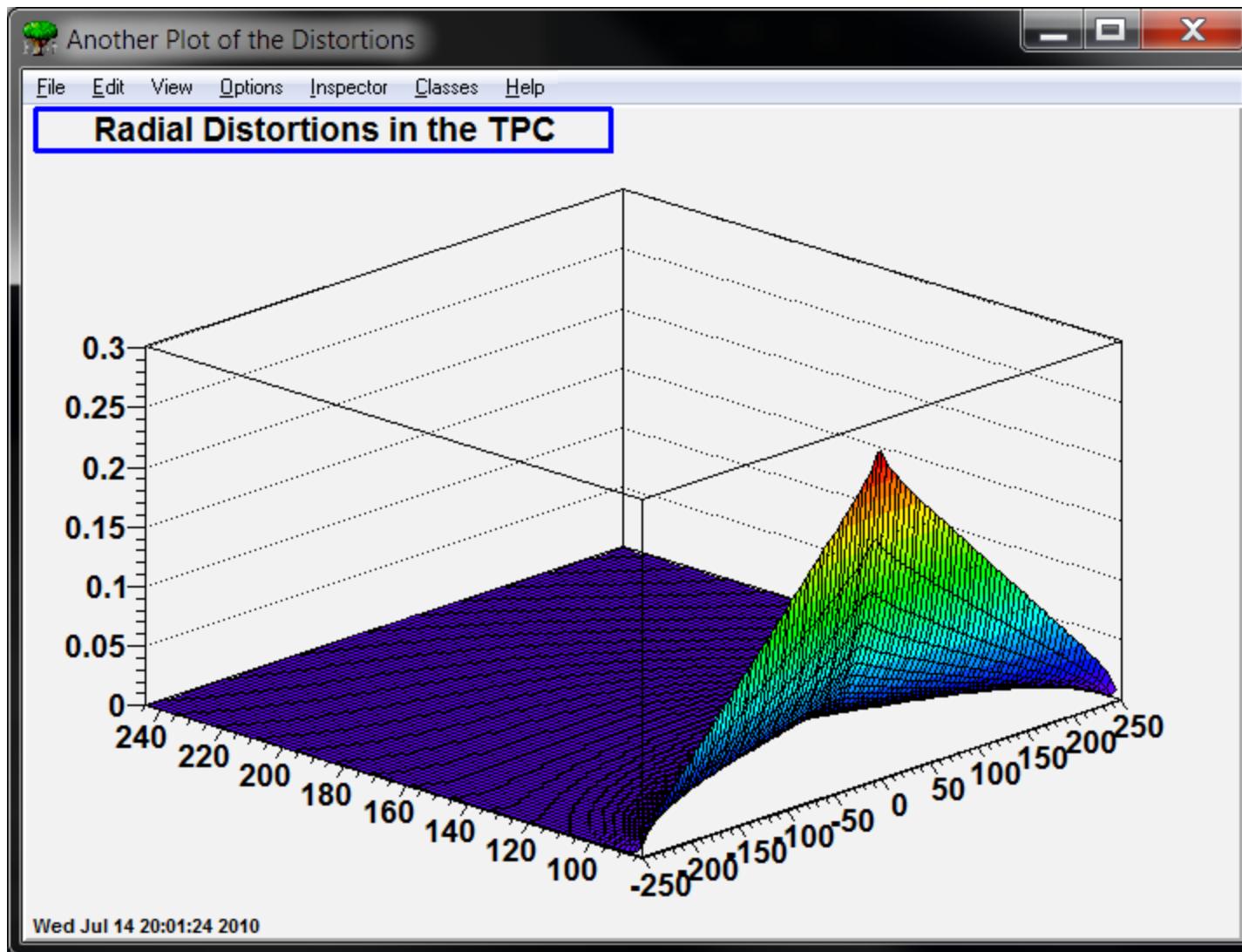


Radial: Very low threshold for shifted rod distortion



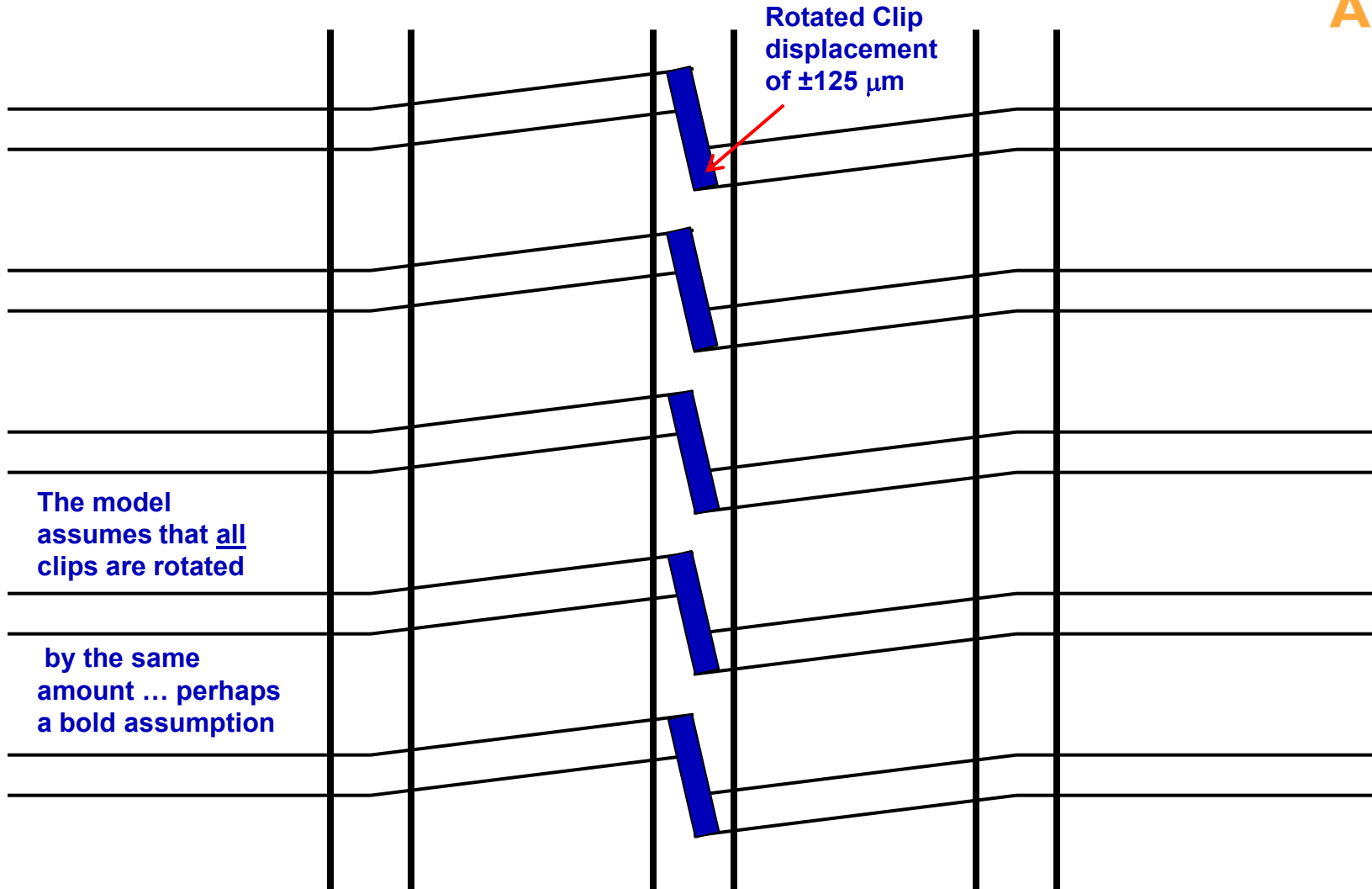
Flip back to the previous slide and note the position of the rods compared to the location of the nodes

Inner Rod Shifted – B Field On



- R-Z plane
- Note that plots on previous pages are in the transverse plane, located at 100 cm from the CE

Assumed Strip Deformation – rotated clip

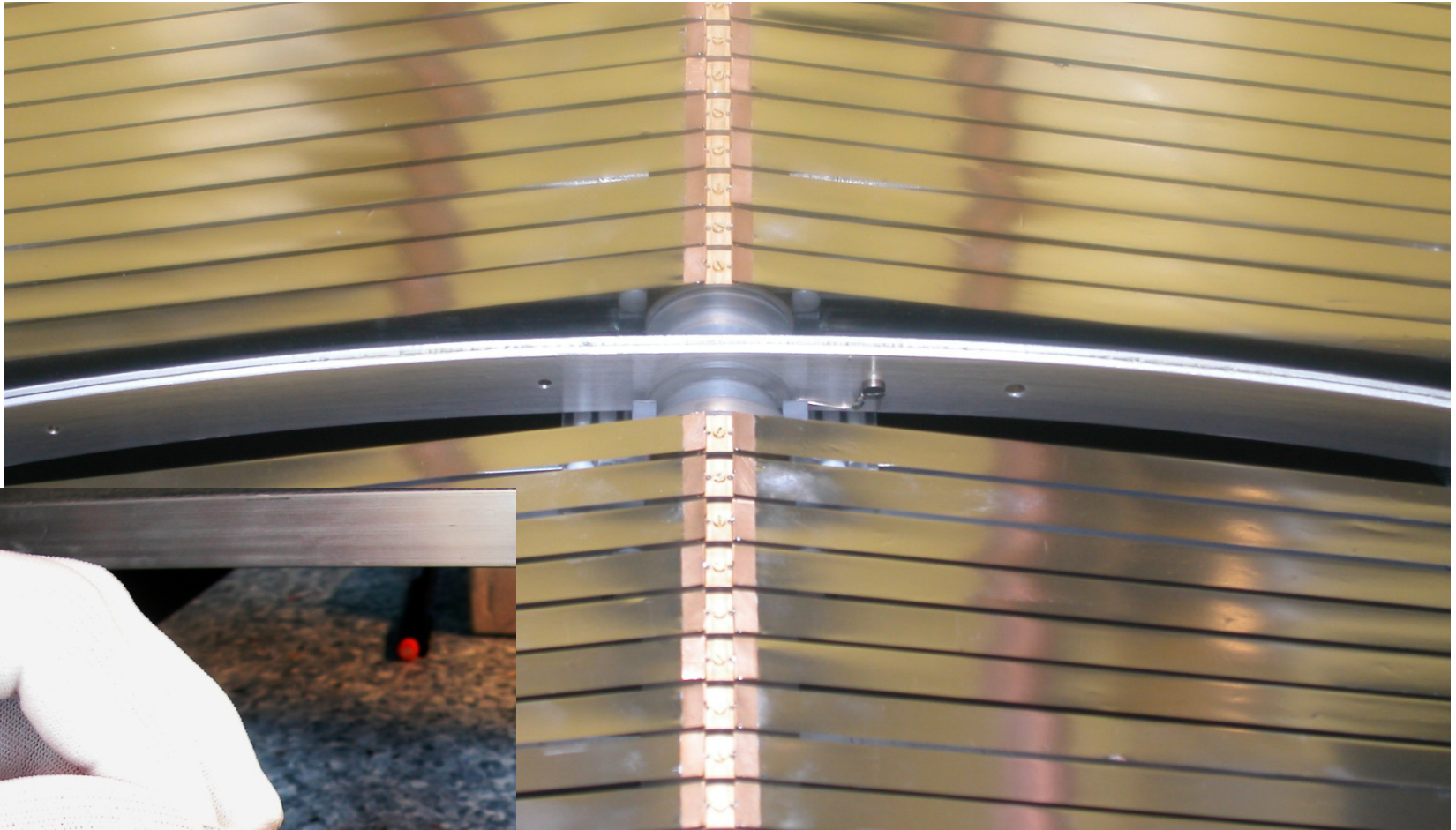


The model assumes that all clips are rotated

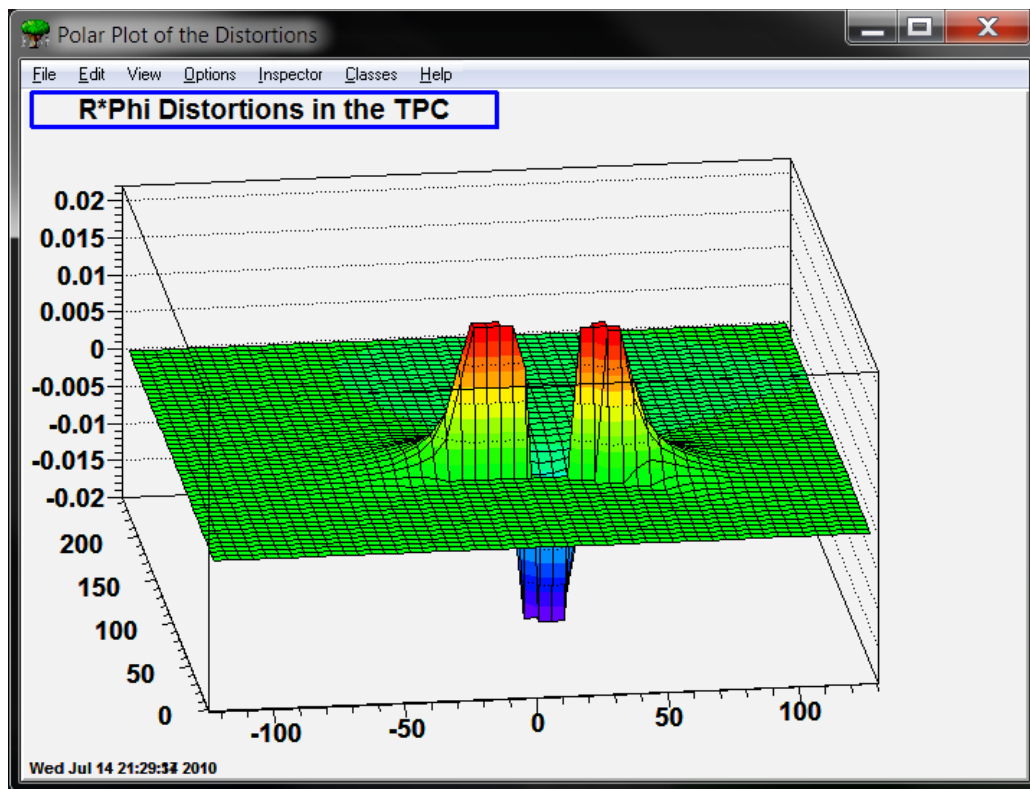
by the same amount ... perhaps a bold assumption

Use error potentials to describe the boundary conditions

Clip Installation Detail

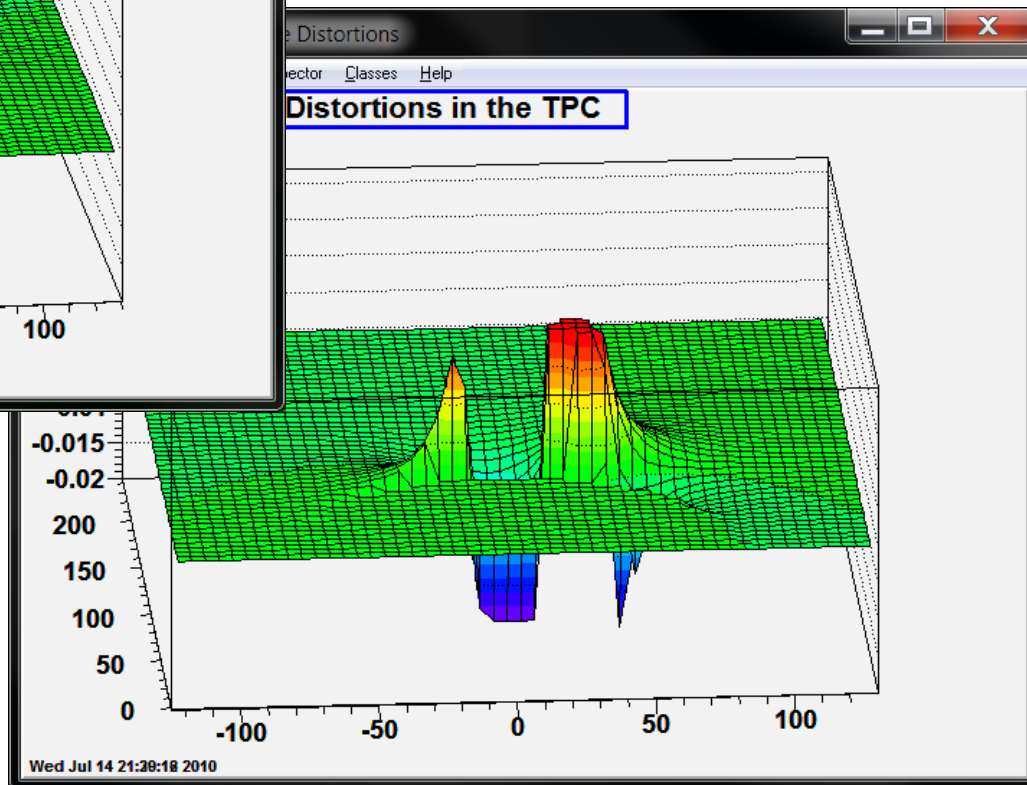


Rotated Clip – B Field On

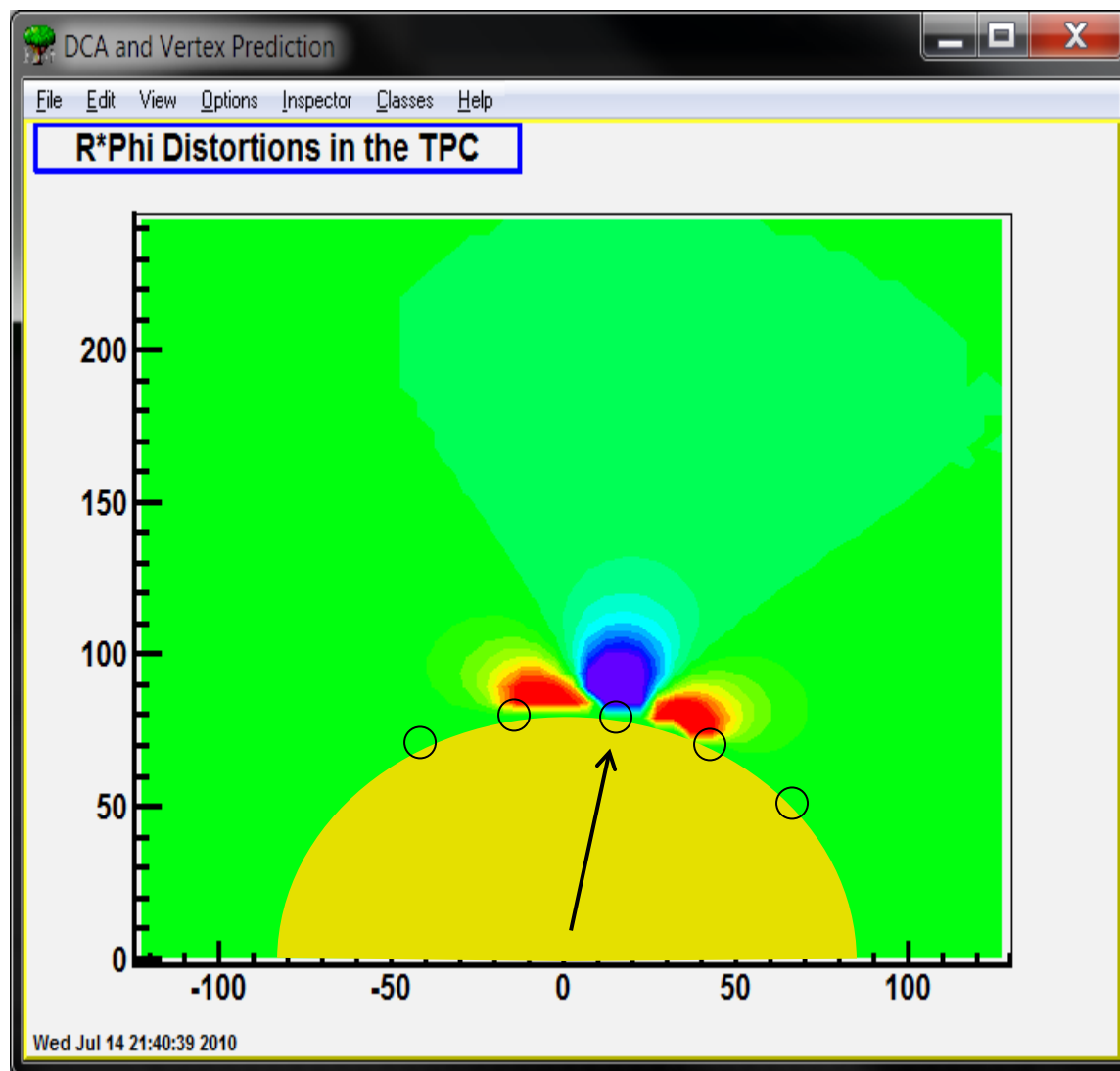


Note reversal of symmetry with respect to the rod for rotated clip Rphi and Radial distortions compared to pure shifted rods

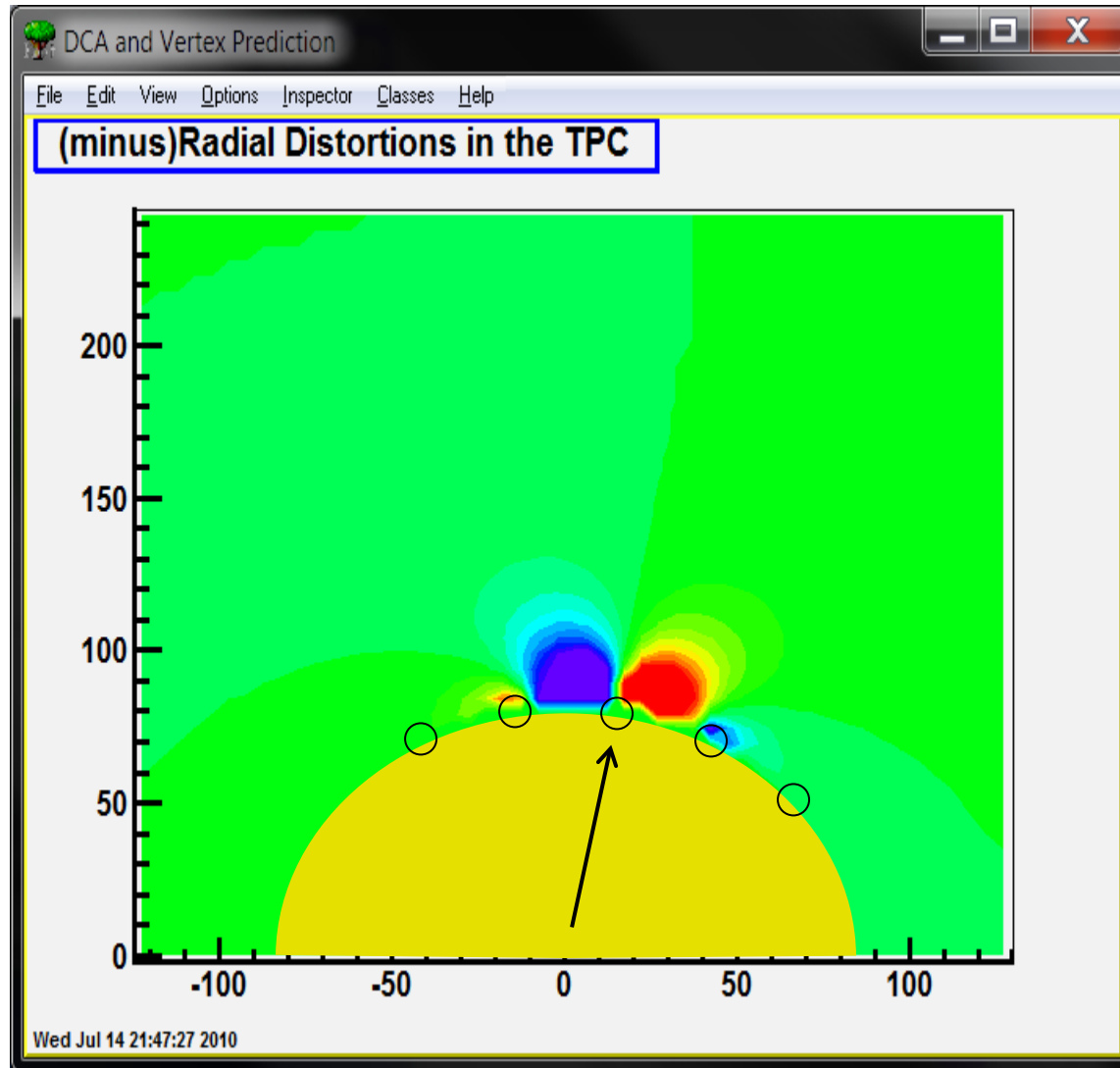
R-Phi threshold set to 200 μm ,
R-Phi unzoomed peak at 2 mm,
Radial peaks at 1.5 mm



R-Phi rotated clip distortion – 200 μm threshold

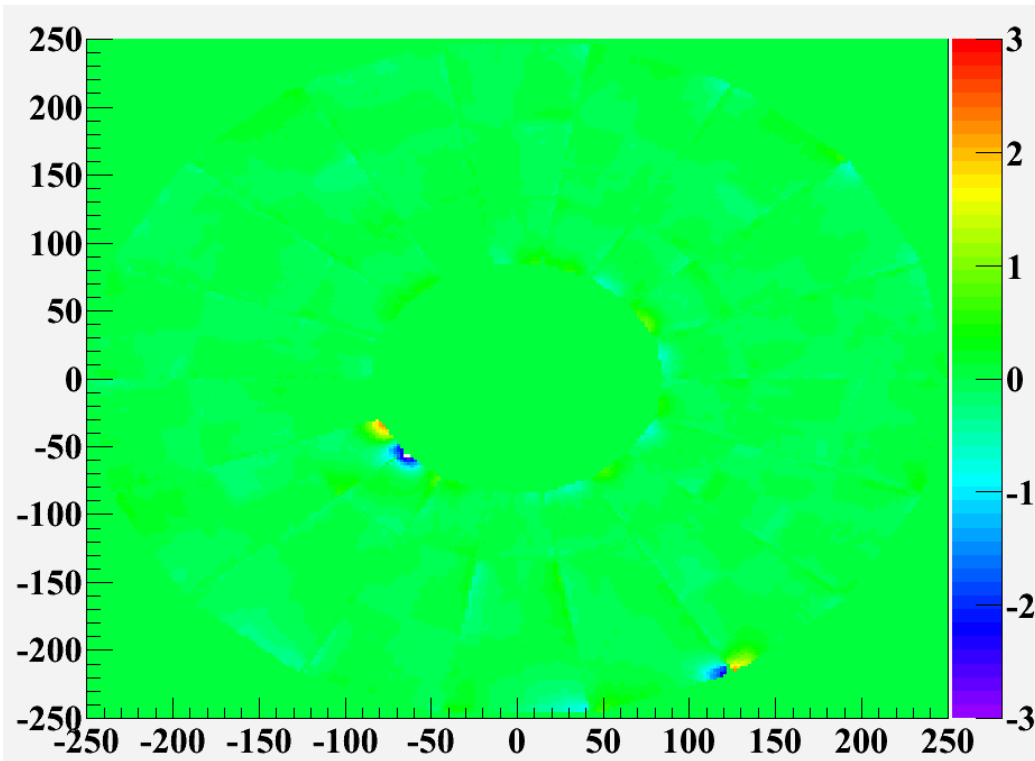


Radial rotated clip distortion – 200 μm threshold

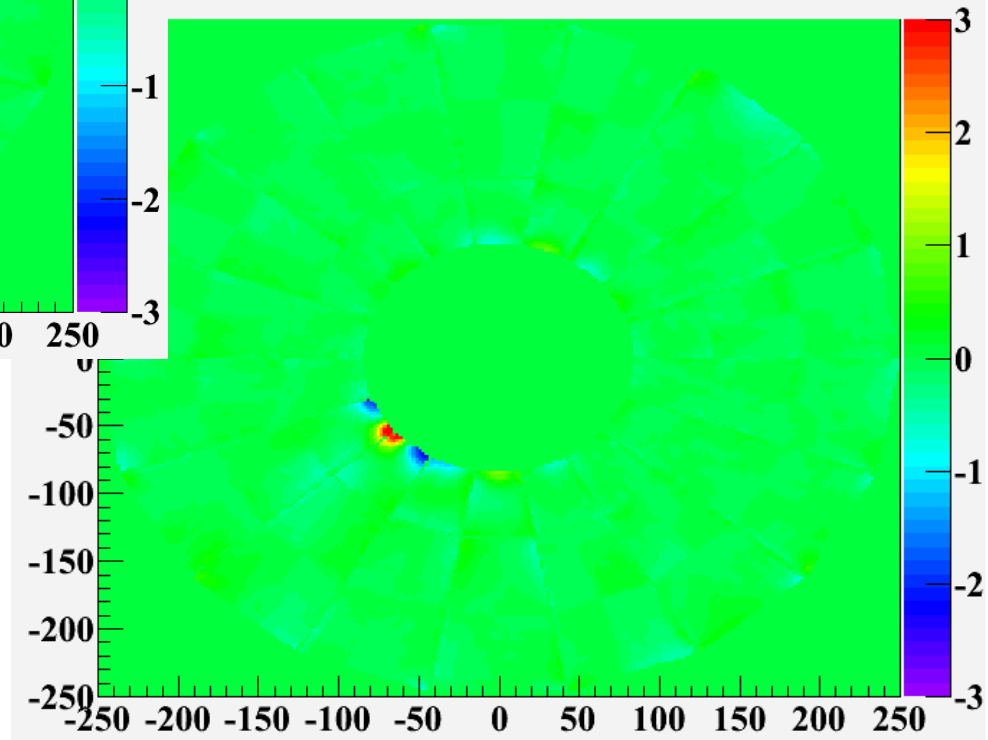


Flip back to the previous slide and note the position of the rods compared to the location of the nodes

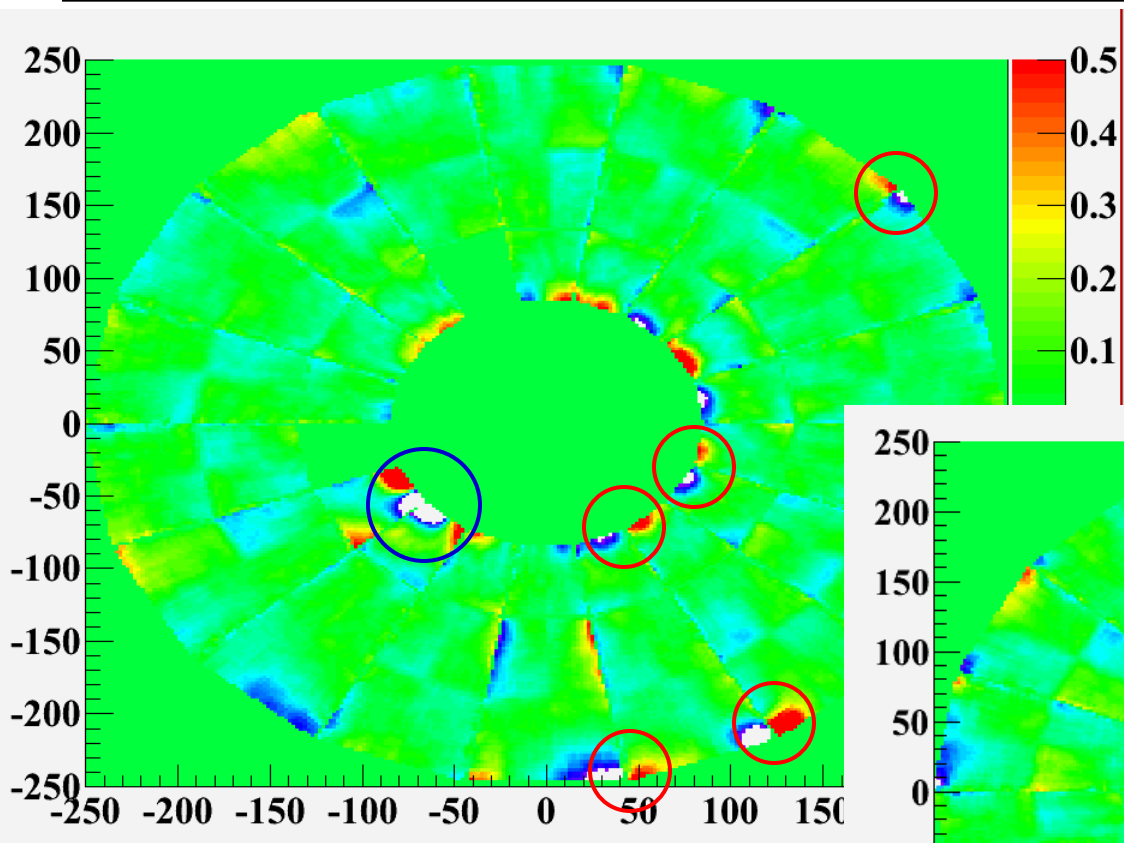
Marian's Residual Plots – 'high threshold setting'



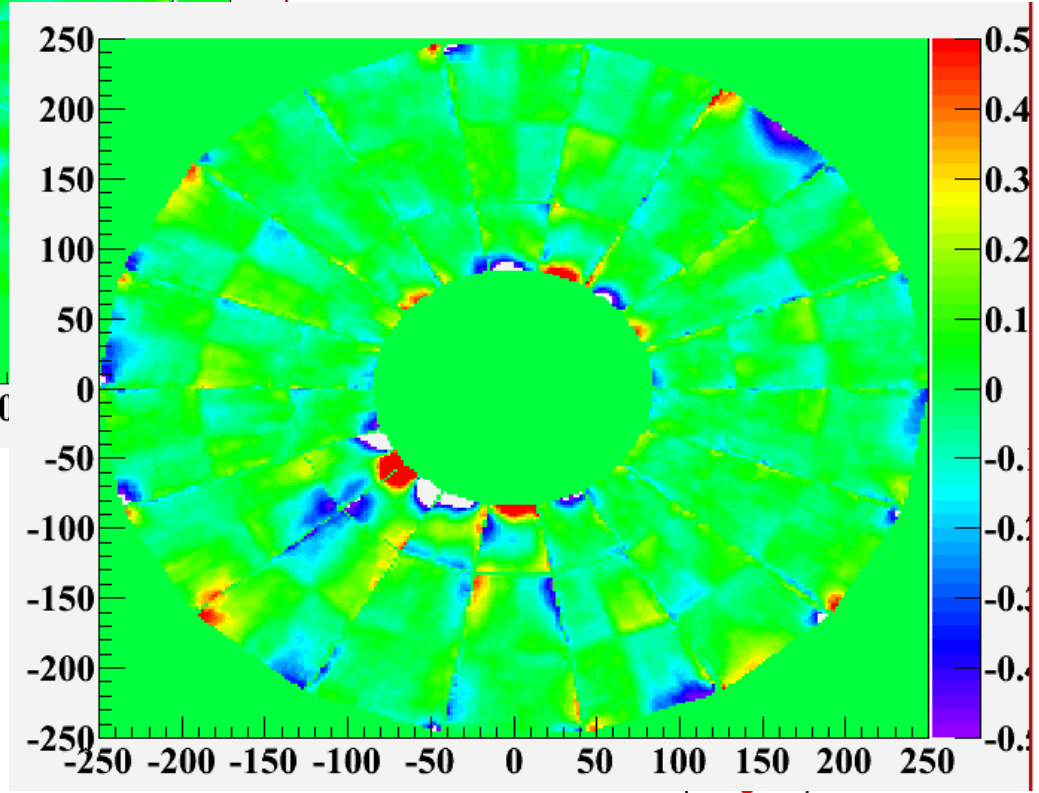
- Distortion on the A and C side – spot at sectors 10 and 11
- Smaller spike at the sector 14/15 only on A side



Marian's Residual Plots – 'low threshold setting'

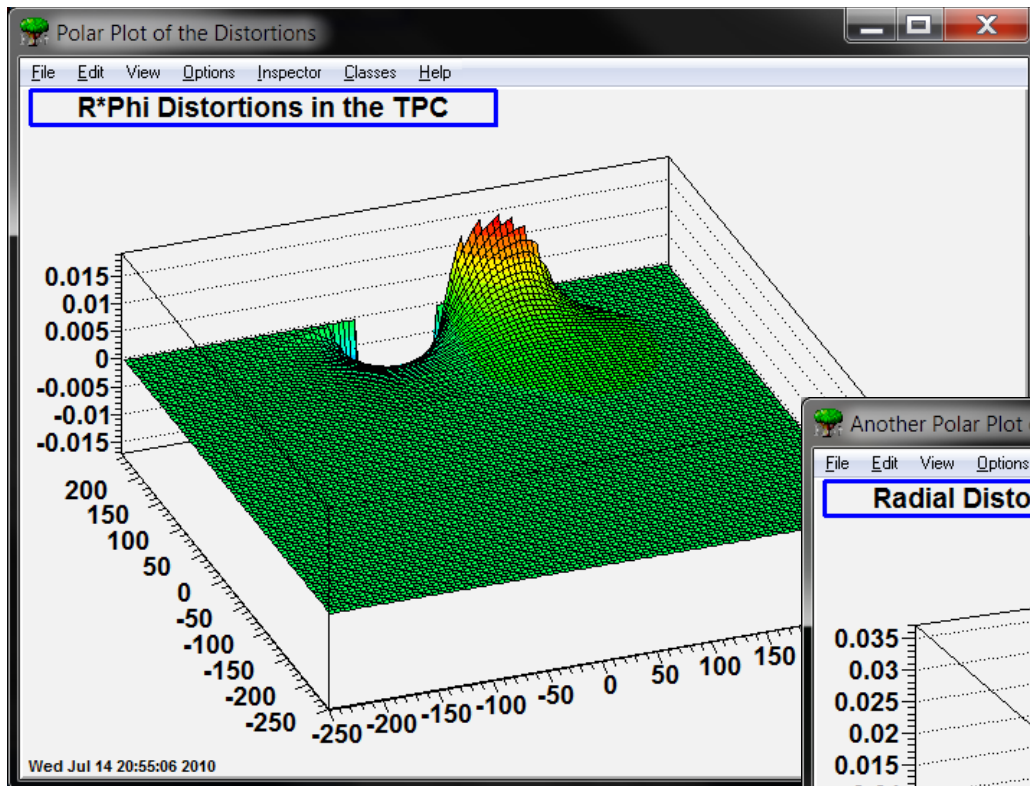


- Distortion on the A and C side – spot at sectors 10 and 11
- Smaller spike at the sector 14/15 only on A side

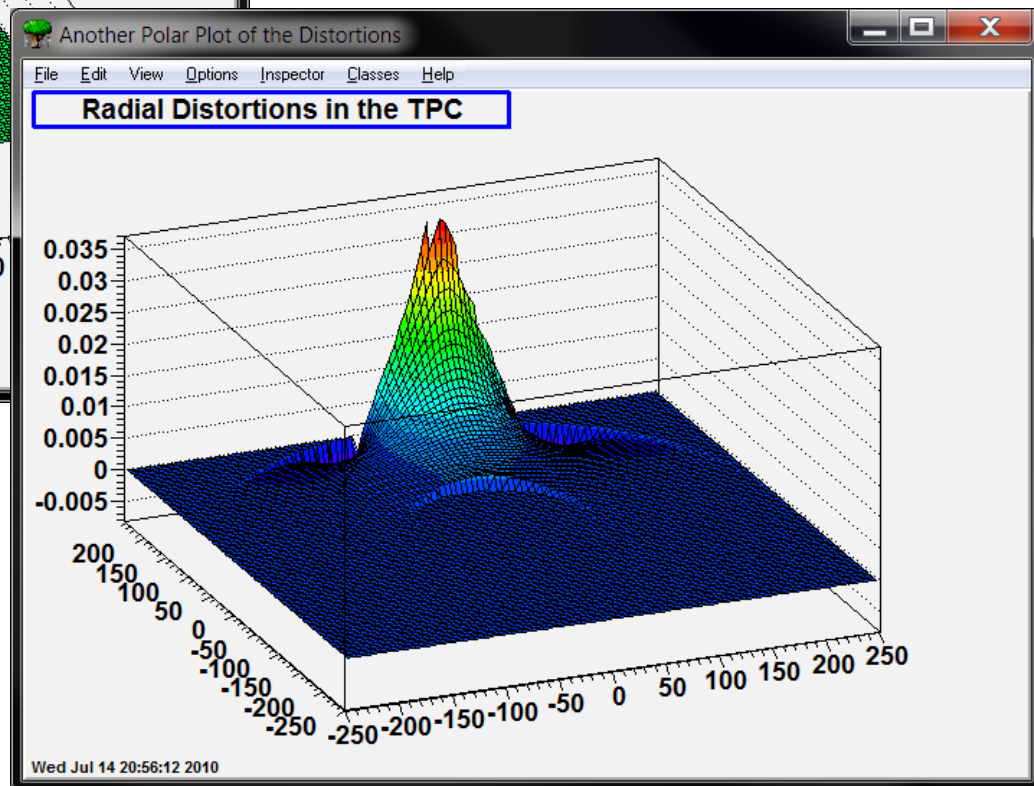


- Shifted Rods
- Rotated Clip (candidate)

Outer Rod Shifted – B Field On



- Outer Rod deformation propagates further compared to IR



- **Shifted Rods and Rotated Clips have similar shapes ...**
 - Note the position of the rods compared to the nodes in the distributions. The distortion map data show two different patterns for the position of the rods with respect to the nodes
 - The majority of the distortions look like shifted rods. One of the distortions, the largest, looks like a rotated clip
 - Note that the R-Phi and Radial maps, for the models, swap roles when comparing shifted rods to rotated clips
- **The model distortions are similar to some of the things that Marian et al. have already mapped out empirically**
 - Would be good to compare the Z (drift) dependence for the maps for better comparison to model calculations & confirmation of systematics
 - Marian has produced an interesting file ... that I (at least) haven't analyzed yet.
- **One small problem is that the rotated clip model assumes that all clips on the resistor rod are rotated by the same amount**
 - Danilo doesn't believe it ... too much of a coincidence
 - But it is clear that the candidate circled in blue (previous page) is not a shifted rod, something else?

Still have one other idea to explore

Backup Slides

Error Budget for Shifted Rods



- Cylindrical Tongue and Groove wobble
 - 100-200 μm
- Machining tolerance in plastic
 - 50-100 μm
- Parts are glued in place by hand so there is also a placement error
 - 200-300 μm (guesstimate, needs to be confirmed with experts)
- Rods are indexed to the Central Electrode. The far end floats, so only the position of the CE and the length of the rods are important.
 - Leads to possible ‘integral’ error in the overall length of the rods
 - This is not what I have modeled for this presentation. I have modeled a uniform shift at all positions down the rod.

Wolfgang says “we see him naked” ... and naked means that 100-200 μm fabrication errors are to be expected. No surprises, here. The remarkable thing is that the TPC is so precise that we can see these things.