TPC Analysis Jamboree – Orsay (May 2009)

Space charge: PART I

Analytical solution of the Laplace equ. for a coaxial cavity

Space charge: PART II

Space charge scenarios for the ALICE TPC

Space charge: PART III

Space point distortions due to space charges and more ...

Stefan Rossegger

Space charge: PART III

Space point distortions due to space charges and more ...

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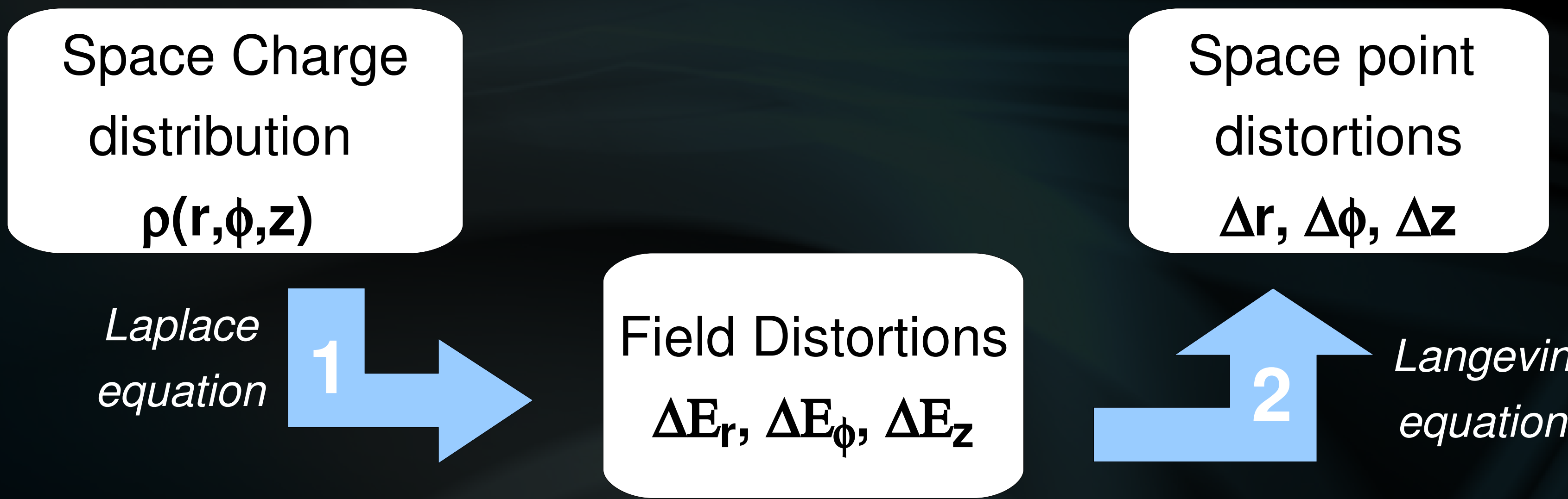
Basic concept



Solved by the ...

... novel analytical solution

(see Part I)

So far **numerically ...**

... with either ALIROOT code

... or within GARFIELD

... Equation of motion

$$\mathbf{u} = \frac{e}{m}\tau|\mathbf{E}|\frac{1}{1+\omega^2\tau^2}\left(\mathbf{E} + \omega\tau[\mathbf{E}\times\mathbf{B}] + \omega^2\tau^2(\mathbf{E}\cdot\mathbf{B})\mathbf{B}\right)$$

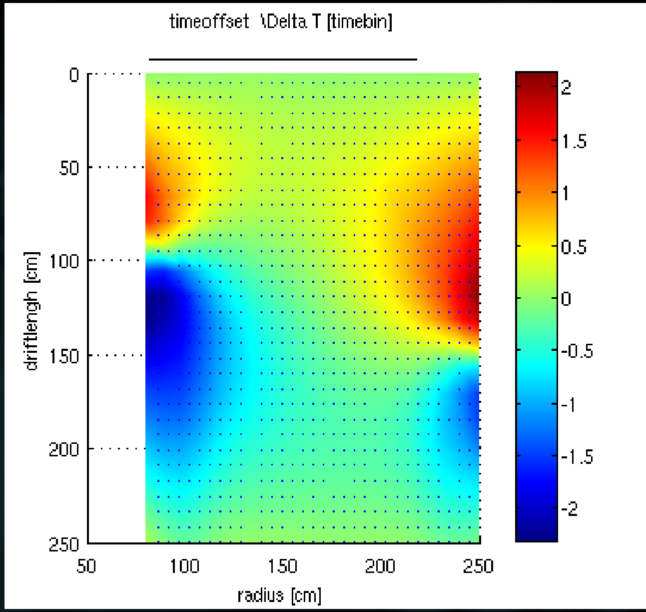
*Included in the numerical algorithm (within **AliRoot**):*

- Inhomogeneous **B-field** (via `AliMagF`)
- Inhomogeneous **E-field** (due to Space Charges)
- **Drift velocity** dependency for changing E field

  (Δvd_E ~ 0.24 [% cm/V])

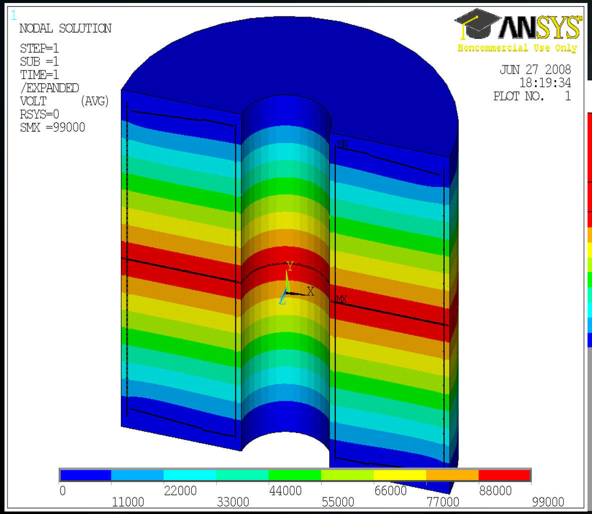
Further studies within Garfield ....

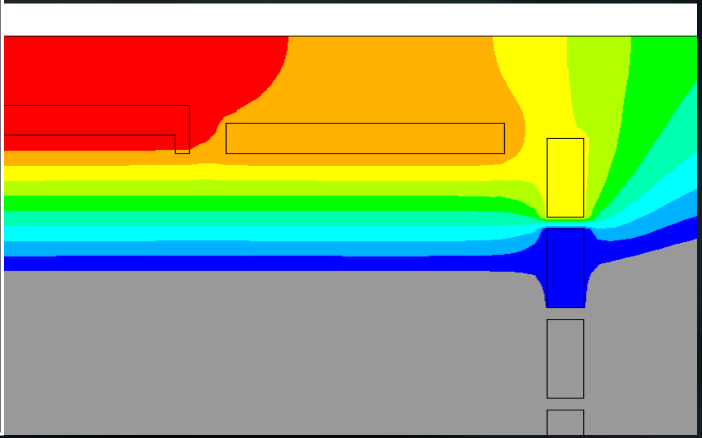
e.g. broken resistor in the field cage

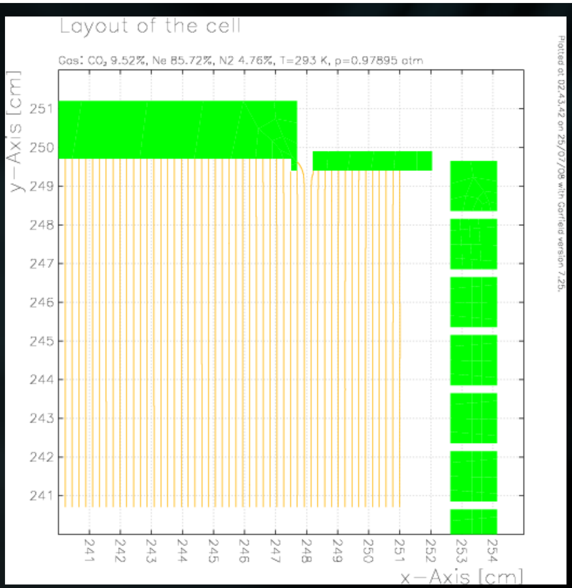


Included (besides the above):

- **E-field deviations** due to Field Cage or Read Out chambers (*Finite-Element* map)
- **Gas density** variations (P,T,gas composition by *Magboltz*)







Case studies: Space Charges

Case I: Primary Ionization

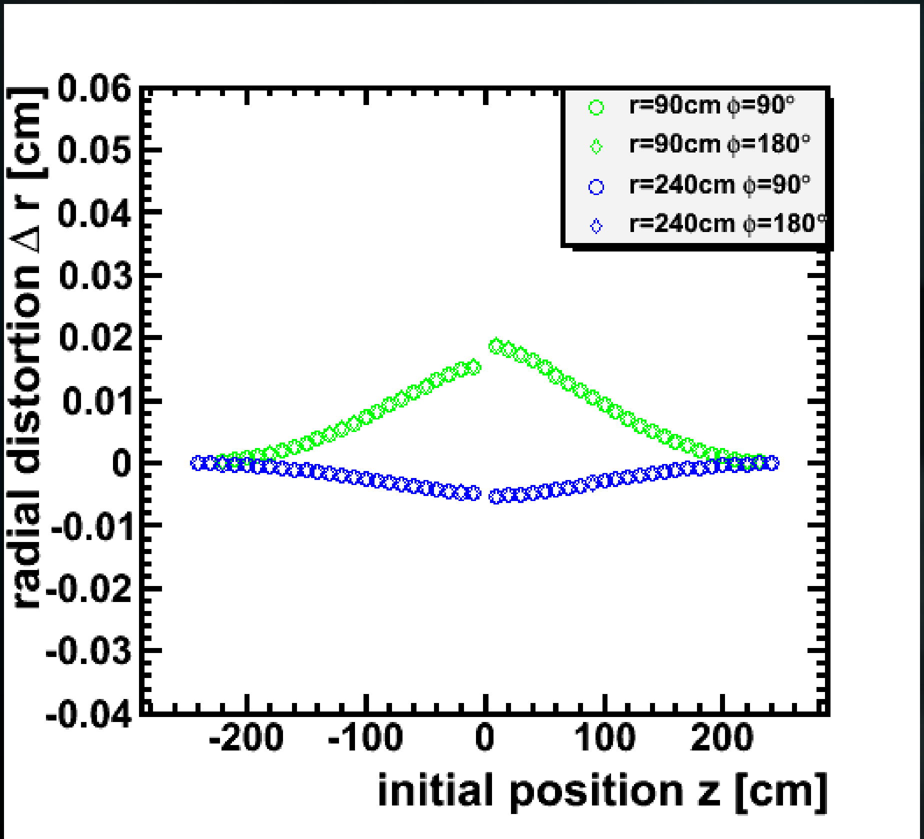
Case II: Primary Ionization + ROC-IFB

Case III: PI + Leaking gate wires

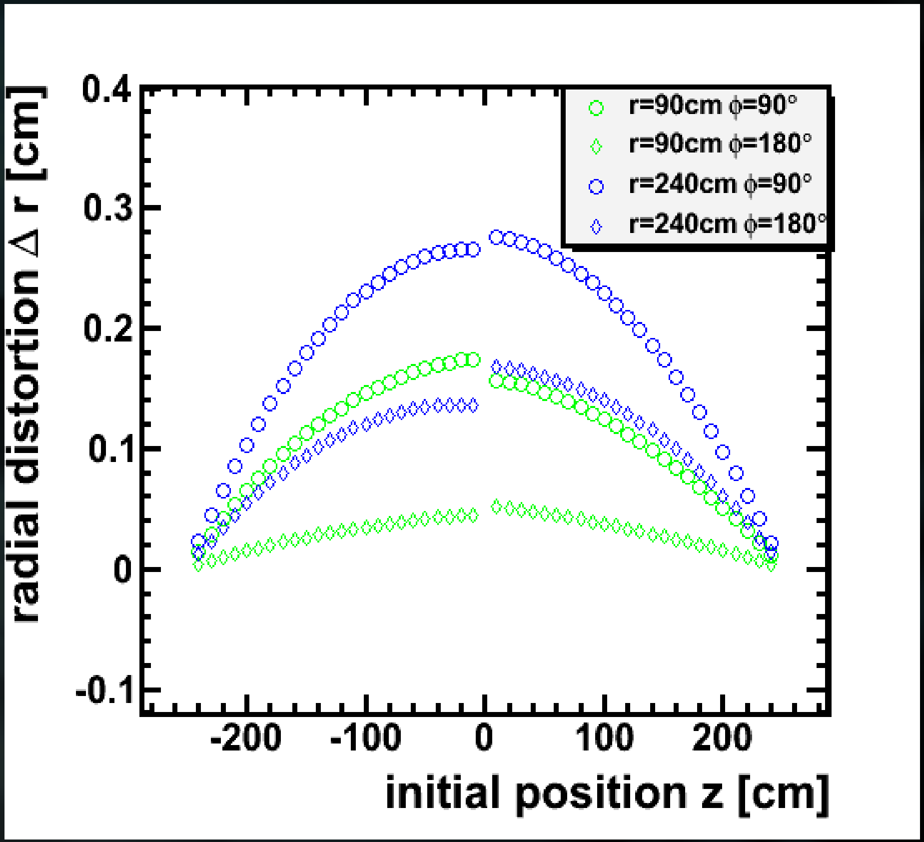
Case IV: Leak between IROC&OROC

Case I: Primary Ionization – Pile Up

Charge distribution is basically radial symmetric. MAX: ~ $2.4e^{-10}C/m^3$



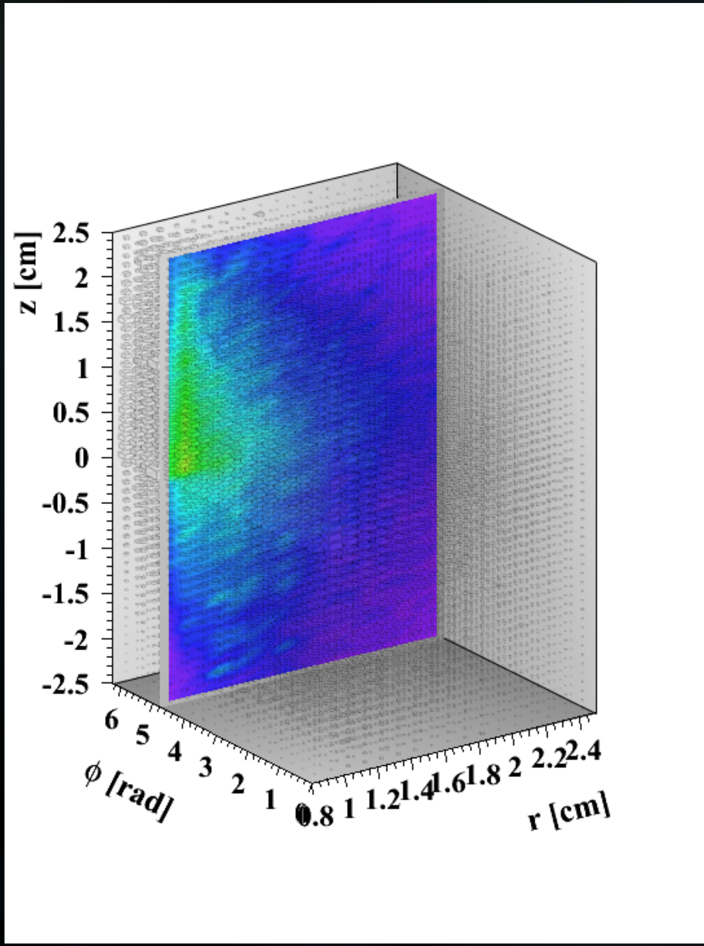
+ uniform B-field (B_z=0.5 T)

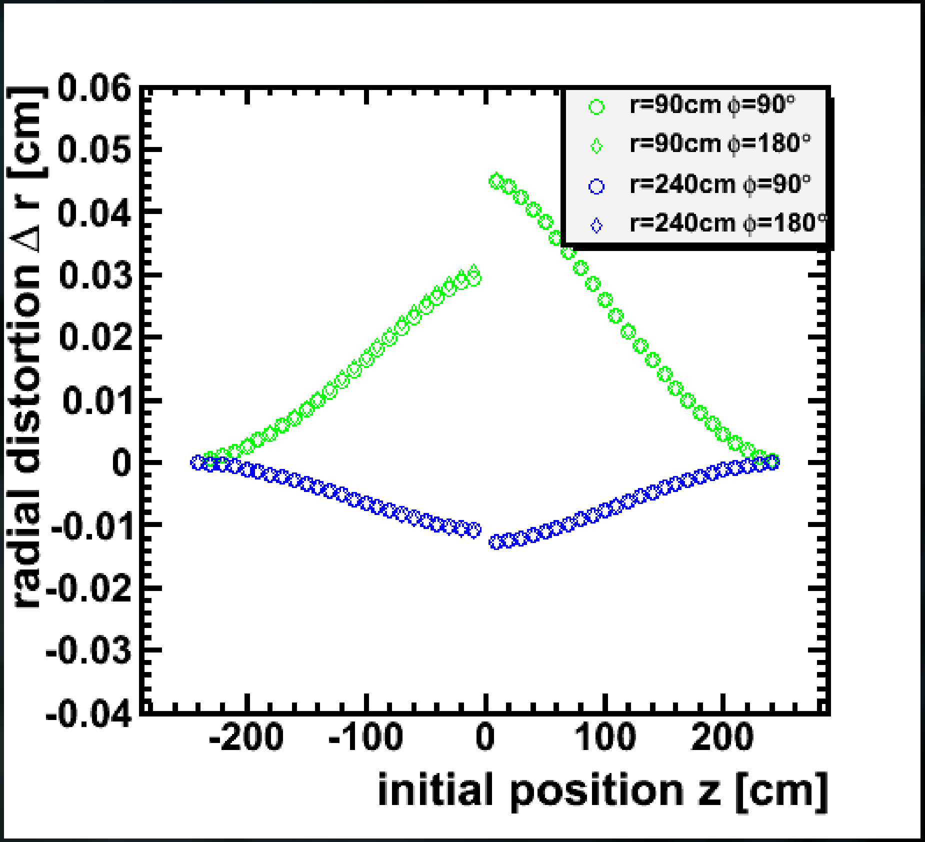


+ measured B-field (AliMagF)

Case II: Primary Ionization + ROC-IFB

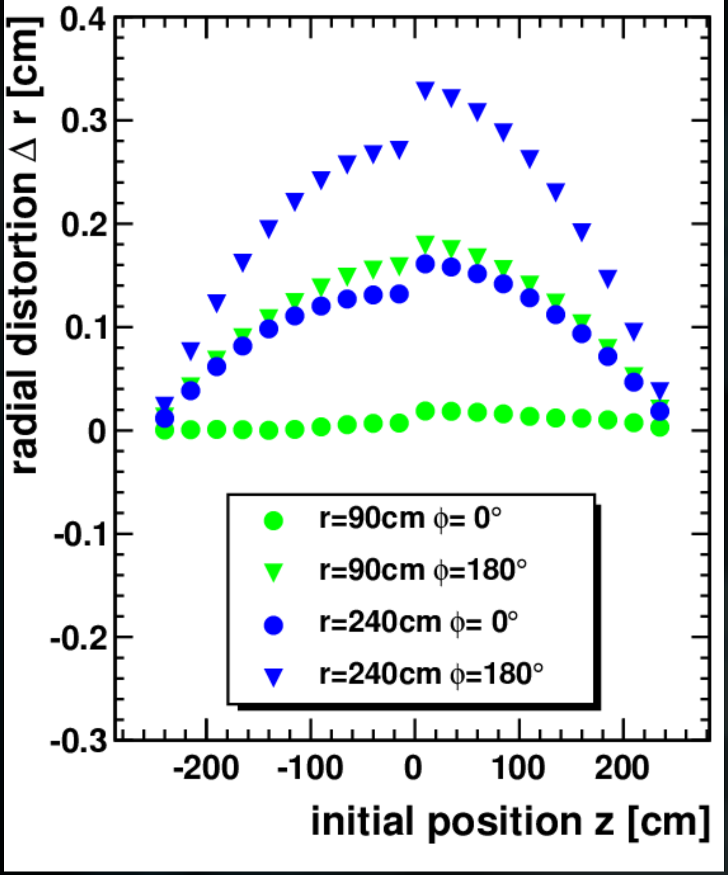
Charge distribution is stil radial symmetric (but not z symmetric)





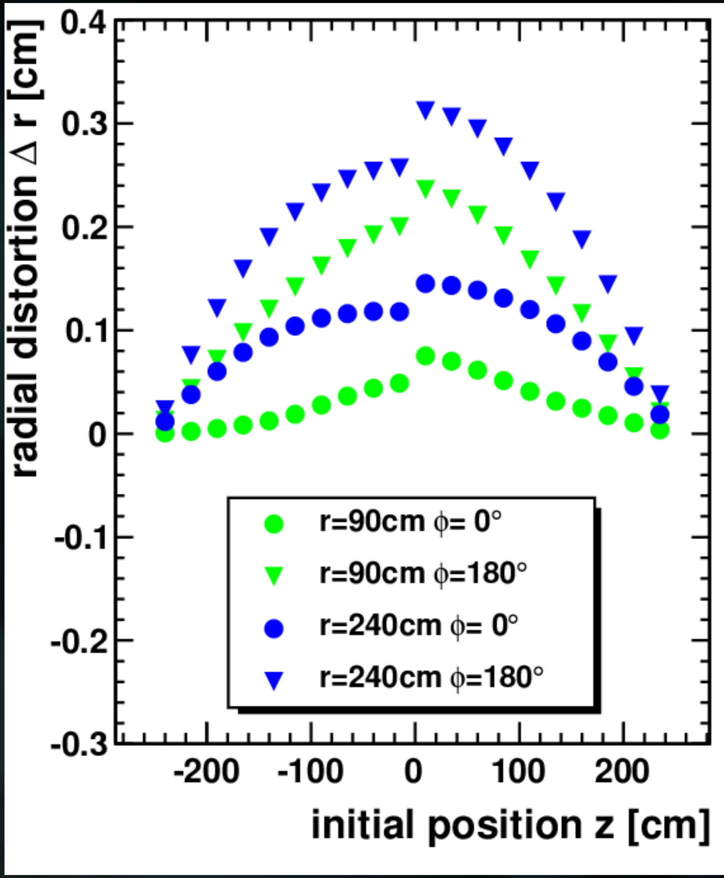
+ uniform B-field (B_Z=0.5 T)

... combined with the B Field inhom.



Δr due to **imperfect B-field**

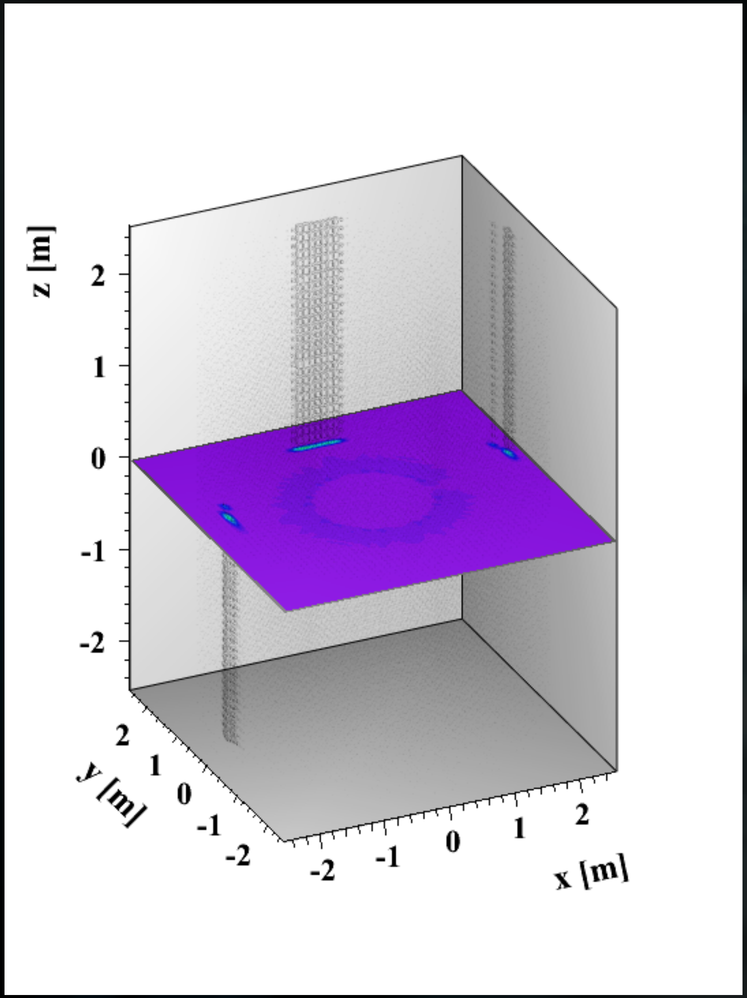
(B_z=0.5 T)

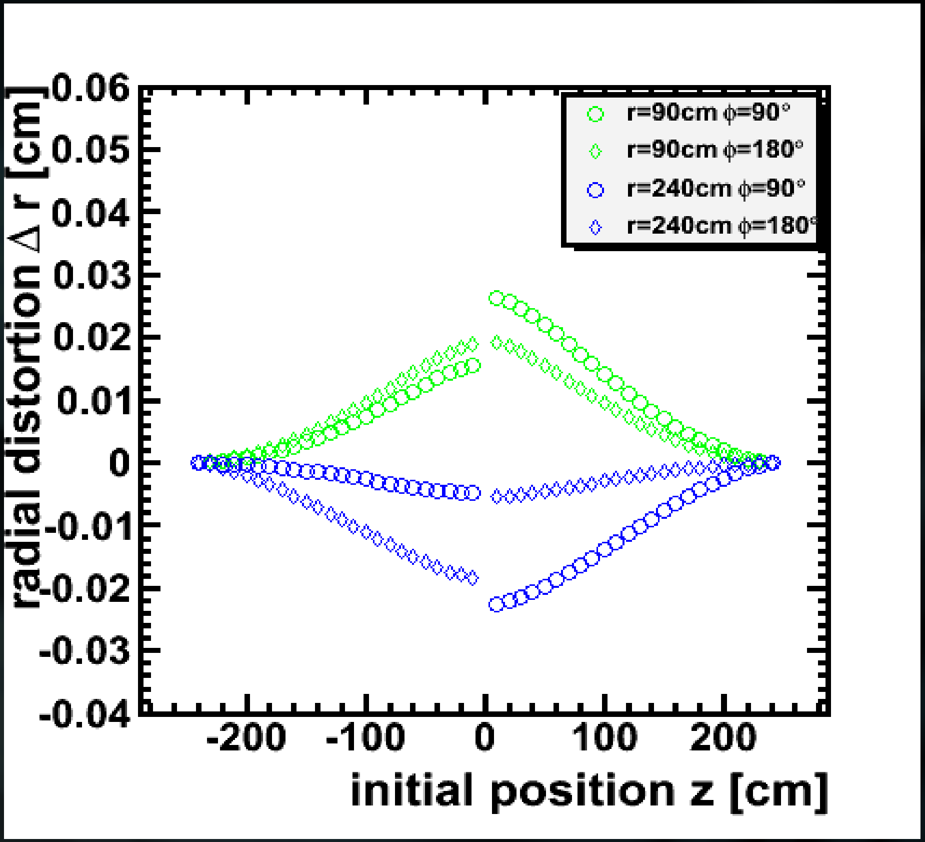


Δr due to **imperfect B-field**

plus **expected space charges**

Case III: PI + Leaking gate wires

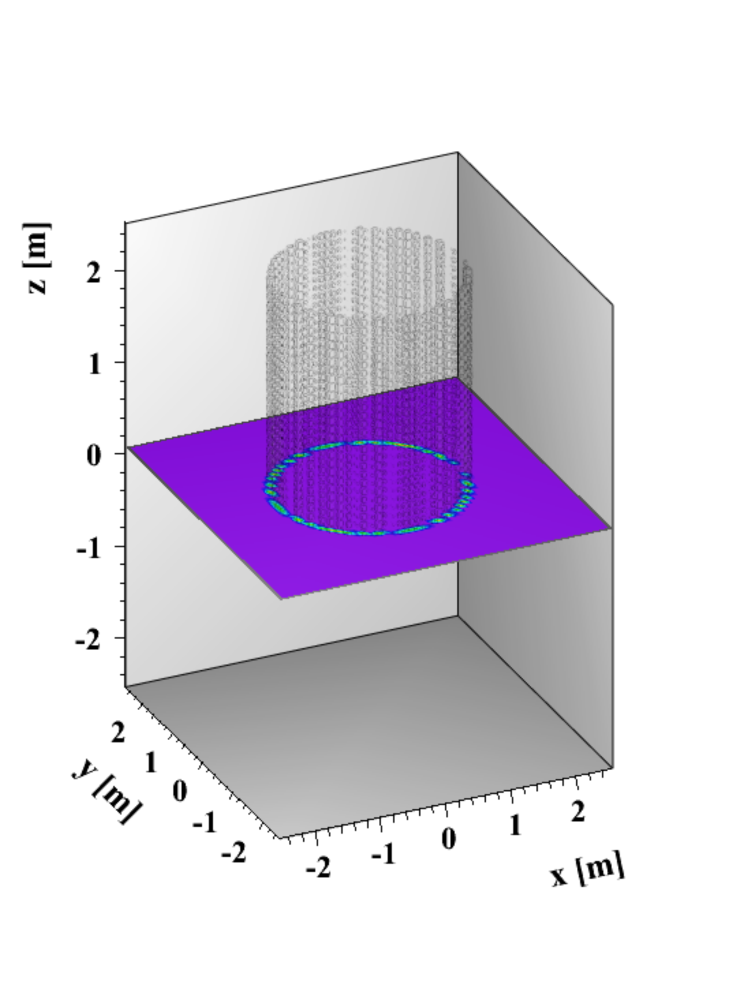


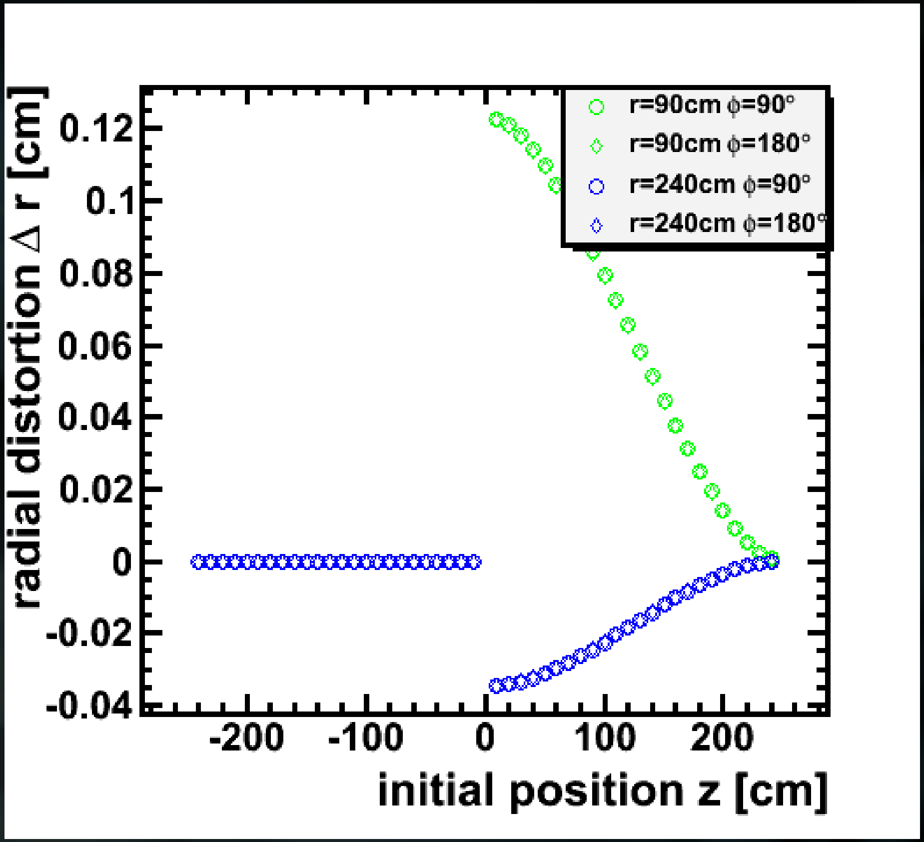


+ uniform B-field (B_z=0.5 T)

THERE IT BECOMES complicated, but it's easy to calculate ;-)

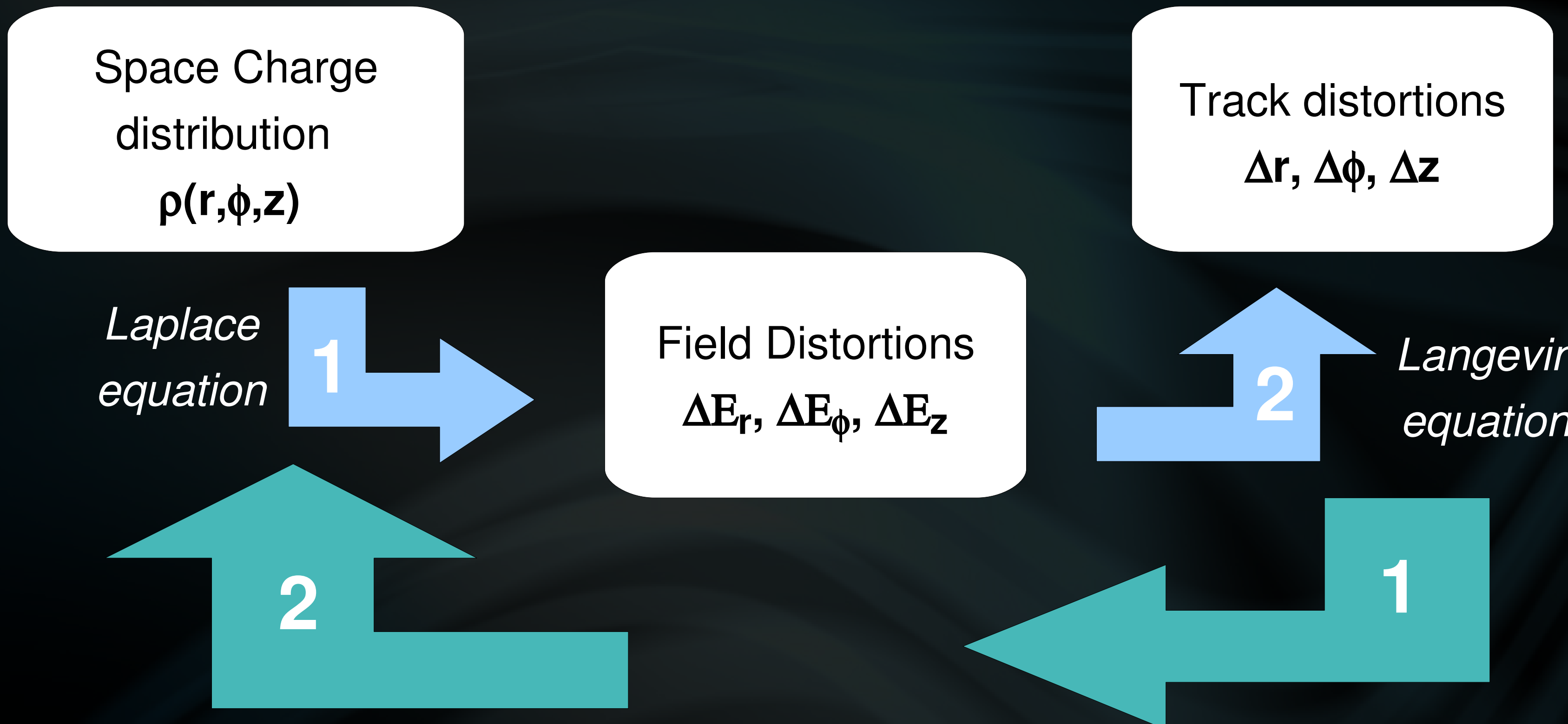
Case IV: Leak between IROC&OROC





Problem of the STAR TPC ... ?

The Inverse Model

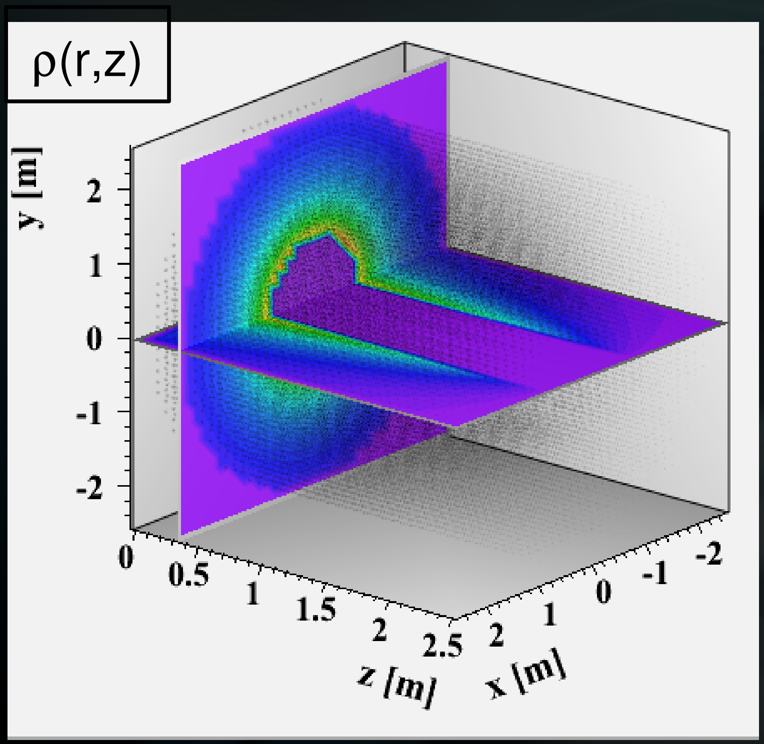


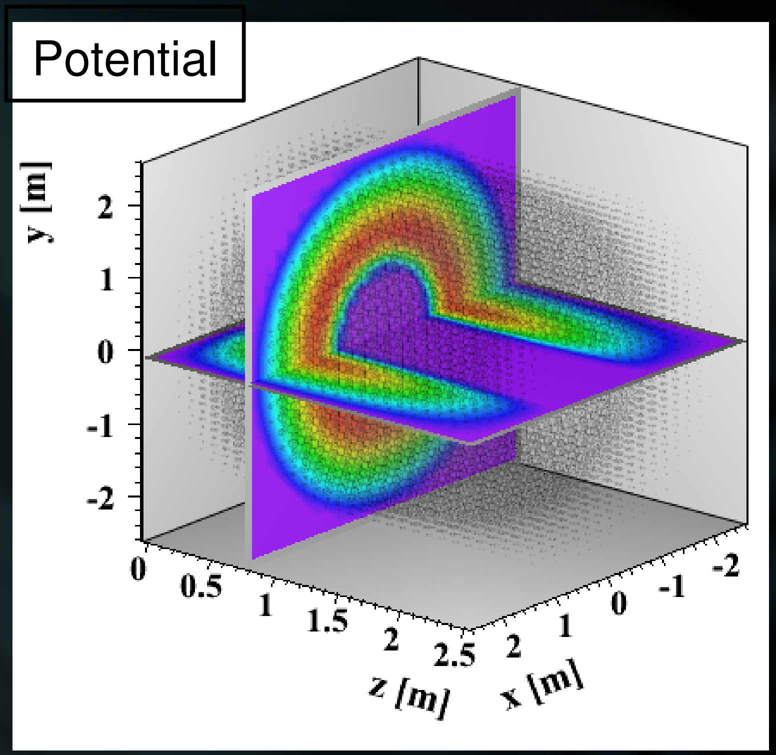
THIS WORKS ALREADY !!

(THIS NEEDS SOME WORK)

Inverse Model: Step 2

Thanks to the analytical solution, this is fast and accurate ...





A_1: $(2.19\ {}^{-}/_{+}\ 0.07)e^{-10}$

A_2: $(-0.87\ {}^{-}/_{+}\ 0.05)e^{-10}$

Model:
$\rho(r,z) = (A_1+A_2 z) / r^2$

... due to simulated events

CONCLUSION

- Forward direction | $\rho(r,\phi,z)$ - $(\Delta E_r, \Delta E_\phi, \Delta \varepsilon_z)$ - $(\Delta r, \Delta\phi, \Delta z)$ | works nicely for any Charge distribution one might find!
- Thanks to *Garfield* (Rob Veenhof), we can include nearly any distortion-effect into our calculations (complete TPC simulation)

➡ **Simulations, predictions and crosschecks possible**

- Inverse Model: Would lead to nice **'tomographic picture'** of inhomogeneities (in charge equivalence) within the TPC

ANY QUESTIONS OR SUGGESTIONS ?