Progress in Garfield Simulation

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Quick overview

- To run the Garfield, we need to prepare the setting files RTPC.geo, and RTPC.sif, and the software Gmsh and Elmer.
  - Gmsh can construct the grids of the geometry with the RTPC.geo, and the output file is RTPC.msh
  - Elmer can help to define the electric potential of the grids with the files RTPC.msh and RTPC.sif. The output file would be RTPC.result.
- Garfield is constructed for Bonus by Nate, and therefore we can compile the code to get the executable file which can simulate the drift region in RTPC. The output file is a root file format.
- Run the analysis code done by Nate, we can get the parameter of fit equations.
- A temporary memo for the step-by-step instruction of running the Garfield simulation for RTPC is written in my GitHub. https://github.com/YuchunHung/garfield-in-rtpc/blob/main/README.md

- Observed:
  - There is a new output file RTPC.msh with running the new Gmsh version.
  - Same RTPC.msh file can produce almost same results (which are located in RTPC/ directory in the garfieldpp) when getting the information of the electric potential in RTPC.

Parameter

- Potential Settings:
  - Electric potential : V_cathode = -4058V
  - B-field : 1.0 T
  - Pressure = 760 torr
  - Gas-Mixture = 80:20 He:CO2
  - Temp = 293 K
- Link of comparing results: https://userweb.jlab.org/~nathand/rgf/parameters/rgf_sum_cosmics/1p0/index.html
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Fitting function of the drift time and drift angle

- Fitting function of the drift time

$$t_d(r,z) = a_t(z) + b_t(z)\left[\frac{1}{2} + \frac{r_{min}^2 - r_{max}^2 + \sqrt{4\left(0.1 + c_t^2(z)\right)(r_{max}^2 - r^2) + (r_{max}^2 - r_{min}^2 - 0.1 - c_t^2(z))^2}}{2(0.1 + c_t^2(z))}\right] + t_{gap}$$

, where $r_{min} = 3.0cm$, $r_{max} = 7.0cm$, and

$$a_t(z) = a_{t,0} + a_{t,1}z^2 + a_{t,2}z^4$$
$$b_t(z) = b_{t,0} + b_{t,1}z^2 + b_{t,2}z^4$$
$$c_t(z) = c_{t,0} + c_{t,1}z^2 + c_{t,2}z^4$$

- Fitting function of the drift angle

$$\phi_d(r,z) = a_\phi(z) + b_\phi(z)\ln\left(\frac{r_{max}}{r}\right) + c_\phi(z)\left(\frac{1}{r^2} - \frac{1}{r_{max}^2}\right) + \phi_{gap}$$

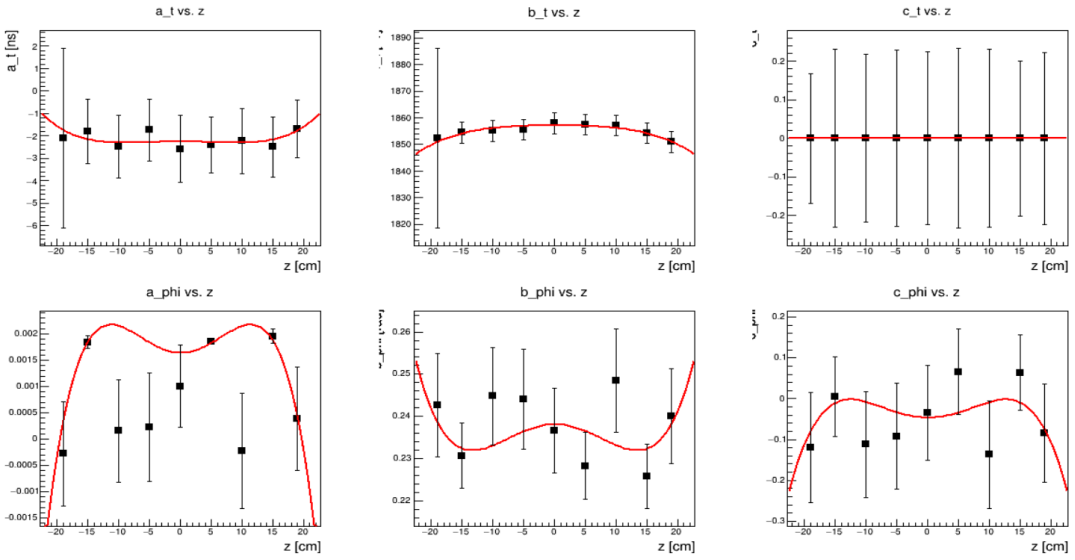
, where $r_{min} = 3.0cm$, $r_{max} = 7.0cm$, and

$$a_\phi(z) = a_{\phi,0} + a_{\phi,1}z^2 + a_{\phi,2}z^4$$
$$b_\phi(z) = b_{\phi,0} + b_{\phi,1}z^2 + b_{\phi,2}z^4$$
$$c_\phi(z) = c_{\phi,0} + c_{\phi,1}z^2 + c_{\phi,2}z^4$$

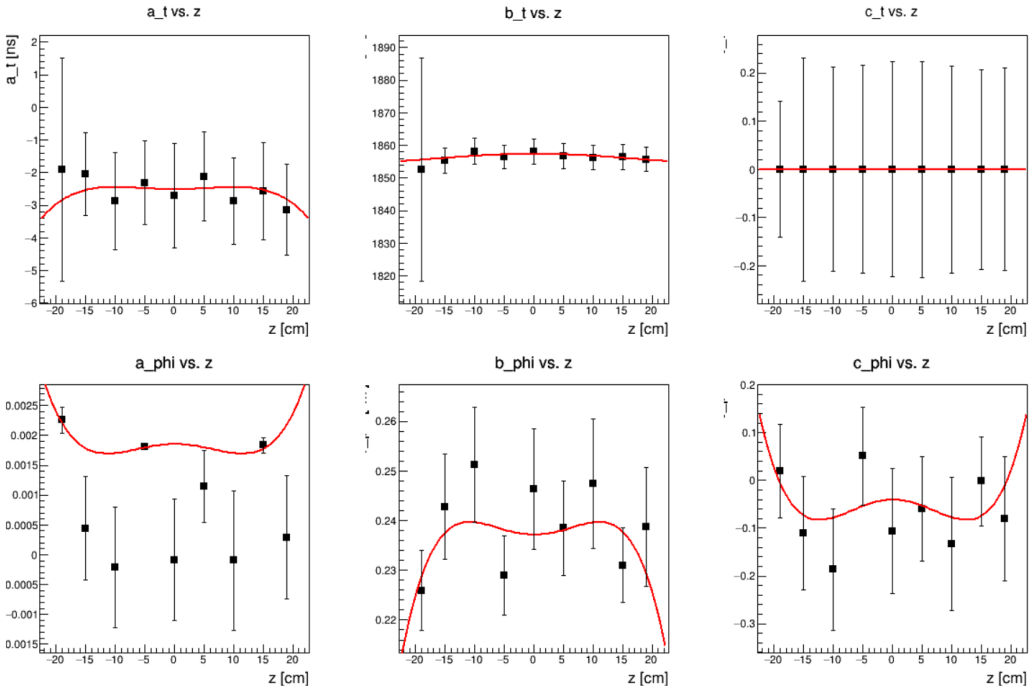
Compare the results with newly RTPC.msh

Nate's results

Parameter fits



My results



Compare the results with newly RTPC.msh

Nate's results

t_{gap} = 434.855 ns

ϕ_{gap} = 0.0297455 rad

$a_{t,0}$ = -2.25522
$a_{t,1}$ = -0.00118122
$a_{t,2}$ = 7.16786e-06

$a_{\phi,0}$ = 0
$a_{\phi,1}$ = 0
$a_{\phi,2}$ = 0

$b_{t,0}$ = 1857.14
$b_{t,1}$ = -0.00670956
$b_{t,2}$ = -2.78852e-05

$b_{\phi,0}$ = 0.238104
$b_{\phi,1}$ = -6.91502e-05
$b_{\phi,2}$ = 1.93561e-07

$c_{t,0}$ = 0
$c_{t,1}$ = 0
$c_{t,2}$ = 0

$c_{\phi,0}$ = -0.0464023
$c_{\phi,1}$ = 0.000566116
$c_{\phi,2}$ = -1.79908e-06

My results

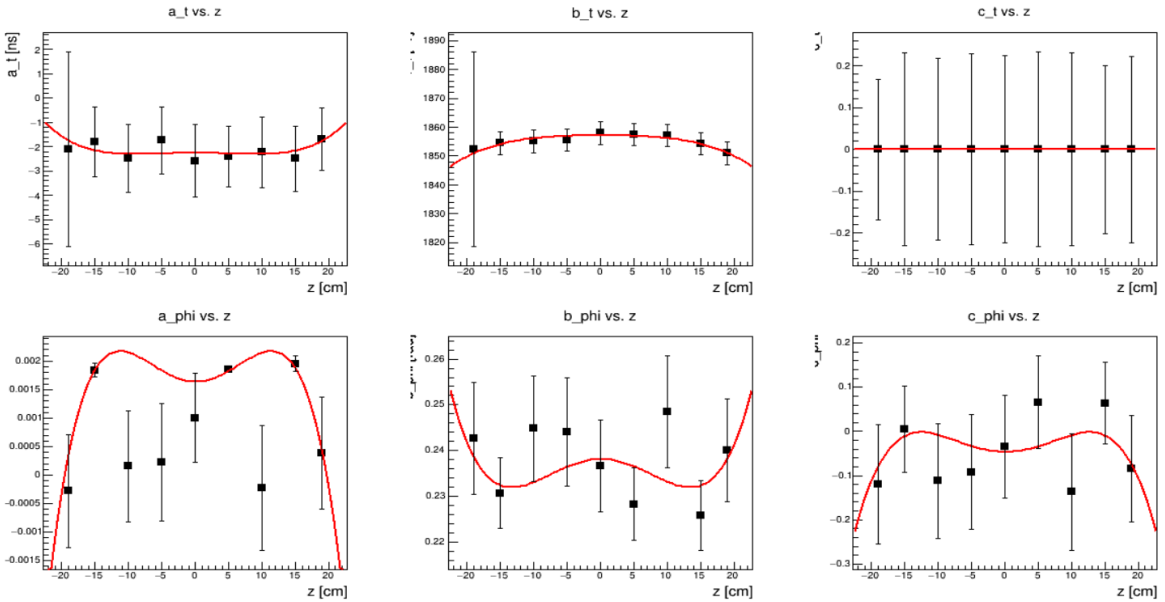
t_{gap} =?
$a_{t,0}$ = -2.5152;
$a_{t,1}$ = 0.0012293;
$a_{t,2}$ = -5.81347e-06;
$b_{t,0}$ = 1857.37;
$b_{t,1}$ = -0.00640233;
$b_{t,2}$ = 4.10212e-06;
$c_{t,0}$ = 0;
$c_{t,1}$ = 0;
$c_{t,2}$ = 0;

ϕ_{gap} =?
$a_{\phi,0}$ = 0;
$a_{\phi,1}$ = 0;
$a_{\phi,2}$ = 0;
$b_{\phi,0}$ = 0.237147;
$b_{\phi,1}$ = 4.34563e-05;
$b_{\phi,2}$ = -1.82163e-07;
$c_{\phi,0}$ = -0.0408317;
$c_{\phi,1}$ = -0.000540843;
$c_{\phi,2}$ = 1.74981e-06;

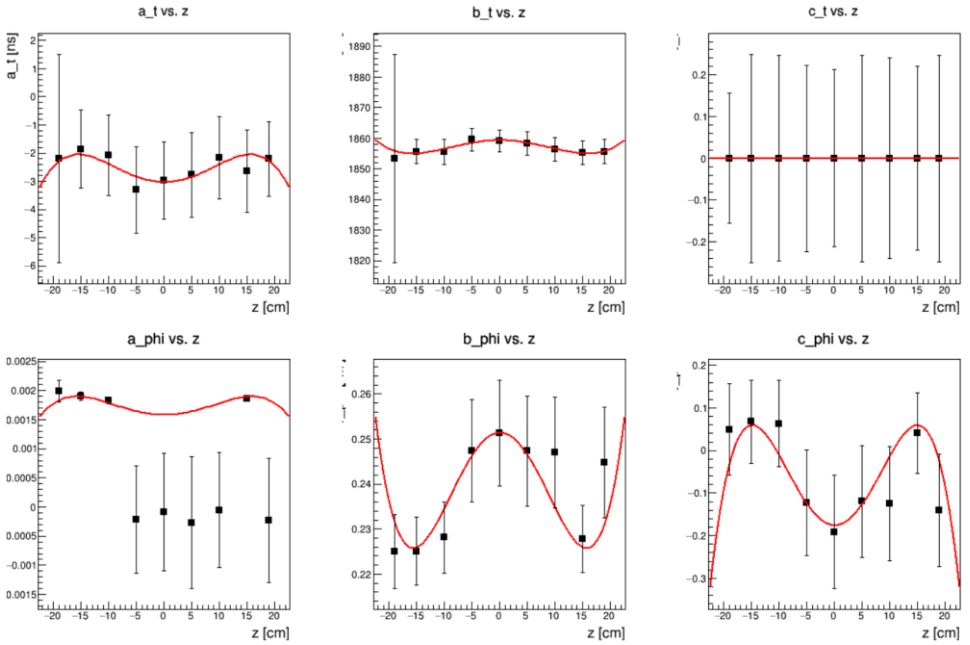
Compare the results with same RTPC.msh

Nate's results

Parameter fits



My results



Compare the results with same RTPC.msh

Nate's results

t_{gap} = 434.855 ns

$a_{t,0}$ = -2.25522
$a_{t,1}$ = -0.00118122
$a_{t,2}$ = 7.16786e-06

$b_{t,0}$ = 1857.14
$b_{t,1}$ = -0.00670956
$b_{t,2}$ = -2.78852e-05

$c_{t,0}$ = 0
$c_{t,1}$ = 0
$c_{t,2}$ = 0

ϕ_{gap} = 0.0297455 rad

$a_{\phi,0}$ = 0
$a_{\phi,1}$ = 0
$a_{\phi,2}$ = 0

$b_{\phi,0}$ = 0.238104
$b_{\phi,1}$ = -6.91502e-05
$b_{\phi,2}$ = 1.93561e-07

$c_{\phi,0}$ = -0.0464023
$c_{\phi,1}$ = 0.000566116
$c_{\phi,2}$ = -1.79908e-06

My results

$a_{t,0}$ = -3.03076;
$a_{t,1}$ = 0.00801126;
$a_{t,2}$ = -1.64058e-05;
$b_{t,0}$ = 1859.32;
$b_{t,1}$ = -0.0344502;
$b_{t,2}$ = 6.83355e-05;
$c_{t,0}$ = 0;
$c_{t,1}$ = 0;
$c_{t,2}$ = 0;

$a_{\phi,0}$ = 0;
$a_{\phi,1}$ = 0;
$a_{\phi,2}$ = 0;
$b_{\phi,0}$ = 0.2514;
$b_{\phi,1}$ = -0.000208073;
$b_{\phi,2}$ = 4.22005e-07;
$c_{\phi,0}$ = -0.175081;
$c_{\phi,1}$ = 0.00208972;
$c_{\phi,2}$ = -4.65743e-06;