Space Charge Determination for TPC SA

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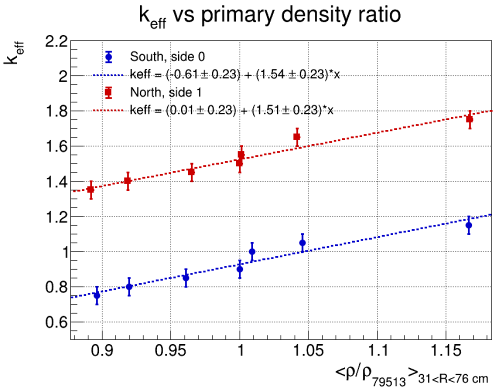
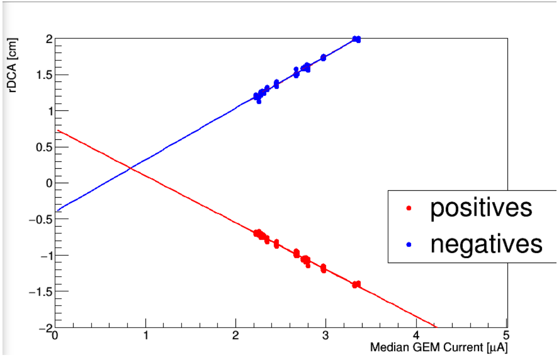
Space Charge Dependence on DC



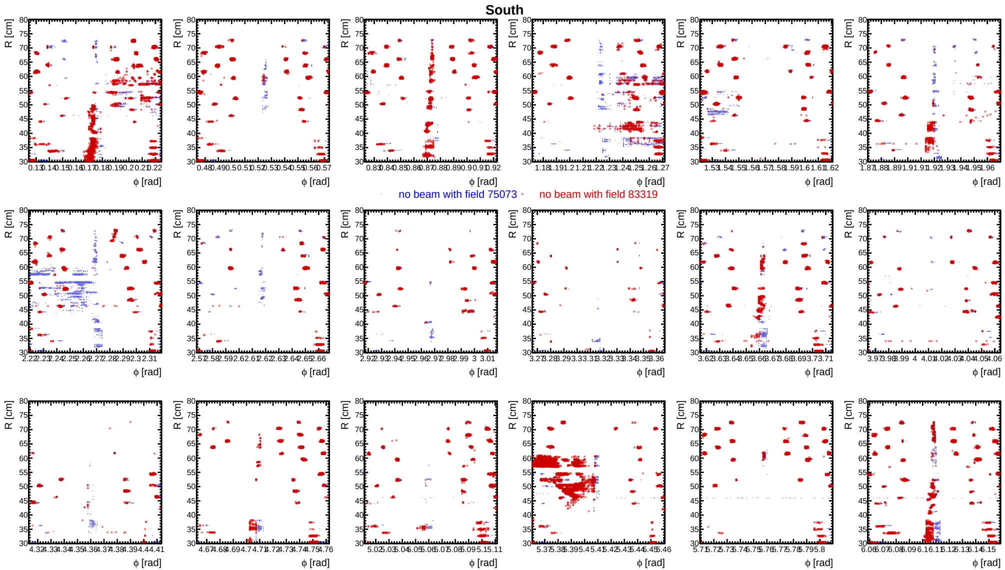


NORTH

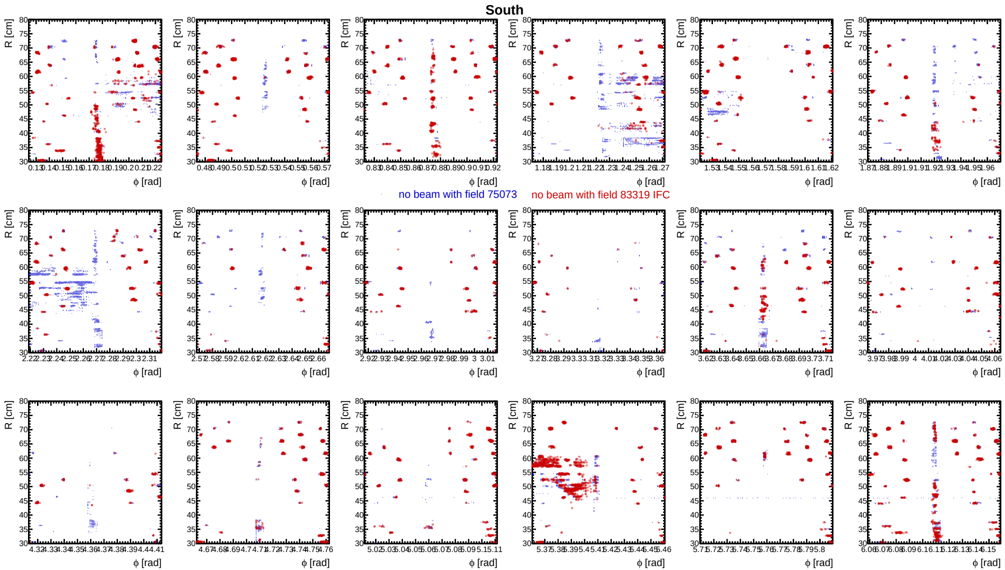
vs

SOUTH

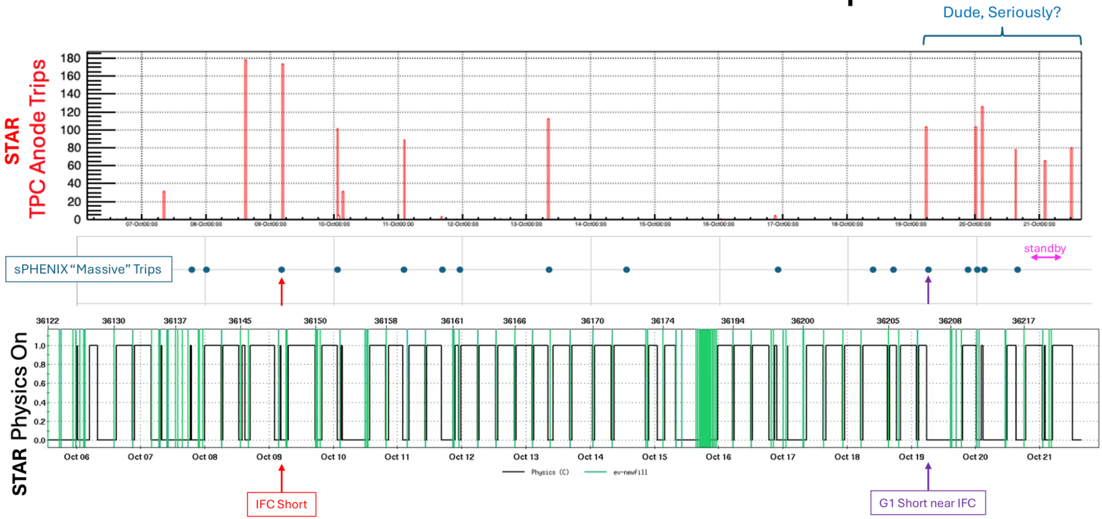
No beam with field 75073 vs No beam with field 83319 South



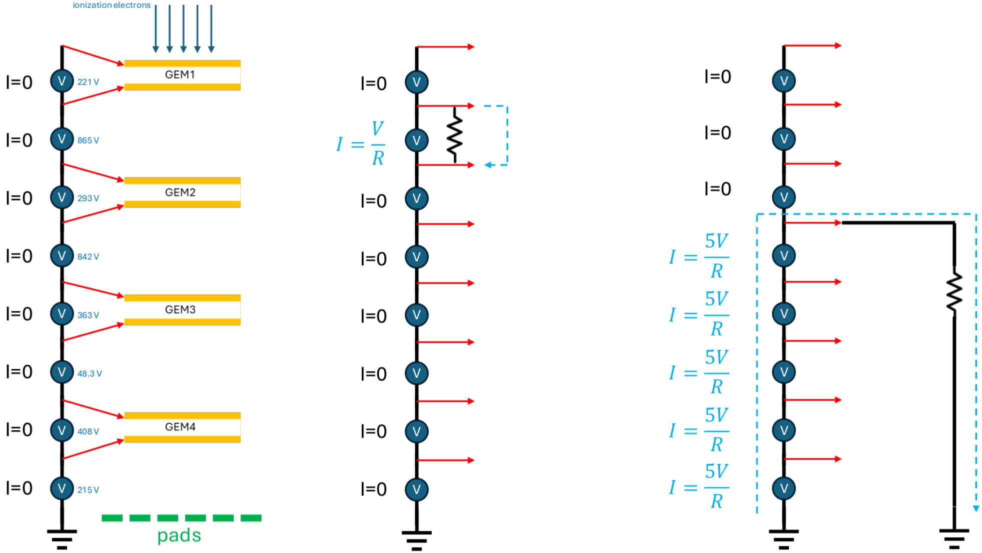
No beam with field 75073 vs No beam with field 83319 IFC



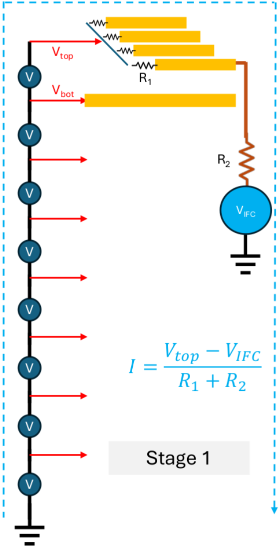
STAR and sPHENIX Records of Recent Trips

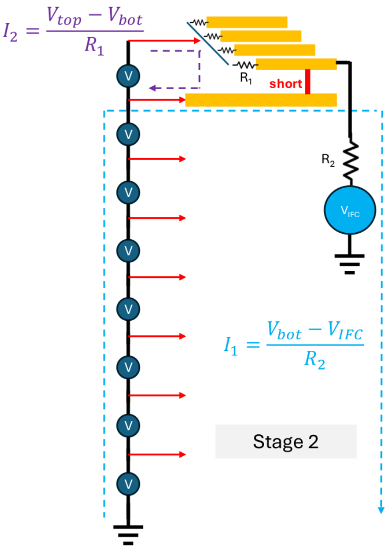


Understanding Current in a Cascaded Power Supply



Evolution of the New Issue/Mediation





Mediation Stage 1:

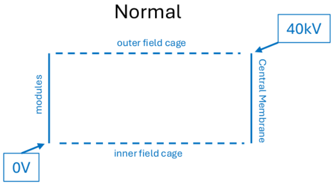
- When operating V_{top}~V_{IFC} (not too much current)
- When ramping, set ramp trip currents (universally) up by a smidgeon.

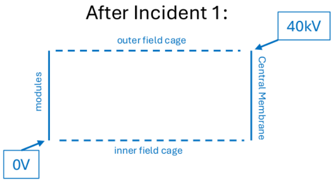
Mediation Stage 2:

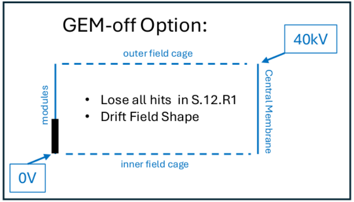
- Can't run with large I_1
- Two options:
  - G1 off (accept. loss)
  - V_{IFC}~V_{bot} (distortion)
- Prepared for either.
- Selected distortion.
  - TKH/CH prefer.
  - Needs discussion.
- When ramping set S.12.R1 ramp trip current (singular) **up by a lot**.

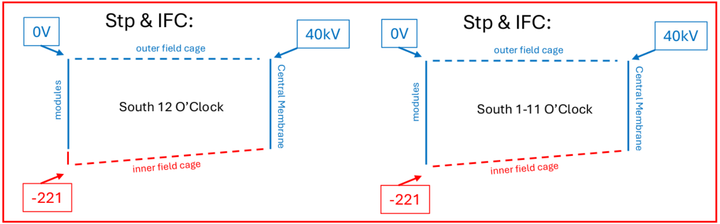
NOTE: IFC at 20 cm, tracking begins at 30 cm, distortion likely small.

Cartoons for Operation Options





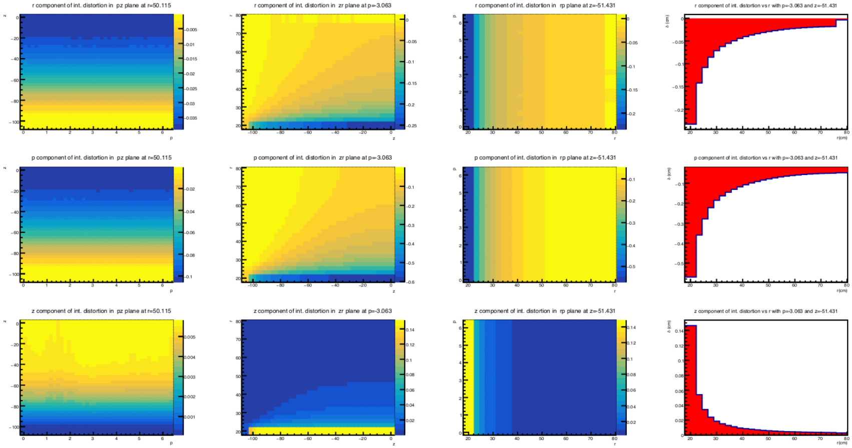




There is one more scenario called "Burn it Off"

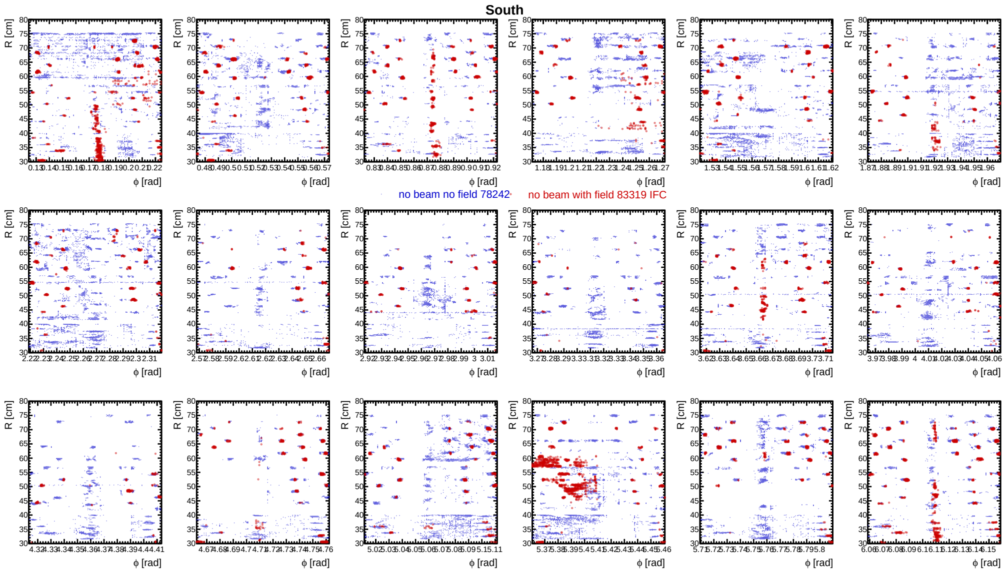
Yes, some risk…

Residuals: IFCmod-Nominal

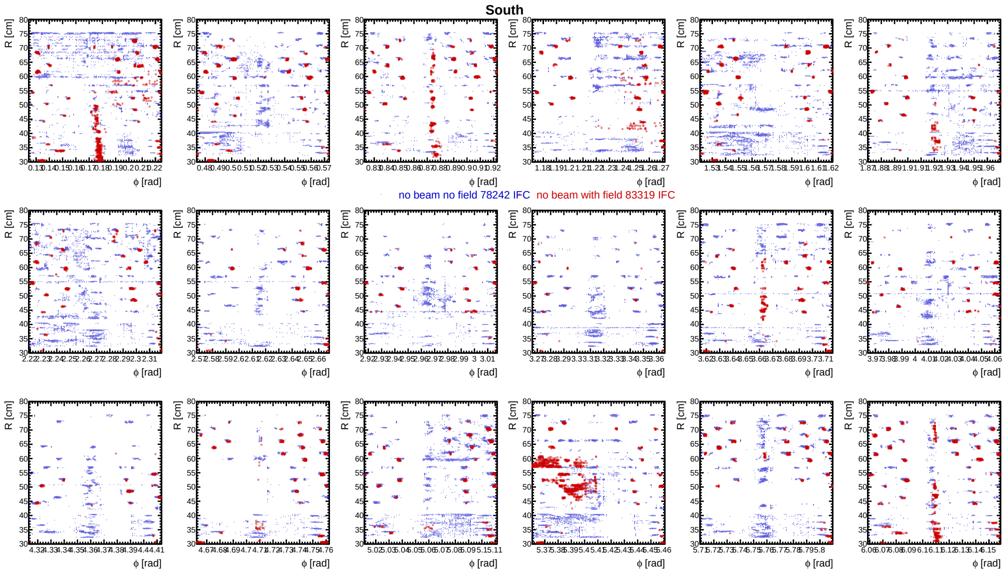


- 2mm phi in some regions of the bulk.
- most variation still R<30cm.

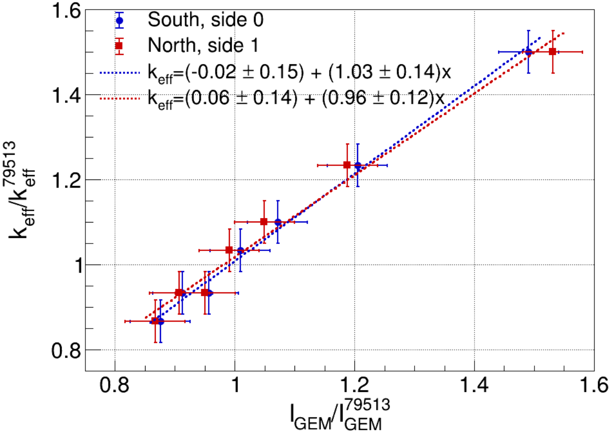
No beam with field 83319 IFC vs no beam no field 78424



No beam with field 83319 IFC vs no beam no field 78424 IFC



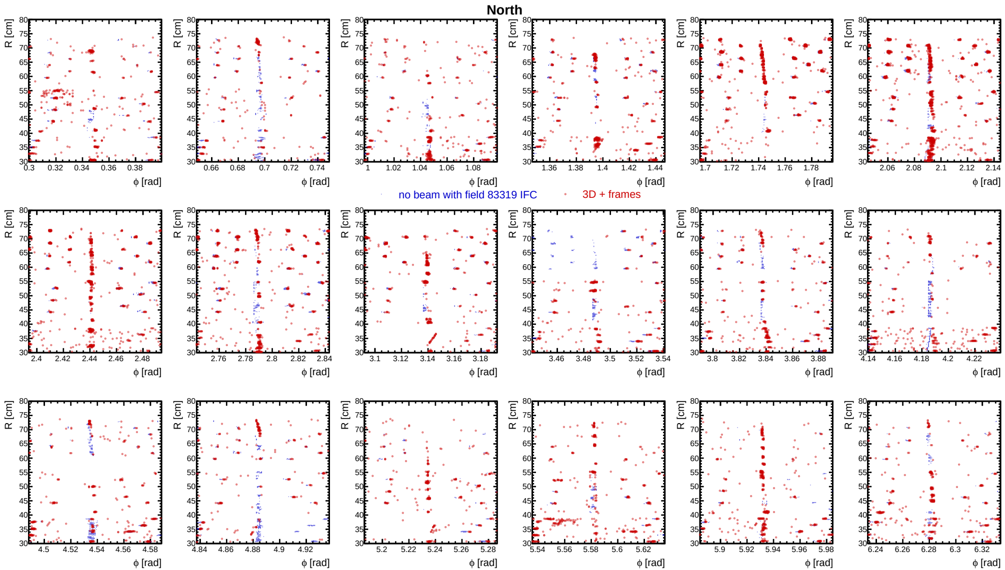
Space Charge Volume is directly proportional to the Undamaged GEM Current



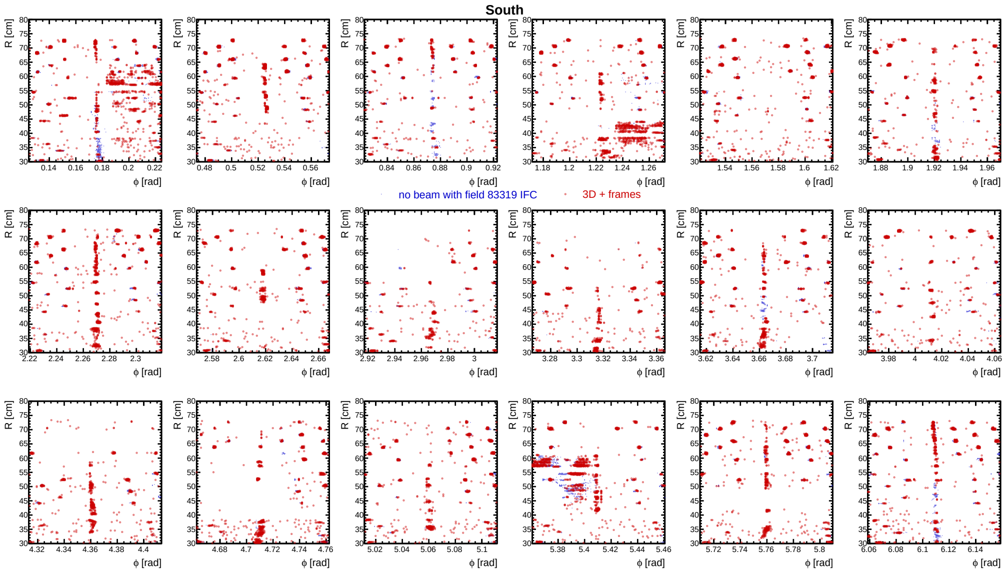
- We used for both North and South sides α i 1.8.
- For run 79513 now for both North and Sout sides K_{eff} was 1.5 $\rightarrow$ we rescale input maps by 1.5
- Now K_{eff} is directly proportional to the Undamaged GEM Current
  - It is 0 for zero of Undamaged GEM Curren
  - If Undamaged GEM Current is 1.5 times bigger than the reference run, K_{eff} is 1.5 times bigger than the reference run

North and South are finnaly consistent

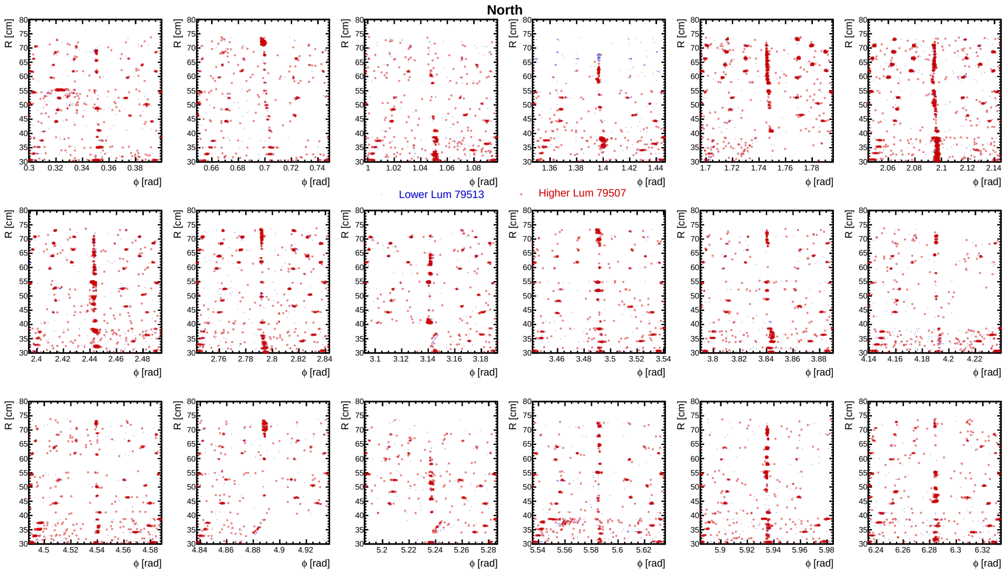
No beam with field 83319 IFC vs beam on 79513 North



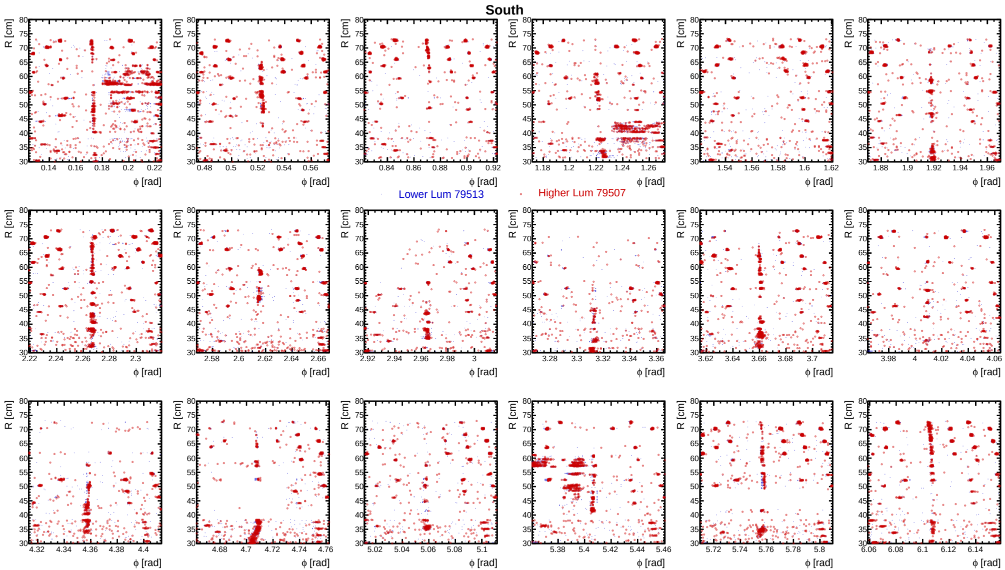
No beam with field 83319 IFC vs beam on 79513 South



Lower Luminosity 79513 vs Higher Luminosity 79507 North

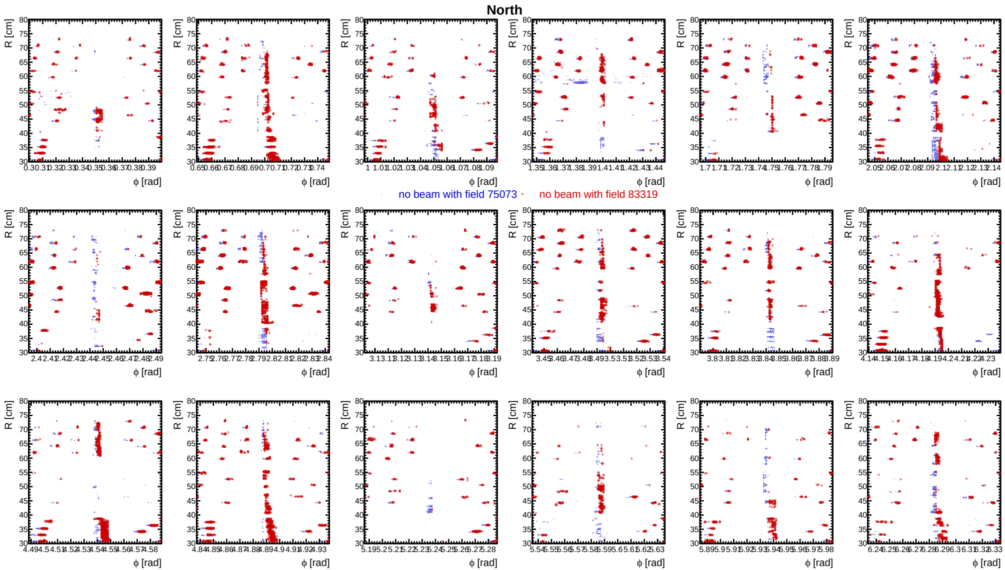


Lower Luminosity 79513 vs Higher Luminosity 79507 South

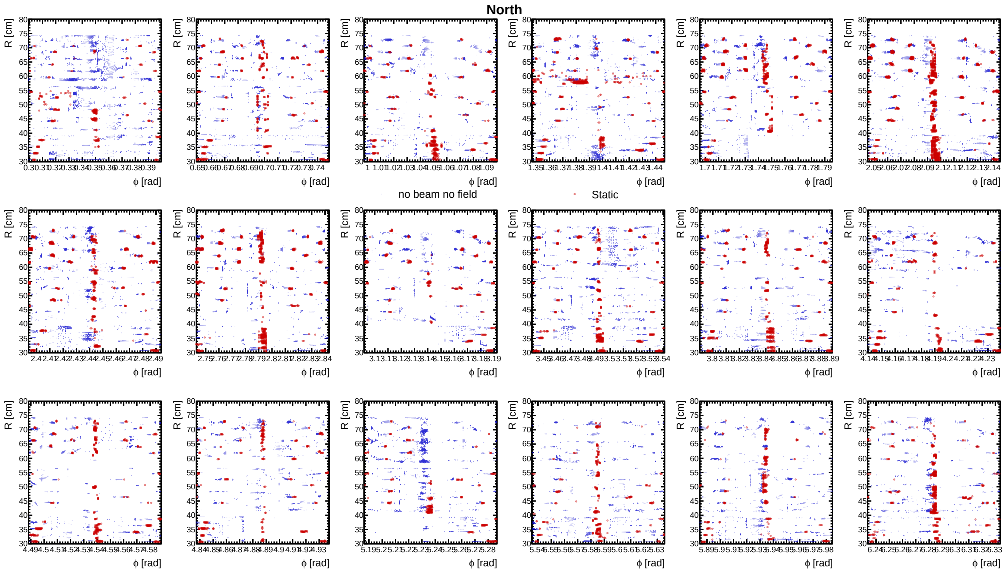


One Step forward and two steps backward

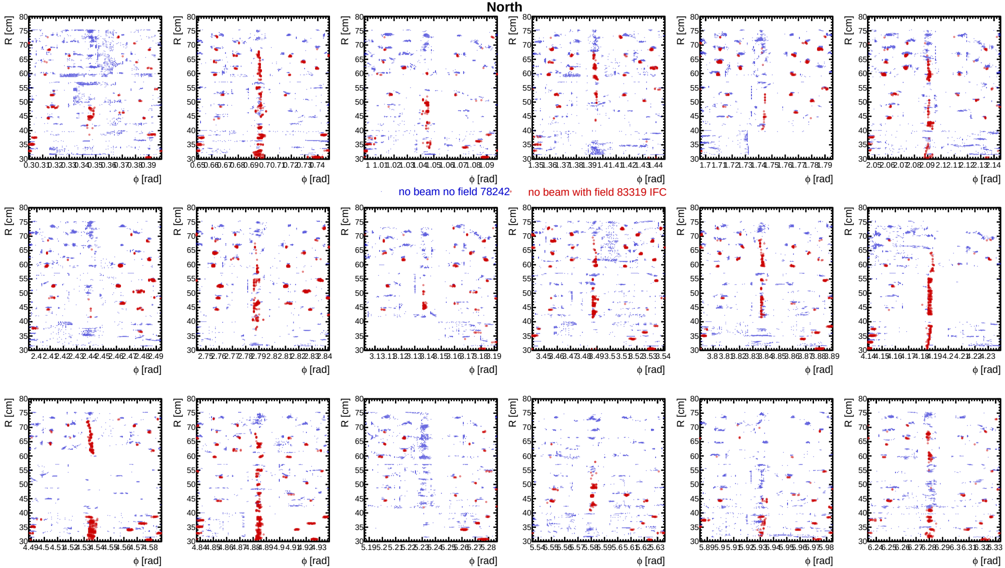
No beam with field 75073 vs No beam with field 83319 North



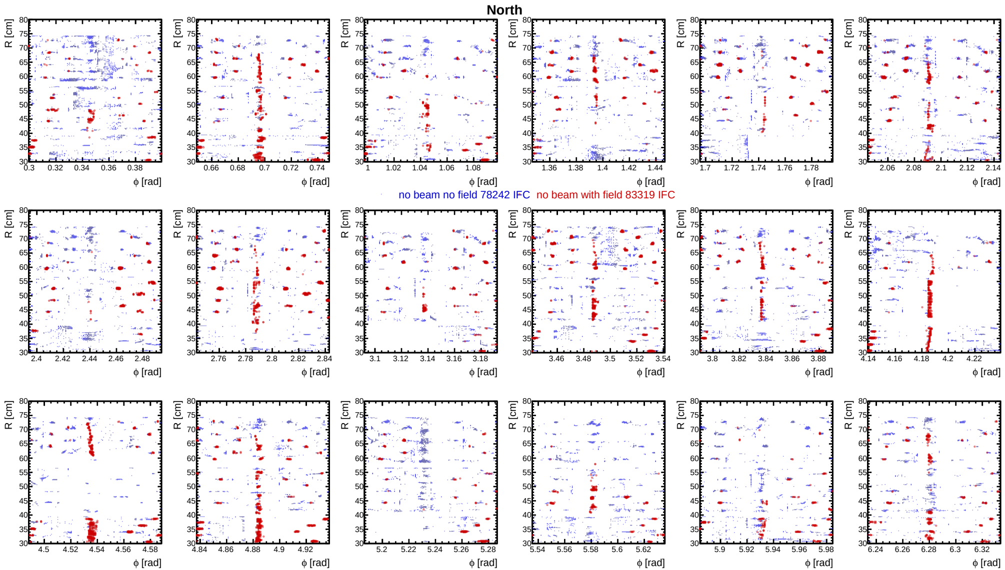
No beam no field 78424 vs No beam with field 83319



No beam no field 78424 vs No beam with field 83319 IFC

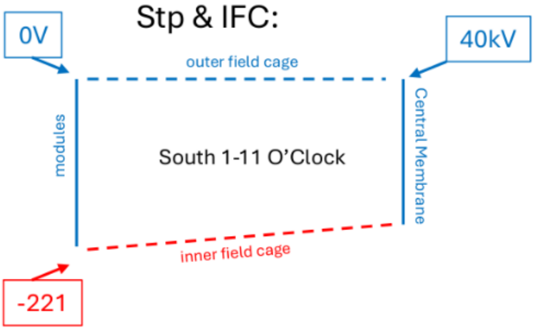


No beam no field 78424 IFC vs No beam with field 83319 IFC

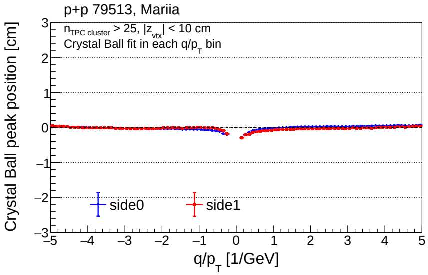


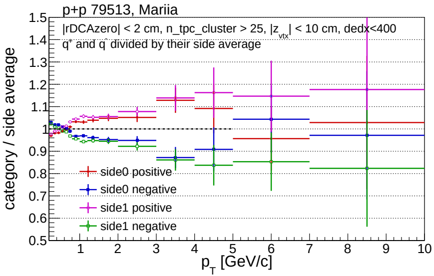
Pin Down Static Correction

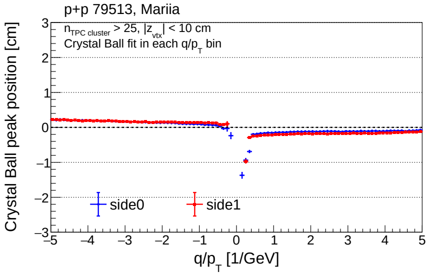
- Now PHGarfield is about to have 9 "free" parameters to tune the B field correction:
  - 3 Translation parameters of the TPC and B field map
  - 2 Rotation parameters of the TPC and B field map
  - 4 Parameters of the IFC and OFC voltage as those can float per TKH
- Latest can drift with time and affect beam off data
- Frames must be taken into account according to MMM study

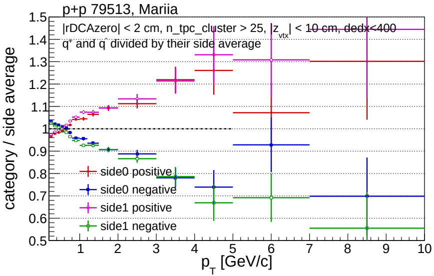


rDCA and Charge Balanced are tricky to tune

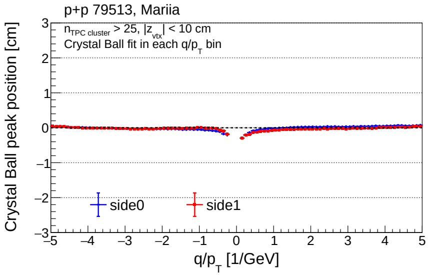


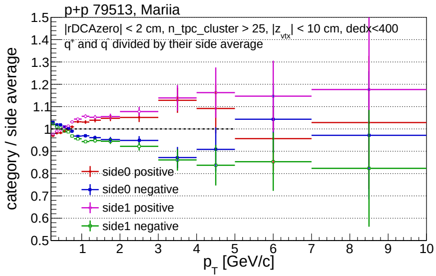


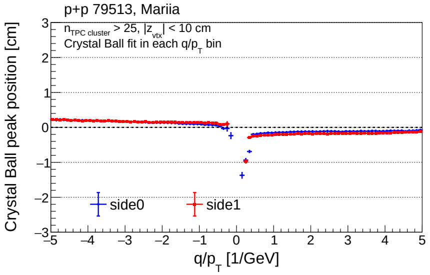


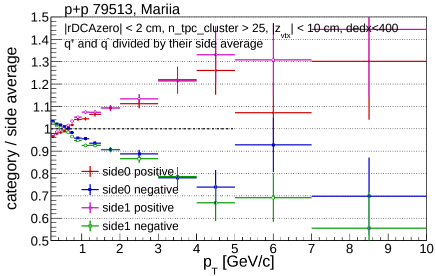


Alpha of 1.0 vs Alpha of 1.8...

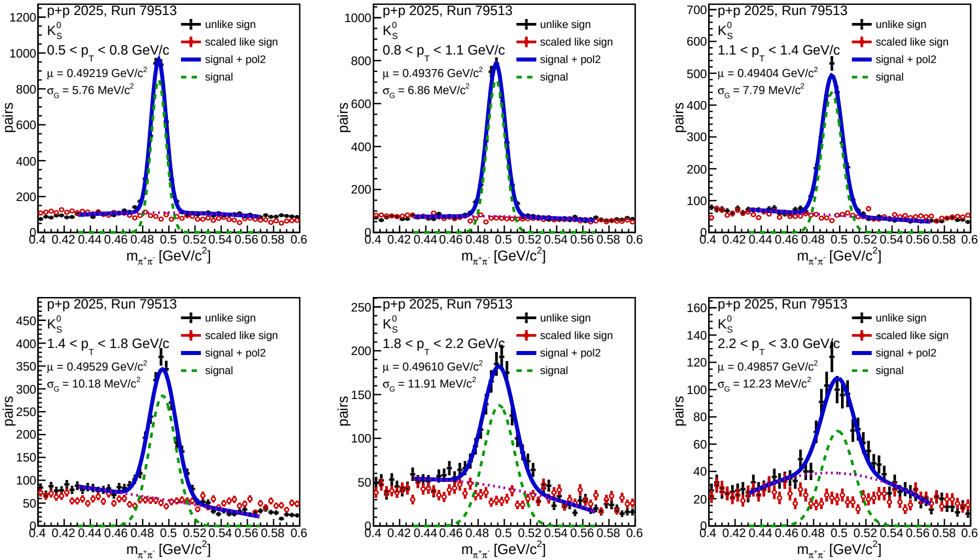




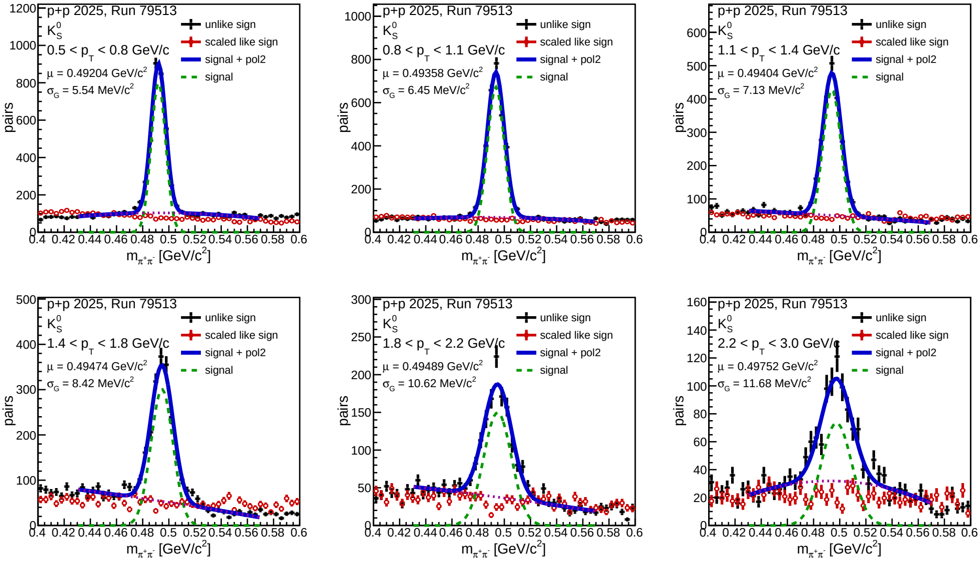




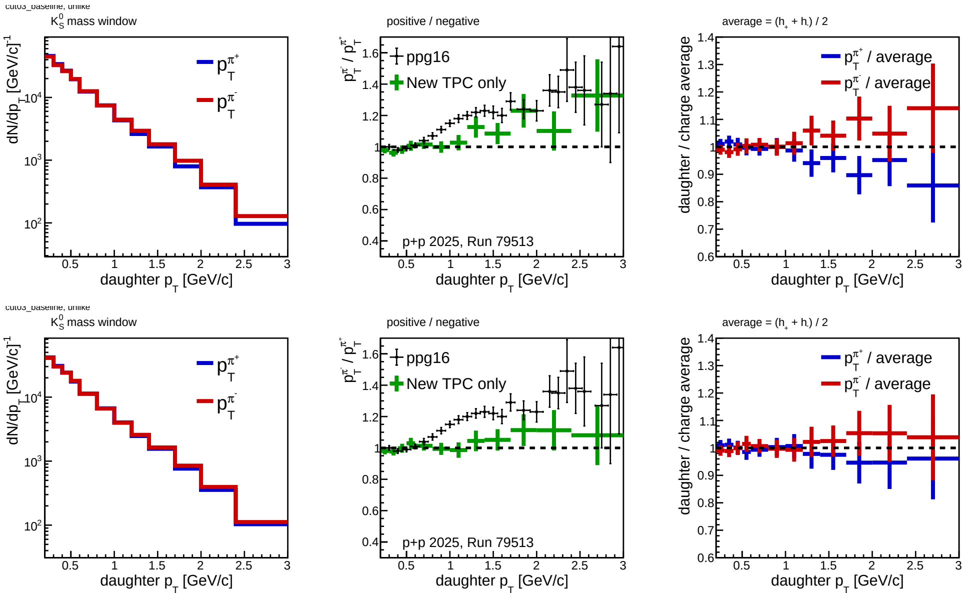
K0s Mass vs Pt for Alpha of 1.0



K0s Mass vs Pt for Alpha of 1.8



K0s Daughter Particles Pt balance for Alpha of 1.0 and 1.8

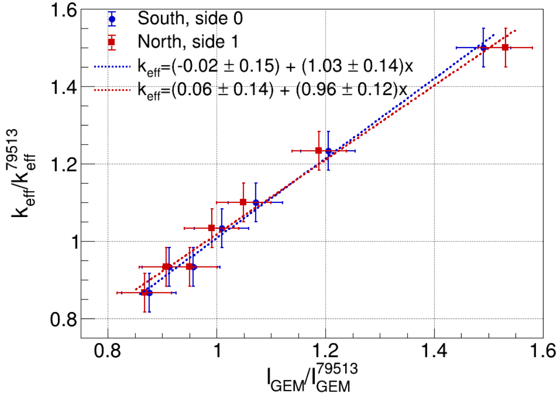


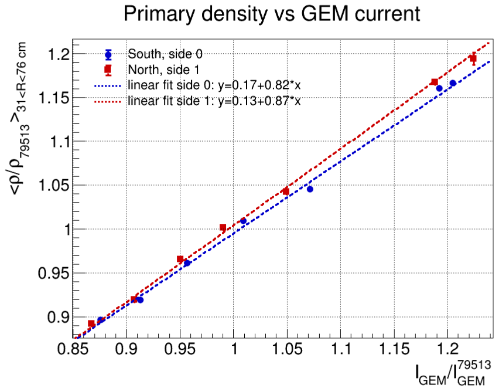
Pin Down Space Charge Correction

- Wehere we are now:
  - First Static Correction referece should be determined
  - We were able to bring South and North toghether and make them consistent
  - We can stabely make same mistake for low and high luminosity runs
  - K0s daughter Pt balance is very sensitive to the Space Charge Correction
  - rDCA and Charge Balanced are tricky as we not fully understand static correction yet
  - We can use K0s daughter Pt balance to tune the Space Charge Correction, but 1M of events is needed to get good statistics for K0s
- We are going to use α of 1.8 for now with flat phi and apply gain to the IBF
- Keff we be determined using its proportionality to the Undamaged GEM Current
- DC can significantly improve space charge determination
  - Run-by-run 3D DC maps can be used to determine the Space Charge Correction for each run
  - Keff can be applyed segment-by-segment using the Undamaged GEM Current for each segment and DC

BACKUP SLIDES

Space Charge Volume is directly proportional to the Undamaged GEM Current

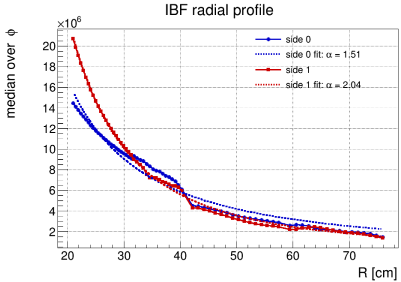


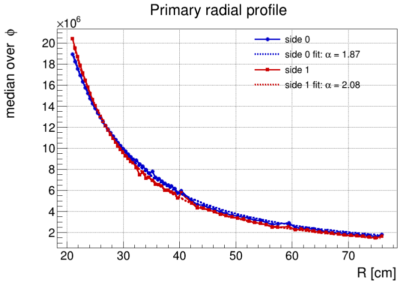


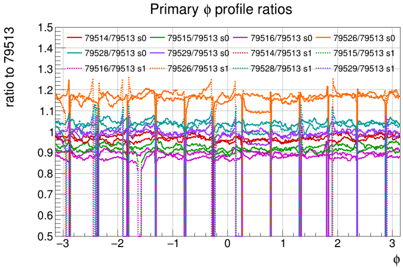
Update to PHGarfield (in proccess)

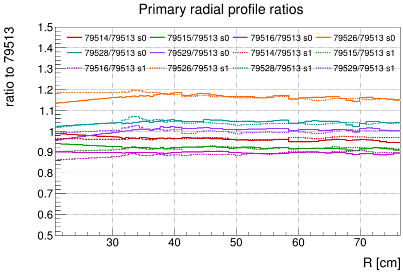
- We are working on updating PHGarfield to generate 2D and 3D Space Charge maps by inputting:
  - α of radial distribution of space charge of the form $\rho = Const/r^{\alpha}$
  - ϕ modulation of the space charge distribution
  - gain maps
- New PHGarfield will generate new polylines by taking as input
  - 2D Generated Space Charge distribution (r-z plane) with or without gain
  - 3D Generated Space Charge distribution (r-z-ϕ) with or without gain
  - OR a 3D space charge distribution from DC or any other source
- To make initial guess for α and K_{eff} we can all use
  - In Future to be tuned further

Examples of 3D E field maps

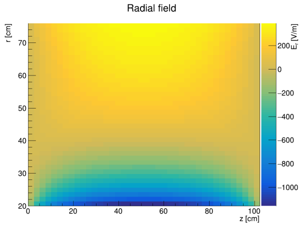


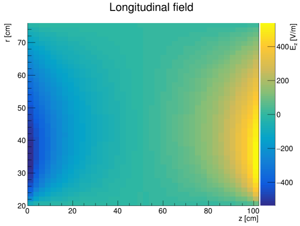


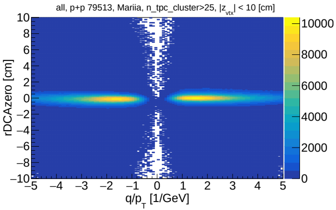


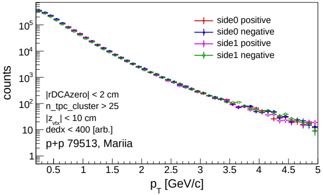


Tuning the E field in PHGarfield





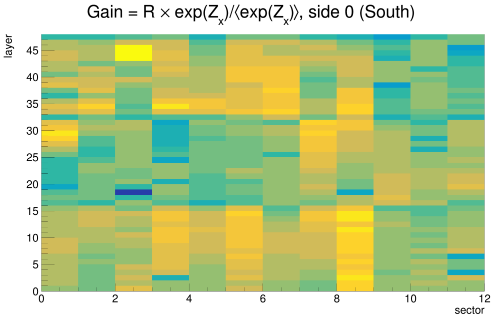


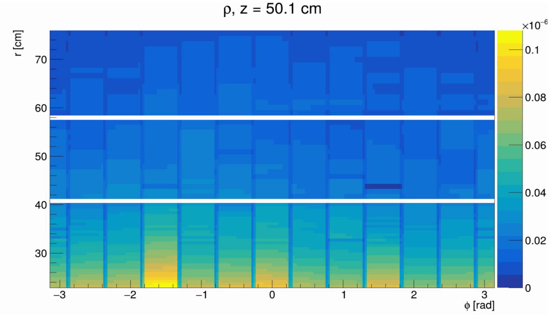


- For now PHGarfield takes as an input 2D E field maps in the r-z plane.
- Part of the E field is calculated from the space charge distribution with $\rho = Const/r^{\alpha}$, where $\alpha = 1.23$.
- We need to tune the magnitude of the total space charge and α
- Those are correlated...

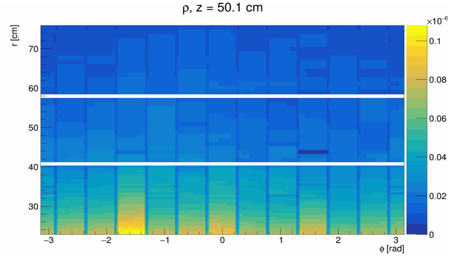
PHGarfield Update

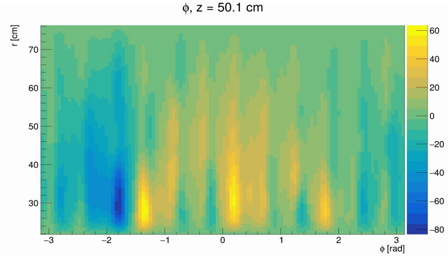
- We are working on updating PHGarfield to generate 3D E field maps for the TPC:
  - It can take α and ϕ modulation
  - It can apply gain to IBF
  - OR it can take a 3D space charge distribution as an input (from DC)
  - It can generate E field 3D maps for both sides in several minutes on 1 CPU core
- New PHGarfield will take those maps and generate new polylines

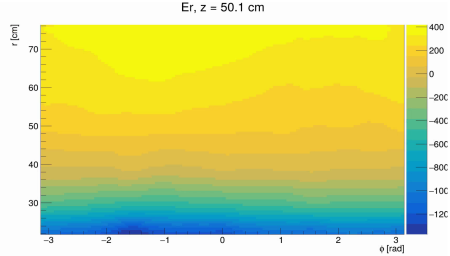


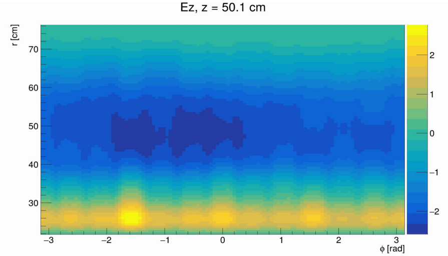


Examples of 3D E field maps









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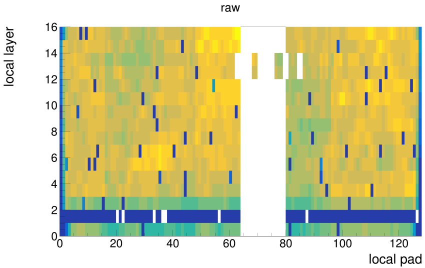
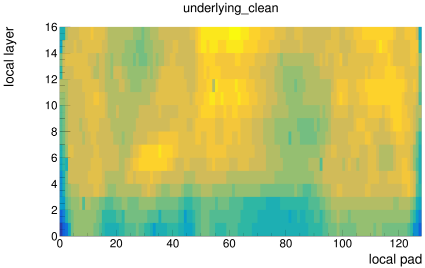
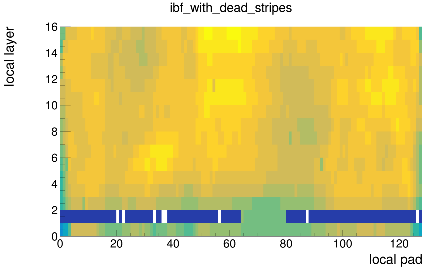


- We looked on at DC but at streaming data without first 15 μs
- We collect sum of ADC per side per module per frame
- We can path dead fees and dead stripes (even though later does not produce IBF)
- Still doest work correctly





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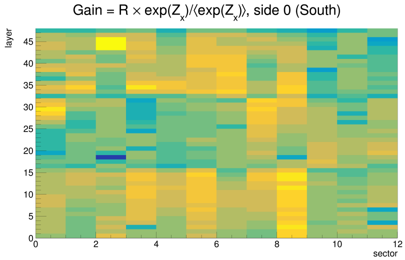

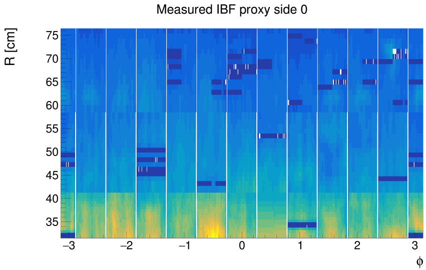

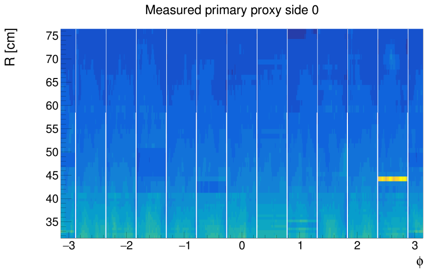

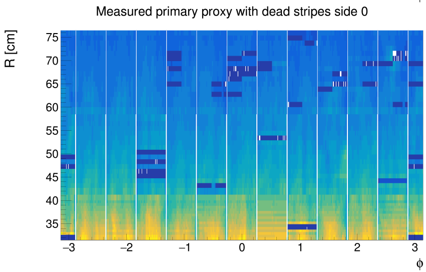

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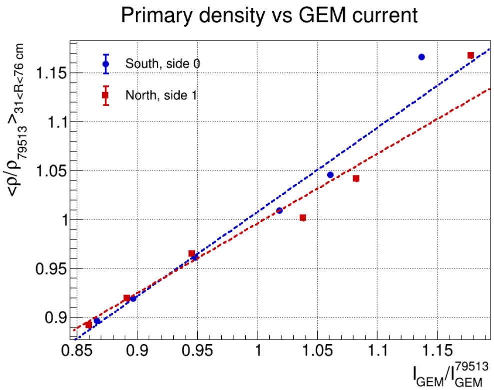

- We hope we can use it to get reliable first guess for Keff and α for each side
- Seems to be pretty stable for this small set of runs