

# B0 Studies

# Overall Goals

- Overall goal is optimize the momentum resolution delivered by the tracker with minimal impact to the acceptance of the EMCAL.
- Tracking disk location(s) need to be optimized with reference to the real field map.
- Engineer at Ben Gurien is also looking at the choices of tracker locations and impact to the calorimeter.

# Running the simulations

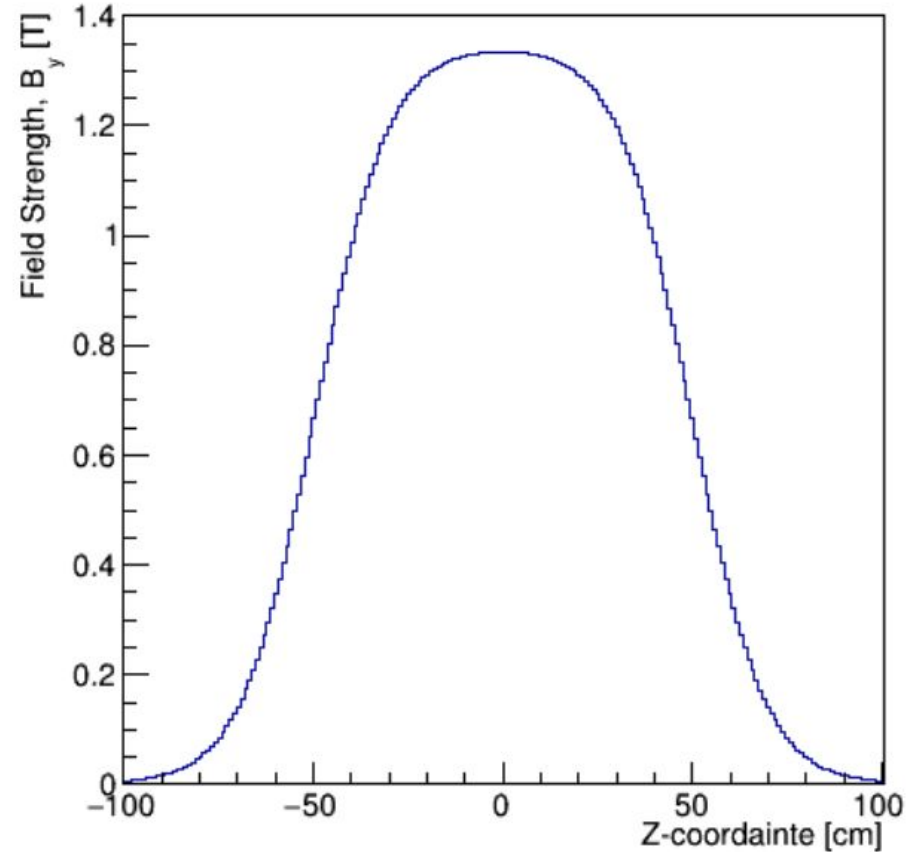
- Need to use the B0 Field Map → git checkout b0-field-map-testing
  - I will update it with the newest geometry parameters and make sure it still works.
- Optimization just provides options for tracker position to then test with the reconstruction and momentum resolution.

After checkout of branch (assuming you have cloned the epic and EICrecon repos):

1. Steering file: /gpfs02/eic/ajentsch/ePIC\_dd4hep\_simulations/ddsim\_steer\_B0\_testing.py
2. **Run:** npsim --steeringFile ddsim\_steer\_B0\_testing.py --N [number\_of\_events] --compactFile \$DETECTOR\_PATH/epic\_craterlake\_18x275.xml --outputFile output.edm4hep.root
3. 80 to 100 GeV protons
4. Options: start with nominal placement of layers, then try shifting WHOLE tracker by 10cm and 20cm from nominal, keeping inter-layer spacing constant.
  - a. Look at resolution for all 3 cases.
  - b. After optimizing position, we can look to spacing between layers (currently at 27cm)

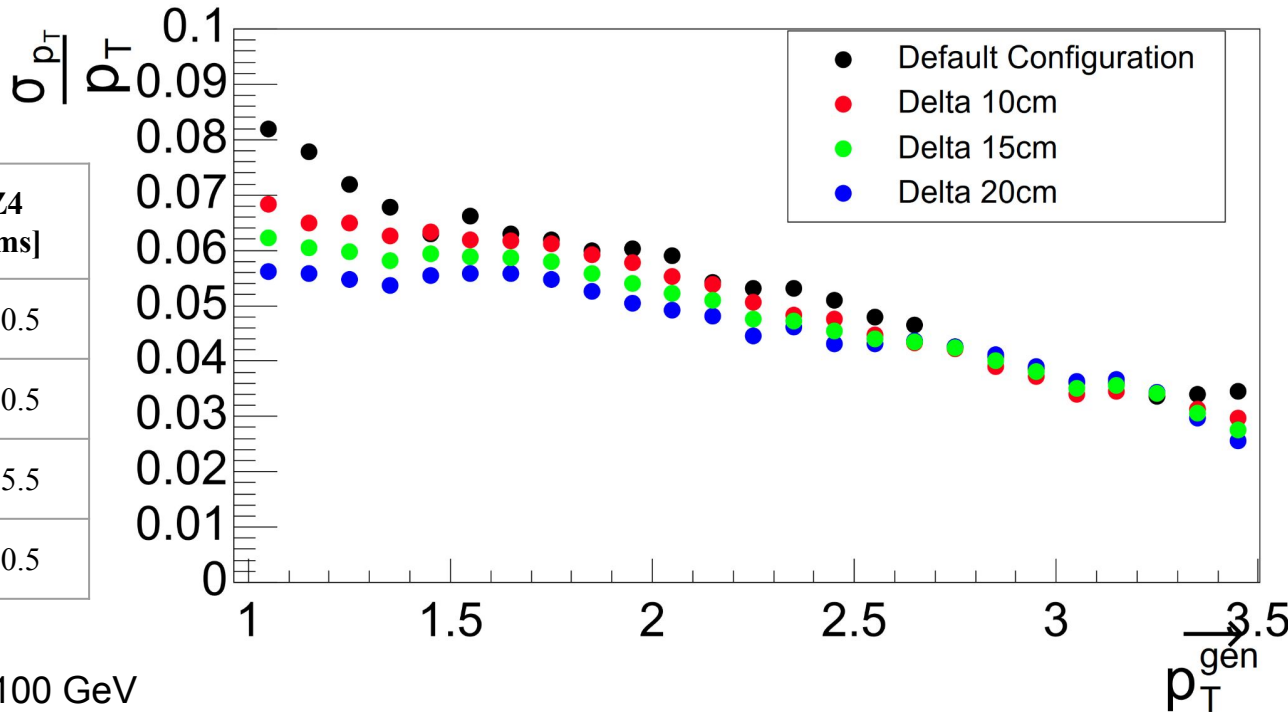
# Field Map

- “Best” cast for tracker is to be centered in the center of the magnetic field, straddling +/- 50cm around the center.



# May 14 2024

Name	Z-center [cms]	Z1 [cms]	Z4 [cms]
Default	630	589.5	670.5
Delta 10	640	599.5	680.5
Delta 15	645	604.5	685.5
Delta 20	650	609.5	690.5



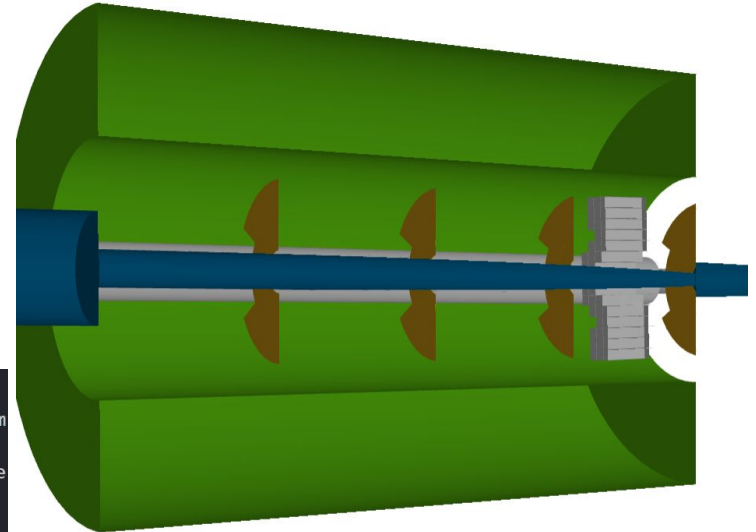
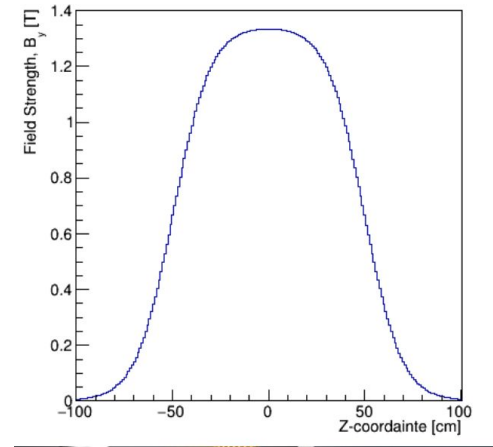
- Momentum - proton : 80 – 100 GeV
- Theta - 0.006 - 0.013 rad
- Distribution : uniform 500k Tracks
- Trackers length = 81.0 cms,  $\Delta Z = 27$  cms (inter layer distance) – currently doing 25, 30 and 32cms study with Z-center = 630cms
- B0 ECAL – Switched off – Default z-center position - 683 cms (zrange 678 - 688 cms)
- Made sure the x positions are also moved to corresponding to z .
- Each settings run after overlap checks

# The Optimization scan

<b>Problem</b>	Optimize the momentum resolution subject to the non-homogenous Magnetic field and to increase occupancy at B0 ECAL.		
<b>Some fixed parameters</b>	Parameter	Value	Remarks
	Tracker Length	81 cms	Should this be fixed?
<b>Objective Space = 2</b>	<b>Objective Parameter</b>	<b>Remarks</b>	
	Momentum resolution ( $p_T$ )	Momentum range of 80 - 100 GeV/c is of interest and specifically proton tracks	
	B0 ECAL/Tracking acceptance?	Ratio of number of tracks before 1st tracking disk to the number of showers detected by B0ECAL?	
<b>Design Space = 4</b>	<b>Design Parameter</b>	<b>Range [cm]</b>	<b>Least count for variation [cm]</b>
	$Z_1$	583.0 - 630.0	1.0
	$\Delta Z_2, \Delta Z_3, \Delta Z_4$ (Inter layer dis)	10.0 - 40.0	1.0
<b>Constraints = 3</b>	$Z_1 + \sum_{i=2,3,4} \Delta Z_i \leq 700.5 \text{ cm};$		
	$ Z_{i+1} + Z_i  \geq 10.0 \text{ cm}; Z_4 - Z_1 \leq \text{Tracker Length (81.0 cms)}$		

# Questions

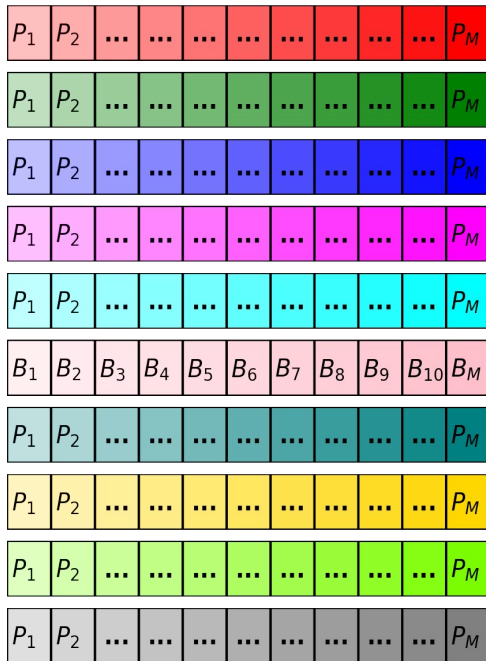
- Does this branch still <https://github.com/eic/epic/tree/b0-field-map-testing> the one to run from?
- “Best” cast for tracker is to be centered in the center of the magnetic field, straddling +/- 50cm around the center. Does 0cm -> 630cms in Z?
- Can the B0ECAL have a range above 700cms? What is the minimum and maximum envelope for this region? Currently not including B0ECAL at all. Should I simply move Z-center according to the tracker (Z4 + 12.5cms?) ?
- Along with the momentum resolution what other quantities should I study?
- Can I weight the Momentum resolution for single performance metric?
- I tried to include B0ECAL when varying Tracking disk distance. For Z-center 650, and B0ECAL IP distance of 700.5, I get overlap with VacuumMagnet.....



```
=== Overlaps for Default ===  
= Overlap ov00000: world_volume/B0ECal_42/wrapper_vol_52 overlapping world_volume/VacuumMagnetElement_assembly_51/GapVacuum0_7 ovlp=0.467539  
= Overlap ov00001: world_volume/B0ECal_42/wrapper_vol_130 overlapping world_volume/VacuumMagnetElement_assembly_51/GapVacuum0_7 ovlp=0.202965  
INFO: +++ Execution finished...
```

# The Summary of MOGA Pipeline for optimization

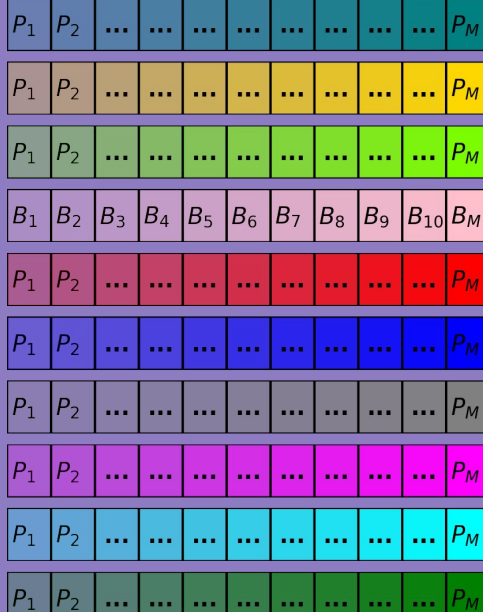
## Initial population creation ( $N_{pop}$ )



Inject baseline Genes  
Faster convergence

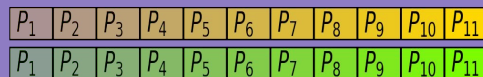
## The Evolution Cycle

### Rank & sort - NSGA2 (Objs)

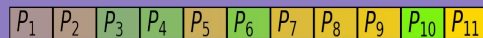


Healthy Design points

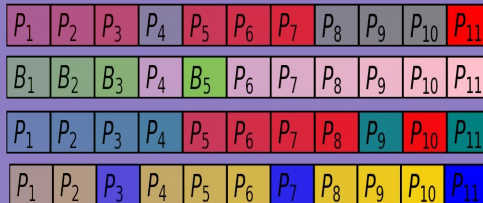
### Genetic Evolution of designs



2 Parents create Offspring



$N_{Offspring}$  for next call



ePIC dd4hep Sim + eic-recon

Yields Performance of the design.  
Objectives that decide evolution