THE UNIVERSITY OF TENNESSEE KNOXVILLE

Muon Beam Dynamics in HFOFO Part of Muon Cooling

Daisy Kalra

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RF phase investigation

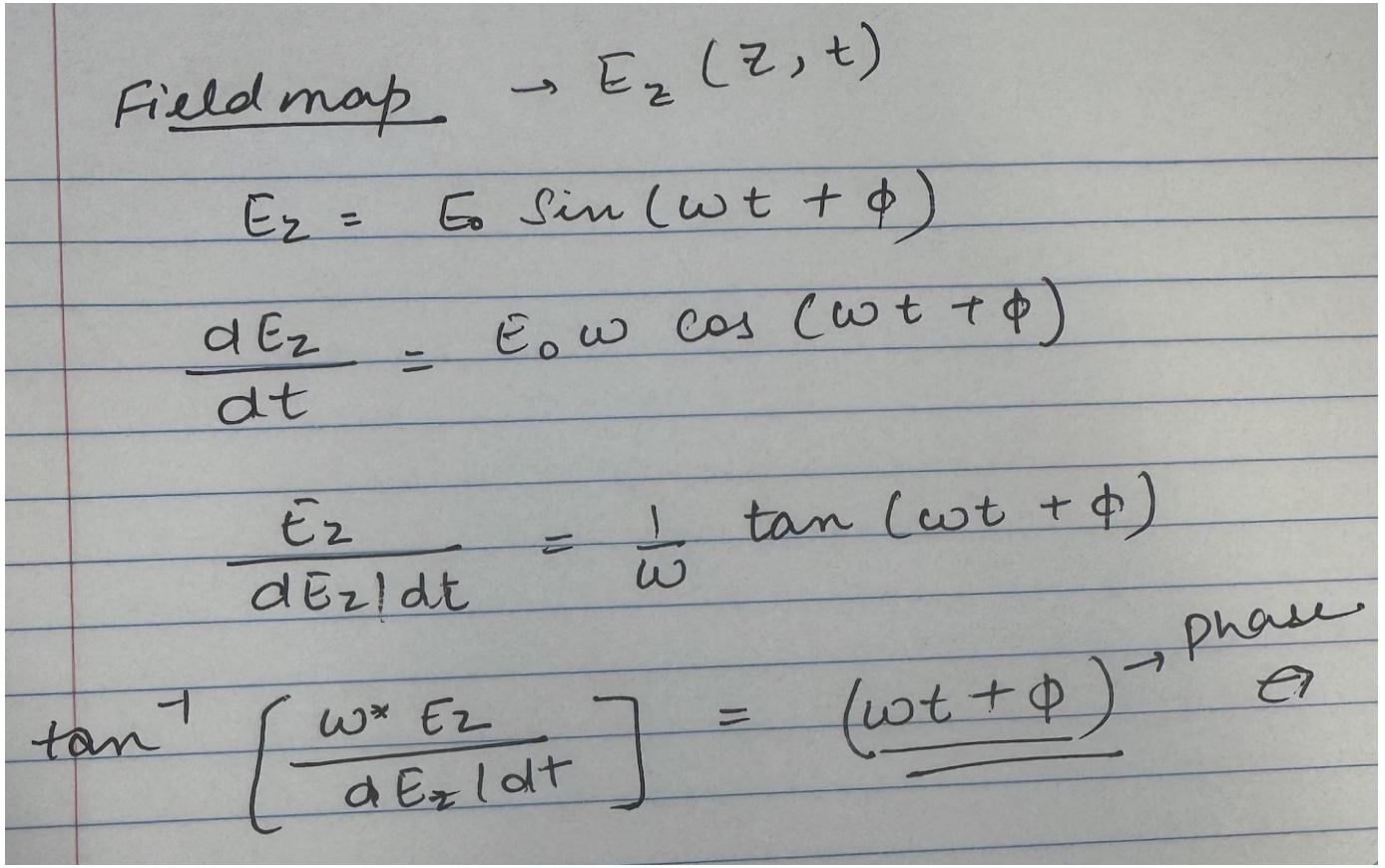
- Our goal is to determine and correct the RF cavity timing so that particles experience the appropriate accelerating phase when traversing the cavities.
- Idea is to look at the field map to evaluate the "true" or "actual" RF phase at particular z location and compare this phase to particle RF phase to obtain the time offsets.
  - Use these time offsets to tune the cavities.

```
param beamtime=-0.671
param toffs0=$beamtime-$beamstart/275.79-0.07 t
param toffs1=$toffs0-.061-.0026+.0115+.006 # ti
param toffs2=$toffs1-.064+.149-.0052-.0029
param toffs3=$toffs2
param toffs4=$toffs3
param toffs5=$toffs4-.008
param toffs6=$toffs5
```

RF phase calculation

1) Field map Ez(t) is sampled at different z positions
   - Z_{start} = –425 mm z_{end} = 5*4200mm; step size = 25mm
   - T_{start} = 300 t_{end} = 600; step size = 0.001 ns)

RF phase calculated from field map at a particular z



RF phase & time offsets

1) Compute Ez and its derivative for each cavity from the fieldmap.
2) Compute actual phase using definition
   on previous slide (phase_field) : wrap to 0-360 deg
3) Compute particle RF phase (phase_particle) using ztuple output
   (using nominal G4bl input card): wrap to 0-360 deg
4) Convert phases to radian and compute time offset =
   phase_field_rad - phase_particle_rad / 2*pi*0.325

RF phase & time offsets

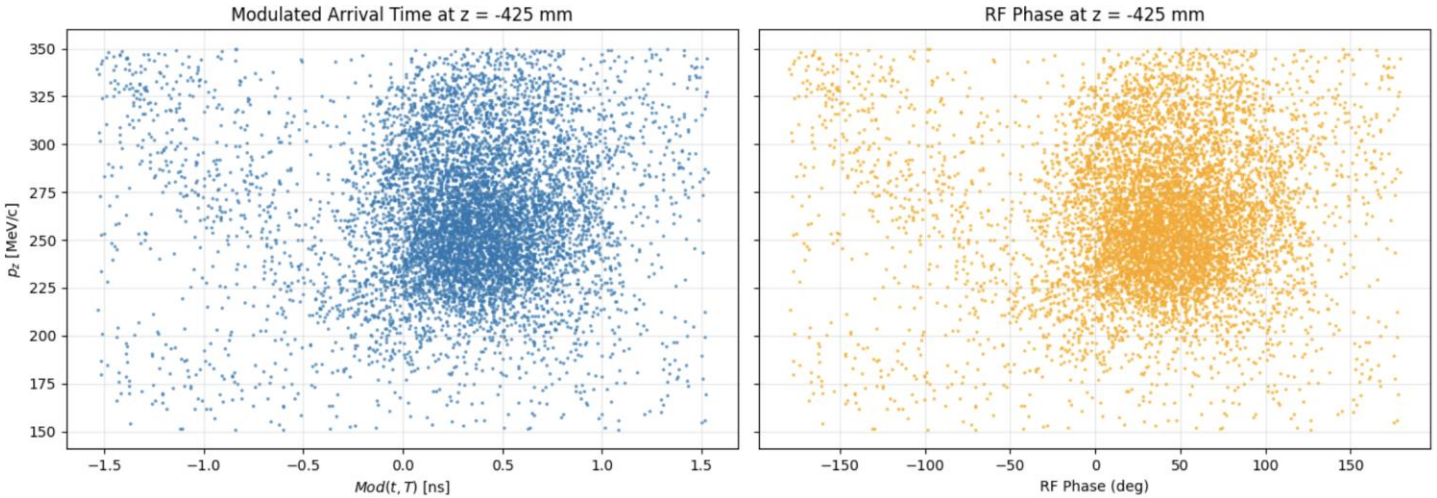
```
=== OFFSETS vs Z ===
          z   delta_t
0      -425 -1.207234
1      -400 -1.207234
2      -375 -1.207234
3      -350 -1.207234
4      -325 -1.207234
..      ...       ...
853   20900  1.296946
854   20925  1.296946
855   20950  1.296946
856   20975  1.296946
857   21000  1.296936
```

```
place RFC0 z=-425. timeOffset=$toffs0-0.77123842
place RFC0 z=-175. timeOffset=$toffs0+0.13491993
place RFC0 z=75. timeOffset=$toffs0+1.0410783
place RFC0 z=325. timeOffset=$toffs0+1.9472366
place RFC0 z=575. timeOffset=$toffs0+2.853395
place RFC z=1075 timeOffset=$toffs1+4.6712809
place RFC z=1325 timeOffset=$toffs1+5.5805068
```

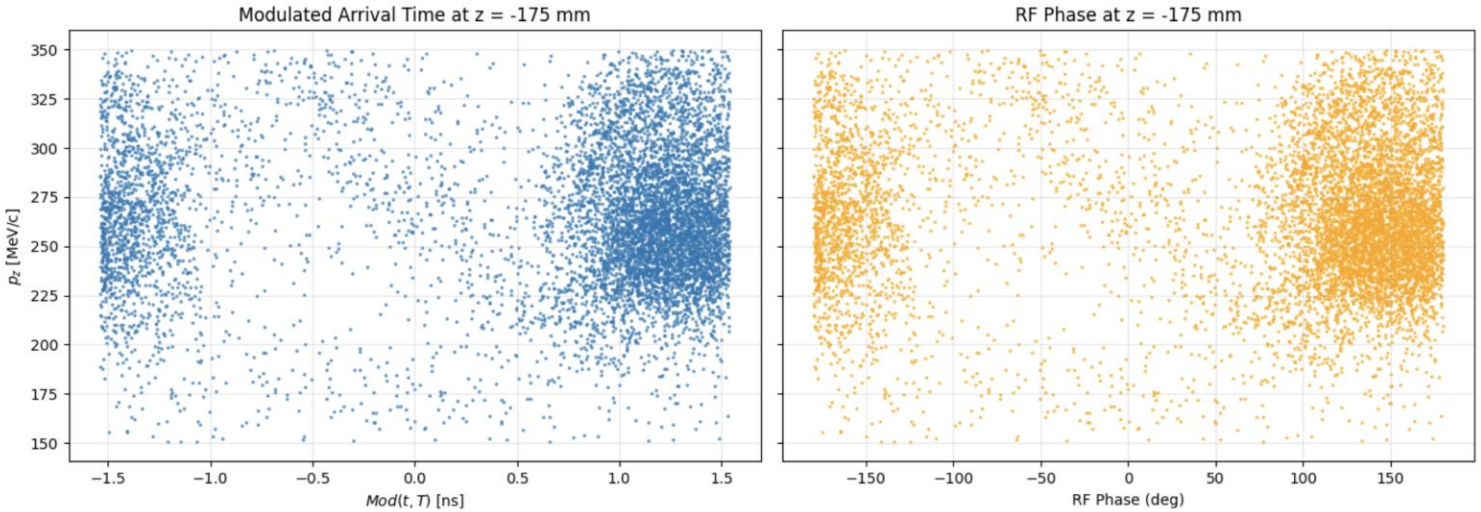
```
groups = {
    "toffs0": (-425, 576),
    "toffs1": (1000, 6300),
    "toffs2": (6300, 42000),
    "toffs3": (42000, 84000),
    "toffs4": (84000, 126000),
    "toffs5": (126000, 170000)
}
```

```
=== GROUP OFFSETS ===
toffs0 = -0.53376 ns
toffs1 = -0.00888 ns
toffs2 = -0.12755 ns
```

```
param toffs0=$beamtime-$beamstart/275.79-0.07-0.53376
param toffs1=$toffs0-.061-.0026+.0115+.006-0.00888 # t
param toffs2=$toffs1-.064+.149-.0052-.0029-0.12755
param toffs3=$toffs2
param toffs4=$toffs3
param toffs5=$toffs4-.008
param toffs6=$toffs5
```




```
place RFC0 z=-425.
place RFC0 z=-175.
place RFC0 z=75. ti
place RFC0 z=325. t
place RFC0 z=575. t
place RFC z=1075 ti
place RFC z=1325 ti
```



Doesn't seem to work earlier in matching section
next slide has plots in cooling channel

Next steps

- Think, and think more ……..
  - Is this method to get time offsets correct?
  - Are we missing anything here?