FFA@CEBAF Working Group|Minutes

## Meeting date | time 04/04/2025 | 11 AM EST | Meeting location <https://jlab-org.zoomgov.com/j/1614898082?pwd=TnUzMS81M2sxbDZIbERJU01tYkJCQT09>

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | Meeting called by | Alex B | | Type of meeting | Weekly Meeting | | Facilitator | Alex B | | Note taker | Ryan | | Timekeeper | Alex B | | Attendees  Alex B, Donish, Ryan, Edith, Volker, Scott, Kirsten, Nick, Salim, Andrei, Dejan, |

# Intro Discussion

* LDRD announcement just made

# Agenda topics

## Time allotted | 50 mins | Agenda topic Sym. Splitter | Presenter Donish

* Table

  AI-generated content may be incorrect.
* Text

  AI-generated content may be incorrect.
  + Very tedious process. Iterative work
  + Problem is b/c of the small betas at FFA interface, system is very sensitive to parameter changes (quad strengths for example)
  + Latter steps oscillate (right side of plot). Optimization takes a long time. This is what kills the progress.
  + To improve, reduced the step sizes – slows down simulation run time
    - No guarantee of success
  + Match backwards
* Graphical user interface, application, email

  AI-generated content may be incorrect.
  + Create generic and symmetric bend system. Beam goes from FFA to LINAC end.
  + Top plot is not a typo – make a periodic system with only FFA betas.
    - This way make an arrangement of magnets that looks reasonable with enough versatility to match FFA to FFA
    - Should get decent layout, and then perturb linac side
  + Using periodic solution, drop the FFA matching conditions on the LINAC side (right side here). Match from BetaFFA to BetaLINAC
    - Reverse system and get the Linac > Splitter > FFA optics
* Diagram

  AI-generated content may be incorrect.
  + Need enough drift space to fit magnets WRT other beamlines
  + Beams exit the first splitter at different angles and positions
  + Ryan – cool to do this based on dispersion instead of magnet sizes and strengths, etc
    - Donish – lengths and strengths will come out if you define the etas.
* A picture containing graphical user interface

  AI-generated content may be incorrect.
  + This is symmetric, BetaFFA matched to BetaFFA
  + Soft constraint – fully aware this is not a solution we want or can be used.
  + Don’t want to optimize this. Just a generic magnet layout
  + Alex – this is mirror symmetric?
    - Yes
  + Triplets, doublet in between first and second dipoles
  + Dejan – this is too many magnets to do the simple problem.
    - 6 center dipoles added for R56 flexibility. 4 didn’t do the job
  + Dejan – provided an example of the simplest possible solution for the chicanes
* A picture containing chart

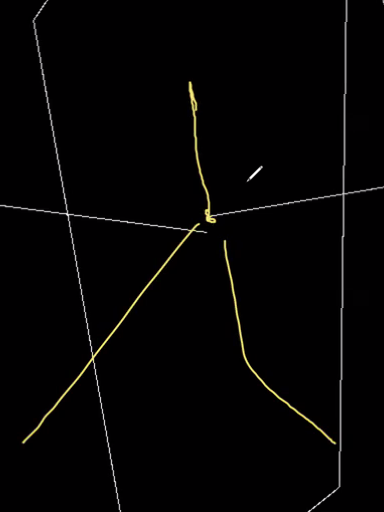
  AI-generated content may be incorrect.
  + Changing the periodic solution, perturb magnets to match into BetaLINAC
  + Not soft constraints.
  + Start sequentially backwards. Increase number of quads from LINAC side
  + Start with at least 4 quads, see if match into LINAC Twiss
  + Work backwards, keep optics created in periodic cell, and only perturb on linac side until match
  + 0.07 m R56 is the “old” values (from standard FFA Arc). 0.0 m R56 is for possible isochronous arc
  + Matching into the Twiss aren’t an issue
  + Difficulty is getting everything matched
  + Ryan – you can probably lower the weight on R56 since we don’t really know what it’ll be in the end.
  + If try to get R56, betas get very large
* Chart

  AI-generated content may be incorrect.
  + Which quads can be used for R56 knob (orthogonal to Twiss knobs)?
  + Not clear analytically where to put it
  + Took beamline, in drifts injected small thin quads, then calculated the effect of it’s impact on betas in both planes and R56 as you change strength of quad
  + This is a map where it shows the effect of any given inserted quad
  + Was hoping for a place where they’d be completely orthogonal
  + Kind of see it at 28ish meters – all lines go to zero except the purple/blue trace – therefore vertical beta would be impacted the most.
  + Green R56 line never has a separate place – it’s always coupled
  + System is so coupled, so any changes destroy what you’ve done
* Scott – you’re heading the right direction.
  + Don’t add quads. Take the quads you have. Forget R56, look at nice solution. Now look to change R56 in whatever direction you want to go.
  + Take constraints and derivatives of constraints WRT variables – get rectangular matrix
  + QR algorithm applied to matrix. You’ll find two groups of orthogonal vectors
  + You’ll have a rectangular R matrix (QR algorithm transposed – PLQ decomposition)
  + PLQ – L matrix is also rectangular. Top block has nonzero values. That’s the bit that gives you the matrix that you effectively invert to have a change in constraints –
    - Invert nonzero block at top of L matrix
  + Right half of L matrix are zeros. That’s the part where you’re not doing anything
    - They don’t impact the Twiss. It’s a space of vectors that won’t affect matching, but WILL impact other things, such as R56. Now you can move around that space.
  + If you’re feeling clever – extend that to find the vector that maximally changes R56 without touching the rest.
  + Here’s the catch: this is very very local. Things are so wacky here.
    - How change R56 by a mm? Things will move
    - Do a small tweak to re-fit the betas again, take the derivative again, then take the next step
  + This is how did things in CBETA – but there had the advantage of only having two extra quads.
  + Would do it in 2 steps: take current R56 as constraint – scan around that space to get Betas (Twiss) as close as possible
    - Step up R56 again, rescan, repeat
  + More quads, more complicated
  + You have to take small steps, refit, find new space, repeat
* Donish – I’ve been seeing that too. Iterative process. Like Scott’s idea
* Dejan – you have to understand what is R56 – it’s momentum compaction. Integral of dispersion over bending radius
  + When you do anything with matching. Have to draw vectors of dispersion to see where it’s at
  + All parameters and matrices are following that.
  + Anything you do, draw the picture of the dispersion function vectors.
  + Dejan – all these matches are fine, but need to see picture of what you’re doing.
* Graphical user interface

  AI-generated content may be incorrect.
  + Donish – yes, I looked into that. Never really used the normalized momentum space before to design them.
  + Lower left plot (yogi)
  + Looked into it, read the papers – it’s a bit ambiguous to Donish to make the connections
  + Dejan – vertical is dispersion/sqrtBeta…describes work
  + Scott – plot a whole lot of intermediate points, especially in the drifts
    - In the drifts, anywhere outside of dipoles, going on arc of circle in plane
      * Having a ton of points in the plot, you’ll see those arc circles, and see where the radius is changing
    - Whenever radius changes, it’s a dipole
* Shape

  AI-generated content may be incorrect.
  + Very helpful in looking at these things.
* Scott – other hint: when you go through this stepwise process, and trying to step up the R56 a mm at a time, at some point, it’s just going to fail.
  + Why? – look at the plot. You’ll see better with more steps.
  + Basically, making a certain number of turns around this.
  + You’ve heard discussions of x/Pi solutions – this is basically that
  + In the parts without dipoles, advances with phase advance
  + You’ll find that you have solutions with phase advances around Pi. Can’t get solutions from ~Pi to ~3Pi
  + Beyond range, you’ll need a completely new solution with more turns
    - Need more or less phase advance
* Donish – If you look at 0, 0 – coming from nonzero dispersion
  + A picture containing shape

    AI-generated content may be incorrect.
    - Scott drew on the screen to show what more points would do
  + Shape, engineering drawing

    AI-generated content may be incorrect.
* Ryan missed a few minutes (school nurse call)
* Donish question:
  + 
    - What would you calculate here?
    - Let’s say 45 degrees: A picture containing diagram

      AI-generated content may be incorrect.
    - Quads define phase difference, not dipoles
* Donish – the plots he read are for periodic systems. They look nicer.
  + Our system is not periodic.
* Scott – when talk about phase advance, ignore last jumps from dipoles. Don’t worry about the first point near zero. Start at the first point on the curve when counting phase advance.
  + A picture containing indoor, computer, dark, set

    AI-generated content may be incorrect.
    - From elbow to elbow
  + A picture containing text, satellite, sword

    AI-generated content may be incorrect.
    - Is that 3Pi?
      * Maybe
* Can phase advance go backwards?
  + Maybe, not usually
  + Look at the “knee” on the yogi – that’s a dipiole. Phase advance going “backwards” but not really
  + PA is only approximatation of PA in this diagram
* Take what you have, find out the R56, and don’t force it. Walk it.
* Graphical user interface, text, application

  AI-generated content may be incorrect.
* Ryan- extraction? Offset, x’, ToF?
  + Donish – not yet. It boggles my mind on how to include that.
  + Dejan – start with ToF, create values of time differences
  + Donish – Ryan means adjustable ToF
  + Kirsten – sometimes you can use magnets, sometimes you need movers
    - Even with some movers, it can be a headache
  + Ryan – we do have doglegs
  + Scott – don’t worry about ToF – the big thing was getting the matching.
    - Ryan – I think we have to “bake it in” from the beginning b/c we move a lot more
    - Kirsten – I think it’s less true for CEBAF than CBETA
    - Scott – RF wavelength similar
      * Do I have to hit a target now? No. Hit it later

|  |  |  |
| --- | --- | --- |
| Action Items | Person responsible | Deadline |
|  |  |  |
|  |  |  |

## Time allotted | 10 mins | Agenda topic AOB | Presenter All

* Table

  AI-generated content may be incorrect.

|  |  |  |
| --- | --- | --- |
| Action Items | Person responsible | Deadline |
|  |  |  |
|  |  |  |

## Special notes

Pathway to Repository: <https://jeffersonlab-my.sharepoint.com/:f:/g/personal/tristan_jlab_org/EqZ5MeS-nipCgPfZB5p0oS4B9Is67d3nQb9sLJI3Zyev9g>