FFA@CEBAF Working Group|Minutes

## Meeting date | time 05/17/2024 | 11 AM EST | Meeting location <https://jlab-org.zoomgov.com/j/1614898082?pwd=TnUzMS81M2sxbDZIbERJU01tYkJCQT09>

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| |  |  | | --- | --- | | Meeting called by | Alex B | | Type of meeting | Weekly Meeting | | Facilitator | Alex B | | Note taker | Ryan | | Timekeeper | Alex B | | Attendees  Alex B, Ryan, Reza, Edith, Roger, Kirsten, Stephen, Vasiliy, Donish, Dejan, Andrei, Tim, |

# Intro Discussion

* Beam studies on Sunday
* Ryan driving to IPAC, as is Randika – rental cars are a pain at times.
* No meeting next Friday due to IPAC
  + Ryan, Randika, Donish, Alex C, Stephen, Dejan, Vasiliy

# Agenda topics

## Time allotted | 25 mins | Agenda topic LINACs| Presenter Alex B

* Graphical user interface

  Description automatically generated with low confidence
  + Over 6 months ago, re-did NL and SL
  + Will revisit and made changes
  + Optimize Twiss to get ready for matching in reasonable way
  + LINACs 250 m long
  + Quads are set once in LINACs
  + No quads in FFA passes for spreaders/recombiners – essentially 30 m drift
* Chart

  Description automatically generated
  + Periodic structure. Triplets between sets of triplets
  + Triplets are reverse polarity at each iteration.
  + 150 degree phase advance per cell – gives stability at lower passes
  + 14 twin cells – betas reproduce
  + Quads will scale with momentum as progress through LINAC
  + Pass 2 in NL (3 in CEBAF naming), betas compressed b/c focusing is weaker for higher E (magnets set for low E pass)
* Chart

  Description automatically generated
  + Comparing pass 11 – tune nearly disappears. Still enough phase advance to contain beam
  + Beta ~168 m for this. Need to do better
  + Triplets morph into FODO-style
* Chart

  Description automatically generated
* Chart, line chart

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  + Dejan – not concerned both tunes are the same?
    - There is some small cavity focusing at lower E
    - Phases go in step
  + Dejan – so as you go from one cell to next cell, due to the energy change, the betas and tunes are changing?
    - No, tunes are the same
  + Dejan – if full E scale is in LINACs – fine
    - Triplets are scaled with E, so tune constant
* Dejan – why is beta going down along LINAC as energy goes up? Energy is gaining, beta should increase
  + Quads stronger at end.
  + Dejan – are they strong enough to reduce beta of next E? First pass is fine. Next energy, expect beta to go upward
    - Alex – I don’t have a crisp answer to that
    - Vasiliy – the relative change in energy is higher in the first pass, so a change in quad strength is linked to the change in momentum. At higher E, the relative changes are lower, but the quads are tuned for 1st pass energy
* Basically – if choose to scale at beginning of pass 1 and scale through with 1st pass to end of LINAC. The higher passes will have a lower ratio of start:end energy
* Dejan – maybe better to do the grading of the quads between cryomodules like Alex is doing. If you do all same, the betas will blow up.
* Vasiliy – another confusing effect: imaging beam through a single cavity, beta lower at start than end.
  + End field focusing
  + R-S formula for cavity gradients and focusing
  + Lowest cell focusing comes from end-field focusing. Almost comparable to quad focusing
  + K is changing in quads – yes
* Dejan – you kept k same in linac
* Amount of focusing WRT to end field focusing diminishes at end of LINACs
* Flat envelope for lowest pass for “elegant” solution – could aim to flatten out other passes. Can’t do it for all passes though.
* Don’t worry about EM passes b/c Spreader/Recombiners: passes 1-4 go through this for EM passes
* However, the FFA passes (5-10), they go through Spreader b/c they must, but are then steered back down to LINAC height co-linearly.
  + No quads here.
  + In terms of betas, it’s basically a drift
* Need to optimize Twiss not at end of NL, but through recombiners and spreaders
  + Optimize for higher FFA passes – optics should minimize betas and alphas at start/end of Recombiners/Spreaders
* Chart, line chart

  Description automatically generated
  + Have added in recombiner on left side, and spreader on the right side.
  + No longer aim for periodic function (168 m) – instead you have weird alphas/betas, and it will break the periodicity. Instead, adjust betas and alphas at the beginning of the recombiner.
    - All you can do is define betas at start of recombiner.
    - Start with alphas = 0, use Monte Carlo to increase betas and see what the beta max would be in the linac
  + Old on top, new on bottom
    - Alpha = 0 is not a hard constraint. Change alpha to get the betas to match through machine
  + To do Monte Carlo, cooked up error function to optimize
    - Produced bottom plot
* Chart, line chart

  Description automatically generated
* **Chart, line chart

  Description automatically generated**
* Ryan – what Monte Carlo tool did you use? OptiM?
  + No, something external – “cooked up function” not something specific
* SL different:
* Chart

  Description automatically generated
  + Rematching cell-by-cell not needed
  + SL a little longer – extra triplet at the beginning
  + Initially when put together, didn’t pay attention to that initial triplet (set to 0)
  + Up to pass 4 things are nice
* Chart, line chart, histogram

  Description automatically generated
  + Higher passes falling apart
  + Couldn’t optimize in a nice way – qualitative difference between horizontal and vertical planes
    - Phase advances cause imbalance of horizontal. Deficiency in vertical focusing
  + Strong, positive alphas – got “wacko” results
* **Chart, histogram

  Description automatically generated**
  + Added focusing to balance horizontal/vertical phase advance
  + Started with negative alphas
  + First triplet set right
* Chart, line chart, histogram

  Description automatically generated
  + Now can play “beta beating” game for higher (FFA) passes
  + Betas kept less than 50 m at end
* Reza – what causes longer wavelength wave through LINAC?
  + If you start with a smaller beta than the one for the periodic solution, it will start beta beating (overshooting) and having an onscillation.
  + So you induce the oscillation by looking for the right initial Alphas/Betas
* Chart, line chart

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* Optics files passed to Donish – he will clean them up and use them
* **Chart

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  + These are the old values – will update
* Every time look into LINACs – room for improvement.
* Summary – re-optimized and changed triplet at beginning of SL
  + Isurumali did excellent stuff with simulations to go further
    - Could use GA
  + Go further than playing with input conditions

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| Action Items | Person responsible | Deadline |
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## Time allotted | 25 mins | Agenda topic IPAC | Presenter All



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| Action Items | Person responsible | Deadline |
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## Special notes

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

NO MEETING NEXT WEEK DUE TO IPAC