FFA@CEBAF Working Group|Minutes

## Meeting date | time 04/11/2025 | 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, Donish, Ryan, Randy, Reza, Dejan, Kirsten, Edith, Stephen, Salim, Donish, Andrei, Nick, Scott, |

# Intro Discussion

# Agenda topics

## Time allotted | 50 mins | Agenda topic White Paper | Presenter Alex

* Need pre-conceptual design white paper
* ToC is done, some chapters written, some not.
* Think about those assigned sections, and add those in.
* Alex will write about multipass linac optics
* Linac Optics:
* Graphical user interface, text, application, chat or text message

  AI-generated content may be incorrect.
* A picture containing chart

  AI-generated content may be incorrect.
  + 140 degree phase advance excessive, but balancing between strength of quads and betas at the higher passes
  + Looked into triplet lattice with smaller phase advance
  + First cell starts at 650 MeV
  + G = 2 kG/cm for both types of magnets in the triplets
  + Diagram

    AI-generated content may be incorrect.
  + Periodicity for twin cell shown
* Timeline

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  + Crank up strengths of triplets
* A picture containing diagram

  AI-generated content may be incorrect.
* A picture containing timeline

  AI-generated content may be incorrect.
  + Increasing energy, the triplet “morphs” into singlets. Reversing polarity gives something similar to a FODO
* Chart, line chart

  AI-generated content may be incorrect.
* Dejan – how high to they go?
  + Passes go around 80ish m
  + For higher passes, no quads
  + Final values of the functions is driven by the beta beating, not so much by initial phase advance needed
* Ryan – still have a problem with the quads are far too strong
* Diagram

  AI-generated content may be incorrect.
  + Ryan – this was a problem we discussed last time, where there is no space, and the permanent magnets are weak enough to just be Ems
* Diagram, line chart

  AI-generated content may be incorrect.
* Instead of bi-polar, got to unipolar:
* Line chart

  AI-generated content may be incorrect.
  + Reachable by permanent magnets
* Chart

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  + What do we get with slightly weaker-focusing linacs?
* Chart

  AI-generated content may be incorrect.
* Table

  AI-generated content may be incorrect.
  + Not very different – numbers are a bit higher, but not bad
  + Lowered quads to get this done
* Dejan – the latest achievements of the light source quads combined with permanent magnets goes up to 100 T/m, depending on aperture
  + The PM allows for superposition
  + Ryan – might be hard with our apertures
* Kirsten – hybrid – length is 80 cm?
  + Alex – yes, but solves the problem of offsetting the strengths
  + Text

    AI-generated content may be incorrect.
    - Pole tip is still very high
  + Alex – Nick gave a follow up with APS magnets
    - Yes – but far smaller aperture
  + Ryan – what about Tief’s shielded lattice?
    - Single/triplet supercell
    - Alex – don’t see benefit
    - Ryan – it gives us space
    - Alex – will still have the same problem – you’ll have a triplet. If you put triplets, you’re removing uniformity
    - Ryan – but gain control of higher passes
    - Alex – You’ll need stronger quads for the triplets
      * Ryan – perhaps, but you’ll get more space
    - It gives every other girder to put things
* Kirsten – aperture is 47.5 mm
* In the chat:
  + Kirsten is correct.  APS
  + Q1 and Q2 quads have an aperture of 11 mm (dia. 22 mm) roughly a factor of two smaller than required for JLab linac vacuum chambers.
* APS quads can’t do that gradient
* Alex – not doing engineering design – need target values for betas
* Stephen – did you try unbalanced triplets?
  + Presently, we have alternating singlets
  + Started singlet, then triplets, then “twin cell” triplets to get betas under control
* Tief replaced every other girder with a triplet
  + Alex – my feeling about the singlet-triplet lattice might be worse – to get comparable betas, probably overload the strength of the triplets
    - Ryan – but they were placed at nodes of each other. Lower passes controlled by one set, higher another, but the triplet would be at a node for the other passes. Complicated
    - Alex – welcome to look. Triplets more robust, figure of merit would be betas
    - Ryan – no disagreement that triplets are more robust. They just take up too much space
      * One BPM might fit in the triplets without the permanent magnets.
      * Right now, we only correct every other girder in a plane anyway
* Dejan – also take into account the beam sizes are larger in lower energies – strong focusing at beginning – can only help wrt to emittance growth
  + Alex – passes 1-4 for current CEBAF, we have a tight envelope for pass 1
  + Spoke with Yves – thinking about adopting for 12 GeV
* Ryan – another point, brought up by Stephen last time, the radiation is too high for the PMs, especially near the C100s. High radiation zones. PMs won’t persist long
* Salim – Light sources reach 100 T/m with EM magnets – imagining lightsource – have radiation
  + Ryan – right, but it’s different. Those are rings, so they won’t have cavity field emission, etc… It’ll be SR
* Stephen – 100 T/m with a too small aperture for needs
  + Hard to beat Jay’s electromagnets in the conditions where you can put these
* Dejan – let’s go back to the optics
  + Ryan – we’re in the middle of discussing a legitimate concern
  + Alex – we’re just looking at concepts, not engineering
    - It’s not just engineering
  + Stephen - We can’t make it a concept if you can’t build the concepts you need
* Dejan – who decided on this aperture of 47.5 mm for a beam with a max mm beam size?
  + Ryan – sit in the control room, we lose beam all the time, it’s tight
  + Kirsten – Having larger diameter apertures where you are near the cryomodules is not uncommon for any machine. Had it in CBETA. There’s only so much vacuum transition you can deal with
    - Even if you neck it down, it take space
    - Even if perfect beam, this is a different concern
    - Dejan – please explain more
      * Look at the cryomodule cross section – have the beam pipe in the cavity – usually larger than the vacuum
      * Dejan – what vacuum? – Kirsten, the beam pipe
      * Dejan – the turbopumps are connected to the beam pipes
      * Kirsten – The pipe aperture next to cavities is often very large – larger than you’d like it to be in other locations.
  + Scott – right now, do you neck down?
    - Kirsten – not sure – can’t imagine we are necking up from the cavities
* Scott – guessing 60-70 mm iris size. May have a slightly larger beampipe outside, not sure
  + Kirsten – the beam pipe is 45.5 mm diameter between cryomodules
    - So necking down, but not a lot
    - It is what it is
* Dejan – I don’t get your argument about vacuum? so what are you saying about vacuum?
  + Kirsten – meant vacuum pipe diameter
    - There’s a spot with vacuum and a spot with cooling
  + Dejan – you have no arguments, you’re speaking nonsense
    - Vacuum is the same in the cavity pipe as it is near the quads. I don’t understand
    - Kirsten – I said vacuum, but I should have said vacuum pipe diameter
      * Regardless of what the decision was at the time, it is what it is
  + Dejan – it is really a very large aperture
    - Not necessary is what I’m saying. Should be 35 mm
* Scott – Let’s be a little careful. What happens when you neck down, you cut off the propagating modes from the cavities. You introduce wakes and HOMs. Might not like that.
  + Dejan – usually they damp the modes
  + Scott – depends how they do it – don’t know to what extent they are catching the propagating modes.
    - Typically only have it on one side
  + Dejan – would be very good if Alex or someone could bring to the next meeting to describe the cryomodules, HOMs, etc… why 45.5 mm? etc…
* Alex – will ask Roger Ruber
  + Lots changing over the next two years – there is a program of refurbishment. Some old beam pipes/flanges will be replaced – good question – we may even have more room in places
    - Ryan – they’ve actually taken up more space with pumps, etc…
* Dejan – my feeling is that the moment you go from 45 to 35 mm, things get easier
* Alex – Nick brought an interesting idea – if you build the LINAC with all C100s, can shrink the LINACs and reduce length by 2
* Dejan – before review, maybe next week, hear experts?
  + Next Friday goes into Easter
* Reza – suspect decision for aperture was to make the radius of curvature large b/c don’t want to have small radius in SRF cavity
  + Length of cavity fixed
  + Make the ratio different between larger/smaller, you have to change the curvature
* Alex – Big picture. 12 GeV upgrade was 10+ years, so looking forward, may have different hardware and modifications – can maybe tailor.
  + Think outside the box, not be overly constrained
* Ryan – Just to be a raincloud, curious – when we started, it was supposed to be a minimally invasive upgrade, but it’s been snowballing. It used to be a cheap, manageable upgrade, to a big upgrade. Are there other more cost-effective means?
* Alex – there will be a LINAC refurbishment with more high gradient C100s – there’s an independent effort we need to keep track of
  + Opportunity, things will change
* Alex – strongly focusing if we go for 110 degrees, can still do periodic twin cells, gradient goes down by 20% and still get the outcome
  + Get things quantitatively
* Dejan – want to ask those running the machine – how do you correct the orbits through the linacs?
  + Ryan – tune mode. Differentiate passes – you steer the lowest energy toward the highest. Adjust initial conditions, massage it down so the lowest E goes toward highest E.
  + BPMs have about half a mm on the screen
  + Dejan – basically correcting mostly at the lowest pass
  + Ryan – rigidity – in tune mode anyway. Mostly needed for threading through
  + Dejan – CBETA – able to correct orbit around but not in the linac itself. Had a separate entrance
    - Linac is like a parabolic function. I like Alex’s solution. I like this more, it’s more controlled
* Ryan – invite Tief to give an update on the shielded lattice
* Alex – Ryan can go through Tief’s idea
  + Ryan – If I had the time, I would. I absolutely do not have the time to do that
  + Alex – you think it’s better, so you can try
  + Ryan – I never said I think it’s better, I said I think it’s more practical and allows us to keep elements in the beamline
  + Alex – it comes down to what’s the gradient and what’s the payoff in terms of beta functions. If you can get the table here, we can compare.
  + Ryan – and I said I don’t have time to do this. Someone else is welcome to, or we can have Tief come give a description, but I don’t have cycles to do that work.
  + Dejan – I worked very hard to understand the properties of the linac. My lowest Beta was higher than whatever Alex is doing. It’s very preferable to matching the linac to the 3 m beta of the FFA
  + Ryan – I’m not arguing that it’s not nice optically. I’m arguing that it’s nice optically, but that the practical side is not. That is my concern.
  + Dejan – We don’t know that, let’s see what the experts have to say about that.
  + Alex – let’s not jump to conclusions.
  + Ryan – I just know how long dipoles are, how long correctors are, and how long BPMs are, and I know we don’t have space with the extended magnets. That is what I know. I walk the tunnel every other week, see it firsthand, touch it, space is a real concern. It must be a constraint we add to the design, as conceptual as you want to make them, we still need some level of practicality.
  + Alex – we have to be clever about that
* Alex – again, this is the example of the 110. If we can bring it lower we can try. This is the idea/concept that actually works.
* Ryan – what about making the weakly focusing lattice stronger. We had a weakly focusing lattice that did the same thing, but was too weak. What about adjusting that one.j
  + Alex – the betas were too large – it wasn’t the same thing
  + Ryan – but it’s alternating triplets.
  + Alex – it was unacceptable, we started with weakly
  + Ryan – we started with strong, then weak, then went back to strong. Weak was alternating triplets as well, maybe make them stronger.
  + Alex – you are welcome to pursue
  + Ryan – again, my cycles are pretty limited – find someone else to explore
  + Alex – if we looked at this and removed the triplet and put a singlet – that would be a weaker focusing solution
  + Ryan – it might be
  + Alex – you’d have to do something about it. You’d need to increase the quad strength to compliment the singlet. Going in the wrong direction. This is handwaving
  + Ryan – I think you should invite Tief as the expert to present that lattice
  + Alex – you’ve described it. It won’t tell you anything different, and it’s limited
    - Wasn’t worth the hassle
    - Ryan – they didn’t need that level of strong focusing for 12 GeV was the reason.
  + Alex – the phase advance, perhaps we can lower it a little bit, but we have a process and a way of designing
    - But it won’t work
* Dejan – We’ve been working on Muon collider lattices with RLA – going on for 25 years. This experience with linac lattice design should not be neglected
  + What Alex is doing is something that comes out from experience of 20 years. All these comments about focusing – we know what we are talking about.
* Argument breaks out here.
* Apologies made here.
* Meeting end.

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| Action Items | Person responsible | Deadline |
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## Time allotted | 10 mins | Agenda topic JLAAC | Presenter Donish

* N/A

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| Action Items | Person responsible | Deadline |
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## Time allotted | 10 mins | Agenda topic AOB | Presenter All

* N/A

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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>