FFA@CEBAF Working Group|Minutes

## Meeting date | time 12/20/2024 | 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, Nick, Donish, Scott, Volker, Kirsten, Stephen, Dejan, Salim, Randika, |

# Intro Discussion

* Ryan – do we need slides for the LDRD on JLAAC?
  + Alex – No, you’ll have a separate presentation
* Welcome to Volker Ziemann!
  + Gives some background on history
* Alex went to Frascati for the physics workshop for 22 GeV
  + Agenda was to respond to a question from the committee: as we go along we are defining beam quality on accelerator side. What are the requirements on the experimental side?
  + WG conveners plan to extract what the physics requirements are for the beam.
* Two weeks ago, mentioned a few things:
  + Alternative hybrid PM/EM quads – alluded to alternative
  + Chart, line chart

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  + Driven by first quads in NL for Strong Focusing
  + G = 2.4 kG/cm – aggressive, drives all focusing
  + Need to scale linearly for FODO along the linac
  + Conventional quads get too strong, so idea is to split the burden:
  + Chart, line chart

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  + Figure of Merit – if we split it this way, get final:
  + Diagram, line chart

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    - Dejan – assumes you’ll move orbits in cavities?
      * Alex – cavities have very large aperture
    - Dejan – not question of aperture. Need to worry about wakefields, etc…
      * Scott knows more
    - Alex – looked at BBU in the past – unsuccessful b/c couldn’t excite
    - If we split things as initially shown – for the NL, we have a ratio of 2.7, SL is 1.6
* South Linac more challenging – end up with 8.4 kG/cm – that’s huge
* You can also partition differently:
  + Chart, line chart

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  + Graphical user interface

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* Stephen – I looked into this, and the best I can get for the pipe size is 50-60 T/m
  + Also wonder, is there any way to lengthen the gaps in triplet
  + There’s only 89.5 cm in the gap, flange-to-flange
* Ryan – so weakly focusing worked for magnets, but not Splitters. Strong focusing works for optics, but not magnets. Is there not something in between that works for both?
  + Yes, that’s an option. Right now, it’s 150 degree phase advance – so maybe too aggressive
  + Feel like it would be easier to start with optics solution first, before looking into adding other PM solutions
    - We need other hardware as well. Correctors, BPMs, etc…
* Dejan – when you take quad w/ standard Halbach, can get even 3 T field inside the pipe depending what is the outer radius vs inner
  + Stephen – no you can’t. Only with dipole, you’ll need a huge magnet
  + Maybe reduce to 1.5 cm?
  + 2.2 cm was radius? -yes
* Scott – that’s a question though. What is the aperture in the LINAC? Is it chosen so radius continues?
  + Ryan: Some down and up, but it’s 5 or 5.5 passes going through.
    - Operators already complain it’s hard. Not a light source or ring, no periodic condition
    - Can we reduce it a bit? Yes, but only a little.
  + Alex – correction and diagnostics is poor. There’s an effort to go with new diagnostics and improve.
* Stephen – Why are the gradients adding? Why are magnets side by side. Are they nested?
  + Alex – I put them side-by-side, yes. But Andrei had a way to nest them
  + Stephen – depends on design, but what you’re really done is double the length of everything
    - But now you’re close to something that can be built with electromagnets. If you can get to 3.9 + 3.9, you can do all EMs and no PMs
  + Based on what Ryan sent, 50 T/m might be doable. But radiation is very high (from paper)
    - Bad for PMs, will maybe need to replace magnets every 6 months. Will need many corrector coils
  + Dejan – maybe SmCo?
    - Stephen – still same problem, lose gradient. Likely need electromagnets.

# Agenda topics

## Time allotted | 50 mins | Agenda topic APS Magnets| Presenter Nick

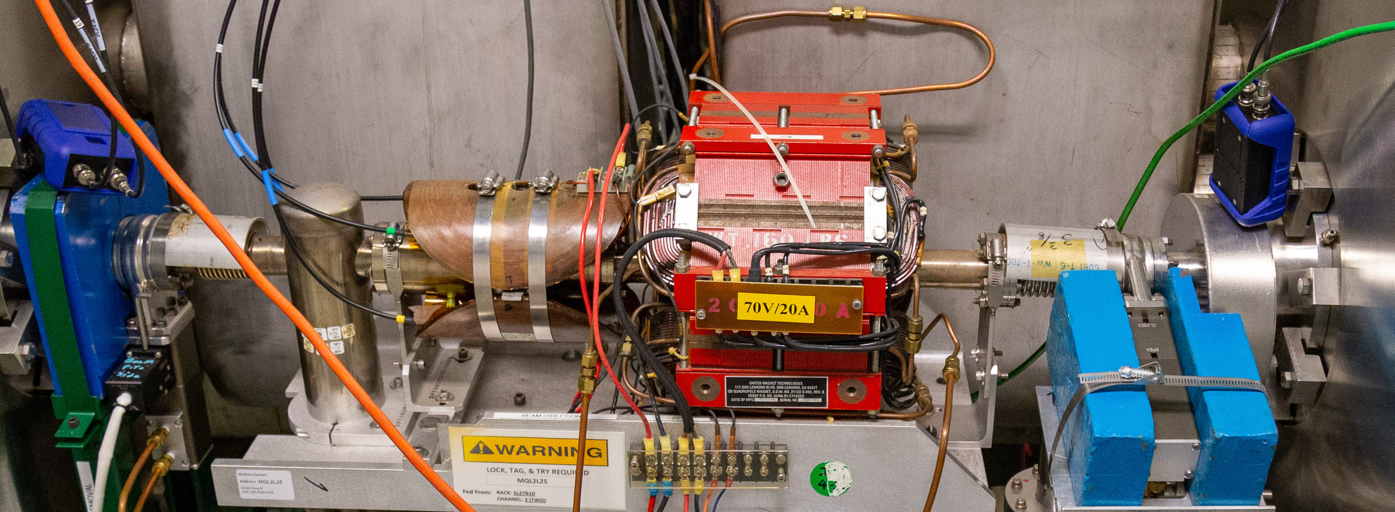
* Last night, APS reached design current of 200 mA!
* Beam pipe is set off axis in multi-function magnets
  + Curved path through magnets
* 2 quads that are normal – might barely work
* 6 GeV machine, very strongly focusing
* Chart, histogram

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* Here you see the 7 bend achromat
* High field upstream, low field downstream
* Betas mostly small, max up to ~20 m, small dispersion
* Dejan – similar peaks in middle to FFA here
* Most quads have big/large yoke – need to get photons out of the front end
  + Very distorted and asymmetric transversely
* Had to be built in the same tunnel from before upgrade – very constrained when adding magnets
* Diagram

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  + Insertion length shown
  + Challenging header design – water to get into coils for cooling
  + All fit into very compact space and moved to side to make them cooled
  + 2017 magnet design
  + Only Q1 and Q2 are final. For all other quads, significant changes were made, and you should look
* Graphical user interface, text, application

  Description automatically generated
  + Aperture about half of what we need, so need to scale for the 45 mm needed
  + Got to design reports to get real numbers for the other (not Q1 and Q2 magnets) magnets
    - Other magnets are longer, these are the short ones (25 cm)
* Chart, line chart

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  + Tried to run Q1 saturation – good around 90-100% efficiency
* Table

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  + Insertion length is ~25 cm
  + Gradient at about 80 T/m
  + Degrade by about 4 for similar magnet design with our aperture requirements
  + Gives about 2 kG/cm after aperture change
* Alex B – our aperture is not that large, right? Isn’t it 2.2 cm diameter?
  + No, it’s 2.2 cm radius
  + Ryan, I think we have roughly 1.5” beam pipe. Will find photo
* Scott – Made statement that gradient would go quadratically – wouldn’t it be linear?
  + Apparently, re-checked from USPAS, goes as 1/r^2. Had assumed constant, but apparently not
  + Same pole tip, increase radius, goes like r^2
  + Stephen – could also add more amp-turns as well
  + But at given radius, the magnitude of the field in a quad is proportional to radius. So field at the end of the iron is just gradient time radius
    - So if quadratic, something else going on
  + Nick – was talking about gradient – assume keep pole tips same
    - Multipole content pretty important as well – satisfied at smaller aperture
  + Alex – if good enough for light source, good enough for us
* Scott – interesting design: mag length far shorter than physical, but tuck coils under the vacuum. That gives you a more compact transverse magnet. Slick idea.
* Stephen – does effective length mean you get less integrated strength though?
  + Yes – basically these are 25 cm slots with 21 cm Leff – about right
* Scott – confusing in Alex’s table – quoting gradient without relative length
  + Nick – integrated field divided out
  + Alex – yes, assumed same length
  + Nick – fringe field fall off
* Longitudinal space is 89.5 cm
* Ryan – ID of 40 mm for the smaller new design. Could go down to 40 mm. 43.68 mm ID is closer to what we have now. Tech note is in the shared area for this.
  + Dejan – that’s enormous!
* Alex – we can go smaller for 22 GeV
* Ryan – yes, but Next Gen BPMs isn’t changing all the hardware. Lots of striplines are staying in. So if we shrink aperture, all BPMs will need to be changed
  + Dejan – we can use buttons
  + Ryan – we’re not.
* Dejan – I think Jay was right! Hard to get these fields! I think we need to drop the ID to 20 mm ID
  + Alex – Agreed
* Scott – ask the right people if that’s OK.
  + Bunch current concerns
  + Ryan – already have problems with field emission at ends of cryomodules b/c mismatch of beam pipes in cold/warm transitions
    - Scott – probably outside of the area where we’d have to worry about it. The taper would have to happen in the warm region
    - Presumably, not worried about field emission. Worried more about short range wakes
    - Alex – bunches are pretty long
  + Ryan – but we’d have to change everything on the girder.
  + Dejan – has to be tapered
  + Scott – going to lose 20 cm (10 on each end) from taper
    - Ryan – so 89.5 to 69.5 cm
      * Probably more beneficial to look at optics changes first before we try to change everything
      * Dejan – I think Alex did it the best way we could. Problem is the LINAC has a large energy range, not easy to do this at all
  + Alex – started Strong focusing, then weak, back to strong
* Alex – as Ryan said, we could maybe find something in between weak and strong focusing, but weighted toward strong
* 
  + Flange-to-flange is 89.5 cm.
  + Scott – that’s BAD. Look at what you have in there. Two bellows (~10 cm). Need at least one of those.
    - Have a stripline?
      * Underneath the strapped-on coils
* Scott – so do you need striplines b/c current?
  + Ryan – so when we increase energy, we’ll also need to drop current to stay in the total power limit.
    - As is now, Hall B flies blind due to low current except in tune mode.
    - Our current will be lower
  + Scott – that tells me that you cannot do buttons here. Have to do striplines b/c current. That’s real estate. That’s another 7-10 cm on a stripline
  + Ryan – there are space concerns. Maybe there’s a clever way to make the BPM inside the quads somehoe?
  + Scott – you need the aperture. Stripline will share inside aperture. Needs another cm radius or so. So no.
* Alex – you can put them in between triplets
  + Scott – no. Buttons yet, but striplines, you need at least 10 cm.
  + Alex – we have 10 cm between magnets
    - Scott – but those aren’t real spaces.
* Nick – BPMs were bellows. Complicated
  + Need a mech. Eng. To look at this
  + 2-20 nCoulombs in light sources
  + Maybe a stripline through quads. But need mech eng to look at the whole space as a unit
* Dejan – what is the distance you require for the energy range of moving the dipole field left and right?
  + If we assume you can go offline in cavities
  + Alex – oversimplified – used 90 cm, and fatter triplets
  + No, want to put a dipole field in the transverse plane? – No, I don’t think so
    - Basically made gradients so can split and play with it
  + More and more, I’m inclined toward NSLS II magnet design
    - Like Timur’s
  + What can we do if we reduce to 10 mm IR
* Stephen – radiation is very high, not a good place to put PMs if you can avoid it
  + Radiation levels are xrays?
  + Neutrons too
  + Shoots Xrays everywhere
* Paper is a tech note from Charlie Reece
  + Alex – ages ago
  + Ryan – no, right before he retired. From 2021
* **A picture containing text, person, screenshot

  Description automatically generated** - mylar from 1L07
* Graphical user interface

  Description automatically generated with low confidence
  + This is normal operation. Not including spin-up.
  + Alex – these are figures of merit
* All along both linacs – measured on the beamline. Can see optichromic rods in vials
* Stephen – lifetime dose limit for CBETA is 100 krad
  + See 20 times that in a single 5 week run here
  + Bad idea to put PMs here
* Alex – for LDRD, are you putting samples here?
  + Yes. Not sitting on pipe, but sitting offset near the NDX detectors on tripods
  + Dose will be lower b/c not on beam pipe
* Alex – Ryan is monitoring neutron and gamma?
  + Trying – dosimetry saturates
* Dosimetry delayed, so not ready in start up, but will be ready soon

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| Action Items | Person responsible | Deadline |
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## Time allotted | 50 mins | Agenda topic Sym Splitters| Presenter Donish

* Saved by the bell

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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>