

FFA@CEBAF Working Group | MINUTES

Meeting date | time 02/21/2025 | 11 AM EST | Meeting location <https://jlab-org.zoomgov.com/j/1614898082?pwd=TnUzMS81M2sxbDZlbERJU01tYkJCQT09>

Meeting called by Alex B

Type of meeting Weekly Meeting

Facilitator Alex B

Note taker Donish

Timekeeper Alex B

Attendees

Alex B, Ryan, Edy, Kirsten, Salim, Reza, Scott, Donish, Andrei, Randika, Roger, Volker

INTRO DISCUSSION

- Next FFA test at CEBAF, a brainstorming session.

AGENDA TOPICS

Time allotted | 25 mins | Agenda topic LDRD | Presenter Alex B

Questionnaire for Scoping a Test.....

- **What** do we want to learn?
 - Proof of principle: beam transport of multiple energies?
 - FFA Optics validation?
 - Technology demonstration?
- **Where** should we set it up? (location at CEBAF)
 - Energies to be probed? Simultaneously, or in sequence
 - Real-estate needed? Extend of measurements, experimental setup and diagnostics
- **When?** Timeline and staging
 - 'Single magnet' test
 - 'Full Cell' test

- What do we want to learn?

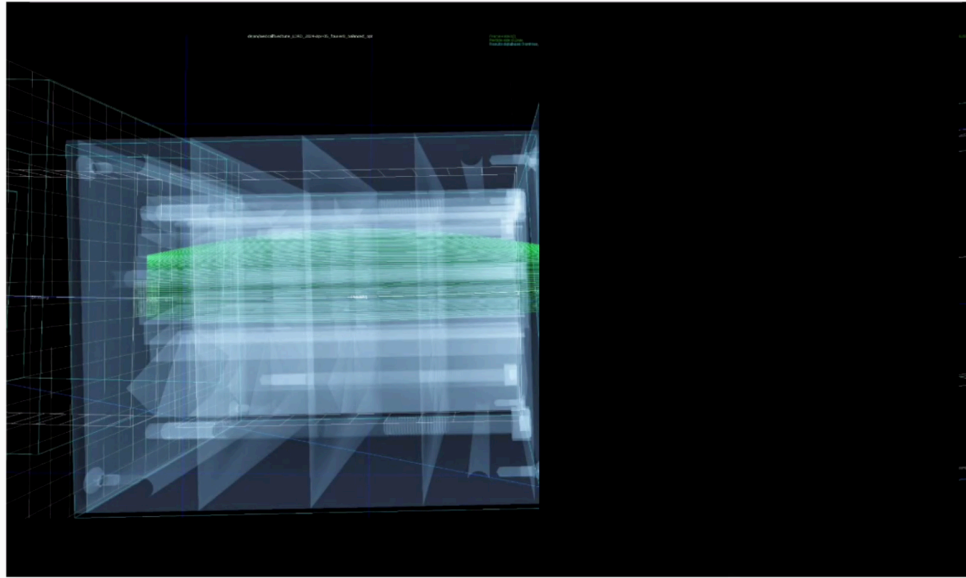
- o Beam transport of multiple energies
 - o Technology demonstration
- Where?
 - o Hall line?
- When?
 - o Split in two: single and full cell tests.

Where are we Now.... Past and Current Tests

- **Done** - Prototype open-midplane BF magnet successfully built and evaluated for mechanical integrity (6 cm section), BNL LDRD
 - >1.5 Tesla measured in good field region
 - Field accuracy of 10^{-3}
- **Ongoing** - Testing magnetic materials for radiation resilience at CEBAF
 - LDRD project started Oct. 1, 2023 to be concluded Sept. 2025
- **Recent SBIR initiative** – Fabrication of a full scale (~ 1 meter) permanent magnet for FFA@CEBAF
 - BNL/SABRE letter of intent for SBIR Phase I, submitted in Aug. 2024
 - Turned down as 'nonresponsive'

- What we have done so far?
 - o Prototype magnet built
 - o Currently testing for radiation resiliency
 - o SBIR initiative turned down as 'non responsive'

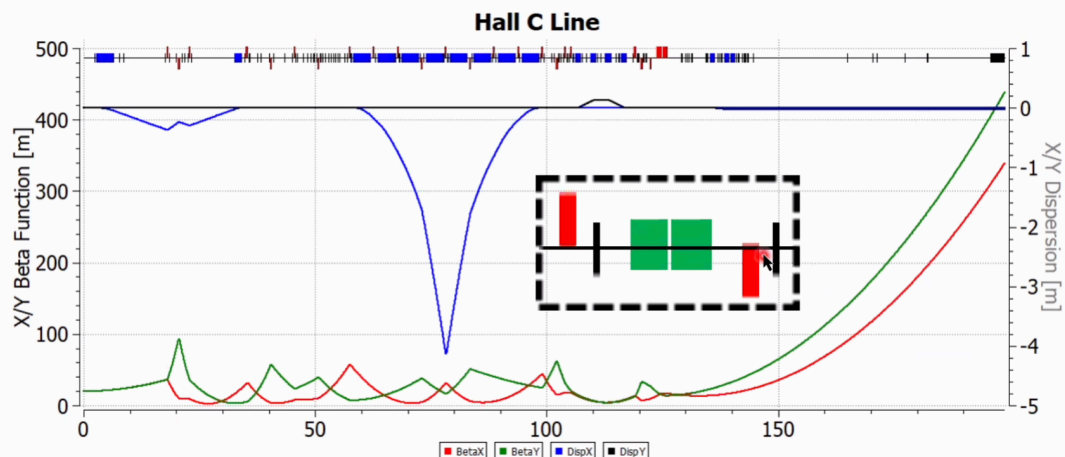
Full Length Compact FODO Cell



What if we only have one magnet?

- What if we only have 1 magnet? Per discussion with Joe Grames:
 - Want the biggest payoff
 - Aim to transport multiple energies; high and low
 - Staged in the BSY dump line

'Full FFC Cell' Test - Possible Location... Hall C



- In Hall C, we have a wide range of energies to test: (4.5, 6.7, 8.9, and 11 GeV)
- Empty space of ~12 m to run tests
- Ryan: Need to take care that the beam is dissipated at the dump location still
- Scott: Can use the two magnets to close orbit i.e. like a DBA

Quad scan with harps – Beam Optics measurement (β , α , ε)

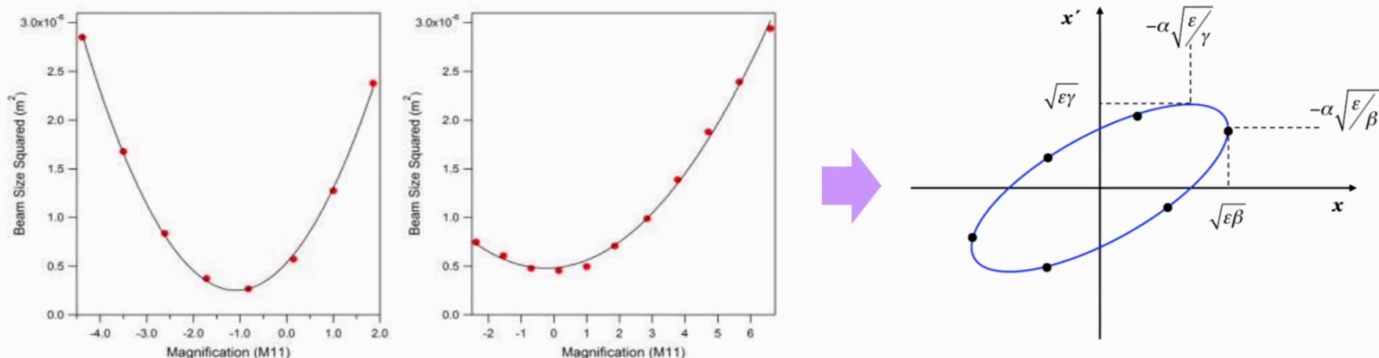


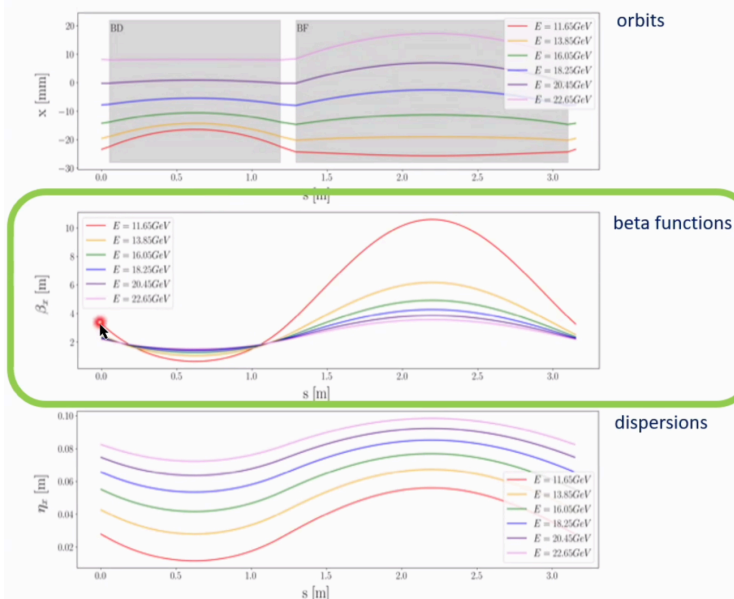
Figure 4: Horizontal (left) and vertical (right) scans with fit.

Table 1: Analysis results of multiple regression fits of three sets of beam size data.

	Harp Analyzer	Gaussian	Asymmetric Gaussian
ε_x (mm-mrad)	0.3777	0.3858	0.3958
ε_y (mm-mrad)	0.2566	0.2571	0.2576
β_x (m)	5.3536	6.3612	6.3709
β_y (m)	2.0776	2.2375	2.2333
α_x	-0.8341	-1.0632	-1.0370
α_y	-0.0419	-0.0427	-0.0458

- Quad scan done currently at CEBAF, so should be straightforward

Non Scaling FFA Arc – Compact FODO Cell

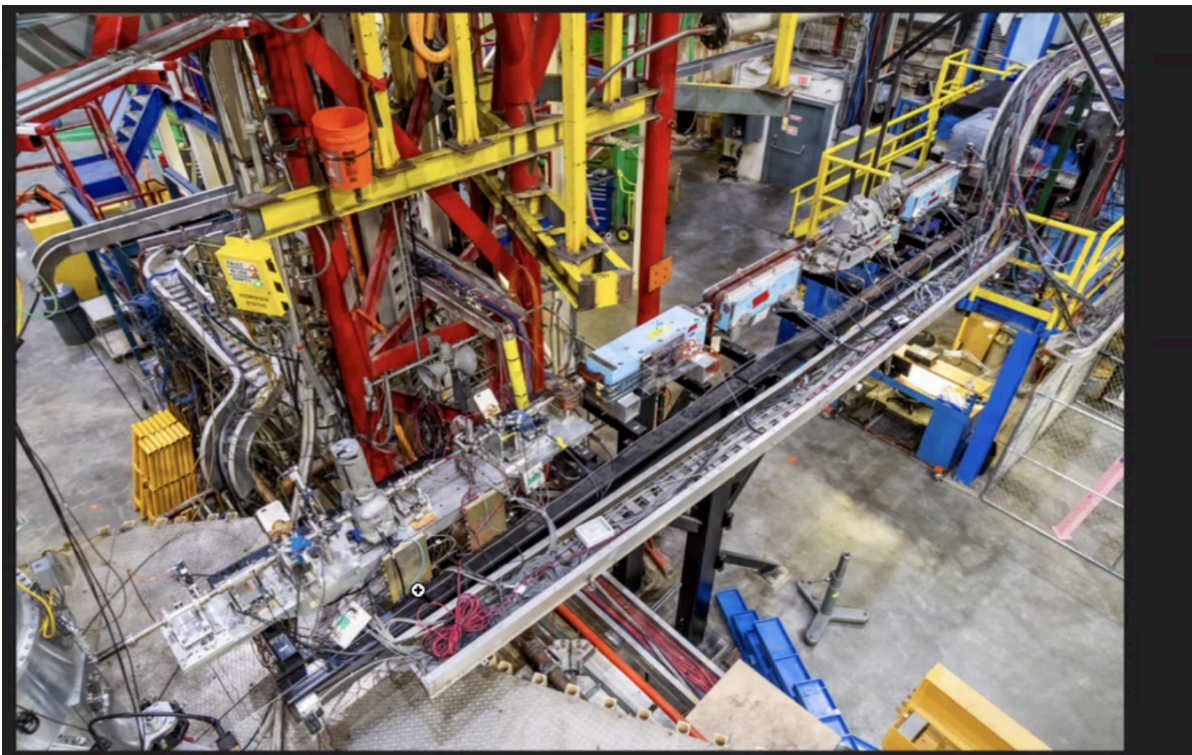


- Large momentum acceptance FFA cell, configured with combined function magnets capable of transporting six beams with energies spanning a factor of two
- Arc composed of 75 cells, $L_{\text{cell}} = 3.15$ m
- Closely spaced orbits for all six beams (~ 4 cm)
- Low betas (~ a few m)
- Extremely low dispersions (a few cm) - Virtue of combined function FFA magnets

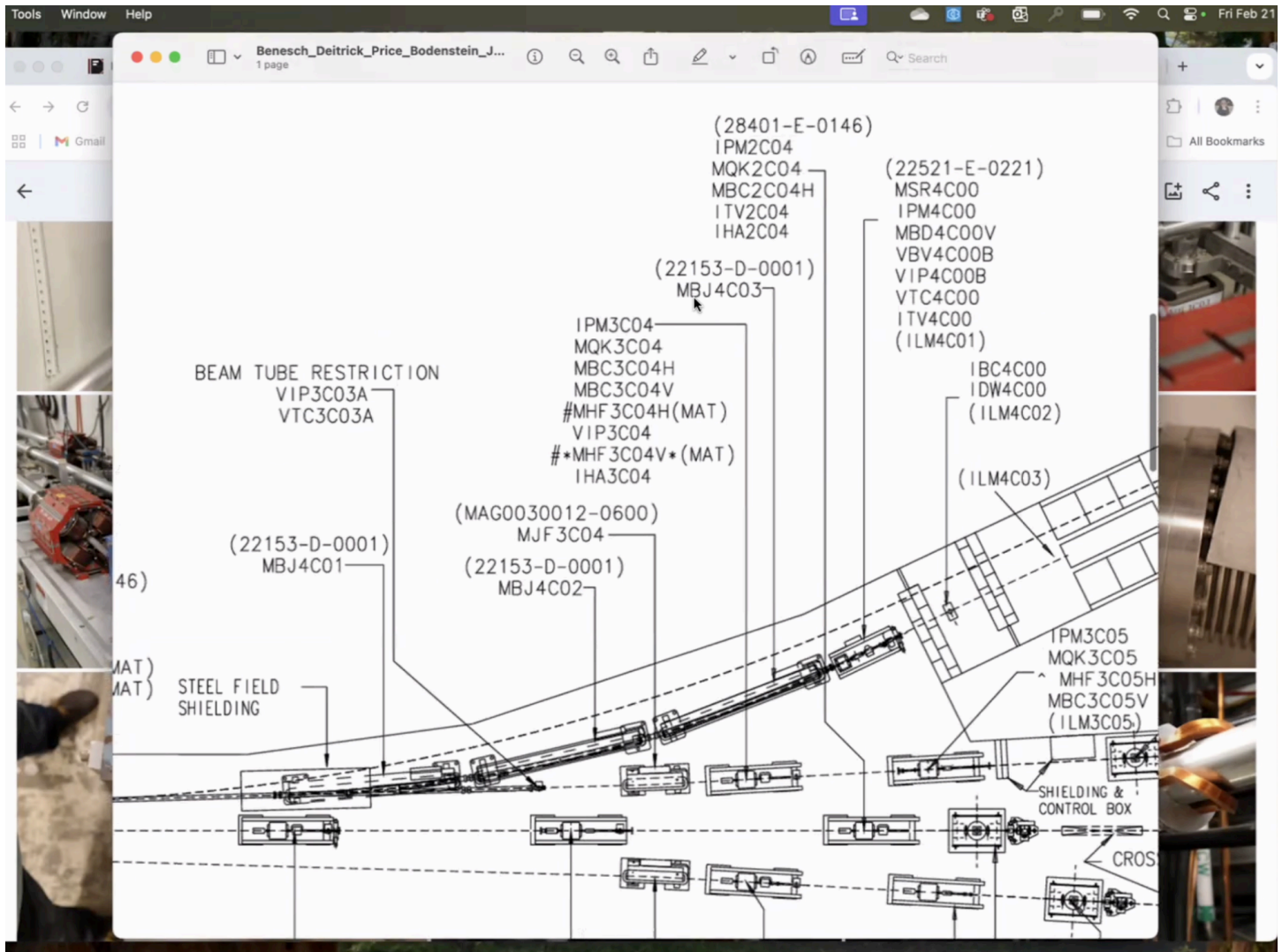
- The experiment aim would be to tune our incoming optics to that of the FODO cell.
- Critical Hardware: Fabrication of BF and BD magnets
- A pair of QA quadrupoles (CEBAF spares)
- A pair of harps (CEBAF surplus)
- Data acquisition (EPICS)
- Analyzing software (CEBAF)

POST DISCUSSION

- Edy: Do we include an electromagnet? Otherwise we would need to install/run our experiment and uninstall to allow for normal Hall C usage.
 - Alex: Great suggestion, we could design a beamline that allow variety of usage of Hall C.
- Salim: Do we need Panofsky quad correctors?
 - Alex: This is a first step so only providing a proof of principle of the FODO cell should be sufficient. Adding the Panofsky quad would be a bonus.
- Scott: You are not (really) demonstrating the periodic cell. You are more so demonstrating that the magnet operate and behave as expected. To demonstrate periodic cell you would need more cells.
 - Alex: There is enough flexibility in the optics to span the range of the magnets
 - Scott: Matching the incoming optics into the periodic cell would be challenging and would require a dedicated matching line
 - Alex: There are 2 dozen quadrupoles you can tune for the beta functions.
- Ryan: Show pictures of the intended experimental site:



- Ryan: We discussed the possibility of using the BSY dump in the 2023 FFA collaboration meeting.



- Ryan: Get rid of the above magnet (unknown length, maybe ~4m).
 - Alex: This is a good idea for a single magnet: room for diagnostics and not interfere with Hall C experiments.
 - Scott: In the single test, can you add BPMs and Kickers? Two BPMs on either side (for trajectory, position and direction) and four kickers before and after (to close bump).
 - Alex: Yes! If we could fit this in the ~4m space in the BSY this would be a very interesting test.
- Reza: This magnet be able to handle a factor of 2 in energy, so the BSY would need to handle more of a dynamic range.
 - Alex: If we could get at least 5 and 10 GeV, then we span the factor of 2 range in energy.
 - Scott: Energy doesn't matter. Trajectories do.
 - Reza: What current do we need? Can it be done in Hall D line which has a lot of distance.
 - Alex: Good question.

- Scott: We care about having reliable diagnostics.
- Alex: In BSY dump, our standard BPMs could give us good measurements for a few micro-amp beams.
- Scott: One concern: Dump lines want diffused beams but for our FODO is point-like.
- Alex: There is some tunability.
- Ryan: There might be a raster at the end.

Action Items

Person responsible Deadline

Special notes

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