

**2023 Workshop on  
Fixed Field Alternating Gradient Accelerators (FFA'23)**

Hosted by Thomas Jefferson National Accelerator Facility  
September 10–15, 2023

# **PROGRAM**

**Sunday, September 10, 2023 - Friday, September 15, 2023**  
**Jefferson Lab, Newport News, VA 23606 USA**

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# 2023 Workshop on Fixed Field Alternating Gradient Accelerators (FFA'23)

Hosted by Thomas Jefferson National Accelerator Facility  
September 10–15, 2023

## WELCOME

The workshop seeks to continue the development of fixed-field accelerators following research in Japan, North America and the UK and to extend the potential range of applications of FFA accelerators. The format will be invited and contributed talks interspersed with periods of focused discussion. The workshop will be preceded by a two-day training school held at JLAB as well, aimed at introducing students (and others) to basic FFA ideas and provide background knowledge leading into the workshop proper.

## General Information

### Venue

Jefferson Lab  
CEBAF Center F113  
12000 Jefferson Avenue  
Newport News, VA 23606  
Main Phone: 757.269.7100

### Local Host

Jefferson Lab  
12000 Jefferson Avenue  
Newport News, VA 23606  
Main Phone: 757.269.7100

### Onsite Registration

Registration opens on Monday from 8:30 a.m. to 9:00 a.m. in the CEBAF Center Atrium

### Name Badges / Lanyards

For security purposes, and to encourage networking, attendees are asked to wear their name badges at all times during the workshop.

***Badges will be required for the tour of Jefferson Lab.***

### Disclaimer

The FFA'23 committees reserve the right to make changes to the workshop program at any time without notice.

## Committees

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### International Organizing Committee:

- [Andreas Adelman](#) PSI, Switzerland
- [J. Scott Berg](#) BNL, USA
- [Georg Hoffstaetter](#) Cornell, USA
- [Nobuo Ikeda](#) Kyushu University, Japan
- [Yoshihiro Ishi](#) KURNS, Kyoto University, Japan
- [Carol Johnstone](#) FNAL, USA
- [Shinji Machida](#) RAL, UK
- [Francois Meot](#) BNL, USA
- [Yoshiharu Mori](#) KURNS, Kyoto University, Japan
- [Jaroslaw Pasternak](#) Imperial College London, UK
- [Thomas Planche](#) TRIUMF, Canada
- [Christopher Prior](#) RAL, UK
- [Akira Sato](#) Osaka University, Japan
- [Dejan Trbojevic](#) BNL, USA
- [Alex Bogacz](#) Workshop Chair, JLAB, USA

### Local Organizing Committee:

- [IOC co-Chair and Local Chair](#) [Alex Bogacz](#), JLAB
- [IOC co-Chair](#) [Dejan Trbojevic](#), BNL
- [FFA School](#) [Stephen Brooks](#), BNL
- [CEBAF Tour](#) [Jay Benesch](#), JLAB
- [Financial Coordinator](#) [Anita Seay](#), JLAB
- [Administrative Coordinator](#) [Tristan Jones](#), JLAB
- [Website](#) [Annabelle Petway](#), BNL

# TIMETABLE

## Sunday, September 10, 2023

Coffee and Pastries (8:30 AM - 9:00 AM)

### Lecture I (9:00 AM - 10:40 AM)

9:00	M[1] Introduction to FFAs - Scott Berg	BERG, J. Scott
9:50	M[2] Transverse Dynamics - Scott Berg	BERG, J. Scott

Coffee Break (10:40 AM - 11:00 AM)

### Lecture II (11:00 AM - 1:00 PM)

11:00	AM[3] Longitudinal Dynamics - David Kelliher	KELLIHER, David
12:00	PM[4] Longitudinal Dynamics/RF - Tom Uesegi	UESEGI, Tom

Lunch Break - Tech. Ctr. (1:00 PM - 2:00 PM)

### Lecture III (2:00 PM - 3:20 PM)

2:00	M[5] BMAD Tutorial - Scott Berg	BERG, J. Scott
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Coffee Break (3:20 PM - 3:40 PM)

### Lecture IV (3:40 PM - 5:00 PM)

3:40	M[6] ZGOUBI Tutorial - Francois Meot	MEOT, Francois
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## Monday, September 11, 2023

Coffee and Pastries (8:30 AM - 9:00 AM)

### Lecture V (9:00 AM - 10:40 AM)

9:00	M[7] Diagnostics in FFAs - Yoshihiro Ishi	ISHI, Yoshihiro
9:50	M[8] FFAs for high power proton machines - Shinji Machida	MACHIDA, Shinji

### **Coffee Break (10:40 AM - 11:00 AM)**

### **Lecture VI (11:00 AM - 1:00 PM)**

11:00	AM[9] Medical FFA Applications - Carol Johnstone	JOHNSTONE, Carol
12:00	PM[10] Electron and ERL FFA Applications - Kirsten Deitrick	DEITRICK, Kirsten

### **Lunch Break - on your own (1:00 PM - 2:00 PM)**

### **Lecture VII (2:00 PM - 3:20 PM)**

2:00	M[11] Analytic tools for FFA design - Max Topp-Mugglestone	TOPP-MUGGLESTONE, Max
2:40	M[12] Halbach Area permanent magnet tool - Stephen Brooks	BROOKS, Stephen

### **Coffee Break (3:20 PM - 3:40 PM)**

### **Lecture VIII (3:40 PM - 5:00 PM)**

3:40	M[13] OPAL Tutorial - Carl Jolly	JOLLY, Carl
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Tuesday, September 12, 2023

## **Tuesday, September 12, 2023**

### **Coffee and Pastries (8:30 AM - 9:00 AM)**

### **Fundamental Ideas I (9:00 AM - 10:40 AM)**

9:00	M[14] Welcome - Andrei Seryi	SERYI, Andrei
9:10	M[15] Logistics - Alex Bogacz	BOGACZ, Alex
9:20	M[16] 12 GeV CEBAF - Andrei Seryi	SERYI, Andrei
10:00	AM[17] 22 GeV CEBAF energy upgrade - Vasliiy Morozov	MOROZOV, Vasiliy

### **Coffee Break (10:40 AM - 11:00 AM)**

### **Fundamental Ideas II (11:00 AM - 1:00PM)**

11:00	AM[18] Isochronous and zero-chromatic FFA - Yoshiharu Mori	MORI, Yoshiharu
11:30	AM[19] Constant-tune FFAs - Dejan Trbojevic	TRBOJEVIC, Dejan
12:00	PM[20] Constant-tune Cyclotrons - Thomas Planche	PLANCHE, Thomas

12:30	PM[21] Analytic model of vertical FFAs - Max Topp-Mugglestone	TOPP-MUGGLESTONE, Max
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**Lunch Break - on your own (1:00 PM - 2:00 PM)**

**Fundamental Ideas III (2:00 PM - 3:20 PM)**

2:00	M[22] FFA-Based Hadron RLA - Vasily Morozov	MOROZOV, Vasily
2:30	M[58] Multi-Pass Correction Scheme for FFA Arcs	COXE, Alex
2:55	M[59] Compact Merger Design for FFA Arcs	GAMAGE, Bumunuvita

**Coffee Break (3:20 PM - 3:40 PM)**

**FFA Applications I (3:40 PM - 5:00 PM)**

3:40	M[23] Permanent magnet and electromagnet designs for nonlinear FFA fields - Stephen Brooks	BROOKS, Stephen
4:10	M[24] New FFA-based CW Ion Therapy facilities - Carol Johnstone	JOHNSTONE, Carol
4:35	M[25] Recent activities at FLASH - Reinhard Schulte	SCHULTE, Reinhard

**Welcome Reception in the CC Atrium (5:20 PM - 7:20 PM)**



## Wednesday, September 13, 2023

Coffee and Pastries (8:30 AM - 9:00 AM)

Virtual Tour of CEBAF (9:00 AM - 10:00 AM)

Tour of LERF Accelerator (10:00 AM - 11:00 AM)

Tour of Hall D (11:00 AM - 12:00 PM)

Tour of Test Lab (SRF) (12:00 PM - 1:00 PM)

Lunch Break - on your own (1:00 PM - 2:00 PM)

### FFA Applications II (2:00 PM - 3:20 PM)

2:00	M[26] FFA-based radiation hardness ion facility - Carol Johnstone	JOHNSTONE, Carol
2:30	M[27] Review of national lab FFA technologies - Francois Meot	MEOT, Francois
2:55	M[28] Design Evolution of FFA LhARA - Jaroslaw Pasternak	PASTERNAK, Jaroslaw

Coffee Break (3:20 PM - 3:40 PM)

### FFA Applications III (3:40 PM - 5:00 PM)

3:40	M[29] FFA Applications (Contributed)	
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## Thursday, September 14, 2023

Coffee and Pastries (8:30 AM - 9:00 AM)

### FFA Hardware and Facilities I (9:00 AM - 10:40 AM)

9:00	M[30] Resumption of PRISM-FFA for next generations muon decay experiments - Akira Sato	SATO, Akira
9:30	M[31] Electron nodel of vFFA for Harmonytron - Kyosuke Adachi	ADACHI, Kyosuke
9:50	M[32] Design Study for RAL FETS-FFA - Shinji Machida	MACHIDA, Shinji
10:20	AM[33] The TATTOOS initiative at PSI - Daniela Kiselev	KISELEV, Daniela

Coffee Break (10:40 AM - 11:00 AM)

### **FFA Hardware and Facilities II (11:00 AM - 1:00 PM)**

11:00	AM[34] Conceptual design of FFA for super heavy element production using ERIT - Yoshihiro Ishi	ISHI, Yoshihiro
11:30	AM[35] TURBO: Novel Large Energy Acceptance Beamline for Hadron Therapy - Steinberg	STEINBERG, Adam
12:00	PM[36] FFA Synchrotron for Proton FLASH Therapy facility - Dejan Trbojevic	TRBOJEVIC, Dejan
12:30	PM[37] Design of the FETS-FFA double spiral magnet - Ta-Jen Kuo	KUO, Ta-Jen

### **Lunch Break / IOC Working Lunch (L102) (1:00 PM - 2:00 PM)**

### **FFA Hardware and Facilities III (2:00 PM - 3:20 PM)**

2:00	M[38] SABR Industries - Industrial Presentation	
2:20	M[53] KYMA - Industrial Presentation	
2:40	M[54] SIGMAPHI - Industrial Presentation	
3:00	M[55] XELERA - Industrial Presentation	

### **Coffee Break (3:20 PM - 3:40 PM)**

### **"Fringe" Ideas I (3:40 PM - 5:10 PM)**

3:40	M[39] Canted-Cosine-Theta SC Magnets - Lucas Brouwer	BROUWER, Lucas
4:10	M[40] Possibility of using the PRISM-FFA idea in the AMF - Robert Bernstein	BERNSTEIN, Robert
4:35	M[41] CBETA as a source of gamma photons from Compton back-scattering - Georg Hoffstaetter	DEITRICK, Kirsten

### **Banquet (6:00 PM - 9:00 PM)**

## **Friday, September 15, 2023**

### **Coffee and Pastries (8:30 AM - 9:00 AM)**

### **FFA Beam Dynamics I (9:00 AM -10:40AM)**

9:00	M[42] Adiabaticity in Relation to Longitudinal Capture - Shane Koscielniak	KOSCIELNIAK, Shane
9:40	M[43] Slow Extraction Techniques from FFAs for Charged Particle Therapy - Adam Steinberg	STEINBERG, Adam
10:10	AM[44] Demonstration of Beam Stacking in a Scaling FFA - David Kelliher	KELLIHER, David

### **Coffee Break (10:40 AM - 11:00 AM)**

**FFA Beam Dynamics II (11:00AM -1:00PM)**

11:00	AM[45] Machine Learning Based Study of vFFA Beam Optics - TBD	
11:30	AM[46] Studies of Beam Dynamics in an FFA Composed of Canted Cosine Theta Superconducting Magnets - Hanna Norman	NORMAN, Hanna
12:00	PM[47] Coasting Instabilities in Scaling FFAs - David Kelliher	KELLIHER, David
12:30	PM[48] The FFA Code Fixfield - Max Topp-Mugglestone	TOPP-MUGGLESTONE, Max

**Lunch Break - on your own (1:00 PM - 2:00 PM)****FFA Beam Dynamics III (2:00 PM - 3:20 PM)**

2:00	M[49] Global Perspectives for the Future of FFA Accelerators - Dejan Trbojevic	TRBOJEVIC, Dejan
2:30	M[56] IOTA - Novel Integrable System - Sergei Nagaitsev	NAGAITSEV, Sergei
3:10	M[57] Closeout - Alex Bogacz	BOGACZ, Alex

# Book of Abstracts

Lecture I / 1

Introduction to FFAs - Scott Berg

Corresponding Author: [jsberg@bnl.gov](mailto:jsberg@bnl.gov)

Lecture I / 2

Transverse Dynamics - Scott Berg

Corresponding Author: [jsberg@bnl.gov](mailto:jsberg@bnl.gov)

Lecture II / 3

Longitudinal Dynamics - David Kelliher

Corresponding Author: [david.kelliher@stfc.ac.uk](mailto:david.kelliher@stfc.ac.uk)

Lecture II / 4

## Longitudinal Dynamics/RF - Tom Uesegi

Lecture III / 5

## BMAD Tutorial - Scott Berg

Corresponding Author: [jsberg@bnl.gov](mailto:jsberg@bnl.gov)

Lecture IV / 6

## ZGOUBI Tutorial - Francois Meot

Corresponding Author: [fmeot@bnl.gov](mailto:fmeot@bnl.gov)

Lecture V / 7

## Diagnostics in FFAs - Yoshihiro Ishi

Corresponding Author: [ishi@rri.kyoto-u.ac.jp](mailto:ishi@rri.kyoto-u.ac.jp)

Lecture V / 8

## FFAs for high power proton machines - Shinji Machida

Corresponding Author: [shinji.machida@stfc.ac.uk](mailto:shinji.machida@stfc.ac.uk)

Lecture VI / 9

## Medical FFA Applications - Carol Johnstone

Corresponding Author: [cjj@fnal.gov](mailto:cjj@fnal.gov)

Lecture VI / 10

## Electron and ERL FFA Applications - Kirsten Deitrick

Corresponding Author: [kd324@cornell.edu](mailto:kd324@cornell.edu)

Lecture VII / 11

## Analytic tools for FFA design - Max Topp-Mugglestone

Lecture VII / 12

## Halbach Area permanent magnet tool - Stephen Brooks

Corresponding Author: [sbrooks@bnl.gov](mailto:sbrooks@bnl.gov)

Lecture VIII / 13

## OPAL Tutorial - Carl Jolly

Fundamental Ideas I / 14

## Welcome - Andrei Seryi

Corresponding Author: [seryi@jlab.org](mailto:seryi@jlab.org)

Fundamental Ideas I / 15

## Logistics - Alex Bogacz

Corresponding Author: [bogacz@jlab.org](mailto:bogacz@jlab.org)



Fundamental Ideas I / 16

## 12 GeV CEBAF - Andrei Seryi

Corresponding Author: [seryi@jlab.org](mailto:seryi@jlab.org)

Fundamental Ideas I / 17

## 22 GeV CEBAF energy upgrade - Vasliiy Morozov

Corresponding Author: [morozov@jlab.org](mailto:morozov@jlab.org)

Fundamental Ideas II / 18

## Isochronous and zero-chromatic FFA - Yoshiharu Mori

Fundamental Ideas II / 19

## Constant-tune FFAs - Dejan Trbojevic

Corresponding Author: [dejan@bnl.gov](mailto:dejan@bnl.gov)

Fundamental Ideas II / 20

## Constant-tune Cyclotrons - Thomas Planche

Fundamental Ideas II / 21

## Analytic model of vertical FFAs - Max Topp-Mugglestone

Fundamental Ideas III / 22

## FFA-Based Hadron RLA - Vasilij Morozov

Corresponding Author: [morozov@jlab.org](mailto:morozov@jlab.org)

FFA Applications I / 23

## Permanent magnet and electromagnet designs for nonlinear FFA fields - Stephen Brooks

Corresponding Author: [sbrooks@bnl.gov](mailto:sbrooks@bnl.gov)

FFA Applications I / 24

## New FFA-based CW Ion Therapy facilities - Carol Johnstone

Corresponding Author: [cjj@fnal.gov](mailto:cjj@fnal.gov)

FFA Applications I / 25

**Recent activities at FLASH - Reinhard Schulte**

FFA Applications II / 26

**FFA-based radiation hardness ion facility - Carol Johnstone**

Corresponding Author: [cjj@fnal.gov](mailto:cjj@fnal.gov)

FFA Applications II / 27

**Review of national lab FFA technologies - Francois Meot**

Corresponding Author: [fmeot@bnl.gov](mailto:fmeot@bnl.gov)

FFA Applications II / 28

**Design Evolution of FFA LhARA - Jaroslaw Pasternak**

FFA Applications III / 29

## FFA Applications (Contributed)

FFA Hardware and Facilities I / 30

## Resumption of PRISM-FFA for next generations muon decay experiments - Akira Sato

FFA Hardware and Facilities I / 31

## Electron nodel of vFFA for Harmonytron - Kyosuke Adachi

FFA Hardware and Facilities I / 32

## Design Study for RAL FETS-FFA - Shinji Machida

Corresponding Author: [shinji.machida@stfc.ac.uk](mailto:shinji.machida@stfc.ac.uk)

FFA Hardware and Facilities I / 33

**The TATTOOS initiative at PSI - Daniela Kiselev**

FFA Hardware and Facilities II / 34

**Conceptual design of FFA for super heavy element production using ERIT - Yoshihiro Ishi**

Corresponding Author: [ishi@rri.kyoto-u.ac.jp](mailto:ishi@rri.kyoto-u.ac.jp)

FFA Hardware and Facilities II / 35

**TURBO: Novel Large Energy Acceptance Beamline for Hadron Therapy – Steinberg**

FFA Hardware and Facilities II / 36

**FFA Synchrotron for Proton FLASH Therapy facility - Dejan Trbojevic**

Corresponding Author: [dejan@bnl.gov](mailto:dejan@bnl.gov)

FFA Hardware and Facilities II / 37

**Design of the FETS-FFA double spiral magnet - Ta-Jen Kuo**

FFA Hardware and Facilities III / 38

**SABR Industries - Industrial Presentation**

"Fringe" Ideas I / 39

**Canted-Cosine-Theta SC Magnets - Lucas Brouwer**

Corresponding Author: [lnbrouwer@lbl.gov](mailto:lnbrouwer@lbl.gov)

"Fringe" Ideas I / 40

**Possibility of using the PRISM-FFA idea in the AMF - Robert Bernstein**

Corresponding Author: [rhbob@fnal.gov](mailto:rhbob@fnal.gov)

"Fringe" Ideas I / 41

**CBETA as a source of gamma photons from Compton back-scattering - Georg Hoffstaetter**

Corresponding Author: [kd324@cornell.edu](mailto:kd324@cornell.edu)

FFA Beam Dynamics I / 42

**Adiabaticity in Relation to Longitudinal Capture - Shane Koscielniak**

FFA Beam Dynamics I / 43

**Slow Extraction Techniques from FFAs for Charged Particle Therapy - Adam Steinberg**

FFA Beam Dynamics I / 44

**Demonstration of Beam Stacking in a Scaling FFA - David Kelliher**

Corresponding Author: [david.kelliher@stfc.ac.uk](mailto:david.kelliher@stfc.ac.uk)



FFA Beam Dynamics II / 45

Machine Learning Based Study of vFFA Beam Optics – TBD

FFA Beam Dynamics II / 46

Studies of Beam Dynamics in an FFA Composed of Canted Cosine  
Theta Superconducting Magnets - Hanna Norman

FFA Beam Dynamics II / 47

Coasting Instabilities in Scaling FFAs - David Kelliher

Corresponding Author: [david.kelliher@stfc.ac.uk](mailto:david.kelliher@stfc.ac.uk)

FFA Beam Dynamics II / 48

The FFA Code Fixfield - Max Topp-Mugglestone

FFA Beam Dynamics III / 49

## Global Perspectives for the Future of FFA Accelerators - Dejan Trbojevic

Corresponding Author: [dejan@bnl.gov](mailto:dejan@bnl.gov)

"Fringe" Ideas II / 50

## IOTA - Novel Integrable System - Sergei Nagaitsev

"Fringe" Ideas II / 51

## Closeout - Alex Bogacz

Corresponding Author: [bogacz@jlab.org](mailto:bogacz@jlab.org)

"Fringe" Ideas II / 52

## Global Perspectives for the Future of FFA Accelerators - Dejan Trbojevic

Corresponding Author: [dejan@bnl.gov](mailto:dejan@bnl.gov)

FFA Hardward and Facilities III / 53

## KYMA - Industrial Presentation

FFA Hardward and Facilities III / 54

## SIGMAPHI - Industrial Presentation

FFA Hardward and Facilities III / 55

## XELERA - Industrial Presentation

FFA Beam Dynamics III / 56

**IOTA - Novel Integrable System - Sergei Nagaitsev**

FFA Beam Dynamics III / 57 **Closeout - Alex Bogacz**

Corresponding Author: [bogacz@jlab.org](mailto:bogacz@jlab.org)

Fundamental Ideas III / 58

**Multi-Pass Correction Scheme for FFA Arcs**

Fundamental Ideas III / 59

**Compact Merger Design for FFA Arcs**

## TOURS

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Tour of LERF Accelerator

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Tour of Hall D

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Tour of Test Lab (SRF)