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IOTA/FAST – Snowmass'2021 "General (Support)" LoI

V.Shiltsev, Z.Huang, Y.K.Kim, S.Nagaitsev, A.Valishev ***and YOU !***

IOTA/FAST Collaboration Meeting 2020

June 17, 2020

https://snowmass21.org/

- *Snowmass LoI:* Max 2 pages - should give brief descriptions of the proposal and cite the relevant papers to study.
- https://snowmass21.org/loi
- Many expected on IOTA/FAST related issues
- This one – “general LoI”

IOTA-FAST

Leading US Facility for Beam Physics and Accelerator Technology R&D: Longer Term Opportunities

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(pls add your name/affiliation below)

July 1, 2020

What's in there? -

Page 1 – general info/intro

The Integrable Optics Test Accelerator (IOTA) is a storage ring for advanced beam physics research built and operated at Fermilab. It will operate with protons and electrons using injectors with momenta of 70 and 150 MeV/c, respectively. The facility includes the electron injector FAST [2] (normal conducting 5 MeV electron RF photoinjector, two 1.3 GHz SRF booster cavities CC1 and CC2, magnetic chicane, 12 m long 1.3 GHz SRF cryomodule), 2.5 MeV RFQ proton injector, IOTA ring, dozens of meters of high energy electron beam lines and absorbers. The design and main parameters of the facility can be found in [1]. The IOTA is dedicated to three main areas of beam physics research: to address the challenges posed by future high-intensity machines, such as instabilities and losses; to carry out basic research in beam physics; and to provide education and training for scientists and engineers.

IOTA is unique in its research mission, as well as in its flexibility and accuracy. It has a circumference of 40 m and a relatively large aperture (50 mm). It is easily reconfigurable to accommodate the installation of different experiments. Because of the quality of the instrumentation, the magnetic lattice can be precisely controlled. In addition, the lattice was designed to have significant flexibility to enable a wide variety of studies. IOTA can store electrons up to 150 MeV or protons at 2.5 MeV.

Because of synchrotron-radiation damping, electrons are suited to the study of linear and nonlinear single-particle effects. Proton dynamics, on the other hand, is dominated by space charge. Electrons were circulated for the first time in August 2018. Proton beams will become available in 2021 and will open up research on high-intensity beams.

The IOTA research program [3] currently includes the experimental study of nonlinear integrable focusing systems based on special magnets or on electron lenses. Because of their nonlinearity, these systems generate a betatron tune spread that protects the beam from instabilities through Landau damping. Integrability ensures that the nonlinear system does not reduce the dynamic aperture of the machine, therefore preserving beam lifetime and emittance. Several other topics will be studied in IOTA, such as the experimental demonstration of optical stochastic cooling and the compensation of space-charge effects. In addition, IOTA has the capability of storing single electrons.

We would like to call attention of the HEP and accelerator community to additional unique opportunities offered by the IOTA/FAST facility along three major categories:

p.2 – What else can be done / we want to do at IOTA/FGAST

…*We would like to call attention of the HEP and accelerator community to additional unique opportunities offered by the IOTA/FAST facility along three major categories:*

I. Beam physics (beyond current program):

- Artificial Intelligence (AI) and machine learning
- Quantum Science with cold ions and single particles
- … (what else? Add your topic)

p.2 – What else can be done / we want to do at IOTA/FGAST

II. Accelerator technology:

- Novel e-, p+, H-, muon frontend setup tests
- Advanced superconducting RF >60MV/m cavities
- Wakefields and high average current studies and optimization
- Electron lens technology
- Advanced beam halo diagnostics for the dynamic range of up to 10^6
- Muon beam diagnostics tests
- 200 T/s HTS rapid cycling magnets, possibly with a small prototype proton booster ring
- DWA multibunch structure tests ?
- XFELO nrad mirror control technology ?
- …

p.2 – What else can be done / we want to do at IOTA/FGAST

III. Integration and design optimization studies

– PIP-III design choices, input and optimization; tests of elements…

– EIC…(cooling?)

– HEP Muon facilities : studies for muon colliders;

– >1 GeV electron energy facility extension for next generation rare muon processes; DM /axion searches; and possibly for the high power Inverse Compton Scattering setup

– Revolutionary accelerator control system(s) tests

– …

So, please go to:

https://docs.google.com/document/d/1Mplk_jUAwjJJ_x4blhbyKoPMJ68N8ExkVirlB3Ud6dM/edit

and

a) **add your name and affiliation on front page**
b) **add your topic on p.2 (optional)**

to be edited and submitted on July 1st