FOCUSED WORKSHOP ON SCIENTIFIC OPPORTUNITIES IN IOTA
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Goal of the Working Groups

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WORKING GROUP 1
Nonlinear Dynamics (ND) and Space Charge (SC)

ND and SC:

This will be a unique opportunity to do relevant experiments in order to shed light on the clever interplay of space-charge dynamics of intense beams and the externally imposed nonlinearities and our ability to control this tricky interplay within an acceptable dynamic range of the phase-space. In this study, we will have to integrate experimental observations with tricky computer modelling and simulations and find a tricky "mountain pass" in the terrain of complicated phase space landscape that will allow us to transport and accelerate space-charge dominated beams quickly, stably and effectively without much particle loss. Concepts of compensating dynamical nonlinear elements should also be explored.

Plans/Questions for us:

(i) Generate a clear plan with a resource-loaded timeline to map-out the nonlinear phase-space of IOTA with a pencil electron beam from its injector. Establish synergistic activities between experiments and simulation;
(ii) Can we really study interplay between space-charge and nonlinear lattice by an electron beam alone? If so, articulate the experiment;
(iii) What does the ion beam from the RFQ injector, to be available in 2017, bring in addition in terms of add new physics insight?
(iv) If we want to study compensation techniques, what compensation element (e.g. electron or plasma lenses) can be envisioned and can it be built?
(v) Is the required hardware for all the above experiments readily obtainable?
(vi) Are the electronics, diagnostics, and instrumentation sufficient?
(vii) Who offers what in terms of resources, hardware, research personnel, software etc. to make this happen?
(viii) Articulate a resource-loaded a schedule for the first two high-impact experiments on IOTA that will be synergistic with studies elsewhere (e.g. UMWER at Maryland and other experiments elsewhere).
(ix) Who are the lead players in this set of experiments?

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WORKING GROUP 2

Optical Stochastic Cooling (OSC) and Single Electron Quantum Optics (SEQO)

OSC:

This will be the first real opportunity and intent to do an actual experiment on Optical Stochastic Cooling. Anything we can achieve in collecting optical radiation from a charged particle beam, properly processing it in amplitude, phase and other parameters, and making it interact back with the same beam and observe carefully the necessary dynamical effect of thie "Maxwell's demon" at optical wavelength on the beam will be the first attempt to affect and control beam optically via self-feedback and deserves high-impact publications.

Questions for us:

(x) What are the design parameters of a realistic experiment?
(xi) What effect do we expect to observe on the beam? Define a simulation algorithm for the estimated results.
(xii) Is the required hardware of undulators and amplifiers realistic?
(xiii) Are the electronics concepts sound?
(xiv) Who offers what in terms of resources, hardware, research personnel, software etc. to make this happen?
(xv) What is the fastest time scale to make the first experiment on OSC a reality?
(xvi) Who ae the lead players in this set of experiments?

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SEQO:

This will be the first real opportunity and intent to conceptualize and implement an actual experiment, if at all possible, to obtain a dynamic understanding of the time-evolution of the quantum wave-function of a free electron moving in a time-varying electromagnetic field and interacting a radiation bath including its own radiation. Anything we can achieve in collecting information about the radiation formation length and the dynamics of the electron wave-function as a trapped charge in a ring interacting with radiation, will be new and deserves high-impact publication

Questions for us:

(xvii) What are some of the realistic concepts for the experiments? Can we really do a meaningful first experiment? If so, clearly define this experiment.
(xviii) Develop a plan at least to repeat the Novosibirsk experiments but now with much higher resolution and precision and with much more dynamic control over the electron ring;
(xix) What exactly do we want to observe experimentally?
(xx) Are the required hardware, instrumentation and software available?
(xxi) What "new" insight can the observations bring even when quantum mechanics is a well-accepted and matured field?
(xxii) Who offers what in terms of resources, hardware, research personnel, software etc. to make this happen?
(xxiii) What is the fastest time scale to make it a reality?
(xxiv) Who are the lead players in this set of experiments?

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WORKING GROUP 3
Emittance Exchange (EE) , Radiation (R) and Laser-Beam Shaping (LBS)

EE, R and LBS:

Much of the time when the IOTA has a stored electron beam, the 300 MeV superconducting linear electron accelerator injector will be available to provide electron beams of unprecedented quality for clever experiments. These experiments may be useful insights for future x-FEL operations at DESY and SLAC as well as generate novel approaches of using bright electron beams and understanding its radiative and interactive properties with various structures and laser beams.

Questions for us:

- (xxv) Articulate an emittance-exchange and phase-space manipulation scheme that will be "game-changer" in various applications e.g. in x-ray FELs. Is such a concept realizable? What will be the required experimental hardware and associated ancillary systems? What effect do we expect quantitatively?
- (xxvi) Are the crystal channeling radiation estimates realistic? Will it be the brightest x-ray pulse? Can such an experiment be realistically performed without damaging the crystal?
- (xxvii) Are there clever and innovative ways to shape an electron beam via a laser that can open up new application of such "shaped" beams?
- (xxviii) Develop a resource loaded schedule for the first two high-impact experiments using the bright electron beams from the IOTA injector with up to 300 MeV electrons directly before it enters the IOTA ring.
- (xxix) Who offers what in terms of resources, hardware, research personnel, software etc. to make this happen?
- (xxx) What is the fastest time scale to make these first experiments?
- (xxxi) Who are the lead players in this set of experiments?

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