1. Introduction
2. Background Theory
   1. Theory of AG focusing
      1. RMS envelope equations and matching
   2. Transverse resonances
   3. Theory of integrable optics
3. UMER Apparatus
   1. UMER set-up and capabilities
   2. UMER beams: 6 mA, 0.6 mA, DC beam
      1. Characterization of DC beam (Dave’s simulation, Santiago measurement)
      2. Mention low-current aperture beams [cite Santiago AAC]
   3. Lattice configurations and matching
      1. FODO
      2. Alternative Lattice
   4. Diagnostics
      1. Beam Position Monitor
      2. Wall Current Monitor
      3. Transverse Imaging
   5. Measurement Techniques
      1. Quad-as-BPM
      2. Tune Scan
4. Nonlinear optics experiments @ UMER
   1. Introduce N4 Octupole lattice, Single Channel lattice
   2. Printed Circuit Octupoles; Generation 1 [NAPAC paper?]
   3. Simulation Codes
      1. WARP
      2. Elegant
      3. VRUMER
   4. Simulation techniques
      1. FMA
5. Transverse Resonances
   1. Theory of resonances w/ space charge
      1. Incoherent resonance
      2. Coherent resonance [use Will’s work?]
   2. Tune scan calibration (Robust Method)
      1. Determination of tune from BPM data
         1. Application of NAFF
      2. Effect of edge focusing experimentally
   3. Measurements
      1. High charge
         1. 6 mA [UMER note]
         2. Pencil [UMER note]
         3. Longitudinal confinement [IOTA workshop]
      2. Low charge
         1. DC [UMER note, IOTA workshop]
6. Steering Correction
   1. Justification
   2. Summary: UMER realignment
   3. VRUMER study for convergent steering algorithm
      1. Horizontal [UMER tech note]
      2. Vertical
         1. SSV steerer upgrade
            1. Rotating Coil measurement
   4. ~~Response matrix with VRUMER?~~
   5. Steering algorithms and procedure [UMER tech note]
      1. Injection and closing ring (2D scans): brute force vs. gradient descent.
   6. Experimental results (need to update w/ factor of 2)
   7. Continued work: Helmholtz coils
7. Quasi-integrable Octupole Lattice
   1. Toy Model
      1. Frequency Map Analysis [FNAL summary note]
      2. Halo Mitigation [early simulations, ‘14]
      3. Invariant tracking [Did I do this?]
      4. Error analysis
         1. Steering
         2. Beta function, phase error
         3. Space Charge
   2. Matching w/ Elegant, WARP [NAPAC paper]
      1. Different Edge-focusing models; effect of edge focusing in match
      2. Approach to empirical matching
      3. Show possible match for beam (Elegant)
      4. Show match in WARP
         1. Dipole edge focusing; Possible experimental bench-marking (Levon)
      5. Mention solenoid focusing [FNAL visit]
      6. Error analysis: Sensitivity to quadrupole errors
      7. Comment on dispersion; chromaticity
      8. Comment on space charge effects
   3. PIC simulation of full planned experiment
   4. Experimental Plans
      1. Magnet mount, magnet lay-out (approximating 1/beta^3)
   5. Comment on high space charge (Lund’s class)
8. N4 octupole lattice [HB paper]
   1. Simulations
      1. Invariant tracking
      2. Frequency map analysis [old research update]
      3. Halo Mitigation [UMER DOE renewal]
   2. Experiments
      1. Compare tune scan simulation + experiment
      2. Update tune map
9. Future work
   1. NLO experiments
   2. Extraction Section Design [Report written]
10. Appendices
11. Implementation of quad-as-BPM technique
12. Implementation of quad-centering steering
13. Tune scan data collection framework
14. VRUMER code
    1. Derivation of Normalized Hamiltonian
    2. VRUMER
    3. Tune scan software
    4. Simulation decks: WARP, FMA, invariant tracking, Elegant decks
    5. How to steer
    6. How to quad-as-BPM

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| Week | Focus |
| June 26-29 (4 days) | Chapter 3 (Steering), lattice matching |
| July 5-7 (3 days) | Chapter 6 (resonances), lattice matching |
| July 10-14 | Chapter 6 (resonances), lattice matching |
| July 17-21 | Chapter 5 (single-channel) / Chapter 4 (N4) |
| July 23-27 (4 days) | Chapter 5 (single-channel) / Chapter 4 (N4) |
| July 31- August 4 | ALASKA (Hamiltonian derivation) |
| August 8-11 (4 days) | Experimental run |
| August 14-18 | Experimental analysis |
| August 21-25 | Chapter 6 (resonances) |
| August 28-Sept1 | Chapter 5 (single-channel) / Chapter 4 (N4) |
| Sept 5-7 (3 days) | Chapter 2 (Apparatus) |
| Sept. 11-15 | Loose ends |
| Sept. 18-22 | Loose ends |
| Sept 25-29 | Chapter 7 (extraction) |
| Oct. 2-6 | Chapter 1 (intro) |
| Oct 9-13 | Send full draft to Tim; prepare appendices |

Defense before thanksgiving?

To-do:

Appoint committee members

Talk to Jessica RE: deadlines